Smarter, Safer, Greener: Reducing Waiting on Weather with Vessel Motion Based Criteria and Offshore Decision Support Tool

BASED ON INSIGHTS FROM THE ADIPEC 2024 TECHNICAL PAPER: SPE-222623-MS - UNLOCKING EFFICIENCY AND SAFETY IN OFFSHORE OPERATIONS; VESSEL MOTION BASED CRITERIA (VMBC) METHODOLOGY AND DIGITAL TOOLS FOR ENHANCED DECISION-MAKING

Offshore operations are time-critical and resource-intensive, involving sophisticated and costly assets such as offshore construction vessels that operate under tight schedules and high daily rates. In such high-stakes environments, making the right call on whether an operation can safely proceed is essential. This is where operability assessment comes into play — the process of determining the feasibility of offshore activities based on forecasted environmental conditions.

FROM ENGINEERING TO OFFSHORE EXECUTION

Traditionally, operability assessments have relied on sea state parameters like significant wave height (Hs) and peak wave period (Tp), which are compared against fixed engineering limits. While these parameters are readily available and simple to interpret, they fail to capture the complex interactions between wave directionality, spectral composition, and vessel response. This often leads to overly conservative decisions—resulting in unnecessary waiting on weather (WoW), increased emissions, and rising operational costs.

This white paper introduces the Vessel Motion Based Criteria (VMBC) methodology and the 4Subsea Offshore Decision Support Tool (ODST) as an integrated solution that delivers a transformative approach to offshore planning and execution. A real-life case study illustrates how ODST powered by VMBC enabled a **13% increase in operability compared to conventional approaches**—equating to substantial savings in cost and carbon footprint.

The challenge: Conservatism in Traditional Weather Criteria

Conventional offshore decision-making often relies on simplistic wave parameters. This is primarily because wave parameters such as significant wave height (Hs) and peak period (Tp) are readily available from forecast providers in tabulated formats, and can easily be compared manually to predefined engineering limits.

Weather at sea is complex and irregular - Manual interpretation is challenging

However, these traditional methods are inherently manual and subjective, depending on individual interpretation and experience rather than standardised, repeatable data analysis. Although experience is—and always will be—a key ingredient in offshore decision processes, manual methods lack the ability to leverage continuous updates, historical patterns, and real-time validation. As a result, decisions are often made without a full understanding of operational risk.

The limitations begin already in the engineering phase. Because traditional operability frameworks rely on environmental parameters like wave height and period, engineers are required to translate real structural response limits—such as curvature, bending moment, or top tension—into environmental thresholds that can be manually compared with forecasted values.

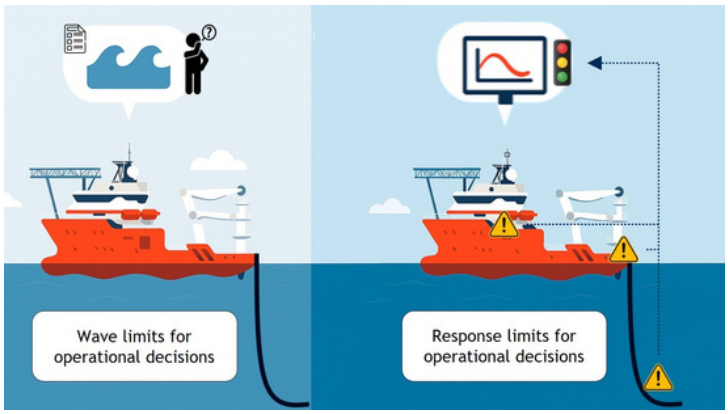
This conversion process is inherently conservative, as it must account for a wide range of assumptions about sea states, vessel heading, and wave directionality. The result is operational limits that are simplified to enable offshore use, but which may exclude viable weather windows that could be safely utilised—leading to lost efficiency across the project lifecycle.

A Smarter Methodology: Vessel Motion Based Criteria (VMBC)

VMBC focuses on the response of the vessel—not just the environment. By defining limits based on e.g. vertical velocity, heave, pitch, and roll at critical installation points, VMBC directly ties environmental conditions to equipment performance. It replaces generalised assumptions with engineered thresholds tailored to each operation.

As a methodology, VMBC is emerging as a key innovation in offshore operations. It is being increasingly adopted across the industry due to its higher degree of precision and its ability to better reflect actual operational constraints under complex sea conditions.

The transition to VMBC represents a shift toward more data-driven, operation-specific decision-making frameworks, aligning closely with digitalisation trends and the industry's push for more efficient and environmentally responsible practices.



