

RSRUK – Technology Network

Tuesday 29th January 2019, 1-4pm, OGA Aberdeen and London

Adam Sheikh – Head of Engineering & Integrity

Darren Stoker – CTO

Technology Network - Tuesday 29th January 2019, 1-4pm, OGA Aberdeen and London

- ▶ **Topsides integrity management:**
 - Benefits of Non-Intrusive Inspections

- ▶ **Subsea inspections**
 - Tracerco Discovery – Unpiggable Pipelines
 - MAPS

Technology Network

RSRUK – Non Intrusive Inspection



- ▶ RSRUK first deployed NII in 2008 on the Bleaeholm FPSO.
- ▶ By 2014 NII was widely adopted in RSRUK .
- ▶ In August 2017 RSRUK Issued a company position paper for the use of Non Intrusive Inspection as a substitute for Major Internal Inspections.
- ▶ The document has now been added as a Gate 3 screen process for all shutdowns. Eg Vessels will not make it on the shutdown list unless they have been screened for acceptability.
- ▶ Training of all our Asset Integrity Engineers has been completed for the use of DNV-RP-G-103. (Essential)

Document Title: NON-INTRUSIVE INSPECTION

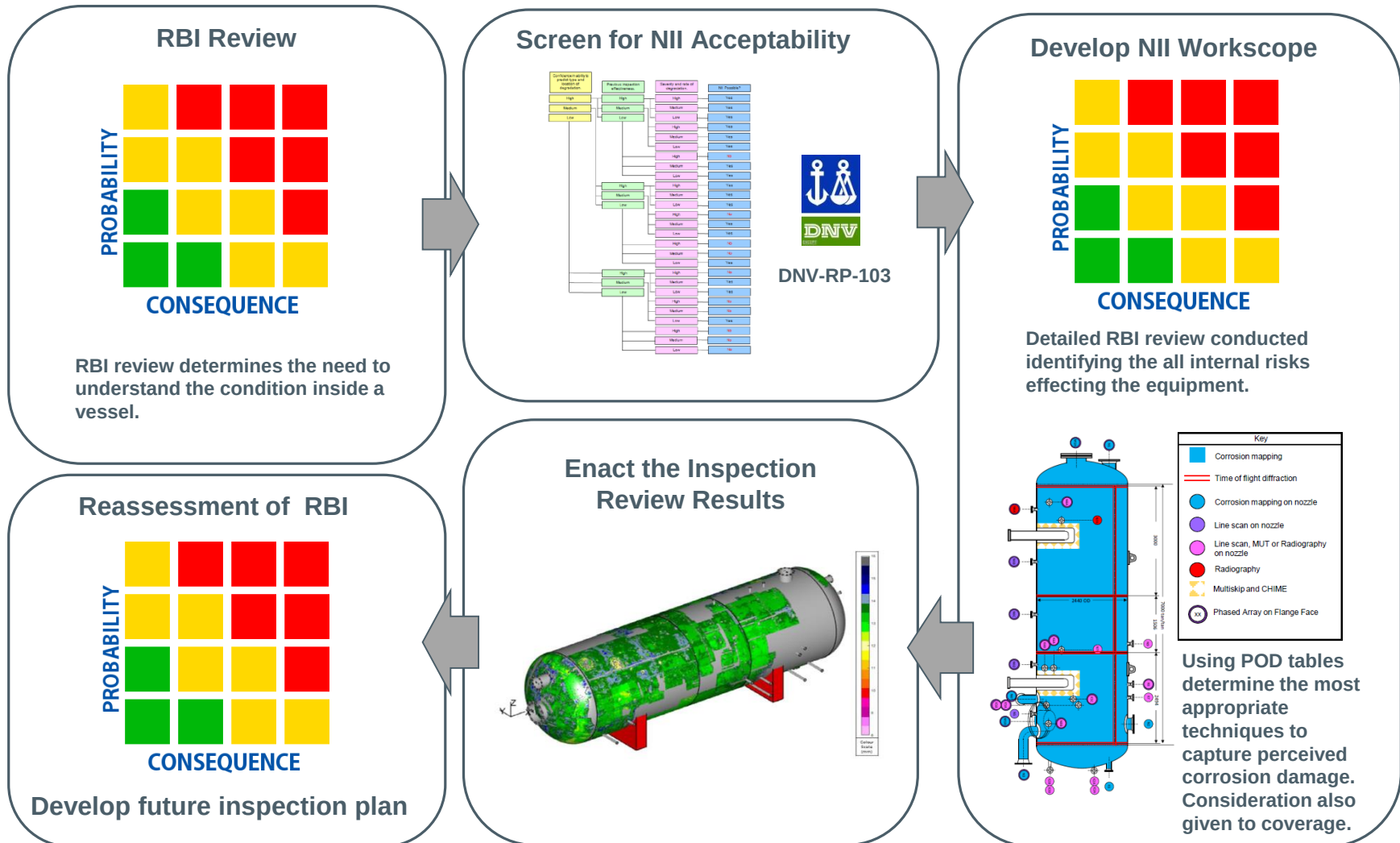
Procedure Owner: INTEGRITY MANAGER

Involved Persons: INTEGRITY ENGINEERS

Rev	Date	Revision / Review Description	Author/ Reviewer	Approved By	Authorised By
0		New document	F G Stewart	A Sheikh	

Technology Network

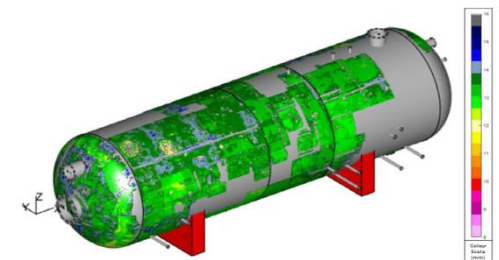
RSRUK – Non Intrusive Inspection Process



Technology Network

Reluctance to change..... Why?

