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Maintenance

Challenge-X
X-ray System

REVISION HISTORY

REVISION	DATE	REASON FOR CHANGE
0	OCT 03, 2022	First Edition

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 HEEDED OR AVOIDED WILL CAUSE SERIOUS PERSONAL INJURY OR DEATH.

ADVISE OF CONDITIONS OR SITUATIONS THAT IF NOT HEEDED 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 MAINTENANCE

The purpose of this Periodic Maintenance is to assure continued safe performance of the X-ray System, 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 equipments.

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

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.*

1.1 GENERAL INFORMATION

For a secure and continuous operation of the X-ray equipment, a periodical maintenance program has to be established. It is the owner's responsibility to carry out and to keep this maintenance. Once the installation is finished, the Overhead Tube Crane needs a maintenance every 12 months.

NEVER ATTEMPT TO CLEAN ANY PART OF THE EQUIPMENT WHEN THE EQUIPMENT IS POWERED ON. SWITCH OFF THE LINE POWER SUPPLY BEFORE CLEANING.

ONLY SERVICE PERSONNEL SPECIFICALLY TRAINED ON MEDICAL X-RAY EQUIPMENT SHOULD WORK ON OR MAINTAIN THIS EQUIPMENT. ALL MAINTENANCE MUST BE DONE BY THE APPROPRIATE MAINTENANCE PERSONNEL, QUALIFIED FOR THE MAINTENANCE OF THIS EQUIPMENT AND AWARE OF THE POTENTIAL DANGERS ASSOCIATED WITH THIS EQUIPMENT.

Do not use cleaners or solvents of any kind as they may dull the finish or blur the lettering. Polish with clean water or paste wax. Do not use a wax containing a cleaning substance.

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.

Note ☞

Maintenance frequency can depend on determinate legal requirements of the country or state in which the equipment is installed. Always check the legislation and local normative when determining the maintenance calendar.

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).*

1.2 CLEANING ADVICES

- Do not use anything but water and soft soap to clean the plastic surfaces. Other cleaning products may damage the plastic covers.
- Never use detergents, corrosive polishers, solvents or abrasives.
- Be sure that neither water nor other liquids can penetrate the equipments. This caution avoids short-circuits and corrosive formation in components.
- Disinfectant methods in use have to conform to legal regulations as well as any directives for disinfectants and protection against explosions.
- If disinfectants which may form explosive gas mixtures are in use, these gases must be dissipated before the equipment is switched on again.
- Aspersion decontamination is not recommended because the disinfectant may penetrate in the X-ray equipment.
- If the room decontamination is carried out with an atomizer, it is recommended to SWITCH OFF the equipment, to let it cool, and to cover it with a plastic bag. When the disinfectant cloud has disappeared, the plastic bag can be removed and the equipment can be disinfected just with a cloth.
- Use only a soft cloth, fluff free, and non-ammonia glass cleaners to clean the screen. Always damp the cloth before cleaning the screen. Be sure to pulverize the liquid on the cloth, not on the screen, to prevent drops from filtrating into the screen or dirty the frame. Avoid abrasive cloths.

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.

1.3 PERIODIC MAINTENANCE SCHEDULE (PMS)

THE MAINTENANCE ACTIVITIES SHOWN IN THE FOLLOWING TABLES HAVE TO BE CARRIED OUT BY AUTHORIZED MAINTENANCE PERSONNEL ONLY. HOWEVER, THE OWNER OR THE EQUIPMENT OPERATOR HAS TO PROGRAM THE SUGGESTED MAINTENANCE ACTIVITIES, WHEN NECESSARY, CONTACTING THE TECHNICAL SERVICE OF THE MANUFACTURER.

