Design

Model Tests for the DP System of a Drilling Semi-Submersible

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Sugar Land, TX.

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Presentation Outline:

- Project Overview
- Objectives
- Semi-Submersible Parameters
- Theoretical Background
- Test Set-Up and Results
- Discussion of Results
- Challenges and Lessons Learned

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➢ Project Overview

- Outfitting an existing Drilling Semi-Submersible with a DP-3 class system

- Semi-Submersible is currently in Shipyard

Objectives

Model Test and Numerical Predictions were Performed to :

- Ensure that DP system will perform as planned.
- Satisfy clients requirements.
- Cross check numerical model vs. physical tests
- Comply with common industry practice

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Semi-Submersible Particulars

Pontoon length	105.00 m
Pontoon width	16.00 m
Pontoon height	12.25 m
Pontoon spacing C-C	55.00 m
Corner Column dimensions	13.6 x 14.6 m
Middle Column dimensions	11.6 x 14.6 m
Column spacing C-C longitudinally	33.50 m
Column spacing C-C transversely	55.00 m
Height to main deck	38.25 m
Height to machinery deck	37.25 m
Transit Displacement	38,137 tones
Operating Displacement	58,000 tones

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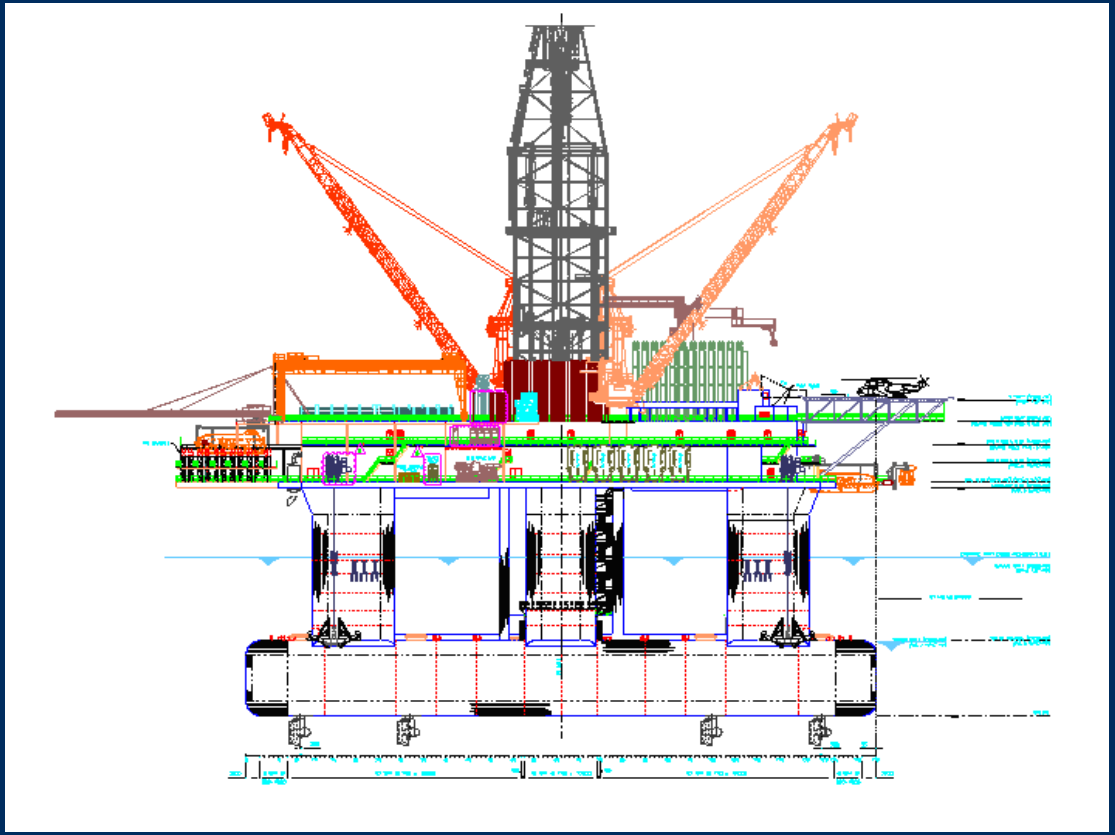
➢ Semi-Submersible Particulars (continued)