- ▶ Technology has continued to improve but upstream oil and gas has been slow to adopt..... Why?
 - Traditional for inspection to include entry to vessels (Culture)
 - May need to open and enter for cleaning anyway
 - NII not suitable for some equipment items
 - Tolerable defect size may be too small to detect reliably from the outside
 - No techniques that cover flange face inspections
 - Need high confidence that deterioration mechanisms (threats) have all been identified
 - Need to justify change to regulator
 - Cost of non invasive inspections may appear higher
 - When the oil price was high, priorities were elsewhere



Technology Network

Why use NII?

Saves Money

- Increases production efficiency
- Reduced process and mechanical Costs
- Can be less damaging to plant

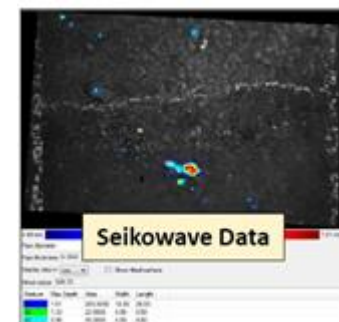
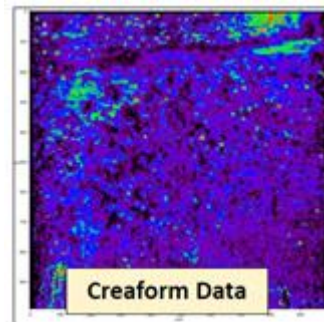
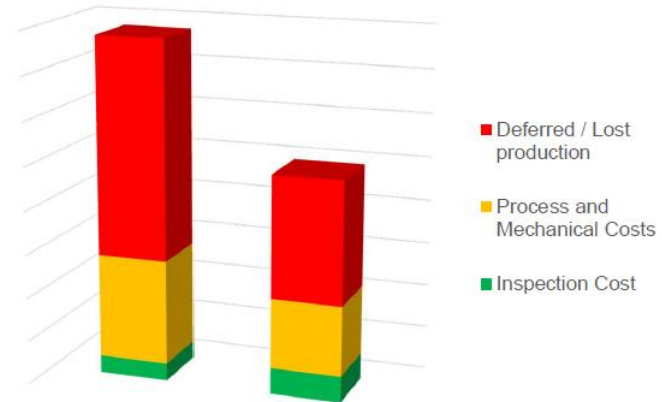
Reduces environmental impact

- No need to decontaminate
- Reduces potential of hydrocarbon losses (fewer shutdown)

Improves safety

- Reduced number of confined space entries
- Requires a better understanding of deterioration – normally through an RBI process
- Shut down and start up carries more risk of incident

Non-Invasive Inspection (NII)
Reducing costs, increasing production efficiency



HOIS JIP project on NII (DNV-RP G103) completed a study on NII v IVI. In many cases NII is being seen as more effective than an internal visual inspection.

RSRUK – Case Study (Claymore Production Separator)

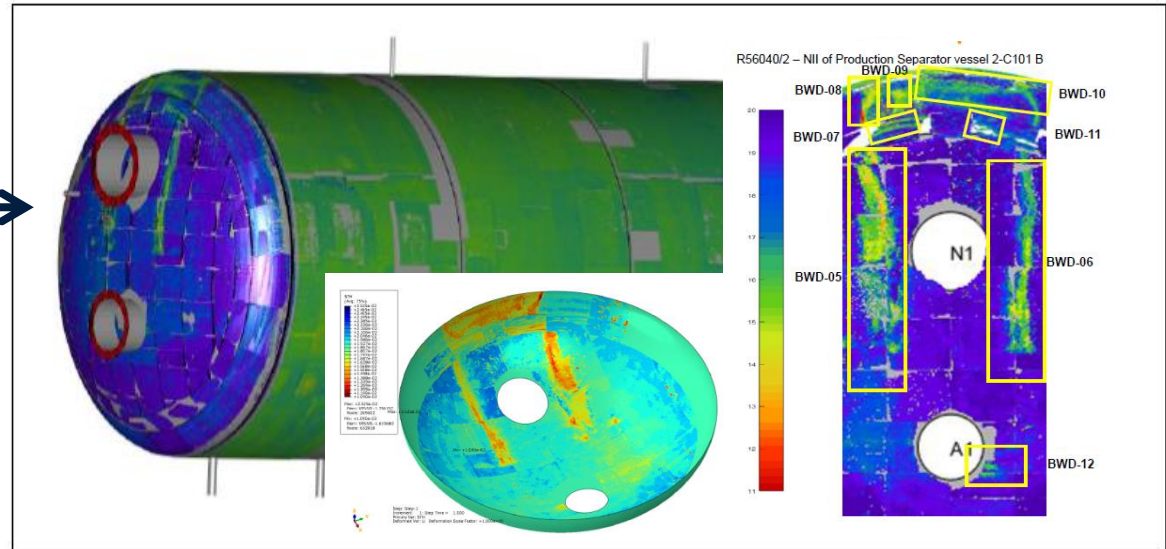
- ▶ NII conducted pre shutdown
- ▶ NII detected significant wall loss in vessel that required repair
- ▶ This provided RSRUK an opportunity to correlate the NII findings to the Internal Inspection findings.

- ▶ The results of this study show that NII provided a greater effectiveness at detecting internal defects than internal visual inspection.
 - All Internal Visual findings correlate to the results seen during the NII.
 - Some wall loss detected using NII was not easily identified during the visual inspection due to previous repairs or diameter of nozzles restricting visual access.
 - NII could not determine the condition of nozzle flange faces and whilst visual assessment gives full access. (Failure mode result in a weep)
 - Some restrictions with the size of NDT equipment meant some areas of the vessel could not be inspected with NDT (Approximately 5%)

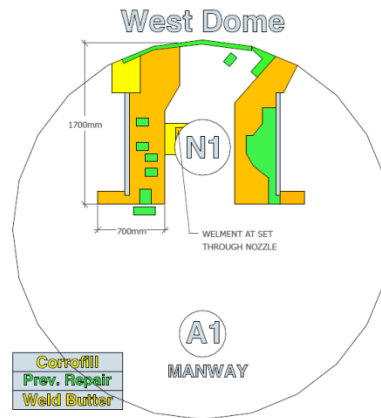
Technology Network

Separator Dome

Non Intrusive
Inspection
(Corrosion mapping)
found significant wall
loss in the separator
dome end with wall
thickness measured
down to 11.3mm.



