ACCEPTANCE INSPECTION PROCEDURES US Army

Diagnostic X-Ray Systems

Not complete

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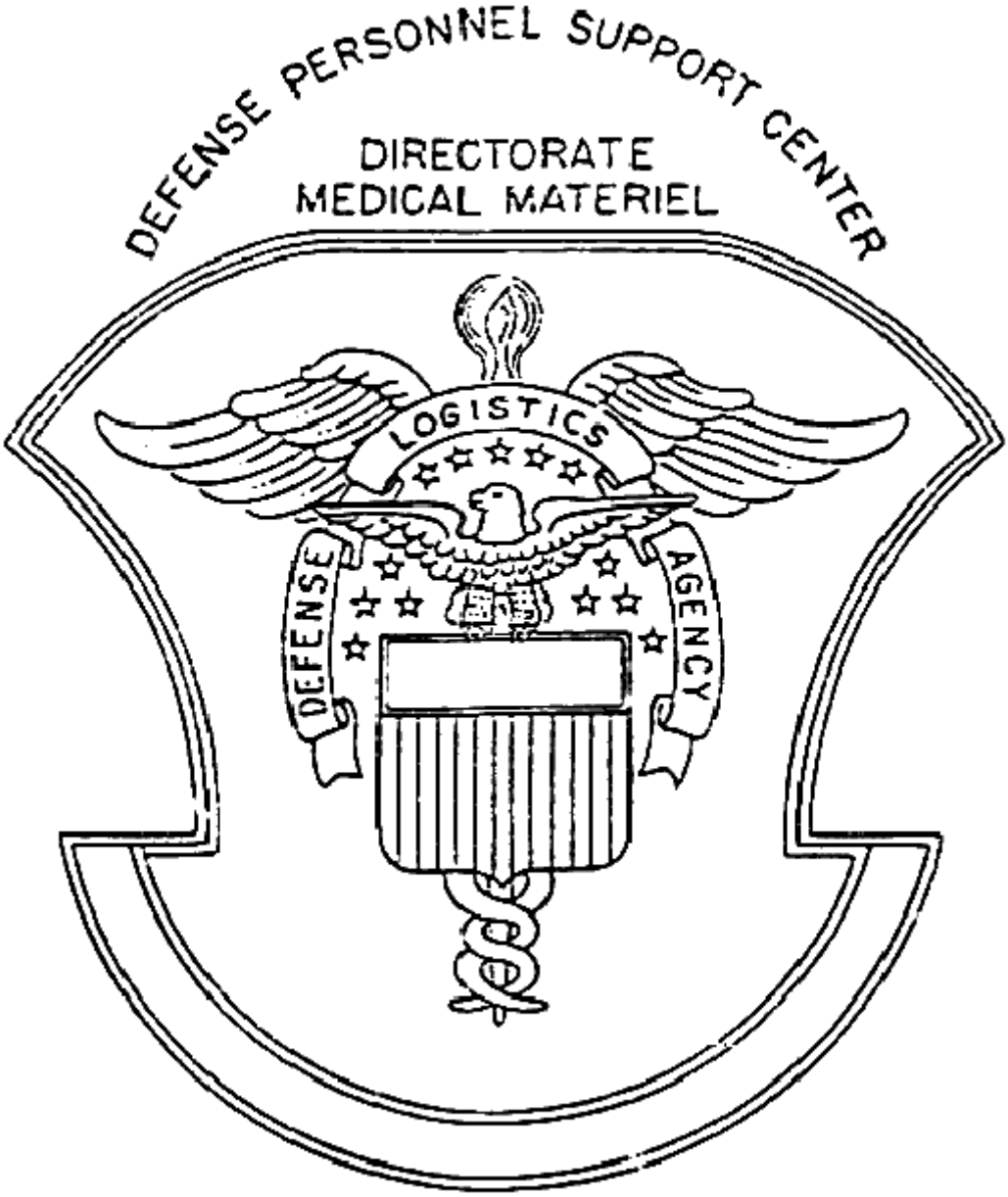


Test equipment and accessories required

Test equipment and accessories which will be required to complete all appropriate tests:

a. High voltage divider.
b. Dual trace storage oscilloscope (with 100X and 10X probes).
c. Radiation survey meter with appropriate ion chambers.
d. Test stand (equivalent to Victoreen or BRH) with inserts for focal spot location and half value measurements (1100 alloy aluminum sheets in .5 and 1.0 mm thicknesses).
e. Phantom with absorbers and mesh.
f. Step wedge (penetrometer).
g. Body sectional device (tomographic phantom).
h. Tape measure (20 foot).
i. Ruler graduated in 1/10 inch increments.
j. Reed tachometer.
k. Light meter for measuring footcandles or lux.
l. Oscilloscope camera.
m. Polaroid camera/film.
n. Phantom for indicating center and dimensions of light and radiation fields with lead markers (included with BRH conformance test stand).
o. Voltmeter capable of reading RMS ac voltage,
p. mAs meter (if not using Machlett dynalyzer).
q. Pull guage (footpounds).
r. Level (three foot minimum).
s. Stopwatch.
t. Publications:

   "Regulations for the Administration and Enforcement of the Radiation Control for Health and Safety Act of 1968".

   GG-X-635d (Federal x-ray specifications).
u. Graph paper for determining half-value layer.
v. Direct print paper (no processing needed).
w. Paper cassettes.
x. Black ink or felt tip pen for completing package.

Inspector's Responsibilities

The following paragraphs describe requirements, suggestions, and clarifications which should make acceptance inspections easier and more effective:

1. Arranging for Inspections

After receiving notification that a system is ready for inspection, the inspecting authority has 30 days in which to complete the inspection.

After 30 days the Government loses all rights to performance of an inspection.

It is the responsibility of the inspector to establish the time of the inspection. Since the inspection time must be coordinated with both the radiology department and manufacturer representatives, the local medical supply officer is normally requested to make the arrangements for the inspector.

It is important to note that the local manufacturer's representative may not always be aware of the Government testing requirements.

The inspector should inform the medical supply officer of the desired date and expected length (normally 2 days) of the acceptance inspection and request that the local manufacturer's representative be asked to be present on those dates.

2. Interviewing Users

Inspectors will find it advantageous to arrive at the inspection site prior to the appointment with the manufacturer's representative.

This time can be used to ask users to describe any operational problems with the equipment, if it is already in use. It will also give the inspector an opportunity to visually inspect the system for general workmanship quality and to become familiar with the system prior to the inspection.

This preparation can considerably shorten the inspection and at the same time make it more effective. The inspector shall not perform any electronic tests of the x-ray system without the presence of the manufacturer's representative. Any discrepancies discovered during the visual inspection should be brought to the attention of the manufacturer's representative and he should be allowed to make appropriate corrections during the course of the inspection.

3. Interpreting Tolerances

Occasionally situations may arise in which there are disagreements between the inspector and the manufacturer's representative over whether a particular point of system performance meets required specifications, or in which the inspector is not sure if a performance factor is a deficiency.

The DPSC contract specifications are based on a combination of manufacturer's published specifications: GG-X-635d and 21 Code pf Federal Regulations.

In some instances, particularly company and manufacturer's specifications, as they apply to GG-X-635d, criteria given by the various systems may differ, the ultimate authority to make deficiency / rejection determinations rests with the contracting officer.

Whenever disagreements or doubts exist, the inspector and/or manufacturer's representative may contact the contracting officer or manufacturer for guidance or interpretations.

All such conversations should be recorded in the formal report.

As a -minimum, all doubts and disagreements should be fully documented in the report for final determination by the contracting officer.

4. Documentation of Deficiencies

Any failure to meet specifications must be completely documented (such as photos of waveforms) with an explanation of the discrepancy which will be submitted to the manufacturer with the rejection letter.

Reproduced copies of the dynalyzer printouts do not copy well and should be retyped if they are unclear. Use black ink or felt tip pen when filling out the inspection report as blue ink does not reproduce well.

5. On the Spot Corrections

Normally deficiencies will be encountered during most acceptance inspections. When these deficiencies consist of minor adjustments or repairs which could be accomplished rapidly on-site by the manufacturer's representatives, the inspector should afford the opportunity to make corrections during the acceptance inspection.

All such corrections should be noted in the inspection report. The decision to terminate the inspection or to permit correction of a certain deficiency is largely a matter of judgement by the inspector.

I. Scope

This procedure contains over 30 tests relating to the design, performance, and radiation safety characteristics of the medical x-ray components systems and the manner in which they are advertised to be used.

The findings vary in importance and the manufacturer's contract compliance. Others are equally important to determine if the assemblers have properly installed the x-ray system.

At the bottem of each test reporting form is the reference to the applicable test requirement publication.

II. Definition

Inspection, 'as utilized herein, is defined as both examination (such as visual and auditory investigation) and testing (determination by technical means with aid of testing equipment) of the components or system.

Note: Upon receipt of this manual it is requested that it be reviewed as soon as possible for workload planning. Should there be any technical questions, it is requested that DPSC-AX, autor von 444-2896, be contacted for resolution prior to the inspection.

III. Responsibilities

A. Contractor Installed

The inspection shall be performed by the Military Technical Representative of the Contracting Officer (TRCO). The TRCO shall be responsible for operating the test equipment and recording the data generated through the use of this equipment. The contractor is responsible for hook-up of the TRCO's test equipment within the x-ray components and for operation and performance of the x-ray components of the diagnostic x-ray system during the acceptance inspection.

B. Government Installed

The TRCO shall perform the same function described above.The Government installer shall be responsible for the hook-up of TRCO's test equipment within the x-ray components of the diagnostic x-ray system during this acceptance inspection.

Note: During this inspection the TRCO must evaluate each defect found and identified in the report. It is the TRCO's responsibility to indicate whether the defect is a manufacturing, shipment, or installation problem.

Test Equipment List

All test equipment used in the required testing is to be listed below:

Nomenclature	Model #	Serial #	Date Last Calibrated
Bleeder (HV)			
Digital Display			
Digital Printer			
Oscilloscope			
Densitometer			
Tachometer			
Light Meter			
Digital VOM			
Radiation Meter			
mAs meter			

Note: Insure that any test equipment which requires calibration has a valid certification label. If any equipment is overdue calibration it should not be used unless its accuracy can be proven by comparing it with an instrument of known accuracy and with the consent of the TRCO (inspector) and the manufacturer's representative.

IMPORTANT NOTICE

Iff inspection is a reinspection, the manufacturer is responsible for the actual cost of transportation, salary, per diem, and other costs. Indicate the actual costs incurred below and attach any supporting documentation. If the request for reimbursement will follow indicate reasons for the delay and the expected mailing date.

Salary: (Include computation) _____

Transportation: (Include airline tickets, etc,) _____

Per Diem: (Include TDY vouchers, etc.) _____

Other Costs: (i.e., excess baggage costs, etc.) _____

TOTAL COST OF RE-INSPSCTION: _____

Inventory List 21 CFR 1020.30 (e)

a. In the process of completing the inventory list, the inspector should check the completeness of the installation against the purchase order.
Particular attention should be paid to literature as it compares to the Service Data Clause (CD7) in the Basic Ordering Agreement (BOA) as stated below and any attachable accessories should be placed on the table so they can be identified when photographs are taken.

b. During the inventory the inspector should also check general Workmanship (wiring, screws, bolts, cleanliness, physical damage, etc) of the installation, including all control cabinets with removable covers.
Deficiencies identified should be documented with photographs.

Note: A copy of the inventory list should be retained and used as a preference to update the historical maintenance records on the equipment.

CD7 Service Data Manual for X-ray Equipment

The contractor shall furnish, in triplicate, manuals, handbooks and/or brochures containing complete operation, installation, and service / maintenance instructions (including pictures or illustrations, as necessary) with complete schematics and wiring diagrams.

All manuals, handbooks, and/or brochures will be written in the English language and all schematics and wiring diagrams will use American electrical and electronic symbols.

The manuals will include electrical data and connection diagrams for all applicable utilities.

The instructions shall also contain a complete list of all replaceable parts showing part number, name and quantity required.

All service notes, service memos, etc., pertaining to the equipment and issued subsequent to the printing of the original instructions shall also be included.

These instructions shall be, as a minimum, that furnished to service engineers (or servicemen) that normally install and service the equipment for the company or distributor.

When the system being procured includes or will operate with other ancillary equipment, the service data shall include complete instructions and drawings which show interfacing of all system components.

Two copies of the above information will be furnished to the Chief of Medical Materiel Services at the hospital receiving the equipment.

In addition, the Contractor will be required to furnish one copy of the above information to DPSC-AX, 2800 South 20th St., Phila., PA 19101. When the supplier has furnished acceptable manuals for the identical item and proposes to furnish manuals identical to those previously accepted, then the requirements for providing one copy to DPSC-AX shall not apply.

For shipboard units, a fourth copy of the service data shall also be forwarded to Commanding Officer, Naval Medical Materiel Support Command, 3500 S. Broad St., Phila., PA 19145. The Government reserves the right to award based upon those contractors which meet the above service data requirements for both contractor and subcontractor items.

COMMENTS: _____

_____

Inventory List

COMPONENTS	MANUFACTURER	MODEL, STYLE, ETC	SERIAL #
Control # 1			
High Speed Starter			
Control # 2			
High Speed Starter			
Transformer # 1			
Transformer # 2			
Tubestand # 1			
Tubehousing			
Insert			
Collimator			
Tubestand # 2			
Tubehousing			
Insert			
Collimator			
Fluoroscopic Tubehead			
Collimator			
Table			
Spot Film Device			
Image Intensifier			
Tube			
Suspension System			
Cine Camera			
TV Camera			
TV Camera Tube			
Monitor			
Video Recorder			
Spot Film Camera			
Cassette Holder			
Chest Unit			
Bucky Stand			
Syringe (Auto)			
Rapid Film Changer			
Programmer			
Heat Integrator			
Extension Cones			
Power Units			
Phototimer Unit			

Collimator PS			
(Other)			

Note: Be sure to record the exposure counter reading on page 19.

Documents

Are two copies of all maintenance literature supplied?