Moving to response based operational limits

In simulations, the VMBC approach, designed to balance accuracy with a prudent level of conservatism, achieved 92.8% operability. In contrast, the traditional sea state method offered only 80.2%. These findings were validated against benchmark time-domain finite element simulations.

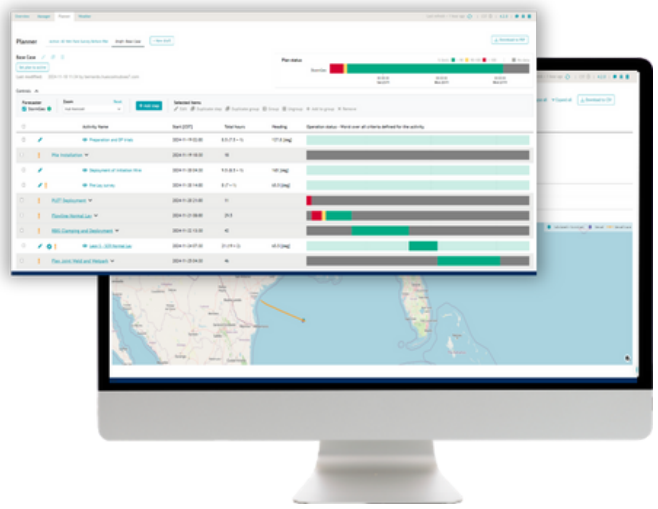
Enabling Technology: The Offshore Decision Support Tool (ODST)

While VMBC offers a technically robust methodology for determining operability based on vessel motions, implementing it in manual processes is highly impractical. It requires:

- Access to high-resolution 2D wave spectral forecasts
- Precise vessel response modeling
- Continuous recalculations as weather updates arrive
- Consistent interpretation of data by offshore teams

ODST addresses all these challenges through automation and intelligent design.

The tool automatically ingests and harmonises directional wave spectra from multiple forecast providers. It leverages cloud computing to calculate vessel responses using preloaded RAOs, and compares these to engineering limits established during the planning phase.



The results are presented in real-time through an intuitive, user-friendly interface, ensuring that both onshore engineers and offshore decision-makers have access to the same consistent and up-to-date information for aligned operational decisions.

In this way, ODST operationalises the power of VMBC at scale—delivering timely, accurate, and standardized decision support.

Key features of ODST:

- 5-7 day forecast of vessel motions
- Activity planner vith GO/No-Go logic
- Color-coded operability visualisation
- Integration of live sensor data for forecast validation
- Support for both traditional and VMBC criteria

Case Study: Umbilical Installation Offshore West Africa

A flex-lay umbilical installation by a mid-sized offshore construction vessel demonstrated the impact of VMBC and ODST in real-world conditions. In this case, the VMBC approach resulted in a 12.6% increase in operability.

Industry benchmarks show that offshore construction vessels experience an average of 40 days of weather-related downtime annually, assuming they are on hire for 80% of the year. Applying a 12.6% reduction in unnecessary waiting on weather to this figure yields a realistic opportunity saving of approximately 5 vessel days per year.

Annual Opportunity Savings
*Mid-sized offshore construction vessel**
- **Time saved**: 5 days
- **Cost saved**: $750,000
- **CO_2 emissions avoided**: 300 tonnes

**Vessel day rate 150 kUSD - Emission rate: 60 t/day*

These figures underscore the significant value of data-driven decision support. Extrapolated across the global offshore fleet, the implications are substantial. Suppose 200 offshore construction vessels working with weather sensitive operations adopt tools like ODST and VMBC, each saving an average of 5 days per year. That translates to 1,000 saved vessel days annually — potentially over $150 million in direct savings and more than 60,000 tonnes of CO2 emissions avoided.

Strategic Benefits
- Lower carbon footprint and cost
- Fewer delays and safer operations
- Improved collaboration between offshore and onshore

By moving beyond traditional weather limits and adopting data-driven decision support, operators and contractors can unlock significant economic and environmental gains. Importantly, this shift does not compromise safety, on the contrary, it enhances it by providing more precise and consistent situational awareness, enabling better-informed decisions and safer operations.

The Path Forward

VMBC and ODST are already enabling safer, smarter, and greener operations. As offshore activities become more complex and sustainability targets more urgent, the demand for accurate, data-driven decision tools will only increase.
4Subsea continues to refine these technologies with partners across oil & gas and offshore wind, ensuring that digital decision support remains at the core of next-generation marine operations.

About 4Subsea

4Subsea is a leading provider of digital decision support and advanced analytics for offshore energy. Through the 4insight® platform, 4Subsea empowers operators and contractors with tools to optimise safety, cost, and environmental performance.