QA in CR/DDR

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CR & DDR tests (from IPEM 91)

Table 5.2 CR reader

Reference paragraph	Physical parameter	Level of expertise	Frequency	Priority	Remedial level	Suspension level
CR01	Detector dose indicator monitoring	A	1–3 monthly	1	Baseline ±20%[a]	Baseline ±50%[a]
CR02	Image uniformity	A	1–3 monthly	1	Dots and lines apparent	Gross non-uniformity
CR03	Condition of cassettes and image plates	A	Supplier's recommendation	1	Dirt on plate	Damage to plate
CR04	Low contrast sensitivity	A	4–6 monthly	2	Baseline ±2 groups	
CR05	Limiting spatial resolution	A	4–6 monthly	2	Baseline minus 2 groups	
CR06	Detector dose indicator repeatability	B	12 monthly	1	Baseline ±10%[a]	Baseline ±20%[a]
CR07	Detector dose indicator reproducibility	B	12 monthly	1	Baseline ±20%[a]	Baseline ±50%[a]
CR08	Measured uniformity	B	12 monthly	1	Mean ±10%	Mean ±20%
CR09	Threshold contrast detail detectability	B	12 monthly	1	See Comments	
CR10	Erasure cycle efficiency	B	12 monthly	2	Blocker visible in second image	
CR11	Limiting spatial resolution	B	12 monthly	2	Baseline minus 25%	
CR12	Scaling errors	B	12 monthly	2	>2%	
CR13	Dark noise	B	12 monthly	2	Baseline +50%	

[a] These remedial and suspension levels are based on dosimetry, since the DDI is not linear with exposure; see Table 5.1.

LEVEL A TESTS – CR01 to CR05

CR01: Detector Dose Indicator Monitoring

- Record the DDI / Sensitivity Index of the system. The long-term decline of the system and plates can be monitored.
- The tolerance for remedial and suspension levels are based on dosimetry; however, the **DDI is not linear with exposure**.

Suggested Method

- 70 kV and 3 mAs
- 1mm Cu at tube head
- SID of 1m

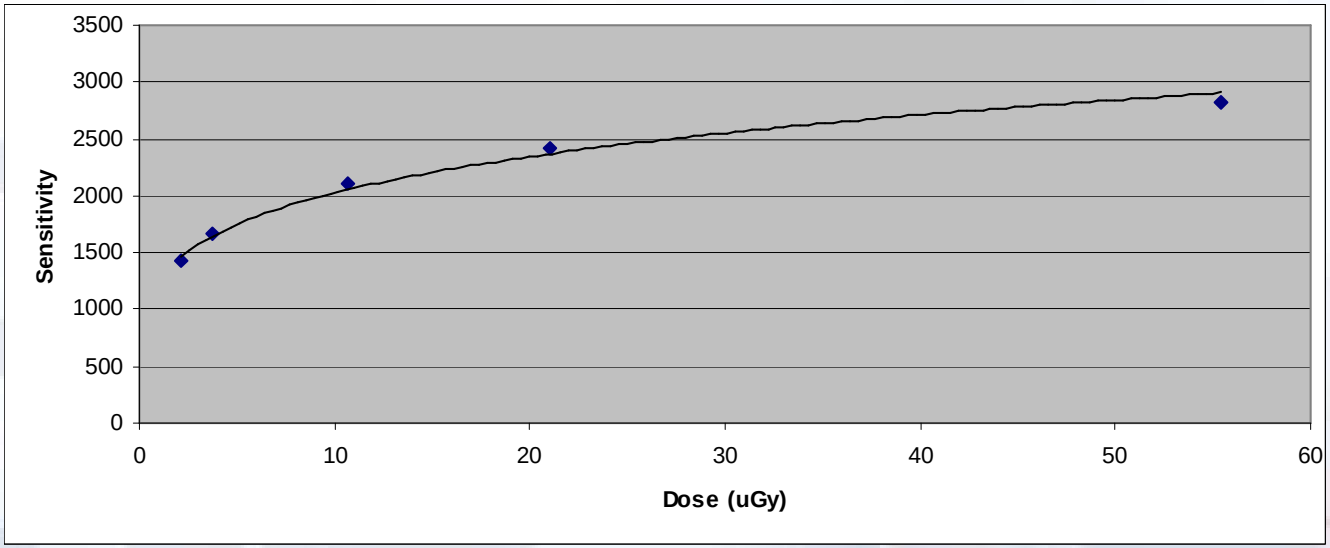
■ Cover entire plate

■ Read plate after consistent time period under a linear algorithm (look-up table)

