



Current Status and Strategies for Deep Sea Oil and Gas Development

JITI Seminar, Tokyo, 25 February 2015

Dr Alf Engseth | Senior Project Manager Front End Spectrum Malaysia

Contents

- Introduction of Aker Solutions
- Overview of Offshore Floating Facilities
- Floating Facilities Selection
- Engineering and Subsea Technologies
 - Subsea Compression
 - Dry Tree Semi
 - KBe Design
- Concluding Remarks

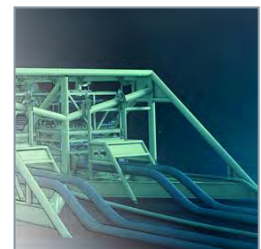
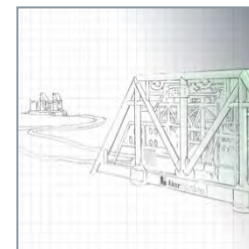
This is Aker Solutions



Employees: **17,000**
Revenue: **29.1 bn**
EBITDA: **2.2 bn**
EBIT: **1.7 bn**
Market Cap: **12.5 bn**

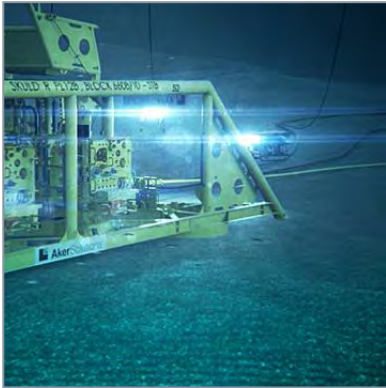
Revenue and profits are in NOK and pro forma for 2013. Market capitalization as of October 15, 2014.

- Aker Solutions is a global provider of products, systems and services to the oil and gas industry
- Built on more than 170 years of industrial tradition
- Employs approximately 17,000 people in 18 countries



Unique Subsea Technology and Field Design

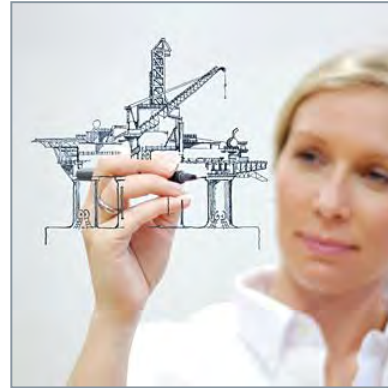
Subsea



Subsea

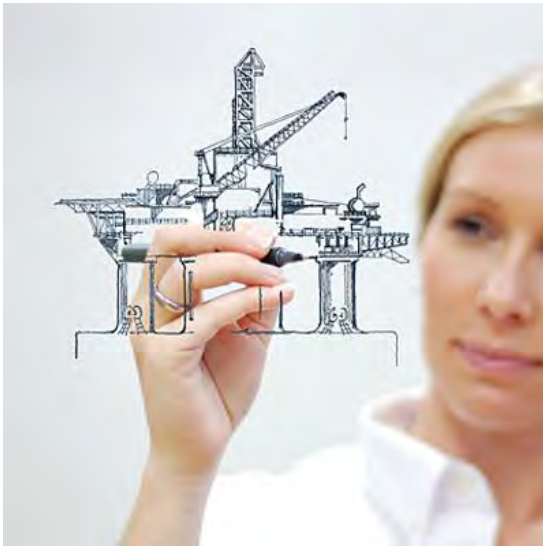
Umbilicals

Field Design

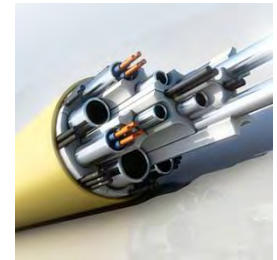
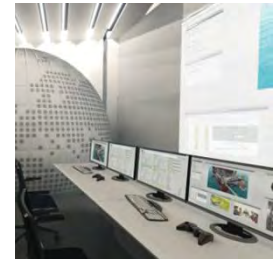


Engineering

Maintenance,
Modifications and
Operations

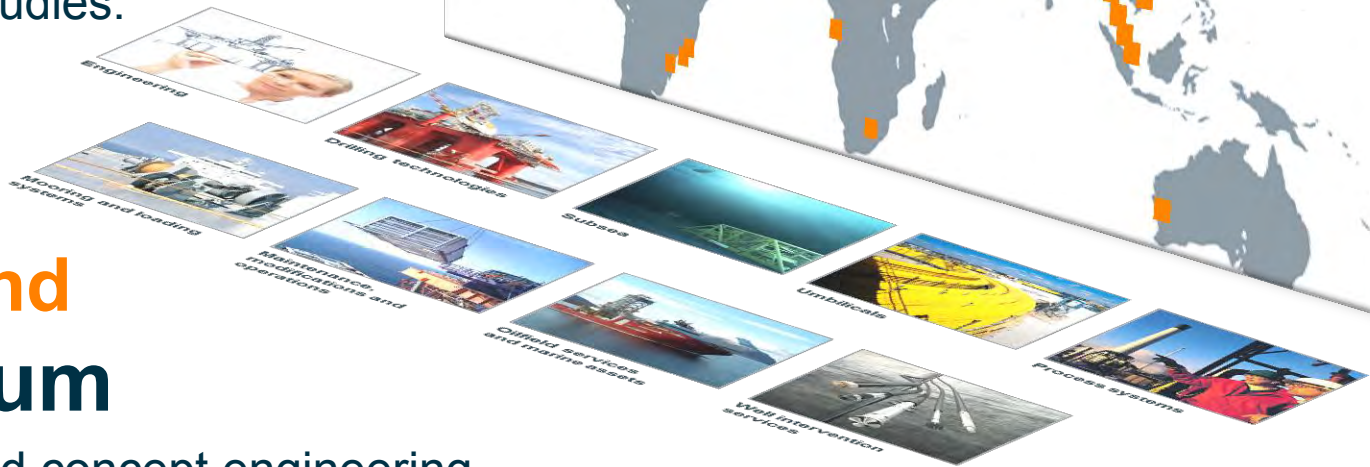


Value creation
through **earliest
involvement**



What is Front End Spectrum?

- Front End Spectrum is a combined offering for study work between all **Business Areas (BA)** in Aker Solutions
- Front End Spectrum is responsible for the total execution, coordination and quality of all cross **BA** feasibility, evaluation, and concept studies.

