NRRC Specific Regulations

Establishment and Implementation of Quality Control (QC) Program for Medical Radiological Equipment

NRRC-R-01-SR03 Rev. 1

2026

هيئة الرقابة النووية والإشعاعية
Nuclear and Radiological Regulatory Commission

Establishment and Implementation of Quality Control (QC) Program for Medical Radiological Equipment

Specific Regulation

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Preamble

In accordance with the provisions of the Radiation Safety Regulation (NRRC-R-01 Rev. 0.1), approved by the NRRC's Board of Directors in resolution No. (R/1/1/2022), dated 20 April 2022, in chapter (12) section (78), this specific regulation establishes detailed requirements for the establishment and implementation of quality control (QC) program for medical radiological equipment. These requirements are integral to the comprehensive Quality Assurance program (QA) for medical exposures outlined in the Radiation Safety Regulation.

The specific regulation is prepared to be consistent with International Atomic Energy Agency (IAEA) standards, international best practices, and in accordance with the Kingdom's international commitments, and it has been presented in "the Public Consultation Platform, Istitlaa" for public review, comments, and feedback.

This specific regulation has been approved by the NRRC's CEO Resolution No. 0311367 dated 25 June 2026.

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Related Regulation(s):

Document ID	Revision	Title
NRRC-R-01	0.1	Radiation Safety

Abbreviations:

Abbreviation	Definition
AEC	Automatic Exposure Control
AKR	Air Kerma rate
BMC	Bone Mineral Content
BMD	Bone Mineral Density
BMD	Bone Mineral Density
BT	Brachytherapy
CBCT	Cone Beam Computed Tomography
Ceph	Cephalometric
COR	Center of Rotation
CR	Computed Radiography
CT	Computed Tomography
CTDI	Computed Tomography Dose Index
DAP	Dose Area Product
DR	Digital Radiography
DSA	Digital Subtraction Angiography
DVH	Dose-volume Histogram
DVH	Dose-volume Histogram
DXA or DEXA	Dual-energy X-ray absorptiometry
EBRT	External Beam Radiotherapy
eBx	Electronic brachytherapy
EDE	Enhanced Dynamic Wedge

Abbreviation	Definition
EMO	Emergency Motion Off
EPO	Emergency Power Off
ESD	Entrance Surface Dose
FID	Focus-Image Detector Distance
FO	Fluoroscopic Operation
FoV	Field of View
GSDF	Gray Scale Display Function
GSDF	Gray Scale Display Function
HCR	High Contrast Resolution
HDMM	High-Definition Motion Management
HDR	High Dose-rate
HVL	Half Value Layer
iso	isocenter
KAP	Kerma Area Product
LINAC	Linear Accelerator
MGD	Mean Glandular Dose
MLC	Multi Leaf Collimator
MTF	Modulation Transfer Function
MU	Monitor Unit
NECR	Noise Equivalent Count Rate
OAF	Off-Axis Factor
OD	Optical Density
ODI	Optical Distance Indicator
ODI	Optical Distance Indicator
OF	Output Factor
OPG	Orthopantomography
PDD	Percentage Depth Dose
PET	Positron Emission Tomography
PPS	Patient Positioning System
PSDL	Primary Standards Dosimetry Laboratory
PV	Pixel Value
QA	Quality Assurance
QC	Quality Control

Abbreviation	Definition
RF	Radiofrequency
SF	Scatter Fraction
SNR	Signal-to-Noise Ratio
SPECT	Single Photon Emission Computed Tomography
SPR	Scan Projection Radiograph
SRS	Stereotactic Radiosurgery
SSC	Systems Structures, and Component
SSD	Source-To-Skin distance
SSDL	Secondary Standards Dosimetry Laboratory
SUV	Standard Uptake Value
TBI	Total Body Irradiation
TGT	Transfer Guide Tubes
TMR	Tissue-Maximum Ratio
TMR	Tissue Maximum Ratio
TMR	Tissue Maximum Ratio
TPS	Treatment Planning System
TPS	Treatment Planning Systems
TSE	Total Skin Electron

Chapter 1: Objective, Scope, and Definitions

Section 1: Objective

1. This specific regulation establishes the detailed requirements for the establishment and implementation of Quality Control (QC) programs for medical radiological equipment in dental radiology, diagnostic radiology, nuclear medicine, and radiotherapy practices.

Section 2: Scope

2. This specific regulation applies to:

    a. All dental radiology equipment that may include:
        i. Intraoral dental radiology equipment;
        ii. Orthopantomography (OPG) equipment (panoramic and cephalometric (Ceph) operation);
        iii. Cone Beam Computed Tomography (CBCT) equipment for dental, maxillofacial examinations;
        iv. Hand-held/portable Dental X-ray unit.

    b. All diagnostic radiology equipment that may include:
        i. Conventional radiography equipment;
        ii. Fluoroscopy equipment;
        iii. Diagnostic screens and diagnostic monitors;
        iv. Dual-energy X-ray absorptiometry (DXA or DEXA) for body composition and Bone Mineral Densitometry (BMD);
        v. Mobile fluoroscopy equipment (C-Arms, O-Arms);
        vi. Computed Tomography (CT) equipment;
        vii. Mammography equipment;
        viii. Computed Radiography (CR) and Digital Radiography (DR);
        ix. Interventional radiology & cardiology equipment.

    c. All nuclear medicine equipment that may include:
        i. Dose calibrators;

ii. Planar Gamma cameras;

iii. Single Photon Emission Computed Tomography (SPECT) equipment;

iv. Positron Emission Tomography (PET) equipment;

v. CT in a Hybrid System with PET (PET-CT) or with SPECT (SPECT-CT) equipment;

vi. Radionuclide generators (i.e., $^{99}Mo/^{99m}Tc$, $^{82}Sr/^{82}Rb$, and $^{68}Ge/^{68}Ga$, generators);

vii. Automated Dispenser/Injector in PET;

viii. Well counter;

ix. Thyroid uptake probe.

d. All radiotherapy (External Beam Radiotherapy and brachytherapy) equipment that may include:

i. Linear Accelerators (LINACs) (conventional LINACs, TomoTherapy);

ii. Orthovoltage X-ray Therapy equipment;

iii. Accelerators for proton and heavy ion therapy;

iv. CyberKnife equipment;

v. Gamma Knife equipment;

vi. On-board imaging equipment;

vii. Conventional simulators;

viii. CT simulators;

ix. External Beam Radiotherapy (EBRT) treatment planning systems;

x. High Dose-Rate (HDR) brachytherapy equipment;

xi. Permanent radioactive implants and radioactive applicators;

xii. Electronic brachytherapy (eBx) equipment;

xiii. Brachytherapy (BT) treatment planning systems (TPSs).

