

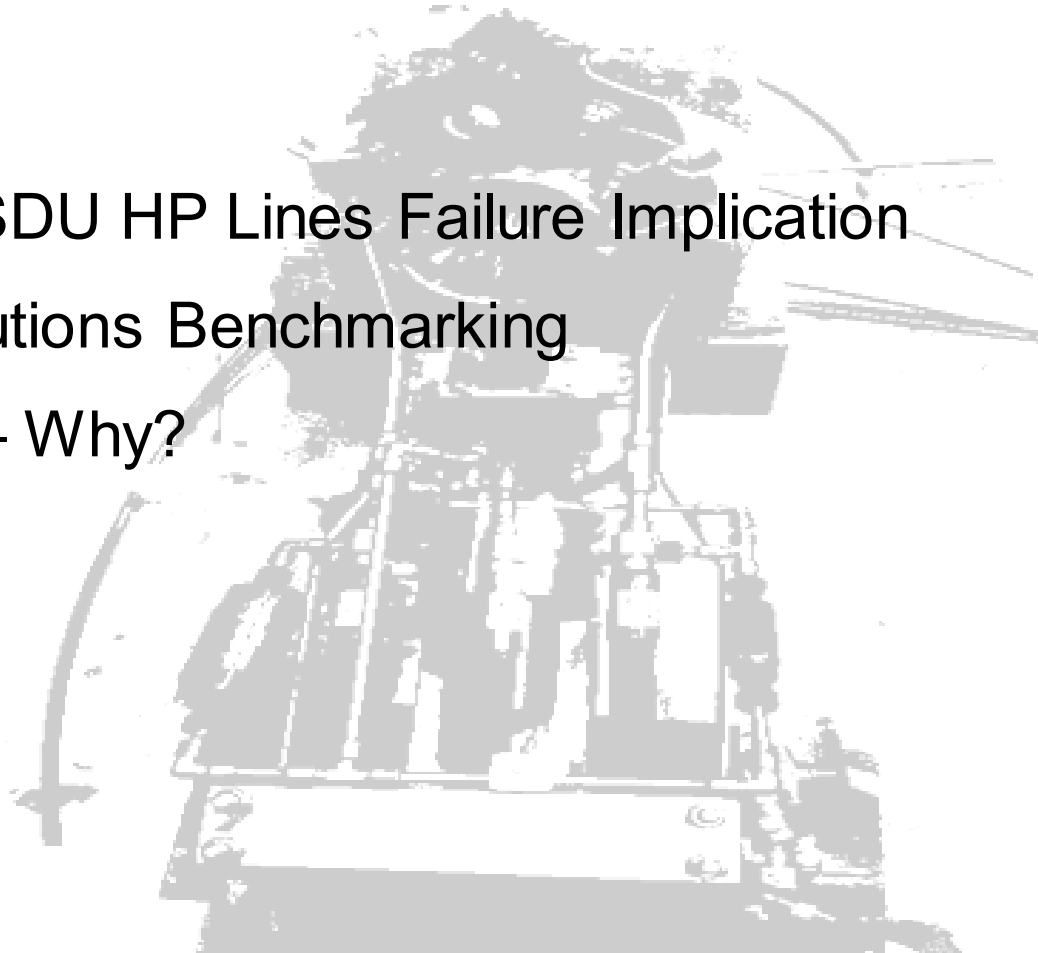
High Pressure Intensifier Application on subsea HFL – The Dalia Case