- General Arrangements, Elevation



- Thrusters Type: Rolls-Royce UUC 355 FP
  - Diameter = 3.5 m
  - Motor Speed = 720 rpm
  - Power = 3750 kW
  - Thrust = 646 kN

- Control System and Software by Converteam (previously Alstom).

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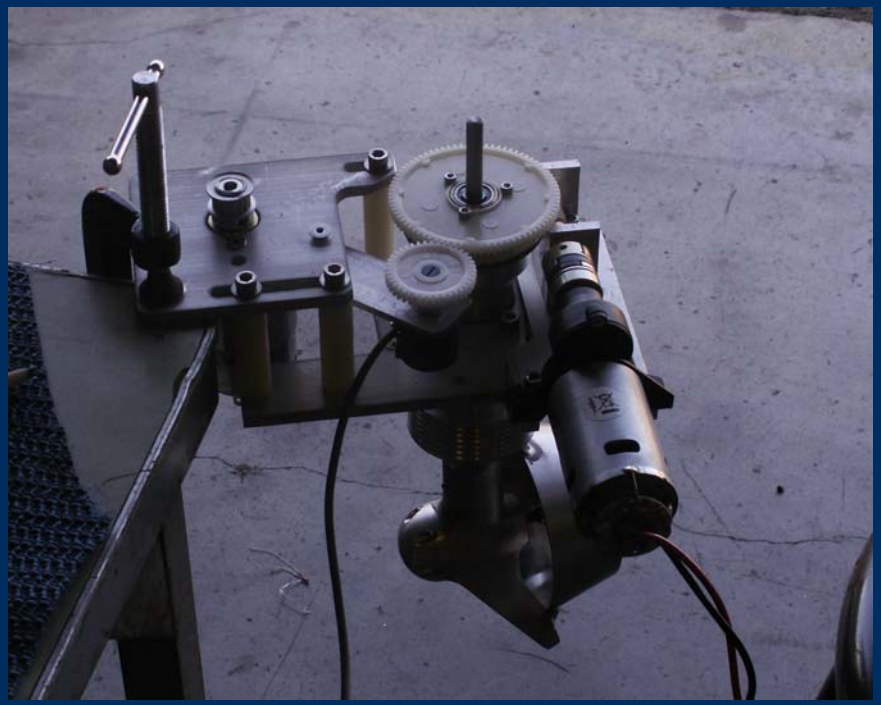
- Model thrusters (8 replicas) were used to represent prototype thrusters.

- Nautronix NMS6000 DPS control system and software was used for the model test to simulate prototype DPS.

- NMS6000 was modified to operate in model test environment at the scale factor chosen.

– $\lambda = 1{:}50$ to meet facility limitations and match model scale.



Thruster Check Outside the Model

Thruster assembly inside the model

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- DPS Control Screen Layout:

Requested Forces %	Jstk	Wind	Curr	Envr	Ctrl	CutBk	Total Forces % Reqst	Achvd
F / A	0	0	0	63	-36	0	27	30
P / S	0	0	0	-40	19	0	-20	-31
Yaw	0	0	0	-20	-4	0	-25	-46

Position	+N / S-	+E / W-	+F / A-	+S / P-
Goal	0.00	0.00	0.00	0.00
Setpoint	0.00	0.00	0.00	0.00
Vessel	0.17	-0.19	0.22	-0.14
Error	0.17	-0.19	0.21	-0.14

