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C H A P T E R

Nondestructive Testing Glossary

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Terms

Introduction

Purpose

Standards writing bodies take great pains to ensure that their standards are definitive in wording and technical accuracy. People working to written contracts or procedures should consult definitions referenced in standards when appropriate. For example, persons who work in accordance with standards published by ASTM International are encouraged to refer to definitions in the ASTM standards.¹

The definitions in this *Nondestructive Testing Handbook* volume should not be referenced for tests performed according to standards or specifications or in fulfillment of contracts. This glossary is provided for instructional purposes. No other use is intended.

On References

Definitions from other volumes of the *Nondestructive Testing Handbook* are not referenced. This volume's antecedent in the second edition was the *Nondestructive Testing Handbook: Volume 10, Nondestructive Testing Overview* (1996).² However, most of the definitions in this glossary are from the various, superseding method volumes.³⁻¹¹

Measurement units and their symbols are covered in the introduction to this volume.

For physical quantities and properties in materials science, the reader is served by reference books such as the *CRC Handbook of Chemistry and Physics*¹² and Leonard Mordfin's *Handbook of Reference Data for Nondestructive Testing*.¹³

A

absolute measurement: (1) Measurement made with an absolute coil. (2) Measurement of a property without reference to another measurement of that property. Compare *comparative measurement*; *relative measurement*.

absolute pressure: Pressure above absolute zero value or pressure above that of space empty of all molecules. Equal to sum of local atmospheric pressure and gage pressure.

absolute temperature: Thermodynamic temperature measured from absolute zero temperature, expressed in kelvin (K).

absorbed dose: In radiographic testing, 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 *gray* (Gy) or *rad*. See also *dose rate*; *dosimeter*.¹⁴

absorptance; absorptivity: Proportion (as a fraction of 1) of the radiant energy impinging on a material's surface that is absorbed into the material. For a *blackbody*, this is unity (1.0). Technically, absorptivity is the internal absorptance per unit path length. In thermography, the two terms have sometimes been used interchangeably.

absorption: In nondestructive testing, reduction of the intensity of any form of radiated energy as a result of energy conversion (absorption) in a medium, such as the conversion of sound energy into heat. Compare *attenuation*.

absorption coefficient, linear (μ_l): Fractional decrease in transmitted intensity per unit of absorber thickness. Expressed in units of cm^{-1} .¹⁵

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 *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; 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.
- accumulation test technique:** In *leak testing*, detecting the total amount of leakage by enclosing the component under test within a hood, bag, box, shroud or container. For pressure testing, any gas leaking from the component accumulates in the space (volume) between the component and the enclosure. For vacuum testing, any gas leaking into the component accumulates in the leak detector sampling the evacuated component. Accumulation of tracer gas in a measured time period provides a measure of the leakage rate.
- accuracy:** Degree of conformity of measurement to a standard or true value.
- ACGIH:** American Conference of Governmental Industrial Hygienists.
- acoustic emission:** (1) Transient elastic waves resulting from local internal microdisplacements in a material.
- acoustic emission activity:** Number of bursts (or events, if the appropriate conditions are fulfilled) detected during a test or part of a test.
- acoustic emission count:** Number of times the signal amplitude exceeds the preset reference threshold. Sometimes called *ringdown counts*.
- acoustic emission event:** Microstructural displacement that produces elastic waves in a material under load or stress.
- acoustic emission hit:** *Acoustic emission signal* received on one channel.
- acoustic emission rate:** Number of times the acoustic emission signal amplitude has exceeded the threshold in a specified unit of time.
- acoustic emission signal:** Electrical signal obtained through the detection of acoustic emission.
- acoustic emission testing (AE):** Passive nondestructive testing method that monitors a component or assembly for transient elastic waves and converts these ultrasonic waves into electrical signals. Acoustic waves may be produced by the formation or movement of microstructural dislocations during crack propagation, melting, phase transformations or thermal stresses.
- acoustic impedance (z):** Frequency dependent property of a medium through which acoustic waves propagate in units of $\text{kg}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$. In its simplified form, acoustic impedance is the product of longitudinal ultrasonic wave velocity ($\text{m}\cdot\text{s}^{-1}$) and material density ($\text{kg}_m\cdot\text{m}^{-3}$). The relative transmission and reflection at an interface are governed in part by the acoustic impedances of the materials on each side of the interface.
- acoustic impedance, characteristic:** In ultrasonic testing, acoustic impedance typical or *characteristic* of a particular material.
- acoustic impedance, specific:** In ultrasonic testing, acoustic impedance in a particular test object or a defined volume of a specified material.
- acoustic microscopy:** In ultrasonic testing, general term referring to the use of high resolution, high frequency ultrasonic techniques to produce images of features beneath the surface of a test object.
- activation:** In radiographic testing, process by which neutrons bombard stable atoms and make them radioactive.
- activity:** In radiographic testing, degree of radioactivity of a particular isotope. Activity is expressed as the number of atoms disintegrating per unit of time. Measured in *becquerels*.
- AE:** Acoustic emission testing.
- acuity:** See *neural acuity, vision acuity*.
- adhesive wear:** See *wear, adhesive*.
- agency:** Organization selected by an authority to perform nondestructive testing, as required by a specification or purchase order.
- agglomeration:** Clustering where smaller particles collide and adhere as groups.
- aging:** (1) The effect of long term environmental exposure on materials or components. (2) Heat treatment method that alters material properties and microstructure because of the duration of time at ambient (natural aging) or elevated (artificial aging) temperature. Aging is commonly applied to alloys after hot working, quenching from an elevated temperature or cold working. See also *precipitation hardening*.
- air flow:** In leak testing, flow of air from the probe inlet to the sensitive element of the halogen leak detector that carries the tracer gas from the leak to the sensing diode.
- algorithm:** Prescribed set of well defined rules or processes for the solution of a mathematical problem in a finite number of steps.¹⁶

alkali ion diode: Sensor type for halogen gases. In this device, positive ions (cations) of an alkali metal are produced on the heated surfaces (usually platinum) of the diode. One electrode is at a negative potential and attracts cations that are released when a halogen gas passes between the sensor electrodes. Provides an output current to operate the indicator on the halogen leak detector.

alpha iron: See *ferrite*.

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.¹⁴

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

alternating current (AC): Electric current whose waveform changes cyclically in magnitude and direction.¹⁷

alternating current field: In electromagnetic and magnetic testing, varying magnetic field produced around a conductor by alternating current flowing in the conductor.

alternating current magnetization: In magnetic particle testing, technique for inducing an active magnetic state by a cyclically reversing waveform, a state generally characterized by its form following ability and by shallow penetration.

ambient light: Light in the environment as opposed to illumination provided by a testing system.

ambient temperature; atmospheric temperature: Temperature of surrounding atmosphere. Also called *dry bulb temperature*. Compare *standard atmospheric conditions*.

ampere (A): SI unit of electric current. **ampere per meter (A · m⁻¹):** SI derived unit of magnetic field intensity. The measurement 1 A · m⁻¹, for example, describes a current of 1 A flowing through a coil that is 1 m in diameter. Compare *oersted*.

ampere turn (At): In magnetic particle testing, unit for expressing the magnetomotive force required for magnetization using a coil in terms of the product of the number of coil turns and the current in amperes flowing through the coil.

amplitude, echo: In ultrasonic testing, the vertical height of a received signal on an A-scan, measured from base to peak for a video presentation or from peak to peak for a radio frequency presentation.

amplitude response: That property of a test system whereby the amplitude of the detected signal is measured without regard to phase.¹

analog-to-digital converter: Circuit whose input is information in analog form and whose output is essentially the same information in digital form.¹⁶

angle beam: In ultrasonic testing, ultrasound beam traveling at an acute angle into a medium. The *angle of incidence* or *angle of refraction* is measured from the normal to the entry surface.¹⁵

angle beam test technique: In ultrasonic testing, inspection technique in which transmission of ultrasound is at an acute angle to the entry surface.¹⁸

angle of field: (1) In visual testing, included angle between those points on opposite sides of a beam axis at which the luminous intensity is 10 percent of the maximum value. This angle may be determined from an illuminance curve or may be approximated by use of an incident light meter. Also known as *field of view*. Compare *depth of field*.¹⁹ (2) In infrared and thermal testing, angular subtense (expressed in angular degrees or radians per side if rectangular and angular degrees or radians if round) over which an instrument will integrate all incoming radiant energy; the projection of the detector at the target plane. In a radiation thermometer, this angle defines the target spot size; in a line scanner or imager, it represents one resolution element in a scan line or a thermogram and is a, index of spatial resolution.

angle of incidence: In ultrasonic testing, the angle included between the beam axis of the incident wave and the normal to the surface at the point of incidence.¹⁸

angle of reflection: In ultrasonic testing, included angle between the beam axis of the reflected wave and the normal to the reflecting surface at the point of reflection.¹⁸

angle of refraction: In ultrasonic testing, the angle between the beam axis of a refracted wave and the normal to the refracting interface.¹⁸

angle of view: In visual testing, the angle in degrees between the field of view axis and the axis of the fiberscope's articulating section. Also called *direction of view*

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

angular subtense: (1) Angular diameter of an optical system or subsystem, expressed in angular degrees or milliradians. (2) In thermography, the angle over which a sensing instrument collects radiant energy.

- anisotropy:** Material characteristic in which different values of a property (acoustic velocity, for example) are noted in different directions. Compare *isotropy*.
- annealing:** Process of heating a material to, and holding at, a desired temperature followed by cooling at a desired rate, usually to reduce residual stresses or bring about some other desired change.
- annular coil:** See *coil, encircling*.
- 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*.
- anomaly:** Variation from normal material or product quality. (1) In nondestructive testing, a nonrelevant indication. (2) In nondestructive testing, an unintentional or undesired material condition that may qualify as a defect. Compare *defect; discontinuity*.
- antinode:** Point in a standing wave where certain characteristics of the wave field have maximum amplitude. Compare *nodal point*.¹⁸
- apposing field:** See *bucking field*.
- arc:** Current flow across a gap, producing intense heat and light.
- arc strike:** Localized thermal damage to object from an electric arc caused by breaking an energized circuit. Also called *arc burn*.
- arc welding:** See *welding, arc*.
- area linearity:** See *linearity, area*.
- argand diagram:** In electromagnetic testing, graphical representation of a *vector quantity* on the *complex plane*.
- articulate:** Ability of a device, such as a flexible *borescope*, to be remotely deflected in a plane with respect to the axis of the undeflected working section.
- articulated pole piece:** In magnetic particle testing, independently adjustable legs of a *contour probe* that enable satisfactory contact on irregular test object profiles.
- artifact:** See *indication, false*.
- A-scan:** One-dimensional display of ultrasonic *echo amplitude* as function of time or depth in test object. See also *marker*. Compare *C-scan*.
- ASNT Recommended Practice No. SNT-TC-1A:** See *Recommended Practice No. SNT-TC-1A*.
- ASNT:** American Society for Nondestructive Testing.
- atmospheric pressure:** Ambient pressure caused by the weight of the earth's atmosphere. Because the weight of the earth's overlying atmosphere varies inversely with altitude, atmospheric pressure decreases with elevation. Also called *barometric pressure*. At sea level, *standard barometric pressure* is taken as 101.325 kPa (14.696 lb_f-in.⁻²). It is also equal to the pressure exerted by a mercury column 760 mm (29.92 in.) high — that is, equal to 760 mm Hg (29.92 in. Hg) or 760 torr.
- attenuation:** (1) Decrease in energy or signal magnitude in transmission from one point to another. Can be expressed in decibels or as a scalar ratio of the input magnitude to the output magnitude.¹⁶ (2) Change in signal strength caused by an electronic device such as an attenuator. (3) Decrease in intensity caused by absorption, leakage, reflection, scattering or other material characteristics. See also *neper*.
- attenuation coefficient:** Factor determined by the degree of diminution in sound wave energy per unit distance traveled. It is composed of two parts, one (absorption) proportional to frequency, the other (scattering) dependent on the ratio of grain size or particle size to wavelength.²⁰ See also *ultrasonic absorption*.
- atmospheric windows (infrared):** In infrared and thermal testing, spectral intervals within the infrared spectrum in which the atmosphere transmits radiant energy well (atmospheric absorption is a minimum). These are roughly defined as 2 to 5 μm and 8 to 14 μm.
- austenite:** Face centered cubic phase of iron, which phase is stable between 906 °C (1663 °F) and 1390 °C (2535 °F) and often acts as a solvent for carbon. Also called *gamma iron*.
- 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*.

B

- background:** Formations on or signals from a test object that constitutes the background to a discontinuity. 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*.
- back reflection:** In ultrasonic testing, signal received from the far boundary or back surface of a test object.

backscatter: (1) In radiographic testing, interaction of radiation with matter such that the direction of travel after scattering is over 90 degrees and often close to 180 degrees 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. (3) Of scatter imaging, interaction of incident radiation with a specimen that scatters the radiation through large angles frequently greater than 90 degrees 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.

backscatter imaging: In radiographic testing, a family of radioscopic techniques that use *backscatter*.

backstreaming: Movement of pumping fluids from a pump back to the vacuum chamber.²¹

baffle: System component, typically a plate, that condenses pump fluids before they reach the vacuum chamber and returns fluid to the pump.²¹

barium clay: Molding clay containing barium, used to eliminate or reduce the amount of scattered or secondary radiation reaching an *X-ray* sensor.

barometric pressure: Ambient pressure caused by the weight of the Earth's atmosphere. See atmospheric pressure.

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

bath: In magnetic particle testing, combination of well agitated water based or oil based *carrier fluid* with a controlled concentration of suspended magnetic particles.

beam: In radiographic testing, defined stream of radiation particles in which stream all particles are traveling in parallel paths.

beam quality: In radiographic testing, penetrating energy of a radiation beam.

beam spread: (1) In radiographic testing, divergence from a beam of radiation in which all particles are traveling in parallel paths. (2) In ultrasonic testing, *divergence* of a sound beam as it travels through a medium.¹⁸ Specifically, the solid angle that contains the main lobe of an ultrasonic beam in the far field.

bearding: See *furring*.

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

beta particle: Electron or positron emitted from a nucleus during radioactive decay.¹⁴

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.¹⁴ Sometimes the electrons are used directly as the radiation.

berthold penetrometer: Shared flux indicator of magnetic field orientation, for use during continuous magnetization. Similar to a pie gage but containing a cover plate with height adjustable to vary the magnetic flux density required to form an indication. See also *shared flux indicator*. Compare *pie gage*.

binary system: In metallurgy, a two-element alloy system. See also *phase diagram*.

birefringence: Splitting of light into two beams, through double refraction, as it passes through specific types of translucent materials.

blackbody: In physics, a theoretical object whose incandescent radiation emission distribution (intensity versus wavelength) depends only on the absolute temperature of the blackbody and not on its internal nature or structure. A blackbody absorbs all energy falling on it. As the blackbody temperature increases, peak emission wavelength decreases. See also *absorptivity*; *Planck's law*; *stefan-boltzmann law*; *Wien's displacement law*.

black light: See *UV-A*.

bleed back technique: In liquid penetrant testing, procedure for verifying fluorescent penetrant indications by fully removing the indication and then reinspecting the area of interest. The technique begins by removing the indication smoothly using a soft paintbrush or cotton tipped applicator lightly moistened with a volatile solvent (acetone). If the indication was linear, apply a light coating of solvent based nonaqueous wet developer to the area of interest. If the indication was nonlinear no developer is applied. The indication is confirmed if the fluorescent indication reappears within 600 s. Also called *doubt removal technique*, *rebleed technique* or *wipeoff technique*.

bleedout: In liquid penetrant testing, action by which liquid penetrant is drawn from a discontinuity into the developer layer, thus forming an indication on the surface of the specimen.

- blind spot:** Portion of the retina where the optic nerve enters, without rods or cones, and where the retina is insensitive to light.¹⁹
- blister:** Discontinuity in metal, on or near the surface, resulting from the expansion of gas in a subsurface zone. Very small blisters are called *pinheads* or *pepper blisters*.
- blotch:** (1) An irregularly spaced area of color change on a surface. (2) The nonuniform condition of a surface characterized by such blotches.
- blowhole:** Hole in a casting or a weld caused by gas entrapped during solidification.
- blue haze:** Temporary blurred vision caused by UV-A photons entering the eye and exciting fluorescence of the vitreous humor. See also *vision acuity*.
- blue light hazard:** Danger of long term retinal damage posed to the eye by exposure to visible light with a wavelength between 400 and 520 nm at elevated intensities and/or extended durations. See also *American Conference for Industrial Hygienists*.
- bolometer, infrared:** Thermal infrared detector in which electrical conductivity changes with temperature.
- borescope:** Remote viewing device consisting of fiber bundles and/or a series of lenses with an objective lens at one end and an eyepiece at the other, for viewing objects not accessible to direct viewing. Borescopes are so called because they were originally used in machined apertures and holes such as gun bores. Borescopes, which may have diameters as small as 0.5 mm (0.02 in.), fall into two categories: flexible and rigid.
- borescope, blending:** Borescope comprised of a flexible shaft and a rotary tool to smooth out (blend) damage. There are generally custom designed kits for use with specific applications.
- borescope, calibrated:** Borescope with a gage on external tube to indicate the depth of insertion during a test. Borescopes with calibrated reticles are used to determine angles or sizes of objects in the field when held at a predetermined working distance.
- borescope, fiber optic:** Flexible industrial endoscope that uses glass or quartz fibers to transmit light and the optical path to and from the test object. Generally used in areas where tortuous bends or curves necessitate a flexible device, a fiber optic borescope consists of a coherent fiber optic bundle, light guide fiber and a flexible protective sheath enclosing wires for probe deflection.
- borescope, panoramic:** Borescope with a revolving prism mounted in front of the objective lens system. Prism angle is adjusted at the ocular end of the instrument to scan in forward oblique, right angle and retrospective (backward) directions.
- borescope, rigid:** Borescope that does not bend, typically to keep the geometrical optics in alignment through a light train system.
- borescope, ultraviolet:** Borescope with the ability to transmit ultraviolet radiation to the distal end while transmitting visible light to the eyepiece.
- borescope, video:** Borescope that uses a video camera instead of an eyepiece and transmits the image electronically. Compare *borescope*.
- borescopy:** Viewing or inspection with a borescope.
- boundary echo:** In ultrasonic testing, reflection of an ultrasonic wave from an interface.¹⁵
- brazing:** Joining of metals and alloys by fusion of nonferrous alloys that have melting points above 430 °C (806 °F), but below melting points of materials being joined.
- brehmsstrahlung:** 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.
- brinell hardness testing:** Evaluation method for determining the hardness of a material by forcing a hard steel or carbide ball of specified diameter (often 10 mm) into it under a specified load. The diameter of the indent is measured, and the result is reported as the material's *brinell hardness number*. Compare *rockwell hardness testing*.
- brinelling:** Permanent surface deformation caused by contact stress above the material's limit. Compare *false brinelling*.
- 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*.
- brittleness:** Quality of material that leads to crack propagation without appreciable plastic deformation. Compare *ductility*.

broad band: In ultrasonic testing, having a relatively wide frequency bandwidth. Used to describe pulses that display a wide frequency spectrum and receivers capable of amplifying them. Compare *narrow band*.

B-scan: In ultrasonic testing, data presentation technique typically applied to ultrasonic pulse echo techniques. It produces a two-dimensional view of a cross sectional plane through the test object. The horizontal sweep is proportional to the distance along the test object and the vertical sweep is proportional to depth, showing the front and back surfaces and discontinuities between.¹⁵

bubbler: See *water column*.

bucking field technique; opposing field technique: In magnetic particle testing, *field flow magnetization* technique where magnetic poles of like polarity are induced on the ends of a test object to force magnetization into extremities that are normally field free. Bucking fields are generally imparted with a pair of iron core induction coil pole extenders on a wet horizontal machine.

buckle: (1) Indentation on a flat face of a casting that may be caused by expansion of molding sand or by the dip coat of an investment casting peeling away from the pattern. (2) Local waviness in rolled metal sheet or bar stock, usually transverse to the rolling direction. (3) Failure mode of a compressed component that is characterized by unstable lateral deflection.

burr: Raised or turned over edge occurring on a machined part and resulting from cutting, punching or grinding.²²

burn through: In welding, coalescence of metal protruding beyond the root of the weld. Sometimes called *icicles*.

burnt-in sand: In manufacturing, discontinuity consisting of mixture of sand and metal cohering to surface of casting.

burst: (1) In metal forming operations, external or internal rupture caused by poor process control or inherent material discontinuities. (2) In acoustic emission, signal whose oscillations have a rapid increase in amplitude from an initial reference level (generally that of the background noise), followed by a gradual decrease to the initial level. Compare *pulse*.

C

caked: In penetrant testing, condition of dry developer powder having a semisolid condition caused by moisture or other liquid contaminants.

calibration: (1) Ratio of the output from a device to a reference input. Knowledge of this ratio helps to infer a device's input from its output. (2) Statement of the scale of a device. Compare *verification*. (3) Adjustment of instrument readings to known *reference standard*.

calibration reflector: In ultrasonic testing, reflector with a known dimensioned surface in a specified material, established to provide an accurately reproducible reference level in ultrasonic testing. See also *flat bottom hole; reference standard; working standard*.

candela (cd): Base SI unit of luminous intensity, in a given direction, of a monochromatic radiation source that has a frequency of 5.4×10^{14} Hz and that has a radiant intensity in that direction of $1.464 \text{ mW}\cdot\text{sr}^{-1}$.

capacitance, thermal: Amount of heat that an object can store. The term *thermal capacitance* describes heat capacity in an electrical analogy, where loss of heat is analogous to loss of charge on a capacitor. Structures with high thermal capacitance change temperature more slowly than those with low thermal capacitance. Compare *capacity, heat*.

capacitor discharge technique: In magnetic particle testing, magnetization technique generally characterized by a short duration, high intensity electrical pulse, often performed on *oil country tubular goods*.

capacity, heat: Ability of a material or structure to store heat. The product of the specific heat and the density of the material. This means that denser materials generally will have higher heat capacities than porous materials. Heat capacity is the amount of energy ($\text{J}\cdot\text{m}^{-3}\cdot\text{K}^{-1}$) required to elevate by one degree a given volume of material. Among common materials, water has one of the highest heat capacities; air, one of the lowest. Compare *capacitance, thermal; conductivity, thermal*.

capillary action: Tendency of liquids to penetrate or migrate into small openings, such as cracks, pits or fissures. The positive force that causes movement of certain liquids along narrow or tight passages.

