TECHNICAL RESOURCE · INFRARED THERMOGRAPHY

Why a Hot Spot Alone Is Not a Finding

Load, emissivity, and reflected temperature all sit between the image and a defensible severity call. Here is how they connect.

A glowing spot in a thermal image feels like proof. It is not. It is an *observation* that a surface is emitting more apparent infrared energy than what surrounds it. Whether that observation is trivial, worth watching, or a shutdown-now problem is a separate question, and answering it is what turns an image into a finding.

Three variables sit between the pixel and the call: how hard the equipment was working, how the surface radiates, and what the surface was reflecting. Get any one wrong and the same image reads as alarming when it is benign, or gets waved off when it is about to fail.

01 The image is an observation, not a conclusion

An infrared camera does not measure temperature. It measures radiance, the infrared energy arriving at the detector, then converts that to an **apparent temperature** using the settings you gave it. Change the emissivity value or the reflected temperature you told the camera to assume, and the same physical surface reports a different temperature with nothing on the equipment having changed.

The palette compounds it. Most cameras auto-scale color to the hottest and coldest pixels in frame, so a 2° spread and a 40° spread can look equally dramatic. A vivid image is a reason to investigate. It is not, by itself, evidence of a defect. Before a hot spot becomes a finding, you account for load, emissivity, and reflected temperature, then compare the corrected result against a reference and a standard.

02 Three variables sit between the pixel and the call

- **Load** asks whether the fault was even working when you looked. Electrical and mechanical heating scale with the work being done, so a real problem can hide at light load.
- **Emissivity** asks how efficiently the surface radiates. A shiny bus bar and a painted panel at the same true temperature report very different apparent temperatures.
- **Reflected temperature** asks how much of what you are seeing belongs to something else. Low-emissivity surfaces act like mirrors, so the sun, sky, adjacent gear, or the thermographer can end up in the reading.

03 Load: the fault only shows up if it is working

Resistive heating in an electrical connection follows I^2R. The heat a defect produces rises with the square of the current through it, so the same high-resistance connection that runs dangerously hot at full load can look unremarkable at a quarter load. This is the most common way a serious problem gets missed: the survey happened on a light shift, and the fault never had the current it needed to declare itself.

The standards expect data collected under real conditions. Survey at normal or near-normal loading, and a widely used field threshold is to inspect at roughly 40 percent of rated load or higher before drawing conclusions about electrical connections. When you cannot get full load, correct for it rather than guess. The Infraspection Institute load-corrected maximum method (§11.6) scales the expected temperature rise by the square of the load ratio:

> LOAD-CORRECTED MAXIMUM TEMPERATURE
>
> $$T_{max\ corr} = [\ (A_{meas} \div A_{rated})^2 \times T_{rated\ rise}\ ] + T_{ambient}$$

The corrected maximum is the temperature the component *should* reach at rated load if nothing is wrong. Compare your measurement against it and you have a load-independent verdict instead of a reading that only describes the moment you happened to be standing there. A low temperature at low load is not a clean bill of health, and a modest temperature at partial load can still be a serious finding once corrected.

04 Emissivity: the number the camera trusts

Emissivity is how efficiently a surface radiates infrared energy compared with a perfect emitter, on a scale from 0 to 1. It is the most influential setting in the camera, because the instrument uses it to back-calculate temperature from received radiance. The surfaces we care about most in electrical work are often the worst emitters:

- **Bare, shiny metal** (polished copper bus, aluminum lugs): emissivity as low as 0.05 to 0.10. Radiates almost nothing, reflects almost everything, reads far cooler than it truly is.
- **Oxidized or weathered metal:** higher and more stable, but still variable across the same part.
- **Painted, taped, or coated surfaces** and most nonmetals: roughly 0.90 to 0.95, high and predictable, which is why they are reliable to measure.

