

# **Decom Tools, Summary Report from visiting Companies in the Decommissioning Industry, NORWAY**



Interreg North Sea Region – Project Number: 20180305091606

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February, 2020

## **Introduction**

In connection with the Interreg project DECOM Tools (“Eco-innovative concepts for the end of offshore wind energy farms lifecycle”), several companies already involved in decommissioning activities were visited during 2019. In this summary report we concentrate on the visits in Norway, a similar report from visits in the UK will follow later.

In the Appendix of this summary report the Minutes of Meetings from each visit are included.

In Norway, the following companies were visited;

- DeepOcean AS (Subsea operation /construction company, also involved in decommissioning projects), visited the 25<sup>th</sup> of January 2019
- Reach Subsea AS(Subsea operation /construction company, also involved in decommissioning projects), visited the 22<sup>nd</sup> of February 2019
- Kvaerner AS (Decommissioning company with their own onshore decommissioning site /deep water quay), visited the 15<sup>th</sup> of March 2019
- AF Decom AS (Decommissioning company with their own onshore decommissioning site /deep water quay), visited the 24<sup>th</sup> of April 2019

The Minutes of Meetings also include pictures from the decommissioning sites and project references, where relevant and available.

Reference is also made to the report from the stakeholder workshops, ref. “Stakeholder Analysis, DECOM Tools 2020”.

Before the visits, a list of questions were prepared and sent to the companies (these questions may differ somewhat for the different visits);

### **Questions related to company visits**

(Not all questions may be relevant for your company)

#### ***Introduction***

- Which decommissioning projects (oil and gas) have your company been involved in?
- What has been your Scope of Work in these projects?

#### ***Cutting offshore***

- What methods and tools have been used for cutting /dismantling the structures offshore (subsea and topside)?
- What is your experience using these methods /tools?

### ***Logistics***

- How have the parts been lifted onboard the vessel(s) and transported to the onshore base?
- Which types of vessels have been used?
- Has towing of structure elements been used?

### ***Cleaning***

- Do you consider cleaning the parts of the rig/structure before and during decommissioning?

### ***Onshore Dismantling /Recycling /Waste disposal***

- Which onshore bases or quay facilities have you been using for the further dismantling and recycling process?
- Which cutting methods and tools have been used on the site?
- What is your experience using these methods /tools?
- Where has the material been sent for further processing /recycling /waste disposal?
- Specific rules and regulations to be taken into account during this process?  
Licenced ports in Europe for scrapping?

### ***Wind farms***

- Have you been involved in installation of offshore windmills? Which windmills /parks?
- What has been your Scope of Work in these projects?
- Can the installation process be easily reversed for decommissioning of the windmills?

### ***Business/marketing***

- Will decommissioning projects related to oil and gas be a growing part of your business for the next five years?
- Are you planning to expand your international operations related to decommissioning projects or will your main focus be in the Norwegian sector for the next five years?
- Are you interested in entering the business regarding decommissioning of wind parks? Have you already been involved in such projects? If so, what has been the Scope of Work?
- What needs do you identify in terms of labour market and infrastructure today and if entering this new business?
- How important is international cooperation in general and for you particularly?

- Do you consider this “DECOM Tools”-project to be relevant and helpful? What do you expect from the project?

The mentioned Norwegian companies have considerable experience from decommissioning projects, but mainly from the offshore /oil & gas industry. Though, this knowledge and experience is regarded as relevant also for decommissioning of offshore wind farms.

## **Main findings**

Main findings from the company visits in Norway;

- Companies like Kvaerner and AF Decom claim that they already have the necessary facilities, personnel and competence also to receive offshore wind turbines. These facilities include large deep-water quays in the deep and sheltered Norwegian fjords. These quays also have systems to take care of spills and pollution, and advanced cutting equipment is available. This cutting equipment, mainly based on using hydraulic energy, is also environment friendly compared to f. ex. oxy-arc cutting.

These companies can also take care of the offshore dismantling and removal activities, but as per today they then utilize subcontractors like Heerema and DeepOcean for these parts. Generally, they prefer as few cutting operations offshore as possible, as offshore vessel time is expensive. Large sections are then transported ashore for further dismantling and recycling.

- If decommissioning of offshore wind turbines shall be of commercial interest to companies like Kvaerner and AF Decom, it will depend on the volume. One or two turbines is not of any interest, but decommissioning a total wind farm consisting of 100 turbines will be very interesting.
- Many tools and methods originally developed for the offshore oil- and gas industry are also applicable for decommissioning of offshore wind farms. For example, a wide range of cutting tools have been developed for different applications, both for top-side- and subsea use. Reference is here also made to the Master Thesis reports executed at the Western Norway University of Applied Sciences (HVL);
  - “Methods for Decommission of Offshore Wind Parks on the Basis of the Knowledge from the Oil- and Gas Industry”, Martin Urnes, Spring 2019
  - “Cutting tools/-methods for potential Use During Decommissioning and Dismantling of Offshore Wind Parks”, Børre Mæland, Spring 2019
  - ”Optimization of the Dismantling Process of Wind Turbine Blades from Offshore Wind Farms during Decommissioning”, Jan Hechler, Autumn 2019

Especially cutting tools based on the diamond wire- and hydraulic shear /scissor principles are promising, as they are relatively simple and environmentally friendly in use, compared to f. ex. oxy-arc cutting.

One question to be raised here, can the use of explosives be an alternative to conventional cutting methods? This can be an effective method, but there are also

reasons for why this method has been utilized only to a minor degree in relation to oil & gas decommissioning projects;

- The material quality and wall thicknesses can be unpredictable. It will cause a big problem if the cutting process does not penetrate 100%, or if the charges will not explode correctly. How then to approach and correct the charges in a safe manner?
  - Environmental issues with marine life
  - Debris on the seafloor to be picked up afterwards
- Many operations conducted for several years in connection with decommissioning of oil & gas structures are also relevant for decommissioning of offshore wind farms. To be mentioned here are;
- Pre-operation survey of the seafloor prior to the actual decommissioning activities
  - Dredging of seafloor sediments (the time for this can be difficult to estimate). Must often be done before cutting.
  - Top-side- and subsea lifting of structures (after cutting)
  - Retrieval of piles
  - Retrieval of concrete protection mats
  - Retrieval of cables, also sometimes submerged cables
  - Retrieval of debris
  - Post-operation survey

### **Special challenges and possibilities**

Special challenges and possibilities related to decommissioning of offshore wind farms compared to decommissioning in the offshore oil & gas industry;

- So far, the offshore wind farms have been installed in relatively shallow waters (10 – 40 m). This can actually represent a problem for typical offshore- and heavy lift vessels, due to the maximum allowable draught. Also operations conducted by ROV's (Remotely Operated Vehicles) or diving can be challenging due to the wave impact in the splash-zone or near to the splash-zone.
- When decommissioning a total offshore wind farm consisting of for example 100 identical turbines, there should be room for automation and optimization of the process, both offshore and on land ("Serial production"). This has so far not been done in any extent for oil & gas structures, as the structures have been "One of a kind" and not standardized in size and configuration.
- The possibility of towing the turbine towers /structures ashore should be looked closer into. Then cheaper vessels can be utilized. Either the structures themselves can be made buoyant, or buoyancy tanks can be added.

- As mentioned, the use of explosives should be investigated as a potential and alternative cutting method.
- Most of the same receiving /recycling entities /facilities for materials as being used today, can also be used for the materials and components from offshore wind turbines. However, there is one important exception; the blades for the turbine. These are usually made of a composite material not easily recycled. This needs to be investigated further.

The companies that we visited were positive to the ambitions in the DECOM Tools project, and are looking forward to the results. They may also be contacted on a later stage in the project.

## **APPENDIX**

Minutes of Meetings from industry visits.

In Norway, the following companies were visited;

- DeepOcean AS (Subsea operation /construction company, also involved in decommissioning projects), visited the 25<sup>th</sup> of January 2019
- Reach Subsea AS(Subsea operation /construction company, also involved in decommissioning projects), visited the 22<sup>nd</sup> of February 2019
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## Minutes of Meeting, DeepOcean AS, 25<sup>th</sup> of January 2019

### **DECOM Tools Project**

This document is a summary of minutes of meeting at DeepOcean AS on the 25<sup>th</sup> of January 2019.

Participants:

Geir Helge Bachmann, Operations Director Subsea Services, DeepOcean AS  
Rune Haraldseid, Lead Commercial Engineer, DeepOcean AS  
Jens Christian Lindaas, HVL  
Andres Olivares Lopez, HVL  
Børre Mæland, Master Student, HVL  
Martin Urnes, Master Student, HVL

Questions related to company visits (subsea operation- /construction companies):

- **Which decommissioning projects (oil and gas) have your company been involved in?**  
DeepOcean have been involved in many projects subsea and offshore; removal of two different loading buoys, debris removal, drill string recovery, two times wellhead decom, mattress recovery, structural removal, drill cutting removal, pipeline decom. Reference is also made to the enclosed project sheets.
- **What has been your Scope of Work in these projects?**  
DeepOcean has done engineering, project management and execution of the subsea operations. Operations include all types of dredging, a variety of lifting operations, cutting horizontal and vertical, cutting internal and external, pre-operation survey and post-operation survey, recovery of items into baskets and directly onto deck.
- **What methods and tools have been used for cutting/dismantling the structures (subsea and topside)?**  
DeepOcean has only been involved with subsea cutting operations. Mostly diamond saw /diamond blade cutting. However, high pressure water jetting with grit /abrasives has also been used. Guillotine cutting also used. Whatever method, it is always depending on the cost, scope of work and material being cut.

