Radiographic Collimation, Centering and Auto Field Sizing Test Procedure for CR Systems

It is necessary to ensure that the radiation field appropriately matches the light field definition and that the field is properly centered to the CR detector(s). Additionally, some X-ray systems automatically set a field size depending on the cassette inserted into the Bucky. Evaluation of a "pre-set" radiation field size is necessary to ensure that the collimation feature is operating as expected. Centering of the x-ray tube to the CR detector(s) is also necessary to ensure proper positioning and to prevent repeat exposures to patients.

Prepared by Upstate Medical
Physics - DR, MN, MH TRP, P.C.

CR Detector:

1) For Table Bucky Work: Position the x-ray tube 40" from the CR detector (Bucky), or set the clinically used source-image receptor (detector) distance (SID).

40" measured from bucky to focal point.

For Upright Bucky Work: Position the x-ray tube 72" from the CR detector (Bucky), or set the clinically used source-image receptor (detector) distance (SID).

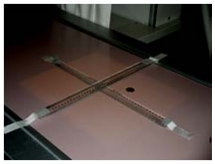
72" measured from bucky to focal point.

2) Insert into the Bucky a CR cassette of the largest size used clinically (likely 35x43 cm).

Philips Diagnost Table Bucky in the open position.

3) With Bucky tray extended, use tape measure to measure distance from surface of cassette to surface of table. Record this distance and use it to calculate magnification factor, and move Bucky tray into position for imaging.

4) Open collimators to expose the entire image receptor (may occur automatically with some units).
5) Position large (18 inch) radio-opaque rulers in each dimension of image receptor, centering them as well as possible. Position marker (e.g. coin, paper clip, etc.) to identify image orientation.
6) Expose image receptor to very low technique (e.g. 65 kVp, ~1 mAs/AEC).



Radio-opaque rules securely taped to the table. Open collimation boundary is visible.

Philips Diagnost Control Panel – Thumb is on the Expose button.

7) Record outermost visible ruler graduations for each edge of image receptor.
8) Do not move the radio-opaque rulers.
9) For systems equipped with automatic field sizing for different cassette sizes, insert into the Bucky a commonly used cassette size (10"x12").
10) For systems without automatic field sizing, insert into the Bucky a 35x43cm CR cassette and collimate to approximately 10x12" (24x30 cm).

11) Record the ruler graduations corresponding to each edge of the light field. If the system has automatic field sizing, remove the smaller cassette, and insert a larger one.
12) For systems with automatic field sizing, manually collimate light field to dimensions recorded in 11, above.
13) Expose image receptor to the same low technique used previously.
14) Record outermost visible ruler graduations for each edge of image.

Data Analysis & Permissible Limits:

- Automatic field sizing is determined by measuring the size of the radiation field in both directions and comparing against the nominal size as indicated on the collimator or the pre-set field displayed at the control console.
- They must not differ by more than **3% SID in any one dimension; the total difference may not be more than 4% SID. The image must be centered on the image receptor to within 2% of the SID. The sum of X-ray field to light field variation in each dimension (left-right and top-bottom) must not exceed 2% of the SID**.

The Excel spreadsheet has been designed to perform all of the necessary calculations using the data entered throughout this procedure.

Radiographic Collimation, Centering and Auto Field Sizing Test Procedure for DR Systems

It is necessary to ensure that the radiation field appropriately matches the light field definition and that the field is properly centered to the DR detector(s). Additionally, some X-ray systems automatically set a field size depending on the cassette inserted into the Bucky. Evaluation of a "pre-set" radiation field size is necessary to ensure that the collimation feature is operating as expected. Centering of the x-ray tube to the DR detector(s) is also necessary to ensure proper positioning and to prevent repeat exposures to patients.

DR Table Detector:

1) Position the x-ray tube 40" from the DR detector, or set the clinically used source-image receptor (detector) distance (SID).
2) Open collimators to expose the entire image receptor.
3) Position large (18 inch) radio-opaque rulers (on table top) in each dimension of image receptor, centering them as well as possible. Position marker (e.g. coin, paper clip, etc.) to identify image orientation.
4) Expose image receptor to very low technique (e.g. 65 kVp, ~1 mAs).
5) Record outermost visible ruler graduations (from processed image) for each edge of image receptor.
6) Do not move the radio-opaque rulers.
7) For systems equipped with automatic field sizing for different body parts, select a commonly performed exam. For systems without automatic field sizing for different body parts, collimate to approximately 10x12 inches (24x30 cm).
8) Record the ruler graduations corresponding to each edge of the **light field.**
9) Expose image receptor to the same low technique used previously.
10) Record outermost visible ruler graduations (from processed image) for each edge of image.
11) Repeat 2-10 for the Upright or Chest Detector (72"), if present. Technique should be increased to ~4 mAs at 65 kVp, and rulers should be securely taped during procedure.
12) For those systems with only one detector, evaluate the collimation, automatic sizing, and centering using the tube-vertical (table mode) setup, with an SID of approximately 40".

