INDEPENDENT X-RAY
QUALITY ASSURANCE

FLUORO-X-4-150

USER MANUAL

X-ray Phantoms

Blank Page

FLUORO-DIGIX-4-150

Fluoroscopy Phantom

DESCRIPTION

The FLUORO-X-4-150 phantom has been designed to meet the quality assurance requirements of fluoroscopy systems, as set out in DIN 6868-4 and 6868-150. The phantom enables the user to perform the following tests in a robust, repeatable fashion:

- Patient dose - requires additional dosemeter
- Dose indicator
- Limiting spatial resolution
- Contrast resolution
- Effective radiation field
- Light field to X-ray field alignment
- Beam Centring
- Artifacts

Test equipment included in the set:

- FLUORO-X-4-150 test object

- Optional patient-equivalent filter (25mm Al) + 1mm Cu + 0.5mm Cu
- Fluoroscopy Stand

ACCEPTANCE TESTING

Baseline values should be determined when:

- A new X-ray system is brought into use (acceptance testing)
- A new detector/CR reader is brought into use
- Any other factor which may affect image quality is altered

The radiograph obtained at acceptance testing should be retained and marked 'Reference Image' so that it can be compared with future radiographs obtained during constancy testing. The baseline values and X-ray system settings used at acceptance should be recorded on the relevant test record sheet, and used in all subsequent tests.

The acceptance test results should be recorded on a form such as that found in DIN 6868-57.

CONSTANCY TESTING

Constancy tests should be carried out on a monthly basis, and when:

- Malfunction is suspected
- Immediately after maintenance on components which might affect the image quality.
- The test leads to results outside the established criteria, in order to confirm the test results.

The constancy values should be recorded on the relevant test record sheet, such as the one found within DIN 6868-4.

TEST PROCEDURES

These tests should be performed using both manual and automatic exposure control, if both are used clinically. Tube potential should be set at 75kV. The mAs parameter should be set as per manufacturer recommendations (manual control only). Place the test object directly on top of the image detector. Place the Al attenuator into the rails of the X-ray tube head.

DOSE

Expose the dosemeter in the position marked ‘Dose-Detector Area’. Note: the dosemeter should be exposed in the same position/orientation each time the test is carried out.

Record the reading and compare it with previous values for the same exposure settings.

Constancy Test Tolerance:

AEC (70 kV) Al attenuator – maximum ±30% from baseline value

DOSE INDICATOR

Compare the recorded reading, with the estimate given by the system under test.
Calculate the percentage deviation as follows:

$$\frac{\text{Dose(Indicator)} - \text{Dose(Dosemeter)}}{\text{Dose(Indicator)}}$$

Constancy Test Tolerance

Percent Deviation should be no greater than 50%

EFFECTIVE RADIATION FIELD

Open the lamellae fully, such that the edges can be seen on two adjacent sides. If less than two edges are visible, test the function of the lamellae.

Constancy Test Tolerance

No electric mask should cover any area of the effective radiation field.

SPATIAL RESOLUTION

Visually inspect and note those line pair groups where the bars and spaces are all visible (i.e. resolved), and determine the highest spatial frequency that can be resolved in this way.

The groups are marked with values of 0.6, 0.7, 0.8, 0.9, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2, 2.5,2.8, 3.1, 3.4, 3.7, 4.0, 4.3, 4.6, 5.0 LP/mm

Constancy Test Tolerance

The number of resolved groups should be no fewer than that observed on the baseline reference image.

CONTRAST RESOLUTION

Visual inspection of the step wedge and the low contrast circular details.

A 17-step stepwedge with the values as shown below:

Step Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Copper (mm)	0.00	0.18	0.36	0.54	0.74	0.95	1.16	1.38	1.50
PMMA (mm)	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	17.00
Step Number	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	
Copper (mm)	1.73	1.96	2.21	2.45	2.70	2.96	3.22	3.48	
PMMA (mm)	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	

Each of the steps 1-8 and 10-17 of the stepwedge contains a contrast detail:

Detail Number	**1 to 17**
Depth (mm)	2.50
Diameter (mm)	4.00

A row of 8 low contrast details with the values shown below:

Detail Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Depth (mm)	0.40	0.60	0.80	1.20	1.70	2.40	3.40	4.00
Contrast (%)	0.90	1.30	1.80	2.80	4.00	5.60	8.00	9.40

Constancy Test Tolerance

The number of resolved details (steps or circular details) should be no fewer than that observed on the baseline reference image. For the 17 step stepwedge, at least step 4 - 12 should be resolved.

