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Report

Operational Criteria for DP-operated Vessels

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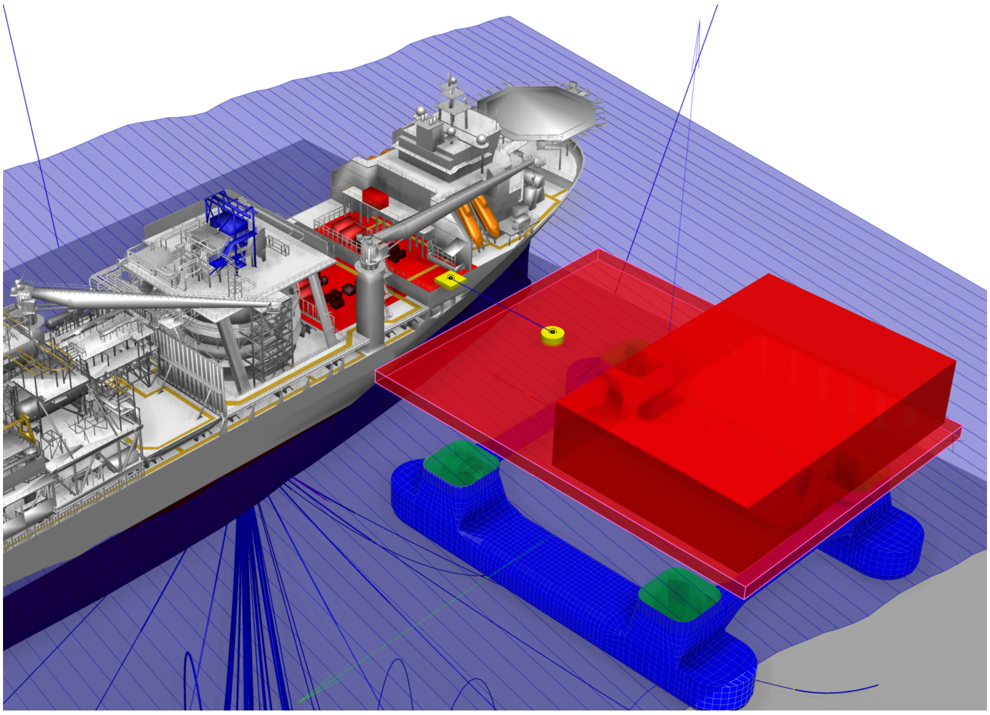

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Operational Criteria for DP-operated Vessels

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ABSTRACT

This report presents a recommended framework for establishing operational criteria for dynamically positioned (DP) vessels, transitioning from single-statistic acceptance thresholds toward risk-adjusted probability-of-non-exceedance criteria. The methodology is demonstrated through two representative marine operations: (i) station-keeping for a semi-submersible drilling unit, and (ii) relative-motion response during gangway operations between a floatel and a turret-moored FPSO.

The proposed approach uses time-domain simulation models that capture first-order wave excitation, second-order (slow-drift) wave loads, turbulent wind, and steady current, along with realistic DP control logic that includes thruster dynamics. We recommend tuning these models against model-test data to capture the damping and stiffness characteristics.

Central to the approach is the Probability of Success (PoS) metric, with the target probability set to reflect the consequences of exceedance. Ensembles of simulations across environmental conditions yield extreme-value distributions of the maximum response, from which the probability of non-exceedance for critical limit states is quantified. Common descriptors of the maximum response — the Most Probable Maximum (MPM, the mode of the extreme-value distribution) and the Expected Maximum ($E_{\max}$, its mean) — are not, in themselves, conservative acceptance criteria. For a Gumbel-distributed maximum response, the MPM is exceeded in approximately 63% of realisations and $E_{\max}$ in approximately 43%; therefore, a high quantile such as P_{90} or P_{99}, or an explicit PoS target, is preferred for risk-critical decisions.

The two case studies illustrate fundamentally different exceedance mechanisms: the drilling rig is capacity-limited, governed by thrust margin against environmental forces, whereas the gangway operation is precision-limited, sensitive to lateral and vertical relative motions that first-order waves readily excite. The report provides procedural guidance for operators, consulting engineers, and research bodies, including recommendations for selecting environmental test cases from hindcast data, defining simulation durations to ensure statistical reliability, and managing weather-forecast uncertainty through parametric, spectral, and ensemble-spectral approaches that resolve heading- and composition-dependent effects beyond a scalar α-factor.

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Contents

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Executive Summary

This report outlines a practical workflow for establishing operational criteria for dynamically positioned (DP) marine operations, with a focus on non-exceedance probabilities rather than reliance on single-statistic acceptance thresholds. The aim is to translate time-domain simulation results into operational acceptance criteria and decision support tools that explicitly account for environmental variability and forecast uncertainty. For clarity, abbreviations and symbols are summarised in Table 1, and terminology is defined in Appendix A.

To illustrate the methodology, two representative DP-operated cases have been selected:

1. Station-keeping of a semi-submersible drilling rig, evaluated through horizontal position and yaw performance.
2. A floatel-to-FPSO gangway operation, comprising a semi-submersible floatel operating at the side of a turret-moored FPSO, where operability depends on both DP station-keeping (relative position and heading) and gangway displacement and velocity limits at the connection point.

For both cases, time-domain simulation models have been developed and calibrated using decay tests to accurately represent damping and stiffness characteristics. The models incorporate key physical and control-system elements relevant to the operational environment, including first- and second-order wave loads, turbulent wind (with the NPD wind spectrum from ISO 19901-1 as a reference), steady current, and realistic DP control logic with thruster dynamics (see Section 2). A systematic variation of environmental conditions is simulated to assess the Probability of Success (PoS) and the proximity to thrust saturation, as indicated by the Thruster Utilisation Factor (TUF).

Main findings from the Case Studies

- **Drilling rig (Capacity-Limited):** The PoS boundary is typically reached first in short, steep sea states (high significant wave height, H_s, combined with low peak period, T_p). A steady collinear current provides a stabilising directional bias to the DP allocation and does not by itself reduce operability; wind influence is non-monotonic, with a slight benefit at moderate speeds and contraction once the turbulent load approaches DP saturation. Heading effects are evident: oblique headings (30°, 60°) result in a wider envelope compared to 0°/180°, where free-rotating thruster-chasing against an unstable yaw equilibrium delays thruster response, or 90°, where increased beam drag forces occur. The transition from operable to non-operable conditions is gradual rather than abrupt across the cells of the H_s–T_p scatter diagram (each cell being one combination of significant wave height and peak period). For the drilling rig, introducing a secondary, non-collinear wave system — a second group of wave components centred on a different period and arriving from a different direction than the primary sea — has only a minor effect on PoS near the operability boundary.
- **Floatel-to-FPSO gangway operation (Precision-Limited):** The operability envelopes for the floatel are restricted to a lower H_s range consistent with the reduced window selected for gangway operations. For the investigated semi-submersible floatel and gangway configuration, failures near the PoS boundary are overwhelmingly driven by relative gangway kinematics, specifically exceeding telescoping-stroke and luffing-angle limits, rather than insufficient DP thrust capacity (P_{99} TUF rarely exceeds approximately 0.5 even in non-operable cells). Wind intensity has a minor influence near head seas but a pronounced one at the off-bow headings (150°, 210°), where the wind yaw moment on the floatel degrades DP heading-keeping accuracy; relative vessel heading has a pronounced influence due to the complex, coupled motion responses of the two vessels, and the asymmetric two-vessel geometry produces materially different operability for mirrored secondary-wave directions.

Suggested Best Practices for Operational Criteria and Decision Logic

- **Risk-adjusted response metrics:** The Most Probable Maximum (MPM, the mode of the extreme-value

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distribution) and the Expected Maximum (E_{max}, its mean) are not inherently conservative acceptance criteria. For a Gumbel-distributed maximum response, which is the standard model for short-term sea-state maxima, the MPM is exceeded in approximately 63% of realisations and E_{max} in approximately 43% of realisations. Consequently, the actual peak response often surpasses both descriptors within the same sea state. We recommend linking acceptable risk levels to operational consequences and expressing them explicitly through PoS targets or high quantiles (e.g., P_{90}, P_{99}) of the maximum response. The empirical magnitude of this gap is demonstrated in the rig results, where approximately 1–2 m in H_s separates the cells where the median first reaches the limit from those where the high quantile first reaches the limit (Section 6).

- **PoS-based operational decisions:** Presenting results as PoS for a given sea state allows an operator to select an appropriate acceptance level (e.g., PoS $\geq$ 0.90) tailored to the specific operation, context, and risk level.
- **Explicit accounting for non-collinearity:** For operations sensitive to secondary seas, purely collinear criteria can be non-conservative; either explicit non-collinear simulation or additional margins applied to collinear envelopes are recommended.
- **Robust configuration control:** A frequent cause of mismatch between predicted and realised operability is the difference between the simulated configuration and the conditions actually encountered offshore. Recommended consistency checks and re-evaluation triggers are summarised in Section 6.2.

Handling Forecast Uncertainty in Practice In practice, operational decisions are frequently based on total-sea H_s and T_p, combined with a single α-factor to account for forecast uncertainty. While this approach is practical, it may be overly simplistic for operations where operability is sensitive to wave direction and sea-state composition. A more robust approach would treat wind sea and swell separately in parametric forecasts and use spectral forecasts when available. A single forecast spectrum improves the *representation* of the sea state's directional and spectral structure; representing the forecast *uncertainty* explicitly, however, requires an ensemble of spectral forecasts, from which a probability distribution of operability can be derived (Section 6.3).

The importance of this is illustrated by the heading-dependence observed in the results. Where operability degrades gradually with increasing H_s, as seen for the drilling rig at any heading and for the floatel at 180°, a forecast error of $\pm$0.5 m in H_s has only a modest effect on the predicted operability. Where operability degrades steeply, as seen for the floatel at 150° or 210°, the same forecast error can produce a large change in predicted operability. In such cases, a single scalar α-factor is inadequate, and direction-resolved forecast methods are needed (Section 6.3).

Further Work on Computational Acceleration and Operational Application A key practical challenge remains the computational effort required to assess high-resolution stochastic forecast scenarios. To enable the transition of this framework into daily operational use, a follow-up industry project is recommended. Future work, including ongoing research at SINTEF Ocean, should aim to develop computationally efficient predictive surrogate models, such as machine-learning approaches, to complement established physics-based simulation models. In our view, such a system should prioritise accuracy, with simulation speed as a secondary consideration, and always retain a physics-based fallback. For onboard deployment, the framework should be capable of ingesting daily ensemble weather forecasts to provide a dynamic, 24-hour vessel-capability timeline with visual PoS confidence bands. When combined with transparent hybrid verification and an integrated feedback loop between crew and researchers, this approach could support the development of a continuously improving and trustworthy decision-support framework for the industry (see Section 6.4).

Abbreviations and Symbols

Table 1 summarises abbreviations and symbols used throughout the report to support consistent interpretation. Special terms used in this report are explained in Appendix A.

Table 1: Abbreviations and symbols used in this report.

Abbrev./Symbol	Unit	Meaning
α	[-]	Forecast uncertainty factor (safety factor)
ALS	–	Accidental Limit State (design check against accidental load events)
ASOG	–	Activity-Specific Operating Guidelines
BL	–	Baseline (reference line for vertical coordinates and angles)
CFD	–	Computational Fluid Dynamics
CG	–	Centre of gravity
CL	–	Centreline (vessel longitudinal symmetry line)
Δ	[mt]	Displacement (metric tonnes)
Δt	[s]	Simulation time step
$\Delta\psi$	[°]	Yaw deviation / heading tolerance
DNV	–	Det Norske Veritas (recognised classification society and standards organisation)
DOF	–	Degrees of freedom
DP	–	Dynamic Positioning
$E_{\max}$	same as response	Expected maximum of short-term response maxima
ERA5	–	ECMWF fifth-generation atmospheric reanalysis hindcast dataset [1]
FPSO	–	Floating Production Storage and Offloading unit
γ	[-]	JONSWAP spectrum peakedness parameter
GM	[m]	Metacentric height ($GM = KM - KG$)
H_s	[m]	Significant wave height (in this report, of the primary (larger) wave system unless otherwise noted)
$H_{s,\text{pri}}$	[m]	Significant wave height of primary (larger) wave system (synonymous with H_s)
$H_{s,\text{sec}}$	[m]	Significant wave height of secondary (smaller) wave system
IMCA	–	International Marine Contractors Association
ISO	–	International Organization for Standardization
I_{xx}, I_{yy}, I_{zz}	[kg m^2]	Mass moment of inertia about x (roll), y (pitch), and z (yaw) axes
JONSWAP	–	Joint North Sea Wave Project
KG	[m]	Vertical centre of gravity above keel/baseline
KM	[m]	Distance from keel to metacentre
LCG	[m]	Longitudinal centre of gravity
L_{OA}	[m]	Length overall
L_{Pon}	[m]	Pontoon length (semi-submersible model)
L_{PP}	[m]	Length between perpendiculars
m	[kg]	Vessel mass
Mode A	–	Forecast-Driven Operability assessment, the preferred operational mode (Section 3.1.1)
Mode B	–	Hindcast-Driven Database assessment, used as a fallback for early planning (Section 3.1.2)

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Table 1 – continued from previous page

Abbrev./Symbol	Unit	Meaning
MPM	same as response	Most Probable Maximum of short-term response maxima
NORA3	–	Norwegian Reanalysis Archive (3 km resolution North Sea / Norwegian Sea hindcast) [2]
NPD	–	Norwegian Petroleum Directorate [3]
P_{50}	same as response	50th percentile (median) of short-term response maxima
P_{50} TUF	[-]	Median of seed-specific maximum thruster utilisation factors within an H_s–T_p bin
P_{90}	same as response	90th percentile of short-term response maxima
P_{99}	same as response	99th percentile of short-term response maxima
P_{99} TUF	[-]	99th percentile of seed-specific maximum thruster utilisation factors within an H_s–T_p bin
p_{exc}	[-]	Probability of exceedance of a specified limit over the evaluation duration
PoS	[-]	Probability of Success
QTF	varies	Quadratic Transfer Function (second-order wave excitation; units depend on response definition)
R	[m]	Horizontal position excursion/radius
R_{lim}	[m]	Position excursion limit (operational threshold for horizontal position)
RAO	varies	Response Amplitude Operator (units depend on response definition)
RIFLEX	–	Time-domain riser system analysis program in SIMA [4]
R_{44}, R_{55}, R_{66}	[m]	Radius of gyration for roll, pitch, and yaw
SIMA	–	Simulation platform (see Appendix B, [5, 6])
SIMO	–	Time-domain marine dynamics solver in SIMA (see Appendix C, [7])
TCG	[m]	Transverse centre of gravity
T_{eval}	[s]	Evaluation simulation duration (window over which response statistics are computed; T_{eval} = 3600 s in this report)
T_{init}	[s]	Initialisation (warm-up) simulation duration before the evaluation window; data discarded (T_{init} = 1200 s in this report)
T_p	[s]	Peak wave period
$T_{p,\mathrm{pri}}$	[s]	Peak wave period of primary wave system (synonymous with T_p)
$T_{p,\mathrm{sec}}$	[s]	Peak wave period of secondary wave system
TUF	[-]	Thruster utilisation factor (fraction of available thrust in use)
U_c	[m/s]	Current speed
U_{10}	[m/s]	1-hour mean wind speed at 10 m above mean sea level [8]
ULS	–	Ultimate Limit State (design check against extreme load events)
VCG	[m]	Vertical centre of gravity (same as KG)
W2W	–	Walk-to-work
WAMIT	–	3D boundary-element hydrodynamic solver [9]

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1 Introduction

1.1 Background and Scope

Marine operations are planned and executed within *operability envelopes*, multi-dimensional regions of metocean conditions within which a specified task can be safely and efficiently performed. While traditional design criteria focus on survival (Ultimate and Accidental Limit States), operational criteria focus on the safe and efficient execution of defined offshore work tasks, such as drilling, heavy lifting, or walk-to-work (W2W) transfers, within these envelopes.

Typical metocean parameters defining operational limits include the significant wave height H_s, peak wave period T_p, representative wind speeds (e.g., the 1-hour mean U_{10}), and ambient current profiles [8, 10]. Frequency-domain analyses of vessel response under these parameters can be limited in accuracy, particularly where non-linear couplings between motion, control logic, and mechanical constraints govern operability. Time-domain (dynamic) simulations explicitly capture these couplings, including interactions with features such as gangway telescoping limits and DP thrust allocation, and yield more accurate predictions of the operational window while remaining consistent with regulatory safety requirements. DNV identifies this holistic system approach as the preferred method for predicting the success of marine operations [11].

The framework presented in this report is intended to supplement existing regulatory standards (e.g., DNV [12, 13, 14], ISO [8], IMCA [15]) rather than replace them. Common descriptors of the maximum response — the Most Probable Maximum (MPM, the mode of the extreme-value distribution) and the Expected Maximum ($E_{\max}$, its mean) — are not in themselves conservative: for a Gumbel-distributed maximum response, the MPM is exceeded in approximately 63% of realisations and $E_{\max}$ in approximately 43% (Section 4.4.1). The framework therefore adopts probability-of-non-exceedance criteria, with the choice of acceptance levels discussed in Section 1.3 and the empirical scale of the conservatism gap demonstrated in Section 5.3.

1.2 Modelling Elements

The reliability of an operability assessment depends on the modelling elements retained in the time-domain simulation. For DP-controlled vessels, recommended practice is to incorporate the following coupled elements [8, 10]:

- **Hydrodynamics:** First-order wave excitation and second-order (slow-drift) wave forces.
- **Aerodynamics:** Turbulent wind forces using an appropriate spectrum, such as the NPD spectrum specified in ISO 19901-1 [8, 3] in combination with wind coefficients of the vessel's hull and superstructure included in the simulation.
- **Current:** Steady current load in combination with current coefficients of the vessel's wetted hulls included in the simulation.
- **Control systems:** Realistic Dynamic Positioning (DP) control logic, including thrust allocation and power-management constraints.

Validating vessel behaviour against full-scale data during marine operations is challenging for two reasons: the wave excitation actually encountered offshore is often uncertain or inadequately measured, and the hydrostatic and hydrodynamic vessel properties required for model verification are frequently proprietary and unavailable to third-party analysts. We therefore recommend tuning the damping and stiffness parameters of the numerical model against model-test data during model setup, as a well-tuned, model-test-validated numerical model substantially enhances the accuracy and reliability of operational predictions.

1.3 Motivation

Despite the recognised advantages of dynamic simulation, existing industry guidelines lack a unified framework for its practical application in operability assessment. Three gaps are addressed in this report:

1. **Methodology:** the absence of agreed conventions on simulation duration, statistical seed counts, and discretisation of environmental conditions.
2. **Interpretation:** ambiguity in translating dynamic response time-series into actionable operability criteria. Common descriptors of the extreme response values (MPM, $E_{\max}$) describe the most likely and the average peak value across realisations and are not in themselves conservative; high-quantile descriptors (P_{90}, P_{99}) or explicit PoS targets are preferred where the consequence of exceedance is non-trivial. The treatment is described in Sections 4.4 and 6.1.1.
3. **Forecast integration:** the absence of a unified method for incorporating weather-forecast uncertainty into the operational limit state beyond the partly overconservative α-factor.

This report addresses these gaps by providing a reproducible workflow that converts simulation results into transparent, risk-adjusted decision support.

1.4 Scope of this Report

The scope of this report is to establish a generic framework for time-domain operability assessment of DP-operated marine operations, demonstrated through two representative case studies:

1. Station-keeping of a semi-submersible drilling rig.
2. Relative-motion response during gangway operations between a semi-submersible DP-floatel and a turret-moored FPSO.

Specifically, the report addresses:

- the methodology for developing multi-body time-domain prediction models;
- procedures for selecting representative environmental load cases by screening hindcast data;
- the statistical treatment of simulation ensembles to derive the Probability of Success (PoS);
- the handling of uncertainty in weather forecasting and model sensitivity;
- recommendations for establishing acceptance criteria for marine operations, including the choice between peak-response descriptors (MPM, $E_{\max}$, P_{50}) and high-quantile descriptors (P_{90}, P_{99}, or explicit PoS targets, Section 6.1.1).

1.5 Structure of the Document

The document is organised to follow the workflow of an operability assessment:

- Chapter 2 (Numerical Models): recommended practices for equations of motion, hydrodynamic coefficients, and control-system representations.
- Chapter 3 (Environment and Data Selection): strategies for processing hindcast data and defining representative collinear and non-collinear load cases.
- Chapter 4 (Simulation Setup): procedures for simulation duration, integration schemes, and the statistical methodology for extreme-value estimation.
- Chapter 5 (Simulation Results): demonstration of the methodology applied to the drilling rig and floatel case studies, illustrating the derivation of PoS envelopes.
- Chapter 6 (Conclusions and Recommendations): summary of the proposed framework, including acceptance criteria and implementation guidance for operational decision support.

2 Numerical Models

To establish valid operational criteria, the numerical model must accurately reflect the vessel's physical properties, hydrodynamic behaviour, and control-system logic. This section provides recommended modelling practices for such analyses.

For the purpose of demonstrating the methodology in this report, three representative numerical models were developed:

1. A **Semi-submersible drilling rig** ($\approx$ 39,000 mt), based on the Exwave hull [16] (Enclosure E-1.2).
2. A **Generic floatel** ($\approx$ 30,000 mt), scaled from the semi-submersible drilling rig hull (Enclosure E-1.5).
3. A **Turret-moored FPSO** ($\approx$ 148,000 mt), representing a standard production unit (Enclosures E-1.9 and E-1.10).

These models were implemented in the SIMA/SIMO time-domain simulation framework [5, 6, 7].

2.1 Coordinate System and Conventions

A consistent reference frame is essential for multi-body simulations. The standard convention used in this framework (and recommended for regulatory reporting) is a right-handed system (Enclosure E-1.1):

- Origin: Located at the mean free surface ($Z = 0$), centreline ($Y = 0$), and midship section ($L_{pp}/2$).
- Directions: Positive X forward (Surge), positive Y to port (Sway), positive Z up (Heave).
- Environment: 0° corresponds to the following sea case (waves approaching from the stern), while 180° represents head seas (waves approaching from the bow).

2.2 Modelling Best Practices and Applicability

Operational predictions are most reliable when the numerical model closely matches the actual vessel's configuration during operation. Differences between the simulated and actual vessel state are a primary source of prediction error and therefore of operational risk. We therefore recommend explicitly defining and verifying the following parameters.

1. Mass Distribution and Inertia: The simulation model should reflect the operational load condition (draft and trim). Importantly, the radii of gyration (R_{44}, R_{55}, R_{66}) should determine the rotational inertias (I_{xx}, I_{yy}, I_{zz}) to ensure precise dynamic responses. *Recommendation:* A sensitivity analysis should be performed if the specific loading condition (e.g., variable deck load) varies significantly ($> 10\%$) during the operation.

2. Restoring Stiffness (Stability). The metacentric height ($GM = KM - KG$) influences the natural periods in roll and pitch. Since GM determines the vessel's resonant response, the VCG (KG) used in simulations must accurately reflect the actual stability calculations for the operation.

3. Damping Representation: While potential theory calculates radiation damping, it neglects viscous effects, which are critical for resonant motion damping (especially for roll). We recommend calibrating linear or quadratic damping coefficients against model-test data, supplemented where appropriate by CFD results or full-scale decay measurements [10, 17]. Unverified rule-of-thumb damping levels may yield non-conservative operational limits and should not be used without verification against model-test or measured data.

4. DP and Thruster Logic: Station-keeping performance depends strongly on the thrust-allocation strategy. The simulation should replicate the mode actually used offshore:

- **Free-rotating mode:** thrusters rotate to the demanded direction, maximising the available thrust envelope but introducing azimuth rotation latency in addition to thrust ramp-up time. We recommend modelling realistic rotation speeds for the thruster type used, along with ramp-up times, maximum thrust limits, and thrust deductions due to thruster-to-thruster or thruster-to-hull interactions.
- **Biased / fixed (star) mode:** thrusters are pre-positioned in opposing directions, typically to increase response time and minimise azimuth drive wear; thrust is generated by ramping up the thruster output along fixed axes without azimuth rotation. In simulation, the biased mode should be modelled by fixing the thruster azimuth angles to the preset values.

In our opinion, simulations should not use a perfect-allocation assumption (infinite rotation speed) as a substitute for either mode: it neither represents the fixed kinematics of the biased mode nor the finite rotation latency of the free-rotating mode, and will yield non-conservative operational limits.

2.3 Semi-Submersible Models (Drilling rig & Floatel)

The two semi-submersible models introduced above represent standard station-keeping operations. The drilling rig demonstrates position-keeping criteria for a single vessel, while the floatel demonstrates relative-motion criteria for two-vessel gangway operations against a turret-moored FPSO. Their geometric and mass properties are listed in Table 2; visualisations of the panel models and hull geometries are provided in Enclosures E-1.2 and E-1.5.

Table 2: Model properties for the semi-submersible case studies.

Parameter	Unit	Drilling rig	Floatel
Displacement	[mt]	38,890	32,696
Draft	[m]	23.0	19.0
$GM_{Transverse}$	[m]	3.0	4.5
Radii of gyration (Roll/Pitch/Yaw)	[m]	36.1 / 34.4 / 42.3	31.0 / 30.0 / 33.0

Hydrodynamic and Aerodynamic Models: First-order wave excitation, mean drift forces, and second-order quadratic transfer functions (QTFs) were calculated using the 3D potential-theory code WAMIT [9] on 81 wave periods spanning 3.5 to 60 s, for a representative water depth of 300 m. Detailed drift-force coefficients are documented in Enclosure E-1.4 (drilling rig) and Enclosure E-1.7 (floatel). Wind and current coefficients were derived from wind-tunnel tests conducted in earlier project work at SINTEF Ocean and scaled to the specific hull and deck geometry of each unit. For the floatel, the windage area was adjusted to 1,900 m^2 (side-projected at zero heel) to represent the accommodation block; see Enclosures E-1.3 and E-1.6.

Damping & Natural Periods: To account for viscous effects, a linear damping matrix corresponding to $\approx$ 3.5 – 4% of critical damping was applied. The damping contribution was validated against decay tests (Table 3), ensuring the model reproduces the correct resonant response. The decay time traces of these verification tests are provided for the drilling rig in Enclosure E-2.1 and for the floatel in Enclosure E-2.3.

Table 3: Verified natural periods (T_n) and relative damping (ζ) from decay tests.

	Heave		**Roll**		**Pitch**	
Unit	T_n [s]	ζ [-]	T_n [s]	ζ [-]	T_n [s]	ζ [-]
Drilling rig	23	3%	72	5%	57	4%
Floatel	21	4%	42	5%	35	4%

DP System Model: Both rigs are equipped with four 4 MW azimuth thrusters. The DP controllers used in this study were tuned in a research setting to produce response characteristics representative of industry practice, summarised in Table 4 (response periods 135–195 s, relative damping 56–67%). Step response plots demonstrating the tuned behaviour are provided in Enclosure E-2.2.

For studies in which a specific vessel controller is available, we recommend replacing the generic controller with the actual controller in the simulation framework to reduce uncertainty introduced by generic tuning. Vessel-specific controller integration follows the same DP commissioning workflow used in delivery (simulation tuning followed by sea-trial validation) and is fully compatible with the methodology presented here.

Table 4: Results of DP system documentation test (step test).

Parameter	Unit	Surge	Sway	Yaw
Period first oscillation	[s]	135	160	195
Relative damping	[-]	67%	56%	63%

2.4 Turret-Moored FPSO Model

The second case study features a ship-shaped production unit (FPSO, $L = 265$ m, displacement ≈ 148,000 mt) moored via a generic internal turret. This model demonstrates the complexity of coupled dynamics in close-proximity operations: the FPSO has a DP heading control to maintain a desired heading. The floatel operates at the FPSO's side at a 90° relative heading and thus experiences the same wave motion on the beam. The gangway is deployed from the floatel's fore section, slewed approximately 90° from the floatel's centreline to reach the FPSO's side. The geometry is illustrated in Enclosure E-1.8. The specific wind and current coefficients used for the FPSO are provided in Enclosure E-1.11, and the wave drift coefficients are listed in Enclosure E-1.12.

Coupled Modelling Elements: Unlike the semi-submersibles, the FPSO model includes the coupling between the hull and the station-keeping system:

- **Mooring and risers:** modelled as non-linear restoring forces, including mooring line current drag.
- **Turret damping:** the model includes quadratic yaw damping representing rotational friction at the turret bearing and hydrodynamic drag on the hull during yaw motion.

Coupled Decay Verification: Decay tests were conducted on the fully coupled system (hull, risers, and thrusters). As shown in Table 5, obtaining clean decay curves for turret-moored vessels is challenging because of the strong coupling between sway and yaw. The uncoupled hull decay tests are documented in Enclosure E-2.4; the fully coupled decay time-traces, which represent operational conditions, are provided in Enclosures E-2.5 (surge/sway/heave) and E-2.6 (roll/pitch/yaw).

Table 5: Decay test results for FPSO (coupled system of mooring lines, risers, and thrusters).

Parameter	Unit	Surge	Sway	Heave	Roll	Pitch	Yaw
Period first oscillation	[s]	200	~300	10.5	18.3	9.5	170
Relative damping	[-]	7%	36%	14%	5%	15%	37%

Verification of FPSO Heading Control: For weathervaning units, the ability to maintain heading against oblique weather is essential. Before conducting statistical simulations, this capability should be verified through a benchmark simulation under non-collinear environmental loading (wind and current at 150°, waves at 180°, Enclosure E-2.7). With assistance from the DP system, the FPSO maintained its heading set-point (15°) after the initial transient, confirming that the thrust-allocation logic operates correctly within the time-domain simulator.

3 Methodology and Environmental Modelling Strategy

This chapter describes how a complex environmental scatter, representing the meteorological and oceanographic variability at a given site, is converted into a tractable set of simulation cases that characterises the vessel's operational envelope. Two complementary approaches are described: a forecast-driven approach (preferred for operational decision support) that targets the upcoming weather window with its uncertainty band, and a hindcast-driven approach (demonstrated here as a fallback for early planning) that builds a generic decision-support database from long-term metocean statistics. The chapter then introduces the regime distinction (capacity-limited vs precision-limited) that determines which environmental dimensions matter most for the data reduction, the computational strategies that make a high-resolution sweep tractable, and the procedure for reducing raw hindcast data into representative simulation inputs.

3.1 Two Approaches to Simulation-Set Generation for Operability Prediction

The numerical methodology serves two complementary purposes in the lifecycle of a marine operation. While the core physics engine (vessel model and time-domain solver) remains the same, the environmental inputs and the interpretation of the results vary significantly between the two approaches.

3.1.1 Mode A: Forecast-Driven Operability (Preferred)

In the execution phase, the goal is to verify whether the upcoming operation can be performed within a specified forecast window. This mode replaces the traditional use of static α-factors [18] with a physics-based evaluation of the vessel's ability to withstand a specific, upcoming weather pattern under the actual planned heading and operational configuration.

- **Input:** A specific time-series forecast (wind, wave, current) covering the planned operational duration, ideally including ensemble predictions with directional energy spectra and uncertainty bandwidths (e.g., P10, P50, P90).
- **Method:** The simulation reproduces the forecast time windows directly, including the actual planned heading, operational configuration, and uncertainty propagation through the ensemble.
- **Output:** A dynamic "Go/No-Go" timeline or a PoS specific to the forecast time frames or the operational window.

The advantage of this approach is that the simulated environment reliably reproduces the expected on-site conditions, including the vessel's actual heading and the time-varying evolution of sea state and wind over the planned operational window. The computational effort is aligned with the operationally relevant forecast window rather than with a generic synthetic matrix.

3.1.2 Mode B: Hindcast-Driven Database (Fallback)

If specific forecasts are unavailable (as is common in the early planning stage) or on-the-fly simulation capacity is unavailable during execution, the aim is to identify the limiting environmental criteria that populate the ASOG. Mode B is the approach demonstrated in the case studies presented in this report.

- **Input:** A structured matrix of synthetic environmental conditions, derived from site-specific hindcast statistics, covering the range of H_s and T_p over which operability is to be determined.
- **Method:** A systematic sweep across the matrix is conducted to identify the boundary conditions where operability becomes uncertain (the transition zone between "Green" and "Red" zones).
- **Output:** Operability envelopes (e.g., polar plots or H_s–T_p limit tables) that form the environmental decision criteria within the ASOG, serving as a decision-support database for the crew.

The hindcast-driven approach is necessarily a compromise: each simulated condition is a representative idealisation rather than a reliable reproduction of the conditions actually encountered during any single operation. This compromise is the price paid for transferability and early-planning utility. The data-reduction procedure described in Section 3.4 aims to minimise the compromise.

3.2 Regime-Driven Environmental Sensitivity

To establish robust criteria, it is essential to recognise that the maximum environmental load does not always correspond to the minimum safety margin. The framework distinguishes between two governing regimes that determine which environmental dimensions are most important for operability and, consequently, which environmental statistics must be resolved in the simulation matrix.

3.2.1 The Capacity-Limited Regime

In operations subject to high mean environmental loads (e.g., a drilling rig in rough seas, limited by horizontal 3-DOF motions), the primary constraint is the overall force generation required to counteract environmental loads. The governing physics are power availability and thruster saturation, characterised by high TUFs. In this regime, the additive combination of collinear wind, wave, and current produces the worst-case mean drift force and the smallest remaining thrust margin. Operability is therefore dominated by the magnitude of the directionally aligned environmental loads, and the simulation matrix must resolve the H_s–T_p scatter, as well as the magnitudes of the conditional wind and current that co-occur within each primary wave bin.

3.2.2 The Precision-Limited Regime

In operations governed by strict 6-DOF relative-motion limits (small allowable footprint, as in floatel-to-FPSO gangway operations), the limiting factor is station-keeping accuracy rather than power. The physics involved are first-order wave-frequency motions, low-frequency drift oscillations, and the DP system's response characteristics. In this regime, secondary-wave directionality and the conditional joint distribution of primary and secondary wave systems become first-order drivers of operability. The simulation matrix must resolve not only the primary H_s–T_p scatter but also the bin-conditional secondary-wave statistics ($H_{s,\mathrm{sec}}$, $T_{p,\mathrm{sec}}$) and their relative directions.

Implications for DP System Configuration: The regime distinction also informs DP system choices that are not parameterised in the environmental matrix itself. The choice of filter time constants and controller gains, the use of feed-forward target-motion input (Section 6.3), and the selection of thruster-allocation strategy (free-rotating vs biased/star, Section 2.2) are all influenced by the expected environmental loading and its directional consistency. These configuration choices are made at the model-setup stage (Chapter 2) and are not parameters of the environmental sweep. As a general principle, free-rotating thruster allocation is preferred in the capacity-limited regime, where maximising the available thrust envelope is the primary objective. In contrast, biased or star mode is preferred in the precision-limited regime, where a preset directional bias reduces azimuth rotation latency and improves the DP system's ability to track rapid changes in relative position.

3.3 Computational Strategy and Efficiency

A high-resolution simulation campaign in Mode B can involve a large number of conditions (primary H_s–T_p bins × secondary-wave variants × wind and current sensitivities), each of which requires an ensemble of seeds for statistical reliability. The strategies described below reduce the total simulation effort without compromising the operational boundary's resolution. They are most directly applicable to Mode B; in Mode A, the simulation set is already narrowed to the forecast window, and aggressive computational reduction is generally less critical.

3.3.1 The Transition Zone Strategy

Simulating the full range of wave heights is unnecessary. Conditions with very low H_s are clearly operable, while conditions with very large H_s are clearly non-operable. The simulation effort should focus on the *Transition Zone*, that is, the range of H_s over which the vessel's capability is uncertain and must be determined by simulation. This simulation approach concentrates resolution on the boundary that determines the Go/No-Go decision while minimising effort spent confirming what is already known.

3.3.2 Adaptive Sampling (Fail-Fast Loop)

A robust statistical assessment typically requires a large number of seeds (e.g., 100) per condition. Running complete seed sets for clearly non-operable conditions is wasteful. The framework therefore uses a within-condition early-rejection loop:

1. **Screening Batch:** Conduct an initial run of 5 to 10 realisations (seeds) for the target environmental condition.
2. **Early Rejection:** Inspect the results immediately. If all of the screening seeds exceed the defined limits, the condition is flagged as non-operable.
3. **Termination:** The remaining seeds are cancelled for this condition.
4. **Full Execution:** If the screening batch yields mixed results (borderline operability) or all seeds remain below the defined limits, the remaining seeds are executed to compute the precise PoS.

