

# INFRARED THERMOGRAPHY

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# OVERVIEW

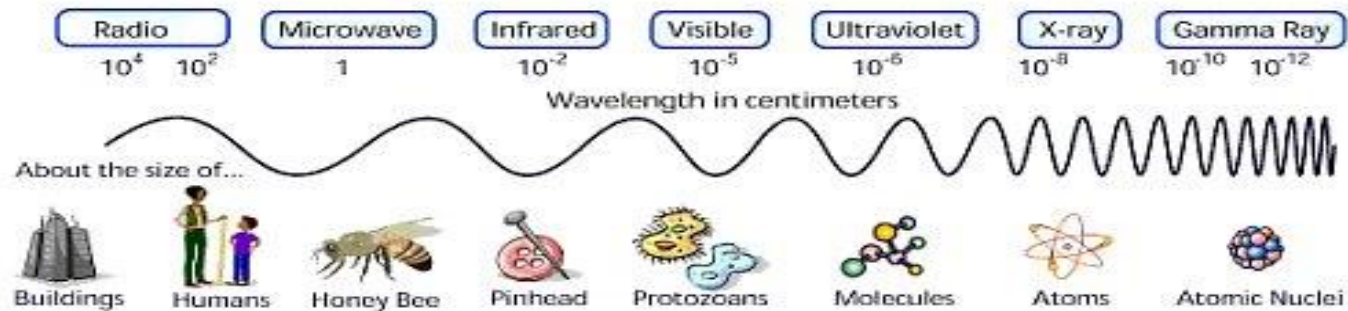
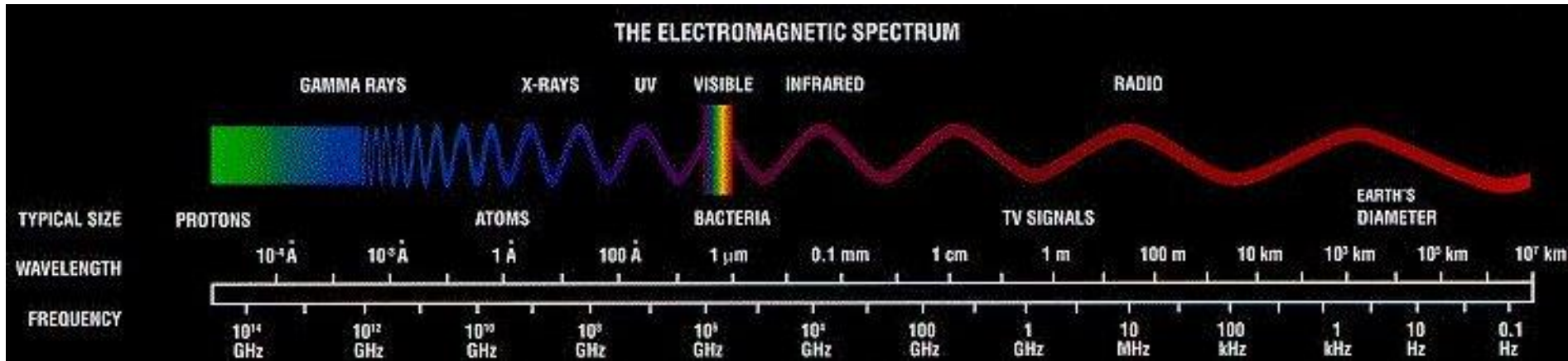
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# INTRODUCTION

- Infrared thermography is a proactive troubleshooting and predictive maintenance tool.
- It is the process of acquisition and analysis of thermal information from non-contact thermal imaging devices.
- Thermal or infrared energy = Light which is not visible because its wavelength is too long to be detected by the human eye: it's the part of the electromagnetic spectrum we perceive as "heat".
- Thermography = The use of an infrared imaging and measurement device to "see" and "measure thermal energy emitted from an object.
- Infrared testing is essentially a non-invasive, non-destructive inspection process that uses thermography cameras.
- These devices gather temperature signatures that lie far beyond the range of visible light.

# ELECTROMAGNETIC SPECTRUM

- The *electromagnetic spectrum* is the distribution of electromagnetic radiation according to energy. It is the range of all possible frequencies of electromagnetic radiation.
- The electromagnetic spectrum extends from below the low frequencies used for modern radio communication to gamma radiation at the short-wavelength (high-frequency) end, thereby covering wavelengths from thousands of kilometers down to a fraction of the size of an atom.



# THERMAL SCIENCE

- Heat is thermal energy associated with temperature-dependent motion of particles

- Photography can be described as writing with Light

- Thermography can be described as writing with Heat

- Heat Transfer Modes:

