

How to Reduce Data Errors on Infrared Surveys

By: Harley Denio

Over the last couple of decades, there have been many changes to infrared (IR) imagers and ancillary equipment that make thermographic data gathering and processing easier and more accurate. Over the past 16 years as an infrared thermographer (6 years in-house and 10 years as a contractor) I have performed inspections on a wide array of applications and captured over 100,000 IR images. During that time, I have run across many examples of common problems in gathering accurate data which I call 'data errors'. Below, I will illustrate some lessons learned and I hope to help thermographers avoid some of the same mistakes that I have made.

Every time a thermographer goes out into the field to perform a survey, the conditions are different. You could be in a factory that has highly loaded, heat generating equipment all around or in an office building that has only one mechanical room on each floor with lightly loaded equipment. You could be scanning all day on the roof of a complex looking at A/C units on a sunny day or in a computer room that is air-conditioned. Different types of electrical equipment (fuses, contactors, breakers, load, etc.) have different heat signatures and require consideration on an individual basis for accuracy. Every situation requires the thermographer to look around at the surrounding environment and make a judgment as to what special conditions might exist, and how to gather the data accurately.

Below, a guide for proper data collection procedures and examples of what you should remember during a survey.

General Thermography: Setting up the Job

- **Camera Set-up**

Set as many parameters at the job site as possible and practical:

- Atmospheric temperature setting
- Background temperature
- Emissivity of targets
- Distance to target

These are all done on the camera and should be addressed at each change of environment, for example, going from inside to outside of building.

- **Safety**

- When doing work around electrical equipment, wear all necessary personal protective equipment as required by NFPA 70E.
- While scanning, always take a look around, above and below and change positions.
- When looking through a viewfinder, keep the other eye open.
- Never work alone if you can help it.
- Don't wear things hanging around you when working around rotating equipment, like the lens cap, ID tags, hanging clipboard, etc.
- Don't wear rings or any conductive jewelry around electric devices.
- Always carry a means for communication such as cell phones, radios, etc.
- If you have to scan from a ladder, have an assistant hold it steady.

- **Data Gathering**

- Talk to end-user about any special safety hazards.
- Talk to end-user about any recent failures, like leaks, tripped breakers, failed motors, moisture in the building, bad recent storms, etc.
- Use a PDA or laptop for data entry. Use paper only when necessary.
- Don't rely on your memory. Always take the time to enter data before moving to the next area, when making the scan list or recording exception temperatures.
- Start and keep an 'accumulated images' file on the computer and save every image that you take (thermal and visual). This is for backup & archival purposes.
- Get a very good photo camera and set it to a high mega-pixel setting. Do not use the visual camera on the imager for making reports. It is extra work-but worth it for the better detail and archiving images that can be zoomed-in for details later.
- Make sure all batteries needed for the job are fully charged.

Electrical Scanning: General

- Wear the safety gear:
 - Minimum (when not near the equipment) is a hard hat, safety glasses, ear protection when required, and protective boots.
 - Minimum (when removing covers) is mandated by NFPA 70E.
- Be a licensed electrician in the state you are working in before removing any covers.
- Observe that all screws are in place before removing any covers, especially on electrical panel deadfronts. Otherwise a slipped cover can cause injury, or a tripped breaker.
- Look for burned wires visually. There may have been a problem in the past, but there is no load at the time of scanning and no heat signature.
- Form an exit strategy when entering an area in case of any problems.
- Use all your senses for any indications of problems. Smell the heat, hear the failing motor, see the arcing connection.
- Remove all jewelry when working around electrical and mechanical equipment.
- Do not reset any tripped breakers without communicating with customer.

Electrical Scanning: Data Errors

- **Reflections**
When scanning highly reflective [low emissivity] targets such as bus bars, be sure to change your angle to eliminate the reflections on the image. The reflection could be from your body heat, or some other heat source in the area -a piece of machinery, light bulb or a transformer. Reflections will give you incorrect data in the thermal image, and if not understood, it is a data error.