A complementary between-condition exclusion rule is applicable in hierarchical simulation campaigns. Where a simpler configuration has shown an H_s–T_p bin to be fully operable with the full collinear sea state present (primary and secondary components aligned), that same bin can be excluded from the more complex non-collinear configuration, on the expectation that redistributing the same total wave energy across direction is unlikely to move a fully operable cell across the operability boundary. This is a screening simplification to conserve computational effort, not a guarantee; where an operation is known to be acutely sensitive to secondary-wave direction, the exclusion should be reviewed. Such excluded cells appear as white regions in the operability matrices, indicating areas where the vessel is expected to remain within the operable envelope. The implementation used in this report is described in Section 4.3.

3.4 Environment and Hindcast Data Selection

For the generic example presented in this report (Mode B), hindcast data is used to establish realistic correlations among wind, wave, and current. The objective of this section is to describe how an extensive hindcast dataset can be reduced to a minimal, representative set of cases that covers the Transition Zone, that is, the range of environmental conditions between a clearly operable low-sea-state and a clearly non-operable heavy-sea scenario.

3.4.1 Overview of the Reduction Procedure

The proposed procedure converts raw hindcast data (multidirectional waves, wind, and current) into inputs suitable for simulation:

1. **Source Data:** Download raw or statistical hindcast data for the sea area of interest (e.g., NORA3/ERA5, [2, 1, 19, 20]) and create a scatter diagram of the total sea (Section 3.4.2 and Figure 1).

2. **Implement the Transition Zone Strategy:** Instead of modelling the entire range of wave heights (e.g., $H_s \in [0, 10]$ m), narrow the dataset to the operational window of interest as outlined in Section 3.3.
   - Exclude H_s ranges that are clearly operable (Green Zone) or clearly non-operable (Red Zone).
   - For the reference cases, this results in a targeted window of $H_s \in [2.5, 7.5]$ m for the drilling rig and $H_s \in [2.5, 5.5]$ m for the FPSO-to-floatel gangway operation (Figure 2).
3. **Wave Component Separation into Primary and Secondary Wave:**
   - Designate the wave component with the higher significant wave height as the primary wave, and the smaller component as the secondary wave.
   - Remove samples with negligible secondary energy ($H_{s,\text{sec}} < 0.5$ m or $H_{s,\text{sec}} < 1.0$ m depending on the wave sensitivity of the operational exceedance characteristics). This filter is applied as a secondary system below a certain threshold, where contributions from secondary systems are negligible in this report's screening (see Section 3.4.3); the remaining primary energy is unaffected by this filter and continues to drive the response in the same way as in any single-system case. The appropriate thresholds are case-specific and should be verified against the sensitivity of operability to $H_{s,\text{sec}}$. In the present study, a threshold of 0.5 m was applied to both case studies; in retrospect, a threshold of 1.0 m would have been adequate. The sensitivity of operability to $H_{s,\text{sec}}$ is reported in Section 4.2.
   - Prune sparsely populated peak-period bins outside the main wave-period range. The hindcast scatter contains rare combinations at the extreme tails of T_p (typically $T_p < 5$ s or $T_p > 18$ s) where sample counts are insufficient for reliable operational statistics. These bins are removed to avoid generating simulation cases anchored to under-sampled hindcast input. The retained range covers the operationally relevant wind-sea and swell band for the site; the corresponding behaviour at the lower-T_p edge of the simulation matrix is discussed in Section 5.1.
4. **Statistical Screening:** Calculate P10, P50, and P90 percentiles for secondary wave height, secondary peak period, relative direction, and wind speed within each primary wave bin ($H_{s,\text{pri}}, T_{p,\text{pri}}$) (Figure 3).

Hs\Tp	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0.5	112	753	2680	6593	3403	5772	2045	3490	1122	1270		322	298	80		31		2		1		
1.0	2	1480	5754	16072	11300	21370	5935	7979	3326	5896		1293	1081	201		151		9		3		
1.5		108	3678	14994	10418	24767	10522	8468	3334	5593		1745	1991	291		119		22		6		2
2.0			477	9151	11106	20543	10456	10050	4663	4765		1821	2252	389		163		9				
2.5			18	2236	6909	20452	8018	9272	5780	4220		1463	2066	330		180		4		3		
3.0				352	2363	17210	6811	6504	4792	3872		1329	1850	416		179		14		6		
3.5				20	424	10280	7082	5270	3497	3399		1246	1393	407		193		16				
4.0				2	36	4177	6110	4735	2742	2581		1118	919	224		184		6		1		
4.5					1	1172	4021	4318	2277	1754		828	705	164		111		10		2		
5.0						239	1789	3485	2037	1450		707	505	131		100		2				
5.5						37	624	2219	2054	1224		540	359	103		73						
6.0						2	141	1191	1719	1094		552	294	62		60		1				
6.5							14	459	1246	806		483	248	66		18		3				
7.0							1	137	635	622		368	247	46		17		10				
7.5								22	318	516		311	157	33		26						
8.0								2	131	383		191	151	40		15						
8.5									38	238		195	100	38		4						
9.0									7	122		106	60	49		4						
9.5									1	86		104	65	40		3						
10.0										35		80	43	36		2						
10.5										9		54	34	11		10						
11.0										2		49	27	11		2						
11.5												8	20	12		3						
12.0												6	11	11								
12.5												1	7	10		1						
13.0													4	6		1						
13.5													6	2		1						
14.0													1	4								
14.5													2	4								
15.0														2								
15.5														1								

Figure 1: Annual scatter diagram of total significant wave height $H_{s,\text{tot}}$ vs. peak period T_p.

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	2295	8257	18224	7180	8870	5771	4056		1283	1859	284
3.0	163	2146	17251	4647	5203	4642	3783		1266	1497	416
3.5	8	218	9888	6110	2851	2926	3222		1235	896	268
4.0		10	3728	5868	3194	1329	1818		999	583	128
4.5			898	3797	3749	1205	948		780	432	90
5.0			149	1664	3087	1574	556		494	390	84
5.5			16	530	2082	1871	500		279	273	55
6.0			3	113	1063	1583	748		167	160	69
6.5				10	442	1120	695		183	78	56
7.0				3	131	611	614		207	48	35
7.5					14	302	490		237	33	17

Figure 2: Reduced annual scatter diagram using bin midpoints for primary wave $H_{s,\mathrm{pri}}$ vs. $T_{p,\mathrm{pri}}$.

3.4.2 Scatter Diagram and Quality Control

Hindcast data are typically available at 1- or 3-hourly temporal resolution as time series of spectral parameters. For this study, 1-hourly NORA3 data are used [2, 19]. The total significant wave height $H_{s,\mathrm{tot}}$ is calculated from the primary (larger) and secondary (smaller) components:

$$H_{s,\mathrm{tot}} = \sqrt{H_{s,\mathrm{pri}}^2 + H_{s,\mathrm{sec}}^2} \tag{1}$$

Figure 1 shows the annual scatter diagram for the selected reference location.

3.4.3 Secondary Wave Statistics

To account for the complexity of multi-modal seas, the reduced dataset (Figure 2) preserves the variability of the secondary wave system rather than collapsing it into a single representative value. For each bin of the primary wave $(H_{s,\mathrm{pri}}, T_{p,\mathrm{pri}})$, the conditional distribution of the secondary wave is characterised by computing the 10th, 50th, and 90th percentiles of both the secondary significant wave height $H_{s,\mathrm{sec}}$ and the secondary peak period $T_{p,\mathrm{sec}}$ (Figure 3).

P50 Hs of secondary wave [m]

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.3	1.2	1.3	1.4	1.3	1.3	1.3	1.3	1.4	1.4	1.5
3.0	1.3	1.2	1.2	1.4	1.5	1.3	1.4	1.4	1.4	1.5	1.5
3.5	1.2	1.3	1.1	1.3	1.6	1.7	1.6	1.6	1.5	1.7	1.6
4.0		0.9	1.1	1.1	1.4	1.9	1.9	1.7	1.6	1.8	2.4
4.5			1.1	1.0	1.2	1.9	2.1	2.1	2.0	2.0	1.8
5.0			1.2	1.0	1.1	1.4	2.4	2.3	2.3	2.3	2.1
5.5			1.7	1.1	1.0	1.2	1.6	1.9	2.2	2.7	2.3
6.0			1.7	1.1	1.0	1.0	1.3	1.8	2.2	2.8	2.4
6.5				1.6	1.0	0.9	1.0	1.3	1.6	2.5	2.5
7.0				1.0	1.0	0.8	0.8	0.9	1.0	1.8	1.7
7.5					0.7	0.7	0.7	0.7	0.7		

P90 Hs of secondary wave [m]

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	2.0	2.0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.3	2.3
3.0	2.3	2.1	2.3	2.5	2.5	2.5	2.6	2.6	2.5	2.6	2.6
3.5	1.5	2.2	2.3	2.8	2.8	2.9	3.0	2.9	2.9	3.0	3.1
4.0		1.2	2.2	2.6	3.1	3.4	3.3	3.2	3.1	3.3	3.7
4.5			2.3	2.2	3.1	3.7	3.6	3.7	3.8	3.9	3.9
5.0			2.0	2.1	2.6	3.5	4.2	4.1	4.0	4.5	4.1
5.5			3.0	2.1	2.2	2.9	4.1	4.0	3.9	4.4	4.2
6.0			1.7	2.2	2.1	2.3	3.0	3.3	3.6	4.2	3.8
6.5				2.2	1.9	2.0	2.4	2.7	3.1	3.5	3.5
7.0				1.4	1.7	1.7	1.8	1.8	1.9	2.7	2.2
7.5					0.9	1.2	1.3	1.2	1.1		

P10 Tp of secondary wave [s]

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	7.6	7.6	5.2	4.3	4.3	3.9	4.3	4.3	4.3	4.3	4.3
3.0	8.4	8.4	7.6	4.7	4.3	3.9	3.9	3.9	3.9	4.3	4.3
3.5	9.7	8.4	9.2	5.7	4.7	4.3	3.9	3.9	3.9	4.3	4.7
4.0		8.6	9.2	10.2	5.7	4.7	3.9	3.7	3.6	4.3	5.1
4.5			9.2	10.2	8.4	5.7	4.7	4.3	3.9	3.9	4.3
5.0			9.2	10.2	10.2	6.9	5.2	5.0	4.7	4.7	4.7
5.5			9.1	10.2	11.2	10.2	5.7	5.2	4.7	4.3	3.9
6.0			13.5	10.2	11.2	11.2	8.4	6.4	4.3	4.3	4.3
6.5				11.1	11.2	11.2	10.2	7.4	4.7	4.7	6.3
7.0				14.9	11.2	11.2	10.2	11.2	12.3	6.2	5.9
7.5					12.3	11.2	11.2	12.3	13.5		

P90 Tp of secondary wave [s]

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	13.5	14.9	13.5	9.2	8.4	7.6	7.6	7.6	7.6	7.6	7.6
3.0	12.3	14.6	14.9	11.2	9.2	8.4	8.4	8.4	8.4	8.4	8.4
3.5	11.7	13.5	14.9	13.5	12.3	9.2	9.2	8.8	8.4	9.2	9.2
4.0		12.8	14.9	14.9	13.5	12.3	10.2	10.2	10.2	9.2	10.2
4.5			14.9	14.9	14.9	13.5	11.2	11.2	11.2	10.2	10.2
5.0			14.9	14.9	14.9	14.9	13.5	12.3	11.2	11.2	10.2
5.5			12.7	14.9	14.9	14.9	14.9	13.0	11.2	11.2	10.2
6.0			14.6	14.9	14.9	14.9	14.9	14.9	14.9	11.2	10.2
6.5				13.5	14.9	14.9	16.4	16.4	16.4	11.2	10.2
7.0				14.9	14.9	14.9	16.4	16.4	16.4	16.5	7.6
7.5					14.1	14.9	16.4	16.9	17.5		

Figure 3: Bin-conditional secondary-wave statistics: $H_{s,\mathrm{sec}}^{P50}$ and $H_{s,\mathrm{sec}}^{P90}$ (top), $T_{p,\mathrm{sec}}^{P10}$ and $T_{p,\mathrm{sec}}^{P90}$ (bottom), evaluated within each primary wave bin.

These percentiles serve as inputs to the simulation campaign, defining the range of secondary-wave conditions that may co-occur within each primary bin. As Figure 3 shows, the P90 secondary wave height generally increases with the primary wave period, reflecting the correlation between developed seas and longer-period swell at the site. The conditional secondary-period statistics ($T_{p,\mathrm{sec}}^{P10}$ and $T_{p,\mathrm{sec}}^{P90}$) are used to bracket the period range over which the simulation matrix is swept. For each primary bin, the simulation matrix sweeps $T_{p,\mathrm{sec}}$ across the full conditional range from $T_{p,\mathrm{sec}}^{P10}$ to $T_{p,\mathrm{sec}}^{P90}$ in 1 s increments and records the secondary $T_{p,\mathrm{sec}}$ producing the lowest PoS as the reported case (Section 4.2); the reported envelope therefore reflects the worst surviving secondary-period combination at the site, rather than a single conditional statistic such as the P50.

3.4.4 Wind and Current Statistics

Wind Statistics Wind speeds (U_{10}) are grouped by primary wave conditions in the same conditional manner as the secondary-wave statistics. While the hindcast data show a continuous range of wind speeds (Figure 4) across the primary wave peak periods $T_{p,\mathrm{pri}}$, the generic simulation framework simplifies this distribution to fixed levels ($U_{10} \in \{5, 10, 20\}$ m/s) to ensure comparability across primary wave bins. This simplification allows the sensitivity of operability to wind speed to be assessed systematically and is consistent with the discrete wind speed levels typically communicated in operational weather forecasts.

Current Statistics The current is modelled using site-specific statistics. For the generic example, a sensitivity check is used to assess the operability-degrading effect of low versus high current conditions, framed in terms of the operational regime:

- **Capacity case:** Collinear current set to the site-specific P99 value (e.g., $U_c = 0.70$ m/s) to test the worst-case mean-drift loading.
- **Precision case:** Reduced or zero current to assess low-frequency stability under slack conditions, where the absence of a steady directional bias may produce more variable thruster activity.

P10 wind speed [m/s]

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	12.7	10.6	8.1	7.0	6.8	6.8	7.1	7.1	7.0	7.1	7.5
3.0	13.7	13.6	10.5	7.1	6.8	6.4	6.6	6.8	6.9	6.9	6.7
3.5	13.5	15.0	12.3	8.8	7.2	6.8	6.6	6.6	6.7	7.1	7.4
4.0		13.0	14.2	12.4	8.7	7.3	6.2	6.2	6.2	7.3	7.8
4.5			16.5	14.1	12.3	8.8	7.2	7.0	6.8	7.0	6.8
5.0			18.3	16.4	14.1	10.1	7.8	7.5	7.3	7.7	7.6
5.5			17.8	18.4	15.3	14.1	8.5	7.9	7.2	7.2	6.6
6.0			18.6	20.5	16.9	14.9	11.7	9.2	6.7	7.0	6.6
6.5				19.7	19.1	16.0	14.9	11.0	7.1	8.3	9.1
7.0				20.4	19.6	17.8	15.6	15.9	16.1	8.6	8.0
7.5					21.8	18.3	16.5	16.4	16.4		

P50 wind speed [m/s]

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	14.5	13.0	11.4	9.4	9.4	9.4	9.6	9.6	9.7	9.6	10.2
3.0	17.1	15.4	13.1	10.5	9.6	9.4	9.5	9.6	9.7	9.7	9.9
3.5	15.1	17.9	15.0	13.2	10.6	10.1	9.9	9.9	9.9	10.1	10.4
4.0		14.3	16.7	15.0	13.7	10.8	10.4	10.1	9.8	10.5	12.5
4.5			18.6	16.8	15.1	13.8	11.0	10.8	10.7	11.1	10.7
5.0			20.4	18.6	16.9	15.2	12.0	11.6	11.2	11.3	10.6
5.5			23.0	20.2	18.4	16.5	15.1	13.1	11.2	11.7	11.7
6.0			22.6	21.9	19.9	17.9	16.4	14.0	11.7	12.1	10.6
6.5				24.1	21.5	19.4	17.1	16.4	15.7	11.5	11.5
7.0				21.1	22.6	21.2	18.7	18.0	17.4	10.9	9.2
7.5					23.4	21.8	19.0	18.4	17.7		

P90 wind speed [m/s]

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	16.4	14.6	13.2	11.9	11.7	12.2	12.5	12.5	12.6	12.3	13.2
3.0	19.1	17.1	15.0	13.3	12.3	12.2	12.7	12.7	12.8	12.9	13.2
3.5	17.2	19.5	16.9	14.9	14.0	12.8	12.9	13.2	13.6	13.3	14.0
4.0		20.2	18.6	16.7	15.5	14.2	13.2	13.4	13.5	13.8	14.8
4.5			20.4	18.2	16.9	16.0	14.6	14.3	14.0	14.2	14.8
5.0			22.8	20.1	18.5	17.1	16.0	15.1	14.2	14.9	14.4
5.5			24.2	21.9	20.0	18.3	17.4	15.8	14.2	14.6	15.0
6.0			22.7	23.3	21.5	19.7	18.6	17.7	16.9	14.2	14.2
6.5				26.2	22.9	21.1	19.6	19.1	18.5	13.8	13.4
7.0				21.8	24.3	22.7	20.6	19.8	19.0	18.6	10.1
7.5					24.8	23.6	21.3	20.4	19.5		

Figure 4: P10, P50, and P90 wind speeds [m/s] per primary-wave bin.

4 Simulation Setup and Numerical Modelling

This chapter describes the specific numerical settings, vessel models, and operational constraints used in the simulations. It links the definitions of numerical models (Section 2), the choice of environmental conditions (Section 3), and the simulation results (Section 5) by explaining how the time-domain simulations are modelled, executed, and analysed.

All time-domain simulations were performed within SINTEF Ocean's SIMA framework, using the SIMO physics engine to calculate hydrodynamic responses, mooring characteristics, and DP control actions [6, 7].

4.1 Software and Physics Settings

To capture the relevant non-linear physics of the coupled vessel–mooring–thruster system, the time-domain solver was configured as follows:

- **Integration Method:** A Runge-Kutta-type predictor-corrector scheme is used for stable integration of the coupled vessel–mooring equations across all simulations in this report.
- **Time Step:** A fixed time step of $\Delta t = 0.1$ s is used. With wave periods of interest at $T \geq 3.0$ s, this resolution provides at least 30 time steps per wave period, comfortably above the conventional 20-step threshold for time-domain marine simulation, and is sufficient to resolve the control-system dynamics without aliasing.

4.2 Environmental Implementation

While Chapter 3 describes the selection strategy for environmental conditions (Transition Zone Strategy), this section specifies the spectral formulations used to produce the stochastic time-series inputs in the solver. To ensure reproducibility within this general framework, we use the formulations below.

4.2.1 Wave Spectrum and Directionality

Irregular waves are modelled using the JONSWAP sea spectrum with the following parameters:

- **Wave spectrum:** Modelled as single or dual independent wave systems (primary wind sea and secondary swell). To maintain a conservative estimate of vessel response, each wave system is modelled as a long-crested JONSWAP spectrum.
- **Peakedness (γ):** A variable peakedness parameter is calculated from H_s and T_p following DNV-RP-C205 [10] to characterise the typical energy distribution of North Sea and North Atlantic conditions.
- **Directionality:** Consistent with the regime definitions in Section 3.2, the framework utilises two configurations:
    1. **Collinear case:** Primary waves, wind, and current are aligned to represent the maximum additive mean drift loads. These cases are particularly relevant when the operation is capacity-limited.
    2. **Non-collinear case:** A secondary wave system is introduced at relative angles to the primary wave, while wind and current remain aligned with the primary wave. These cases are particularly relevant when the operation is precision-limited.

Secondary-Wave Screening and Selection For the non-collinear configuration, the secondary parameters were selected from a screening matrix swept across each primary H_s–T_p bin. Primary wave conditions were chosen so that the operation remained at least partly feasible, i.e. that the operability envelope had not yet collapsed. Within this primary-wave window, the secondary system was screened over the following parameters:

- **Secondary significant wave height:** $H_{s,\text{sec}} \in \{0.5, 1.5, 2.5\}$ m for both case studies. The full set of three secondary heights is documented in the enclosures (rig: Enclosures E-4.1–E-4.9; floatel: Enclosures E-6.1–E-6.12), including the 2.5 m floatel cases that are non-operable across the screened range.
- **Secondary peak period:** swept from the bin-conditional 10th to 90th percentile in 1 s increments, derived from the site hindcast statistics (Section 3).
- **Relative direction:** $\{30°, 60°, 90°\}$ relative to the primary wave.

For the secondary-wave screening, the full 100-seed ensemble was run for every combination of secondary H_s, T_p, and direction, rather than under the fail-fast adaptive sampling protocol used for the primary-wave matrix sweep (Section 3.3). The simulation of the complete set of seeds was necessary because the screening identifies the worst-case secondary-wave combination by minimum PoS, which requires resolving PoS values across the full operability range, including fully non-operable cells (e.g., PoS ≤ 0.4 in Enclosures E-4.1–E-4.9 and E-6.1–E-6.12). The configurations reported in Chapter 5 correspond to the secondary-wave combination producing the lowest PoS per primary bin. The most critical secondary T_p consistently fell at the short end of the swept range (typically 6–9 s), consistent with the second-order wave-drift force coefficient peaking in this short-period band (Enclosure E-1.4). Reporting the worst-surviving secondary-wave combination per primary bin yields a conservative per-cell PoS: it represents the least favourable secondary period within the conditional $T_{p,\text{sec}}$ range rather than the expected PoS over the full conditional distribution. This worst-case selection is the rule applied throughout this report. The same conservative intent underlies the discrete treatment of current and wind as fixed levels (Section 3.4.4) rather than as full conditional distributions, where exhaustive screening is not feasible. A complete probabilistically weighted estimate would require the joint distributions of $T_{p,\text{sec}}$, U_c, and U_{10}, and is left to a forecast-driven (Mode A) assessment of a specific operation.

The Chapter 5 figures show the largest secondary H_s at which each vessel remains at least partly operable within the screened primary-wave window: $H_{s,\text{sec}} = 2.5$ m for the drilling rig (Figure 6), and $H_{s,\text{sec}} = 1.5$ m for the floatel (Figure 8). The 0.5 m secondary height produced no measurable effect on operability in either case and is therefore not shown in the reported figures.

4.2.2 Wind and Current Models

- **Wind:** Turbulent wind is generated using the NPD ISO 19901-1 energy spectrum [8] at fixed reference levels $U_{10} \in \{5, 10, 20\}$ m/s (Figure 4; rationale in Section 3.4.4).
- **Current:** The sea current is modelled as a steady, uniform flow field aligned with the primary wave direction. The velocity levels are chosen to represent both low and high current forces within the typical range, aiming to cover the worst-case scenario through a sensitivity analysis linked to the operational regimes as defined in Section 3.2:
  - **Capacity case:** $U_c = 0.7$ m/s (representing the site-specific P99 condition).
  - **Precision case:** $U_c = 0.2$ m/s (representing a slack/calm condition to test low-frequency stability).

The collinear current-wind-wave assumption is appropriate for a generic hindcast-driven screening (Mode B, Section 3.1.2), where the objective is to characterise vessel response across a representative range of conditions rather than to predict a specific operational scenario. In reality, the current direction bears no systematic relationship to the primary wave direction and is therefore rarely strictly collinear with the local wave field. As a consequence, a forecast-driven assessment of a specific operation (Mode A, Section 3.1.1) should model the current direction explicitly. The operational implications of this assumption for DP behaviour in the precision-limited regime are discussed in Section 5.2.

4.3 Simulation Execution Strategy

4.3.1 Simulation Duration and Stationarity

To ensure independent samples, the methodology avoids extracting evaluation windows from a single long realisation. Instead, each realisation (seed) is run as a separate simulation event with a unique random phase set, so that the seeds are uncorrelated under linear superposition.

- **Initialisation (T_{init}):** Each simulation begins with a 20-minute (1200 s) warm-up period. This initialisation period allows the vessel model to settle, the filters to converge, and any transient start-up effects to decay. These data are discarded before analysis.
- **Evaluation Window (T_{eval}):** Following initialisation, the simulation continues for a dedicated 1-hour (3600 s) evaluation period.

Minimum Evaluation Window and Statistical Reliability A 1-hour (3600 s) evaluation window is used for the reference cases in this report. Although a 3-hour duration is generally preferred to ensure complete sea-state stationarity and to capture extreme-value statistics, the 1-hour window serves as a practical minimum for DP-operated vessels. The 1-hour duration also aligns with the temporal resolution of the hindcast data, making it a natural choice that balances statistical robustness with computational efficiency. Running multiple independent 1-hour realisations ensures that approximately 20–30 cycles of the governing low-frequency responses (with typical periods of 100 s to 200 s) are captured per realisation, which is sufficient to establish the vessel's mean position-keeping performance and thruster-utilisation trends, provided it is combined with a large ensemble of independent seeds to compensate for the shorter individual observation time.

4.3.2 Ensemble Size and Adaptive Sampling

To robustly estimate the 99th percentile (P_{99}) of the response distribution without relying on extrapolation, a high-resolution ensemble is required. The stochastic nature of the environment is efficiently managed via the "Fail-Fast" Adaptive Sampling Protocol detailed in Section 3.3. Following the initial screening batch, conditions that pass or are marginal are expanded to a full verification ensemble of 100 independent seeds. Running 100 independent 1-hour realisations provides a statistical basis equivalent to 100 hours of operation, ensuring that the estimated P_{99} is not an artefact of extrapolation but a value supported by direct simulation data.

This protocol applies to the primary H_s–T_p matrix sweep. For secondary-wave screening, the full 100-seed ensemble was run for every combination to resolve PoS across the full operability range, including non-operable cells (Section 4.2).

The between-condition exclusion rule defined in Section 3.3 is also applied to the non-collinear cases: H_s–T_p bins that are fully operable in the collinear baseline are excluded from the more complex non-collinear configuration, producing the white-region patterns visible in the upper-right portion of the non-collinear results matrices in Chapter 5.

4.4 Statistical Post-Processing of Responses

The raw time-series output from SIMO is processed to derive the design metrics used for the "Go/No-Go" decision and operability contour generation.

4.4.1 Most Probable Maximum (MPM)

To account for statistical variability between seeds, the maxima from all seeds are fitted to a Gumbel distribution. The MPM is then taken as the mode of the fitted distribution, that is, the location parameter λ in the Gumbel cumulative form $F(x) = \exp[-\exp(-(x-\lambda)/\delta)]$. By construction, the MPM corresponds to the most likely maximum value to be observed in a single 1-hour realisation drawn from the fitted distribution.

The exceedance probabilities of common response descriptors follow directly from this CDF.

$$P(X > \lambda) = 1 - F(\lambda) = 1 - e^{-1} \approx 0.632 \tag{2}$$

The mean of the Gumbel distribution is $E_{\max} = \lambda + \gamma_E\,\delta$, where $\gamma_E \approx 0.5772$ is the Euler–Mascheroni constant and δ is the scale parameter. Its exceedance probability is:

$$P(X > E_{\max}) = 1 - \exp(-e^{-\gamma_E}) \approx 0.430 \tag{3}$$

The median (P_{50}) is exceeded in exactly 50% of realisations by definition. The MPM, $E_{\max}$, and P_{50} are therefore frequently exceeded by definition; the operational consequences of using any of them as an acceptance criterion are discussed in Sections 5.3 and 6.1.1.

4.4.2 Probability of Success (PoS)

As introduced earlier, the PoS is calculated as the fraction of independent seeds where the response remains strictly within the operational limits:

$$PoS = 1 - P_{exc} = \frac{N_{pass}}{N_{total}} \tag{4}$$

where N_{pass} is the number of seeds where no limit was exceeded. In this report, the PoS $\geq$ 0.9 level is used as the working threshold that delimits the operable envelope — that is, the set of H_s–T_p cells with PoS $\geq$ 0.9 — analogous to a P_{90} operability criterion. The boundary of this set is referred to as the PoS = 0.9 contour, although it is not drawn explicitly as a contour on the presented figures in Section 5. The value of 0.9 is a demonstration choice, not a prescription: the appropriate threshold depends on the specific operation and on a risk assessment of the consequences and uncertainty of an exceedance, as discussed in Sections 6.1.1 and 6.3.

4.4.3 Thruster Utilisation Factor (TUF)

To evaluate the proximity to thrust saturation, the TUF is computed. For each seed, the maximum sum of (total) thrust demand over the evaluation period is identified and normalised by the installed capacity. The reported TUF is the 99th percentile (P_{99}) of these seed-specific maxima within each H_s–T_p bin.

4.5 Case Study A: Drilling Rig

This case illustrates the **capacity-limited regime**, where the main constraint is the total force generation against the horizontal 3-DOF drift loads.

- **Vessel Model:** The 39,000 mt semi-submersible model defined in Section 2.
- **DP Logic:** The thrust allocation logic utilises a **free-rotating** thruster mode to maximise the available thrust in challenging environmental conditions.
- **Operational Limit Criteria:** The operation is considered non-operable if the position excursion exceeds $R_{\lim} = 7$ m or the heading deviation exceeds $|\Delta\psi_{\lim}| = 10°$, representing the physical limits of the riser system.

4.6 Case Study B: Accommodation Vessel (Floatel)

This operation falls within the **precision-limited regime**, where safety depends on the relative motion (typically all 6-DOF) between two independently moving bodies.

- **Vessel Model & Orientation:** The 30,000 mt accommodation semi-submersible model defined in Section 2.3. The turret-moored FPSO is assumed to actively keep heading, aligning its bow towards a setpoint 0°, ±15°, or ±30° towards the primary environmental direction, while the floatel maintains an orientation of approximately 90° relative to the FPSO.
- **DP Mode (Follow Target / Relative DP):** The floatel's DP set-point is referenced to the FPSO's low-frequency position rather than to an earth-fixed point. Hence, the floatel tracks the FPSO's slow drift while its own DP system filters wave-frequency excitations on the floatel hull. Thruster allocation uses the free-rotating mode (Section 2.2).
- **Governing Physics:** For this geometry, the operability boundary is determined primarily by relative vessel motions driven by 6-DOF first-order wave forces, with second-order drift acting on the slower timescale handled by the DP system.

Gangway Limit Criteria The operational boundaries are defined by the physical limits of the gangway system, derived from an operation-specific set of ASOG evaluations (Table 6). Note that the telescoping displacement is defined in absolute coordinates relative to the gangway pedestal.

Table 6: Operational limits for the telescopic gangway (Case B).

Quantity	Lower limit	Upper limit
Telescoping displacement [m]*	26.7	33.3
Telescoping velocity [m/s]	-1.5	1.5
Luffing displacement [°]	-10	10
Luffing velocity [°/s]	-6.7	6.7
Slewing displacement [°]	-15	15
Slewing rate [°/s]	-7.2	7.2

*Corresponds to a nominal length of 30.0 m ± 3.3 m stroke.

5 Simulation Results

This chapter presents the time-domain simulation results for the drilling-rig and floatel-to-FPSO gangway case studies. The full PoS and P_{99} TUF matrices for the complete heading, wind, current, and secondary-wave parameter range are provided in Enclosures E-3.1–E-4.9 (drilling rig) and E-5.1–E-6.12 (floatel); the figures below summarise the main findings.

5.1 Drilling Rig

The drilling-rig case study illustrates the capacity-limited regime introduced in Section 3.2. The semi-submersible has port–starboard and fore–aft symmetry, so following-sea (0°) responses are equivalent to head-sea (180°) responses; the figures use the following-sea cases as representative examples. Figure 5 consolidates the collinear current sensitivity (columns 1 and 2) and the +60° non-collinear case at $H_{s,\mathrm{sec}} = 2.5\,\mathrm{m}$ (column 3) across the four primary headings at $U_{10} = 10\,\mathrm{m/s}$.

PoS: Coll., Dir 0˚, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.97	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.94	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.82	0.83	0.96	1.00	1.00	1.00	1.00	1.00
6.0			0.92	0.55	0.59	0.93	1.00	1.00	1.00	1.00	1.00
6.5				0.28	0.28	0.73	0.97	1.00	1.00	1.00	1.00
7.0				0.12	0.09	0.44	0.93	1.00	1.00	1.00	1.00
7.5					0.03	0.21	0.75	0.97	0.98	0.99	1.00

PoS: Coll., Dir 0˚, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.89	0.90	0.98	1.00	1.00	1.00	1.00	1.00
6.0			0.95	0.71	0.69	0.96	1.00	1.00	1.00	1.00	1.00
6.5				0.38	0.43	0.89	1.00	1.00	1.00	1.00	1.00
7.0				0.15	0.16	0.61	0.96	1.00	1.00	1.00	1.00
7.5					0.09	0.33	0.87	0.99	1.00	1.00	1.00

PoS: Non-coll., Dir: 0˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 60˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.99	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.99	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.95	0.87	0.91	0.99	1.00	1.00			
6.0			0.85	0.71	0.69	0.95	1.00	1.00	1.00		
6.5				0.35	0.43	0.87	0.99	1.00	1.00	1.00	1.00
7.0						0.62	0.94	1.00	1.00	1.00	1.00
7.5							0.85	0.99	1.00	1.00	1.00

PoS: Coll., Dir 30˚, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.78	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.52	0.79	0.99	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.59	0.94	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.24	0.85	0.98	1.00	1.00	1.00	1.00	1.00
7.5					0.58	0.89	1.00	1.00	1.00	1.00	1.00

PoS: Coll., Dir 30˚, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.85	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.59	0.88	0.99	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.69	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.37	0.88	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.74	0.97	1.00	1.00	1.00	1.00	1.00

PoS: Non-coll., Dir: 30˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 90˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	0.99						
4.5			1.00	1.00	0.99	1.00					
5.0			0.95	1.00	0.99	1.00	1.00				
5.5			0.84	0.97	0.99	1.00	1.00	1.00			
6.0			0.53	0.87	0.98	1.00	1.00	1.00	1.00		
6.5				0.68	0.96	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	0.99	1.00	1.00

PoS: Coll., Dir 60˚, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.92	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.70	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.80	0.99	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.60	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.86	1.00	1.00	1.00	1.00	1.00	1.00

PoS: Coll., Dir 60˚, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.76	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.71	0.98	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.96	1.00	1.00	1.00	1.00	1.00	1.00

PoS: Non-coll., Dir: 60˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 120˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			1.00	1.00	1.00	1.00	1.00				
5.5			0.92	1.00	1.00	1.00	1.00	1.00			
6.0			0.74	0.96	1.00	1.00	1.00	1.00	1.00		
6.5				0.88	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

PoS: Coll., Dir 90˚, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.97	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.93	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.96	0.81	0.87	0.98	1.00	1.00	1.00	1.00	1.00
6.0			0.81	0.53	0.57	0.96	1.00	1.00	1.00	1.00	1.00
6.5				0.26	0.32	0.82	1.00	1.00	1.00	1.00	1.00
7.0				0.11	0.14	0.56	0.96	1.00	1.00	1.00	1.00
7.5					0.07	0.34	0.86	0.98	1.00	1.00	1.00

PoS: Coll., Dir 90˚, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.96	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.91	0.95	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.92	0.77	0.79	0.98	1.00	1.00	1.00	1.00	1.00
6.5				0.47	0.52	0.95	1.00	1.00	1.00	1.00	1.00
7.0				0.23	0.32	0.80	1.00	1.00	1.00	1.00	1.00
7.5					0.17	0.51	0.96	1.00	1.00	1.00	1.00

PoS: Non-coll., Dir: 90˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 150˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.95	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			1.00	0.96	0.98	1.00	1.00				
5.5			0.95	0.91	0.94	1.00	1.00	1.00			
6.0			0.92	0.74	0.77	0.98	1.00	1.00	1.00		
6.5				0.44	0.53	0.92	1.00	1.00	1.00	1.00	1.00
7.0						0.76	1.00	1.00	1.00	1.00	1.00
7.5							0.94	1.00	1.00	1.00	1.00

Figure 5: Drilling-rig PoS on the H_s–T_p matrix at $U_{10} = 10\,\mathrm{m/s}$. Columns compare two effects at fixed primary heading (rows, 0°, 30°, 60°, and 90°): the current sensitivity between $U_c = 0.2\,\mathrm{m/s}$ (left) and $U_c = 0.7\,\mathrm{m/s}$ (middle), both collinear, and the effect of non-collinearity between the collinear case at $U_c = 0.7\,\mathrm{m/s}$ (middle) and the same condition including a secondary wave of $H_{s,\mathrm{sec}} = 2.5\,\mathrm{m}$ at +60° relative angle to the primary direction (right).

