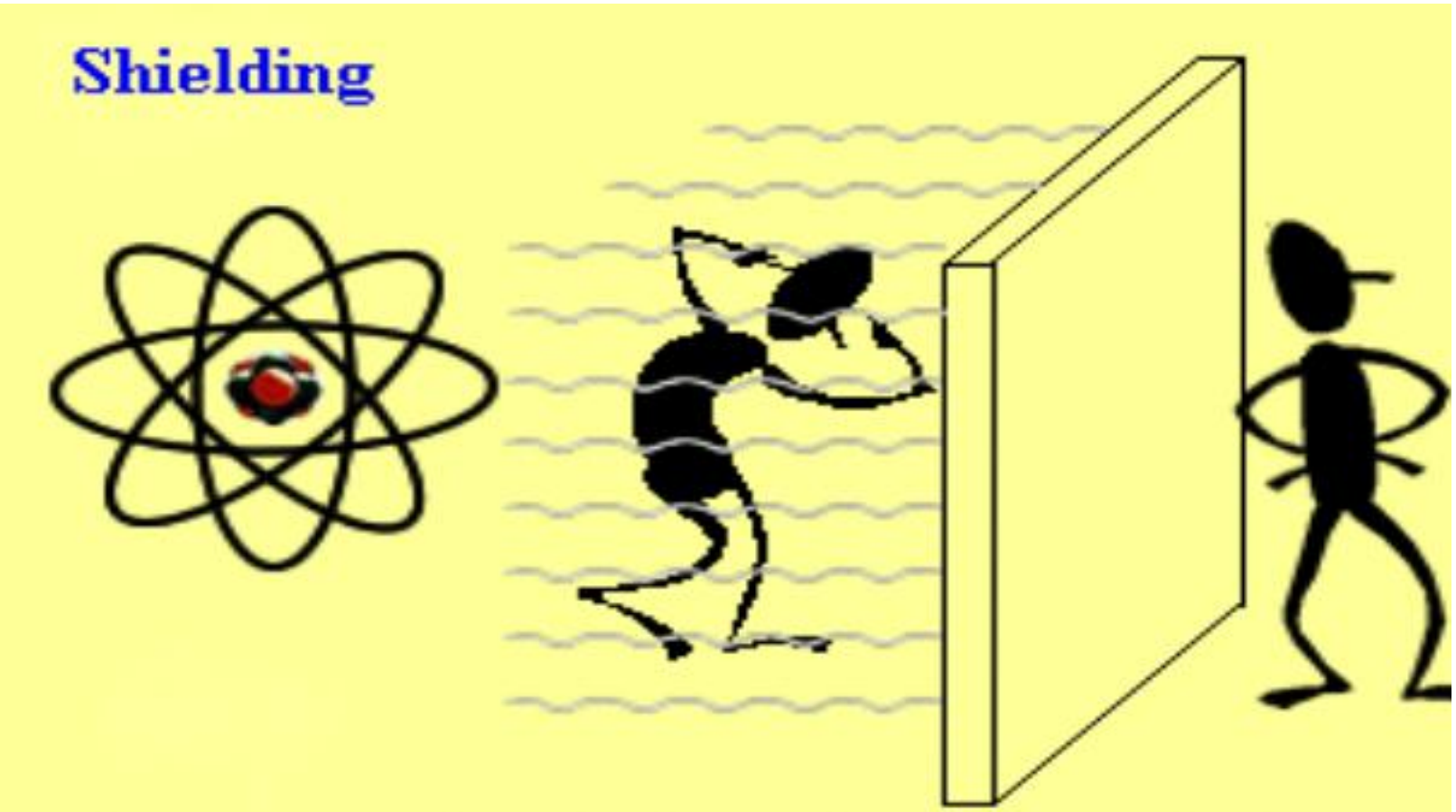
RADIATION PROTECTION IN DENTISTRY



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What is meant by radiation “dose” of X rays?

Radiation dose is a measure of how much energy is absorbed when something or someone is exposed to X-rays. This is important because it is this absorption of energy that can cause damage to a person. **Different quantities are used to express dose.**

Which quantity is used in practice to relate radiation dose to risk?

