READING HOSPITAL SCHOOL OF HEALTH SCIENCES
MEDICAL IMAGING PROGRAM
RADIATION PROTECTION—2020

RADIATION PROTECTION OF OCCUPATIONALLY EXPOSED PERSONNEL

I. NCRP Dose Limits

a. Annual Effective Dose

- 50mSv (5 rem)
- Does not include medical or background radiation exposure

b. Cumulative Effective Dose

- Age in years X _____mSv (age X 1 rem)

c. ALARA

- As Low As Reasonably Achievable
  - Collimate, technique, shielding, minimize repeats

II. Reducing Occupational Exposures

a. Avoid repeats

b. Collimation

c. Cumulative Timer

d. Highest exposures are in fluoro, portables and OR

e. Stand _____ degrees from the patient

- Patient is a source of _____ radiation
- _____ feet or 1 meter from the patient, the scatter radiation is approx. 1/1000 the intensity

f. Filtration

- Non useful _____ energy photons are removed, less scatter

g. Protective apparel

- Lead aprons and barriers

h. Exposure factors

- Controls scatter

i. Correct processing

- Reduces repeats

j. High speed image receptors

- High speed systems use smaller exposures which causes less scatter

k. Beam limiting devices

- Reduces scatter

III. Pregnant Personnel

a. Should be able to continue their duties without interruption of employment

b. Voluntary declaring vs. not declaring

c. After declaring

- Counseling
- Second “baby badge” is issued worn at _____ level

d. To reduce risk of leukemia or other malignancies

- _____mSv (0.05 rem) in one month
- _____ mSv (0.5 rem) for the entire pregnancy

e. Must read and sign a form acknowledging counseling

f. If wearing a lead apron the badge is worn _____ the apron at waist level

g. Baby badge has a separate reading on the dose report

h. Maternal tissue decreases fetus dose by _____%

i. Work schedule rotation

- Does not necessarily have to be done

IV. Types of Radiation

a. Primary radiation- useful beam

- Emerges directly from the _____

b. Scatter radiation- highest dose to technologist

- Primary beam passes through matter and goes in various directions

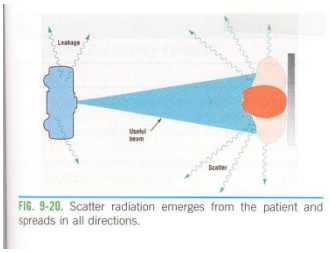


FIG. 9-20. Scatter radiation emerges from the patient and spreads in all directions.

c. Leakage radiation

- Escapes the tube housing

V. Protective Structural Shielding

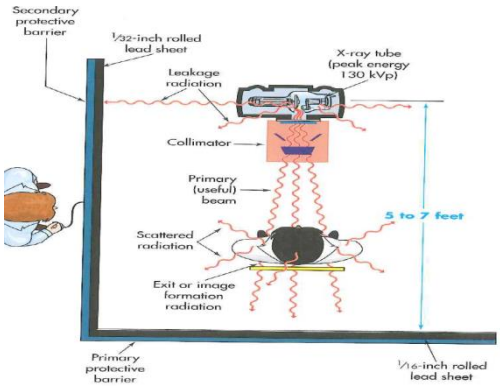
a. Usually lead or concrete

b. Types of barriers

- Primary protective barrier
  - Located _____ to primary beam travel (beam can directly hit)
  - Prevents direct or unscattered radiation from reaching personnel and general public

- For 130 kVp of peak energy a _____ inch of lead or lead equivalent and extends _____ feet upward from the floor if the tube is 5-7 feet from the wall

- Secondary protective barrier
  - Any wall or barrier that is never hit by the primary beam
  - Protects against scatter and leakage radiation
  - _____ inch of lead or lead equivalent
  - Overlaps the primary barrier by _____ inch and extends to the ceiling
  - The control booth is regarded as a _____ barrier
    a. Technologist must remain behind the booth
    b. The exposure cord length must be short enough that the technologist must remain behind the booth to take the exposure
    c. Window is _____ mm lead equivalent



VI. Protective Device Requirements

a. Lead Apron

- Older guidelines state 0.25mm lead (Pb)
- Newer guidelines state _____ mm lead (Pb) for fluoroscopy, AIR, or operating systems above 100kVp (NCRP #102)

b. Gloves

- _____mm lead (Pb)

c. Neck & Thyroid

- Must be at least _____ mm lead (Pb)

d. Protective Eyeglasses

- Contains lead (Pb)

TABLE 13-1 Physical Attributes of Protective Lead Aprons

Percentage X-Ray Attenuation				
Lead Equivalent Thickness (mm)	Weight (kg)	Kilovolts at Peak 50	75	100
0.25	1-5	97	66	51
0.50	3-7	99.9	88	75
1.00	5-12	99.9	99	94

At 100 kVp, x-ray attenuation for a 0.50-mm lead equivalent apron and a 1-mm lead equivalent apron is 75% and 94%, respectively.

