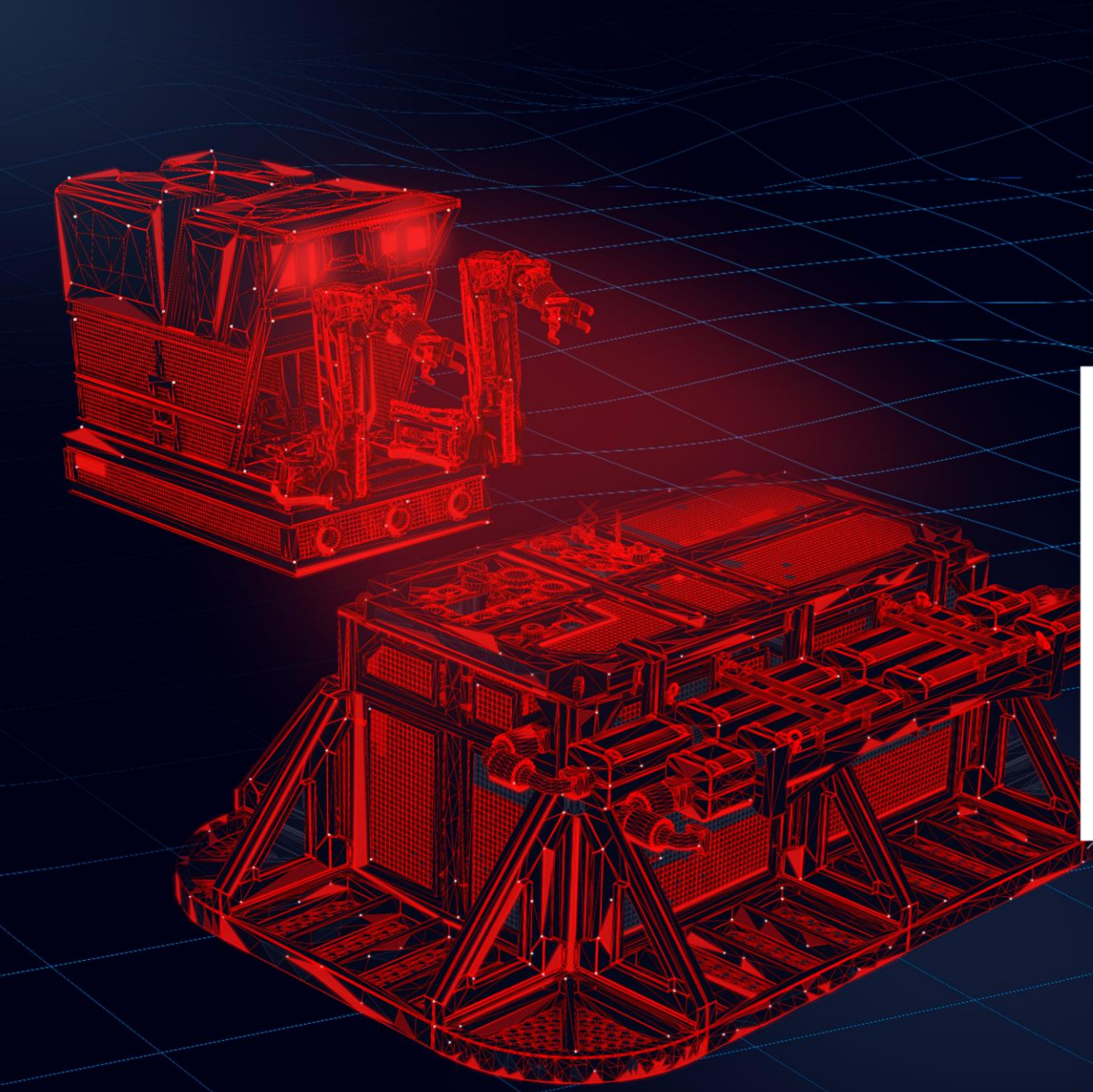


Subsea chemical storage and pumping in support of 42” pipeline cleaning and inline inspection

