GE Medical Systems

Technical Publications

Direction 2115682–100
Revision **5**

AMX–4 Periodic Maintenance (Model 2115090 Series)

Operating Documentation

WARNING

- THIS SERVICE MANUAL IS AVAILABLE IN ENGLISH ONLY.
- IF A CUSTOMER'S SERVICE PROVIDER REQUIRES A LANGUAGE OTHER THAN ENGLISH, IT IS THE CUSTOMER'S RESPONSIBILITY TO PROVIDE TRANSLATION SERVICES.
- DO NOT ATTEMPT TO SERVICE THE EQUIPMENT UNLESS THIS SERVICE MANUAL HAS BEEN CONSULTED AND IS UNDERSTOOD.
- FAILURE TO HEED THIS WARNING MAY RESULT IN INJURY TO THE SERVICE PROVIDER, OPERATOR OR PATIENT FROM ELECTRIC SHOCK, MECHANICAL OR OTHER HAZARDS.

AVERTISSEMENT

- CE MANUEL DE MAINTENANCE N'EST DISPONIBLE QU'EN ANGLAIS.
- SI LE TECHNICIEN DU CLIENT A BESOIN DE CE MANUEL DANS UNE AUTRE LANGUE QUE L'ANGLAIS, C'EST AU CLIENT QU'IL INCOMBE DE LE FAIRE TRADUIRE.
- NE PAS TENTER D'INTERVENTION SUR LES ÉQUIPEMENTS TANT QUE LE MANUEL SERVICE N'A PAS ÉTÉ CONSULTÉ ET COMPRIS.
- LE NON-RESPECT DE CET AVERTISSEMENT PEUT ENTRAÎNER CHEZ LE TECHNICIEN, L'OPÉRATEUR OU LE PATIENT DES BLESSURES DUES À DES DANGERS ÉLECTRIQUES, MÉCANIQUES OU AUTRES.

WARNUNG

- DIESES KUNDENDIENST−HANDBUCH EXISTIERT NUR IN ENGLISCHER SPRACHE.
- FALLS EIN FREMDER KUNDENDIENST EINE ANDERE SPRACHE BENÖTIGT, IST ES AUFGABE DES KUNDEN FÜR EINE ENTSPRECHENDE ÜBERSETZUNG ZU SORGEN.
- VERSUCHEN SIE NICHT, DAS GERÄT ZU REPARIEREN, BEVOR DIESES KUNDENDIENST−HANDBUCH NICHT ZU RATE GEZOGEN UND VERSTANDEN WURDE.
- WIRD DIESE WARNUNG NICHT BEACHTET, SO KANN ES ZU VERLETZUNGEN DES KUNDENDIENSTTECHNIKERS, DES BEDIENERS ODER DES PATIENTEN DURCH ELEKTRISCHE SCHLÄGE, MECHANISCHE ODER SONSTIGE GEFAHREN KOMMEN.

AVISO

- ESTE MANUAL DE SERVICIO SÓLO EXISTE EN INGLÉS.
- SI ALGÚN PROVEEDOR DE SERVICIOS AJENO A GEMS SOLICITA UN IDIOMA QUE NO SEA EL INGLÉS, ES RESPONSABILIDAD DEL CLIENTE OFRECER UN SERVICIO DE TRADUCCIÓN.
- NO SE DEBERÁ DAR SERVICIO TÉCNICO AL EQUIPO, SIN HABER CONSULTADO Y COMPRENDIDO ESTE MANUAL DE SERVICIO.
- LA NO OBSERVANCIA DEL PRESENTE AVISO PUEDE DAR LUGAR A QUE EL PROVEEDOR DE SERVICIOS, EL OPERADOR O EL PACIENTE SUFRAN LESIONES PROVOCADAS POR CAUSAS ELÉCTRICAS, MECÁNICAS O DE OTRA NATURALEZA.

ATENÇÃO

- ESTE MANUAL DE ASSISTÊNCIA TÉCNICA SÓ SE ENCONTRA DISPONÍVEL EM INGLÊS.
- SE QUALQUER OUTRO SERVIÇO DE ASSISTÊNCIA TÉCNICA, QUE NÃO A GEMS, SOLICITAR ESTES MANUAIS NOUTRO IDIOMA, É DA RESPONSABILIDADE DO CLIENTE FORNECER OS SERVIÇOS DE TRADUÇÃO.
- NÃO TENTE REPARAR O EQUIPAMENTO SEM TER CONSULTADO E COMPREENDIDO ESTE MANUAL DE ASSISTÊNCIA TÉCNICA.
- O NÃO CUMPRIMENTO DESTE AVISO PODE POR EM PERIGO A SEGURANÇA DO TÉCNICO, OPERADOR OU PACIENTE DEVIDO A' CHOQUES ELÉTRICOS, MECÂNICOS OU OUTROS.

AVVERTENZA

- IL PRESENTE MANUALE DI MANUTENZIONE È DISPONIBILE SOLTANTO IN INGLESE.
- SE UN ADDETTO ALLA MANUTENZIONE ESTERNO ALLA GEMS RICHIEDE IL MANUALE IN UNA LINGUA DIVERSA, IL CLIENTE È TENUTO A PROVVEDERE DIRETTAMENTE ALLA TRADUZIONE.
- SI PROCEDA ALLA MANUTENZIONE DELL'APPARECCHIATURA SOLO DOPO AVER CONSULTATO IL PRESENTE MANUALE ED AVERNE COMPRESO IL CONTENUTO.
- NON TENERE CONTO DELLA PRESENTE AVVERTENZA POTREBBE FAR COMPIERE OPERAZIONI DA CUI DERIVINO LESIONI ALL'ADDETTO ALLA MANUTENZIONE, ALL'UTILIZZATORE ED AL PAZIENTE PER FOLGORAZIONE ELETTRICA, PER URTI MECCANICI OD ALTRI RISCHI.

警告

・このサービスマニュアルには英語版しかありません。
・ＧＥＭＳ以外でサービスを担当される業者が英語以外の言語を要求される場合、翻訳作業はその業者の責任で行うものとさせていただきます。
・このサービスマニュアルを熟読し理解せずに、装置のサービスを行わないで下さい。
・この警告に従わない場合、サービスを担当される方、操作員あるいは患者さんが、感電や機械的又はその他の危険により負傷する可能性があります。

注意:

- 本维修手册仅存有英文本。
- 非 GEMS 公司的维修员要求非英文本的维修手册时，客户需自行负责翻译。
- 未详细阅读和完全了解本手册之前，不得进行维修。
- 忽略本注意事项会对维修员，操作员或病人造成触电，机械伤害或其他伤害。

Direction 2115682–100

Revision **4**

AMX–4 Periodic Maintenance (Model 2115090 Series)

IMPORTANT! . . . X-RAY PROTECTION

X-ray equipment if not properly used may cause injury. Accordingly, the instructions herein contained should be thoroughly read and understood by everyone who will use the equipment before you attempt to place this equipment in operation. The General Electric Company, Medical Systems Group, will be glad to assist and cooperate in placing this equipment in use.

Although this apparatus incorporates a high degree of protection against x-radiation other than the useful beam, no practical design of equipment can provide complete protection. Nor can any practical design compel the operator to take adequate precautions to prevent the possibility of any persons carelessly exposing themselves or others to radiation.

It is important that everyone having anything to do with x-radiation be properly trained and fully acquainted with the recommendations of the National Council on Radiation Protection and Measurements as published in NCRP Reports available from NCRP Publi- cations, 7910 Woodmont Avenue, Room 1016, Bethesda, Maryland 20814, and of the International Commission on Radiation Protection, and take adequate steps to protect against injury.

The equipment is sold with the understanding that the General Electric Company, Medical Sys- tems Group, its agents, and representatives have no responsibility for injury or damage which may result from improper use of the equipment.

Various protective material and devices are available. It is urged that such materials or devices be used.

CAUTION: United States Federal law restricts this device to use by or on the order of a physician.

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If you have any comments, suggestions or corrections to the information in this document, please write them down, include the document title and document number, and send them to:

GENERAL ELECTRIC COMPANY MEDICAL SYSTEMS
MANAGER − INFORMATION INTEGRATION,
AMERICAS W−622
P.O. BOX 414
MILWAUKEE, WI 53201−0414

CERTIFIED ELECTRICAL CONTRACTOR STATEMENT

All electrical installations that are preliminary to positioning of the equipment at the site prepared for the equipment shall be performed by licensed electrical contractors. In addition, electrical feeds into the Power Distribution Unit shall be performed by licensed electrical contractors. Other connections be- tween pieces of electrical equipment, calibrations, and testing shall be performed by qualified GE Medical personnel. The products involved (and the accompanying electrical installations) are highly sophisti- cated, and special engineering competence is required. In perform- ing all electrical work on these products, GE will use its own specially trained field engineers. All of GE's electrical work on these products will comply with the requirements of the applicable electrical codes.

The purchaser of GE equipment shall only utilize qualified personnel (i.e., GE's field engineers, personnel of third-party service companies with equivalent training, or licensed electricians) to perform electrical servicing on the equipment.

DAMAGE IN TRANSPORTATION

All packages should be closely examined at time of delivery. If damage is apparent, have notation "damage in shipment" written on all copies of the freight or express bill before delivery is accepted or "signed for" by a General Electric representative or a hospital receiving agent. Whether noted or concealed, damage MUST be reported to the carrier immediately upon discovery, or in any event, within 14 days after receipt, and the contents and containers held for inspection by the carrier. A transportation company will not pay a claim for damage if an inspection is not requested within this 14 day period.

Call Traffic and Transportation, Milwaukee, WI (414) 827–3449 / 8*285–3449 immediately after damage is found. At this time be ready to supply name of carrier, delivery date, consignee name, freight or express bill number, item damaged and extent of damage.

