OIL & GAS HYDRAULIC ANALYSIS CASE STUDIES

SUT Subsea Controls Downunder Conference 2022

PRESSURE DYNAMICS

AGENDA

- Why is a hydraulic analysis required?
- What is in a hydraulic analysis?
- What software is used for hydraulic analysis?

Case Studies (chronological):

- CLIENT A , 2020
- CLIENT B (IWOCS), 2020
- CLIENT C (combined), 2019
- CLIENT D (full), 2019

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OIL & GAS PRODUCTION CONTROL SYSTEMS: DESIGN ANALYSIS

According to ISO13626-6 and API 17F, following analysis **shall be** performed on Production Control Systems:

- Hydraulic system operation and response time analysis
- Failure mode effects and criticality analysis
- Reliability, availability, and maintainability analysis

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OIL & GAS PRODUCTION CONTROL SYSTEMS: DESIGN ANALYSIS

A simulation of hydraulic control system **minimum requirements** :

1. Time to prime the hydraulic system from a depressurized state;
2. Opening and closing response time of the process valves under condition of min/max process pressure;
3. Time for the pressure to recover following a process valve opening;
4. Time to carry out a sequence of valve opening such as opening a tree;
5. Stability of opened control/process valve during operation of other control/process valves
6. Response time to close process valves in the event of ESD
7. Response time and pressure for multiple simultaneous choke operation
8. Response time and pressure for subsea quick dump
9. Impact of failure or loss of subsea accumulation
10. Extent of control fluid total loss rate
11. Chemical system flow analysis

OIL & GAS PRODUCTION CONTROL SYSTEMS: DESIGN ANALYSIS

Software tools used:

SIMULATION X

AUTOMATION STUDIO™

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CASE STUDY: CLIENT A- overview

Software:	Control Simulator 8, Automation Studio
Project:	• Adding 4 subsea wells to the field • Adding one surface well to WHP • Finding a solution for supplying WHP circuit due to failure of umbilical lines • Failure of HIPPS valves remote operation
Solution:	• Decrease the HP pump flow rate to reduce the hi cycling of the pump • Booster on the platform could be used to convert LP to HP • Confirmation the HIPPS has been design correctly however we found a potential issue that needed investigation on site which infers to a potential leakage

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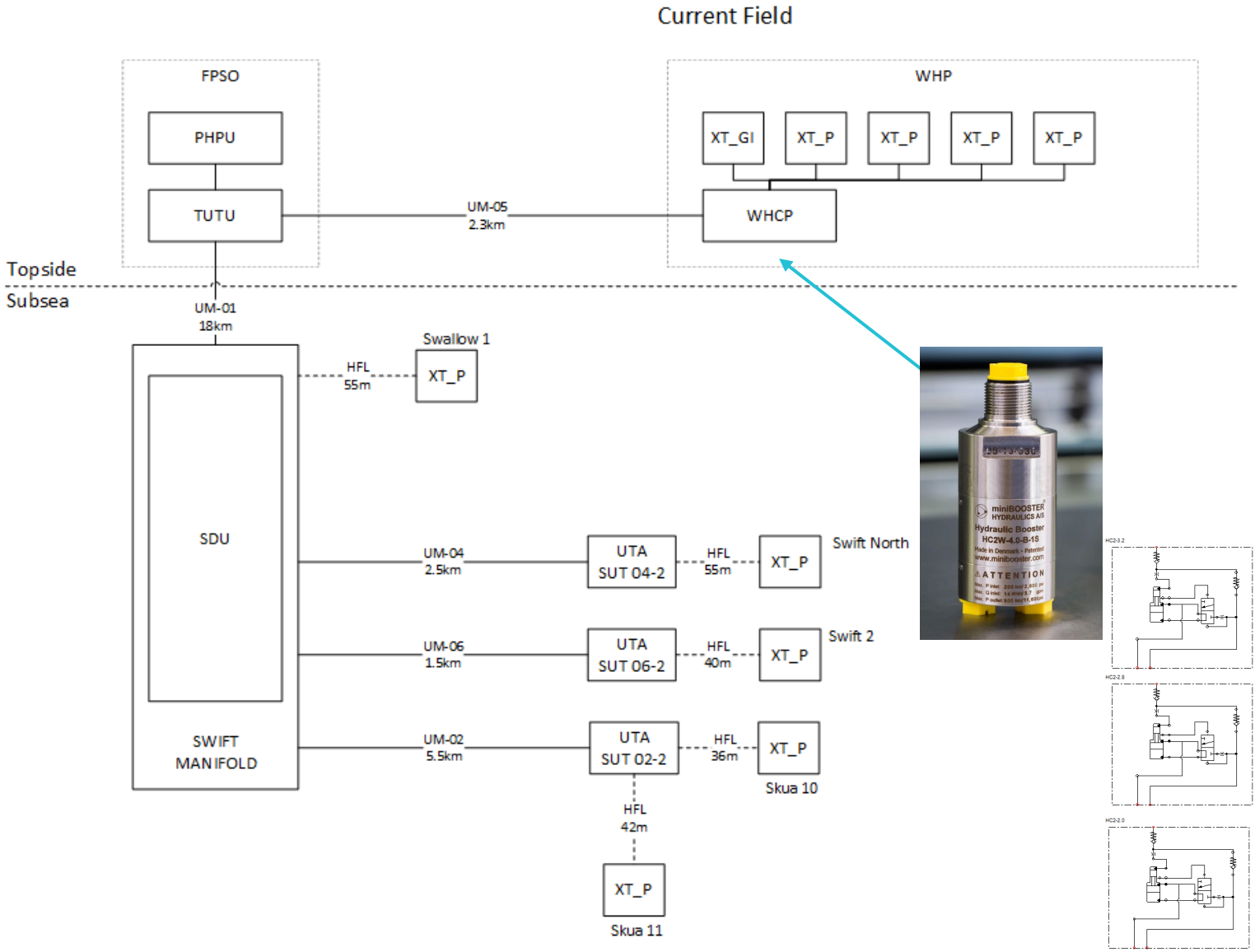
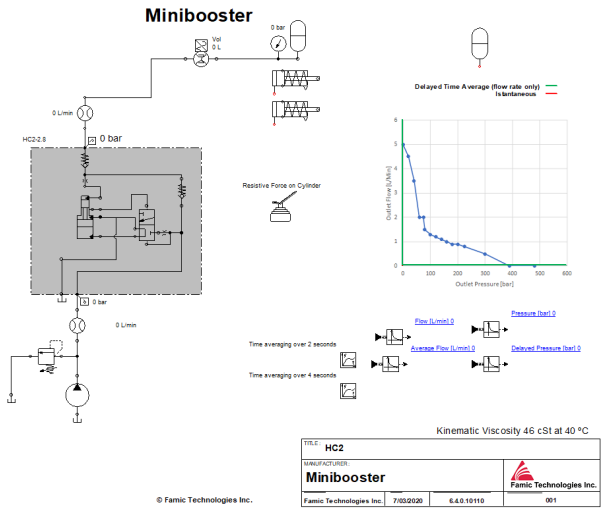
CASE STUDY: CLIENT A - model

