

# **THERMOGRAPHY APPLICATIONS FOR ELECTRICAL INSTALLATIONS IN BULIDINGS**

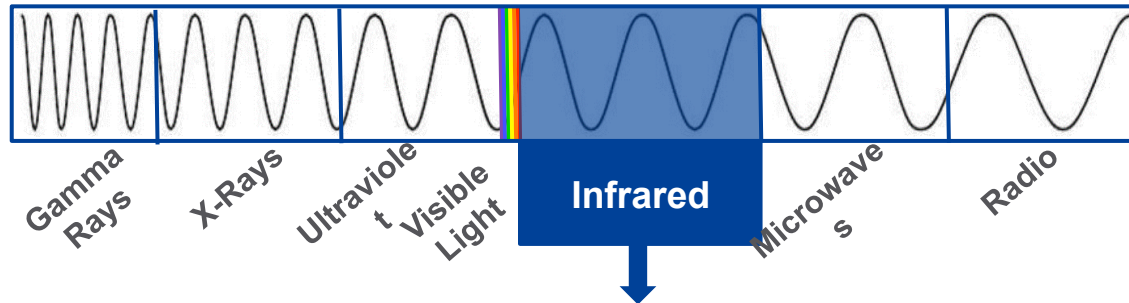
**Binalarda Elektrik Tesisatı Sempozyumu  
18 Ekim 2019, Cuma // Saat : 12.10-12.30**

**T.P.SINGH  
FLIR Systems**

# Objective

1. Basics- Infrared Theory
2. What What is Thermography
3. Basics- Understanding Thermal Image
4. Applications overview
5. Electrical Applications-
  - a) Sub Station Monitoring for Predictive Maintenance
  - b) Case Studies-Transformers
  - c) Predictive Maintenance of other Critical Installations
    - I. Inspection of Cables and Joints
    - II. Inspection of exposed cables
    - III. Inspection of Buildings
    - IV. Visualization of SF6 leakage
    - V. Visualization of Hydrogen Gas Leaks in Real Time
6. Conclusion

## Leveraging an Area of the Electromagnetic Energy Spectrum Beyond Our Eyesight



To Develop Imaging Solutions That Enhance Peoples' Perception and Awareness

See in Total Darkness



See Through Obscurants



Measure Temperature



Enhanced Long Range Imaging

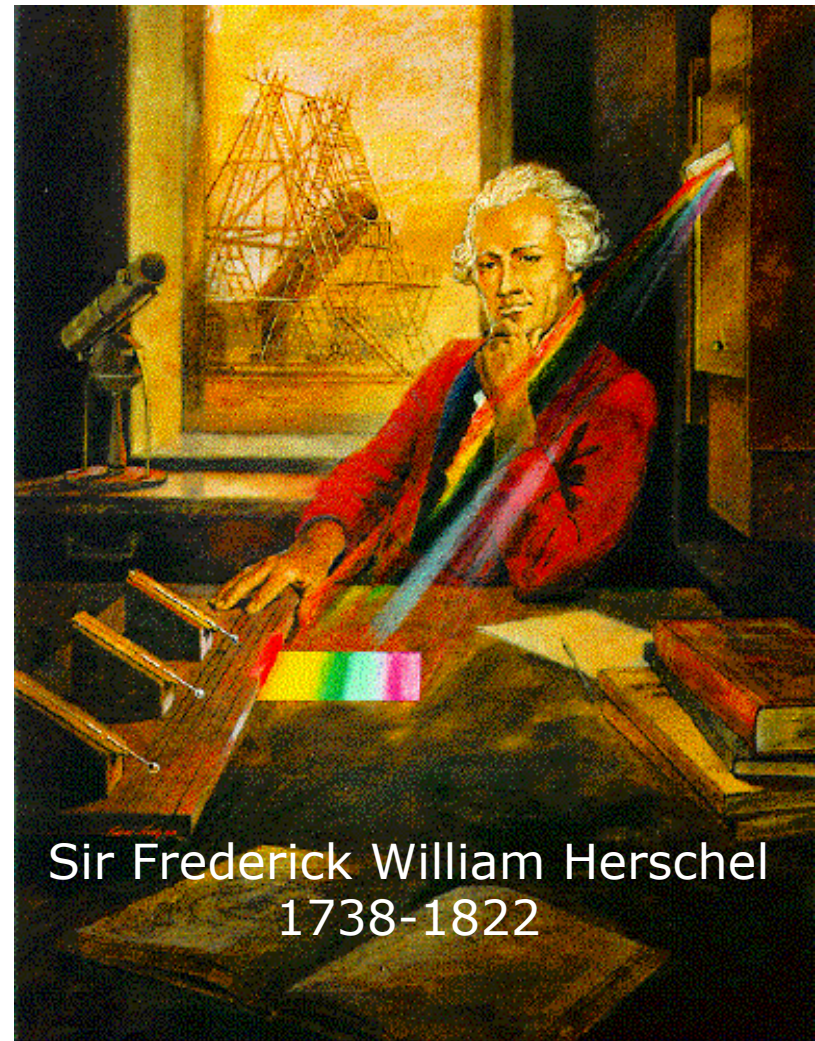


Accurately Detect People & Animals



# IR History

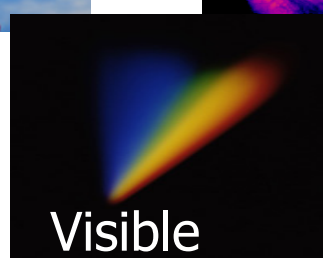
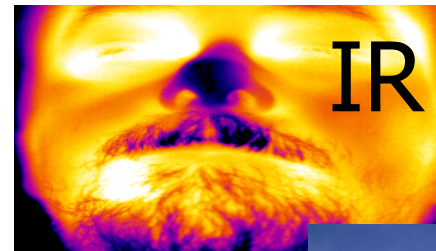
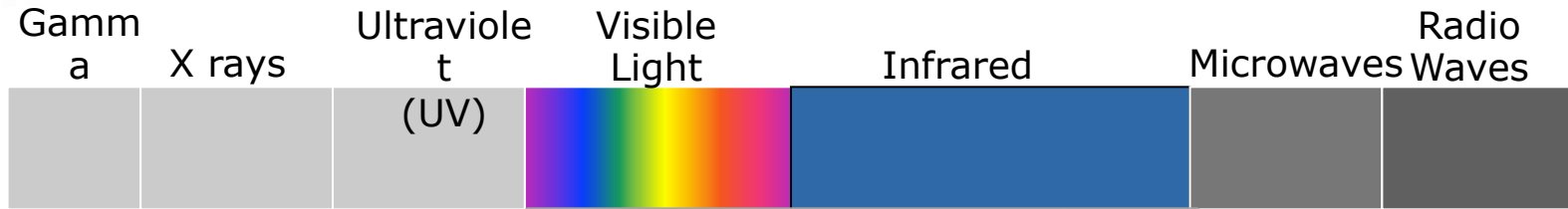
The discovery of infrared radiation is generally accredited to Sir Frederick William Herschel. In 1800 he passed light through a prism and measured the temperatures of the different colours of light. He noticed that the greatest temperature rise was beyond the visible red.