Complete instructions regarding claim procedure are found in Section "S" of the Policy & Procedure Bulletins.

6/17/94

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REVISION HISTORY

REV	DATE	REASON FOR CHANGE
0	Sept. 2, 1994	Initial product release.
1	June 23, 1995	Modified to account for AMX Zero Installation Time project.
2	June 22, 2000	Modified PM Flowchart in Section 2.
3	21FEB2013	Updated Section 1–3 and Section 1–4 to add hand switch cleaning/ replacement instructions. Refer to CAPA 5970812.
4	21APR2015	Replaced procedure in Section 2-8.
5	10APR2019	Added new Appendix 6 and added FLUKE ESA 612 6 (Modified changes due to ECR2252536).

LIST OF EFFECTIVE PAGES

PAGE NUMBER	REVISION NUMBER	PAGE NUMBER	REVISION NUMBER	PAGE NUMBER	REVISION NUMBER
All Pages	4				

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SECTION 1
INTRODUCTION

1-1 General

In order to assure continued performance of this x–ray equipment, a periodic inspection program must be established. Functional Check should be part of this program. It is the owner's responsibility to supply or arrange for this service.

Periodic Maintenance can locate potential problems before they occur. Since maintenance checks involve cost, it is not practical to attempt to assure zero failures. The following inspection requirements, with suggested inspection intervals, are GE Medical Systems' recommendation for the most cost effective maintenance schedule.

Inspection intervals are based on average daily use of one eight hour shift. More frequent inspection is appropriate where equipment use is above average. Equipment that regularly exhibits out of tolerance conditions should also be inspected more frequently.

The AMX–4 contains operating safeguards to provide maximum safety. Before calling for service, be certain proper operating procedures are being used. Refer to Direction 2115603–100, *AMX–4 Operation (Model 2115090 Series),* or Direction 2115602–100, *AMX–4 International Operation (Model 2115090 Series),* for proper operating procedures.

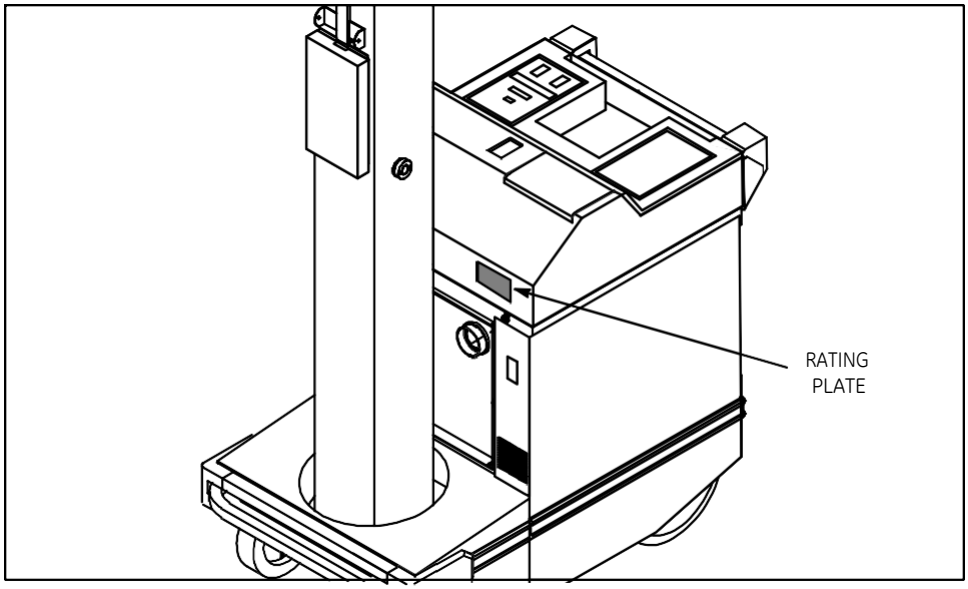
Satisfactory equipment performance requires the use of service personnel specially trained on x–ray apparatus. GE Medical Systems is responsible for the effects on safety, reliability, and performance only if the following conditions are met:

- The electrical wiring of the relevant rooms complies with all national and local codes.
- All assembly operations, extensions, re–adjustments, modifications, or repairs are carried out by GE Medical Systems' authorized service representatives.
- The equipment is used in accordance with the instructions for use. Refer to Direction 2115603–100, *AMX–4 Operation (Model 2115090 Series),* or Direction 2115602–100, *AMX–4 International Operation (Model 2115090 Series),* for proper operating procedures.

Only trained and qualified personnel should be permitted access to the internal parts of this equipment.

GE Medical Systems, and its associates, maintain a worldwide organization of stations from which one may obtain skilled x–ray service. If desired, arrangements can usually be made to furnish preventive and/or emergency service on a contract basis. A GE Medical Systems representative will be glad to discuss this plan.

ILLUSTRATION 1–1
AMX–4 IDENTIFICATION



1-2 Identification

See Illustration 1–1. The AMX–4 is identified by one of the following Model Numbers on the rating plate located on the top cover: 2115090, 2115090–2, 2115090–4, 2115090–5,
2115090–6, 2115090–7, 2115090–8, 2115090–9, 2115090–10, 2115090–11.

1-3 Cleaning

The AMX–4 should be cleaned frequently, particularly if corroding chemicals are present. Use a cloth slightly moistened in warm, soapy water to clean all surfaces. Wipe with a cloth slightly moistened in clean water. Do not use cleaners or solvents of any kind. They may remove markings and could damage the finish and plastic covers.

1-3-1 Hand Switch Cleaning and Disinfecting Instructions

SAFETY PRECAUTIONS – Before you Begin

- Disconnect the hand switch cord from the body of the hand switch before performing the maintenance / cleaning procedures
- Never use solvents or flammable solutions to clean the hand switch
- Never use a dripping cloth (or) immerse hand switch in water or cleaning solutions

INSTRUCTIONS

Use a cloth moistened in warm soapy water (use mild soap) to clean the hand switch.

APPROVED CLEANERS

The cleaners listed below are approved for cleaning the hand switch:

- Bleach – 50% mix with water (5–8% household Bleach)
- Glutaraldehyde <5%

- Polyethylene Glycol <20% (tested as Cidex Plus 28)
- Isopropyl Alcohol 70% concentration
- Hydrogen Peroxide 15–40% concentration

Never use cleaners or solvents of any kind if you are uncertain of the nature of the cleaning agent. The hand switch should be cleaned using EPA cleared and EPA registered high–level disinfecting agents.

1-4 Inspection

Periodic Maintenance verifies that the AMX–4 is functioning to specifications. It does not identify all operational requirements. Refer to Direction 2115680–100, *AMX–4 Functional Check (Model 2115090 Series)* for operational requirements.

Note: The hand switch **MUST** be replaced at least once in every 3 years.

1-5 HHS Testing

The United States Department of Health and Human Services (HHS) has established performance requirements for diagnostic x–ray equipment. These requirements are defined in Title 21 of the Code of federal regulations (21 CFR), and apply only to certain specified components identified as "certified equipment."

The manufacturer of specified diagnostic x–ray components must certify that the components:

1. Perform as required by the HHS standard when installed, adjusted, and tested as specified in the manufacturer's instructions to the assembler.

   HHS compliance testing for AMX–4 units is done at factory. In addition to HHS tests, the factory performs a Signature test and supplies the test result data with each shipment. In the event the field engineer determines that verification of HHS compliance is needed, acceptance testing in the field can be performed per Direction 46–017401, *Signature Tests for AMX–4.* (Under normal circumstances, neither HHS tests or Signature tests are required to be performed in the field.)

   Note: If a Mobil–AID AEC is field installed in the AMX–4, AEC HHS tests described in Section 5 of Direction 2115678–100, *AMX–4 Installation (Model 2115090 Series),* must be done in the field, even for new installations.

2. Will continue to comply when maintained in accordance with the manufacturer's instructions.

The importance of HHS compliance testing cannot be over emphasized. Before starting Periodic Maintenance procedures, review Direction 46–013894 *System Field Test for HHS*. Pay particular attention to "Introduction" (Tab 1 of Direction 46–013894).

With the exception of Collimator Function and Beam Quality, all field tests for HHS compliance are to be performed at specified intervals. Collimator Function and Beam Quality tests are required if the collimator is replaced.

1-6 Tools and Materials

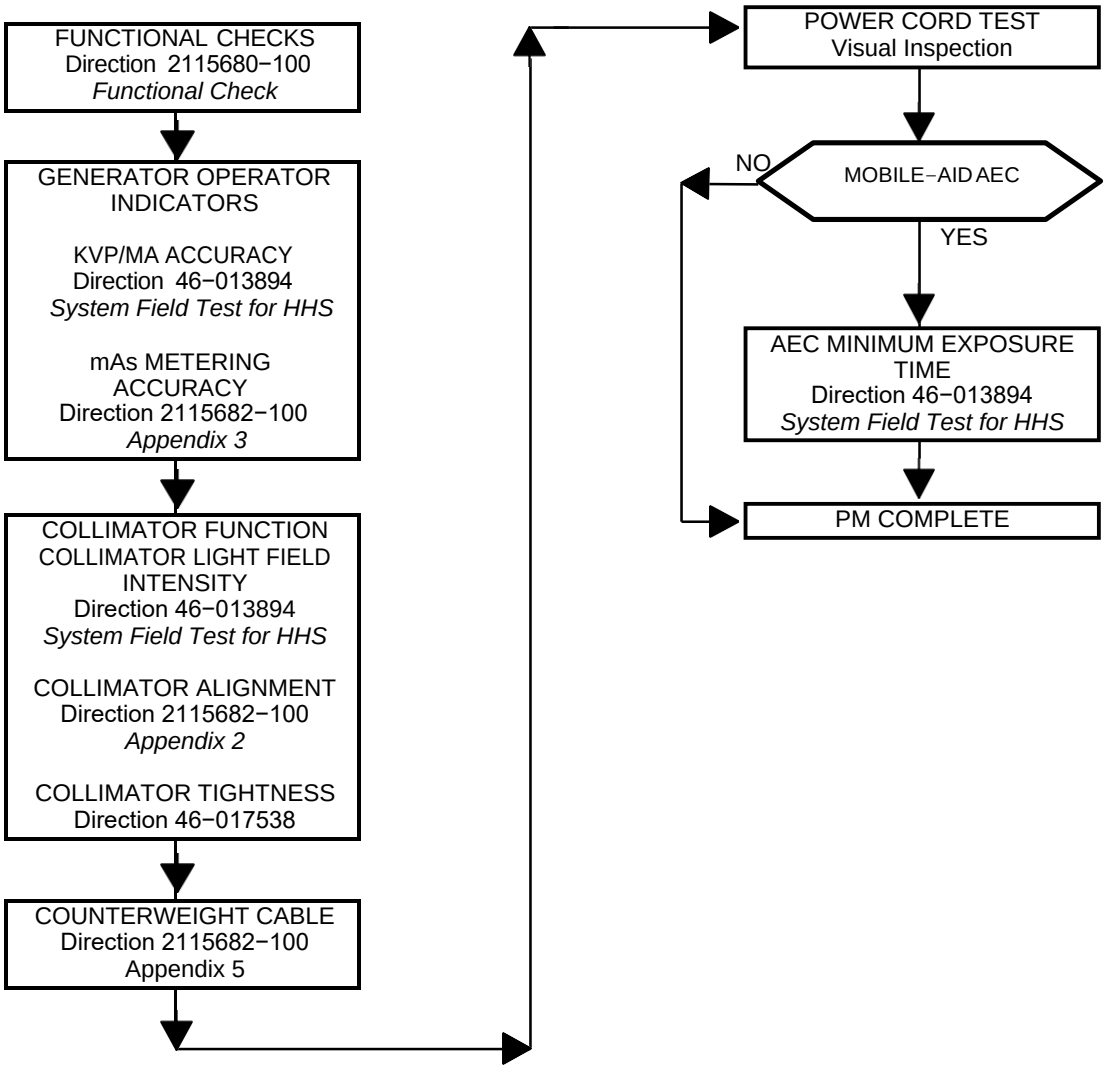
In addition to the standard service representatives tool kit, the following items are required:

- Direction 46–013894 System *Field Test for HHS*
- Direction 2115679–100, *AMX–4 Calibration (Model 2115090 Series)*
- Direction 2115680–100, *AMX–4 Functional Check (Model 2115090 Series)*
- Standard wrench number 507A935G1 for GE Type II cable terminals
- Tektronix 564 or equivalent dual trace, memory type oscilloscope with algebraic addition and 10X 10 Meg. Ohm input impedance probes
- Digital multimeter, Beckman 3030 RMS or Fluke 8030A
- 14 x 17 inch (or metric equivalent) cassette and suitable x–ray film
- High Voltage Divider, Catalog Number C1515A, with Direction 46–013288 *Bleeder, High–Voltage Dual Type*
- MDH Model 2025 or equivalent integrating dose radiation meter
- Silicone Insulating Compound, 46–125224P3 (3 oz tube), with Direction 46–013871 *Silicone Grease for Hi Voltage Terminals*
- Transformer oil T0552G, 1 gallon
- High Voltage Cables 5 Foot, Catalog Number C1665A
- Dale 600 or Fluke ESA612 Safety Analyzer (or equivalent)

SECTION 2
INSPECTION

The following flow chart shows the recommended sequence for performing a 12 month pe- riodic maintenance check on the AMX–4.

TWELVE MONTH PERIODIC MAINTENANCE INSPECTION SEQUENCE FOR AMX–4



Do the functional tests of Direction 2115680–100, *AMX–4 Functional Tests (Model 2115090 Series).*

Then do the following periodic maintenance procedures, and record inspection results in the Procedure column listed below. Record notes and comments next to the procedures. Requirements are listed in Direction 2115603–100, *AMX–4 Operation (Model 2115090 Series),* or Direction 2115602–100, *AMX–4 International Operation (Model 2115090 Series).* Match the inspection with the specifications. Service is necessary if any requirement is not within the limits specified.

2-1 Generator Operator Indicators

	Inspect	Procedure	Inspector's Notes
1.	Operator Indicator Checks	Refer to "Generator Operator Indicators" in Tab 3 of Direction 46–013894, *System Field Test for HHS,* and perform all applicable checks.	

2-2 kVp Accuracy

	Inspect	Procedure	Inspector's Notes
1.	Actual kVp matches select kVp	Refer to "Technique Accuracy – kV/mA" in Tab 3 of Direction 46–013894, *System Field Test for HHS,* and perform all applicable checks.	
2.	Rise time kVp waveform	=:_____ *milliseconds*	
3.	Fall time kVp waveform	=:_____ *milliseconds*	
4.	Rise time kVp waveform	=:_____ *%*	

2-3 mAs Metering Accuracy

	Inspect	Procedure	Inspector's Notes
1.	mAs display matches perform measured mA	Refer to Appendix 3 and the specified procedure.	
2.	mAs on display	=:_____ *mAs*	
3.	mA on meter	=:_____ *mA*	
4.	% of difference	=:_____ *%*	
5.	Meter accuracy	=:_____ *%*	

2-4 Reproducibility of Exposure and AEC Minimum Exposure Time

Inspect	Procedure	Inspector's Notes
1. Reproducibility of Exposure, non–AEC Mode (applies to all units)	Refer to "Reproducibility of Exposure" in Tab 3 of Direction 46–013894, *System Field Test for HHS*, and perform all applicable checks of procedure "for exposures made without the use of AEC."	
2. Reproducibility of Exposure, AEC Mode (applies to units equipped with Mobil–AID)	Refer to "Reproducibility of Exposure" in Tab 3 of Direction 46–013894, *System Field Test for HHS,* and perform all applicable checks of procedure "for exposures made with an AEC."	
3. AEC Minimum Exposure Time (applies to units equipped with Mobil–AID)	Refer to "AEC Minimum Exposure Time" in Tab 3 of Direction 46–013894, *System Field Test for HHS,* and perform specified procedure.	

2-5 Collimator Function

Inspect	Procedure	Inspector's Notes
1. Manual Collimator	Refer to "Functional Test – Manual Rad Collimator Version" in Tab 6 of Direction 46–013894, *System Field Test for HHS*, and perform inspection.	

2-6 Collimator Alignment

Inspect	Procedure		Inspector's Notes
	Refer to Appendix 2 and perform specified procedure.		
1. X–Ray Field Size	*40 inch SID*	= :_____ *inches.*	
	72 inch SID	= :_____ *inches.*	
2. Light Field Size	*40 inch SID*	= :_____ *inches.*	
	72 inch SID	= :_____ *inches.*	

2-7 Collimator Light Field Intensity

Inspect	Procedure	Inspector's Notes
	Refer to "Collimator Light Field Intensity" in Tab 6 of Direction 46–013894, *System Field Test for HHS*.	
1. Illumination	*100cm* = : _____ *foot candles.*	

2-8 Collimator Tightness

Inspect	Procedure	Inspector's Notes
1. Collimator Tightness	Every 12 months, verify that there is no movement between the collimator and X–ray tube. If there is no movement, verify mounting screws tightness for torque specifications per Direction 46-017538. If any movement is detected, you MUST remove the collimator and inspect all related fasteners. Refer to Direction 46–017538, AMX Collimator Interface Inspection and Torquing Procedures, following the Periodic Maintenance manual for additional information.	

2-9 Counterweight Cables

Inspect	Procedure	Inspector's Notes
1. Cable Inspection	Refer to Appendix 5 and perform all applicable checks.	

2-10 Power Cord Test

Inspect	Procedure	Inspector's Notes
1. Visual Inspection	Verify good condition of power cord and plug.	
2. Ground Impedance Test	Use a Dale 600 or Fluke ESA 612 Safety Analyzer (or equivalent) to verify the following: Ground impedance shall not exceed 0.15 ohms from the ground pin of the plug to any accessible conductive part which could become live.	

APPENDIX 1
SYMBOLS

All symbols used on the equipment and in its accompanying documents are shown and ex- plained in this appendix.

Caution advises of an avoidable condition that could cause minor physical injury, or damage to equipment or data.

Warning advises of an avoidable condition that may allow or cause a personal injury or the catastrophic destruction of equipment or data.

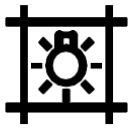
Danger advises of an avoidable condition that will cause serious or fatal injury.

Type B Equipment. Internal electrical power source provides an adequate degree of protection against electrical shock.

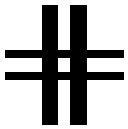
X–ray emission. X–ray tube head is emitting x–rays. Take adequate precautions to prevent the possibility of any persons carelessly, unwisely, or unknowingly exposing themselves or others to radiation.

Battery power on. This does not apply mains voltage.

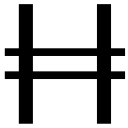
Battery power off. This does not remove mains voltage.



Control for indicating radiation field by using light.



Collimator blades closed. The controlled blades are shown in thicker lines.



Collimator Blades open. The controlled blades are shown in thicker lines.

Functional Earth (ground) Terminal. Terminal directly connected to a point of a measuring supply or control circuit or to a screening part which is intended to be earthed for functional purposes.

Alternating Current. Indicates equipment that is suitable for alternating current only.

Direct Current. Indicates equipment that is suitable for direct current only.

Equipotentiality. Identifies terminals that bring the various parts of equipment or systems to the same potential when connected together. These terminals are not necessarily at earth (ground) potential. The value of the potential may be indicated next to the symbol.

Indicates lock release or brake release.

Indicates receptacle location for hand–held radiographic prep/expose and field–light control cable.

APPENDIX 2 COLLIMATOR ALIGNMENT

Application

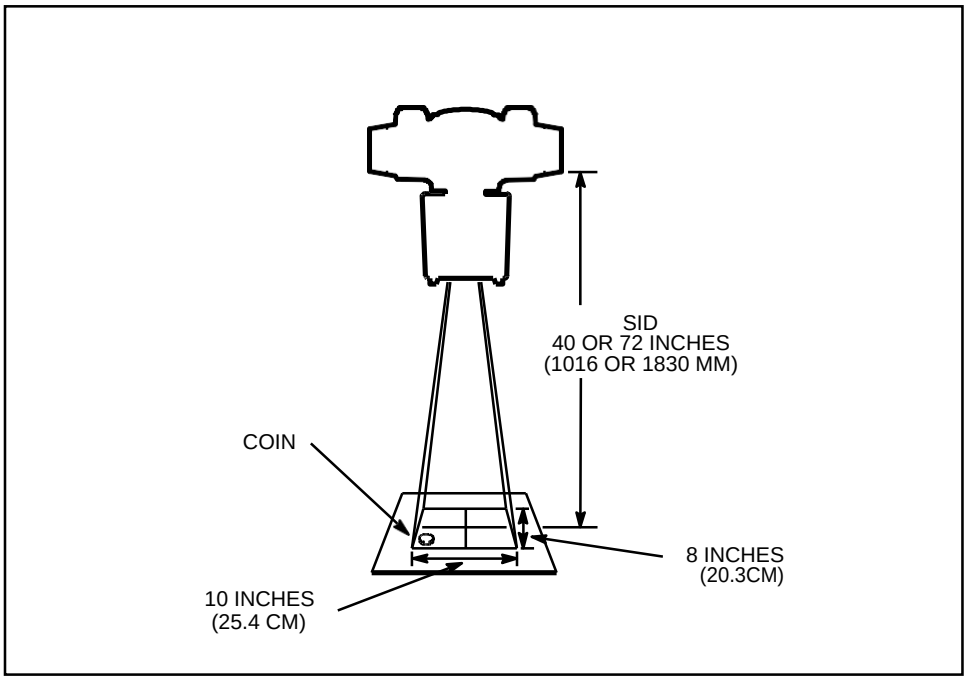
Collimator Alignment must be performed whenever any repair has been made which might affect collimator function.

Requirement

Collimator Alignment tests are performed at both 40 inches (1016 mm) and 72 inches (1830 mm).

- The x-ray field size must agree with the indicated field size within 1.7% of SID: 0.68 inch at 40 inches and 1.3 inches at 72 inch SID.
- Total misalignment of parallel edges of the light field with the edges of its x-ray field must not exceed 1.8% of SID: 0.72 inch at 40 inches and 1.3 inches at 72 inch SID.

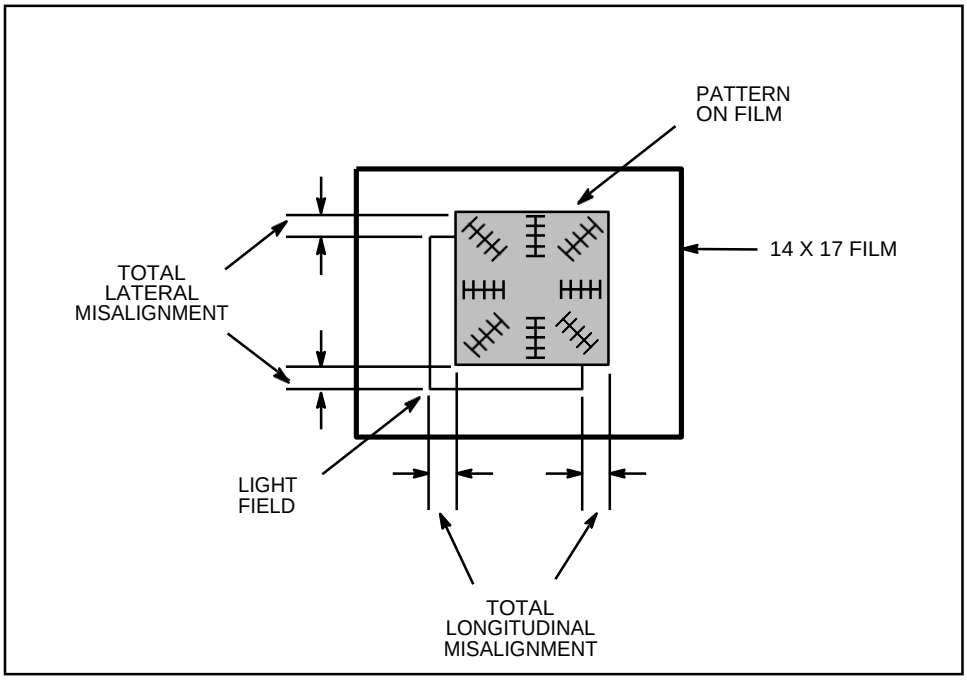
ILLUSTRATION A−1 COLLIMATOR ALIGNMENT TEST SETUP



Procedure

1. See Illustration A–1. Adjust x–ray tube to 40 inch SID and carefully adjust collimator field indicators to 8X10 inches (20.3X25.4 cm).

ILLUSTRATION A–2
LIGHT FIELD MISALIGNMENT



2. Place a loaded 14X17 inch (or metric equivalent) cassette on the floor under the colli- mator. Center *Light Field to X–ray Field Test Pattern* 46–198466P1 on top of cassette.

3. Using the collimator light field, center the cassette and test pattern under the collima- tor. Record where light field edges appear on test pattern.

4. Expose and develop film. Exposure recommendation for par speed film with medium screeds is 50 kVp at 4 mAs for 40 inch SID and 50 kVp at 16 mAs for 72 inch SID.

5. Measure and record the x–ray field size. The x–ray field size must agree with the indi- cated field size within 1.7% of SID: 0.68 inch at 40 inches and 1.3 inches at 72 inch SID.

6. See Illustration A–2. Mark the film to show light field size in relation to the x–ray field size. Total misalignment of parallel edges of the light field with the edges of its x–ray field must not exceed 1.8% of SID: 0.72 inch at 40 inches and 1.3 inches at 72 inch SID.

7. Repeat steps 1 through 6 at 72 inch (1830 mm) SID.

APPENDIX 3
MAS METERING ACCURACY

Application

Milliamp–second Metering Accuracy must be performed at installation, during Periodic Maintenance, after repair or replacement of mAs meter circuits, and after replacement of the tube unit.

Requirement

Accuracy of mA reading at the approximate 100 mA test condition is ± 0.1 mA. Meter accuracy must be added to this value before making judgment on the final reading.

Familiarity with Direction 2115679–100, *AMX–4 Calibration (Model 2115090 Series),* is assumed.

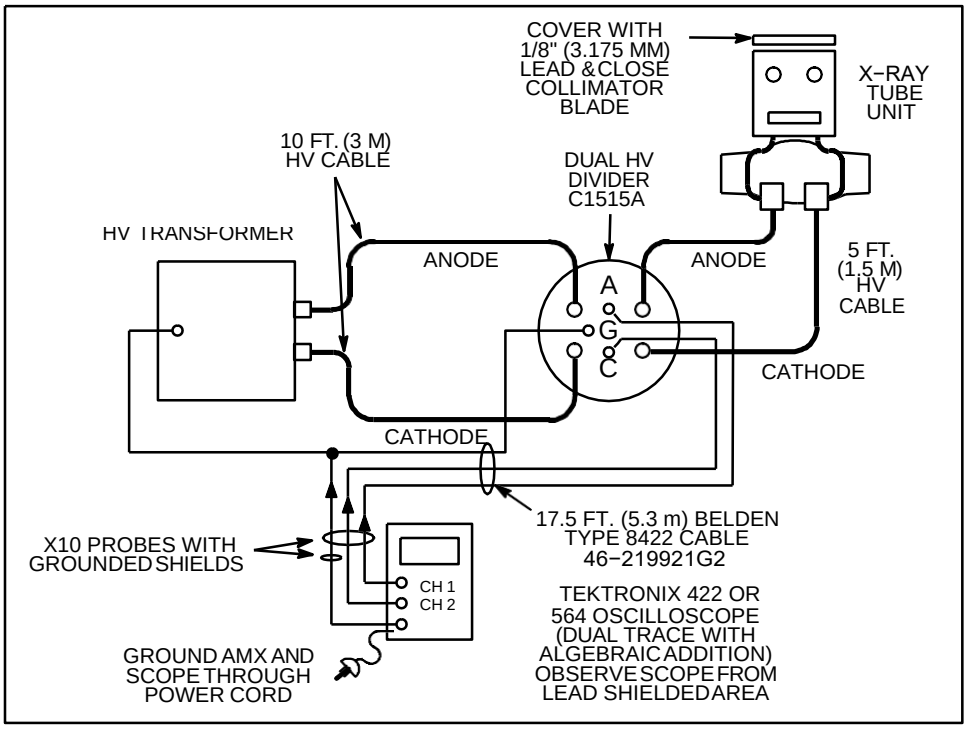
Procedure

Measuring mAs Metering Accuracy is done by injecting 100 mA into the mAs integrating circuit and comparing the response with a meter installed in the circuit. Reference Direction 2115679–100, *AMX–4 Calibration (Model 2115090 Series).*

1. Enter mAs calibration and install meter.
2. At the prompt ENTER VALUE compare meter reading with displayed reading.
3. Readings shall agree within ± 0.1mA, ±meter accuracy.

