

THERMOGRAPHY- APPLICATION NOTE

Infrared Thermal Imaging-Principle

All objects, which have a temperature above absolute zero (0 Degree Kelvin) emit infrared radiation, which can be measured on the infrared spectral band of the electromagnetic spectrum. The technique of measuring & viewing this energy is called infrared thermography or thermal imaging. Most thermal imaging systems respond to wavelengths of 3 - 5 micrometers or 8 –12 micrometers.

Why Thermal Imaging?

Thermography is nothing but '*capturing heat images on film*'. Swedish power board began inspecting a large number of electrical components (1.5 lakhs plus) way back in 1965 & UK power generation board began effectively utilizing Thermography for predictive maintenance of transmission lines.

The application of both Thermal imaging & Ultra sonic detection techniques are based on a fundamental principle, '*Electrical Failures are preceded by rise in temperature & sound*'. If you understand this basic principle, carry out effective techniques to detect these failure 'pre-cursors' and take timely corrective action, electrical equipment failures can be avoided. Although T-imaging applications are numerous (quality checks, tank level monitoring, detection of steam leaks, integrity of furnace refractory lining, etc.), we will discuss electrical applications in this application note.

The electrical maintenance practices evolved over a period of time. Breakdown to preventive to predictive to risk /reliability based maintenance practices. Logically, high reliability plant & equipment requires to be maintained accordingly. In countries like USA, UK, France, Netherlands, etc., infrared inspections are now recognized and recommended as a best practice for the inspection of electrical installations.

The Risk/Reliability based maintenance of the plant & equipment needs to be carried out considering the following aspects:

- *Age*
- *Location*
- *Past failure /accident history*
- *Risk level*

- *Desired equipment Reliability Level (RL) or Safety Integrity Levels (SIL)*
- *Criticality of Equipment (size, redundancy, cost, replacement time, available spare, business interruption)*
 - *Emergency DC distribution panel feeders*
 - *UPS /DCS /SCADA /DAS power distribution panels*
 - *Tele-Communication power distribution panels*
 - *Power plant load centers*
 - *Main switchyards*
 - *Main transformers*

Many pro-active organizations have started re-aligning their electrical maintenance practices based on international maintenance practices (IEEE / NFPA, IEC,BS). A specific example is IEEE 625 - *Recommended Practice to Improve Electrical Maintenance and Safety in the Cement Industry*.

In order to assess the equipment condition by predicting failures, without losing production, applications such as thermal imaging are gaining importance. In western countries, plants that are scanned with thermal imaging camera are given fire premium discounts by the insurance companies. After the de-tariff scenario in the general insurance industry, India might also experience similar trends regarding thermal imaging. Due to the high cost of this equipment, most end users hire the Thermographic imaging services.

Thermal Images & Prediction of Failures

Modern infrared scanning systems have a temperature range of –15 degree centigrade to 2000 degree centigrade with a sensitivity of 0.1 degree centigrade.

We will try to explain how thermal images are interpreted to predict equipment failures. A few cases are explained below:

CASE 1

Equipment: Main cable termination inside power panel.

Detected unsafe condition: High temperature in R-phase cable lug & insulator.

Recommendations: Re-lug the R-core and re-terminate the cable. Replace the R-phase insulator also. After taking the above corrective measures, carry out T-imaging again and ensure that the hotspots do not exist.

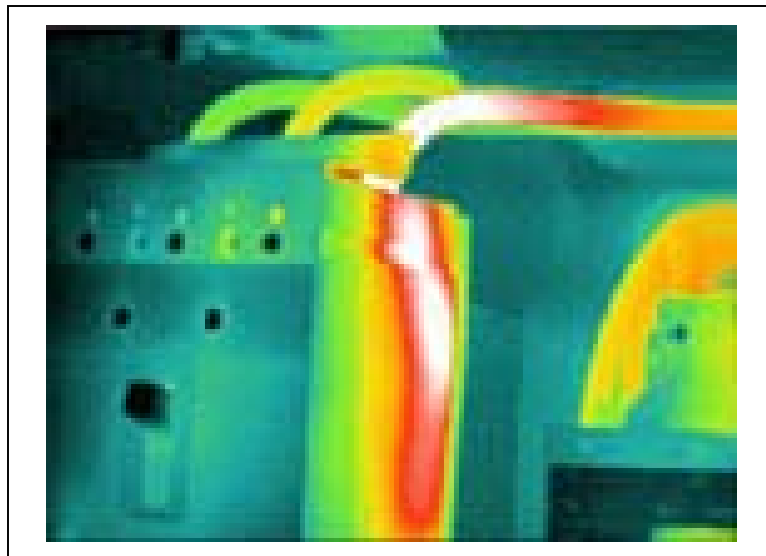


CASE 2

Equipment: Moulded Case Circuit Breaker (MCCB).

Detected unsafe condition: High temperature in B-phase terminal of MCCB, feeding emergency lighting loads.

Recommendations: Re-lug the cable B-core and re-terminate the cable properly. If the high temperature problem persists, then replace the R-phase terminal contacts. After taking the above corrective measures, carry out T-imaging again and ensure that the electrical hotspot do not exist.

