Localization of a failure on a submarine link

Sequence of techniques for improved efficiency

Antoine NAUD, RTE (France)
Replaced by Jean CHARVET, RTE

WETS'15 Workshop

Organization: Jicable and Prospective 21OO
Palais des Congrès de Versailles, France
Thursday, 25 June 2015

WETS'15

Réseau de transport d'électricité

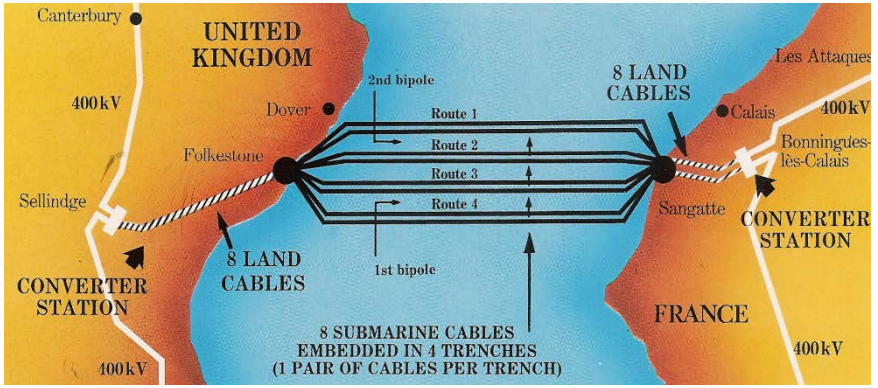
IFA 2000 + HISTORY

- A cross-channel link, commissioned in 1986
- 2000MW at 270kV, 930mm² copper core, paper insulated
- 46km of submarine link (onshore link : 19km in England, 7km in France)
- 4 pairs of cables embedded in trenches, 1000m from each others

- In March 2003 a cable fault occurred at sea. Time Domain Reflectometry (TDR) is performed on French and English ends, but there are doubts on velocity measurements.

- **Cable is cut according to TDR result**
- **The fault is actually 1.7km from the cut**
- **2 cuts and repairs must be done**

  (4 joints)



Development of a new fault location method

- **2003-2007** — **Method developped by RTE**
  (pre-location by improved TDR)
  (pinpointing by magnetic field measurements)

- **2008-2009** — **RTE applies for European and international patent protection**
  Still under progress

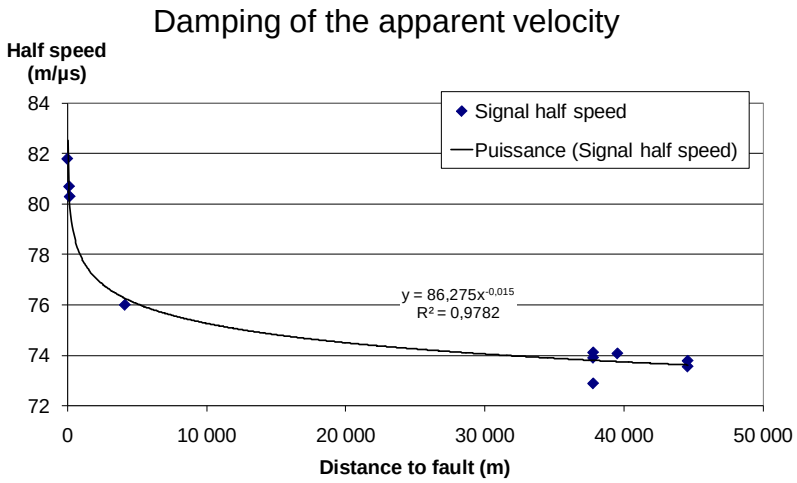
- **January 2011** — **New packaging for international operations**
  (new service offer is launched)

