The Scatter Radiation and methods of control it

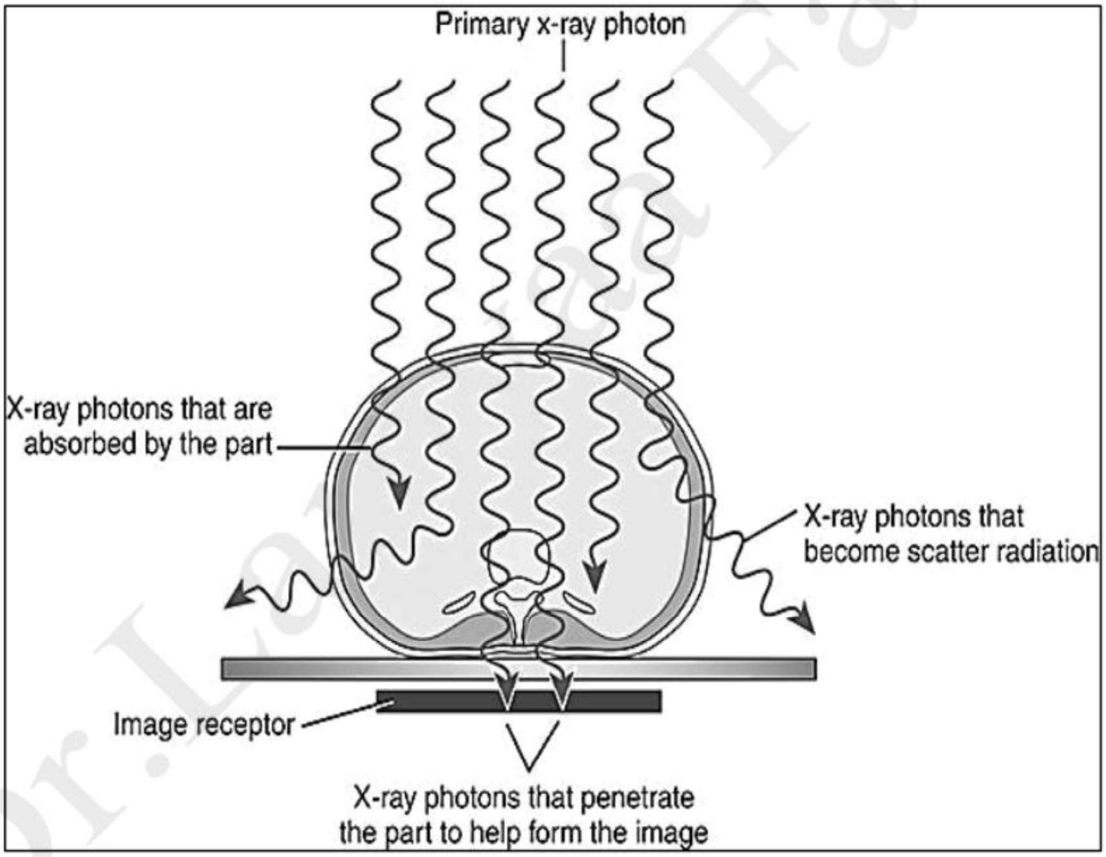
When a radiographic exposure is performed, the primary photons will either:

➥ Pass through the body tissue unaffected. (without interacting).

➥ Become absorbed by the tissues within the body.

➥ Interact with body tissues and change direction (Compton's scatter).

