RADIATIONS PROTECTION
Apparatus emitting X-rays
Laws and regulations

• Food and Drugs Act
  ➢ Medical Devices Regulations

• Radiation Emitting Devices Act
  ➢ Radiation Emitting Devices Regulations

• Health Canada (guidelines) :
  ➢ Safety Code 34. Radiation Protection and Safety for Industrial X-ray Equipment
  ➢ Safety Code 32. Safety Requirements and Guidance or Analytical X-ray Equipment

• Provincial level:
  The reference is « Loi sur la santé et la sécurité du travail »
Generators of X-rays

• X-rays are generated when electrons (or other charged particles) undergo severe deceleration.

• Any electronic device that operates at several kilovolt or more (e.g. electron microscopes)

• X-ray generators (synchrotron and rotating anode vacuum tube).
X-ray Spectrum

Most of the X-ray output of rotating anode sources has a continuous energy range that extends up to a maximum value ($E_{\text{max}}$).
Dose rates

• X-rays present no contamination hazard (no activation)

• X-ray generators are perfectly safe when switched off

• X-ray generators can deliver dose rates greatly in excess of those available from laboratory radioactive sources. Exemple:
  • Typical operating conditions
    (V = 30 kV; I = 20 mA), copper anode
    Dose rates in the primary beam:
    • 0,5 Sv/min à 1 m
    • 50 Sv/min à 10 cm
Radiation Protection X-rays

• Shielding

• For typical 50 KeV X-rays:

  The half value thicknesses

  ❖ Air ::: ~ 10 m
  ❖ Body tissue ::: ~ 3 cm
  ❖ Lead (Pb) ::: ~ 0,1 mm
  ❖ Steel ::: ~ 0,5 mm
X-ray Leakage and Scatter

- Enough shielding at the appropriate places
- Interlocks of various kinds must be included to prevent unsafe operation
Radiation monitoring

Leak testing:

• Radiation detector sensitive enough

   Ex: Sodium iodide (NaI) detector (solid scintillator)

Measure of the dose rate:

• Survey-Meters (tissue-equivalent) ::= microSv/h

Personnel Dosimeters:

• Required for the maintenance, the repairs or any modification

• Not likely to detect accidental exposure to collimated beams
Annual dose limits:

• The same than those used for the work with laboratory radioactive sources:

  ➢ Whole body ::: 1 mSv
  ➢ Skin ::: 50 mSv
  ➢ Hands and feet ::: 50 mSv
  ➢ Lens of an eye ::: 15 mSv
Radiation monitoring

Posting:
All generators of X rays must be designed and maintained to keep enough radiation protection using the appropriate shielding and interlocks.

Never override safety interlocks.

Never operate prior a risk assessment any equipment having malfunctions, that is too old or that was stored for a long time.

Report all equipment faults, or any accident, or incident to the persons in charge of the radiation safety.
RADIATIONS PROTECTION

Radiofrequency Electromagnetic Fields
Laws and regulations

- Radiation Emitting Devices Act
  - Radiation Emitting Devices Regulations

- Health Canada (guidelines):
  - Safety Code 6. Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz
Radiation monitoring

Levels:

- Exposure Limits (W/m²)
- Specific Absorption Rate Limits
  - Prevention of thermal effects
    - 0.08 W/kg (whole body)

Hypersensitivity:

- Review of limits needed (review safety code 6)
- Few data are available
Detection and measurement:

- Measure of low frequencies: 5 Hz to 400 kHz
  - Electric Fields (V/m)
  - Magnetic Fields (nT)
- Measure of high frequencies: (microW/m²)
  - 800 MHz à 2500 MHz
  - 2.4 GHz à 6 GHz
Radiation monitoring

Posting:
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