



X-RAY PRODUCTS, LLC

USER ASSEMBLER MANUAL

TXR 325 X-Ray Control with 325-1 High Voltage Generator

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table of contents

I. APPENDIX B — Information to Assemblers..... Page 4

II. APPENDIX C — Information to Users Page 9

INTERCONNECT WIRING FOR THE TXR 325 X-RAY CONTROL

Applicable to the 325. Connect wiring from the control console to the following points.

CONTROL

P1
P2
GND

XC
XS
XL
M1

HIGH VOLTAGE TRANSFORMER

P1
P2
GND (caution should be taken when
tightening lugs on the high
voltage transformer)

XC
XS
XL
M1

ROTOR CIRCUIT

07 (black)
08 (green)
09 (white)

07 Rotor lead to X-Ray Tube (black)
08 (Eureka Tube, red) (Machlett, black)
09 (white)

PBL INTERLOCK CIRCUIT

1 has been jumpered to 4 on top of the mother board toward the left side.

For connecting PBL Interlocks into the circuit you may cut the jumper into in the middle and butt splice the isolated contact circuit into both ends.

COLLIMATOR POWER SUPPLY (24 vac, 150 VA transformer)

Connect both red leads from the collimator power supply transformer to the supply leads going to the collimator.

MAGNETIC LOCK CONNECTIONS

A mag pack may be provided with the input connected parallel to the output of the collimator transformer. The output of the mag pack will be 30 VDC filtered. (This mag pack is only provided for controls which go with an X-Ray system). (The mag pack may not come installed in which case you would install it yourself).

<p>WARNING: Incorrect wiring can burn open various traces on the boards which may not be repairable. Every unit has been calibrated and burned in with approximately 100 exposures at the factory. Quality Assurance Records are available for every unit and are kept on file.</p>
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INTERCONNECT WIRING FOR THE TXR 325A X-RAY CONTROL

Applicable to the 325A. Connect wiring from the control console to the following points.

CONTROL

P1
P2
GND
XC
XS
XL
M1

HIGH VOLTAGE TRANSFORMER

P1
P2
GND
XC
XS
XL
M1

ROTOR CIRCUIT

07 Rotor (black)
08 (green)
09 (white)

07 Rotor lead to X-Ray Tube (black)
08 (Eureka Tube, red) (Machlett, black)
09 (white)

PBL INTERLOCK CIRCUIT

A1 Jumpered to 3 on top left corner of mother board.

For connecting PBL Interlocks into the circuit you may cut the jumper into in the middle and butt splice the isolated contact circuit into both ends.

COLLIMATOR POWER SUPPLY (24 vac, 150 VA transformer)

Connect both red leads from the collimator power supply transformer to the supply leads going to the collimator.

MAGNETIC LOCK CONNECTIONS

A mag pack may be provided with the input connected parallel to the collimator transformer. The output of the mag pack will be 30 vdc filtered. (This mag pack is only provided for controls which go with an X-Ray system). (The mag pack may not be installed in which case you would install it your self).

WARNING: Incorrect wiring can burn open various traces on the boards which may not be repairable. Every unit has been calibrated and burned in with approximately 100 exposures at the factory. Quality Assurance Records are available for every unit and are kept on file.

TINGLE X-RAY 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 since 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 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 x-ray machine. Our power requirements are as follows: 200-270 volts ac 60 cycles, 37.5 kva single phase. Maximum line current is 136 amps at 230 vac. 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 minutes.

WIRE SIZES

From power transformer to switch box, 50 feet #2, 100 feet #1

LINE VOLTAGE REGULATION

Line voltage regulation at maximum rated line current must be

$$\text{Percent line voltage regulation} = 100 (V_n - V_l) / V_n$$

V_n = No load line voltage

V_l = Line voltage at maximum line current.

$$\text{Maximum line current at an alternate line voltage} = (V_r) (A_r) / V_a$$

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 (fuse box) readily accessible (this is a *National Electric Code Requirement*). Make sure wire sizes are **SIZES** as listed in this Information to Assemblers pamphlet.

All lead line barrier requirements should be met as required by local or City Health Codes (*Radiation safety codes*). Normally the control box will be behind this barrier.

REMOVE FUSES FROM THE CONTROL BOX (FUSE BOX)

1. Connect 10 feet line cord to control box (fuse box).
2. Place High Voltage Generator in its designed place floor.
3. Connect control to High Voltage Generator interconnect leads. Leads are labeled correctly (*Leave P1 and P2 loose at the High Voltage Generator*).
4. **STOP!** Make sure your GROUND lead is connected securely. Do not go any further.
5. Connect Rotor leads.
6. Connect collimator power supply.

3. Energize control box (fuse box).
4. Depress ON button on control, set timer to 1/2 second.
5. KVP meter should read pre-set condition.
6. Vary kVp major and minor switches and see if kVp meter readings vary. Also switch mA stations, this should also vary the kVp meter.
7. Depress Rotor button (*after 2-second delay, ready lamp should light*) then depress exposure pushbutton. You should hear the contactor come in and an audible signal sounding termination of exposure.
8. Turn OFF control switch 4 control box off and connect P1 and P2 at the High Voltage Generator.
9. Turn Control on and start calibration.

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 vaporproofing compound. **NOTE:** This compound is packed with the X-Ray Tube from the factory.

CLEANING HIGH VOLTAGE CABLES (USED OR NEW CONTAMINATED)

1. All compound or any other agent should be removed using tri-chloroethane 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 ENDS.

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 complete, 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 switch but if a bucky is not to be used jump B1 and 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 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.

ADJUSTING THE CONTROL FOR EXISTING LINE VOLTAGE

Voltage range is shown on wiring diagrams and on the inside of each control.

1. Measure the incoming line voltage.
2. Locate Line Strap, adjust lead to correspond to incoming line. Location at left hand bottom of mother board. *(comes from factory set at 240 vac and is marked).*
3. If voltage is different than 240 vac remove Line Strap, Adjust lead and connect to the nearest voltage corresponding to the incoming line *(all voltage levels are tagged).*

CHECKING TRANSFORMER OIL LEVEL

Oil level in the High Voltage Transformer should be no lower than 3/4 inch and no closer than 1/2 inch from the top. *(Make sure the transformer is level.)*

ADJUSTING THE MILLIAMPERE SETTINGS

The TXR 325 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 milliamperere readings.

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. Set mA selector switch to 50 mA. Set kVp switches to 76 kVp. Set timer to 1-4/10 seconds. Make exposure if mA on meter reads lower or higher adjust 50 mA stations tagged.

Set each mA station 100, 200, 300, in the same manner as above.

