HEALTH PHYSICS
CHAPTER NO. 3: SAFETY AND PROTECTION IN TEXTBOOK, PAGE NO 29

Dr. Irfan Adil Majid
Assistant Professor of
Oral Medicine and Radiology

LECTURE LEARNING OUTLINE

- Lecture learning outcomes.
- Sources of radiation.
- Annual dose limits
- Reducing dental exposure
  - Patient selection
  - Conducting the Examination
    - Image Receptor
    - Focal Spot –to-Film Distance
    - X-ray Beam Collimation
    - Filtration
    - Lead Apron and Collar
  - Protecting personnel
- Dosimetry

LECTURE OUTLINE

- Enumerate the sources of radiation to man
- Recall the annual dose limits of radiation
- Describe methods of radiation dose reduction

??? RADIATION SAFETY and PROTECTION

Deterministic Effects[Cell Death]

Are "Definitive" damaging effects to the body when exposed to specific high dose radiation, depending upon the radiation dose.Eg: Organ Damage, Acute Radiation Syndrome

Stochastic Effects [Heritable DNA damage]

Are effects that "May" develop when exposed to radiation, donot depend on the amount of radiation dose Eg: Radiation Mutation, Radiation Carcinogenesis

SOURCES OF RADIATION

I. Background [Natural]

- A. External

1. Space radiation/Cosmic

2. Terrestrial : nature

- B. Internal

1. Radon and its progeny

II. Medical [Artificial]

A. X-rays

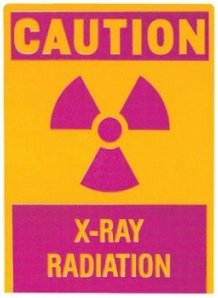
B. Nuclear Medicine

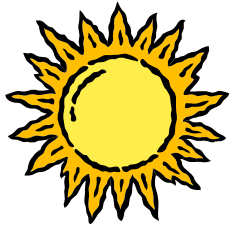
III. Consumer Products

Occupational

Nuclear Fuel

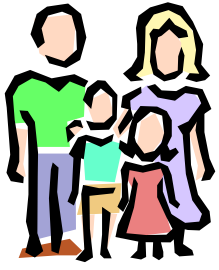
Background Ionising Radiation





Cosmic Rays

14%



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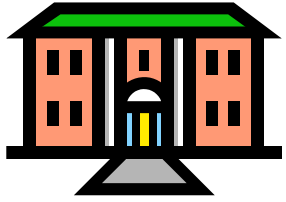
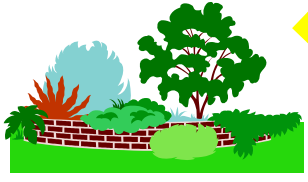


