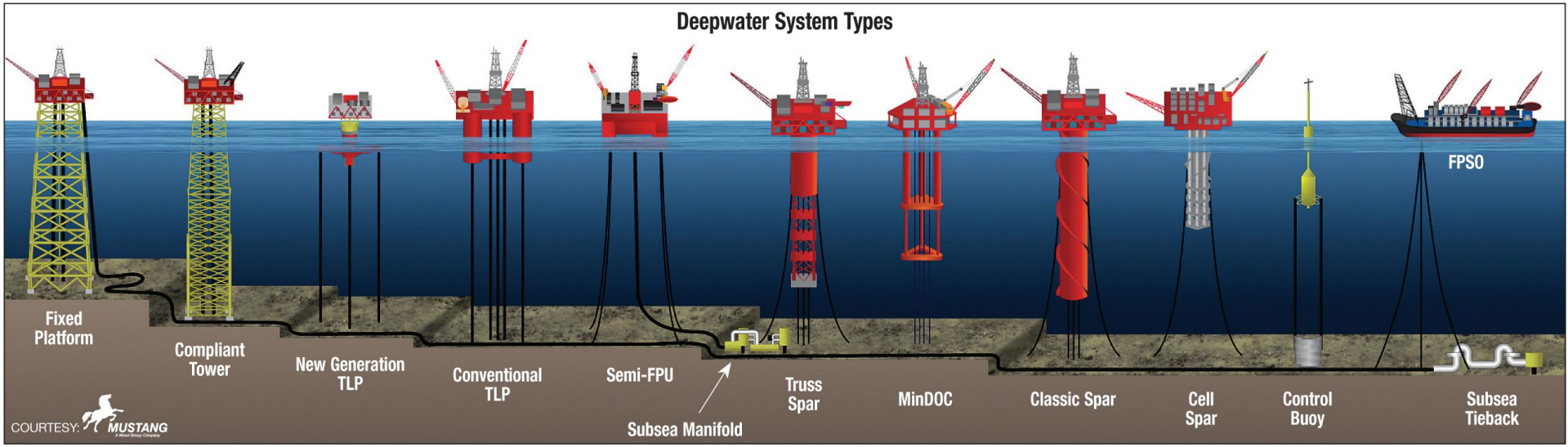
An Overview of Offshore Concepts



SPE Expanding Facilities Knowledge Workshop
Session 1: Offshore Concepts Selection

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Upstream Project Director

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SPE International

An Overview of Offshore Concepts

- Safety Minute
- Introduction
- Background Information
- Offshore Facility Descriptions
- Fabrication and Transport Considerations
- Installation Considerations
- Advantages/Disadvantages of Concepts
- Drivers for Selection
- Developing the “Right” Concept

Safety Minute

- The offshore oil and gas industry is important to the United States.
- It can be a dangerous industry.
- As engineers and designers we have a huge impact on the safety of others and the environment.
- It is important to consider safety and the environment in our design and our decisions.

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Safety Minute

BP Macondo Well Incident Information:

- 11 people died
- Transocean Deepwater Horizon Drillship sank
- According to the US government, between 12,000 and 25,000 BOPD and its associated gas have been released into the GOM.
- According to BP, the present cost of the response exceeds to $1.3 billion, including the cost of spill response, containment, relief well drilling, grants to Gulf states, claims paid, federal costs, and Louisiana barrier islands construction project.
- Thousands of offshore workers will likely face unemployment due to the effects of placing a drilling moratorium. Support industries will also be affected.
- Harm to marine and wildlife is still being assessed.

Typical incidents have to be avoided in the future.

Introduction

This presentation will cover:

- An overview of offshore concepts
- Advantages and disadvantages of concepts
- Drivers for selection
- A proposed process to help in selection of the “right concept”

Background Information

Offshore Industry Milestones:

- 1947 – First offshore platform installed in 20 ft. of water
- 1984 – First TLP installed in 480 ft. of water
- 1988 – Bullwinkle Offshore Platform installed in 1,350 ft. of water
- 1997 – First Spar installed in 1,930 ft. of water
- 2007 – Independence Hub Semi installed in 7,918 ft. of water
- 2010 – Perdido Spar installed in 7,820 ft. of water

Background Information

Oil Production in 2009:

- Global Oil Production: 86.2 MMBOPD (International Energy Agency)
- Global Offshore Oil Production – 27.8 MMBOPD (Douglas Westwood)

- US Oil Production – 5.3 MMBOPD (Energy Information Administration)
- US Offshore Oil Production – 1.7 MMBOPD (Energy Information Administration)

