Decommissioning and Restoration methodologies

NAP Studium Generale: Decommissioning and Industrial Cleaning

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Shell's net carbon intensity

Also, in this **[report]** we may refer to Shell's "Net Carbon Intensity", which includes Shell's carbon emissions from the production of our energy products, our suppliers' carbon emissions in supplying energy for that production and our customers' carbon emissions associated with their use of the energy products we sell. Shell only controls its own emissions. The use of the term Shell's "Net Carbon Intensity" is for convenience only and not intended to suggest these emissions are those of Shell plc or its subsidiaries.

Shell's net-Zero Emissions Target

Shell's operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, they reflect our Scope 1, Scope 2 and Net Carbon Intensity (NCI) targets over the next ten years. However, Shell's operating plans cannot reflect our 2050 net-zero emissions target and 2035 NCI target, as these targets are currently outside our planning period. In the future, as society moves towards net-zero emissions, we expect Shell's operating plans to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell may not meet this target.

Forward Looking Non-GAAP measures

This **[report]** may contain certain forward-looking non-GAAP measures such as **[cash capital expenditure]** and **[divestments]**. We are unable to provide a reconciliation of these forward-looking Non-GAAP measures to the most comparable GAAP financial measures because certain information needed to reconcile those Non-GAAP measures to the most comparable GAAP financial measures is dependent on future events some of which are outside the control of Shell, such as oil and gas prices, interest rates and exchange rates. Moreover, estimating such GAAP measures with the required precision necessary to provide a meaningful reconciliation is extremely difficult and could not be accomplished without unreasonable effort. Non-GAAP measures in respect of future periods which cannot be reconciled to the most comparable GAAP financial measure are calculated in a manner which is consistent with the accounting policies applied in Shell plc's consolidated financial statements.

The contents of websites referred to in this **[report]** do not form part of this **[report]**.

We may have used certain terms, such as resources, in this **[report]** that the United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov.

Agenda

This presentation provides a general overview of decommissioning practices used in Shell

ID	Topic
1	Overview
2	Industrial Cleaning
4	Onshore & Offshore Pipelines
5	Onshore Facilities Decommissioning
6	Offshore Facilities Decommissioning
7	Closing Remarks

1.0

OVERVIEW

Shell Assets – some typical examples







Total decommissioning scope: 20,285 $ million (YE 2022, ref. Shell Annual Report 2022)

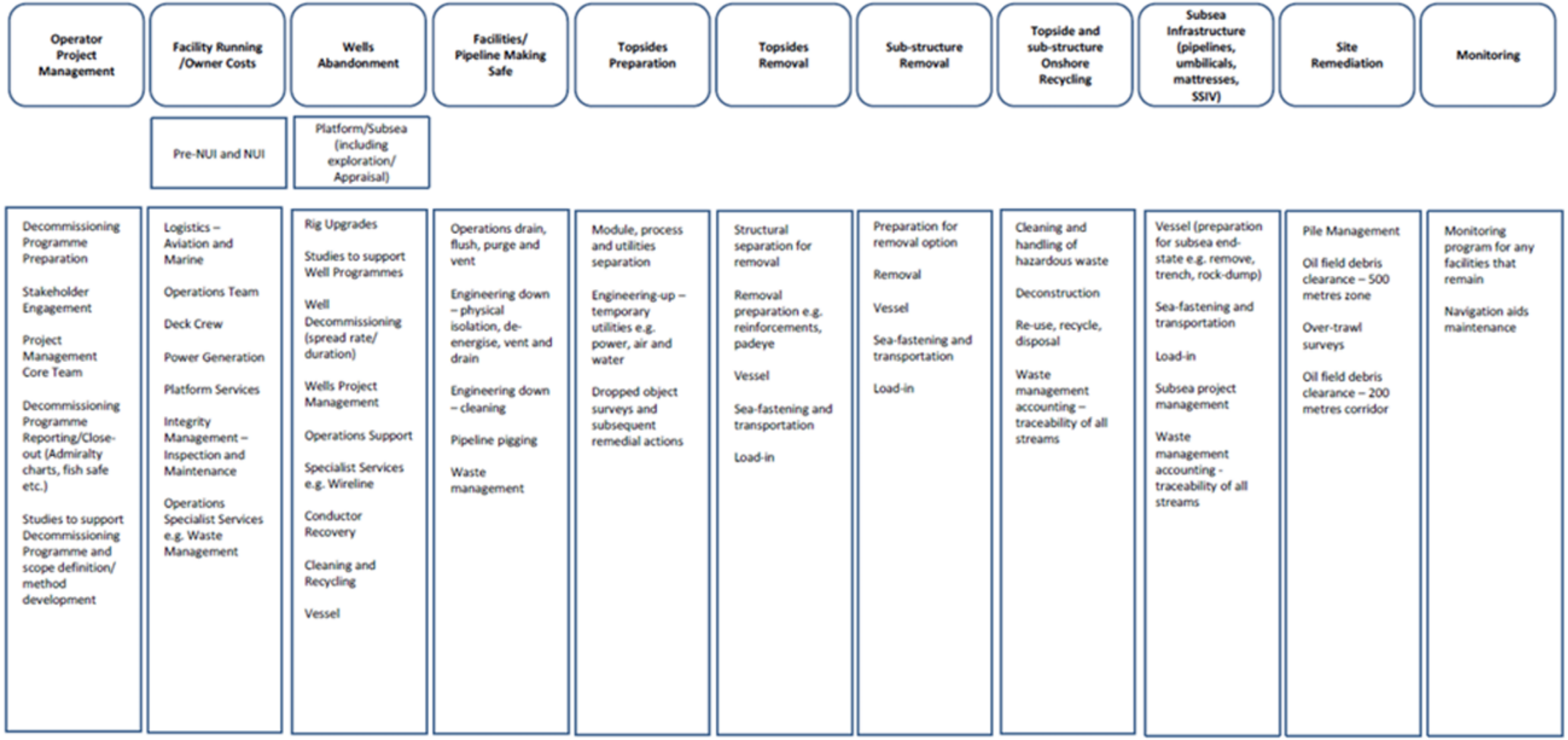
Decommissioning & Restoration: Key Principles