- carrier fluid:** (1) Liquid that acts as a transport mechanism for the active materials. In magnetic particle testing, for example, the fluid may be oil or water based. See also *centrifuge tube*; *conditioning agent*. (2) In liquid penetrant testing and leak testing, fluid in which fluorescent and visible dyes or particles are dissolved or suspended.
- case crushing:** Longitudinal gouges and fracture of a case hardened surface, such as the tooth of a gear.
- casings:** 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:** Often spelled *cassette*. In radiographic testing, lightproof container for holding radiographic film in position during the radiographic exposure. The cassette may be rigid or flexible and may contain intensifying screens, filter screens, both or neither.¹⁴
- casting:** In manufacturing, an object produced through the solidification of a material within a mold.
- casting, die:** (1) Casting made in a reusable metallic cavity. (2) Casting process where molten metal is forced under high pressure into the cavity of a metal mold. See also *parting line*.
- casting, investment:** (1) Casting metal into a mold produced 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*. (2) A casting made by the process.
- cathode:** (1) Negatively charged terminal in an arrangement that produces current by chemical reactions. Compare *anode*. (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.¹⁵
- 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.
- CCD:** See *charge coupled device*.
- celsius (centigrade):** Temperature scale based on 273 K (0 °C = +32 °F) as the freezing point of water and 373 K (100 °C = 212 °F) as the boiling point of water at standard atmospheric pressure. A relative scale related to the kelvin scale (0 °C = 273.12 K; 1 °C = 1 K).
- cementite:** A hard brittle compound of iron and carbon known chemically as iron carbide (Fe₃C) and found in steels and cast irons.
- central conductor:** See *internal conductor*.
- centrifuge tube:** In magnetic particle testing, vial that holds liquids and has graduations to indicate the concentration of solids that settle out of a known suspension volume.
- 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*.
- channel:** In biology, mechanism functioning as a band pass filter in the visual cortex of mammals, causing sensitivity to visual stimuli in particular frequencies and range. See also *vision*.
- chaplet:** In manufacturing, metal support used to hold a *core* in place on a mold.
- charge coupled device (CCD):** Solid state image sensor. Charge coupled devices are widely used in inspection systems because of their accuracy, high speed scanning and long service life.
- chatter:** (1) In machining or grinding, vibration of tool, wheel or workpiece producing a wavy surface on the work. Chatter marks on the surface finish are produced by a vibrating machining tool
- check cracking:** Clustered small surface cracks often caused by overheating or thermal cycling. See also *grinding crack*.
- 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.

- choked flow:** In leak testing, phenomenon where, while pressure downstream is gradually lowered, velocity through an orifice increases until it reaches the speed of sound in the fluid. Also known as *sonic flow*. Compare *transition flow*.
- circular magnetic field:** In magnetic particle testing, active or residual magnetization oriented along the circumference.
- circular magnetization:** Result of *current flow technique* or *internal conductor technique* where a *circular magnetic field* is imparted. See also *field flow technique*; *right hand rule*. Compare *longitudinal magnetization*.
- circumferential:** Direction around the perimeter of a cylindrical surface. Compare *longitudinal*; *radial*; *transverse*.
- circumferential coil:** See *coil*, *encircling*.
- clean:** Free from interfering solid or liquid *contaminants* on the test surface and within voids or discontinuities. See also *water break free*.
- 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*.
- cleanup time; cleanup:** In leak testing, time (time constant) required after a tracer gas has ceased to enter a leak test system, for the system to reduce its signal output to 37 percent of the signal indicated before the tracer gas had ceased to enter the leak testing system.
- closing:** In image processing, dilation followed by erosion. A single pixel by closing connects a broken feature separated by one pixel. See also *opening*.
- closure:** Process by which a person cognitively completes patterns or shapes that are incompletely perceived.
- cobalt-60:** Radioactive isotope of element cobalt, having half life of 5.3 years and photon energies of 1.17 and 1.33 MeV.
- cocoa:** Debris (usually oxides of the contacting metals) of fretting wear, retained at or near the site of its formation — a condition easily identified during visual tests. With ferrous metals, the debris is brown, red or black, depending on the type of iron oxide formed. For this reason, ferrous debris is called *cocoa* or, when mixed with oil or grease, *red mud*.
- 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.
- coercive force:** Reverse external magnetic field intensity required to reduce the test object's bulk magnetism to zero. See also *hysteresis loop*.
- coil:** One or more loops of a conducting material. A single coil may be an exciter and induce currents in the material, or a detector, or both simultaneously.
- coil, absolute:** In electromagnetic testing, a coil that responds to the electromagnetic properties of that region of the test object within the magnetic field of the coil, without comparison to the response of a second coil at a different location on the same or similar material. Compare *coil*, *comparator*; *coil*, *differential*.
- coil, bobbin:** In electromagnetic testing, cylindrically wound absolute or differential probe useful for inspecting the inside diameter of tubular products.
- coil clearance, annular:** In electromagnetic testing, mean radial distance between the inner diameter of an encircling coil assembly and test object surface. See also *fill factor*.
- coil clearance, probe:** In electromagnetic testing, perpendicular distance between adjacent surfaces of the probe and test part. See *lift-off*.²³
- coil, comparator:** In electromagnetic testing, two or more coils electrically connected in series opposition and arranged so that there is no mutual induction (coupling) between them. Any electromagnetic condition that is not common to the test specimen and the standard will produce an imbalance in the system and thereby yield an indication. See also *coil*, *differential*.²³

- coil, demagnetizing:** In magnetic particle testing, solenoid or coil carrying the current for demagnetization. Current waveform may be alternating for pass-through solenoids or a rectified current for a multiple-step downcycle demagnetization. Some residual magnetization may remain in large parts magnetized with direct current or rectified current, but subsequently demagnetized with alternating current. See also *direct current downcycle demagnetization*.
- coil, differential:** In electromagnetic testing, two or more physically adjacent and mutually coupled coils connected in series opposition such that an imbalance between them, causing a signal, will be produced only when the electromagnetic conditions are different in the regions beneath two of the coils. In contrast, comparator coils are not adjacent or mutually coupled.
- coil, encircling:** In electromagnetic testing, a solenoid or coil assembly that surrounds the test object. Such a coil is also called an *annular coil*, *circumferential coil* or *feed-through coil*.²³ See also *coil technique*.
- coil, excitation:** In electromagnetic testing, coil that carries the excitation current. Also called *primary coil* or *winding*. Compare *coil*, *sensing*.
- coil, horseshoe:** In electromagnetic testing, probe coil in which the ferrite core of the coil is horseshoe shaped. Also called a *U shaped coil*.
- coil, inside diameter:** In electromagnetic testing, coil or coil assembly used for electromagnetic testing by insertion into the test piece, as with an inside probe for tubing. See also *coil*, *bobbin*.²³
- coil, pancake:** In electromagnetic testing, probe coil whose axis is normal to the surface of the test material and whose length is not larger than the radius.
- coil, reference:** In electromagnetic testing, the section of the coil assembly that excites or detects the electromagnetic field in the reference standard of a comparative system.²³
- coil, search:** In electromagnetic testing, detection coil, usually smaller than the excitation coil.
- coil, sensing:** In electromagnetic testing, coil that detects changes in the flow of eddy currents induced by an excitation coil; sensing and excitation coils can be one and the same. Also called *detector coil*. Compare *coil*, *excitation*.
- coil shot:** In magnetic particle testing, one instance of the *coil technique*, or one pulse of current in the coil technique. See also *shot*.
- coil spacing:** In electromagnetic testing, the axial distance between two encircling or inside coils of a differential or remote field test system.²³
- coil technique:** In magnetic particle testing, *field flow magnetization* technique using an encircling current carrying solenoid that imparts a longitudinal magnetic field in ferromagnetic components with a length-to-diameter ratio greater than 3. See also *end effect*; *L·D⁻¹ ratio*; *self-demagnetizing factor*.
- coil, test:** In electromagnetic testing, section of a coil assembly that excites or detects the magnetic field in the material under electromagnetic test.²³
- cold shut:** (1) Casting discontinuity caused by two streams of semimolten metal coming together within a mold but failing to fuse. (2) A cracklike discontinuity caused by forging, where two surfaces of metal fold against each other without joining. See *lap*. (3) Freezing of the top surface of an ingot before the mold is full.
- cold trap:** Device that condenses vapors and prevents oil or water molecules from entering a vacuum chamber.
- cold working:** Permanent deformation produced by an external force in a metal below its recrystallization temperature. Compare *hot working*.
- collimator:** In radiographic testing, device for restricting the size, shape and direction of the irradiating beam, thereby limiting beam spread and its consequences.
- cold light:** Disused word for *fluorescence*.
- color:** Visual sensation by means of which humans distinguish light of differing hue (predominant wavelengths), saturation (degree to which those radiations predominate over others) and lightness. See also *vision*.
- color blindness:** Deficiency in ability to perceive or distinguish hues.
- color discrimination:** Perception of differences between two or more hues.
- color temperature:** Rating of a light source, in degrees kelvin, for color vision.
- comparative measurement:** In electromagnetic testing, a measurement based on the imbalance in a system and using comparator coils in contrast to differential and absolute measurements. See also *coil*, *comparator*. Compare absolute measurement; *relative measurement*.²³

comparator, penetrant: (1) Transparent plastic device containing circles and/or lines of known lengths used to evaluate indication dimensions.

(2) Aluminum test block with artificial cracks or special surface conditions, typically having two separate but adjacent areas for application of different liquid penetrants or processing materials or operations so that direct visual comparison can be made between different liquid penetrant processes or materials. This block is 50 mm wide by 76 mm long by 10 mm thick and is divided into halves by a machined groove. Also called *aluminum test block* and *ASME penetrant cracked test piece*.

compensator: Electrical matching network to compensate for electrical impedance differences.¹⁵

complex plane: Plane defined by two perpendicular reference axes, used for plotting a complex variable (such as impedance) or functions of this variable (such as a transfer function).¹⁶

complex plane diagram: Graphical presentation of complex quantities where the real and imaginary components are represented along the horizontal and vertical axes, respectively. Types of complex plane diagram include *impedance plane diagram*, voltage plane diagram and phase amplitude diagram. See also *argand diagram*.

compton scatter: Reduction of energy of incident photon by its interaction with an electron. Part of the photon energy is transferred to the electron, giving it kinetic energy, and the remaining photon is redirected with reduced energy. Compare *diffraction*.

computed tomography technique (CT): In radiographic testing, inspection procedure by which computer analysis of the radiation passing through a rotating 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*).

conditioning agent: In magnetic particle testing, additive to water based *carrier fluid* aiding with defoaming, surface wetting, particle dispersion, corrosivity pH or or antifungal properties.

conductance: (1) In leak testing, the flow characteristics of a tube, manifold or leak path expressed in $\text{m}^3 \cdot \text{s}^{-1}$.

(2) Transmission of electric current through material. Conductance (G) is measured in siemens (S). Inversely related to electrical *resistance* (R):

$$G = \frac{1}{R}$$

conduction: Heat transfer occurring when more energetic particles collide with — and thus impart some of their heat energy to — adjacent less energetic (slower moving) particles. This action is passed on from one atom (or free electron) to the next in the direction of cooler regions. Thus, heat always flows from a warmer to a cooler region. Compare *convection*; *radiation*.

conductivity, electrical (σ): Ability of material to transmit electric current, measured in siemens per meter. Reciprocal or inverse of *resistivity* ρ :

$$\sigma = \frac{1}{\rho}$$

conductivity, thermal (k): Material property defining the relative ability to carry heat by conduction in a static temperature gradient. Conductivity varies slightly with temperature in solids and liquids and with temperature and pressure in gases. It is high for metals (copper has a k of $380 \text{ W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}$) and low for gases and porous materials (concrete has a k of $1.0 \text{ W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}$). Compare *capacity*, *thermal*.

cone: Part of the eye; color sensitive photoreceptor at the fovea centralis. Cones assist with mesopic vision and are responsible for photopic vision. Compare *rod*.

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

contact pad, contact head: In magnetic particle testing, replaceable metal pad, usually made of braided copper and/or lead, that prevents electrical arcing between the headstock and test object in the *current flow technique*.

contact technique: (1) In ultrasonic testing, technique in which an ultrasonic transducer face makes direct contact with the test object through a thin film of couplant. Compare *immersion technique*.¹⁵ (2) In magnetic particle inspection, see *current flow technique*.

contact time: See *dwell time*.

contaminant: Any foreign substance on the surface of a part, in a discontinuity or in the inspection materials, that adversely affects an inspection.

continuous casting: Manufacturing method in which an ingot, billet, tube or other shape is continuously solidified while being poured so that its length is not determined by mold dimensions.

- continuous technique:** In magnetic particle testing, a test sequence where the particles flow over the test object only during active magnetization. Compare *residual technique*.
- contour probe:** In magnetic particle testing, electromagnetic *yoke* with *articulated pole pieces* for evaluating specimens with an irregular shape. See also *lifting power*; *field flow magnetization*.
- contracted sweep:** In ultrasonic testing, misnomer that refers to extending the duration of the ultrasonic sweep to permit viewing discontinuities or back reflections from deeper in the test object. The sweep appears to be compressed.
- contrast:** (1) Difference in color or brightness between a test indication and background. (2) Difference between the amount of light reflected or transmitted by an object and by the background in the field of view.
- control:** See *in control*; *process control*; *quality control*.
- control cable:** In radiographic testing, cable connected to isotopic radiographic source and used to move the source in and out of the exposure device. See also *guide tube*; *pigtail*; *pill*.
- convection:** Type of heat transfer that takes place in a moving medium and is almost always associated with transfer between a solid (surface) and a moving fluid (such as air), whereby energy is transferred from higher temperature sites to lower temperature sites. Compare *conduction*; *radiation*.
- core:** (1) In manufacturing, specially formed material inserted in a mold to shape the interior of another part of a casting that cannot be shaped as easily by the pattern. (2) In a heat treated ferrous alloy, the inner portion that is softer than the outer portion or case.
- corner effect:** In ultrasonic testing, strong reflection obtained when an ultrasonic beam is directed toward the intersection of two or three intersecting surfaces.¹⁵
- corrosion:** Deterioration of a metal by chemical or electrochemical reaction with its environment. Removal of material by chemical attack, such as the rusting of automobile components.
- corrosion, crevice:** Localized corrosion found in regions where part or assembly geometry limits full exposure to the environment.
- corrosion embrittlement:** Severe loss of ductility of a metal, resulting from corrosive attack, usually intergranular and often not visually apparent.
- corrosion erosion:** Accelerated loss of material because of the simultaneous actions of erosion and corrosion when exposed to a moving corrosive liquid.
- corrosion, exfoliation:** 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 products.
- corrosion fatigue:** Fatigue cracking caused by repeated load applications on metal in a corrosive environment.
- corrosion, fretting:** 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. See also *false brinelling*.
- corrosion, poultice:** Corrosion occurring under a layer of foreign material (for example, under mud in automobile rocker panels).
- cosine law:** In nondestructive testing, physical law stating that the illumination of a surface varies as the cosine of the incidence angle. Maximum illumination is obtained where the cosine equals one and when the source is perpendicular to the surface.
- coulomb (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⁻¹).
- couplant:** In ultrasonic testing and leak testing, substance used between a transducer and the contacting surface to permit or improve transmission of ultrasonic energy into or from the test object.¹⁵
- coupled:** (1) Of two electric circuits, having an impedance in common so that a current in one causes a voltage in the other.²³ (2) Of two coils, sharing parts of their magnetic flux paths. See also *coupling*.
- coupling:** In electromagnetic testing, percentage of magnetic flux from a primary circuit that links a secondary circuit; effectiveness of a coil in inducing eddy currents in the test object.
- coupling coefficient:** In electromagnetic testing, fraction of magnetic flux from one circuit (test coil) that threads a second circuit (test object); the ratio of impedance of the coupling to the square root of the product of the total impedances of similar elements in the two meshes. See also *fill factor effect*.¹⁶

- coupon:** Piece of metal from which a test object is prepared, often an extra piece, as on a casting or forging.
- 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:** See *fatigue*.
- crack, forging:** Stress induced discontinuity formed during mechanical shaping of metal; see *crack; discontinuity, primary processing*.
- 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 degree rotation) to the direction of the grinding wheel. See also *grinding burn*.
- 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.
- 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. See also *deformation*.
- crevice corrosion:** See *corrosion, crevice*.
- critical angle:** (1) In ultrasonic testing, incident angle of the ultrasound beam where the refracted beam is parallel to the surface and above which a specific mode of refracted energy no longer exists. See also *mode conversion*.¹⁸ (2) In visual testing, incident angle above which total internal reflection occurs. Critical angle is key to the operation of *fiber optics*.
- cross talk:** Unwanted signal leakage (acoustic or electrical) across an intended barrier, such as leakage between the transmitting and receiving elements of a dual transducer.¹⁵ Also called *cross noise* and *cross coupling*.
- crush:** Casting discontinuity caused by a partial destruction of the mold before the metal was poured.
- crystal:** See *transducer element*.
- crystal, X cut:** In ultrasonic testing, cut with face perpendicular to the X direction of the piezoelectric crystal. In a quartz slice so cut, a thickness mode of vibration occurs when the slice is electrically stimulated in the X direction. See also *transducer element*.¹⁵
- crystal, Y cut:** In ultrasonic testing, piezoelectric crystal whose cut face is perpendicular to the Y direction. In quartz, a transverse mode of vibration is obtained when the slice is electrically stimulated in the Y direction. See also *transducer element*.¹⁵
- crystal mosaic:** In ultrasonic testing, multiple crystals mounted in the same surface on one holder and connected so as to cause all to vibrate as one unit. See also *transducer element*.¹⁵
- C-scan:** In ultrasonic testing, presentation technique applied to acoustic data and displaying an image of two-dimensional test object with scaled grays or colors representing the ultrasonic signals. The amplitude represented in each pixel may be a *pulse echo, through-transmission* or *pitch catch* value calculated from each *A-scan* datum.
- cumulative characteristic distribution:** In acoustic emission signal processing, a display of the number of times a characteristic meets a preselected criterion.
- 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 = 3.7×10^{10} Bq.
- curie point (T_c):** Temperature at which a phase transformation causes ferromagnetic materials to lose their magnetic properties.

current flow magnetization: In magnetic particle testing, magnetization of a test object by passing electric power directly through the test object. Common current flow techniques include *prods* and the *head shot technique*. Compare *field flow magnetization*.

current induction technique: See *induced current magnetization*.

cutoff frequency: In ultrasonic testing, upper or lower spectral response of a filter or amplifier, at which the ultrasonic response is a specified amount less (usually 3 or 6 dB) than the maximum response.

cycle: (1) Interval of time during which a procedure occurs. For example, a demagnetization cycle. (2) A single complete period of a waveform or other variable.

D

D^* (detectivity star): In infrared and thermal testing, sensitivity figure of merit of an infrared detector. Detectivity is expressed inversely so that higher D^* s indicate better performance. D^* is taken at specific test conditions of chopping frequency and information bandwidth and displayed as a function of spectral wavelength. D^* is the detectivity scaled to the unit sensitive detection area, with detectivity corresponding to the inverse of the noise equivalent flow.

damping: (1) Limiting the duration, or decreasing the amplitude of vibrations, by introducing an absorbent material or through instrument or transducer control. (2) Deliberate introduction of energy absorbers to reduce vibrations.

damping capacity: Measure of the ability of a material to dissipate mechanical energy.²⁰

damping material: Highly absorbent material used to cause rapid decay of vibration.

dark adaptation: Process by which the eye becomes accustomed to low luminance levels. For example, an adjustment to less than approximately $0.034 \text{ cd}\cdot\text{m}^{-2}$ for scotopic vision.¹⁹ In dark adaptation, the pupils dilate and the two types of photoreceptors in the retina change chemical balance. After a finite amount of time, possibly 10 min, vision will change from photopic vision to mesopic or scotopic low illumination vision.

dark adapted vision: See *accommodation*; *mesopic vision*; *scotopic vision*.

dead zone: In ultrasonic testing, interval following the initial pulse at the surface of a test object to the nearest inspectable depth.¹⁸ Any interval following a reflected signal where additional signals cannot be detected.

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

decibel (dB): Logarithmic unit for expressing relative acoustic signal power, such as the loudness of a sound, in proportion to the intensity of a reference signal. Decibel in signal amplitude is twice that in signal power. Twenty decibels is commensurate with ten-fold voltage amplification.

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 *anomaly*; *crack*; *discontinuity*; *indication*. See also *flaw*.

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

degreasing fluid: Chemical cleaning agents used to remove *contaminants* from test surfaces before inspection. See also *cleaning, chemical*.

delay line: In ultrasonic testing, material (liquid or solid) placed in front of a transducer to cause a time delay between the *initial pulse* and the *front surface reflection*.¹⁵

delta effect: In ultrasonic testing, reradiation or diffraction of energy from a discontinuity.¹⁵ The reradiated energy may include waves of both the incident mode and converted modes (longitudinal and transverse).

delta (t): In acoustic emission testing, time interval between the detected arrival of an acoustic emission wave at two sensors. Also called *time differential* or *difference in time of arrival*.

demagnetization cycle: Reduction of residual magnetism to an acceptable level, generally less than 0.2 to 1.0 mT (2 to 10 G). See also *coil, demagnetizing* and *direct current downcycle demagnetization*.

demagnetizing factor: See *self-demagnetizing factor*.

