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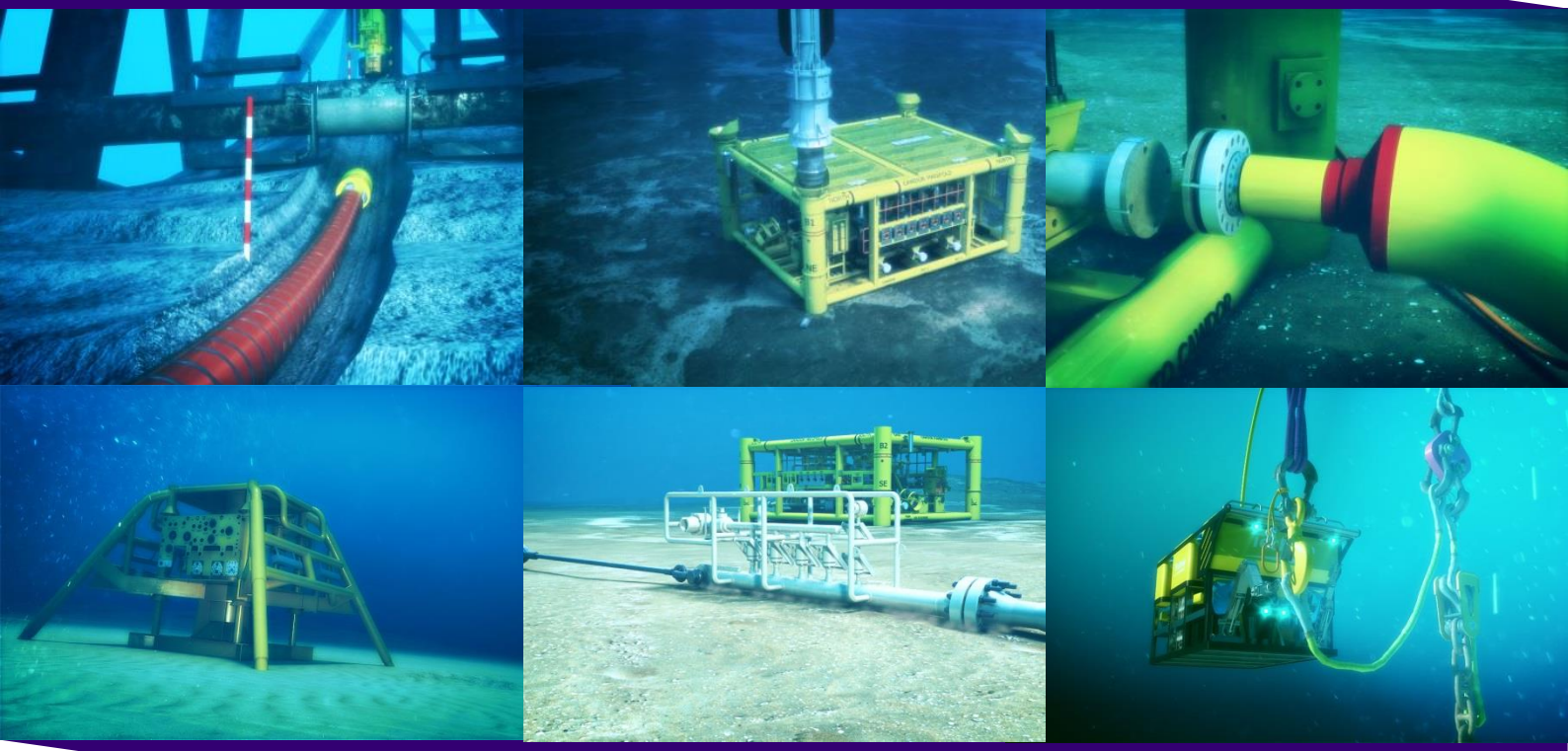

Subsea Standardisation – Guidelines on Adopting a Simplified and Fit for Purpose Approach

Issue 1

January 2017

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January 2017

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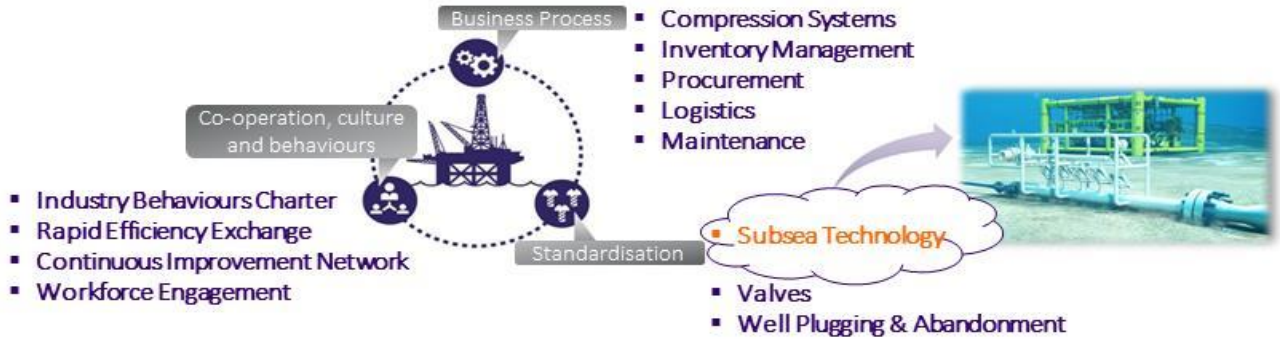
1 Purpose and Approach

1.1 Background

The Oil & Gas UK executive formally launched the Efficiency Task Force (ETF) in September 2015, to drive a pan-industry improvement in efficiency – with the aim of creating a sustainable industry in a lower oil price world. Significant cost savings are key to the success of the UKCS basin, which will in turn support the unlocking of stranded and sub economic pools for development.

