NRRC Specific Regulations

Establishment and Implementation of Quality Control (QC) Program in Diagnostic Radiological Facilities

NRRC-R-01-SR03

2023

هيئة الرقابة النووية والإشعاعية
Nuclear and Radiological Regulatory Commission

Specific Regulation

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Preamble

In accordance with the provisions of the radiation safety Regulation (NRRC-R-01), approved by the NRRC's Board of Directors in resolution No. (R/1/1/2022), dated 20 April 2022, chapter (12) section (78) article (224), this specific regulation provides detailed requirements for the quality control tests that mentioned in the radiation safety Regulation.

This specific regulation has been prepared on the basis of International Atomic Energy Agency (IAEA) standards, as well as the and the international best practices and the experiences of similar international regulatory bodies, and in accordance with the Kingdom's international commitments, and it has been approved by the NRRC's CEO resolution No. 1368 dated 9/7/2023.

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Chapter 1: Objective, Scope, and Definitions

Section 1: Objective

1. This specific regulation sets out the specific detailed requirements for the establishment and implementation of Quality Control programs in diagnostic radiology facilities.

Section 2: Scope

2. This specific regulation applies to all diagnostic and interventional radiology equipment that may include but not limited to:

    a. Conventional radiography equipment;

    b. Fluoroscopy equipment;

    c. Diagnostic screens

    d. Bone densitometry equipment;

    e. Intraoral dental radiology equipment;

    f. Orthopantomography equipment (panoramic and cephalometric operation);

    g. Cone Beam Computed Tomography (CBCT) equipment for dental, maxillofacial examinations;

    h. Cone Beam Computed Tomography (CBCT) equipment and fluoroscopy equipment for use in operation rooms (O-ARMS);

    i. Computed Tomography (CT) equipment;

j. Conventional mammography equipment;

k. Computed (CR) and Digital (DR) mammography equipment;

l. Mammography screens

m. Interventional radiology & cardiology equipment.

Section 3: Definitions

Acceptance testing

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

Commissioning

The process by means of which systems and components of facilities and activities, having been constructed, are made operational and verified to be in accordance with the design and to have met the required performance criteria.

Medical physicist

A Health Professional 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 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.) used for the performance of the 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 Program

Section 4: General Requirements

3. The authorized person shall:

    a. Establish and implement a Quality Control program for the

diagnostic and interventional radiology equipment clinically used in the diagnostic radiology facility.

b. Ensure that the established QC program includes, the corresponding tests and criteria specified in Appendix I as a minimum.

4. The authorized person shall ensure the availability of the necessary resources for the proper implementation of the established QC program.

5. In addition to the scheduled QC tests defined in the facility's QC program, the authorized person shall ensure that diagnostic and interventional radiology equipment undergoes QC tests, as follows:

    a. At the time of acceptance, commissioning and relocation of the equipment, prior to their clinical use on patients, the QC tests in Appendix I that has the frequency of "During Acceptance" shall be carried out.

    b. After any major maintenance or modification procedure that could affect the protection and safety of patients the QC tests in Appendix I that has the frequency of "Annually" shall be carried out.

    c. After any major maintenance or modification procedure that could affect the protection and safety of patients the QC tests in Appendix I that has the frequency of "Annually" shall be carried out.

d. After any installation of new software or modification of existing software that could affect the protection and safety of patients the QC tests in Appendix I that has the frequency of "Annually" shall be carried out.

6. In case the results of the QC tests show that a diagnostic or interventional radiology equipment performs out the respective tolerance limits defined in this specific regulation, the authorized person shall ensure that the equipment will not be clinically used until all the necessary corrective measures are taken, and after it has been verified that its performance is within the respective tolerance limits.

Section 5: Personnel

7. The authorized person shall ensure that the QC tests of the established QC program are performed by:

    a. Medical Physicist of the facility or under the supervision of a Medical Physicist; or

    b. The Medical Physicist may assign the performance of the QC tests to other members of the diagnostic radiology facility staff only if they have adequate training and the competence to perform the tests.

