

Questions and Answers

Levels I, II and III

Neutron Radiographic Testing Method

Supplement to
Recommended Practice
No. SNT-TC-1A
Book F



The American Society
for Nondestructive Testing, Inc.



Documents

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ASNT exists to create a safer world by advancing scientific, engineering, and technical knowledge in the field of nondestructive testing.

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Recommended Training References

Neutron Radiographic Testing Method

The following references were used in formulating the questions contained in this book.

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Each question found in this book contains letter(s) and page number(s) in bold type and sometimes chapter or section number(s) immediately following the answers. For example,

17. Short wavelength electromagnetic radiation produced during the disintegration of nuclei of radioactive substances is called:

- a. X-radiation
- b. gamma radiation
- c. scatter radiation
- d. back-scattered radiation

B.3

In this example, the letter "B" refers to Reference B in the list provided above. The "3" is the specific page in Reference B where the answer to the question can be found.

Reference Usage List

Neutron Radiographic Testing Method

Reference A: Total = 120

Level I (57)
Level II (43)
Level III (20)

Reference B: Total = 7

Level I (5)
Level II (0)
Level III (2)

Reference C: Total = 6

Level I (0)
Level II (0)
Level III (6)

Reference D: Total = 85

Level I (34)
Level II (34)
Level III (17)

Reference E: Total = 0

Level I (0)
Level II (0)
Level III (0)

Reference F: Total = 27

Level I (11)
Level II (9)
Level III (7)

Reference G: Total = 1

Level I (1)
Level II (0)
Level III (0)

Reference H: Total = 12

Level I (3)
Level II (9)
Level III (0)

Reference I: Total = 0

Level I (0)
Level II (0)
Level III (0)

Reference J: Total = 4

Level I (0)
Level II (1)
Level III (3)

Reference K: Total = 9

Level I (6)
Level II (0)
Level III (3)

Reference L: Total = 1

Level I (1)
Level II (0)
Level III (0)

Reference M: Total = 2

Level I (1)
Level II (1)
Level III (0)

Reference N: Total = 3

Level I (3)
Level II (0)
Level III (0)

Reference O: Total = 5

Level I (1)
Level II (2)
Level III (2)

Reference P: Total = 3

Level I (2)
Level II (1)
Level III (0)

Reference Usage List (continued)

Reference Q: Total = 3

Level I (1)
Level II (2)
Level III (0)

Reference R: Total = 1

Level I (0)
Level II (0)
Level III (1)

Reference S: Total = 15

Level I (0)
Level II (0)
Level III (15)

Reference T: Total = 1

Level I (0)
Level II (0)
Level III (1)

Reference U: Total = 1

Level I (0)
Level II (0)
Level III (1)

Reference V: Total = 3

Level I (0)
Level II (0)
Level III (3)

Reference W: Total = 2

Level I (0)
Level II (0)
Level III (2)

Reference X: Total = 1

Level I (0)
Level II (0)
Level III (1)

Reference Y: Total = 1

Level I (0)
Level II (0)
Level III (1)

Reference Z: Total = 1

Level I (0)
Level II (0)
Level III (1)

Reference AA: Total = 1

Level I (0)
Level II (0)
Level III (1)

Reference BB: Total = 1

Level I (0)
Level II (0)
Level III (1)

Reference CC: Total = 2

Level I (0)
Level II (0)
Level III (2)

Reference DD: Total = 1

Level I (0)
Level II (0)
Level III (1)