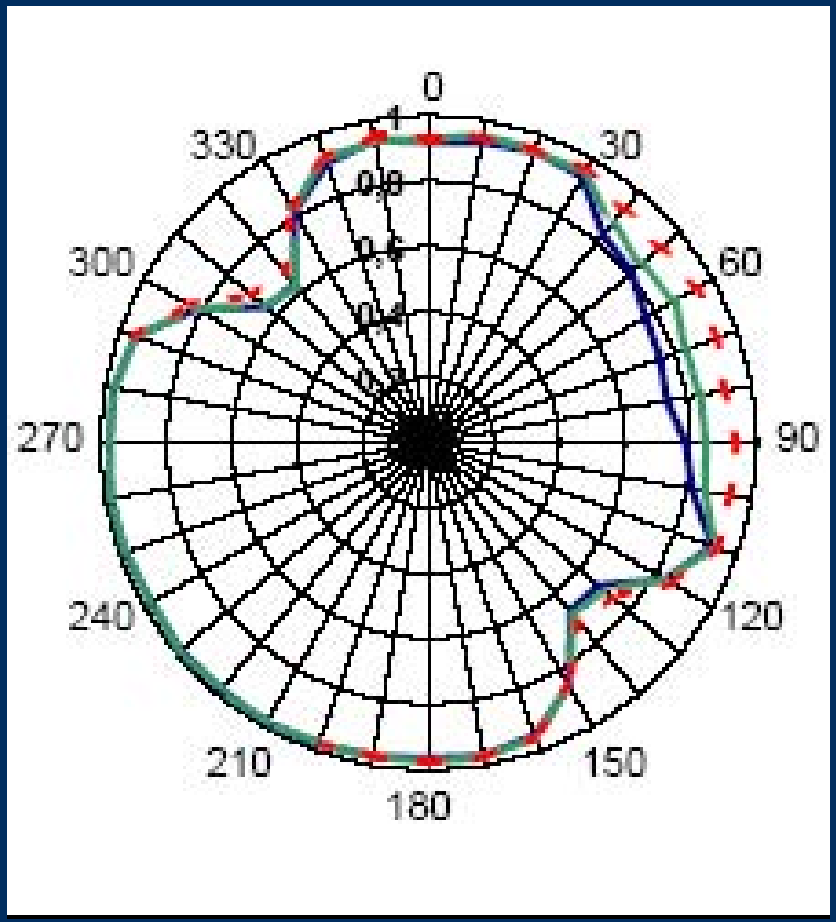
- Environmental Conditions:

Environment	Wave		Current	Wind
	Hs (m)	Tp (sec)	knots	Knots
10-yr GoM WS	4.9	10.5	1.6	48
1-Yr Brazil	5.7	13.7	3.1	38

➢Theoretical Background

- Typical Thrust losses in DP system occur due to thruster-hull interactions and thruster-thruster interactions.
- Thruster-hull interactions depend on design, dimensions, hull shape, draft, etc.
- Thrust losses in a twin hull DP semi-submersible can reach up to 40-50% if the jet from one thruster is directed to the opposite hull.
- Frictional losses and Coanda effect have a large contribution on the performance of any DP system.
- These losses can be reduced if the thrust jet is directed away from the hull and other thrusters.

- Effect of Tilting Thruster (or Nozzle) on Thruster Efficiency:



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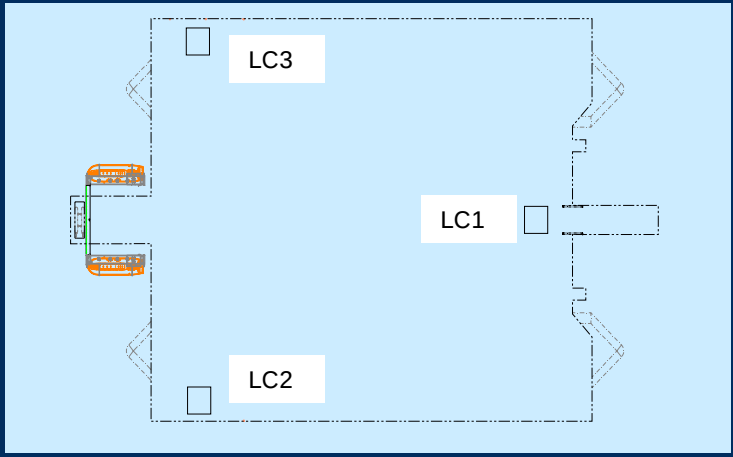
➢ Test Set-Up and Results

- Calibration and Interaction Tests



Three sets of dual-axis load cells were used to measure thrust forces during thruster-hull and thruster-thruster interaction tests.