A commonly used quantity to express the dose to a person is effective dose, which takes into account the dose to different organs/tissues which are exposed (as different organs/tissues have varying sensitivity to radiation).
Effective dose is related to the risk for **stochastic effects** (cancer and genetic effects).
Effective dose and its associated risk should not be applied to individuals, but can be used to compare between **modalities**, techniques and other sources of exposure (e.g. natural background levels). **Non-stochastic effects** (tissue reactions / deterministic effects may also occur at organ dose levels above a specific threshold.

Since the effective dose cannot be measures, in practice, other dose quantities that are directly measurable are used for the purpose of optimization, dose monitoring, and quality assurance. They are specific to a certain imaging modality.
The measurable quantity is the entrance surface air kerma/dose. The unit of entrance surface kerma is the gray (Gy), but in dental radiology the dose levels are usually a small fraction of one gray - milligray (mGy), or even microgray (μGy).
In cephalometric, panoramic radiography and in CBCT the measurable quantity is usually the product of **kerma (dose) and the X ray field, called Kerma-area product, measured in mGy.cm2.**

What is a typical dose from a dental radiological procedure?

In the scope of quality assurance, measurable doses from radiological procedures are often expressed as **diagnostic reference levels (DRL)**, based on local surveys of typical patient doses. **DRL** values for adult exposures from various national surveys are in the following ranges:

•0.65 to 3.7 mGy in terms of entrance surface kerma, and 26 to 87 mGy.cm2 in terms of kerma-area product for intraoral radiography;

•3.3 to 4.2 mGy in terms of **entrance surface dose**, and 84 to 120 mGy.cm2 in terms of kerma-area product for panoramic radiography;

•41 to 146 mGy.cm2 (adults) and 25 to 121 mGy.cm2 (children) in terms of kerma-area product for lateral cephalometric radiography.

Typical effective doses are for:

•intraoral dental X ray imaging procedure 1–8 μSv;

•panoramic examinations 4-30 μSv;

