Thermal Imaging Definitions: From A to Z

Absolute temperature: Absolute zero is the lowest temperature that can be obtained in any macroscopic system. Absolute temperature means temperature measured on a scale with absolute zero as 0. This conventionally measured in units Kelvin.

Absolute zero: At absolute zero, a hypothetical temperature, all molecular movement stops. All actual temperatures are above absolute zero. Absolute zero would occur at -273.16 degrees Celsius, -459.69 degrees Fahrenheit, or 0 Kelvin.

Absorption: The ratio of how much infrared radiation is absorbed by a surface, and later emitted, as a percentage of the total amount of energy exposed to the surface. The percentage of absorption is basically equal to its emissivity.

Accuracy: A measure of the similarity of an instrument reading to the actual value for that reading. The accuracy of temperature measurement indicators on thermal imagers is affected by emissivity, the distance from the object, the angle of the object and a number of other factors.

Ambient Temperature: The temperature of the surrounding air and environment, which can impact the heat transfers around an object. Most temperature indicators on thermal imagers do not measure ambient air temperatures.

Amorphous Silicon: material used to create infrared detectors. These types of detectors are used in a number of fire service thermal imagers.

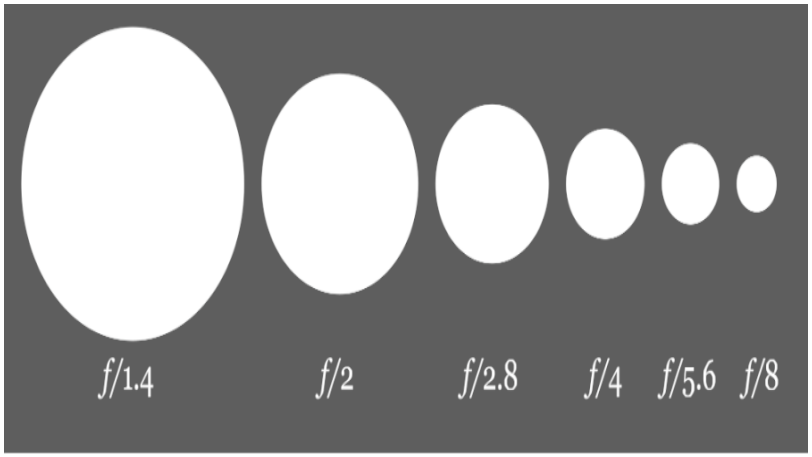
Angstrom: A unit of measure equal to one-thousandth of a micron.

Anomaly: The deviation of the value of a parameter, such as temperature, from its average or normal value. This is often mentioned in qualitative thermography where they are not looking for exact temperature measurements but rather temperatures outside of normal ranges.

ANSI: American National Standards Institute

ASNT: American Society for Non-Destructive Testing. All thermal imaging curriculum has meet the requirements of this organization.

Aperture: A hole or opening that limits the amount of infrared radiation that reaches a detector. Bullard's Thermal Throttle on the TIC and TI Commander is also called an aperture control. This is also found on manufacturer's specification sheet as an alpha numeric designation such as f/1. When you hit the shutter release button of your camera a hole opens up that allows your cameras image sensor to catch a glimpse of the scene you're wanting to capture. The aperture that you set impacts the size of that hole. The larger the hole the more light that gets in – the smaller the hole the less light.



Aperture is measured in 'f-stops'. The smaller the number the larger the opening. Aperture has a big impact upon depth of field. Large aperture (remember it's a smaller number) will decrease depth of field while small aperture (larger numbers) will give you larger depth of field.

Apparent Temperature: The uncompensated reading from an IR camera where emissivity is set to 1.0 and distance is set to 0. This is the common term used when describing readings from Fire Service IR Cameras as they are generally not able to adjust their emissivity settings.

Aspect Ratio: The ratio of the horizontal width to the vertical length of a display. Many video displays are 4:3, as are the infrared detectors. This is the ratio of the common television. Some newer displays have a 16:9 aspect ratio.

