



IMAGING PHYSICS

Acceptance Testing

of

Diagnostic Imaging Equipment

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Introduction

Testing

This document specifies the Acceptance or baseline tests which will be performed on new Diagnostic Imaging Equipment.

The goal of the acceptance testing is to ensure that the equipment meets or exceeds the specifications provided by the manufacturer as part of the purchase process.

The results will also provide as comparison for later measurements.

Acceptance testing will be performed by a Medical Physicist following the completed installation of the equipment and prior to clinical usage.

Reports

It is expected that a verbal report will be given to the site within a few days of the completion of testing. A full written report should be completed within 14 days.

If the results are unsatisfactory or cannot be completed for technical reasons, and interim report may be issued not later than 30 days after the testing was performed. A final report will follow when the required remedial action has been taken or the tests are satisfactorily completed.

Professional Accountability

Mammography Accreditation tests must be performed by a Physicist accredited in Mammography Physics by the Canadian College of Physicists in Medicine.

The Canadian Association of Radiologists will only accept Mammography test reports signed by an accredited Physicist.

The Canadian Association of Radiologists recommends that MR testing is performed by a Physicist accredited by the Canadian College of Physicists in Medicine.

Test procedures have been based on recommendations from various Professional Associations including:

- American Association of Physicists in Medicine

- American College of Radiology

- American Institute of Ultrasound in Medicine

- British Institute of Radiology

- Canadian Association of Radiologists

- Institute of Physics and Engineering in Medicine

- National Electrical Manufacturers Association

Specific reports used are referenced in each section.

Computed Radiography Equipment.

Protocols followed:

AAPM Task Group Report No.10: Acceptance Testing and Quality Control of Photostimulable Storage Phosphor Imaging Systems.

This document addresses the intrinsic differences between 3 systems: Agfa, Fuji and Kodak.

Kodak acceptance testing (CR800/900).

1. AAPM Task Group No.10 Report.
2. Kodak Technical Report: Guidelines for Acceptance Testing and Quality Control.
3. Kodak Technical Report: Kodak DirectView Total Quality Tool for CR800 and CR900.

Agfa acceptance testing (Solo or Compact)

1. AAPM task Group Report No.10.
2. ADC Compact Auto QC software User Manual.

Fuji acceptance testing (Fuji, Philips, GE, Siemens)

1. AAPM task Group Report No.10.

For any system, the tests performed are:

1. Inventory and physical examination for defects of each imaging plate
2. Gray scale matching between each unit and the laser printer
3. Throughput (general duty and high resolution, at each plate size available)
4. System linearity (match between exposure reading and exposure index)
5. System uniformity and artifacts
6. Geometrical Accuracy (distance and aspect ratio for each size of plate and general duty and high resolution)
7. Erasure (for each plate available)
8. Noise (for each plate available)
9. Spatial frequency response (for general duty and high resolution at each plate size available)

CT Scanners.

Protocol followed :

AAPM Report No.39: Specification and Acceptance Testing of Computed Tomography Scanners, 1993.

Tests performed:

1. Scan Localization
 - 1.1. Iso-centre Alignment and Accuracy of Sagittal and Coronal Scan Localization Lights
 - 1.2. Accuracy of Gantry Tilt
 - 1.3. Table index and Position

2. Image Scan precision
 - 2.1. Image Scan Width (Section Sensitivity Profile)
 - 2.2. Radiation Dose profile
 - 2.3. Accuracy of scan prescription from scout localization image

3. Image Display and analysis
 - 3.1. Display monitor
 - 3.2. Laser Printer
 - 3.3. Accuracy of Distance Measurements
 - 3.4. CT number Calibration
 - 3.5. CT number Constancy

4. Image Quality
 - 4.1. CT Number
 - 4.2. Noise
 - 4.3. Low Contrast Resolution
 - 4.4. High Contrast Resolution
 - 4.5. MTF

A phantom is supplied by each manufacturer. The Quality Assurance section of the User manual, gives procedures for measuring image quality with the phantom supplied. These include measurements of:

1. Contrast Scale
2. High Contrast Spatial Resolution
3. Low Contrast Detectability
4. Noise and Uniformity
5. Slice Thickness
6. Laser light accuracy
7. Accuracy of positioning
8. Scan localization

Digital Fluoroscopy Equipment (including Catheter Lab).

Protocols followed:

AAPM Report No.15: Performance Evaluation and Quality Assurance in Digital Subtraction Angiography.