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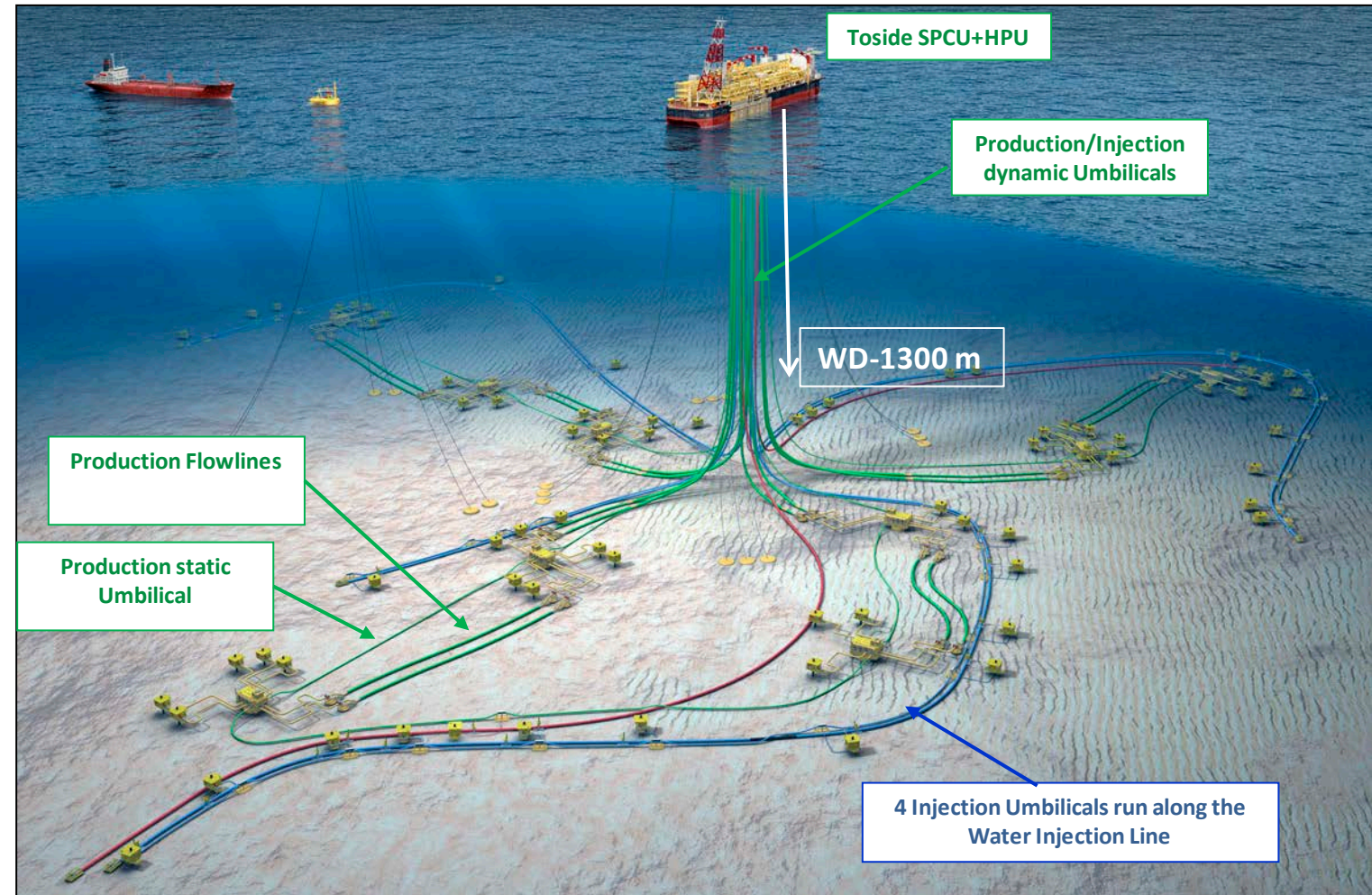
Agenda

- Dalia SPS Overview
- Injection Umbilicals Context - SDU HP Lines Failure Implication
- Hydraulic Leaks Remedial Solutions Benchmarking
- HPI on Hydraulic Flying Lead – Why?
 - ✓ Post Deployment Feedback
- Challenges & Opportunities
- Recommendations



Dalia SPS Overview

- Topside Subsea Equipment
 - SPCU
 - HPU
 - Chemical Injection System
- Seafloor/Underwater Subsea Equipment
 - Umbilicals
 - Production/Injection Flexibles Risers
 - Subsea Distribution Units
 - HFL+EFL
 - Christmas Trees
 - Productions Manifolds
 - Well Jumpers
 - Subsea Flowlines

