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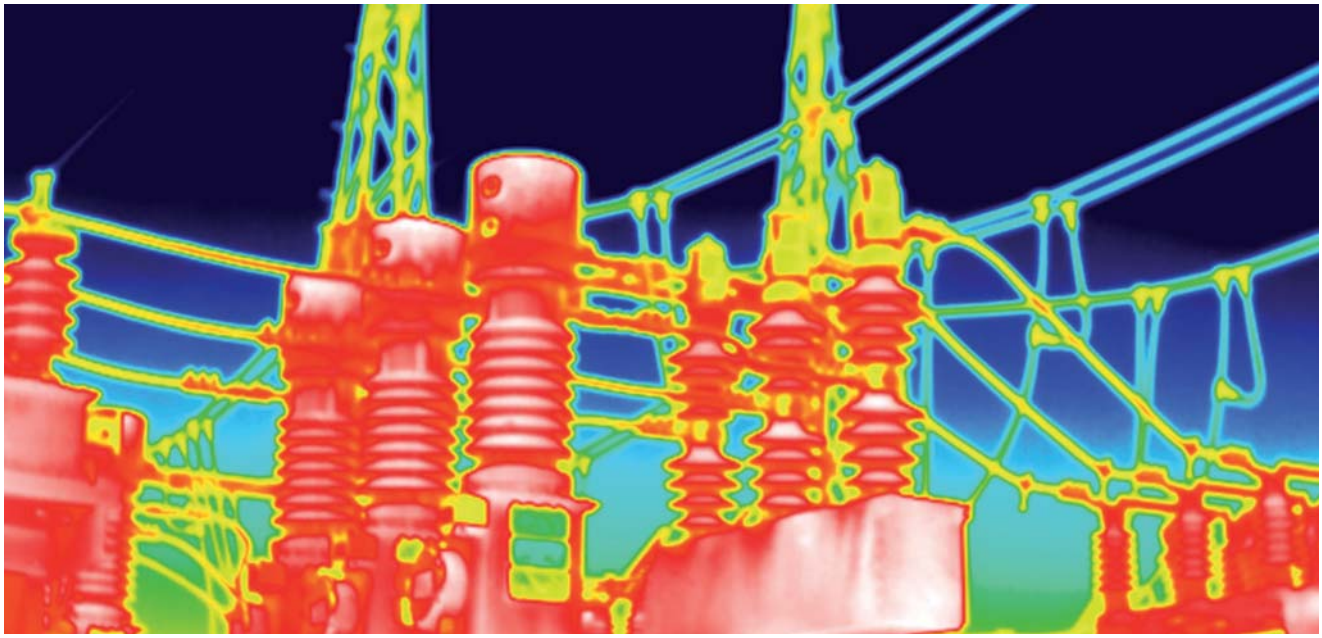
IR Inspections of Power Transformers

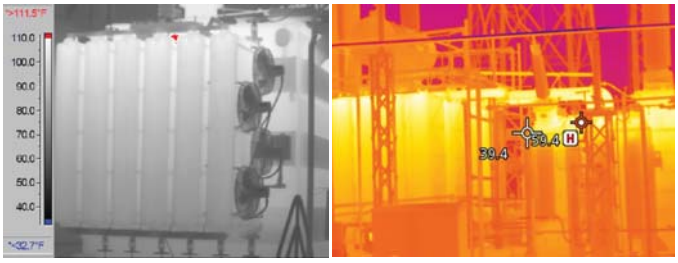


Power sector majorly depends on energy production, transmission & distribution systems and there are several equipments that carry the load of efficient operation & are significant in the overall governance of the segment. Transformers are one such crucial element and it is necessary to ensure proper maintenance of transformers. Infrared inspections turn out to be the ideal method of maintenance.

Infrared inspections should be conducted annually while equipment is energized and under full load, if possible. IR inspections and analysis should also be carried out after any maintenance or testing to see if connections that were broken was re-fixed properly or not. Also, if IR inspection is performed during factory heat run of the power transformer, the results can be used as a baseline for later comparison. IR scanning and analysis requires trained staff, experienced in these techniques. Infrared scanning and analysis are required annually for trending purposes as specified in National Fire Protection Association NFPA – 70 B (Recommended Practice for Electrical Equipment Maintenance).