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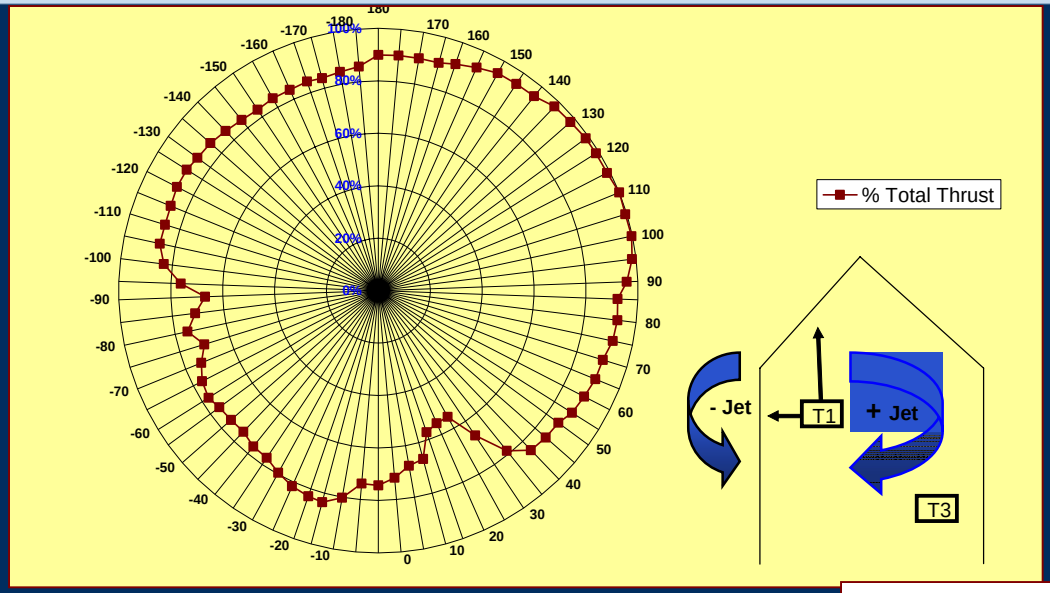