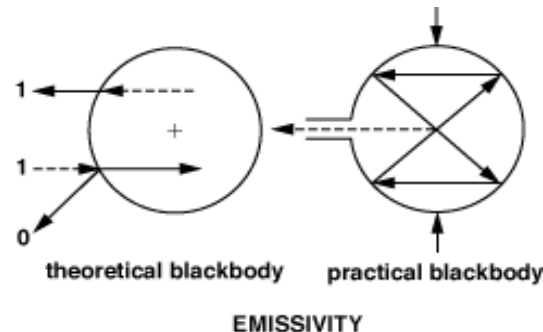
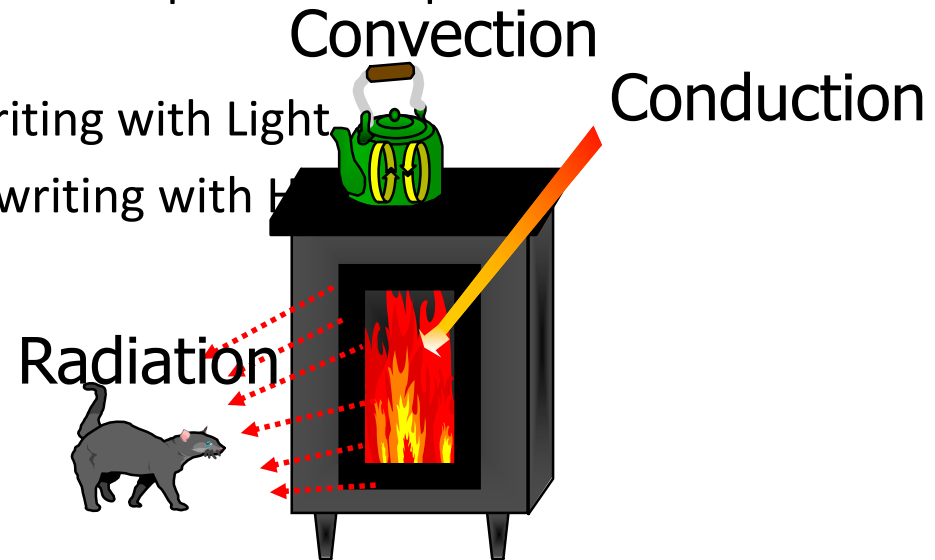
- Conduction

- Convection

- Radiation

- EMISSIVITY

- Emissivity is a term representing a material's ability to emit thermal radiation

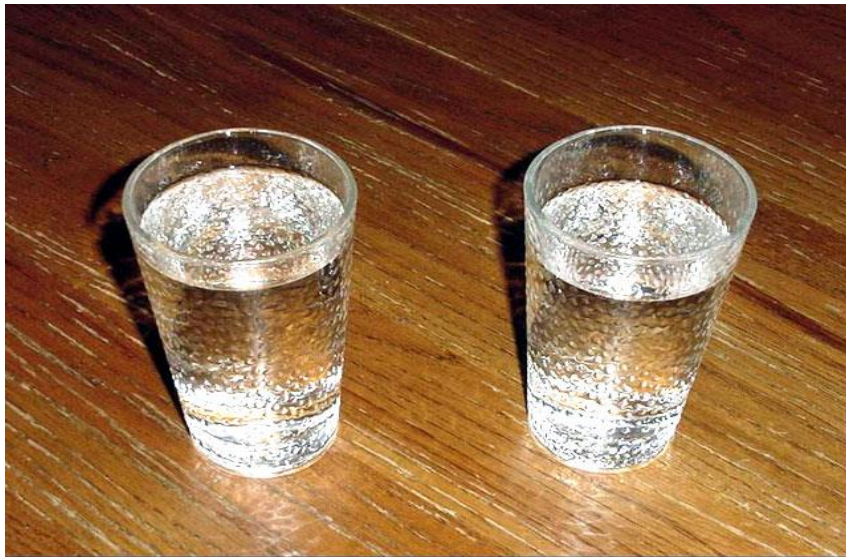


# PRINCIPLE OF IR THERMOGRAPHY

- Since infrared radiation is emitted by all objects based on their temperatures, according to the black body radiation law, thermography makes it possible to “see” one’s environment with or without visible illumination.
- The amount of radiation emitted by an object increases with temperature; therefore thermography allows one to see variations in temperature.
- All objects emit a certain amount of black body radiation as a function of their temperatures. The higher an object’s temperature is the more infrared radiation as black-body radiation it emits.
- A special camera can detect this radiation in a way similar to an ordinary camera does visible light.
- It works even in total darkness because ambient light level does not matter.

# Visual Image

These two glasses visually appear the same.



# Thermal image

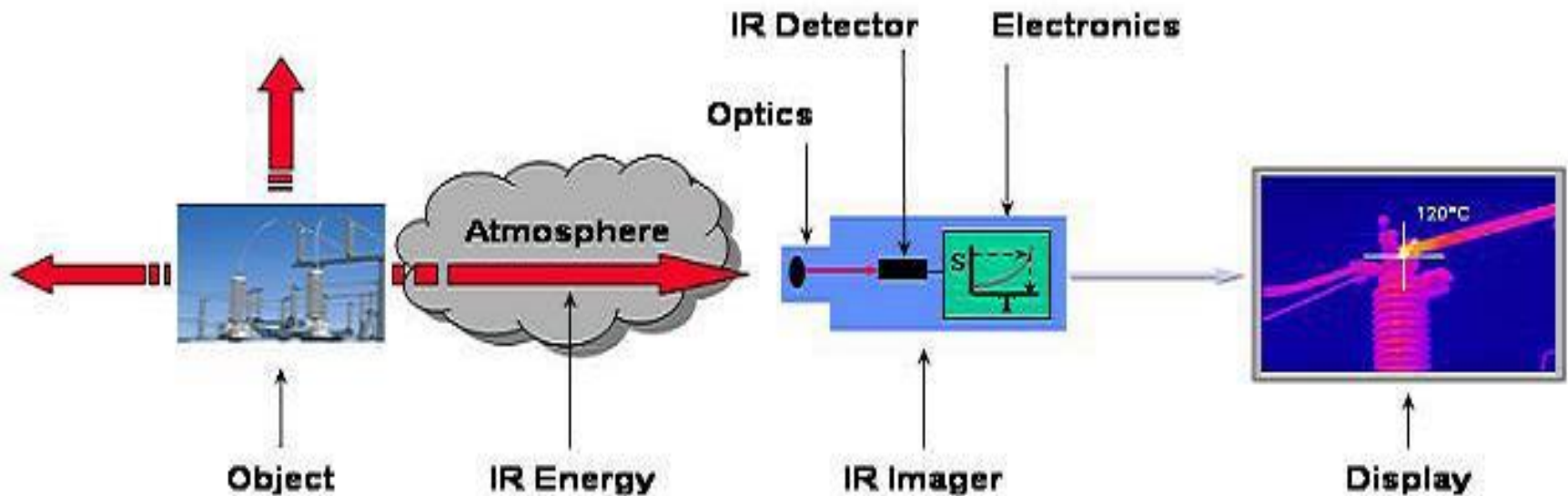
Thermal Imaging with an infrared camera.  
“Paints a different picture.”





