Collaboration in Subsea Integrity, Inspection, Maintenance and Repair

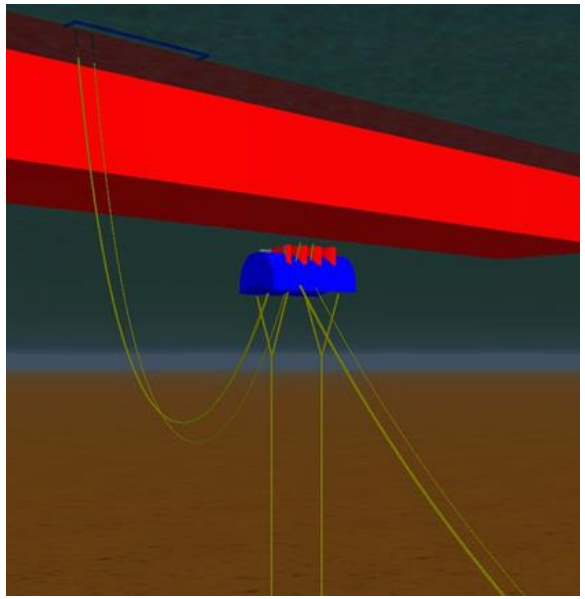
BEDE ANI

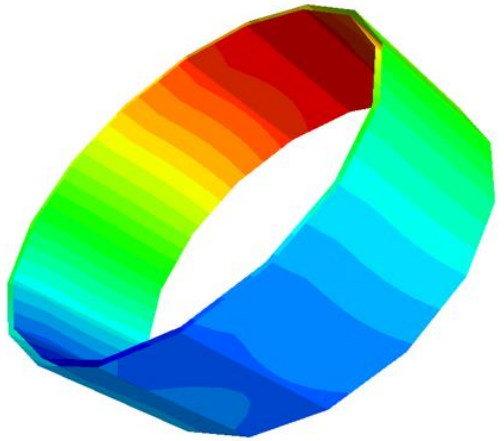
NOVEMBER 2025

Havtil

Robust Service Life Assessment (1)

- All operating parameters are summarised
  - Pressure
  - Temperature
  - Bore composition
- Inspection data is included
  - ROV GVI
  - Annulus test reports
  - CP measurements, etc.
- Data is assessed, summarised and compared with Design parameters
- Quantitative assessments are performed – E.g Structural Capacity Analysis, Fatigue Analysis, Ageing Assessment.
- Output is presented as % utilisation/design
- RBI targeted towards key system criticalities





Flexlife – Oceaneering Partnership (1)

- Together, the partnership offers engineering expertise and inspection technologies to mitigate integrity concerns
- Global presence
  - > Norway
  - > UK

Degradation Grouped by Pipe Layer Risers, Flowlines	Flexlife	Oceaneering	Partnership	Example Activities
Carcass	✓	✓	✓	Borescope Camera Inspection
Internal Damage - Pigging		✓	✓	Borescope Inspection
Internal Pressure Sheath	✓		✓	- Polymer Ageing Assessment - Polymer coupon pull
Armours	✓	✓	✓	- Structural Capacity Assessments - Wire thickness measurement using UT Scans - Wire breakage check using UT Scans - Tensile Armour wire Fatigue life predictions
Annulus Flooding	✓	✓	✓	- Annulus Test - UT Scanning
Outer Sheath	✓		✓	- Annulus Test - Venting Re-instatement (Vent Clamps)
End Fitting Leak / Failure	✓		✓	Annulus Test (sometimes)
Ancillary Equipment		✓	✓	ROV GVI
Global Pipe Defect	✓	✓	✓	- ROV GVI - Dynamic Analysis

Sureflex JIP, 2023

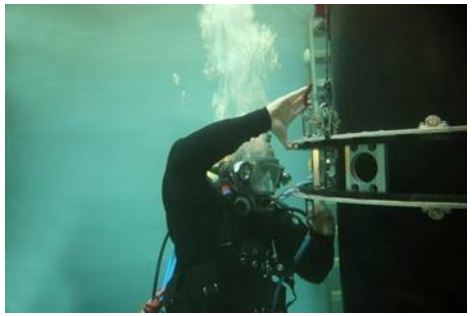
Flexlife – Oceaneering Partnership (2)

