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## C H A P T E R

# Infrared and Thermal Testing Glossary

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# PART 1. Terminology

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## Introduction

Many of the definitions in this glossary are adapted from the *Nondestructive Testing Handbook*, second edition: Volume 10, *Nondestructive Testing Overview*.<sup>1</sup> These and other definitions in this glossary have been modified to satisfy peer review and editorial style. References given in this glossary should be considered not attributions but rather acknowledgments and suggestions for further reading.

The definitions in this *Nondestructive Testing Handbook* volume should not be referenced for inspections performed according to standards or specifications or in fulfillment of contracts. Standards writing bodies take great pains to ensure that their documents are definitive in wording and technical accuracy. People working to written contracts or procedures should consult definitions referenced in real standards when appropriate.

This glossary is provided for instructional purposes. No other use is intended.

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## A

- absolute temperature:** Temperature measured from absolute zero temperature, expressed in kelvin (K) in SI.<sup>1</sup>
- absolute temperature scale:** Temperature measurement scale based on coldest possible temperature equal to 0. (See *rankine* and *kelvin*).<sup>2</sup>
- absolute zero:** Temperature that is zero on the kelvin or rankine temperature scales. The temperature at which no molecular motion takes place in a material.<sup>3</sup>
- absorptivity (absorptance):** 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.<sup>3</sup>
- acceptance level:** In contrast to *rejection level*, test level above or below which, depending on the test parameter, test objects are acceptable.<sup>1</sup> Compare *rejection level*.
- accuracy:** Degree of conformity of a measurement to a standard or true value.<sup>1</sup>
- adaptive thresholding:** Threshold value varying with inconstant background gray level.<sup>1</sup>
- agency:** Organization selected by an authority to perform nondestructive testing, as required by a specification or purchase order.<sup>1</sup>
- algorithm:** Prescribed set of well defined rules or processes for the solution of a mathematical problem in a finite number of steps.<sup>1,5</sup>
- ambient light:** Light in the environment as opposed to illumination provided by a visual testing system.<sup>1</sup>
- ambient operating range:** Range of ambient temperatures over which an instrument is designed to operate within published performance specifications.<sup>3</sup>
- ambient temperature:** Temperature of immediate surroundings and environment where a test or measurement takes place. A parameter used to compensate for radiation reflected from test object and air in the field of view.
- ambient temperature compensation:** Correction built into an instrument to provide automatic compensation in the measurement for variations in instrument ambient temperature.<sup>3</sup>
- amplitude response:** That property of a test system whereby the amplitude of the detected signal is measured without regard to phase.<sup>1,4</sup>
- analog-to-digital converter:** Circuit whose input is information in analog form and whose output is the same information in digital form.<sup>1,5</sup>
- anisotropy:** A material's characteristic of exhibiting different values of a property (acoustic velocity, for example) in different directions in the material because of different arrangements of atoms.<sup>1</sup>
- annealing:** Process of heating and cooling a material, usually to reduce residual stresses or to make it softer.<sup>1</sup>

**anomaly:** *Discontinuity.* A variation from normal in product quality or material property.<sup>1</sup>

**AOQ:** Average outgoing quality.

**AOQL:** Average outgoing quality limit.

**AQL:** See *acceptable quality level.*

**apparent temperature:** Target surface temperature indicated by an infrared point sensor, line scanner or imager, generally taking the emissivity into account.<sup>3</sup>

**arc:** Luminous high temperature discharge produced when an electric current flows across a gap.<sup>1</sup>

**arcing:** Electric current flow through a gap, often accompanied by intense heat and light.<sup>1</sup>

**arc welding:** See *electric arc welding.*

**artifact:** In nondestructive testing, an indication that may be interpreted erroneously as a discontinuity.<sup>1</sup>

**artificial discontinuity standard:** See *acceptance standard.*

**artificial discontinuity:** Reference point, such as a hole, groove, implant or notch, that are introduced into a reference standard to provide accurately reproducible sensitivity levels for nondestructive test equipment. A manufactured material anomaly.<sup>1</sup>

**ASNT:** The American Society for Nondestructive Testing.

**ASNT Recommended Practice No. SNT-TC-1A:** 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.<sup>1</sup>

**atmospheric temperature:** Temperature of atmosphere sensed by scanner.

**atmospheric windows (infrared):** 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  $\mu\text{m}$  and 8 to 14  $\mu\text{m}$ .<sup>3</sup>

**attenuation:** Decrease in signal magnitude during energy transmission from one point to another. This loss may be caused by absorption, reflection, scattering of energy or other material characteristics or may be caused by an electronic or optical device such as an attenuator.<sup>1</sup>

**automated system:** Acting mechanism that performs required tasks at a determined time and in a fixed sequence in response to certain conditions and instructions.<sup>1</sup>

## B

**background noise:** Signals that originate from the test object, the test instrument and their surroundings and that interfere with test signals of interest. It may have electrical or mechanical origins. Sometimes called *grass* or *hash*.<sup>1</sup>

**background signal:** Steady or fluctuating output signal of a test instrument caused by the presence of acoustic, chemical, electrical or radiation conditions to which the sensing element responds.<sup>1</sup>

**background temperature, instrument:** Apparent ambient temperature of the scene behind and surrounding the instrument, as viewed from the target. The reflection of this background may appear in the image and affect the temperature measurement. Most quantitative thermal sensing and imaging instruments provide a means for correcting measurements for this reflection.<sup>3</sup>

**background temperature, target:** Apparent ambient temperature of the scene behind and surrounding the instrument, as viewed from the instrument. When the FOV of a point sensing instrument is larger than the target, the target background temperature will affect the instrument reading.<sup>3</sup>

**backscattering, infrared:** Reflection of thermal energy — e.g., generated by the ground and reflecting off the underside of clouds or inversion layers, or unwanted front surface reflections from a transparent optical element.

**black body:** See *blackbody.*

**blackbody:** Hypothetical radiation source that yields the maximum radiation energy theoretically possible at a given temperature. A blackbody will absorb all incident radiation falling on it. By definition it has an emissivity of 1.0. See also *emissivity*.<sup>1</sup>

**bolometer, infrared:** Thermal infrared detector in which electrical conductivity changes with temperature.

**borescope:** Industrial *endoscope.*

**borescopy:** Technology of the *borescope* and its application to *nondestructive testing.*

**burning:** Extreme overheating of a metal. Makes grains excessively large and causes the more fusible constituents of steel to melt and run into the grain boundaries or it may leave voids between the grains. Steel may be oxidized to the extent that it is no longer usable and cannot be corrected by heat treating but may be remelted.<sup>1</sup>

