Subsea System Design: Same Dog New Tricks

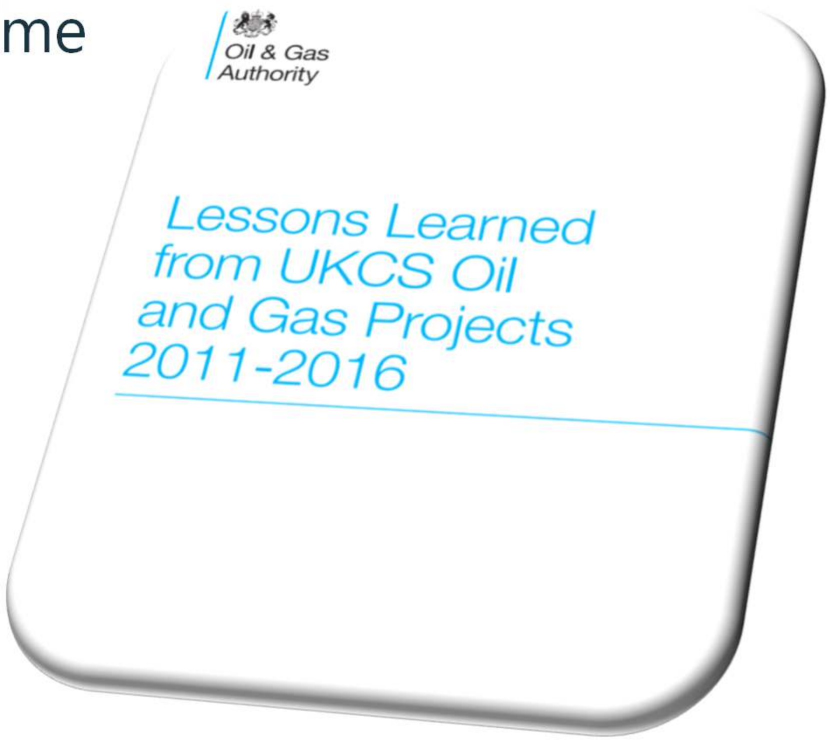
By K.Milne

Same Dog…

- OGA analysed 58 oil and gas projects
  - Input from 11 Operators

- Less than 25% delivered on time

- Average overspend = 35%

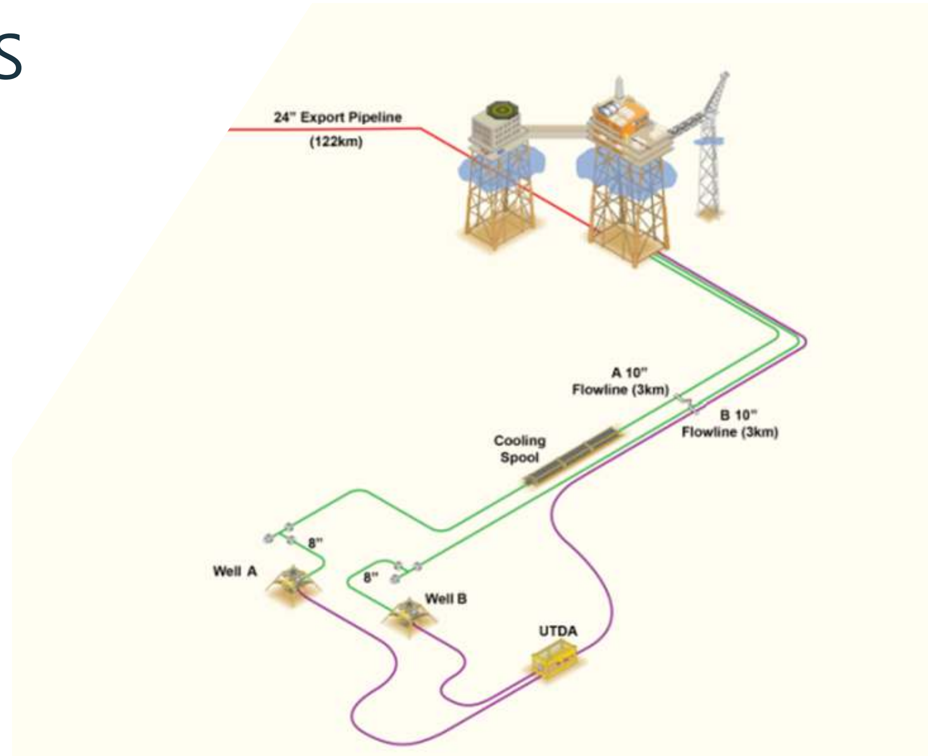


Case Study: Subsea Production Tree Leak

- The Issue
- The Traditional Response
- What We Did
- Key Point Comparison
- Example Key Item Design Philosophy