Atmospheric Attenuation: A decrease in the intensity of Infrared Radiation due to absorption and scattering in the atmosphere. –or- The amount of signal reduction that occurs when infrared radiation travels through the atmosphere between the target and a thermal imager. Dust, humidity and precipitation can all reduce the effectiveness of the thermal imager, and the accuracy of any surface temperature measurement device.

Auto Image Adjust: Automatic camera or software function that adjusts Level and Span based on image content.

Background Noise: The noise naturally present in an infrared detector, independent of the signal strength or ambient temperature. This is usually masked by software, but it may occasionally appear as image graininess in very bland scenes.

Blackbody: A theoretical object that radiates the maximum amount of energy at a given temperature, and absorbs the entire energy incident upon it. An ideal thermal radiator, normally used as a testing standard. The most common can be set to a specific temperature as the device emits almost 100% of the infrared radiation expected at a given temperature. Emissivity ratings are essentially a percentage value, compared to the blackbody. (Emissivity = 1.0, Reflectance = 0.0, Transmittance = 0.0) An object that absorbs all electromagnetic radiation that falls onto it. No radiation passes through it and none is reflected

Bland Scene: A very stable scene viewed by a thermal imager. The scene is characterized by little temperature variation and a lack of strong emitters. Bland scenes can be difficult for thermal imagers to generate quality images.

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

BST (Barium Strontium Titanate): A material used to create infrared detectors. These types of detectors are used in a number of fire service thermal imagers. (no longer available)

BTU: British Thermal Unit-The amount of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit.

Bucket Head: A material used to create infrared detectors. These types of detectors are used in a number of fire service thermal imagers.

Calibration: The process of adjusting an instrument to read accurately under specific conditions.

Calorie: The standard unit of energy measurement in nutrition. Equal to one kilocalorie or 1,000 calories.

Calorie: Energy unit; a single calorie is the amount of heat needed to increase the temperature of one gram of water by one degree Celsius.

Celsius (Centigrade): A scale for measuring temperature, where Absolute Zero is -273.2° C, water freezes at 0° C, and water boils at 100° C.

Certification: A written testimony of qualification.

Chopper Wheel: A small wheel that rotates rapidly in front of a BST-based infrared detector. The wheel has a spiral cut out that partially blocks different portions of the detector momentarily. This process generates fluctuation in the amount of infrared energy reaching the detector, allowing it to create an accurate thermal image.

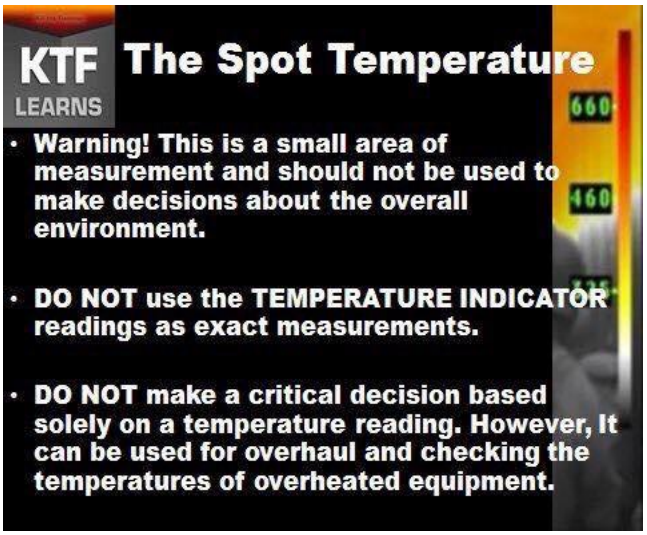
Color palette: Scheme that assigns colors to various image gray levels.

Condensation: The change of phase of a substance from a vapor to a liquid. This is the opposite of evaporation. The process of condensation releases energy; this energy is known as latent heat.

Conduction: The transfer of heat energy through a solid.

Convection: The transfer of heat energy through a liquid or gas due to the motion of that liquid or gas.

Crosshair (and spot temperature): The intersecting vertical and horizontal line superimposed on the thermal imager display. It is commonly used to indicate the approximate area from which a thermal imager is taking a surface temperature reading. A small "+" shape that aids in aiming a thermal imager for temperature measurements. This is also known as the spot temperature which is usually displayed in the lower right hand corner of the display. It is important to note that this is an approximate measurement of a defined area and NOT the entire image. Notice the spot temperature in the image to the right. It is obviously hotter than 87 degrees Fahrenheit but the TIC is measuring the temperature of the concrete wall of the burn building within the cross hairs.



