

**ATLANTIS NDT**

Radiographic Testing (RT) Level II General Examination — Practice Questions

40 multiple-choice questions with an answer key and explanations

Candidate name	
Date	
Time allowed (suggested)	90 minutes
Score	____ / 40

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Before you start

Forty original questions on radiation physics and sources, film and digital equipment, exposure and geometry calculations, technique, interpretation of weld radiographs, and radiation safety, pitched at what an RT Level II must know and be able to calculate.

Choose the single best answer for each question. Work without notes first, then check yourself against the answer key at the back. Under ASNT SNT-TC-1A your employer's written practice sets the passing grade and the number of questions in the real examination.

These are original study questions written by Atlantis NDT. They are not taken from, and do not reproduce, any ASNT or employer examination.

1. In an X-ray tube, the continuous (bremsstrahlung) part of the spectrum is produced mainly when:

- A. Fast electrons are slowed down in the electric field of the target nuclei
- B. Outer-shell electrons drop into vacancies in the inner shells of target atoms
- C. Unstable target nuclei decay and emit photons of fixed energy
- D. The heated filament releases electrons toward the anode

2. Using $\lambda_{\min} \text{ (in angstroms)} = 12.4 / \text{kV}$, what is the shortest wavelength produced by an X-ray tube operating at 200 kV?

- A. 0.62 Å
- B. 2.48 Å
- C. 0.062 Å
- D. 16.1 Å

3. Why is a gamma-ray source with high specific activity (activity per unit mass) preferred for radiography?

- A. Its gamma rays have higher energy, so they can penetrate much thicker sections of steel
- B. For the same activity the source can be physically smaller, which reduces geometric unsharpness
- C. Its half-life is longer, so the source needs replacing less often
- D. It produces less scattered radiation inside the part, so masking is unnecessary

4. A sealed source emits two principal gamma rays of about 1.17 MeV and 1.33 MeV. Which isotope is it?

- A. Ir-192
- B. Se-75
- C. Yb-169
- D. Co-60

5. Radiographic contrast, the difference in density between two areas of a radiograph, is the combined result of:

- A. Geometric unsharpness and inherent unsharpness
- B. Graininess and the type of screen used
- C. Subject contrast and film (detector) contrast
- D. The source-to-film distance alone

6. Which one of these changes, on its own, increases the inherent (film) unsharpness of a radiograph?

- A. Increasing the source-to-film distance while keeping the same source
- B. Changing to a higher-energy source, such as Co-60 instead of Ir-192
- C. Shortening the development time while keeping the same temperature
- D. Radiographing a thinner part of the same material with the same source

7. Which sequence is correct for manual processing of industrial radiographic film?

- A. Fix, develop, stop bath, wash, dry
- B. Develop, wash, dry, fix
- C. Stop bath, develop, fix, dry, wash
- D. Develop, stop bath, fix, wash, dry

8. In manual processing, the developer is several degrees warmer than the temperature the development time was set for, and the time is not adjusted. The most likely result is:

- A. Higher density and increased chemical fog
- B. Lower density and less fog
- C. No change, because only time affects development
- D. Lower contrast with unchanged density

9. After development and the stop bath, the film goes into the fixer. What does the fixer mainly do?

- A. Convert exposed silver halide into black metallic silver
- B. Remove the unexposed silver halide and harden the emulsion
- C. Neutralize the developer and stop development
- D. Reduce surface tension so the film dries without water spots

10. On the straight-line portion of a film's characteristic curve the average gradient is 4.0. Two adjacent areas receive exposures that differ by 0.05 in log relative exposure. What density difference should be expected between them?

- A. 0.0125
- B. 0.05
- C. 0.20
- D. 0.80

11. Two films from a double-film exposure are viewed superimposed. At one spot the individual film densities are 1.4 and 1.7. What is the combined density at that spot?

