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**DNV GL DP Capability Standard ST-0111 - Challenges and
Updates One Year from Publishing**

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Abstract

In July 2016, DNV GL published a new standard for the assessment of vessel DP capability, DNV GL ST-0111. The new standard includes methodologies for documenting a vessels DP capability in three different levels: DP Capability Level 1, 2 and 3. Together with the standard, a free web-app was developed and released on My DNV GL for supporting the DP Capability Level 1. Level 1 is based on a prescriptive static method with generalized environmental and propulsion forces such that results calculated for different vessels will be fully consistent and comparable. Level 1 is applicable only for ship-shaped mono-hull and employs a Beaufort weather scale.

During the last year, DNV GL has collected feedback and suggestions from the industry, including MTS, both regarding improvements for the standard and new features for the web-app. Some challenges on how to apply and use the standard and web-app have also emerged.

A common request from industry has been to have DP Capability Level 2 and Level 2-Site available in the web-app to be able to support vessel/project specific calculations. Based on this feedback a new version of the web app will be released on the My DNV GL this year, where users will be able to run Level 2 and Level 2-Site calculations. The new version will also provide the opportunity to compute the vessel DP Capability for other vessel shapes than mono-hulls (like semi-submersibles and catamarans), to apply site-specific environmental conditions, include external forces, and vessel specific environmental load coefficients and thruster forces. The paper will include a description of the new features and their applications.

The aim of this paper is also to share with industry the experience gained and challenges encountered so far with the use of the new standard and web-app and how these have been solved.

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Introduction and History

Reliable documentation of a vessel's position and heading keeping capabilities is vital for planning and execution of safe and reliable operations with dynamic positioning (DP) vessels. A vessel's station keeping capabilities is one of the key DP performance indicators. This applies to both the intact vessel condition, and for redundant DP vessels, even more important after the worst case single failures associated with the vessels Dynamic Positioning class notation.

In July 2016, a new DNV GL standard for the assessment of the station keeping capability of DP vessel was published [6][7]. The primary objective with the [DNVGL-ST-0111 standard](#) was to set clear and consistent requirements for DP station keeping capability assessment.

The new standard was a natural progression of the well-known DNV GL ern (environmental regularity numbers) concept established in 1977. This concept has served the industry well for many years, but due to the general technical development and the development of the DP industry in general, it gradually became apparent that there was a need for developing a new standard for assessment of DP Station keeping capability.

The standard includes three different levels:

- DP Capability Level 1 numbers shall be calculated based on a prescriptive static method so that results calculated for different vessels will be fully consistent and comparable.
- DP Capability Level 2 sets requirements for the assessment of the DP station keeping capability based on a more comprehensive quasi-static method which allows for more flexibility and project specific adjustments compared to the DP Capability Level 1 method.
- DP Capability Level 3 provides requirements for computing a vessels DP station keeping capability based on time-domain simulations.

The standard also opens for assessment based on site specific environmental data different from the Beaufort environmental scale required for Level 1, 2 and 3, with the introduction of two additional sub-levels: **DP Capability Level 2-Site** and **DP Capability Level 3-Site**. These use the same methods as Level 2 and Level 3, respectively, in addition to allowing for site specific environmental data (and other operation specific aspects) to be used and inclusion of external forces.

Together with the new standard, DNV GL developed a web tool to calculate the DP Capability numbers for Level 1. The Level 1 DP Capability tool is available free of charge at <https://my.dnvgl.com/>¹.

Since the release, both the new standard and the web tool have created a lot of interest in the offshore and maritime industry. During the last year, DNV GL has collected a good number of feedback and suggestions from the industry, including MTS, both regarding improvements for the standard and new features for the web-app. Some challenges on how to apply and use the standard and web-app have also emerged.

Based on the feedback received, DNV GL is updating the standard and the web-app. The new standard release is planned for the last quarter of 2017. The proposed updates will be presented in the paper together with the experience gained and the challenges encountered after the standard was first released.

Feedback from industry

Since the standard and web application was introduced in 2016, DNV GL has received useful feedback on the standard itself, the web application and on the application of these in the market. This section will sum up the most important feedback and comments received. The feedback can be categorized in two main groups:

¹ The DP Capability web-tool will be available at the DNV GL Market Place from the end of 2017.

