FLUKE®
Biomedical

# Nuclear Associates 07-649

## CDRH Fluoroscopic Phantom

## Users Manual

March 2005
Manual No. 07-649-1 Rev. 2

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# *Section 1*
# *General Information*

## 1.1 Specifications

Fluoroscopic Phantom, Model 07-649 is designed to meet the requirements for the NEXT* protocols.

This patient-equivalent phantom of uniform thickness consists of a 7" thick acrylic block, one Fluoroscopic Image Quality Test Object, one Lead Stop Plate and one Copper Attenuation Plate. The base of the phantom is comprised of two type-1100 aluminum plates, each 2.3 mm thick. The phantom has four lead beads embedded on top, to be used as collimation orientation points. It stands on two legs, approximately 4" off the tabletop. One leg is specially designed as a probe holder.

### Fluoroscopic Image Quality Test Object

This aluminum disk is (2" diameter; 0.25" thick), comprised of eight low-contrast test holes (each 0.375" diameter, and ranging in depth from 0.0063" to 0.068") and eight wire meshes (ranging from 12 to 60 wires per inch). The test object is used for the assessment of spatial resolution, and can easily be taken on and off the phantom.

### Lead Stop Plate

This 3.2 mm (1/8") plate simulates maximum attenuation, and can be used to measure the maximum air kerma rate (free in air).

### Copper Attenuation Plate

This 1.6 mm (1/16") copper filter simulates the presence of a 2 mm thick layer of barium sulfate, and can be used to measure the air kerma rate (free in air).

NOTE

This phantom is now required in order to comply with QC tests recommended in the ACR's Barium Enema QC Manual.

**NEXT (Nationwide Evaluation of X-Ray Trends is a committee of The Conference of Radiation Control Program Directors (CRCPD) that oversees quality control procedures for diagnostic radiology. They issue procedure protocols and guidelines for imaging modalities.*

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# *Section 2*
# *Operation*

## 2.1 Setup Procedure Under-Table Units

1. Attach the side and probe support to the fluoroscopic phantom.
2. Place the probe, resting on the table, in the slot provided in the probe support. The probe should be centered under the phantom body.
3. Select the 9" field size of the image intensifier. Align the phantom and probe in the center of the field. If you cannot see the four lead shot, the image intensifier field is less than 9".
4. Bring the image intensifier down until it rests on the top of the phantom side extension. Lock the image intensifier in this position. Once you have set up the phantom, probe and unit, do not move them until you have completed the exposure and exposure rate movements.
5. By making fluoroscopic exposure and observing the image of the phantom, adjust the collimator until the beam is limited in size to the area indicated by the four lead shot marking on the phantom top (area indicated by the four lead shot located at the center of each edge of the phantom top).

## 2.2 Setup Procedure Over-The-Table Units

1. Attach the probe support to the fluoroscopic phantom-do not attach the lexan side. Place the phantom on the tabletop with the probe support nearest the tube head.
2. Place the probe in the slot provided in the probe support. The probe will be centered over the phantom body.
3. Select the 9" field size of the image intensifier. Align the phantom and probe in the center of the field. If you cannot see the four lead shot, the image intensifier field is less than 9”.
4. Have the operator position the tube assembly at the normal height for the upper GI examination. Lock the assembly at this height. Once you have set up the phantom, probe and unit, do not move them until you have completed the exposure and exposure rate measurements.
5. By making fluoroscopic exposures and observing the image of the phantom, adjust the collimator until the beam is limited in size to the area indicated by the four lead shot markings on the phantom (area indicated by the four lead shot located at the center on each edge of the phantom).

## 2.3 Fluoroscopy Exposure Rate Date

Set the electrometer selector switch to the "Exposure Rate" mode. Without making any changes in the standard patient techniques, with the phantom and the probe properly positioned, and the beam collimated to the four markings on the phantom, make an exposure of at least 15-second duration. Record this exposure rate in mR/min as Fluoroscopy Exposure Rate #1. Record the fluoroscopic kVp selected as Fluoroscopy kVp #1. If the unit has an mA indicator, read and record the mA value during the 15-second exposure as Fluoroscopy mA #1.

If the exposure rate is greater than 1 R/min, the values are recorded as 1000 mR/min per R/min. For example, 12 R/min would be recorded as 12000 mR/min.

