DayCor® Rail - Targeted Analysis of Corona in Overhead Electrical Systems

DayCor® Rail is a corona detection driven system dedicated to assist electrical railways management maintain ongoing safe operation of their mass transportation networks. **Rail combines monitoring, processing and reporting modules** that interact automatically to supply in real time information about the condition of overhead catenary systems.

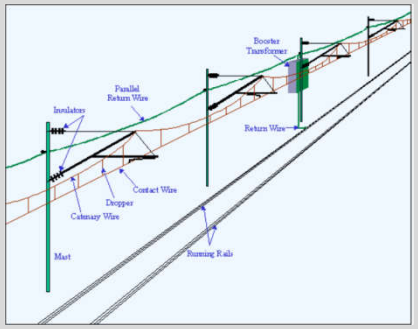
Rail is a **proven cost effective solution** due to its unique mode of operation and to its output, namely, the valuable information collected and reported. DayCor® Rail is unique because it provides processed concrete information, in real-time, of the catenary wires' and insulators' condition and thereby eliminates the tedious weary task of analyzing imagery of lengthy recorded trips. As such, by using DayCor® Rail maintenance teams get the exact information they expect to get, while management get the exact tools needed to control and manage their assets condition and the yield of their staff.

> *"…The 10:22pm train from Grand Central Terminal pulled down the wires because a component called an insulator that ensures the wires are properly aligned failed.. Approximately 3,000 feet of wire were pulled down, and a registration arm smashed the windshield of the train cab, though the engineer was uninjured. Riders faced delays of up to 40 minutes. The damaged wires and other equipment were activated about nine months ago, after being installed as part of a 20 year project to replace the railroad's overhead catenary power system that began in 1991…" [1]*

Improving the main transportation parameters: **fluency, regularity, speed and safety** is what railways management strives to achieve. These parameters are governed by the ongoing appropriate supply of electricity for traction. That is why technological solutions such as

DayCor® Rail are being used. These technological solutions monitor the condition of both fixed installations and contact-line networks that constitute the basic components of electrical railways. In particular, when safety is at stakes monitoring systems have a decisive role in alerting of existing hazardous situations.

Monitoring Insulators



According to Kosakov A.A from the Urals States University of Railway Transport, between 1994 and 2004 50% of all failures on Sverdlovsk railway were caused by insulation failures. Moreover, as a result of ongoing research Kosakov states that **one of the best methods to diagnose insulation failure is partial discharges detection (PD).** Detecting PD with Ofil's DayCor® is effective and nondestructive and therefore most appropriate. [2]

The effects of electrical partial discharge on the chemical properties of composite insulators used in HV railways was investigated by a group of researchers from Alstom Transport, Areva T&D and the Institute Pluridisciplinaire de Recherche sur l'Environment et les Materiaux. Both the origin and consequences of electrical failure of in-service composite hollow insulators used in railway transportation were studied. The conclusions of that study revealed that the polymers of the silicone insulators were oxidized after electrical failure by the Ozone and UV emitted by corona partial discharge.

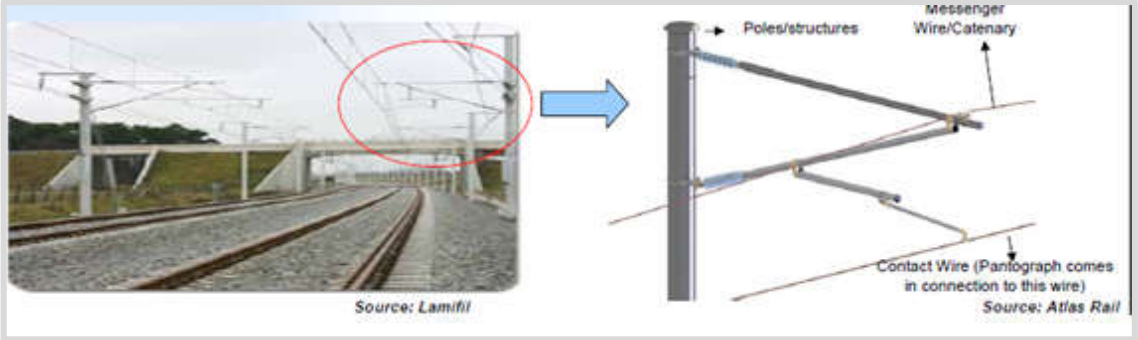
Hollow composite insulators are being used in railway transportation. These insulators have a central glass reinforced polymer (GRP) tube and many other materials such as an elastomeric housing (silicone, Ethylene-Propylene Diene Monomer EPDM, Ethylene Vinyl Acetate EVA, etc.) and metallic elements (connections, copper braids, etc.). The durability of hollow composite insulator is affected by structural and external environmental factors and is subjected during service to a large range of electrical, physical and chemical stresses.

