

# Radiographic Intensifying Screens

Radiation Physics

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# Intensifying Screens

- ▶ There are three key parts of the Image Receptor for Conventional Radiography:
  - Film to record the image
  - Intensifying Screens to expose the film

◦ Cassette to protect the screens and film

# Radiographic Intensifying Screens

- ▶ Less than 1% of the incident x-rays interact with the film to contribute to the latent image.
- ▶ The intensifying screens convert the remnant radiation to light that produces the latent image. They act as an amplifier of the

# Radiographic Intensifying Screens

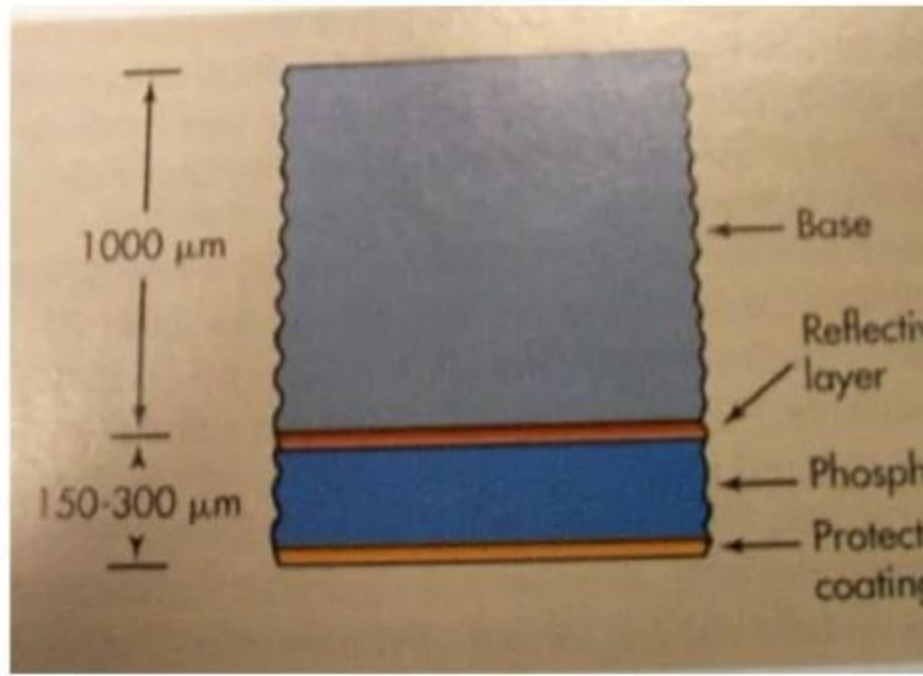
- ▶ About 30% of the x-rays striking the screens interact with the screens producing a large number of visible light photons.
- ▶ The use of intensifying screens results in considerable lower radiation dose to the patient but has the disadvantage of causing a

# Radiographic Intensifying Screens

- ▶ Most conventional radiographic cassettes have a pair of screens that sandwich the film. This design used double emulsion film.

# Screen Construction

- ▶ Four Distinct Layers
  - Protective Coating
  - Phosphor
  - Reflective layer
  - Base



# Protective Coating

- ▶ Coating is transparent to light.
- ▶ Resistant to abrasion and damage from handling.
- ▶ Resistant to static electricity
- ▶ Provide a surface for cleaning while protecting the phosphors.

# Phosphors

- ▶ The active layer of the screen is the phosphors.
- ▶ The phosphors emit light when stimulated by x-rays.
- ▶ Prior to 1970 the most common phosphor was a crystalline form of Calcium Tungstate.



