APPLICATION NOTE

INFRARED SCANNING FOR ENERGY EFFICIENCY ASSESSMENT

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May 2017

ECI Publication No Cu0192

Available from www.leonardo-energy.org

Document Issue Control Sheet

Document Title:	Application Note – Infrared scanning for energy efficiency assessment
Publication No:	Cu0192
Issue:	02
Release:	Public
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Editorial and language review	Bruno De Wachter (editorial), Noel Montrucchio (English language)
Content review:	Tom Capiau (Agidens)

Document History

Issue	Date	Purpose
1	January 2014	Initial publication in the context of the Good Practice Guide
2	May 2017	Publication of a revised version after review
3		

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SUMMARY

After a short introduction to the technique of infrared thermography, we will explain why infrared thermography is such an interesting tool for the analysis of the health of an electrical installation. We will also discuss how it can be of great help to industrial companies in their effort to reduce energy consumption.

There are different levels of competence needed to carry out infrared thermography, but it remains a relatively easy method that can readily be used by technicians after a short training period.

Infrared scanning makes it possible to achieve a good image of the condition of an electrical installation without having to switch off the installation or even coming into direct contact with the components. Infrared scanning offers a method of discovering wasted energy and emerging faults due to overheating, bad or loose contacts, et cetera. In addition to avoiding unscheduled shutdowns and loss of production, infrared scanning can play a role in the assessment of energy consumption. The cost of regular infrared scanning is small compared to the benefits gained. It has the best Return on Investment (ROL) of any of the available electrical inspection tools.

INTRODUCTION

Energy consumption is an important cost burden for most industrial companies. Investing in energy efficiency is therefore largely beneficial and often even of strategic importance. In any energy efficiency assessment, whether a self-assessment or one carried out by consultants, the electrical installation itself plays an important role. This is due to the very nature of electricity. Whenever electrical current flows, it will cause a rise in temperature. Such a rise will invariably result in efficiency losses in the form of heat. It is therefore of the utmost importance to verify that these losses and that the related rise in temperature stays within predetermined limits. Electrical energy should flow from the source (the connection to the public grid) to the consuming installation with the least possible loss of energy. This energy loss is minimized by correctly calculating electrical installations, providing electrical conductors of sufficient size, and avoiding unbalanced loads and bad contacts. However, the goal is not to just avoid the waste of energy; it is also avoiding unnecessary shutdowns and undesirable incidents such as fires or explosions.

It is well documented that electrical installations are a major cause of fires. Of the two greatest hazards connected with electricity (electric shock and thermal effects), the danger of electricity causing a fire is the one most frequently noted. Worldwide statistics show that most accidents involving electricity result in fires, arcs, burns, and other thermal related incidents.

According to the French ONSE (Observatoire National de la Sécurité Electrique) [1], 25% of the residential fires in France are of electrical origin, or 50,000 per year (reported or not). This was concluded after the investigation of 6 different independent studies that covered the period from 1995 to 2014. Those fires resulted in an average of 77 fatalities per year. According to the UK Electrical Safety Council [2], the figures from the UK show similar patterns, with an average of 50,000 domestic fires of electrical origin (reported or not) resulting in 67 fatalities per year.

Likewise, in the USA, the number of fires from electrical origin is substantial. In the NFPA's report of March 2017 we read the following:

- Fires involving electrical failure or malfunction:
    - Between 2010 and 2014, U.S. municipal fire departments responded to an average of 45,210 home structure fires involving electrical failure or malfunction. These fires caused annual averages of 420 civilian deaths, 1,370 civilian injuries, and $1.4 billion in direct property damage.
    - Non-residential structure fires involving some type of electrical failure or malfunction accounted for an estimated annual average of 12 civilian deaths, 210 civilian injuries, and $614 million in direct property damage during the same period.

- Fires involving electrical distribution or lighting equipment:
    - U.S. fire departments responded to an estimated annual average of 31,960 non-confined home structure fires involving electrical distribution or lighting equipment in 2010-2014.
    - An estimated annual average of 14,760 non-confined and non-residential fires involving electrical distribution and lighting equipment resulted in 20 civilian deaths, 190 civilian injuries, and $659 million in direct property damage each year

As will be discussed in detail later, infrared thermography has the property of making heat visible. This characteristic is useful in detecting unwanted heat in electrical installations. Indeed, undersized conductors, bad or loose contacts, et cetera, increase resistance and result in an abnormal rise in temperature. It is this rise in temperature that must be detected and corrected before things start to go dangerously wrong.

