

AIFA

An Alternative Flow Assurance Philosophy for a Gas Condensate Asset

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AlFA – An Alternative Flow Assurance Philosophy

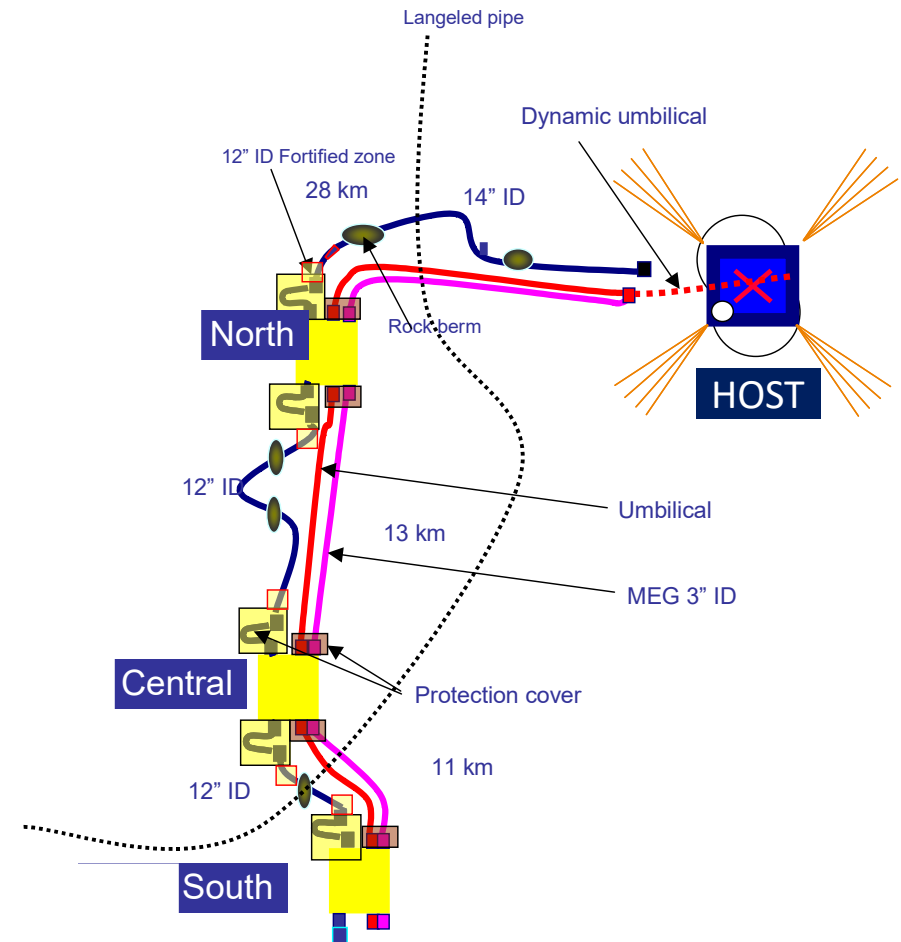
Agenda

- Introduction to the Field and its Challenges
- AlFA project
 - Potential solution identification
 - Technology qualification
- Flow Assurance work to plan and prove subsea qualification
 - Simulations pre-test
 - Simulation post-test
- Way forward

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General Overview of the Field

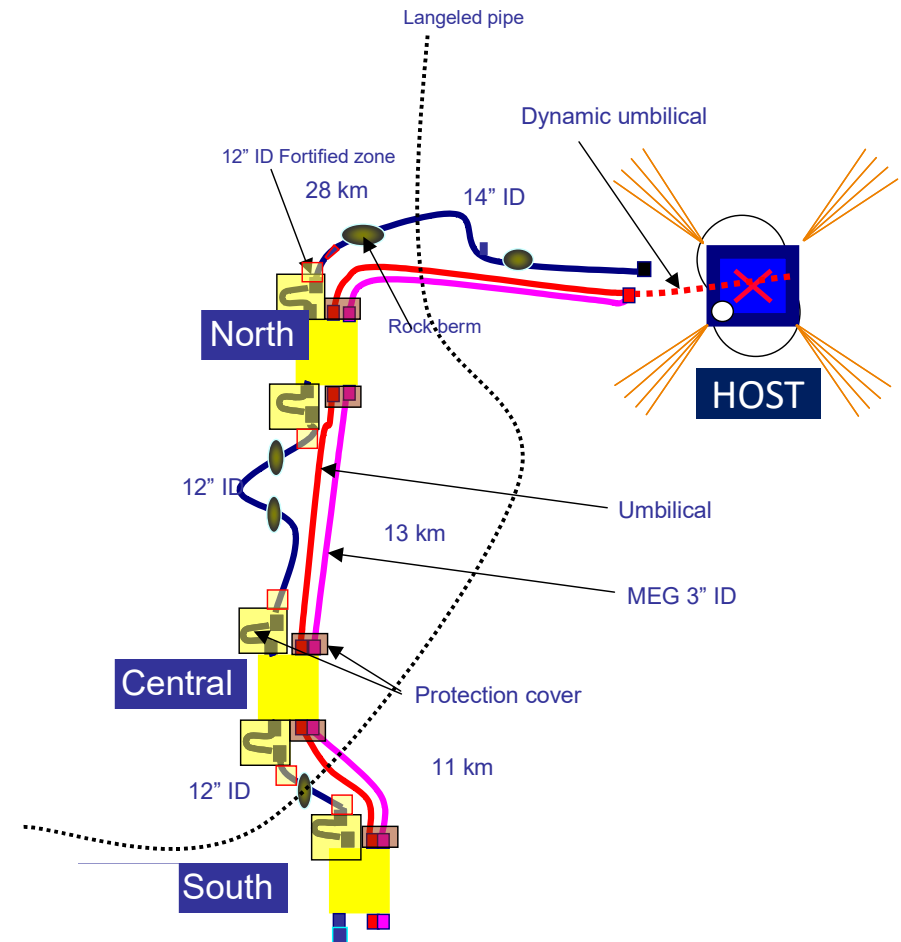
- Subsea gas condensate asset
- 375 m water depth
- Three templates:
 - South, 3 wells
 - Central, 3 wells
 - North, 2 wells
- Daisy chained on a long subsea pipeline (52 km)
- Originally high temperature, high pressure
- Produced by depletion