# Phosphors

- ▶ Modern screens use rare earth elements such as:
  - Gadolinium
  - Lanthanum
  - Yttrium

# Properties of Phosphors used in Intensifying Screens

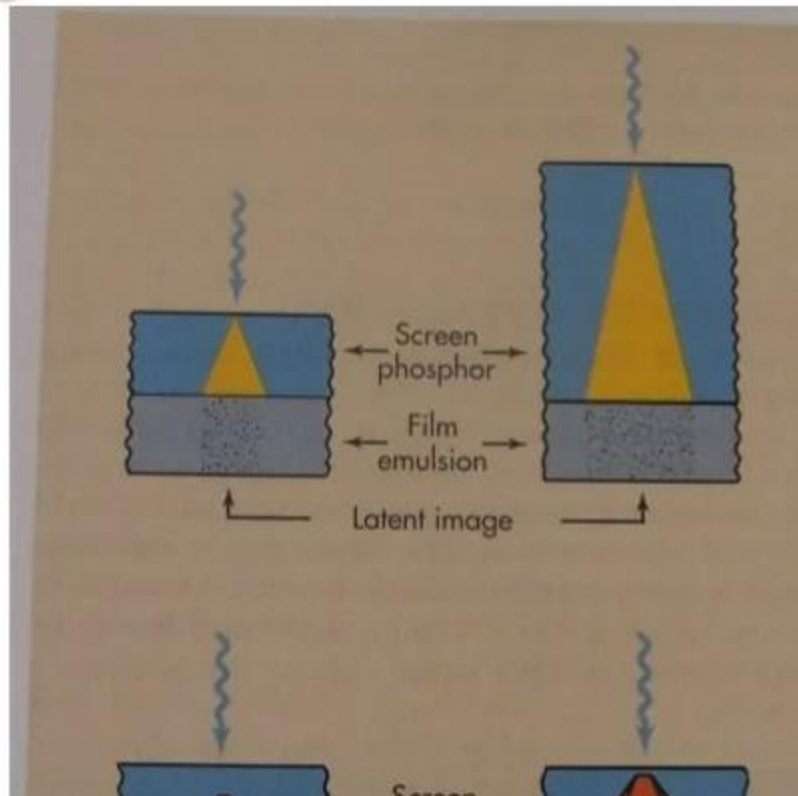
- ▶ High atomic number so x-ray absorption will be high. Quantum Detective Efficiency (DQE)
- ▶ Emit a large amount of light per x-ray absorption. Conversion Efficiency

# Properties of Phosphors used in Intensifying Screens

- ▶ Phosphor Afterglow should be minimal.
- ▶ Phosphor should not be affected by heat humidity or other environmental conditions

# Influences of the Action of Intensifying Screens

- ▶ Thickness of the phosphor Layer
- ▶ Concentration of the crystals



# Reflective Layer

- ▶ The light from the phosphors is emitted isotropically.
- ▶ Without a reflective layer, only half of the light would interact with the film.

