



Infrared Glossary

For further information regarding terms and definitions, please also refer to **ISO 10878:2013** Non-destructive testing – Infrared thermography – Vocabulary.

Aberration – Any undesired factor that distorts an image. Typical sources of image aberrations are: noise, such as signal crosstalk and external signal pickup; optical effects, such as chromatic aberration and; vignetting; video effects, such as barrel distortion and pin cushion; and digitising effects, such as pixel clock crosstalk; video levelling; inadequate sampling and so on.

Absolute temperature scale – A temperature measurement scale based on the coldest possible temperature equal to zero (see Rankine and Kelvin).

Absorptance (absorptivity) – The ratio between the amount of energy absorbed and the total energy incident (irradiance), usually measured at a surface. The absorptance of a surface is equal to its emissivity.

Accuracy – A measure of the similarity of an instrument reading to the actual value for that reading. Instrument accuracy is affected by many factors, including instrument drift, environment, temperature, time and operator expertise.

Active element – The area on a detector that responds to radiation by creating a signal output. Many detectors contain both unused (inactive) elements and unused areas that are not part of the active, or responsive, element area.

Active IR system – A system using an (active) IR source to illuminate a scene, much like the way in which a visible image scene is illuminated with a floodlight. An active IR system monitors the illuminated scene in much the same way as a passive system.

Ambient temperature – The temperature of the surrounding air and environment considered the baseline measurement for heat transfers around an object.

Anti-reflective coating – A thin layer of material applied to the surface of an optical element to increase the transmission of the element by reducing backscattering due to surface reflections. A simple A/R coating will comprise a one-quarter wavelength-thick coating of a material whose refractive index is between the indexes of the air and the element material.

Angstrom – One millimicron; a unit to measure the wavelength of high-frequency electromagnetic radiation such as visible light.

Apparent temperature – The temperature determined for an object calculated by a remote infrared sensor based solely on the amount of radiation it emits, assuming the object has blackbody emission characteristics.

Aspect ratio – The ratio of the vertical length to the horizontal width. For a television display the aspect ratio is 3:4.

Atmospheric windows – Spectral radiation regions not absorbed by atmospheric gasses. These windows are transparent to radiation at those wavelengths. The most obvious window is the visible light window: if the smog is not too bad we can see through the atmosphere indefinitely.

Atmospheric attenuation/atmospheric absorption – The amount of signal reduction occurring when IR radiation travels through the atmosphere between the target and imaging system. The amount of attenuation can be very small on clear days with short transmission paths and can be very large on foggy, smoggy, dusty days with long transmission paths.

Attenuation – The reduction in the intensity of the radiation after processing through a filter. This can be measured in dB.



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Azimuth angle – The angle measurement of horizontal dimension on an optically generated display. Normally zero azimuth is taken to be the centre of the field of view and dimensions to the right and left are positive and negative azimuth angles.

Backscattering – The re-reflection of thermal energy generated on the ground and reflecting off the underside of clouds or inversion layers. Also can refer to unwanted front surface reflections off of a transparent optical element.

Background noise – The noise present in a sensor (detector) independent of the signal strength or ambient temperature. This is normally caused by thermal, generant-recombinant characteristics or $1/f$ effects.

Background temperature – The average temperature of the environment around an object under study. The background temperature creates the radiation level available as reflected energy.

Blackbody – An ideal thermal radiator, usually one whose temperature can be controlled, radiating and absorbing the maximum possible thermal radiation for the set temperature (emissivity = 1.0, reflectance = 0.0, transmittance = 0.0).

Bolometer – A temperature measuring instrument using a strip thermistor to achieve higher sensitivity than of a simple thermistor. Unlike thermistors that are used for contact temperature measurements, bolometers have been used to measure radiation levels.

British Thermal Unit (BTU) – The amount of thermal energy required to raise one pound of water one degree Fahrenheit at or near freezing.

Calibration – The process of adjusting an instrument to read accurate results or, in some cases, accurately constructing a table of errors so that the instrument reading can be adjusted offline or post measurement to correlate the reading accurately to the true value.

Cavity Celsius (centigrade) – A scale for measuring temperature where absolute zero is -273.2°C , the melting point of water (ice point) is 0°C and the boiling point of water is 100°C .

Certified – As in 'certified infrared thermographer'. A level of competence in understanding the laws of thermal dynamics with regard to infrared thermography, requiring a 40-hour course plus an examination that must be passed.

Clear aperture – The useful area of a lens. The edges of a lens can not be used due to edge effects in coating and due to the mounting hardware interfering with ray transmission. The clear aperture is usually specified to exclude the edges and is usually circular in diameter.