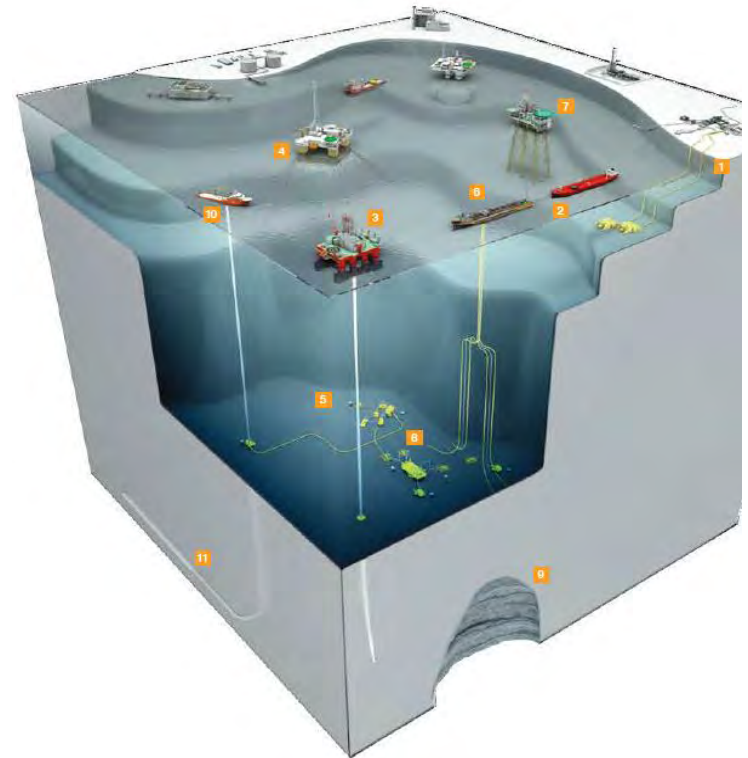


Front End Spectrum

Feasibility and concept engineering by Aker Solutions

Front End Spectrum

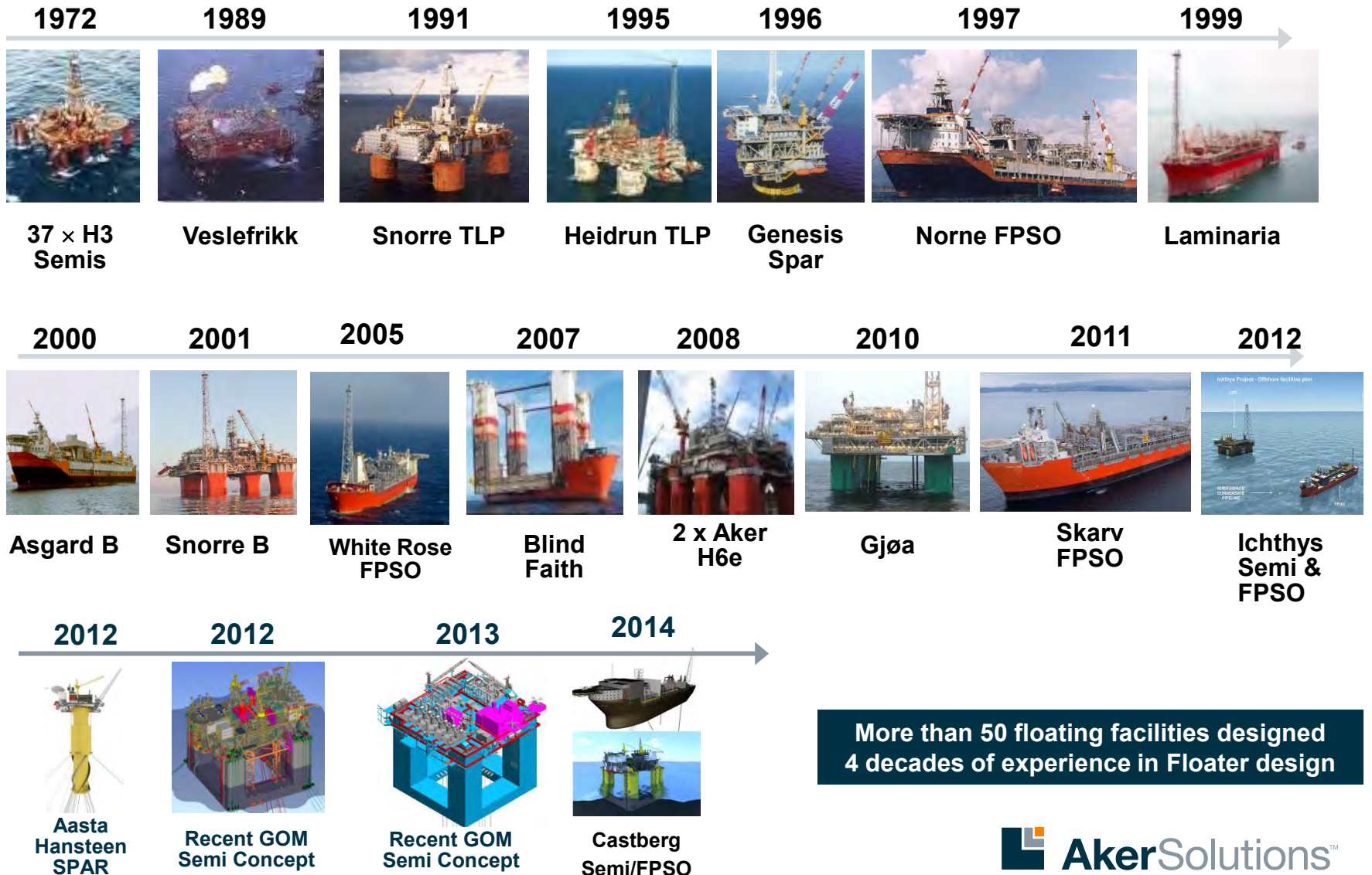
- 25 years experience in Front End / Field Development solutions
- Approximately 350 front end work personnel worldwide covering both greenfield and brownfield developments
- Expertise includes:
 - Floaters - Semi's, TLP's, FPSO's
 - Drilling Technology
 - Subsea systems
 - Flow Assurance
 - Fixed offshore platforms
 - Onshore and Offshore developments
 - Brownfield / Rejuvenation projects



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Floating Platform Experience / References

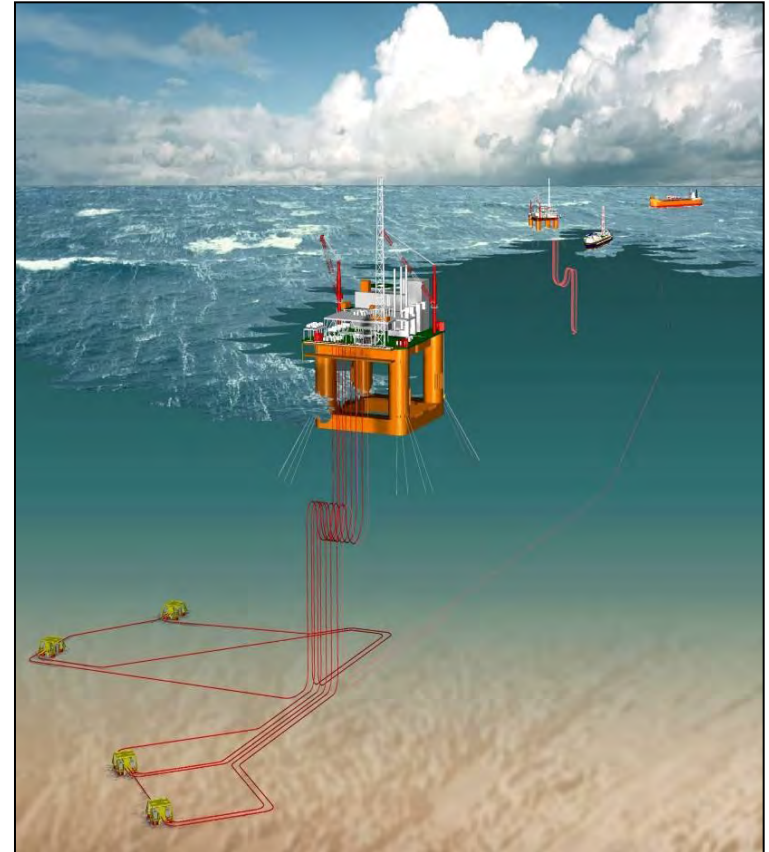


More than 50 floating facilities designed
4 decades of experience in Floater design



Semi – Main Characteristics

- Subsea completed wells
 - Remote subsea wells with workover by specialist vessel
 - Wells below with integrated drilling/workover facilities
- No oil storage
- Wide range of payload capacity
- Large number of flexible risers possible
- Short to medium development schedule
- Installed as fully integrated system
- New-build or conversion
- Good motions, feasible for Steel Catenary Risers (SCRs) in deep water



Blind Faith – Deep Draft Semi



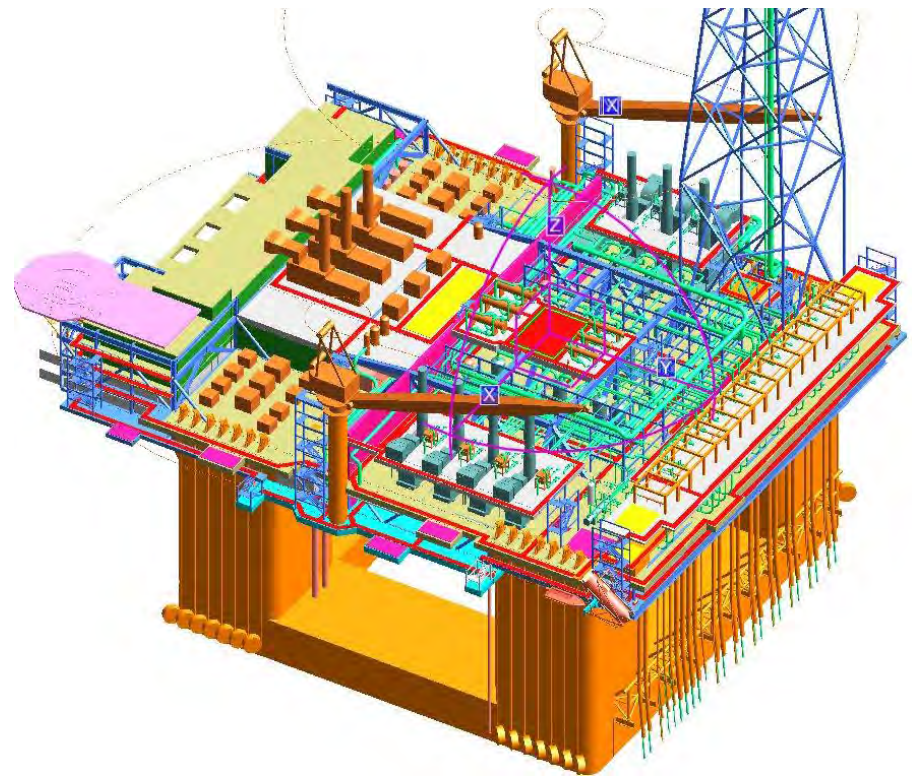
Semi - Fabrication and Installation

- World wide fabrication facilities
- Simple transport and installation
- No offshore lift and integration
- Dry transport of Semi on heavy lift vessel is possible.



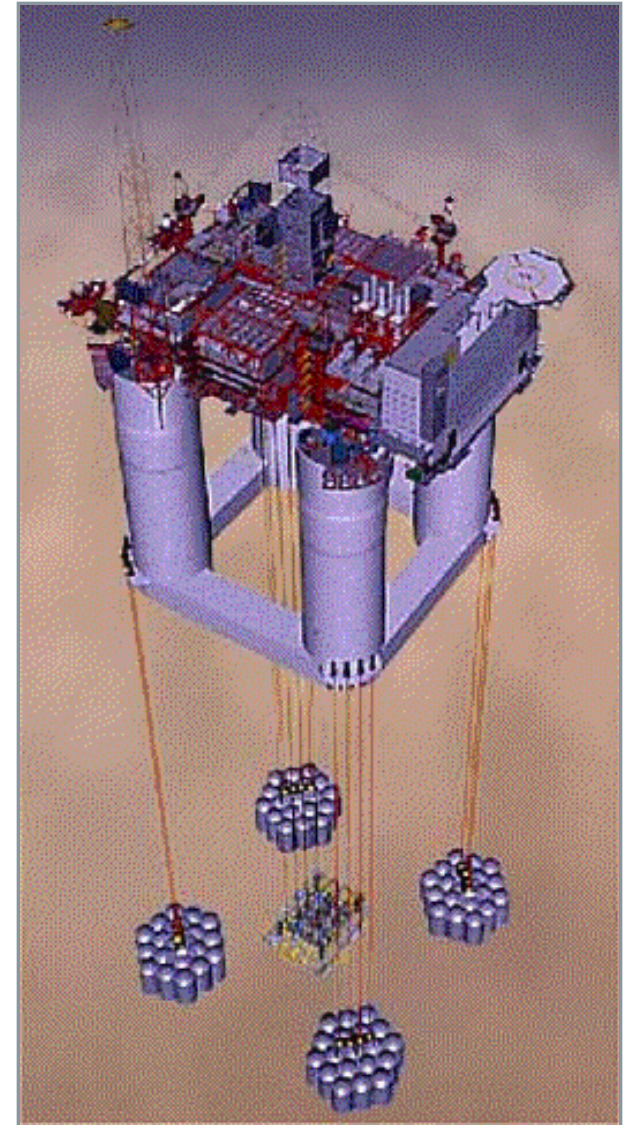
Ichthys Semi – Hull Design Requirements

- Support a fully integrated topside with “not to exceed” weight of 67,800 tonnes
- Designed for Far East construction with float-over integration or topside assembly on top of hull.
- 27 flexible risers in guide tubes
- 40 years service life
- Water depth 260m
- Hull dry weight 41,600 tonnes
- Displacement 152,700 tonnes