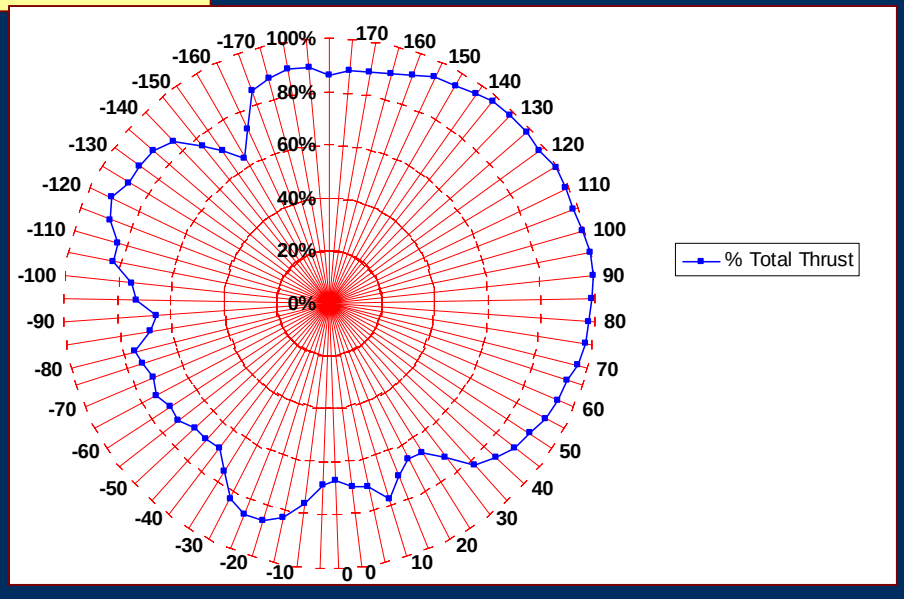
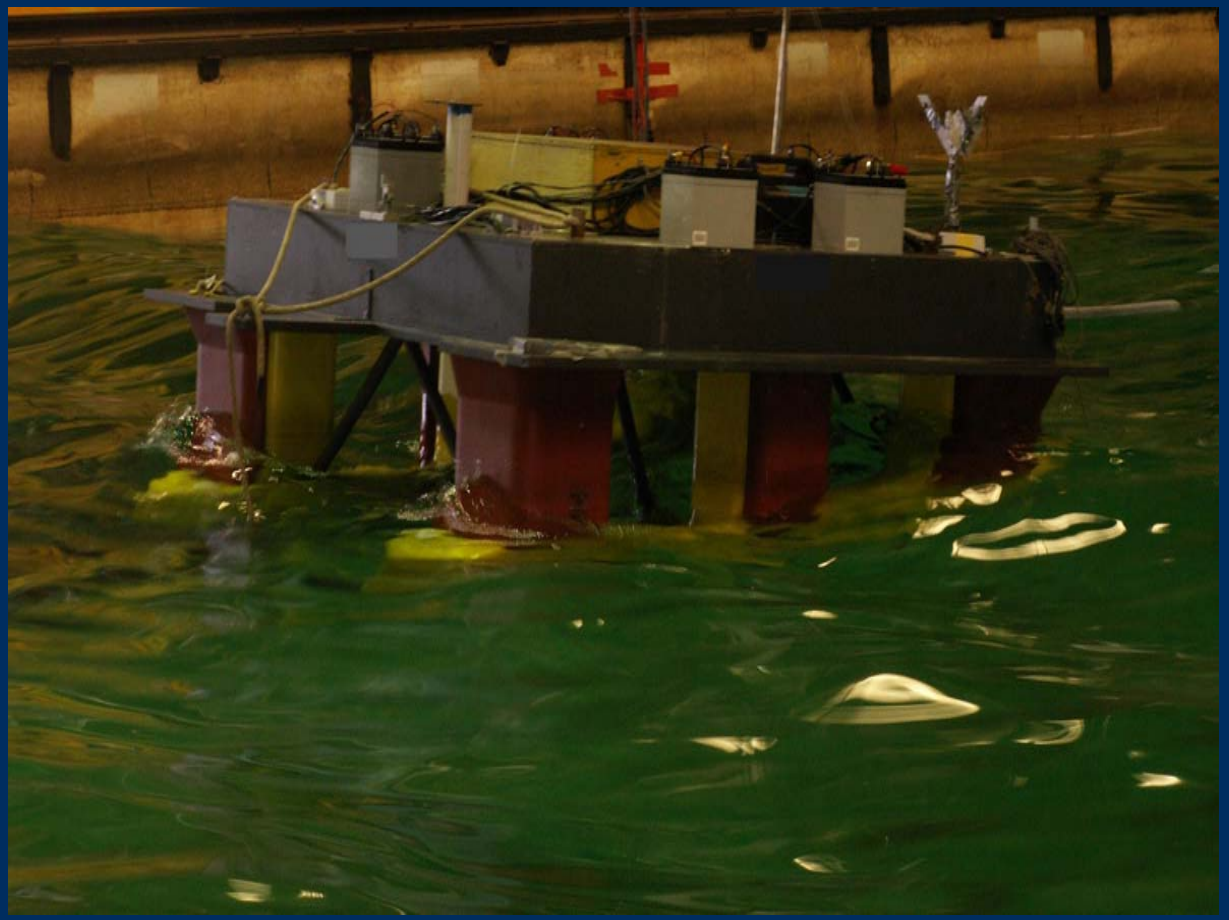