Modified from Bushong SC: *Radiologic science for technologists: physics, biology and protection,* ed 10, St. Louis, 2013, Mosby.

VII. Protective Tube Housing

a. Lead lined metal that protects personnel and patients from leakage and off focus radiation

b. Cannot exceed _____mGy per hour at 1m away from housing

c. No one should be touching the x-ray tube housing during an exposure

VIII. Fluoroscopy

a. Proper position to be standing
    - Avoid high scatter areas
    - Try to stand behind the _____
    - _____ degrees from the patient

b. Wrap around lead
    - Have to move around the room to obtain supplies

c. Should wear a thyroid shield
    - Unprotected areas are getting _____X more exposure

d. Collimation

e. Filtration

f. Technical exposures

g. High speed image receptors

h. Correct processing

i. Appropriate skin to source distance

j. Cumulative timer

k. Rotational scheduling of personnel

l. Personnel must wear the badge on the _____of the lead apron at _____

m. Remote control fluoro units
    - Can perform the study from the control booth and enter only when necessary

n. Shielding (NCRP #102) lead (Pb)

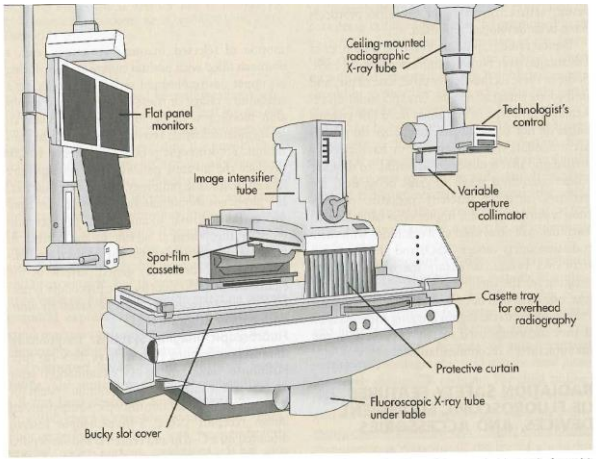
- Apron- 0.25mm or 0.5mm (fluoro, AIR or above 100kVp)
- Gloves- 0.25mm
- Thyroid- minimum 0.5mm
- Eyeglasses- 0.35mm

o. Protective lead curtain

- _____ mm lead equivalent
- Protects from _____ radiation

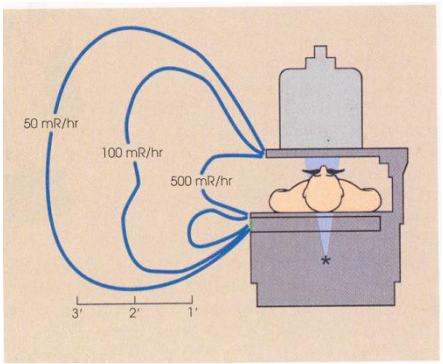
p. Bucky slot cover

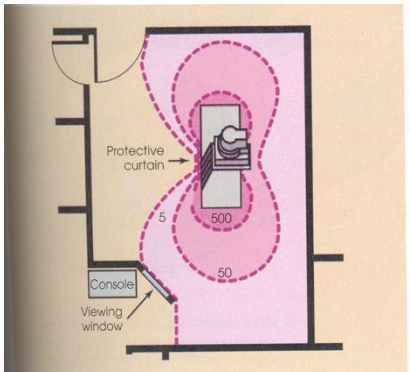
- _____ mm lead equivalent
- Protects _____



IX. Isoexposure Curves

Dose from scatter radiation at 90 degrees/ 1 meter away= dose X 0.001





X. Mobile X-ray

a. Cord length should be long enough to stand _____ feet (2m) from the patient

b. Stand _____ from the patient

c. Use distance as a means of protection

d. Wear shield

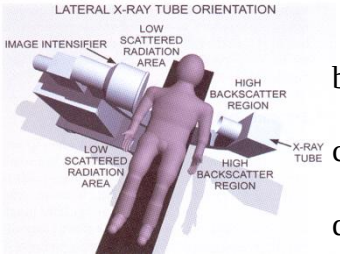
e. Yell “x-ray” before taking exposure

f. Do not hold the image receptor

- Use cassette holders, pillows, sponges, or even a box of gloves

XI. C-arm Fluoroscopy

a. Proper position to be standing



- In a lateral view, on the side of the patient away from the x-ray tube

b. Protective shields and radiation monitors for all personnel

c. Properly orient the c-arm with the _____on top

d. Minimize beam on time

e. Position the II as close to the patient as possible to lower the beam intensity needed

