Loss Prevention Standards

Thermographic Surveys

Introduction

Electrical systems are at the heart of every business and functioning building. Without it or part of it, a building, an integrated system or a piece of equipment will probably be unable to operate. In addition, loss statistics confirm that electrical faults are one of the primary causes of fires, and this applies equally to both newly installed or older items of electrical equipment. Consequently, anything that can improve electrical reliability and availability, together with reducing the number of potential ignition sources, is a very positive and powerful tool to utilise. As part of a broader joined-up electrical and mechanical maintenance regime, thermographic surveys are an example of one such tool which Aviva recommends for all sites.

Thermographic surveys should be considered as part of a comprehensive maintenance regime, and not as a replacement for electrical testing and inspection services, such as in respect of fixed wiring or portable appliances.

Implementing a structured and comprehensive thermographic survey programme, coupled with good proactive risk management, planned servicing and preventative maintenance, will reduce the number of equipment and machinery failures along with the number of potential ignition sources. This will result in reduced costs and business losses, whilst improving the organisation's overall standard of risk management.

Background

An electrical fire not involving or spreading to any other combustible material has the potential to affect the equipment directly involved and that immediately adjacent; the wider building, the operation within, the supply chain and the infrastructure network. Then consider the impact of smoke damage and contamination, or worse the fire does spread to adjacent combustible materials or construction.
This is true for:

- Older electrical installations where age related failure rates can increase with time
- New electrical installations which may not have been completed correctly or accepted appropriately
- Critical equipment which is not duplicated (in separate fire compartments/buildings) or is exposed by non critical equipment
- Where equipment/plant is located in remote or unoccupied premises, etc.

Then consider:

- Access to replace the damaged equipment may also be difficult
- The equipment or components may have a long lead time
- The damage is wider than first thought

A consequence of the above is increased costs, delays in replacing key equipment and machinery etc., all of which will result in an increase in the business interruption period. This emphasises the need to have joined-up, robust, planned preventative maintenance programmes and business continuity plans in place, to help reduce the risks.

Thermographic surveys/inspections can detect a wide range of defects and are an important part of any planned maintenance programme. Thermography is a non-invasive and non-destructive test (NDT) procedure that uses infrared technology to identify excessive temperature increases (hot spots – which are usually invisible to the naked eye), caused by factors such as electrical faults, overloaded circuits, friction, under-rated equipment, loose connections and poor terminations. The majority of equipment using power will experience an increase in temperature prior to failure.
Thermographic inspections can be used to survey:

- Electrical systems
- Mechanical systems
- Buildings
- Mobile plant
- Storage (rising temperature)
- Insulated systems
    - Poor insulation
- Hot or cold circuits: to measure heat loss or gain
    - Over heating
- Corrosion
- Cracks in materials or to detect metal fatigue
- Fluid systems; water, liquid and gas leakages, etc.

Infrared radiation in varying wave lengths are emitted from objects that have a temperature above -270^{o}C. By monitoring the levels of varying heat emitted, via an infrared detector (camera), and with the results interpreted by an appropriately trained operator, the infrared equipment can identify most faults before a machinery/equipment failure or potential fire.

There are numerous differing thermographic cameras available, but in general the higher the image definition and the larger the format, the better the camera image. For example, cameras having a 640 by 480 resolution is one of the highest available for use commercially, by trained and certificated thermographic surveyors. Cameras with lower resolutions will provide lower quality images and may lead to mistakes in identifying defects.

It is essential that the electrical engineers completing the thermographic survey are fully trained, competent in using the equipment and certificated. This should be by an internationally accredited certification body (e.g. ISO 18436-7, this specifies the requirements for qualification and assessment of individuals who perform machinery and condition monitoring and diagnostics using infrared thermography), to achieve a recognised Personnel Certification to at least Level 2 - although there are three levels of qualification, Level 2 is generally considered the minimum level required for undertaking a survey. Ideally the engineer should also have an understanding of equipment and component failure mechanisms; general property and equipment loss prevention; the threat or exposure to the business from failure of that item; and a wider understanding to be able to interpret the potential impact of an incident in that area.