Ground & Buildings

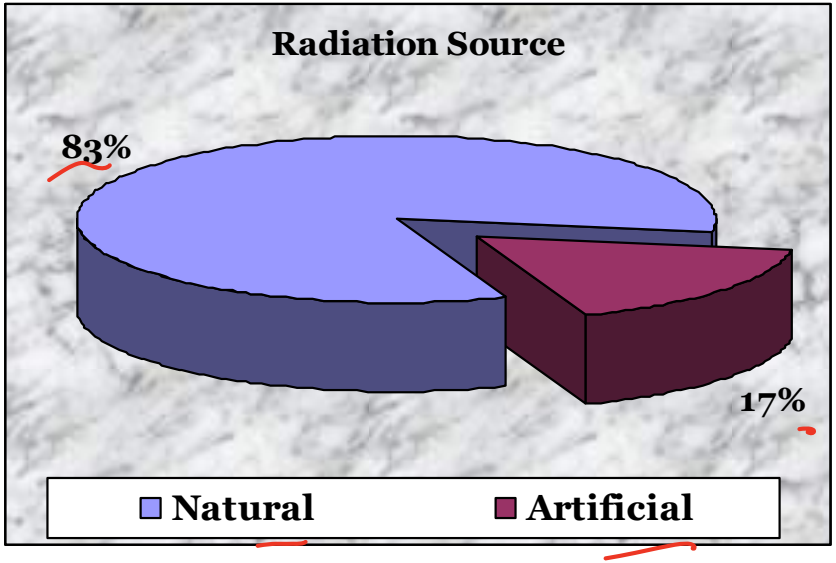
37%

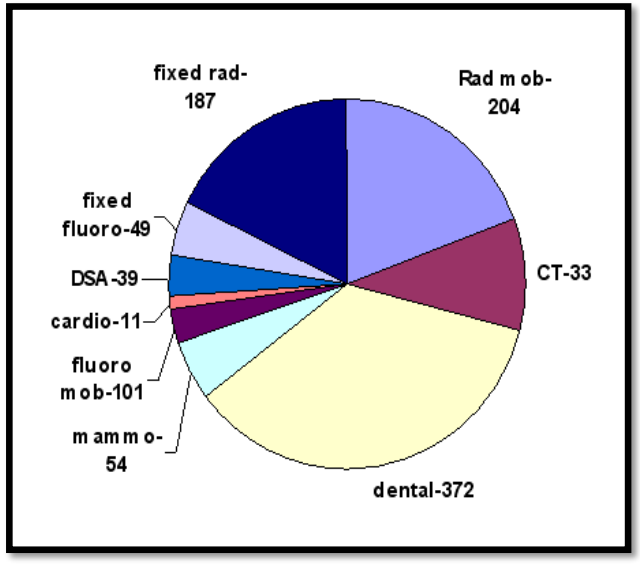


Natural Radioactivity

17%

Food & Drink



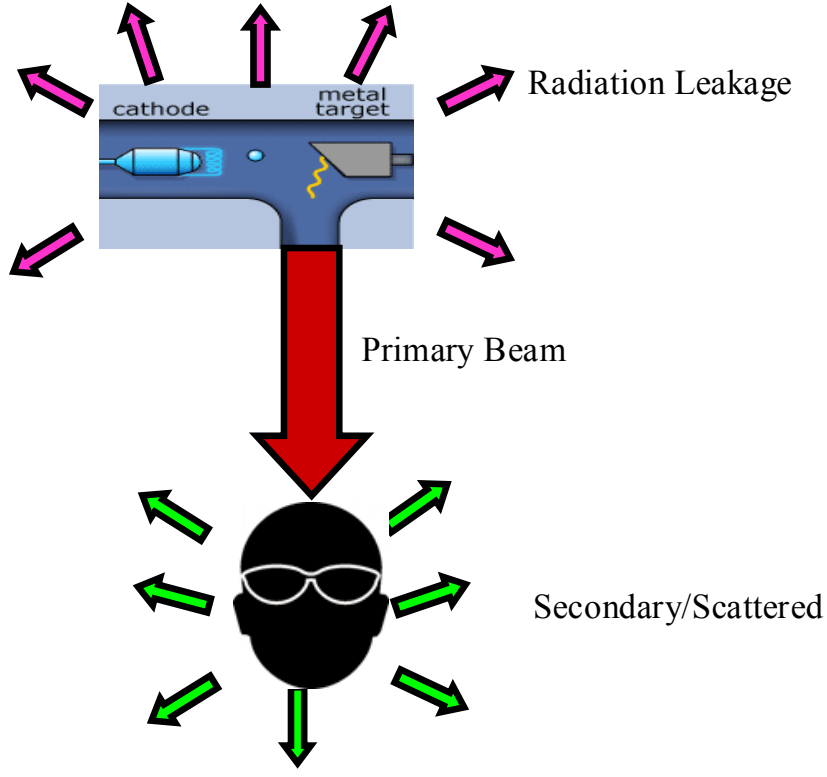


Artificial Radiation Source

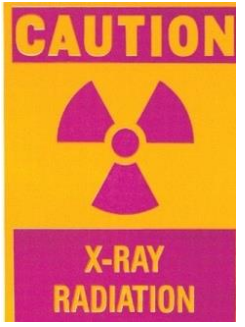
Refer to figure 3-1and 3-2 on page no. 30 in the textbook

Sources of Radiation in Dental Radiology

- **Primary beam:** Emitted by the Focal Spot of the target
- **Radiation Leakage:** Radiation emitted by any other part of the x-ray tube other than the focal spot
- **Secondary and Scattered Radiation:** Radiation emitted by the substance through which x-rays are passing