Infrared scanning (reading of the spot or line temperatures) and infrared thermography (thermal imaging) inspections are particularly well suited tools for checking the temperature, any abnormal rise in temperature, or any abnormal difference in temperature, among other thermal related characteristics. In short, all the potentially hazardous points in an electrical installation that can indicate failing components—excessive electrical resistance, short circuits, insulation faults, and all other thermal related conditions—that can lead to the unscheduled shutdown of an installation. It is one of the best tools to avoid unnecessary loss of energy and a quintessential proactive tool in avoiding trouble in an electrical installation.

Many insurance companies require regular inspections of electrical installations using infrared thermography. They know that yearly or more frequent thermal inspections can prevent fires and save both lives and money.

Although infrared thermographic inspections can reduce the need for periodic visual inspections, it does not mean that other maintenance activities are not necessary. Infrared thermography is just one of many necessary inspection activities, but it is a very important one. This application note will go a bit deeper into the various aspects of using infrared thermography.

SOME DEFINITIONS OF TERMS USED IN THIS APPLICATION NOTE

- Infrared, infrared thermography, infrared radiometry, infrared imaging, infrared condition monitoring, infrared inspection of an electrical system: the use of infrared imaging equipment to provide specific thermal information and related documentation about an electrical system

- (Infrared) imaging radiometer: a thermal imager capable of measuring temperature

- Infrared camera or (infrared) thermal imager: a camera-like device that detects, displays and records the apparent thermal patterns across a given surface

- (Infrared) thermographer: a person who is trained and qualified to use an imaging radiometer

- Infrared thermometer (non-imaging radiometer): an instrument that measures the average apparent surface temperature of an object based upon the object's thermal radiance

- Thermogram: a recorded visual image that maps the apparent temperature pattern of an object into a corresponding contrast or colour pattern

- Emissivity: the ratio of energy emitted by an object to the energy emitted by a blackbody at the same temperature. The emissivity of an object depends upon its material and surface texture. It is rated on a scale of 0 to 1.0

What is Infrared Thermography and how does it work?

Let us examine the meaning of the term *Infrared Thermography*. Infra means below, infrared is below the colour red, i.e. it is below the last visible colour, which is red.

Thermography. Thermo: everything pertaining to heat. Graph: graphical representation, visual representation.

Infrared thermography, or infrared scanning, or thermal imaging, is a thermal analysis methodology. It is based on the fact that all objects emit infrared and the radiation emitted from a surface is a function of the temperature of that object. There is a direct correlation between infrared energy and temperature; therefore, it can be used to measure the temperature of an object. The amount of radiation increases with temperature.

Infrared is an electromagnetic wave beyond the red light visible to the human eye. Infrared (thermal imaging) cameras can operate in wavelengths as long as 14,000 nm (14 µm).

Thermal imaging cameras convert infrared energy into a visible light display. A special lens focuses the infrared light; this focused light is converted into a *thermogram*, which in turn is translated into electric impulses. These impulses are translated into data for the camera display. This information appears on the display as different colours, depending on the intensity of the infrared emission and therefore of the temperature of the object.

In other words, thermal imaging makes the invisible infrared radiation visible. **Thermal images are visual displays of the amount of infrared energy emitted, transmitted and reflected by an object.**

The use of infrared thermography in electrical installations is usually not simply to determine the temperature of the object (electric component), but rather to visualize the variations in temperature between various components. Infrared thermography has mainly proved its worth when the temperature difference is significant or when excessive heat is produced (hot spot).

It has **many advantages**, such as:

- No need to take the electrical installation out of service since it can be used during normal operating conditions
- It is a non-contact and a non-destructive test method, taken from a safe distance
- It gives a visual picture of the condition of the installation and its components
- The results are available in real-time and there is little or no processing needed
- The IR cameras are relatively easy to use
- It can detect conditions and defects before they become serious problems
- Large electrical cabinets and whole electrical installations can be quickly scanned
- The exact location of the potential problematic point can be easily determined

There are **some disadvantages**:

- It requires experience and knowledge to correctly interpret the results
- Highly accurate measurements can be difficult because, among other causes:
    - the emissivity varies according to the material
    - there might be reflections from other surfaces
    - the same viewing angle should be used when comparing different readings
    - the figures only apply to surface temperatures
- A direct view of the electrical components being scanned is required, i.e. covers have to be removed and this can be a hazardous activity since the installation remains energized

GOAL OF INFRARED THERMOGRAPHY

The goals of infrared thermography are multiple:

- **Increase the safety** of the electrical installation by checking the condition of the various components of the electrical installation (wiring, contacts, circuit breakers, transformers, motors, other windings, et cetera). Since electrical components typically give indications of impending failure in the form of increased heat, a proper routine inspection can minimize the potential effects of electrical failures. This increase in heat *(Joule's Law)* can be due to loose connections, faulty or deteriorated components, overloads or short-circuits, unbalanced load, and insufficient size of the conductors, among others.