Background Information
Deep Water Definitions

MMS Definitions

Shallow Water
0 -1,000 feet

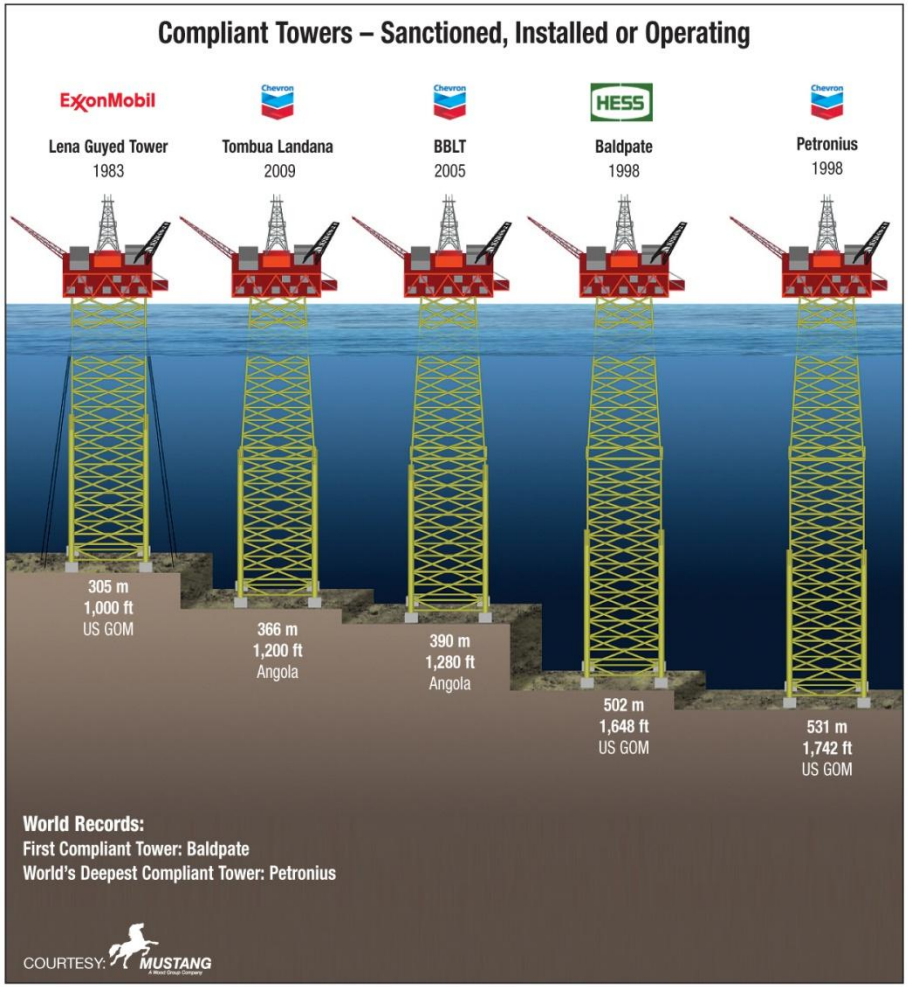
Deepwater
1,000 – 5,000 feet

Ultra Deepwater
5,000 – 10,000 feet

Tallest Land-Based Structure
Burj Dubai – 2,864 feet

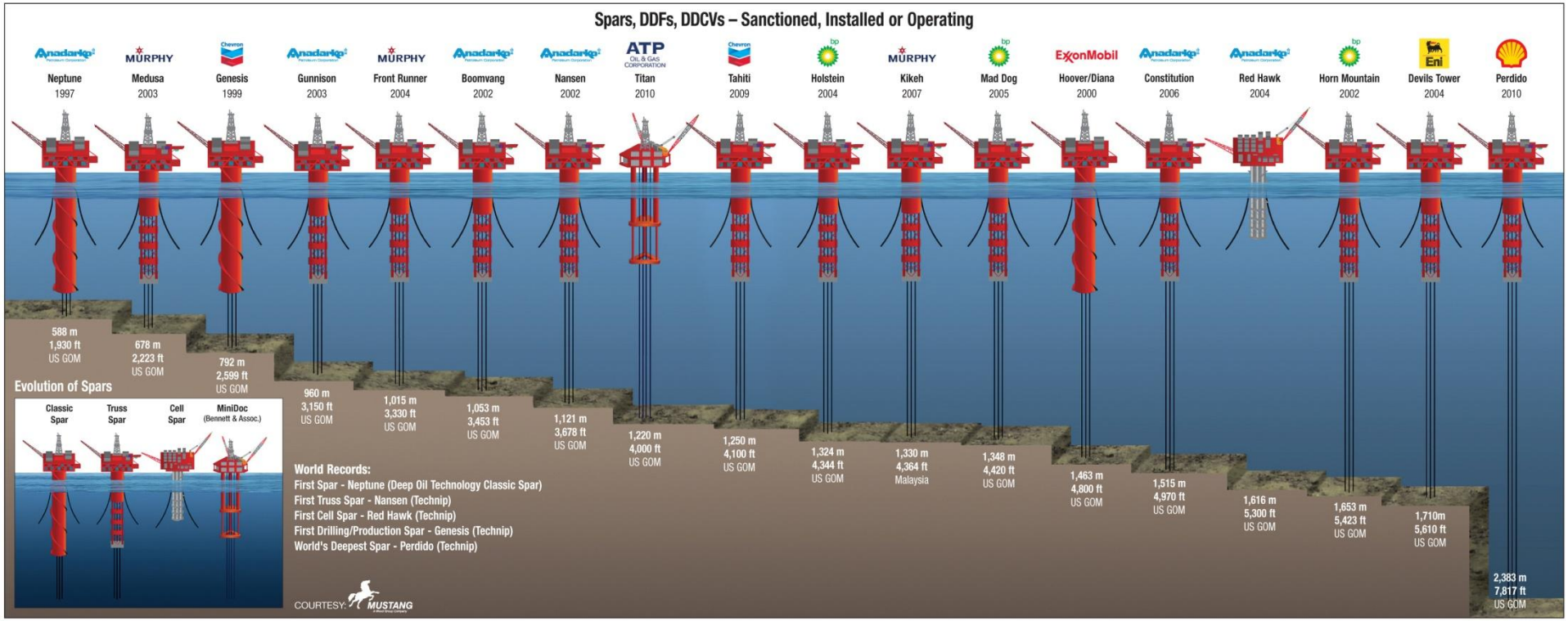
Background Information
Bottom Founded Platforms Installed

