Crane Electrical Insulation Monitoring in Potlines: New CANDI™ 4.0 Performance

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Abstract

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The still on-going productivity improvement achieved in potlines outlines the importance of the tending crane availability, which results from both their reliability and easiness of repair. In the field of the crane electrical insulation monitoring – essential for ensuring operator safety and avoiding equipment damage, it is now expected that preliminary incidents are quickly tracked and fixed, in order to minimize the investigation time. This paper presents the new Fives monitoring system: CANDI™ 4.0. It deals with a new modular architecture, which allows its implementation both on greenfield and retrofit projects. The paper also focuses on the evolution of the scanning which is faster in CANDI 4.0 than in the previous generations of crane insulation monitoring. It finally presents the information that operation or maintenance people will benefit from, thanks to a thoroughly redesigned human-machine interface and new data transmission abilities.

Keywords: Potroom operations, pot tending cranes, electrical insulation safety monitoring, CANDI 4.0, crane maintenance.

1. Project Objectives

Insulation monitoring systems are essential devices for ensuring optimum Pot Tending Machine (PTM) cranes operation in a potline environment and maintaining high performance in terms of safety and availability. CANDI™ family products developed by Fives have evolved significantly since the first generation released 34 years ago. The latest version named Gold introduced the first help for investigating possible defects and could cope with large high voltage potlines. Nevertheless feedbacks from potline operation and maintenance people expressed some additional need or improvements of this key function for PTM performances.

Fives ECL team made a survey to track internal users' expectations:

- Compliant with a potline voltage up to 2000 V.
- Ability to monitor a three- or four-potential PTM architecture;
- Ability to monitor any types and all generations of Fives machines working above pots;
- Ability to be integrated on a new PTM or installed stand alone for refit (PTM with or without programmable logic controllers (PLC));
- Ability to monitor TN or IT type power distributions;
- Upgradable product (hardware and software);
- Ability to easily adapt the system to customer's needs;
- Embedded documentation for default tracking supports;
- Readiness for data collection and analysis;
- Ability to communicate through the PTM network and/or via Wi-Fi;
- Ability to interface the CANDI™ with smartphone or tablet.

Some interviews were done with PTM users. Additional expectations came to light:

- Ability to locate the default during operation (scan launched by crane operator as soon as the "Alarm" threshold is activated);
- Ability to produce clear and relevant messages to operation and maintenance people;
- Ability to continue operation after lock out of the faulty subassembly;
- Fast and accurate default location to reduce trouble shooting down time as much as possible.

Expressions of concerns having been analysed, the CANDI™ 4.0 project was launched in 2016 to enhance the Fives ECL insulation controller technology.

2. A Modular Architecture

The team key challenge when developing the new CANDI™ 4.0 was to design a solution available not only for the brand new cranes, but also for the existing fleet, where the oldest cranes can exceed thirty years and lead to obsolescence concerns.

The new system should cope with a wide variety of configurations:

- There are cranes equipped with PLCs, others with "traditional" relay logic;
- Some of them are built with three successive insulating barriers (i.e., four insulation levels between ground and pot potential), others with two barriers (i.e. three insulation levels between ground and pot potential);
- The number of trolleys can vary from one to three, each of them being an intermediate ground structure with two insulation barriers to monitor;
- The PTM electrical power supply can be grounded either with the TN mode (neutral to ground) or the IT mode (impedance grounded neutral).

The new monitoring system is based on a modular architecture comprising:

- A core unit in a cabinet, which integrates a controller, a local Human Machine Interface (HMI) screen, high voltage relays and an Insulation Monitoring Device (IMD);
- A batch of local "Equipotential bounding" boxes related to one single potential structure (for example a trolley), allowing for the adaptation of the monitoring architecture to the crane physical architecture. Thanks to their internal arrangement, they allow for the differentiation of sub-grounded parts through a set of contactors;
- All the cabinets and the boxes are connected together through a communication network, for example the PTM one if existing.

Product development is now completed. CANDI™ 4.0 has been sold to several clients in Europe (Trimet Saint-Jean-de-Maurienne), South Africa (South32 Hillside) and Mozambique (South32 Mozal) for PTM retrofit and also for new PTM cranes of Alba Line VI project.

Main options available to date are:

- IT power supply monitoring;
- Fourth potential structure monitoring;
- Wi-Fi connection to portable devices such as smartphone or tablet;
- Embedded trouble shooting (documentation related to the identified default accessible throw the HMI);
- Embedded Key Process Indicators (KPI) which give the ability to track relevant information for operator safety and PTM reliability.

A CANDI™ 4.0 bench test has been installed in Fives premises in Ronchin, France (Figure 1), embedding all the proposed options. It is available both for training and software customisation tests.

but not least, its modular design allows for implementation on a wide variety of cranes, including the oldest ones.

Maintenance people will keep pace with the best industry practices which promote predictive maintenance on the basis of data collection and processing.