8. The Radiation Safety Officer of the diagnostic radiology facility shall ensure the proper implementation of the QC program.

Section 6: QC equipment

9. The authorized person shall ensure that:

    a. Appropriate QC equipment and tools are used for the performance of the QC tests.

    b. All the measuring equipment used for the performance of QC tests have a valid calibration certificate.

Section 7: Records

10. The authorized person shall keep appropriate records of the implementation of the established QC program in the radiology facility including, at least, 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 the performance of the QC tests and the associated preventive and corrective actions undertaken.

    d. Information on:

        i. The preventive maintenance and servicing,

        ii. Any repair(s)

        iii. Any major component replacement(s),

        iv. Any manufacturer's upgrade(s), and

v. Any calibration of the diagnostic and interventional radiology equipment used in the QC tests.

f. Records and reports of the implemented QC program.

g. (f) Records of the results of the QC tests performed in line with the provisions of article 5.

11. The authorized person shall ensure that the records of the implemented QC program are available to the NRRC at all times.

Section 8: Annual reporting

12. The authorized person shall ensure that an annual QC report is prepared for all diagnostic and/or interventional radiology equipment of the facility, either separate for each of them or for a set of equipment which shall include, at least, the following information:

a. General information about the facility.

b. Details of the personnel performing the QC tests.

c. Detailed list of the QC equipment used for the performance of the QC tests.

d. The calibration certificates of the measuring equipment used for the performance of the QC tests and the details of the reference sources used in QC testing.

e. Information on the diagnostic or interventional radiology equipment tested including their type, model and serial number of the X-ray tube.

f. Detailed list of the QC tests performed to the diagnostic or interventional radiology equipment, including:

   i. The date of performance of each QC test,

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

   iii. A conclusion regarding the performance of the diagnostic or interventional radiology 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.

13. In case an annual report is prepared for a set of diagnostic and/or interventional radiology equipment, the information of article 12 a-e may be provided only once, as applicable.

14. The Medical Physicist shall review and approve the QC reports.

15. The Radiation Safety Officer shall ensure that the QC reports:

    a. Are signed by the Medical Physicist who conducted or supervised the performance of the QC tests.

    b. Are communicated to the authorized person and the main findings and conclusions are presented in detail.

16. The authorized person shall submit to the NRRC the annual QC report for the diagnostic or interventional radiology equipment of the facility on an annual basis and within three (3) months of the specified QC dates.

Appendix I

This Appendix covers the required Quality Control (QC) tests for the diagnostic radiology equipment including their frequency and tolerance limits.

Table I: Required QC tests for conventional radiography equipment

QC test	Frequency	Tolerance limit
Adequacy of shielding	During acceptance and annually	According to the specified limits and constraints
Leakage radiation	During acceptance and annually	At the maximum rating specified by the manufacturer
Focal spot size	During acceptance and annually	≤± 1.5 f (f: nominal value of focal spot size)
Focus-Image Detector Distance (FID)	During acceptance and annually	<±2cm
X-ray beam and light field alignment/cantering	During acceptance and annually	±2%/±1% FID
X-ray beam verticality	During acceptance and annually	Deviation from 90o <1.5o
Grid operation	During acceptance and annually	According to the test tool specifications
Automatic collimation	During acceptance and annually	< ±2% of the FID
Half Value Layer (HVL)	During acceptance and annually	>2.9 mm Al at 80kV
kV accuracy	During acceptance and annually	<±5% or ±5 kV, whichever is greater
kV reproducibility	During acceptance and annually	< ±5%

Exposure time accuracy	During acceptance and annually	For exposure times >100 msec: < ± 10% For exposure times ≤ 100 msec: < ± 20%
Exposure time reproducibility	During acceptance and annually	< ±5%
Radiation output	During acceptance and annually	25-80μGy/mAs at 80 kV (and 2.5 mmAl total filitration) at 100 cm from the x-ray tube focal spot
Linearity of radiation output	During acceptance and annually	<±15%
AEC system performance with the absorption thickness	During acceptance and annually	LEI≤ 5μGy Acceptable max deviation: LEI ≤ 20% Achievable max deviation: LEI ≤ 15%
AEC system performance with kV	During acceptance and annually	LEI ≤ 5μGy Acceptable max deviation: LEI ≤ 20% Achievable max deviation: LEI ≤ 15%
AEC reproducibility	During acceptance and annually	≤10%
AEC chambers	During acceptance and annually	Max deviation of mAs ≤20%
Typical patient dose	Annually	According to the nationally established DRLs
Spatial resolution	During acceptance and annually	>1.6lp/mm
Low contrast resolution	During acceptance and annually	According to the test tool specifications