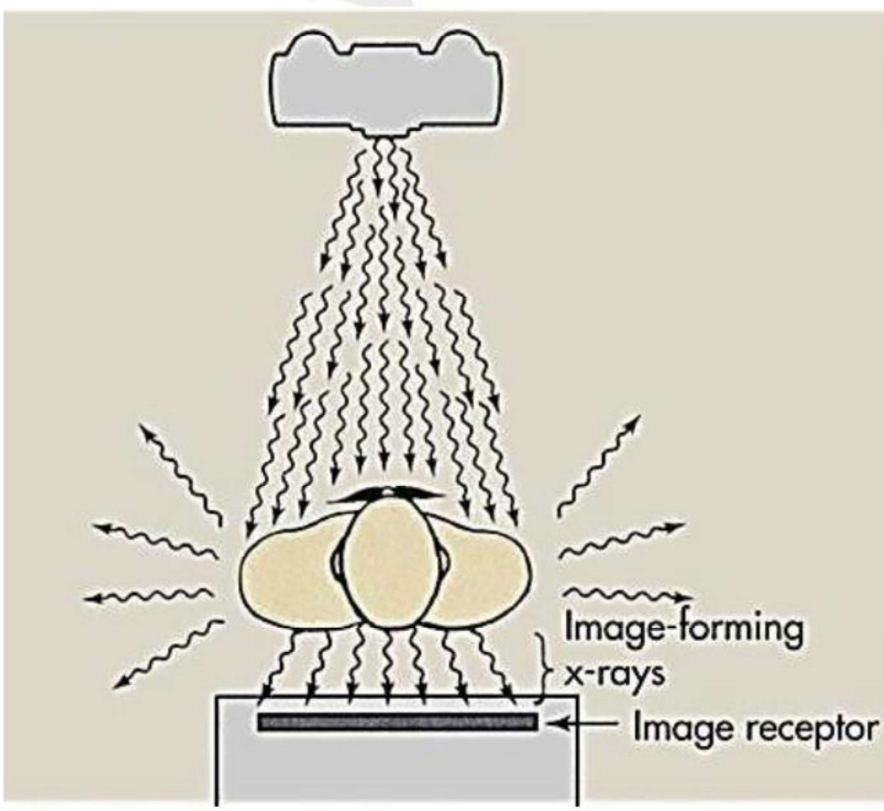
X-rays that exit the patient interact with the IR are Image-forming x-rays



Scatter Radiation

By definition, "Scatter radiation occurs when radiation deflects off an object, causing x-rays to be scattered. It is important to keep in mind that scatter radiation has the ability to travel in all different directions," In the case of X-rays, the most common source of scatter radiation for most humans, is the patient, and those scattered rays can continue to scatter around the room based on various design features.

Scatter radiation is probably the biggest single factor contributing to decreased film quality. It is the result of a redirection of the primary x-ray beam and production of new x-rays following the interaction with the patient. Therefore, scatter radiation is present in each radiographic examination. The effect of scatter radiation is to produce a generalized photographic fog on the film, which reduces the contrast between adjacent areas on the radiograph.



Scatter Radiation Occurs in Three Ways:

⇉ **Bulk Scatter radiation.** This type of radiation derives from the X-rays bouncing off the patient's body.

⇉ **Back scatter.** This type of scatter radiation is created from behind the film and directed back towards the X-ray tube. To prevent backscatter, the industry has adopted the standard procedure of adding a 0.005 lead screen in front and a 0.01 screen behind the film for added protection. Additionally, a letter "B" is placed on the back of the cassette to indicate an abundance of backscatter. If the B is visible in the resulting image, backscatter is occurring, the strength of the "B"'s visibility indicating the level of backscatter taking place.

⇉ **Side scatter.** Side scatter is caused by objects in the immediate areas, such as walls, floors and tables. To mitigate side scatter, the X-ray rooms are typically void of other objects and the table is located in the center of the space. This isolates the X-rays as much as possible so they are less prone to side scatter.

Factors contribute to an increase in scatter are:

➥**Increased kVp**

As x-ray energy increases, photoelectric decrease and Compton interactions increases. At 50 kVp 79% photoelectric, 21% Compton & less than 1% transmission. At 80 kVp 46% photoelectric, 52% Compton & 2% transmission.

➥**Increased x-ray field size**

As field size increases, the intensity of scatter radiation also increases rapidly. especially during fluoroscopy.