- **October 2012**
  September 2013 — **Tests at sea with the new packaging**

Land/sea cable interface on the French shore

Pre-location: improved TDR

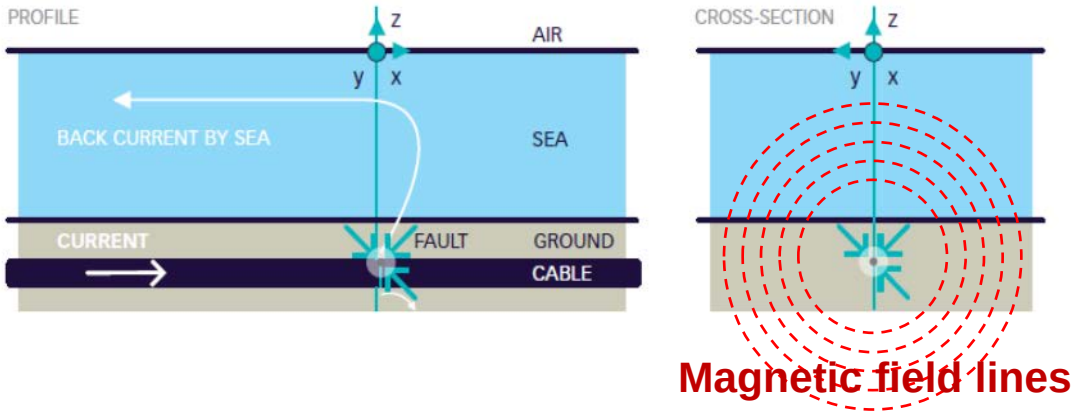
- **RTE's studies showed that in paper insulated cables, the high frequency spectrum of the voltage impulse is strongly damped**
- **The TDR records only the lower frequencies which travel at a lower speed and as a result, the apparent velocity decreases with the distance to fault**



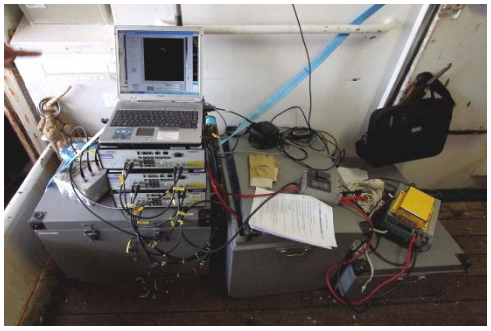
- **A model is developed in order to correct the standard TDR result, taking into account:**
  - the impedance change between land and submarine cable (if performing TDR on the end of the land cable instead of the submarine cable)
  - the apparent velocity damping of the signal
- **The improved TDR shows an accuracy of 1% of the distance to fault (i.e. +/- 400m on IFA2000) while the standard TDR was rather around 3%**

Fault pinpointing

- The cable end is energised with an **AC current**
- If part of the return current goes through the sea, the current distribution creates a magnetic field around the cable, between the cable end and the fault point.