Data Analysis & Permissible Limits:

- Automatic field sizing is determined by measuring the size of the radiation field in both directions and comparing against the nominal size as indicated on the collimator or the pre-set field displayed at the control console.
- They must not differ by more than **3% SID in any one dimension; the total difference may not be more than 4% SID. The image must be centered on the image receptor to within 2% of the SID. The sum of X-ray field to light field variation in each dimension (left-right and top-bottom) must not exceed 2% of the SID**.

The Excel spreadsheet has been designed to perform all of the necessary calculations using the data entered throughout this procedure.

Radiographic Collimation, Centering and PBL Test Procedures

(Penny Method for film/screen)

It is necessary to ensure that the radiation field appropriately matches the light field definition and that the field is properly centered to the bucky. Additionally, the Positive Beam Limitation (PBL) feature, if the unit is so equipped, must yield a radiation field which is acceptably close in size to the size of image receptor in the bucky.

Procedure:

1) Position the x-ray tube 40" from the table receptor, source-image receptor distance (SID).
2) For systems equipped with PBL, place a cassette in the bucky with PBL engaged.
3) Place two pennies on each side of the light field, one just inside the light field, one just outside the light field. Repeat for all sides. Place one coin in the radiation field for orientation.
4) Remove the cassette from the bucky and place a larger cassette in the bucky.
5) Reposition the collimators so that the light field again matches that from the small (original) cassette.
6) Make a photo-timed exposure at approximately 80 kVp and process the film.
7) Establish the centers of the film and the radiation field.

8) Measure any misalignment of the edges of the radiation field that is between the two coins along each edge of the film.
9) PBL is determined by measuring the size of the radiation field in both directions and comparison against the nominal size.
10) Repeat 2-9 for the **upright bucky** (72"), if present.
11) Repeat 3-8 for systems not equipped with PBL, using a manually set field.
12) For systems without a bucky (portable), place a loaded cassette and collimator test tool on top of the cassette on a hard surface.
13) Adjust the light field to the pattern on the collimator test tool
14) Expose and process the film.
15) Evaluate the film using the tolerances noted

Data Analysis & Permissible Limits:

- Automatic field sizing is determined by measuring the size of the radiation field in both directions and comparing against the nominal size as indicated on the collimator or the pre-set field displayed at the control console.
- They must not differ by more than **3% SID in any one dimension; the total difference may not be more than 4% SID. The image must be centered on the image receptor to within 2% of the SID. The sum of X-ray field to light field variation in each dimension (left-right and top-bottom) must not exceed 2% of the SID**.

The Excel spreadsheet has been designed to perform all of the necessary calculations using the data entered throughout this procedure.

For Portables:

1) If available, the Unfors collimation test tools can be used in place of a film/cassette.
2) Set each of the Unfors test tools at the edge of the light field so that the red line or arrow is precisely at the intersection.
3) Make a manual exposure, using 5-8 mAs at 80 kVp. Determine the misalignment on each edge of the radiation field by comparing the Unfors line or arrow against the actual edge of the radiation field, using the increments of the Unfors test tool (0.25cm). Enter the misalignment numbers into the Excel template.

Data Analysis & Permissible Limits:

- Automatic field sizing is determined by measuring the size of the radiation field in both directions and comparing against the nominal size as indicated on the collimator or the pre-set field displayed at the control console.
- They must not differ by more than **3% SID in any one dimension; the total difference may not be more than 4% SID. The image must be centered on the image receptor to within 2% of the SID. The sum of X-ray field to light field variation in each dimension (left-right and top-bottom) must not exceed 2% of the SID**.

The Excel spreadsheet has been designed to perform all of the necessary calculations using the data entered throughout this procedure.

Generator Testing

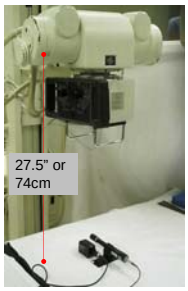
Generator performance is evaluated to ensure adequate equipment performance and optimal image quality

*Results are compared against state (NY, PA, or Conn) QA guidelines and manufacturer's published performance specifications, as appropriate.