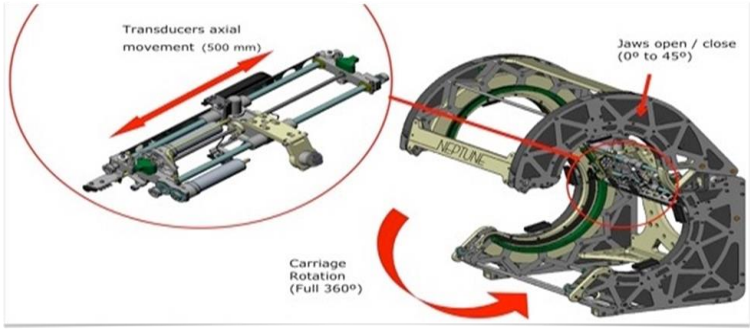
- Oceaneering
  - IROV, WROV, MicroROV
  - AUV
  - UT scanning
  - Digital radiography (DRT)
  - Metrology
  - Marine growth cleaning

- Flexlife
  - Annulus testing
  - CVI, bore, I-tube and difficult to reach areas
  - Polymer coupon retrieval
  - UT scanning
  - Hydrotesting
  - Repair solutions
  - Forensic dissection and testing

Collaboration - FlexScan® Ultrasonic Riser Scanning

- Technology is provided as a Joint Venture between Flexlife and Oceaneering
- Flexlife IP - WO 2009007670 A1
  - A method of monitoring the condition of a flexible pipeline comprising the step of scanning the pipeline with an ultrasonic scanner to produce and/or record a signal indicative or the level of flooding within the annulus of the pipeline and/or indicative of the integrity of the layers of the pipeline.
- Oceaneering IP – US 20210063353A1
  - A system which is capable of differentiating flooding and non - flooding condition of the annulus of the flexible pipeline which is subjected to high pressure. Using the system, an indicator of a flooded or non - flooded condition within the flexible pipeline may be calculated using transmitted and detected reflective waves or the lack of detected reflective waves.
- Oceaneering equipment
  - Neptune
    - ROV deployed
    - 6” to 20” pipe diameter
    - Rated to 3000m
  - Trident
    - Diver deployed
    - World’s first subsea phased array UT scanner
    - Suitable for larger diameter risers