Level I Questions

Neutron Radiographic Testing Method

- | | |
|--|--|
| <p>1. Neutron penetration is greatest in which of the following materials?</p> <ul style="list-style-type: none"> a. hydrogenous material b. water c. lead d. boron carbide <p style="text-align: right;">A.7</p> | <p>6. Many of the absorption differences between neutrons and X-rays indicate clearly that the two techniques:</p> <ul style="list-style-type: none"> a. cause radiation problems b. complement each other c. increase exposure speed d. fog radiographic film <p style="text-align: right;">A.5-8</p> |
| <p>2. In general, by increasing the neutron energy from a neutron radiographic source:</p> <ul style="list-style-type: none"> a. greater neutron penetration is achieved b. greater neutron radiographic contrast can be obtained c. radiographic exposure time can be reduced d. resolution can be increased <p style="text-align: right;">A.10</p> | <p>7. The neutron cross section is the term normally used to denote:</p> <ul style="list-style-type: none"> a. the danger in handling radioactive material b. the absorbing power of a material for neutrons c. the atomic number of neutron reactor material d. radiation detection equipment <p style="text-align: right;">A.10</p> |
| <p>3. The time required for one-half of the atoms in a particular sample of radioactive material to disintegrate is called:</p> <ul style="list-style-type: none"> a. the inverse square law b. a curie c. a half-life d. the exposure time <p style="text-align: right;">A.65, 136</p> | <p>8. The sharpness of the outline in the image of the radiograph is a measure of:</p> <ul style="list-style-type: none"> a. subject contrast b. radiographic definition c. radiographic contrast d. film contrast <p style="text-align: right;">D.67</p> |
| <p>4. Generally, the attenuation of neutrons by a given material is:</p> <ul style="list-style-type: none"> a. reported to the Atomic Energy Commission b. greater for fast neutrons than thermal neutrons c. an indication of the quality of the X-radiographic technique d. appreciably greater for thermal and epithermal neutrons than for fast neutrons <p style="text-align: right;">A.10</p> | <p>9. The highest quality direct neutron radiographs obtainable today use:</p> <ul style="list-style-type: none"> a. imaging screens using lithium-zinc sulfide as the imaging materials b. high-speed radiographic films c. dysprosium as an imaging screen d. gadolinium as an imaging screen <p style="text-align: right;">A.59</p> |
| <p>5. The mass absorption coefficients for thermal neutrons when plotted against regularly increasing atomic numbers of periodic elements presents a:</p> <ul style="list-style-type: none"> a. blurred picture b. regularly increasing picture c. random picture d. dark picture <p style="text-align: right;">A.6-7</p> | <p>10. When doing neutron radiography on radioactive materials, the materials are best handled:</p> <ul style="list-style-type: none"> a. directly by personnel equipped with special protective clothing b. by remote handling equipment c. directly by personnel with special protective clothing except when radiographs are being made d. by the same methods used for nonradioactive materials <p style="text-align: right;">A.137-138</p> |

Neutron Radiographic Testing Method, Level I

11. Gadolinium conversion screens are usually mounted in rigid holders called:
- a. film racks
 - b. cassettes
 - c. emulsifiers
 - d. diaphragms
- A.90**
12. The best high-intensity source of thermal neutrons is:
- a. a Cf-252 source
 - b. an accelerator
 - c. a nuclear reactor
 - d. a Cf-252 source plus a multiplier
- A.24-27; F.341**
13. Scattered radiation caused by any material, such as a wall or floor, on the film side of the specimen is referred to as:
- a. primary scattering
 - b. undercut
 - c. reflected scattering
 - d. back-scattered radiation
- D.39-40**
14. What has the highest thermal neutron absorption cross section?
- a. gold
 - b. Indium
 - c. gadolinium
 - d. dysprosium
- A.6-7**
15. Conversion screens are used in neutron radiography:
- a. to convert neutron energy into ionizing radiation
 - b. to increase the exposure time
 - c. both a and b are reasons for using conversion screens
 - d. neither a nor b is a reason for using conversion screens
- A.46**
16. A curie is the equivalent of:
- a. 0.001 mCi
 - b. 1 000 mCi
 - c. 1 000 MCi
 - d. 100 MCi
- K.61**
17. Short wavelength electromagnetic radiation produced during the disintegration of nuclei of radioactive substances is called:
- a. X-radiation
 - b. gamma radiation
 - c. scatter radiation
 - d. back-scattered radiation
- B.3**
18. A photographic record produced by the passage of neutrons through a specimen onto a film is called:
- a. a fluoroscopic image
 - b. a radiograph
 - c. an isotopic reproduction
 - d. none of the above
- A.46**
19. Possible reactions that can occur when a fast neutron strikes a nucleus are:
- a. scattering and radiative capture
 - b. microshrinkage and static charges caused by friction
 - c. sudden temperature change and film contrast
 - d. uniform thickness and filtered radiation
- A.39**
20. For inspection of radioactive objects or those that emit gamma radiation when bombarded with neutrons, a preferable detection method is the:
- a. direct exposure method
 - b. transfer method
 - c. isotopic reproduction method
 - d. electrostatic-belt generator method
- A.64, 86-87**
21. Materials that are exposed to thermal neutron beams:
- a. must not be handled for at least 3 minutes after exposure has ceased
 - b. must be stored in a lead-lined room
 - c. may be radioactive after exposure to neutrons has ceased
 - d. should be monitored by means of a neutron counter
- A.91**
22. Hydrogenous material has a:
- a. high macroscopic scattering cross section
 - b. high absorption cross section
 - c. high microscopic absorption cross section
 - d. low microscopic scattering cross section
- A.40**
23. The penetrating ability of a thermal neutron beam is governed by:
- a. attenuation characteristics of the material being penetrated
 - b. time
 - c. source-to-film distance
 - d. all of the above
- A.9-10**

