INNOVET SELECT™ HF APR

Installation and Service Manual

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NOTICE TO INSTALLERS

All freight is shipped FOB from the factory. This means it is the installer's responsibility to inspect the shipment for damage and proper count. Upon receipt of the merchandise, any visible damage to the cartons should immediately be examined while the shipper is present.

If the visible damage to the cartons also includes damage to the merchandise, the installer is responsible for making all claims with the shipping company.

If there is hidden damage to the merchandise, it is the installer's responsibility to discover that damage within a reasonable amount of time and contact the shipping company to make a claim.

To protect your company in the case of hidden damage it is recommended to accept freight "subject to inspection". This makes it easier to make a claim with the freight company in the event of hidden damage.

WARNING

X-RAY EQUIPMENT IS DANGEROUS TO BOTH PATIENT AND OPERATOR UNLESS MEASURES OF PROTECTION ARE STRICTLY OBSERVED

Though this equipment is built to the highest standards of electrical and mechanical safety, the useful X-ray beam becomes a source of danger in the hands of the unauthorized or unqualified operator. Excessive exposure to x-radiation causes damage to living tissue.

Adequate precautions must be taken to prevent unauthorized or unqualified persons from operating this equipment or exposing themselves or others to its radiation. Only qualified personnel should install, set up, maintain, and operate this equipment. Only qualified service personnel should remove electrical covers.

Before operation, persons qualified and authorized to operate this equipment should be familiar with the Recommendations of the International Commission on Radiological Protection, contained in Annals Number 26 of the ICRP, and with the applicable national and local standards.

The equipment described in this manual will perform reliably when installed, maintained, and operated, in accordance with the instructions of this manual by qualified personnel. This equipment is sold with the understanding that the user assumes sole responsibility for radiation safety and that the manufacturer does not accept any responsibility for the following:

- Equipment improperly installed.
- Equipment improperly operated.
- Equipment improperly maintained or repaired.
- Equipment, which has been modified or altered in any way.
- Injury or damage to patient or other personnel for any of the above causes.

We are proud of our products and are confident they will provide many years of useful and enjoyable service.

Summit Industries

CAUTION: THIS MANUAL IS FOR USE BY PERSONNEL QUALIFIED TO INSTALL, CALIBRATE, MAINTAIN AND SERVICE RADIOGRAPHIC EQUIPMENT. HAZARDOUS VOLTAGES MAY BE PRESENT, AND PERSONS UNFAMILIAR WITH SAFE OPERATING PROCEDURES SHOULD NOT ATTEMPT TO PERFORM SERVICE ON THIS DEVICE.

Installation and Service Manual Revisions History

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1.0 PRE-INSTALLATION

1.1 General

This manual contains installation, calibration, and service information for the InnoVet Select HF APR System. The system includes the generator, table and tubestand, as well as other equipment (such as collimator and x-ray tube) not described in this manual. To gain an understanding of the complete system, study the operator's and service manuals for all associated equipment.

1.2 Use of This Manual

Throughout the manual there are indented statements, which are preceded by alert words. These alert words and the following statements may direct the user in the performance of a task, or inform the user of a potentially hazardous situation. Each alert word is always used with only one specific type of information. The alert words and the information they reference are as follows:

☞ NOTE: Information that assists the user of the manual in the performance of a task. It may provide the user with better methods of conducting the task, or it may point out conditions that could cause the system to fail to operate properly.

CAUTION: Information that alerts the user of the manual to situations that could result in damage to the equipment.

WARNING: Information that alerts the user of the manual to situations that could be hazardous to the health of the patient, the operator, the maintenance person, or others.

This manual is generally broken into three main sections, dealing first with the assembly of mechanical structures, then electrical connections and calibration, then mechanical alignments and radiographic acceptance testing.

1.3 Equipment Description

1.3.1 General

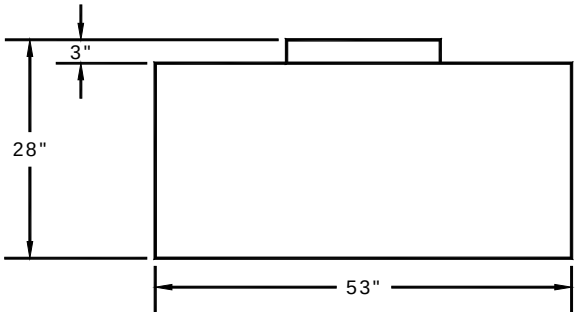
The 20 kHz HF APR Generator is a high-frequency constant potential system with the following features:

- 30 kW constant potential output from a single phase line.
- Two-point control (kVp and mAs) in manual mode. Maximum available mA is automatically selected for minimum exposure time. Operator override is allowed.
- Protection circuitry to prolong tube life and increase system performance.
- Self-diagnostic displays to inform users and service personnel of system condition.
- The generator is designed to fit entirely within the table base.
- The InnoVet Select HF APR system is a fully integrated table/tubestand structure with the generator and transformer installed within the table base for use in veterinary radiography.

1.3.2 Space Requirements - Figure 1

INNOVET SELECT SYSTEM DRAWING
Model S305

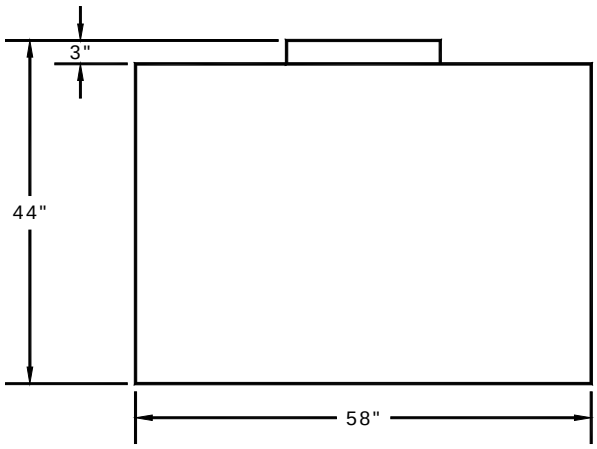
1. For STANDARD Fixed-Top tables



HEIGHT
82-1/2"

(A 12" extension is available for this version only)

2. For tables with Float-Top option



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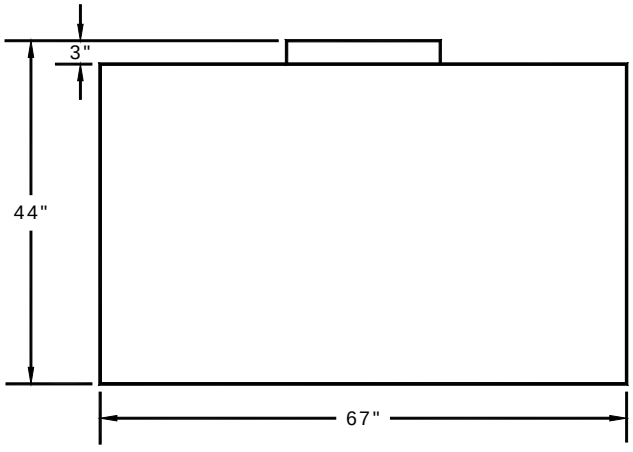

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1.4 Safety

1.4.1 General

It is important that everyone associated with x-ray work is familiar with the recommendations of the Department of Health, National Bureau of Standards, and the National Council on Radiation Protection. The control of diagnostic medical x-ray equipment varies in detail from state to state. However, in general, all of the states adhere strictly to the established recommendations of the NCRP. Prior to operation, be sure that all personnel who are authorized to operate the x-ray system are familiar with the established regulations of the authorities named above. Also, they should be monitored to assure that they conform to the recommendations.

Current sources of information include:

- National Council on Radiation Protection Report No. 33 (Medical X-Ray and Gamma-Ray Protection for Energies up to 10 MEV-Equipment Design and Use).
- National Bureau of Standards Handbook No. 76 (Medical X-Ray Protection up to Three Million Volts). Refer to MCRP Report No. 33.
- Current recommendations of the International Committee on Radiation Protection.

Although x-ray radiation is hazardous, x-ray equipment does not pose any danger when it is properly used. It is the responsibility of all service and operating personnel to be properly informed on the hazards of radiation. Also, those responsible for the system must understand the safety requirements for x-ray operation. Study this manual and the manuals for each component in the system to become aware of all the safety and operational requirements.

1.4.2 Manufacturer's Responsibility

Although this equipment incorporates protection against x-ray radiation other than the useful beam, practical design cannot provide complete protection. This equipment does not prevent the possibility of improper use, which results in authorized or unauthorized persons from carelessly, unwisely, or unknowingly exposing themselves or others to direct or secondary radiation. Allow only authorized, properly trained personnel to operate this equipment.

Be certain that all personnel authorized to use the equipment are aware of the danger of excessive exposure to x-ray radiation.

This equipment is sold with the understanding that the manufacturer, its agents, and representatives do not accept any responsibility for over-exposure of patients or personnel to x-ray radiation. Furthermore, the manufacturer does not accept any responsibility for over-exposure of patients or personnel to x-ray radiation generated by this equipment which is a result of poor operating techniques or procedures.

Also, no responsibility will be assumed for any machine that has not been serviced and maintained in accordance with the system technical manual, or which has been modified or tampered with in any way.

1.4.3 Radiation Protection

WARNING

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

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

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

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

Those working in the immediate area must protect themselves with lead shielding. These items would include but not necessarily be limited to goggles, thyroid shield, apron and gloves with a lead equivalency of not less than 0.5 mm.

The best safety rule for x-ray operators is:

"Avoid exposure to the primary beam at all times."

1.4.4 Monitoring of Personnel

Monitoring of personnel to determine the amount of radiation to which they have been exposed provides a valuable cross-check to determine whether or not safety measures are adequate. The most effective method of determining whether or not the existing protective measures are adequate is the use of instruments to measure the exposure in Rads. This measurement should be taken at all locations where the operator or any portion of his body may be during exposure.

A common method of determining whether personnel have been exposed to excessive radiation is the use of film badges. These are x-ray sensitive film enclosed in a badge which incorporates metal filters of varying degrees of transparency to x-ray radiation. Even though this device only measures the radiation, which reaches the area of the body on which it is worn, it does furnish an indication of the amount of radiation received.

1.4.5 Electrical

WARNING

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

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

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

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

1.4.6 Mechanical

WARNING

Particular care should be taken when servicing the inside of the tubestand. There is an extreme threat of mechanical pinching between the vertical slide and counterweight due to their close proximity and opposite directions of motion.

All of the movable assemblies and parts of x-ray equipment should be operated with care. Only properly trained and qualified personnel should be permitted access to any internal parts of the x-ray system.

1.5 Compatibility Statement

This x-ray system is compatible with the following equipment:

X-RAY TUBES:

Toshiba E7239 (1.0/2.0 mm focal spots), Toshiba E7242 (0.6/1.5 mm focal spots), Varian RAD 13 (1.0/2.0 mm focal spots), Varian RAD 14 (0.6/1.2 mm focal spots). Contact the factory for tube compatibility not listed.

COLLIMATOR:

Summit G800 and D800, Progeny MC150 and Linear II or Linear IV

1.6 Accuracy Statement

All measurements are made in compliance with the directions of the 20 kHz HF APR Generator Service Manual in the Installation, Accuracy testing, and Calibration procedures sections.

☞ **NOTE: Specified accuracy for kVp and mA does not include test equipment tolerance.**

1.6.1 Exposure kVp

Output kVp within ± 5% of indicated kVp, ± 1 kVp

1.6.2 Exposure mAs

Output mAs within ± 10% of indicated mAs, ± 1 mAs

1.6.3 Duty Cycle

The duty cycle is continuous for radiographic use. However, operation should be limited to the capacity of the x-ray tube.

1.7 Maximum Outputs

The maximum rating for the output is listed in Table 1-1. The maximum line current is listed in Table 1-2.

FACTOR	MAX VALUE
kVp	125 kVp
mA	300 mA
Power	30 kW

Table 1-1: Maximum Power Rating

1.8 Maximum Momentary Line Current

Complete power requirements are shown in Section 1.8 below.

LINE VOLTAGE (60 Hertz)	LINE CURRENT (Single Phase)
208 VAC	230 Amps
220 VAC	220 Amps
240 VAC	200 Amps

Table 1-2: Maximum Line Current

1.9 Technique Factors That Constitute Maximum Line Current

Maximum line current will occur during exposures of 100 kVp, 300 mA.

1.10 Power Line Requirements

The line currents given in Table 1-2 (for the 208 to 240 volt line) are the momentary line currents during an exposure. This is not the recommended circuit breaker rating. The recommended supply power requirements are:

100AMP circuit breaker
37.5 kVA distribution transformer
#2 AWG wire for 50 feet run
#00 AWG wire for 100 feet run
250 mcm wire for 200 feet run
Maximum load voltage drop under full load to be not more than 5%

These wire sizes are for copper conductors between the distribution transformer and the 100 Amp service disconnect. The 100 Amp breaker listed for 240 VAC operation must be upgraded to 125 Amp for operation below 240 VAC as indicated by the line currents listed in Table 1-2 above.

1.11 Preliminary Room Inspection

Prior to beginning installation, inspect the x-ray room to verify compliance with specifications for the following:

- Incoming Line
- Service Disconnect
- Lead Shielding per local code
- Conduit
- Space Requirements

1.12 Unpacking

Upon receipt of the x-ray generator and associated equipment, inspect all shipping containers for signs of damage. If damage is found, notify the carrier or his agent immediately. When the equipment is unpacked, inspect all pieces for visible damage. If any damaged parts are detected, repair or order replacements to prevent unnecessary delay in installation.