- **What is your experience using these methods/tools?**

Diamond wire – relatively slow, but reliable. Easy transport /mobilization.

Diamond saw blade – fast, more durable.

High pressure water jet – fast, but more complex mobilization /installation due to more equipment and bigger team topside. Possibly problems with mixing grit. Additionally, uncertain if cut is successful (achieve full penetration).

DeepOcean hires often sub-contractors for cutting operations. Subcontractors for cutting equipment: CUT (Cutting Underwater Technologies), Proserv, Norse, Oceaneering, potentially Scanmudring. Mostly same methods as 10 years ago. Challenges related to shallow water, both for vessel and ROV.

DeepOcean estimates digging /dredging outside f. ex. a pile, enabling cutting 2m below mudline, to 4-5 day's work.

- **How have the parts been lifted onboard the vessel(s) and transported to the onshore base?**

Depending on the size of the pieces;

Heavy – entire structure /platform.

Medium – structure cut into a few pieces.

Small – structure cut into several smaller pieces.

- **Which types of vessels have you been using?**

Construction vessels (max 600 tons crane capacity) and jack-up rigs.

- **Has towing of structure elements been used?**

Yes, but mostly for whole structures (e.g. loading buoy). For this purpose, usually towing vessel is acquired, as this is often cheaper.

- **Which onshore bases or quay facilities have you been using for the further dismantling and recirculation process?**

It is typical procedure to keep the elements in the country where the structures is based. Alas, for floating structures on the Norwegian continental shelf the UK /German coast is not always suitable.

- **Which cutting methods and tools have they been using?**

This is not within the scope /knowledge of the subsea construction company.

- **Where has the material been sent for further processing/recirculation?**

This is not within the scope /knowledge of the subsea construction company.

- **Have you been involved in installation of offshore windmills? Which windmills/parks?**

Not for the windmills themselves, but for installation of cable grid and export cables for a few projects. For Ørsted and Dong.

- **What has been your Scope of Work in these projects?**

Cable laying and trenching, dredging and connection. Mattress installation.

- **Can the installation process be easily reversed for decommissioning of the windmills?**

Yes, but what is most cost effective is usually a different method.

- **Will decommissioning projects related to oil and gas be a growing part of your business for the next five years?**

Yes, DeepOcean would like to be part of the “Decom-wave” hopefully hitting Norway at full impact in 5-10 years. In today’s market, the price is too low due to underestimation of cost when planning decom. Companies involved need to lose money before it is possible to earn.

- **Are you planning to expand your international operations related to decommissioning projects or will your main focus be in the Norwegian sector for the next five years?**

DeepOcean are involved in decom in UK. UK is already in the “Decom-wave”

- **Are you interested in entering the business regarding decommissioning of wind parks? Have you already been involved in such projects? If so, what has been the Scope of Work?**

Yes, if this can increase revenue.

# FRIGG STEEL REMOVAL

SUBSEA DECOMMISSIONING



## FRIGG EXTERNAL STEEL REMOVAL

<b>Client</b>	Total E&P Norway AS
<b>Ultimate Client</b>	Total E&P Norway AS
<b>Period</b>	Offshore campaign: Phase 1 winter and spring 2005/Phase 2 spring and summer 2006
<b>Vessel</b>	The whole offshore operation carried out directly from the platforms. Recovered steel transported to shore on regular supply vessels in the field.
<b>Location</b>	North Sea
<b>Equipment</b>	Various ROV tools, mechanical cutting equipment, saws and shearers, high pressure water jet/grit cutting equipment, saws and shearers, high pressure water jet/grit cutting equipment, purpose made lifting arrangements

### Scope of Work

- Removal of the external steel from the concrete gravity bases TP1 and TCP2 on the Frigg field for Total
- Onshore planning and preparation work and execution of the offshore operations
- Work included removal of external risers, utility risers, vent pipes, support and misc. steel structures subsea
- Removal of ladders and platforms above sea level
- A total amount of approx. 1250Te steel was recovered from the concrete gravity bases.
- DeepOcean project team on board the platforms as well as two of DeepOcean installer WROC-spreads

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## SFC SPMC LOADING BUOY REMOVAL

### AND DISPOSAL



### DEMANDING SUBSEA WORK BY USE OF ROVS

<b>Client</b>	Statoil Petroleum AS
<b>Period</b>	Contract Award August 2011 / Survey-Inspection 2011 / Removal-Disposal 2012-13
<b>Vessel</b>	Volstad Surveyor / Rem Forza / Tugs for tow operation's
<b>Location</b>	North Sea Statfjord field
<b>Equipment</b>	WROVs, screw jacks, pin pull cylinders, diamond wire cutters, flushing clamp, blind caps.

### Scope of Work

- Engineering, preparation, removal and disposal (EPRD) of the SPM C Loading buoy.
- Engineering, procurement, construction and installation (EPCI) of 139 Te protection cover.
- Project management.
- Pre-survey and inspection of the Loading buoy structure by use of subsea vessel with ROVs
- Preparation campaign for testing of equipment subsea.
- Release and removal out of 500 meter zone
- Tow to disposal site
- Installation of protection cover
- Inshore marine operations, de ballasting, laydown, removal of heavy ballast, heavy lifting.
- Disposal of loading buoy at disposal site.

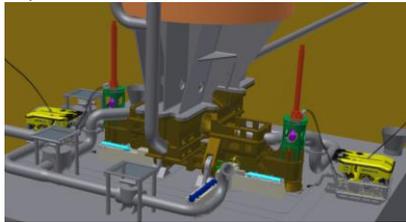
**Pre-Survey & Inspection**

The subsea pre-survey and inspection operation was performed with the vessel "Volstad Surveyor" in 2011. This pre-survey included inspection of loading buoy conditions, NDT and at the same time inspections of critical interfaces for the removal campaign. In addition to this a pre-survey of towing route was performed.



**Removal**

The removal operation was performed in the spring / summer of 2012 involved Tugs for tow, and the subsea support vessel Rem Forza for the subsea work on the project. Method was to release the buoy from the base by pulling out the pin connections between loading buoy and base structure on the seabed. This was performed with special made equipment monitored by ROV and controlled from the vessel. All tools needed were designed by our design department.



After release the buoy was towed from the field and anchored in Vats fjord where it was prepared for the demolition work.



**Cover Installation**

Installation of the protection cover was done by Rem Forza that loaded the cover on deck in two pieces and lifted it in place with the vessel crane. Guide wires were established for controlling the installation of the cover.



**Disposal**

Disposal work was performed by one of our subcontractors at their disposal base from July 2012.

A challenging marine operation scope of work was performed before loading buoy was landed on the key side early in 2013. Disposal of the buoy was performed with excavator's special made for demolition of structures. Waste from the buoy was delivered to professional receivers certified for the waste handling.



**Main Challenges/Critical part**

- Condition of the connection pins for disconnection of buoy.
- Design of new equipment.
- Release operation.
- Handling of buoyancy forces.
- Inshore marine operations.

**HSE Performance**

The project was performed with no serious injuries.

**Key Highlights & Statistics**

- All subsea operations done by ROV.
- Purpose made specialised equipment was developed and ensured a successful operation.
- Release of buoy according to plan.
- Complex operations prepared and executed in a short timeframe.
- Recycling of waste 95% .

**Key figures**

- Loading buoy weight approx. 8000 Te.
- Loading buoy 180 m high.
- Water Depth 145 m.