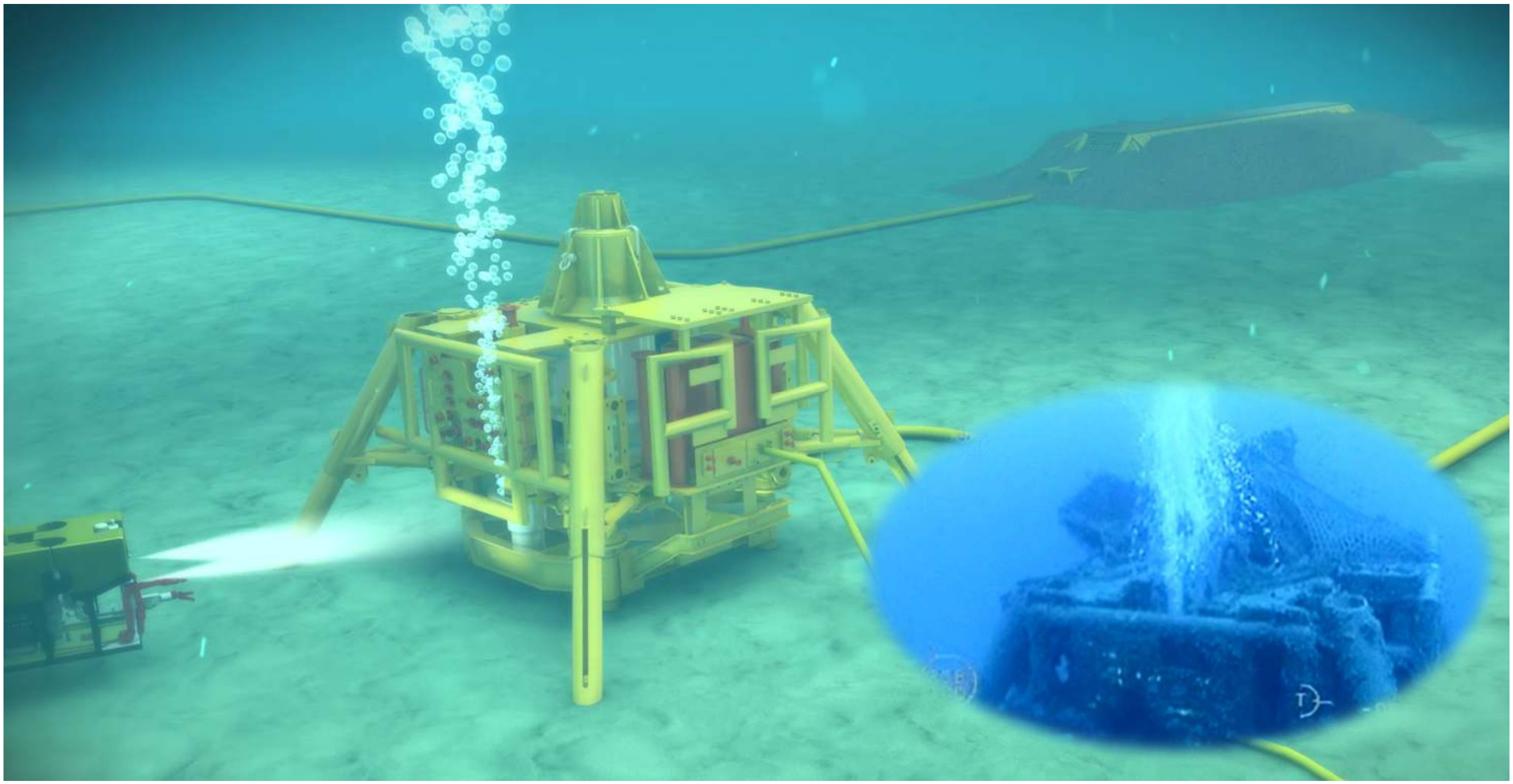
Case Overview

- 2 well subsea tie-back
- Sour 3-phase production
  - Well A ~30,000ppm H_2S
  - Well B ~ 3,000ppm H_2S
- Water depth is ~60m
  - Designed for routine ROV intervention
  - Installed by sat divers



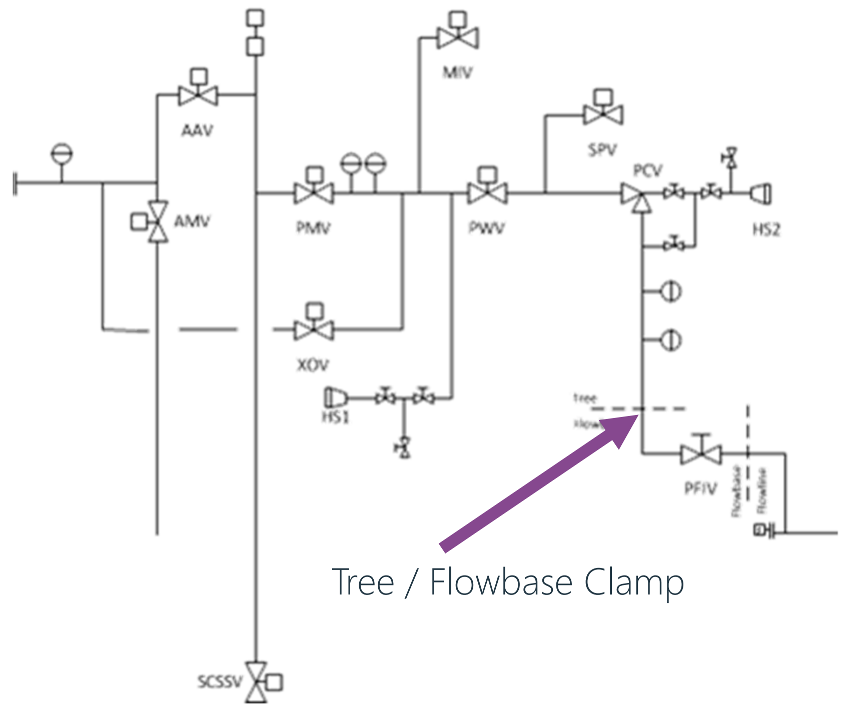
Bypass Requirements

- Leak Identified in 2014



Case Overview

- Horizontal production tree
- Leak point identified at Tree / Flowbase interface
- No leak during stable flow, only during shutdown
  - Estimated 42 pressure cycles observed in 2015
  - Leak observed to continue even when pipeline was blown down
- PFIV failed ~60% /Open



How to Repair a Leaking Tree?

- The tried and tested method is:
  - Change out the Tree and Flowbase

Equipment & Services Required

- DSV – Preparation & deconstruction
- Drill Rig – Tree & flowbase change Out
- DSV – Re-connection & commissioning
- Horizontal production tree
- Production flowbase
- Upper completion inc. valves & sensors

Tree Change Out Scenario

Campaign One: DSV

- Isolate tree
- Flood pipeline
- Remove tie-in spool
- Disconnect subsea control system

Campaign Two: MODU

- Set downhole isolation plugs
- Pull upper completion
- Recover tree & flowbase
- Install new tree & flowbase
- Recomplete well

Campaign Three: DSV

- Install tie-in spool
- Leak test pipeline
- De-water pipeline
- Re-connect subsea control system
- Commission well