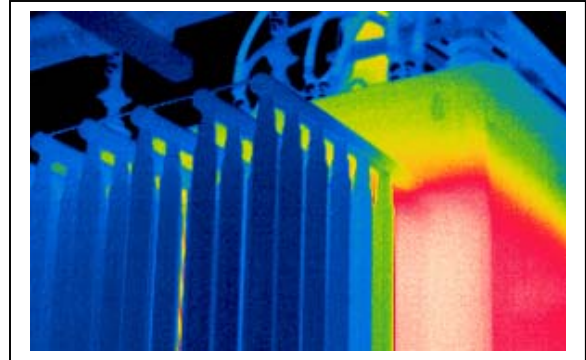


CASE 3

Transformer-Normal view



Transformer-T-image



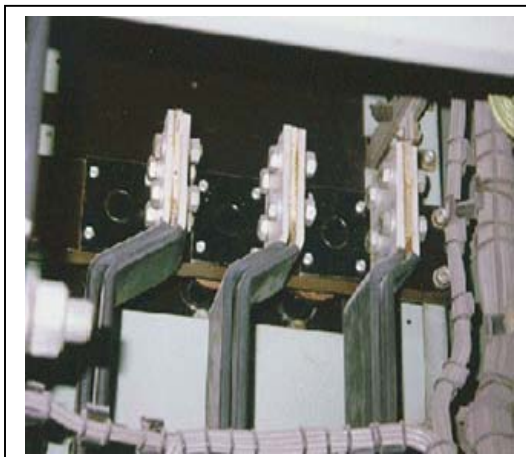
Equipment: 1500 KVA outdoor transformer

Detected unsafe condition: High temperature indicating low oil level in transformer.

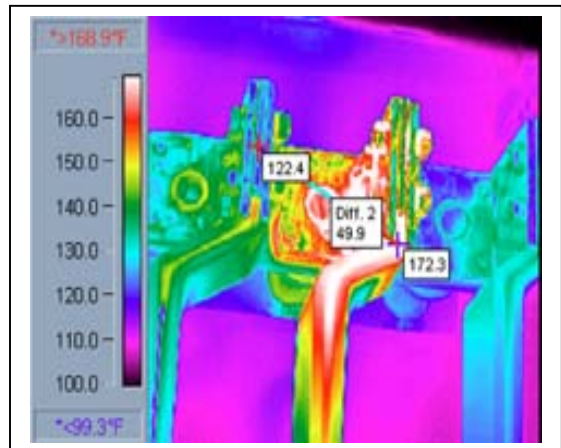
Recommendations: Investigate the problem of low oil level in transformer and take corrective action (Settings of OTI & WTI, arrest oil leak, interlock low oil level with an alarm, daily visual inspection).

CASE 4

Busbar connection-Normal view



Busbar Connection-T-image



Equipment: Busbars inside main PCC, feeding critical loads.

Detected unsafe condition: High temperature in Y-Phase busbar connection indicating hotspot, probably due to improper / loose bolting.

Recommendations: Correct the improper busbar bolt connection.

Thermography Survey -Cost-Benefit Analysis (CBA)

The annualized cost (of hiring the T-camera & not owning it) is obviously insignificant when the benefits from Thermogrphy surveys are compared. The advantages of T-Surveys outweigh the hiring cost of the T-survey equipment, as can be seen below:

Sl. No.	Advantages
1.	Avoidance of unplanned power outages by identifying hotspots /problem areas.
2.	Faster mode of troubleshooting & predictive maintenance.
3.	Reduced inspection costs.
4.	Accurate fault / hotspot detection.
5.	Planned shuts downs can be arranged if problem areas /equipment are identified.
6.	Reduced power outage costs.
7.	Reduction of overall failure rate.
8.	Lower operational cost.
9.	Equipment need not be shutdown in order to scan for internal temperatures.
10.	Enhanced safety & loss prevention. Faulty components & equipment often result in loss to property & life.

Interpreting Results

Conducting regular thermographic surveys is fine but unless the Thermographs are interpreted and implementation priorities defined, the effectiveness of the whole exercise will not be complete.

The following organizations have defined guidelines for operating temperatures, test methods, and frequencies of inspection for various equipment:

- *Factory Mutual (FM)*
- *IEEE (Institute of Electrical & Electronics Engineers)*
- *NFPA (national Fire Protection Association)*
- *NETA (National Electrical Testing Association)*
- *ASTM (American Society of Testing Materials)*

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- *ANSI (American National Standards Institute)*
- *NEC (National Electric Code) from NFPA, USA*

Reference & Courtesy:

- RAYTEK, *Application Note on Hotspot Detection*
- IRL, Brochure on *Thermography*
- Zurich Risk Engineering, *Infrared Thermography*
- Condition Monitoring with Infrared Thermography (*A.K. Yadav, DGM-PGCL-Electrical India 15 May 1999*)
- Photos & T-images – culled from various web resources.

Thermography Services from Cholamandalam MS Risk Services Ltd.

Cholamandalam MS Risk Services Ltd. (CMSRSL) offers T-Surveys for its direct clients and select clients of Cholamandalam Mitsui Sumitomo General Insurance Company Ltd. (CMSGICL) –at the discretion of CMSGICL.

CMSRSL has professional tie-ups with expert organizations to carry out T-surveys. The T-survey (equipment, number of days, etc.) will be decided based on client's requirements and risk assessment carried out by CMSRSL. The report will contain analysis (identification of hotspots and implementation of recommendations for hazard control) based on T-images.

To have more information on areas of '**Risk Management**', please write to sreejithPG@chola.murugappa.com.

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