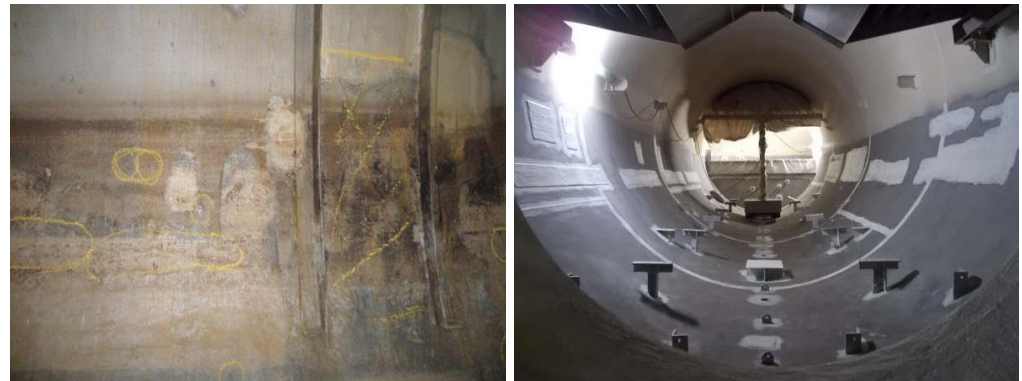
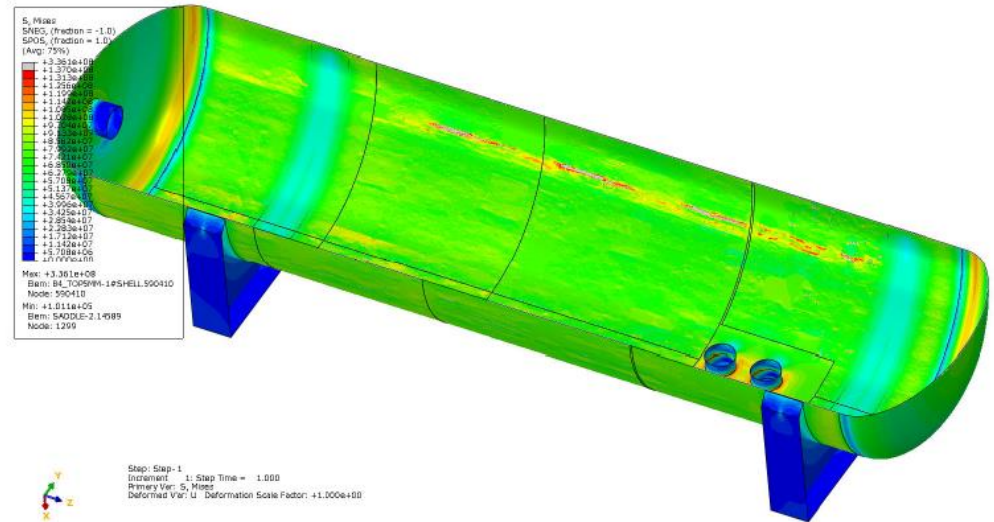
Internal visual
Inspection Verified
this internal wall loss
and also measure
wall thickness down
to 11.5mm.



Technology Network

Separator Shell

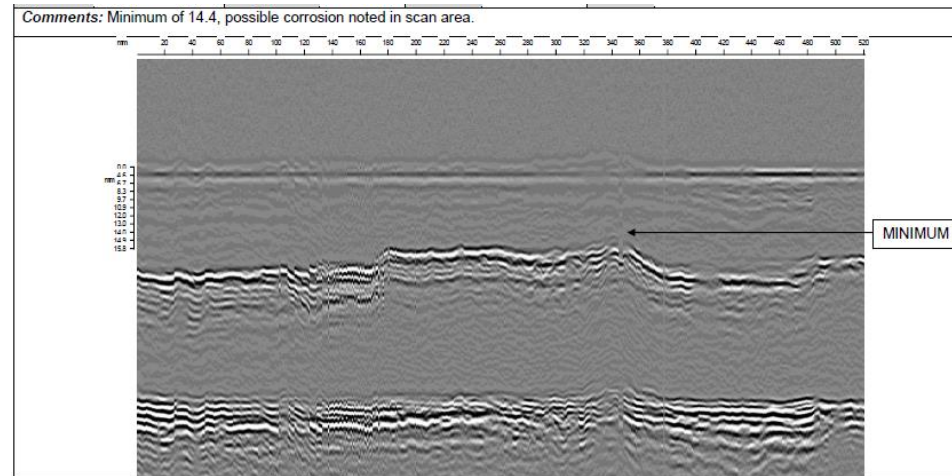
Non Intrusive
Inspection
(Corrosion Mapping)
found significant wall
loss on the
separator shell with
longitudinal wall
thickness measured
down to 7.3mm.
Internal visual
Inspection Verified
this internal wall loss
and also measure
wall thickness down
to 7.3mm.



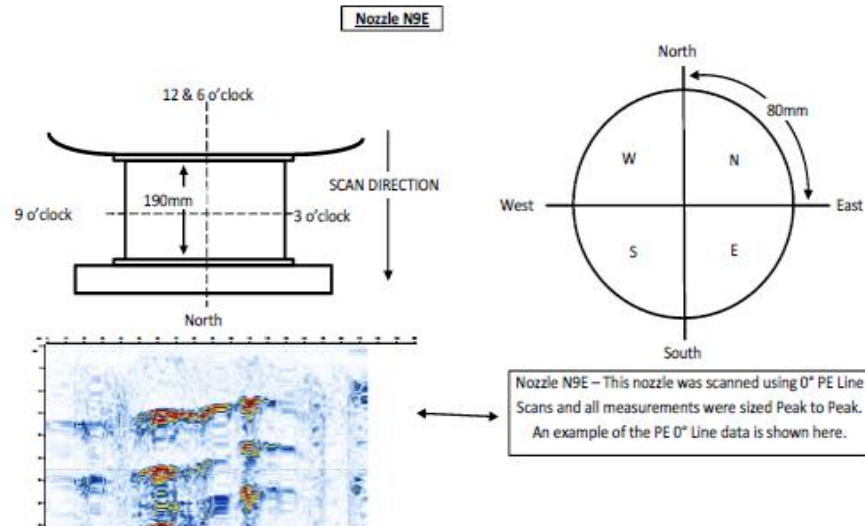
Technology Network

Separator Nozzle & Welds

Non Intrusive Inspection (TOFD) found light corrosion to the internal seam weld. This was verified internally.