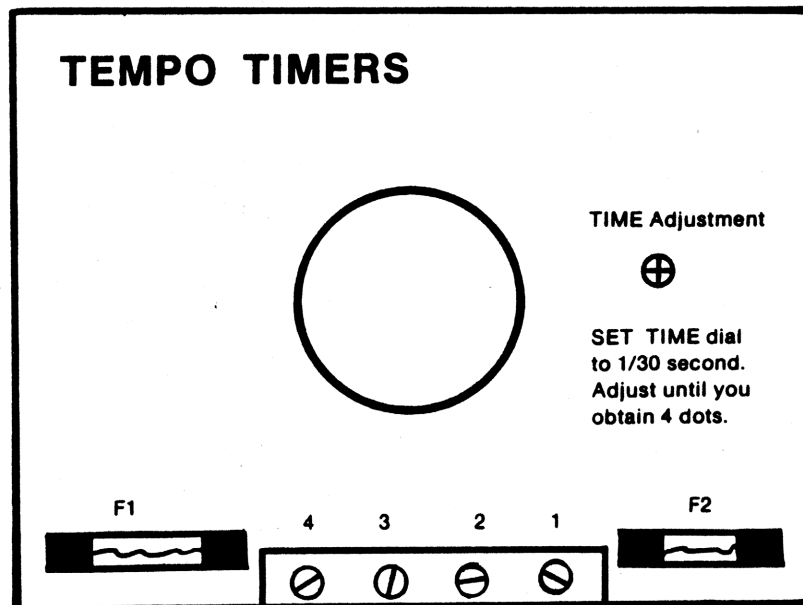
NOTICE: Space Charge characteristics of x-ray tubes is linear only above and about 55 to 60 kVp, so complete compensation cannot be obtained from that kVp and below from time to time.

If dynalyzer or similar test equipment is not used a ballistic mAs meter may be used. Calibrate 200 and 300 mA at the 1/4 second time station.

ADJUSTING THE TIMER

We use Tempo timers which have many years of engineering and durability behind their belt. These units can be adjusted to offset the effects of contactor lag. Set the timer dial to 1/30 seconds and adjust timer to obtain 4 dots using a spinning top. This adjustment will not add or subtract the longer time stations by any significant amount.

Notice figure below:



I.E.D. Microprocessor Timers with SCR Contacting need no adjustment.

TINGLE X-RAY 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, D.C. 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 representative 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.

KILOVOLT METER AND THE KILOVOLT SELECTORS

The kilovolt meter is an ac 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 increase Kvp and counter clockwise decreases kVp.

When setting your kVp set your milliamperage setting first because of the space charge effect. **NEVER CHANGE KVP DURING AN EXPOSURE.**

CAUTION

At milliamperage settings below 300, the kVp meter will peg and could damage the movement. Also the kVp at this point(s) will exceed the kVp rating of the Tube, Cables and High Tension Transformer.

EXPOSURE SIGNAL AND LAMP INDICATOR

An audible sonalert signal will sound in the control to indicate the termination of an exposure. Also the control panel has above the expose pushbutton an exposure indicating lamp which is energized during expose for handicapped technicians. A mA meter serves as a visual indicator that an x-ray exposure has been terminated.

OPERATION

THE MILLIAMPMETER

The mA meter is a single scale meter which reads directly in milliamps. It indicates only during the exposure when current is flowing through the x-ray tube and thus also serves as an x-ray ON indicator. For handicapped persons, the control panel is also equipped with an exposure lamp indicator.

The operator and the service engineer should always use the mA meter as a first indicator of any problem in the x-ray system. I believe, if the following guidelines are met, you can eliminate a lot of random checks when encountering a problem.

You must believe your Milliampmeter. For x-ray equipment problems look for these four signs as provided by your milliampmeter.

HIGH mA

The ma calibration is too high, unstable or gassy x-ray tube, faulty high tension transformer circuit and more. If high tension cables have been changed and shorter ones installed this will happen.

LOW mA

The mA calibration is too low, faulty high tension circuit (transformer) rectifier in transformer out. Part of bridge rectifier out in mA meter circuit. Output of mA stabilizer.

NO mA

The filament is out in the x-ray tube, or exposure inhibited. See Generator Test Procedure.

ERRATIC mA OR MR OUTPUT

Test and Calibration exposures are not spaced far enough apart. Unstable or gassy x-ray tube, faulty high tension cables.

SIMPLE GENERATOR TEST PROCEDURE

1. Turn Line Switch on to X-Ray Control.
2. Depress on pushbutton. (On lamp should energize).
3. Set mA selector on 200 kVp selector to 76 kVp Timer 1 second.
4. Depress Rotor pushbutton (*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 pushbutton watch mA meter reading. The mA should be in the range of $\pm 10\%$ of mA selection.

6. If there is no exposure and unit is switched to bucky ON, change the switch to bucky OFF and retest. *(If exposure meets condition of 5, trouble is in bucky circuit.)*
7. If there is no exposure initiated under condition 6, the problem is most likely in the PBL interlock circuit, Timer, or Connector.

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

OPERATION

THE MILLIAMPERE SELECTOR

The milliampere selector does four things. It selects Relay 1, 2, 3, and 4 on the control panel which does the following three functions: selects the focal spot; milliampere setting; and the proper space charge network, so that the kVp meter will read correctly for each station.

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 out 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 bucky ON. 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 on an installation, please jump B1/B2 together. If Bucky will not run make sure B2 lead from Bucky Switch is connected to B2 on bottom of mother board! B2 must be jumped to B3.

MAIN LINE SWITCH

The main line switch operates a Main Line Contactor which in turn energizes the Autotransformer. It is a pushbutton located on the left front corner of the control panel. To turn unit off, simply depress OFF pushbutton located beside the ON pushbutton on the left bottom front of the control panel. **NEVER LEAVE THE CONTROL ON WHEN NOT IN USE AS THIS WILL SHORTEN X-RAY TUBE LIFE.**

THE TIMER

The timer has a range of 1/60 second to 6 seconds in 23 approximate geometric progressive steps. SCR with microprocessor has 1/120 time station

CAUTION: If mA meter should read past normal time of selected time quickly depress OFF pushbutton, throw 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. Depress ON pushbutton.
3. Select mA.
4. Select kVp.
5. Select Time.
6. Select bucky ON or OFF.
7. Position source and image.
8. Take up position behind protective barrier.
9. Depress rotor pushbutton (*after approximately 2 seconds ready lamp energizes*).
10. Depress Exposure switch keeping rotor pushbutton depressed. Exposure lamp will energize and an audible signal will be noticed upon termination.

OPERATION

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: $\text{kVp} \times \text{mA} \times \text{seconds} = \text{HEAT UNITS}$. Thus a technique which calls for 80 kVp, 200 mA, and 1/2 second, produces $80 \times 200 \times 1/2 = 8000$ 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 large focus.
2. Starting at about 50 or 60 kVp make 3 exposures at 1/10 second each waiting approximately 30 seconds between exposures.