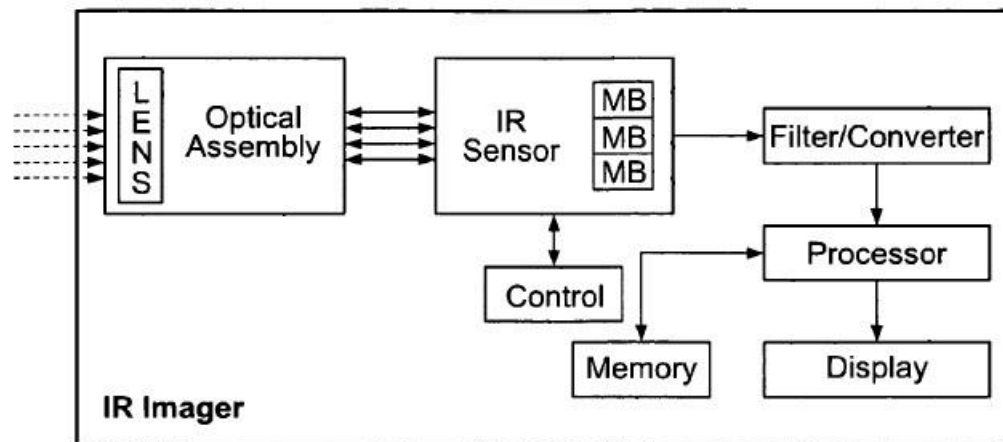
# CONSTRUCTION

## Total Infrared System



OVERALL EQUIPMENT SETUP

# FUNCTIONAL BLOCK DIAGRAM



# COMPONENTS FOR IR IMAGER

- **Detector**

There are two options for a thermal imaging detector, cooled and uncooled, both types of detector absorb infrared energy which in turn affect the detectors electrical properties to produce an image.

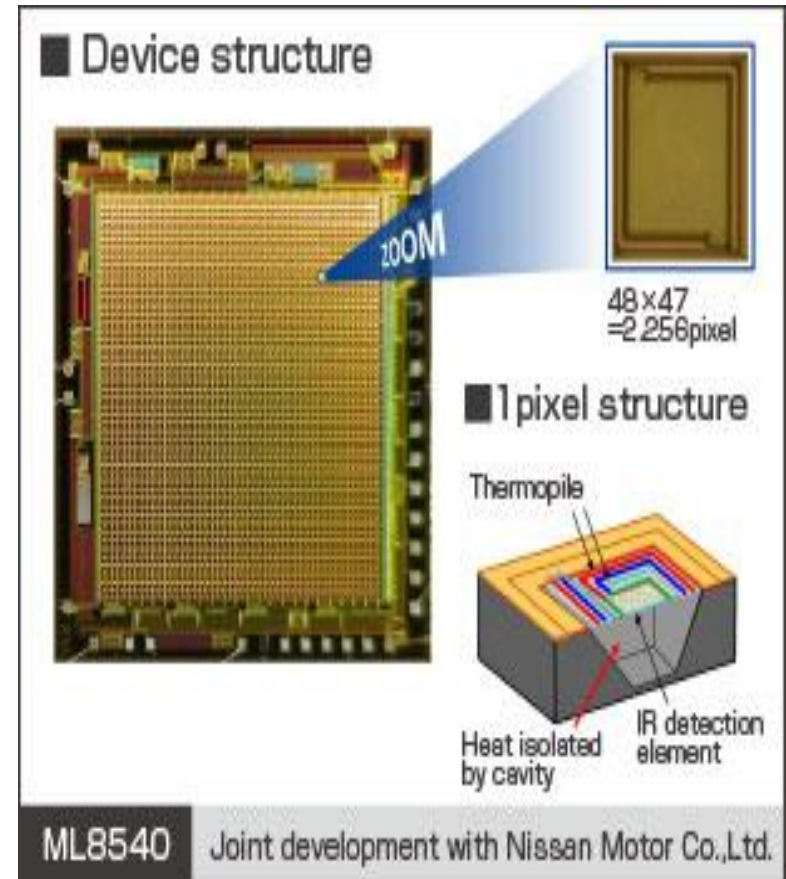
- These detectors use narrow gap semiconductors to offer high sensitivity to infrared radiation. These semiconductors have to be housed in a vacuum sealed case and cryogenically cooled (typically to below a temperature of 110K).