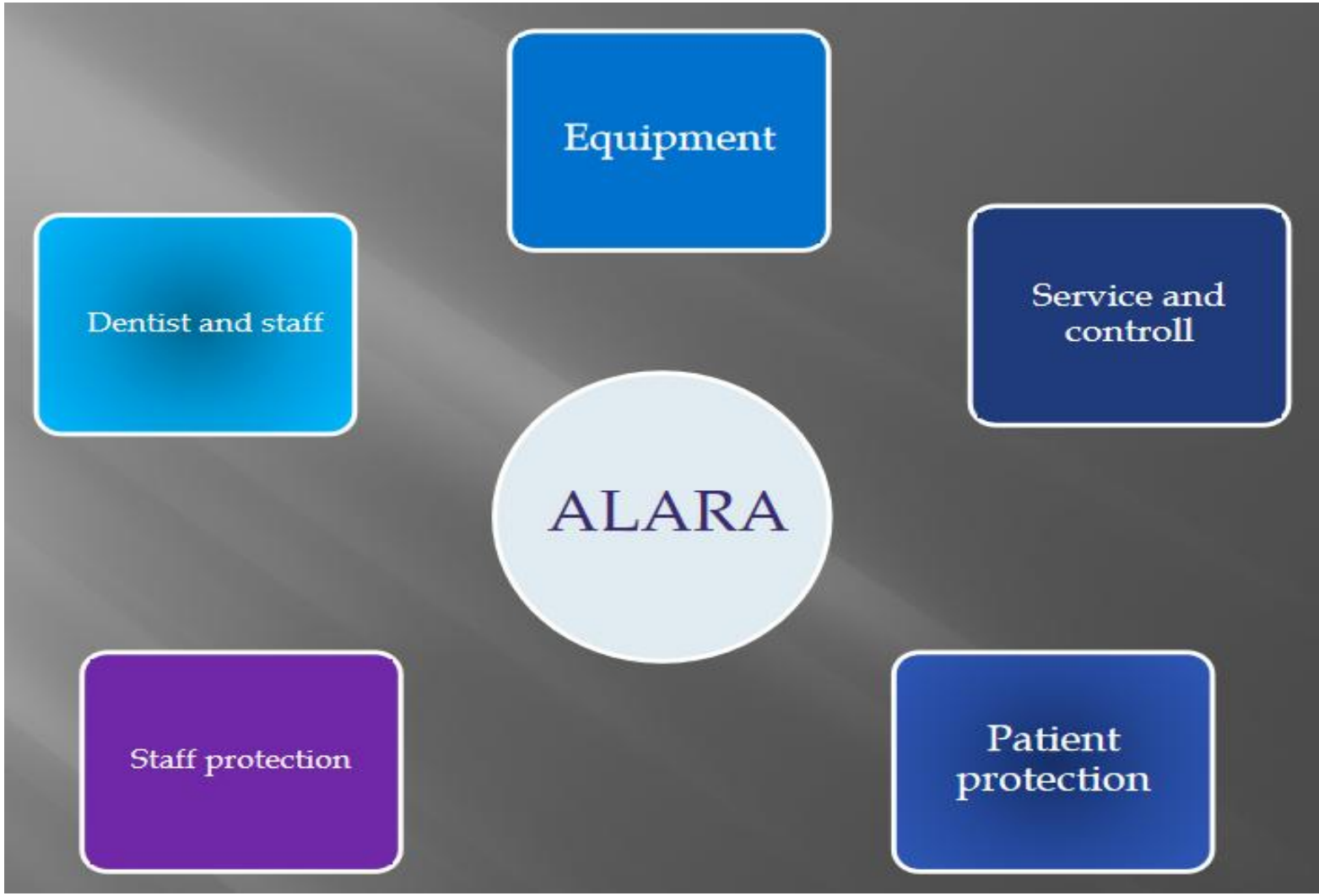
•cephalometric examinations 2-3 μSv,

•CBCT procedures (based on median values from literature): **50 μSv** or below for small- or medium-sized scanning volumes, and 100 μSv for large volumes.

Thus the doses from intraoral and cephalometric dental radiological procedures are lower, usually less than one day of natural background radiation. Doses for panoramic procedures are more variable, but even at the high end of the range are equivalent to a few days of natural background radiation which is similar to that of a chest radiograph. **CBCT doses cover a wide rang**e, but may be tens or even hundreds of μSv of effective dose higher than conventional radiographic techniques, depending upon the technique. **Rapid technological improvements to CBCT equipment mean that typical dose ranges are likely to change.**

What are we protecting?

- Patient
- Ourselves
- Colleagues
- Environment



The 3 bases of radiation protection

Reasonable :*Benefit* > ***Risk***

Optimization :*ALARA* ***(As Low As Reasonably Achievable)***

Dose limitation: Reducing Dental Exposure:

There are three guiding principles in radiation protection:

- **The first** is the *principle of justification*, the dentist must do **more good** than **harm**.
- In radiology this means the dentist should identify those situations where the benefit to a patient from the diagnostic exposure exceeds **the low risk of harm**.
- **The second guiding rule is the *principle of optimization*.**
- **This principle holds that dentists should use every means to reduce unnecessary exposure to their patient and themselves.**
- **This philosophy of radiation protection is often referred to as the principle of ALARA (*As Low As Reasonably Achievable*)** .
- ALARA holds that exposures to ionizing radiation should be kept as low as reasonably achievable, economic and social factors being taken into account.

- **The third** principle is that of ***dose limitation*.**

  Dose limits are used for occupational and public exposures to ensure that no individuals are exposed to unacceptably high doses.

Who may be present in the room during radiographic exposure?

In the case of a **single-chair room**, persons must not be present in the room during a radiographic exposure **unless their presence is necessary for conduct of the examinations**.

Persons present must be **located behind a shield allowing a view of the patient and the "exposure on" indicator, or wearing protective apron**, or at **least 2 m from the source of scattered radiation(meters preferably 3 m)**., i.e. the **patients head**, and **not in line with the primary beam**.

The person accompanying a minor can't be pregnant, or under 18, also has to wear a protecting suit!(APRON

In the case of the multi-chair room, there should be **adequate shielding** between the chairs.