Table II: Required QC tests for fluoroscopy equipment

QC test	Frequency	Tolerance limit
Adequacy of shielding	During acceptance and annually	According to the specified limits and constraints
Leakage radiation	During acceptance and annually	At the maximum rating specified by the manufacturer
Half Value Layer (HVL)	During acceptance and annually	>2.9 mm Al at 80kV
kVp accuracy	During acceptance and annually	<±5% or ±5 kV, whichev-er is greater
kVp reproducibility	During acceptance and annually	< ±5%
Patient entrance dose rate	During acceptance and annually	≤ 40 mGy/ min
Maximum patient dose rate	During acceptance and annually	≤ 88 mGy/min for ABC standard mode ≤ 176 mGy/min for ABC high dose rate mode
Maximum dose rate at the entrance of the image receptor	During acceptance and annually	< 1 µGy/sec
Typical patient doses	Annually	Corresponding national DRLs
Low Contrast Detectability	During acceptance and annually	< 4 % for all the sizes field
High Spatial Resolution	During acceptance and annually	>0.8 lp/mm for field > 23 cm > 1 lp/mm for field ≤ 23 cm

Table III: Required QC tests for bone densitometry equipment

QC test	Frequency	Tolerance limit
Adequacy of shielding	During acceptance and annually	Pencil beam equipment: Background. Fan/cone beam equipment: <2μSv/hr at operator's position at least 2m from the examination bed.
Daily QC test	During	Pass/fail
BMD, BMC accuracy	During acceptance and annually	<± 2 % or ± 3 %
BMD, BMC reproducibility	During acceptance and annually	< ± 5%
Change of BMD and BMC values with thickness	During acceptance and annually	<± 2 % or ± 3 %

Table IV: Required QC tests for intraoral dental radiology equipment

QC test	Frequency	Tolerance limit
Instantaneous dose rates	During acceptance and annually	<1μSv/hr at operator's position and < 0.5μSv/hr at general public areas
Radiation field size	During acceptance and annually	< of the nominal field diameter
kV accuracy and reproducibility	During acceptance and annually	Accuracy < ± 10% Reproducibility < ± 5%
Half Value Layer (HVL)	During acceptance and annually	>2.5 mm Al at 70kV
Exposure time accuracy and reproducibility	During acceptance and annually	Accuracy < ± 10% Reproducibility < ± 5%
Radiation output	During acceptance and annually	<3.7mGy for conventional equipment <1.2mGy for DR and CR equipment
Linearity of radiation output	During acceptance and annually	≤ ± 20%
Reproducibility of radiation output	During acceptance and annually	< ±5%
High contrast resolution	During acceptance and annually	According to the test tool specifications
Typical patient doses	According to the NRRC guidelines	According to the NRRC guidelines

Table V: Required QC tests for orthopantomography equipment (panoramic and cephalometric operation)

QC test	Frequency	Tolerance limit
Shielding adequacy	During acceptance and annually	According to the specified limits and constraints
Radiation field size	During acceptance and annually	≤ 10 x 150mm
Radiation output	During acceptance and annually	30 - 80μGy/mAs at 1m and in the clinical range of kV settings
Half Value Layer (HVL)	During acceptance and annually	>2.5 mm Al at 70kV
Symmetry	During acceptance and annually	Max measured distance <±5%.
High contrast resolution	During acceptance and annually	> 2.5 lp/mm
Low contrast detectability	During acceptance and annually	According to the test tool specifications
Typical patient doses	According to the NRRC guidelines	According to the NRRC guidelines

Table VI: Required QC tests for Orthopantomography CBCT equipment for dental, maxillofacial examinations.