YES ☐ NO ☐ 21 CFR 1020.30 (h) (1) (ii)

Have the anode cooling and tube rating charts bean supplied
and are they correct for the x-ray tube supplied?

YES ☐ NO ☐ 21 CFR 1020.30 (h) (2) (ii) / (iii)

Has the FD 2579 been filled out and copies appropriately filed?

YES ☐ NO ☐ 21 CFR 1020.30 (d)

The above equipment is located in Room: _____

Note: Be sure and read the entire test procedure and all the notes prior to beginning the test.

Deficiencies or Discrepancies

Deficiencies or Discrepancies found during this inspection are as follows:

(Insert additional pages as required)

(List deficiencies in detail using black ink)

Attached is the inspection requirement folder along with the documentation of findings.

Personnel contacted and/or assisting in this inspection were:

_____

_____

_____

_____

_____

_____
Inspector(Signature)

_____

Record the reading on the exposure counter:

Beginning Reading: _____

Ending Reading _____

Total Number of Exposures Taken: _____

_____

Photographs of Room

Provide photographs of the control booth, table, tubestand, transformer, electronics cabinets, etc., and attach to page 21.

Note: If possible, one photograph should be taken to show as much of the room as possible, oriented to show table, tubestand and cable drape.

More than one component may be included on each photo if it helps to show relative position of the components with respect to each other.

a. Room Identification

Hospital	Give full name of medical facility and location.
X-Ray Room	Give the radiology number (i.e., X-ray Room 31).

b. Take two photographs of any deficiencies, crowding, or other inappropriate component location and attach. The extra copies of the photos will be sent by DPSC to the manufacturer to more closely identify the discrepancies as photos do not reproduce well.

Note 1: When taking photos of any discrepancies which require close-up detail, remember that most cameras have a minimum focus distance of three feet unless the camera is equipped with a special close up lens.

COMMENTS: _____

_____

_____

_____

_____

PHOTOGRAPHS OF ROOM

Medical Facility _____

X-Ray Room or Location _____

Views shall show equipment both front and back side views where practical.

Table and Table Operation

Inspection of the table should include inspection of spot film drive, locks, and releases, and the Bucky to be counter-balanced without a cassette to avoid interference with fluoroscopy.

With the table vertical and the Bucky unlocked without a cassette in place, there should be no Bucky drift. The Bucky lock should hold the Bucky in place with a cassette in the top vertical position.

a. Is table as specified on purchase order?

(1200) _____

b. Record all missing accessories and literature. (May be taken from page 17)

(1206) _____

c. Smoothness of Operation: Does power top support and move freely with a 300 pound patient load? (You may have to use two people and get as close as posssible to 300 pounds.)

Check the operation of the table bucky throughout the entire range of travel and verify that the grid oscillates prior to exposure.

(1213) _____

d. Variable Speed Tilt: (Use stopwatch or tilt indicators)

(1) Tilt operation is quiet and smooth without vibration?

(2204) _____

(2) Table tilt indicator is accurate, moves freely, and readily visible?

(2210) _____

(3) The table motor brake performance is not erratic or jerky?

(2201) _____

(4) Cassette size sensing circuits operate properly.
Circuits should open past 15 degrees tilt and operate again at 90 degrees tilt.

(2218) _____

(5) Tubehanger does not interfere with table tilt when the tubahanger is "parked".

(2107) _____

(6) Foot rest supports 300 pounds; moves with table top; and doesn't strike the floor when tilting.

(1210) _____

(7) Maximum tilt motor speed: 4,5 +/- 0.3 degrees per second.
Minimum tilt motor spaed: 1.2 degrees per second. (Use stopwatch)

(2206) _____

(8) Visually check all counterweight cables for cut and frayed areas?
This defect will be more predominate in clamnpdown areas.

(9) Is the table securely fastened to the floor?

(1220) _____

e. Table Top

(1) Minimum table top speed 2 inches per second to 30 inches past either end of table; 1 inch per second transverse to 4.5 inches either side of the center line.

(2212) _____

(2) Does the table top support 250 pounds at fully extended ends?

(1204) _____

(3) Is the table top center line clearly marked?

(2200) _____

(4) Is table cover shield (under the tabla top) properly mounted, in good condition, and suitable for protection of interior parts?

(1213) _____

(5) Does the table top permit mounting of required accessories?

(1205) _____

(6) Compression device attachable to table sides; sufficient to cross the abdomen of a 300 pound patient and adjusts to the full width of the table top?

(1209) _____

f. Other:

Is a mounting step supplied, skidproof and retractable?

(1212) _____

The radiation shield doesn't interfere with use of the table,
doesa not fall down easily, and projects a minimum of five inches above the table top (fixed and 2 way tops)?

(1211) _____

g. Table Bucky:

(1) Bucky release switch operational?

(2214) _____

(2) The bucky slot cover is present and operable? (Indicate whether automatic or manual close.)

(1215) _____

(3) Does the positive beam (PBL) sensing circuits deactivate when the tray is removed?

(2218) _____

(4) Check table top to Bucky distance. (1219)

(a) Fixed Top (Maximum 2-5/8"). _____

(b) Movable Top (Maximum 3-3/8"). _____

(c) Tomo unit as specified by manuf: _____

h. Undertable Tube:

(1) The X-ray tube is supplied with proper cable horns and federal standard cable wells.

(13369) _____

(2) Tube blower is not noisy, works, and is properly installed?

(1338) _____

(3) Anode visual inspection.
On some systems, visual inspection of the anode could be very time-consuming due to the possible requirement to remove the collimator and the degree of difficulty involved. If there are any unusual rotational noises, a complete visual inspection should be performed.

(4) Rotor Speed Verification: (1337)

(a) Check anode rotor speed with a suitable tachometer.

(1) Standard Speed _____ RPM

(2) High Speed _____ RPM

(b) Are there any unusual rotor bearing noises?

(1333) _____

(c) Does the HS rotor brake operate within manufacturer's specifications? _____
(2112)

i. Room lights activate when fluoroscopic foot switch is depressed.
If not, check the contract to see if special provisions for this feature were provided for. It is the customer's responsibility to provide the necessary wiring if this feature is desired.

(1117)

_____

j. X-ray radiation is not possible from the fluoroscopic tube when the spot film device is in the "parked" position. 21 CFR 1020.32 (a) (1)

(1306)

_____

Tubestand Operation

a. Drag:

(1) Is the tubestand free of binding, bearing noise, or drift?

(1101) _____

(2) The force required to position the tubestand is not over 7 pounds as measured with a pull gauge? This value should be taken once the tubestand is in motion. Measurements should be taken in several positions and the values averaged. Any excessive measurement should be annotated.

(2101) _____

(3) The x-ray tube is properly counterbalanced?

(2100) _____

b. Operation of Locks:

(1) The locks are quiet acting, positive locking, easily operated and within easy reach of the operator? (Most locks are for "maintaining" position, not brakes for stopping equipment from counterweighing motion.)

(2104) _____

(2) The tubestand remains firmly in place when the locks are applied?

(1105) (1104) _____

(3) Additional special purpose cones (auch as mammo cones) are ertified, properly collimate the x-ray beam with no visible clipping nd the tubestand is counterbalanced when the cones are attached.
A radiograph should be taken with each cona attached and discrepancies oted.
Radiographs should be taken with the extension cones fully extended. Check the tube angulation locks at several points with the sinus cones in place.

(1120) _____

c. Tube Angulation and Rotation:

(1) Ease of Operation: The tube angulates smoothly and is free of whip and backlash?

(2106) _____

(2) The detent is positive acting in longitudinal (2103) and lateral (1102) positions.

_____

(3) The tube housing can be rotated a minimum of 180 degrees (1115) and the tube scales are easily read and permit accurate positioning of the tubehead.

(1106) _____

d. Cable Dress:

(1) The cable retractor is properly installed and is operating properly?

(1113) _____

(2) The cables are properly dressed and do not cause the tubestand to "drift" when the tubestand is positioned at its most distant point from cable origination. The cables are protected by strain reliefs and are covered when required?

(1114) _____

e. Tube Carriage Travel and Rigidity

(1) The tube carriage is properly aligned vertically and horizontally (as checked with a level)?

(1103) _____

(2) The tubestand and carriage are rigidly assembled?

(1105) _____

(3) The tubehanger properly accommodates the x-ray tube and associated components?

(1100) _____

(4) The floor rails of the tubestand (ceiling-floor mounted only) do not interfere with passage of wheeled stretchers?

(2108) _____

(5) Longitudinal positioning of the tube housing does not prevent the primary beam from striking the center of the table Bucky, when the table is vertically positioned and the bucky is at it's lowest point?

(1116) _____

(6) The illuminated distance scales light up as required?

(1117) _____

(7) The tube hanger tracks allow for minimum transverse travel distance in manufacturer's specifications?

(1118) _____

(8) Visually check all counterweight cables for cut or frayed areas. This discrepancy will be

more predominate at clampdown areas.

f. Accuracy of Scales (1106):

In order to verify the accuracy of the scales, it is necessary to determine the focal spot location using the following procedure:

(1) Using the BRH conformance test stand, locate a cardboard cassette 14" from a 2" beam defining aperture.

(2) Initiate a radiographic exposure and develop the film. Use the procedure outlined on page 95 to determine the focal spot location.

(3) The distance obtained is the distance from the 2" aperture to the actual focal spot location.

Note: You may permit the manufacturer's representative to permanently mark/remark this location on the tubehousing for future reference.

(4) Using the focal spot location, measure the source-image-distance (SID) and compare the actual distance to the SID indicators and any tape measures at several distances and annotate the results below and on page 101 of this report: (2105)

(a) Longitudinal:

_____

(b) Lateral:

_____

(c) Vertical:

_____

(5) Can the center of the beam be brought to within 1.5 inches of the table top for lateral radiography? If not, how far can it be lowered? Record the distance below.

(1107) _____

(6) Check that the focal spot (source) can be positioned at least 43 inches above the table top? If this is not possible, measure the ceiling height and annotate the distance below. Also record the maximum SID obtainable.

(1108) _____

(7) Check that the focal spot can be brought to within 40 inches of the vertical bucky stand and 36 inches of the table bucky with the table vertical?

(1109) _____

g. Overhead Tube:

(1) X-ray tube is supplied with proper cable horns and federal standard cable wells.

(1123) _____

(2) Tube blower is not noisy, works, and is properly installed?

(1112) _____

(3) Anode Visual Inspection.
On some systems, visual inspection of the anode could be very time-consuming due to the possible requirement to remove the collimator and the degree of difficulty involved. If there are any unusual rotational noises, a complete visual inspection should be performed.

CAUTION: Verify that radiation is not being produced when verifing anode rotation. The safest method is to inspect the anode using a mirror or piece of polished metal.

(4) Rotor Speed Verification: (1124)

(a) Check anode rotor speed with a suitable tachometer.

(1) Standard Speed _____ RPM

(2) High Speed _____ RPM

(b) Is there any unusual rotor bearing noise?

(2111) _____

(c) Does the HS rotor brake operate within manufacturer's specifications?

(2112) _____

(5) Visually check that the total fixed filtration as stated on the certification labels (including the collimator) is not less than 2.5 mm of aluminum equilavent for units over 90 KVP.
21 CFR 1020.30 (h)(4)

(2110) _____

h. Collimator:

(1) Check to insure proper centering of the tube unit to table (horizontal and vertical) and chest unit?

(2) The interval-timer collimator light works properly and is adjusted for the length of time as determined by the using activity?

(1121) _____

(3) The bucky centering light is provided and aligns properly on the table bucky?

(2113) _____

(4) The bucky centering light aligns properly on the vertical bucky cassette holder?

(2113) _____

(5) If the unit is equipped with a special purpose multidiaphragm, it properly adjusts?

(1121) _____

i. Other:

(1) The vertical bucky is as specified: proper spaed, grid, smooth operation, proper travel and properly counterbalanced with and without a cassette?

1216) (1217) _____

(2) Workmanship:
There are no broken components, dents, marred finishes, or any other discrepancy which indicates poor or unprofessional installation practices?

(2219) _____

_____

_____

(3) Vertical and longitudinal stereo shifts are electrically controlled and shift over a range of 3.6 to 7 inches without excessive vibration after shift termination. If "excessive" vibration is observed, it can'be validated by taking resolution films and attached to page 81.

COMMENTS: _____

_____

_____

_____

Control and Transformer

a. Are the control and transformer as specified in the contract?

(1400) _____

b. Is the control and transformer suitably mounted and supported?

(1401) _____

c. Do the control meters indicate "zero" and are they operational?

(1403) _____

d. The high tension transformer does not leak oil, the tube cable wells are fully seated, the cables are fully seated in the cable wells without stress, and any unused cable wells are properly covered? Also verify that the high voltage cable ends are properly protected against HV breakdown. This will require removing the cables from the wells.

(1406) _____

e. There are no broken or cracked interior components, loose wire terminals or circuit boards, improper wire dress, or cracked or uncovered terminal panels?

(1407) _____

f. The control main-line switch breaks both sides of the line.
The circuit breaker is supplied and is within easy reach of the operator (accessible)?

(1412) _____

g. Is the control adequately cooled/vented and does it have strain reliefs provided on all cable exit ports?

(1413) _____

h. Are the control knobs/switches tight and will they index properly?

(2400) _____

i. Are there lamps in the control panel which are burned out?

(2401) _____

j. Is the MA selector positive acting and properly indexed?
(Timer accuracy will not be checked here.)

(2402) _____

k. Is the exposure switch properly secured in the control booth and in such a position that would permit an exposure while the operator is outside the confines of the control booth?

(2403) _____

l. Are there any sharp edges where operator may come in contact with control or transformer?

(2407) _____

m. Does the control indicate proper changeover of components or electrical equipment Buckys, tubes, phototimers, etc.)

(2403) _____

COMMENTS: _____

_____

_____

_____

Tables

These tables will be used to assist in the performance of later tests.