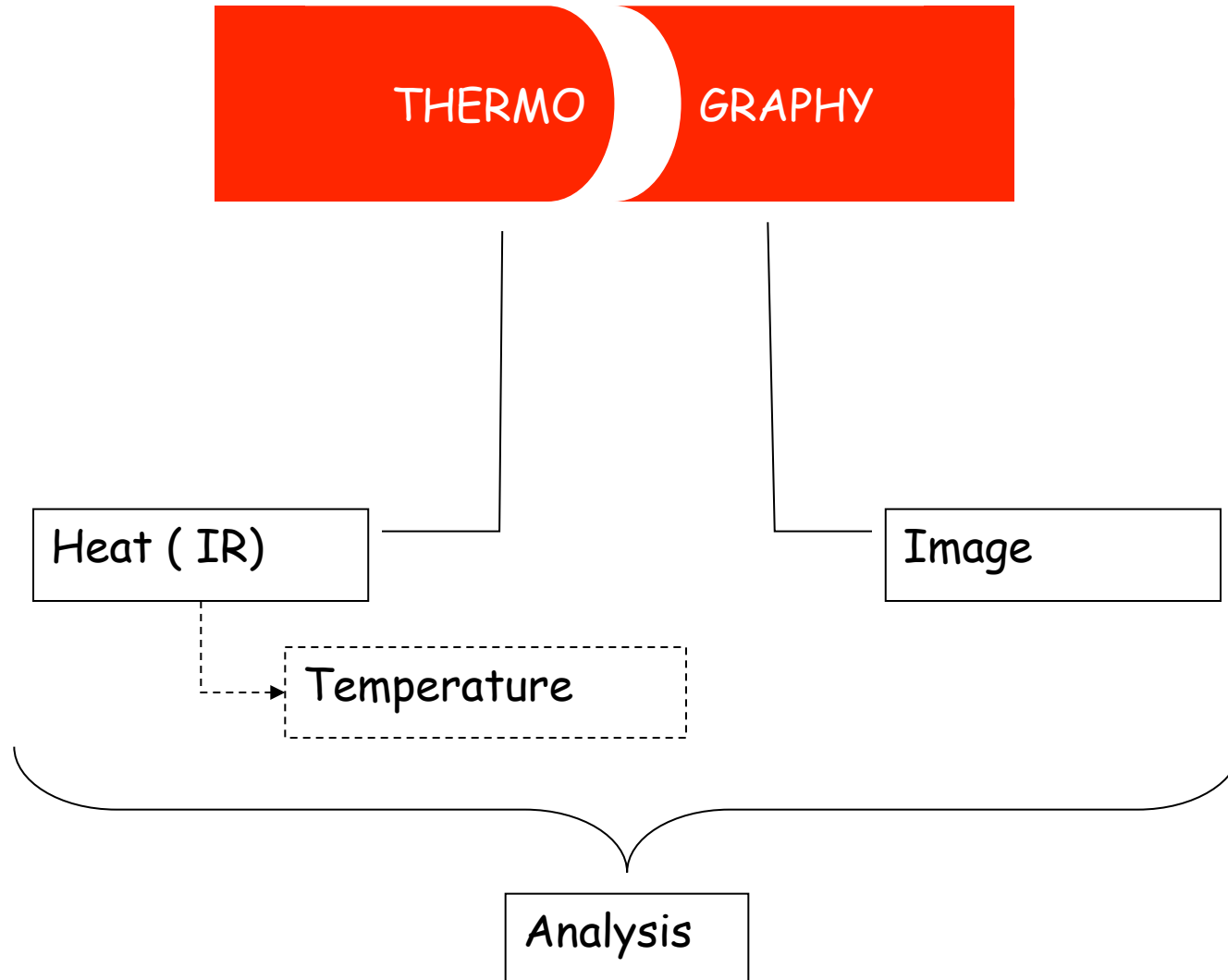
Sir Frederick William Herschel  
1738-1822



# The Electromagnetic Spectrum

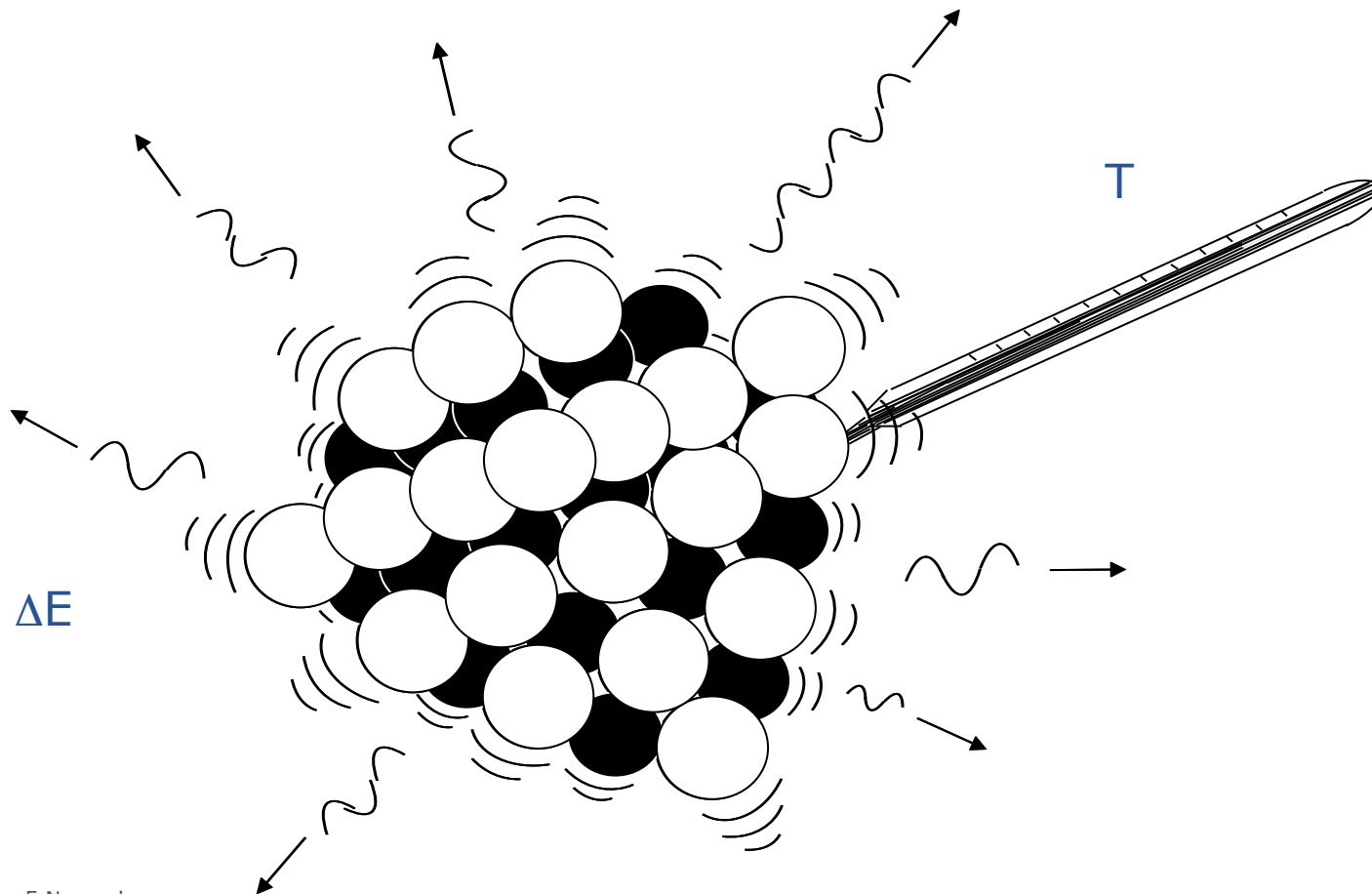


# What is thermography?



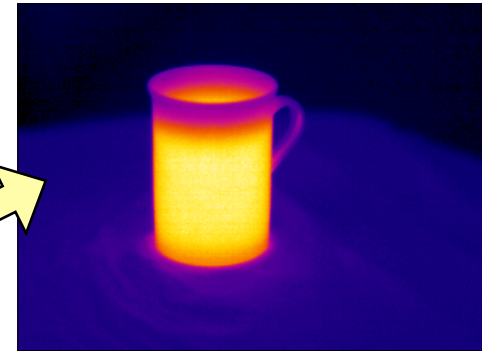
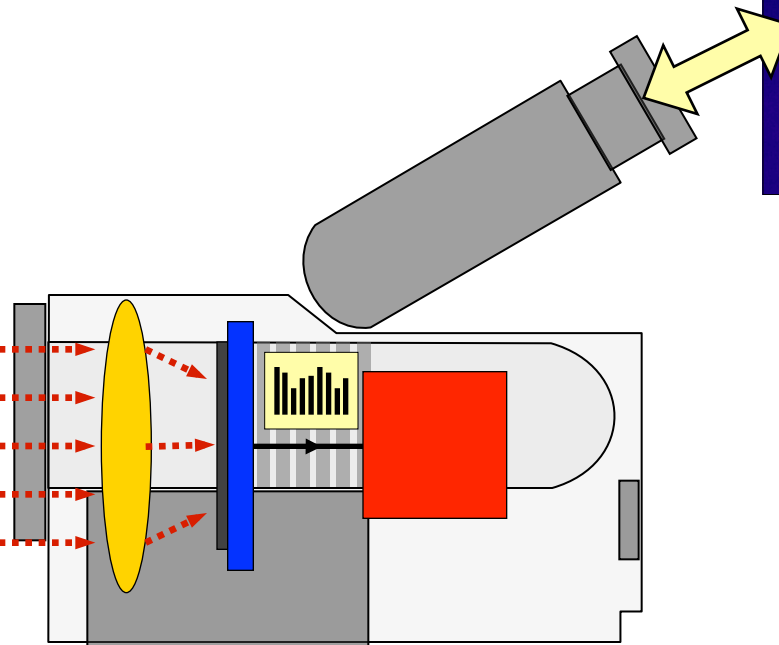
# How Does it Work?