APPENDIX 4 CONNECTING HIGH VOLTAGE DIVIDER

ILLUSTRATION A−3
HIGH VOLTAGE DIVIDER CONNECTION



Application — Observation of kV wave form for calibration or performance verification.

Requirement — The following conditions must be met to make valid kV wave form measurements.

- Oscilloscope probes must be calibrated.
- A 46–219921G2 cable (17.5 feet [5.3 m] of Belden Type 8422 shielded coaxial cable) must be installed between high voltage divider and oscilloscope probes.
- Experience with proper techniques of connecting GE Type II Cable Terminations. Reference Direction 46–013871, *Silicone Grease for Hi Voltage Terminations*.

Procedure

1. Remove power by turning key switch and circuit breaker off.
2. Using standard wrench, number 507A935G1 for GE Type II Cable Terminals, remove high voltage cables from the tube unit.
3. See Illustration A–3. Using transformer oil in the cable receptacles, install AMX ca- bles in High Voltage Transformer receptacles of divider.
4. Using transformer oil in the divider cable receptacles and silicone insulating com- pound on cable terminations for x–ray tube receptacles, install five foot (1.5 m) cables between divider x–ray tube receptacles and the x–ray tube receptacles.
5. Install a 46–219921G2 cable (17.5 feet [5.3 mm] of Belden Type 8422 shielded coax- ial cable) between between high voltage and oscilloscope probes.
6. Close collimator blades and tape a sheet of 1/8 inch (3 mm) lead over collimator win- dow. Cover tube unit with a lead apron or place lead screens around tube for additional protection from x–rays.
7. Position tube unit about 2 feet (.6 meter) from the floor with the port up.

APPENDIX 5
SIGNS OF CABLE FAILURE

This Appendix is based upon Service Note 1625, which included recommendations from the American Chain and Cable Company, Inc.

Description

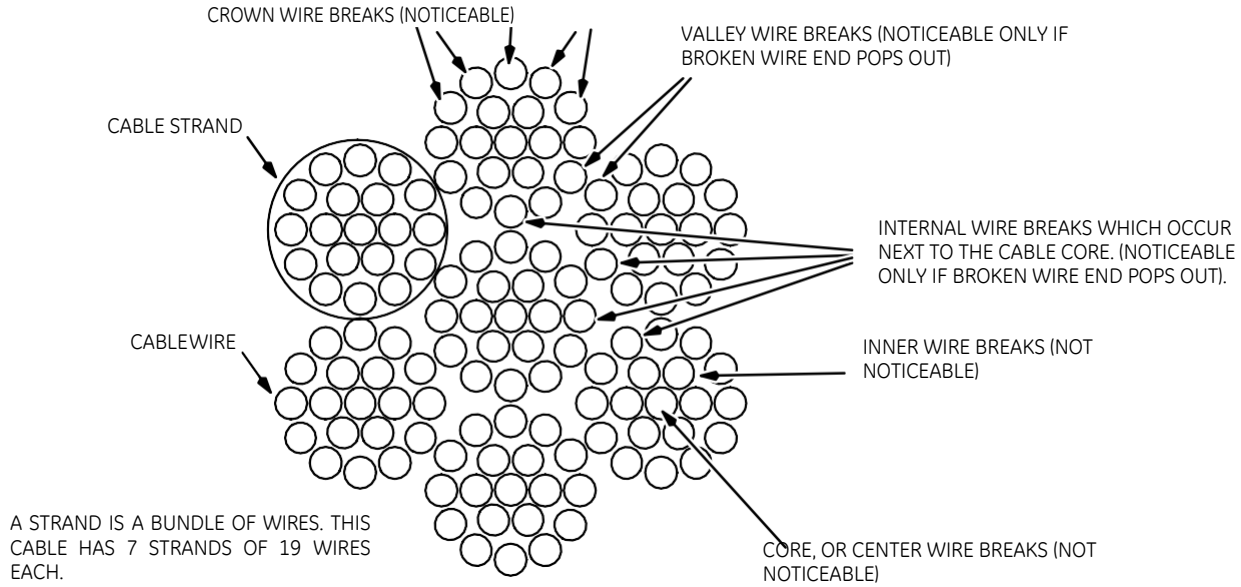
Steel counterweight cables, as used in the AMX–4, have load carrying capabilities many times that of the loads carried. This statement is only true provided that the cable is in good condition and properly installed.

During the early period of use, a cable assembly need not be replaced if one or two broken wires are detected. However, the same number of broken wires in an old assembly should justify immediate replacement. In an older assembly, the rate of broken wires is indeterminate and maybe accelerated.

Normal use will cause slow cable deterioration. Broken wire progression is related to time and equipment usage. Normally, large numbers of broken wires do not occur in a short span of time, therefore there is a warning period between the beginning of wire breakage and complete cable failure. This is why periodic inspection is very important so that corrective action can be taken.

Refer to Illustration A–4 for counterweight cable configuration and common types of cable defects.

ILLUSTRATION A–4
7X19 CABLE CROSS SECTION



Types of Cable Failure

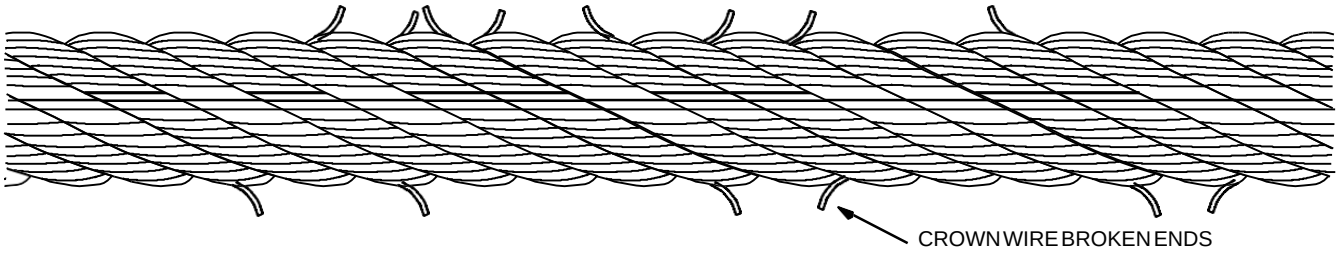
Broken Wires

Cable strength is not necessarily impaired by an occasional broken wire. However consideration should be given as to its location, length of time the assembly has been in service and the general condition of the remainder of the cable.

Crown Wire Breaks

Crown breaks are breaks that occur in the outer wires of the outer strands of a cable. Refer to Illustration A–4. Because they are on the outer surface of the cable, they are visible upon inspection and are represented by short broken wire ends. This failure mode will generally show both broken protruding wire ends. Refer to Illustration A–5.

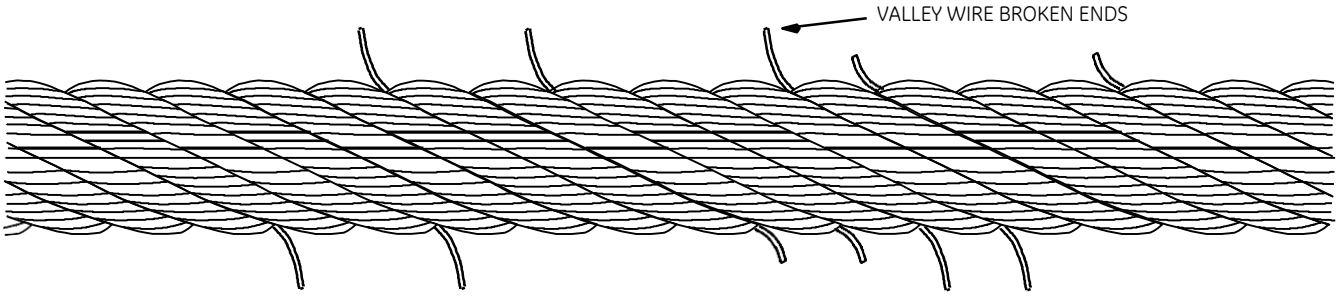
ILLUSTRATION A–5
CROWN WIRE BREAKS



Valley Wire Breaks

Valley wire breaks occur down in the valley between two adjacent strands. Refer to Illustration A–4. The protruding wire end resulting from this type of break would be longer and would stand out further from the cable than a crown wire break. Only one end, the long end of a valley wire break can usually be detected, since the other end remains buried in the valley between two adjacent strands. Refer to Illustration A–6. Unfortunately, a valley wire break usually does not visibly manifest itself until quite an advanced stage of deterioration has taken place. It is also very often true that valley wire breaks may exist without having the free end spring out of place.

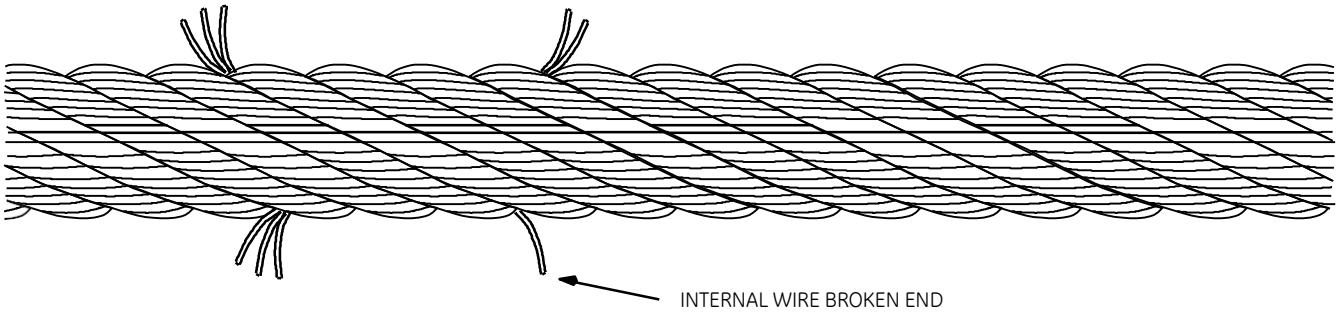
ILLUSTRATION A–6
VALLEY WIRE BREAKS



InternalWireBreaks

Another type of cable deterioration is the internal wire failure. This failure cannot be detected visually. This type of break takes place in the outer wires of the main strand and the outer wires of the outer strands located inside the cable. Refer to Illustration A–4. It is underneath where the outer strands come in contact with the cable center member. Usually these breaks can only be detected by slackening the cable and bending it opposite to the curvature it normally assumes over the pulley sheave. This however is often most impractical to do because of inaccessibility. Here again the protruding wire end would be consider- ably longer than those of a crown wire break and would be even slightly longer than the protruding end of a valley wire break. Refer to Illustration A–7.