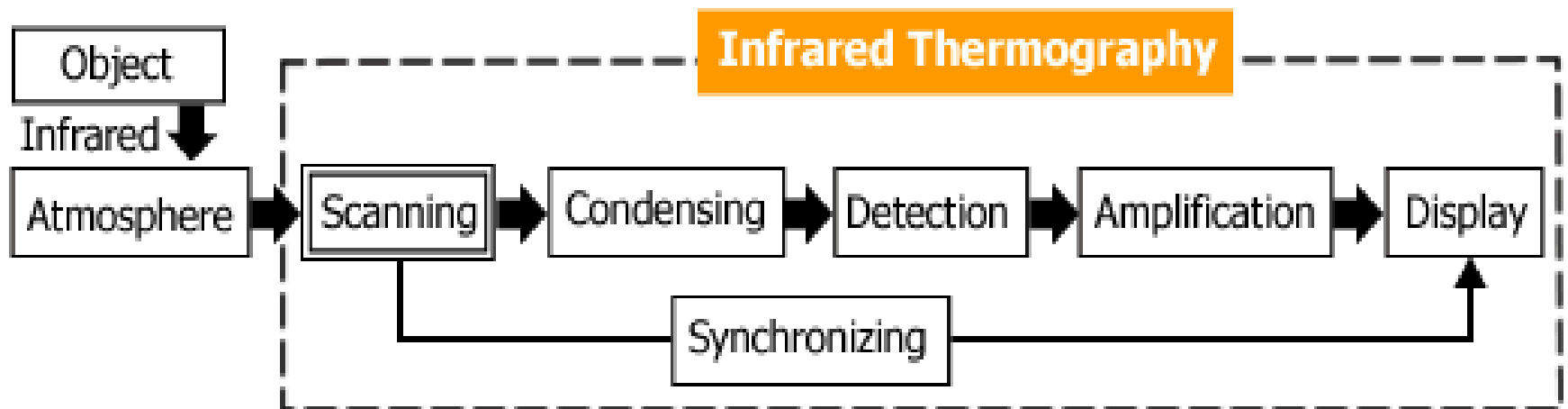
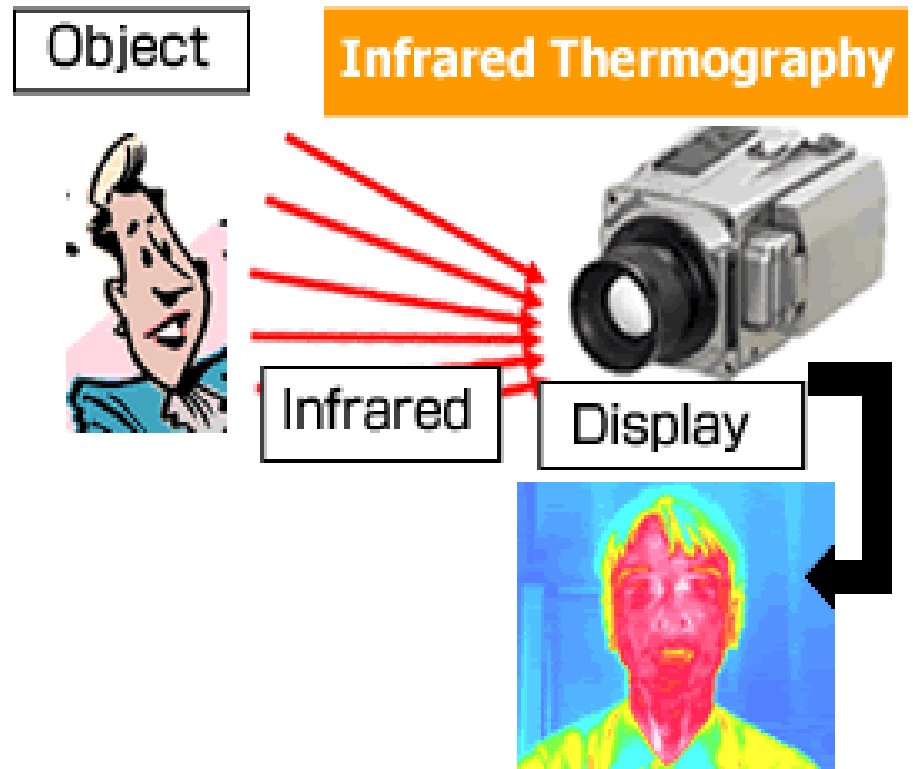
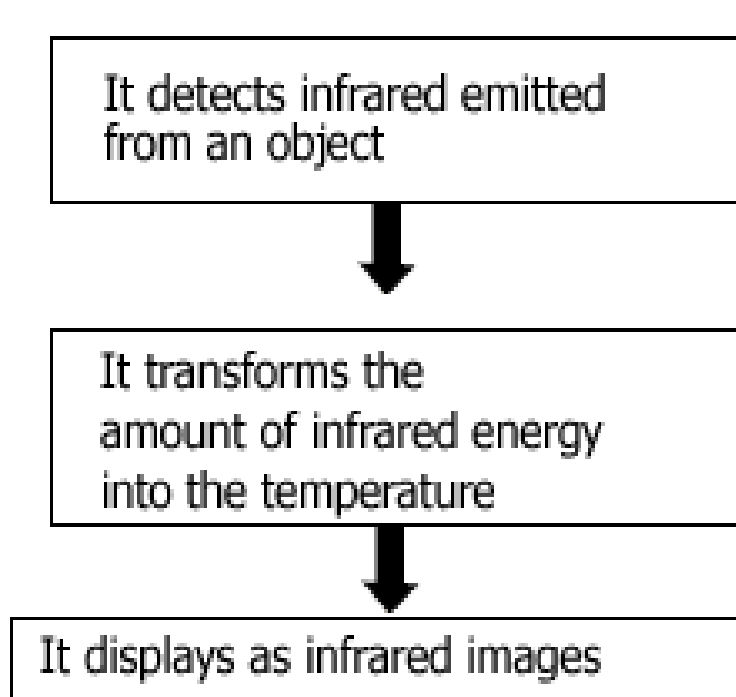
- **Lens**