- Everything with a temperature above absolute zero emits infrared energy (heat)



# Camera operating principle

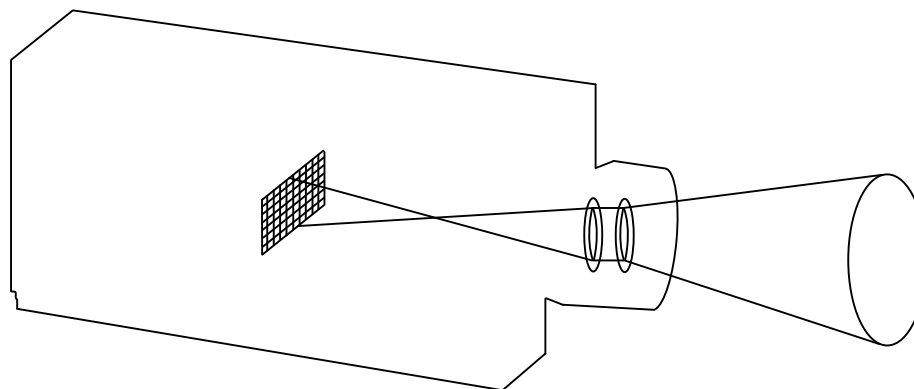
The camera converts invisible infrared radiation into a visible image





# Detector Resolution

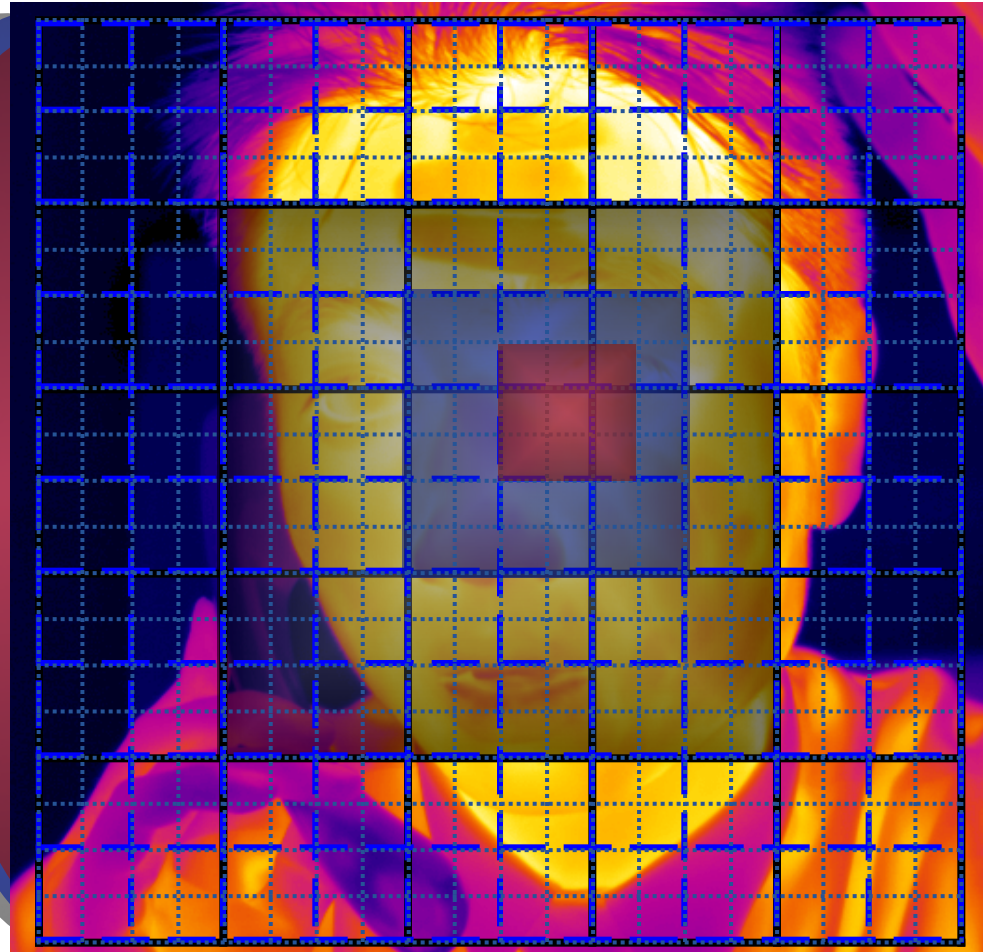
- Modern day system use a Focal Plane Array (FPA) detector:



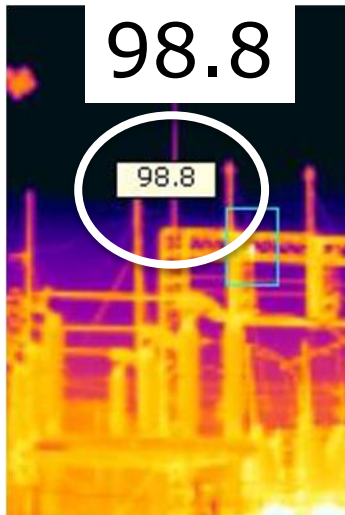
- 60 X 60 ( 3600 pixels)
- 140 x 140 (19,600 pixels)
- 160 x 120 (19,200 pixels)
- 320 x 240 (76,800 pixels)
- 640 x 480 (307,200 pixels)
- 1024 X 768 ( 786,432 pixels)

# Impact of Detector Resolution

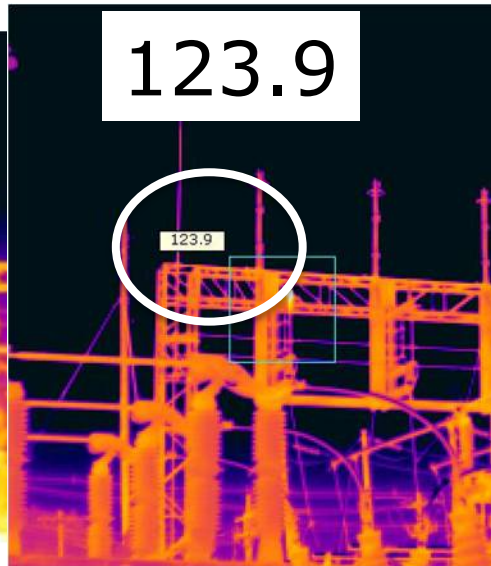
( Mainly Transmission Lines)



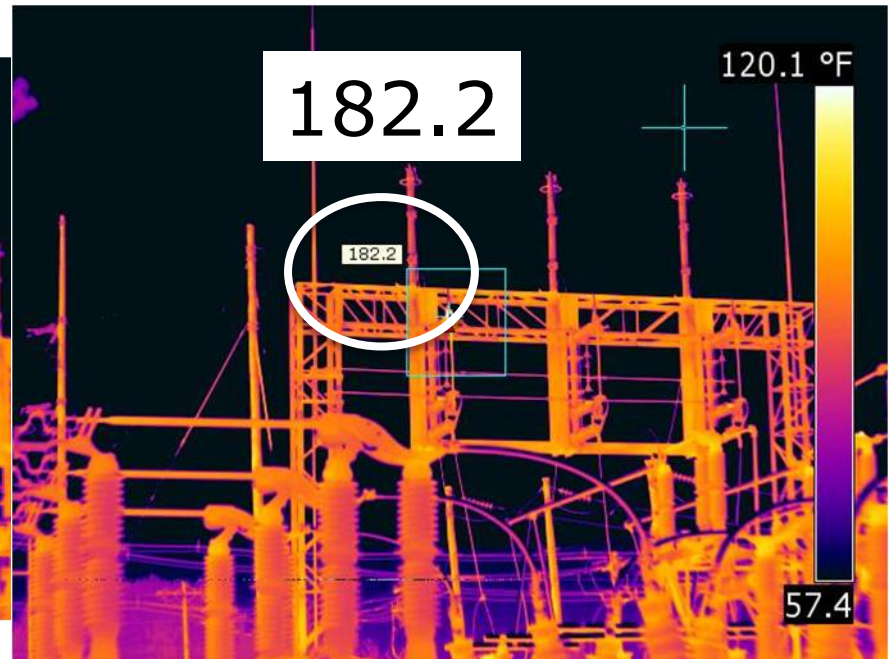
## Many pixels measure better



120x120  
14 400



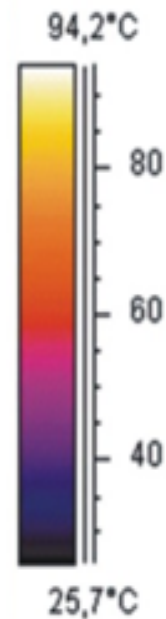
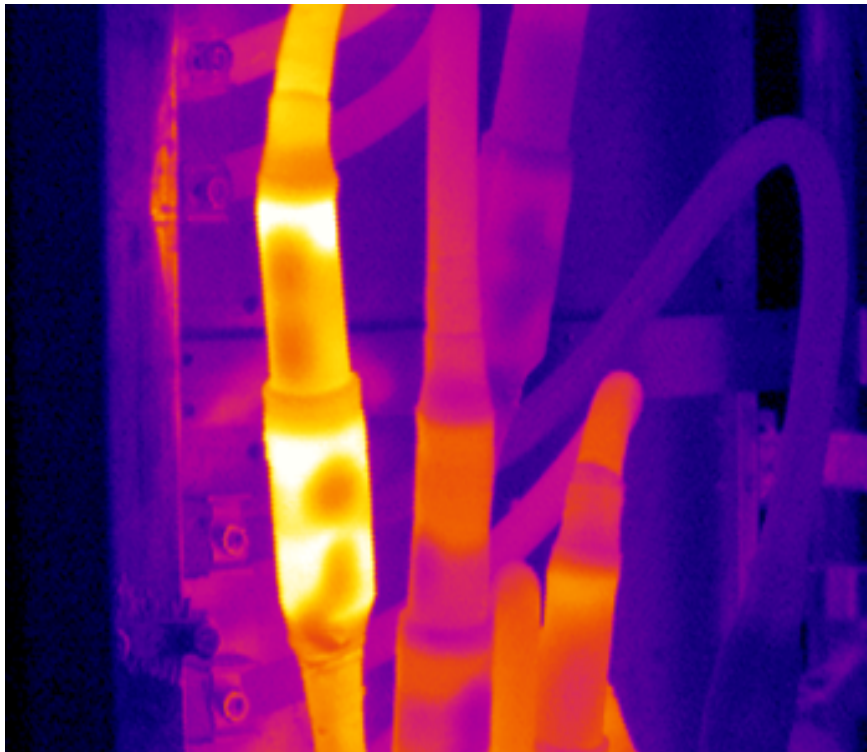
320x240  
76 800



640x480  
307 200



## Understanding IR/thermal Image



All Colours in the image are distributed based upon this colour bar. In this image Iron pallet has been used where white colour means temperature is around 94 Deg C and black means less than 40 DegC. All three phases shown in thermal image have different temperature.

