Retrofit MLT: Innovative Solution to Unlock Reservoir Potential & Increase Recovery

The Goliat Experience

Agenda

- **Introduction and Scope of Work**
- **Multilateral Retrofit technology**

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Goliat

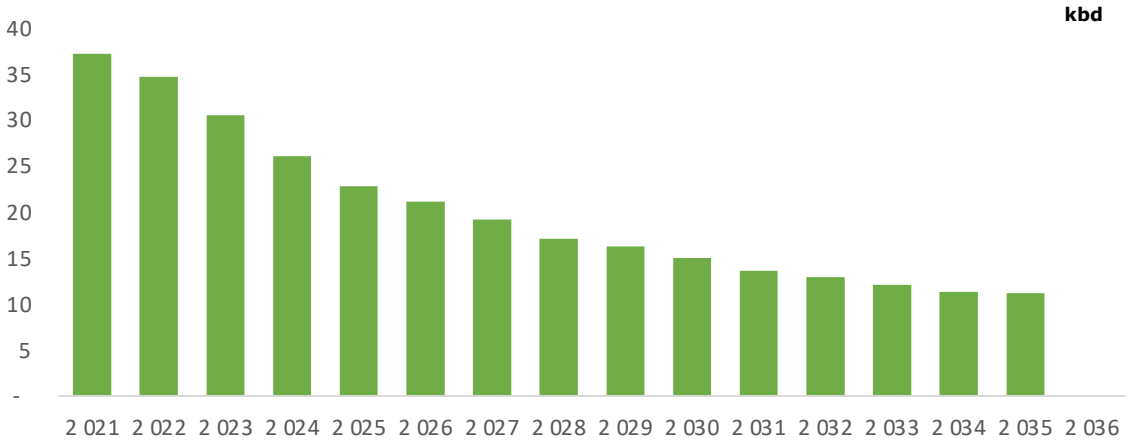
Asset description

- **First oil field to go into production in the Barents Sea**
  - The plan for development and operations was approved in 2009
  - First oil from the field in March 2016, followed by a rapid production ramp-up of all wells
  - 2020 gross production of 14.55 MMbbl
- **Ground-breaking technologies have been applied for the field**
  - World's largest and most sophisticated circular, floating, production, storage and offloading (FPSO) unit
  - Fully winterized and is specially designed for operations in the Barents Sea
  - With power from shore, the CO2 emissions from Goliat are amongst the lowest in the industry
- **Vår Energi is the Operator of the Goliat field**

Field facts

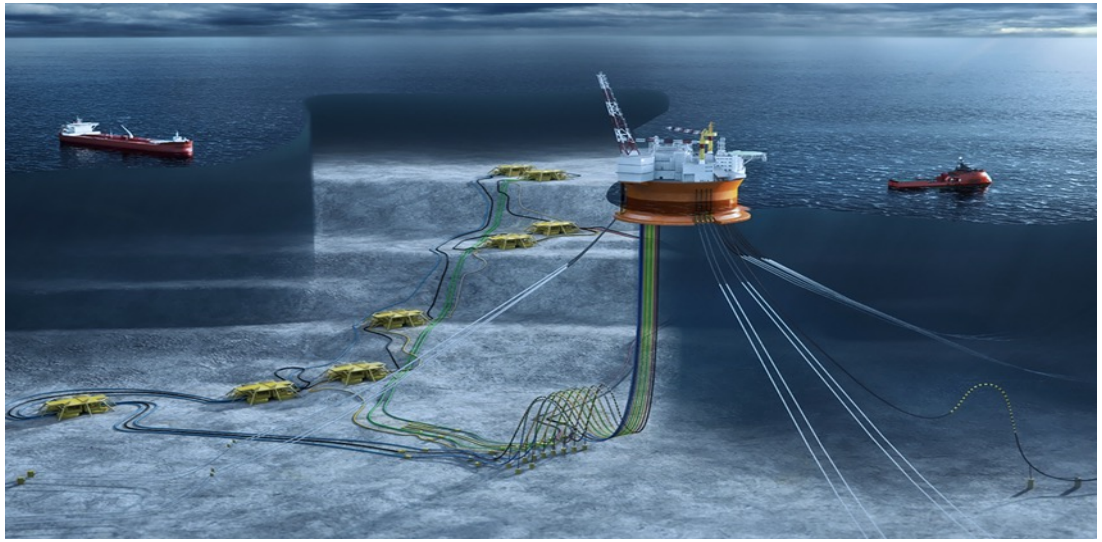
- **Partners:** Vår Energi (65.00%), Equinor (35.00%)
- **Discovered:** 2000
- **Production start:** 2016 –peak production 100 kbd
- **Ultimate recovery:** 190 MMboe