## C

- calibration:** Adjusting an instrument so that its readings agree with a standard.<sup>3</sup>
- calibration accuracy:** Accuracy to which a calibration is performed, usually based on the accuracy and sensitivity of the instruments and references used in the calibration.<sup>3</sup>
- calibration check:** Routine check of an instrument against a reference to ensure that the instrument has not deviated from calibration since its last use.<sup>3</sup>
- calibration reflector:** Reflector with a known dimensioned surface established to provide an accurately reproducible reference level.<sup>1</sup>
- calibration source, infrared:** Blackbody or other target of known temperature and effective emissivity used as a calibration reference.<sup>3</sup>
- candela:** Base unit of measure in SI for measuring luminous intensity. The luminous intensity in a given direction of a source that emits monochromatic radiation of frequency  $540 \times 10^{12}$  Hz and that has a radiant intensity in that direction of  $1.4641 \text{ mW}\cdot\text{sr}^{-1}$ . Symbolized *cd*. Formerly known as *candle*.<sup>1</sup>
- candle:** Former name for *candela*.<sup>1</sup>
- capacitance, thermal:** Amount of heat that an object can store. The term *thermal capacitance* is used to describe heat capacity in terms of 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.<sup>3</sup>
- 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.<sup>3</sup> 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.
- casting:** Object of shape obtained by solidification of a substance in a mold.
- CCD:** See *charge coupled device*.
- celsius (centigrade):** Temperature scale based on 273 K ( $0^\circ\text{C} = +32^\circ\text{F}$ ) as the freezing point of water and 373 K ( $100^\circ\text{C} = 212^\circ\text{F}$ ) as the boiling point of water at standard atmospheric pressure. A relative scale related to the kelvin scale ( $0^\circ\text{C} = 273.12 \text{ K}$ ;  $1^\circ\text{C} = 1 \text{ K}$ ).<sup>3</sup>
- certification:** Process of providing written testimony that an individual is qualified. See also *certified*.<sup>1</sup>
- certified:** Having written testimony of qualification. See also *certification*.<sup>1</sup>
- charge coupled device (CCD):** Solid state optical sensor widely used in imaging inspection systems for its accuracy, high speed scanning and long service life.<sup>1</sup> Incoming radiation induces electrical charges stored in a capacitor-like semiconductor structures and later transferred to identical neighbor structures, ready for reading.
- closing:** In image processing, dilation followed by erosion. A single pixel closing connects a broken feature separated by one pixel.<sup>1</sup> See also *mathematical morphology* and *opening*.
- code:** Standard enacted or enforced as a law.<sup>1</sup>
- coefficient of thermal expansion:** Linear expansion or contraction per unit length per degree of temperature change between specified lower and upper temperature limits.<sup>1</sup>
- coefficients of the filter:** Values in a mask that serves as a filter in image processing.<sup>1</sup>
- color:** Aspect of visible light sometimes used to identify wavelength or spectral band, as in *two-color radiometry* (meaning a method that measures in two spectral bands); also used conventionally (visual color) as a means of displaying a thermal image, as in color thermogram.<sup>3</sup>
- colored body:** See *nongraybody*.
- complete testing:** Testing of an entire production lot in a prescribed manner. Sometimes complete testing entails the inspection of only the critical regions of a part. One hundred percent testing requires the inspection of the entire part by prescribed methods. Compare *sampling, partial*.<sup>1</sup>
- 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.<sup>1</sup>
- conductivity, thermal (k):** Material property defining the relative capability 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  $1.0 \text{ W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$ ).<sup>3</sup>

**continuous annealing furnace:** Furnace in which castings are heat treated, by being passed through different heat zones kept at constant temperatures.<sup>1</sup>

**continuous casting:** Casting technique 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.<sup>1</sup>

**contrast:** Difference in visibility (brightness, color or temperature) between an indication and the surrounding surface.<sup>1</sup>

**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.<sup>3</sup>

**cooling stresses:** Residual stresses resulting from nonuniform distribution of temperature during cooling.<sup>1</sup>

**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.<sup>1</sup>

**crack, cold:** Cracks that occur in a casting after solidification, due to excessive stress generally resulting from nonuniform cooling.<sup>1</sup>

**crack, cooling:** Cracks in bars of alloy or tool steels resulting from uneven cooling after heating or hot rolling. They are usually deep and lie in a longitudinal direction, but are usually not straight.<sup>1</sup>

**crack, grinding:** Thermal cracks caused by local overheating of the surface being ground.<sup>1</sup>

**crack, hot:** Cracks that develop before the casting has completely cooled, as contrasted with cold cracks, that develop after solidification.<sup>1</sup> Also called *hot tear*.

**crack, transverse:** Cracks at right angles to the length of the test object.<sup>1</sup>

**crack, weld:** Cracks in weld fusion zones or adjacent base metal. Usually a result of thermal expansion or contraction stresses related to temperature changes during welding.<sup>1</sup>

**crack:** (1) A break, fissure or rupture, usually V shaped and relatively narrow and deep. A discontinuity that has a relatively large cross section in one direction and a small or negligible cross section when viewed in a direction perpendicular to the first.<sup>1</sup> (2) Propagating discontinuities caused by stresses such as heat treating or grinding. Difficult to detect unaided because of fineness of line and pattern (may have a radial or latticed appearance).<sup>1</sup>

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

**C-scan:** Data presentation technique applied to reflection and transmission techniques. It yields a two-dimensional plan view of the object but no depth indications unless special gating procedures are used.<sup>1</sup>

**cutoff frequency:** Upper or lower frequency corresponding to the spectral response of a filter or amplifier, at a specified amount less (usually 3 dB power or 6 dB voltage/amplitude) than the maximum response.<sup>1</sup>

## D

**D\* (detectivity star):** Detectivity expressed inversely so that higher  $D^*$ s indicate better performance. Sensitivity figure of merit of an infrared detector.  $D^*$  is taken at specific test conditions of chopping frequency and information bandwidth and displayed as a function of spectral wavelength.<sup>3</sup>  $D^*$  is the detectivity scaled to the unit sensitive detection area, with detectivity corresponding to the inverse of the noise equivalent flow.

**defect:** Discontinuity whose size, shape, orientation or location make it detrimental to the useful service of its host object or which exceeds an accept/reject criterion of an applicable specification.<sup>1</sup> Note that some discontinuities may not affect serviceability and are therefore not defects.<sup>1</sup> Compare *discontinuity* and *indication*.<sup>1</sup>

**deformation:** Change of shape under load.<sup>1</sup> See also *creep* and *elastic deformation*.

**delamination:** Laminar discontinuity, generally an area of unbonded layers of materials.<sup>1</sup>

**depth of field:** In photography or thermography, the range of distance over which an imaging system gives satisfactory definition when its lens is in the best focus for a specific distance.<sup>1</sup>

**depth of fusion:** Depth to which the base metal melted during welding.<sup>1</sup>

**detector, infrared:** Transducer element that converts incoming infrared radiant energy impinging on its sensitive surface to a useful electrical signal.<sup>3</sup>

**diffuse reflector:** Surface that reflects a portion of the incident radiation in such a manner that the reflected radiation is equal in all directions. A mirror is not a diffuse reflector.<sup>3</sup>

**diffusion, heat:** See *thermal diffusion*.

**diffusion, mass:** Process by which molecules intermingle as a result of concentration gradients or thermal motion.<sup>1</sup> Spreading of a gas through other gases within a volume.

**diffusivity, thermal:** See *thermal diffusivity*.

**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*, *mathematical morphology* and *opening*.<sup>1</sup>

**directional properties, material:** Properties whose magnitudes depend on the relation of the test axis to the specific direction in the metal, resulting from preferred orientation or from fibering in the structure. See *anisotropy*.<sup>1</sup>

**directional properties, radiation:** Radiation properties (emissivity, absorptivity, reflectivity) as referenced to a particular direction. See also *hemispherical properties, radiation*.<sup>1</sup>

**direct viewing:** 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.<sup>1</sup>

**discernible image:** Image capable of being recognized by sight without the aid of magnification.<sup>1</sup>

**discontinuity:** Intentional or unintentional interruption in the physical structure or configuration of a part.<sup>1,4</sup> After nondestructive testing, unintentional discontinuities interpreted as detrimental in the host object may be called *flaws* or *defects*. Compare *defect*, *dislocation* and *indication*.<sup>1</sup>

**discontinuity, artificial:** Reference discontinuities such as holes, indentations, cracks, grooves or notches that are introduced into a reference standard to provide accurately reproducible indications for determining sensitivity levels.<sup>1</sup>

**discontinuity, primary processing:** In metals processing, a material anomaly produced from the hot or cold working of an ingot into forgings, rod and bar.<sup>1</sup>

**discontinuity, service induced:** Material anomaly caused by the intended use of the part.<sup>1</sup>

**display resolution, thermal:** Precision with which an instrument displays its assigned measurement parameter (temperature), usually expressed in degrees, tenths of degrees, hundredths of degrees and so forth.<sup>3</sup>

**dissipation:** Generation of heat by plastic deformation.

**distal:** In a manipulative or interrogating system, of or pertaining to the end opposite from the eyepiece and farthest from the person using the system. Objective; tip.<sup>1</sup>

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## E

**effective emissivity ( $\epsilon^*$ ):** 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.<sup>3</sup>

**effusivity, thermal:** Ability of heat to escape from a body, expressed as a characteristic of that body.<sup>3</sup> Square root of the product of thermal conductivity, mass density and specific heat.

