

# Operability Study for DP Vessel Operations at a Deep water Spar-A Decision Support Tool

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# OBJECTIVE OF THE STUDY

- Consider the requirements of the vessel to operate within the established ASOG
- Qualify and identify the DP control accuracy for various environmental conditions
- Provide practical guidance in execution planning to operational and project teams

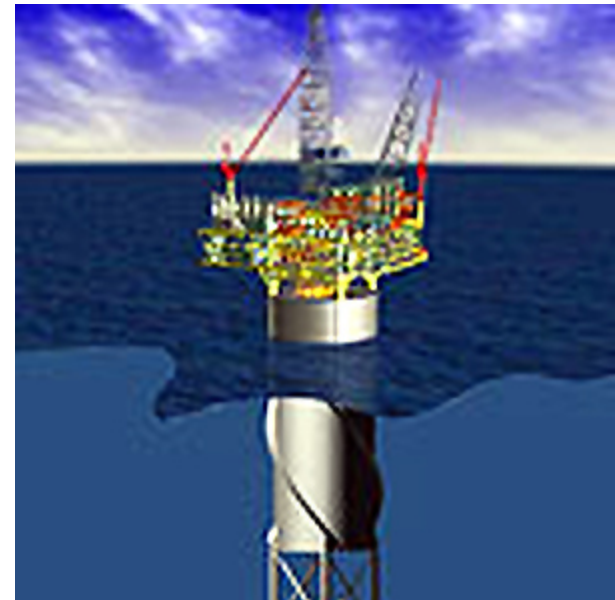
# Approach and Iterative Process

- Project variables and ASOG
- Dynamic coupled Motion Analysis of the two bodies
  - Calculate the hydrodynamic and response parameters of the DP vessel and Spar
  - Obtain time series of relative motions between the DP vessel and Spar
- Use DP Simulator to quantify the DP control accuracy for various environmental Conditions
- Calculate operability

# Contents

- Environmental Conditions
- Bridge Connected Criteria
- Availability Calculation Procedure
- DP Simulator Results
- Conclusions

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# Service Vessel

- The DP vessel is a multi Purpose Service Vessel, of 131.7 m in length, 22.0 m in width.
- Two fixed pitch, Z type, converter driven, variable speed, azimuth thrusters aft, each rated at 3000kW.
- Two CPP, constant speed tunnel thrusters are fitted forward, each rated at 1335kW
- One CPP, constant speed retractable azimuth thruster fitted forward, rated at 1200 kW