While recognising that some behavioural change will be company-specific, Oil & Gas UK is taking the lead to help drive industry initiatives to achieve efficiency improvements and transformational change, formalising those initiatives under the ETF.

The task force is taking a three pronged approach under the following themes:



As part of the ETF work stream on Standardisation, the Subsea Standardisation Project was formed with the goal of identifying efficiencies that could be applied to subsea developments. Through adopting a simplified and fit for purpose approach, **sustainable savings of 25%** were demonstrated as achievable.[1]

1.2 Purpose and Approach of the Application Guidelines

The purpose of this document is to provide an overview on how to apply a simplified and fit for purpose approach to subsea prospects and future developments to provide efficiency improvements and cost reductions.

Focusing exclusively on the UKCS basin, this guideline provides a list of worked examples to help users gain a better understanding on their application. These examples are by no means exhaustive.

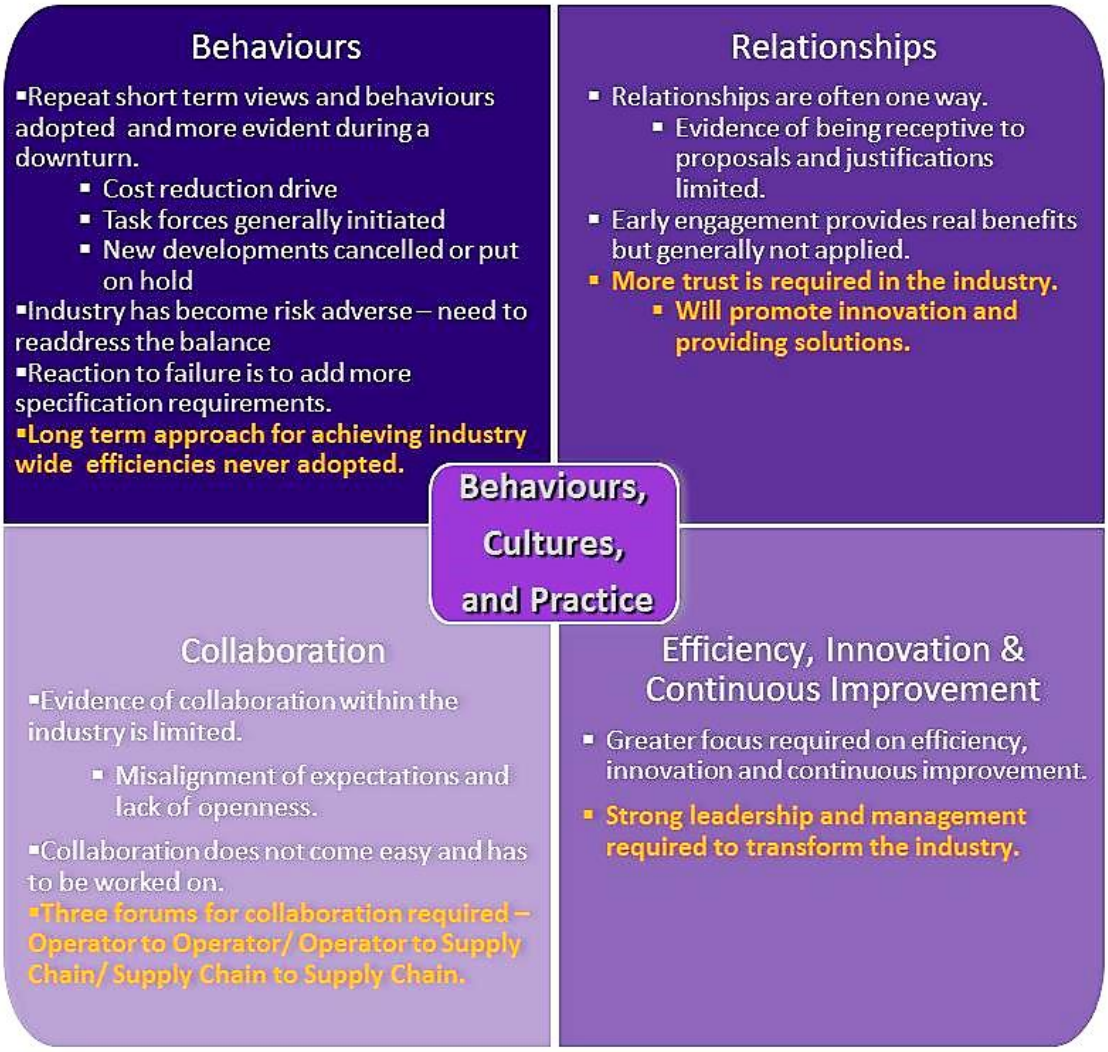
Within this guideline, behaviours, cultures and practices are covered, as these are instrumental to the adoption of change necessary to implement efficiency improvements.

The ultimate goal is to promote adoption and application of this approach to prospects and future projects in the UKCS basin going forward.

