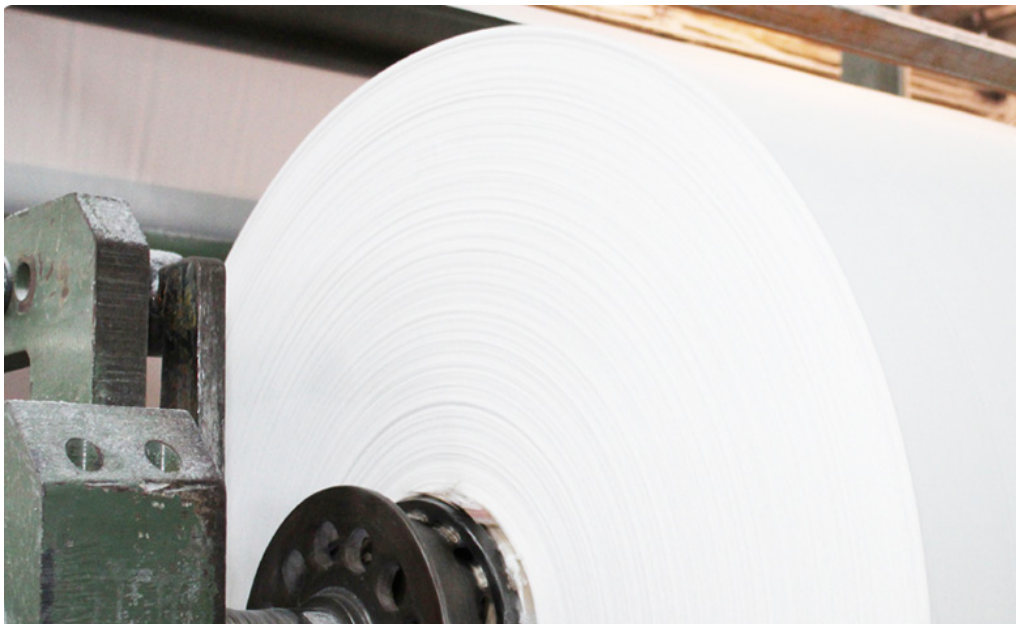

Paper Mill Grows RCM Program With Savings Developed From IR Window Program

By Martin Robinson, CMRP Level III Thermographer President, IRISS Inc.

Overview:

A paper mill in Georgia had run a very successful infrared inspection program for a number of years via a local contract thermographers working with the mill's in-house electricians. Although the program had a good track record, senior management was concerned about the potential impact that NFPA 70E requirements, and how best to comply with them. The plant commissioned IRISS, Inc. to complete a cost benefit analysis and present its recommendations.

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Analysis of Inspection Program

The annual infrared surveys focused on the power distribution equipment as detailed in Table 1.

Application	Total Qty	Qty Insp
13.8 kV Primary Switch	27	15
Secondary Switchgear	48	48
Transformers (13.8kV)	22	14
MCC's	50	50
Miscellaneous Switchgear	26	26
Generators	6	6
Total Assemblies	179	159

Table 1

Twelve of the twenty-seven pieces of 13.8kV primary switchgear were not included during the inspection due to switched interlocks (which automatically de-energize the equipment upon opening). In addition, the thermographer was unable to inspect eight HV (high voltage) transformer cable compartments under load due to the energized work restrictions implemented by the plant safety manager. The review showed that 11% of the plant's critical assets were never inspected during the annual survey.

A time study was completed detailing the man-hours and the costs involved in completing the annual IR inspection based on NFPA and OSHA safety mandates.

Cost Analysis of Traditional Inspection

The client had been using a contract thermography company for more than seven years, and it was very happy with the service. The scanning crew consisted of two in-house electricians and one contact thermographer. The hourly wrench time (time spent on productive labor) rate for the electricians were calculated at $68 per hour, and the contract thermographer's rate was $150 per hour ($1,200 per day). Traditionally, the whole inspection required 29 days to complete. This translated into 787 billable hours (as seen in table 2).

Application	159	Man Hours
Inspection Compartments	233	
PPE Suit-Up Time		88.0
Time Taken to Remove Covers	0.4 Hrs.	186.4
Time Taken for IR Inspection	0.2 Hrs.	46.6
Time Taken to Replace Covers	0.4 Hrs.	186.4
Electrician Waiting Time		93.2
Electrician Waiting Time		186.4
Total Billable Man Hours	179	787.0

Table 2

The entire inspection team dressed in 40 Cal/cm2 PPE (personal protective equipment) in accordance with NFPA 70E and OSHA mandates for energized work. They spent on average 30 minutes to suit-up and dress-down - twice a day. This was a total of 88 hours related to PPE over a 29-day inspection cycle.

The thermographer spent 186.4 hours waiting for panel covers to be opened/closed to provide him with access. Similarly, the electricians spent 93.2 hours (46.6 hours x two men) waiting for the thermographer to complete his work once the panels were removed.

