**MTS Dynamic Positioning Conference 2025**
**Primary Category:** Learning from Incidents and Insights
**Title:** Enhancing DP Drilling Operations with Consistent Dynamic WSOG
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## Abstract:

The concepts of ‘fixed’ and ‘dynamic’ Well Specific Operating Guidelines (WSOG) for DP drilling operations are well established. Fixed WSOG are the outcome of pre-operational riser analysis and are inherently conservative. Real-time (dynamic) WSOG use a combination of measured data and metocean forecasts to reduce conservatism and increase uptime.
However, a challenge with this approach is that the fundamental methodology used for determining ‘fixed’ and ‘dynamic’ WSOG may be quite different. Pre-operational analyses typically use high-fidelity riser analysis tools, while dynamic WSOG may be based on a different methodology and simpler riser model, potentially leading to inconsistency between onshore and offshore guidance, which is undesirable. To avoid this, it is preferable that the models and methodologies used onshore and offshore are the same and the only variable is the use of real-time/forecast inputs.
This paper describes a consistent approach to extending the pre-operational ‘fixed’ WSOG to less-conservative ‘dynamic’ WSOG, utilizing the same high-fidelity riser models and analysis methodologies. Cloud-computing and advancements in high-speed satellite internet allow seamless connection between onshore and offshore environments, combining the benefits of dynamic WSOG with the supervision and control of onshore riser analysts. Drilling contractor experience highlighting the benefits of the approach is described.

## Introduction:

In the dynamic world of DP drilling operations, a significant challenge persists in the quest for optimal safety and efficiency: the inherent conservatism associated with traditional "fixed" Well Specific Operating Guidelines. While these guidelines, determined from pre-operational analyses, prioritize caution, they often come at the cost of operational uptime, leading to increased "Waiting on Weather" time and unnecessary costs. The promise of "dynamic" WSOG, leveraging real-time data and metocean forecasts to unlock greater operational flexibility is clear. Yet a critical hurdle persists: the inconsistency between the high-fidelity models used for pre-operational planning and the simpler methodologies often employed for dynamic guidance, creating a risky disconnect between onshore and offshore teams.
But what if we could bridge this gap entirely? What if the very same advanced, high-fidelity models used for pre-operational analysis could seamlessly extend to provide dynamic, less-conservative guidance in real-time?
This paper presents an industry leading approach that transforms this vision into reality. By harnessing the power of consistent, state-of-the-art riser models and analysis methodologies across all operational phases, it’s possible to eliminate the historical inconsistencies between onshore and offshore guidance. Furthermore, the advent of cloud computing and reliable high-speed satellite internet has provided the crucial technological backbone, enabling unprecedented, seamless collaboration between onshore engineering teams and offshore operations. This powerful synergy not only maximizes operational uptime and enhances safety by providing precise, dynamically calculated limits, but also fosters a continuous learning environment. Illustrated by drilling contractor experience, this paper explores how this integrated strategy redefines the future of safe, efficient, and optimized well specific operating guidance.

## Background:

### Pre-Operations Global Drilling Riser Analysis

In the early 2000s, the industry needed a specialized software tool for global marine drilling riser analysis, as general structural analysis tools proved inadequate due to their lack of specific features and extensive pre/post-processing requirements. Consequently, an integrated tool was developed with significant industry input [1]. This tool incorporates a widely validated non-linear finite element solver, alongside automated model-building and post-processing capabilities, specifically tailored for drilling riser analysis. It utilizes a 3D hybrid beam-column formulation with coupled degrees of freedom, supporting both time and frequency domain dynamic analysis [2], [3]. Over time, enhanced features like a detailed hydro-pneumatic tensioner model, drilling mud flow simulation for emergency disconnect and riser recoil [4], [5], and a pipe-in-pipe model for conductor/casing strings were added to increase realism [6].

### Initial Forecast Analysis Capability – Drift-off

A key application of this tool is drift-off analysis, which simulates a dynamically positioned vessel losing station-keeping. Should this occur, an emergency riser disconnect is critical to prevent system damage. This analysis determines the "Point of Disconnect" and establishes "alert offsets" (red and yellow). The red alert offset (sometimes referred to as the “time to go”) determines the specific distance & time from the well at which the Emergency Disconnect Sequence must be initiated. The time to reach these offsets is directly influenced by prevailing metocean conditions (wind, current, and waves) [7].

