

FMC-(MPS) SUT Training Manifold and Pipeline Systems

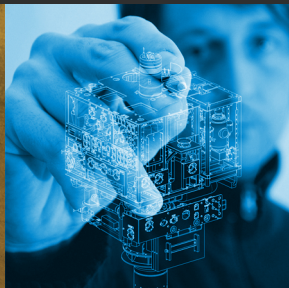
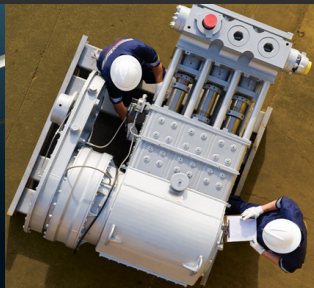
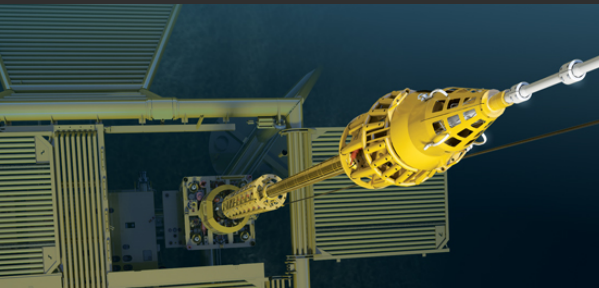
**Presented by:
Eric Stagner**

**Author:
Castaneda**



We put you first.
And keep you ahead.

Manifolds & Tie In Systems



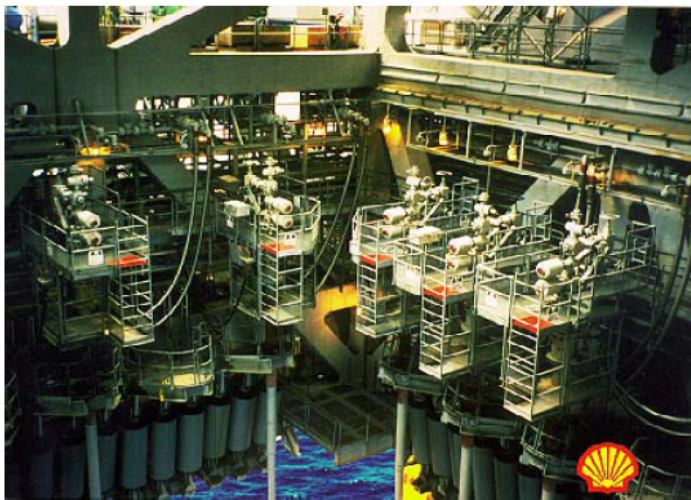
Objectives of Presentation

- History of MPS
- Understanding of Field Layouts
- MPS Scope of Supply
 - Core Components
 - Assemblies
- Design Considerations
- Fabrication / Transportation / Installation
- MPS Around the World
- The Future of MPS

MPS History

The History of How MPS came to be

MPS History



Surface "Dry" Trees



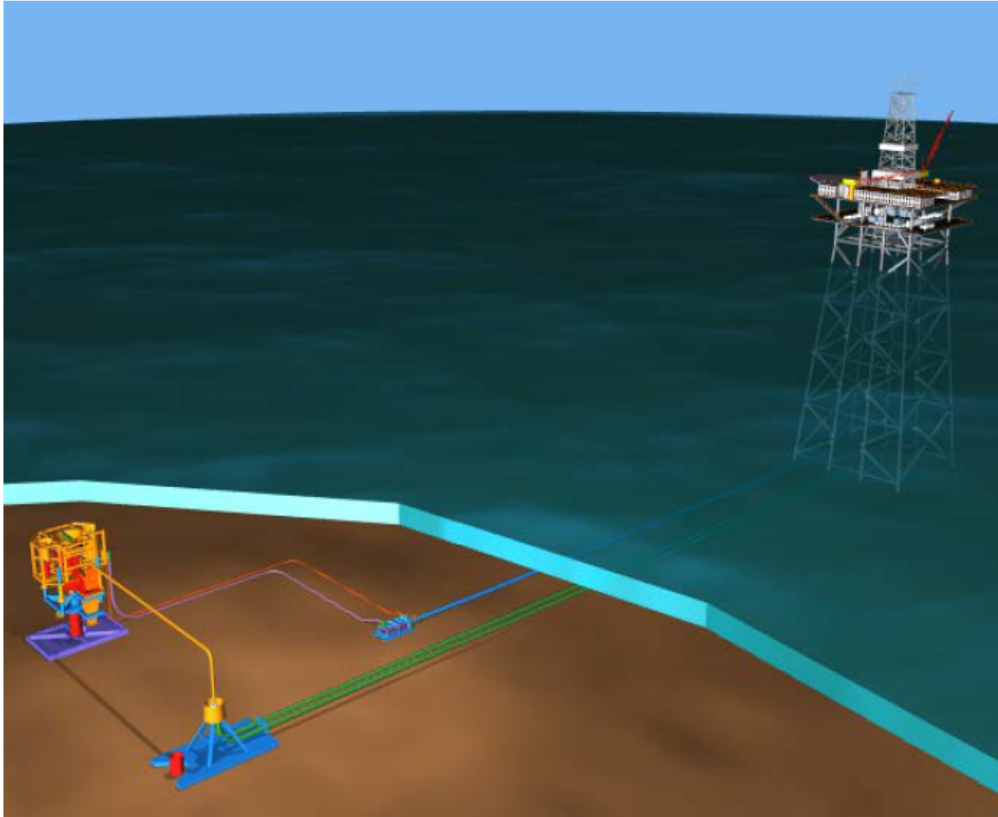
**Subsea
Wellhead**



Production Riser



MPS History

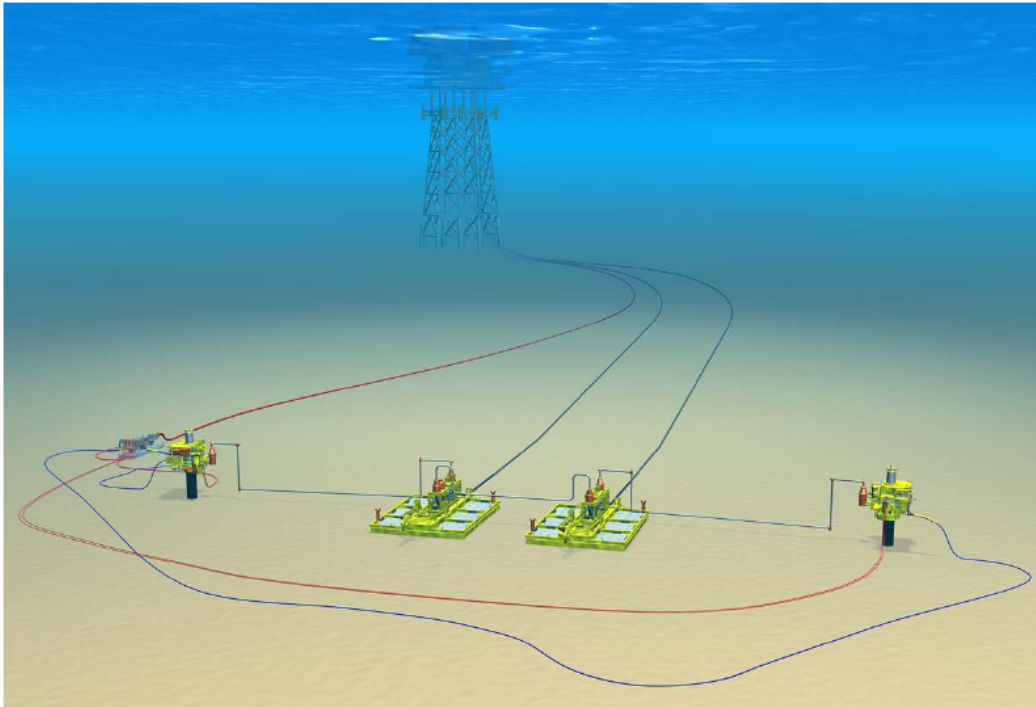


Sled



Well Jumper

MPS History



Sled

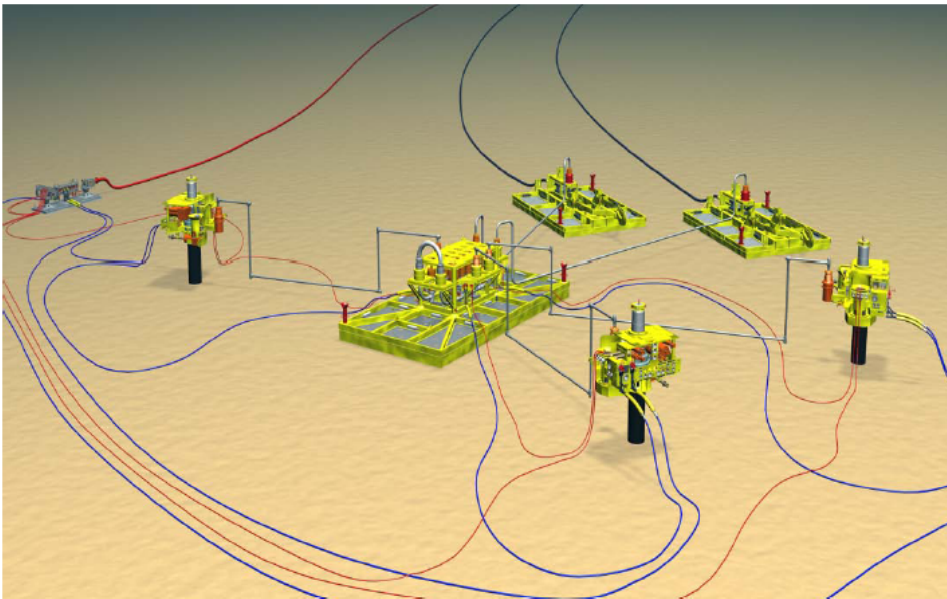


**Well
Jumper**

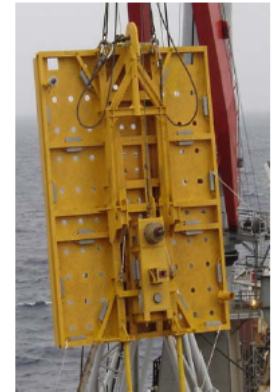


**Flowline
Jumper**

MPS History



Manifold



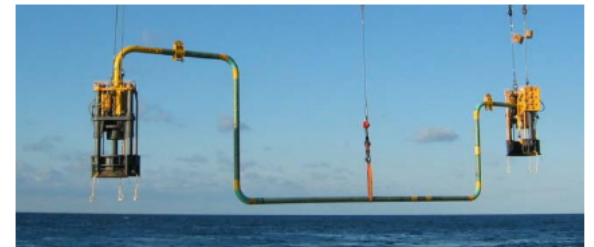
Sled

Pigging Loop

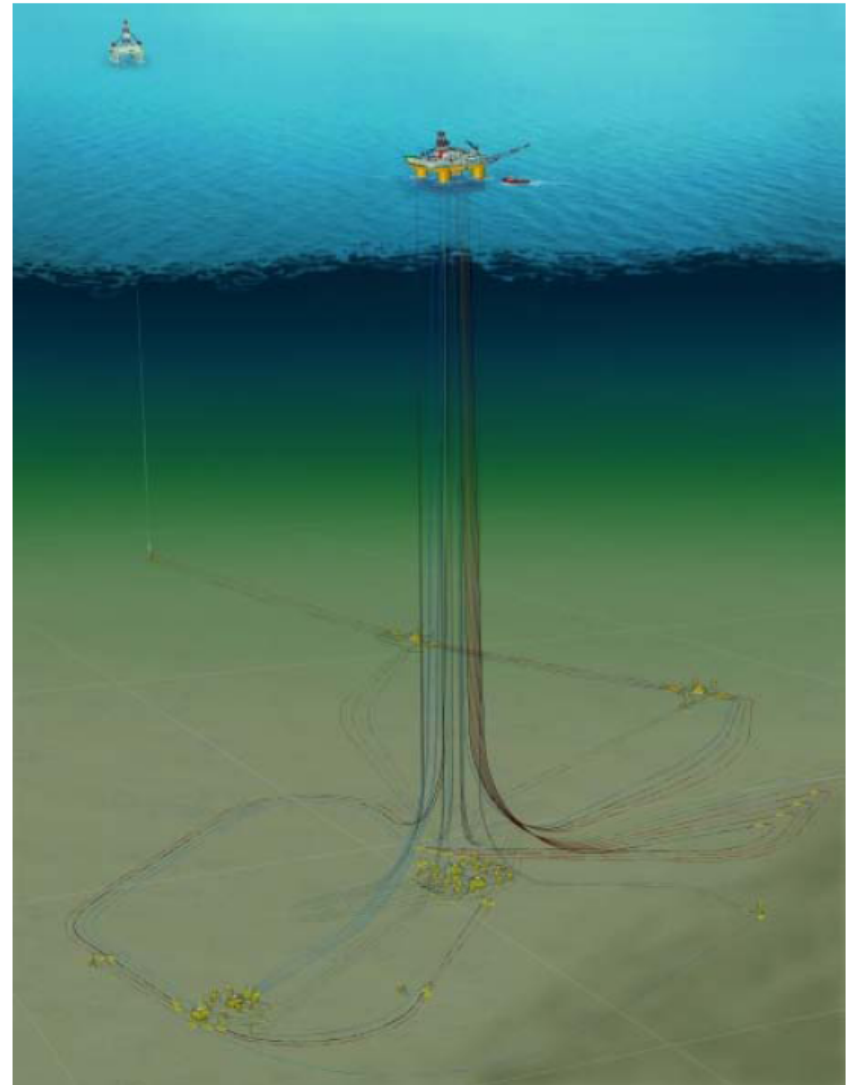
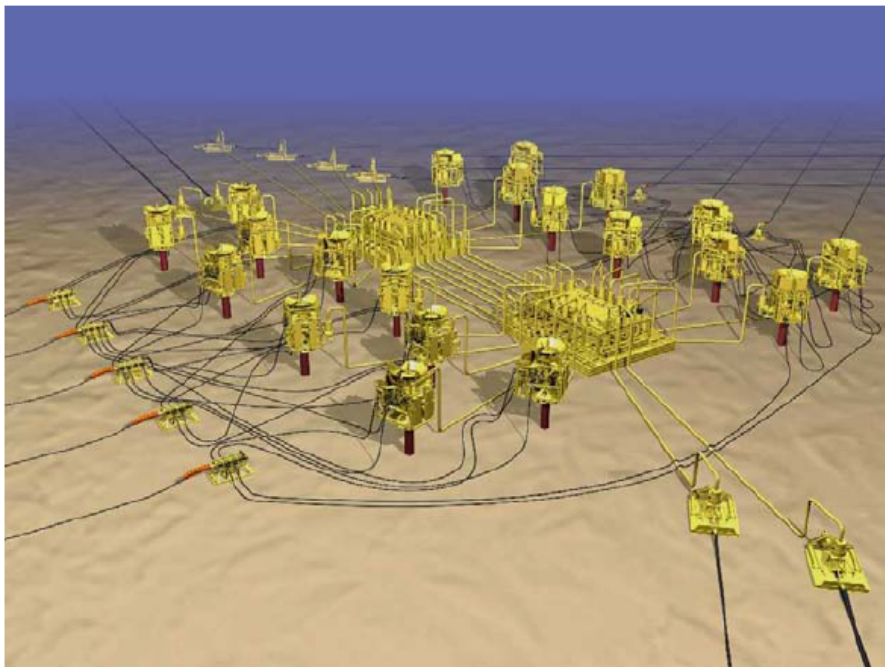