24. A graph showing the relationship between film optical density and exposure is called:
- a. a bar chart
 - b. a characteristic curve
 - c. an exposure chart
 - d. a logarithmic chart
- D.53**
25. The three main steps in processing a radiograph are:
- a. developing, frilling, and fixation
 - b. developing, fixation, and washing
 - c. exposure, developing, and fixation
 - d. developing, reticulation, and fixation
- D.80-81**
26. Radiographic contrast in a neutron radiograph is least affected by:
- a. developer temperature
 - b. radiographic exposure time
 - c. radiographic beam collimation
 - d. radiographic film fog
- D.66**
27. Higher resolution can be achieved in direct neutron radiography by:
- a. placing lead intensifying screen between a gadolinium screen and film
 - b. increasing the L/D ratio of the collimation system
 - c. increasing the exposure time
 - d. increasing the distance between the object and the film cassette
- F.340**
28. The main reason for using neutron radiography in place of X-radiography is:
- a. lower cost
 - b. higher resolution in all cases
 - c. the ability to image objects and materials not possible with X-rays
 - d. simpler radiographic procedure required than X-radiography
- A.5**
29. The best material for mounting specimens for neutron radiographic inspection is:
- a. cardboard
 - b. plastic
 - c. steel
 - d. aluminum
- A.90**
30. Which of the following materials is best for making identification labels when using the neutron radiographic process?
- a. aluminum
 - b. brass
 - c. cadmium or gadolinium
 - d. lead
- A.6-7, 33**
31. As a check on the adequacy of the neutron radiographic technique, it is customary to place a standard test piece on the source side of the cassette. This standard test piece is called:
- a. a reference plate
 - b. a lead screen
 - c. a penetrometer
 - d. an image quality detector
- A.95**
32. A densitometer is:
- a. a meter used to measure neutron intensity
 - b. an instrument used to measure film density
 - c. a meter used to measure the density of a material
 - d. a meter used to measure gamma content
- B.91**
33. The ability to detect a small discontinuity or flaw is called:
- a. radiographic contrast
 - b. radiographic sensitivity
 - c. radiographic density
 - d. radiographic resolution
- D.67**
34. Movement, geometry, and screen contact are three factors that affect radiographic:
- a. contrast
 - b. unsharpness
 - c. reticulation
 - d. density
- D.21, 66**
35. The difference between the densities of two areas of a radiographic film is called:
- a. radiographic contrast
 - b. subject contrast
 - c. film contrast
 - d. definition
- D.67**