# DP Control System

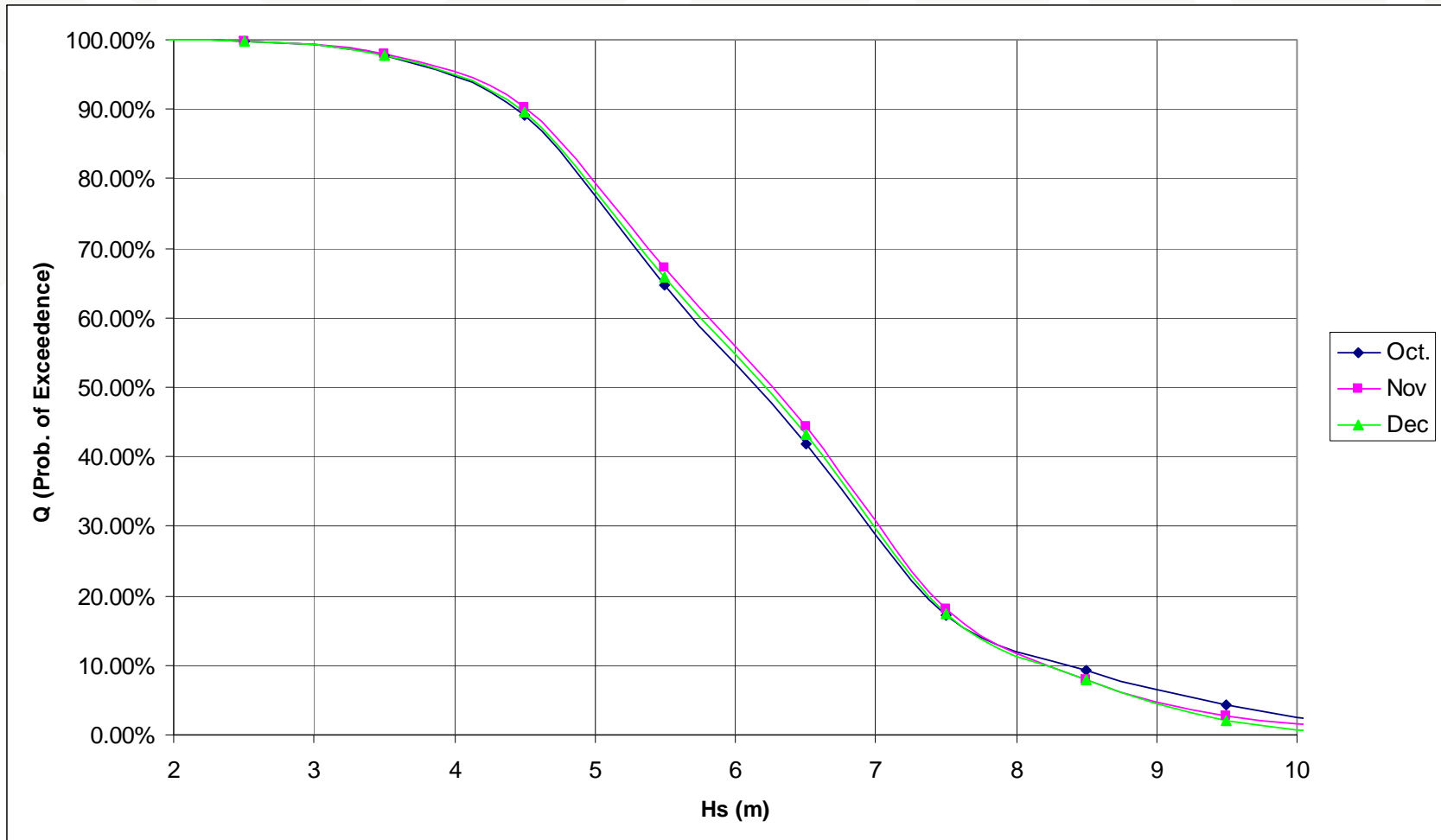
DP System is Kongsberg K-POS DP2 System

- “Follow Target” Operational Mode
- A mixture of absolute and relative position reference system
  - Absolute system for vessel positioning
  - Relative for automatic update of setpoints

# Spar

- A large-diameter, single vertical cylinder supporting a deck
- Moored to seafloor with chains and polyester ropes
- Ultra deep water