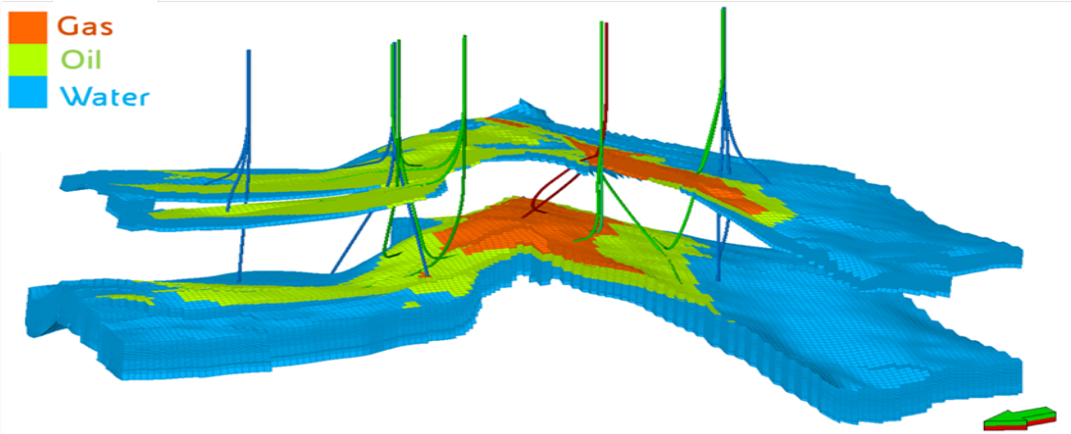
Gross field production



Goliat- Development Scheme

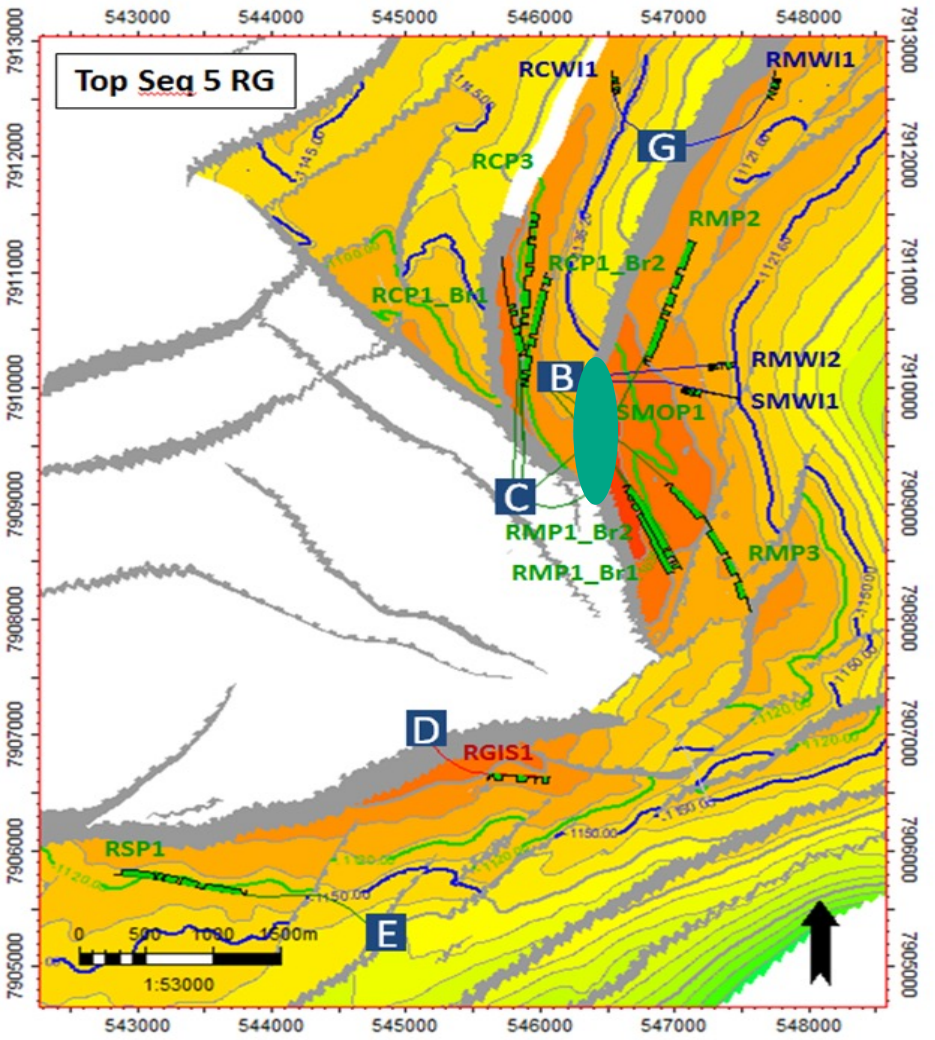
- 3 Main Reservoirs
  - Realgrunnen
  - Snadd
  - Kobbe
- Water depth ranging between 320m and 450m
- Development included a total of 8 templates with 28 active wells:
  - 16 Oil producers (4 MLT)
  - 9 water injectors
  - 3 gas injectors
- Oil producers have been completed with stand alone screens, with typical reservoir length of 700/1400 m MD
- Last RMLT wells have new branches reservoir length of 1300-2000 m MD





Goliat - Enhanced Recovery by Retrofit MLT

- ✓ Unlocked potential and enabled **fast track drilling** (reduced time to market)
- ✓ This allowed to produce volumes, with **reduced capex** in sub-economic targets:
  - ✓ Goliat West from C-2 slot – the drainage of the Goliat west discovery was possible in **timely and cost-effective manner**
  - ✓ Snadd from C-1 slot – adding a second branch to a low performance well
- ✓ Support **additional infill activity**, with lack of free available slots
- ✓ New wells drilled adding new branch to an already existing producing well. Enhanced production with **no need of additional subsea infrastructure**; significant acceleration and significant capex savings
- ✓ Retrofit MLT technology: **first application on NCS**, **first application worldwide on subsea wells**