Ultrasonic inspection of the nozzles revealed wall thinning down to 5mm. This was verified using a borescope although accurate wall loss could not be determined visually



Technology Network

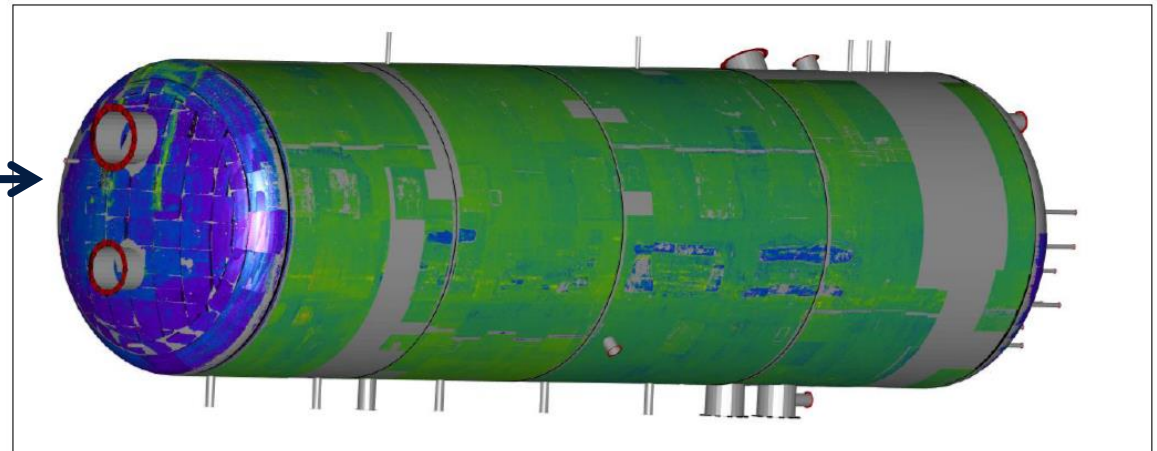
Nozzle Flange Faces/ Shell Restrictions

Not a Non Intrusive method available to determine flange face corrosion.



Saddle Supports

Restrictions with the NDT tool and vessel appetencies leave some areas inaccessible. Around (5%)



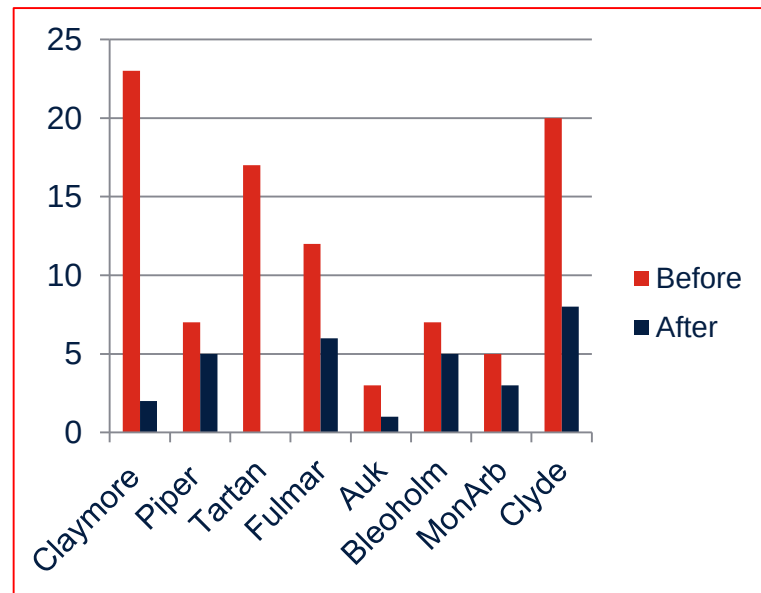
Technology Network

What effect has NII had on RSRUK in 2018?

Whilst it is hard to pin point the immediate effect of the NII approach we do know the following

- 2018 shutdown days have reduced from 340 – 175
- Planned losses have reduced showing an increase in PE
- Labour costs associated with shutdowns have significantly reduced

IVI Inspection Before and After Screening



(68% Reduction)

Key Messages:

NII is a very effective method however the application and scoping of such scope must be done in a robust manner and those applying this technique must have a good understanding.

The robustness of the corrosion risk assessment is key in determining if NII will be suitable eg you have to know your risk for this method to be effective.

The assessment of the NII inspection must consider restrictions in the techniques and also the areas that no data has been obtained. It is important this feeds back into the corrosion risk assessment.

If applied correctly NII is a significant lever to reducing operating costs, reducing risk to personnel and significantly increasing production efficiency.

