

Technical Publication
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Maintenance

HF Series Generators

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
0	APR 15, 2014	First Edition.
1	DEC 04, 2014	Fans maintenance and general updates.
2	OCT 20, 2015	CTSC Touch Screen Console.
3	MAR 19, 2020	HV Transformer maintenance updated.

This Document is the English original version, edited and supplied by the manufacturer.

The Revision state of this Document is indicated in the code number shown at the bottom of this page.

ADVISORY SYMBOLS

The following advisory symbols will be used throughout this manual. Their application and meaning are described below.



DANGERS ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.



ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEDED OR AVOIDED COULD CAUSE SERIOUS PERSONAL INJURY, OR CATASTROPHIC DAMAGE OF EQUIPMENT OR DATA.



Advise of conditions or situations that if not heeded or avoided could cause personal injury or damage to equipment or data.

Note 

Alert readers to pertinent facts and conditions. Notes represent information that is important to know but which do not necessarily relate to possible injury or damage to equipment.

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SECTION 1 INTRODUCTION

The purpose of this Periodic Maintenance is to assure continued safe performance of the X-ray Generator, to increase serviceability, to reduce the costs (down time, repairs, etc.) and to assure the safety (personal risk).

The following checks and maintenance procedures, together with the suggested intervals, are the manufacturer's recommendation for the most effective Periodic Maintenance schedule for this Generator.

Service tasks here described must be performed exclusively by service personnel specifically trained on medical X-ray Generators.

The first Periodic Maintenance Service should be performed six (6) months after installation, and the subsequent services every twelve (12) months. Periodic Maintenance Service depends on the working load of the Generator and X-ray Tube.

Note 

Take note in the Data Book of all the periodic maintenance services carried out and the data changes made during any maintenance service.

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SECTION 2

PERIODIC MAINTENANCE PROCEDURES



When any major component, such as an X-ray Tube, HV Transformer or major circuit board, is replaced in the system, perform the respective Configuration and Calibration procedures.



Whenever the HV Transformer or X-ray Tube is replaced in the Generator, the respective configuration and calibration procedures must be performed.

If the A3640-XX Control board is replaced, restore the configuration data from the backup file saved in the computer and perform the required calibration procedures, or transfer the U66-EEPROM from the old board to the new board and perform the calibration procedures. U66-EEPROM contains configuration and calibration data.

If the backup file cannot be restored and U66-EEPROM is not transferred, complete configuration procedure must be performed.

Update and record in the Data Book any new calibration data.

Before starting the periodic maintenance procedures, it is recommended to make a test exposure using the same operating factors and conditions as a typical exposure.

Perform the X-ray tube warm-up procedure if the tube has not been in use for approximately one hour. (*Refer to Operator Manual of the Console.*)

2.1 TEST EQUIPMENT

The tools and test equipment required to perform the Periodic Maintenance Service are the same as specified in the “*Installation*” document.

2.2 GENERAL CAUTIONS



MAKE SURE THAT THE MAIN STORAGE CAPACITORS OF THE HIGH VOLTAGE INVERTER DO NOT CONTAIN ANY RESIDUAL CHARGE. WAIT UNTIL THE LIGHT EMITTING DIODES ON THE CHARGE/DISCHARGE BOARD AND ON THE ROTOR CONTROLLER ARE OFF (APPROX. 3 MINUTES AFTER THE UNIT IS TURNED OFF).



ALWAYS HAVE THE "IPM DRIVER BOARD" CONNECTED IN THE GENERATOR PREVIOUS TO MAINS POWER IS ACTIVATED IN IT. IF THE "IPM DRIVER BOARD" IS NOT CONNECTED, PERMANENT DAMAGE WILL OCCUR TO IGBTs.



THIS GENERATOR IS PERMANENTLY CONNECTED TO THE POWER LINE AND POWERED ON UNLESS THE SAFETY SWITCH INSTALLED IN THE ROOM ELECTRICAL CABINET IS OFF. WHEN THE GENERATOR IS POWERED, THE NEON LAMP (GREEN) LOCATED IN THE TRANSFORMER T2 (GENERATOR CABINET) IS ON.