**elasticity:** Ability of a material to resume its former shape after deformation.<sup>1</sup>

**electric arc welding:** Joining of metals by heating with electric arc. Also called *arc welding*.<sup>1</sup>

**electromagnetic interference:** See *EMI/RFI noise*.

**EMI/RFI noise:** Disturbances to electrical signals caused by electromagnetic interference (EMI) or radio frequency interference (RFI). In thermography, this may cause noise patterns to appear on the display.<sup>3</sup>

**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 rough or corroded materials.<sup>1</sup> Emissivity values range between 0 for a perfect reflector to 1.0 for a *blackbody*.

**endoscope:** Device for viewing the interior of objects. From the Greek words for *inside view*, the term *endoscope* is used mainly for medical instruments. Nearly every medical endoscope has an integral light source; many incorporate surgical tweezers or other devices. Compare *borescope*.<sup>1</sup>

**environmental rating:** Rating given an operating unit (typically an electrical or mechanical enclosure) to indicate the limits of the environmental conditions under which the unit will function reliably and within published performance specifications.<sup>3</sup>

**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. (2) In image processing, condition of a binary image where the pixel in the output image is a 1 if each of its eight neighbors is a 1 in the input image. See also *closing*, *dilation*, *mathematical morphology* and *opening*.<sup>1</sup>

**eutectic liquid:** Liquid having a proportion of metals such that two or more solid phases form at the same temperature during cooling.<sup>1</sup>

**eutectic point:** Temperature and proportion of metals at which two or more phases of a eutectic liquid form. Compare *eutectoid*.<sup>1</sup>

**eutectoid:** Similar to eutectic but in a solid system during cooling.<sup>1</sup>

**evaluation:** Process of determining the magnitude and significance of a discontinuity after the indication has been interpreted as relevant. Evaluation determines if the test object should be rejected, repaired or accepted. See *indication* and *interpretation*.<sup>1</sup>

**examination:** Process of testing materials, interpreting and evaluating test indications to determine if the test object meets specified acceptance criteria.<sup>1</sup>

**exfoliation:** Corrosion that progresses approximately parallel to the outer surface of the metal, causing layers of the metal to be elevated by the formation of corrosion product.<sup>1</sup>

**exitance, radiant:** See *radiosity*.

**external discontinuities:** Discontinuities on the outside or exposed surface of a test object.<sup>1</sup>

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## F

**fahrenheit:** Temperature scale 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 [ $0\text{ °F} = 459.67\text{ R}$ ;  $1\text{ °F (DT)} = 1\text{ R (DT)}$ ].<sup>3</sup>

**false indication:** Test indication that could be interpreted as originating from a discontinuity but which actually originates where no discontinuity exists.<sup>1</sup> Distinct from nonrelevant indication.<sup>1</sup> Compare *defect*.<sup>1</sup>

**feature extraction:** From an enhanced image, derivation of some feature values, usually parameters for distinguishing objects in the image.<sup>1</sup>

**fiber optic, infrared:** Flexible fiber made of a material that transmits infrared energy, used for making noncontact temperature measurements when there is not a direct line of sight between the instrument and the target.<sup>3</sup>

**fiber optics:** Technology of light transmission through fibers such as plastic, glass or quartz.<sup>1</sup>

**field:** In video technology, one of two video picture components that together make a frame. Each picture is divided into two parts called *fields* because a frame at the rate of thirty frames per second in a standard video output would otherwise produce a flicker discernible to the eye. Each field contains one half of the total picture elements. Two fields are required to produce one complete visible light picture or frame so the field frequency is sixty fields per second and the frame frequency is thirty frames per second.<sup>1</sup> In infrared technology there can be four fields.

**field of view:** Range or area where things can be seen through an imaging system, lens or aperture.<sup>1</sup> Angular subtense (expressed in angular degrees or radians per side if rectangular, and angular degrees or radians if circular) over which an instrument will integrate all incoming radiant energy. In a radiation thermometer, the *field of view* is the target spot size; in a scanner or imager the *field of view* is the scan angle or picture size or total field of view (TFOV).<sup>3</sup> Compare *depth of field*.

**field of vision:** Range or area where things can be perceived organoleptically at a point in time, assuming the eye to be immobile.<sup>1</sup>

**filter:** (1) Network or device that passes electromagnetic wave energy over a described range of frequencies and attenuates energy at all other frequencies.<sup>1,4</sup> (2) Processing component or function that excludes a selected kind of signal or part of a signal.<sup>1</sup> (3) In optics, a sequence of materials so arranged to pass selected wavelengths and to block or attenuate others.

**filtering:** See *low pass filtering*.

**filter, spectral:** Optical element, usually transmissive, used to restrict the spectral band of energy received by an instrument's detector.

**fine crack:** Discontinuity in a solid material with a very fine opening to the surface, but possessing length and depth greater than the width of this opening. Usually the depth is many times the width.<sup>1</sup>

**finite element analysis:** Numerical technique for the analysis of a system whereby that system is decomposed into a collection of finite sized elements.<sup>1</sup>

**focal plane array (FPA):** Linear or two-dimensional matrix of detector elements, typically used at the focal plane of an instrument. In thermography, rectangular FPAs are used in *staring* (nonscanning) infrared imagers. These are called IRFPA imagers.<sup>3</sup>

**focal point:** Point at which the instrument optics image the infrared detector at the target plane. In a radiation thermometer, this is where the spot size is the smallest. In a scanner or imager, this is where the instantaneous field of view (IFOV) is smallest.<sup>3</sup>

**focal zone:** 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*.<sup>1</sup>

**focus:** Position of a viewed object and a lens system relative to one another to offer a distinct image of the object as seen through the lens system. See *accommodation* and *depth of field*.<sup>1</sup>

**focusing, automatic:** (1) Feature of camera, usually incorporating a range finder, whereby the lens system adjusts to focus on an object in part of 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.<sup>1</sup> Longer depths of field are obtained by reducing the optical aperture.

**focusing, primary:** Focusing of an image by the lens onto a fiber optic bundle at the tip of a probe.<sup>1</sup>

**focusing, secondary:** Focusing at the eyepiece of a borescope or other optical instrument, specifically the manual refocusing needed when the viewing distance changes.<sup>1</sup>

**focus, principal plane of:** Single plane actually in focus in a photographic scene.<sup>1</sup>

**foreground temperature** (see *instrument ambient background*): Temperature of the scene behind and surrounding the instrument as viewed from the target.

**foreign materials:** They may appear as isolated, irregular or elongated variations not corresponding to variations in thickness of material or to cavities. May be sand, slag, oxide or dross metal or any material included in the material being examined.<sup>1</sup>

**forging crack:** Discontinuity formed during mechanical shaping of metal.<sup>1</sup>

**founding:** Establishment or building where metal castings are produced.<sup>1</sup>

**frame:** Complete raster scan projected on a video screen. In North America, there are 30 frames per second in a standard video output, either Electronics Industry Association (EIA) RS-170 or National Television Standards Committee (NTSC) format; in Europe, 25 frames per second in phase alternation line (PAL) or *Système Electronique Couleur avec Mémoire* (SECAM) formats. A frame may be comprised of two interlaced fields, each displaying part of the total frame. See also *field*.<sup>1</sup>

**frame repetition rate:** Time it takes an infrared imager to scan (update) every thermogram picture element (pixel); in frames per second.<sup>3</sup>

**full scale:** The span between the minimum value and the maximum value that any instrument is capable of measuring. In a thermometer, this would be the span between the highest and lowest temperature that can be measured.<sup>3</sup>

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## G

**gas tungsten arc welding (GTAW):** Inert gas shielded arc welding using a tungsten electrode. Also called *tungsten inert gas (TIG) welding*.<sup>1</sup>

**general examination:** 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 testing 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*.<sup>1</sup>

**gray body:** See *graybody*.

**graybody:** Radiator whose spectral emissivity is uniform for all wavelengths (but not 1.0) and has value less than 1.0. See *blackbody*.<sup>1</sup>

**gray level:** Integer number representing the brightness or darkness of a pixel or, as a composite value, of an image comprised of pixels.<sup>1</sup>

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## H

**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  $9.481 \times 10^{-4}$  British thermal units (BTUs). Compare *infrared radiation* and *temperature*.<sup>1</sup>

**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. Sometimes called *thermal fatigue*.<sup>1</sup>

**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 working is excluded from the meaning of this definition.<sup>1</sup>

**heat wave:** Thermally produced variation in flue gas density that distorts images of objects in a firebox.<sup>1</sup>

**hemispherical properties, radiation:** Radiation properties (emissivity, absorptivity, reflectivity) as referenced to all directions of hemispherical space.

