

Ormen Lange Pipeline Inspection

A Climb to Success

Ryan Fenwick (ROSEN) & Andy Studman (Shell International) | PPSA 2024 | Aberdeen | 20th Nov 2024

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ORMEN LANGE PARTNERS:



Operator

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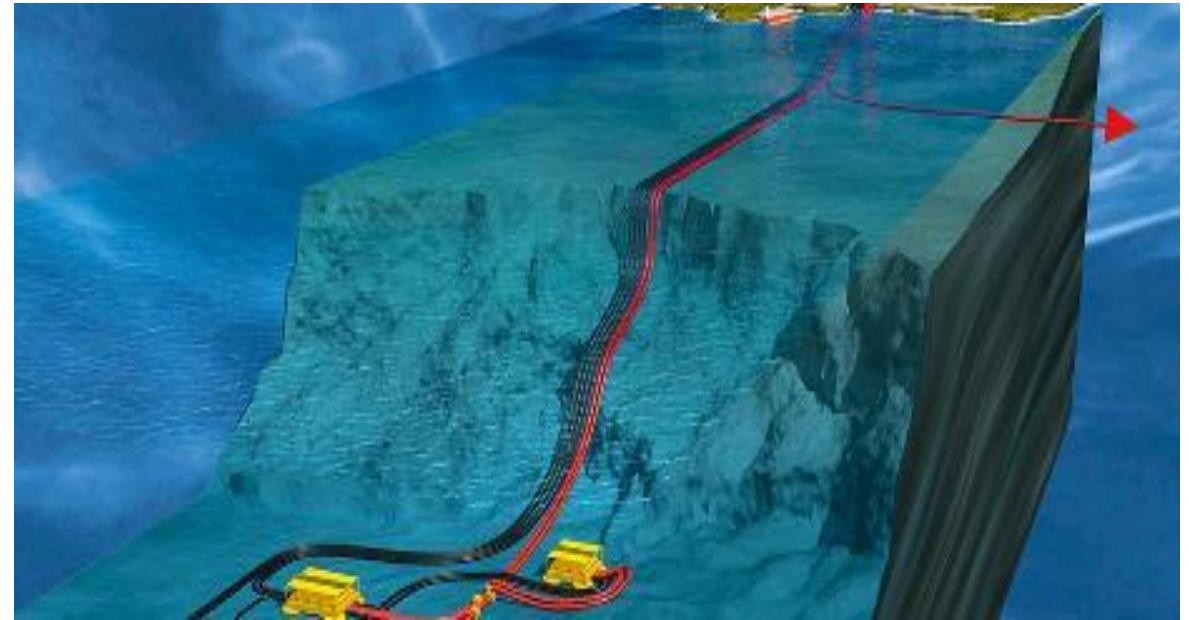
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Background

Ormen Lange Pipeline System

- Ormen Lange is a deep-water subsea tieback development off the coast Norway. Natural Gas is transported onshore to the Nyhamna processing facility via two 30" 120km pipelines.
- Each pipeline is equipped with a pig launcher. A subsea pigging loop allows for round trip pigging with the pipeline system configured for bi-directional pigging operations.
- Pipeline maximum depth is 1100m subsea
- Wall thicknesses ranging from 29.5 to 35.5mm
- 3D bends.
- Pipeline shut-in for pigging, dry gas provided from Nyhamna.
- No routine pigging.
- The pipeline was previously subjected to ILI in 2007 during commissioning
- ILI was due to verify corrosion control systems were working as expected, determine presence of any metal loss due to past or still active corrosion processes and to predict remaining life of the pipeline system under current operating conditions.



