Study Committee B1

Insulated cables

10960_2022

Instrumentation on HV Cable Systems for preventive maintenance

T. LUCIGNANO, J. MATALLANA

STATNETT SF

Motivation

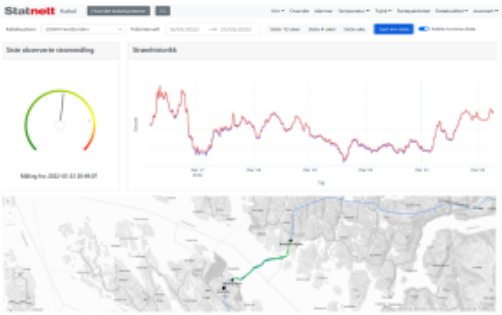
- Statnett experiences a growing need for collecting more information from power cable systems in operation for condition-based maintenance.
- The service conditions to which the cables are subjected are getting constantly more demanding during the lifetime to meet the requirements of increased power transmission and optimised use of existing assets.

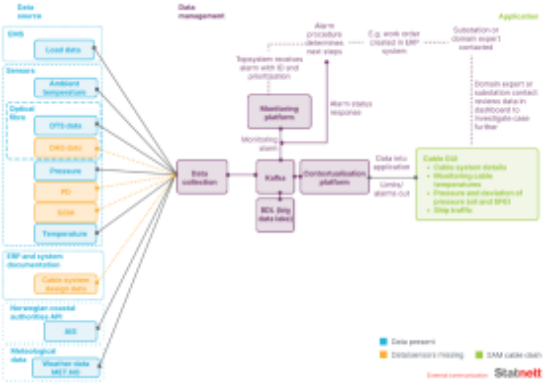
Method/Approach

- Due to the increasing amount of instrumentation and monitoring systems, a clear approach for data management has been defined.
- information from sensors and monitoring systems is directed to a 24/7 monitoring centre that controls the parameters used for preventive maintenance. In this way alarms can be triggered, and maintenance activities planned based on trend analysis.

GUI

- Statnett has developed an application for the visualisation and condition assessment of cable systems. The application is accessible by different user groups for visualisation of specific information.
- Engineers in the field are able to have a holistic view of the complete cable system where data is combined in one place.





Discussion and conclusion

- Several approaches are available for instrumentation of HV cable systems. Statnett chose to focus on temperature and pressure monitoring in a first time and developed in parallel an interface for data management. use bullet points with clear statements.
- The use of DTS systems is now generalised in Statnett on new cable systems where optical fibers are systematically added either bundled with the cables or integrated in the sheath.
- With the increasing amount of sensor types from different suppliers, it is particularly important to have a clear strategy to define standards for data management and consequently secure the availability of data in the Cable Systems GUI. Pre-warnings are generated based on trending of data. Maintenance activities, such as visual inspections and surveys can be scheduled based on the triggered pre-warnings.

Study Committee B1

Insulated cables

10960_2022

Instrumentation on HV Cable Systems for preventive maintenance

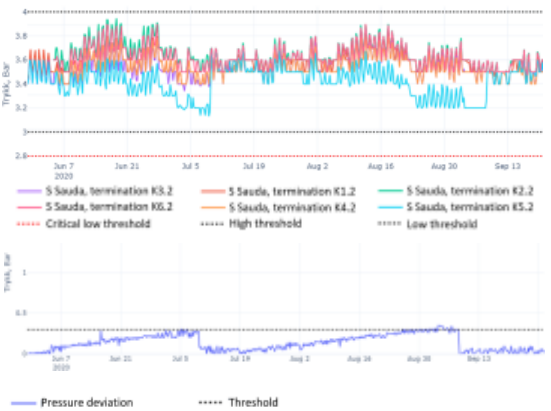
T. LUCIGNANO, J. MATALLANA

STATNETT SF

SF6 Pressure monitoring at Sauda

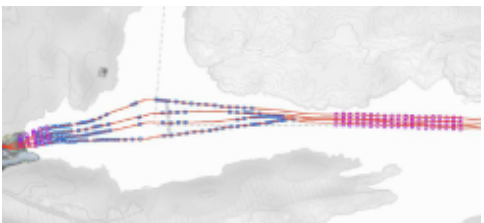
- The refurbishment works in Sauda substation required the installation of three underground cable systems instead of direct aerial connection.
- The cable systems consist of 2500 mm2 Al 420 kV XLPE cables with SF6 filled outdoor terminations.
- The pressure varies to some extent that makes often difficult to determine whether it is related to temperature or a leakage occurs. This phenomenon is particularly emphasized in harsh climate as in Norway, with large temperature variations which lead to many condensation issues in electrical cabinets.