**hertz (Hz):** A unit of measurement of signal frequency; 1 Hz = 1 cycle per second.<sup>3</sup>

**holes:** Voids remaining in an object as a result of improper manufacturing processing. Often called *gas holes*, *cavities* or *air locks*.<sup>1</sup>

**hot tear:** See *crack, hot*.

**hue:** Characteristic of light at a particular bandwidth that gives a color its name.<sup>1</sup>

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

**hyperthermia:** Heating so excessive that it can damage or kill plant or animal cells.<sup>1</sup>

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## I

**illuminance:** Density of luminous flux on a surface. Measured in the SI system by lux.<sup>1</sup>

**illuminate:** Shed light on.<sup>1</sup>

**illumination:** Act of illuminating or state of being illuminated. See also *illuminate*. Compare *illuminance*.<sup>1,6</sup>

**image:** Visual representation of a test object or scene.<sup>1</sup>

**image display tone:** Gray shade or color hue on a thermogram.<sup>3</sup>

**image enhancement:** Any of a variety of image processing steps, used singly or in combination to improve the detectability of objects in an image.<sup>1</sup>

**image guide:** Fiber bundle that carries the picture formed by the objective lens at the distal end of a fiber optic borescope back to the eyepiece.<sup>1</sup>

**image, infrared:** See *thermogram*.

**image orthicon:** Television tube that uses photoemission to create an image.

**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*.<sup>1</sup>

**image processing, thermal:** Analysis of thermal images, usually by computer; enhancing the image to prepare it for computer or visual analysis.<sup>3</sup> In the case of an infrared image or thermogram, this could include temperature scaling, spot temperature measurements, thermal profiles, image manipulation, subtraction, discontinuity detection, qualitative assessment, quantitative characterization and storage. See *signal processing*.

**image segmentation:** Process in which the image is partitioned into regions, each homogeneous.<sup>1</sup>

**imager, infrared:** An infrared 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.<sup>3</sup>

**imaging radiometer:** Infrared thermal imager that provides quantitative thermal images.<sup>3</sup>

**impurities:** Elements or compounds whose presence in a material is unintentional.<sup>1</sup>

**incandescence:** Emission of visible radiation due to thermal excitation.<sup>1</sup>

**incandescent:** Emitting visible radiation as a result of heating.<sup>1</sup>

**inclusion:** Foreign particles or impurities, usually oxides, sulfides, silicates and such retained in metal (welds or castings), forming during solidification or subsequent reaction of the solid metal.<sup>1</sup>

**in control:** Within prescribed limits of process control.<sup>1</sup>

**indication:** Nondestructive testing discontinuity response that requires interpretation to determine its relevance. Compare *defect*, *discontinuity* and *false indication*.<sup>1</sup>

**indication, discontinuity:** Visible evidence of a material discontinuity. Subsequent interpretation is required to determine the significance of an indication.<sup>1</sup>

**indication, false:** Indication produced by something other than a discontinuity. Can arise from improper test procedures.<sup>1</sup>

**indication, nonrelevant:** Indication due to misapplied or improper testing. May also be an indication caused by an actual discontinuity that does not affect the usability of the object (a change of section, for instance).<sup>1</sup>

**indication, relevant:** Indication from a discontinuity (as opposed to a nonrelevant indication) requiring evaluation by a qualified inspector, typically with reference to an acceptance standard, by virtue of the discontinuity's size or location.<sup>1,4</sup>

**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  $\mu\text{m}$ ).

**inertia, thermal:** See *thermal effusivity*.

**infrared:** Beyond infrared, referring to radiation with frequency lower than, and wavelength greater than, that of the color red. See *infrared radiation*.

**infrared and thermal testing:** Nondestructive testing that uses heat diffusion and infrared radiation as interrogating energy.

**infrared camera:** Radiometer that collects infrared radiation to create an image of the infrared radiance field. This image may then be transformed to an image of the temperature field.<sup>1</sup>

**infrared focal plane array (IRFPA):** Linear or two-dimensional matrix of individual infrared detector elements, typically used as a detector in an infrared imaging instrument.<sup>3</sup>

**infrared radiation:** Radiant energy beyond the color red, of wavelengths from the red visible (0.75  $\mu\text{m}$ ) to about 300  $\mu\text{m}$ , between the visible and microwave regions of the electromagnetic spectrum.<sup>1,6</sup>

**infrared radiation thermometer:** Instrument that converts incoming infrared radiant energy from a spot on a target surface to a measurement value that can be related to the temperature of that spot.<sup>3</sup>

**infrared thermal imager:** 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.<sup>3</sup>

**infrared thermography:** Imaging of a temperature field through the emitted infrared radiation. See *infrared radiation*. Compare *thermography*.

**inspection:** See *examination*.

**instantaneous field of view (IFOV):** 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 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 measure of spatial resolution.<sup>3</sup>

**intensity, radiant:** Luminous flux per steradian emanating from a visible source, measured in  $\text{lm}\cdot\text{sr}^{-1}$ . Also, the radiant flux per steradian emanating from that source and measured in  $\text{W}\cdot\text{sr}^{-1}$ .

**interface:** Boundary between two adjacent media.<sup>1</sup>

**interpretation:** Determination of the significance of test indications from the standpoint of their relevance or irrelevance. The determination of the cause of an indication or the evaluation of the significance of discontinuities from the standpoint of whether they are detrimental or inconsequential.<sup>1</sup>

**IR:** (1) Abbreviation for *infrared*. (2) In ASNT, an abbreviation for the *infrared and thermal testing* method.

**IRFPA:** See *infrared focal plane array*.

**IRFPA imager or camera:** Infrared imaging instrument that incorporates a two-dimensional *infrared focal plane array* and produces a thermogram without mechanical scanning.<sup>3</sup>

**irradiance:** Power of electromagnetic radiant energy incident on or radiated from the surface of a given unit area. Compare *radiance*.<sup>1</sup>

**isotherm:** Locus or pattern superimposed on a thermogram or on a line scan that includes or highlights all points that have the same apparent temperature.<sup>3</sup>

**isotropy:** Condition in which significant medium properties (velocity, for example) are the same in all directions.<sup>1</sup>

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## K

**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 degrees are not used in describing kelvin temperatures.<sup>3</sup>

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

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## L

**lack of fusion:** Discontinuity due to lack of union between weld metal and parent metal or between successive weld beads.<sup>1</sup> Also called *incomplete penetration*.

**lambertian:** Having a surface that emits uniformly in all directions. A *blackbody* is a lambertian source.

**lamination:** Discontinuity in plate, sheet or strip caused by pipe, inclusions or blowholes in the original ingot. After rolling, laminations are usually flat and parallel to the outside surface. Laminations may also result from pipe, blisters, seams, inclusions or segregation elongated and are made directional by working. Lamination discontinuities may also occur in metal powder compacts.<sup>1</sup> May appear in the form of rectangles or plates as inclusion stringers between rolled surfaces. Short, intermittent laminations may be detrimental if the object is subjected to high bending stresses in service.<sup>1</sup>

**laser:** Acronym (*light amplification by stimulated emission of radiation*). The laser produces a highly monochromatic and coherent (spatial and temporal) beam of radiation. A steady oscillation of nearly a single electromagnetic mode is maintained in a volume of an active material bounded by highly reflecting surfaces, called a resonator. The frequency of oscillation varies according to the material used and by the methods of initially exciting or pumping the material.<sup>1,6</sup>

**laser pyrometer:** 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.<sup>3</sup>

**leak:** Opening that allows the passage of a fluid.<sup>1</sup>

**leakage:** Measurable quantity of fluid escaping from a leak.<sup>1</sup>

**leakage rate:** 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.<sup>1</sup>

**leak testing (LT):** Nondestructive testing method for detecting, locating or measuring leaks or leakage in pressurized or evacuated systems or components.<sup>1</sup>

