

Infrared Wavelengths

Volume 10, Issue 3

Thermal Infrared Predictive Maintenance

An Overview

Sierra Pacific Innovations

Like vibration monitoring, oil analysis and other forms of predictive maintenance (PdM), infrared (IR) thermography often spares facilities from minor periods of downtime at the least; catastrophic equipment failure at worst. Most commonly used to find "hot spots" in electrical equipment, infrared technology has uses in plenty of other places in around the plant, particularly as more plants incorporate comprehensive PdM programs into their routines. "About every two weeks, we scan our conveyor systems and look for hot bearings in the rollers," says one Predictive Maintenance supervisor at an apparel mfg plant. "You can use it for anything, production-wise, even the buildings themselves."

New Infrared cameras range from between \$10000 and \$60000, cost depends on the type of system and it's features. Demo cameras are also available.

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Electrical Predictive / Preventative Maintenance

The proven application

J. Powers

Most electrical problems within industrial facilities are manifested or are accompanied by temperature changes as an effect prior to failure. For this reason IR thermography has become an integral part of most predictive / preventative maintenance programs. Infrared cameras can pick up small variations in temperature not visible to the human eye. It is a non-contact, non-destructive, and fairly simple method of detecting impending electrical problems. It is widely known that as temperature in a conductor raises, so does it's resistance. Conversely, as resistance increases (in most conductors) temperature rises. The majority of thermal electrical problems involve improper torque specifications or improper installation at the junction points. A loosely torqued connector effectively reduces the surface area in which current can flow and consequently an increase in the contact resistance. Oxidation build up at the connection point can also cause a rise in resistance. The origin of most conductor, insulation, and component problems can be traced to a poor connection using an infrared camera.

One Infrared expert says; "With infrared, you're measuring intangibles-how much downtime you've eliminated, or how many fires you haven't had. With a utility company we can come in and say, 'If your substation goes down, you have 2,000 homes that have no meters turning for eight hours; how much does that cost?' And then they can start calculating payback.

Indeed, electric utilities usually have little problem getting their moneys' worth out of infrared equipment. A senior engineering associate for Energy Transmission & Distribution Systems, New Orleans, LA, argues that

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An Overview

Today's small, medium and large companies are either buying thermal infrared cameras, or contracting the work out to an infrared inspection firm.

Large, medium and small operations have an extensive inventory of equipment requiring an uninterrupted power source for operation; an unscheduled shutdown is a disaster. Because plants and facilities runs around the clock, 365 days a year, downtime is equivalent to lost revenue. To prevent such losses, all electrical components in the plant can be scanned with a thermal infrared imaging camera for suspect hot spots. Some areas that can be thermally scanned are circuit breakers, transformers, fuses, disconnects switches, bus, panels, etc. Once the problem has been detected with an Infrared imager, proper measures can then be applied for correction. Companies use infrared imagers and thermographers to detect hot spots in electrical equipment in plants. By scanning substations, distribution lighting panels, and electrical motors problems are easily and quickly eliminated before they cause system failure. The results: avoidance of costly operations downtime. By taking a thermograph of site electrical panels, thermographers develop and read a "heat picture" which reveals components that are overloaded or may become faulty. Unlike normal component operating conditions, faulty components exhibit readily detectable temperature increases over the ambient temperature profile. Thermography verifies that electrical connections are properly made and maintained. Thermography also detects hot spots that might be overlooked by visual inspections. Recently, in a U.S factory, staff quickly interrupted the power supply to an above ground trailer when infrared test equipment detected a hot spot registering 123 degrees over the baseline ambient temperature. A fire could have started, resulting in the probable loss of valuable records and equipment, had the problem not been uncovered. ❏

he has seen a return on his company's \$300,000 investment in about a year. "We have transformers that cost between four and five million dollars a piece; if we can find a problem that will save one transformer, we've paid for our program for years."

In a manufacturing plant, it often isn't quite that simple to figure Return On Investment (ROI). An expert points to equipment availability as a way of measuring payback. "If we can catch a problem before it becomes a failure and schedule the repair during a planned shutdown, we've recouped some of our investment," he says. "We have between \$35,000 and \$40,000 worth of equipment that we purchased about four years ago and it has paid for itself very easily."

This type of scenario is easily referenced after the purchase, but justifying costs to management beforehand can be tough. "We have documentation on steam traps," says an infrared professional, "where we look at the cost of steam production at, say, \$12 to produce 1,000 lbs with a 60% efficiency in the trap.

If you can reduce that figure by 25% with infrared, you can calculate very easily what the energy savings will be for that plant." Most all-newer thermal imaging cameras will be portable, handheld and will store images for documentation. The newer thermal imagers generally use the point and shoot method, and are easy to operate. Training should be considered because while the camera does most of the work, the user needs to be able to interpret the images he/she has acquired. The more time and usage you get with the infrared camera, the more familiar you get to calling a problem. The use of infrared thermography is likely to aid in locating potential problems, therefore reducing downtime. ❏

Proper Procedures for Electrical PDM Inspections

Caution: Unless you are a qualified electrician **DO NOT** ever handle electrical wires, panels, or components.

If properly conducted infrared electrical surveys are safe, fast, and reliable. Infrared cameras are non-contact so inspections can be performed at any time without shutting down the facility.

Safety Tip: A qualified electrical contractor or facility engineer **should always** accompany you on the inspection. Have them open the panels and guide your access to components. They can also provide useful information on components you are inspecting (making your job easier).

