



X-RAY PRODUCTS, LLC

User Assembler Manual



MODEL TXR-325D X-RAY CONTROL WITH
325-1 HIGH VOLTAGE GENERATOR
Serial Numbers: _____

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For Models Manufactured between 3/23/1995 — 4/3/2006

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INTERCONNECT WIRING FOR THE 325 D and M X-RAY CONTROLS

Applicable to the 325 D and M. Connect wiring from the X-Ray console to the following points.

CONTROL	LINE BOX <i>(Power supply 240 VAC nominal - 100 amp single phase)</i>
L1	L1
L2	L2
Ground	Ground
Neutral	Neutral

CONTROL	HIGH VOLTAGE TRANSFORMER
P1	P1
P2	P2
Ground	Ground
XC	XC
XS	XS
XL	XL
M1	M1

BUCKY CONNECTIONS	
Midwest Bucky	
X-Ray Control	Bucky
B1	B1
B2	B2
A2	B3
B4	B4

ROTOR CIRCUIT	X-RAY TUBE
07	07 <i>(Black)</i>
08	08 <i>(For Eureka lead is Red)</i> <i>(For Machlett lead is Green)</i>
09	09 <i>(White)</i>

THERMAL SWITCH

Connect thermal switch in series with the SID or PBL interlock circuit.

PBL INTERLOCK CIRCUIT

3 Jumped to 4 on top of the Mother Board Terminal Strip. For connecting PBL, SID or other interlocks into the circuit, remove the jumper and connect the isolated contacts or switches into those terminal points (3 & 4). *(Notice):* The rotor will not run or the **ready lamp will not light** if PBL, SID or other interlocks (switches) have not been aligned properly.

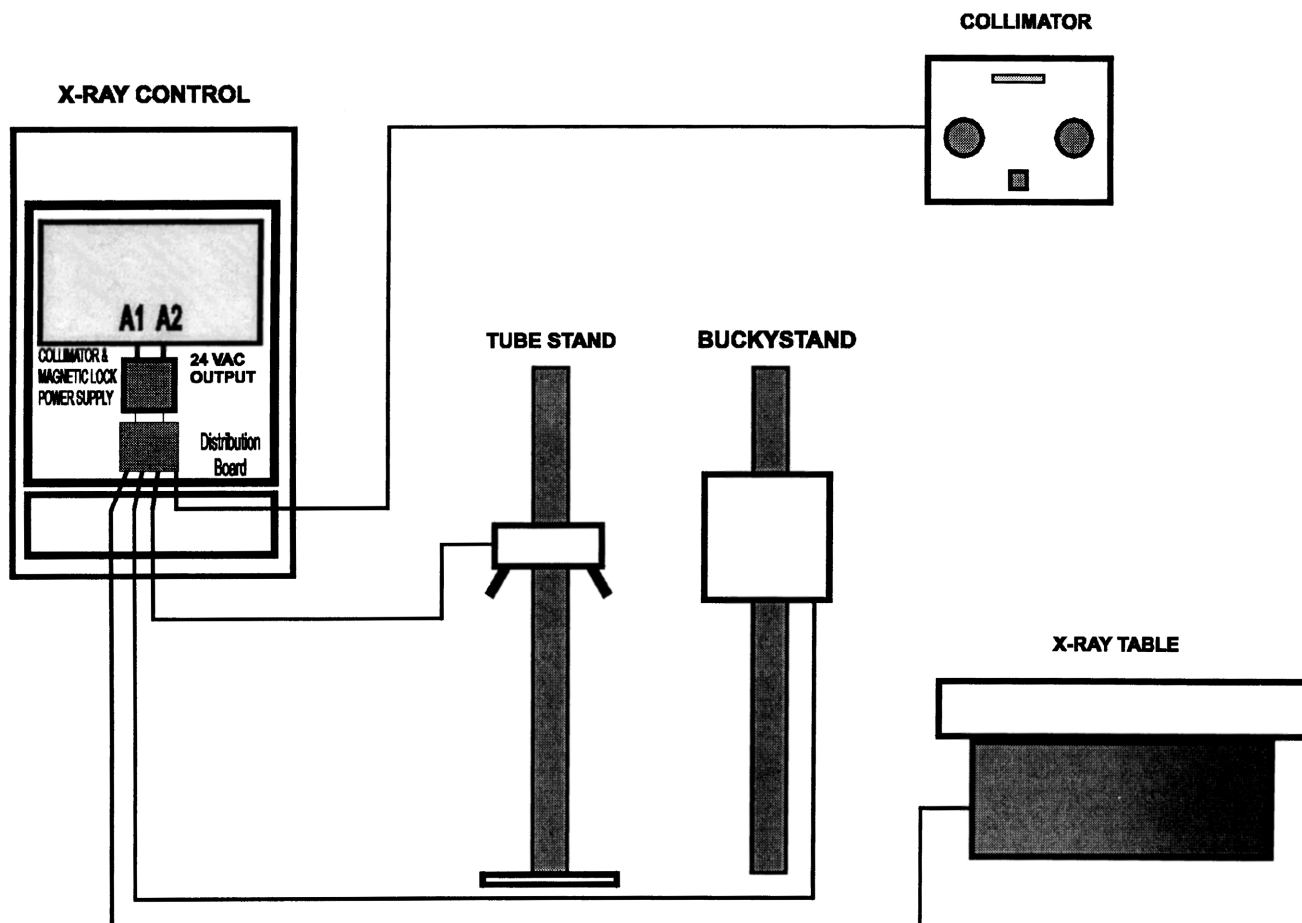
COLLIMATOR POWER SUPPLY *(24 VAC, 150 VA Transformer)* and MAGNETIC LOCKS

Connect leads from the 24 VAC power distribution board to the collimator and the magnetic lock circuits (See drawing page 4).

C A U T I O N *(PINCH POINT)*

Use CARE when opening and closing the hinged console. Keep hands and fingers clear from the sides and rear.

Collimator & Magnetic Lock Interconnect



INSTALLERS MAY JUNCTION ALL INTERCONNECTS INSIDE THE X-RAY CONTROL, INSIDE THE TABLE BASE OR A SEPARATE JUNCTION BOX PROVIDED BY THE BUILDING CONTRACTOR. THE INSTALLER MUST PROVIDE HIS OWN TERMINAL STRIP. TUBE STANDS, BUCKY STANDS AND X-RAY TABLES ARE EQUIPPED WITH FULL-WAVE BRIDGE RECTIFIER FILTER PACKS, THEY ONLY REQUIRE 24 VAC POWER TO OPERATE.

APPENDIX B Information to Assemblers

NOTICE:

The X-Ray machine supplied by Tingle X-Ray Products, Inc. and covered in this instruction will perform reliably when operated, maintained, and repaired according to these instructions. The machine should be checked and repaired as necessary to insure reliable operation. Missing, worn, inaccurate parts should be replaced. Any medical diagnostic X-Ray equipment should not be altered in design. Tingle X-Ray Products, Inc. will not assume any responsibility for malfunctions resulting from improper operation, maintenance or repair, or if any of the components are damaged or modified.

Persons operating this machine must know and understand the danger of excessive radiation exposure. This X-Ray equipment is sold with the understanding that its proper use and application is in the hands of the operator and beyond the control of the manufacturer or his agents that Tingle X-Ray Products, Inc. disclaims all responsibility for any injury resulting from improper use and applications of this equipment.

UNPACKING OR UNCRATING

The shipper is relieved of any responsibility for damage during shipment after it is picked up by the carrier.

1. Closely examine all packaging or crating.
2. If damage is found to the above, have driver write a bad order note on all copies of freight bill and sign all copies. (Do not forget to obtain a clear copy with his signature for your records).
3. If concealed damage is discovered notify the transportation agent at once and ask for an inspection Report of Damage.

REMEMBER

Carriers will not accept concealed damage claims after 15 days have elapsed from date of receipt of equipment. Open packaging and crating carefully and do not dispose of them until machine has been completely assembled.

POWER REQUIREMENTS

Full steady power is essential to the efficient operation of any type of X-Ray machine. Our power requirements are as follows:

- **200-278 volts AC - 60 cycles**
- **37.5 kva single phase**
- **Maximum line current is 137 amps at 240 VAC nominal.**

This condition is met when the unit is operated at 300 mA and 125 kVp simultaneously. Duty cycle is 1%, condition is 300 mA at 125 kVp for 5 seconds every eight {8} minutes.

WIRE SIZES

From power transformer to switch box, 50 feet #2, 100 feet #00, 200 feet 250 MCM.

LINE VOLTAGE REGULATION

Line voltage regulation at maximum rated line current must not exceed 5%.

Percent line voltage regulation = $100 (V_n - V_l) / V_n$

- V_n = No load line voltage

- V_l = Line voltage at maximum line current.

Maximum line current at an alternate line voltage = $(V_r)(A_r)/V_a$

- V_r = Rated line voltage (no load).
- A_r = Maximum line current at 240 V.
- V_a = Alternate line voltage to be used.

ACTUAL ASSEMBLY

Make sure there is a control box (*breaker or fuse box*) readily accessible from the control panel (*this is a National Electric Code Requirement*). Make sure wire sizes conform to Title: WIRE SIZES as listed in this information to Assemblers pamphlet.

All lead line barrier requirements should be met as required by Federal, State and County or City Health Codes (*Radiation safety codes*). Normally the control along with the operator will be behind this barrier.

REMOVE FUSES FROM THE CONTROL BOX (*Breaker or Fuse box*)

1. Connect 10 feet line cord to control box (fuse box).
2. Place High Voltage Generator in its designed place floor plan.
3. Connect control to High Voltage Generator interconnect making sure all wires are labeled correctly (*Leave **P1** and **P2** loose at the High Voltage Generator*).
4. **STOP!** Make sure your **GROUND** lead is connected securely before you go any further.
5. Connect Rotor leads.
6. Connect Collimator power supply to tubestand and X-Ray table if applicable.
7. Connect PBL lockout or other interlocks and switches required.
8. Connect High Voltage Cables from X-Ray tube to High Voltage transformer.

CHECKING TRANSFORMER OIL LEVEL

Oil level in the High Voltage Transformer should be no lower than 1 inch and no closer than $\frac{3}{4}$ inch from the top. (*Make sure the transformer is level, use washers or shims*).

SETTING THE LINE STRAPS

The factory settings of the line straps are 220 and 8 VAC. The straps are located on the **MAJOR** and **MINOR KVP** switches. To set, remove each strap, and strap to your corresponding line voltage. For the closest match connect a digital volt meter between A1 and A2. Move the MINOR STRAP until 120 - 122 VAC is obtained.

CONTROL CHECK OUT

1. Turn Supply Power ON, energize X-Ray Control, check Line Voltage and move line straps so line voltage matches the autotransformer. Connect a Digital Volt Meter from A1 to A2 and adjust minor strap until 120 - 122 VAC is obtained. Turn control OFF and remove the digital voltmeter. Turn supply power OFF.
2. **MAKE SURE P1 and P2 ARE DISCONNECTED.**
Place a Digital Voltmeter between H1 to H2 in the X-Ray Control. Turn Supply Power ON, energize X-Ray Control and vary Major and Minor kVp switches until 120 VAC is obtained between H1 and H2, set timer to **2 second**. Switch Power OFF and remove the digital voltmeter.
3. **SIMULATED LOAD TO TEST SCR's.** Connect a 120 VAC light bulb between X-Ray Control P1 and P2. Connect a Digital Voltmeter to P1 and P2 also. Switch Power ON X-Ray Control.

DISREGARD KVP METER READOUT AT THIS TIME.

4. Depress rotor button (*After 2-second delay, ready lamp should light*), then depress push-button.
(A) You should hear the back-up contactor come in and the console exposure lamp light.

- Observe the simulated load test lamp light.
- (B) During the time that the simulated load test lamp lights you should read 120 VAC on the digital voltmeter.
 - (C) If you read 120 VAC, the SCR's are operating properly.
 - (D) At the end of the exposure, the exposure lamp should extinguish and an audible signal sounding termination should be observed.
 - (E) If you read 60 to 70 VAC, the SCR's are half waving. There are three causes possible, beginning with most likely:
 - I. Timer to SCR Gate Harness has an OPEN lead.
 - II. The SCR itself is defective
 - III. One of the Timer Pulse Transformers are OPEN.

AFTER A SHORTED OR HALF-WAVING SCR, DEFECTIVE SCR HARNESS OR TIMER HAS BEEN REPLACED, YOU MUST RUN A SIMULATED LOAD TEST TO ENSURE PROPER OPERATION OF THE SCR OUTPUT.

REPEATED FIRING OF SCR's HALF-WAVING WILL EVENTUALLY CAUSE THE SCR TO SHORT. IN THIS CASE YOU WOULD REPLACE THE SCR ONLY TO FIND ANOTHER PROBLEM, SUCH AS KICKING THE CIRCUIT BREAKER OR LOADING THE HIGH VOLTAGE TRANSFORMER. NORMALLY YOU MAY SUSPECT THE HIGH VOLTAGE TRANSFORMER, WHEN THE PROBLEM IS THE HALF-WAVING SCR. THIS IS THE REASON FOR ADMINISTERING THE SIMULATED LOAD TEST AFTER REPLACING A SHORTED OR HALF-WAVING SCR. THE SIMULATED LOAD TEST IS THE ONLY WAY TO BE SURE ANY X-RAY CONTROL IS FUNCTIONING PROPERLY.

5. Turn OFF X-Ray Control, remove light bulb and Digital Voltmeter.
6. Connect **P1** and **P2** to the High Voltage Generator.
7. Turn Unit ON. Vary kVp Major and Minor Switches to see if kVp meter readings vary. Also switch mA stations, this should also vary the kVp meter readout.
8. Turn control OFF, connect all test instruments.

(See Trouble Shooting Section on Page 27)

INSTALLING HIGH VOLTAGE CABLES (*New*)

1. Make sure they are clean and dry.
2. When connecting make sure anode goes to anode and cathode to cathode. The X-Ray Tube and Transformer receptacles will carry these markings.
3. The space between the terminal and the receptacle needs to be lightly filled with vapor proofing compound. This compound is packed with the X-Ray Tube from the factory.

NOTE: Do not use the washer like gasket sometimes shipped with high voltage cables, use only vapor proofing compound.

CLEANING HIGH VOLTAGE CABLES (*USED OR NEW CONTAMINATED*)

1. All compound or any other agent should be removed using tri-chlorethane or a similar degreasing solvent.
2. Then follow directions listed under Installing High Voltage Cables.

EXTREME CARE SHOULD BE TAKEN SO AS NOT TO TOUCH THE INSULATING SURFACES OR THE RECEPTACLE, AND THE CABLE END.

Insert the terminal in its receptacle and screw on the cable nut as tightly as possible using two hands to grip the nut. **DO NOT** use a wrench, however, after installation is completed, the cable nuts should be checked and tightened periodically if required.

BUCKY CABLE CONNECTION *(This is not required when using grid cabinets).*

Control panel contains a bucky ON/OFF/TABLE/WALL switch but if a bucky is not to be used jump B1 to B2 to eliminate the possibility of switching the circuit to bucky on by accident. *(If this is done through cleaning, etc., the unit will not make an exposure).*

To use table or wall bucky connect the bucky cable leads to corresponding lead numbers from X-Ray control terminal to Bucky terminal. Note a 3-wire connection is used with B2/B3 jumped. Refer to Schematic. For Super Speed Bucky connections refer to Schematic also.

For Two-bucky operation, refer to the drawing titled: **“Instructions For Connecting and Operating Two Bucky in a PBL System.”**

ADJUSTING THE MILLIAMPERE SETTINGS

The TXR 325 D & M X-Ray Control with High Voltage Generator comes from the factory pre-set and tested. Normally when the line to auto transformer is set, you will notice very little variation in the milliampere readings. *Yet, since High Voltage Cable lengths vary, you must recalibrate all X-Ray Controls.*

TESTING and CALIBRATING MA

For calibrating and testing the milliamperes connect an accurate mA or mAs meter to + and - terminal on the right bottom end of the terminal strip on the 325-91 Mother Board. Select S1 switch to Test and run all tests and mA calibrations. Select 80 kVp and calibrate each mA station. Record actual mAs in the calibration data sheet on page 38.

Be sure to switch S1 back to its original position for normal operation with the test equipment removed.

TESTING and CALIBRATING KVP

Now that you know all mA stations are calibrated properly you must insure that kVp selected is within calibration limits. Select each individual mA station, then adjust both Major and Minor kVp selectors until the output at the X-Ray Tube is 80 kVp, then adjust the kVp meter compensation band adjustment so that the digital kVp meter readout indicates 80. The digital kVp meter circuitry will track up and down scale and will internally adjust for varying line voltages so that the line is also adjusted automatically. Record actual kVp in the calibration data sheet on page 38.

Space Charge. As the kVp is increased from anode to cathode across an X-Ray tube, you have a space charge affect. We use a space charge compensation network in our controls that will offset the effect to kVp causing the selected current to track across the entire kV range. The mA will be maintained at **10% (plus or minus)** of full scale. The rotor circuit works with the mA circuit as when the rotor is initiated the filament is boosted reducing the time that the filament has to be at full mA production.

1. Cover X-Ray Tube port with lead sheeting or make sure collimator shutters are closed. *(Arrange for operation where beam limiting lockout devices are incorporated in equipment).*
2. Locate test switch on right lower section of the 325-91 Motherboard. Switch to TEST mode *(on)*. Connect MA or MAS meter between +/- terminals located underneath the test switch. NOTE POLARITY.
3. Set mA selector switch to 50 mA. Set kVp switches to 80 kVp. Set timer to 2 seconds. Make exposure, if mA on meter reads lower or higher adjust 50 mA stations tagged.

Set each mA station 100 and 150 in the same manner as above. If a Dynalyzer or similar test equipment is not used, a Ballistic MAS Meter. Calibrate 200 and 300 MA at the $\frac{1}{4}$ second time station.

NOTICE: Space Charge characteristics of X-Ray Tubes are linear only above and about 55 to 60 kVp, so complete compensation cannot be obtained from that kVp and below from time-to-time.

ADJUSTING THE TIMER

Microprocessor timers do not require adjustment. There are basically three components to the timer section, a timer board, timer selector (switch), ribbon cable interconnecting the switch to the timer board.



APPENDIX C

Information to Users

OPERATION

Protective measures: X-Ray equipment improperly used may cause injury. Persons using this equipment must be familiar with the hazards involved and the necessary protective measures before using the equipment.

THIS EQUIPMENT MUST BE OPERATED ONLY BY INFORMED COMPETENT PERSONNEL.

Handbooks on radiation Protection have been compiled by the NATIONAL COMMITTEE ON RADIATION PROTECTION and are available from *NCRP Publications, Box 4867, Washington, DC 20008.*

The operator must become familiar with and use this equipment as recommended in these handbooks.

This equipment is sold with the understanding that since Tingle X-Ray Products, Inc. has no control over the way the equipment is used, Tingle X-Ray Products, Inc., its agents or representatives cannot assume responsibility for injuries suffered by anyone through the use of this equipment.

All personnel must be protected from the useful and secondary x-rays that are produced when x-rays strike any object. Various protective materials and devices are available. We strongly urge you to use such materials and devices.

To keep this equipment properly calibrated and functioning properly, it must be electrically and mechanically inspected annually or less. If anything irregular is noticed, notify your local service personnel. If problems are handled promptly, you should be able to use this equipment for many years.

DIGITAL KILOVOLT METER AND THE KILOVOLT SELECTORS

The kilovolt meter is an AC digital voltmeter, calibrated in kilovolts, and is compensated to read the actual kilovolts at the mA selected. The kVp selection is accomplished by a nine-step major and an eight-step minor tap switch furnishing steps of kVp within the range. Accuracy is plus and minus 10% of full scale. Turning kVp selectors clockwise increases kVp and counter clockwise will decrease kVp.

When setting your kVp set your milliampere setting first because of the space charge effect.

NOTE: NEVER CHANGE KVP DURING AN EXPOSURE.

C A U T I O N

At milliampere settings below 300, the kVp meter may indicate higher than 125 kVp. The kVp at this point{s} will exceed the kVp rating of the Tube, Cables and High Tension Transformer. Observe the tube rating charts.

EXPOSURE SIGNAL AND LAMP INDICATOR

An audible sonalert signal will sound in the control to indicate the termination of an exposure. Located toward the right corner of the red LED window is the exposure indicator. When an exposure is made, a red lamp lights up next to the word **"EXPOSURE."**

OPERATION

THE DIGITAL MILLIAMMETER

The mA meter is a digital meter which reads preset milliamperes. It indicates the preset readings before and during the exposure. For calibrating or testing the unit, refer back to Page 8 "ADJUSTING THE MILLIAMPERE SETTINGS".

High MA or SCR's Half Waving Kicks Circuit Breaker

The mA calibration is too high, unstable or gassy X-Ray Tube. If high tension cables have been changed and shorter ones installed this will happen.

LOW mA

The mA calibrations too low, faulty high tension circuit (transformer) rectifier in the transformer is out. Part of bridge rectifier is out in mA meter circuit. Output of mA stabilizer should be checked.

NO mA

The filament is out in the X-Ray Tube, or exposure inhibited. See Generator Test Procedures.

ERRATIC mA or mR OUTPUT

SCR's are half-waving, test and Calibration exposures are not spaced far enough apart, unstable or gassy X-Ray Tube or faulty high tension cables. Check consistency of Time Stations.

For additional information, see Trouble Shooting Section.

THE DIGITAL MAS/COUNT METER *(See Troubleshooting Guide)*

The digital MAS meter is a digital meter which reads Pre-Set MAS and Actual MAS output during exposures.

SIMPLE GENERATOR TEST PROCEDURE

1. Switch Control Power ON and turn Line Switch ON to X-Ray Control.
2. LED's should energize.
3. Select 200 MA, 80 kVp, 1 Second.
4. Depress Rotor push-button (after a 2.2 second delay ready lamp should energize. If ready lamp does *not* energize, the problem is in rotor circuit or before). See Schematic.
5. When ready lamp energizes, depress Exposure push-button, watch mA test meter reading. The mA should be in the range of **+/- 10% of mA selection**.
6. If there is no exposure and the unit is switched to Bucky ON, change the switch to Bucky OFF and retest. *(If exposure meets condition of 5, trouble is in buckycircuit).*
7. If there is no exposure initiated under condition 6, the problem is most likely in the Timer, Timer Switch, the Ribbon Cable connecting the timer to the timer switch, or the back-up contactor.

YOU SHOULD CONTACT YOUR SERVICE PERSONNEL IF ANY OF THE ABOVE PROBLEMS ARE EVIDENT. NEVER GO INTO THE X-RAY CONTROL BOARD SECTION YOURSELF.

THE MILLIAMPERE SELECTOR

The millampere selector does two things. It selects Relay 1, 2, 3, 4 and 5 on the control panel which does the following three functions: selects the focal spot, milliamperes setting, and the proper space charge network, so that the kVp meter will read correctly for each station. Also it selects the mA meter station. The selector is connected by ribbon cable to plugs on the mother, processor, and mA meter boards.

HOW TO SET MILLIAMPERES

You should select your desired milliamperes before choosing kVp or a time station because a change in the mA station will also change the kVp meter reading, which in turn will also change the actual kVp potential at the X-Ray Tube.

USING THE BUCKY SWITCH

The Bucky ON/OFF switch is located in the center of the control panel at the bottom. If your equipment does not have a Bucky, select bucky OFF. If you have a bucky and wish to use it, select Table or Wall. For x-rays where bucky is not needed, switch bucky to the OFF position. Both stationary grid holders or grid cabinets are in use today as well as buckys and both have advantages. When a bucky is not used in an installation, please jump B1/B2 together. If Bucky will not run, make sure B2 lead from Bucky Switch is connected to B2 on the bottom of mother board. B2 must be jumped to B3 for more than one bucky operation, ask for drawing titled: *“For Connecting and Operating Two Buckys.”*

MAIN LINE SWITCH

The main line switch breaker energizes the Autotransformer. To turn unit off, simply switch to OFF. ***NEVER LEAVE THE CONTROL ON FOR LONG PERIODS OF TIME WHEN NOT IN USE.***

THE TIMER

The timer has a range of 1/120 second to 6 seconds in 23 approximate geometric progressive steps.

CAUTION: If mA Test meter or exposure indicator should read past normal time of selected time, quickly throw the main line switch to OFF and notify qualified X-Ray Service Personnel.

TO MAKE AN X-RAY EXPOSURE

1. Turn main line switch ON.
2. Turn X-Ray Control power switch ON. (*Power ON*).
3. Select mA.
4. Select kVp.
5. Select Time.
6. Select bucky OFF, TABLE or WALL.
7. Position source and image receiver.
8. Take up position behind protective barrier.
9. Depress rotor push-button (*After approximately 2 seconds, ready lamp energizes*).
10. Depress Exposure switch keeping rotor push-button depressed. Exposure lamp will energize and an audible signal will be noticed upon termination.

X-RAY TUBE AND FOCAL SPOT RATINGS

Most of the electrical energy delivered to the X-Ray tube is converted into waste heat; only a small fraction of this energy is converted into x-rays. There are three considerations involving this waste heat:

1. If too much energy is supplied to the X-Ray Tube, the focal area of the target may melt away and destroy the X-Ray Tube. Ratings which tell you how to avoid this are called FOCAL SPOT RATINGS, and tell you how much energy you can apply in a single exposure to a cold tube.
2. If energy is applied to the X-Ray Tube at a faster rate than the anode can dissipate the heat produced, the anode may melt or liberate gas, and thus destroy the X-Ray Tube. Ratings which tell you how to avoid this trouble are called ANODE HEAT STORAGE RATINGS, or perhaps just anode ratings.
3. If energy is applied to the X-Ray Tube at a faster rate than can be dissipated by the tube housing, eventually the oil will expand so much that the expansion chambers will compress beyond capacity and the tube housing will begin to leak oil. Ratings that tell you how to avoid this trouble are called HOUSING THERMAL CHARACTERISTICS and include the HOUSING HEAT STORAGE CAPACITY, and HOUSING COOLING CHARACTERISTICS.

