

Summary of Digital Mammography QC Tests for Siemens, Lorad and GE

S. Guru Prasad, Ph.D, Uday Rao, M.S., Kinga Lewinski



Digital Mammography

- Siemens (Mammomat Novation)
- General Electric (Senographe 2000D)
- Lorad (Selenia)



Detector calibration

- Objective: To ensure that the system is calibrated properly and that images are free from significant non-uniformities
- Siemens and GE include the test as part of both Physicist and Technologist QC tests.
- Lorad Selenia: Flat field test is included as part of Technologist Biweekly QC.

Collimation

- Objective: To ensure congruence between x-ray and light field, no excessive extension of radiation beyond the image receptor and that chest wall edge of paddle aligns with chest wall edge of receptor.
- Performed for all targets(Mo/ Rh/ W) as applicable.
- 2000D: 24 x 30 cm size not available!

System Resolution

- Objective: To check performance of the imaging system by using a high contrast resolution pattern
- Film screen has higher requirements: 11 lp/mm and 13 lp/mm for bars perpendicular and parallel to A-C axis respectively.
- Lorad and Siemens requirements: minimum 7 lp/mm
- GE 2000D: 4.5 lp/mm requirement for bars placed parallel and perpendicular to A-C axis.
- The geometry of bar pattern is different between the systems.

Artifact Detection

- Objective: To assess the degree of artifacts using phantom images.
- GE2000D and Lorad: contact mode as well as magnification modes.
- GE 2000D : different target/filter combinations
- Siemens: Artifacts assessed in contact mode

Phantom Image Quality

- Objective: To evaluate and assess image quality.
- Higher requirements with regard to phantom score for some units.
- Screen Film: minimum 4 fibers, 3 speck groups and 3 masses
- Siemens and Lorad requirements: minimum of 5 fibers, 4 speck groups and 4 masses.
- 2000D: 4 fibers, 3 speck groups and 3 masses.

Modulation Transfer Function measurement

- Objective: To check image contrast over a range of spatial frequencies using a line-pair bar pattern.
- Performed for GE2000D and not for Lorad or Siemens.
- GE MTF Performance criteria at 2 lp/mm and 4 lp/mm: 58 and 25 percent minimums.

AEC performance Tests

- Siemens:
 - AEC reproducibility: Check to see if the coefficient of variation for mean pixel value, mAs, and entrance exposure for a series of exposures is less than 5 percent, and the SNRs do not vary by more than 15 percent from Mean SNR value.

AEC performance Tests

- Siemens:
 - AEC Thickness tracking: performed for a range of thicknesses from 2cm to 6 cm.
 - Calculated SNR value for each should be greater than 40, and maximum deviation of SNR should be less than 15 percent.

AEC performance Tests

- GE 2000D: AEC thickness tracking done over 2.5cm to 6 cm.
- SNR measured for each of the above thicknesses should be greater than 50.
- In addition to the minimum SNR value listed, technique factors for each thickness are also prescribed. For example, for 2.5 cm thickness, the target/filter combination selected by the AEC should be Mo/Mo, kVp should be 27, and the mAs should be in the prescribed range of 20-60

AEC performance Tests

- Lorad: AEC thickness tracking performed over 2cm to 8 cm, and also for 4 cm in magnification mode.
- Range of mean pixel values for the above thicknesses in contact mode and magnification mode should not vary by more than 10 percent from the “mean” of all the mean pixel values.

AEC performance Tests

- Lorad: AEC exposure compensation function also evaluated.
 - Using a 4 cm phantom, exposure compensation from -5 to +5 are evaluated . Allowable range of pixel ratios for each exposure compensation step is prescribed by the manufacturer.

CNR and SNR Test

- CNR calculated and base value established during equipment acceptance and evaluation
- Phantom image used to compute the CNR value.
- Tech QC: CNR value should be within 15 percent of established value.

CNR and SNR Test

- Using the same phantom image for the CNR test, the SNR is calculated.
- Lorad and Siemens have a minimum SNR value of 40.
- For GE, the SNR is calculated as part of the AOP/ AEC test as discussed in the previous slides.

Monitor checks

- Siemens:
 - Acquisition Workstation (AWS) quality is assessed by loading and viewing the SMPTE pattern. The grayscale steps should be distinguishable, 0/5 percent and 95/100 percent should be differentiable, high contrast bars in the corners and center of the pattern should be visualized in both horizontal and vertical directions.

Monitor checks

- GE 2000D Review Workstation Check: in addition to assessing the SMPTE pattern, monitor light output measurements are made using the attached dome photometers. Luminance levels in ft-L are specified for black and white.
- RWS screen uniformity is performed to check for non-uniformities, scratches and other defects.
- Lorad Review Workstation QC: White Level Performance (cd/m^2)

Printer Check

- Follow QC instructions of Printer manufacturer. (SMPTE print)
- Phantom image quality is also evaluated for printed hardcopy.
- View box Luminance and Room luminance evaluated for hardcopies.

Radiation Measurements

- Breast Glandular Dose
- kVp accuracy
- kVp and Exposure reproducibility
- Radiation Output Rate (Air Kerma)
- Half Value Layers

Radiation Measurements

- kVp measurement in W/Ag mode
- Radiation output rate for some units less than 800 mR/sec (Lorad W/Rh : 230 mR/sec or 2.0 mGy/sec)
- Breast Glandular dose: < 300 mRads per view