Protecting wall

The best option: Protected cabin

The wall can be made of:

brick

concrete

Lead between wooden plates

In case of low circulation: protecting wall

At least 1.5 m from the focus of the X-ray machine

At least 2 m high

At least 0.7 mm lead-equivalent

At eye-level: **600 cm² 1 mm lead-equivalent lead-glass window**

Equipment

We have to choose:

Which is the most ideal X-ray machine for our purposes

What is our purpose:

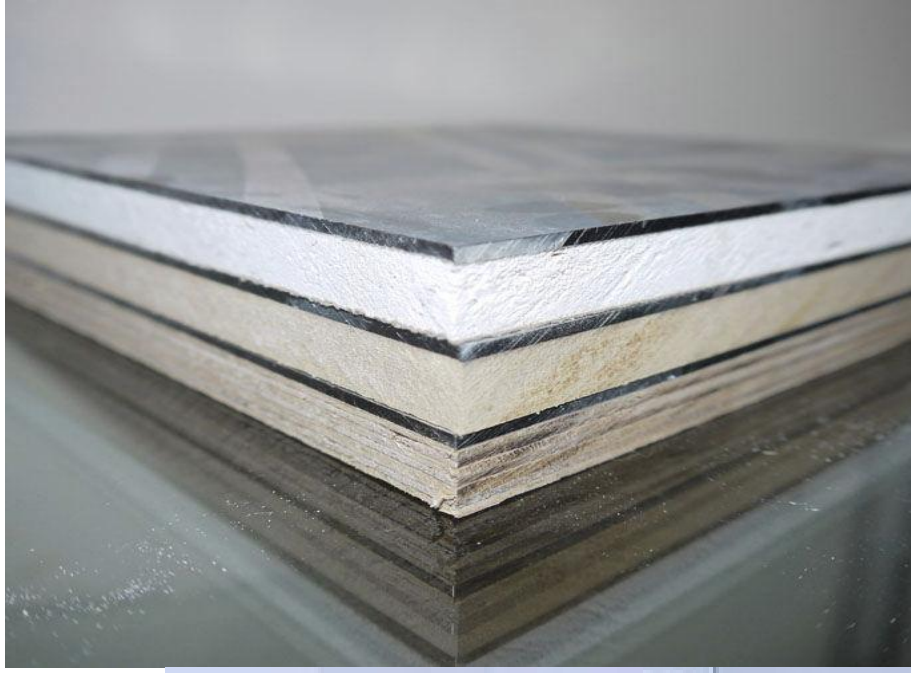
The lowest achievable radiation dose

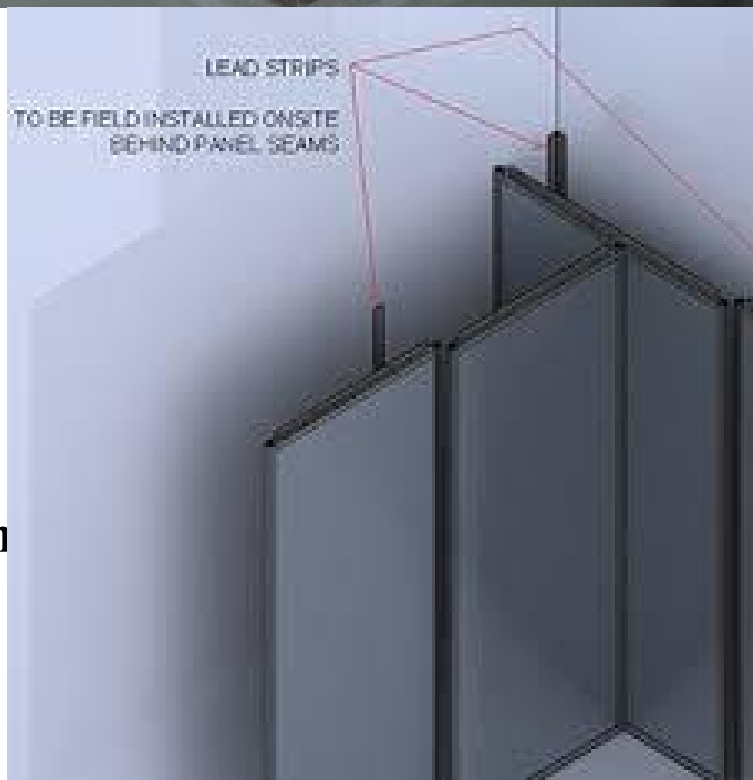
The highest achievable image quality

A lower dose of diffuse radiation can usually be achieved using modern equipm

How does the digital system help?

