

The Oslofjord Project - The world's first installed 420 kV submarine cable connection combining SCFF cables and XLPE cables with flexible factory joints

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ABSTRACT

Statnett, the Norwegian Transmission System Operator (TSO) commissioned and put into service the new 420 kV AC cable connection across the outer Oslofjord in 2014. The cable system is based on a dual technology concept with six paper insulated self contained fluid filled (SCFF) cables with state of the art pumping stations on both sides of the fjord and three cross-linked polyethylene (XLPE) cables. Each XLPE cable contains two factory joints fully qualified and type tested. To our knowledge this is the world's first installed 420 kV XLPE submarine cable system with flexible joints.

This paper address all aspects of the submarine cable projects including system design, cable routing, technical solution, testing, installation and protection.

KEYWORDS

420 kV submarine cable link, XLPE cable, SCFF cable, XLPE factory joints, pumping plant, DTS

INTRODUCTION

Statnett had since 1981 operated a 420 kV AC cable connection across the outer Oslofjord in Norway, just south of Horten and Moss, see map in Figure 1. The cable connection was very important to secure stable power supply in the eastern part of Norway and for power exchange with Sweden. The connection consisted of six fluid filled paper insulated cables with oil pressure tanks at each transition station and a jointing chamber at the island of Bastøy. The cable link had been in continuous operation for 27 years when a cable fault occurred in 2008. The fault made it necessary to reduce the maximum allowable transmission capacity to 65% of the original 1800 MW. In order to increase transmission capacity and secure reliability a decision was made to replace the connection. In 2010 Nexans Norway was awarded the turn key contract for the Oslofjord project.



Fig. 1: Geographical location

AMBIENT CONDITIONS AND GENERAL REQUIREMENTS

Number of cables:	9
Capacity requirements:	1350 A pr. cable
Maximum water depth:	220 meter
Length:	13 km
Air Temperature:	-25 - +30°C
Sea Temperature:	5 - 17°C
Distance between cables:	Nominal 20 m
Target burial depth:	Nominal 1 m

TECHNICAL SOLUTION

In this project Statnett decided to combine the well known and proven SCFF technology with the emerging XLPE technology. The new 420 kV cable connection consist of six SCFF cables and three XLPE cables. Both cable types have a 1200 mm² Cu conductor giving a total transmission capacity of about 2700 MW. The cable route is 13 km long and two factory made flexible joints were required for each XLPE cable, i.e. six joints in total. The lack of service experience for XLPE joints at this voltage level motivated the choice of a combined SCFF/XLPE solution: Statnett wanted to start accumulating service experience with long length 420 kV XLPE cables while still keeping the risk level acceptable for the connection which is a vital part of the grid in the Oslo area.

Both cable designs were type tested according to relevant IEC standards and Cigré recommendations. Mechanical tests were carried out for a design water depth of 400 meter. This ensured a robust margin with respect to the actual maximum laying depth of 220 meter. For XLPE a more extensive development and test program was carried out at an early stage of the project. This work has previously been reported in [1].

XLPE submarine cable

The XLPE cable design for the Outer Oslofjord Project was based on the Ormen Lange cable design [2], with a traditional stranded conductor cross section of 1200 mm², filled with a water blocking compound. The cable was armoured with flat copper wires in two layers, with a total armour cross section of approximately 2700 mm². In addition a steel tube with fibres was embedded in the PE sheath, see DTS section for further details.