Other common palletes used are Grey, Histogram etc but basic concept need to be understood that all colours in thermal image are distributed as per this bar.



# Applications

## Thermography Applications

Using somewhat arbitrary groupings, some present applications areas/ industries are:

PREDICTIVE MAINTENANCE

AEROSPACE

AUTOMOTIVE

BIOLOGICAL / BIOMEDICAL / FOOD

BUILDING

CERAMIC-GLASS, COMPOSITES, PLASTIC & RUBBER

CHEMISTRY

CONSTRUCTION & BUILDING

CONSUMER & COMMERCIAL PRODUCTS

ELECTRONIC & ELECTRICAL

ENVIRONMENTAL, GEOLOGICAL & METEOROLOGICAL

MEDICAL

METALS, MACHINERY & MANUFACTURING

PETROLEUM & PETROCHEMICAL

PAPER & TEXTILES

QUALITY ASSURANCE

RESEARCH & DEVELOPMENT

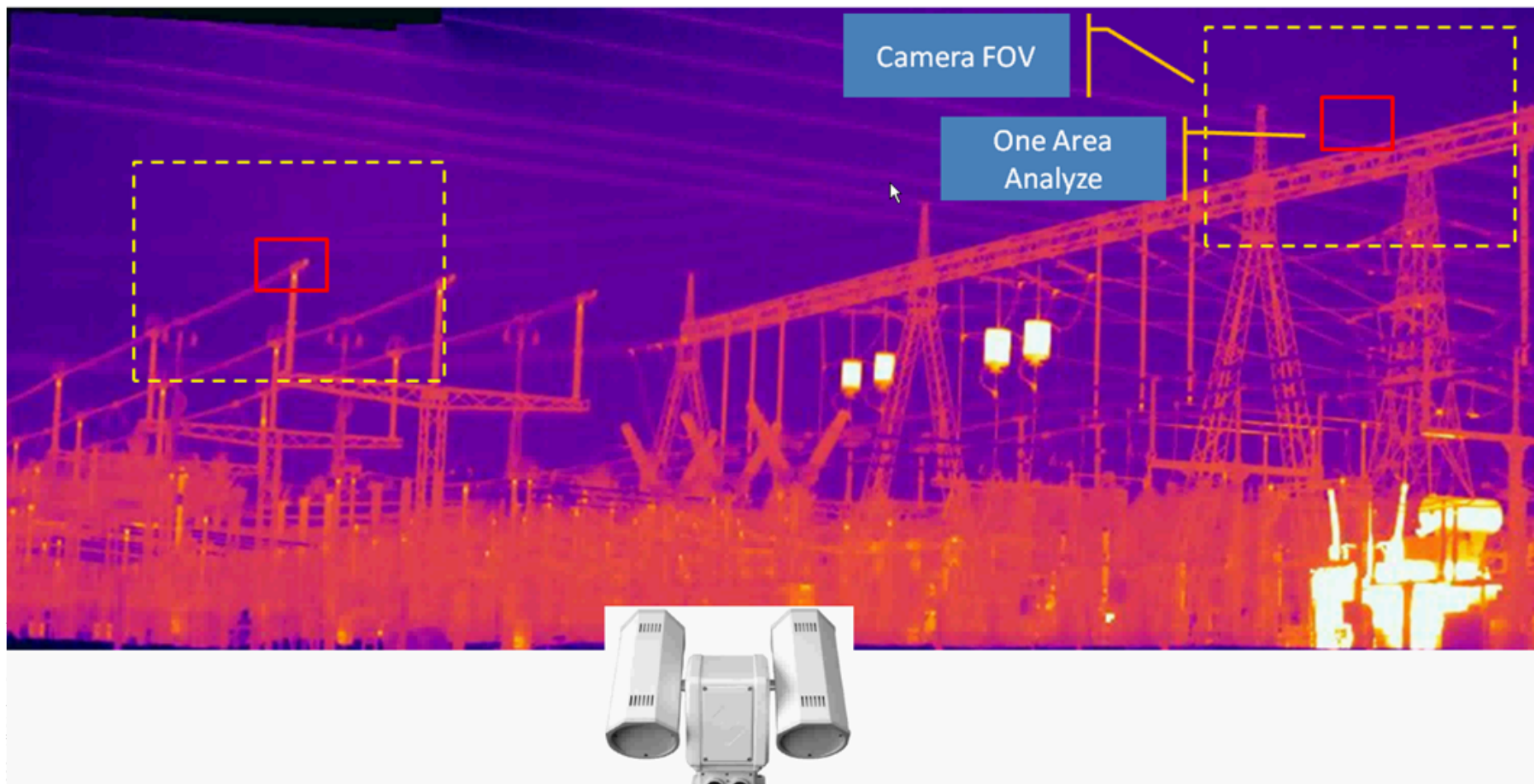
SURVEILLANCE & SECURITY

# Online-Electrical Substations

- Isolated, often unmanned
- Remote monitoring
- No lighting



# How it works



# TRANSFORMERS

**Table : Equipment - Technology Matrix for Transformers**

| Equipment                  | Ultrasonic Test |           | IR Therm. | Vibration | Sound    | DGA      | Special Tests | Visual   |
|----------------------------|-----------------|-----------|-----------|-----------|----------|----------|---------------|----------|
|                            | Contact         | Air borne |           |           |          |          |               |          |
| <b>MAIN TANK</b>           | <b>Y</b>        | <b>Y</b>  | <b>Y</b>  | <b>Y</b>  | <b>Y</b> | <b>Y</b> | <b>X</b>      | <b>Y</b> |
| <b>PUMP</b>                | <b>Y</b>        | <b>X</b>  | <b>Y</b>  | <b>Y</b>  | <b>X</b> | <b>X</b> | <b>FLOW</b>   | <b>Y</b> |
| <b>FANS/<br/>RADIATOR</b>  | <b>X</b>        | <b>X</b>  | <b>Y</b>  | <b>X</b>  | <b>X</b> | <b>X</b> | <b>X</b>      | <b>Y</b> |
| <b>BUSHINGS</b>            | <b>X</b>        | <b>Y</b>  | <b>Y</b>  | <b>X</b>  | <b>X</b> | <b>X</b> | <b>X</b>      | <b>Y</b> |
| <b>CONTROL<br/>CABINET</b> | <b>X</b>        | <b>Y</b>  | <b>Y</b>  | <b>X</b>  | <b>X</b> | <b>X</b> | <b>X</b>      | <b>Y</b> |
| <b>OLTC</b>                | <b>Y</b>        | <b>X</b>  | <b>Y</b>  | <b>X</b>  | <b>X</b> | <b>Y</b> | <b>X</b>      | <b>Y</b> |



# TRANSFORMERS

## CASE STUDY 2 DETECTION OF LOW LEVEL THERMAL FAULTS IN 210 MW GT

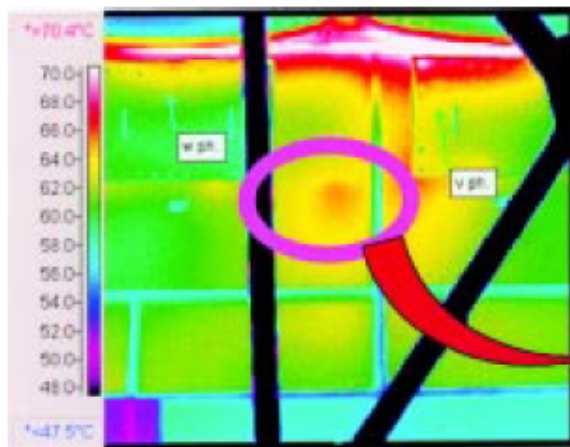


Figure 2



Figure 3

- Base line established with multiple technologies. No gas norms violation in DGA. Locations of acoustic activity recorded.
- Thermal hot spots detected on LV side by IRT with reference to base line (Fig.2). DGA analysis showed normal ageing by CIGRE method & overheating by IEEE method during next periodic PDM survey.
- Acoustic activity increased on LV side, temperature of hot spots increased by 2 deg C in a fortnight, location coincided with high acoustic activity, DGA sampling and analysis recommended.
- DGA indicated rise in fault gases though overall gases within norms, low thermal faults (150 deg C) indicated by IEEE & CIGRE method.
- Presence of thermal faults