Degree: An increment of temperature measurement.

Detector (Infrared): The individual chip or wafer that senses infrared energy.

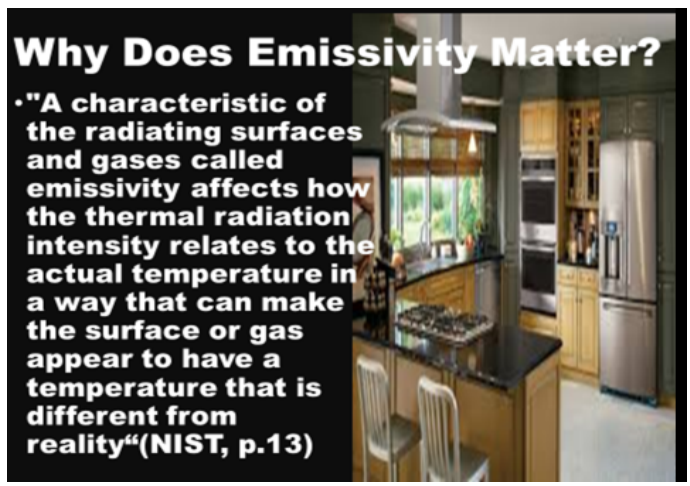
Diffuse Reflection: The random reflection from a rough surface, which results in a fuzzy scattered reflection.

Distance to Spot Ratio(or Spot Size Ratio SSR): A measurement of the area a pyrometer or radiometric thermal imager views from a specific distance. A 10:1 ratio indicates the surface temperature measurement taken at 10 feet is averaging an area of 1 square foot.

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. Radio waves, infrared energy and visible light are all portions of the spectrum.

Emissivity, Emission: What is emissivity and why is it important to the proper use of a TIC? Emissivity is an objects ability to emit heat. Emissivity ratings are defined as fraction of energy (rated between zero and one) in comparison to a perfect black surface which has an emissivity value of 1.



A TIC detects thermal radiance from solid surfaces and from gases that radiate in the 8-14 um spectral range. Emissivity affects the

radiation in a way that can make the surface or gas appear to be a temperature that is different than it actually is. In general surfaces that are black and rough in surface texture tend to have a high emissivity's and surfaces that are shiny/smooth have lower emissivity's. Emissivity is the single most important attribute necessary for thermal measurement. Fire Service TIC's do not generally offer adjustable emissivity settings. The majority of TI manufacturers have the TIC preset at .95 which is the most common emissivity of materials made from carbon. As a general rule, any object that is shiny or reflective, will have a low emissivity and the temperature measurement displayed upon the TIC screen will be inaccurate (can be off by several hundred degrees in some cases).

Energy: is the ability to do work (the application of force through distance). There are three types of energy that strike a thermal imaging detector: emitted, reflected, and transmitted.

Engine: The core component of a thermal imager. This includes the FPA, the circuit boards that run the FPA, and the software that controls the FPA and interprets the signals to generate a thermal image.

Equilibrium: A system is in equilibrium when its temperature properties are uniform and not changing with time.

Evaporation: The process whereby atoms or molecules in a liquid state gain sufficient energy to enter the gaseous state. This takes thermal energy and cools the surface where evaporation is occurring. This effect is noted when observing a structure from the exterior when winds are above 3 mph. This results in a 50 percent decrease in radiated energy observed through the IR camera.

F-number (f/#): The ratio of focal length to aperture for a lens assembly. Smaller numbers represent faster lenses, which means that scene changes are conveyed to the detector more rapidly.

Fahrenheit: A temperature measurement scale, in which Absolute Zero is -459.7° F, water freezes at 32° F and water boils at 212° F.

Far Infrared: The longest wavelength of infrared radiation, measured as roughly 8 to 14 microns. This is the range used by fire service thermal imagers. Also referred to as Long Wave Infrared.