# Environmental Conditions



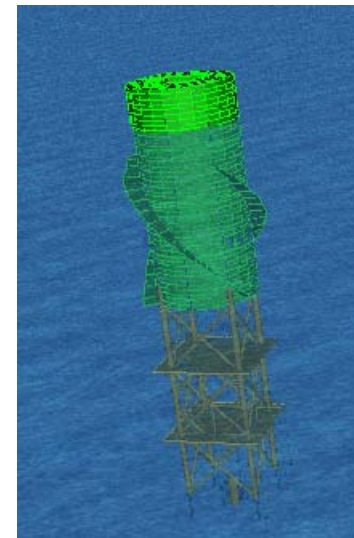
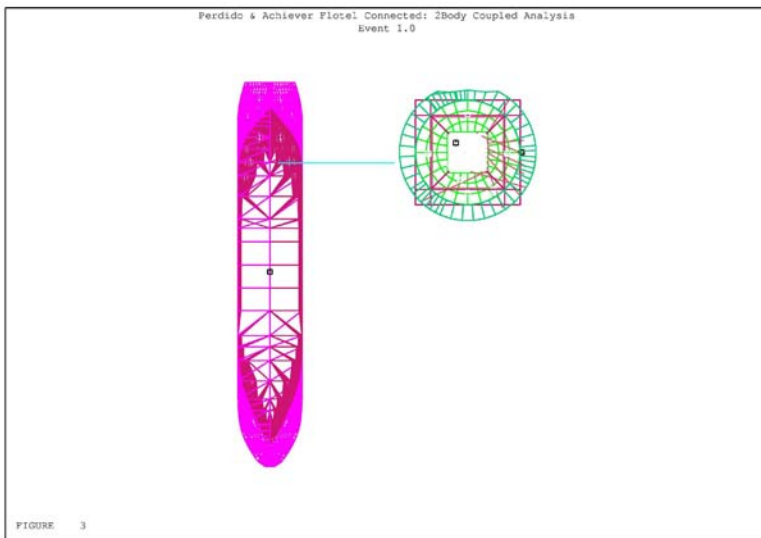
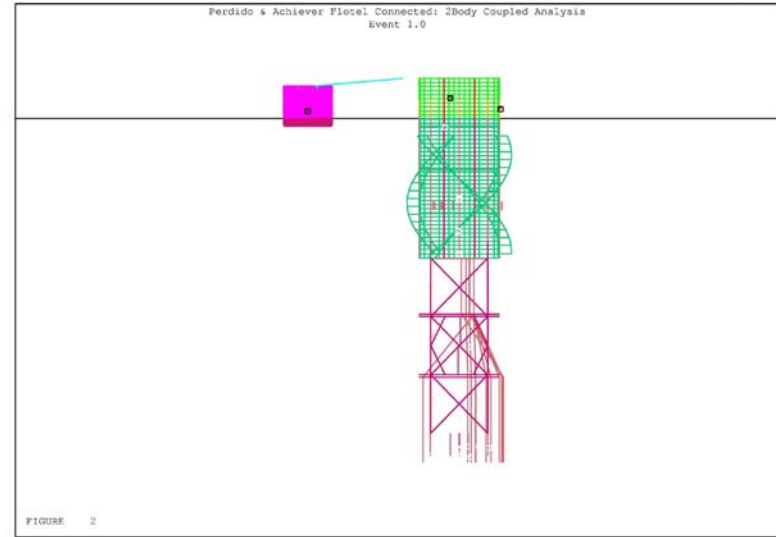
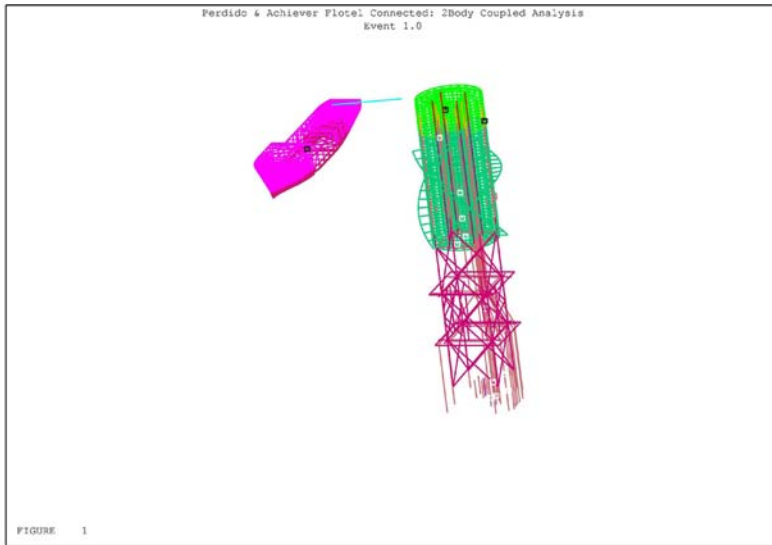


# Operating Criteria

The decision to disconnect the gangway is made when:

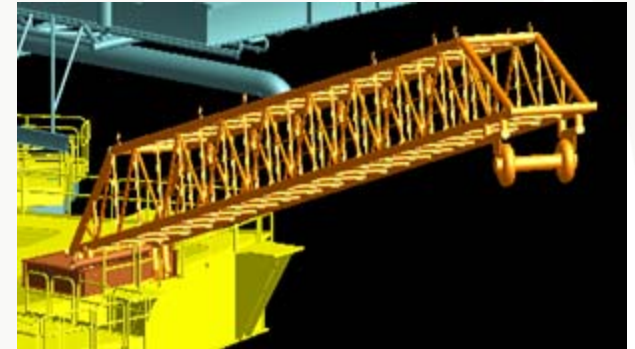
- The gangway predicted motion is beyond the acceptable limits of the landing area on the DP vessel. The limits were predetermined and included in the ASOG granting warning conditions for the operational status.
- The Thruster capacity reached a pre-determined value indicated in the ASOG. These values were calculated using this operational study report and each particular thruster capacity and their combination. This value considered the worst case scenario of loosing power or thruster failure.