- Experiences from practical use
- Comments related to the application of the standard

Experiences from practical use

Since its release, the standard and the free web-app has been used by ship designers, vessel owners, consultants, oil companies, equipment vendors, research institutions and universities. In general, the feedback regarding both the standard and the web-app has been very positive. However, most first releases can always be improved and a lot of suggestions were received based on user experience.

Standard

The main feedback regarding the standard was related to the calculation of thrust forbidden sectors due to the presence of a skeg. This resulted in a thrust forbidden zone where the actuator was not allowed to produce any net force. Typically, for vessels where the redundancy design is so that one bow tunnel and one main azimuth will remain in operation after worst case single failure, the forbidden sector from the skeg would not allow the main azimuth to push towards the skeg. This often resulted in zero capability for some headings, yielding the last number (D) in the DP Capability string equal to zero. Typically, industrial DP control systems allow thrusters to point their races against skegs. In the new version of the standard, the interaction between a thruster race and a skeg will result on a thrust loss factor, in line with industry practice and providing more realistic results. An illustration of the vessel with a skeg is shown in Figure 1

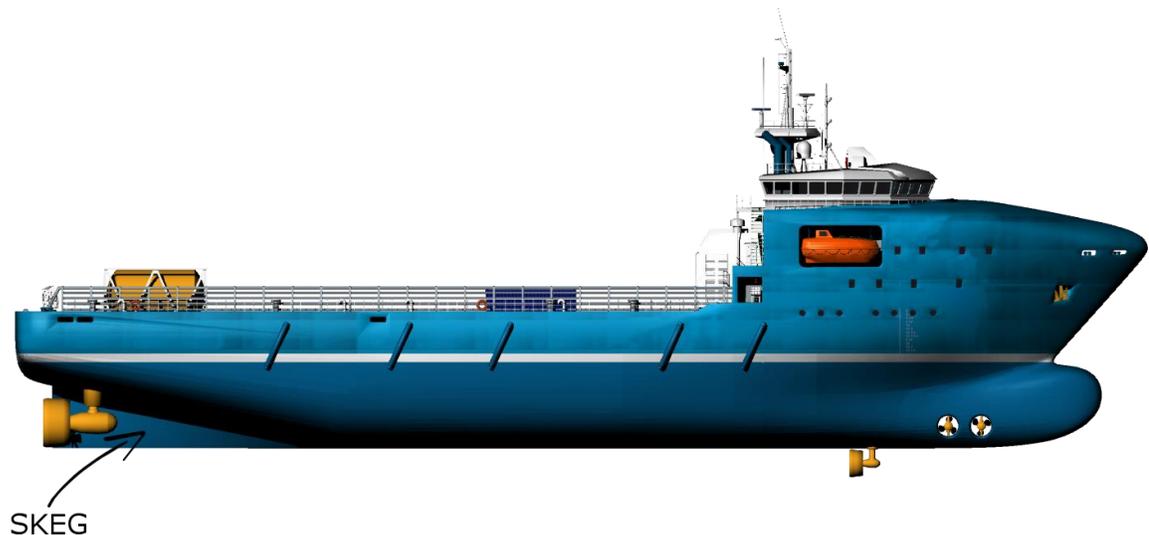


Figure 1: Example of vessel with a skeg

Other suggestions for improvement to the standard were provided mainly towards definitions and wording which were not clear. In the new release, most of these suggestions will be implemented. The proposed updates are described in the following sections.

Web-app

Users have provided significant feedback on usability and desired new features. When the standard was first released, only the Level 1 calculation was available in the web-app and many users have requested to have both Level 2 and Level 2-site. Level 2 was e.g. requested for assessing the station-keeping capability

for semi-submersible while Level 2-site for adding external forces and applying site specific environmental conditions. Another new feature that has been requested by many is the possibility to compare results from different vessel in the tool. This was requested both for vessel selection and design. It was also requested to include the possibility to reduce the heading resolution as this can be useful for complying to the requirements for shuttle tankers in the Norwegian Continental Shelf (NCS), which requires 2 degrees heading resolution. Inline help and improvements to the user manual were highly requested to avoid trivial user mistakes when configuring the vessel and the runs. Details on the updates in the web-app can be found in the section below.