Table 1-1
System Performance Schedule

MAINTENANCE TASK	FREQUENCY (Months)	REQUIRED TIME (min.)	PROCEDURE
GENERAL TASK			
Visual Inspection	12	60’	Check the System for proper operation (*refer to Section 1.4.1 Visual Inspection & Cleaning*).
Cleaning and General Painting	When necessary	90’	*Refer to Section 1.2 Cleaning Advices* and *Section 1.4.1 Visual Inspection & Cleaning.*
Functional Checking	12	30’	Carry out the tasks described in Functional Checks Section in Installation document.
System Cables	12	30’	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. *(Refer to Section 1.4.2 System Cables Checking)*. Check that all cables are correctly routed. Change them every 10 years.
Ground Cables	12	30’	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. (*Refer to Section 1.4.3*). Check that all cables are correctly routed. Change them every 10 years.
SYSTEM CALIBRATION			
Perform all Positioners Alignment and Adjustment Procedures	12		Refer to document CC-1236RX
Perform all Detector Calibrations	12		Refer to the Detector specific documentation

MAINTENANCE TASK	FREQUENCY (Months)	REQUIRED TIME (min.)	PROCEDURE
SYSTEM Procedures			
AC Power Supply in X-ray Room	12	10’	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.
HV Transformer Condition	12	15’	Check that there is not oil leakage. If found, remove the oil fill plug from the top of the HV Transformer and verify that the oil level is within 20 mm (3/4”) of the top surface of the HV Transformer. If necessary add oil “Shell Diala AX”. Make sure that HV oil in the HV Cable terminals is clean and shows no evidence of arcing. Make sure that HV Cable terminal rings are tight.
X-ray Tube Condition	12	10’	Make sure that all parts are mechanically secure with no oil leaks. Make sure that HV grease on the HV Cable terminals is clean and shows no evidence of arcing. Make sure that HV Cable terminal rings are tight.
Radiographic Parameters	12	10’	Refer to *Section 1.4.7 Radiographic Parameters*.
AEC Check	12	10’	Make sure that System accurately measures dosage during AEC (*Refer to Section 1.4.8 AEC Checks*).
Emergency OFF Switches	12	5’	Check all Emergency OFF Switches of the System for correct operation (*refer to Section 1.4.9 Emergency OFF Switches Checking*).

Table 1-2
Periodic Maintenance Schedule for the Overhead Tube Crane

MAINTENANCE TASK	FREQUENCY (Months)	REQUIRED TIME (min.)	PROCEDURE
GENERAL PERFORMANCE			
Visual inspection	12	10’	Search for evidences that indicate damages and wrong operation.
Check Movement	12	15’	Check that the Suspension can be moved smoothly in all directions. Verify the full range of motion. Pay attention to any high moving efforts, noises and vibrations.
Check for obstacles for any movement	12	5’	Check for all movements where is present any interference (i.e., rubbing, cabling, etc.)
Electrical Cables & Hose	12	10’	Check for firm and secure electrical connections 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 the Cables routing along the Hose, without knots and strains. Change all Cables every 10 years.
LONGITUDINAL RAILS			
Fixations to Ceiling	12	15’	Check the fastening screws of Longitudinal Rails for tight conditions.
Leveling	12	10’	Check Rails for leveling and readjust, if required.
Greasing	12	15’	Clean the tracks of rails and lubricate them.
Belt	12	5’	Check the fixations of the Longitudinal Belt for tightness and also for excessive wear of the notches, which indicates wrong operation and misadjustment with the Potentiometer.
End Stops	12	5’	Check the End Stops for excessive wear or loose fixations which indicate wrong operation.
TRANSVERSE RAIL BRIDGE			
Fixations to Longitudinal Rails	12	10’	Check the fastening screws of Transverse Rails, Transverse Trays and Wheels for tight conditions.
Leveling	12	10’	Check Rails for leveling and, if required, readjust.
Greasing	12	15’	Clean the tracks of rails and lubricate them.
End Stops	12	5’	Check the End Stops for excessive wear which indicates wrong operation.