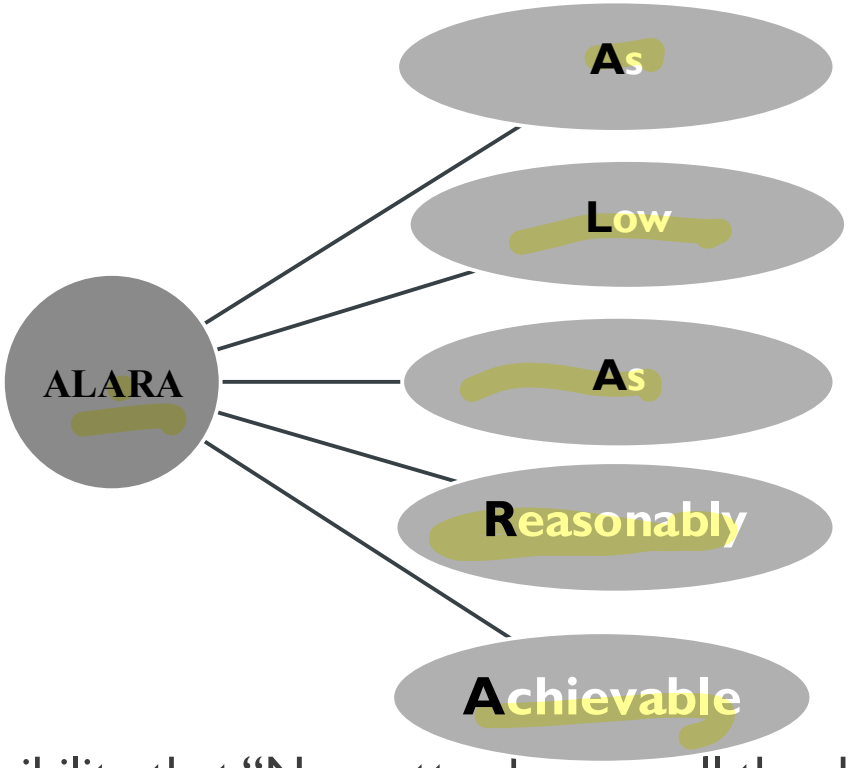


RADIATION REGULATORY BODIES AND AIM OF RADIATION PROTECTION



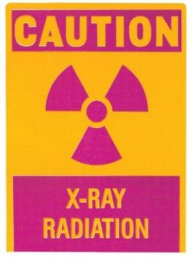
- **ICRP:** International Commission on Radiation Protection
- **NCRP :** National Council on Radiation Protection
- Aim: "To provide an appropriate standard of protection for man without unduly limiting the beneficial practices giving rise to radiation exposure"

THE ALARA PRINCIPLE



This recognizes the possibility that "No matter how small the dose, some Stochastic effect may result"

RADIATION DOSE LIMITS



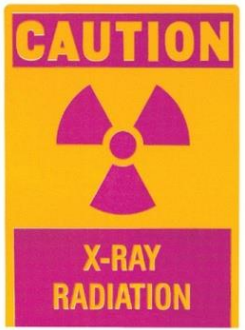
- Prevention of Deterministic effects by keeping doses below the set thresholds
- Reduce the incidence of Stochastic effects to a level that is deemed acceptable by society

ANNUAL DOSE LIMITS

TABLE 3-2
Recommended Annual Limits for Human Exposure to Ionizing Radiation

RECOMMENDATION	NCRP	ICRP
Occupational Dose Limits		
Relative to stochastic effects	50 mSv annual effective dose limit and 10 mSv age (yr) cumulative effective dose limit	50 mSv annual effective dose limit and 100 mSv in 5-yr cumulative effective dose limit
Relative to deterministic effects	150 mSv annual equivalent dose limit to lens of eye and 500 mSv annual equivalent dose limit to skin and extremities	150 mSv equivalent dose limit to lens of eye and 500 mSv annual equivalent dose limit to skin and extremities
Nonoccupational (Public) Dose Limits		
Relative to stochastic effects	5 mSv annual effective dose limit for infrequent exposure and 1 mSv annual effective dose limit for continuous exposure	1 mSv annual effective dose limit and, if higher, not to exceed annual average of 1 mSv over 5 yr
Relative to deterministic effects	50 mSv annual equivalent dose limit to lens of eye, skin, and extremities	15 mSv annual equivalent dose limit to lens of eye and 50 mSv annual equivalent dose limit to lens of eye, skin, and extremities
Embryo-fetus	0.5 mSv equivalent dose limit per month after pregnancy is known	2 mSv equivalent dose limit after the pregnancy has been declared
Negligible individual dose*	0.01 mSv annual effective dose	None established

From National Council on Radiation Protection and Measurements: NCRP Report 116, 1993, and International Commission on Radiological Protection: Radiation protection, ICRP Publication 60, 1990.
*That dose below which any effort to reduce the radiation exposure cannot be justified.