Section 3: Definitions

Acceptance Testing

The process by which it is verified that newly installed medical radiological equipment, imaging and auxiliary equipment, systems, and components used in medical exposures, operate in accordance with the associated specifications and performance criteria, and can be safely introduced into clinical practice.

Authorized Person

Person granted authorization under the relevant NRRC Laws.

Commissioning

The process where the Structures, Systems, and Components (SSCs), of facilities and activities, after being constructed, are made operational and verified to be in accordance with the design, and that they meet the required performance criteria.

Medical Physicist

A Health professional in the concepts and techniques of applying physics in medicine and recognized by the competent authority of the Kingdom.

Quality Assurance (QA)

The function of a management system that provides confidence that specified requirements will be fulfilled.

Quality Control (QC)

Part of a Quality Assurance (QA) program intended to verify that structures, systems, and components correspond to predetermined requirements.

Quality Control Equipment

The equipment (measuring devices, phantoms, test tools, etc.) is used to perform Quality Control (QC) tests.

Quality Control Program

A written set of procedures and activities established and implemented by a facility for the performance of the required QC tests to medical radiological equipment.

Quality Control Test

Testing or inspection to determine whether particular equipment or components perform within defined tolerance limits.

Tolerance Limit

The limiting value above or below a measured or estimated value of a function or condition indicator must be found in order to be acceptable.

Chapter 2: Quality Control (QC) Program

Section 4: General Requirements

3. The authorized person shall:
    a. Establish and implement a QC program for dental radiology, diagnostic radiology, nuclear medicine, and/or radiotherapy equipment that are clinically used in medical practices.
    b. Ensure that the established QC program:
        i. Includes the corresponding tests and criteria specified in the Appendices of this specific regulation as a minimum;
        ii. Defines the necessary roles and responsibilities of relevant workers for the proper implementation of the QC program;
        iii. Includes the necessary arrangements for the maintenance of appropriate records for the QC program testing results;
        iv. Includes the tolerance limits that are used for the evaluation of the QC testing results.
4. In addition to the scheduled QC tests defined in the QC program, the authorized person shall ensure that the dental radiology, diagnostic radiology, nuclear medicine, and/or radiotherapy equipment undergo QC tests, as follows:
    a. At the time of commissioning and relocation of the equipment, prior to their clinical use on patients, the corresponding QC tests in Appendices 1-3 shall be carried out;
    b. After any major maintenance, major upgrades, significant repairs, or modification procedure that could have an impact on image quality and/or patients' safety, the corresponding QC tests in Appendices 1-3 shall be carried out;
    c. After any installation of new software/hardware or modification of existing software that could affect the protection and safety of patients, the corresponding QC tests in Appendices 1-3 shall be carried out;

d. After any corrective actions have been taken, when QC results indicate that the equipment performs outside the respective tolerance limits to verify its adequacy for clinical use.

5. The authorized person shall ensure that the QC results are compared against the manufacturing tolerance limits that are justified and approved by the NRRC. The authorized person shall ensure that:
    a. Only qualified staff members who have received adequate training and have demonstrated the necessary competence may be involved in performing the QC tests of the established QC program;
    b. Only recognized and appropriately competent service providers may be involved in performing the QC tests of the established QC program;
    c. The established QC program is reviewed on a regular basis, and revised appropriately if needed, taking into account the most recent requirements established by the NRRC.
6. The authorized person shall ensure the availability of the necessary resources for the proper implementation of the established QC program.

Section 5: Personnel

7. The authorized person shall ensure that:
    a. The assigned responsibilities of the Radiation Safety Officer (RSO) include:
        i. The proper implementation of the QC program;
        ii. The proper documentation of the QC testing results;
        iii. The onsite availability of a written QC manual with all the required QC tests for the equipment of the dental radiology, diagnostic radiology, nuclear medicine, and/or radiotherapy practice;
        iv. The reporting of the corrective actions taken based on the QC testing results;

v. The reporting of the main findings and conclusions of the QC tests to the authorized person.

b. For radiotherapy equipment, the QC tests of the established QC program and any additional QC tests are performed by or under the supervision of a Medical Physicist;

c. For diagnostic, dental, interventional radiology, and nuclear medicine equipment, the QC tests of the established QC program and any additional QC tests are performed by or under the oversight of or with the documented advice of a Medical Physicist, whose degree of involvement is determined by the complexity of the radiological procedures and the associated radiation risks.

Section 6: Quality Control Equipment

8. The authorized person shall ensure that:
   a. Appropriate QC equipment and tools (e.g., phantoms, measuring instruments, reference/calibration sources, etc.) are used for performing the QC tests;
   b. All the measuring equipment used for performing the QC tests have a valid calibration certificate.

Section 7: Records

9. The authorized person shall keep appropriate records of the implementation of the established QC program in diagnostic radiology, nuclear medicine, or radiotherapy practice, including the following:
   a. Detailed description of QC tests included in the established QC program;
   b. Periodic review of the QC program;
   c. Non-conformities identified during performing the QC tests and the associated preventive and corrective actions undertaken;
   d. Information on:
      i. Preventive maintenance and service;

ii. Any repair(s);
iii. Any major component replacement(s);
iv. Any manufacturer's upgrade(s);
v. An inventory of all equipment used in the QC tests with their calibration certificates.

e. Records and reports of the implemented QC program;
f. Records of the results of the QC tests performed in line with the provisions of Section 4, Article 5.

10. The authorized person shall ensure that the records of the implemented QC program are updated periodically and available to the NRRC.