[1] Visit http://oilandgasuk.co.uk/etf-toolkit.cfm to find out more on the Subsea Standardisation Project and access the report presentation

2 Behaviours, Cultures and Practice

A literature review was undertaken as part of the project to gain a perspective on current knowledge and substantive findings of the oil and gas industry. The research covered previous oil & gas industry initiatives, predominately during low oil price periods; a cross sector industry review; and behaviours, cultures and practice within the oil & gas industry. It was evident from the findings that behaviours, cultures and practice were key to driving through change. The following behaviours, cultures & practice graphic, was therefore developed to highlight the key factors that need to be considered when implementing the effective changes necessary to provide efficiency improvements and the savings identified by the subsea standardisation project.



All stakeholders involved need to be receptive to new proposals. Greater trust between each other will promote working together, more closely, to achieve common goals, and provide optimisation and innovation leading to efficiencies. Three forums of collaboration are required between the key stakeholders, namely: operator to operator; operator to supply chain; and supply chain to supply chain. Stakeholder engagement will promote the sharing of knowledge and best practices.

3 Standardisation Themes

3.1 Background

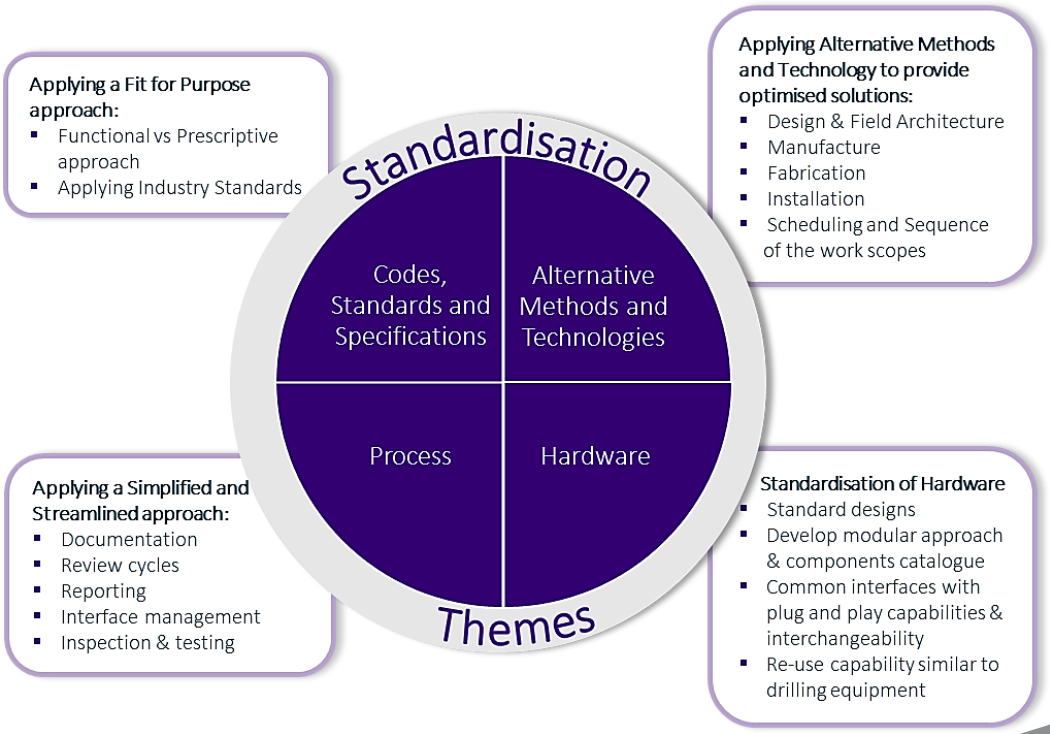
The projects initial brief was around subsea technology standardisation. True standardisation of this nature is considered long term and creates complex challenges, where some could be categorised as new technology. On this basis and giving consideration to the following:

- Immediate solutions are required now to provide efficiency improvements and cost reductions.
- The majority of small pools are within tie back range and therefore new technology is not essential, however making these pools economically viable to promote investment and development is the challenge.

The direction and the focus of the project therefore evolved to adopting a simplified and fit for purpose approach in terms of project delivery. The above culminated with the findings of the literature review resulted in the development of the following Standardisation Themes, as summarised in the graphic below. Each theme and its application is explained in greater detail in the following pages. An element of Subsea Technology was retained as part of the scope under "Hardware" but this provided a minimal contribution in terms of efficiency cost savings. As previously mentioned, this is considered a longer term goal for the industry.

True Subsea Technology Standardisation

- Equipment Hardware with:
  - Standard modular designs with standard footprints
  - Developing & applying a subsea component catalogue
  - Common interfaces with plug & play capabilities
  - Re-use capability similar to drilling equipment
- Standard processes and documents developed across industry:
  - Common UKCS standards applied covering the full EPCI scope
  - Common ITPs plus MRBs



3.2 Applying a Fit for Purpose Approach – Codes, Standards and Specifications

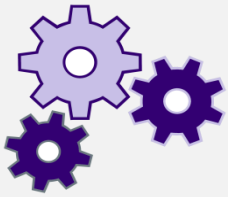
Prescriptive requirements, generally in the form of customer specifications, invariably result in additional criteria being requested, which leads to additional cost and schedule implications. This impact is compounded as the project size and level of complexity increases.

If the customer were to provide only the functional requirements in lieu of prescriptive requirements (such as customers own specifications) it creates an opportunity to provide a fit for purpose and optimised solution.