The main findings for the drilling rig are:

- **Envelope shape.** The PoS boundary is reached first in short, steep sea states (elevated H_s combined with low T_p). The lower-T_p edge of the simulated matrix tracks the wave-steepness limit of fully developed seas (Section 3.4.1) and does not point to an unsimulated operational regime.
- **Heading dependence.** The 30° and 60° headings produce a wider operability envelope than 0°/180° and 90°. At 0°/180° the semi-submersible sits in an indifferent rotational equilibrium about its symmetry axis, and the free-rotating thrusters chase the stochastic yaw excitation, consuming thrust capacity that is then unavailable for surge and sway control. At 90°, by contrast, the projected lateral area is larger, producing higher aerodynamic and hydrodynamic drag.
- **Current and wind sensitivity.** Both effects are heading-dependent and act through the same DP-stabilisation mechanism: a steady collinear load biases the free-rotating thruster allocation and reduces rotational hunting (Section 6.2). At 0°, increasing U_c from 0.2 m/s to 0.7 m/s, or U_{10} from 5 m/s to 10 m/s, slightly improves PoS in marginal cells (e.g. from 0.25 to 0.42 at $H_s = 6.5$ m, $T_p = 9$ s). This benefit fades towards 30° and is effectively absent at 60°, before partially recovering at 90°, where the response is quantitatively intermediate between the 0° and 30° cases. A further increase to $U_{10} = 20$ m/s reverses the picture at all headings: the dynamic load from the turbulent wind component saturates the DP capability and contracts the operability envelope. The degradation is mild at 0°, larger at 30° and 90°, and most severe at 60°, which — despite its wide baseline envelope at $U_{10} = 10$ m/s — retains no fully operable H_s–T_p cell at 20 m/s across the simulated range (Enclosures E-3.1 onwards).
- **Local minimum at $T_p \approx$ 9–10 s.** At the 0° and 90° headings, a local minimum in PoS appears at $T_p \approx$ 9–10 s (visible in Figure 5 and in the PoS tables and boundary curves of Enclosures E-3.1 onwards). This corresponds to secondary peaks in the surge (0°) and sway (90°) wave-drift coefficients at that period (top and middle panels of Enclosure E-1.4, respectively). At 30° and 60° the corresponding drift-coefficient peaks are shifted to $T_p \approx$ 7–8 s and do not produce a comparable degradation in the simulated T_p range.
- **Operability gradient profile.** Gradual at all headings. In the 90° case at $U_c = 0.7$ m/s, $U_{10} = 20$ m/s, the transition from PoS ≈ 1.00 to PoS ≈ 0 spans approximately 2 m of H_s (Enclosure E-3.8).
- **Thrust margin at the boundary.** The P_{99} TUF approaches saturation at the PoS boundary, with the PoS = 0.9 contour aligning with P_{99} TUF in the range of approximately 0.7–0.9 depending on heading and current speed (Enclosures E-3.1–E-3.8).

Non-collinear conditions Figure 6 resolves the effect of the secondary-wave direction at the 0° primary heading. Adding a secondary system at $H_{s,\text{sec}} = 2.5$ m has only a minor effect on PoS; where degradation occurs, it is confined to isolated H_s–T_p cells and is generally negligible. The same holds for the lower secondary-wave heights of $H_{s,\text{sec}} = 0.5$ m and 1.5 m, as presented in Enclosures E-4.1–E-4.9.

White cells in the upper-right portion of the non-collinear matrices indicate H_s–T_p combinations that were fully operable in the collinear baseline and were therefore excluded from the non-collinear sweep (Section 4.3); the same convention applies to Figure 8.

5.2 Floatel and Gangway Operation

The floatel-to-FPSO gangway case study illustrates the precision-limited regime introduced in Section 3.2. Because the FPSO keeps the heading close to head seas and the floatel sits at 90° relative to the FPSO, the simulated primary wave headings cluster around the FPSO bow (180°) with ±15° and ±30° offsets. Figure 7 shows the collinear PoS matrices at the two current speeds across these five headings. The main findings are:

- **Failure mode.** Limit exceedance is driven by gangway kinematics — specifically, the telescoping-stroke and luffing-angle limits in Table 6 — rather than by DP thrust margin. The P_{99} TUF stays below approximately 0.5 across the full simulated H_s–T_p range, including cells where PoS ≈ 0 (Enclosures E-5.1–E-5.10). Velocity-threshold exceedances (e.g. luffing rate) occur infrequently in severe-weather combinations.

- **Heading sensitivity.** The widest operability envelope occurs at 180°: with the FPSO headed into head seas, its turret-moored response is dominated by pitch and heave, while roll at the gangway landing point remains comparatively small. At 150° and 210° the FPSO is excited in roll, which translates directly into vertical motion at the gangway tip on the FPSO side and drives telescoping-stroke and luffing-angle exceedances. The ±15° offsets (165°, 195°) are intermediate.
- **Asymmetric two-vessel geometry.** The operability envelope is governed by the FPSO's response to the wave field rather than by the floatel's motions in isolation. The combined system has no reflectional symmetry about the FPSO's longitudinal (bow-stern) axis, so equivalent H_s–T_p cells need not produce symmetric PoS about the 180° heading.
- **Wind sensitivity.** Heading-dependent, and most pronounced at the off-bow headings. At 180° and the ±15° offsets (165°, 195°), increasing U_{10} from 5 m/s to 10 m/s has little or no effect on PoS, and the further increase to 20 m/s produces only a slight reduction. At 150° and 210°, PoS falls marginally from 5 to 10 m/s and then strongly from 10 to 20 m/s. The cause is not thrust saturation: the P_{99} TUF remains around 0.5 over a wide H_s–T_p range. Rather, the wind-induced yaw moment on the floatel's superstructure grows with off-bow angle (Enclosure E-1.6), so the DP system must trade heading control against position control and oscillates between the two; the resulting heading excursions, compounded by FPSO roll that the gangway must counteract through luffing and telescoping, degrade the relative-motion accuracy at the landing point and drive the operability loss. The operability limit is therefore set by gangway-motion exceedance (a kinematic), not by DP thrust capacity.
- **Current effect.** Increasing the collinear U_c from 0.2 m/s to 0.7 m/s improves PoS across all headings, through the same DP-stabilisation mechanism identified for the rig: the steady current load provides a directional bias that reduces rotational hunting and aids heading control (Section 6.2).
- **Operability gradient profile.** Strongly heading-dependent. At off-bow headings (150°, 210°) the transition from PoS ≈ 1.00 to PoS ≈ 0 is steep, spanning less than approximately 1 m of H_s. At 180° the same transition is gradual, comparable in H_s span to the rig case.

PoS: Coll., Dir: 0˚, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.89	0.90	0.98	1.00	1.00	1.00	1.00	1.00
6.0			0.95	0.71	0.69	0.96	1.00	1.00	1.00	1.00	1.00
6.5				0.38	0.43	0.89	1.00	1.00	1.00	1.00	1.00
7.0				0.15	0.16	0.61	0.96	1.00	1.00	1.00	1.00
7.5					0.09	0.33	0.87	0.99	1.00	1.00	1.00

PoS: Non-coll., Dir: 0˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 30˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.98	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.99	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.95	0.86	0.91	0.99	1.00	1.00			
6.0			0.85	0.66	0.70	0.95	1.00	1.00	1.00		
6.5				0.36	0.41	0.85	0.99	1.00	1.00	1.00	1.00
7.0						0.57	0.94	1.00	1.00	1.00	1.00
7.5							0.85	0.98	1.00	1.00	1.00

PoS: Non-coll., Dir: 0˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 60˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.99	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.99	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.95	0.87	0.91	0.99	1.00	1.00			
6.0			0.85	0.71	0.69	0.95	1.00	1.00	1.00		
6.5				0.35	0.43	0.87	0.99	1.00	1.00	1.00	1.00
7.0						0.62	0.94	1.00	1.00	1.00	1.00
7.5							0.85	0.99	1.00	1.00	1.00

PoS: Non-coll., Dir: 0˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 90˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.99	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.98	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.99	0.89	0.90	0.98	1.00	1.00			
6.0			0.95	0.71	0.69	0.96	1.00	1.00	1.00		
6.5				0.37	0.42	0.89	1.00	1.00	1.00	1.00	1.00
7.0						0.60	0.96	1.00	1.00	1.00	1.00
7.5							0.85	0.99	1.00	1.00	1.00

Figure 6: Drilling-rig results for a following-sea heading (0°) at U_{10} = 10 m/s and U_c = 0.7 m/s. Top left: Collinear. Others: Non-collinear with secondary wave ($H_{s,\mathrm{sec}}$ = 2.5 m) at relative angles of 30°, 60°, and 90°.

SINTEF

In the precision-limited regime, operability is influenced not only by the magnitude of the correcting force produced by the DP system, but also by the response time before this force is applied. Minimising this response time is essential for reducing footprint excursion and achieving higher operational DP precision. Several factors contribute to the overall system lag, including the low-pass filtering of measured vessel motions, the availability of thrusters when they are already engaged in yaw or position control, the time required to rotate free-rotating thrusters to the desired thrust angle, and the ramp-up period needed to reach the commanded thrust level. These delays become particularly relevant when heading and position control may compete for the same thruster resources. In such cases, each transition between heading-keeping and position-keeping may involve thruster rotation and thrust ramp-up before the correcting force can be applied.

PoS: Coll., Dir 150°, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.84	0.91	0.97	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.18	0.27	0.53	0.58	0.65	0.86	1.00	1.00	1.00	1.00	1.00
3.5	0.00	0.02	0.02	0.08	0.14	0.24	0.77	1.00	1.00	1.00	1.00
4.0		0.00	0.00	0.02	0.01	0.02	0.21	0.82	0.99	1.00	1.00
4.5			0.00	0.00	0.00	0.00	0.01	0.33	0.87	0.95	0.98
5.0			0.00	0.00	0.00	0.00	0.00	0.03	0.32	0.62	0.75
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.16	0.30

PoS: Coll., Dir: 150°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.93	0.96	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.46	0.49	0.75	0.84	0.88	0.99	1.00	1.00	1.00	1.00	1.00
3.5	0.02	0.06	0.15	0.26	0.26	0.57	0.96	1.00	1.00	1.00	1.00
4.0		0.00	0.00	0.04	0.04	0.08	0.59	0.94	1.00	1.00	1.00
4.5			0.00	0.00	0.00	0.00	0.10	0.64	0.93	0.98	0.99
5.0			0.00	0.00	0.00	0.00	0.00	0.17	0.55	0.78	0.83
5.5			0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.33	0.45

PoS: Coll., Dir 165°, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.97	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.90	0.92	0.93	0.95	0.98	1.00	1.00	1.00	1.00	1.00
4.5			0.61	0.65	0.62	0.72	0.92	1.00	1.00	1.00	1.00
5.0			0.16	0.18	0.17	0.31	0.61	0.95	1.00	1.00	1.00
5.5			0.02	0.01	0.01	0.03	0.21	0.72	0.97	1.00	1.00

PoS: Coll., Dir: 165°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.94	0.95	0.94	0.93	0.99	1.00	1.00	1.00	1.00	1.00
4.5			0.72	0.71	0.65	0.83	0.97	1.00	1.00	1.00	1.00
5.0			0.34	0.31	0.22	0.41	0.83	0.97	1.00	1.00	1.00
5.5			0.07	0.02	0.01	0.12	0.39	0.89	0.99	1.00	1.00

PoS: Coll., Dir 180°, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.99	1.00	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.94	0.84	0.96	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.82	0.58	0.64	0.85	0.95	1.00	1.00	1.00	1.00
5.5			0.51	0.26	0.33	0.50	0.83	0.98	1.00	1.00	1.00

PoS: Coll., Dir: 180°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.97	0.91	0.96	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.87	0.69	0.72	0.89	0.99	1.00	1.00	1.00	1.00
5.5			0.61	0.36	0.42	0.59	0.87	1.00	1.00	1.00	1.00

PoS: Coll., Dir 195°, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.97	0.99	0.98	0.98	0.98	0.99	1.00	1.00	1.00	1.00	1.00
4.0		0.83	0.85	0.86	0.79	0.83	0.94	1.00	1.00	1.00	1.00
4.5			0.52	0.47	0.32	0.48	0.74	0.95	1.00	1.00	1.00
5.0			0.13	0.10	0.08	0.10	0.36	0.82	1.00	1.00	1.00
5.5			0.00	0.03	0.01	0.01	0.04	0.57	0.92	1.00	1.00

PoS: Coll., Dir: 195°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.97	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.90	0.90	0.95	0.89	0.91	0.97	1.00	1.00	1.00	1.00
4.5			0.60	0.67	0.61	0.65	0.86	1.00	1.00	1.00	1.00
5.0			0.22	0.23	0.20	0.25	0.62	0.90	1.00	1.00	1.00
5.5			0.01	0.06	0.05	0.05	0.20	0.76	0.98	1.00	1.00

PoS: Coll., Dir 210°, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.84	0.88	0.96	0.96	0.96	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.27	0.35	0.50	0.56	0.54	0.80	1.00	1.00	1.00	1.00	1.00
3.5	0.02	0.02	0.02	0.06	0.10	0.21	0.74	0.99	1.00	1.00	1.00
4.0		0.00	0.00	0.01	0.02	0.02	0.22	0.84	1.00	1.00	1.00
4.5			0.00	0.00	0.00	0.00	0.02	0.38	0.88	0.99	1.00
5.0			0.00	0.00	0.00	0.00	0.00	0.09	0.60	0.91	0.98
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.57	0.71

PoS: Coll., Dir: 210°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.94	0.95	0.96	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.44	0.47	0.64	0.75	0.74	0.93	1.00	1.00	1.00	1.00	1.00
3.5	0.04	0.07	0.09	0.16	0.20	0.45	0.90	1.00	1.00	1.00	1.00
4.0		0.00	0.00	0.01	0.04	0.08	0.51	0.91	1.00	1.00	1.00
4.5			0.00	0.00	0.00	0.01	0.10	0.69	0.94	0.99	1.00
5.0			0.00	0.00	0.00	0.00	0.00	0.25	0.75	0.96	0.99
5.5			0.00	0.00	0.00	0.00	0.00	0.04	0.40	0.74	0.83

Figure 7: Floatel-to-FPSO PoS for collinear conditions, comparing $U_c = 0.2$ m/s (left) and $U_c = 0.7$ m/s (right) at $U_{10} = 10$ m/s. Rows show primary headings from 150° to 210°.

PoS: Non-coll., Dir: 180°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	0.95	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
4.0		0.95	1.00	0.99	1.00	1.00	1.00	1.00	1.00		
4.5			0.97	0.93	0.96	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.87	0.70	0.73	0.91	0.99	1.00	1.00	0.99	1.00
5.5			0.58	0.38	0.46	0.59	0.88	0.95	1.00	0.99	1.00

PoS: Non-coll., Dir: 180°, Wind 10 m/s, Cur 0.7 m/s, Sec: 210°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
4.0		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00		
4.5			0.97	0.92	0.96	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.88	0.70	0.76	0.89	0.99	1.00	1.00	1.00	1.00
5.5			0.65	0.40	0.44	0.65	0.86	1.00	1.00	1.00	1.00

PoS: Non-coll., Dir: 165°, Wind 10 m/s, Cur 0.7 m/s, Sec: 195°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.99	1.00	0.99	1.00	1.00	1.00	1.00	1.00			
4.0		0.93	0.96	0.94	0.94	0.99	1.00	1.00	1.00		
4.5			0.69	0.70	0.71	0.81	0.96	1.00	1.00	1.00	1.00
5.0			0.30	0.33	0.23	0.42	0.79	0.97	1.00	1.00	1.00
5.5			0.05	0.05	0.00	0.08	0.35	0.75	0.95	0.95	0.99

PoS: Non-coll., Dir: 195°, Wind 10 m/s, Cur 0.7 m/s, Sec: 165°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.97	0.99	0.99	0.99	0.99	1.00	1.00	1.00			
4.0		0.90	0.89	0.93	0.88	0.92	0.95	1.00	1.00		
4.5			0.62	0.68	0.60	0.64	0.87	1.00	1.00	1.00	1.00
5.0			0.22	0.23	0.20	0.25	0.58	0.90	1.00	1.00	1.00
5.5			0.03	0.06	0.05	0.06	0.20	0.76	0.98	0.99	0.95

PoS: Non-coll., Dir: 150°, Wind 10 m/s, Cur 0.7 m/s, Sec: 210°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.91	0.95	0.99	1.00	1.00	1.00					
3.0	0.32	0.48	0.71	0.76	0.84	0.98	1.00				
3.5	0.00	0.04	0.10	0.20	0.22	0.52	0.93	1.00			
4.0		0.00	0.00	0.02	0.01	0.09	0.49	0.91	1.00		
4.5			0.00	0.00	0.00	0.00	0.04	0.61	0.90	0.94	0.98
5.0			0.00	0.00	0.00	0.00	0.00	0.11	0.50	0.68	0.78
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.28	0.31

PoS: Non-coll., Dir: 210°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.92	0.87	0.96	0.95	0.99	1.00					
3.0	0.36	0.42	0.52	0.54	0.68	0.89	0.99				
3.5	0.02	0.01	0.06	0.06	0.12	0.34	0.87	1.00			
4.0		0.00	0.00	0.00	0.01	0.06	0.45	0.89	0.99		
4.5			0.00	0.00	0.00	0.00	0.05	0.53	0.93	0.99	1.00
5.0			0.00	0.00	0.00	0.00	0.00	0.14	0.67	0.95	0.98
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.60	0.77

Figure 8: Floatel-to-FPSO PoS comparison at U_{10} = 10 m/s and U_c = 0.7 m/s for non-collinear combinations with a secondary wave of $H_{s,\text{sec}}$ = 1.5 m. The direction pairs (left vs. right) utilise mirrored primary and secondary wave directions relative to the FPSO head-wave direction (180°).

Non-collinear conditions The asymmetric two-vessel geometry produces direction-resolved sensitivity that is not captured by a single-sided primary-direction sweep. Figure 8 illustrates this through three pairs of mirrored secondary-wave directions across the FPSO head-wave axis: 180°/150° versus 180°/210° (top), 165°/195° versus 195°/165° (middle), and 150°/210° versus 210°/150° (bottom). Each mirrored pair corresponds to a geometrically symmetric environment about the FPSO bow-stern axis, yet the resulting PoS matrices differ. Consistent with the collinear heading sensitivity, a secondary wave arriving from an off-bow direction excites FPSO roll and increases the demand on the gangway's motion-compensation envelope, principally in luffing and telescoping. Detailed matrices for both wind speeds are provided in Enclosures E-6.1–E-6.12.

5.3 Synthesis Across Regimes

These two case studies apply a consistent statistical framework to two distinct operational regimes: a capacity-limited drilling rig and a precision-limited floatel-to-FPSO gangway operation. The broader conclusions developed in Chapter 6 are grounded in the results presented here.

1. **Choice of Statistical Metric:** The chosen metric directly affects the conservatism of the response limit. Where the operability gradient is gradual — as for the drilling rig at all headings and for the floatel at 180° — the H_s separation between the cell at which the median (P_{50}) maximum response first reaches the operational limit and the cell at which the high quantile (P_{99}) first reaches it is of the order of 1–2 m. This separation sets the scale of the conservatism gap between acceptance criteria based on MPM or $E_{\max}$ and those based on P_{90}, P_{99}, or explicit PoS targets (Section 6.1.1).
2. **Thruster Utilisation as a Regime Fingerprint:** The P_{99} TUF distinguishes the two regimes. In the capacity-limited rig case it rises to saturation at the operability boundary; in the precision-limited floatel

case it remains around or below 0.5 even where operation is infeasible. The limiting mechanism of an operation can therefore be diagnosed from TUF behaviour rather than from PoS alone. The diagnosis is most informative for capacity-limited operations; in precision-limited cases, TUF reflects DP workload rather than proximity to the thrust-saturation limit.

3. **Operational Asymmetry and Screening Coverage:** Asymmetry can arise from vessel geometry, from the location of a relevant motion point off the centreline, or from the environmental configuration; in each case a screening sweep over only one side of the primary wave direction is insufficient. The floatel-to-FPSO geometry breaks symmetry by configuration. Less obviously, an operation that appears symmetric — a vessel with a crane or gangway operating over the side — can still exhibit asymmetric motion whenever the boom tip or gangway pedestal lies off the centreline: for a beam wave from the opposite side, the roll response reverses phase by 180° while the vertical response does not, so the heave-plus-roll superposition at the off-centre point differs between two mirrored waves. Mirrored wave directions that are geometrically symmetric about the bow-stern axis therefore produce different motion at the connection point, and hence different PoS.

4. **Forecast Sensitivity of the Operability Decision:** The steepness of the operability gradient — itself dependent on heading and on the spectral composition of the sea state — governs how sensitive an operability decision is to forecast error in H_s. A forecast error of ± 0.5 m spans only a small fraction of a gradual gradient but most of a steep one, so a single scalar α-factor applied to H_s cannot represent this sensitivity consistently across headings and sea-state compositions (Section 6.3).

6 Conclusions and Recommendations

The examples and procedures in this report emphasise the importance of using risk-adjusted statistical criteria when defining operational limits for marine operations. A key goal of this framework is to reduce conservatism arising from modelling uncertainty by improving configuration fidelity and statistical resolution while maintaining the conservatism necessary to avoid overpredicting vessel operability and the safety risks that would result.

6.1 Key Findings

6.1.1 Choice of Response Metric based on Risk Level

Because the extreme-value distribution of short-term maxima is typically right-skewed, metrics such as MPM and $E_{\max}$ describe the most likely or average peak across realisations and are not, in themselves, conservative acceptance criteria. As derived in Section 4.4.1, the MPM is exceeded in approximately 63% of realisations, and $E_{\max}$ in approximately 43%, confirming that neither descriptor provides a conservative bound on the maximum response. The drilling-rig results in Section 5.1 demonstrate the operational scale of this gap: a span ranging between 1–2 m in H_s separates the cells where the response limit is reached in half of the cases (P_{50} corresponding to PoS = 0.5) from those where the limit is rarely exceeded (P_{99} corresponding to PoS = 0.99). A criterion built on $E_{\max}$ and MPM descriptors therefore admits operation in cells where between 43% and 63% of realisations exceed the operational limit. For risk-critical decisions, the appropriate operational target should be selected based on the consequences of an exceedance:

- **Low consequence:** The response descriptors MPM, P_{50}, and $E_{\max}$ are frequently exceeded by definition (Section 4.4.1); they can be used as the acceptance criterion when an exceedance carries no high operational cost or safety risk.
- **Higher consequence:** A high response quantile (P_{90}, P_{95}, or P_{99}) should be preferred as the acceptance criterion when an exceedance carries operational consequences — for example, equipment damage, hazard to personnel, an unscheduled helicopter evacuation, or a forced shutdown of the operation in combination with increased ramp-up costs.

6.1.2 Regime-Specific Limitation Mechanisms

The simulations demonstrate that limiting mechanisms and the necessary environmental scenario coverage depend on the physics of the operation, distinguishing between:

- **Capacity-Limited Operations (e.g., Drilling Rig):** Governed primarily by global station-keeping 3-DOF performance and proximity to DP thrust saturation in challenging sea states (indicated by high P_{99} TUF when the operational limit is reached, Section 5.1). Collinear conditions represent the critical case, as the additive alignment of all environmental forces produces the maximum mean drift load. Non-collinear wave systems may reduce the operable envelope but are generally of secondary effect compared to the collinear condition (Section 5.3).
- **Precision-Limited Operations (e.g., Floatel-to-FPSO Gangway):** Governed by relative 6-DOF motion kinematics, where limit exceedance is driven by first-order wave-frequency motions rather than by thrust saturation from second-order wave-drift forces. The P_{99} TUF rarely exceeds approximately 0.5 even in non-operable cells (Section 5.2), confirming that thrust availability is not the limitation. Secondary wave directions significantly affect vessel motion exceedance (Section 5.3).

6.2 Recommendations for Operational Use

In our experience, discrepancies between predicted and real-world offshore operability are often due to configuration or input mismatches rather than limitations of the time-domain method itself.

6.2.1 Common Causes of Mismatch

Before applying operability envelopes offshore, the following parameters should be verified against those used in the simulation model. Any mismatch may introduce errors in the predicted operability and compromise the reliability of the operational performance estimates:

- **Sea-state composition and directionality:** The relative directions and energy split between wind sea and swell components used in simulation should reflect the actual multi-modal sea state; a mismatch in wave composition or directionality may shift energy into or out of the vessel's response-sensitive period bands.
- **Wave period mismatch:** Using non-representative peak periods, or an inaccurate spectral shape in a multi-peaked spectrum, may shift response energy into or out of the vessel's resonant period bands.
- **Current modelling:** The simulated current direction and magnitude differ from the actual current at the operation site. A current that is realistic in magnitude but assumed collinear with the wave direction can introduce a non-conservative bias. The collinear current provides a steady directional load that biases the free-rotating thruster allocation and reduces rotational hunting, which can produce an apparent improvement in PoS in marginal cells (Sections 5.1 and 5.2). Where a forecast-driven assessment is performed (Mode A) and reliable current data are available, the actual current direction and magnitude should be modelled explicitly. Where current information is unavailable, applying no current is preferable to applying a default collinear current of unknown alignment, since the default introduces an optimistic bias.
- **Load condition drift:** The simulated mass distribution, draft, trim, or VCG/GM deviates from the true operational state.
- **Motion-reduction devices:** Roll-damping devices (e.g., anti-roll tanks) are assumed inactive in simulation but are active offshore, or vice versa.
- **DP thruster allocation and azimuth strategy:** The simulation assumes one allocation strategy (e.g., free-rotating) while the offshore operation utilises another (e.g., biased/star allocation).
- **Thruster and power availability:** Interactions between thrusters and/or thrusters and the hull, along with maintenance status, power management limits, or degraded capabilities, decrease the control forces achievable compared to the simulated baseline.
- **Heading constraints:** The simulation assumes favourable heading selection, while the actual operation enforces a constrained heading in relation to the dominant loads.
- **Asymmetric vessel geometry and directional screening coverage:** For single- or two-vessel operations where the geometry or the type of limitation criterion (e.g., luffing) is asymmetric (e.g., a floatel-to-FPSO configuration with the floatel at 90° relative to the FPSO), the two sides will behave differently. The recommendation to verify operational symmetry applies equally to mirrored secondary-wave directions (Section 5.3); in such cases, the screening matrix must explicitly cover both sides of the primary axis.

6.3 Recommendations for Operational Decision Support

A robust, forecast-specific decision support system, accessible both on board and onshore, is recommended for translating simulation results into timely go/no-go decisions. Feed-forward decision support can be achieved either by running forecast-driven simulations on demand (running an ensemble of at least 50–100 independent realisations) or by querying a pre-existing database of hindcast-derived scenarios. The system should present PoS as the primary go/no-go metric, with P_{99} TUF as a complementary continuous indicator for capacity-limited operations (Section 5.1). For precision-limited operations, where TUF is only a weak indicator of failure proximity, the decision should be based on PoS for the relevant gangway-response variables, with TUF retained as a DP-workload monitor rather than a saturation-margin indicator.

The selection of an acceptable PoS threshold should follow a risk-adjusted assessment, complementing the risk-adjusted choice of response descriptor in Section 6.1. The two selections operate along different dimensions of the same risk-acceptance criterion: the response descriptor (e.g., MPM, P_{90}) defines what counts as the criterion-relevant maximum for a single sea-state realisation. At the same time, the PoS threshold specifies the fraction of realisations that must remain within that criterion across the simulated ensemble. The acceptable statistical likelihood should be chosen based on the consequences of an exceedance and documented in the activity's ASOG. The framework does not prescribe a single combination; the PoS ≥ 0.9 contour used as the working envelope in this report is a demonstration consistent with the lower-consequence end of the scale set out in Section 6.1.

6.3.1 Feed-Forward Target-Motion Input

For operations that require maintaining a controlled relative position to a moving object, such as floatel-to-FPSO gangway operations, we recommend providing the DP controller with a feed-forward input based on target-motion measurements and short-horizon predictions. Feed-forward control reduces the effective phase lag associated with filtered relative-position measurements, which becomes important when the target's horizontal motions (surge, sway, yaw) contain significant energy at frequencies approaching the cut-off of the DP system's low-pass filter. Vertical motions (heave, pitch) of the target are compensated within the gangway's motion-compensation range, and drive a gangway limit only when that range is exceeded.

6.3.2 Handling Weather Forecast Uncertainties

Operational decisions traditionally rely on an α-factor applied to the total sea H_s. While this approach is practical, it can be overly simplistic for direction- and composition-sensitive operations. As shown in Section 5.3, the sensitivity of PoS to H_s forecast error is heading- and composition-dependent. A scalar α-factor applied uniformly to H_s cannot capture this heading-dependent forecast sensitivity. To more accurately represent forecast uncertainty, the industry may consider methods that explicitly resolve directional and spectral structure. Further research is needed to systematically evaluate and differentiate the practical efficacy and reliability of these advanced approaches. As a baseline for such future evaluations, it is advisable to consider applying:

- **Spectral Forecasts:** Rather than scaling the total H_s by a single factor, controlled perturbations are applied to the spectral shape — such as scaling or shifting energy between frequency bins — to capture uncertainties in spectral composition and peak period that a scalar α-factor cannot resolve.
- **Ensemble Spectral Forecasts:** Uncertainty bands from weather models are propagated directly through vessel-response simulations to yield a probabilistic PoS distribution across the forecast range. This approach is considered the most complete representation of forecast uncertainty and is recommended as the long-term target for operability decision support.

6.4 Further Work: Computational Acceleration and Operational Application

The main practical challenge in implementing this framework is the computational cost of evaluating a high-resolution matrix of stochastic forecast scenarios. To integrate this framework directly into operators' day-to-day routines, functioning alongside the daily weather updates already used by the crew, future research could be structured around four progressive pillars. A follow-up industry project would be useful to bridge the gap between complex time-domain physics and daily operational planning:

1. **Development of Predictive Surrogate Models (The Operability Prediction Framework):** Future research should focus on developing computationally efficient predictive surrogate models (e.g., machine

learning algorithms) trained on accumulated time-domain simulation data to supplement established physical models. SINTEF Ocean is actively conducting research in this area to identify which specific machine learning architectures provide the greatest benefits for hydrodynamic response prediction. While these surrogates could serve as the frontline computational engine, providing rapid estimates of PoS and response metrics without the latency of continuous time-domain solving, we recommend maintaining a fallback to the physics-based simulation models. In any instance of uncertainty or low confidence in the predictive results, the system should automatically revert to a time-domain solver. This hybrid approach prioritises accuracy and operational safety over simulation speed while maintaining a robust overall framework.

2. **The 24-Hour Capability Forecast (Day-to-Day Onboard Application):** A critical next step is the actual implementation of this framework into the daily business routines of vessel operators. Just as the crew reviews the standard weather forecast each morning, this predictive tool should be integrated directly into their daily operational planning cycle on board. The framework should be adapted to automatically ingest daily ensemble weather forecasts and translate them directly into a 24-hour vessel capability timeline. Rather than forcing the crew to interpret raw metocean data against static tables, the system will output a vessel-specific forecast of its actual capability to perform the scheduled work. Crucially, this onboard interface should translate weather-forecast uncertainty into a clear *PoS confidence band*, visually communicating the best-case and worst-case operational windows, along with the weather-forecast scenarios for the upcoming 24 hours, directly to the decision-makers on the vessel.

3. **Hybrid Verification and Transparency for Operational Trust (Human-in-the-Loop):** To foster trust and establish high confidence in the vessel's capability among the crew, the system should avoid the "black-box" pitfalls of pure machine learning. The surrogate models should include explicit statistical confidence measures. In scenarios where the weather forecast introduces conditions outside the surrogate's trained confidence zone, the system should dynamically trigger time-domain simulations in the background. To further support this trust, the system should provide full operational transparency. The crew should always be able to easily pinpoint exactly how a prediction was established, specifically, whether a given operational capability was derived from the machine learning surrogate or explicitly calculated by the physical solver. Additionally, the interface should clearly display the underlying data that drives the prediction, such as the assumed vessel load condition, the specific weather-forecast scenario, and other relevant input parameters. This transparent, hybrid approach ensures that any operational "Green Light" presented to the crew is backed by verifiable data, creating a continuously improving, trustworthy decision-support framework for the industry.

4. **Continuous Feedback Loop for Model Refinement (Crew-to-Researcher):** To ensure the long-term accuracy of the validated simulation models, the decision-support system should include an integrated mechanism for experience-data feedback. Such an integrated feedback loop would enable the crew to easily report scenarios in which the actual, experienced vessel behaviour deviated noticeably from the predicted capability forecast. Providing this structured field data will allow researchers and engineers to investigate the root causes of model deviations. By analysing this feedback against the recorded vessel data, the industry can identify and correct hidden operational discrepancies, such as unlogged load condition drift, active motion-reduction devices, or unmodeled thruster limitations (as outlined in Section 6.2), thereby creating a closed-loop system that continuously refines the applied models.

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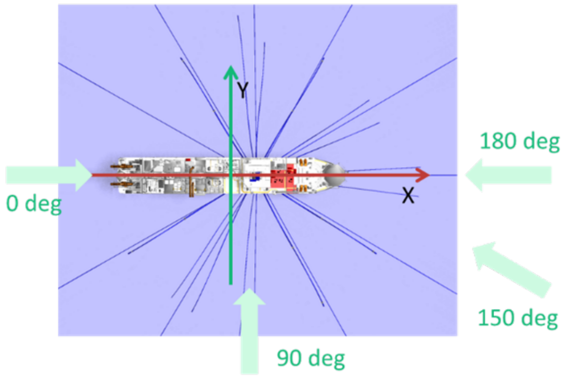
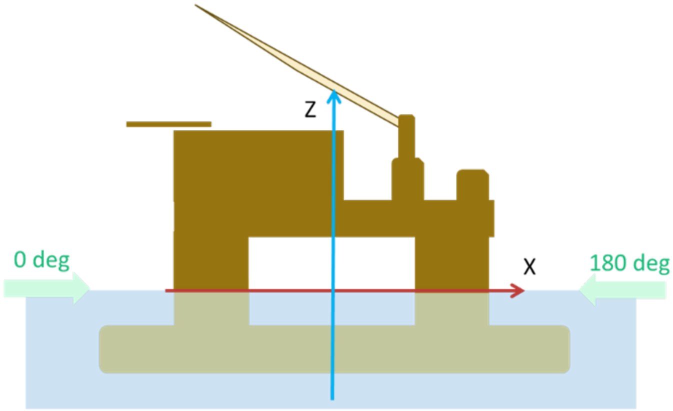
E-1 Model Development and Verification

E-1.1 Conventions and Coordinate System



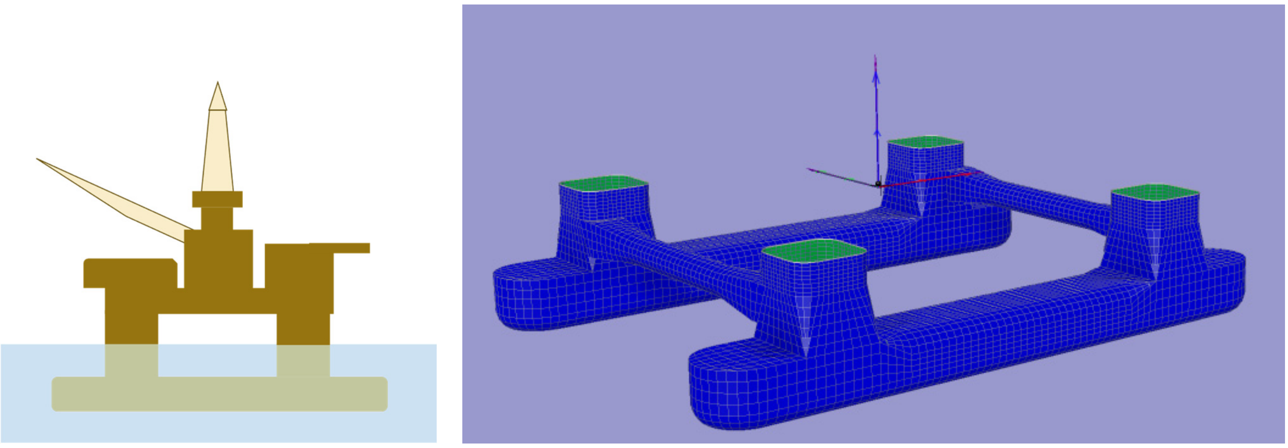


A right-handed coordinate system is used for all models. The positive X-axis points forward, with $X = 0$ at $L_{Pon}/2$ for the semi-submersibles and $L_{PP}/2$ for the FPSO. The positive Y-axis points to port, and the positive Z-axis points upward. The origin for Y is at the centerline, and $Z = 0$ corresponds to the still-water free surface. Wind, wave, and current direction 0° corresponds to following seas, while 180° represents head seas.

