PRO-LINE

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LOAD IS THE KEY

Infrared thermography is a valuable condition assessment tool for electrical systems. However, the value of the technology is often short-circuited by infrared electrical inspections that do not give appropriate consideration to electrical load.

Most thermographers know that it is imperative to have the electrical system under load during an infrared inspection. However, some thermographers and the organizations that employ them believe that as long as they can see some thermal energy emitting from the components, there is sufficient load on the circuits.

But how much load is enough?

Without knowing the actual load, temperature measurement is mis-leading. Without accurate temperatures, it is difficult, if not impossible, to evaluate and classify the severity of the problem.

For example, the temperature of a specific anomaly on a circuit loaded to only 20% of its rated capacity will be significantly lower than if the circuit were carrying 70% of its rated load. This change in electrical load would take the temperature level of the anomaly from a low priority classification to an emergency situation. A qualitative inspection can be performed without knowing the amount of electrical load. However, the anomaly cannot be classified into a repair priority and trending cannot be used. The maintenance response to such a qualitative inspection is to correct every anomaly found unless some exceptionally warm overall pattern was identified.

If thermographic inspections are being performed without taking load readings, the thermographer must properly report that no attempt was made to establish loads and that the temperature measurements are not an accurate indication of the severity of the anomaly. In other words, the thermographer must be honest and indicate the level and accuracy of the inspection work. In a qualitative inspection, no measurements are made; the thermal image is simply evaluated to find an anomaly and identify where it exists.

The advantages of this approach are outlined in the accompanying section: "Qualitative approach to IR Electrical Inspection." The reason electrical load must be measured to make an accurate diagnosis of an anomaly in an

electrical system is apparent form a review of basic electrical theory. The relationship of current, voltage, and resistance is expressed in Ohms Law. The amount of current in amperes flowing in a circuit is equal to the difference in potential in volts divided by the resistance in Ohms of the circuit. Ohms Law can be expressed by the equation: $I=E/R$
Where:
I = Current, amps
E = Potential
R = Resistance, Ohms

The concepts of work, energy and power are also important to IR electrical inspection. Work is the overcoming of resistance. Energy is the ability to do work. Power is the rate of doing work or the rate at which energy is expended. This relationship is illustrated by the equation: Power = Work x time

The basic unit of electrical power is the watt (the product of voltage and current), which represents the rate at any given instant at which work is being done to move electrons through the circuit. Electrical power is described by the equation: $P=EI$
Where:
P = Power, watts
E = Voltage, volts
I = Current, amps

Substituting the Ohms Law Equivalent of E, the power equation becomes: $P=I2R$.

Power gives an indication of the rate at which a device converts electrical energy into another form of energy: such as heat, light, or motion.

Using 2 Ohms of resistance for a loose electrical connection as an example anomaly in a circuit loaded to 100 amps, power is calculated to be 10 x 2 = 200 watts. If the resistance in the anomaly doubles to 4 Ohms and current remains constant, power draw doubles to 400 watts of heating capacity. If current doubles to 20 amps and resistance remains constant, power draw at the anomaly quadruples to 800 watts of heating capacity. Since the electrical energy is being changed quite efficiently, temperature will change accordingly. If the poor condition continues to deteriorate and the load increases, temperature will increase dramatically.

With this understanding, it is the author's opinion that all thermographers must take a load reading at the time of inspection. Obviously there are exceptions to the rule, but very few.

Along with load, the thermographers must consider a number of additional parameters including:

Size and mass of component
Heat transfer rates of conduction, radiation and convection
Size of the target and distance
Importance of component to the system or process
Calibration of the infrared instrument
Ambient fluctuations
Equipment Cycling
Component temperature rating and so on.

These subjects and many more are discussed at length in certification courses on electrical thermography.