INTRODUCTION


The definitions in this Nondestructive Testing Handbook volume should not be referenced for inspections performed according to standards or specifications or in fulfillment of contracts. Standards writing bodies take great pains to ensure that their documents are definitive in wording and technical accuracy. People working to written contracts or procedures should consult definitions referenced in those standards when appropriate. This glossary is provided for instructional purposes. No other use is intended.

A

A: See angstrom.

absorbed dose: Amount of energy imparted to matter by an ionizing event per unit mass of irradiated material at the place of interest. Absorbed dose is expressed in joules per kilogram, or gray (Gy). Absorbed dose is not a direct indicator of the potential biological effect of radiation exposure. See also dose equivalent; dose rate; dosimeter; exposure; equivalent dose; film badge; quality factor; radiation absorbed dose.

absorption: Phenomenon where incident photons of ionizing radiation interact with electrons and/or the nucleus of the penetrated material to liberate a charged particle, or to produce a lower-energy photon. The likelihood of photon interaction varies with path length, atomic number of the penetrated material, and photon wavelength. See also absorption coefficient.

absorption coefficient, linear (µ): Density-dependent expression of the decrease in radiation beam intensity per unit of thickness penetrated. Offered in units of cm⁻¹, this expression varies with energy of incident photon as minimum levels required for various electronic transitions are satisfied. Compare absorption coefficient, mass.

absorption coefficient, mass (µ/ρ): Expression of the decrease in radiation beam intensity equal to the linear absorption coefficient divided by the density of the penetrated material. Expressed in units of cm²/g, this is the absorption expression most commonly found in reference resources.

accelerator: (1) Device that accelerates charged particles to high energies. Examples are X-ray tubes, linear accelerators, and betatrons. (2) Linear accelerator.

acceptable quality level (AQL): Maximum percent defective (or the maximum percentage of units with rejectable discontinuities) that, for the purposes of sampling tests, can be considered satisfactory as a process average. Compare lot tolerance percent defective.
acceptance criterion: Benchmark against which test results are to be compared for purposes of establishing the functional acceptability of a part or system being examined.

acceptance level; acceptance limit: (1) Test signal value used to establish the group to which a material under evaluation belongs; (2) Measured value or values above or below which test objects are acceptable. Compare to rejection level.

acceptance standard: (1) Specimen, similar to the product to be tested, containing natural or artificial discontinuities that are well defined and similar in size or extent to the maximum acceptable in the product. (2) Document defining acceptable discontinuity size limits. See also reference standard; working standard.

accommodation: Of the eye, adjustment of the lens’ focusing power by changing the thickness and curvature of the lens through its movement by tiny muscles.

accuracy: Degree of conformity of measurement to a standard or true value.

activation: Process by which incident neutrons captured by previously stable atoms are made radioactive.

activity: Degree of isotope radioactivity, expressed as the number of unstable atomic nuclei disintegrating per second. Measured in becquerel.

acuity: See neural acuity; vision acuity.

adaptive thresholding: More advanced than the simpler global threshold operator; a dynamic process of separating, or segmenting, desirable foreground image objects from their background surroundings based on differences in local pixel intensities. The term threshold refers to the grayscale value used as segmentation level; all pixels whose intensity is above the threshold are set to a foreground value, and all remaining pixels are set to a background value. See threshold; thresholding.

agency: See outside agency.

algorithm: Prescribed set of well-defined rules or processes for the solution of a mathematical problem in a finite number of steps (ASNT 1986; IEEE 1984).

alpha particle: Positively charged helium ion emitted by certain radioactive materials. It is made up of two neutrons and two protons; hence, it is identical with the nucleus of a helium atom.

alpha ray: Ionizing radiation in the form of a stream of alpha particles. Compare beta ray; gamma ray; X-ray.

alternating current: Electric current whose electron flow changes direction and whose waveform changes in magnitude cyclically.

amorphous: In materials science, a noncrystalline solid without long-range atomic ordering. Long-range ordering is what creates crystal structures in crystalline and polycrystalline materials. Also called glassy solid. Polymers are amorphous. See digital detector array.

ampere (A): SI unit of electric current (also called amp) named after Andre-Marie Ampere.


analog-to-digital converter: Circuit whose input is information in analog form and whose output is essentially the same information in digital form.

angstrom (Å): Disused unit of length. 1 Å = 0.1 nm.

anode: (1) In radiography, the positive electrode of a cathode ray tube that generates ionizing radiation. (2) Positively charged terminal, which may corrode electrochemically during production of an electric current. Compare cathode.

AQL: See acceptable quality level.

arc welding: See welding, arc.

artifact: See indication, false.

artificial discontinuity standard: See acceptance standard.

artificial discontinuity: See reference standard.


ASNT Recommended Practice No. SNT-TC-1A: See Recommended Practice No. SNT-TC-1A.

attenuation: (1) Decrease in energy or signal magnitude in transmission from one point to another. Can be expressed as a scalar ratio of the input magnitude to the output magnitude. (2) Decrease in intensity caused by absorption, diffraction, scattering, or other phenomenon.

austenite: Face-centered cubic phase of iron, that is stable between 906 °C (1663 °F) and 1390 °C (2535 °F) and often acts as a solvent for carbon. Also called gamma iron.

austenite, retained: Face-centered cubic iron phase that remains at room temperature due to iron content, alloy content (e.g., nickel or manganese), quenchant temperature, or post-processing. The presence and amount of retained austenite desired varies with end use.
**automated system**: Acting mechanism that performs required tasks at a determined time and in a fixed sequence in response to certain conditions or commands.

**axial**: See *longitudinal; transverse*.

**axis**: An imaginary line about which a body rotates that forms a reference for measuring coordinates.

**B**

**background**: Image grayscale or signal levels from a test object that constitute the intensity variations from which a discontinuity is detected. The higher the level of background noise, the more difficult it is to distinguish a discontinuity. Background signals may arise from visual, acoustic, chemical, electrical, or radiation sources that the sensor responds to. See also *neural acuity; sensitivity; signal-to-noise ratio*.

**backscatter**: (1) In radiographic testing, interaction of radiation with matter such that the direction of travel after scattering is over 90° and often close to 180° to the original direction of travel. (2) In transmission radiography, interaction of radiation with matter behind the image plane such that scattered radiation returns to the image plane, often adding fog and noise that interfere with production of an image of the specimen. See also *backscatter imaging*.

**backscatter imaging**: In radiographic testing, interaction of incident radiation with a specimen that scatters the radiation through large angles frequently greater than 90° to the original direction of travel. Such radiation is used to form an image or to measure a parameter of the specimen, usually through digital techniques.

**barium clay**: Molding clay containing a barium compound, used to eliminate or reduce the amount of scattered or secondary radiation reaching a radiation detector. See also *compensator block*.

**barn (b)**: Unit of area equal to $10^{-24}$ cm$^2$. Used in nuclear physics for the effective cross-sectional area of the nucleus, which represents a probability of interaction with nuclei for a given nuclear reaction.

**baseline**: Standard, average, prior measurements, or other criteria for comparison and evaluation.

**beam**: Defined stream of radiation particles in which all particles are traveling in parallel or nearly parallel paths.

**beam hardening**: Increase in the average energy of an x-ray beam (usually from a bremsstrahlung source) due to the more rapid attenuation of the lower energy photons relative to the higher energy photons passing through an object or shielding.

**beam quality**: Intensity, or penetrating power, of an X-ray beam controlled by the average photon energy across the emission spectrum. Beam quality is a governing factor in half-value-layer calculations, and varies with tube voltage, choice of filter, and anode target angle.

**beam spread**: Divergence of a beam of radiation. Over distance a beam of radiation, originating at a source, will increase in size and decrease in area intensity. Compare *scattering*.

**becquerel (Bq)**: SI unit for measurement of radioactivity, equivalent to one disintegration per second. Replaces curie (Ci), where 1 Ci = $3.7 \times 10^{10}$ Bq.

**beta particle**: Electron or positron emitted from a nucleus during radioactive decay (IEEE 1984).

**beta ray**: Radiation beam consisting of beta particles. Compare *alpha ray, gamma ray*, X-ray.

**betatron**: Circular electron accelerator that is a source of either high-energy electrons or X-rays. The electrons are injected by periodic bursts into a region of an alternating magnetic field (IEEE 1984).

**binary image**: Image represented by pixels of value one or zero (black or white).

**biological dose equivalent**: See *dose equivalent*.

**blind riser**: Feeder reservoir of molten metal attached to a casting that helps prevent shrinkage cavities during solidification, and is contained wholly within the casting mold. A blind riser's counterpart is a top riser, which is larger and open to the surface.

**blind spot**: Portion of the retina where the optic nerve enters the eye that is insensitive to light due to lack of photoreceptors (such as rods and cones).

**blister**: In castings, slightly subsurface pore that can expand in post-treat. Very small blisters are called pinheads or pepper blisters.

**blowhole**: In castings or welds, smooth-walled cavity caused by gas. Also called *blow*.

**Bq**: See *becquerel*.

**Bragg’s law**: Mathematical relationship commonly used in X-ray diffraction to relate coherent and incoherent photon scattering to atomic spacing of a crystalline material. Bragg’s law is a special case of the more general set of three laue diffraction equations.
brazing: Thermal joining process where a molten metallic alloy is used to fuse together solid metallic components. The brazing material melting temperature is lower than the melting temperatures of the materials to be joined.

breakout: In a steel continuous casting process, failure of the cast strand's solid external shell that allows the still-molten metal contained within to spill out. See also bridging.

bremsstrahlung: Electromagnetic radiation produced when electrons' path and kinetic energy brings them close to the positive fields of atomic nuclei—as when, for example, electrons strike a target provided for this purpose. The electrons slow down, giving up kinetic energy as X-radiation. See also primary radiation; secondary radiation.

bridging: In a steel continuous casting process, premature solidification of steel or slag where liquid metal is stagnant and super-cooled. This condition may cause a breakout.

brinelling: Permanent surface deformation caused by contact stress above the material's elastic limit. Compare wear; fretting.

brittle crack propagation: Very sudden propagation of crack with absorption of no energy except that stored elastically in body. Microscopic examination may reveal some deformation invisible to the unaided eye. Compare ductile crack propagation; fatigue crack propagation.

buildup factor: The ratio of the radiation quantity detected after passing through an object or shielding to the radiation quantity from the primary beam only, without any scatter contribution (narrow beam signal). The buildup factor is due to multiple scattering of a broad beam of radiation on an object or shielding that results in radiation ultimately being scattered in the forward direction and reaching the detector. Buildup factors affect image quality in radiography by contributing to the background radiation noise level on the detector for imaging and increasing the dose on the far side of a shielding wall.

burning: See overheating.

burnt-in sand: See metal penetration.

burr: Raised or turned-over edge occurring on a machined part and resulting from cutting, punching, or grinding (ASNT 1993; EPRI).

burst: In metal-forming operations, external or internal rupture caused by poor process control or inherent material discontinuities. See also crack, forging.