Comments related to application of the standard One of the challenges that users, as well as DNV GL, have faced when running calculation was the definition of the worst case single failure (WCSF). Both defining and agreeing on the WCSF and verify these as per FMEA has been a challenge in some cases, especially for complex/flexible systems with many redundancy groups and technical system set-ups. This is a clear indication that the industry needs higher focus on this key element, and the new standards ensures that this aspect is analysed and considered properly.

The need for making good specification when requiring DP Capability assessments is another high relevant aspect that has been identified. Industry, in general, needs some time to adapt to changes and this is valid also when new standards are released. One of the main goal when the standard was first developed was to provide an alternative to the old methods for assessing vessel station-keeping, including DNV GL environmental regularity numbers (ern) and other standards such as IMCA M140. Many specifications up till then, especially in the NCS, were requiring calculations according to the ern concept. After the standard was release, some operators have been requesting the assessment also according to the new standard but at the same time also using the old ern concept. The reason for this may be to obtain experience with the results from the new standard and learn how to set the new requirements, and comparison with the traditional ern may be the easiest way to go. However, some vessel owners have regarded this a duplicated requirement adding additional burden. At the same time, some specifications resulted in wrong requirements as some of the constraints from the new standard were not properly taken in considerations (for example if Level 1 based solely on the Beaufort weather scale would be requested for the North Sea conditions). Discussions around how to set specifications for DP Capability assessments has also brought to light another aspect which is “how to choose the right assessment level”. A separate section is written on this matter below.

Another concern being raised is that some existing vessels may get relatively lower results compared to existing assessments based on older method and standards. This may be the result of having high flexibility in the old standards resulting in assessments not always applying sufficient conservatism. The new standard goal was, among other, to remove some flexibility regarding the assessment requirements with the intention of provide a better tool for benchmarking vessel performance. Hence, the new standard may be more conservative in the results than the older methods. It is difficult to claim that the new standard provides results closer to reality but applying DP capability 1 will ensure consistency in the applied method and results for benchmarking purposes. In addition, it is well known that previous methodologies often were providing too optimistic results. One clear conclusion based on these discussions and experiences is that, the responsibility lies on the user of the results to evaluate the assessment with respect to the actual DP Capability and capacity needed, and not solely base their decisions on which vessel has the highest DP Capability numbers or largest limiting wind speed.

At the same time as the applicability of the standard for sailing vessel is recognised by the industry, it is important to specify that DNV GL do not require any DP Capability assessment to be calculated for existing vessels as part of the ship classification requirements. Application of the new standard is only required for new buildings classed under DNV GL per the rule revision where this was introduced (i.e. DNV GL RU-SHIPS January 2017 edition and onwards).

In order to help with implementation and provide guidance on how to run calculations in the web-app and how to apply the standard, DNV GL has performed a webinar [7] and provided specific training.

Updates in the new revision of the standard

The following main changes in the standard are proposed to be implemented based on the feedback from industry, and DNV GL experience in applying the standard and verifying analyses:

1. Definition of the DP Capability Numbers format
The DP Capability result string is defined with the smallest DP Capability on each correspondent heading sector. In the previous version, it was defined with the largest DP Capability number and that was not the intention. An example is given in Figure 2.
2. Requirements for verification
Requirements for the verification of the DP Capability analyses are improved by adding also a check on the actuator and environmental forces as these are required to be included in the analysis report.
3. Definition of the water plane area coefficient for computing the wave drift forces
Some vessel may result in the water plane area coefficient outside the validity range of the Level 1 method. Therefore, it has been defined that values outside the valid range will be set equal to the maximum (or minimum) allowed value in the range.
4. Definition of propeller diameter for contra-rotating Pods actuators
For contra-rotating pods with one propeller in each end of the pod house, the propeller diameter to be used in the calculation is defined as the diameter of the largest propeller.
5. Efficiency of Cycloidal actuators
The efficiency factor for Cycloidal actuators has been increased from 850 to 900. This was done after reviewing additional documentation for such actuators.
6. Definition of the propeller submergence for calculating actuator force
The definition of the propeller submergence has been rewritten for the sake of clarity. A formula is now provided for calculating it.
7. Thrust losses due to thruster-skeg interaction
This represents a major update as it can affect results significantly. The interaction between a thruster race and a skeg will now result on a thrust loss factor as described in the previous sections.
8. Average wind speed to be used for site analyses
For the site analyses, both Level 2 and Level 3, the standard now suggests to use 1-min average wind speed. This is according to industry practice for these types of analyses.
9. Usage of the thrust ventilation loss formulation
By running hydrodynamics calculations, it was found that the formulation to derive thrust losses due to propeller ventilation can be used also with the JONSWAP wave spectrum and directional wave spreading from 2 to 8 see [2], paragraph 3.5.8.4.

