**Kursus : Quality Control (Qc) For Computed Radiography (Cr) System**

**Tempat : Malaysian Nuclear Agency, Bangi**

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***Topic 1: Principle of Radiation Protection.***

**Objective**: to achieve an appropriate levelof protection and safety for patients, staffs, and public members.

**Main aim**: prevent non-stochastic effects and reduce the probability of stochastic effects as much as taking into account economic and social considerations.

**Basic principles of radiation protection**:

* Justification.
* dose limitation.
* optimization.

***Topic 2: Hazard Identification, Risk Assessment and Programme for Dose Reduction.***

**3 types of hazard:**

* external exposure.
* internal exposure.
* both combination (contamination).

**Risk Management with 4 steps:**

1. Identify hazard
2. Assess the risk
3. Control the risk
4. Review risk control

**Methods to minimize the external radiation hazard:**

1.Shielding.

* Use appropriate shielding. E.g: adequate wall shielding, lead apron, thyroid shield.
* For mobile xray, provide a lead apron to any person who is required to remain less than 2 m from the patient under examination.

2.Limit time spent.

* Dose = dose rate **X** time.

3.Keep maximum possible distance.

4.Conduct regular area and personnel monitoring checks.

* Use detector to detect the radiation at the controlled area and supervised area.
* Personnel monitoring e.g. OSL.

**Methods for patient dose reduction-radiological procedures:**

* Exclude clinically unhelpful examinations.
* Minimize number of radiographs per examination.
* Introduce QAP to optimize staff and equipment performance.
* Regular assess film rejected rates and reason for rejection.
* Audit of x-ray radiograph.
* Periodically measure patient doses and take action if they exceed guideline doses.
* Collimate x-ray beam to minimize size.
* Shield sensitive organs when possible.
* Choose projection which minimize dose to sensitive organs.
* Specify a low optical density for radiographs.
* If exposure factors are selected manually,employ reliable & accurate methods for matching to patient stature.
* Reduce attenuation between patient and image receptor,use carbon-fibre.
* Improve reliability of AEC and use more widely.
* Install anti-scatter grid with lowest grid factor. Use grid if only necessary.
* Use equipment with automatic beam collimation to image receptor.
* Replace conventional radiography with computed radiography.
* Equipment comply with essential design requirement and dose saving in modern x-ray equipment.

***Topic 3: X-ray Machine and Computed Radiography (CR) System.***

Xray are produced when highly energetic electrons interact with matter and convert their kinetic energy into electromagnetic radiation. This interaction produced 99% heat, 1% x-rays.

**X-ray component:**

* X-ray tube.
* High voltage (HV) generator.
* Tube stand/mounting.
* Table and bucky.
* Control panel.
* Automatic exposure control (AEC).

**Parameters Which Affect the Characteristics of X-ray:**

* Tube voltage, kV.
* Filament current, mA.
* Target material (W, Mo, Rh, etc.)
* Total filtration.

**Routine for Checks x-ray:**

Quality control (QC) to ensure the production of optimum quality images with lowest possible cost and minimum dose to patients.

Preventive and corrective maintenance to ensure the compliance with radiation safety requirements.

Warm-up procedures.

**General inspection:**

* Radiation warning signal
* Mains-on light
* X-ray on red warning light
* Filtration
* Direction of the primary beam

**Mechanical and electrical safety inspection:**

* Abnormal wear and strange sounds in moving parts
* Brakes, lock, rail fixing, suspension
* Tightness all fixing screws
* Marking e.g: scale, limit, labelling.
* Cables for proper layout and damage free
* Collimation adn illumination
* Hand and foot switch
* Indicator lamps and display
* Tube indicator lights and interlocks

**Record Keeping:**

All records shall be kept and maintained according with the radiation safety requirements and authority.

**Computed Radiography:**

* Use same x-ray machine
* Use imaging plate which ccontains photo stimulator phosphor
* Need cassette reader
* Image in DICOM (Digital Imaging and Communications in Medicine) format. Image can be printed, burned in CD or send to PACS.