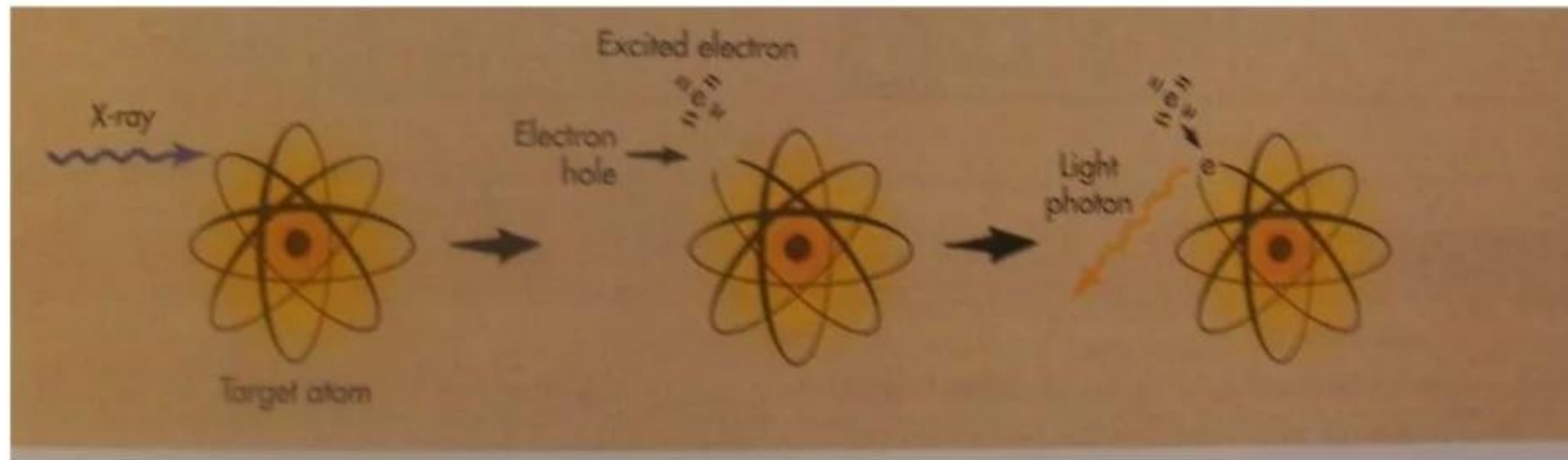
# Reflective Layer

- ▶ Some screens have special dyes that absorb the light photons coming at a large angles.
- ▶ These photons would increase the image blur.

# Base

- ▶ The base is the layer farthest from the film.
- ▶ It is usually made of polyester. The base should be:
  - Rugged and moisture resistant
  - Can not be damaged by radiation or discoloration

# Luminescence



- ▶ The x-ray photon is absorbed by the target atom.
- ▶ The outer shell electron is raised to an excited state.



# Luminescence

- ▶ Any material that gives off light in response to a stimulus is a luminescent material.
- ▶ Two types of luminescent material.
- ▶ **Fluorescent:** gives off light only during stimulus. Good for screens
- ▶ **Phosphorescence:** continues to give off

# Properties of Screens

- ▶ **Phosphor composition:** Rare earth screens are very efficient in conversion of x-ray to light.

# Properties of Screens

- ▶ **Phosphor thickness:** The thicker the phosphor layer, the higher the number of x-rays converted to light.
- ▶ High speed screens have thick layer. Detail screens have a thin layer.
- ▶ **Reflective layer** will increase speed and

# Properties of Screens

- ▶ **Dye:** Light controlling dyes are added to control the light spread to improve spatial resolution.
- ▶ **Crystal size:** Larger crystal produce more light per interaction. Detail screens have

# Properties of Screens

- ▶ Concentration of crystals:
  - The higher the concentration of crystals, the higher the speed.

# Rare Earth Screens

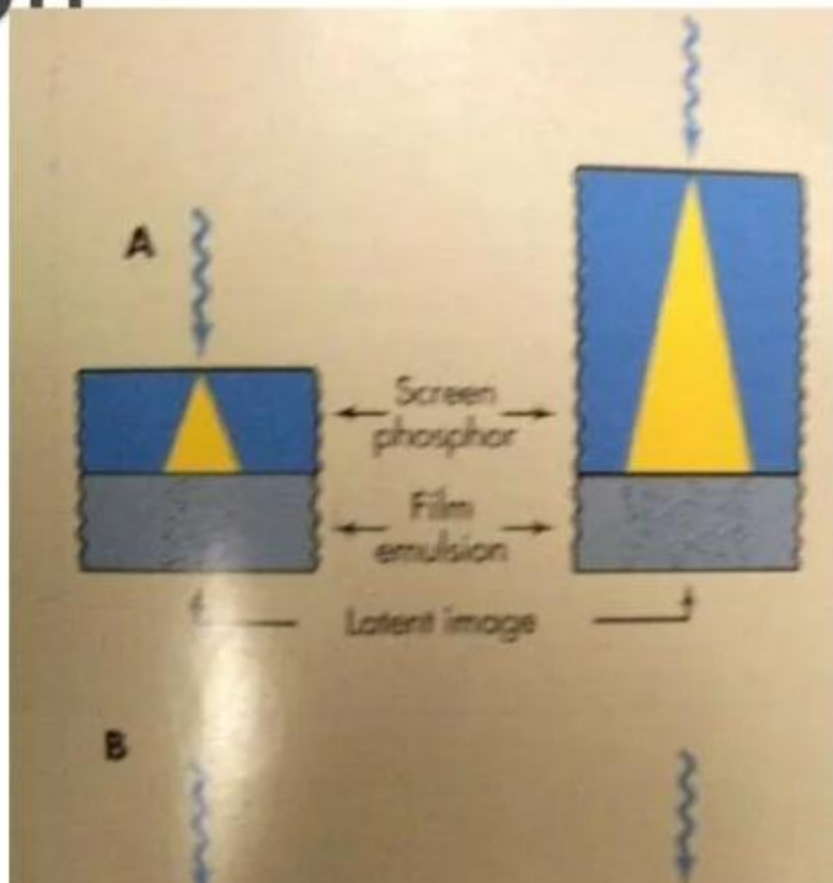
- ▶ Rare earth screens have increased speed for two reasons:
  - **Detective Quantum Efficiency (DQE)** or the ability to absorb the photons ( High Z number)
  - **Conversion Efficiency:** Amount of light emitted