In Practice: Customer provides functional requirements and industry standards apply:

Design

- Functional requirements specified by the customer
- Applying only industry standards without customer specifications.
- Apply pre-qualified designs
- Use API purchasing guidelines where applicable.
- Realistic and representative approach applied in terms of the number of load cases applicable during analysis and levels of conservatism applied.
- Design in line with the field life (many of the future fields will have a field life less than 10 years.)



Materials

- Use of pre-qualified materials where possible
- Materials supplied to industry standard requirements
- Material certification endorsed by manufacturer representative.
- Fit for purpose approach adopted for material selection
- Material selection aligned to stock materials

Component, Product and Qualification Testing

- Apply testing criteria from industry standards with no additional specific customer requirements.
- Consider pre-qualified testing & qualifications in lieu of above
- Integration testing and product testing to manufacturers recommendation.
- Accept qualification testing to cover a range of sizes, i.e. scaling allowed
- Minor deviations are accepted on the basis of a desktop study

Manufacturing, Fabrication & Installation Requirements

- Supplier chooses their preferred manufacturing process
- Manufacturing tolerance set to manufacturers and industry standards rather than customer defined preference
- Installation tolerances set by the contractor with respect to combination of ease of installation, vessel time and equipment requirements

3.3 Applying a Simplified and Streamlined Process

Simplifying and streamlining the process will improve the overall schedule and reduce the number of engineering and project management hours associated with the scope.

In Practice: Focus on a simplified approach which will not impact the scope whether it is design, manufacture, fabrication or installation:

Documentation

- Move away from independent design review verifications
- Documentation streamlined to contractor's standard documentation
- Simplified ITPs and MRBs etc.
- Reduction of review cycles on key documents (1 comment cycle, 2 week turn around)

Interface Management

- One client focal point with limited involvement in the engineering process and design validation
- Reporting to a reduced format
- Simplified approach to project communications

Supply Chain Management

- Allow contractor to use their own approved vendors in accordance with ISO 9001
- Contractor allowed to manage supplier or sub-contractor without customer constraints
- No restrictions on supplier location.

Inspection

- Trusting the contractor / supplier to work to their approved processes
- Limiting the presence of inspectors on site during the manufacture or fabrication scope
- Challenge the value of front end control

3.4 Applying Alternative Methods & Technology to Provide Optimised Solutions

The size, complexity and schedule of a development influences how effective the application of alternative methods and technology will be.

Early engagement with key stakeholders increases the potential to realise alternative methods and technologies. The earlier the engagement at the preliminary stages of the development life cycle will offer the greatest potential to provide an optimised design with the greatest cost / schedule benefit.

In Practice: Alternative methods and technology can be applied across all elements of the work scope to considerable effect:

Design

- Combining design elements
- Revisiting field layout
- Simplifying subsea manifold structures
- Optimising pipeline sizes and coating requirements
- Reduction in dropped object and over-trawlability requirements
- Reducing levels of redundancy
- Alternative materials

Manufacture

- Manufacturers can provide fit for purpose materials
- Optimising and de-risking manufacturing schedule
- Using split gate valves for double isolations in manifolds
- Alternative manufacturing routes

Fabrication

- Combining leak and strength tests
- Alternative jointing details
- Alternative fit for purpose materials & coating systems

Installation

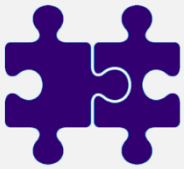
- Alternative installation and pre-commissioning methods
- Vessel activity optimisation
- Simplified constructability
- Schedule optimisation, vessel sharing and cluster development strategy

3.5 Standardisation of Hardware

The standardisation of hardware has the potential to deliver significant cost savings but faces complex challenges and is heavily influenced by companies' proprietary knowledge, commercial sensitivity, and the numerous systems/ equipment/ interfaces that individual operators utilise. Standardisation is therefore considered as a longer term objective for the industry.

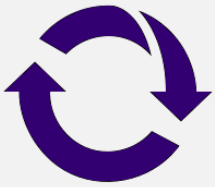
A shorter term approach to standardisation is to apply repeat solutions, where possible, and one example is the re-use of existing designs. Other longer term areas have been included below for consideration.

In Practice: Standardisation of hardware can be applied as follows:



Standard and Modular Designs

- Pre-defined equipment groupings (LP / LT, HP / HT etc.)
- Off-the shelf equipment
- Modularised and building block approach
  - Catalogue of components
  - Standard footprint / envelope for design components



Re-Use

- Re-use of equipment from one project to the next
  - Manifolds / trees / PLETS / flexibles / umbilicals
- Re-use of standard designs

Interchangeability

- Standard connections and interfaces
- Plug and play
- Standard communications protocols

4 Applied Examples

The following examples are taken from the Subsea Standardisation Project[2]. Each scope provided significant individual savings, which culminated in achieving the **overall savings of 25%** being demonstrated for subsea developments.

Combining FEED and Detailed Design

Significant savings can be achieved to front end engineering through combining FEED and detailed design phases. Schedule acceleration can be achieved through:

- Omission of detailed design tender
- Streamlining of the design process and duration
- A consistent design team re-using analysis models and calculations.