Before beginning the installation, verify the following:

- All internal connections and fasteners are secure
- All internal wiring is secure

2.0 MECHANICAL ASSEMBLY

2.1 Radiographic Table

1. During shipment, the tabletop is banded to the table base. Cut loose the banding and set the table top aside for assembly later. Loosen the hold-down screws underneath the front rail of the table to release the grid cabinet. Remove packing material from rear of grid cabinet.

2. Install the five leveling feet by threading them into the holes at the two front corners of the table and at the ends and middle of the back rail. The two feet with a 4" long body should be installed at the front corners of the table. The three feet with a 1" long body should be installed at the back rail. (In the accessory bag there are six blue and six red “U” shaped plastic spacers. When leveling the table fully tighten the foot until the shoulder of the foot is firmly against either these spacers or the bottom of the table/back rail). Use of the spacers makes the table base/leveling feet union a solid “one piece” structure, minimizing any wobble or table base motion.

   Position the table close to its final location, using the leveling feet and spacers to bring the table close to level at this time. Final leveling can be done at end of assembly.

2.2 High Voltage Generator and Transformer placement

1. Verify that the oil level in the HV transformer is approximately 1/2" to 3/4" below the underside of the cover. Refill with "Shell Diala oil AX" or remove oil as necessary.

2. Using a piece of cardboard to protect the floor, push the transformer onto the shelf in the table by tilting the transformer and sliding it up onto the right side of the shelf. Once the transformer is in place, loosen the screw on the vent plug to allow for oil expansion. Cover the vent plug and flange with one of the loose fitting plastic covers provided with the HV transformer to prevent contaminants from entering the oil.

3. Place the Power Module close to the front left side of the table but not inside, leaving access on all sides. This allows the installer to establish the proper wiring, routing and lengths for all cables.

2.3 Tubestand Installation

The sequence of assembly is different between Fixed-Top and Float-Top tables. For Fixed-Top (standard) tables, proceed directly to section 2.3.1 below.

For Float-Top (optional) tables the table, top frame must first be removed before the tubestand can be mounted. Skip to section 2.3.2. for instructions on this type of table.

2.3.1 For Standard Fixed-Top Table

1. Remove tubestand stop from the left end of the table's lower rear rail. See figure 2.

2. Position the tubestand so that it is a few inches from the end of the back rail of the table with the lower tubestand bearings in line with the back rail. See figure 3.

Figure 2 - Back Rail and End Stop

AWK286-01

Figure 3 - Tubestand Positioning

AWK286-02

(The tubestand shown in the pictures above is for a Float-Top table, but mounting the tubestand to the rail is done the same for either configuration.)

3. Carefully tilt the tubestand away from the table until the elevated tubestand bearing can be pushed into the lower bearing rail. Now straighten the tubestand and push it completely into the upper and lower bearing rails. See figure 4.

4. Reinstall the tubestand stop on the lower rail. If leveled properly in step 2.1, the tubestand should glide easily from end to end and stay in position without drifting to either side.

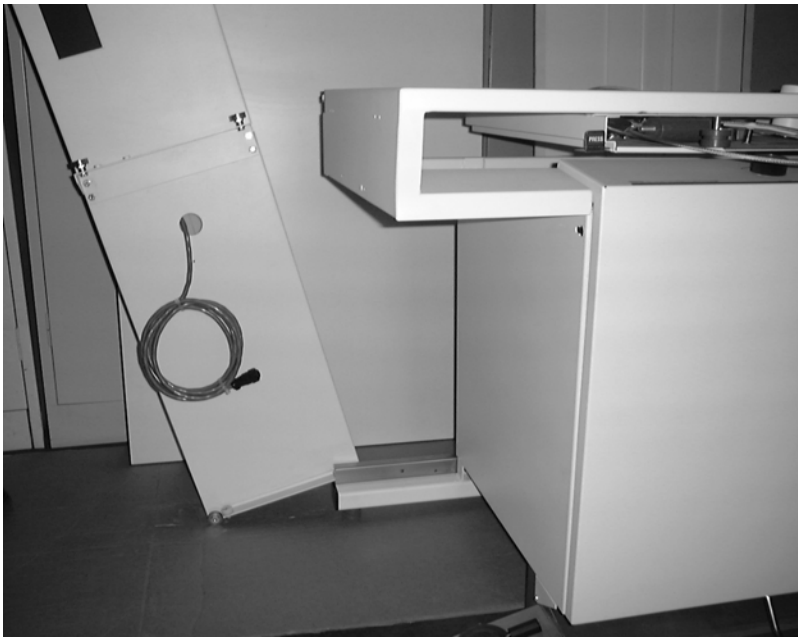

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Figure 4 - Mounting Tubestand to Lower Rail

2.3.2 **For Optional Float-Top Table** (Refer to figures on preceding pages for reference.)

1. Mount the tubestand bearing carriage to the tubestand using the four (4) 1/4" x 3/8" hex head screws provided. The picture on page 19 shows a tubestand with a mounted bearing carriage. **Verify that the safety rollers are mounted on the tubestand bottom to prevent the table from tipping backwards from the weight of the tubestand**. (This may occur if the high voltage transformer or control is not yet installed).

2. To mount the tubestand, the table top frame will need to be moved forward for access to the upper tubestand bearing rail at the left end of the table. Refer to figures 5 and 6 for reference.

   A) Remove the single, large Phillips head screw found at the front and rear interior corners of the tabletop frame.

   B) Now that the table top frame is free from the bearing tracks, raise the frame slightly to gain access to the four small Phillips head screws which secure the table top frame's bearing track at the exterior head end of the table. Remove these four screws, sliding the bearing track forward. See figures 5 and 6.

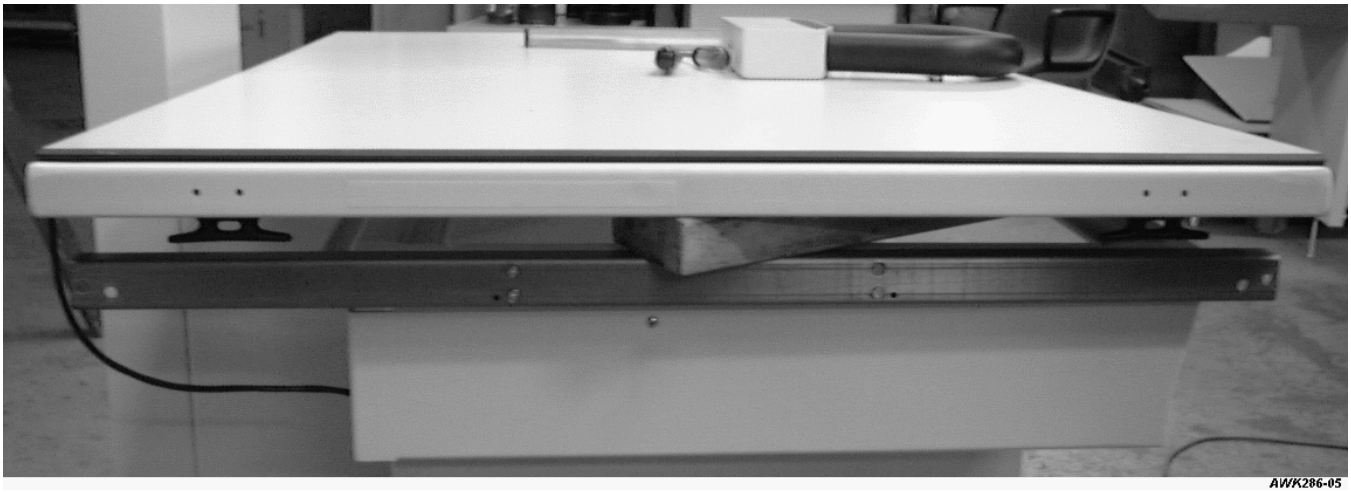
   C) Manually release the transverse lock solenoid pins and slide the table top frame forward to expose the upper tubestand bearing rail.

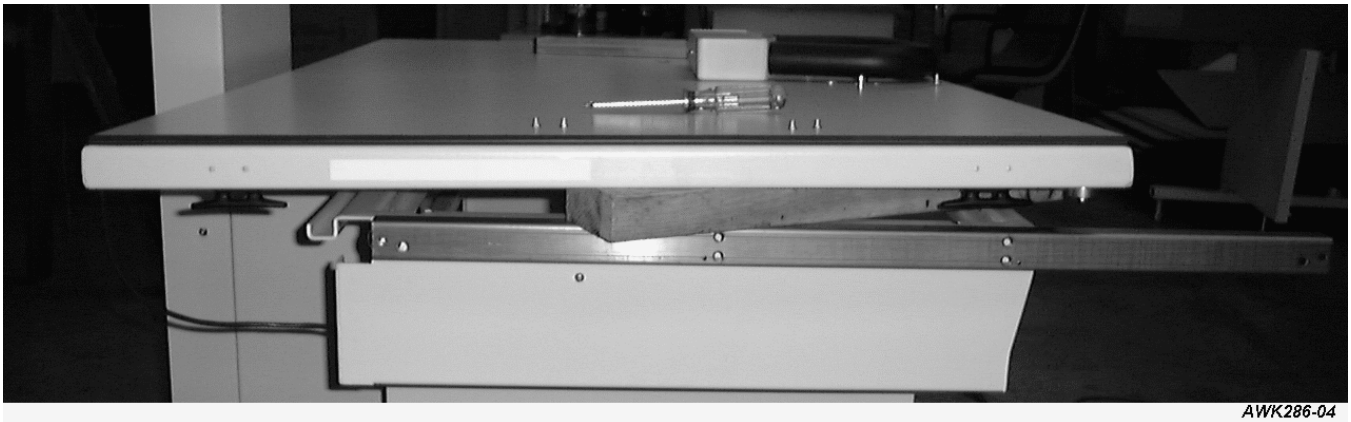
3. Remove the tubestand stop on the left end of the table's lower rear rail (viewed from the front.) Position the tubestand so that it is a few inches from the end of the back rail of the table with the lower tubestand bearings in line with the back rail. See figures 2 and 3 for reference.

4. Carefully tilt the tubestand away from the table until the lower tubestand bearing can be pushed into the bearing rail. Now straighten the tubestand and push it completely into the upper and lower bearing rails. See figure 4 on page 20 for reference. Reinstall the tubestand stop on the lower rail. A well-leveled table will allow smooth motion of the tubestand with no drift in either direction.

5. Reassemble the table frame by repeating step 2 above in reverse. Replace the tubestand stop on the lower rail. If not done previously, remove the phenolic tabletop panel at this time via the nuts located at the underside corners of the tabletop frame.

Figures 5 and 6 - Exposing Upper Rail For Mounting Tubestand





2.4 Tube Arm, X-Ray Tube And Collimator Installation

NOTE: The "Roll" potentiometer setting will be preset at the factory but will need to be verified before installation of the tube arm. The following procedure is not a "roll" potentiometer calibration, only a preset.

1. Place the tube arm assembly on a known level surface and remove the "roll" potentiometer assembly cover. (Two 10-32 screws) Verify the "roll" potentiometer drive belt tension. Belt tension should be adjusted as to prevent any slack within the drive belt wheels. If adjustment is required, loosen the two 10-32 screws that secure the "roll" potentiometer assembly and move the entire assembly left or right to achieve proper drive belt tension. Ensure not to over tension the drive belt. Reinstall "roll" potentiometer cover and hardware.

2. Remove the 3/8-16 locking bolt. Measure the resistance of the "roll" potentiometer across pins 1 and 4 on the DB9 connector or across pins 1 and 2 at the "roll" potentiometer. Resistance should read 500ohms +/- 20 at 0 degrees. If adjustment is necessary, rotate the tube arm shaft until the correct resistance is achieved. Once proper resistance is set, install the tube arm-locking knob to secure the tube mount to the tube arm shaft.

3. Install the tube mount assembly by inserting the 1-1/2" diameter tube arm shaft into the collar on the face of the tubestand. Ensure the tube arm shaft is fully inserted, with the tube mount in the beam-down position. Secure the shaft by tightening the two screws on the outside diameter of the collar.

WARNING:

Do not remove the two hex head shipping bolts, which lock the main counterweight and vertical carriage together until the tube, collimator, high voltage cables and operators console have been mounted.

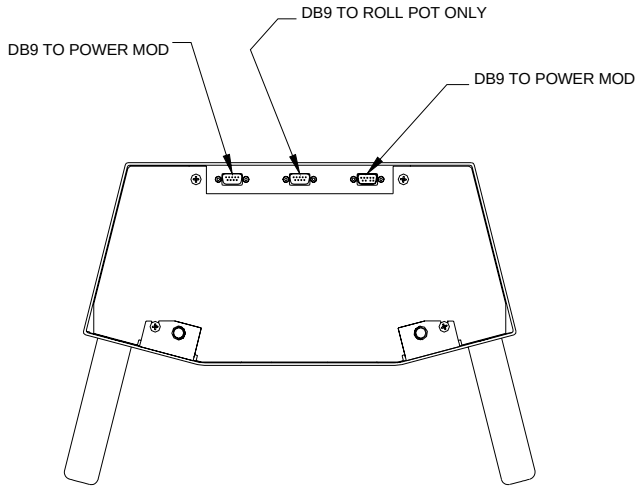
4. Mount the x-ray tube and collimator**. When using the standard tube and collimator, two 1/8" spacers will achieve the proper field size coincidence.** The standard tube has a part number of C458, and the collimator G800 (refer to their respective manuals for detailed instructions as needed).