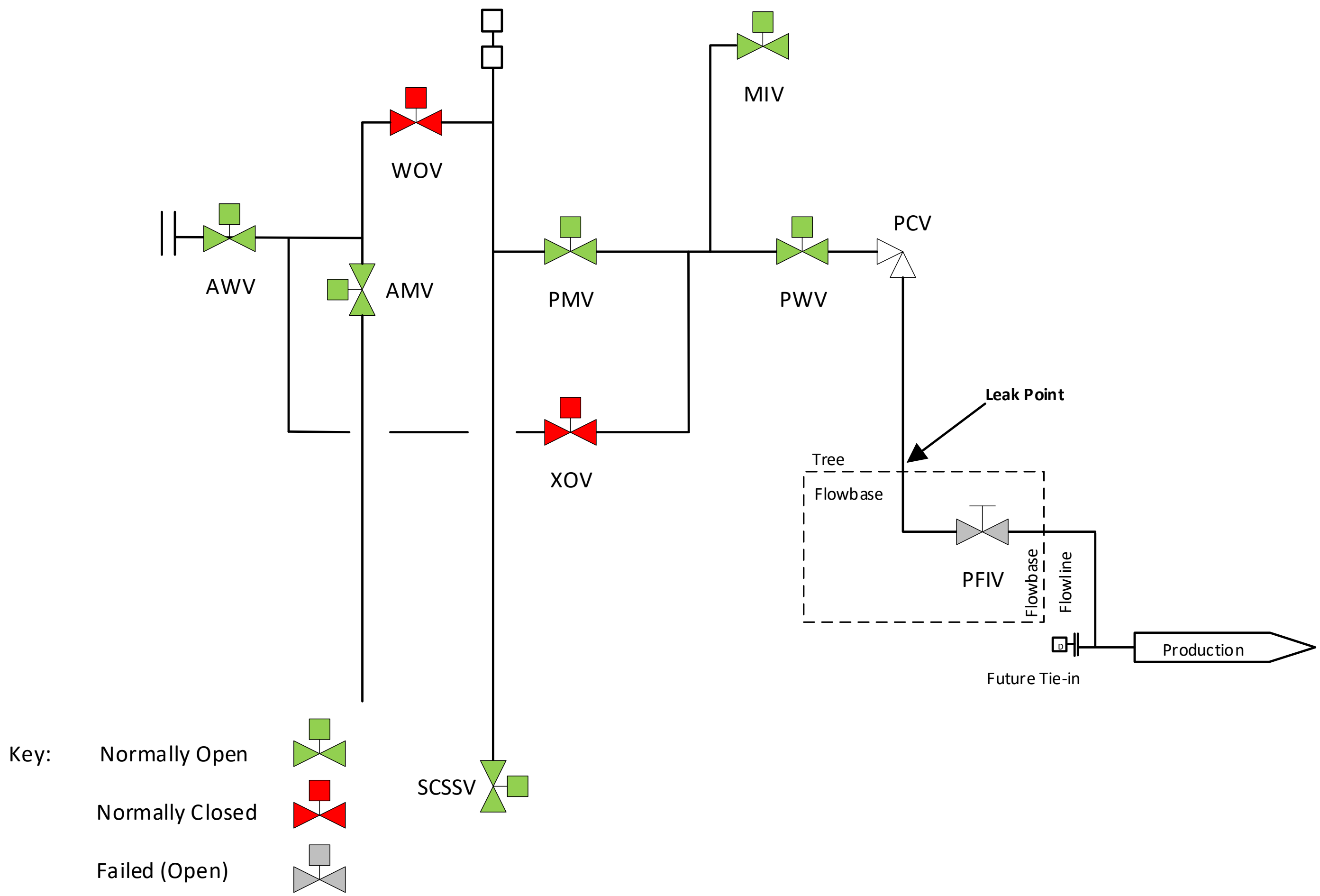
Tree Change Out Scenario

- Campaign One: Est. 6 Days (inc. Mob)
- Campaign Two: Est. 30 Days
- Campaign Three: Est. 7 Days (inc. Mob)
- Total Repair Cost £53.5M not economically viable for this Asset

Task	Duration	Cost
Engineering	18 months	£4.5M
Equipment	12 months	£7M
Offshore Execution	44 days	£35M
Lost Production	42 days*	£7M
Total	19 months	£53.5M

*Does not allow for delays between campaigns

…New Tricks: Bypass Solution



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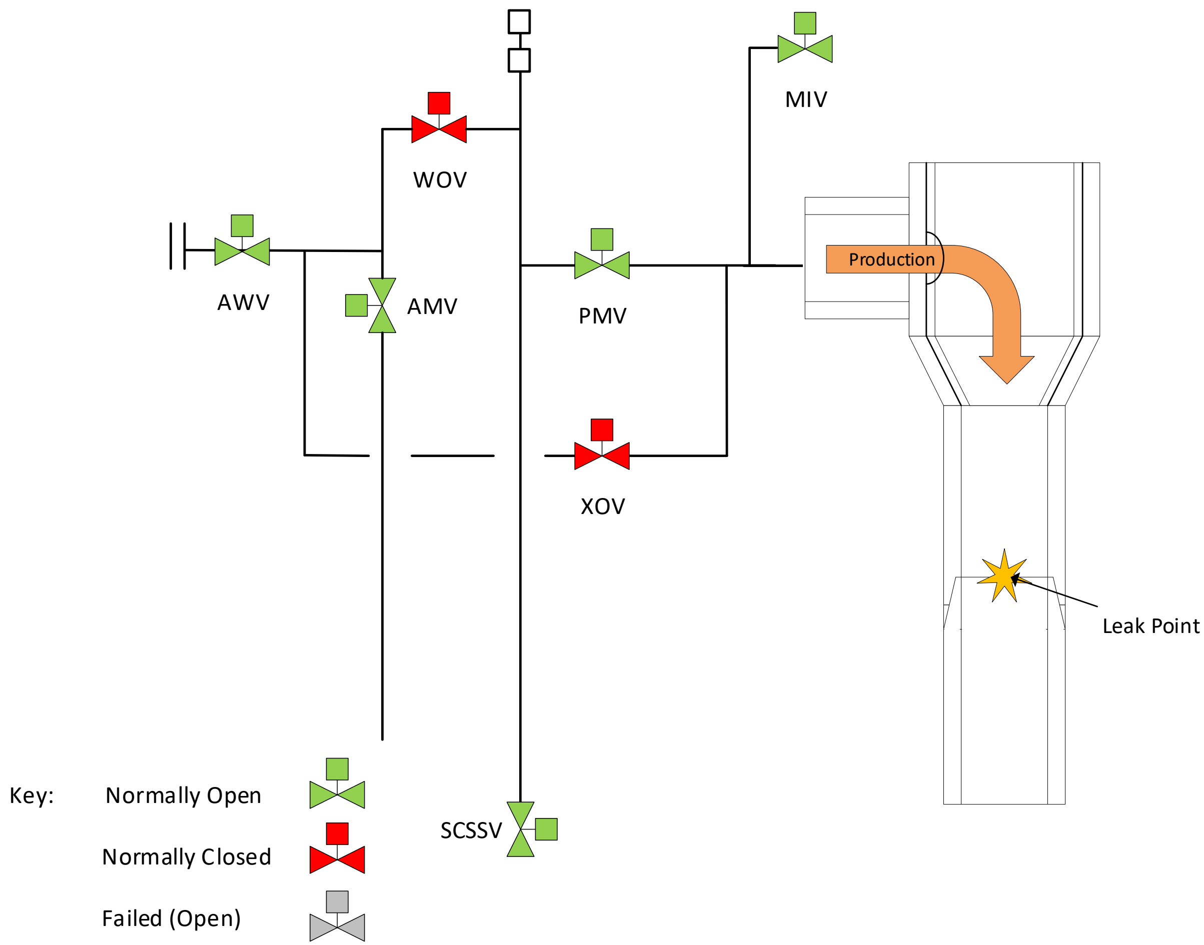

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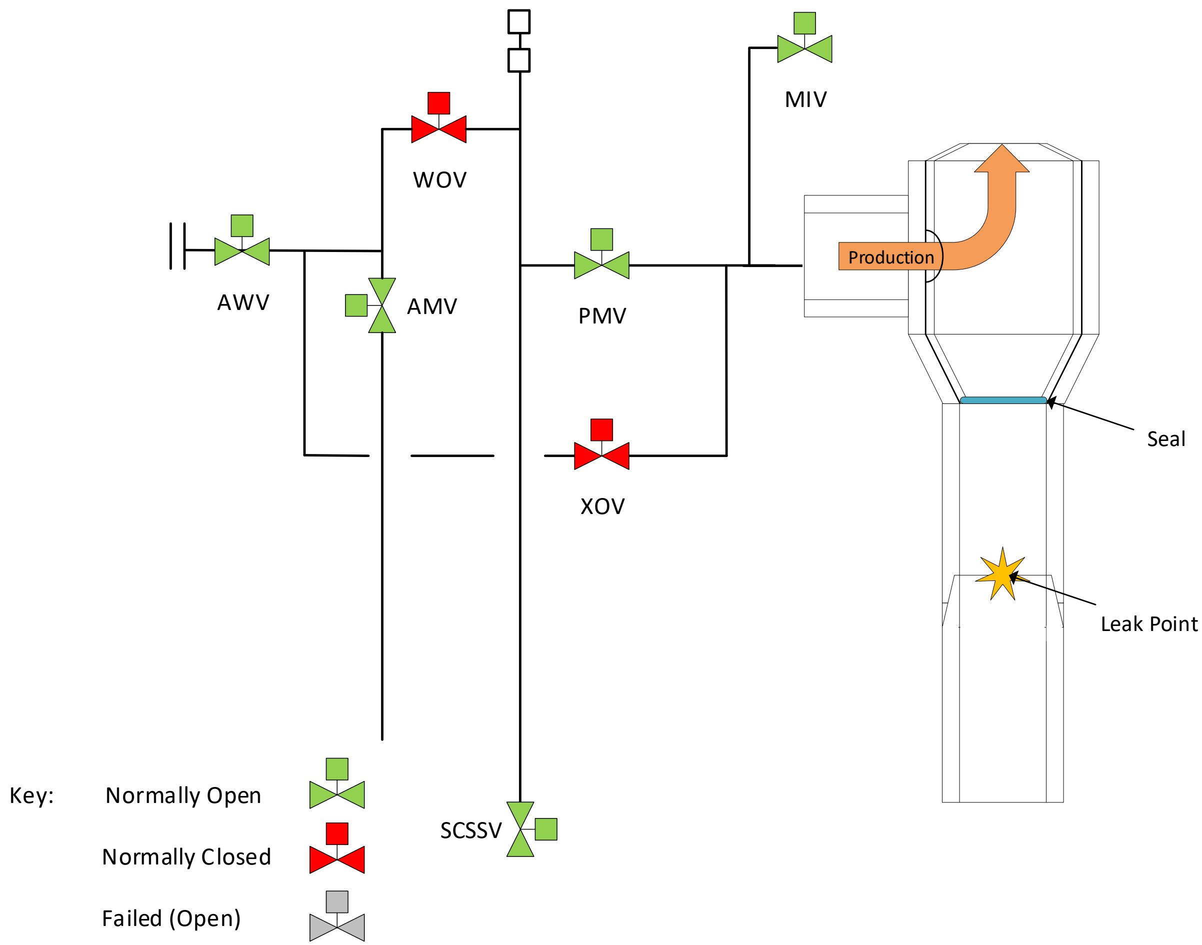