Field layout





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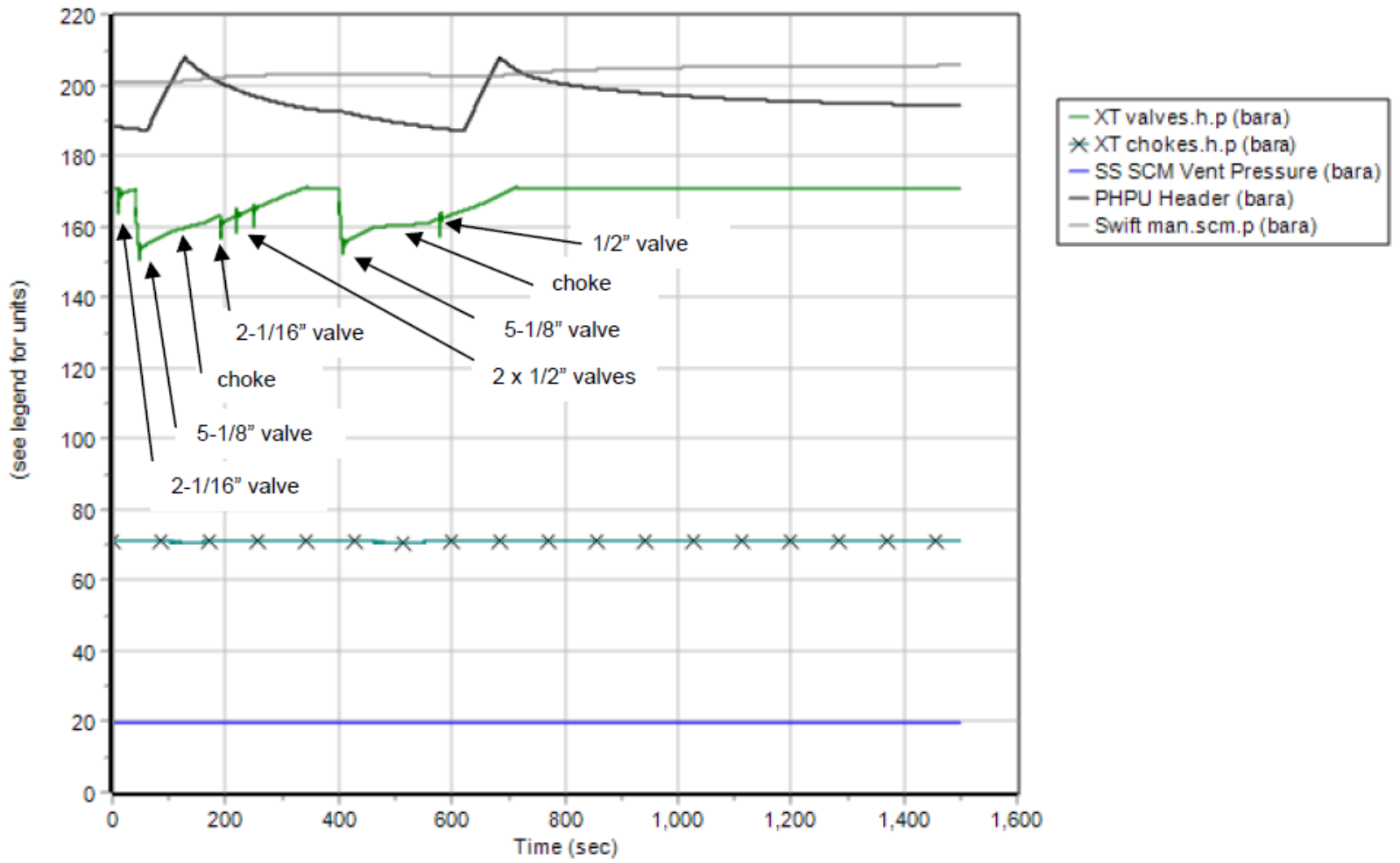
CASE STUDY: CLIENT A - results