C

C: See coulomb.

cadmium ratio: The ratio of the response of an uncovered neutron detector to that of the same detector when covered with cadmium. A higher cadmium ratio indicates higher thermal neutron content in the neutron beam.

calibration: The comparison of an instrument with, or the adjustment of an instrument to, a known reference(s) often traceable to the National Institute of Standards and Technology (NIST). Refer to ASTM 1316. Compare standardization, verification.

camera: In radiography, device that contains a sealed radiation source, where the source or shielding can be moved so that the source becomes unshielded (to make a radiographic exposure) or shielded (for safe storage). See also guide tube.

candela (cd): Base SI unit of luminous intensity, in a given direction, of a monochromatic radiation source that has a frequency of $5.4 \times 10^{14}$ Hz and that has a radiant intensity in that direction of $1.464 \text{ mW/sr}$.

carbon fiber reinforced plastic (CFRP): composite material made from carbon fibers in a polymer matrix. Also called carbon fiber reinforced polymer. Product can be made in a variety of forms, but commonly constructed as layered plies. See composite materials.

case crushing: Longitudinal gouges and fracture of a case-hardened surface, such as the tooth of a gear. Compare galling; subcase fatigue.

casing: In the drilling industry, many sections of pipe that line the hole during and after drilling of a water, gas, or oil well. See also oil country tubular goods.

casing string: In the drilling industry, tubular structure on the outer perimeter of a water, gas, or oil well hole. The casing string is a permanent part of the well, and many casing strings are cemented into the formation. See also oil country tubular goods; tubing string.

cassette, film: Lightproof container for holding radiographic film in position during exposure. The cassette may be rigid or flexible and may contain radiographic screens, filter screens, both, or neither.

cast structure: Internal physical micro- or macro-structure of a casting evidenced by shape, orientation of grains, and segregation of impurities.
casting: In manufacturing, an object produced through the solidification of a molten material placed within a mold. See also foundry; parting line.
casting, centrifugal: Casting process where a mold (sand, plaster, or permanent) rotates while molten metal solidifies under the pressure developed by centrifugal force.
casting, continuous: Manufacturing method in which a billet, bloom, slab, or other shape is continuously solidified while being poured so that its length is not determined by mold dimensions. Also called strand casting.
casting, die: Casting process where molten metal is forced under high pressure into the cavity of a metal mold. Hot-chamber machines use a gooseneck immersed in a reservoir of molten material of low-melting-point (such as magnesium, zinc), while cold-chamber machines require higher-melting-point metals (such as aluminum) to be ladled into an unheated shot chamber. See also unit die.
casting, investment: Casting metal into a mold by surrounding (investing) an expendable pattern with a refractory slurry that sets at room temperature, after which the wax, plastic, or frozen mercury pattern is removed. Also called precision casting or lost wax process.
casting, sand: Casting process where molten metal is poured into an expendable mold made from one or more mesh sizes of sand and some combination of water, binders, and coatings. Cope (top) and drag (bottom) are sections of a two-part casting flask, which is a frame that contains the molding sand and that provides support as metal is poured. See also chaplet; core.
casting shrink: In nondestructive testing, internal rupture occurring in castings due to contraction during cooling, usually caused by variations in solidification rates in the mold. Includes sponge shrinkage, small voids (stringers or bunches), or a fingerprint pattern of semifused seams. Also applied to surface shrinkage cracks.
cathode: (1) Negatively charged terminal in an arrangement that produces current by chemical reactions. Compare anode (ASNT 1993). (2) In radiography, the negative electrode of an X-ray tube, the electrode from which electrons are emitted.
cathode ray: Stream of electrons emitted by a heated filament and projected in a more or less confined beam under the influence of a magnetic or electric field (ASNT 1991; TO33B-1-1).
cavitation erosion: Loss of material due to the repeated formation and collapse of bubbles at the surface of an object in contact with a rapidly flowing liquid. See also pitting.
cementite: A hard brittle compound of iron and carbon known chemically as iron carbide (Fe₃C) and found in steels and cast irons.
certification: With respect to nondestructive test personnel, the process of providing written testimony that an individual has met the qualification requirements of a specific practice or standard. See also qualification.
certified: With respect to nondestructive test personnel, having written testimony of qualification. See also qualified.
cesium 137: Radioactive isotope of element cesium, having a half-life of 30 years and photon energy of about 660 keV.
CGS system: Obsolete system of measurement units based on the centimeter, gram, and second. Compare SI.
chaplet: In manufacturing, metal support used to prevent core movement within a mold. Chaplets are available in a variety of shapes and sizes, and may be coated.
characteristic curve: For film, semi-logarithmic graphical representation of the relationship between optical density and the logarithm of relative exposure. Gamma value for a film is the maximum slope observed on the characteristic curve. Also called sensitometric curve, hurter and driffield curve, H & D curve, or density curve. See also exposure factor.
charge-coupled device (CCD): Solid-state image sensor. CCDs are widely used in inspection systems. Compare image orthicon; vidicon tube.
chill: (1) Metal insert embedded in the surface of a sand mold or core or placed in a mold cavity to increase the cooling rate at that point. (2) Hard shell of an iron casting formed by rapid cooling and/or careful control of alloy chemistry. Chill depth may be evaluated using a wedge test.
Ci: See Curie.
circumferential: Direction around the perimeter of a cylindrical surface. Compare longitudinal; radial; transverse.
clean: Free from interfering solid or liquid contaminants on the test surface and within voids or discontinuities.
cleaning, chemical: Use of detergents, solvents, or vapors at carefully controlled temperatures, concentrations, pH, and contact times to remove contaminants from the surface and within discontinuities of a component.

cleaning, mechanical: Method of removing contaminants or material from a surface, through an accelerated stream of media. Media include glass beads, plastic particles, metallic shot or wire, natural products, and dry ice. Pressurized air, liquid, or a rotating wheel may propel the media stream. Acid etching is required if liquid penetrant testing will be performed after abrasive blasting. Compare peening.

cleavage fracture: See brittle crack propagation.

closing: In image processing, dilation followed by erosion. A single pixel by closing connects a broken feature separated by one pixel. See also dilation; erosion. Compare opening.

closure: Process by which a person cognitively completes patterns or shapes that are incompletely perceived.

CMOS: See complementary metal oxide semiconductor.

cobalt 60: Radioactive isotope of element cobalt, having half-life of 5.27 y and photon energies of 1.17 and 1.33 MeV.

code: Standard enacted or enforced as a law. Compare recommended practice; standard.

coefficients of the filter: Values in a mask that serves as a filter in image processing.

coefficient of thermal expansion (cte): Rate of expansion or contraction per unit length, volume, or area per degree of temperature change between specified lower- and upper-temperature limits.

coherent radiation: Degree of correlation between the phase and frequency of two-wave functions, or two points or times of a single-wave function.

cohesive scatter: One type of photon interaction with matter; deflection of a low-energy photon from its original direction with no energy transfer. Also called elastic, unmodified, rayleigh, or classical scatter. A photon may scatter, be absorbed, or not interact. See also X-ray diffraction. Compare copton scatter; pair production; photoelectric effect.

cold cathode ionization gauge: See ionization gauge.

cold shut: Casting discontinuity caused by two streams of semimolten metal coming together inside a mold but failing to fuse. Also called knit line. Compare misrun.

cold work: Permanent deformation due to external force on a metal processed below its recrystallization temperature. Compare hot working.

collimator: Device for restricting the size, shape, and direction of the irradiating beam, thereby limiting beam spread and its consequences.

compensator block: Shielding material added to the specimen in an effort to minimize the effect of dramatic thickness changes on the radiographic image. For example, a rectangular block with a cylindrical hole that accepts a cylindrical sample. See also barium clay.

complementary metal oxide semiconductor (CMOS): A style of digital circuit design and family of processes that are used to manufacture that circuitry onto integrated circuits. CMOS circuits are used in digital detector arrays. Compare image orthicon; vidicon.

complete testing: Testing of an entire production lot in a prescribed manner. Sometimes complete testing entails the inspection of only the critical regions of a part. One-hundred percent testing requires the inspection of the entire part by prescribed methods. Compare sampling.

composite materials: Engineered materials formed through layering of physical elements aimed at specific mechanical and chemical performance criteria. Often fiber material in a material matrix such as carbon or graphite fibers embedded in a polymer matrix. See carbon fiber reinforced plastic.

compton scatter: One type of photon interaction with matter; photon energy is incoherently transferred to a forward-scattered electron, and photon energy loss is related to deflection angle. Also called compton effect. A photon may scatter, be absorbed, or not interact. Compare coherent scatter; pair production; photoelectric effect.

computed radiography: Two-step radiographic testing imaging process: a flexible imaging plate containing a photostimulable luminescent storage phosphor is first exposed to ionizing radiation, and then the stored luminescence in the plate is detected and digitized. The plate is generally read with a visible light laser. Also called storage phosphor imaging; digital storage phosphor imaging; digital luminescence radiography; photostimulated luminescence technique. See also laser scanner; radiography. Compare digital radiography.
computed tomography (CT): Radioscopic inspection technique by which computer analysis of the radiation passing through an object at many orientations (projections) about the object is used to construct virtual two-dimensional slices or three-dimensional representations of a component. Three-dimensional data uses volumetric picture elements (voxel), rather than their two-dimensional counterpart (pixel). See also radiography; projections.

confidence level: Level of assurance for detecting a specified discontinuity size with a specified probability. See also probability of detection.

corrosion: Deterioration of a metal by chemical or electrochemical reaction with its environment. The process occurs when current flows between cathodic and anodic areas, which one conductor corrodes preferentially to another when both are in electrical contact in the presence of an electrolyte. The process occurs when one conductor corrodes preferentially to another when both are in electrical contact in the presence of an electrolyte. The process occurs when the combination of film contrast and subject contrast generally equates to better indication visibility.

corrosion, exfoliation: Severe type of intergranular corrosion that progresses parallel to the outer surface of the metal along grain boundaries oriented in the rolling direction, causing layers of the metal to be elevated by the formation of corrosion product. Usually associated with aluminum.

corrosion fatigue: Fatigue cracking caused by repeated load applications on metal in a corrosive environment.

corrosion, frettin: Wear caused by repeated small relative movements between mating surfaces. Transferred material and freshly exposed surfaces quickly corrode, often forming a product harder than the parent material, thus increasing the wear rate. Also called friction oxidation; wear oxidation. See also wear; fretting.

corrosion, galvanic: Electrochemical process in which one conductor corrodes preferentially to another when both are in electrical contact in the presence of an electrolyte. The process occurs when current flows between cathodic and anodic areas on the two conductors.

corrosion, general: Chemical or electrochemical attack that proceeds uniformly over the entire surface, or over a large area. Also called uniform corrosion.

corrosion, intergranular: Electrochemical process that occurs preferentially at the junction between crystals in a polycrystalline material. One example of intergranular corrosion is called sensitization of stainless steel, where the formation of chromium carbides leaves chromium-depleted grain boundaries that are more reactive. See also corrosion, exfoliation.

corrosion, poulite: Form of crevice corrosion that occurs under a layer of foreign material (for example, under mud in automobile rocker panels).

couls (C): SI unit for electric charge, replaces faraday and ampere hour, where 1 A/h = 3600 C. X-ray or gamma ray intensity is measured in coulomb per kilogram (C/kg).

coupons: Piece of material from which a test object is prepared, often an extra piece, as on a casting or forging (ASNT 1985).
crack: (1) Stress-induced break, fissure, or rupture, sometimes V-shaped in cross section and relatively narrow. By convention, a crack is called linear if it is at least three times longer than it is wide. (2) Propagating discontinuity caused by fatigue, corrosion, or stresses such as heat-treating or grinding. May be difficult to detect unaided because of fineness of line and pattern (may have a radial or latticed appearance). Compare fracture.

crack, cold: (1) Discontinuity that forms near room temperature while a casting cools due to stresses caused during nonuniform cooling. (2) Discontinuity that may form in a weld either as it cools or later, if stress, hydrogen contamination, and microstructural conditions allow.

crack, crater: Multisegment crack in a weld crater. Segments radiate from a common point, often called star cracks.

crack, fatigue: Crack that develops from the weakening of a material due to repeated load cycling. See fatigue crack propagation.

crack, forging: Stress-induced discontinuity formed during mechanical shaping of metal. See crack; discontinuity, primary processing. Compare burst.