5. Install the high voltage cables. Cable drape brackets are included with the hardware accessories bag. The cable drape brackets are installed above and below the handle on the right side of the tubestand. Loosely drape the HV cables with the collimator and stator cables within the brackets until the vertical slide has been freed to move. The cables will route directly into the right rear of the table base, above the lower tubestand rail.

2.5 Mounting Operators Console and Routing Communication Cables

NOTE: The communication cables will be factory connected at the operator's console. These are the outer DB9 connections as viewed from the back of the operator's console. (See figure 7)

Figure 7: Rear view of operator's console



1. Remove the two ¼-20 cap head screws and washers located in the mounting holes at the bottom of the operator's console. Use this hardware to mount the operator console to the tube arm. Ensure hardware is tight.

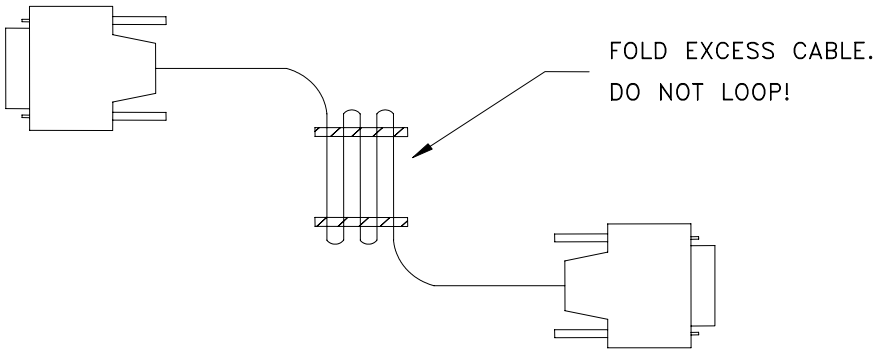
2. Route the "roll" potentiometer cable under of the x-ray tube and connect to the operator's console at the middle DB9 connector. Ensure the connection is secure.

3. Route the communication cables under the tube and along side the high voltage cables and rotor cable. Ensure the cable drape does not hinder the movement of the vertical and roll motion of the tube assembly or the swivel movement of the collimator. At the Power Module, the cables will plug into H13 and H14 on the System Controller pcba. (See warning below)

Refer to Section 6 of this manual for information on generator connections and all other electrical issues related to this system.

WARNING

Any excess amount of communication cables should be bundled outside of the power module enclosure. Fold and tie the cables together carefully in a fashion that avoids any "large-area" loop, as shown below.



WARNING:

*Particular care should be taken when servicing the inside of the tubestand. There is an **extreme** threat of mechanical pinching between the vertical slide and counterweight due to their close proximity and opposite directions of motion. All of the movable assemblies and parts of x-ray equipment should be operated with care. Only properly trained and qualified personnel should be permitted access to any internal parts.*

4. It is now safe to remove the shipping bolts which lock the main counterweight and vertical carriage together, taking care to insure that the counterbalance is adequate to avoid uncontrolled motion of the vertical slide. Remove the back panel of the tubestand for access to all tubestand adjustments. Any additional counterweights required to counterbalance the tube arm vertically can be placed in the brackets at the top of the main counterweight.

2.6 Foot Treadle Installation (skip if using standard foot switch)

The latching prep foot treadle is installed with the table front cover removed.

1. Put the treadle in position across the front of the table base.

2. Thread the spring guide pins located at either end of the treadle up through the table base and lock each guide pin in place with the cotter pin provided.

3. Bolt the foot treadle bracket to the table base using the hex head bolts provided.

4. Plug the foot treadle cable into the S4 location of the junction box at the right side of the table frame.

5. Plug the air hoses from the pads on the end of the treadle into the air switches located on the front of the power module.

2.7 Film Bin Installation

(skip this section if no film bin is to be installed)

The film bin comes in either a right-hand or left-hand configuration. Slide the PEM studs of the film bin through the holes in the front edge of the appropriate side of the table and secure it using the hardware provided. Bolt the back side of the film bin to the rear of the table using the bolts provided. Install the plastic organizer in the top drawer of the film bin. Note that for left-hand film bins the control serial tag may be partially obscured. Be certain to record the control's serial number in the user and installation manual if this is the case.

2.8 Table front cover installation

NOTE: The table front cover should not be installed until after the generator calibration is completed. If you are installing a foot treadle, the foot treadle must be installed before installing the table front cover.

1. Install the front cover by placing the notches on the bottom of the cover over the pivot rollers located on the bottom left and right sides of the table base.

2. Locate the two; cover mounting brackets located in the small parts kit. While holding the door in place, slide one bracket underneath the front flange of the cover and secure in place with 10-32 hardware. Repeat process on opposite side.

3.0 FINAL MECHANICAL ADJUSTMENTS

3.1 Leveling The Tubearm

An adjustment screw for leveling the tube arm is provided on the front of tubestand, just below the tube arm base. First remove the decorative hole cover to access the adjustment screw. Next turn the screw clockwise to raise the tube arm or counterclockwise to lower the tube arm. Replace the decorative hole cover when finished leveling.

3.2 40 Inch SID Detents

To position the tube 40" from either the table top or the film cassette, detents are provided. These detents are factory adjusted, however some adjustment is provided if needed. Access to the adjustments is from the rear of the tubestand**.**

3.3 Verification Of X-Ray To Light Field Coincidence

The coincidence of x-ray to light field must be verified. Specific instructions can be found in the manual for the G800 collimator.

3.4 Verification Of X-Ray To Image Receptor Alignment

1. Any left-to-right adjustment required for coincidence between the central ray and the center of the image receptor can be achieved by adjusting the grid cabinet-to-tubestand interlock bracket, located on the lower front surface of the tubestand.

2. Any front-to-back adjustment of the central ray (after the arm has been leveled from 3.1 above) can be achieved by loosening the tube arm collar screws and sliding the tube arm shaft within the collar to achieve proper alignment. Total adjustment is ¾ inches.

3.5 Securing Table To Floor

Once the table is in final position and all checks have been made, it can be secured to the floor using the four (4) clamps provided with the feet. Slide the clamp into the notch at the base of each foot, turn at 45^{o} to the table and secure with a lag screw.

4.0 Options For Field Installation

Many options for the *InnoVet Select HF APR* will arrive at the jobsite pre-installed. However, all of the following features can be added after the installation is complete if the user so desires.

4.1 Table Top Extension (For Fixed-Top tables only)

The table top extension adds 12" of additional table top surface and can be mounted on either end of the table. To attach the extension, align notches in extension with buttons mounted on end of table support and slide over buttons.

4.2 Animal Restraints

The animal restraints used are nautical-style tie-down cleats. They are screwed to the underside of the table top frame at either end of the table. This prevents lead aprons from snagging on the cleats.

4.3 FOOT TREADLE

If the *InnoVet Select HF APR* has the latching prep Foot Treadle Option, the treadle must be installed prior to mounting the table front cover. If the Foot Treadle Option is being added to an existing system, the tabletop and the table front cover will need to be removed to install the treadle.

1. Remove the tabletop by removing the four wing nuts which secure the table top to the table frame. These are located under the tabletop one in each corner. Remove the two front cover mounting brackets by removing the two10-32 mounting screws and washers. Once this hardware is removed the cover is free to tilt out and be removed.

2. Put the treadle in position across the front of the table base. Thread the spring guide pins located at either end of the treadle up through the table base until they protrude out the top of the base, securing each guide pin in place with the cotter pin provided.

3. Bolt the foot treadle brackets to the underside of the table base using the hex head bolts provided.

4. Plug the foot treadle cable into the S4 location of the junction box at the right side of the table frame.

5. Remove Power Module from the table and remove the enclosure.

6. Remove the front panel of the Power Module. Install the air switch packets using the screws and nuts provided so that the nozzle of each exits the front of the Power Module. Replace cover.

7. Connect the wires from the air switches to TB5-2 and TB5-4 inside the right side of the Power Module. Connect the air hoses to the air switches by pushing them over the nozzles that exit the front of the control.

8. Verify on the APR Console board (L510) that DIP2-7 is in the CLOSED or ON position (switch actuator to the right) to enable the Latching Prep mode. This DIP switch will be preset at the factory.

9. Reinstall the front cover by placing the notches on the bottom of the cover over the pivot rollers. Reinstall the two cover mounting brackets and ensure hardware to tight.

5.0 GENERATOR PRE-INSTALLATION

5.1 Introduction

This section describes procedures necessary for the installation of the following units:

- Table front cover
- High Voltage Transformer
- Power Module
- Connections to ancillary devices common to an X-ray room

This material is presented in sequence to facilitate an orderly and safe installation. Complete calibration procedures are presented in Section 8.

5.2 Installation Items and Test Equipment

The following test equipment is required for the installation:

- Fluke Digital Multimeter or equivalent
- Machlett Dynalyzer or equivalent high voltage divider for kVp and mA values
- Keithley dosimeter or equivalent for linearity and reproducibility
- Tektronics 210 dual trace storage oscilloscope or equivalent for waveform shape

The following miscellaneous items are required or may prove useful for the installation:

- Silicone Insulating Grease - DC4 vapor-proofing compound, or equivalent.
- Alcohol
- Standard tool kit
- Victoreen mAs meter or equivalent
- Keithley Non-invasive kVp meter or equivalent

5.3 Component Access

5.3.1 Access to Operator's Console PCBA

Access to the Operator Console PCBA is achieved by removing the two 10-32 screws located on the top rear of the operators console as viewed from the front, and loosening the two bottom 10-32 screws which are slotted. The back cover will then lift straight up and off.

5.3.2 Access to Power Module

Access to the Power Module is achieved by removing the two screws from each side of the cover, located near the front, and two screws from the back, located near the bottom. Lift the cover up slightly and back from the Power Module frame. All cables will exit the front.

5.3.3 Access to the High Voltage Transformer

Terminal connections P1, P2, and GND can be accessed by removing the two screws at the terminal cover on top of the unit. Cathode is left, anode is right. The mAs meter connection is on the left behind the cathode well.

CAUTION: There is no access to the interior of the High Voltage Transformer. This is a sealed unit and opening it in the field without guidance by Summit Technical Support will void the factory warranty.

5.4 Circuit Board Identification

5.4.1 Operators Console

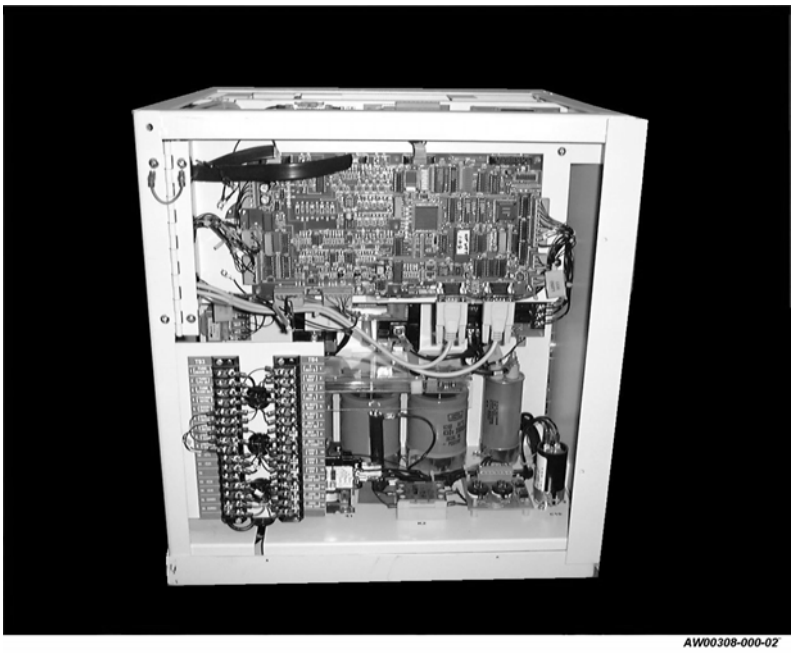
- L510 APR Console Board
- 01360-000 Memory Card Interface Board
- 01392-000 Extended Memory Card Board
- 00417-000 Memory card

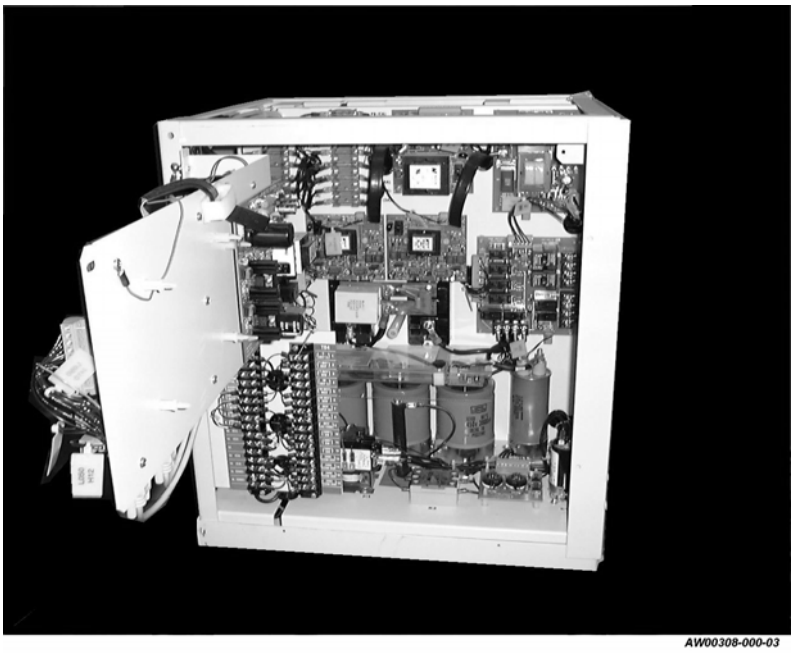
5.4.2 Power Module

- 01003-000System Controller Board
- 01780-000IPM Driver Board (2 each)
- 01770-000Filament Driver Board
- K444 Rotor Sense Board
- K660 Relay board
- K445 Charge Monitor board
- 01710-000 ON/OFF board
- K650 Power Supply Board

Figure 8: Power Module and Transformer in Table Base
(FRONT VIEW)

Figures 9 and 10 - Power Module Interior





6.0 Generator Installation Procedure

6.1 Line Voltage

Measure and note the incoming line voltage. 240 VAC is required for full 30 kW output. If 30 kW output is desired and the line voltage is below 240 VAC, a line matching transformer kit (part number L246) will be required.

