

Radiographic Testing Method, Level II

143. An exposure technique is established to obtain a 2.0 density using type "D" film and automatic processing at 27 °C (81 °F). In order to obtain comparable results using manual processing at 20 °C (68 °F) and 5-minute development time, it would be necessary for the original exposure time to be:
- a. reduced by approximately 30 percent
 - b. increased by approximately 99 percent
 - c. increased by approximately 30 percent
 - d. reduced by approximately 99 percent

A.19.3

Note: The two characteristic curves of Figures 1 and 2 on pages 35 and 36 may be used in solving this problem.

Figure 1

**Exposure: 200 kVp Lead Screens
Developer: 81 °F with 11 Minute Dry-to-Dry Cycle**

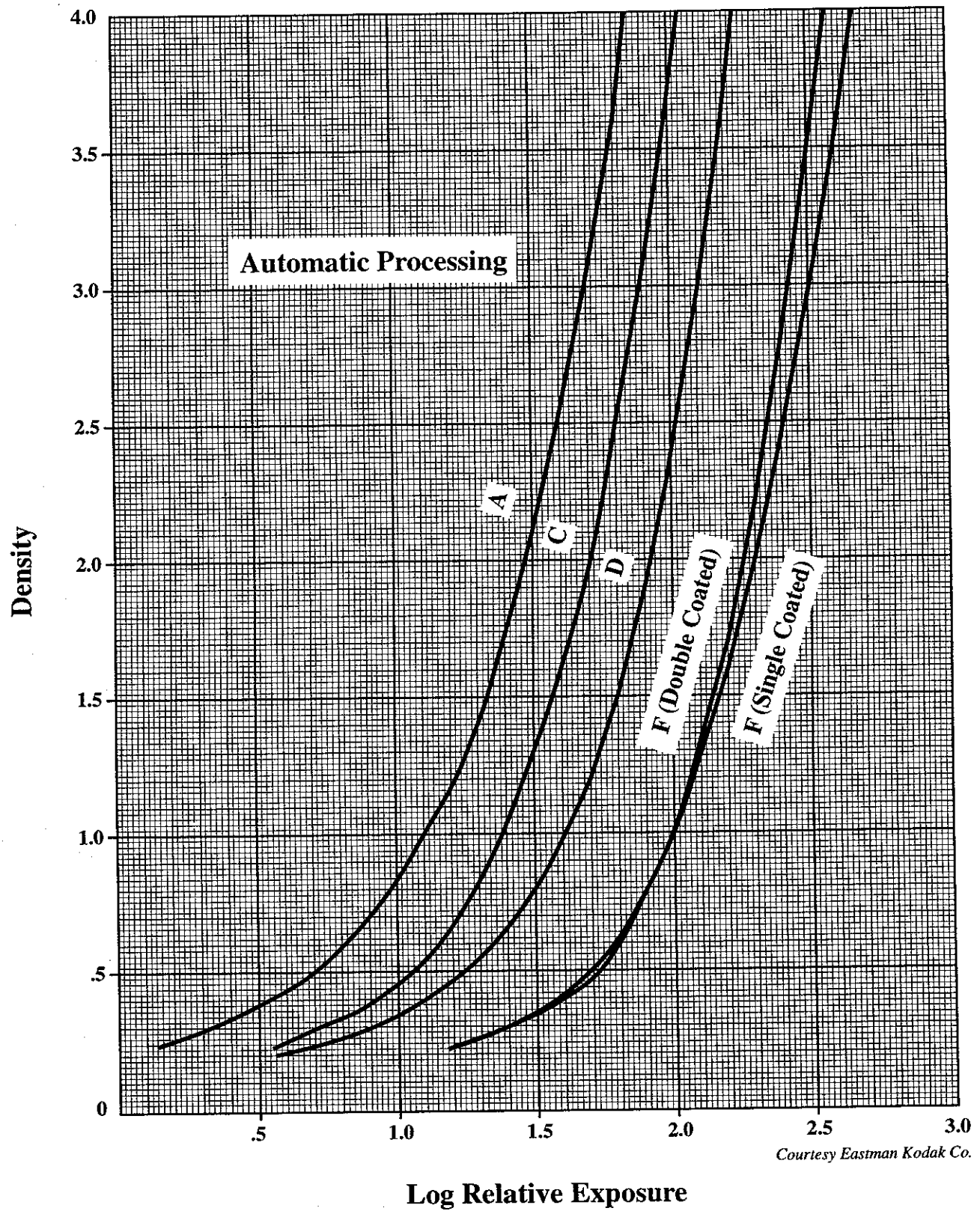
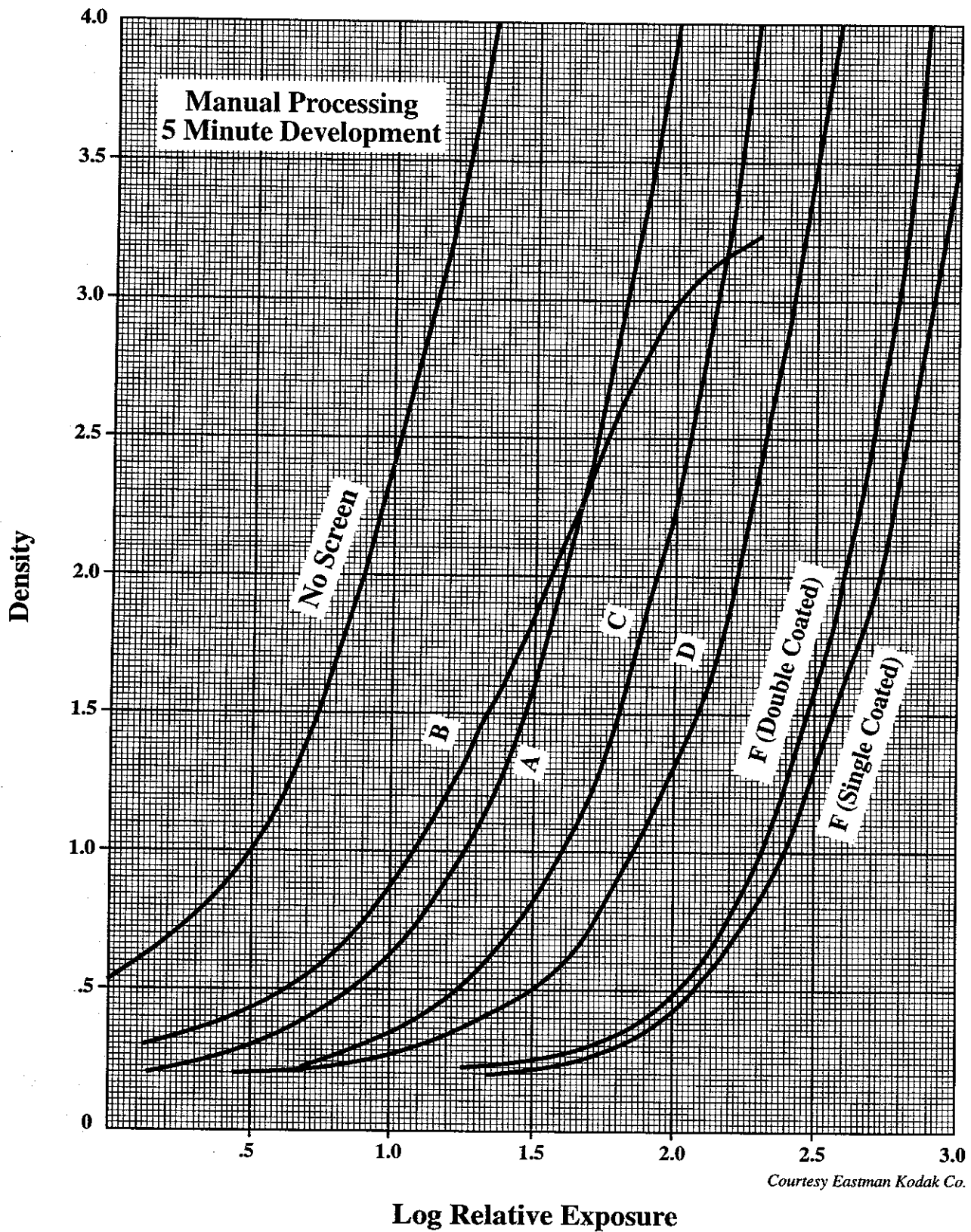