Step 1:

Meet with appropriate staff on site and review the service order covering what will be inspected, who will accompany the thermographer, and what type of reporting is expected (i.e. videotape, written report, and / or verbal reporting).

Step 2:

Prepare inspection with the designated staff member or electrical contractor. Have them remove panels or prepare your access to components. Discuss what each type of component is to determine how you will inspect it. Have them determine (with clamp on ammeter) that electrical circuits are operating at 50% of rated load or more, if possible.

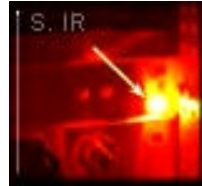
Step 3:

Inspect with infrared camera. Record the sharpest images you can. Be wary of reflections and emissivity values. Keep detailed records of load reading, temperature measurements, and all infrared images of any suspect components found.

Safety Tip: When inspecting electrical panels and components be aware of your distance. High energy electrical power can arc out and ruin your day!



Regular Image



Thermal Image



Regular Image



Thermal Image

Step 4:

Prepare the report. Write a clear concise report of all problem areas found. Include your load readings, live and thermal images, and properly written recommendations.

Hint: Whenever possible, inspect electrical systems when loading exceeds 50%

Attention Contractors: Now is the time to invest in infrared technology. Camera prices have reached an all time low. An experienced thermographer can demand \$500 to \$1500 per day depending on the electrical inspection performed. A thermographer who is also an experienced electrical contractor may be able to command double that rate (depending on experience and the nature of the inspection). In addition, an electrical contractor with an infrared camera can not only diagnose a wide variety of electric faults, the electrician can perform the repair generating increased revenue for the contractor and providing a level of convenience to the customer. Contact Bob Richards (530)543-1186 to discuss your unique situation. Sierra Pacific Infrared can provide complete infrared camera packages including software, training, and all accessories. **¥**

Infrared Charts

Thermal Problem Classification Chart

<i>Problem Classification</i>	<i>Phase to Phase Temperature Rise</i>	<i>Comments</i>
Minor	1° - 10° C	Repair in regular maintenance schedule; little probability of physical damage
Intermediate	10° - 30° C	Repair in the near future (2-4 weeks). Watch load and change accordingly. Inspect for physical damage. There is probability of damage in the component, but not in the surrounding components.
Serious	30° - 70° C	Repair in immediate future (1-2 days). Replace component and inspect the surrounding components for probable damage.
Critical	above 70° C	Repair immediately (overtime). Replace component, inspect surrounding components. Repair while IR camera is still available to inspect after.

** With wind speed less than 15mph*

** With load conditions greater than 50%*

Hint:

Wind Speed Correction Chart

<i>Wind Speed (Miles Per Hour)</i>	<i>Correction Factor</i>
2	1.00
4	1.30
6	1.60
8	1.68
10	1.96
12	2.10
14	2.25
16	2.42
18	2.60

INFRARED RESOURCES DIRECTORY

Contacts

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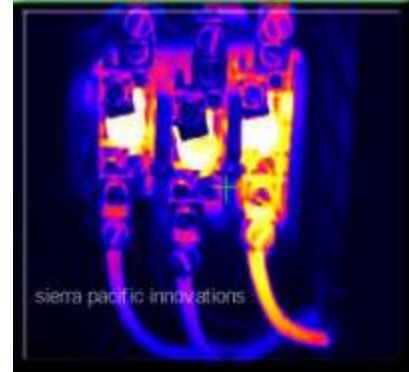
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805-320-4024
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Web Links

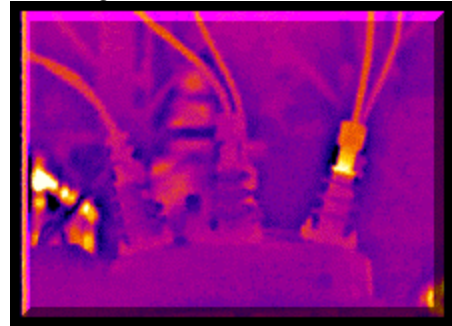
Sample predictive maintenance electrical report
www.x26.com/ireport_busbar.htm
Sample R&D circuit board IR report
www.x26.com/ireport_print_head.htm
Emissivity: An Infrared White Paper (includes emissivity table)
www.x26.com/ireport_print_head.htm
How Infrared Works: A Primer
www.x20.org/library/thermal/how.htm
Sierra Pacific Infrared Inspection Site
www.x26.com
Infrared Camera Comparison Site
www.x20.org

THERMOGRAPHY APPLICATIONS:

- Electrical inspections of buildings, plants, facilities, and refineries
- Thermal heat loss inspections for buildings, plants, facilities, and refineries
- Moisture contamination evaluations in buildings, condo's, plants, and facilities
- Concrete integrity inspections
- Concrete Water Heated floor inspections for leaks and even temperature distribution
- Flat roof leak detection for buildings, plants, and facilities
- Power generation generator inspections
- Power Plant boiler flue gas leak detection
- Substation Electrical inspections, transformers and capacitor evaluation
- Overhead urban and rural distribution electrical inspections
- Electrical motor inspections, mechanical bearing inspections
- Heat ventilation air conditioning equipment evaluation
- Cold Storage cooling losses
- Refinery process line insulation loss or leak detection
- Refinery process evaluation
- Heat exchanger Quality and efficiency evaluation
- Furnace refractory (insulation) inspections
- Furnace Internal flame evaluation and tube inspections
- Flame propagation explosion analysis



Right connection shows hot



Power Distribution Transformer