Traditionally, pre-operations planning relied on static, conservative Well Specific Operating Guidelines derived from statistical metocean conditions, often leading to over-conservatism and increased "Waiting on Weather" time.

To address this, a customized on-board tool was developed in 2004, enabling dynamic alert offsets and WSOG to be calculated using real-time or forecast metocean conditions [8], [9]. Crucially, this on-board tool employs the same high-fidelity riser model and analysis methodology as used in the pre-operations analysis, ensuring seamless consistency between planning and operational phases. This consistent approach, combined with operator-oriented results and minimal data input, simplifies its use for offshore personnel, removing the need for specialized riser analysis experience. Figure 1 shows an example display of results from the tool, with the alert offsets illustrated graphically on the left of the display (as yellow and red arcs) and with key numerical results tabulated on the right of the display.

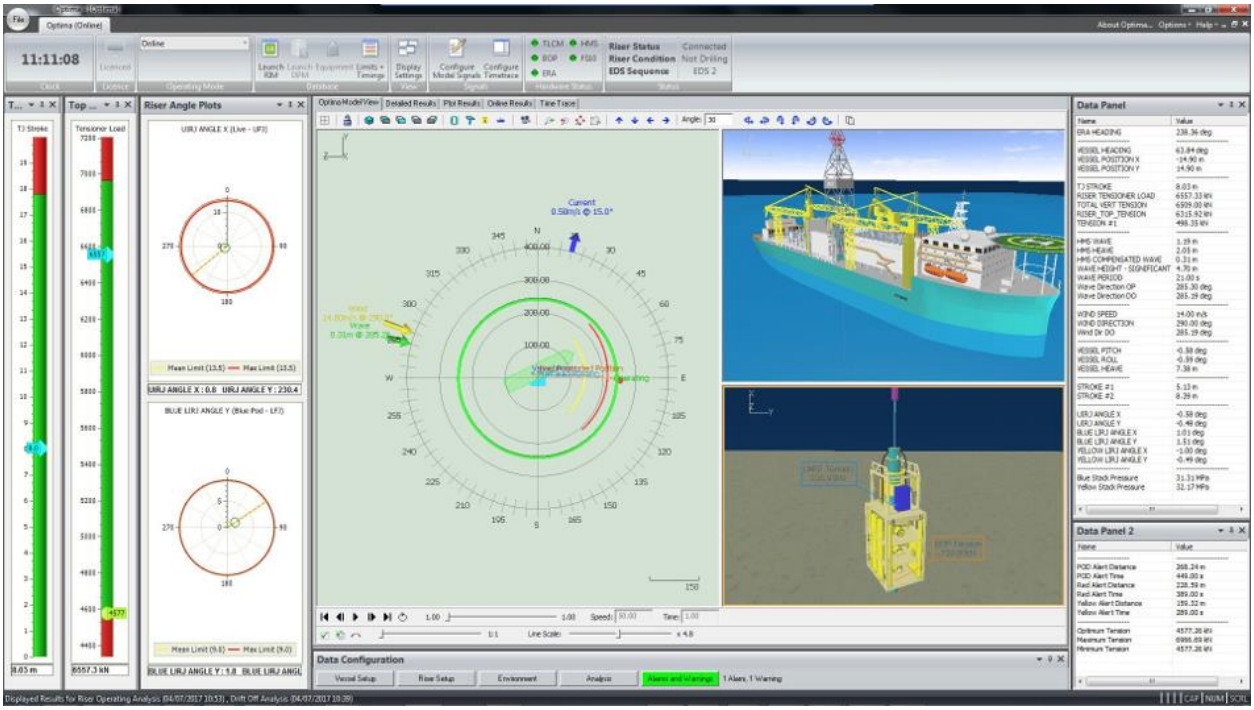


**Figure 1: Sample Display from On-board Simulation Tool**

## Modelling Features:

The advanced finite element model used in the pre-operational and forecast analysis tools incorporates two key features that enhance realism and reduce over-conservatism:

### 1. Fully Coupled Vessel and Riser Model

The simulator integrates the vessel directly into the analysis, treating it as an integral part of the riser system. It accounts for the vessel's mass, hydrodynamic added mass, and environmental forces (wind, wave and current) applied at the appropriate reference points, [10].

- **How it works**: The drift response of the vessel and the corresponding riser response are solved simultaneously, ensuring that the influence of one on the other is fully considered.
- **Contrast**: Unlike uncoupled approaches that predict vessel drift independently, the fully coupled method provides a more realistic representation.
- **Benefit**: This state-of-the-art approach significantly impacts drift speed, especially in shallower waters where the riser acts as an anchor. By fully coupling the vessel and riser models, it helps maximize the operating window by eliminating over-conservatism associated with uncoupled methods.

Figure 2 shows results from a drift-off study in which a full-scale drift test was performed on a 6$^{th}$ generation semisubmersible DP drilling rig. The measured vessel drift response was compared with predicted vessel-only and coupled vessel and riser model results from the drift-off simulator. The results showed excellent agreement between the predicted and measured drift-off for the no-riser case, thereby validating the vessel model used in the drift-off simulator. It also clearly shows that the presence of the riser has a significant effect on the drift-off speed, with this effect becoming more pronounced for shallower water depths.

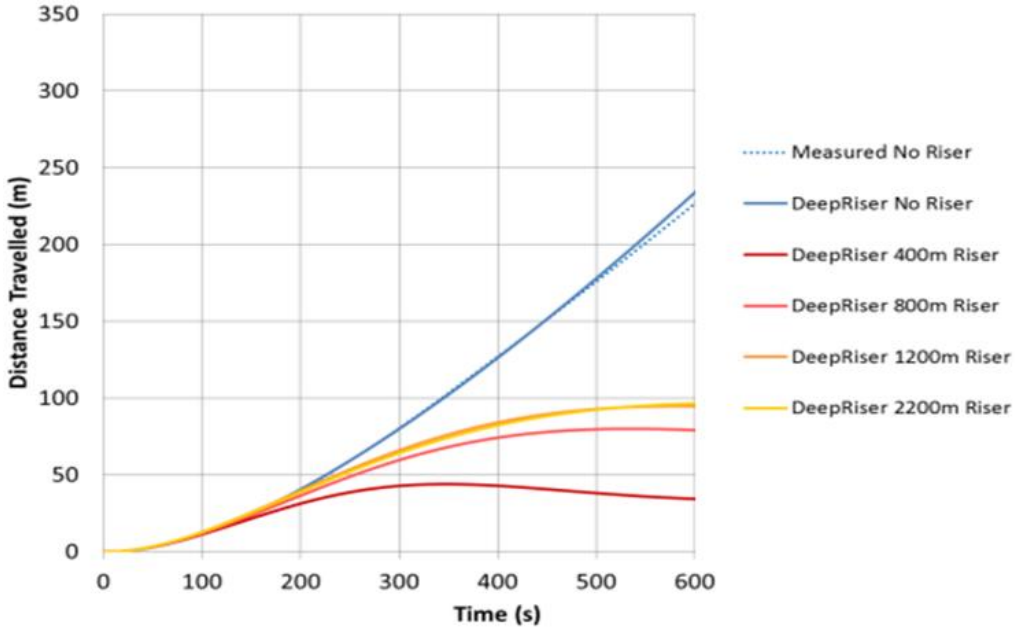


**Figure 2: Drift-off Results Comparison**

### 2. Detailed Wellhead, Conductor, and Casing Model with Non-Linear Soil Interaction

This feature includes a comprehensive model of the well's tubular elements and annular cement using pipe-in-pipe elements, incorporating non-linear soil resistance via P-y and T-z curves [7].

- **How it works**: Instead of simply fixing the model at the wellhead, it explicitly accounts for the conductor's deflection under applied loads. The model incorporates multiple strings (e.g. conductor, intermediate and surface casing) using an advanced pipe-in-pipe methodology.
- **Contrast**: This contrasts with simpler models that assume no deflection below the wellhead.
- **Benefit**: By allowing the conductor to deflect, the model accurately predicts bending moments and angles at the lower flex joint and wellhead. This more realistic modelling approach reduces over-conservatism, thereby expanding the operational window.

## Consistent Well Specific Operating Guidance:

Complete consistency in WSOG is achieved by applying identical modelling and analysis procedures for both onshore pre-operational analysis and offshore forecast/real-time operational guidance. To illustrate this consistency, a pre-operational analysis was initially conducted. The exact same model was then seamlessly imported into the offshore tool, where various simulations were performed using a range of different environmental inputs. As anticipated, the results clearly demonstrate that when the same environmental data is specified for offshore operations, there is precise agreement between the pre-operational results and the dynamic WSOG generated offshore. Table 1 shows sample pre-operational load case results for a shallow water well (500ft WD), while Figures 3 and 4 show the reported offshore guidance when the same environmental inputs were applied.

**Table 1 Sample Fixed WSOG Results**

| Load Condition | | | | POD | | Red Alert | | Yellow Alert | | Limit Criterion |
|---|---|---|---|---|---|---|---|---|---|---|
| Environment | Wave Hs | Wind | Current | Time | Distance | Time | Distance | Time | Distance | |
| | [ft] | [kts] | [kts] | [sec] | [ft] | [sec] | [ft] | [sec] | [ft] | |
| Operating Env Test 1 | 8.0 | 22 | 0.9 | 109 | 74.5 | 69 | 32.7 | 39 | 11.0 | Lower Flex Joint Angle |
| Operating Env Test 2 | 10.0 | 28 | 1.2 | 87 | 75.4 | 47 | 24.0 | 17 | 3.2 | Lower Flex Joint Angle |

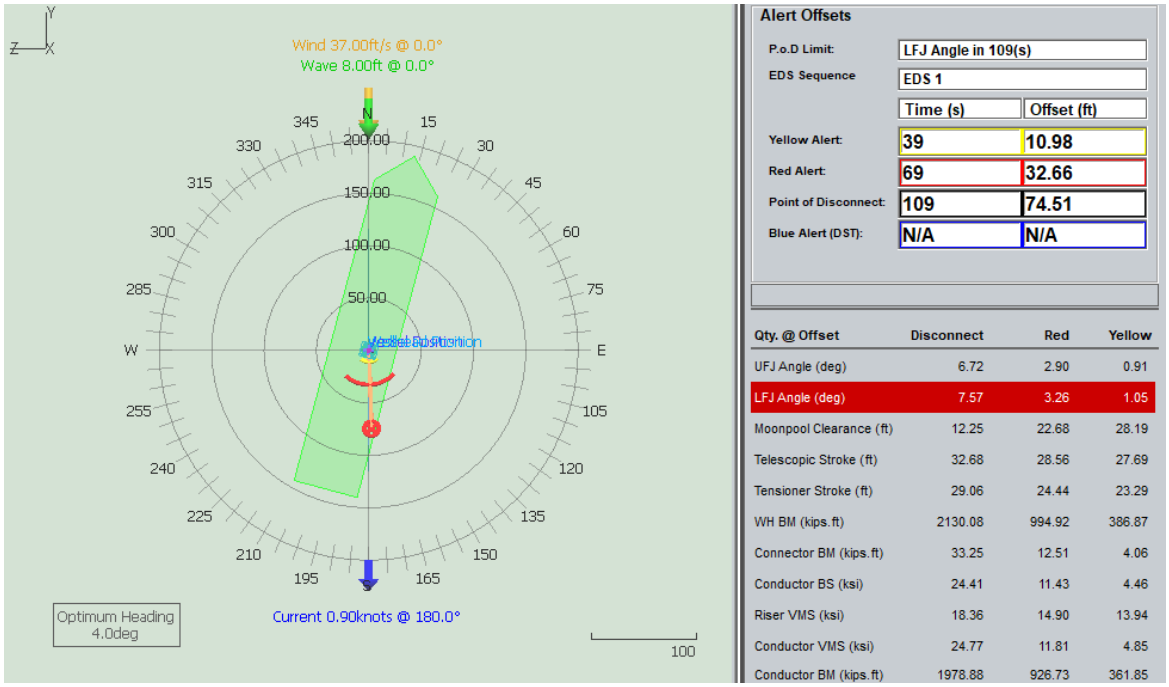


**Figure 3: Offshore Results for 'Operating Env Test 1'**

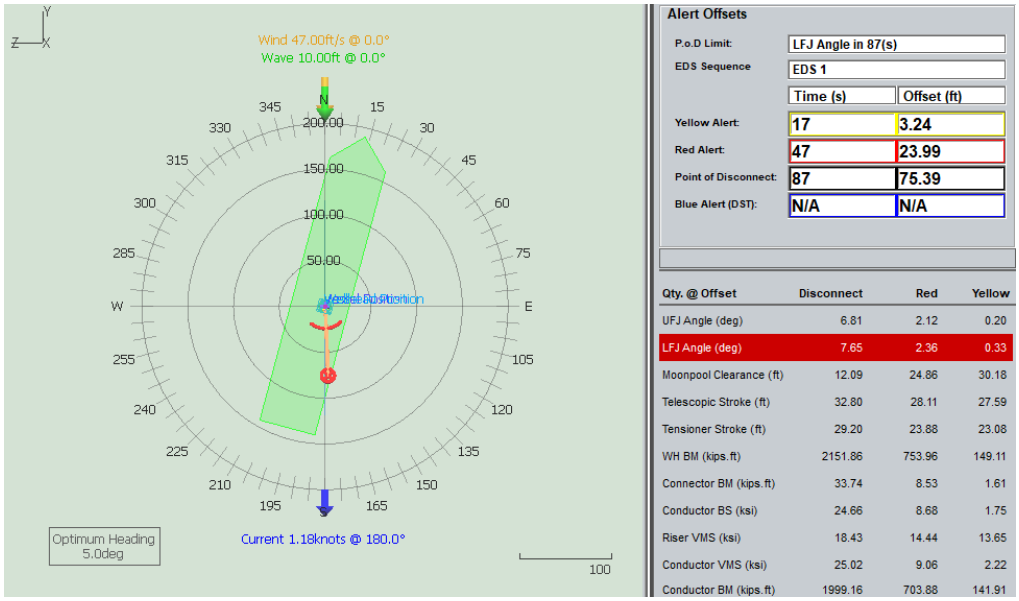


**Figure 4: Offshore Results for 'Operating Env Test 2'**

Furthermore, when realistic and often more complex data is inputted into the offshore tool – for instance, scenarios where environmental forces are not acting colinearly – the watch circles are less restrictive. This outcome underscores the well-established benefits of providing dynamic WSOG directly to the rig, as it allows for more accurate and less conservative operational limits based on actual conditions. Figure 5 shows such a case, where the same environment conditions were used as above, but directions were updated so that the wind, wave and current were not aligned. As can be seen, the different directions of the environmental forces lead to a less severe outcome and increased operating conditions.

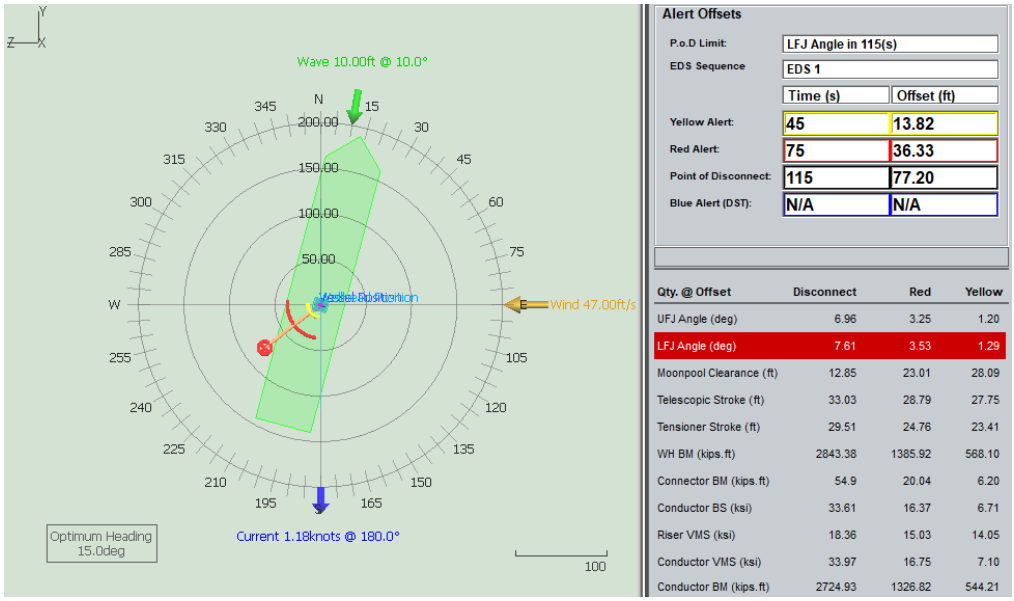


**Figure 5: Offshore Results for multi-directional environment**

This comprehensive consistency is paramount for several reasons:

- **Mitigates Operational Inconsistencies**: It eliminates discrepancies that could arise from using different models or methodologies, ensuring a unified understanding of operational limits across all stakeholders.
- **Provides a Unified Framework for Decision-Making**: All phases of drilling operations, from planning to execution, are guided by a consistent set of methodologies and data, enhancing coordination and efficiency.
- **Minimizes Human Error**: By automating the calculation of WSOG and displaying only the prevailing and forecast results onscreen directly to operators, the risk of errors associated with manual interpretation of detailed reports or inconsistent data sources is significantly reduced. This leads to more reliable and safer drilling operations.