Section 8: Annual Reporting

11. The authorized person shall ensure that an annual QC report is prepared for each dental and diagnostic radiology, nuclear medicine, or radiotherapy equipment, which shall include the following information:
    a. General information about the facility including but not limited to;
        i. Name of the facility;
        ii. Authorized person's name and corresponding legal address.
    b. Information on the performance of the QC test including but not limited to:
        i. Details of the personnel who performed the QC tests;
        ii. A detailed list of the QC equipment used for the performance of the QC tests;
        iii. Calibration certificates of the measuring equipment used for performing the QC tests and the details of the reference sources used in the case of nuclear medicine equipment;
        iv. Information on the diagnostic radiology, nuclear medicine, or radiotherapy equipment tested, including the type, model, and serial number.
    c. A detailed list of the QC tests performed, including but not limited to:
        i. The date of each QC test performed;

ii. The data collected during each QC test, the related analysis results, and the respective tolerance limit;

iii. A conclusion regarding the performance of diagnostic radiology, nuclear medicine, or radiotherapy equipment (acceptable or not acceptable);

iv. A description of any suggested preventive and/or corrective actions, if applicable;

v. The main findings of the QC tests and related recommendations.

12. The Medical Physicist who conducted or supervised the QC tests shall review and approve the annual QC reports.
13. The Radiation Safety Officer (RSO) shall ensure that the annual QC reports:
    a. Are signed by the Medical Physicist who conducted or supervised the performance of the QC tests;
    b. Are maintained within the medical facility;
    c. Are communicated to the authorized person, and the main findings and conclusions are presented in detail.
14. The authorized person shall submit the QC report for all medical radiological equipment to the NRRC annually, within three (3) months of the completion of the specified QC test(s).

Appendices

Appendix 1: This Appendix specifies the Required Quality Control (QC) Tests for the Diagnostic Radiology Equipment and their frequency

Table A1-1 Required QC tests for conventional diagnostic radiography systems

QC test	Frequency
Leakage radiation	During acceptance
Focus-Image Detector Distance (FID)	During acceptance and annually
X-ray beam and light field alignment/centering	During acceptance and annually
X-ray beam verticality	During acceptance and annually
Grid operation	During acceptance and annually
Automatic collimation	During acceptance and annually
Half Value Layer (HVL)	During acceptance and annually
kV accuracy	During acceptance and annually
kV reproducibility	During acceptance and annually
Exposure time accuracy	During acceptance and annually
Exposure time reproducibility	During acceptance and annually
Radiation output	During acceptance and annually
Linearity of radiation output	During acceptance and annually
Automatic Exposure Control (AEC) system performance with the absorption thickness	During acceptance and annually
AEC system performance with kV	During acceptance and annually
AEC chambers	During acceptance and annually
Typical patient dose	Annually
High contrast resolution	During acceptance and annually
Low contrast resolution	During acceptance and annually

Table A1-2 Required QC tests for bone mineral densitometry equipment

QC test	Frequency
Daily QC test	Daily
BMD, Bone Mineral Content (BMC) accuracy	During acceptance and annually
BMD, BMC reproducibility	During acceptance and annually

Table A1-3 Required QC tests for Intraoral dental radiology equipment, Hand-held/Portable X-ray unit.

QC test	Frequency
kV reproducibility	During acceptance and annually
Radiation output	During acceptance and annually
Radiation output reproducibility	During acceptance and annually
Linearity of radiation output	During acceptance and annually
Half Value Layer (HVL)	During acceptance and annually
High contrast resolution	During acceptance and annually
Low contrast detectability	During acceptance and annually

Table A1-4 Required QC tests for Orthopantomography CBCT equipment for dental, maxillofacial examinations

QC test	Frequency
kV reproducibility	During acceptance and annually
Radiation output	During acceptance and annually
Radiation output reproducibility	During acceptance and annually
Linearity of radiation output	During acceptance and annually
Half Value Layer (HVL)	During acceptance and annually
Pulse duration accuracy (for pulsed equipment)	During acceptance and annually
Exposure/examination time accuracy	During acceptance and annually

QC test	Frequency
Computed Tomography Dose Index (CTDI) accuracy	During acceptance and annually
Dose Area Product (DAP) accuracy	During acceptance and annually
Typical patient doses	Annually
Verification of radiation field sizes – FOV	During acceptance and annually
High Contrast Resolution (HCR) – Modulation Transfer Function (MTF)	During acceptance and annually
CBCT pixel values (PV)	During acceptance and annually
Image noise	During acceptance and annually
Uniformity of the reconstructed image	During acceptance and annually

Table A1-5 Required QC tests for fluoroscopy equipment and C-Arm

QC test	Frequency
Leakage radiation	During acceptance
Half Value Layer (HVL)	During acceptance and annually
kVp accuracy	During acceptance and annually
kVp reproducibility	During acceptance and annually
Patient entrance dose rate	During acceptance and annually
Maximum patient dose rate	During acceptance and annually
Typical patient doses	Annually
Low Contrast Detectability	During acceptance and annually
High Spatial Resolution	During acceptance and annually

* Tests shall be done for all magnifications and modes

Table A1-6 Required QC tests for fluoroscopy systems for use in operating rooms (O-Arm)

QC test	Frequency
Leakage radiation	During acceptance
kV accuracy	During acceptance and annually
kV reproducibility	During acceptance and annually
Radiation output	During acceptance and annually
Radiation output reproducibility	During acceptance and annually
Half Value Layer (HVL)	During acceptance and annually
Pulse duration accuracy (for pulsed systems)	During acceptance and annually
Patient entrance dose rate	During acceptance and annually
Maximum patient entrance dose rate	During acceptance and annually
Characteristic fluoroscopy curve	During acceptance and annually
Dose Area Product (DAP) accuracy	During acceptance and annually
Typical patient doses	Annually
Low contrast detectability	During acceptance and annually
High contrast resolution (HCR)	During acceptance and annually
CTDI accuracy	During acceptance and annually
Slice thickness	During acceptance and annually
Reconstruction slice thickness	During acceptance and annually
High contrast resolution	During acceptance and annually
Image noise	During acceptance and annually
Uniformity of reconstructed images	During acceptance and annually

