



The Queens Award for
Enterprise: Innovation 2019



C-Kore: Fast Automated Subsea Testing

Greg Smith – General Manager



C-Kore Applications

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Subsea Tools to save **Time & Money** on:

Installation/Commissioning

Fault-finding Operations

Decommissioning and Down-hole



Simplify Subsea Testing

C-Kore History

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200+ Units Deployed



35+ Different Customers



40+ Different Fields



25+ Assets Installed



50+ Faults Located in Fields



Simplify Subsea Testing

C-Kore Subsea Testing Tools

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Cable Monitor



Subsea TDR



Sensor Monitor



Pressure
Monitor



Simplify Subsea Testing

C-Kore

Subsea Testing Tools

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Brains

Cable Monitor

(IR & Continuity)

Subsea TDR

Sensor Monitor

Pressure Monitor

Bodies



Siemens Tronic



Teledyne ODI



Simplify Subsea Testing

C-Kore

Subsea Testing Tools

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Brains

Cable Monitor

(IR & Continuity)

Subsea TDR

Sensor Monitor

Pressure Monitor

Bodies



T-Shape



In-Line



Simplify Subsea Testing

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Subsea Testing Tools

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ROV Mate



Diver Mate



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Plug



Receptacle



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Simplify Subsea Testing

C-Kore Cable Monitor



Cable Monitor Specification

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I	Insulation Resistance	1kΩ to 10GΩ
C	Capacitance	1nF to 99uF
R	Continuity Resistance	0Ω to 1MΩ
S	Shock & Vibration	0 to ±200G (3 Axis)
	Temperature	-40 to 100°C



Simplify Subsea Testing



Cable Monitor **New Installation**

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Asset **installation** with the **Cable Monitor**...



Simplify Subsea Testing

Cable Monitor New Installation

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Setup

Test routine **pre-programmed** for
simple subsea deployment

Connect directly to subsea equipment,
no downlines required

Trigger measurement with **light sensor**,
proximity sensor or **schedule**



Simplify Subsea Testing

Cable Monitor New Installation

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Baseline Measurement



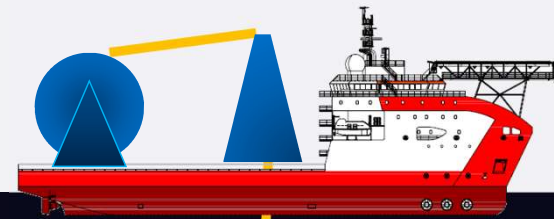
Spooling and
Transit Monitoring



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Cable Monitor New Installation

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Vessel performs **lay**
C-Kore **measurement** throughout



Simplify Subsea Testing

Cable Monitor New Installation



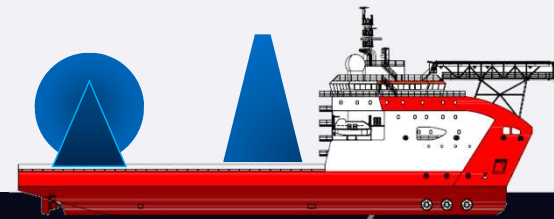
C-Kore **deployed** subsea with UET



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Cable Monitor New Installation

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Subsea **measurement** (after lay and/or wet-storage)

