Floater Concept Review

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The Jukes Group

Floating Production Systems

Contents

- **Floating Platform Selection Criteria**
- **Overview of Established Floater Capabilities**
  - Spar
  - TLP
  - Semi-Submersible
  - FPSO
- **Review of New Floater Concepts**

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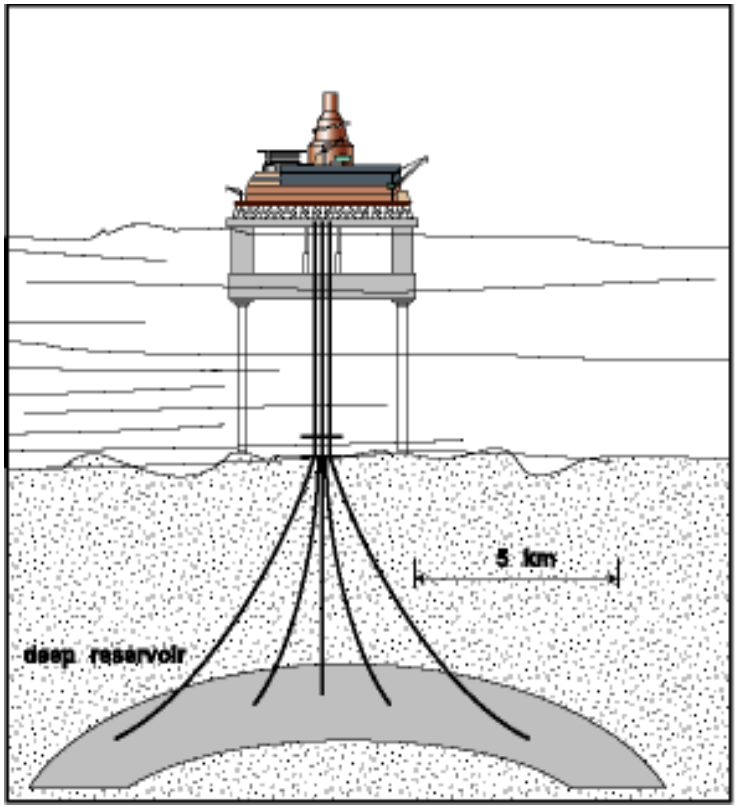
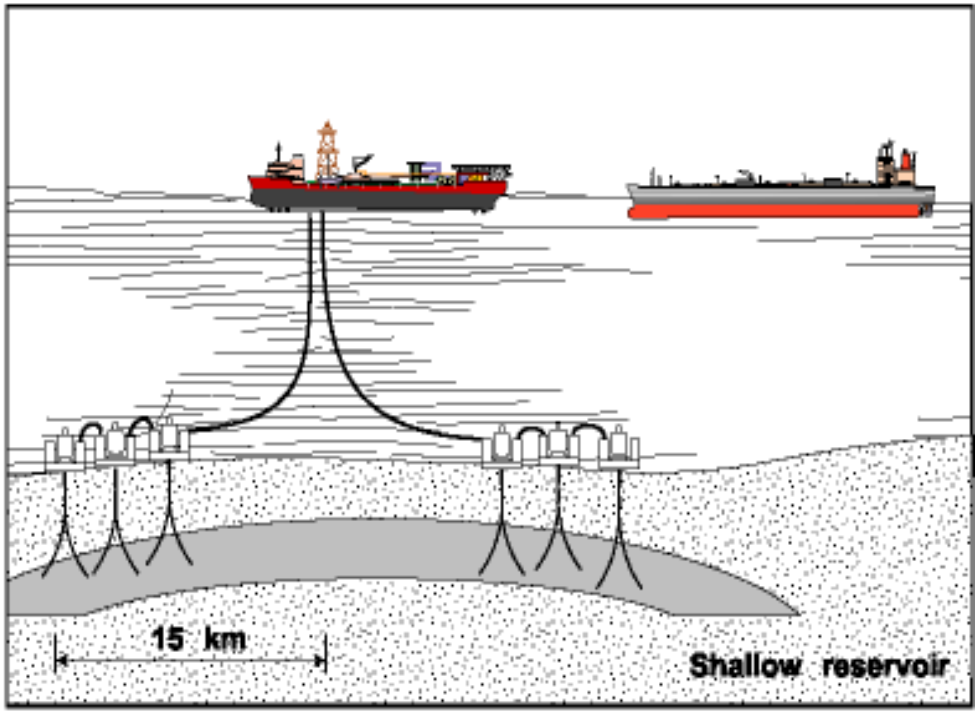
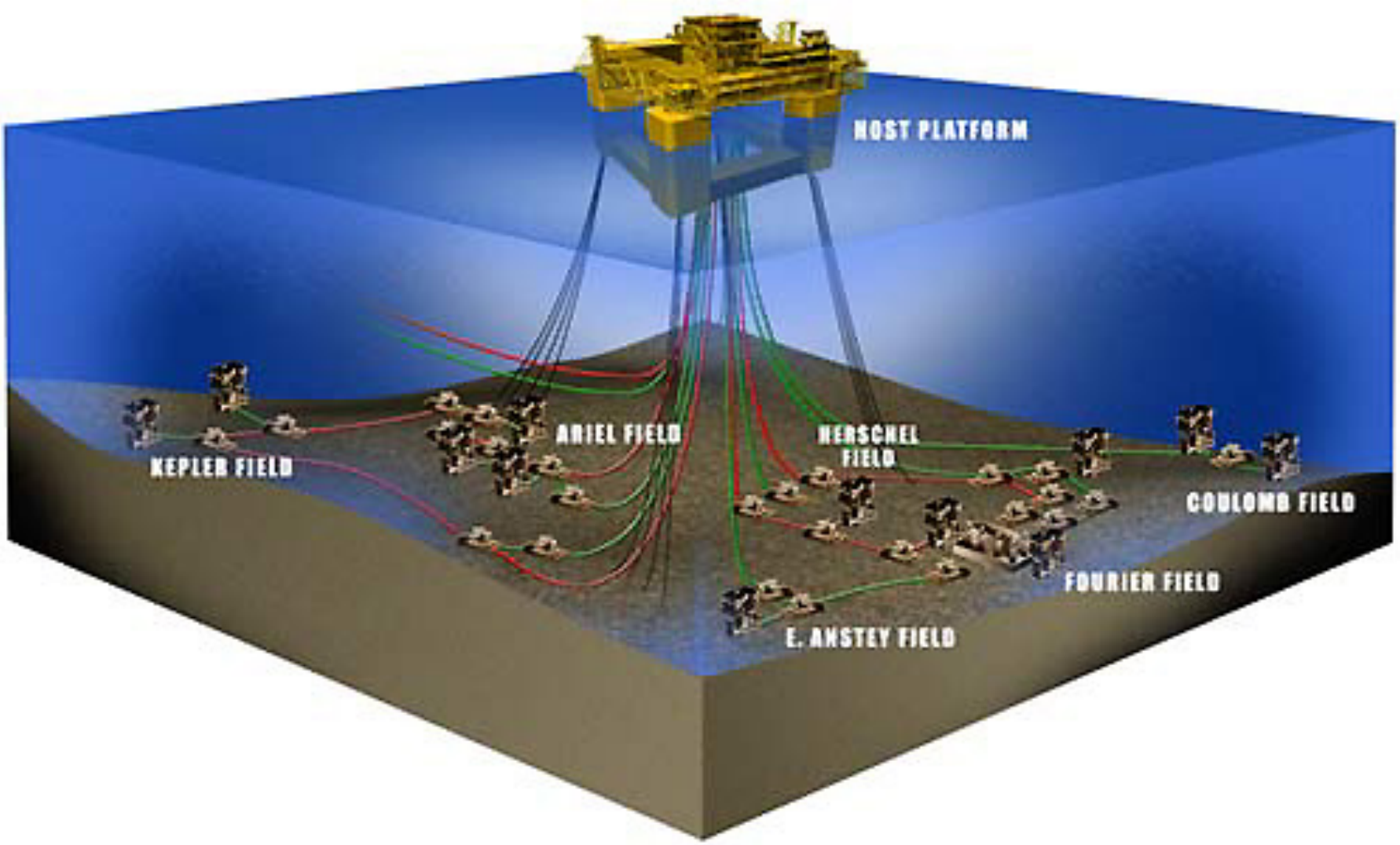
Dry or Wet Trees? – Reservoir Geometry Drivers