INTERNAL PARTS OF THE GENERATOR (ALL FUSES, LINE CONTACTOR [K2], INPUT TRANSFORMER [T2] AND ON/OFF RELAY [K1]) ARE PERMANENTLY POWERED ON THROUGH POWER LINE EVEN IF THE GENERATOR IS OFF. BE SURE THAT THE SAFETY SWITCH IS OFF BEFORE HANDLING ANY INTERNAL PART OF THE EQUIPMENT.

2.3 GENERAL CLEANING



NEVER ATTEMPT TO CLEAN OR HANDLE ANY PART OF THE X-RAY GENERATOR WHEN IT IS TURNED ON. SWITCH OFF THE GENERATOR MAIN DISCONNECT BEFORE CLEANING OR INSPECTING.

2.3.1 EXTERNAL SURFACES

Clean external covers and surfaces frequently, particularly if corroding chemicals are present and specially parts in contact with the patient, with a cloth moistened in warm water with mild soap solution. Rinse wipe with a cloth moistened in clean water. Do not use cleaners or solvents of any kind.

Clean Console keyboard and displays with a cloth dampened in warm water. Rinse wipe with a cloth dampened in clean water.

Also check painted surfaces for scratching and touch up as required.

2.3.2 INTERNAL CABINET CLEANING

Remove the external covers from the Generator Cabinet.

Turn on the Generator and make sure that the fans operate properly. Then, turn off the equipment and switch off the Generator main disconnect to perform the rest of the cleaning procedure.

Visually inspect all major components for dust or foreign items. Search carefully to detect objects which might cause short circuits and for loose connections.

If excess dust is present, clean the interior of the Generator Cabinet using a dry brush or vacuum cleaner. Clean the fans and make sure that the vent holes of the cabinet are not obstructed.

Remove the ventilation grille below the fans (two screws on the outside of the bottom of the Generator) in order to clean it and screw it back in place.

2.3.3 INTERNAL CTSC CONSOLE CLEANING



MAKE SURE THAT THE TOUCH SCREEN CONSOLE IS POWERED OFF OR UNPLUGGED.

Remove the back covers of the Touch Screen Console.

Visually inspect internally for dust or foreign items. Search carefully to detect objects which might cause short circuits and for loose connections.

If excess dust is present, clean the interior of the CTSC Console using a dry brush or vacuum cleaner. Make sure that the fans operate properly and the vent holes are not obstructed.

Clean the Touch Screen with an isopropyl alcohol and water solution ratio of 50:50, always damp the lint-free cloth and then clean the screen. Spray the cleaning liquid onto the cloth, never spray directly on the screen.

2.4 CABLE CHECKS



CAREFULLY HANDLE ALL INTERNAL PARTS OF THE UNIT.

Check that all electrical connections are firm and secure and that all cable clamps and strain reliefs are in place. Also check that connectors do not have exposed wire-veins and check cable sheaths (cable cover) for wear and fraying.

Check that all cables are correctly routed.

2.4.1 GROUND CABLE CONNECTIONS

The central reference ground of the X-ray System and Generator is located at the Generator Cabinet.

Check the ground lead interconnections continuity using a multimeter at its lowest ohms range.

2.4.2 AC POWER SUPPLY IN X-RAY ROOM

Measure the value of AC power supply between all phases, neutral and ground. Check that these values comply with the tolerances established at the original installation.

2.5 CONTROL CONSOLE CONDITION

Check the proper connection and condition of the cables connected to the Console.

If applicable, check the Handswitch condition. Verify that the Handswitch cable and its connection to the Console are in good condition.