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Current hydrate management strategy

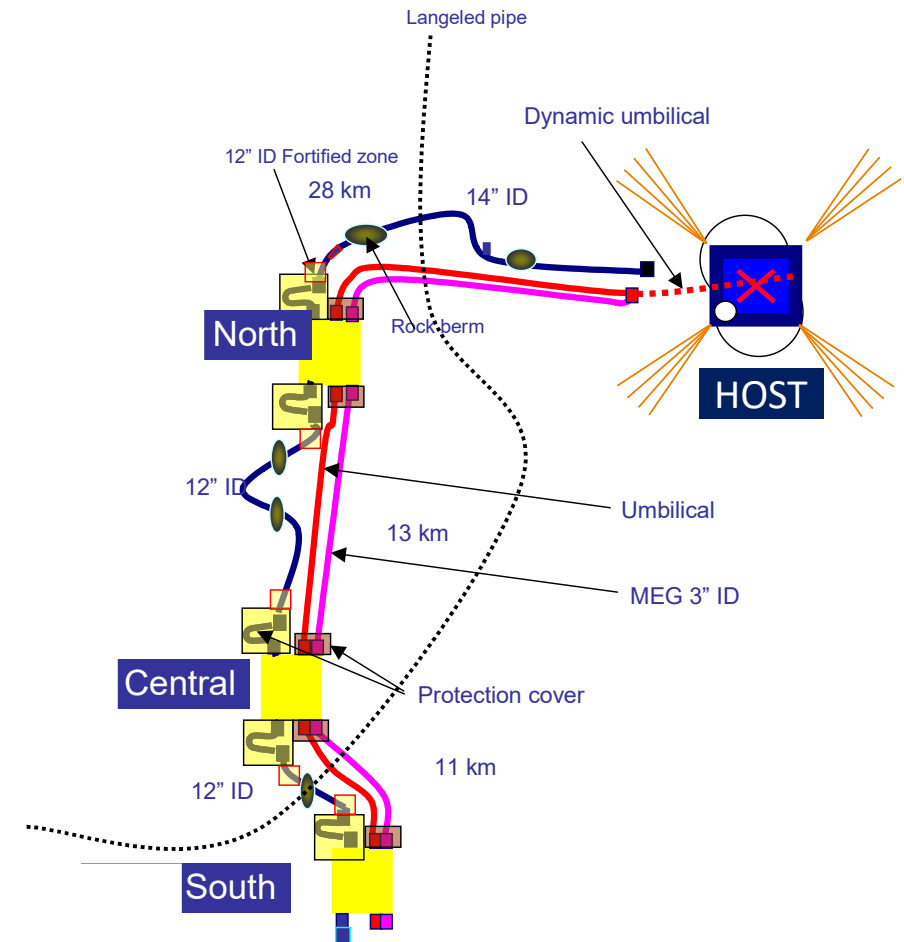
- Continuous MEG injection to the templates
- MEG cocktail:
 - Hydrate prevention via MEG (goal 50% in rich MEG due to reclamation)
 - Corrosion prevention via MEG, pH stabilization, and corrosion inhibitor
 - Scale prevention via scale inhibitor
- MEG reclamation on topside host facility
 - Design capacity about 220 Sm³ rich MEG per day
 - Design capacity about 10 Sm³ saline formation water per day



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The Challenge

- Increasing rates of saline formation water being produced
 - Volume of salt from this water cannot be handled by MEG reclamation unit
 - Production from formation water producing wells need to be optimized (choking, work-over etc)
- Result: Lower Ultimate Recovery
- Challenge: Identify a feasible concept for flow assurance, integrity, and water management without continuous MEG injection



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Potential solution

- Anti Agglomerant products
 - Hydrates are allowed to form
 - Hydrate particles are dispersed into the liquid hydrocarbon phase
 - Application concentration about 2-4% (volume on water)
 - Up to now, no commercial product on NCS



for comparison without AA



with AA 1 hr after starting rocking motor

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AA Laboratory Tests for Technology Qualification

