HIGH RELIABILITY – LOW COST SUBMARINE CABLE DEPLOYMENT

Gunnar Berthelsen

gunnar.berthelsen@nexans.com

Nexans Norway AS, PO.Box 6450 Etterstad, 0605 Oslo, Norway.

Abstract: A method is developed to utilize the topology of the seabed and a detailed discussion with the permitting parties to protect the submarine cables, so that burying has become un-necessary.

1 INTRODUCTION

In most parts of the world submarine systems are protected by burial of heavy cables into the seabed to different depths, depending on the risk of external damage. Normally very heavy cables and deep burial is used in shallow waters, choosing gradually lighter cables and shallower burial as the water depth increases. This leads to very high costs in installing repeater-less submarine systems, which are normally deployed in "shallow" waters.

Norway has a coastline of more than 22.000 km with many deep fjords and dotted islands along the coast, so submarine cables is a natural way of deploying broadband networks. (Fig 1)

Fig 1: Map of Norway

However, it was very early (1985) realized that "normal" methods involving heavy cables and heavy burial equipment would make the submarine solutions non-viable. This due to the fact that such solutions are expensive even for long systems, and with very short coastal cables (each in the order of some km's up to 70 km) the cost would be phenomenal.

Thus, a concept has been developed (where cables are not buried) based on five principles:

- Cable protection is achieved by detailed discussions with the permitting parties to define areas that must be avoided due to fishing and other commercial activity
- Cable protection is achieved by detailed mapping of the allowable areas in order to identify a route where the cable is protected by the seabed topology
- The protection is so successful that a lighter-than-normal cable can be used
- The cable is installed with a very high accuracy relative to the pre-defined route
- As the route lengths are short and the cables light, very small, dedicated cable ships can be used.

2 ROUTE SELECTION

Norway has a huge fishing industry, which works from the coastline out to the oceans, and since fisheries is the most dreaded source of damage to a submarine cable it has been imperative to co-operate with them from day one. There are local and regional fisherman's organizations all along the coast, so there have been a large number of detailed discussions with these organizations, in order to determine which areas should be avoided. However, it has always been possible to find a route avoiding fishing areas, but the cable has often had to make significant detours.

When it has been determined which areas can be used to deploy the cable the route selection is based on modern charts generated from multi-beam echo-sounder data. The national cartographic organization has recently mapped a large portion of the coast by such means, and charts are therefore available with a very high resolution (objects <1m can be identified). Where data are not yet available, new data has to be generated specifically for the project using the same technology.

Using these high resolution charts the cable route is selected, placing the cable in the "valleys" of the seabed, avoiding deployment along steep slopes, avoiding ship wrecks, etc. (Fig 2)

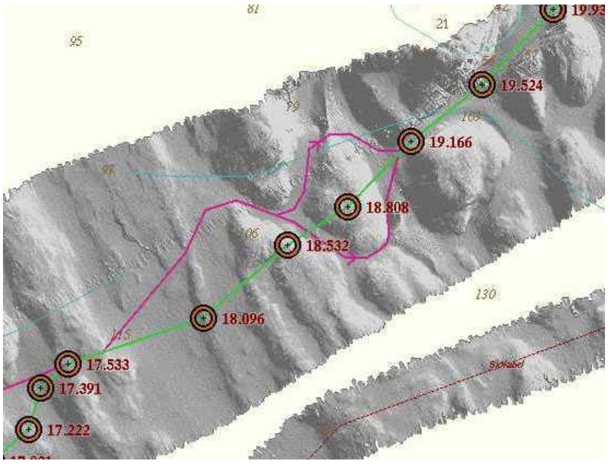

Fig 2: High resolution chart. Green line was initial route. Red lines show alternative routes defined after charting

From these charts it is possible to define the accurate length of cable along the seabed to be installed, and an accurate route position list.

3 CABLE DESIGN

The cable used is Nexans' well known URC-1 design, with a central steel tube containing the fibres, an inner sheath, one or two layers of steel wires and an outer polyethylene sheath. (Fig 3).