msv = milli siverte

REDUCING DENTAL EXPOSURE

Are Methods Of x-ray exposure and dose reduction

I. Patient Selection

II. Conduct Of Examination

II.1 Choice of Equipment

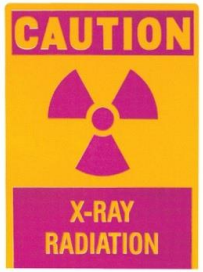
II.2 Choice of Intra Oral Technique

II. 3 Operation of Equipment

III. Processing of Films

IV. Protection of Personnel

I. PATIENT SELECTION



- Professional judgment
- Diagnostic radiograph should be advised only after clinical examination
- Not as an alternative to Clinical assessment
- Selection of appropriate radiographs

II. CONDUCTING THE EXAMINATION

II.1 Choice of Equipment

II.1.A. Image Receptor

II.1.B. Focal Spot –to-Film Distance

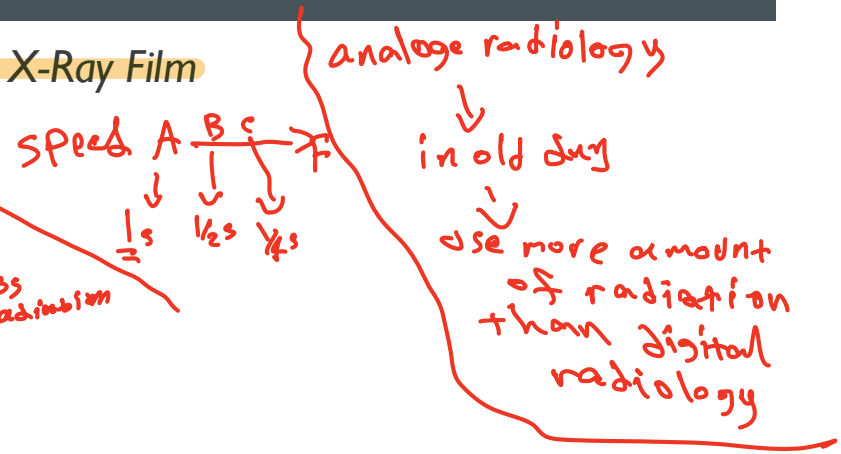
II.1.C. X-ray Beam Collimation

II.1.D. Filtration

II.1.E. Lead Apron and Collar

II.1.A: IMAGE RECEPTOR

- In 1920 Eastman kodak Company introduced *Regular Dental X-Ray Film*
- Types of Films: Fast, Slow
- Speed of film is designated alphabetically from A to F
- Fast film: require less exposure time
- Faster films reduce the Radiation Dose
- Currently Intra-Oral dental films are available in three speed groups D, E, and F



slow film : more exposure of radiation

less radiation

less radiation than Extra-oral

II.1.A: IMAGE RECEPTOR CONT…

- *Regular Dental X-Ray Film* would need 9 seconds of exposure time to make a radiograph of maxillary molar

- Speed E film is two times faster than Speed D film, Speed F film twice as fast as E film [Eg: E film exposure time 1 sec, F film exposure time 0.5 sec]

- Fast Films reduce the patient exposure but at the same time decrease the Image Quality

II.1.A: IMAGE RECEPTOR CONT…

- Intensifying Screens Films
- Combination of Rare earth Screen + X-ray film: 55% reduction of Radiation Exposure [Panoramic and Cephalometric Radiography]
- T-grain films have greater grain cross-section therefore have greater ability to gather light from the intensifying screen
- Inorganic salts or phosphors fluoresce [emit visible light] when exposed to an x-ray beam
- Rare Earth elements: chemicals

1. Gadolinium, Lanthanum emit Green Light
2. Calcium Tungstate emits Blue Light

II.1.B: FOCAL SPOT -TO-FILM DISTANCE [FSFD]

- The combination of proper Collimation and extended Source-Patient distance [FSFD] will reduce the amount of radiation to the patient

- Long FSFD reduces patient exposure by 32%

↑ distance → ↓ radiation

1 cm → ↓ 4 times

2 cm → ↓ 8 times

- At greater FSFD the X ray beam is less Divergent

- Longer FSFD also increases the resolution of the radiograph

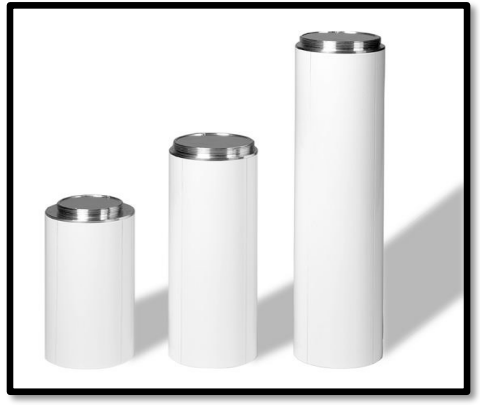
II.1.B: FOCAL SPOT -TO-FILM DISTANCE [FSFD] CONT..

