

Medical Diagnostic Radiography Discussion For Health Physicists



Bureau of Radiation Control



Division of Environmental Health

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- Regulate and Inspect x-ray machines

Resources

- Local regulations (www.myflorida.com)
- FDA
- CRCPD
- AAPM
- Manufacturer sites
- Local Medical physicists
- Consultants
- Regulators
- Text books (Bushong)
- NCRP

Types of x-ray machines

- Medical
- Industrial

Types of Medical X-ray Machines

- Therapy
- Fluroro
- Radiography
- Dental
- Specials
- Other

Types of Medical Radiography Machines

- Fixed
- Mobile
- Portable

Objectives

- Maximize Diagnostic Value
- Minimize Exposure

X-ray Systems

■ X-ray Machine

- Console
- Generator
- Tube

■ Imaging System

- Film / Processor
- CR Screens
- Full Field Digital

■ Exam Room

- Table
- Upright
- Barriers and Shielding

■ Techniques

- Manual
- Automatic Exposure Control (AEC)

X-ray Techniques (settings)

- kVp
- mA
- Time (sec)
- kVp
- mAs (mA x Time)



Typical X-ray Techniques

- Hand

- 50kVp, 1mAs, 5mR

- Chest

- 109kVp, 5mAs, 10mR

- Abdomen

- 75kVp, 30mAs, 280mR

- Lumbar

- 78kVp, 35mAs, 320mR



Quality Assurance

- Policy & Procedures
- Evaluation of Setup
- Reviews
- Tests

Policy and Procedures

- Are good policy and procedures in place and available to staff?
 - Patient holding
 - Technique charts specific to equipment
 - QC procedures
 - Maintenance
 - What is serviced and at what frequency?

Evaluate Setup

- Barrier placement – Primary vs Secondary
- Console placement vs Patient and Tube placement
- Equipment matchup – Film to screen, Film to processor
- Lead Gloves, Aprons
- Entrance Warnings, Locks
- Comfort – Table cushion, chair, step stool, bathroom, adjustable lighting

Evaluate Setup (cont)

- Darkroom – Light leaks, Fluorescent bulbs, Darkroom Filters, Positive Locks, Warning Signs
- X-ray centering to image receptors
- Tube stability
- Interlocks
- Reading Room – Quiet, Lighting, Viewer, Chair.

Record Reviews

- Periodic review of procedures
- Personnel monitoring reports
- Maintenance / Service logs
- Quality Control logs



Tests

- Need appropriate equipment.
 - X-ray meters (exposure reproducibility, Timer and kVp accuracy, Linearity, HVL)
 - ~50-120 kVp range
 - 0.008 sec
 - Need special scatter probes to accurately measure scatter x-rays.
 - Markers, Testing film (Beam accuracy)
 - Copper or Acrylic (AEC)





Primary Barrier



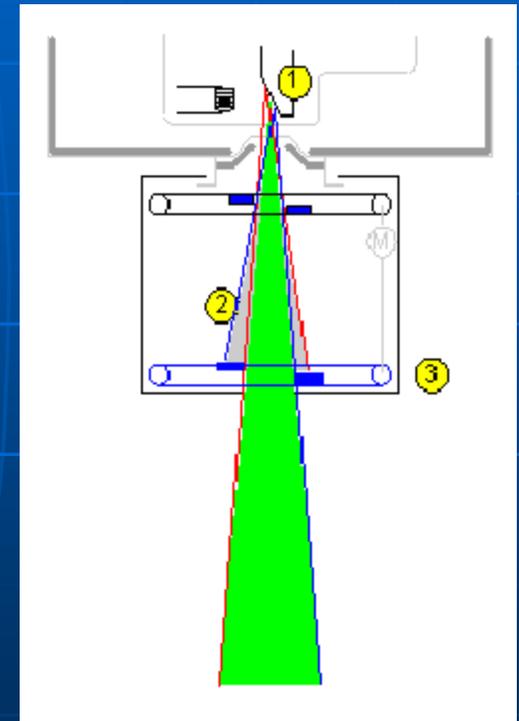
- 1/16" (~2mm) Pb equivalent (Florida)
 - 1/32" or 8' for secondary
- Rule of thumb: 1/10th exposure at 80kVp with a radiation meter.
- Area monitors are excellent for MOP surveys.



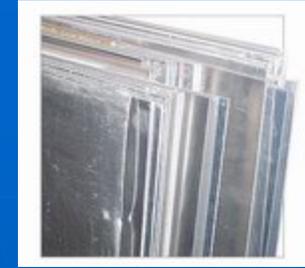
Collimation Test



- Light field must match x-ray field within 2% of the SID ($40'' = 0.8''$ and $72'' = 1.4''$).
- Beam cannot exceed image receptor.
- Need film, markers, and a measuring tape.