D&R supports Shell's strategy of Powering Progress through Respecting Nature and Shareholder Value

As a responsible corporate citizen, we need to know and understand D&R

We recognize the importance of the supply chain and service industry in executing D&R

Decommissioning Steps & Activities (Ref. Offshore Energies UK WBS)



2.0

INDUSTRIAL CLEANING (IC) Make Safe

Industrial Cleaning - Principles

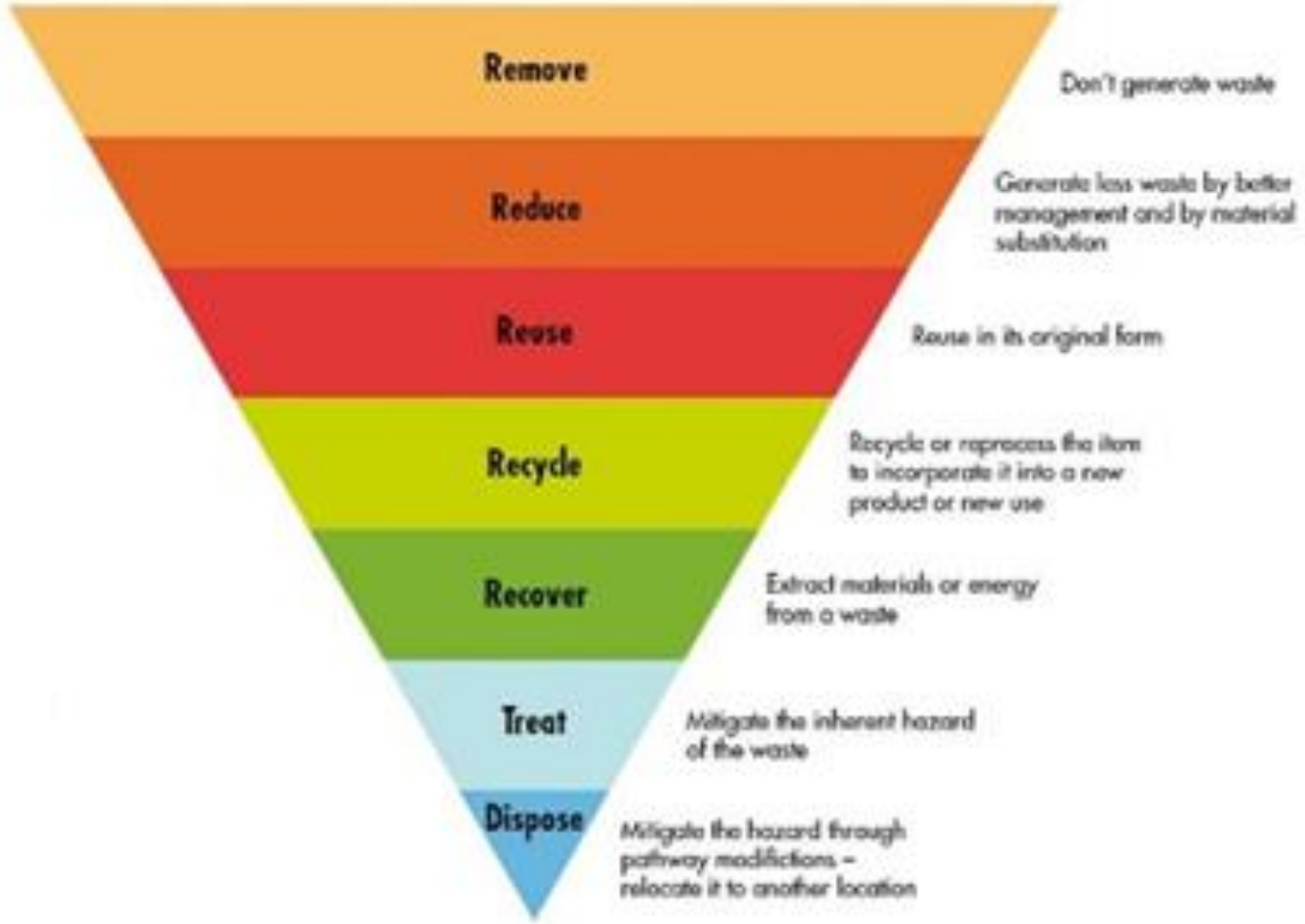
- Before asset shut-down, Operations should execute support cleaning
- No man-entry for cleaning, unless the equipment was not designed to clean without manual access
  - Atmospheric storage tanks – clean with tank wash heads mounted on the roof or on the man-hole.
  - Robots for tank cleaning
- Minimize waste generation - A case-by-case analysis is required to determine which fluids are required for cleaning (for example, use cold water, use hot water or water with chemicals)


