Challenge of fault location on long submarine power cables

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Submarine power cables are designed to withstand extreme harsh environmental conditions in order to grant long endurance performances and reliability to the whole cable systems. Submarine power cables are subjected to strong mechanical stresses during the laying operations and critical service conditions in their working ambient.
Submarine cables are randomly exposed in all water depth to destructive mechanical stresses caused by fishing activity, boats anchors, off shore wind park jack up rigs and natural hazards like land slides, earth quakes and others.

Based on surveys about submarine cable failure data recorded worldwide over long periods, it can be concluded that the probability of experiencing at least one fault during lifetime is close to certainty for long submarine links. Statistically most damages to submarine cables are caused by human activities, only a low percentage is caused by natural hazards.

Based on growing energy demand and dependency on offshore produced renewable energy, submarine power cables become essential for reliable electric power supply and often can be classified as critical infrastructure.

Repair of damaged submarine power cables requires specialized ships as well as experts to recover the cable from the sea bed and replace the faulty cable section. Another critical aspect associated with long submarine cables is that, whenever a fault occurs, a fairly long time is spent for repair. For this reason, fast and efficient fault detection is essential in order to reduce the overall outage time as much as possible.

The best practice commonly employed for classifying submarine power cable fault types are included in the paper, together with unique measurement results carried out in the field.

1. The paper points out that fault location on submarine power cables differs by much from classical cable fault location on buried land cables as to both conditions and measuring methods, thereby illustrating the most efficient cable fault location methods. Field results on submarine power cable faults are provided, measured on AC submarine cables as well as on HVDC submarine links.
2. A unique case study of fault location on longest HVDC Submarine Link will illustrate TDR based measurements on cable length above 400 km. The paper further focus on TDR diagram analysis in order to explain how to identify cable joints.
3. The results prove that the overall outage time for repair activities can drop significantly if the fault location system is particularly designed for detecting faults in very long submarine cables with a good measuring accuracy.
4. The hazards for operators and instruments connected to the huge amount of electrical energy that may be stored in very long links are also tackled in the paper, thereby addressing the particular safety issues involved by extra-long submarine cables.

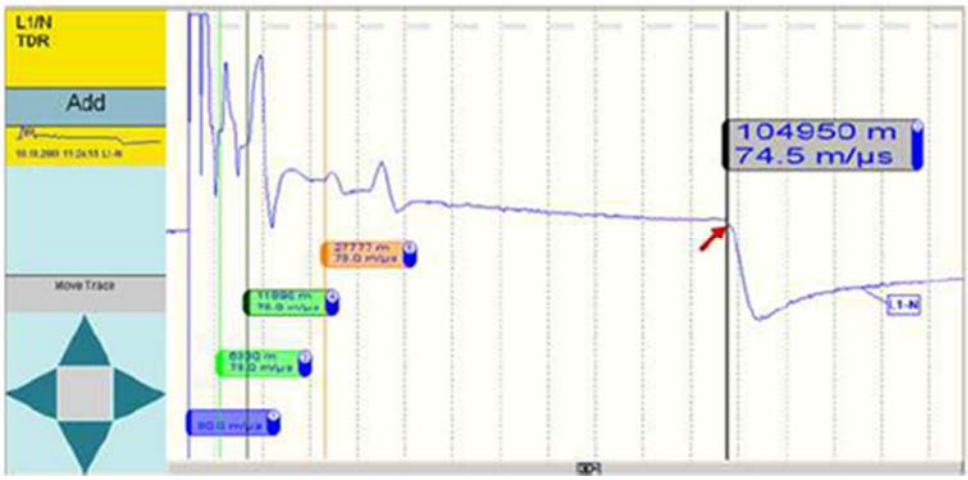

Fig. 1: TDR Trace of a long HVDC submarine cable: SA.CO.I, Italy to Corsica, 105 km