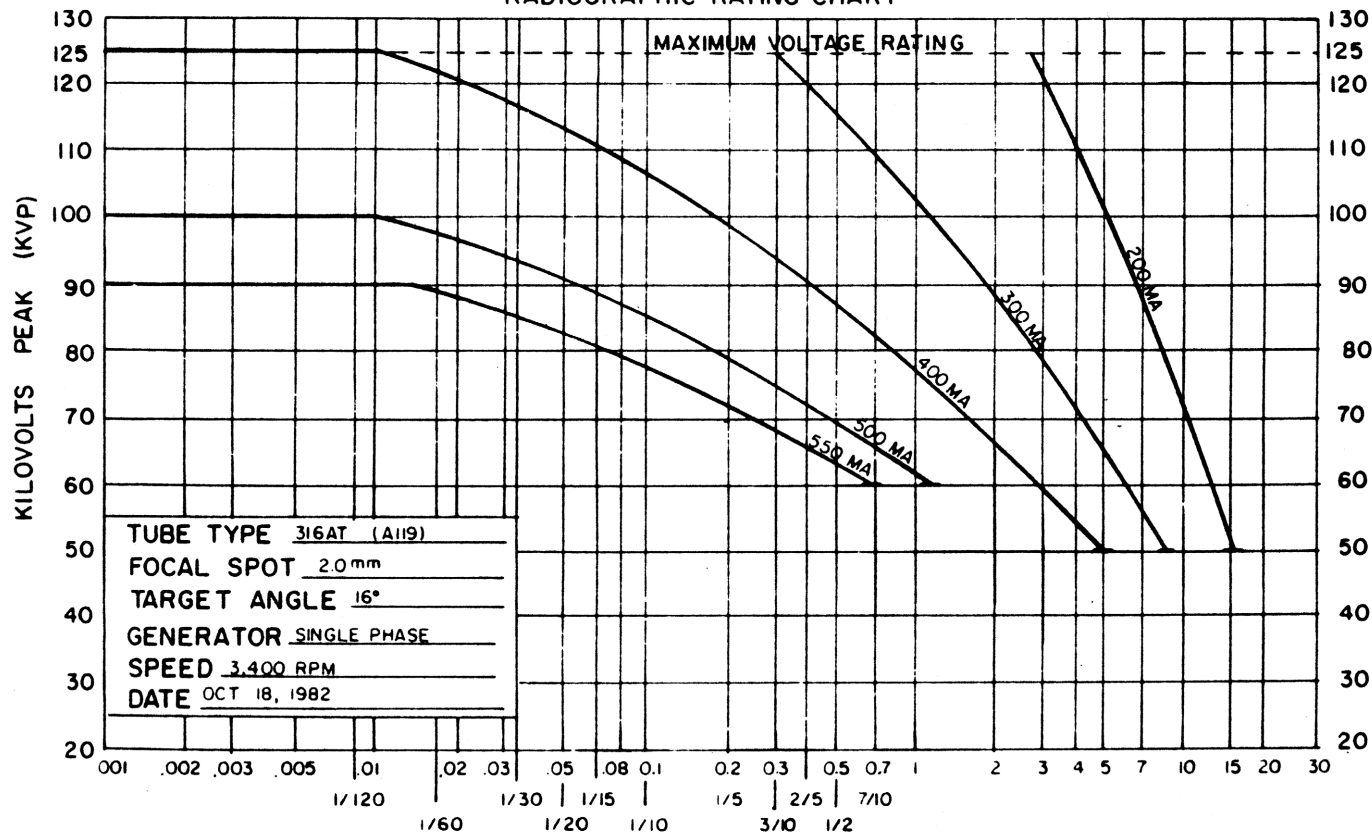
CAUTION: Be sure the tube collimator is closed and that the operator or anyone else is not exposed to any radiation.

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.

EIMAC ROTATING ANODE TUBE
 RADIOGRAPHIC RATING CHART

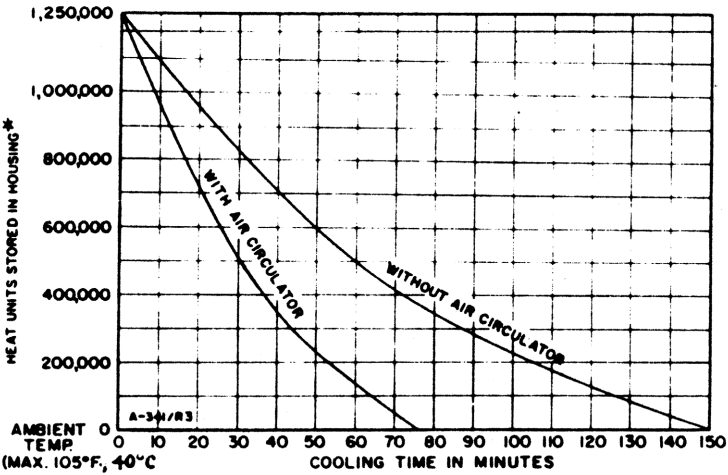


MAXIMUM EXPOSURE TIME IN SECONDS

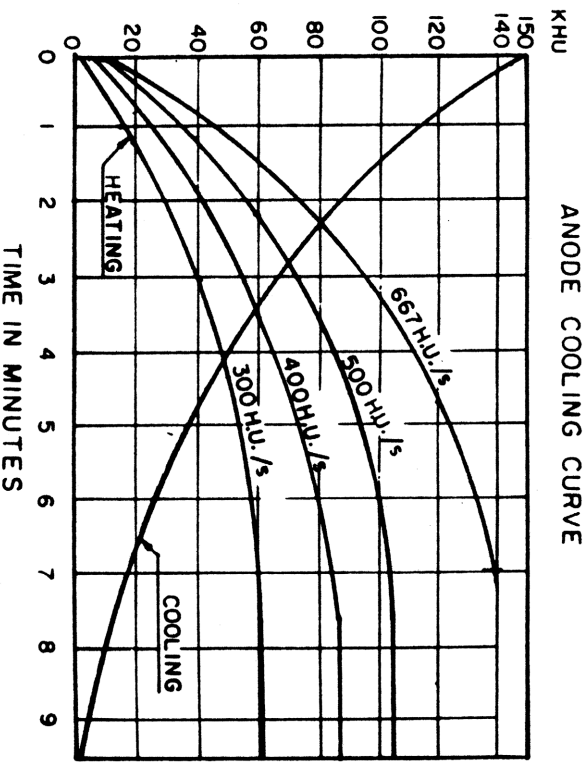
ANODE HEAT UNITS

HOUSING COOLING CHARACTERISTICS

For Single-Phase Equipment
 HU (heat units) = kVp x mA x seconds
 HU/sec (heat units/second) = kVp x mA
 HU/min (heat units/minute) = kVp x mA x 60
 For Three-Phase Equipment: use three-phase factors in equations and multiply products by 1.35.