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36. The selection of the proper type of film to be used for neutron radiographic examination of a particular part depends on the:
- a. thickness of the part
 - b. material of the specimen
 - c. neutron energy
 - d. none of the above
- D.75** **D.20-21, 100**
37. When radiographing a part that contains a large crack, the crack will appear on the radiograph as:
- a. a dark, intermittent, or continuous line
 - b. a light irregular line
 - c. either a dark or light line
 - d. a fogged area on the radiograph
- B.459** **L**
38. Radiographic sensitivity, in the context of defining the minimum detectable flaw, depends on:
- a. the graininess of the film
 - b. the unsharpness of the flaw image in the film
 - c. the contrast of the flaw image on the film
 - d. all of the above
- D.19, 67, 69** **A.39-40**
39. An Image Quality Indicator is used to measure the:
- a. size of discontinuities in a part
 - b. density of the film
 - c. amount of film contrast
 - d. quality of the radiographic technique
- D.69**
40. Unwanted inclusions in a part will appear on a radiograph as:
- a. a dark spot
 - b. a light spot
 - c. a generalized gray area of varying contrast
 - d. either a dark or a light spot or area depending on the relative absorption ratio of the part material and the inclusion material
- A.130**
41. A sheet of cadmium with an opening cut in the shape of the part to be radiographed may be used to decrease the effect of scattered neutrons, which undercuts the specimens. Such a device is called a:
- a. mask
 - b. filter
 - c. back-scatter absorber
 - d. lead-foil screen
- A.60; D.40**
42. The accidental movement of the specimen or film during exposure or the use of a source-film distance that is too small will:
- a. produce a radiograph with poor contrast
 - b. make it impossible to detect large discontinuities
 - c. result in unsharpness of the radiograph
 - d. result in a fogged radiograph
43. Dysprosium conversion screens emit:
- a. low-energy betas and gammas
 - b. high-energy betas, low-energy gammas, and internal-conversion electrons
 - c. beta particles only
 - d. low-energy gamma rays only
44. Materials in common usage for moderation of fast neutron sources include:
- a. aluminum, magnesium, and tin
 - b. water, plastic, paraffin, and graphite
 - c. neon, argon, and xenon
 - d. tungsten, cesium, antimony, and columbium
45. In the converter screen technique, the neutron image is produced by alpha, beta, or gamma radiation and it is thereby:
- a. used to measure neutron beam divergence
 - b. externally cooled during the process
 - c. photographically more detectable than the unconverted neutron image
 - d. an important factor for determining Young's modulus of the material
- A.46**
46. Converter screen material characterized by lithium, boron, and gadolinium has little tendency to become radioactive but does:
- a. protect the radiographic film from excessive pressure
 - b. recharge the focal point size of the neutron source
 - c. filter and collimate the excess neutrons
 - d. emit radiation immediately upon the absorption of a neutron
- A.46-47**
47. Gadolinium is frequently employed as a neutron absorber because of its:
- a. extremely low cost
 - b. high neutron absorption for a given thickness
 - c. ability to absorb gamma rays
 - d. ability to diffract alpha particles
- A.7**

48. An excellent radiograph is obtained under given exposure conditions with a thermal neutron flux of 2×10^6 n/cm²-s for 10 minutes. If other conditions are not changed, what exposure time would be required if the neutron flux was lowered to 1×10^6 n/cm²-s?

a. 5 minutes
b. 10 minutes
c. 20 minutes
d. 30 minutes

A.102

49. Neutron converter screens should be inspected for flaws or dirt:

a. daily
b. each time they are used
c. occasionally
d. when flaws are detected on the radiograph

50. The primary advantage of using a Cf-252 source for neutron radiography is its:

a. portability
b. low cost per unit neutron flux compared to other neutron radiographic sources
c. high resolution
d. long useful life without source quality degradation

A.20-24; F.341-343

51. Neutron beams used in nondestructive testing normally contain:

a. alpha particles
b. positrons
c. gamma rays and neutrons
d. X-rays

F.242-246

52. In neutron radiography, L/D refers to the:

a. limiting neutron energy divided by the neutron density
b. largest neutron flux in the system divided by the beam diameter
c. distance from the neutron source to the object divided by the source diameter
d. distance from the neutron source to the picture divided by the beam diameter

F.339

53. A type of neutron beam collimator is a:

a. mean free path diaphragm
b. divergent beam collimator
c. polycellular field generator
d. neutron beam catcher

F.339

54. Commonly used converter screens are:

a. gadolinium, dysprosium, and indium
b. neodymium, plutonium, and technetium
c. gadolinium, lead, and indium
d. gold, silver, and cadmium