Well Jumper

**Flowline
Jumper**



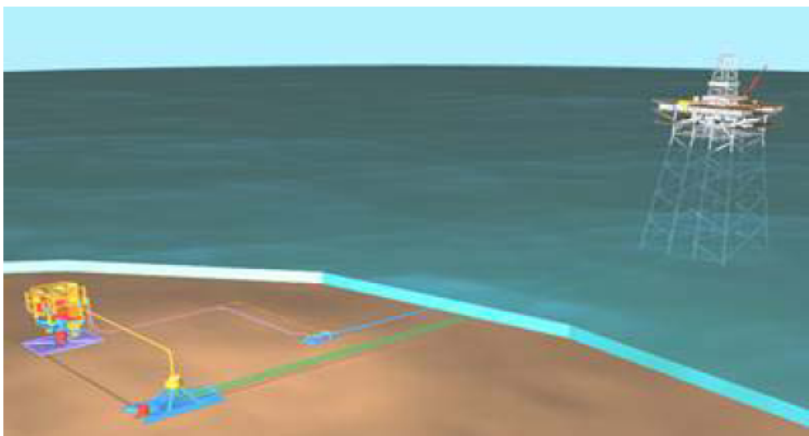
MPS History



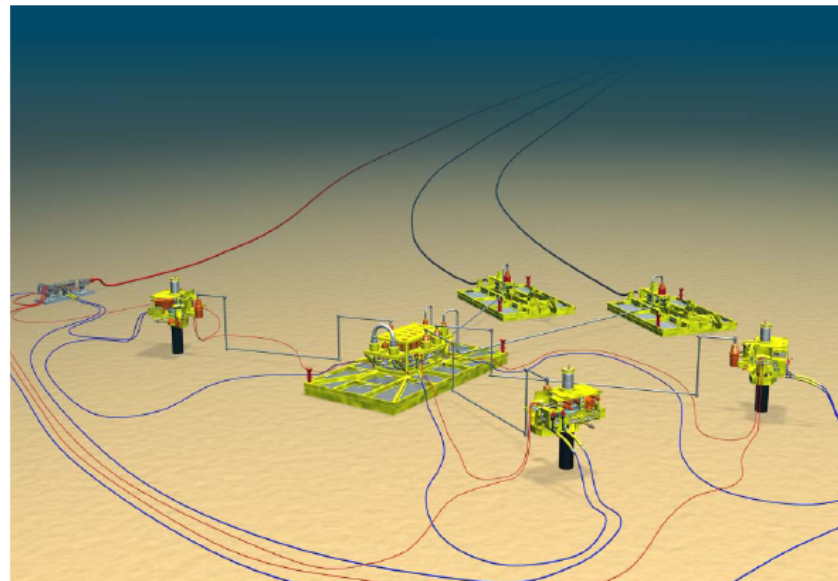
Subsea Field Layouts

Field Layouts Define MPS

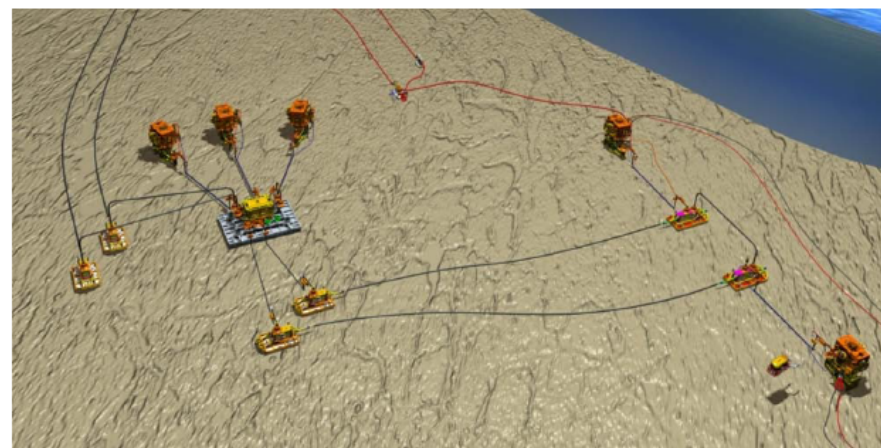
Subsea Field Layouts



1-2 Well Tiebacks



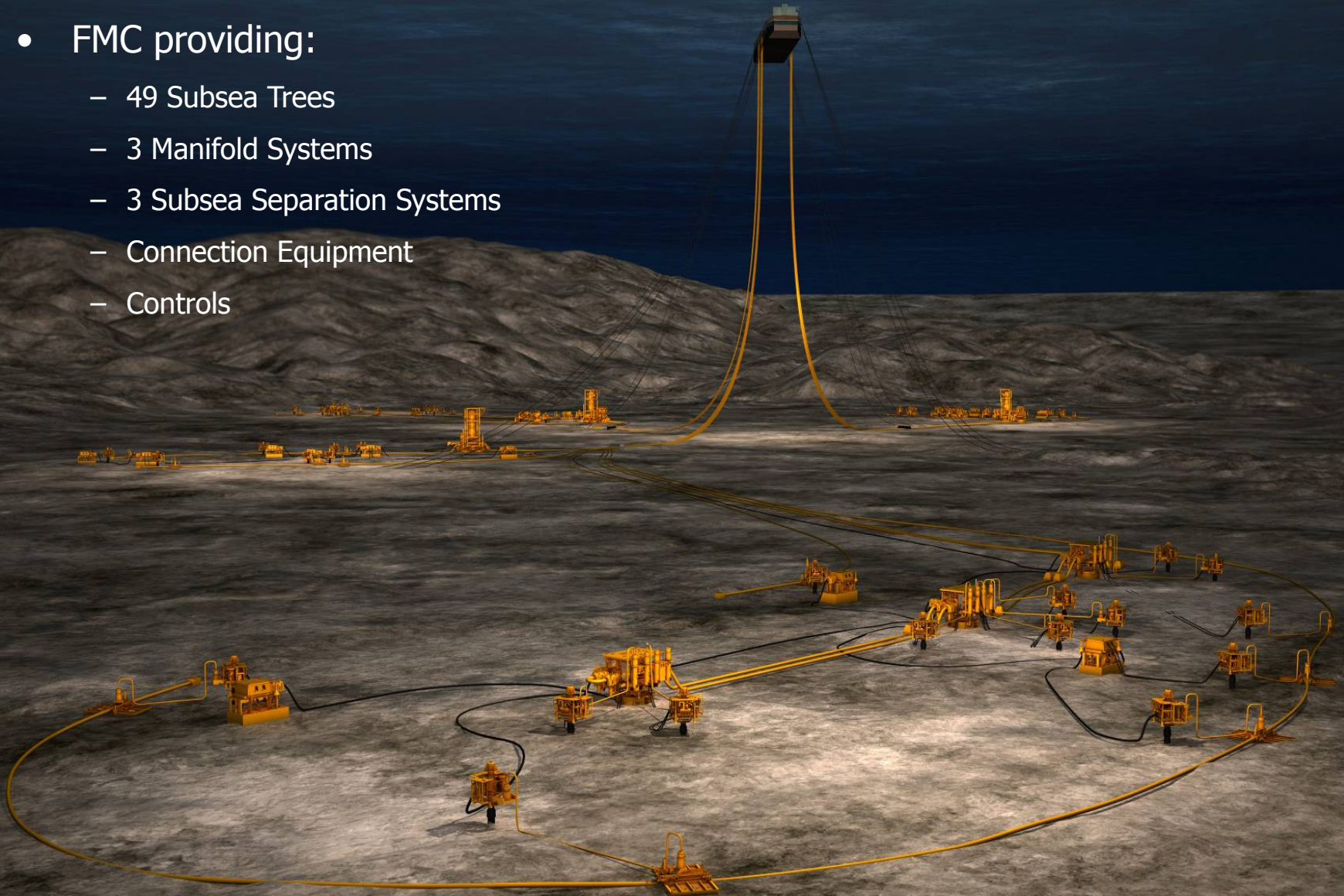
Multiple Tiebacks



Hybrid Development

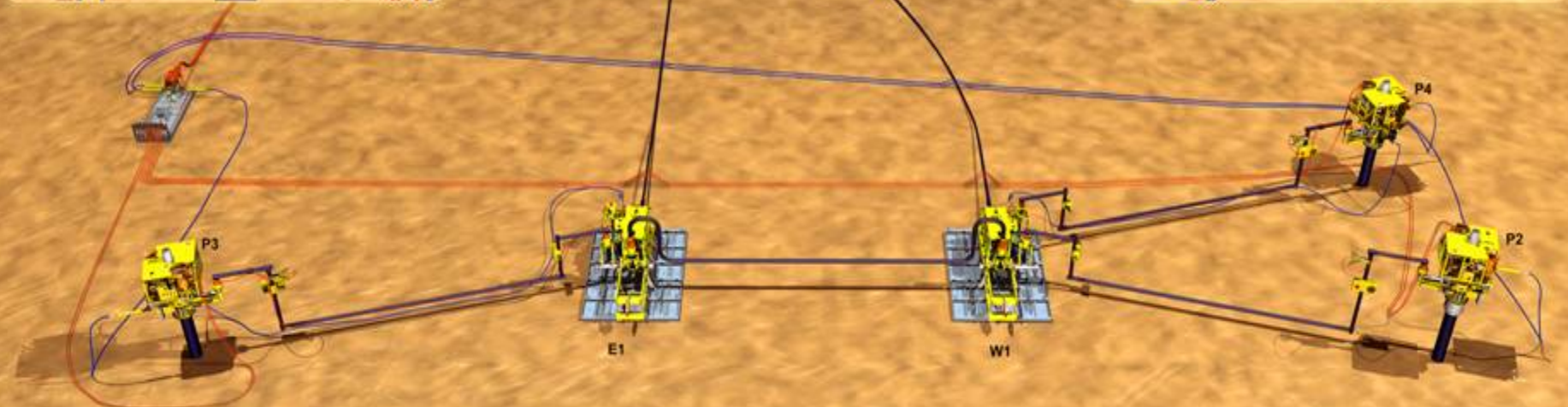
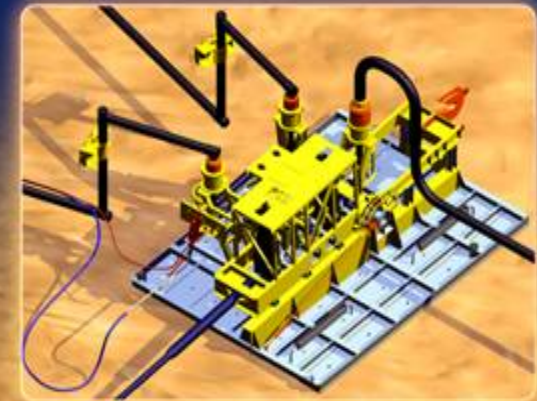
Pazflor - Angola

- FMC providing:
 - 49 Subsea Trees
 - 3 Manifold Systems
 - 3 Subsea Separation Systems
 - Connection Equipment
 - Controls

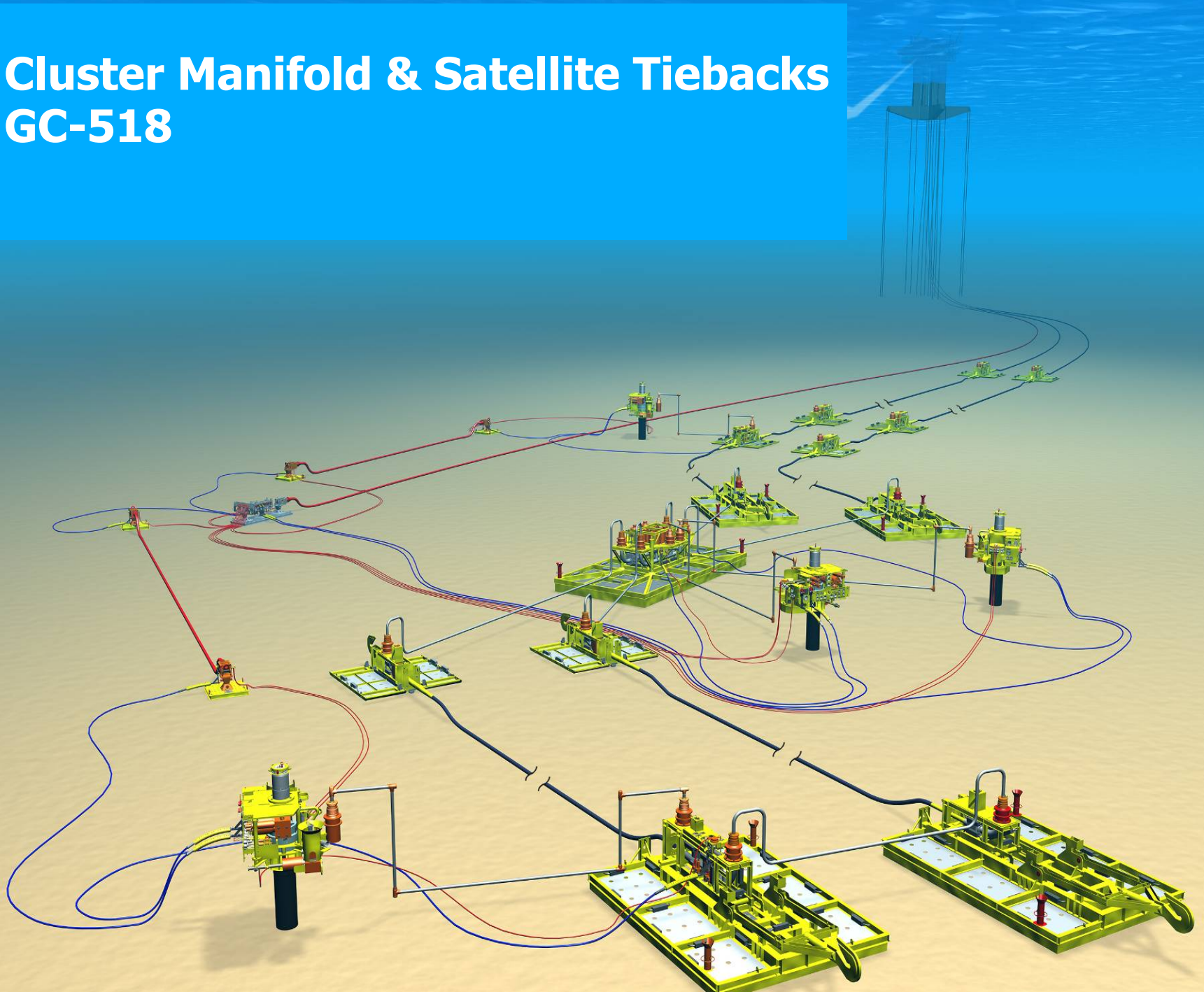


Princess

3 mile tieback to Ursa TLP
3,700 ft water depth
11,000 to 14,000 psi / 190°F

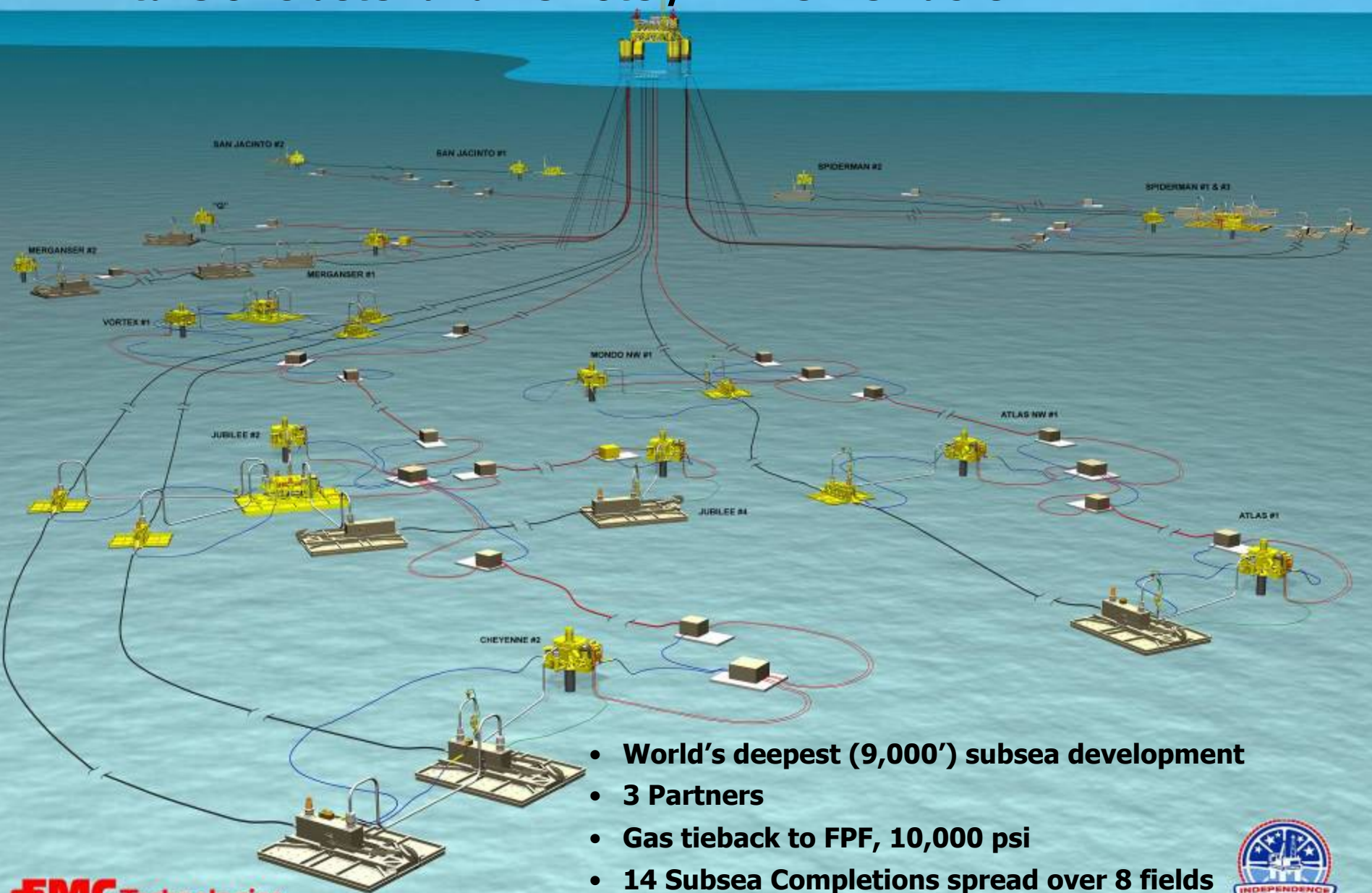


Cluster Manifold & Satellite Tiebacks GC-518



Independence Hub

Mixture of Cluster and Remote / Inline Tie Backs



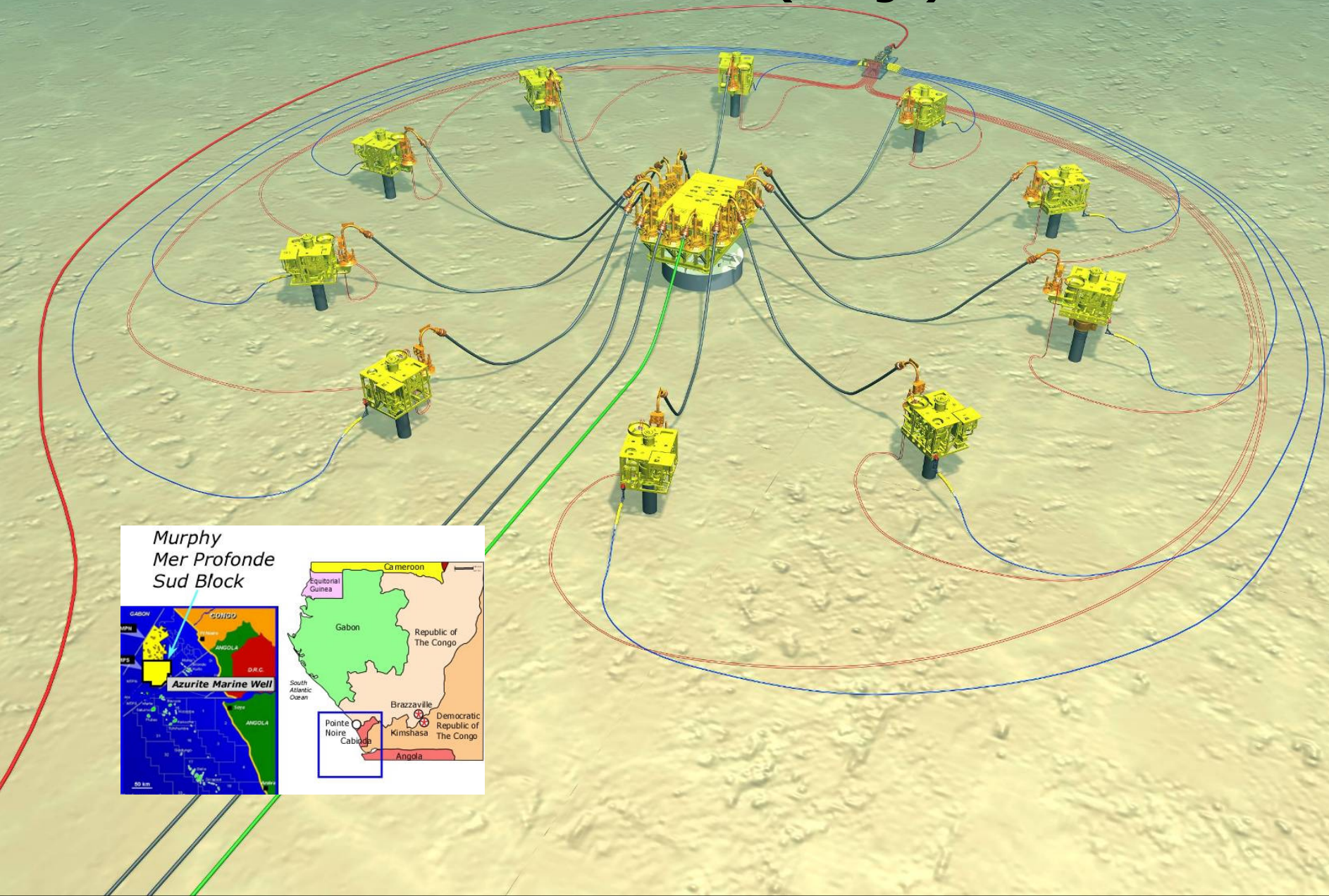
- World's deepest (9,000') subsea development
- 3 Partners
- Gas tieback to FPF, 10,000 psi
- 14 Subsea Completions spread over 8 fields

Agbami

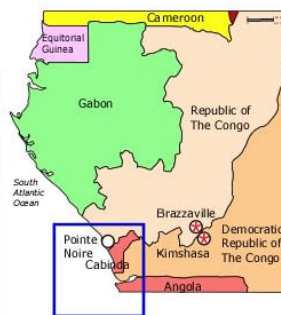
Mixture of Small Clusters and Remote Tie Backs



Cluster Manifold - Azurite (Congo)



*Murphy
Mer Profonde
Sud Block*

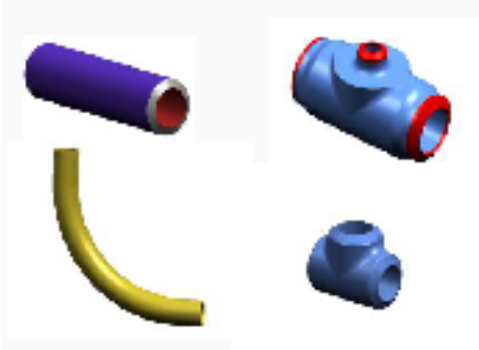


MPS Core Components

Building Blocks for MPS Equipment

MPS Core Components – Building Blocks

Engineered Pipe & Fittings



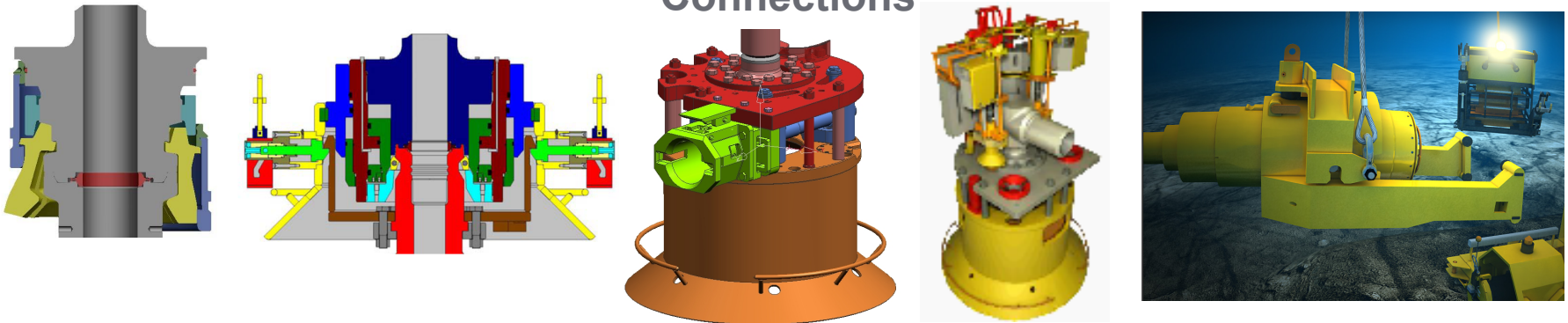
- Suppliers Pipe and Fittings

Valves



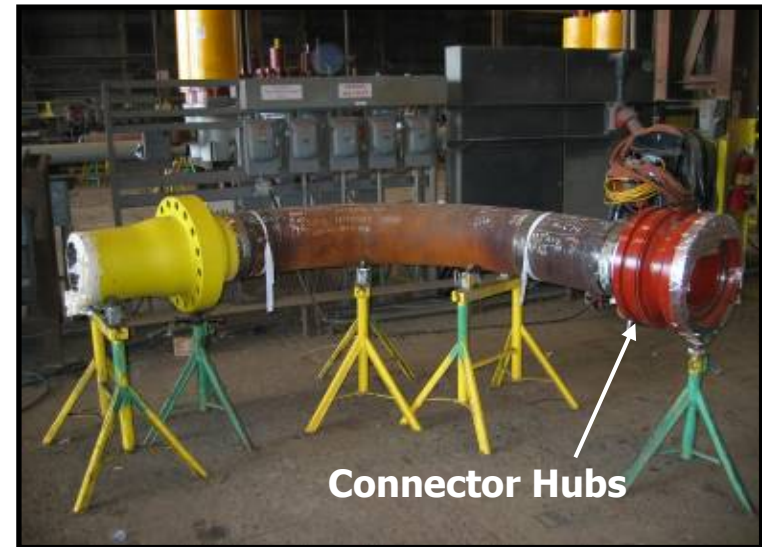
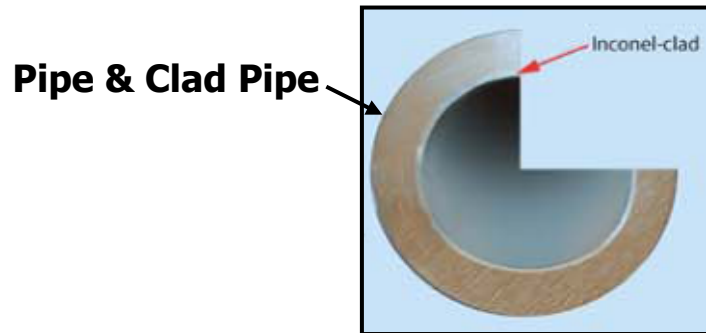
- FMC Gate Valves
- OEM Gate, Ball & Check Valves