crack, grinding: Shallow discontinuity formed in the surface of relatively hard materials because of excessive grinding heat or the brittleness of the material. Grinding cracks typically are oriented perpendicular (90° rotation) to the direction of the grinding wheel. See also heat checking.

crack, hot: (1) Discontinuity formed in a weldment caused by the segregation at grain boundaries of low melting constituents in the weld puddle. (2) Postsolidification casting discontinuity caused by internal stresses.

crack, underbead: Discontinuity formed wholly subsurface within the heat-affected zone of a weld after the joint has cooled.

crater: (1) In machining, depression in cutting tool face eroded by chip contact. (2) In arc- or gas-fusion welding, cavity in the weld bead surface, typically occurring when heat source is removed and insufficient filler metal is available to fill the cavity. See also crack, crater.

creep: Gradual and permanent change in dimensions of a solid body subjected to constant load at a stress level below the material’s yield strength. Creep often occurs at elevated temperature.

crush: In sand casting, discontinuity caused by displacement of the mold sand before molten metal was poured.

curie (Ci): Disused unit for measurement of the quantity of radioactivity, corresponding originally to radiation from atomic disintegrations from 1 g of radium; replaced by becquerel (Bq) in SI, where 1 Ci = 3.7 × 10¹⁰ Bq.

decay curve: In radiographic testing, graph showing activity as a function of time for an isotope. Decay curves are used in determining exposure times.

defect: Discontinuity whose size, shape, orientation, or location (1) makes it detrimental to the useful service of its host object or (2) exceeds an accept/reject criterion of an applicable specification. Some discontinuities do not exceed an accept/reject criterion and are therefore not defects. Compare crack; discontinuity; indication. See also flaw.

definition: Detail sharpness of an object outline in a radiographic image. See resolution; geometric unsharpness; inherent unsharpness; total unsharpness.

definition: Change in dimensions, due to stress or strain. Deformation may be completely reversible (elastic deformation) or permanent (plastic deformation). See also creep.

delamination: Planar discontinuity, generally an area of unbonded materials. As examples, a delamination may be encountered in wrought products such as plate or in composite laminate materials.

densitometer: In radiography, device used to quantify film density by directly measuring the amount of transmitted light.

density: (1) Material property of mass per unit volume. (2) In radiographic testing, degree of X-ray film darkness as a result of exposure as measured with a densitometer.

depth of field: See depth of focus.

depth of focus: The region in front of and behind the distance within which objects still may be sharply resolved. In a fixed-focus system, this parameter is sometimes called depth of field.

depth of fusion: Depth to which base metal has melted during welding (ASNT 1999).

detail: See resolution.
**developer**: In film radiography, a chemical solution that reduces exposed silver halide crystals to metallic silver.

**diaphragm**: Shielding material with a cutout or opening aperture for penetrating radiation to pass through. The opening in the diaphragm material forms a particular radiation beam size or beam pattern. See *collimator*.

**diffraction**: Special case of scatter, where coherently scattered photons or particles undergo constructive or destructive interference, which creates peak patterns indicative of the atomic structure of the scattering medium. Diffraction for the study of materials and structures may use X-rays, neutrons, or electrons. See also *Bragg's law*.

**diffusion**: Process by which molecules intermingle as a result of concentration gradients or thermal motion.

**digital**: In signals or test data, information stored as a number or series of numbers. See also *analog-to-digital converter*. Compare analog signal.

**digital detector array (DDA)**: Radioscopic device that converts ionizing radiation into analog signals, which are then digitized and transferred to a computer for display. The number of incident photons to each pixel of the array are directly related to grayscale level in the resultant image. Arrays may be linear or two-dimensional, and may directly detect photons of ionizing radiation (such as *amorphous selenium*), or may indirectly detect these photons through the use of an intermediary phosphorescent material (such as *amorphous silicon*). Array panels may connect to a computer wirelessly, or be connected with wires. Compare *image intensifier*; *photostimulable phosphor*.

**digital image**: A two-dimensional digital representation of a field of view. This field of view may be a reproduction of a two-dimensional object or scene, three-dimensional information projected into two dimensions, or plane from a three-dimensional volume.

**digital radiography**: Technique in which gamma rays, X-rays, or neutrons are used to produce a digital image on a video or screen display through the use of a rigid digital detector array, as opposed to developing a latent image on a film or photostimulable phosphor screen through secondary processes. Compare *computed radiography*.

**dilation**: In image processing, one of the two fundamental operators of morphological image processing for binary images where the pixel in the output image is a 1 if any of the closest neighbors around the structuring element is a 1 in the input image. See also *closing*; *erosion*; *opening*.

**direct current (DC)**: Electricity that flows continuously in one direction through a conductor. The only true source of direct current is a battery, although some rectified power waveforms may resemble direct current. Compare *alternating current*.

**discontinuity**: Interruption in the physical structure or configuration of a test object. After nondestructive testing, a discontinuity indication may be interpreted as a defect (Lovejoy 1993). Compare *defect*; *indication*.

**discontinuity, artificial**: Reference anomaly such as hole, indentation, inclusion, crack, groove, or notch introduced into a reference standard to provide accurately reproducible indications for determining test sensitivity levels.

**discontinuity, inherent**: Discontinuity produced in the material at the time it is formed. For example, during solidification from the molten state.

**discontinuity, primary processing**: Discontinuity produced from the hot or cold working of an ingot into forgings, rods, bars, and other shapes (EPRI, n.d.).

**discontinuity, secondary processing**: Discontinuity produced during machining, grinding, heat treating, plating, or other finishing operations (EPRI, n.d.).

**discontinuity, service-induced**: Discontinuity caused by the intended use of the part.

**dose rate**: In radiographic testing, ionizing radiation delivered per a specified unit of time and measured, for instance, in sievert per minute (or in rem per hour). See also *absorbed dose*; *dose equivalent*; dosimeter; exposure; radiation absorbed dose.

**dosimeter**: Device that measures exposure to, or dose rate of, ionizing radiation. Common dosimeter types include the film badge, quartz fiber dosimeter (such as a pocket dosimeter), survey meter, and the electronic personal dosimeter.

**drag**: See *casting*, *sand*.

**drop**: Discontinuity in a sand casting due to a portion of the mold sand moving, or falling from the cope or overhanging section.

**dross**: Refuse byproduct comprised of low-melting-point nonferrous material and liquid nonmetallic components created during air exposure during smelting, refining, casting, and welding operations. Dross is the typical term used when working with nonferrous alloys. Compare *slag*.
ductile crack propagation: Slow crack propagation that is accompanied by noticeable plastic deformation and that requires energy to be supplied from outside the body. See also fatigue crack propagation. Compare brittle crack propagation.

dynamic range: The range of possible values a signal or digital image element can have for a piece of equipment or system. Mathematically, it is the difference between maximum and minimum possible signal values divided by the minimum measurable increment.

E
effective focal spot: Apparent dimensions of an X-ray target due to anode geometry, and relative position of the X-ray exit window.

elastic deformation: Temporary change in shape linearly proportional to the amount of applied force. Elastically deformed material returns to its original size and shape after the load is removed. Elastic deformation is the state in which most components are used in service. Compare creep; modulus of elasticity; plastic deformation.

elasticity: Ability of a material to regain its former shape after removal of applied stress.

electric field: Vector field of either the electric field intensity (V/m²) or the electric flux density (C/m²).

electron: Stable elementary particle with a negative charge that orbits the nucleus of an atom.

electron diffraction: Study of the structure of crystalline materials through the use of electrons. See also diffraction.

electronvolt (eV): Kinetic energy acquired by an electron in passing through a potential difference of 1 V in vacuum; 1 eV = ~1.60 J. The electronvolt is commonly used to express the energy of gamma rays and X-rays.

element: Chemical substance distinguished by the number of protons in the nuclei of its atoms, and unable to be further broken down into simpler substances.

enrichment (enriched isotope): An element that contains one or more isotopes that are at a higher concentration or abundance than normally occurs in nature. For example, natural iridium contains 37% of the natural isotope iridium 191, whereas the enriched iridium that is used to make small-focal gamma radiography sources may contain 80% enriched iridium 191. Ytterbium 169 and selenium 75 gamma radiography sources are also made using highly enriched isotopes of ytterbium 168 and selenium 74.

equivalent dose: Calculated quantity used in the ICRP system of radiological protection representing the statistical likelihood of health effects due to human exposure to of low levels of ionizing radiation. It is derived from the physical quantity absorbed dose, but also takes into account the biological effectiveness of the radiation, which is dependent on the radiation type and intensity. See also absorbed dose; dose rate; dosimeter; exposure; radiation absorbed dose.

erg: CGS unit of energy and work equal to 10⁻⁷ joules or J.

erosion: (1) Loss of material or degradation of surface quality through friction or abrasion by moving fluids, made worse by solid particles in those fluids or by cavitation in the moving fluid. (2) In morphological image processing, one of the two fundamental operators for binary images where the pixel in the output image is a 1 if all of the closest neighbors around the structuring element is a 1 in the input image, or a 0 if any of the neighbors is a 0. See also closing, dilation; opening.

eV: See electronvolt.

evaluation: Process of determining the magnitude and significance of a discontinuity after the indication has been interpreted as relevant. Evaluation determines if the test object should be rejected, repaired, or accepted. See indication; interpretation (ASNT 1999; ASNT 1989, ASNT 1991).

exposure: Amount of radiation traveling through the air. Many radiation monitors measure exposure, which is measured in units of roentgen (R) and coulomb per kilogram (C/kg). See also shielding.

exposure factor: In X-radiography, the quantity that combines source strength, time (usually minutes), and source-to-film distance. It is the product of milliamperage and time, divided by distance squared, and determines the degree of film density. See also characteristic curve.

F
false brinelling: Bearing damage caused by fretting, similar to brinelling but caused by a different mechanism. See wear, fretting. Compare brinelling.

fahrenheit: Disused scale for temperature (T) based on 32 °F as the freezing point of water and 212 °F as the boiling point of water at standard atmospheric pressure; a relative scale related to the rankine scale [0 °F = 459.67 °R; 1 °F ΔT = 1 °R ΔT].
fatigue crack propagation: Initiation and progressive growth of a discontinuity under repeated stress cycles. The phenomenon leading to fracture under repeated or fluctuating stresses having a maximum value less than the tensile strength of the material. See also ductile crack propagation. Compare brittle crack propagation.

feature extraction: From an enhanced image, derivation of some feature values, usually parameters for distinguishing objects in the image (ASNT 1993).

ferrite: Solid solution of iron with a limited amount of carbon, which has a body-centered cubic structure stable below 910 °C (1670 °F). Also called alpha iron.

field: In video technology, one of two video picture components that together make a frame. Each picture is divided into two parts called fields, because a frame at the rate of 30 frames per second in a standard video output would otherwise produce a flicker discernible to the eye. Each field contains one-half of the total picture elements. Two fields are required to produce one complete picture or frame so the field frequency is 60 fields per second and the frame frequency is 30 frames per second (ASNT 1993).

field of view: Range or area that can be seen through an imaging system, lens, or aperture (ASNT 1993). Compare depth of field.

film badge: Package containing a flexible radiation-sensitive emulsion worn to record and measure the change in optical density due to absorbed dose of ionizing radiation.

film emulsion: A gelatin colloid layer containing light-sensitive silver halide grains spread on a substrate, usually flexible.

film speed: Exposure factor required to attain a specified optical density in a flexible radiation-sensitive emulsion.

film undercut: See undercut, film.

filter: (1) In radiography, a thin layer of material placed between the source of ionizing radiation and the specimen to preferentially absorb lower-energy wavelengths. (2) Electrical circuit or physical device that leaves a signal unaffected over a prescribed range of frequencies and attenuates signal components at all other frequencies. Common filter types include neutral density, low pass, band pass, and high pass. (3) Software process for altering digital files and used for image enhancement.