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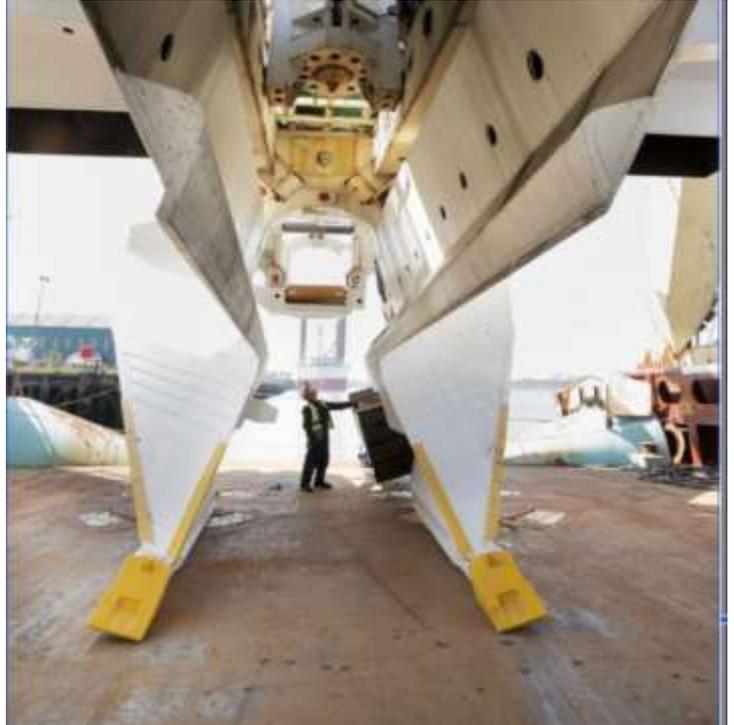
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Revision Date 17.02.2014

# ODIN PIPELINE DECOMMISSIONING

## DECOMMISSIONING - TRENCHING



### PIPELINE LOWERING AS PERMANENT DECOMMISSIONING METHODOLOGY

<b>Client</b>	ExxonMobil
<b>Period</b>	March 2007
<b>Vessel</b>	Maersk Assister
<b>Location</b>	Central North Sea, Norway
<b>Equipment</b>	AMP 500 mechanical plough, Work ROV, ObsROV
<b>Water depth</b>	95 – 150 m

#### Scope of Work

Description of work:

- Project Management, Engineering , offshore operations
- Decommissioning of a 27km 25” concrete weight coated pipeline by means of lowering the pipeline into the seabed to a target depth of 1m (0.3m top of product). and ploughing of a 26.6 km 25” pipeline to a target depth of 1 m below mean seabed level. (0.3m top of product). Seabed conditions along the pipeline route included superficial sands and stiff clay with occasioned dense sand layers.
- Debris clearance

Ploughing and re-trenching of medium and large pipelines are accepted as permanent decommissioning methodologies. Odin was the first decommissioning project involving a plough that worked successfully in harsh winter weather conditions. DeepOcean has suitable assets for these operations.





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**DEEPOCEAN**



## Minutes of Meeting, Reach Subsea AS, 22<sup>nd</sup> of February 2019

### **DECOM Tools Project**

This document is a summary of minutes of meeting at Reach Subsea AS on the 22<sup>nd</sup> of February 2019.

Participants:

Morten Roth Stranden, Project Manager, Reach Subsea AS  
Sveinung Dalen, Reach Subsea AS  
Torstein Grutle, Reach Subsea AS  
Jens Christian Lindaas, HVL  
Jan Hechler, Master Student, HVL  
Børre Mæland, Master student, HVL  
Martin Urnes, Master student, HVL

Questions related to company visits (subsea operation- /construction companies):

- **Which decommissioning projects (oil and gas) have your company been involved in?**  
Brent – removal of debris in relation to the decom of two of the Brent field fixed platforms.  
Pile removal of Wikinger wind farm (40m depth).  
Removal of trawl protection structure and recovering of concrete subsea structures.  
Please also find enclosed a presentation of the company and project references.
- **What has been your Scope of Work in these projects?**  
Brent – engineering, project management and execution of the scope.  
Wikinger wind farm – removed 9 piles in the Baltic sea. Mobilized soil plug removal, dredging equipment, abrasive high pressure water jet.  
Trawl protection removal – engineering, project management, execution and disposal of recovered items.
- **What methods and tools have been used for cutting/dismantling the structures (subsea and topside)?**  
Reach Subsea has been involved with many methods, depending on the scope of work.  
Diamond wire, scissor cutting, guillotine and abrasive water jet have all been used.  
Subcontractors: Deep Sea, Oceaneering and Proserv.

- **What is your experience using these methods/tools?**

Reach Subsea rely on diamond wire cutting, as a standard method. This is always the go-to method if possible. Reliable and simple method, both subsea and top-side. Diamond wire is easy to set up and when doing the mobilization of vessel. Does not need third party /technical operator! HILTI is expanding and entering the subsea cutting market – with a diamond wire cutting technique that is double the speed as today. Scanmudring is also entering the cutting tool market. Dredging is always a cost driver and is an uncertainty in the plan, it is difficult to estimate time used.

- **How have the parts been lifted onboard the vessel(s) and transported to the onshore base?**

Reach Subsea has used subsea basket, due to simple and safe sea fastening of the gathered material.

- **Which types of vessels have you been using?**

Offshore construction vessels, IMR-vessels, PSV.

- **Has towing of structure elements been used?**

No.

- **Which onshore bases or quay facilities have you been using for the further dismantling and recirculation process?**

N/A.

- **Which cutting methods and tools have they been using?**

This is not within the scope /knowledge of the subsea construction company.

- **Where has the material been sent for further processing/recirculation?**

This is not within the scope /knowledge of the subsea construction company.

- **Have you been involved in installation of offshore windmills? Which windmills/parks?**

Not for wind turbines themselves, but for installation of the concrete stabilization mattresses. And also for the packs of rock, used to lay on cables for protection. Scour protection has also been laid. Has also been involved in the initial survey /seabed mapping operations.

- **What has been your Scope of Work in these projects?**

Mattress installation of different kinds and survey, ref. previous question.

- **Can the installation process be easily reversed for decommissioning of the windmills?**  
Yes, but what is most cost effective is usually a different method.
- **Will decommissioning projects related to oil and gas be a growing part of your business for the next five years?**  
Yes, they would like to be part of the “Decom-wave” hopefully hitting Norway at full impact in 5-10 years.
- **Are you planning to expand your international operations related to decommissioning projects or will your main focus be in the Norwegian sector for the next five years?**  
As long as they can make money, they do anything.
- **Are you interested in entering the business regarding decommissioning of wind parks? Have you already been involved in such projects? If so, what has been the Scope of Work?**  
Yes, if this can increase revenue.

# REACH SUBSEA

ADVANCE, PERFORM, ACHIEVE



**REACH**  
SUBSEA



# REACH SUBSEA IN BRIEF

## In brief

- Established in 2008
- Based in Norway
- Listed at Oslo Stock Exchange (REACH)

## Fleet

- 7 vessels
- 8 owned WROV's
- 2 dedicated SROV



Main Office

## Organization

- Head office in Haugesund
- 100 employees
- Average employee age 35
- 0 LTI's (Lost Time Injuries)
- World record in survey speed
- Experience with over 100 clients worldwide

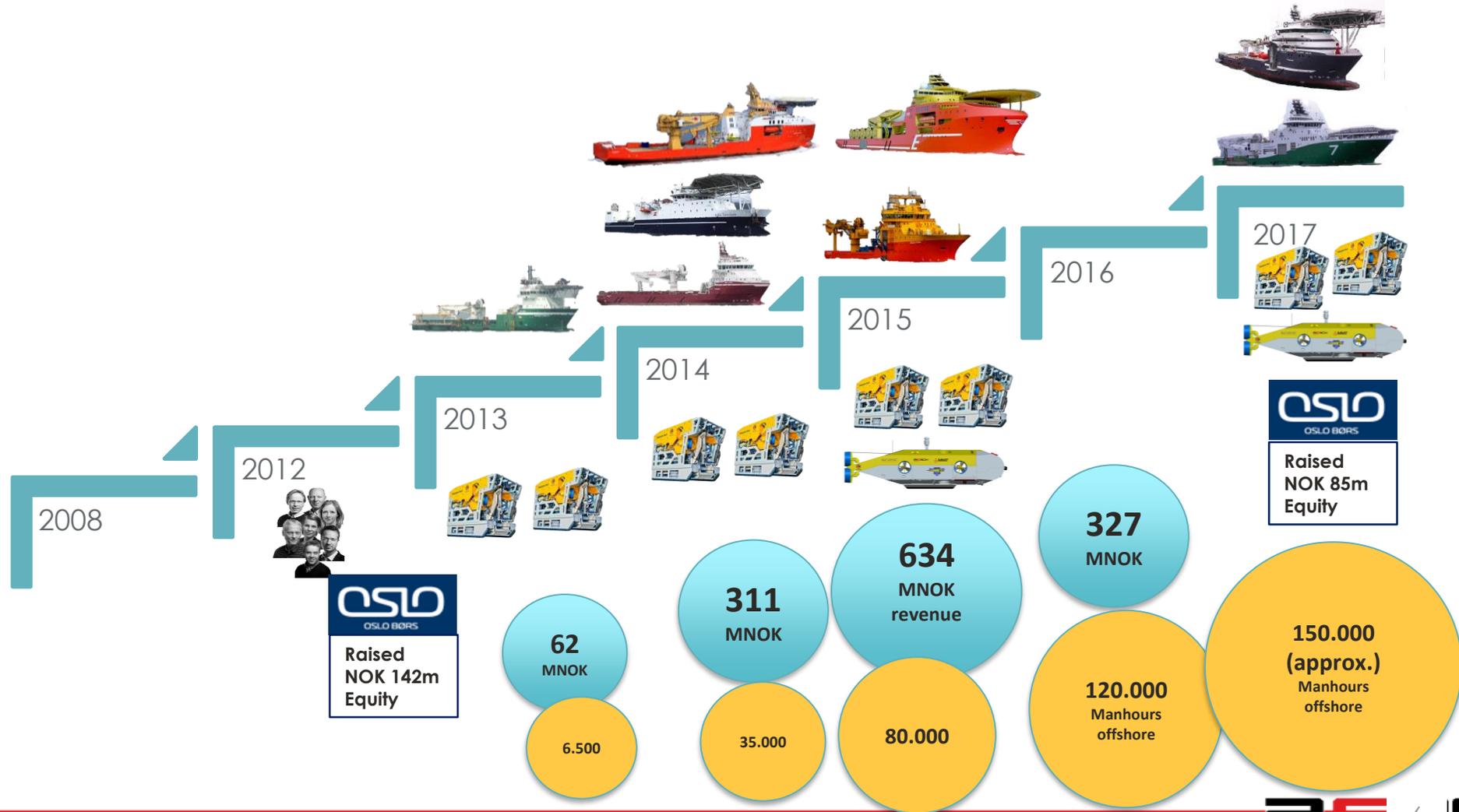


Killingøy base





# OUR HISTORY



# VESSEL FLEET



Edda Fonn



Normand Reach



Havila Subsea



Stril Explorer



Viking Neptun



Olympic Delta

# VESSEL FLEET 2018



Viking Neptune



Normand Reach



Olympic Challenger



Havila Subsea



Olympic Delta



Edda Fonn



Stril Explorer



Havila Harmony

# OUR BUSINESS

## SERVICES

Remotely operated equipment and technology (ROV)