☞ **NOTE:** **If the line voltage is below 240 VAC (i.e., 208 VAC), it will not be possible to produce the full output capability of the generator without a line-matching transformer.**

6.2 Position System Components

Place the Power Module close to the front of the table but not inside, leaving access on all sides. This allows the installer to establish the proper wiring, routing and lengths for all cables.

6.3 Operator's Console

Run the two communication cables from the operator's console to the Power Module. (See section 2.5 for mounting the operator's console and communication cable routing.)

6.4 Transformer Installation

Place the HV Transformer in front of the bottom shelf of the Power Module. The high voltage cables cannot be inserted or removed when the transformer is inside the table.

☞**NOTE:** **Release the 8-32 screw in the oil fill plug (1) full turn counter-clockwise to allow the oil level to expand with temperature and barometric changes.**

6.5 System Interconnection

Inspect the power module for loose connections and potential electrical hazards. At this time, the Power Module can be connected to the operator's console and the HV Transformer.

The Communication Cable, for the operator's console connects to the Power Module as described in Section 2.5.

Connect the Filament and Feedback cables to the HV Transformer and ensure the mate-n-lock receptacle J1 and J2 at the top of the transformer are tight and secure.

Three leads marked "P1, P2 and GND" should be routed from the Power Module to the HV Transformer through the metal strain relief and terminated at the connections labeled "P1, P2 and GND".

6.6 Connecting the Mains Input Voltage

240 VAC Input
Single-phase power is terminated at the line fuses (F1, F2) in the Power Module. This Fuse Block is located on the right side of the Power Module. Ground is connected to the Ground Stud just below and to the left of the fuse block.
Wires "1", "1B" and "2A" should be on TB1-2, the 240 V tap. Wire "2J" must be on TB2-1, the 240 V tap.

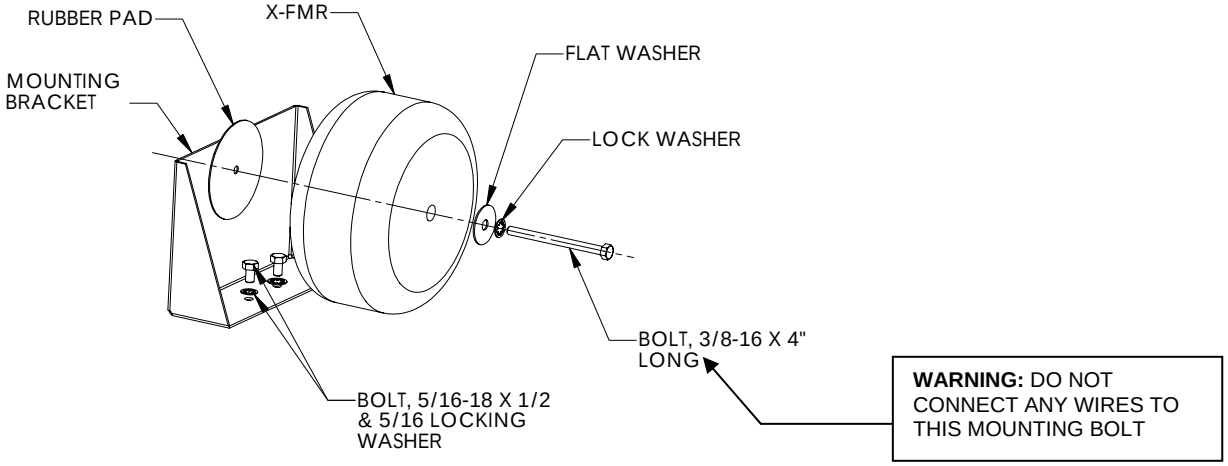
208 or 220 VAC Input with Line Matching Transformer (Field Installation Only)
Single-phase power below 230 VAC will require a line-matching transformer. See the transformer kit, part # L246 for further details or section 6.7 below. Line voltages below 230 VAC will only support low power exposures for light field to x-ray field congruence and system alignments. This is only a stop-gap measure. Obtain a line match transformer kit immediately!

6.7 Field Installation of a Line Matching Transformer

Generally, if a line-matching transformer is required it is installed in the field. In the event that the supply voltage is below 230 VAC and a transformer is not installed, follow these instructions. If a line-matching transformer is required, contact the factory to order a line matching transformer kit, part number **L246**.

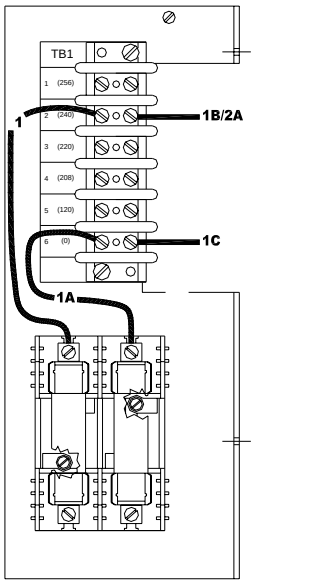
Warning: **Make absolutely certain that the AC mains supply is off and that the DC capacitor bank voltage within the generator is fully discharged before beginning this procedure. The capacitor bank voltage requires a minimum of 20 minutes to discharge. Verify that no voltages are present.**

1. Turn off the incoming power supply at the service disconnect. Remove the Power Module cover (see the service manual for details as required).
2. At the bottom of the Power Module locate two #5/16 threaded holes. Place mounting bracket above them and secure with 5/16-18 x ½ lg bolts and locking washers.
3. Carefully place the toroid line-matching transformer with rubber gasket inside the bracket (as shown below) so as not to scratch the transformer insulation on the bracket. Orient the transformer so that the leads exit the bracket to the top and right.
4. Secure the transformer to the bracket using #3/8-16 x 4-1/2" long hex bolt and locking hardware. The bolt is to be snug, but not tightened so excessively that it crushes the epoxy center of the toroid style transformer.

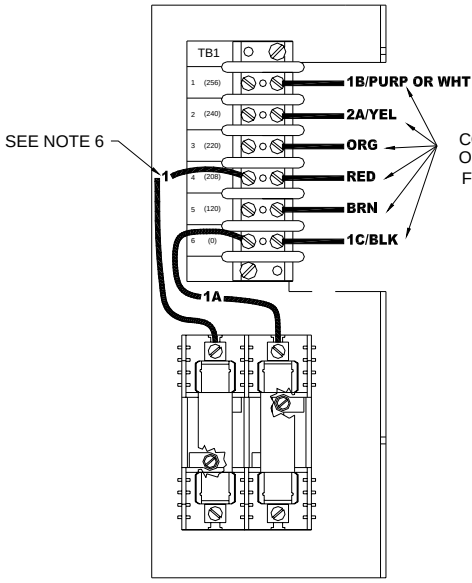


ITEM NO.	QTY.	PART NO.	DESCRIPTION
1	1	01970	X-FMR, AUTO, 240V @ 200A
2	1	01970(REF)	RUBBER GASKET
3	1	HC31	WASHER, FLAT, 3/8 ID, 1-1/2 OD
4	2	HB54	WASHER #5/16, SHAKEPROOF
5	1	HC23	WASHER, #3/8 SHAKEPROOF
6	1	HZ02	BOLT, 3/8-16 X 4-1/2", HEX HD.
7	2	HE81	SCREW, 5/16-18 X ½, HEX HD.
8	1	01026	WELDMENT BRACKET
9	1	L321	ASSEMBLY INSTRUCTIONS

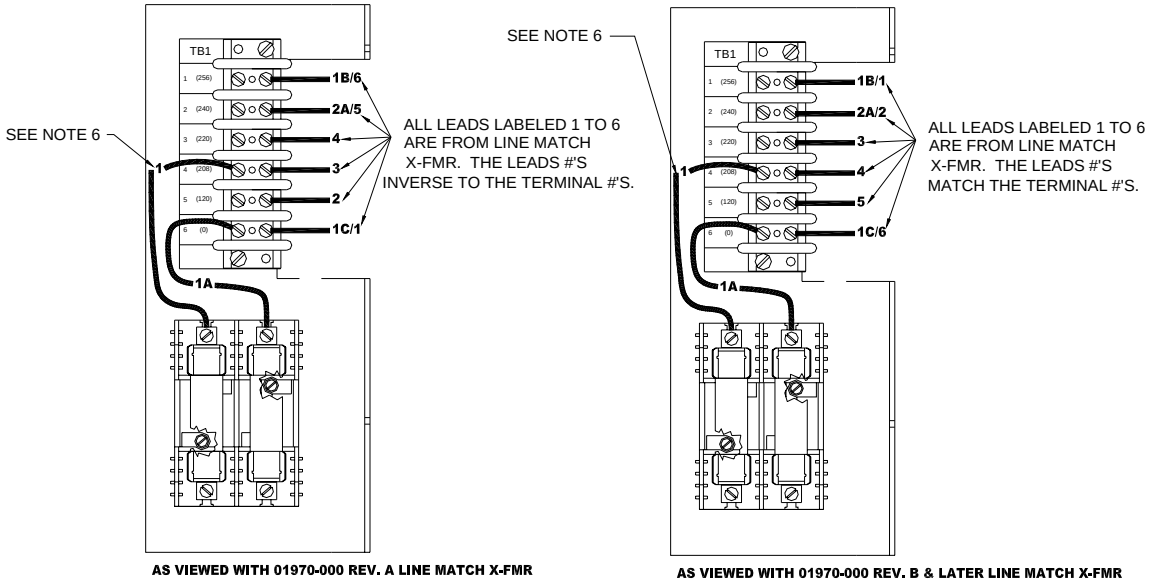
5. Depending on which kind of AUTO X-FRM, connect the transformer leads to the right side of TB1 in the Power Module as shown in the pictures below.



AS VIEWED WITHOUT LINE MATCH X-FMR



AS VIEWED WITH L021 LINE MATCH X-FMR



6. On the left side of TB1, locate the wire labeled “1”. This is the line voltage adjust wire. Move wire “1” to the TB1 tap which most closely matches the incoming line voltage (208 VAC or 220 VAC).
7. On TB2, located just in front and to the right of TB1, verify the following connection: The wire labeled “2J” should be on TB2-1, the terminal labeled “240”.
8. When all connections above have been verified, it is safe to turn on the mains input voltage. Confirm that the voltages on TB1 and TB2 are correct as referenced to the “0 Volt” tap on the respective terminal block.
9. Once the voltages have been verified, turn off the mains input voltage and continue with the installation and calibration procedure of the generator as outlined in the manual.

6.8 High Voltage Cables

Connect the high voltage cables from the HV Transformer to the x-ray tube. With the vent to the front, the cathode (-) receptacle is on the left, near the red and black mAs meter jumpers. The anode (+) receptacle is on the right. Verify polarity and that all connections are made correctly.

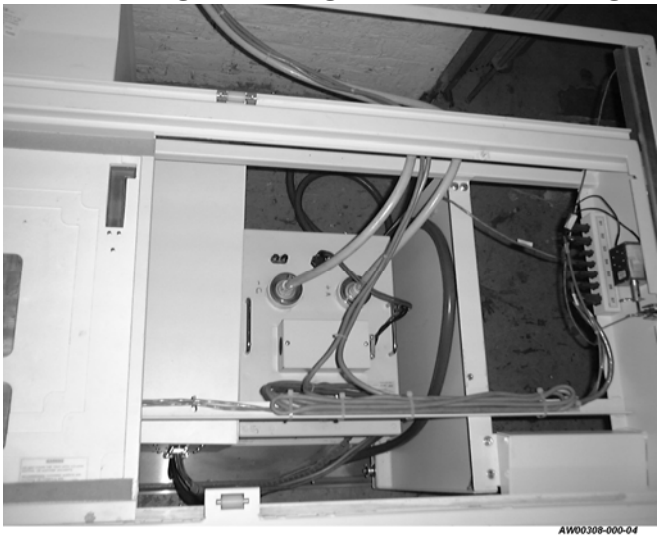
CAUTION: The high voltage cable terminal pins are delicate. Take particular care to handle them carefully.

