Equipment Quality Control for Digital Radiography
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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 typically part of a QC program for digital radiography equipment, including portables with a dedicated detector. 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 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, or under the guidance of, a medical physicist. A typical QC program includes the following:

Acceptance Testing

Acceptance testing must be performed by or under the oversight of a medical physicist when a system is installed, relocated (where relevant) or undergoes significant upgrades or maintenance. Acceptance testing verifies vendor specifications and establishes performance baselines. It is the facility's responsibility to make arrangements for acceptance testing by a medical physicist.

Daily

1. Inspect system operation and verify operational status. Follow manufacturer's recommendations for equipment warm-up. Check meters and audible and visual indicators for proper function. Inspect equipment for mechanical soundness and smooth motion (including collimator).
2. For the image acquisition system, inspect operation and verify operational status.

Monthly

1. For CR systems, erase all plates in the inventory. Scan a randomly selected unexposed cassette of each size, and check for obvious non-uniformities and artefacts.

2. Perform an image quality test with a phantom. An image quality test based on a phantom manufactured by CancerCare Manitoba is described below. If you wish to use a manufacturer's QC test, contact Imaging Physics to confirm that the test is appropriate.

3. Perform retake and reject analysis. A reasonable target reject rate for general radiography is 8%, with thresholds for investigation set at 10% and 5%. A low reject rate can mean that recording or analysing rejects is not being done correctly. For paediatrics, the reject rate should be around 5%, with thresholds for investigation at 7% and 3%[1]. If these requirements are not met, causes should be identified and documented, along with any corrective action taken, if applicable. In consultation with medical physics, the target reject rates can be modified to fit clinical practice. For sites that do less than 250 patients per month, the reject analysis can be done quarterly[2].

4. Verify performance of modality displays qualitatively by displaying and evaluating an image of the SMPTE pattern or equivalent. Verify visibility of the 5% contrast patches and the absence of distortions or artefacts. Refer to the modality display QC instructions available on the Imaging Physics website.

Quarterly

1. For CR systems, clean all imaging plates if recommended by the manufacturer or deemed necessary in consultation with the physicist.

2. .

Annually

1. Annual testing by or under the oversight of a medical physicist to evaluate performance against vendor specifications and baseline levels established at acceptance.

2. Annual equipment QC review by a medical physicist.

With regard to the suggested test frequencies, daily refers to each day the equipment is used.

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[1] Ongoing quality control in digital radiography: Report of AAPM Imaging Physics Committee Task Group 151. American Association of Physicists in Medicine Report No. 151. 2015.

[2] Quality control in diagnostic radiology: Report of Task Group #12 Diagnostic X-ray Imaging Committee. American Association of Physicists in Medicine Report No. 74. 2002.

QC data should be recorded in a manner that allows monitoring of trends in performance levels. It is recommended that QC data trends be reviewed at least semi-annually.

Note that manufacturer-supplied QA software that only provides a pass or fail result is not adequate.

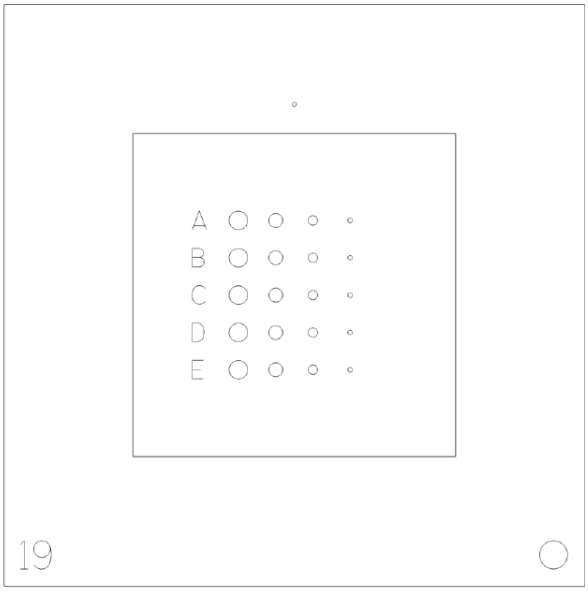
Where to go for help?