- To **reduce downtime and avoid unscheduled shutdowns** by detecting failing components before they break down. A routine thermal imaging inspection can detect potential electrical failures.

- To **save energy**: energy losses can be detected in undersized wiring systems because they produce unnecessary heat.

***Joule's law**: the heat produced by an electric current is equal to the product of the resistance of the conductor, the square of the current, and the time for which it flows. This means that, if the resistance does not change and the current doubles, the power consumption will increase four times and this will increase the temperature of the component.*

$$Q = I^2.R.t$$

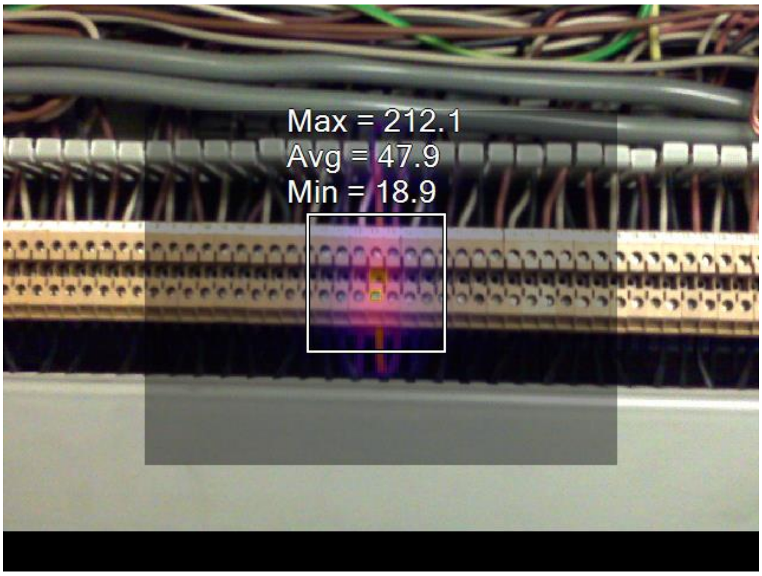

Figure 1—A loose or corroded connection.

For a thermal imager to accurately measure the object's surface temperature the emissivity of the material must be relatively high and/or the emissivity level on the imager must be set close to that of the object.

Although the emissivity of the various objects and materials differs, abnormal temperatures can be found through thermal imaging in a comparative way. **A qualitative check** may be sufficient when checking for hot spots in electrical equipment and in electrical connections. The condition of the electrical component must be compared with another component under the same operating conditions. However, it will be very difficult to establish the severity of the deficiency using only a comparative process. Determining the severity requires **a qualitative check**, which determines the actual temperature values. This will then identify the elements that require actions (corrective or preventive) and the priority to be given to those actions.

Once the condition is known, the **necessary steps** to reduce energy losses, avoid breakdowns, and reduce fire hazards can be taken.

One of the great advantages of regular infrared thermography is the ability to observe the behaviour of the electrical installation over time. **Changing thermal trends over the years can be tracked**.

TYPICAL PROBLEMS IN ELECTRICAL INSTALLATIONS THAT CAN BE DETECTED WITH INFRARED THERMOGRAPHY INCLUDE:

- Loose connections
- Bad connections (badly installed, corroded, deterioration due to mechanical stress, et cetera)
- Unbalanced loads
- Defective equipment
- Undersized conductors
- Overheated motors
- Overloaded circuits
- Potential fire hazards
- Undersized conductors
- Accelerated wear of components
- Thermal abnormalities in batteries
- Harmonic problems

ENERGY EFFICIENCY

All heat created by the electrical current in the electrical installations—and certainly the abnormal heat in unhealthy electrical installations (insufficient cable sizing, bad contacts etc.)—result in a pure waste of energy. More than 40% of the industrial energy use is electrical. Savings by optimizing the electrical installation or by rectifying faults can be very worthwhile.

A recent study found that average electrical distribution system losses accounted for a figure between less than 1% up to more than 4% of the plant’s total annual energy use. Losses due to poor connections represented one-third of these losses and accounted for 40% of the savings after corrective actions were taken. (Source: U.S. Department of Energy, “Energy Efficiency & renewable Energy” “Advanced Manufacturing Office” November 2012)

BAD CONTACTS

In the event of a bad contact, the resistance of the contact increases, causing a temperature rise. When this occurs on a small surface, there is a limited heat drain and the temperature rise is exacerbated. Soon the insulation or other materials in the vicinity will lose their properties and a fire can occur.

One study demonstrated that a bad contact of 0.5 ohm rose to 1 ohm after one week and to 10 ohm after one year. The following tables below give a good indication of the amount of heat generated by bad contacts compared to contacts in good condition.