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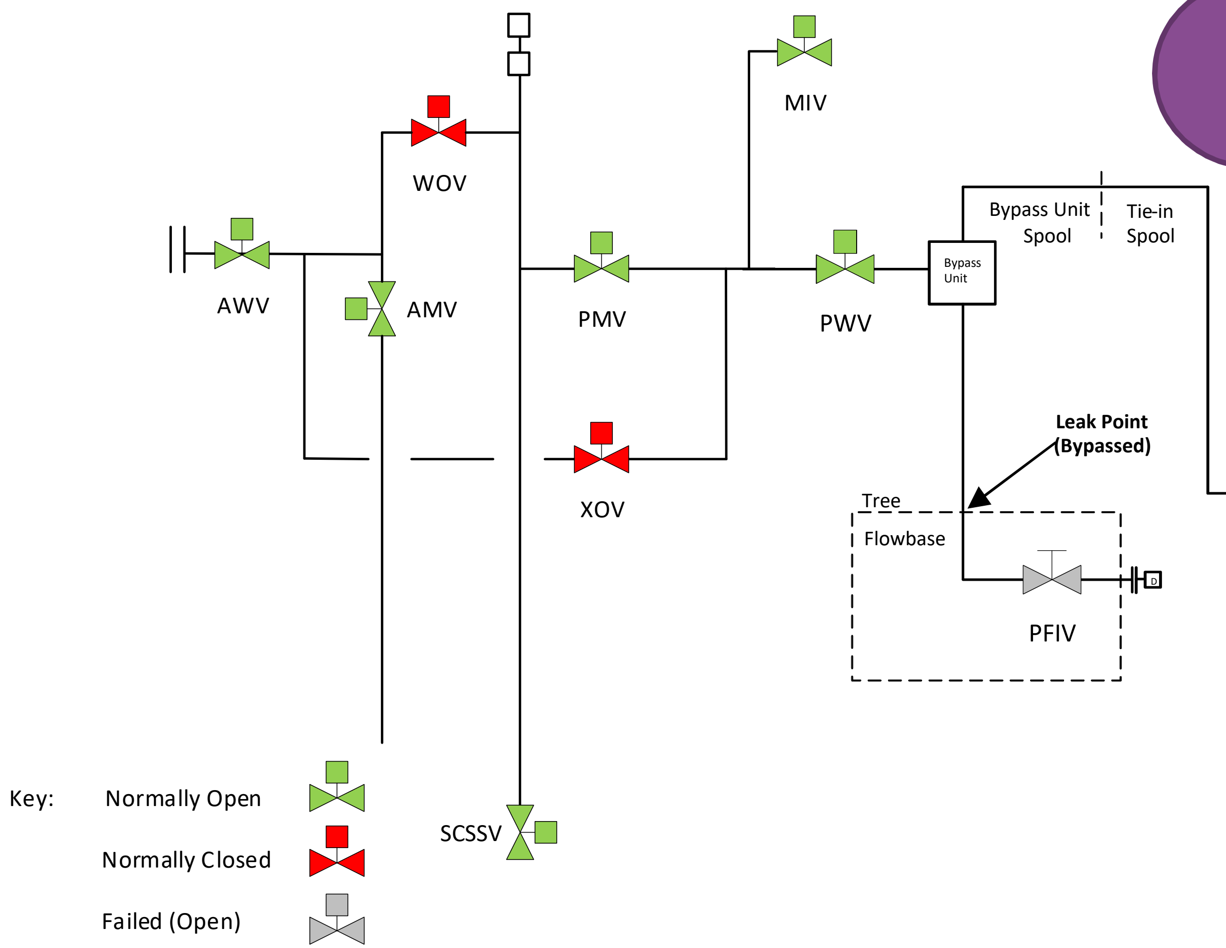
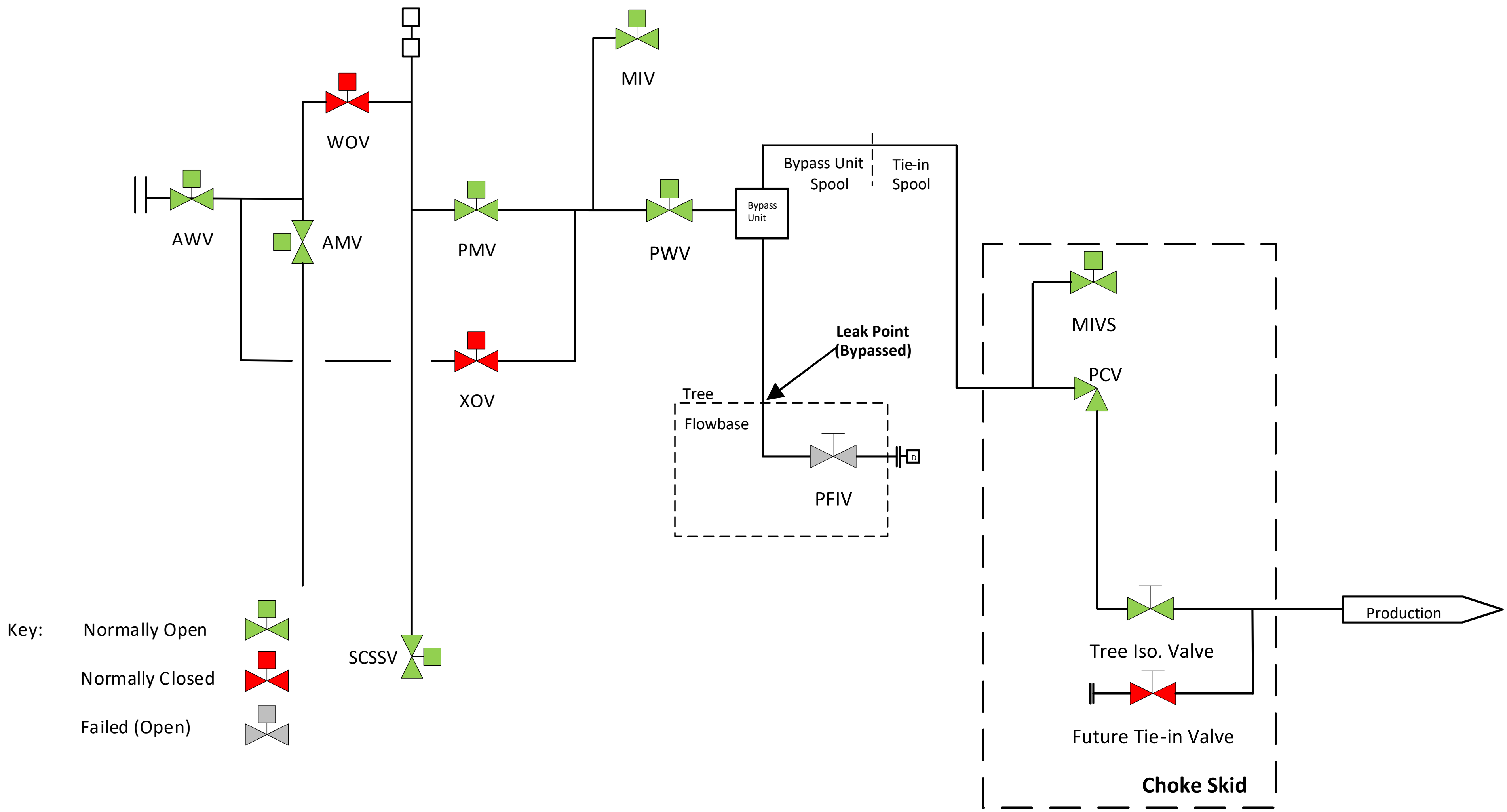