Figure 1 - Reflection of transformer in panel

- **Mismatched and Wrong-sized Fuses**
Sometimes in facilities maintenance work, a piece of equipment will cause a fuse to fail and it needs to be up and running right away. Maybe it continues to fail regularly and becomes a nuisance. Often the repair personal will rummage through a box of spare fuses and install a fuse of the same size amperage rating, but of a different brand and fail setting. Also, when a piece of equipment fails regularly [due to a PROBLEM], the maintenance person might install a fuse of the next size up in amperage rating from proper rating, just to make the problem go away. I'm not saying this is right - but that it happens and often! Fuses installed this way have a particular heat signature and can be found with infrared thermography. If the fuse is too large, it will read cool as compared to the others in the group. If it is too small, then of course it will read warmer than the group. If there is a different trip setting in the mismatched fuse, it will have yet a different heat signature.

- **Trip Sensors**

Trip sensors are electric devices in breakers that measure temperature or amperage in the device, and when it reaches above the set limit, the breaker trips. These devices put out a particular thermal signature. It is common data error, often misdiagnosed as an internal problem inside the breaker. GFCI breakers and GFCI receptacles also have a similar heat signature.

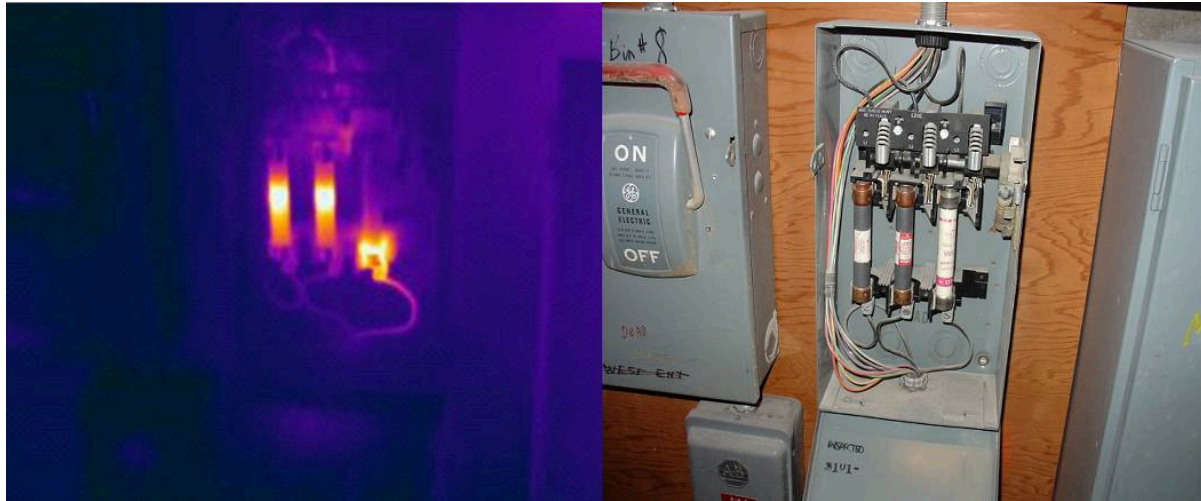


Figure 2 - Mismatched and wrong size fuses

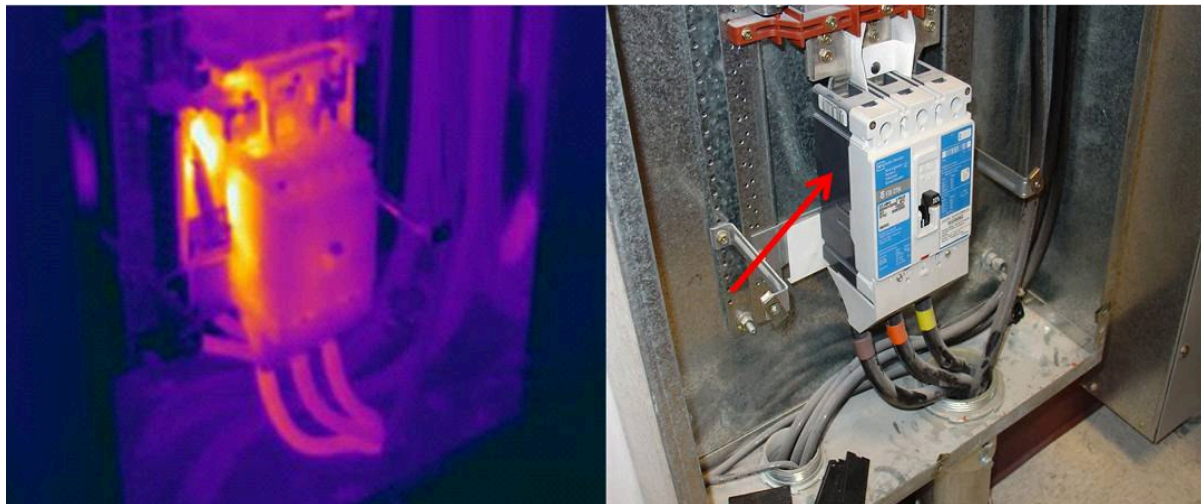


Figure 3 - Trip sensor on a molded case breaker

- **Bad Photo Angle**