MA FOR CONTINUOUS OPERATION

MA FOR CONTINUOUS OPERATION

MAX KVP	Anode Cooling Rate (H.U. /minute)								
	25,000	30,000	35,000	40,000	45,000	50,000	60,000	70,000	100,000
90	4.63	5.55	6.48	7.41	8.33	9.26	11.1	12.9	18.5
100	4.17	5.00	5.83	6.67	7.50	8.33	10.0	11.7	16.6
110	3.79	4.54	5.30	6.06	6.82	7.57	9.09	10.6	15.2
120	3.47	4.17	4.86	5.55	6.25	6.94	8.33	9.72	13.8
130	3.21	3.85	4.49	5.13	5.77	6.41	7.69	8.97	12.8
140	2.98	3.57	4.19	4.76	5.36	5.75	7.14	8.33	11.9
150	2.77	3.33	3.89	4.44	5.00	5.55	6.67	7.77	11.1

To find the MA for continuous operation for an anode cooling rate not given: Divide the anode cooling rate by 60 and then divide this value by the KVP (i.e., 150) to be used in the test.

CHART FOR DETERMINING FOCAL SPOT LOCATION

CHART FOR DETERMINING FOCAL SPOT LOCATION

Image Size	STFD	Image Size	STFD	Image Size	STFD	Image Size	STFD
2.40	84.00	3.45	33.31	4.50	25.20	5.70	21.57
2.50	70.00	3.55	32.06	4.60	24.77	5.80	21.37
2.60	60.67	3.65	30.97	4.70	24.37	5.90	21.18
2.70	54.00	3.75	30.00	4.80	24.00	6.00	21.00
2.80	49.00	3.85	29.14	4.90	23.66	6.10	20.83
2.90	45.11	3.95	28.36	5.00	23.33	6.20	20.67
3.00	42.00	4.05	27.66	5.10	23.03	6.30	20.51
3.10	39.45	4.15	27.02	5.20	22.75	6.40	20.36
3.20	37.33	4.25	26.44	5.30	22.48	6.50	20.22
3.30	35.54	4.35	25.91	5.40	22.24	6.60	20.09
3.40	34.00	4.45	25.43	5.50	22.00	6.70	19.96

X-Ray Tube Protection

Purpose: To insure the maximum techniques will not exceed the tube rating charts.
Be sure the tube rating chart matches the particular tubehead being tested, i.e., focal spot size, low/high speed operation, etc.

a. Provide several examples of techniques at which the protector circuit just operates (the next lower setting will permit exposure).
Techniques at each MA station should be checked.
Verify than an exposure inhibit of overload light operates and exposure is prohibited. (Note: Some units may require the rotor circuit to be activated in order for the tube protection circuit to operate.)

b. On the larger MA stations it is necessary to check the linearity of the tube protection circuitry. This will require the inspector to plot the tube rating chart at two other KVP points and adjust the time to the point where the tube protection circuitry just operates. Record these additional settings.

c. These values should be compared to the tube rating chart and should not exceed the tube rating. They will normally be set 80 to 90 percent of the tube rating values if it is with the concurrence of the radiology department. The purpose for this would be to extend tube life. You may want to perform this test after the maximum advertised load test on page 44 to negate having to readjust these values.

COMMENTS: ____

____

____

____

____

Record the settings at which integrated tube protection circuits operate and the actual values observed.

VALUES PER TUBE CHART	ACTUAL VALUES UNDER TEST		
MA ____________			
KVP ____________	KVP ____________	KVP ____________	KVP ____________
TIME ____________	TIME ____________	TIME ____________	TIME ____________
FS ____________	FS ____________	FS ____________	FS ____________
MA ____________			
KVP ____________	KVP ____________	KVP ____________	KVP ____________
TIME ____________	TIME ____________	TIME ____________	TIME ____________
FS ____________	FS ____________	FS ____________	FS ____________
MA ____________			
KVP ____________	KVP ____________	KVP ____________	KVP ____________
TIME ____________	TIME ____________	TIME ____________	TIME ____________
FS ____________	FS ____________	FS ____________	FS ____________

MA ____________________

KVP ____________	KVP ____________	KVP ____________	KVP ____________
TIME ____________	TIME ____________	TIME ____________	TIME ____________
FS ____________	FS ____________	FS ____________	FS ____________

MA ____________________

KVP ____________	KVP ____________	KVP ____________	KVP ____________
TIME ____________	TIME ____________	TIME ____________	TIME ____________
FS ____________	FS ____________	FS ____________	FS ____________

MA ____________________

KVP ____________	KVP ____________	KVP ____________	KVP ____________
TIME ____________	TIME ____________	TIME ____________	TIME ____________
FS ____________	FS ____________	FS ____________	FS ____________

MA ____________________

KVP ____________	KVP ____________	KVP ____________	KVP ____________
TIME ____________	TIME ____________	TIME ____________	TIME ____________
FS ____________	FS ____________	FS ____________	FS ____________

MA ____________________

KVP ____________	KVP ____________	KVP ____________	KVP ____________
TIME ____________	TIME ____________	TIME ____________	TIME ____________
FS ____________	FS ____________	FS ____________	FS ____________

Scope Alignment and Probe Calibration

Purpose: The purpose of the scope photographs is to indicate proper adjustment of oscilloscope focus, astigmatism, scope calibration, and trace rotation.

a. Provide, as a minimum, scope photographs of the following and include the time setting and volts/division.

(1) In chopped mode both channel A and B baselines on separate horizontal graticules.

(2) Both channel A and B superimposed on the center graticule in the add mode.

b. If the Machlett Dynalyzer will be used during testing, provide a photograph of a calibrated waveform (1 KHz, 0.6V square wave) for each channel. The photo should show two complete square waves with a height of six graticules.

c. If a GE bleeder is used, provide oscilloscope photographs for each 10X probe used. If the 100X probe is to be used for line load drop tests, provide a photograph as in (b) above.

Photo 1 _____

Settings: _____ V/div

_____ time

Photo 2 _____

Settings: _____ V/div

_____ time

Photo 3 _____

Settings: _____ V/div

_____ time

Photo 4 _____

Settings: _____ V/div

_____ time

Line Load Drop Test

21 CFR 1020.30 (b) (23)

Purpose: To observe the drop in supply voltage at the maximum KVA demand of the x-ray unit. The test should be performed at the maximum MA and KVP product obtainable. Multiply each MA station times the maximum allowable KVP on that station and use the setting which gives the highest value. For example, if a unit allows 110 KVP at 1000 MA and 150 KVP at 800 MA, the test should be performed at 150 KVP on the 800 MA station since 800 X 150 is greater than 1000 X 110. Time should normally be no longer than 1/20 second. Observe tube charts and warmup procedures.

a. Procedures for using oscilloscope:

(1) For Single Phase Units. With the scope ungrounded, connect 100X probes across incoming power and adjust scope vertical gain to obtain a sine wave as large as possible within the limits of
the vertical graticules. Set oscilloscope on single sweep, time on 0.2 sec/div. With maximum technique at 1/20 seconds, press rotor switch. When the rotor is up to speed, press scope reset and then initiate an exposure. This should provide a single 1 second sweep displaying a 1/20 second drop caused by the exposure. Check each line to ground for proper balance.

(2) For Three Phase Units. Provide a photograph for each ossible phase to phase connection following the above procedure.

b. If a dynalyzer is used:

Scope photographs are not required. Dynalyzer printouts will be attached, labeled to show line volts during pre-exposure and exposure for each phase.
Note: In order for the digital display to update the load voltage during a short time exposure, the HV divider roust be connected. Insure that the ink bar on the printer is replaced or new for these tests as a dry ink bar will not produce readable or reproducible results.

c. Calculate the percentage of line regulation and compare it against the manufacturer's specifications. If the line regulation exceeds the specifications, the unit should have been derated by the manufacturer during installation. Identify any discrepancies and annotate any corrective action taken.

CAUTION

USE EXTREME CAUTION WHEN PERFORMING THESE TESTS AS THE SCOPE IS NOT GROUNDED (FLOATED).

CONTACT WITH AN UNGROUNDED SCOPE DURING EXPOSURE CAN CAUSE SERIOUS SHOCK

Scope Settings: (If used)

Mode

Volts/Div _____

Time/Div _____

Probe _____

X-ray Control Settings:

MA _____

KVP _____

TIME _____

CAUTION: DO NOT EXCEED TUBE LIMIT

Manufacturer's Specification % Line Regulation: _____ % @ _____ KVP

Calculated Percent Regulation _____

Calculate the percentage of regulation from the formula:

Percent Regulation $100 \times \frac{(V_{nl} - V_l)}{V_l}$

Where: V_{nl} = No-load Voltage

V_l = Voltage under load

COMMENTS:

_____ _____

_____

_____

_____

_____

Transformer Balance Test

Purpose: To insure the high voltage transformer is properly balanced on both the anode and cathode side of the transformer.

a. Connect the bleeder or dynalyzer to the radiographic tubehead with the anode output connected to oscilloscope channel 1 and the cathode to oscilloscope channel 2.

b. The vertical gain should be set to obtain 20 KVP per major division and channel 2 should be in the normal (not inverted) position. Insure the oscilloscope is in the chopped mode

c. This will provide an indication of anode voltage in the positive direction and the cathode voltage in a negative direction.

d. At the lowest MA station on the large focal spot, provide a photograph of a family of curves at the KVP settings indicated in the report. Exposure time shall be 1/20 (.05) seconds. Be sure and include the lowest and highest KVP stations. Settings which should normally be checked are 40, 60, 80, 100, 120, 140, and 150 KVP settings

Note: It is not necessary to record the results at the 140 KVP station as it makes it difficult to observe the maximum (150) KVP station. The 140 KVP station should be shot, however, as part of the step-up procedure to the maximum setting to reduce the possibility of high voltage breakdown.

COMMENTS:

_____

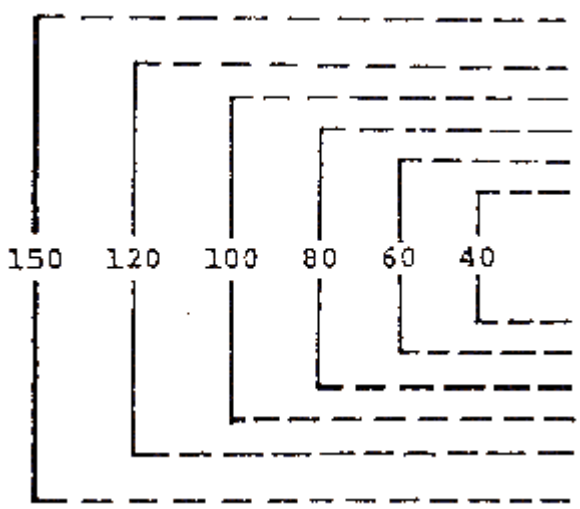
_____

_____

_____

Record Manufacturer's Specification Limits:

KVP _____ @ _____ %



PLACE PHOTOGRAPH HERE

Scope Settings in Chopped Mode:

Volts/Div _____

Time/Div (5 ms/div) _____

Probe _____

X-Ray Control Settings:

KVP

MA

Time (1/20) .05 Seconds

GE Bleeder |___|

Machlett Dynalyzer |___|

Timer Test

Purpose: To verify the accuracy of the exposure timer.

a. Provide either oscilloscope photographs or dynalyzer printouts to verify timer accuracy. If oscilloscope photographs are provided, more than one timer setting can be indicated per photograph by varying the horizontal position control.
If dynalyzer printouts are provided, each should be labeled with the timer setting (milliseconds).

b. Documentation for each available timer setting need not be provided. However, results for the longest available time (can be taken from page 45), one second, and all settings below 1/2 second should be provided with additional selected settings in other ranges. If minor discrepancies occur at the lower timer settings, it may be beneficial to attach an oscilloscope and count the number of pulses (single phase units only).

Note 1: When using the digital display be sure to switch the delay switch in the back to the "OFF" position when measuring all timer settings less than 1/120 of a second. When using the dynalyzer on three.phase units, note that changing the KVP to a lower setting at any time will require taking another initial exposure to re-establish the 70% threshold point of the KVP waveform for measuring time.

Note 2: If the dynalyzer is used, the measured values need not be written on page 43. Attach the dynalyzer printout and label each setting. Insure that the ink bar on the dynalyzer printer is new or has recently been replaced. A dry ink bar produces results which do not reproduce well.

COMMENTS: _____

_____

_____

_____

_____

Scope Settings: (If used)

Be sure to include the time/division setting on the oscilloscope for each photo taken.

X-ray Control Settings:

MA _____

KVP _____

INDICATED	MEASURED
Time _____	Time _____
Time _____	Time _____
Time _____	Time _____
Time _____	Time _____
Time _____	Time _____
Time _____	Time _____
Time _____	Time _____
Time _____	Time _____
Time _____	Time _____
Time _____	Time _____
Time _____	Time _____
Time _____	Time _____

CAUTION: Do Not Exceed Tube Limits.

Verify the following does or does not.occur:

(1) An audible signal indication upon termination of exposure?

(1402) 21 CFR 1020.31 (i) Yes |___| No |___|

(2) Is there a visual indication when an exposure is in progress?

(1403) 21 CFR 1020.31 (i) Yes |___| No |___|

(3) Does the unit allow uncontrolled or repeated timed exposures?

(1411) 21 CFR 1020.31- (a) (2) (i) Yes |___| No |___|

Maximum Advertised Load Test

Purpose: To verify that the x-ray system will provide the advertised KW output and withstand the advertised KVP. It is not a tubehead heat unit endurance test.
Do not exceed tubehead rating charts. The tube protection circuitry may have to be temporarily readjusted to 100% of the maximum tube rating in order to perform these tests.

a. Provide a KVP photograph of the maximum rated KVP at the highest MA station that can be obtained. For example, if the system is a 1000 MA unit rated at 150 KVP, but the integrated tube protect circuit prevents an exposure at 150 KVP and 1000 MA, reduce the MA until an exposure can be made. Follow the manfacturer's and x-ray tube rating chart for these exposures.

b. Provide a KVP photograph of the maximum rated MA at the highest KVP station that can be obtained. For example, if the system is a 1000 MA unit rated at 150 KVP, but the integrated tube protect circuit prevents an exposure at 1000 MA and 150 KVP, reduce the KVP until an exposure can be made.

c. Provide a KVP photograph of the maximum time at the highest KVP that can be obtained. This is a test of high voltage insulation and not a tubehead heat unit endurance test.