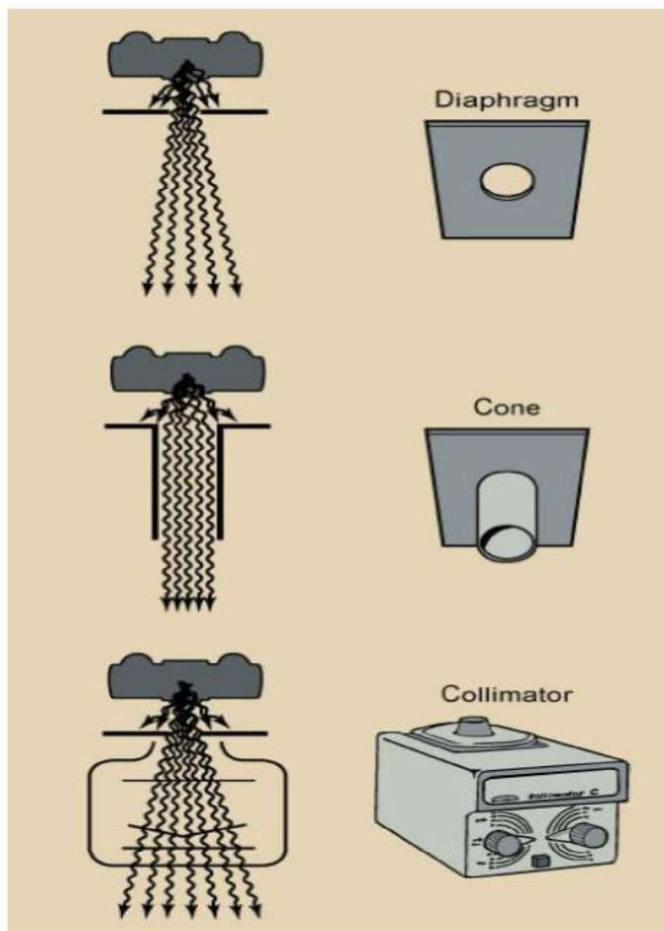
➥Increased patient thickness

Imaging thick parts of the body results in more scatter radiation than thin. The radiographer can control the patient thickness by compression devices, to improve the spatial resolution and bringing the object closer to the IR (image receptor). Compression also reduces patient dose (reducing fog).

Control of Scatter Radiation

The unrestricted primary beam is cone shaped and projects a round field on the patient and IR. If not restricted in some way, the x-ray field extends and goes beyond the boundaries of the anatomic area of interest and IR size, resulting in increasing the amount of scatter radiation reaching the IR and unnecessary patient exposure. So, the x-ray beam field size must be limited to the anatomic area of interest. Technologists routinely use many types of devices such as:

1. beam-restricting devices, which include: Aperture Diaphragm, Cones & Cylinders



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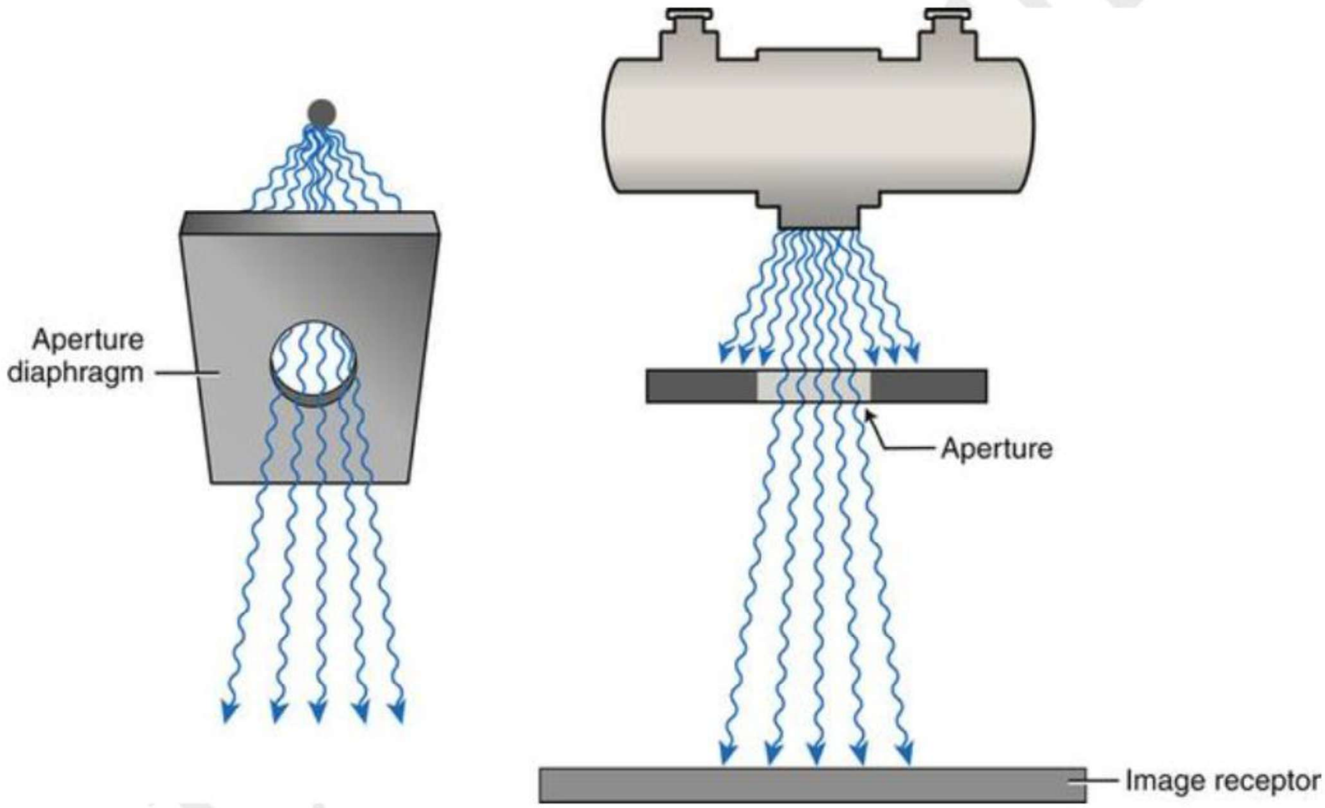
A. Aperture Diaphragm