Connections



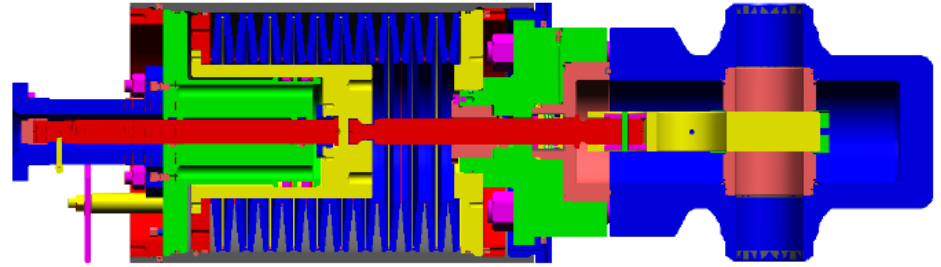
- UCON-H, ROVCON, STABCON, Hubs, Caps, Tools
- UCON-V, TORUS III, MAX collet

Piping Components – Hubs, Pipe and Pipe Fittings



Valves

- Application
 - Well Branch/Flowline Isolation
 - Pigging Isolation
 - Injection Service
- Sizes
 - 1/2" – 10"
- Unique to MPS (ManTIS)
 - Larger sizes
 - Butt weld connections

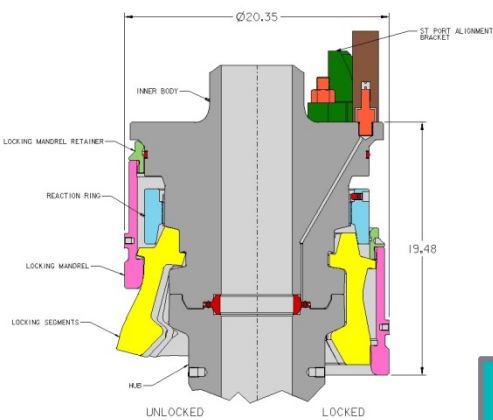


Large Bore Gate Valves

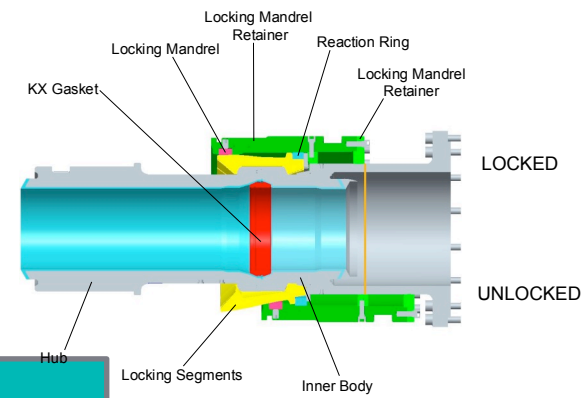
- Designed and qualified for 10,000 ft water depth
 - 7"- 10K Manual Valve
 - 7"- 10K FSC/FSO Actuated Valve
 - 7"- 15K Manual Valve
 - 7"- 15K FAI/FSO Actuated Valve
 - 8.5"- 12.5K FAI/FSO Actuated Valve
 - 9"- 6.65K FSC/FSO
 - 9"- 10K Actuated Valve (Surface)
 - 10"- 12.5K Manual Valve
 - 10"- 12.5K FAI/FSO Actuated Valve



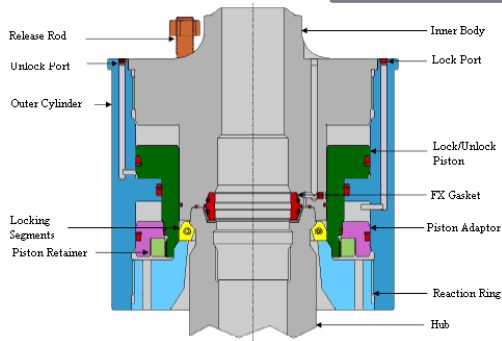
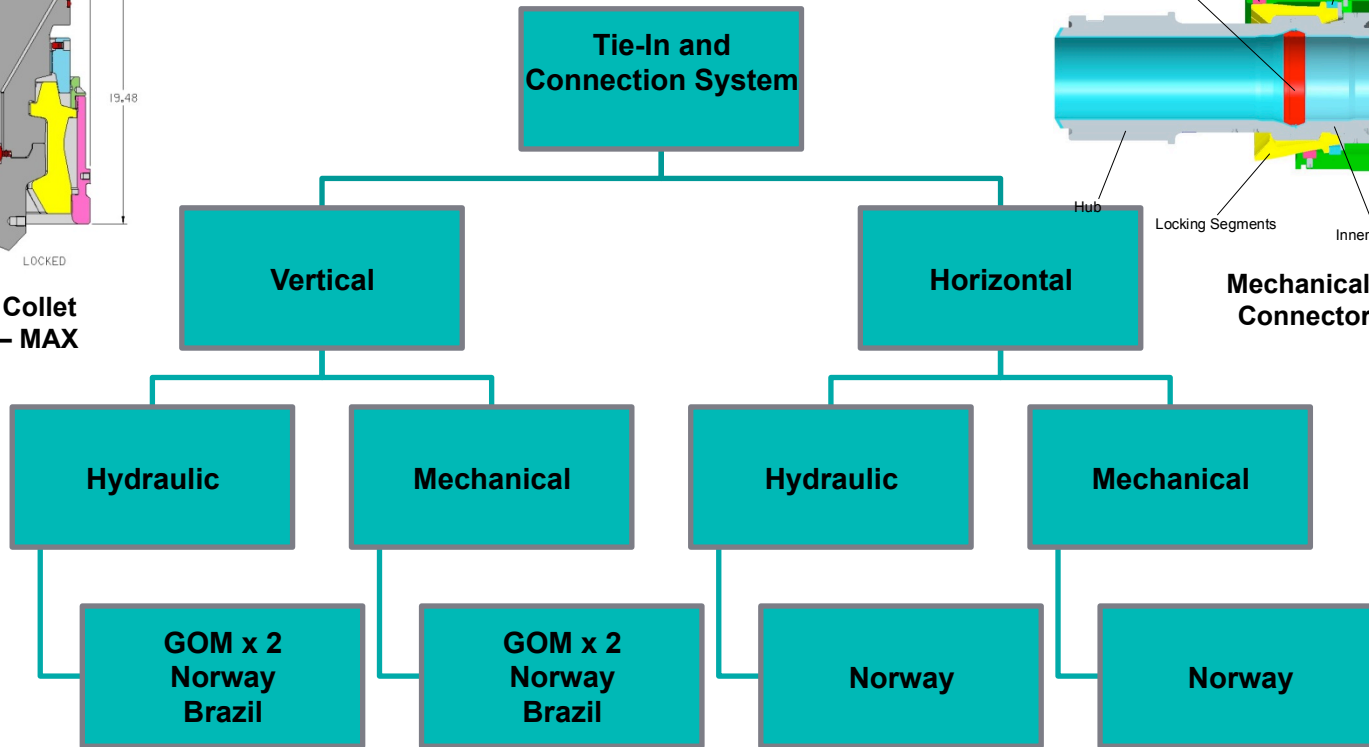
Connector – Snap Shot



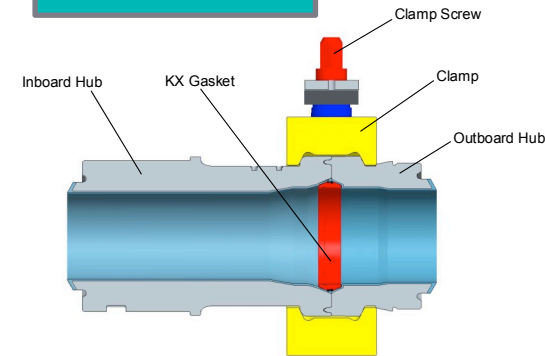
Mechanical Collet Connector – MAX



Mechanical Collet Connector - KC4



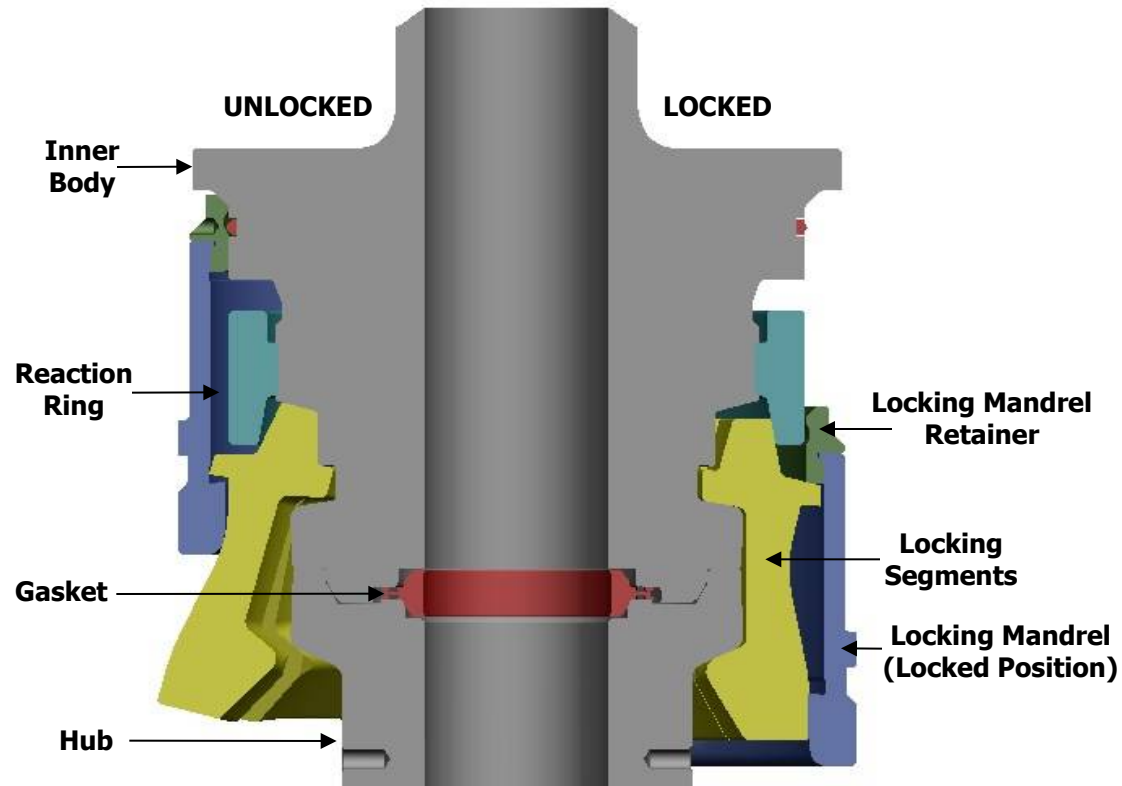
Hydraulic Lock Segment Connector Torus III & IV



Mechanical Clamp Connector - KL4

Mechanical Connectors

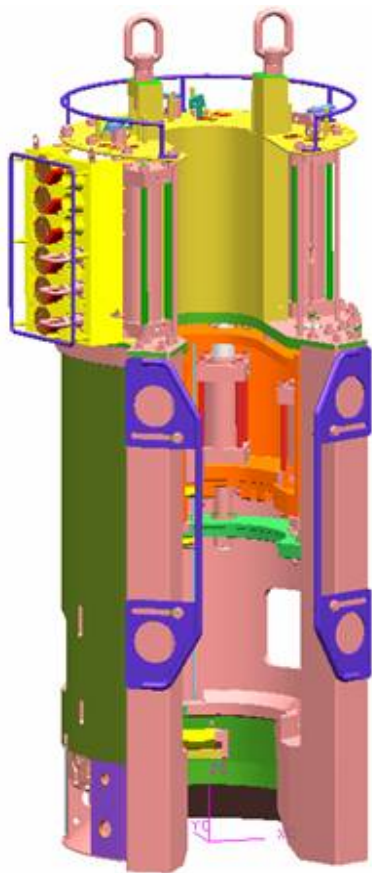
- Working pressure up to 15,000 psi
- MAX-8 designed to accommodate up to 8" pipe; MAX-14 up to 14" pipe
- Connector Actuating Tool (CAT) performs external lock/unlock, hub alignment, and gasket replacement
- All hydraulic components integral to recoverable CAT (no hydraulics left subsea)
- MC gasket provides primary metal seal and secondary non-metal seal



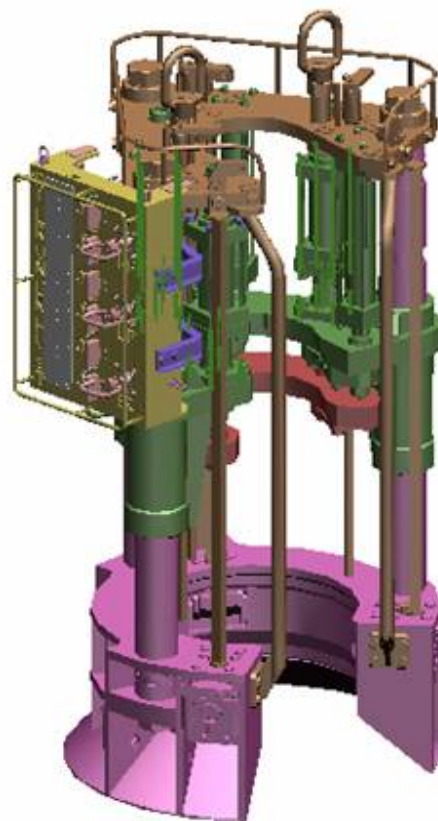
MAX-8 / MAX-14

Mechanical Connectors

CAT Variations

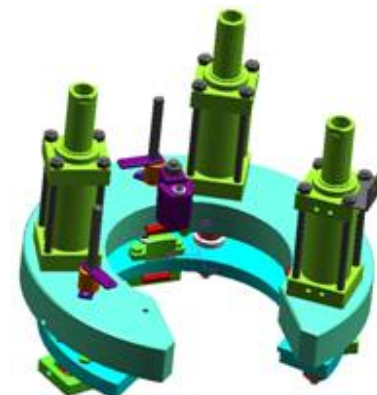
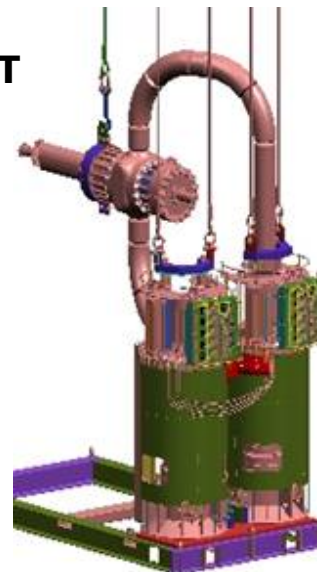


CAT



CAT-Lite

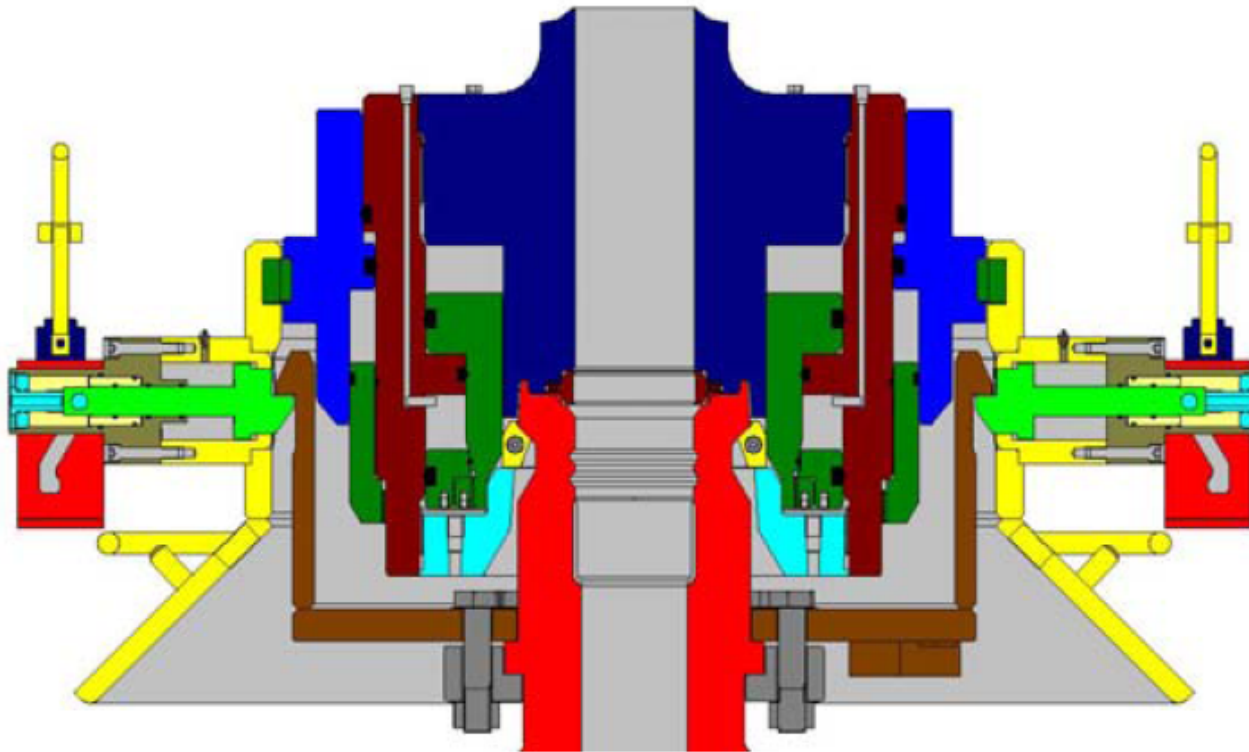
Dual CAT



Land CAT

Hydraulic Connectors

5" – 20" pipe sizes

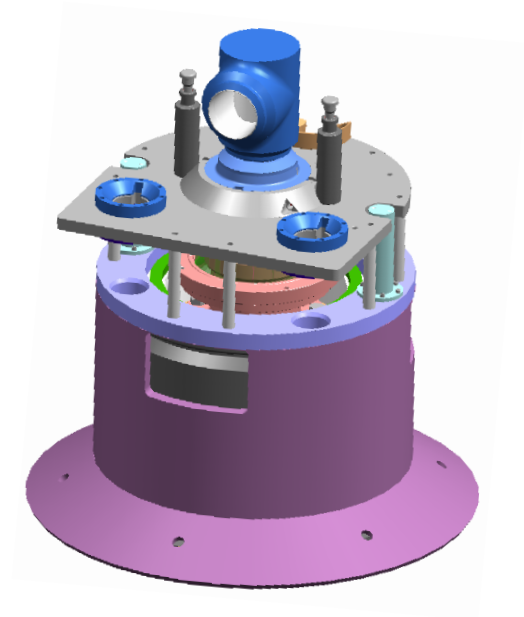
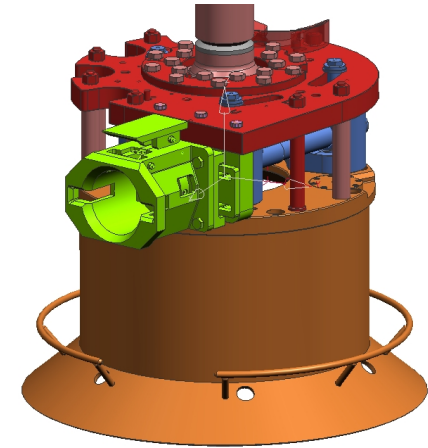