Umbilical **health proven**



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Cable Monitor Results

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Insulation
Resistance



Continuity
Resistance



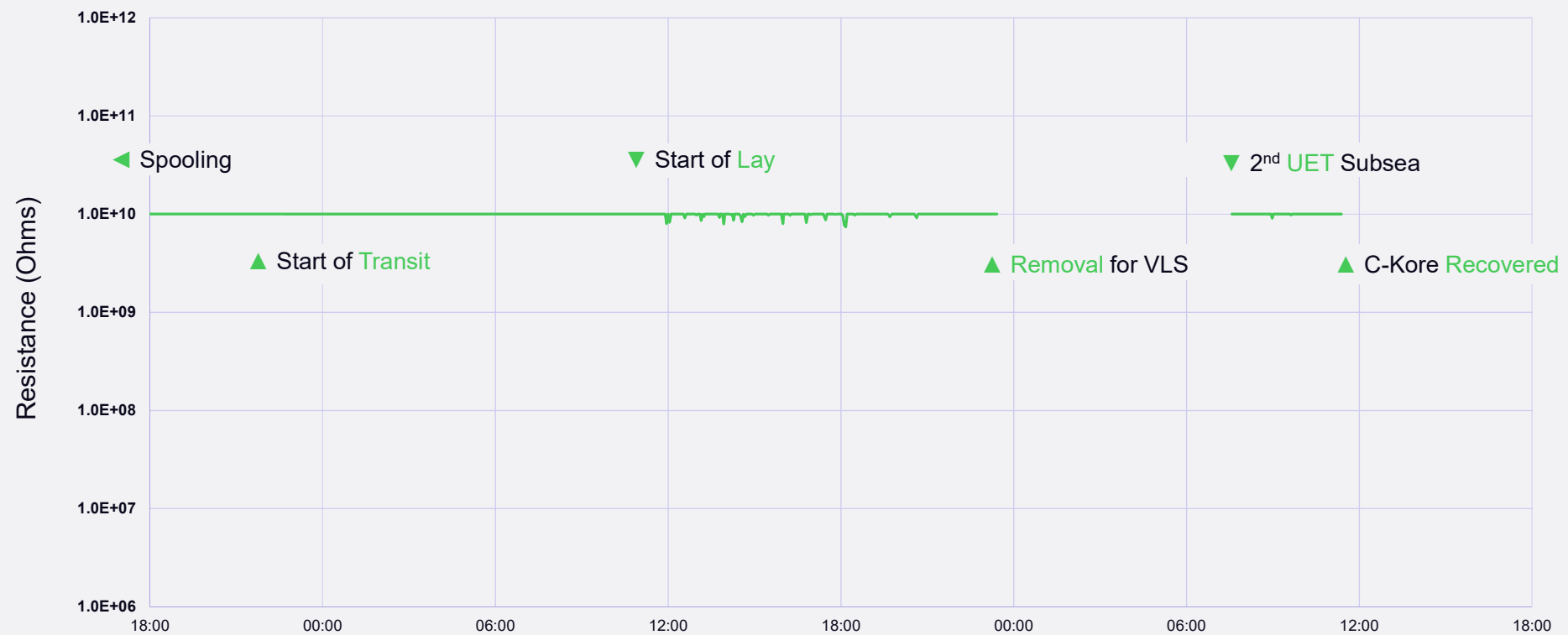
Capacitance

Cable Monitor Results

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Insulation Resistance



Cable Monitor Fault Types

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- **IR** - Failures and changes
- **CR** - Failures and changes
- **Capacitance** - Confirmation and final value
- **Shock** - Impacts and drops, transit and installation



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Cable Monitor New Installation Summary

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fast, automated

Repeatable test routine.
Removes operator delays,
errors and differences.

sealed, accurate

Stops weather and
equipment change-over
effects. Trustable results.

full traceability

Condition recorded from
factory to subsea. Second
end not deployed blind.



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Cable Monitor **Fault Finding**

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Fault-finding with the Cable Monitor...



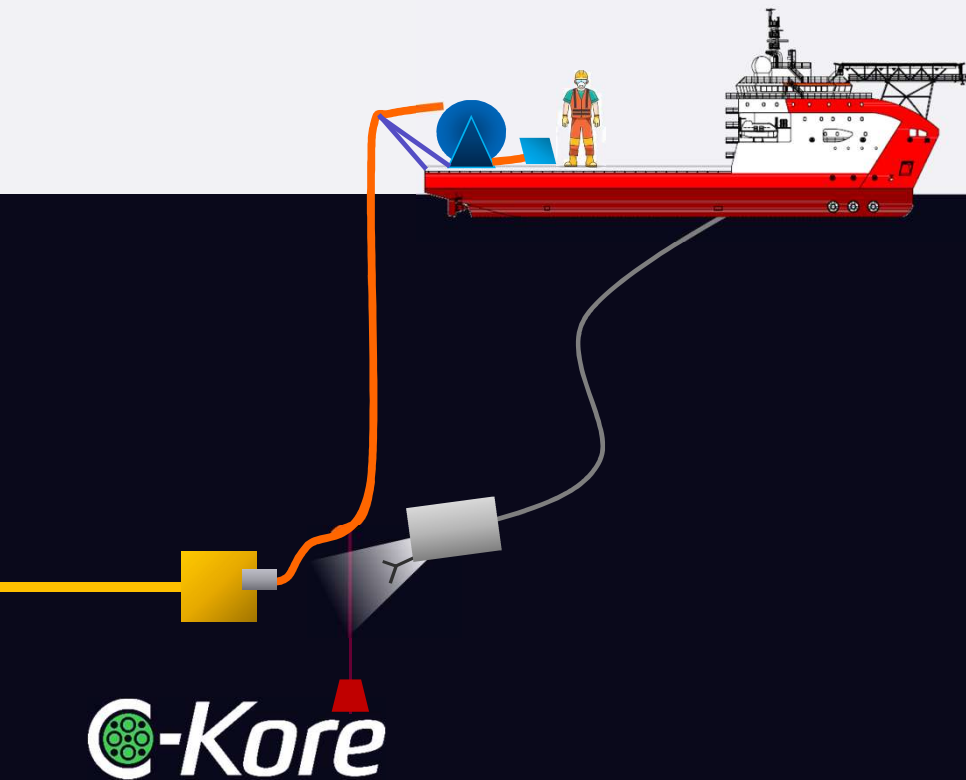
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Deployment Traditional Method