Note 1: Any high voltage breakdowns which occur should be documented in detail.
Provide additional photographs of any arcing or HV breakdowns which occur.

Note 2: Any reluctance on the part of the manufacturers representative to perform these tests should be documented here.
If questions arise concerning the maximum advertised limits, consult the procurement contract.

Note 3: If the tubehead will not allow a test at the maximum capacity of the generator, the test can still be performed by removing the tubehead completely from the circuit and take an exposure with the HV bleeder connected.
If this is the case, dummy plugs should be placed in the "TUBE" wells.

COMMENTS: _____

_____

_____

_____

_____

Photo 1: Maximum KVP with the maximum allowable-MA and time.

Photo 2: Maximum MA with the maximum allowable KVP and time.

Photo 3: Maximum time with the maximum allowable KVP, low MA.

Maximum Advertised Limits

Scope Settings in ADD Mode:

Volts/Div _____

Millisec/Div _____

Probe (If Used) _____

X-Ray Control Settings #1:

KVP _____ PLACE PHOTOGRAPH HERE

mA _____

Time _____

X-Ray Control Settings #2:

KVP _____ PLACE PHOTOGRAPH HERE

mA _____

Time _____

X-Ray Control Settings #3:

KVP _____ PLACE PHOTOGRAPH HERE

mA _____

Time _____

Space Charge and KVP Test

Purpose: To insure the space charge compensation circuit is properly adjusted, i.e., the mA remains relatively constant throughout the KVP range, and that the KVP stations are accurate.

a. Dynalyzer printouts may be provided in lieu of oscilloscope photographs for this test. If this option is selected, the inspector should have the oscilloscope connected during testing and observe all waveforms. Photographs of all discrepancies or suspicious waveforms should be provided.

b. Label all dynalyzer printouts.

c. If oscilloscope photographs are provided, the ADD mode should be used at 20 KVP per division, and all waveforms for the mA station superimposed in a single photograph. Exposure time should be at least 1/10 second.

d. Record mAs for each exposure using a mAs meter or the dynalyzer mAs setting. mAs values per mA station checked shall be within 5 percent of the average mAs recorded for that mA station.

e. Measurements shall be taken for the two lowest and the two highest mA stations and exposures shall be taken at the lowest, neutral, and the highest KVP stations. If discrepancies are observed, the inspector will check each of the other mA stations also. In order to establish a baseline for all future calibrations, the inspector may want to verify each of the mA stations regardless of whether any discrepancies are observed in the initial testing. The manufacturer's representative should be given the opportunity to correct any discrepancies.

Note 1: If the dynalyzer is being used the cathode cable should be removed. mAs can be significantly reduced by the test equipment. The cause of low readings should be annotated in the report. True readings should be obtained by using the anode only connected and doubling the KVP obtained, providing transformer balance was previously verified.

Note 2: In order to keep heat units from building up, it is advised to start at the highest mA station and work down, but start at the lowest KVP station and work up.

COMMENTS: _____

_____

Space Charge and KVP Test

Scope Settings:

Volts/Div _____

Time/Div _____

Indicate High and Low KVP settings used: Low _____ High _____

MA Station: _____

mAs

Low KVP _____

80 KVP _____

High KVP _____

MA Station: _____

mAs

Low KVP _____

80 KVP _____

High KVP _____

MA Station: _____

mAs

Low KVP _____

80 KVP _____

High KVP _____

Rapid Film Changer Tests

Purpose: To verify the proper exposure rate, uniformity of KVP, exposure time, and a uniform time between exposures.

a. Data for these two sections can be obtained simultaneously.

b. Place a Westinghouse penetrometer and wire mesh on the film changer and select the technique that will produce a readable film.

c. With the oscilloscope connected to the dynalyzer or bleeder obtain KVP photographs of 2 second long series for a 2 second rate, and six second rate. Sweep speed should be .2 seconds per division (two seconds per sweep.)

d. During the 4 per second rate, set the x-ray timer at the maximum allowable exposure time, and attach sections of film to this page. (Use the same section each time.) Inspect films for non-uniformity or blurring due to movement and attach films to this page.

e. Attach oscilloscope photographs; dynalyzer printouts are not acceptable for this test. The photographs should be inspected for proper exposure rate, uniformity of KVP and exposure time, and uniform time between exposures.

f. Define any irregularities, pulses, or timing errors which may be present on the waveform. Misadjustment of the timing cams in the rapid film changer can cause extra pulses and should be corrected.

Scope Settings:

"ADD" mode _____

Volts/Div _____

Millisec/Div _____

2/Second

X-Ray Settings: .

PLACE PHOTOGRAPH HERE

KVP _____

mA _____

Time _____

4/Second

X-Ray Settings: .

PLACE PHOTOGRAPH HERE

KVP _____

mA _____

Time _____

Note: Additional sheets should be added if provisions for both AP and Lateral exist

6/Second

PLACE PHOTOGRAPH HERE

PLACE FILM HERE	PLACE FILM HERE	PLACE FILM HERE	PLACE FILM HERE

Maximum Tube Current and Exposure Time

(Table Bucky) 21 CFR 1020.31 (a)(3)(iii)

Purpose: To verify that the automatic safety circuits limit maximum possible exposure to either 600 mAs or 60 KW's (KVP X mA X Time) at exposures above 50 KVP in the automatic exposure control (Phototimed) mode, and to less than 2000 mAs below 50 KVP in the same mode. This is normally accomplished by providing automatic backup time in the phototimed mode.

a. Consult the manufacturer's literature for the maximum limits specified for 50 KVP and greater, and for any setting below 50 KVP and record in paragraph 1 and 2 on the next page.

b. Select a KVP setting above 50 KVP and initiate a phototimed exposure with the x-ray beam blocked with lead. If a manual backup timer is available it should be set to the longest time. Measure mAs obtained using the dynalyzer or mAs meter, or calculate mAs from mA and actual time of exposure.

c. If the manufacturer specified a 600 mAs limit, record maximum mAs obtained. If 60 KW's was specified, calculate this by multiplying the KVP settings by the mAs obtained and record the maximum.

d. Repeat the above procedure at a KVP setting below 50 KVP and verify that 2000 mAs cannot be exceeded and record the results.

e. If the unit is equipped with an integrated heat unit indicator, record the readings prior to, and immediately after, each exposure.

Note: This test needs to be performed on the overhead radiographic tube only as manufacturers use the same circuitry for both radiographic and fluoroscopic mode.

COMMENTS: _____

_____

_____

_____

_____

(Table Bucky)

a. Prior to, and immediately after each exposure, record the readings on the heat unit indicator if the unit is so equipped.

b. Record the maximum mAs or KWs limits the manufacturer specified for 50 KVP or greater.

mAs _____ or KWs _____

Record the maximum mAs or KWs developed during testing.

mAs _____ or KWs _____

c. Record the maximum mAs or KWs limits the manufacturer specified for less than 50 KVP

mAs _____ or KWs _____

Record the maximum mAs or KWs developed during testing.

mAs _____ or KWs _____

d. Compare the results obtained with the maximum limits. (1411)

e. Attach dynalyzer printout or scope photograph if available.

f. Verify that the following occurs:

(1) Upon exposure termination does a visual indication occur?

21 CFR 1020.31 (a) (3) (iv) Yes |___| No |___|

(2) The automatic exposure control requires manual resetting after a backup timed exposure?

21 CFR 1020.31 (a) (3) (iv) Yes |___| No |___|

g. Record the readings on the heat unit indicator as stated above.

Exposure 1:	Before	_____
	After	_____
Exposure 2:	Before	_____
	After	_____

Minimum Exposure Time for AEC (Table Bucky)

21 CFR 1020.31 (a) (3) (ii)

Purpose: To verify that the automatic exposure controls (AEC) meet the minimum response time required by 21 Code of Federal Regulations.
Automatic exposure controls must be capable of terminating exposures in 1/60 second or less (or allow less than 5 mAs for status below 300 mA).

a. To perform this test select 70 KVP, automatic exposure control, and initiate exposures at several mA stations with the tube aligned to the receptor and the shutters open (do not use a phantom or block the view). Block receptors which are not being tested with lead or limit the radiation field to the receptor under test to insure the receptor being tested is the one providing the data to terminate the exposure. The manufacturer's literature should provide the exact location of each detector with respect to the table and may have to be consulted in order to cover the appropriate detector with lead.

b. Using the dynalyzer or bleeder and oscilloscope, verify that exposures do not exceed 1/60 second or 5 mAs, whichever is the greater mAs limit. For example, on a 600 mA station, 1/60 second would be the limit since that time results in a 10 mAs exposure. On a 100 mA station, 5 mAs would be the limit since a 1/60 second exposure would result in only 1.7 mAs.

c. Some phototimers offer selectable fields for phototiming. Repeat the test for each selectable receptor field if they are provided.

d. Repeat for each phototime receptor.

e. Label and attach dynalyzer printouts or oscilloscope photos if available.

Note: Most ion detectors have at least three separate detectors.

COMMENTS: _____

_____

_____

_____

_____

a. Record minimum mAs or millisecond the manufacturer specified.

mAs _____ or Millisecond _____

b. Record the minimum mAs or exposure time observed.

	# 1	# 2	# 3	# 4
Exposure Time				
mAs				

c. Compare the results with the manufacturer's specifications and record any discrepancies.

d. Attach and label dynalyzer printout or oscilloscope photos.

Minimum Exposure Time for AEC (Vertical Cassette Holder)

21 CFR 1020.31 (a) (3) (ii)

Purpose: To verify that the automatic exposure controls (AEC) meet the minimum response time required by 21 Code of Federal Regulations. Automatic exposure controls must be capable of terminating exposures in 1/60 second or less (or allow less than 5 mAs for status below 300 mA).

a. To perform this test select 70 KVP, automatic exposure control, and initiate exposures at several mA stations with the tube aligned to the receptor and the shutters open (do not use a phantom or block the view). Block receptors which are not being tested with lead or limit the radiation field to the receptor under test to insure the receptor being tested is the one providing the data to terminate the exposure.

b. Using the dynalyzer or bleeder and oscilloscope, verify that exposures do not exceed 1/60 second or 5 mAs, whichever is the greater mAs limit. For example, on a 600 mA station, 1/60 second would be the limit since that time results in a 10 mAs exposure. On a 100 mA station, 5 mAs would be the limit since a 1/60 second exposure would result in only 1.7 mAs.

c. Some phototimers offer selectable fields for phototiming. Repeat the test for each selectable receptor field if they are provided.

d. Repeat for each phototime receptor.

e. Label and attach dynalyzer printouts or oscilloscope photos if available.

Note: Most ion detectors have at least three separate detectors.

COMMENTS: _____

_____

_____

_____

_____

a. Record minimum mAs or millisecond the manufacturer specified.

mAs _____ or Millisecond _____

b. Record the minimum mAs or exposure time observed.

	# 1	# 2	# 3	# 4
Exposure Time				
mAs				

c. Compare the results with the manufacturer's specifications and record any discrepancies.

d. Attach and label dynalyzer printout or oscilloscope photos.

Minimum Exposure Time for AEC (Fluoroscopic)

21 CFR 1020.31 (a) (3) (ii)

Purpose: To verify that the automatic exposure controls (AEC) meet the minimum response time required by 21 Code of Federal Regulations. Automatic exposure controls must be capable of terminating exposures in 1/60 second or less (or allow less than 5 mAs for status below 300 mA).

a. To perform this test select 70 KVP, automatic exposure control, and initiate exposures at several mA stations with the tube aligned to the receptor and the shutters open (do not use a phantom or block the view). Block receptors which are not being tested with lead or limit the radiation field to the receptor under test to insure the receptor being tested is the one providing the data to terminate the exposure.

b. Using the dynalyzer or bleeder and oscilloscope, verify that exposures do not exceed 1/60 second or 5 mAs, whichever is the greater-mAs limit. For example, on a 600 mA station, 1/60 second would be the limit since that time results in a 10 mAs exposure. On a 100 mA station, 5 mAs would'be the limit since a 1/60 second exposure would result in only 1.7 mAs.

Note: Insure the shutters are wide open and a full size cassette program is selected to prevent TV raster burn.

c. Some phototimers offer selectable fields for phototiming. Repeat the test for each selectable receptor field if they are provided.

d. Be sure and remove any grids from the beam which could affect the exposure time.

e. Repeat for each phototime receptor.

f. Label and attach dynalyzer printouts or oscilloscope photos if available.

COMMENTS: _____

_____

_____

_____

_____

a. Record minimum mAs or millisecond the manufacturer specified.

mAs _____ or Millisecond _____

b. Record the minimum mAs or exposure time observed.

	# 1	# 2	# 3	# 4
Exposure Time				
mAs				

c. Compare the results with the manufacturer's specifications and record any discrepancies.

d. Attach and label dynalyzer printout or oscilloscope photos.

Phototimer Performance Test (Table Bucky)

Purpose: To verify that the phototimer density control varies mAs. There are no standards to look for other than those found acceptable to the activity.

a. Check to see if the radiology department was consulted when the densities were adjusted. If they have not been, radiographs of each setting may be required.

b. Perform the tests at a commonly-used technique, i.e., 80 KVP 300 mA with the Westinghouse phantom or equilavent with absorbers 1 and 2 in the beam. Record the mAs obtained from three settings, light, normal, and dark. Dynalyzer printouts may be used in lieu of oscilloscope photographs.

Note: Depending upon the distance from the source to the receptor, one of the absorbers may have to be removed if the backup timer energizes.