Check correct operation of the buttons, displays and indicators by performing the following test:

1. Turn the Generator/Console ON.
2. If the Console is a CTSC Console, touch on different points of the operator application on the Touch Screen to check that the Touch Screen Sensor is properly calibrated. It is factory calibrated and it does not require any calibration procedure.
3. If applicable, check the Handswitch condition. Verify that the Handswitch cable and its connection to the Console are in good condition.
4. Select a radiographic technique and observe:
 - Indicators of the selected workstation and Focal Spot.
 - Technique parameters are displayed on the Console. Change the technique parameters and observe that changes are correctly displayed.
 - Select the parameters for an usual exposure. Press “Prep” and verify that the “Ready” indicator is activated. Release “Prep” and observe that the “Ready” indicator is deactivated.
 - Make the exposure, and verify that radiographic exposure signal sounds and the “Prep” and “X-ray On” indicators are activated during the exposure.
5. If AEC is installed, select a technique with AEC and observe that the indicators of the selected AEC controls are activated.
6. If APR is installed, select an APR technique and observe:
 - Indicators of the selected Patient Size are activated and the Body Region/Anatomical Views are shown on the APR Display and its corresponding parameters are shown on the RAD Display.
 - Change the APR technique and observe that selection and parameters changes on both Displays.

7. If Fluoro is installed, select a workstation for Fluoro operation and observe:
 - Fluoro parameters are displayed on the Fluoro Display.
 - Change the Fluoro kV and observe that changes are correctly displayed.
 - Check selection of another functions related to Fluoro if they are present (ABC, PPS, etc.).

2.6 HV TRANSFORMER CONDITION

Make sure that:

- HV oil in the HV Cable terminals is clean and shows no evidence of arcing.
- HV Cable terminal rings are tight.

2.7 X-RAY TUBE CONDITION

Make sure that:

- All parts are mechanically secure with no oil leaks.
- HV grease on the HV Cable terminals is clean and shows no evidence of arcing.
- HV Cable terminal rings are tight.

2.8 RADIOGRAPHIC PARAMETERS

With the generator power OFF, connect:

- Non-invasive kV Meter to measure kV.
- mAs Meter to the banana plug connections on the Control Board (TP85 & TP86) to measure mA or mAs.

Note

*Test points on the Control board can also be used to monitor the kV and mA readings but **should not be used** to calibrate the unit. These test points must be checked with scope:*

- mA test point is TP48 and the scale factor is:
 - up to 10 mA, 1 volt=1 mA
 - from 10 to 80 mA, 1 volt=10 mA
 - from 100 mA, 1 volt=100 mA
 - kV test point is TP54 and the scale factor is 1 volt=33.3 kV.
1. Verify that dip switch 3640SW6-4 on the Control board is set to **Off** (enables Filaments) and Filaments are not disabled by software.
 2. Turn the generator ON and select one workstation (e.g. "Direct").
 3. Select the following parameters, make an exposure and note the kV and mAs values read on the kV and mAs Meters.
 - 80 kV, 100 ms, minimum mA for Small Focal Spot.
 - 80 kV, 100 ms, maximum mA for Small Focal Spot.
 - 80 kV, 100 ms, minimum mA for Large Focal Spot.
 - 80 kV, 100 ms, maximum mA for Large Focal Spot.
 4. Check that
 - The kV value read on the kV Meter must be 80 ± 2 kV.
 - The mAs values read on the mAs Meter must be the same mAs displayed on the Console with a tolerance of $\pm 3\%$ mAs.

If the kV and mAs values do not comply with the above values, perform the respective Calibration procedures.

2.9 AEC CHECKS

Note 

For AEC test with Film, use the same Film and Cassettes used by the customer. AEC test must be performed using all the Film/Screen speed combinations used by the customer. The Medium Film/Screen speed has to be double of the Slow and half of the Fast (a.e. 200-Slow, 400-Medium, 800-Fast).

Note 

When using CR (Computed Radiography) or DR (Digital Radiography) test the sensitivities used by the customer and instead of measuring Optical Density:

- measure the Image Gray level by using the needed software tools inside each application (refer to CR or DR documentation).

- or measure the Dose level:

- For CR, placing the Dosimeter as close as possible to the Cassette and centered with the Central Area of the Ion Chamber.