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1. Vessel **arrives** in field
2. **ROV** launched
3. **Downline** deployed (move to safe distance)
4. ROV derigs and **connects** downline
5. **Testing** from back-deck



Downline Issues:

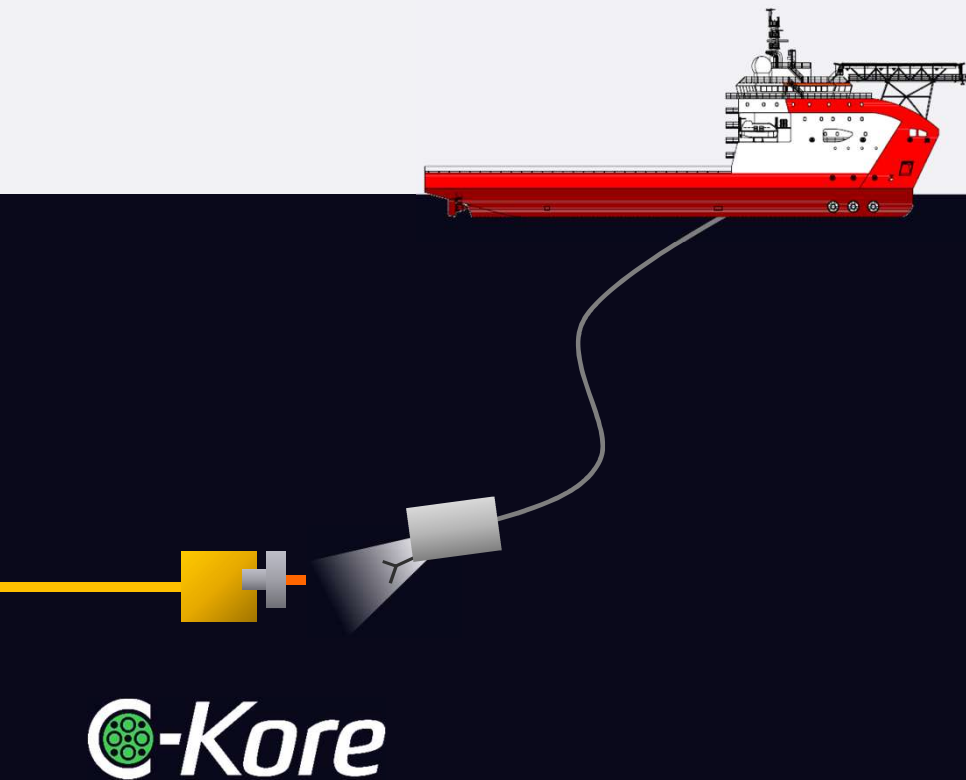
Slow deployment and permits required
Downline faults, attenuation, reflections
Back deck weather affects readings
Operator skill under time pressure
Quality of saved data

Deployment C-Kore

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1. Vessel **arrives** in field
2. **ROV** launched
3. ROV **connects** and triggers C-Kore unit



C-Kore Benefits:

Fast deployment

No permits required (no high voltage)

Direct measurement

Automated and repeatable

Interactive result analysis

Fault Finding Strategies

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- Most Probable Cause
- Divide and Conquer
- Disconnect and Rebuild



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Cable Monitor Fault Finding Summary

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automated

Pre-programmed test routine removes the need for skilled TDR operator.

fast, liberated

No downline deployment / recovery time. No waiting for platform testing.

direct, reliable

Measurements made directly subsea. No errors from impedance mismatches.

