

Lillebælt - installation and commissioning of world's first 400kV 3-core submarine cable

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In this paper, the experiences of the design, production, installation and commissioning of the world's first 400kV 3-core submarine cable are described.

The Lillebælt project was based on a political agreement from 2009 which objective was visually to enhance the existing 400kV grid at a number of specified locations across Denmark.

The scope of the Lillebælt project was to replace the two existing overhead lines crossing the Lillebælt Straight with underground and submarine cables.

Through detailed project engineering including seabed surveys, soil investigations and intense dialogue with authorities it was determined that the optimal project layout required the cable to be subjected to:

- Crossing several roads
- Crossing nature protected commons and streams
- Up to 50 meter deep waters with significant currents in the highly trafficked Lillebælt Straight
- 1 km underground cable route through a golf course
- Crossing under a forest
- Safety issues due to parallel overhead lines
- Cable pulling in HDD's

The cable chosen to solve this scope was the ABB produced 400kV 3 x 1400 mm² Al stainless steel armored submarine cable, the first of its kind on this voltage level. In addition to being the first ever 400kV 3-core cable, the cable is also the biggest power cable (dimension wise) in the world to date. Cable type testing according to IEC was performed on an experimental cable of similar design which ABB had produced prior to contract award

In addition to the submarine cable also 33 km of 400kV single core underground cables for connecting the submarine cable to the remaining overhead lines were included in the project. The underground cables are connected to the overhead line using innovative new designs for the transition compounds.

Installation of the underground cables showed to be challenging, mostly because the main part of the cable route was running in parallel with, and relatively close to, the 400kV overhead lines which the cables were to replace. A fault on these overhead lines could result in dangerously high induced voltage levels in the parallel cables during installation of cables, joints and terminations.

A challenging part of the submarine cable installation was the installation of a Rigid Sea Joint on this world record cable. Due to all potential risks it was early decided to use the local Danish submarine cable installation contractor (J.D. Contractor) as they were familiar with both the location and installation of large size submarine cables. In general the installation went very well, mostly due to extensive planning.

After installation of the two parallel circuits (submarine cable, underground cable and accessories), a Site Acceptance Test (SAT) was performed on both circuits in September 2013. After six hours of HVAC testing the world record cable system was ready for handing over from ABB to Energinet.dk.

The two 400kV cable systems were commissioned in November and December 2013.