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10 Reasons for Why the Temperature, or Temperature Rise, of an Abnormally Hot Electrical Component Should Be Reported As 'At Least'

1. The emissivity may be lower than that reported.

Thermographers are encouraged to make measurements on high emissivity (>0.8) surfaces, such as wire insulation or cavity radiators adjacent to the low emissivity connector. Temperature measurements on high emissivity surfaces are much more accurate and less sensitive to errors in emissivity value or background reflected temperature. But while wire insulation can be reliable measurements they will be heated by conduction from the fault, and therefore cooler than the actual fault (2nd Law).

2. The temperature at the fault location will be hotter than at the surface.

This again is simply the 2nd law of thermodynamics: heat flows from hot to cold. Contact resistance faults are usually between the surface of contact and not in direct line of sight of the camera, resulting in a thermal gradient between the internal fault and the surface being observed. The further from the surface being inspected the greater the thermal gradient.

3. There may be a wind or forced convection during the inspection.

Forced convection occurring during the inspection will cause a lower surface temperature than will occur when the convection stops. A 15 mph wind may drop the delta T phase by as much as 66%.

4. The object may be smaller than IFOV measure.

All optical instruments have resolution limits. Infrared images have two different limits: the distance for detection and the distance for measurement. Just because you can detect a hot spot does not mean you can measure it. Typically $IFOV_{measure}$ is about 3X larger than IFOV. When operating beyond the IFOVmeasure capabilities the hot spot is averaged with the surroundings resulting in a lower temperature reading than actual.

5. There may be an alternative path of heat flow.

Heat flow takes the path of least resistance. And it may not be towards the surface you are inspecting. A disconnect mounted on a cold outside concrete wall, may shed the majority its heat to the wall rather than into the (heated) room.

6. The load may increase.

Contact resistance faults power is proportional to current squared times electrical fault resistance (Power = I^2R). If current doubles fault power increases by a factor of 4. This will cause the fault and surface temperature to rise.

7. The air temperature may increase.

A typical fault is a constant power generator if the load remains the same. The majority of this power goes into heat so a fault is also considered to be a constant heat generator. This heat flows from the fault to the surroundings, the majority of the time of which is the ambient air temperature. Given all other conditions being equal if the ambient air temperature increases so will the surface temperature and the fault temperature.

8. The temperature may be cooler because the cabinet is open.

This is related to point 7 but perhaps not obvious. Opening panels and cabinet doors allows (cooler) room air to circulate around the fault and cool it down from what it was prior to opening the door. Similarly the temperature will rise once the cabinet is closed back up.

9. The fault may experience radiant (e.g. solar)gain.

The fault, and consequent surface temperature, will be influenced by the surrounding radiant conditions. If a hot source, such as the sun or boiler, radiates directly on the fault surface, the surface temperature, (and consequently the fault temperature) will rise.

10.The fault may be an arcing fault rather than a pure resistive fault.

Internal arcing faults (micro-arcs) are in reality very fast, very high temperature, but very small intermittent thermal events. Therefore, these are transient events often occurring on large mass components (e.g. buss components, disconnects, etc.) and therefore are often masked by the thermal capacitance of the material. Arcing faults are often identified post-mortem by evidence of pitting and carbonization. The next time you find a fault ask yourself whether it is possible that this may be an (micro) arcing fault and then think about what the temperature inside really might be (10,000 degrees plus!)