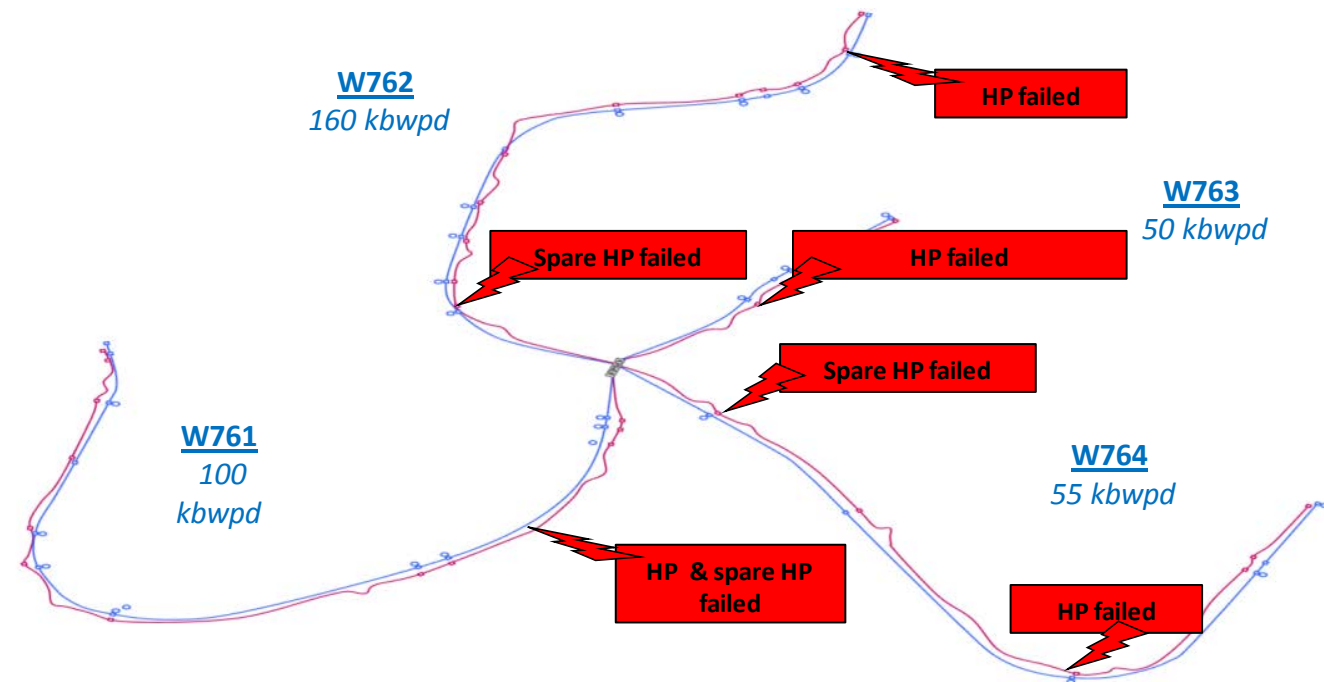
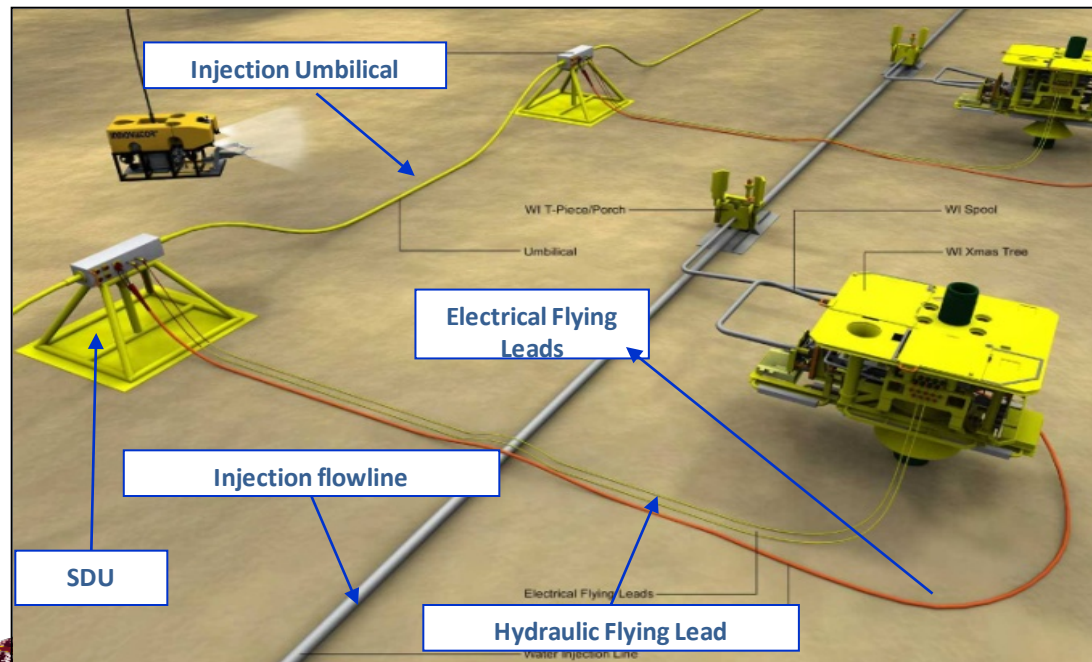