In conclusion, CANDI™ 4.0 is the most valuable tool for trouble shooting assistance, while relying on a modular and upgradable measuring system.

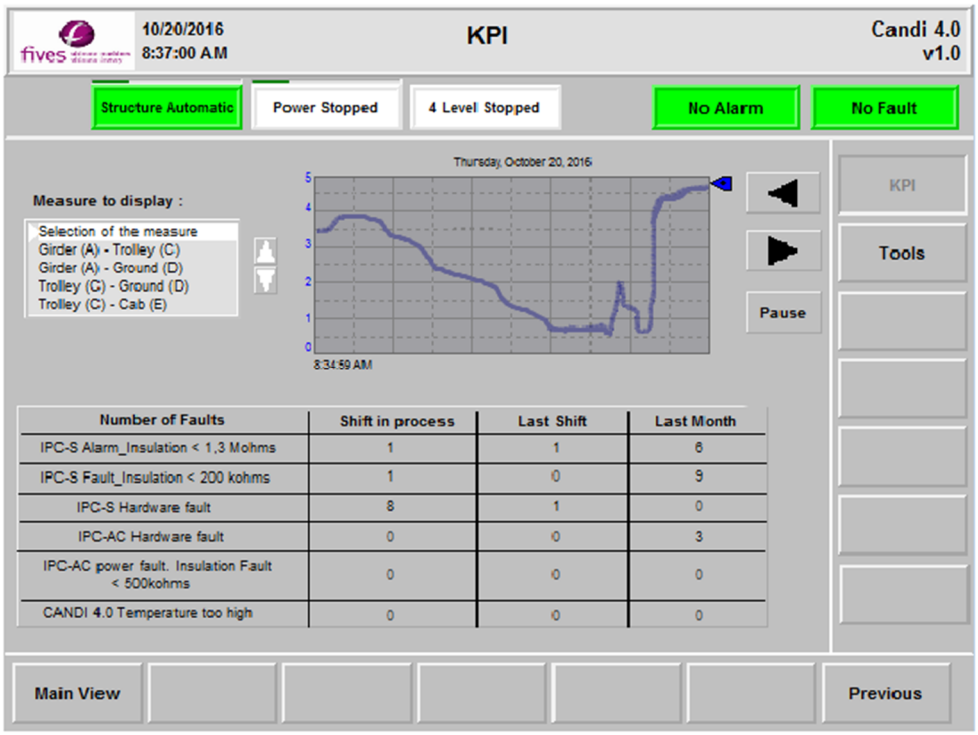

Figure 5. HMI page showing an insulation level trend.

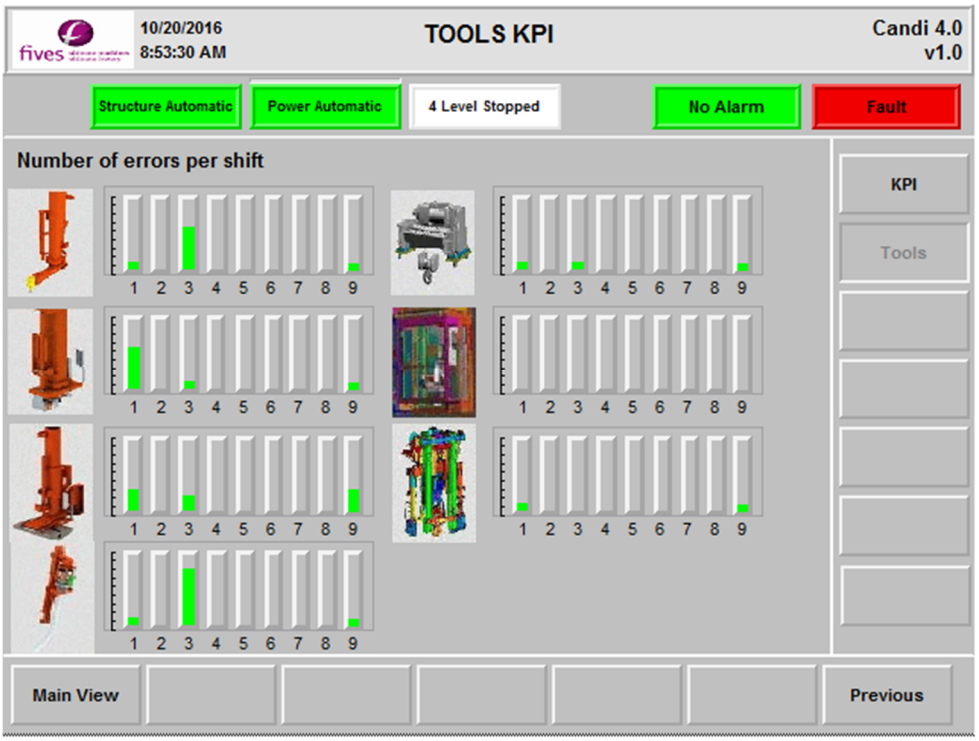

Figure 6. HMI page showing the alarm numbers per tool.