HVL



- Need a meter with Auto HVL readout or
- ~3.5mm Al attenuation and a x-ray meter.
 - $(\text{mmAl}) (\ln(2)) / \ln(\text{Exp1} / \text{Exp2})$

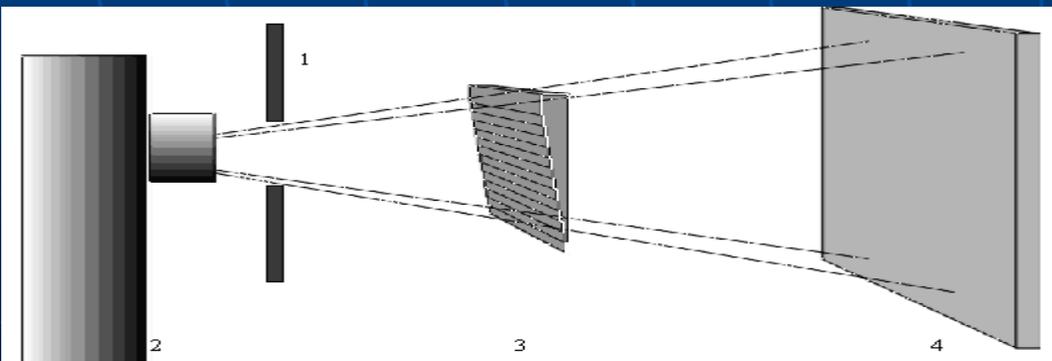


Figure 1: Scheme for the measurement of the SNR with the step wedge method.



Exposure Reproducibility

- Need X-ray meter
- $E_{\text{mean}} \geq 12 (E_{\text{max}} - E_{\text{min}})$



- 146mR, 148mR, 150mR, 148mR
 - $148 \geq 48$, True

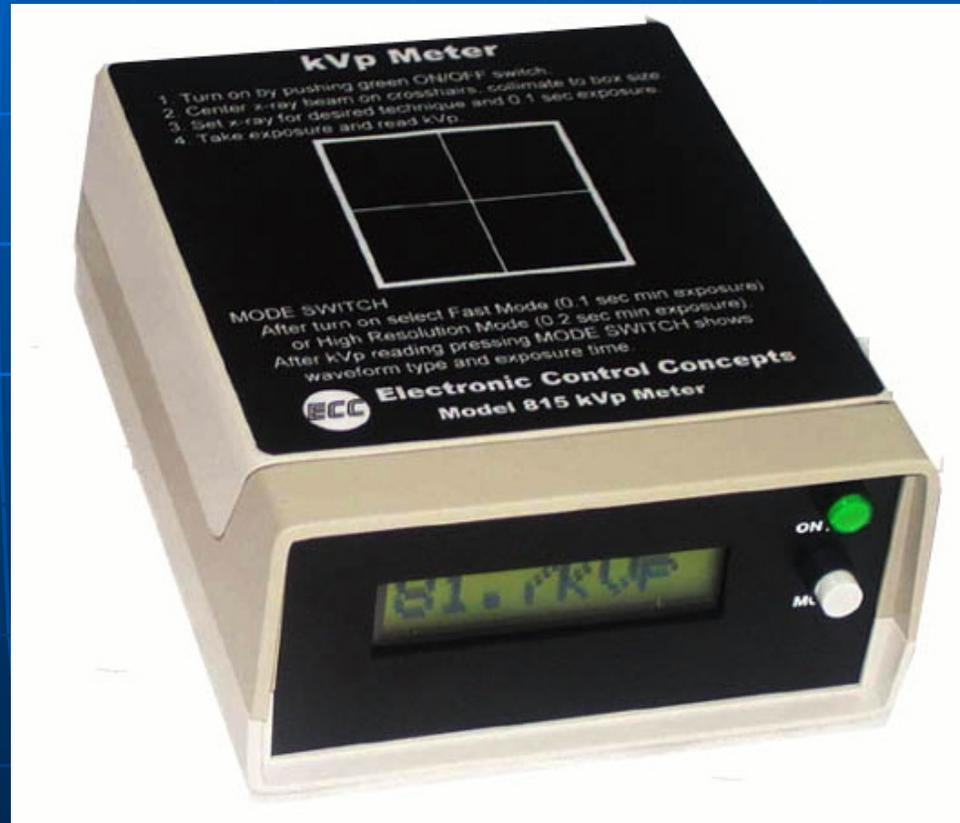
Timer Accuracy

- Need X-ray meter
- Within 10%



kVp Accuracy

- Need X-ray meter
- Within 5%



Exposure Linearity

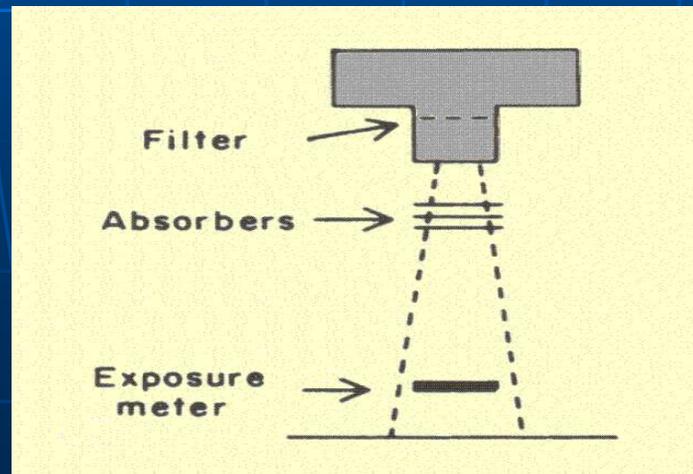
- Need X-ray meter



- Where X = output ratio, Exp/mAs
- $(X_a - X_b) \leq (0.05)(X_a + X_b)$ if adjacent
- $(X_a - X_b) \leq (0.10)(X_a + X_b)$ if not adjacent

AEC Reproducibility

- Need attenuators to simulate patient
- Need x-ray meter
- $E_{\text{mean}} \geq 12 (E_{\text{max}} - E_{\text{min}})$



AEC Compensation

- Need multiple attenuators to simulate patient.
- Need x-ray meter



Darkroom Fog

- Need light sensor or
- sensitized film and cardboard