Injection Umbilicals Context - SDU HP Lines Failure Implication

- The 4 injection umbilicals designed with the same design spec but different in term of lengths and number of SDU's. SDUs are flanged and welded to the umbilical sections thus;
 - ✓ No section or SDU of injection umbilicals can be retrieved alone at surface for repair
- SDU distribute hydraulics via HFL and power/signal via EFL

Operation Mode Under Failures Condition

Hydraulic override of SCSSV by locking in the HP line at the Xmas tree level (HP isolation valve closed @SDU level, SCSSV won't close on ESD 0)



Injection Umbilicals SDU HP Lines Failure View

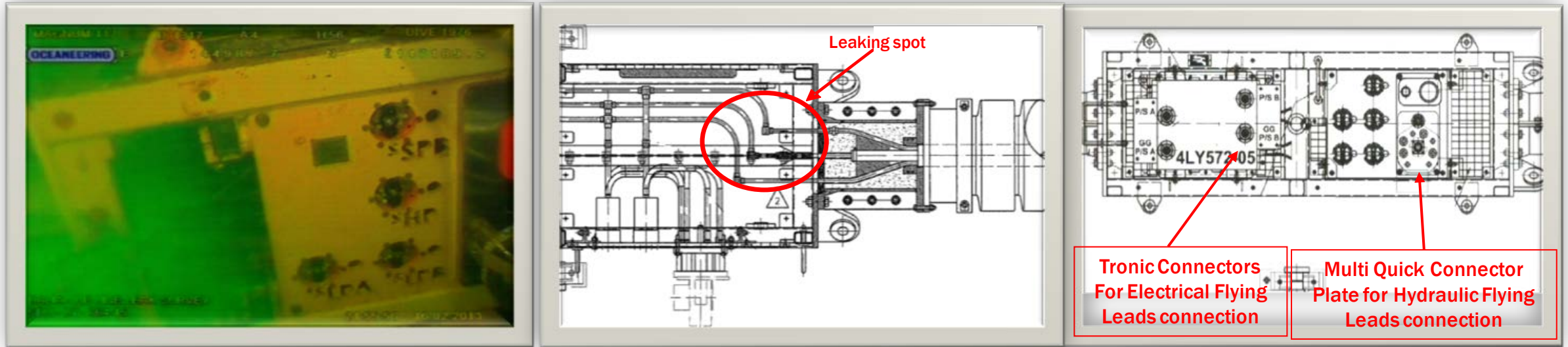


Fig 1 . SDU -LY -764 -15 leaking spot



