The Critical Examination of Radiological Installations

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What is a ‘Critical Examination’?

- Not defined anywhere!
- Sources
  - Reg 31(2) of IRR99
  - IPEM Report No.79
  - Paragraphs 522 to 526 of L121
  - Chapter 1 of the Medical and Dental Guidance Notes (2002).

Purpose of a ‘Critical Examination’?

- The purpose of the CE is to facilitate the installer/Supplier in demonstrating to the purchaser that
  - the **designed safety features** & **warning devices** operate correctly
  - there is **sufficient protection for persons** from exposure to ionising radiation, &
  - the **equipment is safe to use** in normal circumstances

Why Standardise?

- Commercial Liability
- Record
- Common Approach & Homogeneity
- Education
- Audit

12 Different Types of Radiation Equipment

- **X4** Fixed Imaging: Radiographic, Fluoroscopic, CT, Dental
- **X4** Mobile: Radiographic, Fluoroscopic, CT, Dental
- **X4** Radiotherapy: Linac, Brachytherapy, Simulator, Orthovoltage/Superficial

The Elements

- **Radiation Equipment: Exposure Control**
  - safety design features, interlocks and warning devices
- **Radiation Equipment: How Erected or Installed**
  - safety design features, interlocks and warning devices
- **Other Radiological Protection Review Elements (not part of CE)**
  - **Installation Design Review**
  - **Pre-clinical Use Review**

Other Radiological Protection Review Elements

- Reg 8, Restriction of Exposure
- Reg 10, Maintenance & examination of engineering controls etc
- Reg 19, Monitoring of Designated Areas
- Reg 32(1), Equipment used for Medical Exposure
- IRMER 2000

Radiation Equipment: Exposure Control

- **Exposure Mode**
  - Is the exposure mode clearly identified on the control console
- **Exposure Termination**
  - Are all exposure switches dead-man
  - For CT & BMD, confirm that the exposure Abort (Pause) button operates correctly
- **Exposure Initiation**
  - Is it possible to initiate an exposure from outside the protective cubicle
- **Post-exposure Display**
  - Confirm that the control console has an appropriate post-exposure display

Radiation Equipment: Exposure Control

- **Protection of Exposure Switch against Accidental Activation**
  - Is there adequate protection of exposure switch from accidental exposure
  - Is there an X-ray Disable button
  - Is the X-ray Disable button clearly identified and does it operate correctly
- **Beam Filtration**
  - HVL to confirm the correct filtration

Radiation Equipment: Exposure Control

- **Collimation:** Confirm that
  - the radiation beam does not exceed the maximum detector size and/or image size
- **AEC Devices:** Confirm that there is
  - an appropriate calibration for the image receptors used
  - a dose-rate termination (high or low IDR)
  - an alarm warning if an exposure fails to terminate or terminates prematurely
  - an appropriately low back-up timer
  - a clear chamber and mode selection

Radiation Equipment: Exposure Control

- **Anatomical Programmes:** Confirm that
  - appropriate anatomical programmes are available for all image receptors
- **Fluoroscopy:** Confirm that there is:
  - Automatic dose-rate control
  - an appropriate timer
  - an appropriate alarm at 5 mins
  - auto-termination at 10 mins, (ask engineer)
  - a maximum skin dose rate limitation (< 100 mGy/min @ 20 cm H2O)

Radiation Equipment: Exposure Control

- **X-ray Tube Warm-up & Detector Calibration Indicators**
  - Is X-ray tube Warm-up mode clearly indicated on the control console
  - Is Calibration mode clearly indicated on the control console
- **Additional Exposure Control Features**
  - Are there additional Exposure Control Features identified by Installer/Supplier
  - Do they operate correctly

Radiation Equipment: Erected or Installed

- **Emergency-off Buttons & Start/Stop Switch**
  - Is the number of Emergency-offs in the room adequate
  - Are they positioned to facilitate quick & unobstructed operation
  - Do the Emergency-offs operate correctly
  - Are they shrouded & positioned to prevent accidental engagement
  - Is there a Start/Stop switch at the operator position behind the protective cubicle
  - Are Emergency-offs clearly labelled
- **Emergency Stop Buttons Fitted on Equipment**
  - Do the emergency stop buttons operate correctly