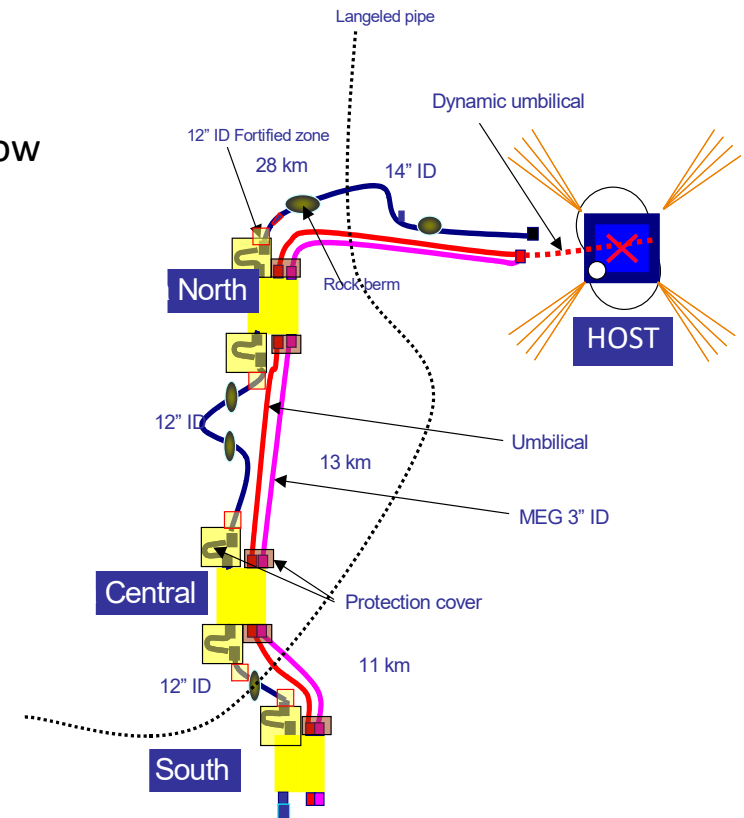
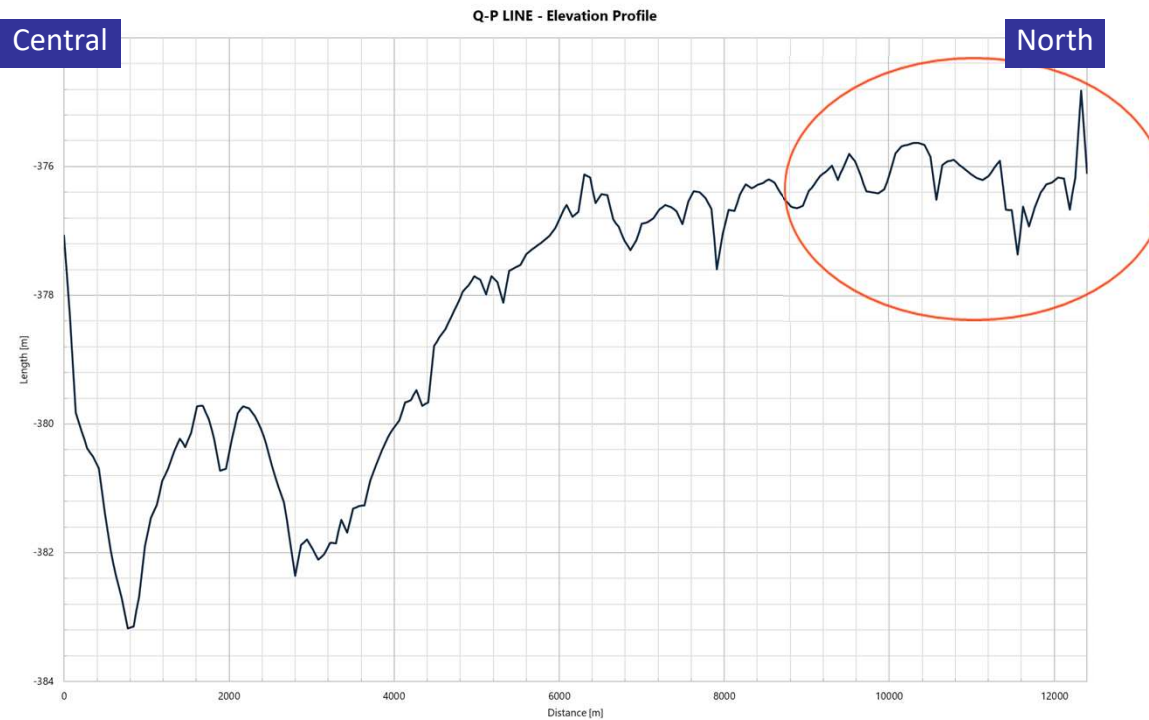
- Environment
- Functionality
 - Rocking cells, Autoclaves; Wheel tests; Viscosity Testing
 - General good performance for product
 - Up to significant subcooling (14 K), dependency on salinity level (minimum effective dosage)
 - Some salt in the system helps significantly
- Separation, partitioning
 - No major impact on separation in lab testing
 - Partitioning mainly into liquid hydrocarbon phase
- Subsea
 - Depflux testing

Readiness Level	Definitions for AA LDHI Strategy Readiness	
	TRL Technology Development	ERL Engineering Activities
0 Unproven Concept	Preliminary analysis shows promising AA performance and process potential.	Concept is scientifically sound but has little or no track-record in the industry.
1 Proven Concept	Lab testing or field experience shows that NCS performance requirements can be achieved.	Concept has received support from industry as a valid solution.
2 Validated Concept	Lab testing is conducted with industry methods for a small number of operating conditions, using field fluids and selected AA chemical; OR, extensive industry experience has been documented and validation of lab testing (limited) and gap analysis indicates that chemical qualification will be possible with further testing, analysis or research.	Concept has been validated extensively using a prototype system or lab test. Successful testing has been performed with a similar system and at similar operating conditions, but not using specific field fluids or chemicals. Industry standard analysis methods* exist.
3 Prototype Tested	Lab testing has assessed a wide range of operating conditions. Where lab testing is impractical, qualification is achieved by a combination of literature review, expert view and case study experience. HSEQ rating meets regional standards.	Actual system has been qualified using lab testing or industry standard analysis methods* for a full range of operating conditions with the field fluids.
4 Environment Tested	Lab testing has assessed the full operating envelope. Chemical properties during integration test have benchmarked well against lab performance and HSEQ measurements.	Actual system has been tested in the field for the full range of operating conditions.
5 System Tested	Successful implementation of AA strategy for hydrate mitigation. Processes / Procedures / Strategies are in place and routinely used in offshore operations. No performance, HSEQ or export issues reported but limited experience with challenging operating conditions (e.g. limited extended shutdowns).	Actual system is used in the field. Processes / Procedures / Strategies are in place and routinely used in offshore operations. Inspection programme is in place and integrity / reliability are routinely monitored.
6 System Installed	Extensive field experience including several prolonged shutdown/start-up operations. Chemical performance is well aligned with lab predictions. No performance, HSEQ or export issues reported.	Extensive field experience. System performance meets expected requirements. No HSEQ, integrity or reliability issues identified.
7 Field Proven	* DNV GL RP A203 (s9.2) lists that acceptable analytical methods include handbook solutions, methods from existing standards, empirical correlations, mathematical formulas, process simulation models, CFD, FEM, corrosion models, experiments, engineering judgement (documented). This is not an exhaustive list.	