The experimental results of the above study correlated between the premature failure of hollow insulators and the formation of corona discharges. These discharges were **detected at triple point junctions** of the metal fitting – dielectric - and air and created Ozone. Ozone, known as a highly oxidizing gas, corroded the metallic parts and induced the mechanical breaking of the nitrile piston seal, known for poor ozone resistance. Such results ascertain the need for routine inspection with DayCor® Rail. [3]

Commissioning

"… The MTR Corporation has promised to replace a suspect batch of electrical insulators on the East Rail Line after a second fault in 10 days that caused delays for three hours during the evening rush… Services were hit from about 4pm after a faulty insulator in an overhead cable near Fanling station triggered a short circuit". It took 10 days and 70 staff members to replace all the insulators from the installed batch at 65 critical locations.

Commissioning of newly installed insulators and of any other catenary component is performed by DayCor® Rail efficiently because testing is nondestructive and the information provided is immediate so that errors are found before the system becomes operational. Corona is deemed to develop in locations with mismatching components that trigger irregular elevated fields. Sharp edges, air gaps, protruding elements, compromised insulation, voids, gaps etc., will be detected by a corona camera when energized. CoronaCatch, the software used by DayCor® Rail to process inspections and generate reports, takes notes of each corona event and generates a report at the end of each ride. In case of a systematic problem, a pattern of repeated failures will draw attention leading to deeper analysis of the sources.



Contact Wires

Numerous occurrences of catenary wire failures at loading platforms cause disruption to passenger services, and unplanned maintenance. The failure mode of catenary wires is attributed to arcing that takes place at points of pantograph (the electric collection device mounted on the roof of a railway employing an overhead supply system) and wires contacts. Damage can propagate over time causing the wire to fray and eventually collapse. Very low contact force leads to the formation of arc while an extremely high contact force causes wear at pantograph contact strip and catenary.

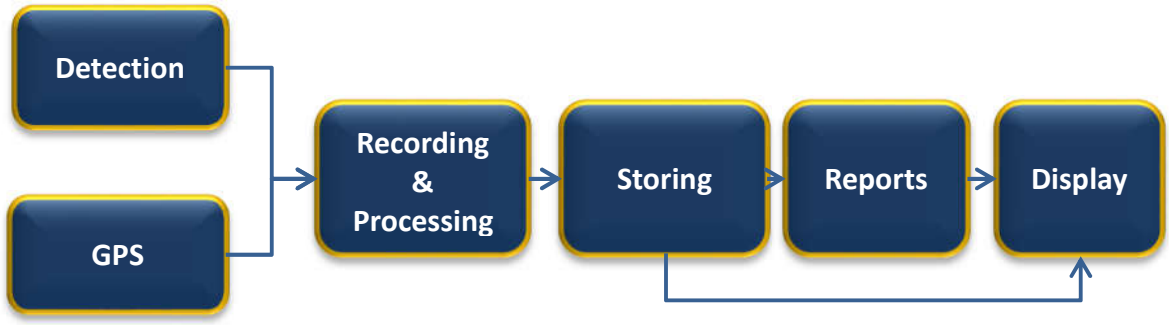
An incident occurred at UK Network Rail Elstree Tunnel when staff who, after replacing a 'flashed over' insulator went to check the Overhead Line Catenary (OLE); upon their approach the OLE Catenary parted in front of them causing a dewirement of the OLE. It appeared that the OLE conductor had only one or two strands holding it, and the movement of the cantilever whilst the insulator was being changed added to the stress on the stranded wires resulting in the wire parting. As a result UK Network Rail published in its **safety bulletin instructions** that state that prior to checking and changing any OLE insulator staff must inspect the suspension points where there is an increased risk of premature conductor failure, and in particular inspect the catenary for parted or flattened strands, abnormal wear and corrosion arc erosion or signs of burning.[4]

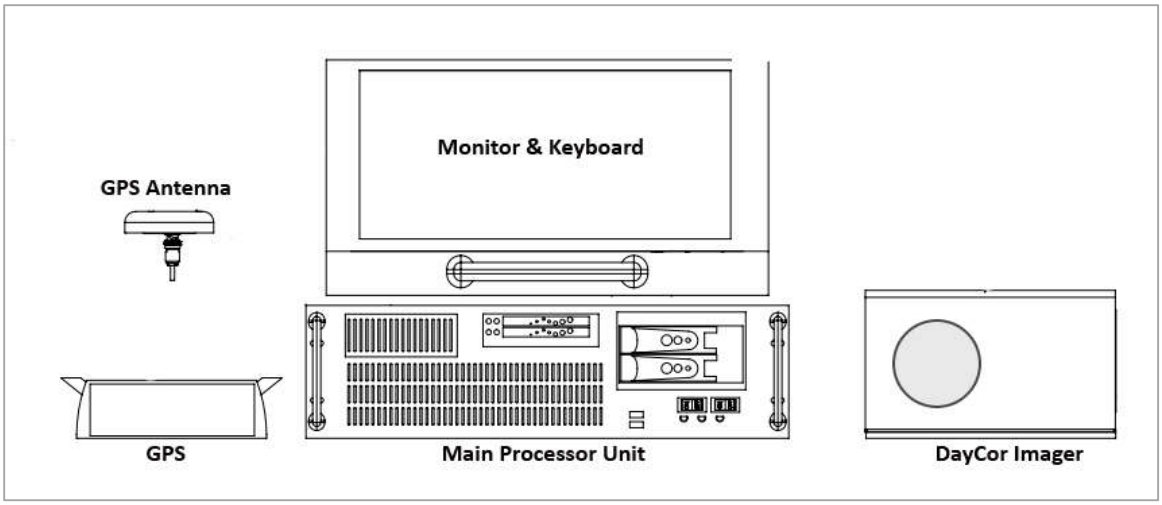
Broken strands, bird cages and any protruding elements on catenary OLE conductors have corona and are therefore captured and reported by DayCor® Rail. GPS data is stamped on the recorded images and enable finding on time the exact cases of fray conductors. To guarantee continuous and uninterrupted electrical supply the interaction and the mechanical contact between the pantograph and the catenary must be complete. **Periodic condition monitoring, fault detection and pre-estimation are extremely important in the electrical railway systems**.