Planning offshore operations

Engineering and analysis

Project execution



## SEGMENTS

Construction and installation

Inspection, Maintenance and repair

Decommissioning

Survey and inspection



## CLIENTS

Tier 1 and 2 contractors

Oil & gas

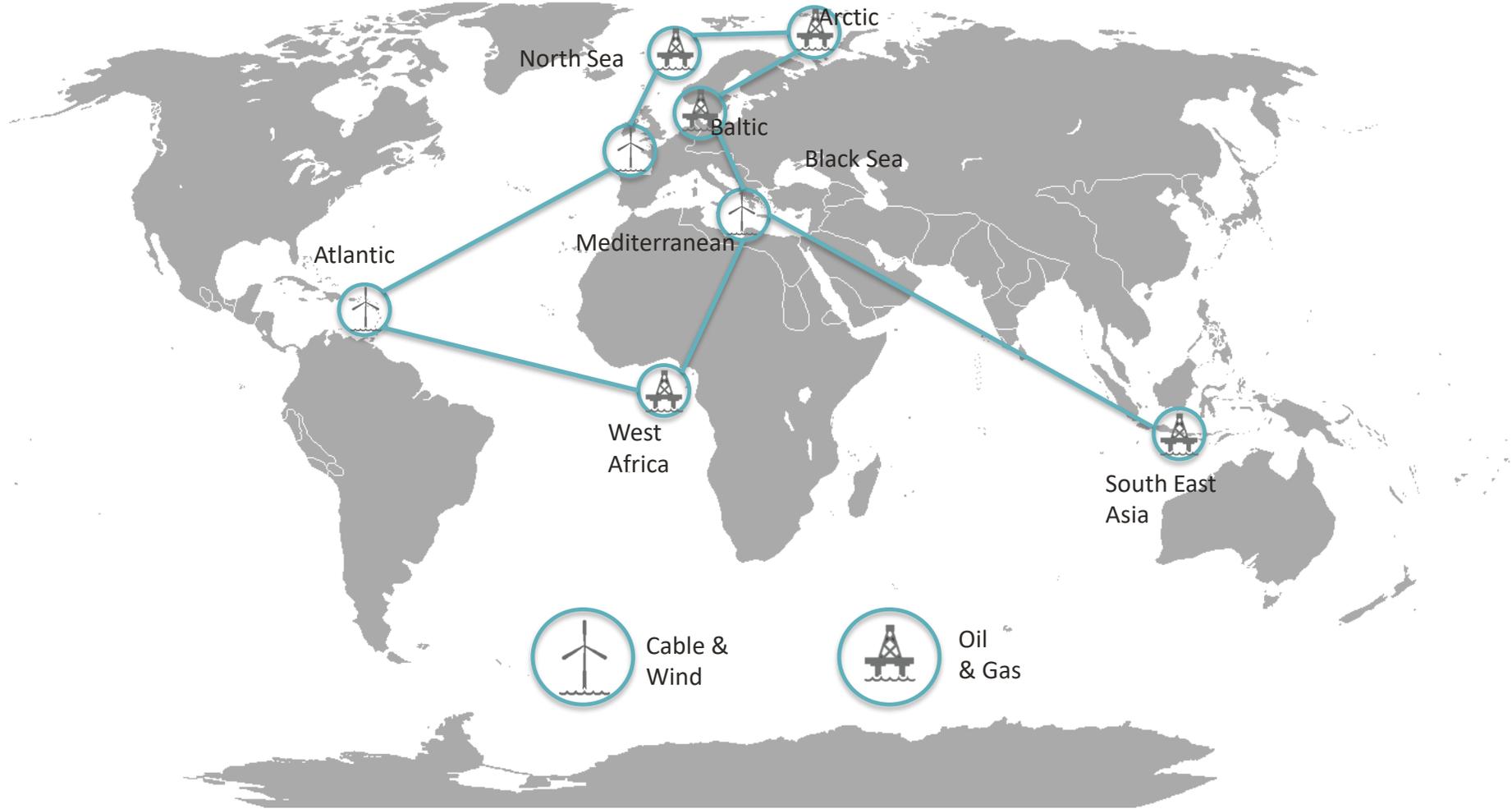
Renewables (wind and tidal)

Cables

Subsea mining



# WORLDWIDE PROJECTS



# CUSTOMERS



100%  
Customer  
satisfaction

- Our services have been well received in the market

# REACH SUBSEA TRACK RECORD

## Pile removal on the Wikinger Wind Farm (40m water depth):

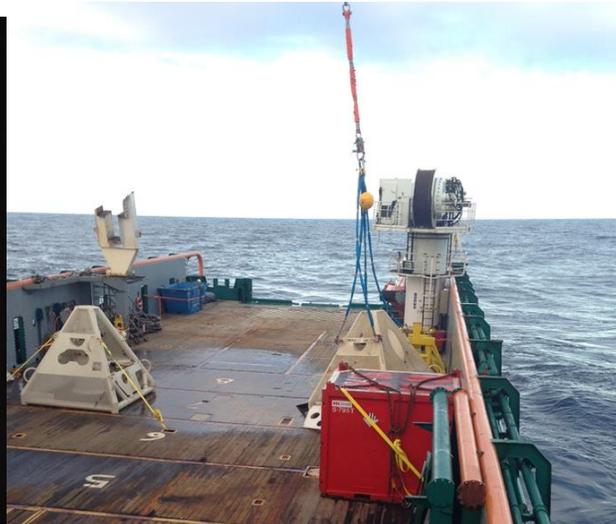
- Removed 9 piles on the Wikinger wind farm in the Baltic Sea
- Mobilised soil plug removal tool, dredging equipment, abrasive water jet cutter and seabed levelling equipment on the Normand Mermaid
- Performed the pre and post sureys
- Performed engineering, project management, execution of the project, government applications and disposal of the nine piles
- End client was Iberdrola/Scottish Power



# REACH SUBSEA TRACK RECORD

## Removal of subsea trawl protection structureLundin:

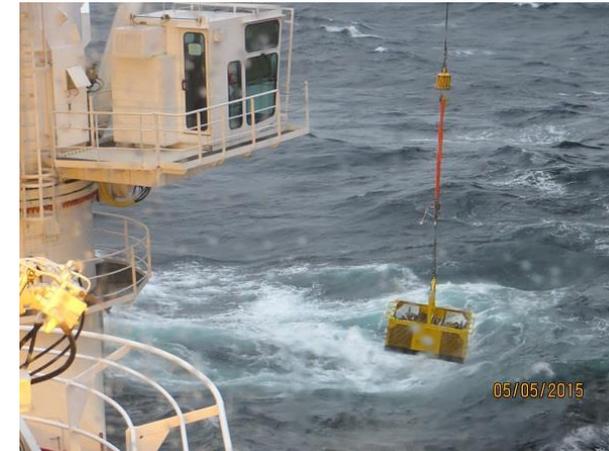
- Removed several subsea trawl protection structures and performed cutting and recovery of concrete subsea structures
- Mobilised all required tooling (high pressure water jet, ROV chisel, dredger) on the Bourbon Emerald
- Performed engineering, project management, execution of the project and disposal of the recovered items
- End client was Lundin



# REACH SUBSEA TRACK RECORD - DECOM

## Brent decommissioning:

- Debrief removal on the decommissioning of two of the Brent field fixed platforms
- Performed engineering, project management and execution of the scope
- End client was Shell UK



# REACH AND AIBEL COOPERATION



- Reach Subsea and Aibel has entered into a formal cooperation agreement for projects within subsea oil and gas, renewables, ship and rig repairs and decommissioning of existing platforms/subsea structures or other offshore installations
- The two companies operate within the same market segments, but have different client bases and contracting approaches
- By efficiently utilizing resources from both parties, we will be able to undertake complex projects requiring project management, engineering, fabrication, installation, MC (mechanical completion), commissioning, decommissioning and ROV marine services/operations"
- For further optimisation of synergies, Reach Subsea moved into Aibel's office building 01.10 2016