Well Start-up WHP



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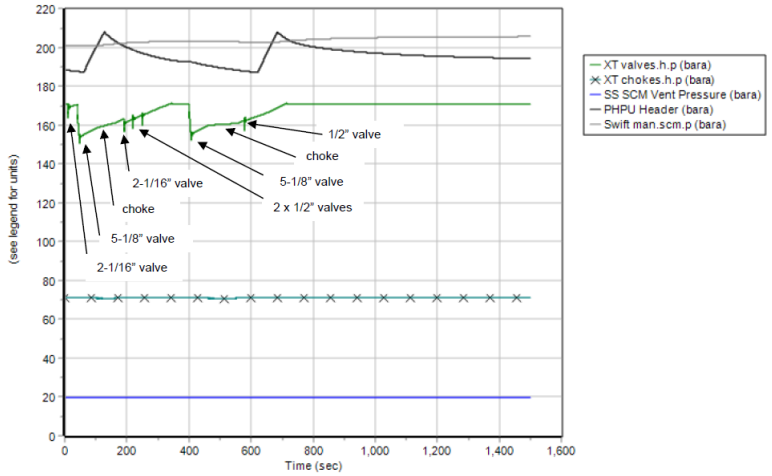
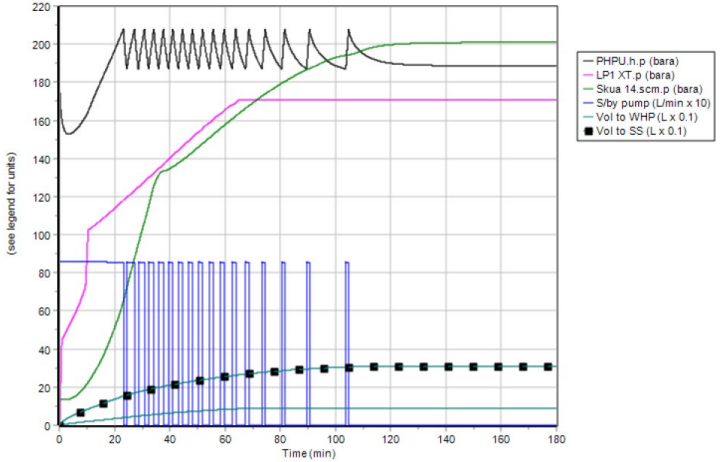
CASE STUDY: CLIENT A - results

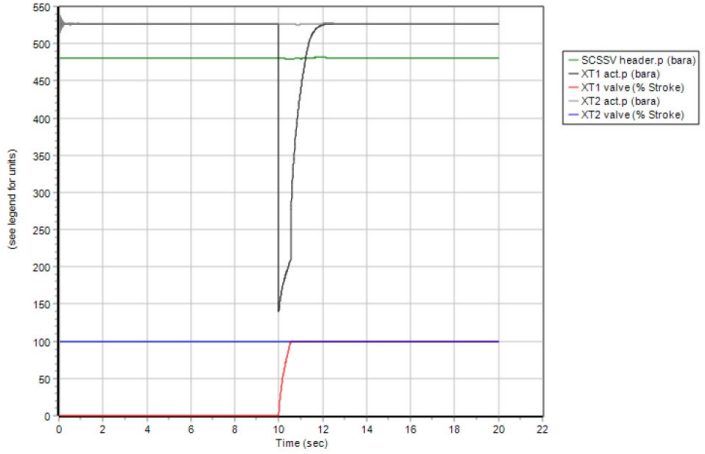
Well Start-up WHP



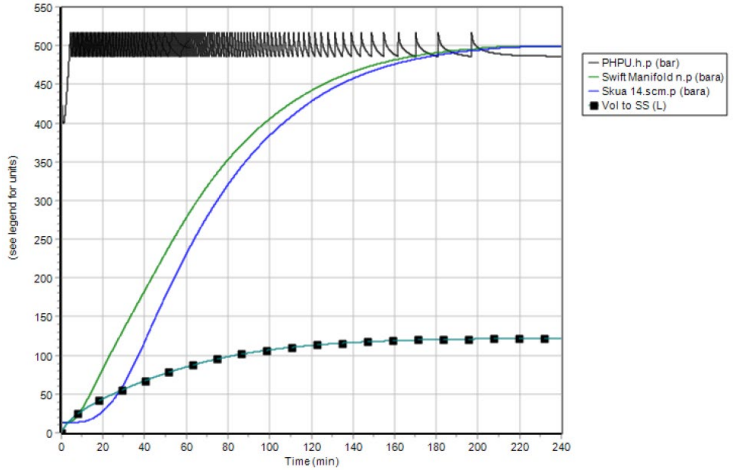
Charge up LP subsea and WHP system



SCSSV (Valve) opening on WHP



Charge of the HP subsea systems



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CASE STUDY: CLIENT B – overview IWOCS

Software:	Control Simulator 8, Automation Studio
Project:	• Using Client B Intervention Work Over Control (IWOC) PHPU as a temporary measure for top side and subsea valves operation during upgrading of the PHPU
Description:	• IWOC PHPU and topside and subsea hydraulic circuit was modelled • Temporary disconnection of Client B PHPU and connection of IWOC HPU • Defining LP and HP pressures for the temporary arrangement
Solution:	• IWOCS was sufficient for temporary use for approx. 3-4 weeks while there was PHPU maintenance and modification.