Figure 2

Exposure: 200 kVp Lead Screens
Developer: 5 Minutes at 68 °F



Level II Answers

Radiographic Testing Method

- | | | | |
|-------|-------|--------|--------|
| 1. b | 37. c | 73. d | 109. c |
| 2. d | 38. a | 74. c | 110. c |
| 3. c | 39. b | 75. d | 111. b |
| 4. a | 40. c | 76. c | 112. c |
| 5. c | 41. b | 77. b | 113. b |
| 6. a | 42. b | 78. b | 114. a |
| 7. d | 43. b | 79. c | 115. d |
| 8. c | 44. a | 80. b | 116. d |
| 9. a | 45. c | 81. d | 117. b |
| 10. c | 46. a | 82. c | 118. d |
| 11. c | 47. a | 83. c | 119. b |
| 12. c | 48. d | 84. a | 120. b |
| 13. a | 49. c | 85. c | 121. b |
| 14. d | 50. c | 86. b | 122. c |
| 15. b | 51. a | 87. b | 123. d |
| 16. c | 52. d | 88. c | 124. d |
| 17. b | 53. b | 89. d | 125. c |
| 18. d | 54. b | 90. c | 126. a |
| 19. d | 55. c | 91. b | 127. b |
| 20. c | 56. d | 92. a | 128. b |
| 21. b | 57. b | 93. d | 129. c |
| 22. d | 58. a | 94. c | 130. a |
| 23. b | 59. d | 95. d | 131. c |
| 24. c | 60. b | 96. c | 132. d |
| 25. d | 61. b | 97. c | 133. b |
| 26. b | 62. a | 98. b | 134. c |
| 27. a | 63. d | 99. b | 135. c |
| 28. c | 64. b | 100. d | 136. a |
| 29. b | 65. c | 101. a | 137. b |
| 30. d | 66. d | 102. c | 138. d |
| 31. a | 67. d | 103. c | 139. c |
| 32. b | 68. b | 104. b | 140. c |
| 33. c | 69. b | 105. d | 141. c |
| 34. a | 70. d | 106. a | 142. d |
| 35. b | 71. a | 107. d | 143. b |
| 36. d | 72. b | 108. a | |

Level III Questions

Radiographic Testing Method

Nature of Penetrating Radiation

1. Atoms of the same element that have different numbers of neutrons are called _____ of the element.
 - a. molecules
 - b. isotopes
 - c. isotones
 - d. isomers

D.6

2. The number of positive charges on the nucleus of an atom equals the:
 - a. number of neutrons
 - b. atomic number
 - c. number of photons
 - d. atomic weight

D.6

3. Unlike beta and alpha particles, neutrons have no:
 - a. charge
 - b. mass
 - c. spin
 - d. half-life

A.13.3

4. Radiation scattering increases as:
 - a. the energy of the incident radiation decreases
 - b. the size of the radiation field increases
 - c. the angle of scatter decreases
 - d. all of the above

A.26.10

Interaction between Penetrating Radiation and Matter

5. It has been found from experiment that a homogeneous radiation beam of intensity I passing through a thickness of material Δx undergoes a decrease in intensity ΔI . This can be expressed by the equation, $\Delta I = -\mu/\Delta x$, where μ is a constant of proportionality. This expresses which of the following phenomena?
 - a. photoelectric effect
 - b. Compton scattering
 - c. absorption
 - d. half-value thickness

B.103

6. The number of ion pairs produced per centimeter of track in air is called:
 - a. secondary ionization
 - b. total ionization
 - c. specific ionization
 - d. roentgen

D.25

7. Which of the following particles or rays have the highest ionizing effect in air?
 - a. alpha particles
 - b. beta particles
 - c. neutrons
 - d. gamma and X-rays

D.25

8. The intensity of a monoenergetic radiation after passing through a material may be calculated by the formula $I = I_0 e^{-\mu x}$. This formula does not take into account:
 - a. linear absorption
 - b. buildup
 - c. half-value layer thickness
 - d. attenuation

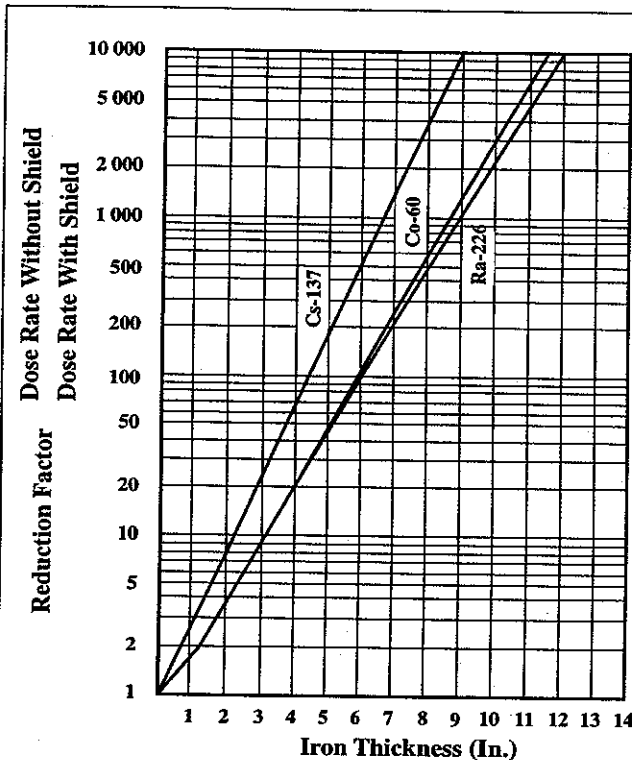
D.30

Radiographic Testing Method, Level III

9. A Co-60 source has an intensity of 1 600 mR/h at a distance of 1.8 m (6 ft). Workers need to be at that distance from the source but should receive only 2 mR/h approximately. How much steel shielding is required? (Figure 3 may be used to determine the correct answer.)

