

INFRARED THERMOGRAPHY

An Infrared Contractor Promotes Spot Radiometer for P/PM Programs

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INTRODUCTION

Infrared Predictive Maintenance (IR/PM) activities, especially as they relate to predicting electrical/mechanical systems equipment failure, are increasing in popularity. This is in no small part due to the efforts of the IR industry to educate engineering and maintenance department managers as to the advantages of predicting, and subsequently preventing, problems from becoming system failures by using infrared thermographic equipment and/or contract services. However, many companies and plants have failed to achieve what they really need: An extensive and effective Infrared Predictive Maintenance Program. One "Hot Spot" survey per year does not make a successful infrared program. The annual survey of equipment, regardless of whether the imaging is performed by a contractor or by an in-house group, should only be a part of the program. For a program to be effective it must be accepted by management as well as other maintenance personnel. Getting other maintenance people involved in Infrared Thermography is a good way of gaining acceptance not to mention the fact that, more people scanning equipment will find more problems, more quickly, resulting in payback more quickly for the plant. This paper discusses the approach which I am implementing with varying degrees of success at my client's plant sites and which could be implemented in plants with existing IR imagers. In the past, I have considered my services a very valuable part of my client's maintenance activities. They have obviously concurred, since I have returned to their facilities year after year. However, when I left a site, I was leaving with the only means of performing infrared testing. Now, I see my role changing. My goal as an infrared thermographer is to report potential problems on their critical electrical/mechanical systems prior to failure in a timely and cost-effective manner. However, there are two problems:

- 1) I do not inspect everything that needs to be inspected. While performing infrared surveys, we literally walk past hundreds of pieces of equipment that are in different stages of failure. But, we have been given a limited number of hours or days to check critical systems, so we pass by this equipment.
- 2) There is nothing remedial about infrared thermography itself. Sometimes repairs are either not made or not correctly made. In some facilities I report the same problems or

types of problems on the same pieces of equipment year after year. To address these two issues, I have set out to provide my clients with what they need: The start of (or at very least the chance to start) an effective IRIPM Program where my services are a part of the overall program, but not the program itself.

A LITTLE HISTORY

I performed infrared surveys annually or biannually at sites ranging from small office buildings to steel mills. I would perform a survey, make a report and present it to my clients in person the next day. I did this, and still do, for several reasons:

- I need to personally make sure that they are happy with my work and get feedback on how I can improve my operation.
- I need them to understand everything in the report, especially the seriousness of the findings and the importance of what was not found.
- I want to transfer the liability for making repairs and trending the temperatures of equipment to the client.
- I want to be 100 percent finished with the job when I leave.

The feedback that I have received has been favorable and positive, but I wanted constructive criticism about my procedures and the accuracy of my diagnoses, which for the most part had not been forthcoming. In the past I have gone back to check repairs as part of the original contract or as a separate contract on an as-needed basis. This is not cost-effective because it costs almost as much to schedule and perform a reinspection of a few items as it does to perform the original survey. I decided that reinspections were not the answer to improving my service. Furthermore, I noticed that a lot of problems were being repeated survey after survey. I couldn't understand what was going on until, while performing an annual survey for a client, I realized that I was making the third thermographic report on the same starter in as many surveys. It was identical to the two previous thermograms! This caused me to ask some serious questions:

- Why hadn't they fixed this problem?
- Were my thermographic reports being ignored?
- Was the maintenance staff not properly trained to make the repair?
- Was I misdiagnosing the problem?

First, I was misdiagnosing the problem. I had twice before reported a loose connection on the line side lug connection on Phase C. The first time, the electrician had tightened the lug. The second time, the lug was disassembled and cleaned. Now, it was still hot. As it turns out, the contacts in the starter were damaged and the heat was being conducted up to the lug. My lack of familiarity with that piece of equipment could have caused it to fail, which isn't good for my business or for the credibility of any IR program. I realized that the plant had no way of checking the lug temperature after they made a repair once I left with the scanner. I pulled out my spot radiometer, handed it to the electrician, and he verified the delta-T. I thought I had the answer to the problem of my clients checking repairs without exceeding their imaging services budget or breaking my finances by making free return inspections. All I had to do was convince my clients to purchase a

spot radiometer; then, they could check the repairs themselves and trend temperatures on other equipment. So, for a year or so, whenever I made an inspection, I would work with the electrician during the survey with my spot radiometer and talk with my clients about the advantages of them owning one. Unfortunately, I soon found that allocating a few hundred dollars to purchase an instrument, or finding their spot radiometer and installing fresh batteries in it weren't problems for the plants. The problems were:

- They did not know how to use a spot radiometer.
- They did not have a plan for using it.
- The management was not sure they wanted to spend the time and the money using it.
- Some were not even convinced that they should be using it.