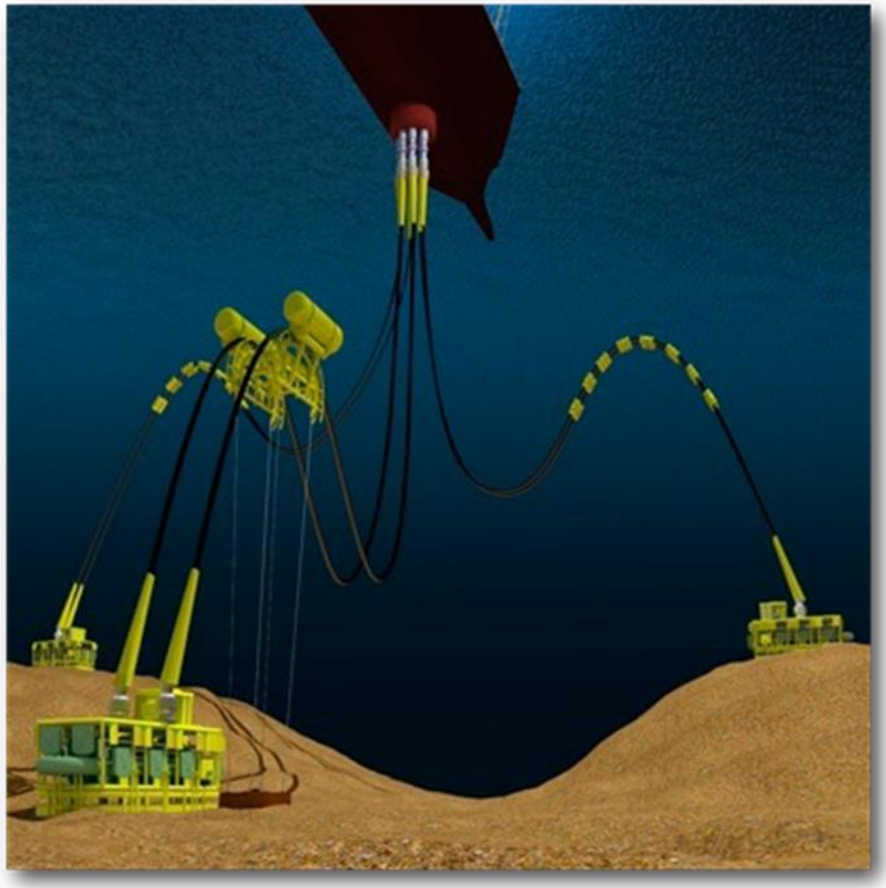


Video Footage

SUBSEA

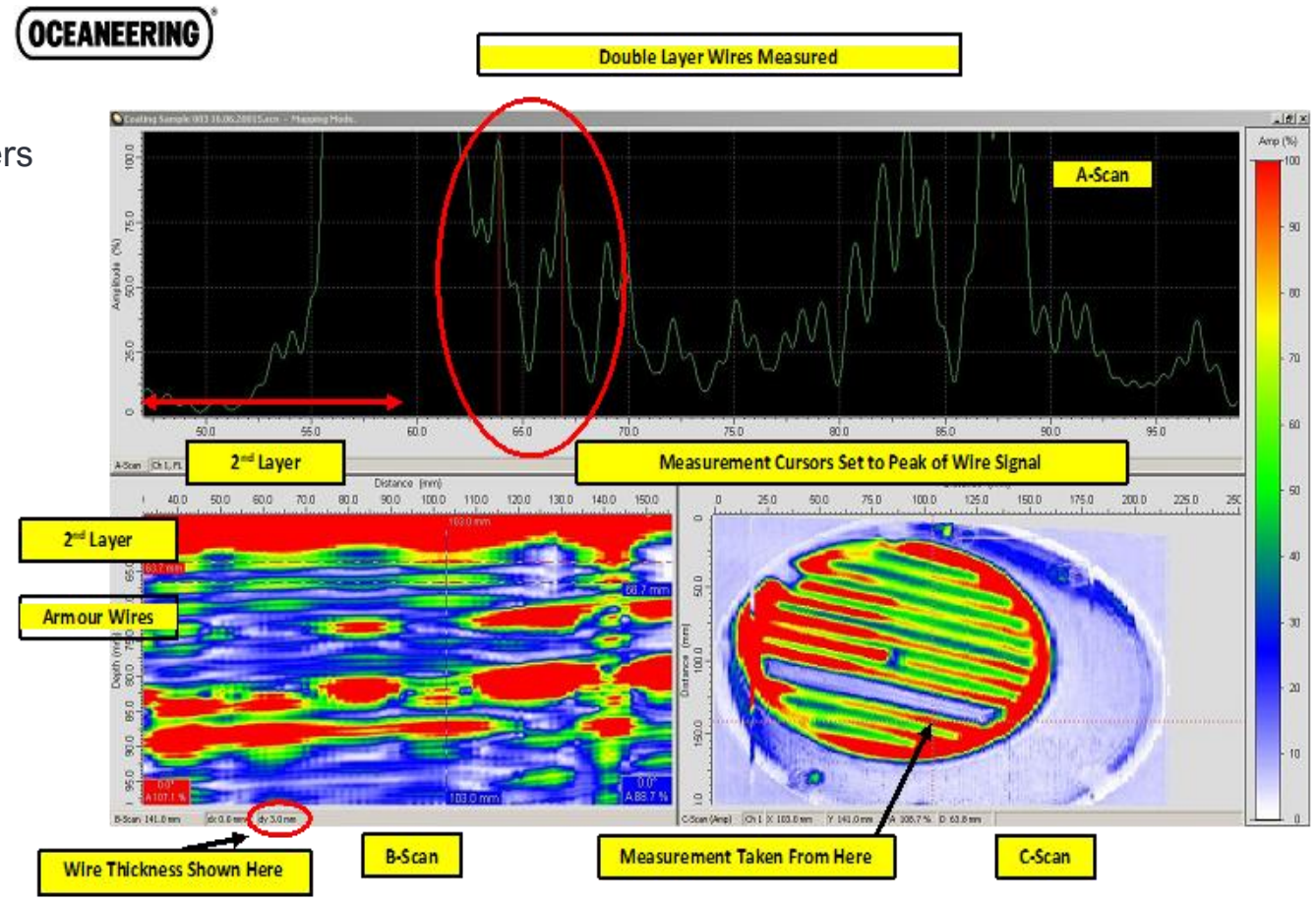
Typical Scan Locations

- Typical inspection methodology, scanning for flooding
  - Scan high in catenary, as close to MSL or the tip of the bend stiffener as practicable
    - If dry, this indicates that the riser outer sheath is intact
    - If flooded, option to carry out detailed armour wire scan at this critical location
  - Scan above touch down point to determine level of permeation within riser annulus
  - Scan above sag bend to determine level of permeation within annulus
  - Scan at entry/exit of MWA or between buoyancy modules at area of maximum curvature
- Scanning for flooding is carried out at 1mm resolution over a quadrant defined by the pipe outer diameter at each cardinal point of each scan location