Values with a good connection (left column) and a bad connection (right column):

Current **A**	**Voltage drop** **mV**	**Heat developed** **mW**	**Voltage drop** **mV**	**Heat developed** **mW**
20	4-10	80-200	1,000-2,000	20,000-40,000
15	3-8	45-120	1,200-1,400	18,000-36,000
10	2-5	20-50	1,500-3,000	15,000-30,000
5	1-3	5-15	2,000-4,000	10,000-20,000
0.8	0.15-0.4	0.1-0.3	4,000-7,000	3,000-5,000

Table 1—Voltage drop and power dissipated through good and bad contacts.

Another example of excess energy consumption *(Source: U.S. Department of Energy* "Energy Efficiency & renewable Energy" "Advanced Manufacturing Office" November 2012)

Measurements at a motor control centre (MCC) breaker indicate voltage drops of 8.1, 5.9 and 10.6 volts on L_1, L_2 and L_3 respectively (see Table 3). The equipment being driven is operated continuously. Measured line currents are 199.7, 205.7 and 201.8 amps for L_1, L_2 and L_3 (see Table 3). The voltage drop measurements for circuits serving similar loads indicate that a voltage drop of 2.5 V should be obtainable. The potential annual energy and electrical demand savings from correcting the problem is shown in the following table:

Circuit	Measured voltage drop V	Excess voltage drop V	Current A	Excess Power kW	Excess energy use kWh/year
L_1	8.1	5.6	199.7	1.12	9.796
L_2	5.9	3.4	205.7	0.7	6.126
L_3	10.6	8.1	201.8	1.63	14.318
			TOTAL	3.45	30.240

Table 3—Measurements on the three phases of a MCC.

The U.S. Department of Energy makes the following assumption:

Assuming a utility charge of $0.08 per kilowatt-hour (kWh) with a demand charge of $8.00 per kilowatt (kW) per month, potential savings are valued at:

In the hypothetical assumption that such energy losses could be maintained for a full year, the savings would be = 3.45 kW x $8.00/kW per month x 12 months per year + 30,240 kWh per year x $0.08/kWh =$331 +$2,420 = $2,750 per year (for a single breaker). However, in reality, such losses would most likely cause overheating of the cabinet in a relatively short time, given that 3.45kW is the equivalent of several electrical room heaters.

Carrying out an infrared thermographic survey is one of the best methods of verifying and visualizing the condition of an electrical installation and determining where energy is being lost.

WHO CAN CARRY OUT INFRARED THERMOGRAPHY?

Only very well-trained personnel should be designated to carry out infrared thermography.

- They should **know the camera** well, and know how to work with it. Camera settings are very important. A wrong setting will result in erroneous readings, leading to incorrect and potentially dangerous conclusions.
- They should **be able to recognize the effects of environmental influences** such as sunshine and shadows, ventilation and heating, and reflections off of walls.
- They should also have a **thorough knowledge of electrical equipment** and of the manner in which electrical installations are built.
- They should **be acutely safety-minded** when working near electrical installations under load. As we will see, it is necessary for the camera to have a good view of the electrical components. This requires that covers and shields be removed. This can be a hazardous activity.

Ideally, personnel will have **a certificate of competence**, issued by a recognized infrared training centre. Most infrared camera manufacturers offer training for their customers and issue such certificates.

CERTIFICATION LEVELS

LEVEL I INFRARED THERMOGRAPHY CERTIFICATION (QUALITATIVE THERMOGRAPHY)

Level I thermographers are typically new to infrared thermographic diagnostics. The course for Level I covers among other topics, infrared theory, heat transfer concepts, critical camera parameters such as emissivity, reflection, distance to target, equipment operation and selection, standards compliance, image analysis and report generation. Level I thermographers can operate their infrared cameras and software correctly and identify and measure thermal anomalies based on thermal patterns, comparisons with similar equipment, and their own experience. A Level I certificate is mandatory prior to participation in the Level II training course.

LEVEL II INFRARED THERMOGRAPHY CERTIFICATION (QUANTITATIVE THERMOGRAPHY)

Level II professionals are experienced thermographers and trouble-shooters. The course for Level II covers advanced infrared theory, equipment calibration, error sources, cross verification with contact thermometers, advanced equipment operation, use of windows and filters, assigning temperature limits and repair priorities, and quantitative report generation. They usually deploy more than one diagnostic technology to determine the root cause of a problem. The Level II expert will be competent to recommend repairs. Because of their more advanced infrared training, Level II thermographers are qualified to provide technical direction to Level I certified personnel. A Level II certificate is mandatory prior to participation in the Level III training course.