Torus III Connector w/ Integral Soft-Land System

UCON™ and Clamp Connectors

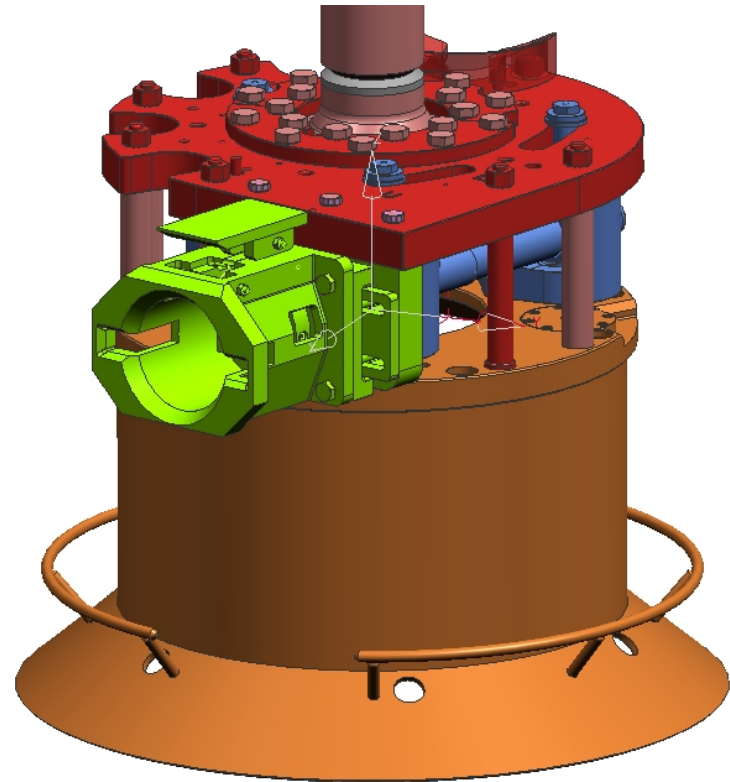


The UCON™ Tie-In system is developed in close co-operation with StatoilHydro



UCON-V / KLV Clamp Connector Benefits

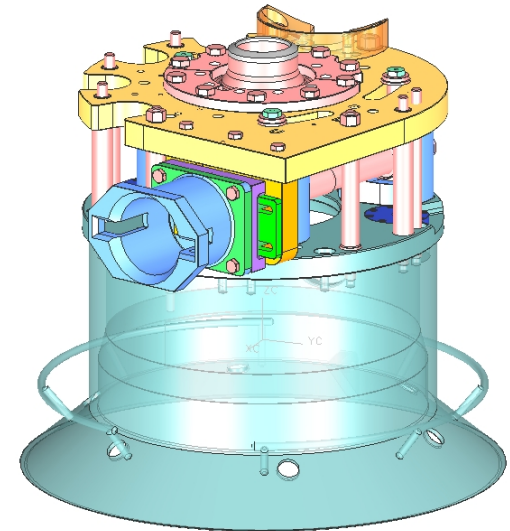
- Lowers installed cost for well and flowline jumpers.
- Eliminates need for proprietary hydraulic connector actuation tools (CATs)
- Simplifies offshore operations, eliminating difficulty with handling and resetting CATs
- Allows more jumpers to be carried offshore per deployment.
- Eliminates future risk that CATs are not available for a future intervention



KLV-8 Clamp Connector



- KLV Clamp Connector - initially designed to interface with existing MAX hubs
- Connector tooling is now ROV installable and removable
- Significantly lowers total installed cost



**MAX Collet Connector
& Connector Actuation Tool (CAT)**

KLV-8 Clamp Connector

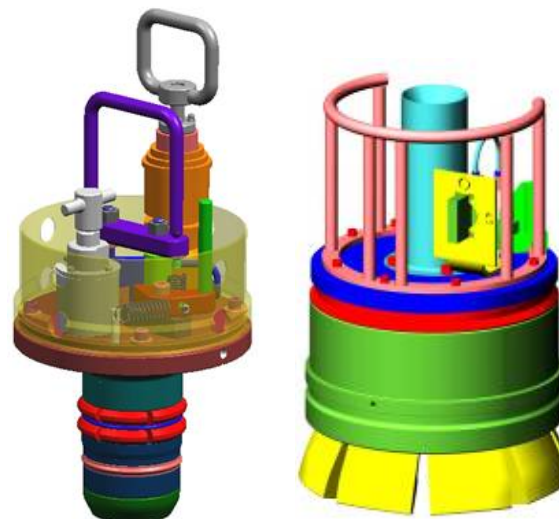
Pressure Caps

- Application

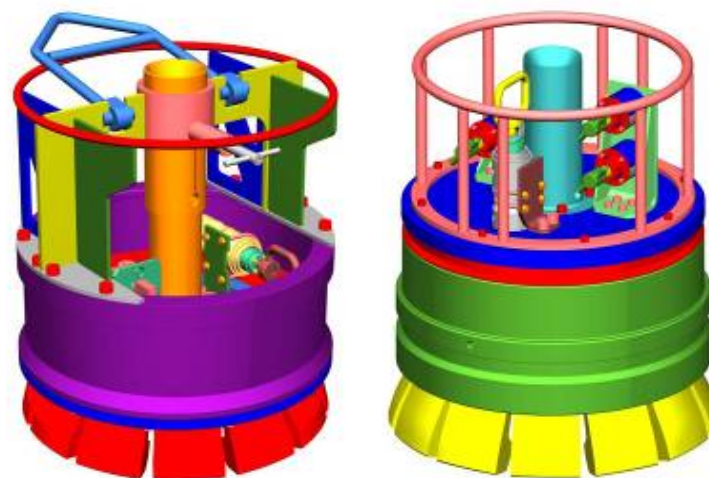
- Permanent / Temporary pressure barrier
- Flowline flooding
- Jumper metrology
- Surface or subsea installable and subsea retrievable by ROV or w/ CAT
- 15,000 psi WP
- 10,000 ft w.d.
- 20-year life

- Sizes

- 5" – 14" pipe



Elastomer and Metal Sealing Pressure Caps (5" – 8" Pipe)



Elastomer and Metal Sealing Pressure Caps (9" – 14" Pipe)

Pressure Caps

Externally Locking
MAX-14



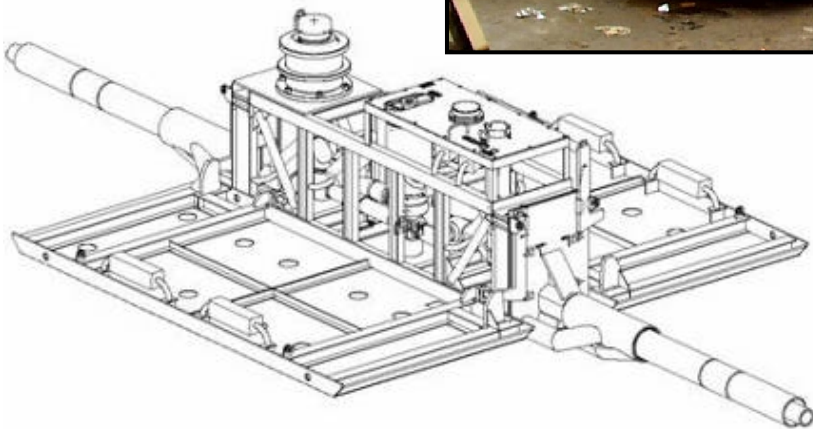
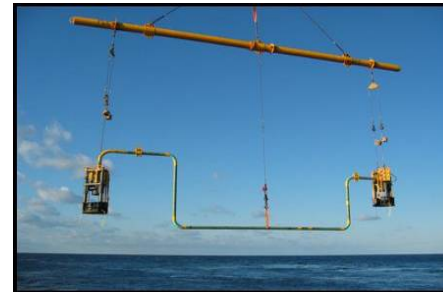
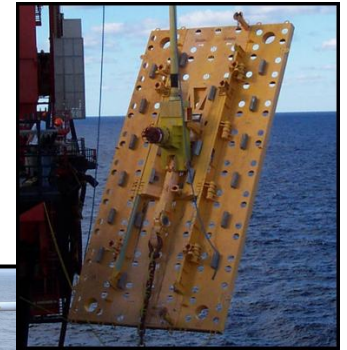
MAX-8

MPS Assemblies

Upper Level Products

MPS Assemblies

- Manifolds
- Foundations
- PLETs
- PLEMs
- Sleds
- In-Line Tees
- Jumpers



Manifolds



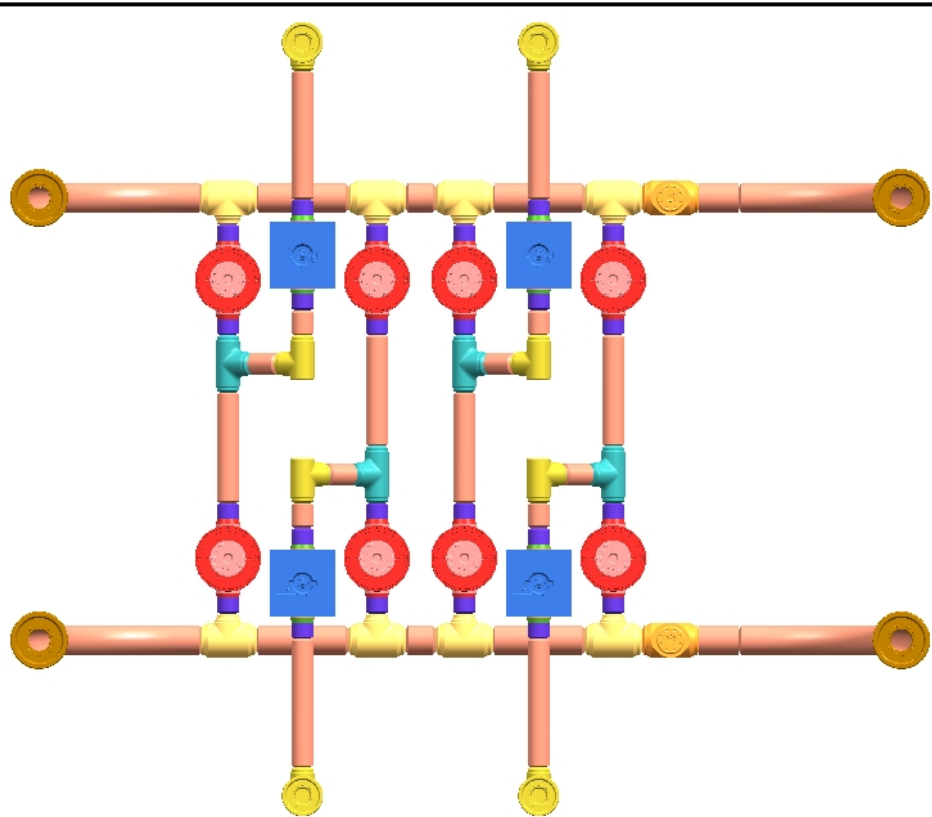
- Application
 - Co-mingle flow several wells into 1-2 flowlines
- Manifold Sizes
 - 2 – 10 Slot
- Branch Sizes
 - 4" – 7"
- Flowline Sizes
 - 5" – 12"

Manifolds

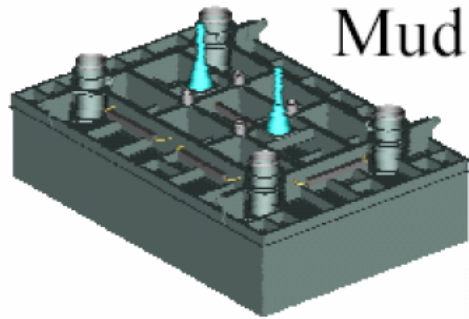


2-Header, 5-Slot Manifold
10ksi w.p.
6" branches, 8" headers
Pig Loop, SCM, C/I, Mudmat

2-Header, 4-Slot Manifold



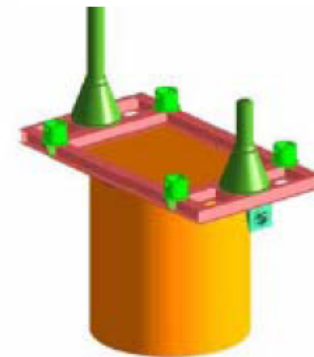
Foundations



Mud Mat



Drilled &
Cemented
Monopile



Suction
Pile

Decreasing Soil Strength
↓

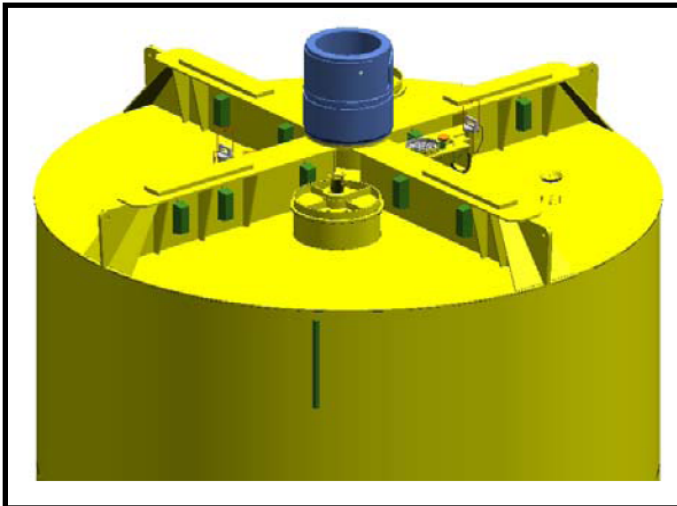
→ Increasing Cost

Foundations - Mudmats



Foundations - Suction Piles

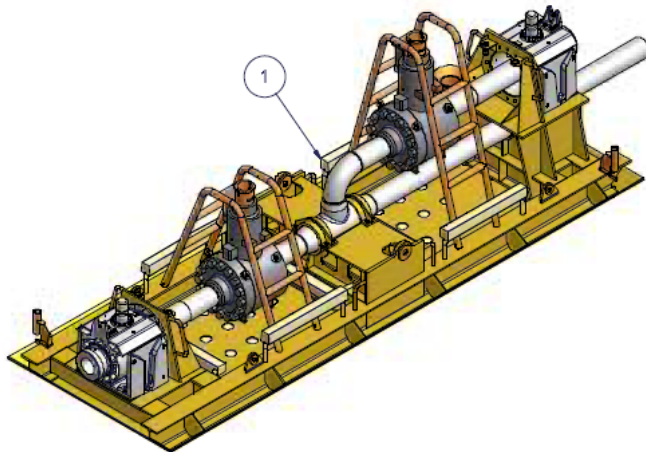
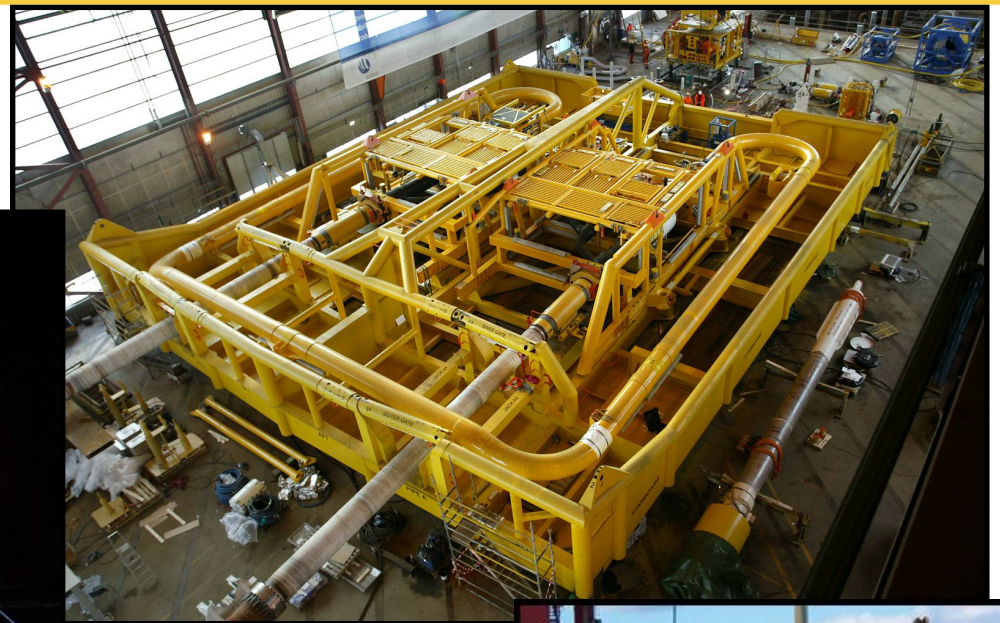
- Up to 20 ft diameter
- Up to 90 ft long
- Suction pile penetrates soil under its own weight
- ROV closes valve on top and pumps water out of can
- Sea head (.44 psi/ft) pushes suction pile into sea floor



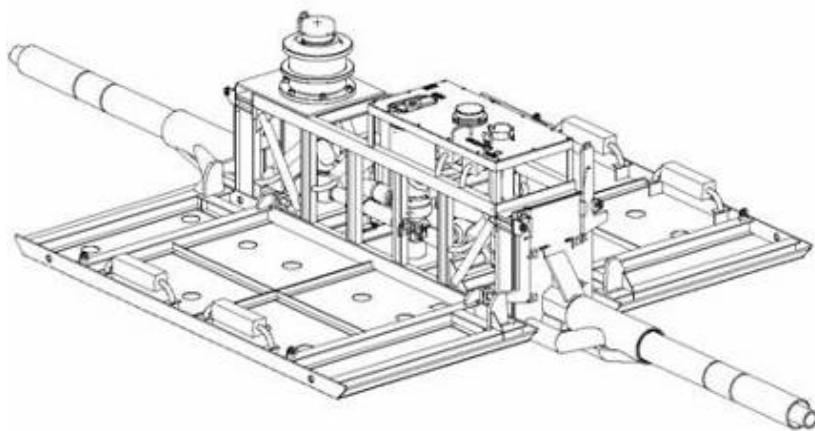
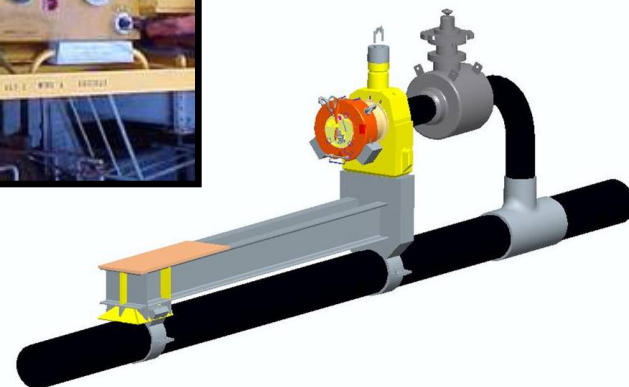
Foundations - Suction Piles (Agbami)