- A. 1.55
- B. 1.7
- C. 2.38
- D. 3.1

12. Why are offset (dark) and gain (flat-field) calibrations performed on a digital detector array (DDA)?

- A. To correct pixel-to-pixel differences in dark signal and sensitivity, so a uniform exposure gives a uniform image
- B. To convert grey values into film-density units so that film density limits can be applied directly to the digital image
- C. To erase the latent image held in the photostimulable phosphor before the next exposure
- D. To measure the effective focal spot size of the X-ray tube

13. Which image quality indicator is used to measure the basic spatial resolution (total image unsharpness) of a digital radiograph?

- A. Hole-type (plaque) IQI
- B. Single-wire IQI set
- C. Duplex wire IQI
- D. Step wedge

14. In an X-ray tube, the target face is set at an angle to the electron beam mainly so that:

- A. The beam leaving the window contains photons of a single energy instead of a continuous spectrum
- B. The effective focal spot seen from the film is smaller than the area the electrons actually strike
- C. Electrons that miss the target are trapped before they can reach the tube window
- D. Tube current can be raised without any change in the filament temperature

15. Limited access forces the source-to-film distance down from 36 in. (914 mm) to 24 in. (610 mm). The original technique needed 4.0 min. How long should the new exposure be to keep the same film density?

- A. 9.0 min
- B. 6.0 min
- C. 2.67 min
- D. 1.78 min

16. A technique calls for 90 Ci·min. The Ir-192 source measured 60 Ci exactly 74 days ago. Taking the half-life as 74 days, what exposure time is needed today?

- A. 1.5 min
- B. 3.0 min
- C. 4.5 min
- D. 6.0 min

17. A Co-60 source had an activity of 20 Ci when it was installed. Taking the half-life as 5.27 years, what is its approximate activity 10.5 years later?

- A. 5 Ci
- B. 10 Ci
- C. 2.5 Ci
- D. 1.9 Ci

18. A procedure limits geometric unsharpness to 0.020 in. (0.51 mm). The source size is 0.15 in. (3.8 mm) and the distance from the source side of the weld to the film is 1.5 in. (38 mm). Using $U_g = F \cdot d/D$, what is the minimum source-to-object distance D?

- A. 7.5 in.
- B. 12.75 in.
- C. 11.25 in.
- D. 16.9 in.

19. An X-ray exposure of 15 mA·min gives the required density at a source-to-film distance of 600 mm. The distance must be increased to 750 mm and the tube will run at 5 mA at the same kV. What exposure time is needed?

- A. 1.9 min
- B. 3.0 min
- C. 3.75 min
- D. 4.7 min

20. A feature inside a part is 10 mm wide. The source is 600 mm from the feature and the feature is 150 mm from the film. Ignoring unsharpness, how wide is its image on the film?

- A. 8.0 mm
- B. 12.5 mm
- C. 10.0 mm
- D. 15.0 mm

21. A planar crack is most likely to be detected by radiography when the radiation beam is:

- A. Parallel to the plane of the crack
- B. Perpendicular to the plane of the crack
- C. At about 45° to the plane of the crack
- D. At any angle, provided the IQI sensitivity is met

22. What is the main advantage of placing an Ir-192 source on the axis of a vessel to radiograph a girth seam, with film wrapped around the outside?

- A. Both walls are imaged, so each film carries two weld images
- B. Geometric unsharpness is eliminated
- C. The full circumference can be radiographed in a single exposure
- D. No IQIs are needed, because the geometry is fixed

23. Two exposures are made with the source shifted parallel to the film between them. The image of a discontinuity moves farther than the image of a lead marker taped to the film-side surface. This shows that the discontinuity is:

- A. At the film-side surface, level with the marker
- B. Closer to the film than the film-side marker itself
- C. Outside the part, on the cassette or film holder
- D. Farther from the film than the marker, toward the source side

24. On a radiograph of a butt weld with the cap left on, a dark, irregular line follows the edge of the cap image along one toe. The most likely cause is:

- A. Excess cap reinforcement
- B. Undercut at the cap toe
- C. A tungsten inclusion
- D. Incomplete penetration at the root

25. Two roughly parallel, dark, intermittent lines running along the weld on either side of the root pass, often called 'wagon tracks', are usually caused by:

- A. Slag trapped along the toes of the root bead
- B. Transverse cracks running across the root pass
- C. Burn-through at intervals along the root pass
- D. Uniformly scattered porosity in the fill passes

26. A fine, dark, slightly wavy line runs across a weld roughly perpendicular to its axis, with tapering ends. Reflected-light examination shows the emulsion is undamaged at that spot. The indication is most likely:

- A. Elongated slag
- B. Lack of sidewall fusion
- C. A transverse crack
- D. Root concavity

27. A radiograph of a coarse-grained austenitic stainless steel weld shows a mottled pattern that changes markedly when the beam angle is altered by a few degrees. The pattern is most likely:

- A. Cluster porosity spread through the weld metal
- B. Microfissuring along the weld centerline
- C. Developer streaking from uneven agitation
- D. Diffraction mottling from the grain structure

28. Dark, branching, tree-like marks appear on a processed radiograph. The most likely cause is:

- A. A network of fine, interconnected cracks in the part
- B. Static electricity discharged during film handling
- C. Film that was bent sharply before it was exposed
- D. Scratches in the surface of the lead intensifying screen

29. A film was sharply bent while being loaded into its cassette, before exposure. After processing, the crimp mark will usually appear:

- A. Lighter than the surrounding film
- B. Darker than the surrounding film
- C. Invisible, because processing removes pressure effects
- D. Darker on one side and lighter on the other

30. Before recording a small, light, rounded indication in a steel weld as a tungsten inclusion, what should the interpreter check first?

- A. That the IQI was placed on the film side
- B. That the density at the spot exceeds 4.0
- C. Whether a slower, finer-grained film would show the indication more clearly
- D. Whether spatter or another surface feature is present at that spot

31. A survey meter reads 50 mR/h (about 0.5 mSv/h) at 10 ft (about 3 m) from an unshielded gamma source. Using the inverse square law, at about what distance will the dose rate fall to 2 mR/h (about 0.02 mSv/h)?

- A. 20 ft (6 m)
- B. 125 ft (38 m)
- C. 50 ft (15 m)
- D. 250 ft (76 m)

32. Assume an exposure-rate constant of 0.5 R/h per curie at 1 m for an Ir-192 source. What is the approximate unshielded exposure rate 10 m from a 40 Ci source?

- A. 2 R/h
- B. 0.2 R/h (200 mR/h)
- C. 0.02 R/h (20 mR/h)
- D. 20 R/h

33. A shielding material has a tenth-value layer (TVL) of 16 mm for a given gamma source. What thickness reduces a narrow-beam dose rate of 1,000 mR/h to 1 mR/h?

- A. 16 mm
- B. 32 mm
- C. 160 mm
- D. 48 mm

34. At a work position the dose rate is 400 mR/h. Two half-value layers of shielding are placed between the source and the worker, and the worker moves to twice the original distance. What is the new dose rate?

- A. 25 mR/h
- B. 50 mR/h
- C. 100 mR/h
- D. 12.5 mR/h

35. A technician receives 0.04 mSv (4 mrem) while working for 6 minutes at 3 m from a source. If the same task were done in 3 minutes at 6 m, what dose would be received?

- A. 0.02 mSv (2 mrem)
- B. 0.01 mSv (1 mrem)
- C. 0.005 mSv (0.5 mrem)
- D. 0.0025 mSv (0.25 mrem)

36. Before using a survey meter at the start of a radiography job, the radiographer should confirm that:

- A. It reads exactly zero inside the darkroom
- B. Its calibration is current, the battery check is satisfactory and it responds to a check source
- C. Its alarm has been set to the annual occupational dose limit
- D. Its serial number matches the serial number stamped on the exposure device it will be used with

37. While approaching an exposure device after an exposure, a radiographer sees a Geiger-Mueller survey meter that had been reading upscale suddenly drop to near zero. What is the safest interpretation?