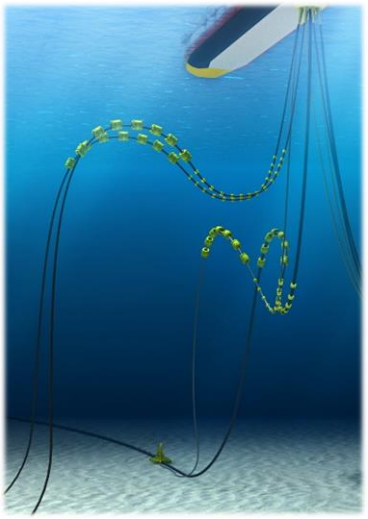
Re-Use of Standard Designs

Currently a vast majority of subsea equipment designed for the UKCS is bespoke in nature and designed/ manufactured to suit a specific field requirement.

- Significant savings could be made by deploying standard designs that would significantly reduce engineering time.
- Re-use of standard designs can also be applied. Through applying a standard design of control system to the Pegasus West Prospect, the SPS sub group identified a saving to the project management and engineering cost.

Flexible Riser Design Analysis

Design analysis has increased dramatically over the last two decades:



- In the 90's it was typical that only 12-60 load cases were used, today the number of load cases has increased to 5,000 – 12,000.
  - As a result, design analysis has become a project delivery critical path activity.
  - Similarly, analysis to allow replacement risers cannot be proven to work.
- There is no history of major failures from existing systems to justify the increasingly adverse number of design methodologies employed.
- A pragmatic approach to defining the number of load cases should be approached and an upper limit of load cases applied.

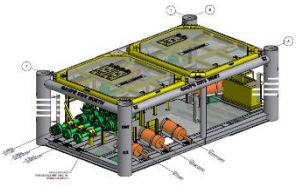
[2] http://oilandgasuk.co.uk/etf-toolkit.cfm

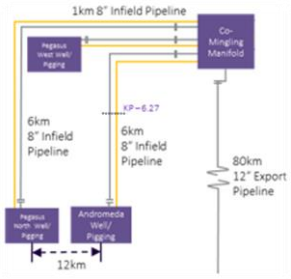
3rd Party Design Validation

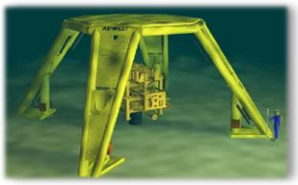
3rd party design validation is not a statutory requirement. Design houses work to approved quality management systems with mandatory internal checking prior to release of designs. Reducing the requirement for 3rd party design validation removes significant engineering hours associated with the scope.

Revised Field Layout

Working with design consultants and installation contractors, the following efficiencies were identified for the Centrica Pegasus West Prospect:







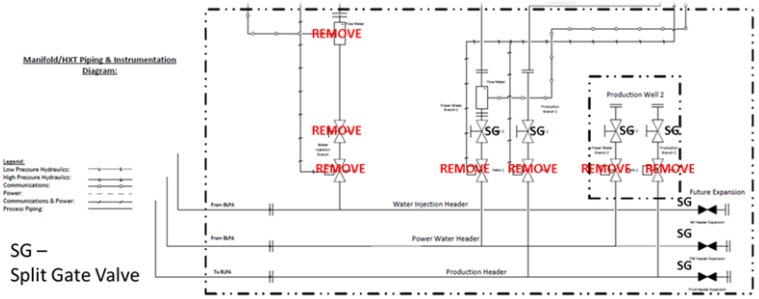
- Field layout optimised by introducing a co-mingling manifold to replace the well daisy chain configuration this reduced the number of valves including number of actuated valves.
- Simplified pipework at trees avoided protection structure plus reduced dewatering methodology.
  - To remove the complexities of fitting a barred tee under the Tree, it is feasible to preload the pigs in the downstream closing spools prior to installation.
  - 2" double block and bleed valve on the underside of drop down spool can be used to facilitate dewatering of the pipelines from the trees.
  - This solution removes the need for diving time in and around the tree to install valves and associated pipework, skids and protection structures for a barred tee.

Manifold Simplification

Working with Design Consultants, and Fabricators the following efficiencies were identified:

- Manifold P&ID simplified:
  - Using split gate valves for double isolation on production and power water branches
  - No actuation on valves in the manifold. Wells can be shut down at the tree so valves will only need to be closed for intervention or future expansion
  - Valves removed from water injection branch
    - If any intervention is required, it would be possible to shut down and de-pressure to hydrostatic pressure without the requirement for valves.
- Removal of flow meter from water Injection branch.
- Savings were identified through the fabrication by:
  - Soft strops used over lifting pad eyes
  - Re-using pile guides
  - Using square joints over mitred joints

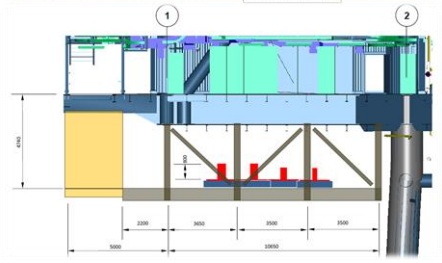
- Using pre-qualified welding procedures and welder qualifications.
- Reduced inspection requirements.
- Reduced documentation requirements.
- Combined strength and hydrostatic test.
- Working to industry standards and not applying client specifications.