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Agenda

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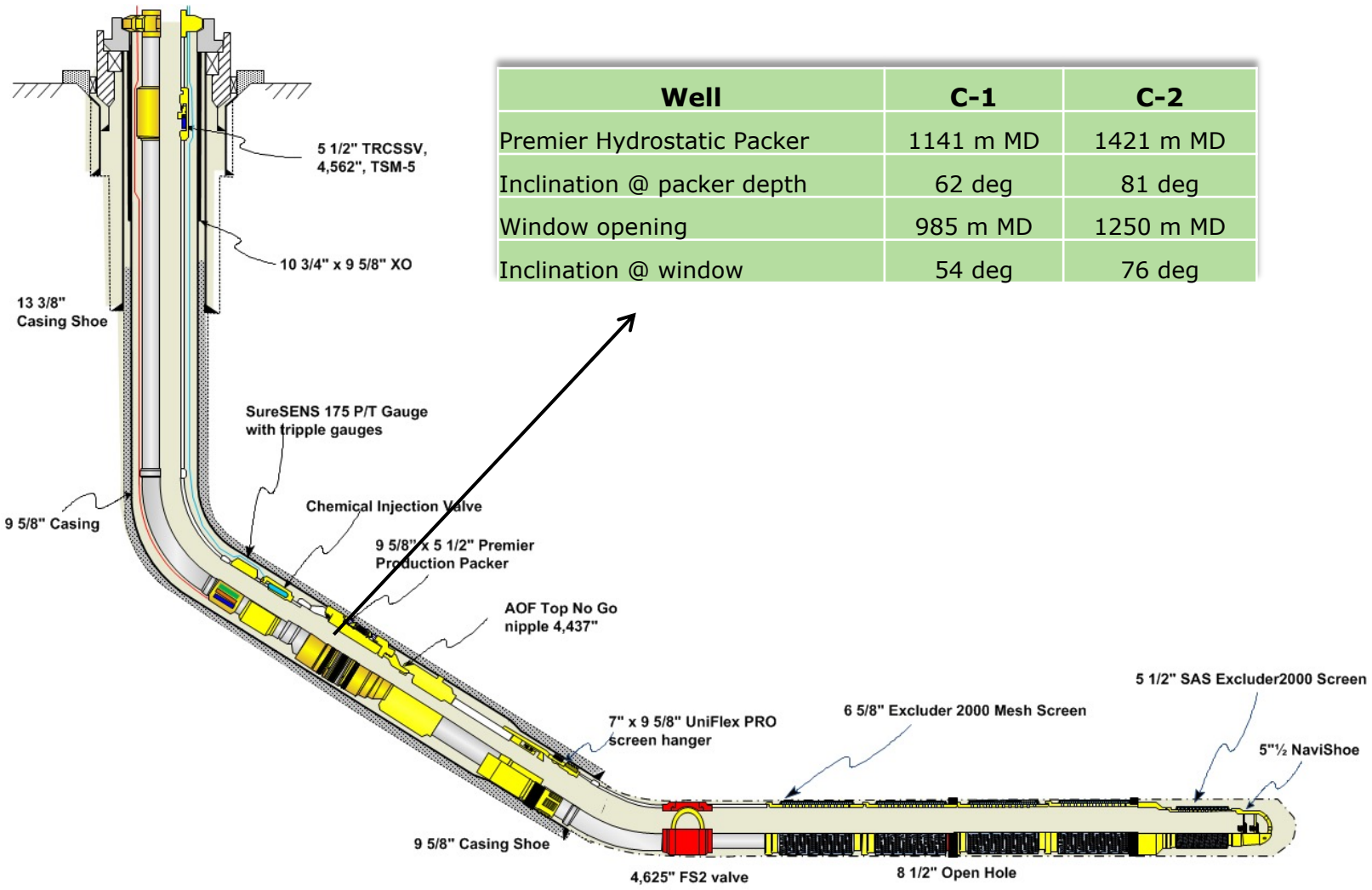
Old Completion Schematic



Well	C-1	C-2
Premier Hydrostatic Packer	1141 m MD	1421 m MD
Inclination @ packer depth	62 deg	81 deg
Window opening	985 m MD	1250 m MD
Inclination @ window	54 deg	76 deg

Lower Completion

- 5 ½'' NaviShoe
- 5 ½'' SAS Exluder 2000
- 6 5/8'' SAS Exluder 2000
- FS-2 barrier valve (ID 4,625" Drift 4,595")
- UniFlex PRO screen hanger

Upper Completion

- Ratcheting mule shoe
- 9 5/8'' Premier Production Packer + AOF nipple (top no go) ID 4,437"
- DHPTG
- CIV
- SPM
- TR-SCSSV