ANODE HEAT STORAGE RATINGS

Heat storage and dissipate rating are based on **HEAT UNITS**. To determine the number of **HEAT UNITS**, which you will apply to the X-Ray tube anode, multiply the exposure factors: **kVp X mA X seconds = HEAT UNITS**. Thus a technique which calls for **80 kVp, 200 mA, and 1/2 second**, produces **80 X 200 X 1/2 = 8000 HEAT UNITS**.

SEASONING X-RAY TUBE

An X-Ray Tube that is put into service for the first time should be seasoned before bringing up to full kilovoltage use.

1. Select 100 mA small focus.
2. Starting at about 50 or 60 kVp make 3 exposures at 1/10 second each, waiting approximately 30 seconds between exposures.

C A U T I O N

Be sure the tube collimator is closed and that the operator or anyone else is not exposed to any radiation. Make similar exposures increasing the kVp in 10 kVp steps up to 90% of the maximum ratings.

Should any instability appear while breaking in, then the kVp should be reduced until the instability disappears.

INFORMATION TO USERS* Please see tube rating charts in Tube Box.

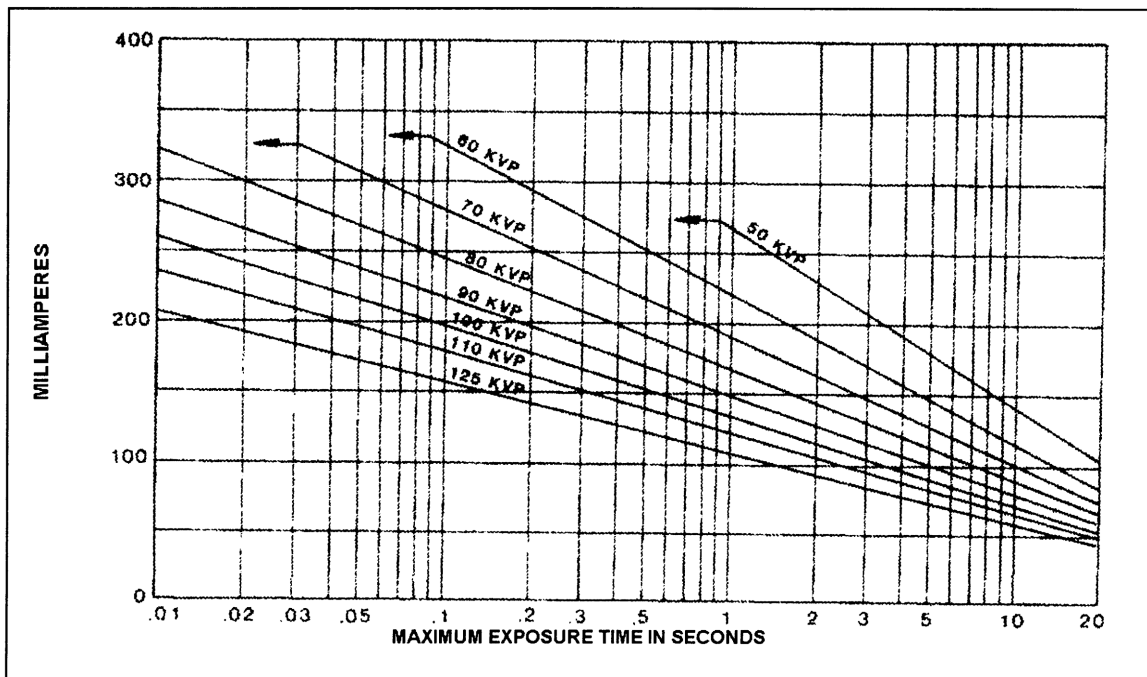
EUREKA RAD 8 X-RAY TUBE RADIOGRAPHIC RATING CHART

Single Phase - Full Wave

Target: 2.8" Diameter, 16°, 150,000 H.U.

Stator Frequency: 60 Hz. - 3,450 RPM

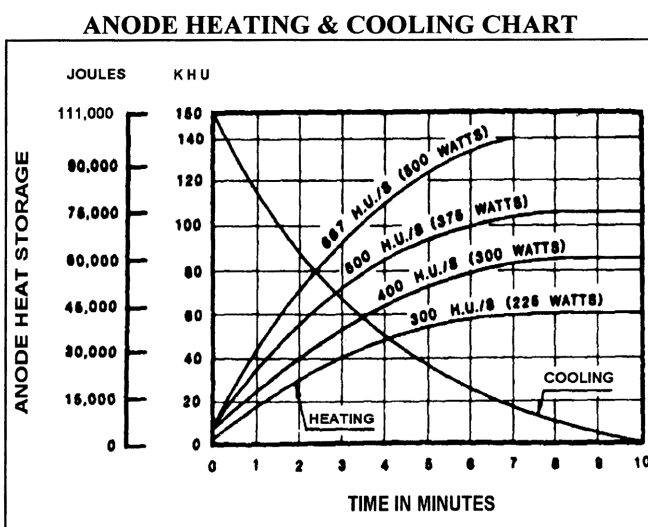
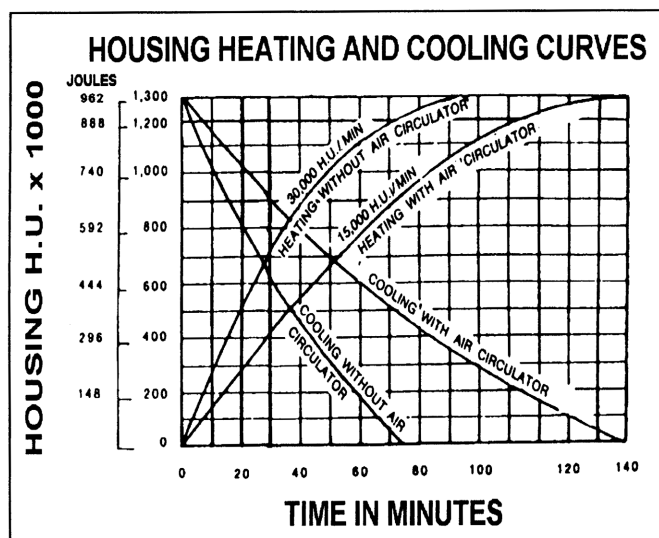
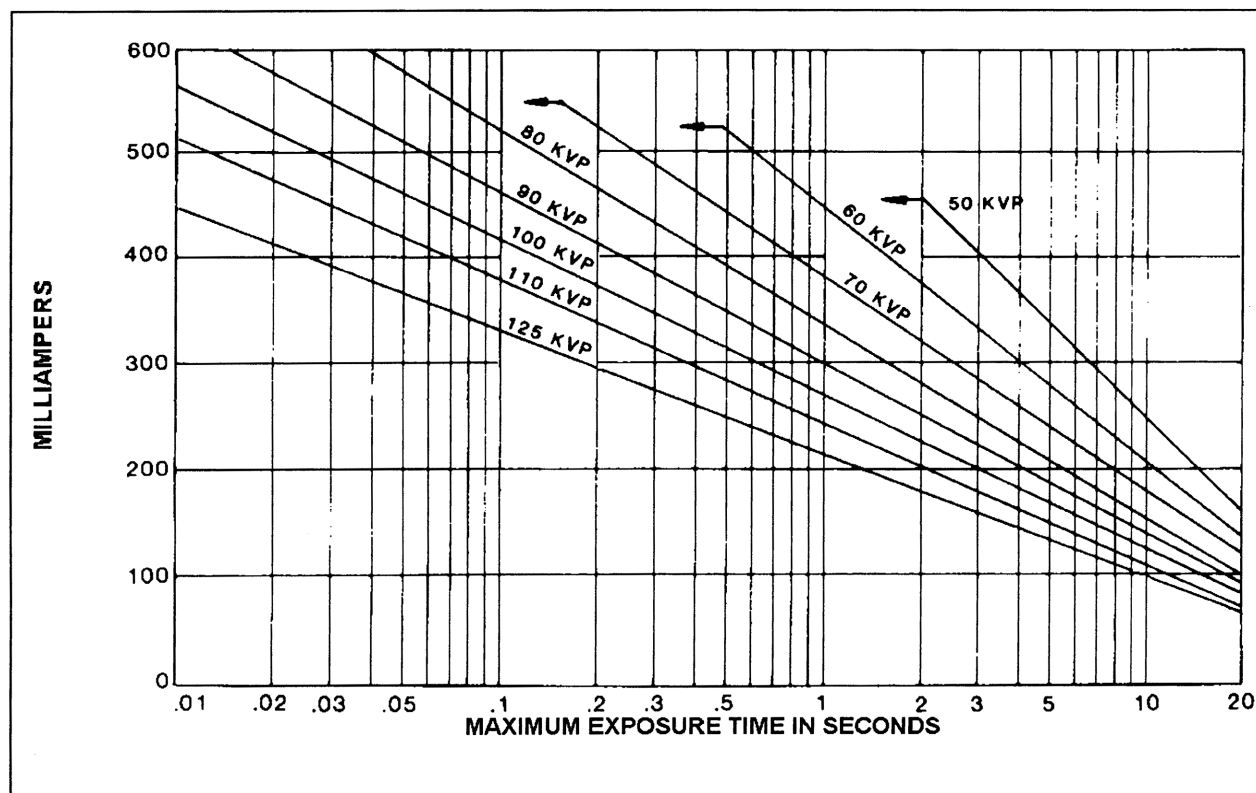
1.0 mm Focal Spot

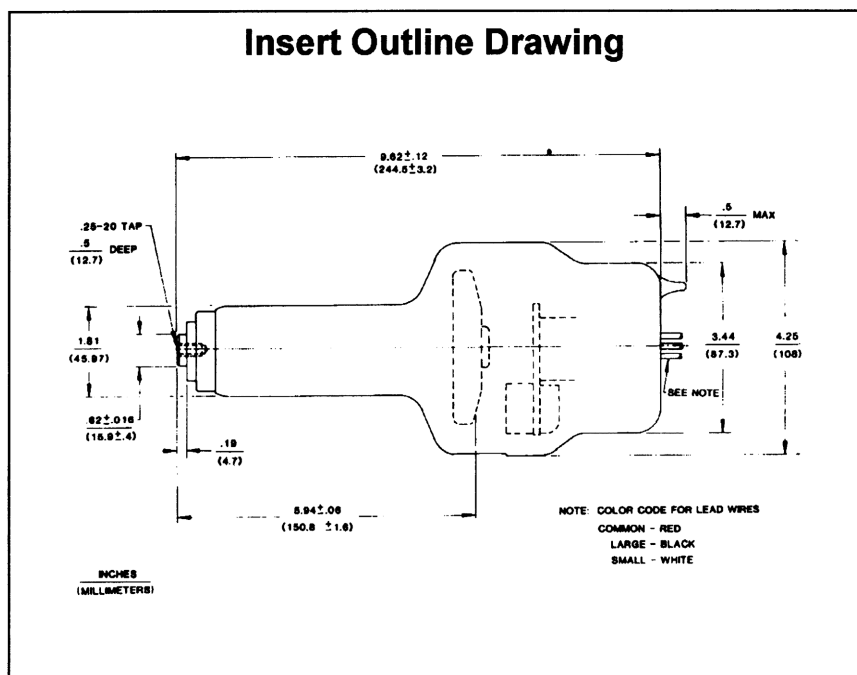


EUREKA RAD 8 X-RAY TUBE RADIOGRAPHIC RATING CHART

Single Phase - Full Wave
Target: 2.8" Diameter, 16°, 150,000 H.U.
Stator Frequency: 60 Hz. - 3,450 RPM