Go to Section Numerical Models.

E-1 Model Development and Verification

E-1.2 Drilling Rig – Model & Properties



Semi-Submersible Drilling rig outline (left) and panel model at 23 m draught (right)

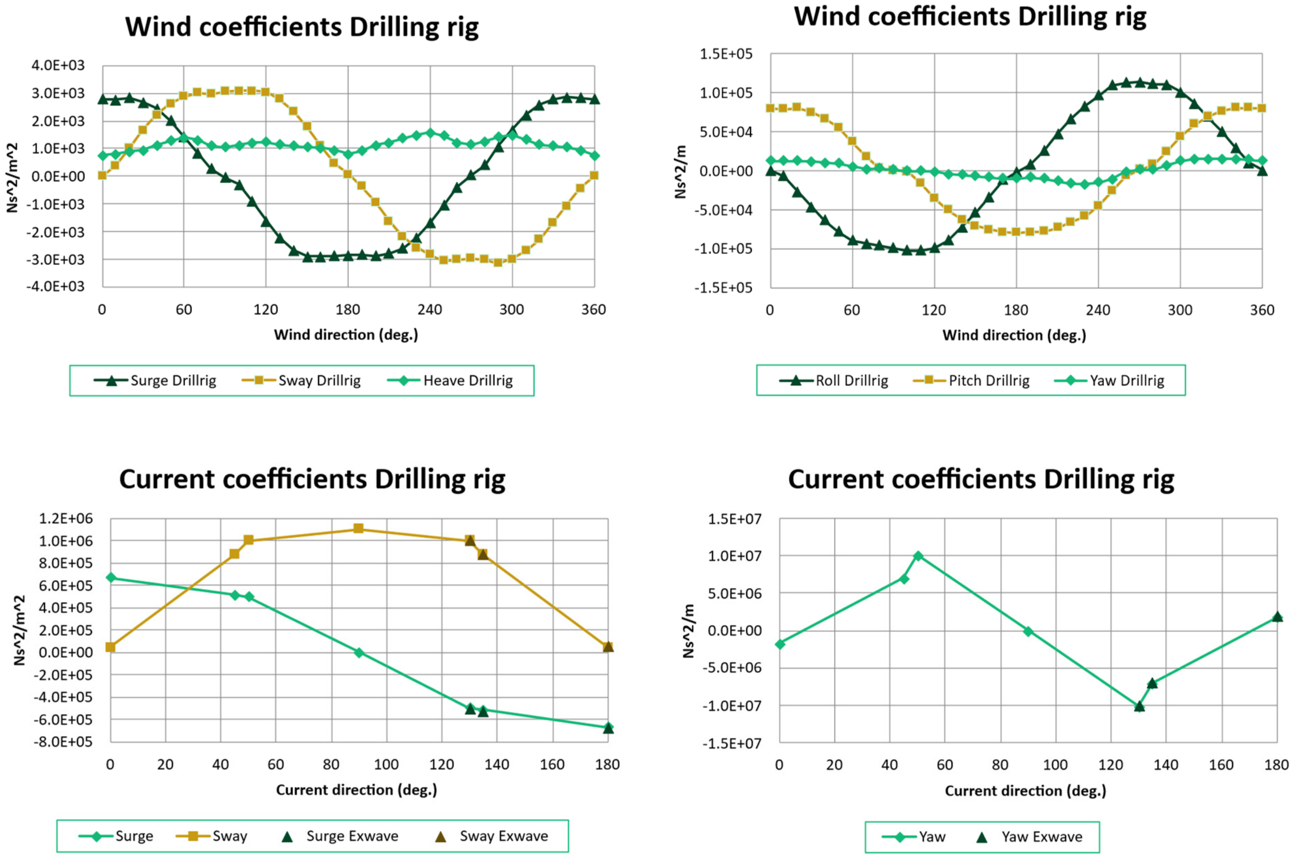
Main properties of the semi-submersible drilling rig:

Parameter	Unit	Value
Length of pontoons (L_{Pon})	[m]	107.5
Width (outside pontoons)	[m]	81.25
Draught	[m]	23.0
Displacement	[mt]	38,890
Longitudinal center of gravity (LCG)	[m]	0 (at center)
Vertical center of gravity (VCG)	[m]	23.65 (above keel)
Radii of gyration: Roll, Pitch, Yaw	[m]	36.1, 34.4, 42.3
Width of pontoons	[m]	14.26
Height of pontoons	[m]	9.5
Length of columns	[m]	12.5
Breadth of columns	[m]	12.5

Go to Section Numerical Models.

E-1 Model Development and Verification

E-1.3 Drilling Rig – Wind & Current Coefficients



Generic drilling rig at 23 m draught. Top: wind coefficients; bottom: current coefficients.

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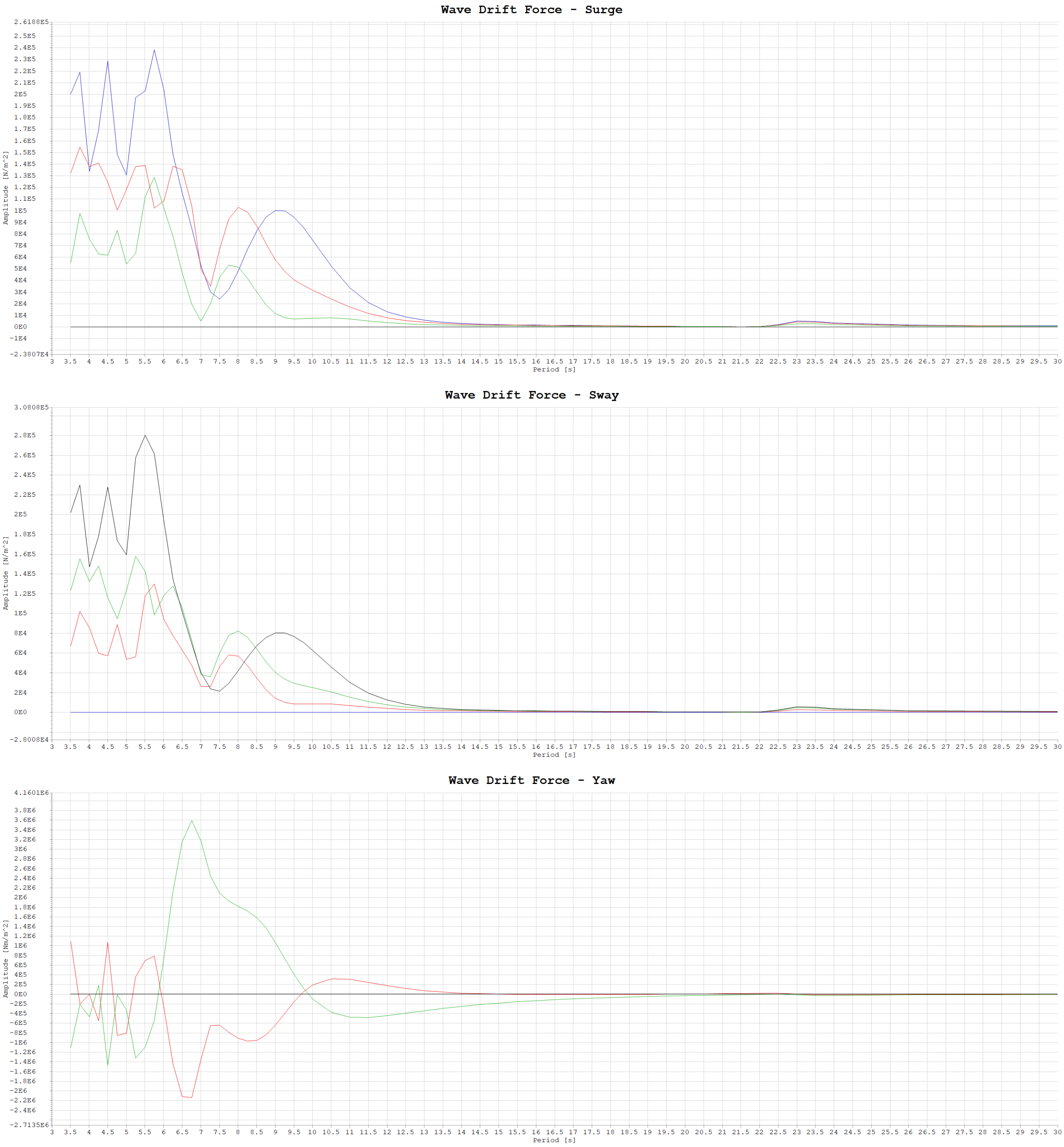
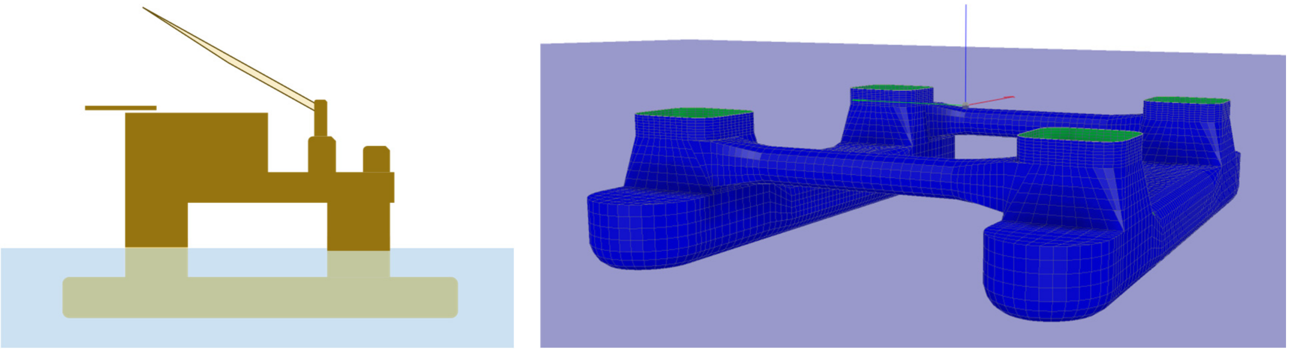


Mean wave drift coefficients calculated using WAMIT for the drilling rig in surge (top), sway (middle), and yaw (bottom). Results are presented for wave headings of 0° (blue), 30° (red), 60° (green), and 90° (black).

Go to Section Numerical Models.

E-1 Model Development and Verification

E-1.5 Floatel – Model & Properties



Semi-Submersible Floatel outline (left) and panel model with 19 m draught (right)

Main properties of the semi-submersible floatel:

Parameter	Unit	Value
Length of pontoons	[m]	93.25
Width (outside pontoons)	[m]	71.25
Draught	[m]	19.00
Displacement	[mt]	32,696
Longitudinal center of gravity (LCG)	[m]	0 (at center)
Vertical center of gravity (VCG)	[m]	19.00 (above keel)
Radii of gyration: Roll, Pitch, Yaw	[m]	31.0, 30.0, 33.0
Width of pontoons	[m]	15.00
Height of pontoons	[m]	9.00
Length of columns	[m]	12.75
Breadth of columns	[m]	13.25

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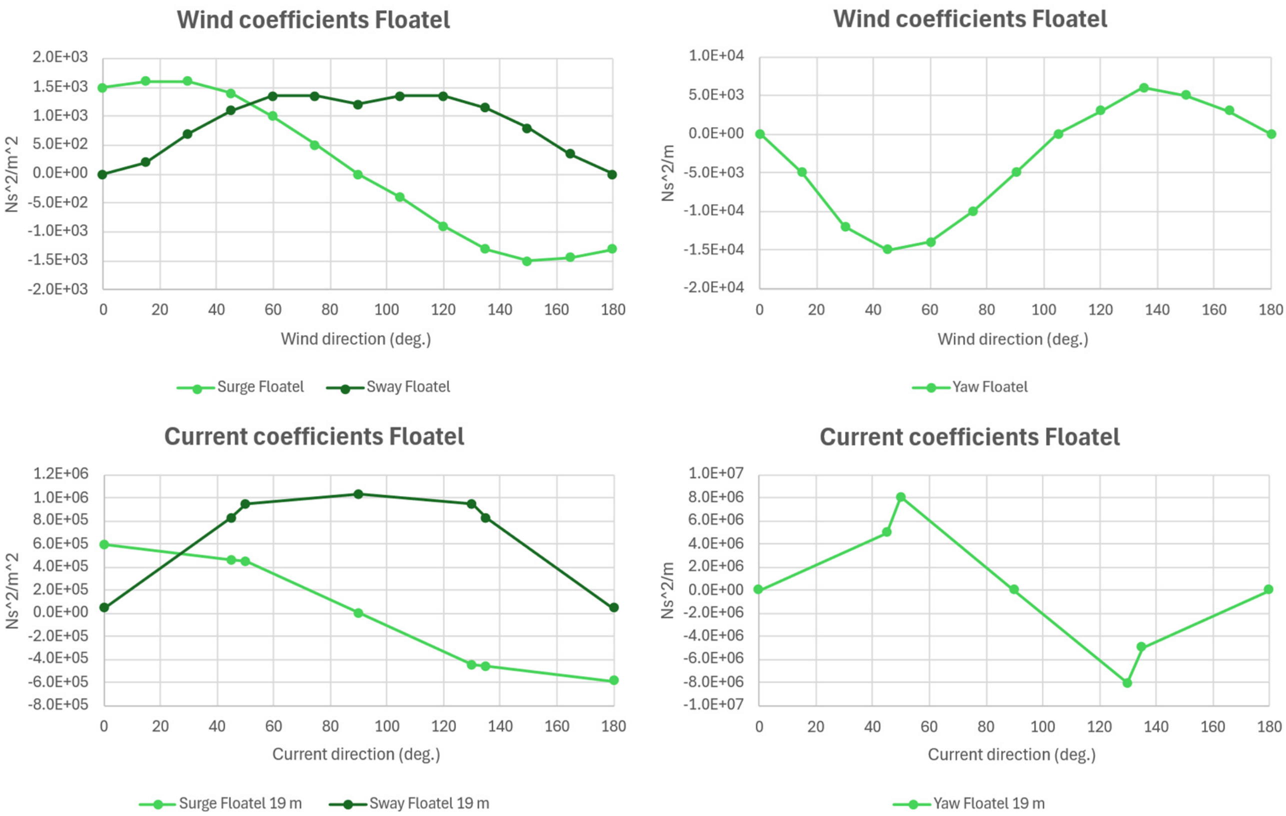
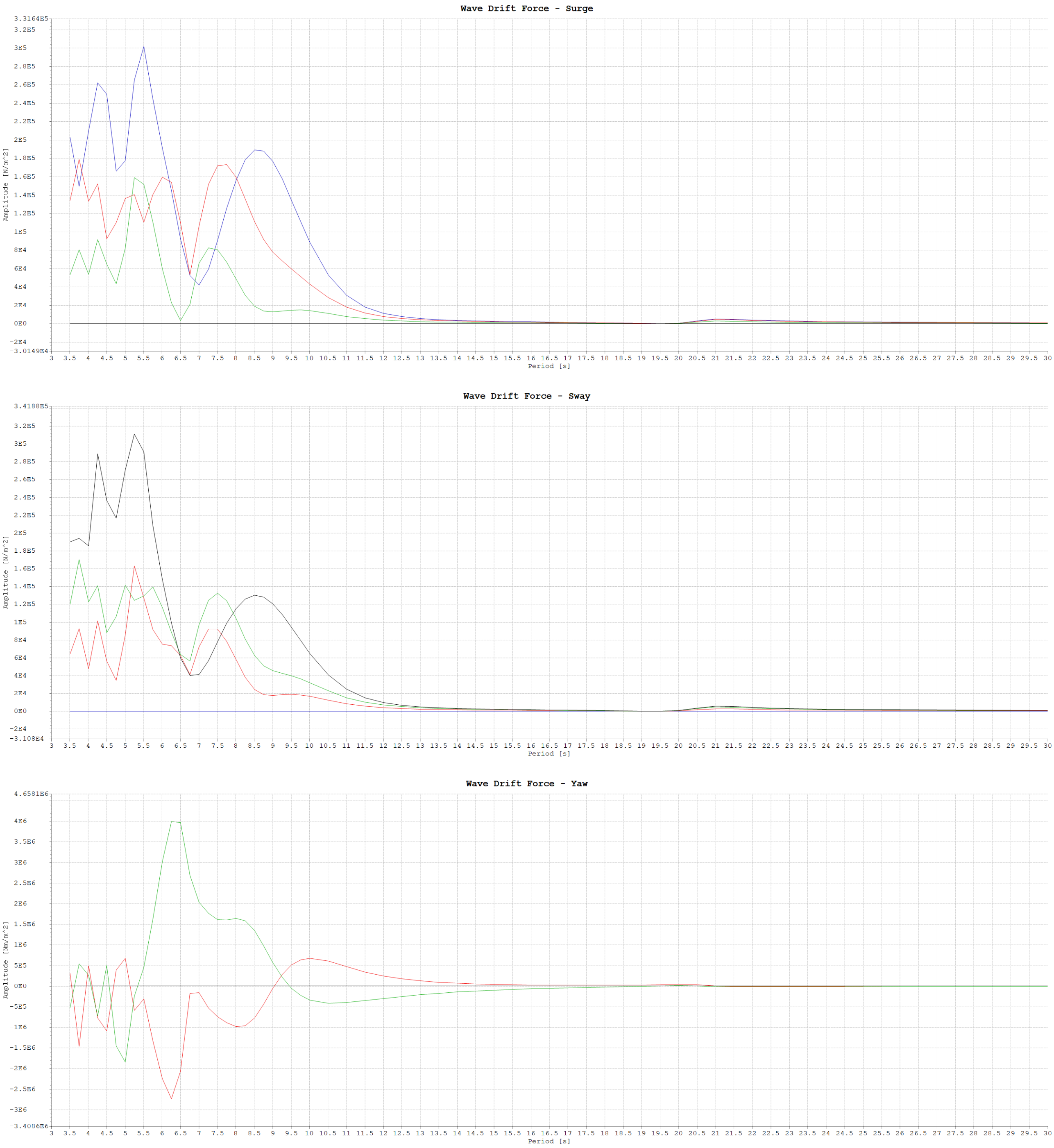


Generic floatel at 19 m draught. Top: wind coefficients; bottom: current coefficients. Left: surge and sway; right: yaw.

Go to Section Numerical Models.

E-1 Model Development and Verification

E-1.7 Floatel – Wave Drift Coefficients

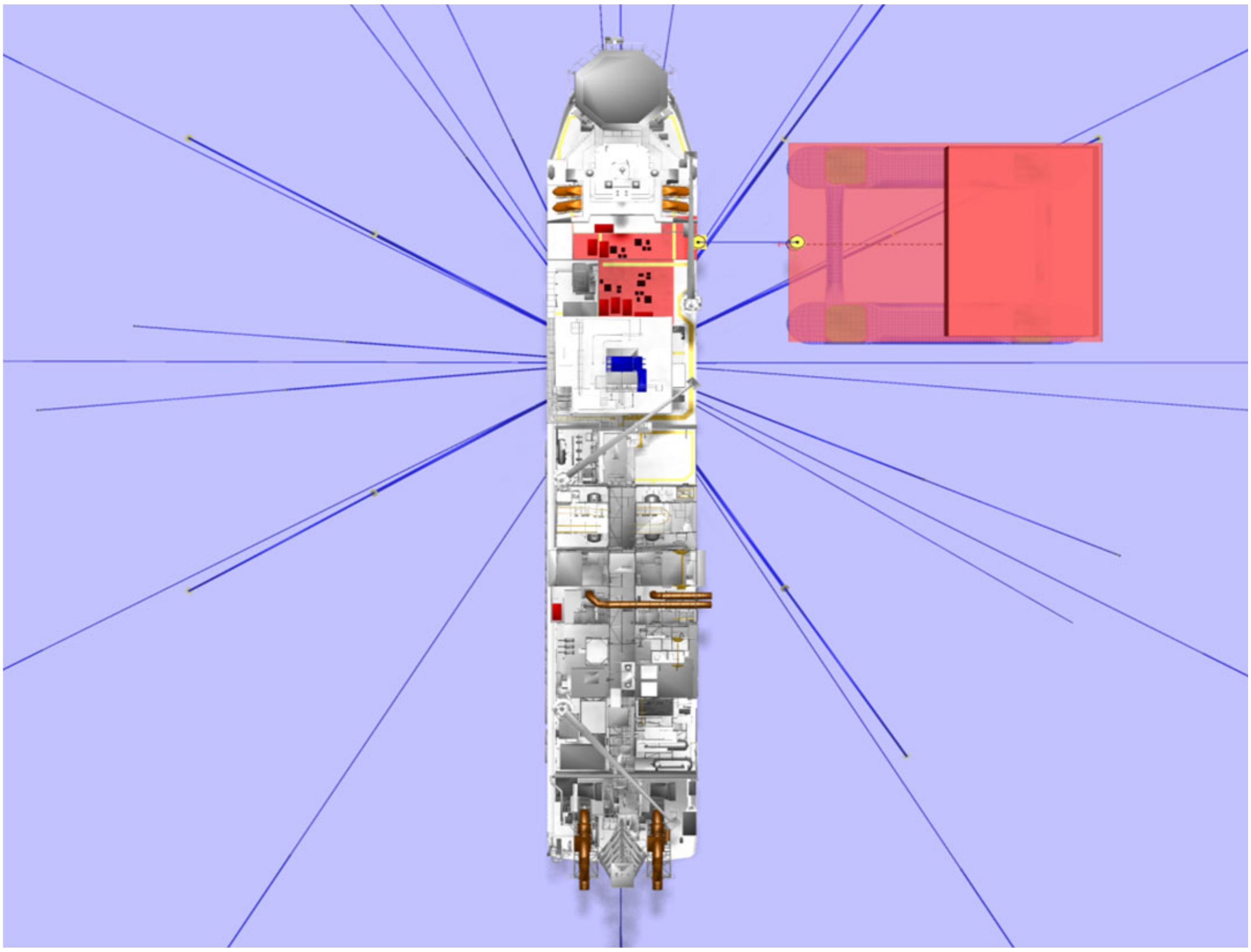


Mean wave drift coefficients calculated using WAMIT for the floatel in surge (top), sway (middle), and yaw (bottom). Results are presented for wave headings of 0° (blue), 30° (red), 60° (green), and 90° (black).

Go to Section Numerical Models.

E-1 Model Development and Verification

E-1.8 Floatel-to-FPSO Gangway Setup



Operational arrangement of Floatel and FPSO.

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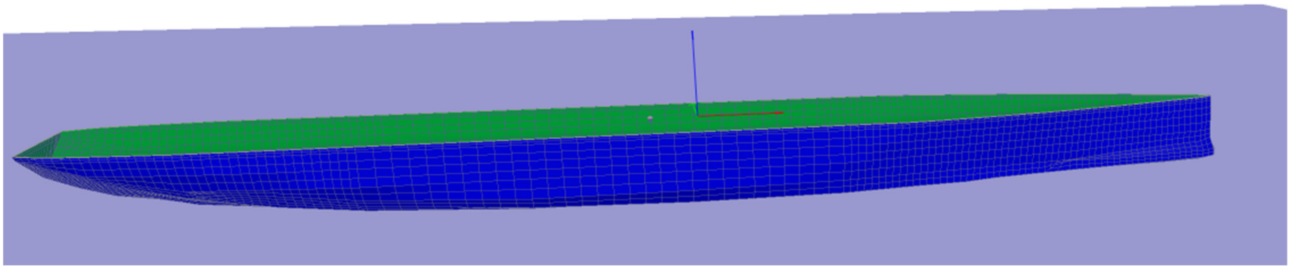

Panel model of FPSO with draught 16.5 m

Main properties of the FPSO model:

Parameter	Unit	Value
Length	[m]	265.0
Width	[m]	45.4
Draught	[m]	16.5
Displacement	[mt]	148,200
Longitudinal center of gravity (LCG)	[m]	-10.8 (aft of $L_{PP}/2$)
Vertical center of gravity (VCG)	[m]	-0.18 (below still-water line)
Radii of gyration: Roll	[m]	16.0
Radii of gyration: Pitch	[m]	65.0
Radii of gyration: Yaw	[m]	66.5

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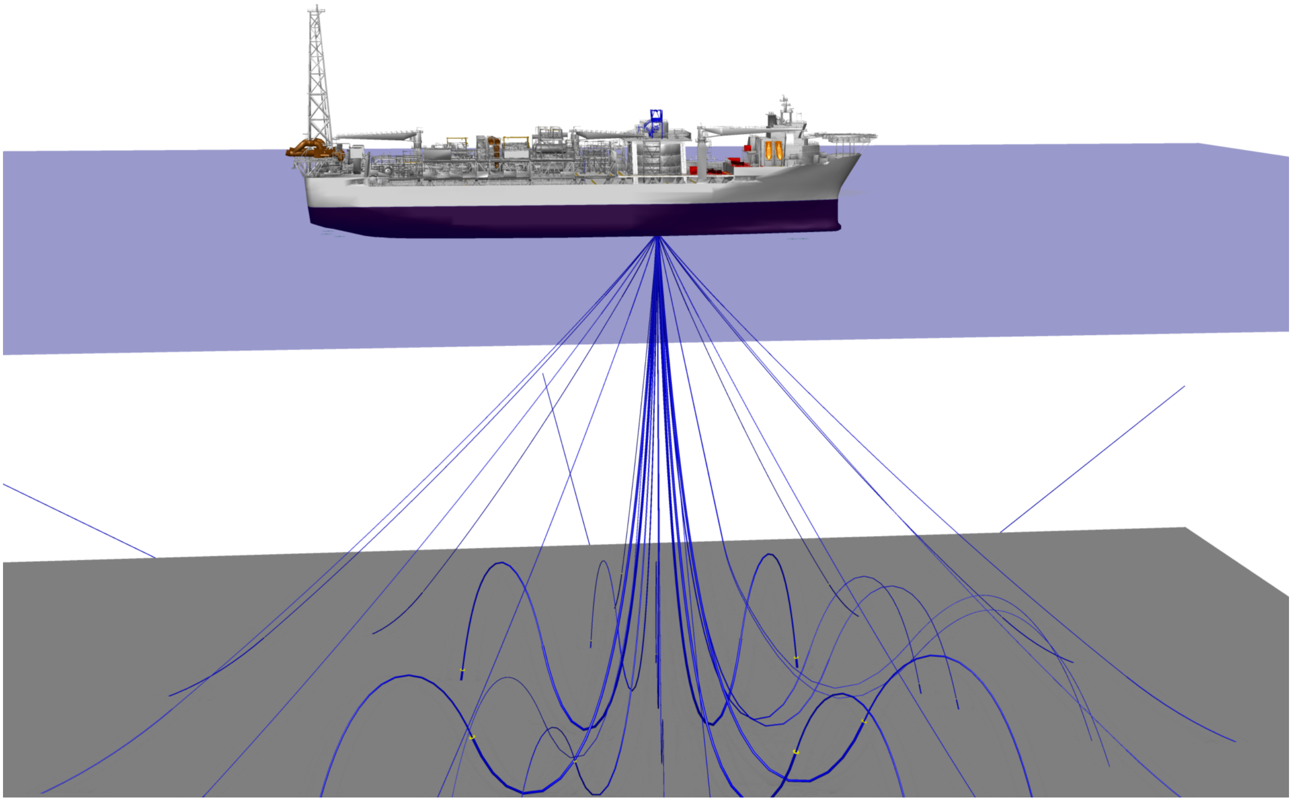
E-1 Model Development and Verification

E-1.10 FPSO – Turret System



FPSO with mooring and risers

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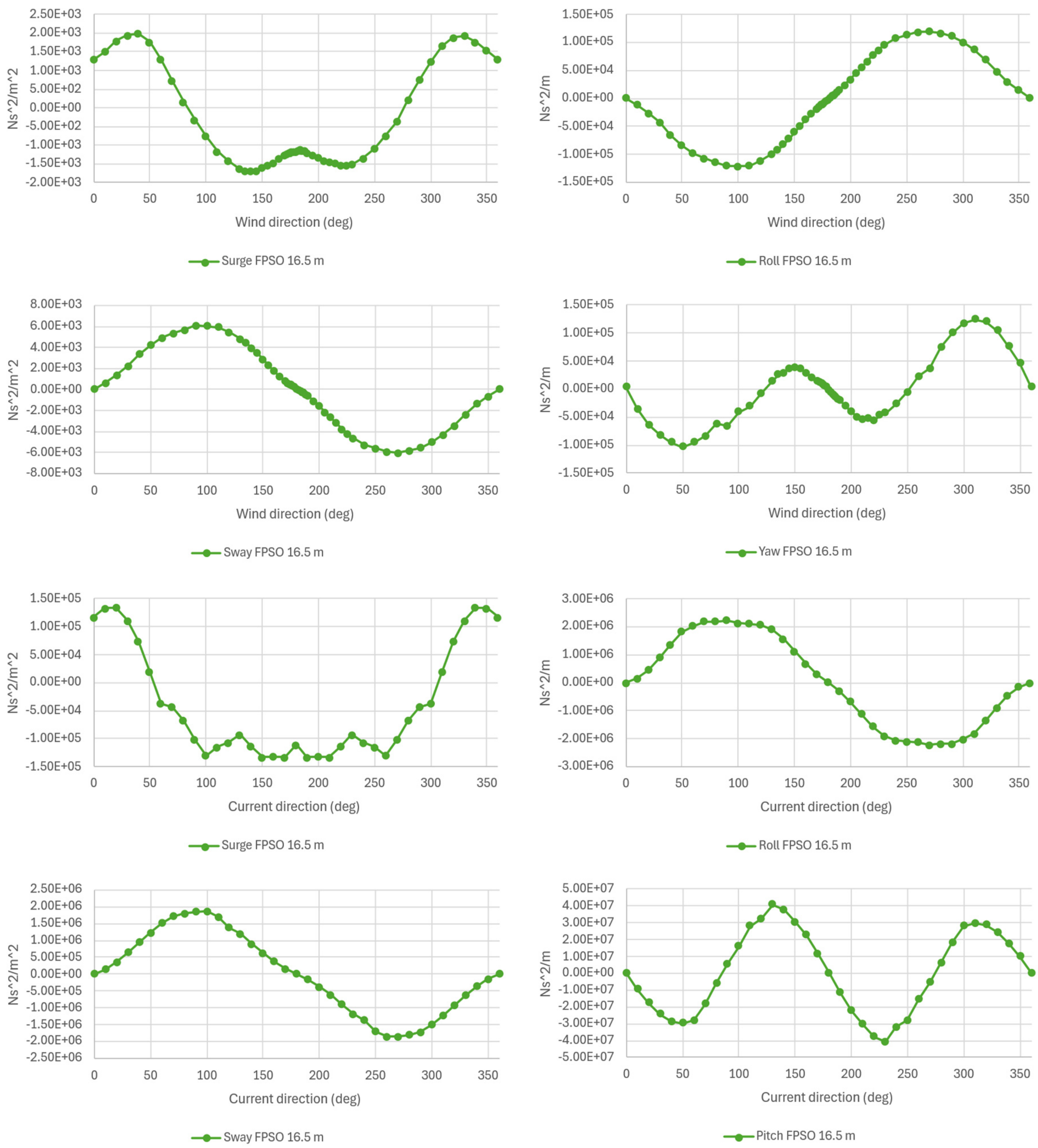
E-1 Model Development and Verification

E-1.11 FPSO – Wind & Current Coefficients



Generic FPSO at 16.5 m draught. Upper four plots: wind coefficients; Lower four plots: current coefficients. Left: surge and sway; right: roll and pitch or yaw.

Go to Section Numerical Models.

E-1 Model Development and Verification

E-1.12 FPSO – Wave Drift Coefficients

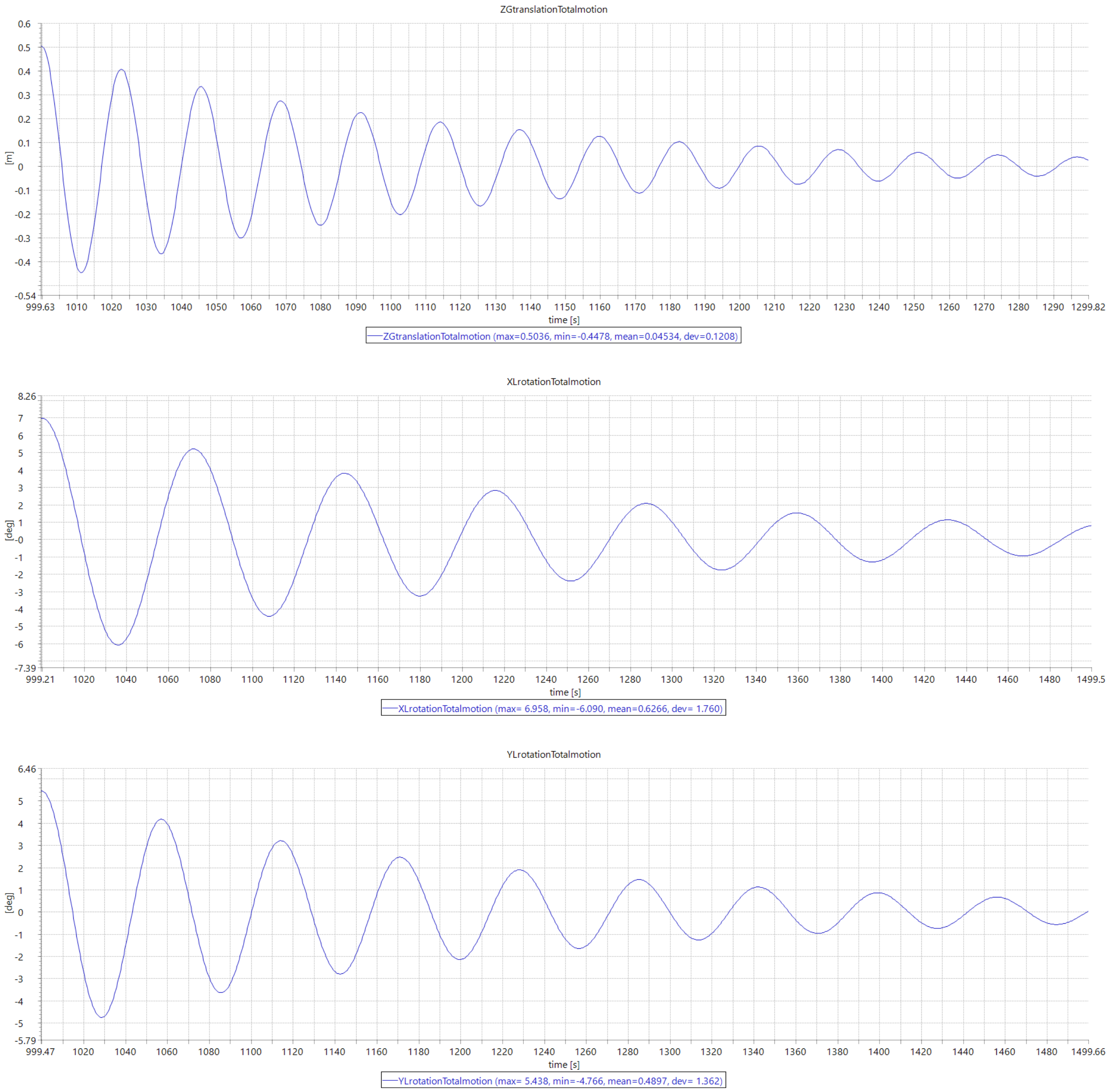
Mean wave drift coefficients calculated using WAMIT for the FPSO in surge (top), sway (middle), and yaw (bottom). Results are presented for wave headings of 0° (blue), 30° (red), 60° (green), 90° (black), 120° (purple), 150° (yellow), and 180° (pink).