**lens:** Translucent object that refracts light passing through it in order to focus the light on a target.<sup>1</sup>

**lens optics:** See *geometrical optics*.

**light:** Radiant energy that can excite the retina and produce a visual sensation. The visible portion of the electromagnetic spectrum, from about 380 to 770 nm.<sup>1,6</sup>

**light, speed of:** See *speed of light*.

**limited certification:** Individuals who are certified only for specific operations are usually called *limited Level (I, II or III)* or are 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.<sup>1</sup>

**line pair:** Pair of adjacent, parallel lines used to evaluate the resolution of a specific imaging system. See also *minimum line pair*.<sup>1</sup>

**line scanner, infrared:** Instrument that scans an infrared field of view along a straight line at the target plane in order to collect infrared radiant energy from a line on the target surface, usually done by incorporating one scanning element within the instrument. If the target (such as a sheet or web process) moves at a fixed rate normal to the line scan direction, the result can be displayed as a thermogram.<sup>3</sup>

**line scan rate:** Number of target lines scanned by an infrared scanner or imager in one second.<sup>3</sup>

**liquid crystals:** Liquids (generally cholesterol esters) whose 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).<sup>1</sup>

**lot tolerance percent defective:** In quality control, the percent defective at which there is a 10 percent probability of acceptance in a production run.<sup>1</sup>

**low pass filtering:** Passage of low frequencies or long wavelengths, with attenuation of high frequencies or short wavelengths.

**lumen:** Luminous flux per steradian from a source whose luminous intensity is 1 candela. Symbolized *lm*.<sup>1</sup>

**luminance:** Ratio of a surface's luminous intensity in a given direction to a unit of projected area. Measured in candela per square meter.<sup>1</sup>

**luminosity:** Luminous efficiency of radiant energy.<sup>1</sup>

**lux:** Unit of measure for illuminance in SI. Equivalent to lumens per square meter and symbolized *lx*. Formerly known as *meter-candle*.<sup>1</sup>

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## M

**machine vision:** Automated system function of acquiring, processing and analyzing images to evaluate a test object or to provide information for human interpretation. A typical system consists of a light source, a video camera, a video digitizer, a computer and an image display.<sup>1</sup>

**magnitude:** Absolute value of a complex number.

**manual zero:** Control on a test instrument that allows the user to zero the instrument panel meter.<sup>1</sup>

**mask:** (1) Spatial filter in the sensing unit of a surface inspection system. (2) An  $n \times n$  matrix that serves as a filter in image processing.<sup>1</sup>

**material noise:** Random signals caused by the material structure of the test object. A component of background noise.<sup>1</sup>

**mathematical morphology:** Image processing technique of expanding and shrinking. The basic operators in mathematical morphology are dilation (expanding), erosion (shrinking), opening and closing.<sup>1</sup>

**matte:** Tending to diffuse light rather than reflect it; not shiny. The term *matte* is generally applied to smooth surfaces or coatings. Compare *specular*.<sup>1</sup>

**measurement spatial resolution, IFOVmeas:** 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 IFOVmeas.<sup>3</sup>

**measurement system:** Entire system from sensor to display inclusive.<sup>1</sup>

**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).<sup>1</sup>

**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.<sup>3</sup>

**melting point coatings:** Coatings that melt at some specific temperature. Anomalies are usually associated with a temperature increase, so the materials melt first over anomalies. Melting point compounds also are comparatively insensitive and require relatively high surface temperatures.<sup>1</sup>

**mercury cadmium telluride (HgCdTe):** Material used for fast, sensitive infrared photodetectors used in infrared sensors, scanners and imagers that requires cooled operation.<sup>3</sup> Operation is in the long wavelength region (8 to 12  $\mu\text{m}$ ).

**micrometer ( $\mu\text{m}$ ):** One millionth of a meter ( $1 \times 10^{-6}$  m); a unit used to express wavelength in the infrared band.

**micron:** Disfavored term for *micrometer*.  
**milliradian (mrad):** One thousandth of a radian ( $1 \text{ radian} = 180 \cdot \pi^{-1}$ ); a unit used to express instrument angular field of view; an angle whose tangent is equal to 0.001;  $1 \text{ mrad} = 0.05729578^\circ$ .<sup>3</sup>

**minimum line pair:** Closest distance that a specific imaging system can resolve between a pair of adjacent, parallel lines (line pair) used to evaluate spatial system resolution.<sup>1</sup>

**minimum resolvable temperature**

**difference:** Thermal resolution; thermal sensitivity: the smallest temperature difference that an instrument can clearly distinguish out of the noise, taking into account characteristics of the display and the subjective interpretation of the operator.<sup>3</sup>

**MKSA:** System of measurement units based on the meter, kilogram, second and ampere.

**modulation:** In general, the changes in one wave train caused by another; in thermal scanning and imaging, image luminant contrast

$(L_{\max} - L_{\min}) \cdot (L_{\max} + L_{\min})^{-1}$ .<sup>3</sup>

**modulation transfer function (MTF):**

Measure of the ability of an imaging system to reproduce the image of a target. A formalized procedure is used to measure MTF. It assesses the spatial resolution of a scanning or imaging system as a function of distance to the target.<sup>3</sup>

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## N

**narrow banded:** Relative term denoting a restricted range of frequency response.<sup>1</sup>

**National Institute of Standards and Technology:** See *NIST*.

**NBS:** See *NIST*.

**NDC:** *Nondestructive characterization*.

**NDE:** (1) *Nondestructive evaluation*. (2) *Nondestructive examination*.

**NDI:** *Nondestructive inspection*.

**NDT:** *Nondestructive testing*.

**NIST:** National Institute of Standards and Technology (formerly National Bureau of Standards), United States Department of Commerce, Gaithersburg, Maryland.<sup>3</sup>

**NIST traceability:** Traceability to the National Institute of Standards and Technology (NIST) is a means of ensuring that reference standards (such as calibrated leaks or heat sources) remain valid and that their calibration remains current.<sup>3</sup>

**noise:** Any undesired signals that tend to interfere with normal reception or processing of a desired signal. The origin may be an electrical, photonic, thermal or acoustic source — indicating either small discontinuities or abrupt changes in properties of the test material.<sup>1</sup>

**noise equivalent temperature**

**difference:** Temperature difference that is just equal to the noise signal; a measure of thermal resolution, but not taking into account characteristics of the display and the subjective interpretation of the operator.<sup>3</sup>

**nondestructive characterization (NDC):**

Branch of *nondestructive testing* concerned with the description and prediction of material properties and with the 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.<sup>1</sup>

**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.<sup>1</sup>

**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.<sup>1</sup>

**nondestructive testing (NDT):**

Determination of the physical condition of an object without affecting that object's ability to fulfill its intended function. Nondestructive testing techniques typically use a probing energy to determine material properties or to indicate the presence of material discontinuities. See also *nondestructive characterization*, *nondestructive evaluation*, *nondestructive examination* and *nondestructive inspection*.<sup>1</sup>

**nongraybody:** Radiating object that does not have a spectral radiation distribution similar to a blackbody and can be partly transparent to infrared (transmits infrared energy at certain wavelengths); also called a *colored body*. Glass and plastic films are examples of nongraybodies.<sup>3</sup> The emissivity of a colored body has a spectral dependence.

**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.<sup>1</sup>

## O

**objective:** In discussion of a lens system (camera, borescope, microscope, telescope), of or pertaining to the end or lens closest to the object of examination — at the end opposite from the eyepiece. Distal; tip.<sup>1</sup>

**objective lens:** Primary lens of an optical system, on an infrared instrument, usually the interchangeable lens that defines the total field of view.<sup>3</sup>

**one hundred percent testing:** Testing of all parts of an entire production lot in a prescribed manner. Sometimes, *complete testing* entails the testing of only the critical portions of the part. Compare *sampling*, *partial*.<sup>1</sup>

**opaque:** Impervious to radiant energy. In thermography, an opaque material is one that does not transmit thermal infrared energy.<sup>3</sup>

**optical element, infrared:** Any element that collects, transmits, restricts or reflects infrared energy as part of an infrared sensing or imaging instrument.<sup>3</sup>

**opening:** Image processing operation of erosion followed by dilation. A single opening eliminates isolated single pixels. See also *closing*.<sup>1</sup>

**optimum frequency:** 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.<sup>1</sup>

**organoleptic:** Relying on or using sense organs, such as the human eye.<sup>1</sup>

**orientation:** Angular relationship of a surface, plane, discontinuity or axis to a reference plane or surface.<sup>1</sup>

**orthicon:** See *image orthicon*.

## P

**parts per million (ppm):** Expression of concentration of a substance as a ratio. For example, a tracer gas concentration might be 10 ppm in air or nitrogen. The more specific terms  $\mu\text{L}\cdot\text{L}^{-1}$  and  $\mu\text{g}\cdot\text{g}^{-1}$  are often used for proportions of volume and mass, respectively.

**pass:** In welding, a single bead along the entire weld length or the process of laying down that bead.<sup>1</sup>

**peak hold:** Feature of an instrument whereby an output signal is maintained at the peak instantaneous measurement for a specified duration.<sup>3</sup>

**period:** Absolute value of the minimum interval after which the same characteristics of a periodic waveform or a periodic feature recur.<sup>1,5</sup>

**photoconduction:** Method by which a vidicon television camera tube produces an electrical image, in which conductivity of the photosensitive surface changes in relation to intensity of the light from the scene focused onto the surface. Compare *photoemission*.<sup>1</sup>

**photodetector (photon detector):** 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,<sup>3</sup> because, unlike thermal detectors, direct photon interaction obviates external heating of the detector for the signal to be sensed.

**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.<sup>3</sup>

**photoemission:** Method by which an image orthicon television camera tube produces an electrical image, in which a photosensitive surface emits electrons when light from a viewed object is focused on that surface. Compare *photoconduction*.<sup>1</sup>

**photometer:** Basic measuring instrument of photometry. Accurate meters measuring radiant energy incident on a receiver, producing measurable electrical quantities.<sup>1</sup>

**photometric brightness:** Luminance of a light source.<sup>1</sup>

**photometry:** Science and practice of the measurement of light or photon-emitting electromagnetic radiation. See also *relative photometry*.<sup>1</sup>

**photon:** Particle of electromagnetic radiation (not limited to visible light).

**photoreceptor:** Light sensor.<sup>1</sup>

**physical properties:** Nonmechanical properties such as density, electrical conductivity, heat conductivity and thermal expansion.<sup>1</sup>

**picture element:** See *pixel*.

**picture processing:** See *image processing*.

**Planck's distribution law:** Fundamental law that relates the emitted energy spectral radiance to wavelength and to emitted surface temperature.

**porosity:** Discontinuity in metal resulting from the creation or coalescence of gas.<sup>1</sup>

**practical examination:** In certification of nondestructive testing personnel, a hands-on examination using test equipment and sample test objects. Compare *general examination* and *specific examination*.<sup>1</sup>

**process:** Repeatable sequence of actions to bring about a desired result.<sup>1</sup>

**process control:** Application of quality control principles to the management of a repeated process.<sup>1</sup>

**process testing:** Initial product testing to establish correct manufacturing procedures and then by periodic tests to ensure that the process continues to operate correctly.<sup>1</sup>

**propagation:** Advancement of energy through a medium.

**pseudocolor:** Image enhancement technique wherein colors are assigned to pixels in an image according to their intensity.

**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 and/or repetitive activities over a period of time.<sup>1</sup>

**pulsed thermography:** See *thermal wave imaging*.

**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.<sup>3</sup> (Heating or cooling of pyroelectric material creates charge accumulation.)

**pyroelectric vidicon (PEV):** Video camera tube with its receiving element fabricated of pyroelectric material and sensitive to wavelengths from about 2 to 20  $\mu\text{m}$ ; used in infrared thermal viewers. Sometimes called *pyroelectric vidicon*.<sup>3</sup>

**pyrometer:** Optical radiation thermometer for remote measurement of spot radiation levels, rather than imaging a scene in the manner of an infrared video camera.<sup>1,2</sup> Usually a device with digital outputs. It may be mounted in place or hand held. See *pyrometry*.

**pyrovidicon:** See *pyroelectric vidicon*.

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

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## Q

**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 capabilities. See also *qualified*.<sup>1</sup>

**qualified:** Having demonstrated the required amount and the required type of training, experience, knowledge and abilities. See also *qualification*.<sup>1</sup>

**quality:** Ability of a process or product to meet specifications or to meet the expectations of its users in terms of efficiency, appearance, longevity and ergonomics.<sup>1</sup>

**quality assurance:** Administrative actions that specify, enforce and verify a quality program.<sup>1</sup>

**quality control:** Physical and administrative actions required to ensure compliance with the quality assurance program. May include nondestructive testing in the manufacturing cycle.<sup>1</sup>

**quality of lighting:** Level of distribution of luminance in a field of view or in a visual environment.<sup>1</sup>

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## R

**radian:** Angle equal to  $180 \cdot \pi^{-1}$  degrees or 57.295 78 angular degrees.<sup>3</sup>

**radiance:** Radiant flux per unit solid angle and per unit projected area of the source. Measured in watt per square meter steradian. Compare *irradiance*.<sup>1</sup>

**radiant energy:** Energy transmitted through a medium by electromagnetic waves. Also known as *radiation*.<sup>1</sup> See also *radiance*.

**radiant flux:** Radiant energy's rate of flow, measured in watt.<sup>1</sup>

**radiant intensity:** Electromagnetic energy emitted per unit time per unit solid angle. Measured in watt per steradian.<sup>1</sup>

**radiant power:** Total radiant energy emitted per unit time.<sup>1</sup>

**radiation, thermal:** Mode of heat flow that occurs by emission and absorption of electromagnetic radiation, propagating at the speed of light and, unlike conductive and convective heat flow, capable of propagating across a vacuum; the form of heat transfer that allows infrared thermography to work because infrared energy travels from the target to the detector by radiation.<sup>3</sup>

**radiation reference source:** 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.<sup>3</sup>

**radiation thermometer:** See *infrared radiation thermometer*.

**radio frequency display:** Presentation of unrectified signals on a display screen.<sup>1</sup> See also *video presentation*

**radio frequency interference:** See *EMI/RFI noise*.

**radiometer:** Instrument for measuring radiant power of specified frequencies. Different radiometers exist for different frequencies.<sup>1</sup>

**radiosity:** Total infrared energy (radiant flux) leaving a target surface. This is composed of radiated, reflected and transmitted components. Only the radiated component is related to target surface temperature. Also called *exitance*.<sup>3</sup>

**radiometric photometer:** Radiometer for measuring radiant power over a variety of wavelengths.<sup>1</sup>

**rankine:** Absolute temperature scale related to the fahrenheit relative scale. The rankine unit (°R) is equal to 1 °F; 0 °R = -459.72 °F; the degree sign and the word *degrees* are not used in describing rankine temperatures.<sup>3</sup>

**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.<sup>1</sup>

**ratio pyrometer:** 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 ≅ 300 °F).<sup>3</sup>

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

**recommended practice:** Set of guidelines or recommendations.<sup>1</sup>

**reference junction:** In a thermocouple, the junction of the dissimilar metals that is not the measurement junction. This is normally maintained at a constant reference temperature.<sup>3</sup>

**reflectance or spectral reflectance:** Ratio of wave energy (radiant flux) reflected from a material to incident wave energy (incident radiant flux) per unit area.<sup>1,3</sup> See also *reflectivity*.

**reflection:** General term for the process by which the incident flux leaves a surface or medium from the incident side, without change in frequency. Reflection is usually a combination of specular and diffuse reflection.<sup>1,6</sup>

**reflectivity:** Ratio  $\rho$  of the intensity of the total energy reflected from a surface to total radiation on that surface:

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

For a perfect mirror, reflectivity  $\rho$  approaches 1.0; for a blackbody the reflectivity is 0.<sup>3</sup> See also *reflectance* and *reflection*.

