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# CAPTURING THE ESSENCE OF PREVENTATIVE MAINTENANCE

WHITEPAPER

Thermal imaging records the concentration of radiation in the infrared part of the electromagnetic spectrum and converts in into a visible image. Today, thermal imaging is often the first choice in preventative maintenance and is one of the most non-intrusive, non –invasive and non-destructive diagnostic tools for predictive maintenance of a UPS.

The use of thermal imaging helps to quickly identify problems, allowing for safe, controlled shutdown. This helps eliminate any unplanned disturbances, prevents untimely failure and with regular diagnostics, can extend equipment life. Significant commercial and operational efficiencies can also be recognised with the correct and frequent use of thermal imaging.

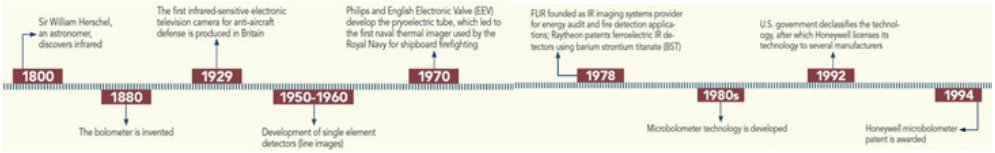
## HISTORY

Thermal imaging owes its stature to the discovery of infrared. Records show that infrared was first recorded by astronomer Sir William Herschel in 1800. Having made the discovery of the planet Uranus, Sir William Herschel was looking for new optical material. It was during the process of testing different coloured glass that he was able to unveil a new portion of the electromagnetic spectrum. Something he referred to as the "thermometrical spectrum". The term infrared did not appear until late in the 19th century.

A major breakthrough for infrared came with the development of an instrument used to measure infrared, heat and radiation came in 1880 and was made by the American astronomer Samuel Pierpont Langley. Known as the bolometer, this very sensitive thermometer was able to detect heat from objects 400m away.

Building on this discovery, in 1929, Hugarian physicist, Kalaman Tihanyi invested the first infrared – sensitive electronic television camera, which was used for anti-aircraft defence in Britain. The device converted infrared images into a visible image through differential evaporation, or condensation of oil on a thin membrane.

The real advances in thermal imaging began in the 1950s and early 1960s, when single element detectors where invented to produce line images. It was these basic detectors that paved the way for today's thermal imaging technology.




Nick Gromicko and John McKenna, InterNACHI's Infrared-Certified® Instructor, https://www.nachi.org/history-ir.htm

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## HOW THERMAL IMAGINNG WORKS

Unlike standard imaging which generally requires light, thermal imaging works from heat – hence the term thermal imaging. Rather than identifying visible properties, thermal imaging represents objects using their temperature.

Objects warmer than absolute zero (-273°C/-459°F) emit infrared radiation in the MWIR (medium wavelength infrared) and LWIR (long wavelength infrared) wavelengths (3µm–14µm) in an amount proportional to the temperature of the object. Radiation is then detected and the temperature variations translated into grey scale images using darker shades to represent warmer temperatures and lighter tones to indicate cooler temperatures. Coloured thermography typically uses white and red colours to denote hotter areas and black and blue to illustrate cooler ones.

### THERMAL IMAGING CAMERA

Infared energy (A) coming from an object is focused by the optics (B) onto an infrared detector(C) sends the information to sensor electronics (D) for image processing. The electronics translate the data coming from the detector into the image (E) that can be viewed in the viewfinder or on a standard video monitor or LCD screen. Infrared thermography is the art of transforming an infrared into a radiometric one, which allows temperature values to be read from the image. So every pixel in the radiometric image is in fact a temperature measurement. In order to do this, complex, algorithms are incorporated into the thermal imaging camera. This makes the thermal imaging camera a perfect tool for industrial applications.

FLIR Systems Trading Belgium, Thermal Imaging Guidebook for Industrial Applications, 2011

In simple terms, a thermal image device known a thermal imager or thermograph will scan an area, capture the infrared emissions and convert them into a visual image. This is a very effective non-invasive, non-destructive method of testing and analysing.

## THERMAL IMAGING FOR PREVENTATIVE MAINTENANCE

As most electrical components raise in temperature when there is fault, thermal imaging has become the essential diagnostic tool for easily identifying any 'hot spots' in electrical systems. Heat patterns captured through thermal imagery can help to pinpoint the origin of any problem areas and be used to identify and prevent any future causes of equipment failure.