TLP - Main Characteristics

- Allows surface wellheads (dry trees) with vertical access to wells
- Station keeping and stability by tethers
- Tensioned rigid risers for production
- Drilling and workover capability
- Single drill center
- Support of remote wells
- Improved motion characteristics
- No oil storage
- Water depth/payload limited
- Relatively long development schedule
- Installed as fully integrated system
- Custom designed for site specific application



TLP - Browse DTUs

Design Parameters

- Condensate export capacity 69000 bopd
- Gas export capacity 2000 MMscfd
- Topside Dry weight 16000 tonnes + drilling modules
- Topsides size 96 x 45m
- Water depth 590 m

Topside

- 1st stage separation
- Modular drilling
- Gas export to CPF (jacket)

Hull

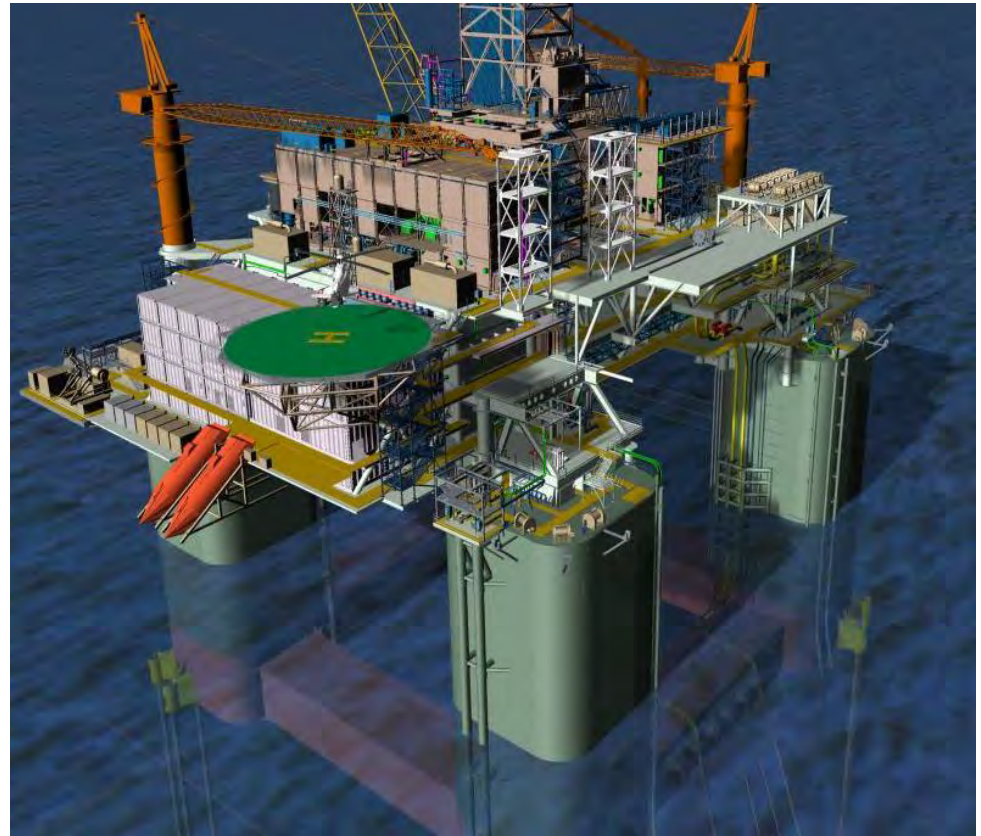
- Column spacing 72 m
- Draft 32.00 m
- Displacement 88,000 tonnes

Mooring system

- 12 tethers, 44" dia.
- Gravity anchors

Risers

- 14 TTR (3,400 tonnes)
- SCR export

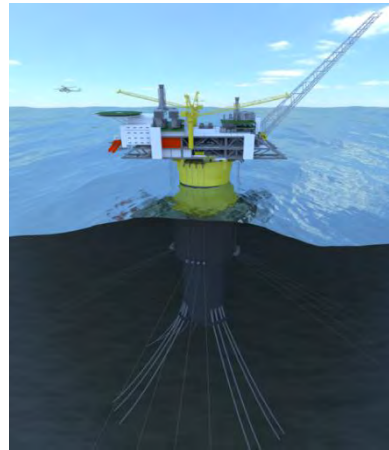


SPAR - Characteristics

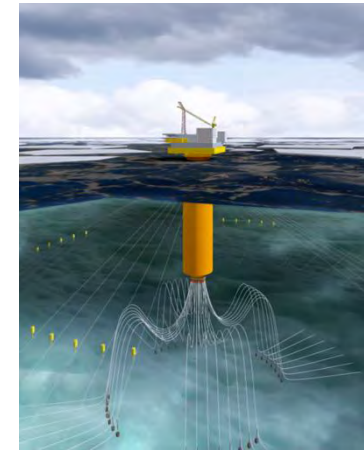
- Weight stable (by counter weight)
- Limited capacity, offshore lift of topside.
- Limited footprint
- Excellent motions, TTRs
- Dry Trees
- Storage (limited)
- Integration and commissioning offshore



Genesis



Aasta Hansteen



Arctic Shtokman

Spar Upending



FPSO – Characteristics

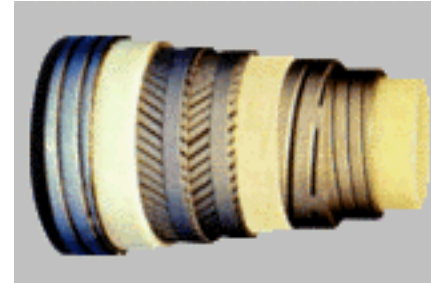
- Remote subsea completed wells
- Drilling/workover requires specialist vessel
- Integrated oil storage and offloading
- Large topside capacity, good separation between hazardous and non-hazardous areas
- Flexible risers
- Short development schedule
- Integration and commissioning inshore
- Installed as fully integrated system
- New-build or tanker conversion



Risers

■ Main types:

- Flexible risers
 - Consist of layers of steel and plastic to make it flexible, wet trees
- Top Tensioned Risers (TTRs)
 - Vertical pipe with tension, allow dry trees
- Steel Catenary Risers (SCRs)
 - Steel tube hanging in a catenary shape, wet trees
- Hybrid Risers



DNV-OS-F201 Dynamic Risers, January 2001
Page 4 Section 1

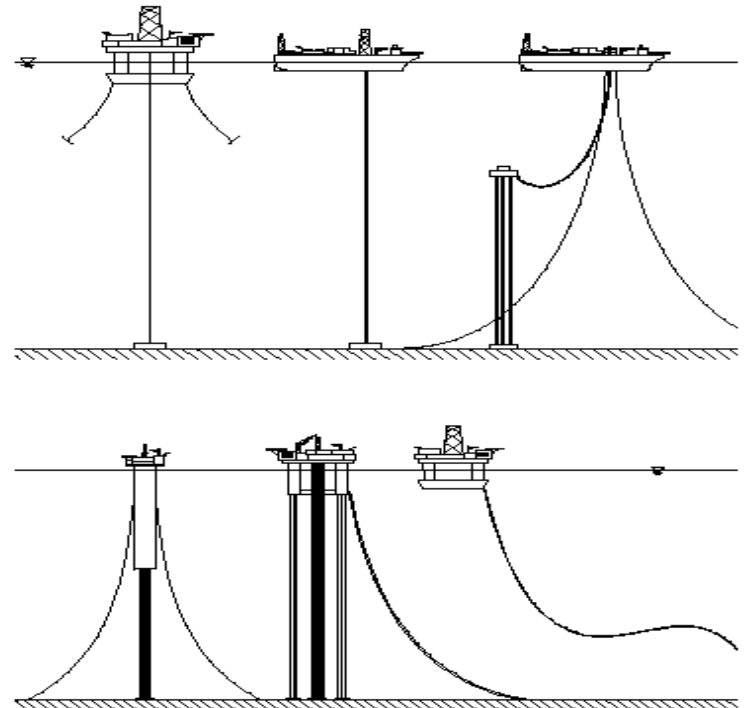


Figure 1-2 Examples of metallic riser configurations and floaters

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Managing and Engineering what You need - From reservoir to processing facility

- 1 Land-based production and processing
- 2 Terminals
- 3 Marine concrete structures for harsh environments
- 4 Floating production, storage & offloading (FPSO) vessels
- 5 Mooring and transfer systems
- 6 Floating LNG and methanol systems
- 7 Drilling systems
- 8 Tension Leg Platforms (TLP)
- 9 Riser and tether technologies
- 10 Semisubmersibles
- 11 Deep draft semisubmersibles
- 12 LNG terminals, onshore and offshore
- 13 Topsides and modules
- 14 Installation and removal (floatover/mating)
- 15 Jacket technology
- 16 Pipelines and flow assurance
- 17 Subsea solutions
- 18 Umbilicals and flowlines
- 19 Downhole technologies
- 20 Reservoir modelling and interpretation



Front End Spectrum Methodology

The front end phase is a unique opportunity to optimise the overall cost of the project

Our execution method provides a reliable decision base that is transparent, traceable, and unbiased:

- **Transparent**

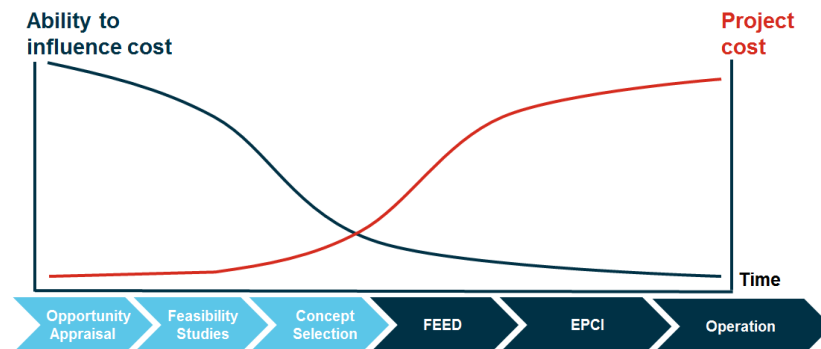
Aker Solutions use a staged process developed to accommodate the decision gates of our clients. Close cooperation with our clients is a key success factor

- **Traceable**

As-built data from multiple sources within our organisation is systematically used as basis for all estimation in any deliverable

- **Unbiased**

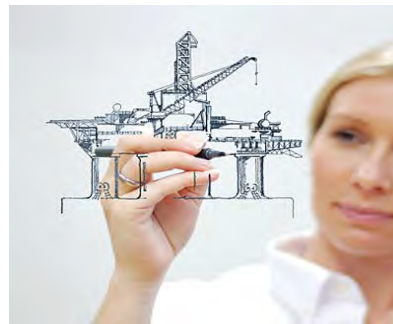
Front End Spectrum will recommend solutions that optimise the value for our clients



Front End Spectrum

Key elements that distinguish our services

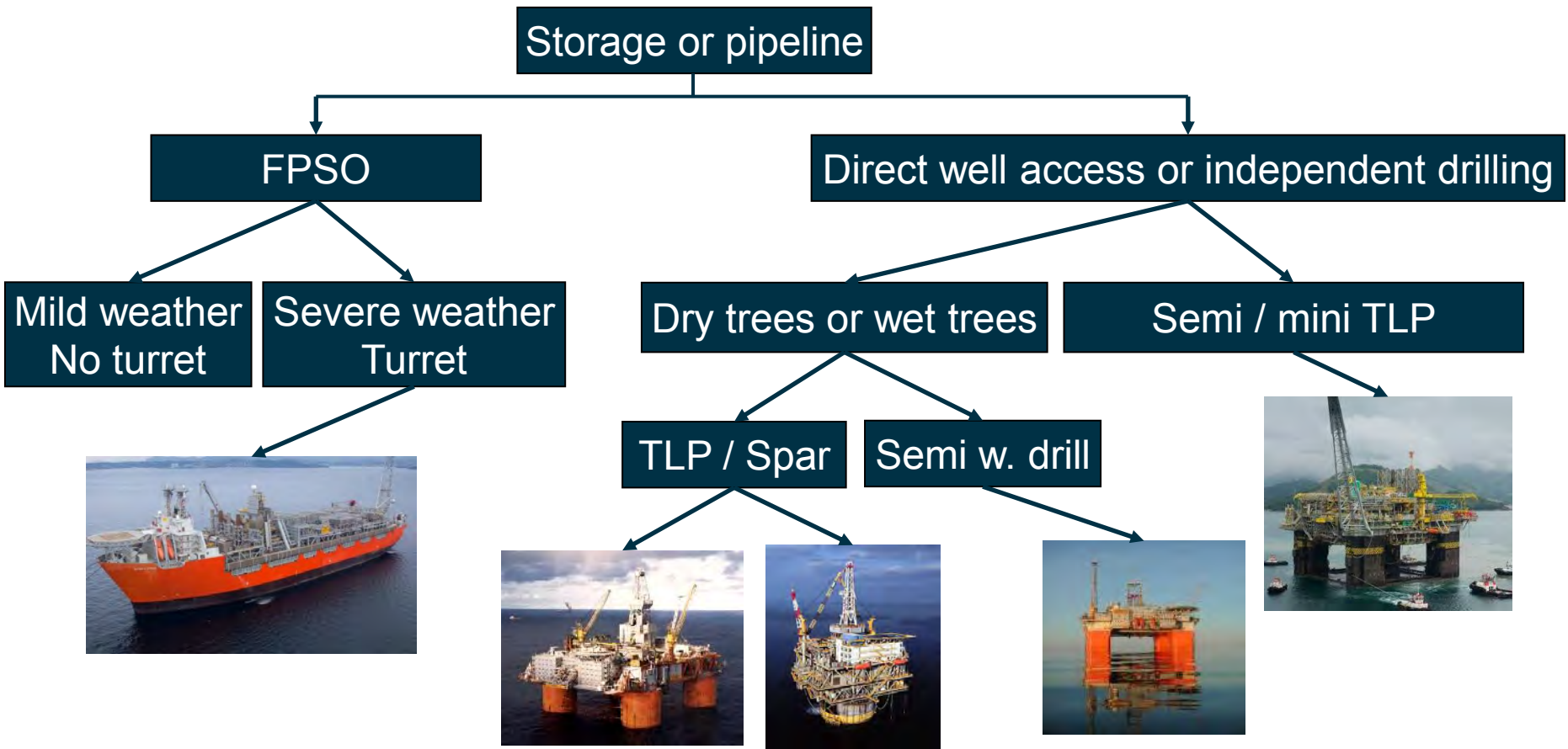
- We work concurrently in **multidisciplinary teams**, removing silos and barriers
- We include **reservoir, flow assurance and SURF** expertise in our study teams
- We have hands on experience with **state of the art** technologies and products
- We use project managers and technical experts with a **holistic view**
- We feed knowledge from **detailed engineering, construction, commissioning, installation and operation** back to our front end team



Concept Selection Criteria

- Location
 - Environmental conditions
 - Water depth
 - Infrastructure
 - Geophysical and geotechnical conditions
- Production rates and volumes
- Reservoir area extent, depth and complexity
- Well intervention frequency
- Production chemistry

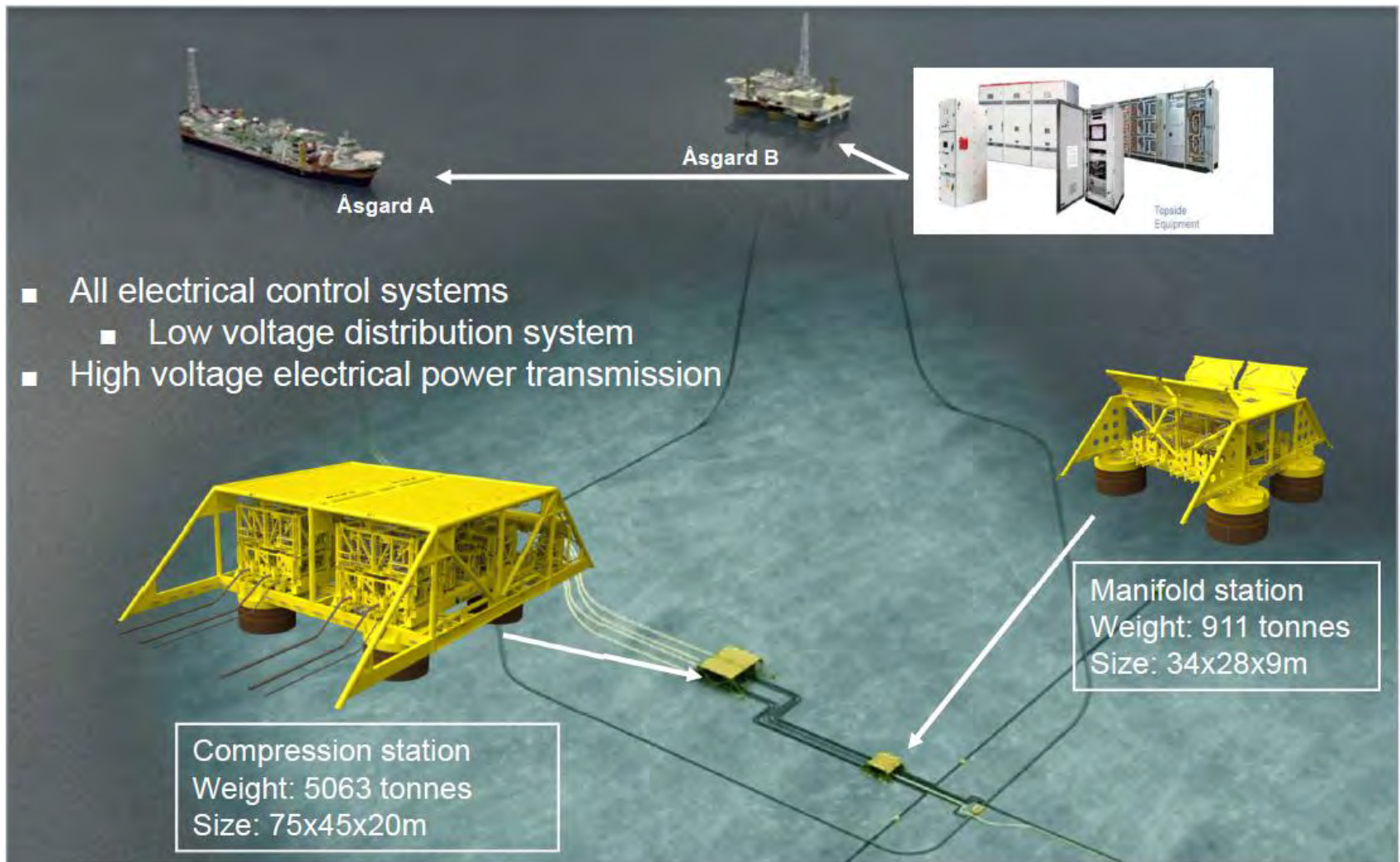
Building Blocks – Floater Concept Selection