- For DR, placing the Dosimeter as close as possible to the Panel, centered with the Central Area of the Ion Chamber and with the Grid removed.

Note 

The Film Optical Density/Dose Level must be measured always on the same point. The recommended point is on the central axis of the Receptor with relation of the Anode and Cathode.

1. Set the SID at any Focal Distance from 1 to 2 meters (39 to 78 inches).
2. Collimate the X-ray beam so that it completely covers all three fields but does not extend beyond the limits of the phantom.

3. Add a filtration based on the RQA5 standard (21 mm Al) in the Collimator Filter Holder.

Note 

Make sure to keep the same SID during the whole process and that the Exposure field covered by the X-ray beam remains constant.

4. Select on the Console:
 - A Workstation configured for the Ion Chamber to be tested.
 - RAD: 50 kV, 200 mA, Large Focal spot and 1 second back-up time.
 - AEC: "Central Area", "Density 0" and the Film/Screen combination to be tested.
5. Make an exposure with the previously selected values and measure the Optical Density or the Dose level.
 - a. If the Optical Density/Dose Level is not as required, perform the AEC Calibration procedure.
 - b. If the Optical Density/Dose Level is as required, perform the following steps.
6. Repeat the previous procedure for 80 and 120 kVp.
7. Check that the Optical Density/Dose Level obtained with those exposures is as required and the same ± 0.2 of the Optical Density (or $\pm 20\%$ of Image Gray Level/Dose Level with CR or DR) obtained at 50 kVp.
8. If the Optical Density/Dose Level is not as required, perform the AEC Calibration procedure.
9. Repeat the above steps for all the Ion Chambers installed with the Generator.

2.10 FLUORO CHECK

Fluoro functions are tested by performing the following steps:

1. Turn the Generator ON.



Make sure that the Small Filament of the X-ray tube is properly warmed-up.

2. Set up a Dosimeter to measure the Maximum Entrance Skin Exposure Dose Rate. Position the Probe at the center of the primary beam with the entire active volume within the primary beam. Place the Tube-Collimator Assembly at 1 meter SID of the Table-Top, fully open the Collimator Blades and align the Image Intensifier with the light beam. Block radiation input to Image Intensifier with a Lead Apron.

Note

Note that in practice, the rejection limits for entrance exposure rate must be somewhat less than the maximum specified due to Dosimeter calibration accuracy.

METER CALIBRATION ACCURACY	REJECTIONS LIMITS		
	FOR 5 R/min (43.5 mGy/min) MAXIMUM	FOR 10 R/min (87 mGy/min) MAXIMUM	FOR 20 R/min (174 mGy/min) MAXIMUM
±5%	4.75 R/min (41.3 mGy/min)	9.5 R/min (82.7 mGy/min)	19 R/min (165.4 mGy/min)
±10%	4.50 R/min (39.2 mGy/min)	9.0 R/min (78.3 mGy/min)	18 R/min (156.6 mGy/min)
±15%	4.25 R/min (37.0 mGy/min)	8.5 R/min (74.0 mGy/min)	17 R/min (148.0 mGy/min)

3. For testing the Dose, make a Fluoro exposure at maximum kV and measure the dose applied, it should not be over the Rejection Limits for 5 R/min (43.5 mGy/min), 10 R/min (87 mGy/min) or 20 R/min (174 mGy/min) (refer to the above table).

In case that the value is not acquired, perform the respective Fluoro calibration process.

4. The Fluoro mA values are obtained by measuring the average mA using a mA meter in Fluoro.

During Fluoro exposure, mA values are read directly with a mA Meter connected to the mA Test Points (TP85 and TP86 of the Control Board). Only for this purpose, remove the link between TP85 and TP86.

5. For testing the mA, make a Fluoro exposure at 50 kV, 80 kV and 120 kV.

Check that the mA values read on the mAs Meter must be the same mA displayed on the Console with a tolerance of $\pm 10\%$ mA. If the mA value does not comply with the above values, perform the respective Calibration procedures.

6. Remove the Dosimeter and the Lead Apron (Blocker).

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