Ferroelectric: The physical property of a material that leads to thermal detection. This refers to the material's ability to polarize as a direct result of temperature change. The stronger the relationship between temperature change and polarization, the better the material's ability to function as a detector. The most common ferroelectric TIis BST-based. **What does ferroelectric mean?** A TIC's detectors that are ferroelectric in nature detect heat by storing it as a value on each individual pixel. BST and pyroelectric vidicon tubes are examples of ferroelectric detectors

Field of View (FOV): The total field, measured as an angle, within which objects viewed by a thermal imager. Narrower FOVs generate more life-size images and distances, while wider FOVs place more image on the display. The most common FOV for fire service TIs is about 50°.

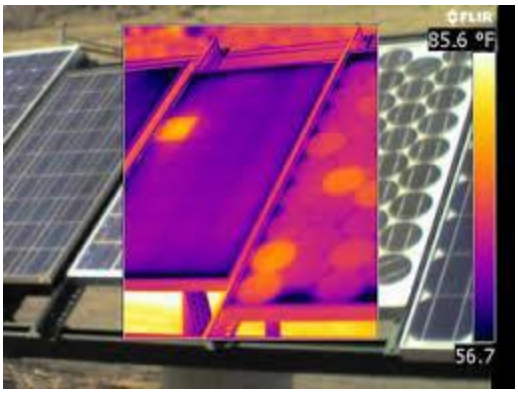
- HFOV: Horizontal Field of View
- VFOV: Vertical Field of View
- IFOV: Instantaneous Field of View
- MFOV: Measurable Field of View

FORD: An acronym in thermography that states in order to have a good thermogram to analyze it must be in Focus, Range (proper temperature range), and Distance

FPA (Focal Plane Array) The infrared detector itself, usually a thin wafer less than 1" square. The most common fire service FPAs are 320x240 pixels or 160x120 pixels. Higher resolution FPA's are becoming available as high as 640x480.

Frequency (or Frame Update Rate): The number of cycles an operation occupies per period of time. The normal unit of measurement for frequency is Hertz (Hz), or cycles per second. The human eye sees images at 27 Hertz. Any fire service Thermal Imager should therefore be at least 30 Hertz to avoid lag. **This is also called "refresh rate"** Refresh rate (or frame update rate) is the number of times per second that a new image is "created" by the sensor. The refresh rate is determined by mechanical attributes (eg. chopper wheel), where applicable, and the speed of the electronics.

Fusion: A mode that allows a TIC to perform picture in picture. This allows a thermogram and an optical in the same shot. This is an industrial application often used for inspections. **Photo from FLIR**

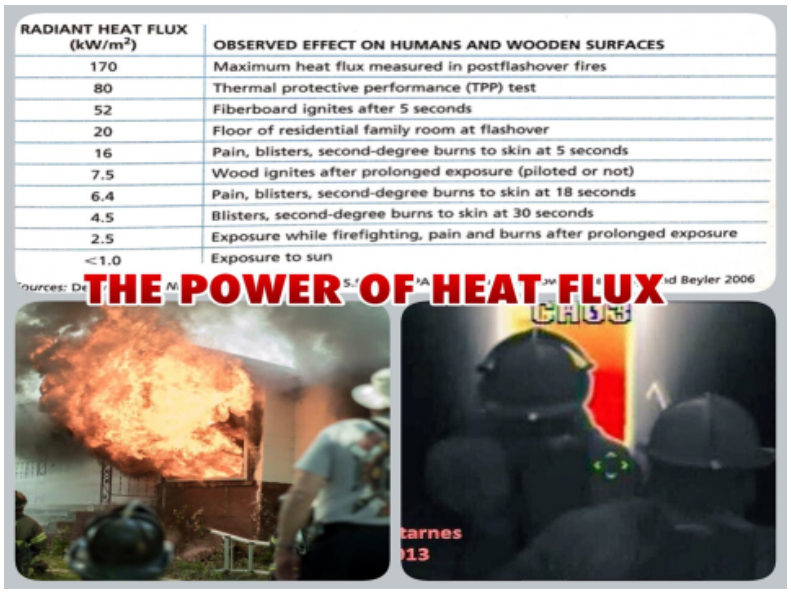


Germanium: Why do TICs have a Germanium window on the front of the camera? The Germanium window allows thermal energy to transmit through it (unlike glass) and provides impact protection for the internal lens (also made of Germanium) that focuses the thermal image onto the detector's focal plane array. In certain cases, the Germanium lens is coated with AR (an Anti-Reflective Coating) and excessive cleaning can remove the AR Coating causing more transmission loss and resulting in calibration error.