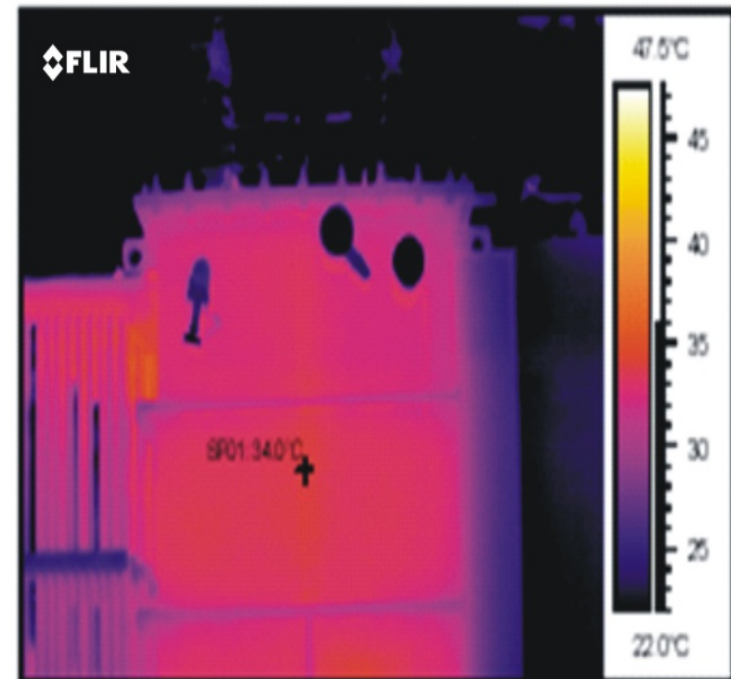
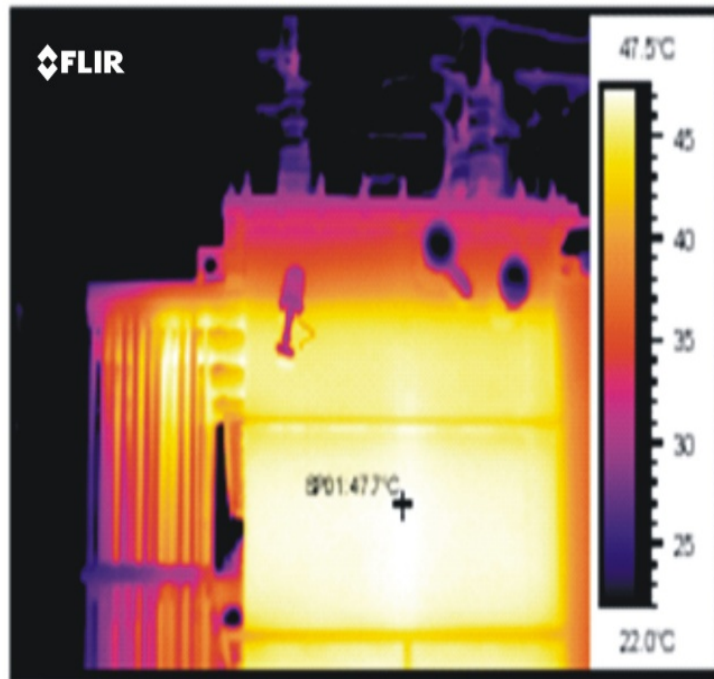
concluded by correlating the data on technology matrix, faults on LV side at specific locations of high acoustic activity & high temperature and faults progression though not critical.

### INSPECTION DURING ANNUAL OVERHAUL REVEALED LOOSE BOLTS ON LV BUS BAR (FIG 3).

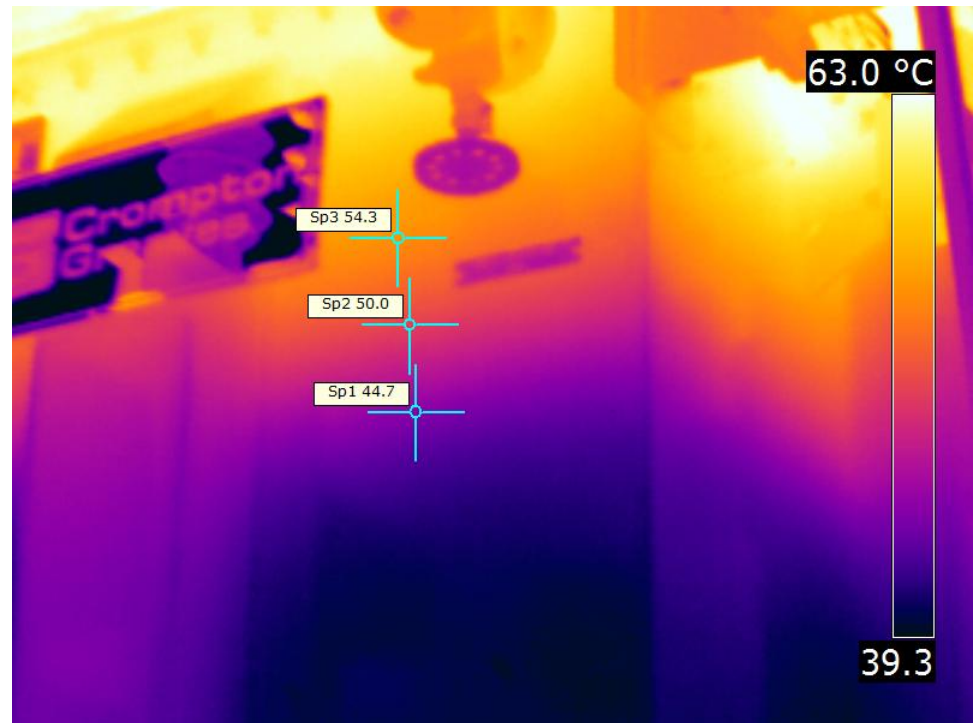
Repair eliminated the thermal fault indication & acoustic activity on surface and DGA indicated normal ageing.



## Predictive Maintenance- Critical equipments



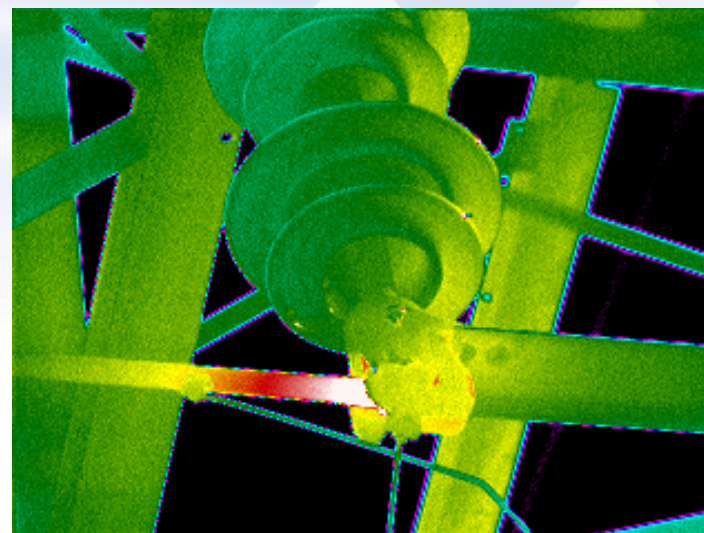
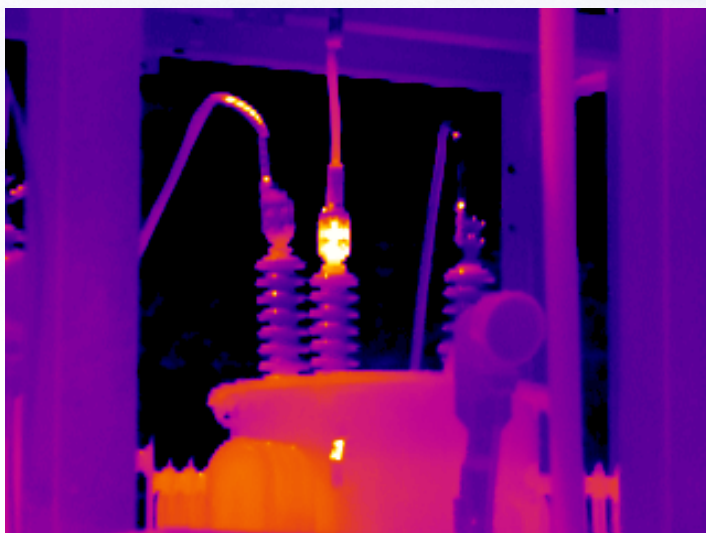
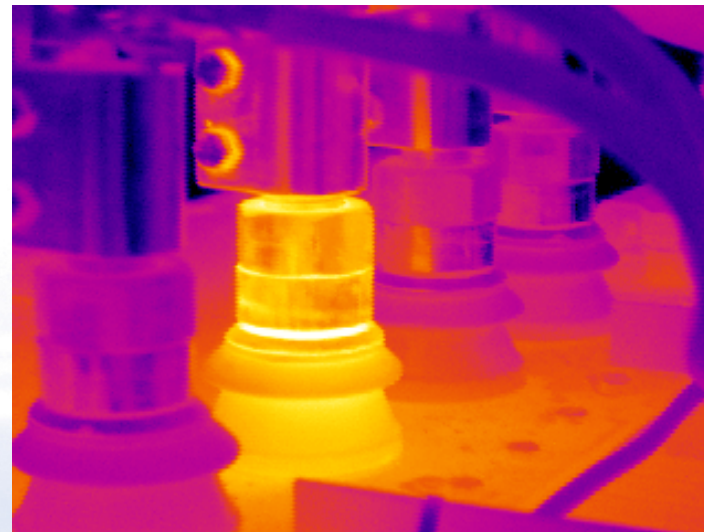
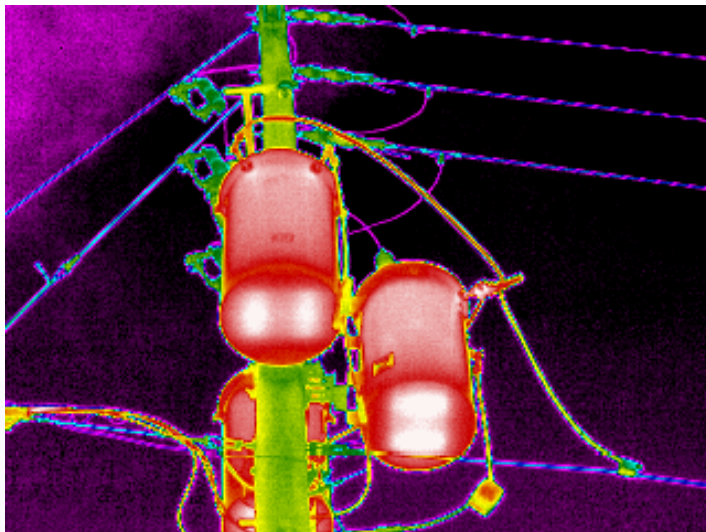
# Transformers