filtering: Act of using a filter. See filter.

finite element analysis; finite element modeling (FEA; FEM): Numerical modeling technique for the analysis of a continuous system, whereby that system is decomposed into a collection of finite-sized elements. See also model, analytical.

fit up: In manufacturing, to secure one or more joint members into proper position with special external fixturing in order to prevent movement during welding.

fixing: Procedure used in radiographic film processing that removes undeveloped silver salts in the emulsion from the surface of the film, leaving only the developed black silver of the image on the film. See film emulsion.

flakes: Short discontinuous internal fissures in ferrous metals attributed to stresses produced by localized transformation and/or decreased solubility of hydrogen during cooling, usually after hot working. Flakes appear as bright silvery areas (fish eyes) on an otherwise ductile fracture surface. Flakes appear as short, discontinuous cracks on a polished and etched cross section.

flammability: Tendency to combust; considered to be characteristic of liquids having flash point below 60 °C (140 °F) and a vapor pressure not exceeding 275 kPa (40 lb, × in.–2) at 37.8 °C (100 °F).

flaw: See defect.

fluence: Time integrated flux or intensity of a radiation beam, usually expressed as photons/cm² or neutrons/cm².

fluoroscopy: Radiographic testing method where the penetrating radiation is viewed directly on a phosphor screen by the inspector at the time of exposure. Fluoroscopy is no longer advocated or allowed for safety reasons.

focal spot: Area on an X-ray tube anode target that receives bombardment of electrons. In the case of gamma radiography sources, the focal spot is the maximum dimension of the radioactive material inside the source. If it is a cylindrical shape, the focal spot is the diagonal of the cylinder; if it is a spherical shape, it is the diameter of the sphere. Compare effective focal spot.

focus: Position of a viewed object and a lens system relative to one another to offer a distinct image of the object as seen through the lens system. See accommodation and depth of field (ASNT 1993).

fog: Increase in film density caused by sources other than from the intended primary beam exposure. Heat, humidity, pressure, and scatter radiation can all cause fogging of the film.
foil: Very thin rolled metal product, generally with a thickness less than 0.13 mm, and width less than 610 mm.

footlambert (fl): Disused unit of luminance, where 1 fl = 3.426 cd/m².

foreign materials: Exogenous inclusion that may be more or less dense than the desirable material. In castings these may be sand, slag, oxide, or dross. In radiographic film, foreign materials may appear as isolated, irregular, or elongated variations of film density not corresponding to variations in thickness of material or to cavities.

foundry: Location where metal castings are produced through one or more casting processes.

fovea centralis: A small pit in the macula lutea that contains the largest concentration of cone cells in the eye and is responsible for central, high-resolution vision.

fracture: Break, rupture, or crack large enough to cause a full or partial separation.

fracture mechanics: Field of solid mechanics that deals with behavior of cracked bodies subjected to stress and strain.

frame: Complete raster scan or bitmapped image projected on a video screen. There may be 24, 25, or 30 frames per second, depending on the video standard used. See also field.

frequency (f, ν): Number of times per second that a cyclical waveform repeats. The unit of frequency is hertz (Hz).

gouge: Surface indentation caused by forceful abrasion, impact, or flame-cutting. Also called nick. Compare tool mark (ASNT 1993).

gradient: Average slope of characteristic curve between two specified film density values; for example, the highest and lowest density values. Gamma value is the maximum slope observed.

graininess: Subjective impression of an X-ray film’s image irregularity that is due to clumping together of the small silver grains into masses visible to the naked eye or with slight magnification. See also noise. Compare mottle.

grains: (1) Solid particle of metallic silver or silver halide held within the emulsion of a film. (2) Individual crystal in a polycrystalline material. See also grain boundary.

grain boundary: Interface that forms between grains of solidifying metal as the randomly oriented crystal lattices meet.

gray (Gy): SI unit for the amount of energy imparted due to ionizing photons interacting with any medium (such as water, tissue, and air). 1 Gy = 1 J/kg = 100 rad. Replaces radiation absorbed dose (rad). See also absorbed dose; dose equivalent; dose rate; dosimeter; exposure.

gray level: Integer number representing the brightness or darkness of a pixel or, as a composite value, of an image composed of pixels (ASNT 1993).

guide tube: Flexible tube connected to isotope radiographic source that allows the source to be moved in and out of the camera to the exposure location. See also control cable; pigtail; pill.

Gy: See gray.
halation: Spreading of light around a bright image due to reflections at boundaries that contribute to image blur. Typical boundaries for film include film emulsion, film base, intensifying radiographic screens, and cassette surfaces. Single-emulsion films may incorporate an anti-halation light-absorbing layer coated onto the opposite side of the base.

half-life, biological: The time required for one-half of ingested radioactive material to be passed from the body as waste.

half-life, effective: A combination of the radioactive half-life and biological half-life, or the time required for one-half of ingested radioactive material to be reduced to 50% as a result of the combination of radioactive decay and biological elimination.

half-life, radioactive: The time required for one-half of a given number of radioactive atoms to disintegrate or decay.

half-value layer: The thickness of an absorbing material required to reduce the intensity of a beam of incident radiation to one-half of its original intensity. See also absorption coefficient.

halide: Compound of two or more elements, one of which is a halogen.

halogen: Any of the nonmetallic elements—fluorine, chlorine, bromine, and iodine—or any gaseous chemical component containing one or more of these elements.

hardness: In materials science, the resistance of a material to deformation, scratching, abrasion, or cutting.

heat-affected zone (HAZ): Base material of a metal or thermoplastic not melted, but still altered, due to a process of high heat input. Example processes are cutting or welding.

heat checking: Surface cracking caused when metal rapidly heated (or cooled and heated repeatedly) is prevented from expanding freely by colder metal below the surface. Example heat inputs could be a grinding operation, or molten metal into a die-casting die. Sometimes called thermal fatigue. See also crack, grinding.

heat treatment: Heating and cooling a metal or alloy in such a way as to obtain desired conditions or properties. Heating for the sole purpose of hot working is excluded from the meaning of this definition.

histogram: a plot of the frequency or number of elements for each different numerical value for a digital image.

hot tear: Crack formed in a cast metal during solidification and due to excessive tensile stress associated with hindered contraction during volumetric shrinkage. Hot tears often occur where areas of different thicknesses adjoin.

hot working: Permanent deformation due to external force on a metal processed above its recrystallization temperature. Compare cold working.

human factors: The mental and physical makeup of the individual, the individual's training and experience, and the conditions under which the individual must operate that influence the ability of the nondestructive testing system to achieve its intended purpose. The human factor is one of the principal elements affecting the reliability of nondestructive tests. See also psychophysics; vigilance decrement.

hundred-percent testing: See complete testing.

icicles: Excessive penetration of a weld into the inside of a component such that gravity causes protruding spikes of filler metal to form.

ICRP: International Commission on Radiological Protection.

image: Representation of a test object or scene. In nondestructive testing, the image may be created by various physical principles.

image enhancement: Any of a variety of image-processing steps, used singly or in combination to improve the detectability of objects in an image.

image intensifier: Device that converts incident ionizing radiation photons into a real-time display of radioscopic data. Incident photons enter the image intensifier tube and are transformed by an input phosphor screen into light; the photons of light strike a photocathode and cause it to emit electrons; these electrons are then accelerated towards an output phosphor through a combination of electric field and focusing lenses; a video camera is focused on the output phosphor and sends its information to a display screen. See also radioscopy; scintillation.

image orthicon: Prior to the introduction of CCD- and CMOS-based devices, a television tube that used the photoemission method. Compare charge-coupled device; vidicon tube.
**image processing**: Actions applied singly or in combination to an image; in particular the measurement and alteration of image features by computer. Also called picture processing. See also image enhancement; neural network.

**image quality indicator (IQI)**: (1) In radiographic testing, strip of material of the same composition as that of the material being tested, representing a percentage of object thickness and provided with a combination of steps, holes, or slots or alternatively made as a series of wires. When placed in the path of X-rays, its image provides a check on the radiographic technique. Three IQI types are common: wire, step hole, and plaque hole. (2) In neutron radiography, IQIs are constructed of particular materials, shapes, and sizes such that their image provides a measure of the quality of the neutron radiography beam. See also penetratometer.

**image segmentation**: In image processing, technique in which the image is partitioned into regions, each homogeneous.

**impregnation**: (1) Treatment of porous castings with a sealing medium to stop pressure leaks. (2) The process of filling the pores of a sintered compact. (3) The process of mixing particles of a nonmetallic substance in a matrix of metal powder (ASNT 1985).

**impurity**: Element or compound whose presence in a material is unintentional or unwanted.

**in control**: Of a measureable feature of interest, stable between the upper and lower bounds as plotted on a control chart. See also statistical process control.

**incident radiation**: Beam of ionizing photons first reaching a surface or sample.

**inclusion**: Particles composed of elements not soluble in the host matrix, which may offer benefits or decrease properties, depending on type and concentration. Endogenous inclusions form due to reactions with the molten metal (such as oxides, sulfides, silicates), while exogenous inclusions come from elsewhere (such as slag, welding rod, or refractory). Inclusions may be beneficial (such as lead particles enhancing machinability of a steel), or may cause problems (such as sludge particles decreasing ductility of an aluminum die casting). See also tungsten inclusion.

**incomplete penetration**: See lack of penetration.

**index of refraction**: Ratio of photon velocity in a vacuum to phase velocity of the photon in a material or medium. For X-rays, the refractive index is very close to 1.0, so they tend to penetrate rather than altering direction.

**indication**: Nondestructive test response that requires interpretation to determine its relevance. Compare defect.

**indication, false**: (1) Test indication that could be interpreted as originating from a discontinuity, but that actually originates where no discontinuity exists in the test object. (2) Indication due to misapplied or improper testing.

**indication, nonrelevant**: Indication that has no relation to a discontinuity that might constitute a defect. Test response caused by geometry or by a physical condition that is not a discontinuity (a change of section, for instance).

**indication, relevant**: Indication from a discontinuity (as opposed to a false indication) requiring evaluation by a qualified inspector, typically with reference to an acceptance standard, by virtue of the discontinuity’s size or location.

**inherent unsharpness**: Lack of detail definition due to the pixel or particle grain size of the imaging detector system.

**interface**: Physical boundary between two adjacent media.

**interlaced scanning**: Process originally developed for cathode-ray tube technology, whereby the picture appearing on a video screen is divided into two parts. Interlaced scanning reduces flicker by increasing the electron beam's downward rate of travel so that every other line is sent. When the bottom is reached, the beam is returned to the top and the alternate lines are sent. The odd- and even-line scans are each transmitted at 1/60 s, totaling 1/30 s per frame and retaining the standard rate of 30 frames per second. The eye’s persistence of vision allows the odd and even lines to appear as a single image without flicker. Compare progressive scanning.

**interpretation**: Determination of the cause, significance, and relevance of test indications.

**inverse square law**: Physical law for a point source of energy. The quantity or strength is inversely proportional to the square of the distance from the origin.
ionizing radiation: Form of electromagnetic radiation that can remove tightly bound electrons from atoms and leave that atom with an altered electrical charge. Types include X-rays, gamma rays, particles such as electrons (beta particles), alpha particles, and the more energetic ultraviolet wavelengths. Neutrons are indirectly ionizing due to the potential for activation.

ionization gauge: High-vacuum gauge that depends on the measuring of electrical current resulting from ionization of gas. Examples include thermionic ionization gauges (bayard-alpert), cold cathode gauges (penning or philip), and alphatron gauges.