A.46-47, 67

55. In order to decrease geometric unsharpness:

a. neutrons should proceed from as small a source as other considerations will allow
b. neutrons should proceed from as large a source as other considerations will allow
c. the film should be as far as possible from the object being radiographed
d. the distance from the source to the material examined should be as small as practical

D.20-21

56. High-resolution gadolinium conversion screens are produced by:

a. flame spray techniques
b. being grown in large flat crystals
c. vacuum vapor deposition
d. large brazing systems

57. In order to increase the neutron beam intensity:

a. the L/D could be lowered
b. the neutron energy must be increased
c. the test specimen should be moved further from the film
d. a smaller source size could be used

F.338-339

58. Neutron exposure may be due to:

a. the direct beam from the neutron source
b. scatter radiation arising from objects in the direct beam
c. both a and b
d. neither a nor b

A.96

59. Gadolinium conversion screens emit:

a. gamma rays and conversion electrons
b. beta particles only
c. alpha particles and positrons
d. gamma rays only

A.60, 73-74

60. Which elements are commonly used in the indirect transfer method?

a. gadolinium and cadmium
b. rhodium and samarium
c. dysprosium and indium
d. cadmium and dysprosium

A.67

Neutron Radiographic Testing Method, Level I

61. Which element is commonly used for direct neutron radiography?
- a. cadmium
 - b. indium
 - c. dysprosium
 - d. gadolinium
- A.49-64, 85**
62. Neutron sensitive scintillators provide:
- a. high quality radiographs with long exposures
 - b. low quality radiographs with long exposures
 - c. low quality radiographs with short exposures
 - d. none of the above
- A.85**
63. Lead is:
- a. a good neutron shield
 - b. easily activated by neutrons
 - c. a poor neutron absorber
 - d. an efficient conversion screen
- A.7**
64. Neutron energy, exposure time, and film type are three important neutron radiographic parameters that can be controlled. What other parameter can be controlled?
- a. L/D
 - b. conversion efficiency
 - c. type of conversion screen
 - d. both a and c
- F.338-340, 350-351**
65. The purpose of vacuum cassettes is to:
- a. eliminate scattered radiation
 - b. block unwanted gamma radiation
 - c. assure intimate film-to-foil contact
 - d. protect parts from the radiation emitted by the conversion screen
- D.38**
66. In making a californium isotope exposure in an unshielded area, you find the dose rate 1.9 m (6 ft) from the source is 1 200 mR/h. What would be the dose rate at 7.3 m (24 ft)?
- a. 75 mR/h
 - b. 100 mR/h
 - c. 200 mR/h
 - d. 300 mR/h
- M.6**
67. In developing film by hand technique without agitation:
- a. the radiograph will not show proper contrast
 - b. it will be impossible to fix the radiograph
 - c. there will be a greater fogging of the film
 - d. there will be a tendency for each area of the film to affect the development of the area immediately below it
- A.83**
68. Film developed by automatic processors:
- a. will have improved detail of the image
 - b. will have a general increase in the film density
 - c. takes longer to develop than when processing manually
 - d. will create less fog on the film
- N.9-11**
69. The emulsion side of a single-coated photographic X-ray-type film used for neutron radiography can be detected in the darkroom using standard safe lights as the:
- a. printed identifying marks on the emulsion side
 - b. darker of the two sides
 - c. duller and lighter color of the two sides
 - d. printed identifying marks on the non-emulsion side
- D.14**
70. The purpose of film containers is to:
- a. protect the film from light
 - b. protect the film from scratches
 - c. neither a nor b
 - d. both a and b
- D.6**
71. The two most common causes for excessively high density radiographs are:
- a. insufficient washing and overdeveloping
 - b. contaminated fixer and insufficient washing
 - c. overexposure and contaminated fixer
 - d. overexposure and overdevelopment
- D.147, 151**
72. Single-emulsion high-resolution X-ray film is very good for neutron radiography because:
- a. it has a very thin emulsion
 - b. it is sensitive to low-energy radiation and insensitive to high-energy radiation
 - c. it is faster than other films
 - d. both a and b
- D.74; N.18-19**