Manway cannon (Mourik)

Cleaning robot(KOKS)

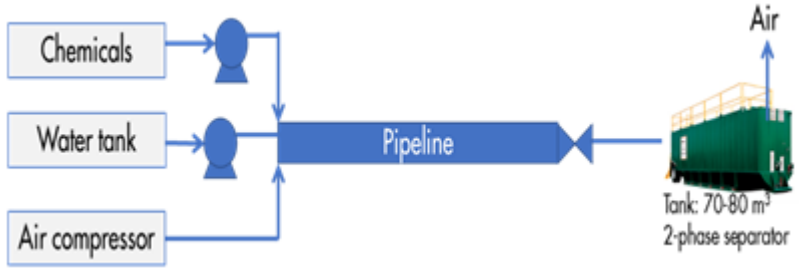
Industrial Cleaning - Waste Management

- Follows decision hierarchy:
  - minimize the generation
  - optimize reuse, recycling and disposal
- Examples of good practices:
  - filtering and reuse flush water
  - concentrate pollution in sludge
  - minimize chemical volume and hazardous waste management



Pipeline cleaning options

- Cleaning method depends on the cleaning target and **expected** type and volume of sludge
- Several pipeline cleaning options are possible

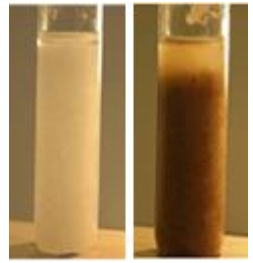


Air/water/chemical flushing

Potential solutions	Cleaning Target					Possibilities			Pipeline fluid	
	De – oiling	Sand	Wax	Mer cury	Norm	Multi diameter	Long length	Not require pig launcher	Gas lines	Liquid lines (oil/water)
Flush seawater **										
Gel pigging										
Pigging (e.g. bi-di by-pass pigging)*										
Air(or N2)/water / chemicals flushing ***										
Ice pigging							Ice will melt			
Uptake biofibers										
Hydro-jetting							< ~ 300 m			

* Progressive pigging may be required depending on the amount of solids
** Flushing velocity and duration needs to exceed the minimum velocity and time, respectively
*** For large diam. pipelines many air compressors are required, air is not suitable for volatile oil (explosion risk): N2 should be used

Gel pigging



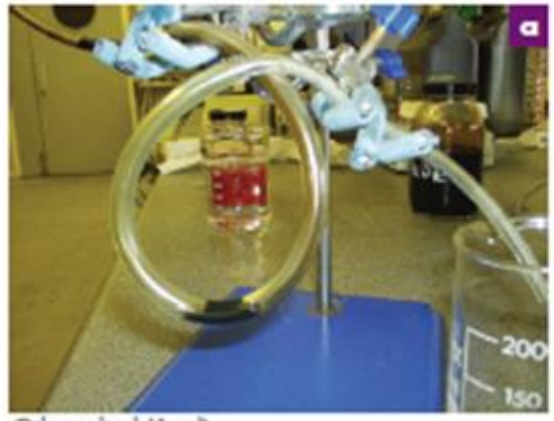
Uptake™ suspension without and with sand