* INCLUDING HEAT INPUT FROM STATOR



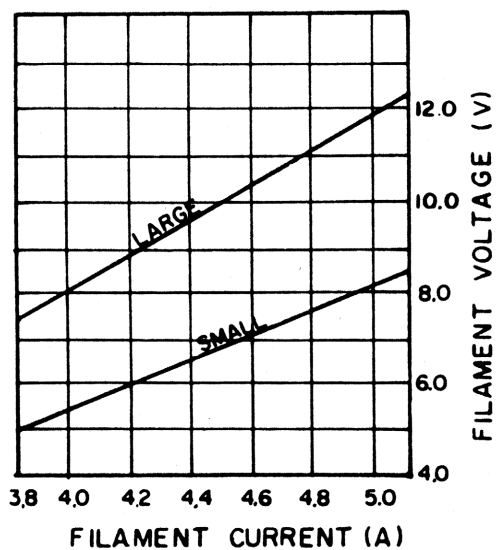
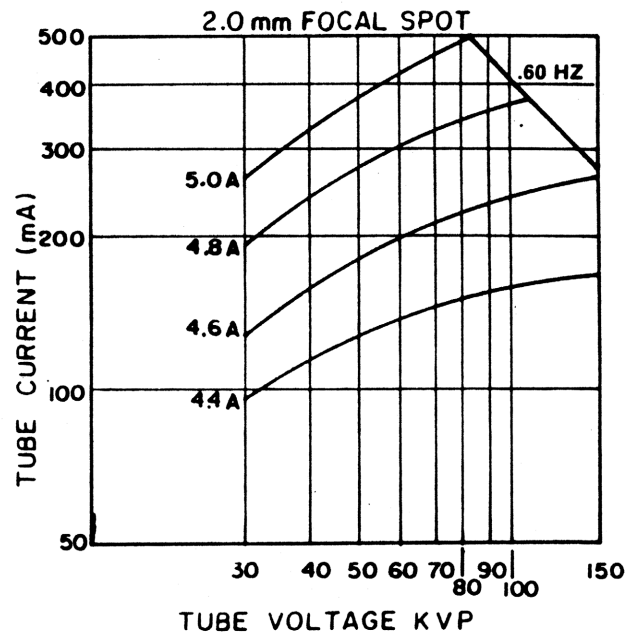
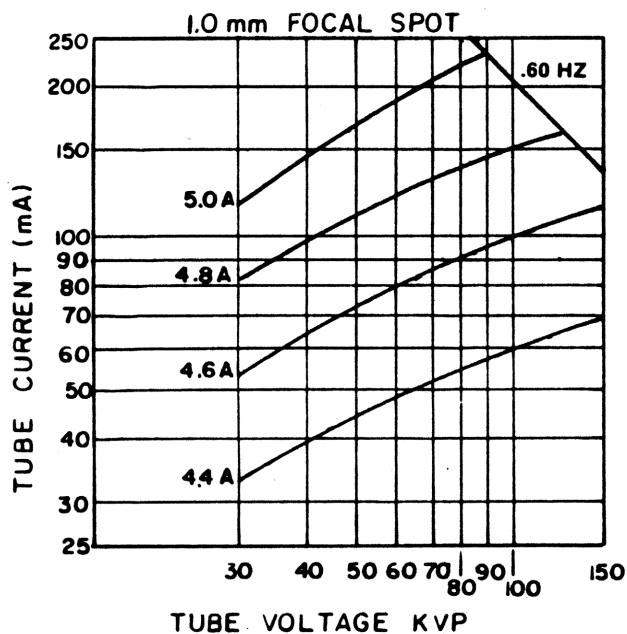
Information to Users

Eimac A119-B140

DX 52 R/40 X-Ray

Tube Characteristics

ANODE COOLING CURVE EMISSION & FILAMENT CHARACTERISTICS SINGLE - PHASE



PRODUCTS SPECIFICATIONS:

The TXR 325 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 thirteen-foot control to high voltage generator cable.

Rating is 300 milliamperes at 125 kVp (Kilovolts Peak). Milliamperage is selected by a 4 position tap switch. The 4 positions are 50 milliamps small focus. 100, 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 $\pm 10\%$ 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 $\pm 10\%$ of full scale.

TIMER

Timer is a Tempo stabilized electronic interval with mechanical contacting. (SCRs optional with I.E.D. Timer microprocessor). Range is 1/120 to 6 seconds in 23 steps.

The steps are as follows:

(1/120), 1/60, 1/30, 1/20, 1/15, 1/12, 2/20, 3/20, 4/20, 5/20, 6/20, 8/20, 10/20, 13/20, 16/20, 1 second, 1-4/10, 2, 2-1/2, 3, 4, 5, and 6 seconds.

Error is:

1/120 thru 1/10 second ± 1 pulse
3/20 thru 1 second ± 2 pulses
1-4/10 thru 6 second $\pm 5\%$ of selected time

Filament isolated by static transformer.

Power requirements are 200-270 vac 60 cycles, 37.5 kva, single phase. Maximum line current is 136 amps at 230 vac. This condition is reached when the unit is operated at 300 mA and 125 kVp simultaneously. Duty cycle is 1%, condition is 300 mA at 135 for 5 seconds every eight minutes.

Starter is an electronic type 110 vac 1-3 second time delay with sensing.

Rectifiers are solid state (Silicon Full Wave).

Contactors are electromechanical type (SCRs Optional).

Dimensions are as follows:

X-Ray Control		X-Ray High Voltage Generator	
Width	20	17	inches
Depth	12	26	
Height	37	16	
Weight	150	325	pounds

MEASUREMENT BASIS

The measurement basis to ensure 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 which 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 Tektronic 10 MHz Dual Trace Storage Oscilloscope. Divider is a C1515A and is calibrated annually.

Uses for this device is General Purpose Radiography.

MAINTENANCE

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 X-Ray Control is actually a 0-240 vac voltmeter calibrated in kVp. At 240 vac, the meter should read 125 kVp.

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 man.

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.

REMEMBER

Notice that 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.

TIMER CALIBRATION

If the timer deviates over 1 cycle for 1/30 thru 1/2 second or more than 10% from 1 thru 5 seconds recalibrate the timer. See Information to Assemblers — Adjusting The Timer.

FUSE LOCATIONS

Two sixty amp fuses L1 and L2 located on the electronic panel board in the rear of the x-ray unit. Also four fuses F1, 2, 3, and 4 are located on the right lower electronic panel board above the terminal strip 07, 08, and 09. F1, 2, and 3 are 10-amp 250 vac buss fuses. F4 is a 1-amp 250 vac ,buss fuse for the kVp meter circuit. (**SAFETY**) Timer fuses are 3 AG type 8/10 amp 250 volts.

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 men 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.

Oil: Cold oil contracts, warm oil expands. Make sure transformer is no lower than 3/4 of an inch from the top and no closer than 1/2 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. **NEVER SPRAY ANY SOLUTION INSIDE THE CONTROL BOARD** (located inside rear cover of control).

TROUBLESHOOTING

See Information to Users — Simple Generator Test Procedure. Then refer to Information to Users — The Milliampmeter. If the problem is revealed in tranformer circuit, please use the following guidelines.

TROUBLESHOOTING (Continued)

NO KILOVOLTMETER READINGS

If there is no kilovoltmeter reading when the main switch is on, make the following checks:

1. Check line supply. Disconnect switch may be open or fuses blown. If you have voltage coming out of the line supply switch and fuse box.
2. Be sure that the kilovolt selector is not stuck between contacts, but is properly indexed on a contact point.
3. Check kilovoltmeter, it may be open circuit or stuck.
4. May be open circuit in voltmeter compensating transformer circuit.

NO X-RAY TUBE ANODE ROTATION

In the TXR 325 with automatic motor control, the anode does not rotate until the motor switch is depressed. If the rotor switch is closed and the anode does not rotate:

1. Check continuity of wires from control terminals 07, 08, and 09 to tube stator. If any of these wires are open circuit, the anode will not rotate.
2. Check continuity of tube stator winding. You should find continuity between any pair of the three terminals.
3. Gently shake tubehead, or look into the port to see if the x-ray tube is broken. If the tube is broken, the anode will not rotate, and probably the filament will not light up.
4. Check the capacitor in the motor control. If this capacitor is either open or shorted, the anode will not operate.
5. On 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.

NO MILLIAMMETER READING when x-rays are turned on by closing exposure switch.