QC test	Frequency	Tolerance limit
Shielding adequacy	During acceptance and annually	According to the specified limits and constraints
Leakage radiation	During acceptance and annually	<1 mSv/h @1m
Focal spot size	During acceptance and annually	≤ 1.5 f (f = nominal focal spot size)
kV reproducibility	During acceptance and annually	≤ ± 5 %
Radiation output	During acceptance and annually	≤ ±10% of baseline
Radiation output reproducibility	During acceptance and annually	short-term ≤± 5 % long-term ≤ ± 10 %
Linearity of radiation output	During acceptance and annually	-
Half Value Layer (HVL)	During acceptance and annually	>2.5mmAl
Pulse duration accuracy (for pulsed equipment)	During acceptance and annually	≤ ±10% for pulses < 10ms ≤ ±5% for pulses > 10ms
Exposure/examination time accuracy	During acceptance and annually	≤ ±15%
CTDI accuracy	During acceptance and annually	0.8 ≤ R ≤1.2
DAP accuracy	During acceptance and annually	0.85 ≤ R ≤1.15
Typical patient doses	Annually	According to the corresponding national DRLs
Verification of radiation field sizes – FOV	During acceptance and annually	0.8 ≤ R ≤1.2

High Contrast Resolution (HCR) – Modulation Transfer Function (MTF)	During acceptance and annually	$MTF_{50} \geq 0.4$ lp/mm $MTF_{10} \geq 1.0$ lp/mm
CBCT pixel values (PV)	During acceptance and annually	<± 20 HU
Image noise	During acceptance and annually	<±20% of the established baseline
Uniformity of the reconstructed image	During acceptance and annually	PV_{per}-PV_{c} should be <40PV or <±20% of the established baseline

Table VII: Required QC tests for CBCT and fluoroscopy equipment for use in operation rooms (O-ARMS)

QC test	Frequency	Tolerance limit
Shielding adequacy	During acceptance and annually	According to the specified limits and constraints
Leakage radiation	During acceptance and annually	<1 mSv/h @ 1 m
Focal spot size	During acceptance and annually	≤ 1.5 f (f = nominal focal spot size)
kV accuracy (fluoroscopy)	During acceptance and annually	≤ ± 10 %
kV reproducibility (fluoroscopy)	During acceptance and annually	≤ ± 5 %
Radiation output	During acceptance and annually	≥25 µGy/mAs at 1m, ≤ ±10 % of baseline
Radiation output reproducibility	During acceptance and annually	short-term ≤± 5 % long-term ≤ ± 10 %
Half Value Layer (HVL)	During acceptance and annually	≥ 2.5mmAl
Pulse duration accuracy (for pulsed equipment)	During acceptance and annually	≤ ±10% for pulses < 10ms ≤ ±5% for pulses > 10ms
Patient entrance dose rate (fluoroscopy)	During acceptance and annually	>20% from the baseline in each recheck
Maximum patient entrance dose rate (fluoroscopy)	During acceptance and annually	>20% from the baseline in each recheck.
Characteristic fluoroscopy curve	During acceptance and annually	-
DAP accuracy	During acceptance and annually	0.85 ≤ R ≤1.15

Typical patient doses	Annually	According to the corre-sponding national DRLs
Clinical low contrast de-tectability (LCD)	During acceptance and annually	< 3.9 %
Low contrast detectability (LCD)	During acceptance and annually	< 3.9 %
High Contrast Resolution (HCR)	During acceptance and annually	>30cm: ≥ 1lp/mm 24-30cm: ≥ 1.4lp/mm 18-24cm: ≥ 1.6lp/mm 15-18cm: ≥ 1.8lp/mm <15cm: ≥ 2lp/mm
CTDI accuracy	During acceptance and annually	0.8 ≤ R ≤1.2
Slice thickness (ST) Reconstruction slice thick-ness (ST)	During acceptance and annually	<±35% For ST<2mm <50% For ST>2mm <1mm
High Contrast Spatial Res-olution (HCSR)/MTF	During acceptance and annually	> 7 lp/cm. For MTF50 ≥ 0.4 lp/mm For MTF10 ≥ 1.0 lp/mm Deviation from the base-line ≤ ±20%
CBCT pixel values (PV)	During acceptance and annually	<± 20 HU
Image noise	During acceptance and annually	<±20% of the established baseline
Uniformity of reconstruct-ed images	During acceptance and annually	PVper-PVc should be <40PV or <±20% of the established baseline

Table VIII: Required QC tests for diagnostic screens.