Technology Network

Subsea Inspection Technology



- ▶ Discovery CT Scan (Unpiggable Pipelines)
- ▶ MAPS
- ▶ Advanced structural modelling (Different form of technology)

Technology Network

Discovery Tool - Case Study

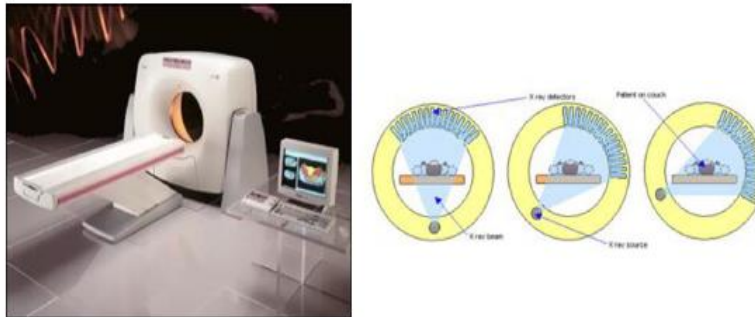


There are no reliable subsea detection tools to accurately detect and characterise hydrate, wax, scale and asphaltene blockages

“It is believed that up to 40% of the world oil and gas pipelines are deemed to be unpiggable.”¹

- ▶ RSRUK Petronella field is a subsea back to tartan commissioned in 1986.
- ▶ Petronella field is currently not in service since 2012.
- ▶ No subsea pig launching and topside pig receipt facility installed.
- ▶ Due to re-configuration in 2009, riser section and subsea section of various diameters.
- ▶ Cost
 - Pipeline cleaning
 - Installation of topside & subsea pigging facilities
 - Engineering cost
 - Dive vessel cost
- ▶ Due to the above challenges involved in conventional pigging, we opted for alternative technology to measure pipe wall integrity along the pipeline route using Tracerco CT scan technology.

- ▶ Externally deployed non-intrusive inspection.
- ▶ Eliminate the cost & risk of removing coatings subsea.
- ▶ Reduce operational intervention time so critical decisions can be made immediately by getting data online
- ▶ Visualisation of flow assurance issues online.
- ▶ Provides detailed images and measurement of pipe wall integrity to approximate 1mm wall thickness accuracy. Based upon medical Computed Tomography (CT) principles



Now, for the first time, CT technology has been taken subsea for the inspection of any type of flowlines

Technology Network

In operation on pipeline

CAGE
THR: 209 '
DPT: 3565 '
HDG: 002
TRN: 0.0

315 330 345 0 375 390 405
P: 1 358 R: 1
TRN: -0.0

ROV
DPT: 3686 '
ALT: 22 '
BTY: 3708 '