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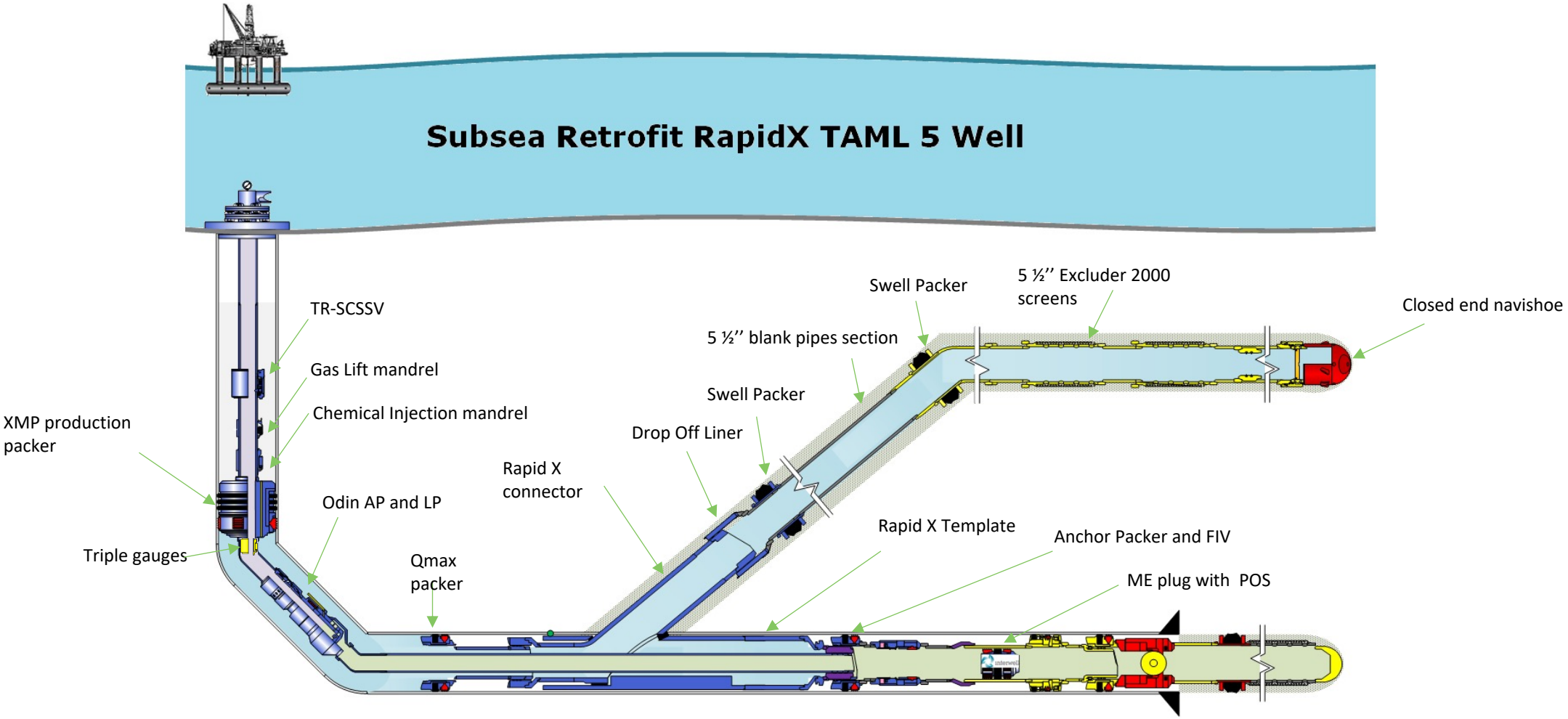
Challenges

Re-entering existing subsea wells adding a second branch to the existing producer was identified as the most economically favorable solution

- Longest reservoir section ever drilled on Goliat field
- Perform D&C operation without damaging Main Bore
- Tight control over mud weight and rheology in order to maintain wellbore stability without inducing losses
- Narrow window depth for casing exit
- Run lower completion to TD
- First RapidX Junction Installation in NCS

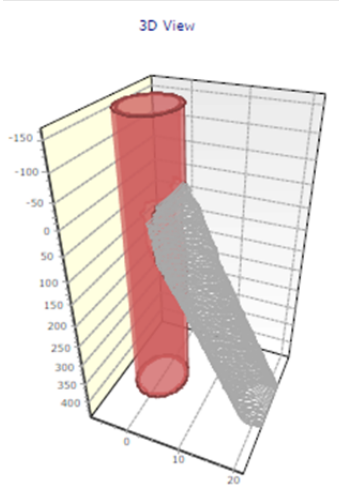
Actual Well Design



Drilling – Success Factors

Whipstock window milling and retrieving operations

- Whipstock window assessment
- Casing window milling:
  - torque limitation of drilling latch
  - Milling with constant ROP, without P/U off bottom resulted in good window and stable rathole. No issues for subsequent BHA and assemblies to pass through
- Swarf recover and BOP cleaning
- Rat hole allowed good kickoff for Motor, RSS assy and for MLT Connector installation.



