Seanamic Group

- Caley: Design, manufacture and lifecycle maintenance of offshore handling systems. [www.caley.co.uk](http://www.caley.co.uk)
- Umbilicals International: Dynamic and static cables and umbilicals. [www.umbilicals.com](http://www.umbilicals.com)
- IMES International: Integrity assurance through inspection, monitoring and engineered solutions. [www.imesint.co.uk](http://www.imesint.co.uk)
- Flexlife: Integrity assurance of flexibles, umbilicals and mooring systems. [www.flexlife.co.uk](http://www.flexlife.co.uk)
The requirement to test sub sea cables and connections has long being recognised in the Offshore Oil and Gas industry.

1990s a need was identified for quicker, safer and more effective means of electrical testing.

Traditional methods involved a substantial undertaking in time and money for support vessels, manpower, and production downtime.

Electrical architecture was put at further risk performing these tasks.

1997 Imes began working with BP and Aker solutions on a solution – SETS has come along way since then....

Imes Subsea Test Development
Reasons for Testing

Original reasons – there was an electrical fault somewhere subsea that had made itself apparent as an essential piece of equipment had shutdown. Immediate investigation ensued in an attempt to narrow the fault to a particular connect or cable.

A shift to active (Integrity testing) rather than reactive (Fault finding) testing along with an increased requirement for life extension and an appetite for integrity data on the whole, has driven integrity testing growth.

More accurate and advanced systems have appeared to encompass testing of all phases of the construction, installation and operation of subsea electrical infrastructure;

Post lay commissioning
Pre start up commissioning
Datum & Monitor after lay
Fault finding works
Field Extensions and Tiebacks
Post repair proving
Most subsea cable types can be tested as long as there is access to a connection point.

Both connector genders, the number of connections 4, 7, 9 and 12 ways (typical) and the common connector types such as Siemens (Tronic) and Teledyne ODI, plus others.

Power Communications and control lines
Long Distance submarine cables
Umbilicals and Umbilical Terminations
Jumpers and Flying Leads (EFL)
Subsea Control Modules (SCM)
Subsea Distribution Units (SDU)
Both O&G and Renewables

IR
CR
TDR
OTDR

Tronic test Connect
Stab plate multi connect
SETS with Stabs
PI testing and DAR testing help assess the deterioration of insulation and involves repeat IR tests following complete energization of the line. DAR for example is calculated as a simple ratio between the IR figures taken at 30 second and 60 second intervals following complete polarisation.

The DAR Ratio is calculated as \( \frac{IR_{60}}{IR_{30}} \)

The higher the DAR ratio the better. <1.25 considered suspect, >1.6 being good.
Real Time Electrical and Optical Integrity Testing
Subsea Electrical Test System SETS™ - Overview

IMES International SETS system has been successfully used worldwide to measure and monitor the characteristics of Subsea Electrical Architecture during pre-commissioning and fault finding campaigns:

Delivered By ROV, SETS Offers:

- Safer, faster more accurate testing
- Varying test voltages allowing for a true test
- **Real Time** subsea electrical integrity testing and logging
- IR, CR and TDR and now OTDR measurements
- Rapid mobilisation and reduced testing time
- Any field connector type can be utilised
Information Requirements

• Field Architecture Information
• Length of Cables/Umbilicals to be Tested
• Umbilical/Cable Specification
• Type of Connector
• Pin Configuration of SS Connector
• Type of ROV – 110v – 2 Comms Lines (1 x FO for OTDR)
• Test plan
Subsea Electrical Test System SETSTM - Connection

- SETS-DAQ
- SETS-SCU
- Client Field Connect
- ROV Com & Power
- 3000 MSW SETS-SMG Pod Onboard ROV
- SETS-SMG
Stabs in – tests controlled from surface
Live data to surface display and log

Based on the test information received, the ROV can move off and plug into next test position, rapidly completing many tests in a few hours or can continue testing by increasing voltage or conducting IP and DAR testing.
Type of Testing - TDR

But what do these tests really tell you?

Okay you may find an issue with low IR or poor core conductivity but where in the line is this fault. In short cable lengths it may be simpler just to “change out than find out” – but what about long runs, trenched cables and umbilicals covering many Kilometres?

In these circumstances knowing the location to effect a repair (if possible) is essential;

Time Domain Reflectometry (TDR)

This is where TDR really comes into its own. TDR basically sends a fast rising short duration electrical ‘ping’ down the cable and monitors the time delay, the amplitude and sign (Pos or Neg) of the reflected return signal. This allows the operator, via the software, to determine the type and location of a problem. The standard characteristics of the cable are required to accurately determine the signal propagation speed, and hence the distance, and the attenuation hence the actual loss (or gain) in impedance at the location providing more information on the cause and location over and above standard testing.

However the limitation of TDR should be understood - The distance accuracy is a percentage of measurement range so as the cable length increases so does the uncertainty of fault location distance – for example a 20KM cable at 0.1% accuracy would give a 20m possible resolution
Subsea Electrical Test System - Specification

SETS subsea electrical testing equipment

- SETS SMG Pod – ROV mounted
- SETS SCU - surface control unit
- SETS DAQ – data visualisation and recording

Measurement specification at a glance

- Testing to IEC Standards
- IR Measurement 50V to 5KV in steps, 1Ω max Accuracy 0.07%
- CR Measurement Accuracy 0.07% of range 1Ω to 10kΩ in steps
- PI and DAR Testing
- TDR max distance 20KM light version, standard 150km and high VM at 300km
- TDR distance accuracy ±0.1% of the set measuring Range

External Requirements

- Power – 110V 3A from ROV (24V 4A alternative), 110VAC 5A SETS SCU and DAQ laptop logger at Surface,

Environmental

- Useable depth rating – 3000msw
- Temperature -20° to +60° C
As Fibre Optic based systems become more prevalent for communications subsea the need has arisen to test the FO lines in umbilicals and connections. OTDR technology is well proven for surface communication and standards cover many aspects of testing. IMES have developed this technology in a similar fashion to SETS -surface controlled subsea testing.
• OPTI-plus OTDR – 60KM+
• Multiple FO cores simultaneously or singular
• Single Mode and Multi Mode
• Light and dark fibres
• Live Surface data
• Multiple Frequency
• Budget Line loss, attenuation, multiple events, breaks
• Intuitive Interface and error reporting

Optical Time Domain Reflectometry (OTDR)

In a similar fashion to TDR, OTDR uses pulses, this time of light, to determine the location of any potential issues, again working in the time domain (rather than frequency) to determine location from propagation of back scattered light from an event.
Summary

1. Cost effective and safe subsea electrical and fibre optic cable testing
2. IR, CR with follow up IP, DAR and TDR testing
3. Deployable within 48 hours
4. Live information at the surface allowing for plan changes based on results
5. Speed of testing and real time information
6. Adaptable to suite clients needs.
Electrical and Optical Integrity Testing of Subsea Umbilicals and Cables

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