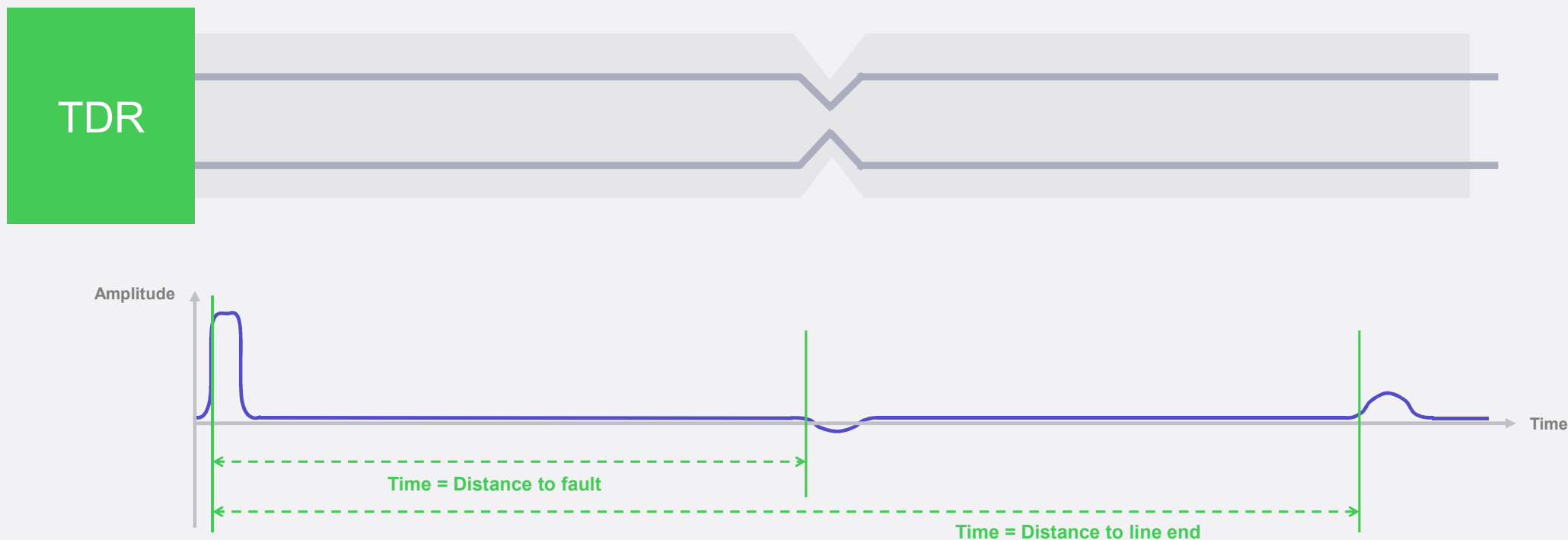


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C-Kore Subsea TDR

Subsea TDR Theory



Subsea TDR Examples

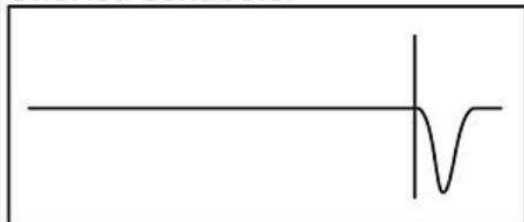
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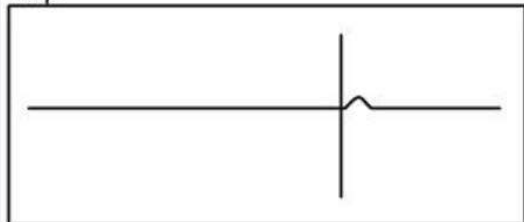
Open conductor