LEVEL III INFRARED THERMOGRAPHY CERTIFICATION (BEST PRACTICES)

This is the most advanced infrared training level available. A Level III thermographer is primarily a thermography programme manager who writes the company's written predictive maintenance/inspection practices, develops the test procedures and severity criteria, determines how often equipment should be inspected, and calculates the return on investment of the thermography programme. The course for Level III covers advanced topics related to developing, implementing, and managing a successful infrared inspection programme. Topics include latest applications, hardware and software, current industry standards and specifications, safety standards, marketing and promoting an infrared inspection programme, thermography as legal documentation, heat transfer analysis software, current industry certification criteria, and how to develop and implement standards and written compliance practices and procedures.

By completing this advanced infrared training, a Level III thermographer can provide guidance to Level I and II certified personnel. The Level III thermographer is the resource to consult when recurrent equipment problems necessitate a review of operating and maintenance procedures, or involve a redesign of equipment.

THERMOGRAPHIC CAMERAS

The camera does not have to produce a clear photo of the installation, but must be able to produce a clear thermal picture.

There are two principal types of camera: **those with cooled and those with uncooled image detectors**. The cooled infrared cameras provide better image quality, but are more expensive and less easy to work with.

There are quite a number of camera manufacturers and a large range of models. Most cameras have built-in digital cameras and an appropriately professional quality camera will have a Thermal Fusion and Picture-in-Picture functionality that **merges visual and infrared images**. This will be of great help in analysing images and for reports.

Questions to ask when buying a camera: are the **pictures to be saved** and/or **shared with others**? Is **the actual temperature** of the component required or only **temperature differences**?

- A lower cost—and therefore usually less comprehensive—model can be used for a quick scan of the installation. Infrared thermometers are reliable and very useful for single-spot temperature readings. The area is then panned to note the difference in temperature, but it is easy to miss hot spots. (P1)
- A thermal line scanner shows the radiant temperature viewed along a line. The thermogram shows the line superimposed over a picture of the area. This way one can see temperature variations along the line.
- A thermal imaging camera can scan entire motors, components, or panels and the likelihood of missing a hot spot is therefore greatly reduced. (P2)
- The most accurate thermographic inspection device is the thermal imaging camera. It produces a thermal picture of an area showing the hot spots.
- Modern cameras have become very sophisticated and hundreds of thousands of temperature measurement points in one image will give very accurate readings.

Figure 2—P1: Infrared thermometer, temperature measurement in one spot (FLIR brand on the left, FLUKE brand on the right).

Figure 3—P2: Thermal imaging camera (FLIR brand on the left, FLUKE brand on the right).

How to carry out infrared thermography

With and without component covers

The thermographer(s) should first familiarize themselves with the electrical installation to be scanned.

It is advisable to check the entire electrical installation, including other electrical components (transformers, motors, equipment and apparatus) connected to the elements being inspected. The installation must be in service, if possible under full load. Since the electrical installation is in service, only qualified personnel, using appropriate personal protective equipment, are allowed to open the distribution boards and remove the protective covers. A thermographic camera is not an X-Ray device and cannot see through solid materials and surfaces. The components of the electrical installation must be in the line of view of the infrared camera.

A rise in temperature will also be noticeable (visible by the camera) on the surface of the cover or the door of the cabinet. However, it has been demonstrated that temperature readings cannot be relied upon when the covers are not removed. Wrong conclusions can be drawn, that do not correspond with the actual problems inside the cabinet (i.e. behind the covers).

On the other hand, a serious problem on the inside leading to high temperatures on the outside of the cover may indicate that it is dangerous to open the cabinet under tension. It is therefore necessary to first assess electrical panels while they are still closed. If they appear abnormally warm, appropriate safety precautions must be taken before opening.

Under full load

The higher the load on the electrical installation, the greater the accuracy of the data achieved. More current means higher temperatures and more clearly visible (to the infrared camera) differences in temperature. In any case, the load should be noted on the report so that correct decisions can be made in subsequent thermographic inspections.

Measure similar installations

The thermographer shall compare similar components under similar load to each other. When they come across unusual thermal situations, they will take a thermogram and a normal photo. They must make the necessary annotations that will enable the right decision on the action to be taken. These annotations include, among others the exact description of the component, the exact location, the temperature, the load of the circuit, and the environmental conditions.

Report

At the end of the survey, a detailed report must be delivered that indicates precisely what has been scanned, the location of hot spots, the action to be taken, et cetera.

Conclusions

The most difficult part of infrared scanning is the interpretation of the results. It is therefore of the utmost importance to **carry out scanning on a regular basis** (at least once a year) in order to have an accurate idea of the thermal trends over the years.

Temperature difference will generally be used to come to a conclusion about the actions to be taken.

There will be three or four Priority Levels (PL) depending upon the Standard used.