2.0 mm Focal Spot

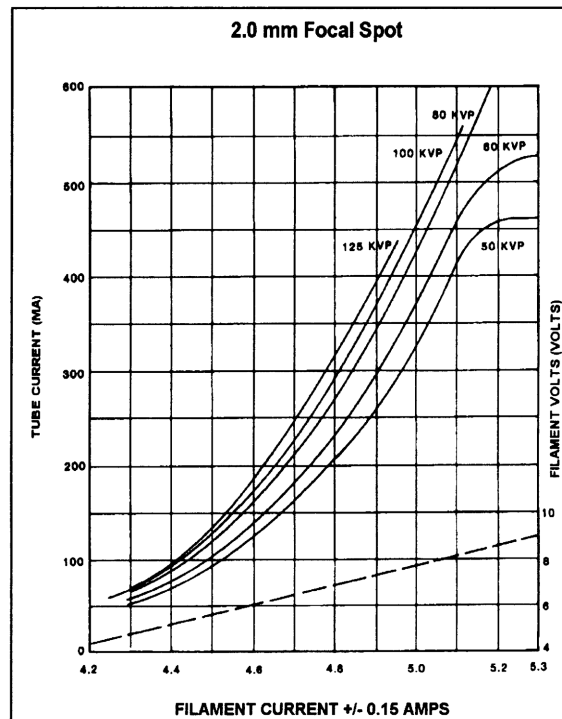
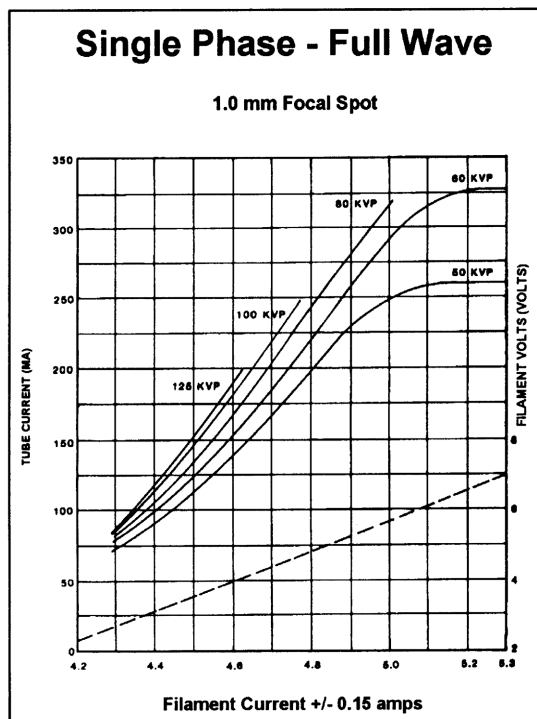




Insert Outline Drawing

EUREKA RAD - 8 X-Ray Tube Characteristics

ANODE COOLING CURVE EMISSION & FILAMENT CHARACTERISTICS (*Single Phase*)



Tube Limits TXR-7776-15 RAD 8

MA	50	100	150	200	300	400	500
kVp	MAX Allowed Exposure Time In Seconds						
50	6.0	6.0	6.0	3.0	2.0	1.5	0.5
60	6.0	6.0	6.0	3.0	2.0	1.5	0.5
70	6.0	6.0	6.0	3.0	2.0	0.75	0.25
80	6.0	6.0	6.0	3.0	1.5	0.4	0.15
90	6.0	3.0	6.0	3.0	1.0	0.2	0.05
100	6.0	3.0	6.0	3.0	0.5	0.1	0.025
110	6.0	2.0	3.0	2.0	0.3	0.066	0.008
120	6.0	1.5	3.0	1.5	0.25	0.041	None
125	6.0	1.0	3.0	1.25	0.15	0.25	None

TUBE: RAD 8
F.S. LARGE: 2.0

F.S. SMALL: 1.0
500 MA

PRODUCT SPECIFICATIONS

The TXR 325 D & M X-Ray Control with High Voltage Generator is a full wave rectified general purpose radiographic unit and is designed to operate one Double Focus Anode X-Ray Tube. The unit is supplied with federal standard high voltage cable receptacles, an eight-foot line cable and a fifteen-foot Control to High Voltage Generator cable.

Rating is 300 milliamperes at 125 kVp (Kilovolts Peak). Milliamperage is selected by a 5 position PC Board switch. The 5 positions are: 50 and 100 milliamps small focus; 150, 200, and 300 milliamps large focus.

SPACE CHARGE COMPENSATION

The mA is fully compensated to offset the effect of kV causing the selected current to track across the entire kV range. mA is maintained with +/- 10% of full scale.

Kilovoltage range is 50 through 125 and is selected by a nine-step (major) and an eight-step (minor) tap switch furnishing steps of kVp within the range. Accuracy is +/- 10% of full scale.

TIMER

The Timer is an IED Microprocessor type with SCR Contactors; The Range is *1/120 to 6 seconds in 23 steps*. The steps are as follows:

S E C O N D S							
<i>1/120</i>	<i>1/60</i>	<i>1/40</i>	<i>1/30</i>	<i>1/24</i>	<i>1/20</i>	<i>1/15</i>	<i>1/12</i>
<i>1/10</i>	<i>3/20</i>	<i>1/5</i>	<i>1/4</i>	<i>3/10</i>	<i>4/10</i>	<i>1/2</i>	<i>3/4</i>
<i>1.0</i>	<i>1 1/4</i>	<i>1 1/2</i>	<i>2.0</i>	<i>2 1/2</i>	<i>3.0</i>	<i>6.0</i>	

Timer Accuracy is +/- 2 ms. or 2%, whichever is greater.

Filament isolated 60 Hz stabilizer power supply.

Power requirements are 200-278 VAC 60 cycles (*50 Hz optional*), 37.5 kVa, single phase. Maximum line current is 136 amps at 240 VAC. This condition is reached when the unit is operated at 300 mA and 125 kVp simultaneously. The Duty cycle is 1%, condition is 300 mA at 125 for 5 seconds every eight minutes.

Rotor Starter is an electronic type 220 VAC start, 50 VAC run. 1-3 second time delay with sensing.

Rectifiers are solid state (*Silicon Full Wave*).

Contactors are SCR's with backup electromechanical type.

DIMENSIONS

X - Ray Control		X-Ray High Voltage Generator	
Width	18	20	Inches
Depth	12	18.5	"
Height	37	19.5	"
Weight	150	325	Pounds

MEASUREMENT BASIS

The measurement basis to insure accurate technique factors are as follows: Timer radiation sensitive counter at the X-Ray Tube port counts pulses. Accuracy is one part in 10,000. Electronic counter DHEW design. Counts primary pulsed accurately to +/- zero pulses.

Milliamperes: All mA meters are checked against a standard lab meter that is calibrated against the NRC Standard Semi-Annually. Error is less than 1/2 of 1%.

KILOVOLTS PEAK

General Electric Divider Unit, located on both sides of the tube, is accurate to 3 kVp using T-912 Tektronix 10 MHz Dual Trace Storage Oscilloscope. Divider is a C1515A and is calibrated annually. Uses for this device are General Purpose Radiography.

MAINTENANCE

WARNING

NEVER SPRAY ANY SOLUTION DIRECTLY ON OR INSIDE THE X-RAY CONTROL, PRINTED CIRCUIT BOARDS, HIGH VOLTAGE TRANSFORMER, X-RAY TUBE OR COLLIMATOR. *The preferable method is to spray cleaner on a soft cloth and clean. Dry with soft towel and allow to air dry for one {1} hour minimum.*

KILOVOLTMETER CALIBRATION

This test requires a 300 VAC meter having an accuracy of 1% or better, and of known calibration. Turn on the machine and vary the kVp with the AC meter connected parallel to it. The kVp meter in the TXR 325 D & M X-Ray Control is actually a 300 VAC voltmeter calibrated in kVp. See Load Line Chart for Voltage Settings and kVp meter readouts.

REMEMBER

Notice that the proper way to calibrate or test kVp is by the use of a Divider or High Voltage Bleeder, and should only be accomplished by an X-Ray service person.

MILLIAMMETER CALIBRATION

This test will require a DC Milliampmeter having a 300 mA full scale reading, with a known accuracy of 1% or better, and of known calibration. Connect the milliampmeter in series with the machine milliampmeter and test. If the meter reads reverse switch leads. Errors should not exceed 5% of full scale.

Notice: The proper way to calibrate the mA stations is not through this method but through the method covered in Information to Assemblers - Adjusting The Milliampere Settings.

SERVICING THE HIGH VOLTAGE GENERATOR

Remove **P1** and **P2**. Remove screws from around top. Windings and all parts are connected to the top part. Lift by using Hi-Jack or by two persons lifting the two ends by the hand holds provided. *(We strongly urge you to use a lifting device.)* Your physical well being is worth more than a transformer.

BREAKER LOCATIONS

A 60 amp, 800 MAS circuit breaker is located on the right side of the console. This breaker provides power on and overcurrent protection. Fuses 1, 2, 3, 4 and 5 are located on the bottom toward left side of 325-91 Mother Board. **F1** and **F2** are 8 amp 125 VAC, **F3** is 5 amp, 240 VAC, and **F4** is 1 amp, 250 VAC. **Fuse 5** is 1 amp, 125 VAC and **fuse 6** is 1 amp, 240 VAC.

OIL: Cold oil contracts, warm oil expands. Make sure transformer is no lower than 1 inch from the top and no closer than $\frac{3}{4}$ inch.

Do Not Contaminate Oil by immersing hands into oil. Oil is most of the high voltage insulation.

Do not let moisture saturate oil by leaving the cover off the tank or by storing in a cold room then heating repeatedly. This will cause moisture.

When Transformer is reinserted into oil and the oil fill level is up to standard, operate the unit on lower kVp levels. The best method is to leave the transformer submerged over night before restarting to eliminate air bubbles.

SERVICING THE X-RAY TUBE

The service you should receive is simply to clean, calibrate, and reinsulate the receptacles of your X-Ray tube. It should be performed as stated in Information to Assemblers - Installing High Voltage Cables. **Caution:** Do not spray cleaner onto X-Ray tube. The preferable method is to spray on a soft rag and clean allowing 1 hour to dry.

TROUBLESHOOTING ERROR MESSAGES

Effective November 1998, 325D & M's began shipping with a more advanced timer. This new timer has all the same functions as the previous units plus a new error code feature. Should a problem arise, by using the mAs meter this timer may display one of the following error codes.

ERROR CODE	DESCRIPTION
O.L.	Indicates – Exceeds Tube Limit
E02	Indicates – KVP over range
E03	Indicates – KVP under range
E04	Indicates – Opening in MA cables or switch
E05	Indicates – Opening in Timing cable or switch
SCR	Indicates – Leaky or shorted SCR

THREE MAIN INDICATORS FOR PROPER TROUBLE SHOOTING

HIGH - LOW - NO MA

See Information to Users - Simple Generator Test Procedure. Then refer to Information to Users – The Milliampmeter

SYMPTOM	MOST COMMON PROBLEM	HOW AND WHERE TO TEST
X-Ray Control will not energize	No power for X-Ray L1, L2 and ground	Check Power feeding X-Ray including main panel. 200-278 VAC.
	Circuit Breaker Defective	With Circuit Breaker in the on position check voltage across major to minor line strap. 200-278 VAC
Control Energizes but LED's are not lit.	Open fuse or loose fuse holder A1 or A2 .	With Line to Auto Strapped properly and with the Circuit Breaker on, check voltage from A1 to A2 . 120-130 VAC.
No MA Meter Reading	Open fuse or lose fuse holder F6 .	With Line to Auto Strapped properly and with the Circuit Breaker on, check voltage from A1 to F6 . 8 VAC
	Defective MA Meter	Replace MA Meter, Ribbon Cable Connector or MA Selector.
No kVp Meter Reading	Open Fuse or loose Fuse Holder F4 or F5 .	With Line to Auto Strapped properly and with the Circuit Breaker on, check voltage from A1 to F5 = 24 VAC . For Fuse 4 check voltage MT-1 to MT-2 = 100 VAC.
	Major or Minor Selector defective.	Be sure that the kilovolt selectors are not stuck between contacts, but are properly indexed on a contact point. Make sure ALL contact points on both switches are good.
	KVP Meter Compensation Circuit	There maybe an OPEN in the kVp Compensation Resistor, Compensation Transformer, or K1 - K5 Relays are NOT ENERGIZING.
	Defective Kilovolt Meter	Check Kilovolt Meter, it may have a defective part.
Rotating Anode doesn't start.	Open fuse or loose holder F1 or F2 on the Mother Board.	Test Voltage A1 to A2 with unit ON. 120-130 VAC.

SYMPTOM	MOST COMMON PROBLEM	HOW AND WHERE TO TEST
Rotating Anode doesn't start. <i>(Continued)</i>	Open Fuse or loose fuse holder on Rotor Board.	Replace fuse or tighten fuse holders on Rotor Board.
	Defective Prep Switch	Test Voltage #3 to A1 PREP. 120-130 VAC.
	Open PBL/SID/Thermal/DOOR Interlock Safety Switch Circuit.	Test Voltage #4 to A1 PREP. 120-130 VAC.
	Defective Rotor Cable or improper connections 07-08-09	Check continuity of wires from Control Terminals 07 - 08 and 09 to Tube Stator. If any of these wires, terminals, or butt splices are OPEN CIRCUIT or loose, the Anode will NOT ROTATE. Check Harness from Rotor Control PC Board to Motherboard.
	Defective Tube Stator or broken insert.	Check continuity of tube stator. You should find continuity between any pair of the three {3} terminals. Gently shake Tube Head or look into port to see if X-Ray Tube is BROKEN. If the tube is broken the anode will NOT ROTATE nor the filament LIGHT UP.
	Defective Rotor Start Capacitor.	Check Capacitor with a capacitor tester. If this capacitor is either OPEN or SHORTED, the anode will not operate.
	Defective 7634 Rotor Board	Replace Rotor Board.
Rotating Anode Starts and Runs but <u>"READY"</u> does not energize nor can an exposure be initiated.	Tube installed in new installations or where tube is changed	Check out current draw in the stator circuit leads No. 7 and 8. The current in each of these leads should be 1.75 amperes or more.
	OPEN FUSE or loose fuse holder on Rotor Board.	Replace fuses or tighten fuse holders.
	Rotor connections are improper. Leads may be reversed.	Make sure 07-08-09 leads are connected properly.
	G. E. HRT or High Impedance X-Ray Tube are connected.	See service note contained on the Rotor Control Schematic. You will have to change sensing resistor.
Ready lamp lights but Exposure cannot be initiated. BACKUP CONTACTOR <u>will not come in.</u>	SCR's are shorted.	Test voltage from # J1-8 to # J1-10 on the bottom left end of the Mother Board. No voltage should be present. If there is voltage present and you can vary it by adjusting the Major and Minor Selectors , the SCR's are shorted and must be replaced.
	Expose Switch is defective or leads to and from it are loose or open.	Test voltage from #7 to A1 with Prep and Expose depressed voltage should be 120 -130 VAC , after Prep Time Delay.
	Defective Bucky Selector Switch or Internal Bucky Exposure Switch.	Turn OFF Bucky. Test voltage from # B1 to A1 with Prep and Expose Push Button depressed. The Voltage should be 120 - 130 VAC , after Prep Time Delay.
	Fuses Defective or Fuseholders loose on Timer Board	Replace fuses or tighten fuseholders on Timer Board.
	Defective Timer Selector or loose Ribbon Cables from Timer to selector.	Ensure all ribbon cable is docked properly at the Timer and the Selectors. Replace Timer Selector if needed.
	Backup Contactor Coil open or no power to it.	Test voltage across Backup Contactor Coil. 120 -130 VAC during exposure.
	Defective Timer Board.	Replace Timer.

