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Condition Monitoring of Ring Main Units

by Ludovic Lamberti and Yves Chollot

Executive summary

As electrical distribution networks continue to age past their targeted lifetime and electrical distribution companies face increasing budget pressures, the terms “asset management” and “capital improvement planning” have become buzzwords in the new energy world.

An effective asset management and capital improvement program aims to pinpoint the exact location of the distribution network where maintenance and repair work is necessary, without the guesswork.

Introduction

This document explains features implemented inside field devices located at the Ring Main Unit (RMU). These health monitoring features are referred to as “Condition Monitoring of RMU’ (CMR) and are based on new sensor technology and connected product devices. Once processed through the relevant algorithms and analytics, the collected data provides accurate information to inform and guide better management and use of this RMU.

Condition monitoring

How does this work? The service and maintenance provider of RMU performs a survey of their equipment during energization to see when maintenance work is required. Primarily, to prevent any operational failures of the equipment, as well as to optimize the lifespan of the equipment.

If energy use is due to increase 30% by 2050 (driven by the growth of distribution network grids), and the RMU’s were installed more than 25 years ago, failures of equipment are guaranteed to increase and impact the network. The major benefits of implementing condition monitoring in RMUs are:

- Reduced power outage duration for customers: Prevention of any potential unplanned outages can reduce the number, and duration of outages (SAIDI index for utilities)
- Reduced cost and deferred cost of equipment replacement: Manual overrides can prevent unnecessary operations and extend the lifespan of RMU
- Reduced equipment maintenance activities: With remote information, maintenance activities can be planed and be more targeted to adjust the device or RMU settings and solve RMU issues more easily.

Grid sensor technology and parameters

The first step in condition monitoring is to install sensors on the key components in order to provide monitoring or real-time alarms of abnormal RMU conditions. Additional analytics can help utility engineers plan preventative maintenance, including replacement or repair.

With new electronic devices, CMR will provide utilities with new tools and capabilities to improve their operational efficiency and reduce the frequency and duration of power outages. This is thanks to the data being collected through the CMR.

The device integrated in the RMU can be configured to measure parameters such as:

a) Ring main unit temperatures

Common examples are the cable terminations and are more prone to failures than the cable itself. Temperature and voltage stress are the main factors that accelerate aging of the solid insulation. Excess heat can reduce efficiency, damage equipment and reduce the lifespan of the termination cables of the RMU.

Thermal monitoring allows detection of anomalies at the cable connections or bus bar joints which are due to poor, failing or compromised connections that would otherwise remain undetected. Secondly, excessive or imbalanced temperatures may provide a way to notify or detect that a phrase is imbalanced, or an overload situation exists.

b) SF6 levels, dry contact switch

SF6 gas is used to insulate and suppress electrical discharges. Loss of SF6 pressure is monitored to identify if the RMU can operate properly.

c) Water levels, dry contact switch

Rainwater can penetrate RMU vessels, causing equipment failures or corrosion.

d) Humidity sensors

Insulation on cable terminations depends on the humidity of the environment.

These wireless sensors provide 24/7 data which can be connected to an information management or control system via a Remote Terminal Unit (RTU). In an MV/LV sub-station, particular attention has to be paid to isolation between LV, MV and electronic devices. Wireless sensors bring a perfect solution to this constraint.

Algorithm specification

Once all sensors are communicating and data is being received by the utility back office systems, a diagnostic process is used to determine an equipment failure. This is usually integrated with distribution management systems or within the maintenance software to retrieve sensor data for analysis.

The information is commonly transmitted remotely by communication mediums, such as 3G/4G networks, fiber optics or radio.

The data allows the following functions to be performed:

1. SF6 Monitoring status
2. Condition monitoring on MV RMU connections, to prevent potential corrosion
3. Humidity and condensation measurement analysis with algorithms

Two levels of alerts should be available according to how critical the actions are:

- The first level is used for pre-alarm, where a visual check is needed before the next maintenance visit.
- The second level determines a critical status, where immediate action is required.

The range of alarms will be generated based on the absolute temperature with a fixed threshold (Fig. 1) or on the phase discrepancy temperature (Fig. 2)

Using permanent communication media, the alarms will be generated in real time in order to trigger on-site inspections or preventive actions as per the maintenance plan.

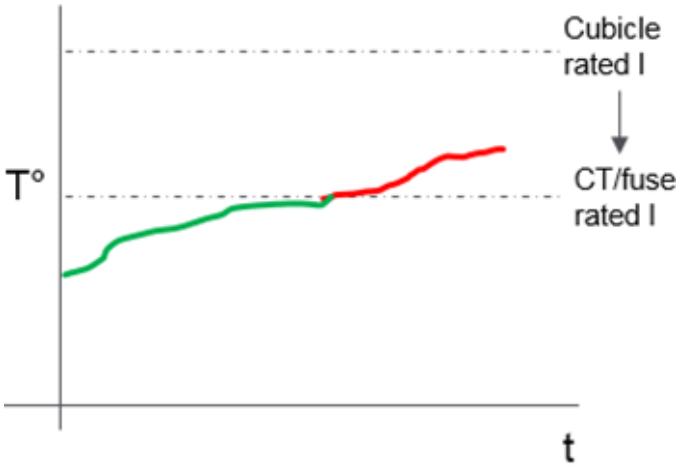

Figure 1

Absolute temperature evolution with a fixed threshold

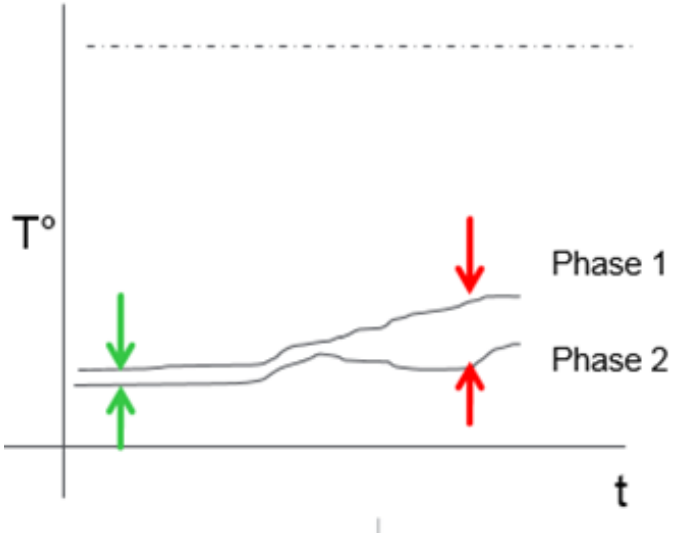

Figure 2

Phase discrepancy evolution

Conclusion

The goal of CMR is to help operators have more visibility of their installation in order to conduct preventive maintenance, or dispatch maintenance crews more efficiently.

It can be a cost-effective solution and provide earlier detection when compared to regular field inspections and the use of thermography.

CMR allows the RMU to be remotely monitored and controlled, meaning that the causes of abnormal thermal activity can be corrected earlier to prevent both future failures or immediate damages. This in short can prevent thousands of customers from losing power while providing cost savings for utilities

About the authors

Ludovic Lamberti is a Schneider Electric Energy Division Automation Product Manager responsible for product offer management. He has 14 years of professional experience working in energy business as a global leader, over 10 years of this with Schneider Electric. He holds an Electrical and Electronics Engineering master's degree from ESIEE in Paris. Ludovic is specialized in product automation and system, with a wide experience of project management, and knowledge of the electricity companies market.

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Contact us

For feedback and comments about the content of this white paper:

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