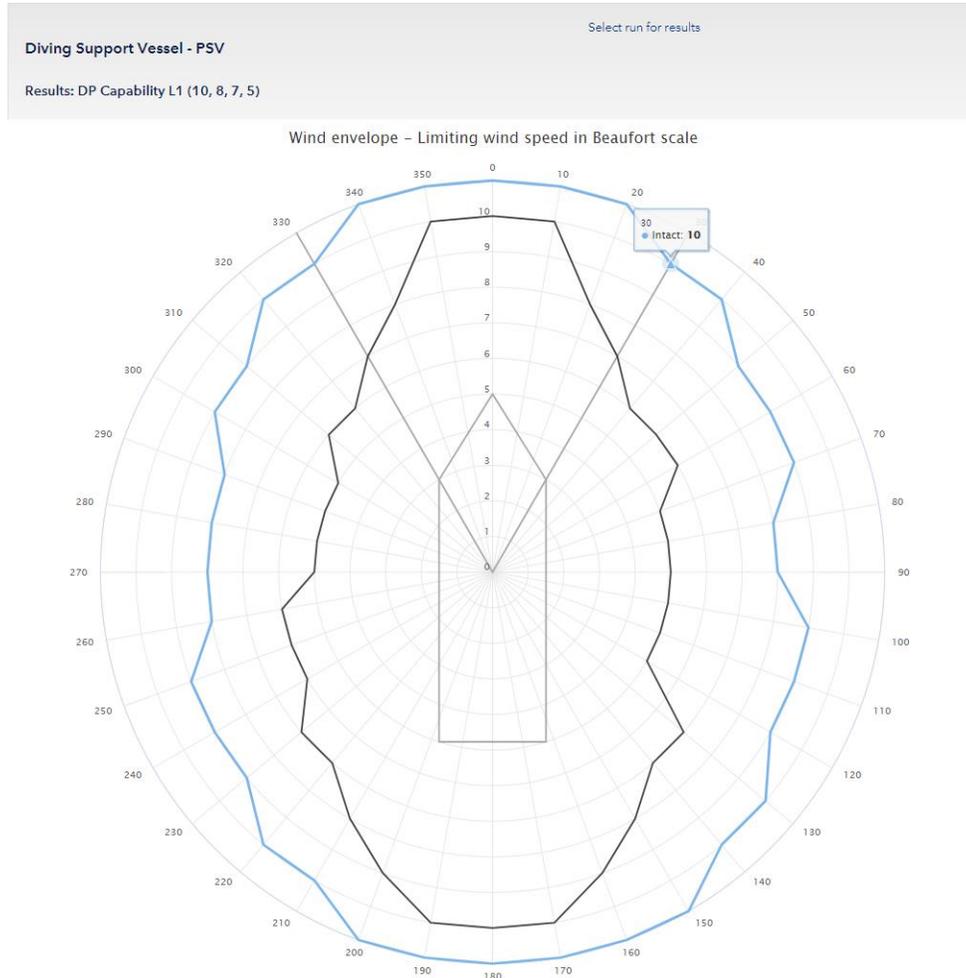


Figure 2: Example of DP Capability Level 1 plot and result string

Updates in the new release of the web-app

This section will summarize the updates to the web-app. The main changes and new features are listed and described below.

1. Improved guidance and user error handling

The user interface is improved with more help on how to do correct configuration of vessel parameters and run setting. This is achieved by adding more inline help and by adding validations of the input fields (such as range checks, dropdown menus with limited choices, etc.)

2. Implemented smaller heading resolution

The heading resolution can be set down to 2 degrees. This allow running analyses and providing results with less than 10 degrees resolution when this is required.