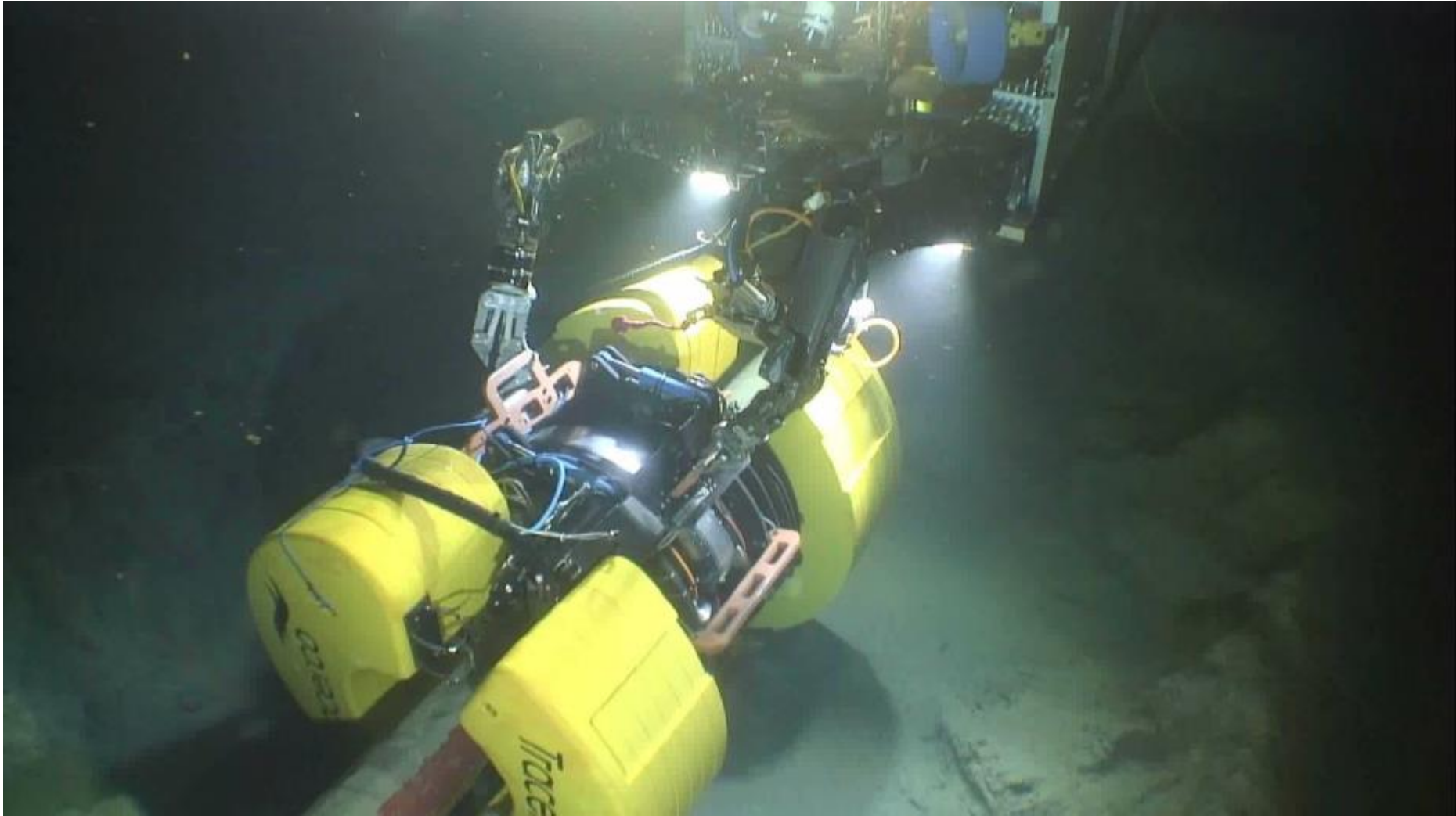
Real-time data
transmission

ROV

Surface

Technology Network

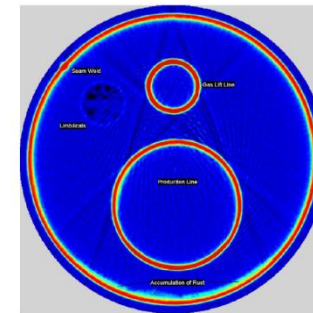
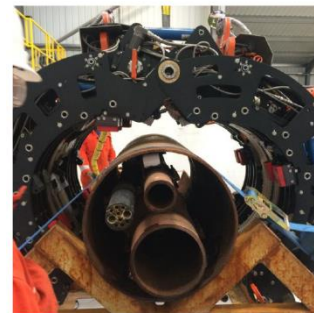
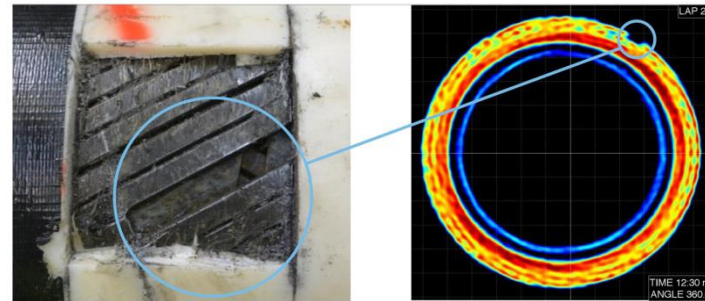
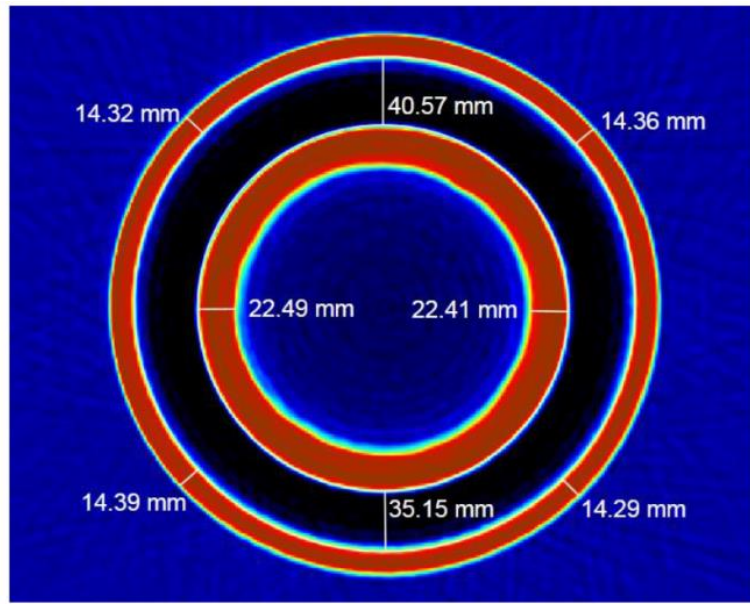
In operation on pipeline



Technology Network

Technique and Applications

- Provides detailed images and measurement of pipe wall integrity to approximately 1mm wall thickness accuracy.
- Fully Operational and Field Proven–TRL 7
- DNV RP-A203 Certified
- 3000m Water Depth rated
- Diameter range currently 2" to 26" (larger versions can be manufactured for larger lines)



Technology Network

Discovery Case Study – RSRUK Results

- ▶ Average WT was found to be 12.6mm. However lowest recorded WT was 10.3mm.
- ▶ There is evidence of small layer of corrosion build-up (consistent with water) or deposits around the bottom half of the pipe in all scan locations.
- ▶ One location detected significant build up of wax deposit.

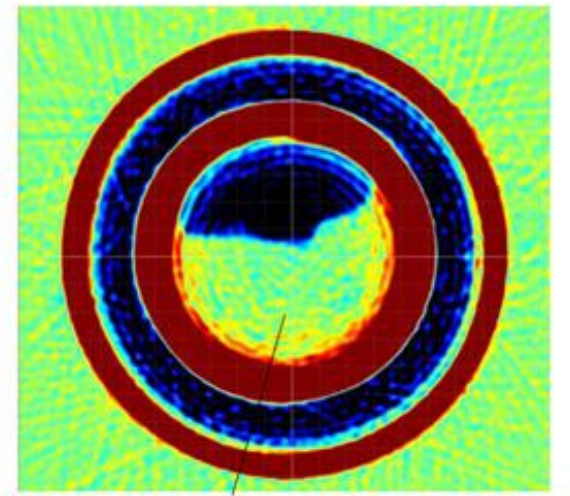
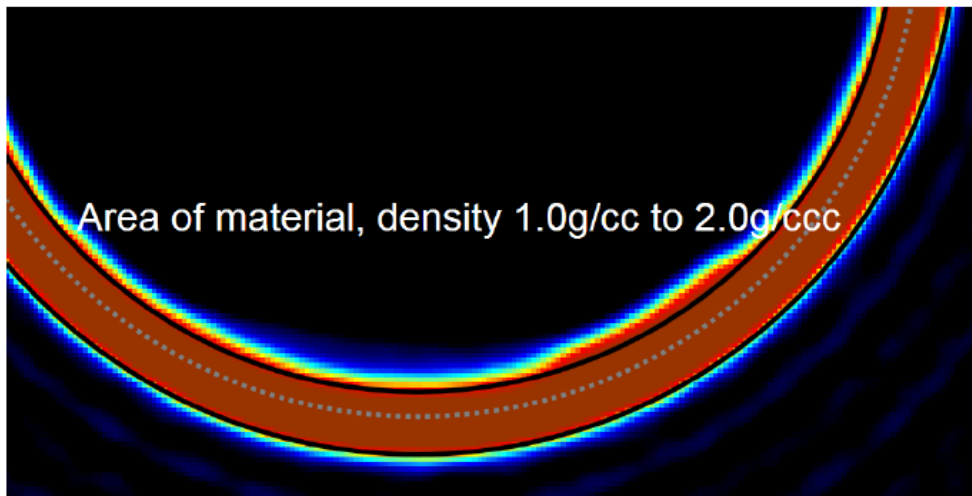


Figure 18: Representative Scan Reconstruction for Location 3 with Appropriate Flow Assurance Scale; Focused on Area of Identified Build-up

- ▶ The inspection was effective, however due to inclement weather only 3 of the 5 locations were inspected.
- ▶ The tool inspected a total of 510mm (34scans) of pipeline at each locations.
- ▶ Cost
 - Conventional pigging would have cost £8m due to dive vessel, pigging facility, pipeline cleaning & other engineering costs.
 - The total cost for Petronella CT scan inspection is £850k.
- ▶ Pipeline integrity
 - Conventional pigging would have provided complete Wall thickness profile of the pipeline, however CT scan inspection provided us only indicative wall thickness on selected location along the pipeline route.
- ▶ Overall the CT scan inspection is effective and we are progressing with other Unpiggable RSRUK pipelines.
- ▶ Lessons learnt
 - The inspection should be planned during summer to get favourable weather conditions.
 - Flow assurance study should be carried out to select optimum inspection locations.

