

## Thermal Imaging Tests on Generator Set Systems

Information Sheet # 19

### 1.0 Introduction

Thermal imaging or thermography, detects heat patterns or temperature changes in objects. These changes allow the user to discover problems prior to costly downtime, or monitor developing problems so maintenance can be scheduled during a planned downtime or when budget is available.

*This information sheet discusses use of thermal imaging with generator set systems.*

### 2.0 What is Thermal Imaging

Thermal imaging is employed during maintenance or trouble shooting in order to check electrical connections in circuit breakers, transfer switches and switchgear in electrical emergency generators for hot spots, while the generator set or power distribution system is operating/running.

Many service technicians use infrared guns, which show any such hot spots but these are unable to provide a hard copy for the record. Today's thermal imagers have ability to view live images of heat emitted from equipment and are becoming ever more affordable, making them highly practical and cost-effective. *(Continued over)*



Hand Held  
Thermal Imaging  
Device

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As any bad electrical connection can generate additional heat and therefore this will reduce system efficiencies and has the potential to risk more serious damage - is the biggest cause of electrical fires. All electrical connections deteriorate over time, so thermal imaging can be utilized to detect and repair in advance so as to prevent any such failures.

### 3.0 Operation

The technician points the imager at the equipment in question, scans the immediate area for unexpected hot spots, then squeezes the trigger to capture a specific image. Once the inspection has been completed, the saved images can be uploaded to a computer for closer analysis, reporting or future trending. While imagers are simple to operate, they are most effectively employed when in the hands of a qualified technician, who understands electrical measurement and the equipment being inspected.

1. **Testing requirements.** The electrical equipment being inspected must be under at least 40% of nominal load in order to detect any problems, while maximum power and loads are ideal, if at all possible.
2. **Safety.** Electrical measurement safety standards still apply under NFPA 70E (1). Standing in front of an open, live electrical panel requires personal protective equipment (PPE). Dependent on the situation and incident energy level (Bolted Fault Current) of the equipment being scanned, this may include:
  - Flame resistant clothing
  - Leather-over-rubber gloves
  - Leather work boots
  - Arc flash rated face shield, hard hat and hearing protection, or full flash suit
3. **Emissivity.** Emissivity describes how well an object emits infrared energy or heat. This affects how well a thermal imager can accurately measure the object's surface temperature. Different materials emit infrared energy in different ways. Every object has a specific Emissivity that is rated on a scale of 0 to 1.0. The higher the Emissivity, the better it is for thermal imagers to record accurate temperatures. Objects that have high Emissivity emit thermal energy well and are usually not very reflective. Materials that have low emissivity are usually fairly reflective and do not emit thermal energy well. This can cause confusion and incorrect analysis of the situation if the user is not careful. The thermal imager can only accurately calculate the surface temperature of an object if the emissivity of the material is relatively high, and/or the emissivity level on the imager is set close to the emissivity of the object. Most painted objects have a high emissivity level of about 0.90 to 0.98. Ceramic, rubber and most electrical tape and conductor insulation have relatively high emissivities as well. Aluminum bus, copper and some kinds of stainless steel, however, are very reflective. The good news is that most thermal imaging performed for electrical inspection purposes is a comparative – or qualitative process. Users typically do not need to know a specific temperature measurement. Instead they should look for a spot that is hotter than similar equipment under the same load conditions – spots that are unexpected.
4. **Troubleshooting electrical systems.** There are specific things to check when chasing breaker problems or load performance issues. Once repairs are completed, another thermal scan should be conducted. If the repair (clean or replace) was successful, the previous detected hot spot should have disappeared. Note! Not all electrical hot spots are caused by loose connections. For a correct diagnosis, it is wise to have a qualified electrician either perform the thermal scan or be present while it is being completed.
5. **Three-phase imbalance.** Capture thermal images of all electrical panels and other high-load connection points such as drives, disconnects, controls, etc. Wherever higher temperatures are discovered, follow that circuit and examine associated branches and loads. Compare all three-phases side by side and check temperature differences. A cooler than normal circuit or leg might signal a failed component. More heavily loaded phases will appear warmer. Hot conductors may be undersized or overloaded. However, since an unbalanced load, an overload, a bad connection and harmonics all can create a similar pattern, it is important to follow up with electrical or power quality measurements to accurately diagnose the problem. Note! Voltage drops across fuses and switches also can show up as unbalance at the motor and excess heat at the root trouble spot. Before it is assumed that the cause has been found, double check current measurements with both the thermal imager and a multi meter or clamp meter.
6. **Connections and wiring.** Look for connections that have higher temperatures than similar connections under similar loads. That could indicate a loose, over-tightened or corroded connection with increased resistance. Connection-related hot spots usually, but not always, appear warmest at the spot of resistance, cooling with distance from that spot. Broken or undersized wires or defected insulation also may be found. The International Electrical Testing Association guidelines recommend immediate repairs when the temperature difference between similar components under similar loads exceeds 25° F (15° C)

### 4.0 Who is Using Thermal Imaging

It is becoming more of a test requirement around switchgear cabinets and electrical components, particularly in hospitals. For further information the following manufacturer provides information on thermo imaging devices:

<http://www.fluke.com/fluke/usen/products/CategoryTI>