5c/6

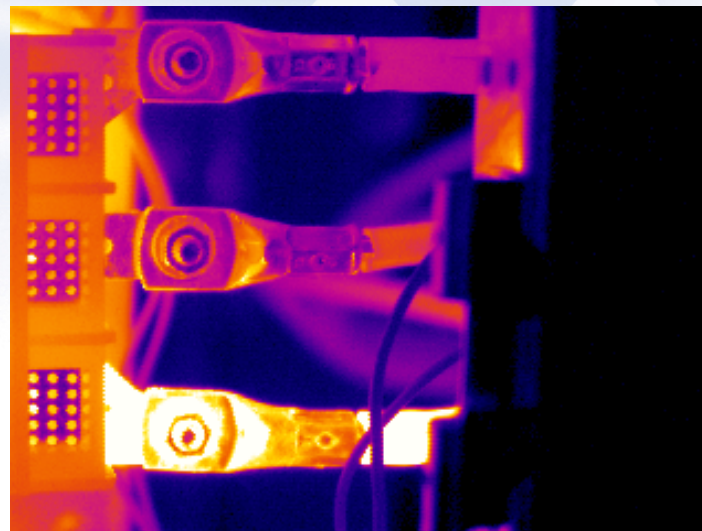
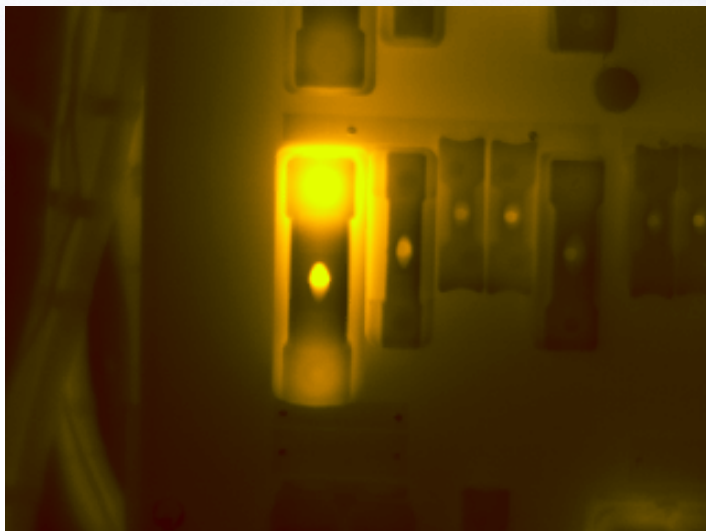
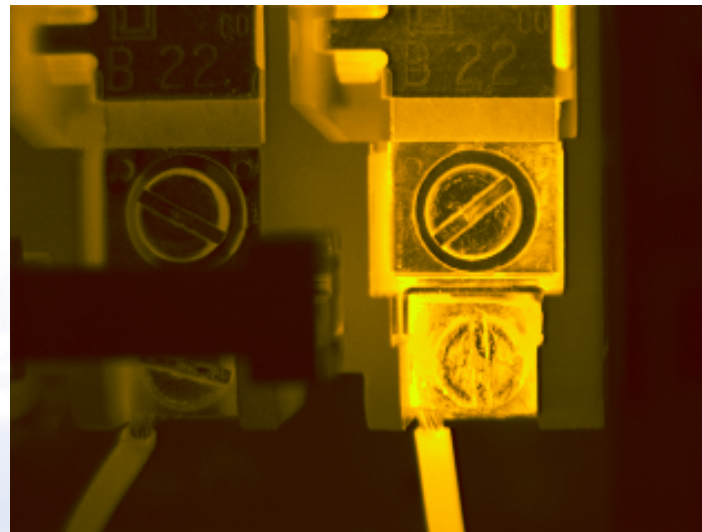
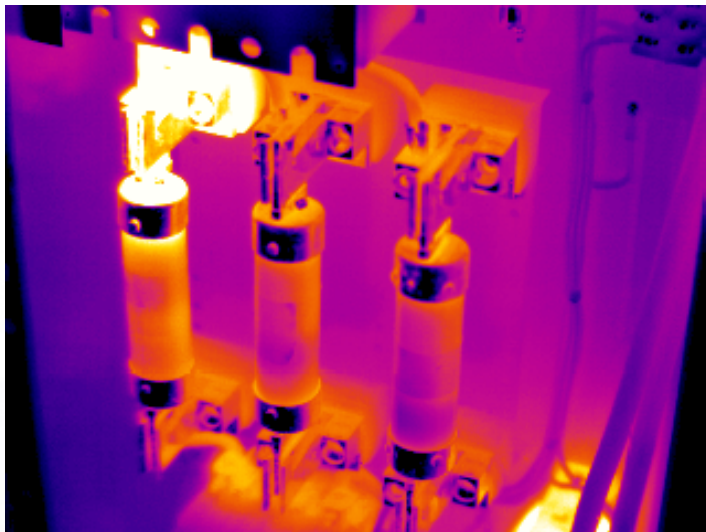
## Power Gen/Dist/Trans





