Data Bulletin

Infrared Thermographic Inspection Guidelines
Class 0110

INTRODUCTION

Infrared thermography is a thermal analysis tool that has become widely used for preventative maintenance on mechanical and electrical systems. Square D recognizes the benefit of such technology to the industry. Thermography can be useful in identifying potential issues. The primary benefit of including a thermographic survey in a preventative maintenance program is the ability to monitor thermal trends over time. However, infrared reports often fall short, by not including necessary information required to understand historical trends. This information is necessary for the electrical equipment manufacturer to assist the customer with evaluating equipment operational concerns.

This document is intended to discuss important components and considerations for thermographic surveys. It will also establish the type of information that is necessary in a thermographic report to help the equipment manufacturer determine if the equipment is appropriately operating in the electrical system.

BENEFITS AND LIMITATIONS OF INFRARED THERMOGRAPHY

Infrared thermography is currently being used in two distinct ways for preventative maintenance.

One expectation of the survey is for the infrared report to provide “exact” operating temperatures of electrical equipment components. Since electrical equipment is manufactured using a number of different materials–from copper to plastics–the camera settings will impact the readings obtained in a report. If the infrared camera is set improperly, a component that does not create heat, such as the product label, can show up on an infrared scan as being the hottest point on the equipment. Therefore, one should not have an expectation that an exact temperature reading can be provided on the components of equipment.

A more realistic expectation for applying infrared thermography is to monitor thermal trends. An initial infrared scan is conducted as a baseline. Periodic scans are then performed as part of a routine preventive maintenance program, and any temperature differential is identified between the baseline scan and each periodic scan. Over time, trends can be plotted to identify equipment with a potential problem that may need further inspection to identify if a real problem exists.

National Fire Protection Association (NFPA) 70B Recommended Practices for Electrical Equipment Maintenance provides guidance on setting up and performing an infrared scanning program. The program will contain regular periodic infrared inspections to identify trends as historical data is compiled on the equipment. NFPA 70B provides guidance on temperature differentiation over time and suggested maintenance steps.

It is important to remember that infrared scans are only one of many activities necessary in a preventative maintenance program. They should not replace the standard maintenance procedures found in the instruction and maintenance manuals for the electrical equipment.

IDENTIFY A QUALIFIED PERSON TO PERFORM SURVEY

A sound thermographic survey can only be conducted by a person who is proficient with the infrared scanning equipment. The analysis of electrical equipment can be very complex. As noted previously, the multiple camera settings required by the various types of material in electrical equipment will impact the readings obtained in a report. It is very difficult for anyone to discriminate among all of the various materials and camera settings and obtain an exact temperature difference between two adjacent components of different materials.

Using a qualified person with extensive knowledge of electrical equipment and a working knowledge of the physics behind the thermographic equipment will enhance the quality and accuracy of the survey. The information presented in a surveyor's report is critical in understanding if an issue exists and if corrective action or further investigation should take place. Concluding that an issue exists does not rest solely on the thermographic survey but also on a number of other parameters. The parameters defined later in this paper will help in arriving at an appropriate conclusion.

A qualified person must understand the electrical equipment, electrical systems, and hazards involved. Electrical safety is extremely important when working with electrical equipment. NFPA 70B recommends the following, "Equipment enclosures should be opened for a direct view of components whenever possible." Understanding that infrared scans are only useful when performed on systems that are operational implies that enclosures of energized electrical equipment should be opened for the survey. This is a potential safety issue and not a job for a surveyor who has not been trained in electrical safety. One method to reduce the electrical hazard for a continuous preventive maintenance program is to install infrared windows that permit the scan to be performed without opening the enclosure.

Figure 1: Danger Message

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment and follow safe electrical work practices. See NFPA 70E.
- Turn off all power supplying the equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Replace all devices, doors, and covers before turning on power to the equipment.

Failure to follow these instructions will result in death or serious injury.

The 2002 National Electrical Code (NEC) introduced a new requirement in NEC 110.16 requiring that electrical equipment that is "likely to require examination . . . while energized shall be field marked to warn a ***qualified person*** of the potential electric arc flash hazards." See Figure 1.

The NEC defines a qualified person as:

> "One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training on the hazards involved."

The thermographic survey team must be qualified persons with a working knowledge of:

1. The equipment and system hazards

   Example—medium voltage, low voltage, environment.

2. NFPA 70E, Electrical Safety Requirements for Employee Workplaces

   Example—wear the appropriate personal protective equipment (PPE), clothing, face shielding, gloves.

Working on or examining energized equipment must be taken seriously. The removal of covers and shields in or on electrical equipment is not recommended while the equipment is energized. Evidence of elevated temperature only establishes that further investigative information should be collected in order to understand why a thermal issue may exist.