Federal Regulation for FSFD:

- Length of PID Not less than 18 cms [7 inches] from skin
- Distance of PID from Skin Not less than 2.5 cms [1 inch]

Types of FSFD [Length of PID]:

1. 20 cms [8 inches] Aiming cone
2. 41 cms [16 inches] Aiming cone



II.1.C: X-RAY BEAM COLLIMATION

- Federal Government requirement for Intra-Oral radiography

"Patient skin surface exposed by X-rays should NOT BE more than 7 cms when the X-Ray Machine is operated above 50kVp"

- Beneficial effects of Collimation

1. Results in less Patient Exposure
2. Decreased Scattered Radiation
3. Decreased Film Fog
4. Increased Image Quality

II.1.C: X-RAY BEAM COLLIMATION

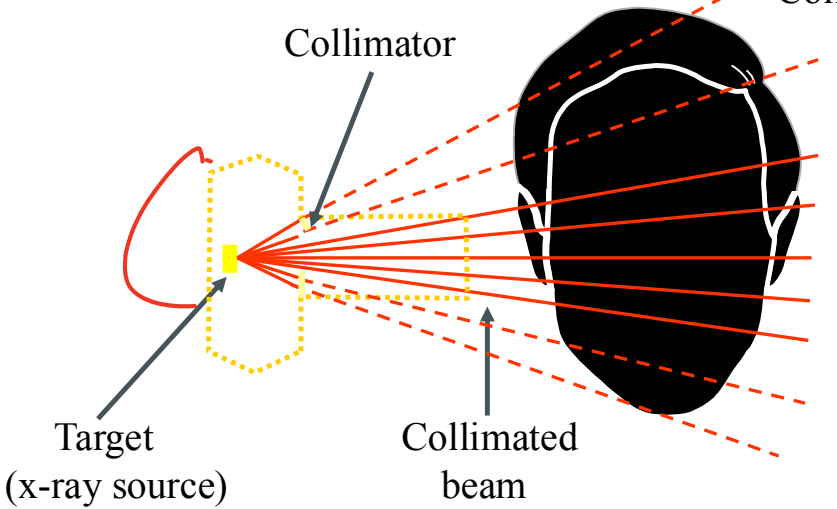
- Methods of limiting the X-ray beam Size

1.Lead Collimator

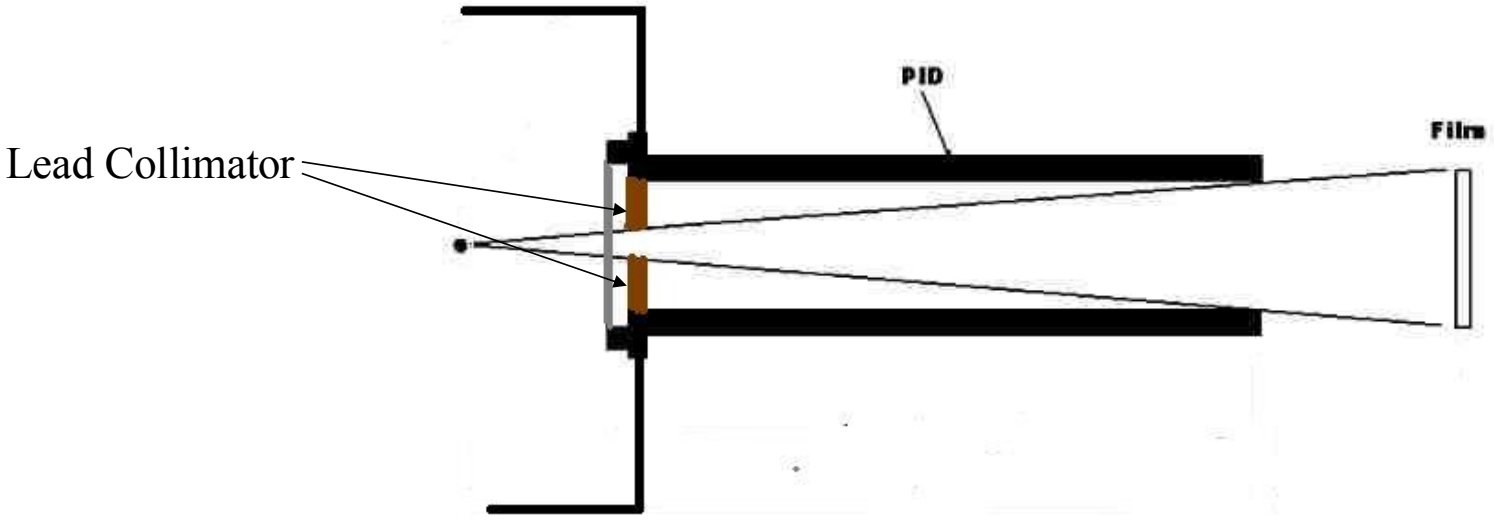
2.Position Indicating device [PID]:

Rectangular, Round

3.Film Holders



II.1.C: X-RAY BEAM COLLIMATION CONT…

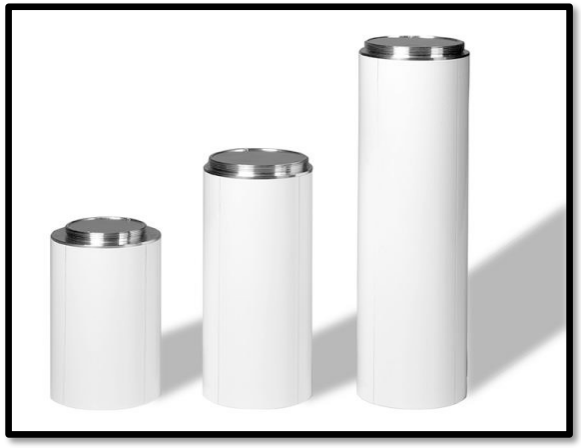


- Circular Lead Disc placed at the portrt of exit of X-rays from the X-ray head

II.1.C: X-RAY BEAM COLLIMATION CONT…

- PIDs are Open End Lead-lined Cone Circular or rectangular

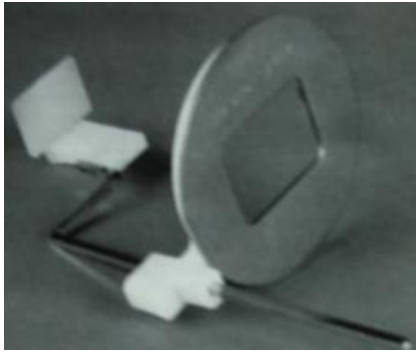
- Rectangular PID [Open End Lead-lined Cone] have an exit opening of 3.5X4.4 cms and reduce patient exposure by 71%-80% better than circular

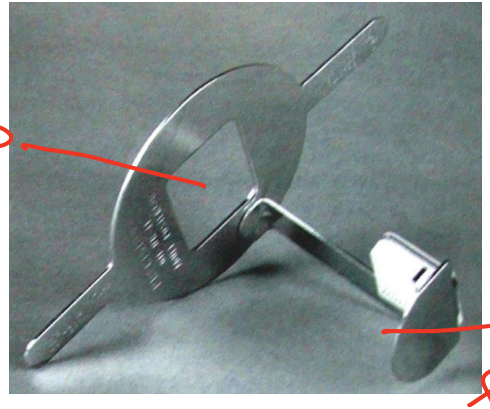


- Circular PID have a larger exit opening than rectangular PIDs

II.1.C: X-RAY BEAM COLLIMATION CONT…

- Film holder Rectangular or Circular reduce patient exposure by 60%





هنا أحط الـ PID

هنا أحط الـ Filter

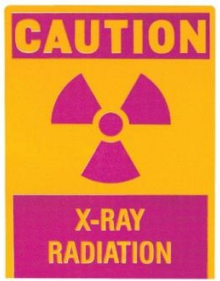
II.1.D: FILTRATION

internal filtration: Two glasses and oil inside head tube → absorb long wave l. → reduce heat

external filtration: aluminium 1.5 mm → 70KVp, 2mm → 70KVp → absorb long wave length.

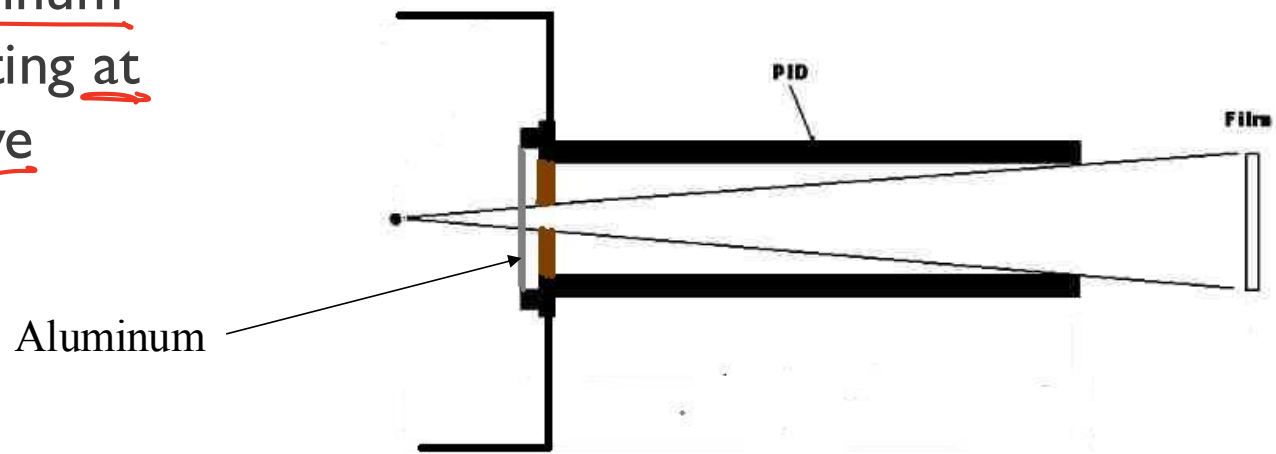
long wave length is bad for patient

short ≠ ≠ is good for patient



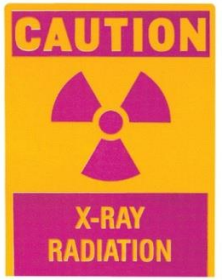
- Federal regulation for Intra-Oral Radiography states "A minimum of 1.5 mm Aluminum for X-Ray Machine operating at 70kVp and 2 mm for above 70kVp"

filter: absorb all long wave length and passage all short wave length



kVP: Killo Volt Peak

III. PROCESSING OF THE FILM



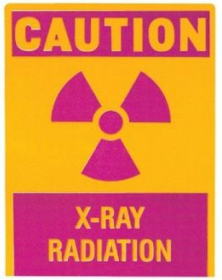
- Manual processing ***VS*** Automatic processing (better)

Time Temperature Method

- Quality of Processing chemicals

- Film manufacturer's recommendation ***VS*** Solution manufacturer's recommendation