QC test	Frequency	Tolerance limit
S/N and display – back-light lifetime	During acceptance and every six months	-
Ambient light	During acceptance and every six months	≤ 20 lux
Artefacts	During acceptance and every six months	-
Luminance	During acceptance and every six months	Deviation between successive steps of the grayscale ≤10%
Luminance uniformity	During acceptance and every six months	≤ 30% for UNL10 ≤ 10% for UNL80

Table IX: Required QC tests for Computed Tomography (CT) equipment.

QC test	Frequency	Tolerance limit
Geometric accuracy of lasers and SPR	During acceptance and annually	≤ ±5mm for positioning with the lasers and ≤ ±2mm for positioning with the SPR
Table movement accuracy	During acceptance and annually	<±2mm
Gantry angle accuracy	During acceptance and annually	≤±1o
CT number accuracy (CT#w) & noise (SDw)	Every four months at 120kV and annually	CT# w: 0±5 HU SD ≤ ±25%
CT# w uniformity	Every four months at 120kV and annually	≤ ±5 HU
CT number accuracy and Linearity	Annually	According to the manufacturer's limits
Imaged slice thickness (ST)	Annually	For ST ≤1mm: ≤ nominal + 0.5mm For 1<nominal ST ≤2mm: ≤ nominal ± 50% For nominal ST >2mm: ≤ nominal ± 1mm
Spatial Low Contrast Detectability (SLCD)	Annually	According to the manufacturer's limits
Spatial High Contrast Resolution (SHCR)	Annually	According to the manufacturer's limits in lp/mm
Accuracy of CTDI displayed indications	Annually	≤ ±20%
CTDI in air	Annually	≤ ±20% from manufac-turer's value
Typical patient doses	Annually	According to the estab-lished national DRLs
kV accuracy	Annually	≤ ±5%

Table X: Required QC tests for conventional mammography equipment.

QC test	Frequency	Tolerance limit
Shielding adequacy	During acceptance and annually	According to the specified limits and constraints.
Leakage radiation	During acceptance and annually	<1 mSv/h at 1m
System reproducibility	During acceptance and annually	< ± 5% mAs or < ± 0.20 OD
Coincidence of image receptor with the radiation field	During acceptance and annually	On all sides: the radiation field should not extend more than 5mm outside the film. On the thoracic wall: The distance between the film edge and the bucky edge should be ≤ 5mm
Focus – Image receptor Distance (FID)	During acceptance and annually	According to system's specifications
Focal spot size	In case of spatial high-resolution degradation	According to system's specifications
Breast compression system force	During acceptance and annually	Maximum applicable force stable for 1min: 130-200N
Thickness Indication	During acceptance and annually	<±5mm
kV accuracy and reproducibility	During acceptance and annually	Accuracy: ≤±1kV Reproducibility: ≤±0.5kV
Half Value Layer (HVL)	During acceptance and annually	For Mo/Mo combination at 28kV ≥ 0.3mm Al. For all anode/filter combinations: (kV/100) + 0.03 ≤ HVL ≤ (kV/100) + C, where C = 0.12 for Mo/Mo, 0.19 for Mo/Rh, and 0.22 for Rh/Rh.

