WORKSWELL

Thermodiagnostics in the power engineering sector

Nowadays, we cannot imagine life without electricity. Although we take it for granted as a part of out lives we do not always realize how demanding it is to be produced and supplied by power plants directly to our homes. The transmission and distribution network is a highly complex system of lines that interconnecting electric energy sources, transformer stations and consumers. Unfortunately, failures can occur within electricity networks that can lead to electricity breakdowns as well as destructive fires. A UAV (drone) with a thermal imaging system installed can be a very useful tool to prevent such problems.

Introduction to the issue

Electrical power stations produce AC currents with voltages of several thousand volts. When transmitting over long distances, the voltage is transformed by electrical power stations to very high voltages of 110 kV, 220 kV or 400 kV. Individual electrical power stations are connected to the distribution network by overhead lines. The element that connects the transmission and the distribution part of the distribution network are the transformer stations.

Columns and distribution lines for high voltage networks.

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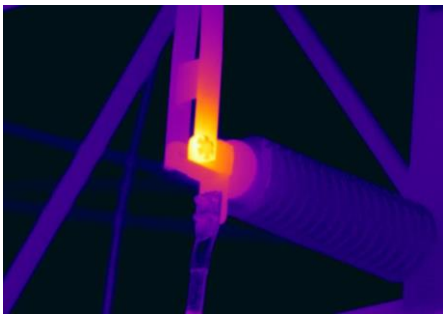
Each element of the distribution network is at risk of a series of defects that can result in energy losses and/or a major security risk. Unfortunately, the breakdown of the electricity supply from a failure in the distribution network does not only affect the electricity supplier financially, but also a very high number of inhabitants, as well as companies and health facilities. Failures mean that direct threats to lives can occur. Therefore, all elements of the distribution network must be checked to prevent any of the mentioned problems.

One of the most frequent failures in the distribution network is the overheating of individual components due to transition resistance. Transition resistance occurs in imperfect places (damaged, outdated or un professionally installed) electric joints.

Joint on the high voltage distribution line. The place where a problem may occur, i.e. origination of transient resistance with consequent overheating.

Due to the increase in series resistance, there are energy losses in the form of what is known as heat loss. It is not only economic problem but also a security problem - due to the further worsening of parameters, the temperature of the damaged joint can increase its temperature until a fire breaks out that may be highly destructive due to the high voltage.

Thermographed joint on a high voltage distribution line



Transition resistance on the high-voltage distribution line leads to local heating of the stated joint. This problem results in energy losses and can result in fire breaking out in the future.

Thermography is a technical field dealing with the issue of contact-free determination of the allocation of the temperature field on the surface of the measured body. Special measuring devices, known as thermal cameras are used for this purpose. A thermo-camera is able to state the surface temperature of the measured objects within a few meters (at a sufficiently high emissivity value).

Using a thermal camera, the inspection can unearth problems that cannot be seen on a traditional camera and can lead to serious problems in the near future.

A major advantage of this method is that the inspection is always conducted for installations that are already in operation at full or partial operational loading. A technological shut-down is not necessary to conduct this inspection although its operation is required. Fully operating loading is actually better for the inspection.

The inspection is conducted within regular time frames because the problem can occur any time (due to ageing or affection of climate conditions) including places that were previously fine.

Aviation inspection using the Workswell WIRIS system

The question is how to check equipment located at great heights, is under high voltage and is located in areas with complicated access. How do you check the network of lines in large transformer stations when the whole system takes up a large area and the inspected elements are difficult to access? The option of aviation inspection is available that has been used in this area for many years.

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The thermal imaging system for Workswell WIRIS drones from Workswell are designed for assembly on the drone (UAV). **The set is light, mobile and fully controlled using a standard RC controller**. The system combines two camera systems - **a camera for visible spectrum (for inspection of visible defects to piping) and a thermal camera (for detection of hidden defects). The servicing software enables to remotely switch camera regimes, record radiometric videos and to produce static images in the visible and infra-red spectrum.** The operator sees any objects under the drone in real time and can analyse the records in order to identify damaged areas.

Photographic image from an aviation inspection of high-voltage distribution lines. Although there is nothing to be seen on the photo, there is a defect on the joint in the form of high transient resistance. The electric joint has become overheated and according to the recommendation in ISO 18434-1 should be repaired as soon as possible.

Moreover, unlike similar systems, Workswell WIRIS enables to manually set the range of temperatures, e.g. in intervals of 15 °C to 25 °C. Even this range of temperatures can be changed during the flight. Without the need to land, the system can be set for actual situation to easily achieve the required thermal sensitivity setting, **which is needed to localize minor moisture defects that may worsen after time and lead to serious problems.** Moreover, the system can be equipped with a **GPS sensor** for storing information on the position of the drone when recording.

The system can measure temperature in the central point, as well as in the local minimum and maximum. Minimum and maximum are localized by the blue (minimum) and red (maximum) crosses. This function can be used to navigate the drone because the system automatically shows where the largest potential problem is located.

However, Workswell WIRIS also has additional functions suitable for this application: **for example, continuous ZOOM** (up to 14x for thermal camera and 16x for colour camera) for exact localization of the problem or to control NUC calibration so it is done at the correct moment.

Workswell WIRIS can be fully controlled by a traditional RC controller from which all system functions can be accessed. In addition to all functions, the monitor displays images from the thermal camera as well as colour camera. Information is available about the measured temperature (min/max and central spot) during the flight.

The calibrated system and radiometric data are essential

All data obtained (video and individual images) is fully radiometric so the measured images can be evaluated in the comfort of the office and a measurement report produced with clean and easy-to-orientation identification of serious problems, **for example according to ISO 18434-1, which is the standard in this area**.

Moreover, the Workswell WIRIS system is fully calibrated. During production, the exactness of measurement is checked and the delivery of the system includes a calibration sheet with the stated precision of the measurement. The measurement results are then detectable! The system fulfils the requirements stated by the most widely acknowledged standard — ISO 18431-1. The emission and apparently reflected temperature values can be corrected during measurement or at any other time. Experts know that without this option they measured data cannot really be used.

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Summary

Thermography is currently a well-established technique for checking electrical installations. It was first used in 1965 and since then has been the most widespread commercial use of thermography.

Aviation thermography has been standard in this field from the very beginning. The Workswell WIRIS system provides a complete aviation inspection system that fulfils the requirements of the ISO 18434-1 standard for such measurements (calibration, radiometric data, correction of emissivity and other parameters of measurement, etc.). During the flight, live images from both cameras can be monitored and a record of the whole flight produced for later analysis to identify damaged areas. Inaccessible terrains or large substation areas do not present any problems for drones with cameras. The whole system is comfortably controlled from a safe distance unlike standard visual inspections or inspections from the ground using a traditional manual thermal camera.

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