# Ormen Lange Pipeline Inspection

# A Climb to Success

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### **Ormen Lange Partners:**



Operator





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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 1100 m subsea
- Wall thicknesses ranging from 29.5 to 35.5 mm
- 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**



### **Flow Assurance Modelling**



Flowrate / Schedule Optimization

Hydrate Mitigation

Pig Bypass Efficiency Liquids Management

**Pig Behavior** 

### **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 (Ø676mm vs Ø690mm)
- · Provision for additional bypass not utilized
- Medium density
- Minimal aggression
- Negotiate reductions up to 40% Pig OD
- Fitted with EM Transmitter
- Embedded Magnets for triggering magnetic signalers
  Photos courtesy of Pipeline Innovations & Norske Shell

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#### Pathfinder Foam-Bodied Caliper Tool

- Foam Pig OD Ø717mm
- 12 x 50mm bypass holes added (6.3%)
- Fitted with EM Transmitter
- Embedded Magnets for triggering magnetic signalers



## Phase One Execution April 2023



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

Photos courtesy of Pipeline Innovations & Norske Shell

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

Volume of deposits per 100m section

- 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 minimize transfer distance for solids

### **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

Photos 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

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## Phase Two Execution September 2023







#### 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

Photos & Images courtesy of Rosen & Norske Shell

#### 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



## Phase Two Execution September 2023





**Decision to Proceed** 

#### 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

Photos courtesy of Rosen & Norske Shell Note – Due to HSE the receiver was flushed with hot water after pig receipt

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#### Run 5

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

### Phase Two Execution September 2023



### Run 6

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

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### Run 7

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

Photos courtesy of Rosen & Norske Shell

## Phase Two Execution Decision to Proceed with MFL



Maximum Average Minimum

Photos courtesy of Rosen & Shell

# Phase Two Execution

# RoCorr MFL-A with IEC Sensor technology

- MFL Received on October 1st 2023 at 13:19
- Average Velocity 0.97m/s



Photos courtesy of Rosen & Norske Shell

# **Pre-Inspection Pigging and ILI Schedule**

Shell Ormen Lange Pigging Project - Nyhamna Operations, 24-Jul-23 08:41																
Activity ID	Activity Name	Start	Finish	Sep 03		Sep	10			S	ep 17			Sep:	24	Det
				W Thr Fri Sat	Sun	Mon Tue V	V Thr Fri	Sat S	Sun Mo	n Tue	W Thr	Fri Sa	t Sun Mo	n Tue W	Thr Fri	i Sat Sur
Shell Orm	en Lange Pigging Project - Nyhamna Operations, September															-
												_				
P50 Activi	tes															
Pre-pigging	Activities															
A3500	Production ramp-doan and shut in of wells	08-Sep-23.08:00*	08-Sep-2314:00	•												
Dynamic Pig	igging the second se															
A2780	Dynamic pigging	08-Sep-23 14:00*	10-Sep-2306:00													
Gauge Pig I	Brush & Mag-slotted Discs				-											
A2700	Isolations	10-Sep-23.03:30	10-Sep-2305:30		•											
A2760	Depressurisation	10-Sep-23.05:30	10-Sep-2308:30		1											
A2770	N2purge	10-Sep-2308:30	10-Sep-2308:30													
A2800	Opendoor	10-Sep-2308:30	10-Sep-2309:30													
A2810	losibol	10-Sep-23.09:30	10-Sep-2311:30		i.											
A2040	Process relation with N2	10-Sep-23 11:30	10-Sep-23.13:30		÷.											
A 2820	Value operations	10 Sep 22 12:20	10-Sep 22 14:00		- î.											
A2820	La mah	10 Sep 22 14:00	10 Sep 22 14:20		÷.											
42050	Disa since	10.040-2014:00	10-Sep-23 14:50													
A2340	Figruname	10-Sep-23 14:30	11-Sep-23 15:00													
A2800	vave operations	11-Sep-231000	11-Sep-23 10:30													
A2960	Vent down to 4 bar	11-Sep-23 15:36	11-Sep-231021			<u> </u>										
A2870	Purge, N2, flushing with hot water	11-Sep-231621	11-Sep-23 20:21													
A2980	Debris assessment	11-Sep-232021	11-Sep-232221													
A2990	Open door	11-Sep-232221	11-Sep-23/23:21			I										
A2900	Pigremoval	11-Sep-232321	12-Sep-2301:21													
A2910	Pigwashing	12-Sep-2301:21	12-Sep-230321	-												
A2920	Report preparation & issue to Shell	12-Sep-230321	12-Sep-230621	-												
A2930	SME report approval	12-Sep-230821	12-Sep-230921													
Brush & Ma	o-disc Pio Standard - run 1															
A2710	Operations as per "Gauge Pig Brush & Mag-slotted Discs" above - runtime 24.6 hours	12-Sep-230321	14-Sep-2309:12													
Brush & Ma	o-disc Pio Standard - nm 2						-									
A3200	Operations as per "Gauge Pig Brush & Mag-slotted Discs" above - nutrime 24.6 hours	14-Sep-2303:12	16-Sep-230903													
Buildozer D	in and		10 0 0 20 20 20 20 20 20 20 20 20 20 20 2					-	_							
A2720	Orenations as ner "Ga ne Pin Brish & Maruslated Discs" abrue - nintime 24 6 hours	16-Sep-23/03/03	18-Sep-230857	+												·
Dulldorer D	operational per oranger ignorant magnotations above na inner short and	1004220000	10-049-20-00.07						_		-					
A2210	Querrations on analifications Dia Datable 2 Marcalational Discontrations on a stress 24.8 https://www.	10.0 20.00/7	20.0	-												
A3210	Operations as per roauge Mig Brush & Mag-slotted Discs" above - runtime 24.0 hours	10-Sep-23025/	20-Sep-230848													
ACI												-				
A2730	Operations as per "Gauge Pig Brush & Mag-slotted Discs" above - runtime 19.4 hours	20-Sep-2302:48	22-Sep-2303:30													
HDCP																
A2740	Operations as per "Gauge Pig Brush & Mag-slotted Discs" above - runtime 22.9 hours	21-Sep-2321:30	24-Sep-2301:42													
ILI - MFL +	IEC Combo												*		•	
A2750	Operations as per "Gauge Pig Brush & Mag-slotted Discs" above - runtime 70.8 hours	23-Sep-23 19:42	27-Sep-2323:48													
MEG redist	ibution														*	
A2790	MEG redistribution	27-Sep-23/23:48	30-Sep-230212													
Post-piggin	g Activities															-
A3510	Production ramp-up	30-Sep-2302:12	30-Sep-2320:12													
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	annaisian I aval of Effort Astual Work								-							
R	emaining Level of Effort Actual Work		Page 1 of	1			TASK	(filters	s: P5(	0, Pigg	ging.					
A	Actual Level of Effort  Corporation  Corporation															
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### **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 though 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