Radiation output and re-producibility of radiation output	During acceptance and annually	Mo/Mo combination, 28kV: > 30μGy/mAs at 1m Reproducibility <±5%
Linearity of radiation output	During acceptance and annually	<±10%
Change of optical density (OD) with phantom thick-ness and kVp	During acceptance and annually	≤± 0.15OD ≤± 0.5cm
Standard exposure time	During acceptance and annually	<2s
Grid uniformity	During acceptance and annually	YES/NO
Grid system factor	In case of a sudden in-crease in dose or the expo-sure time	<3
High contrast resolution (HCR)	During acceptance and annually	>12lp/mm
Low contrast resolution (HCR)	During acceptance and annually	Masses: Diameter <0.7mm, Fibers: Thick-ness <0.7mm, Micro-calcifications: Di-ameter <0.3mm. Masses of diam-eter 5 - 6mm of variable contrast: <1.5%
Artefacts	During acceptance and annually	YES/NO
Entrance Surface Dose (ESD)	During acceptance and annually	According to the es-tab-lished national DRLs
Mean Glandular Dose (MGD)	During acceptance and annually	According to the es-tab-lished national DRLs

Table XI: Required QC tests for Computed (CR) and Digital (DR) mammography equipment.

QC test	Frequency	Tolerance limit
Shielding adequacy	During acceptance and annually	According to the specified limits and constraints as in the authorization
Leakage radiation	During acceptance and annually	<1mSv/h at 1m
System reproducibility	During acceptance and annually	< ± 5% mAs
Coincidence of image receptor with the radiation field	During acceptance and annually1	≤ 5mm
Focus – Image receptor Distance (FID)	During acceptance and annually	According to system spec-ifications
Focal spot size	In case of spatial high-resolution degradation	According to system's specifications.
Breast compression system force	During acceptance and annually	<±20N of the measured value
Thickness Indication	During acceptance and annually	<±5mm
kV accuracy and reproducibility	During acceptance and annually	Accuracy ≤ ±1kV Reproducibility ≤ ±0.5kV

Half Value Layer (HVL)	During acceptance and annually	For Mo/Mo combination at 28kV ≥ 0.3mm Al. For all anode/filter combina-tions: (kV/100) + 0.03 ≤ HVL ≤ (kV/100) + C, where C = 0.12 for Mo/Mo, 0.19 for Mo/Rh, and 0.22 for Rh/Rh.
Radiation output and re-produci-bility of radiation output	During acceptance and annually	For Mo/Mo combination at 28kV > 30μGy/mAs at 1m. Reproducibility <±5%
Linearity of radiation output	During acceptance and annually	<±10%
Change of mAs with the darkening step	During acceptance and annually	mAs values per darkening step in the range: 5-15%.
Change of selected expo-sure pa-rameters with the phantom thickness	During acceptance and annually	PMMA(cm) CNR/CNR5cm (%) 2.0> 115 3.0> 110 4.0> 105 4.5> 103 5.0> 100 6.0> 95 7.0> 90
Standard exposure time	During acceptance and annually	<2s
Detector response	During acceptance and annually	R^2 > 0.99

Image uniformity	During acceptance and annually	Maximum deviation of the mean MVP value from this in the whole image <± 15%. Max SNR de-via-tion <± 15% from the mean SNR value in all the ROIs.
Detector noise- Signal to Noise Ratio (SNR)	During acceptance and annually	R2 value calculated during the acceptance of the mammography system is used as the reference value.
Artefacts	During acceptance and annually	YES/NO
Detector ghosting	During acceptance and annually	GIF < 0.3
High Contrast Resolution (HCR)	During acceptance and annually	> 7 lp/mm
Low Contrast Resolution (LCR)	During acceptance and annually	Masses: Diameter < 0.7mm, Fibers: Thickness < 0.7mm, Micro-calcifica-tions: Diameter < 0.3mm. For masses of diameter 5 – 6mm of variable contrast: < 0.85% (Mo/Mo, 28kV).
Relative cassettes' response (CR equipment)	During acceptance and annually	Deviation of the SNR val-ue among different cas-settes < ± 15%. De-viation of mAs among the differ-ent cassettes: < ±10%. Deviation of the EI value among the var-ious cas-settes: < ±10%. The uni-formity should be satis-factory in all images

Degradation of the ac-quired imag-es (CR equip-ment)	During acceptance and annually	According to reference values
Entrance Surface Dose (ESD)	During acceptance and annually	According to the estab-lished national DRLs
Mean Glandular Dose (MGD)	During acceptance and annually	According to the es-tab-lished national DRLs

Table XII: Required QC tests for mammography screens.