1. Check anode rotation. Relay sense circuits prevent the time delay safety relay from energizing unless the stator is drawing normal current.
2. See if the x-ray tube filament lights up. The filament is visible through the plastic window. Permanent built-in filters will need to be removed. Another check is to check between XC and XS for small and XC and XL for large focal spot. If no voltage is present then the trouble is possibly in the control to transformer cable, control or line. If there is a voltage reading then check the cathode high voltage terminals at the transformer or the tube end.

TROUBLESHOOTING (Continued)

CAUTION

Be sure to remove the P1 and P2 lead from the transformer before checking the cathode end of the transformer or high voltage cable. Remove the cathode bushing at the tube and place a voltmeter across C and L or C and S depending on which position the focal switch is set. A voltage reading will indicate that the circuit is complete through tube end of the cathode cable and that the filament in the tube is open.

It is advisable to check to be sure that the cable terminals make good contact at both the transformer and tube end of the cathode cable. The contacts can 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.

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 the cathode side appears to have an 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.

3. Make sure the timer is operating properly. Check this by connecting a voltmeter or test lamp across the control terminals P1 and P2, or better yet the High Volt generator Terminals P1 and P2 (Remove terminal cover for access). If no voltage is obtained, check back starting with the timer. If the timer is operating, you should be able to hear the connector closing and opening. Use the control schematic diagram to follow the exposure circuit.

The voltage measured between P1/P2 varies from approximately 90 volts to 280 volts, depending on the position of the kilovolt selectors. However, a voltage reading will only be obtained when the exposure switch is closed and the x-ray contactor energized. Cover x-ray tube port opening with a piece of lead (or close collimator shutters) in case the machine is working and x-rays are being produced.

4. Determine if x-rays are being produced by directing the rays on a fluoroscopic screen or into an open cassette in a darkened room. The fluoroscopic screen or intensifying screen will glow when x-rays are turned on. If x-rays are produced and the milliammeter does not read, the trouble may be a short between M and ground, or a defective meter rectifier.

TROUBLESHOOTING (Continued)

The milliammeter can be checked by connecting a known good milliammeter directly in series with the control milliammeter, or by temporarily replacing the control milliammeter with a known good milliammeter. Use dc meters and if the meter reads backwards, reverse the leads.

5. If the tube filament lights up and the test mA meter also does not read indicating the fault is not in the meter, and no x-rays are being produced as checked by means of a screen (item 4 above), then the trouble may be in the high voltage generator. The high voltage generator can be carefully lifted out of the tank part way and all terminals and wires should be checked to establish that there are no breaks in the wires. See Information to Users — Servicing the High Voltage Generator, for instructions on how to lift the High Voltage Generator out of its tank.

MILLIAMMETER INDICATES BUT FLUCTUATES

If milliampere meter indicates but fluctuates—if circuit breaker kicks out constantly.

1. Check tube by looking into port (with filters removed). Turn machine on but do not make an exposure. This will light up filament only, shiny ring or spots on target, tungsten deposit on glass, or melted target or heavy metallic reflection off of tube port indicates an overloaded tube.

An x-ray tube in housing is available from factory stock on an exchange basis. It is not practical to replace the insert tube in the field and current federal requirements require manufacturers certification of tube in housing when any repairs are made.

2. Remove both high volt cables from tube and make an exposure using approximately 70 kVp. If mA meter does not fluctuate or circuit breaker does not kick out then transformer and cables are o.k. and trouble is in the tube.

CAUTION: Be sure that the cable bushings removed from the high voltage generator positioned far apart from each other and suspended in free air away from ground and not within reach of any person during test. There is high voltage applied during test to the ends of these cables.

3. If unit still acts up with cables removed from the tube, then remove one cable from the high voltage generator and test. This will determine if either cable is punctured.

TROUBLESHOOTING (Continued)

4. If unit still acts up with both cables removed from the high voltage generator then the trouble is in the generator or the control. Disconnect generator from control by removing P1 and XC at control or generator. If operating the control disconnected from the generator corrects the trouble then the problem is in the generator.
5. Check oil level in high voltage generator tank. Remove filter plug. Oil should be 1/2 inch to 3/4 inch below bottom of cover when at room temperature. Use only special high grade insulating x-ray transformer oil.
6. Carefully lift high voltage generator out of tank (see Information to Users — Servicing High Voltage Generator) and check to see if all wires are properly connected and spaced.
7. If circuit breaker kicks out only at high values of kVp, then the trouble may be in the tube becoming erratic as a result of overloading or excessive filament evaporation through age or misuse. It can also be caused by oil contamination or breakdown or low oil level in the high voltage generator.
8. Normal values of current draw are given below. The current draw will be high if either or both High Voltage Cables are shorting, or if the x-ray tube is shorting as a result of exceeding the tube rating. If current draw is still high and High Voltage cable removed from the cable receptacles in the high voltage generator, then the trouble is in the high voltage generator and may be caused by a broken wire, shorted or grounded high voltage or filament transformer rectifiers, or by contaminated oil. In this case, the high voltage generator should be returned to the factory for service.
9. If current readings are about twice as high for the same value of milliamperes then look for an open high voltage rectifier or a defective rectifier in the milliammeter circuit, or half cycle switch on TXR 325 transformer is open.

Milliammeter indicates but readings are about 1/2 normal setting.

- a. Check mA meter the needle may be sticking.
- b. Check the mA meter bridge rectifier. There may be an open circuit in one leg of the bridge.
- c. To establish if the meter is reading correctly and that the fault may be in the filament transformer primary or secondary circuit, check the total transformer current drawn.

TROUBLESHOOTING (Continued)

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.

If a partial breakdown has occurred in the transformer this can be detected quite easily by measuring the current draw in the primary winding of the high voltage transformer (P1 or P2) under no load conditions.

Turn off the main power to the control and make the following connections.

Remove both high voltage cables from the transformer and fill the high voltage sockets with oil or insert dummy high voltage plugs. This is done to prevent access to high voltage by humans and also to reduce possibility of high voltage tracking breakdown of bushings.

Connect an ac 10 amp ammeter (or a good clip on ammeter) in the P1 or P2 circuit.

Re-energize the equipment by turning on the main switch and make an exposure of approximately 2 seconds at the lowest kVp, the mA selector can be set at the lowest value on the large focal spot. No x-rays will be produced therefore there will be no reading on the mA meter. Observe the ac ampere meter reading. The reading should be negligible and at no setting of higher kV should it exceed 2 amps. A current reading higher than 2 amps at 230 volts primary would indicate a possible short between turns or a rectifier shorted.

To check if a rectifier is shorted, lift the transformer out of the oil enough to expose the rectifier sticks. Disconnect the transformer coil. Space removed leads so that they are not shorting to one another. Drop transformer back in oil and check again as above using lowest value of kV. If current draw is negligible (below two amps) then trouble is in one or more of the rectifiers. Reconnect rectifiers one at a time and test until defective rectifier is spotted.

CAUTION: 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 busings.**
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.

GENERATORS AND CONTROLS (Continued)

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 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

1. 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

1. 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 modifications which would alter the attenuation characteristics.

CASSETTE HOLDERS (Continued)

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 stepless 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 imagereceptor within 3% of S.I.D. per axis an 4% of S.I.D. total.
- c. Verify operation of optional field size reduction and that field can be reduced to 5 x5 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 10o 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 override 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% o 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 therespective 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.

