

Equipment Quality Control for Nuclear Medicine Systems

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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 nuclear medicine and PET equipment. Contact Imaging Physics for assistance in setting up a 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 more 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. Equipment which requires acceptance testing includes gamma cameras, PET scanners, radionuclide calibrators, well counters, thyroid probes and any other radiation detecting equipment used in a clinical capacity.

Gamma Cameras

Daily

1. Perform a physical and operational inspection and verify operational status.
2. Verify image uniformity is within manufacturer/local performance specifications/tolerances.

Monthly

1. Perform high count assessment of image uniformity.
2. For gamma cameras performing tomographic imaging, verify Centre of Rotation (COR) alignment.

Quarterly

1. For systems performing tomographic imaging, perform a SPECT image quality test using an appropriate phantom (e.g. Jaszczak/Carlson phantom)

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.

PET Systems

Daily

1. Perform a physical and operational inspection and verify operational status.
2. Test and visualize proper functioning of detector modules.
3. Inspect 2D sinograms.

Monthly

1. Perform a normalization (assess the system response to activity inside the field of view)

Quarterly

1. Calibration accuracy. Verify that activity concentration reported in uniform phantom agrees with measurement from dose calibrator.

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

Radionuclide (Dose) Calibrators

Daily

1. Perform a physical and operational inspection and verify operational status.
2. Assess constancy of operation (i.e. with a reference source)
3. Measure, and if appropriate correct for background levels of radiation
4. Check for, and if appropriate remove any radioactive contamination

Monthly

1. Verify operation of all clinically used preset calibrations (i.e. by checking relative response to a reference source).

Annually

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

4. Annual equipment QC review by a medical physicist

Thyroid/Uptake Probes and Well Counters

Daily

1. Perform a physical and operational inspection and verify operational status
2. Assess stability of operation (i.e. with a reference source)
3. Measure, and if appropriate correct for background levels of radiation

Quarterly

1. Verify reproducibility, (usually by performing a chi-squared test)

Annually

1. Assess energy resolution
2. Measure the system counting efficiency for all clinically used isotopes
3. Annual testing by or under the oversight of a medical physicist to evaluate performance against vendor specifications and baseline levels established at acceptance
4. Annual equipment QC review by a medical physicist

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

For all of the above, QC data should be recorded in a manner that allows monitoring of the trends in performance levels. It is recommended that QC data trends be reviewed at least semi-annually for all stated equipment.

In the case of dual modality equipment, e.g. SPECT/CT, PET/CT, PET/MR; each component must comply with the appropriate modality standards and individual QC

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

Modality-specific guidance documents are available at:

http://www.cancercare.mb.ca/home/cancer_research/medical_physics/imaging_physics/guidance_quality_control/

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 nuclear medicine specialists are Ms. Samantha Eustace (204-787-8619) and Mr. Mahmoud Al-Abedi (204-787-4703). The PET specialist at the Health Sciences Centre is Dr. Andrew Goertzen (204-975-7771).

Annual Medical Physics Review – Nuclear Medicine

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 S/N		System Location	
System make/model		Contact Person	
Date of review		Time period of data reviewed (mm/yy to mm/yy)	
Overall QC Program Assessment		<input type="checkbox"/> ACCEPTABLE <input type="checkbox"/> ACCEPTABLE but requires remediation <input type="checkbox"/> NOT Acceptable. Immediate action required	

QC Test – Gamma Cameras	Status	Comments
Daily Physical and Operational Inspection		
Daily Uniformity Test		
Monthly High Count Image Uniformity Test		
Monthly COR Verification		
Monthly Modality Display Performance Test		
Quarterly SPECT Phantom Image Quality Test		
Annual Physics Testing (or acceptance if Equipment is new or relocated)		

QC Test – PET Systems	Status	Comments
Daily Physical and Operational Inspection		
Daily Detector Modules Test		
Daily Inspection of 2D Sinograms		
Monthly Normalization		
Monthly Modality Display Performance Test		
Quarterly Calibration Accuracy		
Annual Physics Testing (or acceptance if Equipment is new or relocated)		

QC Test – Dose Calibrators	Status	Comments
Daily Physical and Operational Inspection		
Daily Constancy Check		
Daily Background Level Measurement		
Daily Contamination Check		
Monthly Calibration Check		
Annual Linearity Check		
Annual Repeatability Check		
Annual Physics Testing (or acceptance if Equipment is new or relocated)		

QC Test – Thyroid Probes and Well Counters	Status	Comments
Daily Physical and Operational Inspection		
Daily Stability Check		
Daily Background Level Measurement		
Quarterly Reproducibility Check		
Annual Energy Resolution Check		
Annual Counting Efficiency Measurement		
Annual Physics Testing (or acceptance if Equipment is new or relocated)		

Additional Comments:

Overall QC Program Assessment:

Required changes:

Additional Recommendation:

<p>Review conducted by</p> <p>Signature</p> <p>Date</p>