Challenges & Considerations



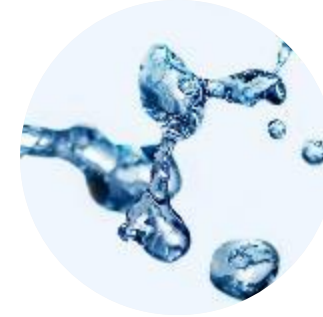
Product Deferment



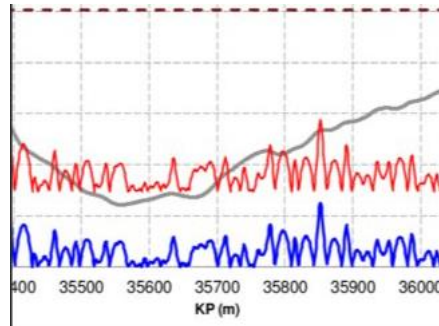
Debris



Elevation
Profile



Liquid Management



Operating Conditions

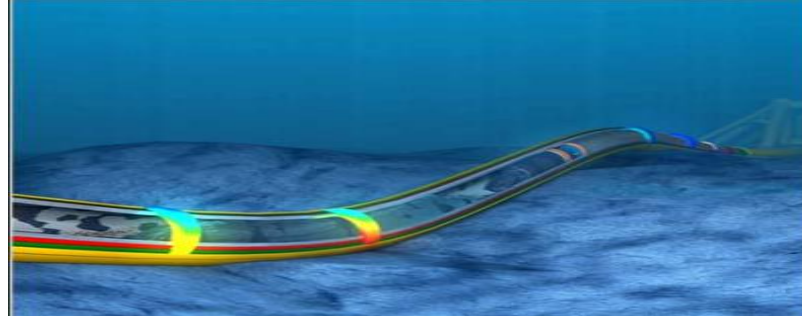


Reporting Specification



Multiple High Interest
Stakeholders

Flow Assurance Modelling



Flowrate /
Schedule
Optimisation

Hydrate
Mitigation

Pig Bypass
Efficiency

Liquids
Management

Pig
Behaviour

Phase One



Photos courtesy of Pipeline Innovations & Norske Shell

Phase One

- Confirm piggability, debris quantification, conservative, liquids removal
- High velocity flush
- Undersized Foam Pig
- Pathfinder foam bodied caliper tool

Undersized Foam Pig

- Dummy Pathfinder
- Sized at 98% of pipeline nominal ID ($\text{Ø}676\text{mm}$ vs $\text{Ø}690\text{mm}$)
- Provision for additional bypass not utilised.
- Medium density
- Minimal aggression
- Negotiate reductions up to 40% Pig OD
- Fitted with EM Transmitter
- Embedded Magnets for triggering magnetic signallers

Pathfinder Foam-Bodied Caliper Tool

- Foam Pig OD $\text{Ø}717\text{mm}$
- 12 x 50mm bypass holes added (6.3%)
- Fitted with EM Transmitter
- Embedded Magnets for triggering magnetic signallers

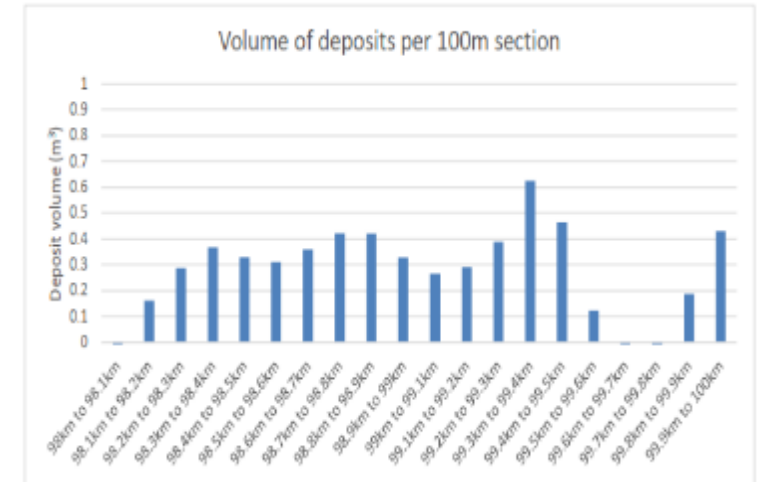
Phase One – Execution April 2023



Photos courtesy of Pipeline Innovations & Norske Shell

- Received at 08:38 on 21st April
- Average Velocity 3.42m/s
- No damage
- Minimal wear