Repeat the 15-second exposure and record the values for Fluoroscopic Exposure Rate #2, Fluoroscopic mA #2, and Fluoroscopic kVp #2, respectively.

## 2.4 Fluoroscopy High Level Exposure Rate Data

NOTE

The following measurements are to be made only on those systems that have the High Level option. Do not make this measurement for Manual systems.

Set the electrometer selector switch to the "Exposure Rate" mode. Without making any changes in the standard patient techniques, with the phantom and probe properly positioned and the beam collimated to the four markings on the phantom, place the system in the High Level mode of operation and make an exposure of at least 15-second duration. Record this exposure rate as Fluoroscopic High Level Exposure Rate #1. Record the selected kVp as Fluoroscopic High Level kVp #1. If the unit has an mA indicator, read and record the mA value during the 15-second exposure as Fluoroscopic High Level mA #1. Reset the electrometer to zero and repeat the 15-second exposure and record the values for Fluoroscopic High Level Exposure Rate #2, Fluoroscopic High Level kVp #2, and Fluoroscopic High Level mA #2, respectively.

## 2.5 High Level Fluoroscopy Exposure Rate Data with Barium Simulation (Copper)

NOTE

The following measurements are to be made only on those systems that have the High Level option. Do not make this measurement for Manual systems.

Set the electrometer selector switch to the "Exposure Rate" mode. Without making any changes in the standard patient techniques, with the phantom and the probe properly positioned and the beam collimated to the four markings on the phantom, select High Level mode of operation, and make an exposure of at least 15-second duration. Record this exposure rate as Fluoroscopic Copper High Level Exposure Rate #1. Record the selected kVp as Fluoroscopic Copper High Level kVp #1. If the unit has an mA indicator, read and record the mA value during the 15-second exposure as Fluoroscopic Copper High Level mA #1. Reset the instrument to zero, repeat the 15-second exposure and record the values for Fluoroscopic Copper High Level Exposure Rate #2, Fluoroscopic Copper High Level kVp #2, and Fluoroscopic Copper High Level mA #2, respectively.

## 2.6 Maximum Fluoroscopy Exposure Rate Data (with Copper and Lead)

NOTE

Do not make this measurement for Manual systems.

Set the electrometer selector switch to the "Exposure Rate" mode. Without making any changes in the standard patient techniques, with the phantom and MDH probe properly positioned, and the beam collimated to the four markings on the phantom, place the 1 mm sheet of copper and the lead sheet on top of the phantom, select the standard mode of operation, and make an exposure of at least 15-second duration. Record this exposure rate as Fluoroscopic Maximum Exposure Rate #1. Record the selected kVp as Fluoroscopic Maximum kVp #1. If the unit has an mA indicator, read and record the mA value during the 15-second exposure as Fluoroscopic Maximum mA #1. Reset the MDH to zero and repeat the 15-second exposure and record the values for Fluoroscopic Maximum Exposure Rate #2, Fluoroscopic Maximum kVp #2, and Fluoroscopic Maximum mA #2, respectively.

## 2.7 Maximum High Level Fluoroscopy Exposure Rate Data (With Copper and Lead)

NOTE

The following measurements are to be made only on those systems that have the High Level option. Do not make this measurement for Manual systems.

Set the electrometer selector switch to the "Exposure Rate" mode. Without making any changes in the standard patient techniques, with the phantom and MDH probe properly positioned, the beam collimated to the four markings on the phantom and the 1 mm sheet of copper and the lead sheet on top of the phantom, place the system in the High Level mode and make an exposure of at least 15-second duration. Record this exposure rate as High Level Maximum Exposure Rate #1. Record the selected kVp as High Level Maximum kVp #1. If the unit has an mA indicator, read and record the mA value during the 15-second exposure as High Level Maximum mA #1. Reset the MDH to zero and repeat the 15-second exposure and record the values for High Level Maximum Exposure Rate #2, High Level Maximum kVp #2, and High Level Maximum mA #2, respectively.

## 2.8 Film Recording

Remove the copper and lead sheets from the top of the phantom.

Raise the image intensifier housing to allow adequate space for the compression cone to come into the field during film recording procedures.

