Periodic Infrared Inspection Best Practices: Route-based Surveys

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ABSTRACT

Infrared thermographic inspection is an established PdM inspection modality. Recent advances in infrared camera platforms have created a new class of infrared imaging instrument which incorporates pen-based computing and application specific software into a powerful thermal inspection data logger with many traits similar to mature vibration data collection systems. The potential impact of this integration on productivity, thermography program ROI, training and integration of thermal inspection data with CMMS systems is described and presented.

KEYWORDS: Infrared imaging, thermography, infrared surveys, route-based maintenance, asset database

Introduction

By adopting a route-based thermography approach along with an in-camera database and intuitive data logger PdM users can save time, get more consistent results and dramatically improve their thermography program return on investment (ROI).

Beginning in the late 1960's, thermal imaging was limited to power line and substation inspection of overheating electrical connections. Those systems were bulky vehicle-mounted systems that cost perhaps as much as $500,000 in today's dollars. While these systems offered for the first time an easy and intuitive method of identifying connection problems, these systems could not measure temperature or digitally record images for later analysis and reporting. The worldwide market in 1970 for infrared cameras was less than 50 units. Today the market for infrared cameras used for maintenance inspections is projected to exceed 18,000 cameras. Thermography along with vibration monitoring, oil analysis, laser sighting-based rotating machinery shaft alignment and ultrasonic testing have become the toolset used by maintenance departments at an ever increasing number of capital intensive facilities.

Today's operations manager is under tremendous pressure to increase asset availability, decrease costs, deal with employee skill levels and turn over, safety regulations, ISO quality compliance and an ever increasing competitive environment. A new class of thermography data collectors is now available designed to create and follow user-created routes, capture in-the-field incident details and automate report generation and run database synchronization. By adopting a route-based thermography approach along with an in-camera database and intuitive data logger, PdM users can save time, get more consistent results and dramatically improve their thermography program return on investment (ROI).

CMMS Isn't Route-based Maintenance

The dilemma is that the CMMS provider does not think in terms of route-based activities at all. Their systems are driven by work orders. If each inspection is given a work order number, you can do the inspections in a route documented with more than 250 work orders. First of all, this is impractical for the person doing the inspections, and secondly, it will require a lot of time for someone to close all the work orders.

Another way route-based activities are performed in a work order-driven CMMS is to give each route a work order number and describe each inspection in a sub-work order. This still creates complications and administrative time. A third example of how some plants try to document and administer route-based activities is to give each route a work order number and have the route documented in a spreadsheet. Again, the dilemma is that this method will not support effective routes and will make it more cumbersome than necessary to change the content of inspections, transfer tasks to operators, change frequencies, merge mechanical and electrical inspections, and so forth. All of these activities are frequently done if you have a good system implemented.

The solution is, therefore, to have a standalone system for route-based activities. Even in a time when it seems like all activities must be integrated into one company-wide system that covers everything, the best solutions can still be standalone systems. There are very few things—if any at all—in a route-based system that need to be tied with other activities. Therefore, you can very well buy a standalone system for this activity. A single-user system that can do this well is not expensive.

Pen-based Computers Simplify Field Data Collection

The pen tablet is the most widely used device to be deployed in field applications because of the versatility of its interface, its touch screen for data input and significant memory capability.

Pen tablet computers allow the technician to collect infrared inspection data, perform temperature analysis, diagnose the problem, evaluate their urgency, suggest corrective actions and capture a visible reference image. Powerful handheld, pen-based computers are now integrated into infrared cameras that provide a field technician performing on-site inspection and maintenance all the computer power needed to do the job swiftly and efficiently—whether it is integrating their operations with the computerized maintenance management system or testing, diagnosing, and repairing equipment on the spot.

HANDHELD PEN COMPUTERS

For industry and the military, the problems with using laptops in the plant or the field are being solved by handheld pen-based computers—a pen tablet or a personal digital assistant (PDA). To date, the pen tablet—almost as powerful as a laptop but smaller and lighter—has become the most widely used device to

be deployed in field applications because of the versatility of its interface, its touchscreen for data input and significant memory capability.

The HotShot HD infrared camera by Electrophysics incorporates a tablet PC processor running on the Microsoft Windows CE operating system. The touchscreen features direct-function icons large enough for finger actuation and additional data-type features like file naming using a stylus.

Stylus Input for Data Entry

Finger Control Over Camera

Familar Windows GUI

Simple Icon-based GUI

Stylus QUERTY Keyboard

Large Direct Function Buttons

More reliable data is obtained. Error-prone, handwritten records are replaced by reliable data, automatically gathered, stored, and consistently available throughout the enterprise. Record keeping costs are reduced. Less paperwork lowers administrative overhead because data is processed more efficiently and disseminated widely without producing redundant copies—or even any printed record at all.

Decision making is faster and more cost-effective. By integrating real-time field reports with the computerized maintenance management system (CMMS), managers at all levels share complete, up-to-the-minute information, and can react quickly to

changing field conditions or emergencies. Condition monitoring tests involving a number of parameters—vibration, heat, oil quality, pressure—can be compared quickly to confirm impending problems before they become catastrophic.
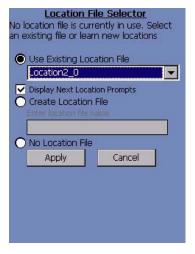
DATA COLLECTION

Maintenance starts with knowing what is going on—how equipment is operating, what increased stresses are being applied, how conditions have changed. Data must be collected, either by a remote monitoring system or by workers on-site. In the latter case, the handheld computer makes data collection faster, more accurate, and more flexible.