Go to Section Numerical Models.

ENCLOSURE	2
REPORT NUMBER	OC2025 F-073
DATE	2026-06-03
REFERENCE	2025/720

E-2 Model Tuning and Documentation

E-2.1 Drilling-Rig – Motion Decay Behaviour



Motion decay time series for drilling rig in heave (top), roll (middle), and sway (bottom).

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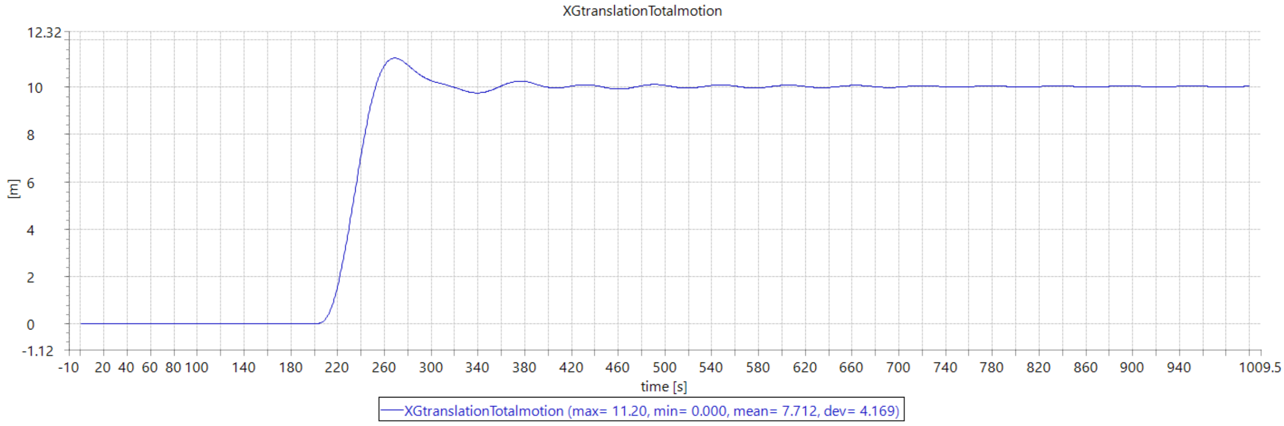

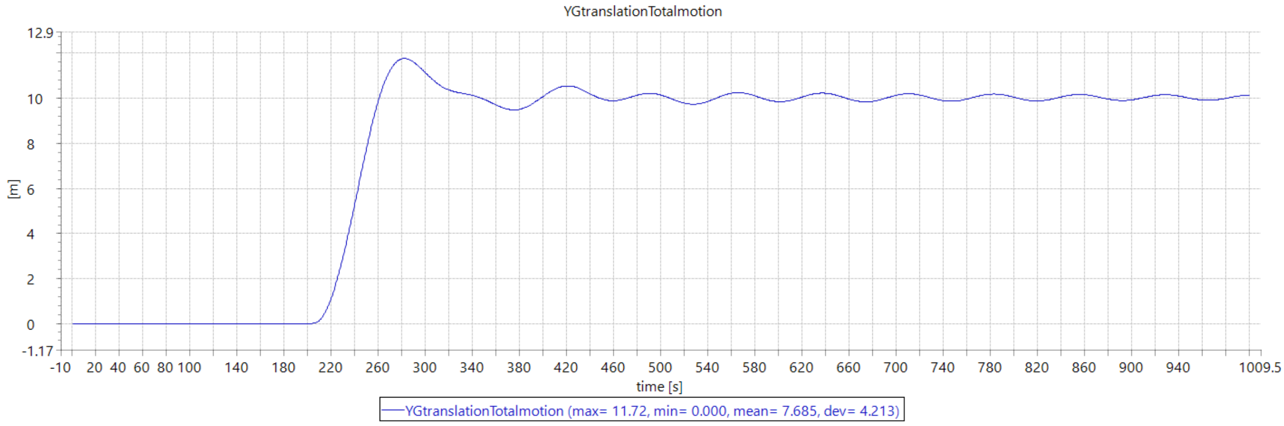

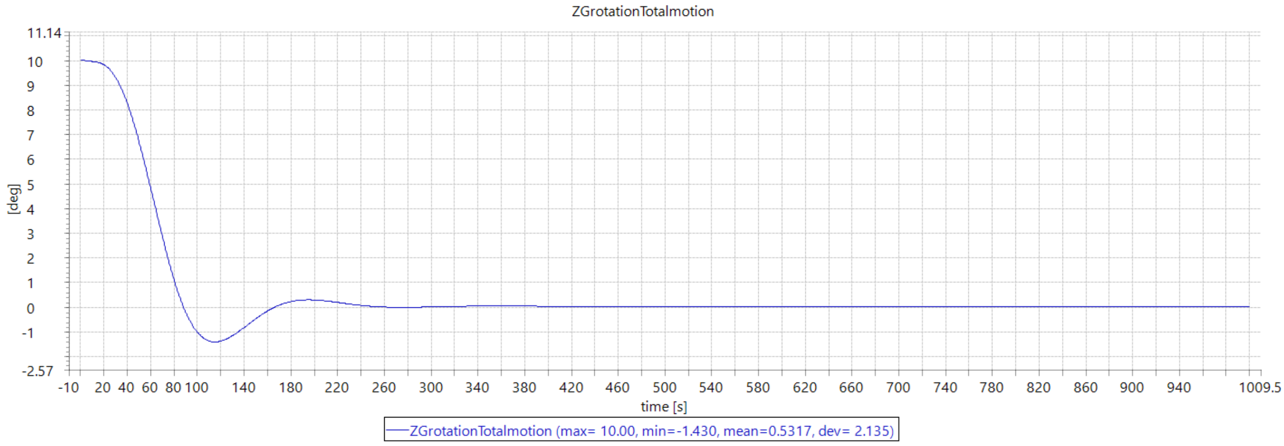

System documentation tests for drilling rig DP system in surge (top), sway (middle), and yaw (bottom).

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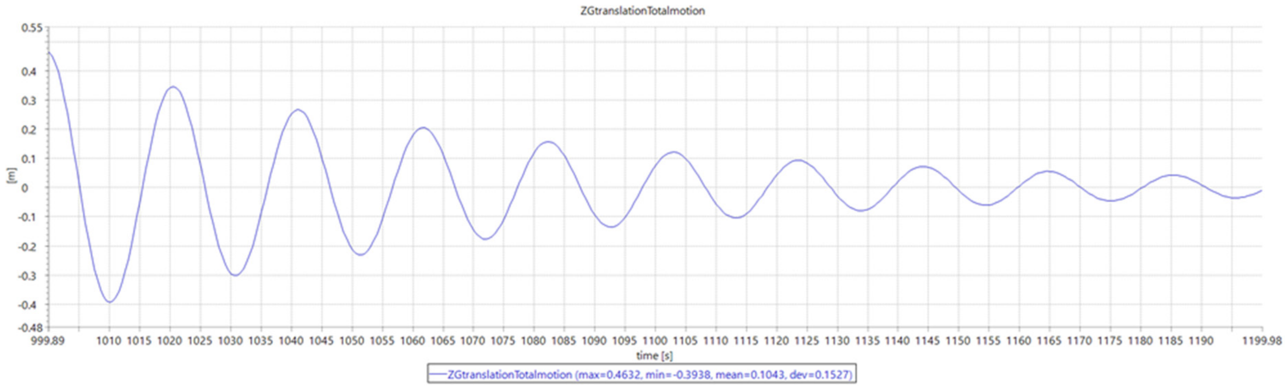
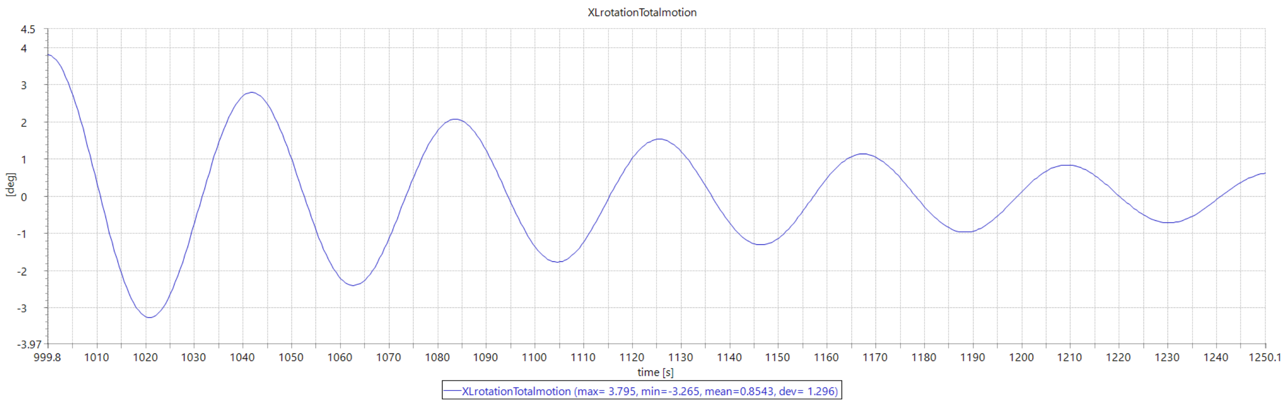
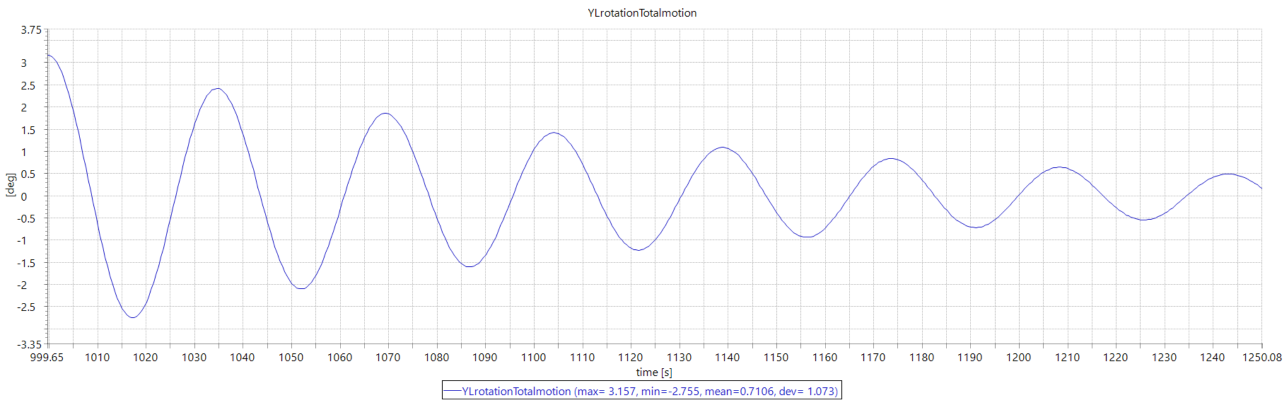
E-2 Model Tuning and Documentation

E-2.3 Floatel – Motion Decay Behaviour

ENCLOSURE	2
REPORT NUMBER	OC2025 F-073
DATE	2026-06-03
REFERENCE	2025/720







Motion decay test results of floatel in heave (top), roll (middle), and pitch (bottom).

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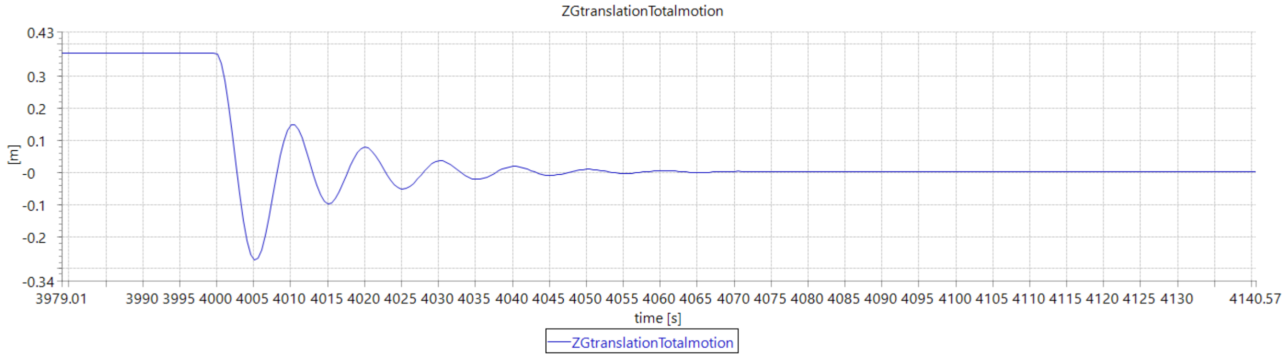
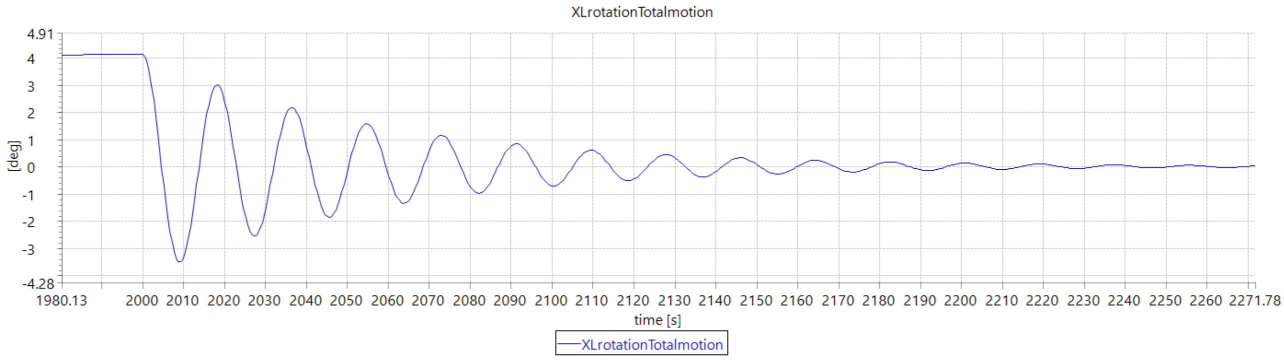
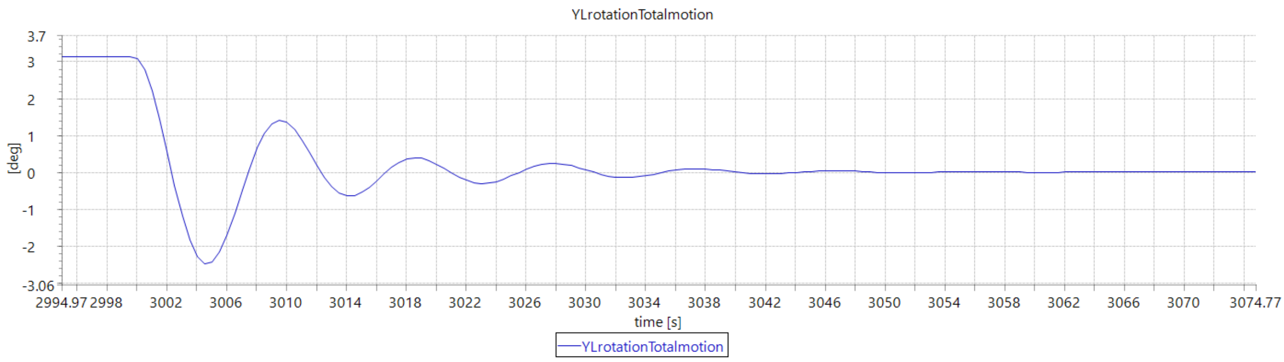
E-2 Model Tuning and Documentation

E-2.4 FPSO – Motion Decay Behaviour





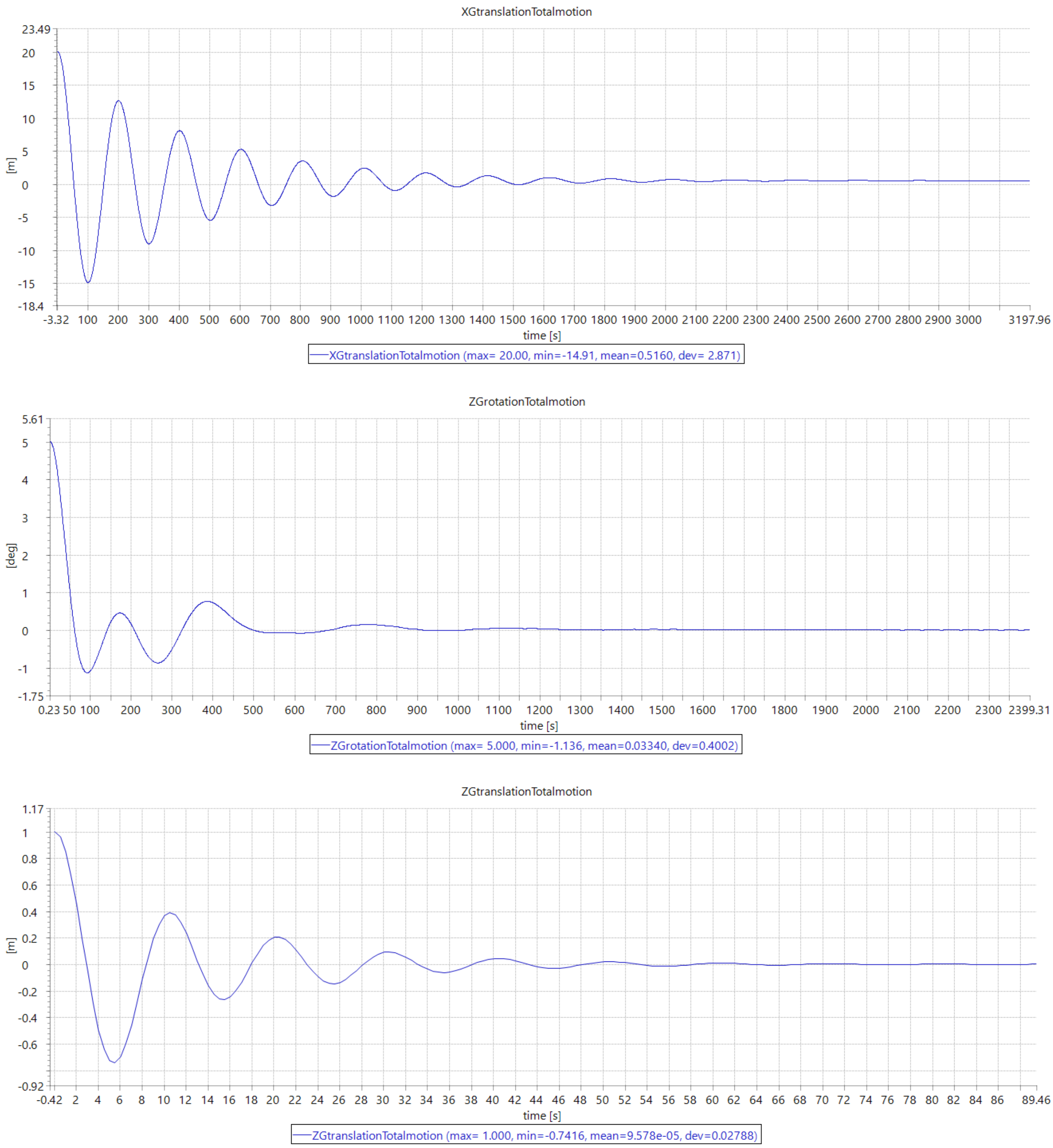


Motion decay test results for FPSO in horizontal dummy mooring (no risers or thrusters in heave (top), roll (middle), and pitch (bottom).

Go to Section Numerical Models.

E-2 Model Tuning and Documentation

E-2.5 FPSO – Motion Decay Behaviour

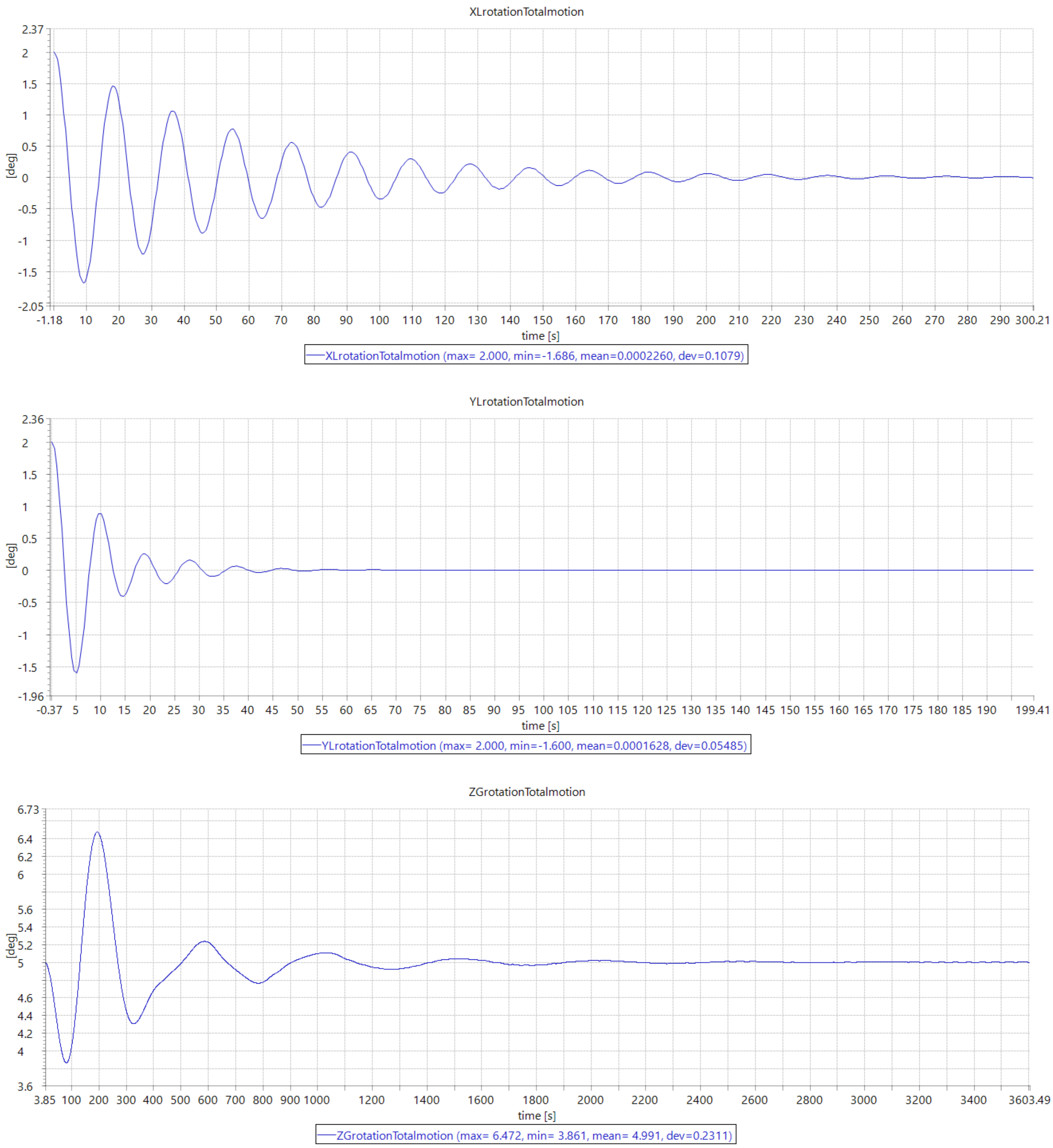


Motion decay for FPSO with mooring lines, risers, and DP system in surge (top), sway, and heave (bottom).

Go to Section Numerical Models.

E-2 Model Tuning and Documentation

E-2.6 FPSO – Motion Decay Behaviour (cont.)



Motion decay for FPSO with mooring lines, risers, and DP system in roll (top), pitch (middle), and yaw (bottom).

Go to Section Numerical Models.

E-2 Model Tuning and Documentation

E-2.7 FPSO – DP Heading Control

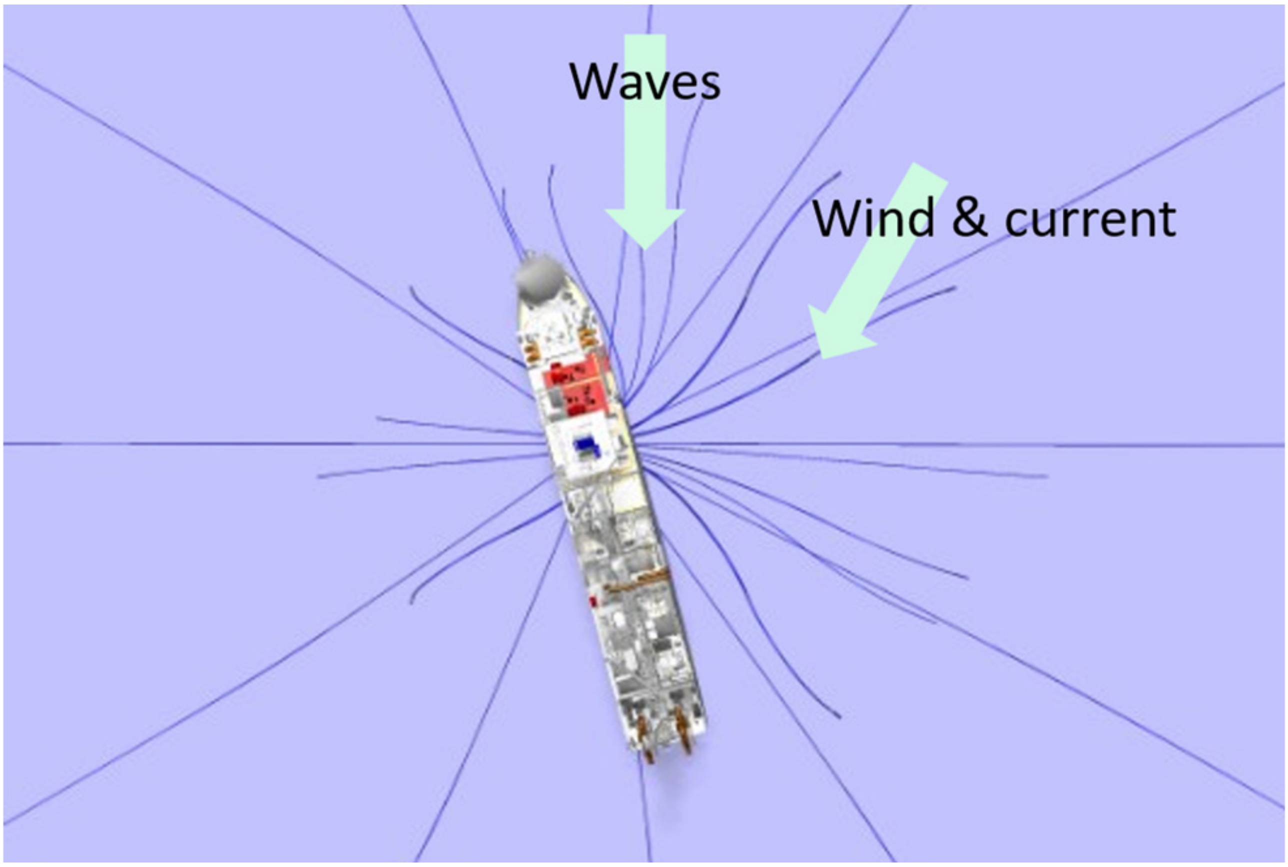
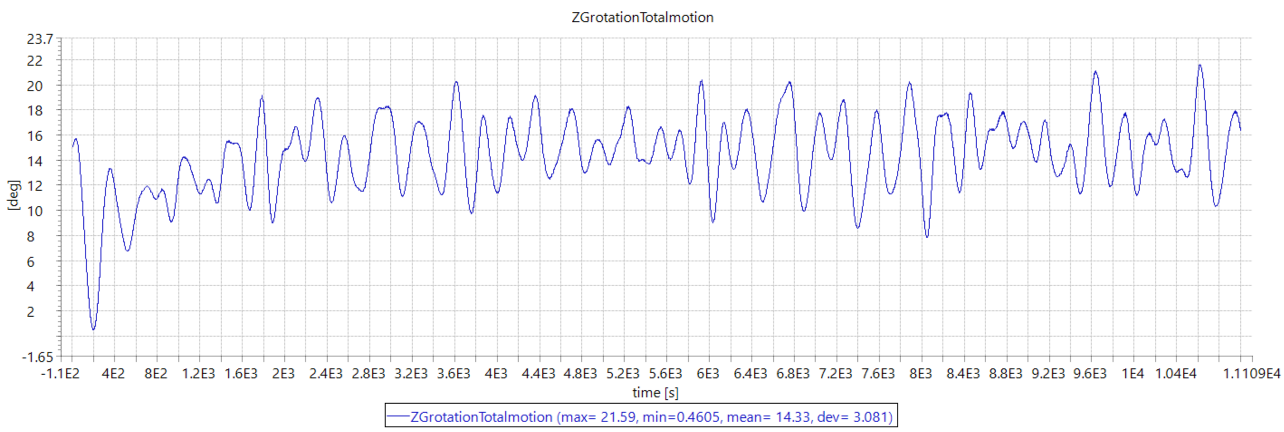


Illustration of vessel, wave, current, and wind directions in the test simulation.



Verification of DP Heading Control: FPSO maintaining 15° heading under oblique environmental loads.

Go to Section Numerical Models.

E-3 Results for Drilling Rig - Collinear

E-3.1 0° Environment, 0.2 m/s Current

PoS: Collinear, Dir 0°, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.99	0.97	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.91	0.92	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.77	0.79	0.96	1.00	1.00	1.00	1.00	1.00
6.0			0.90	0.50	0.57	0.89	1.00	1.00	1.00	1.00	1.00
6.5				0.25	0.25	0.71	0.97	1.00	1.00	1.00	1.00
7.0				0.10	0.10	0.39	0.91	1.00	0.99	1.00	1.00
7.5					0.02	0.16	0.74	0.97	0.98	0.99	1.00

TUF P99: Collinear, Dir 0°, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.26	0.19	0.13	0.14	0.13	0.11	0.09	0.09	0.08	0.08	0.08
3.0	0.35	0.24	0.19	0.19	0.17	0.14	0.12	0.10	0.10	0.09	0.09
3.5	0.45	0.30	0.23	0.25	0.22	0.18	0.14	0.12	0.11	0.10	0.10
4.0		0.37	0.29	0.31	0.28	0.22	0.17	0.14	0.13	0.12	0.11
4.5			0.35	0.38	0.35	0.27	0.20	0.17	0.15	0.13	0.13
5.0			0.42	0.46	0.42	0.32	0.24	0.19	0.17	0.15	0.14
5.5			0.50	0.55	0.50	0.38	0.28	0.23	0.19	0.17	0.16
6.0			0.59	0.65	0.59	0.44	0.33	0.26	0.22	0.19	0.18
6.5				0.76	0.69	0.51	0.38	0.30	0.25	0.22	0.20
7.0				0.90	0.83	0.59	0.43	0.33	0.28	0.25	0.22
7.5					0.93	0.70	0.49	0.38	0.31	0.27	0.25

PoS: Collinear, Dir 0°, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.97	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.94	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.82	0.83	0.96	1.00	1.00	1.00	1.00	1.00
6.0			0.92	0.55	0.59	0.93	1.00	1.00	1.00	1.00	1.00
6.5				0.28	0.28	0.73	0.97	1.00	1.00	1.00	1.00
7.0				0.12	0.09	0.44	0.93	1.00	1.00	1.00	1.00
7.5					0.03	0.21	0.75	0.97	0.98	0.99	1.00

TUF P99: Collinear, Dir 0°, Wind 10 m/s, Cur 0.2 m/s

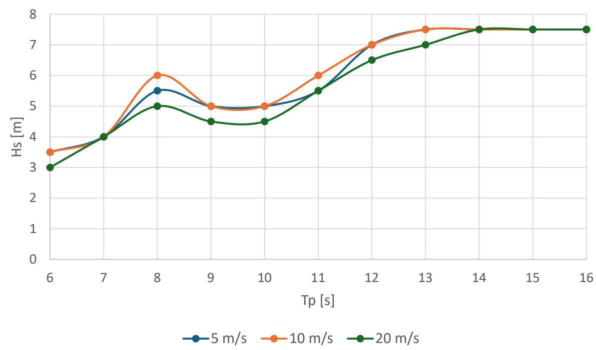
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.34	0.27	0.23	0.24	0.23	0.21	0.20	0.19	0.19	0.19	0.19
3.0	0.43	0.32	0.28	0.28	0.26	0.23	0.21	0.20	0.20	0.19	0.19
3.5	0.53	0.38	0.32	0.34	0.31	0.26	0.23	0.22	0.21	0.20	0.20
4.0		0.45	0.37	0.39	0.37	0.30	0.26	0.24	0.22	0.21	0.21
4.5			0.43	0.46	0.43	0.35	0.29	0.26	0.24	0.23	0.22
5.0			0.50	0.54	0.50	0.40	0.33	0.28	0.26	0.24	0.23
5.5			0.57	0.62	0.57	0.46	0.37	0.32	0.28	0.26	0.25
6.0			0.65	0.72	0.66	0.52	0.41	0.35	0.31	0.28	0.26
6.5				0.82	0.75	0.58	0.45	0.38	0.34	0.31	0.29
7.0				0.94	0.87	0.65	0.50	0.41	0.36	0.33	0.30
7.5					0.95	0.74	0.56	0.45	0.39	0.35	0.32

PoS: Collinear, Dir 0°, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.88	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.94	0.96	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.98	0.82	0.88	0.99	1.00	1.00	1.00	1.00	1.00
5.5			0.85	0.52	0.66	0.94	1.00	1.00	1.00	1.00	1.00
6.0			0.63	0.22	0.29	0.81	0.99	1.00	1.00	1.00	1.00
6.5				0.07	0.08	0.56	0.93	1.00	1.00	1.00	1.00
7.0				0.01	0.01	0.23	0.84	0.99	1.00	1.00	1.00
7.5					0.00	0.09	0.63	0.90	0.99	1.00	1.00

TUF P99: Collinear, Dir 0°, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.83	0.80	0.77	0.77	0.77	0.75	0.75	0.74	0.73	0.73	0.72
3.0	0.89	0.82	0.80	0.79	0.78	0.77	0.75	0.74	0.74	0.73	0.73
3.5	0.95	0.86	0.82	0.82	0.80	0.78	0.76	0.75	0.74	0.74	0.73
4.0		0.91	0.85	0.86	0.83	0.80	0.77	0.76	0.75	0.74	0.74
4.5			0.89	0.90	0.87	0.82	0.79	0.77	0.76	0.75	0.74
5.0			0.93	0.95	0.92	0.85	0.81	0.78	0.77	0.76	0.75
5.5			0.96	0.97	0.96	0.89	0.83	0.80	0.78	0.76	0.75
6.0			0.97	0.98	0.97	0.93	0.86	0.82	0.79	0.77	0.76
6.5				0.99	0.99	0.96	0.89	0.84	0.81	0.79	0.77
7.0				0.99	1.00	0.97	0.92	0.86	0.82	0.80	0.78
7.5					1.00	0.99	0.95	0.89	0.84	0.82	0.80



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom). The graph at the bottom shows the maximum H_s for each T_p with a POS above 0.9.

Go to Section Simulation Results.