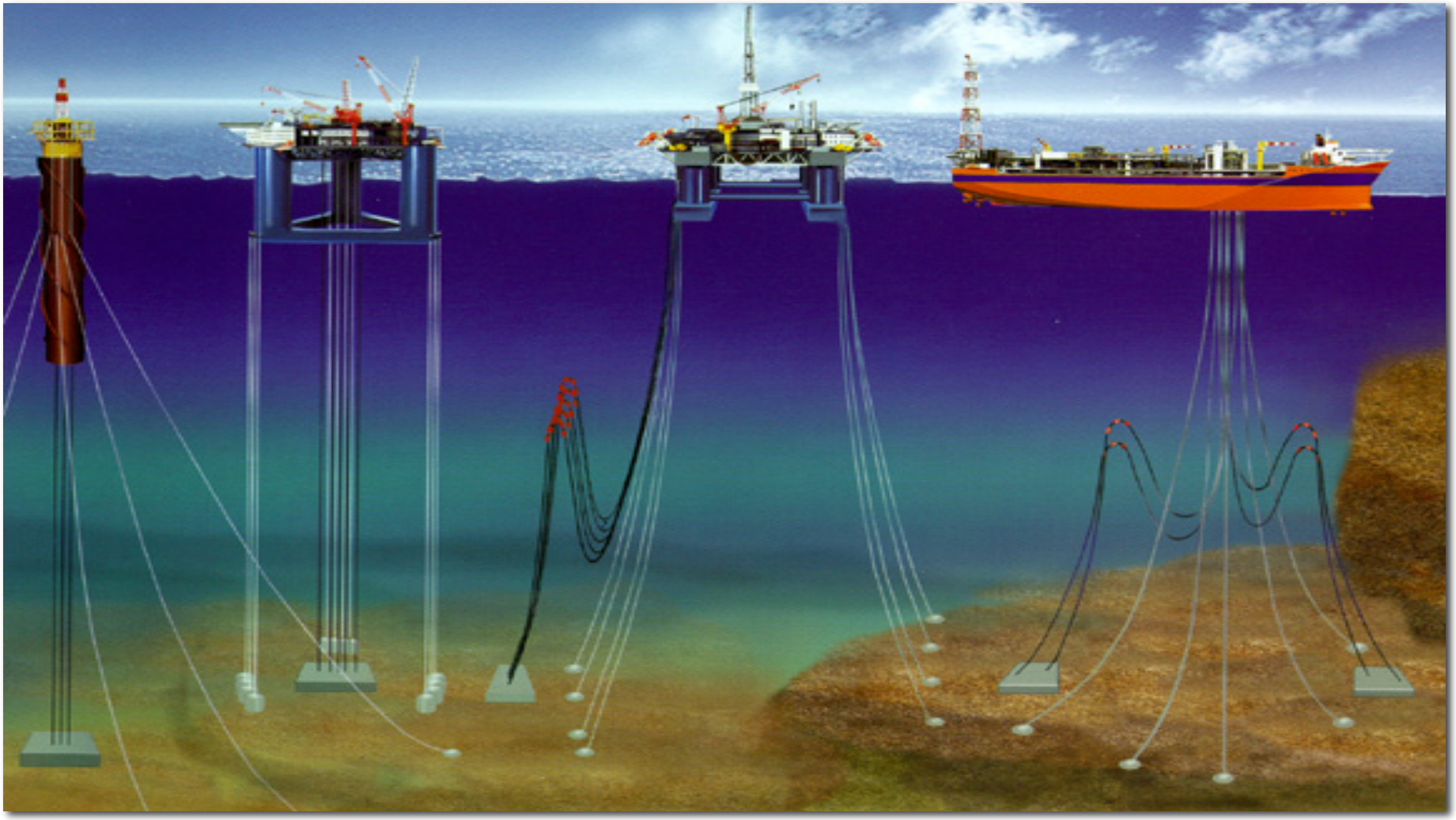




Wet Tree Hub Platform Example – Na Kika



Dry or Wet Trees? - Hull Selection Impact



Export options – Pipeline or Tanker Offloading

Pipeline

- Best solution in areas of existing infrastructure (pipeline tie-ins and access to market)
- High cost if large distances to tie-in
- Lowest cost operation

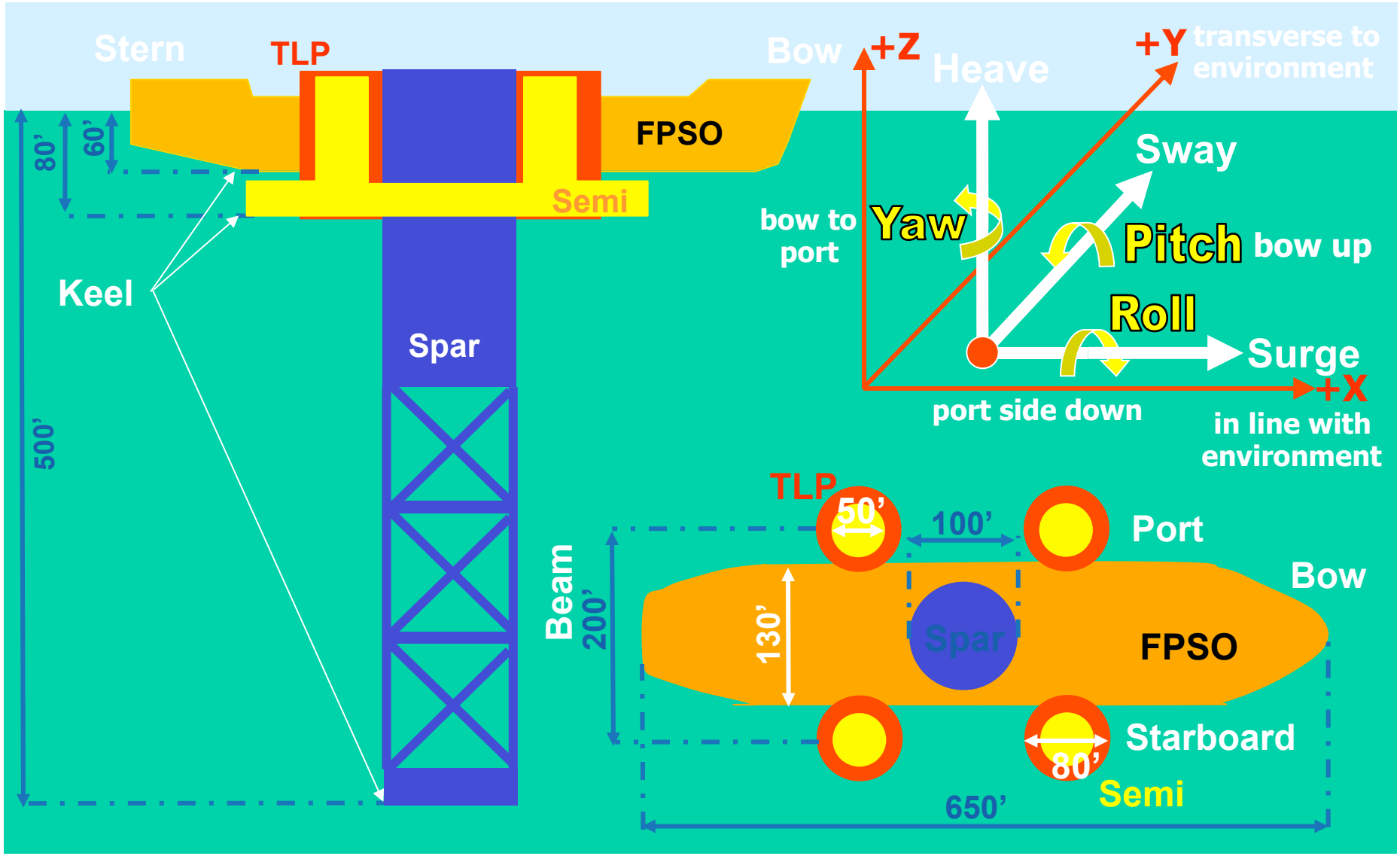
- Semi, Spar, TLP

Tanker Offloading

- Best (sometimes only) solution in remote areas
- High operational cost
- Requires local storage

- FPSO, FSO
- possible Spar, Semi

Hull Selection - Relative Profiles & Nomenclature

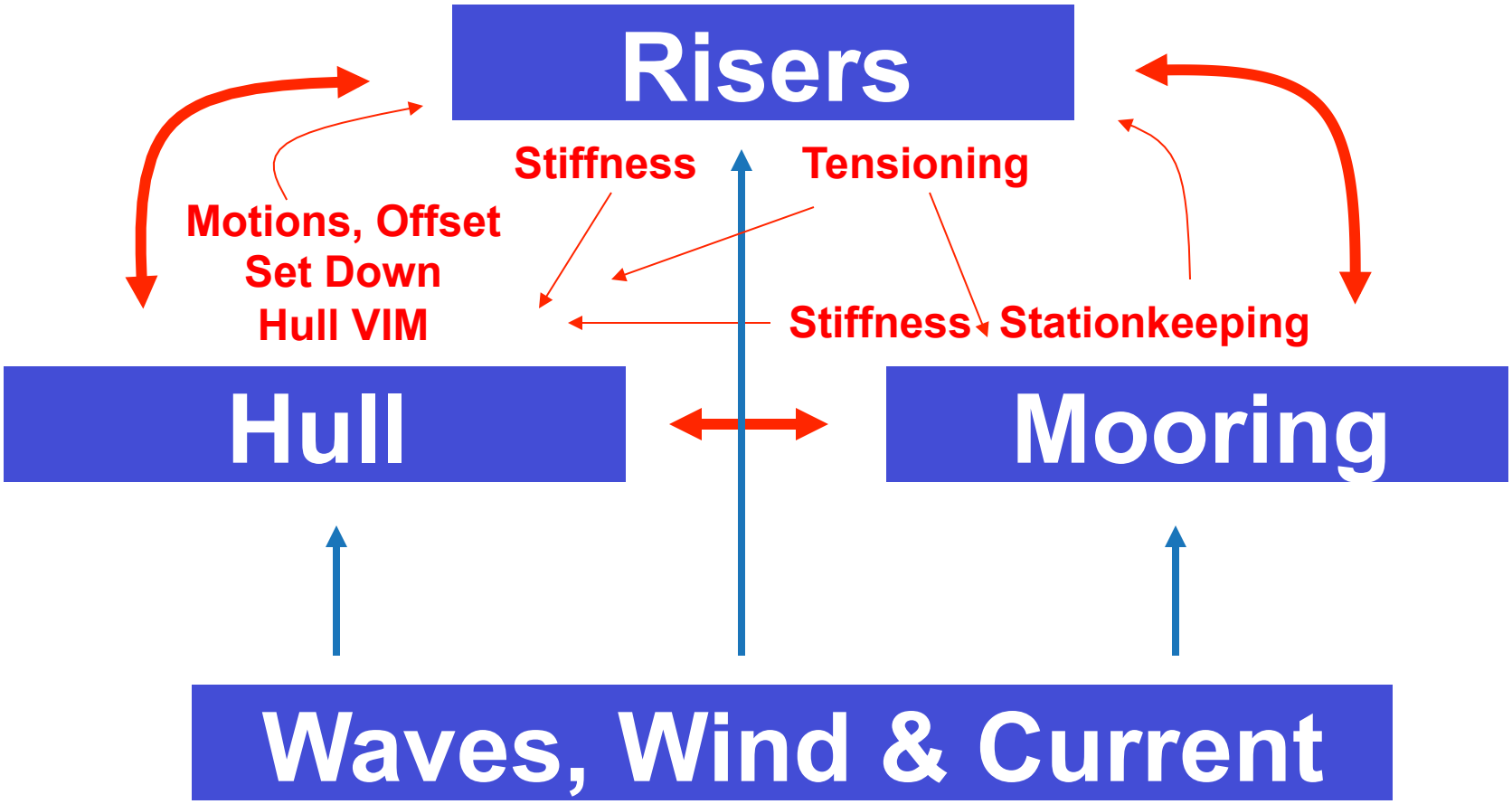


Hulls are Riser (and Topsides) Support Platforms

- Hulls receive a lot of attention
  - 100 new ways to provide buoyancy every year at OTC
  - This does not mean that there are 100 new, viable hull forms at OTC
- Hull is designed to:
  - Support topsides with sufficient stability, buoyancy margins, and trim capacity
  - Support risers
  - Provide sufficient access to well systems (i.e for drilling platforms)
- **A good hull is a good riser support platform**