When taking thermal images, make sure there is enough view of the surrounding area to help find what component is being identified for attention. Always take the thermal image and visual image from the same angle and distance. This will help the end-user return to the same place when repairs are to be done.

Outside Scanning: General

The weather affects all forms of infrared thermography. A big issue in electrical scanning is the effect that different ambient conditions and solar loading has on the components. Move around to note solar reflections. If it is windy and a fuse disconnect enclosure is opened, there is little time before the

convective cooling effect of the wind cools the connections and accurate temperature data becomes elusive. Be ready in front of the component, camera running, in focus and imager settings set before opening the box to be sure to gather the most accurate temperature data.

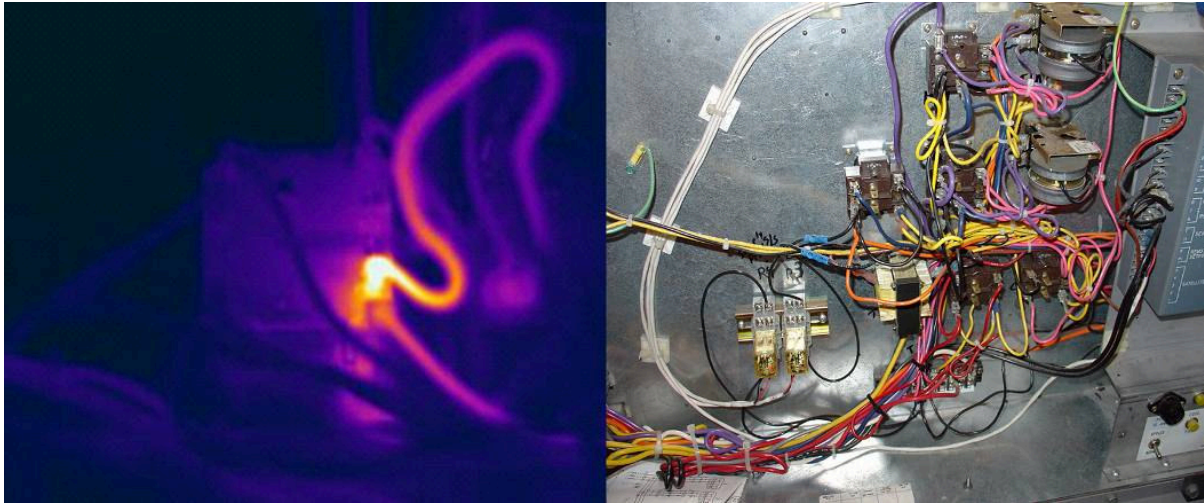


Figure 4 - Bad photo angle

Utility Scanning: General

Scanning utility lines in the rain or snow is really just a washout. Unless the utility company wants to push on with the survey (which does happen), it is best to wait for better conditions. Here in the Pacific Northwest, the saying is “just wait 5 minutes or 5 miles...the weather will change”. This is so true and here we may just wait a short while or travel to another substation. Here are few considerations:

- Always go into substations with an experienced assistant who works for the utility. Going in alone is asking for safety trouble.
- Don't wander around the yard. Stand where the most experienced person is standing.
- Do not point at components (it makes you a good path to ground).
- Ask for a description of each component that is found to have exceptional temperature signatures. Every utility company will call equipment by different names and have different switch nomenclature.
- Wear appropriate safety gear.