- If known defect exists, armour wire scanning
  - Detailed 150mm, 1mm resolution armour wire scans over, above and below damage location



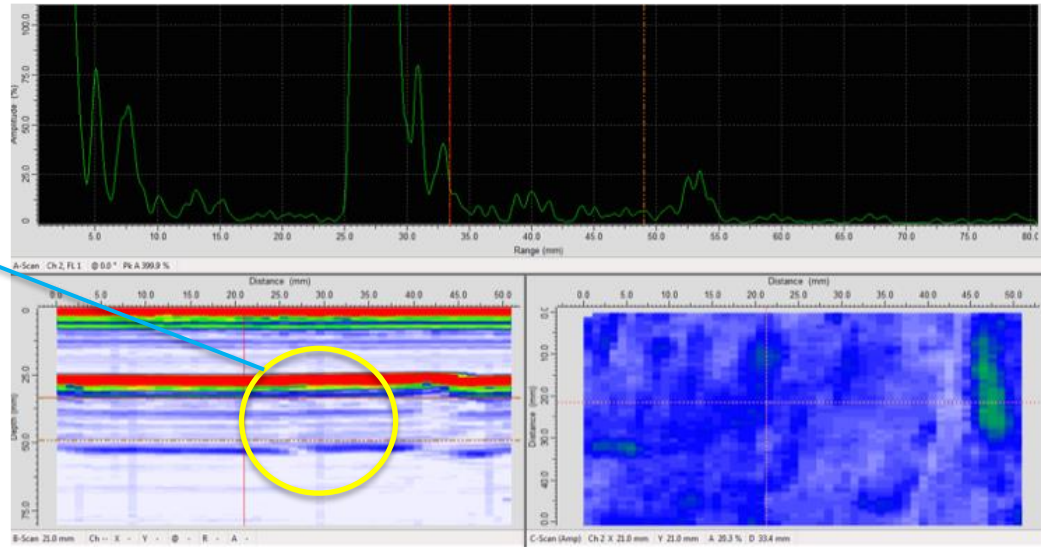
State of Technology

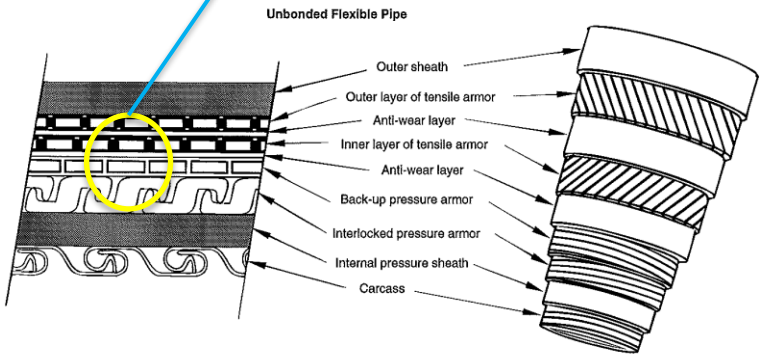
- Extensive offshore scanning experience has yet to uncover evidence of significant metallic layer degradation
  - Corrosion fatigue continues to be a concern, particularly on risers
  - General corrosion is also prevalent in both risers and flowlines
- Induced defects have been scanned to determine technology capability
- What can you expect to see using UT scanning technology?
  - Reduction in tensile armour cross section
  - Thinning
  - Armour wire breakage
  - Armour wire disorganisation
- Significant potential to utilise the technology to inform and augment life extension