Whilst UPS systems are designed to deliver power protection, they can still breakdown. UPS failure can be due to a number of factors such as batteries, capacitors, filters and operating conditions. Planned preventative maintenance of these critical elements can not only improve performance and reliability but also extend the lifespan of equipment and avoid any unplanned downtime.

Thermal imaging is often the first choice in preventative maintenance and is one of the most non-intrusive, non –invasive and non-destructive diagnostic tools for predictive maintenance of a UPS. By detecting anomalies, that are often unnoticed by the naked eye, corrective action can be taken promptly to ensure costly system failures do not occur - giving total piece of mind.

A thermal imaging camera is used to detect hot and cold spots using an image. Used to scan a UPS system, thermal imaging can help detect faulty connections or components that are running at a higher temperature than normal or safe. Most UPS systems and their components will normally give off heat but an increase in heat may confirm a fault is emerging. This way of periodic testing can also highlight changes and the potential demise of an internal component. It is also a way to ensure maintenance can be budgeted for and downtime can be planned in advance if used regularly.

With the promotion of preventative and predictive maintenance, thermal imaging is an integral part of a solid and regular maintenance programme and will almost certainly enable long lasting confidence in equipment. A typical thermal imaging service will involve the inspection if all electrical components of an installation. In analysing the temperature, preventative failure evaluations can be achieved for all electrical items including UPS, switchboards, power factor correction systems, distribution cables, batteries and transformers.

A more detailed analysis used for UPS systems and associated equipment can improve reliability and contribute to enhance its MTBF (mean time between failures) and reducing MTTR (mean time to repair). Thermal imaging diagnostics can be undertaken in live operating environments and can very quickly identify any critical areas that need addressing. These can include loose connections, corrosion, harmonic interferences and load fluctuations.

## THERMAL IMAGING BEST PRACTICE

Thermography can be influenced by different situations and it is therefore important to consider the following for thermal imaging best practice recommendations.

### - The load

Anomalies in performance can be more easily detected when equipment is running as close to full load as possible and thermal imaging should be done at no less than 40% load.

### - Temperature

Extreme temperature environments (hot or cold) must be indicated on the analysis to show a true representation of thermal imaging results.

### - Consistency

Thermal imaging will be undertaken on several occasions throughout the lifecycle of a preventative maintenance programme so equipment settings, load and conditions ideally need to be the same to achieve an accurate view.

### - Photo image

To support any thermal imagery captured it is also advised to take a photo image of the equipment to be used as a reference point to identify key components.

### - General observations

The condition of the equipment and environment in which it is operating should be documented as this can be used in the final analysis and towards identifying key failure signals and pinpoint areas that need further inspection/ maintenance.

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## OPTIMISING THERMAL IMAGING ANALYSIS

When analysing a thermal image and for a true interpretation of the image to give best overall analysis, the following factors need to be considered:

### - Measurement conversion

For true analysis, the settings on the thermal imager should be in line with the temperature limits that it is being compared with. If this is not possible then accurate temperature conversion must be undertaken. The universal conversion formulas to use are

[°C] = ([°F] - 32) × 5/9

[°F] = [°C] × 9/5 + 32 °F to °C (or vice versa)

### - Colour grades

Analysers of thermal images need to have a good understanding of the colour scale of their testing equipment. Differing colour scale settings will give a skewed view of hot-spots/problem areas. As part of a preventative maintenance programme, these settings must remain consistent throughout to gain good trend analysis.

### - Discharged energy

The equipment's emitted energy plays an important part in the thermal imaging process as it is a prime indicator of the overall equipment temperature. This consideration looks largely to reflective heat. It is important to include discharge energy values in any analysis.

### - Physical compound makeup

Staying on the topic of temperature, all equipment will have varying thermal properties with different abilities to retain and release heat. Understanding specific thermal conductivity is essential to avoid distorted results.

Whilst thermal imaging can be a principle preventative maintenance tool for identifying any potential faults, risks and failures, it should not be carried out in isolation. Other preventative maintenance practices should also be adopted and analysis of each collated to form reasonable conclusions.

## CONCLUSION

Thermography can increase the reliability and efficiency of equipment and generally prevents breakdowns and stoppages, which overall can reduce maintenance costs and production losses. Preventative and predictive maintenance should form part of all business power protection strategies. Thermal imaging forms an integral part of these solid and regular maintenance programmes and will almost certainly deliver long lasting confidence in equipment.

At Power Control, we understand how important it is to have minimal downtime. Thermal imaging provides a solution to detect faults with no direct contact with the UPS. There is no interference with the load or power

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