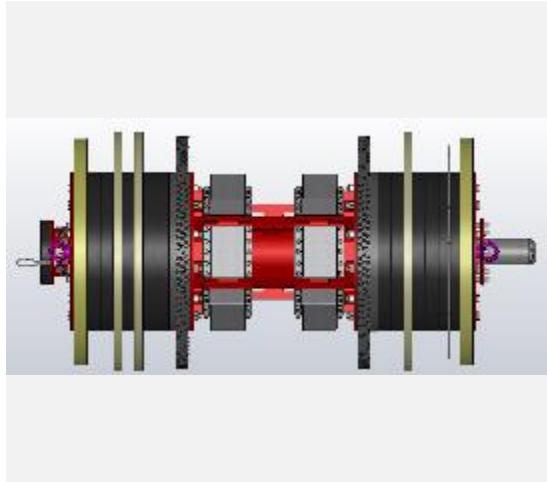
- Received at 11:58 on 23rd April
- Average Velocity 2.44m/s
- Superficial damage
- Minimal wear



- 100% data recovered
- Estimated deposits 56m³ between 50-123km
- Minimum bore consistent with known features in the pipeline
- Recommendation to switch pigging direction from A-B to B-A for phase 2 to minimise transfer distance for solids

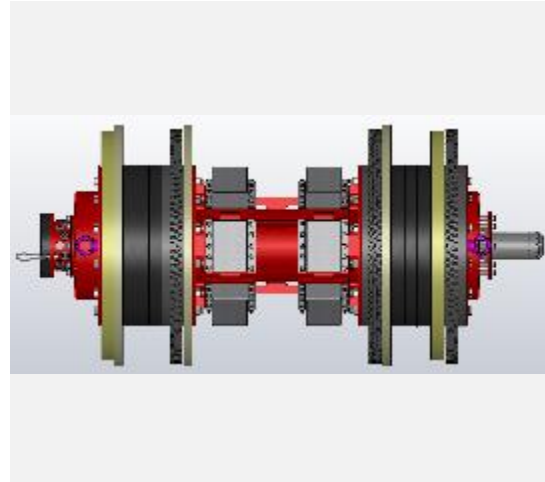
Note – Due to HSE the receiver was flushed with hot water after pig receipt

Phase Two



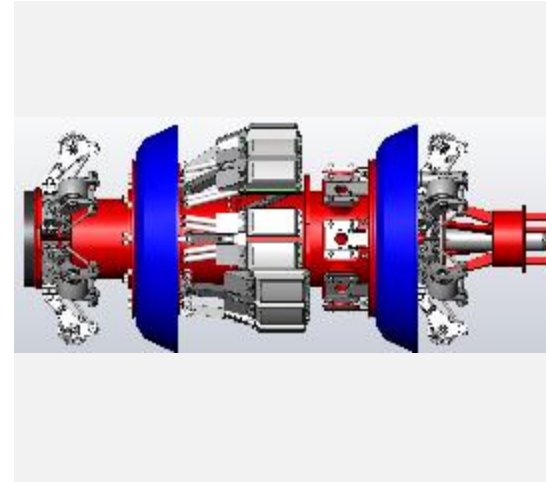
Gauge Pig

- Bi-directional setup
- Slotted gauge plate
- Double magnet packs
- High wear setup (brushes & guides)
- Bypass – 3.82%
- PDL recording DP, temperature, pressure, accelerometers XYZ, rotation and inclination
- Transmitter