☞ **NOTE: The HV Cable knurled nuts are delicate and can be damaged by dropping or banging on the floor. This can deform the threads, making it difficult to install them fully into the HV receptacles**

Use a clean, dry, lint-free cloth and alcohol to clean the insulating surfaces of the terminals and receptacles. Use particular care in cleaning the flat insulating surface. Do not touch the insulating surface after cleaning. Apply vapor-proofing compound to both cable plugs at each end. See the manufactures high voltage cable installation manual for specific cable preparation.

The high voltage cables will route into the table base as shown in the figure below (top view looking down with tabletop panel removed).

Figure 11 - High Voltage Cable Routing



Top view looking down w/tabletop panel removed

6.9 Stator Cable

Table 6-2: Tube Stator Cable Connections

Origin (tube)	Destination (Power Module)	Function
black 07	TB3-1	stator main
red 08	TB3-2	stator phase
white 09	TB3-3	stator common
blue T5	TB3-4	thermal switch (N.C.)
orange T6	TB3-8	thermal switch return

The stator cable will route into the front of the Power Module, down and along the right side of the divider wall to the rear of the unit. It will then go up through the access hole, down the left side of the divider wall, along the bottom rear, and around to TB3 which is located at the rear left of the Power Module. **This routing keeps the stator cable away from the more noise sensitive components such as the System Controller board and the communication cables.**

☞ **NOTE: Remove Jumper from TB3-4 to TB3-8 before connecting tube stator cable to terminal TB3.**

6.10 Table Interface Connections TB5

NOTE: The TB5 terminal strip located in the power module is used to interface the collimator, prep/exposure switch, air switches etc. to the generator via the table interface cable.

Table 6-3: Table Interface Cable Connections at TB5

Origin	Destination	Function
Collimator cable C1	TB5 - 12	24 VAC
Collimator cable C2	TB5 - 13	24 VAC
Collimator cable GND	TB5 - 11	GROUND
Collimator cable CSW1	TB5 - 5	Hip switch
Collimator cable CSW2	TB5 - 6	Hip switch
Table Interface cable - BROWN	TB5 - 2	Common
Table Interface cable - BLUE	TB5 - 4	Exposure
Table Interface cable - RED	TB5 - 5	Hip switch for collimator
Table Interface cable - GREEN	TB5 - 6	Hip switch for collimator
Table Interface cable - ORANGE	TB5 - 7	+ 24 VDC
Table Interface cable - VIOLET	TB5 - 8	To float-top lock switch
Table Interface cable - BLACK	TB5 - 9	To Solenoid
Table Interface cable - WHITE	TB5 - 10	- 24 VDC

(table continued on next page)

Table 6-3: Table Interface Cable Connections at TB5 (continued)

NOTE: The air switches are connected in parallel. The two wires (red) and (black) need to connect to the TB5 terminal strip. See below

Origin	Destination	Function
Air Switch cable - RED	TB5 - 1	Common
Air Switch cable - BLACK	TB5 - 4	Prep/Expose
Traditional Two-stage Footswitch - S1	TB5 - 2	Common
Traditional Two-stage Footswitch - S2	TB5 - 3	Prep
Traditional Two-stage Footswitch - S3	TB5 - 4	Expose

6.11 Interlocks

There are two possible interlocks besides the thermal interlock from the x-ray tube. Terminals TB3-6 and TB3-8 are provided for connection of an isolated switch contact for collimator interlock. If the collimation is manual, jumper these two points.

Terminals TB3-5 and TB3-8 are provided for connection of an isolated switch contact for door interlock. If no door interlock is being used, jumper these two points.

TB3-7 to TB3-9 is a spare interlock.

TB3-8 and TB3-9 are electrically the same point and can be used interchangeably.

7.0 INITIAL POWER UP AND INSPECTION

7.1 General

The 20 kHz HF APR system comes in a standard configuration with typical default calibration values stored in memory. If required, the factory defaults can be reloaded into memory. After initial inspection and interconnections have been made, the system will be ready for power up, voltage checks and calibration.

WARNING: The main storage capacitors retain their charge for some time after the unit is turned off. Although the areas where this voltage may be present are covered with a protective layer of Lexan, it is imperitive that all service personnel are respectful of the significant shock hazard the capacitor bank voltage represents. Prior to servicing the power components, ensure that the LED on the Charge Monitor PCB is not lit, and verify there is no capacitor bank voltage with a DC voltmeter.

7.2 System Configuration

System configuration will be done via the Operator's Console in the utility section of the power module set up screen, and also the DIP switch settings located on the system controller board (01003-000) and APR console board (L510).

Observe DIP1 on the System Controller PCBA in the Power Module and DIP2 on the APR Console PCBA in the Operator's Console, and verify that all switches are set to their default settings. Refer to the chart below for information on the functions of the switches.

Table 7-1: DIP1 Functions (System Controller PCBA)

Dip Switch	OPEN (OFF)	CLOSED (ON)
DIP1-1	**Normal Operation**	Simulator mode (demo)
DIP1-2	**Normal Operation**	Disables capacitor bank charging. Exposure with mA and kVp is allowed to verify feedback system. Exposures will discharge the capacitor bank.
DIP1-3	**Normal Operation**	Rotor and filament disable: this allows exposure (kVp only) to check for high voltage breakdown of the transformer (high pot test).
DIP1-4	mA feedback OFF (mA feedback disabled)	**Normal Operation mA feedback ENABLED (ON)**
DIP1-5	**Normal Operation**	Not used
DIP1-6	**Normal Operation**	Not used
DIP1-7	**Normal Operation**	Not used
DIP1-8	**Normal Operation**	When booted up in cal mode this reloads the factory defaults for all configuration and calibration data. Used to clear E14

Table 7-1A: DIP1 Functions (System Controller PCBA)

DIP Switch	**OPEN (OFF)**	**CLOSED (ON)**
DIP3-1	**Normal Operation** Sets mA feedback scale for 300mA	Sets mA feedback scale for 500mA option.
DIP3-2	**Normal Operation** Sets mA feedback scale for 300mA	Sets mA feedback scale for 500mA option.
DIP3-3	**Normal Operation** Not used	Not used
DIP3-4	**Normal Operation**	Used in service mode only, to allow adjustment of steady state exposure mode inverter frequency for 500mA units.

Table 7-2: DIP2 Functions (APR Console PCBA)

Dip Switch	OPEN (OFF)	CLOSED (ON)
DIP2-1	**Normal Operation**	Not used
DIP2-2	**Normal Operation**	PCMCIA card write protect
DIP2-3	**Normal Operation**	Simulator mode (demo)
DIP2-4	**Normal Operation**	Simulator mode (demo)
DIP2-5	**Normal Operation**	Simulator mode (demo)
DIP2-6	**Normal Operation**	Simulator mode (demo)
DIP2-7	Latching Prep Disabled	**Latching Prep Enabled**
DIP2-8	**Normal Operation**	Not used

7.3 Power-Up

7.3.1 Start-Up

Turn the main disconnect switch ON. Press the Operator Console ON key and observe the display screen during the start-up phase. The screen will display the date and time, and the choice of APR or MANUAL (2 Point) mode of operation.

Note that in MANUAL mode of operation, EXPOSURE COUNT can be selected to momentarily display the total number of exposures taken on this x-ray control.

7.3.2 Status LEDs

Upon power up, there are a number of LEDs, which will illuminate on boards within the power module. Verify that the following are true.

01003-000System Controller PCB: LED1 lights will strobe back and forth across the bar.

K650 Power Supply PCB: LED 1, 2 and 3

01710-000 Power on/off PCB: LED 1, 2 and 3

K660 Relay PCB: LED 6

01770-000Filament PCB: LED 1 and 2, LED 3 for Large filament select

7.3.3 Power Supply Test and Fuse Designation

Verify the following output voltages from the Power Supplies referenced to ground.

Table 7-3: Fusing for DC Voltages

F3	**0.5 Amp, Fast Acting**	**+5 VDC**
F4	**0.5 Amp, Time Delay**	**+12 VDC**
F5	**0.5 Amp, Time Delay**	**-12 VDC**

The following fuses are also present.

Table 7-4: Fusing for AC Voltages

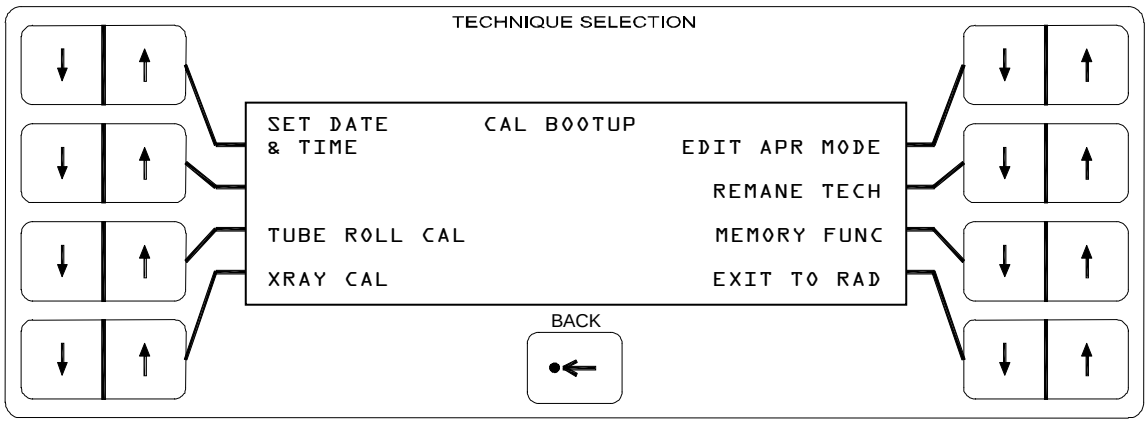
Fuse #	Rating	Function
F1	**50 Amp, Time Delay**	**Mains**
F2	**50 Amp, Time Delay,**	**Mains**
F6	**10 Amp, Time Delay**	**240 VAC autotransformer return**
F7	**10 Amp, Time Delay**	**240 VAC autotransformer hot**
F8	**7 Amp, Time Delay**	**Collimator supply**
F9	**5 Amp, Time Delay**	**Electric lock supply (24 VDC)**
F10	**1 Amp, Time Delay**	**Relay pcb supply**
F11	**0.8 Amp, Time Delay**	**12 VAC Console supply**
F12	**1.5 Amp, Time Delay**	**Bucky supply (Not used for vet)**
F13	**8 Amp, Time Delay**	**240 VAC rotor supply**
F14	**8 Amp, Time Delay**	**240 VAC rotor common**
F15	**3 Amp, Time Delay**	**240 VAC power supply pcb input**

8.0 SYSTEM CONFIGURATION USING THE OPERATOR CONSOLE

☞ **Note: Throughout this manual "CAPS" text is used to indicate the wording on the console or display.**

8.1 CAL BOOTUP screen. This screen is the entry point for all Operator Console based system configuration such as tube type and image receptor configuration. It is also where manipulation of the anatomical technique database and calibration screens are accessed.

To access the CAL BOOTUP screen: Turn the control OFF. Press and hold the BACK button while pressing the ON button. The CAL BOOTUP screen will display as shown below.

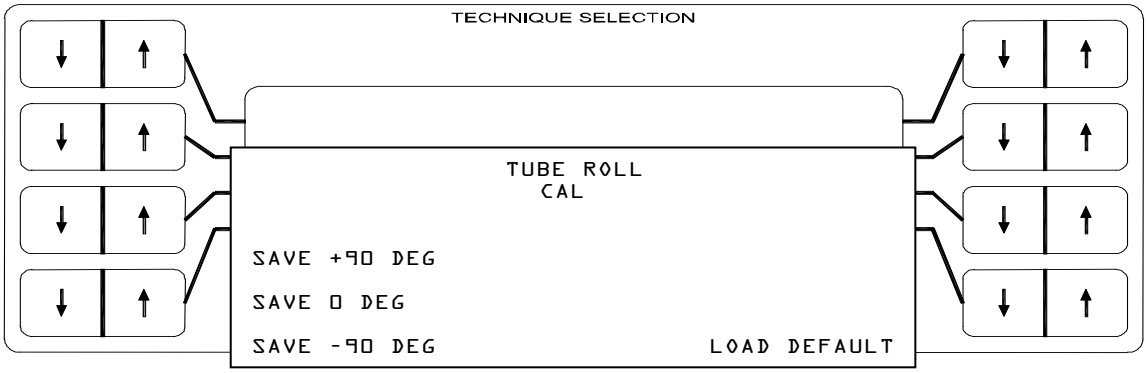


DATE AND TIME: Allows the user to program local time.
TUBE ROLL CAL: Allows the installer to calibrate the tube roll potentiometer
XRAY CAL: Installers access to configuration and calibration screens.
EDIT APR MODE: Allows the user to make changes to the technique database.
RENAME TECH: Allows the user to add more techniques/change view names.
MEMORY FUNC: Allows the installer to save configuration and/or technique data to a manufacturer supplied memory card and transfer it between sites.
EXIT TO RAD: Returns the operator to APR or MANUAL modes of operation.

