115kV Underground Power Cable Monitoring

Dammam, Kingdom of Saudi Arabia

Saudi Electricity Company (SEC) is responsible for generation, transmission and distribution of power in the Kingdom of Saudi Arabia. The company operates 45 power generation plants and required a reliable Distributed Temperature Sensing (DTS) system for monitoring an interconnection cable from an overhead line to grid station, situated in an urban area. The objective was not only deploying a well-performing system, but one 100% integrable with the existing automation system, providing greater monitoring and control capabilities to operations and management teams. AP Sensing's solution was trusted for this project and satisfied the challenging project requirements.

Khudriyah-2 BSP is a newly built grid station situated on the outskirts of Dammam city, Saudi Arabia. Our DTS system was deployed to monitor the temperature of two 115 kV underground circuits from the overhead line (OHL) transition area to the Khudriyah-2 grid station. Each single phase cable is monitored by the DTS to ensure complete circuit coverage.

Our technology not only provides the thermal profile of the power cables, but also greater insights to the actual conductor temperature and transient statuses with our Real Time Thermal Rating (RTTR) engine. AP Sensing is one of SEC's approved vendors and provider of DTS technology for many of its projects.

Overhead Line Termination

Configuration

The project utilizes an AP Sensing N4415A DTS unit equipped with 12 integrated measurement channels with a reach of 12 km each. Although only six channels are in use to cover this double circuit, the client chose to prepare for future expansion of the power grid. Each power cable is approximately 9 km long, subdivided into 34 monitoring sections. 147 alarm zones were configured for each power cable, forming 882 alarm zones for both circuits. Segregated alarm zones were deployed for specific sections and joints in overlapping schema to generate warning pre-alarms and alarms at 60°C and 70°C thresholds respectively.

Installation

A multimode fiber optic sensing cable, 6 mm in diameter, was attached to the outer surface along the power cable from the OHL transition area to the switch gear sealing inside the grid station. This ensures the end-to-end monitoring of the cable. As the underground power cables run through densely populated urban areas, these are subject to various crossing techniques such as HDDs or duct banks for areas such as roads, buildings and pipelines. With DTS monitoring, thermal burdens due to poor thermal conductivity are now visible to operators. AP Sensing's single-ended solution provides the contractor with full flexibility to deploy the DTS rack on the far end of the circuits and achieve desired outcomes.

SmartVision™

The system rack was equipped with an industrial PC and SmartVision. SmartVision is a centralized software responsible for data collection, storage, processing and visualization. It effectively collects DTS data and further maps it to power cable lengths, so the operator can visualize the data.

Live view of underground cable temperature

With the comprehensive GUI, the software enables our client's team to create history graphs of any point or section along the cable, plus satisfy open and closed-loop communication testing requirements. SmartVision provides two-way communication via modern and industry standard communication protocols.

RTTR

A real time thermal rating (RTTR) engine was also included in the project to calculate conductor temperature and emergency ratings dynamically. Utilizing the power cable manufacturing record, as-built route plan, cross-section schematics and crossing details, four RTTR thermal models were tailored to provide the real time thermal ratings. The purpose of this detailing was to ensure the software calculations are based on actual information from the ground and no inaccurate assumptions are included. Thus, the rating results are precise and key decisions can be made.

System Compatibility

One major project requirement was full integration with the substation automation system (SAS) via the IEC 61850 communication protocol and PRP for redundancy. A special systems interoperability test was conducted at the SAS vendor's facility and commissioned to ensure the DTS and substation automation systems are compatible with each other. AP Sensing's SmartVision software was able to receive current load data and transmit alarms and values to SAS platforms via the IEC 61850 over dual fiber optic cable PRP links. Further SAS testing was completed to ensure the signals are grouped and transmitted via legacy protocols IEC 60870-5-101 and -104.

Underground Cable Termination

Representatives from all project stakeholders worked together closely to plan, conduct and validate the systems interoperability test. This activity enables Khudriyah-2 and various other SEC projects to seamlessly integrate our system with the SAS platform.

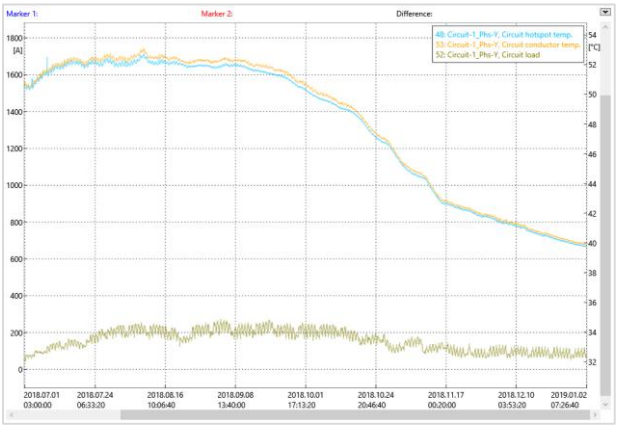

Fig 1: Circuit 1 - Temperature and load histories in summer and winter seasons.

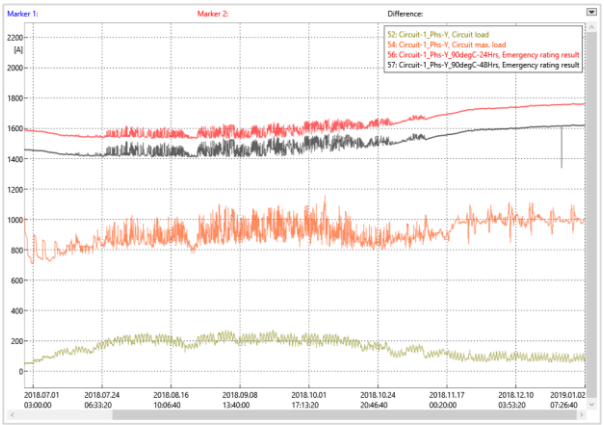

Fig 2: Circuit 1 – Current Load, Maximum Load and Safe Overloading limits for 24 and 48 hours.