  (risers are often the most challenging part of requirements)

Risers, Hulls and Mooring are Interdependent



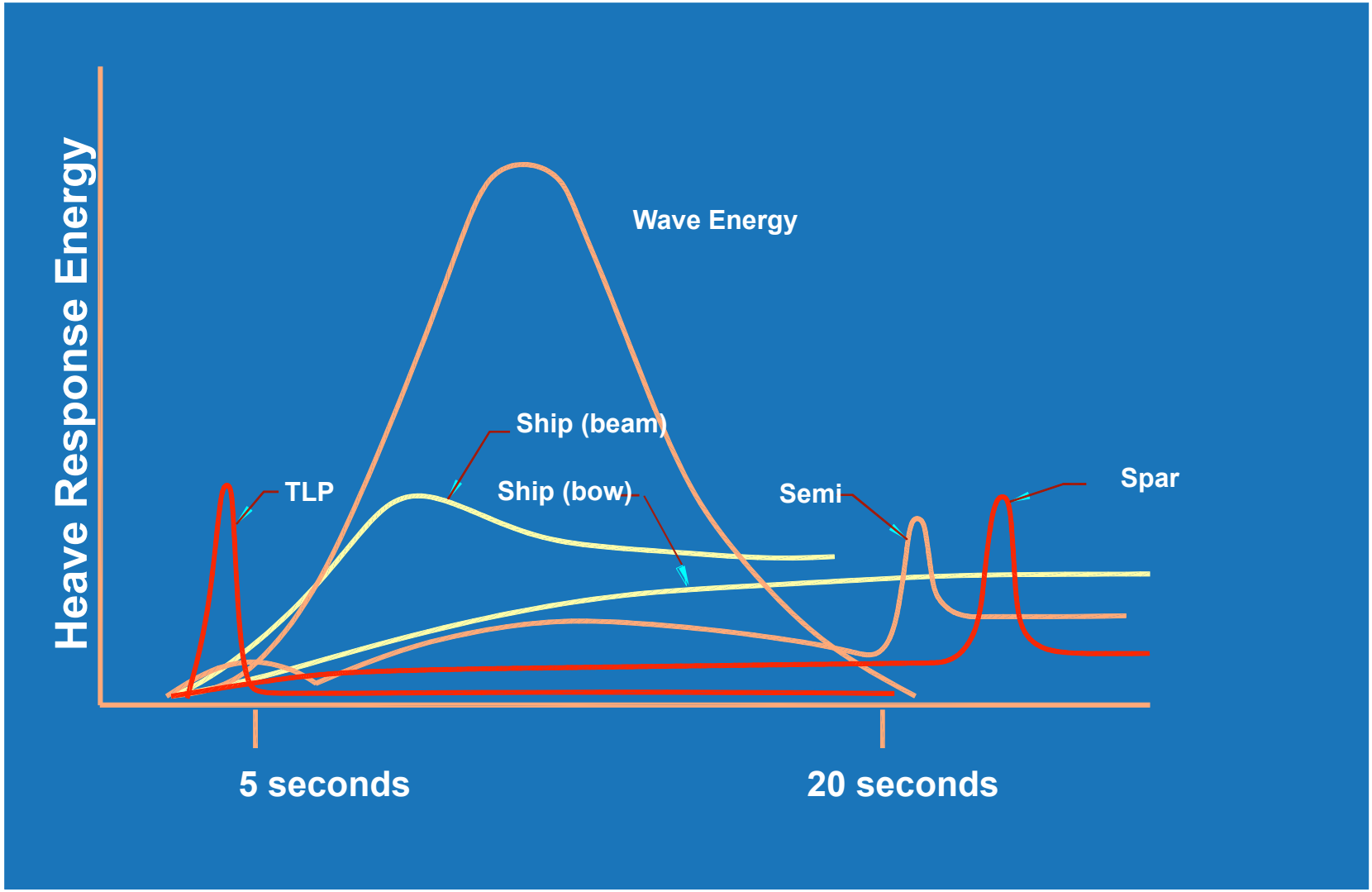
Global Performance Design Approach

- Strong interface between risers, moorings, hull
  - Mooring design loads, offsets dependent on riser unbalanced forces
  - Riser design offsets dependent on mooring system performance
  - Riser strength driven by extreme offsets and pitch angles
  - Riser fatigue driven by operational motions
- Philosophy is to design from the inside out - I.e. design around riser configuration (a balancing issue!)
- Risers are the most critical aspect of the design - hull and configuration are set up to treat the risers well
- A good hull is a good riser support platform

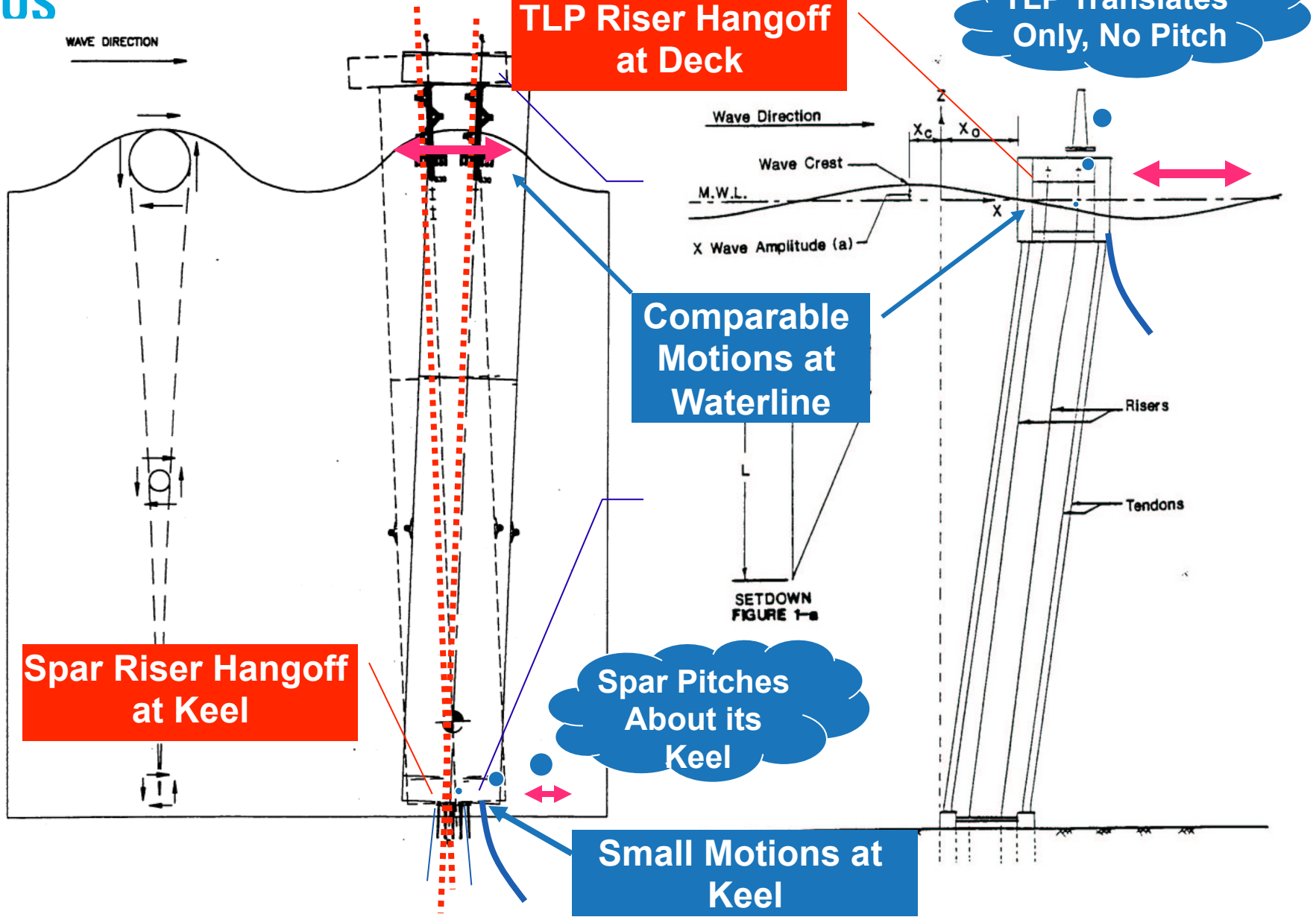
Hull-Riser Interaction

- Hull and riser system design must “match” each other
- Option 1: provide for hull with minimal motions
  - Dry tree riser approach
    - ➔ Spars
    - ➔ TLPs
  - Risers primarily sensitive to heave motions
- Option 2: provide a riser system which can handle larger motions
  - Flexible risers
    - ➔ Semis
    - ➔ FPSOs
- Option 3: Balanced approach, minimize system cost
  - SCR’s, SLWR’s
    - ➔ Semis
    - ➔ FPSOs
    - ➔ TLP’s
    - ➔ Spars