- 71 mm (2.8 in.)
- 18 mm (6.9 in.)
- 24 cm (9.3 in.)
- cannot be determined from data given

D.35



Broad-Beam Shielding for Absorption of Gamma Rays in Iron
Figure 3

10. Pair production occurs when electromagnetic radiation consists of photons in what energy range?

- 0.025 to 0.1 MeV
- 30 to 50 MeV
- 1.02 or greater MeV
- 0.1 to 1.0 MeV

D.26

11. In the photoelectric interaction process:

- electrons are emitted
- characteristic X-rays are emitted
- secondary photons are emitted
- all of the above

E.2-14

12. The Compton interaction process is characterized by:

- absence of secondary radiation
- no transfer of energy upon interaction
- production of an electron-positron pair
- partial transfer of energy upon collision

E.2-14

13. The "build-up" factor in radiation attenuation is the:

- ratio of broad-beam intensity to narrow-beam intensity at a particular absorber thickness
- absorption coefficient divided by the half-value layer
- ratio I_1/I in $I_1 = I_0 e^{-mx}$
- percentage of radiation absorbed in unit thickness of material

A.15.37

14. The major component of scatter is the low-energy electromagnetic radiation produced by photons weakened in the:

- photoelectric process
- Compton process
- pair production process
- ionization process

E.2-16

15. The increase in radiation passing through matter due to scatter in the forward direction is called:

- build-up
- reduction factor
- backscatter
- bremsstrahlung

D.33; E.2-16

16. High-energy photons of 1.02 MeV or greater typically interact with matter by which one of the following?

- photoelectric process
- Compton process
- pair production process
- thermionic process

D.27; E.2-14

17. In which of the following processes will some energy of the interacting photon be used to dislodge the electron from its orbit and the remainder used to give the electron kinetic energy?

- photoelectric process
- Compton process
- pair production process
- ionization process

D.26

18. Radiation particles and photons lose their energy primarily through which of the following processes?
- radioactive decay
 - ionization
 - atomic absorption
 - thermionic emission

D.25

Imaging by Film

19. According to accepted theory, the spots at which the latent image is localized on the emulsion are local concentrations of:
- silver sulfide
 - silver bromide
 - silver iodide
 - silver nitrate

F.135

Imaging by Fluorescent Materials

20. The Bunsen-Roscoe reciprocity law, which states that the developed film density depends only on the product of radiation intensity times exposure duration, fails for:
- direct gamma ray exposures
 - fluorescent screen exposures
 - lead screen exposures
 - direct X-ray exposures

F.129

21. In photofluorography where a fluoroscopic screen is used for radiographic imaging, it is important to choose a screen that has a visible light emission that is relatively high at the X-ray wavelengths to be used and that:

- matches the wavelength sensitivity of the human eye
- has a minimum decay time
- can be viewed directly without the use of leaded glass or mirrors
- matches the wavelength sensitivity of the particular image detector being used

A.16.14-17

22. When comparing fluorescent intensifying screens with lead foil screens, their primary advantage is:

- improved image resolution
- markedly increased exposure times
- markedly decreased exposure times
- relative insensitivity to scattered radiation

C.130

23. Fluoroscopy of a specimen using a 140 kVp 10 mA X-ray source results in an intensity of 66R per minute at the screen surface. Of the screen brightness values and approximate screen colors below (for the stated radiation level), which represents the most desirable screen for use in direct viewing fluoroscopy?

- Brightness – 9.8 lx (0.91 ftc); color – green
- Brightness – 8.5 lx (0.79 ftc); color – yellow
- Brightness – 7 lx (0.65 ftc); color – blue
- Brightness – 4.6 lx (0.43 ftc); color – green

A.19.9, 19-13

Imaging by Electronic Devices

24. Unlike other commercially available X-ray intensification systems, the direct X-ray pick-up tube:

- has quantum energy losses exceeding a factor of 500
- has extremely low sensitivity
- converts the X-ray image directly into an electrical signal
- converts X-rays to light and light to electrical signals

A.19.40

25. A fundamental difficulty of fluorescent imaging is the relatively low brightness level of the images. Electronic fluoroscopy can help to eliminate this problem by all but which one of the following?