Hundreds of Platforms



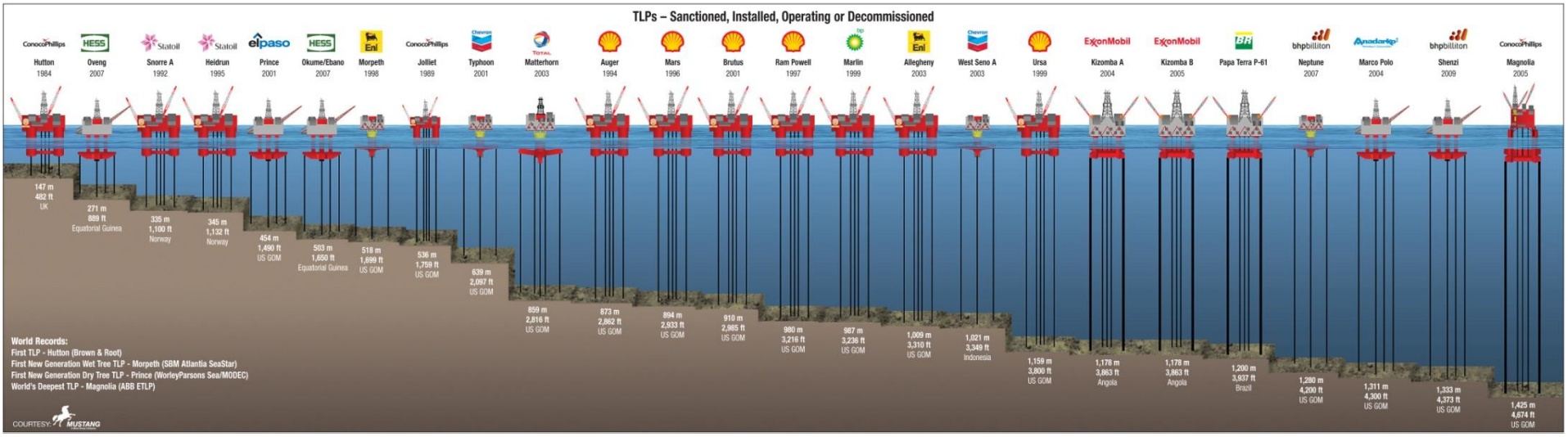
5 Compliant Towers

Background Information
Deepwater Floaters Installed



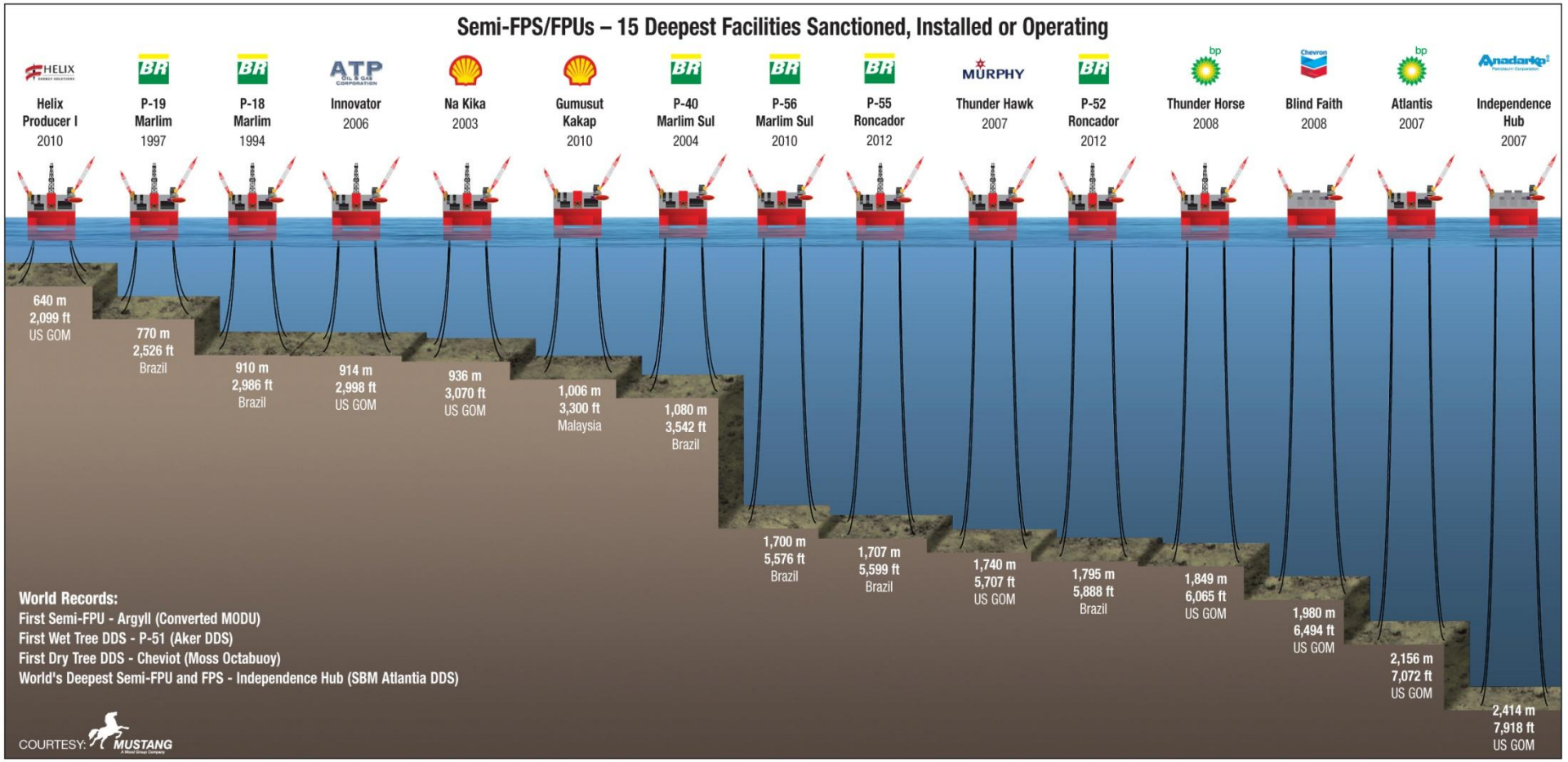
18 Spar Facilities

Background Information
Deepwater Floaters Installed



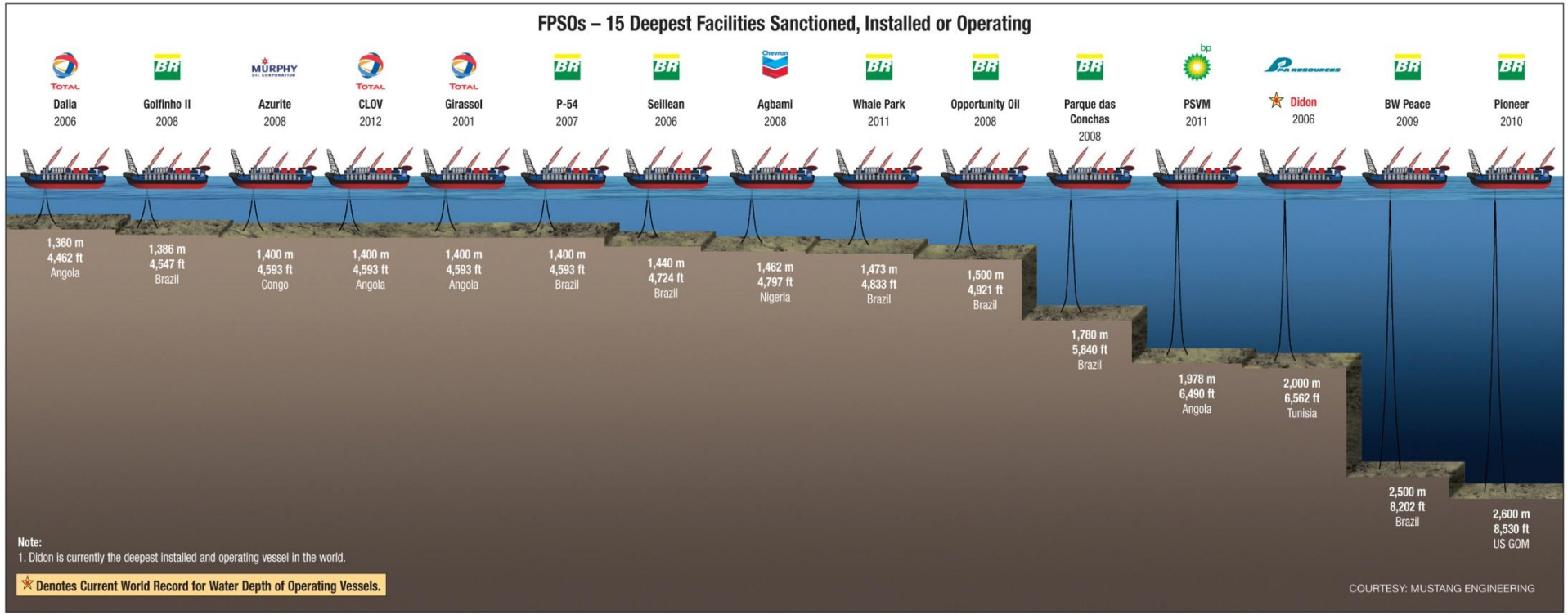
25 Tension Leg Platforms

Background Information
Deepwater Floaters Installed



39 Semi-FPS Facilities