E-3 Results for Drilling Rig - Collinear

E-3.2 0° Environment, 0.7 m/s Current

PoS: Collinear, Dir 0°, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.99	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.90	0.90	0.98	1.00	1.00	1.00	1.00	1.00
6.0			0.97	0.73	0.72	0.96	1.00	1.00	1.00	1.00	1.00
6.5				0.42	0.43	0.89	1.00	1.00	1.00	1.00	1.00
7.0				0.18	0.19	0.61	0.96	1.00	1.00	1.00	1.00
7.5					0.09	0.34	0.87	0.99	1.00	1.00	1.00

TUF P99: Collinear, Dir 0°, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.35	0.28	0.24	0.25	0.24	0.22	0.21	0.20	0.20	0.20	0.20
3.0	0.43	0.33	0.29	0.29	0.28	0.25	0.23	0.22	0.21	0.21	0.20
3.5	0.53	0.39	0.33	0.35	0.32	0.28	0.25	0.23	0.22	0.22	0.21
4.0		0.45	0.38	0.40	0.38	0.32	0.27	0.25	0.24	0.23	0.23
4.5			0.44	0.46	0.43	0.36	0.30	0.27	0.26	0.24	0.24
5.0			0.50	0.54	0.50	0.41	0.34	0.30	0.27	0.26	0.25
5.5			0.57	0.61	0.57	0.46	0.38	0.33	0.29	0.28	0.26
6.0			0.65	0.70	0.65	0.52	0.42	0.36	0.32	0.30	0.28
6.5				0.80	0.73	0.58	0.46	0.39	0.35	0.32	0.30
7.0				0.92	0.84	0.64	0.50	0.42	0.37	0.34	0.32
7.5					0.93	0.72	0.55	0.46	0.40	0.36	0.34

PoS: Collinear, Dir 0°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.89	0.90	0.98	1.00	1.00	1.00	1.00	1.00
6.0			0.95	0.71	0.69	0.96	1.00	1.00	1.00	1.00	1.00
6.5				0.38	0.43	0.89	1.00	1.00	1.00	1.00	1.00
7.0				0.15	0.16	0.61	0.96	1.00	1.00	1.00	1.00
7.5					0.09	0.33	0.87	0.99	1.00	1.00	1.00

TUF P99: Collinear, Dir 0°, Wind 10 m/s, Cur 0.7 m/s

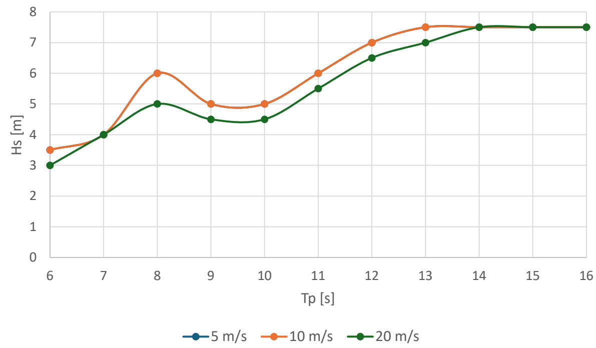
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.38	0.34	0.35	0.34	0.32	0.31	0.31	0.30	0.30	0.30
3.0	0.52	0.42	0.38	0.38	0.37	0.34	0.33	0.32	0.31	0.31	0.31
3.5	0.61	0.47	0.42	0.44	0.41	0.37	0.34	0.33	0.32	0.32	0.31
4.0		0.54	0.47	0.49	0.46	0.40	0.37	0.35	0.34	0.33	0.32
4.5			0.52	0.55	0.52	0.45	0.39	0.37	0.35	0.34	0.33
5.0			0.58	0.62	0.58	0.49	0.43	0.39	0.37	0.35	0.35
5.5			0.65	0.70	0.65	0.54	0.46	0.42	0.39	0.37	0.36
6.0			0.73	0.79	0.73	0.60	0.50	0.45	0.41	0.39	0.37
6.5				0.89	0.82	0.66	0.54	0.48	0.44	0.41	0.39
7.0				0.95	0.91	0.72	0.59	0.51	0.46	0.43	0.41
7.5					0.96	0.80	0.64	0.54	0.49	0.45	0.43

PoS: Collinear, Dir 0°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.84	1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.98	1.00	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.99	0.93	0.96	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.96	0.74	0.85	0.98	1.00	1.00	1.00	1.00	1.00
5.5			0.77	0.38	0.55	0.95	1.00	1.00	1.00	1.00	1.00
6.0			0.39	0.11	0.22	0.75	0.99	1.00	1.00	1.00	1.00
6.5				0.00	0.07	0.51	0.94	1.00	1.00	1.00	1.00
7.0				0.00	0.01	0.22	0.81	1.00	1.00	1.00	1.00
7.5					0.00	0.06	0.60	0.90	1.00	1.00	1.00

TUF P99: Collinear, Dir 0°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.93	0.90	0.88	0.88	0.87	0.86	0.85	0.85	0.84	0.84	0.83
3.0	0.95	0.92	0.90	0.90	0.89	0.87	0.86	0.85	0.85	0.84	0.84
3.5	0.97	0.94	0.92	0.92	0.91	0.88	0.87	0.86	0.85	0.85	0.84
4.0		0.96	0.94	0.94	0.93	0.90	0.88	0.87	0.86	0.85	0.85
4.5			0.96	0.96	0.95	0.92	0.89	0.88	0.87	0.86	0.85
5.0			0.97	0.97	0.97	0.94	0.91	0.89	0.87	0.87	0.86
5.5			0.97	0.98	0.98	0.96	0.92	0.90	0.88	0.87	0.86
6.0			0.98	0.99	0.99	0.97	0.94	0.92	0.90	0.88	0.87
6.5				0.99	1.00	0.98	0.96	0.93	0.91	0.89	0.88
7.0				1.00	1.00	0.99	0.97	0.94	0.92	0.90	0.89
7.5					1.00	1.00	0.98	0.96	0.93	0.91	0.90



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom). The graph at the bottom shows the maximum H_s for each T_p with a POS above 0.9.

Go to Section Simulation Results.

E-3 Results for Drilling Rig - Collinear

E-3.3 30° Environment, 0.2 m/s Current

PoS: Collinear, Dir 30°, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.96	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.80	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.55	0.79	0.99	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.59	0.94	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.27	0.84	0.98	1.00	1.00	1.00	1.00	1.00
7.5					0.60	0.88	0.99	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 30°, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.22	0.18	0.16	0.13	0.11	0.10	0.09	0.08	0.08	0.08	0.08
3.0	0.29	0.24	0.22	0.17	0.14	0.12	0.10	0.10	0.09	0.09	0.09
3.5	0.37	0.30	0.27	0.23	0.17	0.14	0.12	0.11	0.10	0.10	0.10
4.0		0.37	0.34	0.28	0.22	0.17	0.14	0.13	0.12	0.11	0.11
4.5			0.41	0.34	0.26	0.21	0.16	0.14	0.13	0.12	0.12
5.0			0.50	0.41	0.31	0.24	0.20	0.16	0.15	0.14	0.13
5.5			0.60	0.49	0.36	0.28	0.23	0.19	0.16	0.15	0.14
6.0			0.71	0.57	0.42	0.32	0.26	0.22	0.19	0.17	0.15
6.5				0.66	0.48	0.37	0.29	0.24	0.21	0.19	0.18
7.0				0.78	0.56	0.42	0.33	0.27	0.23	0.21	0.19
7.5					0.63	0.47	0.37	0.30	0.25	0.23	0.21

PoS: Collinear, Dir 30°, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.78	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.52	0.79	0.99	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.59	0.94	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.24	0.85	0.98	1.00	1.00	1.00	1.00	1.00
7.5					0.58	0.89	1.00	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 30°, Wind 10 m/s, Cur 0.2 m/s

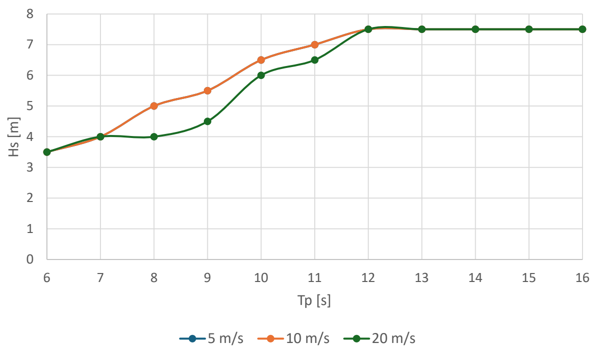
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.32	0.29	0.26	0.25	0.23	0.22	0.21	0.21	0.21	0.20	0.20
3.0	0.38	0.34	0.32	0.28	0.25	0.23	0.22	0.22	0.21	0.21	0.21
3.5	0.46	0.39	0.37	0.33	0.28	0.25	0.23	0.23	0.22	0.22	0.21
4.0		0.47	0.44	0.38	0.32	0.27	0.25	0.24	0.23	0.22	0.22
4.5			0.51	0.44	0.36	0.31	0.27	0.25	0.24	0.23	0.23
5.0			0.59	0.51	0.41	0.34	0.30	0.27	0.25	0.24	0.24
5.5			0.69	0.58	0.46	0.38	0.33	0.30	0.27	0.26	0.25
6.0			0.80	0.66	0.51	0.42	0.36	0.32	0.30	0.27	0.26
6.5				0.75	0.58	0.46	0.39	0.34	0.31	0.29	0.28
7.0				0.86	0.65	0.51	0.42	0.37	0.33	0.31	0.29
7.5					0.72	0.56	0.46	0.40	0.35	0.33	0.31

PoS: Collinear, Dir 30°, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.90	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.60	0.90	0.99	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.18	0.69	0.97	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.04	0.26	0.91	0.99	1.00	1.00	1.00	1.00	1.00
6.5				0.08	0.73	0.97	1.00	1.00	1.00	1.00	1.00
7.0				0.00	0.36	0.84	0.99	1.00	1.00	1.00	1.00
7.5					0.10	0.67	0.94	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 30°, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.91	0.89	0.88	0.86	0.85	0.84	0.83	0.83	0.82	0.82	0.81
3.0	0.94	0.92	0.91	0.88	0.86	0.85	0.84	0.83	0.82	0.82	0.81
3.5	0.96	0.94	0.93	0.91	0.87	0.86	0.85	0.84	0.83	0.82	0.82
4.0		0.96	0.95	0.93	0.90	0.87	0.85	0.84	0.83	0.83	0.82
4.5			0.96	0.95	0.92	0.89	0.86	0.85	0.84	0.83	0.82
5.0			0.97	0.96	0.94	0.91	0.88	0.86	0.85	0.84	0.83
5.5			0.97	0.97	0.95	0.92	0.89	0.88	0.85	0.84	0.83
6.0			0.98	0.98	0.97	0.94	0.91	0.89	0.87	0.85	0.84
6.5				0.98	0.97	0.95	0.92	0.90	0.88	0.86	0.85
7.0				0.99	0.98	0.97	0.94	0.91	0.89	0.87	0.86
7.5					0.99	0.97	0.95	0.93	0.90	0.88	0.87



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom). The graph at the bottom shows the maximum H_s for each T_p with a POS above 0.9.

Go to Section Simulation Results.

E-3 Results for Drilling Rig - Collinear

E-3.4 30° Environment, 0.7 m/s Current

PoS: Collinear, Dir 30°, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.87	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.61	0.90	0.99	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.72	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.46	0.90	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.75	0.97	1.00	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 30°, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.34	0.31	0.29	0.27	0.24	0.23	0.23	0.22	0.22	0.22	0.22
3.0	0.40	0.36	0.34	0.30	0.27	0.25	0.24	0.23	0.23	0.23	0.23
3.5	0.47	0.41	0.39	0.35	0.30	0.27	0.26	0.25	0.24	0.24	0.24
4.0		0.48	0.45	0.40	0.34	0.30	0.27	0.26	0.25	0.25	0.25
4.5			0.52	0.45	0.38	0.33	0.29	0.28	0.27	0.26	0.25
5.0			0.60	0.51	0.42	0.36	0.33	0.29	0.28	0.27	0.26
5.5			0.68	0.58	0.47	0.40	0.35	0.32	0.30	0.28	0.28
6.0			0.78	0.66	0.52	0.44	0.38	0.34	0.32	0.30	0.29
6.5				0.74	0.58	0.48	0.41	0.37	0.34	0.32	0.31
7.0				0.84	0.64	0.52	0.44	0.39	0.36	0.34	0.32
7.5					0.72	0.57	0.48	0.42	0.38	0.35	0.34

PoS: Collinear, Dir 30°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.85	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.59	0.88	0.99	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.69	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.37	0.88	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.74	0.97	1.00	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 30°, Wind 10 m/s, Cur 0.7 m/s

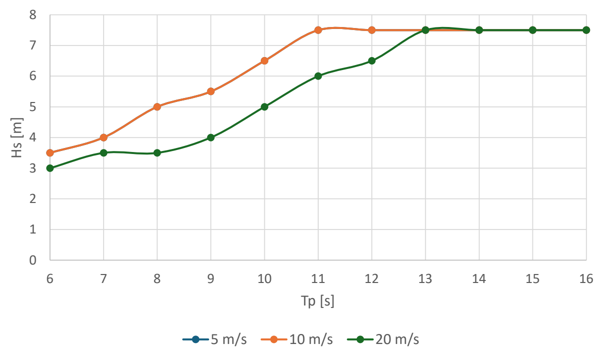
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.42	0.39	0.38	0.36	0.35	0.35	0.35	0.35	0.34	0.34
3.0	0.50	0.46	0.45	0.41	0.38	0.37	0.36	0.35	0.35	0.35	0.35
3.5	0.57	0.51	0.49	0.45	0.40	0.38	0.37	0.36	0.36	0.36	0.35
4.0		0.58	0.55	0.50	0.44	0.40	0.39	0.37	0.37	0.36	0.36
4.5			0.62	0.55	0.48	0.44	0.40	0.39	0.38	0.37	0.37
5.0			0.69	0.61	0.52	0.47	0.43	0.40	0.39	0.38	0.38
5.5			0.78	0.68	0.57	0.50	0.46	0.43	0.40	0.39	0.38
6.0			0.88	0.75	0.62	0.54	0.48	0.45	0.43	0.40	0.40
6.5				0.84	0.67	0.58	0.51	0.47	0.44	0.43	0.42
7.0				0.92	0.74	0.62	0.54	0.49	0.46	0.44	0.43
7.5					0.81	0.67	0.58	0.52	0.48	0.46	0.44

PoS: Collinear, Dir 30°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.84	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.86	0.90	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.64	0.86	0.99	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.21	0.69	0.99	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.03	0.28	0.88	0.98	1.00	1.00	1.00	1.00	1.00
6.0			0.00	0.06	0.67	0.95	0.99	1.00	1.00	1.00	1.00
6.5				0.01	0.31	0.80	0.97	1.00	1.00	1.00	1.00
7.0				0.00	0.06	0.54	0.89	0.97	1.00	0.99	1.00
7.5					0.01	0.25	0.74	0.95	0.96	0.99	0.99

TUF P99: Collinear, Dir 30°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.96	0.96	0.96	0.96	0.95	0.95	0.95	0.95	0.94	0.94	0.94
3.0	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95	0.94	0.94	0.94
3.5	0.97	0.97	0.97	0.96	0.96	0.96	0.95	0.95	0.95	0.94	0.94
4.0		0.97	0.97	0.97	0.97	0.96	0.96	0.95	0.95	0.95	0.94
4.5			0.97	0.97	0.97	0.97	0.96	0.96	0.95	0.95	0.94
5.0			0.98	0.98	0.97	0.97	0.96	0.96	0.95	0.95	0.95
5.5			0.98	0.98	0.98	0.97	0.97	0.96	0.96	0.95	0.95
6.0			0.98	0.99	0.98	0.98	0.97	0.97	0.96	0.96	0.95
6.5				0.99	0.99	0.98	0.98	0.97	0.96	0.96	0.96
7.0				0.99	0.99	0.99	0.98	0.97	0.97	0.96	0.96
7.5					1.00	0.99	0.99	0.98	0.97	0.97	0.96



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom). The graph at the bottom shows the maximum H_s for each T_p with a POS above 0.9.

Go to Section Simulation Results.

SINTEF

E-3 Results for Drilling Rig - Collinear

E-3.5 60° Environment, 0.2 m/s Current

ENCLOSURE 3
REPORT NUMBER OC2025 F-073
DATE 2026-06-03
REFERENCE 2025/720

PoS: Collinear, Dir 60°, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.90	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.69	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.78	0.99	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.57	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.82	1.00	1.00	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 60°, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.21	0.17	0.14	0.12	0.10	0.09	0.09	0.08	0.08	0.08	0.08
3.0	0.27	0.21	0.19	0.15	0.12	0.11	0.10	0.09	0.09	0.09	0.08
3.5	0.35	0.27	0.24	0.20	0.15	0.12	0.11	0.10	0.10	0.09	0.09
4.0		0.33	0.29	0.24	0.19	0.15	0.13	0.11	0.11	0.10	0.10
4.5			0.35	0.28	0.22	0.18	0.15	0.13	0.12	0.11	0.11
5.0			0.42	0.33	0.25	0.21	0.18	0.14	0.13	0.12	0.12
5.5			0.50	0.39	0.29	0.24	0.20	0.18	0.14	0.13	0.13
6.0			0.59	0.45	0.34	0.27	0.22	0.19	0.17	0.15	0.14
6.5				0.52	0.38	0.30	0.25	0.21	0.19	0.17	0.16
7.0				0.60	0.43	0.34	0.28	0.23	0.21	0.19	0.17
7.5					0.49	0.38	0.31	0.26	0.22	0.20	0.18

PoS: Collinear, Dir 60°, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.92	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.70	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.80	0.99	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.60	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.86	1.00	1.00	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 60°, Wind 10 m/s, Cur 0.2 m/s

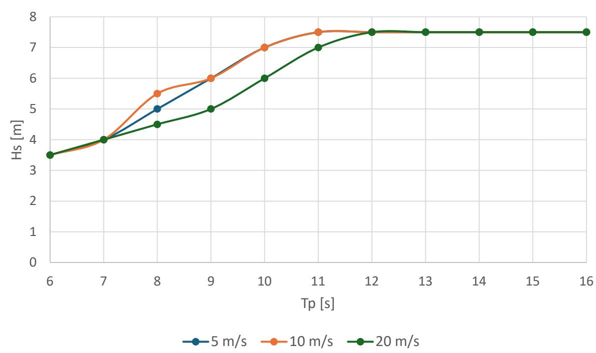
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.32	0.29	0.26	0.25	0.23	0.23	0.22	0.22	0.21	0.21	0.21
3.0	0.38	0.33	0.31	0.27	0.25	0.23	0.23	0.22	0.22	0.21	0.21
3.5	0.45	0.37	0.35	0.31	0.26	0.25	0.24	0.23	0.22	0.22	0.22
4.0		0.43	0.40	0.34	0.30	0.26	0.25	0.24	0.23	0.23	0.22
4.5			0.45	0.39	0.33	0.30	0.26	0.25	0.24	0.23	0.23
5.0			0.52	0.43	0.36	0.32	0.29	0.26	0.25	0.24	0.23
5.5			0.60	0.49	0.39	0.34	0.31	0.29	0.26	0.25	0.24
6.0			0.68	0.55	0.43	0.37	0.33	0.30	0.28	0.26	0.25
6.5				0.62	0.48	0.41	0.35	0.32	0.30	0.28	0.27
7.0				0.69	0.53	0.44	0.38	0.34	0.31	0.29	0.28
7.5					0.58	0.48	0.41	0.36	0.33	0.31	0.29

PoS: Collinear, Dir 60°, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.69	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.30	0.80	0.99	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.07	0.49	0.95	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.18	0.87	0.98	1.00	1.00	1.00	1.00	0.99
7.0				0.05	0.64	0.93	1.00	1.00	0.99	0.99	0.99
7.5					0.29	0.82	0.97	0.99	0.99	0.99	0.99

TUF P99: Collinear, Dir 60°, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.94	0.93	0.91	0.90	0.89	0.88	0.87	0.86	0.85	0.85	0.84
3.0	0.95	0.94	0.93	0.91	0.90	0.88	0.87	0.86	0.86	0.85	0.84
3.5	0.96	0.95	0.94	0.93	0.91	0.89	0.88	0.87	0.86	0.85	0.85
4.0		0.96	0.95	0.94	0.93	0.90	0.88	0.87	0.86	0.86	0.85
4.5			0.96	0.95	0.94	0.92	0.89	0.88	0.87	0.86	0.85
5.0			0.97	0.96	0.94	0.93	0.91	0.89	0.87	0.86	0.86
5.5			0.97	0.97	0.95	0.94	0.92	0.90	0.88	0.87	0.86
6.0			0.98	0.97	0.96	0.95	0.93	0.91	0.89	0.87	0.86
6.5				0.98	0.97	0.95	0.94	0.92	0.90	0.89	0.88
7.0				0.98	0.97	0.96	0.95	0.93	0.91	0.89	0.88
7.5					0.98	0.97	0.95	0.94	0.92	0.90	0.89



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom). The graph at the bottom shows the maximum H_s for each T_p with a POS above 0.9.

Go to Section Simulation Results.

E-3 Results for Drilling Rig - Collinear

E-3.6 60° Environment, 0.7 m/s Current

PoS: Collinear, Dir 60°, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.81	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.74	0.98	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.97	1.00	1.00	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 60°, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.38	0.34	0.32	0.30	0.29	0.28	0.27	0.27	0.27	0.27	0.27
3.0	0.43	0.38	0.37	0.33	0.30	0.29	0.28	0.28	0.28	0.27	0.27
3.5	0.49	0.43	0.41	0.37	0.33	0.31	0.30	0.29	0.29	0.28	0.28
4.0		0.48	0.45	0.40	0.36	0.33	0.31	0.30	0.30	0.29	0.29
4.5			0.50	0.44	0.39	0.36	0.33	0.31	0.31	0.30	0.30
5.0			0.57	0.49	0.42	0.38	0.36	0.33	0.32	0.31	0.30
5.5			0.64	0.54	0.46	0.41	0.38	0.36	0.33	0.32	0.31
6.0			0.71	0.60	0.49	0.44	0.40	0.37	0.36	0.33	0.32
6.5				0.66	0.53	0.47	0.42	0.39	0.37	0.36	0.35
7.0				0.73	0.58	0.50	0.45	0.41	0.39	0.37	0.36
7.5					0.63	0.54	0.48	0.43	0.40	0.38	0.37

PoS: Collinear, Dir 60°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.76	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.71	0.98	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.96	1.00	1.00	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 60°, Wind 10 m/s, Cur 0.7 m/s

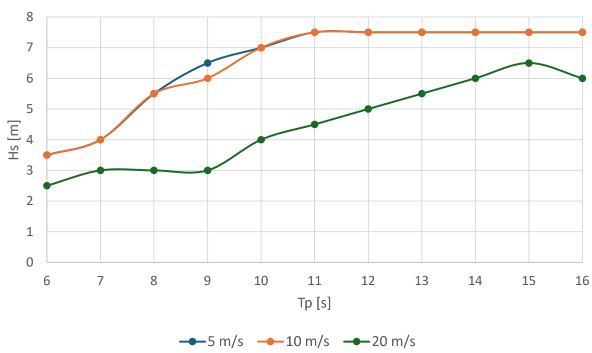
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.49	0.46	0.44	0.43	0.42	0.41	0.41	0.40	0.40	0.40	0.40
3.0	0.54	0.49	0.48	0.44	0.43	0.42	0.41	0.41	0.41	0.40	0.40
3.5	0.60	0.54	0.52	0.48	0.44	0.43	0.42	0.41	0.41	0.41	0.40
4.0		0.59	0.56	0.51	0.48	0.44	0.43	0.42	0.42	0.41	0.41
4.5			0.61	0.55	0.50	0.47	0.44	0.43	0.43	0.42	0.42
5.0			0.67	0.59	0.53	0.49	0.47	0.44	0.43	0.43	0.42
5.5			0.74	0.64	0.56	0.52	0.49	0.47	0.44	0.44	0.43
6.0			0.81	0.70	0.60	0.54	0.51	0.48	0.47	0.45	0.44
6.5				0.76	0.63	0.57	0.53	0.50	0.48	0.47	0.46
7.0				0.82	0.68	0.60	0.56	0.52	0.50	0.48	0.47
7.5					0.73	0.64	0.58	0.54	0.51	0.49	0.48

PoS: Collinear, Dir 60°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.91	0.95	0.94	0.96	0.97	0.98	0.98	0.98	0.98	0.98	0.98
3.0	0.69	0.91	0.91	0.94	0.96	0.96	0.98	0.98	0.98	0.98	0.98
3.5	0.40	0.70	0.82	0.88	0.95	0.95	0.96	0.97	0.97	0.98	0.98
4.0		0.42	0.57	0.82	0.93	0.95	0.95	0.96	0.97	0.97	0.97
4.5			0.25	0.62	0.85	0.93	0.94	0.94	0.96	0.97	0.97
5.0			0.03	0.34	0.71	0.89	0.94	0.94	0.94	0.95	0.96
5.5			0.00	0.09	0.56	0.77	0.89	0.93	0.94	0.95	0.96
6.0			0.00	0.02	0.32	0.62	0.80	0.89	0.92	0.94	0.94
6.5				0.00	0.12	0.43	0.67	0.82	0.88	0.91	0.90
7.0				0.00	0.03	0.25	0.56	0.72	0.81	0.87	0.88
7.5					0.00	0.06	0.35	0.62	0.76	0.81	0.84

TUF P99: Collinear, Dir 60°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.96	0.96
3.0	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.96
3.5	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
4.0		0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
4.5			0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97
5.0			0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97
5.5			0.98	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97
6.0			0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.97	0.97
6.5				0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.97
7.0				0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98
7.5					1.00	0.99	0.99	0.99	0.98	0.98	0.98



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom). The graph at the bottom shows the maximum H_s for each T_p with a POS above 0.9.

Go to Section Simulation Results.

E-3 Results for Drilling Rig - Collinear

ENCLOSURE	3
REPORT NUMBER	OC2025 F-073
DATE	2026-06-03
REFERENCE	2025/720

E-3.7 90° Environment, 0.2 m/s Current

PoS: Collinear, Dir 90°, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.93	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.96	0.79	0.86	0.98	1.00	1.00	1.00	1.00	1.00
6.0			0.82	0.56	0.56	0.94	1.00	1.00	1.00	1.00	1.00
6.5				0.25	0.33	0.82	1.00	1.00	1.00	1.00	1.00
7.0				0.10	0.17	0.57	0.97	1.00	1.00	1.00	1.00
7.5					0.05	0.35	0.86	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 90°, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.25	0.17	0.13	0.13	0.12	0.10	0.09	0.08	0.08	0.08	0.07
3.0	0.33	0.21	0.18	0.16	0.15	0.12	0.10	0.09	0.09	0.08	0.08
3.5	0.44	0.27	0.21	0.21	0.19	0.15	0.12	0.11	0.10	0.09	0.09
4.0		0.33	0.26	0.26	0.24	0.18	0.14	0.12	0.11	0.10	0.10
4.5			0.30	0.31	0.28	0.22	0.17	0.14	0.12	0.11	0.11
5.0			0.36	0.37	0.34	0.26	0.20	0.16	0.14	0.13	0.12
5.5			0.43	0.44	0.39	0.30	0.23	0.19	0.15	0.14	0.13
6.0			0.50	0.51	0.46	0.35	0.26	0.21	0.19	0.15	0.14
6.5				0.59	0.53	0.40	0.30	0.24	0.20	0.18	0.17
7.0				0.68	0.61	0.45	0.33	0.26	0.22	0.20	0.18
7.5					0.69	0.51	0.37	0.29	0.25	0.22	0.19

PoS: Collinear, Dir 90°, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.97	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.93	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.96	0.81	0.87	0.98	1.00	1.00	1.00	1.00	1.00
6.0			0.81	0.53	0.57	0.96	1.00	1.00	1.00	1.00	1.00
6.5				0.26	0.32	0.82	1.00	1.00	1.00	1.00	1.00
7.0				0.11	0.14	0.56	0.96	1.00	1.00	1.00	1.00
7.5					0.07	0.34	0.86	0.98	1.00	1.00	1.00

TUF P99: Collinear, Dir 90°, Wind 10 m/s, Cur 0.2 m/s

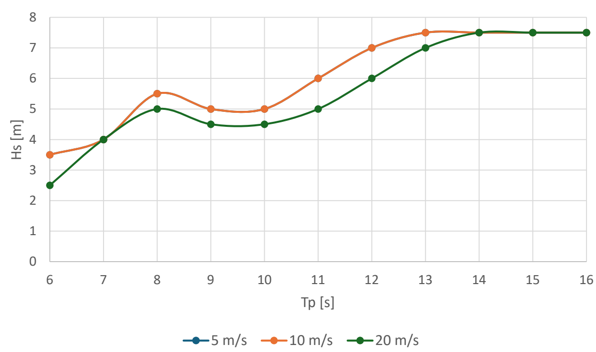
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.36	0.29	0.25	0.25	0.24	0.23	0.22	0.21	0.21	0.20	0.20
3.0	0.43	0.33	0.29	0.28	0.26	0.24	0.23	0.22	0.21	0.21	0.21
3.5	0.53	0.37	0.32	0.32	0.29	0.26	0.24	0.23	0.22	0.21	0.21
4.0		0.43	0.36	0.36	0.34	0.29	0.25	0.24	0.23	0.22	0.22
4.5			0.40	0.41	0.38	0.32	0.27	0.25	0.24	0.23	0.22
5.0			0.46	0.47	0.43	0.36	0.31	0.27	0.25	0.24	0.23
5.5			0.52	0.53	0.49	0.40	0.33	0.29	0.26	0.25	0.24
6.0			0.58	0.60	0.55	0.44	0.36	0.31	0.29	0.26	0.25
6.5				0.68	0.62	0.49	0.39	0.34	0.31	0.28	0.27
7.0				0.77	0.70	0.54	0.43	0.36	0.32	0.30	0.28
7.5					0.78	0.60	0.46	0.39	0.34	0.32	0.29

PoS: Collinear, Dir 90°, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.70	0.99	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.96	1.00	0.96	0.98	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.92	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.93	0.78	0.84	0.96	1.00	1.00	1.00	1.00	1.00
5.5			0.72	0.51	0.60	0.90	1.00	1.00	1.00	1.00	1.00
6.0			0.44	0.23	0.31	0.77	0.98	1.00	1.00	1.00	1.00
6.5				0.03	0.11	0.58	0.90	0.99	1.00	1.00	1.00
7.0				0.00	0.01	0.29	0.82	0.98	0.99	0.99	0.99
7.5					0.01	0.14	0.69	0.90	0.96	0.99	0.99

TUF P99: Collinear, Dir 90°, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.94	0.91	0.88	0.88	0.87	0.85	0.84	0.83	0.82	0.81	0.81
3.0	0.96	0.92	0.91	0.89	0.88	0.86	0.84	0.83	0.82	0.81	0.81
3.5	0.96	0.94	0.93	0.92	0.90	0.87	0.85	0.84	0.83	0.82	0.81
4.0		0.96	0.94	0.94	0.92	0.88	0.86	0.84	0.83	0.82	0.81
4.5			0.95	0.95	0.94	0.91	0.87	0.85	0.84	0.83	0.82
5.0			0.96	0.96	0.95	0.93	0.89	0.86	0.84	0.83	0.82
5.5			0.97	0.97	0.96	0.94	0.91	0.88	0.85	0.84	0.83
6.0			0.97	0.98	0.97	0.95	0.92	0.89	0.87	0.84	0.83
6.5				0.98	0.98	0.96	0.94	0.90	0.88	0.86	0.84
7.0				0.99	0.99	0.97	0.95	0.92	0.89	0.87	0.85
7.5					0.99	0.98	0.96	0.93	0.90	0.88	0.86



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom). The graph at the bottom shows the maximum H_s for each T_p with a POS above 0.9.

Go to Section Simulation Results.

E-3 Results for Drilling Rig - Collinear

E-3.8 90° Environment, 0.7 m/s Current

PoS: Collinear, Dir 90°, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.96	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.91	0.95	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.94	0.76	0.83	0.98	1.00	1.00	1.00	1.00	1.00
6.5				0.49	0.55	0.94	1.00	1.00	1.00	1.00	1.00
7.0				0.24	0.34	0.79	1.00	1.00	1.00	1.00	1.00
7.5					0.18	0.52	0.96	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 90°, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.41	0.34	0.31	0.31	0.30	0.29	0.28	0.27	0.27	0.27	0.27
3.0	0.48	0.38	0.35	0.34	0.33	0.31	0.29	0.28	0.28	0.27	0.27
3.5	0.57	0.43	0.38	0.38	0.36	0.33	0.31	0.29	0.29	0.28	0.28
4.0		0.48	0.42	0.42	0.40	0.36	0.32	0.31	0.30	0.29	0.29
4.5			0.46	0.47	0.44	0.39	0.35	0.32	0.31	0.30	0.30
5.0			0.51	0.52	0.49	0.42	0.38	0.34	0.32	0.31	0.30
5.5			0.57	0.58	0.54	0.46	0.40	0.37	0.34	0.32	0.32
6.0			0.63	0.64	0.60	0.50	0.43	0.39	0.36	0.34	0.33
6.5				0.71	0.66	0.55	0.46	0.41	0.38	0.36	0.35
7.0				0.79	0.73	0.59	0.49	0.43	0.40	0.38	0.36
7.5					0.80	0.64	0.53	0.46	0.42	0.39	0.37

PoS: Collinear, Dir 90°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.96	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.91	0.95	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.92	0.77	0.79	0.98	1.00	1.00	1.00	1.00	1.00
6.5				0.47	0.52	0.95	1.00	1.00	1.00	1.00	1.00
7.0				0.23	0.32	0.80	1.00	1.00	1.00	1.00	1.00
7.5					0.17	0.51	0.96	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 90°, Wind 10 m/s, Cur 0.7 m/s

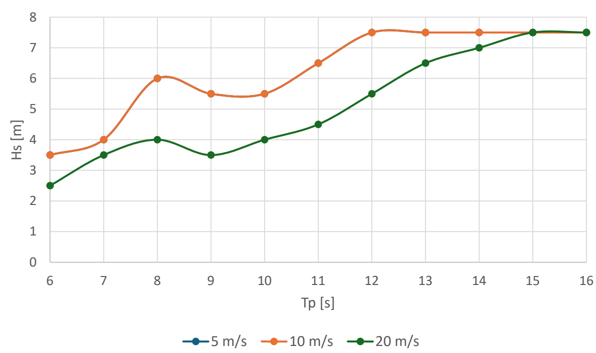
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.52	0.46	0.43	0.43	0.42	0.41	0.40	0.40	0.40	0.39	0.39
3.0	0.59	0.49	0.46	0.45	0.44	0.42	0.41	0.40	0.40	0.40	0.39
3.5	0.67	0.53	0.49	0.49	0.47	0.44	0.42	0.41	0.41	0.40	0.40
4.0		0.58	0.52	0.53	0.50	0.46	0.44	0.42	0.41	0.41	0.40
4.5			0.56	0.57	0.54	0.49	0.45	0.43	0.42	0.42	0.41
5.0			0.61	0.62	0.59	0.52	0.48	0.45	0.43	0.42	0.42
5.5			0.66	0.67	0.64	0.56	0.50	0.47	0.45	0.43	0.43
6.0			0.72	0.74	0.69	0.60	0.53	0.49	0.47	0.45	0.44
6.5				0.81	0.75	0.64	0.56	0.51	0.48	0.47	0.45
7.0				0.89	0.82	0.69	0.59	0.53	0.50	0.48	0.46
7.5					0.89	0.74	0.62	0.56	0.52	0.49	0.48

PoS: Collinear, Dir 90°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.94	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.64	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.22	0.92	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.66	0.95	0.90	0.96	0.99	1.00	1.00	1.00	1.00	1.00
4.5			0.78	0.79	0.89	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.45	0.35	0.63	0.90	1.00	1.00	1.00	1.00	0.99
5.5			0.10	0.07	0.23	0.77	0.97	1.00	0.99	0.99	0.99
6.0			0.00	0.00	0.02	0.47	0.89	0.97	0.97	0.99	0.99
6.5				0.00	0.00	0.19	0.72	0.92	0.97	0.98	0.99
7.0				0.00	0.00	0.03	0.50	0.82	0.92	0.96	0.97
7.5					0.00	0.00	0.28	0.70	0.84	0.93	0.95

TUF P99: Collinear, Dir 90°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
3.0	0.97	0.97	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.96	0.96
3.5	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.96	0.96	0.96	0.96
4.0		0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.96	0.96	0.96
4.5			0.97	0.98	0.98	0.97	0.97	0.97	0.97	0.96	0.96
5.0			0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.96	0.96
5.5			0.98	0.99	0.99	0.98	0.98	0.97	0.97	0.97	0.96
6.0			0.99	0.99	0.99	0.99	0.98	0.98	0.97	0.97	0.97
6.5				0.99	0.99	0.99	0.98	0.98	0.97	0.97	0.97
7.0				1.00	1.00	0.99	0.99	0.98	0.98	0.97	0.97
7.5					1.00	1.00	0.99	0.99	0.98	0.98	0.97



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom). The graph at the bottom shows the maximum H_s for each T_p with a POS above 0.9.