Heat: The energy or sensation that humans associate with infrared radiation. Also known as the form of energy that is transferred by a difference in temperature.

Heat Capacity: The amount of heat required to raise the temperature of a specific quantity of a substance by one degree.

Heat Flux: the rate of heat energy transfer through a given surface per unit time. The SI derived unit of heat rate is joule per second, or watt. Heat flux density is the heat rate per unit area. This is commonly measured in failure ratings of firefighter PPE and measured in Kilowatts/meter squared.



RADIANT HEAT FLUX (kW/m^2)	OBSERVED EFFECT ON HUMANS AND WOODEN SURFACES
170	Maximum heat flux measured in postflashover fires
80	Thermal protective performance (TPP) test
52	Fiberboard ignites after 5 seconds
20	Floor of residential family room at flashover
16	Pain, blisters, second-degree burns to skin at 5 seconds
7.5	Wood ignites after prolonged exposure (piloted or not)
6.4	Pain, blisters, second-degree burns to skin at 18 seconds
4.5	Blisters, second-degree burns to skin at 30 seconds
2.5	Exposure while firefighting, pain and burns after prolonged exposure
<1.0	Exposure to sun

Heat Sink: A device for dissipating heat; it absorbs heat by conduction from heat producing devices and dissipates heat by means of convection. Heat sinks are common inside older fire service thermal imagers to help maintain proper operating temperatures.

Heat Transfer: The flow of thermal energy from one object to another, by means of conduction, convection or radiation and also condensation and evaporation. Also known has ***Heat Flux***.

Hertz (Hz): A unit for measuring frequency. One Hertz is one cycle per second.

<u>High Resolution: What makes a quality high resolution thermal imaging picture?</u>

Thermal imaging picture quality is determined by a number of factors:

1. The quality of the lens that focuses the thermal image onto the FPA. One measurement of lens speed is the f-number. ***The smaller the f-number, the wider the lens, and the better the image quality***. Generally, the main constraints to lens quality include weight and size (the better the lens, the bigger and heavier it will be).

2. The number of pixels on the FPA. With all other thermal system components being equal, ***the more pixels on the FPA, the finer the image details that can be resolved***.

3. Whether it's micro bolometer or BST. BST pixels are mechanically interconnected, whereas micro bolometer pixels are mechanically isolated. The thermal energy seen by an individual BST pixel can therefore "bleed" onto nearby pixels, ***but isolated micro bolometer pixels sense independently and provide clearer, crisper image lines.***

4. The electronic signal processing (video enhancement electronics). Most fire service thermal imaging cameras are controlled by microprocessors, which not only monitor the system but also "enhance" the thermal image. For example, some cameras are able to generate near 320 x 240 FPA performance by using a 160 x 120 array and "averaging" to generate the remaining image points. Others are able to determine if a pixel is not functioning properly and approximate its correct output using surrounding pixels to generate a smoothed image.

5. The MRTD. (See definition)
6. The NETD. (See definition)

7. The Dynamic Range. (See definition)

8. The amount of system signal noise. Signal processing and components may add noise (or “snow”) to the image. The cleaner the system, the better the image (difficult to measure but easy to see).

9. The display used to interface with the user. The better quality display provides a better image.

Hot Spot Tracker/Cold Spot Tracker: A feature/option offered by Fire Service TIC manufacturers that is borrowed from Industrial applications where the IR camera seeks out the hottest/coldest pixel within the Field of View.

Imager: A fully incorporated infrared detecting system that contains the detector, optics, processor, power source and display.

Incident Radiant Power = Emitted Radiant Power + Transmitted Radiant Power + Reflected Radiant Power; Which is the total radiation going to an object.

Infrared (IR): electromagnetic radiation which occupies the band from 0.7 microns to 100 microns. infrared radiation is between the visible spectrum and microwave radiation.