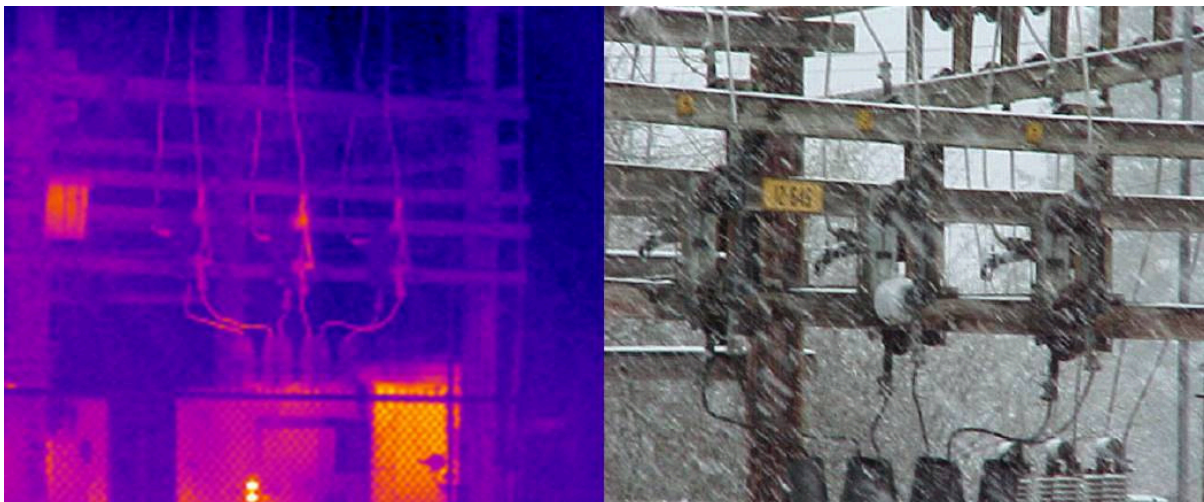


Figure 5 - Weather can cause signal attenuation

Roof Scanning: General

For roof surveys, special attention must be given to various factors such as composition of roof material, type of decking, age of roof, the environment below the roof, and the weather conditions at the time of scan and as much as 48 hours prior to the survey. Ignoring these factors can result in inaccurate information, which may result in problems that are missed or non-existent issues which look like problems but really are not. Either way, the result may incur an unwanted or surprise expense to the customer.

Roof Scanning: Equipment

- Use a mid-wave camera (3-5 microns) if at all possible.
- Bring an assistant...always. His/her job is to make marks on the roof of areas of suspect moisture intrusion and more importantly, to watch out for the thermographer so that no injuries or damage to roof happens.
- Walk-on roof scanning requires a 10-foot ladder. This allows a better angle when looking for the spots. A flat board should be used under each foot of the ladder to reduce damage to the roof.
- Bring fluorescent red, orange or yellow marking paint and plenty of it. Use the 'dashed line' method of outlining areas. This minimizes paint use and roof impact.
- Bring flashlights and lots of batteries. The head-mounted types work well.
- Bring a laser pointer. Many cameras have laser pointers built-in and are a useful tool. But be aware that the pointer does not always get the assistant to the exact spot of interest that you are seeing in the camera. It is usually best to track the assistant's foot to the first corner of the area that shows wetness, then proceed to outline the area.
- Mark each area with a distinctive numbering system using the spray paint. Spray the number just before taking the thermograph and the image saved will contain the number thermally, because the aerosol in the can comes out cold.
- Make sure all batteries are charged.

Roof Scanning: Data Errors

- **Solar Loading**
As the Sun goes down in the West, the flashing and stem wall on the East side of the building will remain in the Sun longer, therefore the IR image will show an elevated thermal signature early in the night. This is important, because some of the roof will be ready to scan for moisture while the East stem wall is still cooling off. Don't mistake this for subsurface moisture.
- **Debris on Roof**
Stains, dirt, leaves, and other debris usually accumulate in corners and roof drains as the wind blows them around the roof. As the Sun goes away, this debris will retain heat longer than the rest of the roof and can lead to a common data error.
- **Interior Environment**
Make sure you know what the environment under the roof decking is. There may be a boiler room or mechanical room that is producing heat and will show up as a heat signature. (The arrow in figure 7 points to the heat signature of a mechanical room and not a problem.)
- **Uneven Gravel**
Some roofs are ballasted with gravel. Uneven installations, and as time goes on, the gravel gets kicked around or pushed into piles to facilitate repairs. This material will retain its solar load well into the night when scanning for roof leaks. Once again this is a common data error.
- **Mechanical Equipment**
Often there is mechanical equipment on the roof that you are examining. If it is a type that pushes air from the interior of the building, like an exhaust fan or a roof top a/c unit, the air that is exhausted will usually be warmer than the outside environment, thus creating a heat signature on the roof. This is another potential data error.