- demodulation:** In electromagnetic testing, process wherein a carrier frequency *modulated* with a signal of lower frequency than the carrier frequency is converted to a close representation of the original modulating signal.²⁴
- density:** (1) In radiographic testing, degree of X-ray film darkness as a result of exposure as measured with a densitometer. (2) Material property of mass per unit volume.
- depth compensation:** See *distance amplitude correction*.
- depth of field:** See *depth of focus*.
- depth of focus:** The region in front of and behind the focused distance within which objects still may be resolved. In a fixed focus system, this parameter is sometimes called *depth of field*. See also *transducer, focused*.
- depth of penetration:** See *skin effect; effective depth of penetration; standard depth of penetration*.
- descaling:** Removal of a thick layer of high temperature oxides from a metallic surface through *mechanical cleaning* or *chemical cleaning* means.
- detectivity star:** See *D**.
- detector coil:** See *coil, sensing*.
- detector probe:** In leak testing, an adjustable or fixed device through which air and/or tracer gas is drawn into the leak test instrument and over the sensing element or detector. Also called a *sampling probe* or a *sniffer probe*.
- detector probe test:** In leak testing, pressure leak test in which the leakage of a component, pressurized with a tracer rich mixture, is detected by scanning the test object boundary surface with a detector probe connected to an electronic leak detector. Leakage tracer gas is pulled from the leak through the probe inlet to the sensing element to cause a visible or audible signal on the indicator of the leak test instrument.
- detergent remover:** See *emulsifier, hydrophilic*.
- developer:** (1) In liquid penetrant testing, a material that is applied to the surface after excess liquid penetrant has been removed and that is designed to enhance the liquid penetrant *bleedout* to form *indications*. May be a fine dry powder, a solution that dries to form a dry powder or a suspension (in solvent or water) that dries leaving an absorptive film on the test surface. (2) In radiography, a chemical solution that reduces exposed silver halide crystals to metallic silver.¹⁴
- developer, dry:** In liquid penetrant testing, a finely divided dry powder that is applied to the surface after excess liquid penetrant is removed and the surface is dried in order to increase the bleedout by *capillary action*.
- developer, nonaqueous wet (NAWD):** In liquid penetrant testing, fine particles suspended in a volatile solvent. The volatile solvent assists bleedout by diluting the penetrant. Sometimes called *solvent developer*.
- developer, soluble:** In liquid penetrant testing, fine particles completely soluble in its carrier that dries to form an adsorptive coating.
- developer, suspendible:** In liquid penetrant testing, the developer that consists of fine particles suspended in water and that dries to an absorptive coating. Applied to the part after removal of excess liquid penetrant and before drying.
- developing time:** In liquid penetrant testing, the elapsed time necessary for the developer to absorb and show indications from penetrant entrapments.
- dewetting:** Flow and retraction of liquid on a surface, caused by contaminated surfaces or dissolved surface coatings. Compare *water break free*.
- diamagnetic material:** Substance with a magnetic permeability less than 1 that weakly repels an external magnetic field. Compare *ferromagnetic material; paramagnetic material*.
- differential amplifier:** Amplifier whose output signal is proportional to the mathematical difference between two input signals.¹⁶
- differential measurement:** In electromagnetic testing, the measurement of system imbalance by using differential coils, in contrast to absolute and comparative measurements.²³
- differentiated signal:** An output signal proportional to the input signal's rate of change.²³
- diffraction:** (1) In radiographic testing, special case of scatter, where coherently scattered (full intensity is retained) photons undergo interference or reinforcement, resulting in patterns indicative of the scattering medium. See also *X-ray diffraction*. (2) In ultrasonic testing, deflection of a wavefront when passing the edge of an ultrasonically opaque object.¹⁵
- diffuse indication:** In magnetic particle testing, particle cluster not clearly defined — for example, an indication from a subsurface discontinuity.
- diffuse reflection:** Scattered, incoherent reflections from rough surfaces. See also *lambertian; matte*.¹⁸

diffusion: Process by which molecules intermingle as a result of concentration gradients or thermal motion. Spreading of a gas through other gases or solids within a volume.

diffusion, thermal: Process by which thermal energy is transferred from hot or cold regions and finally is spread out. See also *conduction* and thermal *diffusivity*.

diffusivity, thermal (α): Speed at which heat diffuses through an object. Expressed as the rate α of temperature change with time. Each material has its own characteristic value of diffusivity, combining the overall influence of thermal conductivity k , density ρ and specific heat C_p :

$$\alpha = \frac{k}{\rho C_p}$$

In a practical sense, thermal diffusivity determines how fast a material will heat up or cool down. The rate of temperature change with time is more rapid in a material with a high thermal diffusivity (for example, metals) and slower in a material with a lower diffusivity (for example, plastics).

dilation: In image processing, the condition of a binary image where the pixel in the output image is a 1 if any of its eight closest neighbors is a 1 in the input image. See also *closing*; *erosion*; and *opening*.

diopter: In optics, term used to identify the refractive (light bending) capacity or resolving power of a lens. Equal to the inverse of the length (in meters) of the optical axis.

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. See also *full-wave current* and *half-wave current*. Compare *alternating current*.

direct current downcycle

demagnetization: In magnetic particle testing, massaging the magnetism of a component down to an acceptable level through a 25-step to 30-step process, where the persistence of one polarity is overcome in decreasing steps by a field reversing at each step.

directional lighting: Lighting provided on the work plane or object predominantly from a preferred direction.¹⁹

direction of view: See *angle of view*.

direct photometry: Simultaneous comparison of a standard lamp and an unknown light source.¹⁹

direct viewing: (1) Viewing of a test object in the viewer's immediate presence. The term *direct viewing* is used in the fields of robotics and surveillance to distinguish conventional from remote viewing. (2) Viewing of a test object during which the light image is not mediated through a system of two or more lenses (as in a borescope) or transduced through an electronic signal (as with a charge coupled camera). The term *direct viewing* is used in some specifications to mean viewing possibly with a mirror or magnifier but not with a borescope. Compare *indirect viewing*; *remote viewing*.

direct vision instrument: Device offering a view directly forward. A typical scene is about 20 mm (0.75 in.) wide at 25 mm (1 in.) from the objective lens. See also *borescope*.

discontinuity: Interruption in the physical structure or configuration of a test object. After nondestructive testing, a discontinuity indication may be interpreted as a defect.²⁵ Compare *anomaly*; *defect*; *indication*.

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

discontinuity, inherent: Material anomaly originating from solidification of metal. Pipe, banding and nonmetallic inclusions are the most common inherent discontinuities and can lead to other types of discontinuities in fabrication.²²

discontinuity inversion: In electromagnetic testing, technique for measuring some dimension(s) of a discontinuity by the application of a mathematical algorithm to the measured test data.

discontinuity, primary processing: Discontinuity produced from the hot or cold working of an ingot into forgings, rods, bars and other shapes.²²

discontinuity, secondary processing: Discontinuity produced during machining, grinding, heat treating, plating or other finishing operations.²²

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

dispersion: In acoustics, variation of wave phase with frequency. See also *refraction*.

dispersive medium: Medium in which the propagation velocity depends on the wave frequency.

dissipation: In infrared and thermal testing, generation of heat by *plastic deformation*.

distal tip: In a manipulative or interrogating system, of or pertaining to the end opposite from the eyepiece and farthest from the person using the system. The steel end portion of a *borescope* insertion tube where the image bundle, light guides and channel (if applicable) terminate. It often has three or four holes: one for the image bundle, two for the light guides and possibly a fourth hole as a working channel. See also *objective*.

distance amplitude correction (DAC): Compensation of gain as a function of time for difference in amplitude of reflections from equal reflectors at different sound travel distances. Refers also to compensation by electronic means such as swept gain, time corrected gain, time variable gain and sensitivity time control.¹⁵

divergence: In ultrasonic testing, term sometimes used to describe the spreading of ultrasonic waves beyond the *near field*. It is a function of transducer diameter and wavelength in the medium. See *beam spread*.

domain: Macroscopic dipole substructure within a *ferromagnetic material* permanently magnetically saturated. Domains are randomly oriented in a demagnetized material, but their orientation may be preferentially rotated through the application of an external magnetic field.

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*.¹⁴

dosimeter: Device that measures ionizing radiation dose, such as a *film badge* or ionization chamber.¹⁴

downcycle: See *direct current downcycle demagnetization*.

dragout: In liquid penetrant testing, carryout or loss of liquid penetrant materials as a result of their adherence to objects dipped into the materials.

drain time: In liquid penetrant testing, portion of dwell time during which the excess liquid penetrant, emulsifier, detergent remover or developer drains off an object.

drying oven: In liquid penetrant testing, oven used for increasing the evaporation rate of rinse water or of an aqueous developer vehicle from parts.

dry powder: (1) For magnetic particle testing, see *magnetic particle, dry*. (2) For liquid penetrant testing, see *developer, dry*.

dry technique: Magnetic particle test technique, generally used with portable equipment, where the ferromagnetic particles are applied as powder.

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*.

ductility: Ability of a material to undergo *plastic deformation* without fracture. Compare *brittleness*.

dwell time: In liquid penetrant testing, the time when a penetrant or emulsifier is in contact with the test surface. Compare *soak time*.

dynamic range: In ultrasonic testing, ratio of maximum to minimum reflective areas that can be distinguished on the display at a constant gain setting.¹

E

echo: In ultrasonic testing, reflected acoustic energy or signal indicating such energy. See also *pulse echo technique*.

eddy current: Electrical current induced in a conductor by a time varying magnetic field.

eddy current testing (EC): Nondestructive test method in which eddy current flow is induced in the test object. Changes in the flow caused by variations in the specimen are reflected into a nearby coil, coils, hall effect device or other magnetic flux sensor for subsequent analysis by suitable instrumentation and techniques. See also *electromagnetic testing*.²³

edge effect: In electromagnetic testing, the disturbance of the magnetic field and eddy currents because of the proximity of an abrupt change in geometry, such as an edge of the test object. Sometimes called *end effect*. The effect generally results in the masking of discontinuities within the affected region.²³

effective depth of penetration: In electromagnetic testing, the minimum depth beyond which a test system can no longer practically detect a further increase in specimen thickness.

effusivity, thermal: Ability of heat to escape from a body, expressed as a characteristic of that body. Square root of the product of thermal conductivity, mass density and specific heat.

- 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 ($V \cdot m^{-2}$) or of the electric flux density ($C \cdot m^{-2}$).
- electrical center:** In electromagnetic testing, center established by the electromagnetic field distribution within a test coil. A constant intensity signal, irrespective of the circumferential position of a discontinuity, is indicative of electrical centering. The electrical center may be different from the physical center of the test coil.²³
- electromagnet:** Ferromagnetic core surrounded by a coil of wire that temporarily becomes a magnet when an electric current flows through the wire.
- electromagnetic testing (ET):** Nondestructive test method for materials, including magnetic materials, that uses electromagnetic energy, either alternating or direct current, to yield information regarding the quality and characteristics of the tested material.²³
- 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.
- electrostatic spraying:** Technique of applying a uniform surface coating, wherein the material being sprayed is given a high electrical charge (potential) while the test piece is grounded.
- emissivity:** Variable ratio of the total energy radiated by a given surface at a given temperature to the total energy radiated by a *blackbody* at the same temperature. Emissivity can be *total*, *directional* or *hemispherical*. Emissivity is a surface phenomenon depending on surface condition and composition. Smooth materials have lower emissivities than *matte* or corroded materials. Emissivity values range between 0 for a perfect reflector to 1.0 for a *blackbody*.
- emissivity, effective (ϵ^*):** In infrared and thermal testing, the measured emissivity value of a particular surface under existing measurement conditions (rather than the generic tabulated value for the surface material) that can be used to correct a specific measuring instrument to provide a correct temperature measurement.
- emulsifier:** In liquid penetrant testing, liquid that mixes with an oily liquid penetrant such that the mixture can then be washed from the surface with water. See also *soak time*.
- emulsifier, hydrophilic:** In liquid penetrant testing, water based liquid that interacts with the liquid penetrant oil in the manner of a detergent, allowing the liquid penetrant to be washed from the surface with water.
- emulsifier, lipophilic:** In liquid penetrant testing, oil based liquid that mixes with liquid penetrant oil to form an emulsion that can be removed from the surface with water.
- end effect:** In bar and tube testing, *edge effect*. See also *coil technique*.
- endoscope:** See *borescope*.
- equivalent 20/20 near vision acuity:** Vision acuity with remote viewing or other indirect viewing that approximates 20/20 direct viewing closely enough to be considered the same for visual testing purposes.
- erosion:** (1) Loss of material or degradation of surface quality through friction or abrasion from moving fluids, made worse by solid particles in those fluids or by cavitation in the moving fluid. See *wear*. (2) In image processing, condition of a binary image where the pixel in the output image becomes a 1 if each of its eight neighbors is a 1 in the input image. See also *closing*, *dilation* and *opening*.
- erosion-corrosion:** Simultaneous occurrence of erosion and corrosion leading to an accelerated loss of material.
- etch crack:** Shallow crack in hardened steel containing high residual surface stresses, produced in an embrittling acid environment.²²
- etching:** (1) In liquid penetrant testing, *chemical cleaning* process for the controlled removal of surface material by chemical agents before inspection. (2) Subjecting the surface of a metal to preferential chemical or electrolytic attack to reveal structural details before viewing under a microscope.

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 also *indication*; *interpretation*.

expanded sweep: In ultrasonic testing, a short duration horizontal sweep positioned to allow close examination of a signal.

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

evaluation: Process of deciding the severity of a condition after an indication has been interpreted, to determine whether it meets acceptance criteria.

eye sensitivity curve: Graphic expression of vision sensitivity characteristics of the human eye to monochromatic light wavelengths. In the case of a physical photometer, the curve should be equivalent to the standard observer. The required match is typically achieved by adding filters between the sensitive elements of the meter and the light source. See *photopic vision*.

F

false brinelling: See *wear*, *fretting*.

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.
 $0\text{ °F} = 459.67\text{ °R}$; $1\text{ °F } \Delta T = 1\text{ °R } \Delta T$.

far field: In ultrasonic testing, zone beyond the near field in front of a plane transducer in which signal amplitude decreases monotonically in proportion to distance from the transducer. Also called the *fraunhofer zone*. Compare *near field*.

false indication: See *indication*, *false*.

farsightedness: Vision acuity functionally adequate for viewing objects at a distance, generally farther than arm's length. Also called *hyperopia*. Compare *nearsightedness*.

far vision: Vision of objects at a distance, generally beyond arm's length. Compare *near vision*.

fatigue crack propagation: Progressive fracture of a material that begins at a discontinuity and increases under repeated cycles of stress. 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.

felicity effect: In acoustic emission testing, appearance of significant acoustic emission at a load (or pressure) level below the previous maximum applied.

felicity ratio: In acoustic emission testing, measurement of the *felicity effect*. Defined as the ratio between (1) the applied load (or pressure) at which acoustic emission reappears during the next application of loading and (2) the previous maximum applied load.

ferrite: Form of pure iron that has a body centered cubic structure stable below 910 °C (1670 °F). Solid solution of one or more other elements in alpha iron. Also called *alpha iron*. (2) In electromagnetic testing, any of several magnetic substances that consist essentially of an iron oxide combined with one or more metals (such as manganese, nickel or zinc) having high magnetic permeability and high electrical resistivity.

ferromagnetic material: Material such as iron, nickel or cobalt whose relative permeability is considerably greater than unity, depends on the magnetizing force and often exhibits hysteresis. Materials that are most strongly affected by magnetism are called *ferromagnetic*. See also *domain*; *curie temperature*. Compare *diamagnetic material*; *paramagnetic material*.

fiber optics: Technology of efficient transmission of light through transparent fibers such as glass, quartz and plastic by means of total internal reflection. Groups of fibers carrying light to the distal end are in random order, while the *image bundle* carrying the image back to the eyepiece is coherent. See also *borescope*; *critical angle*.

fiberscope: See *borescope*, *fiber optic*.

- field flow magnetization:** In magnetic particle testing, imparting a magnetic field within a component by using at least a portion of the test object to complete the magnetic circuit. Field flow magnetization may impart *longitudinal*, *circular* or toroidal magnetization depending upon the tools and test configuration. Common field flow magnetization tools include *electromagnetic yokes* or *contour probes*, *ferromagnetic cores*, rigid or flexible *encircling coils*, iron core induction coil pole extenders, permanent magnets and *internal conductors*. Compare *current flow magnetization*.
- fiberscope:** Jargon for fiber optic borescope.
- field of view:** Range or area where things can be seen through an imaging system, lens or aperture. See also *angle of field*. Compare *depth of field*.
- field of vision:** Range or area where things can be perceived by eyesight at a point in time, assuming the eye to be immobile.
- filled crack:** Cracklike discontinuity, open to the surface but filled with some foreign material, such as oxide or grease, that tends to prevent liquid penetrants from entering.
- fill factor:** (1) In magnetic particle testing, convenient quantity for characterizing how closely the outside diameter of a specimen matches the inside diameter of the magnetizing coil. With a high fill factor, the ratio of the cross sectional area of the coil divided by the cross sectional area of the specimen is less than 2; intermediate, 2 to 10; low, greater than 10. See also *coil clearance*, *annular*. (2) For encircling coil electromagnetic testing, the ratio of the cross sectional area of the test object to the effective cross sectional core area of the primary encircling coil (outside diameter of coil form, not inside diameter that is adjacent to the object).^{23,13} For internal probe electromagnetic testing, the ratio of the effective cross sectional area of the primary internal probe coil to the cross sectional area of the tube interior.²³
- fill factor effect:** In electromagnetic testing, effect of fill factor on coupling between coil and test object. See *coupling coefficient*.⁴
- film badge:** In radiographic testing, package of photographic film worn as a dosimeter badge by radiographic personnel and workers in the nuclear industry to measure exposure to ionizing radiation. *Absorbed dose* can be calculated by the film *density* caused by irradiation.
- film speed:** In radiographic testing, relative exposure required to attain a specified film density.¹⁴
- filter:** (1) 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. (2) Data analysis process for reducing data files.
- filtering:** (1) Network that passes electromagnetic wave energy over a described range of frequencies and attenuates energy at all other frequencies.²³ (2) Processing device or function that excludes a selected kind of signal or part of a signal. (3) In radiography, the thickness of absorbing material placed in a primary radiation beam to selectively remove longer wavelength radiation, thereby adjusting the quality of the radiographic image.
- 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.²²
- fixing:** In radiographic testing, 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.
- 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 etch cross section.²²
- 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_f-in.⁻²) at 37.8 °C (100 °F).
- flash magnetization:** See *capacitor discharge technique*.
- flash point:** Lowest temperature at which a substance will form an ignitable mixture in air. The value varies with circumstances.

- flat bottom hole:** In ultrasonic testing, type of reflector commonly used in reference standards. The end (bottom) surface of the hole is the reflector. See also *calibration reflector*.
- flaw:** *Anomaly* or unintended discontinuity. See also *defect*. Compare *discontinuity*.
- flaw location scale:** In ultrasonic testing, specially graduated ruler that can be attached to an angle beam transducer to relate the position of an indication on the display to the actual location of a discontinuity within the test object.
- flexible laminated strip:** In magnetic particle testing, a *shared flux indicator* in the form of a thin ferromagnetic shim containing a series of longitudinal artificial discontinuities, which is used only to verify the direction of magnetic induction.
- fluorescence:** Phenomenon of absorption of electromagnetic radiation and its reemission at a lower energy (longer) visible light wavelength. Fluorescence in NDT may be a material's response to ultraviolet or ionizing radiation. The emission ceases as soon as the exciting energy is removed. Differs from phosphorescence, which continues to emit after excitation energy is removed. See also *spectrofluorometer*.
- flux:** See magnetic flux.
- focal plane array (FPA):** Linear or two-dimensional matrix of detector elements, typically used at the focal plane of an instrument. In thermography, rectangular focal plane arrays are used in *staring* (nonscanning) infrared imagers.
- focal spot:** (1) Point at which the instrument optics image the infrared detector at the target plane. In a radiation thermometer, this point is where the spot size is the smallest. In a scanner or imager, this point is where the instantaneous field of view (IFOV) is smallest. (2) In radiographic testing, area on target that receives bombardment of electrons. See also *effective focal spot*.
- focal zone:** In infrared and thermal testing, distance before and after the focal point in which the intensity differs a specified amount (usually 6 dB) from the focal intensity. Also called *depth of field* or *depth of focus*.
- 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*; *depth of field*.
- focusing, automatic:** (1) Feature of a camera whereby the lens system adjusts to focus on an object in the field of view. (2) Metaphorical attribute of a borescopic instrument's depth of field (the range of distance in focus). The depth of field is so great in the case of video borescopes that focusing is unnecessary for most applications. Despite the name, no mechanism is actively adjusted. The depth of field is large both because of the small diameter of the lens aperture and because of the proximity of the lens to the charge coupled device.
- focusing, primary:** Focusing by the lens of the image onto a fiber optic bundle at the tip of a probe.
- focusing, secondary:** Focusing at the eyepiece of a borescope or other optical instrument, specifically the manual refocusing needed when the viewing distance changes.
- fog:** Increase of 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.
- footcandle (ftc or fc):** Disused unit of illuminance, where
 $1 \text{ ftc} = 1 \text{ lm}\cdot\text{ft}^{-2} = 10.76 \text{ lx}$.
- footlambert (ftl):** Disused unit of luminance, where $1 \text{ ftl} = 3.426 \text{ cd}\cdot\text{m}^{-2}$.
- 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. See also *cone*; *macula lutea*; *photopic vision*; *rod*.
- foveal vision:** See *photopic vision*.
- FPI:** Fluorescent penetrant inspection. See *fluorescent penetrant testing*.
- 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*.
- fraunhofer zone:** See *far field*.
- frequency (f, v):** Number of times per second that a cyclical waveform repeats. The unit of frequency is hertz (Hz).
- frequency, fundamental:** In resonance testing, the frequency at which the wavelength is twice the thickness of the test material. See also *harmonic*.¹⁵
- fretting wear:** See *wear*, *fretting*.
- friction oxidation:** See *wear*, *fretting*.
- fresnel field:** See *near field*.

front surface echo: In ultrasonic testing, first surface of the test object encountered by an ultrasonic beam. Compare *back surface echo*.

full-wave rectified alternating current (FWRAC): Single-phase or three-phase alternating current converted to produce unidirectional current. Rectified current contains more amplitude variation, or ripple, than *direct current* from a battery.

furring: In magnetic particle testing, buildup of dry magnetic particles at magnetic poles resulting from overmagnetization of the test object.

G

galling: Surface damage more severe than fretting, caused by friction between high spots leading flaking due to subsurface fatigue. See also *galling*. Compare *wear*, *fretting*.

galvanic series: List of metals, alloys and graphite (a nonmetal) in sequence with the most anodic (easily corroded) in liquids at one end of the list and the most cathodic (least easily corroded) at the other end. For practical reasons, this sequence is compiled using seawater as the electrolyte — 3 to 5 percent sodium chloride and other salts dissolved in water.

gamma iron: see *austenite*.

gamma ray: High energy, short wavelength electromagnetic radiation emitted by the nucleus of a radioactive isotope. Energies of gamma rays are usually between 0.01 and 10 MeV. X-rays also occur in this energy range but are of nonnuclear origin. Compare *alpha ray*; *beta ray*; *X-ray*.¹⁴

gas ballast: Gas (air) admitted into the pumping chamber of a mechanical pump and inhibiting condensation of vapors in the chamber.

gasket seal: Resilient ring, usually virgin polytetrafluoroethylene (PTFE), in a piping or tubing connection. Compare *interference sealing thread*.

gate: (1) Electronic device for selecting signals in a segment of the trace on an *A-scan display*. (2) The interval monitored along the *baseline*.

gauss (G): Disused CGS unit of magnetic flux density denoting one flux line or maxwell, passing through one square centimeter. The preferred unit of flux density is the *tesla* (T), where $1\text{ T} = 10^4\text{ G}$.

gauss meter: See *tesla meter*.

general examination: In personnel qualification, a test or examination of a person's knowledge, typically (in the case of nondestructive testing personnel qualification) a written test on the basic principles of a nondestructive test method and general knowledge of basic equipment used in the method. (According to ASNT's guidelines, the general examination should not address knowledge of specific equipment, codes, standards and procedures pertaining to a particular application.) Compare *practical examination* and *specific examination*.

geometrical optics: Mathematical study of how light rays are reflected and refracted and practical techniques based on such understanding, including the transmission of images by lenses and mirrors. Also called *lens optics*.

geometric unsharpness: In radiographic testing, fuzziness or lack of definition in a radiographic image resulting from the source size, object-to-film distance and the source-to-object distance.¹⁴

getter: Reactive material that traps gas and removes it from a vacuum chamber. Several metals such as titanium, zirconium and tantalum can form getters for gases.

ghost: In ultrasonic testing, aliasing indication arising from certain combinations of pulse repetition frequency and time base frequency.²⁰ See also *wrap around*.

glare: Excessive brightness (or brightness varying by more than 10:1 within the field of view that interferes with observation or interpretation of a test response. Glare may be absolute or blinding (dazzle), disability or discomfort depending upon intensity. Often caused by reflection, whether *specular* (smooth surface) or diffuse (rough surface), of light or radiation sources.

gloss meter: Reflectometer used to measure specular *reflectance*.¹⁹

gnomon: Artifact intended to cast a shadow. The shadow may be used to measure time or distance (an example would be the indicator on a sundial).

gouge: Surface indentation caused by forceful abrasion, impact or flame cutting. Also called *nick*. Compare *tool mark*.

grain: Individual crystal in a polycrystalline material. See also *grain boundary*.