ILLUSTRATION A–7
INTERNAL WIRE BREAKS



Basis for Cable Replacement

Causes of Deterioration

Counterweight cables deteriorate from common causes such as normal wear and fatigue during equipment operation. All of these factors eventually result in the development of broken wires and if the broken wires accumulate in large enough numbers in localized areas, complete cable failure will result. Broken cable wires cause unbalanced cable structure resulting in an unbalanced load distribution. This results in increased stress on the remaining unbroken wires.

PM Inspection

Although some cable deterioration cannot be detected by visual external inspection, the visible extent of cable surface deterioration can be used as a reliable basis for cable replacement.

Because of the serious consequences of possible cable failure, the field service person must be prepared to use judgment regarding cable condition and never hesitate to make a re- placement. Several months or a half year's usage is small compensation if there is any dan- ger of cable failure.

Frequency of Inspection

This is a variable factor and often can be partially based on equipment usage. It is recom- mended that counterweight cables be inspected once every twelve months and at more fre- quent intervals if equipment usage warrants.

Inspection Procedure

Record inspection data. This inspection history data can be valuable in making a cable re- placement determination.

WARNING

USE CARE, SHORT SHARP BROKEN WIRE ENDS CAN INFLICT PERSONAL INJURY DURING CABLE INSPECTION.

Visual inspection, plus running a soft cloth over the cable's surface should be used to detect broken wires, cable abrasion and cable corrosion which are major types of cable deterioration.

Note: When inspecting a cable that disappears at one point and reappears at another, be sure to mark the cable at that point and then move the cable so that when the mark reappears no portion of the cable that passes over a pulley or that is subjected to abrasion is neglected.

External lubrication guards against corrosion and reduces abrasion. Coat soft cloth with STP lubricant and apply to the external surface during regular PM inspection.

Note: Excessive wear not only weakens the cable but increases the development and rate of wire failure.

Close inspection should be made of cable terminations. Broken wires at cable terminals will require immediate cable replacement.

Because valley wire breaks accompany advanced stages of cable deterioration, the cable should be replaced immediately regardless of outward appearance. A cable badly affected by crown fatigue wire breaks should be replaced. Attention is called to a crown wire break as shown in Illustration A–8, longer broken wire ends of both valley and internal wire breaks and also the unbalanced cable structure resulting not only from the uneven occurrence of wire failure but also from an unbalanced load distribution.

ILLUSTRATION A–8
SINGLE CROWN WIRE BREAK

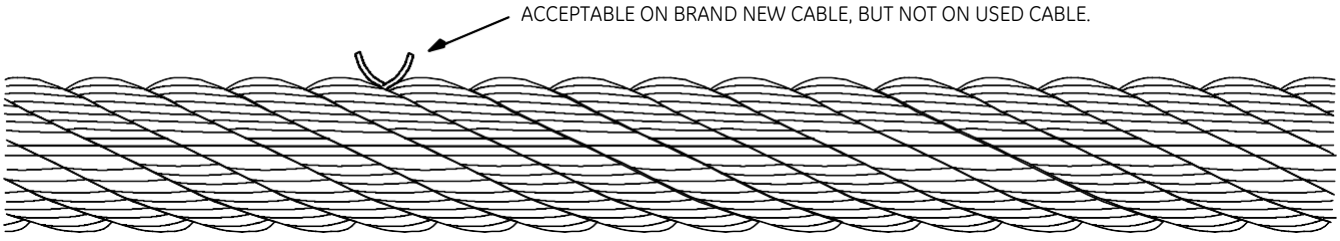


ILLUSTRATION A−9
TWISTED WIRE SPLICE IN 1 OF 12 INNER WIRES

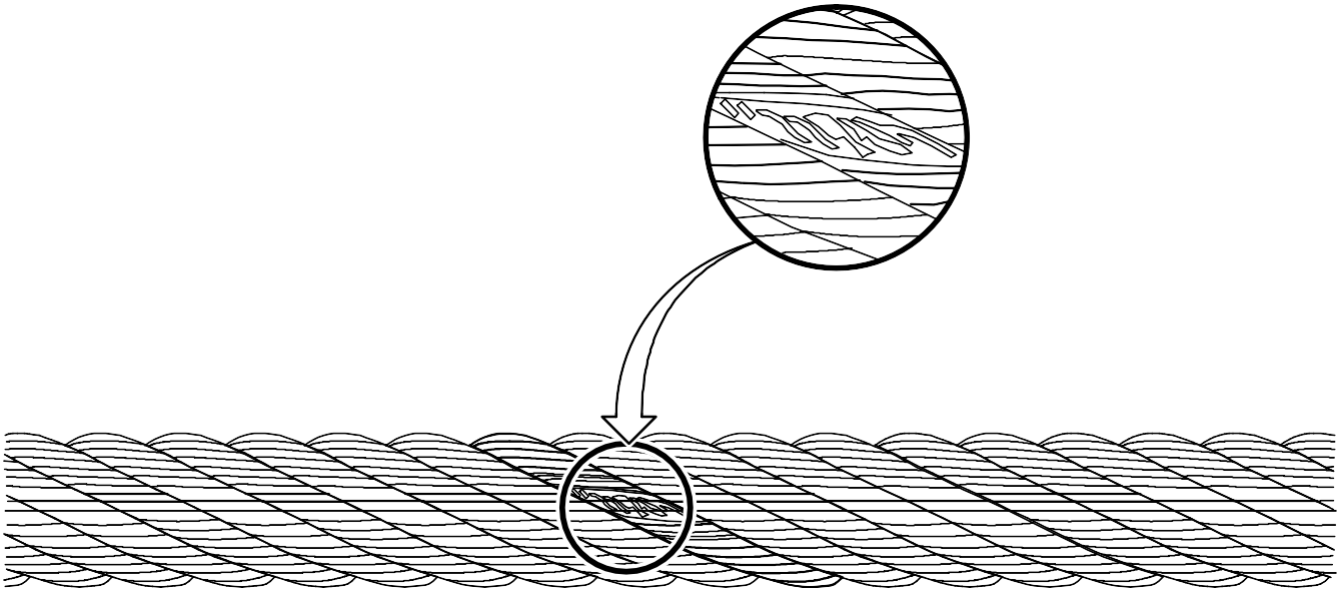
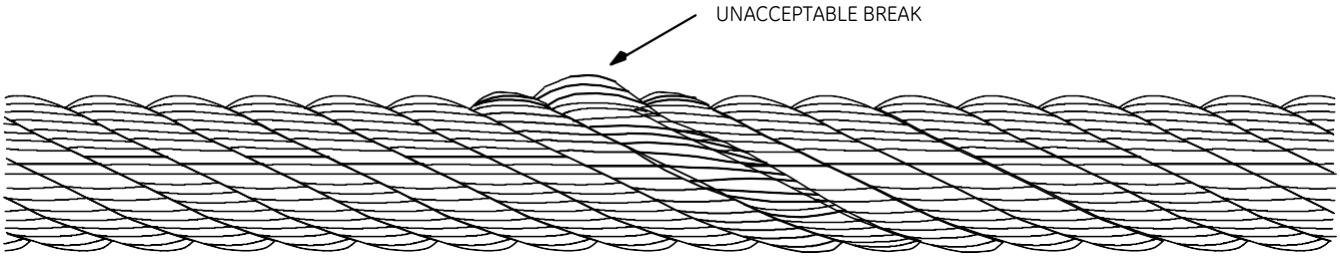


ILLUSTRATION A−10
TWISTED WIRE SPLICE IN 1 OF 6 INNER WIRES



APPENDIX 6
Fluke ESA612 tool

Ground Resistance testing

This procedure is intended for the field engineer and describes the test procedure for the IEC 62353 Planned Maintenance and power plug replacement for the mobile X-ray products.

The IEC 62353: Medical Electrical Equipment - Planned Maintenance and power plug replacement of Medical Electrical Equipment standards ensures the electrical safety of medical electrical equipment.

Perform Ground Resistance testing			
Site Location	**Installation**	**PM**	**Repair**
Within USCAN	Fluke ESA612	Fluke ESA612	Fluke ESA612
Outside USCAN	Hioki Tool Using 25A current source	Fluke ESA612	Fluke ESA612

Perform Leakage Current testing			
Site Location	**Installation**	**PM**	**Repair**
Within USCAN	Fluke ESA612	Fluke ESA612	Fluke ESA612
Outside USCAN	Fluke ESA612	Fluke ESA612	Fluke ESA612

Personnel requirements

Required Persons: 01

Timing: 30mins

PM frequency: 12 months

Preliminary requirements

Tools and test equipment

- **Standard Toolkit**
- **Fluke ESA612 or below equivalent specification**

Specification	
Test Standard Selections	ANSI/AAMI ES-1, IEC62353, IEC60601-1, and AN/NZS3551

Voltage	
Ranges (Mains voltage)	90.0 V to 132.0 V ac rms 180.0 V to 264.0 V ac rms
Range (Point-to-point voltage	
5000 m	0.0 V to ≤150 V ac rms
2000 m	0.0 V to ≤300.0 V ac rms
Accuracy	(2% of reading + 0.2 V)

Earth Resistance	
Modes	2-Wire
Test Current	>200 mA ac
Range	0.000 Ù to 2.000 Ù
Accuracy	(2% of reading + 0.015 Ù)

Equipment Current	
Range	0.0 A to 20.0 A ac rms
Accuracy	(5% of reading + (2 counts or 0.2 A, whichever is greater))

Leakage Current	
Modes*	AC+DC (True-rms)
AC only	
DC only	

* For tests that do not use MAP voltage, AC+DC, AC ONLY, and DC ONLY modes are available for all leakages. MAP voltages are available only in True-rms (shown as AC+DC).