MAINTENANCE TASK	FREQUENCY (Months)	REQUIRED TIME (min.)	PROCEDURE
MAIN CARRIAGE			
Fixations of Parts	12	10’	Check the fastening screws of the Pulley, Motors and Brakes for tight conditions.
Steel Cables & Central Pulley	12	10’	Check the status of the steel cables, that neither rubbings nor threads appear. Change them every 10 years. Check the Pulley for shavings, wears or deformations. *refer to Section 1.5.1 Cleaning and Checking the Steel Cables & Central Pulley).*

Table 1-3
Periodic Maintenance Schedule for the RAD Table

MAINTENANCE TASK	FREQUENCY (Months)	REQUIRED TIME (min.)	PROCEDURE
TABLE BASE AND TELESCOPIC COVERS			
Visual inspection	12	10’	Search for evidences that indicate wrong operation.
Covers	12’	5’	Check covers for proper operation, free of noises and vibrations in the case of the NET500 Table.
Control Pedals	12’	5’	Check their state an operation. Be sure that the pedals and the switches can be freely moved, with no obstructions.
Electrical Cables	12	10’	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 the Cables routing, without knots and strains. Change all Cables every 10 years.
ELEVATION MECHANISM			
Motors	12’	10’	Check its state and proper operation, free of noises and vibrations.
Motor Fastening and Scissors	12’	10’	Check the fastening screws of the motor for tight conditions.
Scissors Guides and Wheels	12’	10’	Clean and grease with light machine oil, if necessary.
TABLETOP AND FRAME			
Surface Finish	12’	5’	Check its state and clean.
Supports	12’	5’	Clean and grease with light machine oil, if necessary.
Longitudinal Tracks	12’	5’	Check its state, and clean and grease with light machine oil, if necessary.
Transversal and Longitudinal End Stops	12’	5’	Check the fastening screws of the End Stops for tight conditions.

Table 1-4
Periodic Maintenance Schedule for the RAD Wall Stand

MAINTENANCE TASK	FREQUENCY (MONTHS)	REQUIRED TIME (min.)	PROCEDURE
COLUMN			
Visual Inspection	12	10’	Search for evidences that indicate wrong operation.
Electrical Cables	12	10’	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 the Cables routing, without knots and strains. Change all Cables every 10 years.
Floor Fixation	12	10’	Check the fastening screws of Column to the Floor for tight conditions.
Covers	12’	5’	Check its state and proper operation, free of noises and vibrations.
Counterweight Chain	12’	10’	Inspect and grease length of chains. Replace them if excessively rusty.
Carriage Roller Bearing Inspection	12’	5’	Check roller bearings and tracks.
Vertical Lock	12’	5’	Functional check
RECEPTOR CABINET			
Grid Oscillating Mechanism	12’	5’	Check that the movement is not obstructed.
Bucky/Detector Switch	12’	10’	Check the visual aspect and the switch operation.
Lineal Tracks	12’	5’	Check its state, and clean and grease with light machine oil, if necessary.
Rubber Bumper End Stops	12’	5’	Check their state and tighten the anchorages.
Tray	12’	5’	Check its general state.
Blocking System	12’	5’	Check the state and the blocking system. Clean and grease with light machine oil, if necessary.

When proceeding to Receptor vertical displacement, if it suddenly gets more difficult and goes harder, please stop operating and get in contact with technical service.

Table 1-5
Periodic Maintenance Schedule for the X-ray Generator and PC Interface Box

MAINTENANCE TASK	FREQUENCY (MONTHS)	REQUIRED TIME (min.)	PROCEDURE
Visual Inspection	12	10’	Search for evidences that indicate wrong operation.
Cabling & Connections	12	10’	
Cleaning	12	10’	Vacuum Dust.
Generator Battery Check	12	15’	Measure Voltage.