PLETs, PLEMs

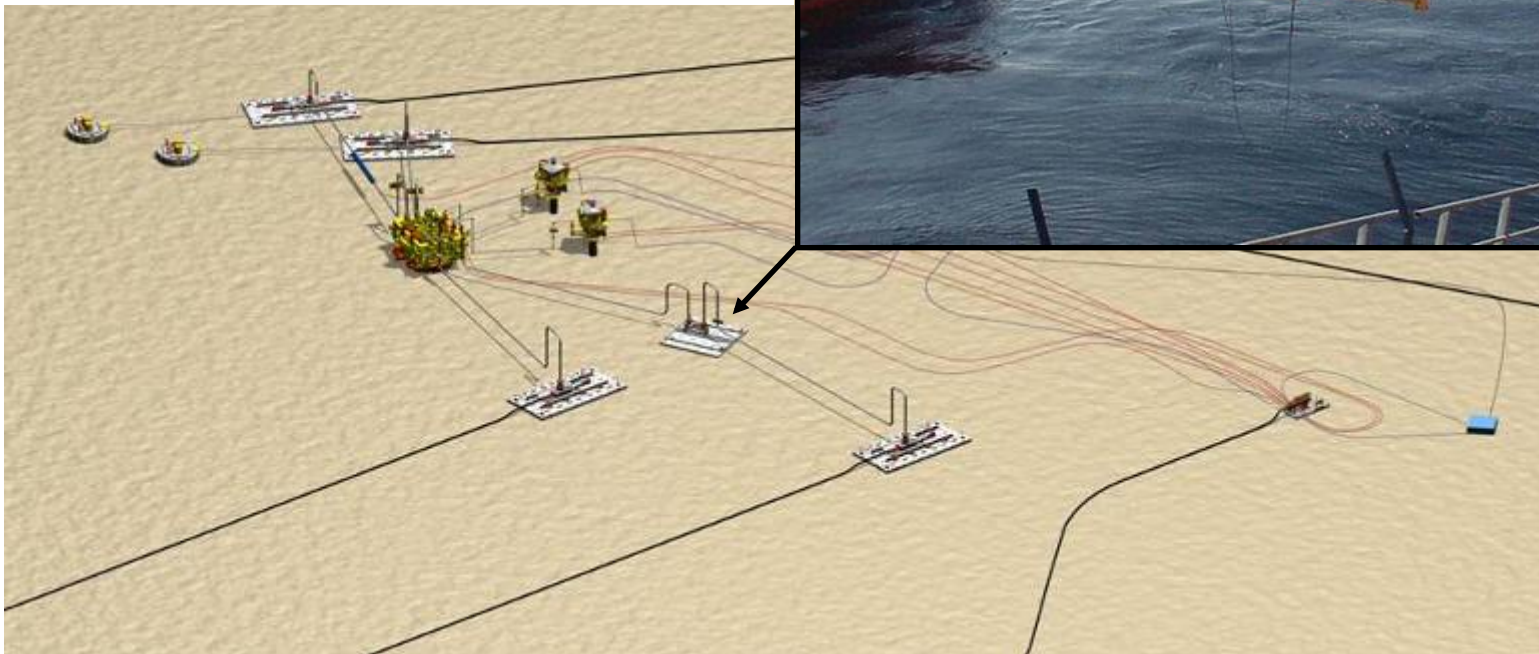
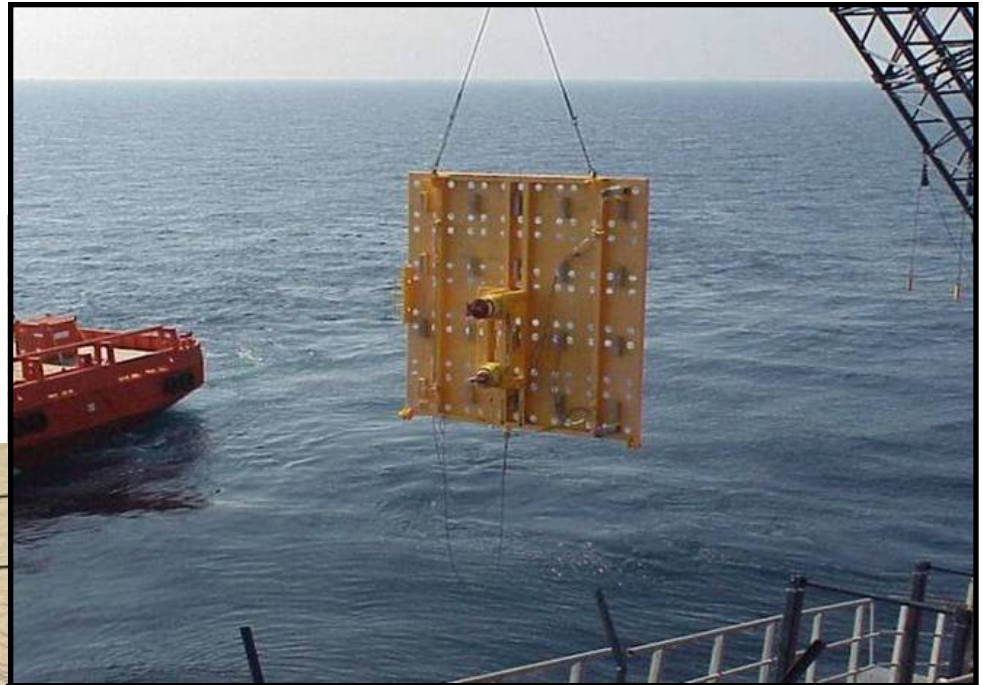


In-Line Tees

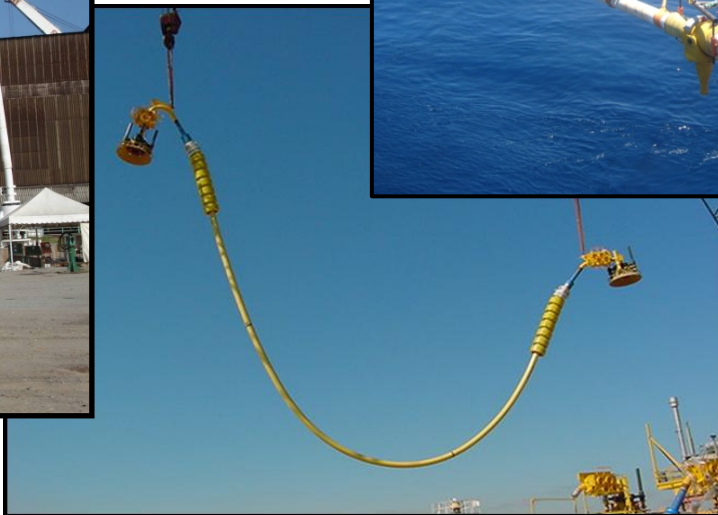
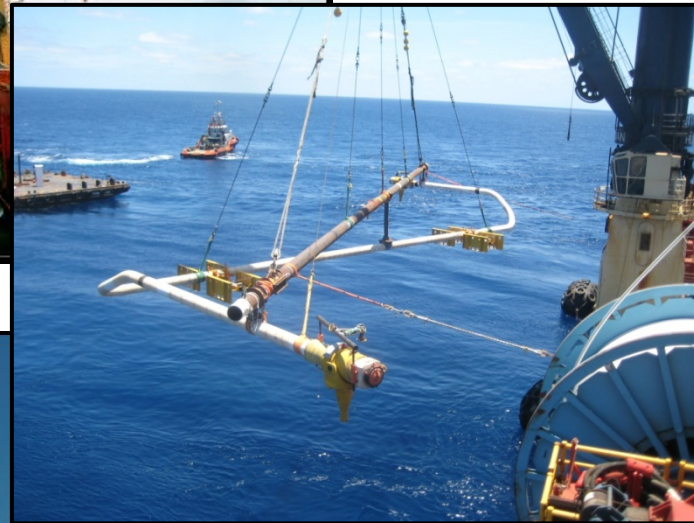
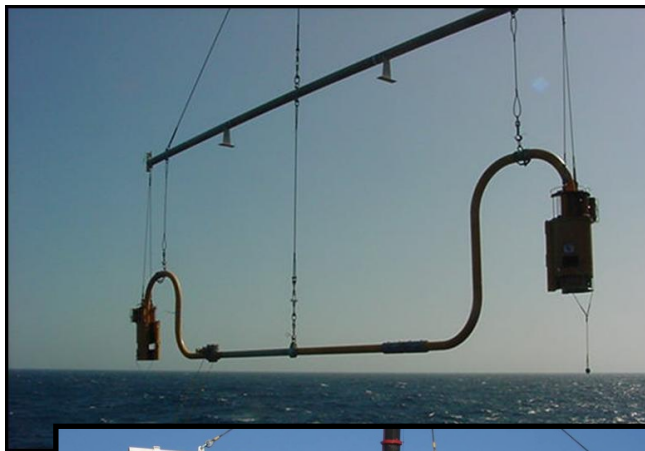


Intermediate Sled

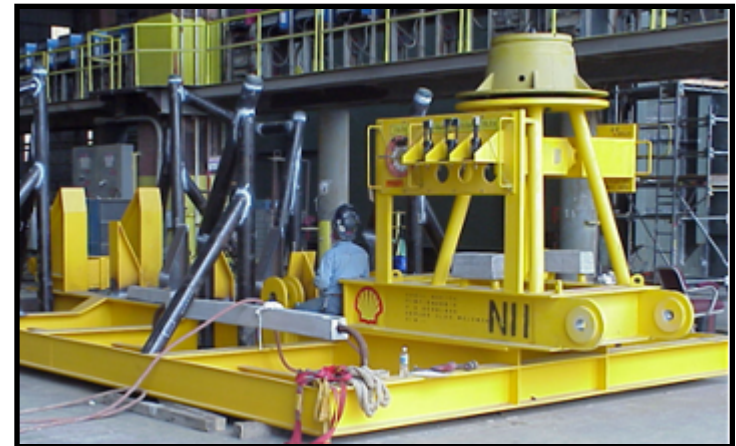
- Allows for extra long Jumper reach via multiple Jumpers
- Fixed Mudmat



Jumpers



Various Gas Lift Sleds & Manifolds



Design Considerations & Analysis

Design Considerations

Pressure

- Operating
- Hydro Test

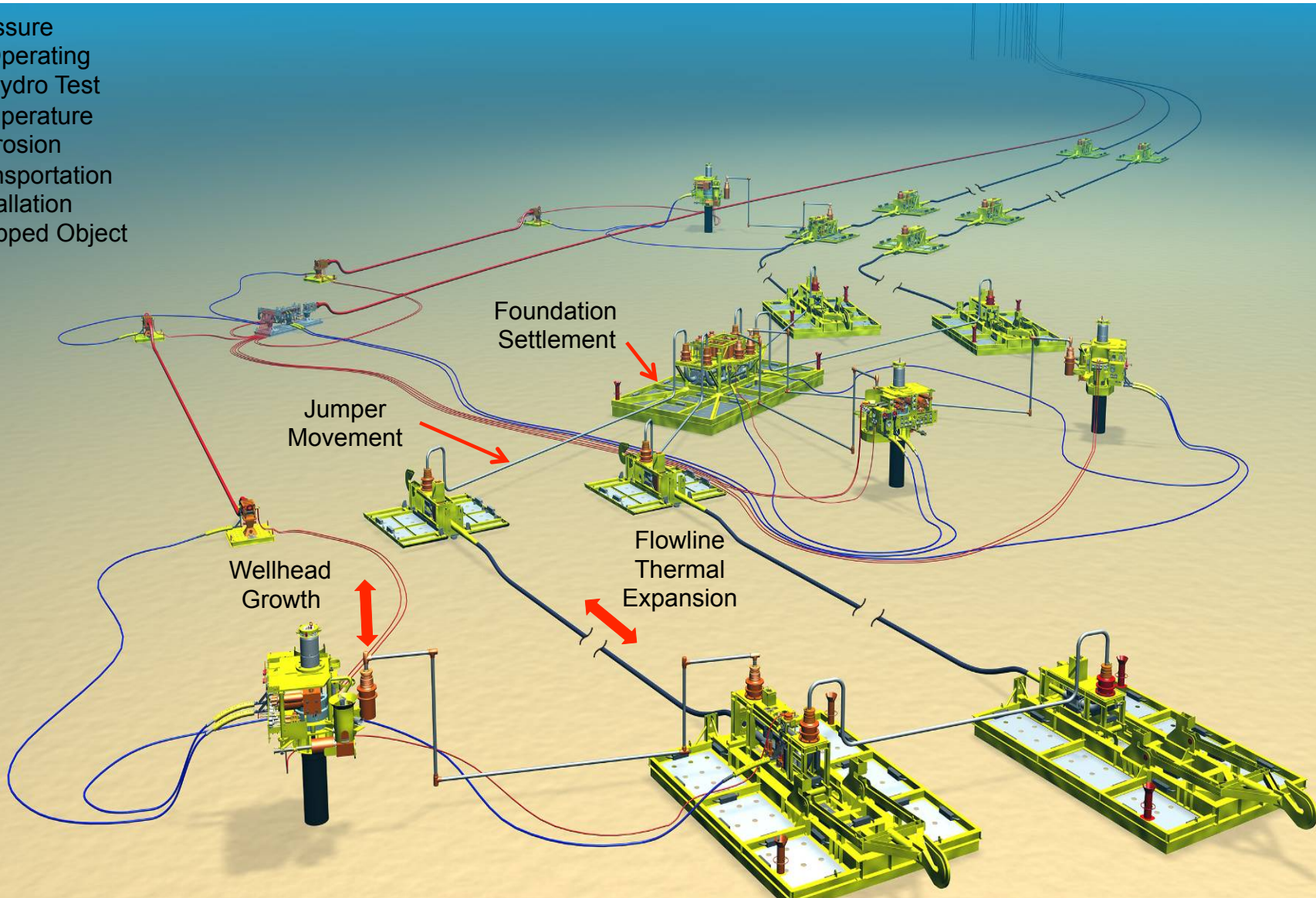
Temperature

Corrosion

Transportation

Installation

Dropped Object



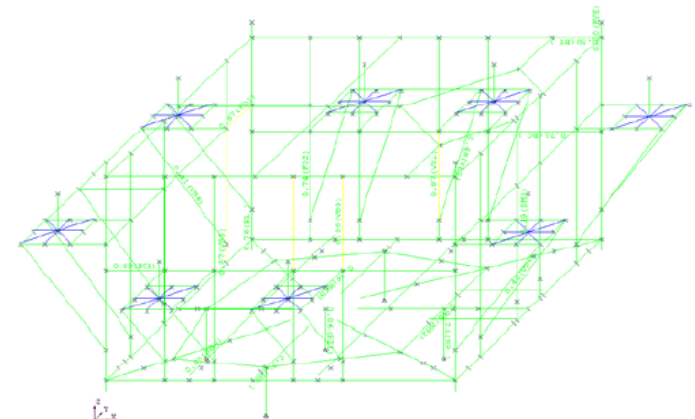
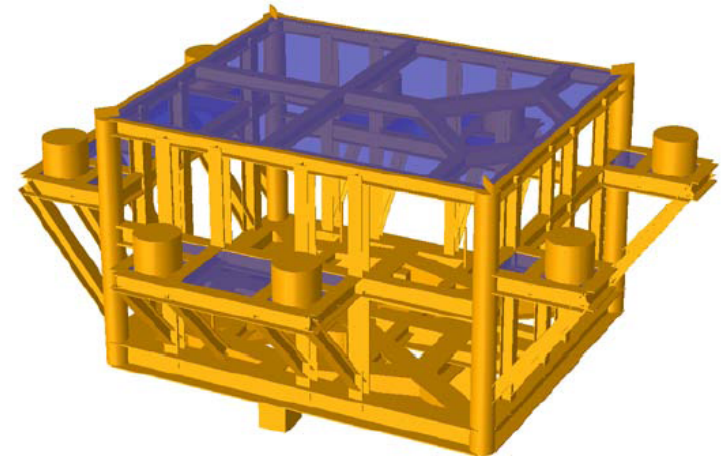
Manifold Piggability

Various Pig shapes:

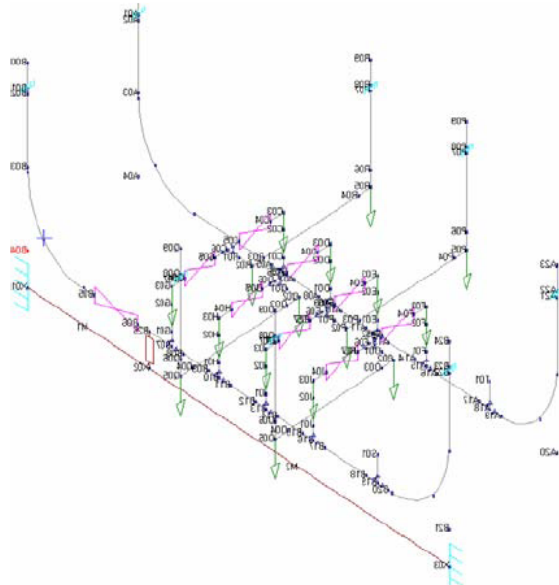
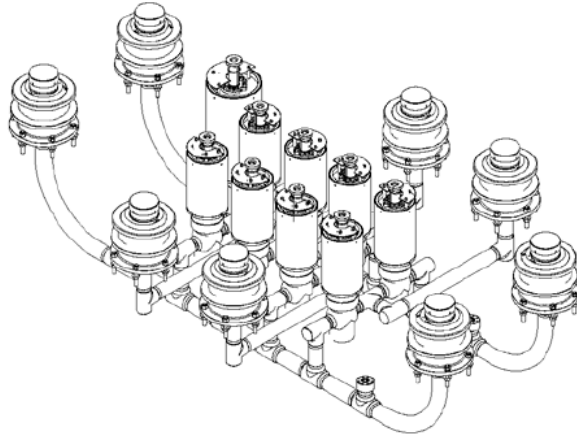


Structural Analysis - SACS

Analysis Cases	
Lift Analysis	Dead weight of structure and piping + Dead weight of pigging loop
Transportation	2.0g vertical, 0.5/0.3 g lateral
	2.0g vertical, 0.3/0.5 g lateral
Jumper Installation	Dead weight of structure and piping + Pigging loop loads + CAT weight + Jumper operating loads
Operating	Dead weight of structure and piping + Piping thermal loads + Pigging loop operating loads + Jumper operating loads
Snag	Dead weight of structure and piping + Pigging loop operating loads + Jumper operating loads + Snag load on hub
Dropped Object	Dead weight of structure and piping + Pigging loop operating loads + Jumper operating loads + Dropped object
ROV Impact	ROV Impact on MQCs

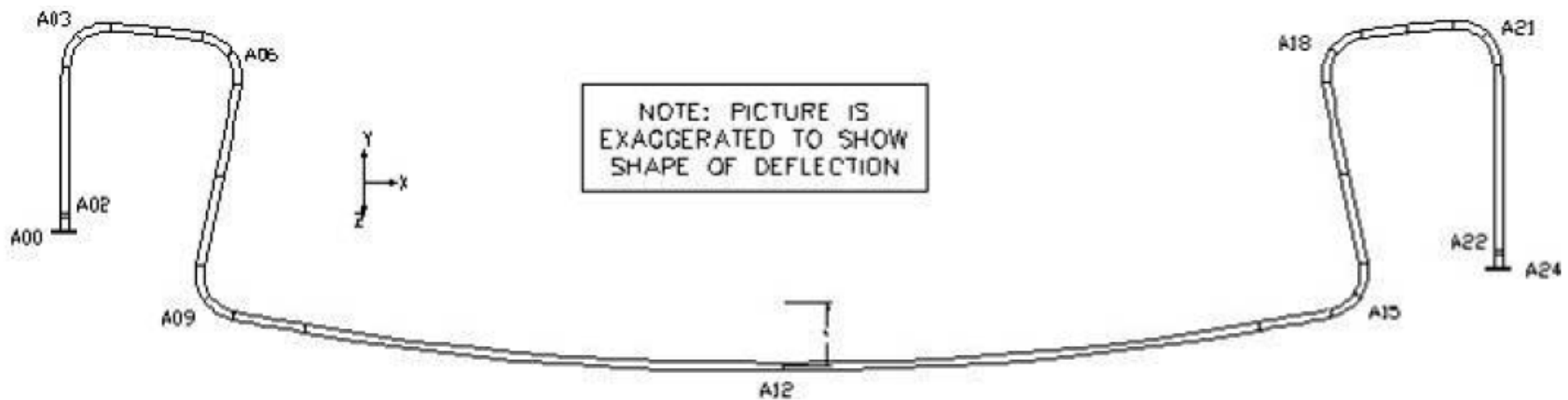
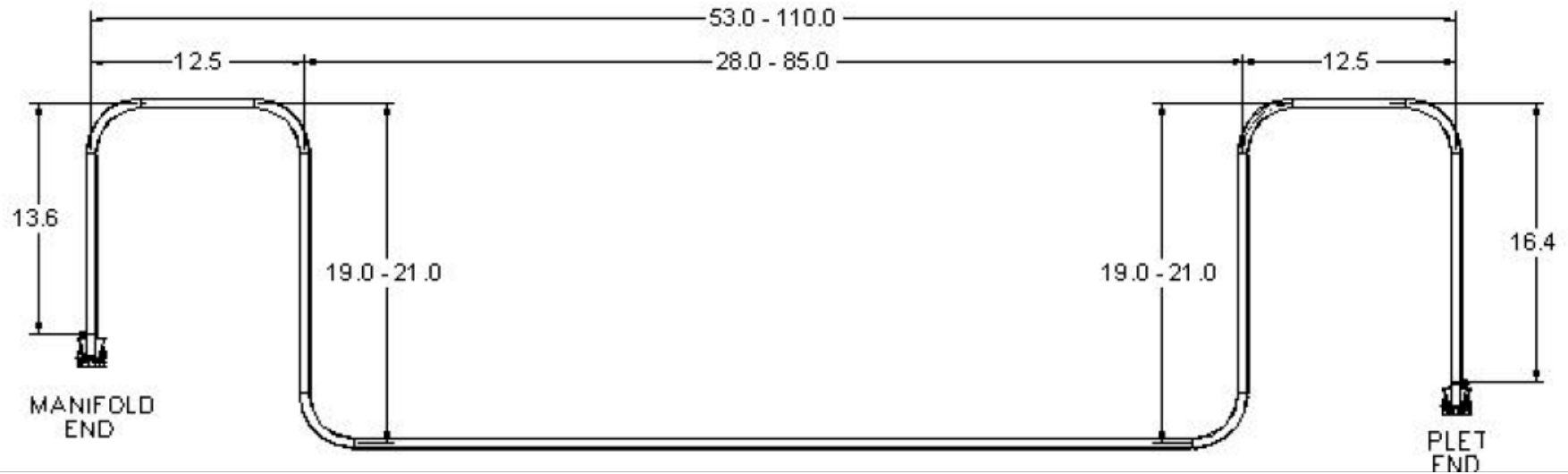