# Coupled two-body system



## Bridge Details

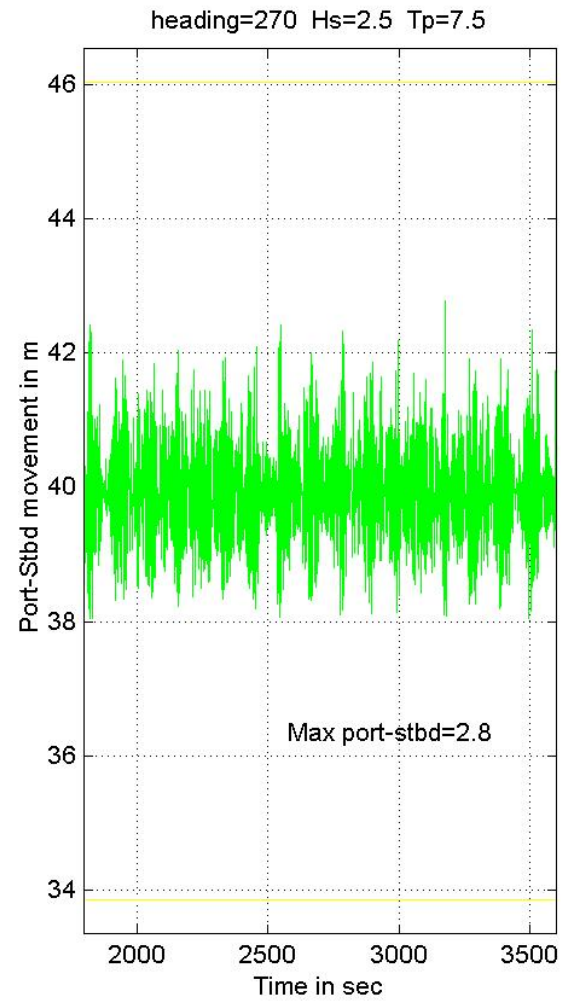
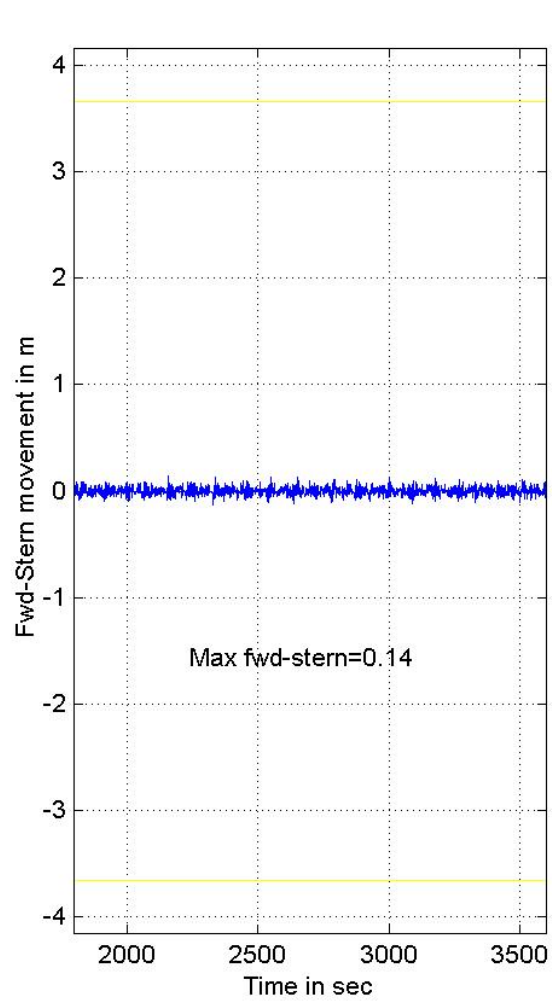
- Gangway Length is 40m
- Gangway originates from the main deck of the spar
- The gangway's wheels will roll across deck of the DP Vessel
- The approximate landing area on the vessel is 12mx7m



## Methodology for Gangway Availability Calculation

- Extract the maximum acceptable environmental condition of the vessel according to the thrust utilization and the relative positioning performance.
- Apply the percentage of occurrence for that maximum acceptable environmental following the wave scatter diagrams
- Sum up the percentage of occurrence for each environmental quadrant.
- Combine the percentages of the eight environmental quadrants to obtain the total percentage of operability.

