Asset management of submarine cables and lessons learned from a repair

06/03/2018

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Publication REE N° REE 2018-1 Dossier Systèmes de câbles HT à courant continu


DOI : http://dx.doi.org/10.23723/1301:2018-1/22500

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Paris, le 28 avril 2013

REE N°1/2018 Z109 JICABLE HVDC’17 DOSSIER 2 REE N°1/2018 Z 109 Asset management of submarine cables and lessons learned from a repair Jean Charvet, RTE (France), Jean.charvet@rte-france.com

Context Service experience of HVDC submarine cables CIGRE brochure TB379 – Update of service experience of HV underground and submarine cable systems, December 2009 – presents a failure rate for HVDC cables of approximately one failure per year per 1000 km of circuit, mostly caused from external damage. However, this figure is to be taken with great care because it is based on rather old service experience between 1990 and 2005, while in the past ten years, a lot of improvements has been achieved in marine engineering and routing, cable design, installation, protection and preventive maintenance. TB379 is currently being updated by CIGRE Working Group B1.57 with more recent data but results will not be published before end of 2018. In the meantime, RTE carried out a similar survey on the following sample: s

(6$#SUBMARINELINKSIN%UROPE RANGINGFROM K6TO K6 s3ERVICEEXPERIENCEFROMK6$%VENIF THOSE lGURES SEEMS REASSURING A TREND OF decreasing failure rates), it is worth mentioning that HVDC submarine links are being built on increasingly long length, and thus can be more vulnerable to faults. Unavailability and cost of repair 3UBMARINE CABLES GENERALLY DONT NEED ANY PLANNED unavailability, but can suffer from unplanned availabilities due to faults or the need for remedial protection works. Even with low failure rates, the fact that HVDC submarine cable failures takes a long time to repair can lead to significant impact on interconnector business models and security of electricity supply. &OR ASINGLEFAULTTWO TO THREE MONTHSISATYPICALTIME to be considered for repair, excluding hazards, while cost of repair and losses of revenue can be in the order of tens of million euros. &OR A LONG INTERCONNECTOR OF KM FOR INSTANCE SUP posing a failure rate of one failure per year per 3000 km would mean that, as an average, 2 to 3 months unavailability CANBEEXPECTEDON A YEARSPERIODHISCORRESPONDSTOAN average of 3 to 4% of the time which is significant to impact profitability of the interconnector. KEYWORDS : 3UBMARINECABLES3SERVICEEXPERIENCE0REVENTIVE-AINTENANCE2EPAIR0REPAREDNESS/FFSHORE2EPAIR3PAREPARTS Provided that submarine cable are correctly designed and installed, failures are rare but do happen on some occasions. Consequent repairs can be very costly and cause long unavailabilities. This article aims to identify the levers to improve reliability of submarine cable assets by limiting occurrence of failures and induced losses. Asset manage- ment policies including preventive maintenance, repair preparedness, and spare parts are described and discussed from a TSO perspective. Finally, lessons learned are shared from repairs.
managed by RTE on HVDC submarine cables of the IFA2000 interconnector (FR-UK) during the winter 2016-2017. ABSTRACT IFA 2000 experience /N th OF

Design measures Fault causes and preventive design measures Risk mitigation regarding fault occurrence and induced losses starts from the design phase of

Submarine links. Type of faults and design measures to prevent them are described below. External faults may be caused either by human activities, natural

phenomena or a combination of those: e 3 E ABED MOVEMENTS LINKED TO SEISMIC ACTIVITY OR CURRENTS AND WAVES s

On the 22nd of March 2017. Lesson learned: > It took slightly more than three months in total to repair four cable damages, > # ONSIDERING THE EXTENT OF WORKS

THIS GOOD PER

formance was made possible by hiring two repair vessels and two jointing teams working in parallel. JICABLE HVDC’17 DOSSIER 2 110 ZREE N°1/2018

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Internal faults may be caused by: s % R R O R D E F E C T DURING MANUFACTURING OR ASSEMBLY OF JOINTS AND TERMINATION s