- Priority Level 1 will always mean that immediate corrective action must be taken. It occurs whenever the temperature difference between the hot spot and its environment is more than 40 °C (or more than 15 °C between the hot spot and a similar component under the same conditions).
- PL 2 will require corrective actions as soon as possible. It occurs whenever the temperature difference between the hot spot and its environment is between 11 °C and 40 °C (or between 4 °C and 15 °C between the hot spot and a similar component under the same conditions).
- PL 3 and/or PL 4 do not require immediate action; action should be taken at the next maintenance period or as time and resources permit. This generally occurs whenever the temperature difference between the hot spot and its environment is between 1 °C and 10 °C (or between 1 °C and 3 °C between the hot spot and a similar component under the same conditions).

It is also possible to use **Absolute Temperature Criteria** for electrical components. This is used less often. The absolute temperature criteria are based on equipment operating at the stated ambient temperature and at 100% of their rated load. Values can be found in different standards and are stated as follows: 'rated ambient temperature/rated temperature rise/maximum allowable temperature.'

A few examples (all values are given in degrees C):

- Bare conductors in ambient air: 55/25/80
- Circuit breakers, moulded case: 40/20/60
- Connectors and terminations (metals, copper): 40/50/90

Temperatures in the standards are based on equipment operating at the stated ambient temperature and at 100% load. To arrive at the corrected maximum allowable temperature, it is necessary to carry out a linear transposition towards the actual ambient temperature and the actual (reduced) load and its related temperature rise.

There are different sets of **temperature severity criteria** available. It is necessary to take into account all of the necessary factors such as indirect measurements, environmental effects and load conditions.

Measure again after corrective action

It is good practice to inspect components after repair to ensure that maintenance was properly carried out.

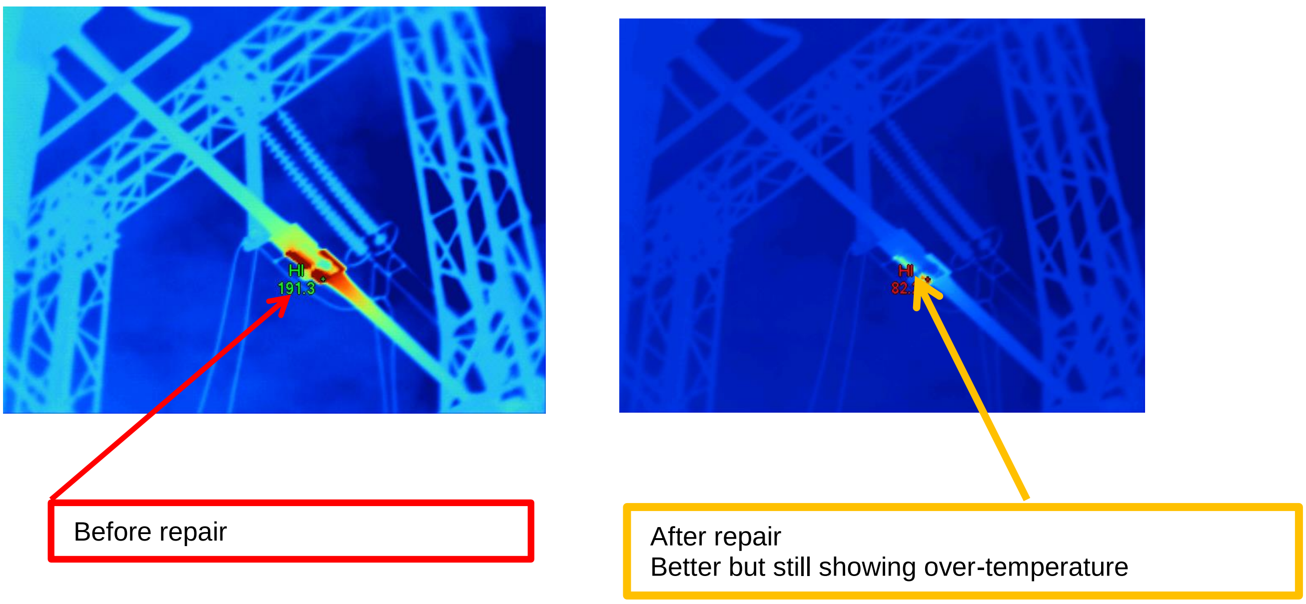

Figure 4—Thermal image before and after repair.