Iain Shepherd

HALLIBURTON

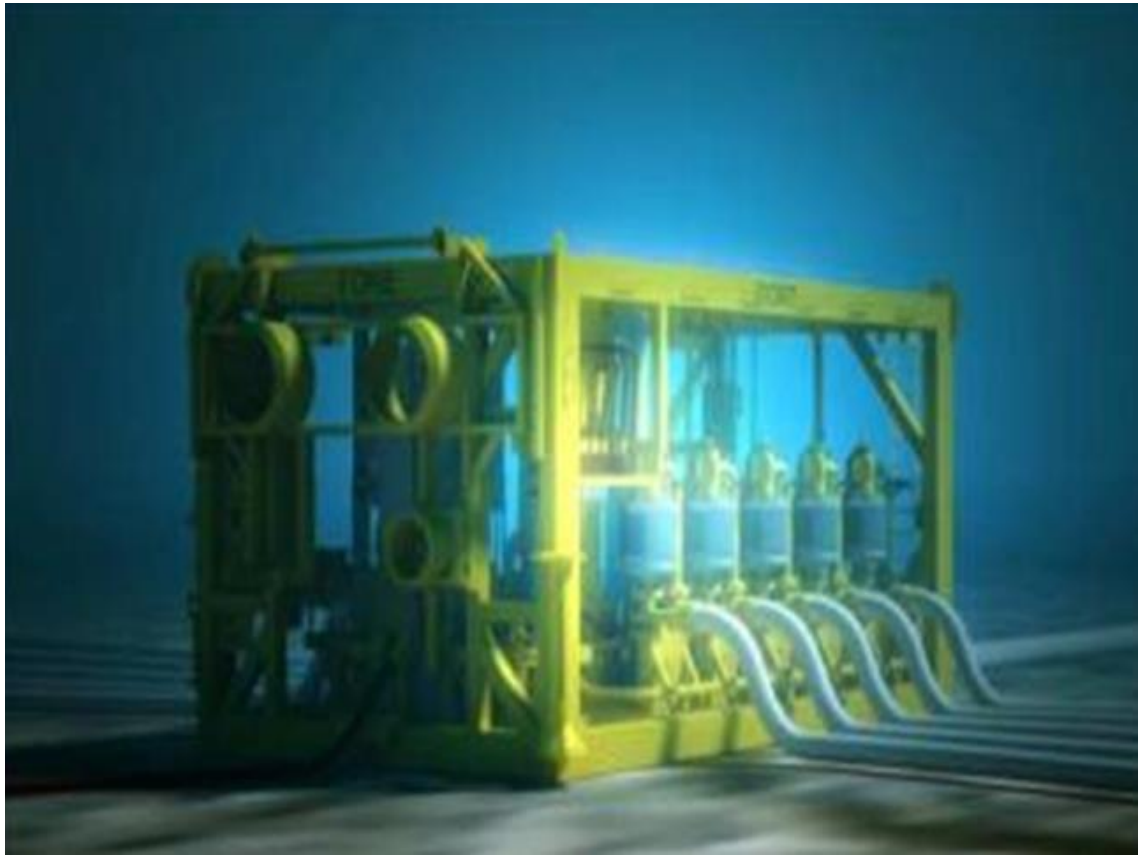
Introduction

- Client required a subsea chemical storage & pumping system for Try-ethylene Glycol (TEG)
- Deployed from a Subsea Support Vessel
- To support an ILI operation on a 42” gas pipeline.
- A temporary 42” PLR with preloaded cleaning pig and ILI tool deployed subsea
- Location, offshore Northern Australia
- Our scope was in support of PLR installation, testing, pig launch and reinstatement

HALLIBURTON

Introduction (Continued)

- Chemical Storage and Pump System was required to:
  - Displace seawater from temporary PLR with TEG prior to launch
  - Leak test and barrier test PLR prior to launch
  - Purge hydrocarbon gas from the PLR post launch with TEG
  - Total quantity of TEG required: approx. 95,000 litres



Customer Challenge

The project posed many challenges:

- Remote location: Northwest Australia
- Size, weight and complexity of PLR
- Stringent local regulatory requirements
- Risk due to huge gas inventory of pipeline
- Relatively deep-water diver-less operations
- Short lead time for initial mobilisation
- Large quantity of TEG to be stored and pumped
- Equipment availability / lead time

Project Methodology

- Initial question: why a subsea chemical system?
- Decision made to eliminate risk of using a downline
- Downline from vessel to PLR gave concerns:
  - Hydrocarbon gas flow-back via downline
  - Consequences of vessel run-off
  - Downline connection/disconnection
  - Damage if downline not disconnected
  - Gas plume: if vessel still connected
  - Huge inventory of gas in pipeline
- Subsea chemical storage and pumping reduced or eliminated risks, gave easier regulatory approval
- Commitment made to the regulatory authorities couldn't be changed without causing delay

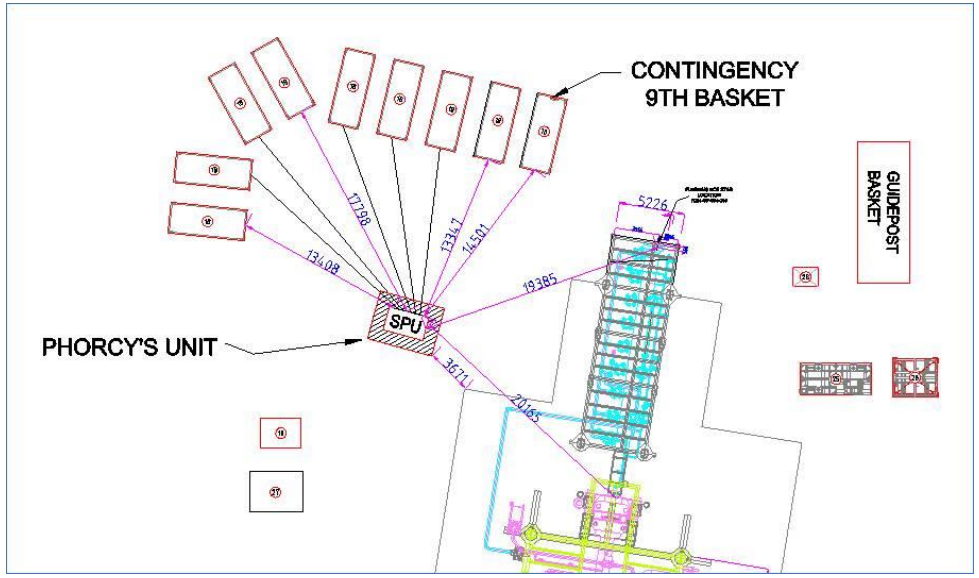
HALLIBURTON

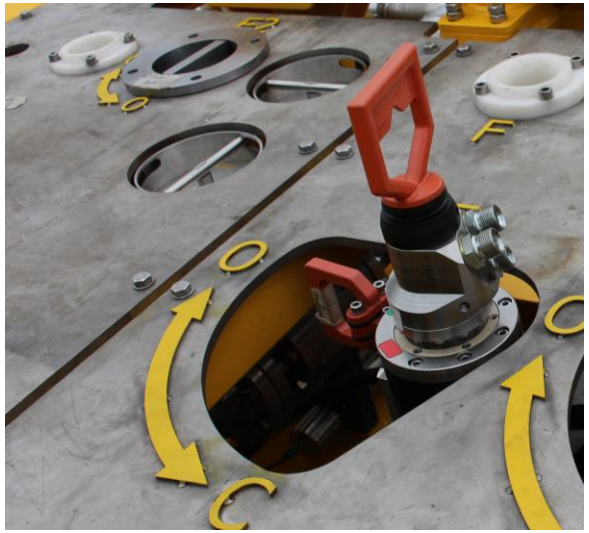
Overview of Subsea Chemical Storage & Pumping System

Proposed system comprised of:

- Multiple subsea chemical storage baskets
- Each basket containing 10 x 1,000 litre bladders
- Baskets connected to subsea pumping unit
- Baskets and pump unit deployed by support vessel
- ROV connects, controls, monitors and hydraulically powers
- Vessel to ROV link is electrical and fibre optic umbilical
- Consequently, no flow path for gas from pipeline to vessel
- ROV connects to the pump unit via hydraulic valve-stab and optical link
- In emergency, valve stab is unlatched by ROV or failsafe weak link

This solution removed and mitigated downline risks





HALLIBURTON

Project Timeline

Plan was to complete 5-year ILI run by mid 2023

- Initial proposal submitted to client end of 2022
- Based on modified subsea precommissioning equipment
- Contract award: March 2023, mobilising in August via Malaysia
- Detailed design and procurement commenced immediately
- Existing pump skid available in the UK could be modified
- 9 x 10,000 litre subsea storage baskets designed & built
- Existing, proven designs used, with client modifications.
- Big challenge was ability to connect 8 baskets simultaneously
    - Manifold with 8 hot stabs designed and built
    - Procuring hot stabs was difficult, solved by repurposing
- Project Mobilisation Schedule was met

HALLIBURTON

Project Timeline (Continued)

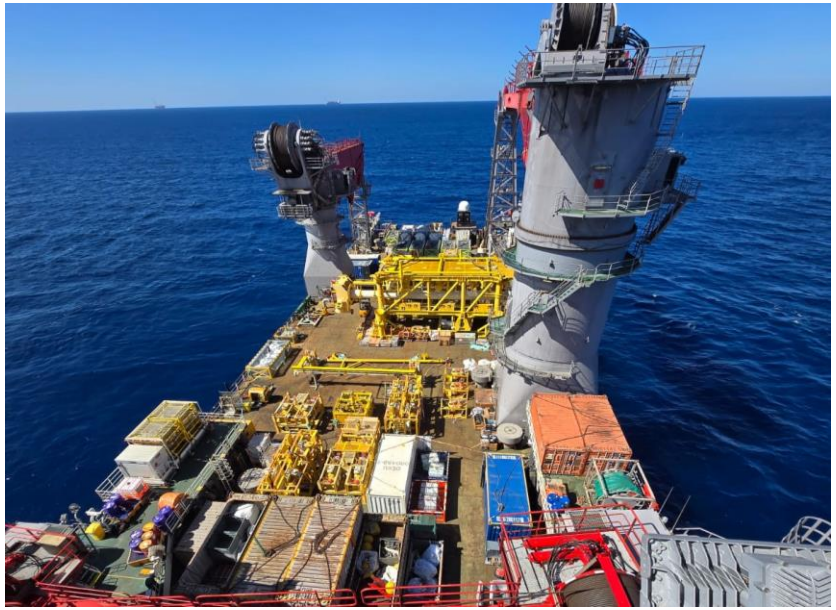
- Construction & testing completed; equipment shipped mid-June 2023
- Mobilised via Singapore, integration & testing performed in August
- Due to vessel availability the project was put on hold
- In May 2024, operations recommenced, testing was repeated
- All equipment was moved to the mob point in Southern Malaysia
- Issue with the basket bladders leaking into IBC containers
- IBCs protect and give secondary containment to the bladders
- Bladder design used for 15 + years, failing due to manufacturing defect
- Changed from 10 x 1000 litre IBC bladders in each basket to a previous design: a single heavy-duty 10,000 litre bladder
- ILI tool & cleaning pig were installed in the PLR and it was filled with TEG in preparation for deployment
- Due to further delays, the PLR, subsea pump, baskets, TEG were shipped via a cargo vessel to Australia, then loaded on to the construction vessel.