IQI: See image quality indicator.

iridium 192: Radioactive isotope of element iridium, having half-life of 73.83 days and principle photon energies between 296 keV and 612 keV.

irradiance: Total radiant power, in watts per square meter (W/m²), falling upon a known surface area at a given angle.

Ishihara™ plate: Trade name for a kind of pseudoisochromatic plate used for color differentiation vision testing.

isotope; isotopic: Radioactive source of gamma rays, or particles such as neutrons, beta particles, or alpha particles. See also cesium 137; cobalt 60; selenium 75; iridium 192; ytterbium 169.

jaeger eye chart: Eye chart used for near-vision acuity examination.

joint: Region where two joined parts meet. Examples include butt-, lap-, or tee-joints.

joint efficiency: Strength of a joint expressed as a percentage of the strength of the base material. As examples, strength may be related to welded, brazed, or riveted structures.

joint penetration: Amount of weld fusion within a joint. Welds are generally complete joint penetration (CJP), or partial joint penetration (PJP). See also lack of penetration.

lack of fusion: Discontinuity due to lack of union between weld metal and parent metal or between successive weld beads (ASNT 1999).

lack of penetration: In welding, root penetration that is less than desired, or failure of a root pass and a backing pass to fuse with each other. Also called incomplete penetration.

lamination: Planar discontinuity parallel to the surface caused when an ingot anomaly is deformed along with the product leaving a region where the upper and lower portions of the product are not completely fused. Lamination discontinuities may occur in plate, sheet, strip, or metal powder compacts.

land: see weld land.

lap: Surface-breaking discontinuity appearing as a fold or seam in a wrought product and caused by folding hot metal, and then rolling or forging it into the surface without full fusion. Forging laps and rolling laps are common examples, and such discontinuities may be filled with oxides that were present on the surfaces during their formation.

laser: Acronym (light amplification by stimulated emission of radiation). A device that produces a high-power monochromatic and coherent (spatial and temporal) beam of radiation.

latitude: The ability of a radiographic system to produce acceptable radiographs over a range of exposure (fluence), such as thickness variation.

level, acceptance: In contrast to rejection level, test level above or below which, depending on the test parameter, test objects are acceptable.

level, rejection: Value established for indication or test signal above or below which, depending on the test parameter, test objects are rejectable or otherwise distinguished from the remaining objections. See level, acceptance.

light: Electromagnetic radiation that can excite the retina and produce a visual sensation. The visible portion of the electromagnetic spectrum extends from 380 to 780 nm.

light metal: Low-density engineering metal or alloy, based on aluminum, magnesium, titanium, or beryllium.

limited certification: Of a person, certified only for specific operations; usually called Limited Level I or II or designated as having limited certification because he or she is not qualified to perform the full range of activities expected of personnel at that level of qualification, for a given method.

linear accelerator (LINAC): Source of high-energy and high-intensity X-ray beam produced as magnetically guided electrons traveling at nearly the speed of light impact the target anode. Linear accelerators generally operate in the million-electronvolt energy range, and may be portable or operated solely in a bunker.
line pair: Pair of adjacent, parallel lines used to evaluate the spatial resolution of a specific imaging system. Minimum line pair is a measure of system resolution and refers to the smallest distance that a specific imaging system can resolve between a line pair.

longitudinal: Direction parallel to the long axis of an object and perpendicular to its radius—for example, down the length of a cylinder. Compare circumferential; radial; transverse.

lost-wax process: See casting, investment.

Lot tolerance percent defective (LTPD): The poorest quality, in percent defective, individual lot that is acceptable in a sampling plan. LTPD is the percent defective that will be accepted by the sampling plan, at most 10% of the time. With such a plan, the producer agrees to supply just enough nonconforming product such that the consumer will accept the lot using the agreed to sampling plan and acceptable quality level. Compare acceptable quality level.

low pass filtering: In image processing, linear combination of pixel values to smooth abrupt transitions in a digital image. Also called smoothing.

luminance: Photometric brightness of a light source defined by the density of its luminous intensity, measured as luminous flux per unit solid angle per unit area in a given direction. Reported in candela per square meter (cd/m²).

M

machine vision: Automated system function of acquiring, processing, and analyzing images to evaluate a test object or to provide information or interpretation for human interpretation. A typical machine vision system consists of a light source, a video camera, a video digitizer, a computer, and an image display.

macroshrinkage: In a casting, voids with a dendritic (for instance, jagged) internal appearance that are caused by sections of the casting solidifying later than surrounding areas, which do not have enough molten metal to adequately fill them. Macrophrinkage can occur in the cope or drag, and can aid in the formation of a hot tear.

macula lutea: Oval, highly pigmented yellow spot near the center of the retina of the human eye. Diffuse ring of yellow pigment which partly overlaps the fovea and surrounds it out to around 10° and which absorbs blue light, thus changing the color of the light reaching receptors beneath. See also fovea centralis.

magnification: The ratio of apparent image size of an object viewed through an optical system to its actual size.

martensite: Generic term for a rapid diffusionless phase transformation that deforms the parent phase and may also change its volume. While common to many metals and alloys, martensite commonly refers to a hard metastable phase of steel.

mask: (1) A spatial filter in the sensing unit of a surface inspection system that ensures image quality. (2) An $n \times n$ square matrix with different values that serves as a filter in image processing. (3) In radiographic testing, a selective radiation filter. (4) In radiography, a cover with an aperture to view a specific area.

material safety data sheet (MSDS): Document that contains information relative to safety and health in handling and disposal of chemicals. Manufacturers of liquid penetrant materials are required to provide material safety data sheets to users in accordance with the OSHA Hazard Communication Standard.

mathematical morphology: Image processing technique most commonly used for digital images. The most common basic operators in mathematical morphology are dilation, erosion, opening, and closing.

measurement system: Entire system, from sensor to display inclusive (ASNT 1998).

mechanical properties: Properties of a material that reveal its elastic and inelastic behavior where force is applied, thereby indicating its suitability for mechanical applications. For example, modulus of elasticity, tensile strength, elongation, hardness, and fatigue limit (ASNT 1999).

metal penetration: In sand castings, surface discontinuity consisting of a mixture of sand and metal adhering to the rough exterior.

metallography: The study of the structure of metals and alloys by various methods, including optical and electron microscopy.

metallurgy: The science and technology of metals and their alloys. A metallurgist may focus on the mining and processing of ores into useful form (extractive metallurgy), focus on the physical or mechanical properties that vary with composition, thermal history, or environment (physical metallurgy), or focus on a material’s response to applied forces (mechanical metallurgy).

microporosity: Porosity visible only with aid of a microscope.
microscope: Instrument that provides enlarged images of small objects. There are many types of microscopes, only some of which are optical in nature. Some optical microscope types include binocular (stereo), confocal, inverted, and compound. Other types include acoustic microscopes and electron microscopes.

microsegregation: Localized differences in alloy composition that occur as rejected solute atoms are rejected by the growing dendrites. Unlike the larger-scale macrosegregation, a homogenizing heat treatment can significantly reduce microsegregation through solute diffusion. Also called coring if occurring between equiaxed grains.

microshrinkage: In castings with a wide solidification temperature range, interdendritic voids are only detectable during destructive metallography that are caused by contraction during solidification. As in the larger-scale shrinkage, this discontinuity occurs where there is not an adequate opportunity to supply filler material to compensate. See also riser.

misrun: Incomplete mold fill due to poor gating or pouring temperature. Compare cold shut.

MKSA: System of units, based on the meter, kilogram, second, and ampere, which was a precursor of the SI unit system.

model, analytical: Mathematical representation of a process or phenomenon by a set of solvable equations. See also finite element analysis.

modulation transfer function (MTF): A plot of the spatial resolution versus contrast for a digital imaging system.

modulus of elasticity: Measure of a material’s rigidity or stiffness, related to the slope of the stress-versus-strain curve within the linear elastic deformation range. Measured in megapascals (MPa). Also called Young’s modulus.

monochromatic: Of a single wavelength or color.

monochromator: Device that uses prisms or gratings to select and separate a single wavelength of the electromagnetic spectrum. A monochromator is often used to transmit a desired narrow band of light or energy. See also X-ray diffraction.

mottle: Nonuniform film density or image intensity where it should be uniform, caused by the process statistical variations, scattered radiation, secondary radiation, and detector irregularities. Mottling may resemble discontinuity indications (for example, casting shrinkage). It may be useful to reexamine using change of setup or exposure. See also noise. Compare graininess.

N

NDC: Nondestructive characterization.

NDE: (1) Nondestructive evaluation. (2) Nondestructive examination. See nondestructive testing.

NDI: Nondestructive inspection. See nondestructive testing.

NDT: See nondestructive testing.

near-surface discontinuity: Subsurface interruption in the physical structure or configuration of a test object that is close to, but not breaking, the test object’s surface. (This sense of near surface differs from that of methods that distinguish a test object’s near surface from its far surface.)

necking down: Localized reduction in area of a specimen or structural member during tensile deformation.

neural acuity: Ability of the eye and brain together to discriminate patterns from background. Discrimination is influenced by knowledge of the target pattern, by the scanning technique and by the figure-to-ground (figure-ground) relationship of a discontinuity. The figure-ground relationship can be described as having a level of visual pattern description from the background noise. Compare vision acuity.

neural network: Computational process for solving problems or performing tasks based loosely on the human brain’s structure of interconnected logic paths. It is common for a neural network to be fed a training set of data during supervised learning, and the relative weights and biases of various parameters may be adjusted, often through a mathematical process called backpropagation. Also called connectionist system.

neutron: Uncharged atomic particle with mass nearly equal to that of the proton.

neutron diffraction: Study of the atomic or magnetic structure of crystalline materials through the use of neutrons. See also diffraction.

neutron fluence: Neutron flux integrated over a period of time, usually expressed as n/cm².

neutron flux: The neutron beam intensity given in neutrons per unit area and time in the direction of the axis of the neutron beam, usually expressed as n/cm²/s. See also neutron fluence.

nick: See gouge. Compare tool mark.
**NIST:** Acronym for the National Institute of Standards and Technology (formerly National Bureau of Standards), US Department of Commerce, Gaithersburg, Maryland.

**NIST traceability:** Property of the result of a measurement, or the value of a standard; instruments, calibration reports, and laboratories are not traceable. Traceability can be related to stated references or standards, through an unbroken chain of comparisons all having stated uncertainties.

**noise:** Undesired signal providing nonrelevant information, and interfering with detection or processing of a desired signal. See also graining; mottle.

**nondestructive characterization (NDC):** Branch of nondestructive testing concerned with the description and prediction of material properties and behaviors of components and systems.

**nondestructive evaluation (NDE):** Another term for nondestructive testing. In research and academic communities, the word examination is often preferred because it emphasizes interpretation by knowledgeable personnel.

**nondestructive examination (NDE):** Another term for nondestructive testing. In the utilities and nuclear industry, examination is sometimes preferred because testing can imply performance trials of pressure containment or power generation systems.

**nondestructive inspection (NDI):** Another term for nondestructive testing. In some industries (utilities, aviation), the word inspection often implies maintenance for a component that has been in service.

**nondestructive testing (NDT):** Determination of the physical condition of an object without affecting that object’s ability to fulfill its intended function. Nondestructive test methods typically use an appropriate form of energy to determine material properties or to indicate the presence of material discontinuities (surface, internal, or concealed). Sometimes called nondestructive evaluation, nondestructive examination, or nondestructive inspection.

**nonrelevant indication:** See indication, nonrelevant.

**nuclear spallation source:** High-powered accelerator that generates neutrons through the impact of protons with a target material such as tantalum, tungsten, lead, or mercury.

**numerical analysis:** Area of mathematics and computer science that develops, studies, and utilizes algorithms for solving real-world problems that may be described by continuous mathematics.