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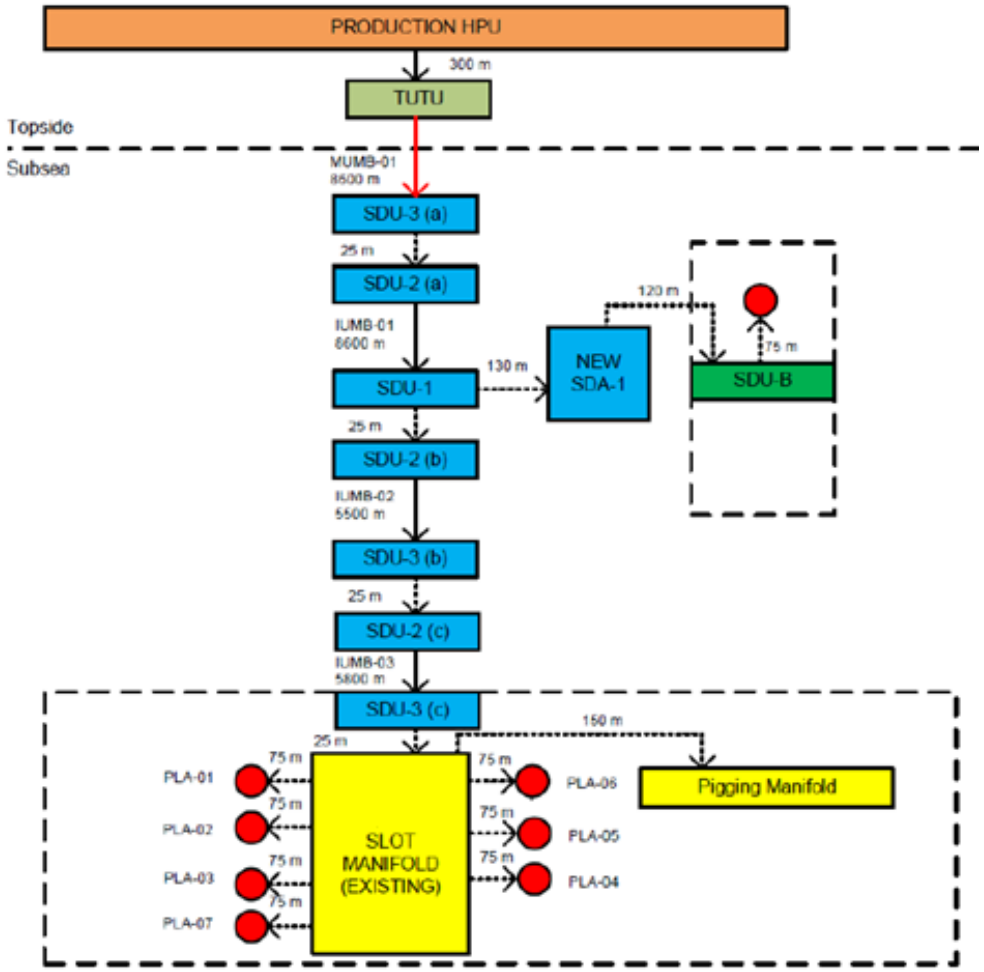
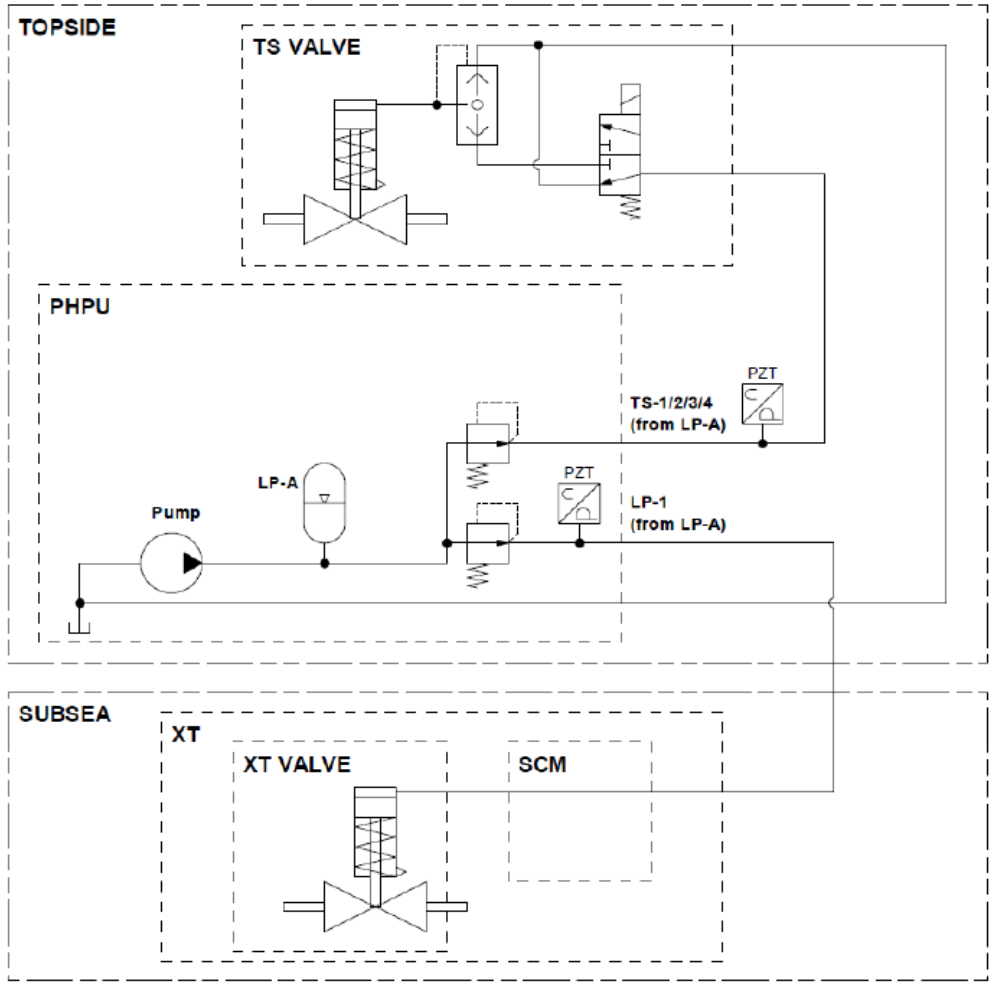
CASE STUDY: CLIENT B - model