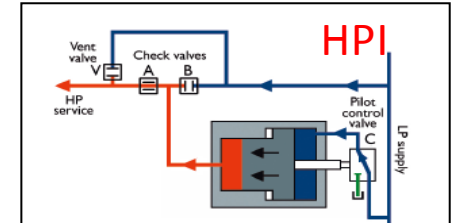
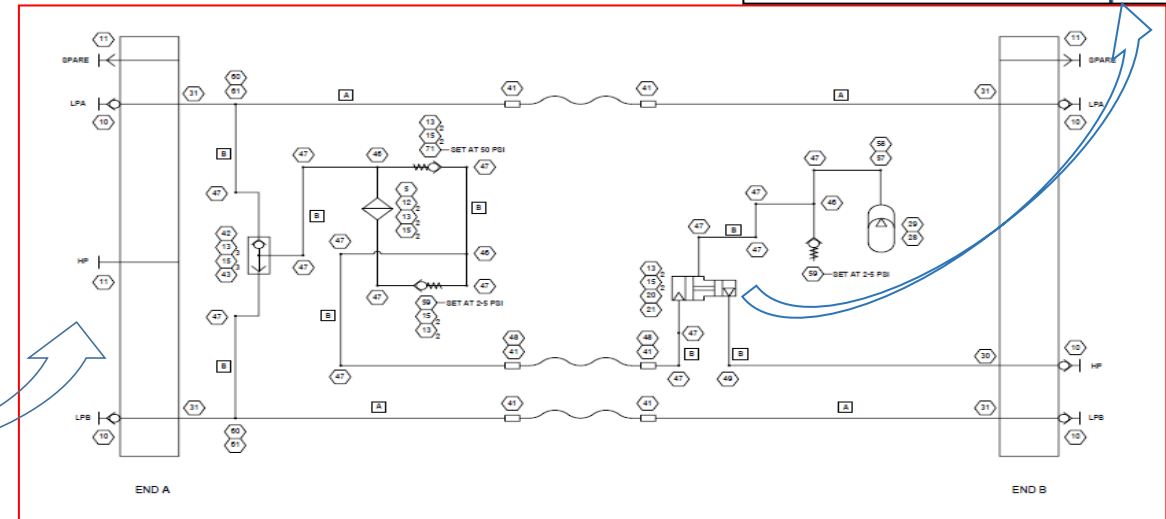
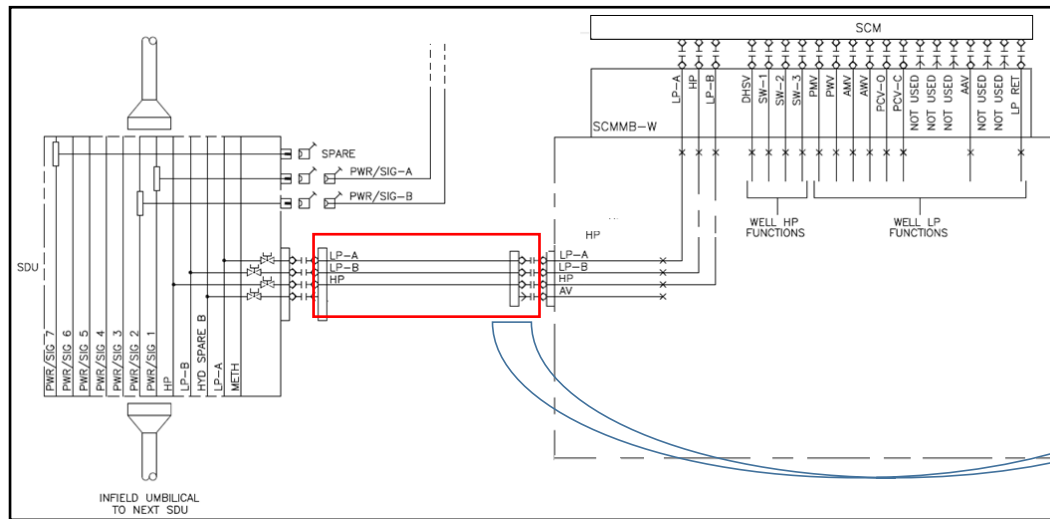
SDU-LY-762-05 (1 week inspection to detect failure location)

Hydraulic Leaks Remedial Solutions Benchmarking

Solution	Feasibility	Technical Requirement	Cost	Comments
Umbilical Recovery to re-weld SDU HP line connections	Feasible	Repair project + installation vessel	Extremely expensive	100-500M\$
Replace SCSSV with Injection safety valve flapper type (SSCSV)	Feasible	Rig intervention	Expensive	100-400M\$
SCSSV hydraulic pressure lock (override)	Feasible	FSV intervention	Moderated	2+ M\$/Year
Modified existing HFL with HPI	Feasible	Use existing SEV LOF contract & FSV	Moderated	1- 5M\$