**oil country tubular goods (OCTG):** Hollow cylindrical components, such as pipes, used in petroleum wells to case the hole and to convey petroleum and related products. See also casing.

**one hundred percent testing:** See complete testing.

**opening:** In image processing, the operation of erosion followed by dilation. A single opening eliminates isolated single pixels. Compare closing.

**organoleptic:** Using the sense organs to evaluate taste, color, odor, and/or feel.

**orientation:** Angular relationship of a surface, plane, discontinuity, or axis to a reference plane or surface (ASNT 1991; ASNT 1996).

**outside agency:** Company or individual providing NDT Level III services as required by specification or purchase order, and whose qualifications have been reviewed by the recipient of these services.

**overheating:** Excessive temperature exposure of a metal or alloy to the point where properties are degraded and are unable to be recovered by any combination of heat treatment or mechanical working. May be called burning.

**pair production:** One type of photon interaction with matter; formation of two charged particles due to complete absorption of a high-energy photon by a nucleus. The photon’s energy is converted into an elementary particle, its antiparticle, and their kinetic energy. A photon may scatter, be absorbed, or not interact. Compare coherent scatter; compton scatter, photoelectric effect.

**parallax:** The apparent change in position of an object due to change in the position from which it is viewed. Also called parallax error.

**parting line:** In manufacturing, mark left on a die casting where the die halves meet. Also, the surface between the cover and ejector portions of the die.

**pascal (Pa):** An SI derived unit of pressure, stress, modulus of elasticity and tensile strength. Pressure is force per unit area, and a pascal is defined as one newton per square meter.
pass: In welding, a single bead of weld metal along the entire joint or the process of laying down that bead. See also weld, multi-pass.

pearlite: Most often, a lamellar structure of cementite and ferrite in some steels and cast irons; sometimes, a lamellar alpha and beta structure in nonferrous alloys.

peening: Mechanically working a surface to induce a compressive residual stress through the use of impacting metallic shot, hammer blows, or laser pulses. Compare cleaning, mechanical; plastic deformation.

penetrameter: Uniform thickness plaque with three through-thickness holes whose diameters are 1\(\times\), 2\(\times\), and 4\(\times\) the plaque thickness. Penetrameter plaques are identified by a number between 5 and 200, which is plaque thickness in thousandths of an inch. See also image quality indicator.

penning gauge: See cold cathode ionization gauge.

peripheral vision: Seeing of objects displaced from the primary line of sight and outside the central visual field. Compare photopic vision.

phase: (1) A circuit conductor carrying alternating current of a given frequency, as in one-phase or three-phase power. (2) Point on a 360-degree harmonic power waveform. (3) In metallurgy, a physically homogeneous portion of a material system, specifically the portion of an alloy characterized by its microstructure at a particular temperature during melting or solidification.

phase diagram: In materials science, graph showing the temperature and composition limits of phase fields in a material system under specific heating or cooling conditions.

phillips discharge gauge: See cold cathode ionization gauge.

photoconduction: Method by which a vidicon television camera tube produces an electrical image in which a photosensitive surface emits electrons when light reflected from a viewed object is focused on the surface. Compare photoemission.

photometer: Device used to measure luminance or illuminance. Illuminance photometers are often called lux meters. Photometer sensors are filtered such that their responsivity closely matches the spectral responsivity curve of the human eye. Compare radiometer.

photometric brightness: See luminance.

photometry: Study and measurement of electromagnetic radiation with approximate wavelengths between 380 and 780 nm, which are within the human eye’s spectral responsivity. See also photometer; photopic vision. Compare radiometry.

photon: Particle of light, hypothesized to explain those behaviors of light in which its behavior is corpuscular (such as little particles), rather than wavelike.

photopic vision: Average spectral responsivity curve of the human eye when adapted to well-lit conditions (greater than 0.034 cd/m\(^2\)). The photopic spectral luminous efficiency response curve is governed by an averaged retinal cone response with sensitivity peaks centered at about 555 nm. Also known as foveal vision and light adapted vision. Compare peripheral vision.

photoreceptor: Light sensor. See also charge-coupled device (CCD); complementary metal oxide semiconductor; photopic vision.

photostimulable phosphor: In computed radiography, radiographic sensor material utilized in a reusable imaging plate that acquires and stores two-dimensional data until it may be read and digitized. The process by which light is released from the phosphor due to interaction with a laser is also called photostimulated luminescence. See also laser scanner. Compare digital detector array; image intensifier.

physical properties: Nonmechanical properties such as density, electrical conductivity, heat conductivity, and thermal expansion (ASNT 1999).

picture element: See pixel.

pigtail: In gamma radiography, flexible cable to which an isotope-bearing capsule may be attached for movement in and out of a shielding container. See also control cable; guide tube; pill.
pilil: In gamma radiography, capsule containing isotopic source of radiation. See also control cable; guide tube; pigtail.

pipe: (1) Cast or wrought tubular product. (2) Longitudinal centerline discontinuity inherent in ingots or imparted to some rolled metal and consisting of a concavity or voids. May also be called worm holes.

pitting: Forming of small cavity discontinuities in a surface by corrosion, wear, or other degradation. See also cavitation erosion.

pixel: Single addressable point in a raster digital image. The image from a conventional computer is an array of pixels, and each has a numerical value. Formerly called picture element.

plastic deformation: Permanent distortion due to an applied stress above a material's elastic limit. See also peening; work hardening. Compare elastic deformation.

pores: (1) Small voids within a metal. See also porosity. (2) Minute cavities, sometimes intentional, in a powder metallurgy compact. (3) Minute perforations in an electroplated coating.

porosity: Discontinuity in a manufactured material resulting from the creation or coalescence of gas bubbles. Very small pores open to the surface are called pinholes. The internal surface of a pore is smooth. See voids. Compare shrinkage.

poultice corrosion: See corrosion, poultice.

pouring basin: Basin on top of a mold to receive the molten metal before it enters the sprue or downgate. Also called pouring box or cup.

practical examination: In certification of nondestructive testing personnel, a hands-on examination using test equipment and sample test objects. Compare general examination; specific examination.

primary radiation: Radiation emitting directly from the target of an X-ray tube or from a radioactive source. Compare secondary radiation.

probability of detection (PoD): The probability of finding an anomaly of given characteristics, under precise conditions, while using a specific test procedure. See also confidence level.

process: Repeatable sequence of actions to bring about a desired result.

process control: See statistical process control.

progressive scanning: Display method designed for liquid crystal displays and other new video technologies where each row of an image is refreshed in sequential order. This method is less prone to jaggedness or flicker and is better suited for viewing fine details. Compare interlaced scanning.

projection: In computed tomography, the radiographic attenuation data set taken at a particular view or orientation of the object. Computed tomography reconstructions are made from multiple projection data sets.

pseudocolor: Image-enhancement technique wherein colors are assigned to an image at several grayscale intervals.

pseudoisochromatic plate: Image used for color vision examinations. Each plate bears an image, which may be difficult for the examinee to see if his or her color vision is impaired. See also Ishihara™ plate.

psychophysics: Interaction between vision performance and physical or psychological factors. One example is the so-called vigilance decrement, the degradation of reliability based on performing visual activities over a period of time. See also human factors; vigilance decrement.

pupil: Black aperture in the center of the iris, through which light enters the lens to impinge on the retina.

qualification: Process of demonstrating that an individual has the required amount and the required type of training, experience, knowledge, and abilities. See also certification and qualified.

qualified: Having demonstrated the required amount and the required type of training, experience, knowledge, and abilities. See also certified and qualification.

quality: Ability of a process or product to meet specifications or expectations of its users in terms of efficiency, appearance, longevity, and ergonomics (ASNT 1993).

quality assurance: Administrative actions that specify, enforce, and verify quality.

quality control: Physical and administrative actions required to ensure compliance with a quality assurance program. Quality control may include nondestructive testing in the manufacturing cycle.
quality factor: Mathematical value used for converting absorbed dose to dose equivalent based on relative damage caused by a given type of ionizing radiation.

quantum mottle: Irregular density variation or noise in a radiograph due to the statistical fluctuations of the radiation. The variation is normally related to the square root of the integrated radiation intensity in the radiographic image. See mottle.

R
R: See roentgen.
rad: See radiation absorbed dose.
radial: Of, or pertaining to, direction from center of a circle (or a sphere or cross section of a cylindrical object) to its surface and perpendicular to its axis. A radial pattern appears to radiate from a point, like the spokes from the hub of a wheel. Compare circumferential; longitudinal; transverse.
radian: Angle equal to 180°/π or 57.29578°.
radiance: A measure of radiant flux density (per unit projected area) per unit solid angle. Radiance is independent of distance, is measured in watts per square meter steradian (W/m²/sr), and may describe emitted or received energy. Compare irradiance.
radiant energy: Total energy, in joules, of electromagnetic radiation emitted by a source. Radiant energy is determined by integrating radiant flux with respect to time.
radiant exitance: Radiant power per area, emitted or reflected from a certain location on a surface. Measured in watts per square meter (W/m²). In infrared and thermal testing, sometimes called radiosity.
radiant flux: Radiant energy’s rate of flow, measured in watts or joules per second (J/s). Compare luminous flux.
radiant intensity: Electromagnetic flux emitted per unit solid angle in a given direction from the source. Measured in watts per steradian (W/sr).
radiant power: See radiant flux.
radiation: The transfer of energy through propagation of electromagnetic waves. See radiant energy.
radiation absorbed dose (rad): Disused unit for the amount of energy imparted due to ionizing photons interacting with any medium (such as water, tissue, air). An absorbed dose of 1 rad means that 1 g of material absorbed 100 ergs of energy. The SI unit for absorbed dose is the gray (Gy), where 1 Gy is equivalent to 100 rad. See also absorbed dose; dose equivalent; dose rate; dosimeter; exposure.
radiation safety officer: Individual supervising program to provide radiation protection. The representative appointed by the licensee for liaison with the applicable regulatory agency.
radiograph: Image formed by the use of penetrating radiation.
radiographic screens: Thin sheets used to intensify the effect of radiation on films. The screens can be made of a fluorescent material or a metal such as lead. Metallic screens absorb secondary and scattered radiation, which helps to improve image quality. See also scintillation.
radiographic sensitivity: a general or qualitative term referring to the size of the smallest detail that can be seen on a radiograph.
radiographic testing (RT): Nondestructive testing method based on the use of penetrating radiation, such as X-rays, gamma rays, and neutrons, to provide images of a specimen. See also radiology.
radiography: (1) Radiographic testing process in which penetration radiation is used to produce an image using a radiographic sensor, either through transmission or backscatter techniques. (2) General collection of industrial radiographic testing techniques including, as examples, backscatter imaging, computed radiography, computed tomography, digital radiography, and film-based radiography.
radiology: (1) Science of imaging or analysis of test specimens through the use of ionizing radiation. (2) Branch of medicine that uses ionizing radiation for diagnosis and therapy.
radiology sensor: Device or material that changes with, and provides evidence of, contact with ionizing radiation. Examples include X-ray film, X-ray sensitive phosphors, and electronic devices such as digital detector arrays and photostimulable phosphor imaging plates.
radiometry: Study and measurement of electromagnetic radiation emitted by a source or falling upon a surface. Compare photometry.
**radioscopy**: Radiographic testing technique where penetrating radiation produces an image on a video display, and the frame rate of that display offers a fast update so that the specimen may be viewed during motion, in action, or from a multitude of orientations rapidly. Radiographic imagers in real-time radioscopy are generally image intensifiers, CCD cameras, or digital flat-panel detectors.