8.2 TUBE ROLL CAL Screen and Calibration

This selection will allow the installer to calibrate the tube roll display. Ensure the "roll" potentiometer has been pre-set before the calibration procedure. (See section 2.4 for "roll" pot pre-set procedure)

Once in the CAL BOOTUP screen, select TUBE ROLL CAL. The following screen will be displayed.



Tube Roll Calibration

1. Rotate the entire operator's console and tube head to the left until the primary beam is horizontal. This will be the +90 degree point. Use a level to verify this position. Push the **SAVE +90 DEG** up/down buttons to input this setting. Unit will give an audible tone and display **SAVING**. +90 degree calibration is complete.

2. Rotate the entire operator's console and tube head until the primary beam is pointed vertically downward. This will be the 0 degree point. Use a level to verify this position. Push the **SAVE 0 DEG** up/down buttons to input this setting. Unit will give an audible tone and display **SAVING**. 0 degree calibration is complete.

3. Rotate the entire operator's console and tube head to the right until the primary beam is horizontal. This will be the –90 degree point. Use a level to verify this position. Push the **SAVE -90 DEG** up/down buttons to input this setting. Unit will give an audible tone and display **SAVING**. -90 degree calibration is complete.

4. Tube roll calibration is complete. Verify various tube angle displays and repeat calibration if necessary.

NOTE: The "roll" angle will only be displayed in normal operating RAD mode. The "roll" display will not be displayed in any of the set-up utility menus or during an error condition in normal RAD mode.

☞ NOTE: Use the BACK button just below the console display to return to the previous screen whenever necessary. From the CAL BOOTUP screen the EXIT TO RAD command returns the system to normal operation.

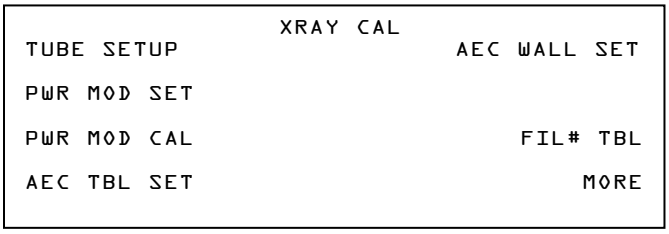
8.3 XRAY CAL Screen

For all system configuration and generator calibration select XRAY CAL.

The console will require the installer to ENTER PASSWORD TO CONTINUE. Press the outer most upper left, lower left, lower right and upper right arrow buttons in a counter-clockwise sequence to enter the password.

WARNING:
Only personnel authorized to make system configuration selections and perform generator calibration are to access the XRAY CAL screen. Unauthorized changes by persons unfamiliar with the system will cause equipment damage NOT COVERED BY WARRANTY!

The XRAY CAL screen will display as shown below.



TUBE SETUP: To select x-ray tube type used at this installation while either keeping existing calibration values or loading factory default calibration values for this tube type.

PWR MOD SET: To select kW, configure buckys/grid cabinets.

PWR MOD CAL: To adjust independent mA leading edge points, master mA leading edge for large and small spot, mA stabilized levels and master kVp.

AEC TBL SET: Inactive

AEC WALL SET: Inactive

FIL# TBL: To view all filament numbers, which control mA leading edge.

MORE: Factory settings only.

Press the BACK button to return to the CAL BOOTUP screen if desired.

8.4 TUBE SETUP Screen

TUBE: Press the arrow buttons beside the display to toggle through the compatible tubes. Select the tube type being used here. This selection allows the installer to choose between keeping the existing calibration data or loading the factory default calibrations for this tube type.

kV LIMIT: Default is 125. Can be reduced if high voltage breakdown is a problem.

STND-BY I: Sets stand-by filament current, factory set to 2.5 filament Amps.

BST TIME: Rotor delay time, factory set to 1.5 seconds.

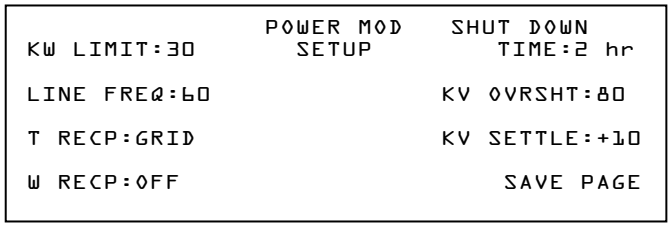
E-CNT: Exposure counter. Automatically records total # of exposures taken.

☞ **Note: Press the SAVE PAGE button to store any changes to the values.**

Press the BACK button to return to the XRAY CAL screen.

8.5 PWR MOD SET Screen

The PWR MOD SETUP screen will display as shown below.



KW LIMIT: Sets kW limit, adjustable in 1 kW increments. Values lower than 30 allow for operation on poor power lines where line voltage drop is a problem. Maximum mAs and mA will not be affected, only kW.

T RECP: Toggles between BUCKY, GRID (grid cabinet), and OFF (no receptor).

W RECP: Toggles between BUCKY, GRID (grid cabinet), and OFF (no receptor).

SHUT DOWN TIME: Selects hours of inactivity which cause automatic turn off of control.

kV OVERSHOOT: Factory set only, 80 is default value.

kV SETTLE: This number is factory set to 10. It controls the kVp leading edge. Only in rare cases will a change in this number be required. Contact the factory for more details before making a change to this number.

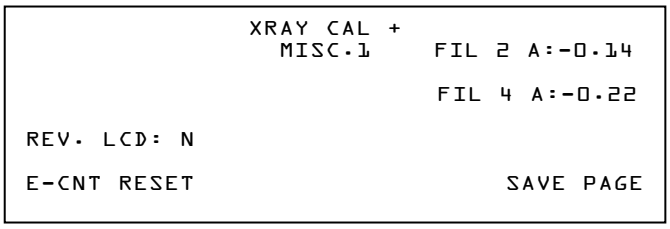
☞ **Note: Press the SAVE PAGE button to store any changes to the values.**

Press the BACK button to return to the XRAY CAL screen.

8.6 PWR MOD CAL, FIL# TBL Screens

These screens are branches of the XRAY CAL screen which relate specifically to calibration of kVp and mA.
Their use will be described in **Section 9 - Generator Calibration**.

8.7 MORE Screen



This screen is reserved for factory use only. Changing the factory defaults for FIL2 and FIL4 will put the x-ray tube at risk and void warranty. There are no values in this screen that may be changed in the field.

9.0 GENERATOR CALIBRATION USING THE OPERATOR CONSOLE

Calibrations will be done through software adjustments on the Operator Console. The XRAY CAL screen, which is password protected, allows access to the screens which control kVp, mA leading edge, and stabilized mA levels.

☞ **NOTE: It is best to view both the kVp and the mA waveforms simultaneously when calibrating the system. The PWR MOD CAL screen is set up to allow control of mA leading edge, stabilized mA and stabilized kV all at one time.**

9.1 Required Equipment for Calibration

Recommended test equipment is as follows:

- Dual trace storage oscilloscope
- mR meter (for verification of linearity and reproducibility)
- Dynalyzer or equivalent

(If Dynalyzer is unavailable the following equipment can be used as a replacement. See below for further explanation.)

- Non-invasive kVp meter
- Digital mAs meter
- Digital Multimeter

9.1.1 Using the Required Test Equipment

The installer is responsible for achieving waveforms which are both of the proper amplitude and of the proper "square" waveshape, where the desired amplitude is achieved and maintained throughout the entire exposure.

A Machlett Dynalyzer (or equivalent high voltage divider) and a storage oscilloscope are required for calibration. The Dynalyzer will indicate total kVp and mA, while the scope allows a view of the waveform shape. It is preferable for the scope to be dual trace, 100 MHz response. Some hand-held scope/meters have a frequency response and pixel resolution that do not give a reliable and discernible view of the output waveforms. **Using a dual trace storage oscilloscope, connect to the Dynalyzer kV and mA output. Set the scope to trigger from the kV waveform.**

If no Dynalyzer is available an alternate method is to use a mAs meter between the mA jumpers on the HV transformer, a kVp meter in the x-ray beam, and a scope on the kV/mA test points on the 01003-000System Controller board. The meters and scope will give the proper total output, and the scope the proper waveshape.

Connect the scope to the kV and mA test points on the 01003-000System Controller board. Set the scope to trigger from the kV waveform.

TP8 is the kVp feedback test point. One volt is equal to 33.3 kVp.
TP9 is the mA test point. One volt is equal to 100 mA.
TP2 is ground.

The test points are located in the upper left hand corner of the 01003-000System Controller pcb, which is on the front of the hinged door in the Power Module. Make exposures, monitoring and adjusting the leading edge and stabilized levels of mA and kVp until satisfactory outputs have been achieved across the operating range.

A mAs meter can be put between the red and black terminals behind the cathode receptacle. **Be certain to remove the jumper when using the mAs meter and replace the jumper when removing the meter at end of calibration.**

☞ **NOTE: While it is possible to calibrate this generator without a Dynalyzer, is it absolutely essential that an oscilloscope be used for calibration. Because the leading edge and stabilized levels of kV and mA are independently controlled, the shape of the waveforms must be verified and adjusted to proper levels during installation. Using a kV meter and mAs meter alone will not allow the installer to calibrate the unit properly, with component damage a possible result.**

9.2 Overview of Calibration

☞ PLEASE READ THIS SECTION BEFORE CALIBRATION!

A good overall understanding of the calibration procedure will save time and prevent problems. Please take a moment to read this section before starting calibration. **Always press SAVE PAGE to activate the change of a calibration value.**

☞ **NOTE: When the tube type is selected, the installer has the option of keeping the existing calibration data or replacing the existing calibration data with factory defaults.**

First, **set mA leading edge for Small filament.** With the correct tube type selected and the mA feedback disabled (DIP1-4 of System Controller board OFF) select 50 kVp, 50 milliseconds and 100 mA (Small filament) from the POWER MODULE CALIBRATION screen and take an exposure. If the mA leading edge needs adjustment, press MASTER mA and increment or decrement the SM F.S. value that displays in the lower left corner and SAVE. Press BACK button and repeat as needed to achieve proper output.

Second, **set mA leading edge for Large filament.** With DIP1-4 still OFF, initially select 50 kVp, 50 milliseconds, and 200 mA. If the leading edge of mA needs adjustment, press MASTER mA and increment or decrement the LG F.S. value that displays in the lower left corner and SAVE. Press the BACK button and repeat as needed to achieve proper output. Now select 300 mA and verify output, again adjusting the MASTER mA value as needed to achieve proper mA.

Third, **set mA stabilized levels for Small and Large filament.** Enable mA feedback (DIP1-4 ON). Select 50 kVp, 200 milliseconds and 50 mA. Adjust mA OFFSET as needed to achieve the proper stabilized mA level and proper mAs. With the same kVp and time, select 300 mA, and adjust the mA SLOPE to achieve the proper stabilized mA level and proper mAs.

Fourth, **verify that the mA waveforms are square for all mA stations** at 40, 50, 70, 90, 110 and 125 kVp. Adjust the individual FIL AMPS number at these points as needed to fine tune the mA leading edge to achieve a square waveform.

Fifth, **adjust kVp**. Select 70 kVp, 50 mA, 100 milliseconds. Adjust the MASTER kV value as needed to achieve proper output. Each number change equals one kVp.

9.3 Step-by-Step Calibration

1. Connect the test equipment.

Connect test equipment per section 9.1.1 above.

2. Enter Calibration Mode and turn off mA feedback.

On the System Controller board set DIP1- 4 to OFF to disable mA feedback. Turn the Operator Console on while holding down the BACK button. The CAL BOOTUP screen will display as shown below.

```
SET DATE       CAL BOOTUP
& TIME                          EDIT APR MODE

                                  RENAME TECH

TUBE ROLL CAL                     MEMORY FUNC

XRAY CAL                          EXIT TO RAD
```

Select XRAY CAL, and enter the password (upper left, lower left, lower right, upper right outer-most arrow keys). The XRAY CAL screen will display as shown below.

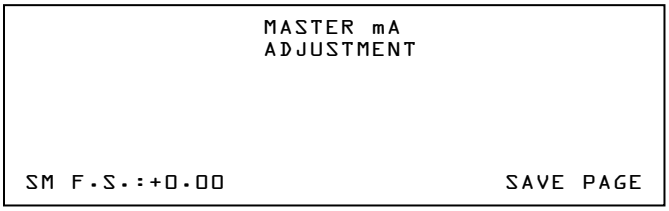
```
                    XRAY CAL
TUBE SETUP                        AEC WALL SET

PWR MOD SET

PWR MOD CAL                           FIL# TBL

AEC TBL SET                               MORE
```

Select PWR MOD CAL. The PWR MOD CAL screen will display as shown below.

```
                  POWER MOD
kVp STEP:40     CALIBRATION

FIL AMPS:4.30                  mA OFFSET:+2

mA:50 SM                           MASTER mA

TIME(ms):50      TABLE TOP         SAVE PAGE
```

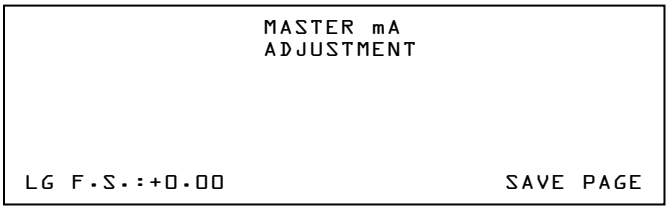
3. Make a master adjustment of mA leading edge for Small focal spot.