- using X-ray tubes of lower operating potential
- using an image tube
- using X-ray tubes of greater effective loading
- using the X-ray television system

A.19.37

Radiometry

26. The roentgen is defined as the amount of:

- radiation emitted by 1 Ci of Ir-192 at a distance of 1 m (3.3 ft)
- X- or gamma radiation of 0.1 μJ (1 erg) of energy in 1 g of dry air at standard temperature and pressure
- X- or gamma radiation that will produce 1 electrostatic unit of charge in 1 cm^3 of dry air at standard temperature and pressure
- X- or gamma radiation absorbed by 1 cm^3 of water at 0 °C (32 °F) and 101 kPa (760 mm of Hg)

D.51

Radiographic Testing Method, Level III

27. The rad (radiation absorbed dose) is defined as the amount of:

- radiation energy absorbed by 1 cm³ of material
- radiation energy absorbed by 1 g of material
- radiation energy representing the absorption of 10 μ J (100 ergs) of energy per cm³ of material
- radiation energy representing the absorption of 10 μ J (100 ergs) of energy per g of material

D.51

28. The need for the concept of the rem (roentgen equivalent man) arises from the fact that:

- there is no way to accurately measure the production of ions in air
- the roentgen represents such a small amount of energy as to be cumbersome in calculations used in radiography applications
- the amount of energy required to produce an ion pair in animal tissue differs from the amount of energy required to produce an ion pair in air
- the roentgen incorporates the effect of neutron and electron radiation in air that it does not incorporate the effect of X-rays in animal tissue

D.51

29. The rem is defined as the quantity of radiation:

- of any type which, when absorbed by any animal tissue, produces a physiological effect equivalent to that produced by the absorption of 258 μ C/kg (1 roentgen) of X- or gamma rays
- absorbed by 1 cm³ of animal tissue
- necessary to absorb 0.1 μ J (1 erg) of energy by 1 g of animal tissue
- absorbed by one gram of animal tissue