# Image Noise

- ▶ **Conversion Efficiency:** High conversion efficiency results in increases image noise.
- ▶ Noise (any unwanted information) can be speckled appearance or grainy
  - It occurs with fast screens and use of high kVp.
- ▶ The factors that make rare earth screens have greater speed also contribute to

# Spatial Resolution

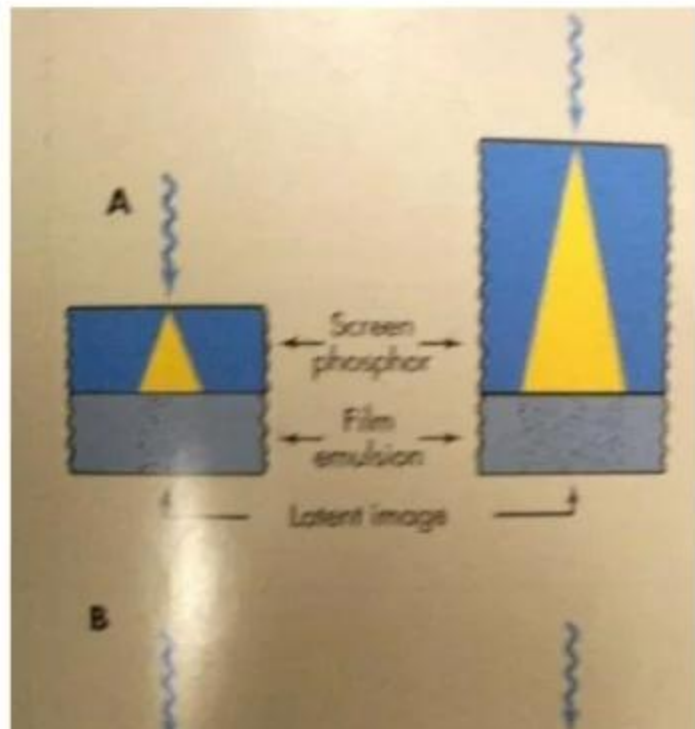
- ▶ Image detail is the result of *spatial resolution* and *contrast resolution*.
- ▶ Generally the conditions that





# Spatial Resolution

- ▶ When screen phosphors reacts with x-rays a larger area of the film is exposed than what would be exposed by radiation alone.



# Spatial Resolution

- ▶ Direct exposure can resolve 50 lp/mm with a very small focal spot.
- ▶ High speed screens can resolve 7 lp/mm.
- ▶ Detail screens can resolve 15 lp/mm