# PARTNERS IN DECOM

## Reach subsea is cooperating with Fred Olsen Windcarrier:

- Reach Subsea is cooperating with Fred Olsen Windcarrier on decom projects where there are need for jackup vessels
- The business idea is to be able to provide a turnkey solution with jackup and subsea tonnage working in parallel or sequential
- With pooling the resources we are able to provide a very sound technical solutions at attractive price levels
- We have been cooperating on several tenders and the cooperation is well established, both technically and commercially

### Fred Olsen Windcarrier vessels:

Brave Tern and Bold Tern

LOA:	132m
Beam:	39m
Leg length:	92m
Crane:	900t @ 24m, 102m above deck
Transit speed:	12 knots
Payload:	6600t



# JOINT VENTURE WITH MMT

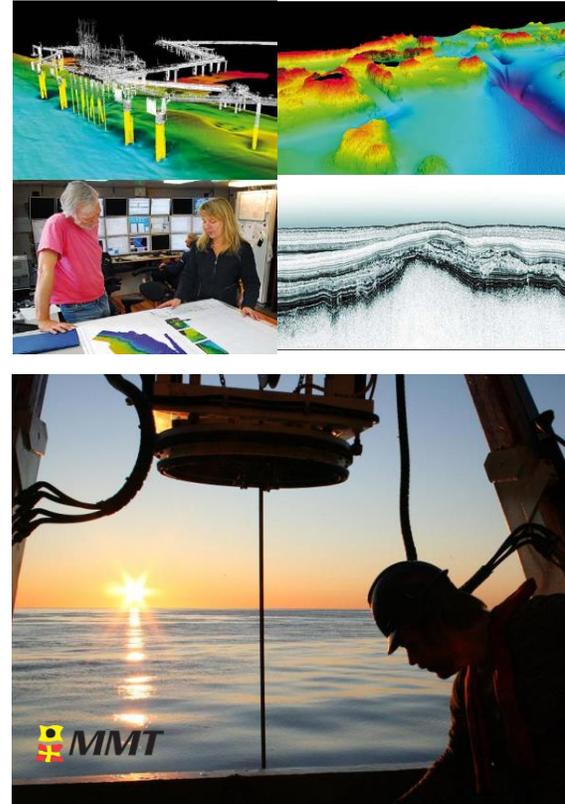
Reach Subsea and MMT is a powerful entity offering cost efficient solutions to the market.

MMT was established in 1976, founded by Ola Oskarsson and based in Gothenburg, Sweden.

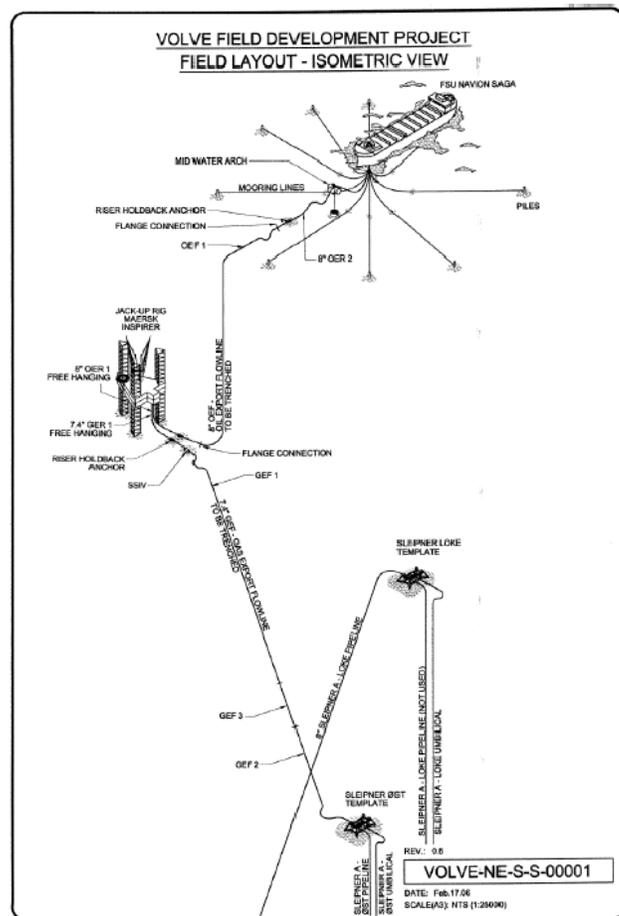
MMT brings 40 years of innovative surveying to the market, and has over 250 employees.

Together, Reach Subsea and MMT offers:

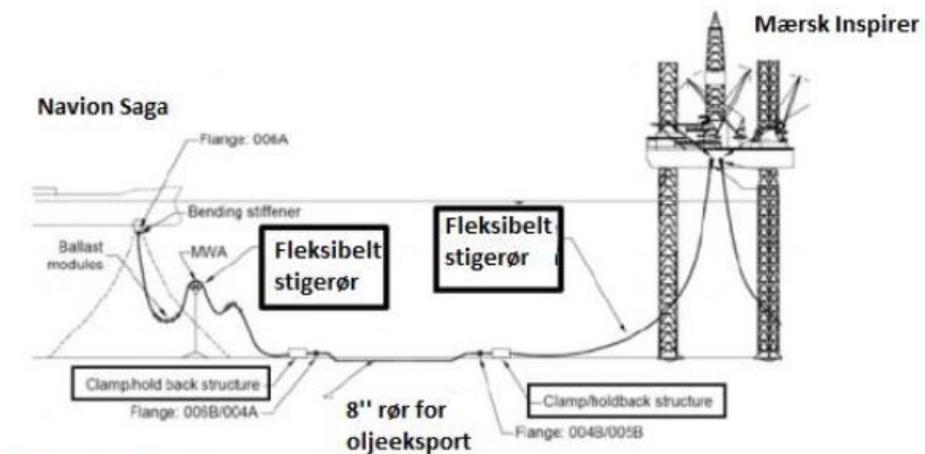
- Pipeline / Structure Inspections
- Reconnaissance Surveys
- Detailed Seabed Mapping
- Light Construction / Construction Support
- Geotechnical Investigations
- Uxo Survey, detection and detonation



# VOLVE – STATOIL/NORGE - 2016



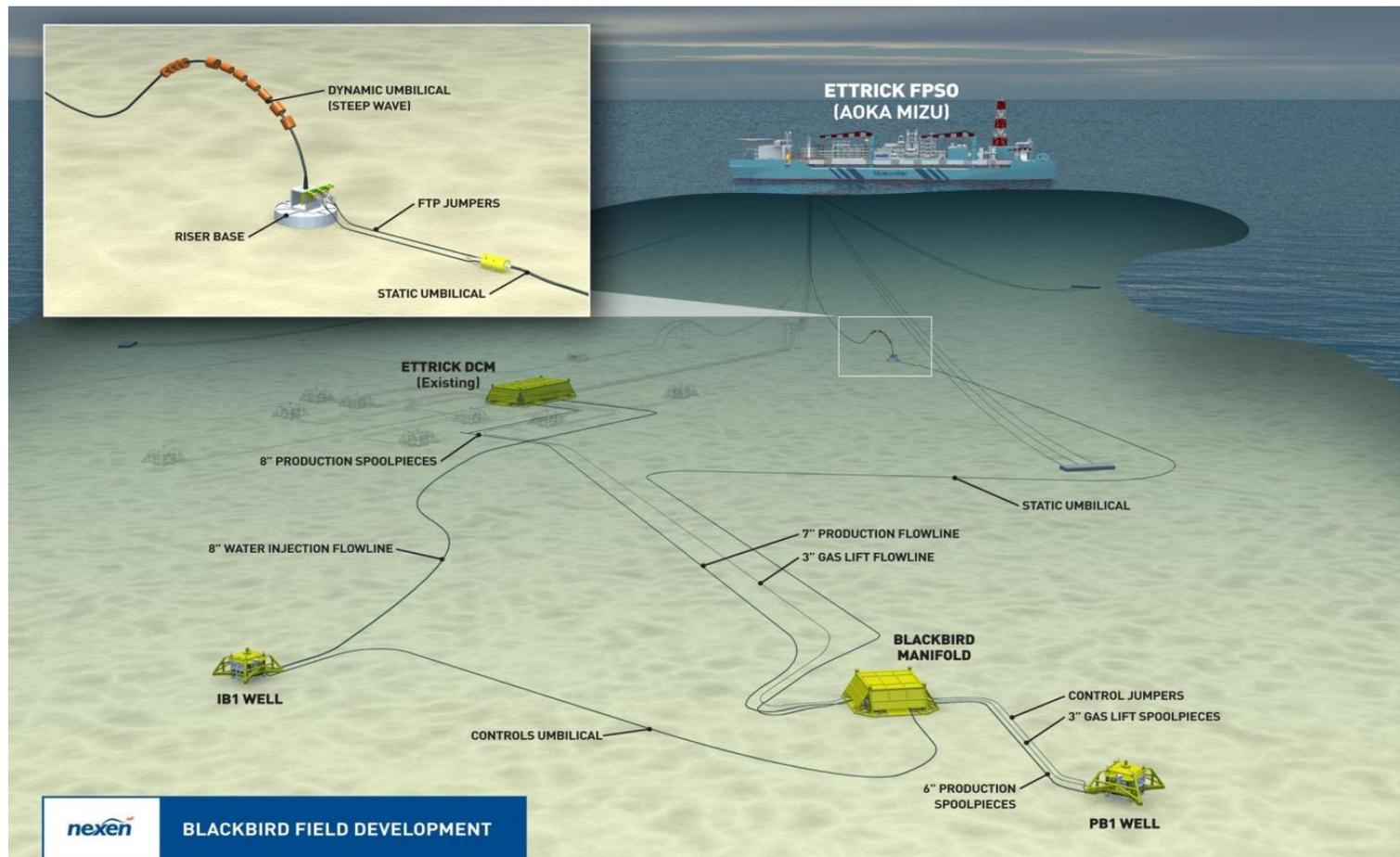
Figur 2.3 Skisse over feltstrukturer på Volve.