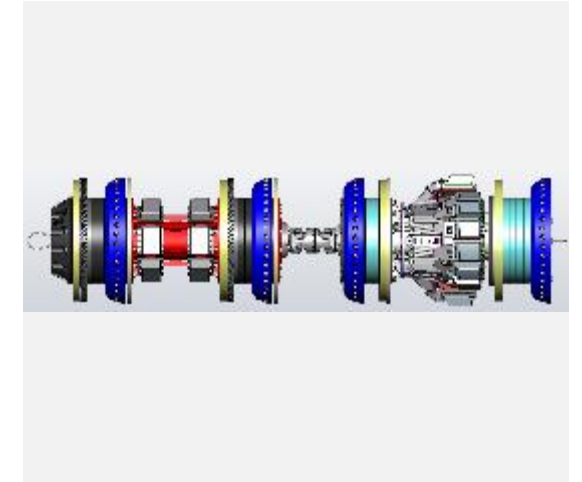
Images Courtesy of Rosen
Bulldozer

- Additional spare parts such as oversized guide discs allowed for customization
- Medium Aggression setup
- Bypass – 3.82%
- PDL
- Transmitter



Active Cleaning Tool (ACT)

- High bypass tool creates a vortex against the pipe wall. The evacuated mediums is then sucked through the tool and emitted as a high velocity jet of gas downstream of the pig at a simulated velocity of up to 30m/s at pig velocity of 3.5m/s.
- Bypass - 1.9%



Heavy Duty Cleaning Pig (HDCP)

- Bypass – 3.03%
- High Aggression setup
- Descaling cups
- Lamella brushes

Phase 2 – Execution September 2023

Maximum
Average
Minimum



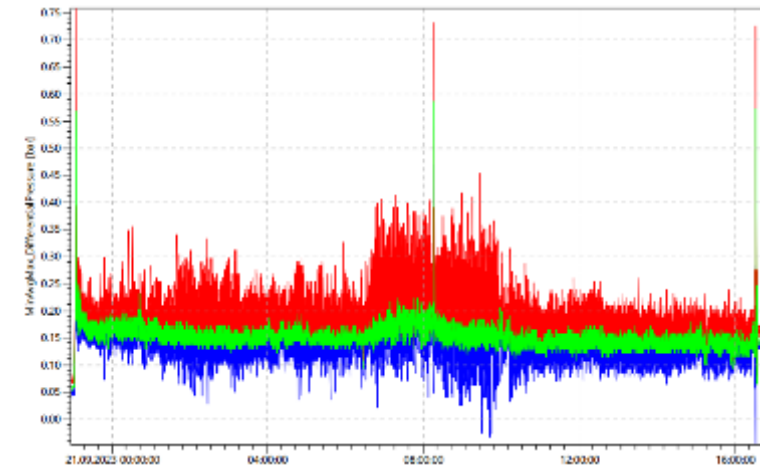
Photos & Images courtesy of Rosen & Norske Shell

Run 1

- Gauge Pig was received at 05:18 on 20th September
- Average Velocity 3.55m/s
- No Damage Minimal Wear
- No spikes in DP from the PDL

Run 3

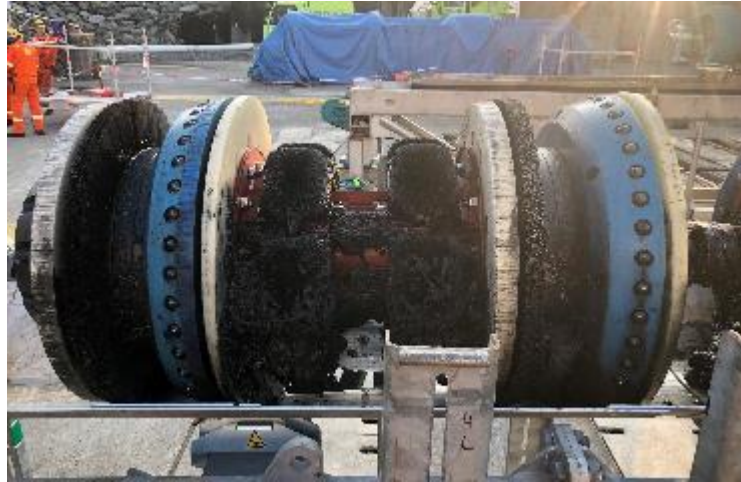
- Bulldozer Pig was received at 17:36 on 23rd September
- Average Velocity 3.78m/s
- No Damage Minimal Wear
- No spikes in DP from the PDL