Route-based Infrared Inspection

Many PdM technicians are familiar with, or are users of, route-based vibration data collectors. Many of today's vibration instrument vendors provide software tools on both a PC platform and their portable vibration data collectors to organize and create route instructions that are uploaded into portable systems that assist the user through a series of inspection points. For example, Electrophysics' HotShot HD is the first infrared camera of its kind to integrate route logic and all the necessary interfaces to create routes and capture all the inspection details within its pen-based computer with in-camera data logger. The camera features two route programming modes.

Mode 1: Learn Route (on the fly)

Mode 2: Follow PC-created Route

MODE 1: LEARN A ROUTE

At most facilities it is advantageous to create a route file by simply walking along and entering each point according to the natural flow of how equipment is laid out and to optimize any support labor or the need to comply with safety regulations such as personnel protective equipment (PPE) policies. At each point the operator captures a reference image and enters location and equipment detail. At the conclusion of the walk/learn route creation the route log file is uploaded into the PC database application for editing and to add any additional information desired.

MODE 2: CREATE ROUTE FILE IN PC AND UPLOAD TO CAMERA

In this mode the user populates the thermography asset database with data exported from a CMMS system or with new data records and creates a route by selecting files in order of intended inspection sequence. A route log file will be created and once uploaded to

the camera will pull all relevant data sets into the camera. On-screen prompts will direct the user from point to point. An additional feature enables the user to add a point not on the current route and then synchronize the updated route log file if the new inspection point is intended to be included on a recurring basis.

ROUTE PROMPTS GUIDE DATA COLLECTION

Once a route is created and uploaded to the camera, the camera presents prompts to help guide the user from point to point. It is possible to add descriptive information that gives the inspection some level of instruction about the point.
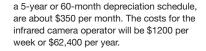

Benefits of Route-based Inspection Practices

• Best possible organization of infrared inspection program.

• Optimize manpower planning.

• Inspection program will grow manageably with the consistent use of route tools improving productivity after each inspection cycle.

• The highly interactive route guidance will facilitate field implementation and reduce problems due to operator turnover and lack of elaborate cross-technology training programs.

• All collected data will be consistently formatted. For example naming conventions will be easier to adopt.

• Automation of report generation yields detailed reports showing locations, equipment, diagnoses and recommended actions without the need for additional editing.

• Integration of thermography programs with CMMS databases.

RETURN ON INVESTMENT

In order to fully appreciate the impact of a comprehensive software suite (asset database, route management and report generation) we have constructed an analysis of costs of a thermography program and the potential improvements that can be realized with highly integrated in camera and PC host software.

For this analysis we will make the following assumptions:

1. The cost of camera and software is $20,000[1]

2. The burdened hourly salary of an infrared technician is $60 an hour or about $125,000 per year.

3. The technician uses the infrared camera 50% of the hours worked.

4. The thermography program documents 20 incidents per week or about 1000 per year.

5. The camera is a capitalized asset and is depreciated over 5 years

[1] The monthly costs for the camera, based on a 5-year or 60-month depreciation schedule, are about $350 per month. The costs for the infrared camera operator will be $1200 per week or $62,400 per year.

Thermography Program Costs					
Costs	Capitalized	Hourly	Weekly	Monthly	Yearly
Camera	$350/month			$ 350	$ 4,200
Operator (20 hours/week)		$ 60	$1,200	5,000	60,000
Total Program Costs				**$ 5,350**	**$ 64,200**

Productivity Software Suite Savings					
Costs	Capitalized	Hourly	Weekly	Monthly	Yearly
Camera	$350/month			$ 350	$ 4,200
Operator (16 hours/week)		$ 60	$ 960	3,840	46,080
Savings			**$ 240**	**$ 1,160**	**$ 13,920**

- Yearly savings of nearly $14,000 can be realized
- The ROI on productivity tools is very high since they are integrated into systems available for less than $20,000.

As you can see, while the cost of the camera is a significant consideration, however the cost of the operator is a much more significant investment. In addition you should expect overall program quality to improve with productivity software organizing and driving your infrared inspection program.

Comparison of Point and Shoot Style Cameras and
Pen-based Tablet Inspection Systems

Point and Shoot Thermography

Step 8.
Send Report
1. Email
2. Mail
3. Walk over

Step 1.
Plan Day's Work

Step 2.
Create Inspection List
1. Paper List?
2. New items
3. Confirm repair status

Step 7.
Generate Report
1. Place IR image
2. Place visible image
3. Enter written notes about
   equipment and condition

Step 3.
Inspect Points

Step 6.
Analyze Data
1. Temperaure analysis
2. Determine severity
3. Make repair
   recommendations

Step 4.
Record Incident
1. Record IR image
2. Record visible image
3. Make written or voice notes
   about equipment condition

Step 5.
Transfer image
files to PC

FIGURE 1

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Route-based Thermography

Step 1.
Create Inspection Route

Step 2.
Inspect Points on Route
• Follow prompts
• Follow instructions

Step 6.
Send Report
1. Email
2. Mail
3. Walk over

Step 3.
Record Incidents
1. Analyze problem
2. Record IR and visible images
3. Add incident detail
   • diagnosis
   • repair suggestion
   • assign severity code

Step 5.
Generate Report
1. Select image records
2. Select report layout
3. Select inspection summary detail
4. One-button "Make Multiple-Page Report"

Step 4.
1. Download route data set
2. Synchronize camera and PC asset database

FIGURE 2

Conclusions

The largest cost in a thermography inspection program is the camera operator/technician. By focusing on incorporating advanced features including route management and in camera data logging operators can dramatically improve their programs efficiency and cost while improving work quality and ease operator training demands.

Ongoing developments to integrate infrared inspection data into CMMS and asset performance software systems will result in the next step in convergence on the plant floor and continue the development of new and innovative solutions designed to improve overall facility operation and capital equipment availability.

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