Bypassed Functionality

- Production choke valve
- Flowbase Isolation Valve (PFIV)
- D/S choke pressure sensor
- D/S choke temperature sensor

...New Tricks: Bypass Solution



Bypass Requirements

- Bypass is a DSV based approach
- Opportunity to improve existing field architecture

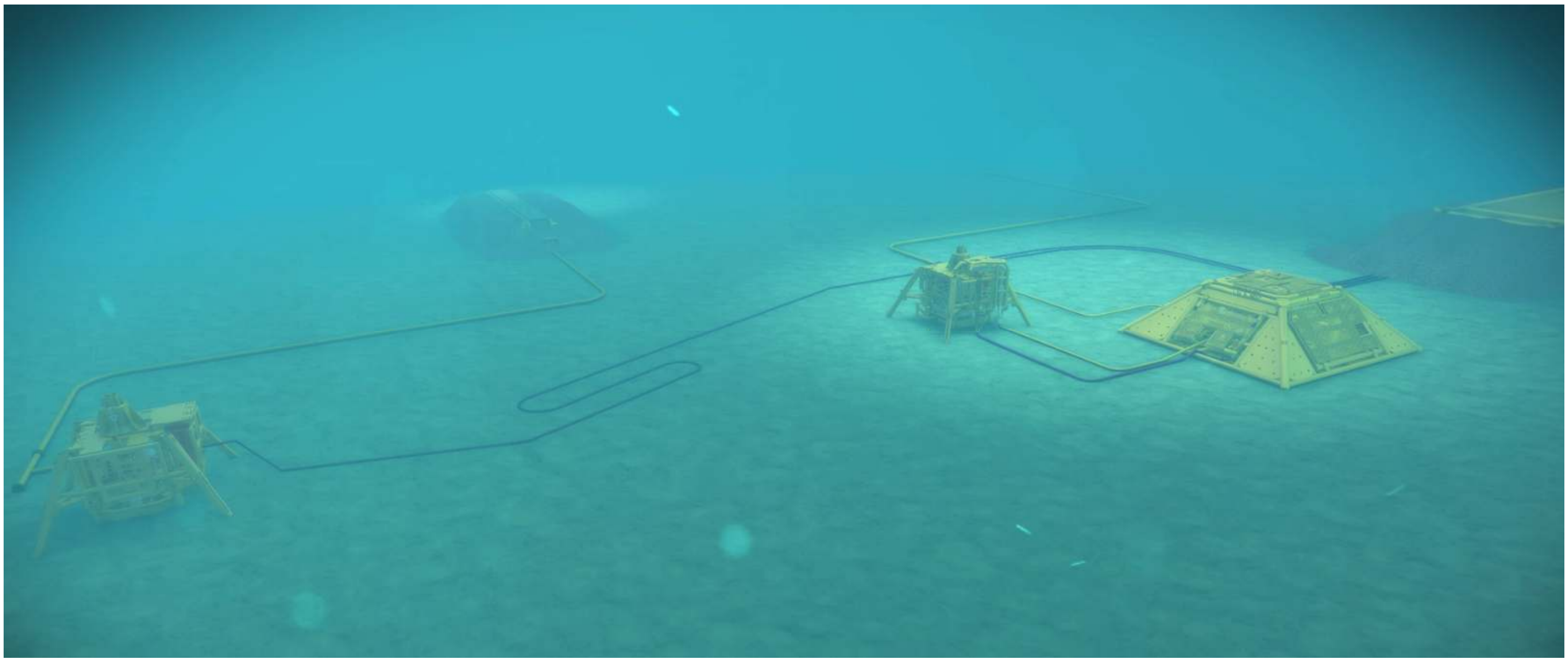
Equipment & Services Required

- DSV – isolation, repair & commissioning
- Proprietary choke bypass tool (modified)
- Remote choke skid (inc. valves and sensors)
- Choke control jumper extensions
- Tie-in spools

Improvements

- Increase LP hydraulic supply
- Local subsea control system isolations
- Include isolation points at future tie-in point

Bypass Scenario



Bypass Scenario

- DSV Repair campaign: est. 21 days (inc. Mob)
  - Assumed metrology spools delivered to worksite

Task	Duration	Cost
Engineering	18 months	£6M
Equipment	20 months	£3M
Offshore Execution	21 days	£5M
Lost Production	21 days	£3.5M
Total	21 months	£17.5M

- Actual repair time: 20 Days (inc. Mob)