Recorded DP Run 1 (top) and run 3 (bottom)

Note – Due to HSE the receiver was flushed with hot water after pig receipt

Phase 2 – Execution September 2023



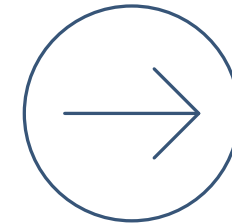
Photos courtesy of Rosen & Norske Shell

Run 4

- ACT was received at 14:49 on 24th September
- Average Velocity 3.55m/s
- No Damage Minimal Wear
- PDL - some evidence of moving debris

Run 5

- HDCP was received at 23:27 on 26th September
- Average Velocity 3.36m/s
- No Damage Minimal Wear
- Increase in ferrous debris



Decision to Proceed

Note – Due to HSE the receiver was flushed with hot water after pig receipt

Phase 2 – Execution September 2023



Run 6

Photos courtesy of Rosen & Norske Shell

- ACT was received at 15:35 on 28th September
- Average Velocity 3.51m/s
- No Damage Minimal Wear
- PDL - Some evidence of moving debris



Run 7

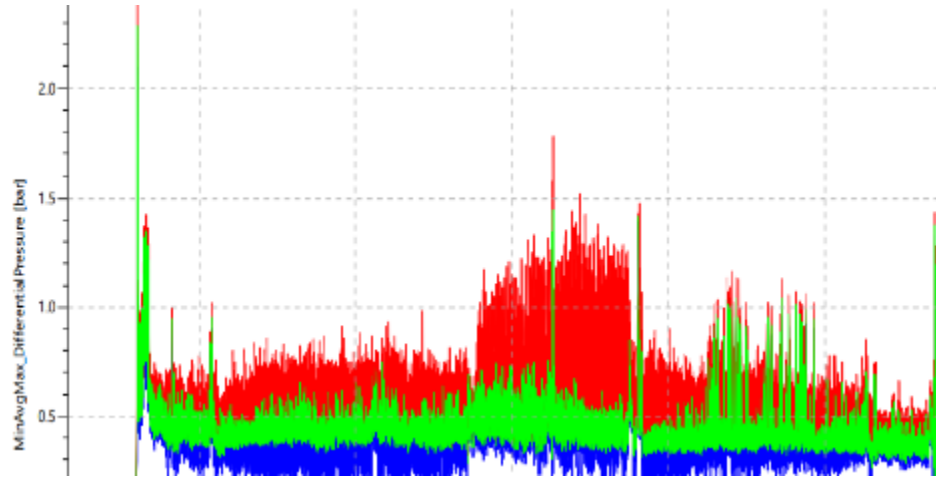
- HDCP was received at 23:27 on 26th September
- Average Velocity 3.36m/s
- No Damage Minimal Wear
- Increase in ferrous debris

Phase 2 Execution

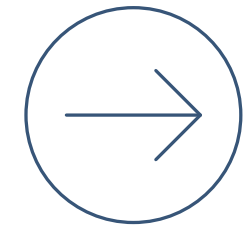
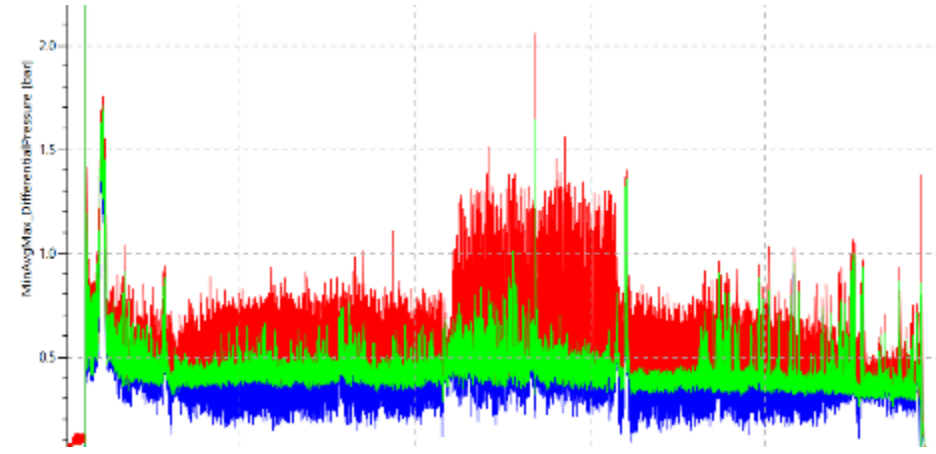
Decision to Proceed with MFL