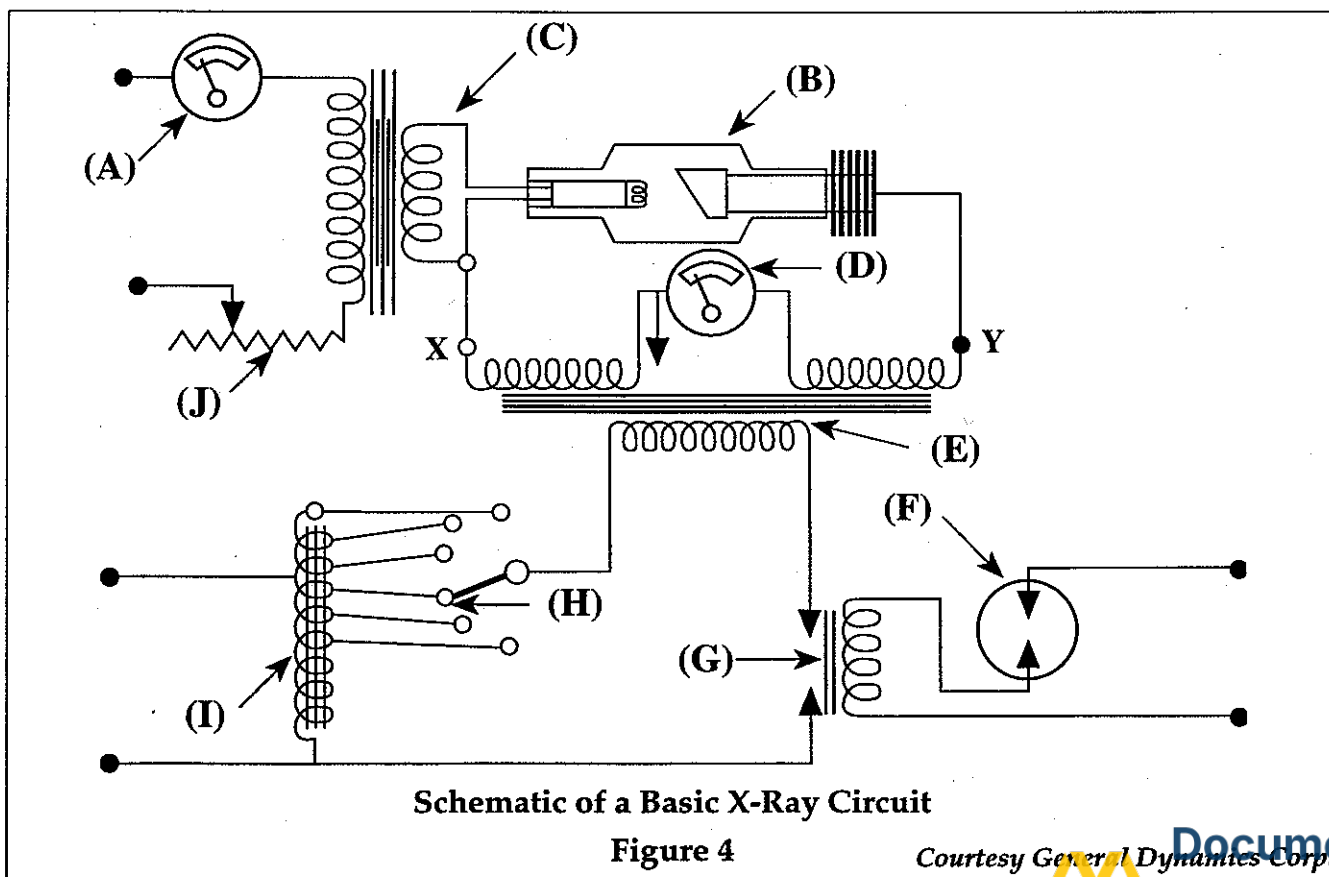
D.51

Generators and Tubes as an Integrated System

30. X-ray generators built to provide X-rays at very low energy levels are used in special areas in nondestructive testing. The single section X-ray tubes in these low voltage units are usually built with thin windows of what material to permit soft X-rays to emerge from the vacuum envelope?

- beryllium
- germanium
- selenium
- PyrexTM glass

A.14.12



Note: Use Figure 4 in order to answer questions 31-35

Sources of Electrons

31. The meter that typically shows the beam current is:

- a. B
- b. D
- c. F
- d. C

32. The filament transformer is shown by:

- a. G
- b. I
- c. C
- d. E

33. The autotransformer is shown by:

- a. G
- b. I
- c. C
- d. E

34. The kilovoltage selector is shown by:

- a. F
- b. A
- c. D
- d. H

35. The timer is shown by:

- a. J
- b. H
- c. F
- d. I

36. The beam current in an X-ray tube is critically dependent upon:

- a. target material
- b. filament voltage
- c. distance between anode and cathode
- d. all of the above

37. The focal spot should be as small as conditions permit, in order to obtain:

- a. the sharpest possible definition
- b. the minimum size of the unit
- c. the maximum energy density
- d. none of the above

38. The focusing cup of the cathode in an X-ray tube acts as an electrostatic lens, determining the size of the electron beam by:

- a. capturing stray electrons emitted by the filament
- b. limiting the maximum amperage of the filament current
- c. reducing the negative charge on the glass walls of the tube caused by secondary electrons scattered by the target
- d. controlling the electric field between the anode and the cathode

A.14.27

39. The most common source of electrons in high-vacuum X-ray tubes is:

- a. reflection from the anode
- b. the heated cathode
- c. the heated anode
- d. the tungsten target

A.14.3; F.9

40. The most common technique for releasing electrons in gas X-ray tubes is:

- a. reflection from the target in the anode of the tube
- b. increasing the kilovoltage
- c. positive ion bombardment of the cold cathode
- d. heating a filament

A.14.3

41. The most commonly used cathode type for industrial X-ray tubes is:

- a. cold cathode
- b. hot cathode
- c. rotating disk cathode
- d. solid rectangular cathode