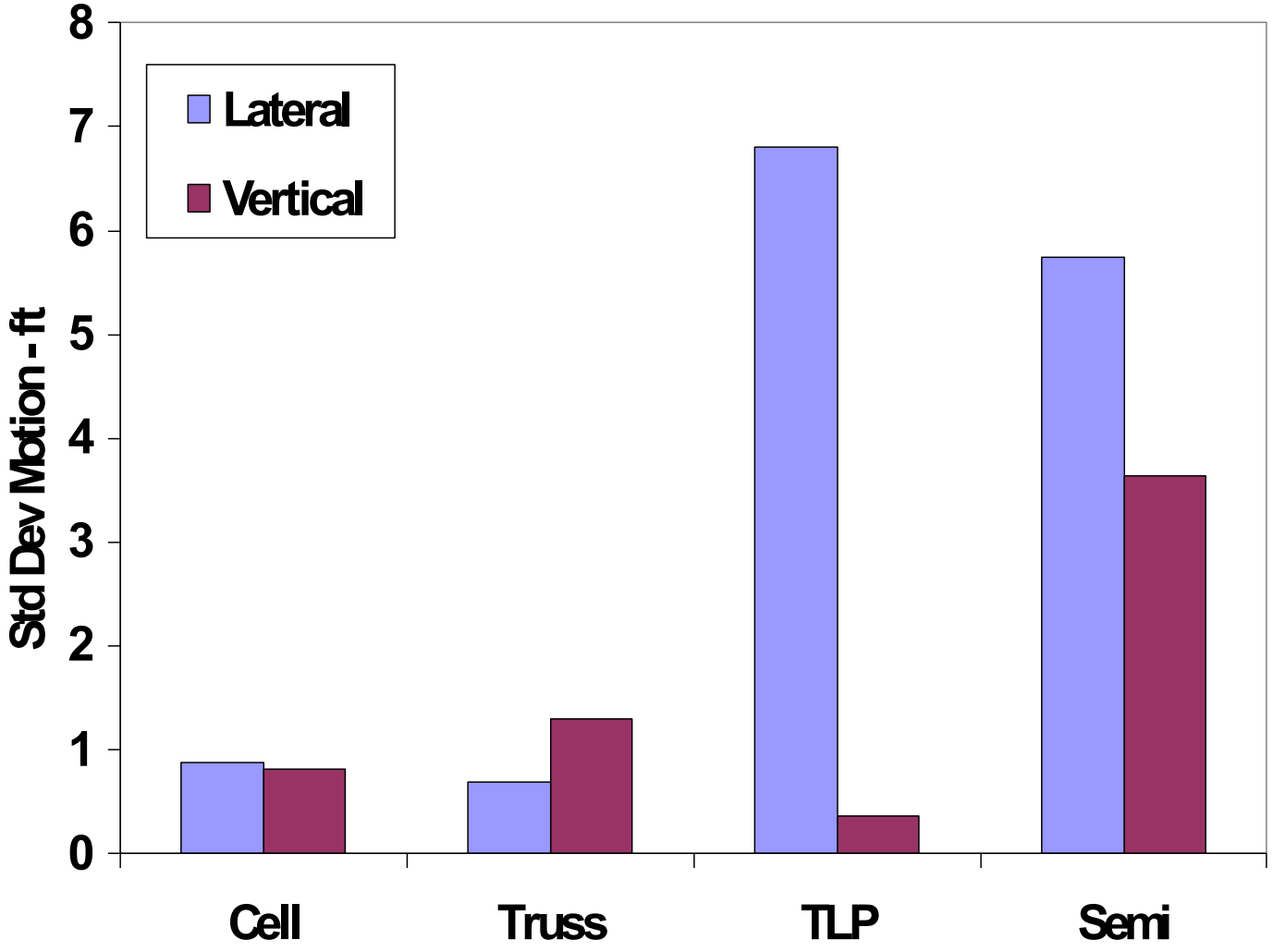
Vertical Motion Principles



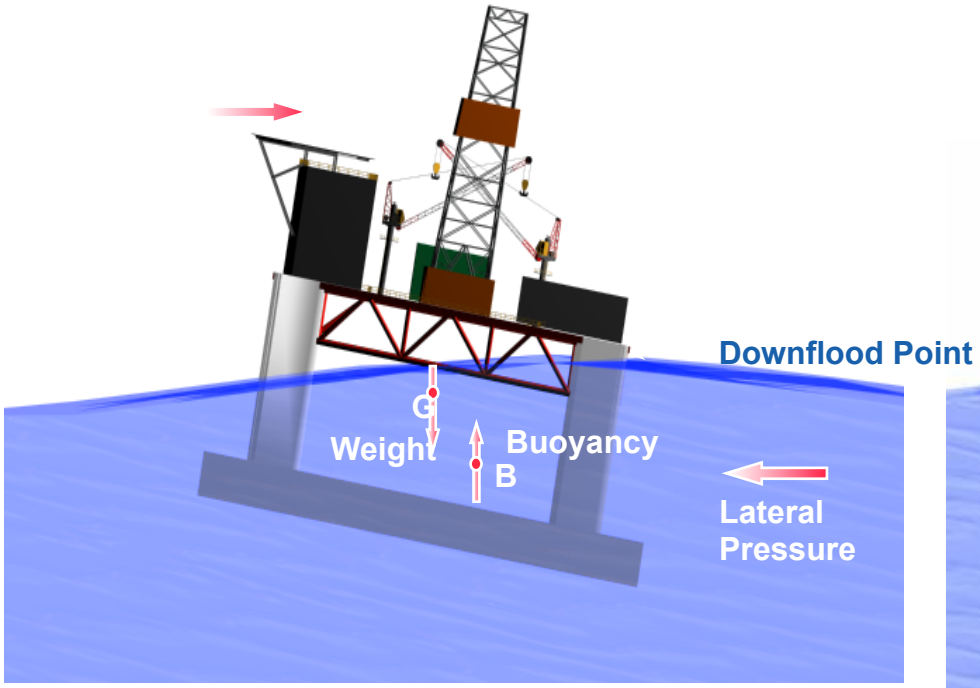
Horizontal Motion Principles

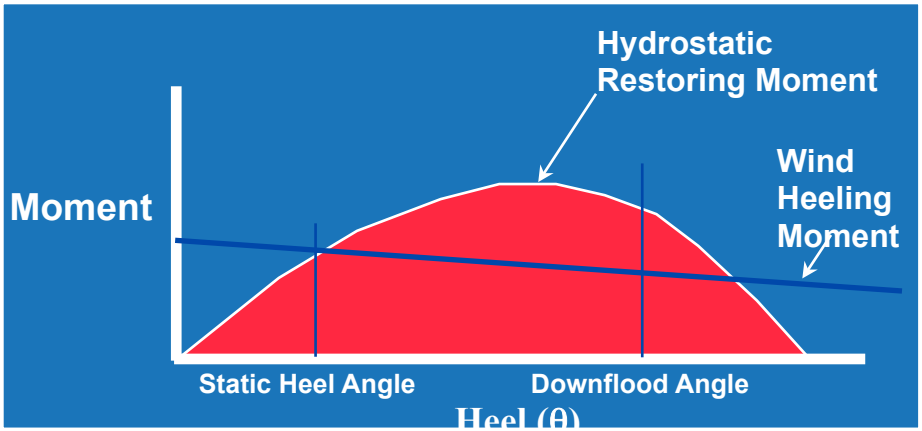


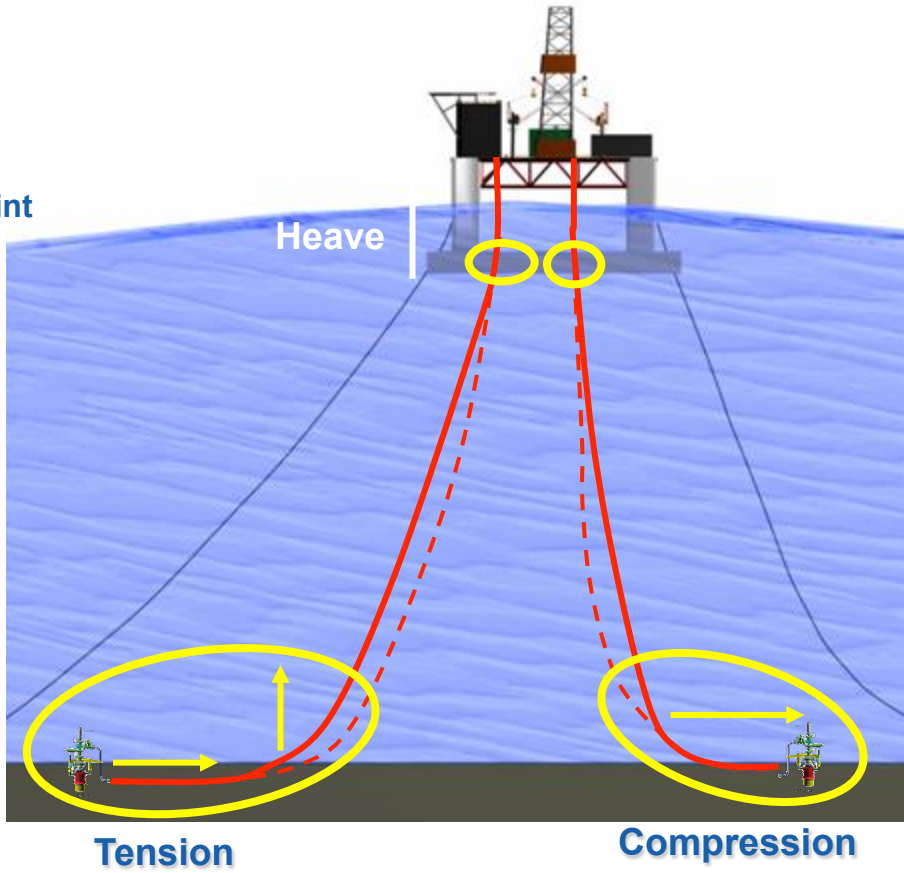
Wave Frequency Motions at Riser Hangoff in 100 Year Hurricane