Procedure:

- Generator performance is evaluated using computerized noninvasive measurement equipment. The computerized system collects data and evaluates performance. Timer accuracy and reproducibility, kVp accuracy, mR/mAs linearity, and beam quality are assessed and compared against published manufacturer's specifications and/or state DOH QA guidelines and regulatory requirements (NY, PA, or Conn).

1) Position the tube above the tabletop so that the focal spot to non-invasive meter/ center of chamber distance is 27.5" (74cm).
2) Place the non-invasive meter in the center of a collimated field beneath the tube so that the tube axis is properly aligned with the meter as indicated. (kVp detector and ion chamber are perpendicular to tube axis)
3) Properly connect your Radcal and security USB drive to your computer.
4) Choose "kV Pulse".



4) Hold "ctrl" + "shift" and press "K", this will initiate communication between your computer and the Radcal.
5) Once a beep is heard or a "D" visible on the Radcal or "Capturing data" is seen at the bottom of the Excel sheet you are ready to make an exposure
6) Make the necessary exposures that are set by the computer software program to complete the generator performance tests.
7) Use clinically relevant exposures.

Timer evaluation:

- Timer accuracy is determined by making multiple exposures using different time settings. Timer accuracy data is collected when evaluating the linearity performance.
- For portable radiographic units, timer accuracy is not easily accomplished. These are typically mAs only generators, and the mA is not known.

Permissible Limits: The measured exposure time shall not differ from the indicated by more than 10% or manufacturer specifications (if available).

mA or mAs linearity:

- This is evaluated by making multiple exposures at the same kVp setting while changing the mA and time settings.
- Both small and large focal spots are evaluated.
- For mAs generators *(including mobile radiographic units)*, mAs linearity is evaluated similarly, but the mAs is changed while maintaining the same kVp.

Permissible Limits: The average ratios of exposure to the indicated milliampere-seconds product (mR/mAs) obtained at any two consecutive tube current settings shall not differ by more than 0.10 times their sum.

kVp evaluation:

a) Accuracy is assessed by making exposures at different kVp settings, typically from 50 to 120 kVp (get adequate signal to kVp sensor/diodes).
b) Reproducibility is assessed by making four exposures using the same kVp, mA, and time (or mAs).
c) For a dedicated Chest unit, clinically used kVp's will be tested (refer to the posted ESE chart for max kVps)

Permissible Limits: Unless otherwise specified in the manufacturers' specification, all equipment shall meet:
2 kVp of the indicated for < 30 kVp,
3 kVp of the indicated for 31 - 100 kVp, and,
6 kVp of the indicated for > 100 kVp.

Reproducibility evaluation:

- Reproducibility is determined by making 4 exposures using an identical technique (kVp; mA and time, or mAs).

Permissible Limits: The coefficient of variation of radiation of exposures shall be no greater than 0.05.

Beam Quality (HVL):

- Beam quality is evaluated through the half-value layer (HVL) at approximately 80 kVp. An exposure is made with no added filtration in the beam, followed by identical exposures with approximately 2.3 and 3.3 mm Al placed in the beam. Additional filtration is used if needed.
- Results are compared against the established table (see right) of acceptable beam filtration found in the state DOH QA guidance documents, and in Part 16 for New York State facilities.
- Note the change after 6/10/06

X-Ray Tube Voltage Designed Operating Range	**Measured Range (kVp)**	**Minimum HVL (mm Al) for Systems Manufactured:**	
		Prior to 6/10/06	**On or after 6/10/06**
Below 51	30	0.3	0.3
	40	0.4	0.4
	50	0.5	0.5
51 - 70	51	1.2	1.3
	60	1.3	1.5
	70	1.5	1.8
Above 70	71	2.1	2.5
	80	2.3	2.9
	90	2.5	3.2
	100	2.7	3.6
	110	3.0	3.9
	120	3.2	4.3
	130	3.5	4.7
	150	4.1	5.4

Conventional Linear Tomography Quality Control Test Procedures

Conventional tomographic function is evaluated with a tomographic test tool to ensure that the section level (fulcrum), slice thickness, uniformity, beam path, and spatial resolution yield high quality tomograms.