A.14.8

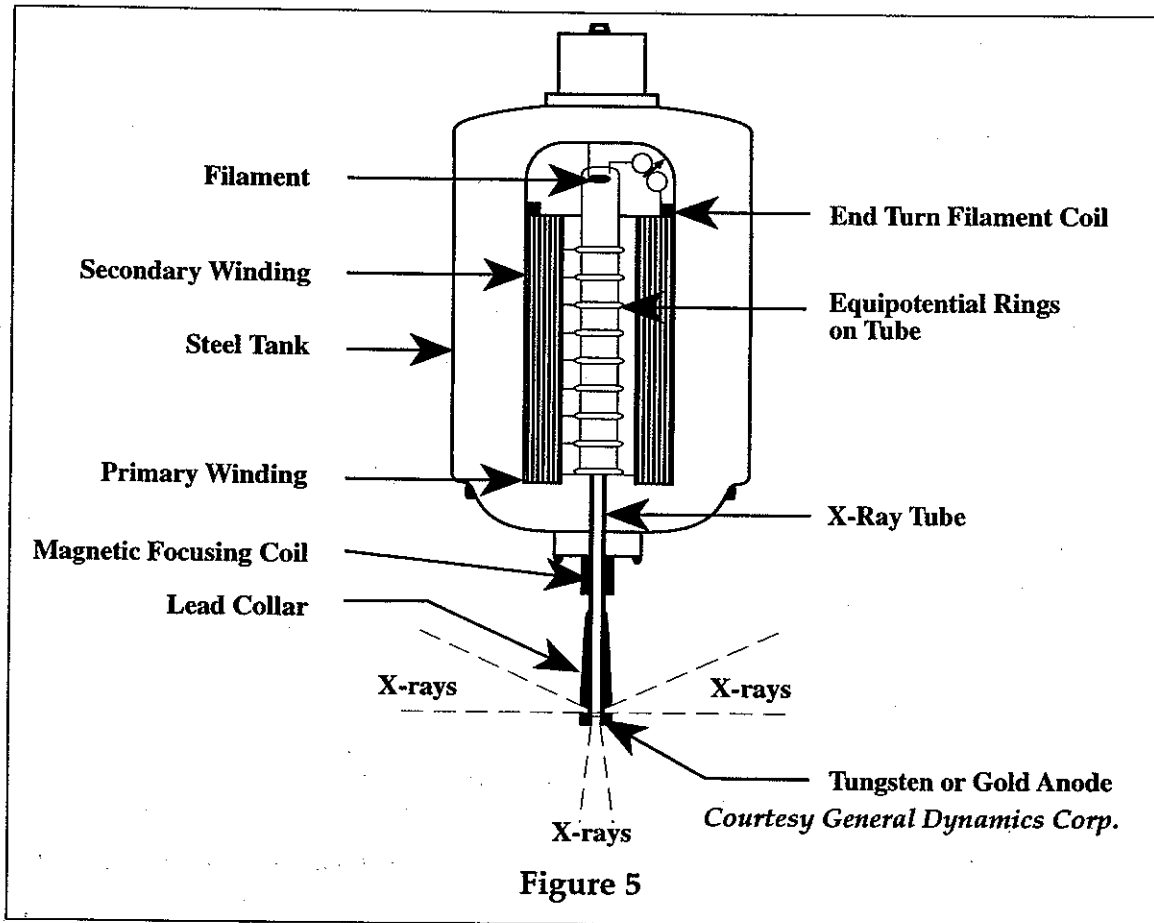
A.18.8

42. The design and spacing of the electrode and the degree of vacuum are such that no flow of electrical charge between the cathode and anode is possible until the:

- a. filament is heated
- b. high-voltage waveform reached 180°
- c. circulation system is operated
- d. none of the above

F.9

F.9



Electron Accelerating Methods

43. The type of X-ray generator illustrated in Figure 5 is a:

- a. electrostatic generator
- b. resonant transformer generator
- c. linear accelerator
- d. tank type generator

E.3-9

44. The betatron accelerates electrons in a circular path by:

- a. radio frequency energy
- b. magnetic induction
- c. use of a nonconducting charging belt
- d. resonating the high voltage to the frequency of the AC power

A.14.18; E.3-10

45. What method is used for generation of X-rays in the multimillion volt range?

- a. electrostatic generator
- b. betatron
- c. linear accelerator
- d. all of the above

F.12-13

46. In a betatron, electrons are accelerated by which of the following?

- a. field emission
- b. changing magnetic field of an AC electromagnet
- c. high-frequency electrical wave
- d. accelerating magnets

F.12

47. In a linear accelerator, the electrons are accelerated by which of the following?

- a. high-frequency electrical wave
- b. accelerating magnets
- c. neutron bombardment
- d. changing magnetic fields of an AC electromagnet

F.13

48. In a high-voltage generator of the Van de Graaff type, by which method are the particles accelerated?

- a. accelerating magnets
- b. high-frequency electrical waves
- c. static negative charges
- d. none of the above

F.13

49. Flash X-ray tubes are usually designed to produce electrons for acceleration by which one of the following methods?
- hot emission
 - field emission
 - changing magnetic field of a transformer primary
 - high-frequency electrical waves

F.12

54. In choosing a suitable metal for a target material, the principal properties to be considered are all but which one of the following?
- high atomic number
 - high melting point
 - high thermal conductivity
 - high vapor pressure

A.14.3

Target Materials and Characteristics

50. Tungsten is the preferred target material for X-ray tubes used in industrial X-ray machines because it provides a double advantage. One of the advantages is that:

- the efficiency of the tungsten material in the production of X-rays is proportional to its atomic number
- it has a low melting point
- the efficiency of the tungsten material in the production of X-rays is inversely proportional to its atomic number
- it has a high curie point

F.9

51. Gold and platinum are also used in X-ray tubes for radiography, but targets made of these metals must:

- be more effectively heated than targets made of tungsten
- be more effectively cooled than targets made of tungsten
- be able to withstand increasing pressure
- have low thermal conductivity

G.108

52. Tungsten is the most commonly used target material in X-ray tubes. Which one of the following materials, although not common, is commercially used for industrial X-ray tube targets?