Patient Load Selection	AAMI ES1-1993, IEC 60601
Crest factor	≤3
Range	0.0 µA to 199.9 µA
200 µA to 1999 µA	
2.00 mA to 10.00 mA	

Frequency response/Accuracy	
DC to 1 kHz	(1 % of reading + (1 ⌈A or 1 LSD, whichever is greater))
1 kHz to 100 kHz	(2 % of reading + (1 ⌈A or 1 LSD, whichever is greater))
1 kHz to 5 kHz (current >1.6 mA)	(4 % of reading + (1 µA or 1 LSD, whichever is greater))
100 kHz to 1 MHz	(5 % of reading + (1 ⌈A or 1 LSD, whichever is greater))

Consumables
None

Replacement parts
None

Safety
None

Required conditions
None

Ground Resistance Test using FLUKE ESA612

Note: **Before you start the test, ensure the system is in OFF position and the system input power plug is connected to test socket on the side of Fluke ESA612 meter.**

It is recommended to use Fluke ESA612 to set up the test conditions. The nominal AC Mains should be 120VAC or 220VAC to match the standard system plug. Refer to Appendix 1: Test Point Locations for AMX series for earth resistance test points of AMX series 120VAC or 220VAC AC Mains (site-specific input source).

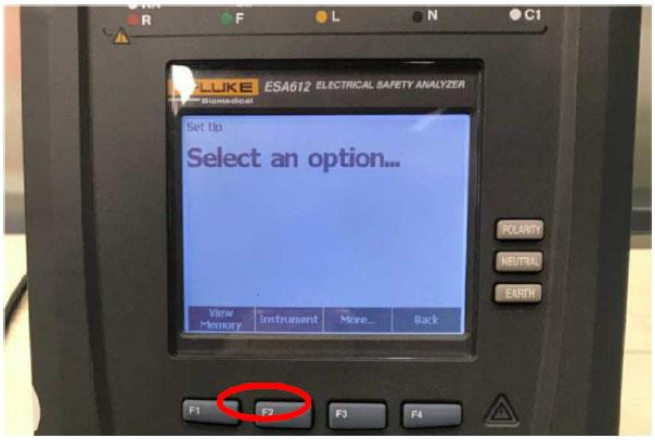
Test Procedure

Note: **It is important to 'Zero/Null' leads to eliminate resistance in test leads as follows.**

1. Make sure the power cord from the DUT is connected into outlet of the Fluke ESA612.

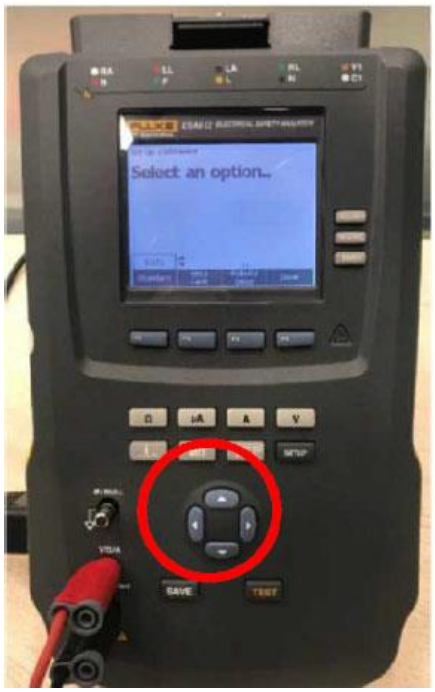
2. From the setup menu, press **F4** button, on the blue screen press **More** to reveal additional menu selections.

3. Press **F2** button, on the blue screen press **Instrument** to select the instrument setup.

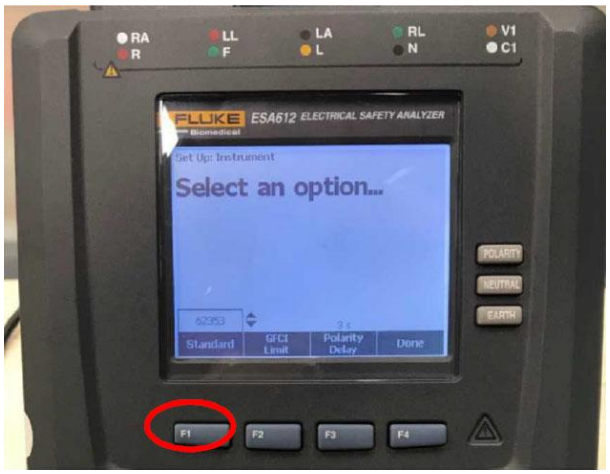


4. Press **F1** button, on the blue screen press **Standard** to open scroll box.

5. Press up or down to scroll through the standard selections.

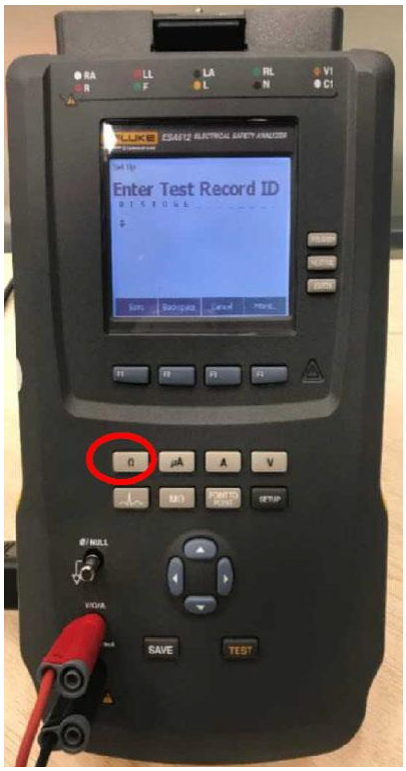


6. Select IEC62353 standard is displayed, press **F1** button, on the blue screen press **Standard** to confirm the standard.



7. Press **F4** button, on the blue screen press **Done** to complete the standard setup.

8. Push [Ω] to reveal the resistance function menu.



9. Connect one end of a test lead to the V/ Ω /A jack.

10. If you use an accessories probe, connect it to the other end of the test lead and put the probe tip into the Ø/Null jack. If you use an alligator clip accessory, connect it to the other end of the test lead, put the null post adapter in the Ø/Null jack, and clamp the alligator clip to the null post adapter.

Note: **The Ø/Null jack does not accept the test leads supplied with the Product.**

⚠ CAUTION

To avoid electric shock, remove the null post adapter from the Null jack after a test lead zero is performed. The Null jack becomes potentially hazardous during some of the other test conditions.

11. Push **ZERO LEADS** button until the display shows 0.000 Ω

12. Now connect one end of the test lead between the V/Ω/A jack of the test meter and other end to an exposed conductive surface of the DUT ensuring that the input power plug of the DUT remains in the test socket on the side on the Fluke ESA612. Refer to Table 1: Conductive surface test points for AMX for the list of conductive surfaces (accessible dead metal parts) of the AMX system.

NOTICE

When a current of 200mA from the current source with a no-load voltage not exceeding 24V at a frequency of 50/60Hz is applied between conductor terminals for 5 to 10 seconds, the voltage drops between the terminals. The resistance determined using the current and voltage drop should not be greater than 0.2 Ohm (200 mΩ).
The resistance value will be displayed on the Fluke. Record the test results in Table 2: Results of the Protective Earth Resistance Test for AMX series

13. Using steps 10 - 12 above, take measurements for each test point identified in Table 1: Conductive surface test points for AMX Record test results in Table 2: Results of the Protective Earth Resistance Test for AMX series as appropriate. Appendix 1: Test Point Locations for AMX series for images of test points for respective systems).

NOTICE

Manufacturer recommendation is to perform Null test before testing each test point.

Test Point	Component	Test Point Description
1	Collimator	Collimator Skin Spacers
2	Tube	X-ray Tube (On the HV Cable Cathode Ring)
3	Column	Rivets on the top column cover (Applicable only for AMX4+)
4	Bin	M4 Screw inserted into PEM nut on receptor bin
5	Tube latch	Park Latch Assembly on the Chassis

Table 1: Conductive surface test points for AMX

Expected Test Results

The resistance, when measured, should **NOT** be greater than 0.3 Ohm (300mOhm).

Test Point	Units	Expected Value	Measured Value	Result (Pass/Fail)
Collimator Skin Spacers	Ω	≤ 0.3		
X-ray Tube (On the HV Cable Cathode Ring)	Ω	≤ 0.3		
Rivets on the top column cover (Applicable only for AMX4+)	Ω	≤ 0.3		
M4 Screw inserted into PEM nut on receptor bin	Ω	≤ 0.3		
Park Latch Assembly on the Chassis	Ω	≤ 0.3		

Table 2: Results of the Protective Earth Resistance Test for AMX series

⚠ CAUTION

If the measured value exceeds the expected value, then refer to Appendix 3: AC Power plug troubleshooting for power plug troubleshooting procedure to fix the grounding issues.

