Underground Cable Link

245 kV cable installation in Stockholm city

Cable data	
Voltage	245 kV AC
Power	250 MVA
Length	2500 m
Conductor	630 mm^2 Al
Insulation	XLPE
Weight	10,9 kg/m
Customer	Stockholm Energi
Year	1985

Project content

XLPE cable and accessories

Cable system design

Project management

Installation

The first 245 kV cable installation for the distribution network of the city of Stockholm was commissioned during the late spring of 1985. It supplies the Ropsten district heating plant with electricity. This installation, with a length of 830 m, comprises three single-core cables, insulated with cross-linked polyethylene (XLPE). The good experience obtained from the installation and service of other high-voltage XLPE cable installations in the network of the Stockholm utility Stockholm Energi, was an important factor when the utility had to decide on the choice of cable type in connection with a step up to a service voltage of 220 kV. The cable is designed for a continuous rating of 650 A, corresponding to about 250 MVA.

Cable installation

The cable installation consists of three single-core XLPE insulated cables, connected directly to the 220 kV grid in an outdoor substation. In the district heating plant the 220 kV distribution takes place in a gas-insulated substation, which made it possible to meet the requirements for indoor installation.
The cable is partly buried in the ground over a distance of 230 m and partly laid in an underground tunnel with a length of 600 m.
The part of the cable buried in the ground determines the thermal rating. With the aim of assuring stable natural cooling of the cables in the ground, the temperature of the sheath is allowed to rise to a maximum value of 40-45 °C at a temperature of 15 °C in neutral soil, related to long-term duty at the rated load, 650 A/phase. This limitation of the sheath temperature made it necessary to adopt a plane configuration with a distance of about 10 cm between the cables in the ground. A more compact triangular configuration proved to be fully acceptable for the open laying in the tunnel. To eliminate screen losses and in this way raise the transmission capacity of the cables, the cables have been transposed and provided with cross-bonded screens.

The cable

The cable has one 630 mm^2 conductor of aluminium wires that have been stranded and compressed together.
The insulation system is produced by means of a triple extrusion process, which means extrusion and cross-linking of the insulation and the two conductive layers in the same operation. This eliminates the risk of impurities and inhomogeneities in the sensitive interface surfaces. The manufacturing process also includes a fully enclosed system for feeding raw materials, which excludes dust and other particles. In addition, the cross-linking of the XLPE cable takes place in an environment absolutely free from water, which means that vapour diffusion into the insulation is eliminated.
The cable screen area is 325 mm^2 and consists of round copper wires in two layers with an intermediate copper strip. On the outside the cable has a sheath of PVC. This acts both as mechanical protection and as insulation for the screen to earth.

Terminations

The cable installation interconnects an outdoor substation and a gas-insulated substation. This means that different types of termination had to be selected for the two ends. A termination type LXGA is used in the GIS and this is unconventional in so far as it does not have any separate insulation. It is based on the principle that the field grading system and the termination of the cable end are made gas-tight in themselves, which means that no additional gas-tight epoxy barrier is required. The open terminations APEC 2455 at the other end are more of conventional design with the field grading system enclosed in a porcelain insulator. This also includes a synthetic insulating fluid, polybutene. The field grading system is of geometric type, based on a prefabricated cone of EPDM rubber.

Splicing

The splices included in the cable installation are of the moulded type. This means that they are made from the same insulating material as used in the cable. Due to good dielectric properties of the insulating material, the splice insulation can be made with the same thickness as the cable insulation. Because the conductor joints are welded together and will not therefore be thicker than the cable conductor, the overall diameter of the splice will be practically identical to that of the cable. The splice can therefore be considered to be equivalent to the cable both electrically and mechanically. For cables laid in tunnels, as here, this is of great importance from the space point of view.

Cross-bonding

The cables are transposed and the cable screens in the three-phase group are cross-bonded so that each cable screen on an average will have the same mutual inductance to all three-phase conductors over the entire installation. This procedure means that the voltage to earth induced by the conductor current in each cable screen at full symmetry will be zero at the end points of the installation. These can therefore be earthed without screen currents with accompanying screen losses arising.

Testing

The cables and accessories have been tested according to applicable standards and a type test programme. Each cable length also underwent routine tests in the factory with 283 kV (= 2 U_o), AC for 30 minutes in sequence with PD measurement at 177 kV (= 1.25 U_o). The sheaths were tested with 25 kV DC, for 1 minute. After the completion of the installation the cables were tested with the normal service voltage for 24 hours before they were taken into full service. The cable sheaths were tested with 10 kV DC for 1 minute.

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