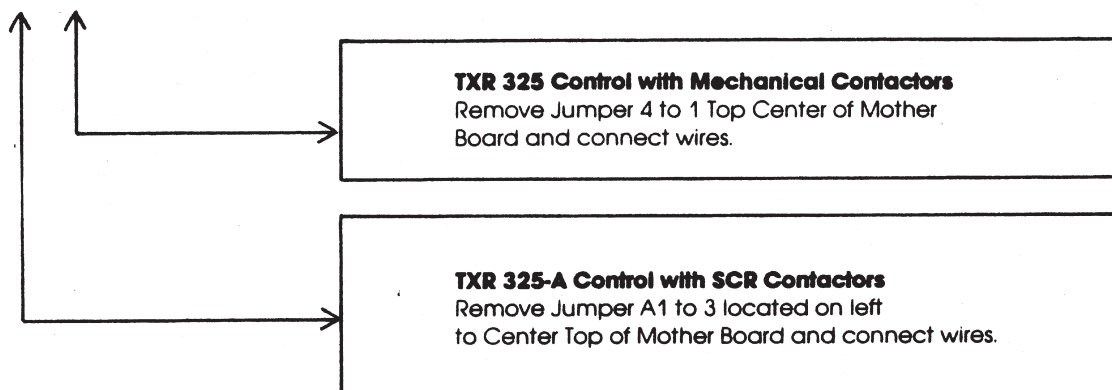
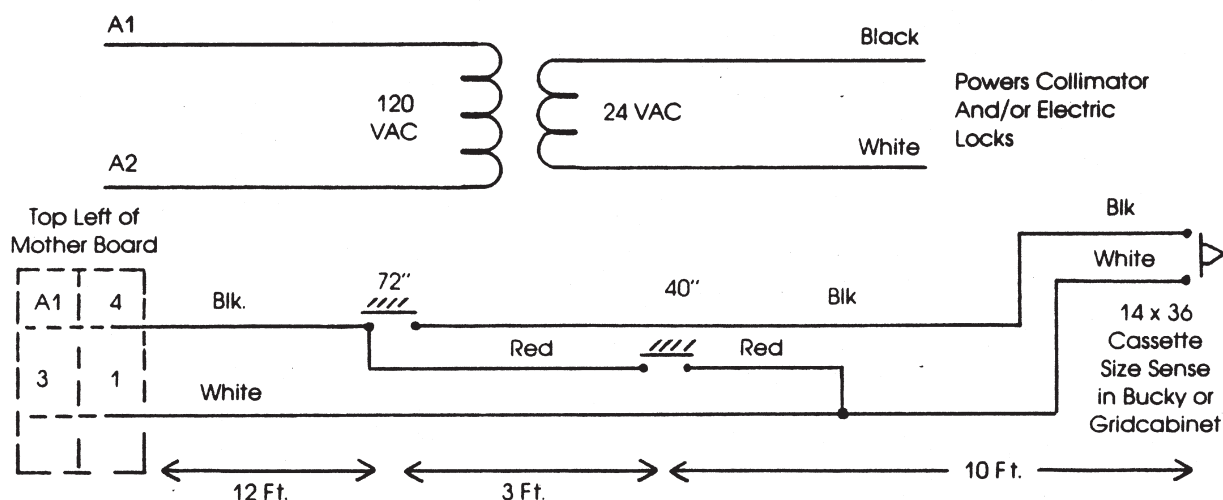
Consult DHEW Publication No. (FDA) 75-8003 dated July, 1974 for specific compliance requirements.

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.

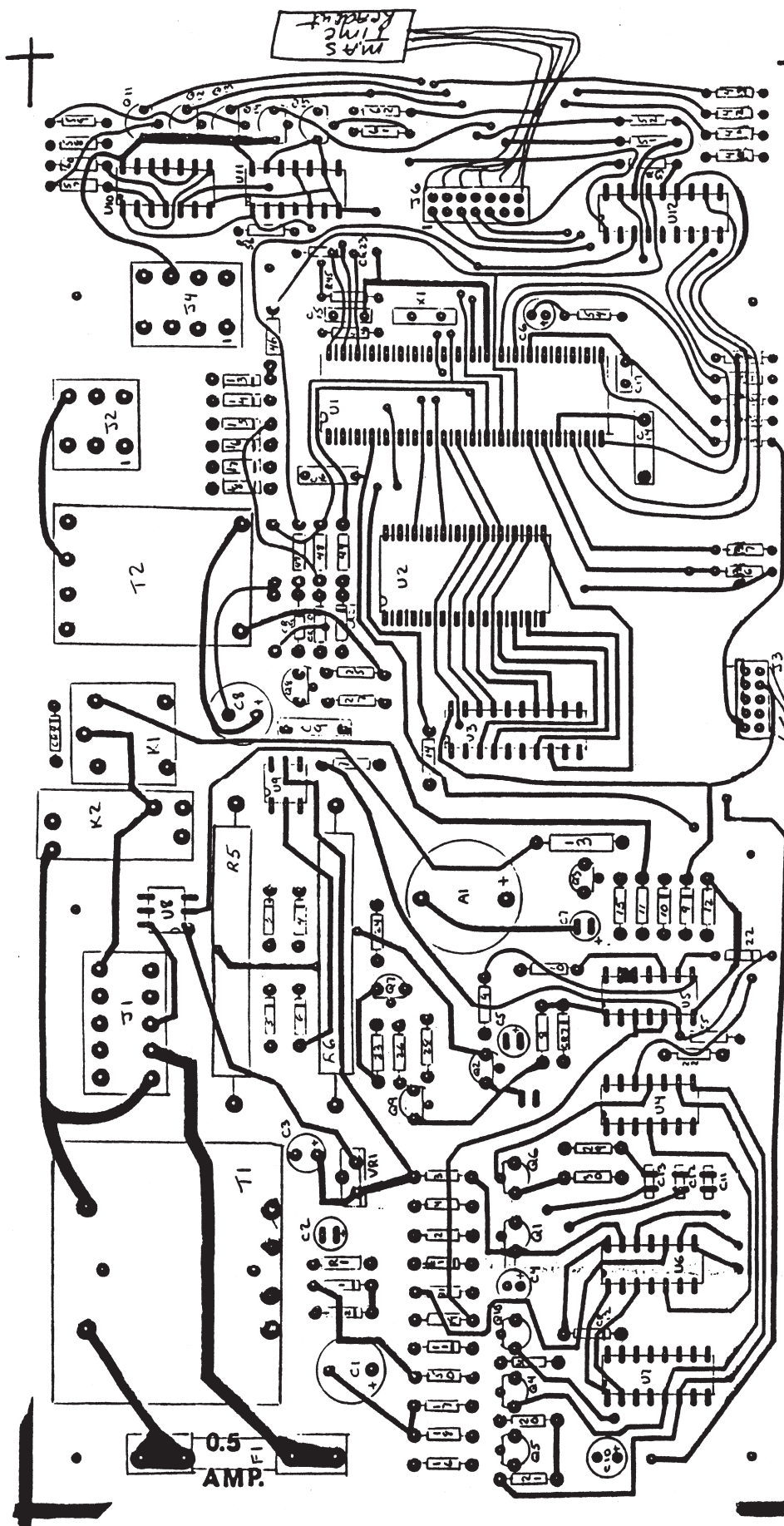
After initial installation, performance of these periodic activities is the responsibility of the owner/user, as they are not provided at no cost under the manufacturers warranty.