Test Procedure using six discs:

- **3 acrylic spacer discs,**
- **1 acrylic disc that contains lead numbers in a helix,**
- **1 acrylic disc that contains four tilted copper mesh pieces of .8, 1.2, 1.6, and 2.0 holes/mm**
- **1 lead disc with a 4mm aperture.**

Tomographic QC procedure:

1) Set up the radiographic unit for tomographic imaging.
2) On the table top, place the number helix disc on top of the 3 spacer discs.
3) Measure the distance from the table top to the level of the "5" in the number helix disc. The cut height should be around 7.5 cm (or 75 mm).
4) Set the cut level, fulcrum, to the measured height in 3.
5) Select a setting to produce a large angle, thin cut tomogram.
6) Place a loaded cassette or imaging plate (IP) in the bucky and make an exposure.
7) Evaluate the image for section level and slice thickness by verifying that the position of least blurring is within 5 mm of the set cut height.
8) Position the resolution section, tilted mesh disc, in place of the cut height section at a 45° angle to the tube motion.
9) Place a loaded cassette in the bucky and make an exposure that produces a thin cut tomogram.
10) Verify the smallest mesh that was clearly resolved for at least 3 mm of the strip length.
11) On the table top, stack the 3 spacer discs on top of the lead aperture plate.
12) Set the fulcrum at 11 cm.
13) Place a cassette in the bucky and make a thin cut tomogram.
14) The image will produce a line sufficient for checking the uniform film density and beam path.
15) Compare results to manufacturer's specification or other accepted standards (NCRP, etc.)

(Note that steps 2-11 may be accomplished simultaneously, depending on the tomographic test tool being used.)

Data Analysis & Permissible Limits:

- *Cut Level* – the slice or cut level shall be within **5mm** of the indicated level.
- *Cut Thickness* – the slice or cut thickness with an arc setting of 30 degrees shall have a slice thickness of **2 or 2.5mm**.
- *Resolution* – each Tomographic unit **should** be capable of resolving a #40 mesh pattern and **shall** be capable of resolving a #20 mesh pattern.

The Excel spreadsheet has been designed to perform all of the necessary calculations using the data entered throughout this procedure.

Evaluation of Automatic Exposure Control (AEC) Systems

The automatic exposure control (AEC) function of radiographic imaging equipment must be periodically evaluated as part of a department-wide quality assurance program. Described below is the procedure used by Upstate Medical Physics, P.C. for assessing AEC performance

AEC Testing Procedure:

1) Position the radiographic tube over the table bucky at a source to image receptor distance (SID) of 40".
2) If necessary to allow an exposure, place a cassette or IP in the table bucky. Center the bucky and tube.
3) Position the 1.5" of Type 1100 aluminum, copper sheets, lead apron, or other attenuator in a collimated x-ray field such that the attenuator covers the AEC sensor(s) to be evaluated.
4) Select the AEC system and center chamber on the control panel.
5) Select a kVp between 75-85 (such as 80 kVp and 200 mA), ensuring that the minimum response time of the system is exceeded. Place the Radcal meter/chamber in the light field in front of the attenuator, but not in front of any of the AEC detectors.
6) Make 4 exposures and record the exposure time or radiation exposure for each.
7) Repeat steps 4-6 for right and left AEC chambers.
8) If an upright bucky is present, the process is repeated (using the same kVp and mA) with the tube oriented appropriately at 72" SID.
9) AEC system performance is analyzed.

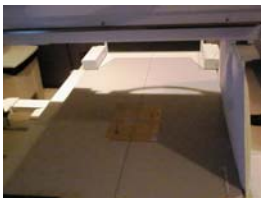
Permissible Limits: Unless otherwise specified in the manufacturer's specification, most AEC systems are capable of maintaining a reproducibility of exposures to within a **coefficient of variation of 5%**. If this reproducibility is not achieved through the 4 exposures, take an additional 6 exposures and average the results of all 10 exposures.

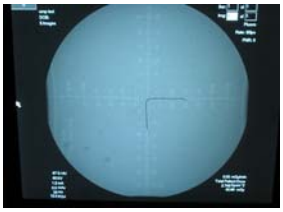
Fluoroscopic Imaging Equipment Quality Control Test Procedures

In order to meet and comply with specific quality assurance program requirements as described in Part 16 of the NYS Sanitary Code, Upstate Medical Physics, P.C. outlines below the testing protocols and procedures used to evaluate fluoroscopic imaging equipment. Mobile C-Arm fluoroscopic units as well as fixed units will be evaluated as follows. The Quality Assurance limits as specified in the NYSDOH QA Guide, or manufacturer's published specifications will be followed.