* Tests shall be done for all magnifications and modes

Table A1-7 Required QC tests for Computed Tomography (CT) systems

QC test	Frequency
Geometric accuracy of lasers and a Scan Projection Radiograph (SPR)	During acceptance and annually
Table movement accuracy	During acceptance and annually
CT number water uniformity	During acceptance and annually
CT number accuracy	During acceptance and annually
Imaged slice thickness	During acceptance and annually
Low contrast detectability	During acceptance and annually
High contrast resolution	During acceptance and annually
$CTDI_{vol}$	During acceptance and annually
$CTDI_{air}$	During acceptance and annually
kV accuracy	During acceptance and annually
Half Value Layer (HVL)	During acceptance and annually

Table A1-8 Required QC tests for mammography systems

QC test	Frequency
Leakage radiation	During acceptance
System reproducibility	During acceptance and annually
Coincidence of image receptor with the radiation field	During acceptance and annually
Focus – Image receptor Distance (FID)	During acceptance and annually
Focal spot size	In case of spatial high-resolution degradation
Breast compression system force	During acceptance and annually
Thickness Indication	During acceptance and annually
kV accuracy and reproducibility	During acceptance and annually
Half Value Layer (HVL)	During acceptance and annually
Radiation output and reproducibility of radiation output	During acceptance and annually
Linearity of radiation output	During acceptance and annually
Change of Optical Density (OD) with phantom thickness and kVp	During acceptance and annually
Standard exposure time	During acceptance and annually
Grid uniformity	During acceptance and annually
Grid system factor	In case of a sudden increase in dose or the exposure time
High contrast resolution	During acceptance and annually
Low contrast resolution	During acceptance and annually
Artefacts	During acceptance and annually
Entrance Surface Dose (ESD)	During acceptance and annually
Mean Glandular Dose (MGD)	During acceptance and annually

Table A1-9 Required QC tests for mammography display screens/monitors

QC test	Frequency
Diagnostic room lighting	During acceptance and in case of problems with image quality
Contrast visibility	Daily
Resolution	Biannually
Image distortion	Daily
Brightness range	Annually
Brightness uniformity	Annually
Uniformity and artefacts	Weekly
Gray Scale Display Function (GSDF)	Annually

Table A1-10 Requirements for QC tests for interventional radiology and cardiology systems

QC test	Frequency
Leakage radiation	During acceptance
Spatial high contrast resolution	During acceptance and every six months
Low Contrast Detectability	During acceptance and every six months
Source-To-Skin Distance (SSD) and Table-detector distance – Fluoroscopic Operation (FO)	During acceptance and annually
Geometric distortion (systems with image intensifier) - FO	During acceptance and annually
Patient entrance dose rate - FO	During acceptance and annually
Maximum patient dose rate - FO	During acceptance and annually
Dose rate at the detector entrance - FO	During acceptance and annually
Typical patient doses - FO	Annually

QC test	Frequency
Automatic Exposure Control (AEC) - FO	During acceptance and annually
Half Value Layer (HVL) - FO	During acceptance and annually
Radiation field vs image receptor	During acceptance and annually
Patient entrance dose rate - CINE/DA/DSA (DSA= Digital Subtraction Angiography)	During acceptance and annually
Dose rate at the detector entrance - CINE/DA/DSA	During acceptance and annually
Automatic Exposure Control (AEC) - CINE/DA/DSA	During acceptance and every six months
Typical patient dose - CINE/DA/DSA	Annually
Air Kerma Rate (AKR) accuracy - CINE/DA/DSA	During acceptance and annually
Kerma Area Product (KAP) accuracy - CINE/DA/DSA	During acceptance and annually

Appendix 2: This Appendix specifies the Required Quality Control (QC) Tests for the Nuclear Medicine Equipment and their frequency

Table A2-1 Required QC tests for the Dose Calibrator

QC Test	Frequency
Auto Zero	During acceptance and daily
Background Count Rate	During acceptance and daily
Chamber voltage	During acceptance and daily
Constancy	During acceptance and daily
Synchronization of PET equipment and dose calibrator clocks	During acceptance and quarterly
Linearity	During acceptance and quarterly
Accuracy	During acceptance and annually
Geometry	During acceptance
Volume response	During acceptance

Table A2-2 Required QC tests for Planar Gamma Camera

QC Test	Frequency
Background count rate	During acceptance and daily
Energy peaking/ Photopeak window	During acceptance and daily
Intrinsic Uniformity	During acceptance and weekly
Extrinsic Uniformity	During acceptance and daily
Intrinsic Spatial Resolution	During acceptance and annually
Extrinsic Spatial Resolution	During acceptance and weekly
Intrinsic Spatial Linearity	During acceptance and annually
Extrinsic Sensitivity	During acceptance and annually
Intrinsic Energy Resolution	During acceptance and annually
Intrinsic Count Rate	During the acceptance and annually

Table A2-3 Required QC tests for SPECT equipment

QC Test	Frequency
The required tests for Planar Gamma Camera systems specified in Table A2-2 must be performed in addition to the following tests:	
Center of Rotation (COR)	During acceptance and monthly (weekly for cardiac application)
Overall system performance (Tomographic uniformity, spatial resolution and contrast)	During acceptance and quarterly
Slice thickness	During acceptance and annually

Table A2-4 Required QC tests for PET equipment

QC Test	Frequency
Blank scan	During acceptance and daily
Normalization	During acceptance and monthly
Image Uniformity	During acceptance and quarterly
Coincidence Timing Resolution	During acceptance and weekly
Spatial Resolution	During acceptance and annually
Sensitivity	During acceptance and annually
Scatter Fraction (SF)	During acceptance and annually
Noise Equivalent Count Rate (NECR)	During acceptance and annually
Standard Uptake Value (SUV)	During acceptance and annually
Image Quality	During acceptance and annually
Energy Resolution	During acceptance and annually
PET-MRI Alignment*	During the installation and after mechanical manipulations on PET-MRI gantry or software updates

*These tests only applicable for systems with MRI component, to ensure proper co-registration of the PET and MRI images.