Colour scale – An area of the display screen set aside to display the full range of available colours. Used to demonstrate how each colour is assigned a temperature or radiation level.

Colour thermogram – A display of temperature differences that has been enhanced by the assignment of discrete colour values to each of the thermal intensity levels. This is considered the normal visual display mode for a thermal video system.

Conduction – The transfer of energy through a solid without motion of the conducting solid as a whole.

Conduction band – The energy band above the energy gap in a semiconductor. Electrons with enough energy to reach the conduction band can freely move within the semiconductor in response to externally applied potential gradients.

Convection – The transfer of energy through a liquid or gas due to the motion of the medium.



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Coolant – A medium, usually gas or liquid, that is either held at low temperatures or generates low temperatures when it expands and is used to reduce the temperature of another object.

Critical angle – The smallest incident radiation angle at which total internal reflection occurs. This angle is defined using Snell's Law, setting the sine of the refraction angle of the lower index material equal to one.

Degree – An increment of temperature measurement value.

Delta-T – Small differences of temperature.

Depth of field – The range of object distances that are in focus around a set focus distance value (object space distance).

Depth of focus – The range of motion of the focus assembly around a set focus distance which will not defocus an object at that focus distance (image space distance).

Detectivity – The ability of a detector to sense radiant power; the signal-to-noise ratio. The inverse of a noise power reading. Detectivity is related to noise since the signal power must be at least as large as the noise power to be distinguished as signal, not noise.

Detector, IR – A device which converts infrared irradiance into electrical energy.

Detector element – A small area etched out of a detector material (called the substrate) that does the actual photon sensing and conversion. Most of the rest of the substrate is inactive and either covered with a plating or not activated. Many detector elements can be put on one substrate and used for sensing IR radiation.

Diffuse reflections – Non-specular reflections of defocused, uniform intensity for a wide range of reflection angles. A perfectly diffuse surface is defined as a Lambertian surface and the intensity is constant no matter what the angle of view.

Edge effects (optical) – Image or data distortions that can occur at the edges and corners of an image due to optical aberrations building up at the extreme range of the field of view. These aberrations can include geometric distortion (fish eye), vignetting (hot centre/dark corners) and ray distortion (apparent corner defocusing).

Electromagnetic radiation – The field effects given off by accelerating a charged particle in a magnetic field. Depending on field strength and speed of acceleration, many types of electromagnetic radiation are created.

Electromagnetic spectrum – A plot of the range of wavelengths and types of electromagnetic radiation found to exist from subsonic waves to cosmic rays.

Emissivity – The ability of an object to radiate and absorb energy from its surroundings measured as a ratio of the actual object emission to the blackbody equivalent emission.

Endothermic – Pertaining to heat absorption. A chemical reaction is endothermic if it requires heat to complete the reaction.

Equilibrium – A condition where all of the thermal changes in a system have stabilised. To observe true heat flow characteristics, a gradient must be developed across an object or interface and allowed to stabilise; this is a thermal equilibrium.

Exothermic – Pertaining to heat generation. A chemical reaction is exothermic if it liberates heat as the reaction proceeds.



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Fahrenheit – A temperature measurement scale that defines the ice point of water as 32°F and the boiling point of water as 212°F. Absolute zero is –459.7°F.

Far infrared (LWIR) – Infrared radiation whose wavelength is in the range from 8 to 100 microns.

Field of view (FOV) – The total field measured in an angle within which objects can be imaged or measured and displayed by an infrared system.

Filter (optical) – An optical device that modifies the characteristics of radiation that is passed through it. Usually, filters either attenuate all wavelengths of radiation by a certain controlled amount or modify the optical passband of the radiation, eliminating selected wavelengths or bands while allowing others to pass.

Focal length – The distance from the convergent point for the radiation (focal point) to its affiliated principal plane.

Focal plane – The plane created by mapping the points of convergence for rays that pass through a lens assembly from an object that is moved on a plane perpendicular to the optical axis at a great distance from the lens assembly (*ie* collimated rays). For a detector to work properly, all of its active elements must be placed in the same focal plane for such an object. Otherwise, portions of the object space will appear defocused.

Front surface mirror – A mirror whose reflective surface is on the same side as the incident radiation. Front surface mirrors coated for maximum reflection are normally used in infrared optics to maximise the signal strength of the reflected radiation.

Geometric concentration – The ability of a lens to concentrate radiation on the focal point; the ratio of aperture size to active detector area.

Greybody – A thermal reference source that maintains an output, not at 100% emission (which would be a blackbody) but at a lesser ratio. Greybody emissions maintain a constant emission ratio over a wide frequency range. This distinguishes them from spectral radiators.