INFORMATION REQUIRED IN THERMOGRAPHIC REPORT

General Information

A general information section should be included in the overall report that establishes a basic understanding of the survey conditions for future reference by:

1. Identifying the technician(s) and organization conducting the survey
2. Providing credentials for the technician

   Example—electrical contractor for 10 years, infrared thermography certification, safety training including a class on NFPA 70E and OSHA regulations.
3. Documenting the overall time frame of the survey and climate

   Example—July 14 through August 1 the high temperature and air temperature during the day varied from 85 °F to 95 °F and the low at night was around 55 °F, or maybe a table for each day indicating the high, low, rain, sun, clouds, wind speed.
4. Catalog number and calibration information for the thermographic equipment and any other equipment utilized in the survey

   Example—multimeters
5. Criteria used to identify potential issues

   Example—NFPA 70B temperature differentiation guidelines will be used, equipment/components operating in excess of XX °C.

Specific Information

A set of specific parameters must be generated for each identified component of electrical equipment that is included in the survey:

1. Catalog number or identification of the device being surveyed and installation date or time frame (if known).
2. Photo of the device along with thermogram
   a. Identify the “window” of the thermogram

   Example—Is the thermogram restricted to a specific area of the equipment being surveyed? What is the material in the window?
3. Thermographic equipment settings for each thermogram
   a. Emissivity measurement

      Emissivity mapping or table? Identify tables
   b. Distance from equipment
   c. Instantaneous field of view or magnification multiplier
4. Define reference temperature

   Example—room ambient, bus bar in equipment.
5. Provide explanation of how reflected radiation was handled for low emissivity parts

   Example—Significant light source near equipment was shielded to reduce reflection.
6. Operating Environment
   a. Ambient temperature near the equipment. Locations near the ceiling in a high bay facility may be much warmer than near the floor and the temperature outside during a winter may be much cooler, either impacting the thermal performance of the equipment.
   b. Dry location, damp, wet, humidity level, oil, dust.

7. Date and time device was surveyed (cyclical loads will impact).
8. Current and voltage at the device (measure all phases and neutral using a true RMS meter). An overload condition may also be identified by an increase in thermal readings.
9. Equipment/load being served along with a brief description if not a generally known loading characteristic. Lighting may not need further explanation, but a process with cycling loads or unique characteristics would assist in understanding the demands being placed on the equipment.
10. Length of time the device has been under load. Assist in understanding if the device has reached steady state for an accurate survey of the equipment.
11. Wire size connected to equipment. Improper wire sizing that is not in accordance with NEC 310.15 and Table 310.16 can establish thermal transfer issues.
12. Identified signs of damage or overheating. Signs of physical damage or thermal damage in existence at the time of the survey will provide good documentation if a component is removed for examination and it is further discovered the equipment is damaged. Was it damaged in removal, shipping, or was the device operating in this condition?
13. Equipment History

    Example—identify maintenance, repair, or replacement of the equipment being surveyed.
14. Size and type of fuses installed

    Example—Fuse class, one-time or renewable type.

Sample Thermographic Report

Thermographic Survey Report

Date _____
Time _____
Company Name _____
Location _____

General Information

Thermographic Technician(s)

- ☐ Name(s) _____
- ☐ Certification level / Technical training / Safety training _____

Thermographic Equipment Information

- ☐ Manufacturer _____
- ☐ Model / Catalog number _____
- ☐ Calibration date / Source _____
- ☐ Criteria used to identify potential issue _____

Specific Information on Equipment

Electrical Equipment

- ☐ Equipment / Manufacturer _____
- ☐ Model / Catalog number _____
- ☐ Manufacturing date code or estimated date of service _____
- ☐ Length of time the equipment has been under load _____

Usage

- ☐ Equipment load _____
- ☐ Description of load characteristics _____
- ☐ Measured current and voltage levels for ALL three phases and neutral:
  Voltage (A) _____ (B) _____ (C) _____ (Neutral) _____
  Current (A) _____ (B) _____ (C) _____ (Neutral) _____
- ☐ Wire size connected to equipment _____

Thermographic Equipment Settings

- ☐ Emissivity _____
- ☐ Distance from equipment _____
- ☐ Instantaneous Field of View (IFOV) _____
- ☐ Reference temperature _____
- ☐ Reflective radiation issue addressed _____

Operating environment

- ☐ Weather conditions _____
- ☐ Ambient temperature near the equipment _____
- ☐ Humidity level _____
- ☐ Location description (Is the location dry, wet, dusty, oily, etc.?)
  _____
- ☐ Mounting location _____
- ☐ Include photo in report along with thermogram and the above information. Define the area of the equipment being tested on the photograph.

Physical Equipment Inspection

- ☐ Visual physical damage? Y/N
- ☐ Overheating? Y/N
- ☐ Observations _____

NOTE: The first thermographic survey can be used as a baseline for future studies to identify trends. Methods, equipment, parameters, and settings should be consistent from one survey to the next for trend analysis. When conducting the survey, the above determinants are important.

Square D Company
1601 Mercer Road
Lexington, KY 40511 USA
1-888-SquareD (1-888-778-2733)
www.SquareD.com