Figur 2-6. Skisse over system for oljeeksport.



# ETTRICK / BLACKBIRD – NEXEN/UK - 2017



# VESLEFRIKK – STATOIL/NORGE - 2018



# JOTUN – EXXONMOBIL/NORGE - 2018

## Project Overview



### Execution Timeline

~ 2018 - 2020

- Remove topsides, jacket, risers
- Onshore disposal/recycle
- FPSO removal

~ 2016-2018

- De-energize and clean
- Engineering down

~ 2016 - 2017

- Wireline campaign (well diagnostic)
- Coil tubing campaign (Place reservoir barriers)
- P&A unit campaign (Place environmental barriers, remove conductors)

~ 2016

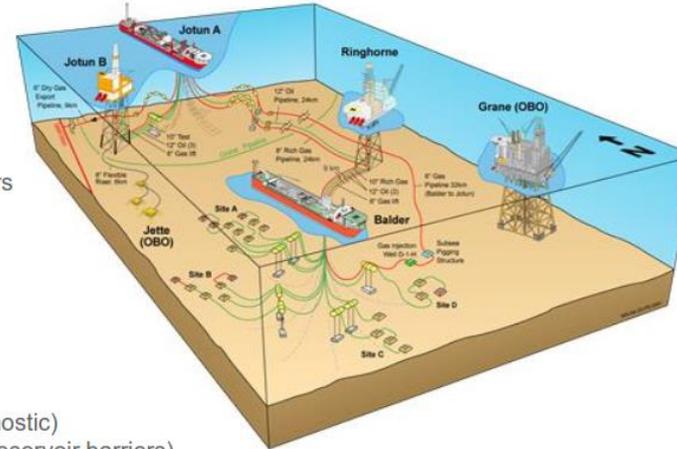
- Phased mobilization of wireline unit, coil tubing unit, purpose built P&A unit
- Platform integration

~2015

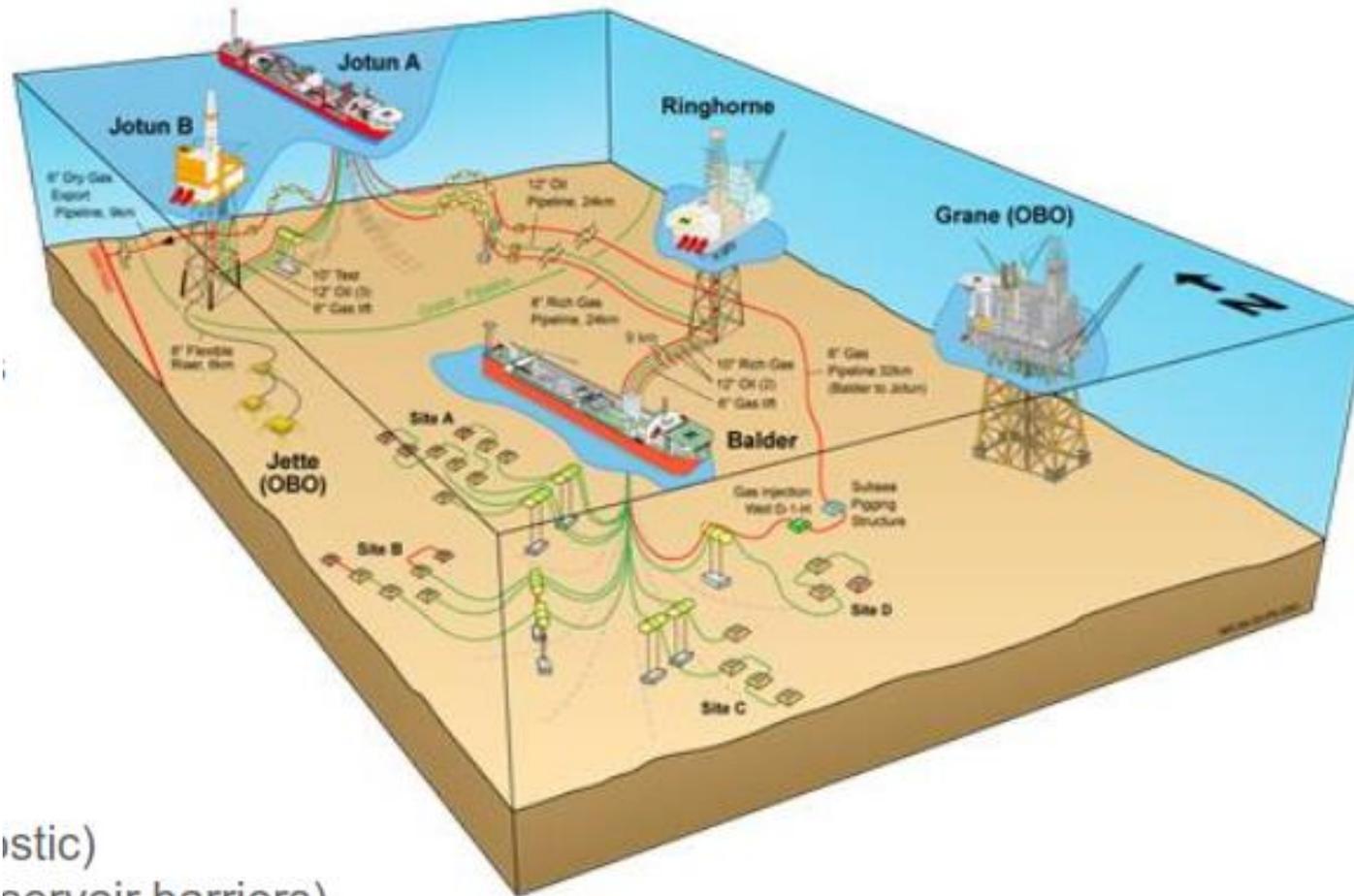
- Removal of derrick, and potentially other structures/equipment on drill floor
- Re-commission relevant systems for P&A execution (skidding system, electricity, F&G etc.)

~2014

- Project Team mobilized
- Business case and Pre-Feed studies

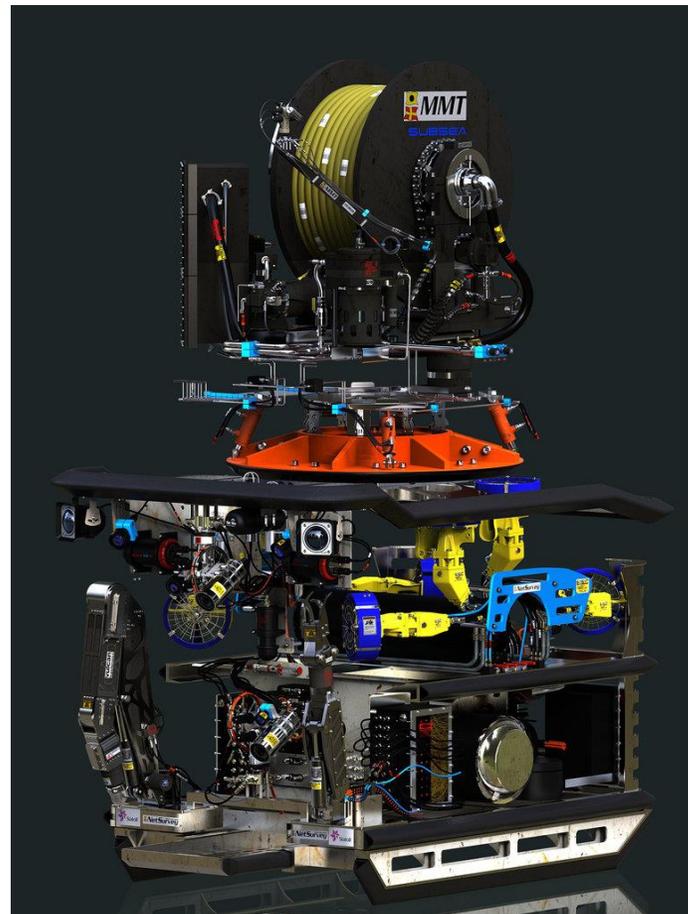


# JOTUN – EXXONMOBIL/NORGE - 2018



istic)  
servoior barriers)

# KYSTDESIGN SUPPORTER ROV



# SCHILLING HD ROV



THANK YOU!



