QUALIFICATION, SUPPLY AND INSTALLATION OF THE WORLDS FIRST 420 KV XLPE SUBMARINE CABLE SYSTEM IN NORWAY

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ABSTRACT

The worlds first 420 kV XLPE insulated submarine cable link has been installed from the mainland grid to the island Gossen for power supply to the Ormen Lange gas processing plant. This paper describes the background for selection of a 420 kV XLPE insulated cable system and the extensive qualification testing that has been performed to verify the cable system. The design of the cables and accessories is also described. The cable system was installed in summer 2006 and subjected to an after installation test at 1.7 Uo, 374 kV, before it was energized.

KEYWORDS

420 kV XLPE cable system, type testing, prequalification testing, installation, after installation testing

INTRODUCTION

Outside the west coast of Norway large gas resources has been found. The Ormen Lange gas field exploration is planned to be a main gas supplier to Great Britain. A large gas processing plant is under construction at Nyhamna on the island Gossen. There are other large consumers in the region which has lack of electrical generating capacity. To improve the power supply to the region Statnett has built a new 100 km long 420 kV overhead line and a new transformer station at Fraena on the mainland.
The power supply to the gas processing plant is built as a radial extension from Fraena sub station to the new Nyhamna substation on Gossen.
The 420 kV radial extension includes 6 km overhead line, Hamneset transition compound, 420 kV submarine cables, short land cable sections and the new Nyhamna sub station on island Gossen.
In the procurement process Statnett invited suppliers to tender oil-filled cable solutions as a base case with XLPE cable solutions as an alternative. In the negotiations with Nexans it was agreed to use the XLPE solution as base case and with oil-filled cable as a back-up solution in case the progress in type tests and fatigue tests was deemed to be unsatisfactory and not concluded within a defined milestone.
Statnett SF has been responsible for pre-engineering, procurement and building of the industrial radial in agreement with Hydro representing the owners in the gas field exploration. Hydro and partners in the Ormen Lange license will be owners of the 420 kV radial when all construction work has been finalized.

AMBIENT CONDITIONS AND FUNCTIONAL REQUIREMENTS

The power requirement for the processing plant is planned to be 200 MW as large compressors have to be installed after some years. Offshore field developments in the future may cause need of more power and after evaluation of various potential future developments in the area, the transmission capacity of the cable link was defined to be 1000 MW.
The submarine cables are crossing a straight at maximum water depth 210 m with steep slopes approx. 30 ° towards landfalls on both sides. Heavy wave action may occur at landfalls. Consequently a special protection with pre-installed PE pipes has been chosen near-shore at landfall down to 10 m water depth. These pipes were finally filled with bentonite to secure the required transmission capacity.

At one landfall the routing had to have a significant change of direction at top of the slope. An under water hang-off arrangement was designed and installed at 25 m water depth to prevent sliding of the cables.

As the power supply is a radial cable link it was decided to install a spare cable with completed terminations in both ends. The SF_6 switchgear in Nyhamna substation has been designed with a system that enables fast change between each main cable and the spare cable.

Fatigue testing of the lead sheath of the XLPE design was to be performed to verify the 40 year design life required for cables, accessories and components.

As part of an enhanced QA regime it was concluded to include an AC test of all cable lengths with a maximum stress at the conductor shield of 26 kV/mm in the factory.

TECHNICAL SOLUTION

The design of the cable system was based on Nexans experience from EHV XLPE/oil filled underground cables and the long experience with EHV submarine oil filled cables. Land cable design was used in 400-500 m long land sections on each side. Transition joints were installed in joint locations close to each landfall. Due to very steep slope at Nyhamna landfall the jointing pit was located some 70 m from the landfall close to top of the slope, see Figure 1. The land sections were short enough to allow use of single point bonded underground cables.