- Maximum
- Average
- Minimum

ACT PDL Run 4



ACT PDL Run 6



Decision to Proceed

Phase 2 Execution ILI

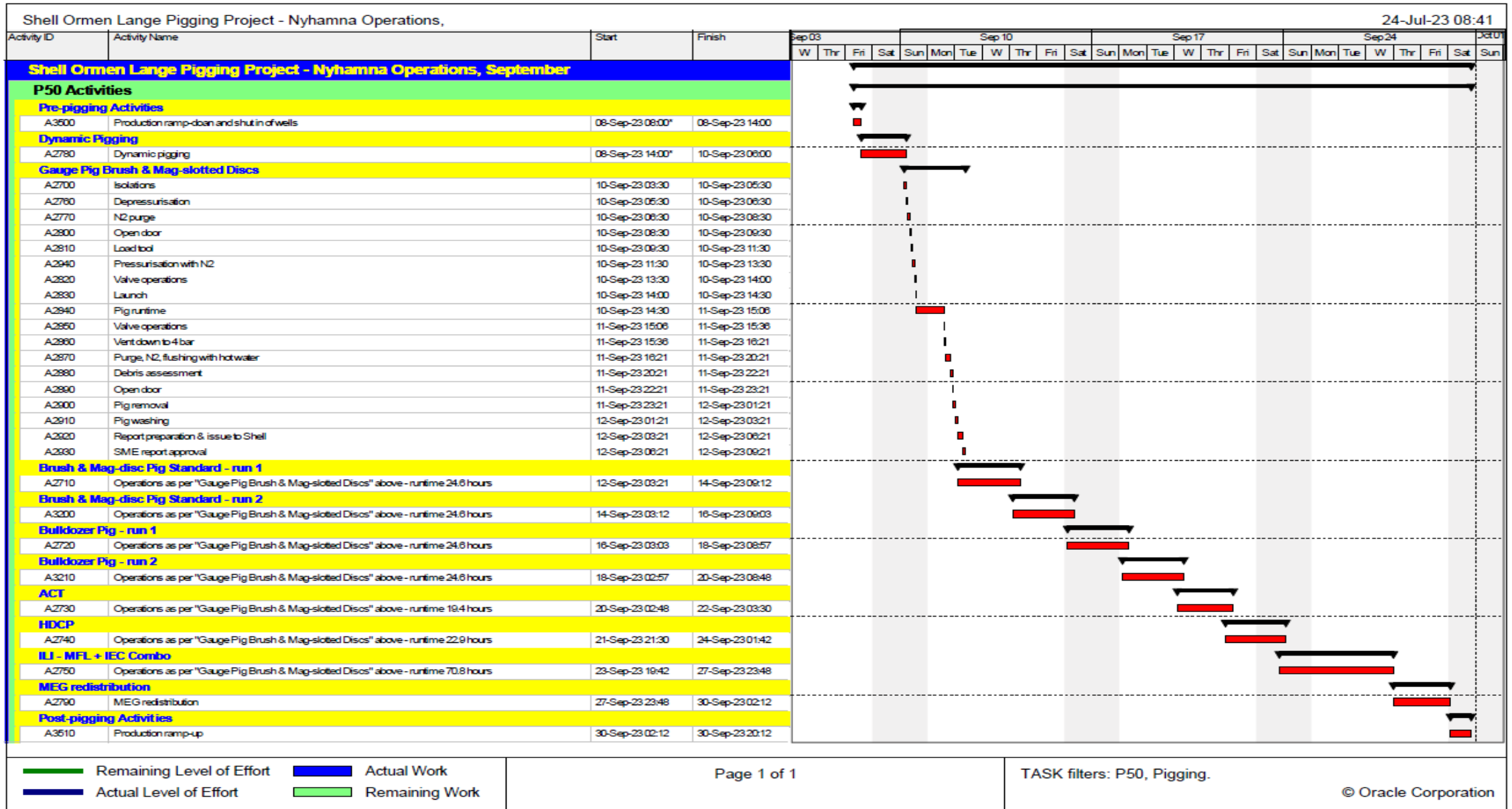


RoCorr MFL-A with IEC Sensor technology

MFL Received on October 1st 2023 at 13:19

Average Velocity 0.97m/s

Pre-inspection pigging and ILI schedule



Assurance Milestones

Assurance Activity	Status
Project Kick Off Meeting	Complete
Pigging Workshop	Complete
Dummy Pig Launch	Complete
HAZID	Complete
Piggability Review	Complete
HAZOP	Complete
Pigging on Paper with Nyhamna Ops	Complete
Stuck Pig Contingency Workshop	Complete
Pre-Execution Readiness Review	Complete
Vessel HIRA & Marine Assurance Review	Complete
DRB Go / No-Go for flushing and debris mapping pigging	Complete
DRB Go / No-Go for cleaning pigging and ILI	Complete

Key Challenges and Solutions

Challenges	Solutions selected
Significant volumes of liquid hold up	Flow modelling as input to decision to perform high velocity sweeping with export gas
Significant volumes of solids	Debris mapping pigging upfront of main pigging campaign. Use of high bypass (inc ACT), bypassing of pig receiver to send solids direct to slug catcher
Significant pipeline elevation profile changes in areas of Storegga slide	Flow modelling leading to setting minimum pressure during pigging operations to prevent pig velocity excursions
Pipeline not regularly pigged	Upfront checks of all equipment and procedures, briefing to operations personnel, pigging on paper exercise