Go to Section Simulation Results.

E-4 Results for Drilling Rig - Non-Collinear

E-4.1 0° Primary and 30° Secondary Wave

PoS: Coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.89	0.90	0.98	1.00	1.00	1.00	1.00	1.00
6.0			0.95	0.71	0.69	0.96	1.00	1.00	1.00	1.00	1.00
6.5				0.38	0.43	0.89	1.00	1.00	1.00	1.00	1.00
7.0				0.15	0.16	0.61	0.96	1.00	1.00	1.00	1.00
7.5					0.09	0.33	0.87	0.99	1.00	1.00	1.00

TUF P99: Coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.38	0.34	0.35	0.34	0.32	0.31	0.31	0.30	0.30	0.30
3.0	0.52	0.42	0.38	0.38	0.37	0.34	0.33	0.32	0.31	0.31	0.31
3.5	0.61	0.47	0.42	0.44	0.41	0.37	0.34	0.33	0.32	0.32	0.31
4.0		0.54	0.47	0.49	0.46	0.40	0.37	0.35	0.34	0.33	0.32
4.5			0.52	0.55	0.52	0.45	0.39	0.37	0.35	0.34	0.33
5.0			0.58	0.62	0.58	0.49	0.43	0.39	0.37	0.35	0.35
5.5			0.65	0.70	0.65	0.54	0.46	0.42	0.39	0.37	0.36
6.0			0.73	0.79	0.73	0.60	0.50	0.45	0.41	0.39	0.37
6.5				0.89	0.82	0.66	0.54	0.48	0.44	0.41	0.39
7.0				0.95	0.91	0.72	0.59	0.51	0.46	0.43	0.41
7.5					0.96	0.80	0.64	0.54	0.49	0.45	0.43

PoS: Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 30°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.99	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.98	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.95	0.89	0.90	0.98	1.00	1.00			
6.0			0.90	0.71	0.70	0.96	1.00	1.00	1.00		
6.5				0.39	0.43	0.90	1.00	1.00	1.00	1.00	1.00
7.0						0.62	0.96	1.00	1.00	1.00	1.00
7.5							0.87	0.99	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 30°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.43	0.37									
3.0	0.51	0.41	0.37								
3.5	0.61	0.47	0.41	0.43							
4.0		0.53	0.46	0.48	0.46						
4.5			0.52	0.54	0.51	0.44					
5.0			0.58	0.61	0.57	0.49	0.42				
5.5			0.65	0.69	0.64	0.54	0.46	0.41			
6.0			0.73	0.78	0.72	0.59	0.50	0.44	0.41		
6.5				0.88	0.81	0.65	0.54	0.47	0.43	0.40	0.39
7.0						0.72	0.58	0.50	0.45	0.42	0.40
7.5							0.63	0.54	0.48	0.45	0.42

PoS: Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 30°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.99	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.98	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.95	0.87	0.91	0.99	1.00	1.00			
6.0			0.85	0.71	0.70	0.96	1.00	1.00	1.00		
6.5				0.37	0.45	0.87	0.99	1.00	1.00	1.00	1.00
7.0						0.59	0.96	1.00	1.00	1.00	1.00
7.5							0.87	0.99	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 30°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.38									
3.0	0.52	0.42	0.39								
3.5	0.62	0.48	0.42	0.44							
4.0		0.54	0.47	0.49	0.47						
4.5			0.52	0.55	0.52	0.45					
5.0			0.59	0.62	0.58	0.50	0.43				
5.5			0.66	0.70	0.65	0.55	0.47	0.42			
6.0			0.74	0.79	0.73	0.60	0.50	0.45	0.42		
6.5				0.89	0.82	0.66	0.55	0.48	0.44	0.41	0.40
7.0						0.73	0.59	0.51	0.46	0.43	0.41
7.5							0.64	0.55	0.49	0.45	0.43

PoS: Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 30°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.98	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.99	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.95	0.86	0.91	0.99	1.00	1.00			
6.0			0.85	0.66	0.70	0.95	1.00	1.00	1.00		
6.5				0.36	0.41	0.85	0.99	1.00	1.00	1.00	1.00
7.0						0.57	0.94	1.00	1.00	1.00	1.00
7.5							0.85	0.98	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 30°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.47	0.41									
3.0	0.54	0.46	0.42								
3.5	0.64	0.51	0.45	0.46							
4.0		0.57	0.50	0.51	0.49						
4.5			0.55	0.57	0.54	0.48					
5.0			0.61	0.64	0.60	0.52	0.46				
5.5			0.68	0.72	0.67	0.57	0.49	0.45			
6.0			0.76	0.81	0.75	0.62	0.53	0.47	0.44		
6.5				0.91	0.83	0.68	0.57	0.50	0.46	0.44	0.42
7.0						0.74	0.61	0.53	0.49	0.46	0.44
7.5							0.66	0.57	0.51	0.48	0.45

Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

E-4 Results for Drilling Rig - Non-Collinear

E-4.2 0° Primary and 60° Secondary Wave

PoS: Coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.89	0.90	0.98	1.00	1.00	1.00	1.00	1.00
6.0			0.95	0.71	0.69	0.96	1.00	1.00	1.00	1.00	1.00
6.5				0.38	0.43	0.89	1.00	1.00	1.00	1.00	1.00
7.0				0.15	0.16	0.61	0.96	1.00	1.00	1.00	1.00
7.5					0.09	0.33	0.87	0.99	1.00	1.00	1.00

TUF P99: Coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.38	0.34	0.35	0.34	0.32	0.31	0.31	0.30	0.30	0.30
3.0	0.52	0.42	0.38	0.38	0.37	0.34	0.33	0.32	0.31	0.31	0.31
3.5	0.61	0.47	0.42	0.44	0.41	0.37	0.34	0.33	0.32	0.32	0.31
4.0		0.54	0.47	0.49	0.46	0.40	0.37	0.35	0.34	0.33	0.32
4.5			0.52	0.55	0.52	0.45	0.39	0.37	0.35	0.34	0.33
5.0			0.58	0.62	0.58	0.49	0.43	0.39	0.37	0.35	0.35
5.5			0.65	0.70	0.65	0.54	0.46	0.42	0.39	0.37	0.36
6.0			0.73	0.79	0.73	0.60	0.50	0.45	0.41	0.39	0.37
6.5				0.89	0.82	0.66	0.54	0.48	0.44	0.41	0.39
7.0				0.95	0.91	0.72	0.59	0.51	0.46	0.43	0.41
7.5					0.96	0.80	0.64	0.54	0.49	0.45	0.43

PoS: Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 60°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.95	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.98	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.95	0.89	0.90	0.98	1.00	1.00			
6.0			0.90	0.71	0.69	0.96	1.00	1.00	1.00		
6.5				0.38	0.43	0.90	1.00	1.00	1.00	1.00	1.00
7.0						0.62	0.96	1.00	1.00	1.00	1.00
7.5							0.87	0.99	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 60°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.43	0.36									
3.0	0.51	0.41	0.37								
3.5	0.61	0.47	0.41	0.43							
4.0		0.53	0.46	0.48	0.46						
4.5			0.51	0.54	0.51	0.44					
5.0			0.58	0.61	0.57	0.49	0.42				
5.5			0.65	0.69	0.64	0.54	0.46	0.41			
6.0			0.73	0.78	0.72	0.59	0.49	0.44	0.41		
6.5				0.88	0.81	0.65	0.54	0.47	0.43	0.40	0.39
7.0						0.72	0.58	0.50	0.45	0.42	0.40
7.5							0.63	0.54	0.48	0.45	0.42

PoS: Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 60°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.99	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.98	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.95	0.88	0.91	0.98	1.00	1.00			
6.0			0.90	0.72	0.70	0.96	1.00	1.00	1.00		
6.5				0.39	0.44	0.88	1.00	1.00	1.00	1.00	1.00
7.0						0.63	0.96	1.00	1.00	1.00	1.00
7.5							0.87	0.99	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 60°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.37									
3.0	0.52	0.42	0.38								
3.5	0.61	0.47	0.42	0.43							
4.0		0.54	0.47	0.49	0.46						
4.5			0.52	0.55	0.52	0.45					
5.0			0.58	0.62	0.58	0.49	0.43				
5.5			0.65	0.70	0.65	0.54	0.46	0.42			
6.0			0.73	0.78	0.73	0.60	0.50	0.44	0.41		
6.5				0.89	0.82	0.66	0.54	0.47	0.43	0.41	0.39
7.0						0.72	0.59	0.51	0.46	0.43	0.41
7.5							0.63	0.54	0.49	0.45	0.42

PoS: Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 60°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.99	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.99	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.95	0.87	0.91	0.99	1.00	1.00			
6.0			0.85	0.71	0.69	0.95	1.00	1.00	1.00		
6.5				0.35	0.43	0.87	0.99	1.00	1.00	1.00	1.00
7.0						0.62	0.94	1.00	1.00	1.00	1.00
7.5							0.85	0.99	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 60°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.45	0.39									
3.0	0.53	0.43	0.40								
3.5	0.62	0.49	0.44	0.45							
4.0		0.55	0.48	0.50	0.47						
4.5			0.53	0.56	0.53	0.46					
5.0			0.60	0.63	0.59	0.50	0.44				
5.5			0.67	0.71	0.66	0.55	0.48	0.43			
6.0			0.74	0.79	0.74	0.61	0.51	0.46	0.43		
6.5				0.90	0.83	0.67	0.55	0.49	0.45	0.42	0.41
7.0						0.74	0.60	0.52	0.47	0.44	0.42
7.5							0.65	0.55	0.50	0.46	0.44

Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

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E-4 Results for Drilling Rig - Non-Collinear

E-4.3 0° Primary and 90° Secondary Wave

PoS: Coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.99	0.89	0.90	0.98	1.00	1.00	1.00	1.00	1.00
6.0			0.95	0.71	0.69	0.96	1.00	1.00	1.00	1.00	1.00
6.5				0.38	0.43	0.89	1.00	1.00	1.00	1.00	1.00
7.0				0.15	0.16	0.61	0.96	1.00	1.00	1.00	1.00
7.5					0.09	0.33	0.87	0.99	1.00	1.00	1.00

TUF P99: Coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.38	0.34	0.35	0.34	0.32	0.31	0.31	0.30	0.30	0.30
3.0	0.52	0.42	0.38	0.38	0.37	0.34	0.33	0.32	0.31	0.31	0.31
3.5	0.61	0.47	0.42	0.44	0.41	0.37	0.34	0.33	0.32	0.32	0.31
4.0		0.54	0.47	0.49	0.46	0.40	0.37	0.35	0.34	0.33	0.32
4.5			0.52	0.55	0.52	0.45	0.39	0.37	0.35	0.34	0.33
5.0			0.58	0.62	0.58	0.49	0.43	0.39	0.37	0.35	0.35
5.5			0.65	0.70	0.65	0.54	0.46	0.42	0.39	0.37	0.36
6.0			0.73	0.79	0.73	0.60	0.50	0.45	0.41	0.39	0.37
6.5				0.89	0.82	0.66	0.54	0.48	0.44	0.41	0.39
7.0				0.95	0.91	0.72	0.59	0.51	0.46	0.43	0.41
7.5					0.96	0.80	0.64	0.54	0.49	0.45	0.43

PoS: Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.95	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.98	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.95	0.89	0.90	0.98	1.00	1.00			
6.0			0.90	0.71	0.69	0.96	1.00	1.00	1.00		
6.5				0.38	0.43	0.89	1.00	1.00	1.00	1.00	1.00
7.0						0.61	0.96	1.00	1.00	1.00	1.00
7.5							0.86	0.99	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.43	0.36									
3.0	0.51	0.41	0.37								
3.5	0.61	0.46	0.41	0.43							
4.0		0.53	0.46	0.48	0.46						
4.5			0.51	0.54	0.51	0.44					
5.0			0.58	0.61	0.57	0.49	0.42				
5.5			0.65	0.69	0.64	0.54	0.46	0.41			
6.0			0.73	0.78	0.72	0.59	0.49	0.44	0.41		
6.5				0.88	0.81	0.65	0.54	0.47	0.43	0.40	0.39
7.0						0.72	0.58	0.50	0.45	0.42	0.40
7.5							0.63	0.54	0.48	0.44	0.42

PoS: Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.95	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.98	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.95	0.89	0.90	0.98	1.00	1.00			
6.0			0.90	0.71	0.69	0.96	1.00	1.00	1.00		
6.5				0.38	0.43	0.89	1.00	1.00	1.00	1.00	1.00
7.0						0.61	0.96	1.00	1.00	1.00	1.00
7.5							0.86	0.99	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.43	0.36									
3.0	0.51	0.41	0.37								
3.5	0.61	0.46	0.41	0.43							
4.0		0.53	0.46	0.48	0.46						
4.5			0.51	0.54	0.51	0.44					
5.0			0.58	0.61	0.57	0.49	0.42				
5.5			0.65	0.69	0.64	0.54	0.46	0.41			
6.0			0.73	0.78	0.72	0.59	0.49	0.44	0.41		
6.5				0.88	0.81	0.65	0.54	0.47	0.43	0.40	0.39
7.0						0.72	0.58	0.50	0.45	0.42	0.40
7.5							0.63	0.54	0.48	0.44	0.42

PoS: Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	0.99	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	0.98	0.98	1.00					
5.0			1.00	0.95	0.95	1.00	1.00				
5.5			0.99	0.89	0.90	0.98	1.00	1.00			
6.0			0.95	0.71	0.69	0.96	1.00	1.00	1.00		
6.5				0.37	0.42	0.89	1.00	1.00	1.00	1.00	1.00
7.0						0.60	0.96	1.00	1.00	1.00	1.00
7.5							0.85	0.99	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.43	0.37									
3.0	0.51	0.41	0.38								
3.5	0.61	0.47	0.41	0.43							
4.0		0.53	0.46	0.48	0.46						
4.5			0.52	0.54	0.51	0.44					
5.0			0.58	0.61	0.58	0.49	0.42				
5.5			0.65	0.69	0.65	0.54	0.46	0.41			
6.0			0.73	0.78	0.72	0.59	0.50	0.44	0.41		
6.5				0.88	0.81	0.65	0.54	0.47	0.43	0.41	0.39
7.0						0.72	0.58	0.50	0.46	0.43	0.40
7.5							0.63	0.54	0.48	0.45	0.42

Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

SINTEF

ENCLOSURE	4
REPORT NUMBER	OC2025 F-073
DATE	2026-06-03
REFERENCE	2025/720

E-4 Results for Drilling Rig - Non-Collinear

E-4.4 30° Primary and 60° Secondary Wave

PoS: Coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.85	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.59	0.88	0.99	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.69	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.37	0.88	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.74	0.97	1.00	1.00	1.00	1.00	1.00

TUF P99: Coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.42	0.39	0.38	0.36	0.35	0.35	0.35	0.35	0.34	0.34
3.0	0.50	0.46	0.45	0.41	0.38	0.37	0.36	0.35	0.35	0.35	0.35
3.5	0.57	0.51	0.49	0.45	0.40	0.38	0.37	0.36	0.36	0.36	0.35
4.0		0.58	0.55	0.50	0.44	0.40	0.39	0.37	0.37	0.36	0.36
4.5			0.62	0.55	0.48	0.44	0.40	0.39	0.38	0.37	0.37
5.0			0.69	0.61	0.52	0.47	0.43	0.40	0.39	0.38	0.38
5.5			0.78	0.68	0.57	0.50	0.46	0.43	0.40	0.39	0.38
6.0			0.88	0.75	0.62	0.54	0.48	0.45	0.43	0.40	0.40
6.5				0.84	0.67	0.58	0.51	0.47	0.44	0.43	0.42
7.0				0.92	0.74	0.62	0.54	0.49	0.46	0.44	0.43
7.5					0.81	0.67	0.58	0.52	0.48	0.46	0.44

PoS: Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 60°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			0.97	1.00	1.00	1.00	1.00				
5.5			0.85	0.98	1.00	1.00	1.00	1.00			
6.0			0.60	0.88	0.99	1.00	1.00	1.00	1.00		
6.5				0.69	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 60°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.43	0.41									
3.0	0.49	0.45	0.44								
3.5	0.56	0.50	0.48	0.45							
4.0		0.57	0.54	0.49	0.44						
4.5			0.61	0.54	0.47	0.43					
5.0			0.69	0.60	0.51	0.46	0.42				
5.5			0.78	0.67	0.56	0.49	0.45	0.42			
6.0			0.88	0.75	0.61	0.53	0.47	0.44	0.42		
6.5				0.83	0.67	0.57	0.50	0.46	0.44	0.42	0.41
7.0						0.61	0.53	0.48	0.45	0.43	0.42
7.5							0.57	0.51	0.47	0.45	0.43

PoS: Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 60°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			0.97	1.00	1.00	1.00	1.00				
5.5			0.85	0.97	1.00	1.00	1.00	1.00			
6.0			0.59	0.87	0.99	1.00	1.00	1.00	1.00		
6.5				0.68	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 60°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.42									
3.0	0.50	0.46	0.45								
3.5	0.57	0.51	0.49	0.46							
4.0		0.58	0.55	0.50	0.45						
4.5			0.62	0.55	0.48	0.44					
5.0			0.70	0.61	0.52	0.47	0.43				
5.5			0.79	0.68	0.57	0.50	0.46	0.43			
6.0			0.89	0.75	0.62	0.54	0.48	0.45	0.43		
6.5				0.84	0.67	0.58	0.51	0.47	0.45	0.43	0.42
7.0						0.62	0.54	0.49	0.46	0.44	0.43
7.5							0.58	0.52	0.48	0.46	0.44

PoS: Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 30°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			0.96	1.00	1.00	1.00	1.00				
5.5			0.81	0.97	1.00	1.00	1.00	1.00			
6.0			0.51	0.87	1.00	1.00	1.00	1.00	1.00		
6.5				0.65	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 0°, Wind 10 m/s, Cur 0.7 m/s, Sec: 30°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.47	0.45									
3.0	0.52	0.49	0.47								
3.5	0.59	0.54	0.52	0.48							
4.0		0.60	0.57	0.52	0.47						
4.5			0.63	0.57	0.50	0.47					
5.0			0.72	0.63	0.54	0.49	0.46				
5.5			0.80	0.70	0.59	0.52	0.48	0.46			
6.0			0.90	0.77	0.64	0.56	0.51	0.47	0.46		
6.5				0.86	0.69	0.60	0.53	0.49	0.47	0.46	0.44
7.0						0.63	0.56	0.52	0.49	0.47	0.46
7.5							0.60	0.54	0.51	0.48	0.47

Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

E-4 Results for Drilling Rig - Non-Collinear

E-4.5 30° Primary and 90° Secondary Wave

PoS: Coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.85	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.59	0.88	0.99	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.69	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.37	0.88	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.74	0.97	1.00	1.00	1.00	1.00	1.00

TUF P99: Coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.42	0.39	0.38	0.36	0.35	0.35	0.35	0.35	0.34	0.34
3.0	0.50	0.46	0.45	0.41	0.38	0.37	0.36	0.35	0.35	0.35	0.35
3.5	0.57	0.51	0.49	0.45	0.40	0.38	0.37	0.36	0.36	0.36	0.35
4.0		0.58	0.55	0.50	0.44	0.40	0.39	0.37	0.37	0.36	0.36
4.5			0.62	0.55	0.48	0.44	0.40	0.39	0.38	0.37	0.37
5.0			0.69	0.61	0.52	0.47	0.43	0.40	0.39	0.38	0.38
5.5			0.78	0.68	0.57	0.50	0.46	0.43	0.40	0.39	0.38
6.0			0.88	0.75	0.62	0.54	0.48	0.45	0.43	0.40	0.40
6.5				0.84	0.67	0.58	0.51	0.47	0.44	0.43	0.42
7.0				0.92	0.74	0.62	0.54	0.49	0.46	0.44	0.43
7.5					0.81	0.67	0.58	0.52	0.48	0.46	0.44

PoS: Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			0.97	1.00	1.00	1.00	1.00				
5.5			0.85	0.98	1.00	1.00	1.00	1.00			
6.0			0.59	0.88	0.99	1.00	1.00	1.00	1.00		
6.5				0.69	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.43	0.41									
3.0	0.49	0.45	0.44								
3.5	0.56	0.50	0.48	0.45							
4.0		0.57	0.54	0.49	0.44						
4.5			0.61	0.54	0.47	0.43					
5.0			0.69	0.60	0.51	0.46	0.42				
5.5			0.77	0.67	0.56	0.49	0.45	0.42			
6.0			0.87	0.75	0.61	0.53	0.47	0.44	0.42		
6.5				0.83	0.67	0.57	0.50	0.46	0.44	0.42	0.41
7.0						0.61	0.53	0.48	0.45	0.43	0.42
7.5							0.57	0.51	0.47	0.45	0.43

PoS: Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			0.97	1.00	1.00	1.00	1.00				
5.5			0.85	0.97	1.00	1.00	1.00	1.00			
6.0			0.58	0.87	0.99	1.00	1.00	1.00	1.00		
6.5				0.68	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.41									
3.0	0.50	0.46	0.44								
3.5	0.57	0.51	0.49	0.45							
4.0		0.57	0.55	0.50	0.44						
4.5			0.62	0.55	0.48	0.44					
5.0			0.69	0.61	0.52	0.46	0.43				
5.5			0.78	0.68	0.57	0.50	0.45	0.43			
6.0			0.88	0.75	0.62	0.53	0.48	0.45	0.43		
6.5				0.84	0.68	0.57	0.51	0.47	0.44	0.43	0.42
7.0						0.62	0.54	0.49	0.46	0.44	0.43
7.5							0.58	0.52	0.48	0.46	0.44

PoS: Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	0.99						
4.5			1.00	1.00	0.99	1.00					
5.0			0.95	1.00	0.99	1.00	1.00				
5.5			0.84	0.97	0.99	1.00	1.00	1.00			
6.0			0.53	0.87	0.98	1.00	1.00	1.00	1.00		
6.5				0.68	0.96	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	0.99	1.00	1.00

TUF P99 Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.46	0.44									
3.0	0.52	0.48	0.47								
3.5	0.59	0.53	0.51	0.47							
4.0		0.59	0.57	0.51	0.46						
4.5			0.63	0.56	0.50	0.46					
5.0			0.71	0.62	0.54	0.48	0.45				
5.5			0.79	0.69	0.58	0.51	0.47	0.45			
6.0			0.89	0.76	0.63	0.55	0.50	0.47	0.45		
6.5				0.85	0.69	0.59	0.53	0.49	0.46	0.45	0.44
7.0						0.63	0.56	0.51	0.48	0.46	0.45
7.5							0.59	0.53	0.50	0.48	0.46

Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

E-4 Results for Drilling Rig - Non-Collinear

E-4.6 30° Primary and 120° Secondary Wave

PoS: Coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.85	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.59	0.88	0.99	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.69	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.37	0.88	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.74	0.97	1.00	1.00	1.00	1.00	1.00

TUF P99: Coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.42	0.39	0.38	0.36	0.35	0.35	0.35	0.35	0.34	0.34
3.0	0.50	0.46	0.45	0.41	0.38	0.37	0.36	0.35	0.35	0.35	0.35
3.5	0.57	0.51	0.49	0.45	0.40	0.38	0.37	0.36	0.36	0.36	0.35
4.0		0.58	0.55	0.50	0.44	0.40	0.39	0.37	0.37	0.36	0.36
4.5			0.62	0.55	0.48	0.44	0.40	0.39	0.38	0.37	0.37
5.0			0.69	0.61	0.52	0.47	0.43	0.40	0.39	0.38	0.38
5.5			0.78	0.68	0.57	0.50	0.46	0.43	0.40	0.39	0.38
6.0			0.88	0.75	0.62	0.54	0.48	0.45	0.43	0.40	0.40
6.5				0.84	0.67	0.58	0.51	0.47	0.44	0.43	0.42
7.0				0.92	0.74	0.62	0.54	0.49	0.46	0.44	0.43
7.5					0.81	0.67	0.58	0.52	0.48	0.46	0.44

PoS: Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 120°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			0.97	1.00	1.00	1.00	1.00				
5.5			0.85	0.98	1.00	1.00	1.00	1.00			
6.0			0.59	0.90	0.99	1.00	1.00	1.00	1.00		
6.5				0.69	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 120°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.43	0.40									
3.0	0.49	0.45	0.43								
3.5	0.56	0.50	0.48	0.44							
4.0		0.57	0.54	0.49	0.44						
4.5			0.61	0.54	0.47	0.43					
5.0			0.69	0.60	0.51	0.46	0.42				
5.5			0.77	0.67	0.56	0.49	0.45	0.42			
6.0			0.87	0.75	0.61	0.53	0.47	0.44	0.42		
6.5				0.83	0.67	0.57	0.50	0.46	0.44	0.42	0.41
7.0						0.61	0.53	0.48	0.45	0.43	0.42
7.5							0.57	0.51	0.47	0.45	0.43

PoS: Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 120°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			0.97	0.99	1.00	1.00	1.00				
5.5			0.85	0.98	1.00	1.00	1.00	1.00			
6.0			0.60	0.88	0.99	1.00	1.00	1.00	1.00		
6.5				0.69	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 120°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.43	0.41									
3.0	0.49	0.45	0.44								
3.5	0.57	0.50	0.48	0.45							
4.0		0.57	0.54	0.49	0.44						
4.5			0.61	0.54	0.47	0.43					
5.0			0.69	0.60	0.51	0.46	0.42				
5.5			0.78	0.67	0.56	0.49	0.45	0.42			
6.0			0.88	0.75	0.61	0.53	0.47	0.44	0.42		
6.5				0.83	0.67	0.57	0.50	0.46	0.44	0.42	0.41
7.0						0.61	0.53	0.48	0.45	0.43	0.42
7.5							0.57	0.51	0.47	0.45	0.43

PoS: Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 120°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			0.98	0.99	1.00	1.00	1.00				
5.5			0.85	0.98	1.00	1.00	1.00	1.00			
6.0			0.60	0.88	0.99	1.00	1.00	1.00	1.00		
6.5				0.67	0.97	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 30°, Wind 10 m/s, Cur 0.7 m/s, Sec: 120°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.41									
3.0	0.50	0.45	0.44								
3.5	0.57	0.51	0.49	0.45							
4.0		0.57	0.55	0.49	0.44						
4.5			0.61	0.54	0.47	0.43					
5.0			0.69	0.60	0.51	0.46	0.43				
5.5			0.78	0.67	0.56	0.49	0.45	0.42			
6.0			0.88	0.75	0.61	0.53	0.48	0.44	0.42		
6.5				0.83	0.67	0.57	0.50	0.46	0.44	0.42	0.41
7.0						0.61	0.54	0.49	0.46	0.44	0.42
7.5							0.57	0.51	0.48	0.45	0.44

Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

ENCLOSURE	4
REPORT NUMBER	OC2025 F-073
DATE	2026-06-03
REFERENCE	2025/720

E-4 Results for Drilling Rig - Non-Collinear

E-4.7 60° Primary and 90° Secondary Wave

PoS: Coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.76	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.71	0.98	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.96	1.00	1.00	1.00	1.00	1.00	1.00

TUF P99: Coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.49	0.46	0.44	0.43	0.42	0.41	0.41	0.40	0.40	0.40	0.40
3.0	0.54	0.49	0.48	0.44	0.43	0.42	0.41	0.41	0.41	0.40	0.40
3.5	0.60	0.54	0.52	0.48	0.44	0.43	0.42	0.41	0.41	0.41	0.40
4.0		0.59	0.56	0.51	0.48	0.44	0.43	0.42	0.42	0.41	0.41
4.5			0.61	0.55	0.50	0.47	0.44	0.43	0.43	0.42	0.42
5.0			0.67	0.59	0.53	0.49	0.47	0.44	0.43	0.43	0.42
5.5			0.74	0.64	0.56	0.52	0.49	0.47	0.44	0.44	0.43
6.0			0.81	0.70	0.60	0.54	0.51	0.48	0.47	0.45	0.44
6.5				0.76	0.63	0.57	0.53	0.50	0.48	0.47	0.46
7.0				0.82	0.68	0.60	0.56	0.52	0.50	0.48	0.47
7.5					0.73	0.64	0.58	0.54	0.51	0.49	0.48

PoS: Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			1.00	1.00	1.00	1.00	1.00				
5.5			0.94	1.00	1.00	1.00	1.00	1.00			
6.0			0.75	0.97	1.00	1.00	1.00	1.00	1.00		
6.5				0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.48	0.45									
3.0	0.53	0.48	0.47								
3.5	0.59	0.53	0.51	0.47							
4.0		0.58	0.55	0.50	0.47						
4.5			0.60	0.54	0.49	0.46					
5.0			0.66	0.58	0.52	0.48	0.46				
5.5			0.73	0.63	0.55	0.51	0.48	0.46			
6.0			0.80	0.69	0.59	0.53	0.50	0.48	0.46		
6.5				0.75	0.63	0.56	0.52	0.49	0.47	0.46	0.45
7.0						0.60	0.55	0.51	0.49	0.47	0.46
7.5							0.57	0.53	0.50	0.48	0.47

PoS: Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			1.00	1.00	1.00	1.00	1.00				
5.5			0.93	0.99	1.00	1.00	1.00	1.00			
6.0			0.74	0.97	1.00	1.00	1.00	1.00	1.00		
6.5				0.87	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.49	0.46									
3.0	0.54	0.50	0.48								
3.5	0.60	0.54	0.52	0.49							
4.0		0.59	0.56	0.52	0.48						
4.5			0.61	0.55	0.50	0.48					
5.0			0.67	0.60	0.53	0.50	0.47				
5.5			0.74	0.64	0.56	0.52	0.49	0.47			
6.0			0.81	0.70	0.60	0.55	0.51	0.49	0.47		
6.5				0.76	0.63	0.58	0.53	0.50	0.48	0.47	0.46
7.0						0.60	0.56	0.52	0.50	0.48	0.47
7.5							0.58	0.54	0.51	0.49	0.48

PoS: Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	0.99						
4.5			1.00	1.00	0.99	1.00					
5.0			0.98	0.99	0.99	1.00	1.00				
5.5			0.91	0.99	0.99	1.00	1.00	1.00			
6.0			0.71	0.96	0.99	1.00	1.00	1.00	1.00		
6.5				0.85	1.00	1.00	1.00	1.00	0.99	1.00	1.00
7.0						1.00	1.00	1.00	0.99	1.00	1.00
7.5							1.00	0.99	0.97	1.00	1.00

TUF P99 Non-coll., Dir:60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 90°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.53	0.51									
3.0	0.57	0.53	0.52								
3.5	0.63	0.57	0.55	0.52							
4.0		0.62	0.59	0.55	0.51						
4.5			0.62	0.58	0.54	0.51					
5.0			0.70	0.62	0.56	0.53	0.51				
5.5			0.77	0.67	0.59	0.55	0.53	0.51			
6.0			0.83	0.72	0.63	0.58	0.54	0.52	0.51		
6.5				0.78	0.65	0.61	0.56	0.54	0.52	0.51	0.50
7.0						0.62	0.59	0.55	0.53	0.52	0.51
7.5							0.61	0.57	0.55	0.53	0.51

Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

E-4 Results for Drilling Rig - Non-Collinear

E-4.8 60° Primary and 120° Secondary Wave

PoS: Coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.76	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.71	0.98	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.96	1.00	1.00	1.00	1.00	1.00	1.00

TUF P99: Coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.49	0.46	0.44	0.43	0.42	0.41	0.41	0.40	0.40	0.40	0.40
3.0	0.54	0.49	0.48	0.44	0.43	0.42	0.41	0.41	0.41	0.40	0.40
3.5	0.60	0.54	0.52	0.48	0.44	0.43	0.42	0.41	0.41	0.41	0.40
4.0		0.59	0.56	0.51	0.48	0.44	0.43	0.42	0.42	0.41	0.41
4.5			0.61	0.55	0.50	0.47	0.44	0.43	0.43	0.42	0.42
5.0			0.67	0.59	0.53	0.49	0.47	0.44	0.43	0.43	0.42
5.5			0.74	0.64	0.56	0.52	0.49	0.47	0.44	0.44	0.43
6.0			0.81	0.70	0.60	0.54	0.51	0.48	0.47	0.45	0.44
6.5				0.76	0.63	0.57	0.53	0.50	0.48	0.47	0.46
7.0				0.82	0.68	0.60	0.56	0.52	0.50	0.48	0.47
7.5					0.73	0.64	0.58	0.54	0.51	0.49	0.48

PoS: Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 120°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			1.00	1.00	1.00	1.00	1.00				
5.5			0.94	1.00	1.00	1.00	1.00	1.00			
6.0			0.76	0.97	1.00	1.00	1.00	1.00	1.00		
6.5				0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 120°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.48	0.45									
3.0	0.53	0.48	0.47								
3.5	0.59	0.53	0.51	0.47							
4.0		0.58	0.55	0.50	0.46						
4.5			0.60	0.54	0.49	0.46					
5.0			0.66	0.58	0.52	0.48	0.46				
5.5			0.73	0.63	0.55	0.51	0.48	0.46			
6.0			0.80	0.69	0.59	0.53	0.50	0.47	0.46		
6.5				0.75	0.63	0.56	0.52	0.49	0.47	0.46	0.45
7.0						0.60	0.55	0.51	0.49	0.47	0.46
7.5							0.57	0.53	0.50	0.48	0.47

PoS: Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 120°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			1.00	1.00	1.00	1.00	1.00				
5.5			0.93	1.00	1.00	1.00	1.00	1.00			
6.0			0.74	0.97	1.00	1.00	1.00	1.00	1.00		
6.5				0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 120°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.48	0.46									
3.0	0.53	0.49	0.48								
3.5	0.60	0.53	0.51	0.48							
4.0		0.58	0.56	0.51	0.47						
4.5			0.61	0.55	0.49	0.47					
5.0			0.67	0.59	0.52	0.49	0.47				
5.5			0.74	0.64	0.56	0.51	0.48	0.46			
6.0			0.81	0.69	0.59	0.54	0.50	0.48	0.46		
6.5				0.75	0.63	0.57	0.53	0.50	0.48	0.46	0.45
7.0						0.60	0.55	0.52	0.49	0.47	0.46
7.5							0.58	0.54	0.51	0.49	0.47

PoS: Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 120°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			1.00	1.00	1.00	1.00	1.00				
5.5			0.92	1.00	1.00	1.00	1.00	1.00			
6.0			0.74	0.96	1.00	1.00	1.00	1.00	1.00		
6.5				0.88	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 120°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.50	0.48									
3.0	0.55	0.51	0.49								
3.5	0.61	0.55	0.53	0.49							
4.0		0.60	0.57	0.52	0.49						
4.5			0.62	0.56	0.51	0.49					
5.0			0.68	0.60	0.54	0.50	0.48				
5.5			0.75	0.65	0.57	0.53	0.50	0.48			
6.0			0.82	0.70	0.60	0.55	0.52	0.50	0.48		
6.5				0.77	0.65	0.58	0.54	0.51	0.49	0.48	0.47
7.0						0.62	0.56	0.53	0.51	0.49	0.48
7.5							0.59	0.55	0.52	0.50	0.49

Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

ENCLOSURE 4
REPORT NUMBER OC2025 F-073
DATE 2026-06-03
REFERENCE 2025/720

E-4 Results for Drilling Rig - Non-Collinear

E-4.9 60° Primary and 150° Secondary Wave

PoS: Coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.0			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.5			0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.0			0.76	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.5				0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0				0.71	0.98	1.00	1.00	1.00	1.00	1.00	1.00
7.5					0.96	1.00	1.00	1.00	1.00	1.00	1.00

TUF P99: Coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.49	0.46	0.44	0.43	0.42	0.41	0.41	0.40	0.40	0.40	0.40
3.0	0.54	0.49	0.48	0.44	0.43	0.42	0.41	0.41	0.41	0.40	0.40
3.5	0.60	0.54	0.52	0.48	0.44	0.43	0.42	0.41	0.41	0.41	0.40
4.0		0.59	0.56	0.51	0.48	0.44	0.43	0.42	0.42	0.41	0.41
4.5			0.61	0.55	0.50	0.47	0.44	0.43	0.43	0.42	0.42
5.0			0.67	0.59	0.53	0.49	0.47	0.44	0.43	0.43	0.42
5.5			0.74	0.64	0.56	0.52	0.49	0.47	0.44	0.44	0.43
6.0			0.81	0.70	0.60	0.54	0.51	0.48	0.47	0.45	0.44
6.5				0.76	0.63	0.57	0.53	0.50	0.48	0.47	0.46
7.0				0.82	0.68	0.60	0.56	0.52	0.50	0.48	0.47
7.5					0.73	0.64	0.58	0.54	0.51	0.49	0.48