Pipeline cleaning – Gel pig

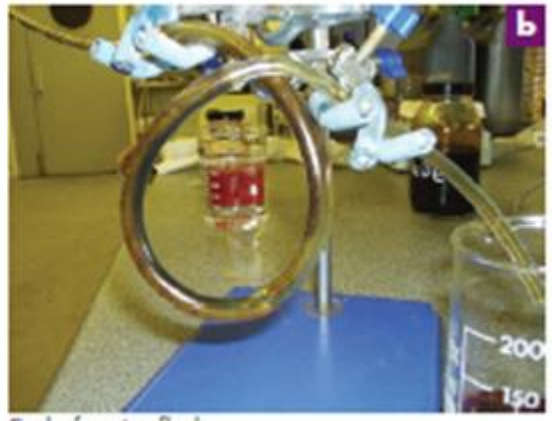
Only water flush to clean oil line – leaves oil behind

Objective: increase effectiveness of deoiling pipelines

- Aqueous gel is a base chemical (>90% water) crosslinked with gelling agent
- Effective to sweep oil and loose debris out of the pipe
- Requires minimum differential pressure to pump

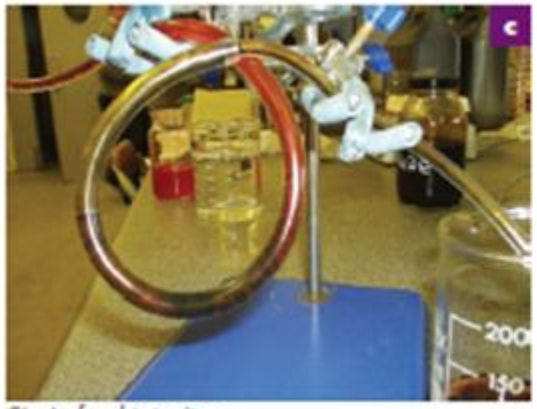


Oil applied (1 ml)

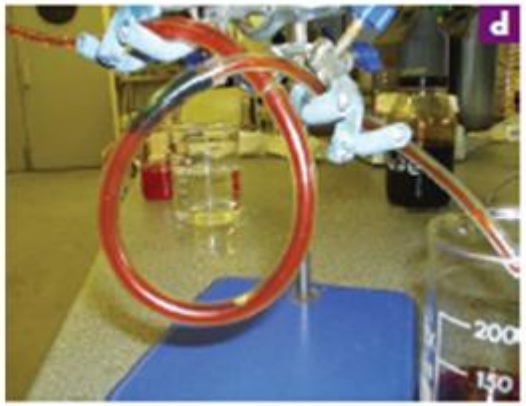


End of water flush

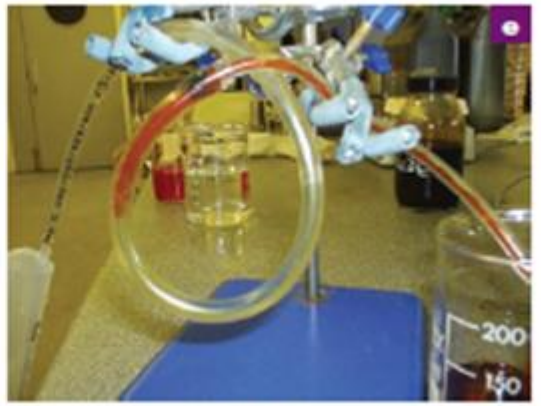
Gel pig used to sweep oil out



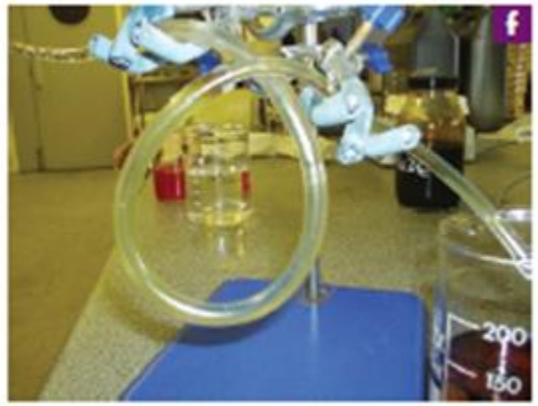
Start of gel injection



End of gel injection



Start of second water flush



End of second water flush

Pipeline cleaning: Air/water/chemical flushing

The Problem/challenge

- Pipeline needs to be cleaned prior to inspection (pigging)
- Foam pig is riding over the debris and not able to clean the line
- Not able to run a BI-DI pig because of debris volume
- Pipeline has 48 "un-piggable" 90 degrees bends (expansion loops)