Piping Analysis - AutoPIPE



Analysis Cases	
Hydrotest	- 12,800 psi Internal Pressure
	- Ambient Temperature
	- Gravity (pipe dead load, insulation, water)
	- No jumper loads
Transportation	- 2.0g vertical, 0.5/0.3 g lateral
	- 2.0g vertical, 0.3/0.5 g lateral
	- No jumper loads
Operation	- 10,000 psi Internal Pressure
	- 250F Operating Temperature
	- Gravity with bouyancy
	- No jumper loads

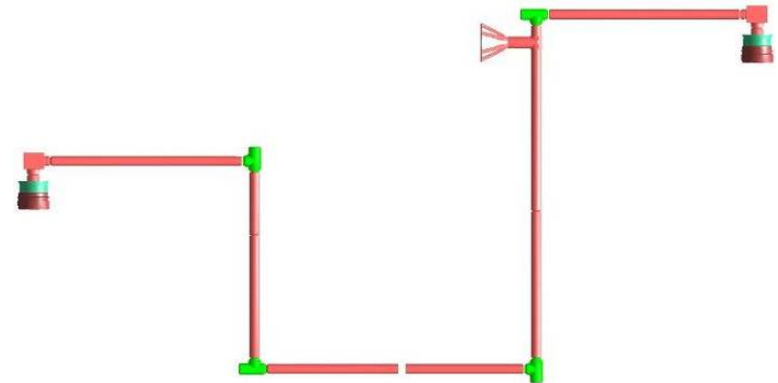
Jumper Analysis - AutoPIPE



Rigid Pipe Vertical Jumper Configurations

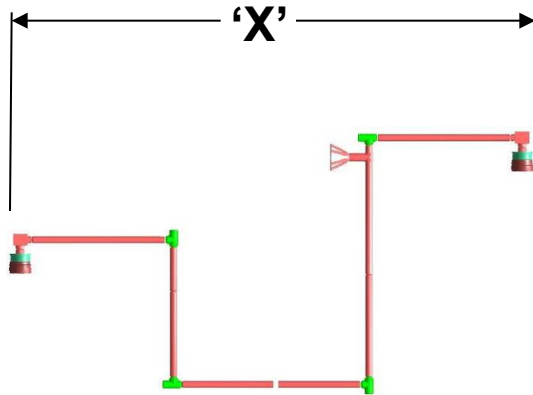


Inverted 'U' Shaped Jumper



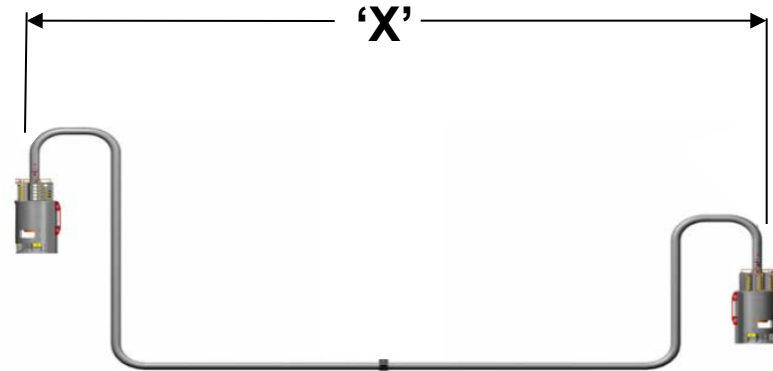
'M' Shaped Jumper

Rigid Jumper Lengths



Well Jumpers

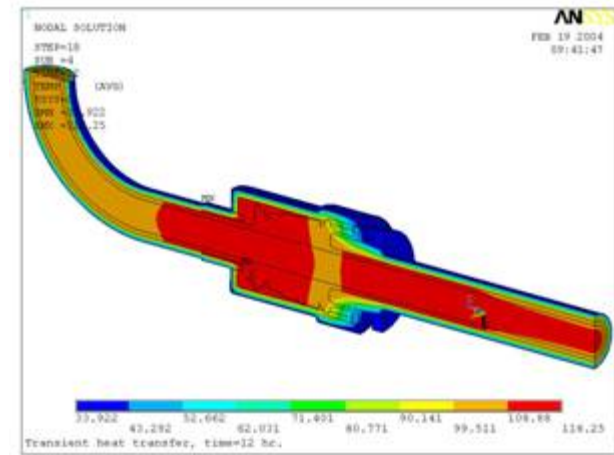
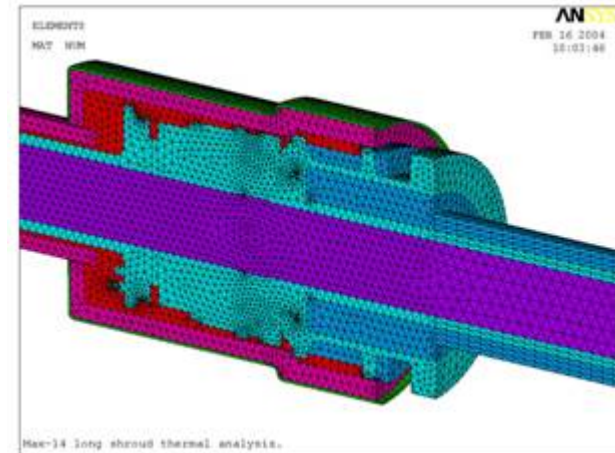
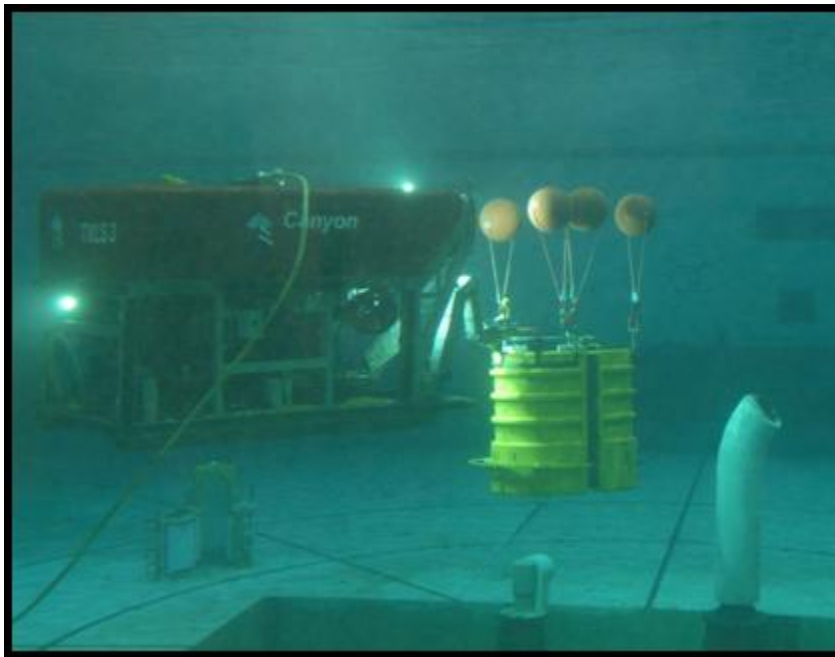
Well Jumpers (O.D. in.)	Min. / Max. Length ('X' ft.)
4"	50' – 100'
5"	50' – 100'
6"	50' – 100'
7"	60' – 100'



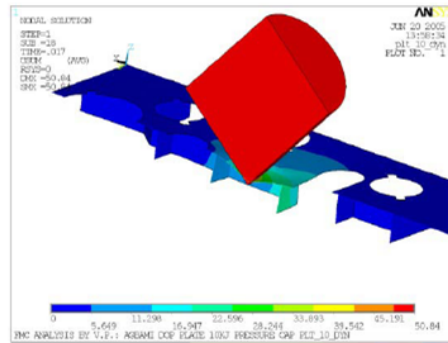
Flowline Jumpers

Flowline Jumpers (O.D. in.)	Min. / Max. Length ('X' ft.)
8"	60' – 120'
10"	80' – 120'
12"	80' – 150'
14"	100+'
16"	100+'
18"	100+'

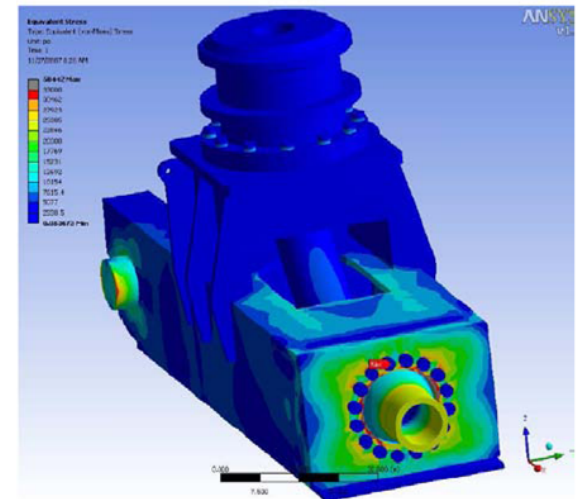
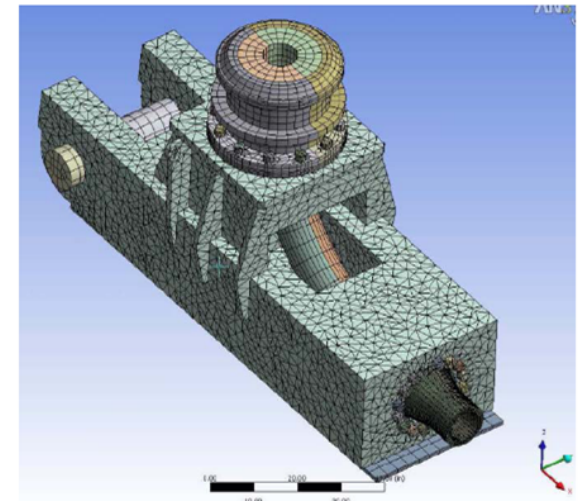
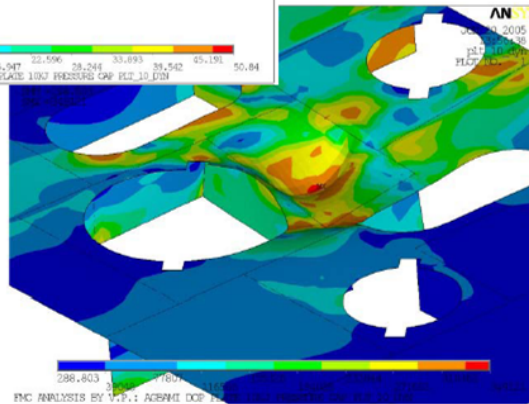
Thermal Analysis – ANSYS



FEA Analysis



Dropped Object



Finite Element

MPS Fabrication

MPS Fabrication



Kiewit - Corpus Christi



Grinaker - Nigeria



Spitzer - Houston

Manifold Fabrication - Structure



Structure

Manifold Fabrication – Pipe Kit



Manifold Structure w/ Flowlines, Headers, Hubs, Valves & Actuators

Manifold Fabrication – Integration



Manifold Fabrication – Controls (SCM)



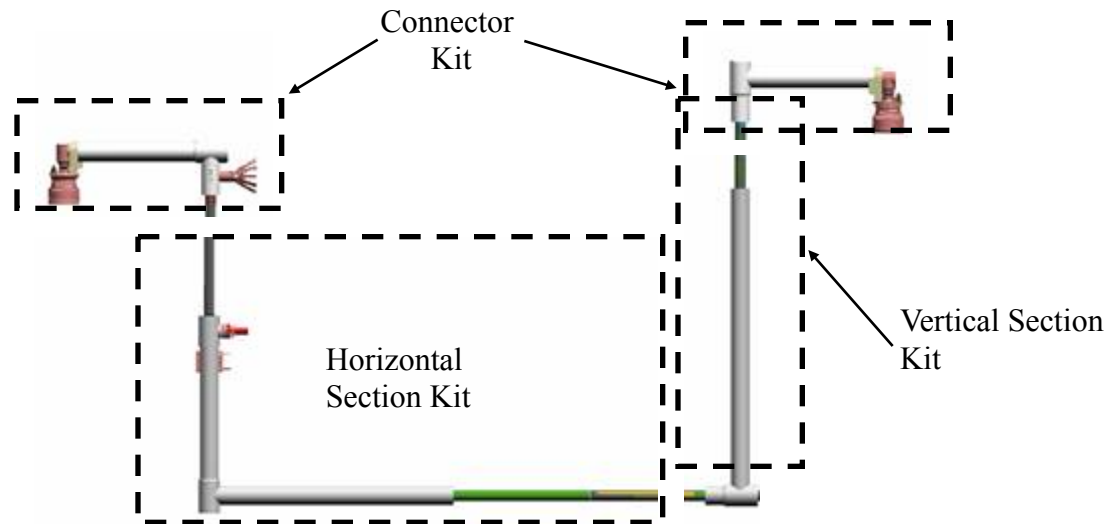
Manifold Fabrication – Insulation



Manifold Lift Test and Interface Test



Jumper Fabrication



- Connector kits locked onto vertical facing hubs.
- Horizontal & Vertical section kits are fitting and welded out.
- Jumper is hydrostatically test
- Final assembly of remaining components.
- Trial Lift



Jumper Fabrication



Petrobras *Cascade/Chinook* - 4-slot Manifold SIT



Petrobras *Cascade/Chinook* - Manifold and Jumpers SIT



Transportation and Installation

Manifold Transportation and Installation



Agbami Manifold Sail Away



In-Country capabilities - A key success factor

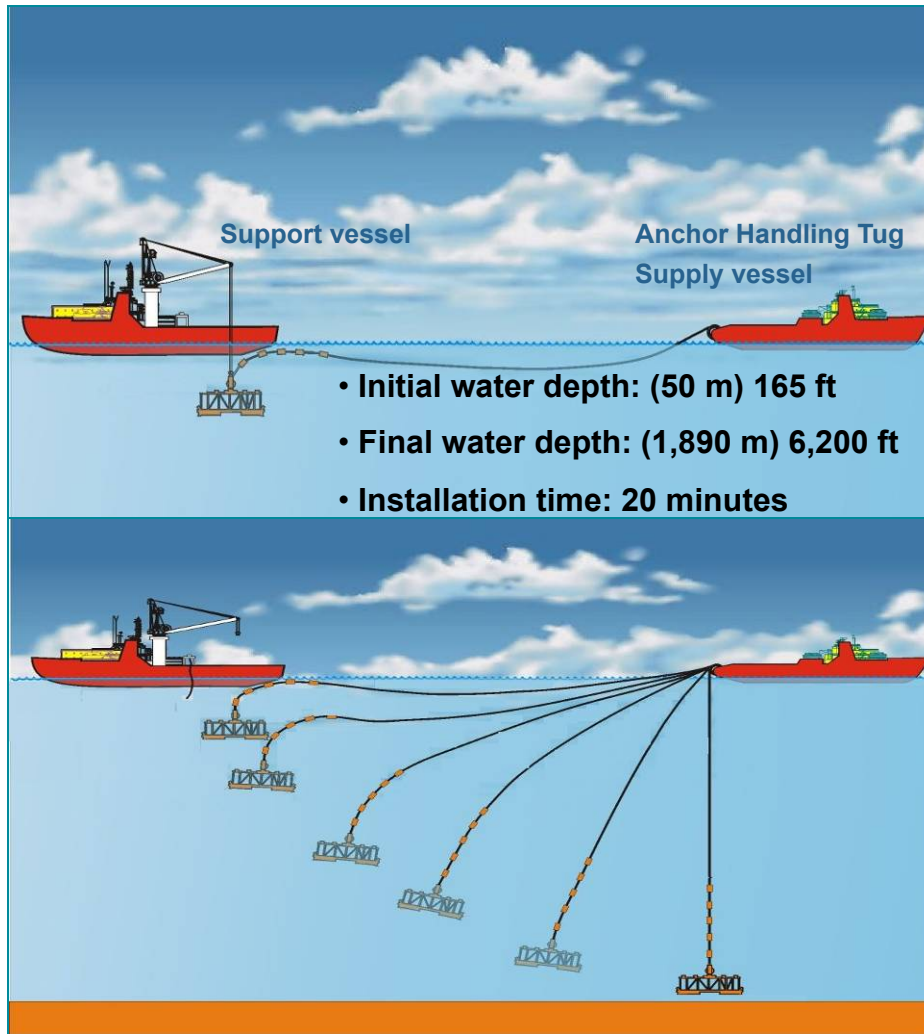
Agbami Project (Nigeria)



Heerema - DCV *Balder*



Pendulous Manifold Installation Method - Roncador



FULL SCALE TEST

Anadarko/Kosmos/Tullow *Jubilee* - Riser Base Installation



Atlantis Manifold Installation



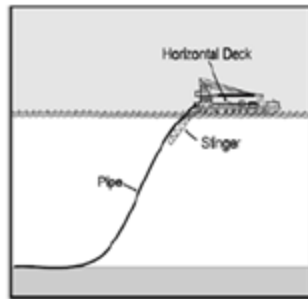
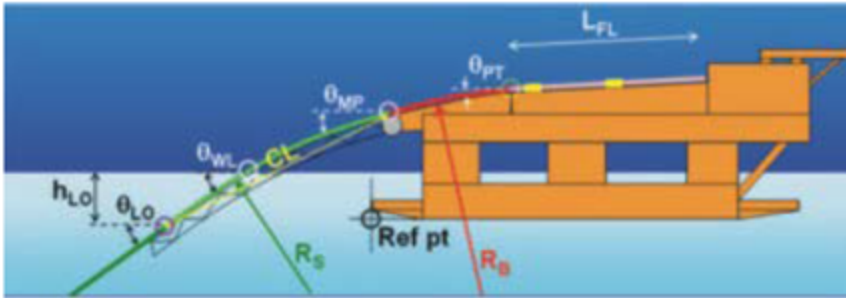
Blind Faith Manifold Installation