AAPM Report No.70: Cardiac Catheterization Equipment Performance

Tests performed:

1. Mechanical inspection of all moving parts
2. Safety interlock inspection
3. Gray scale matching between all monitors and printers
4. Check minimum collimator to skin distance
5. HVL
6. kVp accuracy
7. High contrast spatial resolution
8. Low contrast discrimination
9. Focal spot size (using star pattern)
10. Lag
11. Distortion
12. Field of View (for each fov available)
13. Collimator and collimator tracking check
14. Image Intensifier input exposure rate
15. Automatic Brightness Control
16. II Contrast ratio
17. Veiling Glare
18. Cine film sensitometry
19. Cine film density
20. With radiation protection, scatter and exposure measurements at typical techniques, maximum fluoro rates including boost or high contrast modes, and dose area product validation.

In addition for the Catheter/Vascular LAB:

21. Faxitl DSF (Digital Subtraction Fluoroscopy) phantom to measure image misregistration, contrast and detail, dynamic range, and linear/logarithmic step wedges.

Mammography

Protocols followed:

Mammography Quality Control Manual, revised edition. 1999, American College of Radiology.

Tests performed:

1. Mammography Unit Assembly Evaluation
2. Collimation Assessment
3. Evaluation of focal spot size performance
4. kVp accuracy and reproducibility
5. Beam Quality Assessment (Half value layer)
6. Automatic Exposure Control System Performance Assessment
7. Uniformity of Screen Speed
8. Breast Entrance Exposure, Average Glandular Dose, and AEC Reproducibility
9. Image Quality Evaluation
10. Artifact Evaluation.
11. View box luminence and room illumination.

MRI

Protocols followed:

AMP Report No.28: Quality assurance methods and phantoms for magnetic resonance imaging: Report of AAPM nuclear magnetic resonance Task Group No. 1. Med. Phys.1990 17:287-295.

AAPM Report No.34: Acceptance testing of magnetic resonance imaging systems. Med. Phys. 1992 19:217-229.

ACR Magnetic Resonance Imaging (MRI) Quality Control Manual. Copyright 2001, American College of Radiology.

CAR Standards for Magnetic Resonance Imaging. Copyright 1999 Canadian Association of Radiologists.

Firbank M.J., Harrison R.M., Williams E.D. and Coulthard A. 'Quality assurance for MRI: practical experience'. British Journal of Radiology, 73 (2000) 376-383.

IPEM Report No.80: Quality Control in Magnetic Resonance Imaging 1998

Actual test may deviate from the guidelines due to the capabilities and limitations of the scanner and phantoms. At a minimum the scanner will meet the performance levels specified in the ACR MRI Quality Control Manual.

Tests performed:

1. Image uniformity
2. Image SNR
3. High-contrast resolution
4. Slice profile & thickness
5. Geometric distortion
6. Mapping of fringe fields, e.g. 5 Gauss line
7. Linearity of RF pulse duration (tip angle versus pulse duration)
8. Linearity of pulse amplitude (tip angle versus pulse amplitude)
9. Accuracy of slice locations & alignment lights
10. Accuracy of slice separation
11. Accuracy and precision of T1 and T2 measurements
12. Evaluation of image artefacts including ghosting
13. Spectral accuracy or calibration of single voxel spectroscopy
14. Spectral accuracy or calibration of CSI if applicable
15. Interslice RF interference
16. Low contrast object detectability
17. Tip angle accuracy
18. Short term temporal stability

Nuclear Medicine

Protocols followed:

NEMA standards No. NU-1 : Performance Measurements of Scintillation Cameras 2001.

IPSM Reprt No.66: Quality Control of Gamma Cameras and Associated Computer Systems.

Tests performed:

1. Intrinsic Uniformity
2. Intrinsic Energy Resolution
3. Intrinsic Spatial Resolution
4. Intrinsic Linearity
5. Intrinsic Count Rate Performance
6. Intrinsic Uniformity at 75 kcps
7. Intrinsic Spatial Resolution at 75 kcps
8. Multiple Window Registration
9. System Uniformity
10. System Spatial Resolution with scatter
11. System Spatial Resolution without scatter
12. System Planar Sensitivity and Penetration
13. Spect Reconstructed Resolution with scatter
14. Spect Reconstructed Resolution without scatter
15. Whole Body Scanning Resolution
16. Spect Uniformity and Contrast - Jaszczak Phantom

Ultrasound

Protocols followed:

AIUM “Methods for measuring performance of pulse-echo ultrasound imaging equipment Part II: digital methods” 1995.

AIUM “Standard methods for measuring performance of pulse-echo ultrasound imaging equipment” 1990.

Tests performed:

1. Doppler
2. Spectral Doppler
3. Mean velocity
4. Effect of aperture
5. Sample volume length
6. Colour Doppler
7. Mean velocity
8. B-mode
9. Beam former artefacts
10. check for dead elements
11. Dynamic range
12. Spatial resolution
13. Image noise
14. Image comparison