APPH 226:

Line Focus Principle and The Anode Heel Effect

Objective: 1.5

MRT Program

Line Focus Principle

- States that: by angling the face of the anode target, a large actual focal spot size can be maintained, and a small effective focal spot can be created
- Relationship between the actual and effective focal spot

Line Focus Principle

- Allows for a larger area for heating while maintaining a small focal spot
  - Achieved by angling the target
- Focal spot is:
  - The area of the target where x-rays are emitted
  - Actual x-ray source

Actual Focal Spot

- Area of the target that is actually bombarded with filament electrons
- Size of the electron stream is determined by the filament size selected
- Ideal for this area to be as large as possible for better heat distribution
  - The smaller the electron stream is, the greater the heat produced in a small area
    - Better to have the heat spread out over a larger area

Actual and Effective Focal Spot Size

- Direct relationship
- The smaller the actual focal spot, the smaller the effective focal spot size
- The larger the actual focal spot, the larger the effective focal spot size

- Large actual focal spot will have less heat on the anode, than a small focal spot
  - Same quantity of photons over a larger area vs. a smaller area

Effective Focal Spot

- Origin of the x-ray beam
- X-ray beam area as seen from the patient's perspective
- When specifying focal spot sizes, this is the focal spot that is being identified
- The smaller the area, the sharper the image will be
- For the best image quality, it is desirable to keep this as small as possible

Effective Focal Spot

- Controlled by actual focal spot, which is controlled by:
  - Filament length
  - Target angle
  - Charge on the focusing cup
  - Depth of filament in focusing cup
  - Dimensions and shape of focusing cup

Limitations

- Line Focus Principle achieves goal to balance heat area and effective focal spot size, but with trade offs
- The target angle should be as small as possible, right?
  - No….If the target angle is too small:
    - X-ray beam area (field size) may be too small to effectively image all required anatomy
    - Useful beam will be too narrow

With the good…comes the bad…

- Anode Heel Effect is
  - affected by the line focus principle
  - Intensity of radiation on the cathode side of the x-ray field is greater than that on the anode side

Anode Heel Effect

- How does this happen?
- The 'heel' of the target is in the path of the beam
  - As electrons bombard the target, x-rays are produced and emitted at angles between 45-90° in the direction of electron travel
- X-rays on the anode side must first penetrate a portion of the target before exiting the tube
  - Loss of x-ray photons
  - Loss of energy

Anode Heel Effect

- Intensity of x-rays that are emitted through the 'heel' are reduced due to:
  - Longer path to travel
  - Increased absorption

- This is the anode heel effect

Radiation Intensity

- As a result of the anode heel effect, the useful beam will have a variation of radiation intensity
- Central Ray is the imaginary center most x-ray in the beam
- Designated as 100% radiation intensity
- Cathode side has higher intensity
- Anode side has lower intensity

Working with the Anode Heel Effect

- When imaging areas with great differences in thickness or mass density, need to be conscientious of the Anode Heel Effect
- Cathode and anode are clearly indicated on the tube housing
- In general, when possible:
  - Position the cathode over the thicker part of the anatomy to produce more uniform exposure on the image receptor
    - E.g. Femur, Thoracic spine
  - Designated 'head end' of the table

Readings

- Radiologic Science for Technologists 11th Edition
  - Pg 113-116