The Lens is not made out of glass like the lens of a normal CCTV camera. The properties of glass mean that it does not transmit infrared radiation very well and would be an impractical lens material for thermal imagers. Instead Germanium is used which is a naturally occurring chemical element that is transparent to IR Radiation (that is that it will allow IR Radiation to pass through it).

- **SENSOR:**

- The ML8540 is a medium-resolution (approximately 2,000 pixels) infrared image sensor that allows noncontact temperature measurement of an object and easy obtaining of thermal images.
- The ML8540 receives infrared rays from an object at 48×47 (2,256) pixels resolution, converts them into voltage through a thermopile, and selects pixels in accordance with external CPU clocks to output signals.

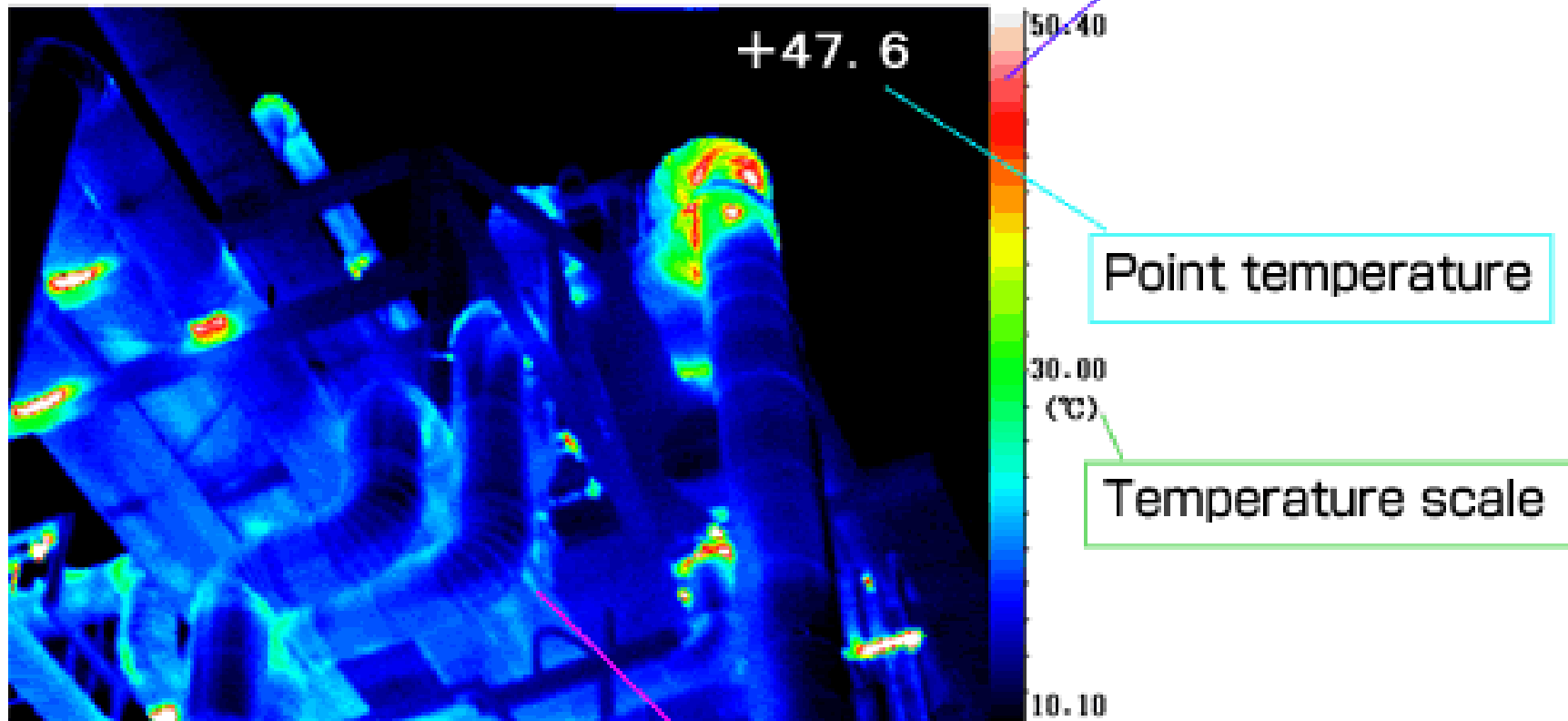




# IR THERMOGRAPHY IN ELECTRICAL INSPECTION

- The infrared electrical testing allows for inspection of a large amount of electrical equipment in a short time as opposed to the alternative method of physically inspecting and tightening electrical components.
- The infrared electrical systems survey locates faulty electrical items not generally found during a physical inspection.
- The infrared electrical systems survey locates problems before they lead to an unscheduled outage, equipment damage or a fire. Today's facilities engineers are avoiding costly expenses every year with infrared electrical surveys.
- Infrared thermography testing is non-contact and nondestructive testing (NDT), there is no need to interrupt system production.