Select 50 kVp, 50 milliseconds, and 100 mA on Small focal spot. Make an exposure. If adjustment is needed, press the MASTER mA button and increment or decrement the value for SM F.S. that appears in the lower left corner of the screen as shown below and SAVE the change. Press the BACK button to return to the exposure screen. Repeat as needed to achieve the proper mA amplitude and mAs.



4. Make a master adjustment of mA leading edge for Large focal spot.

Initially select 50 kVp, 50 milliseconds and 200 mA. If adjustment is needed, press the MASTER mA button and increment or decrement the value for LG F.S. that appears in the lower left corner of the screen as shown below and SAVE the change. Press the BACK button to return to the exposure screen. Repeat as needed to achieve the proper mA amplitude and mAs.



Using the same kVp and time, now select 300 mA and verify mA output. If adjustment of mA leading edge is needed at 300 mA, press the MASTER mA button, change the LG F.S. number and SAVE as before. Press the BACK button and repeat as needed to achieve the desired mA amplitude and mAs.

5. Set mA feedback (stabilized mA level) for Small and Large focal spot.

On the System Controller board set DIP1-4 to ON (right) to enable mA feedback. This switch will remain in this position for the remainder of calibration and during normal use.

Select 50 kVp, 200 milliseconds and 50 mA. Take exposures and adjust the mA OFFSET value as needed to achieve the proper stabilized mA and mAs. SAVE the change.

```
                POWER MOD
kVp STEP:50   CALIBRATION

FIL AMPS:4.09              mA OFFSET:+0

mA:50 SM                       MASTER mA

TIME(ms):200   TABLE TOP       SAVE PAGE
```

Using the same kVp and time, now select 300 mA. Take exposures and adjust mA SLOPE as needed to achieve the proper stabilized mA and mAs. SAVE the change.

```
                POWER MOD
kVp STEP:50   CALIBRATION

FIL AMPS:4.83              mA SLOPE:+17

mA:300 LG                      MASTER mA

TIME(ms):200   TABLE TOP       SAVE PAGE
```

6. Verify mA outputs are square for all mA stations across the kVp range.

Take exposures at 40, 50, 70, 90, 110 and 125 kVp at all mA stations (where allowed by kW limits) using 50 milliseconds. Adjust the individual FIL AMPS number at these points as needed to fine tune the mA leading edge to achieve a square waveform of the proper mAs.

7. Calibration of kVp.

Select 70 kVp, and 50 mA. Select a time appropriate to your test equipment, not less than 100 milliseconds. The MASTER kV adjustment will appear in the upper right corner of the screen as shown below. Take exposures and adjust the kVp by changing the MASTER kV value. One number change is equal to one kVp.

```
                POWER MOD
kVp STEP:70   CALIBRATION  MASTER kV:-2

FIL AMPS:4.26

mA:50 SM                       MASTER mA

TIME(ms):100   TABLE TOP       SAVE PAGE
```

IMPORTANT: Due to kW limits, exposures at 125 kVp/250 mA, 110 kVp/300 mA and 125 kVp/300 mA are not possible. Change the filament value numbers at these points as needed to reflect the pattern of values established at other points. Example: 110 kVp/300 mA will typically be .02 less than the value at 90 kVp/300.

☞ **Note: At lower power levels the mA leading edge may have a one-millisecond spike of no more than 50 mA. This is from cable capacitance, and can not be adjusted out by the master or individual filament value numbers.**

8. The Filament Number Table and Recording Calibration Values.

All of the filament numbers can be viewed at one time by selecting the XRAY CAL screen. Selecting FIL# TBL will display all of the numbers that control mA leading edge, with the mA stations in columns and the kVp stations in rows. Notice how the numbers neatly decrease as kVp increases (space charge compensation) and how for a given kVp the values increase as mA increases.

Table 9-1: Typical Filament Values for a Toshiba 1 x 2 mm X-ray Tube

FIL # TABLE	50 mA	100 mA	150 mA	200 mA	250 mA	300 mA
40 kVp	4.30	4.57	4.54	4.64	4.74	4.83
50 kVp	4.28	4.54	4.51	4.61	4.71	4.79
70 kVp	4.26	4.50	4.46	4.56	4.66	4.73
90 kVp	4.24	4.47	4.43	4.53	4.62	4.70
110 kVp	4.22	4.44	4.40	4.50	4.60	4.67*
125 kVp	4.20	4.42	4.38	4.48	4.57*	4.64*

*** Exposure is not possible at these techniques. Enter values, which follow the pattern established at lower kVp for the mA station.**

Each tube type has individual default filament numbers. These tube specific defaults will likely be changed during calibration. This chart is shown for reference only, not as a site-specific calibration record. The actual filament amps required at this installation will be determined during calibration.

☞ **Note: As kVp is increased, the filament value number is decreased slightly due to the space charge effect.**

☞ **Note: We recommended recording the final calibrated FIL#TBL and MASTER mA/MASTER kV values from the XRAY CAL screen in the tables below for future reference.**

Table 9-2: For Recording FILAMENT AMPS Calibration Values

	SMALL FILAMENT		LARGE FILAMENT			
	50 mA	100 mA	150 mA	200 mA	250 mA	300 mA
40 kVp						
50 kVp						
70 kVp						
90 kVp						
110 kVp						
125 kVp						

Table 9-3: For Recording MASTER kV and MASTER mA Calibration Values

MASTER mA Small Focal Spot	MASTER mA Large Focal Spot	MASTER kV

Note that in APR edit mode, only 100 mA small and 300 mA large are selectable.

10.0 TROUBLESHOOTING

10.1 Overview

The 20 kHz HF APR generator has an extensive internal monitoring system. A number of error codes are displayed to alert the operator or service engineer to the status of the system. Some error codes are momentary alerts, and will automatically reset once the offending button has been released. Other error codes indicate simple or serious problems with the system. The chart below shows all error codes, what they mean, and how to correct them.

Table 10-1: Table of Error Codes

Error Code	Likely cause	How to clear the fault	Secondary actions
INVALID kVp LIMIT	**Operator Selected value out of range**	**Release kVp button**	**Unit resets to valid techniques**
INVALID mAs LIMIT	**Operator Selected value out of range**	**Release mAs button**	**Unit resets to valid techniques**
INVALID TUBE LIMIT	**Operator Selected value out of range**	**Release the button**	**kVp and mAs are reset**
INVALID kW LIMIT	**Operator Selected value out of range**	**Release the button**	**Unit resets to valid techniques**
INVALID TIME LIMIT	**Operator Selected value > 5 seconds**	**Release the button**	**Unit resets to valid techniques**
INVALID TIME LIMIT	**Operator Selected value < .01 seconds**	**Release the button**	**Unit resets to valid techniques**

Error Code	Likely cause	How to clear the fault	Secondary actions
INVALID BUTTON	**Press another button to make desired change.**	**Release the button**	**Unit resets to valid techniques**
INVALID mA LIMIT	**User attempted to select < 50 mA or > 300 mA.**	**Release the button**	**Unit resets to valid techniques**
INVALID cm LIMIT	**User attempted to select a cm value beyond APR data.**	**Release the button**	**Unit resets to valid techniques**
ERROR MICRO-P RESTART SYSTEM	**Electrical noise, HV arcing, +5v supply, 01003-000pcb.**	**Cycle power.**	**The filament is disabled.**
ERROR NO COMM. RESTART SYSTEM	**Communication cables**	**Cycle power, find break in serial link.**	
ERROR +/- 12 v LIMIT RESTART SYSTEM	**Power supply pcb, lock noise, or DC fusing**	**Cycle power, put diodes across locks, find damaged component.**	
ERROR EEP R/W	**The calibration data (checked during operation) is corrupted.**	**Cycle power. Call for service. See "troubleshooting guide" below.**	
ERROR EEP CHECKSUM	**Calibration data (checked at power up) is corrupted.**	**Press any button. See "troubleshooting guide" below.**	
ERROR PREP STUCK RESTART SYSTEM	**Prep signal or switch may be shorted.**	**Find the damaged component.**	
ERROR EXPOSE STUCK RESTART SYSTEM	**Expose signal or switch may be shorted.**	**Find the damaged component.**	

Error Code	Likely cause	How to clear the fault	Secondary actions
ERROR SYSTEM COOL DWN	**Wait 10 times exposure length before next exp.**	**Press any button.**	**Unit counts down until exposure is allowed.**
INVALID APR DATA LIMIT	**Receptor configuration at odds with APR receptor selection**	**Press RESET and correct configuration error.**	**See troubleshooting guide below.**
ERROR DOOR INTLK	**Open connection or opto chip on 01003-000pcb.**	**Verify TB3-5 is at ground. Press any button.**	
ERROR TUBE INTLK	**Open connection or opto chip on 01003-000pcb.**	**Verify TB3-4 is at ground. Press any button.**	
ERROR COLMTR INTLK	**Open connection or opto chip on 01003-000pcb.**	**Verify TB3-6 is at ground. Press any button.**	
ERROR GENRL INTLK	**Open connection or opto chip on 01003-000pcb.**	**Verify TB3-7 is at ground. Press any button.**	
ERROR DC BUS LOW RESTART SYSTEM	**Checked at prep; not enough capacitor bank voltage.**	**Cycle power and find damaged component.**	**Confirm K1, BR1, R1, K660 Relay pcb and K445 Charge Monitor pcb are OK.**
ERROR STILL ANODE	**No rotor current during prep.**	**Press any button.**	**Check rotor supply voltage, stator.**
ERROR ANODE ROT RESTART SYSTEM	**Rotor current sensed when not in prep.**	**Cycle power and find defective components.**	**Confirm rotor voltage and SSR1 is not shorted.**
ERROR PREP HELD	**Prep switch or operator.**	**Release prep button.**	**20 sec is max prep time.**
ERROR NO BUCKY MOT	**No B1/B2 closure.**	**Confirm closure and opto. chip on 01003-000, press any key.**	**Confirm image receptor configuration**

Error Code	Likely cause	How to clear the fault	Secondary actions
ERROR mA PRESENT RESTART SYSTEM.	**Check 01003-000at H9 pins 5 and 6.**	**Cycle power. Find defective components.**	
ERROR kV PRESENT RESTART SYSTEM	**Check 01003-000at H9 pins 1 and 3.**	**Cycle power. Find defective components.**	
ERROR LOW FIL AMPS	**Open secondary, filament pcb, or poor mA leading edge calibration.**	**Press any key.**	**Check mA output with/without feedback.**
ERROR HI FIL AMPS	**Filament pcb, or poor mA leading edge calibration.**	**Press any key.**	**Check filament pcb, and mA output with and without feedback.**
ERROR EXP. RELEASE	**Prep/exp switch or operator error.**	**Press any key.**	
ERROR IPM OVERLOAD RESTART SYSTEM	**Excessive current through inverter.**	**Cycle power. Find defective components.**	**See "Trouble-shooting Guide" below.**
ERROR kVp OVERLOAD	**Secondary arcing, kVp > 135.**	**Press any button.**	**Inspect secondary and calibration.**
ERROR kV IMBALANCE	**Anode/Cathode kV feedback missing or wrong polarity**	**Cycle power, fix kV feedback circuit**	**see "trouble codes" below**
ERROR mA OVERLOAD RESTART SYSTEM	**Secondary arcing, calibration, mA is > 380.**	**Cycle power.**	**Inspect secondary and calibration.**

Error Code	Likely cause	How to clear the fault	Secondary actions
ERROR NO MEM CARD	**User error in database transfer operation.**	**Release button, cycle power and insert card when power is OFF.**	**See Memory card function section 11**
INVALID CAL DATA LMT	**Attempted data entry beyond limits.**	**Release button.**	
ERROR APR CHECKSUM	**A change in APR data since last power up.**	**Press any button. Reburn APR defaults from the memory function screen or load APR data from a Memory Card.**	
INVALID TUBE ANGLE	**"Roll"/Angle potentiometer is out of range**	**Perform "roll" pot pre-set procedure**	**Calibrate "roll" potentiometer**

10.2 Troubleshooting Guide

EEPROM READ/WRITE ERROR

If at any point during normal operation the calibration data stored within the Operator Console and within the Power Moudle are in disagreement this error code will display. Cycling power will usually clear the error. See section 11.0 below.

EEPROM CHECK-SUM CORRUPT

If during boot-up of the system the calibration data stored within the Operator Console and the Power Module are in disagreement this error code will display. Reload factory defaults through the MEMORY FUNC screen described below.

ERROR LOW FILAMENT AMPS

There is little or no filament current. Verify that filament supply voltage is present at the filament pcb and that there is continuity in the high voltage secondary. If problem occurs at exposure, inspect the mA waveform with and without mA feedback enabled. Confirm LED 1 and 2 are lit on Filament pcb. Check fuses on Filament pcb.

ERROR HI FILAMENT AMPS

This can occur with mA feedback ON and a leading edge which is too high or too low. The mA stabilizer can overcompensate for the filament number and generate this error code. Confirm feedback circuit integrity of about 68 ohms between H9-4 and H9-5 as well as between H9-4 and H9-6 on System controller pcb. Also inspect the Filament pcb for shorted components.

mA OVERLOAD

Excessive mA. Can come from poorly adjusted mA stabilizer or leading edge. Secondary arc in the mA circuit is possible. Scope the mA waveform with feedback enabled and disabled to determine cause.