5 c/6

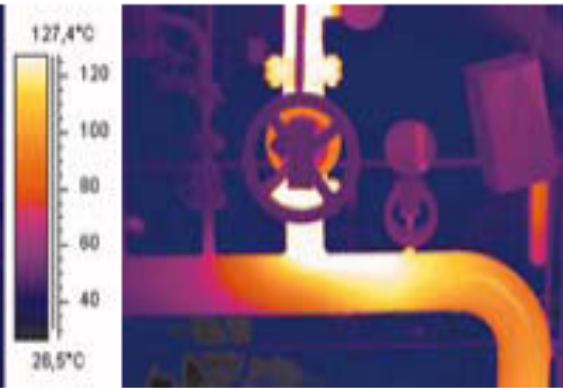
## Switchboards



# Insulation & Pipework



Blocked pipework



Steam trap



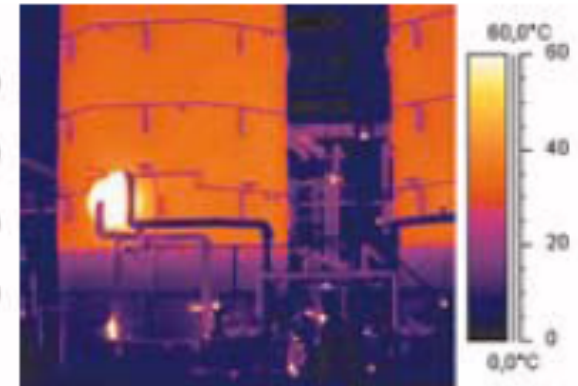
Insulation breakdown



Inspection of industrial chimneys



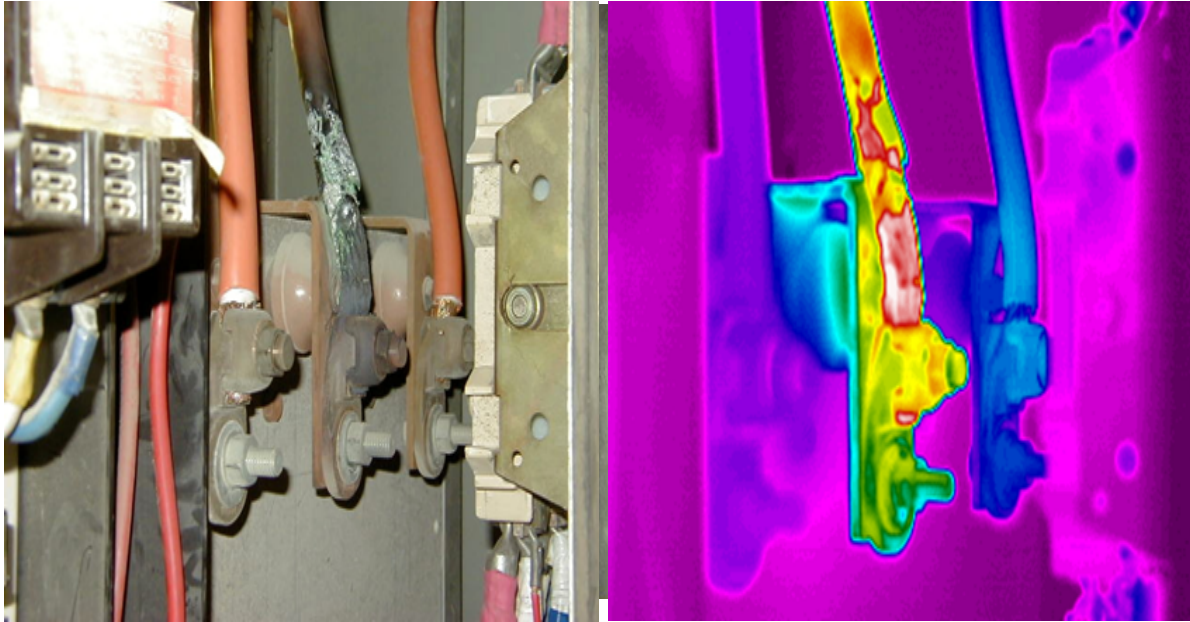
Damaged insulation



Insulation defect

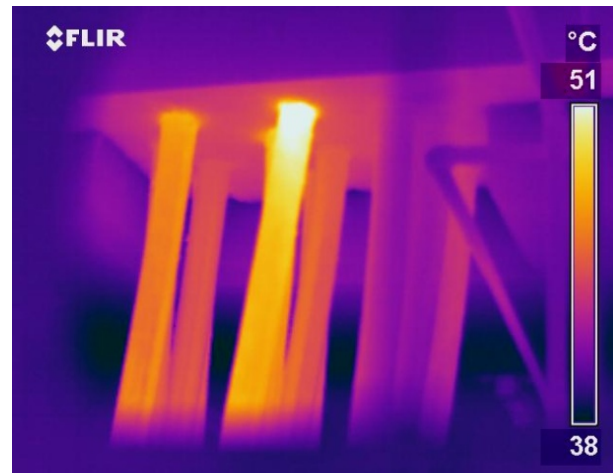
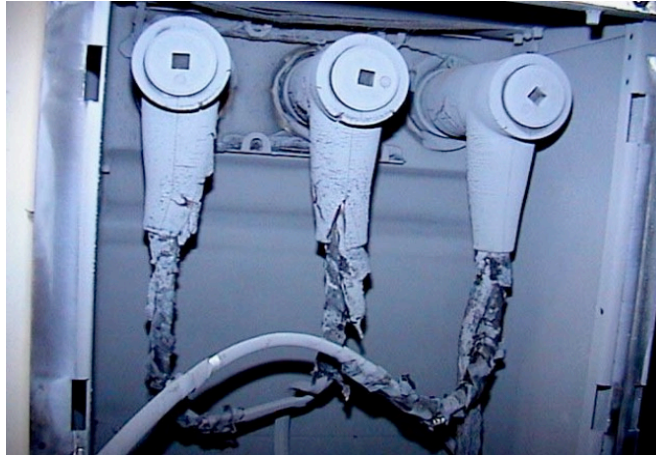


# Cable Terminations, Joints





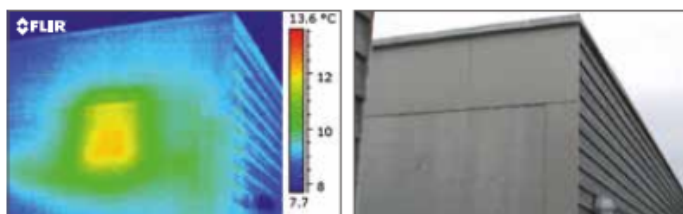
## Cable terminations and Joints- Contd..



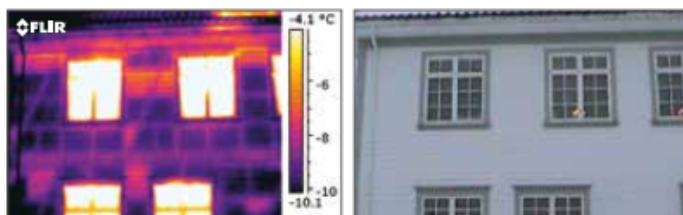
# Buildings Inspection

## Insulation defects and air leaks

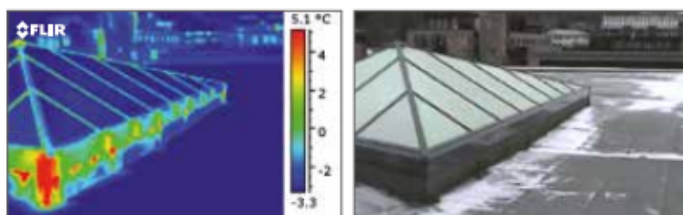
Thermal imaging is an outstanding tool to locate building defects such as missing insulation, delaminating render and condensation problems.



*This building is warmer on the inside. It is a sandwich construction, concrete - insulation - concrete. One section of insulation is missing which is not possible to see visually either from the inside or the outside. Here thermal imaging can see what the human eye can't.*



*Framework construction. Many of the sections are missing insulation as indicated by the warmer colors.*



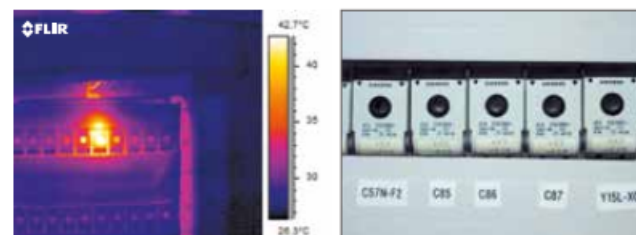
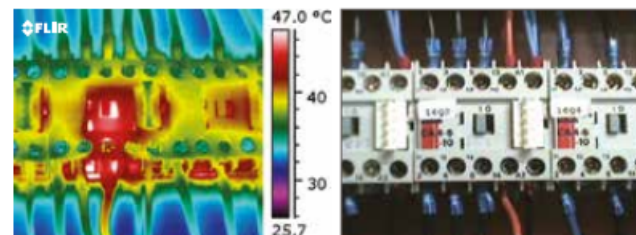
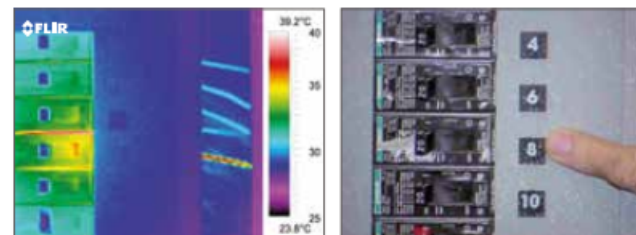
*Glass roof above an atrium. It is watertight, but not air tight. Warm air escapes because of the over pressure. The solution is to air tighten the glass roof.*

## Electrical faults

Every building also contains a lot of electrical installations. Thermal imaging can also be used to scan electrical cabinets, fuses, connections, etc.

By detecting problems that are invisible to the naked eye the problem can be repaired. If left unchecked, electrical problems can cause high temperatures. Furthermore, sparks can fly which might set the surroundings on fire.

For more information about checking electrical systems with a thermal imaging camera, please read the "Thermal imaging guidebook for industrial applications".



*One of the fuses is overheated, a potential fire risk.*



# Leakage Visualisation



5.1



# Gas Leakages

- Many chemical compounds and gases are invisible to the naked eye.
- Earlier methods of gas detection required close or near contact using “sniffer” technology and probes. The limitations of these methods are that they are time consuming and run a risk of missing gas leaks. They may expose inspectors to invisible and potentially harmful chemicals.
- The Gas Detection cameras are infrared cameras which are able to visualize gas.
- The camera produces a full picture of the scanned area and leaks appear as smoke on the camera’s viewfinder. The image is viewed in real time and can be recorded in the camera for easy archiving.