Approach Comparison

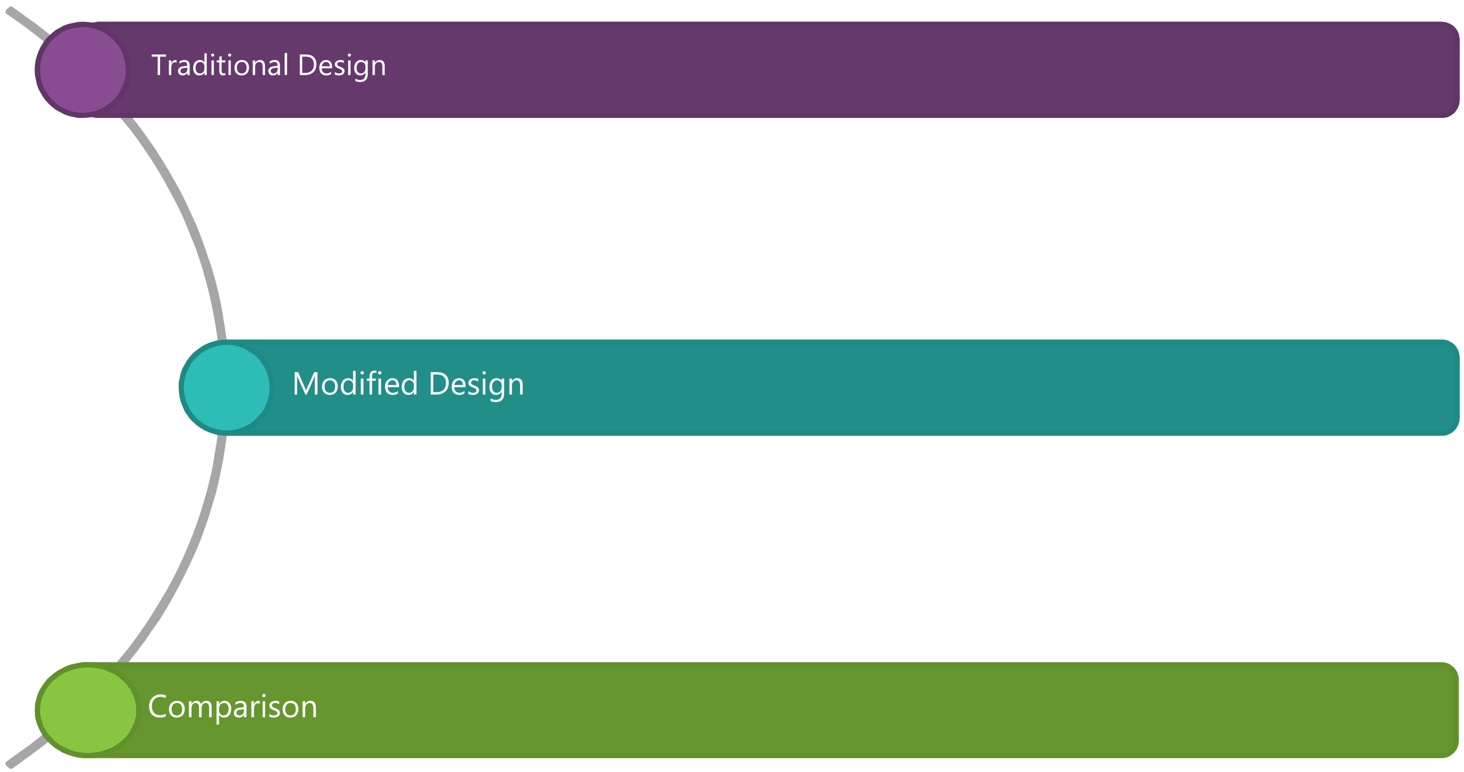
	Engineering & Equipment	Offshore Campaign Costs	Deferred Production Costs	Total
Tree Change	£11.5M	£35M	£7M	£53.5M
Bypass	£9M	£5M	£3.5M	£17.5M
Saving	*£2.5M*	*£30M*	*£3.5M*	£36M

- Bypass Option was ~1/3 of the estimated cost
  - Repaired tree has been in operation since Q2 2018

- This was achieved by applying the same strategy to all elements of the system

Leak Bypass: Manifold Design

Case Study: Manifold Design



Manifold Requirements

Bypassed Functionality

- Production choke valve
- Flowbase Isolation Valve (PFIV)
- D/S choke pressure sensor
- D/S choke temperature sensor

Design Requirements

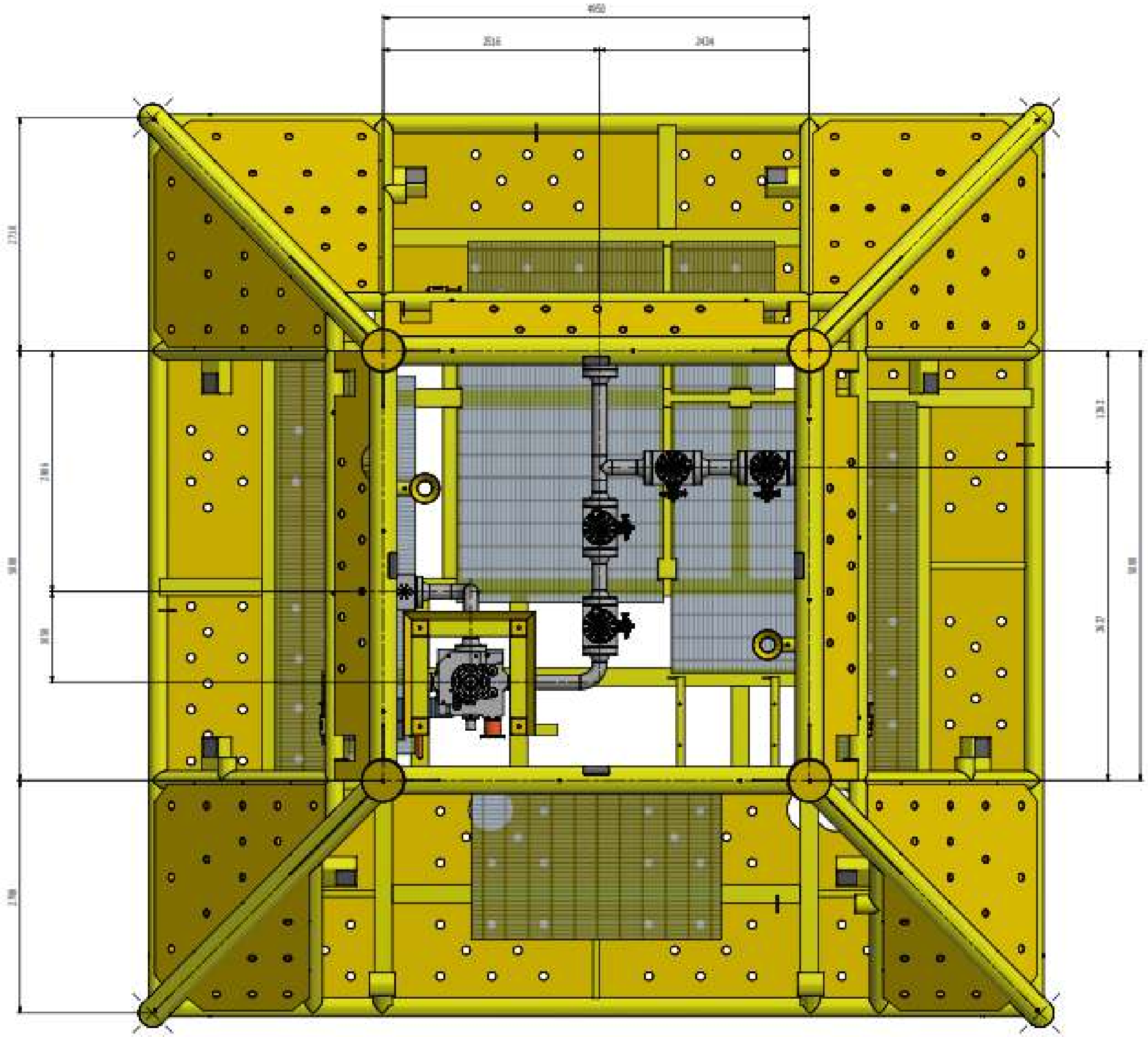
- Sour service materials
- Chemical injection
- Diverless choke insert change out
- Local hydraulic/ chemical isolations
- Fishing friendly
- Gravity base