# Spatial Resolution

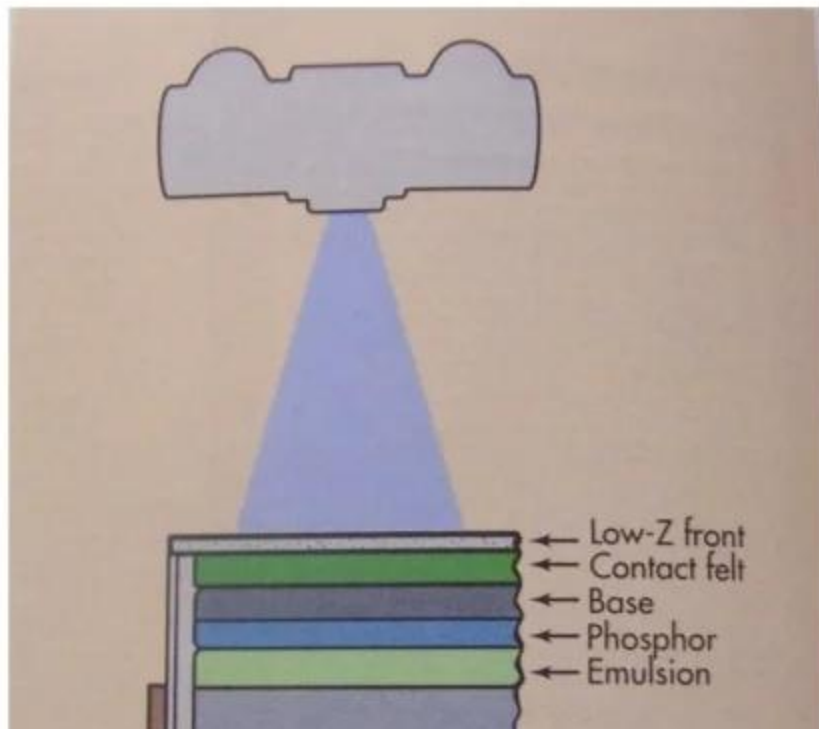
- ▶ High speed screens have thick layers of crystal and /or large crystals.
- ▶ High detail screens have a thin layer of small crystals.

# Screen film Combinations

- ▶ Screens in pairs and double emulsion film is the standard of the industry. Less than 1% of the image is produced by the x-ray photons.
- ▶ Each screen contributes relatively evenly in the production of the image.

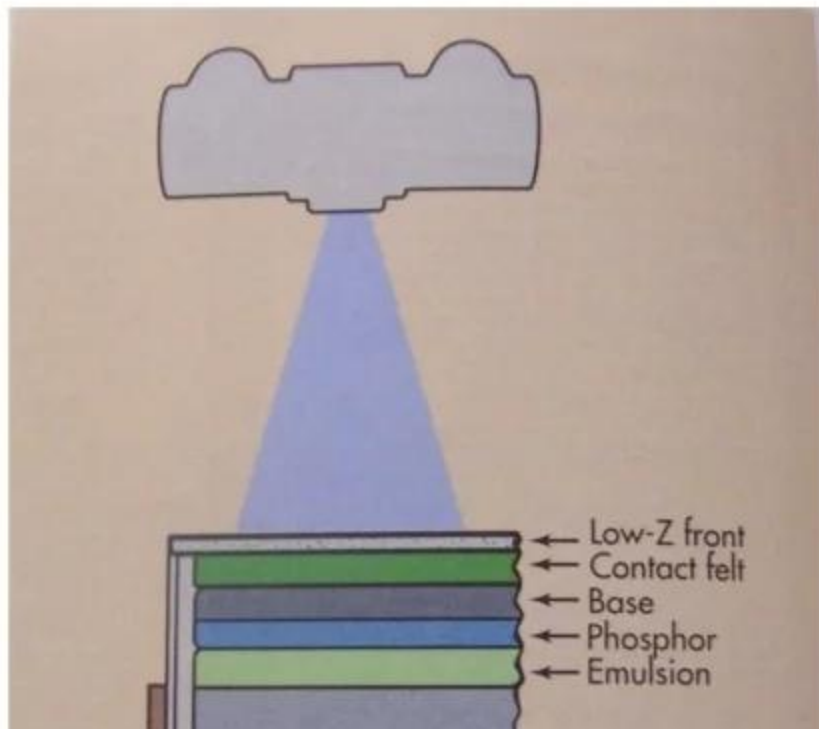
# Cassettes

- ▶ The cassette is a rigid holder for the film and screens.
- ▶ It will contain some form of compression to push the film in close contact with the