Subsea Field Layout



Simulation Hydraulic Model Layout

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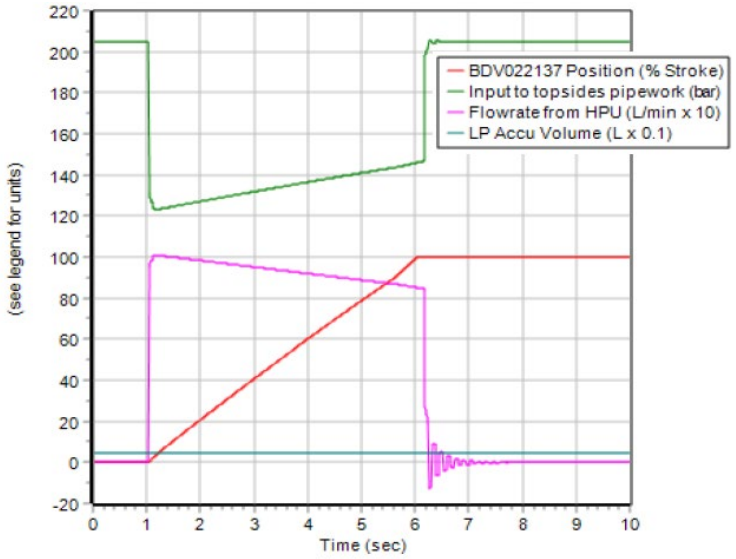
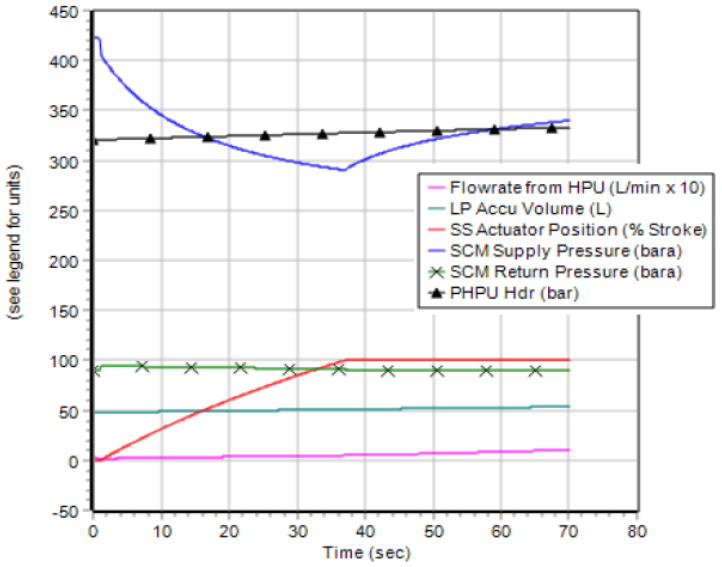
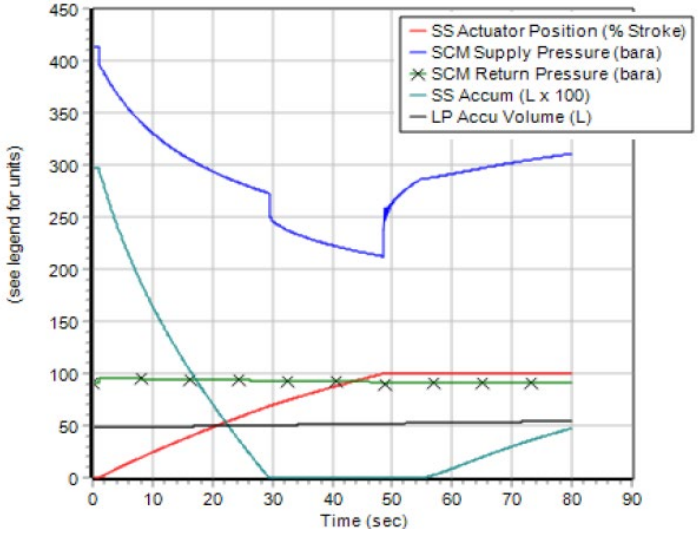
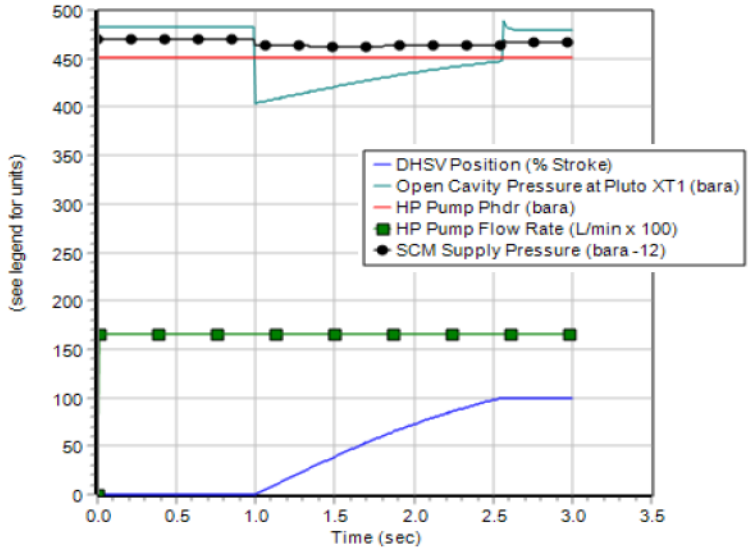
CASE STUDY: CLIENT B - results









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CASE STUDY: CLIENT C - overview

Software:	Control Simulator 8
Project:	• Hydraulic analysis of current and proposed subsea field with 13 XT's controlled from a FPSO with a total umbilical length of ~15km.
Description	1. Computer Hydraulic Simulation No. 1 - Benchmark simulation of installed Client C PHPU, comprising: • Twenty two (22) wells • Total umbilical length = 16.35 km • Well Head Shut in Pressure (WHSP) = 135 bar. • Existing PHPU operating in accordance with the original project specification. 2. Computer Hydraulic Simulation No. 2 - Resulting performance of current and future fields: • Incorporation of the proposed design changes to the PHPU to improve system reliability, operability and maintainability by removing problematic components from the system.
Solution:	• Confirmed PHPU for future wells • Remove potential problematic components for the system but need to update the number of accumulators and update system pressure settings.