Tie-in Functionality

- Well B tie-in
- Future tie-in point

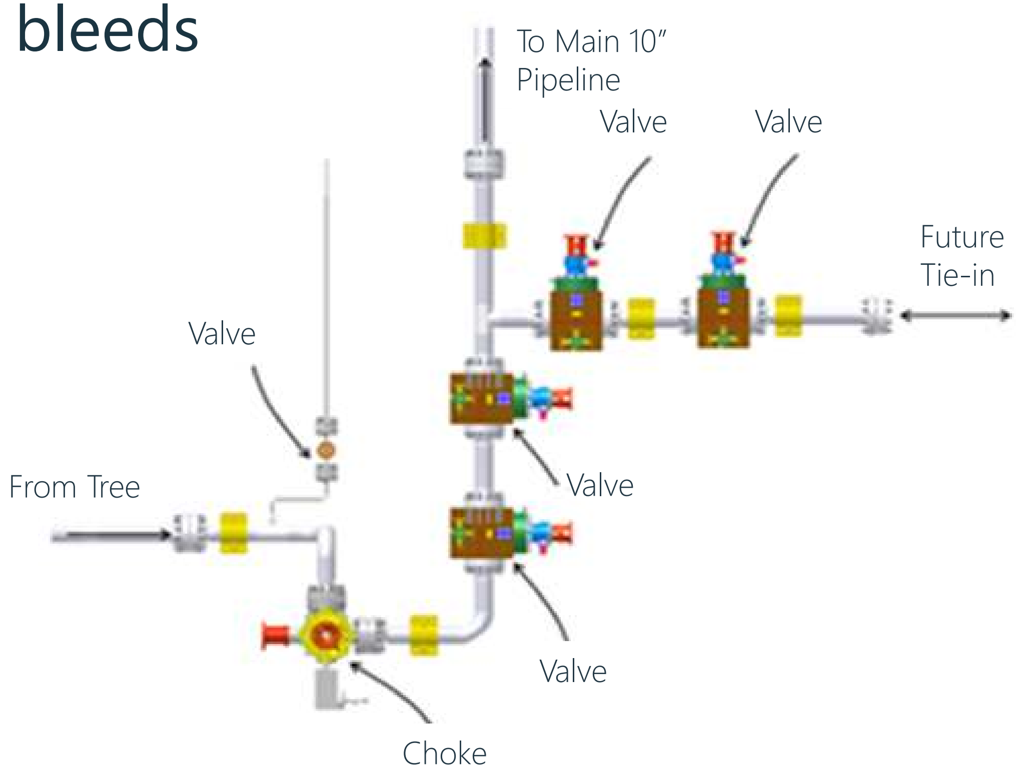
Traditional Manifold Design

- Sloped side gravity based design
- Removable roof & hinged side panels allow access for interventions



Traditional Manifold Design – Valves

- 4 x 6″ Manual gate valves
- 1 x 1″ Hydraulic gate valve inc. check valve
- 2 x ½ Double block and bleeds
- 1 x Production choke



Traditional Manifold Design

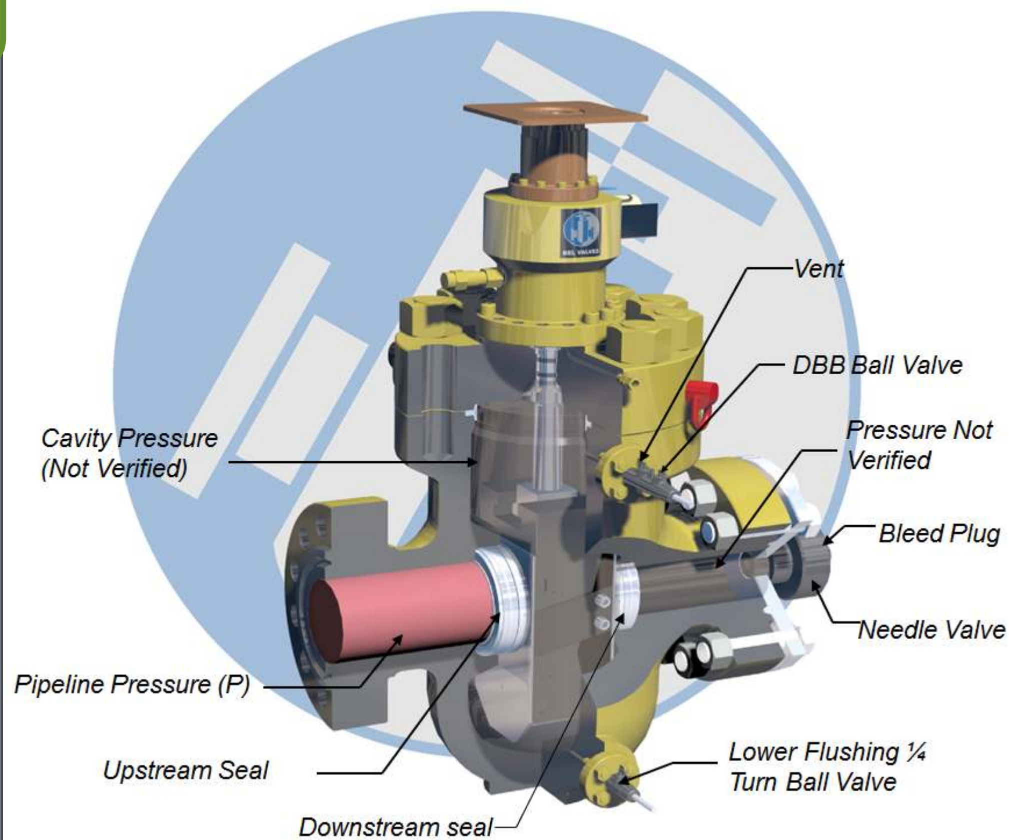
- Valves arrangement dictates size and weight of this structure
  - Valves arrangements were identified as key area for optimisation

Item	Qty	Cost
6″ Manual, Slab Gate Valve (5ksi)	4	£320k
½″ Needle Valve Double Block and Bleed Assembly	2	£140k
1″ Actuated Gate Valve with Check Valve	1	£26.5k
Structural Fabrication, Pipework and Assembly	-	£840k
Total		£1.3M