IV. PROTECTION OF PERSONNEL

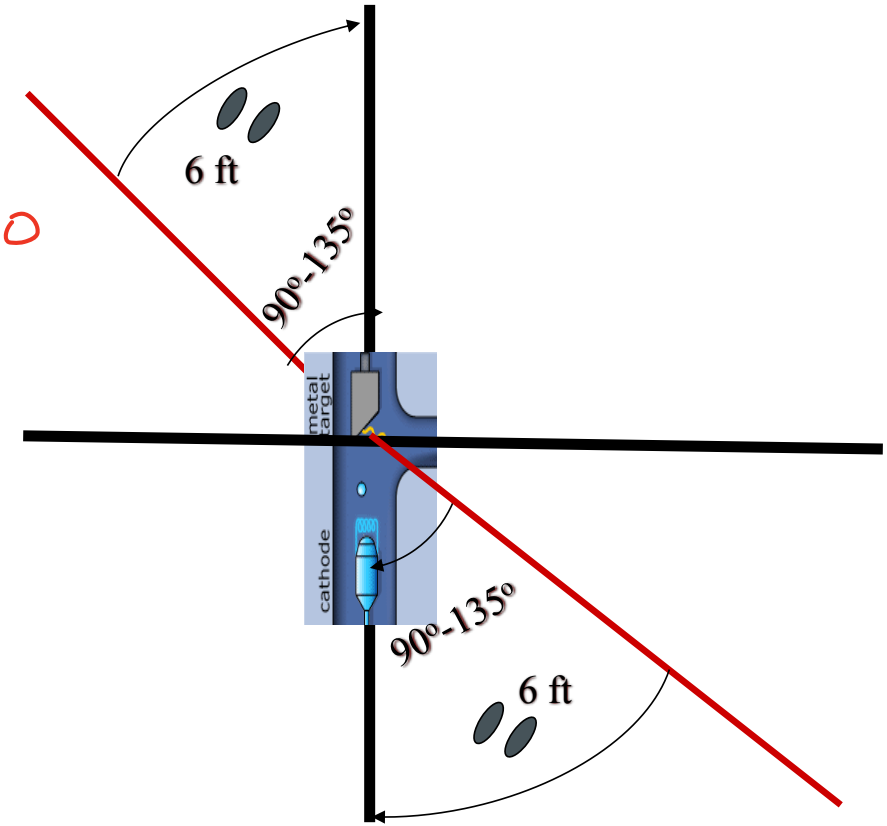


IV.1: Operator Position

IV.2: Barriers

IV.1: Position Distance Rule

6 feet distance from the machine at angle of 90°-135°



IV.2: BARRIERS
LEAD APRON AND COLLAR

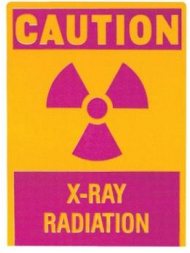
Lead Thyroid Collar

Thyroid

gloves

lead screen

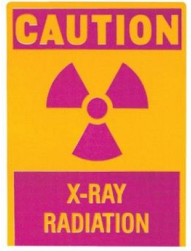
IV.2: BARRIERS CONT…



IV.2: BARRIERS CONT…

Lead Apron

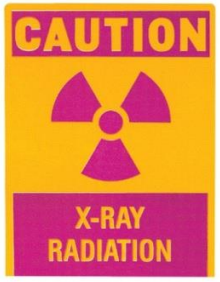
Lead Bricks



Lead Curtain

Lead Sheet

LEAD FREE APRONS



- Xenolite alloy sheeting in Dental x-ray aprons offers the same radiation protection as conventional lead aprons without the heavy weight or risk of lead exposure

DOSIMETRY

Determining the unit of radiation exposure or dose is termed as "Dosimetry"

Types

1. Film Badges
2. Ionization Chambers
3. Thermo-luminescent Dosimetry

1. FILM BADGES

- Film may be used to monitor exposure to x radiation
- The film is usually worn in metallic film badges
- The film is subsequently prosseced and extent of exposure measured by the degree of darkening

1. FILM BADGES CONT…

- They are used to monitor exposure to low levels of radiation received over time
- May be used to evaluate the adequacy of radiation safety practices

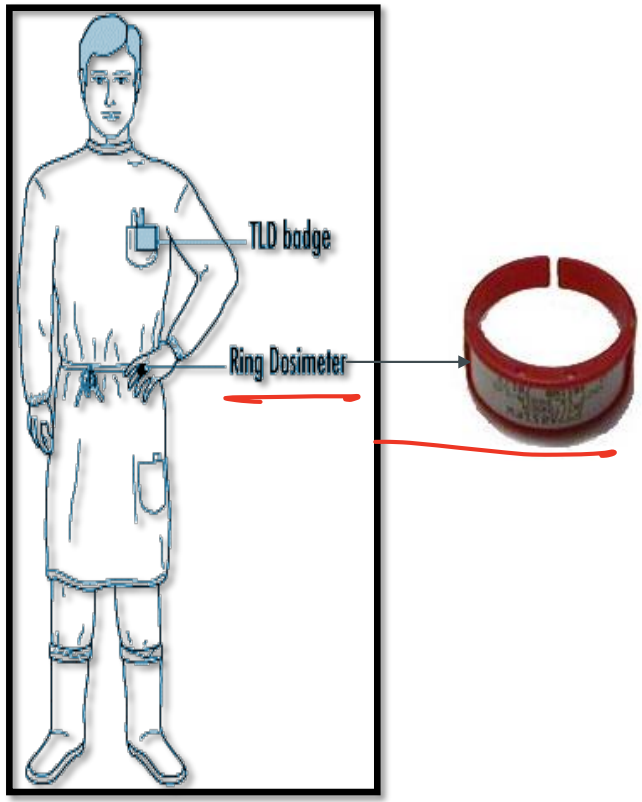
2. THERMO-LUMINESCENT DOSIMETRY [TLD]

- Lithium fluoride[LiF] and to a lesser extent Calcium Fluoride containing Manganese are the most widely used crystals for Radiation Dosimetry
- The ionizing radiation raises the energy of the outer electron in some of the atoms of the crystal
- When the crystal is heated the trapped electrons release Visible Light
- The total light emitted is α to the energy absorbed by the crystal

2. THERMO-LUMINESCENT DOSIMETRY [TLD] CONT…

- LiF has a low atomic number, its radiation absorption characteristics are similar to that of soft tissue

- Because of their small size, accuracy, and easy handling characteristics, thermoluminescence dosimeters are frequently used in specific investigations and in personnel monitoring applications.



3. IONIZATION CHAMBERS

- It is described as a pair of collecting plates, each with an opposite charge, separated by a standard volume of air

- The plates are connected to an electrometer capable of measuring a small electric charge

- The Victoreen condenser r – meter is frequently used for measuring x ray exposure


Thank You