Background Information
Deepwater Floaters Installed



183 FPSO Vessels

Types of Facilities
Bottom Founded Structures

Jacket

CPT

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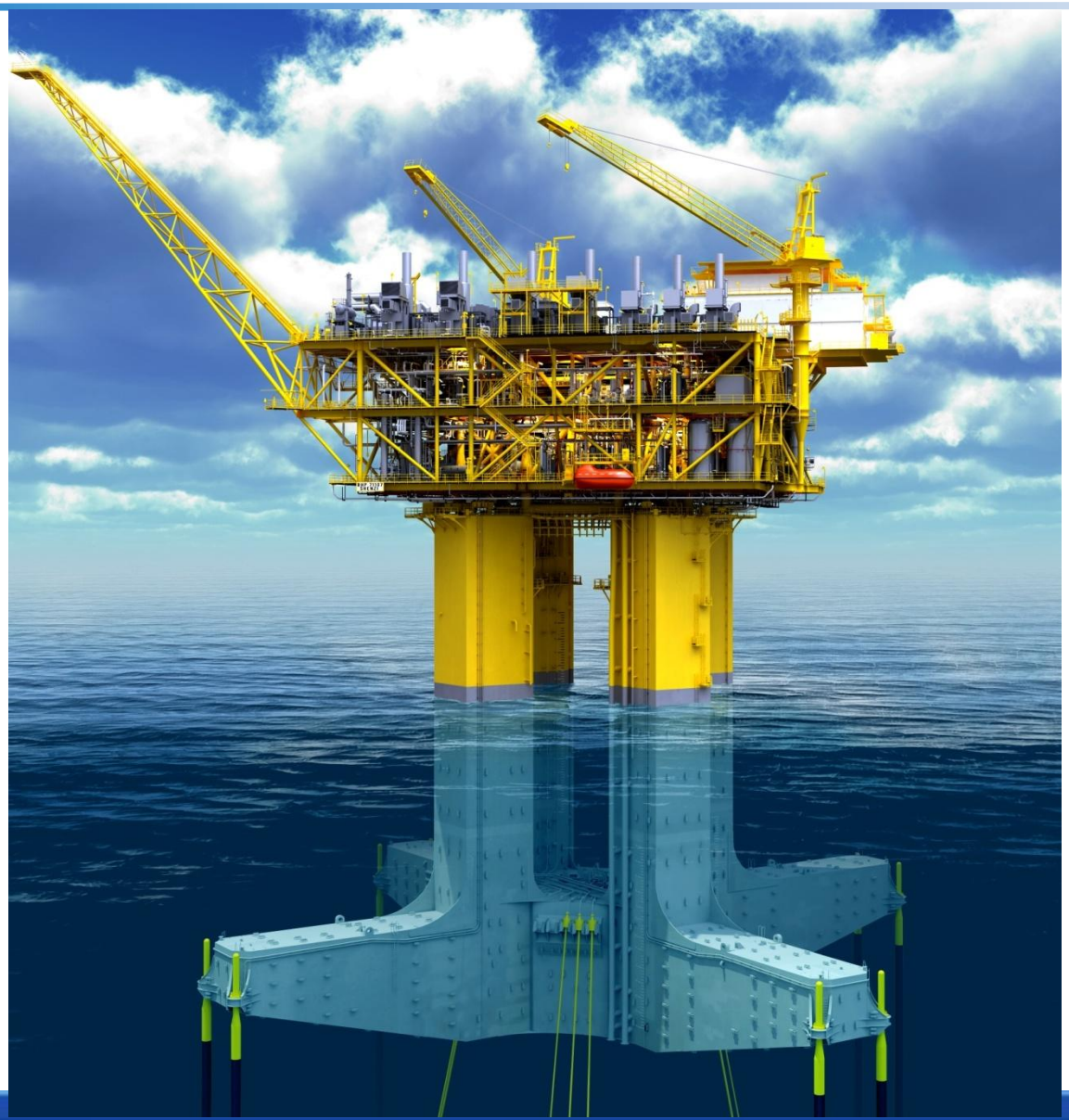
Types of Facilities
Tension Leg Platforms



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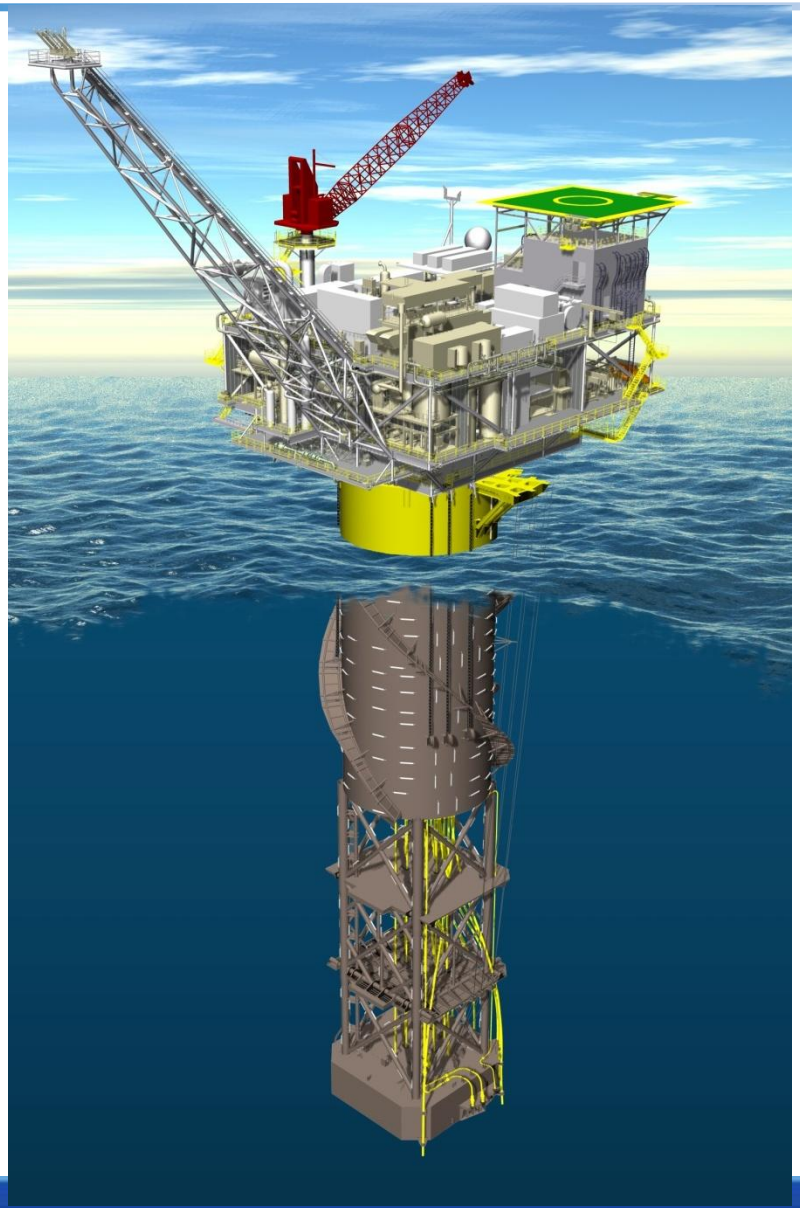
Types of Facilities
Spar