Grey scale – An area of the screen reserved for displaying an increasing ramp of image intensities to be used as a calibration aid. Periodic intensity levels are labelled with the temperature or radiation value they represent.

Heat capacity – A measurement of an object's ability to store thermal energy. Heat capacity equals the specific heat of an object multiplied by its density multiplied by its size (or specific heat multiplied by mass).

Heat transfer – The flow of thermal energy from one object to another, by means of conduction, convection or radiation.

Ice point/ice point reference – The temperature at which water freezes. A device that creates the ice point temperature very accurately as a reference for thermocouple temperature measurement.

Image enhancement – Techniques used to modify an image to present an observer with more readily accessible information.

Imager – The part of an infrared system that contains the detector, optics and scanning mechanism. The imager must be held and pointed at whatever scene is to be studied. The word imager is sometimes used instead of viewer to mean an infrared system which creates relative radiation images without calibration.

Incident radiant energy – Total energy impinging on a surface from the surroundings.



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Infrared (IR) – Electromagnetic radiation that occupies the band from 0.7 microns to 100 microns. Infrared radiation is between the visible spectrum and microwave radiation.

Infrared – The region of the electromagnetic spectrum that covers from 1 to 100 microns. The term comes from the Latin base of 'beyond the red', referring to the fact that beyond the red colour of the light spectrum there is still energy but it is invisible to the human eye without the aid of an infrared imaging instrument. The discipline of viewing objects based on their thermal properties is called infrared thermography.

Infrared camera – An optical/electrical device that transfers thermal radiation into a visible image that is displayed on a CRT screen, monitor, LCD or other display. Infrared cameras are primarily used by certified infrared thermographers in civilian industrial applications and research and development in infrared thermography. Infrared imaging systems come with many capabilities and specific uses. They may only be able to display the infrared image, or they may be able to digitally record the image and perform temperature measurements and analysis at the same time. Infrared image cameras primarily work in 3-5 or 7-14 micron ranges. They should not be confused with infrared film that is primarily used in photographic cameras. Infrared film works in the 0.7-1 micron range and does not see the thermal energy that is emitted from objects at close to ambient temperatures. Infrared film sees the energy reflected from objects at temperatures of greater than 1,100°F.

Infrared thermography – The science of viewing and understanding objects based on their ability to give off thermal radiation. The use of specialised infrared imagers that can allow someone to view the object based on the amount of thermal radiation that the object either gives off or reflects.

Infrared thermographer – Someone that is trained in the sciences of viewing, measuring and understanding how objects give off their thermal radiation when viewed through an infrared imaging system. Most infrared thermographers today are certified by certain infrared training programmes such that they have passed a criteria of proficiency in the science of infrared thermography. Certification alone does not indicate a level of proficiency or quality when performing services, but it shows that the thermographer has taken the time to further their level of knowledge. Just as in any trade, the level of education, years of experience, degree of professionalism and quality of past work must be taken into consideration.

Infrared window – An optical element usually placed on the front of an infrared system that is transparent to infrared radiation but excludes radiation of other wavelengths and protects the internal sensor components.

Instantaneous field of view (IFOV) – The angle in milliradians derived by dividing the active detector element's size by the system's effective focal length. An effective figure of merit for system resolution can be derived by dividing the field of view by the instantaneous field of view.

Irradiance – The intensity of radiation impinging on a surface, the rate of impact of radiation.

Isoradian – Areas or lines of constant thermal irradiance.

Isotherm – Areas or lines of constant temperature.

Isothermal windowing – An image processing feature that allows the user to enhance a range of isotherm or isoradian levels. This feature allows the user to highlight areas of similar temperature and easily find the hottest and coldest objects in an area such as an electrical distribution panel.

Joule – A measurement of thermal energy. 1 J is equal to 1n·m, 10^7 erg, or approximately 0.737 ft·lb.



Kelvin – The most commonly used absolute temperature scale. The scale is based on the Celsius scale degree increment with 0 K equal to absolute zero.

Kinetic energy – The energy of motion.

Linear array – A collection of active detector elements set in a straight line on a plane usually spaced equal distances apart from each other with a single element in the perpendicular direction.

Luminance – The portion of a colour display that is related to display intensity; how bright a colour is perceived to be by the eye.

Micron (micrometre) – A measurement of length in the metric system appropriate for measuring infrared radiation wavelengths. 1,000,000 microns equals one metre.

Mid-infrared (mid-wavelength infrared (MWIR)) – The middle infrared spectrum, usually from 2.4-7.0 microns.