One Thruster Operating (T1)

Two Thrusters Operating (T1 & T3)



- Sea-Keeping Tests



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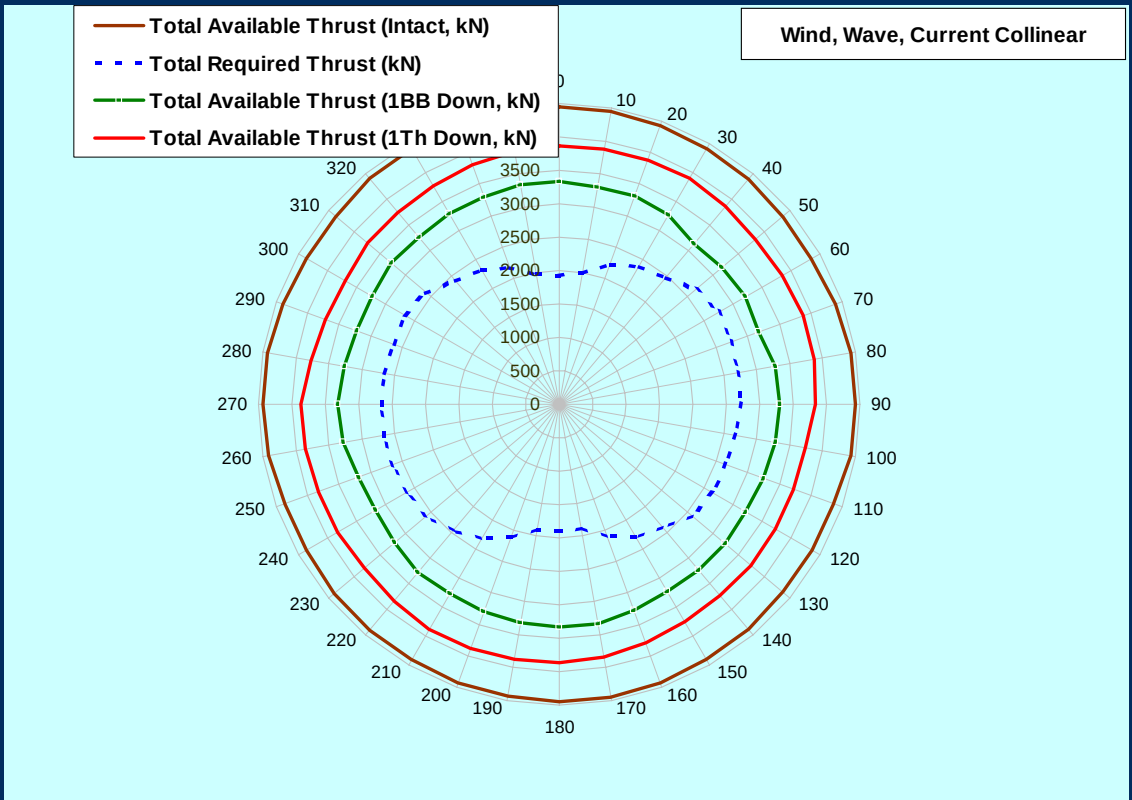
-Numerical Predictions:

GoM 10-Yr Winter Storm

Hs =4.9m , Tp = 10.5s

Wind = 48 knots, Current = 1.6 knots



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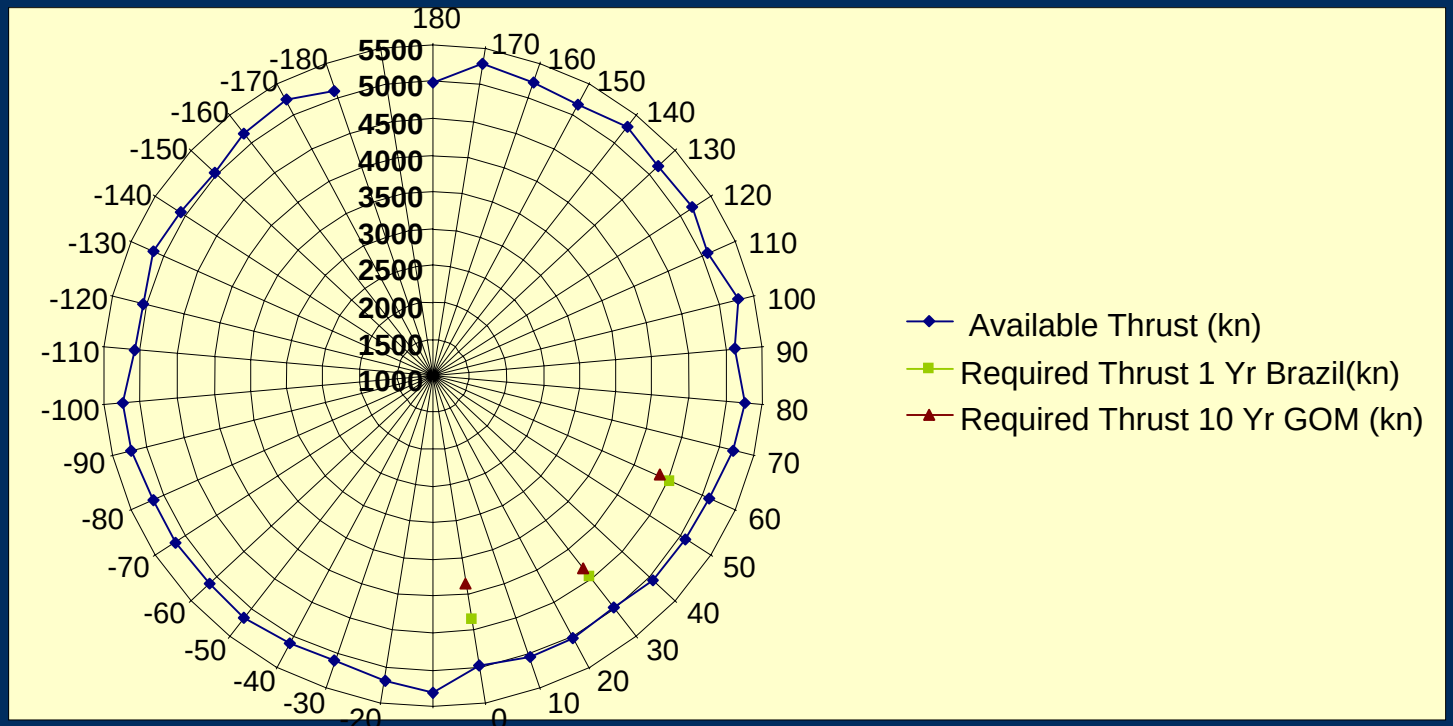
-Model Test:

Tests were conducted at four headings

Wind, Waves and Current are collinear

All thrusters operating

Output from Motion Measurement device is used as position indicator



➢ Discussion of Results

1. Both numerical predictions and model test show available thrust is greater than required thrust.
2. Difference between numerical predictions and actual measurements can be attributed to estimation of percentage losses.
3. Model test limitations and large scale factor may also affect the test results.

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➢ Challenges and Lessons Learned

- Interaction tests and propulsion tests are usually carried on large models (small scale factor). These scale factors are usually between 1:25 to 1:30. Model testing facility limitations may dictate the model size.
- Previous tests have shown that tilting the thrusters reduces losses and hull effects by about 15 to 20%. After the test, it was decided to use tilted thrusters to overcome any future increase in rig load or changes in environmental conditions.

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Thank You for Your Attention, Any Questions?

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