## SF<sub>6</sub>- Electrical

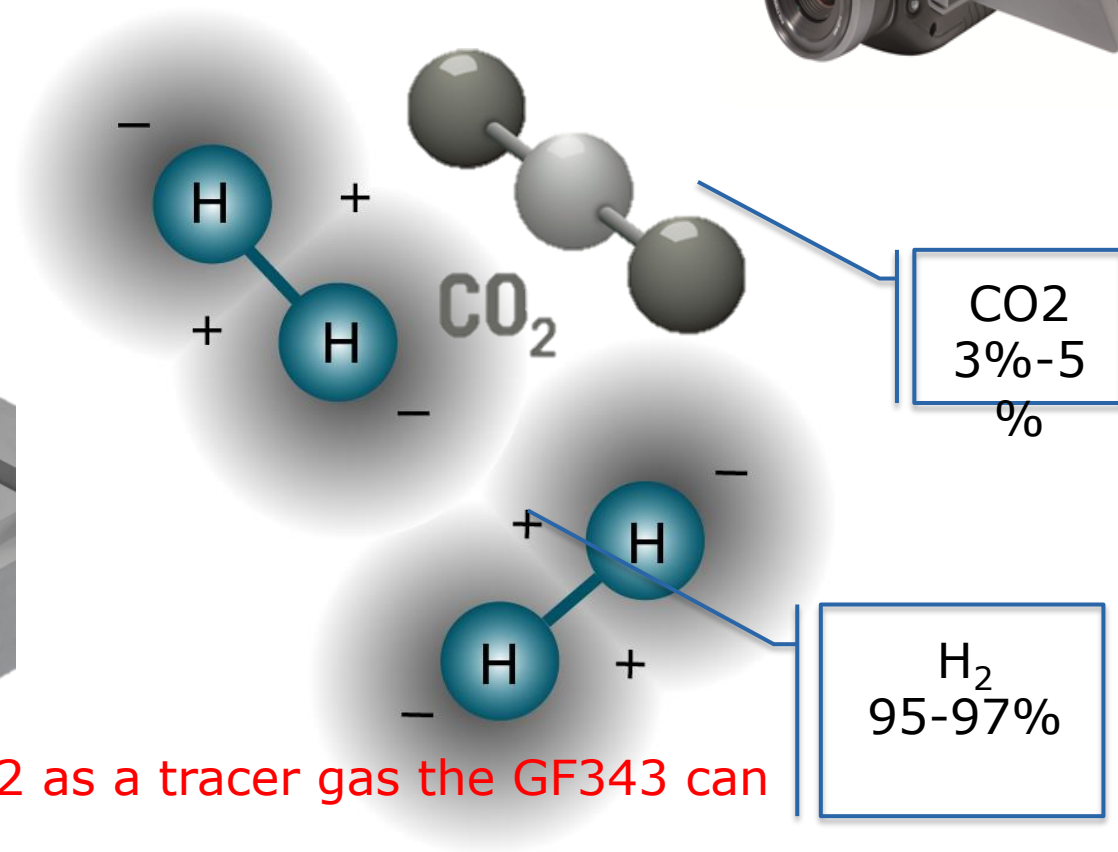
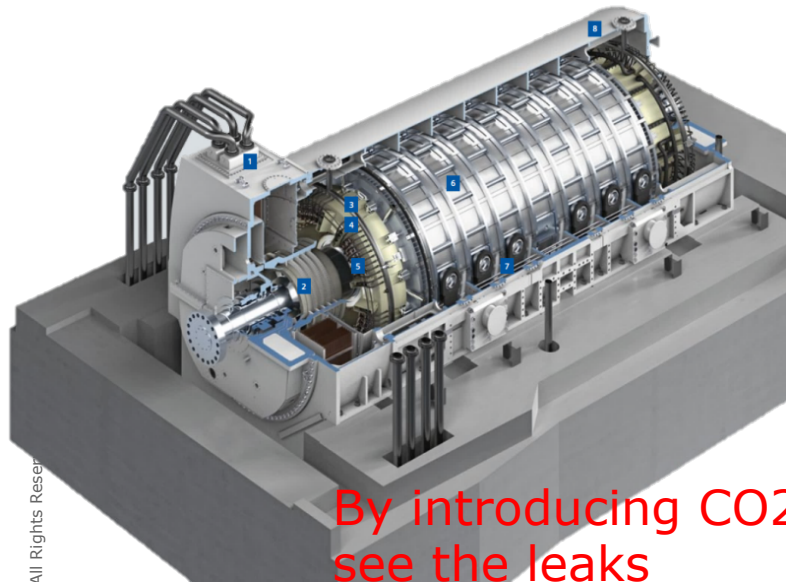
### Environmental Compliance

- SF<sub>6</sub> is as an electrical insulator in equipment that transmits and distributes electricity-used extensively !
- SF<sub>6</sub> has a very high potential for global warming.  
-23 900 times bigger than carbon dioxide, CO<sub>2</sub>.
- Even a relatively small amount of SF<sub>6</sub> can have a significant impact on global climate change.

# FLIR GF343

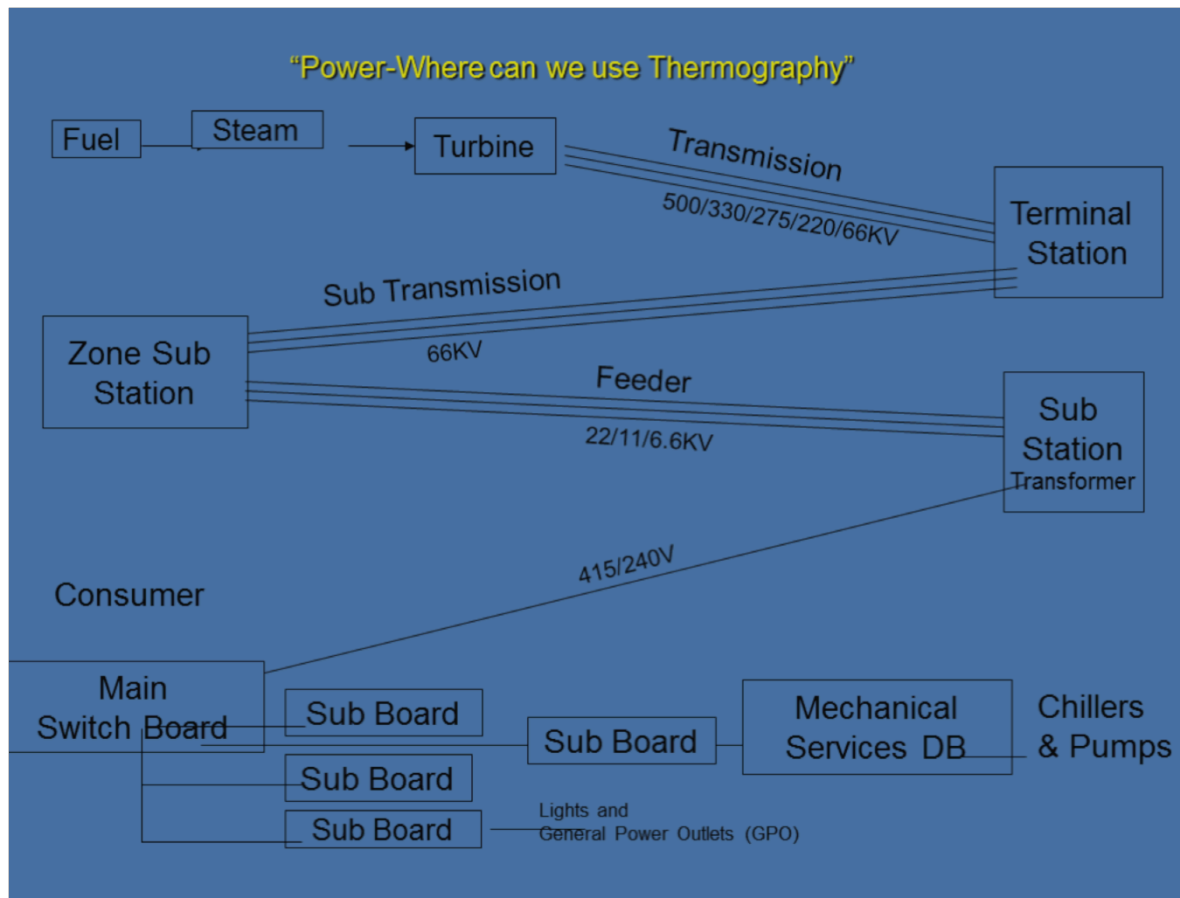
## Leak Detection w/ CO<sup>2</sup> Tracer Gas

[VIDEO](#)



By introducing CO<sub>2</sub> as a tracer gas the GF343 can see the leaks

# Conclusion



Thermal Camera due to its vast applications and advantages can be used almost everywhere saving millions of Rupees, if utilized intelligently.





# Any Questions

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