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Drilling – Success Factors

Kick off and Reservoir section drilling

BHA and exit strategy

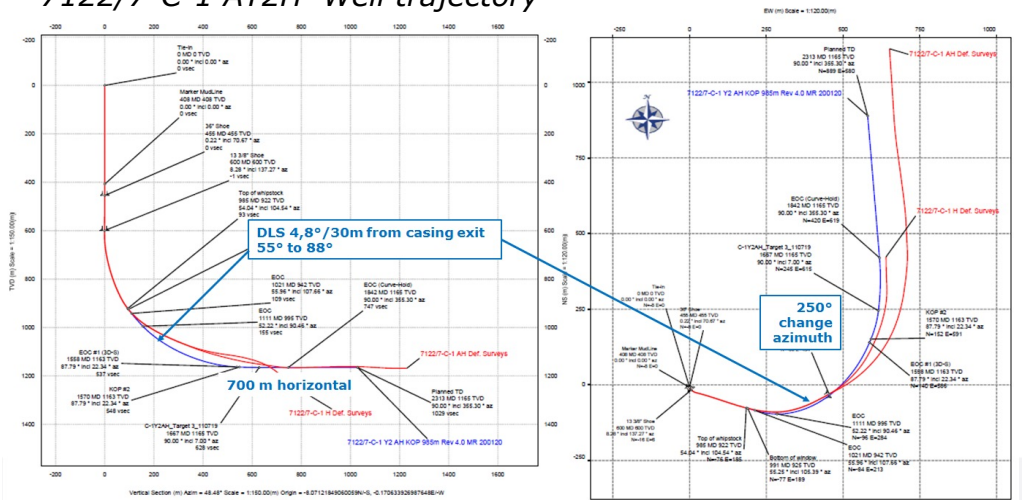
C-1

- Two BHA used, first BHA with motor to kick off and drill extended rathole. Second, RSS BHA with LWD scope to complete the section
- Motor with bent sub solution due to challenging kickoff, dogleg requirement and less tolerance to achieve required departure and kick off

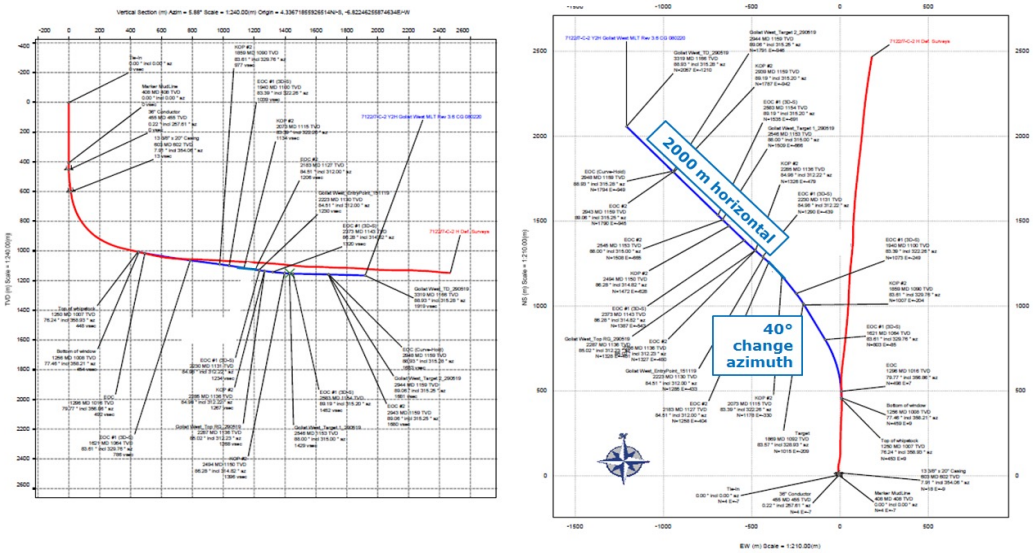
C-2

- Vortex BHA was used (combined motor and RSS) with 0 deg bent sub.
- Motor used to drill 'extended' rat hole allowed drilling the whole section in rotation mode

7122/7-C-1 AY2H Well trajectory



7122/7-C-2 Y2H Well trajectory



Drilling – Success Factors

Kick off and Reservoir section drilling

Reservoir section drilling

C-1 & C-2

- Detailed geomechanical study
- Focus on ECD. Reaming one single was proven to reduce ECD in shale section. This is most likely due to shale packing in the BHA
- Realtime monitoring of wellbore stability and ECD
- Good planning and communication with subsurface and well placement team minimizing unnecessary geosteering actions
- Backreaming resulted in clean hole and no issues in running lower completion to TD
- Integral torque reducer subs used to limit torque, stick & Slip as well as casing wear