Radiation shielding panel





Radiation protection in regards of digital radiography:

The radiation dose is lower comparing intraoral images

Can be stored electronically, images are easily multiplied and thereby no need for re-takes

The benefits of the **software**:

No need for re-takes

Over- or underexposed images can be salvaged

The contrast and the definition can be modified

PATIENT SELECTION CRITERIA

Dentists should not prescribe **routine dental radiographs** at preset intervals for all patients. Instead, they should prescribe radiographs after an evaluation of the patient ' s needs that includes

1-health history review,

2-clinical dental history assessment,

3-clinical examination, and

4-evaluation of susceptibility to dental diseases

1-Film and Digital Imaging :

High speed films or digital sensors may be used.

Currently, intraoral dental x-ray film is available in three speed groups: **E, and F.**

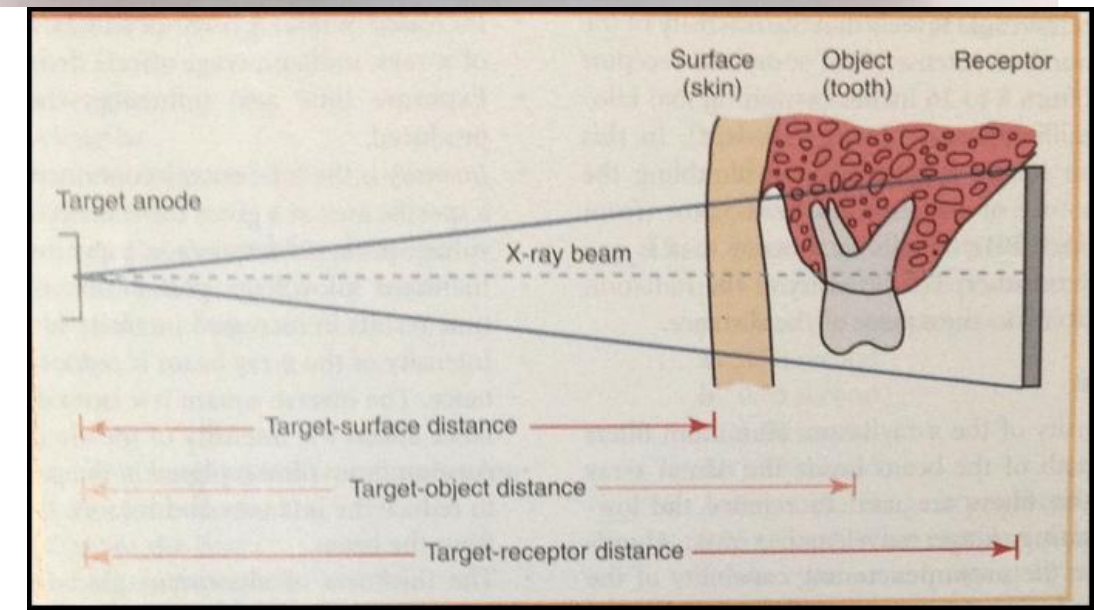
Clinically, film of speed group E is almost twice as fast (sensitive) as film of group D.

The current F-speed films require about **75%** **the exposure of E-speed film and only about 40% that of D-speed.**

2-Source-to-Skin Distance:

Two standard **focal source-to-skin distances** have evolved over the years for use in intraoral radiography, one 20 cm (8 inches) and the other 41 cm (16 inches).

Use of the distance results in a 32% reduction in exposed tissue volume because the x-ray beam is less divergent .



3- Rectangular Collimation

According to (ADA, 2006) since a rectangular collimator decreases the radiation dose by up to fivefold as compared with a circular one,

radiographic equipment should provide rectangular collimation for exposure of periapical and bitewing radiographs.