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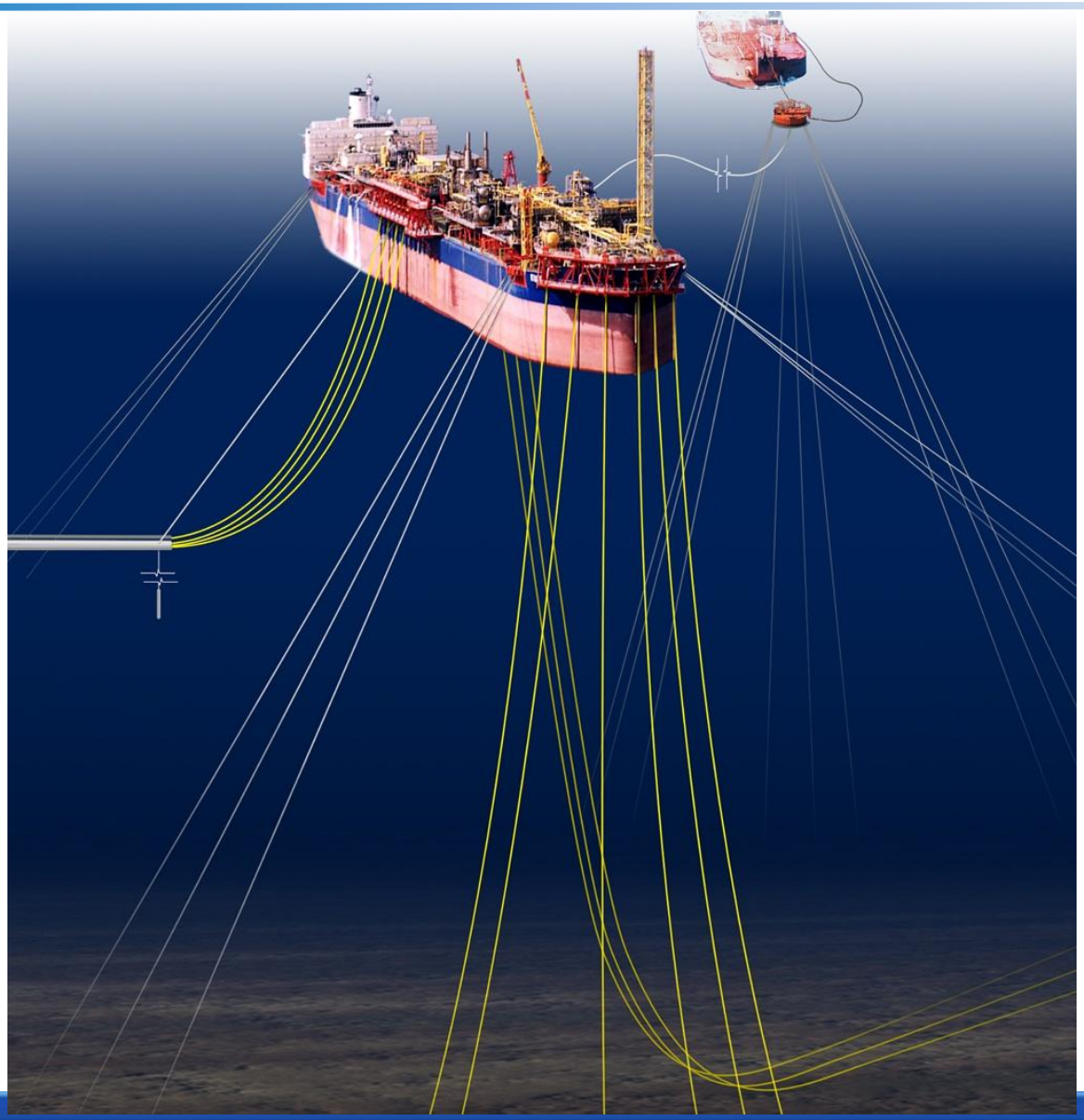
Types of Facilities
Semi-Submersible

Types of Facilities
FPSO



Other

Min Doc

Circular FPSO

Fabrication and Transport Considerations

- Where can the structure/hull and topsides be built?
- What is the largest size built?
- How can the structure be transported?
- Can integration be done at quayside?

Installation Considerations

- Large Derrick Barge required?
- Launch barges required?
- Offshore hook-up required?
- Is the topsides a candidate for a floatover?

Advantages and Disadvantages Fixed Platform

Description: Fixed Structural Jacket with Piles

Advantages:

- Tallest structure exceeds 1,300 feet
- Can handle significant topsides weights
- Good motion characteristics
- Suitable for drilling/workover operations

Limitations:

- Mating of jacket structures
- Weight increases as water depth increases
- Large Derrick Barge may be required
- May require considerable offshore hook-up

Bullwinkle
Gulf of Mexico

Advantages and Disadvantages Compliant Piled Towers (CPT)

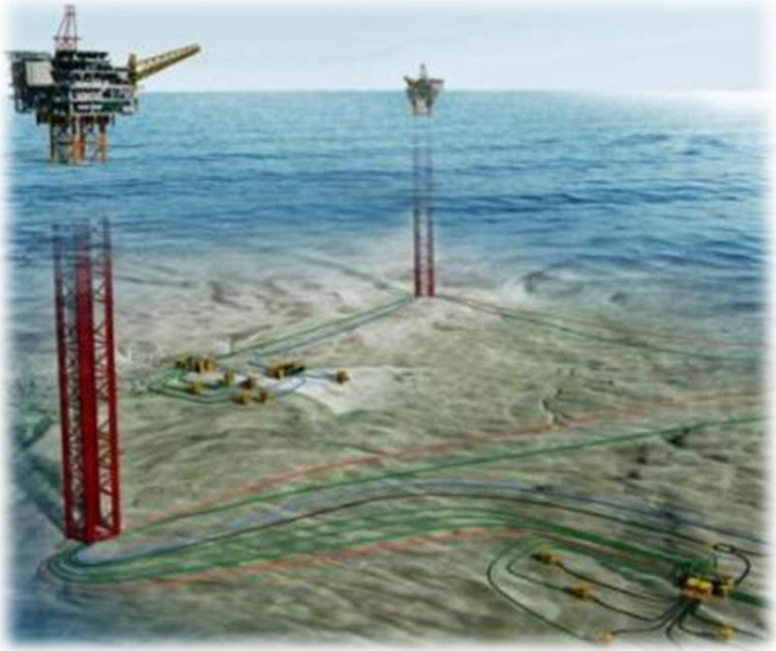
Description: Multi-Sectioned Tower with Piles

Advantages:

- 1,200 to 2,500 feet water depth range
- Can handle significant topsides weights
- Good motion characteristics
- Suitable for drilling/workover operations
- Lighter than fixed jacket

Limitations:

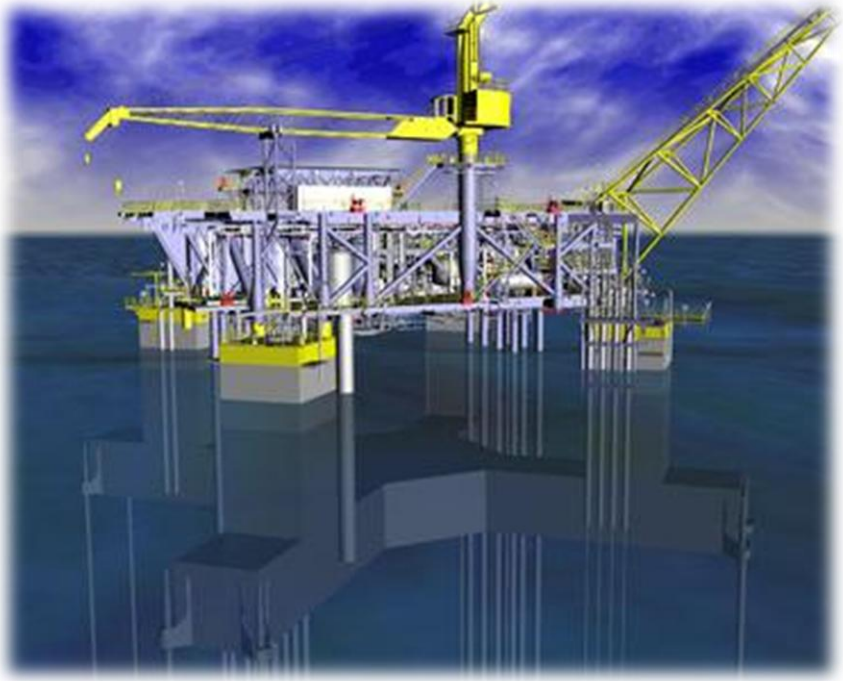
- Water depth dependent (< 3,000 feet)
- Weight increases as water depth increases
- Requires heavy lift Derrick Barge
- May require considerable offshore hook-up



Benguela Belize and Tombua Landana
Offshore West Africa

Advantages and Disadvantages Tension Leg Platforms (TLP)

Description: Floating Hull form held in place by Steel Tendons



Advantages:

- Can be installed in water depths up to 5,000 feet
- Can handle significant topsides weights
- Good motion characteristics
- Can support dry trees

Limitations:

- Tendon diameter increases with water depth and may not be as competitive over 4,500 feet of water depth

Advantages and Disadvantages Semi Submersible (SEMI) or Deep Draft Semi

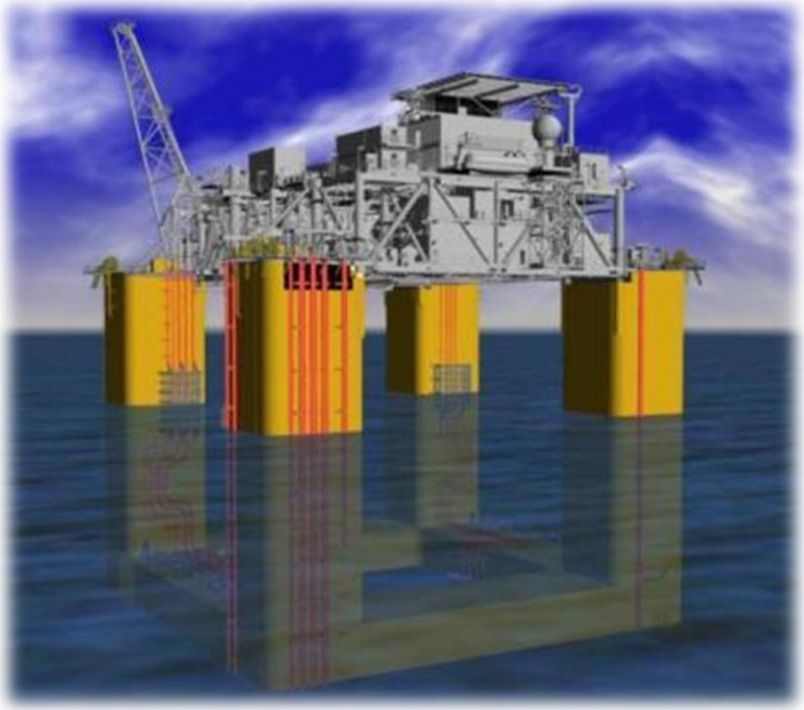
Description: Floating Hull form held in place by Steel or Polyester Moorings

Advantages:

- Good choice for wide range of water depths – 1,000 to 9,000 feet
- Can handle significant topsides weights
- Good motion characteristics
- Deep Draft Semi is a good choice for Marginal Fields
- Good solution for wet trees

Limitations:

- Hull motions in 5,000 feet or less could cause SCR fatigue issues
- Need to address motions if drilling operations are required

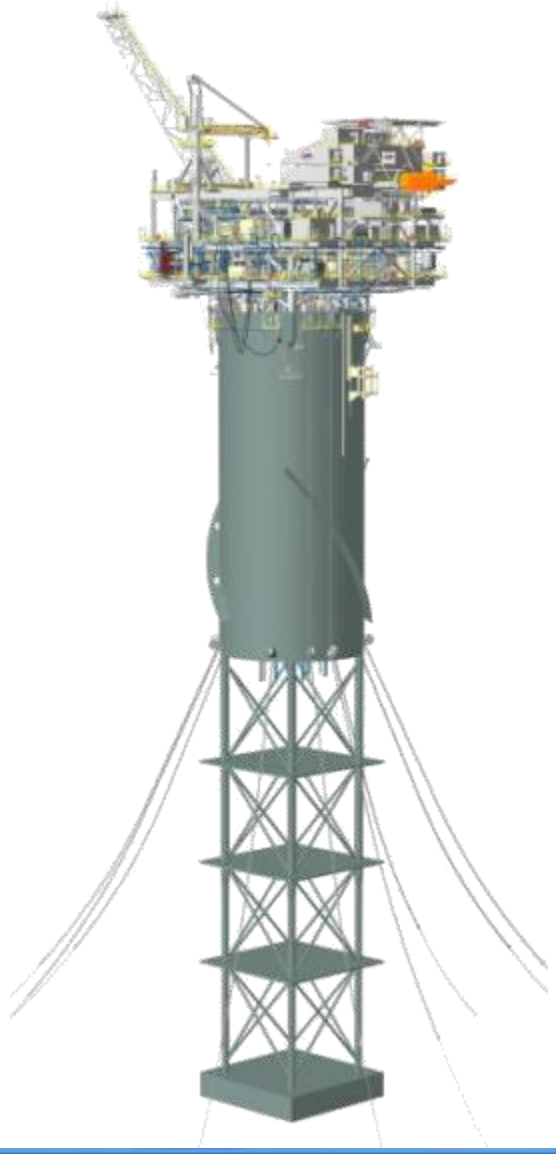


Blind Faith
Gulf of Mexico

Advantages and Disadvantages Truss Spar or Cell Spar

Description:

Floating Hull consisting of a single cylindrical construction at the top with steel truss sections at the bottom, or a Floating Hull consisting of multiple pipes or tubes. Both types of Spars can have steel or polyester moorings.