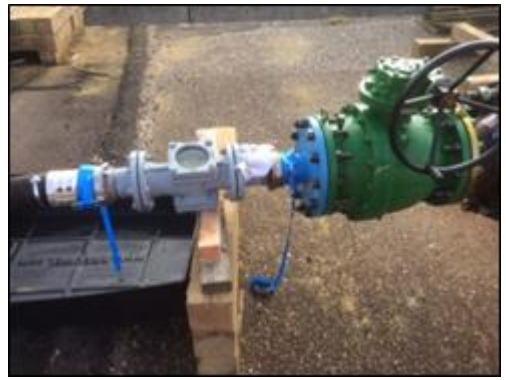
Approach / Process / Technology summary

- Air, water and chemical flushing is used to clean the pipeline (i.e. remove hydrocarbons/scale)
- Water/chemicals/air mixture is injected at one side
- Sludge is removed at the other side

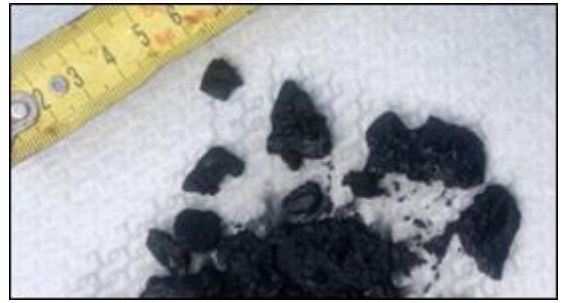
Business Impact / Results

- Successfully cleaned a line where it was impossible to run a pig
- 20-30 tons sludge removed

Injection point for the water, chemicals and air



Outlet of the pipeline



20-30 ton sludge removed

Pipeline cleaning: Air/water/chemical flushing for decom

Extending the air/water/chemical flushing to remove mercury and NORM

- Inlet: mix 1) water, 2) air or N2 and 3) chemicals
- Outlet: Liquid-air separation. Tank for liquid storage.

Business impact:

- Successfully removed mercury, NORM in-situ
- Reduce cleaning and waste costs (faster, less waste)
- Increase potential pipe re-use options
- Possible to clean non-piggable pipelines (no pig traps needed)


Rendo neemt 36 kilometer aan Drentse leidingen over van de NAM: 'Helemaal schoongemaakt'

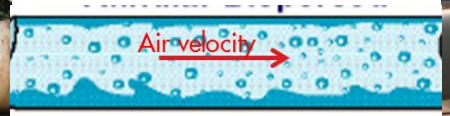
14 september, 15:37 • 1 minuut leestijd

Rendo-directeur Eddy Veenstra
© RTV Drenthe / Bastian van de Belt

Netbeheerder Rendo neemt vier oude leidingen van de Nederlandse Aardolie Maatschappij (NAM) over. Het bedrijf wil de leidingen, met een totale lengte van 36 kilometer, gebruiken voor het transporteren van groen gas in Zuidwest-Drenthe en de kop van Overijssel.

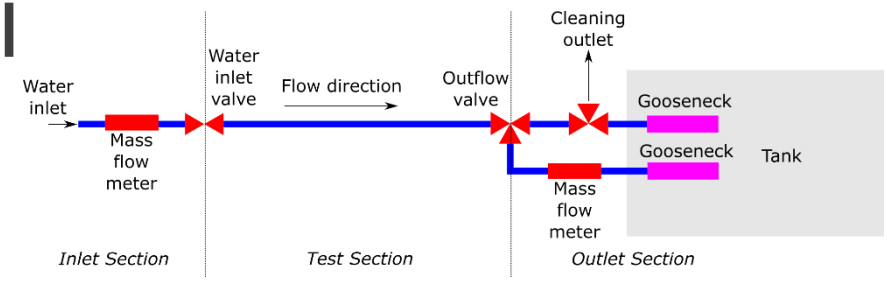
De leidingen, die tussen Meppel en Hoogeveen onder de grond liggen, waren volgens Rendo-directeur Eddy Veenstra al enkele jaren buiten bedrijf. De NAM gebruikte ze voor de transport van fossiel gas.