If the facility uses film recording as a part of the upper GI examination, record the selected technique factors (kVp, mA, mAs and time). Using the procedure below, measure and record the exposure, time, and obtain a film. If the facility uses both spot and photospot, do your recording and measurements for the spot film system only.

Select the (four-on-one) mode for all film-recording measurements.

### Spot or Photospot Film - Exposure and Time

Place a loaded spot film cassette in the unit and, without making any changes in the standard patient techniques, with the phantom and probe properly positioned and the beam collimated to the four markings on the phantom, take a spot or photospot film. Record the exposure as Film Exposure #1. Do not record this initializing time. The processed film should be retained, the optical density determined, and the radiograph sent along with the other data.

# 2.9 Time and mAs (Manual Mode Only)

If AEC is not used routinely for spot films, then record the following Manual mode technique values. If time is pre-selected as part of the technique, then record it in the appropriate boxes. Time values are recorded in milliseconds. Some units have pre-selected mAs; for these units, record the mAs value selected and leave the mA and time blank. If the unit gives a post exposure digital readout of mAs, this value should be recorded as mAs.

## Spot or Photospot Technique Data with Barium Simulator (Copper)

Have the operator set up, at the console, the techniques routinely used for a spot or photospot film for the upper GI examination of a standard patient with barium in the beam. Record the film copper kVp and film copper mA selected.

If AEC is not used routinely for spot films, then record the following Manual mode technique values. If time is pre-selected as part of the technique, then record it in the appropriate boxes. Time values are recorded in milliseconds. Some units have pre-selected mAs; for these units record the mAs value selected and leave the mA and time blank. If the unit gives a post exposure digital readout of mAs, this value should be recorded as mAs.

## Setup

Place the 1 mm sheet of copper on top of the phantom. Use an empty cassette for the barium spot film measurements.

Set the x-ray unit for the four-on-one format. Without making any changes in the standard patient techniques, with the phantom and probe properly positioned and the beam collimated to the four markings on the phantom, take a spot or photospot film. Record the exposure as Film Copper Exposure #1.

Be sure that an empty cassette is in the spot film device: you are ready to make subsequent exposures. Make an exposure, read and record the exposure measurement in mR as Film Copper Exposure #2 Time. Repeat this procedure, read and record Film Copper Exposure #3 and Copper Film #3 time.

# 2.10 Fluoroscopy HVL Data

Remove the copper from the top of the phantom. For the HVL measurement on all units, use the same kVp used for the fluoroscopic upper GI examination.

## HVL Manual Mode

The unit must be in the Manual mode with automatic brightness control (ABC) disabled for this method.

With the phantom and probe properly positioned, adjust the size of the fluoroscopic x-ray beam until it is slightly larger than the sensitive volume of the probe head.

Set the probe selector switch to the Exposure Rate mode. Without making any changes in the standard patient techniques, make an exposure of at least 15-second duration. Adjust the mA to obtain an exposure rate of at least 1000 mR/min (1 R/min).

Record the kVp in the HVL section of the data form. Record the exposure rate in mR/min as exposure rate for 0 mm of aluminum.

Place 1.5 mm aluminum on the tabletop directly beneath the sensitive volume of the probe and make a second exposure of 15-seconds. Record the output in mR/min for 1.5 mm of aluminum.

Place an additional 1 mm of aluminum on the tabletop directly beneath the sensitive volume of the probe. Take a 15-second exposure and record in mR/min the reading for 2.5 mm of aluminum.

Place an additional 2 mm of aluminum on the tabletop directly beneath the sensitive volume of the probe. Take a 15-second exposure and record in mR/min the reading for 4.5 mm of aluminum.

Place an additional 2 mm of aluminum on the tabletop directly beneath the sensitive volume of the probe. Take a 15-second exposure and record in mR/min the reading for 6.5 mm of aluminum.

This step need only be performed if the value obtained with 6.5 mm aluminum is not less than half the 0 mm aluminum value. Record the resulting exposure rate value and the total thickness of aluminum (in mm).

## 2.11 HVL for ABC Units that Cannot be Placed in Manual Mode

The following procedure is to be used only on those units that cannot be switched into the Manual mode for HVL determination.

It is essential that a fixed amount of attenuating material remain in the beam between the x-ray tube and the ABC during all measurements. The position of the aluminum filters in the beam will vary during the procedure.