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

graininess: Film characteristic that results from improper film processing and that consists of the grouping or clumping together of many small silver grains into masses visible to the naked eye or with slight magnification. Compare *mottle*.¹⁴

gray (Gy): SI unit for measurement of the dose of *ionizing radiation* absorbed per unit mass at a specified location. Replaces the *rad* where *rad* denotes *radiation absorbed dose*, not *radian*.
 $1 \text{ Gy} = 1 \text{ J}\cdot\text{kg}^{-1} = 100 \text{ rad}$.

gray body: In physics, a theoretical object whose spectral absorptivity and emissivity are constant for all wavelengths. Compare *blackbody*.

gray level: Integer number representing the brightness or darkness of a pixel or, as a composite value, of an image comprised of pixels.

green rot: Form of high temperature attack on nickel chromium and nickel chromium iron alloys. Degradation is due to precipitation and subsequent oxidation of chromium carbide particles. Common to furnace environments.

grinding burn: Surface anomaly caused by improper steel machining parameters. Term describes the etched appearance of localized regions of untempered and self-tempered martensite caused by excessive heating. See also *crack*, *grinding*; *tarasov etching technique*.

group velocity: Speed at which the envelope of an ultrasonic pulse (many frequencies) propagates through the medium.

guide tube: Cable connected to isotopic radiographic source and used to move the source in and out of the exposure device. See also *control cable*; *pigtail*; *pill*.

H

halation: In radiographic testing, spreading of light around a bright image on a fluorescent screen or developed film.

half-wave rectified alternating current: Power waveform rectified from single-phase alternating current to produce a pulsating unidirectional field.

hall effect: Potential difference developed across a conductor at right angles to the direction of both the magnetic field and the electric current. Produced when current flows along a rectangular conductor subjected to a transverse magnetic field.

hall effect detector: Semiconductor element that produces an output electromotive force proportional to the product of the magnetic field intensity and a biasing current. Such sensors are available commercially in axial and transverse form. See also *tesla meter*.

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. See also *brinell hardness*; *rockwell hardness*.

harmonic: Vibration frequency that is an integral multiple of the fundamental frequency. See also *frequency*, *fundamental*.¹⁸

heading: Upsetting wire, rod or bar stock in dies to form parts having some of the cross sectional area larger than the original. Example products are bolts, rivets and screws.

headstock: In magnetic particle testing, one of two points on a *wet horizontal unit*, often equipped with a pneumatic ram, which contacts and supports the test object during *current flow magnetization* in the *head shot technique*.

head shot technique: In magnetic particle testing, imparting circular magnetization in a component by passing current directly through it. See also *current flow magnetization*; *headstock*; *shot*.

heat: Energy associated with the random and chaotic motions of the atomic particles from which matter is composed. All materials (hot or cold) contain heat and radiate infrared energy. The unit for measuring heat is the joule (J), equal to about 0.24 calorie (cal) or 9.481×10^{-4} British thermal units (BTUs). Compare *infrared radiation*; *temperature*.

heat affected zone (HAZ): Portion of base metal not melted during brazing, cutting or welding but with mechanical properties altered by the heat.

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. Friction may produce the heat. See also *grinding burn*; *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.
- hemispherical properties, radiation:** Radiation properties (emissivity, absorptivity, reflectivity) as referenced to all directions of hemispherical space.
- hermetic seal:** Fusion seal that is leak tight.
- hertz (Hz):** Measurement unit of frequency, equivalent to one cycle per second.
- hit lockout time:** In acoustic emission testing, time interval set to suppress late arriving parts of an acoustic emission signal.
- horseshoe magnet:** U shaped bar magnet. See also *keeper*.
- 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 thermionic ionization gage:** Absolute pressure gage that monitors ion current proportional to gas density at pressures less than 0.1 Pa (1 mtorr). Electrons produced by a heated filament (usually of tungsten or iridium and often thorium coated) ionize the gas and produce a positive ion current that flows to a wire collector. This current is proportional to gas density over the absolute pressure range below 100 mPa (1 mtorr) for a given gas composition.
- hot working:** Deforming metal plastically at temperature and rate such that strain hardening does not occur. Low temperature limit is recrystallization temperature. Compare *cold working*.
- hsu-nielsen source:** See *pencil break source*.
- hue:** Characteristic of light at a particular bandwidth; the degree to which a visual stimulus can be described in terms of primary colors (red, green, blue and yellow).
- human factors:** The mental and physical make of the individual, the individual's training and experience and the conditions under which the individual must operate that influence the ability of the NDE system to achieve its intended purpose. Human factors is one of the principal elements affecting the reliability of nondestructive tests.
- hyperopia:** See *farsightedness*.
- hysteresis:** In magnetic and electromagnetic testing, apparent lagging of the magnetic effect when the magnetizing force acting on a ferromagnetic body is changed; phenomenon exhibited by a magnetic system wherein its state is influenced by its previous history. See also *coercive force; magnetic saturation*.
- hysteresis loop:** In magnetic and electromagnetic testing, curve showing flux density *B* plotted as a function of magnetizing force *H* as *H* is increased to the saturation point in both negative and positive directions sequentially. The curve forms a characteristic loop.
-
- I**
- IACS:** International Annealed Copper Standard. See *percent International Annealed Copper Standard*.
- illuminance:** Intensity of visible light per unit area (density of luminous flux) on a surface. Illuminance is measured in lumens per square meter ($\text{lm}\cdot\text{m}^{-2}$) or *lux*. Compare *luminance*.
- illuminate:** Cast light on (something). Compare *illuminance*.
- image:** Reproduction of an object produced by light rays. An image forming optical system gathers a beam of light diverging from an object point and transforms it into a beam that converges toward another point, thus producing an image.
- 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 bundle:** The main component of a fiber optic borescope, comprised of a group of optical fibers carrying the image to the eye. The image bundle averages between several thousand to tens of thousands of individual fibers arranged in numerical order on the distal and eyepiece ends (coherent). Fiberscope resolution depends on the size, quality and configuration of the fibers. The fiber diameter ranges from 6 μm to 10 μm — smaller diameter fibers demonstrate finer resolution. Compare *light guide bundle*.
- image orthicon:** Television tube that uses the photoemission method. Compare *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*.

- image quality indicator (IQI):** In radiographic testing, strip of material 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.¹⁴
- imager, infrared:** In thermal and infrared testing, an instrument that collects the infrared radiant energy from a target surface and produces an image in monochrome (black and white) or color, where the gray shades or color hues correspond respectively to target exitance.
- image segmentation:** In image processing, technique in which the image is partitioned into regions, each homogeneous.
- immersion technique:** In ultrasonic testing, technique in which the test object and the transducer are submerged in a liquid (usually water) that acts as the coupling medium. Compare *contact technique*.¹⁵ The transducer is not usually in contact with the test object.
- impedance:** In electromagnetic testing, opposition that a circuit presents to the flow of an alternating current, specifically the complex quotient of voltage divided by current.²³
- impedance analysis:** In electromagnetic testing, an analytical technique that consists of correlating changes in the amplitude, phase, quadrature components or all of these of a complex test signal voltage to the condition of the test object.²³
- impedance plane diagram:** In electromagnetic testing, graphical representation of the locus of points indicating the variations in the impedance of a test coil as a function of a parameter, such as *conductivity* or *lift-off*. See also *argand diagram*; *complex plane diagram*.
- impedance plane diagram, normalized:** In electromagnetic testing, diagram in which the impedance of the probe in air is a reference value to which impedance values in other conditions are compared. Usually the plotted data are (1) the measured reactance divided by the reactance of the coil in air versus (2) the measured resistance less the resistance in air divided by the coil reactance in air.
- impurity:** Element or compound whose presence in a material is unintentional or unwanted.
- incandescence:** Emission of visible radiation as a result of heating. See also *Planck's distribution law*.
- inclusion:** In manufacturing, foreign particles or impurities, usually oxides, sulfides, silicates and such, that are retained in metal (welds or castings) during solidification or that are formed by subsequent reaction of the solid metal.
- incomplete fusion:** In welding, the failure of a weld bead to join completely with the base metal or preceding bead. Also called *lack of fusion*.
- incomplete penetration:** In welding, root penetration less than complete or failure of a root pass and a backing pass to fuse with each other. Also called *lack of penetration*.
- 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*.
- index of refraction:** Ratio of velocity of light in a vacuum to velocity of light in a material. See also *Snell's law*.
- indication:** Nondestructive test response that requires interpretation to determine its relevance. Compare *defect*; *discontinuity*; *indication, false*; *indication, nonrelevant*.
- 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. Compare *nonrelevant, nonrelevant; defect*.
- 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.
- indirect viewing:** Viewing of a test object during which the light image is mediated through a system of two or more lenses (as in a borescope) or transduced through an electronic signal (as with a charge coupled camera). Compare *direct viewing*; *remote viewing*.
- indium antimonide (InSb):** Material from which fast, sensitive photodetectors used in infrared scanners and imagers are made. Such detectors usually requiring cooling while in operation. Operation is in the short wave band (2 to 5 μm).

- induced current magnetization:** In magnetic particle testing, noncontact means for testing delicate ring shaped objects for circumferential discontinuities. The technique is based on the fact that a time varying current passing through an internal conductor, often a soft iron or laminated core, self-induces an encircling magnetic field. This time varying magnetic field will induce a secondary current circling through the ring. This secondary current then self-induces the toroidal magnetic field used for testing. See also *right hand rule*.
- inductance:** Property of electric circuit, by which current in it or in a nearby circuit creates magnetic flux in the other circuit. Inductance is measured in henries, where one henry equals one weber per ampere ($1 \text{ H} = 1 \text{ Wb} \cdot \text{A}^{-1}$). See also *self-inductance*.
- inductor:** In magnetic and electromagnetic testing, device consisting of one or more associated windings, with or without a magnetic core, which impedes the flow of current.
- infrared and thermal testing:** Nondestructive testing that uses heat diffusion and infrared radiation as interrogating energy.
- infrared radiation (IR):** Electromagnetic energy with a wavelength between 750 nm (400 THz) and 1 mm (300 GHz). Compare *visible light*; *ultraviolet radiation*.¹⁹
- infrared thermography:** Imaging of a temperature field through the emitted infrared radiation. Technique incorporates the use of an instrument or system that converts incoming infrared radiant energy from a target surface to a thermal map, or *thermogram*, on which color hues or gray shades can be related to the temperature distribution on that surface. See *infrared radiation*.
- initial pulse:** Pulse applied to excite the transducer. It is the first indication on the screen if the sweep is undelayed. Also called the *main bang*. May refer to an electrical pulse or an acoustic pulse. See also *dead zone*. Compare *echo*; *back reflection*; *front surface reflection*.
- insonification:** In ultrasonic testing, irradiation with acoustic energy, such as ultrasound.
- interface:** Physical boundary between two adjacent media.¹⁸
- interface triggering:** In ultrasonic testing, triggering the sweep and auxiliary functions from an interface echo occurring after the initial pulse. Also called *interface synchronization*.
- interference:** Production of a series of maxima and minima of a wave (electromagnetic or standing sonic waves) as a consequence of the superposition of waves having different phases.¹⁵
- interference objective:** In a *microscope*, a small, metallized glass mounted in contact with the test object and adjustable for tilt to control fringe spacing.
- interference sealing thread:** Piping seal using a tapered connection made up under great pressure, forcing the mating surfaces together more tightly than possible with a spiral thread. Compare *gasket seal*.
- 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*.
- internal conductor:** In magnetic particle testing, rod of conductive material threaded through a hole in a cylindrical test object to induce circular magnetic flux. An internal conductor may be centered in the hole (a central conductor) or be offset near or touching one side of the cylinder's inside surface.
- internal conductor technique:** In magnetic particle testing, circular magnetization technique that uses an *internal conductor*.
- 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.
- inversion:** See *discontinuity inversion*.
- ion current:** In leak testing, current that flows at all times from the positive emitter (heater) to the negative cathode collector of the heated anode (alkali ion) halogen vapor detector. This current increases in the presence of halogenated gases.

ionizing radiation: Form of electromagnetic radiation that can displace orbital electrons from atoms. Types include X-rays, gamma rays and particles such as neutrons, electrons (beta particles) and alpha particles.

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

iris: Ring of variable area around the pupil and in front of the lens of the eye. The surface area of the iris adjusts spontaneously to change the amount of light entering the eye.

irradiance: Total radiant power, in watts per square meter ($W \cdot m^{-2}$), falling upon a known surface area at a given angle. Compare *radiance*. See also *radiometer*.

irradiance, spectral: Measure of energy emitted by a radiation source as function of wavelength. Units of spectral irradiance are watts per square meter ($W \cdot m^{-2}$) and are often plotted versus wavelength. See also *spectral*.

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

isobaric: Having constant barometric pressure.

isotherm: In infrared and thermal testing, locus or pattern superimposed on a *thermogram* or on a line scan that includes or highlights all points that have the same apparent temperature.

isotropy: Condition of material whose properties are independent of test axis with respect to coupon orientation. Compare *anisotropy*.

J

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

joint: (1) Part of the casting mold where the cope and cheek, cope and drag or cheek and drag come together. (2) Part of weld where two welded parts meet.

joint efficiency: Strength of a welded joint expressed as a percentage of the strength of the unwelded base metal.

K

kaiser effect: In acoustic emission testing, absence of detectable acoustic emission until the previous maximum applied stress level has been exceeded.

keeper: Ferromagnetic material placed across the pole faces of a permanent *horseshoe magnet* to reduce the reluctance of the gap and to prevent loss of magnetism.

kelvin: Absolute temperature scale related to the celsius (or centigrade) relative scale. The kelvin unit is equal to 1 °C; 0 kelvin = -273.16 °C; the degree sign and the word *degree* are not used in expressing kelvin temperatures.

ketos ring: See *test ring*.

kinematic viscosity: Ratio of absolute viscosity divided by the liquid's density. Kinematic viscosity is often reported in centistokes.

kinetic vision acuity: Vision acuity with a moving target. Studies indicate that 10 to 20 percent of visual efficiency can be lost by target movement.

Kirchoff's law: Principle that the summation of all flux exchanges (absorbed, reflected, transmitted) on a semitransparent object equal unity.

known discontinuity standard (KDS): Part containing artificial anomalies of a desired size and location used to perform system performance checks or to classify test materials. A set of KDS samples or panels may be manufactured to be twins of each other.

known discontinuity standard, nickel-chrome (Ni-Cr): Set of two twin panels used to evaluate liquid penetrant material or process sensitivity. The brass Ni-Cr panel twins are 35 mm wide by 100 mm long and have a pattern of 10, 20, 30 or 50 μm deep cracks across their width. Compare *penetrant system monitor*.

knudsen number: In leak testing, the ratio of mean free path to characteristic dimension of the system.²³

L

lack of fusion: See *incomplete fusion*.

lack of penetration: See *incomplete penetration*.

lambert cosine law: See *cosine law*.

lambertian: Having a surface that reflects light or acoustic energy diffusely in all directions rather than specularly. See also *matte*. Compare *specular*.

laminar flow: Class of viscous flow where velocity distribution of fluid in a cross section of a tube is parabolic.

lamination: Planar discontinuity rolled into plate, sheet or strip caused by pipe, inclusions or blowholes in the original ingot or by rollover during rolling mill operations. After roll forming of the product, laminations are usually flat and parallel to the outside surface.

lap: In NDT, a surface imperfection that appears as a seam and is caused by folding and then by rolling or forging metal without actually joining.

- 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.
- $L \cdot D^{-1}$ ratio:** Convenient means for expressing the shape of a test object in terms of length L divided by diameter D . In magnetic particle testing, ratio used to judge whether a test object is appropriate for *coil technique* magnetization or demagnetization alone or whether pole extensions or stacking is required. See also *self-demagnetizing factor*.
- leakage field:** See *magnetic flux leakage field*.
- leakage rate:** In leak testing, quantity of leakage fluid per unit time that flows through a leak at a given temperature as a result of a specified pressure difference across the leak.
- leaked visible light:** In fluorescent nondestructive testing, electromagnetic radiation with a wavelength between 380 and 780 nm that is generated by a UV-A source but not filtered out of the emission spectrum. Leaked visible light is generally violet and not accurately measured using a photometric sensor. See also *light contamination; photometer; radiometer; UV-A; UV-A filter; visible light*.
- leak testing (LT):** Nondestructive testing method for detecting, locating or measuring leaks or leakage in pressurized or evacuated systems or components. Leaks are sought by looking (bubble or dye tests), sniffing (gas or tracer detection) or by listening (ultrasonic test). See also *manifold; mass flow rate; response time*.
- leak testing, acoustic:** Technique that monitors for elastic waves resulting from the flow of fluids through leaks, generally in the frequency range 30 to 100 kHz. See also *choked flow; transition flow*.
- leak testing, bubble:** Technique in which a leak in a pressurized component is indicated by the formation of bubbles of escaping gas. Methods include immersion, vacuum box and bubble solution tests. See also *accumulation test technique; air flow; alkali ion diode; soak time*.
- leak testing, dynamic:** Technique in which the system under test is pumped continuously. See also *leak testing, hood test*.
- leak testing, foam:** Bubble leak testing technique in which the tracer gas blows a hole through a blanket of foam covering the test object, thus indicating the location of the leak.
- leak testing, halogen detector probe:** Pressure leak technique in which the leakage of a component, pressurized with a halogen rich mixture, is detected by scanning over the test object boundary surface with a probe connected to a halogen leak detector. Halogen gas is pulled from the leak through the probe inlet to the sensing element to cause a visible or audible signal on the indicator of the leak test instrument. See also *clean up time; detector probe; ion current; response factor*.
- leak testing, hood test:** Quantitative technique in which a test object under vacuum test is enclosed by a hood filled with tracer gas so as to subject all parts of the test object to examination for leakage at one moment. A form of dynamic leak testing in which the entire enclosure or a large portion of its external surface is exposed to the tracer gas while the interior is connected to a leak detector, with the objective of detecting leakage or measuring its total rate. See also *clean up time; leech box*.
- leak testing, integrated leakage rate test:** Technique performed for an entire system or component by pressurizing the system to the calculated peak containment internal pressure related to the design and determining the overall integrated leakage rate.
- leak testing, optical:** Technique that uses a visual means of leak detection, such as holographic laser interferometry. Optical leak testing is used for microelectronic and pharmaceutical packaging. See also *hermetic seal; standard leakage rate*.
- leak testing, pressure:** Technique of leak testing objects pressurized with a tracer gas with the subsequent detection and location of any existing leaks with a sampling probe (a qualitative test). Tests performed by increasing the pressure inside a test boundary to a level greater than the surrounding atmosphere and detecting leakage by systematic examination of the outside of the test surface. Leaks are located at time of detection; however, it is impossible to accurately determine a total leakage rate for the object being pressure tested. See also *soak time*.
- leak testing, radioactivity:** Technique of using a radioactive tracer gas, such as krypton-85, to detect leaks because of its radioactivity.
- leak testing, ultrasonic:** Leak test that detects ultrasound in the 40 kHz range from gas flowing through the leak path. See also *leak testing, acoustic*.

- leech:** In magnetic particle testing, permanent magnetic or electromagnetic accessory used to ensure adequate electrical contact during current flow magnetization. Sometimes spelled *leach*.
- leech box:** In leak testing, the double compartmented box of which the outer compartment is evacuated and then the inner compartment is pressurized to produce a pressure differential across the test boundary under the inner compartment.
- lens:** Transparent object, whether artificial or natural, that refracts light passing through it in order to focus the light.
- lens optics:** See *geometrical optics*.
- lifting power:** In magnetic particle testing, the mass of a ferromagnetic bar that a yoke can suspend through attraction. Often this mass is a minimum that the yoke must meet or exceed.
- liftoff:** In electromagnetic testing, distance between the probe coil and the test object.
- liftoff effect:** In electromagnetic testing, the change in system response observed because of a change in *coupling* between a test object and a *probe* whenever the distance between them is varied.
- 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 adapted vision:** See *photopic vision*.
- light contamination:** In fluorescent nondestructive testing, unwanted visible light present in darkened test area. Sources may include gaps in curtains, *leaked visible light* from the UV-A source or fluorescence from the inspector's clothing.
- light guide bundle:** Bundle of filaments, usually glass, that carries noncoherent light (optical fibers are arranged in random order) from a high intensity source through a fiber optic borescope to illuminate an object. Contrast with *image guide bundle*.
- lighting, back:** Placement of light source and image sensor on opposite sides of the test object, used when the silhouette of a feature is important. Example back lighting applications would be optical profile projectors and industrial optical comparators.
- lighting, front:** Placement of light source and image sensor on the same side of the test object.
- lighting, strobe:** Lighting that flashes intermittently at a rate that may be adjusted and is often perceived as a flicker, used to image moving objects or still objects with potential movement.
- lighting, structured:** Combining a light source with optical elements to form a light pattern at a known angle. This technique can be useful for imaging or acquiring dimensional information.
- light meter:** See *photometer*. Compare *radiometer*.
- limited certification:** Of a person, certified only for specific operations; usually called *limited Level I or II* or designated as having limited certification because they are not qualified to perform the full range of activities expected of personnel at that level of qualification, for a given method.
- linearity, area:** In ultrasonic testing, constant proportionality between the signal amplitude and the areas of equal discontinuities located at the same depth in the far field. Necessarily limited by the size of the ultrasonic beam and configuration of the reflector.
- linearity, horizontal:** In ultrasonic testing, measure of proportionality between positions of indications on the horizontal trace and the positions of their corresponding reflectors.
- linearity, vertical:** In ultrasonic testing, constant proportionality between the signal input to the receiver and the amplitude of the signal appearing on the display of the ultrasonic instrument or on an auxiliary display.¹ Also called *amplitude linearity*.
- line pair:** Pair of adjacent, parallel lines used to evaluate the 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.
- lines of force:** See *magnetic flux*.
- liquid crystals:** In infrared and thermal testing, thermochromic (change color with temperature) chemical compounds with the mechanical properties of a liquid and the optical properties of a solid. Liquid crystal (some combination of cholesteric and/or chiral nematic compounds) optical properties cause them to reflect vivid spectral colors for temperature changes. Their adjustable response is sensitive and can be made to change from red to blue over a temperature gradient as small as 1 K (1 °C = 1.8 °F).
- liquid penetrant, dual-response:** Liquid penetrant that produces discontinuity indications visible under either ultraviolet radiation or visible light.
- liquid penetrant, fluorescent:** Highly penetrating liquid used in the performance of liquid penetrant testing and characterized by its ability to fluoresce under ultraviolet radiation.

