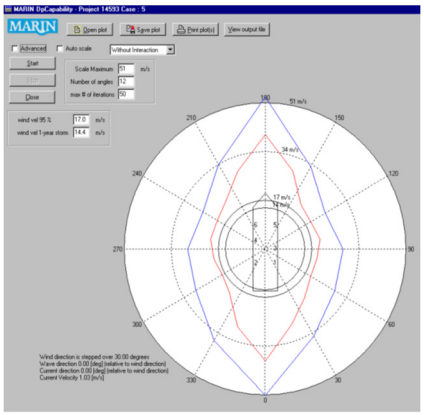
Dynamic Positioning Analysis

Methods to predict the DP performance of a vessel

With its wide expertise on hydrodynamics, MARIN is the ideal partner for ship owners, designers and shipyards. Thanks to extensive DP knowledge and modern testing facilities, we can support them through determining and optimising the DP performance of the vessel. To assess the performance of a DP vessel a number of analysis methods can be carried out. This leaflet gives an overview of analysis methods that are available at MARIN to investigate the capability of DP systems.

The most important aspects to be investigated are:

- DP Capability:
  can the vessel keep position?
- DP system performance:
  how accurate is the positioning?
- Thruster interaction effects:
  what is the maximum effective thrust in each direction?
- Redundancy:
  what happens to the station keeping ability in case of worst single failure?



The present document describes a typical scope of work for DP analysis at MARIN. For DP vessels the available power determines whether or not the vessel can stay in position in a certain environmental condition. Depending on the design stage, different methods with corresponding accuracy can be chosen to analyse the DP behaviour for any kind of vessel or offshore construction.

- Static capability analysis (TRUST)
- Dynamic analysis (aNySIM)
- Model Tests
- Tuning of aNySIM numerical model

These methods and their advantages/disadvantages are described in more detail below.

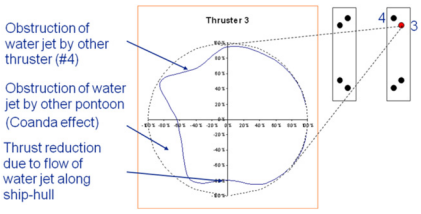
Static capability analysis (TRUST)

Static analysis is generally used in initial design phases. It predicts whether the average environmental forces – current, wind and waves – can be counteracted by the thrusters, based on their bollard pull capacity. This is done by computing a footprint of the maximum allowable wind velocity that the vessel can counteract at each incidence angle. Wind-wave relationships are used to determine the corresponding wave height and wave mean drift forces. Current can be specified co-linear to wind and waves or from a fixed direction. Because this is a static computation, no dynamics are included and therefore no information about the positioning accuracy can be retrieved. This method is a relatively fast and can be used to compare different thruster configurations during early design phase.

Summary

- In the design of DP vessels analysis methods with increasing complexity may be used. Depending on the requirements of the operator the focus may be on DP capability, positioning accuracy or powering aspects.

Evaluation Method	Accuracy	Complexity
- DP capability plots (Footprint)	≈ 30%	-
- Numerical time domain simulations	≈ 20%	+
- DP model tests	≈ 5-10%	++
- Full scale measurements ('as built')	≈ 0%	++



- In the above picture it can be observed that up to 40% of the nominal thrust may be lost due to thruster interaction effects. Therefore, it is strongly recommended to take these effects into account in the assessment of the DP performance.

The software tools as described in this leaflet are available at MARIN, but can also be made available for your own use.

For more information, contact:
Bruno Rossin
Project Manager, Offshore
T + 31 317 49 36 19
E b.rossin@marin

For input, TRSUT uses:

- Wind coefficients of the vessel
- Current coefficients of the vessel
- Database with wave coefficients (diffraction database)
- Thruster configuration (including maximum thrust per thruster)
- Empirical thruster degradation effects
- Wind and current coefficients can be derived from database, CFD or wind tunnel tests

Dynamic Analysis (aNySIM)

Dynamic (time-domain) simulations provide insight about the positioning accuracy and power consumption of the vessel. The dynamics introduced by the DP filter and controller, thruster latency and slow varying wave drift forces are accounted for in these simulations. The model can also be used to assess vessel drift-off after worst single failure. The accuracy of the results depend on the accuracy of the input data and correct modelling of the DP system, in which MARIN has extensive experience.

Model tests

Dynamic positioning model tests can be performed to accurately determine the station keeping accuracy of the vessel on DP, under different environmental conditions. During these experiments, all hydrodynamic effects affecting DP performance are captured: thruster ventilation, thruster interaction effects, viscous effects, etc. Prior to the full environment tests, thruster interaction tests are performed to measure thruster efficiency. These generally include:

- Thruster-Thruster interaction
- Thruster-Hull interaction
- Thruster-Current interaction
- Thruster-Current interaction

CFD may also be used to quantify these effects. The adjacent graph shows a typical thruster-hull degradation plot of an azimuth thruster of a semi-submersible.

Tuning of aNySIM numerical model

Model test results can be used to improve the input data of the aNySIM time-domain model. This model can then be used to predict the DP behaviour in other environmental conditions than those that were tested.

Powering aspects

Most DP vessels have multiple modes of operation: they have to perform well during dynamic positioning operations as well as during transit. The powering and DP requirements may be conflicting. For example a single propeller vessel can be more fuel efficient in transit conditions than a vessel with two azimuth thrusters. But the two azimuthing thrusters are favourable with respect to DP capability, and during harbour manoeuvring. If the operational criteria are known, MARIN can assist by optimising the design for the operational life of a vessel by comparing the DP performance and powering requirements.

Third-party DP systems can be used during model tests and also coupled to the aNySIM model.