# Cassettes

- ▶ The back of the cassette may contain some form of metal that can absorb x-rays that are not absorbed by the screens.
- ▶ Sometime with cassettes that do not

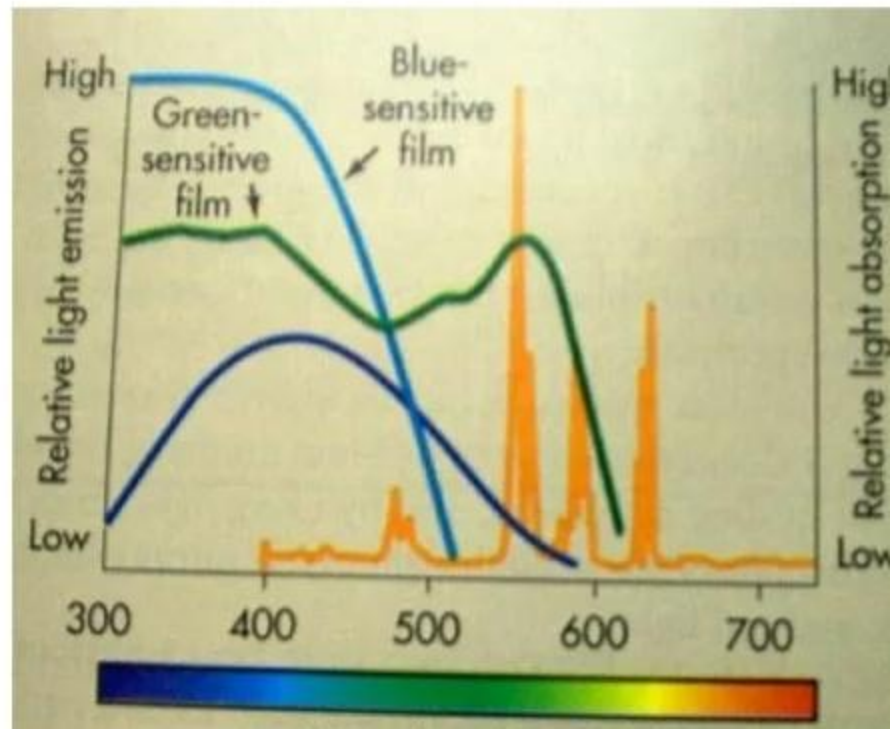


# Spectrum Matching

- ▶ For the screen to work at maximum efficiency, the light absorption characteristics of the film must be matched to the light emitted from the screens.
- ▶ This is called spectrum matching.

# Spectrum Matching

- ▶ Calcium Tungstate emits a broad blue spectrum.
- ▶ Rare earth emits a green spectrum.
- ▶ The film screens





# Asymmetric Screens

- ▶ Screens in the cassette can be of two types or speeds. Some people use two different speeds in cassette for full spine radiography.
- ▶ When types of screens are different, they are referred to as Asymmetric screens. One side

# Care of Screens and Cassettes

- ▶ High quality radiography requires that the screens be clean and free of artifacts.
- ▶ Avoid touching the screens with your hands.
- ▶ Clean the screens with screen cleaner.

# Care of Screens and Cassettes

- ▶ Keeping the dark room clean will help reduce dirt or dust getting into the cassette.
- ▶ Don't stack the cassette on top of each other as the weight can damage the cassette.

# Care of Screens and Cassettes

- ▶ Clean the screens at least quarterly
- ▶ Use only specially formulated screen cleaner with anti static properties
- ▶ Never use alcohol to clean screens

# Examples of Screen Problems

- ▶ The hinge of the cassette has failed, resulting in a light leak.



# Cassette & Screen Problems

- ▶ Card inside cassette



# Cassette Artifacts

- ▶ This cassette popped partly open.
- ▶ With cassette artifacts, think about how the



# Cassette Artifacts

- ▶ Dirty screens will appear as white spots on the film.
- ▶ This film also has some static electricity artifacts.