- liquid penetrant testing, fluorescent:** Inspection technique that uses a dyed liquid that is usually green in color and fluoresces brilliantly under ultraviolet radiation. The sensitivity of a fluorescent penetrant depends on its ability to form indications that appear as small sources of light against a dark background. Also known as *fluorescent penetrant inspection* (FPI).
- liquid penetrant leak testing:** Technique of penetrant testing in which the penetrant is applied to one surface of a test material while the opposite surface is tested for indications that would identify a leak or void passing through the material thickness.
- liquid penetrant, liquid oxygen (LOX) safe:** Liquid penetrant material or system specifically designed to be compatible with or nonreactive in presence of liquid oxygen.
- liquid penetrant, postemulsifiable:** Liquid penetrant that requires the application of a separate emulsifier to render the excess surface liquid penetrant water washable. See also *emulsifier; soak*.
- liquid penetrant testing (PT):** Nondestructive testing method using a liquid that can enter discontinuities open to the test surface. When drawn into a layer of developer, the liquid is highly visible in small traces. *Fluorescent liquid penetrants* fluoresce brightly under ultraviolet radiation, whereas *visible dye penetrants* are intensely colored to be readily visible on developer backgrounds when illuminated with visible light. See also *liquid penetrant testing, fluorescent; visible dye penetrant*.
- liquid penetrant, water washable:** Liquid penetrant with built in emulsifier that makes it directly water washable.
- location plot:** In acoustic emission testing, a spatial representation of acoustic emission sources calculated by using an array of transducers.
- logarithmic decrement:** In ultrasonic testing, the natural logarithm of the ratio of the amplitudes of two successive cycles in a damped wave train.
- 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*.
- longitudinal magnetic field:** Active or residual magnetization oriented along the longest axis of the part. See also *longitudinal magnetization*.
- longitudinal magnetization:** Result of magnetic field flow magnetization where induced magnetic flux lines flow parallel to the long axis of the component. Longitudinal magnetization occurs within an encircling coil, between the poles of an electromagnetic yoke or contour probe, between iron core induction coil pole extenders or between a pair of permanent magnets. See also *field flow magnetization*.
- 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 percent of the time. With such a plan, the producer agrees to supply just enough nonconforming product such 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 smoothen abrupt transitions in a digital image. Also called *smoothing*.
- lumen (lm):** SI photometric unit of luminous flux, weighted according to the photopic vision response. One lumen equals the light emitted by one candela (cd) point source into one steradian (sr) solid angle ($1 \text{ lm} = 1 \text{ cd}\cdot\text{sr}^{-1}$).
- lumen method:** In visual testing, lighting design procedure used for predetermining the relation between the number and types of luminaires (lamps), the room characteristics and the average illuminance on the work plane. It takes into account both direct and reflected flux. Also called *flux method*.¹⁹
- 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 ($\text{cd}\cdot\text{m}^{-2}$). Compare *illuminance*.
- luminous efficacy; luminous efficiency:** Ratio of the total luminous flux of a light source to the total radiant flux or to the power input.
- luminous exitance:** luminous flux per area, emitted or reflected from a certain location on a surface. Measured in lumens per square meter ($\text{lm}\cdot\text{m}^{-2}$). Compare *radiant exitance*.
- luminous flux:** Luminous energy per unit time as measured in lumens. Compare *radiant flux*.
- luminous intensity:** Luminous flux per unit solid angle in the direction of interest. Measured in candela. Compare *luminance; radiant intensity*.

lux (lx): SI unit of illuminance, equal to one lumen per square meter ($1 \text{ lx} = 1 \text{ lm}\cdot\text{m}^{-2}$).

luxmeter: Device used to measure illuminance. See *photometer*.

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.

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 degrees and which absorbs blue light, thus changing the color of the light reaching receptors beneath. See also *fovea centralis*.

magnetic circuit: Path followed by flux lines that may include the test object, any air gaps and an electromagnetic or permanent magnet yoke.

magnetic field: Energy vector field surrounding a magnet or electric circuit.

magnetic field indicator: In magnetic particle testing, small, hand held device used to display the intensity of uniform external magnetic flux as angular deflection of a display needle. The device contains a permanent reference magnet coupled to a movable, field sensing magnet, and some units may be calibrated. Often called a *pocket field indicator*.

magnetic field intensity (H): Magnitude of the vector field surrounding a magnetic dipole,²⁶ in ampere per meter. Often called *magnetic field strength*.

magnetic field, tangential: Magnetic field at an object's surface parallel to the surface. The tangential field is continuous (equal on either side) with the interface of material to air. Measurement can be influenced by external fields.

magnetic flow magnetization: See *field flow magnetization*.

magnetic flux: Convenient concept for visualizing the vector field of magnetic induction that comprises a magnetic field. Flux lines form closed loops that do not cross. Magnetic flux is governed by the density of flux lines. The number of flux lines is expressed in weber (Wb), where $1 \text{ Wb} = 10^8$ maxwell (Mx). The density of flux lines is expressed in tesla (T), where $1 \text{ T} = 10^4$ gauss (G).

magnetic flux density (B): Amount of magnetic induction passing perpendicularly through a given area, measured in tesla.

magnetic flux indicator: See *flexible laminated strip*; *shared flux indicator*. Compare *magnetic field indicator*.

magnetic flux leakage field: Magnetic field that leaves or enters the surface of an object.

magnetic flux leakage testing (MFL): Nondestructive test method where induced magnetism in a ferromagnetic object forms localized poles at surface. Near-surface discontinuities are indicated by a signal in an induction coil or hall element. Compare magnetic particle testing.

magnetic flux meter: Device that measures total change in magnetic flux density by monitoring the voltage induced in a coil.²⁷ See also tesla meter.

magnetic gradient: Change in magnetic field intensity with distance, in amps per square meter ($\text{A}\cdot\text{m}^{-2}$).

magnetic particle: In magnetic particle testing, finely divided ferromagnetic powder of proper size, shape, relative permeability, visibility and retentivity for use in a test.

magnetic particle, dry powder: In magnetic particle testing, ferromagnetic particles, larger than those used in wet suspensions, introduced to the test object surface by dusting or puffing. See also *powder bulb*; *powder blower*.

magnetic particle; dual-use: In magnetic particle testing, particle coated with pigment that provides contrast when viewed under controlled levels of ambient white light but that also fluoresces under ultraviolet radiation. Testing with fluorescent particles is performed under low ambient lighting and controlled ultraviolet radiation.

magnetic particle; fluorescent: In magnetic particle testing, a particle coated with pigment that fluoresces when excited with UV-A radiation. Testing with fluorescent particles is performed under low ambient lighting and controlled ultraviolet radiation.

- magnetic particle testing (MT):** Nondestructive testing method where induced, or residual, magnetism in a ferromagnetic test object forms localized poles at surface and near-surface discontinuities indicated by a finely divided iron based powder. Compare *magnetic flux leakage testing*.
- magnetic particle, visible:** In magnetic particle testing, common term describing finely divided powder for nonfluorescent magnetic particle tests. The particles may be their natural color or may be coated to enhance contrast. Testing using visible particles is performed under a controlled level of ambient lighting and typically does not need any ultraviolet irradiation.
- magnetic pole:** One of two opposite ends of a dipole where flux enters or leaves a magnetized object. Any location where flux enters or leaves a test object.
- magnetic rubber:** In magnetic particle testing, replica casting medium containing magnetic particles, which when cured and removed from a properly magnetized recess, provides a permanent mold with visible indications.
- magnetic saturation:** Result of complete domain alignment where an increase in the coercive field H produces no change in flux density B . See also *hysteresis loop*.
- magnetic sector:** In leak testing, permanent magnet that separates the ion species in the spectrometer tube of the helium mass spectrometer.
- magnetic stripe card:** In magnetic particle testing, a credit card sized device with encoded magnetic reversals of varying strength for regular evaluation of bath sensitivity. See also *particle concentration*. Compare *settling test*.
- magnetic writing:** In magnetic particle testing, nonrelevant indication that may be caused when two magnetized objects come into contact.
- magnetization:** (1) Induced dipole moment per unit volume of a solid. (2) Act of inducing a magnetic field in a ferromagnetic object.
- magnetizing force:** Magnetomotive force per unit length of a magnetic circuit. Measured in ampere turns per meter ($\text{At}\cdot\text{m}^{-1}$).
- magnetomotive force:** Magnetic field intensity, measured in air or vacuum in ampere turns.
- magnetometer:** In magnetic particle testing, device for measuring the strength of magnets or the intensity of magnetic fields. See *pocket field indicator*.
- magnification:** The ratio of apparent image size of an object viewed through an optical system to its actual size.
- main bang:** See *initial pulse*.
- manifold:** In leak testing, a collection of vacuum hardware such as valves, piping and chambers connected together to form a test system.
- manipulator:** In the immersion technique of ultrasonic testing, a device for angular orientation of the transducer²⁸ and for scanning motion in three axes.
- magnitude:** Absolute value of a complex quantity (number) without reference to the phase of the quantity.
- marker:** In ultrasonic testing, series of indications on the horizontal trace of the A-scan display screen to show increments of time or distance.¹⁸
- 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) Covering of a portion of a test object or film so as to prevent tracer gas from entering leaks that may exist in the covered section. (4) In radiographic testing, a selective radiation filter. (5) In radiography, a cover with an aperture to view a specific area.
- mass flow rate:** In leak testing, weight, moles or number of molecules passing through a system as function of time.
- mass spectrometer leak detector:** Device that measures the mass-to-charge ratio and has design factors optimized to produce an instrument that has high sensitivity to a single tracer gas.
- mass-to-charge ratio:** Ratio of mass (kilogram) to electrical charge (coulomb) of a molecule or the atomic mass of the molecule divided by the atomic charge of the molecule.²³
- match bend effect:** Optical illusion whereby an area of uniform brightness appears to be nonuniform because of contrast with the brightness of an adjacent area.
- material safety data sheet:** 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*.¹⁹

mathematical morphology: Image processing technique of expanding and shrinking. The basic operators in mathematical morphology are dilation (expanding), erosion (shrinking), opening and closing.

matte: Having a surface that reflects light diffusely rather than at an angle equal to the angle of incidence; not shiny. If reflection from a surface is completely isotropic, it is *lambertian*. The term *matte* is generally applied to smooth surfaces or coatings. Compare *specular*.

Maxwell's equations: Fundamental equations of electromagnetic field theory:

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{H} = \frac{\partial \mathbf{D}}{\partial t} + \mathbf{J}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \cdot \mathbf{D} = \rho$$

where \mathbf{B} is magnetic flux density, \mathbf{D} is electric flux density, \mathbf{E} is electric field intensity, \mathbf{H} is magnetic field intensity, \mathbf{J} is current density, t is time, ρ is volume charge density and ∇ is the del operator.

measurement spatial resolution,

IFOV_{meas}: In infrared and thermal testing, smallest target spot size on which an infrared imager can produce a measurement, expressed in terms of angular subtense (mrad per side). The slit response function (SRF) test is used to measure IFOV_{meas}.

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).

medium; transmitting medium:

Composition of the measurement path between a target surface and the measuring instrument through which the radiant energy propagates. This can be vacuum, gaseous (such as air), solid, liquid or any combination of these.

mercury cadmium telluride (HgCdTe):

Material used for fast, sensitive infrared photodetectors used in infrared sensors, scanners and imagers that requires cooled operation. Operation is in the long wavelength region (8 to 12 μm).

mesopic vision: Vision adapted to a level of light between photopic (greater than 3 $\text{cd}\cdot\text{m}^{-2}$) and scotopic (less than 0.01 $\text{cd}\cdot\text{m}^{-2}$). An official definition of the human eye's mesopic composite spectral response has not yet been developed. See also *dark adaptation*.

Compare *photopic vision*; *scotopic vision*.

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.

microsegregations: (1) Segregation within a grain, crystal or small particle. Also called *coring*. (2) Narrow cracks, usually long and straight, on the surfaces of highly finished wrought metals. Often very shallow, their identity must be established to ensure that indications are not from detrimental cracks, deep laps or long inclusion stringers.

microwave testing: Nondestructive testing method that uses, for its probing energy, electromagnetic radiation at radio frequencies — from 0.3 to 300 GHz, with wavelengths from 1 mm to 1 m.

MIG welding: See *welding, gas metal arc*.

minimum line pair: Closest distance that a specific imaging system can resolve between a pair of adjacent, parallel lines (line pair) used to evaluate system resolution.

mode conversion: Change of ultrasonic wave propagation mode upon reflection or refraction at an interface.

mode converted signal: Unintended signal from mode conversion of primary test angle, due to interaction with component geometry such as the signals after back wall signal when testing a long narrow bar.

- mode of vibration:** Manner in which an acoustic wave is propagated, as characterized by the particle motion in the wave¹⁸ (transverse, lamb, surface or longitudinal).
- model, analytical:** Mathematical representation of a process or phenomenon.
- modulation:** (1) In infrared and thermal testing, changes in one wave train caused by another. (2) In thermal scanning and imaging, image luminant contrast
 $(L_{\max} - L_{\min}) \cdot (L_{\max} + L_{\min})^{-1}$.
- modulation transfer function:** In infrared and thermal testing, measure of the ability of an imaging system to reproduce the image of a target. A formalized procedure is used to measure modulation transfer function. It assesses the spatial resolution of a scanning or imaging system as a function of distance to the target. See also *slit response function*.
- 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*.
- molecular flow:** In leak testing, phenomenon occurring when mean free path length of gas molecules is greater than the largest cross sectional dimension of a leak or the tube through which flow is occurring.
- molecular weight:** For a gas, the mass of 22.4 L (0.8 ft³) at standard conditions.
- 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.
- morphology:** See *mathematical morphology*.
- mottle:** (1) Apparently random positioning that creates an accidental pattern. (2) In radiographic testing, nonuniform density where it should be uniform, resulting from scattered radiation, secondary radiation, forward scatter and film irregularities. Often confused with *graininess*.
- multidirectional magnetization:** In magnetic particle testing, two or more magnetic fields in different directions imposed on a test object sequentially and in rapid succession through phase control of the supplied current. See also *phase* and *swinging field magnetization*.
- multifrequency:** In electromagnetic testing, two or more frequencies applied sequentially or simultaneously to the test coil.
- multifrequency technique:** In electromagnetic testing, use of the response of a test specimen to more than one frequency, usually to separate effects that would be indistinguishable at a single frequency.
- multiparameter; multivariable:** In electromagnetic testing, of or pertaining to a test system having many parameters that affect the response. These parameters can often be distinguished with a multifrequency technique.
- multiple-echo technique:** In ultrasonic testing, technique where thickness is measured between multiple back reflections, minimizing error from coatings or from changes in temperature or contact pressure.
- mutual inductance:** Property of two electrical circuits whereby a voltage is induced in one circuit by a change of current in the other circuit. See also *coupled*.¹⁶
- myopia:** See *nearsightedness*.

N

- narrow band:** Relative term denoting a restricted range of frequency response. Compare *broad band*.¹⁵
- NDE:** (1) Nondestructive evaluation. (2) Nondestructive examination. See *nondestructive testing*.
- NDI:** Nondestructive inspection. See *nondestructive testing*.
- NDT:** See *nondestructive testing*.
- near field:** Distance immediately in front of a plane transducer in which the ultrasonic beam exhibits complex and changing wavefronts. Also called the *fresnel field* or *fresnel zone*. Compare *far field*.¹⁸
- near ultraviolet radiation:** See *UV-A*.
- near vision:** Vision of objects nearby, generally within arm's length. Compare *far vision*.
- nearsightedness:** Vision acuity functionally adequate for viewing objects nearby, generally within arm's length. Also called *myopia*. Compare *farsightedness*.
- 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 in methods that distinguish a test object's near surface from its far surface, a distinction rarely made in magnetic particle testing.)

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

negative sliding: Rolling and sliding of meshing gears or rollers when the rolling and sliding are in opposite directions. Compare *positive sliding*.

neper (Np): Disused unit of physical field and power quantities; the natural logarithm of a ratio of two amplitudes (equal to 8.686 dB) used as a measure of attenuation. Power ratios are expressed as half the natural logarithm.

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 relationship of a discontinuity. The figure/ground relationship can be described as having a level of visual background noise.

neutron: Uncharged elementary particle with mass nearly equal to that of the proton.¹⁴

neutron fluence: Integrated exposure (product of current and time) of neutrons per unit area.

neutron flux: Neutron current; quantity of neutrons passing through a unit area per unit time.

nick: See *gouge*. Compare *tool mark*.

NIST: Acronym for the National Institute of Standards and Technology (formerly National Bureau of Standards), United States 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.

nit (nt): Disused unit for measuring *luminance*, equivalent to one candela per square meter.

noble metals: Cathodic metals (such as gold, platinum and silver), which strongly resist corrosion.

nodal point: In ultrasonic testing angle beam inspections, the location of reflections at opposite surfaces as a wave progresses along a test object. Compare *antinode*.

noise: Component of physical quantity, such as voltage, that provides nonrelevant information. Compare *signal*.

noise equivalent temperature

difference: In infrared and thermal testing, temperature difference equal to the noise signal; a measure of thermal resolution, but not taking into account characteristics of the display and the operator's subjective interpretation.

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 *evaluation* 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*.

nonferromagnetic material: Material not magnetizable and essentially not affected by magnetic fields. Compare *ferromagnetic material*.

normal incidence: (1) In ultrasonic testing, condition in which the axis of an ultrasonic beam is perpendicular to the entry surface of the test object. (2) Condition where the angle of incidence is zero.

normalize: Adjust a display or graph such that the maximum value is unity.

null: In electromagnetic testing, to adjust a bridge circuit so that the test sample and reference arms produce equal and opposite currents through the detector.

null signal: In electromagnetic testing, fixed component of the test coil signal that is subtracted from the output signal leaving only that part of the signal that varies with the test object conditions; it reduces dynamic range requirements.

nonrelevant indication: See *indication, nonrelevant*.

numerical analysis: Technique to generate numbers as the solution to a mathematical model of a physical system; used in place of a closed form analytic expression; usually requires digital computation.

O

objective: In discussion of a lens system (camera, borescope, microscope or telescope), of or pertaining to the end or lens closest to the object of examination — at the end opposite from the eyepiece. See also *distal*.

oersted (Oe): Disused CGS measurement unit of magnetizing force, or magnetic field intensity. Replaced in SI by ampere per meter, or ampere turns per meter: $1 \text{ Oe} = 79.57747 \text{ A}\cdot\text{m}^{-1}$.

ohm (Ω): Measurement unit of electrical resistance.

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*.

opaque: In infrared and thermal testing, impenetrable to radiant energy. In thermography, an opaque material is one that does not transmit thermal infrared energy.

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

opsin: See *visual purple*.

optic disk: Area in the retina through which the fibers from the various receptors cross the inner (vitreous humor) side of the retina and pass through it together in the optic nerve bundle. This transitional area is completely blind.

optics: Physical science of the transmission of radiation, especially of light. See also *geometrical optics*.

optimum frequency: Test frequency that provides the highest signal-to-noise ratio compatible with the detection of a specific discontinuity. Each combination of discontinuity type and material may have a different optimum frequency.

organoleptic: Relying on or using sense organs, such as the human eye.

orthicon: See *image orthicon*.

oscillogram: Common term for a record or photograph of data displayed on an oscilloscope screen.

outgassing: Forms of gas coming from material in a vacuum system. Includes gases adsorbed on the surface, dissolved in material and trapped in pockets and those due to evaporation.

P

parafoveal vision: See *scotopic vision*.

parallax: Apparent difference in position of an imaged point according to two differently positioned sensors.

parallel magnetization: In magnetic particle testing, the dubious practice of imparting circular magnetization in a sample near a current carrying conductor. Compare *internal conductor*.

paramagnetic material: A material that has a relative permeability slightly greater than unity and is practically independent of the magnetizing force. Compare *diamagnetic material; ferromagnetic material*.

parameter distribution: In acoustic emission testing, display of the number of times an acoustic emission parameter falls between the values x and $x + \delta x$ as a function of x . Typical parameters are amplitude, rise time and duration.

parasitic echo: See *spurious echo*.

particle concentration: In magnetic particle testing, amount of powder suspended within a known sample volume of bath. Typically measured with a settling test or through evaporation and weighing. See also *centrifuge tube*.

parting line: In manufacturing, mark left on the 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*.

parts per million (ppm): Concentration of a substance in a mixture. For example, the amount of solvent vapor in a working environment that is a health and safety hazard. The ratio of parts per million is expressed in units — for example, $\mu\text{L}\cdot\text{L}^{-1}$ or $\mu\text{g}\cdot\text{g}^{-1}$.

peak hold: Feature of an instrument whereby an output signal is maintained at the peak instantaneous measurement for a specified duration. Compare *valley hold*.

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 *mechanical cleaning*; *plastic deformation*.

pencil break source: In acoustic emission testing, an artificial source using the fracture of a brittle graphite or equivalent cylinder in a suitable fitting to simulate an acoustic emission signal. Also called *hsu-nielson source*.

penetrability: Ability of a material to be penetrated by an energy or liquid. For example, the ability to allow a liquid into very fine openings such as cracks, or the ability of an X-ray beam to pass through a material because of kilovoltage.

penetrameter: See *image quality indicator*.

penetrant: See *liquid penetrant*.

penetrant system monitor (PSM): Stainless steel panel that is used for regular liquid penetrant system verification to show that test sensitivity has not degraded with time. The penetrant system monitor panel is 100 mm (4 in.) wide \times 150 mm (6 in.) long \times 1.16 mm (0.085 in.) thick and is divided into two vertical halves. One half is chrome plated, which may or may not be media blasted, and contains five radial cracks of increasing size. The other half is media blasted and acts as a liquid penetrant removability tool. This panel is *not* designed to be a liquid penetrant sensitivity check. Also called *star burst panel* or *TAM panel*. Compare *known discontinuity standard*; *nickel-chrome known discontinuity standard*.

percent International Annealed Copper Standard (%IACS): Traditional measurement of *conductivity* σ as a percentage of the conductivity of pure copper, arbitrarily rated at 100 percent. In SI, conductivity is measured in siemens per meter ($S \cdot m^{-1}$). See also *conductivity*.

peripheral vision: Seeing of objects displaced from the primary line of sight and outside the central field of vision.¹⁹

permanent magnet: Material with high retentivity, which maintains magnetization after a coercive field has been removed. In magnetic particle testing, permanent magnet yokes must also have a high coercivity. Compare *electromagnet*.

permeability (μ): (1) Ability of a material to be magnetized, measured as increase in flux density. (2) Ratio of magnetic induction B over magnetizing force H . Absolute permeability in SI units is measured in henries per meter ($H \cdot m^{-1}$). The value and dimension of absolute permeability depend on the system of units used. In anisotropic media, permeability is a matrix. Compare *reluctance*. See also *hysteresis loop*; *permeability of free space*; *permeability, relative*.

permeability, incremental: In electromagnetic testing, ratio of the change in magnetic induction to the corresponding change in magnetizing force.

permeability, initial: Slope of the induction curve at zero magnetizing force as the test specimen begins to be magnetized from a demagnetized condition (slope at the origin of the B, H curve before hysteresis is observed).

permeability of free space (μ_0): Calculation constant describing the ratio of magnetic induction B to magnetizing force H within a vacuum. $1 \mu_0 = 4 \times 10^{-7} H \cdot m^{-1}$.

permeability, relative (μ_r): Unitless ratio of a material's *permeability* to the *permeability of free space*.

pH: A measure of the acidity or alkalinity of a solution. Negative of $\log C$, where C is the concentration of hydrogen ions. Values lower than 7.0 are acidic; values equal to 7.0 are neutral; values higher than 7.0 are alkaline.

phantom: In ultrasonic testing, reference standard or realistic model used to verify the performance of diagnostic ultrasound systems.