Color Bar:  
It is colored by the temperature



Temperature distribution image data:

It is colored up pixel by pixel  
based on temperature

# MAINTENANCE OF EQUIPMENT BY IR THERMOGRAPHY

- Electrical switchgear and panels are the lifeblood of a data center. Without it, equipment failure is immediate.
- If there is dual power or utilizing redundant power sources, anytime we switch over power from primary to a backup power source infrared scan the switchgear and backup electrical panel boards and branch circuits for excessive heat.
- Testing while under load will tell us if there has been any degradation in the system components that could lead to future equipment failure and a possible outage.

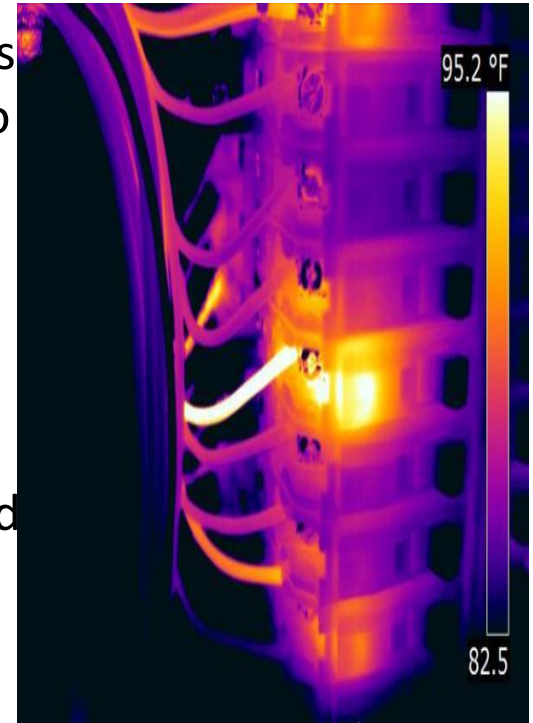


# CHECKING OF VARIOUS EQUIPMENTS

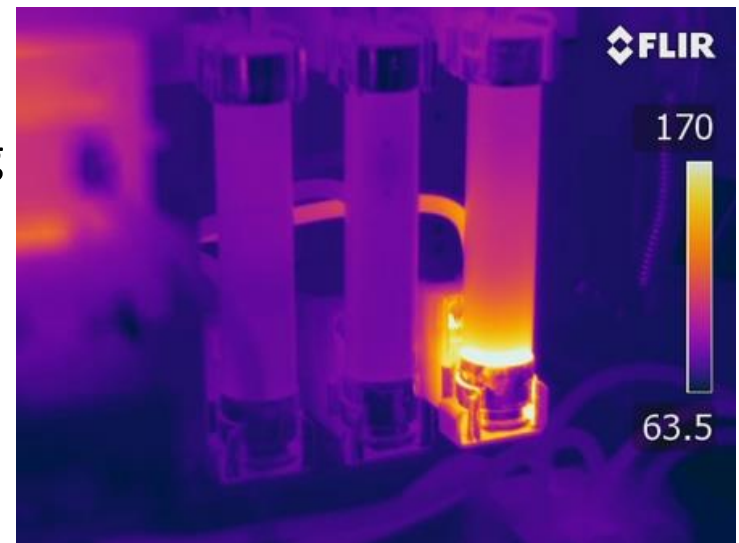
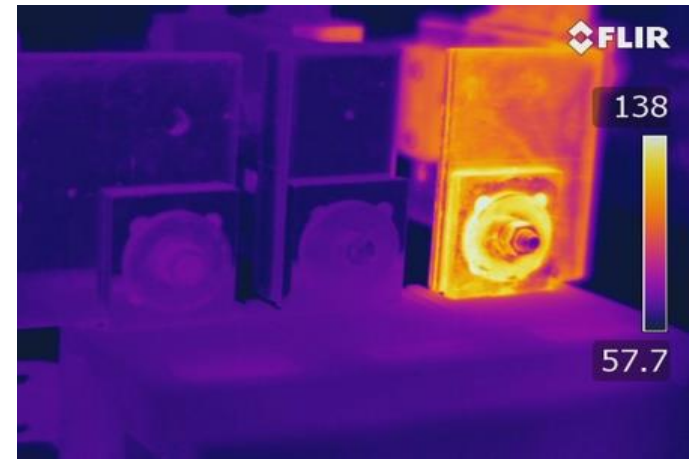
- ELECTRICAL PANELS:

Open and scan the electrical panel and look for hot spots. Loose or weak connections between breakers and the main panel bus and other deficiencies including overloaded circuits, load imbalances, harmonic problems and defective electrical components can all contribute to a thermal scan heat signature.

- Anytime someone needs to access an electrical panel, power distribution unit or remote power panel, they should infrared scan the branch circuits and breakers for excessive heat. Even if you find yourself in an electrical panel every week, it only takes a few seconds to scan and determine if a problem exists.