## Minutes of Meeting, Kvaerner AS, 15<sup>th</sup> of March 2019

### DECOM Tools Project

This document is a summary of minutes of meeting at Kvaerner AS on the 15<sup>th</sup> of March 2019.

Participants:

Eirill Hatlevik, VP Decommissioning, Kvaerner AS  
Magne Bjelland, Senior Manager Methods and Execution, Kvaerner AS  
Jens Christian Lindaas, HVL  
Andres Olivares, HVL  
Børre Mæland, Master student, HVL  
Martin Urnes, Master student, HVL

Questions related to company visits (decommissioning companies):

- **Which decommissioning projects (oil and gas) have your company been involved in?**  
Kvaerner have been involved in decom projects from 1995 and onwards. Reference is made to the enclosed Experience List.
- **What has been your Scope of Work in these projects?**  
The projects have been related to engineering and preparation for decommissioning, some projects include removal operation offshore, and most include the onshore deconstruction and disposal operations.
- **What methods and tools have been used for cutting /dismantling the structures offshore (subsea and topside)?**  
For offshore and inshore works, the techniques for onshore are utilised above waters. For subsea, water and water grit cutting technology are used as well as diamond wire, special shears etc. There are various specialised suppliers for subsea cutting tools. Examples of subcontractors: Stena, Cut, Proserv, Oceaneering and Behrenberg.
- **How have the parts been lifted onboard the vessel(s) and transported to the onshore base?**  
Modules and structures have been lifted onboard the vessel /HLV (Heavy Lifting vessel) using the vessel crane.

- **Which types of vessels have you been using?**

Modules and structures have been lifted onboard the vessel /HLV using the vessel crane. Often HLV that can take big modules /topside decks to reduce the need for cutting offshore. This saves expensive offshore time.

- **Has towing of structure elements been used?**

Yes, eg. towing of subsea structures using pencil buoy and removing of jacket structure using buoyancy tanks.

- **Which onshore bases or quay facilities have you been using for the further dismantling and recirculation process?**

Mainly Kvaerner's Disposal site at Eldøyane, Stord, and for part of Frigg the Greenhead Base at Lerwick, Shetland.

- **Which cutting methods and tools have you been using onshore?**

Main methods used onshore are mechanical cutting by shears (mobile and stationary) and gas cutting. Some automatic cutting and semi-automatic cutting techniques and tools are used. Cold cutting like eg. diamond wire is used for certain operations.

There was a discussion on the use of explosives, but Kvaerner would rather use other methods if possible. This due to unpredictable steel quality and uncertain method. Also, it will cause a big problem if it won't explode correctly.

- **What is your experience using these methods /tools?**

The most efficient tools as per today are mechanical cutting by shears and gas cutting. Other tools are used tactically for specific tasks. The experience from using the different tools depend on the application, and the correct tools and cutting techniques must be selected based on the structure to be cut and working conditions.

They are working towards more automatically cutting tools.

- **Where has the material been sent for further processing /recirculation?**

The steel materials are cut in chargeable sizes and shipped to ironworks in Europe. Stainless steel, copper, zink etc. are transported to more specialised recycling facilities. Wastes are treated, incinerated or disposed off through approved waste handling contractors.

- **Have you been involved in installation of offshore windmills? Which windmills /parks?**

No.

- **What has been your Scope of Work in these projects?**

N/A

- **Can the installation process be easily reversed for decommissioning of the windmills?**

Yes, it can.

- **Will decommissioning projects related to oil and gas be a growing part of your business for the next five years?**

The decom business segment is expected to grow; however the new build and modification activity is still expected to form the major part of our business the next years.

- **Are you planning to expand your international operations related to decommissioning projects or will your main focus be in the Norwegian sector for the next five years?**

The decom business segment is expected to grow with engagements also outside the Norwegian sector.

- **Are you interested in entering the business regarding decommissioning of wind parks? Have you already been involved in such projects? If so, what has been the Scope of Work?**

Yes, offshore wind will be part of our decommissioning business. No, we have not been involved yet.

Additional questions;

- **Do you consider cleaning the parts of the rig /structure before and during decommissioning?**

Yes, and Kværner are using high-pressure waterjet for this purpose.

- **Specific rules and regulations to be taken into account during this decommissioning process? Licenced ports in Europe for scrapping?**

Strict national regulations in Norway in relation to pollution. Foreign ports in Europe can be used, but this will imply a lot of extra paperwork (but not impossible).

- **What needs do you identify in terms of labour market and infrastructure today and if entering this new business?**

Kværner have sufficient infrastructure and manning today to execute current decommissioning projects, and also for future wind mill decommissioning.

- **How important is international cooperation in general and for you particularly?**

International cooperation and business have always been important for Kværner. This is nothing new in relation to installation and decommissioning of offshore wind mills.

- **Do you consider this “DECOM Tools” -project to be relevant and helpful? What do you expect from the project?**

Yes, Kværner may be an industry “Partner” that can be contacted for advice and discussion. Kværner also hope to get insight in new ways to perform decommissioning and logistics that may be the results of this project, and thus are positive to join the “Expert Committee”.

Below are pictures from the decommissioning site.



Oil & gas modules and a steel jacket being decommissioned.

One of the brand new Johan Sverdrup platforms in the background.



Topside of an oil & gas platform being decommissioned.



Heavy duty cutting equipment in operation.



Big dimensions in the oil & gas industry!

Andres Olivares is smiling. He enjoys being part of the DECOM Tools project team!





Hydraulic operated shears /scissors is used to a large extent when cutting the steel platforms into pieces. This is a very environmental friendly cutting method compared to f. ex. oxy arc /gas cutting.



11	08.02.2019	Update	EHA	GE	EHA	
10	02.10.2018	Update	PTA	VHØ	EHA	
09	18.04.2018	Updated	ADO	VHØ	EHA	
08	13.03.2018	Updated	ADO	VHØ	EHA	
07	25.01.2018	Updated	ADO	MML	EHA	
Rev.	Issue date	Description	Made by	Chk'd by	Disc. Appr.	Proj. Appr.

**Title: Project Experience List**

## Kvaerner – Deconstruction Experience

Kvaerner has long experience with decommissioning projects and the table below summarizes key data:

Project	Client	Role Kvaerner	Description of work & methods	Start / Completion
Jette	Aker Solutions	Disposal Contractor	Deconstruction and disposal of the Jette Facilities	2019
VARG A	Saipem (Repsol)	Disposal Subcontractor	Deconstruction and disposal of the VARG A platform.	2018 - 2019
Gyda	Repsol	Disposal study contractor	Level II offshore hazardous materials inventory survey	2018
Valhall Decommissioning	Allseas	Disposal Subcontractor	Deconstruction and disposal of the Valhall QP platform	2018 ongoing
Subsea Compression Pilot	Shell	Removal and Disposal contractor	Removal of the Subsea Compression Pilot test plant from Nyhamna. 2200 Te. Ship to Stord for disposal	2017 - 2018
Miller Decom	Saipem (BP UK)	Disposal sub-contractor	Disposal of the Miller topsides and jacket. Quantity approx.. 40.000Te	2016 - ongoing
Njord Future Project	Statoil	EPC contractor	Engineering, waste management and waste removal, segregation and disposal from the Njord A Platform.	2016 - 2018
Draugen FLP	AS Norske Shell	Disposal contractor	Tenderer took over the buoy inshore, transported it wet and placed it in our dry dock for piece large sectioning. The sections were transported to Eldøy for final disposal.	2014 – 2015
Goliat	Internal	Disposal contractor	Removal and disposal of the large obsolete gantry crane Goliat	2014
Ekofisk 2/4S	Statoil	Disposal contractor	Disposal of the Ekofisk 2/4S Jacket. Jacket removed 2014 by Saipem on separate contract.	2012 -2015
TOGI	Statoil	Disposal contractor	Disposal of the TOGI template. Substructure removed 2013 by Saipem on separate contract.	2012 – 2013
Kollsnes KOP	Statoil	Main contractor	Modification of the Kollsnes refinery including disposal	2009 - 2011
Frigg Cessation	Total E&P Norway	Team-agreem. with AOP (Aker Solutions).	Engineering, preparation, removal and disposal of the Frigg Field and MCP-01 facilities. In total 6 topsides and 3 jackets. The DP2 jacket was removed using buoyancy tanks, the	2004 - 2010