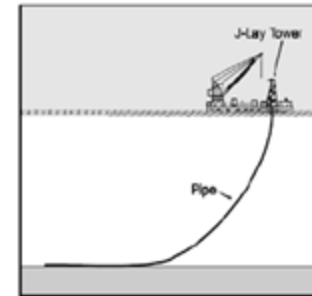
***Blind Faith* - PLET Transportation**



PLET Installation



'S' Lay

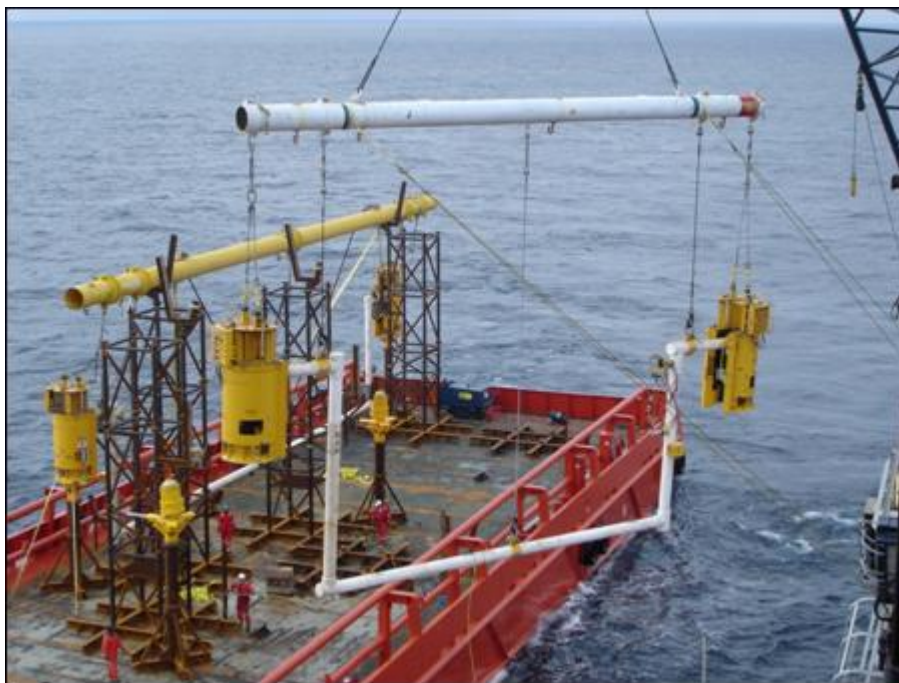


'J' Lay



Jumper Transportation

Shipping Stands



Sea Fastening on Shipping Stands



Jumper Transportation (Offshore)

- Jumpers are transported vertically on barge or AHV
- Stands are designed for 1G roll motion based on the weight of heaviest anticipated jumper
- Spreader Bar can be shipped pre-rigged to jumper in own shipping stands

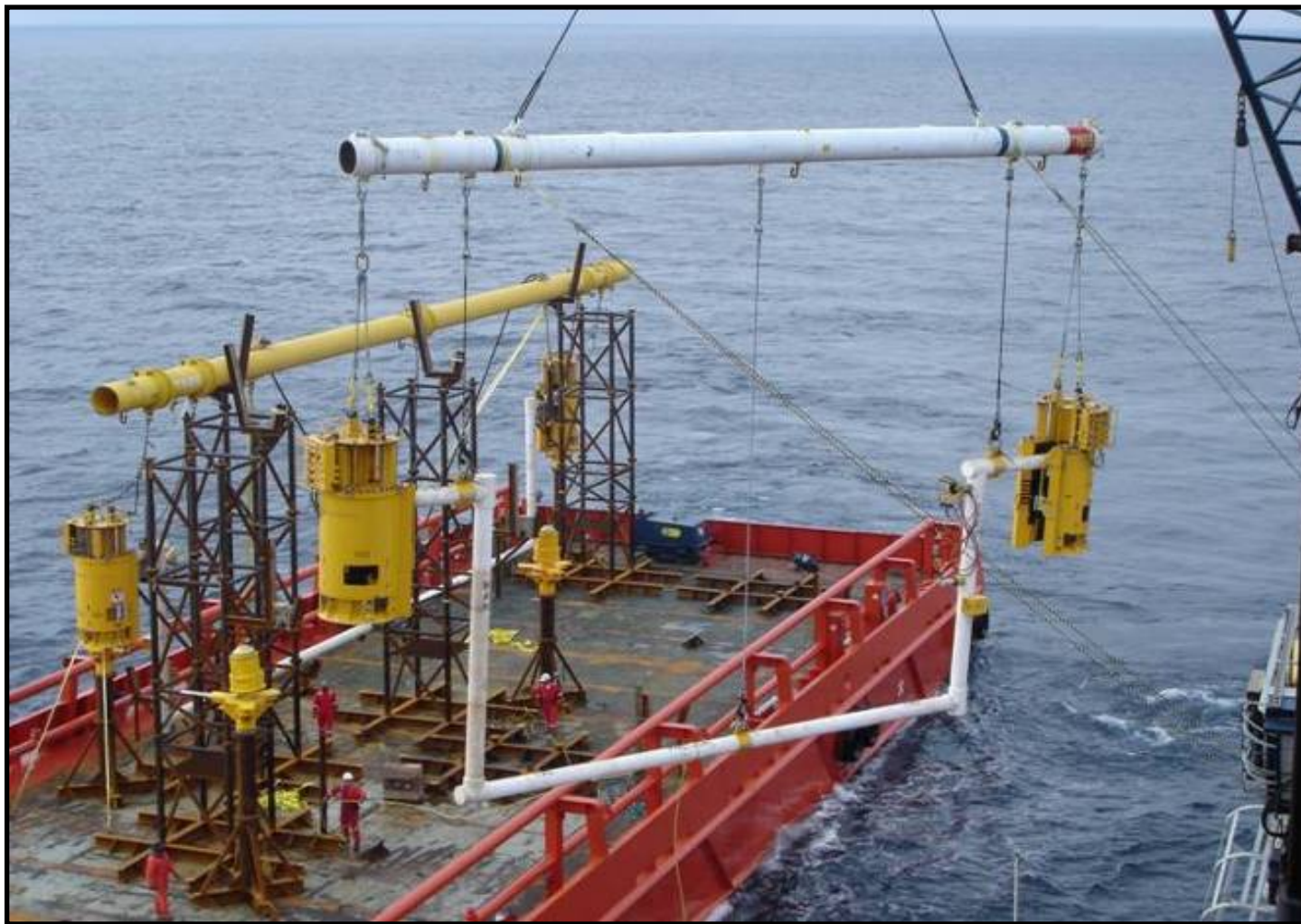


Rigid Jumper Transportation



Flexible Jumper Transportation

Jumper Installation

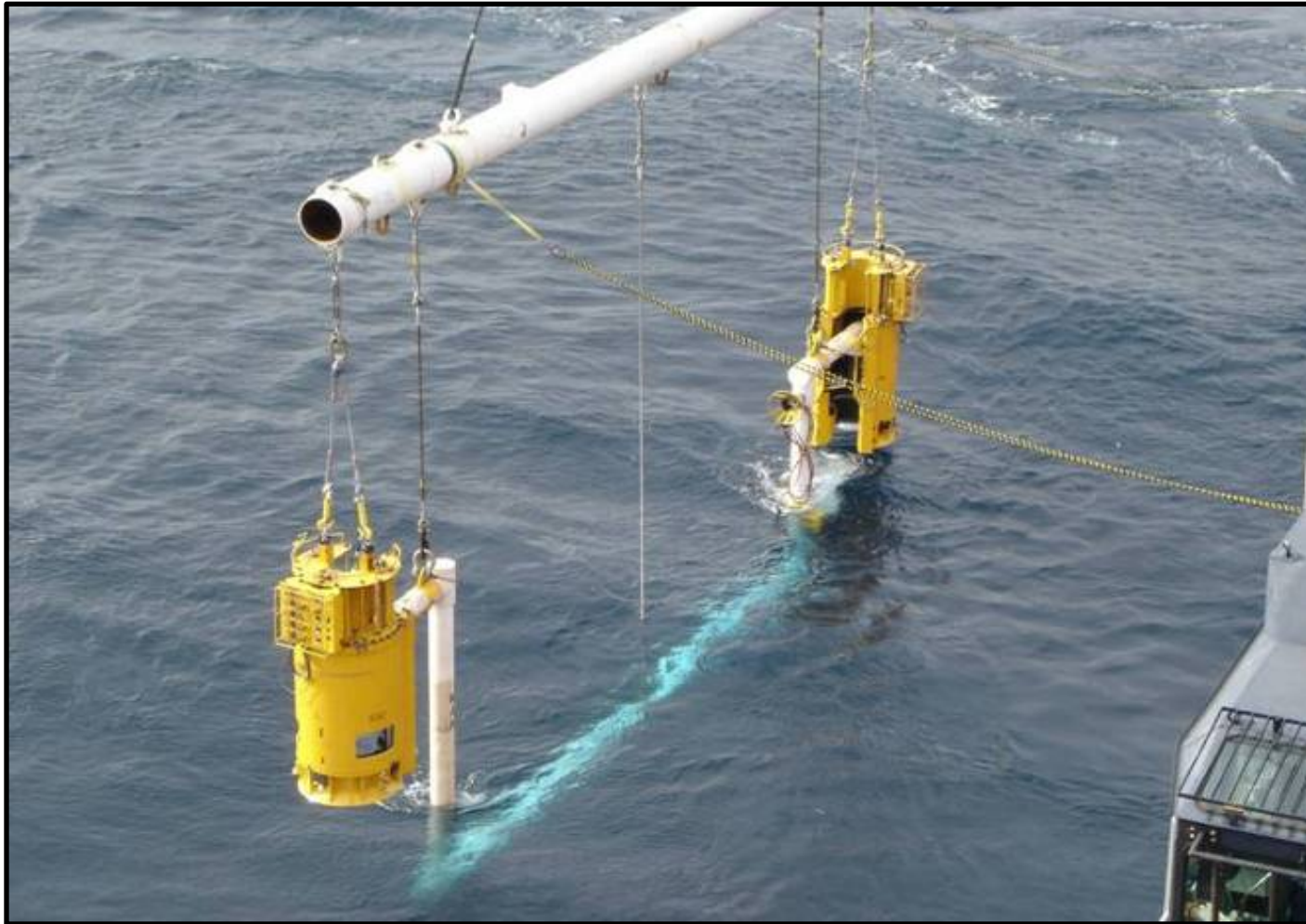


50' lg. 5" Well Jumper

12" Flowline Jumper Installation (153' lg.) Using MAX-14 Connectors & CATs



Jumper Installation



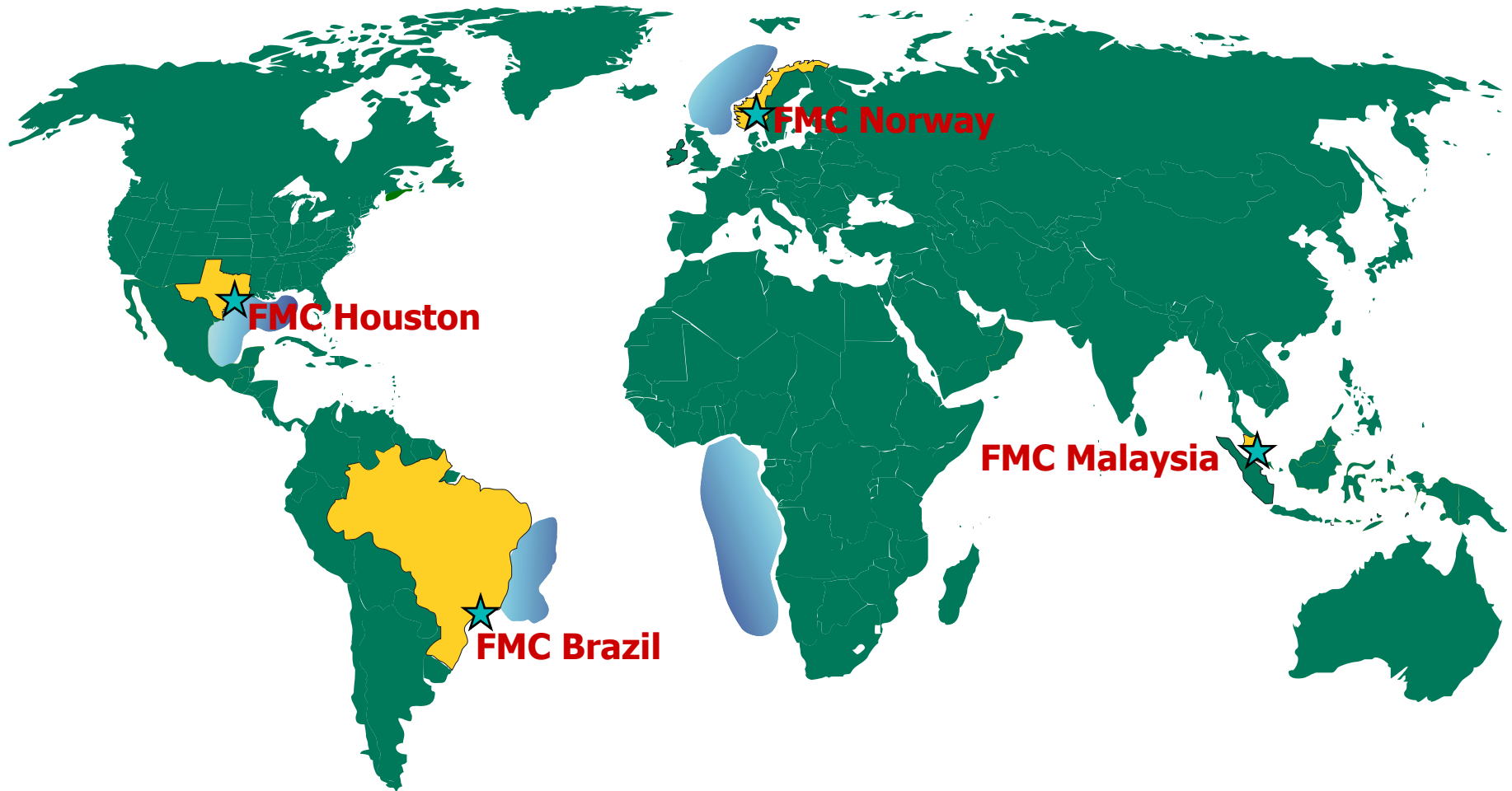
Callisto Well Jumper Installation - UCON-V KLV-8 Clamp Connectors, Deepwater GoM (8k' w.d.)