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 (thyristors, for example, vary total power output through phase control). (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 analysis: In electromagnetic testing, analytical technique that discriminates between variables in a part undergoing electromagnetic testing by the different phase angle and amplitude changes that these conditions produce in the test signal. See also *phase detection*.²³

- phase angle:** In electromagnetic testing and magnetic particle testing, angular equivalent of the time displacement between corresponding points on two sine waves of the same frequency.²³
- phased array:** In ultrasonic testing, mosaic of transducer elements in which the timing of the elements' excitation can be individually controlled to produce certain desired effects, such as steering or focusing the beam. See also *transducer, array*.
- phase detection:** In electromagnetic testing, derivation of a signal whose amplitude is a function of the phase angle between two alternating currents, one of which is used as a reference.²³
- 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.
- phase sensitive system:** In electromagnetic testing, system whose output signal depends on the phase relationship between the voltage returned from a pickup or sensing coil and a reference voltage.²³
- phase shift:** In electromagnetic testing, change in the phase relationship between two alternating quantities of the same frequency.²³
- phase velocity:** In ultrasonic testing, velocity of a continuous acoustic wave at a particular frequency.
- phasor:** Complex number that represents the amplitude and *phase* of a quantity that varies sinusoidally with time. A phasor is not a *vector quantity*, because the orientation of a vector represents direction.
- photochromic lens:** Eyeglass material that automatically darkens to reduce light transmission when exposed to ultraviolet radiation.
- photoconduction:** Method by which a vidicon television camera tube produces an electrical image, in which the conductivity of the photosensitive surface changes in relation to the intensity of the light reflected from the scene focused onto the surface. Compare *photoemission*.
- photodetector; photon detector:** In infrared and thermal testing, type of infrared detector that has fast response (on the order of microseconds), limited spectral response and usually requires cooled operation. Photodetectors are used in infrared radiation thermometers, scanners and imagers because, unlike thermal detection, direct photon interaction obviates external heating of the detector for the signal to be sensed. Compare *pyroelectric detector*.
- photoelasticity:** Effect of a material's elastic properties on the way that it refracts or reflects light. This phenomenon is commonly used to estimate the magnitude and distribution of stress in a component through the use of either a transparent model of a part or a thin layer of photoelastic material bonded to a component.
- photoelectric effect:** Emission of free electrons from a surface bombarded by sufficiently energetic photons. Such emissions may be used in an illuminance meter, calibrated in lux.¹ Interaction of photons with atoms in which the full energy of the photon is absorbed by an orbital electron, removing the electron from the atom.
- photoemission:** Method by which an image orthicon 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 *photoconduction*.
- 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; relative photometry*. Compare *radiometry*.
- photon:** Particle of light, hypothesized to explain those behaviors of light in which its behavior is corpuscular 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 *mesopic vision; scotopic vision*.¹⁹
- photoreceptor:** Light sensor.
- physical properties:** Nonmechanical properties such as density, electrical conductivity, heat conductivity and thermal expansion.
- picture element:** See *pixel*.

- pie gage:** In magnetic particle testing, one type of *shared flux indicator* in the form of a handle mounted disk comprised of ferromagnetic wedges surrounded by a copper matrix. When properly demagnetized before use the space between wedges provides artificial discontinuities at 0, 45 and 90 degrees and provides verification of magnetic flux direction during dry powder testing. Compare *berthold penetrometer*.
- piezoelectric effect:** Ability of certain materials to convert electrical energy (voltage) into mechanical energy (stress) and vice versa.¹⁵
- pigtail:** In gamma radiography, flexible cable to which an isotope bearing *pill* may be attached for movement in and out of a shielding container. See also *control cable; guide tube*.
- pill:** In gamma radiography, capsule containing isotopic source of radiation. See also *control cable; guide tube; pigtail*.
- pipe:** (1) 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*. (2) Cast or wrought tubular product.
- pirani gage:** In leak testing, a *wheatstone bridge* circuit that measures the effect of gas thermal conductivity changes corresponding to pressure variations. Measures pressure from atmospheric down to 0.1 Pa (1 mtorr).
- pitch catch technique:** Ultrasonic test technique that uses two transducers, one transmitting and the other receiving on the same or opposite surface.^{15,18 21} Also called *double-crystal technique* or *two-transducer technique*. Compare *multiple echo technique; pulse echo technique*.
- 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*.
- plane of focus:** See *focus, principal plane of*.
- Planck's distribution law:** Fundamental law that relates the emitted energy spectral radiance to wavelength and to emitted surface temperature. See also *blackbody; incandescence; stefan-boltzmann law; Wien's law*.
- plane wave:** See *wave, longitudinal*.
- plastic deformation:** Permanent distortion due to an applied stress above a material's elastic limit. See also *dissipation*. Compare *elastic deformation*.
- plate wave:** See *wave, lamb*.
- pocket field indicator:** See *magnetic field indicator*.
- point of incidence:** In ultrasonic testing, point at which the axis of a sound beam leaves the wedge of an angle beam transducer and enters the test object.¹⁵ See also *probe index*.
- pole:** See *articulated pole piece; magnetic pole*.
- poling:** Process of reorienting crystal domains in certain materials by applying a strong electric field at elevated temperatures, inducing macroscopic polarization and piezoelectric behavior.
- pooling:** In liquid penetrant testing, collection of excessive amounts of liquid penetrant, emulsifier, water or developer in an incompletely drained area of a part.
- 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 metal resulting from the creation or coalescence of gas. Very small *pores* open to the surface are called *pinholes*.²²
- positive sliding:** Rolling and sliding of meshing gears or rollers when the directions of rolling and sliding are the same. Compare *negative sliding*.
- postemulsification:** Liquid penetrant removal step that uses a separate *emulsifier* applied over the surface liquid penetrant to render it removable by water spray. See also *prerinse technique*.
- poultice corrosion:** See *corrosion, poultice*.
- powder blower:** In magnetic particle testing, compressed air device used to deliver a cloud of dry magnetic particles to the surface of a test object.
- powder bulb:** In magnetic particle or liquid penetrant testing, pneumatic device compressed by hand to deliver a cloud of dry magnetic particles or dry powder developer to the surface of a test object.
- practical examination:** In certification of nondestructive testing personnel, a hands-on examination using test equipment and sample test objects. Compare *general examination; specific examination*.
- precipitation hardening:** Hardening in metals caused by the formation (precipitation) of a constituent from a supersaturated solid solution. Method commonly applied to many aluminum alloys to increase strength. See also *aging*.

- prerinse technique:** In liquid penetrant testing, postemulsifiable penetrant removal step in which major portion of a nonwater washable liquid penetrant is mechanically removed with a water spray before application of *emulsifier*. Sometimes called *prewashing*. See also *postemulsification*.
- pressure proof testing:** In leak testing, test of system at pressure considerably above the allowable working pressure to demonstrate structural capability.
- primary radiation:** Radiation emitting directly from the target of an X-ray tube or from a radioactive source.¹⁴
- primary reference response level:** Ultrasonic response from the basic reference reflector at the specified sound path distance, electronically adjusted to a specified percentage of full screen height. See also *distance amplitude correction*.
- probability of detection (PoD):** The probability of finding an anomaly of given characteristics, under precise conditions, while using a specific test procedure.
- probe:** See *sensor; transducer*.
- probe index:** Point on a transverse wave or surface wave transducer through which the emergent beam axis passes.²⁰ See also *point of incidence*.
- process:** Repeatable sequence of actions to bring about a desired result.
- process control:** See *statistical process control*.
- prod:** In magnetic particle testing, handheld pair of electrodes for transmitting magnetizing current from a portable power source to the test object during the prod magnetization technique. See also *leech*.
- prod magnetization technique:** In magnetic particle testing, imparting circular magnetization in a component by passing current directly through it via a *prod*. See also *current flow magnetization*.
- 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 to *interlaced scanning*.
- propagation:** Advancement of energy or a crack through a medium.
- pseudocolor:** Image enhancement technique wherein colors are assigned to an image at several gray scale 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™ plates*.
- 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*.
- PT:** Liquid penetrant testing.
- pulse:** In ultrasonic testing, transient electrical or ultrasonic signal that has a rapid increase in amplitude to its maximum value, followed by an immediate return. Compare *burst*.
- pulse echo technique:** Ultrasonic test technique in which discontinuities are detected by return echoes from the transmitted pulses. Compare *multiple echo technique*.
- pulse technique:** In electromagnetic testing, *multifrequency technique* in which a broadband excitation such as an impulse is used. Either the frequency components are extracted and analyzed or the interpretation is based directly on characteristics of the time domain waveform.
- pulse tuning:** Control of ultrasonic ultrasonic pulse frequency to optimize system response.
- pump, adsorption:** Pump that creates a vacuum by collecting gas on the interior surfaces of the pump. Pressures of 2 Pa (20 μ bar) are readily attained. The pump has a finite capacity but may be regenerated for additional use. See also *backstreaming; baffle*.²³
- pump, cryogenic:** Pump that condenses chamber gas on a cold surface of 4 to 80 K (–269 to –194 °C). Cooling is provided by liquid gas such as liquid helium or by refrigeration. See also *backstreaming; baffle*.²³
- pump, diffusion:** High vacuum pump with no moving mechanical parts that uses a vapor jet to sweep gas from the vacuum chamber and achieve pressures as low as 1 nPa (10 ptorr).²³
- pump, displacement:** Mechanical pump that physically sweeps gas out of a volume and creates a vacuum. Rotary piston and rotary vane pumps are two examples. A displacement pump can achieve pressures in the 0.1 to 1.0 Pa (10 to 1 mtorr) range. See also *backstreaming; baffle*.
- pump, fore:** Mechanical pump in a helium mass spectrometer that performs initial evacuation of a system to a pressure of 0.1 Pa and then accepts the exhaust from the high vacuum pump such as a diffusion pump. The forepump lowers pressure to less than 10 kPa into which the diffusion pump can exhaust its gas.

pump, ion: Pump that combines electric and magnetic fields to ionize gas and trap the gas inside the pump, thus removing it from the vacuum chamber. See also *ionization gage*.²³

pump, mechanical: Mechanical device with pumping fluid and seals that physically removes a portion of the gas from a system with each revolution of the armature. A mechanical pump can pump a chamber down to about 0.1 Pa (1 mtorr). See also *gas ballast*; *roots blower*.

pump, sorption: Pump consisting of a sieve and liquid nitrogen with ability to pump to 0.1 Pa (1 mtorr).²³

pump, turbomolecular: Molecular turbine that drives gas out of a vacuum chamber, achieving a high vacuum pressure in the 10 nPa (0.1 ntorr) range.

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

pyroelectric detector: Type of thermal infrared detector that acts as a current source with its output proportional to the rate of change of its temperature (heating or cooling of pyroelectric material creates charge accumulation). Compare *photodetector*.

pyroelectric vidicon: Video camera tube with its receiving element fabricated of pyroelectric material and sensitive to wavelengths from about 2 to 20 μm ; used in infrared thermal viewers. Sometimes called *pyrovidicon*. Compare *vidicon tube*.

pyrometer, laser: Infrared radiation thermometer that projects a laser beam to the target, uses the reflected laser energy to compute target effective emissivity and automatically computes target temperature (assuming that the target is a diffuse reflector). Not to be confused with laser aided aiming devices on some radiation thermometers.

pyrometer, ratio: Infrared thermometer that uses the ratio of incoming infrared radiant energy at two narrowly separated wavelengths to determine a target's temperature independent of target emittance; this assumes *graybody* conditions and is normally limited to relatively hot targets, above about 420 K (150 °C \approx 300 °F).

pyrometry: Measurement of fire or of hot objects, such as the monitoring of furnace or foundry conditions.

Q

Q of a coil: *Quality factor* of an electromagnetic testing coil; related to the ratio of maximum energy stored to the total energy lost per period.

quadrature: Relation between two periodic functions when the phase difference between them is 90 degrees (that is, the time delay is one-fourth of a period).

qualification: Process of demonstrating that an individual has the required amount and the required type of training, experience, knowledge and abilities.¹⁹ 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 to meet the expectations of its users in terms of efficiency, appearance, reliability and ergonomics.¹⁹

quality assurance: Administrative actions that specify, enforce and verify quality.¹⁹

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.¹⁹

quality factor (Q): Of a coil used in electromagnetic testing, the ratio of *reactance* to *resistance* defined at the operating *frequency*.

quantitative quality indicator (QQI): In magnetic particle testing, a *shared flux indicator* containing an artificial discontinuity held in intimate contact with a test object's surface during active magnetization to ensure that proper magnitude and direction of magnetic induction have been obtained for testing. The artificial discontinuity may be circular or linear and is defined in terms of percent of total shim thickness.

quick break: In magnetic particle testing, sudden cessation of magnetizing current. A quick break is needed when using three-phase full-wave rectified alternating current during coil or induced current magnetization. The rapid change in current produces strong magnetic induction during toroidal magnetization and reduces the disturbing flux near poles for sensitive testing of the test object's ends during coil magnetization.

R

- rad:** Radiation absorbed dose. Unit of absorbed dose of ionizing radiation. One rad is equal to the absorption of 10^{-5} J (100 erg) of ionizing radiation energy per gram of matter.¹⁴ Replaced by the gray (Gy).
- 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 $180 \cdot \pi^{-1}$ degrees or 57.29578 angular degrees.
- 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 ($\text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$) 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 ($\text{W} \cdot \text{m}^{-2}$). In infrared and thermal testing, sometimes called *radiosity*. Compare *luminous exitance*.
- radiant flux:** Radiant energy's rate of flow, measured in watts or joules per second ($\text{J} \cdot \text{s}^{-1}$). Compare *luminous flux*.
- radiant intensity:** Electromagnetic flux emitted per unit solid angle in a given direction from the source. Measured in watts per steradian ($\text{W} \cdot \text{sr}^{-1}$). Compare *luminous intensity*.
- radiant power:** See *radiant flux*.
- radiation:** The transfer of energy through propagation of electromagnetic waves. See *radiant energy*. Compare *conduction*; *convection*.
- radiation reference source:** In infrared and thermal testing, *blackbody* or other target of known temperature and effective emissivity used as a reference to obtain optimum measurement accuracy, ideally, traceable to the *National Institute of Standards and Technology*.
- radiation safety officer:** Individual supervising program to provide radiation protection. The representative appointed by the licensee for liaison with the applicable regulatory agency.¹⁴
- radio frequency (RF) display:** In ultrasonic testing, presentation of unrectified signals.¹⁵ See also *A-scan*; *video presentation*.
- radiographic screens:** In radiographic testing, thin sheets used to intensify the effect of radiation on films.¹⁴ 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.
- radiographic testing:** Use of penetrating radiant energy in the form of X-rays, gamma rays or neutrons for nondestructive testing of objects to provide images of the objects' interiors. Also called *radiography*; *radiologic testing*.
- radiography:** See *radiographic testing*.
- radiological testing:** Disused term for *radiologic testing*.
- radiologic testing:** Another term for *radiographic testing*. Compare *radiology*.
- radiology:** Study of ionizing radiation and its interaction with material. Compare *radiologic testing*.
- radiometer:** Device used to measure *irradiance*. In nondestructive testing, radiometers are used to measure UV-A output or visible light in watts per square meter ($\text{W} \cdot \text{m}^{-2}$). Used in fluorescent liquid penetrant and magnetic particle testing to measure output of excitation sources. See also *irradiance*. Compare *photometer*.
- radiometry:** Study and measurement of electromagnetic radiation emitted by a source or falling upon a surface. Compare *photometry*.
- radiosity:** See *radiant exitance*.
- range:** In ultrasonic testing, maximum ultrasonic path length that is displayed. See also *sweep length*.¹⁵
- rankine:** Disused scale for absolute temperature and related to the fahrenheit relative scale. The rankine unit ($^{\circ}\text{R}$) is equal to 1°F ; $0^{\circ}\text{R} = -459.72^{\circ}\text{F}$.
- rarefaction:** Of particles in a propagating medium, thinning or separation due to the decompression phase of an ultrasonic cycle. Opposite of compression. A compressional wave is composed of alternating compressions and rarefactions.¹⁸

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 video pictures or frames and for a sensor bearing armature to cover a predetermined part of the surface of a test object.

rat's tooth principle: (1) The tendency for hard material on a tooth's front surface to wear more slowly than soft material on the back surface, keeping the edge sharp. (2) Mechanism of wear whereby adjacent hard and soft surfaces wear at different rates, producing a self-sharpening edge.

rebleed technique: See *bleed back technique*.

receiver: (1) Section of an ultrasonic instrument that amplifies echoes returning from the test object. (2) In ultrasonic testing, transducer that picks up the echoes.

recommended practice: Set of guidelines or recommendations. Compare *code*; *standard*.¹⁹

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.

recovery time: Time required for a test system to return to its original state after overload or signal reception.

rectified alternating current: See *half-wave current* and *full-wave current*.

red mud: Debris (usually oxides of the contacting metals) of fretting wear, mixed with oil or grease and retained at or near the site of its formation. See also *cocoa*; *wear*, *fretting*.

reference junction: In a thermocouple, the junction of the dissimilar metals but not the measurement junction. The reference junction is normally maintained at a constant reference temperature.

reference number: In electromagnetic testing, number associated with the impedance of a coil adjacent to a test sample.

reference standard: (1) In NDT, an object containing known 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 which measurements made there are derived. Compare *working standard*.

reflectance; spectral reflectance: Ratio of wave energy (radiant flux) reflected from a material to incident wave energy (incident radiant flux) per unit area. Compare *reflectivity*.

reflection: General term for the process by which the incident energy leaves a surface or medium from the incident side, without change in frequency. Reflection is usually a combination of specular and diffuse reflection.¹⁹

reflection probe: Coil system that uses both an excitation and a detection or sensing coil on the same side of the sample.²³

reflectivity: Ability of a surface to reflect radiation, expressed as the ratio ρ of the intensity of the total energy reflected from a surface to total radiation on that surface:

$$\rho = 1 - \varepsilon - \tau$$

For a perfect mirror, reflectivity ρ approaches 1.0; for a *blackbody* the reflectivity is 0. Compare *reflectance*; *reflection*.

reflectometer: Instrument used for quantitative analysis of surface reflectance and appearance by describing surface reflectance properties like gloss, roughness and refractive index.

refracted beam: Beam transmitted in the second medium when an ultrasonic beam is incident at an acute angle on the interface between two media having different sound speeds. See also *Snell's law*.¹⁵

refraction: Deflection of a wave due to a change in its speed as it passes from one material to another. For ultrasonic energy, a change in both direction and mode occurs at acute angles of incidence. At small angles of incidence, the original mode and a converted mode may exist simultaneously in the second medium. See also *Snell's law*.

refractive index: Ratio of the speed of the incident wave to that of a refracted wave. It is known as the *refractive index* of the second medium with respect to the first.

refractometer: Device that measures the *refractive index* of a liquid. This value varies with concentration and hence has been used to measure hydrophilic remover, coolant or detergent concentrations.

reject: In ultrasonic testing, minimize or eliminate low amplitude signals (such as electrical or material noise) so that other signals may be further amplified. This control can reduce vertical linearity. Also called *suppression*.¹⁵

rejection level: Level above or below which a signal is an indication of a rejectable discontinuity.¹⁵

relative humidity: Ratio (in percent) of the water vapor content in the air to the maximum content possible at that temperature and pressure.

relative measurement: Evaluation of a property that is based upon some variable rather than a *calibration standard*. For example, relative irradiance would evaluate one radiation source based upon the emission of another radiation source, while absolute irradiance would be a calibrated measurement. Compare *absolute measurement*; *comparative measurement*.

reluctance: Resistance of a material to changes in magnetization. Reciprocal of *magnetic permeability*.

rem: Roentgen equivalent man. Disused unit of absorbed radiation dose in biological matter. It is equal to the *absorbed dose* in *rads* multiplied by the quality factor of the radiation. Compare *sievert*.¹⁴

remanent magnetism: See *residual magnetic field*.

remote viewing: (1) Indirect viewing of a test object far from the viewer's immediate presence — for example, viewing with telemetry or crawlers. The term *remote viewing* is used in the fields of robotics and surveillance to distinguish conventional from distant viewing tasks. (2) Viewing of a test object during which the light image is mediated through a system of two or more lenses (as in a borescope) or transduced through an electronic signal (as with a charge coupled camera). This use of the term *remote viewing* in some specifications is a misnomer, intended merely to distinguish borescopy from direct viewing. Compare *direct viewing*; *indirect viewing*.

repeatability: Ability to reproduce a result, for example a detectable indication, in separate processings and tests from a constant source.

repetition rate: In ultrasonic testing, number of pulses generated or transmitted per unit of time (usually seconds).

replica: Piece of malleable material, such as polyvinyl or polystyrene plastic film, molded to a test surface for the recording or analysis of the surface microstructure.

replication: Method for copying the topography of a surface by making its impression in a plastic or malleable material.

residual magnetic field: Magnetization remaining in a ferromagnetic material after magnetizing force H is reduced to zero.

residual technique: In magnetic particle testing, testing procedure used only with highly retentive materials where a remnant magnetic field is relied on to attract magnetic particles. Compare *continuous technique*.

resistance, electrical (R): Opposition to transmission of electric current through material; ratio of voltage to current. Measured in ohms (Ω). Inversely related to *conductance*:

$$R = \frac{1}{G} = \frac{\rho L}{A}$$

where A is the conductor's cross sectional area (square meter), G is conductance (siemens), L is the length of the conductor (meter) and ρ is resistivity (ohm meter).

resistance, thermal (R): Measure of a material's resistance to the flow of thermal energy, inversely proportional to its thermal conductivity k , where $k = 1 \cdot R^{-1}$.

resistance temperature device: Sensor that measures temperature by a change in resistance as a function of temperature.

resistivity (ρ): Ability of material to resist electric current. Measured in ohm meter ($\Omega \cdot m$), which is the resistance of a cube made of the material whose dimensions are 1 m on each side. Inversely related to *conductivity* σ (siemens per meter):

$$\rho = \frac{1}{\sigma}$$

resolution: A system's ability to depict two objects or signals in close proximity as separate from one another. Resolution, or resolving power, varies with size, distance, sensor characteristics, object shape, object color and contrast. See also *line pair*.