Fluoroscopic Collimation & Interlock Procedure:

1) Select the fluoroscopic mode on the control console to activate the tube, image intensifier, flat panel, and viewing monitor.
2) Position the table bucky out of the way of the fluoroscopy tube.
3) Attempt to make an exposure with the fluoro tower not fully engaged to the x-ray tube; no exposure should be possible. This evaluates the tube "Park" position (interlock).
4) Position the image intensifier/flat panel/fluoroscopic tower assembly over the table.
5) Raise the tower assembly to achieve the maximum source to image distance (SID).
6) Place the collimator test tool on the table top. Center the test tool in the x-ray beam so that it appears centered on the imaging monitor (tape in place). Open the collimating shutters to maximize the x-ray field. Select the normal FOV.
7) Read and record the field size from the collimator test tool image in the horizontal and vertical dimensions. (If the collimating shutters are visible on the monitor, then no hard copy films are necessary to document the collimation.)

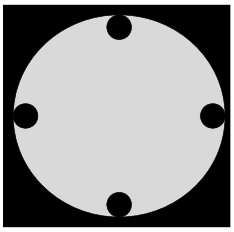




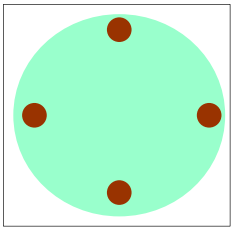
8) Place a loaded cassette larger than the field size on top of the collimation test tool with the back of the cassette facing the tube. Make an exposure by depressing the foot switch just long enough to see an image begin to form on the monitor.
9) Process the film and compare the field size on the monitor with the field size on the processed film.
10) Repeat 7-9 for the magnification modes.
11) **CR processing:** Process exposed IP and compare measurements with monitor measurements.
12) For evaluating spot film collimation, select a format for spot filming (1:1, 2:1, 4:1). Load a cassette into the spot film device.
13) Raise the tower to maximum SID so that the focal spot to tabletop distance approximates the same as from the table top to image intensifier distance.
14) With the collimation test tool centered in the image, place a loaded cassette on the test tool with the back of the cassette facing the x-ray tube.
15) Make a phototimed spot film exposure.
16) **CR processing:** Process exposed IP's and compare measurements with monitor measurements. Use distance measurement tool if available.
17) Permissible Limits: Measure the dimensions of the image on both films. The size of the image on the table film should be approximately 1/2 the size of the image on the spot film device film, to within 3% in one dimension or 4% total both dimensions of the SID.

Alternate Fluoroscopic Collimation Procedure:

1) Select the fluoroscopic mode on the control console to activate the tube, image intensifier, flat panel, and viewing monitor.
2) Position the table bucky out of the way of the fluoroscopy tube.
3) Position the image intensifier (II)/flat panel (FPD)/fluoroscopic tower assembly over the table.
4) Raise the tower assembly to achieve the maximum source to image distance (SID).
5) Place the intensifying screen on the table so that the white screen faces the operator. Open the collimating shutters to maximize the x-ray field. Select the normal FOV. Center the screen approximately in the center of the FOV.
6) Place four coins (eg. Pennies) on the screen. Make fluoroscopic exposure and align the coins using a stick to the four edges of the visible FOV (left, right, top and bottom) on the monitor.
7) Turn off as many lights as possible in the room.
8) Manually increase the technique parameters or place a lead block between the screen and the II/FPD so that a green shadow of the x-ray field is visible on the screen.



Coins aligned to the edges of the visible field as seen on the monitor.



Coins with respect to the x-ray field as seen on the screen.

9) Record the distance between the edge of the green shadow and the edge of the coin for each of the edges of the x-ray field.
10) Repeat steps 6-10 for all the magnification modes.
11) For evaluating spot film collimation, select a format for spot filming (1:1, 2:1, 4:1). Load a cassette into the spot film device.
12) Raise the tower to maximum SID so that the focal spot to tabletop distance approximates the same as from the table top to image intensifier distance.
13) With the collimation test tool centered in the image, place a loaded cassette on the test tool with the back of the cassette facing the x-ray tube.
14) Make a phototimed spot film exposure.
15) **CR processing:** Process exposed IP's and compare measurements with monitor measurements. Use distance measurement tool if available.
16) Permissible Limits: Measure the dimensions of the image on both films. The size of the image on the table film should be approximately 1/2 the size of the image on the spot film device film, to within 3% in one dimension or 4% total both dimensions of the SID.

Note: The test images acquired using this alternate method may not be available on the facility's PACS system for review at a later date.