**raster**: Repetitive pattern whereby a directed element (a robotic arm or a flying dot on a video screen) follows the path of a series of adjacent parallel lines, taking them successively in turn, always in the same direction (from top to bottom or from left to right), stopping at the end of one line and beginning again at the start of the next line. Following a raster pattern makes it possible for electron beams to form analog video pictures or frames and for a sensor-bearing armature to cover a predetermined part of the surface of a test object (ASNT 1993).

**real time**: Live display of radioscopy data at a fast frame rate, or playback of video streams at a frame rate replicating the event originally recorded.

**real-time radiography**: See radioscopy.

**recommended practice**: Set of guidelines or recommendations. Compare code; standard.

**Recommended Practice No. SNT-TC-1A: Personnel Qualification and Certification in Nondestructive Testing**: Set of guidelines for employers to establish and conduct a nondestructive testing personnel qualification and certification program. SNT-TC-1A was first issued in 1968 by the Society for Nondestructive Testing (SNT, now ASNT) and has been revised every few years since.

**reference standard**: (1) In NDT, an object containing known artificial or natural discontinuities at known distances and used to establish a baseline for comparison and standardization of nondestructive test inspection equipment. (2) Standard, generally having the highest metrological quality available at a given location or in a given organization, from where which measurements made are derived. Compare acceptance standard; working standard.

**reinforcement of weld**: See weld reinforcement.

**rejection level**: See level, rejection.

**relevant indication**: See indication, relevant.

**rem**: See roentgen equivalent mammal.

**repeatability**: Ability to reproduce a result, for example a detectable indication, in separate identical repeats of a given inspection procedure.

**residual elements**: Elements that may unintentionally be present in a metallic alloy in small quantities, and often not analyzed or reported on a mill’s heat certificate. Also called unspecified elements; trace elements.

**resolution**: A system’s ability to show fine detail, separation between features in close proximity, or image contrast. Fine detail resolution, such as the separation between line pairs, is called spatial resolution. Ability to show differences in image intensity, or grayscale value, is called contrast resolution.

**riser**: Feeder reservoir of molten metal attached to a casting that helps prevent shrinkage cavities during solidification. See also blind riser.

**robotic system**: Automated system programmed to perform purposeful movements in variable sequences (ASNT 1993).

**roentgen (R)**: Disused unit for measurement of ionizing radiation intensity; amount of ionizing radiation that will generate one electrostatic unit in 1 cm³ of dry air at standard atmospheric conditions. The roentgen has been replaced by an SI compound unit, coulomb per kilogram (C/kg). 1 C/kg = 3876 R.

**roentgen equivalent mammal (rem)**: Unit of absorbed dose of radiation in biological matter. It is equal to the absorbed dose in rads multiplied by the dose equivalent of the radiation. See sievert.

**RT**: See radiographic testing.

**sampling, partial**: Testing of less than 100% of a production lot. Compare complete testing.

**sampling, random partial**: Partial sampling that is fully random.

**sampling, specified partial**: Partial sampling in which a particular frequency or a sequence of sample selection is prescribed. An example of specified partial sampling is the testing of every fifth unit.

**saturation**: Signal amplitude at or above sensor’s maximum capability.

**scalar quantity**: Quantity completely specified by a single number and unit. Example scalar quantities include mass, charge, temperature, electric potential at a point inside a medium, and the distance between two points in three-dimensional space. Compare vector quantity.

**scanning**: Movement of a sensor over the surface of a test object in a controlled manner so as to achieve complete coverage.
**scan position accuracy:** For a line scanner, the precision with which instantaneous position along the scan line can be set or measured.

**Small Controlled Area Radiography (SCAR):** The process of carrying out radiography within a small radiological safety zone to minimize the impact of radiological safety hazards within the area. SCAR enables radiography to be performed without needing to shut down site operations or evacuate staff who may be working nearby or to take radiation-sensitive instrumentation off line during radiographic testing.

**scattering:** Reflection and refraction of radiation caused by interaction with material it strikes or penetrates. See also backscatter; compton scatter; coherent scatter diffraction; fog; mottle.

**scintillator:** Material used to convert X-rays to light by the process of scintillation.

**scintillation:** Emission of light of specific frequencies after the absorption of electromagnetic radiation, such as X-rays or gamma rays. See also radiographic screen; radioscopy.

**scrap:** (1) Manufactured materials not suitable for intended use. (2) Discarded material that may be reclaimed through melting and refining.

**seam:** Linear surface discontinuity, often oriented parallel to the component’s axis and produced during metal rolling. Seams can originate from ingot blowholes, cracks, and improper forging.

**secondary radiation:** Radiation originating as the result of absorption of, or interaction with, incident primary radiation. See also bremsstrahlung.

**seeability:** See visibility.

**segregation:** Nonuniform distribution of alloying elements, impurities, or microphases. See also microsegregation.

**selectivity:** Characteristic of a test system that is a measure of the extent to which an instrument can distinguish the desired signal from noise.

**selenium 75:** Radioactive isotope of element selenium, having half-life of 119.8 days and principle photon energies between 121 keV and 401 keV.

**sensitivity:** Ability of a sensor or system to distinguish a signal or indication from background noise. Limited by the signal-to-noise ratio. See also probability of detection.

**sensitization:** (1) In materials science, precipitation of chromium carbides in the grain boundaries of a corrosion-resistant alloy, resulting in intergranular corrosion that would otherwise be resisted. (2) In radiographic testing, condition of exposed silver halide emulsion in radiographic film before development.

**shielding:** Material or object used to reduce intensity of, or exposure to, penetrating radiation. See also barium clay; compensator block; half-value layer; zircon sand.

**shrinkage:** Internal void located at the last locations to solidify within castings caused by lack of molten metal from risers. The internal surface of macroshrinkage is rough, as opposed to the smooth surface of porosity. Also called shrinkage cavity. Microshrinkage occurs between the growing dendrites, and may be caused by gas evolution.

**SI (International System of Units):** International measurement system in which the following seven units are basic: meter, mole, kilogram, second, ampere, kelvin, and candela. Compare CGS System.

**sievert (Sv):** SI unit for measurement of exposure to ionizing radiation; replaces rem. 1 Sv = 1 J/kg = 100 rem.

**signal:** Response containing relevant information (ASNT 1986; ASTM 1981).

**signal electrode:** Transparent conducting film on the inner surface of a vidicon tube’s faceplate and a thin photoconductive layer deposited on the film.

**signal processing:** Acquisition, storage, analysis, alteration, and output of digital or analog data. See also image processing.

**signal-to-noise ratio:** Ratio of signal values (responses that contain relevant information) to baseline noise values (responses that contain nonrelevant information).

**sink:** Negative surface depression on a casting caused during the creation of subsurface shrinkage.

**slag:** Refuse byproduct composed of high-melting-point nonferrous material and liquid nonmetallic components created during air exposure during smelting, refining, casting, and welding operations. Slag is the typical term used when working with ferrous alloys. Compare dross.

**smoothing:** In image processing, linear combination of pixel values to smooth abrupt transitions in a digital image.
**SNT-TC-1A**: See ASNT Recommended Practice No. SNT-TC-1A.

**source**: Machine or material from which ionizing radiation emanates.

**spalling**: Cracking or flaking of small particles of metal, usually in thin layers, from the surface of an object. See also **galling**.

**spatial resolution**: Ability of a system to display fine detail and separation between features in close proximity. Line pairs per millimeter is a measure of spatial resolution, and this measure may be improved by a number of factors, including an increased number of pixels used in construction of an image and optical or geometric magnification. Compare **contrast resolution**.

**specific examination**: In certification of nondestructive testing personnel, a written examination that addresses the specifications and products pertinent to the application. Compare **general examination**; **practical examination**.

**specification**: Set of instructions or standards invoked to govern the properties, results, or performance of a specific set of tasks or products. Compare **code**; **recommended practice**; **standard**.

**spectral power distribution**: Radiant power per unit wavelength as a function of wavelength. Also known as **spectral energy distribution**, **spectral density**, and **spectral distribution** (ASNT 1993).

**spectral reflectance**: Radiant flux per unit wavelength reflected from a material divided by the incident radiant flux (ASNT 1993).

**spectral responsivity**: Measure of a photometric or radiometric sensor's sensitivity over a wavelength range of interest, often presented as percent versus wavelength. Photometric sensors should exhibit a bell-shaped spectral responsivity curve over the visible light range, whereas radiometric sensors may exhibit a flat or other response curve.

**spectral transmittance**: Radiant flux passing through a medium divided by the incident radiant flux (ASNT 1993).

**spectrometer**: Device used to characterize the emission spectrum of a source of electromagnetic radiation in counts per integration time, relative irradiance, or absolute irradiance versus wavelength or frequency.

**spectrometer, mass**: Instrument capable of measuring the mass-to-charge ratio of a charged particle. The device first ionizes the particle (imparts a positive charge) and then measures the accelerated particle's deflection as it passes through a known magnetic field. In leak testing, a common instrument encountered is a helium mass spectrometer.

**spectrophotometer**: Instrument capable of measuring the amount of visible light reflected from or transmitted through a sample. A spectrophotometer may, for example, be used to measure the spectral transmittance of an optical filter.

**spectrophotometry**: Quantitative measurement of visible light reflected from or transmitted through a sample as a function of wavelength.

**spectroradiometer**: Instrument used to measure the spectral power distribution of a radiation source. Common spectroradiometers observe the ultraviolet, visible light, and infrared wavelengths.

**spectroradiometry**: Quantitative measurement of electromagnetic radiation. Spectroradiometry encompasses absolute radiometric measurements of any wavelength, including visible light.

**spectroscopy**: The study of how radiant energy and a medium interact with respect to wavelength or frequency. See also **spectrophotometer**; **spectroradiometer**.

**spectrum**: (1) Amplitude distribution of frequencies in a signal. (2) Representation of radiant energy in adjacent bands of hues in sequence according to the energy's wavelengths or frequencies. A rainbow is a well-known example of a visible spectrum.

**speed of light**: Speed of all radiant energy, including light, is $2.997925 \times 10^8$ m/s in vacuum (approximately 186 000 mi/s). In all transparent materials, the speed is less and varies with the material's index of refraction, which itself varies with wavelength.