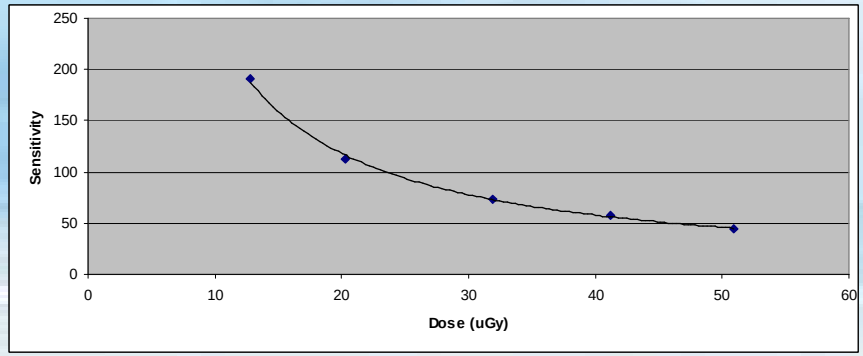
Reference paragraph	Physical parameter	Level of expertise	Frequency	Priority	Remedial level	Suspension level
CR01	Detector dose indicator monitoring	A	1–3 monthly	1	Baseline ±20%[a]	Baseline ±50%[a]

Dose Detector Indicator (DDI) vs Dose (µGy)

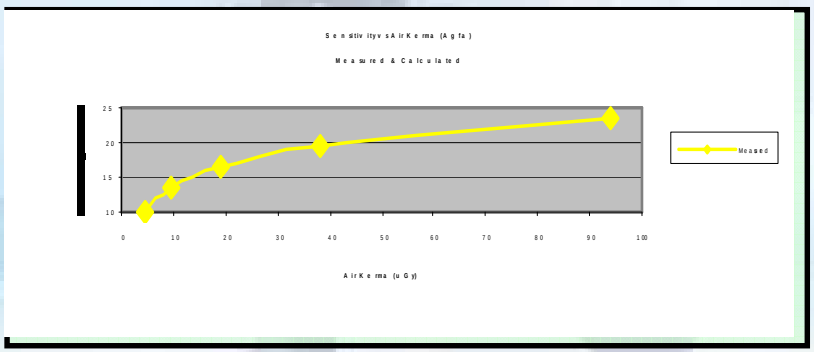
- Kodak's DDI vs Dose (µGy)



- Philips/Fuji's DDI (S) vs Dose (µGy)



- Agfa's DDI (lgM) vs Dose (µGy)



Sensitivity Index (DDI) Calculations

- **Expose Plate to ~10µGy**
- **Read Sensitivity**

•Fuji Exposure = 1740/S

•Agfa Exposure = $9.33*10^{lgM-3.2768}$

•Kodak Exposure = $8.7*10^{n}$ (where n = (EI-2000)/1000))

Calculating the Tolerances in EI

Remedial and Suspension values are 20% and 50% of the baseline **dose**, respectively.

D = 1740/S

S = 1740/D

	Bucky Dose (µGy)	Sensitivity (EI)
+ve suspension failure (+50% dose)	5.196	335
+ve remedial failure (+20% dose)	4.156	419
Baseline	3.464	502
-ve remedial failure (-20% dose)	2.771	628
-ve suspension failure (-50% dose)	1.732	1005

DDI Changes

The table below demonstrates DDI changes (i.e. how to calculate tolerances).

Table 5.1 DDI change

Plate exposure change (%)	Agfa (SAL) (%)	Fuji (S) (%)	Kodak (EI)	Konica (S) (%)
+60	+27	–38	+205	–38
+50	+23	–33	+175	–33
+30	+14	–23	+114	–23
+20	+10	–17	+80	–17
+10	+5	–9	+4	–9
–10	–5	+11	–5	+11
–20	–10	+25	–100	+25
–30	–16	+43	–155	+43
–50	–30	+100	–300	+100
–60	–37	+150	–400	+150

IPEM91 Table 5.1

CR02: Image Uniformity

- Quick and simple check for artefacts in the image.
- A narrow window should be used for viewing the image.
- Generally, spots will indicate that the plates need to be cleaned, while a line will indicate the reader's optics need to be cleaned.
- Cracks at the edge of image may suggest the plate should be removed from service and replaced.

Suggested Method

- Use image from DDI monitoring and repeat for other cassettes.
- Check image visually.

Reference paragraph	Physical parameter	Level of expertise	Frequency	Priority	Remedial level	Suspension level
CR02	Image uniformity	A	1–3 monthly	1	Dots and lines apparent	Gross non-uniformity

CR03: Condition of Cassettes and Imaging Plates

Comments

- Once it has been cleaned, put the plate through an erasure cycle.
- Systems should be in place to ensure that plates are not left for significant periods of time without being used or erased, as the background exposure can affect the image quality.

Suggested Method

- Open Cassette and inspect image plate for dirt or damage.

■ Clean according to the supplier's instructions or replace the plate.