Radiation Equipment: Erected or Installed

- **Mains-On & Radiation-On Indications**
  - Is the Mains-On indication satisfactory
  - Is there an audible indication of radiation exposure (beep)
  - Is there a visible indication of radiation exposure
  - For fluoroscopy units, is there a radiation exposure light on the display monitor support

Radiation Equipment: Erected or Installed

- **Warning Signals & Entry Warning Signs**
  - Are there Controlled Area and Restrictive Access warning signals, & is the wording used appropriate
  - Do all the Warning Lights work appropriately
  - Is the location of the Warning Lights and Signs satisfactory
  - Do the Warning Lights give separate indication of the equipment whilst in a state ready to emit Radiation, e.g. Yellow for Mains ON, Red for Prep/Expose

Radiation Equipment: Erected or Installed

- **Tube, Detector & Beam Selection Indications** (e.g. exposure factors, tube selection indicator lights, etc.)
  - Are these clear & unambiguous
  - Do they work correctly, e.g. is exposure prevented if the tube selection indicator lights fail
  - Is focal spot position clearly identified
- **Unambiguous Labelling & Notices**
  - Are all labelling and notices on the control console and equipment clear and unambiguous
  - Are focal distances & indent positions correct

Radiation Equipment: Erected or Installed

- **Microswitch Interlocks**
  - Is exposure prevented when
    - (i) equipment is in motion
    - (ii) beam is not incident on the selected detector
    - (iii) cassette/detector is removed
  - Is movement prevented when compression is applied
- **Unauthorised Use**
  - How is unauthorised use prevented

Radiation Equipment: Erected or Installed

- **X-ray Tube-head Leakage**
  - Is the tube leakage within limits as specified by the manufacturer at 1m
- **Additional Control Features identified by Installer/Supplier**
  - List those fitted, & do they operate correctly

Installation Design Review (not CE)

- **Entrance Doors/Entrance Design**
  - Do these offer adequate radiological protection? (Note overlap of protective materials, lead equivalence and gap at floor)
  - Are there automatic door closing devices fitted
  - Are there thumb-locks for changing cubicles (& Entrances) & are these fitted on the correct side
- **Primary & Secondary Barriers**
  - Have Pb-equivalence measurements been performed
  - Do these barriers afford adequate radiological protection

Installation Design Review (not CE)

- **Penetrations/Baffles** (heating ventilation, air conditioning and cable outlets)
  - Confirm that there are no penetrations in the primary beam
  - Are penetrations in other areas appropriately baffled against scattered radiation
- **Protective Cubicle & Mobile Screens**
  - Have Pb-equivalence measurements been performed
  - Do these afford adequate radiological protection
  - Are they appropriately labelled, of an appropriate size and Pb-equivalence
  - Are any of these a primary barrier
  - Does the operator position behind the protective cubicle afford a clear view of the patient
  - Does the operator position behind the protective cubicle afford a clear view of the entrances

Installation Design Review (not CE)

- **Environmental Monitoring/Dose-rate Measurements**
  - Confirm that environmental monitoring will be performed
  - Perform Instantaneous Dose Rate (IDR) measurements at primary barriers, critical points and boundaries to confirm adequacy of radiological protection afforded. (Include measurements in changing cubicle & behind the protective cubicle)
- **MEIGaN Check**
  - Visually confirm the MEIGaN compliance of the installation
  - Confirm that appropriate checks have been performed.

Pre-clinical Use Review (not CE)

- **Protective Devices**
  - Check the provision, number & adequacy of protective devices for staff (drapes, aprons and shields)
  - Identify if there are adequate Pb aprons provided (Pb equivalence, number & type)
  - Are there adequate & appropriate Pb apron racks/hangers?
- **Patient Protective Devices**
  - Confirm the provision & adequacy of appropriate patient protective devices, e.g. aprons, gonad shields, etc.

Pre-clinical Use Review (not CE)

- **Patient Dose Indication**
  - Confirm that the equipment has appropriate patient dose indication(s) & record the units
- **Anatomical Programmes**
  - Confirm that appropriate anatomical programmes are available for all image receptors
  - Are Adaptive Dose Filters programmed into the Anatomical Programs
  - Is Anatomical Programming password protected
- **Alignment Lasers**
  - Confirm the class, &
  - whether or not appropriate hazard and control measures are in place

Conclusions:

- Generic elements of Critical Examination are clearly identified & the scope defined
- Other (non-CE) radiological protection review elements are also clearly identified