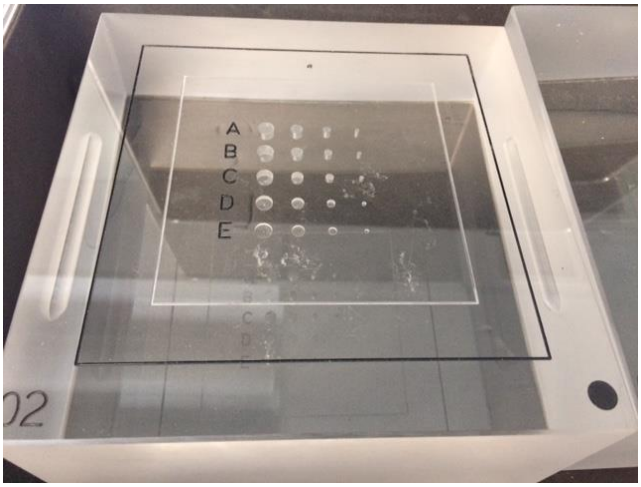
Imaging Physics at CancerCare Manitoba provides physics testing for diagnostic imaging systems, and can assist diagnostic imaging departments in setting up QC programs, training staff to perform QC tests, and identifying appropriate QC tools. You can contact Imaging Physics at Imaging.Physics@cancercare.mb.ca or by calling 204-787-4145.

The radiography specialists are Dr. Idris Elbakri (204-787-2856) and Dr. Harry Ingleby (204-787-2126).

CCMB Monthly Image Quality Test

A phantom consisting of two 10 cm thick blocks of acrylic can be obtained from Medical Physics at cost. One of the blocks has a pattern of low contrast discs as shown in the figure below. This phantom can be used to qualitatively and quantitatively assess image quality.





Instructions for Phantom Image Acquisition

Setup a QC patient. It is important to use the naming convention specified by e-Health. This facilitates remote trouble shooting by the medical physicists.

If using CR, erase the CR cassette prior to acquiring the phantom image. Use the same cassette every time.

Stack the two blocks in the centre of the field of view such that the dark spot in the corner of the top block is aligned with the dark spot on the lower block. The block with the discs should be on top with the discs facing the x-ray tube. Collimate the beam to just inside the edges of the phantom.

Acquire an image using a common clinical protocol (abdomen is appropriate) with AEC. Make note of the AEC configuration, filtration, SID and grid status and use identical conditions every time the test is repeated. Record the kVp, mAs, exposure index and system-reported dose.

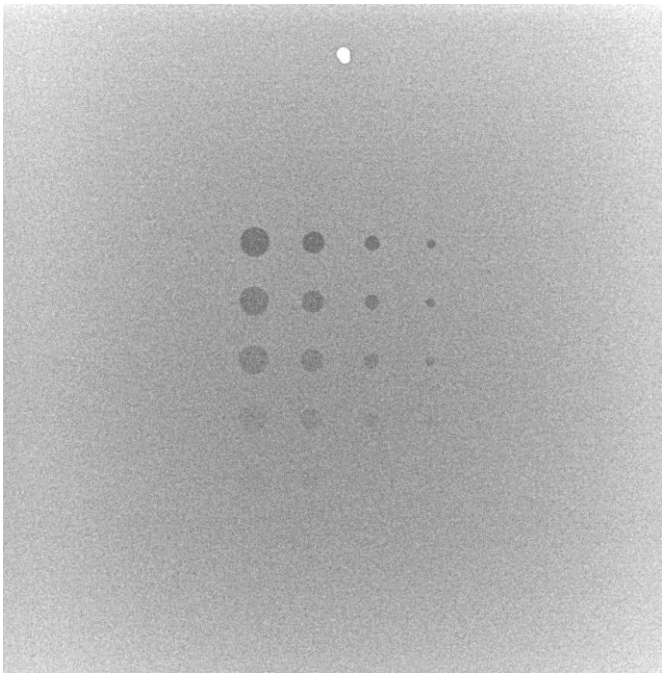
Instructions for Image Scoring

Inspect the image visually using the modality display. Use the same display every time. It is best if the same person performs the image scoring every time.