**speed of vision**: Reciprocal of the duration of the exposure time required for something to be seen (ASNT 1993).

**spot examination**: Local examination of welds or castings. See also **complete testing**; **sampling**.
standard: (1) A physical object with known material characteristics used as a basis for comparison or calibration. (2) A concept established by authority, custom, or agreement to serve as a model or rule in the measurement of quantity or the establishment of a practice or procedure. (3) Document to control and govern practices in an industry or application, applied on a national or international basis and usually produced by consensus. See also acceptance standard, working standard, and reference standard. Compare code.

standard atmospheric conditions: Standard temperature and pressure. Atmospheric pressure of 101.325 kPa (14.6959 lb/in.²) at temperature of 20 °C (293.15 K, 68 °F, or 527.67 °R). The density of dry air at these conditions is 1.2041 kg/m³ (0.07517 lbm/ft³).

standardization (instrument): The adjustment of an NDT instrument using an appropriate reference standard, to obtain or establish a known and reproducible response. (This is usually done prior to an examination, but can be carried out anytime there is concern about the examination or instrument response.) Refer to ASTM 1316. Compare calibration, verification.

statistical process control: Application of statistical methods such as control charts, continuous improvement, and designed experiments to manage and observe the outcome of a repeated process. See also in control.

steel: Iron alloy with less than 2% carbon, which may contain additions of other elements. See also austenite; martensite; pearlite.

stefan-boltzmann law: Relationship governing the wavelength-independent rate of emission of radiant energy per unit area. The law relates the total radiation intensity to the fourth power of absolute temperature and emissivity of the material surface. For example, intensity (heat flow) from a copper block at 100 °C (212 °F) is 300 W/m² (95 BTU × ft² × h). (The stefan-boltzmann constant for photon emission = 1.52041 × 10⁻²³ photons × s⁻¹ × m⁻² × K⁻⁴).

step wedge; stepped wedge: Device with steps of various thicknesses in the range of tested parts' thicknesses, for the radiographic testing of parts having thickness variations or complex geometries. The stepped wedge must be made of material radiographically similar to that of the radiographic test object and may include penetrometric features (such as calibrated holes) in any or all steps.

stereo imaging: Testing technique involving the capture and display of two images of the same object from different angles. Binocular viewing simultaneously of the two images simulates three-dimensional viewing, or an ability to reconstruct its three-dimensional image.

stereo radiography: Radiographic testing using stereo imaging.

stiffness: The ability of a structure or shape to resist elastic deformation. For a given shape, the stiffness scales with its moment of inertia (varies with cross sectional dimensions). Compare modulus of elasticity.

strain: Deflection or alteration of the shape of a material by external forces.

stress: (1) In physics, the action in a material that resists external forces such as tension and compression. (2) Force per unit of area.

stress concentration: Region where force per unit area is elevated, often because of geometric factors or cracks. Also known as a stress raiser.

stress corrosion cracking: Linear discontinuities formed under combined action of corrosion and stress, either applied or residual. Cracking may be either intergranular or transgranular, depending on the metal and corrosive medium (ASNT 1999).

stress raiser: Contour or property change that locally increases stress magnitude.

stress riser: See stress raiser.

stringer: In wrought materials, an elongated configuration of microscopic or relatively large inclusions, or foreign material aligned in the direction of working. Commonly, the term is associated with elongated oxide or sulfide inclusions in steel (ASNT 1999).

strobe: Of or pertaining to irradiation or lighting that flashes intermittently at a rate that may be adjusted, that is often perceived as a flicker, and that is used to image moving objects or still objects with potential movement (ASNT 1993).

subcase fatigue: Fatigue originating below the case depth. Components are generally gears, but may be other rolling mechanisms. Compare case crushing; galling.

substrate: Layer of material underlying a coating, regardless of whether the layer is base material.

subsurface discontinuity: Discontinuity not open to the surface. See also near-surface discontinuity.
subsurface fatigue: Fatigue cracking that originates below the surface. Usually associated with either hard-surfaced or shot-peened parts, but may occur any time subsurface stresses exceed surface stresses.

survey meter: Portable dosimeter that measures rate of exposure dose or ionizing radiation intensity.

tenth-value layer: The thickness of an absorbing material required to reduce the intensity of a beam of incident radiation to one-tenth of its original intensity.

test object, test surface: Physical part or specimen subject to nondestructive testing.

thermoluminescent dosimetry: Dosimeter that measures radiation dose by using a material that stores energy due to irradiation, which energy can be measured as light emission when the material is heated.

threshold: (1) A value in a phenomenon where a significant change of output occurs. (2) Setting of an instrument that causes it to register only those changes in response greater or less than a specified magnitude. See also thresholding.

thresholding: Digital data processing technique that reduces a gray-level image into a binary (black and white) image. See also adaptive thresholding.

throat: See weld throat.

time constant: Time it takes for any sensing element to respond to 63.2% of a step change at the target being sensed.

toe crack: Discontinuity that initiates and propagates at the weld toe.

tolerance: Permissible deviation or variation from exact dimensions or standards (ASNT 1999).

tool mark: Shallow indentation or groove made by the movement of manufacturing tools over a surface. Compare gouge.

total unsharpness: Combination of geometric and inherent unsharpness.

trace: Line formed by an electron beam scanning from left to right on a video screen to generate a picture (ASNT 1993).

transverse: Oriented at a right angle (normal) to the long axis. Compare circumferential; longitudinal; radial.

tubing string: Pipe with which oil or gas has contact as it is brought to the Earth's surface. See also casing; casing string.

tungsten inclusion: Weld inclusion consisting of solidified droplets, particles, or splinters of tungsten from gas tungsten arc welding electrodes. See also welding, gas tungsten arc (GTAW).

ultraviolet radiation (UV): Electromagnetic radiation with wavelengths between 40 and 400 nm.

undertcut: Undesirable groove left unfilled by weld metal, created during welding and located in base plate at the weld toe.

undertcut, film: Activation of silver halide grains in X-ray film by secondary radiation or scattered photons, which cause the edges of high-contrast features to become blurred.

Unified Numbering System (UNS): Alphanumeric system for identifying alloys, according to a registry maintained by ASTM International and SAE International.

unit die: Die block that contains several cavity inserts for making different kinds of die castings. See also casting, die.

unity: In mathematics, a value of one (1.0).

unsharpness: See geometric unsharpness; inherent unsharpness; total unsharpness.

vector quantity: Any physical quantity whose specification involves both magnitude and direction and that obeys the parallelogram law of addition. Example vector quantities include: displacement, force, velocity, acceleration, and momentum. Compare scalar quantity.

verification: To check for discrepancies between a standard result and the inspection device measurement, and to adjust the device so that readings fall within tolerance limits. Compare calibration, standardization.

video: Pertaining to the transmission and display of images at real-time or motion frame rates. See real time.
vidicon tube: Prior to the introduction of CCD- and CMOS-based devices, an analog television tube that used the photoconduction method. Compare charge-coupled device (CCD); image orthicon.

vigilance decrement: Degradation of reliability during performance of visual activities over a period of time. See also human factors; psychophysics.

visibility: Quality or state of being perceivable by the eye. Outdoors, visibility is usually defined in terms of the distance at which an object can be just perceived by the eye. Indoors, visibility usually is defined in terms of the contrast or size of a standard test object, observed under standardized view conditions and having the same threshold as the given object.

visible light: Any radiant energy with a wavelength between 380 and 780 nm. Compare ultraviolet radiation (UV); white light.

vision: Perception by eyesight.

vision acuity: Ability to distinguish fine details visually at a given distance. Quantitatively, it is the reciprocal of the minimum angular separation in minutes of two lines of width, subtending one minute of arc when the lines are just resolvable as separate. Compare neural acuity.

visual perception: Interpretation of impressions transmitted from the retina to the brain in terms of information about a physical world displayed before the eye. Visual perception involves any one or more of the following: recognition of the presence of something (object, aperture, or medium); identifying it; locating it in space; noting its relation to other things; or identifying its movement, color, brightness, or form.

visual performance: Quantitative assessment of the performance of a visual task, taking into consideration speed and accuracy.

voids: Hollow spots, depressions, or cavities. See also discontinuity; porosity.

voxel: The smallest volume element of information in a digital image.

wavelength: Distance between repeating values of a wave. For example, the distance from one peak to the next peak on a sine wave. Compare frequency.

wear, adhesive: Degradation of a surface by microwelding and consequent fracture due to the sliding of one surface against another. Compare fretting.

wear, fretting: Surface degradation by microwelding and microfractures caused over extended periods by light loads and vibration without material deformation, which may involve corrosion. Also called chafing. Compare brinelling; galling; spalling.

weld, arc: General term for joining of metals by heating them to the point of melting with an electric arc.

weld, butt: Weld that joins the edges of two work pieces in the same plane.

weld, fillet: Weld of approximately triangular cross section at the vertex or corner of two surfaces, other than an edge, butt, or spot weld. See also effective throat; weld throat.

weld land: The flat interface section of a weld between two pieces where no bevel exists.

weld, multipass: Weld made by many passes, one pass at a time.

welder’s flash: Clinical condition, specifically keratoconjunctivitis, commonly caused by overexposure to ultraviolet radiation emitted by a welding arc. Compare blue haze; blue light hazard.

welding, gas metal arc (GMAW): Inert gas shielded metal joining process that uses a continuous and consumable wire electrode. Also called metal inert gas (MIG) welding.

welding, gas tungsten arc (GTAW): Inert gas shielded metal joining process that uses a nonconsumable tungsten electrode. Filler material, when needed, is manually fed into the molten weld puddle. Also called tungsten inert gas (TIG) welding. TIG electrode choice generally includes pure tungsten, zirconiated, or ones containing a rare earth element such as 2% thoriated, 2% ceriated, or 1.5% lanthanated. See also tungsten inclusion.

welding, shielded metal arc (SMAW): Joining of metals by heating them with an electric arc between electrode(s) and the work piece, using an inert gas to shield the electrode(s).

welding, submerged arc (SAW): Joining process in which the electrical arc between the continuously fed consumable electrode and the workpiece is protected by a fusible granular flux. The thick flux layer protects the molten weld and protects the welder from ultraviolet radiation from the arc.

weld, multipass: Weld made by many passes, one pass at a time.
**weld reinforcement**: (1) In a butt joint, weld metal on the face of the weld that extends out beyond a surface plane common to the members being welded. (2) In a fillet weld, weld metal that contributes to convexity. (3) In a flash, upset, or gas pressure weld, weld metal exceeding base metal diameter or thickness (ASNT 1999).

**weld root**: Region of a joint furthest from the weld reinforcement and where the filler metal meets the base material.

**weld size**: Thickness of weld metal. In a fillet weld, the distance from the weld root to the weld toe of the largest isosceles right triangle that can be inscribed in a cross section of the weld. Compare weld throat.

**weld throat**: Distance from the root of a fillet weld to its face. Compare weld throat, effective.

**weld throat, actual**: Shortest distance from the root of a fillet weld to its face, as opposed to theoretical throat or weld size.

**weld throat, effective**: In fillet welds, the weld throat including the amount of weld penetration but ignoring excess metal between the theoretical face and the actual face.

**weld throat, theoretical**: Distance from the beginning of the root of a fillet weld perpendicular to the hypotenuse of the largest right triangle that can be inscribed within the cross section of the fillet weld. Compare weld size.

**weld toe**: Location on the external surface where the weld reinforcement and base material meet.

**white light**: Light combining all frequencies in the visible light spectrum (wavelengths from 380 to 780 nm) and in equal proportions.

**work hardening**: Increase in hardness accompanying plastic deformation of a metal. Usually caused in a metal by repeated impacting, bending, or flexing. See also peening; plastic deformation.

**working distance**: Distance from a source of electromagnetic radiation to the specimen. See also geometric unsharpness.

**working standard**: Standard that may be lower in quality and cost than the reference standard against which it is calibrated and that is routinely used to calibrate or check material measures, measuring instruments or reference materials. Compare acceptance standard; reference standard.

**X**

**X-ray**: Penetrating electromagnetic radiation emitted when the inner orbital electrons of an atom are excited and release energy. Radiation is not isotopic in origin and is most often generated by bombarding a metallic target with high-speed electrons. Compare alpha ray; beta ray; gamma ray.

**X-ray diffraction (XRD)**: Study of the structure of crystalline materials through the use of X-ray photons. XRD may be used to observe unit cell dimensions, identify phases (such as presence or quantity of austenite within a steel’s ferrite matrix) in a polycrystalline material, or determine residual stress. Background intensity in an X-ray diffraction pattern is produced by cüpton scatter. See also diffraction; radiology.

**X-ray fluorescence (XRF)**: Radiographic testing technique used for surface material characterization, based on the relative number of secondary radiation photons and their wavelengths when the specimen material is irradiated by X-rays or gamma rays.

**XRD**: X-ray diffraction.

**XRF**: X-ray fluorescence.

**Y**

**Young’s modulus**: See modulus of elasticity.

**ytterbium 169**: Radioactive isotope of element ytterbium, having half-life of 32 days and principle photon energies between 50 keV and 308 keV.

**Z**

**zircon sand**: Highly absorptive material used as a shielding medium for drilled holes, slots, and highly irregular geometries to reduce scattering during radiography. See also barium clay; compensator block.