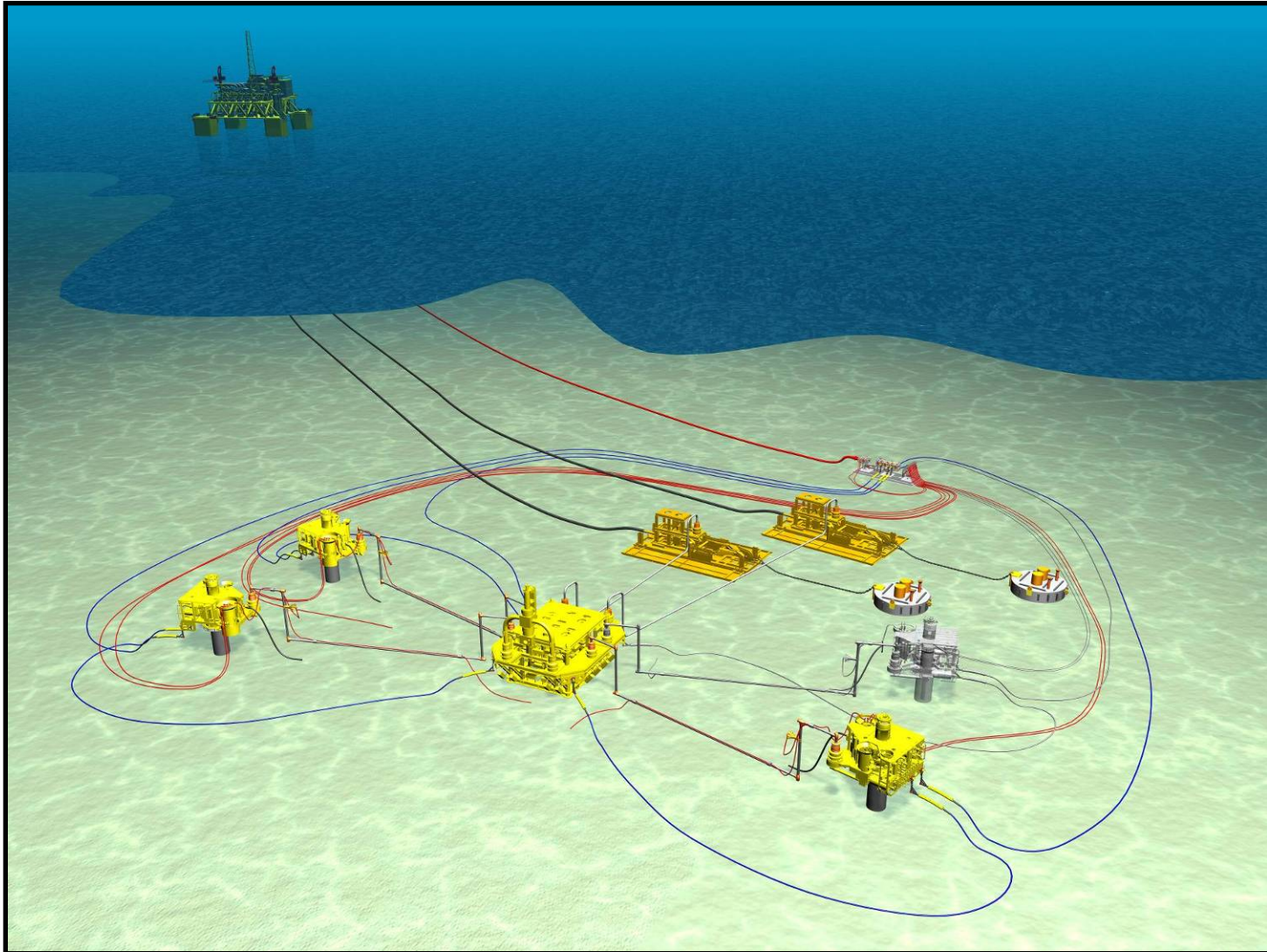
Global MPS

Regional Variations

FMC's Global Manifold & Pipeline Systems Supply



Gulf of Mexico

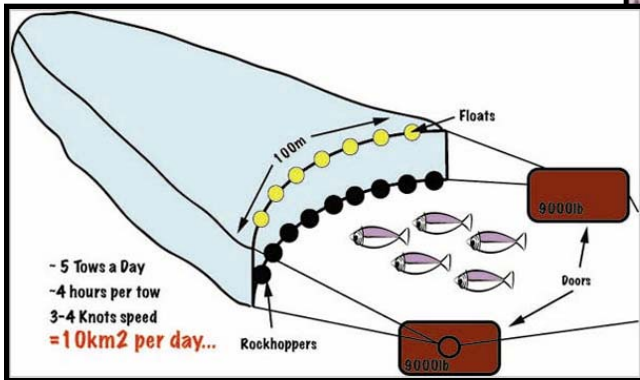


North Sea



HOST – Hinge Over Subsea Template

N. Sea Manifold - Overtrawlable Structure & Diver Assist Flowline Connections

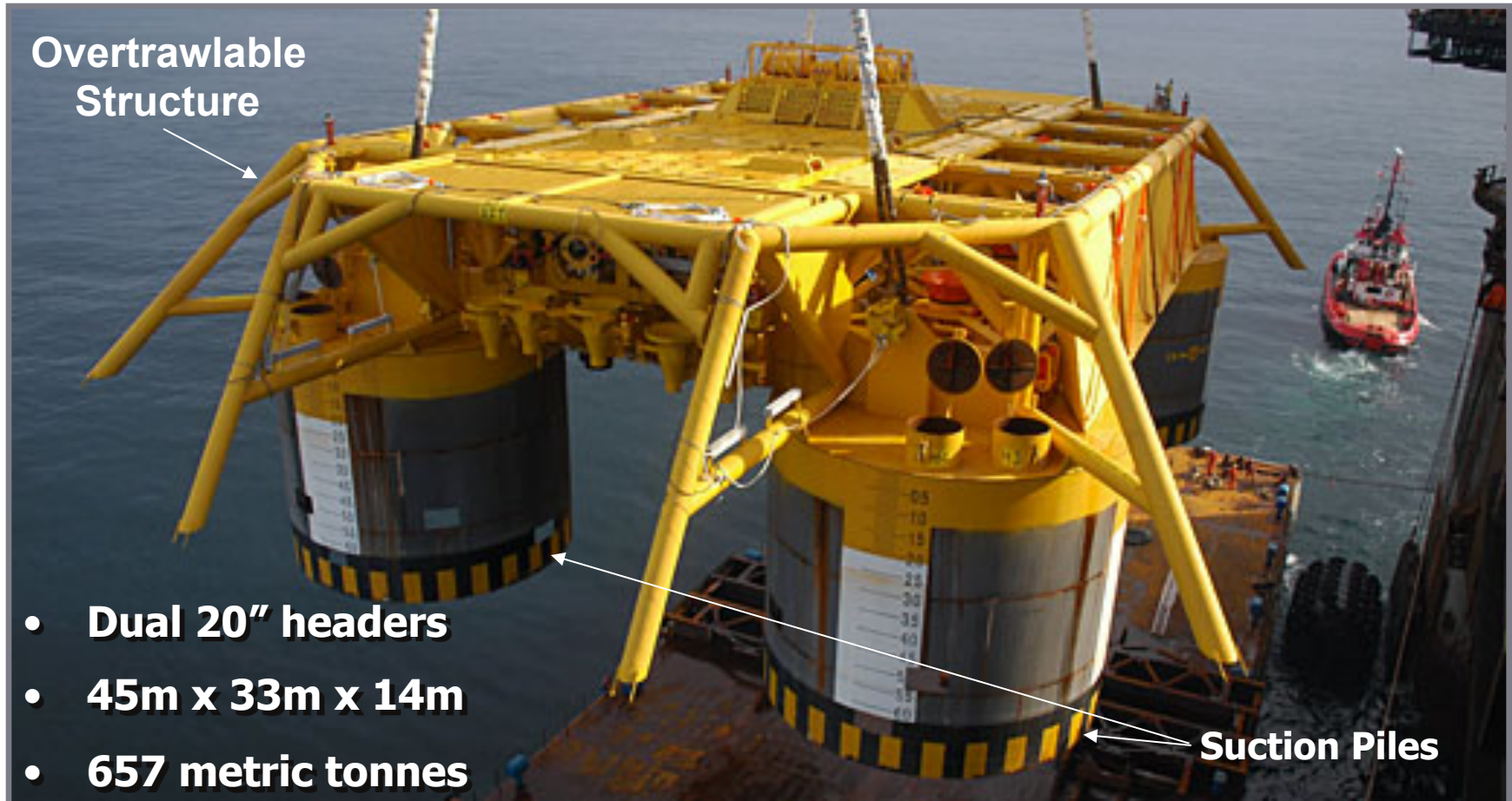


Deepwater Trawling

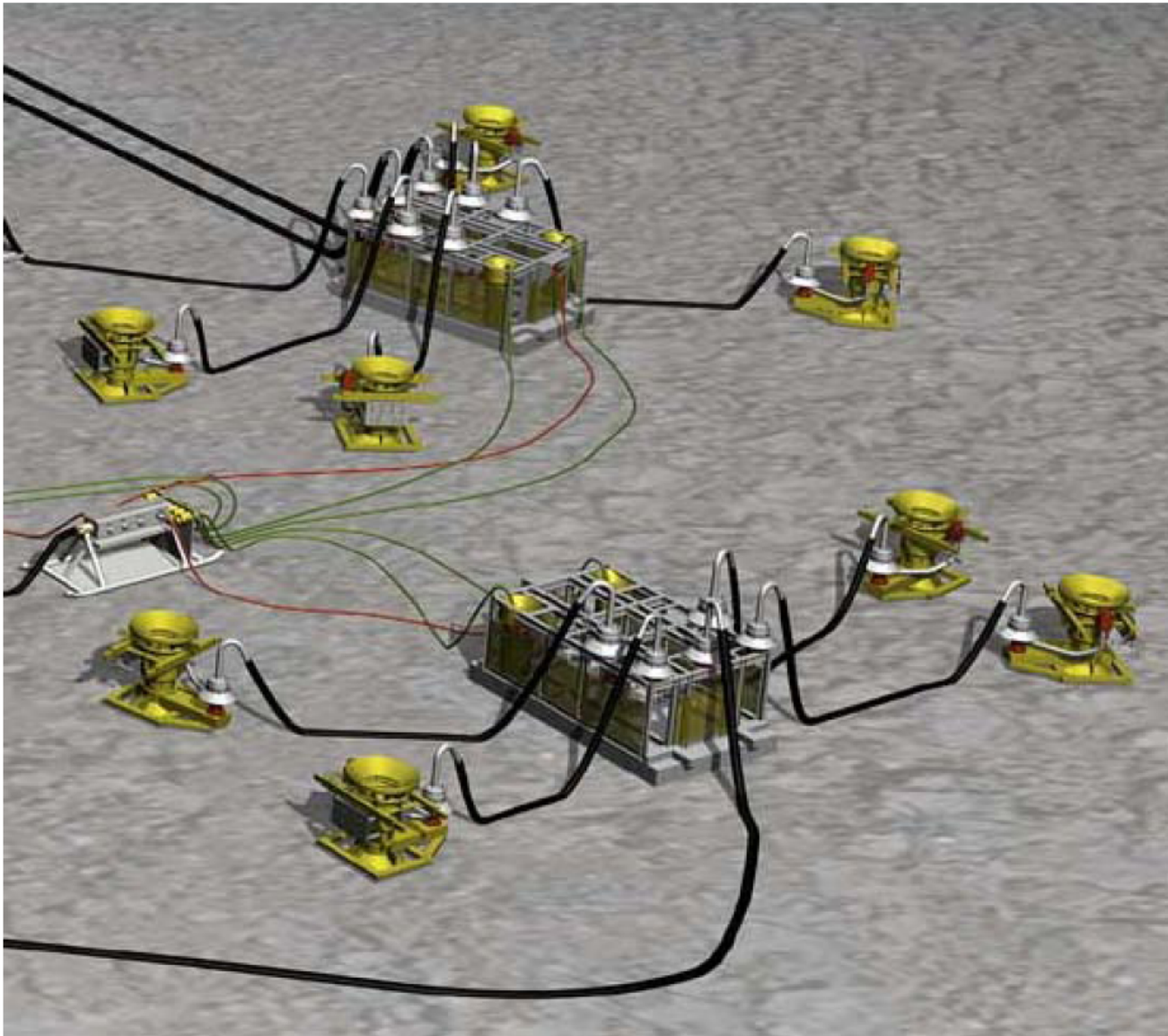


Nelson Project, UK Sector North Sea

Ormen Lange – 20" 8-Slot Manifold



Brazil



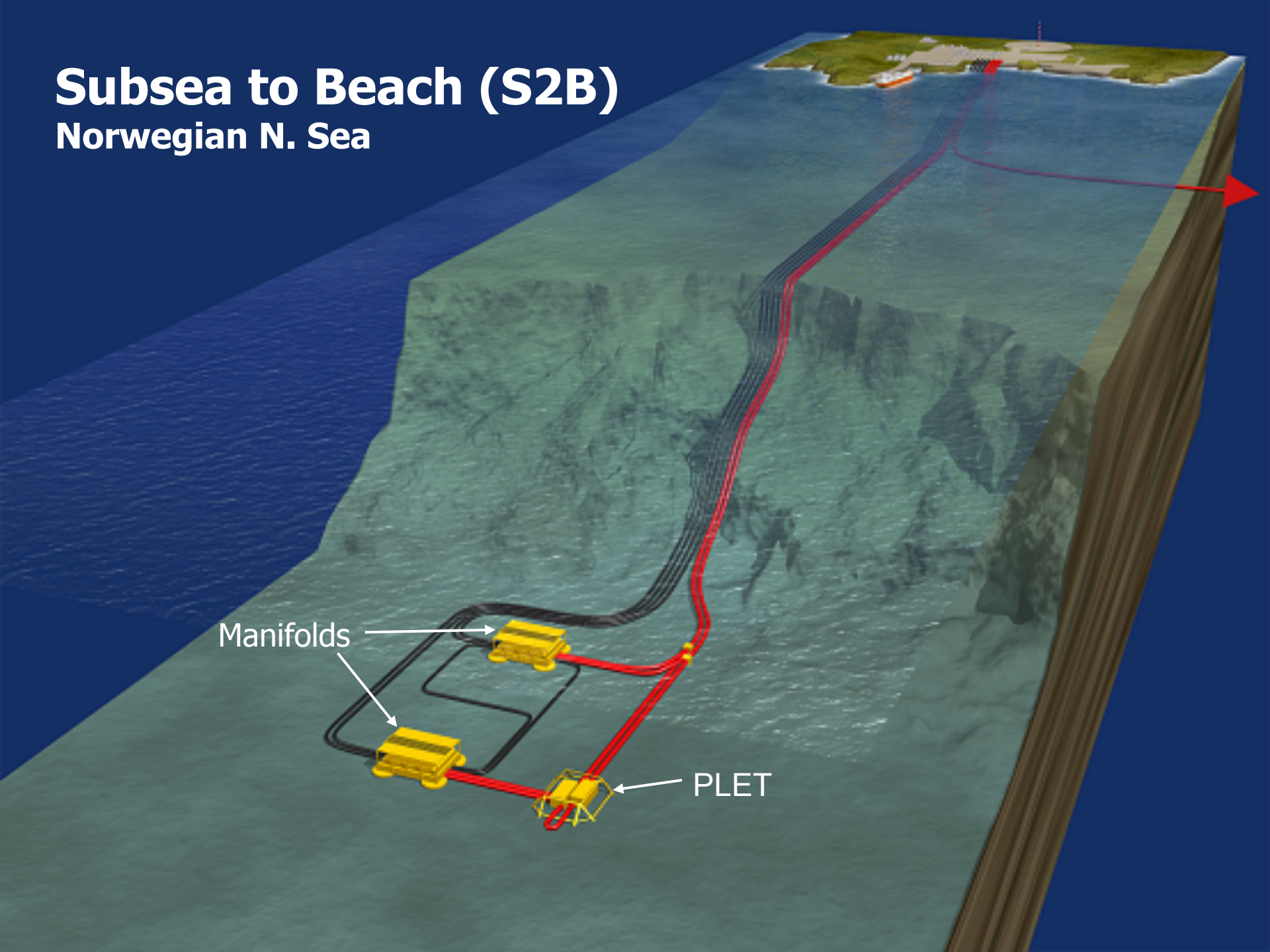
Future MPS

Subsea to Beach (S2B)

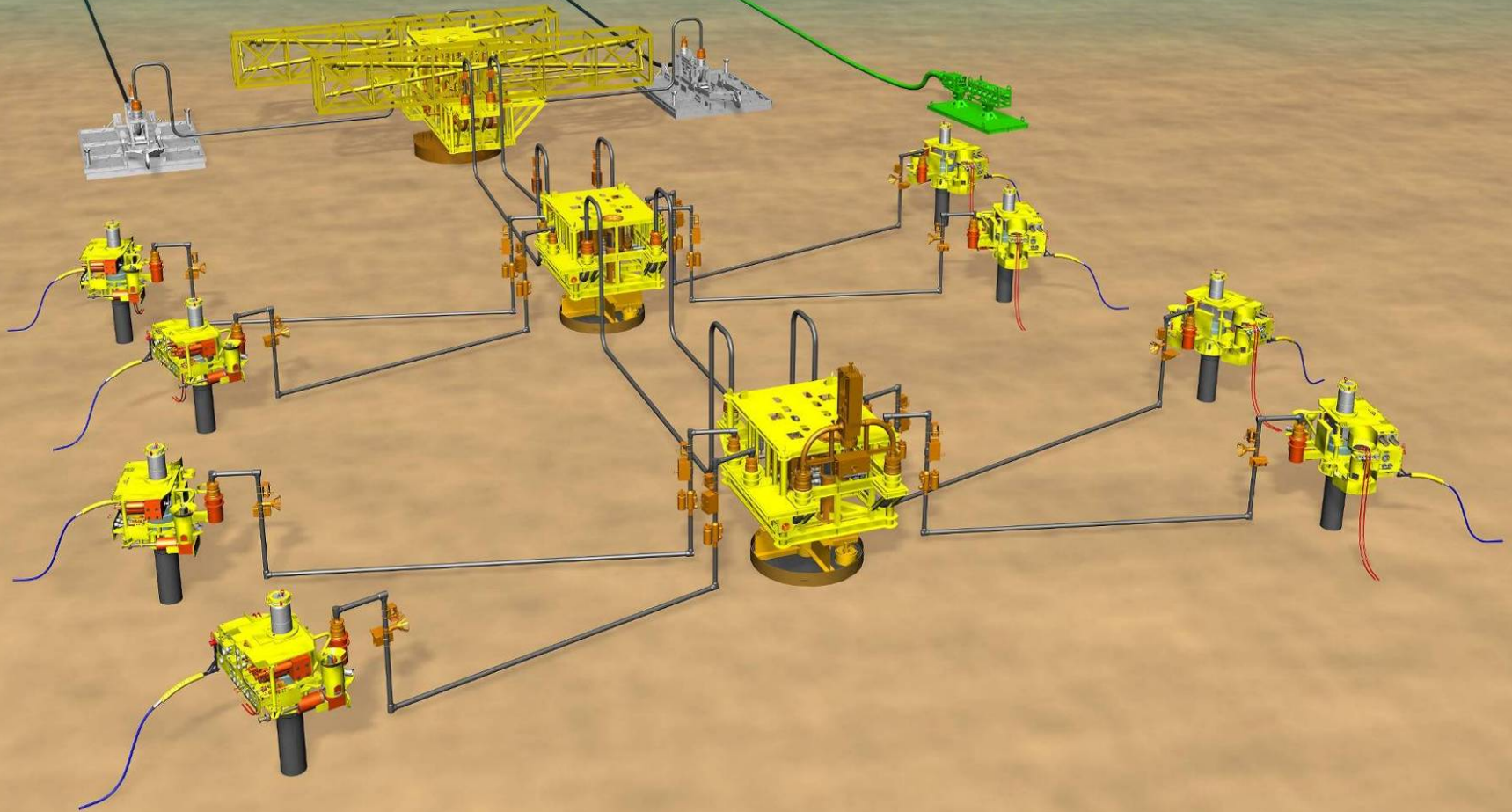
Norwegian N. Sea

Manifolds

PLET

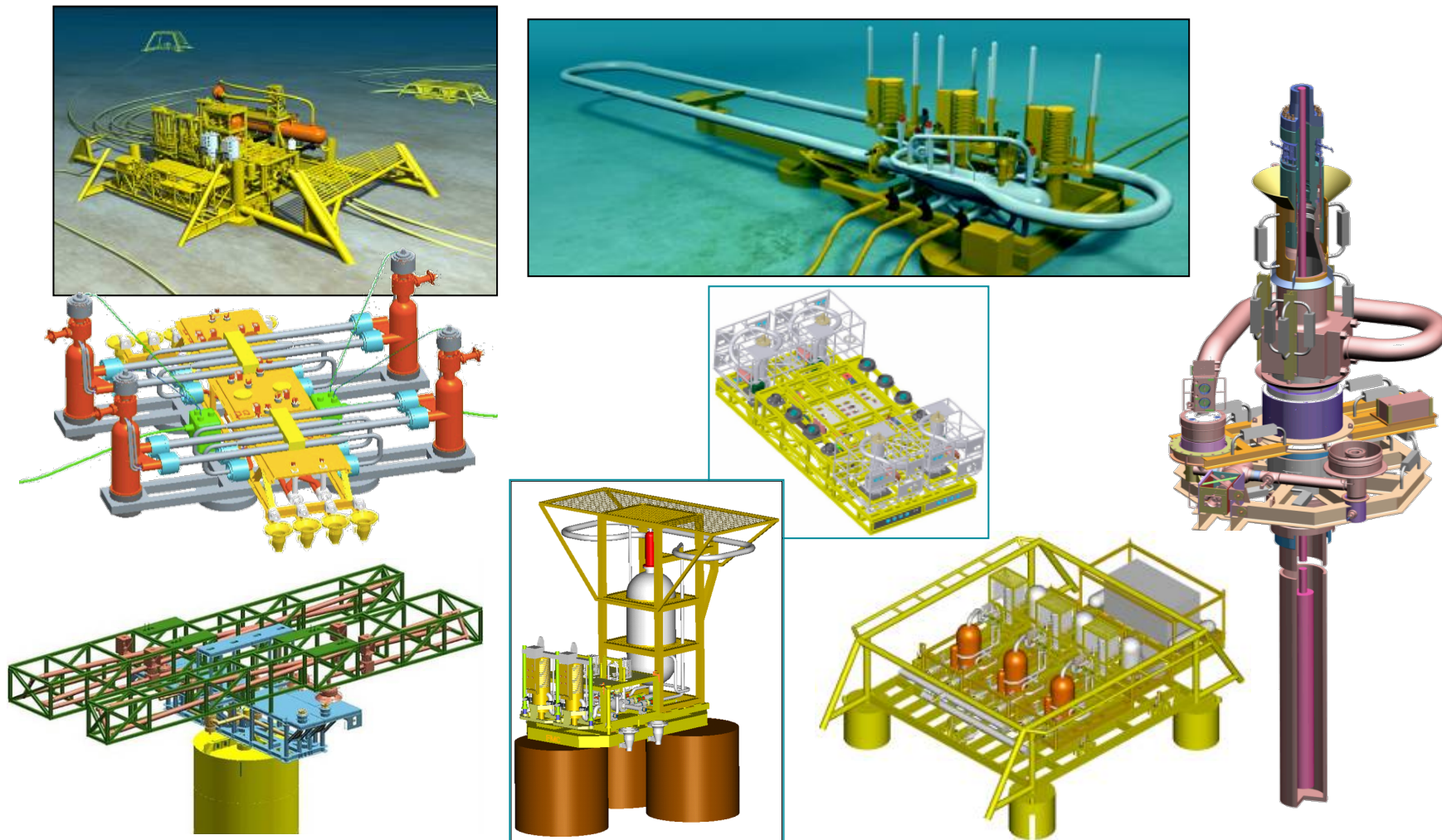


Cluster Manifolds with Boosting



Subsea Processing Systems

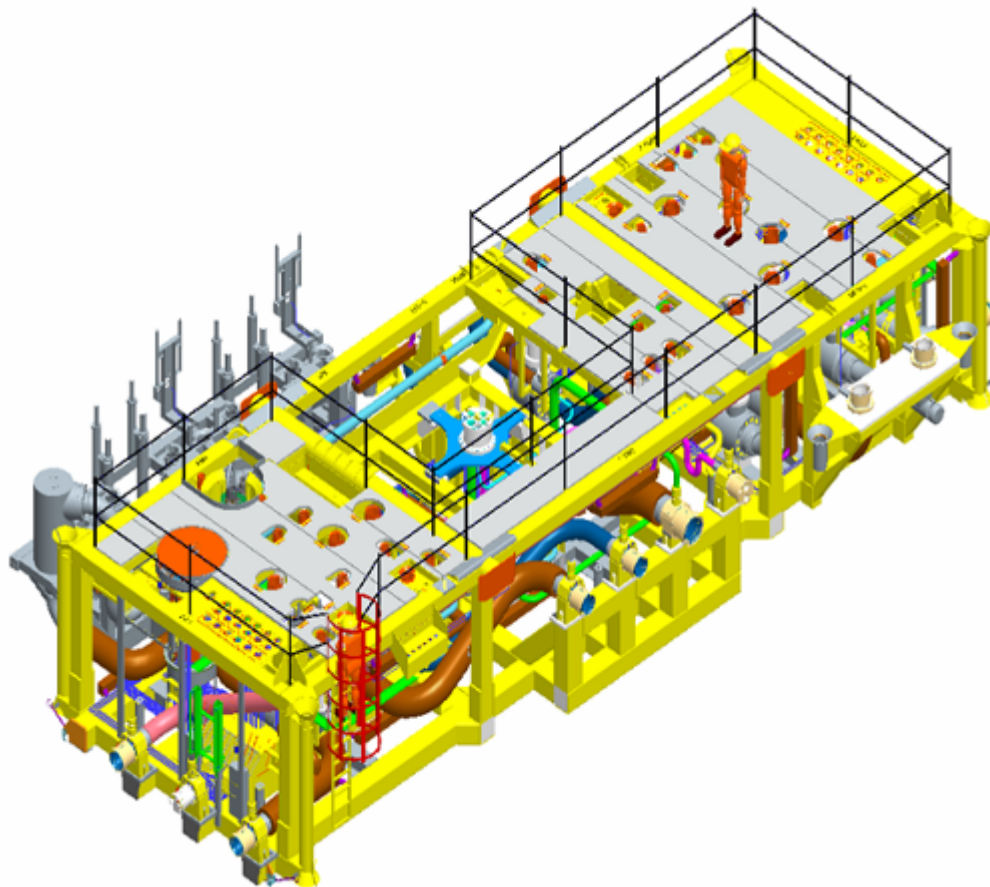
Include significant MPS elements



Subsea Processing – *Tordis* Project



Subsea Processing – *Tordis* Manifold Module



End of Presentation

Thank you for your Attention!