Infrared thermography: is the process of acquisition and analysis of thermal information from non-contact thermal imaging devices. Or in layman’s terms, it is the ability to detect heat off of a surface.

Infrared-window: A protective cover, transparent to infrared radiation, placed on the front of a thermal imager to help protect the primary lens from damage. Many fire service thermal imagers use a germanium window. This is also a term used in industry known as an IR window for inspection purposes. Many industrial machines and components will have an IR window were a thermographer can inspect those components without opening up the machine or electrical panel.

Isotherm: The isotherm is the oldest of the measurement tools, appearing in the earliest measurement cameras from the 1960's. An isotherm is a measurement tool highlighting the same areas of the same thermal radiation intensity. In fire service applications, this is found in the Bullard TIC with the Thermal Throttle, Drager UCF 9000, and FLIR K55-65 series.

Kelvin: The temperature scale used by scientists. The scale is based on the Celsius scale increments, but 0° is Absolute Zero rather than the freezing point of water.

LCD (Liquid Crystal Display): A flat panel display system, common on many modern thermal imagers.

Lens: An optical component constructed of transparent substance with one or two curved surfaces of different curvature that has the ability to change the direction of beam travel. Infrared lenses are used for focusing the detector at a distance of interest and for modifying the size and distance of the focused field of interest.

Light: The region of the electromagnetic spectrum which is visible to the human eye. This is usually considered the region from 0.39 (violet) to 0.77 (red) microns.

Long Wave Infrared (LWIR): The longest wavelength of infrared radiation, measured as roughly 8 to 14 microns. This is the range used by fire service thermal imagers. Also referred to as Far Infrared.

Micro bolometer: A type of infrared detector that is capable of measuring absolute energy levels on each pixel of the FPA. Surface temperature measurement can be done directly from a micro bolometer's FPA. Uncooled Micro bolometer: A micro bolometer is a specific type of bolometer used as a detector in a thermal camera. Infrared radiation with wavelengths between 7.5-14 μm strikes the detector material, heating it, and thus changing its electrical resistance. This resistance change is measured and processed into temperatures which can be used to create an image. Unlike other types of infrared detecting equipment, micro bolometers do not require cooling.

A micro bolometer is the latest type of thermal imaging FPA, which consists of materials that measure heat by changing resistance at each pixel. The most common micro bolometer material is vanadium oxide (VOx). Amorphous silicon (ASi) is another relatively new micro bolometer material. In addition, the ASi model has poor dynamic range and isothermal scene performance which limits the current version(s) for many fire service applications. Although micro bolometers do not require a chopper to refresh the image, they must occasionally be recalibrated for the pixels to provide a consistent output and to avoid oversaturation. The device that occasionally (every 30 seconds to 5 minutes) and automatically recalibrates the FPA is called a "shutter"

Micron (micrometer): A metric measurement equal to one-millionth of a meter.

Mid Infrared (or Mid-wave Infrared, MWIR): Infrared radiation with wavelengths of roughly 3 to 5 microns. MWIR infrared camera's detect up to 90% of the radiation in the atmosphere.

Minimum Resolvable Temperature Difference (MRTD) This number expresses the sensitivity of an infrared detector. It defines the smallest temperature difference the detector can differentiate. *The lower the number, the more sensitive the unit is*. Units with high levels of sensitivity (lower MRTD) tend to produce better, more defined images, especially in bland scenes.

Near Infrared: The shortest wavelength infrared radiation, measuring approximately 1 to 3 microns. This is also referred to as Short Wave Infrared. (more common in military applications)

NETD (Noise Equivalent Temperature Difference)

This is a technical measure of sensitivity for a thermal imager, similar to the MRTD. Generally, a lower NETD will equate to more usable images, especially in bland scenes.

What does Sensitivity (NETD) mean when applied to a Thermal Imager?

Sensitivity expresses the ability of an infrared camera to display a very good image even if the thermal contrast in a scene is low. Put another way, a camera with good sensitivity can distinguish objects in a scene that have very little temperature difference between them.