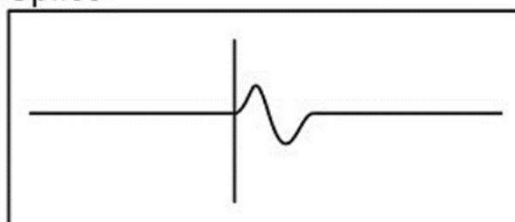
Shorted conductor



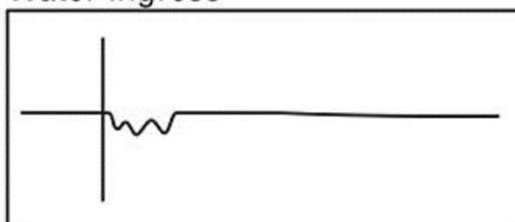
Tap



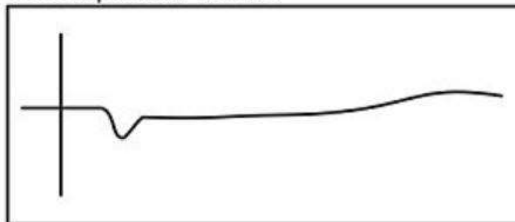
Splice



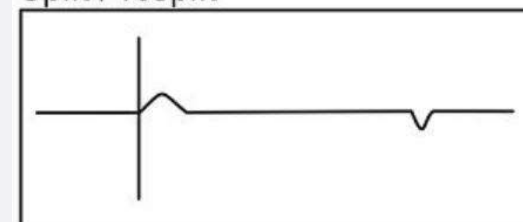
Water ingress



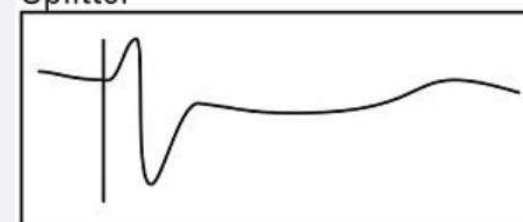
Wet splice / water



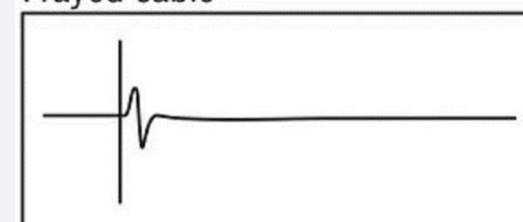
Split / resplit



Splitter



Frayed cable



Subsea TDR Specification

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- Discontinuity Location >20km Range*
- Location Precision 2nS (~15cm*)
- Pulse Width 10nS to 10uS (automated)
- Measurement Gain -18dB to 56dB (automated)
- Temperature, Shock & Vibration



*Dependent on cable properties

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Subsea TDR **New Installation**

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Asset **installation** with the **Subsea TDR**...



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Subsea TDR New Installation

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Baseline

Take **reference point** after
umbilical FAT at factory

Discover **potential discontinuities**
due to umbilical termination

Baseline for post-install **verification**
or future **fault-finding**



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| Subsea TDR Fault Finding

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Fault-finding with the Subsea TDR...



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Subsea TDR Fault Finding

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Umbilicals

- Subsea TDR use follows Cable Monitor
- Discover exact discontinuity location

Down Hole

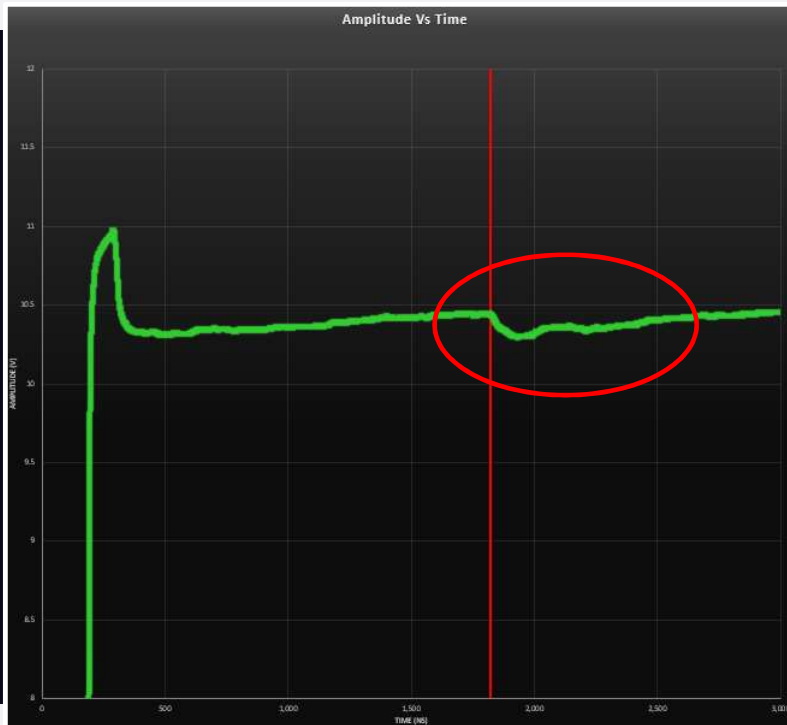
- Identify root cause of down hole failures
- Learn lessons for future installations