After analyzing the time studies, facility management was surprised to learn that a staggering 367.6 hours (46.7%) of the total project time for the traditional open-panel surveys was non-productive (PPE suit-up, thermographer wait-time, electrician wait-time, etc.). A task breakdown is shown in Table 2.

Table 2 details the man-hour costs for the infrared survey using a contract thermographer – without infrared windows or viewports. The following assumptions are made:

- Total man-hours per inspection of “inspectable” equipment: 787 hours (29 days)
- Staff electrician internal charge-out rate $68 per hour
- Contract thermographer charge-out rate $150 per hour
- PPE suit-up twice daily, per man (30 minutes per man, per suit-up)
- 48 minutes per compartment panel for safe removal, refitting, (per man for a two-man team)
- 12 minutes per panel for infrared scan
- 233 individual panels to inspect (Table 2)

Infrared Windows

In search for an alternative approach that was both safer and standard-compliant, the corporate reliability engineer investigated how infrared inspection windows (commonly referred to as IR windows, viewports or sight glasses) might be utilized. It was determined that:

- Use of IR windows would provide non-intrusive access to electrical applications. Surveys could be conducted during periods of peak load without elevating risk to either plant assets or processes.
- Use of IR windows or "sightglasses" would eliminate the need for a supporting cast of electricians to remove and reinstall panel covers. These critical personnel would then be available to perform other tasks which were often being outsourced.
- Use of IR windows and closed-panel inspection would eliminate high-risk tasks during inspections, thereby increasing safety for thermographers.
- Use of infrared windows for routine inspections of healthy equipment did not require the elevated levels of PPE required in 70E, since as stated in 70E 100: "Under normal operating conditions, enclosed energized equipment that has been properly installed and maintained is not likely to pose an arc flash hazard." In NFPA terms, an IR window maintains electrical equipment in an "enclosed" state and it maintains energized components and circuit parts in a "guarded" condition. Therefore, the hazard/risk category would be equivalent to reading a panel meter, using a visual inspection pane for lockout/tag-out confirmations, or walking past enclosed, energized equipment.
- Use of infrared windows would improve inspection efficiency. It would allow increases in inspection frequency for those mission critical or suspect applications.

Total Cost of Traditional Inspection		
Removal and Replacement of Panels	373	$25,316
Infrared Inspection	47	$6,990
Electrician Waiting Time	94	$6,329
Contract Thermographer Wait Time	186	$27,960
PPE Suit-up Time	87	$8,324
Total		$74,919

Table 3

Investment

Application	Quantity
13.8 kV Primary Switch	27
Secondary Switchgear	48
Transformers (13.8kV)	22
MCC's	50
Miscellaneous Switchgear	26
Generators	6
Total Assemblies	179
Inspection Compartments	263
IR Windows	312

Table 4

The facility's 179 applications with 263 inspection compartments required 312 infrared inspection windows (Table 4) in various sizes:

- 143 units, two-inch diameter (VPFR-50)
- 107 units, three-inch diameter (VPFR-75)
- 62 units, four-inch diameter (VPFR-100)

The 312 windows represented an investment of $51,405.00. IRISS also provided a cost-benefit analysis comparing in-house installation versus out-sourced.

IR Window Supply & Contracted Installation Team	
Infrared Windows	$ 51,405
Install Costs for 312 IR Windows	$ 19,760
Total	$ 71,165

Table 5

Out-sourced installation (Table 5) was based on the following assumptions:

- A two-man installation team can comfortably install 40 inspection windows in one shift
- 312 infrared inspection windows would require eight shifts to install completely (shutdowns permitting)
- The cost of the contract installation team was calculated as follows: eight days at $625 per man, per day (total cost $1,300 per day) for a total of $10,400.00
- Installer would charge a flat $30 fee per window – in addition to the daily rate (312 windows x $30 = $9,360)
- Total installation charge: $19,760

IR Window Supply & Internal Installation Team	
Infrared Windows	$ 51,405
Install Costs for 312 IR Windows	$ 8,893
Installers Training Course	$ 995
Total	$ 61,293

Table 6

In-house costs (Table 6) were calculated using the following assumptions:

- A two-man team can comfortably install 40 inspection windows per shift
- 312 infrared inspection windows would require eight shifts, or 128 man-hours, to install.
- The complete project could be managed around shutdowns.
- In-house team costs were calculated as follows: 128 man-hours at $68 per man/per day for a total cost of $8,893
- No additional charge incurred per window
- Client would retain IRISS for a day of on-site installation training at $995

With the savings, the client decided to use in-house manpower for the installation. The Jumpstart Installation training was scheduled for the first day of the shutdown so the in-house electrical staff could be properly trained.

Total savings to the customer by adopting an in-house installation program were $9,872.00 – almost a 14% savings over out-sourced.

The Installation

The installation of the inspection panes was conducted during a seven-day shutdown, using two install teams. The majority of the windows were installed while equipment was de-energized, in what NFPA terms an “electrically safe work condition.” However, some involved energized gear using the traditional safety measures such as use of PPE, energized work permits, etc. The work occurred during normal business hours since this allowed more flexibility.