- resolving power:** Ability of detection systems to separate two points in time or distance. Resolving power depends on the angle of vision and the distance of the sensor from the test surface. Resolving power in vision systems is often measured using parallel lines. Compare *resolution*.
- resonance:** Condition in which the frequency of a forcing vibration (ultrasonic wave) is the same as the natural vibration frequency of the propagation body (test object), possibly resulting in large amplitude vibrations.¹⁸
- resonance technique:** In ultrasonic testing, method using the resonance principle for determining speed, thickness or presence of laminar discontinuities.
- resonance testing, process compensated (PCRT):** Inspection method, generally coupled with computer based resonance spectroscopy, for detecting discontinuities based on a change in the resonance of a component. *Resonance* changes with mass, shape and material properties.
- resonant frequency:** Frequency at which a body vibrates freely after being set in motion by some outside force.¹⁸
- response time:** In leak testing, the time required for a leak detector signal to reach a specified value after the application of a step input.^{23,18} The signal reaches 63 percent of final value in one time constant.
- response factor:** In leak testing, response of a halogen leak detector to $3 \times 10^{-7} \text{ Pa}\cdot\text{m}^3\cdot\text{s}^{-1}$ (3×10^{-6} std $\text{cm}^3\cdot\text{s}^{-1}$) of tracer refrigerant-12 or less, divided by the response to the same quantity of another tracer gas. Thus, the actual leakage rate of a detected leak will equal the indication of the detector multiplied by the response factor of the specific halogen tracer gas used. The response factor of a mixture of tracer and nontracer gases will be the response factor of the tracer divided by the fraction of tracer gas in the test gas (by volume).
- response function:** In electromagnetic testing, ratio of response to excitation, both expressed as functions of the complex impedance.¹⁶
- retentivity:** Material's ability to maintain remnant magnetism in the absence of a coercive field.
- retina:** In the eye, the tissue on back, inside surface of the eyeball, opposite the *pupil*, where light sensitive rods and cones sense light. See also *cone*; *fovea centralis*; *iris*; *pupil*; *rod*.
- retinene:** See *visual purple*.
- rhodopsin:** See *visual purple*.
- right hand rule:** In magnetic particle testing, a technique for visualizing the relationship between a flowing current and its induced magnetic field. When the right hand is closed in a fist with the thumb extended and when current flows out along the thumb, the fingers point in the direction of the self-induced magnetic field.
- ringing signals:** (1) In ultrasonic testing, closely spaced multiple signals caused by multiple reflections in a thin material. (2) In ultrasonic testing, signals caused by continued mechanical vibration of a transducer.¹⁵
- ringing technique:** In ultrasonic testing, test technique for bonded structures in which unbonds are indicated by increased amplitude of ringing signals.¹⁵
- ringing time:** In ultrasonic testing, time that the *ringing signal* of a transducer continues after the electrical driving force behind the *initial pulse* has been removed.
- rinse:** In liquid penetrant testing, process of removing liquid penetrant testing materials from the surface of a test object by means of flooding with another liquid, usually water. Also called *wash* when performed after emulsification.
- rise time:** In magnetic particle testing, the duration of time for a current source to reach its set point.
- rockwell hardness testing:** Evaluation method for determining the hardness of a material by forcing an indenter into it under specified conditions. Conditions and indenter type and size vary with the rockwell hardness scale chosen. Indentation depth is related to hardness, and the result is reported as the material's rockwell hardness. Compare *brinell hardness testing*.
- rod:** Retinal receptor that responds at low levels of luminance even down below the threshold for cones. At these levels there is no basis for perceiving differences in hue and saturation. No rods are found in the fovea centralis.¹⁹ Concentrated toward the outer region of the retina, rods assist with mesopic vision and are responsible for scotopic night vision. Compare *cone*.
- roentgen (R):** Disused unit for measurement of *ionizing radiation* intensity; amount of ionizing radiation that will generate one electrostatic unit in 1 cm^{-3} of air at standard atmospheric conditions. The roentgen has been replaced by an SI compound unit, coulomb per kilogram ($\text{C}\cdot\text{kg}^{-1}$).

roof angle: In a dual-element delay line transducer for ultrasonic testing, the tilt angle by which the transducer elements of the *delay line* are oriented to direct the beams of the two elements to intersect at a specified zone in the medium.

root mean square (RMS): Statistical measure of the magnitude of a varying quantity. Also known as *quadratic mean*, root mean square is especially useful when data varies between positive and negative (for example, a sinusoidal wave).

roots blower: Blower that uses two lobed rotors mounted on parallel shafts with mechanical pumps to obtain greater pumping speeds and lower pressures.²³

rotameter: Meter that uses a float and a tapered glass bore to measure flow.²³

rusting: Formation of hydrated iron oxides on the surface of a ferrous (for example, iron or steel) component. See also *corrosion*. Compare *scaling*.

S

SAM: Acronym for scanning *acoustic microscope*.

sample and hold: Feature of an instrument whereby an output signal is maintained at an instantaneous measurement value for a specified duration after a trigger or until an external reset is applied.

sampling, partial: Testing of less than 100 percent of a production lot.

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: (1) In nondestructive testing, signal amplitude at or above sensor's maximum capability. (2) In magnetic particle testing, that degree of magnetization where a further increase in magnetizing force produces no significant increase in magnetic flux density in an object. (3) In visual testing, relative or comparative color characteristic resulting from a hue's dilution with white light.

scan angle: For a line scanner, the total angular scan possible at the target plane, typically 90 degrees.

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.

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*.

scale: (1) Layer of adherent oxidation product on the surface of a metal, caused by elevated temperature exposure to an oxidizing atmosphere. (2) Layer of insoluble constituents on a metal surface, as in cooling tubes and water boilers.²² Compare *corrosion*; *rusting*.

scattering: Random reflection and refraction of energy caused by interaction with material it strikes or penetrates. See also *backscatter*; *compton scatter*; *fogging*; *mottling*.

schlieren system: In ultrasonic testing, optical system used for visual display of an ultrasonic beam passing through a transparent medium.¹⁵

scintillation: In radiographic testing emission of light of specific frequencies after the absorption of electromagnetic radiation, such as X-rays or gamma rays.

scoring: (1) Formation of deep scratches in the direction of sliding. (2) Reducing the thickness of a part along a line to weaken it purposely at a specific location.²²

scotopic vision: Dark adapted vision, using only the rods in the retina, where differences in brightness can be detected but differences in hue cannot. Vision is wholly scotopic when the luminance of the test surface is below 3×10^{-5} cd·m⁻² (2.7×10^{-6} cd·ft⁻²). Also known as *parafoveal vision*. See also *dark adaptation*. Compare *mesopic vision*; *photopic vision*.

scuff mark: Area covered by fine scratches, usually due to rubbing of one piece against another.

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

secondary magnetic flux: In electromagnetic testing, magnetic flux due to induced flow of eddy currents.

sector: For a line scanner, a portion of the total scan angle over which measurement is made at the target plane.

seebeck effect: See *thermoelectric effect*.

segregation: In manufacturing, nonuniform distribution of alloying elements, impurities or microphases.

- selectivity:** In electromagnetic testing, characteristic of a test system, a measure of the extent to which an instrument can differentiate between the desired signal and disturbances of other frequencies or phases.²³
- self-demagnetizing factor:** Estimate of the resistance of a test object to magnetization, the resistance being due to the proximity of magnetic poles of opposite polarity. For coil magnetization, the internal magnetization within a low $L \cdot D^{-1}$ ratio test object is opposite of the coil's magnetic field and a lower distance between poles results in a greater internal resistance.
- self emulsifiable:** See *penetrant, water washable*.
- self-inductance:** Ratio of magnetic flux formed around a conductor to the amount of current passing through a straight or coiled conductor. Self-inductance is measured in henries, where one henry equals one weber per ampere ($1 \text{ H} = 1 \text{ Wb} \cdot \text{A}^{-1}$). See also *inductance*.
- sensitivity:** Ability of a sensor or system to distinguish a signal or indication from background noise. 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.
- sensor:** Device that detects a material property or mechanical behavior (such as radiation or displacement) and converts it to an electrical signal or physical change.
- settling test:** In magnetic particle testing, one technique for determining the concentration of magnetic particles in a new bath or to check for contamination or other bath problems. See also *centrifuge tube; particle concentration*. Compare *magnetic stripe card*.
- shadow:** In ultrasonic testing, region in a test object that cannot be reached by ultrasonic energy traveling in a given direction. Shadows are caused by geometry or the presence of intervening large discontinuities.
- shadow casting:** In visual testing, technique of vapor depositing a thin metal film onto a replica at an oblique angle in order to obtain a micrograph of a test surface of an opaque test object.
- shared flux indicator:** In magnetic particle testing, device held in intimate contact with test object during active magnetization to show the direction of magnetic induction. Examples include the *berthold penetrometer, flexible laminated strip and pie gage*. See also *quantitative quality indicator*.
- shear wave:** See *wave, transverse*.
- shielding:** (1) In radiographic testing, material or object used to reduce intensity of or exposure to penetrating radiation. (2) In electromagnetic testing, conducting or magnetic material (or a combination of both) placed so as to decrease susceptibility to interference.
- shoe:** In ultrasonic testing, device used to adapt a straight beam transducer for use in a specific type of testing, including angle beam or surface wave tests and tests on curved surfaces.¹⁵ See also *wedge*.
- shot:** In magnetic particle testing, the period of time when current is flowing through the test object or induction coil. Shot duration and the number of shots required for testing may be varied. See also *coil technique; current flow technique*.
- shoulder:** In manufacturing, cylindrical metal component (pipe) surface, machined to receive threading indentations but in fact not threaded, where the thread stops on the outside surface of the pipe.
- 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 shrinkage sponge, small voids (stringers or bunches) or a fingerprint pattern of semifused seams. Also applied to surface shrinkage cracks.
- SH wave:** See *wave, transverse horizontal*.
- siemens per meter ($\text{S} \cdot \text{m}^{-1}$):** SI unit of *conductivity*.
- sievert (Sv):** SI unit for measurement of exposure to *ionizing radiation*; replaces *rem*. $1 \text{ Sv} = 1 \text{ J} \cdot \text{kg}^{-1} = 100 \text{ rem}$.
- SI (International System of Units):** International measurement system in which the following seven units are basic: meter, mole, kilogram, second, ampere, kelvin and candela.
- signal electrode:** In visual testing, transparent conducting film on the inner surface of a vidicon's faceplate and a thin photoconductive layer deposited on the film.
- signal processing:** Acquisition, storage, analysis, alteration and output of digital or analog data.

- signal-to-noise ratio:** Ratio of signal values (responses that contain relevant information) to baseline noise values (responses that contain nonrelevant information).
- signal:** Physical quantity, such as voltage, that contains relevant information.
- silicon controlled rectifier (SCR):** Solid state electronic component used to vary power output in an arcless manner. The power waveform from a silicon controlled rectifier will contain spikes: conversion between peak, root mean square and average is not straightforward across the output range.
- skin depth:** See *standard depth of penetration*.
- skin effect:** In magnetic particle testing and electromagnetic testing, term used to describe the penetration ability of cyclical current or magnetization as a function of frequency, conductivity and relative permeability. In magnetic particle testing, skin effect refers to alternating current's inability to penetrate deeper than 1 to 3 mm (0.04 to 0.12 in.) with typical testing variables.²⁵ See also *skin depth*.
- skip distance:** In angle beam tests of plate or pipe in ultrasonic testing, the distance from the sound entry point to the exit point on the same surface after reflection from the back surface. Also called *V path*.¹⁵
- slag:** Nonmetallic product resulting from the mutual dissolution of flux and nonmetallic impurities in smelting, refining and welding.
- slit response function:** In infrared and thermal testing, measure of the *measurement spatial resolution* ($IFOV_{meas}$) of an infrared scanner or imager. See *modulation transfer function*.
- smoothing:** In image processing, linear combination of pixel values to smooth abrupt transitions in a digital image. Also called *low pass filtering*.
- Snell's law:** In optics and acoustics, the physical law that defines the relationship between the angle of incidence and the angle of refraction. The relationship's numeric expression is the *index of refraction*.
- SNT-TC-1A:** See *Recommended Practice No. SNT-TC-1A*.
- soak time:** In liquid penetrant testing, period of time when the emulsifier remains in contact with the liquid penetrant on the surface of the test object. Soak time ceases when the liquid penetrant emulsifier is quenched with water or completely removed by water rinsing. Also called *emulsification time*. Compare *dwell time*. (2) In leak testing, the period of time between when the system or component reaches test pressure and either when the leak detector solution is applied to the surface or when the leak detector is used to scan that surface.¹⁸
- solvent:** (1) In chemical cleaning, a volatile liquid with the ability to dissolve another material. (2) In liquid penetrant testing, the liquid sometimes used to preclean and/or remove excess liquid penetrant from the specimen. See also *solvent removal*; *visible dye penetrant testing*.
- solvent removal:** In liquid penetrant testing, process of removing excess liquid penetrant from the surface of a test object by hand wiping with a *solvent dampened cloth*. See also *visible dye penetrant testing*.
- spalling:** Cracking or flaking of small particles of metal, usually in thin layers, from the surface of an object.
- spatial resolution:** Spot size in terms of working distance. In an infrared radiation thermometer, spot size is expressed in milliradians or as a ratio of the target spot size (containing 95 percent of the radiant energy, by convention) to the working distance. In scanners and imagers it is most often expressed in milliradians.
- 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*.¹⁹
- 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*.
- specific gravity:** Unitless ratio of the density of a material divided by the density of water. Water has a density of about 1 g·cm⁻³, or 1000 kg·m⁻³, at 15.6 °C (60 °F).
- spectral:** Prefix used to denote a variable that changes as a function of wavelength.
- spectral power distribution:** Radiant power per unit wavelength as a function of wavelength. Also known as *spectral energy distribution*, *spectral density* and *spectral distribution*. See *Planck's law*.
- spectral reflectance:** Radiant flux reflected from a material divided by the incident radiant flux.
- 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:** Fraction of incident radiant flux of a given wavelength that passes through a *medium*. See also *spectrophotometer*.
- spectrofluorometer:** Instrument capable of determining the fluorescent excitation and fluorescent emission spectra of a sample.
- 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 *spectrofluorometer*; *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.
- spectrum response:** In infrared and thermal testing, amplification (gain) of a receiver over a range of frequencies or wavelengths.
- specular:** Pertaining to a mirrorlike reflective finish, as of a metal. Compare *lambertian*.
- specular reflection:** When reflected waves and incident waves form equal angles at the reflecting surface. Compare *diffuse reflection*.
- speed of light:** Speed of all radiant energy, including light, is $2.997925 \times 10^8 \text{ m}\cdot\text{s}^{-1}$ in vacuum (approximately $186\,000 \text{ mi}\cdot\text{s}^{-1}$). In all transparent materials the speed is less and varies with the material's index of refraction, which itself varies with wavelength.¹⁹
- speed of vision:** Reciprocal of the duration of the exposure time required for something to be seen.¹⁹
- spot size:** (1) In infrared and thermal testing, instantaneous size (diameter unless otherwise specified) of the area at the target plane that is being measured by the instrument. (2) In infrared thermometry, the value specified by most manufacturers to contain 95 percent of the radiant energy of an infinitely large target of the same temperature and emissivity.
- spot size, effective focal:** In radiographic testing, size and geometry of focal spot after target interaction. Viewed from along the primary beam central axis at the target the effective focal spot would appear nearly square and smaller than the actual focal spot area covered by the electron stream.
- spurious echo:** In ultrasonic testing, general term denoting any indication that cannot be associated with a discontinuity or boundary at the location displayed. Also called *parasitic echo*.
- SQUID:** Acronym for superconducting *quantum interference device*, a sensitive detector of magnetic fields using quantum effect.
- squint angle:** In ultrasonic testing, angle by which an ultrasonic beam axis deviates from the probe axis. Compare *divergence*.
- squirter:** See *water column*.
- 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*.¹

standard atmospheric conditions:

Standard temperature and pressure. Atmospheric pressure of 101.325 kPa (14.6959 lb_F·in.⁻²). 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·m⁻³ (0.07517 lb_m·ft⁻³).

standard depth of penetration:

In electromagnetic testing, the depth at which the magnetic field intensity or intensity of induced eddy currents has decreased to 37 percent of its surface value. The square of the depth of penetration is inversely proportional to the frequency of the signal, the conductivity of the material and the permeability of the material. See also *skin effect*.

standard leakage rate: In optical leak testing of hermetically sealed packages, the quantity of dry air at 25 °C (77 °F) flowing (in atmospheric cm³·s⁻¹) through a leak or multiple leak paths when the high pressure side is at 100 kPa (1 atm or 760 torr absolute) and the low pressure side is at pressure not greater than 100 Pa (1 torr absolute).²⁹ An *equivalent standard leakage rate* of a given sealed package, with a measured leakage rate, is the leakage rate, of the same package with the same leak geometry, that would exist under the standard leakage rate conditions.

standard: Object, document or 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.¹⁵ See also *reference standard* and *acceptance standard*.

standardization, instrument: Adjustment of instrument readout before use to a specified reference value. Compare *calibration*; *verification*.

standard observer response curve: See *eye sensitivity curve*.

star burst panel: See *penetrant system monitor*.

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.

steel: Iron alloy, usually with less than two percent carbon.

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·m⁻² (95 BTU·ft⁻²·h⁻¹). (The stefan-boltzmann constant for photon emission = 1.52041 × 10¹⁵ photon·s⁻¹·m⁻²·K⁻²). See also *blackbody*; *Planck's law*; *Wien's distribution law*.

step wedge; stepped wedge: (1) In radiographic testing, 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 penetrametric features (such as calibrated holes) in any or all steps. (2) In ultrasonic testing, device made from a material acoustically similar to the test object, with steps of various thicknesses that are used to standardize or calibrate a flaw detector or thickness gage.

stereo photography: Photographic technique involving the capture and viewing of two binocular images of the same object to reconstruct its three-dimensional image.

stick welding: See *welding, shielded metal arc*.

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 *hardness*; *modulus of elasticity*.

straight beam: Ultrasonic wave traveling normal to the test surface. Compare *angle beam*.¹⁵

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

stress riser: See *stress raiser*.

stringer: In wrought materials, an elongated configuration of microconstituents or foreign material aligned in the direction of working. Commonly, the term is associated with elongated oxide or sulfide inclusions in steel.

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

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 hard surfaced or shot peened parts but may occur any time subsurface stresses exceed surface stresses.

suppression: See *reject*.

surface tension: Characteristic of liquids where the outer surface contracts to the smallest possible area.

surface wave: See *wave, rayleigh*.

survey meter: In radiographic testing, portable instrument that measures rate of exposure dose or *ionizing radiation* intensity.¹⁴

SV wave: *Shear vertical wave*.

sweep: In ultrasonic testing, uniform and repeated movement of a spot across the display screen to form the horizontal baseline. Also called *time base*.

sweep delay: (1) In ultrasonic testing, delay in time of starting the sweep after the initial pulse. (2) Control for adjusting the time.¹⁵ Also called *time delay*.

sweep length: In ultrasonic testing, length of time or distance represented by the horizontal baseline on an *A-scan*.¹⁵

swinging field magnetization: One form of *multidirectional magnetization* where two time-varying magnetic fields are combined such that the resultant magnetization vector rapidly rotates through an angle.

system: (1) A combination of test materials, such as a liquid penetrant and an emulsifier, that are furnished by the same manufacturer and are qualified together. (2) Device or set of devices used for a test.

T

TAM panel: See *penetrant system monitor*.

tape head probe: In electromagnetic testing, head of a tape recorder used as an eddy current coil; a type of horseshoe coil.

tarasov etching technique: Visual test technique for detection of *adhesive wear* and *grinding burn* in hardened steels. The tarasov technique uses specific acid etching solutions.

temperature: Measure of the intensity of particle motion in degrees *celsius* (°C), degrees *fahrenheit* (°F) or, in the absolute scale, kelvin (K) or degrees *rankine* (°R). An increment of 1 K = 1 °C = 1.8 °R = 1.8 °F. Compare *heat*.

tempering: In materials science, a process of heating a metal, alloy or glass to alter its properties. Hardened steel is often tempered to improve ductility, and aluminum is tempered to increase strength, whereas glass is tempered to balance internal stresses.

tesla (T): SI derived unit of measure for magnetic flux density. 1 T = 1 Wb·m⁻² = 10⁴ G.

tesla meter: Magnetometer used to measure active or residual magnetic induction in the location and direction of interest. Tesla meter generally use *hall effect sensors*, which may be transverse or axial in type. See also *magnetic flux meter; hall effect*.

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

thermal: Physical phenomenon of heat involving *conduction, convection* or *radiation*.

thermal conductivity vacuum gage: Instrument that operates on principle that as gas molecules are removed from a system, the amount of heat transfer by conduction is reduced. This relationship is used to indicate absolute pressure. See also *conductivity, thermal*.

thermistor: Temperature detector, usually a semiconductor, whose electrical resistance decreases predictably and nonlinearly with increasing temperature. The coefficient of electrical resistance with temperature is typically on the order of -4 percent K⁻¹. Compare *thermocouple*.

thermistor bolometer, infrared: Thermistor configured to collect radiant infrared energy; a type of thermal infrared detector.

thermocouple: Device for measuring temperature based on the fact that opposite junctions between certain dissimilar metals develop an electrical potential when placed at different temperatures. See also *thermoelectric effect*. Compare *thermistor*.

thermoelectric effect: Phenomenon that explains the operation of *thermocouples*; that in a closed electrical circuit made up of two junctions of dissimilar metal conductors, a direct current will flow as long as the two junctions are at different temperatures. The phenomenon is reversible; if the temperatures at the two junctions are reversed, the flow of current reverses. Also called *seebeck effect*.