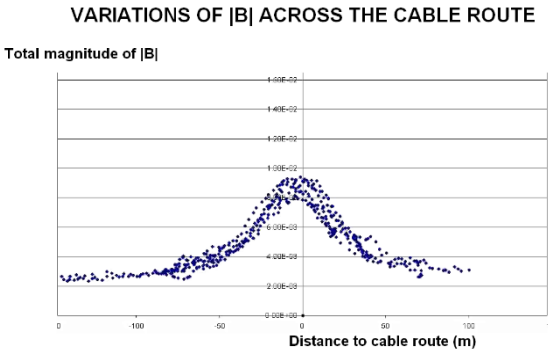


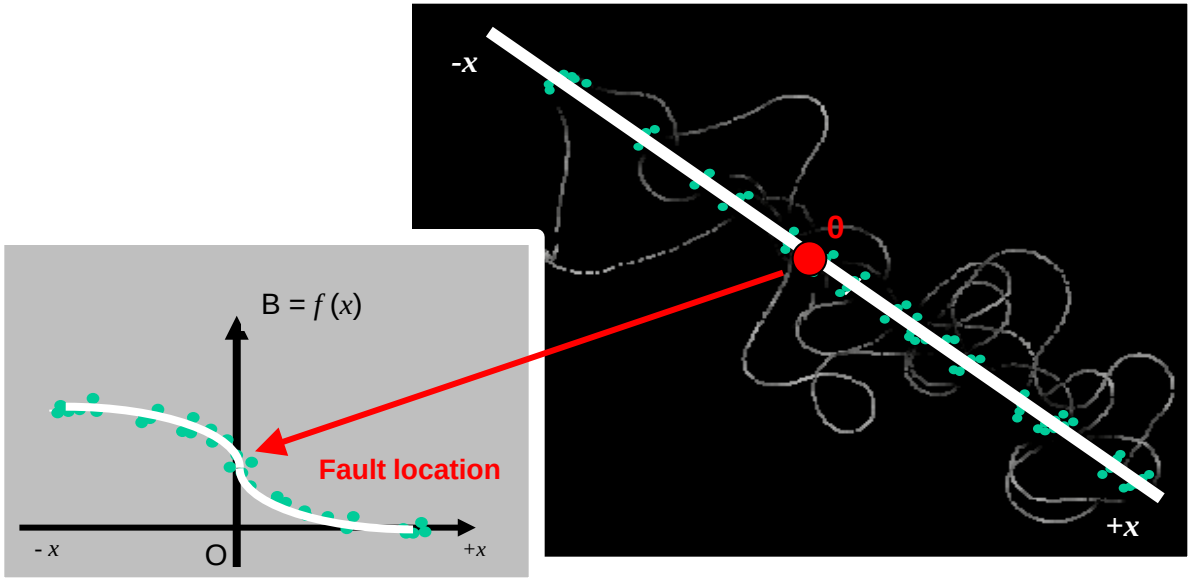
The magnetic field variations are measured using 3 magnetic coils located on a boat. The measurements are synchronised with GPS acquisition in order to draw a **map of the magnetic field** in the area of pre-location.



Fault pinpointing

- **Magnetic field measurements at sea, above the cable route of IFA2000 (specific recording software).**





- **Analysis of the magnetic field measurement**

- **The pinpointing method is developed and tested**
- **The accuracy is equal to the water depth, i.e. +/- 40m on IFA2000**

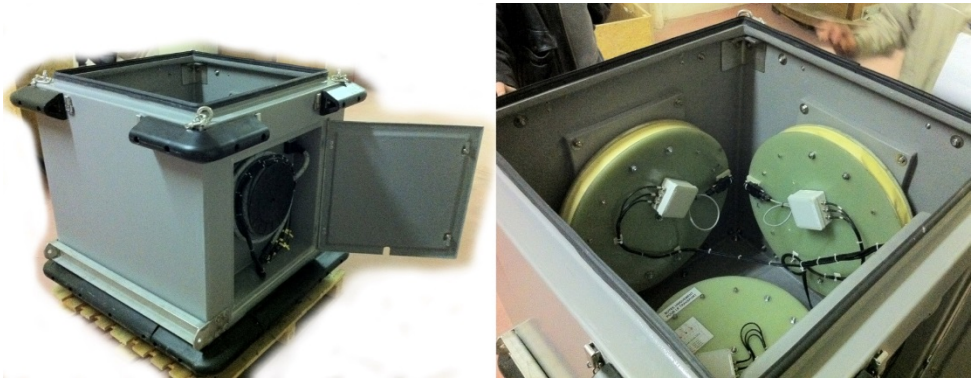
- **The method proved successful for IFA2000 (max water depth 60m), but limitation may arise for water depth over 100m.**

Recommended fault location procedure

- **Pre-location**
  - TDR
  - and/or bridge measurements

- **Pinpointing**
  - Magnetic field method (yearly training of RTE operators)

- **Visual inspection and repair**



New packaging

Thank you for your attention !

Antoine NAUD (France)
Replaced by Jean CHARVET

Réseau de transport d'électricité