The plan called for two teams working a twelve-hour shift. Installers were quickly and safely working at a rate of approximately six windows per hour. As they progressed down the learning curve, the teams became more proficient, achieving an installation rate of 7 to 8 windows per hour (versus the budgeted 5).

Cost Analysis With Windows

With the infrared windows installed, there was no requirement to remove panels or wear increased levels of PPE. In addition, inspections were now performed on the 11% of locations that had previously been considered "uninspectable." Finally, the entire task became a one-man job.

The windows also increased efficiency and economy-of-motion. Total man-hours to complete an inspection dropped to just 53. As a result, the new survey dropped from almost $75,000 to just under $8,000 (as detailed in Table 7). Because of the efficiencies achieved, the mill saves $68,964 per inspection, a 92% savings.

IR Window Supply & Internal Installation Team		
Infrared Windows	53	$7,950
Install Costs for 312 IR Windows	0	$0.00
Total		$7,950

Table 7

Because of the efficiencies which they gain through the use of infrared windows, the paper mill saves $68,964 per inspection cycle, representing a 92% savings compared to the costs of traditional inspections.

ROI

Table 8 combines the data from the previous tables to illustrate the paper mill's ROI (return on investment) that the mill realized from its infrared window program. The table details the total investment using three scenarios: 1 traditional open-panel inspections with a contract thermographer and two staff electricians; 2) the same contractor using infrared windows; and 3) an in-house thermographer using infrared inspection windows. It then compares the ROI that the mill was able to achieve using windows and either a contract or in-house thermographer.

Switching to infrared windows is shown to pay dividends in just one inspection cycle. Over $5,600 in savings can be put back into the budget by the end of the first cycle. After just five inspection cycles, the mill shows a savings of over $273,542.

Plant management was encouraged by these projections, so they decided to invest in an infrared camera and training for two of its engineers (one electrical and one mechanical). Two engineers were enrolled in a Level I thermography course at $1,250 per man. An additional $1,500 per man was budgeted for travel and expenses. The new camera totaled $8,000. The total investment to start up the new internal inspection team was $13,500. The cost of in-house inspection (47 hours x $68) amounted to $3,196 per inspection, yielding a savings of $3,794 per inspection (or 54%) compared to a contractor.

ROI of the new program using internal resources was achieved within the second inspection cycle; by the fifth cycle, the ROI was over $280,000. Because inspections can now be completed with greater ease and without increased risk to plant personnel and processes, the mill increased the frequency to quarterly, reflecting best-practice recommendations that originally were not considered feasible.

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	Contractor Traditional	Contractor Windows	ROI Contractor Windows vs. Contractor Traditional	In-House Windows	ROI In-House Windows vs. Contractor Traditional	ROI In-House Windows vs. Contractor Windows
312 Windows: One-Time investment	None	$51,405		$51,405		
Window Installation: One-Time Investment	None	$9,898		$9,898		
IR Training & Camera: One-Time Investment	None	None		$13,500		
Labor Costs: Per Inspection Cycle	$74,919	$7,950	$66,969	$3,196	$71,723	$4,754
Investment: Inspection Cycle 1	$74,919	$69,253	$5,666	$77,999	$(3,080)	$(8,746)
Investment: Inspection Cycle 2	$149,838	$77,203	$72,635	$81,195	$68,643	$(3,992)
Investment: Inspection Cycle 3	$224,757	$85,153	$139,604	$84,391	$140,366	$762
Investment: Inspection Cycle 4	$299,676	$93,103	$206,573	$87,587	$212,089	$5,516
Investment: Inspection Cycle 5	$374,595	$101,053	$273,542	$90,783	$283,812	$10,270
Total	$1,498,380	$220,303	$1,278,077	$138,723	$1,359,657	$81,580

Conclusion

The new inspection process using infrared windows brought significant ROI to the plant in just one quarter, while reducing the risk of catastrophic failure among the plant's critical power distribution systems.

Management succeeded in:

- Increasing safety
- Facilitating inspections of previously "uninspectable" equipment (11% of critical assets were not inspected in the old program)
- Increasing the frequency of inspection - while saving money
- Safeguarding profitability by eliminating high-risk behavior that posed a risk to plant assets and production

The purchase of the IR camera and training for the maintenance engineers quickly paid dividends. It allowed the plant to improve the maintenance program while operating in full compliance with the requirements of NFPA and OSHA.

An infrared window program provides a cost-effective and safer alternative to traditional open-panel inspections. To learn more, visit www.iriss.com where you will find more case studies and white papers.

Use of IRISS family Electrical Maintenance Safety Devices (EMSDs) such as infrared windows, ultrasound ports, voltage detection ports and online monitoring, allow energized electrical maintenance tasks to safely and efficiently be completed while switchgear enclosure remains closed.

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