WHY NOT AN INFRARED IMAGER NOW

It may seem that the obvious solution is for each and every plant to own and use an infrared imager. This would be an ideal situation, if a program was actually developed rather than the standard annual survey. However, there are a number of problems a plant must overcome to purchase an infrared imager, not to mention the implementation of a complete IR program:

1. Lack of in-plant data to justify the expenditure for prevention of downtime. They do not have real proof that it works.
2. Lack of in-plant data to justify the expenditure for unproven, but possible process improvements. Even less proof is available that it really works.
3. Unknown and ongoing cost for personnel including training, salaries, etc.

WHY A SPOT RADIOMETER NOW

Back to my original premises. I am trying to help my clients and improve my services to them by taking them to true predictive maintenance status. Let's look at some terrible truths:

- The preventive maintenance program in many plants is inadequate, and in some cases nonexistent.
- Plants need a good predictive maintenance program to:
 - A) plan preventive maintenance activities, and
 - B) collect data to become proactive with their maintenance.
- Plants don't have the time to perform PM's in-house, because they are reacting to problems, instead of predicting them, and then preventing them. To get out of the vicious reactive maintenance circle, they are going to need a larger budget. In order to obtain a larger budget, they need tangible evidence that the program will pay. In the meantime, they are going to have to continue "putting out fires," while constructing a workable plan within their present budget to have a starter IR program prove itself on its own merits. More terrible truths:
- Many plants really need an imager, but can't justify buying one.
- They don't have the budget to hire it out full-time.

- They have a limited budget for contracting infrared thermography.
- It is not cost-effective for a contractor or in-house thermographer to inspect everything in the plant.
- It is not cost-efficient for a contractor or in-house thermographer to reinspect all repairs within a plant.
- A plant can get a spot radiometer, but not have a plan of action for using it. What many plants need is a starter program that will lead to justification for purchasing an imager and the investment in human resources for the implementation and administration of a more advanced program. This is why I now promote a starter IR/PM program, using a spot radiometer. They can afford one. I can help them learn how to use it by including a seminar on IR basics and the use of a spot radiometer in my presentation after a survey is completed. They get some experience with IR, have some documented successes, and prove to management that they should get a more advanced piece of equipment. I can help them do these things.

A MEANS TO AN END

First, I can get management's attention by doing an excellent infrared survey. The survey report has to impress not only the engineering staff, but also middle and upper management. Typically, these people come from operations, marketing, sales, or human resources; not engineering backgrounds. I have to make the reports understandable to management and usable to engineering at the same time. To accomplish this I:

- make an extensive, detailed equipment list.
- make an 8mm videotape of everything that I inspect, whether or not there is a problem and provide a VHS copy.
- print full-color visuals and infrared thermograms on thermographic reports, typically four or five prints for each finding. I do this to give perspective to the visual photographs and infrared thermographs.
- copy the spreadsheet file and give them a diskette.

Second, I can get the maintenance staff excited about infrared thermography. This is extremely important. I treat everyone with respect. I listen to their complaints about the plant management and then challenge them to change the way things are done. From the chief electrician to the panel cover-removers, I explain what we are doing and why. I want these people to insist to their boss that they attend the seminar that I plan to put on at the end of the job. Third, I can get them started. They need to get off on the right foot with a few successes. These are easy to find like that corroded starter panel that was not operating when I was there because the machine was down. They can send someone to check it when it is operational. Also during the survey, I usually hand the spot radiometer to a helper and have him check the temperatures of a bunch of small, like operating motors that are in a row. He will come back in 10 minutes, having found a surface winding temperature in excess of 200 degrees F. This, I tell him, is the beginning of his company's infrared program. He has just found a problem before failure, without me or my imager.