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Subsea TDR Umbilicals

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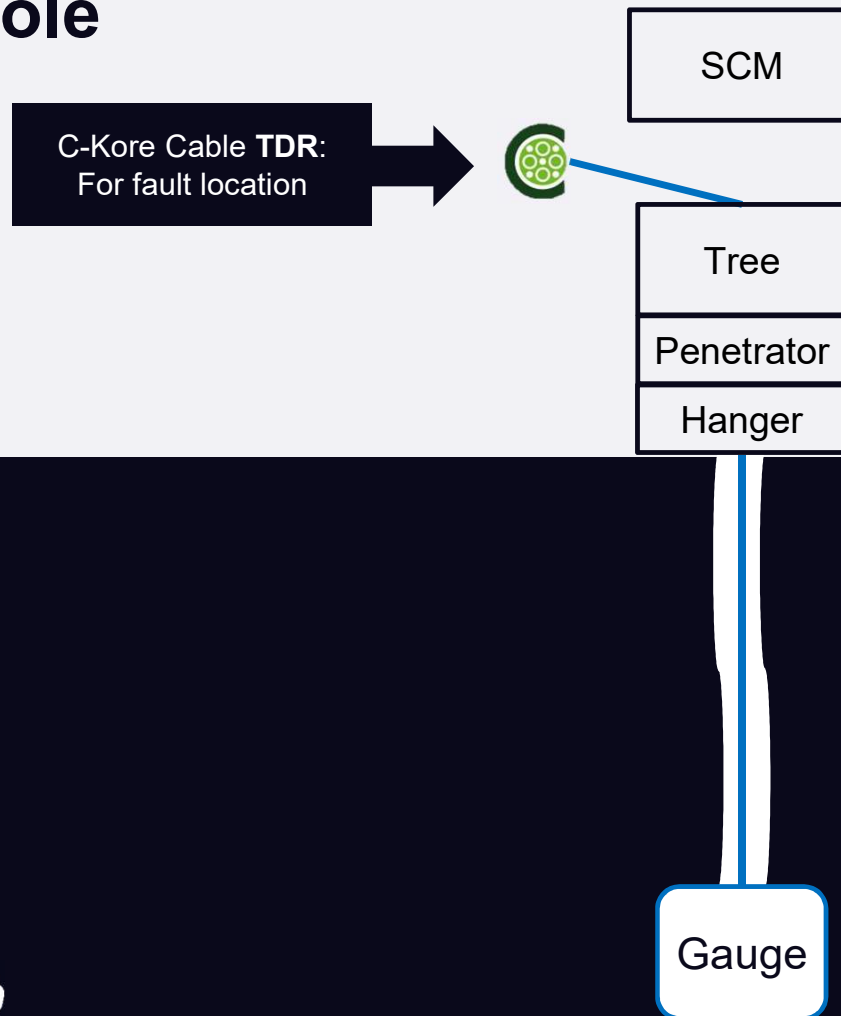
Fault measurement