Completion – Success Factors

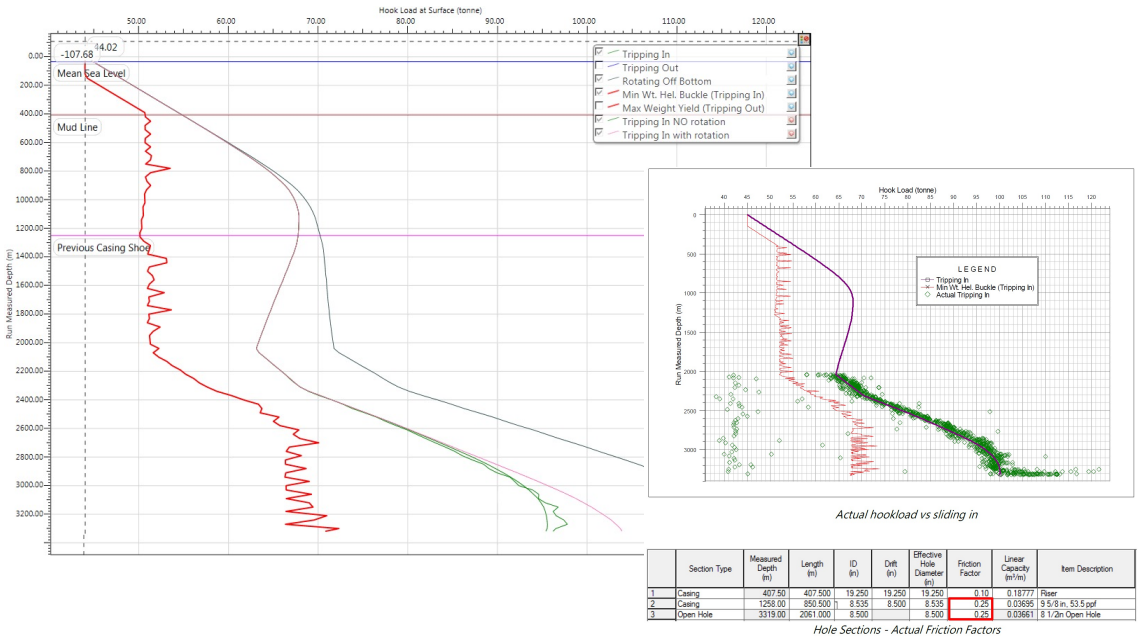
Well re-entry and pull completion

GRA and local wellhead analysis	Landing String and wireline equipment installation	8 5/8’’ CWOR preparation	Main Bore Temporary Suspension Strategy
• Installed motion and strain sensors onto BOP to monitor wellhead fatigue	• Performed Interface test to verify interfaces and rig up • Focus on 8 5/8’’ landing string handling equipment and slotted master bushing	• Performed sand blasting • Applied internal coating for preservation	• Main bore killing procedure • Wireline/Slickline equipment strategic planning

Completion - Key of Success

Running Lower Completion

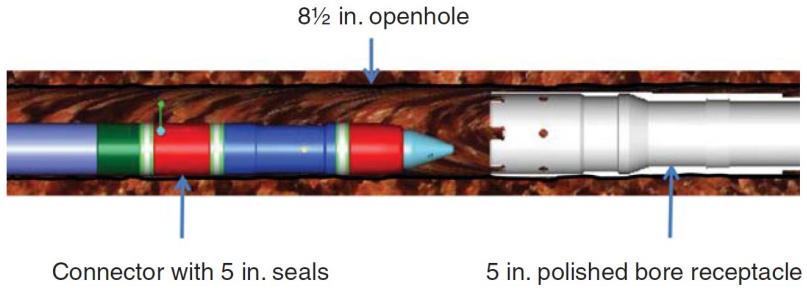
- Reservoir navigation strategy
  - Geosteering actions limited to 2°/30 m limited well tortuosity and open hole actual FF
- Optimized Lower completion string
  - Limited number of Swell packers
  - String Centralizer OD machined down from 8.25'' to 7.5'' to mantain screen standoff and increasing clearance
  - 5 ½'' screen base pipe
- Open hole caliper at the junction location
  - Liner dropp off assembly released in openhole section, around 8 m away from the window



Actual hookload vs sliding in

	Section Type	Measured Depth (m)	Length (m)	ID (in)	Drift (in)	Effective Hole Diameter (in)	Friction Factor	Linear Capacity (m³/m)	Item Description
1	Casing	407.50	407.500	19.250	19.250	19.250	0.10	0.18777	Riser
2	Casing	1258.00	850.500	8.535	8.500	8.535	0.25	0.03695	9 5/8 in, 53.5 ppf
3	Open Hole	3319.00	2061.000	8.500		8.500	0.25	0.03661	8 1/2in Open Hole