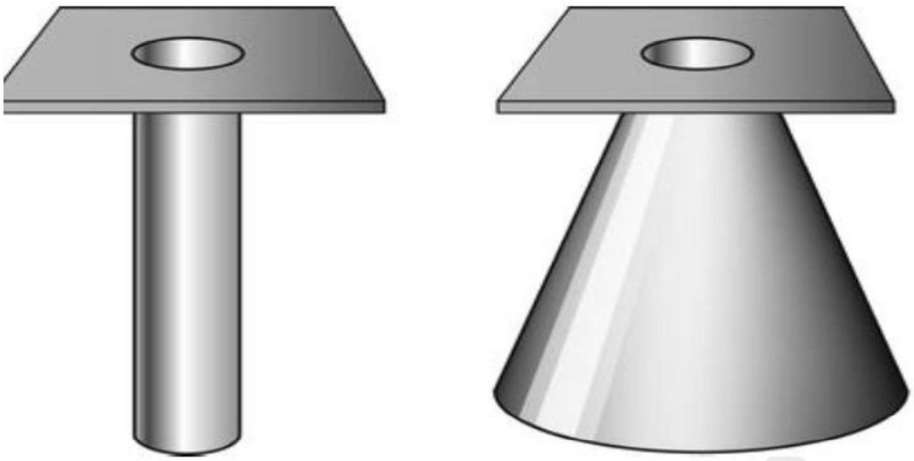
The simplest of all beam-restricting devices. Is a flat piece of lead or lead-lined metal diaphragm attached to the x-ray tube head (diaphragm) that has a hole (aperture) in it. The hole is usually designed to cover just less than the IR used. Aperture diaphragms are easy to use. They are placed directly below the x-ray tube window.



B. Cones & Cylinders

Cones and cylinders are modifications of the aperture diaphragm, and they have many of the same attributes. A **cone** or **cylinder** is essentially an aperture diaphragm that has an extended flange attached to it. The flange can vary in length and can be shaped as either a cone or a cylinder. Like aperture diaphragms, cones and cylinders are easy to use. They slide onto the tube directly below the window.

Cones have a particular disadvantage compared with cylinders. If the angle of the flange of the cone is greater than the angle of divergence of the primary beam, the base plate or aperture diaphragm of the cone is the only metal actually restricting the primary beam. Therefore cylinders generally are more useful than cones.