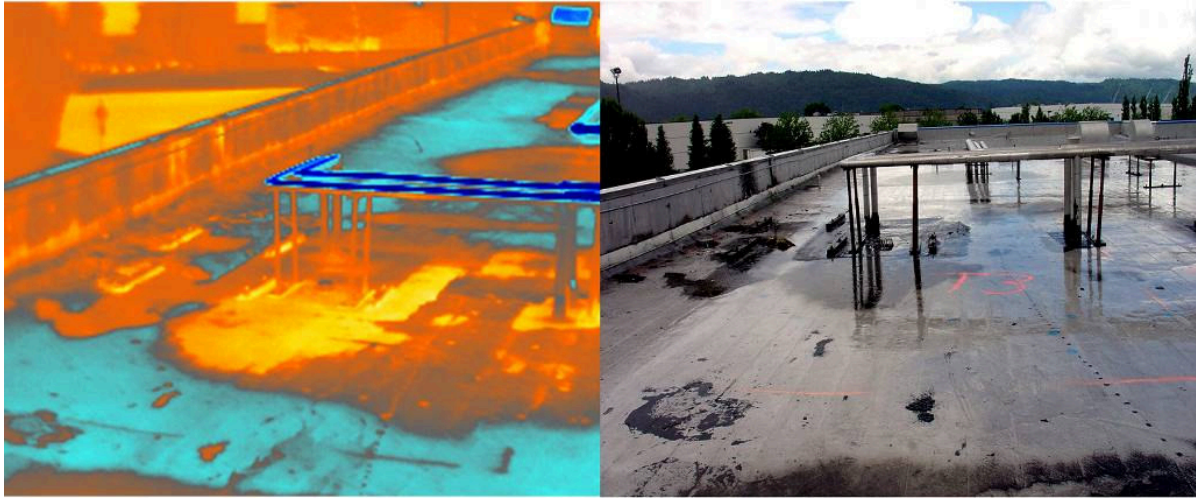


Figure 6 - Debris on roof and solar loading at stem wall

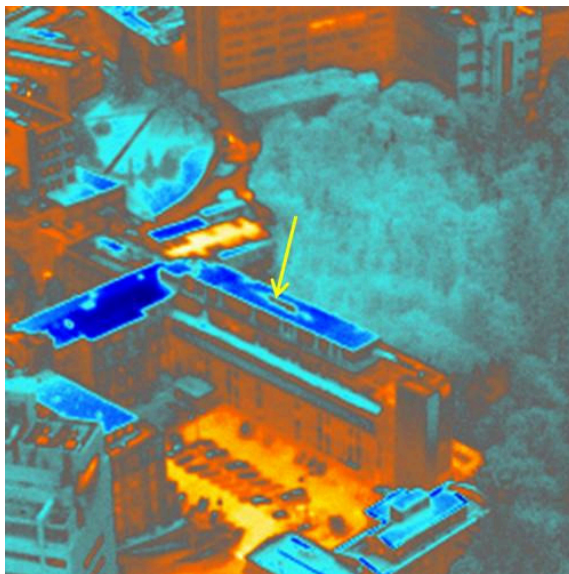


Figure 7 - Mechanical room below roof

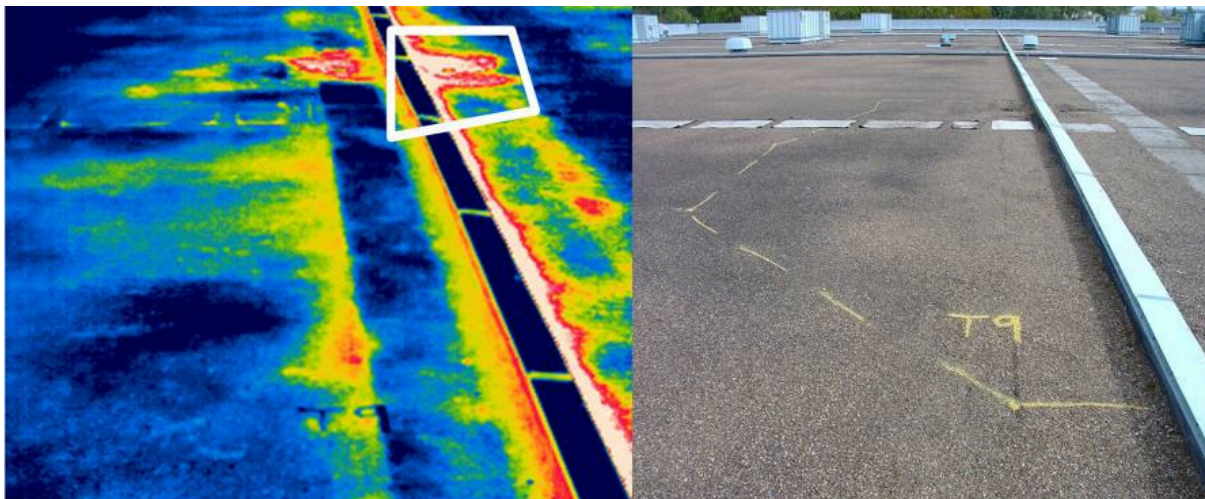


Figure 8 - Thick coating of gravel on roof

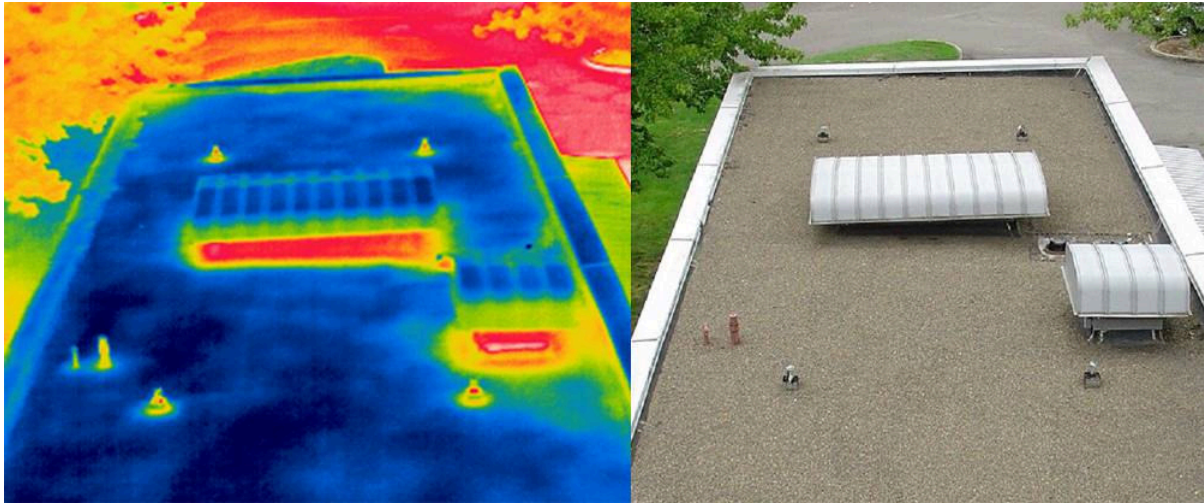


Figure 9 - Mechanical equipment venting warm air onto the roof surface

Building Scanning: Data Errors

Building energy loss and residential inspections for moisture are the fastest growing segments of the infrared thermography field today. This discipline has its own set special conditions. Understanding the effects of weather, the thermal characteristics of building materials, insulation type & quantity are all-important factors in gathering good data.

Conclusions

It's been said at many a thermography training class, that it is important to eliminate all of the bad data that is gathered when taking an infrared image, to get to what good information is available. Infrared thermography is a great tool for finding hidden problems. You just have to know what to look for...and what to ignore.

Author Biography

Harley Denio is President of Oregon Infrared, a full-service infrared service provider based near Portland, OR. He is a Level III Certified Infrared Thermographer and a Licensed Supervisor Electrician. Mr. Denio speaks at infrared seminars and has published four technical papers on infrared thermography. He can be contacted by email (Harley@OregonInfrared.com), by telephone (503) 680-4550, by writing to: Harley Denio, Oregon Infrared, PO Box 6252, Aloha, OR 97007 or by visiting www.oregoninfrared.com.