1. With the phantom and probe properly positioned, adjust the size of the fluoroscopic x-ray beam until it is slightly larger than the sensitive volume of the probe head.
2. Set the probe selector switch to the Exposure Rate mode.
3. Place 6.5 mm of aluminum on the tabletop directly beneath the probe. This places 6.5 mm of aluminum between the tube head and the probe. Without making any changes in the standard patient techniques, make an exposure of at least 15-second duration and note the exposure rate for 6.5 mm of aluminum.
4. Move the 6.5 mm of aluminum to the top of the phantom. Be sure that the aluminum is completely in the beam and is over the probe. This places 6.5 mm of aluminum between the phantom and the ABC. Make a 15-second exposure, and note the exposure rate for 0 mm of aluminum.
5. If the exposure rate obtained in the above step for 0 mm of aluminum is more than twice the reading obtained in the second step for 6.5 mm of aluminum, record the value obtained in the above step as the 0 mm of aluminum exposure rate and the value obtained in the second step as the 6.5 mm of aluminum value. Record the console kVp value in the HVL section of the data form.
6. Do this step only if the second step exposure rate value is not less than half of the step 3 exposure. Add more aluminum and repeat steps 2 and 3 above until you have sufficient aluminum to exceed the HVL. When you have added sufficient aluminum filtration, record the total amount of aluminum. Record the value obtained in step 3 for the total aluminum as the 0 mm of aluminum exposure rate. Record the value obtained in step 2 for the total aluminum exposure rate value. Record the console kVp value in the HVL section of the data form.
7. Move 1.5 mm of aluminum from the top of the phantom and place on the tabletop beneath the probe. This will place 1.5 mm of aluminum between the tube head and the probe, leaving the remainder of the aluminum between the probe and the ABC. Make a 15-second exposure, and record the exposure rate for 1.5 mm of aluminum.
8. Move an additional 1 mm of aluminum from the top of the phantom to the tabletop beneath the probe. This will place 2.5 mm of aluminum between the source and the probe, leaving the remainder of the aluminum between the probe and the ABC. Make a 1-second exposure, and record in mR/min the reading for 2.5 mm of aluminum.
9. Move an additional 2 mm of aluminum from the top of the phantom to the tabletop beneath the probe. This will place 4.5 mm of aluminum between the tube head and the probe, leaving the

remainder of the aluminum between the probe and the ABC. Make an exposure, and record in mR/min the reading for 4.5 mm of aluminum.

10. Move an additional 2 mm of aluminum from the top of the phantom to the tabletop beneath the probe. This will place 6.5 mm of aluminum between the tube head and the probe, leaving the remainder of the aluminum between the probe and the ABC. Make a 15-second exposure, and record in mR/min the reading for 6.5 mm of aluminum.

# 2.12 Estimated HVL

Using a graph, plot the exposure rate versus the aluminum thicknesses used. Determine the HVL to the nearest tenth of a millimeter of aluminum by drawing the best straight line fit to all but the first.

### Low and Low Contrast Fluoroscopy Imaging Data

With the phantom properly positioned in the beam, remove the probe and all aluminum filters. Have the operator set up the unit with the standard patient techniques. Center the Fluoroscopic Test Tool on the tabletop beneath the phantom. Set the system to the one-on-one format. Observe the fluoroscopic image and determine the number of holes you can see on the inner ring, and the number of screen meshes you can see on the outer ring. Repeat this process three times and record the average for the three observations.

# 2.13 Target To Tabletop Distance

Place the Fluoroscopic Test Tool on the tabletop beneath the phantom. The engraved side of the test tool must be toward the phantom; the large aluminum disc rests on the tabletop. Place a loaded cassette in the spot film device, set the format to one-on-one and make a spot film exposure. Measure (in centimeters) and record the distance from the center of the spot film cassette to the tabletop.

On the processed spot film, measure (in centimeters) and record the diameter of the image of the inner aluminum disc (innermost circle).

Use the following equation to calculate the target-to-tabletop distance in centimeters and record the values.

$$\text{Target-to-Tabletop Distance} = \frac{4.4 \times SD}{Diam = 4.4\ cm}$$

where

SD = Distance, in centimeters, from the center of the spot film cassette to the tabletop

Diam = Diameter, in centimeters, of the image of the inner aluminum disk (innermost circle)

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