SYMPTOM	MOST COMMON PROBLEM	HOW AND WHERE TO TEST
Rotor Runs READY lamp lights BACKUP CONTACTOR comes in and EXPOSURE lamp lights during exposure, but no X-Rays are emitted from the X-Ray Tube. <u>NO MA.</u>	SCR's Did Not turn ON. You must confirm that the SCR's are operating properly.	Test Voltage from P1 to P2 at the High Voltage Tank during exposures. H1 to H2 will have the same voltage if SCR's are operating properly. Voltage should be between 100-278 VAC.
		<p data-bbox="898 464 1170 489">VISUAL INSPECTION</p> <p data-bbox="898 522 1421 674">Remove collimator and see if the X-Ray filament lights up during PREP. The filament is visible thru the plastic window. If the filament lights up properly, the problem is in another area.</p> <p data-bbox="898 709 1382 800">EXPECTED VOLTAGE MEASUREMENTS WHEN A SHORTED CIRCUIT EXISTS.</p> <ol data-bbox="800 835 1421 1766" style="list-style-type: none"> <li data-bbox="800 835 1421 1209">1. Measure from XC to XS or XC to XL. <u>Proper voltage should be 100 - 200 VAC</u> when prep switch is depressed. If it is, remove the collimator and observe filament brilliance. If voltage is 60 - 70 VAC, this indicates a SHORT in the X-Ray Tube Filament, Cathode High Voltage Cable or Ring Terminals touching from the Cathode Well C to S, or C to L Well Post, inside the High Voltage Transformer, where they are connected. Ensure ring connectors are separated from each other on the Cathode Well. <li data-bbox="800 1245 1421 1766">2. Remove the cathode cable from the X-Ray Tube and place a Voltmeter across C and L, or C and S, depending on which focal position is selected. During PREP a voltage reading will indicate that the circuit is complete thru tube end of the cathode tube cable and that the filament in the tube is OPEN. It is advisable to be sure that the cable terminals make good contact at both the transformer and tube end of the cathode cable. <i>Sometimes ring seals provided with High Voltage Cables will have to be removed allowing contacts to dock properly.</i> The contacts may also need to be carefully spread apart by means of a knife blade in order to get better contact. This should be done VERY CAREFULLY, and not spread too far since they are hardened and may break.

SYMPTOM	MOST COMMON PROBLEM	HOW AND WHERE TO TEST
(Continued)		<p>EXPECTED VOLTAGE MEASUREMENTS WHEN AN OPEN CIRCUIT EXISTS</p> <p>Measure from <u>XC</u> to <u>XS</u> or <u>XC</u> to <u>XL</u> during prep. Depending on MA focal selection, <u>proper voltage should be 100 - 200 VAC</u>. If voltage is 220 VAC or higher, the selected filament in the X-Ray Tube maybe OPEN, the Cathode High Voltage Cable maybe OPEN, a ring connector on the Cathode Well inside the High Voltage Transformer maybe OPEN or the Ring Connector <u>XC</u> to <u>XS</u> or <u>XC</u> to <u>XL</u> Is loose from the PRIMARY FILAMENT TRANSFORMER.</p> <p><i>Since both the cathode and anode cables are identical, it is possible to use the anode cable for the cathode cable in the event that the cable used at cathode side appears to have a OPEN CIRCUIT. A high voltage cable with an OPEN CIRCUIT in one of the three wires will not affect its use as an anode cable.</i></p>
	<p>P1 or P2 Ring Terminals may be OPEN. May have been broken loose when tightening. Hold cables firmly when tightening.</p>	<p>Remove P1 and P2 Primary Cables. Measure resistance of Primary. Should be approximately 0.7 Ohms. Make sure either P1 or P2 is not shorted to ground. If Primary reads OPEN, remove top of Transformer from the can. Repair P1 or P2 Ring Terminals and resolder. As of <u>February, 1995</u> we have <u>never</u> had a OPEN or SHORTED Primary Winding.</p>
	<p>Feedback Circuit from M1 on the High Voltage Transformer back into the X-Ray Control maybe OPEN.</p>	<p>You must check for continuity M1 on Transformer and interconnect back to X-Ray Control Motherboard including MA Meter Test Circuit full-wave bridge rectifier onto the NEUTRAL CIRCUIT and then to EARTH GROUND.</p>
	<p>Both Rectifiers are OPEN on either anode or cathode side. Lead from sticks on Anode or Cathode side to Cable Wells on the transformer have opened.</p> <p>Cathode High Voltage Cable.</p>	<p>The High Voltage Generator can be carefully lifted out of the tank and all terminals and wires should be checked to established that there are no breaks in them. Check <u>both</u> High Voltage Output Windings. Resistance should be from 5500 ohms to 7500 ohms. Primary P1 and P2 resistance should be .7 ohms. In this case replace <u>all four rectifiers sticks</u>.</p> <p>The X-Ray Cathode Cable being used is shorter than the one previously used for calibration. Indication maybe proper MA and KVP with small focus selected, and high MA and low KVP when large focus selected. Recalibrate the Filament Circuits.</p>
<p>Rotor Runs READY lamp lights BACKUP CONTACTOR comes in and EXPOSURE LAMP lights during exposure. Some X-Rays maybe emitted from the X-Ray Tube, but Milliampers are HIGH. HIGH MA.</p>	<p>X-Ray Tube Filament Characteristics.</p>	<p>Initially, check output pulses at the X-Ray Tube. If pulses are correct, you must LOWER filament voltage.</p> <p>The present X-Ray Tube does not have the same filament characteristics as the one connected previously. In some instances it maybe necessary to lower the voltage strap on the MA stabilizer so that the large filament voltage can be lowered to achieve the proper MA. . Selections are 240 - 250 or 260 VAC. Should you lower the MA Stabilizer Strap, recalibrate the large filament properly. After you calibrate the large filament properly, you may find the small filament operating at too low MA. To correct, increase the small filament resistor setting. Calibrate all stations, measure KVP and Timed Impulses out of the X-Ray Tube.</p>

SYMPTOM	MOST COMMON PROBLEM	HOW AND WHERE TO TEST
HIGH MA (continued)		<ol style="list-style-type: none"> 1. Remove P1 & P2 power cord from the Primary of the High Voltage Transformer. 2. Place Volt Meter between H1 and H2 terminals on the X-Ray Control Motherboard. Adjust Major and Minor kVp selectors until 120 VAC is obtained. 3. Turn unit <u>OFF</u>. Connect 120 VAC lamp from P1 to P2 from X-Ray Control. Then place Volt Meter from P1 to P2. Select <u>2 seconds</u> on the timer and make an exposure. Lamp should light and voltage should be 120 VAC.
		<ol style="list-style-type: none"> 4. If you read 60 to 70 VAC, the SCR's are half waving. There are three causes possible, beginning with most likely: <ol style="list-style-type: none"> I. Timer to SCR Gate Harness has an OPEN lead. II. The SCR itself is defective III. One of the Timer Pulse Transformers is OPEN. (See next page).
		<p>AFTER A SHORTED OR HALF-WAVING SCR, DEFECTIVE SCR HARNESS OR TIMER HAS BEEN REPLACED, YOU MUST RUN A SIMULATED LOAD TEST TO ENSURE PROPER OPERATION OF THE SCR OUTPUT.</p> <p>REPEATED FIRING OF SCR's HALF-WAVING WILL EVENTUALLY CAUSE THE SCR TO SHORT. IN THIS CASE YOU WOULD REPLACE THE SCR ONLY TO FIND ANOTHER PROBLEM, SUCH AS KICKING THE CIRCUIT BREAKER OR LOADING THE HIGH VOLTAGE TRANSFORMER. NORMALLY YOU MAY SUSPECT THE HIGH VOLTAGE TRANSFORMER, WHEN THE PROBLEM IS THE HALF-WAVING SCR. THIS IS THE REASON FOR ADMINISTERING THE SIMULATED LOAD TEST AFTER REPLACING A SHORTED OR HALF-WAVING SCR. THE SIMULATED LOAD TEST IS THE ONLY WAY TO BE SURE ANY X-RAY CONTROL IS FUNCTIONING PROPERLY.</p>
	Both filaments are lit.	With Prep depressed check voltage from XC to XL and XC to XS . You may remove the relay causing the short and bend all top N/C contacts up.
	Ground not proper.	Grounding must be EARTH GROUND. Neutral must be connected to EARTH GROUND at in coming power supply. Loose connections, defective ground rod or the absence of the same will cause erratic exposures. Examples of symptoms are terminating timed exposures too soon, causing the back-up contactor to oscillate or "machine gun". The Service Engineer must understand that <u>0 VAC</u> is <u>NOT GROUND</u> in X-Ray Controls, it is only a reference for electronic circuitry listed as <u>A1</u>.

SYMPTOM	MOST COMMON PROBLEM	HOW AND WHERE TO TEST
HIGH MA <i>(continued)</i>	M1 Feedback Circuit Defective.	<p>The M1 Feedback Circuit serves two {2} functions.</p> <ol style="list-style-type: none"> 1. It allows sampling the current (<i>MA</i>) routed from the High Voltage Output Winding back to the X-Ray Control Terminal M1. Full-Wave Bridge Rectifier AC Legs are in series with terminal M1 and allows rectification of AC Current. The Full-Wave Bridge rectifies this current to DC. DC current measure-ments <u>dc milliamperes</u> (+) and (-) are taken from (+) and (-) terminals on the Motherboard. After the rectifier AC connections the neutral circuit is established to the neutral GROUND POST in the X-Ray Control. 2. The second and the most important function is to provide a neutral High Voltage Return which is connected to EARTH GROUND at the Main Power Supply for the installation. <p>If you do not have an EARTH GROUND or M1 is not making up, you will not have proper X-Rays (If M1 is OPEN you may hear ARCING).</p> <p>A common symptom if M1 circuit has loose connections or defective components would be... the X-Ray Exposure could be terminated too soon. This termination is caused by the loss of EARTH GROUND. EARTH GROUND is electrically placed to M1 Secondary of the High Voltage Transformer. If a loose connection or opening exists inside the X-Ray Control, kVp High Voltage will appear at those points. Spacing of lands and insulation ratings will be exceeded by such high voltage. Instantaneously <u>arcing</u> will jump traces or from wire to wire sending transits throughout the X-Ray Control. Whether the X-Ray Control is equipped with a RC Timer or Digital Timer makes no difference. The transits will cancel voltage across timing capacitors and binary counters with the fault being the same, <u>termination of exposure too soon</u>.</p> <p>A Quick Test is add a JUMPER from M1 to GROUND Post on the High Voltage Transformer. This bypasses the M1 Feedback and Meter Circuit. Check for LOOSE CONNECTIONS, OPEN WIRES, DEFECTIVE TEST SWITCH or BRIDGE RECTIFIER in MA Meter Circuit.</p>

