ARRT Radiography Quality Control (QC) Cheat Sheet

Equipment Performance Tests, Tolerance Limits, Test Tools & Regulatory Frequencies

1. X-Ray Tube & Generator Performance Tests

QC Test	Tolerance Limit	Frequency	Test Tool / Device	Purpose & Clinical Impact
kVp Accuracy	**±5% of set kVp**	**Annually**	Non-invasive electronic kVp meter / oscilloscope	Verifies beam penetrating power matches control console selection; prevents contrast errors and repeat exposures.
Exposure Timer Accuracy	**±5% (> 10 ms)** **±20% (≤ 10 ms)**	**Annually**	Electronic timer / spinning top (synchronous or motorized)	Confirms accurate exposure duration; prevents receptor under/ overexposure and motion blur.
mA Linearity	**±10% (0.10) between adjacent stations**	**Annually**	Ionization chamber / solid-state dosimeter	Ensures constant radiation output (mGy/ mAs) when changing mA and time combinations for equal mAs.
Exposure Reproducibility	**±5% (0.05) across repeated exposures**	**Annually**	Ionization chamber / dosimeter	Verifies identical output when repeating exposures with unchanged technical factors (kVp, mA, time, SID).
Half-Value Layer (HVL) / Filtration	**≥ 2.5 mm Al eq. (above 70 kVp)**	**Annually**	High-purity aluminum (1100 alloy) sheets + dosimeter	Measures beam quality; ensures soft, low-energy photons are filtered out to protect patient skin dose.
Focal Spot Size Measurement	**Within NEMA standards (up to +50% on small spots)**	**Annually / Acceptance**	Slit camera, pinhole camera, or star test pattern	Detects focal spot blooming or filament degradation that degrades spatial resolution (causes geometric unsharpness).
Tube Housing Leakage	**≤ 100 mR/hr (1 mGy/hr) at 1 meter**	**Acceptance / Tube replacement**	Survey meter (ionization chamber) with collimator closed	Ensures lead-lined protective tube housing prevents stray radiation exposure to staff and patients.

2. Collimation, Beam Alignment & Fluoroscopy Limits

QC Test	Tolerance Limit	Frequency	Test Tool / Device	Purpose & Clinical Impact
Light-to-Radiation Field Congruence	**±2% of SID**	**Semiannually (every 6 mos)**	Collimator test template + radiopaque markers	Ensures illuminated light field accurately reflects the actual X-ray beam area to prevent anatomy cutoff or overexposure.

QC Test	Tolerance Limit	Frequency	Test Tool / Device	Purpose & Clinical Impact
Positive Beam Limitation (PBL)	**±2% of SID**	**Semiannually**	Cassette/ detector tray + radiopaque markers	Verifies automatic collimation matches the receptor dimensions inserted into the Bucky tray.
Central Ray Perpendicularity	**Within 1° to 2° of vertical**	**Semiannually**	Wisconsin beam alignment cylinder (steel BBs)	Confirms central ray strikes receptor at 90°; superimposed top/ bottom BBs indicate proper alignment.
Fluoroscopy Tabletop Exposure Rate	**≤ 10 R/min (100 mGy/min) standard; ≤ 20 R/min HLC**	**Annually**	Dosimeter at tabletop (30 cm above image intensifier)	Caps continuous fluoroscopic skin dose rate; High-Level Control (HLC) requires continuous audible/ manual activation.
Fluoroscopy Cumulative Timer	**Audible alarm at 5 minutes**	**Annually**	Stopwatch	Alerts fluoroscopist after 5 minutes of beam-on time to prevent deterministic skin injury.

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Digital Imaging Receptors, Display Monitors, Grids, AEC & Protective Apparel

3. Automatic Exposure Control (AEC), Grids & Protective Apparel

QC Test	Tolerance Limit	Frequency	Test Tool / Device	Purpose & Clinical Impact
AEC Reproducibility & Density	**±5% output; ±0.15 OD / EI target**	**Annually**	Acrylic/water attenuation phantoms of varying thickness	Ensures consistent detector exposure across varying patient thicknesses and kVp changes.
AEC Minimum Response & Backup Time	**Backup ≤ 600 mAs (or 6 seconds)**	**Annually**	Lead blocker over ion chambers	Terminates exposure automatically if ion chamber fails or wrong chamber is selected, preventing severe overexposure.
Grid Uniformity & Alignment	**Uniform exposure; no grid cutoff**	**Annually / As needed**	Uniform acrylic phantom + densitometer / ROI tool	Detects bent/ damaged lead strips, inverted focused grids, or off-center/off-focus grid cutoff.
Protective Apparel Integrity	**No tears/cracks > 15 mm² (or > 2 mm over gonads/thyroid)**	**Annually & upon receipt**	Fluoroscopy unit or high-kVp radiograph	Inspects internal lead-vinyl lining of aprons, thyroid shields, and gloves for hidden cracks from folding.

4. Digital Image Receptor (CR/DR) & Display Monitor QC

QC Test	Tolerance Limit	Frequency	Test Tool / Device	Purpose & Clinical Impact
Phantom Image Quality	**Resolves baseline lp/mm & contrast holes**	**Quarterly / Annually**	ACR or Leeds resolution/contrast phantom	Evaluates spatial resolution (line-pair gauge) and low-contrast detectability simultaneously.
Flat-Field Uniformity & Artifacts	**No dead pixels, lines, dust, or ghosting**	**Daily / Weekly**	Unobstructed receptor exposed to uniform low dose	Identifies dead detector elements (DELs), CR plate scratches/dust, and incomplete erasure ghosting.
CR Cassette Erasure & Dark Noise	**Zero residual latent image**	**Weekly / Monthly**	Unexposed CR imaging plate processed in reader	Confirms bright erasure lamps completely clear previous images and checks electronic background noise.
Exposure Index (EI) Calibration	**Within ±10% of target EI**	**Annually**	Calibrated dosimeter + standard phantom	Prevents "dose creep" by ensuring displayed EI accurately reflects incident receptor exposure.
Display Monitor Evaluation	**5% & 95% patches visible; ≥ 170–350 cd/m²**	**Daily (visual) / Quarterly (meter)**	SMPTE or AAPM TG18 test pattern + photometer	Verifies grayscale contrast differentiation (5% inside 0%, 95% inside 100%), luminance, and geometric accuracy.

High-Yield ARRT Registry Memory Hooks:

- **The "±2% of SID" Rule:** Applies to *both* Collimator Light-to-Radiation Congruence and Positive Beam Limitation (PBL). At a standard 40-inch SID, the maximum allowable misalignment is **0.8 inches** (40 × 0.02 = 0.8 in); at 72-inch SID, it is **1.44 inches**.
- **The "5–10–5" Generator Rule:** kVp Accuracy = **±5%**, mA Linearity = **±10%**, Exposure Reproducibility = **±5%**.
- **Minimum Filtration (HVL):** Machines operating above 70 kVp require at least **2.5 mm Aluminum equivalent** total filtration (inherent + added).
- **Spinning Top Math:** For a 1-phase full-wave rectified unit (120 pulses/sec), expected dots = `120 × exposure time (s)`. For a synchronous top (1 rev/sec), expected arc = `360° × exposure time (s)`. High-frequency generators require an electronic timer because output is nearly constant potential.