- **CIRCUIT BREAKERS:**
- This 2,000A breaker has an obvious over temperature condition on the terminal. A high resistance or loose bolted connection is causing this problem. Early detection and correction of this problem will prevent a major plant-wide power outage. The advanced warning from the thermographic image will also prevent a significant unplanned business interruption.
- **Bad Fuse Clip**
- This fuse clip, on the load-side of the C-phase, has lost its tension. The loose spring tension creates a high-resistance joint that produces excessive heat . Heating at this fuse clip can also cause many nuisance blown fuses due to the internal fuse element heating from this local bad connection.

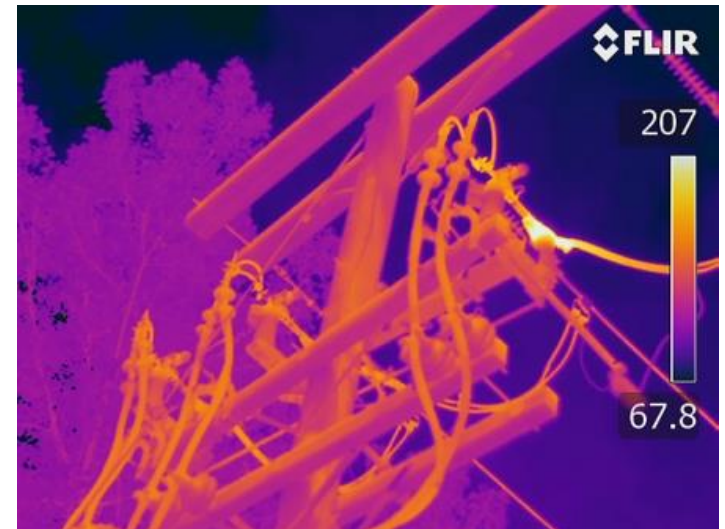
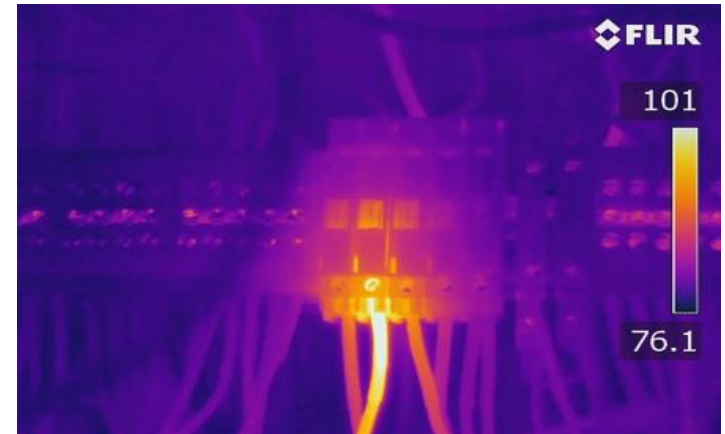


- **Loose Wire**

The load-side wire on this control panel contactor was not installed properly. The wire was cut back and properly re-terminated to allow for continued plant production.

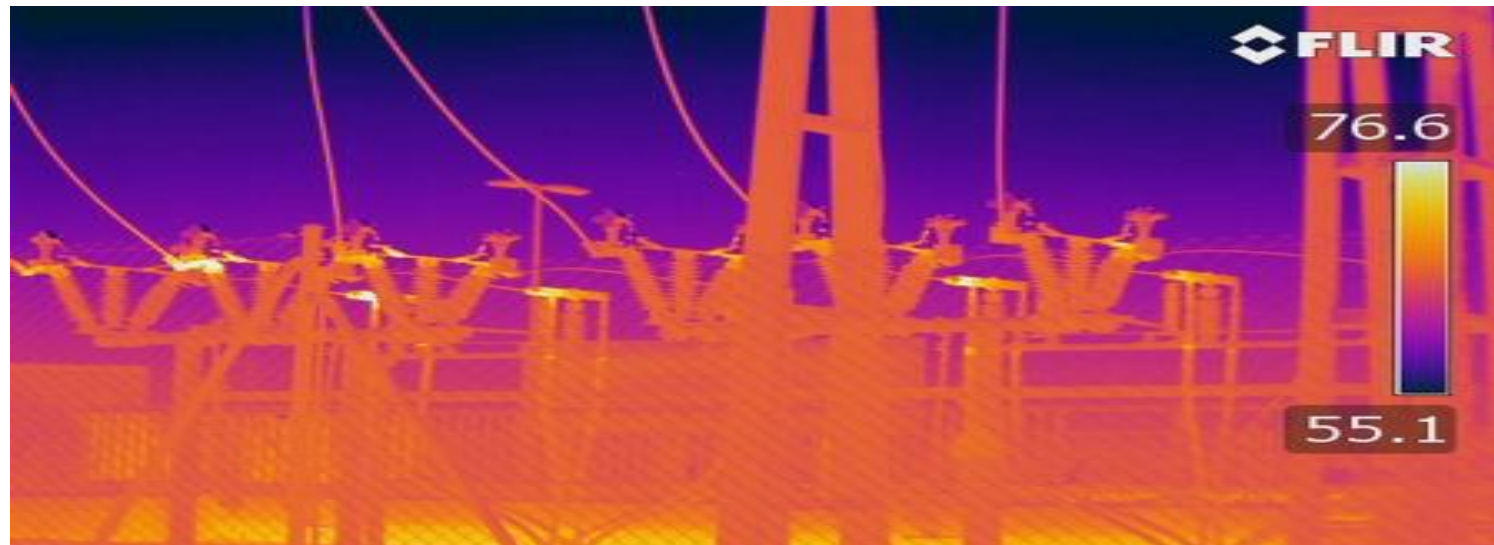
- **Power Feed from Plant**

This is the connection point between a renewable resource power plant and the local utility grid. A medium-voltage cable termination is showing excessive heat compared to the other two phases. Since this connection is high atop a utility pole, it would be hard to smell or see any smoke if it developed. It is also far away from the areas where anyone normally performs work.