Table A2-5 Required QC tests for CT in a Hybrid System with PET or SPECT equipment.

QC Test	Frequency
Co-registration of the PET or SPECT and CT fields of view	During acceptance and annually
The rest of the tests shall be in accordance with those defined in Table A1-7: Required QC tests for Computed Tomography (CT) systems	

Table A2-6 Required QC tests for ^{99}Mo/^{99m}Tc Generators

QC Test	Frequency
^{99}Mo breakthrough	First elution of a new generator

Table A2-7 Required QC tests for ^{82}Sr/^{82}Rb Generators

QC Test	Frequency
^{82}Sr & ^{85}Sr breakthrough	Daily

Table A2-8 Required QC tests for ^{68}Ge/^{68}Ga generator

QC Test	Frequency
^{68}Ge breakthrough	Daily

Table A2-9 Required QC tests for Well Counter

QC Test	Frequency
Background count rate	During acceptance and daily
Auto-calibration	During acceptance and daily
Energy peaking/Resolution	During acceptance and daily
Constancy	During acceptance and daily
Chi-square	During acceptance and annually

Table A2-10 Required QC tests for Thyroid Uptake Probe

QC Test	Frequency
Background count rate	During acceptance and daily
Constancy	During acceptance and daily
Chi-square	During acceptance and semi-annually

Table A2-11 Required QC tests for the Gamma probe

QC Test	Frequency
Background count rate	During acceptance and annually
Spatial Resolution	During acceptance and daily annually
Sensitivity	During acceptance and annually
Constancy	During acceptance and annually
Shielding leakage	During acceptance and annually

Appendix 3: This Appendix specifies the Required Quality Control (QC) Tests for Radiotherapy Equipment and their frequency

Table A3-1 Required Daily QC tests for linear accelerators

QC test	Test type
Output (all beams used)	Dosimetric
Wedge factor (Enhanced Dynamic Wedge) EDW; one wedge)	Dosimetric
Lasers	Mechanical
ODI (at iso)	Mechanical
Jaw position	Mechanical
Robotic couch shift	Mechanical
Safety checks: Door interlock, A/V monitors Beam on indicator Beam off Stereotactic interlocks (SRS) Anti-collision test	Safety

Table A3-2 Required Monthly QC tests for linear accelerators

QC test	Test type
Output (all energies)	Dosimetric
Beam profile	Dosimetric
Photon/Electron PDD	Dosimetric
Dynamic delivery control (IMRT/VMAT)	Dosimetric
Wedge factor (dynamic, universal, or virtual); all	Dosimetric
Optical Distance Indicator (ODI) [full range]	Mechanical
Gantry/Collimator readouts	Mechanical
Jaw settings (multiple field sizes)	Mechanical
Physical graticule (port film)	Mechanical

QC test	Test type
Cross hair centering	Mechanical
Couch position	Mechanical
Physical wedge placement	Mechanical
MLC leaf position accuracy	Mechanical
Gating Beam output constancy Beam control In-room monitoring system	Mechanical
Backup MU chamber	Safety

Table A3-3 Required Annual QC tests for linear accelerators

QC test	Test type
Calibration	Dosimetric
Photon and electron output linearity	Dosimetric
Photon and electron profile shape	Dosimetric
Photon and electron Percentage Depth dose (PDD)	Dosimetric
Photon output vs. Dose rate	Dosimetric
Photon and electron output vs. gantry angle	Dosimetric
Photon and electron OAF vs. gantry angle	Dosimetric
Output factors, photon (jaw and MLC- defined) and electron	Dosimetric
Arc Mode	Dosimetric
Special procedure mode (TBI/TSE) [Total Body Irradiation (TBI) and Total Skin Electron (TSE)]	Dosimetric
Wedge output and OAF	Dosimetric
Jaw position vs. gantry angle	Mechanical
Light vs. rad	Mechanical
Radiation isocentricity (jaws, MLC, gantry, couch)	Mechanical
Electron applicator collimator settings	Mechanical
Beam energy constancy	Respiratory gating

QC test	Test type
Calibration of surrogate Interlock testing	
Safety checks Laser guard/touch guard	Safety

Table A3-4 Required Daily QC tests for orthovoltage equipment

QC test	Test type
Output Verification (for used kV/filter combinations)	Dosimetric
kVp and mA indicators	Safety
Safety checks Beam interrupt Key off	Safety

Table A3-5 Required Monthly QC tests for orthovoltage equipment

QC test	Test type
Field Uniformity	Dosimetric
Timer accuracy	Dosimetric
Backup timer	Dosimetric
Distance indicators	Mechanical
Head tilt and rotation readouts	Mechanical
Radiation field size vs. light field vs. field size indicator (if not cone-based)	Mechanical
Filter/kVp interlocks	Safety
Cone/Filter integrity and indicators	Safety

Table A3-6 Required Annual QC tests for orthovoltage equipment

QC test	Test type
Calibration (all cones, kV, and filter combinations)	Dosimetry
Output linearity	Dosimetric
End-effect	Dosimetric
Output vs. head tilt	Dosimetric
Output with beam interrupt	Dosimetric
Beam Quality	Dosimetric
Alignment of focal spots	Mechanical

Table A3-7 Daily QC tests for accelerated ion therapy equipment (proton)

QC test	Test type
Output	Dosimetric
Distal range verification	Dosimetric
Spot position	Dosimetric
Laser position at isocenter (iso)	Mechanical
Safety checks: Door interlock A/V system Beam on indicator X-ray on indicator Search/clear button Beam off/pause button Emergency motion stop button MU interlock Collision interlock Radiation monitor	Safety

Table A3-8 Required Monthly QC tests for accelerated ion therapy equipment (proton)

QC test	Test type
Beam output	Dosimetric
Flatness / Symmetry	Dosimetric
Range	Dosimetric
Spot size	Dosimetric
Couch translation and rotation	Mechanical
Snout trueness	Mechanical
Light radiation field agreement (if clinical)	Mechanical
Snout extension	Mechanical
Gantry angle readout	Mechanical
Backup chamber	Safety