- A. The source has just retracted into the device, so the area is now safe to enter
- B. The battery has recovered, so the latest low reading is the reliable one to use
- C. Background radiation has fallen; re-zero the meter and continue the approach
- D. The meter may be saturated or failing; withdraw and check with a second, working instrument

38. Under US NRC rules for industrial radiography (10 CFR Part 34), what must each radiographer and radiographer's assistant wear during field radiographic operations?

- A. A direct-reading dosimeter, an operating alarm ratemeter and a personnel dosimeter (film badge, OSL or TLD)
- B. A personnel dosimeter only, processed monthly, since that badge is the legal dose of record for each individual worker
- C. An alarm ratemeter only, because it warns in real time
- D. A survey meter worn on the belt, in place of any dosimeter

39. Under 10 CFR Part 20, a 'high radiation area' is one in which an individual could receive more than what dose in one hour at 30 cm from the source?

- A. 0.02 mSv (2 mrem)
- B. 0.05 mSv (5 mrem)
- C. 1 mSv (100 mrem)
- D. 5 Gy (500 rad)

40. After cranking the source in, the survey shows that an Ir-192 source has not returned to the exposure device. What should the radiographer do first?

- A. Withdraw to a safe distance, keep the boundary secured and watched, and notify the radiation safety officer
- B. Disconnect the guide tube from the device and look inside it to find out exactly where the source has stopped
- C. Lift the guide tube quickly and carry the source back to the device
- D. Keep cranking harder until the drive cable moves freely

Answer key and explanations

1. A	2. C	3. B	4. D	5. C	6. B	7. D	8. A	9. B	10. C
11. D	12. A	13. C	14. B	15. D	16. B	17. A	18. C	19. D	20. B
21. A	22. C	23. D	24. B	25. A	26. C	27. D	28. B	29. A	30. D
31. C	32. B	33. D	34. A	35. C	36. B	37. D	38. A	39. C	40. A

1. A — Bremsstrahlung ('braking radiation') comes from electrons losing energy as target nuclei deflect and slow them, giving a continuous range of photon energies up to the tube kV. Electrons filling inner-shell vacancies produce the separate characteristic lines, and the filament only supplies the electrons. [General radiation physics]

2. C — $\lambda_{\min} = 12.4 / 200 = 0.062 \text{ \AA}$. The shortest wavelength corresponds to an electron giving up all of its 200 keV in a single interaction, so raising the kV shortens $\lambda_{\min}$. [Duane-Hunt relation; general X-ray physics]

3. B — High specific activity packs the required curies into a smaller pellet, which reduces the source size F in $U_g = F \cdot d / D$. Gamma energy and half-life are fixed by the isotope, not by its specific activity. [General RT principle (gamma sources)]

4. D — Co-60 emits gamma rays at about 1.17 and 1.33 MeV, which suits thick steel sections. The main Ir-192 lines lie roughly between 0.3 and 0.6 MeV, and Se-75 and Yb-169 are lower still, which is why they are used on thinner sections. [Isotope properties (general RT knowledge)]

5. C — Subject contrast is the difference in radiation leaving different parts of the object, and film contrast is how strongly the film turns that difference into a density difference. Unsharpness and graininess affect definition, not contrast. [General RT principle (radiographic sensitivity)]

6. B — Higher-energy photons release secondary electrons that travel farther through the emulsion before stopping, so each point is recorded over a wider area. Source-to-film distance affects geometric unsharpness, not inherent unsharpness. [General RT principle (image definition)]

7. D — The developer turns exposed silver halide into metallic silver, the stop bath halts development and protects the fixer, the fixer removes the remaining halide, and washing removes the fixer before drying. Fixer left in the emulsion discolors the film in storage. [General film processing practice (see ASTM E999)]

8. A — Development speeds up as temperature rises, so the film is effectively over-developed and both density and fog increase. This is why manual development follows a time-temperature chart. [General film processing practice]

9. B — Fixer dissolves the silver halide that was not developed, which makes the image permanent, and it hardens the gelatin. The other options describe the developer, the stop bath and a wetting agent. [General film processing practice]