Mobile C-arm Collimation:

1) For general purpose mobile fluoroscopic equipment, collimation is evaluated as follows:
2) Place the collimator test tool on the test stand, and center on the image intensifier.
3) Measure the source to image distance (SID) and test tool to image intensifier distance.
4) Record the visible numbers on the left, right, top, and bottom edges of the monitor image.
5) Repeat for all field sizes.
6) Return to the normal field size and open the collimators
7) Place a loaded cassette (or imaging plate for CR users) under the test tool on the base of the test stand.
8) Make a short exposure, change field size to Mag 1, change to Mag 2, and then process the image.
9) Compare the monitor image against the processed image and record.
10) **CR processing:** Process exposed IP and compare measurements with monitor measurements.
11) **Permissible Limits**: The recorded dimensions should be within 3% in one dimension or 4% total both dimensions of the SID.

Alternate procedure for Mobile C-arm Collimation:

For general purpose mobile fluoroscopic equipment, collimation is evaluated as follows:

1) Flip the C-arm 180 degrees so that the tube points to the floor and the image intensifier points to the ceiling.
2) Place the intensifying screen on the surface of the image intensifier.
3) Measure the source to image distance (SID) and screen to image intensifier distance.
4) Place four coins (eg. Pennies) on the screen. Make fluoroscopic exposure and align the coins using a stick to the four edges of the visible FOV (left, right, top and bottom) on the monitor.
5) Turn off as many lights as possible in the room.
6) Manually increase the technique parameters or place a lead block between the screen and the image intensifier so that a green shadow of the x-ray field is visible on the screen.
7) Record the distance between the edge of the green shadow and the edge of the coin for each of the edges of the x-ray field.
8) Repeat steps 4-9 for all the magnification modes.
9) **Permissible Limits**: The recorded dimensions should be within 3% in one dimension or 4% total both dimensions of the SID.

Note: The test images acquired using this alternate method may not be available on the facility's PACS system for review at a later date.

Mini C-Arms Collimation

(Tube pointing Down, I.I.Up)

1) If a centering laser is available, center a cassette (or imaging plate for CR users) over the image intensifier.
2) Place a cassette or an IP on top of the image intensifier.
3) Place and center the collimator test tool on the cassette or IP.
4) Make a short exposure using the normal field size.
5) Read and record the monitor image size in the Excel worksheet.
6) Without moving the cassette and test tool, change to mag mode and repeat steps 4-5.
7) Process and compare the monitor image against the film or CR image.
8) Record in the appropriate Excel worksheet to determine results.
9) If no centering laser is available, then use a linen container with a plastic cover (metal will not work)
10) With the x-ray tube up and the image intensifier down, position the image intensifier under the linen container.

11) Place the test tool on top of the linen container and center on the monitor.
12) Measure the SID and test tool to image intensifier distances and record.
13) Record the left, right, top, and bottom dimensions.
14) Place a cassette or an IP on top of the image intensifier, under the top of the linen cover. Center the cassette or IP under the test tool.
15) Make a short exposure in normal mode, change to mag mode and repeat.
16) Process the image and compare the monitor image against the processed image.
17) **CR processing:** Process exposed IP and compare measurements with monitor measurements
18) **Permissible Limits**: The recorded dimensions should be within 3% in one dimension or 4% total both dimensions of the SID.

Alternate procedure for Mini C-arm Collimation:

For general purpose mini fluoroscopic equipment, collimation is evaluated as follows:

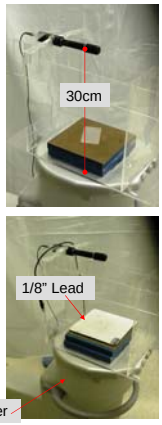
1) Flip the C-arm 180 degrees so that the tube points to the floor and the image intensifier points to the ceiling.
2) Place the intensifying screen on the surface of the image intensifier.
3) Measure the source to image distance (SID) and screen to image intensifier distance.
4) Place four coins (eg. Pennies) on the screen. Make fluoroscopic exposure and align the coins using a stick to the four edges of the visible FOV (left, right, top and bottom) on the monitor.
5) Turn off as many lights as possible in the room.
6) Manually increase the technique parameters or place a lead block between the screen and the image intensifier so that a green shadow of the x-ray field is visible on the screen.
9) Record the distance between the edge of the green shadow and the edge of the coin for each of the edges of the x-ray field.
10) Repeat steps 4-9 for all the magnification modes.
11) **Permissible Limits**: The recorded dimensions should be within 3% in one dimension or 4% total both dimensions of the SID.

Note: The test images acquired using this alternate method may not be available on the facility's PACS system for review at a later date.