## Utilization of Cloud Computing:

Historically, a key challenge in providing dynamic Well Specific Operating Guidelines offshore has been the potential disconnect between onshore operational support teams and offshore operations. While consistent models and tools are now used between onshore and offshore, ensuring consistency in results, the ever-changing environmental conditions mean that dynamic WSOG displayed onboard differ from static pre-operational analyses. Traditionally, onshore teams lacked real-time visibility of these dynamic WSOG results.

The advent of cloud computing and reliable high-speed satellite internet has revolutionized this. Onboard software tools have been adapted to run in the cloud, enabling both onshore and offshore teams to monitor the latest dynamic WSOG results simultaneously. This seamless cloud integration marks a significant advancement, effectively bridging the gap between onshore and offshore teams and combining the benefits of dynamic WSOG with the expert supervision and support of onshore riser analysis personnel.

By utilizing the same model, simulation software, and providing all stakeholders with access to the latest results, the historical problems associated with dynamic WSOG are resolved. A shared web interface facilitates real-time guidance, supervision, and control. Furthermore, specific user profiles ensure that only relevant personnel possess the appropriate access and permissions, preventing unauthorized modifications and maintaining data integrity. This shared platform also fosters a continuous learning loop, where operational insights from offshore activities can directly inform and refine onshore planning and model development.

The cloud-based solution allows for automatic data acquisition from forecast metocean suppliers as well as rig data interfaces. The acquired data is automatically processed and set as simulation input parameters to perform analyses for a series of forecast periods. The results of these simulations are then published to a dedicated web page for each drilling rig, where they are available to offshore personnel. This approach offers the advantages of a fully automated solution with setup and configuration controlled by the office-based engineering team, in addition to seamless integration with the onshore tools used for performing pre-operations global drilling riser analysis. Figure 6 below shows a sample drilling rig web page showing forecast results for the subsequent 48 hours.

A key benefit of this software tool is its modular structure and customization, for example the system can be tailored to run independently on the vessel (without the need for internet connection), or fully on the cloud, or a hybrid approach where the software is installed onboard the rig and automatically sync's with the cloud-based system (providing a robust contingency in case of any disruption to internet connectivity).