Milliradians – A measure of small angles. Two thousand-pi milliradians can be measured in a complete circle. There are 17.4 milliradians per degree of angle.

Near infrared (short-wavelength infrared (SWIR)) – The shortest wavelength infrared radiation band: 0.7-1.4 microns.

Neutral density filter – A filter that attenuates radiation uniformly over a wide range of wavelengths; it is used in infrared systems as a temperature range extension filter.

Noise – Unwanted signal interference, usually separated into various forms of signal crosstalk and random noise generated by means internal to the sensor.

Ohmmeter – An instrument to measure electrical resistance.

Opaque – The characteristic of not passing any incident radiation (transmissivity = 0). An optical filter is said to be blocked in a waveband if it has less than 5% transmission over those wavelengths.

Operating temperature range – The range of ambient temperatures over which a system will function accurately. This range can be defined by a calibration limit (what range of ambient temperature offsets are allowed in the data calculations) or it can be due to a functional limit in the system (the ability to keep the detector cold) or it can be set by a catastrophic limit (batteries may not hold their charge below certain temperatures and integrated circuits will not function above certain temperatures).

Passive infrared system – The normal form of infrared system in use commercially. A passive system does not generate a thermal source to illuminate the scene, it is only acted upon. A passive system monitors the flux of photons already being generated by the scene within its field of view.

Photoconductor – A radiation-sensitive resistor whose resistance decreases as it is exposed to radiant energy.

Photon – A single quantum of electromagnetic energy having momentum hf/c and energy hf . (h is Planck's constant, f is the frequency of the wave and c is the speed of light).

Photovoltaic detector – A detector which responds to radiant flux by generating current.



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Pixel (picture element) – The smallest location size on a display or in memory. The incremental location of picture information in either the horizontal or vertical direction (also called a Pel).

Principal plane – A mathematical construct useful in analysing complex optical assemblies. The principal planes are constructed at the effective focal length distance away from the lens assembly focus and serve to represent the mathematical position of the lens assembly assuming it could be constructed as a single thin lens.

Pyrometer – An optical instrument for remote sensing and measurement of spot temperatures or radiation levels.

Qualitative analysis – An analysis of objects or processes that is concerned with deriving structural, material or relative information. This type of analysis can be done with imagers, line scanners and viewers; temperature or radiometric data output is not required.

Quantitative analysis – An analysis of objects or processes that is concerned with measuring temperatures or radiant energy levels by assigning numerical values to the characteristics of the displayed scene.

Radian – A measurement of angle. There are 2π radians in a full circle of 360 angular degrees.

Radiance – The total intensity of thermal energy (radiant flux) which can be observed from a surface. It is scaled by unit of solid angle of view and by unit of area from the surface. The flux includes all forms of radiation emission, reflection and transmission.

Radiant energy – See radiance.

Radiation – Heat transfer of energy in the form of electromagnetic waves. Forms of radiation include cosmic rays, gamma rays, X-rays, ultraviolet radiation, infrared, visible light, radio, audio and subsonic.

Radiometer – An instrument that measures radiation levels. Such an instrument can be calibrated in power or temperature.

Rankine – A temperature scale based on 0°R equal to absolute zero temperature. The increment of 1°R is equal to one degree Fahrenheit. 459.7 Rankine is equal to 0°F .

Reflectance (reflectivity) – The amount of total radiance which can be attributed to reflected energy. Usually expressed as a percentage of total energy.

Repeatability – A measure of accuracy and stability for an instrument. The capability of an instrument to duplicate a previous answer to a previous experiment within a limited margin of error.

Remote sensing – To obtain a reading or measurement from a distance, without physical contact between the meter and the object to be measured.

Resolution – A measure of the capability of a system to resolve small objects against the viewing field. Measured as a ratio of angles.

Responsivity – A measure of detector performance, measuring the value of the detector output change for a given applied thermal power change.

Scale sensitivity – The minimum adjustment allowed in the system per intensity level. A system is normally configured so that the operator can set a scale sensitivity greater than the system sensitivity. If the NET of a system were 0.5°C , the scale sensitivity might be 0.1°C or 0.05°C to allow enough signal for offline image improvement features such as averaging to reduce the noise level.



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Selective radiator – A source that radiates thermal energy in specific bandwidths and emits little or no radiation in others. An incandescent light is a greybody radiator while a quartz iodine light is a selective radiator. Hot pipes are greybody radiators while flames are selective (spectral) radiators.

Sensitivity – A measure of the minimum amplitude of input signal change to which an instrument will respond. This is a measurement of thermal resolution.

Sensor – The component that converts radiation into electrical signals. Can be used to refer to the detector specifically, the imager or the entire system.