XII. Interventional Radiography (AIR)

a. Low dose fluoroscopy mode

b. Pulsed beam operation

c. Collimation

d. Optimal beam filtration

e. Optical apertures

f. Last image hold

g. Shortened duration of studies

h. Extremity monitors

- Rings- NCRP annual limits to _____mSv

XIII. Personnel Protection

a. Technologist should never stand in the path of the

_____ beam

b. If holding is necessary, try to utilize a non-radiology person or immobilization device

c. Pregnant technologists are not to hold a patient for an exposure

d. Exposures should never be made with the doors to the room open

XIV. Cardinal Principles of Radiation Protection

a. Time- amount of exposure is _____ proportional to duration of the exposure

b. Distance-_____ effective means of protection, it is

_____ proportional

c. Shielding- absorbs most of the energy of scatter radiation

- ~_____% effectiveness

d. ISL- Inverse Square Law

- Equation: _____
- Example: Old: 1 m 2 mR

New: 2 m ___mR

Answer: 0.5 mR

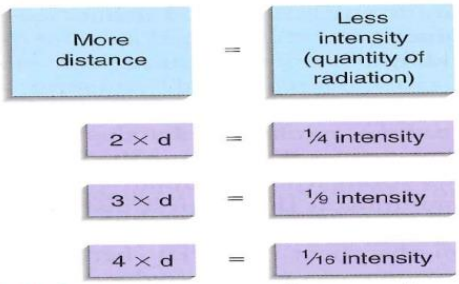


FIGURE 13-3 As the distance between the source of radiation and any given measurement point increases, radiation intensity (quantity) measured at that point decreases by the square of the relative change in distance between the new location and the old.

XV. Diagnostic Protection Design

a. Workload (W)

- Radiation on time during a week
- Measured in: mAs/ week or mA- minute/ week

b. Use (U)

- Amount of time the beam is directed at the structure
- Takes into account primary or secondary radiation

c. Occupancy (T)

- Time that the area is occupied behind a barrier
  - Waiting room
  - Empty courtyard

d. Distance (D)

- Distance from the source to the structure

e. Calculating barrier requirements

- Needs to be calculated for every barrier in a room
- Equation: _____

XVI. Half Value Layer- HVL

a. Insufficient HVL test could mean improper _____

b. Example

- Exposure in a room is 350mR What will be the exposure for:
  - 1 HVL
    a. 175mR
  - 2 HVL
    a. 87.5mR
  - 4 HVL
    a. 21.88mR

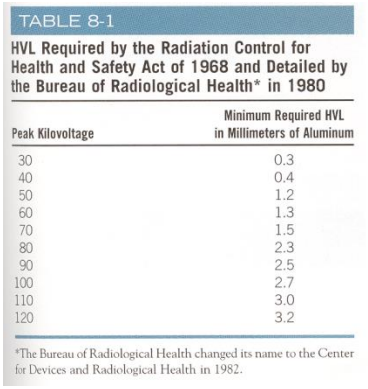


TABLE 8-1

HVL Required by the Radiation Control for Health and Safety Act of 1968 and Detailed by the Bureau of Radiological Health* in 1980

Peak Kilovoltage	Minimum Required HVL in Millimeters of Aluminum
30	0.3
40	0.4
50	1.2
60	1.3
70	1.5
80	2.3
90	2.5
100	2.7
110	3.0
120	3.2

*The Bureau of Radiological Health changed its name to the Center for Devices and Radiological Health in 1982.

c. TVL- tenth value layer

- thickness that will decrease the intensity of the beam by

_____

XVII. Areas of Radiology

a. Controlled

- Occupied by workers who are trained and wearing monitoring devices
- Maximum permitted equivalent dose is_____mGy per week

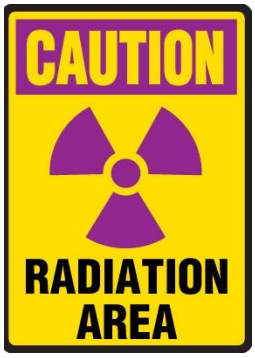
b. Uncontrolled

- Occupied by the _____
- Maximum permitted equivalent dose is _____ mGy per week
  - Waiting rooms
  - Hallways
  - Bathrooms

- Stairways

XVIII. Radiation Sign Posting

a. Radiation symbol that is magenta, purple or black on a _____background



b. Radiation hazard

- Radiation area
- High radiation area
- Very high radiation area

c. Warning signs

- Signs that indicate the room is in use