Semi-Submersible Stability & Motions Fundamentals







Hull Selection - Riser Hang-Off Interfaces

- SCRs
  - Porch
  - Pulltube
  - Stress/ Flex Joint

- Flexibles / Umbilicals
  - Pulltubes
  - Penetrations

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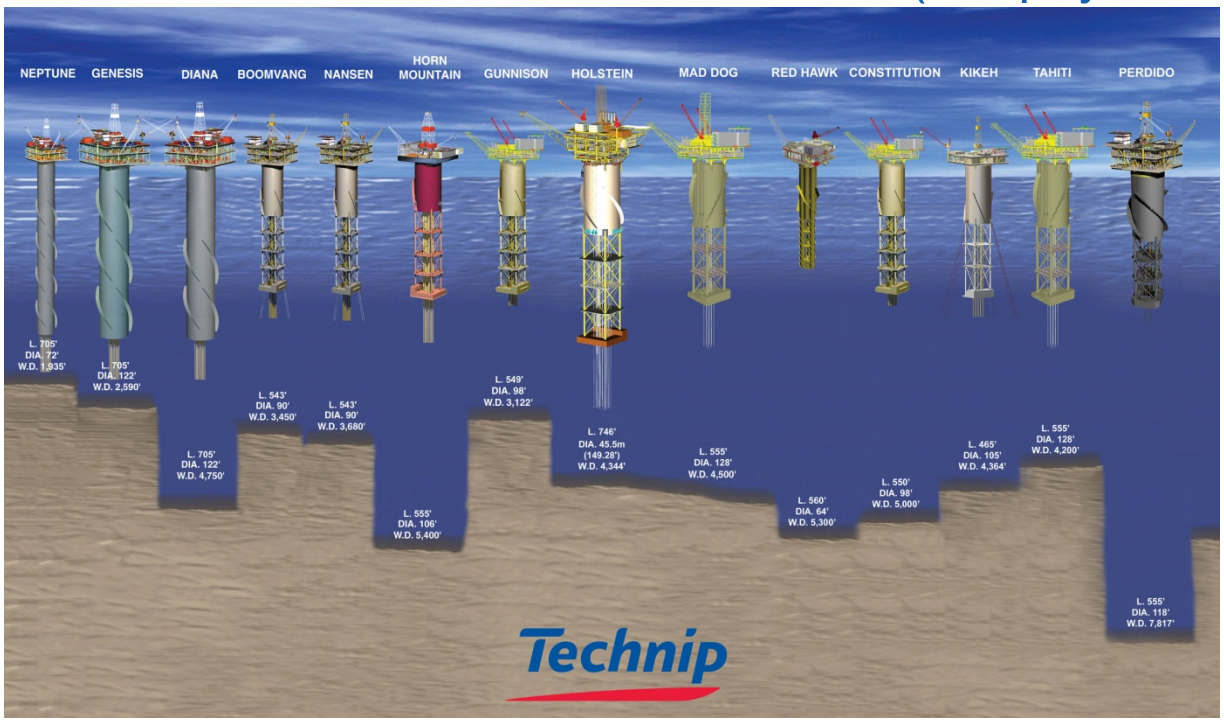
Overview of Established Floater Capabilities - Spar

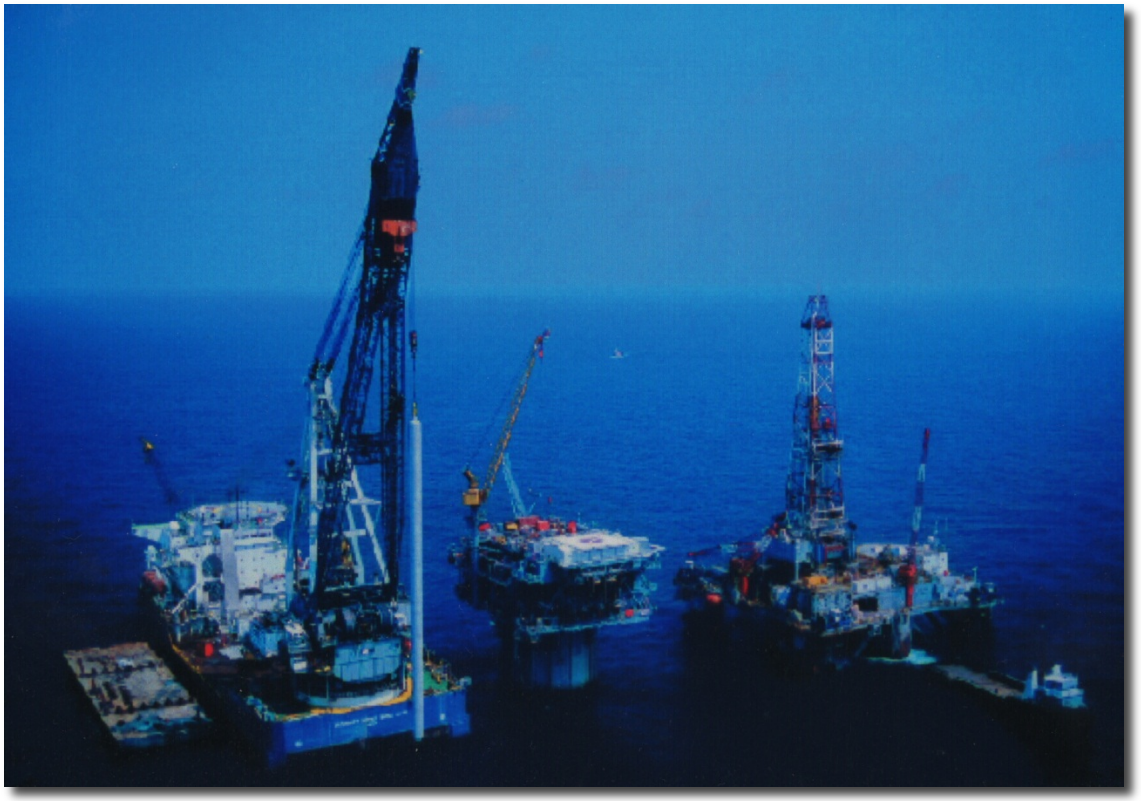
- **Functions**
  - Wellhead Support
  - Drilling
  - Workover
  - Production
  - (Oil Storage)
- **Capabilities**
  - Water Depth (300m - 3,000m)
  - Process 20 -155 kboed
- **Current Presence**
  - GoM
  - SE Asia (Murphy Kikeh)

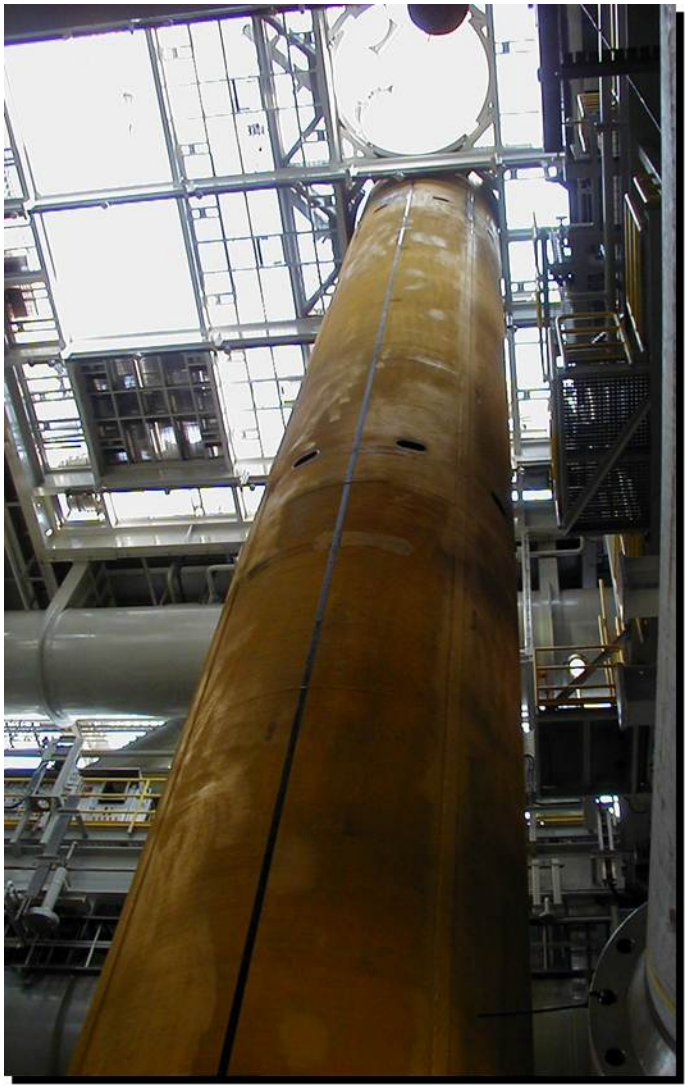


Spar – Topsides Lift

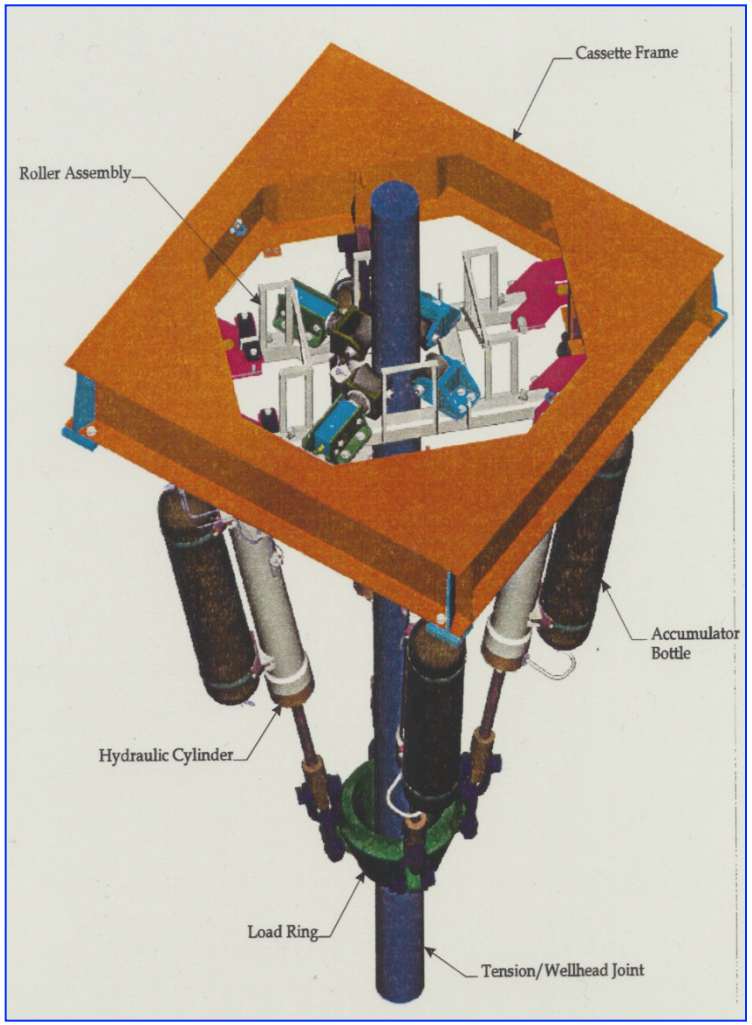
Spar – Topsides Floatover

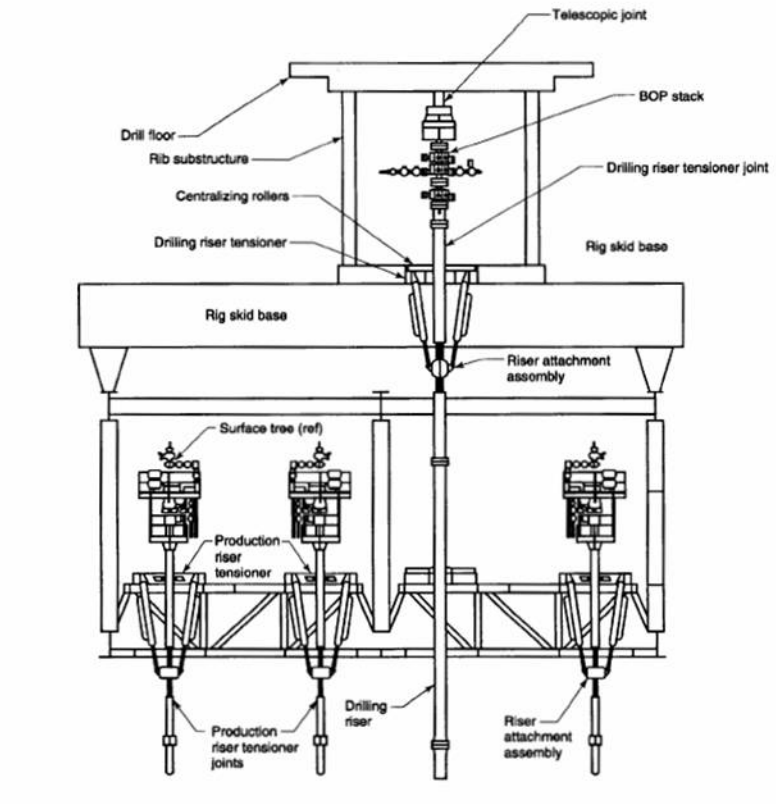
Top Tensioned Riser – Buoyancy Cans





Top Tensioned Riser - Tensioners





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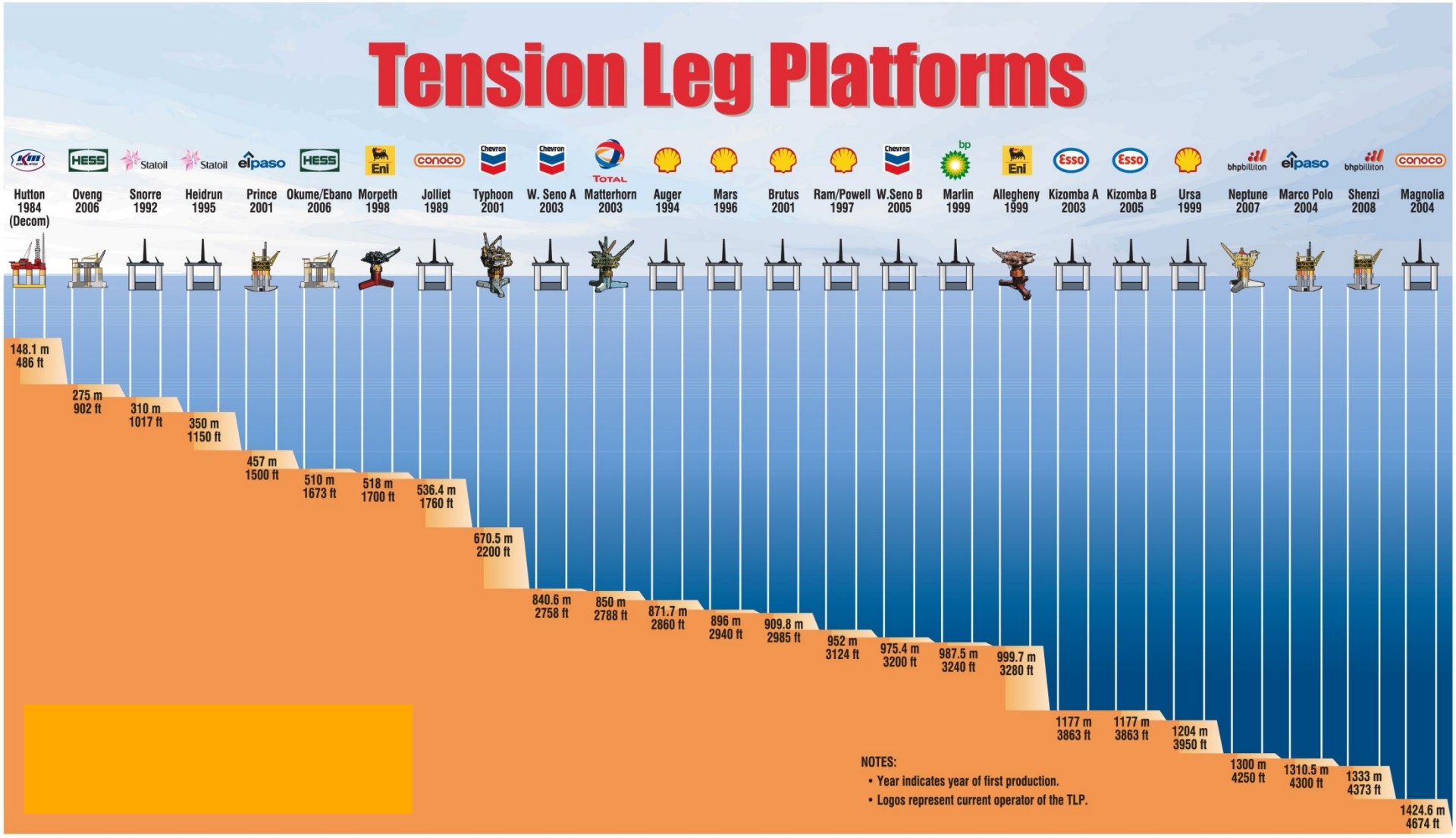
Overview of Established Floater Capabilities - TLP

- **Functions**
  - Wellhead Support
  - Drilling
  - Workover
  - Production
- **Capabilities**
  - Water Depth (150m -1,800m)
  - Process 45 – 250 kboed
- **Current Presence**
  - GoM
  - North Sea
  - West Africa
  - Brazil
  - SE Asia

24 Tension Leg Platforms 1980-2010 (3 more to 2014, plus 4 in design/construction)

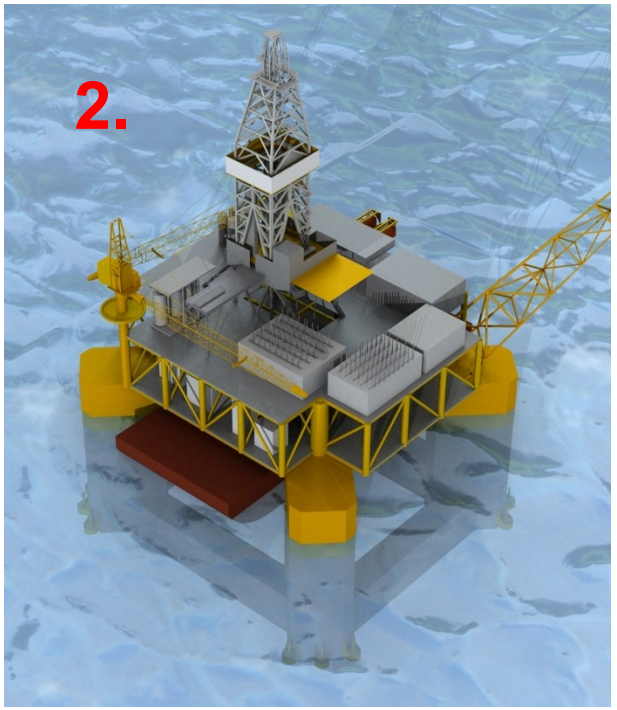


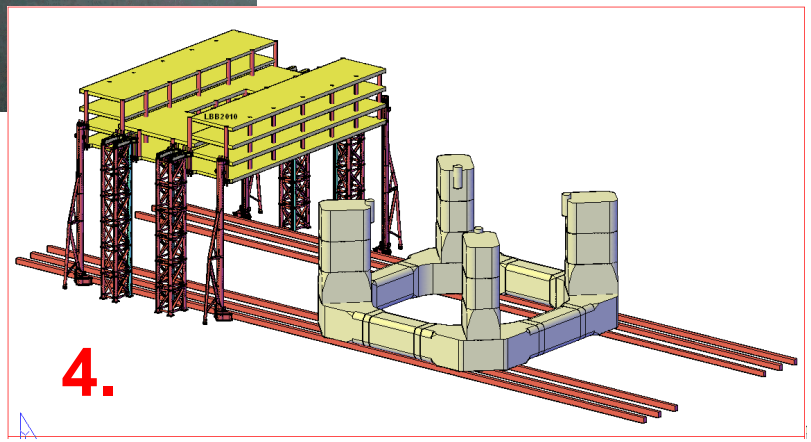
Conventional -TLPs

Mini-TLPs

Semi/TLP Hull/Topsides Integration and Commissioning Options

1. Integrate hull and topsides quayside using shore-based or floating crane facility.
2. Integrate hull and topsides in sheltered location via floatover.
3. Module support frame, module lifts
4. Jacking of deck, skidding of hull





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Overview of Established Floater Capabilities – Semis

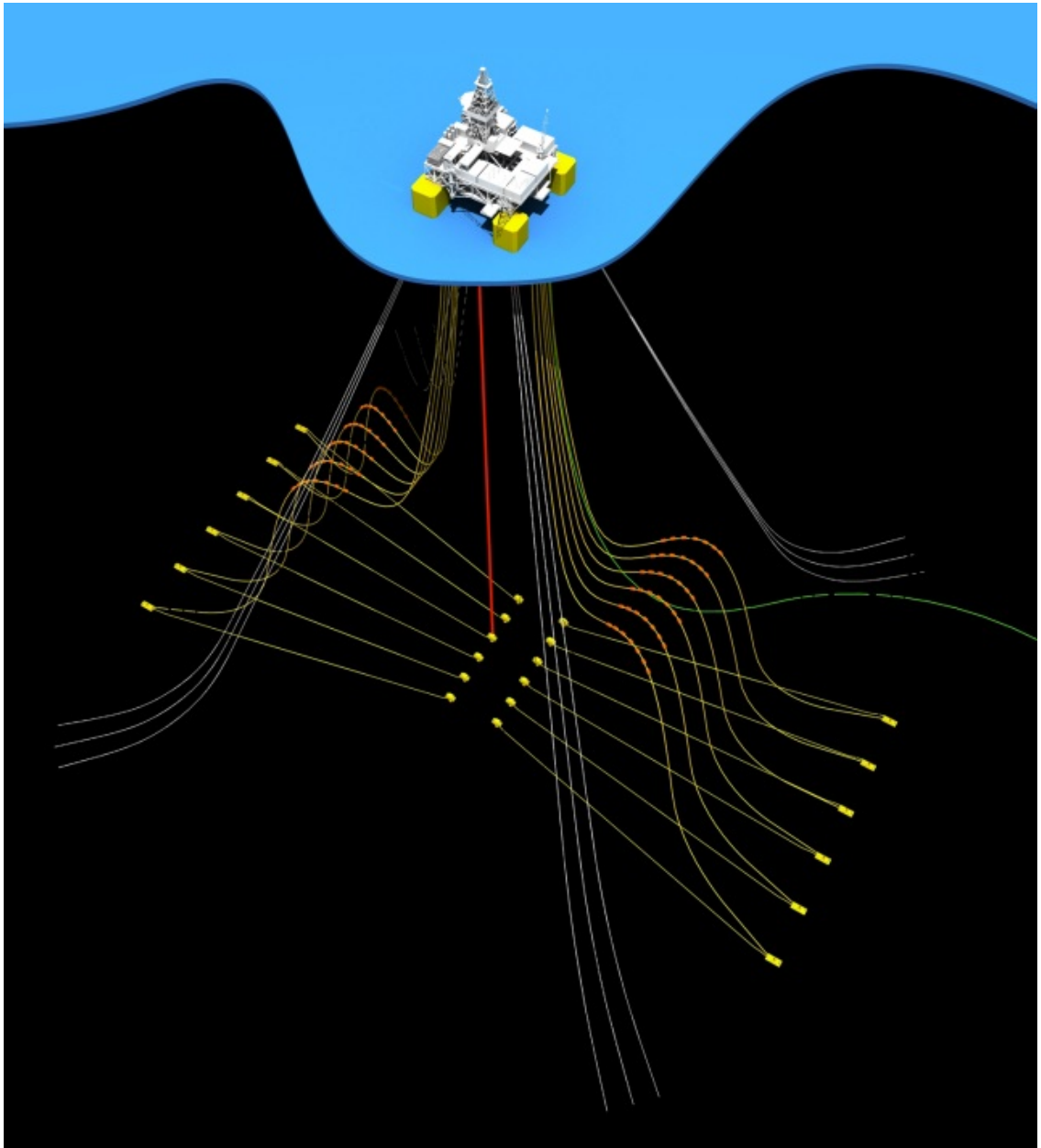
- **Functions**
  - Production
  - Drilling & Workover possible
- **Capabilities**
  - Water Depth (80m –3,000m)
  - Process 12 – 315 kboed
- **Current Presence**
  - China, SE Asia, India
  - Brazil
  - GoM
  - North Sea
  - Australia

"Snorre B"

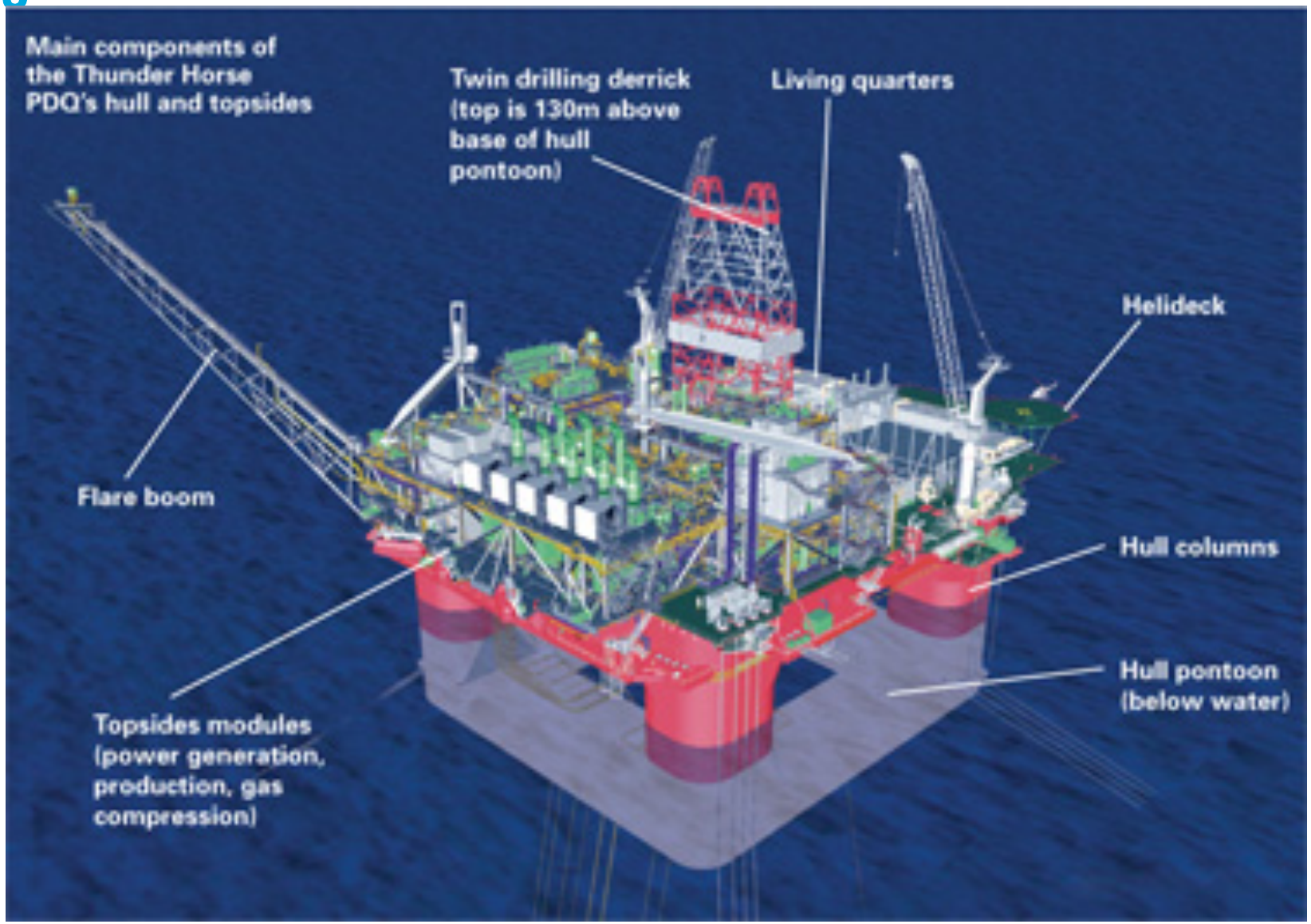
SUT - US

Semi-Submersible

Semi-Submersible Production & Drilling Configuration



PDQ Semi – Thunder Horse



SUT - US

Semi Design Issues affecting configuration

- Payload/Displacement
- Deck area requirements
- Air gap
- Channel/quayside Draft
- Dry transport Draft
- Stability at integration
- Stability in-place
- Overall width for dry dock
- Motions for risers (draft, column/pontoon ratio, column spacing, riser porch location)

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Overview of Established Floater Capabilities – FPSO

- **Functions**
  - Production
  - Storage
  - Offloading
- **Capabilities**
  - Water Depth (30m –3,000m)
  - Process 10 – 330kboed
  - Storage up to 2mmbbl
- **Current Presence**
  - Brazil
  - Asia
  - Africa
  - Australia
  - North Sea & N. Atlantic
  - Canada
  - Mediterranean
  - GoM (Mexico and USA)

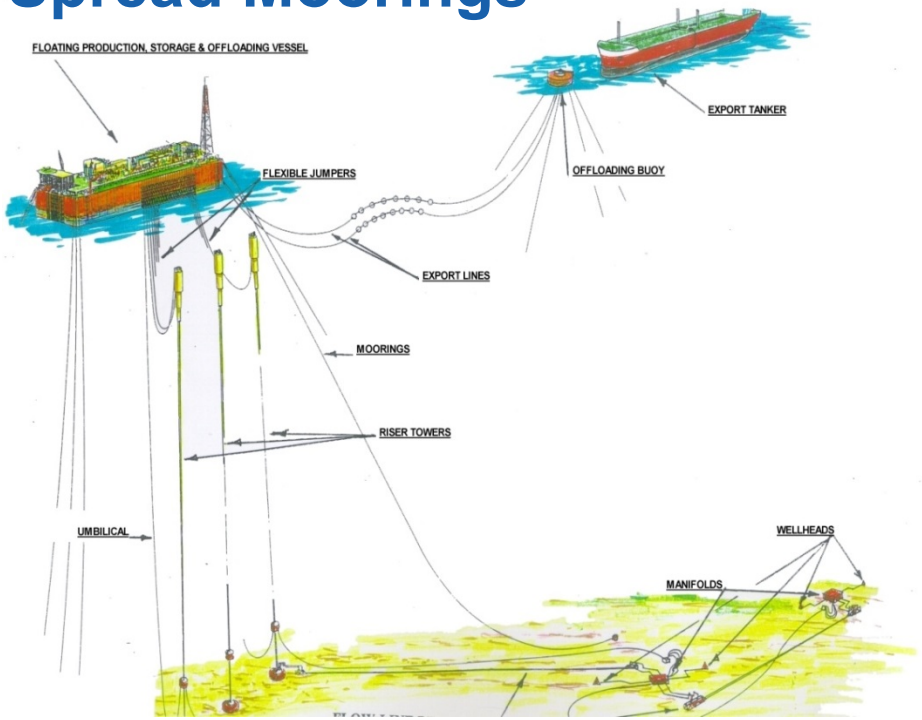
FPSO Mooring Systems –Turret Moored

- **All Mooring Lines Attached to Turret**
  - Internal or External
- **All Risers Routed Through Turret**
  - Requires Drag Chain or Swivels
- **Allows Passive Weathervaning**
  - Function of Turret Location
- **Suitable for Harsh Environments**
  - Omni-directional prevailing conditions
- **Disconnection possible**
  - White Rose, Terra Nova, Stones

North Sea, North Atlantic, GOM, Africa, Australia

FPSO Mooring Systems – Spread Moorings

- **Mooring Lines Routed to Optimum Positions on Vessel**
- **Risers Routed along sides of Vessel**
  - **Reduced Congestion**
  - **Increased capacity**
- **No Weathervaning**
  - DICAS offers limited capacity
- **Suitable for Moderate Environments**
  - **Uni-directional prevailing conditions**