- There is now a 2-level decision-making process with a relay alarm only connected to the dispatching centre for immediate action in case of emergency as well as a constant supervision system accessible from anywhere that enables to anticipate any degradation and then schedule a corrective action a long time before any failure happens.

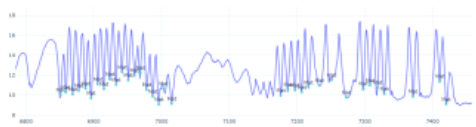


Distributed temperature sensing at Fensfjorden

- The following case is related to a 420 kV submarine cable system which is crossing the Fensfjorden in the west of Norway.
- The cable system consists of four single core cable with an approximate length of 7.8 km each. The fourth full cable length is installed as spare in case of a cable fault on one of the phases occurs.
- All four cables are equipped with integrated optical fibres which are connected to a multiple-channel DTS system.
- The shallow area towards Iledalsvågen comprises soft seabed which would cause sinking of the cable down in the soil for several meters.



- During operation of the cables, temperatures are monitored continuously.



- Any abnormal increase or decrease of temperature in critical areas of the cable route, particularly where concrete mattresses were installed, will trigger the intervention of the Asset Management Team.

Study Committee B1

Insulated cables

10960_2022

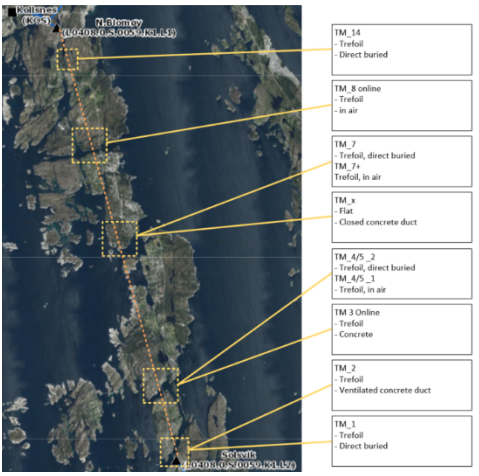
Instrumentation on HV Cable Systems for preventive maintenance

T. LUCIGNANO, J. MATALLANA

STATNETT SF

Temperature measurment at Øygarden

- The Øygarden underground cable system consists of three single core 300 kV SCFF cables with a circuit length of approximately 15 km. Each phase is delivered in 18 lengths between 450 m and 1200 m. The cable system is installed over four islands, Misje, Toftøy, Rongøy and Blomøy and is in operation since 1995.
- Resistance Temperature Detectors (RTD) type Pt100 were laid on cable oversheath during installation in 1995 at various locations along the route. Temperatures were measured once a year for the purpose of maintenance.
- In addition to using the existing Pt100 elements, additional temperature sensors were installed at more locations (such as, unfilled trough and in air inside a bridge) for verification of the thermal conditions.



- Since most of the 4-wire pt100 elements were installed in 1995, some issues were experienced. Several loggers indicated faulty values and were therefore removed from the figure above. The faulty values are considered due to water ingress in the probe and resulting oxidation.

- Temperatures were analysed multiple times during operation and compared with ampacity calculations according to IEC 60287. Although the cable system is not operated towards continuous maximum capacity, the measured temperatures are well below design limits.

Conclusion and further work

- Several approaches are available for instrumentation of HV cable systems. Statnett chose to focus on temperature and pressure monitoring in a first time and developed in parallel an interface for data management. Three different examples are given in this paper to address the three main activities ongoing in Statnett: temperature measurements by means of RTDs or using DTS systems, as well as pressure measurement using pressure gauges or analog transmitters.
- Statnett aims to automatically make data-driven decisions, if this shall be possible, the data quality, uptime and availability from sensors and transmitters must be as high as possible for that the decision must be reliable.
- Implemented instrumentation is often subjected to rigorous climate and strong temperature variations that could affect the reliability of sensors. This constitutes a challenge Statnett is constantly working with.