HPI on Hydraulic Flying Lead - Why

- The solution fits Dalia WI SCSSV operational requirements and re-instates original safety feature
- No change on existing ESS/SCS philosophy
- Main critical hardware (HPI) for this solution is out of shelf & qualified to Dalia water deep.
- Modified HFL w/HPI is deployable to subsea with block 17 FSV fleet leading to major OPEX savings



New HFL w/ HPI design

2014

Preliminary engineering

- Concept Study
- Hydraulic analysis

2015

Detail Engineering

- Drawing Mod/update
- HAZIP/HAZID
- Final design approval

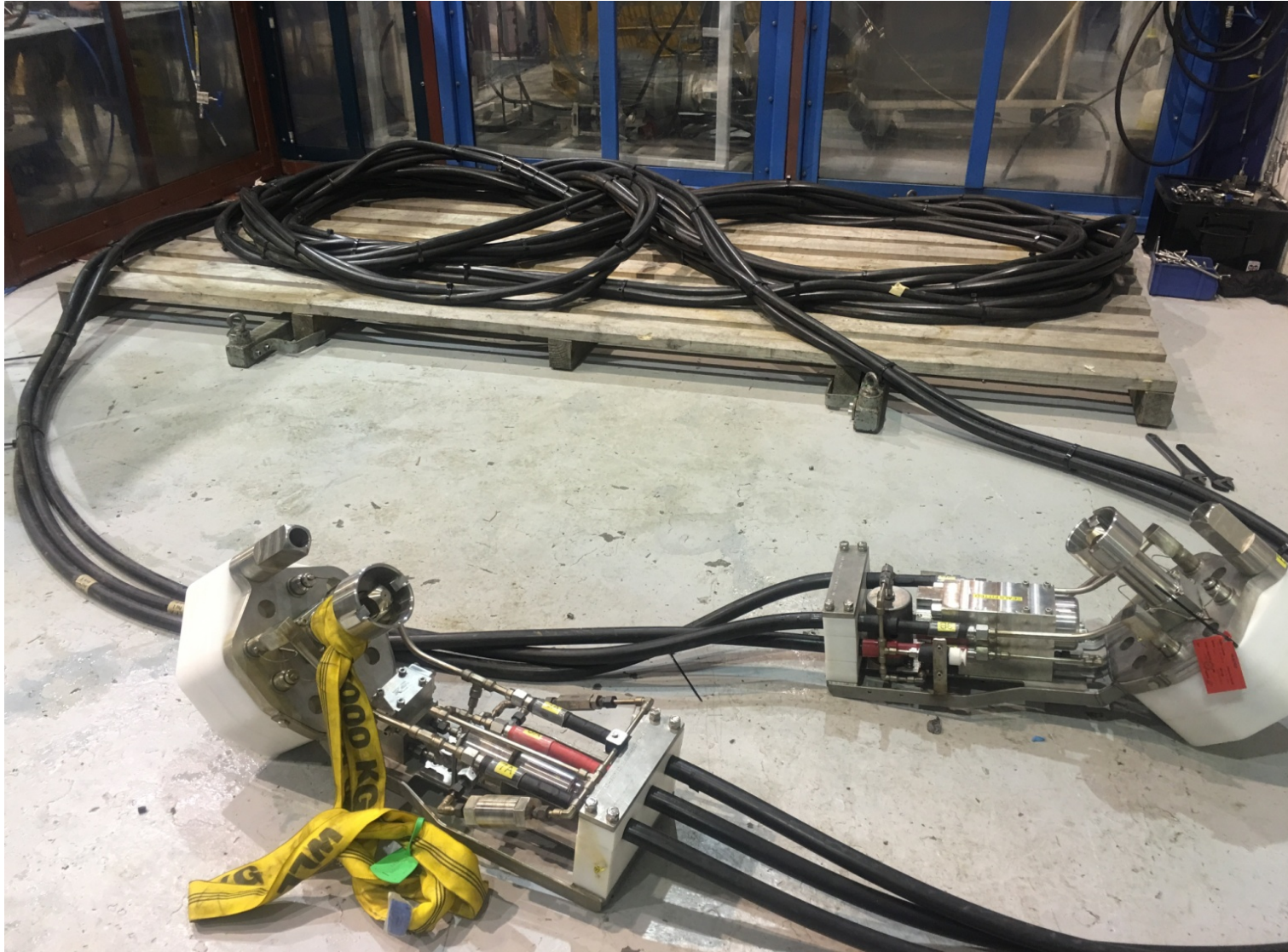
2015-2016

Manuf+Testing+Delivery -1st HFL w/HPI

- Manuf+Test - Dec 2015
- Delivery to Angola Mar/April-2016
- Deployed Subsea June 2016



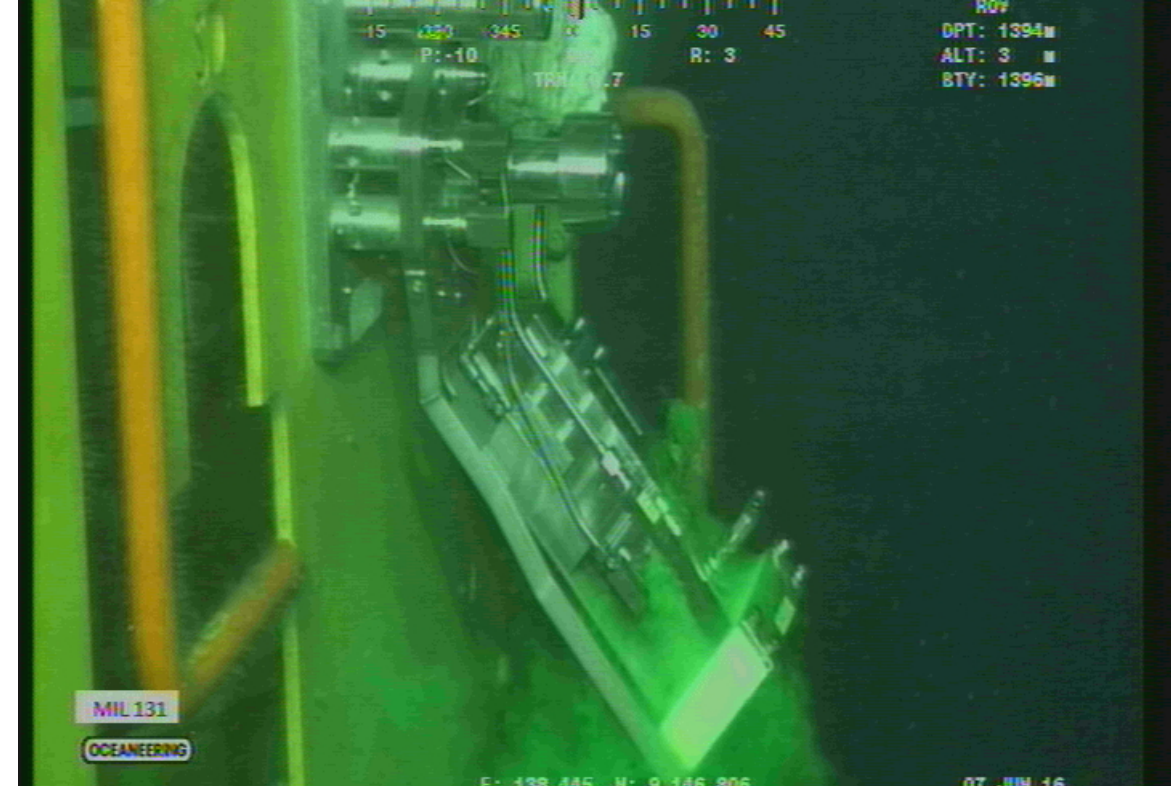
HPI on Hydraulic Flying Lead a Long Term Solution