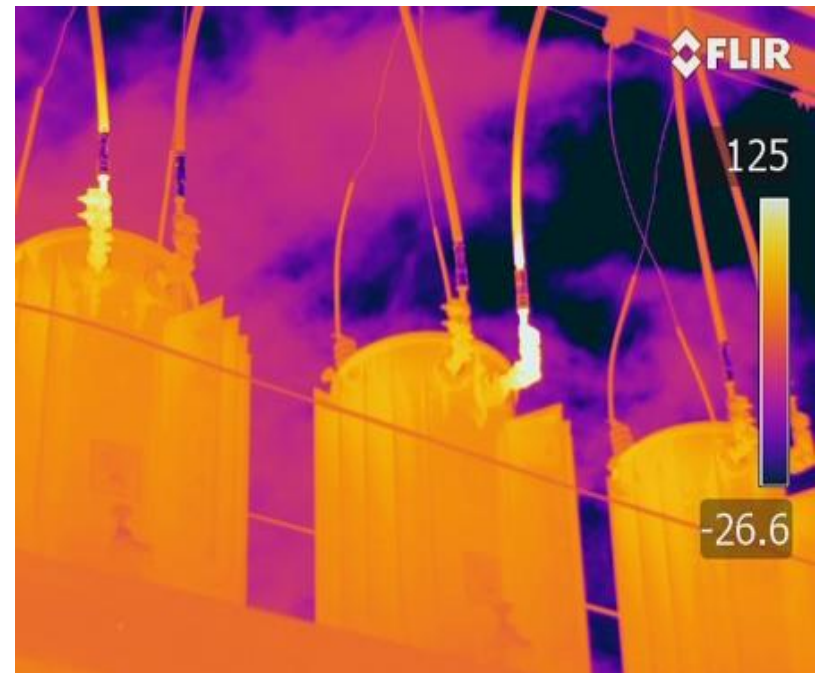
- ## Power Plant

- This power plant has multiple problems with overheating terminations on the network. A single thermographic image can see all of the hot spots in one viewing and at a safe distance away from the medium- or high-voltage equipment. The criticality of any system is based on the consequences of a failure. In a manufacturing plant failure and outage, only one customer is typically affected. On the other hand, when a utility electrical connection fails, entire geographic areas can be affected by the resulting outage.



- - **Transformer Connection**

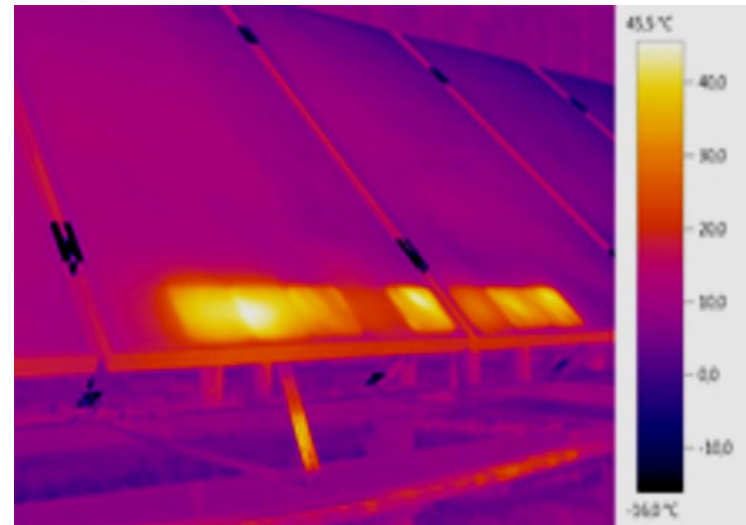
- These three single-phase transformers are connected to provide a 3-phase service to a manufacturing facility. You can see that two of the secondary terminal connections are overheating, a failure at this point in the system means a total unexpected plant shutdown. If the production equipment is running at the time the termination fails, the 3-phase equipment will single-phase and is likely to cause additional production equipment damage beyond the failed termination.





## • Solar Panel

- This is a thermographic image of a solar module. Many individual solar cells make up one solar module. The solar cells are the squares within the grid of dots on the module. You can see the cells that are giving off a much higher heat signature. The hotter cells are not supplying energy to the grid system because they are locally dissipating their energy as heat. As new renewable energy technology advances, new uses are found for the thermographic camera. Viewing the thermographic image needs to be combined with the wisdom of a seasoned thermographer to properly interpret and diagnose conditions.



# Advantages and disadvantages

- Advantages
  - Low Power Requirement
  - Low Circuitry Cost
  - Portable
  - Higher Security
- Disadvantages
  - Blocked By Materials
  - Short Range
  - Slow Data Transmission

# CONCLUSION

- Infrared surveys are a powerful, versatile, and highly accurate diagnostic tool for uncovering a wide range of problems in electrical systems.
- Infrared monitoring and analysis has the widest range of application (from high- to low-speed equipment), and it can be effective for spotting both mechanical and electrical failures.
- It also requires minimum skills for analysis.
- In recent times thermography is being used in firefighting, law enforcement, industrial applications, security, transportation, medical and many other industries.