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Plan the subsea qualification

- Identification of pipeline branch: flowline between Central (Q) and North (P)
- Identification of available injection point for water and AA
- Simulation run utilising CSM proprietary Hydrate kinetics model to identify low points where to expect hydrate plugging without AA injection

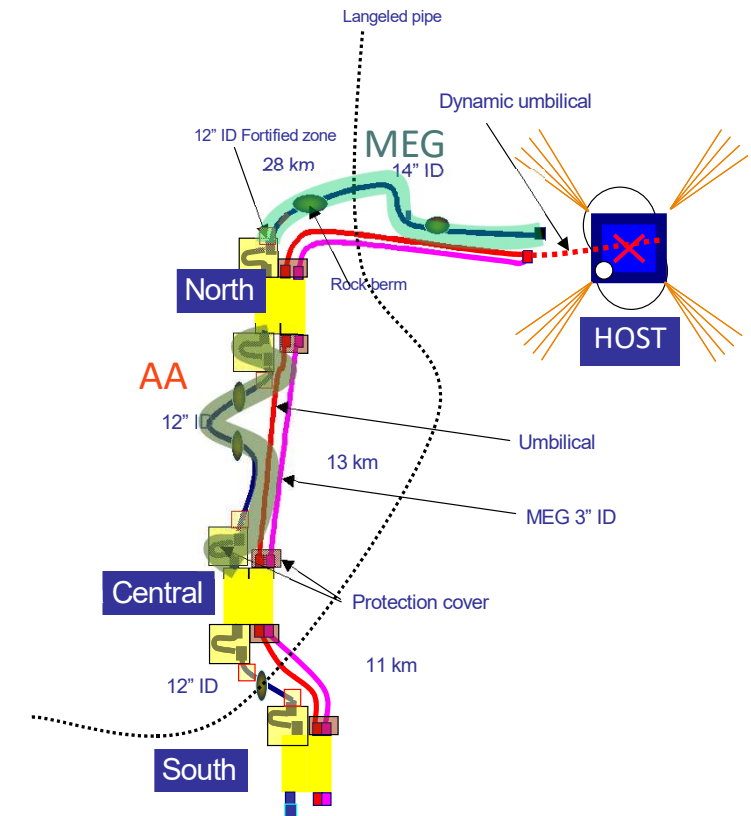
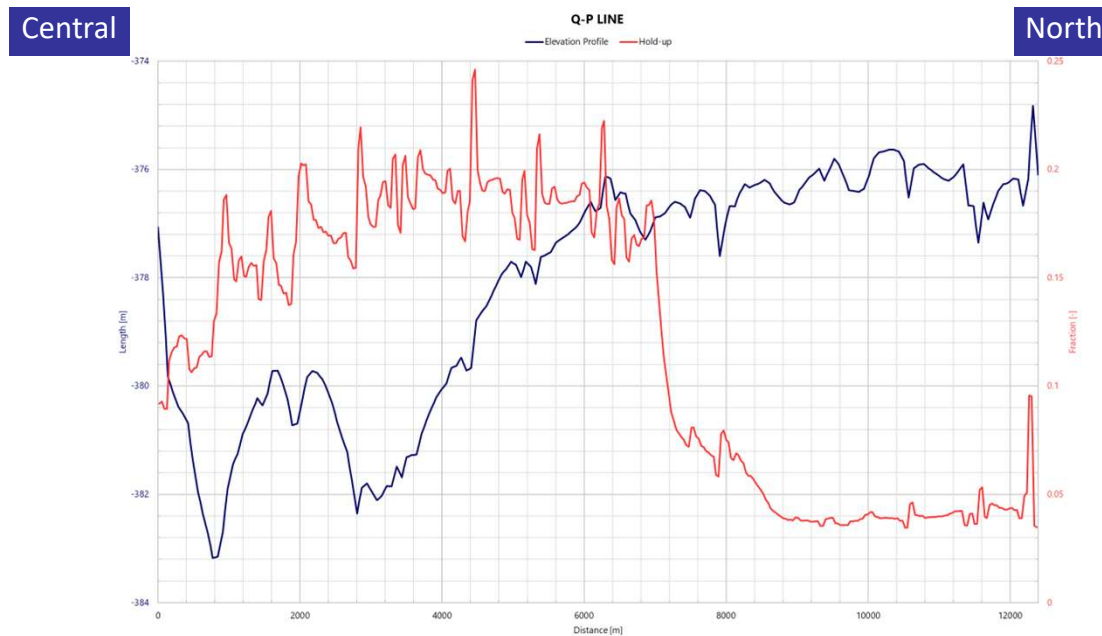


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Flow Assurance simulations to identify operational procedure

■ Program

- Step 1: Steady state production from Central (Q) for 24 hours
- Step 2: Stop MEG injection at Central (Q) while maintaining stable production, and start injection of water package to achieve water loading of Central (Q) to North (P) flowline
 - 70 m³ of KCl water with AA to the flowline through the downline of the vessel