Typical & Maximum Exposure Rate:

1) For under table fluoro units, position the bottom of the image intensifier/flat panel to 30 cm above the tabletop.
2) Place the Radcal ion chamber at the tabletop. Place 0.75" aluminum (1 plate) between the chamber and the image intensifier/flat panel.
3) For over table fluoro units, position the Radcal ion chamber 30 cm **above** the table top. Place 0.75" aluminum between the chamber and the image intensifier/flat panel. Collimate the field to the approximate size of the aluminum patient-equivalent phantom.
4) For C-Arm type fluoroscopy, the exposure rates are measured 30 cm from the image intensifier. Place 0.75" aluminum between the detector and the image intensifier.
5) Use the clinically appropriate technique, no less than 70 kVp. (either ABC mode or fixed mA or kVp).

6) Record the measured exposure rate and the indicated kVp and mA read outs from the control console in the Excel workbook.
7) Repeat procedure adding another Al plate (Small adult).
8) Repeat procedure adding 2 mm Cu to the two Al plates (Large adult).
9) Remove the 2mm Cu and add 0.5 mm Cu (Average adult) and repeat this process for normal and all magnification modes.
10) Return to the Normal fluoroscopy mode. Place the 1/8" lead attenuator on top of the aluminum blocks and 0.5 mm Cu plate. This will drive the ABC mode to its maximum for obtaining maximum exposure rates.
11) Record the measured maximum exposure rate and the indicated kVp, and mA.
12) Repeat steps for evaluating "high fluoro" or "boost" mode.

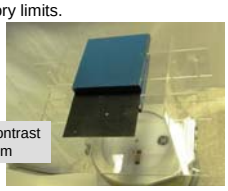


- Compare obtained values with regulatory limits.
- For “mini-C arm” units, one Al block will represent a typical patient, as these units are used for relatively small body parts and joints (ankle, wrist, elbow, foot). Two blocks are used to represent a large part.
- Place one Al block on top of the image intensifier, and place the Radcal chamber 10 cm above the image intensifier for measuring exposure rates. Use 2 plates for max.

- Add mini C-Arm picture here if available

Low Contrast Evaluation:

1) With the image intensifier or flat panel detector positioned 30 cm above the tabletop, place 1.5" Al on the tabletop. For mobile C-Arms, place 1.5" Al 30 cm from image intensifier. For mini C-arms, refer to step 7.
2) Place the low contrast test tool in between the aluminum plates.
3) Center the image on the monitor.
4) Record the size of the smallest holes visible, the kVp and mA.
5) Repeat this for the magnification modes.
6) Compare obtained values with regulatory limits.
7) For mini C-arm units, use one Al block and place the low contrast test tool on top of the Al block. The Al block and test tool are placed on the image intensifier.



Low Contrast Phantom

High Contrast Evaluation: Fluoro Rooms

1) Remove the aluminum plates from the field.
2) For under table fluoro units, place one Al block
3) on the table top.
4) Place the high contrast test tool on top of the
5) Al block, turned 45 degrees.
6) Maintain the image intensifier or flat panel detector 30 cm above the tabletop.
7) Center the test tool as well as possible.
8) Collimate the field to within the Al block.
9) Fluoro and record the highest line pair visible on the monitor image.
10) Repeat this evaluation for the magnification modes.
11) Compare obtained values with regulatory limits.

Permissible limits: NYSDOH specifies high contrast resolution performance as follows:

For regulatory compliance, the minimum number resolution measured at the center of the FOV = 2 lp/mm x (15 cm/FOV). Manufacturer's published specifications will also be used for comparison, when available.

Note: We need to know the accurate field sizes in order to determine compliance.

High Contrast Evaluation for Mobile C-arms and Lithotripsy Units:

1) Position the x-ray tube down and place the fluoro test stand on top of the image intensifier.
2) Place one 0.75" Aluminum block with HC test tool on top of the block on top of the test stand so that the high contrast test tool is 30 cm from the surface of the image intensifier.
3) Collimate the field so that the entire beam is intercepted by the Aluminum block, with the HC test tool centered in the field, turned 45 degrees.
4) Using the “Auto” fluoro mode, read and record the highest line pair pattern that is clearly visible on the monitor image for each field size.
5) Compare results against NYSDOH resolution criteria. For a 6" or 15 cm. field size, the HC resolution must be 2 lp/mm.

Permissible limits: NYSDOH specifies high contrast resolution performance as follows:

For regulatory compliance, the minimum number resolution measured at the center of the FOV = 2 lp/mm x (15 cm/FOV). Manufacturer's published specifications will also be used for comparison, when available.