1. IR inspection for transformer tanks

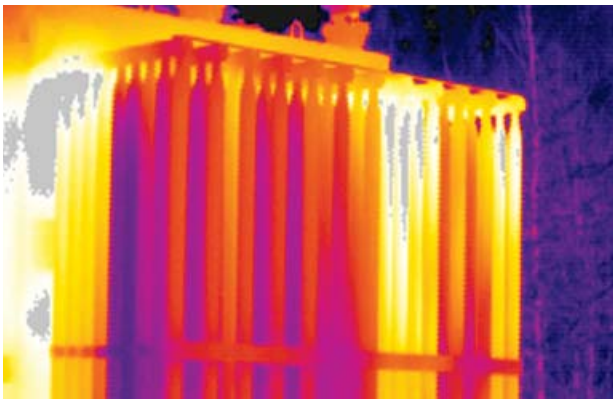
Unusually high external temperatures or unusual thermal patterns of transformer tanks indicate problems inside the transformer, such as low oil level, circulating stray currents, blocked cooling, loose shields, tap changer issues, etc. Abnormally high temperatures can damage or destroy transformer insulation and thus, reduce life expectancy of the equipment or leads to catastrophic failure. Thermal patterns of transformer tanks and radiators should be comparatively cooler at the bottom and gradually warmer towards the top. Below thermal images illustrate the normal pattern of a transformer tank / body / radiators.



Normal transformer IR pattern

2. IR inspection for transformer radiators

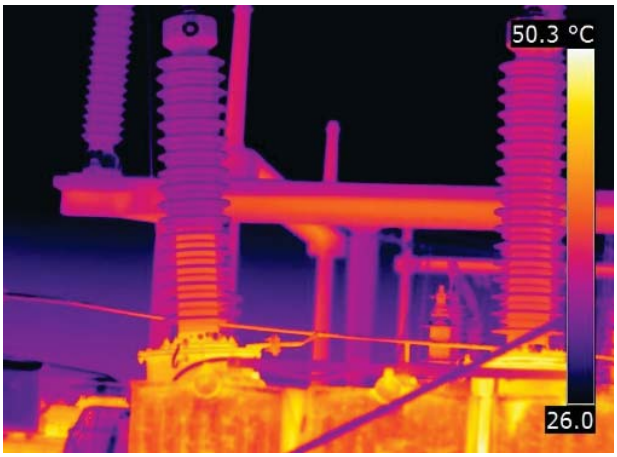
Inspection of transformer radiators is conducted by an IR camera and then compared with each other. A cool radiator or segment indicates that either a valve is closed or the radiator or segment is plugged. The reference IR image below shows that, the cold left radiator section is plugged or blocked with internal corrosion of the fins. If visual inspection shows that the valves are open then the radiator or segment must be isolated, drained, removed, and the blockage must be cleared. Operation of the transformers with reduced cooling should be strictly prohibited as it can drastically affect the transformer life. It is important to note that generally an increased operating temperature of only 8 to 10 °C will reduce transformer life by one-half. Hence IR scanning of all cooling systems, including heat exchangers, fans, pumps, motors, etc is advisable. There is also a need to check inside the control panels for overloaded wiring, loose connections, and overheated relays. Additionally, observation for unusual thermal patterns and comparing with similar equipment is necessary.



Abnormal pattern for transformer radiator

3. Thermal Inspection of transformer bushing

Transformer bushing is very critical component and heart of the entire switch yard electrical equipment. Having done an identification of such critical issues by doing the thermography as a predictive maintenance, asset owner can thereby save catastrophic failure, save costs, increase availability, and ensure equipment and human safety. Following is the thermograph of a transformer bushing. The highest temperature is not expected in the part of bushing where the oil is missing. As we know, the oil in addition to isolating evaporates in its double functionality. That is the case with this bushing shown in the following image. At the top, where the oil is missing, we have lower temperature, what we see, is the temperature of the porcelain of the bushing. While, at the bottom where it has oil, the temperature is higher because through the oil we have seen in the thermal image, the internal temperature of the conductor within the bushing.