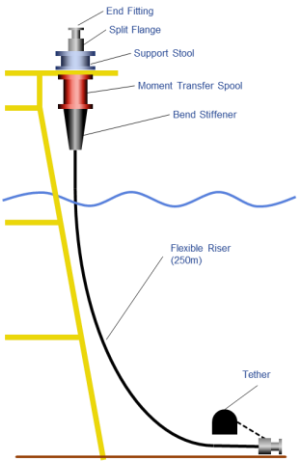
Alternative to Caisson Risers

As an alternative to a caisson riser the West Wick Review looked at free hanging risers, which provide a significant saving.

Through installing a hang-off platform to support three flexible risers and an umbilical, the following were applied:



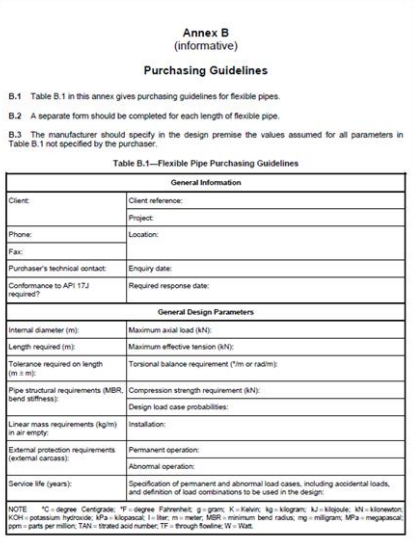
- The platform will be located on the north west corner of the Captain BLPA and supported from the platform cellar deck
- Riser orientation from BLPA lies 30 degrees west of platform north
- Minimum spacing between risers is 2.0m
- Assess to the hang off platform will be from the north-west stair tower
- The underside of the hang-off platform will be +19.56m, this is 1.02m into the 10,000 year wave crest but does not introduce any safety concerns
- Under deck steelwork will be installed via the platform crane. Items will be lowered at the north-west corner and cross hauled into location under the cellar deck
- Proposed location is an inherently safe area in relation to supply boat impact.



Riser hang off loads for risers and umbilical total 98.7t. Hang off platform gross weight equates to 51.6t.

Flexibles

- Using a pre-qualified design
- No 3rd party reviews of design calculations
- Inspection Hold points only for hydrotest and final load out.
- Small load case of circa 2000 load cases applied
- Documentation reduced with only one comment cycle
  - GA drawings, ITP & quality plan, design report, MRB (containing only CoC & material certs.)
- Testing requirements to only API 17J criteria
- Approved vendor savings
  - Using only supplier approved vendors
  - Contractor to control their own supplier process
- Applying UKCS amendment to API 17J
  - Design based on normal operating temperature and not maximum operating temperature
  - Applicability of survival case not relevant to UKCS
  - Allow for combined probability to include the combination of functional loads and environmental loads as previously stated in the 3rd ed. of API 17J



Annex B
(informative)

Purchasing Guidelines

B.1 Table B.1 in this annex gives purchasing guidelines for flexible pipes.

B.2 A separate form should be completed for each length of flexible pipe.

B.3 The manufacturer should specify in the design premise the values assumed for all parameters in Table B.1 not specified by the purchaser.

Table B.1—Flexible Pipe Purchasing Guidelines

General Information	
Client:	Client reference:
	Project:
Phone:	Location:
Fax:	
Purchaser's technical contact:	Enquiry date:
Conformance to API 17J required?	Required response date:
General Design Parameters	
Internal diameter (m):	Maximum axial load (kN):
Length required (m):	Maximum effective tension (kN):
Tolerance required on length (m ± m):	Torsional balance requirement (°/m or rad/m):
Pipe structural requirements (MBR, bend stiffness):	Compression strength requirement (kN):
	Design load case probabilities:
Linear mass requirements (kg/m) in air empty:	Installation:
External protection requirements (external carcass):	Permanent operation:
	Abnormal operation:
Service life (years):	Specification of permanent and abnormal load cases, including accidental loads, and definition of load combinations to be used in the design:

NOTE °C = degree Centigrade; °F = degree Fahrenheit; g = gram; K = Kelvin; kg = kilogram; kJ = kilojoule; kN = kilonewton; KOH = potassium hydroxide; kPa = kilopascal; l = liter; m = meter; MBR = minimum bend radius; mg = milligram; MPa = megapascal; ppm = parts per million; TAN = titrated acid number; TF = through flowline; W = Watt.

Pipelines

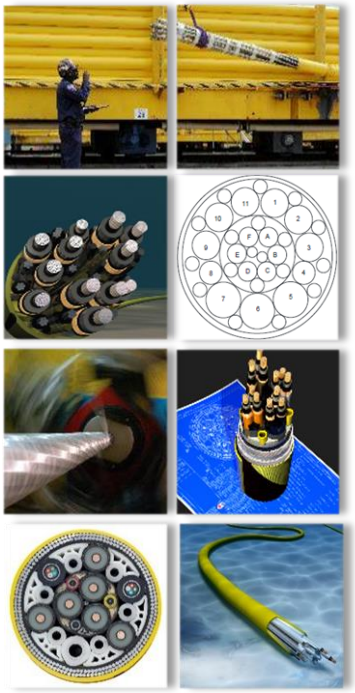
The Pipelines scope identified significant savings in both prospect reviews. These included:

- Material Selection:
  - Use of High Frequency Induction Line Pipe
  - Optimised Wall Thickness
- Inspection and Control:
  - ECA and AUT replaced with manual welding and radiography
- Qualifications:
  - Use of pre-qualified welding and welders qualifications
- Fabrication and Installation:
  - Removal of field joint coatings
    - As there is no requirement for insulation and a short design life of the pipeline opting for additional anodes to provide cathodic protection was a cheaper solution
  - The removal of field joint coating, and ECA and AUT process increases the fabrication time for reel lay pipelines and the lay rate for ‘s’-lay pipelines. This provided significant schedule and cost savings

Umbilicals

Significant savings could be realised on the delivery of an Umbilical. These include:

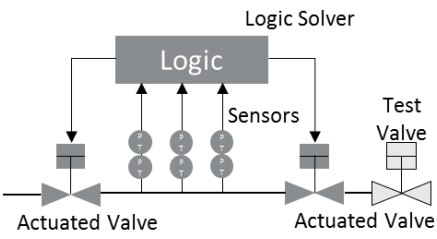
- Umbilical Redundancy:
  - Removal of spare hoses and combining power with communications, reduced the core size of the umbilical
- Materials:
  - Supplier allowed to choose appropriate material and grade to achieve functional requirements:
    - Opting for thermoplastic tubing
    - Wall thickness of the tubing
    - Electrical cables material selection and design optimisation
    - Hose selection using 5000psi over 7500psi
    - Optimisation of armour wire package
- Manufacturing:
  - Allowing manufacture to choose the most efficient lay-up process
- Engineering and Design:
  - Using DNV RP 101 and ISO 13628 as a base case standard for design
- Documentation:
  - Reduce documents to only manufactures standard documentation



Control System

Significant savings were realised on a UKCS Controls System through:

- Adopting a HIPPS system allowed for a smaller line pipe wall thickness to be used. This significantly reduced line pipe procurement and installation costs
- Using standard supplier designs
- Through measuring flow at the host rather than adopting a multiphase flow select meter
- Opting for a single SEM with a dual power source realised substantial cost savings
- Further savings were also realised through:
  - Reducing documentation to GA drawing, ITP, IOM and CoC
  - Inspection only at FAT with only one additional level of inspection (i.e. client inspector)
  - Using supplier approved vendors and allowing control of their own process



Trees:

Significant savings can be realised through simplifying the process on the delivery of a UKCS tree:

- Tying witness and hold points to commercial milestones, so client inspection only occurred during factory acceptance test and delivery
- Assume review can be managed in time for milestones and that Hold point should only be at critical stages of manufacture
- Using only supplier approved vendors where contractor controlled their own supplier process
- Reduction in documentation through accepting contractor standard documentation and reviewing only critical documents through a single review process
- Using standard supplier designs
- Measuring flow at the host rather than adopting a multiphase flow select meter

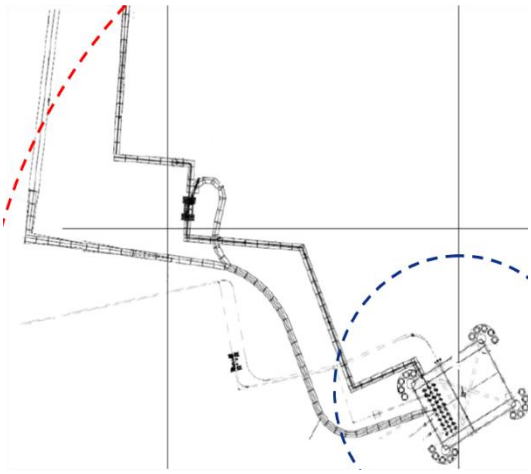
Valves

Significant savings could be realised on a valve scope by applying the following:

- Material Specifications
  - Materials specified on standard material data sheets and/ or standard ASTM requirements
- Equipment Specification
  - Adopt standard contractor sealing arrangements
  - Use cast bodies for gate valves
  - Partial cladding for ball valves
  - Limit the number of different valve types/ designs
  - Use contractor standard sizing factors
- Qualification Testing
  - Existing proven designs
  - Scaling allowed
  - Use of pre-qualified welding and welders' qualifications
- Documentation
  - Documentation limited to GA Drawings/ ITP/ IOM and CoC.
  - Reduce review cycles to 1 comment cycle and 2 weeks' turnaround
- Inspection
  - Trust contractor inspection processes with only a witness point at Pressure Test

Dropped Object and Over-trawlability

- Typical protection requirements are that all exposed pipes below 16" OD require protection
- As no fishing will occur within the 500m zone there is potential to reduce the number of concrete matts around the platforms
- By trenching into the 500m zone there is an area between the dropped object cone and the boundary of the 500m zone where no matts would be required
- The reduction of matts also has a significant cost and schedule saving from vessel duration



Single Trench for Pipeline & Umbilical

- To reduce the trenching and backfill scope and the corridor for boulder clearance prior to trenching, the umbilical can be laid in the same trench as one of the pipelines

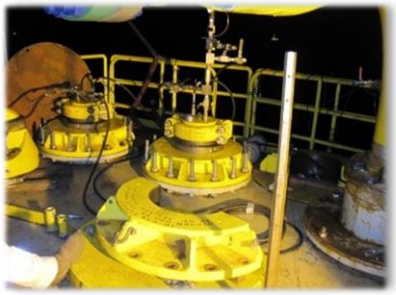
Crossing Designs

Rock quantities and subsequent installation time were reduced, through challenging:

- Crossing separation reduced to 0.3m as per DNV-OS-F101
- Optimised berm height of 0.3m above pipe – suitable for over-trawlability and UHB mitigation
- Trench transitions reduced to 50m
- Using concrete plinths rather than concrete mattresses

Pre-commissioning

Combination of the hydrostatic strength test and the leak test into one activity upon completion of all tie-in spools:



- Pipeline tested at 1.5 x Design Pressure as per DNV-OS-F101
- 24 Hour hold period with reading every 15 minutes
- Dewatering upon completion of testing

5 Summary

The Subsea Standardisation Project has identified **sustainable savings of up to 25%** on subsea developments, which are achievable by applying the standardisation themes. The overall savings and weighting of each of these standardisation themes will vary from project to project, by the cultures and behaviours adopted, and the perception of risk, where:

- Codes, standards and specifications are influenced by the level of prescriptive requirements where applying a functional approach will allow the opportunity to provide a more cost effective and optimised solution.
- Process is influenced by the increasing levels of:
  - Controls being applied
  - Detail and information requested
- Alternative methods and technology is mainly influenced by the scope and level of early engagement from the supply chain where the earlier the engagement, the greatest potential exists for achieving cost and schedule savings.
- Hardware standardisation today offers limited savings in the short term but provides potential for achieving significant savings in the longer term. The success of hardware standardisation achieving the greatest impact is influenced by propriety knowledge, commercial sensitivity and preferential requirements.

With adopting a simplified and fit for purpose approach, there is still a responsibility that the supply chain delivers to the necessary quality levels, where the appropriate assurance processes are in place to achieve this.

Wider adoption of the standardisation themes to prospects and future projects will provide "sustainable savings" going forward.

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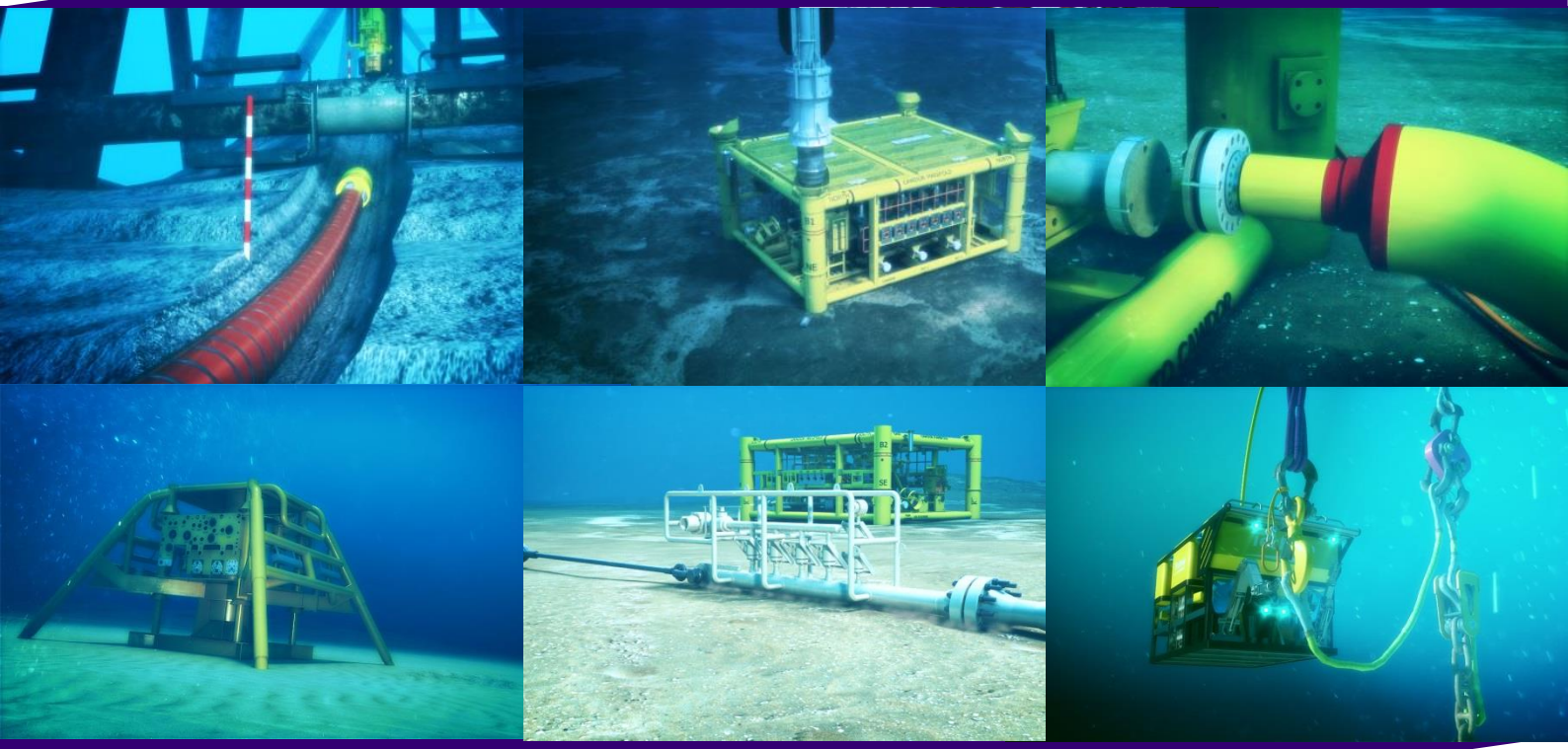

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