# Cassette Artifact Dirty Screens

- ▶ Dirty or damaged screens will cause white spots on the image.



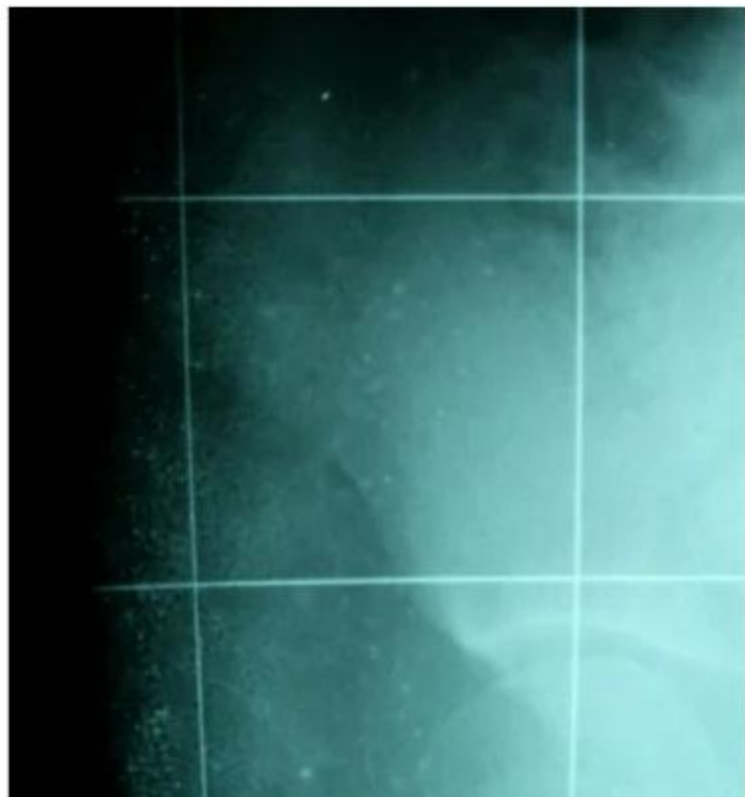
# Dirty or Damaged Screens

- ▶ Dirty or damaged screen will cause white spots on the image.



# Dirty & Damaged Screens

- ▶ The white spots on this film are the result of damaged or worn out screens.



# Poor Screen Contact

- ▶ Poor screen contact will cause an area of the image to appear cloudy and blurry.
- ▶ Common reasons for poor contact include:
  - Worn contact felt
  - Loose, bent or broken hinges
  - Loose bent or broken latches

# Poor Screen Contact

- ▶ Common reasons for poor contact include:
  - Warped cassette front or frame.
  - Sprung or cracked cassette frame.
  - Foreign matter in the cassette.
- ▶ Screen contact is tested using a wire mesh test tool

# Poor Screen Contact

- ▶ A radiograph is taken and the film processed.
- ▶ The image is viewed from 2 to 3 meters from the view box.
- ▶ Poor contact will appear as a cloudy and

# Poor Screen Contact

- ▶ Test the cassette when they are purchased and then twice yearly.

# Screen Contact Testing

- ▶ **Procedure:**
- ▶ Clean screens and let them dry. Use screen cleaner design for the screen used.
- ▶ With a felt tip pen, write an identification number





# Screen Contact Testing

- ▶ **Procedure:**
- ▶ Set SID to 40" Table Top
- ▶ Place cassette on table.
- ▶ Place wire mesh tool on cassette.



# Screen Contact Testing

- ▶ **Procedure:**
- ▶ Hang film on view box.
- ▶ Step back 72" from view box and view film.



## Poor Screen Contact

- ▶ There is a loss of detail in the thoracic and lumbar spine due to poor screen contact.



## Poor Screen Contact

- ▶ Note the blurry image in the spine but sharp image of the ribs.
- ▶ The screens were not in proper contact in