10. C — Gradient is the slope $\Delta D / \Delta \log E$, so $\Delta D = 4.0 \times 0.05 = 0.20$. A film with a higher gradient turns the same small exposure difference into a larger, easier-to-see density difference. [Film characteristic curve]

11. D — Each film transmits a fraction of the light and the fractions multiply, so the logarithmic densities add: $1.4 + 1.7 = 3.1$. Averaging (1.55) or multiplying the densities (2.38) gives the wrong result. [Film density definition ($D = \log_{10}$ of incident / transmitted light)]

12. A — Every pixel has its own dark signal and response, and offset and gain correction removes this fixed pattern so it cannot mask or mimic real features. Erasing a phosphor plate is a CR step, and DDA grey values are not film densities. [General DDA practice (see ASTM E2698 / E2737)]

13. C — The duplex wire IQI carries pairs of high-density wires whose diameter and gap become progressively smaller, and the first pair that can no longer be separated gives the total unsharpness and basic spatial resolution. Hole-type and single-wire IQIs indicate overall contrast sensitivity rather than resolving power. [ASTM E2002; ISO 19232-5]
14. B — This is the line-focus principle: the area struck by electrons can be large enough to spread the heat, while its projection toward the part is small, which keeps geometric unsharpness down. [General X-ray equipment principle]
15. D — Exposure time is proportional to the square of the distance: $4.0 \times (24/36)^2 = 4.0 \times 0.444 = 1.78$ min. 2.67 min is a straight-line correction, and 9.0 min applies the ratio the wrong way round. [Inverse square law]
16. B — One half-life has passed, so the source is now 30 Ci, and $90 \text{ Ci} \cdot \text{min} \div 30 \text{ Ci} = 3.0$ min. Using the original 60 Ci gives 1.5 min and under-exposes the film. [Radioactive decay; exposure in Ci·min]
17. A — 10.5 years is about two half-lives ($10.5 \div 5.27 \approx 2.0$), so the activity is $20 \times (\frac{1}{2})^2 \approx 5$ Ci. Exposure times for the same technique are now about four times those at installation. [Radioactive decay]
18. C — $D = F \cdot d / U_g = 0.15 \times 1.5 / 0.020 = 11.25$ in. (about 286 mm). Adding d gives the minimum source-to-film distance of 12.75 in., which is a different quantity. [Geometric unsharpness ($U_g = F \cdot d / D$)]
19. D — The new exposure is $15 \times (750/600)^2 = 15 \times 1.5625 \approx 23.4$ mA·min, and $23.4 \div 5 \text{ mA} \approx 4.7$ min. 3.0 min ignores the distance change, and 3.75 min applies it linearly. [Inverse square law; exposure in mA·min]
20. B — Magnification = source-to-film distance $\div$ source-to-object distance = $(600 + 150) / 600 = 1.25$, so the image is $10 \times 1.25 = 12.5$ mm. Keeping the object close to the film keeps both enlargement and unsharpness small. [Projection geometry]
21. A — With the beam running along the crack plane, the radiation travels through the crack over its full through-wall height, so the missing-material path and the density change are greatest. Across the plane, a tight crack removes almost no material from the beam path, and a visible IQI does not prove sensitivity to planar flaws. [General RT principle (discontinuity orientation)]
22. C — A centered (panoramic) exposure radiates the whole circumference at once through a single wall, so one exposure covers the seam. Geometric unsharpness is still present and IQIs are still required. [General RT technique (panoramic exposure)]
23. D — In the parallax (tube-shift) method an image moves in proportion to how far its object is from the film. An image that shifts more than the film-side marker belongs to something nearer the source. [General RT technique (parallax method)]
24. B — Undercut is a groove melted into the base metal at the toe, so less metal lies in the beam path and a darker line appears along the edge of the cap. A visual check of the weld surface confirms it, while incomplete penetration normally lies on the root centerline. [General RT interpretation]
25. A — Slag left in the grooves along each toe of the root bead images as two dark lines parallel to the weld. Transverse cracks run across the weld, and burn-through shows as a localized dark area. [General RT interpretation]
26. C — A tight, irregular line with tapering ends is typical of a crack, and its orientation across the weld makes it transverse. Slag and sidewall lack of fusion usually run along the weld, and the reflected-light check has already ruled out an emulsion mark. [General RT interpretation]
27. D — Large grains diffract the beam, and the pattern depends strongly on orientation, so a small change in angle rearranges it. Real porosity or fissures stay in place apart from a small geometric shift.