COMMENTS: _____

_____

_____

_____

_____

Record Exposure Factors:

KVP

_____

mA

_____

Distance

_____

Setting # 1 (-) (Light)

mAs _____

Setting # 2 (Normal

mAs _____

Setting # 3 (+) (Dark)

mAs _____

Phototimer Performance Test (Vertical Cassette Holder)

Purpose: To verify that the phototimer density control varies mAs. There are no standards to look for other than those found acceptable to the activity.

a. Check to see if the radiology department was consulted when the densities were adjusted. If they have not been, radiographs of each setting may be required.

b. Perform the tests at a commonly-used technique, i.e., 80 • KVP 300 mA with the Westinghouse phantom or equilavent with absorbers 1 and 2 in the beam. Record the mAs obtained from three settings, light, normal, and dark. Dynalyzer printouts may be used in lieu of oscilloscope photographs.

c. Check the linearity of the phototimer by varying the distance from the source to the receptor as indicated. In analyzing the results of the mAs values at the different distances, it should be noted that the intensity of the x-ray beam varies inversely as the square of the distance varies, i.e., the "inverse square law." In other words, as the distance from the source to the receptor increases, the exposure time will automatically be increased to a value which will allow the same amount of radiation to strike the photo pickup. As an example, if the distance from the source to the receptor is doubled, the exposure time or the MA value must be increased by a factor of four.

d. The mAs value observed at 60" should be approximately 1.56 times greater than the value at 48". The mAs value observed at 72" should be approximately 1.44 times greater than the value obtained at 60". As a final check of linearity, the mAs value at 72" should be approximately 2.25 times greater than the value obtained at 48".

e. It should be pointed out that this test is not intended to verify the authenticity of the "inverse square law" as it applies to basic x-ray principles, but is intended to insure that the phototimer is adjusted properly to produce somewhat predeterminable results over the entire range of density and distance.

Note: Depending upon the distance from the source to the receptor, one of the absorbers may have to be removed if the backup timer energizes.

Record Exposure Factors:

KVP _____

mA _____

Distance in Inches:	48"	60"	72"
Setting # 1 (-) (Light)	mAs _____	mAs _____	mAs _____
Setting # 2 Normal	mAs _____	mAs _____	mAs _____
Setting # 3 (+) (Dark)	mAs _____	mAs _____	mAs _____

COMMENTS: _____

_____

_____

_____

_____

Phototimer Performance Test (Spot Film Device)

Purpose: To verify that the phototimer density control varies mAs and that the four-on-one spot film is properly aligned.

a. Check to see if the radiology department was consulted when the densities were adjusted.

b. Perform the tests at a commonly-used technique, i.e., 80 KVP 300 mA with the Westinghouse phantom or equilavent with absorbers 1 and 2 in the beam. Record the mAs obtained from three settings, light, normal, and dark. Dynalyzer printouts may be used in lieu of oscilloscope photographs.

c. Set the controls to initiate a four-on-one exposure.
The results of the phototimer test will also be used to verify proper alignment and. operation of the spot film device.

d. Page 69 also contains additional operational tests on the spot film device. It may be more feasible to complete these tests in conjunction with the phototimer performance test at this time.

e. Attach the exposed four-on-one radiograph here. (Three of the four exposures should show the varying densities as determined by the phototimer density settings.)

(1) Are any of the four exposures blurred or fuzzy which would indicate that an exposure occurred before the cassette was stopped?

(2314) _____

(2) Are,there any intermittent dark densities on the film?

(2313) _____

(3) Is it possible to initiate a double exposure in the same area on the same film?

(2313) _____

Note: Depending upon the distance from the source to the receptor, one of the absorbers may have to be removed if the backup timer energizes.

Record Exposure Factors:

KVP

_____

mA

_____

Distance

_____

Density Setting # 1

mAs _____

Density Setting # 2

mAs _____

Density Setting # 3

mAs _____

COMMENTS: _____

_____

_____

_____

_____

Bucky Grid Radiographs

Purpose: To insure the Bucky is operational. Grid lines will be visible if the Bucky is non-functional or if the exposure switches in the Bucky are incorrectly adjusted and an exposure occurs while the Bucky is at one end of it's travel.

Note: Make sure the cassette that will be used for this test is not a "gridded" cassette.

a. Verify that the grid is as stated in the procurement contract and is appropriate, i.e., 36"-40"?

b. Make sure the cassette is placed in the cassette tray for this test and the Bucky switch is turned "ON".

c. Initiate an exposure and process the film.

d. Verify that no visible grid lines are present on the film.

e. If grid lines are visible, insure that all of the switches are in the right position and that the grid is in place.

Note: Prior to exposure the Bucky can usually be heard oscillating.

f. Repeat the test for each Bucky grid in the system and attach any radiographs which indicate that the Bucky is not functioning, that the grid is not present, or if any defects exist in the grid which are visible on the radiograph.

Note: Make sure the cassette is placed in the cassette tray for this test and the Bucky switch is turned "ON".

COMMENTS: _____

_____

_____

_____

_____

Fluoroacopic Imaging Devices

A. Fluoroscopic Carriage

(1) Is the image system as specified in the contract and is it properly counterbalanced?

(1316)(1320) _____

(2) Does the image system move easily on the overhead tracks without binding or drifting?

(2324) _____

(3) Check that the fluoroscopic carriage movement meets the following maximum specifications as measured with a pull gauge:

(a) 8 pounds maximum moving lengthwise.

(b) 5 pounds maximum moving crosswise.

(c) 8 pounds maximum moving up and down.

(2300)._____

_____

(4) Does the cross travel centering lock center within manufacturer's specifications?

(2301) _____

(5) Does the fluoroscopic assembly "creep" in any position longitudinally or laterally?

(2302) _____

(6) Does the vertical carriage drag or bind on the table tracks when the table is horizontal or vertical?

(2306) _____

(7) Is there an adjustable myelographic stop available for myelographic purposes and will it keep the fluoroscopic assembly from going below a predetermined position?

(2308) _____

(8) Is there a quick release compression lock available and is it operational?

(2309) _____

(9) Are there any sharp edges that exist which may come in contact with the operator or patient?

(2321) _____

(10) Is all electrical wiring properly draped and the wires or wire bundles are not cut, stressed, or kinked?

(2322) _____

(11) Are there any missing insulated bushings or other cable supporting devices?

(2323) _____

B. Spot Film Device

(Some or all of the tests may be accomplished in conjunction with the Phototimer Performance Test)

(1) Does the spot film device interfere with the tubestand?

(2302) _____

(2) Does the spot film changeover operate as soon as the cassette in the spot film device moves into position and does the associated circuitry switch to the radiographic mode?

(2311)(2312) _____

(3) Does the cassette fit easily into the spot film device and is it easily removed when the release is activated?

(2318) _____

(4) Are all hand operated table and spot film switches easily operated while wearing lead gloves?

(2320) _____

(5) Does the spot film device move easily when the table is located at various angles and positions?

(1317) _____

C. Mirror Viewing

(1) Is the mirror adjustable and permit true image viewing?

(1325) _____

(2) Are the fluoro shutters properly centered?

(1311) _____

D. Television Viewing

(1) Is the television as specified on the contract?

(1326) _____

(2) Does the output touch the top and bottom of the raster and is the output centered both horizontally and vertically?

(1326)(1311)_____

Imaging Systems

Purpose: To insure a quality and high resolution image is obtainable.

1. Focusing and Resolution:

(a) Place a 1/2" aluminum attenuator on the tabletop and place the resolution pattern on top of the 12" spacer.

(b) Lower the fluoroscopic assembly until it is in contact with the resolution test pattern.

(c) Select a fluoro technique of 60 KVP and initiate an exposure. Adjust the mA for the highest quality image and record the number of mesh wire that can be clearly seen.

(d) Repeat the test for each magnification mode. Run test films on systems with cine and photospot and record the results.

2. Low Contrast Perceptability (T-hole):

(a) Position the T-hole phantom with 1 1/2" aluminum attenuator at the tabletop and lower the imaging assembly to the 12" spacer.

(b) Select 80 KVP, Auto Brightness, and record the smallest pair of holes that can be visualized in the image.

(c) Make sure the fluoro grid is in position for this test.

* The minimum range of mesh numbers for image intensified fluoroscopic imaging systems for various viewing and film recording modes.

	Viewing Mode		Film Recording Mode	
Size	Mirror	TV	Photospot	Cine
4 - 5"	50/60	35/40	50/60	50/60
6 - 7"	40/50	24/35	40/50	40/50
9 - 10"	30/40	20/24	30/40	30/40

* The minimum perceivable hole size for image intensified fluoroscopic imaging systems for various viewing and film recording modes.

	Viewing Mode		Film Recording Mode	
Size	Mirror	TV	Photospot	Cine
4 - 5"	.06"	.06"	.06"	.06"
6 - 7"	.06"	.13"	.06"	.06"
9 - 10"	.13"	.13"	.06"	.06"

Using the above criteria, check and record the mesh/T-Hole:

	4.5" Mode	6" Mode	9" Mode	Photospot	Cine
Resolution	_____	_____	_____	_____	_____
T-Hole	_____	_____	_____	_____	_____

Note 1: The operational KVP of the system used for performing the T-hole test can also influence the results as the test device is optimized around 80 KVP. For some automatic brightness control systems no operator control of KVP is possible and it may be difficult to obtain the desired KVP. However, even for these systems, the majority will stabilize between 70 and 90 KVP for the particular phantom employed.

Note 2: The four sizes of holes are: .25, .19, .13, .06 inch diameter.

Note 3: For small format systems, it may be necessary to use a magnifying glass to evaluate the image on processed films.

* This information was taken from "Quality Assurance for Fluoroscopic X-Ray Units and Associated Equipment" published by the Bureau of Radiological Health, U.S. Department of Health, Education, and Welfare.

TV/VTR (Video Recorder) Display

(Normal and Reversed Modes)

X-Ray Control Settings

85 KVP

1.5 mA

a. Insert the Westinghouse phantom with absorbers # 1 and # 2.

b. Initiate a fluoro exposure and observe the image.

c. Check the image for proper centering, proper linearity at the edges, etc.

d. Switch to the reversed mode and observe the image.

e. Take and attach two photographs of each image which is incorrect. If there is any question as to whether or not an image is incorrect, two photographs should be taken and the determination shall be made by the procurement officer.

f. Repeat the procedure for each magnification mode available.

Note: Color film has been found to drastically improve the image quality of the TV displays.

PLACE PHOTOGRAPHS HERE

Fluoroscopic KVP and Auto Brightness

Purpose: To verify proper KVP in the fluoroscopic mode and that, if automatic brightness control (ABC) is present, the KVP automatically drives upward with an increase in patient density.

a. Select one or two mA, and, with the scope in single trace, provide a family of KVP waveforms by initiating fluoroscopic exposures at several KVP settings. Be sure to include the lowest and highest KVP settings.

b. Dynalyzer printouts may be used in lieu of scope photographs.

Note 1: The image intensifier may be turned off for this test.

c. If the unit has automatic brightness control (ABC) as an option provide an oscilloscope photograph of the following test.

(1) Set the scope for a two second sweep.

(2) Set the fluoro KVP for the lowest setting.

(3) Initiate a fluoro exposure and then close the fluoro shutters. The photograph should show an automatic increase in KVP up to the maximum level.

Note 2: Be sure to use a phantom to keep raw (unattenuated) radiation from damaging the image tube.

COMMENTS: _____

_____

_____

_____

_____

Fluoroscopic and ABC Waveforms

Scope Settings: (If used)

Mode _____

Volts/Div _____

Time/Div _____

X-ray Control Settings:

mA _____

KVP _____

Scope Settings: (Auto Brightness Control)

Mode _____

Volts/Div _____

Time/Div _____

Spot Film Space Charge and KVP Test

This test should only be accomplished if the unit has more than one spot film mA stations which are independent from the radiographic mA' circuitry.

Purpose: To insure the space charge compensation circuit is properly adjusted, i.e., the mA remains relatively constant throughout the KVP range, and that the KVP stations are accurate.

a. Dynalyzer printouts may be provided in lieu of oscilloscope photographs for this test. If this option is selected, the inspector should have the oscilloscope connected during testing and observe all waveforms. Photographs of all discrepancies or suspicious waveforms should be provided.

b. Label all dynalyzer printouts.

c. If oscilloscope photographs are provided, the ADD mode should be used at 20 KVP per division, and all waveforms for each mA station superimposed in a single photograph. Exposure time should be at least 1/10 second.

d. Record mAs for each exposure using an mAs meter or the dynalyzer mAs setting. mAs values per mA station checked shall be within 5 percent of the highest mAs recorded for that mA station.

e. Measurement shall be taken for every mA station. Note any discrepancies between actual KVP, mA, and space charge observed and the manufacturer's specifications. The manufacturer's representative should be given the opportunity to correct any discrepancies.

Note 1: If the dynalyzer is being used the cathode cable should be removed. mAs can be significantly reduced by the test equipment. The cause of low readings should be annotated in the report. True readings should be obtained by using the anode only connected and doubling the KVP obtained, providing transformer balance was previously verified.

Note 2: In order to keep heat units from building up, it is advised to start at the highest mA station and work down, but start at the lowest KVP station and work up.

S Scope Settings:

Volts/Div _____

Time/Div _____

F MA Station: _____

mAs

50 KVP _____

80 KVP _____

130 KVP _____

F

F

(CINE

(CINE

(CINE

MA Station: _____

mAs

50 KVP _____

80 KVP _____

130 KVP _____

MA Station: _____

mAs

50 KVP _____

80 KVP _____

130 KVP _____

Attach other sheets if required.

Body Sectional Device Test

Purpose: To verify that in the tomographic mode (if unit is so equipped) the indicated level of cut is properly focused.

a. Any tomographic phantom calibrated in mm and cm is suitable for this test. Take radiographic films of three separate cuts and attach the film which demonstrates depth and width obtained.

b. If the terminology or settings for section, stroke, or speed are different from those used in this protocol, so indicate.

c. Provide the entire x-ray film for each cut shown below.

Exposure	Level of Cut	Amplitude
1st	4 cm	3 mm
2nd	12 cm	4 mm
3rd	20 cm	5 mm

d. Some units are equipped with special features such as spiral, "X", etc. To verify the performance of these features, place a small hole in a sheet of lead and position the lead sheet approximately 6 inches above the table. Initiate an exposure and develop the film.

e. The movement of the tubehead will cause a tracing on the film which can be compared to the special technique selected. If the tracing is too light, the technique factors will have to be increased.

f. Insure that the tracing is complete and that no overlapping occurs. Attach the radiographic film to the next page.

g. Does the body sectional device operate as specified?