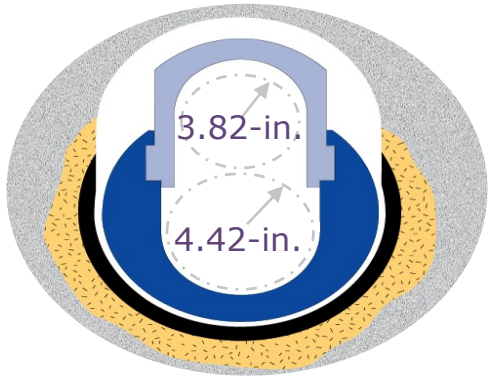
Hole Sections - Actual Friction Factors

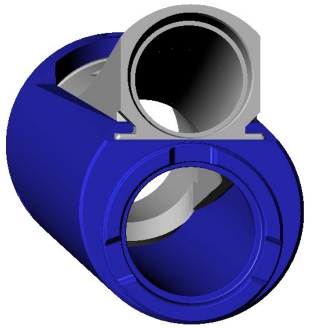


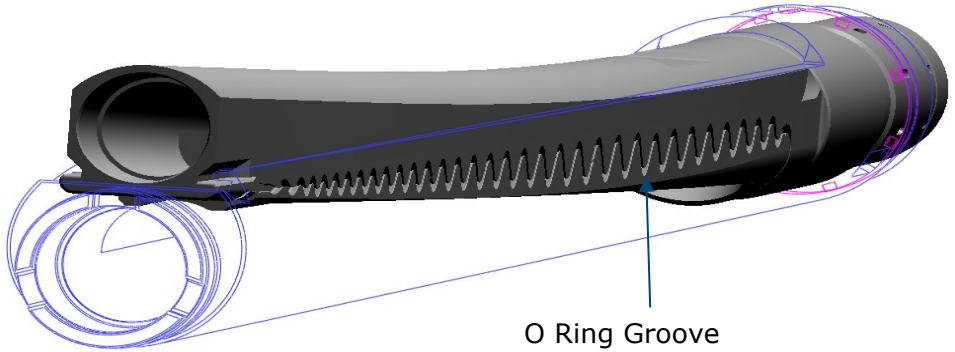
Completion – Success Factors

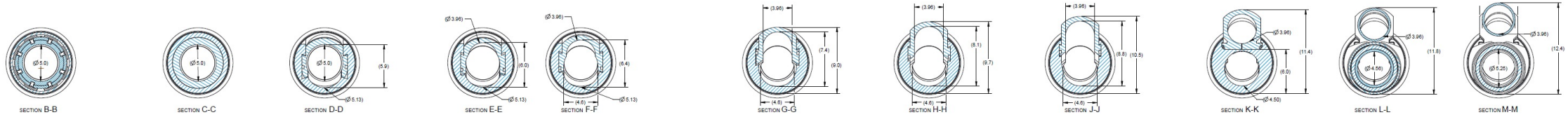
Junction Installation

- Depth control
  - Used same HWDP LS for Tag run, Anchor packer, Template and Connector installation
  - Critical space out for Anchor Packer installation and Connector
- Template run
  - Dedicated clean out run with magnets and 3.5” flush stinger to clean on top of FIV
- Connector run
  - Focus on tool orientation
  - Surge, swab and ECD loads during the MLT operations were properly accounted with the goal of maintaining wellbore stability





