The Locomotive

Infrared Thermography: Taking the Heat off Faulty Connections

By Sandy Sanor, HSB Thermography Services
The Hartford Steam Boiler Inspection and Insurance Company

Introduction
Infrared thermography surveys. You've probably heard about this high-tech tool used to spot problems in electrical systems and equipment. But do you really understand the process, and the possibilities that infrared thermography surveys offer to improve safety, operations and efficiency?

If not, you're not alone. Hartford Steam Boiler’s thermography specialists often field questions from those who are curious or confused about infrared technology. This article can help you learn more about infrared thermography surveys and how they may help your business, regardless of the age of your equipment. That's right, even new equipment, because age has no relationship to overheated electrical connections.

Advances in Technology
The basic technology for finding temperature differences among various surfaces has been in use for more than 20 years to uncover potential problems in equipment such as electrical switchboards. It has only been in the past several years, however, that the use of this great tool has become so widespread.

Why the increase? Several years ago the U.S. government funded two electronics firms to produce a computer chip for government infrared systems. The technology was released to the various makers of infrared scanning equipment in the past three years. Now, cameras that had been very heavy and bulky because of the need for vacuum tubes, small compressors, or bottles of inert gas have been reduced in size to that of an average camcorder. Not only are the cameras smaller, but the graphic and software capabilities have been greatly developed and expanded.
How It Works
Essentially, the camera is detecting the energy levels from one surface and comparing that level with another surface. These energy levels show themselves as invisible light waves that are part of the electromagnetic spectrum known as infrared.

The camera converts these invisible light waves into a graphic image that is displayed on a monitor. The better cameras provide temperature readings, and store the data so that the image can be used in a software program to produce a report showing the infrared images and the temperature readings of selected areas of the image. Excessive temperature differences are a clue that something may not be operating properly.

Interpreting the Results
Gathering the data is the easy part. The real work and value is what the thermographer can do with the information. As in any form of nondestructive testing, the interpretation of the finding is both an art and a science. The thermographer must interpret the finding in order to provide meaningful information.

The American Society for Nondestructive Testing, Inc. (www.asnt.org) has established a recommended practice, number SNT-TC-1A, in which the Thermal/Infrared Testing Method is addressed. Anyone who conducts thermal infrared scanning on equipment should follow the recommendations outlined in this standard.

The practice addresses the minimum training and experience of thermographers. However, a week in school is not enough. The typical Level II Thermographer, capable of working without supervision, has a minimum of 80 hours of classroom instruction and nearly two years of field experience.

People committed to this field are constantly learning, improving their skills, seeking the latest information, and not taking anything for granted. Check the qualifications of anyone who says they are going to scan your equipment. They should be able to refer you to their company’s written practices program and explain their qualifications.

For More Information
The following are answers to some of the frequently asked questions that Hartford Steam Boiler’s thermographers receive from representatives of business and industry. Further information also is available from the American Society for Nondestructive Testing (www.asnt.org) and HSB Thermography Services (www.hsb.com/infrared).

FAQs
Q: Do I need to shut down my equipment to do this inspection?
A: The plant needs to be operational during the inspection. Fully loaded is the optimum for an infrared scan. A poor electrical connection generates heat that can cause power loss at the connection. The higher the current flow, the more power will be dissipated.

Q: Is a hot spot bad?
A: A hot terminal connection affects your system in various ways:
   - It is a power loss. You are paying extra in your electrical bill for all hot connections. The electrical meter does not care where the power is going, whether to turn a motor or heat the air. Therefore a hot connection reduces plant efficiency.
   - Failure. Most damage occurs when the electrical connection actually fails. The arc that is caused when the
connections separate will melt most metals. A connection that would have cost $200 in parts and labor to repair before failure could cost the owner in excess of $500,000 if it goes to failure.

- Fires caused by the failure of the connection can, and have, destroyed an entire complex.

Q: Aren't all electrical connections hot?

A: Any electrical system normally operates at a temperature slightly above ambient; in some cases well above ambient. Problem connections are in excess of these temperatures.

Q: Why is it hot?

A: All electrical connections and even straight runs of cable offer resistance to current flow. This resistance is a system power loss that is dissipated as heat. This is normal. The electrical connection that is as little as .5 degrees F hotter than the others can be detected.

Q: What does this mean in my report: Phase "A", line side, fuse clip? What am I supposed to do with this information?

A: Once a problem has been identified, it is the responsibility of the facility’s management to assure that a qualified technician makes all repairs.

Q: Say a panel has been in place for 25 years. I don't think it's going to fail. Shouldn't we just leave it alone?

A: Failure due to an overheating condition cannot be accurately predicted. When an electrical connection starts to form high resistance and generate heat, there is no method to determine when it will fail. A connection could be elevated in temperature for two or three years and fail in the fourth year. On the other hand, the connection may never fail.

Q: Our equipment is new. There is no reason to check it, is there?

A: Unfortunately, age has no relationship to hot connections. Poor initial installation has been the cause of many failures.

Q: We can't open the motor starters while they are running. How can you see inside the panel?

A: The panels must be opened to conduct the scan. Most electrical equipment, rated 480 volt and below, has an electrical interlock that allows for in-service testing. Personnel familiar with the equipment will know how to open the panels.

Q: We don't have "electricians." We have maintenance technicians. Who should open the equipment?

A: Qualified electrical technicians who are familiar with facility equipment and have a thorough understanding of safety requirements should be the only people opening electrical equipment.

Q: Can't the thermographer open the panels?

A: Due to liability constraints, many thermographers do not open or even touch a customer’s equipment. Some companies that conduct infrared surveys employ licensed electricians who are also thermographers. However, if the thermographer spends time opening panels, the cost of conducting the scan increases. The optimum situation is to have one or two of the plant's technicians opening panels ahead of the thermographer with another technician closing the panels after the scan. Infrared scans are very swift since the image can reveal almost immediately if a problem exists.
**Q: Can you scan anything besides the electrical equipment?**

**A:** Most surveys will focus on electrical systems. However, the infrared camera can be used on any equipment where a heat profile would provide significant data. Some examples are:

- Electrical motors, switchboards, breakers, bus bar, transformers
- Fired vessels’ refractory such as boilers, kilns, ovens and furnaces
- Bearings and mechanical couplings
- Heat exchangers, cooling coils, steam traps, piping and vessel insulation

**About the Author**

Sandy Sanor is the director of HSB Thermography Services, which provides infrared thermography at facilities around the world. He holds a Bachelor’s degree in Business from St. Louis University and is a member of the International Society of Optical Engineering. Sandy joined The Hartford Steam Boiler Inspection and Insurance Company in 1974.