A thermographic survey is of limited value if the equipment is not appropriate or it is in untrained hands.

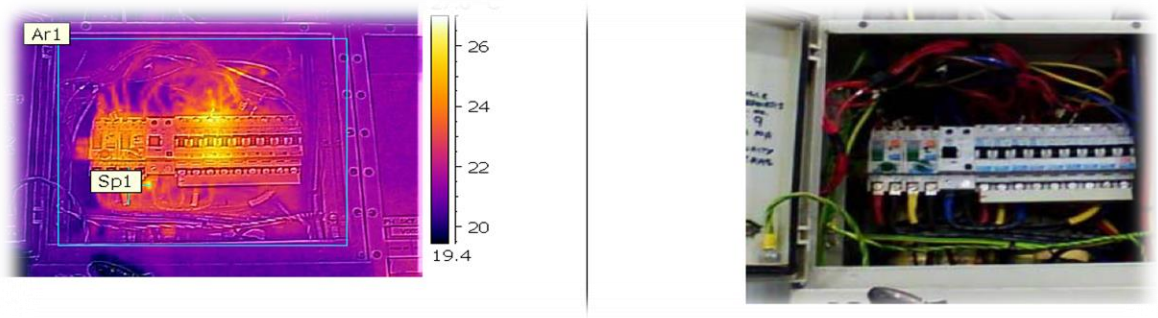
If we ignore the direct impact of preventing a fire, the benefits and savings of a strong maintenance programme that includes comprehensive thermography include:

- Provides improved reliability and greater availability of equipment; less breakdowns and failures
- Reduces unwanted outages and unscheduled downtime. Equipment is repaired before it fails, damages or destroys itself or adjacent items – tests can be undertaken whilst the equipment is in use
- Reduces impact on maintenance employees to react, providing a safer work environment
- Improves planning, effectiveness and availability of resource. Tasks can be planned and grouped for efficiencies
    - Particularly true for normally unoccupied or limited occupancy sites etc.
- Reduces costs associated with immediate repair, out of hours response and emergency repair bills etc. There are fewer costly (capital and business interruption) emergency situations
- Helps smooth spares inventory and management as they are used in a more planned and scheduled environment
- As unforeseen reactive/breakdown repairs are less likely to occur, for unoccupied or limited occupancy sites, where a quick or immediate response to site is normally needed, it can help reduce the exposure to Liability and Motor Fleet risks. There is less of a need to 'dash' to a site at any time of the day or night

Thermal Images

Thermal images produced by the thermographic camera software are visual displays of the amount of infrared radiation emitted, transmitted and reflected by an object(s). The object under inspection and its surrounding areas emit multiple infrared radiations in varying wave lengths and temperatures, which makes obtaining an accurate temperature of the object difficult. Therefore, the infrared camera software interprets the data and builds an image by using the multiple data sources received from the surrounding areas, to determine the approximate temperature of the object under scrutiny.

Example: thermal images of an electrical distribution system



Thermographic Surveys

For a thermographic survey to provide the most benefit, the item being tested should be at as high a loading as possible, as the test should be able to then identify any problems with the equipment which may otherwise go unnoticed. There is normally little value in running equipment at a certain loading and then testing it cold, or at half load, as hot spots may not be apparent when the equipment is not operating as intended.

A wide range of equipment, machinery and plant can be surveyed, as exampled below:

➢ High and low voltage systems ➢ Electrical distribution fuse boards ➢ Switchgears and switchboards ➢ Rectifiers ➢ Control panels ➢ Cable and bus bar systems ➢ Lighting systems and fittings ➢ Transformers ➢ UPS/battery systems ➢ Motors ➢ Mobile plant ➢ Trace heating and insulation	➢ Conveyor belts and moving surfaces ➢ Bearings ➢ Boilers and heaters ➢ Pumps and compressors ➢ Friction hot spots ➢ Process valves ➢ Pipeline flows and integrity ➢ Storage tank integrity ➢ Efficiency of insulation ➢ Storage; changes in temperature ➢ Room or building heat loss; temperature profiles, etc.