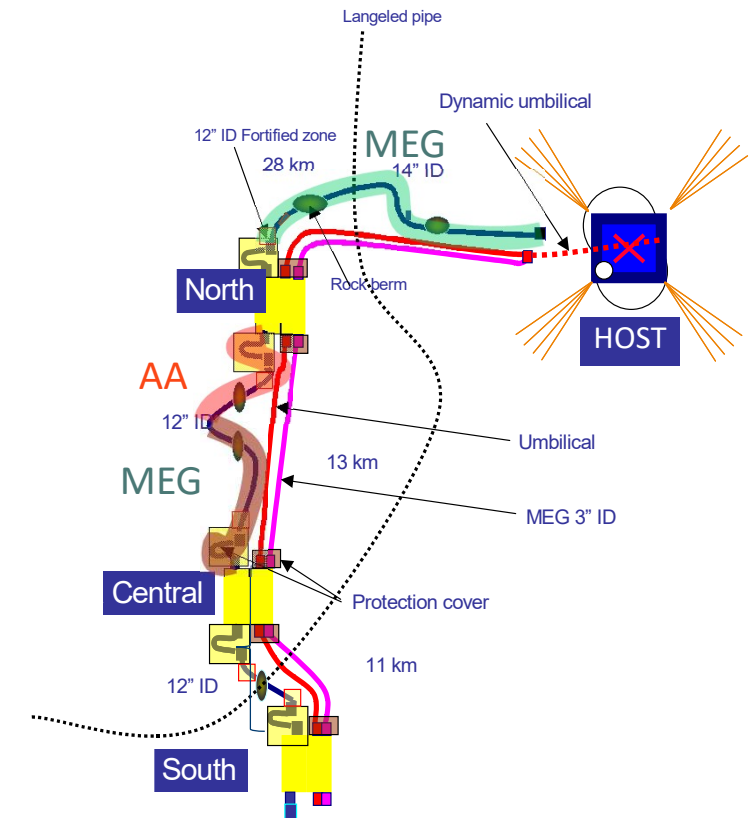
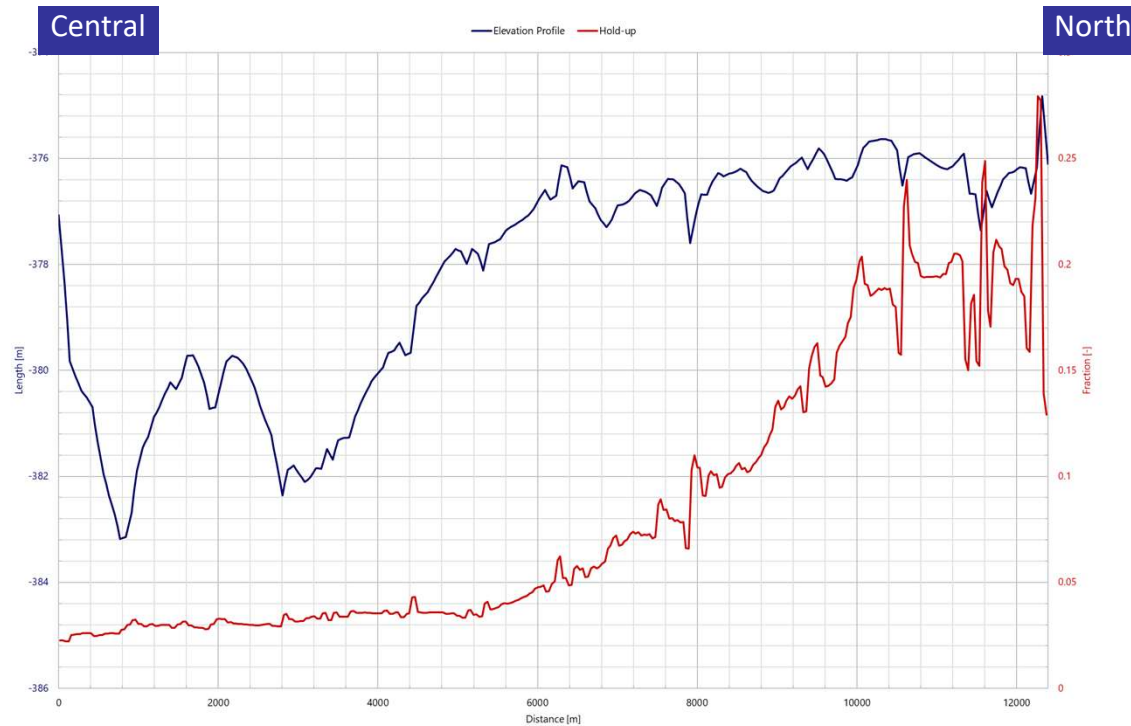


