



## **Radiographic Testing Level I**

### **Course Outline**

#### **1. Introduction**

- a. History and discovery of radioactive materials
- b. Definition of industrial radiography
- c. Radiation protection – why?
- d. Basic math review: exponents, square root, etc.

#### **2. Fundamental Properties of Matter**

- a. Elements and atoms
- b. Molecules and compounds
- c. Atomic particles – properties of protons, electrons, and neutrons
- d. Atomic structure
- e. Atomic number and weight
- f. Isotope vs. radioisotope

#### **3. Radioactive Materials**

- a. Production
  - (1) Neutron activation
  - (2) Nuclear fission
- b. Stable vs. unstable (radioactive) atoms
- c. Curie – the unit of activity
- d. Half-life of radioactive materials
- e. Plotting of radioactive decay
- f. Specific activity – curies/gram

#### **4. Types of Radiation**

- a. Particulate radiation – properties: alpha, beta, neutron
- b. Electromagnetic radiation – X-ray, gamma-ray
- c. X-ray production
- d. Gamma-ray production
- e. Gamma-ray energy
- f. Energy characteristics of common radioisotope sources
- g. Energy characteristics of X-ray machines

#### **5. Interaction of Radiation with Matter**

- a. Ionization
- b. Radiation interaction with matter
  - (1) Photoelectric effect
  - (2) Compton scattering
  - (3) Pair production
- c. Unit of radiation exposure – the roentgen
- d. Emissivity of commonly used radiographic sources
- e. Emissivity of X-ray exposure devices
- f. Attenuation of electromagnetic radiation – shielding
- g. Half-value layers; tenth-value layers
- h. Inverse-square law



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#### 6. Biological Effects of Radiation

- a. "Natural" background radiation
- b. Unit of radiation dose – rem
- c. Difference between radiation and contamination
- d. Allowable personnel-exposure limits and the banking concept
- e. Theory of allowable dose
- f. Radiation damage – repair concept
- g. Symptoms of radiation injury
- h. Acute radiation exposure and somatic injury
- i. Personnel monitoring for tracking exposure
- j. Organ radiosensitivity

#### 7. Radiation Detection

- a. Pocket dosimeter
- b. Difference between dose and dose rate
- c. Survey instruments
  - (1) Geiger-Müller tube
  - (2) Ionization chambers
  - (3) Scintillation chambers, counters
- d. Film badge – radiation detector
- e. TLDs (thermoluminescent dosimeters)
- f. Calibration

#### 8. Exposure Devices and Radiation Sources

- a. Radioisotope sources
  - (1) Sealed-source design and fabrication
  - (2) Gamma-ray sources
  - (3) Beta and bremsstrahlung sources
  - (4) Neutron sources
- b. Radioisotope exposure device characteristics
- c. Electronic radiation sources – 500 keV and less, low-energy
  - (1) Generator – high-voltage rectifiers
  - (2) X-ray tube design and fabrication
  - (3) X-ray control circuits
  - (4) Accelerating potential
  - (5) Target material and configuration
  - (6) Heat dissipation
  - (7) Duty cycle
  - (8) Beam filtration
- d. Electronic radiation sources – medium- and high-energy
  - (1) Resonance transformer
  - (2) Van de Graaff accelerator
  - (3) Linac
  - (4) Betatron
  - (5) Roentgen output
  - (6) Equipment design and fabrication
  - (7) Beam filtration



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- e. Fluoroscopic radiation sources
  - (1) Fluoroscopic equipment design
  - (2) Direct-viewing screens
  - (3) Image amplification
  - (4) Special X-ray tube considerations and duty cycle
  - (5) Screen unsharpness
  - (6) Screen conversion efficiency

#### 9. Special Radiographic Sources and Techniques

- a. Flash radiography
- b. Stereo radiography
- c. In-motion radiography
- d. Autoradiography

#### 10. Introduction of Industrial Radiography

- a. Process of radiography
- b. Types of electromagnetic radiation sources
- c. Electromagnetic spectrum
- d. Penetrating ability or "quality" of X-rays and gamma rays
- e. Spectrum of X-ray tube source
- f. Spectrum of gamma-radioisotope source
- g. X-ray tube – change of mA or kVp effect on "quality" and intensity

#### 11. Basic Principles of Radiography

- a. Geometric exposure principles
  - (1) "Shadow" formation and distortion
  - (2) Shadow enlargement calculation
  - (3) Shadow sharpness
  - (4) Geometric unsharpness
  - (5) Finding discontinuity depth
- b. Radiographic screens
  - (1) Lead intensifying screens
  - (2) Fluorescent intensifying screens
  - (3) Intensifying factors
  - (4) Importance of screen-to-film contact
  - (5) Importance of screen cleanliness and care
  - (6) Techniques for cleaning screens
- c. Radiographic cassettes
- d. Composition of industrial radiographic film
- e. The "heel effect" with X-ray tubes

#### 12. Radiographs

- a. Formation of the latent image on film
- b. Inherent unsharpness
- c. Arithmetic of radiographic exposure
  - (1) Milliamperage – distance-time relationship
  - (2) Reciprocity law
  - (3) Photographic density
  - (4) X-ray exposure charts – material thickness, kV, and exposure
  - (5) Gamma-ray exposure chart
  - (6) Inverse-square-law considerations
  - (7) Calculation of exposure time for gamma and X-ray sources



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- d. Characteristic Hurter and Driffield (H&D) curve
- e. Film speed and class descriptions
- f. Selection of film for particular purpose

#### 13. Radiographic Image Quality

- a. Radiographic sensitivity
- b. Radiographic contrast
- c. Film contrast
- d. Subject contrast
- e. Definition
- f. Film graininess and screen mottle effects
- g. Penetrameters or image-quality indicators

#### 14. Film Handling, Loading, and Processing

- a. Safe light and darkroom practices
- b. Loading bench and cleanliness
- c. Opening of film boxes and packets
- d. Loading of film and sealing cassettes
- e. Handling techniques for "green film"
- f. Elements of manual film processing

#### 15. Exposure Techniques – Radiography

- a. Single-wall radiography
- b. Double-wall radiography
  - (1) Viewing two walls simultaneously
  - (2) Offset double-wall exposure single-wall viewing
  - (3) Elliptical techniques
- c. Panoramic radiography
- d. Use of multiple-film loading
- e. Specimen configuration

#### 16. Fluoroscopic Techniques

- a. Dark adaptation and eye sensitivity
- b. Special scattered radiation techniques
- c. Personnel protection
- d. Sensitivity
- e. Limitations
- f. Direct screen viewing
- g. Indirect and remote screen viewing