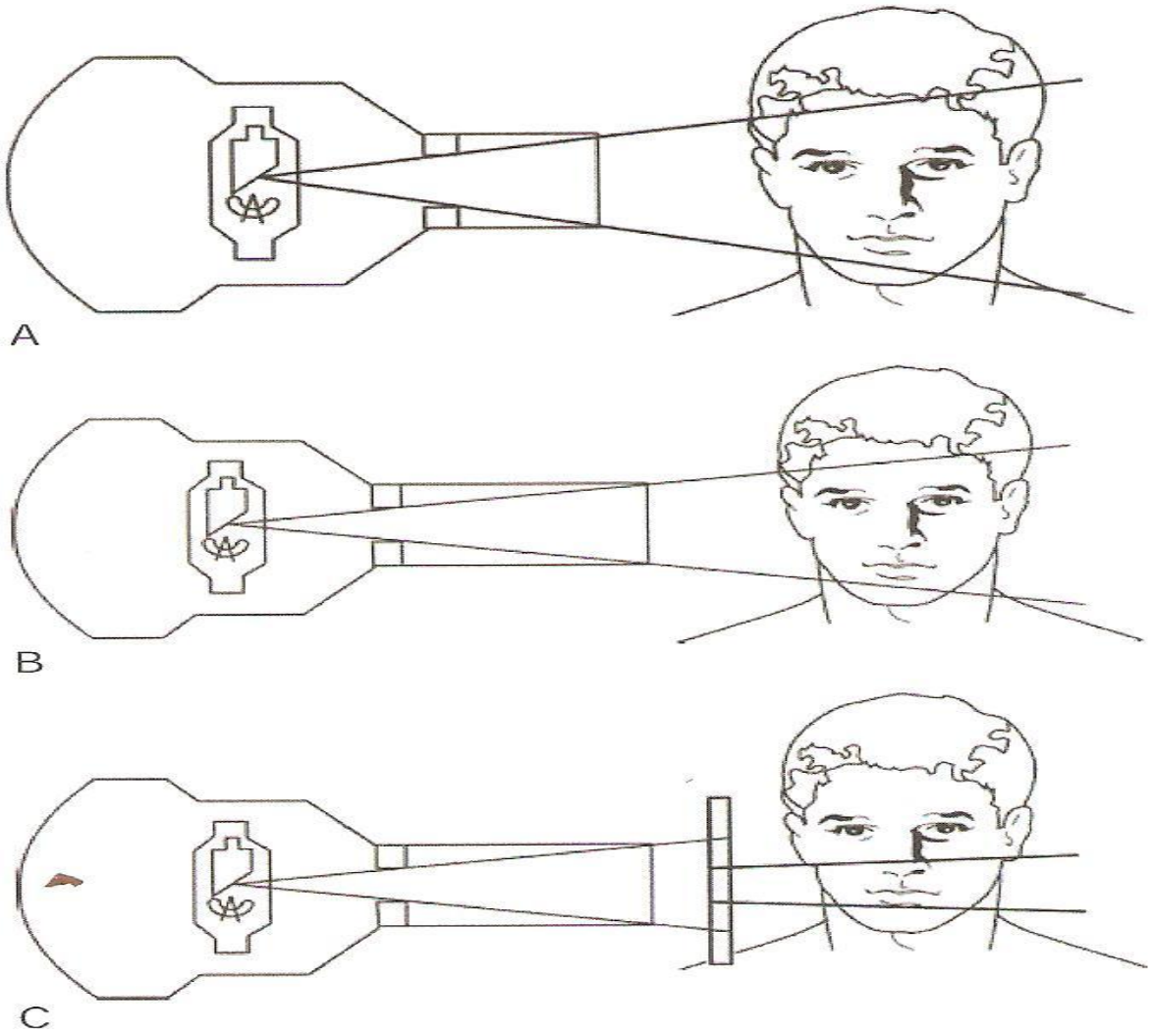
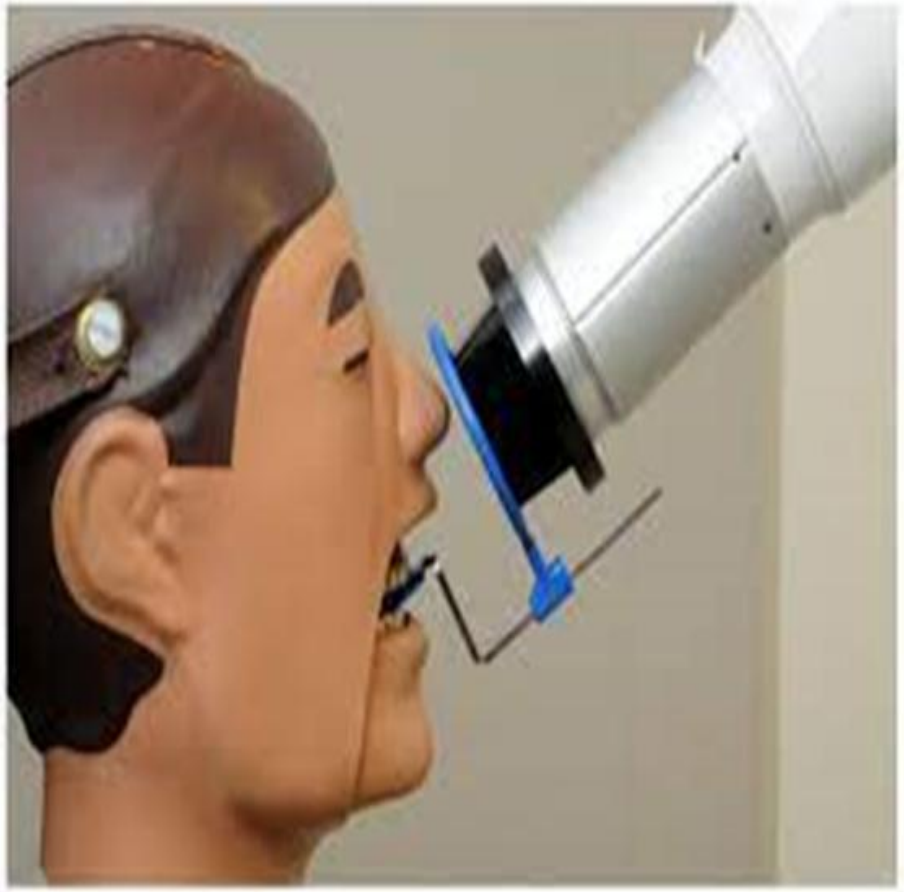