A FEW EXAMPLES OF HOT SPOTS

EXAMPLE 1: HOT SPOTS AND UNEVEN HEAT DISTRIBUTION

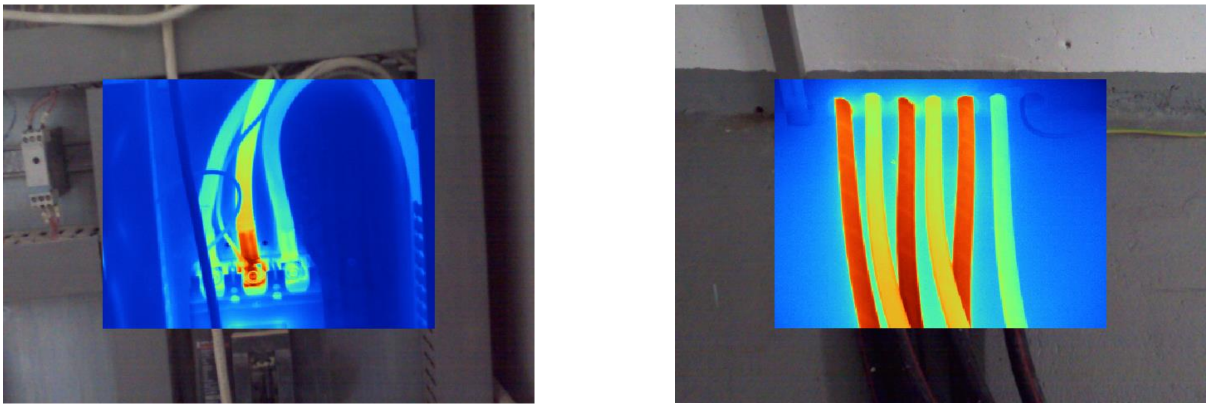

Figure 5—Thermal images of hot spots and uneven heat distribution

Left image: the highest temperature is near the connection and the temperature reduces with increased distance from the connection. This image represents a typical fault caused by a local increase of resistance, perhaps due to a loose or corroded connection.

Right image: the image shows a group of cables with some hotter than others. Note that in this case, the temperature of the cables is the same all along the cable. The overheating can have more than one cause: unbalance, overload, or harmonics.

EXAMPLE 2: ONE CONDUCTOR OVERHEATED ENTIRELY

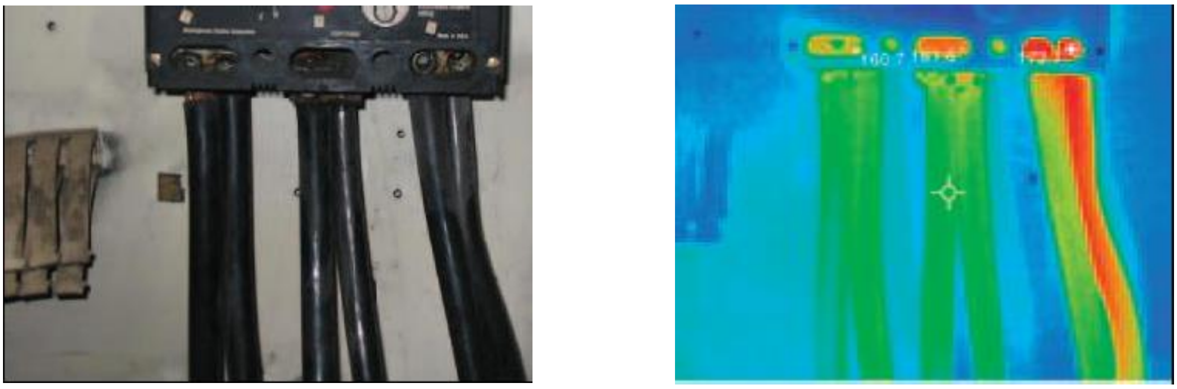

Figure 6—Normal view and thermal image of cables and their connections.

The thermal images of the cables show an almost constant temperature with the exception of the cable on the far right: it looks like a combination of increased local resistance and overload or harmonics.

When a thermal image shows an entire conductor is warmer than other components throughout part of a circuit, the conductor could be undersized or overloaded. Check the conductor rating and the actual load to determine if that is the case.

Before you assume the cause has been found, double check with both the thermal imager and multi-meter or clamp meter current measurements. Use a millimetre or a power quality analyser to check current balance and loading on each phase.

