OPERATIONS I

Temporary Production Facilities at West River Field with Dynamically Positioned FPSO, Munin

South China Sea

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Temporary Production Facilities at West River Field with Dynamically Positioned (DP) FPSO Munin, South China Sea by Hielke Brugts, Bluewater Energy Services
Topics

- Concept General Overview
- Dynamic Positioning (DP) Technical
- Maximize Availability
  - Dynamic Positioning (DP) Operations
  - DP Operation & Offloading
  - Solitons and Typhoons/Hurricanes
- Experience Summary, Future & Conclusion
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West River Field Layout

Existing submerged BTM Buoy with moorings and risers
**New** FPSO External Loading Structure and buoyancy tank

**New** Risers

**New** BTM outrigger + buoyancy tank

Existing submerged BTM Buoy with moorings and risers
External Loading Structure

New FPSO External Loading Structure

New FPSO Buoyancy Tank; to be lifted up out of the water by the outrigger of the ELS

New flexible risers coming from BTM

Concept General Overview
Concept General Overview

New FPSO outrigger and buoyancy tank

New Risers

New BTM outrigger + buoyancy tank

Existing submerged BTM Buoy with moorings and risers

New back chain
Existing BTM plus Adaptations

New buoyancy tank
New outrigger
Existing submerged BTM 30 metres below sea surface
New risers
New BTM Outrigger
Excursion Limits

Concept General Overview
Rotation around DP Setpoint
Offloading Frequency: 1x 5-6 days
Offtake tanker size: 35,000 – 150,000 DWT (200K bbls.-1M bbls.)
Concept General Overview

DP FPSO + Tanker + Tug
Some Key Figures

- FPSO Munin replaced temporarily (half a year) the field’s permanent FPSO

- FPSO Munin has 600,000 bbls. storage cap. = 100,000 DWT

- Production rate 70,000 bbls/day = 11,000 m³/day

- Water depth 100 m.
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- DP Class 2 Notation DNV-AUTR
- 3 Independent Position Reference Systems:
Reference Systems

Artemis

2 x DGPS

HPR

Base station on land
DP Class 2 Notation DNV-AUTR

3 Independent Position Reference Systems:
- 2 x DGPS
- HPR
- Artemis

4 Main Engines, 2 Engine Rooms, 2 Bow Thrusters, 2 Azimuth Thrusters, 1 Main Propeller driven by 2 Electro Motors
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Subsea Installation Assistance

in marginal weather FPSO “Munin” on DP providing lee to the “Fu Lai” installation vessel on DP, to deploy ROV
FPSO delivering clump weight to the installation vessel
FPSO as Crane Barge

FPSO moving in on DP to the installation vessel on DP to pick up and deploy a clump weight
Buoyancy Tank and Riser Pull-in
Dynamic Positioning (DP) Operations

- **Capability/Limitations**

  Set at Hs 5.5-6.5 m. based on:

  - DP Capability Plot diagrams, typical mono hull: limited athwart ship propulsion bow into the environment

  - Experience of personnel on similar sized DP vessels

- **No downtime due to weather**
Wave Distribution Oct-March

Wave distribution versus direction October-March (coming from)

- Distribution [%]
- Direction [-]

- nne: 80%
- ne: 15%
- ene: 10%
- e: 5%
- ese, se, sse, s, ssw, sw, wsw, w, wnw, nw, nnw: 0%
FPSO Heading 050°

Primary DP Setpoint

Outrigger

Hull

30m

40m

50m

3 m

6 m

Wave distribution versus direction October-March (coming from)

- n
- nne
- ne
- ene
- e
- ese
- se
- sse
- s
- ssw
- sw
- wsw
- w
- wnw
- nw
- nnw

5.6% = 10 days

5.6%
Precautions

- Optimized DP set point.
- 2 extra watch circles.
- Procedures:
  - Wind and Waves always on the port bow (on headings between W-N-NE-E-SE) during DP position keeping.

  Resulting in:
  - Vessel “loses” heading to starboard → hull moving away from risers.
DP Operations on NW'ly headings

FPSO Heading 050º

Buoyancy Tank Neutral Position

Primary DP Setpoint

20m

30m

40m

50m
Optimized DP Setpoint

Advantages DP set point to the NE:

- Largest clearance for risers in all circumstances during NE monsoon.

- No need to change DP set point for the various headings during the NE monsoon → reduced risk of operator error.
Optimized DP set point.
2 extra watch circles.

Procedures:
- Wind and Waves always on the port bow (on headings between W-N-NE-E-SE) during DP position keeping.

Resulting in:
Vessel “loses” heading to starboard → hull moving away from risers.
DP Control Display

DP Operations on NW'ly headings
Precautions

- Optimized DP set point.
- 2 extra watch circles.
- Procedures:
  - Wind and Waves always on the port bow (on headings between W-N-NE-E-SE) during DP position keeping.
  