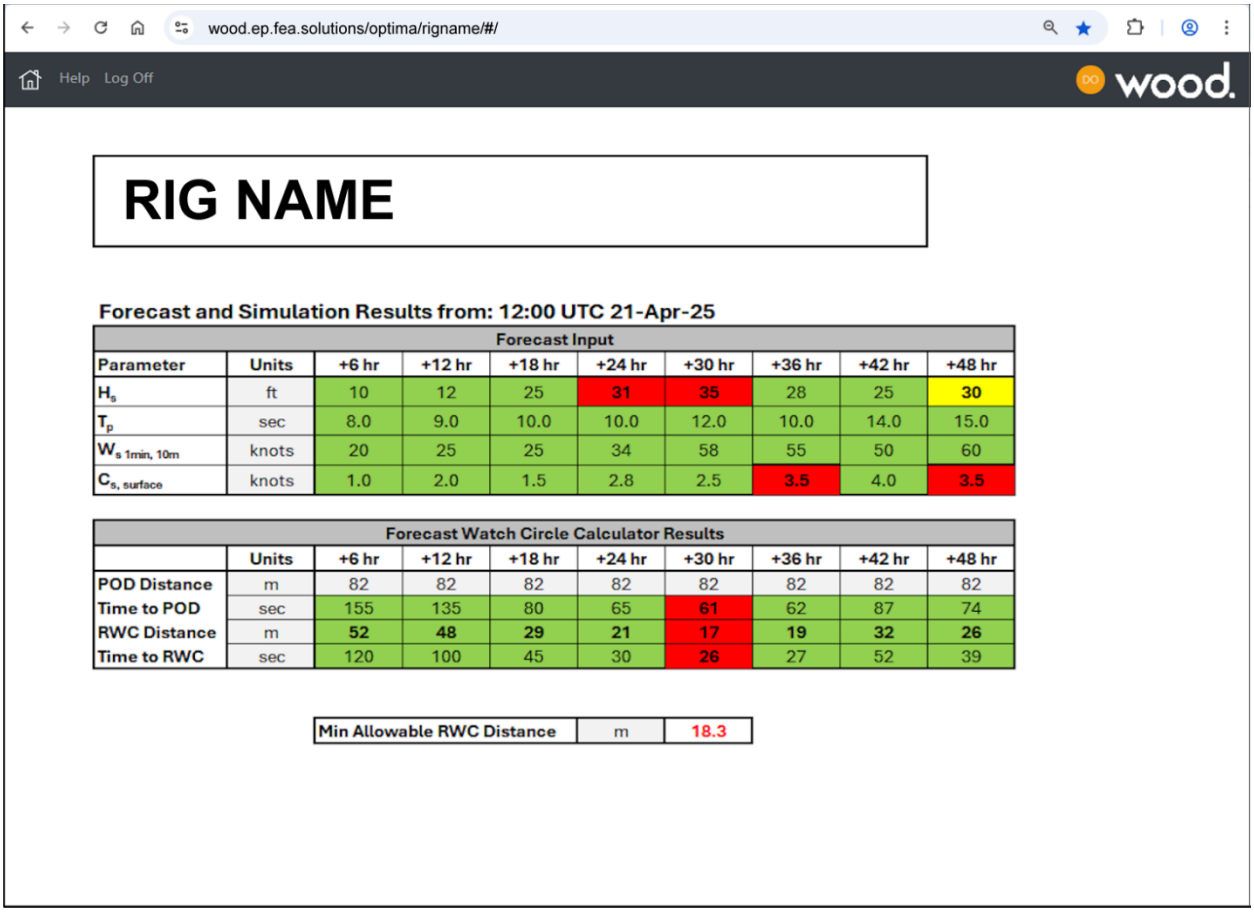


**Figure 6: Sample Vessel-Specific Results Display**

## Deployment Experience

To date, the tool has been deployed on over 40 offshore installations, gaining extensive field experience over more than 20 years. Deployments of the tool have repeatedly demonstrated significant operational advantages.

One deployment in a high-current location effectively reduced vessel Waiting on Weather (WoW) time by 30%, leading to a reported saving of $2.8M in rig day rate alone on a single well [9].

Another deployment on a semi-submersible drilling rig in the Gulf of America highlighted the benefits of dynamic versus static alert offsets. For approximately one month, the onboard tool's dynamic alert offsets were compared against the drilling contractor's standard static offsets (based on water depth percentage). Figure 7 shows how the dynamic alert offsets compared with the static values over the course of the deployment. While static alerts were often conservative, the dynamic values frequently exceeded them, demonstrating greater operational flexibility. Crucially, on at least three occasions, static alert offsets proved unconservative for the prevailing metocean conditions. This clearly illustrates the tool's ability to enhance safety and operational integrity by providing more accurate, dynamically calculated limits [11].

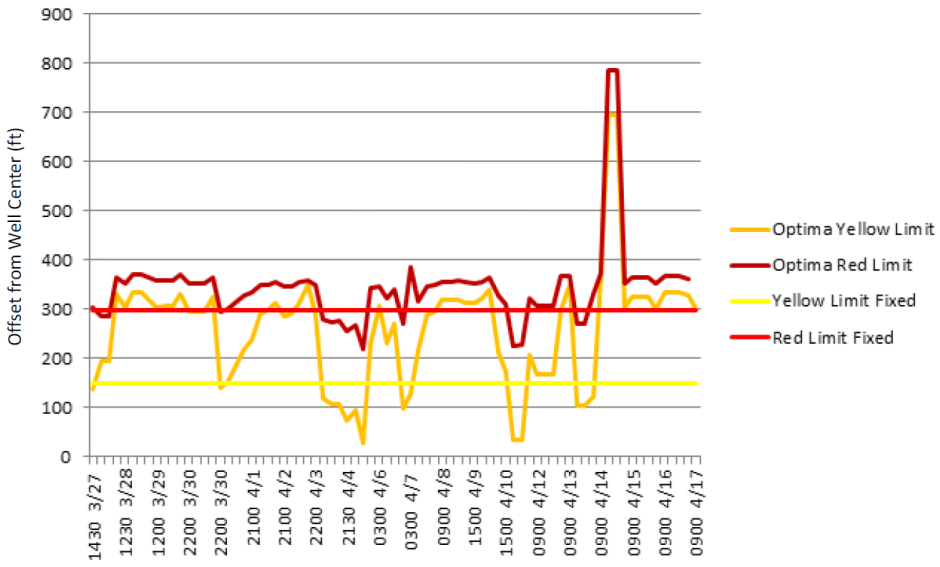


**Figure 7: Real-world Comparison Between Static and Dynamic Alert Offsets**

One drilling contractor, Vantage Drilling, who has been using the onboard software since 2015 has reported the benefits of increased operating windows from real-time dynamic WSOG on numerous occasions. In addition to real-time operational guidance, they have also incorporated automated forecast metocean data to provide accurate forecast results to further enhance operational guidance onboard the rig.