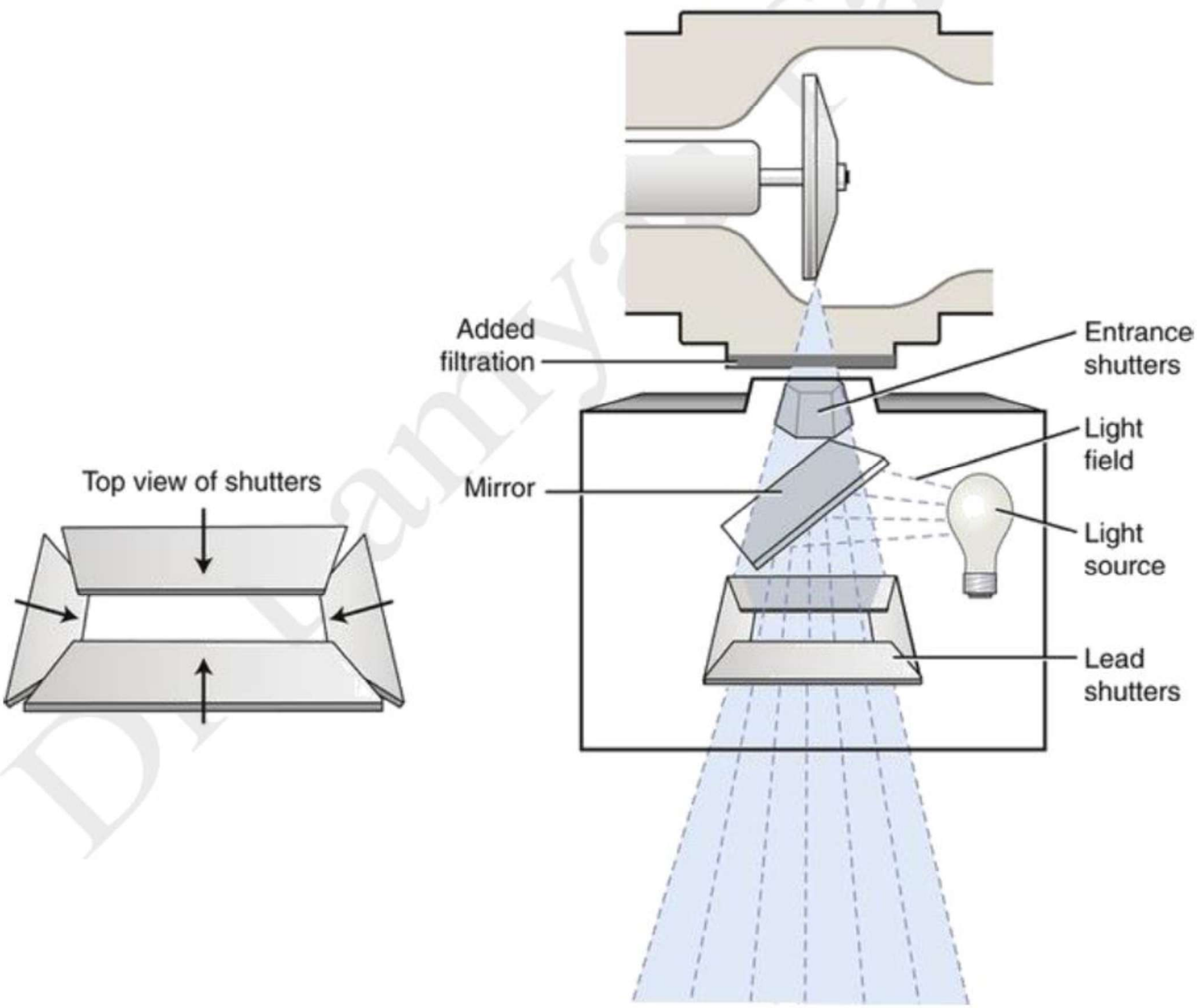
Cyclinder Cone

c. Variable Aperture Collimator

The most sophisticated, useful, and accepted beam-restricting device is the light-localizing variable aperture collimator.

A **collimator** has two or three sets of lead shutters. Located immediately below the tube window, the entrance shutters limit the x-ray beam much as the aperture diaphragm does. These shutters consist of longitudinal and lateral leaves or blades, each with its own control. This makes the collimator adjustable in that it can produce projected fields of varying sizes. Collimators are equipped with a white light source and a mirror to project a light field onto the patient. This light is intended to accurately indicate where the primary x-ray beam will be projected during exposure. The collimator lamp must be adjusted so that the projected light field coincides with the x-ray beam. Misalignment of the light field and beam can result in collimator cutoff of anatomic structures. This helps ensure that the radiographer does not open the collimator to produce a field that is larger than the IR. **Always the collimated area must be smaller than the size of the IR or cassette.**

The Beam-restricting devices are helpful to improve contrast resolution; however the inherent problem is they are placed between the source and the patient. Even under the most favorable conditions, most of the remnant x-rays are scattered.