Sensitivity is most often measured by a parameter called Noise Equivalent Temperature Difference or NETD, for example, NETD @ 30 C : 80mK. A Kelvin degree is the SI base unit of thermodynamic temperature equal in magnitude to a degree Celsius, so mK means thousandths of a degree (80mK = 0.080 K).

ASTM E1543-00 Standard Test Method for Noise

Equivalent Temperature Difference of Thermal Imaging Systems [3].

Non-Contact Surface Measurement: A thermal imager uses remote sensing by detecting IR energy from a target without actually having to intrude upon or affect the target. In many cases the components are hazardous to touch.

NUC (Non-Uniformity Correction) this is where the TIC corrects minor detector drift that occurs as the scene and environment change. It is normal to hear a click and the image may freeze momentarily. The Camera will perform a NUC on its own when needed from every 30 seconds to up to several minutes. It will initially happen at shorter intervals when the TIC is first powered up.

Operating Temperature Range

The acceptable temperature range for an infrared detector to remain calibrated and function properly. This refers to the temperature of the detector itself, not the ambient environment. The use of heat sinks, insulation and construction will affect how well a detector stays in its operating range, especially in a fire environment. Properly designed fire service thermal imagers will have other components that have a similar operating range as the detector.

Pixel (Picture element)

The smallest location size on a display or in memory. FPAs are measured in pixels, with each pixel generating a small portion of the thermal image.

Pyrometer

An instrument used for non-contact measurement of surface temperatures. BST-based thermal imagers with temperature measurement have a pyrometer interlaced with the infrared detector.

Qualification: comprises demonstrated skill, demonstrated knowledge, documented training, and documented experience.

Reverse Polarity: A filter/color palette option that is designed for industrial applications in which it makes all target items that are hot appear black/cold. There are a few fire service TIC's that offer this feature. This is not a recommended feature for firefighting.

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.

Radiometric: The ability of an infrared detector to measure, pixel by pixel, the actual scene temperature and display the results. Micro bolometers can be radiometric. This is important to note if the TIC can store a radiometric image versus a Jpeg image. A radiometric image can be analyzed pixel by pixel for temperature measurements by a trained professional.

Reflectance (Reflectivity): The amount of total infrared radiation reflected by a surface. This value is frequently the inverse of the Absorption (Emissivity).

Saturation: The point at which an FPA or pixel cannot register any more infrared radiation. Saturated pixels will automatically be displayed as the hottest indicator (white, red, etc.) on the system. Also defined as the condition in which a further increase in infrared radiation produces no further increase in the displayed image.

Sensitivity: A measure of the minimum amplitude of input signal change to which an instrument will respond. On a thermal imager, this is a measurement of the smallest temperature differences the unit will detect.

Sensor: The component that converts radiation into electrical signals. This can refer to the detector itself, the engine or the entire thermal imager.

Thermal Imaging Camera Sensor Materials:

Amorphous Silicon: Amorphous silicon (ASi) is another relatively new microbolometer material. In addition, the ASi model has poor dynamic range and isothermal scene performance which limits the current version(s) for many fire service applications.

Vanadium Oxide: Vanadium oxide thin films may also be integrated into the CMOS fabrication process although not as easily as a-Si for temperature reasons. VO is an older technology than a-Si, and for these reasons its performance and longevity are less. Deposition at high temperatures and performing post-annealing allows for the production of films with superior properties although acceptable films can still be made subsequently fulfilling the temperature requirements. VO2 has low resistance but undergoes a metal-insulator phase change near 67 °C and also has a lower value of TCR. On the other hand, V2O5 exhibits high resistance and also high TCR. Many phases of VOx exist although it seems that x≈1.8 has become the most popular for micro bolometer applications.

BST: BST stands for “barium stronium titanate,” and this type of detector was developed by Raytheon Corporation. It is a ceramic-like thermal energy sensing material is used to make BST focal plane arrays, which measure heat by storing it as a fixed value (similar to a capacitor) at each pixel. When the grid of pixels, or focal plane array, is monitored simultaneously, a thermal image is generated. Because of their fixed-image properties, BST pixels must be refreshed regularly in order to maintain the perception of real-time imaging. BST isn’t widely used anymore because of:

- The size of the sensor (too large)
- Could not incorporate color

- White Out

Short Wave Infrared (SWIR): The shortest wavelength infrared radiation, measuring approximately 1 to 3 microns. This is also referred to as near infrared.