Advantages:

- Good choice for a wide range of water depths – 1,000 to 9,000 feet
- Can handle significant topsides weights
- Very good floating characteristics
- Good for drilling/workover operations
- Design allows use of Air Cans to support dry tree risers

Limitations:

- May be heavier than Semi's and TLPs depending on water depth
- Harder to install on site than Semi's and possibly TLPs depending on water depth

Key Technical Drivers for Selection

- Water Depth and Metocean Criteria
- Riser Options/Facility Motions
- Reservoir Characteristics
- Flow Assurance
- Drill Center Locations
- Drilling Plan
- Dry or Wet Trees
- Field Layout
- Market Conditions
- Contracting Strategy
- Owner Familiarity/Biases
- Topsides Payload
- Installation Plan
- CAPEX and OPEX Costs
- Risk Issues and Mitigating Measures

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Fixed or Floating Platform Selection Issues

Platform Configuration	Fixed Platform or CPT	TLP	Spar	Semisub	FPSO
Water Depth (ft)	0 – 2,500	Up to 5,000	No practical limit	No practical limit	No practical limit
Trees	Wet or Dry	Wet or Dry	Wet or Dry	Wet	Wet
Drilling/Workover	Yes	Yes	Yes	Yes	No
Storage	No	No	No	No	Yes
SCR	No constraint	No constraint	No constraint	Evaluate	Evaluate
TTRs	No constraint	No constraint	No constraint	No	No
Topside Integration	Offshore or floatover	Quayside or floatover	Offshore or floatover	Quayside	Quayside
Contracting Flexibility	Good	Good	Good	Better	Best
Hull/Structure Weight Sensitivity to Topside	Somewhat	More	Somewhat	Somewhat	Least

Dry Trees vs. Wet Trees Selection Issues

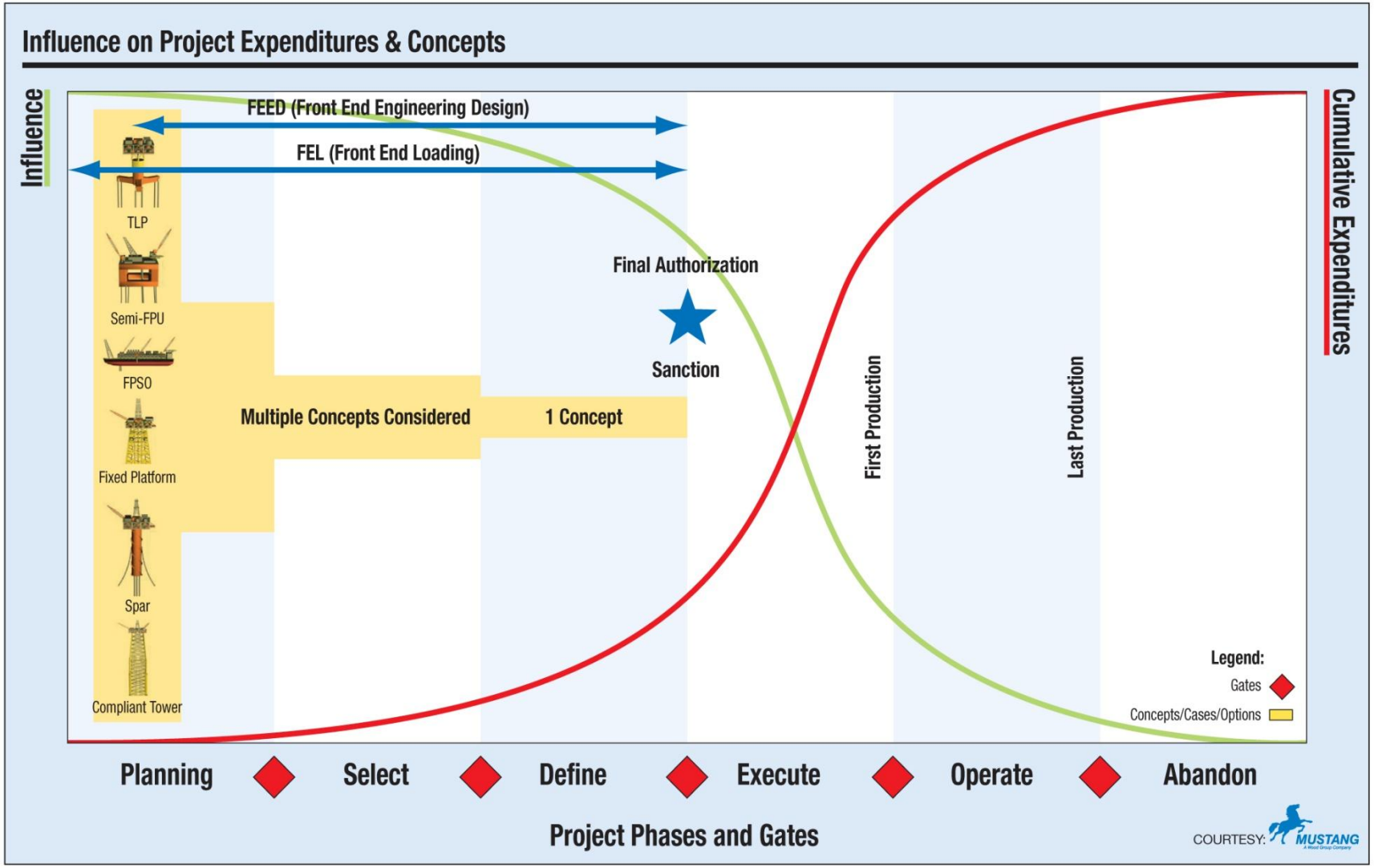
Wet Tree

- Multiple drill centers
- Lower CAPEX, but potentially higher OPEX
- Minimize drilling costs and risks for large area extent reservoirs
- Minimize project schedule
- Maximize development plan flexibility
- Maximize project economics for small developments
- More complex flow assurance issues

