“Continuous Monitoring in Electrical Equipment to Predict Thermal Incidents”

Shelly DeGrate
Bus Dev Manager
Automation Products
Standards & Guidelines

• Why they Exist?
• How do they Correlate?
• What are the Benefits?
Why Do They Exist?
Hot Spots within Electrical Equipment

- Thermal Expansions and Contractions
- Loose or Deteriorated Connections or Conductors
- Unbalanced Loads (high switching activities)
- Overloaded Circuits
- Mechanical Wear & Stress
- Normal deterioration
### Engineering Out the Risks

<table>
<thead>
<tr>
<th>Description</th>
<th>Open Door Thermography</th>
<th>Continuous Monitoring Sol’n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incident energy exposure</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Special skills &amp; certifications</td>
<td>Required</td>
<td>No</td>
</tr>
<tr>
<td>Access to inaccessible locations</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Alarm/Indication</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Plant-wide integration</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Inspection frequency</td>
<td>Intermittent</td>
<td>Continuous</td>
</tr>
<tr>
<td>Data logging</td>
<td>Manual</td>
<td>Auto</td>
</tr>
</tbody>
</table>
Locations of Interest (LOI’s) in 1H MV Switchgear

Visibility barriers

Infrared imaging limitations

ALL Locations of Interest (LOI’s) should be known for optimal predictability
Other Issues

- Interferences
- Window Misplacement
- Real Estate Concerns
- Tight Compartments
Locations of Interest
Locations of Interest
Age of Information

Current Heating Effect

Single Sensor Temp Increase

WARNING!!

OK

Temperature (°C)

Current Heating Effect

Sensor1

Sensor2

Sensor3

Single Sensor Temp Increase

OK

Temperature (°C)

Current Heating Effect

WARNING!!

OK

Temperature (°C)

Current Heating Effect

WARNING!!

OK

Temperature (°C)

Current Heating Effect

WARNING!!

OK

Temperature (°C)

Current Heating Effect

WARNING!!

OK

Temperature (°C)

Current Heating Effect

WARNING!!

OK

Temperature (°C)

Current Heating Effect

WARNING!!
How Can One Measure Temperature Without “Wires”?
Require a Certified Test Report for Equipment

- Rated Max Voltage = 38kV
- Rated Voltage Withstand = 80kV
- Rated Impulse withstand voltage = 150kV
- Rated Power Frequency = 60Hz
- UL, CSA, CE

38kV Test Sample
Typical Installation for Direct Connect Probe

Mount Probes & Route Fiber

Insulate/Boot
Benefit of Current Sensors

MODBUS TCP/IP TO DCS SYSTEM

MCS
CT CURRENT MONITORING

MONITORED BUS CONNECTION

FIBER OPTIC TEMPERATURE MONITORING

CURRENT TRANSFORMER
Networked Data (Simple)
Networked Data (Expanded)
Integration Options

Local

DCS
Using Real-Time Data (w/ Current)
### Investment Justification (Outsource)

#### Scenario:
- (9) Electrical Panels; (3) LOI’s each; (27) TTL LOI’s; (4) TTL Inspections

<table>
<thead>
<tr>
<th>Description of Task</th>
<th>Task Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPE Suit Up Time</td>
<td>30 min</td>
</tr>
<tr>
<td>Remove Panels/Barriers</td>
<td>30 min</td>
</tr>
<tr>
<td>IR Inspect &amp; Log</td>
<td>30 min</td>
</tr>
<tr>
<td>Replace Panels/Barriers</td>
<td>30 min</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description of Task</th>
<th>TTL Billable Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermographer PPE Suit Up Time (2x)</td>
<td>1 hr</td>
</tr>
<tr>
<td>Electrician Time to Remove Panels/Barriers</td>
<td>10 hrs</td>
</tr>
<tr>
<td>Actual Inspection Time</td>
<td>5 hrs</td>
</tr>
<tr>
<td>Wait time for Electricians</td>
<td>5 hrs</td>
</tr>
<tr>
<td>Wait time for Thermographers</td>
<td>10 hrs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Hours</th>
<th>Rate</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermographer PPE Suit Up Time (2x)</td>
<td>15 hrs</td>
<td>$75.00</td>
<td>$1,125.00</td>
</tr>
<tr>
<td>Electrician Time to Remove Panels/Barriers</td>
<td>32hrs</td>
<td>$150.00</td>
<td>$4,800.00</td>
</tr>
<tr>
<td>Actual Inspection Time</td>
<td>3 hrs</td>
<td>$150.00</td>
<td>$  450.00</td>
</tr>
</tbody>
</table>

**Total Cost of One Inspection** $6,375.00
## Investment Justification (Internal)

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Qty/Hrs</th>
<th>Rate</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR Windows</td>
<td>9</td>
<td>$350.00</td>
<td>$3,150.00</td>
</tr>
<tr>
<td>IR Window Installation Time (30 min each x 9 windows)</td>
<td>4.5 hrs</td>
<td>$75.00</td>
<td>$337.50</td>
</tr>
<tr>
<td>Inspection Time per Window (10 min / 4 times)</td>
<td>6 hrs</td>
<td>$75.00</td>
<td>$450.00</td>
</tr>
<tr>
<td>Manual Data Log &amp; Reports (1 hr / 4 times)</td>
<td>4 hrs</td>
<td>$75.00</td>
<td>$300.00</td>
</tr>
<tr>
<td>IR Camera Cost</td>
<td>1</td>
<td>$3,500.00</td>
<td>$3,500.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$7,737.50</strong></td>
</tr>
</tbody>
</table>

Payback Period for a continuous monitoring technology = 2 to 3 Years
Standards & Guidelines

- Why they Exist? **Mitigate Risk**
- How do they Correlate? **Knowledge-based Decisions**
- What are the Benefits? **Safety • Efficiency • Monetary**
“Continuous Monitoring in Electrical Equipment to Predict Thermal Incidents”

Thank you for your time and attention.

Questions?