Sample Result 1 - Shallow Water Dry Annulus Scan Data

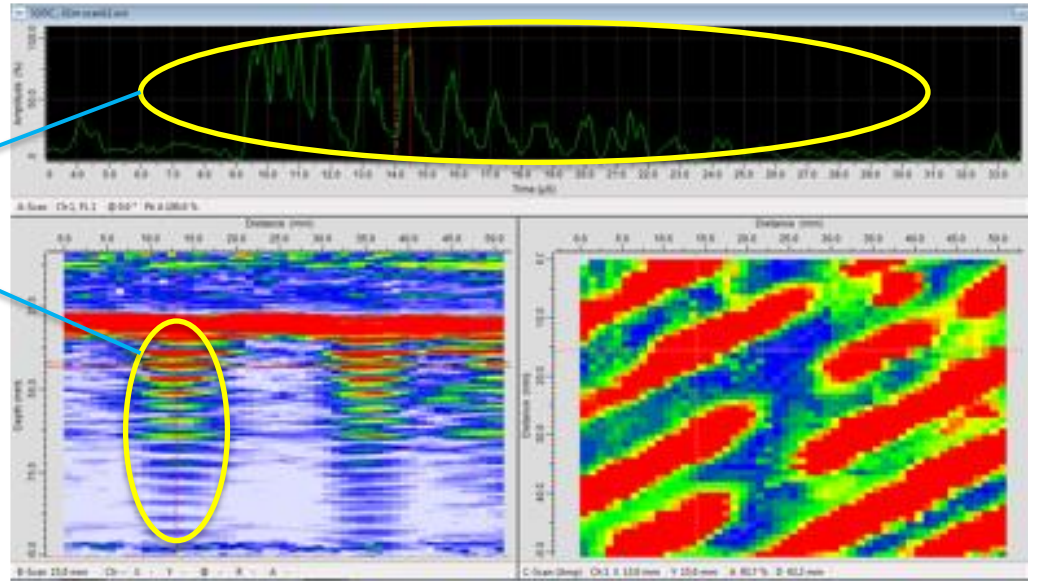
No signal returns indicating absence of couplant in annulus region

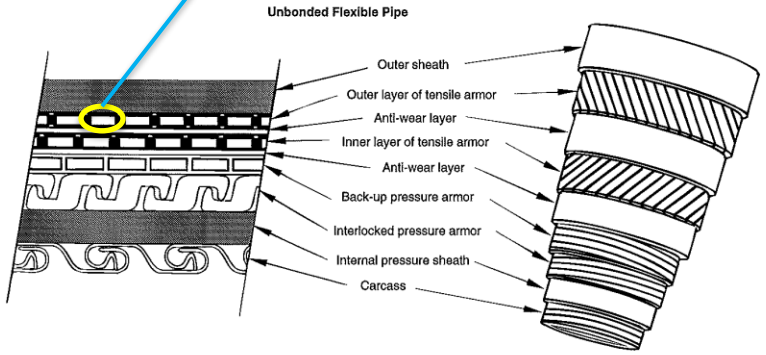




Sample Result 2 - Shallow Water Flooded Annulus Scan Data

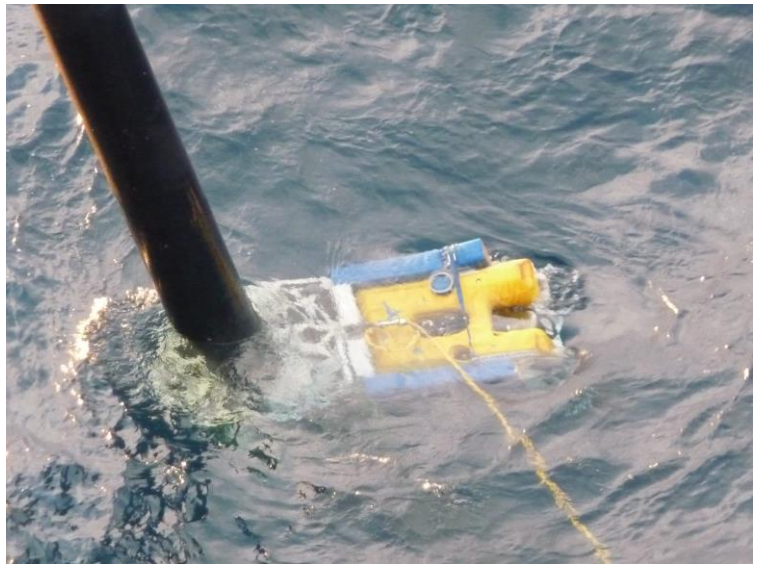
Clear and repeating echoes from tensile armour wire interfaces