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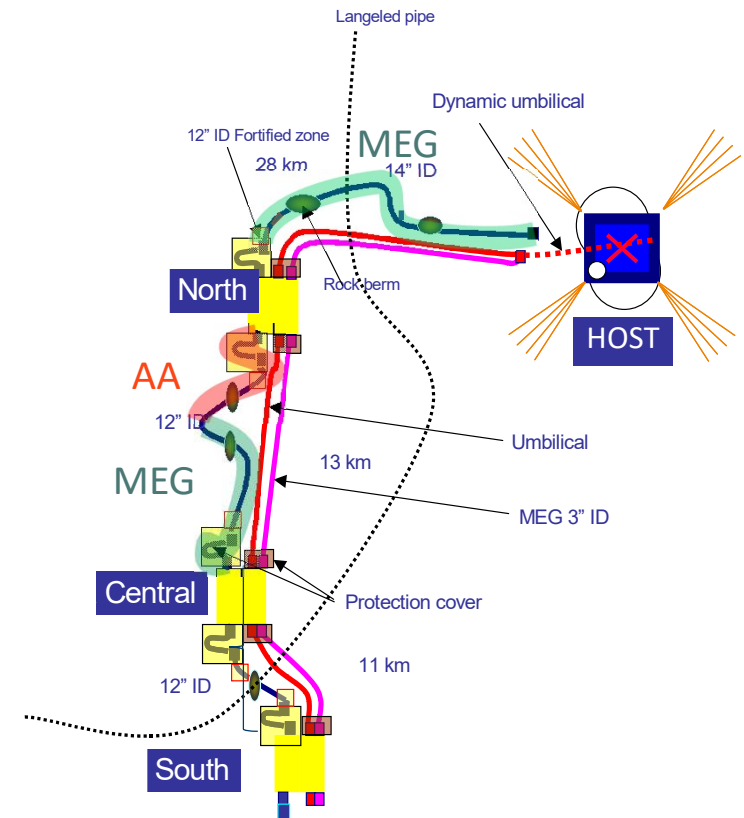
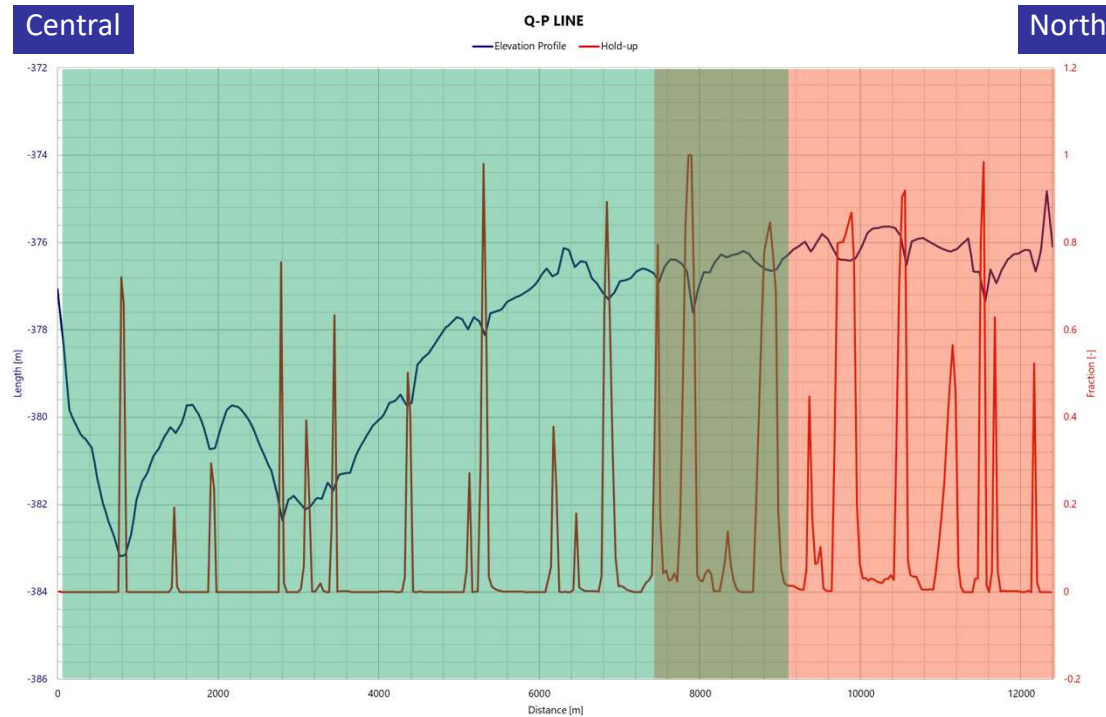
- Step 3: Displace the water package with production while restarting MEG injection



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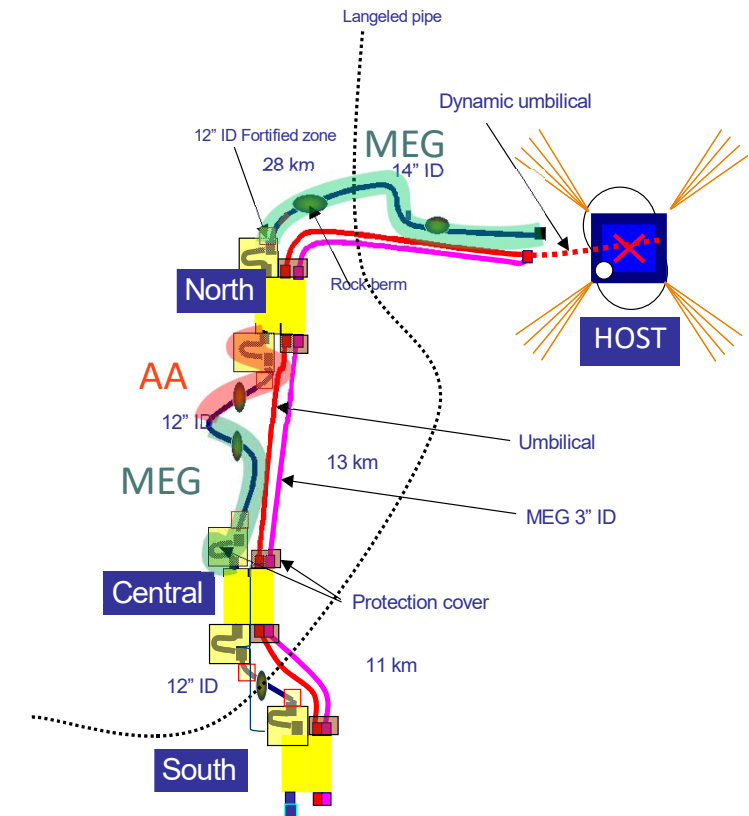
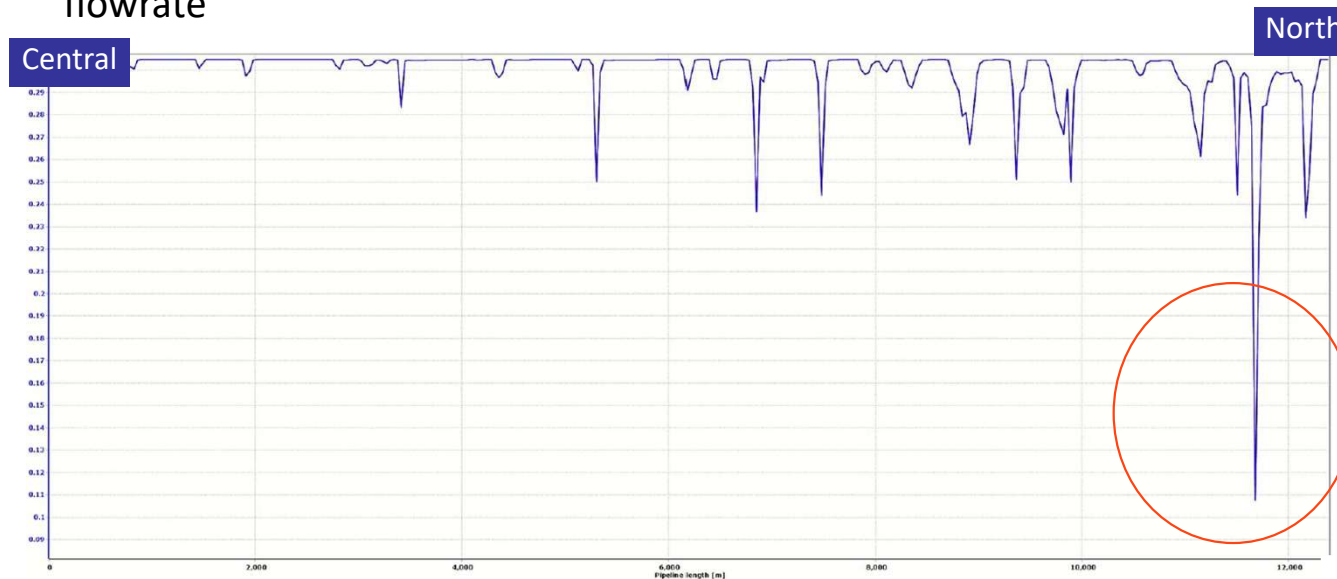
- Program
 - Step 4: Shut-in for 32 hours