SYMPTOM	MOST COMMON PROBLEM	HOW AND WHERE TO TEST
HIGH MA (continued)	Gassy X-Ray Tube	<p>Gassy X-Ray Tubes are the result of three actions. The normal evaporation of filament and anode material over the normal life of an X-Ray Tube, accelerated evaporation of filament and breakdown of anode material caused by exceeding tube limits, and immediate breakdown in new tubes caused by defective material or workmanship. The latter is predominate in causing extensive damage to High Voltage Rectifiers and High Voltage Winding when the defect is not detected and corrected quickly. All these actions result in gasses becoming active inside the vacuum tube. This gas is impure and allows accelerated movement of electrons. The predominate cause is usually the anode run speed is too slow. See "<u>Anode Run Speed Too Slow.</u>"</p> <ul style="list-style-type: none"> This gas is impure and allows accelerated movement of electrons. As KVP is increased MA begins to increase. How radically a tube reacts to the set level of MA and kVp is determined by how gassy the tube maybe. For instance, some tubes react quite well up to 200 MA and 100 kVp, while others react quite violently when the tube is exposed above 50 kVp at 50 MA. Tubes may conduct properly when cold, but become unstable when they are warmed-up. There is no one set level or way to measure how gassy a tube has become. <u>If a tube is only slightly gassy, it must be replaced because it will cause extensive damage to Rectifiers and to the High Voltage Winding.</u> To test for slightly gassy X-Ray Tubes, decrease KVP until the MA stabilizes. The only sure way to test an extremely gassy X-Ray Tube is by replacing the X-Ray Tube and both High Voltage Cables.
	Defective High Voltage Cable.	<ul style="list-style-type: none"> Shorting High Voltage Cables may cause higher MA's or kicking the circuit breaker. Defective High Voltage Cables are the result of breakdown of insulating material that eventually leads to a short. This short allows a path for current to flow to GROUND. During a partial short the cable will cause symptoms much like a gassy X-Ray Tube. The result is higher MA.
		<p>In most cases the cable will short completely pegging the MA Meter. In this case there will not be output from the X-Ray Tube. Shorting X-Ray Cables if left uncorrected can cause opening of High Voltage Rectifier and High Voltage Winding in the Transformer.</p> <p>Most breakdowns occur at the receptacle ends, where the cable enters the plastic and is bound by a pressed ring and at 90° bends. Also pinching and twisting cables or allowing cables to become saturated with oil or other chemicals will break down insulation. <u>To test, replace the High Voltage Cables.</u></p>

SYMPTOM	MOST COMMON PROBLEM	HOW AND WHERE TO TEST
HIGH MA <i>(continued)</i>	Anode Run Speed Too Slow.	Should the rotating anode be operating below 3,000 RPM pitting, chipping and eventually cracking may occur. When this happens the gas contaminates the envelope, allowing electrons to be attracted to the anode easily. This acceleration results in higher MA and can become critical causing arcing in the envelope. Check anode speed with tachometer.
	High Voltage Cables Too Short. Incompatible X-Ray Tube.	Cable length is shorter than the previous set used with the X-Ray Control. Adjust filament resistors. X-Ray Tube filament characteristics maybe incompatible with present MA stabilizer and filament adjustments. You may adjust voltage from 240 - 250 - 260 at the MA stabilizer. Fine adjustments maybe made at each filament resistor.
	Back-up Contactor Coil Capacitor	The <u>0.1 mfd. filter capacitor</u> across the back-up contactor coil is either <u>loose</u> or <u>defective</u> . This will cause erratic exposures. Sometimes too short, sometimes too long. You may hear snapping in the High Voltage Transformer. Can cause contactor to machine gun.
	Defective High Voltage Rectifier.	A defective High Voltage Rectifier may react the same way whether it is shorted or partially OPEN. To test, remove the High Voltage Cables from the High Voltage Transformer and make an exposure. If the X-Ray Control seems to be under load during this exposure test the SCR's. <u>Ensure the SCR's are not half-waving</u> . For Testing SCR's (See " <u>SCR's and X-Ray Control Half-Waving</u> "). If testing confirms that the SCR's are operating properly, remove Cathode and Anode Cable from the High Voltage Transformer and make an exposure. If MA is present you must replace High Voltage Rectifier Sticks. You must establish why the Rectifier Sticks shorted. Normally a High Voltage Cable shorted or the X-Ray Tube is gassy which caused the Sticks (<i>Rectifier</i>) to short. Use a loner X-Ray Tube and High Voltage Cables for final testing and proving which is defective.
	High Voltage Rectifiers too close to the side of the tank	Causes: (1) Dropping or excessive shaking during transport (2) Bending tabs when replacing high voltage rectifier sticks, leads to them becoming too close or in contact with the tanks side. Usually the symptom will appear as kVp is increased beyond the point of breakdown that occurs for certain spacing. At low kVp, mA and kVp may operate properly. As higher kVp's are selected beyond the point of breakdown mA goes high, kVp drops. If left uncorrected improper spacing will cause opening or shorting high voltage rectifiers and opening high voltage windings. Simply stated, your sticks are too close to the metal side of the high voltage tank. Sticks are to be installed leaning slightly toward the core and away from the transformer side: <u>Minimum 1.25 inches</u> from any metal object.

SYMPTOM	MOST COMMON PROBLEM	HOW AND WHERE TO TEST
	Loose Wiring or Connections.	It is unlikely that loose wiring is possible, unless the transformer has been dropped. To test, you must remove the transformer from the can and inspect all wiring and connections using a OHM Meter. (See <u>BOTH RECTIFIERS ARE OPEN</u> , Page 26).
	Contaminated Transformer Insulating Oil	Contaminated Transformer Oil or too low level of good oil will cause arcing in the High Voltage Transformer. Drain, dry windings and refill tank. Wait 24 HOURS before testing.

LOW MA - NO MA

SYMPTOM	MOST COMMON PROBLEM	HOW AND WHERE TO TEST
LOW MA	High Voltage Cables Too Long.	Cable length is longer than the previous set used with the X-Ray Control. Adjust filament resistors.
	Incompatible X-Ray Tube.	X-Ray Tube filament characteristics maybe incompatible with present MA stabilizer and filament adjustments. You may adjust voltage from 240 -250 - 260 at the <u>MA stabilizer</u> . Fine adjustments maybe made at each filament resistor.
	Defective MA Stabilizer.	On PREP test from A1 to H3 . Voltage should be either 240 - 250 - 260 depending on where the stabilizer is strapped. Any voltage <u>less</u> than 235 VAC indicates a problem inside the stabilizer.
	Defective High Voltage Cable.	Partial breakdown of the insulation in a High Voltage Cable can cause lower MA's at Higher kVp selections. As kVp is increased to the point that it begins shunting minute current across conductors MA starts to decrease. Technicians will often increase the kVp further to compensate for the lower MA only to realize that MA has decreased even further. You should always install a <u>NEW</u> set of <u>Cables</u> just to eliminate this possibility.
	Defective High Voltage Rectifier.	Approximately half of expected MA would indicate a OPEN Rectifier Stick in the High Voltage Transformer. Test using a timed impulse counter at the X-Ray Tube. If half waving, half impulses will be present.
	Defective Leads or Connectors in the High Voltage Transformer.	It is unlikely that loose wiring is possible, unless the transformer has been dropped. To test the High Voltage Stick Connectors and wiring, remove the transformer from the can and inspect all wiring and connections using a OHM Meter.
	Open Space-Charge Primary Transformer	Open space charge primary may cause lower MA at lower kVp and higher MA at higher kVp selections. Check Space Charge Input and Output. Use schematics.
	Defective Timer	Too low MA can sometimes be caused by a malfunctioning timer, timer selector or the ribbon cable connecting them. If you cannot be sure which is causing the problem, <u>replace all three</u> .

SYMPTOM	MOST COMMON PROBLEM	HOW AND WHERE TO TEST
NO MA	SCR's shorted	If SCR's are shorted the backup contactor will not come in nor, can an exposure be initiated. Test Voltage from J1-8 to J1-10 on the <u>Motherboard</u> . If voltage is present and can be varied changing kVp settings, you have a shorted SCR. Replace.
	Anode and Cathode Cables not installed correctly.	Ensure Cathode Cable is connected to Cathode on the High Voltage Transformer and to Cathode on the X-Ray Tube. Anode to anode, Cathode to Cathode . If cables are reversed with the anode of the transformer connected to the Cathode of the X-Ray Tube. The filament output circuit is shorted. Immediate indication would be 60 - 70 VAC on FILAMENT PRIMARY, when PREPPED. Measurements should be taken from XC to XS or XC to XL .
	Defective Timer.	Timer is not initiating exposures. Observe... Is the Back-up Contactor energizing? If it is, the problem will be OPEN SCR HARNESS or DEFECTIVE TIMER PULSE CIRCUIT. If the backup contactor is not energizing, test for a shorted SCR.
	MA Stabilizer Defective.	Check output of MA Stabilizer A1 to H3 with PREP Switch Depressed. Voltage should be 240 - 250 - 260 VAC .
	Space Charge Transformer OPEN WINDING.	The Space Charge Secondary winding or terminal connection including jumpers H1 to H8 maybe <u>OPEN</u> . Use schematic to test voltage.
	Open Filament in X-Ray Tube.	Select alternate focal spot. Actuate exposures... If MA is proper on alternate focal spots, tube filament maybe <u>OPEN</u> .
	Shorted Filament in X-Ray Tube.	To test place volt meter from XC to XS or XC to XL and PREP. If a short exists your voltage will be 60-70 VAC . This does not prove the filament in the Tube is shorted unless the voltage rises above 200 VAC with the Cathode Cable removed from the X-Ray Tube. If the voltage remains 60 -70 VAC see section under CONDITION SHORTED (See Page 25) .
	OPEN Cathode High Voltage Cable.	To test Cathode High Voltage Cable, remove from cathode side of the X-Ray Tube. Place Volt Meter from C to S or C to L and depress <u>PREP</u> Switch. You should measure 15 -16 VAC . If you do not measure 15-16 VAC , swap both ends anode and cathode cables and retest.
	Shorted Cathode High Voltage Cable.	To test Cathode High Voltage Cable for short, place Volt Meter from XC to XS or XC to XL and <u>PREP</u> . If short exist with Cathode Cable removed from X-Ray Tube, Proceed. Remove Cathode Cable from the High Voltage Transformer, and <u>PREP</u> . If voltage rises to 200 VAC or above the cathode cable is shorted. Swap Anode and Cathode cables.

SYMPTOM	MOST COMMON PROBLEM	HOW AND WHERE TO TEST
LOW MA - NO MA	Filament Transformer Output Shorted.	Remove Cathode Cable from the High Voltage Transformer. Measurements must be taken inside the Cathode Well on the Transformer. The Female Docking Groove in the receptacle is C (Common) . Place one probe in the pin aligned with the Docking Groove and the other on the S or L pin depending on which focus is selected. Depress PREP and measure voltage. If 15 - 16 VAC is present filament transformer is OK. If voltage is not present, check input voltage XC to XS or XC to XL . If that voltage is 60 -70 VAC then the Ring Terminals on the Cathode Transformer Well that connects to the output of the filament transformers are SHORTED TOGETHER . You must remove Transformer from can and separate the Ring Terminals attached to the Cathode Well.
	Filament Transformer Input OPEN.	If the filament transformer Primary is suspected to be OPEN , remove XC , XS , and XL interconnect cable from the High Voltage Transformer. Measure the resistance from XC to XS or XC to XL . Resistance should be 20 to 25 OHMS . If OPEN , remove Transformer from the can and replace ring connectors or the filament transformer if needed.
kVp Meter read-out on the X-Ray Control does not match the Dyanalyzer or ion chamber reading.	Dyanalyzer or test instrument defective or out of calibration.	All TXR Controls are tested and calibrated at the factory.
	MA is higher or lower than selection indicates.	Check and calibrate all MA stations, check space charge. MA will affect kVp output.
	Excessive voltage drop from power source to X-Ray Control.	Voltage <u>cannot</u> exceed 5% drop on incoming line to the X-Ray Control. Either the service transformer is too light duty, wire sizes are too small or interconnect wire is too long for current demand.
	Voltage Drop caused by too long of interconnect cable from X-Ray Control to Transformer P1 and P2 .	A similar drop in voltage caused by exceeding length and wire sizes for current demand in the High Voltage Primary Circuit will have the same results as above. A 5 volt drop will result in a 6 kVp loss.
	KVP Meter Out of Calibration or Defective	<i>Calibrate kvp meter using load line chart. See kvp meter circuit theory write-up below.</i> F4, MT-1 or MT-2 open. Connect a voltmeter from MT-1 to MT-2 , turn control ON and check voltage. If 95 - 110 VAC is not present, replace fuse, tighten connections, or add 13 to 100 VAC, kVp compensation transformer. 2500 ohm kVp meter compensation resistor OPEN. Turn control OFF, remove <u>fuse 4</u> and measure resistance across the 2500 ohm resistor. If the resistor is OPEN, replace it. NOTE: If the 2500 ohm resistor heats up or opens, you may have a short from MT-1 to MT-2 to a winding on the autotransformer. The only way to correct this is to remove MT-1 and MT-2 leads from the terminal strip and install a 13 to 100 VAC kVp meter compensation transformer.

KVP METER CIRCUIT THEORY

The kVp Meter along with the kVp Compensating Circuit is fairly simple to understand and test. When the X-Ray Control is energized 95-110 VAC potential is present from MT-1 and MT-2 terminals. This voltage is coupled to each end of the kVp Meter Compensation Adjustment Resistor (2500 ohm). You should read the same voltage across the resistor. If you do, turn OFF X-Ray Control and remove FUSE 4 and measure the resistance. If 2500 ohms is not measured replace the resistor. Should the resistor overheat or OPEN, remove MT-1 and MT-2 and order 13 to 100 VAC Compensation Transformer from the factory. If the resistance is 2500 ohms check all connections ensuring H1 Voltage is present at each compensating band that is selected. If all these measurements are proper replace the kVp Meter Board.