Double Expanding Split Gate Valves

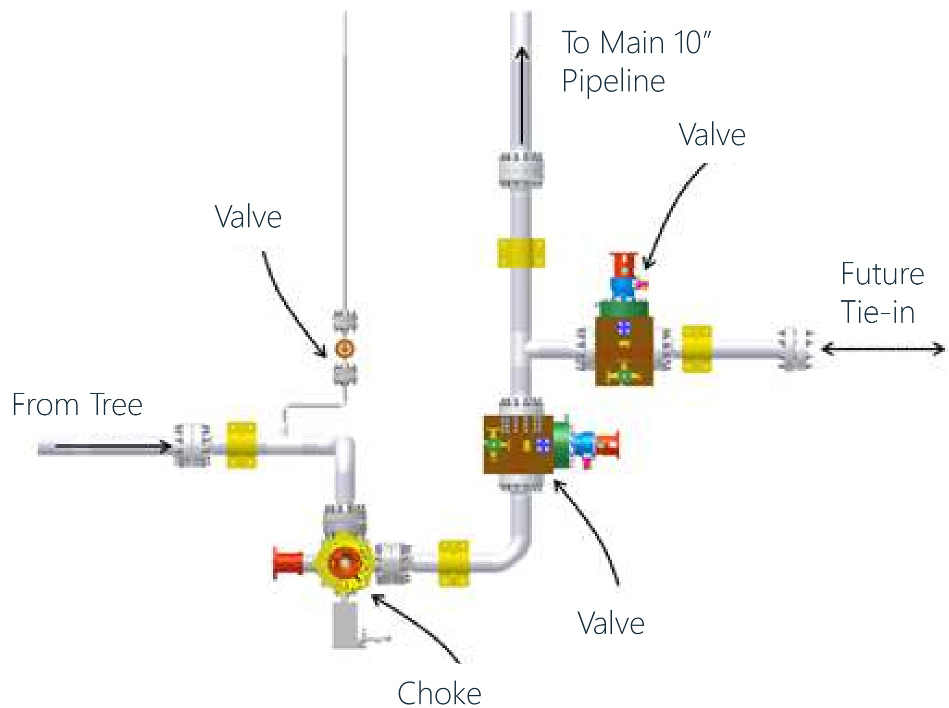
Equipment Overview

- First used subsea by Shell on the Pelican Expansion Manifold
- Seals are mechanically energised not pressure energised and spring loaded
- Mechanical rather than spring return prevents split gate not retracting on closure
- Allow for a double isolation to be achieved using a single valve
  - IMCA recognised

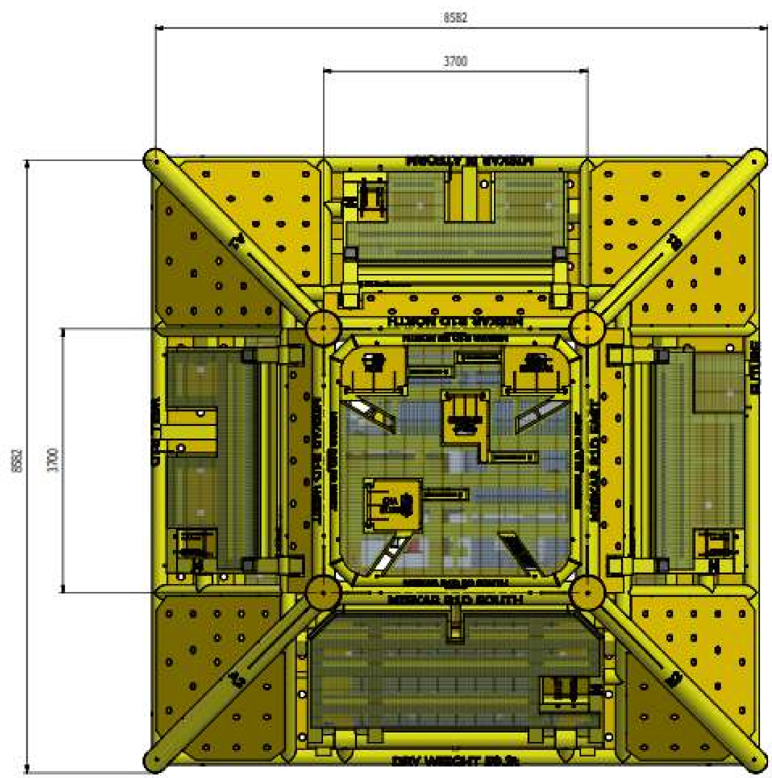


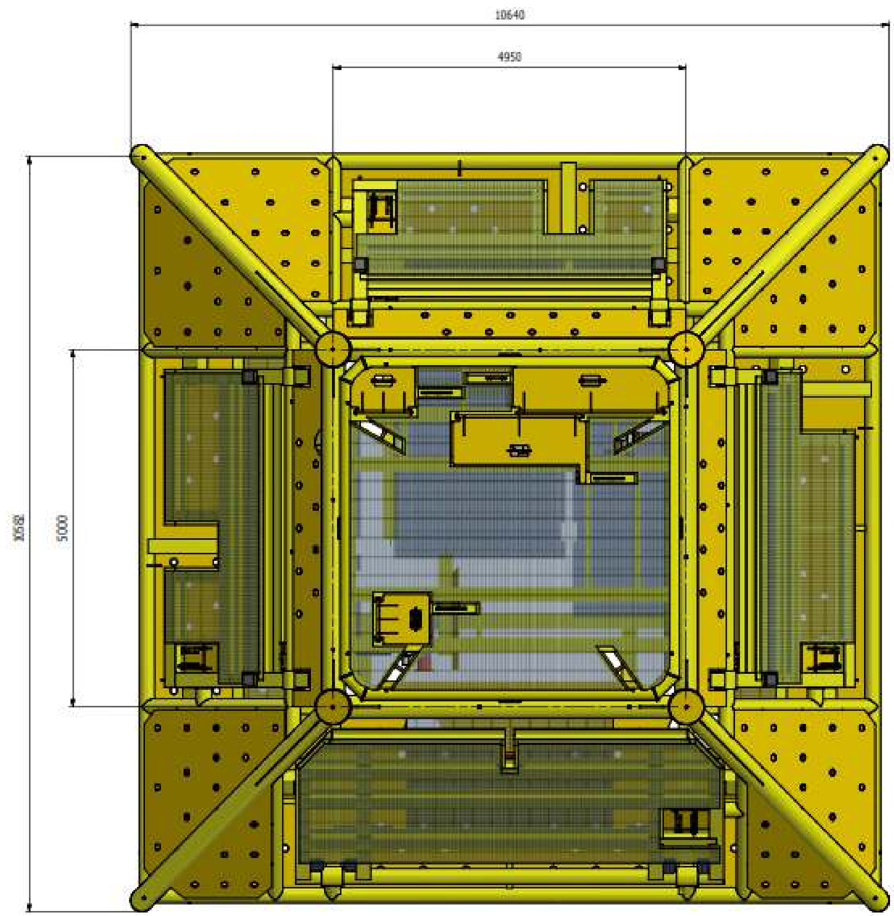
Modified Design – Valves

- 2 x 6” Manual double expanding gate valves
- 1 x 1” Hydraulic gate valve inc. check valve
- 1 x Production choke



Modified Design – Footprint Comparison





Modified Design

- Split Gate valves are more expensive on a 1-to-1 basis
  - ~£80k for manual gate valve
  - ~£95k for double expanding split gate valve
- Halves the number of valves required
- Removes the need for double block and bleed assemblies

Item	Qty	Cost
6" Manual Expanding Split Gate Valve (5ksi)	2	£185k
1" Actuated Gate Valve with Check Valve	1	£26.5k
Structural Fabrication, Pipework and Assembly	-	£650k
Total		£861.5k

Manifold Design Comparison

- One of a number of non-traditional approaches taken
- All technologies used were field proven

Item	Traditional	Expanding Gate	Saving \ Reduction
Skid Length	10.6m	8.8m	*1.8m*
Skid Width	10.6m	8.8m	*1.8m*
Skid Weight (air)	75 Te	59.3 Te	*15.7 Te*
Valve Costs	£486.5k	£211.5k	*£275k*
Fabrication Costs	£840k	£650k	*£190k*
Skid Cost	£1.3M	£861.5k	£438.5k

If you always do what you've always done, you'll always get what you've always got.

- Source Unkown

wood.

woodplc.com