Table A3-9 Required Annual QC tests for accelerated ion therapy equipment (proton)

QC test	Frequency
Beam calibration	Dosimetry
Depth dose verification	Dosimetry
Lateral profile penumbra	Dosimetry
Range Uniformity	Dosimetry
Spot position	Dosimetry
Spot shape uniformity	Dosimetry
Monitor Unit (MU) linearity	Dosimetry
Relative output factors	Dosimetry
Range shifter factors	Dosimetry
Gantry, couch isocentricity	Mechanical
Exposure from long-term activation	Safety
Room and facility beam stop buttons	Safety

Table A3-10 Required Daily QC tests for robotic radiosurgery systems (Cyber knife)

QC test	Test type
Output	Dosimetric
Isocenter test Automated Quality Assurance (AQA) – day of Stereotactic Radiosurgery treatment (SRS)	Mechanical
Laser alignment	Mechanical
Safety checks: Door interlock A/V system Beam on indicator Search/clear button Emergency Motion Off (EMO)/beam off Emergency motion stop button Collision interlock Incorrect collimator Radiation monitor	Safety
Synchrony target offset detection (day of use)*	Mechanical
Synchrony tracking (day of use)*	Mechanical

*These tests only capture the tracking nature of the Synchrony system. The imaging aspects (including image quality, imaging dose) shall also be evaluated according to the standard on-board imaging schedule in Table A3-20.

Table A3-11 Required Monthly QC tests for robotic radiosurgery systems (Cyber knife)

QC test	Test type
Output	Dosimetric
Energy constancy	Dosimetric
Beam profile shape	Dosimetric
Isocenter test Automatic Quality Assurance (AQA)	Mechanical
Verify isocentric plan with isocrystal	Mechanical
Motion tracking accuracy	Mechanical
Synchrony end-to-end test*	Dosimetric

*These tests only capture the tracking nature of the Synchrony system. The imaging aspects (including image quality, imaging dose) shall also be evaluated according to the standard on-board imaging schedule in Table A3-20.

Table A3-12 Required Annual QC tests for robotic radiosurgery systems (Cyber knife)

QC test	Test type
Calibration	Dosimetric
Percent Depth Dose (PDD)/Tissue Maximum Ratio (TMR)	Dosimetric
Output linearity	Dosimetric
Output factors	Dosimetric
Non-isocentric patient QA	Dosimetric
Emergency Power Off (EPO) button	Safety

Table A3-13 Required Daily QC tests for TomoTherapy systems

QC test	Test type
Output (rotational or static)	Dosimetric
Laser alignment (coincidence between laser sets and with isocenter)	Mechanical
Safety checks: Door interlock A/V system Beam on indicator Search/clear button Beam off Collision interlock Radiation monitor	Safety
Synchrony target offset detection (on day of use)*	Mechanical
Synchrony tracking (on day of use)*	Mechanical

*These tests only capture the tracking nature of the Synchrony system. The imaging aspects (including image quality, imaging dose) shall also be evaluated according to the standard on-board imaging schedule in Table A3-20.

Table A3-14 Required Monthly QC tests for TomoTherapy systems

QC test	Test type
Output (static and rotational)	Dosimetric
Energy constancy	Dosimetric
Beam profile (transverse, longitudinal fixed, longitudinal dynamic)	Dosimetric
Continuous jaw sweep	Dosimetric
Red laser movement	Mechanical
Jaw timing / speed	Mechanical
Treatment couch readout	Mechanical
Treatment couch sag	Mechanical
HU calibration (if used for dose calculations)	Imaging
Multi Leaf Collimator (MLC) test (qualitative)	Mechanical

QC test	Test type
Backup MU chamber	Safety
Synchrony end-to-end test*	Dosimetric

*These tests only capture the tracking nature of the Synchrony system. The imaging aspects (including image quality, imaging dose) shall also be evaluated according to the standard on-board imaging schedule in Table A3-20.

Table A3-15 Required Annual QC tests for TomoTherapy systems

QC test	Test type
Calibration	Dosimetric
Rotation output variation (peak to peak)	Dosimetric
X-jaw alignment with source	Mechanical
Y-jaw: centering, divergence, alignment with rotation plane	Mechanical
MLC lateral offset	Mechanical
MLC twist	Mechanical
Synchrony: gantry angle*	Mechanical
Synchrony: Couch speed and translation*	Mechanical

*These tests only capture the tracking nature of the Synchrony system. The imaging aspects (including image quality, imaging dose) shall also be evaluated according to the standard on-board imaging schedule in Table A3-20.

Table A3-16 Required Daily QC tests for Gamma Knife systems

QC test	Test type
Dose rate in Treatment Planning System(TPS)	Dosimetric
Treatment time calculation	Dosimetric
Patient Positioning System (PPS) focus test	Mechanical
High-Definition Motion Management (HDMM) system test	Mechanical
Mattress adjustment feature Docking device on table Frame/mask adapters dock Frame adapter attaches to coordinate frame	Mechanical

QC test	Test type
Date and time in TPS system	Safety
Safety checks: Radiation monitors Warning lights Door interlock A/V monitors System alarm Emergency procedures Emergency release tools Survey meter Couch rail interlock Pause and stop sequences Timer termination	Safety

Table A3-17 Required Monthly QC tests for Gamma knife systems

QC test	Test type
Output	Dosimetric
Timer accuracy	Dosimetric
Timer linearity	Dosimetric
Timer error (on-off)	Dosimetric
Transit dose	Dosimetric
Headframes appear structurally sound	Mechanical
Clearance tool test	Safety
Uninterruptible power supply	Safety
Couch control during power loss	Safety

Table A3-18 Required Annual QC tests for Gamma knife systems

QC test	Test type
Dose profile	Dosimetric
Output factors	Dosimetric
Test plan recalculation	Dosimetric
End to end test (after source exchange)	Dosimetric
Unit center point and radiation focal point match	Mechanical
Unit correctly places treatment site at radiation focal point	Mechanical
Wipe test	Safety