QC test	Frequency	Tolerance limit
Diagnostic room lighting	During acceptance and in case of problems with image quality	LCD screens ≤ 20lux CRT screens ≤ 10 lux
Contrast visibility	Daily	According to the phan-tom specifications
Resolution	Biannually	All the phantom's line patterns should be visible
Image distortion	Daily	YES/NO
Brightness range	Annually	$Max_{LUM}/Min_{LUM}>250$
Brightness uniformity	Annually	Max deviation < 30%

Table XIII: Requirements for QC tests for interventional radiology & cardiology equipment

QC test	Frequency	Tolerance limit
Shielding adequacy	During acceptance and annually	According to the specified limits and constraints.
Leakage radiation	During acceptance and annually	<1 mSv/h @ 1 m
Spatial high contrast resolution (SHCR)	During acceptance and every six months	For new technology fluoroscopy equipment: Field size lp/mm > 30cm > 1.0 24-30cm > 1.4 18-24cm > 1.6 15-18cm > 1.8 < 15cm > 2.0 For older technology fluoroscopy equipment: Field size lp/mm > 25cm > 1.0 < 25cm > 1.2
Low Contrast Detectability (LCD)	During acceptance and every six months	<3.0mm for 2% contrast and < 1.5mm for 4% contrast. The LC thresh-old is < 4% for fluorosco-py and < 2.7% for CINE/DA
SDD and Table-detector distance – fluoroscopic operation (FO)	During acceptance and annually	<±2%

Geometric distortion (equipment with image intensifier) - FO	During acceptance and annually	GD ≤15%
Patient entrance dose rate - FO	During acceptance and annually	<40mGy/min
Maximum patient dose rate - FO	During acceptance and annually	without grid < 88mGy/min (not for HDR modes) and <176mGy/min (for HDR modes)
Dose rate at the detector en-trance - FO	During acceptance and annually	Normal mode of op-era-tion without grid <1μGy/s and with grid <2μGy/s
Typical patient doses - FO	During acceptance and annually	According to the nation-al-ly established DRLs
Automatic Exposure Con-trol (AEC) - FO	During acceptance and annually	<20%
Half Value Layer (HVL) - FO	During acceptance and annually	> 2.9mm Al at 80kV
Radiation field vs image receptor	During acceptance and annually	R < 1.15 for equipment with detector with in-ter-nal diameter > 24cm R < 1.20 for equipment with detector with in-ter-nal diameter between 18 and 24cm R < 1.25 for equipment with detector with in-ter-nal diameter < 18cm R <1.15 for equipment with a rectangular detector

Patient entrance dose rate - CINE/DA/DSA	During acceptance and annually	< 2m Gy/frame (no cardio modes) for max FOV and phantom thickness of 20cm. 0.08-0.2mGy/fr for 15fr/sec, max FOV, and a phantom thickness of 20cm. Difference from reference value < 25%.
Dose rate at the detector en-trance - CINE/DA/DSA	During acceptance and annually	< 0.5µGy/fr without grid or < 1 µGy/fr with grid (Cardiac mode) <5µGy/fr (DSA). Typical values without grid for larger FOVs: 0.1 - 0.2µGy/fr (Cardiac mode), 0.4- 0.8µGy/fr (DA), and 0.8 - 2µGy/fr (DSA)
Automatic Exposure Control (AEC) - CINE/DA/DSA	During acceptance and every six months	< 20%
Typical patient dose - CINE/DA/DSA	Annually	According to the nationally established DRLs
Air Kerma Rate (AKR) accuracy - CINE/DA/DSA	During acceptance and annually	< ±20% (for dose>100mGy and dose rate >6mGy/min)
Kerma Area Product (KAP) accu-racy - CINE/DA/DSA	During acceptance and annually	< ±35% (for KAP > 2.5Gycm^2)

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