Smart Grid Services – Asset Services

Substation Condition Monitoring
Evolution or Revolution?
Poll 1:

In which business do you work?
- TSO/DSO
- EPC
- Power Generation
- Mining
- Oil & Gas
- Systems Manufacturer
- Others
Substation Condition Monitoring – Evolution or Revolution?

Webinar Introduction

“The need for condition monitoring solutions has never been greater than it is now”
The purpose of any Condition Monitoring (CM) system should be to provide information with one aim

- Present information to enable prediction of the time to intervene
- Provide direct guidance on intervention required

Our approach to Condition Monitoring to support in the context of an Electrical Substation or Network focuses on 5 key areas:

- Improved Risk Management
- Optimization of Maintenance regime
- Asset Life Extension
- End of Life prediction
- Enhanced rating
“The need for condition monitoring solutions has never been greater than it is now”
The case for Substation Condition Monitoring:

- Investment in our network dominates the expenditure profile of our business
- The investment that we make determines the reliability of the network
- Good Asset Management decisions require reliable & accurate asset condition data
- Our customers want us to keep bills down and improve service standards
- We plan to spend less on asset replacement in the next regulatory period
- To achieve improved network reliability with reduced expenditure requires that we make smarter Asset Management decisions
- Substation Monitoring will allow trending of key performance parameters to enable end of life to be accurately assessed and maintenance, refurbishment and replacement activities prioritised appropriately
- Supporting the detection of onset of failure such that the operating life of assets can be safely extended
Circuit Breaker Failure Modes – Partial Discharge

- Voids or cracks in insulation systems may result in voltage stress across the void
- If the potential across the gap is sufficiently great a spark (partial discharge PD) will bridge the gap
- Progressive deterioration may lead to dielectric failure and breakdown of the insulation
- Substation Monitoring will monitor PD continuously, providing early warning signals for inspection and maintenance to ensure supply reliability and long-term operational performance
Circuit Breaker Failure Modes – Partial Discharge

- Capacitively coupled transducers shall be used to detect Transient Earth Voltages induced on the surface of the metal cladding by partial discharge activity inside metal clad high voltage plant.

- The monitor shall allow measurement and recording of PD activity of all circuit breakers within a substation simultaneously, allowing comparison of PD activity between assets and analysis of PD activity in individual assets over time.
Circuit Breaker Failure Modes – Failure on Demand

- Circuit breakers may fail to trip when called upon or the required trip time may be exceeded
- Measuring the dc current profile of the trip coil testing can be used to identify the cause of slow operation
- A single trip circuit profile is carried out during protection maintenance at 3 year intervals
- Substation Monitoring will capture all circuit breaker operations allowing trending of specific units and circuit breaker types

It is Northern Powergrid policy to take profile tests during protection maintenance. Camlin Power P3 units are currently used to capture the dc trip circuit profile above (Source: Camlin Power).
Circuit Breaker Failure Modes – Contact Deterioration

- Deterioration of circuit breaker breaking contacts is a function of the energy ($I^2t$) the contacts have been required to interrupt
- Substation Monitoring will record the fault current and interruption time, enabling $I^2t$ to be calculated
- Post fault maintenance can be scheduled based on total energy interrupted rather than number of operations, mitigating the cost and risk of unnecessary maintenance.
Circuit Breaker Failure Modes – Environmental Effects

- It is understood that temperature and humidity impact on the deterioration of materials used in the construction of circuit breakers.

- Substation Monitoring will allow the relationship between environmental conditions and the circuit breaker trip profile and partial discharge activity to be further understood.

Whilst the sealing of cable entries may be adequate in moderate conditions the increased pressure of water may cause leaks in inadequate or incorrectly installed seals resulting in high humidity.
Success Factors

- Prevent an incident relating to circuit breaker failure by triggering intervention based on monitoring data
- Demonstrate trends in partial discharge for specific circuit breakers and circuit breaker by manufacturer and type
- Establish alarm thresholds for each circuit breaker type
- Demonstrate trends in dc trip coil profile for specific circuit breakers and circuit breaker by manufacturer and type
- Establish acceptable profile envelope for each circuit breaker type
- Post fault maintenance triggered by $I^2t$
- Demonstrate the relationship between environmental operating conditions and the level of partial discharge activity
- Demonstrate the relationship between environmental operating conditions and dc trip coil profile
Poll 2:

Do you feel that your organisation is facing similar challenges to Northern Powergrid (UK)?