HALLIBURTON

Project Timeline (Continued)

The construction vessel mobilised offshore and commenced the subsea work scope:

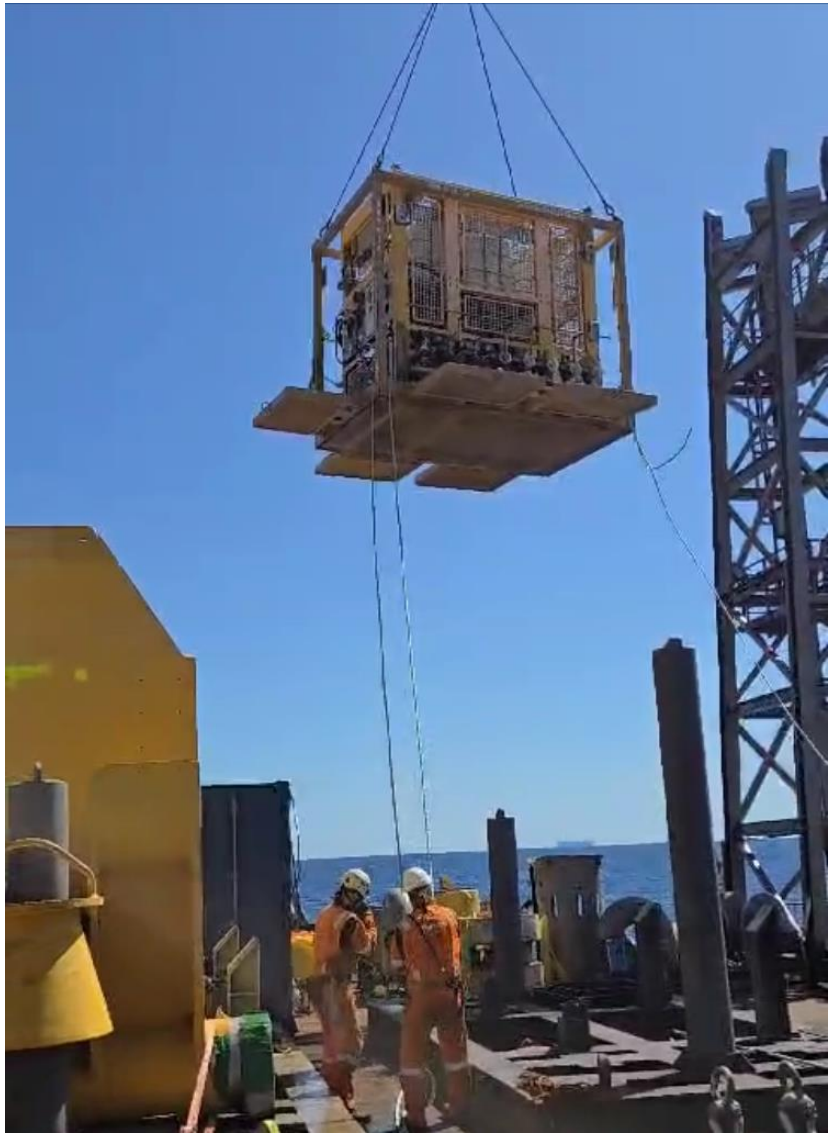
- Isolation testing of the valves on the PLEM using TEG
- Removal of blinds, installation of PLR and kicker line
- Flushing of PLR and kicker line with TEG
- Hydrotest of the PLR and kicker line using TEG
- Valves aligned to launch pig and ILI tool using gas
- Closed 42” PLR isolation valves
- Flushing gas from PLR and kicker into pipeline with TEG
- Closed kicker line valves, perform isolation tests
- Disconnect and recover PLR and kicker spool, reinstate
- Hydrotest of 42” and 12” kicker line blinds
- Recover the PLR, kicker spool, pumping unit & baskets
- Demobilisation and mothballing of equipment



HALLIBURTON

Conclusions

- Project was completed with several challenges
- Very tight initial schedule influenced some decisions
- Aspects could have been handled in a more optimal way
- Some of the key highlights and lessons learned were:
  - Component delivery time can be particularly difficult
  - Re-use of equipment saved time, but had difficulties
  - Small storage bladders were unreliable and complex. Larger bladders worked well and simplified
  - A complex and diverse project with many Interfaces proved to be a challenge
  - Project delays caused difficulties: staff continuity, information transfer, maintenance, recertification



HALLIBURTON

Thank You

Any Questions ?

Iain.Shepherd@Halliburton.com

HALLIBURTON