-ECHANI CAL D ESIGN PARAMETER SXE C E D DURING TRANSPORT STORAGE OR INSTALLATION s "AD THERMAL ENVIRONMENT LEADING TO

EXCEED TEMPERATURE DESIGN VALUES s /V O R T A GE OR OVERLOADS ABOVE DESIGN VALUES

40 PREVENT INTERNAL FAULTS IS IT IS CONSEQUENTLY RECOMMENDED to select properly tested materials, have a robust inspection and test plan during

every step from design, manufacturing and installation of submarine cables, have a robust thermal DESIGN BASED ON ON

SITE MEASUREMENTS AND PUT IN PLACE proper protections against overvoltage and overloads. Maintenance friendly designs In order to allow an

effective preventive maintenance and A QUICK REPAIR THE FOLLOWING KEY POINTS MUST BE CONSIDERED s

JINTEGRATION OF &: UNIT INSIDE POWER CABLES OR ALTERNATIVELY BUNDLED IN BALLENG & BASED CABLE MONITORING

AND FAULT LOCATION s A B L E M U ST B E E A S I L Y ACCESSIBLE IN CASE A REPAIR IS NEEDED this may be contradictory to preventive protection measures

AGAINST EXTERNAL THREATS SHOULD BE FULLY BALANCED s / LIMITING THE NUMBER OF DIFFERENT CABLE DESIGNS AND ACCES

sories or making sure they are compatible between each other in order to rationalise spare parts storage. Preventive maintenance The purpose of preventive

maintenance policies is to de

crease the probability of failure. Cable awareness It is obvious that precise cable position shall be reported on every relevant marine charts. Figure 1: IFA 2000

cable damage. IFA2000 experience 3INCE IT HAS BEEN COMMISSIONED IN THE submarine part of the interconnector has experienced TWO

SIMULTANEOUS EXTERNAL FAULTS IN AFFECTING four cables, presumably caused by anchors although cables were well buried at approx. 1.5 m in

relatively stiff soil, 5 km away from English coast and relatively far from shipping lanes. Lessons learned: > Emergency anchoring is probably more likely to

happen in nearshore areas and not inside a shipping lane. IFA2000 experience 3INCE IT HAS BEEN COMMISSIONED IN THE submarine part of the

interconnector has experienced one internal fault in 2003, affecting one cable, caused by mishandling during installation which created a weak point. Lesson

learned: > OT ALL DEFECTS CAN BE DETECTED DURING COMMISS

sioning tests, neither warranty period, which means that controls during all steps from cable design to cable installation are crucial. R E E N°1/2018 Z 111

Asset management of submarine cables and lessons learned from a repair It is also recommended to work with fishermen to define good practices when they

work in the vicinity of the cables. Moreover, it is also possible to monitor vessels positions and movements in the vicinity of cable routes using real time j31

DATA / DETECTED RISKS SITUATION CAN THEN LEAD TO CONTACT the vessel captain or marine authorities in order to prevent unauthorized activities in the

vicinity of the cable. Cable monitoring 3TANDARD PRACTICE FOR NEWLY BUILT /6& LINKS /SISTOMONITOR TEMPERATURE ALONG THE LINK BY

IMPLEMENTING $43 SYSTEMS Development of local hotspots could indicate an internal defect or an unfavourable thermal environment, while local “cold

spots” could reveal deburial. J T I S A L S O R E C O M M E N D E D T O INSTALL 6& SYSTEMS THAT COULD help locating deburials or external aggressions but

experience is still very limited and signals are not easy to interpret. Partial discharge measurement are also sometimes considered but its interpretation can

also be tricky. Those systems have a limited range and only a part of the submarine link may be monitored for long interconnectors, although technology is

constantly improving. J N ORDER TO ENSURE THE EFFICIENCY OF & / BASED SYSTEMS

BEST PRACTICE IS THAT &: UNITS ARE EITHER BUNDLED OR DIRECTLY integrated to each power cable. This sometimes lead to install

ANEXTRA&/UNIT WHEN PAIR OF POWER CABLE IS UNBUNDLED WHICH IS OFTEN IN THE CASE AT LAND FALLS. The way of interpreting data from those

monitoring systems can vary from regular checks with analysis reports to CONTINUOUS CHECK WITH PRE