A risk assessment of all equipment, machinery or plant, based on actual experience or manufacturer's recommendations should be completed. The risk assessment should focus on three key exposures:

- Its importance to the business if lost or down, and for how long – its business impact
- Its value
- If it catches fire what it exposes, e.g. combustible occupancy or construction

This will help identify the most critical or exposed equipment, allowing these to be graded in importance to the operation.

There should also be focus on learning from own experience and from the type of equipment in use, as this will help decide the schedule of inspections.

Once a thermographic inspection programme is in place and after a number have been completed, the findings (reports) can be compared with each other to help build a record of the equipment and plant performance over time, enabling identification of any trends, etc.

In each case a completion certificate and written report needs to be issued. The report shall record the date of inspection, name of inspector, equipment inspected, together with the camera images, condition of equipment, what action is required and details of when the follow-up work has been completed.

If the service is not provided by a trained in-house resource, it is recommended that several quotations are obtained from differing specialist electrical companies/contractors making clear the purpose of the survey; the required timescales; the equipment, machinery and plant etc. that needs to be included in the survey. Examples of the reports provided by the specialist electrical companies/contractors should be supplied with the quotations.

Thermographic Inspection Intervals

Thermographic surveys should be completed at every site, covering all equipment, machinery and plant at least annually. However, where high-risk equipment, including criticality of equipment, cost of failure to the organisation, etc., or plant has been identified either by risk assessment, actual experience or from manufacturer's own recommendations, these may need to be more frequent.

The results of the surveys from specific areas of the site or equipment should be trended and compared to previous survey results – methods of surveys, parameters and settings should be consistent to allow appropriate trend analysis. If repeated surveys show a trend that is not improving then the frequency should be increased. If repeated surveys show no issues then the frequency can be extended to say every 18 months initially, and then after subsequent visits out to say every two years. Such amendments to the frequency period should be based on learning and trend.

If an appropriately trained in-house provision is in place then this should be benchmarked against an appropriately trained third party survey every three years, ensuring the in-house capability is competent and suitable.

Thermographic surveys should be completed on new electrical installations as soon as possible after the installation, and within the warranty period. This will help highlight any issues, enabling them to be resolved under the warranty.

Note: If a business purchases a thermographic imaging camera not to perform formal thermographic surveys but to help assist with their general preventative maintenance proposition, this can add an immense amount of value. However, this type of approach should not be confused with or used to replace a formal thermographic survey.

Checklist

A generic Thermographic Survey Checklist is presented in Appendix 1 which can be tailored to your own organisation.

Further risk management information can be obtained from Aviva Risk Management Solutions

Appendix 1 – Thermographic Survey Checklist

Location	
Date	
Completed by (name and signature)	

	Thermographic Survey Checklist	Y/N	Comments
1.	Is there a planned and predictive maintenance regime in place?		
2.	Have you had a comprehensive fixed wiring test and inspection, and if so when was it last completed?		
3.	Do you have a formal portable appliance test programme? • Does this include new items before they are used? • Are all items without an up to date test withdrawn from use?		
4.	Is there a comprehensive asset register which identifies all equipment?		
5.	Have formal risk assessments of the equipment been completed, including their: • Business impact? • Value? • Exposure to surrounding occupancy?		
6.	Are all maintenance records maintained and trends established for failures and equipment incidents?		
7.	Has a thermographic survey recently been completed?		
8.	Is a thermographic survey completed at least annually for all areas of the site?		
9.	Is the thermographic survey completed by an appropriately trained person?		
10.	Is the thermographic survey completed in-house or by a third party provider?		
11.	If in-house has this survey been benchmarked by a third party provider in the last three years?		
12.	Are findings from the survey tracked through to completion? Have all findings from the last survey been completed?		

	Thermographic Survey Checklist Contd.	Y/N	Comments
13.	Is the thermographic survey completed when the site is at full load?		
14.	Have any new electrical installations been installed since the last thermographic survey or are any planned in the next 12 months? If so include these in the next survey.		
15.	If there are major projects planned on site is a thermographic survey included as part of the final project handover?		
16.	Are repeated thermographic surveys trended?		
17.	Are findings and learning from thermographic surveys shared within the wider company or group?		
18.	Additional comments: