FPSO Field Installation

Ian Frazer

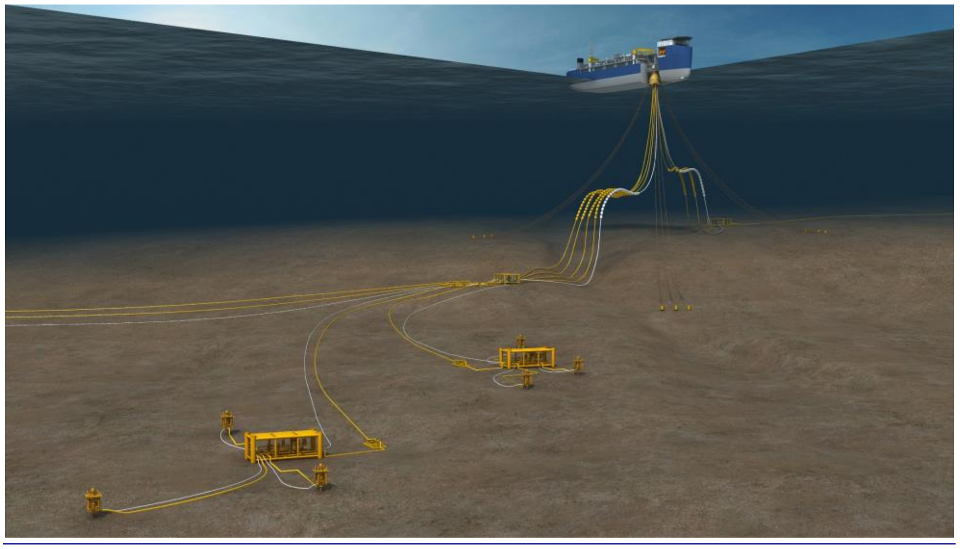
FPSO Training Course

Paris, December 06 - 09, 2016

Overview

- ❑ **Introduction**
- ❑ **Floating Production Systems**
- ❑ **Management and Planning for Installation**
- ❑ **Safety**
- ❑ **Anchor & Mooring Installation**
- ❑ **Riser Installation**
- ❑ **FPSO Installation and Hook-Up**
- ❑ **Summary and Conclusions**

FPSO Field Development



Management and Planning for Installation

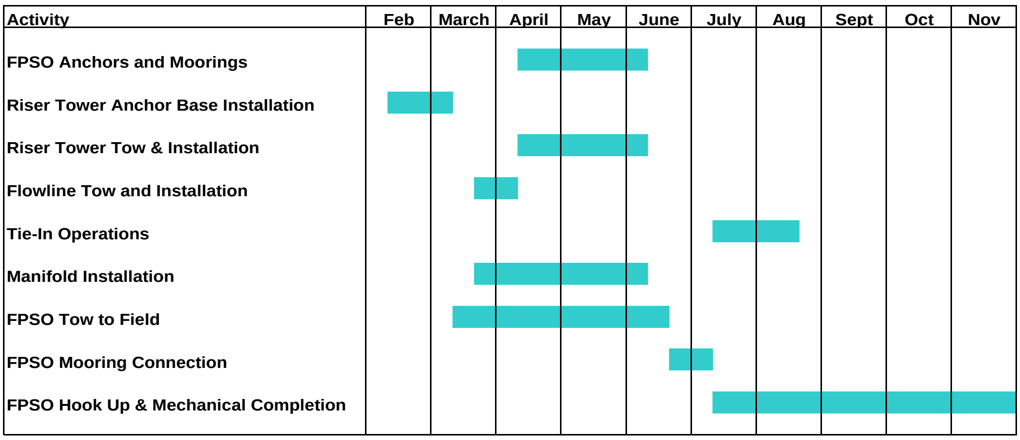
Management and Planning for Installation

- ❑ Installation Team integrated into Project from start
- ❑ Important interfaces during engineering and fabrication
- ❑ Ensure installability
- ❑ Installation planning based on constraints
- ❑ Sufficient time for installation engineering and analysis

Installation Schedule Constraints

- ❑ Fabrication and testing of structures to be complete prior to installation
- ❑ Pre-installation surveys first
- ❑ FPSO moorings installed before risers
- ❑ Riser base installed before flowlines
- ❑ Tie-in metrology after installation of flowlines and risers
- ❑ Moorings & risers installed before arrival of FPSO
- ❑ FPSO commissioning to be complete before leaving yard
- ❑ Build in flexibility

Girassol Installation Schedule



Safety

Safety : FPSO Installation

- ❑ Safety must be considered during all phases of Project
- ❑ Planning / Engineering / Offshore Operations
- ❑ Detailed Review of Operational Procedures
- ❑ Hazard Identification (HAZID)
  - ➢ all possible hazards identified
  - ➢ mitigating measures fed into detailed engineering
- ❑ Hazard and Operational Analysis (HAZOP)
  - ➢ rigorous analysis of operational procedures
  - ➢ contingency plans verified or implemented

Safety : Tool Box Talks

- ❑ Tool Box Talks - prior to actual operations
- ❑ Procedures and safety critical areas highlighted and discussed
- ❑ Hazardous operations include :
  - – lifting
  - – wires under tension
  - – pressure testing
  - – handling mooring components

Safety : Multi-Vessel Operations

- Several vessel in the field at one time
  - Drilling Vessel
  - Anchor Handling Tugs
  - Pipelay Ship
  - Heavy Lift Ship
  - Survey Ship
  - Supply Boats
- Close proximity working
- Potential for conflict
- Pre-determined priorities
- Command and Co-ordination centre offshore

Safety - Adverse Weather Conditions

- All marine operations can be affected by the weather
- Limits to be set for each operation
- Accurate weather information and forecasts essential
- Onboard meteorologist useful, depending on location
- Assessment of available weather window
- Contingency procedures essential

Energy

Anchor and Mooring Installation

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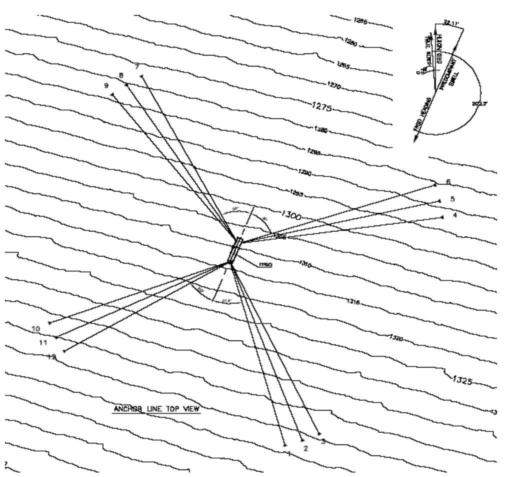
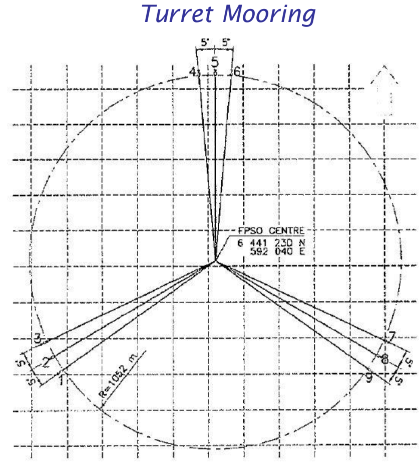
Mooring Systems

Energy



Spread Mooring

Turret Mooring



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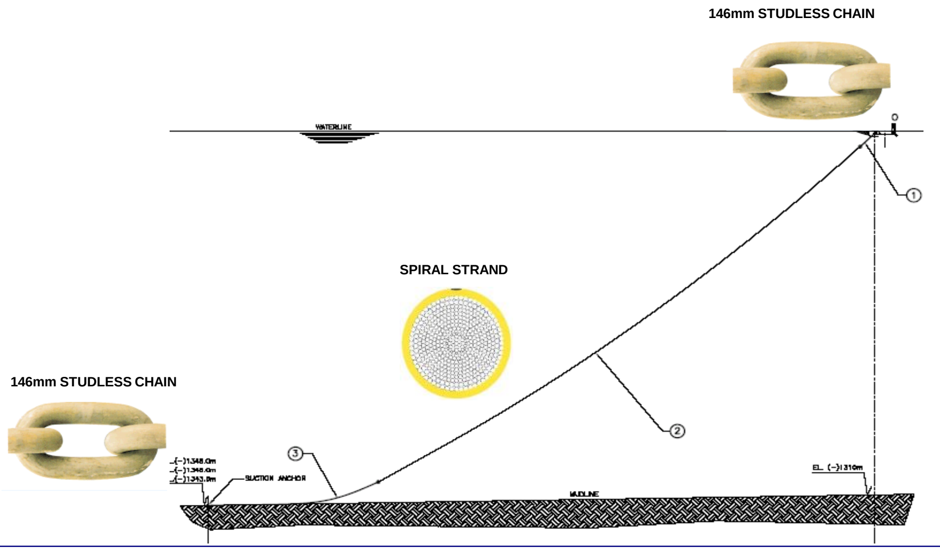
FPSO Mooring Line Profile



Installation Vessel Selection

Two basic options available :-

- ❑ **Large Construction Vessel**
  - ➢ all mooring legs on one vessel
- ❑ **Anchor Handling Vessel**
  - ➢ one mooring leg on vessel

- ❑ **Selection based on economics and availability**

Installation Vessels

Large Vessel

- all mooring legs on one vessel

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Installation Vessels

Large Vessel

- all mooring legs on one vessel or supplied on barge

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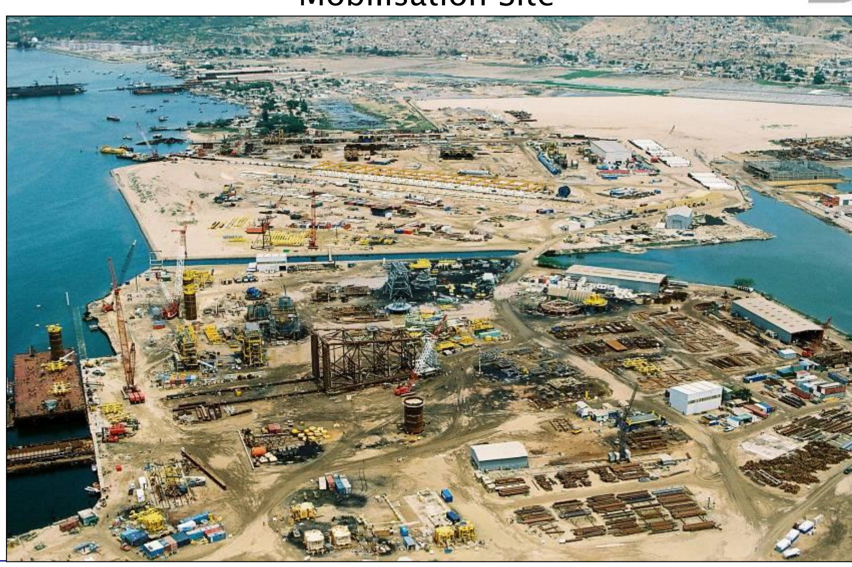
Installation Vessel

Small Vessel - one mooring legs on vessel

Mobilisation Site



Mobilisation

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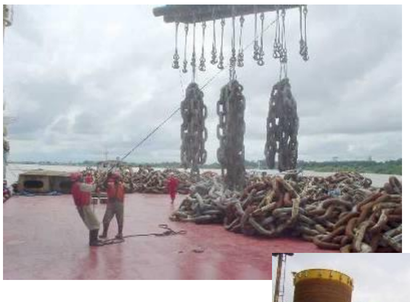
Mooring Line components handling & transportation



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Mooring Leg Installation Procedure

Anchor

- ❑ connection to chain
- ❑ overboading and lowering
- ❑ positioning and heading
- ❑ seabed penetration

Ground Chain

- ❑ pay out
- ❑ twist prevention
- ❑ connection to wire

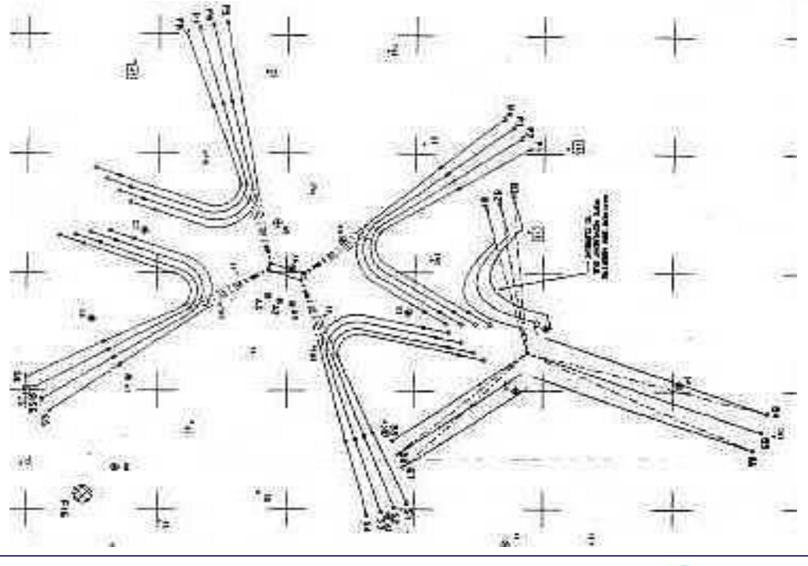
Wire

- ❑ pay out - protect coating
- ❑ connection to top chain

Top Chain

- ❑ lay down ready for pick up

Mooring System Layout



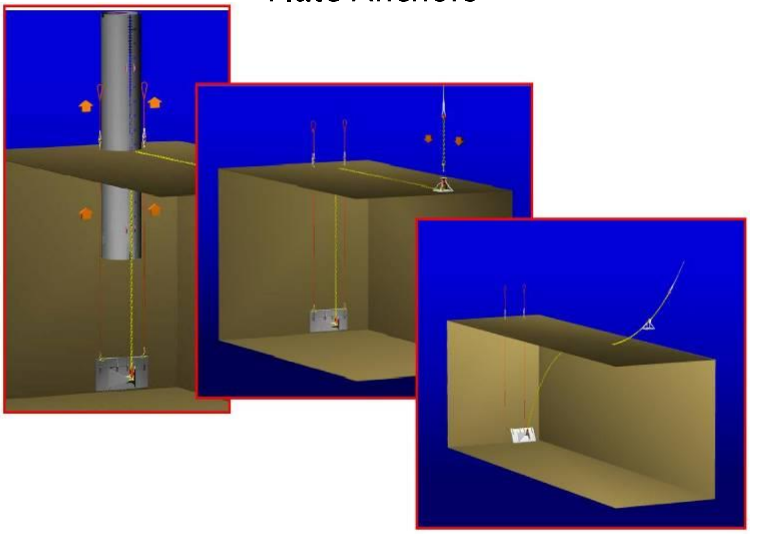
Drag Anchors

Plate Anchors

SEPLA – Suction Embedment Plate Anchor

Intermoor

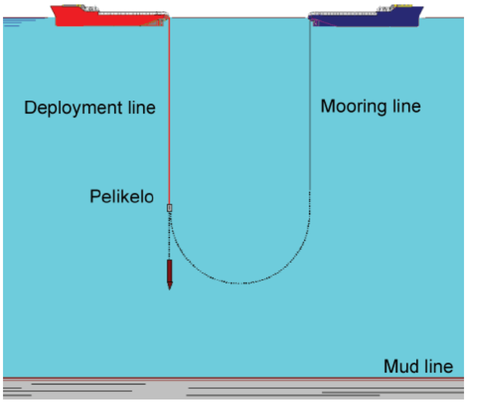
Plate Anchors



Intermoor

Pile Anchors

Torpedo Pile Anchors



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Suction Anchor – Installation

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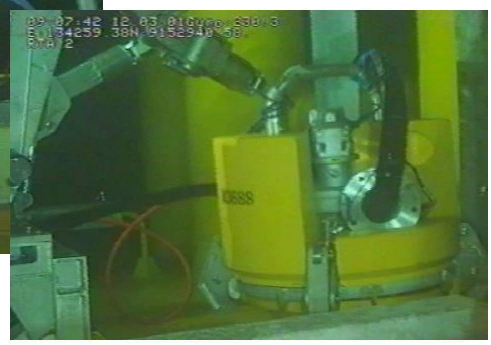
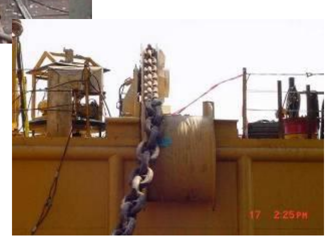
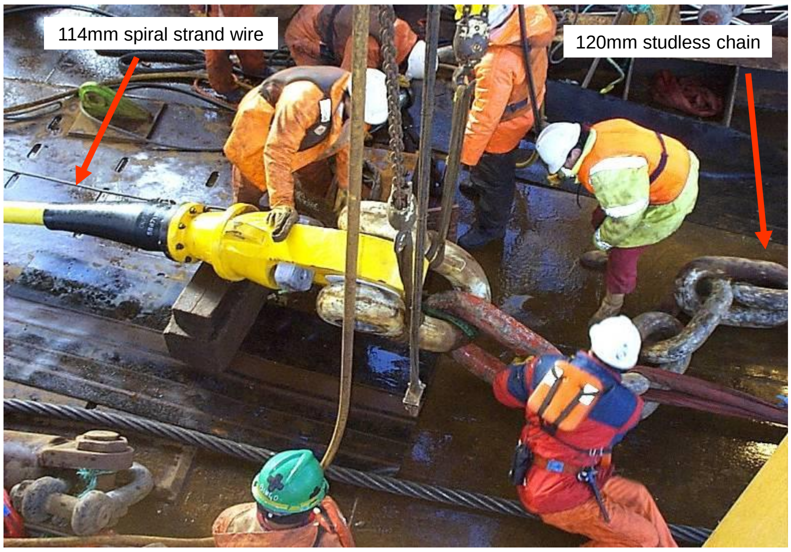
Suction Anchor - Pumping



Chain Installation



Chain - Wire Connection



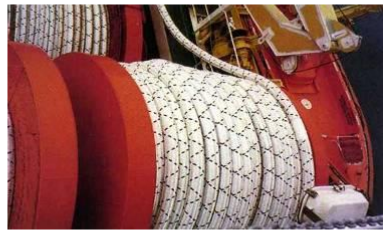
Mooring line deployment

- Deployment of the spiral strand with a large drum winch,
- Spiral strand requires to be transpooled first from the storage reel to the large drum winch

Storage drum

Large deployment winch

Synthetic Fibre Rope Installation

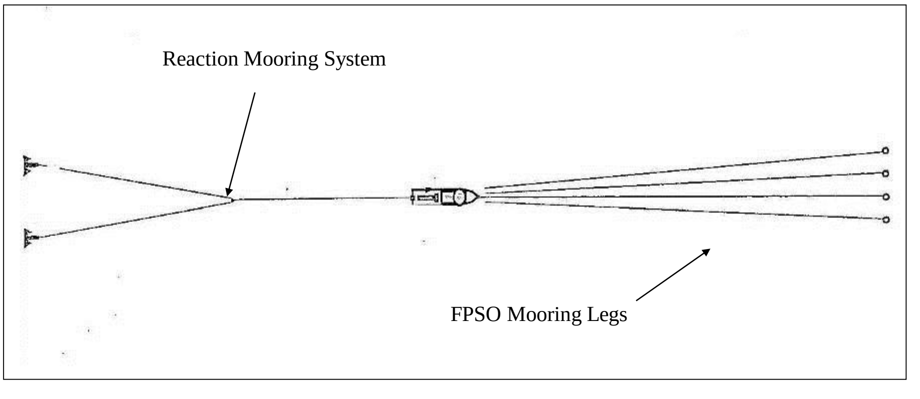


Top Chain Connection

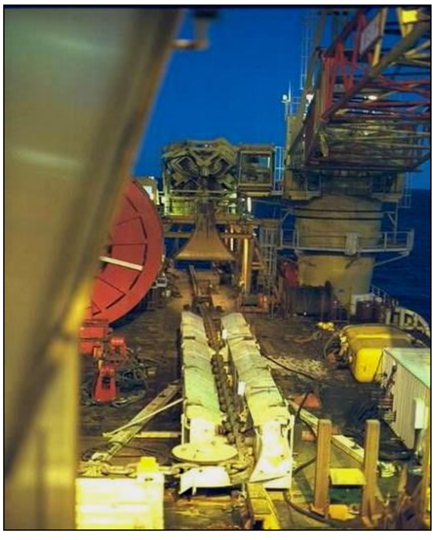
Mooring Leg Tensioning – AHV

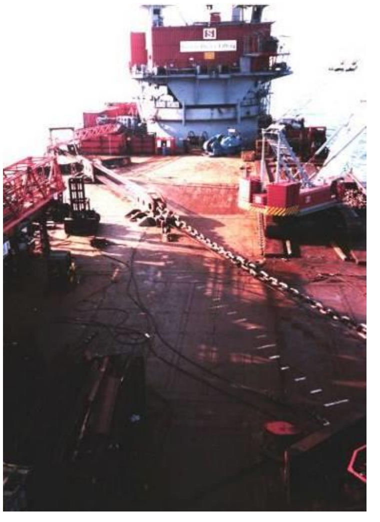
- High loads required (up to 400 T)
- Large or multiple AHV
- High fuel consumption.
- Load and drag measurements are relatively coarse.
- Directionality needs to be controlled.

Mooring Leg Tensioning – Surface Tensioner



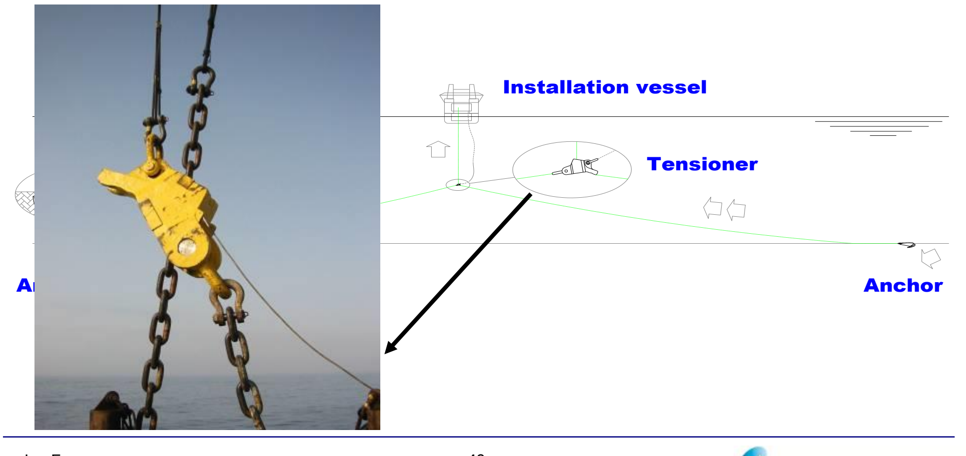
Mooring Leg Tensioning – Surface



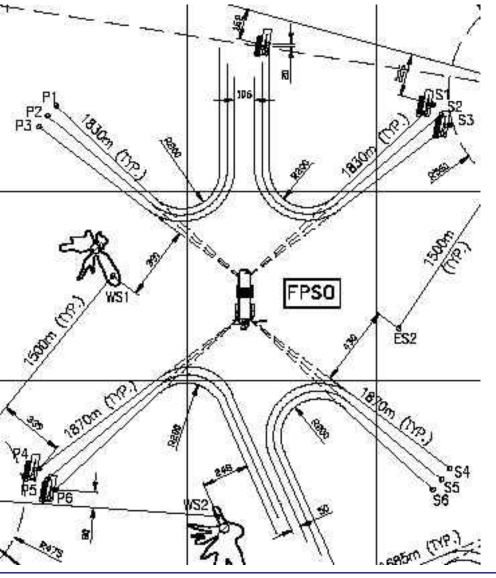


Surface Tensioner *Cross Tensioning*

Mooring Leg Tensioning – Subsea Tensioner



Mooring System Layout

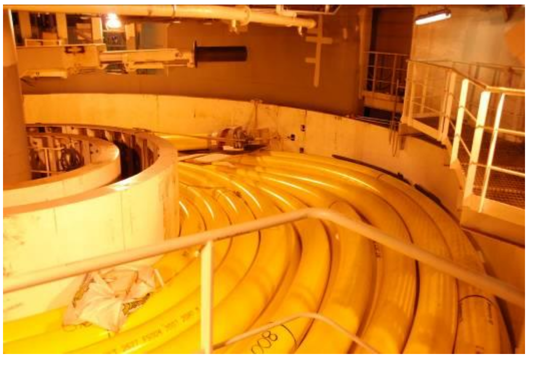


Riser Installation

Riser Systems

- Three basic riser systems available :-
  - Flexible Risers
  - Steel Catenary Risers
  - Hybrid Risers

Flexible Riser Installation



Flexible Riser Installation

Seven Phoenix - Subsea 7

Deep Constructor - Technip

Flexible Riser Installation

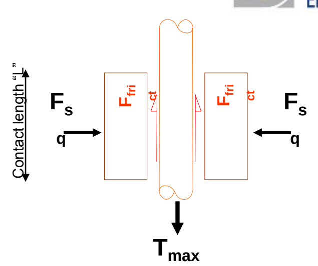
Flexible Riser Installation

Flexible Riser Installation

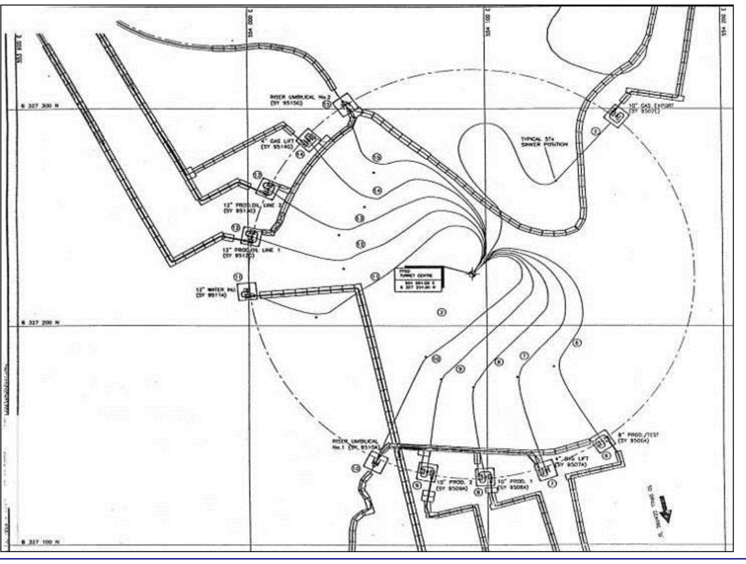
Flexible Riser Installation

Flexible Risers – Installation Issues

- Installation loads part of pipe design
- Water Depth – laying tension
- Tensioner squeeze
- Internal – External friction
- Dynamic loading
- Pipe handling
- Damage to outer sheath



Riser Pre-lay Layout



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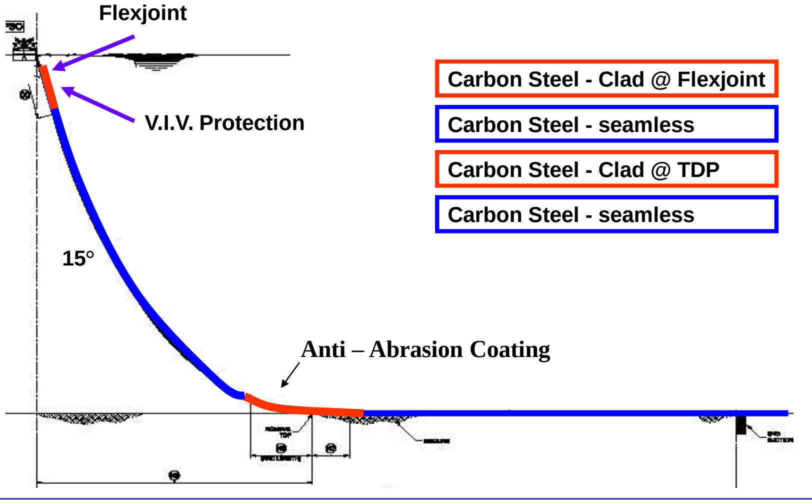
SCR General Components



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Steel Catenary Riser Installation

Steel Catenary Riser Installation

Steel Catenary Riser Installation

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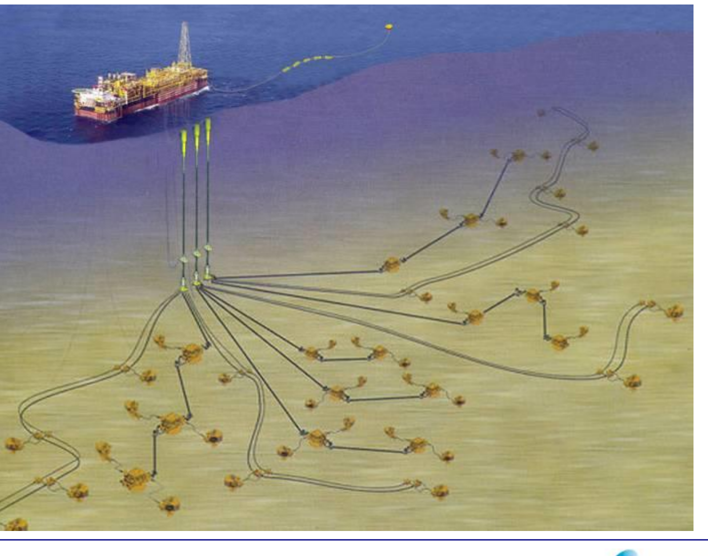
Spread Moored FPSO: with Hybrid Towers



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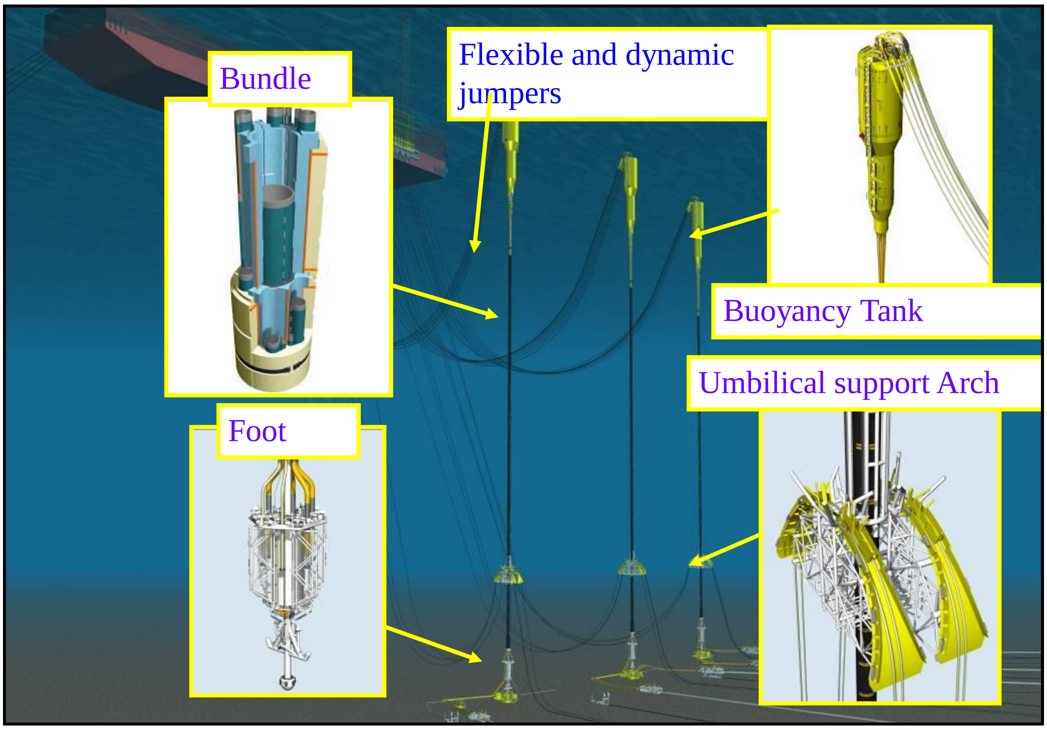
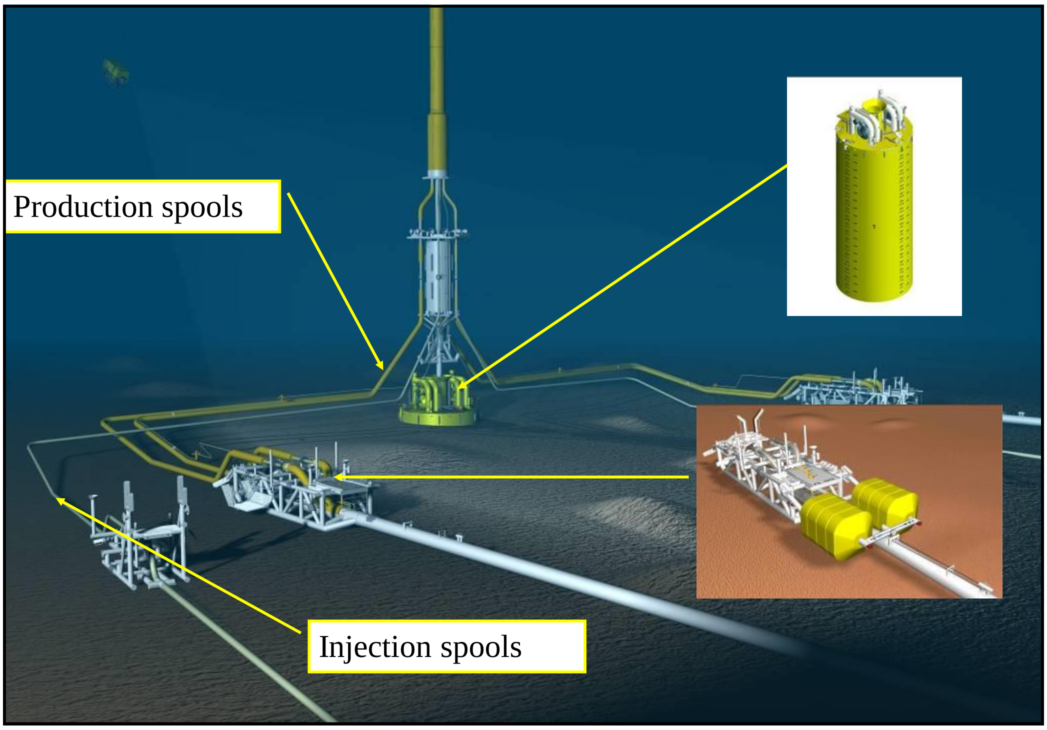
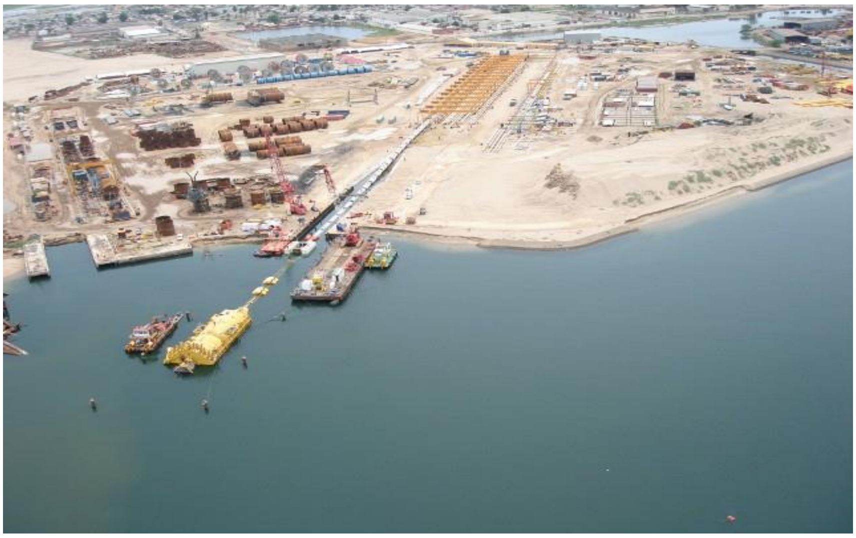

Bundle
Flexible and dynamic jumpers
Buoyancy Tank
Umbilical support Arch
Foot


Production spools
Injection spools

Riser Tower Launch



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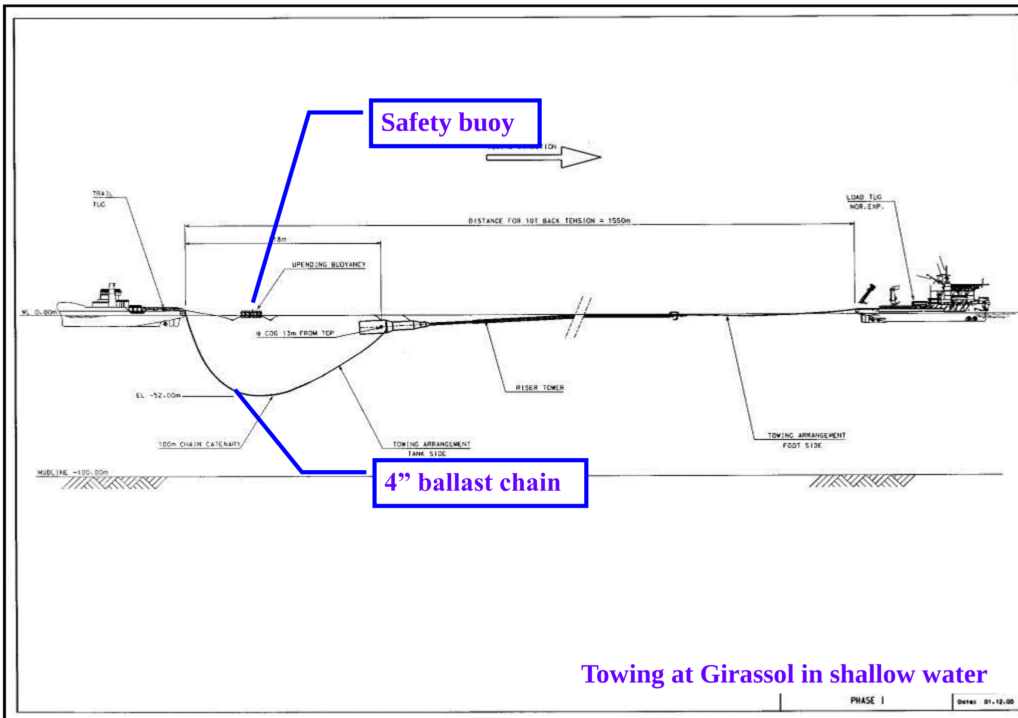
Installation of Suction Anchor



Riser Tower – Tow to Field

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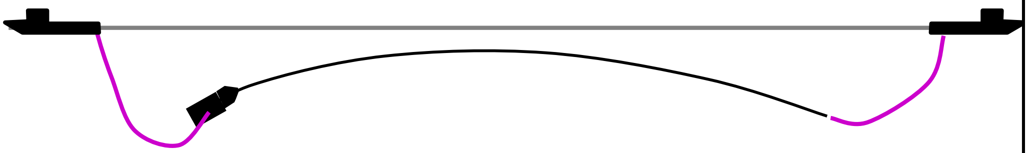
Towing Riser Tower in Harsh Environment to avoid Fatigue



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Riser Tower Field Installation

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Riser Tower Final Docking

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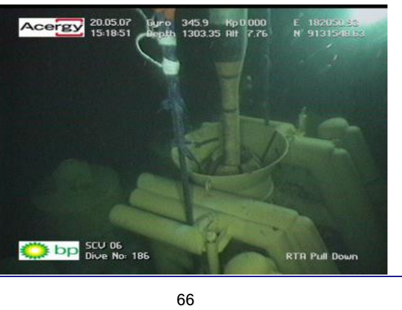

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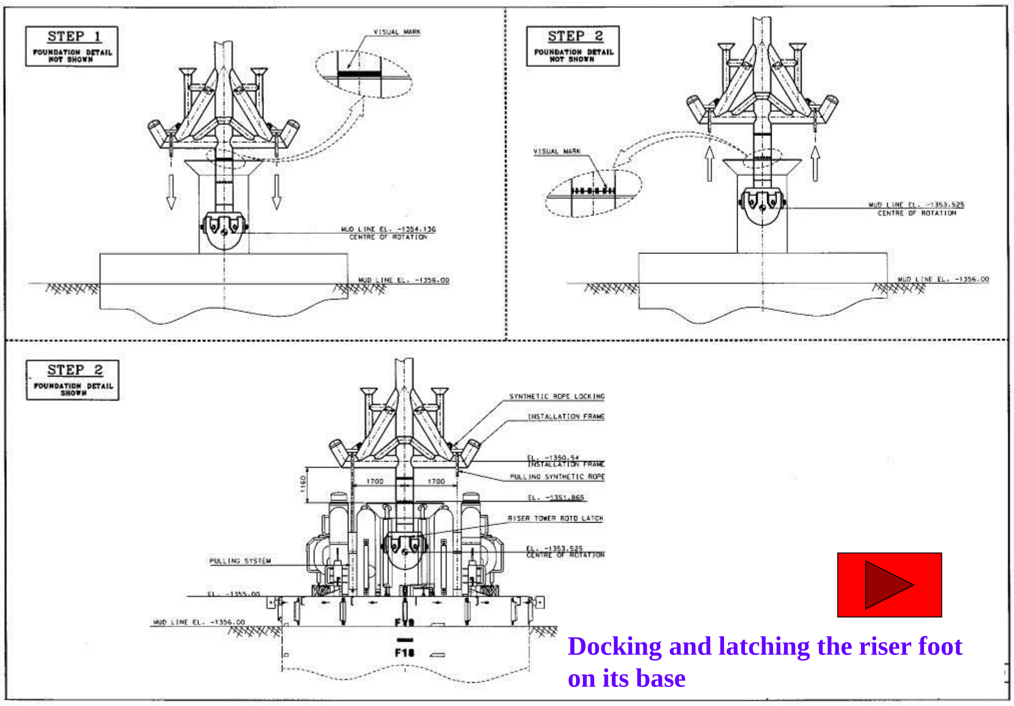
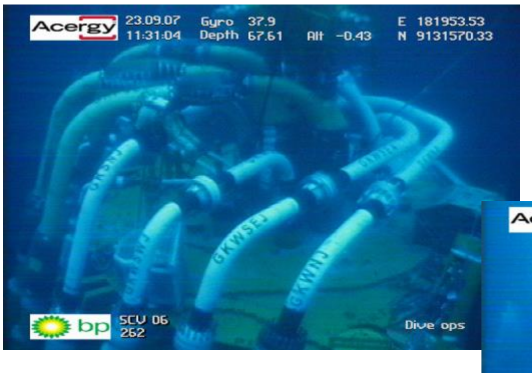
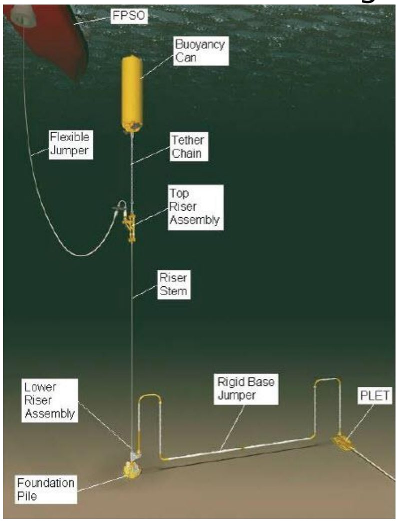


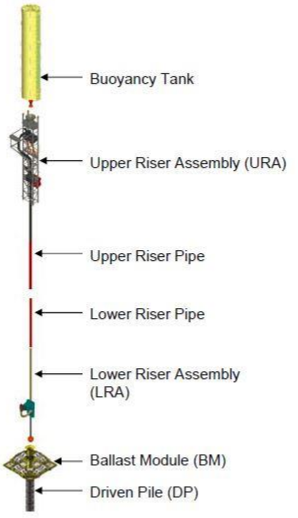
Docking and latching the riser foot on its base

Top of Tower with goosenecks and flexibles



Single Leg Hybrid Risers





ıscade – Chinook (Ref : OTC2011- 21395)   PSVM (Ref : DOT 2013)

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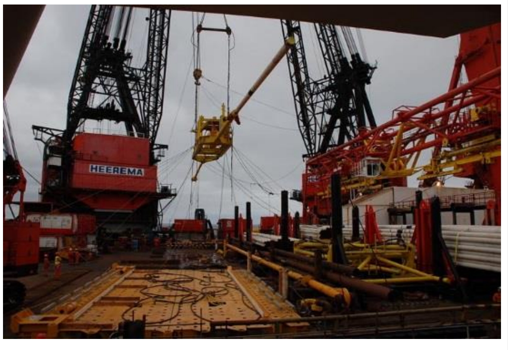
Installation of Free Standing Hybrid Risers



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Installation of Free Standing Hybrid Risers

FPSO Installation and Hook-Up

Interfaces & Training on FPSO

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FPSO Departure

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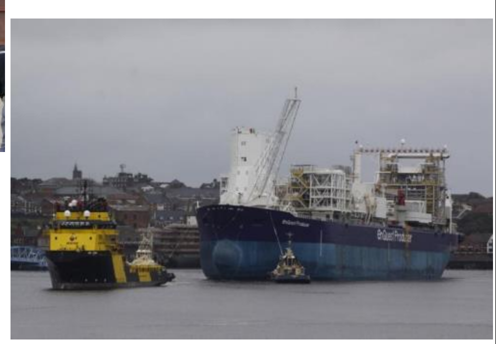

FPSO Tow To Field

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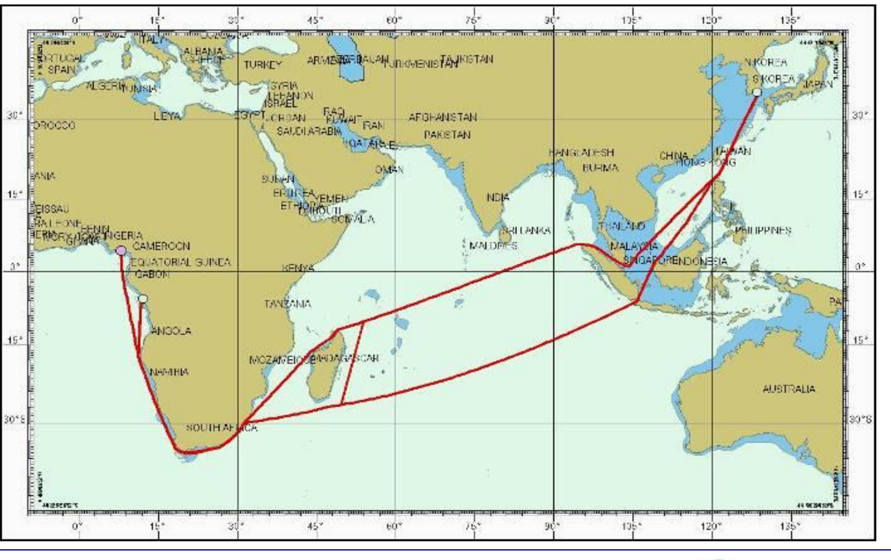
Metocean conditions – marine transportation



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FPSO Tow To Field

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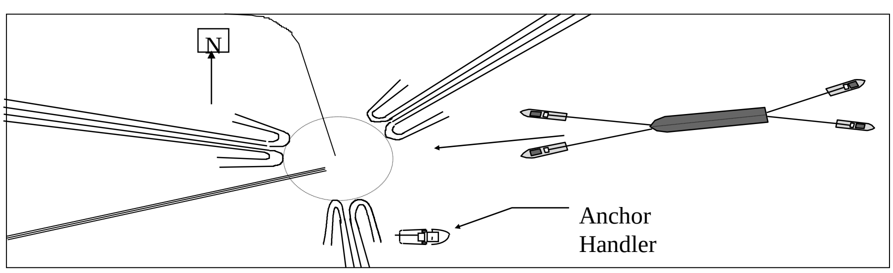
Tow Approaching Mooring Location