Specific heat – A property of materials. The specific heat of a material indicates how much thermal energy (in joules) is required to increase a mass (in grams) of material by a small temperature difference (°C). Specific heat is one of the principal factors in determining heat capacity, conduction rates in a material and the thermal time constant of an object subject to heating.

Spectral – Pertaining to the electromagnetic spectrum, depending on wavelength or frequency, varying based on wavelength.

Spectral absorption – The ability a filter or gas has of transmitting radiation of some wavelength while absorbing materials of other wavelengths. The atmosphere is a spectral absorber for relatively long infrared paths.

Spectral emission – A source that radiates thermal energy in specific bandwidths and emits little or no radiation in others. An incandescent light is a greybody radiator while a quartz iodine light is a selective radiator. Hot pipes are greybody radiators while flames are selective (spectral) radiators.

Specular – Indicating reflections or a shiny surface.

Spot size – The minimum size of object that can be resolved at a given distance by an optical device.

Stability – A measure of system accuracy and reliability that indicates how little a system reading moves from an original value.

Standards, primary – The ultimate physical standard used as a basis for measurements. In the USA, all primary standards are maintained by the National Institute of Standards and Technology (NIST). The primary standards are used to calibrate secondary standards.

Standards, secondary – Secondary standards are physical standards and references, which have been calibrated directly from the NIST primary standards. These standards are normally maintained by the more sophisticated testing laboratories and used to calibrate reference standards.

Standards, reference/standards, working – Tertiary standards are the standards that are actually used in plant facilities for the calibration of products. They are periodically calibrated against the secondary standards. The normal working standards used in the infrared field consist of blackbody sources, thermocouples and thermocouple meters, resistance temperature detector (RTDs) and thermometers.

Temperature – An expression of thermal energy density, *ie* how hot or cold an object is.

Temperature range – The maximum to minimum temperature display capability of a system. It should be specified whether the range under consideration is the range displayed, the total display range capability of the system, or the operating temperature range of the system.



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Thermal conductivity – A property of materials that measures the ability of a material to conduct heat. It can be expressed as power per degree length (watts/metre-C or W/m-kelvin). Metals have a high thermal conductivity (conduct well), while air fibres and plastics have much poorer conductivity.

Thermal expansion – The change of size that materials undergo as their temperature changes. In tight mechanical tolerance assemblies, the thermal expansion coefficients must be matched to maintain tolerances over a significant operating temperature range.

Thermal gradient (or thermal profile) – A graph of temperature changes over a distance. A thermal gradient is usually expressed and displayed as a straight line, sometimes only vertical or horizontal.

Thermal radiation – Electromagnetic energy whose natural wavelength falls between 0.7 and 100 microns.

Thermal viewer/thermal data viewer – A class of remote temperature sensing system. This equipment class offers an image of relative radiation levels and a means for obtaining temperature information from the screen. A common alternative is to have a bullseye target indicator and an alphanumeric overlay display of the temperature and the operator-selected emissivity.

Thermogram – A two-dimensional hard copy record of the apparent scene temperatures displayed on an IR system (usually a photograph of the display).

Thermography – The study of remote temperature measurement.

Thermometer – A meter for measuring temperature.

Thermopile – A number of thermocouples whose junctions are assembled in series to magnify the Seebeck voltage and increase the sensitivity of the reading. Thermopiles have been used in remote sensing pyrometers.

Transmittance (transmissivity) – A measurement of the ability of a material to pass radiation from one side to the other without absorbing or reflecting it. Transmittance is the ratio of transmitted radiant energy to total irradiance.

Viewfinder – A small display attached to a camera (or IR sensor) for aiding the operator in adjusting the location and display characteristics of the equipment. A viewfinder reproduces the final system display at a reduced size and resolution, usually in black and white to help with adjustments.

(Infrared) viewer – An infrared (IR) viewer is a device that produces an image of radiation intensity but has no parameters to allow the user to compensate for the properties of the target object or the effects of the atmosphere between the viewer and the object. This type of device will only produce an image and is not capable of measuring temperature. Examples of this type of device are IR viewers used for security systems, police, search and rescue and many more. In these applications the temperature of the object is irrelevant: we just need to know if something is there.

Vignetting – The loss of radiation intensity due to the blocking of a portion of the beam bundle between the focused point on the object plane and the focused point on the image plane.

Void (thermal) – An area in a surface that displays significantly different thermal impedance from adjacent areas. This can be due to a different object internal structure, such as an insulation void in the wall of a building.

Watt – A measure of power equal to one joule expended for one second.

Wavelength – The length of distance between cycles on a repetitive event.