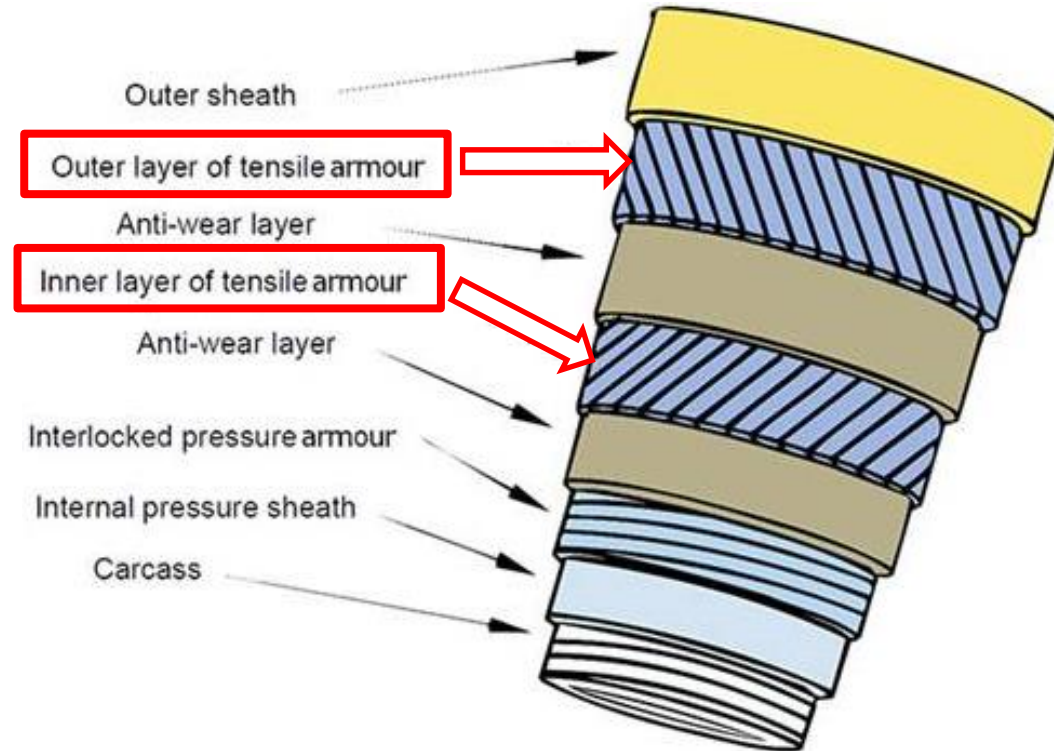
MAPS Inspection Technology

Flexible Risers

Design

Life extension on dynamic riser is a well known industry problem. There is no existing technology that can determine on the internal condition between the carcass and the outer sheath.

- ▶ Each layer has a specific function
- ▶ The polymer outer sheath is most susceptible to damage
 - It is an environmental barrier preventing seawater coming in to contact with the inner steel layers
- ▶ Loss of outer sheath can lead to flooding of the annulus and rapid corrosion of inner layers
- ▶ The Armour wires are the primary load bearing element of the structure
- ▶ Loss of armours wires would compromise the structure of the flexible riser design – this is the component we want to inspect
- ▶ Armour wire inspection technology has historically been limited
- ▶ Flexible risers within I-tubes are at risk due to splash zone and friction damage
 - Access to flexible risers within I-tubes is often difficult: any inspection technology needs to 'reach' into these restricted access areas

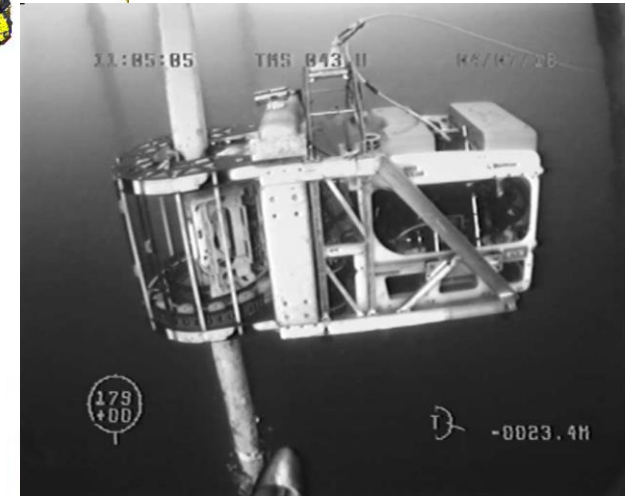
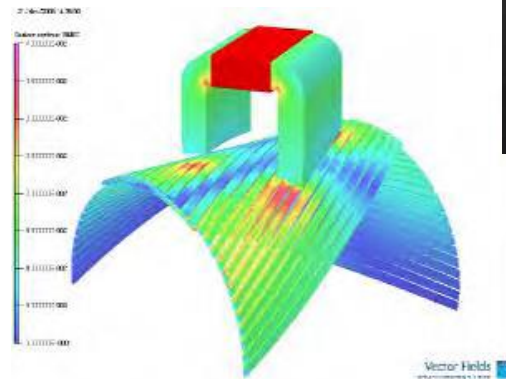
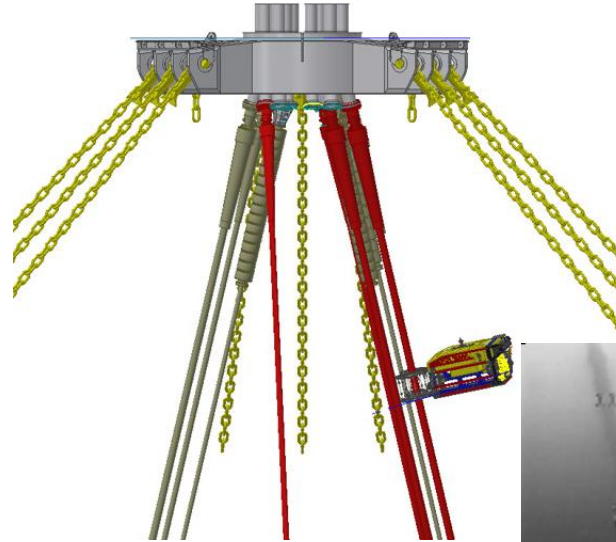