High deferment during pigging operations	Optimised pig selection, application of best, mid and worse case number of pig runs, Contingency planning for stuck / stalled pigs upfront, equipment checks, pigging on paper exercise
High stakeholder interest	Rigorous project management, regular stakeholder updates, development of key milestones, decision points, readiness challenge sessions

Summary

- The challenges associated with conducting pigging operations on this pipeline system were overcome through a rigorous and collaborative approach by relevant parties
- The successful completion of the inspection provided Shell with assurance that the primary threat to the pipeline system of internal corrosion was being well managed.
- The ILI results allowed Shell to confidently update the integrity assessment of the pipeline, (taking account of other relevant data as well such as ongoing subsea external inspection campaigns, testing of the safeguarding systems etc) and concluding it was suitable for safe continued operation.
- The ILI results provided Shell and stakeholders with the confidence to proceed with future development plans, such as a subsea compression project for Ormen Lange.
- Demonstrating degradation mechanisms such as corrosion are being well managed is a key element in extending the service life of a pipeline and supporting decision making on further investment.

Acknowledgement

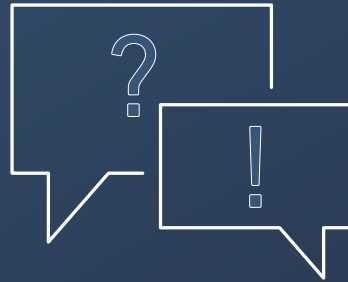
- Thanks to the Ormen Lange partners for allowing us to present this at PPSA 2024

ORMEN LANGE PARTNERS:



Operator

Thank you for listening



Thank you for listening