1.4 GENERAL MAINTENANCE PROCEDURES

1.4.1 VISUAL INSPECTION & CLEANING

1. Disconnect all equipment from the main power.
2. Check the Positioners for debris that would indicate abnormal wear:
   - Scratches and damages in the Covers
   - Metal Shavings
   - Excessive dust
3. Use mild soap to clean the exterior areas of the equipment:
   a. X-ray Generator
   b. Overhead Tube Crane:
      - Exterior areas as Covers, Hose, Telescopic Column, X-ray Tube and Collimator Assembly, and finally the TFT Control Console.
      - Wheels, longitudinal rails and the Bridge, both interior and exterior surfaces.
   c. Elevating Table: Tabletop, Covers and Pedals.

The Receptor Cabinet should be cleaned only with a dry cloth to avoid damaging the board installed in the lower part of the Tray.

   d. Wall Stand: Covers, Vertical Carriage and Receptor Assembly.
   e. Operator Room: Workstation, PC Interface Box, etc.

1.4.2 SYSTEM 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.

1.4.3 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.

1.4.4 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.

1.4.5 HV TRANSFORMER CONDITION

Make sure that:

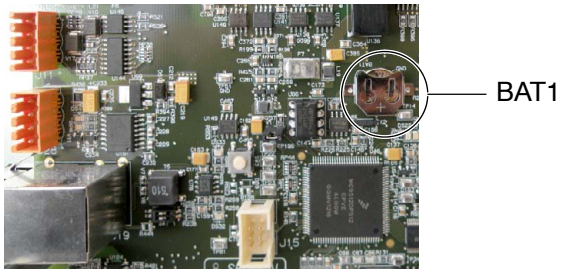
- HV oil in the HV Cable terminals is clean and shows no evidence of arcing.
- HV Cable terminal rings are tight.

1.4.6 GENERATOR BATTERY CHECK

Check the voltage of the A3640-XX Control board battery (BAT1). If the voltage is below 2.8 VDC ⎓, replace the battery with a new one of the same type.

The estimated battery life is about 5 years. It is recommended to replace the battery after this period as a preventive measure, even if the voltage reading is above 2.8 VDC ⎓.

Illustration 1-1
BAT1 Battery on the A3640-XX Control board



1.4.7 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 ±3% mAs.

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

1.4.8 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 ±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.

1.4.9 EMERGENCY OFF SWITCHES CHECK

The System is equipped with different Emergency OFF Switches:

- In the Electrical Room Cabinet,
- at the top of theTube-Collimator Assembly in the Overhead Tube Crane,
- under the right side of the Tabletop of the RAD Table,
- in the Control Box of the RAD Wall Stand.

Illustration 1-2
System Emergency OFF Switches

The System is OFF when any Emergency-OFF Switch of the System is pressed. To release the Emergency OFF Switch just press and turn clockwise the red mushroom shaped switch, the correct direction is indicated with an arrow on it.

Check one by one all Emergency OFF Switches of the System for correct operation:

1. With the System turned ON press the Emergency OFF Switch.
2. Verify that the System has been turned OFF.
3. Release the Emergency OFF Switch and verify that the System is ON and works properly.

In case of wrong operation, check the Switches connectors and cables for incorrect connection or damages.

1.5 OVERHEAD TUBE CRANE MAINTENANCE PROCEDURES

1.5.1 CLEANING AND CHECKING THE STEEL CABLES AND CENTRAL PULLEY

The Steel Cables are a critical component of the Overhead Tube Crane for the safe operation of the vertical movement of the Telescopic Column and X-ray Tube. It is absolutely mandatory to check them every 12 months and also whenever there is an incorrect functioning or a risk to the equipment and / or the patient.

1. Lift the X-ray Tube up to the top of the Column to collect the steel cables around the Central Pulley located at the top of the Carriage.

2. Hold a soft cloth over the Steel Cables.

3. Carefully move up and down the X-ray Tube to allow the steel cables to move through the soft cloth.

4. When the steel cable moves through the soft cloth, check for damaged or frayed wires.

5. Check also the Pulley for metal shavings, excessive wears or deformations that can interfere the correct operation of the vertical movement, can damage the Steel Cables or cause the Cables to disengage from the Pulley.

6. In case of the steel cables are damaged, proceed to replace old steel cables.