Table A3-19 Required half value layer QC tests for in- room imaging systems

Measured operating potential	Minimum HVL (mm Al)
30	**0.3**
40	**0.4**
50	**0.5**
51	**1.3**
60	**1.5**
70	**1.8**
71	**2.5**
80	**2.9**
90	**3.2**
100	**3.6**
110	**3.9**
120	**4.3**
130	**4.7**
140	**5.0**
150	**5.4**

Table A3-20 Required Periodic QC tests for in-room X-ray imaging equipment

QC test	Frequency
Imaging-treatment isocenter alignment (non-SRS) [SRS =Stereotactic Radiosurgery]	Daily
Table position/reposition (non-SRS) [SRS =Stereotactic Radiosurgery]	Daily
Safety Door interlock For non-radiographic imaging: Gantry rotation termination Beam off buttons Indicator lights	Daily
Imaging-treatment isocenter and couch positioning alignment (including CBCT precision test for gamma knife systems with CBCT capability)	Daily when SRS is scheduled
Imaging-treatment isocenter alignment (non-SRS)	Monthly (vs. tx isocenter)
Image scaling	Annual
Imaging dose	Annual
Image quality Spatial resolution Contrast Uniformity (3D modes)	Annual

*If the in-room imaging system is used for treatment planning (e.g., online adaptive therapy), the imaging QC must be expanded to include those tests for CT simulators as described in Table A3-22.

Table A3-21 Required Periodic QC tests for in-room MR imaging equipment

This applies to the MR component of an MR linac.

QC test	Frequency
Safety test: A/V system	Daily
Emergency cart, signage	Daily
Alignment of MR and MV isocenter	Daily

QC test	Frequency
Image spatial integrity	Daily
Central frequency	Daily
Transmit gain	Daily
Basic coil SNR check	Daily
Image quality (T1): Spatial resolution Contrast Uniformity Ghosting Artifacts	Monthly
Alignment of MR and treatment isocenter (e.g., Winston Lutz)	Monthly
Flexible Radio Frequency (RF) coil testing	Monthly
Synthetic CT number accuracy/mapping (multiple points)	Monthly
Image quality (T2): Spatial resolution Contrast Uniformity Ghosting artifacts	Annual
Magnetic field homogeneity (B0)	Annual
Transmitter and gain calibration	Annual
Radiofrequency coil evaluation	Annual
Magnetic field drift	Commissioning / Equipment change
Transmitter gain stability	Commissioning/ Equipment change
Residual gradient nonlinearity	Commissioning / Equipment change
Table alignment with B0	Commissioning / Equipment change

QC test	Frequency
Eddy current compensation	Commissioning/ equipment changes
Safety tests: emergency stop monitoring systems Verify quench circuit viability	Commissioning / Equipment change
Motion verification for 4D imaging	Commissioning / Equipment change

Table A3-22 Required Periodic QC tests for conventional simulation equipment

QC test	Frequency
Localizing lasers	Daily
Optical Distance Indicator (ODI)[at iso]	Daily
Field size indicator (one size)	Daily
Collision safety check	Daily
Crosswires/reticle/block tray aligned	Monthly
ODI (full range)	Monthly
Field size indicator (range)	Monthly
Gantry/collimator angle indicators	Monthly
Cross-wire centering/walkout	Monthly
Focus-axis-distance indicator	Monthly
Light-radiation field coincidence	Monthly
Treatment couch motion	Monthly
Mechanical iso-centricity (collimator, gantry, couch)	Annually
Image quality: Spatial resolution Contrast Uniformity	Annually
Dose/exposure consistency	Annually

QC test	Frequency
Fluoroscopy timer	Annually
Beam quality	Annually

Table A3-23 Required Periodic QC tests for CT simulation equipment

QC test	Frequency
CT number for water	Daily
Alignment of gantry laser(s) with center imaging plane	Daily
Image spatial integrity	Daily
Image noise	Daily
CT number for 4+ materials	Monthly
Field uniformity (single kVp)	Monthly
Table motion	Monthly
Alignment of gantry as well as wall lasers over full length of projection	Monthly
Safety X-ray light on Audio (intercom) Beam off button	Monthly
Patient dose (CTDI)*	Annually
Electron density to CT number conversion (full range)*	Annually
Image quality*: spatial resolution contrast	Annually
Sensitivity profile width	Annually
Table indexing	Annually
Scan localization	Annually
Gantry tilt	Annually
Safety tests:	Annually

QC test	Frequency
emergency stop	
Motion verification for 4D imaging	Commissioning

* For a head and body scan protocol

Table A3-24 Required Periodic QC tests for PET-CT simulation equipment

QC test	Frequency
CT number for water	Daily
Alignment of gantry laser(s) with center CT imaging plane	Daily
CT Image spatial integrity	Daily
CT Image noise	Daily
CT number for 4+ materials	Monthly
Field uniformity (single kVp)	Monthly
Table motion	Monthly
Alignment of gantry as well as wall lasers over full length of projection	Monthly
PET-CT registration	Monthly
Safety X-ray light on Audio (intercom) Beam off button	Monthly
Patient dose (CTDI)*	Annually
Electron density to CT number conversion (full range)*	Annually
CT Image quality*: Spatial resolution Contrast	Annually
CT sensitivity profile width	Annually
Table indexing	Annually
Scan localization	Annually

Safety tests: emergency stop	Annually
Motion verification for 4D imaging	Commissioning

* For a head and body scan protocol

Table A3-25 Required Periodic QC tests for MR simulation equipment

Commissioning tests are also listed; annual tests are to be performed as part of the commissioning process.