Note: The 'annulus' is the space between the Outer Sheath and the Internal Pressure Sheath which contains the remaining layers (except the inner carcass)

MAPS Inspection Technology

What is it?

- ▶ MAPS stands for *Magnetic Anisotropic and Permeability System*
- ▶ Magnetic signals are sensitive to **changes** in stress
- ▶ It is therefore possible to deduce the stress in a magnetic material – accurate to a few % of yield – by measuring the **change** in its magnetic field under different loads



MAPS Inspection Technology

Application to Flexible Risers

- ▶ For flexible pipelines this is achieved by inducing a magnetic field the armour wires at different internal pressures and then measuring the resultant magnetic signature at each pressure
- ▶ It is usually deployed from topsides



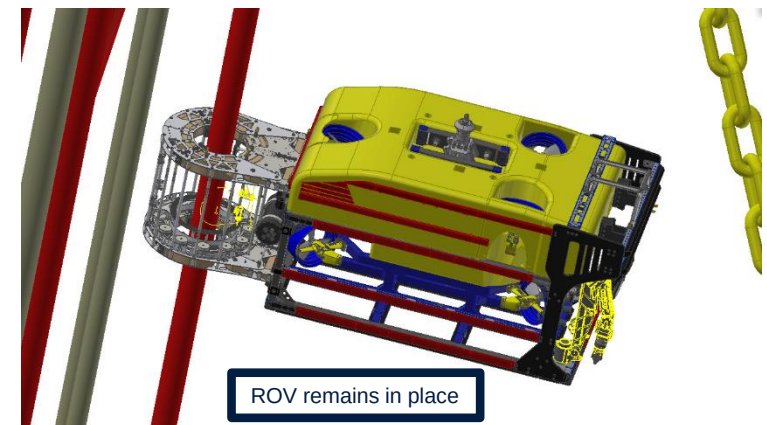
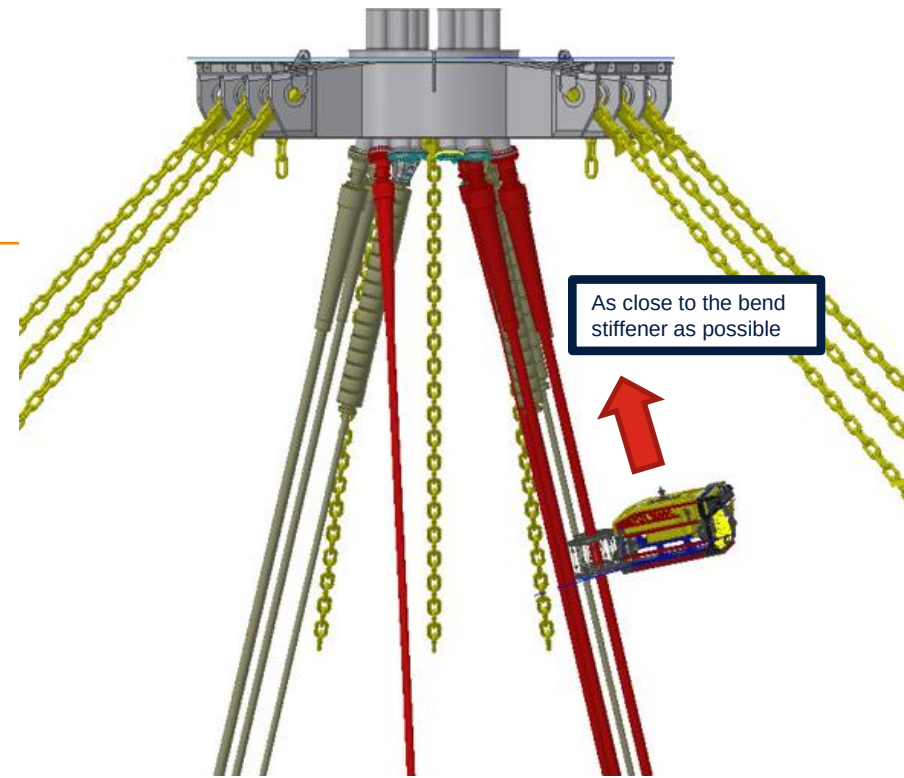
- ▶ A non-loaded (i.e. broken) armour wire can therefore be detected relative to other wires



MAPS Inspection Technology

RSRUK Deployed

- ▶ The MAPS tool was deployed by ROV due to limited topsides access
 - It was clamped around each riser directly under the spider after the exit point from the bend restrictor
- ▶ Each riser was scanned at three different pressures before the next riser is tested.
- ▶ Each test pressure needs to be in a stable hold for the couple of hours before each scan is performed.



MAPS Inspection Technology

Results

- ▶ RSRUK trial of the MAPS inspection reported a riser that had one unloaded outer tensile armour wire
- ▶ This will subsequently require replacement
- ▶ Risers where no loss of tension was detected can be subject to justified life extension.
- ▶ The cost of deployment was around £1.5m for 5 risers.
- ▶ When being deployed subsea the application is very weather dependant.
- ▶ Requirement to increase and decrease pressure whilst tool is in place.