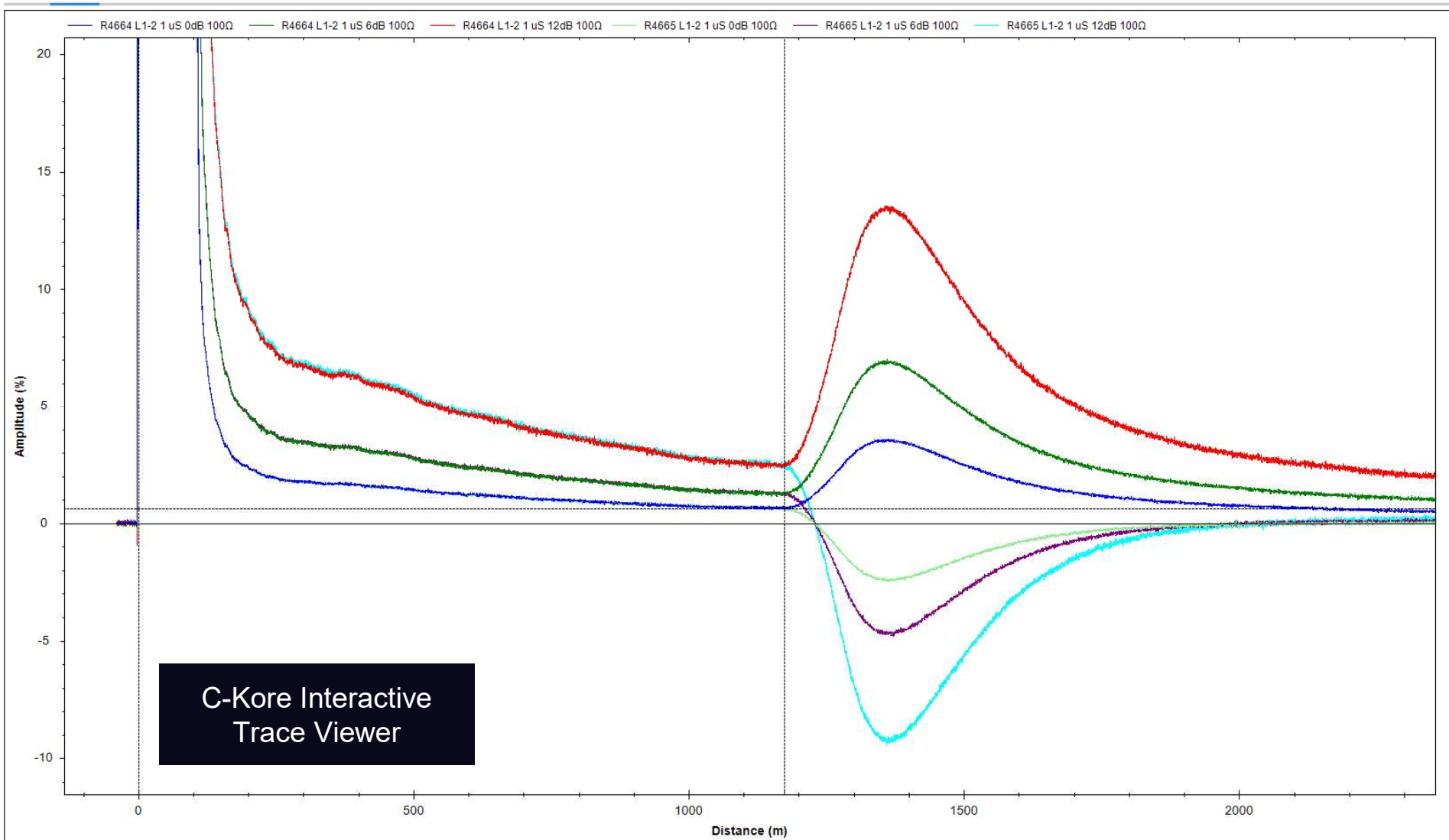
Measurement on cores with **low IR**

EFL to umbilical connection seen in impedance at beginning of graph

Discontinuity seen at **270m** indicating fault location

Subsea TDR Down Hole





Multiple Results

Filter:

All Pulse Widths All Gains

Navigation: ☒ Multi Trace

- Result: 4661
- Result: 4662
- Result: 4663
- Result: 4664
- Lines: 1-2
- ☒ 1 uS 0 dB
 - ☐ 3 uS 0 dB
 - ☐ 6 uS 0 dB
 - ☒ 1 uS 6 dB
 - ☐ 3 uS 6 dB
 - ☐ 6 uS 6 dB
 - ☒ 1 uS 12 dB
 - ☐ 3 uS 12 dB
 - ☐ 6 uS 12 dB
- Result: 4665
- Lines: 1-2
- ☒ 1 uS 0 dB
 - ☐ 3 uS 0 dB
 - ☐ 6 uS 0 dB
 - ☒ 1 uS 6 dB
 - ☐ 3 uS 6 dB
 - ☐ 6 uS 6 dB
 - ☒ 1 uS 12 dB
 - ☐ 3 uS 12 dB
 - ☐ 6 uS 12 dB