EXAMPLE 3: PEN CONDUCTOR OVERHEATING

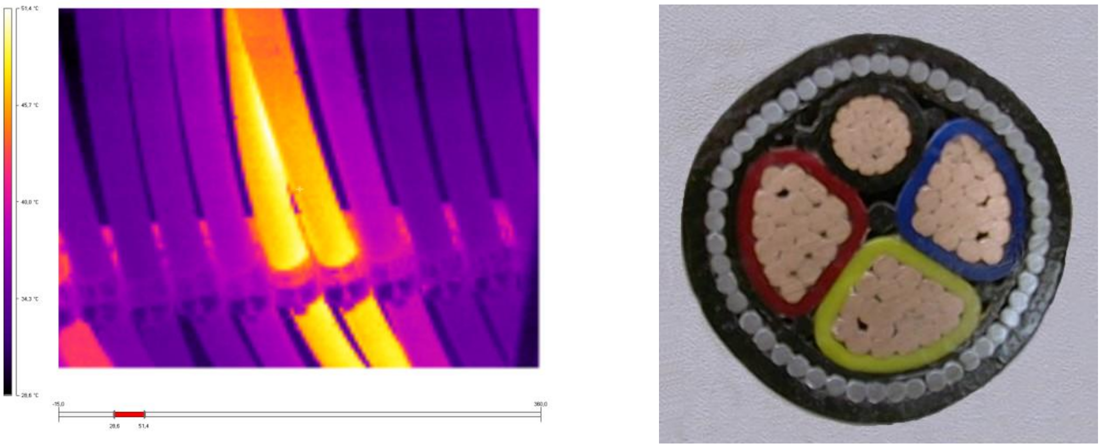

Figure 7—Excessive heat in reduced conductor section (thermal view and normal view).

Many industrial electrical installations make use of the so-called TN earthing system (Terre—Neutre). When one and the same conductor is used to serve both as a neutral and as a protective earth conductor, this conductor is called the PEN and the system is called TN-C (Terre–Neutre–Combined). The PEN will thus carry the phase unbalance currents as well as the 3rd order harmonic currents and their multiples. The current in the PEN conductor can become even higher than that in the corresponding phase conductors due to harmonics. For this reason, the section of the PEN conductor must never be chosen smaller than that of the phase conductors. In the figure above, the PEN is overheating, creating a possible fire risk and a waste of energy.

Energy loss in cables is mainly due to resistive heating. It is dependent, among other things, upon the length of the cable and the current. There are many apparatus that can calculate the power loss. They range from basic to sophisticated, giving you the harmonic power, the phase unbalance power, the effective (active) power, and the reactive power.

EXAMPLE 4: FIRE RISK

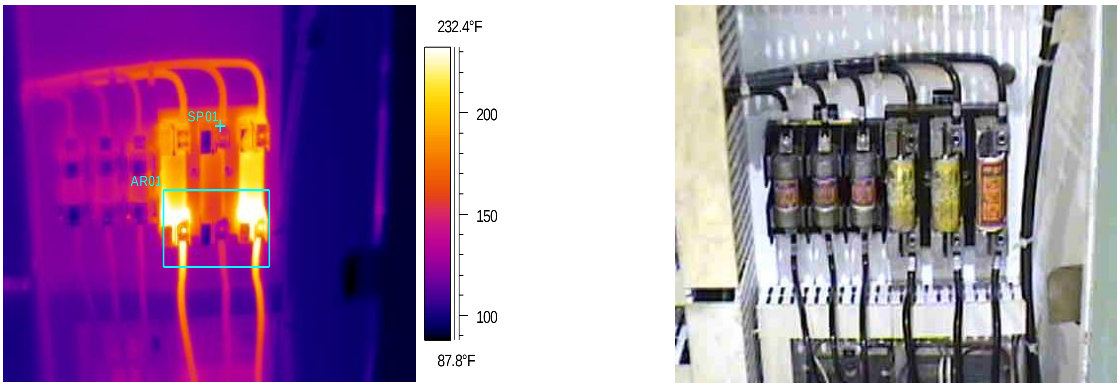

Figure 8—Example of a hot spot that requires immediate action.

Hot spot temperature: 150 °C; reference temperature: 77 °C; difference: 56 °C

Immediate corrective action is required to reduce the fire risk!

CONCLUSION

Infrared thermographic inspections enable the detection of both potential or oncoming problems and loss of energy in electrical installations and electrical equipment, without the need to switch off the installation.

These inspections enable the detection of unwanted heat and hot spots. This excessive heat is caused by increased resistance, coming from faulty contacts, loose connections, overloaded conductors, load imbalances, et cetera.

This excessive heat increases the fire risk, reduces reliability, and is a pure waste of energy.

Qualified thermographers will be able to draw conclusions from the thermal data acquired during the scanning, taking into account the current load, the ambient temperature, and other local conditions.

Based on their knowledge of the camera used and of the electrical installation scanned, they will ask for follow-up actions to be taken, indicating the level of severity of the anomalies and thus establishing repair priorities. Shutdowns due to equipment failure can thus be avoided, the installation will be safer because the fire risk is diminished and energy will be saved through eliminating unnecessary heat loss.

The infrared thermographic inspections should be repeated regularly (at least every year) to have a true picture of the behaviour of the installation its lifecycle.

Together with other maintenance activities, infrared thermography is a great tool to achieve and maintain safe, reliable and energy-efficient electrical installations.

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