FIG. **3-4** Effect of source-to-skin distance and collimation on the volume of tissue irradiated. A larger volume of irradiated tissue results from **A** (with shorter source-to-skin distance) than from **B** (in which the longer source-to-skin distance produces a less divergent beam). In **C** the collimator between the round PID and the patient produces the effect of a rectangular PID on the tube housing or a rectangular collimating face shield on the film-holding instrument. This rectangular collimator (close to the patient in **C**) results in a smaller, less divergent beam and a smaller volume of tissue irradiated than in **A** or **B**.

This results in not only decreased patient exposure,but also increased image quality because the amount of radiation scatter generated is proportional to the area exposed.

There are several means to limit of the size of the x-ray beam.

First, a rectangular position-indicating device (PID) may be attached to the radiographic tube housing.



4- Filtration:

The x-ray beam emitted from the radiographic tube consists of not **only high-energy x-ray photons**, but also many photons with **relatively lower energy**.

The purpose of **filtration is to remove these low-energy x-ray photons selectively from the x-ray beam**.

When an x-ray bea**m is filtered with 3 mm of aluminum**, the surface exposure is reduced to **about 20% of that with no filtration.**

5- Leaded Aprons and Collars

- The function of leaded aprons and thyroid collars is to reduce radiation exposure of the gonads and thyroid gland.
- Thyroid shielding with a leaded thyroid shield or collar is strongly recommended for children and pregnant women,
- as these patients may be **especially susceptible to radiation effects**.

6-Film and Sensor Holders

Film or digital sensor holders should be used when intraoral radiographs are made because they improve the alignment of the film, or digital sensor, with teeth and x-ray machine.
Their use results in a significant reduction in unacceptable images.
This is especially important when the paralleling technique and digital imaging are used.

FIG. 3-6 XCP film-holding instrument. The aiming ring aligns a circular aiming cylinder from an x-ray machine with the sensor to assure that the image plane is perpendicular to the central ray and in the middle of the beam. Note notches to align rectangularly collimated aiming devices such as shown in Figures 3-5 or 3-7. Sensor is in plastic bag to prevent contamination from saliva. (Courtesy Dentsply Rinn, http://www.rinncorp.com/.)

FIG. 3-9 Leaded apron with a thyroid collar. Children are more sensitive to radiation than adults; thus the use of leaded aprons with thyroid collars is especially valuable. (Courtesy Dentsply Rinn.)