REPORT PRESENTATION

Key to successfully setting up a starter program is for every one to be in on its inception. I will have the report presentation at the beginning of the seminar. Hopefully at this point, I have peaked the plant personnel's interest in infrared thermography. I review the report with my attention aimed at the client, the managers, and the electrician (who accompanied me on the survey). Then, I try to very simply explain the theory behind IR to the managers. Toward the end of the report presentation segment, I will show the manager something that I found totally unrelated to electrical or mechanical devices, usually a loose thermogram of something maybe related to production or the processes which he can take with him. This gets them thinking of other uses for IR.

HOW THE CONTRACTOR BENEFITS

I believe it is good for my business to continually improve what I am doing for my clients. I am not about to ignore obvious problems, such as repeat problems or failures on equipment that could have been saved by infrared thermography, even if I am not getting paid to find them. My business lives by favorable word-of-mouth advertising. People network. For every client I lose to an in-house program, I will get two or three new accounts. I believe two factors will come together to benefit my clients over the next few years:

- (1) Prices will come down on infrared equipment. I still have a Texas Instruments calculator that I bought in college for \$75.00. A calculator with more functions can be obtained for \$12.50 today.
- (2) My customers will be ready to take advantage of the price decreases because they started an Infrared PM program, with my help, today. (Editors Note: A new infrared imager was recently released with focal plane array technology, a promise of radiometrics in the future and a price of less than \$10,000.) Also, I may get to work on a research project, as a direct or indirect result of an off-hand comment or a thought that someone had while I was presenting my report or putting on a seminar. There is another less tangible, but nonetheless important reason for me going to these lengths; it keeps me challenged and interested. Reviewing IR theory and its applications weekly is good for me. My thoughts are jelled by having to speak and make sense to these people.

MIXED REVIEWS

Because of the diversity of my clients' operations, different corporate structures, geographical and political make ups; one standard formula does not seem to work for all. I have had different results with virtually every plant. Even with different plants in the same division, the results vary. In preparation for this paper, I spoke with many of my customers about how they are progressing and following are their comments:

- All were pleased overall, with my work
- All said that using a spot radiometer was a good idea.
- None thought that they had taken the program as far as they would like.
- None thought that they would have an imager within a year. · Only a few had not purchased a spot radiometer.

- Only one said it was a waste of time to have the seminar.
- Many thought that I spent too much seminar time on program development, and not enough on how to use the device itself. (More about this below)
- Several were using the spot radiometer on their processes.
- Most had checked to make sure that their repairs were made.
- Most found that some of the repairs were not correctly made.
- All, that were trying, had tangible successes! I consider how to use a spot radiometer to be a detail, far less important than program development and what to inspect. First, they have to know Why (have a program), What (items to include in the program), When (frequency of inspection), and Where (areas of greatest potential improvement). Then, we can worry about How to get repeatable temperature measurements. Infrared Thermography has a big advantage over other predictive technologies as it is immediate, graphic, and relatively easy to understand. A successful IR/PM program can be a springboard to justifying other PM programs. They will be using these technologies in the future, I want them to think of me as the catalyst for taking them to true predictive maintenance status and eventually proactive maintenance. I encourage them to use other predictive technologies like vibration for motors and drive systems and ultrasonics for steam and air systems.

CONCLUSIONS

Infrared Thermography is a useful tool for predicting failure on electrical/ mechanical equipment. All this equipment has one thing in common, it dies a death of heat. When failing, this equipment may have an increase in work, it may vibrate, it may make noise, but it always heats up. The methodology for finding problems before they become failures is being refined by users in the industry. The main problem with an IR/PM program, and indeed predictive maintenance in general, is that it works only when used to plan preventive maintenance activities, such that these activities are carried out prior to equipment failure. I am trying to help my clients to predict failures on all of their equipment, not just equipment that I report as having thermal anomalies. With this in mind, I bring to their plants the next best thing to me being there full time. That is, a starter program for them to take Infrared Thermography in their plants as far as they see fit.