Simplified Wiring Instructions

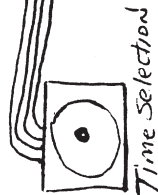
General Collimator Requirements



- For PBL Collimators - Interlock is provided from Logic Box - Remove jumper from 4 to 1 on 325 or A1 to 3 on SCR Unit and connect. Wire is also provided for SID & Size Sensing from PBL Collimator Logic.
- SID Interlock switches and wire is only provided for TXR X-Ray Systems. When ordered separately the cost is \$50.⁰⁰.
- SID Interlock Switches are unnecessary where the tube remains at a fixed distance from the receptor. Certified manual Collimator is necessary.
- 14 x 36 Bucky's or Gridcabinets are allowed 8 x 10 thru 14 x 17 at the 40" SID position. 14 x 36 is allowed only at 72" SID only. Certified manual Collimator is necessary.
- When two receptors are used such as a table bucky and wall cassette holder PBL Collimation is necessary. PBL II or more needed.



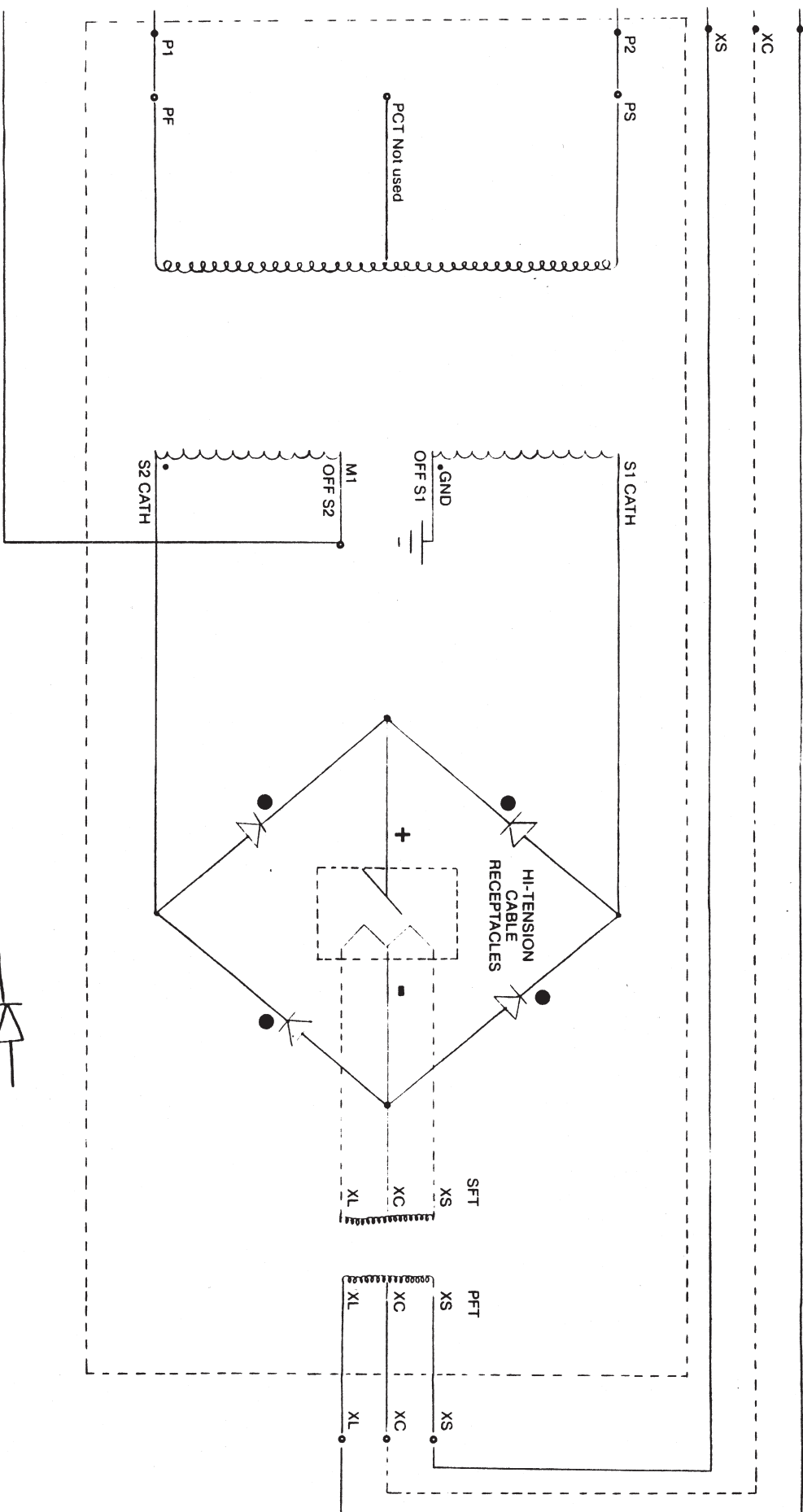
NOTICE:
Ribbon cable ends have docking slits.
If plugged in backward the timer will
not work. GO BY DOCKING SLITS NOT BY
CABLE RUNNING TO AND AWAY FROM BOARD.



APPROVED		BY <i>[Signature]</i>		DATE <i>2/1/89</i>	
DESCRIPTION		DRAWN BY		DATE	
MATERIAL		TOLERANCE ON:		DATE	
PARTS LIST		DRAWING NO. T7740		REV	
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SHEET 1 OF 1