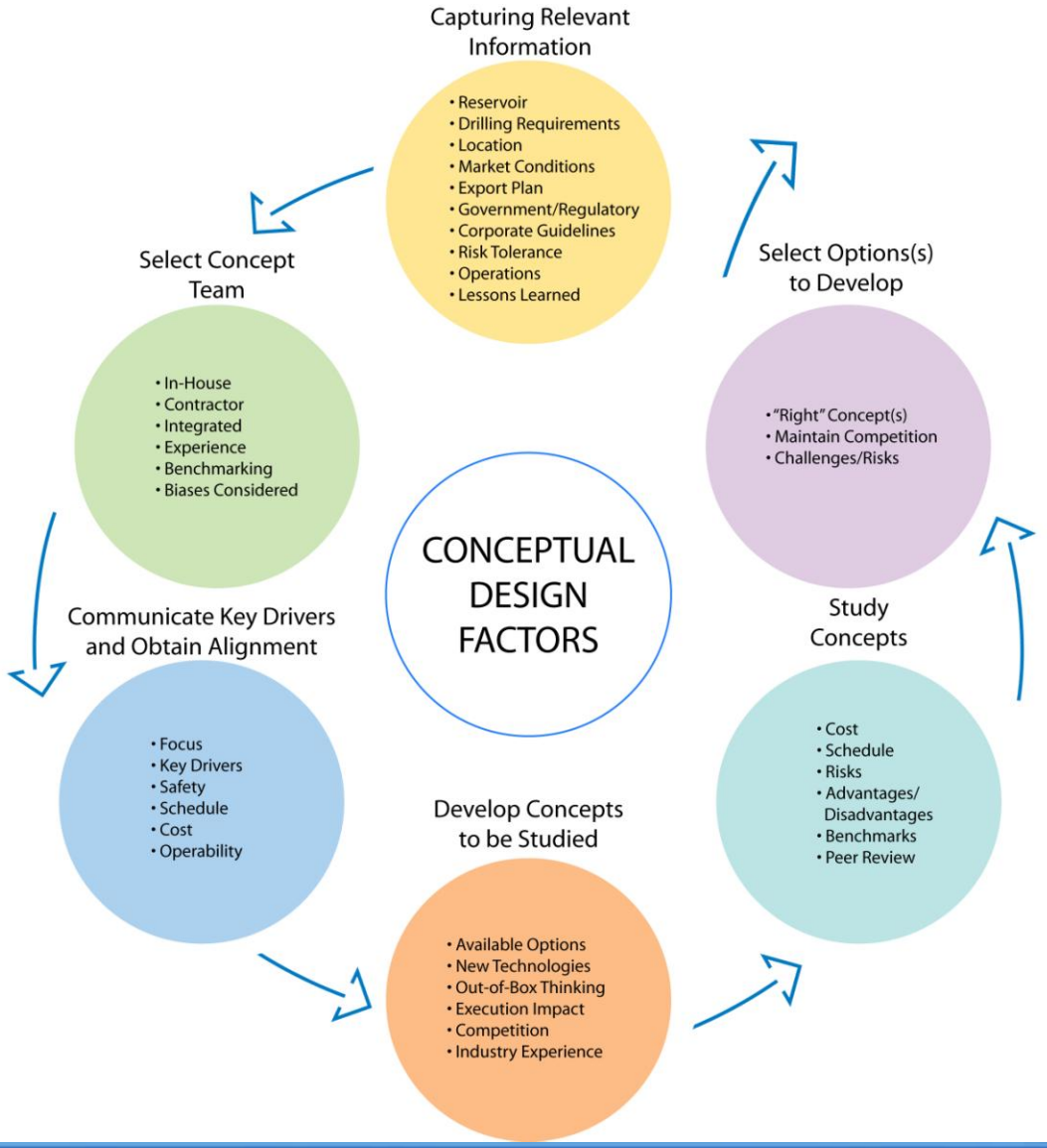
Dry Tree

- Single drill center
- Lower OPEX and life-cycle costs for medium and large developments
- Simpler hardware
- Minimize well intervention costs and downtime
- Less flow assurance risk
- Potentially higher recovery

Developing the Right Concept



Developing the Right Concept



Developing the Right Concept

Capture Relevant Information

- Reservoir
- Drilling Requirements
- Location
- Market Conditions
- Export Plan
- Government/Regulatory
- Corporate Guidelines
- Risk Tolerance
- Operations
- Lessons Learned

Developing the Right Concept

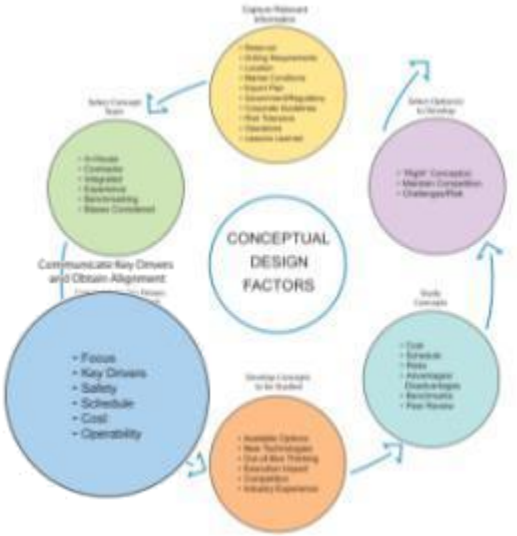
Select Concept Team

- In-House
- Contractor
- Integrated
- Experience
- Benchmarking
- Biases Considered

Developing the Right Concept

Communicate Key Drivers and Obtain Alignment

- Focus
- Key Drivers
- Safety
- Schedule
- Cost
- Operability



Developing the Right Concept

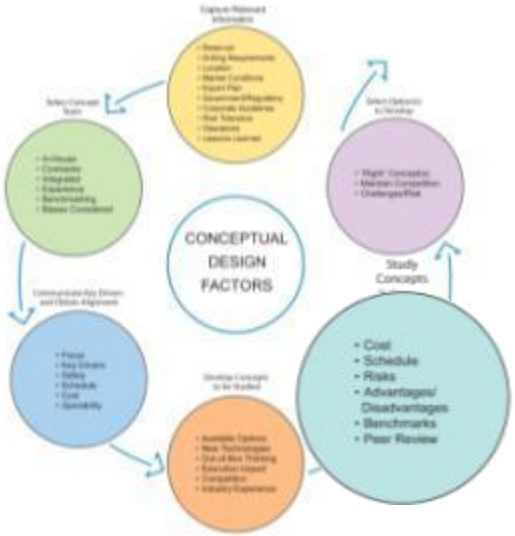
Develop Concepts to be Studied

- Available Options
- New Technologies
- Out-of-Box Thinking
- Execution Impact
- Competition
- Industry Experience

Developing the Right Concept

Study Concepts

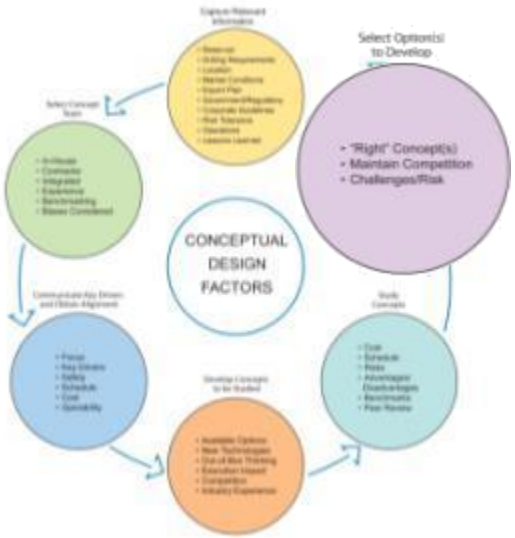
- Cost
- Schedule
- Risks
- Advantages/Disadvantages
- Benchmarks
- Peer Review



Developing the Right Concept

Select Option(s) to Develop

- “Right” Concept(s)
- Maintain Competition
- Challenges/Risk



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Summary

Selecting the Right Offshore Concept Involves:

- Understanding the reservoir and key parameters for the field
- Understanding the possibilities
- Good communication and alignment between all parties
- Integrated and experienced team
- Following the process even though we may immediately select the “right concept”

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Questions?

Thank you