## Applications:

The software provides a versatile suite of capabilities designed to enhance various aspects of drilling operations, from proactive planning to real-time incident management and long-term asset integrity. While this paper focuses primarily on drift-off dynamic WSOG, the tool comprises an extensive range of simulators with the following applications:

- **Forecast Well Specific Operating Guidelines**: Provides operational guidance based on the prevailing or forecast environmental conditions, leading to improved safety and operational efficiency.
- **Real-time Analysis**: Facilitates data acquisition from other on-board vessel systems (such as DP, tensioner tension, etc.) and real-time simulations. Interpretation and visualisation of real-time data provide crucial insights for timely decision-making during drilling.
- **Fatigue Tracking and Condition-Based Monitoring**: Monitors the structural integrity of drilling components, supporting predictive maintenance strategies. Provides comprehensive fatigue tracking and recording of usage history for all joints in the riser string and for the wellhead and conductor/casing; also accumulates the tensioner ton cycles for a wireline tensioner system.
- **Partial Blackout Management**: Facilitates the simulation of a partial blackout scenario in which a drilling rig retains some station-keeping capability. This feature is intended to take advantage of the ability of certain vessels to operate in an open bus DP configuration, where a partial blackout is more likely. In such cases, drift-off will happen more slowly as the DP system tries to keep the vessel on-station. In this case, the time taken by the vessel to reach the point of disconnect will be increased when compared to a total blackout, allowing more time to prepare for an emergency riser disconnect. The additional “time to go” for the watch circles in a partial blackout provides an opportunity to increase up-time versus using the more conservative watch circles from a total blackout scenario.

- **BOP Tethering**: The tool is capable of modelling BOP tethers and incorporates automatic calibration of tension profiles in each line using measured data (where available), ensuring accurate operational guidance for such systems.
- **Additional Forecast Capabilities**: The tool offers comprehensive solutions for managing a wide range of drilling scenarios, including routine operations such as deployment/ retrieval, hang-off, transiting, drift-running, SIMOPs, etc.

In essence, the software provides a robust framework to optimize operational efficiency, enhance safety, and facilitate proactive management across diverse drilling challenges.

## Conclusions:

In the demanding landscape of DP drilling, this paper has described how taking a consistent approach to pre-operations planning and real-time guidance can maximize efficiency without compromising operational integrity. The paper has demonstrated that the inherent conservatism of traditional 'fixed' Well Specific Operating Guidelines, while of its time, no longer needs to be a limiting factor in operational uptime. By demonstrating a consistent, high-fidelity modeling approach that spans both pre-operational planning and dynamic, real-time guidance, the inconsistencies that potentially separate onshore engineering and offshore operations are effectively eliminated.

The power of this unified methodology is advanced by the advent of cloud computing and reliable high-speed satellite internet. This technological development has not only enabled seamless connectivity but has fundamentally transformed how dynamic WSOG are generated, shared, and utilized. Onshore engineering teams can now supervise and support offshore operations in real-time, bridging geographical divides and enabling an enhanced level of collaboration.

A robust fully coupled finite element model, featuring vessel and riser along with detailed well and soil interaction, significantly enhances realism, leading to less conservative, yet equally safe, operational limits. As evidenced by deployment experiences to date, this approach translates directly into tangible benefits: reduced "Waiting on Weather" time, optimized well expenditure, and dynamic alerts that are both more accurate and often less restrictive than their static counterparts. The comprehensive software suite offers versatile applications, from proactive forecasting to critical real-time analysis and long-term asset integrity management.

Ultimately, this integrated strategy redefines the state-of-the-art for Well Specific Operating Guidelines and demonstrates how advanced modeling, coupled with cutting-edge connectivity, empowers operators to unlock greater operational flexibility, elevate safety standards, and drive unprecedented efficiency.

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