Select a maximum of 6 traces at a time

<< < > >>

Mode: Distance [Change to Time](#)

VoP (%): 73

Cursors:

X1: 0.0 m X2: 1.1730 km

Shortcut: Ctrl+Shift+Left/Right Click

Difference: 1.1730 km

Smoothing: None

Zoom Options: [Undo](#) [All](#)

Drag: Zoom to Window
Ctrl + Drag: Pan

Export Screenshot Close



C-Kore Pressure Monitor

Pressure Monitor Specification

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- P** Absolute Pressure 0 to 1000bar (14,500psi)
- S** Shock & Vibration 0 to $\pm 200G$ (3 Axis)
- ⌚** Temperature -40 to 100°C



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Pressure Monitor Connectivity

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Pressure Monitor

- Standalone operation
or
- Use Cable Monitor to display Results



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Pressure Monitor **New Installation**

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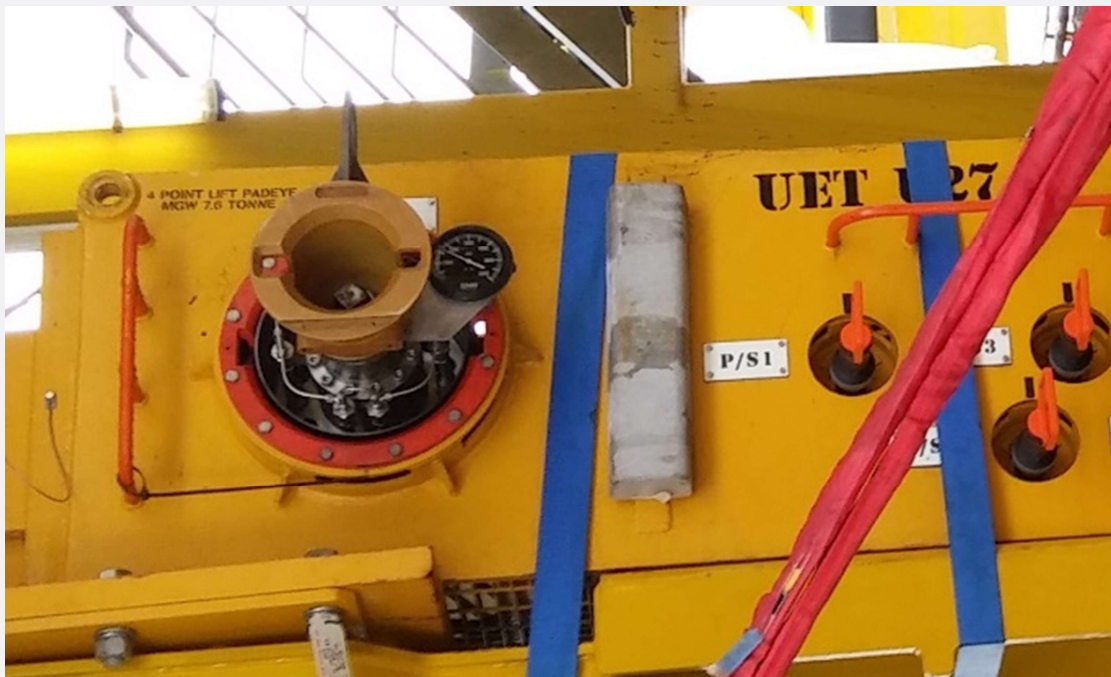
Asset **installation** with the **Pressure Monitor**...



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Pressure Monitor New Installation

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Deployment

Mount on hydraulic **test plate**

Replaces or complements analogue gauge, **datalog**s all results

Link to Cable Monitor for **display**



Simplify Subsea Testing



New!

C-Kore Sensor Monitor

Sensor Monitor Applications

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Read Subsea **Sensors**

Construction, **fault-finding** &
decommissioning campaigns

Ensure **safe** environment for divers

Prevent accidental release of hydrocarbons



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Sensor Monitor Specification

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- I Current Sensors 0 to 20mA
- V Voltage Sensors 0 to 20V
- Connection Modes 2, 3 & 4-wire modes
- Display Units Programmable units
- Datalogging Every measurement



Simplify Subsea Testing

C-Kore Summary

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Save Time & Money on
Installation/Commissioning Operations
Fault-finding Campaigns
Down-hole Testing



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Thank You

Any Questions?

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