Project	Client	Role Kvaerner	Description of work & methods	Start / Completion
			majority of other items were removed by S7000. Some piece small removal was carried out. Quantity: 80 000 tonnes, 66000 Tonnes were deconstructed at Stord and 14 000 Te at Shetland (Lerwick, SDC). 98% Reuse	
Frigg Sealines Cessation	Total E&P Norway	Sub-contractor to AMC/ Sonsub	Disposal of the Frigg Sealines; pipelines, cables, umbilical and ancillaries. Reuse was found for many of the received items, including straight pipes, saddles and most mattresses. Irregular pipes, cables and umbilical were recycled. Quantity: 6 000 tonne	2006 - 2009
Magnus Flare	BP UK	Disposal contractor	Disposal of the flare – materials recycled. Quantity: 85 tonne	2007
Brent Flare and Anchor Blocks	Saipem (SHELL UK)	Disposal Sub-contractor	Saipem performed removal of the flare and anchor blocks on behalf of Shell UK. Kvaerner subcontractor performing load-in and disposal. Anchor blocks reused for seaside supporting, flare deconstructed in dry dock and recycled. Quantity: 8 095 tonne	2004- 2005
Maureen A Platform & ALC Loading Buoy	Conoco Phillips UK	Team-agreement with AOP for inshore and onshore works	Removal and disposal of the Maureen Platform, ALC loading buoy and ancillaries. Aker Kvaerner was awarded both the refloat and deconstruction Contracts for former Phillips Petroleum UK. Maureen Alpha weighted 110 000 T, being the only complete steel gravity based structure in the North Sea. After tow and mooring at Stord in June 2001, Maureen Alpha was prepared for deconstruction. The large oil storage tanks were cleaned. The three tanks were resealed and made watertight in preparation for submergence for the removal of the topsides onto a barge. Some of the modules were removed inshore and the substructure was then submerged in order to lower the deck onto a barge in a reverse procedure to the mating operation. The demating operation went completely according to plan and the 12000 Te deck was skidded onto the Eldøy quay. The deck and modules were deconstructed. The steel lattice framework was removed to shore in liftable sections, and later cut by the scrapping subcontractor. The three tanks have been cut into sections and partly used in the foundations of a new deep-water quay. Approximately 99.5 % of all structures and materials were re-used or re-cycled Quantity: 114 869 tonne	Year 2000-2003

<b>Project</b>	<b>Client</b>	<b>Role Kvaerner</b>	<b>Description of work &amp; methods</b>	<b>Start / Completion</b>
Disposal of Odin	Exxon Norway	JV with Saipem	Disposal of the Odin topside and jacket. This was the first time the Eldøy Disposal Site including deconstruction pad, K-10000 crane and the deep water quay was used, and the area proved to be well suited for the purpose. Quantity: 15 300 tonnes, recycling percent 98.3	1996-1997

In addition to projects listed above, Kvaerner Decommissioning has participated in numerous decommissioning studies.

Kvaerner has 40 years of experience with large offshore new build projects e.g. Edvard Grieg, Eldfisk 2/7 S, H6 drilling rigs, Gjøa, Kristin platforms, Norne and Njord production ships and several other projects. This experience is valuable also for deconstruction.

## Minutes of Meeting, AF Decom AS, 24<sup>th</sup> of April 2019

### **DECOM Tools Project**

This document is a summary of minutes of meeting at AF Decom AS, on the 24<sup>th</sup> of April 2019.

Participants:

Jeroen Wiskerke, Project Manager, AF Decom AS  
Audhild Rygg, AF Decom AS  
Jens Christian Lindaas, HVL  
Andres Olivares, HVL  
Børre Mæland, Master student, HVL  
Martin Urnes, Master Student, HVL

Questions related to company visits (decommissioning companies):

### **Introduction**

- **Which decommissioning projects (oil and gas) have your company been involved in?**  
AF Decom has been involved in many projects concerning removal, dismantling and recycling; Ekofisk-tank, Ekofisk Cession 1 and 2, Murchison, Janice, B11 and H7, Inde Field.
- **What has been your Scope of Work in these projects?**  
Typical Scope of Work for these projects and AF Decom in general is the removal and /or dismantling /recycling. AF Decom has both been main contractor, but also sub-contractor with Heerema.

### **Cutting offshore**

- **What methods and tools have been used for cutting /dismantling the structures (subsea and topside)?**  
Heerema and subcontractors have mainly been responsible for this part.
- **What is your experience using these methods/tools?**  
N/A

## Logistics

- **How have the parts been lifted onboard the vessel(s) and transported to the onshore base?**

Main principle is reverse-installation, where a heavy lift vessel lifts it onto deck and transport it to Vats. The deep quay facilities are the main advantage for AF Decom. Old platforms are built module based, and new ones are also built to be removed as a few big pieces /modules.

- **Which types of vessels have you been using?**

Heavy lift vessels like Heerema's Thialf and similar deepwater construction vessels. These can lift entire jackets and platform decks. Jack-up vessels have also been used, similar to Pacific Osprey.

- **Has towing of structure elements been used?**

Yes, only for floating loading buoys. Other than that – no.

## Cleaning

- **Do you consider cleaning the parts of the rig/structure before and during decommissioning?**

Yes, cleaning is an important part of the decommissioning process. This relates both to removal of marine growth and removal of hydrocarbons and other deposits inside pipes and tanks. High pressure water jet is being used for this purpose.

## Onshore dismantling /recycling /waste disposal

- **Which onshore bases or quay facilities have you been using for the further dismantling and recirculation process?**

AF Decom have been using their own facilities at Vats in Rogaland, Norway. This is a facility specially designed for this purpose with large quay areas, deepwater quays that can accommodate heavy lift vessels, and purpose made cleaning /filtering system to handle water spills and chemicals.

- **Which cutting methods and tools have they been using?**

Oxy-propane due to its fast nature of cutting and low cost. Hydraulic operated shear cutter hanging from a crane, but also shear cutter mounted on excavators.

AF Decom has a stationary shear cutter for 2500 tones – the worlds biggest!

They were looking into the possibilities of wire-cutting onshore. Automation is something they want to get into. They will additionally look into the use of explosives in one of the future dismantling projects.

- **Where has the material been sent for further processing/recirculation?**

Stena Recycling, Eco-fiber, HIM, SIM, Celsa (for pure steel). They have an extensive NORM-check on everything leaving the site. (NORM –naturally occurring radioactive material.)

### Wind farms

- **Have you been involved in installation of offshore windmills? Which windmills /parks?**

Not involved in wind turbines so far.

- **What has been your Scope of Work in these projects?**

N/A

- **Can the installation process be easily reversed for decommissioning of the windmills?**

Yes, but what is most cost effective is most likely a different method.

### Business /marketing

- **Will decommissioning projects related to oil and gas be a growing part of your business for the next five years?**

If they can earn money.

- **Are you planning to expand your international operations related to decommissioning projects or will your main focus be in the Norwegian sector for the next five years?**

Reference is made to a later question.

- **Are you interested in entering the business regarding decommissioning of wind parks? Have you already been involved in such projects? If so, what has been the Scope of Work?**

Yes, if this can be done as serial decommission of many wind turbines. For AF Decom it is about getting big volume into the facilities in a short amount of time.

- **What needs do you identify in terms of labor market and infrastructure today and if entering this new business?**

No special needs compared to what they have already in relation to facilities and personnel.

- **How important is international cooperation in general and for you particularly?**

International cooperation and customers are already very important for them so this will not be something new.

- **Do you consider this “DECOM Tools”-project to be relevant and helpful? What do you expect from the project?**

Yes, it will be interesting to join the “Expert Committee” to follow the project.

Below is pictures from the decommissioning site.



Børre Mæland, Martin Urnes, Andres Olivares and two persons from Heerema. Heerema is an important business partner for AF Decom.



Cutted riser pipes  
ready for cleaning and  
recycling.



Filters for cleaning spill water.

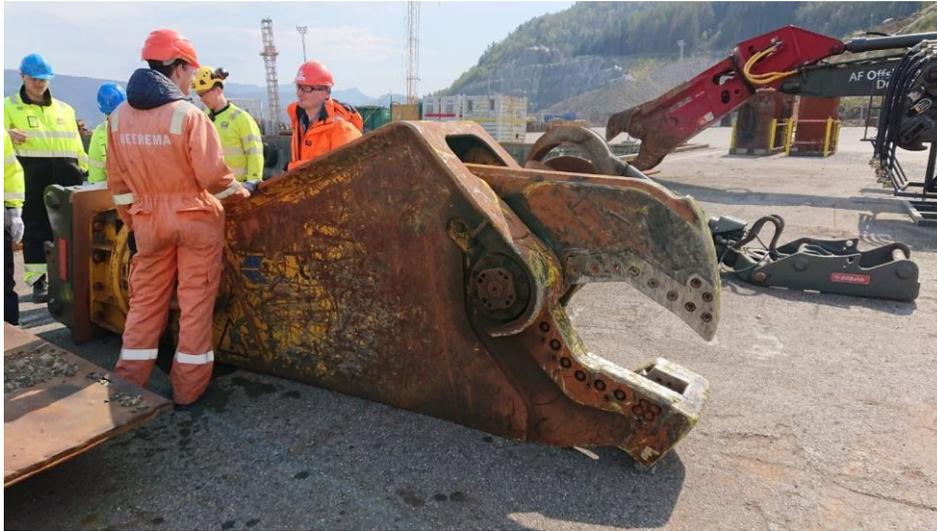


Cutted pieces of  
flexible risers.



Large quay areas  
and available  
cranes for heavy  
lifting.





Environmental friendly heavy duty cutting equipment (hydraulic operated shears /scissors).





One of the largest hydraulic operated cutting machines in the world.