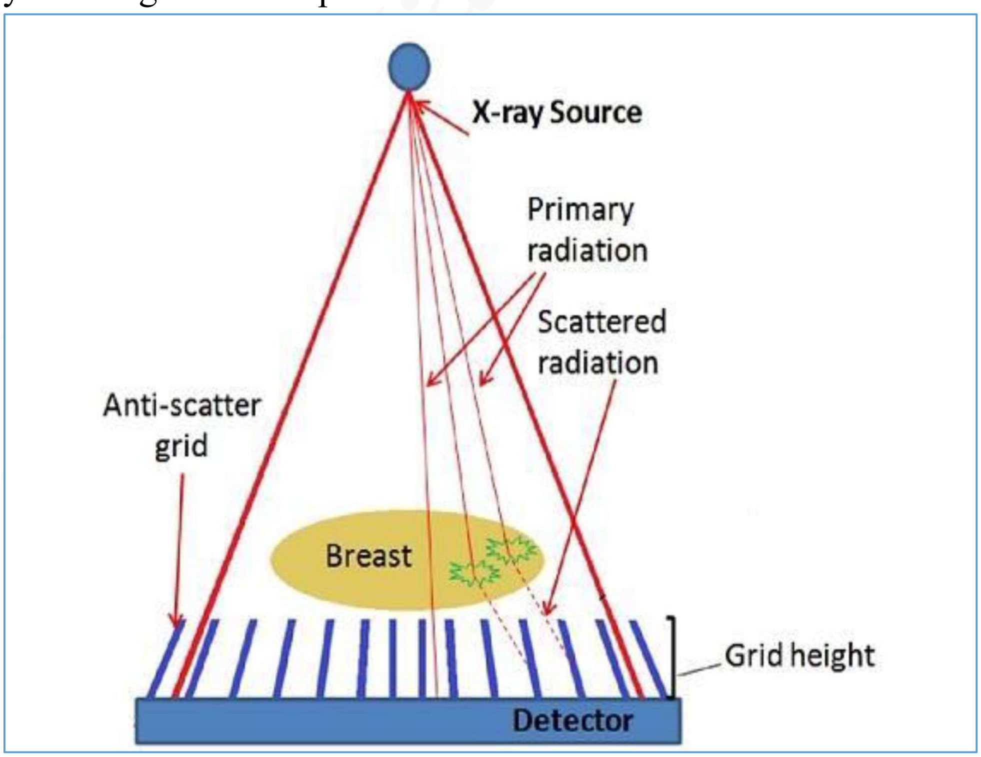
2. Grids

Grid is a device placed between the patient and film to prevent as much scattered radiation as possible from reaching an x-ray film during the exposure of a radiograph. It's used to improve contrast on a radiographic image, by absorption of scatter radiation produced by the patient as the primary beam interacts with the patient's tissues. **Grids are very effective device for reducing and "clean up" scatter radiation.** A high quality grid can attenuate 80 –90 percent of scatter radiation. It is positioned between patient and film.

Grid Construction

It is a flat plate with a series of lead foil strips that is made in various sizes. **Grid strips** should be very thin and have high photon absorption properties. Lead is most common: Tungsten, platinum, gold, and uranium have been tried, but Pb is still most desirable.

Interspace Material (Aluminum or Plastic Fiber) used to maintain precise separation between the delicate lead strips. The grid is encased completely by a thin cover of aluminum , because it provides rigidity for the grid and helps to seal out moisture.



There are some advantages of using aluminum interspaced material than plastic:

1 – Aluminum is no hygroscopic; that is; doesn't absorb moisture as plastic fiber which will result in it to become warped because of its hygroscopicity.

2 – Aluminum – interspace grids are easier to manufacture with high quality because it's easier to form and roll into sheets of precise thickness than fiber.

Grid Ratio

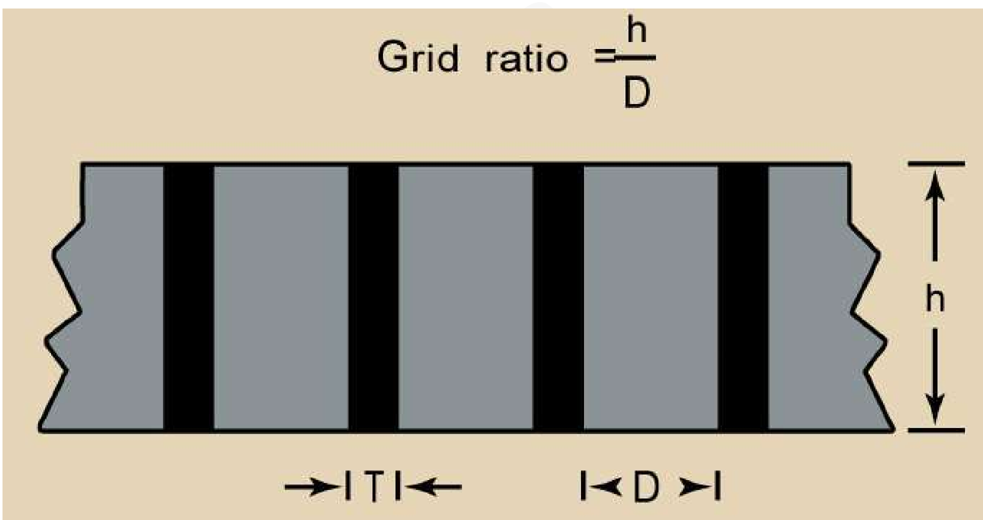
Grid Ratio: Three important dimensions of a grid:

↳ The thickness of the grid strips **(T)**.

↳The width of the interspace material **(D)**.

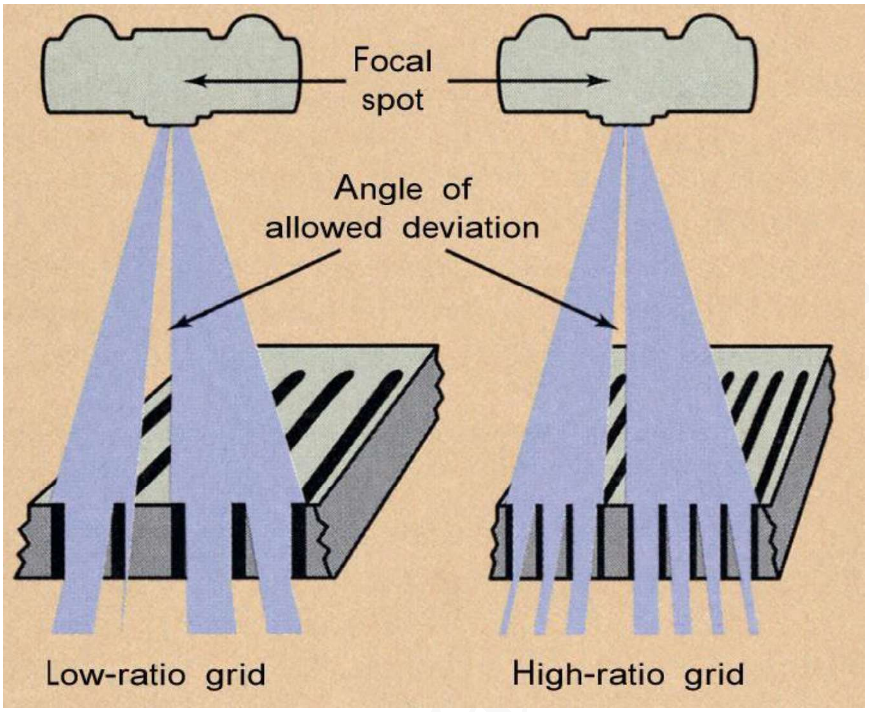
↳The height of the grid **(h)**.

The grid ratio is the **hight** of the grid divided by the **interspace width: Grid ratio = h/D**



High-ratio grids are more effective in cleaning up scatter radiation than low-ratio grids. The angle of deviation is smaller for high-ratio grids and the photon will be traveling in a straighter line to make it through the grid.

High – ratio grids are made by reducing the width of the interspace or increasing the height of the grid material, or as is usual, a combination of both. However, the higher the ratio, the more radiation exposure necessary to get a sufficient number of x-rays through the grid to the IR.



Grid ratios range from **5:1 to 16:1** that will clean up 85% and 97% respectively. Most common **8:1 to 10:1.**

Example:

A certain grid is made of lead 30 µm thick sandwiched between fiber interspace material 300 µm thick. the height of the grid is 2.4 mm. what is the grid ratio?

A/ grid ratio = h/D → 2400/300 = 8:1

Grid Frequency.

The number of grid strips or grid lines per inch or centimeter. The higher the frequency the more strips, and less interspace material and the higher the grid ratio. As grid frequency increases, patient does is increase because more scatter will be absorbed. Some grids reduce the thickness of the strips to reduce the exposure to the patient, this overall reduces the grid clean up. Grids have frequencies in the range of 25 to 45 lines per centimeter (60 to 110 lines per inch).