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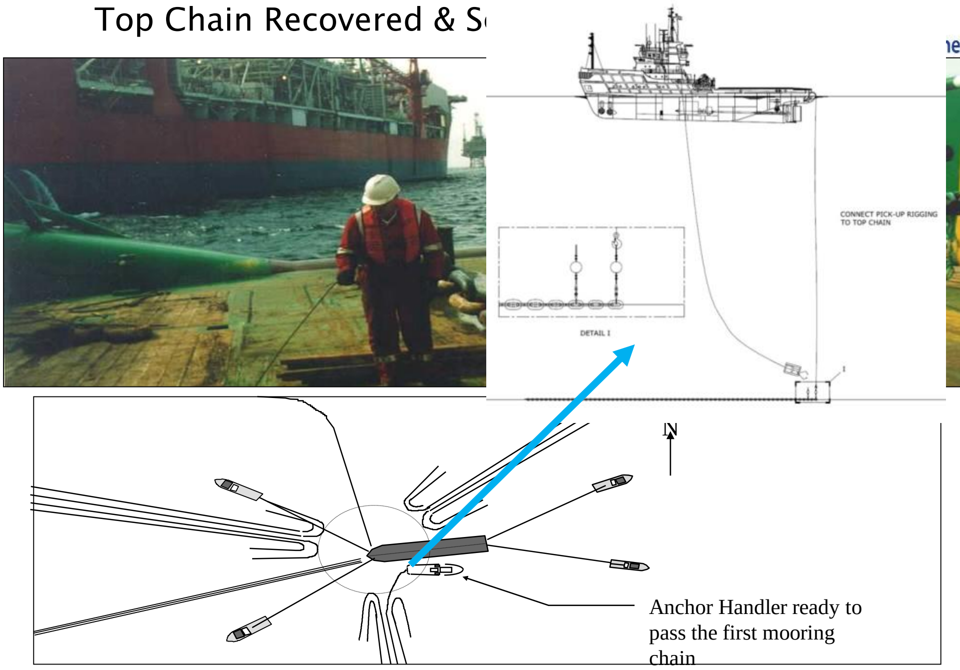
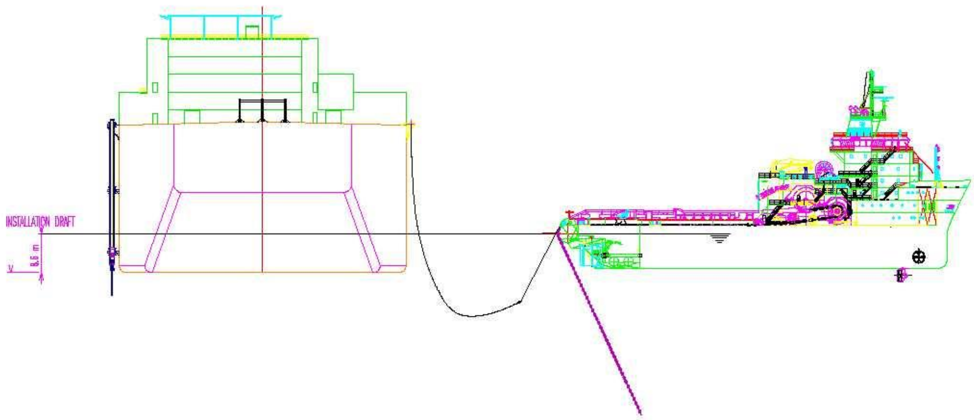
Top Chain Recovered & S

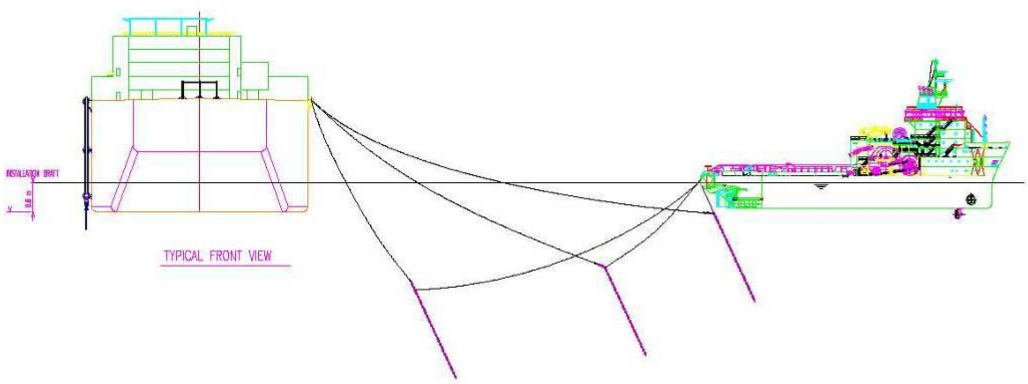


Mooring Line Transfer to FPSO

Mooring Line Transfer to FPSO

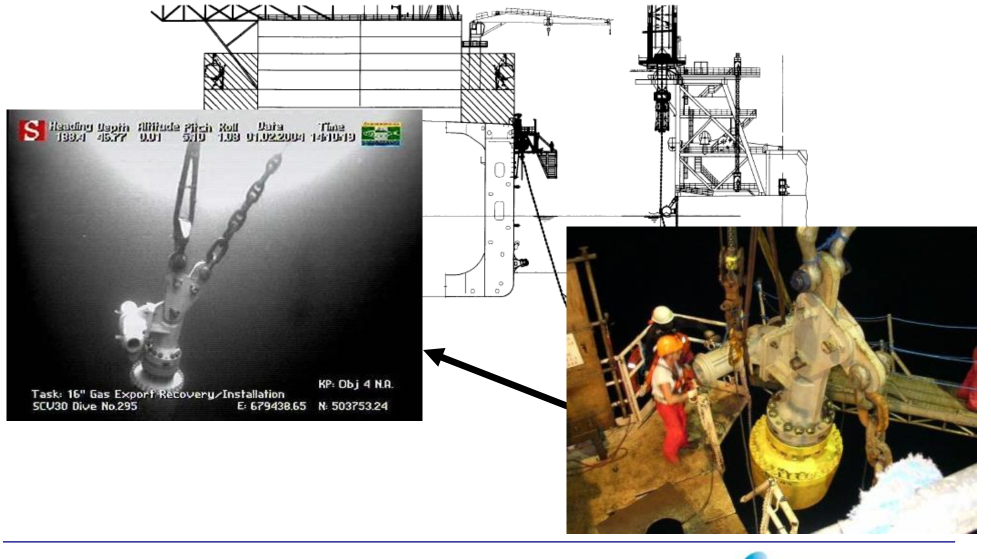


Mooring Line Transfer to FPSO



Mooring Line Pull-In

SCR Hand Over



SCR Hand Over

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SCR Hand Over

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FPSO Riser Hook-up

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FPSO On Location

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Summary and Conclusions

Summary

- ❑ **Overview of FPSO Installation Presented**
- ❑ **Key Issues Include**
  - **Safety**
  - **Early involvement of Installation Team**
  - **Installation Vessel Selection**
  - **Maximizing Installation Vessel Efficiency**
  - **Planning of Offshore Operations**
  - **Contingencies**

Thank You

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