  Resulting in:
  
  Vessel “loses” heading to starboard → hull moving away from risers.
Additional Measures

- Bilge keel removed in the risers/chain area of the hull.

- Protection around risers and around chain, so risers may on an occasional basis touch.

- EMERGENCY DISCONNECT FEATURE.
Emergency response -
40 metres: quick disconnect!

Manually activated with
pushbutton at DP desk.
Main Prop Protection

- Extra feature in DP to select “loading mode” (main propeller cannot run astern)

- Outriggers on SB side to hang of offloading hose (Bft 4 and less)
Main Prop Protection

- Two Outriggers on SB side
Main Prop Protection

- Extra buoyancy in first couple of hose sections
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DP Operation & Offloading

- General Procedure
- Offloading/Hawser Load Tests
- Full Mission Bridge Simulations
- Emergency Response
  - Offloading ESD
  - Quick disconnect risers

Maximize Availability
DP Operation & Offloading

- General Procedure
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General Procedure

DP Operation & Offloading
General Procedure
Weather limits : 2.5-3.5 mHs (irrespective whether DP or non-DP FPSO)
Limits (irrespective whether DP or non-DP FPSO)
Weather : 3.5-4.5 mHs
Hawser load : 3 x >150 t in 60 min.
- General Procedure
- Offloading/Hawser Load Tests
- Full Mission Bridge Simulations
- Emergency Response
  - Offloading ESD
  - Quick disconnect risers
Offloading/ Hawser Load Tests

- Tug @ stern of FPSO
- Change load in force & direction

Purpose:

- Response of DP system’s software (hawser load feed forward interface)
- Validation of computer simulations
DP Operation & Offloading

- General Procedure
- Offloading/Hawser Load Tests
- Full Mission Bridge Simulations
- Emergency Response
  - Offloading ESD
  - Quick disconnect risers
Bridge Simulations

- Multi body simulations:
  - FPSO on DP
  - Offloading Tanker
  - Tug

- Familiarize & Training of:
  - FPSO OIM & DPO
  - Mooring Master
  - Tug Masters

- Response to emergency scenario’s
DP Operation & Offloading

- General Procedure
- Full Mission Bridge Simulations
- Offloading/Hawser Load Tests
- Emergency Response
  - Offloading ESD
  - Quick disconnect risers

Maximize Availability
Offloading Emergency Response
■ Offloading ESD

- ESD 1 =
  Shutdown of offloading pumps +
  Closing offloading valve

- ESD 2 =
  ESD 1 +
  Quick disconnect of hose +
  Quick disconnect of hawser
Quick Disconnect of Risers & Offloading ESD
- Excursion > 40 m of FPSO
- Blackout of FPSO

Tug pulls away offtake tanker

Blackout procedures for various scenarios & recovery situations
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Solitons and Typhoons

Solitons
Soliton Response
Soliton Response
Soliton Response

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Typhoons/ Hurricanes

- Usual typhoon alert system in place
- Experienced one typhoon in Dec 2004; did not have to disconnect (experienced Hs 4.5 m)
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Results after 150 days of operation on full DP:

- Cumulative Production = 11,000,000 bbls of oil
- Average production 73-74,000 bbls/day
- Number of offloadings = 27
- Uptime = 99%
Experience Summary

- Actual DP performance is better than earlier expected.

- Experienced weather during the operations: 15 - 40 knots wind, 1.5 - 4.5 m significant wave height.

- Position Deviation
  - Normally within 1 m from wanted setpoint.
  - Up to 2 m during regular operation.
  - Max. up to 5 m during rapid heading changes.
Experience Summary, Offloading

- Offloading every 5-6 days

- Position deviation:
  - Normally within 1 m from wanted set point (hawser load feed forward into DP working as intended)
  - Up to 5 m with large offtake tankers of 150,000 DWT (1 Mbbls).
Experience Summary, Offloading

- Interaction between the FPSO and the offtake tanker have turned out to be less than expected.
Experience Summary, Offloading

- Normal hawser pull 20 tons
  - maximum values up to 50 tons (on one occasion 150t).

- Heading deviation: with a tanker connected on the stern, the heading stability is even better than in regular operation.
Future

- In deep water further pro’s

  - No cost ‘sunk’ in mooring system

  - Less tight station keeping requirements (prod. risers are more compliant than drilling risers)

  - Less impairment of seafloor
Future

More marginal fields
More deepwater fields
Higher (relative) cost for mooring systems

DP is a viable option
Conclusions

- This project proved flexibility of the DP FPSO concept in general
- DP FPSO concept is reliable and safe
- DP position keeping of the FPSO while offloading to conventional tankers is working very well
Conclusions cont.

- DP FPSO can be used as a “platform” to execute sub sea installation work.

- Ability to escape from hurricanes and reconnect.

- Production operations on DP are an evolution from existing technology.

- DP FPSOs are especially interesting as temporary and/or early field production facilities and/or deep water developments.
QUESTIONS?

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