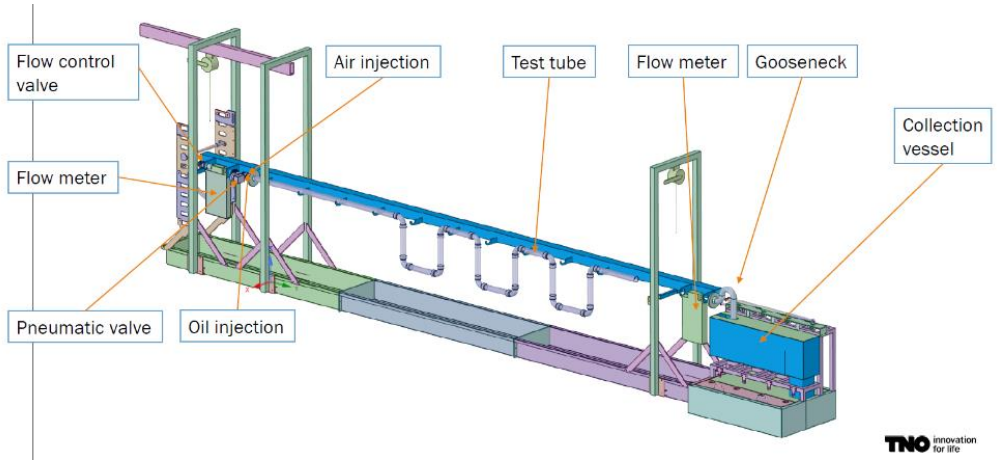
Volgend jaar in gebruik

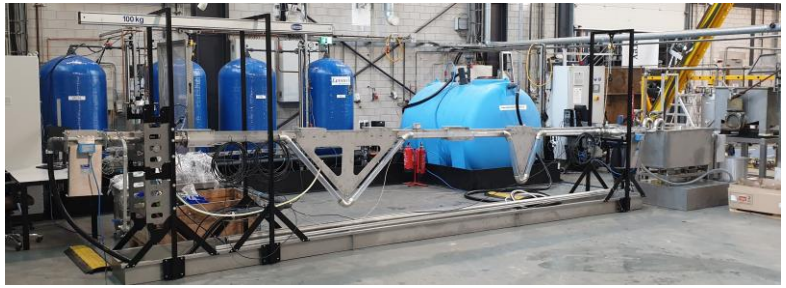


Pipeline cleaning – calibration of flushing model

- Experiments to determine the minimum flushing velocity to flush hydrocarbons out of a pipeline
  - 2-inch piping
  - Maximum water flushing velocity 1.5 m/s
  - Measurement section ~ 5 m
- Procedure
  1. Fill pipe with oil (for a certain geometry, inclination)
  2. Flush 4 pipe volumes with a certain velocity and measure the flow out of the test section
- Conclusions
  - For horizontal pipes low velocities are sufficient to displace oil
  - For downwards inclined pipes larger velocities are required
  - In U and V shaped geometries oil is not flushed easily from horizontal sections.
  - CFD can accurately predict flushing efficiency for oil-water systems for a wide range of velocities, inclinations and configurations







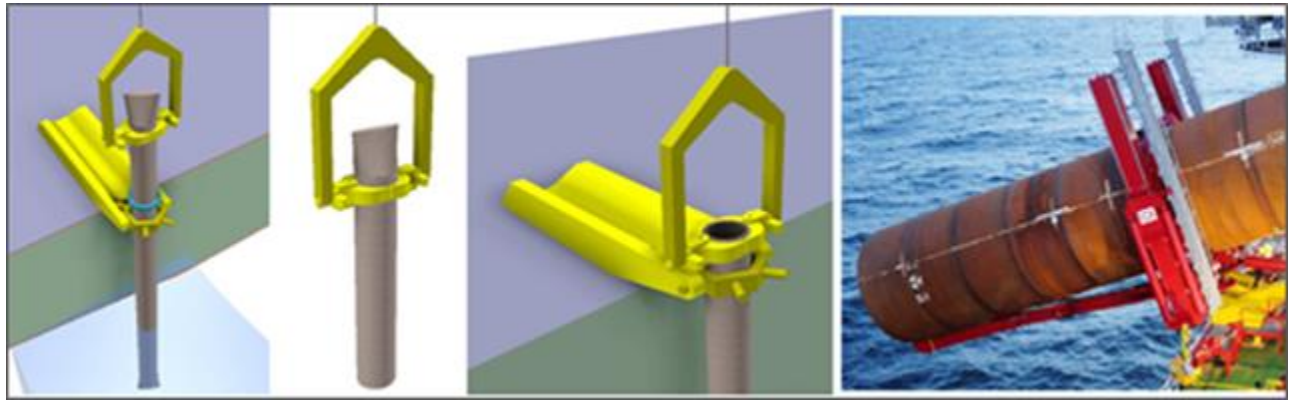
3.0

ONSHORE & OFFSHORE PIPELINES

Pipeline and Umbilical Removal – Objectives & Industry Overview

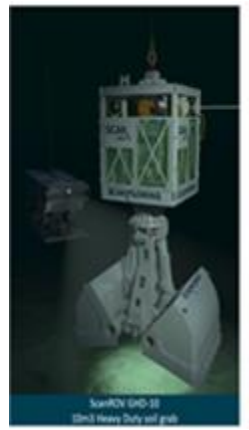
- Identify new technologies & players for subsea facilities cutting & removal, combined tooling, etc.
- Add to competition in the existing "mature" EPC players