- gold
- beryllium
- molybdenum
- germanium

C.108

53. The efficiency of the target material in the production of X-rays is proportional to:

- kilovoltage
- spacing of electrodes
- atomic number
- Avogadro's number

F.9

55. When X-rays are not emitted with the same intensity in all directions from the focal spot, this is called:

- screen effect
- angle of emergence
- heel effect
- astigmatism

A.14.29

Equipment Design Considerations

56. An anode in which the target is located at the bottom of an opening or "pocket" is frequently used in industrial X-ray tubes for improving the distribution of the high voltage field. This type of anode is called:

- rotating anode
- hot anode
- hooded anode
- line-focus anode

A.14.34; H.22

57. High-voltage electrostatic generators of the Van de Graaff type are typically insulated with:

- trichloroethylene
- nitrogen/carbon dioxide
- argon/oxygen
- trichloroethane

A.14.17

58. The most significant consideration of X-ray tubes, based on the low efficiency of X-ray production, is:

- target angle
- focal spot size
- accelerating voltage
- heat dissipation

A.14.3

59. In choosing a suitable metal for an X-ray tube target, which of the following is not a property that is normally considered?

- atomic number
- melting point
- mass attenuation coefficient
- thermal conductivity

A.14.3

Radiographic Testing Method, Level III

60. When the high-voltage transformer is connected directly to the X-ray tube, the arrangement is called a:

- a. full rectified unit
- b. linear accelerator unit
- c. self-rectified unit
- d. tank-type unit

A.14.5

61. In X-ray equipment design, shielding placement and the angle of the coverage of the X-ray beam is *not* a function of:

- a. target angle
- b. filament
- c. X-ray tube port size
- d. geometry of the focal spot

E.3-11

62. A high-vacuum environment for X-ray tube elements is necessary for which of the following?

- a. to prevent oxidation of the electrode materials
- b. to permit ready passage of the electron beam without ionization of gas within the tube
- c. to provide electrical insulation between the electrodes
- d. all of the above

E.3-5

63. Which of the following is the major factor affecting the duty cycle of X-ray equipment?

- a. kV rating of equipment
- b. thickness of specimen
- c. rate of anode cooling
- d. size of focal spot

E.3-11

64. Two factors that limit the electric power that can be absorbed by X-ray tubes are the cooling system used for the anode and:

- a. tube grounding
- b. geometrical size of the focal spot
- c. a high screen effect
- d. the vacuum between cathode and anode

A.14.29

65. The efficiency of X-ray production is given by the following expression: $E = 1.4 \times 10^{-7} ZV$. Given a target of tungsten-coated copper and a tube voltage of 300 kV, determine the percent efficiency where E is in percent.

	Element	Z
a. 8.8%	hydrogen	1
b. 3.11%	aluminum	13
c. 0.31%	copper	29
d. 1.22%	tungsten	74

B.94

Radioisotope Sources

66. Because it is frequently supplied as a water-soluble compound, which of the following is considered to have an additional radiological hazard potential associated with it?

- a. Co-60
- b. Tm-170
- c. Ir-192
- d. Cs-137

E.3-16

67. Tm-170 emits which of the following gamma ray energies?

- a. 1.33 and 1.17 MeV
- b. 0.084 and 0.052 MeV
- c. 0.310 and 0.470 MeV
- d. 0.110 and 0.150 MeV

E.3-15

68. Which one of the following radioisotope sources would be the *best* choice for radiography of a steel specimen 9.5 mm (0.375 in.) thick from an energy standpoint?

- a. Co-60
- b. Tm-170
- c. Ir-192
- d. Cf-252

E.3-15

69. The half-life is a useful characteristic of a radioisotope. After 6 half-lives, the amount of decaying atoms is reduced to approximately what percent of the amount at the beginning?

- a. 2 percent
- b. 3 percent
- c. 6 percent
- d. 1 percent

D.22

70. Generally, sources of high specific activity are more desirable because they have _____ self-absorption.

- a. higher
- b. the same
- c. lower
- d. no

G.110



Documents

Document Sharing Hub