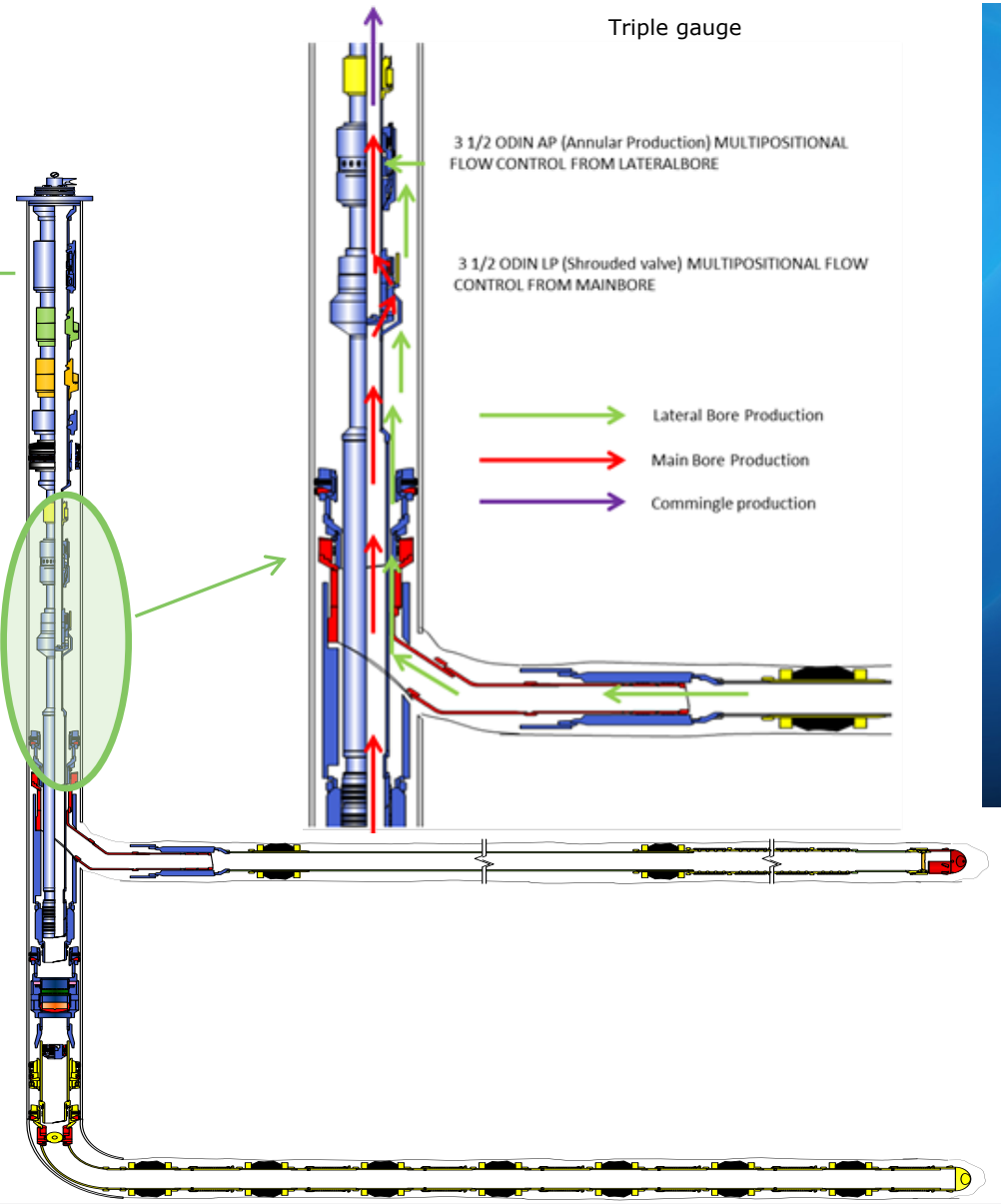




Completion – Success Factors

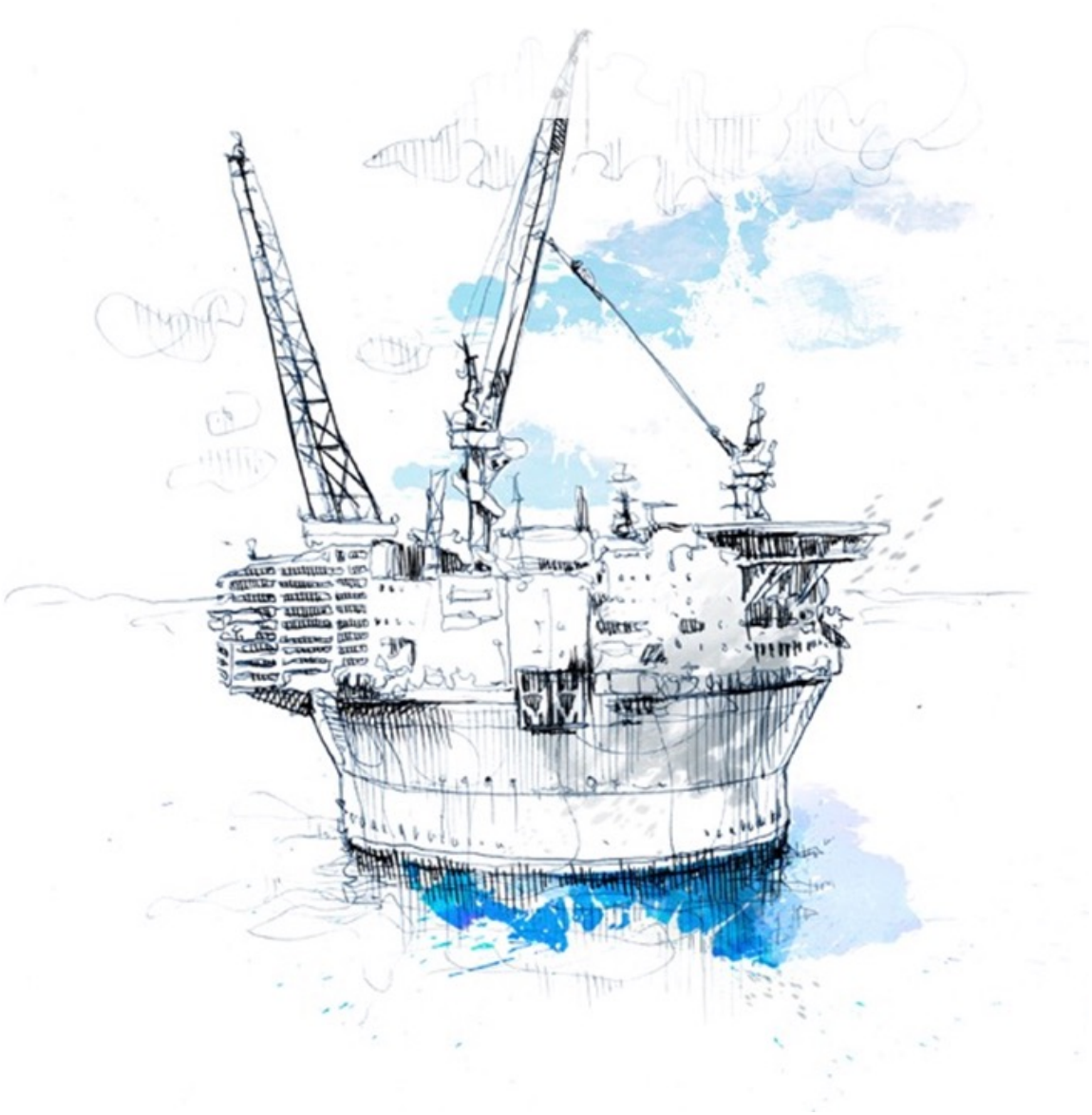
Upper completion installation

- ODIN flow control valve
  - EFAT performed to verify FCV functions control and interface with Goliat control system
  - Programmed logic for Goliat CCR
- DHPTG
  - New type of triple gauge installed for reservoir monitoring purposes. Capable to monitor pressure upstream and downstream on both branches
  - Verified compatibility with existing DIU



Executive Summary

- Retrofit MLT allowed to access/unlock resources, as best cost-efficient solution
- Accelerate time to market from Goliat West discovery
- First Subsea retrofit application in NCS
- First Worldwide retrofit application also for Vår Energi's main stakeholder
- Subsea retrofit wells conversion on mature assets gives operator additional opportunities to increase asset's NPV
- CAPEX saving estimated to be from 350 to 500 MNOK depending on adopted subsea installation solution



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Q&A Section

Vekst
Growth

Integritet
Integrity

Vinnervilje
Will to win

Inspirerende
Inspiring

Lagspiller
Team player