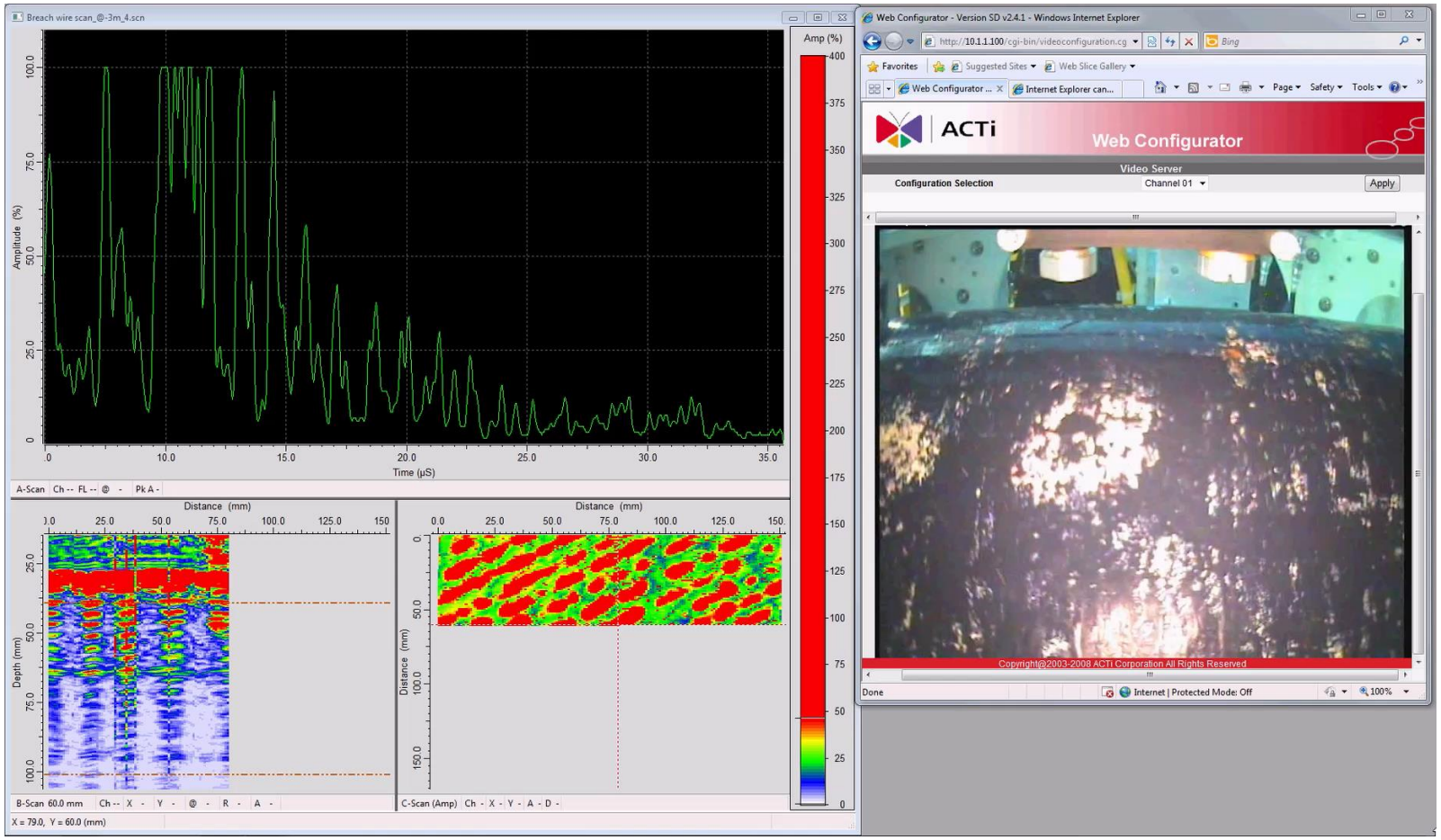




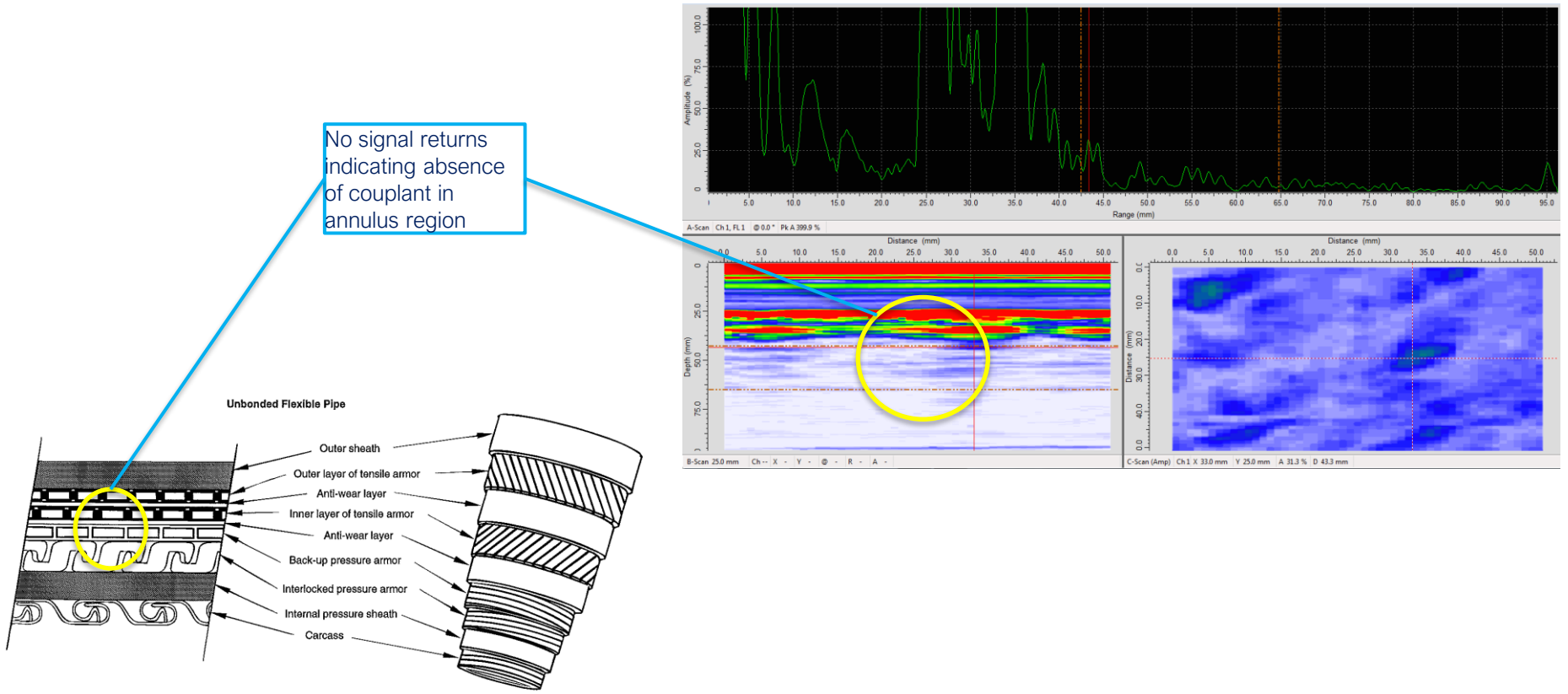
Example Case

- Annulus test only holding 0.6 bar
- Riser breached 6m below MSL
- Scan data directly over breach location indicates negligible general corrosion at breach area
- Flexlife life extension incorporates scan data
- Verified safe remaining operating