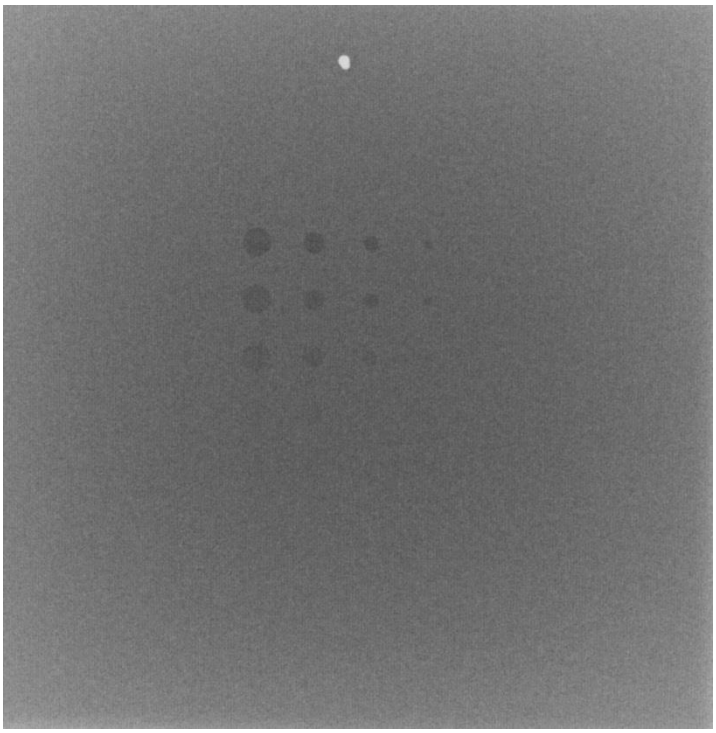
Examine rows A through E. Starting with row A, record the number of rows in which *all* 4 discs are *clearly visible*. A disc is *clearly visible* if its edges are discernible enough to circumscribe its perimeter. Stop scoring when you first encounter a row where less than 4 discs are clearly visible.

Now examine the largest disc in each row. Starting with row A and working towards row E, record the number of large discs that are clearly visible. Stop scoring when you encounter the first large disc that is not clearly visible. The same definition of "clearly visible" applies as before.

The images below give an example of how the images are to be scored.



The image above would be scored as having 3 rows (A, B and C) where all discs are clearly visible. It would have a score of 4 for the number of large discs clearly visible.



The image above would be scored as having 2 rows (A and B) where all discs are clearly visible. It would have a score of 3 for the number of large discs clearly visible.

The first time this QC test is performed establishes baseline values against which future measurements are compared. The baseline values must be established with the help of imaging physicists.

Use the spreadsheet developed by Imaging Physics to record and track your results.

Performance Criteria

If device performance is stable, it is expected that the exposure parameters set automatically by the system, the dose, and the number of visible discs will not change significantly. The system passes if the exposure index remains within ±15%, the number of rows in which all 4 discs are clearly visible does not decrease and the number of visible large discs does not decrease by more than 1 from baseline values. If the test fails, repeat it. If you still get a failure, contact Imaging Physics.

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Annual Medical Physics Review - Digital Radiography

This is a sample form of the annual QC review to be conducted by a medical physicist. This form is required by MANQAP to demonstrate ongoing compliance with the QC requirements.

Facility		**Department**	
System make/model		**System Location**	
Date of review		**Contact Person**	
Overall QC Program Assessment	*( ) ACCEPTABLE* *( ) ACCEPTABLE but requires remediation* *( ) NOT Acceptable. Immediate action required*	**Time period of data reviewed (mm/yy to mm/yy)**	

QC Test	Status	Comments
Daily Radiography System Inspection		
Daily Image Acquisition System Inspection		
Monthly Erasure of all CR Plates		
Monthly Cassette Artefact Check		
Monthly Image Quality Phantom Test		
Monthly Modality Display Performance Test		
Monthly Retake and Reject Analysis		
Quarterly Cleaning of CR Plates (if recommended by vendor)		
Annual Physics Testing (or acceptance if equipment is new or relocated)		

Overall QC Program Assessment:

Required Changes:

Review conducted by

Signature

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Site_____ Radiographic System_____ Acquisition System_____Room_____ Year_____

Daily Digital Radiography QC Log

Month																				
Day																				
Radiographic equipment inspection																				
Acquisition device inspection																				
Month																				
Day																				
Radiographic equipment inspection																				
Acquisition device inspection																				
Month																				
Day																				
Radiographic equipment inspection																				
Acquisition device inspection																				

Site_____ Radiographic System_____ Acquisition System_____Room_____

Digital Radiography Monthly QC Log

Year												
Month												
CR erasure and spot checks												
Image quality phantom test												
Modality display check												
Retake/reject analysis												

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Site_____ Radiographic System_____ Acquisition System_____Room_____

Digital Radiography Quarterly QC Log

Year												
Day/Month												
CR IP cleaning (if applicable)												