3. Implemented vessel comparison

A feature to compare vessel performance has been developed (up to 4 vessels at the time). The user can overlap results from different vessels as long as the run is of the same type.

4. Implemented Level 2 and Level 2-Site

To allow the user to run analyses for hull shapes other than mono hull, the possibility to run Level 2 studies has been implemented. The user can input vessel specific wind, current and wave drift coefficients. In a similar manner, the user can define vessel specific actuator characteristics. For running site-specific analyses, the Level 2-Site feature has been implemented providing the user the opportunity to select among different wave spectra (JONSWAP and PM so far), and chose any environmental direction and magnitude.

5. Implemented changes according to the standard updates

The web-app has also been updated to reflect the changes in the standard.

6. Bug fixes

Some major and minor bugs have been fixed. Among these was a bug that made it impossible to import a vessel from file, if the vessel file was exported with configuration errors.

Guidance on how to apply the standard and characteristics of each level

One of the concerns related to the introduction of the new standard is related to the choice of the right assessment level based on different applications, vessels and needs. This may result from having in practice 5 different levels if we include the site versions, and it is understandable that some guidance is needed to pick the right level.

The below table aims to summarize the typical usage and the value provided by each level. It is important to notice that at the same time as applying a higher number level can provide better information on vessel specific station keeping capabilities, the complexity and cost of the analyses typically increases with the increased level number. Hence, careful consideration should be made when specifying the DP capability assessment level.

Level	Typical use	Value
Level 1	<ul style="list-style-type: none"> High level DP capability assessment (e.g. chartering, early design phase) Vessel benchmarking (can replace older methods providing high variety in the results) Oil companies started to require this in the tenders 	<ul style="list-style-type: none"> Prescriptive method: Consistent and comparable results Improve decision input for choosing vessels Free Web-App Easy to deliver class required DP capability assessment numbers
Level 2	<ul style="list-style-type: none"> When vessel specific parameters are important 	<ul style="list-style-type: none"> Allow to take advantage of equipment/vessel specific performance For other hull shapes than mono hulls
Level 2-Site	<ul style="list-style-type: none"> When site specific environmental conditions are important (e.g. shallow water, high current) When external forces are important (other than those created by environment, e.g. riser, cable or pipe forces) 	<ul style="list-style-type: none"> In addition to the items listed for Level 2: Allow to use site specific weather and to take in to account external forces Preliminary operational planning
Level 3/Level 3-Site	<ul style="list-style-type: none"> When more information of vessel performance is desired (e.g. planning of and vessel selection for critical operations, site specific analysis and inclusion of external forces) When vessel and equipment dynamics are important (e.g. position, heading or other motion in other degrees of freedom, thruster/power dynamics, gangway motion, etc.) 	<p>Designers and yards</p> <ul style="list-style-type: none"> Right size vessels, realistic fuel consumption calculation and operability Effects of hull design, equipment type and rating on the DP capability performance Can be used for battery sizing <p>Operators</p> <ul style="list-style-type: none"> Better data for choosing the right vessel for specific operations in a specific environment Improved planning, improved operating limits – improved risk control <p>DP vessel owners</p> <ul style="list-style-type: none"> Ticket to business – prove to the Oil companies their vessel is suitable for the operations Operational and contingency planning

Conclusion

In July 2016, DNV GL published a new standard for the assessment of vessel DP capability, DNV GL ST-0111. The new standard includes methodologies for documenting a vessels DP capabilities in three different levels: DP Capability Level 1, 2 and 3, plus to sub-levels for site-specific assessment. Together with the standard, a free web-app was developed and released on My DNV GL for supporting the DP Capability Level 1.

Over the last year, DNV GL has collected feedback and suggestions from the industry, including MTS, both regarding improvements for the standard and new features for the web-app. Some challenges on how to apply and use the standard and web-app have also emerged.

This paper has presented the feedback that DNV GL has received from industry for the standard and the web-app and discussed the challenges encountered since the standard and web-app were released. The paper also tried to provide guidance on which level should be used based on different applications and needs. The paper also included the description of the changes in the new update of the standard and in the web-app to answer the request from industry.

Acknowledgements

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