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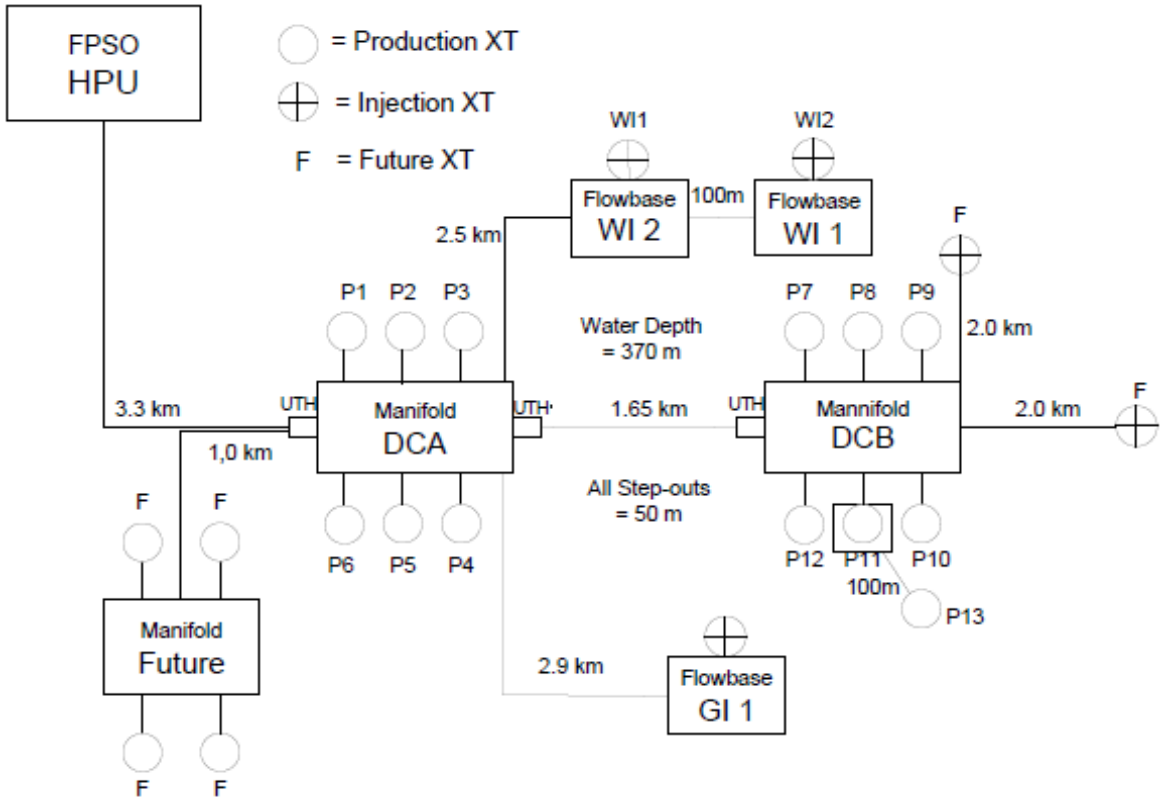
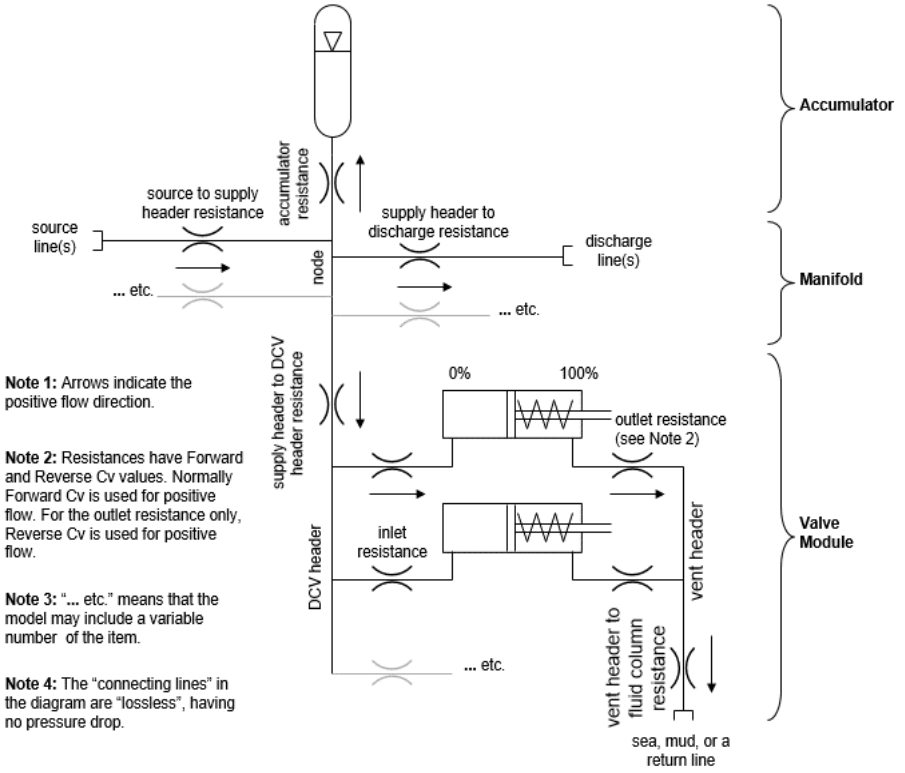
CASE STUDY: CLIENT C - model

Subsea field layout



Hydraulic model for subsea XT



Note 1: Arrows indicate the positive flow direction.

Note 2: Resistances have Forward and Reverse Cv values. Normally Forward Cv is used for positive flow. For the outlet resistance only, Reverse Cv is used for positive flow.

Note 3: "... etc." means that the model may include a variable number of the item.

Note 4: The "connecting lines" in the diagram are "lossless", having no pressure drop.