High Contrast Phantom

Beam Quality (HVL):

Aluminum HVL Filter(s)

1) Position the radiation detector several inches above the image intensifier and center in the visible field.
2) Place 2 Al blocks under the ion chamber on top of the fluoro test stand.
3) Add attenuators, including the 2.3 and 1.0 mm Al plates above the detector until the ABC system stabilizes at approximately 80 kVp.
4) Record the exposure rate, kVp, and mA with no aluminum between the tabletop and radiation detector.
5) Place the 2.3 mm aluminum plate on the table top under the detector.
6) Record the exposure rate with 2.3 mm aluminum in the beam.
7) Place the 1.0 mm aluminum plate on top of the 2.3 mm plate on the tabletop.
8) Record the exposure rate with 3.3 mm aluminum in the beam.
9) The HVL is interpolated from these measurements and reported.
10) For mini C-arms, use a minimum of 70 kVp for evaluating HVL. Get the kVp detector as close as reasonable to the x-ray tube for improved signal.

Permissible results for HVL in fluoroscopy (same as radiographic)

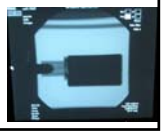
X-Ray Tube Voltage Designed Operating Range	**Measured Range (kVp)**	**Minimum HVL (mm Al) for Systems Manufactured:**	
		Prior to 6/10/06	**On or after 6/10/06**
Below 51	30	0.3	0.3
	40	0.4	0.4
	50	0.5	0.5
51 - 70	51	1.2	1.3
	60	1.3	1.5
	70	1.5	1.8
Above 70	71	2.1	2.5
	80	2.3	2.9
	90	2.5	3.2
	100	2.7	3.6
	110	3.0	3.9
	120	3.2	4.3
	130	3.5	4.7
	150	4.1	5.4

kVp Accuracy: Fluoro Room

1) For under table fluoro units, place the Radcal kVp detector (top side down) on the table top. The detector must be perpendicular to the x-ray tube axis.
2) Add filtration as needed for the ABC system to stabilize at approximately 75 kVp as indicated on the generator control panel.
3) Record the measured kVp and the indicated kVp.
4) Repeat 2 & 3 for approximately 80-90 kVp and 100-110 kVp.
5) Compare kVp errors to manufacturer specifications and NYSDOH guidelines.
6) For mini C-arms, get the kVp detector as close as reasonable to the x-ray tube for improved signal.

- Permissible limits: Use manufacturer's published kVp accuracy specifications for assessment of kVp accuracy. If none are available, compare against NYSDOH QA guidance:
  - **3 kVp of the indicated for 31 - 100 kVp, and, 6 kVp of the indicated for > 100 kVp.**

kVp Accuracy: C-Arm



1) Place the kVp detector on top of one 19mm Al Block (ensuring the sensor is facing the tube and is perpendicular to the tube axis as shown).
2) Manually adjust the kVp to a desired setting (70-75 kVp to start).
3) Take an exposure for 3-5 seconds.
4) Wait for the Radcal to beep, indicating the data collection is complete
5) Record the measured kVp and the indicated kVp.
6) Repeat 2 & 3 for approximately 80-90 kVp and 100-110 kVp.
7) Compare kVp errors to manufacturer's specifications and NYSDOH guidelines.
8) For mini C-arms, get the kVp detector as close as reasonable to the x-ray tube for improved signal.

Permissible limits: Use manufacturer's published kVp accuracy specifications for assessment of kVp accuracy. If none are available, compare against NYSDOH QA guidance:

- **3 kVp of the indicated for 31 - 100 kVp, and, 6 kVp of the indicated for > 100 kVp.**

Timer Evaluation:

1) Throughout all of the fluoroscopic tests, the fluoroscopic timer is accumulating and recording the amount of time the x-ray beam is on. After a period of 5 minutes, an audible and/or visual signal should alarm, requiring a qualified operator to re-set the fluoroscopic timer. A Pass/Fail item should be checked on the Excel worksheet.

Spot Film Reproducibility

The automatic exposure control (AEC) function of fluoroscopic imaging equipment must be periodically evaluated as part of a department-wide quality assurance program. Described below is the procedure used by Upstate Medical Physics, P.C. for assessing AEC performance

Fluoroscopic Automatic Exposure Control (AEC) Systems:

1) Place a loaded cassette or CR plate in the fluoroscopic tower.
2) Place the Radcal meter/chamber close to the table top.
3) Position 1.5" of Type 1100 aluminum attenuator between the fluoroscopic tower and the Radcal meter/chamber .
4) Center the fluoroscopic tower over the Radcal meter/chamber.
5) Select a kVp between 75-85, ensuring that the minimum response time of the system is exceeded.
6) Take 4 exposures and record the exposure time or radiation exposure for each exposure.
7) Results are recorded and analyzed.