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JICABLE'07
Rapporteur's Session Report

A.9 SESSION : SUBMARINE CABLES

Chairman : George BALOG, Nexans, Norway
Rapporteur : David DUBOIS, Nexans, France

The A9 session was dedicated to Submarine Cables. Six papers were presented. Various topics were addressed, including basic design, construction design and protection, monitoring and rejuvenation.

Paper A.9.5 compares different options for a 1 GW, 60 km long power interconnection between a prospective offshore wind farm and the UK transmission grid. All options are based on HVAC XLPE power cable. Three-core and single-core cables are considered. Voltages are 132kV, 220 kV or 400 kV. Overall cost including ohmic losses, repair costs and unavailability related costs are taken into account. Some technical considerations are discussed. The 400 kV single-core with a spare cable appears to be competitive against lower voltages solutions.

Paper A.9.2 presents the application of finite element calculations to the magnetic and thermal design of electro-hydraulic umbilical for the offshore industry.
Induced voltages in signal pair embedded cable were assessed by the finite element method and some measurements were carried out on a 4 km long hybrid umbilical.
Temperature calculations were performed using both the finite element method and the IEC60287 analytical method. The agreement is good and justifies the use of the f.e.m. method for the design of complex constructions.

Paper A.9.1 reports the main features, design, manufacturing, protection and temperature monitoring of the second submarine interconnection between Spain and Morocco. Three new power cables and two new FO cable were manufactured, laid and protected using various techniques such as embedment by jetting, concrete mattresses, cast iron halves and pulling in steel pipe. Owing the use of a remote operated vehicle free spans could be avoided. Two new oil feeding stations were put in service. This new link enhances the power exchange capacity between the UCTE1 and SWME networks.

Paper A.9.3 describes the qualification, supply and installation of the world's first 400kV submarine cable system in Norway. In 2006 a power interconnection was erected between Norway mainland and the island Gossen to feed the large gas processing plant built there for the exploitation of the Ormen Lange gas field. The submarine part is 2.4 km long and it features single-core 1200 mm² copper XLPE cable. The rated power is 1000 MW and the maximum depth is 210 m. Tailored design of submarine cable and transition joint was made and subject to mechanical, electrical and water penetration test according to CIGRE and IEC publications. Fatigue of the lead sheath was simulated with a pressure device and found to be compatible with load cycles during 40 years.

In paper A.9.6 a novel use of imbedded FO core in three-core submarine cable is proposed. Most of 3-core SM cables have an embedded FO core that can act as a distributed sensor for various stresses. Temperature measurement is well known but here the extension to measuring mechanical stresses is proposed. Strain measurement of the fibre optic is only achievable for curvatures that cause elongation in excess of its slack percentage. However the distributed thermal / strain sensor can be used to monitor strain changes caused by cable motions. This new technology offers a wire range of application from testing and qualification to installation and operation.

In paper A.9.4 improvements of the injection technology for rejuvenation of extruded cable is described. Over passing the limitation of some 2 kms is length looks possible with a stepped injection process. First acetophenon mixed with other components is injected to exclude water from the insulation by solubility differential then condensation catalyst can be injected without sacrificing the maximum possible injection length.