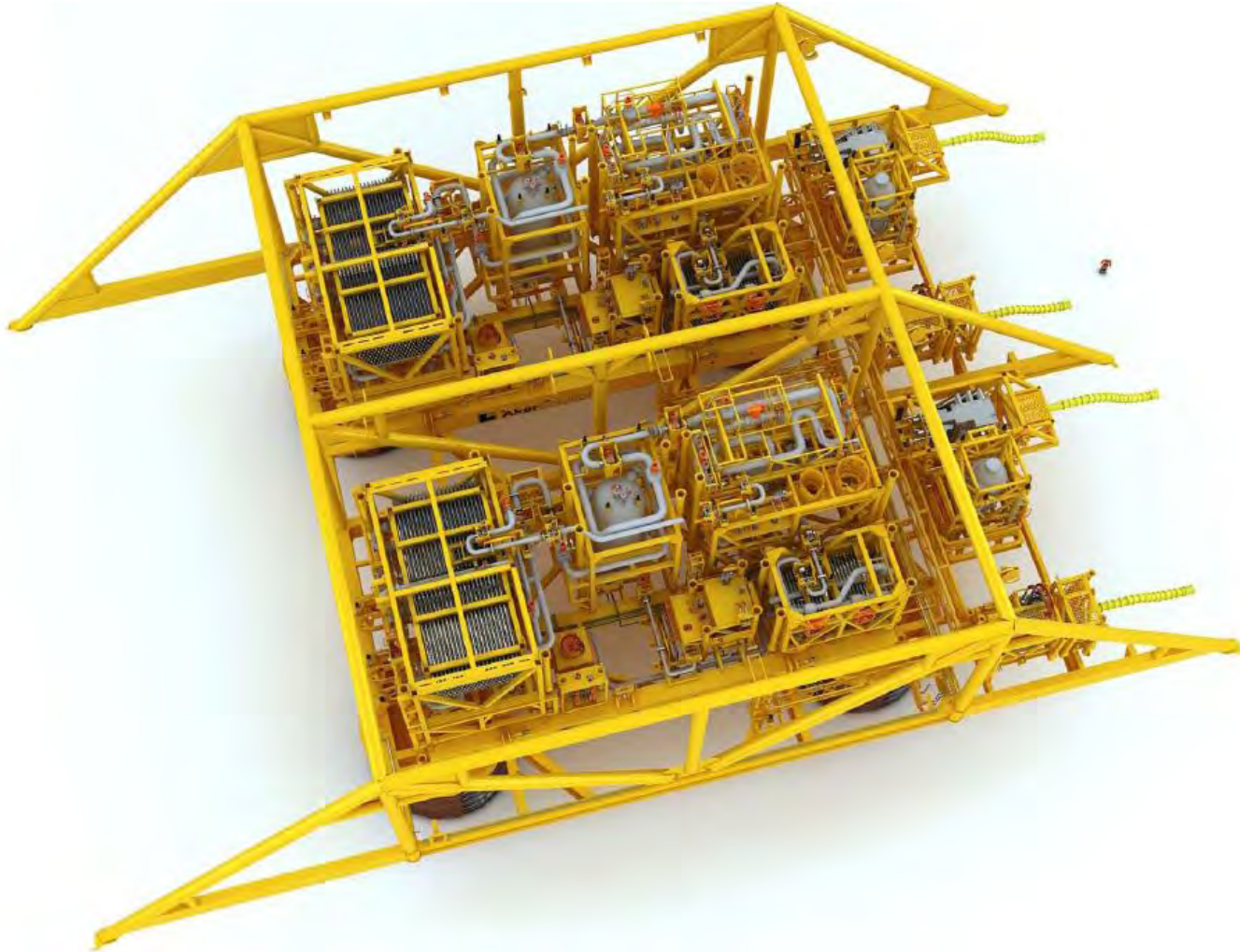
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Asgard Subsea Gas Compression System

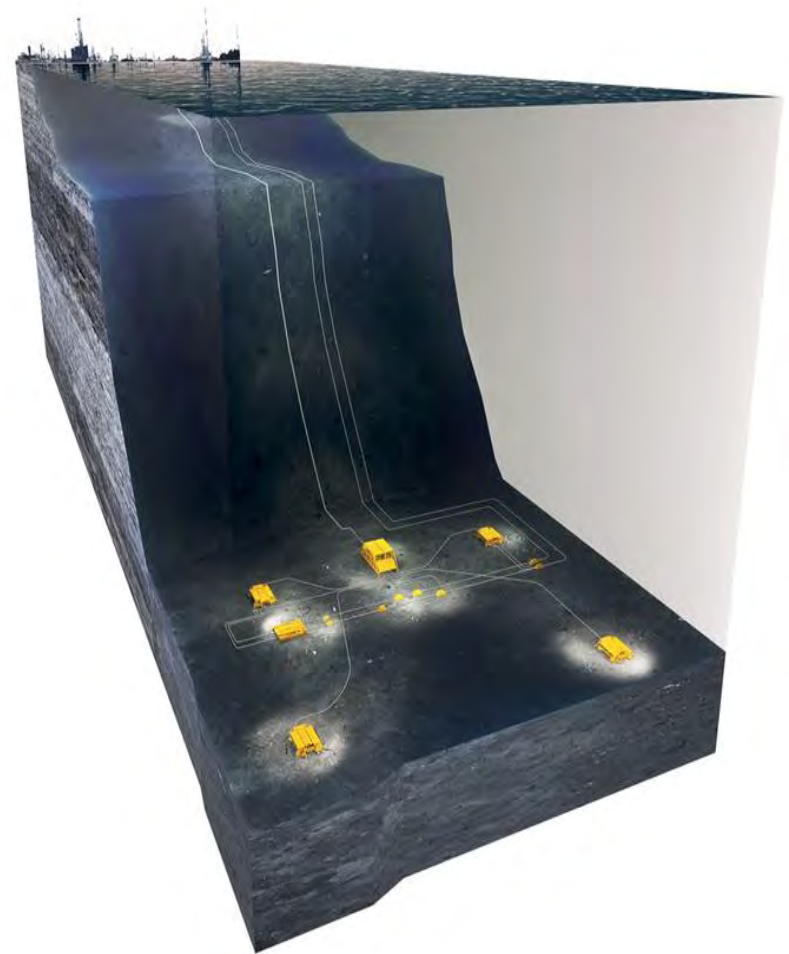


Overall View of Aasgard Subsea Compression Station



Subsea Gas Compression – the Benefits

- Gas fields require boosting of the reservoir flow as reservoir pressure depletes
- Subsea gas compression replaces the need for an offshore platform or onshore compression facility
 - Cost-efficient development solution (CAPEX)
 - Reduced operational costs (OPEX)
- Advantageous to place the compressor close to the well
 - Increased and accelerated production
 - Reducing CO2 emissions through lower energy consumption
 - No emissions or disposals to sea
- Safer due to unmanned operation



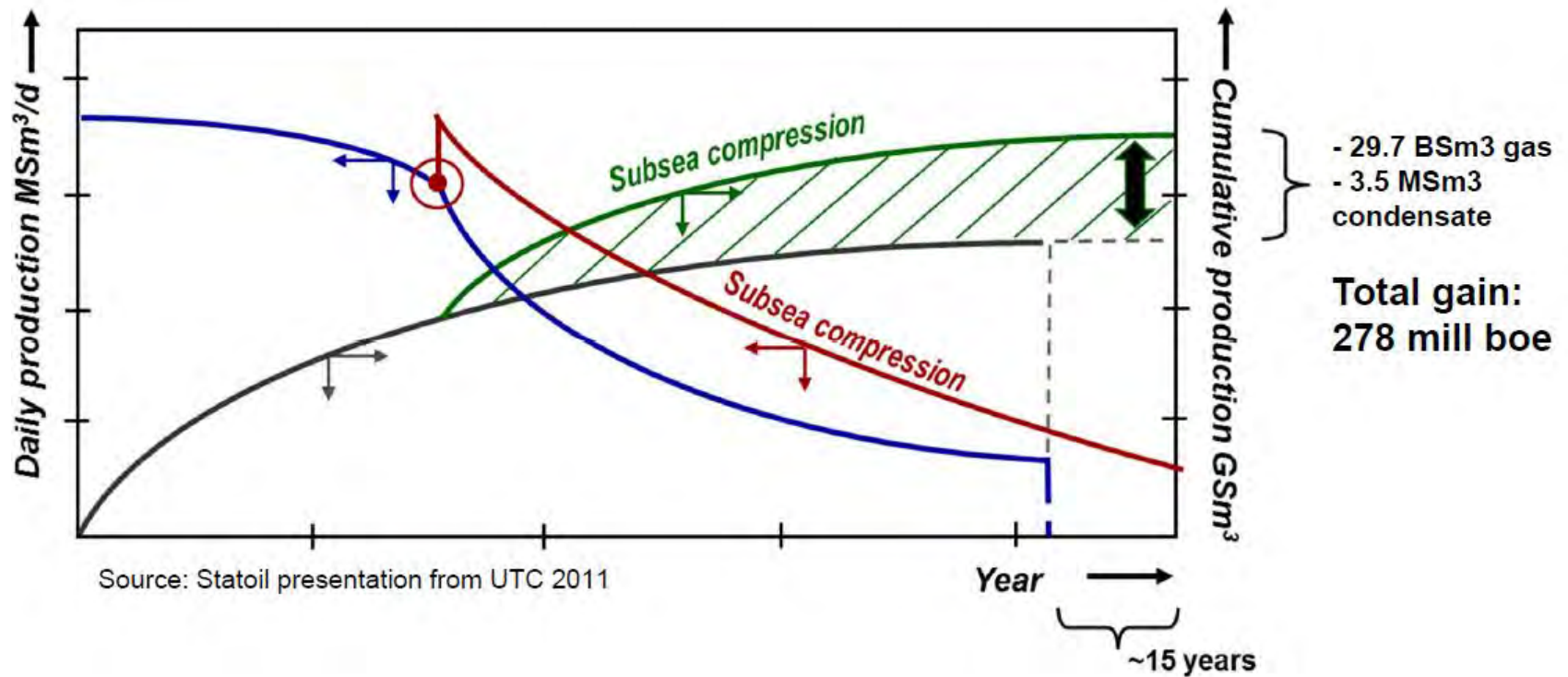
Subsea Gas Compression – the Challenges

Relocating processing systems onto the seabed also introduces challenges:

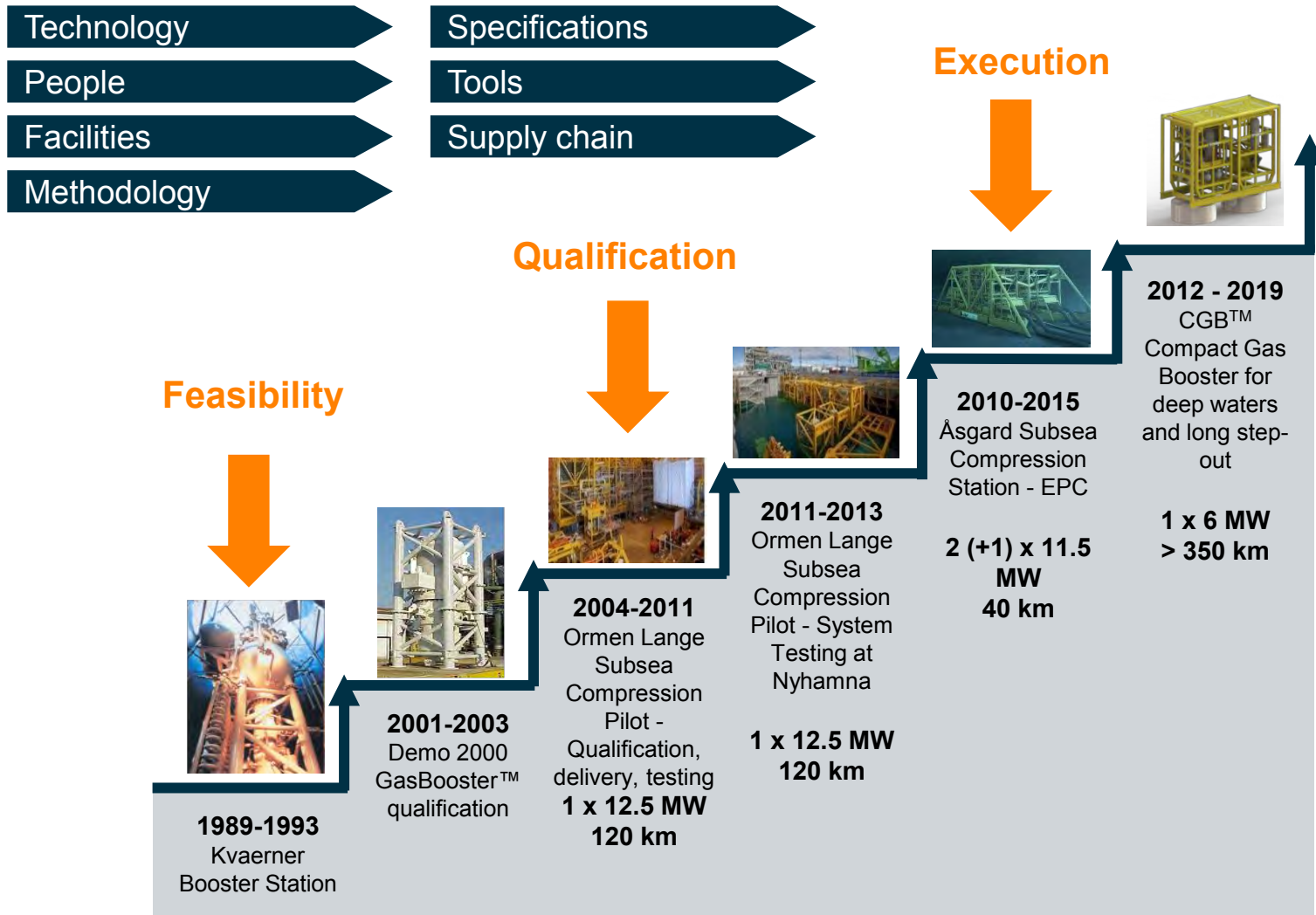
- Subsea development **perception** (conventional vs. “conceptual”)
- **IMR** strategy for remote subsea environment
- **Standardization**
- **Long step outs** (power and controls)



Asgard Subsea Compression – Increasing Recovery



Aker Solutions' GasBooster™ System Road-Map



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Dry Tree Semi (DTS) – Key Features

- The purpose:
 - Add drilling capability to a production Semi with wellheads on the platform
- The motivations:
 - Reach greater water depth beyond TLP
 - Carry larger facilities than Spar
 - Reduce cost vs TLP & Spar
- Design principle:
 - TTRs increase system stiffness
 - Platform natural periods maintained outside wave periods
 - Two general categories:
 - designs that focus on reducing the heave motions
 - designs that focus on optimizing tensioner and wellbay design



DTS compared to other floater solution

Floater type	Deepdraft DTS	TLP	SPAR	Deepdraft SEMI	Conventional SEMI	FPSO (ship shaped)
When used	Dry trees	Dry trees	Dry trees	Subsea trees	Subsea trees	Subsea trees
Water depth (m)	+500-3000	200-1500	500-3000	200-3000	200-3000	50-3000
Integration	Quayside	Quayside	Offshore	Quayside	Quayside	Quayside
Drilling	Yes	Yes	Yes	Yes	Yes	Yes
References	No	Yes	Yes	Yes	Yes	Yes
Flexible wellbay	Yes	Yes	No	Yes	Yes	NA
Riser type	All	All	All	All	All, but Top Tensioned Risers	Flexibles and riser tower
Oil handling	Pipeline/ FSU	Pipeline/ FSU	Pipeline/ FSU	Pipeline/FSU	Pipeline/FSU	Storage

Dry Tree Semi Benefits

- Capability for large topsides (vs Spar)
- Capability for large water depth (vs TLP)
- Flexibility for future expansion and tie-ins
- Relocation and decommissioning friendly
- Cost benefit:
 - Lighter hull and simplified topside integration (vs Spar)
 - Simplified mooring system and installation (vs TLP)
- Combines benefit of Spar (simple mooring and ultradeepwater) and TLP (large topside and quayside integration)



TLP



Deep Draft Semi



Spar

Aker Solutions Dry Tree Semi Development

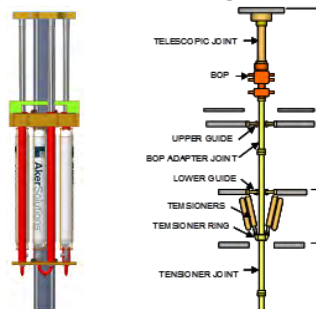
Recent work

- 2010, DeepStar 10404
 - Global engineering
 - Model testing
 - Tensioning system

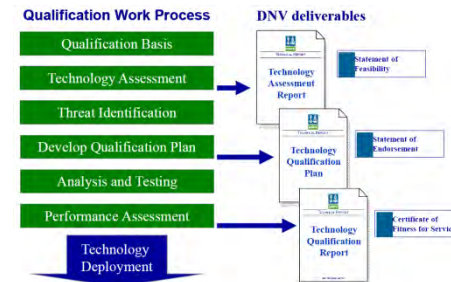
- 2011, Technology Qualification
 - Selected by DeepStar for Technology Qualification by DnV
 - System evaluated
 - Critical component identified: long stroke tensioners



- 2012, Internal study
 - Global engineering
 - Riser engineering
 - Structural design



- 2013, participated in DeepStar 11404
 - Comparison of DTS designs for marginal fields in Gulf of Mexico, West Africa, Offshore Australia



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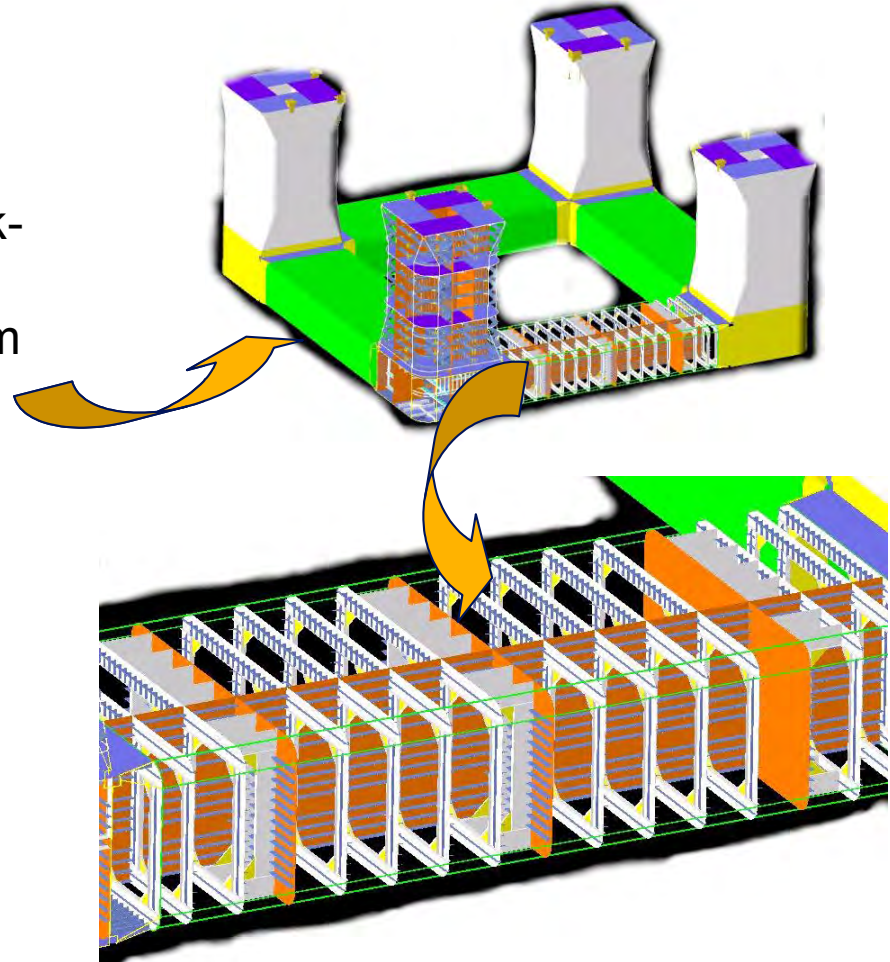
KBeDesign™ - World Class Engineering Automation