# MOSES Simulation, Beam Sea (First Guess of the maximum allowable)

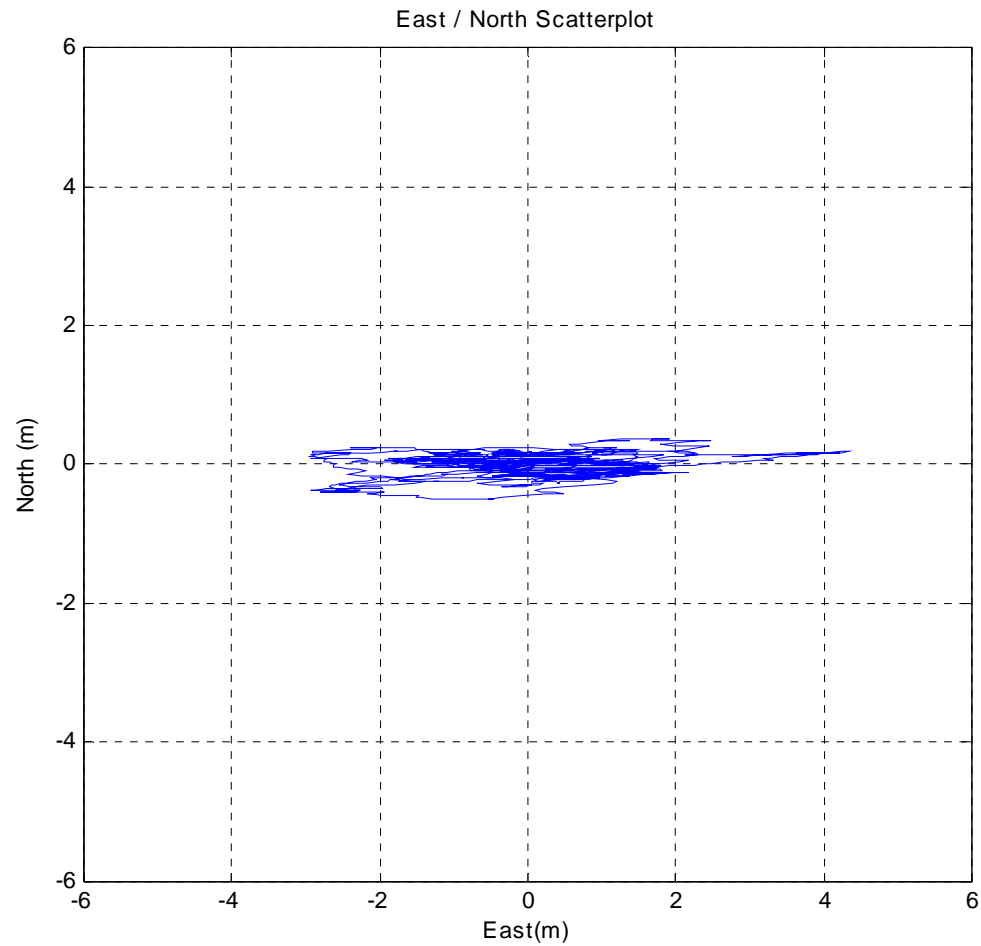


# Environmental Parameters for DP Simulation Cases

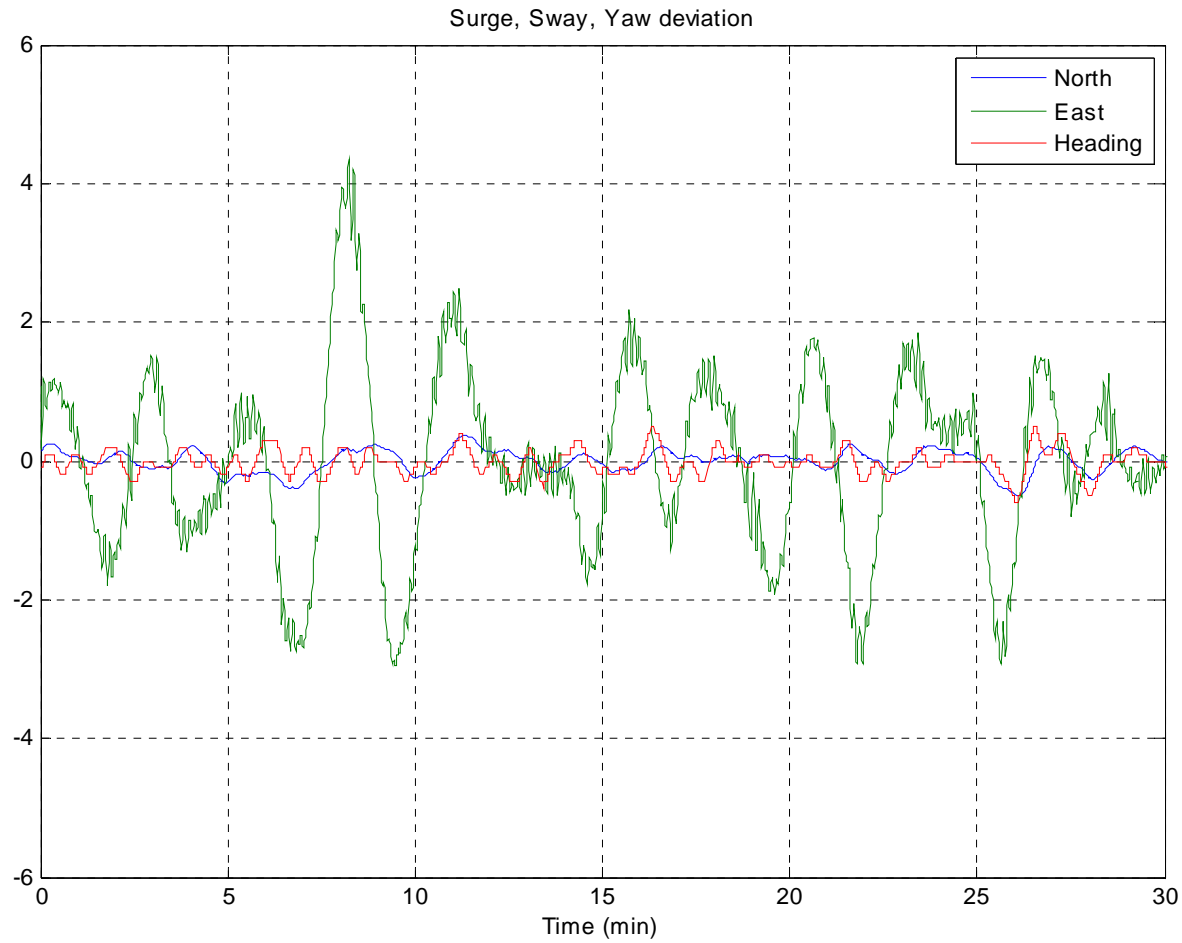
- **Waves**
  - Jonswap Wave spectrum with Gamma 2.0, Wave height and Wave period varied according to table to the right.
- **Wind speed**
  - 17 m/s (API Wind spectrum) or 13 m/s
- **Sea Current**
  - 0.35 m/s.

Case	Wind (m/s)	Wave H <sub>s</sub> (m)	Wave T <sub>p</sub> (s)	Direction
1	17	3.25	6.5	Head
2	17	3.25	10.5	Head
3	17	3.25	14.5	Head
4	17	3.25	6.5	Quartering
5	17	3.25	10.5	Quartering
6	17	3.25	14.5	Quartering
7	17	3.25	6.5	Beam
8	17	3.25	10.5	Beam
9	17	3.25	14.5	Beam
10	17	3.25	7.5	Head
11	13	2.5	7.5	Quartering
12	13	2.5	7.5	Beam