ARTEFACTS

Visual inspection of the image to check for dust, alias details, scratches, missing pixels/lines, interference with scatter grid, raster errors, Moiré interference patterns, line offset, directory errors.

LIGHT FIELD TO X-RAY FIELD ALIGNMENT

The light field and collimators should be set such that the two fields are the same size and, according to the settings, correspond spatially (as for patient imaging). Figure 5a illustrates where these settings are accurate. However, over time, mechanical misalignment of the mirrors and/or collimators can occur as shown below. The convention for measuring such misalignment is to sum the moduli of the displacements ('a' + 'c') and ('b' + 'd') and compare the results with a tolerance level:

$|a| + |c| < 2\%$ FFD; $|b| + |d| < 2\%$ FFD

Figure A: Illustration of the effective radiation field and light fields aligned correctly.

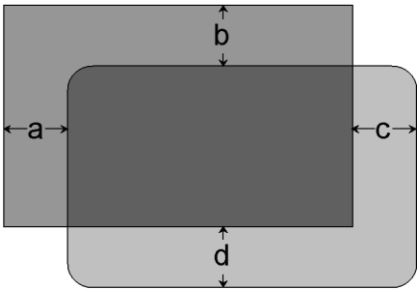

Figure B: Illustration of the fields not aligned correctly: misalignments shown by labelled arrows

KEY:

- Light grey area represents light field
- Mid-grey area represents effective radiation field
- Dark grey area represents field overlap

This test is purely visual, and the test is illustrated in the figure (below). The phantom has been designed such that if the circular detail appears to be just touching the annulus detail, then the unit just passes this constancy test as per IEC 61223-2-11: this implies angular deviation of 1.5º from normal.

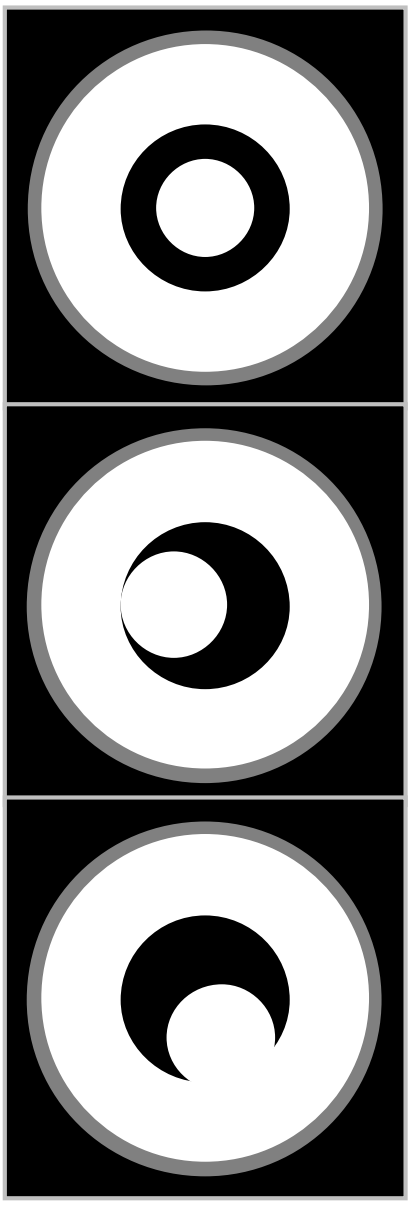

Figure a: Central detail imaged in centre of annulus. PASS

Figure b: Central detail imaged with horizontal displacement from centre of annulus (~1mm). This amounts to an angular deviation of approx. 1.5° from normal. The detail just touches the annulus. PASS

Figure c: Central detail imaged with displacement in both x and y directions of approx. 2mm (~3°) from normal. Thus, the detail image overlaps the annulus. FAIL