CONTROLYOFS H O R L A R M / LEARNING phase in the first month or years of operation may be necessary to fine tune the interpretation of monitoring data. In

case an anomaly occurs and depending on its severity, it may be decided to launch surveys and/or remedial works. 1 AIS: Automatic Identification System,
système d'échanges automatisés de messages entre navires par radio VHF qui permet aux navires et aux systèmes de surveillance de trafic de connaître
The purpose of spare part storage is to make sure that reliable spare materials of the cable system is immediately available in case a repair is needed without delay. Contractor is a common practice in order to save time for negotiations and engineering after occurrence of a fault. Jointing operations, which require specific equipment and expertise, are performed onshore or offshore, depending on the accessibility and water depth of the cable. Storing spare parts and equipment for repairs is crucial, as it allows for quick mobilization and reduction in downtime.

Mobilization of an adapted marine spread to allow the repair operations needs to be done as soon as possible after fault location is confirmed. In addition to vessels that are necessary for fault location and surveys, type of equipment used onboard depends on the situation where the repair is to be performed. For example, in shallow waters, small vessels like barges and tugs are used, while in deeper waters, larger vessels are required. Marine operations and safety are paramount importance, thus it is recommended to have an internal expertise or frame agreement with a specialized provider. Lessons learned from the IFA2000 experience, which happened immediately after a fault happened in November 2018, is to quickly respond to faults and have a contingency plan in place. The repair procedure for different plausible fault scenarios is typically included in the emergency contingency plans. Coordination between different contractors on board, which were sometimes critical and it surely has saved time, is key.

Experience from repairs is valuable to improve contingency plans. JITCABLE HVDC’17 DOSSIER 2 112 ZREE N°1/2018 SUCHAPLANWOULD TYPICALLY INCLUDE:

1. Description of internal organisation andput in place a critical path for repair vessels allowed to handle interfaces between different contractors on board, which were sometimes critical and it surely has saved time and participated to quality and safety.
2. Experience from repairs is valuable to improve contingency plans. JITCABLE HVDC’17 DOSSIER 2 112 ZREE N°1/2018 SUCHAPLANWOULD TYPICALLY INCLUDE:

3. Experience from repairs is valuable to improve contingency plans. JITCABLE HVDC’17 DOSSIER 2 112 ZREE N°1/2018 SUCHAPLANWOULD TYPICALLY INCLUDE:
waiting for remanufacturing. Quantity of spares is project specific and mainly depends on:isks and failures scenarios to cover, sater depth, areas where jointing will have to be avoided, eg: rockberms, sater times and minimum quantities to store, all the stock after it is used, storagesiteisusuallyearbyaquayinaportwithdirectandpermanentaccess to sea, a controlled and secure area air and protected from UV and rain. Conclusion Lessons learned from submarine cable repair experience makes possible to improve asset management policies.

3HARINGOFSERVICEEXPERIENCEANDCOLLABORATIONFORMORE standardization of repair solutions must be encouraged. Glossary


IFA2000 experience RTE and National Grid Interconnector Ltd share a frame agreement for mobilization of marine spread. Considering that failures happened on two distinct locations for each pair of cables, it has been decided to work as much as possible in parallel in order to save time. Two repair vessels and one support vessel were hired within one month and ready before the jointer teams. The support vessel was dedicated to prepare cables, cable cuts, deburials, expertise of damages checks and tests on cables, sealing ends) while the two others were dedicated to jointing operations. Lessons learned: > Having a frame agreement made possible to hire two jointing operations on the 24% submarine cables technology but still needed rehearsal on a piece of spare cable before going offshore. Those operations appeared to be on the critical path of the repair, as marine spread was ready before jointing teams. Lessons learned: > Having the possibility to install compatible joint from a different supplier than the original cable was beneficial and saved time. IFA2000 experience Tests confirmed that spare cable that was stored for more than thirty years in cable tanks were still in good condition. Two cable joints from the spare parts have been used for training of jointers, prior to perform the offshore repairs. Lesson learned: > Regular inventory and maintenance on the spare parts is valuable.