7- Kilovoltage :

The operating potential of dental X-ray machines must range between 50 and 100 kilovolt peak but should range between 60 and 80 kVp.

8- Milliampere-Seconds:

The operator should set the amperage and time settings for exposure of dental radiographs of optimal quality.

In terms of exposure, optimal image quality means

that the radiograph is of diagnostic density, neither overexposed (too dark) nor underexposed (too light).

9- Film Processing:

Radiographs should not be overexposed and then underdeveloped, because this practice results in greater exposure to the patient and dental health care worker and can produce images of poor diagnostic quality.

Dental radiographs should not be processed by sight, and manufacturers ' instructions regarding time, temperature and chemistry should be followed.

Approximately 30% of all films retaken because of incorrect film density were directly related to processor variability.

- **PROTECTING PERSONNEL**

In addition to those mentioned, several other steps can be taken to reduce the chance of occupational exposure.

First the operator should leave the room or take a position behind a suitable barrier or wall during exposure of the image.

If leaving the room or making use of some other barrier is impossible, strict adherence to what has been termed the *position-and distance rule* is required:

The operator should stand at least 6 feet (2 m) from the patient, at an angle of 90 to 135 degrees to the central ray of the x-ray beam

When applied, this rule not only takes advantage of the inverse square law to reduce x-ray exposure to the operator but also take advantage of the fact that in this position the patient's head absorbs most scatter radiation.

Second, the operator should never hold films or sensors in place.

Third, neither the operator nor patient should

hold the radiographic tube housing during the exposure.

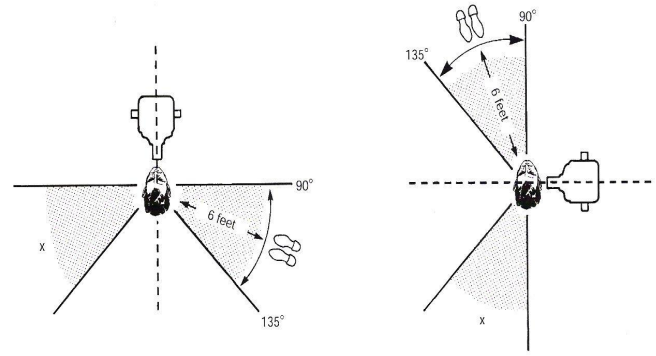


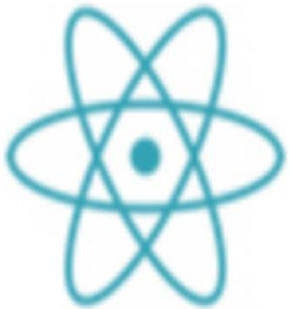
FIG. 3-10 Position-and-distance rule. If no barrier is available, the operator should stand at least 6 feet from the patient, at an angle of 90 to 135 degrees to the central ray of the x-ray beam when the exposure is made.

Exposure time

The less time you are exposed, the lower the dose of radiation you will receive

Distance

The further away you are from the source of the radiation, the less intense its effects will be



Shielding

Shield yourself behind a thick concrete wall or stay indoor. Protective covers made of thick concrete are very good at withstanding radiation penetration

Film badges (dosimeter)

- The best way to ensure that personnel are following office safety rules such as those described previously is with **personnel-monitoring devices**.
- Commonly referred to as ***film badges***, these devices provide a useful record of occupational exposure.
- Film badges contain **either a piece of sensitive film** or a **radiosensitive crystal (thermoluminescent dosimeter)** and a **printed report of accumulated exposure at regular intervals**

Advantages of Film Dosimeters

•A film badge as a personnel monitoring device are very simple and therefore they are **not expensive**.
•A film badge provides a **permanent record**.
•Film badge dosimeters are **very reliable**.
A film badge is used to measure and record radiation exposure due to gamma rays, X-rays and beta particles.

Disadvantages of Film Dosimeters

•Film dosimeters usually **cannot be read on site** instead of they have to be sent away for **developing**.
•Film dosimeters are for **one-time use only**, they cannot be reused.
•Exposures of less than 0.2 mSv (20 millirem) of gamma radiation cannot be accurately measured.

References:


thank you