[General RT interpretation]

28. B — A static discharge, often when film is pulled quickly from its box or interleaving in dry air, exposes the emulsion in jagged, branching patterns. Film bent before exposure gives light crescent-shaped marks instead. [Film artifact guidance (film manufacturers' image guides)]

29. A — Pressure on the emulsion before exposure desensitizes it, leaving a light, lower-density crescent. A crimp made after exposure but before processing shows dark, which helps establish when the damage happened. [Film artifact guidance (film manufacturers' image guides)]

30. D — Spatter and other surface metal also image light, and a visual check of the part settles the question. Tungsten inclusions are expected only where a tungsten-electrode process such as GTAW was used. [General RT interpretation]

31. C — The dose rate must fall by a factor of 25, so the distance must increase by $\sqrt{25} = 5$: $10 \text{ ft} \times 5 = 50 \text{ ft}$ ($3 \text{ m} \times 5 = 15 \text{ m}$). Multiplying the distance by 25 (250 ft) wrongly treats dose rate as falling linearly with distance. [Inverse square law]

32. B — At 1 m the rate is $0.5 \times 40 = 20 \text{ R/h}$, and at 10 m it is $20 \div 10^2 = 0.2 \text{ R/h}$ (200 mR/h). The constant here is a round teaching value; use the figure in your own procedure for real work. [Inverse square law; source output]

33. D — Each TVL cuts the dose rate to one tenth, and 1,000 to 1 is a factor of 10^3 , so three TVLs are needed: $3 \times 16 = 48 \text{ mm}$. Real shielding designs add margin for scattered radiation (buildup). [Tenth-value layer]

34. A — Two HVLs reduce the rate to $(\frac{1}{2})^2 = \frac{1}{4}$, and doubling the distance reduces it by another $\frac{1}{4}$: $400 \times \frac{1}{4} \times \frac{1}{4} = 25 \text{ mR/h}$. Shielding and distance factors multiply. [Half-value layer; inverse square law]

35. C — Dose is dose rate $\times$ time. Halving the time halves the dose, and doubling the distance quarters the dose rate: $0.04 \times \frac{1}{2} \times \frac{1}{4} = 0.005 \text{ mSv}$. [Time, distance and shielding]

36. B — A meter that is out of calibration, has a weak battery or does not respond to a known source cannot be trusted to show whether the source is exposed. Natural background means a working meter rarely reads exactly zero. [Radiation safety practice (survey instruments)]

37. D — Geiger-Mueller detectors can saturate in very high fields and read falsely low, and a failing meter can also drop out. A sudden fall to near zero close to a source must be treated as an instrument problem until a working meter proves otherwise. [Radiation safety practice (survey instruments)]

38. A — Part 34 requires all three: the direct-reading dosimeter gives a running total, the alarm ratemeter warns of high dose rates, and the processed personnel dosimeter is the dose of record. None of them replaces surveys with a survey meter. [10 CFR 34.47]

39. C — A high radiation area is defined at more than 1 mSv (0.1 rem) in one hour at 30 cm. More than 0.05 mSv (5 mrem) in one hour at 30 cm defines a radiation area, and more than 5 Gy (500 rad) in one hour at 1 m defines a very high radiation area. [10 CFR 20.1003 (definitions)]

40. A — The first priorities are to limit exposure by distance, stop anyone entering the area, and call in the people authorized to recover the source under the emergency procedures. Handling the guide tube or forcing the drive can deliver a serious dose or make the situation worse. [Radiation safety practice (source retrieval and emergency procedures)]

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