QC test	Frequency
Safety test: A/V system	Daily
Emergency cart, signage	Daily
Alignment of all lasers with center imaging plane	Daily
Image spatial integrity	Daily
Central frequency	Daily
Transmit gain	Daily
Basic coil Signal-to-Noise Ratio (SNR) check	daily
Image quality (T1): Spatial resolution Contrast Uniformity Ghosting Artifacts	Monthly
Synthetic CT number accuracy/mapping (multiple points)	Monthly
Table motion	Monthly
Alignment, marking, and movement of lasers	Monthly
Flexible Radio Frequency (RF) coil testing	Monthly
Image quality (T2): spatial resolution contrast uniformity	Annual

QC test	Frequency
ghosting artifacts	
Magnetic field homogeneity (B0)	Annual
Transmitter and gain calibration	Annual
Radiofrequency coil evaluation	Annual
Magnetic field drift	Commissioning / Equipment change
Transmitter gain stability	Commissioning/Equipm ent change
Residual gradient nonlinearity	Commissioning / Equipment change
Table alignment with B0	Commissioning / Equipment change
Eddy current compensation	Commissioning/equipm ent change
Safety tests: emergency stop monitoring systems Verify quench circuit viability	Commissioning / Equipment change
Motion verification for 4D imaging	Commissioning / Equipment change

Table A3-26 Required Daily QC tests for HDR brachytherapy equipment

QC test	Test Type
Timer accuracy	Dosimetric
Computer date and time accuracy	Dosimetric
Decayed source strength in console vs. decay chart	Dosimetric
Source positioning	Mechanical
Catheter misconnect/channel check	Mechanical
Visual inspection of integrity of transfer tubes	Mechanical
Length of applicator and Transfer tube	Mechanical

QC test	Test Type
Safety checks: Door interlock Emergency source retraction source out indicators A/V system Interrupt button ɬast person out	Safety
Emergency kit (inc. calibrated survey meter) present	Safety

Table A3-27 Required QC Tests for HDR brachytherapy equipment at the time of source exchange, commissioning, or after major service of the afterloader

QC test	Frequency	Test Type
Source strength measurement	At source exchange	Dosimetric
Emergency procedures source retraction including button and battery backup	At source exchange	Safety
Transit dose / end effect	Commissioning	Dosimetric
Length of applicator and Transfer Guide Tube (TGT) combinations	Commissioning	Mechanical
Match between solid applicator library and physical applicator	Commissioning	Mechanical
Verification of source path and offsets	Commissioning	Mechanical
Operational checks: Connection of components, integrity of applicator	Commissioning	Mechanical
Timer linearity	After service of afterloader	Dosimetric

Table A3-28 Required QC Tests for short half-life LDR brachytherapy elements

QC test	Frequency
Document source: Physical form, encapsulation	Commissioning
Calibration	At use (5% of sources, minimum 5)
Source/spacer pattern for strands	At use

Table A3-29 Required Daily QC tests for electronic brachytherapy equipment

QC test	Test Type
Output verification	Dosimetric
Timer accuracy	Dosimetric
Source positioning	Mechanical
Catheter misconnect/channel check	Mechanical
Visual inspection of integrity of transfer tubes	Mechanical
Length of applicator and Transfer tube	Mechanical
Safety checks: Beam off A/V system System-specific checks as relevant X of t: Source not in nest Applicator not detected Wheels unlocked	Safety

Table A3-30 Required QC Tests for electronic brachytherapy equipment at the time of source exchange

QC test	Frequency	Test Type
Source strength measurement	Source exchange	Dosimetric
Timer linearity	Source exchange	Dosimetric

QC test	Frequency	Test Type
Timer accuracy	Source exchange	Dosimetric
End effect	Commissioning	Dosimetric
Length of applicator and Transfer Guide Tube (TGT) combinations	Commissioning	Mechanical
Match between solid applicator library and the physical applicator	Commissioning	Mechanical
Verification of source path and offsets	Commissioning	Mechanical
Operational checks: Connection of components, integrity of applicator	Commissioning	Mechanical
Match between solid applicator library and physical applicator	Commissioning	Mechanical

Table A3-31 Required Commissioning Tests for External Beam Treatment Planning Systems

QC test	Modality
Treatment Planning Systems (TPS) reproduces absolute dose under reference conditions	All
Spot check commissioning data (reference fields) vs TPS (Treatment Planning System) calculations: PDD/TMR, OAF, OF, Range	All
Small irregularly shaped static field (output and depth dependence [PDD/range])	All
Large irregularly shaped static field (output and depth dependence [PDD/range])	All
Minimum SSD field	Photon

QC test	Modality
Non-physical wedge field	Photon
Oblique incidence field	All
Heterogeneous anatomy	All
Clinical fields (at least 3 different anatomical sites)	All
External end-to-end test	Photon/Proton
Tool validation Contouring, labelling, patient orientation, Dose-volume Histogram (DVH), plan normalization, dose display.	All
Display accuracy: Geometric Greyscale,	CT or MR
Image registration	Rigid registration

Table A3-32 Required Periodic QC tests for external beam treatment planning systems

QC test	Frequency
Integrity Checksum	Annually
Reference plan calculation	Annually [or after Treatment Planning Systems (TPS) upgrades]

Table A3-33 Required Commissioning QC Tests for brachytherapy treatment planning systems

QC test
Source model data
Source decay
Point dose calculation (single/multi source)

QC test
Solid applicator geometry
Source position
Tool validation Contouring, labeling, patient orientation, Dose-volume Histogram (DVH), plan normalization, dose display.
Display accuracy: Geometric Greyscale,
Image registration

Table A3-34 Required Periodic QC tests for brachytherapy treatment planning systems

QC test	Frequency
Integrity Checksum	Annually
Source decay	Source exchange
Source model data	Annually
Reference plan calculation	Annually [or after Treatment Planning Systems (TPS) upgrades]

Table A3-35 Required QC Tests for the Calibration of Dosimetry Equipment

QC Test	Equipment	Frequency
Primary Standards Dosimetry Laboratory (PSDL)/Secondary Standards Dosimetry Laboratory (SSDL) calibration	Reference class ion chamber	2 years
PSDL/SSDL calibration	Well chamber – all used sources	2 years

QC Test	Equipment	Frequency
PSDL/SSDL calibration	Electrometer – all used scales	2 years
Leakage	All chambers	Annually
Internal cross calibration	Non-calibrated chamber	Annually
Verification of sweet spot	Well chamber – all used sources	Annually
Initial calibration followed by internal checks	Thermometer	6-month internal check
Initial calibration followed by internal checks	Barometer	6-month internal check

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