(2329) _____

h. Does the body sectional device interfer with the x-ray system when it is in it's "parked" position?

(2330)(2328) _____

i. If the unit is equipped with a remote control, are there interlocks to the timing and Bucky circuits? Does the exposure control device have a "dead man" type of release when deactivated by the operator?

(1332) _____

Exposure # 11	Exposure # 2	Exposure # 3
Cut 4 cm	Cut 12 cm	Cut 20 cm
Section 3 mm	Section 4 mm	Section 5 mm
Stroke _____ inches	Stroke _____ inches	Stroke _____ inches
Inches/sec _____	Inches/sec _____	Inches/sec _____
KVP _____	KVP _____	KVP _____
mA _____	mA _____	mA _____
Time _____	Time _____	Time _____
Number of Wires 3	Number of Wires 3 to 4	Number of Wires 4

PLACE	PLACE	PLACE
FILM	FILM	FILM
STRIP	STRIP	STRIP
HERE	HERE	HERE

COMMENTS: _____

Positive Beam Limitation

a. Does the system return to positive beam limitation (PEL) with a change in image receptor?

21 CPR 1020.31 (e) (iii) Yes |___| No |___|

b. Is PBL by-passed when the beam axis or table angulation is not within 10 degrees of the horizontal or vertical plane?

21 CPR 1020.31 (e) (iv) Yes |___| No |___|

c. Does the capability exist to override PBL in the event of system failure and can the key be removed when the positive mode is overridden?

21 CFR 1020.31 (e) (v) Yes |___| No |___|

d. Is it possible (in the automatic mode) to adjust the x-ray field size smaller than the selected size?

21 CPR 1020.31 (g) (3) Yes |___| No |___|

e. Does PBL occur at several commonly-used SID'S?

21 CPR 1020.31 (e) (1) (iv) Yes |___| No |___|

f. Does PBL occur within 5 seconds after the cassette is placed in the image receptor?

21 CPR 1020.31 (e) (2) (i) Yes |___| No |___|

g. Are x-rays produced when the source is at a SID in which PBL is not intended to operate?

21 CPR 1020.31 (e) (2) (i) Yes |___| No |___|

Illuminance of Light Localizer

21CFR1020.31 (d) (2) (ii)

Purpose: To verify the light localizer (collimator light) provides at least 15 footcandles at a distance of 100 cm (40") or at the maximum Source-to-image Distance (SID) whichever is less.

a. At a distance of 100 cm or at the maximum SID, record the readings obtained in the center of each quadrant in footcandles.

Quadrant	Footcandles	Background/Ambient At the Tabletop
Anzuzeigender Text da 1		
2		
3		
4		

b. With the collimator light extinguished, record the background readings in each quadrant. Room lights should be left on for this test.

c. Record the average illuminance from the four quadrants.

d. Subtract the average background illuminance.

e. Indicate whether the average illuminance exceeds 14.9 FC.

Yes |___| No |___|

f. A reading of over 20 footcandles (FC) in any quadrant requires a voltage check of the lamp voltage. Record the lamp voltage under load.

_____Lamp Voltage Under Load

Note: The manufacturer's specifications for lamp voltage should be consulted to determine if the voltage is properly adjusted. Lamp voltage which is over that specified will cause premature failure of collimator bulbs.

COMMENTS: _____

_____

_____

_____

_____

POST-CALIBRATION RADIATION INSPECTION PROCEDURE

RADIOGRAPHIC

1. Purpose

"Post-Calibration Radiation Inspection Procedure/Radiographic" provides maintenance technicians with procedures to inspect radiographic x-ray systems for compliance with federal regulations.

2. Procedure

a. Documentation

This procedure follows the same sequence as the form.The inspection record should be filled out in ist entirety. The results will be used as a baseline for all future inspections and calibrations.

b. Identification

Identify all pertinent information. Some of the data may be taken from information annotated earlier in the report.

c. Timer Accuracy

This information may be taken from page 43 of this report.

d. Radiation Leakage

21 CPR 1020.30 (k)

Note: This test is an approximation of the radiation leakage and is used to find gross errors.

With the collimator shutters closed and the beam blocked with at least 10 HVL's (1/8" lead sheet), check the tubehead assembly for compliance with federal standards. The "maximum permissible leakage" is 100 mR in one hour while the tube* is operated at it's maximum continuous rated current for the maximum rated tube potential.

(1) Select the unit's maximum KVP and a time setting approximately equal to the response time of the survey meter to be utilized (usually 1-3 seconds) and select the lowest mA station. The radiation leakage can be considered satisfactory if it is lower than the requirement of 100 mR/hr when tested at an mA station which is higher than the mA setting which would correspond to the "leakage technique factor." The lowest mA station is used to eliminate the necessity to miscalibrate the unit to the actual leakage technique factors as determined by the anode cooling rate of the tubehead.

(2) Position the survey meter approximately one meter (39.5") from the source.

Make sufficient exposures over an area of approximately 100 square centimeters and average the results.

(3) If the average value obtained in (2) above is less than 100 mR/hr, the radiation leakage can be considered satisfactory and there is no need to proceed any further with the test. If the value exceeds 100 mR/hr, the actual mR/hr will have to be calculated using the following procedure:

(a) From the table on page 33, select the mA for continuous operation that corresponds to the maximum KVP of the unit and the anode cooling rate for the tubehead assembly being inspected. The anode cooling rate can be obtained by consulting the manufacturer's literature or the tube rating charts. The mA selected is then divided by the mA setting used for the test and this value is then multiplied by the average mR obtained in step 2.

For example: If an average of 300 mR/hr is obtained at 25 mA, 150 KVP and the anode cooling rate of the tubehead assembly is 30,000 heat units/minute, the value to be recorded is:

3.33 / 25 mA = .133 times 300 mR/hr = 39.9 mR/hr

Since this value is below the maximum permissible leakage of 100 mR/hr, it is considered satisfactory.

(b) Record the calculated leakage and indicate whether satisfactory or unsatisfactory

e. SID Accuracy

21 CFR 1020.31 (e) (1)

This information can be taken from page 27 obtained earlier in the report.

f. Collimator Illumination

21 CFR 1020.31 (d) (2) (ii)

Record the data obtained from page 83 of this report.

g. Radiation vs Light Field

21 CFR 1020.31 (d) (2)

(1) Manually adjust the collimator shutters so the light field, when measured on an unexposed cassette at a SID of 40" or 48", equals a common field size (e.g., 8 X 10, 10 X 12). (Note: If the cassette is placed on the tabletop, the indicated SID will not be correct and the tube will have to be raised.)

(2) Mark the edges of the light field so they will be visible on the exposed film. Expose and develop the film.

(3) Measure the offset between the indicated and actual edges of the radiation field on the exposed film. Sum the two edges of the film ignoring sign and enter on the form.

(4) Calculate the allowable errors in either dimension by multiplying the SID by .02 (2%).

(5) If either the width or length exceeds allowable values, indicate unsatisfactory on the inspection form.

h. Field Size vs Indicators

21 CFR 1020.31 (e) (iii)

(1) Place a cassette at a commonly used SID, observing the need to re-adjust SID if the cassette is on the tabletop.

(2) Manually adjust the collimator field size indicators to indicate a commonly-used field size.

(3) Make an exposure and develop the film.

(4) Measure the actual length and width of the radiation field on the exposed film. Subtract from the indicated dimensions and enter the length and width errors.

(5) Calculate and enter the allowable error by multiplying .02 times the SID used. Indicate whether satisfactory or unsatisfactory.

i. Minimum Field Size

21CFR1020.31 (e) (1) (iii)

Verify that the minimum field size does not exceed a 5 cm square (2").

(1) Close the shutters completely and adjust the unit for the maximum Source-Image-Distance (SID).

(2) With a film in the cassette holder, initiate an exposure and measure the radiated area. Indicate whether satisfactory or unsatisfactory on the form.

j. Field vs Receptor (Center Offset)

21 CFR 1020.31 (e) (1)

This test is to be performed for each tubehead-receptor combination. Table-Horizontal and Table-Vertical are considered two different receptors for this test.

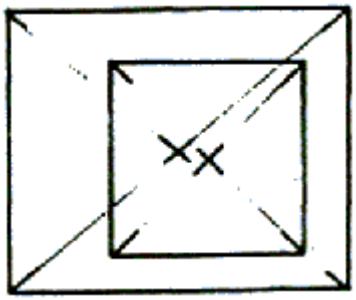
Note 1: There are various test tools available which will simplify the center offset test and are acceptable for use.

(1) Place a loaded cassette in the cassette tray.

(2) Using applicable detents, angulation indicators and centering lights, center the tubehead and collimator to the receptor at a commonly used SID.

(3) Manually adjust the collimator to a field smaller than the cassette. Expose and develop the film.

(4) Draw two sets of cross hairs on the film, one connecting the corners of the film and one connecting the corners of the x-ray field as illustrated below:



(5) Measure the offset between the film center and the field center and record on the form.

(6) Calculate the allowable offset from .02 (2%) times SID and record.

(7) Complete the above test for each remaining tubehead receptor combination.

(8) Label and attach each film.

Note 2: The use of metric size film in standard size cassettes may introduce errors in the center offset test.

k. Field Size (Automatic)

21 CFR 1020.31 (e) (2) (ii)

This test is required for each tubehead-receptor combination. The table cassette holder is considered one receptor whether horizontal or vertical for this test.

(1) Place an 8" ***X*** 10" cassette in the receptor and align the tube with the receptor at a commonly-used SID.

(2) Place a cardboard cassette larger than the test cassette on the surface of the receptor insuring that it will intercept the entire x-ray beam.

(3) Expose and develop both films.

(4) Measure and record the difference in the length and width between the test film placed in the receptor and the film in the cardboard cassette. If the field is smaller than the film that was placed inside the receptor, the measurement can be taken directly from that film. If one or both of the field dimensions were larger than that film, obtain the measurements from the cardboard cassette film using the formula:

w = (SID divided by x) times wt

where:

wt	unknown width (or length) of the x-ray field in the plane of the image receptor.
SID	Test SID (distance from focal spot to image receptor)
x	Distance from focal spot to card board cassette.

(5) Add the length and width differences and record.

(6) Enter the allowable tolerances. The length and width error tolerances are 3% of SID. The sum tolerance of the length and width errors is 4% of SID. Repeat the test for tubehead-chest receptor if unit is so equipped.

I. Beam Quality

21 CFR 1020.30 (m)

Determine the half-value layer (HVL) of the useful beam for the radiographic tubehead.

(1) Position a radiation detector and test stand capable of receiving calibrated thicknesses of 1100 alloy aluminum between the tubehead and detector.

(2) Select 90 KVP and 100 mAs. Keep KVP, mA, time, and distance constant for each exposure.

(3) Remove all selectable filters and initiate an exposure. Record the mR value obtained in the "No Additional Filtration" blank on the form.

(4) Insert 2.5 mm of aluminum between the tubehead and detector. Initiate an exposure and record mR obtained in the "2.5 mm" additional filtration blank and plot mR versus mm of aluminum on the graph paper on page 90 and record the reading plotting mR versus mm*s of aluminum.

(5) Insert 4.5 mm of aluminum between the tubehead and detector and initiate an exposure. Record the value obtained in the "4.5 mm" blank and plot this value on the graph paper.

(6) Draw a line on the graph paper from the values obtained at 2.5 mm and 4.5 mm of additional filtration.

(7) Find the point along the line which corresponds to 50% of the value obtained in step (3) above.

(8) Draw a line down from this point. The value obtained is the half-value layer (HVL) of the useful beam.

(9) If the value obtained in step (4) is less than 50% of the initial value, reduce the aluminum between the detector and tubehead in steps, taking additional mR values. Continue until the mR value exceeds 50% of the "No Additional Filtration" value. Plot thickness versus mR on a graph. The point where mR equals 50% of the initial value is the HVL. If it is less than 2.5 mm at 90 KVP, the difference between the calculated HVL and 2.5 mm is the amount of additional filtration that must be added to the tubehead assembly.

If corrective action cannot be accomplished at the time of inspection, annotate unsatisfactory on the form and notify the department that the unit cannot be operated at a KVP .that is higher than that specified in 21 CFR 1020.30, Table 1, for the actual HVL of the unit until this deficiency can be corrected. (Note: Some x-ray systems have a selectable filter which can be removed to reduce filtration at lower KVP's but will prohibit exposure at 90 KVP when removed.) When this occurs, steps (1) through (4) should be performed with the selectable filters in the beam. An additional test should be performed with the filter removed at the maximum KVP the filter interlock will permit. The HVL should be calculated and compared to the permissible value in 21 CFR 1020.30, Table 1.

m. Radiographic Reproducibility

21 CFR 1020.31 (b)

Check reproducibility by making four consecutive exposures and recording mR obtained. Allow at least one minute between exposures. If all values are within plus or minus 5% of the average, reproducibility can be considered satisifactory. If any mR reading exceeds plus or minus 5% of the average, calculate the coefficient of variation from:

$$c = \frac{1}{\overline{mR}} \sqrt{\frac{(\overline{mR} - mR_1)^2 + (\overline{mR} - mR_2)^2 + (\overline{mR} - mR_3)^2 + (\overline{mR} - mR_4)^2}{3}}$$

$\overline{mR}$ is the average of the four readings. If C is greater than .05, circle the value and indicate unsatisfactory on the form.

n. Radiographic Linearity

Check radiographic linearity by keeping KVP and distance to a radiation detector constant and measuring the ratio of radiation output to selectable mAs for each selectable mA station on the x-ray system. Perform the test at three different KVP settings, one at the neutral KVP (the KVP at which basic mA calibration is performed, usually 80-90 KVP), one at 50-70 KVP, and one at 100-130 KVP. Enter the distance used and the three KVPs tested in the blocks provided on the inspection form.

Note: It may be advantageous to establish a predetermined distance for comparison with future surveys.