CUT & LIFT



Lifting Magnet

GRABBING TOOLS



NEAR SHORE PULL & CUT

AMBIENT LIFT

AMBIENT LINEAR

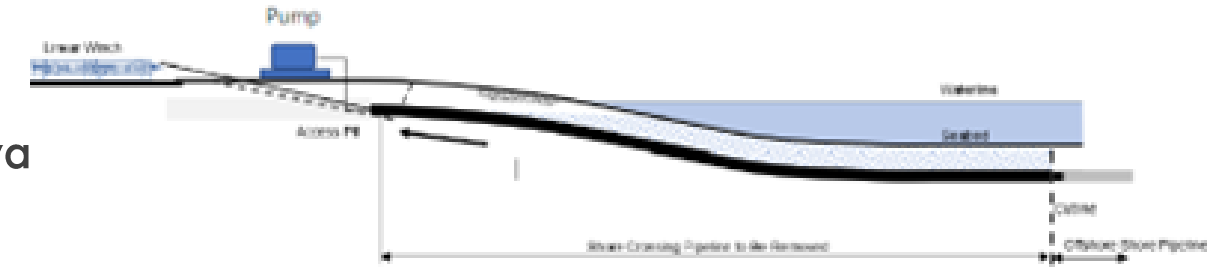
CUT & LIFT

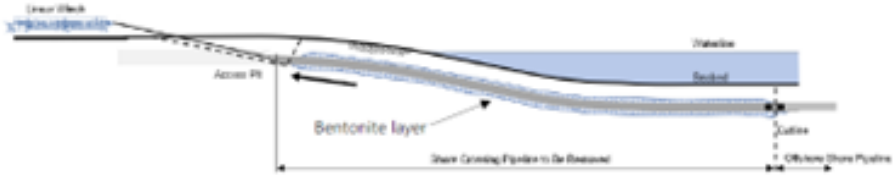
TPR

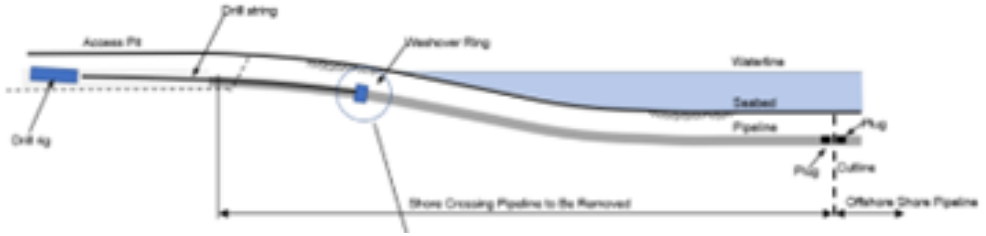
Onshore Pipeline Removal - Fully Mechanised

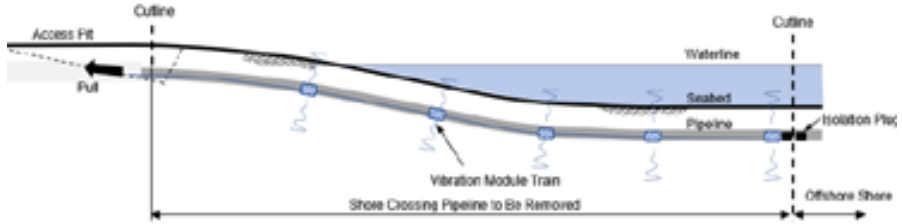
Trenchless Nearshore Pipeline Removal Shell & Intecsea

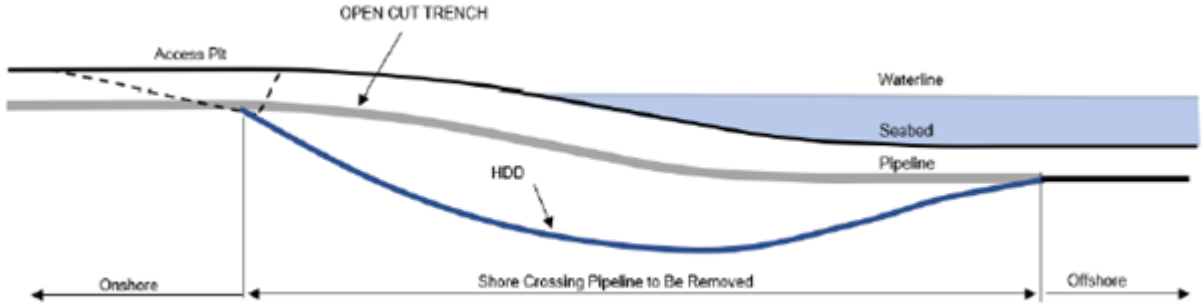
- Tackle nearshore pipeline removal method
- Continuity from the previous offshore pipeline remova
- Focusing on Trenchless Methods
- Engaging with Market
- Couple of Innovative Solutions are Identified
- Finalising the case study HDD & Open Trench