Reference paragraph	Physical parameter	Level of expertise	Frequency	Priority	Remedial level	Suspension level
CR03	Condition of cassettes and image plates	A	Supplier's recommendation	1	Dirt on plate	Damage to plate

CR04: Low Contrast Sensitivity

The tolerance is based on 11 mm diameter detail in TOR CDR; for other test objects use a contrast change of 40%.

- The MPE can give guidance on this and may calculate the number of details from baseline that equate to 40%.

Suggested Method

- Leeds Test Object Ltd test object TOR (RAD or CDR) or equivalent
  - 70kV
  - 1mm Cu

Reference paragraph	Physical parameter	Level of expertise	Frequency	Priority	Remedial level	Suspension level
CR04	Low contrast sensitivity	A	4–6 monthly	2	Baseline ±2 groups	

CR05: Limiting Spatial Resolution

- The grating may be incorporated into the Leeds Test Objects Ltd test object TOR (RAD or CDR) or other test object.

Suggested Method

- Lead grating resolution bar pattern, 50kV, no filtration, at 45 degrees to plate, use highest sampling rate.

Reference paragraph	Physical parameter	Level of expertise	Frequency	Priority	Remedial level	Suspension level
CR05	Limiting spatial resolution	A	4–6 monthly	2	Baseline minus 2 groups	

LEVEL B TESTS – CR06 to CR13

CR06: Dose Detector Indicator Repeatability

- Verify repeatable CR system performance.
- Ensure Dose-DDI response (STP) remains consistent at a reference setting.

Suggested Method

- 70 kV, 1.0 mm Cu filtration at tube head,
- Perform at least 3 times for a reference dose of 10 micro Gray,
- Read plate after a consistent time period (e.g. 1 min) under a linear algorithm (LUT).

CR07: Dose Detector Indicator Reproducibility

- To ensure reproducible STP over a range of representative exposures.
- Useful for physicists at installation, and after any CR system recalibration.

Suggested Method

•70 kV, 1.0 mm Cu filtration at tube head,

•Perform over at least 3 different exposure levels to obtain DDI at each setting,

•Read plate after a consistent time period (e.g. 1 min) under a linear algorithm (LUT).

CR08: Measured Uniformity

- Images from test CR06 may be used.
- Checks for uniform response to a “flat” signal across the whole plate. More detailed than CR02 (level A)
- Depends on several several components (& plates).

Suggested Method

- Take uniform image – analyse 100 x 100 pixel sized regions across several plate locations.
- Examine mean PV and standard deviation.
- NOTE - anode heel effect can affect some systems.

CR09: Threshold Contrast Detail Detectability (TCDD)

- Simple measure of image quality. Not clinically representative, but can be used to intercompare systems and track performance over time.

Suggested Method

- Test object (Leeds type with 1 mm Cu filter, or bespoke CR).
- Expose at 70 kVp, range of clinical doses.
- Establish threshold detectability level. Can be reported as a quality index.

CR10: Erasure Cycle Efficiency

- Ensures adequate performance of erasure cycle.
- Critical components – laser (power, alignment, dwell time per pixel), plate movement devices.
- Also sensitive to plate characteristics (esp. radiation “hardening”). But other QC tests should pick this up first!

Suggested Method

- Create one high contrast test image (e.g. lead disc on uniform background). Read image (normal erase included).
- Re-read same cassette. Examine for residual ghosting.

CR11: Limiting Spatial Resolution

- The grating may be incorporated into the Leeds Test Objects Ltd test object TOR (RAD or CDR) or other test object.

Suggested Method

- Lead grating resolution bar pattern, 50kV, no filtration, at 45 degrees to plate, use highest sampling rate.
- Similar to Level A test CR05, but resolution evaluated over more plate/matrix sizes, geometries (x, y, diagonal).

CR12: Scaling Errors

- Assesses the accuracy of component movement and readout in the scan (fast, “flying spot”) and sub-scan (slower, plate movement) directions.
- The ratio of distance measurements in both axes must be within narrow limits.

Suggested Method

- Radio-opaque grid or ruler.
- Overlay grid on CR cassette
- Acquire linear (fixed/pattern) image (exact dose not critical)
- Use software callipers on system or third party viewer to measure x- and y- distances and the resultant aspect ratio.

CR13: Dark Noise

- A modern-day film-fogging test?!
- Ensures a consistent background in non-irradiated areas.
- Spots (light) leaks, inherent system noise, radiation hardening. Also laser power.

Suggested Method

- Erase plates, leave for about 5 min then re-read under standard conditions. Repeat for all plate sizes.
- Measure the “dark noise” pixel values and DDI reading. Compare to the manufacturer’s STP equation.

Other points to note:

- **CR14-19: CR-AEC Tests**
- Similar approach to film-based AEC systems (currently…)
- AEC receptor dose measurement important.

- **Direct Digital Radiography (DDR)?**
- Different technology – NO PLATES
- Same general approach to testing - (IPEM/KCARE protocols)