The kVp Meter Compensation Resistor serves two purposes:

- (A) The kVp Meter Compensation Resistor is parallel to the Autotransformer allowing immediate correction of kVp Meter Settings should line voltage fluctuate. The fluctuation is normally no lower than 95 and no higher than 110 VAC. This is the proper voltage range.
- (B) The kVp Meter Compensation Resistor is connected for each mA (Load by individual mA relays K1 through K5, C Contacts. Compensation adjustments are for unit loss that occurs when current is moving in the high voltage secondary. Because of loading, kVp will decrease at the X-Ray tube. The bucking voltage selected from the 95-110 VAC supply opposes H1 to H2 Voltage. The final Voltage difference is coupled to the kVp Meter allowing it to pre-read the correct kVp that will appear at the X-Ray tube.

A Training Manual is available for "kVp Indicating Systems for X-Ray Equipment."

A check for loss of kVp through partial breakdown of transformer.

The relationship of kilovoltage output to primary voltage input (P1, P2) will not change unless the turn ratio of the high voltage transformer has changed due to a partial breakdown. Partial breakdown occurrences are very rare. Should you suspect a partial breakdown in the high voltage transformer detection is quite easy. Remove the High Voltage Transformer from the tank and measure the resistance in each winding. The resistance across P1 and P2 is .7 ohms. The resistance across the output of both high voltage transformer windings will vary from 5500 to 7500 ohms, depending on the manufacturing date.

After reassembling the transformer wait 24 hours before testing. Re-energize the equipment by turning on the main switch and make an exposure of approximately 2 seconds at 60 kVp, 50 mA. Observe the mA meter reading. The reading should be 50 mA. Select 90 kVp at 50 MA, 2 seconds, and make an exposure. The reading should be 50 MA. Take an exposure 120 kVp at 50 MA, 1 second. MA should be within the tolerance. Now begin calibrating all MA and kVp stations observing actual MA and kVp outputs. Higher current readings could indicate other problems. See trouble shooting section.

TESTING HIGH VOLTAGE RECTIFIERS

Properly testing high voltage rectifiers requires special test equipment. Replace suspected defective rectifiers and return old set to the factory for testing. This is the simplest and safest way to test these type parts. (See page 32, High Voltage Rectifiers too close to the side of the tank).

C A U T I O N
DO NOT MAKE ANY TEST EXPOSURES WITH TRANSFORMER OUT OF OIL.

MAINTENANCE SCHEDULE FOR RADIATION SAFETY OF X-RAY APPARATUS

In order to assure continued compliance to the Federal Performance Standards, maintenance inspections and test should be carried out by qualified personnel on original installation and at intervals of 6 months or less. Specific instructions for performing these maintenance activities are provided by the individual manufacturers.

This schedule relates to conformance to the Federal Performance Standards and is not intended to assure general equipment performance which must be carried out independently.

TUBE ASSEMBLIES

1. **Radiation Leakage.** Look for obvious physical damage which would affect radiation shielding and proper beam limiting device function.
2. **Beam Quality.** Confirm that the minimum filtration required is in the useful beam. Check interlock where applicable.
3. **Field Limitation and Alignment.** Check indicators on beam axis and centering.

GENERATORS AND CONTROLS

1. **Line Voltage and Voltage Regulation.** Measure line voltage and voltage regulation to confirm that both are within manufacturers specifications and that supply line is connected to the proper line terminals, if applicable.
2. **Calibration.**
 - (A). Perform the manufacturers calibration procedure, including, but not necessarily limited to testing and adjusting kV, mA, mAs, and timer factors to specifications in manufacturers instructions.
 - (B). Confirm that exposure cannot be made if timer is not set on a specific time or if timer is set to zero, if applicable.
3. **Contactors and Relays.** Inspect electromechanical contactors and relays for pitting, poor contact, loose, or missing parts. Replace if necessary.
4. **High Tension Cable and Transformer Bushings.** Check for proper filament circuit contact to insure consistent mA output.
5. **Collimator Filter Interlock.** Confirm, where applicable, that an exposure cannot be activated at 50 kV and above, if the minimum required filtration is not in place.
6. **Visual Exposure Indicator.** Confirm that the means provided and specified by the manufacturer for indicating, visually, the occurrence of an X-Ray exposure (*mA meter, pilot light, etc.*) is functioning during and only during an exposure.
7. **Audible Exposure Indicator.** Confirm that the audible indicator provided by the manufacturer to indicate the termination of an X-Ray exposure is functioning in the manner specified by the manufacturer and only in the manner specified.
8. **Inspect and Test Dials and Knobs.** Inspect knobs on timers, kilovoltage, milliamperage selectors and any other adjusting knobs to be sure that the pointer is indicating to the proper value.
9. **X-Ray Exposure Switch.** Confirm that any switch provided for activating an X-Ray exposure requires continuous pressure to maintain the exposure or that release of the switch terminates the exposure.
10. **Warnings and Indicators Legible.** Inspect and confirm that all warning labels and embossed, painted, silk screened, or other wearable technique factors indicators have not been defaced or worn so as to be illegible.

FLUOROSCOPIC IMAGING ASSEMBLIES - NON IMAGE INTENSIFIED

1. **Radiation Leakage.** Look for obvious physical damage which would affect radiation shielding.

2. **Primary Protective Barrier.** Check that the entire useful beam is intercepted by the primary barrier at an S.I.D. and that the fluoroscopic tube shall not produce X-Rays if the barrier is not in the intercepting position. Check to be sure lead glass has not been unknowingly replaced by ordinary plate glass.
3. Check that the means is provided to further **limit field size function** properly, and that a minimum field size of 5 x 5 cm. at maximum S.I.D. can be provided.
4. **Fluoroscopic Exposure Rate.** Measure fluoroscopic radiation dose rate and adjust, if necessary, to not more than 5 R/minute or not more than 10 R/minute, depending on equipment. Check B.R.H. requirements.

TABLES

Aluminum Equivalent. Inspect table tops and cradles for any physical damage, alterations or deviations from the certified model which might alter the attenuation characteristics.

CRADLES

Beam Attenuation. Check that the cradle has not been modified or changed, that the aluminum equivalence exceeds 2.0 mm.

CASSETTE HOLDERS

1. **Inspect the front cover**, if provided, of the cassette holder for any physical damage or modification which would alter the attenuation characteristics.
2. **Interlocks.** Test and confirm the proper operation of interlocks, if provided for the operation of positive beam limitation.
3. **Alignment Indicators.** Test and confirm the proper operation and accurate indications of means provided to accomplish alignment between the X-Ray field and the image receptor.
4. **Alignment in Positive Beam Limitation (P.B.L.)** If provided for operation with positive beam limitation, test and confirm proper alignment between the X-Ray field and the image receptor.

BEAM LIMITING DEVICES

1. **Radiation Leakage.** Inspect beam limiting device and its attachment to the X-Ray tube housing for physical damage, loosening or wear which might affect leakage radiation. Verify that the combination of tube housing and beam limiting device is listed as compatible.
2. **Beam Quality.**
 - (A). Verify that all filtration elements, incidental and added, as provided by the certified beam limiting device and tube housing, are present and show no evidence of physical damage or alteration which might alter attenuation.
 - (B). Verify operation of filter - kV interlock in systems with more than one thickness of filtration.
 - (C). Perform such maintenance as specified by manufacturer, e.g., tightening of hardware, lubrication, etc.
3. **Variable Field.** Verify functioning of step less adjustment of X-Ray field size. Verify that the minimum field size of 5 x 5 cm. can be achieved at 100 cm.
4. **Visual Definition.**
 - (A). Verify that misalignment between the visually defined field and the X-Ray field does not exceed 2% of S.I.D.

- (B). Verify average illumination exceeds 160 lux (*15 foot candles*).
- (C). Verify that the edge contrast ratio of light field exceeds 4 and 3 respectively for stationary and mobile radiographic equipment.
- (D). Perform manufacturers routine maintenance.

5. **Field Indication and Alignment.**

- (A). Verify the proper functioning of the means for alignment of the center of the X-Ray field with the center of the image receptor.
- (B). Verify that the numerical indications of field size result in X-Ray field dimensions in the plans of the image receptor are within 2% of S.I.D. of the dimensions of the image receptor.
- (C). Perform manufacturers routine maintenance.

6. **Positive Beam Limitation.**

- (A). Verify automatic adjustment of X-Ray field size to image receptor size within 5 seconds of insertion of image receptor, or inhibition of exposure until field congruency is obtained.
- (B). Verify that the X-Ray size conforms to that of the image receptor within 3% of S.I.D. per axis 4% of S.I.D. total.
- (C). Verify operation of optional field size reduction and that field can be reduced to 5 x 5 cm. or less at 100 cm.
- (D). Verify that return to positive beam limitation occurs upon a change in image receptor.
- (E). Verify that the bypass mode, where provided, functions when not using the cassette tray or permanently mounted vertical cassette holder, and when either beam axis or table angulation if not within 10° of the horizontal or vertical during any part of the exposure. Verify automatic return to positive beam limitation when more of the above...
- (F). Verify operation of over ride key, where...

7. **Intraoral Image Receptors.**

- (A). Verify presence and integrity of source to skin distance limiting devices specified for the certified component.
- (B). Verify maximum field size at minimum SSD is 7 cm. or 6 cm., respectively, if minimum SSD is greater than or less than 18 cm.

8. **Single Image Receptor Size.**

Verify presence integrity and functioning of means provided to limit X-Ray field size to not greater than the image receptor, and to align the field and receptor centers to within 2% of S.I.D.

9. **Other X-Ray Systems.**

Verify presence, integrity and functioning of means specified and provided for the certified component to limit the X-Ray field such that each dimension does not exceed image receptor size by more than 2% of S.I.D. and to align the centers of the X-Ray field and receptor to within 2% of S.I.D. Verify presence and visibility of markings identifying image receptor size and S.I.D.

10. **Field Limitation and Alignment.**

- (A). Verify that the total misalignment of X-Ray field with the respective edges of the selected portion of the image receptor does not exceed 3% of S.I.D. for length or width, nor 4% of magnitudes for the two directions.
- (B). Verify that X-Ray field size can be adjusted smaller than the selected portion of the film, and that at maximum S.I.D. a field size of less than 5 x 5 cm. can be provided.
- (C). Verify that the centers of the X-Ray and selected film portion coincide within 2% of S.I.D.
- (D). Perform manufacturers routine maintenance.

11. **Source Skin Distance** (*Mobile Units*).

Verify the presence and integrity of the means specified and provided for the certified component to limit source skin distance to no less than 30 cm.

Check that the certification label and component identification label are affixed to all certified components.

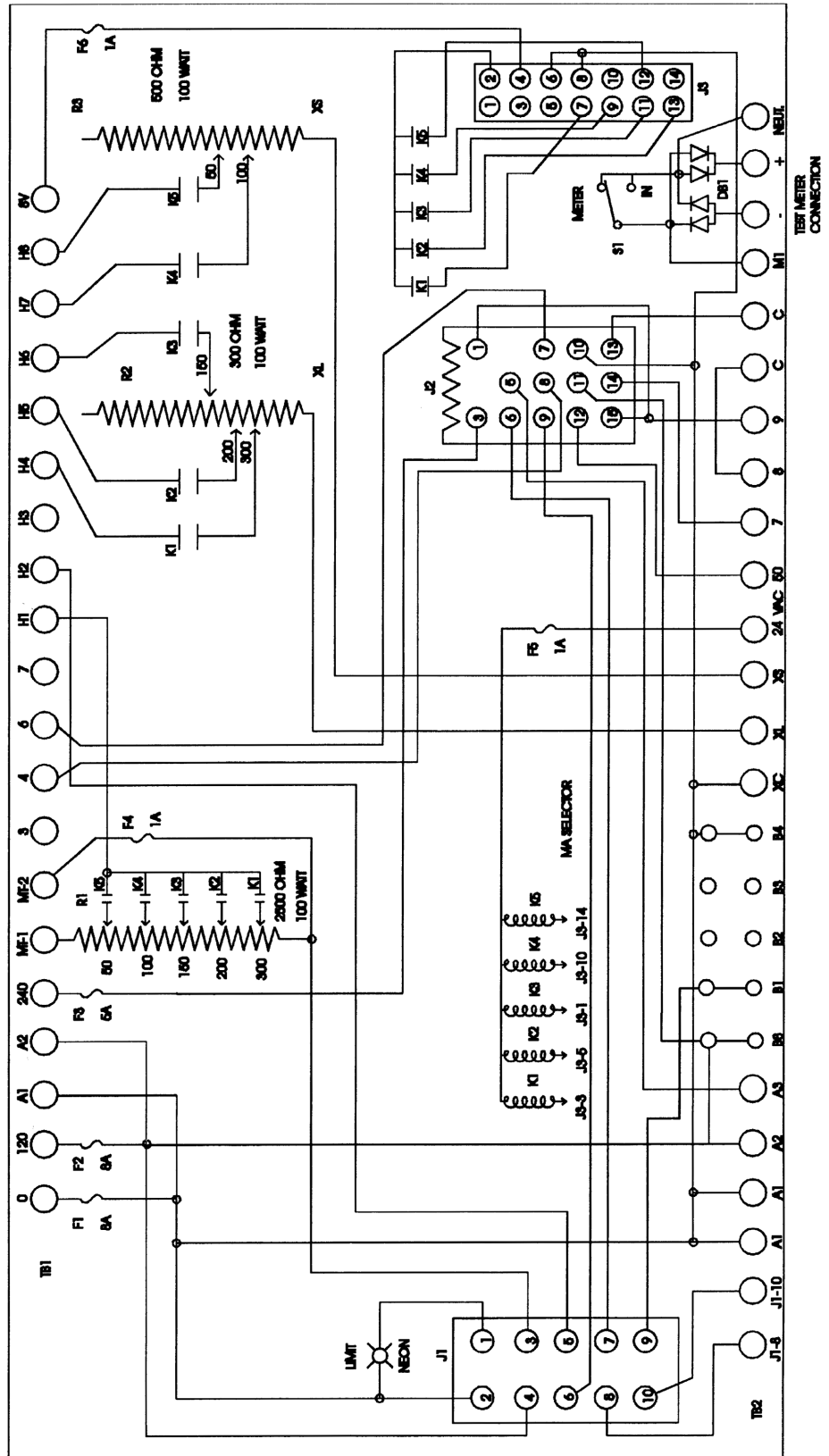
Consult DHEW Publication No. (FDA) 75-8003, dated July, 1974 for specific compliance requirements.