4.0

ONSHORE FACILITIES DECOMMISSIONING

Onshore Demolition Methodologies

- Demolition Mindset
- Salvage Mentality
- Maximum mechanization
- Maximum recycling on site
- Minimum demolition at height
- Minimum transport off site

Concrete Demolition and Disposal

Current practice (in some locations):

Demolition by hand held hydraulic breaker.

Export broken concrete offsite for disposal

Applied Safety in Design:

Demolition by machine mounted hydraulic breaker
Recycle on site
- Crush by machine
- Refill demolished areas with crushed concrete

Process Structures Demolition and Disposal

Current practice (in some locations):

Piecemeal demolition in place (at height)

Applied Safety in Design:

Controlled collapse/pull over

Demolition Mindset

Reverse Construction:

- Dis-assemble "with care"
- Move to laydown for before breaking up
- Labour intensive
- Complex logistics
- Specialist equipment (lifting, transporting)
- Large volumes of **scaffolding**

Expensive & significant HSE exposure

Demolition Mindset

- Use of explosive or controlled collapse
- Highly mechanized
- Simple equipment and methods
- **No scaffolding!**

Reduced cost (>40%) & reduced HSE exposure

5.0

OFFSHORE FACILITIES DECOMMISSIONING

Offshore Platforms

<u>Fixed Leg Jackets</u>

- Make safe/hydrocarbon free
- Prepare topsides for lift and transport
- Remove and transport Topsides,
- Jacket: Cut piles @ - 3m below seabed, remove conductors
- Lift jacket and upper section of piles and transport on barge / on hook
- Demolish onshore
- Site surveys, remove mudmats etc

<u>Floating production systems (FPSOs, TLPs, Semi-submersibles)</u>

- Make safe
- Disconnect from station keeping/mooring/risers
- Tow to cleaning site
- Tow to second site for demolish/sell
- Site surveys, remove mooring etc

Offshore Facilities Platform Removal Options

Table 6: Fixed platform D&R methods by water depth, topside- and jacket weight

Water Depth	Topsides Weight	Jacket Weight	Decommissioning Method Applicable					
(m)	(MT)	(MT)	Single Lift	Multiple Lift	Total Lift	Piece Small	Float Off	Jack Up
<30	<1000	<1000	2	2	1	4	4	3
<50	<1000	<1000	1	1	2	4	4	3
<50	<2000	1000-2000	2	1	3	3	3	3
<50	2000-4000	2000+	2	1	3	3	3	
<50	4000+	2000+	3	1		3	2	
50-100	<2000	<2000	3	1		3	2	
50-100	2000+	2000+	3	1		3	2	
100+	2000+	2000+	3	1		3	2	

Colour cording: Common | Challenging | Not feasible

<u>Pre-requisite</u>

Completion of decommissioning of wells & pipelines (flowlines) prior to commencement of respective offshore facility decommissioning scope

<u>Basic principles of D&R Philosophy</u>

- SALVAGE and DEMOLITION mindset
- COMPANY frames what needs to be done i.e., SOW
- Contractor selects execution methodology and timing
- Maximum use of new (disruptive) ideas to avoid construction mindset

Examples of Industry resources

- Various lift categories
  - Heavy Lift Vessel > 20000 t
  - Mebium Lift Vessel 5000 t -20000
  - Sheer Leg Vessel 1000 – 5000 t
  - Small Lifts < 1000 t

ALLSEAS / PIONEERING SPRIT

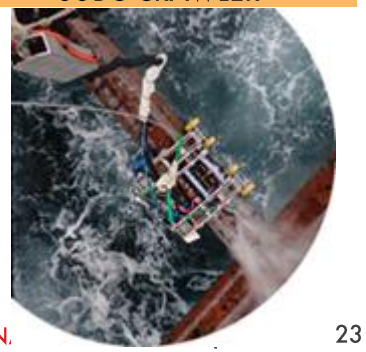
SLEIPNER

SHEER LEG

VERSABAR

PIECEMALL DECOMM

SUBC CRAWLER



6.0

CONCLUDING REMARKS

Any Questions ?