Equipment Quality Control for Digital Mammography
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Imaging Physics
CancerCare Manitoba

Purpose

An equipment quality control (QC) program establishes baseline performance levels, tracks system performance over time, and reveals performance trends. This document outlines the tests that are part of the QC program for digital mammography equipment. These tests will satisfy the QA standards of the Canadian Association of Radiologist's Mammography Accreditation Program (CAR MAP).

Contact Imaging Physics for assistance in setting up your program.

What are the benefits of a QC program?

- Performance degradation can be identified leading to preventative action.
- Patients benefit when equipment performance is maintained at acceptable levels.
- A QC program is an important element in achieving accreditation.

What are the components of a QC program?

The QC program is set up by the facility under the guidance of a medical physicist certified in mammography by the Canadian College of Physicists in Medicine. The program consists of acceptance testing, on-going quality control, and periodic review of QC data and outcomes. Typically, the routine QC activities are carried out by a technologist while in-depth checks are performed by a medical physicist. A typical QC program includes the following:

Acceptance and Annual Testing

Acceptance testing must be performed by a medical physicist when a system is installed, relocated or undergoes significant upgrades or maintenance. Acceptance testing verifies vendor specifications and establishes performance baselines. Thereafter, the equipment must be inspected and tested by a physicist annually.

It is the facility's responsibility to make arrangements for acceptance and annual testing by a medical physicist.

Physicist Testing after Repairs and Upgrades

After repairs or upgrades to the mammography unit or the review workstation (RWS), it is important to independently verify equipment performance. Depending on the repairs or upgrades, the physicist can be involved in one of two ways:

1. The repairs/upgrades are major, and a full or partial on-site physicist inspection must be obtained.

2. The physicist provides oversight and verification of system performance carried out by other personnel (radiographic technologist, biomedical technologist, etc.).

Consult with the medical physicist to determining which option is most suitable. Generally, if on site physicist testing is required, the testing *must take place prior to clinical use.*

Technologists QC Tests

Table 2 provides a listing of technologist QC tests required by the CAR MAP and Medical Physics in Manitoba.

All QC activity must be documented using CAR digital QC forms and additional forms approved by medical physics. Most of the tests are already familiar to mammography technologist. In what follows, we elaborate on tests that go beyond the CAR MAP requirements.

Table 1: List of Technologist QC Tests

Test	Frequency	CAR	MB	Corrective Action Timeline
Visual Check/Daily Checklist	Daily	√	√	N/A
AWS Cleaning	Daily	√	√	Before clinical use.
RWS Cleaning and viewing conditions	Daily	√	√	Before clinical use.
Artefact Evaluation (Flat Field)	Weekly	√	√	Before clinical use.
AWS Monitor QC	Weekly	√	√	Before clinical use for gross defects, otherwise within 30 days.
RWS Monitor QC	Weekly	√	√	Before clinical use.
D Phantom AEC Check (SDNR)	Weekly	√	√	Before clinical use.
Mechanical Inspection	Monthly	√	√	Before clinical use for any items that compromise patient safety, image quality or dose. Otherwise within 30 days.
MAP Phantom Image Quality	Monthly	√	√	Before clinical use.
Radiologist QC Review	Monthly	√	√	Within 30 days.
Breast Thickness Indicator	Monthly		√	Before clinical use.
Repeat/reject Analysis	Quarterly	√	√	Within 30 days.

Compression Force	Semi-annually	√	√	Before clinical use.
Detector Calibration	Per the manufacturer's protocol		√	Before clinical use.
Mobile QC	SDNR after moving		√	Before clinical use.

Weekly D Phantom AEC Check (SDNR)

This test provides a tool to monitor system performance over time and to ensure the system meets quantitative image quality and dose performance levels. It involves tracking the signal-difference-to-noise ratio (SDNR) under imaging conditions mimicking those of an average breast. Sometimes this test is referred to as the contrast-to-noise ratio (CNR).

Please note that the vendor tests using the MAP phantom is not appropriate because the results are sensitive to the exact placement of the ROI in the largest mass. You must use the D phantom for this test.

SDNR Test Instructions

1. Create a QC study/patient and give it an appropriate name.
2. The study category should be QC-raw.
3. Use the OPDOSE AEC option.
4. Use the non-deflecting compression paddle. Use the same paddle very week.
5. Place the D phantom with its flat side aligned along the chest wall edge of the bucky, centered right to left, and the 1 mm disc on top. Use care to position the phantom consistently every time the test is performed. Figure 1. D Phantom positioningFigure 11 illustrates proper phantom positioning.