• Yes
• No
• Some
“The need for condition monitoring solutions has never been greater than it is now”
“We have made it this far without investment in new Condition Monitoring technologies, …why do it now?”

- Changing industry, new challenges, greater load
- The Asset life bottleneck
- Increasing Environmental Awareness
- Race toward “Smart Grids”
- Stakeholder expectation
- Ageing workforce & dilution of key skills
- Capex & Opex reduction targets
- Development & retention of skilled personnel
- Smaller workforce
What have we learnt as a supplier?

Responsible – Excellent – Innovative

- Suitability of Asset Monitoring applications – One size does not fit all
- Governance is essential
- Confidence is key
- Think simplistic to maximize the audience
- System Parameterisation on critical assets
- Asset Monitoring Systems are not enough………Users need more
ISCM® - Integrated Substation Condition Monitoring

- Standard yet modular approach to condition monitoring
- Pre-defined monitoring packages on a single platform
- An approach using best practices throughout
- Fixed reporting functionality
- Common look and feel for the operator
- Effective prediction & prevention of Asset failure
- Proof of Asset Performance
- Aligned communications infrastructure
- Common data archiving media and strategies
Risk Centered Asset Management

Offers
- Present health indexes and forecast
- Present risk evaluation and forecast
- Strategic risk analysis
- Next maintenance

Based on
- Online condition parameters
- Offline condition parameters (measurement)
- Asset information (e.g. SAP stored data)
Poll 3:

We would like to know from the audience whether you already invest in Condition Monitoring technologies or whether future investment is a strategic or policy requirement for your organisation?

- Already active
- 0-1 year
- 2-5 years
- No plans to invest
“The need for condition monitoring solutions has never been greater than it is now”
London Traffic Management system presentation, IET 2010 smarter transport, were they stated “we have the data but the system is not able to support real time decisions” [Houghton 2010].

The future of asset management will not involve simply deploying more sensors, or by integrating current monitoring systems under one umbrella communication network.
The future is to smarten the grid...the evolution begins with Embedded Intelligence.
Substation Condition Monitoring – Evolution or Revolution?
Heriot-Watt University – Embedded Intelligence
Substation Condition Monitoring – Evolution or Revolution?
Heriot-Watt University – PHM System Overview

Diagnosis:
- Fault detection with low false alarm rate
- Techniques such as support vector machines (SVM), decision trees etc

Prognosis:
- Predict life consumption by modelling fault progression
  - Data driven methods
  - Model driven methods
  - Fusion techniques

Health management
- Make appropriate decisions about maintenance
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Heriot-Watt University – Fusion Based Prognostics
Areas of Research include:

- Optimising power management
- Design of sensors that can operate under fault conditions.
- Protection strategies of sensors from lighting strikes, faults, and EMI/corona
- Design of Reliable Wireless Networks
- Front end intelligence
- Agile Manufacturing (Additive Manufacturing) – Functionality as well as Harsh Environment compatibility
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Heriot-Watt University – Smart Sensor Examples
Embedded Intelligence is supporting the evolution from traditional condition monitoring to intelligent asset management.

A combination of new and customised off the shelf technologies will be assembled within intelligent multi-sensor units that will be programmed with fast algorithms, themselves programmed into the FPGAs/microcontrollers.

New standards such as IEEE P1687, will ensure against false readings as the results of sensor drift or in the event of failure.

Power networks will utilise Prognostic and Diagnostic Sensor Systems within an Open Reference Architecture for Intelligent Monitoring of Assets on Power Networks.
Substation Condition Monitoring – Evolution or Revolution?
Closing Statements

“The need for condition monitoring solutions has never been greater than it is now”
Poll 4:

Would you please confirm whether you would like to be contacted by Siemens to discuss any of the topics that we have covered today?

• Yes

• No
Substation Condition Monitoring – Contact

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