# Case 12, Beam Sea, Scatter Plot

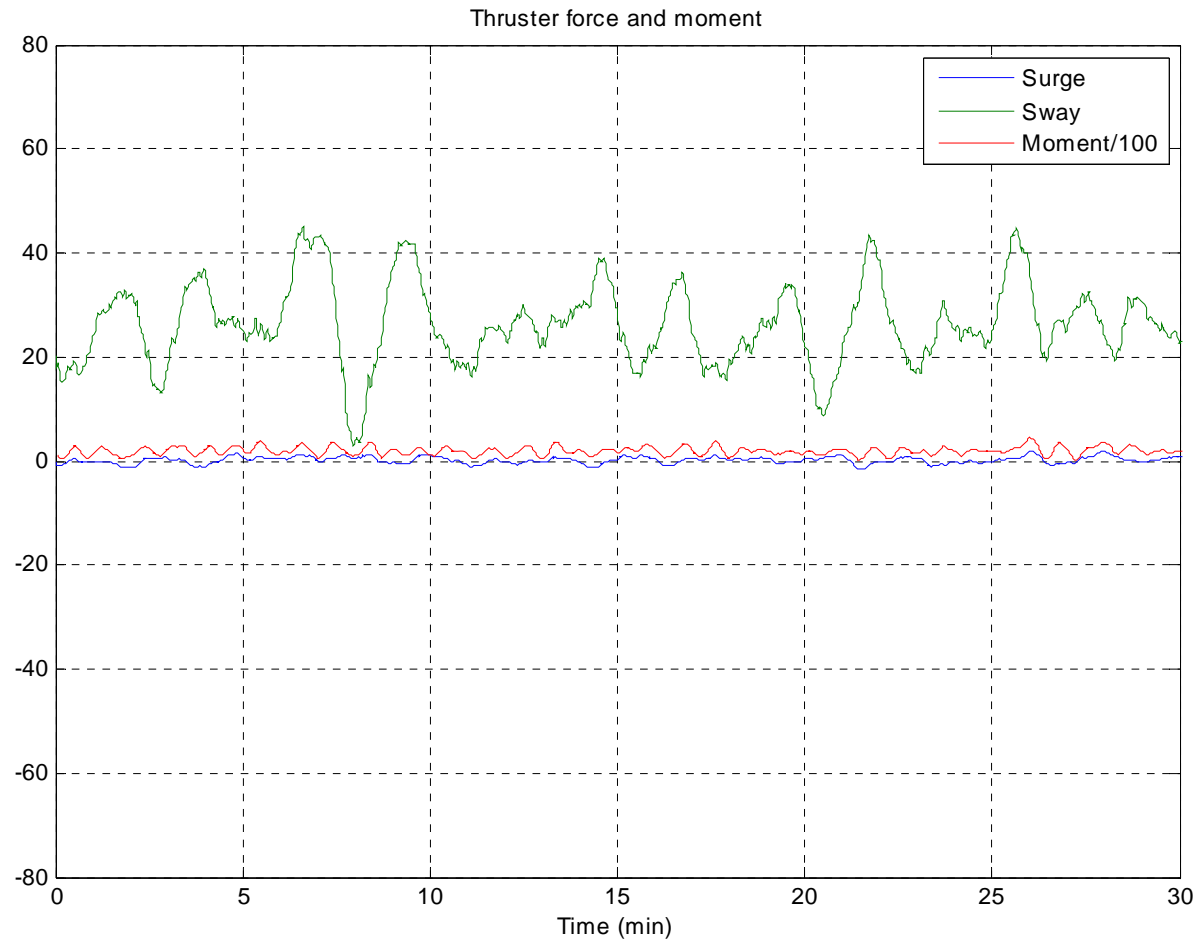


# Vessel Motion

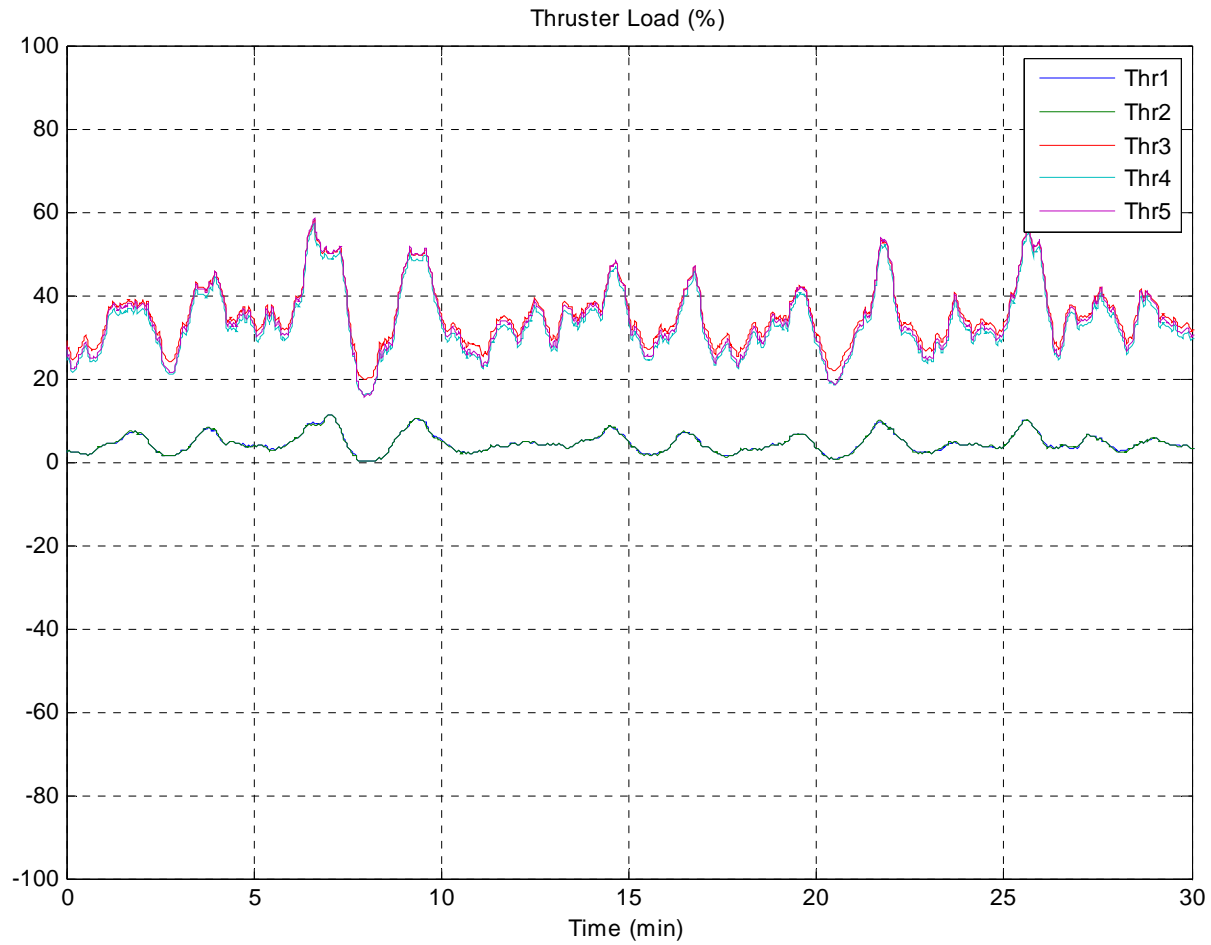




# Thruster force and moment



# Thruster Load



# Kongsberg Simulation Results

Case	Wind (m/s)	Wave H <sub>s</sub> (m)	Wave T <sub>p</sub> (s)	Direction	Position Criterion	Dev <sup>3</sup> (m)	Load Criterion	Load <sup>4</sup> (%)	Thr Nr.
1	17	3.25	6.5	Head	Not OK	4.4 x	OK	23	3
2	17	3.25	10.5	Head	OK	3.6 x	OK	22	3
3	17	3.25	14.5	Head	Marginal	3.9 x	OK	22	3
4	17	3.25	6.5	Quartering	Not OK	8.0 x	Not OK	68	3
5	17	3.25	10.5	Quartering	OK	2.8 x	OK	46	3
6	17	3.25	14.5	Quartering	OK	3.5 x	OK	42	3
7	17	3.25	6.5	Beam	Not OK	8.0 y	Not OK	81	5
8	17	3.25	10.5	Beam	Marginal	6.4 y	Not OK	60	5
9	17	3.25	14.5	Beam	OK	3.5 y	Marginal	57	5
10	17	3.25	7.5	Head	OK	2.5 x	OK	22	3
11	13	2.5	7.5	Quartering	OK	1.6 y	OK	31	3
12	13	2.5	7.5	Beam	OK	4.3 y	OK	35	3

# Conclusions

- This operability study is a tool that can be used in conjunction with the ASOG process to support the project team decision making process of when the DP vessel should be disconnected and safely moved away from the platform
- The wind load is the dominating force for the initial quartering and beam sea simulations.
- Allowable weather is 17 m/s wind speed, 0.35 m/s current and 3.25m of significant wave height for head seas
- For quartering and beam seas, the thruster load criterion is fulfilled by reducing wind speed to 13 m/s and wave height to 2.5 m
- The operabilities for gangway connected condition for a DP vessel at this site are approximately:
  - 93.4% for October
  - 93.2% for November
  - 91.7% for December

Thank you for your attention!

## Comments or Questions?

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