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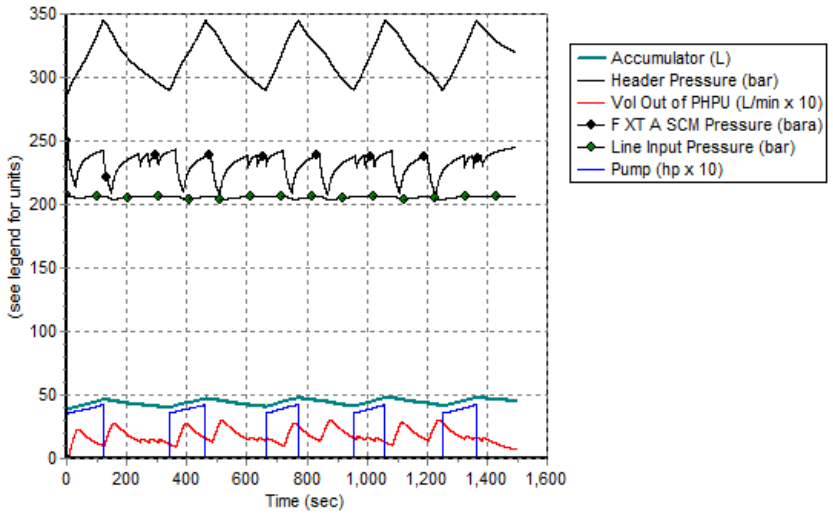
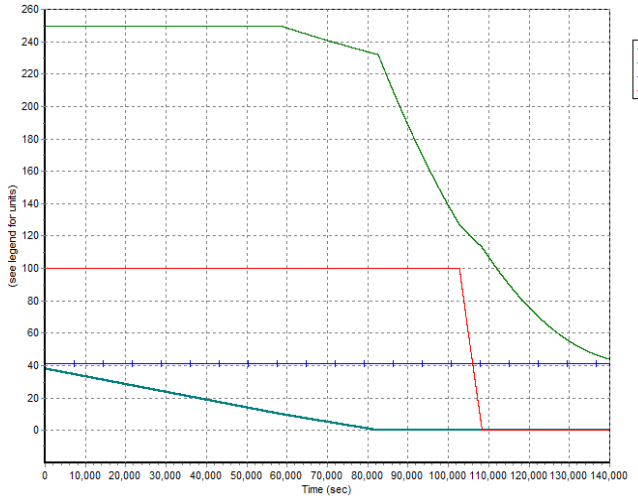
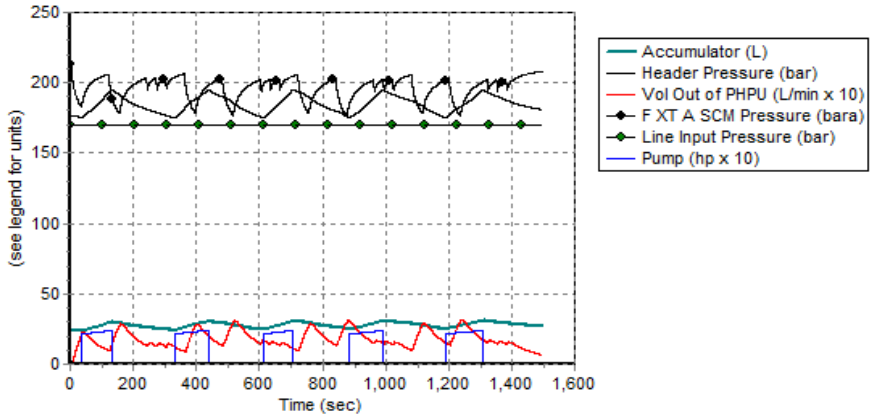
CASE STUDY: Client C - results

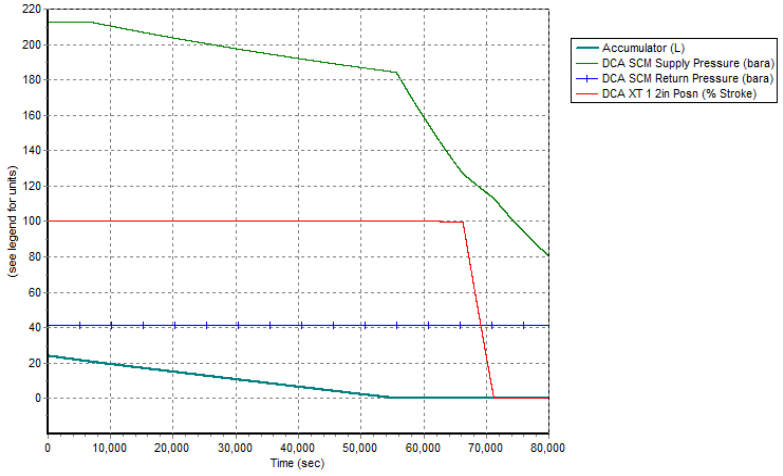
Simulation 1 (benchmark)





Simulation 2 (modifications)





API 17F LP Accumulator Sizing Requirement Check

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CASE STUDY: CLIENT D onshore - overview

Software:	Simulation X,
Project:	• PHPU having LP pumps stop and start frequently after valve actuation until accumulator pressures stabilise • Investigate what modifications need to be made to the PHPU to reduce the wear on the pumps and shocks on the PHPU
Solution:	• Increasing the volume of the HP accumulators was shown in the simulation to reduce the pump starts after a valve actuation from 6 to 2 • Removing the HP header accumulators was shown not to be a viable solution due to the resulting pressures after a valve actuation falling too low