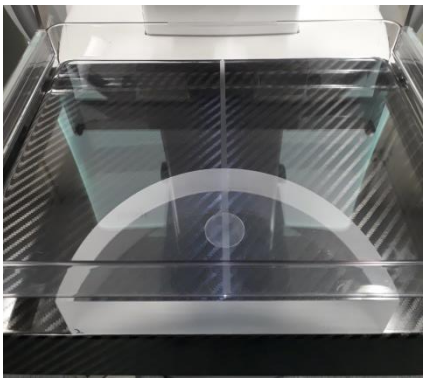

Figure 1. D Phantom positioning

6. Apply compression to the phantom in the range of 50-60 N. The phantom thickness is at the edge of values that can cause the kVp to change. You may have to use the manual compression fine adjustment to ensure that the system reads a thickness of 40 mm.
7. Acquire an image of the test object using AEC-OPDOSE exposure.
8. Record the kV, target, filter, and mAs. Plot the mAs on the mAs chart.

9. Place a region of interest (ROI) over the contrast disc. The ROI area should be between 3 cm^2 and 4 cm^2. Ensure the ROI is completely within the disc and does not touch its edges. Measure the mean and denote it as quantity **A**.
10. Move the ROI to the background region of the phantom, outside but adjacent to the disc and record the mean and denote it as quantity **B** and record the standard deviation and denote it as **C**. Plot the mean on the mean chart. See Figure for an example of ROI placement.
11. Calculate the SDNR as **SDNR=|B-A|/C** and plot it in the SDNR chart.

When the test is being setup for the first time, repeat it 5 times and average the values for mAs, **A**, **B** and **C.** Calculate the SDNR using these averages.

Performance Limits and Corrective Action:

The mAs, mean (**B**) and SDNR should not change by more than ±15%. The kV, target and filter should not change if the test setup is the same every time.

If any of the test results are outside the action limits, the test should be repeated. If the results persist, cease imaging patients and contact medical physics to determine the appropriate course of action.

Please note that a new baseline will need to be established after replacement of tube, detector or service that affects the AEC. Consult with the physicist to determine if a new baseline is needed.

If the test fails, corrective action must be taken before clinical use.

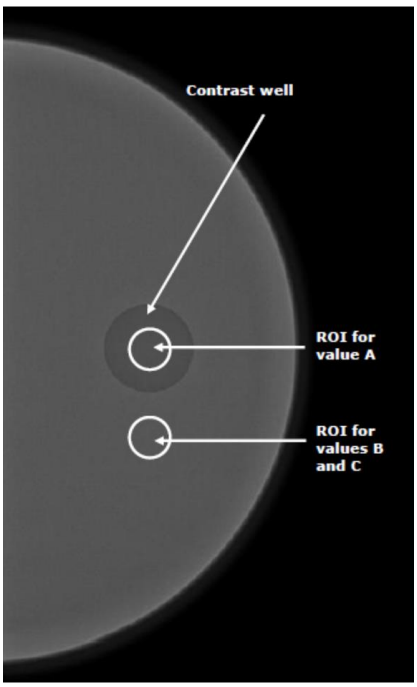

Figure 2. ROI placement in D phantom

Monthly Breast Thickness Indicator

The purpose of this test is to ensure that the indicated compression thickness is accurate. This is important because the AEC system uses the breast thickness to determine the exposure loading factors.

Use an object that is 4 – 6 cm thick, such as two roles of medical tape stacked one on top of the other. You can also use the D or the MAP phantom, provided they do not damage the compression paddle or breast support with their sharp edges. Apply approximately 70 N (15 lbs) of compression using a non-flex paddle. Compare the difference between the indicated and actual thickness of the compressed object. They should not differ by more than 0.5 cm.

If the test fails, corrective action must be taken within 30 days.

Detector Calibration

If applicable to your system, perform periodic vendor-specified detector calibration, in accordance with the instructions of the vendor. This is important to ensure that the mammography digital detector maintains its performance and produces images free of artifacts and defects.

Mobile QC

If operating a mammography system on a mobile device, the weekly D Phantom AEC check (SDNR) test must be performed after every move, prior to imaging patients. This confirms that the system performance has not been affected in between moves.

Where to go for help?

The mammography physics specialist in Manitoba is Dr. Idris Elbakri (204-787-2856), ielbakri@cancercare.mb.ca).