**reflectometer:** Photometer used to measure diffuse, specular and total reflectance.<sup>1</sup>

**reject:** Instrument function or control used for minimizing or eliminating low amplitude signals (electrical or material noise) so that other signals may be further amplified. Use of this control can reduce vertical linearity. Also called *suppression*.<sup>1</sup>

**rejection level:** Value established for a test signal above or below which, depending on the test parameter, test objects are rejectable or otherwise distinguished from the remaining objects.<sup>1</sup> Compare *acceptance level*.

**relative humidity:** Ratio (in percent) of the water vapor content in the air to the maximum content possible at that temperature and pressure.<sup>3</sup>

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

**remote viewing:** Viewing of a test object not in the viewer's immediate presence. The word *remote* previously implied either closed circuit television or fiber optic systems remote enough so that, for example, the eyepiece and the objective lens could be in different rooms. High resolution video and digital signals can now be transmitted around the world with little loss of image quality. Compare *direct viewing*.<sup>1</sup>

**repeatability:** Ability to reproduce a detectable indication in separate processings and tests from a constant source.<sup>1</sup> For thermal measurements, expressed in degrees difference or a percentage of full scale.<sup>3</sup>

**resistance, thermal (R):** Measure of a material's resistance to the flow of thermal energy, inversely proportional to its thermal conductivity  $k$ , where  $k = 1 \cdot R^{-1}$ .<sup>3</sup>

**resistance temperature device (RTD):** Sensor that measures temperature by a change in resistance as a function of temperature.<sup>3</sup>

**resolution:** Aspect of image quality pertaining to a system's ability to reproduce objects, often measured by resolving a pair of adjacent objects or parallel lines. See also *minimum line pair* and *resolving power*.<sup>1</sup>

**resolution, discontinuity:** Property of a test system that enables the separation of indications due to discontinuities located in close proximity to each other in a test object.<sup>1</sup>

**resolution test:** Procedure wherein a line is detected to verify a system's sensitivity.<sup>1</sup>

**resolution threshold:** Minimum distance between a pair of points or parallel lines when they can be distinguished as two, not one, expressed in minutes of arc. Vision acuity in such a case is the reciprocal of one half of the period expressed in minutes.<sup>1,6</sup>

**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*.<sup>1</sup>

**response time:** Time it takes for an instrument output signal or display to respond to a temperature step change at the target; expressed in seconds (typically, to 95 percent of the final value, and approximately equal to 5 time constants).<sup>3</sup>

**retina:** In the eye, the tissue that senses light.<sup>1</sup>

**robotic system:** Automated system programmed to perform purposeful movements in variable sequences.<sup>1</sup>

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## S

**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.<sup>3</sup>

**sampling, partial:** Testing of less than one hundred percent of a production lot. See *one hundred percent testing*.<sup>1</sup>

**sampling, random partial:** Partial sampling that is fully random.<sup>1</sup>

**sampling, specified partial:** Partial sampling in which a particular frequency or sequence of sample selection is prescribed. An example of specified partial sampling is the testing of every fifth unit.<sup>1</sup>

**scan angle:** For a line scanner, the total angular scan possible at the target plane, typically 90 degrees.<sup>3</sup>

**scanning:** Movement of a sensor over the surface of a test object in a controlled manner so as to achieve complete coverage.<sup>1</sup>

**scan position accuracy:** For a line scanner, the precision with which instantaneous position along the scan line can be set or measured.<sup>3</sup>

**sector:** For a line scanner, a portion of the total scan angle over which measurement is made at the target plane.<sup>3</sup>

**seebeck effect:** See *thermoelectric effect*.

**sensitivity:** Measure of a sensor's ability to detect small signals. Limited by the *signal-to-noise ratio*.<sup>1</sup> See *minimum resolvable temperature difference*.

**setpoint:** Any temperature setting at which an activating signal or closure can be preset so that, when the measured temperature reaches the setpoint, a control signal, pulse or relay closure is generated.<sup>3</sup>

**shock:** Sudden application of force, for a specific time duration; also the temporary or permanent damage to a system as a result of a shock.<sup>3</sup>

**shrink:** Internal rupture occurring in castings due to contraction during cooling, sometimes 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.<sup>1</sup>

**SI:** The International System of units of measurement. An international system of measurement based on seven units: meter (m), kilogram (kg), second (s), kelvin (K), ampere (A), candela (cd) and mole (mol).<sup>1,5</sup>

**signal:** Response containing relevant information.<sup>1,4</sup>

**signal processing:** (1) Acquisition, storage, analysis, alteration and output of digital data through a computer.<sup>1</sup> (2) In infrared and thermal testing, manipulation of temperature signal or image data for purposes of enhancing or controlling a process. Examples for infrared radiation thermometers are *peak hold*, *valley hold*, averaging and *sample and hold*. Examples for scanners and imagers are usually referred to as *image processing* and include qualitative characterization, quantitative characterization, alignment, isotherm enhancement, image subtraction, image averaging, and image filtering.<sup>3</sup>

**signal-to-noise ratio:** Ratio of signal values (responses that contain relevant information) to baseline noise values (responses that contain nonrelevant information). See *noise*.<sup>1,4</sup>

**slit response function:** Measure of the measurement spatial resolution (IFOV<sub>meas</sub>) of an infrared scanner or imager.<sup>3</sup> See *modulation transfer function*.

**smoothing:** In image processing, use of positive coefficients in a linear combination of pixel values to smoothen abrupt transitions in a digital image.<sup>1</sup>

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

**spatial resolution:** Spot size in terms of working distance. In an infrared radiation thermometer this is expressed in milliradians or as a ratio (D/d) of the target spot size (containing 95 percent of the radiant energy, according to common usage) to the working distance. In scanners and imagers it is most often expressed in milliradians.<sup>3</sup>

**specular reflector:** Smooth reflecting surface that reflects all incident radiant energy at an angle complementary (equal around the normal) to the angle of incidence. A mirror is a specular reflector.<sup>3</sup>

**spectral response:** Spectral wavelength interval over which an instrument or sensor responds to infrared radiant energy, expressed in micrometer (μm); also, the relative manner (spectral response curve) in which it responds over that interval.<sup>3</sup>

**spectral reflectance:** See *reflectance*.

**spectral transmittance:** See *transmittance, spectral*.

**spot:** Instantaneous size (diameter unless otherwise specified) of the area at the target plane that is being measured by the instrument. In infrared thermometry, this is specified by most manufacturers to contain 95 percent of the radiant energy of an infinitely large target of the same temperature and emissivity.<sup>3</sup>

**storage operating range:** Temperature extremes over which an instrument can be stored and, subsequently, operate within published performance specifications.<sup>3</sup>

**subtense, angular:** Angular diameter of an optical system or subsystem, expressed in angular degrees or milliradians. In thermography, the angle over which a sensing instrument collects radiant energy.<sup>3</sup>

**specification:** Set of instructions or standards invoked by a specific customer to govern the results or performance of a specific set of tasks or products.<sup>1</sup>

**specific examination:** In certification of nondestructive testing personnel, a written examination that addresses the specifications and products pertinent to the application. Compare *general examination* and *practical examination*.<sup>1</sup>

**spectral power distribution:** Radiant power per unit wavelength as a function of wavelength. Also known as *spectral energy distribution, spectral density* and *spectral distribution*.<sup>1</sup> See *Planck's law*.