- thermography:** In infrared and thermal inspection, technique that uses infrared radiation to seek discontinuities in materials, components and structures. Thermography may be active (pulsed thermography or thermosonics) or passive (thermal wave imaging or infrared thermography).
- thermogram:** In infrared and thermal testing, thermal map or image of a target where the gray tones or color hues correspond to the distribution of infrared thermal radiant energy over the surface of the target (qualitative thermogram); when correctly processed and corrected, a graphic representation of surface temperature distribution (quantitative thermogram).
- thermoluminescent dosimetry:** In radiographic testing, means of measuring ionizing 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.
- thermomechanical coupling:** Interaction between mechanical and thermal behaviors of materials. For example the temperature of the alloy may change with applied force, or the mechanical response may change with alloy temperature.
- thermometer:** Any device used for measuring temperature.
- thermopile:** Device constructed by the arrangement of thermocouples in series to add the *thermoelectric effect* voltage. A radiation thermopile is a type of thermal infrared detector, a thermopile with junctions arranged to collect infrared radiant energy from a target.
- three-way sort:** In electromagnetic testing, a sort based on a test object signal response above or below two levels established by three or more calibration standards. Compare *two-way sort*.²³
- threshold:** (1) A value in a phenomenon where a large 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 *thresholding*.
- thresholding:** Digital data processing technique that reduces a gray level image into a binary (black and white) image.
- thresholding, adaptive:** *Threshold* value varying with inconstant background gray level.
- threshold, resolution:** Minimum distance, expressed in minutes of arc, between a pair of points or parallel lines when they can be distinguished as two, not one,. Vision acuity, in such a case, is the reciprocal of one-half of the period expressed in minutes.¹⁹
- through-transmission technique:** (1) In ultrasonic testing, a test technique in which ultrasonic energy is transmitted through the test object and received by a second transducer on the opposite side. Changes in received signal amplitude are taken as indications of variations in material continuity. Compare *angle beam*; *straight beam*. (2) Of or pertaining to electromagnetic techniques where the excitation field penetrates the test object so that the detected signal is responsive to features external to or on the opposite surface.
- thyristor:** See *silicon controlled rectifier*.
- time constant:** (1) Time it takes for any sensing element to respond to 63.2 percent of a step change at the target being sensed. (2) In infrared sensing and thermography, the time constant of a detector is a limiting factor in instrument performance, as it relates to response time.
- time of flight:** In ultrasonic testing, time for an acoustic wave to travel between two points. For example, the time required for a pulse to travel from the transmitter to the receiver via diffraction at a discontinuity edge or along the surface of the test object.
- tone burst:** In ultrasonic testing, wave train consisting of several cycles of the same frequency.
- tool mark:** Shallow indentation or groove made by the movement of manufacturing tools over a surface. Compare *gouge*; *nick*.
- toroidal magnetization:** See *field flow magnetization*; *induced current magnetization*.
- trace:** Line formed by electron beam scanning from left to right on a video screen to generate a picture.
- tracer:** In leak testing, a gas that is sensed as it penetrates an aperture.
- transducer:** (1) In ultrasonic testing and acoustic emission testing, a device that converts mechanical energy to electrical output and vice versa. (2) Piezoelectric device that converts the physical parameters of an acoustic wave into an electrical signal of voltage versus time. May also be called *sensor* or *probe*.
- transducer, air-coupled:** See *transducer, noncontact*.

- transducer, angle beam:** In ultrasonic testing, a probe that transmits or receives ultrasonic energy at an acute angle to the surface. This may be done to achieve special effects such as setting up transverse or surface waves by mode conversion at an interface.¹⁸
- transducer, array:** Ultrasonic transducer made up of several piezoelectric elements individually connected so that the signals they transmit or receive may be treated separately or combined as desired. See also *phased array*.
- transducer, contact:** In ultrasonic testing, transducer used in the ultrasonic *contact technique*.
- transducer damping:** In ultrasonic testing, material bonded to the back of a piezoelectric element of an ultrasonic transducer to limit the duration of vibrations.¹⁸
- transducer, differential:** In acoustic emission testing, piezoelectric twin-element or dual-pole transducer, the output poles of which are isolated from the case and are at a floating potential.
- transducer, electromagnetic acoustic (EMAT):** In electromagnetic testing and ultrasonic testing, electromagnetic device using Lorentz forces and magnetostriction in conductive and ferromagnetic materials to generate and receive acoustic signals for ultrasonic nondestructive tests.
- transducer element:** In an ultrasonic *transducer*, the piezoelectric crystal to be coupled to the test surface. Also called the *crystal*.
- transducer, flat response:** In acoustic emission testing, acoustic transducer whose frequency response has no resonance or characteristic response with its specified frequency band (the bandwidth to -3 dB being defined) and the ratio between the upper and lower limits of the frequency band being typically not less than 500 kHz.
- transducer, focused beam:** In ultrasonic testing, immersion transducer producing a sound beam that converges to a cross section smaller than that of the *transducer element*. Focused beam transducers may be spherically (point) or cylindrically (line) focused and have varying focal distances.
- transducer, immersion:** In ultrasonic testing, transducer type used in a *water column*, *water jet* or the ultrasonic *immersion technique*. Immersion probes may be planar or *focused beam*.
- transducer, noncontact:** In ultrasonic testing, a sensor designed for wave propagation through gas as opposed to propagation through *couplant* or water. Such transducers, with frequencies between 50 and 400 kHz, are useful for inspection of water incompatible materials or for proximity sensing.
- transducer, pulser:** In acoustic emission testing, transducer used as an artificial source, introducing a repeatable, transient signal to calibrate and verify an acoustic emission processor.
- transducer relative sensitivity:** In ultrasonic testing and acoustic emission testing, responsivity of an acoustic transducer to a given source.
- transducer, resonant:** Specialized form of undamped transducer that uses mechanical amplification due to a resonant frequency (or several close resonant frequencies) to give high sensitivity in a narrow band, typically ± 10 percent of the principal resonant frequency at the -3 dB points. Such transducers have high output and longer *ringing time*.
- transducer, single-ended:** Piezoelectric single-element transducer, the output pole of which is isolated from the case, the other pole being at the same potential as the case.
- transducer, send/receive:** Transducer consisting of two piezoelectric elements mounted side by side separated by an acoustic barrier. One element transmits; one receives.¹⁸
- transducer, wheel:** Device that couples ultrasonic energy to a test object through the rolling contact area of a wheel containing a liquid and one or more transducers.¹⁵
- transducer, wideband:** Transducer whose responsivity to surface displacements is flat over a wide band.
- transfer calibration:** In infrared and thermal testing, technique for correcting a temperature measurement or a thermogram for various errors by placing a radiation *transfer standard* adjacent to the target.
- transfer function:** In acoustic emission testing, description of changes to the waves arising as they propagate through the medium or, for a transducer, the relationship between the transducer output signal and the physical parameters of the wave at the source.
- transfer standard:** Precision radiometric measurement instrument with NIST traceable calibration used to calibrate radiation reference sources.
- transient heat flow:** Heat flow occurring during the time it takes an object to reach thermal equilibrium or steady state.

transition flow: Phenomenon that occurs when the mean free path of gas is about equal to the cross sectional dimension of a leak or the tube through which flow is occurring. Compare *choked flow*.

transmission angle: In ultrasonic testing, incident angle of a transmitted ultrasonic beam. It is zero degrees when the beam is perpendicular (normal) to the test surface.¹⁸

transmission characteristics: In ultrasonic testing, test object characteristics that influence the passage of ultrasonic energy, including scattering, attenuation or surface conditions.

transmission technique: See *through-transmission technique*.

transmissivity: In infrared and thermal testing, proportion τ of infrared radiant energy impinging on an object's surface, for any given spectral interval, that is transmitted through the object:

$$\tau = 1 - \epsilon - \rho$$

where τ is transmissivity, ϵ is emissivity and ρ is reflectivity. For a *blackbody*, transmissivity = 0. Transmissivity is the internal transmittance per unit thickness of a nondiffusing material. See also *transmittance, spectral*.

transmitter: (1) Transducer that emits ultrasonic energy. (2) Electrical circuits that generate the signals emitted by the transducer.

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

troland: Unit of retinal illuminance equal to that produced by a surface whose luminance is $1 \text{ cd}\cdot\text{m}^{-2}$ when the pupil measures 1 mm^2 . Unit is convenient as a method for correcting photometric measurements of luminance values impinging on the human eye by scaling them by the pupil size.

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 inert gas (TIG) welding: See *welding, gas tungsten arc*.

two-color pyrometer: See *pyrometer, ratio*.

two-transducer technique: See *pitch catch technique*.

two-way sort: Electromagnetic sort based on a test object signal response above or below a level established by two or more calibration standards. Compare *three-way sort*.²³

U

ultrasonic absorption: Damping or dissipation of ultrasonic waves as they pass through a medium.¹⁸ See also *attenuation coefficient*.

ultrasonic spectroscopy: Analysis of the frequency content of an acoustic wave. Generally performed mathematically using a fast fourier transform.

ultrasonic spectrum: Acoustic frequency range, usually from 20 kHz to 50 MHz but sometimes much higher in special applications.

ultrasonic: Of or relating to acoustic vibration frequencies greater than about 20 kHz.¹⁵

ultrasonic testing (UT): Method of nondestructive testing, using acoustic waves at inaudibly high frequencies at the interrogating energy.

ultraviolet borescope: See *borescope, ultraviolet*.

ultraviolet radiation (UV): Electromagnetic radiation with wavelengths between 40 and 400 nm. See also *irradiance; UV-A*.

ultraviolet radiometer: See *radiometer*.

undercut: In welding, undesirable groove left unfilled by weld metal, created during welding and located in base plate at the toe of a weld.

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

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

U-shaped coil: See *coil, horseshoe*.

UV-A: Electromagnetic radiation with wavelengths between 315 and 400 nm. Fluorescent nondestructive testing has historically used ultraviolet energy centered at 365 nm. See also *irradiance; radiometer*.

UV-A filter: Device used to modify the emission spectrum from an ultraviolet radiation source by eliminating most visible light and all higher energy ultraviolet radiation (UV-B and UV-C).

V

valley hold: Feature of an instrument whereby an output signal is maintained at the lowest instantaneous measurement for a specified duration; opposite of *peak hold*.

- 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 and the unit and to adjust the device so that readings fall within tolerance limits. Compare *calibration*.
- vertical limit:** In ultrasonic testing, maximum useful readable level of vertical indication on an A-scan.
- vertical linearity:** See *linearity, amplitude*.
- video:** Pertaining to the transmission and display of images in an electronic format that can be displayed on a monitor or screen.
- video presentation:** In ultrasonic testing, display presentation in which radiofrequency signals have been rectified and usually filtered. Compare *radio frequency presentation*.¹⁵
- videoscope:** Jargon for *video borescope*. See *borescope, video*.
- vidicon tube:** Analog television tube that uses the photoconduction method. Compare *image orthicon; pyroelectric vidicon*.
- vigilance decrement:** Degradation of reliability during performance of visual activities over a period of time. See also *human factors; psychophysics*.
- viscosity:** The resistance of a fluid to deformation by shear or tensile stress. Lower viscosity equates to greater fluidity.
- viscous flow:** In leak testing, flow of gas or gas mixtures through a leak or duct under conditions such that the mean free path is smaller than the cross section of the leak or opening. Viscous flow may be either laminar or turbulent and is most likely to occur during leak tests at atmospheric or higher pressures. With vacuum conditions, the flow of tracer gases to the leak detector element is usually by diffusion, resulting in slow response to leaks being probed by a tracer jet.
- 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.¹⁹
- visible dye penetrant:** Liquid penetrant characterized by its intense visible color, usually red. Also called *color contrast* or *nonfluorescent penetrant*. Compare *liquid penetrant, fluorescent*.³⁰
- visible light:** Any radiant energy with a wavelength between 380 and 780 nm. Compare *white light*.
- vision:** Perception by eyesight. See *dark adaptation; far vision; machine vision; mesopic vision; near vision; peripheral vision; photopic vision; scotopic vision; speed of vision*.
- 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.¹⁹
- visual acuity:** See *vision acuity*.
- visual angle:** Angle formed by lines drawn from center of eye subtended by an object or detail at the point of observation. It usually is measured in minutes of arc.¹⁹
- visual efficiency:** Reliability of a visual system. The term *visual efficiency* uses 20/20 near vision acuity as a baseline in the United States for 100 percent visual efficiency.
- visual field:** Locus of objects or points in space that can be perceived when head and eyes are fixed. The field may be monocular or binocular.¹⁹
- 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; identifying its movement, color, brightness or form.¹⁹
- visual performance:** Quantitative assessment of the performance of a visual task, taking into consideration speed and accuracy.¹⁹
- visual purple:** Chromoprotein called *rhodopsin*, the photosensitive pigment of *rod* vision. The mechanism of converting light energy into nerve impulses is a photochemical process in the retina. Chromoprotein is transformed by the action of radiant energy into a succession of products, finally yielding the protein called *opsin* plus the carotenoid known as *retinene*.
- visual task:** Appearance and immediate background of those details and objects that must be seen for the performance of a given activity. The term *visual task* is a misnomer because it refers to the visual display itself and not the task of extracting information from it. See *visual field*.

visual testing (VT): Method of nondestructive testing using electromagnetic radiation at visible frequencies.

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

volt (V): Measurement unit of electric potential.

V path: See *skip distance*.

W

water break free: Surface that is chemically and physically clean, upon which applied water will momentarily form an even, continuous film. See also *clean*.

water column: In ultrasonic testing, tube filled with water and attached to the front of a transducer to couple an ultrasonic beam to a test object. *Delay line* between an initial pulse and a front surface signal. See also *delay line*.

water jet: In ultrasonic testing, unsupported stream of water carrying ultrasonic signals between the transducer and the test object surface. Also called a *squirter* or *water column*.

water path: In immersion testing or with a water column in ultrasonic testing, the distance from the transducer face to the test surface.¹⁵

wave, compressional: Wave in which particle motion in the material is parallel to the wave propagation direction. Also called *longitudinal wave*.

wave, continuous: In ultrasonic testing, a wave of constant amplitude and frequency.

wavefront: In ultrasonic testing, a wave disturbance or the locus of points having the same phase.¹⁵

waveguide: Device to transmit elastic energy from a test object to a remote transducer. For example, a wire joined at one end to a test object and at the other end to a transducer.

wave, lamb: Type of ultrasonic wave propagation in which the wave is guided between two parallel surfaces of the test object. Mode and velocity depend on the product of the test frequency and the thickness. Also called *plate wave*.

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*.

wave, longitudinal: Wave in which points of same phase lie on parallel plane surfaces.²⁰

wave, rayleigh: Ultrasonic wave that propagates along the surface of a test object. The particle motion is elliptical in a plane perpendicular to the surface, decreasing rapidly with depth below the surface. The effective depth of penetration is considered to be about one wavelength. Also called *surface wave*.

wave, spherical: In ultrasonic testing and leak testing, acoustic wave in which points of the same phase lie on surfaces of concentric spheres.²⁰

wave, standing: Acoustic wave in which the energy flux is zero at all points. Such waves result from the interaction of similar waves traveling in opposite directions as when reflected waves meet advancing waves. A particular case is that of waves in a body whose thickness is an integral multiple of half-wavelengths, as in resonance testing.^{18,21}

wave train: In ultrasonic testing, series of waves or groups of waves passing along the same course at regular intervals.

wave, transverse: In ultrasonic testing, type of wave in which the particle motion is perpendicular to the direction of propagation.¹⁵ Also called *shear wave*.

wave, transverse horizontal (polarized): In ultrasonic testing, transverse wave in which the particle vibration is parallel to the incidence surface.

wave, transverse vertical (polarized): In ultrasonic testing, transverse wave in which the plane of vibration is normal to the incidence surface.

wear: See *erosion*; *rat's tooth principle*; *wear, adhesive*; *wear, fretting*.

wear face: In ultrasonic testing, protective material on the face of a transducer to prevent wear of the piezoelectric element.¹⁵

wear oxidation: See *wear, fretting*.

wear, adhesive: Degradation of a surface by microwelding and consequent fracture due to the sliding of one surface against another. See also *tarasov etching technique*. Compare *fretting*.

wear, fretting: Surface degradation by microwelding and microfractures caused over extended periods by light loads and vibration without material deformation. Also called *chafing*, *friction oxidation* and *wear oxidation*. See also *cocoa*; *red mud*. Compare *brinelling*; *galling*; *spalling*.

wedge: In ultrasonic testing, device used to direct ultrasonic energy into a test object at an acute angle.¹⁵ See also *shoe*. Compare *delay line*.

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 *weld throat*.
- 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 *MIG (metal inert gas) 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*.
- 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 size:** Thickness of weld metal — in a fillet weld the distance from the root to the 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.
- 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*.
- wet horizontal unit:** In magnetic particle testing, stationary equipment used in the *wet technique*, which supplies a measured amount of electric current to a *headstock* and *tailstock*, allows *carrier fluid* application and may be equipped with a rigid multiple-turn encircling *coil*.
- wet technique:** In magnetic particle testing, technique in which magnetic particles are suspended in a well agitated bath of *carrier fluid*. The wet technique may be incorporated into the *continuous technique* or the *residual technique*. Compare *dry technique*. See also *centrifuge tube*.
- wetting action:** Action of liquid in spontaneously spreading over and adhering to solid surfaces. See also *water break free*.
- wheatstone bridge:** General circuit configuration that uses the balance between two bridge circuit legs to measure an unknown electrical property such as *resistance*, *capacitance*, *inductance* or *impedance*.
- white light:** Light combining all frequencies in the *visible light* spectrum (wavelengths from 380 to 780 nm) and in equal proportions.
- Wien's displacement law:** In infrared and thermal testing, method for determining the wavelength of maximum emittance for a blackbody. See also *blackbody*; *Planck's law*; *stefan-boltzmann law*.
- wipe-off technique:** See *bleed back technique*.
- wobble:** In electromagnetic testing, an effect that produces variations in an output signal of a test system and arises from coil spacing (operational liftoff) variations due to lateral motion of the test specimen in passing through an encircling coil or of a bobbin coil passing through a cylindrical test object.²³
- 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:** (1) Distance from a source of electromagnetic radiation to the specimen. (2) Distance from the target to the instrument, usually to the primary optic.
- working standard:** Standard that is lower in quality and cost than a reference standard against which it is calibrated and that is routinely used to calibrate or check material measures, measuring instruments or reference materials. Compare *reference standard*; *standard*.

wrap around: In ultrasonic testing, display of misleading ultrasonic reflections from a previously transmitted pulse because of excessive pulse repetition frequency.²⁸ See also *ghost*.

X

X-ray: Penetrating electromagnetic radiation emitted when the inner orbital electrons of an atom are excited and release energy. Radiation is nonisotropic 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): Radiographic testing technique used for material characterization, based on change in scattering of X-radiation as a result of interaction with test material. See also *diffraction*.

X-ray fluorescence (XRF): Radiographic testing technique used for surface material characterization, based on wavelengths of fluorescence from material irradiated by X-rays.

Y

yoke: In magnetic particle testing, portable U shaped electromagnet or permanent magnet that induces longitudinal magnetization in the region of the test object between its magnetic poles. See also *articulated pole pieces*; *contour probe*; *field flow magnetization*; *lifting power*.

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

Z

zone: In line scanners for infrared testing, a scanned area created by the transverse linear motion of the product or process under a measurement sector of the scanner.

References

1. ASTM E 1316, *Standard Terminology for Nondestructive Examinations*. West Conshohocken, PA: ASTM International (2007).
2. *Nondestructive Testing Handbook*, second edition: Vol. 10, *Nondestructive Testing Overview*. Columbus, OH: American Society for Nondestructive Testing (1996).
3. *Nondestructive Testing Handbook*, third edition: Vol. 1, *Leak Testing*. Columbus, OH: American Society for Nondestructive Testing (1998).
4. *Nondestructive Testing Handbook*, third edition: Vol. 2, *Liquid Penetrant Testing*. Columbus, OH: American Society for Nondestructive Testing (1999).
5. *Nondestructive Testing Handbook*, third edition: Vol. 3, *Infrared and Thermal Testing*. Columbus, OH: American Society for Nondestructive Testing (2001).
6. *Nondestructive Testing Handbook*, third edition: Vol. 4, *Radiographic Testing*. Columbus, OH: American Society for Nondestructive Testing (2002).
7. *Nondestructive Testing Handbook*, third edition: Vol. 5, *Electromagnetic Testing*. Columbus, OH: American Society for Nondestructive Testing (2004).
8. *Nondestructive Testing Handbook*, third edition: Vol. 6, *Acoustic Emission Testing*. Columbus, OH: American Society for Nondestructive Testing (2005).
9. *Nondestructive Testing Handbook*, third edition: Vol. 7, *Ultrasonic Testing*. Columbus, OH: American Society for Nondestructive Testing (2007).
10. *Nondestructive Testing Handbook*, third edition: Vol. 8, *Magnetic Testing*. Columbus, OH: American Society for Nondestructive Testing (2008).
11. *Nondestructive Testing Handbook*, third edition: Vol. 9, *Visual Testing*. Columbus, OH: American Society for Nondestructive Testing (2010).
12. *CRC Handbook of Chemistry and Physics*, 91st edition. Baton Rouge, LA: CRC Press (2010).
13. Mordfin, L., ed. *Handbook of Reference Data for Nondestructive Testing*. West Conshohocken, PA: ASTM International (2002).
14. *NDT Terminology*. Wilmington, DE: E.I. du Pont de Nemours & Company, Photo Products Department (n.d.).
15. TO33B-1-1 (NAVAIR 01-1A-16) TM43-0103, *Nondestructive Testing Methods*. Washington, DC: United States Department of Defense, United States Air Force (June 1984): p 1.25.
16. *IEEE Standard Dictionary of Electrical and Electronic Terms*. New York, NY: Institute of Electrical and Electronics Engineers, distributed by Wiley-Interscience, a division of John Wiley and Sons (1984).
17. Shull, P. *Nondestructive Evaluation: Theory, Techniques, and Applications*. New York, NY: Marcel Dekker (2002).
18. Weismantel, E.E. et al. "Glossary of Terms Frequently Used in Nondestructive Testing." *Materials Evaluation*. Vol. 33, No. 4. Columbus, OH: American Society for Nondestructive Testing (April 1975): p 42A-44A.
19. *IES Lighting Handbook: Reference Volume*. New York, NY: Illuminating Engineering Society of North America (1984).
20. British Standard 3683, *The Glossary of Terms Used in Nondestructive Testing*. Part 4, "Ultrasonic Flaw Detection." London, United Kingdom: British Standards Institute (1985). Superseded by EN 1330-4, *Nondestructive Terminology: Part 4, Terms Used in Ultrasonic Testing*. Brussels, Belgium: European Committee for Standardization (2000).
21. O'Hanlon, J.F. *A User's Guide to Vacuum Technology*, second edition. New York, NY: John Wiley and Sons (1989).
22. *EPRI Learning Modules*. Charlotte, NC: Electric Power Research Institute (n.d.).
23. ASTM E 268-81, *Definitions Approved for Use by Agencies of the Department of Defense as Part of Federal Test Method Standard No. 151b and for Listing in the DoD Index of Specifications and Standards*. West Conshohocken, PA: ASTM International (1981).
24. Couch, L.W. *Digital and Analog Communication Systems*. Upper Saddle River, NJ: Prentice-Hall (1997).
25. Lovejoy, D. *Magnetic Particle Inspection: A Practical Guide*. New York, NY: Chapman & Hall (1993).
26. Jiles, D. *Introduction to Magnetism and Magnetic Materials*. New York, NY: Chapman & Hall (1998).

27. Betz, C.E. *Principles of Magnetic Particle Testing*. Chicago, Illinois: Magnaflux (1967).
28. MIL-STD-371, *Glossary of Terms and Definitions for Ultrasonic Testing Procedures*. Washington, DC: United States Department of Defense, United States Army (October 1987).
29. MIL-STD-883, *Test Method Standard Microcircuits*. Revision D, Method 1014. Washington, DC: Department of Defense (1995).
30. *Nondestructive Testing: Liquid Penetrant*, fourth edition. Programmed Instruction Handbook PI-4-2. Fort Worth, TX: General Dynamics, Convair Division (1977).