- KBE objects are developed based on:
 - Classification societies rules and regulations
 - Global arrangement based on Aker Solutions extensive track-record of proven designs
 - Standard rules developed from Aker Solutions track record designs



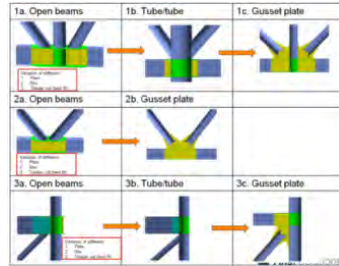
- Automated building of 3D model

KBeDesign



KBeDesign™ - Is about

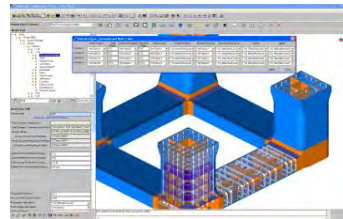
Standardize
Sharing
Reuse



Support standardization, reuse and sharing of knowledge and rules across projects

=> Quality Improvements

Automate
Geometry
Deliverables



Automates deliverables of 3D Models, Analyses Models and Drawing Packages to Front End & Detail Engineering projects

=> Productivity

Empower
Engineering
Projects



KBe Design Dept. Develops technology & provides next gen tools & services to Front End and Detail Engineering projects

=> Innovation

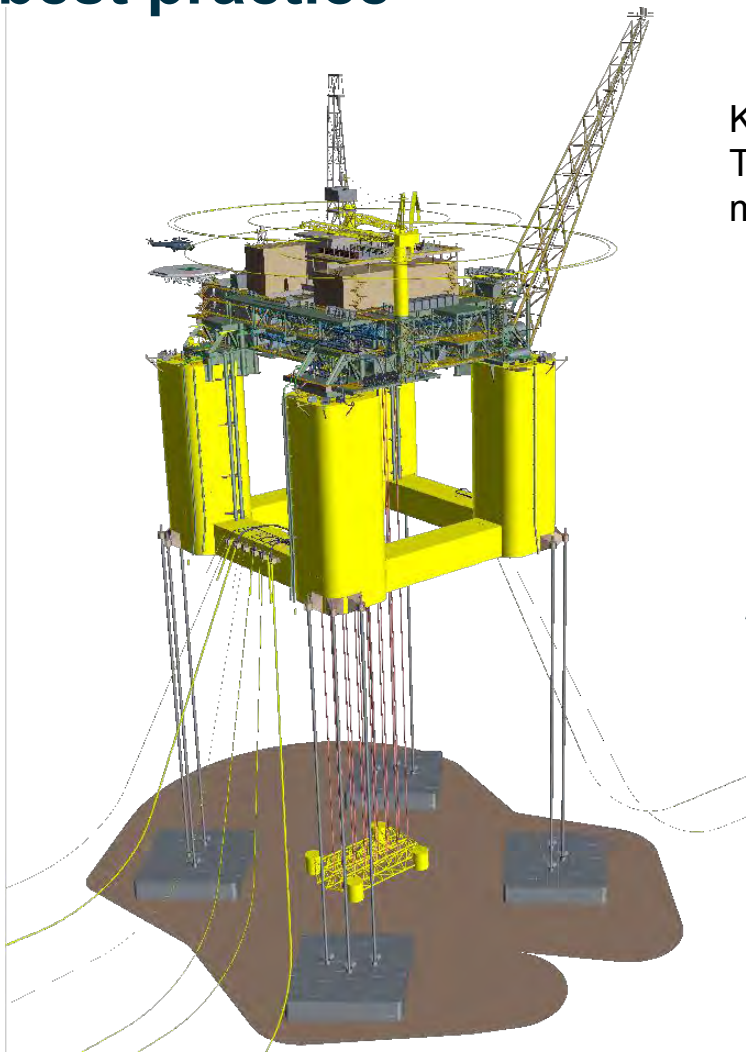
KBeDesign™ Solutions – Key Features

- Re-use proven designs
- Increased engineering capacity – let engineers do engineering
- Continuous improvement
- Increased flexibility
- Effective handling of global changes

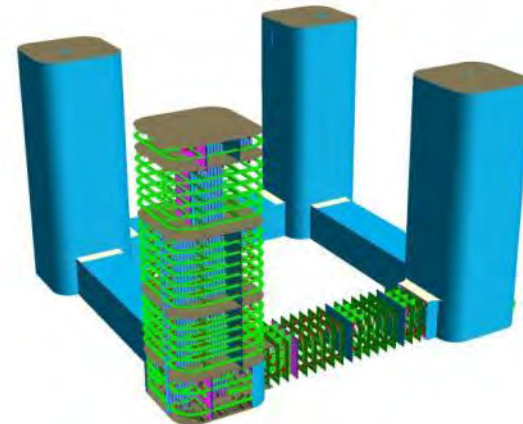
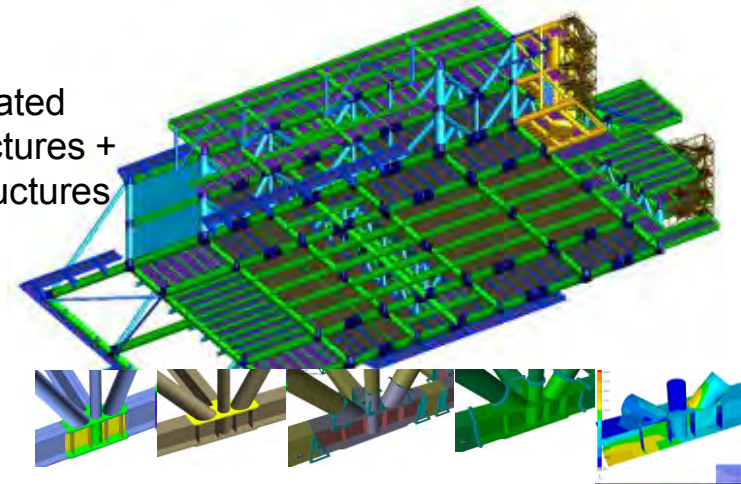


- Improved quality and reduced cost and design time
- Fewer people are needed to deliver high quality results, using less time in shorter schedules

KBeDesign™ is used to efficiently reuse Aker Solutions best practice



KBeDesign Generated
Topside main structures +
major outfitting structures



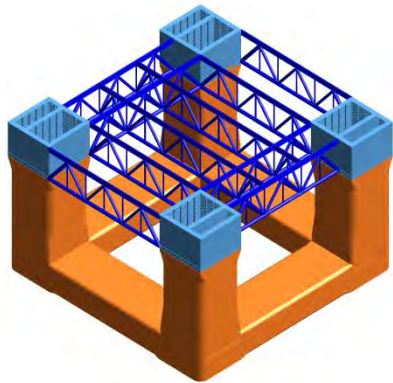
KBeDesign Generated Hull Main
Structures

KBeDesign™ Used on Gjøa SEMI Hull

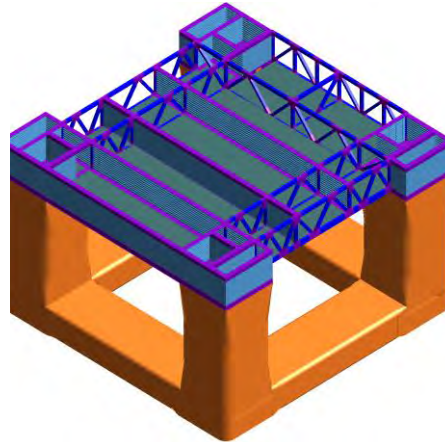


Example: Gjøa Field Development, Statoil – Norway

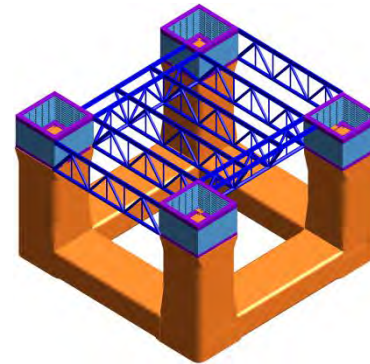
Case 1
Full Process



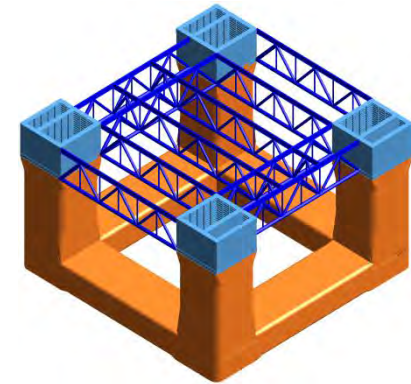
Case 1A
Full Process & Drilling



Case 2
Minimum Process



Case 3
Full Process & Tie-in



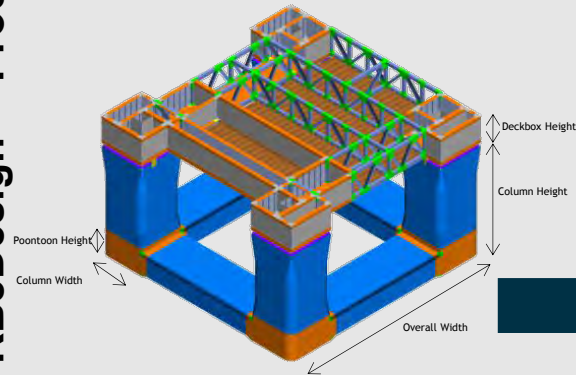
Length of pontoons	: 71.0 m	85.0 m	68.5 m	73.5 m
Column distance C/C	: 55.5 m	67.5 m	53.0 m	58.0 m
Width of pontoons	: 15.5 m	17.5 m	15.5 m	15.5 m
Height of pontoon	: 8.0 m	8.5 m	8.0 m	8.0 m
Height of columns	: 33.5 m	41.0 m	35.0 m	33.5 m
Height to main deck	: 43.5 m	50.5 m	43.5 m	43.5 m
Displacement	: 40 671 t	56 628 t	36 622 t	41 933 t
Draft	: 21.0 m	21.0 m	21.0 m	21.0 m
Freeboard	: 22.5 m	20.0 m	22.5 m	22.5 m