**spectral reflectance:** See *reflectance*.

**spectral transmittance:** See *transmittance*.

**spectrophotometer:** Instrument used for *spectrophotometry*.<sup>1</sup>

**spectrophotometry:** Measurement of electromagnetic radiant energy as a function of wavelength, particularly in the ultraviolet, visible and infrared wavelengths.<sup>1</sup>

**spectroradiometer:** Instrument used for *spectroradiometry*.<sup>1</sup>

**spectroradiometry:** Measurement of electromagnetic radiant power and spectral emittance, used particularly to examine colors and to measure the spectral emittance of light sources.<sup>1</sup>

**spectroscope:** Instrument used for *spectroscopy*.<sup>1</sup>

**spectroscopy:** Spectro photometry or spectroradiometry in which the spectrum, rather than being analyzed only by a processing unit, is presented as a digital signal for computer analysis or in a visible form to the operator for organoleptic examination.<sup>1</sup>

**spectrum:** (1) Amplitude distribution of frequencies in a signal.<sup>1</sup>

(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.<sup>1</sup>

**spectrum response:** Amplification (gain) of a receiver over a range of frequencies or wavelengths.<sup>1</sup>

**specular:** Of a mirrorlike surface, reflective or shiny, with little or no diffusion.

**speed of light:** Speed of all radiant energy, including light:  $2.997\,925 \times 10^8$  m·s<sup>-1</sup> in vacuum (about 186 000 mi·s<sup>-1</sup>). In all materials the speed is less in practical measurements and varies with the material's index of refraction, which itself varies with wavelength.<sup>1,6</sup>

**standard:** (1) Physical object with known material characteristics used as a basis for comparison or calibration. (2) 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.<sup>1</sup> (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*.<sup>1,4</sup>

**standard atmospheric conditions:** Atmospheric pressure of 101.325 kPa (14.6959 lb<sub>f</sub>·in.<sup>-2</sup>). Temperature of 293.15 K (20 °C, 68 °F or 527.67 °R). The density of dry air at these conditions is 1.2041 kg·m<sup>-3</sup> (0.075 17 lb·ft<sup>-3</sup>).<sup>1</sup>

**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  $300 \text{ W}\cdot\text{m}^{-2}$  ( $95 \text{ BTU}\cdot\text{ft}^{-2}\cdot\text{h}^{-1}$ ). (Stefan-Boltzmann constant for photon emission =  $1.52041 \times 10^{15} \text{ photon}\cdot\text{s}^{-1}\cdot\text{m}^{-2}\cdot\text{K}^{-2}$ .)<sup>1</sup>

**stereo photography:** Close range photogrammetric technique involving the capture and viewing of two images of the same object in order to reconstruct a three dimensional image of the object.<sup>1</sup>

**subsurface discontinuity:** Any discontinuity that does not extend through the surface of the object in which it exists.<sup>1</sup> See *near surface discontinuity*.

## T

**target:** Object surface to be measured or imaged.<sup>3</sup>

**temperature:** Measure of the intensity of particle motion in kelvin (K), degrees celsius (°C) or degrees fahrenheit (°F) or, in the absolute scale, kelvin (K) or degrees rankine (°R), where an increment of  $1 \text{ K} = 1 \text{ °C} = 1.8 \text{ °R} = 1.8 \text{ °F}$ . Compare *heat*.<sup>1</sup>

**temperature measurement drift:** Reading change (error), with time, of a target with nonvarying temperature, which may be caused by a combination of ambient changes, line voltage changes and instrument characteristics.<sup>3</sup>

**temperature resolution:** See minimum resolvable temperature (difference), MRT(D).<sup>3</sup>

**test surface:** Exposed surface of a test object.<sup>1</sup>

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

**thermal conductivity:** See *conductivity*, *thermal*.

**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.<sup>1</sup>

**thermal detector, infrared:** Type of infrared detector that changes electrical characteristics as a function of temperature; typically, thermal detectors have slow response, (on the order of milliseconds) broad spectral response and usually operate at room temperature; thermal detectors are commonly used in infrared radiation thermometers and in some imagers.<sup>3</sup>

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

**thermal diffusivity:** Speed at which heat diffuses through an object. Expressed as the rate  $\alpha$  of temperature change with time. Each material has its own characteristic value of diffusivity, combining the overall influence of thermal conductivity  $k$ , density  $\rho$  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).<sup>1</sup>

**thermal effusivity:** See *effusivity*, *thermal*.

**thermal equilibrium:** Condition of an object wherein temperatures throughout the object remain constant.<sup>1</sup>

**thermal viewer:** Nonmeasuring thermal imager that produces qualitative thermal images related to thermal radiant distribution over the target surface.<sup>3</sup>

**thermal wave imaging:** Term used to describe an active technique for infrared nondestructive material testing, in which a sample is stimulated with a pulse of thermal energy and in which the time based returned thermal images are processed to determine flaw depth and severity.<sup>3</sup> Also called *pulse stimulated imaging* or *pulsed thermography*.<sup>3</sup>

**thermistor:** Temperature detector, usually a semiconductor, whose electrical resistance decreases predictably and nonlinearly with increasing temperature.<sup>3</sup> The coefficient of electrical resistance with temperature is typically on the order of  $-4 \text{ percent K}^{-1}$ .

**thermistor bolometer, infrared:** Thermistor so configured as to collect radiant infrared energy; a type of thermal infrared detector.<sup>3</sup>

**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.<sup>3</sup> Also called *seebeck effect*.

**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.<sup>3</sup>

**thermogram:** 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).<sup>3</sup>

**thermograph:** Another word used to describe an infrared thermal imager.<sup>3</sup>

**thermography:** Imaging or viewing of an object or process through sensing of *infrared radiation* emitted by it. The temperature patterns on the material surface produce corresponding radiation patterns. Thus, heat flow by both conduction and radiation may be observed and used to locate material discontinuities.<sup>1</sup> Most often, thermography is based on sensing of infrared radiation.

**thermomechanical coupling:** interaction between mechanical and thermal behaviors of materials.

**thermometer:** Any device used for measuring temperature.<sup>3</sup>

**thermopile:** Device constructed by the arrangement of thermocouples in series to add the thermoelectric voltage. A radiation thermopile is a thermopile with junctions so arranged as to collect infrared radiant energy from a target, a type of thermal infrared detector.<sup>3</sup>

**threshold:** See *adaptive thresholding*, *resolution threshold* and *threshold level*.

**thresholding:** Digital data processing technique that reduces a gray level image into a binary image by application of a threshold.<sup>1</sup>

**threshold level:** Setting of an instrument that causes it to register only those changes in response greater or less than a specified magnitude.<sup>1,4</sup>

**time constant:** Time it takes for any sensing element to respond to 63.2 percent of a step change at the target being sensed. In infrared sensing and thermography, the time constant of a detector is a limiting factor in instrument performance, as it relates to response time.<sup>3</sup>

**total field of view (TFOV):** In imagers, the total solid angle scanned, usually rectangular in cross section. See also *field of view*.<sup>3</sup>

**transducer:** Any device that can convert energy from one form to another. In thermography, and infrared detector is a transducer that converts infrared radiant energy to some useful electrical quantity.<sup>3</sup>

**transfer calibration:** Technique for correcting a temperature measurement or a thermogram for various errors by placing a radiation reference standard adjacent to the target.<sup>3</sup>

**transfer standard:** Precision radiometric measurement instrument with NIST traceable calibration used to calibrate radiation reference sources.<sup>3</sup>

**transient heat flow:** Heat flow occurring during the time it takes an object to reach *thermal equilibrium* or *steady state*.<sup>1</sup>

**transmissivity:** Proportion  $\tau$  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  $\tau$  is transmissivity,  $\epsilon$  is emissivity and  $\rho$  is reflectivity. For a blackbody, transmissivity = 0. Transmissivity is the internal transmittance per unit thickness of a nondiffusing material.<sup>3</sup> See also *transmittance*, *spectral*.

**transmittance, spectral:** Radiant flux passing through a medium divided by the wavelength of the incident radiant flux.<sup>1</sup>

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

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## U

**unity:** One (1.0).<sup>3</sup>

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## 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.<sup>3</sup>

**visual testing:** Method of nondestructive testing using electromagnetic radiation at visible frequencies.<sup>1</sup>

**voids:** Hollow spots, depressions or cavities. See also *discontinuity* and *dislocation*.<sup>1</sup>

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## W

**wavelength:** Distance in the propagation direction that a wave travels in completing a full cycle.

**white light:** Light combining all frequencies in the visible spectrum.<sup>1</sup>

**Wien's displacement law:** For practical infrared imaging, *Wien's displacement law* gives the wavelength of maximum emittance.<sup>1</sup>

**working distance:** Distance from the target to the instrument, usually to the primary optic.<sup>3</sup>

**working standard:** Work piece or energy source calibrated and used in place of expensive reference standards. In the calibrating of photometers, the standard would be a light source.<sup>1</sup>

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## Z

**zone:** In line scanners, a scanned area created by the transverse linear motion of the product or process under a measurement sector of the scanner.<sup>3</sup>