Also consult B.R.H. Routine Compliance Testing for Diagnostic X-Ray Systems or Components of Diagnostic X-Ray, in which 21 CFR Subchapter J is applicable, DHEW Publication (DFA) 75-8012, dated September, 1974 for details on test procedures and equipment specifications and details.

After initial installation, performance of these periodic activities is the responsibility of the owner/user, as they are not provided at no cost under the manufacturers warranty.

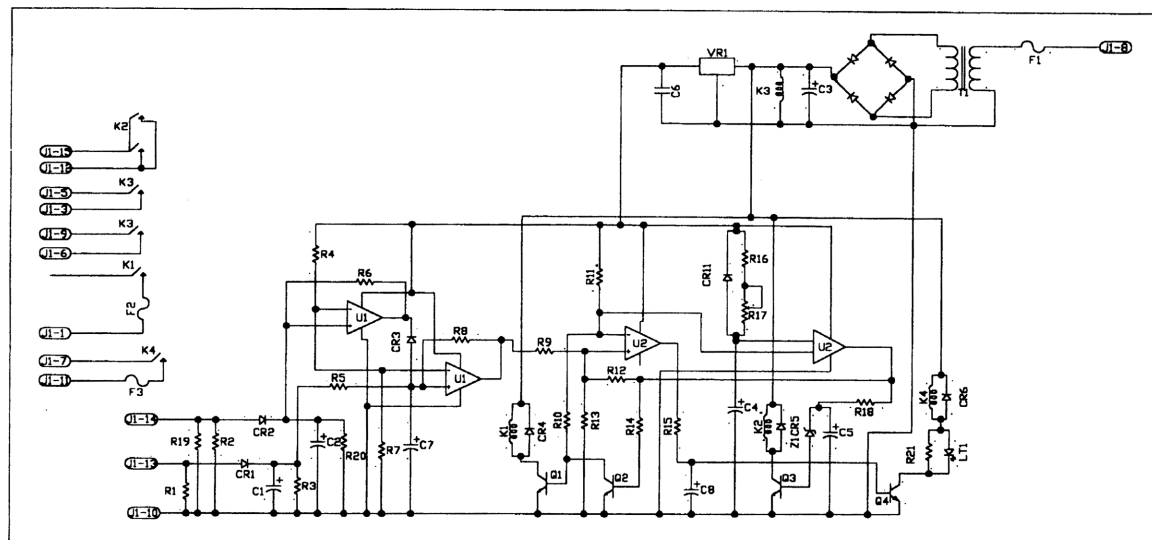
SCHEMATIC DRAWINGS

TXR 325-91 MOTHERBOARD SCHEMATIC

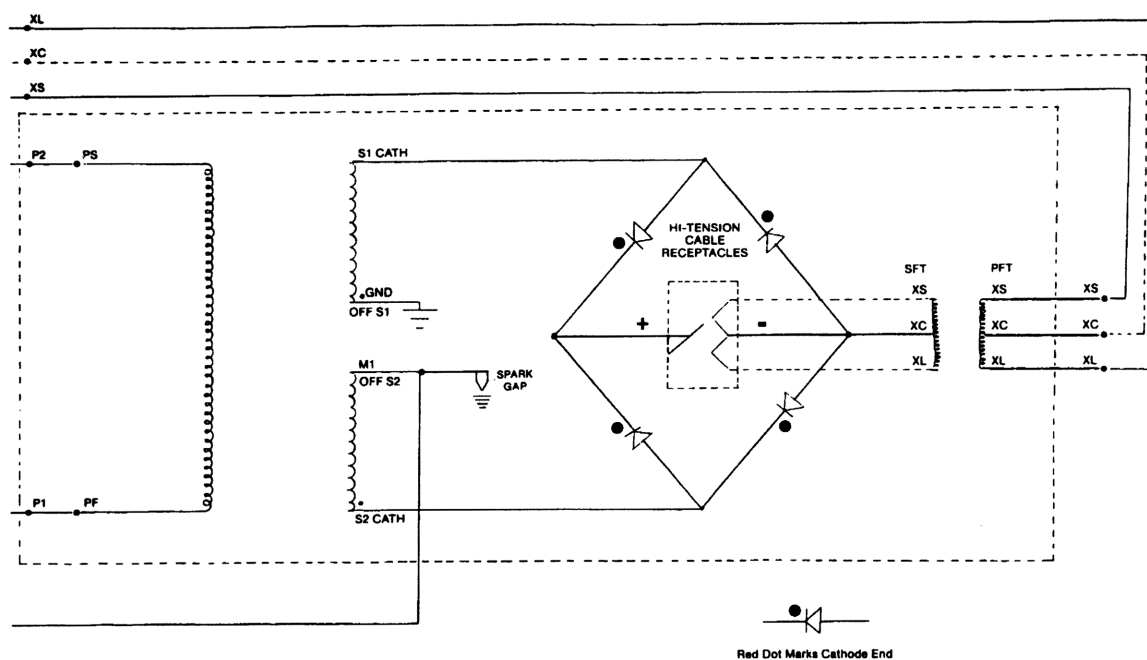


TXR 7634 ROTOR CONTROL BOARD

In some instances because of the age of the X-Ray Tube the sensing circuit may be too sensitive - where the rotor control will not time out, If this happens change value of R7 from 1.5 K to approximately 1.0 K (Ref. GE Tubes).

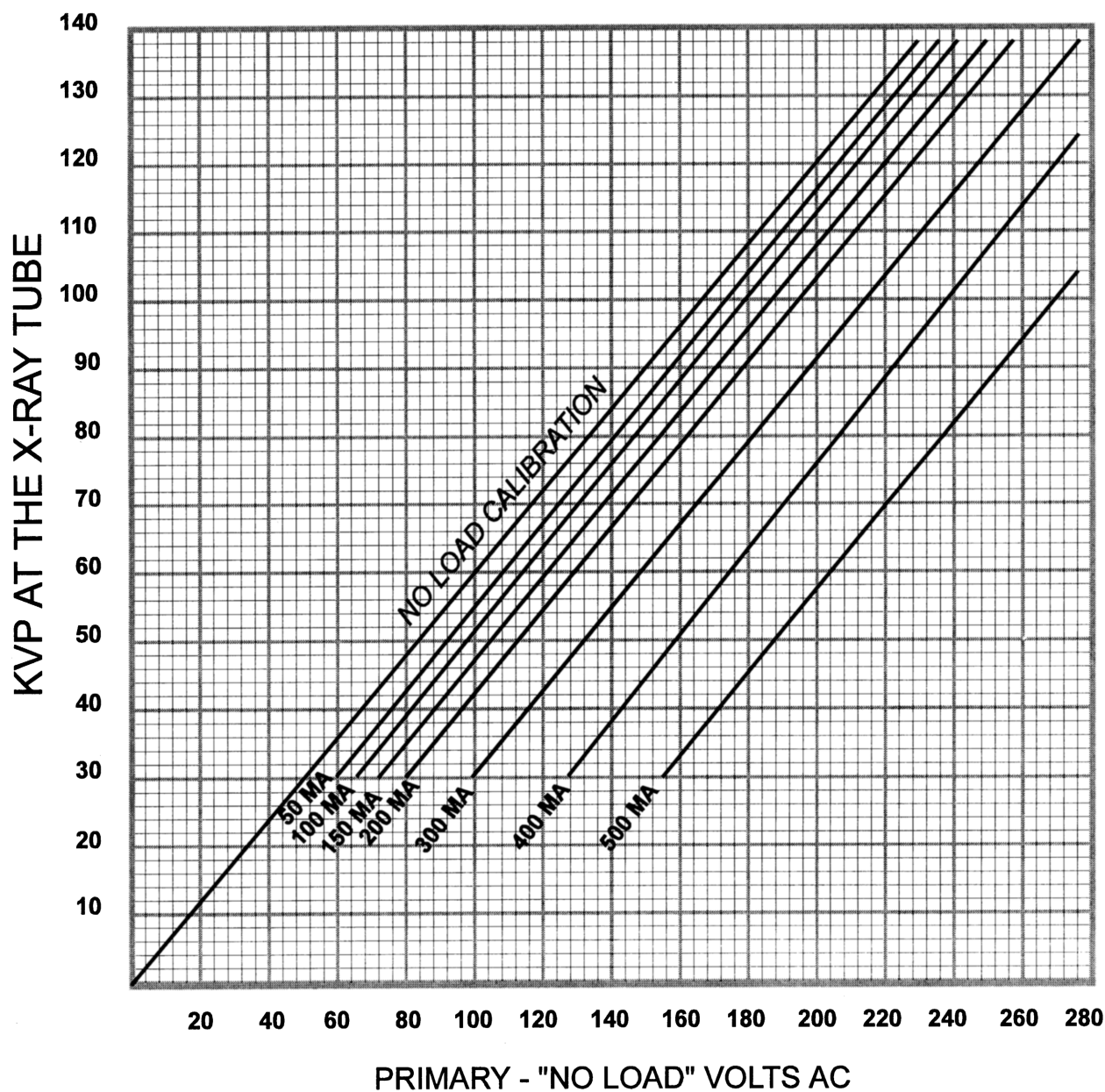


TXR 325-1 HIGH VOLTAGE GENERATOR



TXR

LOAD LINE CHART



Plot of KVP Curve for TXR 325-1 High Voltage Generator
& the TXR 325D, 325M, and 525SFQ X-Ray Control.

Effective August, 1994 and later models.

Calibration Data Sheet

mAs Calibration Data

(Exposures at 1/10 second)

kVp	50 mA	100 mA	150 mA	200 mA	300 mA
60					
80					
110					

(Record actual mAs)

Timer Reproducibility Check

(Exposures taken on 150 mA station at 70 kVp)

Make 4 exposures at 1/30 of a second				
Make 4 exposures at 1/10 of a second				
Make 4 exposures at 1/4 of a second				
Make 4 exposures at 1/2 of a second				

(Record time in milliseconds)

kVp Calibration Data

(Exposures at 1/10 second)

kVp	50 mA	100 mA	150 mA	200 mA	300 mA
60					
80					
110					

(Record actual kVp)

mR Data

(Exposures at 1/10 second)

kVp	50 mA	100 mA	150 mA	200 mA	300 mA
60					
80					
110					

(Record actual mR)

After completing calibration data sheet, make two copies. Keep one for your records, return the other along with the warranty card to Tingle X-Ray at 5481 Skyland Blvd East, Cottondale, AL 35453.

(Note: The original data sheet and manual must stay with the x-ray unit for future use.)

NOTES



TINGLE X-RAY PRODUCTS, INC.

5-Year-Warranty

For a period of 5 years from the date of shipment from the factory, new equipment manufactured by Tingle X-Ray Products, Inc. (TXR), is warranted as follows: any parts proven defective will be repaired or replaced free of charge, F.O.B. factory, if the defective parts are returned to the factory for inspection, charges prepaid. The warranty covers parts only and does not include any on-site labor costs.

This warranty does not apply to high voltage cables and X-Ray tubes, or to damage caused by misuse, neglect, or during shipment, and is void if service is performed by persons other than authorized TXR Dealers or representatives, or if equipment is interconnected with components not manufactured by TXR and/or not approved by TXR for compatibility.

TXR reserves the right to pass judgment on cause of breakage or failure.

Auxiliary equipment not manufactured by TXR is not covered by the above but carries the warranty of the manufacturer.

This warranty is not transferable to a new owner unless authorized by the factory in writing.

This warranty is not in effect unless the warranty card is completed and returned to the manufacturer.

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TXR

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