Preventing Failures Through Thermal Imaging

Thermal Imaging

Thermal imaging is a proven technique useful in locating faults prior to impacting facility operations. Thermal imaging is a non-contact/non-destructive test that quantifies thermal energy radiating from an object. In electrical systems; connections, contacts, moving switch assemblies, spring tension devices, etc. are affected by system operation and stresses associated with current in the system. Interpreting thermal imaging results relies on knowledge and observations of Ohm's Law, specifically, $=I^2R$. Power is the product of a system's current squared and resistance. In a perfect system, conductors, terminations, transitions and splices would all be resistance free, eliminating electrical heat generation. In real world applications all systems have an inherent level of resistance, resulting in low levels of thermal radiation. During system assembly improper connection tightness or contamination of electrical contact points results in higher resistance. Conversely, as components age connections loosen due to cyclical loads as well as vibration.

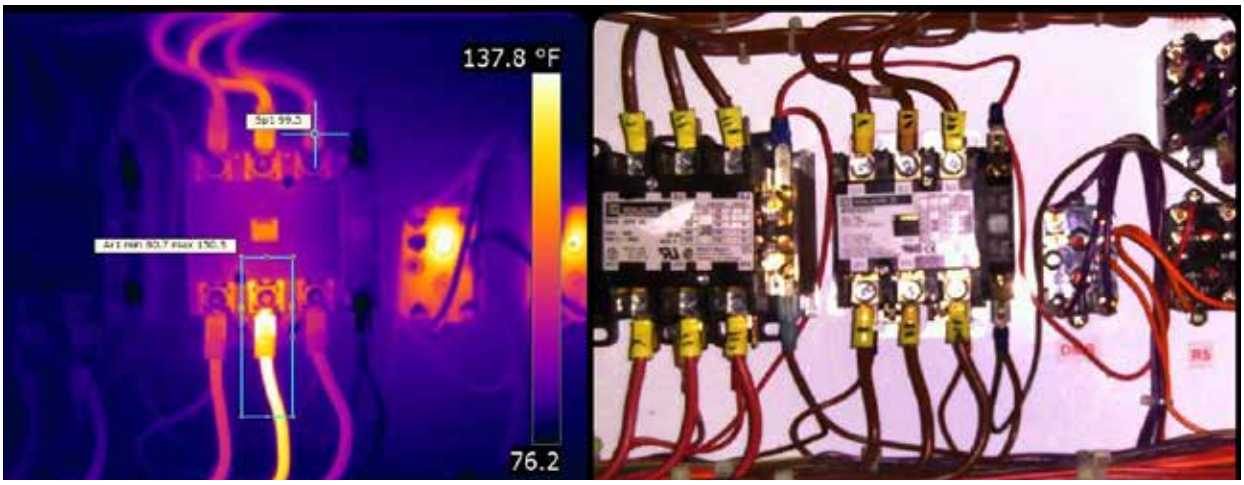
Performance of thermal imaging requires knowledge of how an object's material properties will affect observed heat radiation. Several variables such as emissivity, reflectivity, proximity to adjacent equipment, environmental, distance and system operating conditions at the time of the scan can affect the indications observed by the technician. Readings of more than 2° deviation give reason to investigate.

- Emissivity: a measure of the efficiency in which a surface emits thermal energy. Emissivity is higher for dull, black materials and is more conducive to performing accurate thermal imaging.

- Thermal Reflectivity: a measure of a material's ability to reflect ambient thermal radiation. Thermal reflectivity and emissivity have an inverse relationship. Shiny, metallic surfaces and glass have high reflectivity indexes making direct observation of a material's true temperature through thermal imaging difficult.
- Environmental Conditions: Cloud cover, sunlight, incident heat radiation and humidity are all examples of environmental factors that can interfere with accurately measuring a material's temperature through thermal imaging.
- System Operating Conditions: As with all components, failure is most likely to occur during times of high stress operation. Performing scans during peak loading provides the best opportunity to discover the "weak link" in a system. As Ohm's law states, an exponential relationship exists between emitted heat radiation and current.

Additional Tests

Thermal imaging is an ideal tool for quickly locating



The image (above) shows the B phase of a contactor with a poor wire termination. This high resistance connection is creating heat which will over time cause the connection, and the unit it powers, to fail.

possible problem areas. Thermal imaging is ultimately a qualitative analysis that rapidly identifies areas of concern. Utilizing quantitative methods to measure the magnitude of an issue aids in assessing risk and determining corrective actions. Supplemental tests to aid in diagnosing issued discovered during thermal imaging include:

- Performing millivolt drop measurements across trouble spots and comparing readings from similar equipment.
- Develop a baseline for similar equipment under similar loads, verifying that all systems are operating within design parameters.
- If operational conditions allow for de-energization perform tests in accordance with NETA/ANSI Standard for Maintenance Testing Specifications for Electrical Power Equipment and Systems.
- Ultra-sonic testing is useful for detecting noises that are created by partial discharge or corona. Ultra-sonic testing will also detect chattering contacts or failing coils.

Summary

"Infrared inspections of electrical systems are beneficial to reduce the number of costly and catastrophic equipment failures and unscheduled plant shutdowns" **(NFPA, 2006)**. NFPA also recommends performing thermal imaging on an annual basis. The Building Commissioning Association (BCxA) recommends performing thermal imaging during the commissioning process of a new facility as well as periodically for measuring and verification of system and building performance **(BCxA, 2011)**.

Thermal imaging during the initial acceptance testing of a system or building ensures that baseline data is collected. Baseline data is essential for successfully evaluating a system's or component's current health as well as providing data to predict potential failures.

With the advent of current thermal imaging technology it is tempting to acquire the equipment to perform scans "in-house" by facilities staff. This decision must be evaluated carefully, what value can be placed on CSG's certified technician's understanding of thermal imaging theory and years of field experience?

Call us and let us show you how.

References

BCxA. (2011). Commissioning of Mission Critical Facilities. *19th National Conference on Building Commissioning* (p. 17). Cincinnati, OH: BCxA.

NFPA. (2006). NFPA 70B Infrared Inspection. In N. F. Association, *NFPA 70B Electrical Equipment Maintenance* (p. 73). Quincy, MA: International Codes and Standards Organization.