**Advantage of CR:**

* More tolerant of under/over exposure
* Ability to extract information not possible on conventional radiographs e.g: edge enhancement, masking, cropping
* Rapid storage
* Image can be retrieved
* PACS (storage management)
* DICOM
* E-radiology
* Economic advantage
* Density, contrast, sharpness, noise can be modified

**Disadvantages of CR:**

* Need IP and it is expensive
* Time to produce image same as film
* Processing time
* Tend to over expose degrade contrast
* IP sensitive to fogging
* Increased exposure when compared to film and DR

**Optimization of Images:**

* Erased IP when not used for 24 hrs
* Scatter control-grid
* Scatter control-avoid over exposure
* Centering/collimation-histogram
* Should represent anatomy
* Collimation-reduce scatter and improves contrast
* 1 IP 1 image. If multiple; uniform distribution symmetry
* Strict collimation-no overlap

**Routine Checks CR:**

* Preventive and corrective maintenance
* Cleaning the CR surface reader
* Cleaning the Local User Interface Panel
* Software maintenance

***Topic 4: Quality Control Measurement for Computed Radiography System.***

Quality Control (QC) is a part of Quality Assurance Programme (QAP) that responsible for measurement of image quality and integrity of safety equipment.

QC can be performed by License H holder,KKM (pengujian dan pengesahan).

QC should be done when acceptance/commisioning, routine QC, post repair QC.

**QC CR Instruments:**

* Dosimeter (ion chamber/solid state)
* IP
* CR reader
* Measuring tape
* Leeds TOR CDR test object
* 1mm Cu filter, 1’ acrylic, 2mm Pb sheet
* Adhesive tape
* Film screen contact mesh and tool
* Steel ruler

**Detail performance & Safety Standard of CR Test:**

* **CR01 Dosimetry.**

To establish the exposure factors needed to give known Detector Air Kerma (DAK) values in subsequent tests.

* **CR01 Detector Dose Indicator (EI) Accuracy.**

To assess the accuracy of the EI for a particular image plate size.

* **CR02 Detector Dose Indicator (EI) Reproducibility.**

To check the short-term consistency of the reader.

* **CR03 Detector Dose Indicator (EI) Repeatability.**

To check the short-term consistency of the reader and to set a baseline for long-term monitoring of system sensitivity.

* **CR04 Signal Transfer Property (STP) if ROI analysis tool available.**

To establish the relationship between receptor and pixel value.

* **CR05 Matching of CR IP (if more than one IP available).**
* **CR06 Differences Between CR Readers (applicable if more than 1 reader available).**

To assess the variation in sensitivity between readers.

* **CR07 Dark Noise (if ROI analysis tool available).**

To assess the signal level of dark noise and to test laser power indirectly.

* **CR08 Visual Check of Cassettes and Images.**

To assess the uniformity of the recorded signal from a uniformly exposed IP.

* **CR09 Measured Uniformity (if ROI analysis tool available).**

To assess the uniformity of the recorded signal from a uniformly exposed IP.

* **CR10 erasure Cycle Efficiency (ghosting or Image Retention Test).**

To test whether residual signal (ghosting) remains on IP after read-out and erasure.

* **CR11 Threshold Contrast Detail Detectability.**

To monitor image quality by assessing the visibility of low contrast detail.

* **CR12 variation of Noise with DAK ( if ROI analysis tool available).**

To measure noise relative to dose.

* **CR13 signal-to-noise ratio (SNR).**

To measure the relative noise in an image.

* **CR14 Limiting High Contrast Spatial Resolution.**

To test the high contrast limit of the system’s ability to resolve details.

* **CR15 Blurring.**

To test any localized distortion or blurring of the image.

* **CR16 Laser Beam Function.**

To assess laser beam scan line integrity and jitter.

* **CR17 Scaling Errors: Measurement Calibration & Aspect Ratio.**

To assess the accuracy of software distance indicators and check for distortion.

* **CR18 Moire Patterns and Anti-scatter Grids.**

To test for the presence of Moire pattern artifact caused by grid.

***TOPIC 5: Practical.***