With KBe Design™ alternatives can easily be modelled

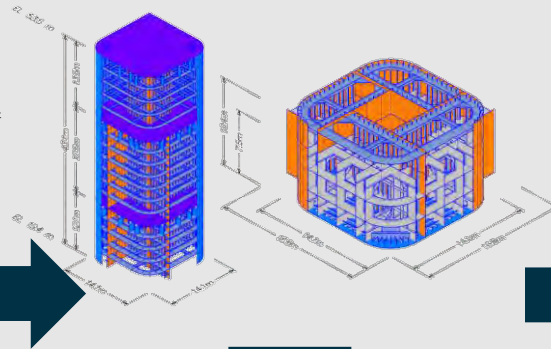
Use of KBeDesign™ for design of Aker Solutions SEMI Structures

KBeDesign™ Process

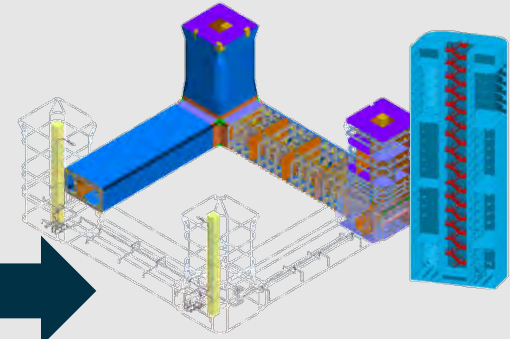
Sizing
Configure & Arrange



Tailor-making based on reuse
Standardized Building Blocks

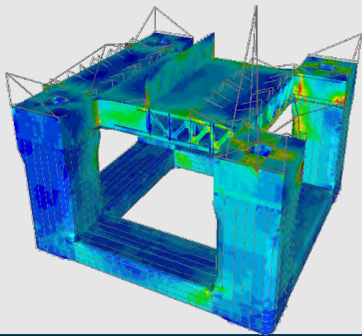


Multidiscipline
Piping & Outfitting Arr.

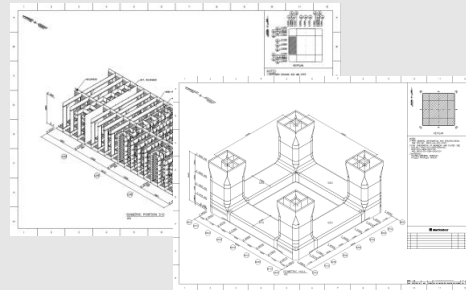


KBeDesign™ Output

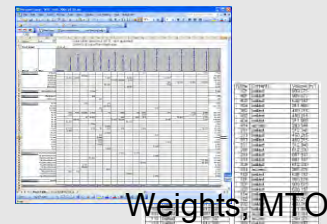
Global/Local Analyses



Gen Arr. Drawings

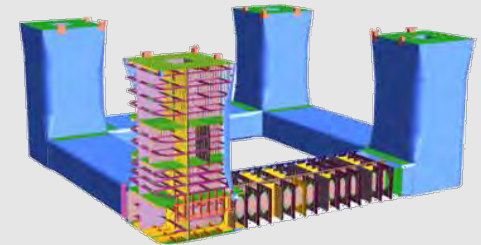


Reports

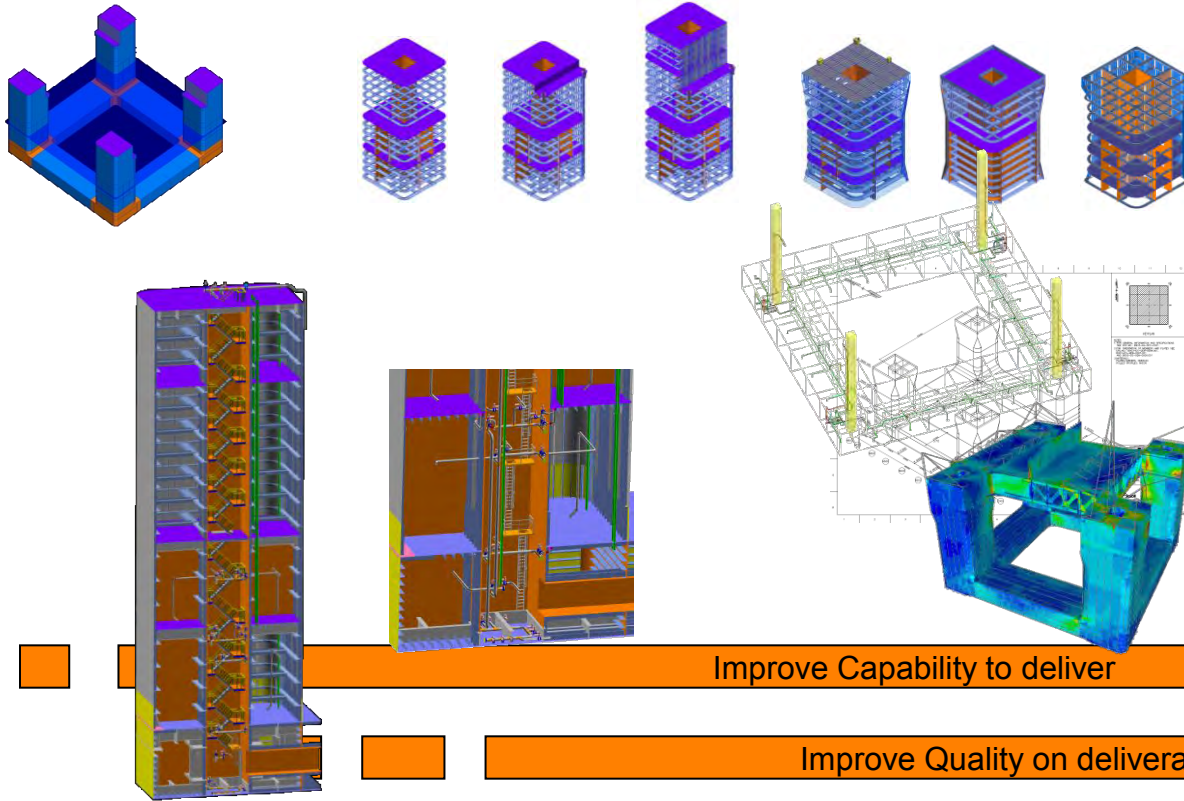


Weights, MTO

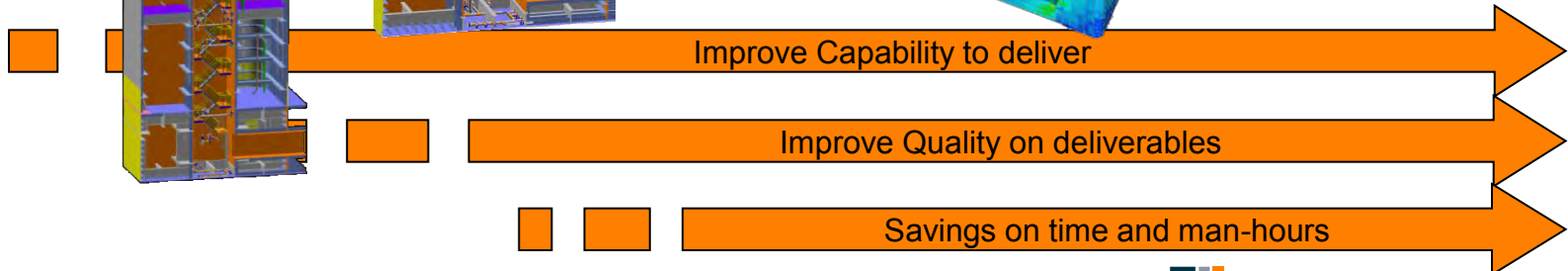
Multidiscipline 3D CAD



KBeDesign™ for Floater - Impact/Competitive Advantage



Material exported very early from model for use by Yard for placing steel orders
 Very little changes from first to last material export from model

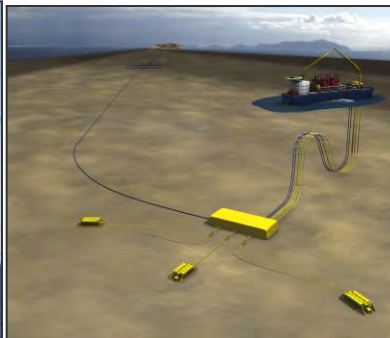


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Concluding Remarks

- How to identify the right deepwater field development solution ?
 - Experience
 - Creativity
 - Toolbox – with all potential concepts/solutions
 - Cost data
 - Agreed evaluation criteria



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