A wrong emissivity value does not shift the reading by a degree or two. On a low-emissivity surface it can swing the apparent temperature by tens of degrees, the difference between routine and critical. ASTM E1933 gives two field procedures for measuring and compensating for emissivity using commonly available materials, such as tape or paint of known emissivity as a reference. A hot-spot temperature quoted without the emissivity used to derive it is an estimate with an undisclosed assumption baked in.

05 Reflected temperature: the heat that is not the target's

Every low-emissivity surface makes up the difference by reflecting. Whatever a bright copper bar fails to emit, it mirrors from its surroundings, and the camera cannot tell the difference between energy the target radiated and energy it bounced. That borrowed energy is the reflected apparent temperature, and it has to be measured and entered, not left at a default.

The usual sources are ordinary and easy to overlook: the sun, a bright sky, hot equipment across the aisle, overhead lighting, and the thermographer's own body heat a few feet away. On a reflective surface these can invent a hot spot that is not there, or mask a real one behind a cool reflection. ASTM E1862 covers this directly, giving the **Reflector Method**, which uses a diffuse reflector such as crumpled and re-flattened aluminum foil to sample the surroundings, and the **Direct Method**. Reflected temperature matters most precisely where emissivity is lowest, so the shiny bus bar that is hardest to read for emissivity is also the one most corrupted by reflection.

06 From measurement to severity

Once load, emissivity, and reflected temperature are settled, a single temperature still is not a finding. Severity comes from comparison, and two comparisons matter:

COMPARISON BASIS	WHAT IT ISOLATES	USE WHEN
ΔT vs. like reference	The anomaly, separated from normal operating warmth, at matched load	A similar component on the same phase or circuit exists
ΔT vs. ambient	The rise above ambient air temperature	No comparable component is available

The published severity scales used in the field, including those referenced through NETA and NFPA 70B practice, key off exactly those two deltas rather than off raw surface temperature. A small ΔT over a like reference points to a minor condition to monitor; a large ΔT over reference, or a high rise over ambient, points to a serious defect for prompt or immediate action. The thresholds belong to those documents; the logic is consistent. It is the difference, corrected and referenced, that sets priority.

A defensible finding is a qualified thermographer, an imager with traceable calibration, emissivity set for the actual surface, reflected temperature measured and entered, load documented or corrected, a ΔT against a like reference and against ambient, a severity rating tied to a recognized scale, and a recommended corrective action, with the thermal and matching visible image retained. NFPA 70B expects the report to carry those inputs; ASTM E1934 frames the examination method behind them.

07 Before you call it a finding

Run any hot spot through this list before it goes in a report as a finding:

- ☐ Emissivity was set for the actual surface, and the value is recorded
- ☐ Reflected apparent temperature was measured and entered, not left at a default
- ☐ Load was recorded, and the read was taken at or corrected to near-normal load
- ☐ A like reference component under the same load was compared
- ☐ ΔT is stated against both a similar reference and ambient
- ☐ Severity is tied to a recognized scale, not to raw surface temperature
- ☐ A specific recommended corrective action is assigned
- ☐ The thermal image and a matching visible-light image are retained

If you can check all eight, you have a finding you can stand behind. If a bright spot is going in the report on temperature alone, you are documenting a color and calling it a condition, which is exactly the gap that fails an audit or falls apart under cross-examination.

> **Look Management Group** reviews thermographic reports and inspection methodology for facilities, insurers, and counsel, and provides expert-witness analysis where a severity call is contested. Because we hold no inspection contracts and sell no equipment, that read is independent.

Standards referenced: NFPA 70B, Standard for Electrical Equipment Maintenance (2023 edition); ASTM E1934, Standard Guide for Examining Electrical and Mechanical Equipment with Infrared Thermography; ASTM E1933, Standard Practice for Measuring and Compensating for Emissivity Using Infrared Imaging Radiometers; ASTM E1862, Standard Practice for Measuring and Compensating for Reflected Temperature Using Infrared Imaging Radiometers; and the Infraspection Institute Standard for Infrared Inspection of Electrical Systems & Rotating Equipment (§11.6, load-corrected maximum). Personnel qualification follows the Infraspection Institute Level I / II / III framework.

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