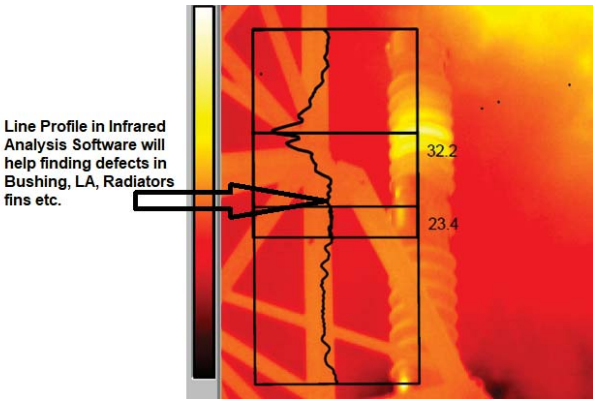


Thermograph showing abnormal bushing

At the top of the capacitive bushing, the media of heat transmission is the air, which is bad conductor of heat, while at the bottom the whole of heat transmission is through the oil. Bushings are susceptible to leakages of transformer oil due to worn out seats and may lead to explosive failure of a transformer. These defects can sometimes be easily rectified, improving transformer service life.

4. IR inspections of surge arresters

Surge arresters are important while conducting infrared scanning on energized transformers. Unusual thermal patterns on the surface of lightning arresters can be seen in the below thermograph. The yellow color in the top right of the image is just a reflection not associated with the arrester. A temperature profile of the arrester is shown as black lines. Actually, the hot spot (yellow part) as we move little down from the top, indicates that an immediate de-energizing process and replacement must be undertaken. Catastrophic failure is imminent which can destroy nearby equipment and can be hazardous to workers too. It is good to compare thermal patterns of the similar units or baseline scan of the same arrester. Even the high-voltage connections should be scanned and compared to nearby connections for unusual temperatures.



IR image of defective arrester

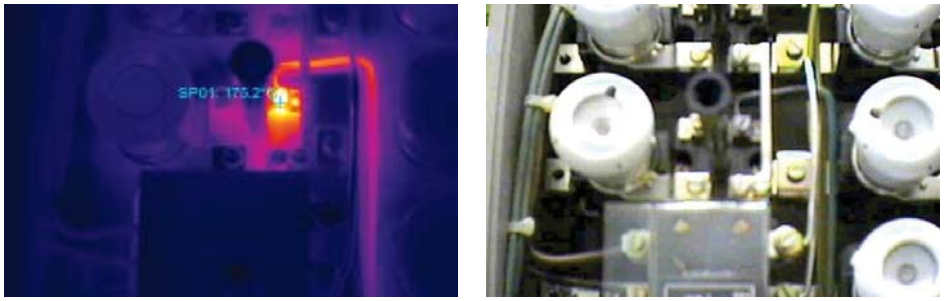
5. Neutral terminal heating in transformer

Neutral conductor has lot of significance in transformer and earthing protection. This neutral conductor is normally solidly grounded. There are two major reasons due to which neutral conductor carries non-zero current to ground:

- Unbalanced load on transformer secondary resulting into considerable potential difference between neutral to ground
- Presence of harmonics in secondary current

The neutral conductor may get overheated significantly if the specified limits of above parameters are crossed. Below thermal image shows such overheated neutral conductor.

The presence of third-order, zero sequence harmonic currents may also result in an overload on a transformer's neutral terminals. At severe levels of harmonic currents, the neutral currents may exceed the phase currents. Any time a thermographer notices the neutral terminal of a transformer heating up, it is likely that severe harmonic conditions exists. Thermography of neutral conductor / bus bar is necessary whenever there are sudden changes in load profile or drastic change in load power factor or the transformer voltage and current either on primary or secondary side are crossing their limits. This will enable us to take corrective actions well before there is any significant loss.



Normal transformer IR pattern

Mr. Parag Yelegaonkar
Business Development Manager – Govt. Business
Testo India Pvt. Ltd.
(Level-3 Infraspection Institute Certified Infrared Thermographer)

For more information, please write to us on **info@testo.in** or visit **www.testo.com**.

Note: - Some images are taken by Testo thermal imager 890 and some thermal images are taken from various publications for reference only