Leakage Current Test using FLUKE ESA612

TEST DESCRIPTION

It is recommended to use Fluke ESA612 or equivalent meter (Refer to Appendix 3: AC Power plug troubleshooting) to establish the test conditions. The nominal AC Mains should be 120VAC or 220VAC, to match the standard system plug.

Note: **Before you start the test, ensure the Equipment input power plug is connected to test socket on the side of Fluke ESA612 meter and the system is in ON condition. If ground testing is required for this system, verify that all ground testing results passed (see Table 1: Conductive surface test points for AMX) are ≤ 0.3 Ohms before conducting leakage testing. Leakage testing must be performed if the AC power plug has been replaced or disturbed. The leakage current must not exceed 300 uA.**

TEST PROCEDURE

The Equipment Leakage Current test must be conducted under both normal condition and Single Fault Condition. The test procedures for both the conditions are described below.

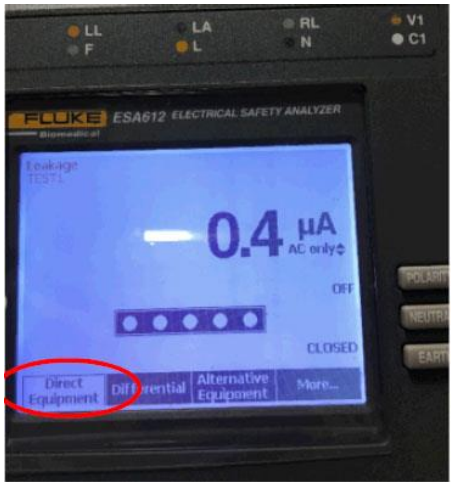
TEST UNDER NORMAL CONDITIONS

To perform the Equipment Leakage Current Test under normal conditions, follow the steps listed below:

Note: **Refer to Table 5: Results of the leakage current test under normal conditions for AMX series for normal test conditions and Appendix 2: Test Equipment for the test equipment used. Refer to Table 4: Test Points for AMX series for the leakage current test points of the AMX system for 120VAC or 220VAC AC Mains (site-specific input source).**

1. Push µA to access the leakage current main menu.

2. Push the 'Direct Equipment button on the Fluke.



3. Push the Polarity button to select NORMAL.

4. Now connect one end of the test lead between the V/ Ω /A jack of the test meter and other end to an exposed conductive surface of the DUT (Refer Table 4: Test Points for AMX series for test points) ensuring that the input power plug of the DUT remains in the test socket on the side on the Fluke ESA612.

5. The leakage current value will be displayed. Record the test results in Table 5: Results of the leakage current test under normal conditions for AMX series for AMX series.

6. Repeat the above steps for each test point in Table 4: Test Points for AMX series and record the test results in Table 5: Results of the leakage current test under normal conditions for AMX series for each test points.

7. Repeat above steps with test conditions 2 & 3 as per Table 3: Test Condition for AMX series.

AMX Series		
Condition	**Power**	**Test Meter Polarity**
1	ON	Normal

Table 3: Test Condition for AMX series

Test Point	Components	Test Point Description
1	Collimator	Collimator Skin Spacers
2	Tube	X-ray Tube (On the HV Cable Cathode Ring)
3	Column	Rivets on the top column cover (Applicable only for AMX4+)
4	Bin	M4 Screw inserted into PEM nut on receptor bin
5	Tube Latch	Park Latch Assembly on the Chassis

Table 4: Test Points for AMX series

Note: **Refer to Appendix 2 for the locations of the AMX series test points.**

Expected Test Results

Test Point	Units	Expected Value	Measured Value	Result (Pass/Fail)
Collimator Skin Spacers	µA	≤ 300		
X-ray Tube (On the HV Cable Cathode Ring)	µA	≤ 300		
Rivets on the top column cover (Applicable only for AMX4+)	µA	≤ 300		
M4 Screw inserted into PEM nut on receptor bin	µA	≤ 300		
Park Latch Assembly on the Chassis	µA	≤ 300		

Table 5: Results of the leakage current test under normal conditions for AMX series

TEST UNDER SINGLE FAULT CONDITION (SFC)

In SFC, a single fault means of protection against electrical hazard is defective or faulty. To create Single Fault Condition, see Table 6: SFC Test conditions for 120VAC or 220VAC AC Mains.

SFC Conditions

Condition	Power	Test Meter Polarity	X-Ray
1	On	Reversed	No
2	On	Earth Open	No

Table 6: SFC Test conditions for 120VAC or 220VAC AC Mains

To perform the Equipment Leakage Current Test under SFC, follow the steps listed below:

Note: **Refer to Table 6: SFC Test conditions for 120VAC or 220VAC AC Mains for the test conditions and Appendix 3: AC Power plug troubleshooting for the test equipment used. Refer to Table 4: Test Points for AMX series.**

1. Set up test condition 1 listed in Table 6: SFC Test conditions for 120VAC or 220VAC AC Mains follow step 2 below.

2. Press the '**Polarity**' button to select '**Reversed**' on the Fluke ESA612.

3. Now connect one end of the test lead between the V/ Ω /A jack of the test meter and another end to exposed conductive surface of the DUT ensuring that the input power plug of the DUT remains in the test socket on the side on the Fluke ESA612.

4. The leakage value will be displayed. Record the test results in Table 7: Results of the leakage current test under SFC conditions for AMX systems.

5. Connect the test lead between the V/ Ω /A jack of the test meter and an exposed conductive surface of the DUT ensuring that the input power plug of the DUT remains in the test socket on the side on the Fluke ESA612. Record the test results in Table 6: SFC Test conditions for 120VAC or 220VAC AC Mains.

6. Set up test condition 2 listed in Table 6: SFC Test conditions for 120VAC or 220VAC AC Mains, Press the '**Earth**' button to select '**Open**' on the Fluke ESA612.

7. Connect the test lead between the V/ Ω /A jack of the test meter and an exposed conductive surface of the DUT ensuring that the input power plug of the DUT remains in the test socket on the side on the Fluke ESA612. Record the test results in Table 6: SFC Test conditions for 120VAC or 220VAC AC Mains as appropriate.

8. Repeat the above steps for each leakage current test point mentioned in Table 4: Test Points for AMX series.

EXCEPTED TEST RESULTS

Condition 1

Test Point (SEE APPENDIX FOR TEST POINT LOCATIONS)	Units	Expected Value	Measured Value	Result (Pass/Fail)
Collimator Skin Spacers	µA	≤ 300		
X-ray Tube (On the HV Cable Cathode Ring)	µA	≤ 300		
Rivets on the top column cover (Applicable only for AMX4+)	µA	≤ 300		
M4 Screw inserted into PEM nut on receptor bin	µA	≤ 300		
Park Latch Assembly on the Chassis	µA	≤ 300		

Condition 2

Test Point	Units	Expected Value	Measured Value	Result (Pass/Fail)
Tube endcap screws or HV cable nuts	µA	≤ 300		
Collimator Skin guards	µA	≤ 300		
Scroll support rivets	µA	≤ 300		
Screw used for mounting strain relief of wired Hand switch1 cable	µA	≤ 300		
Tube latch on top-cover	µA	≤ 300		

Table 7: Results of the leakage current test under SFC conditions for AMX systems

⚠ CAUTION

If the measured value exceeds the expected value, then refer to Appendix 3: AC Power plug troubleshooting procedure to fix the Leakage current.

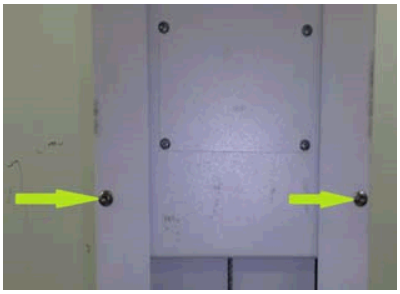
Appendix 1: Test Point Locations for AMX series

This section contains the illustrations of the test points listed in Table 1: Conductive surface test points for AMX.

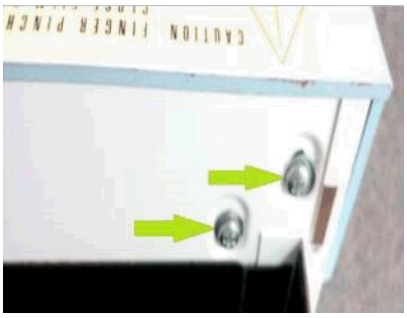
Test Point 1: Collimator Skin Spacer

Test Point 2: X-ray Tube (On the HV Cable Cathode Ring)

Test Point 3: Rivets on the top column cover (Applicable only for AMX4+)



Test Point 4: M4 Screw inserted into PEM nut on receptor bin



Test Point 5: Park Latch Assembly on the Chassis

Appendix 2: Test Equipment

This section contains the illustrations of the meters used in the IEC 62353 tests.

Fluke ESA612 or equivalent (For more details refer the product manuals and video explanation at http://www.flukebiomedical.com/)

Fluke ESA612

Appendix 3: AC Power plug troubleshooting

Tools and Test Equipment

- Standard tool kit

Required Conditions

- Perform LOTO on the system. Leave the AC Plug (E1) exposed.

Procedure

- Remove screws on the top of plug marked
- Check the cable core if any open strands or broken wires, connect properly into plug

- Ensure all ground connections are properly tightened.
- Inspect cord reel box and termination of ground cables.

Note: If system using molded power cord type then check ground connection, Cord reel box and termination of ground cables.

GE Medical Systems

GE Medical Systems: Telex 3797371
P.O. Box 414, Milwaukee, Wisconsin 53201 U.S.A. (Asia, Pacific, Latin America, North America)

GE Medical Systems — Europe: Telex 698626 283, rue de la Miniére, B.P. 34, 78533 Buc Cedex France