About Ofil's DayCor® Rail system:

DayCor® Rail is an automatic corona and arcing discharge detection system designed for railways. The system recognizes corona events on high voltage railway lines, records them for further processing, stores the processed data and provides a report of all encountered events. The raw data as well as the processed information can be viewed at any time on a monitor.

Building block of DayCor® Rail include input units with a bi-spectral UV-Visible detector, GPS & temperature and humidity sensors, a recording, processing and storing unit, and an output unit with a large display and a removable drive containing the generated reports.





System's Features:

Outstanding Corona Detectivity

Sensitivity to UV of 1pC at least from a distance of 10 meters and 7.7dBμV (RIV) @ 1MHz enables detection of distant corona discharges. A fast responding camera enables capturing signals during high speed movement. Captured scenes show corona flecks superimposed without smearing on the emitting objects.

Automatic Mode of Operation

DayCor® Rail is designed to be an autonomous standalone system that is turned on at the beginning of a cruise and turned off upon arriving to the final destination stop without intermittent involvement.

Rugged and Stabilized

All components have high tolerance to jerky rides and can withstand strong vibrations, resulting in smooth movie clips and continuous uninterrupted recordings.

DayCor® Technology Inside

With Ofil's DayCor® technology incorporated, Rail performs as a solar blind system with utmost overlaying accuracy of both UV-Visible channels and high detectivity.

Video Recording & Storing

During a ride the DayCor® Rail records and stores video clips of encountered corona discharges. The captured media is used as a

reference to findings that are classified as suspicious, in need for further investigation.

Customization Options

DayCor® Rail is customizable and can be tailor made to match specific needs, architectures, platforms, languages and general preferences.

Data Processing

Detected corona events are recorded and processed automatically by Ofil's CoronaCatch application, that segregates corona events from non-corona events and attaches to each event its specific meta information, including: GPS, ambient conditions and severity.

Automatic Reports

Ofil's CoronaCatch uses the processed information to generate reports that are compatible with Ofil's Corona-Base Reporting Software.

EPILOGUE

An essential ingredient in the successful running of a railway is a well maintained system. Reliability is the key to successful railway operation and maintenance should be the number one priority to ensure reliability is on-going. Although maintenance is expensive, it will become more expensive to replace the failing equipment early in its life because maintenance has been neglected. Taking into account the high cost involved with maintenance Ofil developed a system that is sensitive enough to be autonomous and automatic, and thereby cut the operating cost of both inspection duration and of post analysis. Within a click of a mouse the Rail inspection system starts monitoring and another click stops it. With Rail there is no need to go over recorded imagery because CoronaCatch software does it automatically and summarizes results in a html form report with links to faulty video clips and images of suspected failures. As with any system, a comprehensive understanding of the catenary condition will be achieved by combining additional inspection technologies.

Sources:

[1] http://blog.ctnews.com/cassidy/2011/01/18/wednesday-morning-trains-expected-to-be-on-time-after-catenary-problems/

[2] Kosakov A. A., IMPROVEMENT OF RAILWAY POWER SUPPLYING DEVICES DIAGNOSTICS, Xl Modern Technique and Technologies, March 2005, p 14-15

[3] Jean-Pierre Habas, Jean-Marie Arrouy, Fabrice Perrot: Effects of Electric Partial Discharges on the Rheological and Chemical Properties of Polymers Used in HV Composite Insulators after Railway Service, http://hal.archives-ouvertes.fr/docs/00/70/90/24/PDF/articleTDEIpublie.pdf

[4] http://www.safety.networkrail.co.uk/Alerts-and-Campaign/~/media/Home/Resource%20Centre/Workforce%20%20Safety/Safety%20Bulletins/IG-Safety-Bulletin-243---Inspection-of-OLE-Catenary.ashx

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