FEASIBILITY OF A 100 KM UNDERGROUND CABLE SYSTEM TO SUPPLY OR DELIVER 135 MVA TO OR FROM A REMOTE PLANT

Mark **STEMMLE**, Nexans Deutschland GmbH, (Germany), mark.stemmle@nexans.com
Ken **BARBER**, Nexans Asia-Pacific, (Singapore), ken.barber@nexans.com

ABSTRACT

In this paper the feasibility of a 100 km underground cable system to supply or deliver 135 MVA to or from a remote plant is investigated. AC as well as DC cable designs, which are especially suited for unprotected environments, are presented. Different cable systems fulfilling the requirements are compared especially with regard to system losses. Further, estimations of the investment costs for the different systems are given.

KEYWORDS

Long length cable systems; HVAC cable systems; HVDC cable systems; comparison AC - DC.

INTRODUCTION

In today's fast changing world we are finding that there are many cases where it is required to provide power to remote locations in a very short time or implement a means of transferring power from renewable energy sources quickly to the grid.

In the first case, it was often considered practical to build remote oil or gas fired power plants adjacent to the location, but with the significant volatility of fuel pricing, due to recent events, this is now becoming an unacceptable risk. At the same time, there are also maintenance and operating factors so that a connection to the grid is very much more desirable.

However, irrespective of the country with modern environmental assessment requirements, it generally takes 6 - 8 years to plan and construct an overhead line. On the other hand, an underground cable installation can often be implemented within 12 - 18 months.

Initially the capital cost of underground cable systems may be considered restrictive, however when all factors are taken into account such as cost of losses in terms of price of "Green Energy", better reliability, reduced maintenance costs and community support, this solution becomes more attractive.

In a review of cable trends some years ago [1], it was noted, that in 1993 the Electric Power Research Institute in the USA set as a goal the lowering of the cost of undergrounding for both transmission and distribution cables by 50 % by the year 2000. This target was quickly achieved and today costs are even lower. Firstly, cable costs have reduced in real terms with the development of cheaper high quality materials, faster processing and reduced insulation levels. Modern construction methods including "trench-less" technology, circuit optimization, improved backfills, and mechanized laying / handling have all played a part. It is vital to consider all factors when making such an assessment such as the slower time / temperature response of underground cables to overload requirements which often means that it is not always necessary to rate underground lines at the same full continuous rating as overhead lines. Often the opportunity to undertake the project on a "design and build" arrangement substantially reduces overall costs.

In the past a limit of 30 - 40 km was set for the length of underground cable systems, based on cable capacitance, but there are already AC systems of 100 km installed. Furthermore, design studies show that AC cable systems with lengths of 200 km are technically feasible [2], exhibit lower losses than DC cable systems with VSC technology and may be even cost-effective.

CABLE DESIGN

The cable design is a very important factor when considering either long length AC or DC underground cable projects. It is particularly important when we are looking at loads of up to 200 MVA, where the cables are relatively small by today's standards. A compromise has to be made between the lowest cost and a robust design, which will enable ease of installation with long service life.

Firstly, for the conductor we can select copper or aluminium. The latter is often considered not only because of the lower capital cost, but mainly because it reduces cable weight, which means longer lengths may be supplied with reduced transport costs. As an example in the case of cable for undergrounding cable circuits prior to the Sydney Olympics in 2000 we supplied 1450 m lengths of 1600 mm^2 aluminium conductor 132 kV XLPE cable with a corrugated stainless steel sheath on drums weighing less than 30 tons for a rating of 200 MVA per circuit.

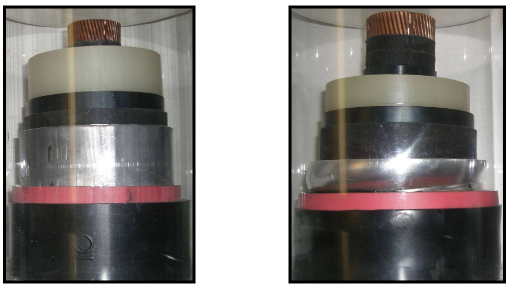

Fig. 1: Cable design with welded smooth or corrugated aluminium sheath

Whether the cable is for AC or DC, the only differences are the type of XLPE insulation, the semi conductive materials and the type of processing, but in both cases good mechanical protection is vital. Some of the earlier designs of DC cables were provided with a copper wire screen and an aluminium foil laminate bonded to the outer MDPE sheath. This is a good cable design for MV cable systems where there are often short lengths of say 500 m or for HV cables where the environment is well protected. However, for long lengths of say 1000 - 2000 m, which are needed to lower jointing and construction costs, and