For each KVP tested, make an exposure at each mA station recording mA and time selected and mR obtained. Times used should normally be in the range of 1/10 second to 1 second. Time can be varied between mA stations since this will be compensated for in the conversion to mAs. If the x-ray system has a mAs selector rather than mA and time, record the settings in the mAs blocks on the form.

Calculate mAs and mR/mAs for each exposure and record. Obtain the average mR/mAs value for all mA stations tested at each KVP by adding the individual mR/mAs values and dividing by the number of stations tested. The upper and lower limits are +/- 10 percent of this average. Determine whether any value falls below or above the limits and readjust the mA stations to obtain satisfactory results. These linearity limits are different from those contained in 21 CFR 1020.30 (c) , but should be obtainable if the unit is properly calibrated.

o. Action Required

If any of the tests were unsatisfactory, indicate so on page 19 of this report regardless of whether or not the discrepancies were corrected during the inspection.

p. Technician

The DoD inspector performing the inspection will enter his name, grade, and position title in block 18.

4. Disposition

The original will be mailed with the Acceptance Inspection Package to DPSC. One copy will be provided to the medical maintenance activity, one copy to the radiology department, and one copy will be sent to the local bioenvironmental engineering activity for review.

POST-CALIBRATION RADIATION INSPECTION PROCEDURE

FLUOROSCOPIC

1. Purpose

"Post-Calibration Radiation Inspection Procedure/Fluoroscopic" provides maintenance technicians with procedures to inspect radiographic x-ray systems for compliance with federal regulations.

2. Procedure

a. Documentation

This procedure follows the same sequence as the form. The inspection record should be filled out in ist entirety. The results will be used as a baseline for all future inspections and calibrations.

b. Identification

Identify all pertinent information. Some of the data may be taken from information annotated earlier in the report.

c. Timer Accuracy

21 CFR 1020.32 (g)

Set the fluoroscopic timer for 30 seconds and activate a fluoro exposure. Insure that upon termination of the exposure time an audible .tone occurs and continues to occur while x-rays are produced until the timer is reset. Indicate the results on the form.

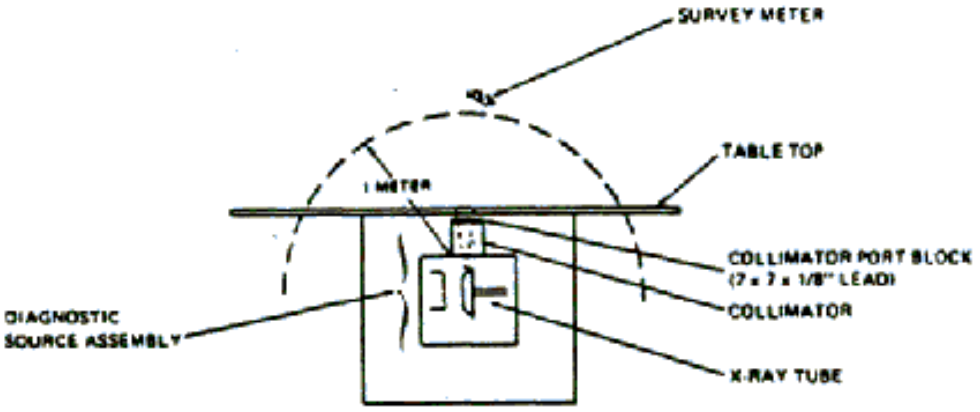
d. Radiation Leakage

21 CFR 1020.30 (k)

With the collimator shutters closed and the beam blocked with at least 10 HVL's (1/8" lead sheet), check the tubehead assembly for compliance with federal standards. The maximum permissible leakage is 100 mR in one hour while the tube is operated at it's maximum continuous rated current for the maximum rated tube potential.

(1) Select the unit's maximum KVP and a time setting of 30 to 60 seconds. Select the mA setting which corresponds to the leakage technique factor in the manufacturer's literature or the MA for continuous operation can be taken from the table on page- 33. If, for some reason, this value cannot be selected, select the highest mA station obtainable.

(2) Position the survey meter approximately one meter (39.5") from the source as illustrated below. Make sufficient exposures over an area of approximately 100 square centimeters and average the results. Record this value.



(3) If the average value is less than 100 mR/hr, the radiation leakage can be considered satisfactory and there is no need to proceed any further with the test. If the value exceeds 100 mR/hr and the mA for continuous operation was not obtainable, the actual mR/hr will have to be calculated using the following procedure:

(a) From the table on page 33, select the mA for continuous operation that corresponds to the maximum KVP and the anode cooling rate for the tubehead assembly being inspected. This mA value is then divided by the mA setting which was used for the test. This value is then multiplied by the average mR obtained in step (2).

For example: If an average of 40 mR/hr is obtained at 4 mA, 150 KVP and the anode cooling rate of the tubehead assembly is 30,000 heat units/minute, the value to be recorded is:

$$\frac{3.33\,\text{mA}}{4\,\text{mA}} = .83 \text{ times } 40\,\text{mR/hr} = 32.8\,\text{mR/hr } 4\,\text{mA}$$

Since this value is below the maximum permissible leakage of 100 mR/hr, it is considered satisfactory.

(b) Record the calculated leakage and indicate whether satisfactory or unsatisfactory on the form.

e. Beam Quality

21 CFR 1020.30 (m)

Determine the HVL for the fluoroscopic tubehead.

(1) Position a radiation detector and test stand capable of receiving calibrated thicknesses of 1100 alloy aluminum between the tubehead and detector. (Use position A on the BRH test stand if used.)

(2) Select 90 KVP. Keep KVP, mA, time, and distance constant for each spot film exposure.

Note: Be sure to shut off the phototimer for this test so the unit will not try to compensate for the added filtration.

(3) Remove all selectable filters and initiate a spot film *exposure. Record the mR value obtained in the "No Additional Filtration" blank on the form and on the graph paper on page 104 plotting radiation (mR) versus mm of aluminum.

(4) Insert 2.5 nun of aluminum between the tubehead and detector. Initiate an exposure and record mR obtained in the "2.5 mm Additional Filtration" blank and on the graph paper. If the value obtained is equal to or larger than 50% of the value without the 2.5 nun additional filtration, the HVL is satisfactory. Proceed to find the approximate HVL:

(5) Insert 4.5 mm of aluminum between the tubehead and detector and initiate an exposure.
Record this value in the 4.5 mm blank and plot this value on the graph paper.

(6) Draw a line on the graph paper from the values obtained at 2.5 mm and 4.5 mm of additional filtration.

(7) Find the point along the line which corresponds to 50% of the value obtained in step (3) above.

(8) Draw a line down from this point.
The value obtained is the half-value layer (HVL) of the useful beam.

(9) If the value obtained in step (4) is less than 50% of the initial value, reduce the aluminum between the detector and tubehead in steps, taking additional mR values^ Continue until the mR value exceeds 50% of the "No Additional Filtration" value. Plot thickness versus mR on a graph. The point where mR equals 50% of the initial value is the HVL. If it is less than 2.5 mm at 90 KVP, the difference between the calculated HVL and 2.5 mm is the amount of additional filtration that must be added to the tubehead assembly.

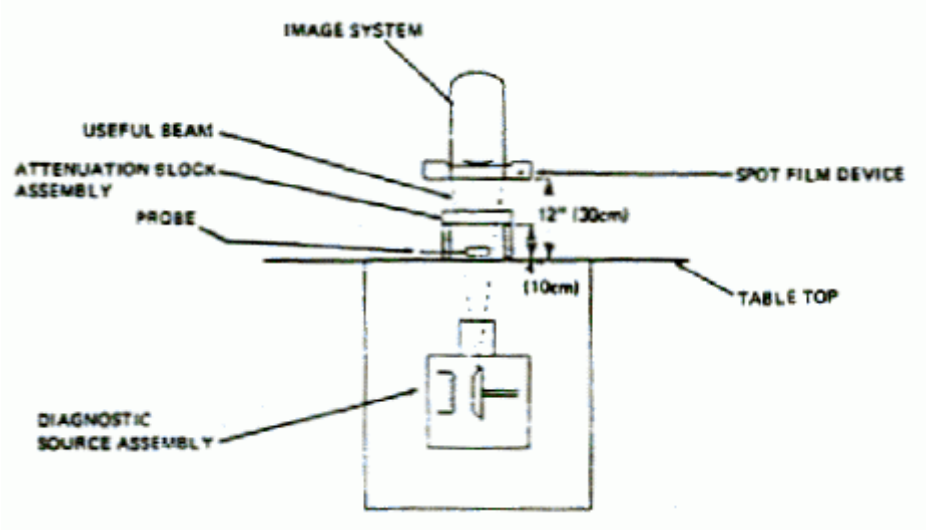
If corrective action cannot be accomplished at the time of inspection, annotate unsatisfactory on the form and notify the department that the unit cannot be operated at a KVP that is higher than that specified in 21 CFR 1020.30, Table 1, for the actual HVL of the unit until this deficiency can be corrected. (Note: Some x-ray systems have a selectable filter which can be removed to reduce filtration at lower KVP's but will prohibit exposure at 90 KVP when removed.) When this occurs, steps (1) through (4) should be performed with the selectable filters in the beam. An additional test should be performed with the filter removed at the maximum KVP the filter interlock will permit.

The HVL should be calculated and compared to the permissible value in 21 CFR 1020.30, Table 1.

f. Fluoro Output Measurements

21 CFR 1020.32 (d)

Measure and record the maximum exposure rates with the radiation detector one centimeter (position B on the BRH test stand) above the tabletop .in the fluoro mode as illustrated below and indicate whether satisfactory or unsatisfactory.



The established limits for determining compliance are:

(1) 5 R/Minute for Manual Operation.
21 CFR 1020.32 (d) (2)

(2) 10 R/Minute for Automatic if there is no High Level.
21 CFR 1020.32 (d)(1)

(3) 5 R/Minute for Automatic if High Level Option is available but it is not activated.
21 CFR 1020.32 (d)(1)(ii)

(4) No limit when High Level is activated but a continuous audible tone must occur.
21 CFR 1020.32 (d) (1) (ii)

Note 1: Depending on the available functions of the radiation meter (electrometer) being utilized, the exposure time may have to be determined with a stopwatch and the calculation of the maximum roentgen per hour made using the measured exposure time and the radiation meter reading (30-60 seconds is usually sufficient).

Note 2: Make sure the maximum technique'settings are used in order to measure the maximum possible exposure rate.

Note 3: Be sure to place a phantom on the test stand to keep raw (unattenuated) radiation from striking the image tube.

g. Minimum Field Size

21 CFR 1020.32 (b) (2) (iv)

Verify that the minimum field size does not exceed a 5 cm square (2").

(1) Close the fluoro shutters completely and adjust the unit for the maximum Source-Image-Distance (SID).

(2) Initiate a fluoroscopic exposure. If the radiated area appears larger than 2" square, determine the actual dimensions and indicate satisfactory or unsatisfactory on the form.

h. Mininum SSD

21 CFR 1020.32 (f)

Verify that the minimum source to skin distance is not less than 38 cm (15") for stationary fluoroscopy or 30 cm (12") for mobile fluoroscopy. If the focal spot location has not been previously determined, it must be located by the following procedure:

(1) Locate a 2" beam defining aperture on the table top. Using fluoroscopy, center the aperture in the radiation field and manually collimate the beam to the aperture.

(2) Insert a film in a cardboard cassette and locate the film 14" above the beam-defining aperture.

(3) Initiate a one-on-one spot film exposure at 80 KVP, 10 mAs.

(4) Develop both films. The exposed film in the spot film device can be used to determine the magnification factor of the system.

(5) Measure the length and width of the image on the developed, film from the cardboard cassette. Take the average of the two readings. Hint: A ruler graduated in tenths of an inch will simplify averaging. Record the average as "Y" below.

(6) The distance from the source (focal spot) to the tabletop can be determined from the table on page 33 or by using the formula:

$$X = \frac{28}{"Y" - 2} \quad Y = \_\_\_\_\_$$

X = distance from aperture to the focal spot (SSD)

Y = dimensions on the film (avg. of length and width)

8 = two times the distance from the aperture to the cardboard cassette.
If another distance is used, simply double that distance and insert in the formula.

(7) Calculate the SSD and record.
This value must not be less than 38 cm (15") for stationary fluoroscopy or 30 cm (12") for mobile fluoroscopy.

SSD = _____ (1302) _____

i. Field Size vs Intensifier

21 CFR 1020.32 (b) (2)

Measure the offset between the edges of the x-ray field and the input phosphor of the intensifier as a percentage of the SID with the shutters wide open. If clipping of the image is visible at all SID's with the shutters wide open, enter 0% on the form. If clipping is not visible, proceed as follows:

(1) Place a beam localizer phantom marked in inches or cm on the tabletop or in a test stand.

(2) Center the image intensifier over the phantom with the input phosphor the same distance above the phantom as the focal spot is below. Measure the SSD from the previous test.

(3) While making a fluoroscopic exposure, adjust the shutters until clipping of the x-ray field is just visible on the image. Record the field dimensions visible on the phantom or mark with lead.

(4) Place a cardboard cassette over the phantom, open shutters fully, .and expose and develop the film.

(5) Measure the total length and width offset of the actual field with the previously marked or recorded visible field. LI + L2 equals the sum of the top and bottom offsets irrespective of sign; Wl + W2 equals the sum of the sides. Multiply these totals by two. (Since the film is halfway between source and image, offset at the image is magnified.) Divide each sum by SID (distance from source to input phosphor) and enter on the form as a percent. Add the two percentages.

(6) Indicate unsatisfactory if the values exceed the tolerances.

j. Field Size vs Spot Film Size

21 CFR 1020.32 (g) (4)

(1) Measure and record offsets of the edges and center of the spot film.

(2) Place a loaded cassette in the spot film device and locate a cardboard cassette and beam localizer phantom midway between the undertable focal spot and the spot film cassette. Before placing the cardboard cassette, center the beam localizer using fluoroscopy.

(3) Manually drive the fluoroscopic shutters wide open. Initiate a spot film exposure at the forma-t being inspected and develop both films.