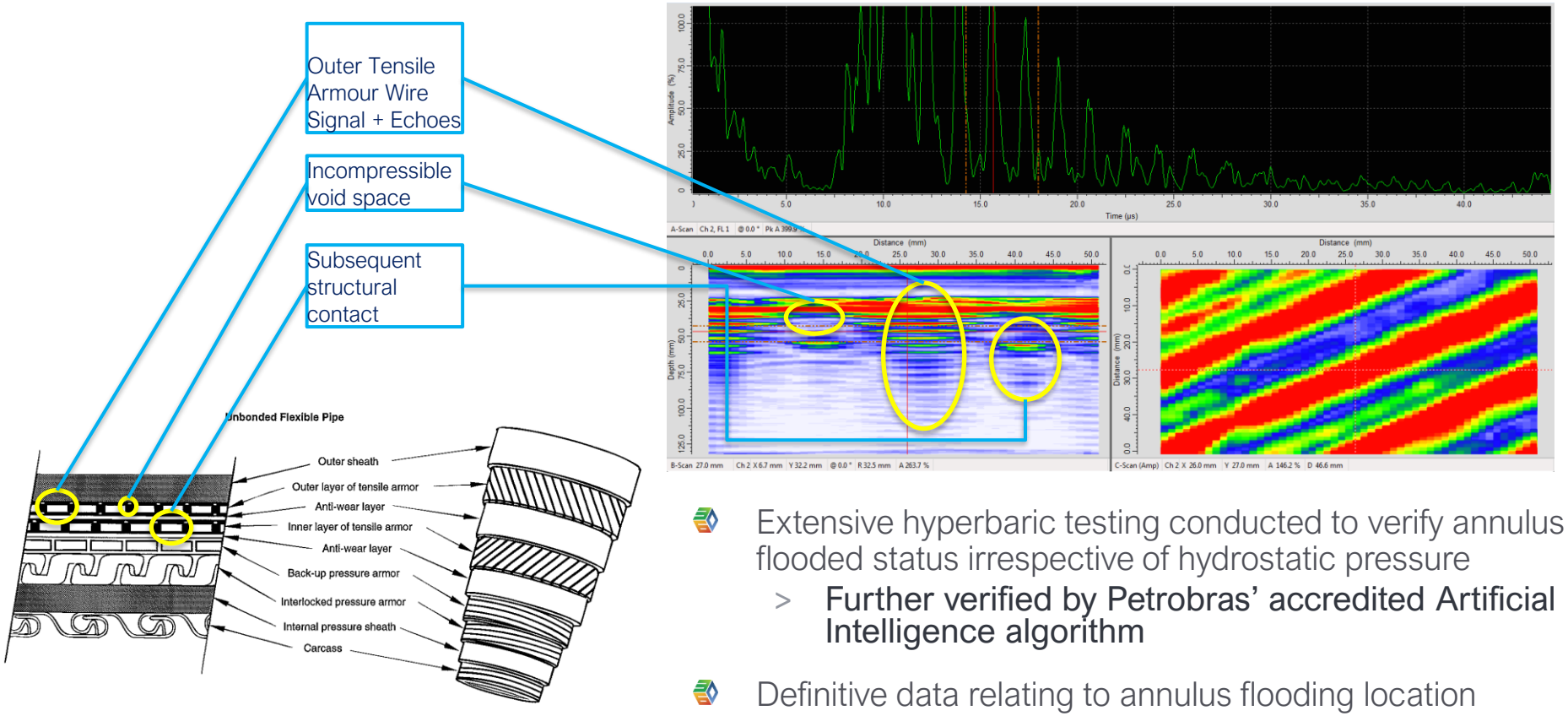




Sample Result 3 - Deepwater Dry Annulus Scan Data



Sample Result 4 - Deepwater Flooded Annulus Scan Data



- Extensive hyperbaric testing conducted to verify annulus dry – flooded status irrespective of hydrostatic pressure
  - > Further verified by Petrobras' accredited Artificial Intelligence algorithm
- Definitive data relating to annulus flooding location
  - > Maximise safe operating life and minimise replacement
- Avoid CO_2 SCC induced catastrophic failure

FlexScan Summary

- As of December 2024
- 650 flexible pipes scanned to date, 23% found to have flooded annulus
  - Brazil 17% flooded
  - Rest of World 38% flooded
  - Shallowest scan to date, 6m below MSL
  - Deepest scan to date, 2600m below MSL
- Most extensive campaign to date, ongoing scanning of risers and flowlines offshore Brazil
- Shortest offshore duration 5 days, UKCS
- Armour wire scan through thickest polymer to date, dual layer polymer outer sheath total thickness 22.5mm PE and 2.3mm tape layer
- Technology can be used to justify major CAPEX and field redevelopment
- Technology is a key tool which can be used to inform, augment and justify life extension studies
- Scanning has been carried out globally in (almost) every continent, Europe, Americas, Africa, Asia and Australasia

Q&A

UT Scan Data Summary, Dry - Flooded Annulus, Dec 2024

- Brazil - Dry
- Brazil - Flooded (global total)
- Rest of World - Dry
- Rest of World - Flooded (global total)