HFL Equipped with HPI installation

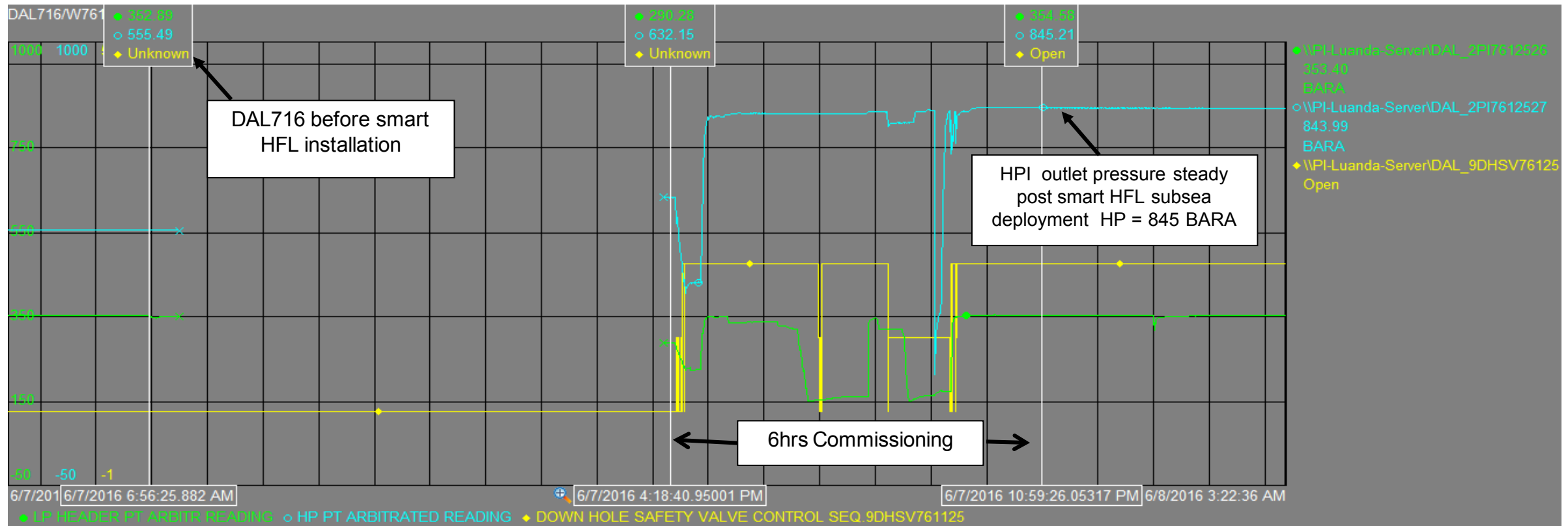


HFL w/HPI on AKER's JDS



HFL w/HPI on DAL716 XT

HFL With HPI Post Subsea Deployment Feedback



HFL w/ HPI subsea commissioning performed to test all SCM functionalities, such as:

- Normal pressurization from both low pressure (LP) supply lines
- Test of the switchover valve in case in one LP line failure
- De-latch test of Pressure Intensifier (bleed from FPSO of both LP lines)
- The Pressure Intensifier was tested successfully and HP outlet was left stable



Challenges & Opportunities

Challenges

- Initial technical query was not fully understood
- First experience in deploying HPI on HFL in deepwater
- High level of control fluid cleanliness requirement (NAS 6 or better)
- Reinstatement of original ESS- ESD 0 philosophy- HP hydraulic function

Opportunities

- Engineering concept and assumptions were proved successfully
- Hydraulic HP function was reinstated with no impact on SPSC shutdown philosophy
- HPI outlet pressure proved stable in long term run
- The application can be extended to production umbilical in Dalia case
- The application can be considered to develop marginal and long infill tiebacks fields



Recommendations

- Ensure that HPI on HFL can be accommodated on existing subsea hydraulic network
- Ensure that high level of cleanliness is maintained (NAS 6 or better) is maintained from the assembly of individual component to the assembly of entire HFL (Thanks to TEPUK REX)– extremely critical to the HPI reliability (Paranoia???)
- Company has decided to full deploy the solution to the rest of Dalia injection wells as its reliability is very good
- A feasibility study to include this application on standard SPSCS to address leaks, develop marginal and long infill tiebacks field shall be considered

§§§ Special One §§§

Due to the challenges we have faced for all stakeholders to understand the high level of cleanliness requirement, during the FAT the HFL with HFL modified with HPI has been renamed as SMART HFL (Jumper)



Thank you !!!

Questions?