(4) If the radiation field left visible unexposed borders on the spot film, measure and record the length and width offsets between the film and the field as a percentage of SID. L1 + L2 is the sum irregardless of sign of the top and bottom offsets. W1 + W2 is of the side offsets. (Note: The beam localizer phantom will leave visible coordinates on both films.) Compare the corresponding coordinates of the edges of the radiation field on the film on the cardboard cassette to insure they are the same. If they are not, the beam is being limited by the spot film orifice in the device rather than by the collimator. In this case proceed to step (5) below. Draw two sets of coordinates on the film, one connecting the film corners and one connecting the field corners. Measure the offset between the film center and field center and record as a percentage of SID.

(5) If one or more edges of the x-ray field did not leave visible unexposed borders on the film, or if a comparison of edge coordinates with the cardboard cassette indicated cutoff by the spot film device, proceed as follows:

(a) Measure the distance between images of the phantom divisions on the spot film. This is necessary because the phantom has been magnified.

(b) Count the number of phantom divisions to the spot film edge being measured. (Note: Phantom center may not correspond to film center. This is unimportant as long as the same reference is used in all steps.)

(c) Count the number of phantom divisions to the corresponding edge of the radiation field shown on the cardboard cassette. Subtract step (b) from step (c) and multiply by step (a)..
This gives the offset for that edge.

(d) Repeat as necessary for other edges and record L1 + L2 and W1 + W2 as a percentage of SID.

(e) On the film from the cardboard cassette, draw lines connecting the corners of the radiation field and determine the center.

(f) Using the phantom coordinates, place a dot on the corresponding spot on the film from the spot film device.

(g) Draw lines connecting the corners of the film and measure and record the center offset as a percentage of SID.

(6) Add the L2 + L2 and Wl + W2 percentages and record.

k. Spot Film Reproducibility

21 CPR 1020.31 (b)

Check reproducibility by making four consecutive exposures and recording mR obtained. Allow at least one minute between exposures. If all values are within plus or minus 5% of the average, reproducibility can be considered satisifactory. If any mR reading exceeds plus or minus 5% of the average, calculate the coefficient of variation from:

$$c = \frac{1}{\overline{mR}} \sqrt{\frac{(\overline{mR} - mR_1)^2 + (\overline{mR} - mR_2)^2 + (\overline{mR} - mR_3)^2 + (\overline{mR} - mR_4)^2}{3}}$$

(where mR is the average of the four readings)

Then record.
If C is greater than .05, circle the value and indicate unsatisfactory on the form.

l. Spot Film Linearity

21 CPR 1020.31 (c)

Measure film linearity at one KVP which should be entered on the form according to the following procedure:

Note: Some systems have only one spot film mA station. If this is the case enter "N/A" on the form.

(1) Make an exposure at each mA station recording mA each time and the mR obtained.

(2) Calculate mAs and mR/mAs for each exposure and record.
Obtain the average mR/mAs value for all mA stations by adding the individual mR/mAs values and dividing by the number of stations tested. The upper and lower limits are plus or minus 10% of this average. Determine whether any value falls below or above the lower and upper limits and readjust the mA stations to obtain satisfactory results. These linearity limits are more strict than those contained in 21 CFR 1020.30 (c).

m. Comments and Recommendations

Annotate any data that would be helpful in analyzing the results of the tests or any recommendations to DPSC.

n. Action Required

If any of the tests were unsatisfactory, indicate so on page 19 of this report regardless of whether or not the discrepancies were corrected during the inspection.

o. Technician

The DoD inspector performing the inspection will enter his name, grade, and position title.

4. Disposition

The original will be mailed with the Acceptance Inspection Package to DPSC. One copy will be provided to the medical maintenance activity, one copy to the radiology department, and one copy will be sent to the local bioenvironmental engineering activity for review.

Comparative Density Tests

Purpose: To insure the unit will provide radiographs of uniform densities on various mA stations with all factors of KVP, distance, and mAs remaining constant.

a. Place a loaded 8" X 10" cassette on the tabletop.

b. Using a step wedge, collimate the radiation field to the size of the stepwedge. Be sure to adjust the x-ray source to 40" SID. This distance should remain constant throughout the remainder of the test.

c. Adjust the KVP to the neutral KVP (the setting in which space charge compensation does not affect mA). This is usually in the range of 70-90 KVP, depending upon the manufacturer.

d. Choose a mAs setting which will allow the same mAs to be used on every mA station. If the exact mAs is not obtainable, more than one exposure may be made at a given mA station to get as close as possible to the required mAs.

e. Provide a stepwedge for every mA station. Do not cut the film strips and be sure to label the mA settings with respect to the film. Densities, as checked with a densitometer, should be uniform to one step.

Note: Be sure to use the same cassette throughout. Use a mAs setting which will provide a radiograph of varying densities from light to dark.

COMMENTS: _____

_____

_____

_____

_____

The following parameters should remain constant:

KVP ______________ Distance ______________ mAs ________________

Do not cut the films.

mA ________________	mA ________________	mA ________________
Time _______________	Time _______________	Time _______________
Focal Spot ______ mm	Focal Spot ______ mm	Focal Spot ______ mm

mA ________________	mA ________________	mA ________________
Time _______________	Time _______________	Time _______________
Focal Spot ______ mm	Focal Spot ______ mm	Focal Spot ______ mm

mA ________________	mA ________________	mA ________________
Time _______________	Time _______________	Time _______________
Focal Spot ______ mm	Focal Spot ______ mm	Focal Spot ______ mm

mA ________________	mA ________________	mA ________________
Time _______________	Time _______________	Time _______________
Focal Spot ______ mm	Focal Spot ______ mm	Focal Spot ______ mm

mA ________________	mA ________________	mA ________________
Time _______________	Time _______________	Time _______________
Focal Spot ______ mm	Focal Spot ______ mm	Focal Spot ______ mm

Be sure to record the ending reading on the exposure counter on page 19.

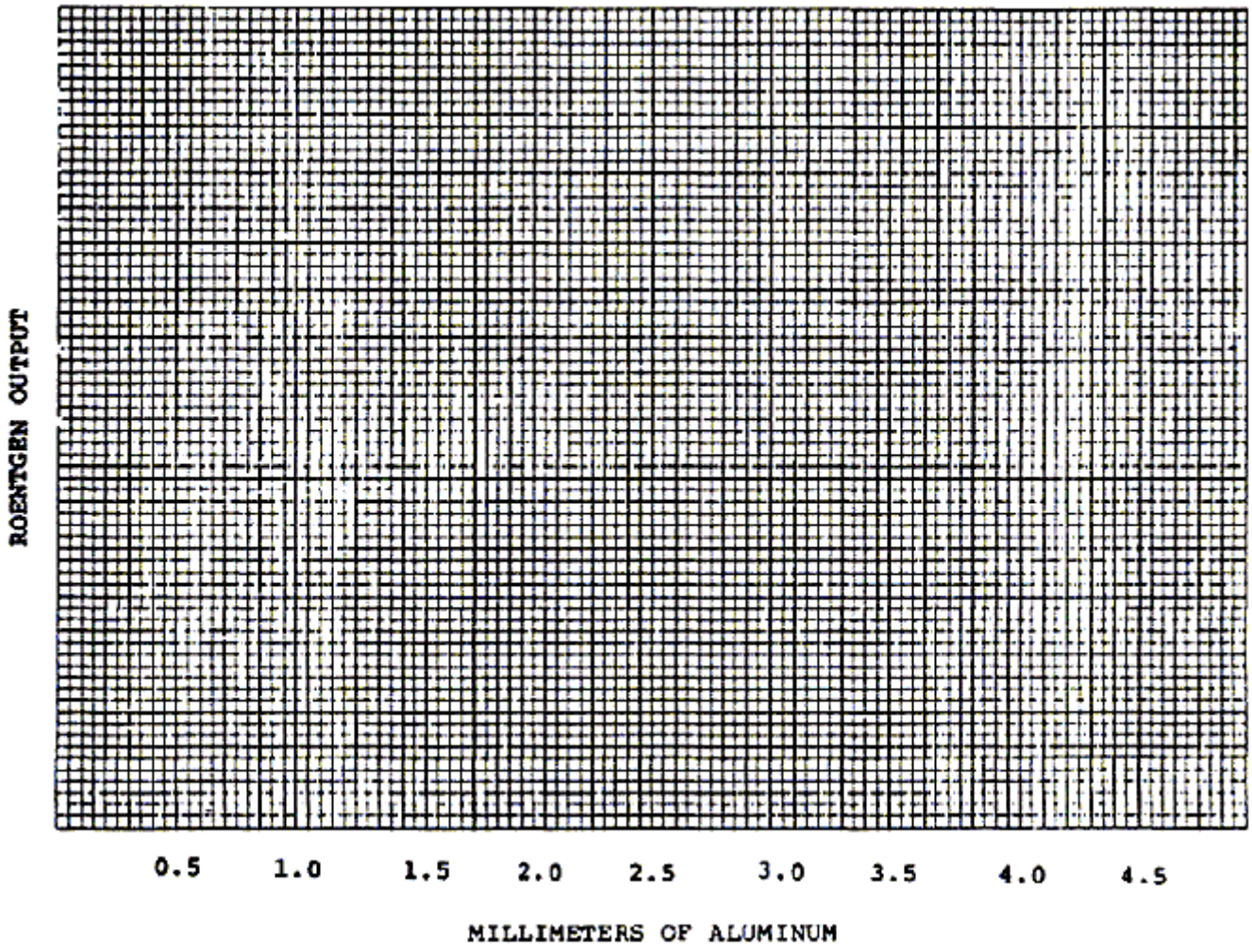
POST-CALIBRATION RADIATION INSPECTION/RADIOGRAPHIC

1. Organization	2. Date	3. Room		4. Inspecting Agency
5. EQUIPMENT IDENTIFICATION	TYPE: 1. ____ Fixed Radiographic 2. ____ Mobile Radiographic 3. ____ Rad/Fluoro			
6. TIMER ACCURACY	Setting			
	Actual			
7. RADIOGRAPHIC LEAKAGE	A. KVP _____ mA _____ Average mR/Hr _____ B. Anode Cooling Rate _____ mR/Hr _____			
8. SID ACCURACY	A. Tube to Table (Horiz): Indicated _____ Actual _____ B. Tube to Table (Vert) : Indicated _____ Actual _____ C. Tube to Chest Receptor: Indicated _____ Actual _____			
9. ILLUMINANCE	Average _____ Ambient _____ Illuminance _____			
10. LIGHT FIELD OFFSET	L1 + L2 _____ W1 + W2 _____ Allowable _____			
11. FIELD SIZE Vs INDICATORS	SID _____ Indicated Size _____ Actual _____			
12. FIELD Vs RECEPTOR OFFSET	A. Table Horiz: SID _____ Center Offset _____ B. Table Vert: SID _____ Center Offset _____ C. Chest Recep: SID _____ Center Offset _____			
13. FIELD SIZE (Automatic)	A. Table Horiz: SID _____ Sum of Errors _____ Error: Length _____ Width _____ B. Chest Recept: SID _____ Sum of Errors _____			
14. MINIMUM FIELD	Maximum SID _____ Shutters Closed: Size _____ Error: Length _____ Width _____			
15. BEAM QUALITY	0 mm _____ 2.5 mm _____ 4.5 mm _____ HVL _____			
16. REPRODUCIBILITY	A. KVP _____ mA _____ Time _____ B. mR1 _____ mR2 _____ mR3 _____ mR4 _____			

17. TUBE CURRENT OUTPUT AND LINEARITY	Distance _____ Low KVP _____ Med KVP _____ Hi KVP _____								
	mA	Time	mAs	mR	mR/mAs	mR	mR/mAs	mR	mR/mAs
18. ACTION REQUIRED Yes |___| No |___|					19. TECHNICIAN				

POST-CALIBRATION RADIATION INSPECTION/FLUOROSCOPIC

1. Organization	2. Date	3. Room		4. Inspecting Agency
5. EQUIPMENT IDENTIFICATION	A. Type: 1. _____ Rad/Fluoro 2. _____ Mobile Fluoro B. Control Manufacturer _____ Model # _____ C. Unit Equipped with Automatic Exposure Rate? Yes _____ No _____ D. Unit equipped with High Level Output Option? Yes _____ No _____			
6. TIMER	A. Tone Occurs After Timer is Set for 30 Seconds? _____ B. Audible Tone Continues Until Timer Is Reset? Yes _____ No _____			
7. FLUOROSCOPIC LEAKAGE	A. KVP _____ mA _____ Average mR/Hr _____ B. Anode Cooling Rate _____ mR/Hr _____			
8. BEAM QUALITY	0 mm _____ 2.5 mm _____ 4.5 mm _____ HVL _____			
9. OUTPUT MEASUREMENTS	A. Manual (Max 5R/min): _____ R/Minute B. Automatic: 1. No High Level Option: _____ R/Minute 2. High Level Output: _____ R/Minute C. High Level Output Option: Audible Tone Yes _____ No _____			
10. MINIMUM FIELD	Shutters Closed At Max SID: (Min 5 cm) Yes _____ No _____			
11. FIELD SIZE Vs INTENSIFIER	A. Clipping Visible With Shutters Open? Yes _____ No _____ B. Length Error: L1 + L2 _____ % Error _____ C. Width Error: W1 + W2 _____ % Error _____ D. Sum of Length and Width Errors: Error _____			
12 FIELD SIZE Vs SPOT FILM SIZE	A. Length Error: L1 + L2 _____ % Error _____ B. Width Error: W1 + W2 _____ % Error _____ C. Sum of Length and Width Errors: % Error _____ D. Center Offset: _____ % Error _____			
13. SPOT FILM REPRODUCIBILITY	A. KVP _____ mA _____ Time :_____ B. mR1 _____ mR2 _____ mR3 _____ mR4 _____			
14. SPOT FILM LINEARITY	KVP / mA			
	Time			
	mR			
	mR/mAs			
	Average _____ Upper Limit _____ Lower Limit _____			
15. COMMENTS AND RECOMMENDATIONS				
18. ACTION REQUIRED Yes |___| No |___|			17. TECHNICIAN	


ROENTGEN OUTPUT
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
MILLIMETERS OF ALUMINUM