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Flow Assurance simulations to identify operational procedure

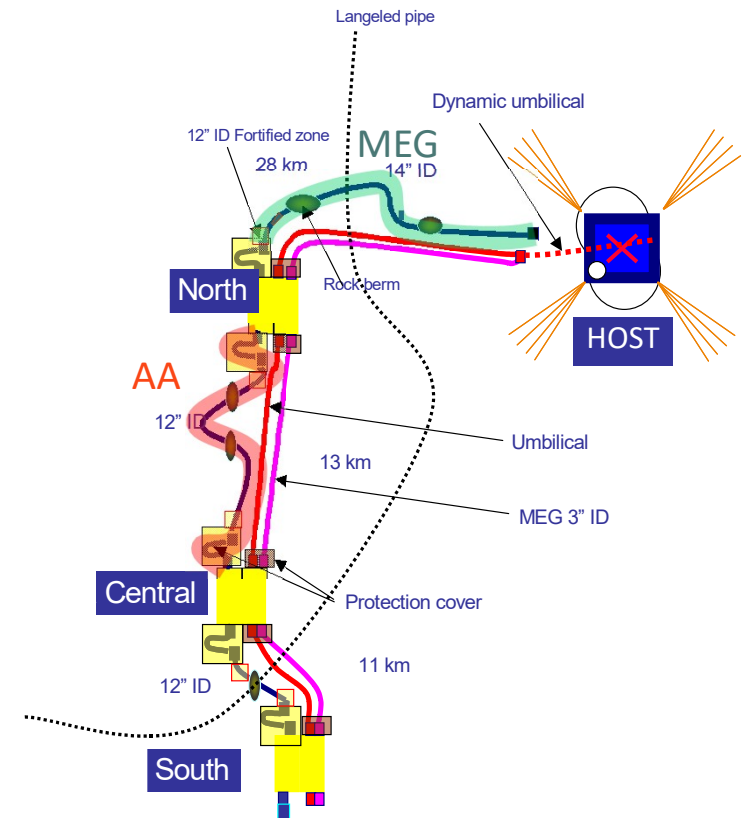
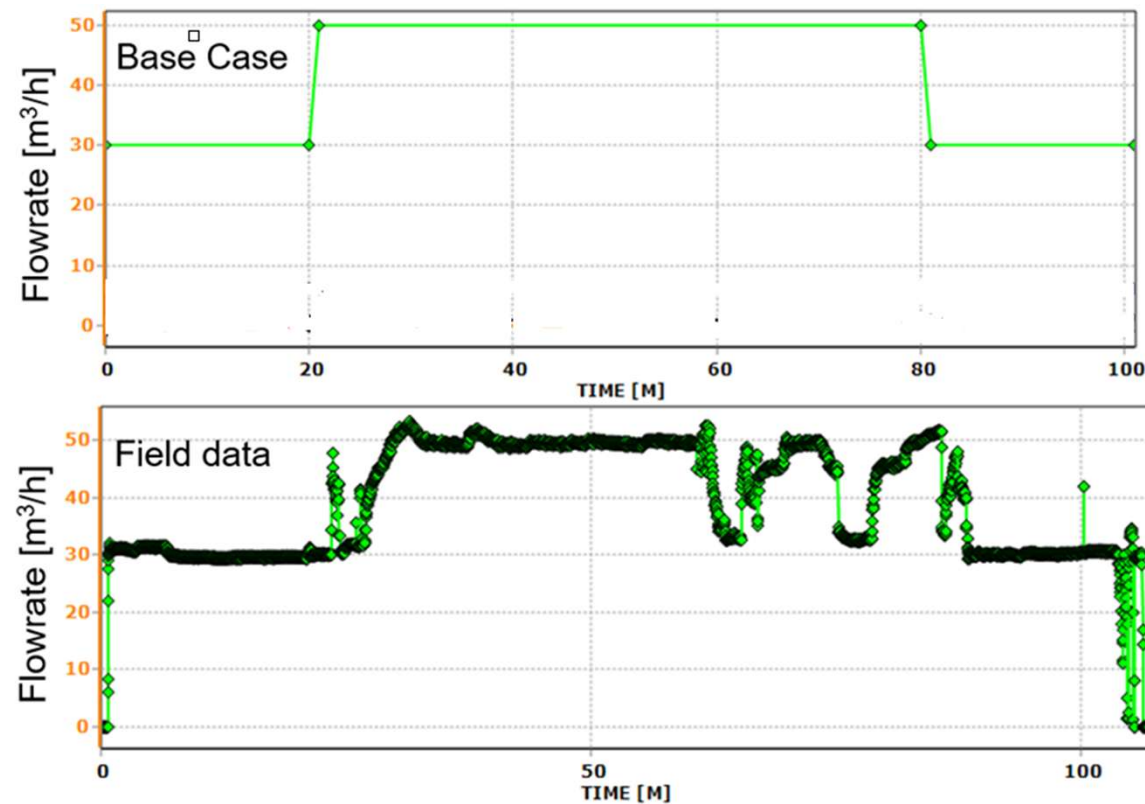
- Shut-in for 32 hours – simulation without AA shows reduction of effective diameter at 11.7 km length
- Step 5: Start-up one of the wells at Central (Q) and reach a stabilized flowrate