TXR 325-1 High Voltage Generator
2/15/85



Red Dot Marks Cathode End

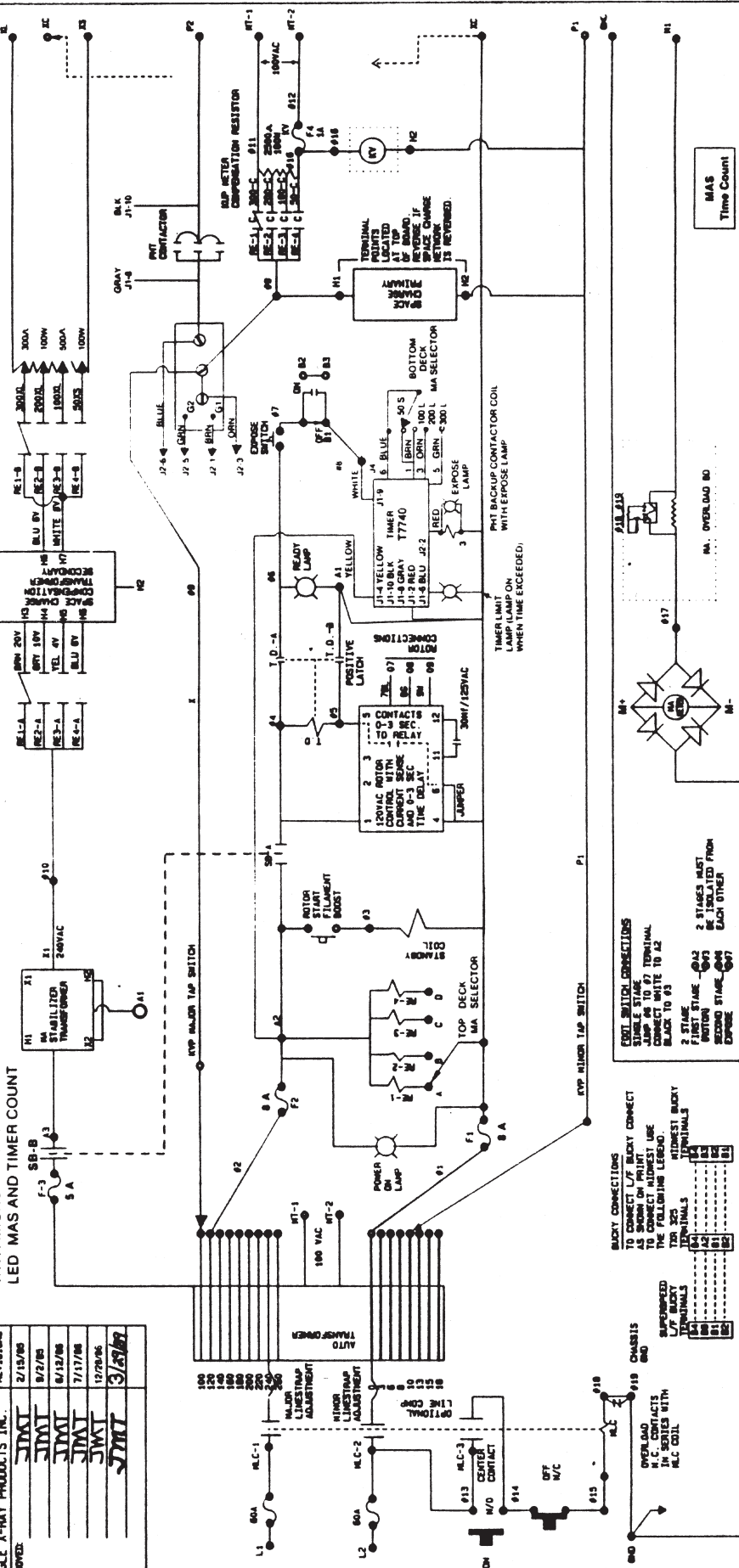
TXR 325A

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CERTIFIED X-RAY CONTROL

WITH MICROPROCESSOR TIMER AND SCR CONTACTING
LED MAS AND TIMER COUNT

Space Charge Compensation
H1 H2 H3 H4 H5 H6 H7
BLK BLK BRN BRN GRAY WHI WHI
FACTORY SET



MAS
Time Count

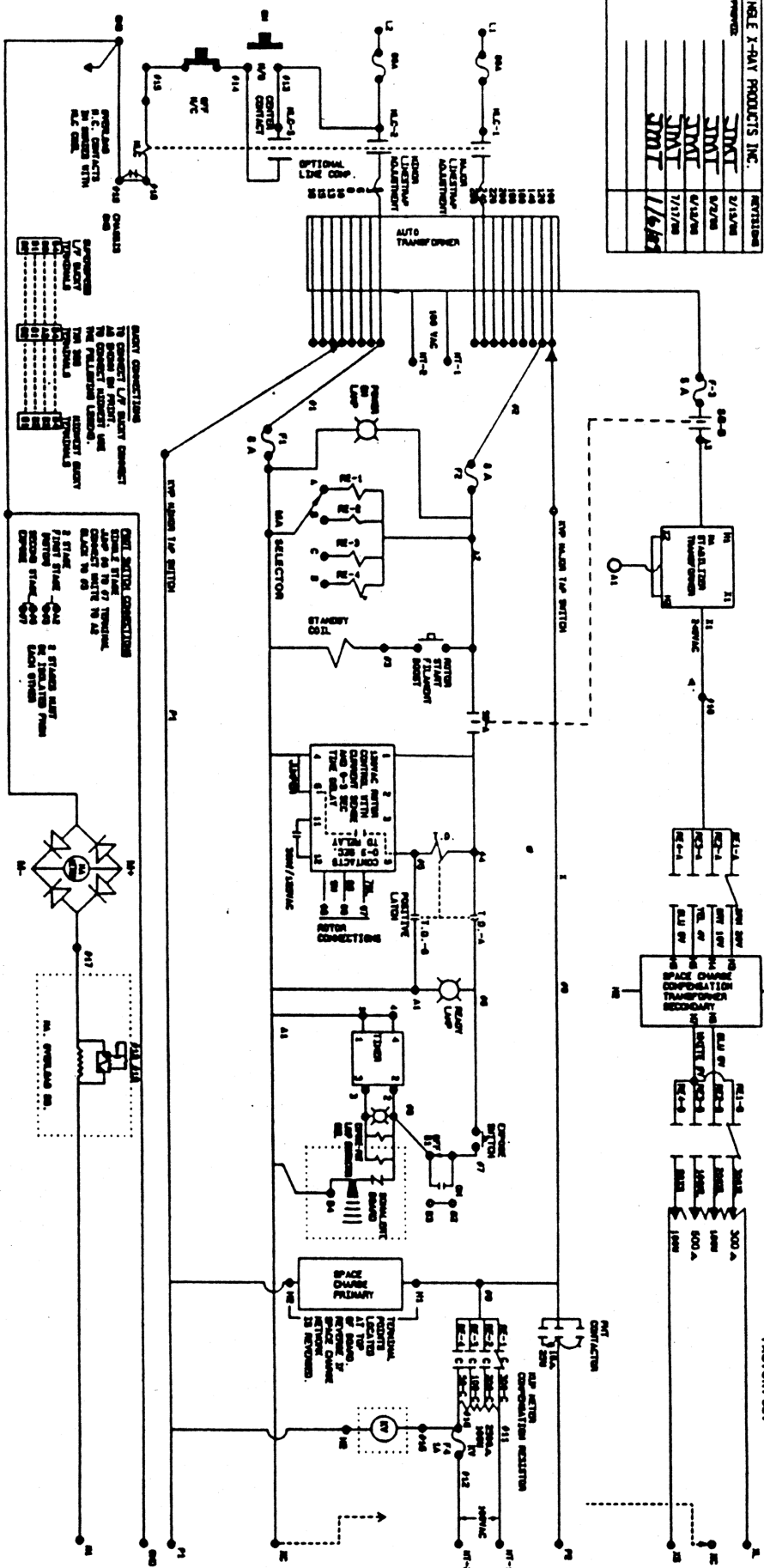
Ribbon Cable Connects
To Microprocessor

TEST SWITCH CONNECTIONS
JUMP 66 TO 67 TERMINAL
CONNECT WHITE TO A2
BLACK TO 63
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BACKY CONNECTIONS
TO CONNECT L/F BACKY CONNECT
AS SHOWN ON PRINT
USE THE FOLLOWING LEGEND
FOR 325
TERMINALS
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Speed Charge Compensation
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TIMELE X-RAY PRODUCTS INC.		REVISION
APPROVED:		
_____	DMT	2/15/78
_____	DMT	5/2/78
_____	DMT	5/15/78
_____	DMT	7/17/78
_____	DMT	1/6/80





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 proving 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. This 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 accident, 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 judgement 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.

TINGLE X-RAY PRODUCTS, INC.

Product _____

Serial No. _____

Warranty Expires _____

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Model No. _____

Serial No. _____

Date _____