ERROR IPM OVERLOAD

Can be tied to mA OVERLOAD, coming from a misadjustment of mA. Can come from excessive inverter capacitor bank voltage; confirm line matching transformer tap voltage feeding capacitor bank does not exceed 256 VAC on TB1. Check for proper supply voltages on IPM Driver pcb. Secondary arcing possible, less likely than above.

kV IMBALANCE

Anode or cathode kVp is missing or wrong polarity. On System Controller board confirm 10k ohms between H9-3 and H9-1 as well as between H9-3 and H9-1. Confirm a positive signal on R71, negative signal on R70 of equal amplitude during exposure. Check for induced noise on these kV feedback signals, and reroute feedback cables between high voltage transformer and power module.

INVALID TUBE ANGLE

Roll potentiometer is either disconnected or out of range. Chech all connections on the roll assembly located on the tubearm assembly. Follow the pot pre-set procedure and calibration procedure if necessary.

10.3 Testing for High Voltage Breakdown

The 20 kHz HF APR generator filament current feedback can be bypassed to allow for shooting the system with an open secondary (no tube or HV cables) to investigate the source of secondary arcing. This procedure should only be performed by personnel familiar with high voltage tests and/or under the guidance of Technical Support.

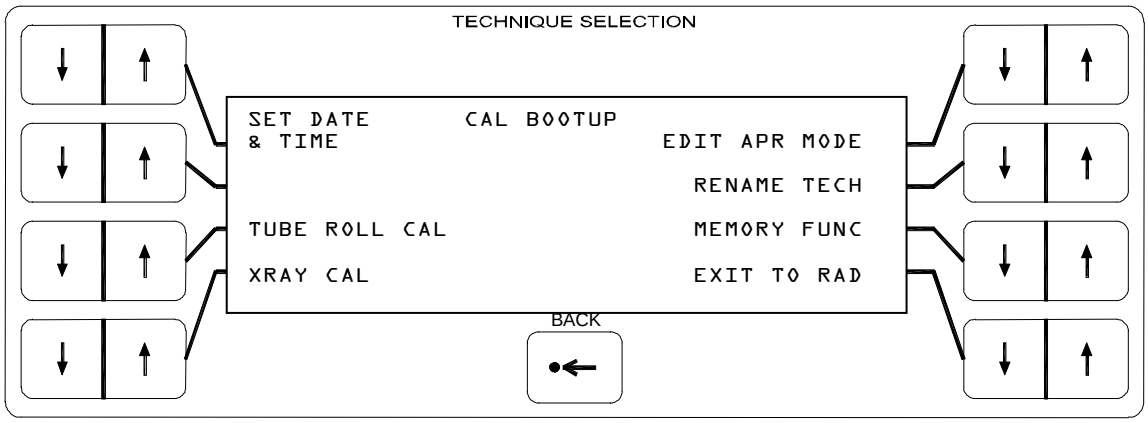
When DIP1 - 3 is in the CLOSED (ON) position (01003-000System Controller pcb), the rotor and filament interlocks and feedbacks are disabled. In this condition, the generator will make kVp, but not mA and will not spin the anode of the tube. This allows potential to be placed on the high tension transformer.

Monitor the kVp feedback test point **TP8** on the System Controller pcb to look for evidence of high voltage breakdown, such as spikes to high potential or spikes to ground. If none are present, the cables or tube would be suspect. Also monitor the mA feedback point **TP9** as there should be no mA. If present, the tank is suspect. When finished with this test, ensure that DIP1-3 is returned to the OPEN (OFF) position.

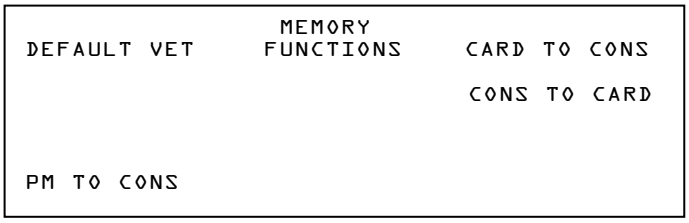
11.0 MEMORY FUNCTIONS

The APR generator has a feature which allows saving the modified anatomical techniques to a remote Memory Card. It is also possible to transfer this information from one generator to another. A memory card will be included with every unit.

11.1 The MEMORY FUNCTION screen. Turn the Operator Console ON while holding down the BACK button. The Console will display as shown below.



Select MEMORY FUNC. The Console will display as shown below.



DEFAULT VET: To reload factory defaults into both Power Module and Operator Console for APR techniques or calibration. (Memory card not required)

CARD TO CONS: To download modified APR techniques from the Memory Card into the Console.

CONS TO CARD: To upload modified APR techniques from Console to Memory Card.

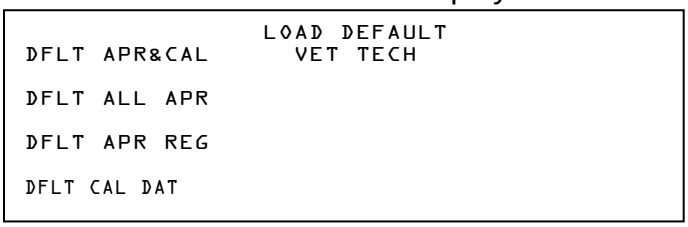
PM TO CONS: To reload the factory default values from the Power Module into the Console. This should be done if the Console is replaced. (Memory card not required)

11.2 Inserting The Memory Card

The memory card insertion slot is located at the bottom of the operator's control near the center. Before selecting any memory card functon, insert the card into the slot. Memory card orientation is important, ensure the **THIS SIDE UP** label is towards you when inserting. The memory card should glide in with out any difficulty. Do not force the memory card into position.

11.3 The DEFAULT VET screen (Memory card not required)

The DEFAULT VET screen will display as shown below.



DFLT APR&CAL allows reloading the factory defaults for both calibration and APR data into the Power Module and Operator Console. Because calibration data is involved, this screen is password protected using the XRAY CAL password. The Console will then ask for confirmation with a NO or YES answer before replacing the data.

DFLT ALL APR allows the user or service personnel to replace all of the existing APR techniques with the factory default values. No password is required, just a NO or YES response.

DFLT APR REG allows the user or service personnel to replace the existing APR techniques with the factory default values one anatomical region at a time. Choose a region and respond NO or YES.

DFLT CAL DAT allows the service personnel to reload the factory default calibration data into the Power Module and Console. Because calibration data is involved, this screen is protected by the XRAY CAL screen password. Enter the password and choose NO or YES.

11.4 The POWER MODULE TO CONSOLE screen. (Memory card not required)

The PM TO CONS screen will allow the installer to reload the site-specific calibration data from the Power Module into a replacement Operator Console. This is required so that the data stored in these two locations is in agreement. Select PM TO CONS, enter the XRAY CAL password, and choose NO or YES.

11.5 The CARD TO CONS screen

The CARD TO CONSOLE screen allows APR data from the Memory Card to be downloaded into the Operator Console. This can be useful if this site is using the same film/screen combination as a previous installation which has modified APR techniques, or if the x-ray service company has an established technique database they like to offer. A confirmation screen will ask if you wish to copy all APR techniques from the selected memory card with a NO or YES response. After the data transfer is complete, turn the console off and remove the card.

NOTE: If EEPROM CHECKSUM ERROR is diplayed, return to the MEMORY FUNCTIONS screen and select PM TO CONS. This will re-copy the existing calibration data from the power module into the operator console and clear the error.

11.6 The CONS TO CARD screen

The CONSOLE TO CARD screen allows uploading APR technique database information from an Operator Console into the Memory Card. This can be useful for on-site back-up storage of a modified APR database, or for carrying a modified database to be downloaded at another site. A confirmation screen will ask if you wish to copy all APR techniques from the Operator Console to the memory card with a NO or YES response. The modified techniques will remain in the Operator Console, but now there will be a back-up copy in the Memory Card.

WARNING: The memory card can only hold one full set of APR data. Saving data from the console to the card overwrites data which was previously stroed.

12.0 ACCURACY TESTING

12.1 Overview

Once the 20 kHz APR generator has been installed and calibrated, the outputs must be verified. Record the kVp and mAs values, ensuring that they are compliant with the accuracies stated in this manual, as well as federal and local guidelines.

Note: When calculating kVp or mAs accuracy, the test equipment accuracy must be subtracted from the stated generator accuracy. If the kVp output is within this new performance standard then the kVp is certain to be within the generator specifications, even if the test equipment is at the maximum of it's error range.

The formula for this calculation is:

(Generator accuracy) – (test equipment accuracy) = performance standard.

For instance, if the generator kVp accuracy is 5% and the test equipment has a 2% error, subtract 2% from 5% to achieve a new required system accuracy of ±(3%+1) kVp.

SAMPLE CALCULATIONS:

For 40 kVp, the output must be within ± (40 x 3%) + 1 = (1.2) + 1 = 40 kVp ± 2.2 kVp.
For 100 kVp, the output must be within ± (100 x 3%) +1 = ± (3) + 1 = 100 kVp ± 4 kVp
These sample calculations are for kVp with a 2% test equipment error. The kVp or mAs output measured and the accuracy of the test equipment used will be different than in these samples, but the method of generating the system accuracy will be the same.

12.2 Accuracy of kVp and mAs Outputs

The published specifications for this generator are ±(5%+1) kVp, and ±(10%+1) mAs. Local regulations may be more or less stringent. Make exposures, recording the selected kVp and mAs below. Calculate the required system accuracy by subtracting test equipment error using the methods described above and record the error percentage.

Table 12-1: Table for Recording kVp and mAs Outputs

Selected kVp	Measured kVp	Selected mAs	Measured mAs

kVp error %		**mAs error %**	

☞ **NOTE: If the unit does not meet the accuracy specifications, view the mA and kVp waveforms, verify calibration, and check for line voltages below 230 VAC in either idle or full load exposure mode. Correct the problem and retest the system.**

13.0 REQUIRED MAINTENANCE

13.1 Overview

Routine maintenance is to be performed 30 to 60 days after the initial installation and every six months thereafter. It is the responsibility of the equipment owner to see that this maintenance is performed as scheduled to meet warranty obligations. The installing dealer or other factory authorized service organization will be able to perform this maintenance. The following list is a minimum checklist: your maintenance procedure may be more extensive than that shown below.

13.2 Routine Maintenance Checks

- ☐ All system cables inspected for wear, binding, and tightness of connections.
- ☐ High Voltage cables inspected for signs of breakdown, abrasion, or wear; receptacles regreased and tightened into the HV transformer and x-ray tube.
- ☐ Line voltage checked, and TB1/TB2 verified to be set properly for the supply.
- ☐ Power module internal connections checked for wear, binding and tight connections.
- ☐ Communication cables checked for wear or binding and tightness of connections.
- ☐ kVp and mAs outputs verified to be within accuracy limits.
- ☐ kVp and mA waveforms verified to be of the proper amplitude and shape.
- ☐ Operate all of the switches on the console and verify that the appropriate switches function properly. Some switches (such as AEC controls) may not be enabled.
- ☐ Note that all text and numbers on the Console screen illuminate properly.
- ☐ Some municipalities require verification of repeatability and linearity.

Table 13-1: Required Maintenance Log

Date of maintenance	Performed by	Notes and results

14.0 THEORY OF OPERATION

14.1 Power Module

The Power Module contains microprocessor-driven control circuitry to spin the anode of the x-ray tube, generate filament supply voltages, supply power for locks and collimation, maintain monitoring of system status, and retain calibration information. Primary voltage for the high voltage transformer is supplied by IPMs operating in a pulse width modulated resonant circuit.

14.2 Operator's Console

The Operator Console is a microprocessor controlled entry/display port connected with the System Controller pcb through serial communications. APR techniques and calibration data is stored in the Console and compared to the data in the Power Module to confirm data accuracy. It is possible to upload site-specific calibration data from the Power Module in the event of changing to a new Console. The factory default values for calibration and APR techniques can be reburned into the Console. APR techniques can be uploaded to a Memory Card or downloaded from a Memory Card into the bottom of the Console if desired. The Operator/User can manipulate the APR techniques, changing and storing as required to achieve the character of images desired.

14.3 High Voltage Transformer

The High Voltage Transformer steps up the voltage received at P1 and P2 to levels required to make the x-ray tube conduct, ranging from 40 to 125 thousand volts. Filter capacitors within the tank are part of the tuned resonant circuit. The assembly is filled with Shell Diala AX, a highly refined non-PCB dielectric oil.

15.0 SCHEMATICS

The following prints are included in the schematic package.

01712-000 schematic, power on/off pcb 01710-000

K439 schematic, high voltage transformer

K505 schematic, HV transformer feedback pcb

K591 schematic, Charge Monitor pcb K445

01782-000 schematic, IPM Driver pcb 01780-000

K594 schematic, Rotor Sensor pcb K444

K653 schematic, Power Supply pcb K650

K662 schematic, Relay pcb K660

K669 schematic, HV Rectifier pcb K467

01794-000 schematic, System, 30 kW, 1 phase

L112 schematic, HV Capacitor pcb L110

L512 schematic, 20 kHz OEM APR Console pcb L510

01005-000 schematic, System Controller pcb 01003-000

01772-000 schematic, Filament Driver pcb 01770-000

01362-000 schematic, Memory Card Interface pcb 01360-000

01394-000 schematic, Extended Memory Card pcb 01392-000