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Test days

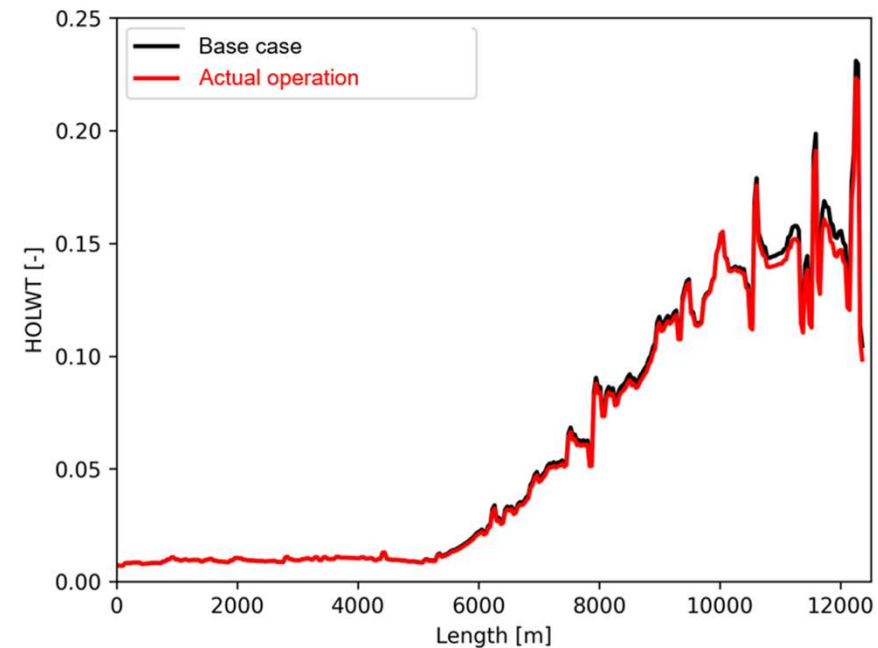
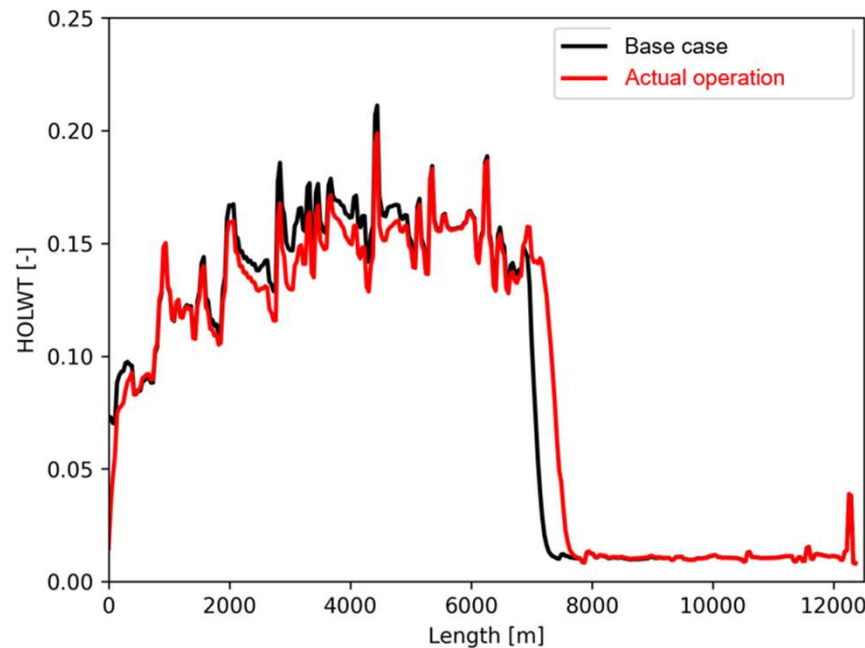
- Discrepancy between simulation and real-life operation
 - Issues with the pumping system



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Test days

- Restarted without issues. Did we achieve the water loading as planned?
 - Simulation showed similar water hold-up.
 - CSM Hydrate Kinetic model showed a dP of 5 bar between Central (Q) and North (P), when parameters were tuned to simulate no AA presence.



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Subsea Technology qualification

- According to Colorado School of Mines:
 - A plug was expected according to the simulations for the given pumping schedule
 - The fact that no plug formed during the operations shows that the AA was effective as planned
- Review by Third Party Contractor
 - AA works fine based on laboratory tests
 - “Results from the field trial indicate successful performance with no sign of plugging”. The “AA performed as expected and is suitable for deployment as a” life of “field solution in operational environments”
 - TRL 5 / early stage TRL 6
- According to internal review (FA, PC, PE), CSM, and Third Party, the technology was successfully qualified subsea
- According to vendor, another E&P company has concluded a successful field trial by now

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Further actions since and Way forward

Further action since...

- Topside test to check on separation and partitioning
 - Squirt test on host platform
 - No major impact on separation during short time injection of three different concentrations
 - OiW and WiO within specification
 - Samples for partitioning taken: 95+% active in liquid hydrocarbon phase
- Discussions with relevant stakeholders started
 - Environmental
 - Export side

Way forward

- AlFA is now officially a project in Harbour Energy
- The project recently went through DG1
- Work in synergy with Host to plan a pilot production in 2027

Contact details

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