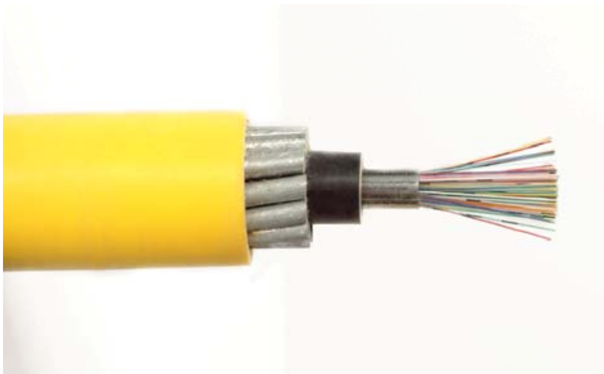

Fig 3: URC-1 cable

The URC-1 is qualified for a number of armor designs, but for the Norwegian projects two lighter versions have been used because experience has shown that a strong cable is not necessary using the protection philosophy described above.

4 CABLE INSTALLATION

With the protection philosophy employed, it is imperative to lay the cable in the allocated corridor to a high degree of accuracy and wherever possible to follow the contours of the seabed in order not to generate free spans or coils. The aim is to install the cable with close to zero bottom tension, but on the positive side (ie no slack). This is achieved through the use of two different "underwater navigation" methods.

The first method is employing an advanced computer model which combines the data from the high resolution charts with data on sub-surface currents and accurate data on the cables' behavior in water, the latter being developed through comprehensive towing tests. The computer is then able to automatically control the position of the cable ship (sternways and sideways) and the feeding-out of cable, such that at any given point along the route the correct amount of cable is fed out at the right position in order that the cable ends up in the pre-defined corridor on the seabed.

The computer calculates the ships' exaggerated turn in order to pay out enough cable to follow the pre-defined route on the seabed at a way-point. In principle, this laying process can be managed from an onshore office, because the system takes full control of the ship.

The second (patented) method employs a "guide weight" which is a unit riding on the cable very close to the seabed. The unit carries an underwater navigation system which gives the position of the cable touch-down on the seabed. The unit is also given sufficient weight so that the cable touch-down is kept much closer to the cable ship than with a normal catenary lay. (Fig 4).

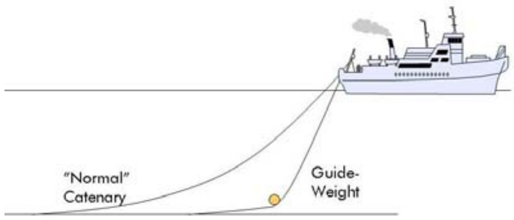

Fig 4: Installation with "Guide Weight"

The guide weight is controlled in the horizontal direction by moving the ship by its' DP (Dynamic Positioning) system, and in the vertical direction through a winch wire to follow the seabed contour. In this way the ship will, in most cases, be well off the cable's seabed position in order that the cable shall end up in the correct corridor. (Fig 5)

Fig 5: Logging of cable and ship position. Solid red line shows pre-defined route. Red squares show guide-weight position and yellow line show ship's position. Top left shows that cable position is 1.1 m off route.

Because the cable is light and the routes are short (<70 km), it is possible to use very small cable ships. Fig 6 shows the cable ship which is used for both methods, and in the picture the guide-weight wire can be seen.

Fig 6: Small cable ship

5 RESULTS

More than 3000 km of cable split between more than 340 individual lengths has been installed using the described concept. The installations are all along the Norwegian coast, from the Oslo Fjord in the south to the arctic waters of the Barents Sea in the north.

The cable is shown (by post-lay ROV survey) to be installed to an accuracy of down to ± a few meters in relation to the pre-defined route.

During all these installations there has not been a single cable damage during installation.

It is the shore ends that normally cause problems and this experience thus includes almost 690 shore ends, and on these 690 shore ends there has been an average repair rate of 0.4 repairs per year!!

In Norway submarine installations are used as part of the total national network(s) and as such must compete with terrestrial solutions. However, the cost of submarine systems using the described concept is far less expensive than a terrestrial aerial installation and only a fraction of the cost of an underground solution. In addition the execution time is far less than that of an aerial installation and again only a fraction of the execution time of an underground solution.

6 CONCLUSION

Through comprehensive experience it has been shown that submarine cable solutions can be very reliable even if the cable is not buried, and by choosing the right tools and equipment it can be very much less costly than “normal” submarine solutions.

7 ACKNOWLEDGEMENTS

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