Deepwater Oil & Gas Facilities

6th China-US OGIF, New Orleans, USA

June 28 – 29, 2005
2005年6月28日至29日

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Definitions of Deepwater

- Relative, change as technologies progress

- 10 Years ago
  - Deepwater: >300 meters

- Today
  - Deepwater: > 500 meters
  - Ultra-deepwater: > 1,500 meters

  - Production – dry tree: 1,710 m, Devils Tower Spar, GOM
  - Production – wet tree: 1,920 m, NaKika Semi, GOM
  - Drilling: 3,051 Meters, Toledo #1, GOM
Advances in Deep Water Production Capability

- 1950: Very shallow water depth
- 1960: Lightly increasing water depth
- 1970: Moderate increase in water depth
- 1980: Slight increase in water depth
- 1990: Significant increase in water depth
- 2000: Major increase in water depth
- 2010: Dramatic increase in water depth

Water Depth in Meters

- 0
- 200
- 400
- 600
- 800
- 1000
- 1200
- 1400
- 1600
- 1800
- 2000
- 2200
- 2400
- 2600
- 2800

Years:
- 1950
- 1960
- 1970
- 1980
- 1990
- 2000
- 2010

Water depth increased significantly from 2000 to 2010.
Deepwater Development Solutions

Solutions for Different Water Depths

- Conv. Fixed Jacket
- Compliant Tower
- TLP
- Semi-sub
- Spar
- FPSO

Water Depth (meter)
Deepwater Production Facilities – for Dry Trees

Compliant Tower  Tension Leg Platform (TLP)  Spar
Deepwater Production Facilities – for Wet Trees

Floating Production, Storage and Offloading (FPSO)

Semi-submersible (Semi)
Inputs to the FPSO vs. non-FPSO Decision

- Access to Pipeline Grid or shore
- Oil Export Site – Political or Economical factors
- Life of Field
- Dry Tree vs. Wet Tree
- Reservoir Development Plan
- Tolerance to Production Down Time
Factors in Choosing between Non-FPSO Solutions (Spars, Towers, TLPs, Semis)

- Water Depth
- Environment Conditions
- Initial vs. future Topside Weight
- No. of Risers
- Drilling Program
- Access to Wells: Wet vs. Dry
- Installation Capabilities
- Initial vs. Total Life Cycle Cost
Hybrid Solution – Obtaining the Benefits of both Types of Facilities

- TLP or Spar
  - Drilling
  - Dry Trees
  - Easy Intervention

and

- FPSO
  - Processing
  - Storage
  - Offloading
Compliant Tower

- **Design:**
  - Tower – Slender jacket
  - Compliant – designed to avoid resonance with large waves

- **Application** – most cost effective in 300 to 670 m.

- **Advantages:**
  - Dry tree
  - Robust relative to payload changes
  - Less steel tonnages required (in the above depth range)
  - Simpler, conventional fabrication
  - Installation flexibility

- **Disadvantages:**
  - Limited water depth range
Compliant Tower – Tallest Man Made Structure
Semi-submersible

- **Design** – vertical columns supporting topsides and supported on large pontoons, anchored to the seafloor with spread mooring lines.

- **Applicable W.D.** – 80 m to 2,500 m

- **Advantages:**
  - Large number of flexible risers possible
  - Quayside Topsides-hull integration

- **Disadvantages:**
  - Wet tree only
  - High maintenance cost
  - Fatigue motion – not friendly to risers
  - Sensitive to deck payload
Tension Leg Platform (TLP)

- **Design** — Similar to a semi-submersible but anchored to the seafloor with vertical tendons.

- **Application** - more cost effective from 600 m to 1,200 m

- **Advantages:**
  - Dry tree
  - Friendly to SCR
  - Quayside topsides-hull integration
  - Low maintenance cost

- **Disadvantages:**
  - Sensitive to deck payload change
  - Active hull system
  - Not friendly to offset drilling
  - Tendon fatigue
**Spar**

- **Design** – Large vertical column supporting topsides and connected below to the ballast tank with a truss section. A spread mooring system is used for station-keeping.

- **Application** – 550 m to 3,000 m

- **Advantages:**
  - Superior stability
  - Dry trees
  - Friendly to SCR
  - Accommodates payload changes
  - Friendly to offset drilling
  - Passive hull system
  - Low maintenance cost

- **Disadvantages:**
  - Topside lift at installation site
  - Large derrick barge required for topsides installation
Deepwater Technology Suppliers

- Compliant Tower
  - J. Ray McDermott
  - Wood Group

- TLP
  - J. Ray McDermott (JV with Keppel)
  - MODEC
  - SBM
  - Aker-Kvaerner

- Spar
  - J. Ray McDermott
  - Technip

- FPSO
  - Various

- Semi-submersible
  - Various
The Industry’s Deepwater Experience

- Compliant Tower – 3 each
- Spar – 13
- TLP – 21
- Semi (production type) – 43
- FPSO – 119
The Future

- Improved design tools – providing lower weight and less expensive hulls
- Improved hull shapes – greater motion stability and payload capacity
- Improved deepwater riser technology
- Synthetic mooring lines for ultra deep water
Conclusion

- China is proceeding with deepwater exploration
- Deepwater solutions are available for China’s O&G development plans, from 300 meters to 3000 meters
- Cooperation between China and the deepwater technology contractors makes good business sense

Thank You