Shutter: A small device that repeatedly obstructs the FPA in a micro bolometer thermal imager. The shutter covers the FPA, stopping all infrared energy from reaching the FPA. During the period the FPA is covered, the thermal imager verifies its calibrations. When this occurs, the image on the display will freeze momentarily. All micro bolometers have a shutter. A shutter is a mechanical device, generally shaped like a flag, which closes in front of the detector to activate the calibration for a uniform temperature (or black body). This automatic, periodic calibration is necessary because pixels in micro bolometers drift and cause image degradation. This is also known as NUC'ing (Non-Uniformity Correction) where the TIC corrects minor detector drift that occurs as the scene and environment change. It is normal to hear a click and the image may freeze momentarily. The Camera will perform a NUC on it's own when needed from every 30 seconds to up to several minutes. It will initially happen at shorter intervals when the TIC is first powered up.

Spatial Resolution: the clarity or fineness of detail attained by an infrared camera in producing an image.

Spectral Response (What range of light the TIC actually sees): Thermal imaging sensors are designed to detect long-wave infrared radiation between 8 to 14 microns. This energy, unlike visible light, can pass through smoke and is undetected by the naked eye. There are LWIR detectors and SWIR detectors.

SWIR: See Short Wave Infrared.

Temperature: An expression of thermal energy density, or how hot or cold an object is. It is also stated as a measurement of the average kinetic energy of the molecules in an object in a system.

Temperature Range: The maximum to minimum temperature display capability of a system. This can be affected by the FPA, the engine's software program or manufacturer's selection.

Thermal Radiation: Electromagnetic energy whose natural wavelength fall between .7 and 100 microns, also called infraredradiation.

Thermistor: A device which measures temperature. The sensor for the thermistor is a semi-conducting resister whose resistance changes significantly with temperature.
Thermocouple: A device that measures temperature through conduction. The device reads temperature difference by measuring the difference in potential generated at the junction of two dissimilar metals.

Thermoelectric Cooling: A solid-state device that converts current into a temperature difference between two junctions. It is possible to put thermoelectric junctions in series or parallel to increase either the overall temperature drop or their power.

Thermography: The study of remote temperature measurement.

Thermoplastic: A general term used to describe a plastic that will hold up to high temperatures.

TI (Thermal Imager): A packaged, independently powered unit that detects infrared radiation and portrays that information on a video display for the user to interpret.

TIC (Thermal Imaging Camera) See TI.

Transmittance (Transmissivity)

A measurement of the ability of a material to pass radiation from one side to the other without absorbing or reflecting it. Infrared transmittance for most materials is near zero. Therefore, absorption/emissivity and reflectivity are usually inverse values.

Vanadium Oxide: A material used to create infrared detectors. These types of detectors are used in a number of fire service thermal imagers.

Wavelength: The distance between the two peaks of an energy wave cycle. Very long wavelengths may be measured in Hertz, or how frequently the peaks occur per second.

White Out (or Over-Saturation):

A condition that afflicted older infrared detectors. When the detector was exposed to strong infrared sources, such as fires, the thermal imager would generate completely white images on the display. Sometimes this was intentional in an effort to protect the detector from damage; sometimes it indicated damage to the detector. Modern thermal imagers do not white out; they may experience saturation. White-out or oversaturation occurs when a thermal imaging detector is subjected to too much thermal energy, and the image, which appears as a white cloud, no longer identifies fine details in the scene. Most thermal imaging cameras have an automatic iris or appropriate software to adjust system controls to avoid white-out immediately after intense thermal energy hits the detector. Pointing the TIC directly at superheated sources, such as the sun, is not

recommended and may damage the detector. If a newer TIC experiences “white out” it is due to condensation on the lens. ***The TIC cannot see moisture so it appears white on the screen. Simply wiping the lens will resolve the issue.***

Works Cited:

Definitions were quoted from the following sources:

http://v1.bullard.com/V3/resources/glossary/#Temperature

Infrared Training Center. Level I Thermography Course Manual