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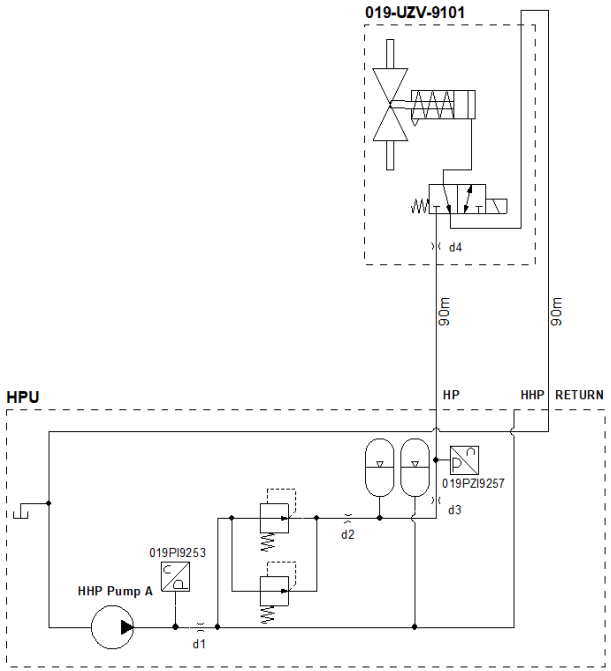
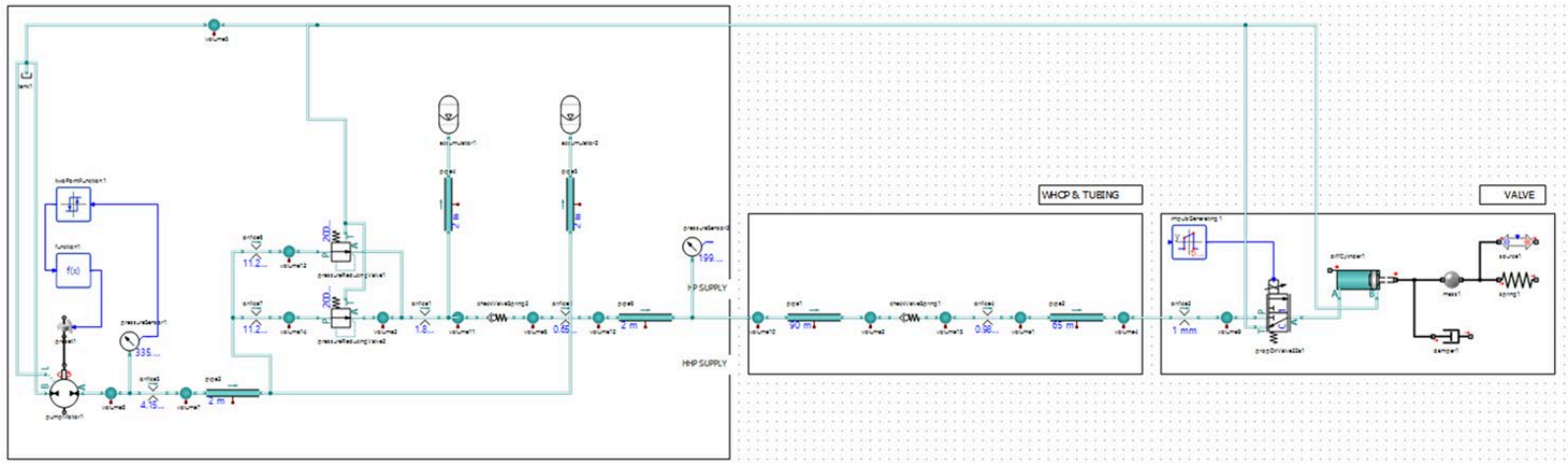
CASE STUDY: ONSHORE FIELD - model

Hydraulic Schematic



Software Model



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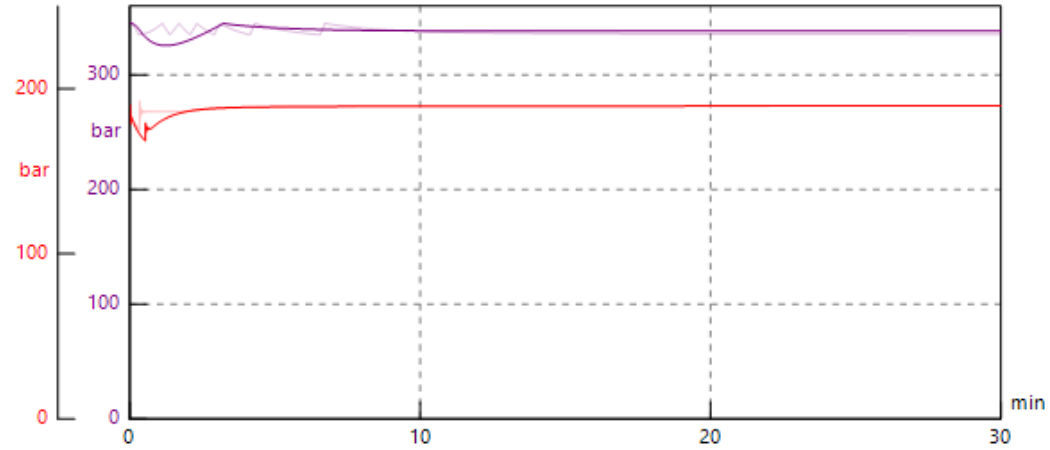
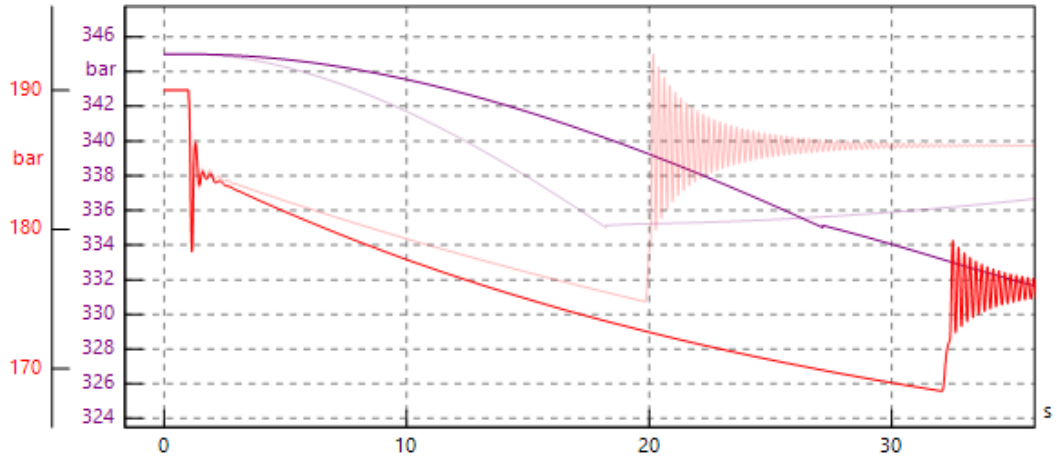
CASE STUDY: ONSHORE FIELD - results

PHPU and valve pressures over 30mins after valve actuation



Close up of plot to showing the first 30 sec



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Thank you

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