Brazil, West Africa, S.E. Asia

Summary of Established Floater Capabilities

	FPSO	Semi-submersible	Spar	TLP
Production	Yes	Yes	Yes	Yes
Storage	Yes	Possible	Yes	No
Drilling	No	Yes	Yes	Yes
Workover	No	Yes	Yes	Yes
Water Depth limitation	No	No	No	1800m

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Semisubmersibles for Dry Tree Application

HVS Semi, Technip

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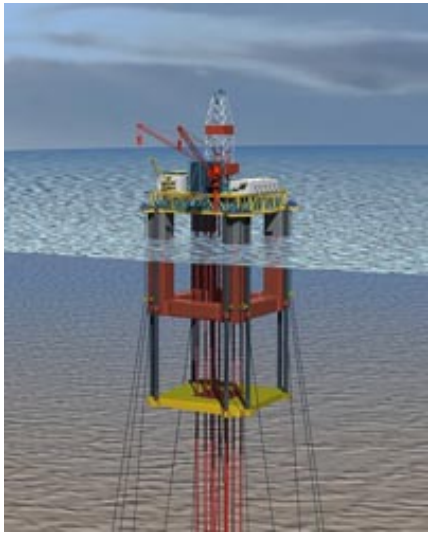
E-semi, Floatec



Octabuoy, Moss Maritime

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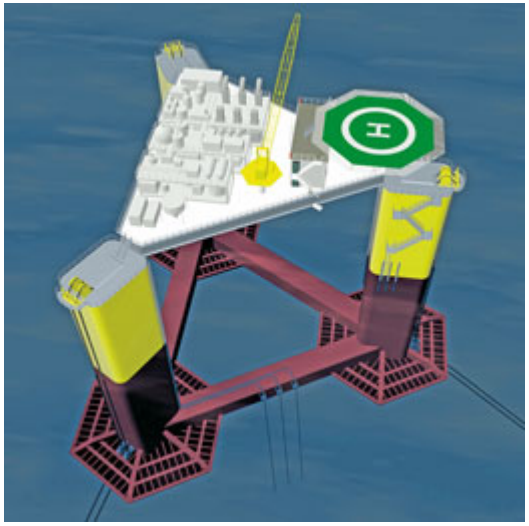
Minifloat- Marine Innovation & Technology(MI&T)



OPTI-EX, Exmar Offshore

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DTS, Aker

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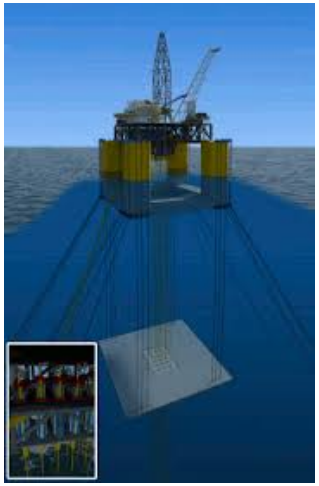
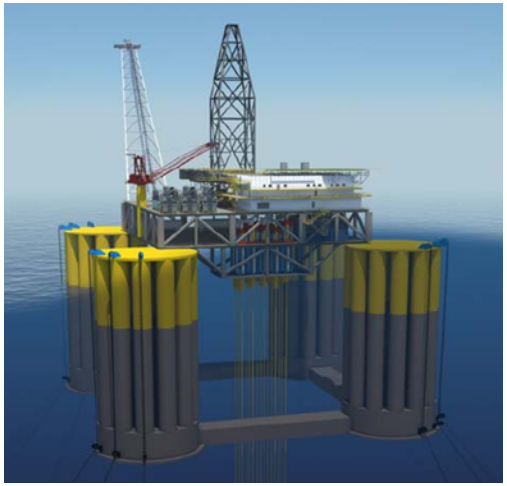
Semisubmersibles for Dry Tree Application

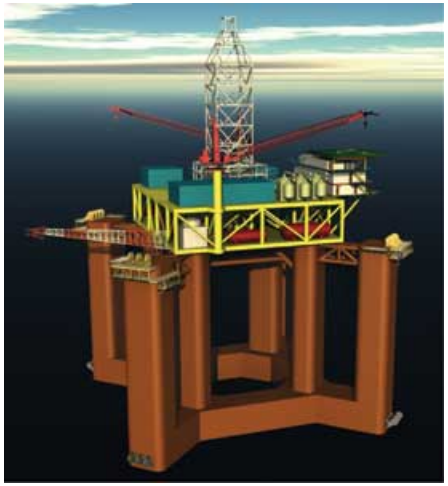
FHS(Free Hanging Solid Ballast) Semi, IntecSea

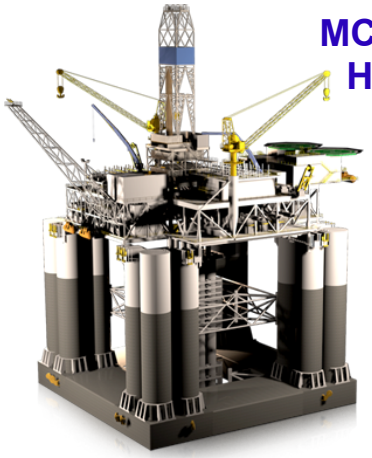


DCC(Damper Chamber Column)Semi, IntecSea

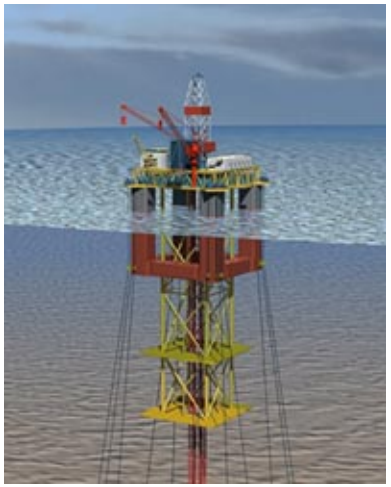


PC(Pair Column) Semi, HOE





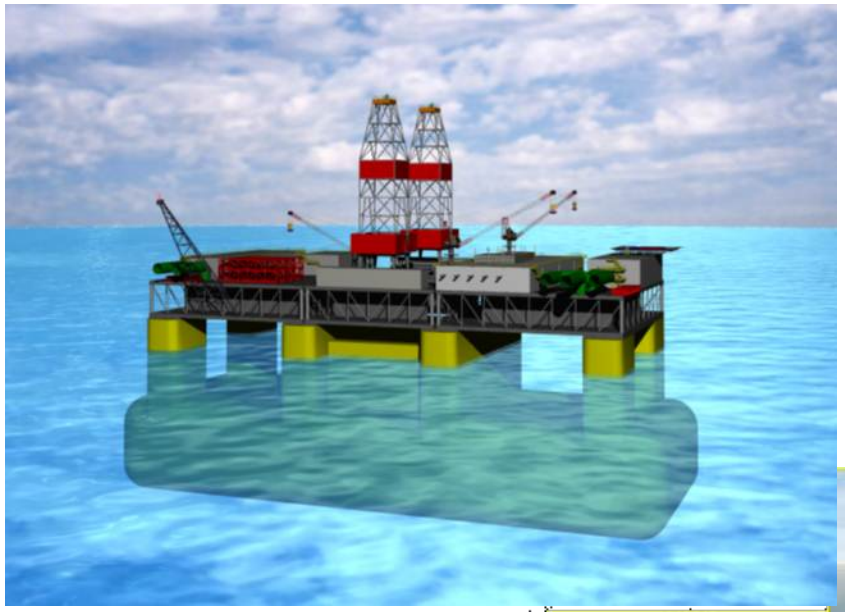
MCF(Multi Column Floater), Horton Wison Deepwater

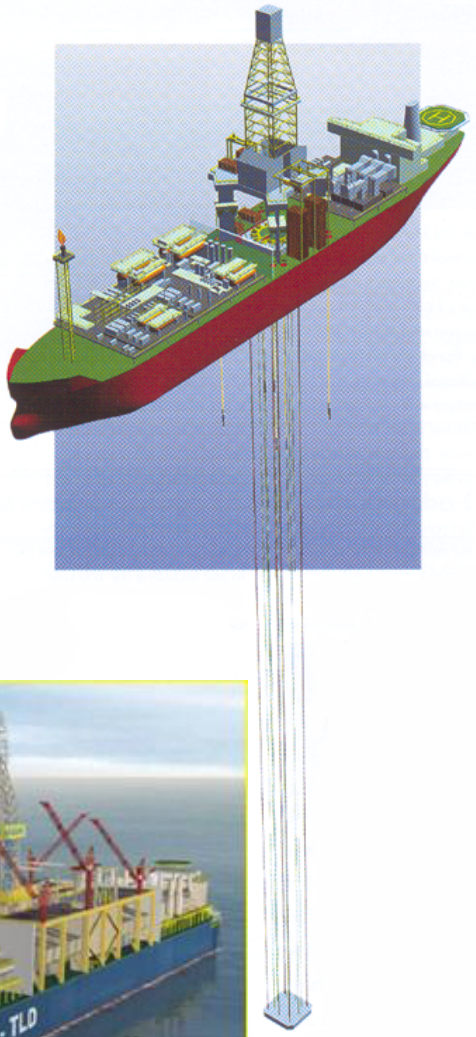


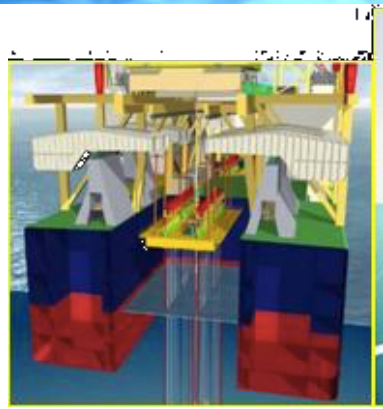
Truss-semi, Floatec

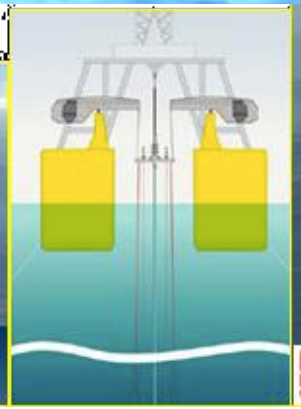
New Concepts - Multi-Function Floaters

- **FPDSO**
  - Integrate Dry tree, Drilling, Processing and Storage









Thank You!

Questions?