PoS: Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			1.00	1.00	1.00	1.00	1.00				
5.5			0.94	1.00	1.00	1.00	1.00	1.00			
6.0			0.76	0.97	1.00	1.00	1.00	1.00	1.00		
6.5				0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.48	0.45									
3.0	0.53	0.48	0.47								
3.5	0.59	0.53	0.50	0.47							
4.0		0.58	0.55	0.50	0.46						
4.5			0.60	0.54	0.49	0.46					
5.0			0.66	0.58	0.52	0.48	0.46				
5.5			0.73	0.63	0.55	0.51	0.48	0.46			
6.0			0.80	0.69	0.59	0.53	0.50	0.47	0.46		
6.5				0.75	0.63	0.56	0.52	0.49	0.47	0.46	0.45
7.0						0.60	0.55	0.51	0.49	0.47	0.46
7.5							0.57	0.53	0.50	0.48	0.47

PoS: Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			1.00	1.00	1.00	1.00	1.00				
5.5			0.94	1.00	1.00	1.00	1.00	1.00			
6.0			0.76	0.97	1.00	1.00	1.00	1.00	1.00		
6.5				0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.48	0.45									
3.0	0.53	0.49	0.47								
3.5	0.59	0.53	0.51	0.47							
4.0		0.58	0.55	0.50	0.47						
4.5			0.60	0.54	0.49	0.46					
5.0			0.66	0.58	0.52	0.48	0.46				
5.5			0.73	0.63	0.55	0.51	0.48	0.46			
6.0			0.80	0.69	0.59	0.53	0.50	0.48	0.46		
6.5				0.75	0.63	0.57	0.52	0.49	0.47	0.46	0.45
7.0						0.60	0.55	0.51	0.49	0.47	0.46
7.5							0.57	0.53	0.50	0.48	0.47

PoS: Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00									
3.0	1.00	1.00	1.00								
3.5	1.00	1.00	1.00	1.00							
4.0		1.00	1.00	1.00	1.00						
4.5			1.00	1.00	1.00	1.00					
5.0			1.00	1.00	1.00	1.00	1.00				
5.5			0.93	0.99	1.00	1.00	1.00	1.00			
6.0			0.76	0.96	1.00	1.00	1.00	1.00	1.00		
6.5				0.87	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7.0						1.00	1.00	1.00	1.00	1.00	1.00
7.5							1.00	1.00	1.00	1.00	1.00

TUF P99 Non-coll., Dir: 60°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.48	0.46									
3.0	0.53	0.49	0.48								
3.5	0.59	0.53	0.51	0.48							
4.0		0.58	0.56	0.51	0.47						
4.5			0.61	0.55	0.50	0.47					
5.0			0.67	0.59	0.52	0.49	0.47				
5.5			0.73	0.64	0.56	0.51	0.49	0.47			
6.0			0.81	0.69	0.59	0.54	0.51	0.48	0.47		
6.5				0.75	0.63	0.57	0.53	0.50	0.48	0.47	0.46
7.0						0.60	0.55	0.52	0.49	0.48	0.47
7.5							0.58	0.54	0.51	0.49	0.48

Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

E-5 Results for Floatel - Collinear

E-5.1 150° Environment, 0.2 m/s Current

PoS: Collinear, Dir 150˚, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.80	0.77	0.86	0.86	0.97	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.21	0.24	0.32	0.43	0.53	0.86	1.00	1.00	1.00	1.00	1.00
3.5	0.00	0.01	0.02	0.08	0.09	0.25	0.78	1.00	1.00	1.00	1.00
4.0		0.00	0.00	0.01	0.01	0.02	0.25	0.80	0.97	1.00	1.00
4.5			0.00	0.00	0.00	0.00	0.00	0.37	0.78	0.95	0.96
5.0			0.00	0.00	0.00	0.00	0.00	0.03	0.40	0.68	0.72
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.22	0.29

TUF P99: Collinear, Dir 150˚, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.20	0.18	0.18	0.14	0.12	0.10	0.09	0.08	0.07	0.07	0.07
3.0	0.28	0.25	0.25	0.20	0.16	0.13	0.11	0.09	0.08	0.08	0.08
3.5	0.37	0.34	0.35	0.28	0.22	0.17	0.14	0.11	0.10	0.09	0.09
4.0		0.45	0.46	0.38	0.30	0.23	0.17	0.14	0.12	0.11	0.10
4.5			0.59	0.49	0.38	0.29	0.22	0.17	0.14	0.12	0.12
5.0			0.75	0.61	0.48	0.36	0.26	0.20	0.16	0.14	0.13
5.5			0.92	0.76	0.58	0.44	0.32	0.24	0.19	0.16	0.15

PoS: Collinear, Dir 150˚, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.84	0.91	0.97	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.18	0.27	0.53	0.58	0.65	0.86	1.00	1.00	1.00	1.00	1.00
3.5	0.00	0.02	0.02	0.08	0.14	0.24	0.77	1.00	1.00	1.00	1.00
4.0		0.00	0.00	0.02	0.01	0.02	0.21	0.82	0.99	1.00	1.00
4.5			0.00	0.00	0.00	0.00	0.01	0.33	0.87	0.95	0.98
5.0			0.00	0.00	0.00	0.00	0.00	0.03	0.32	0.62	0.75
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.16	0.30

TUF P99: Collinear, Dir 150˚, Wind 10 m/s, Cur 0.2 m/s

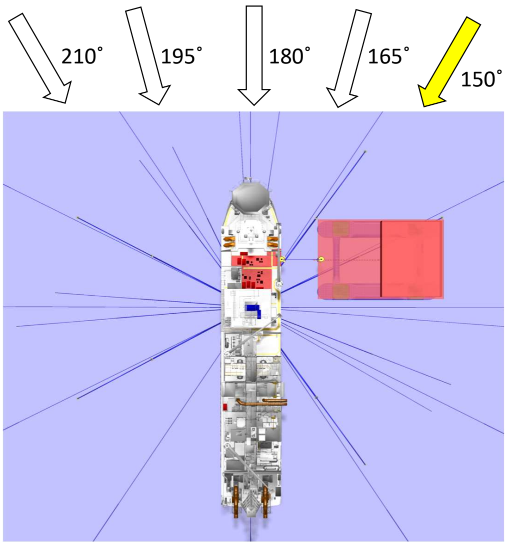
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.25	0.23	0.22	0.19	0.17	0.16	0.14	0.14	0.13	0.13	0.13
3.0	0.32	0.29	0.28	0.23	0.20	0.18	0.16	0.15	0.14	0.14	0.14
3.5	0.40	0.37	0.36	0.29	0.25	0.21	0.19	0.17	0.15	0.15	0.15
4.0		0.46	0.45	0.37	0.30	0.25	0.22	0.19	0.17	0.16	0.16
4.5			0.57	0.47	0.37	0.31	0.25	0.21	0.19	0.17	0.17
5.0			0.72	0.59	0.46	0.37	0.29	0.24	0.21	0.19	0.18
5.5			0.90	0.75	0.57	0.44	0.34	0.27	0.23	0.21	0.20

PoS: Collinear, Dir 150˚, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.10	0.13	0.14	0.22	0.24	0.33	0.54	0.58	0.62	0.61	0.54
3.0	0.02	0.01	0.00	0.03	0.08	0.14	0.26	0.44	0.49	0.50	0.43
3.5	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.23	0.34	0.34	0.25
4.0		0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.15	0.14	0.14
4.5			0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.06
5.0			0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TUF P99: Collinear, Dir 150˚, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.52	0.51	0.50	0.48	0.47	0.46	0.46	0.45	0.45	0.44	0.44
3.0	0.57	0.55	0.54	0.51	0.49	0.48	0.47	0.46	0.45	0.45	0.44
3.5	0.64	0.61	0.60	0.55	0.52	0.50	0.48	0.47	0.46	0.45	0.45
4.0		0.68	0.67	0.60	0.56	0.53	0.50	0.48	0.47	0.46	0.45
4.5			0.77	0.66	0.61	0.56	0.52	0.49	0.48	0.47	0.46
5.0			0.89	0.75	0.67	0.61	0.55	0.51	0.49	0.48	0.47
5.5			0.97	0.85	0.74	0.66	0.59	0.54	0.51	0.49	0.48



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom).

Go to Section Simulation Results.

E-5 Results for Floatel - Collinear

E-5.2 150° Environment, 0.7 m/s Current

PoS: Collinear, Dir 150˚, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.92	0.96	0.98	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.48	0.56	0.77	0.85	0.91	0.99	1.00	1.00	1.00	1.00	1.00
3.5	0.01	0.08	0.17	0.30	0.33	0.59	0.94	1.00	1.00	1.00	1.00
4.0		0.00	0.00	0.04	0.02	0.09	0.56	0.92	1.00	1.00	1.00
4.5			0.00	0.00	0.00	0.00	0.13	0.68	0.94	0.98	0.99
5.0			0.00	0.00	0.00	0.00	0.00	0.20	0.65	0.83	0.86
5.5			0.00	0.00	0.00	0.00	0.00	0.03	0.18	0.44	0.55

TUF P99: Collinear, Dir 150˚, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.38	0.36	0.35	0.32	0.31	0.29	0.26	0.25	0.25	0.25	0.25
3.0	0.44	0.42	0.41	0.36	0.34	0.32	0.30	0.27	0.26	0.26	0.26
3.5	0.52	0.49	0.47	0.41	0.37	0.34	0.32	0.30	0.27	0.27	0.27
4.0		0.56	0.54	0.46	0.41	0.37	0.35	0.32	0.31	0.28	0.28
4.5			0.63	0.53	0.46	0.41	0.37	0.34	0.32	0.31	0.30
5.0			0.73	0.61	0.52	0.46	0.40	0.36	0.34	0.33	0.32
5.5			0.86	0.70	0.59	0.51	0.44	0.39	0.36	0.34	0.33

PoS: Collinear, Dir 150˚, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.93	0.96	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.46	0.49	0.75	0.84	0.88	0.99	1.00	1.00	1.00	1.00	1.00
3.5	0.02	0.06	0.15	0.26	0.26	0.57	0.96	1.00	1.00	1.00	1.00
4.0		0.00	0.00	0.04	0.04	0.08	0.59	0.94	1.00	1.00	1.00
4.5			0.00	0.00	0.00	0.00	0.10	0.64	0.93	0.98	0.99
5.0			0.00	0.00	0.00	0.00	0.00	0.17	0.55	0.78	0.83
5.5			0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.33	0.45

TUF P99: Collinear, Dir 150˚, Wind 10 m/s, Cur 0.7 m/s

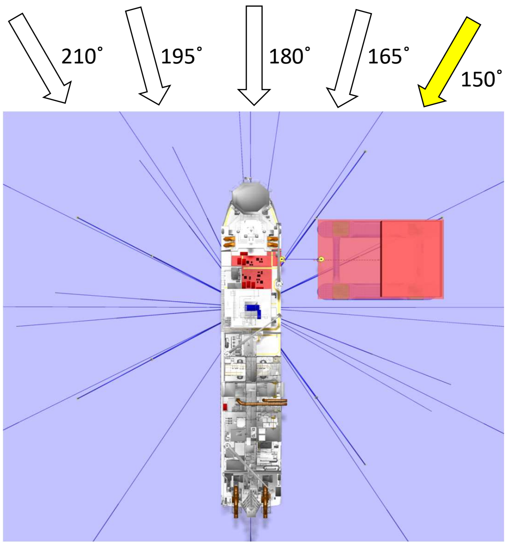
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.43	0.41	0.40	0.37	0.36	0.34	0.32	0.31	0.31	0.31	0.30
3.0	0.49	0.47	0.45	0.41	0.38	0.37	0.35	0.32	0.32	0.31	0.31
3.5	0.57	0.53	0.52	0.45	0.42	0.39	0.37	0.35	0.33	0.32	0.32
4.0		0.61	0.59	0.51	0.46	0.43	0.39	0.37	0.36	0.33	0.33
4.5			0.68	0.57	0.51	0.46	0.42	0.39	0.37	0.36	0.36
5.0			0.78	0.65	0.57	0.51	0.45	0.41	0.39	0.38	0.37
5.5			0.89	0.74	0.64	0.56	0.49	0.44	0.41	0.39	0.38

PoS: Collinear, Dir 150˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.38	0.51	0.64	0.57	0.63	0.79	0.88	0.91	0.90	0.90	0.90
3.0	0.03	0.10	0.11	0.24	0.28	0.44	0.74	0.83	0.87	0.84	0.78
3.5	0.00	0.00	0.01	0.04	0.02	0.10	0.35	0.60	0.75	0.75	0.63
4.0		0.00	0.00	0.00	0.00	0.02	0.10	0.30	0.50	0.55	0.44
4.5			0.00	0.00	0.00	0.00	0.01	0.09	0.22	0.27	0.28
5.0			0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.08	0.08
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02

TUF P99: Collinear, Dir 150˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.69	0.68	0.68	0.66	0.65	0.64	0.62	0.61	0.61	0.61	0.61
3.0	0.74	0.72	0.72	0.68	0.66	0.65	0.64	0.62	0.62	0.61	0.61
3.5	0.81	0.78	0.76	0.72	0.69	0.67	0.65	0.64	0.62	0.62	0.61
4.0		0.85	0.83	0.76	0.72	0.69	0.67	0.65	0.64	0.62	0.62
4.5			0.91	0.82	0.76	0.72	0.69	0.66	0.65	0.64	0.63
5.0			0.97	0.89	0.82	0.76	0.71	0.68	0.66	0.65	0.64
5.5			0.99	0.96	0.88	0.81	0.74	0.70	0.67	0.66	0.65



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom).

Go to Section Simulation Results.

E-5 Results for Floatel - Collinear

E-5.3 165° Environment, 0.2 m/s Current

PoS: Collinear, Dir 165˚, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.98	1.00	0.96	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.88	0.82	0.84	0.91	0.98	0.99	1.00	1.00	1.00	1.00
4.5			0.54	0.53	0.57	0.74	0.91	1.00	1.00	1.00	1.00
5.0			0.15	0.15	0.13	0.28	0.62	0.93	1.00	1.00	1.00
5.5			0.00	0.01	0.01	0.05	0.22	0.76	0.97	1.00	1.00

TUF P99: Collinear, Dir 165˚, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.16	0.13	0.14	0.13	0.11	0.09	0.08	0.07	0.07	0.06	0.06
3.0	0.22	0.18	0.19	0.18	0.15	0.12	0.10	0.09	0.08	0.07	0.07
3.5	0.29	0.23	0.25	0.24	0.19	0.15	0.13	0.11	0.09	0.09	0.08
4.0		0.30	0.33	0.30	0.24	0.19	0.15	0.13	0.11	0.10	0.09
4.5			0.41	0.38	0.30	0.23	0.19	0.15	0.13	0.11	0.11
5.0			0.50	0.46	0.36	0.28	0.22	0.18	0.15	0.13	0.12
5.5			0.60	0.55	0.44	0.33	0.26	0.21	0.17	0.15	0.14

PoS: Collinear, Dir 165˚, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.97	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.90	0.92	0.93	0.95	0.98	1.00	1.00	1.00	1.00	1.00
4.5			0.61	0.65	0.62	0.72	0.92	1.00	1.00	1.00	1.00
5.0			0.16	0.18	0.17	0.31	0.61	0.95	1.00	1.00	1.00
5.5			0.02	0.01	0.01	0.03	0.21	0.72	0.97	1.00	1.00

TUF P99: Collinear, Dir 165˚, Wind 10 m/s, Cur 0.2 m/s

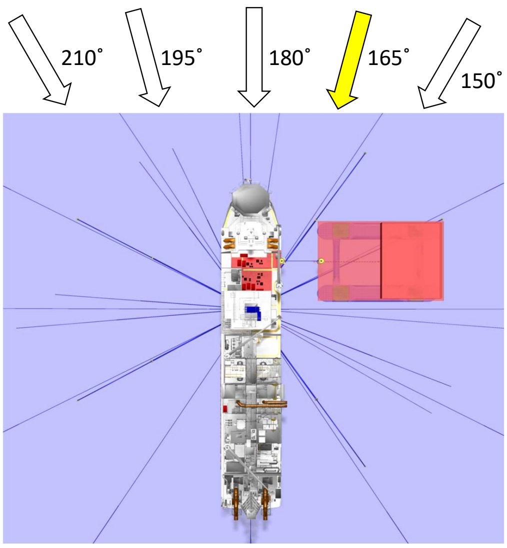
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.21	0.18	0.19	0.18	0.16	0.14	0.13	0.13	0.12	0.12	0.12
3.0	0.27	0.22	0.24	0.22	0.19	0.17	0.15	0.14	0.13	0.12	0.12
3.5	0.34	0.28	0.30	0.28	0.23	0.19	0.17	0.15	0.14	0.13	0.13
4.0		0.34	0.37	0.34	0.28	0.23	0.20	0.17	0.16	0.15	0.14
4.5			0.45	0.41	0.33	0.27	0.23	0.20	0.17	0.16	0.15
5.0			0.53	0.50	0.40	0.32	0.26	0.22	0.19	0.18	0.17
5.5			0.64	0.59	0.47	0.37	0.30	0.25	0.22	0.19	0.18

PoS: Collinear, Dir 165˚, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.99	1.00	1.00	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.93	0.99	0.95	0.95	0.96	0.98	0.99	1.00	1.00	1.00	1.00
4.0		0.78	0.77	0.84	0.76	0.80	0.92	0.99	1.00	1.00	1.00
4.5			0.29	0.36	0.27	0.53	0.77	0.93	1.00	1.00	1.00
5.0			0.06	0.05	0.03	0.14	0.42	0.80	0.97	0.99	1.00
5.5			0.01	0.00	0.00	0.03	0.14	0.55	0.88	0.97	0.97

TUF P99: Collinear, Dir 165˚, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.45	0.43	0.43	0.43	0.41	0.40	0.40	0.39	0.39	0.38	0.38
3.0	0.49	0.46	0.47	0.45	0.43	0.42	0.41	0.40	0.39	0.39	0.39
3.5	0.54	0.50	0.51	0.49	0.46	0.44	0.42	0.41	0.40	0.39	0.39
4.0		0.55	0.57	0.54	0.50	0.46	0.44	0.42	0.41	0.40	0.40
4.5			0.64	0.61	0.54	0.49	0.46	0.43	0.42	0.41	0.40
5.0			0.72	0.68	0.59	0.53	0.48	0.45	0.43	0.42	0.41
5.5			0.82	0.77	0.66	0.57	0.52	0.47	0.45	0.43	0.42



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom).

Go to Section Simulation Results.

E-5 Results for Floatel - Collinear

ENCLOSURE 5
REPORT NUMBER OC2025 F-073
DATE 2026-06-03
REFERENCE 2025/720

E-5.4 165° Environment, 0.7 m/s Current

PoS: Collinear, Dir 165˚, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.99	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.95	0.95	0.95	0.93	0.99	1.00	1.00	1.00	1.00	1.00
4.5			0.73	0.73	0.63	0.84	0.97	1.00	1.00	1.00	1.00
5.0			0.34	0.30	0.24	0.47	0.82	0.97	1.00	1.00	1.00
5.5			0.08	0.01	0.01	0.14	0.42	0.87	1.00	1.00	1.00

TUF P99: Collinear, Dir 165˚, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.36	0.33	0.33	0.32	0.30	0.29	0.26	0.25	0.24	0.24	0.24
3.0	0.41	0.37	0.38	0.36	0.33	0.31	0.30	0.26	0.26	0.25	0.25
3.5	0.47	0.41	0.43	0.41	0.37	0.34	0.31	0.30	0.27	0.26	0.26
4.0		0.47	0.49	0.46	0.41	0.36	0.34	0.32	0.30	0.27	0.27
4.5			0.56	0.52	0.45	0.40	0.36	0.34	0.32	0.31	0.30
5.0			0.64	0.59	0.51	0.44	0.39	0.36	0.33	0.32	0.31
5.5			0.73	0.67	0.57	0.48	0.43	0.38	0.35	0.34	0.33

PoS: Collinear, Dir 165˚, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.94	0.95	0.94	0.93	0.99	1.00	1.00	1.00	1.00	1.00
4.5			0.72	0.71	0.65	0.83	0.97	1.00	1.00	1.00	1.00
5.0			0.34	0.31	0.22	0.41	0.83	0.97	1.00	1.00	1.00
5.5			0.07	0.02	0.01	0.12	0.39	0.89	0.99	1.00	1.00

TUF P99: Collinear, Dir 165˚, Wind 10 m/s, Cur 0.7 m/s

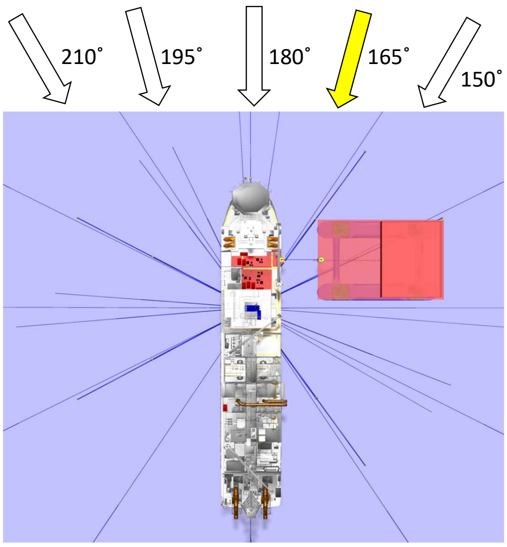
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.40	0.37	0.38	0.37	0.35	0.34	0.31	0.30	0.29	0.29	0.29
3.0	0.45	0.41	0.42	0.40	0.38	0.36	0.34	0.31	0.30	0.30	0.30
3.5	0.51	0.46	0.47	0.45	0.41	0.38	0.36	0.35	0.32	0.31	0.31
4.0		0.51	0.53	0.50	0.45	0.41	0.38	0.36	0.35	0.32	0.32
4.5			0.60	0.56	0.50	0.44	0.41	0.38	0.36	0.35	0.35
5.0			0.68	0.64	0.55	0.48	0.44	0.40	0.38	0.36	0.36
5.5			0.77	0.72	0.61	0.53	0.47	0.43	0.40	0.38	0.37

PoS: Collinear, Dir 165˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.98	0.99	0.98	0.96	0.94	0.99	1.00	1.00	1.00	1.00	1.00
4.0		0.86	0.88	0.81	0.79	0.89	0.98	1.00	1.00	1.00	1.00
4.5			0.46	0.43	0.38	0.64	0.83	0.99	1.00	1.00	1.00
5.0			0.15	0.10	0.06	0.24	0.63	0.90	0.99	0.99	1.00
5.5			0.01	0.01	0.00	0.04	0.22	0.73	0.93	0.97	0.97

TUF P99: Collinear, Dir 165˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.63	0.61	0.61	0.60	0.59	0.58	0.56	0.56	0.56	0.55	0.55
3.0	0.67	0.64	0.64	0.63	0.61	0.59	0.58	0.57	0.56	0.56	0.55
3.5	0.72	0.68	0.68	0.66	0.63	0.61	0.60	0.58	0.57	0.56	0.56
4.0		0.72	0.73	0.71	0.67	0.63	0.61	0.59	0.58	0.57	0.56
4.5			0.80	0.76	0.71	0.66	0.63	0.61	0.59	0.59	0.58
5.0			0.88	0.83	0.75	0.69	0.65	0.62	0.61	0.59	0.59
5.5			0.95	0.91	0.81	0.73	0.68	0.64	0.62	0.61	0.60



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom).

Go to Section Simulation Results.

E-5 Results for Floatel - Collinear

E-5.5 180° Environment, 0.2 m/s Current

PoS: Collinear, Dir 180˚, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	0.99	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.94	0.84	0.94	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.83	0.61	0.63	0.84	0.95	1.00	1.00	1.00	1.00
5.5			0.51	0.25	0.32	0.51	0.83	0.98	1.00	1.00	1.00

TUF P99: Collinear, Dir 180˚, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.22	0.14	0.15	0.15	0.12	0.10	0.08	0.07	0.07	0.06	0.06
3.0	0.30	0.19	0.20	0.20	0.16	0.13	0.11	0.09	0.08	0.07	0.07
3.5	0.40	0.24	0.26	0.26	0.21	0.16	0.13	0.11	0.10	0.09	0.08
4.0		0.31	0.33	0.34	0.26	0.20	0.16	0.14	0.11	0.10	0.09
4.5			0.41	0.42	0.33	0.25	0.20	0.16	0.13	0.12	0.11
5.0			0.51	0.51	0.40	0.30	0.24	0.19	0.16	0.14	0.12
5.5			0.61	0.61	0.48	0.36	0.28	0.23	0.18	0.16	0.14

PoS: Collinear, Dir 180˚, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.99	1.00	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.94	0.84	0.96	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.82	0.58	0.64	0.85	0.95	1.00	1.00	1.00	1.00
5.5			0.51	0.26	0.33	0.50	0.83	0.98	1.00	1.00	1.00

TUF P99: Collinear, Dir 180˚, Wind 10 m/s, Cur 0.2 m/s

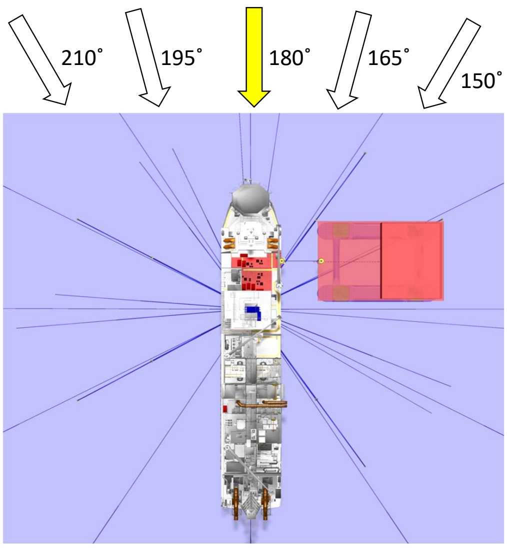
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.25	0.18	0.19	0.19	0.16	0.14	0.13	0.12	0.11	0.11	0.11
3.0	0.33	0.22	0.24	0.24	0.20	0.17	0.15	0.13	0.12	0.12	0.11
3.5	0.43	0.28	0.30	0.30	0.25	0.20	0.17	0.15	0.14	0.13	0.12
4.0		0.35	0.37	0.37	0.30	0.24	0.20	0.17	0.15	0.14	0.13
4.5			0.45	0.46	0.36	0.29	0.24	0.20	0.17	0.16	0.15
5.0			0.54	0.55	0.43	0.34	0.28	0.23	0.19	0.17	0.16
5.5			0.64	0.65	0.51	0.39	0.32	0.26	0.22	0.19	0.18

PoS: Collinear, Dir 180˚, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	0.98	0.94	0.99	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.91	0.80	0.86	0.94	0.98	1.00	1.00	1.00	1.00
5.0			0.72	0.51	0.59	0.78	0.93	0.99	1.00	1.00	1.00
5.5			0.44	0.17	0.25	0.44	0.78	0.93	1.00	1.00	1.00

TUF P99: Collinear, Dir 180˚, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.39	0.39	0.39	0.37	0.35	0.35	0.34	0.34	0.33	0.33
3.0	0.51	0.42	0.43	0.42	0.39	0.37	0.36	0.35	0.34	0.34	0.33
3.5	0.60	0.46	0.48	0.47	0.43	0.39	0.37	0.36	0.35	0.34	0.34
4.0		0.52	0.54	0.54	0.48	0.43	0.40	0.37	0.36	0.35	0.35
4.5			0.61	0.61	0.53	0.46	0.42	0.39	0.37	0.36	0.36
5.0			0.70	0.70	0.60	0.51	0.45	0.41	0.39	0.37	0.36
5.5			0.80	0.80	0.67	0.56	0.49	0.44	0.41	0.39	0.38



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom).

Go to Section Simulation Results.

E-5 Results for Floatel - Collinear

E-5.6 180° Environment, 0.7 m/s Current

PoS: Collinear, Dir 180°, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.97	0.90	0.96	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.87	0.71	0.73	0.88	0.97	1.00	1.00	1.00	1.00
5.5			0.61	0.37	0.41	0.61	0.88	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 180°, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.41	0.35	0.35	0.34	0.32	0.30	0.26	0.25	0.25	0.24	0.24
3.0	0.48	0.38	0.39	0.38	0.35	0.33	0.31	0.27	0.26	0.25	0.25
3.5	0.57	0.43	0.44	0.43	0.39	0.35	0.33	0.31	0.27	0.27	0.26
4.0		0.49	0.50	0.49	0.44	0.39	0.35	0.33	0.31	0.28	0.27
4.5			0.57	0.56	0.49	0.42	0.38	0.35	0.33	0.32	0.31
5.0			0.65	0.64	0.55	0.47	0.41	0.37	0.35	0.33	0.32
5.5			0.74	0.73	0.61	0.51	0.45	0.40	0.37	0.35	0.34

PoS: Collinear, Dir 180°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.97	0.91	0.96	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.87	0.69	0.72	0.89	0.99	1.00	1.00	1.00	1.00
5.5			0.61	0.36	0.42	0.59	0.87	1.00	1.00	1.00	1.00

TUF P99: Collinear, Dir 180°, Wind 10 m/s, Cur 0.7 m/s

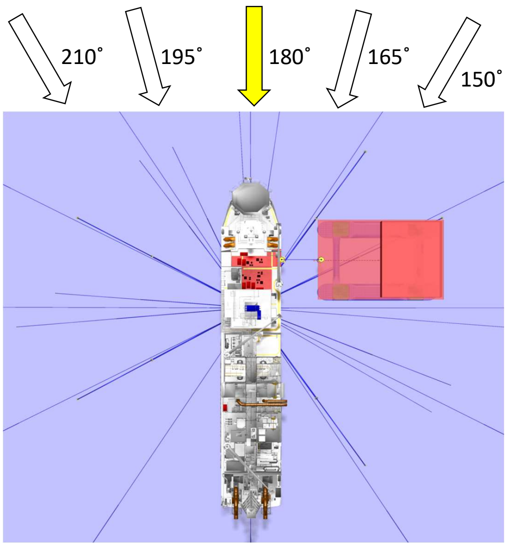
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.38	0.39	0.38	0.36	0.34	0.30	0.29	0.29	0.29	0.29
3.0	0.51	0.42	0.43	0.42	0.39	0.37	0.35	0.31	0.30	0.30	0.29
3.5	0.60	0.47	0.48	0.47	0.43	0.39	0.37	0.35	0.31	0.31	0.30
4.0		0.53	0.54	0.53	0.47	0.42	0.39	0.37	0.35	0.32	0.31
4.5			0.61	0.60	0.52	0.46	0.42	0.39	0.37	0.36	0.35
5.0			0.69	0.68	0.58	0.50	0.45	0.41	0.39	0.37	0.36
5.5			0.78	0.77	0.65	0.55	0.48	0.44	0.41	0.38	0.38

PoS: Collinear, Dir 180°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	0.98	0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.95	0.84	0.89	0.96	0.99	1.00	1.00	1.00	1.00
5.0			0.78	0.61	0.67	0.85	0.95	1.00	1.00	1.00	1.00
5.5			0.49	0.29	0.27	0.50	0.82	0.96	1.00	1.00	1.00

TUF P99: Collinear, Dir 180°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.63	0.58	0.58	0.58	0.56	0.55	0.52	0.51	0.51	0.51	0.51
3.0	0.69	0.61	0.61	0.61	0.59	0.56	0.55	0.52	0.52	0.51	0.51
3.5	0.77	0.65	0.66	0.65	0.61	0.58	0.56	0.55	0.52	0.52	0.52
4.0		0.71	0.71	0.70	0.65	0.61	0.58	0.56	0.55	0.53	0.52
4.5			0.78	0.77	0.70	0.64	0.60	0.58	0.56	0.55	0.55
5.0			0.85	0.84	0.75	0.68	0.63	0.60	0.58	0.56	0.56
5.5			0.94	0.93	0.82	0.72	0.66	0.62	0.59	0.58	0.57



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom).

Go to Section Simulation Results.

E-5 Results for Floatel - Collinear

E-5.7 195° Environment, 0.2 m/s Current

PoS: Collinear, Dir 195˚, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.98	0.99	0.98	0.98	0.98	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.86	0.87	0.84	0.81	0.87	0.93	1.00	1.00	1.00	1.00
4.5			0.53	0.50	0.34	0.47	0.78	0.96	1.00	1.00	1.00
5.0			0.18	0.13	0.05	0.12	0.35	0.84	1.00	1.00	1.00
5.5			0.01	0.01	0.01	0.00	0.07	0.56	0.92	1.00	1.00

TUF P99: Collinear, Dir 195˚, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.16	0.13	0.14	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.06
3.0	0.22	0.17	0.18	0.17	0.15	0.13	0.12	0.10	0.08	0.08	0.07
3.5	0.29	0.22	0.24	0.23	0.20	0.17	0.15	0.12	0.10	0.09	0.08
4.0		0.28	0.30	0.29	0.25	0.22	0.18	0.15	0.12	0.10	0.10
4.5			0.38	0.36	0.31	0.27	0.22	0.18	0.14	0.12	0.11
5.0			0.46	0.44	0.38	0.32	0.27	0.21	0.17	0.14	0.13
5.5			0.55	0.52	0.45	0.39	0.32	0.25	0.19	0.16	0.14

PoS: Collinear, Dir 195˚, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.97	0.99	0.98	0.98	0.98	0.99	1.00	1.00	1.00	1.00	1.00
4.0		0.83	0.85	0.86	0.79	0.83	0.94	1.00	1.00	1.00	1.00
4.5			0.52	0.47	0.32	0.48	0.74	0.95	1.00	1.00	1.00
5.0			0.13	0.10	0.08	0.10	0.36	0.82	1.00	1.00	1.00
5.5			0.00	0.03	0.01	0.01	0.04	0.57	0.92	1.00	1.00

TUF P99: Collinear, Dir 195˚, Wind 10 m/s, Cur 0.2 m/s

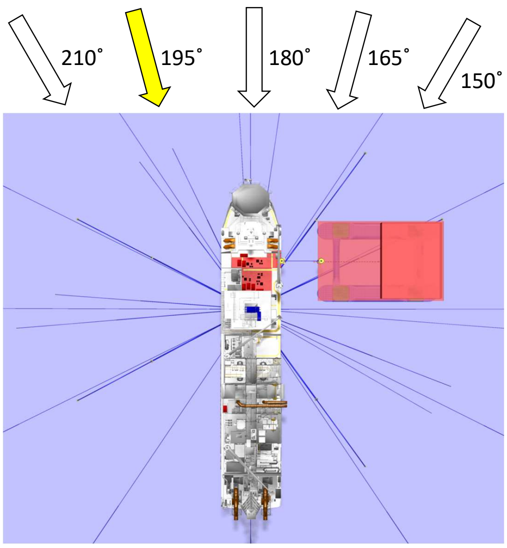
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.20	0.18	0.18	0.18	0.16	0.15	0.14	0.13	0.12	0.12	0.12
3.0	0.26	0.22	0.23	0.22	0.20	0.18	0.16	0.14	0.13	0.13	0.12
3.5	0.33	0.27	0.28	0.27	0.24	0.22	0.19	0.17	0.15	0.14	0.13
4.0		0.33	0.35	0.33	0.29	0.26	0.23	0.19	0.17	0.15	0.14
4.5			0.42	0.40	0.35	0.31	0.27	0.22	0.19	0.17	0.16
5.0			0.50	0.48	0.42	0.37	0.31	0.26	0.21	0.19	0.17
5.5			0.59	0.57	0.49	0.43	0.36	0.29	0.24	0.21	0.19

PoS: Collinear, Dir 195˚, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.98	0.99	0.96	0.97	0.98	0.99	1.00	1.00	1.00	1.00	1.00
3.5	0.85	0.93	0.88	0.83	0.78	0.86	0.96	1.00	1.00	1.00	1.00
4.0		0.55	0.53	0.54	0.54	0.59	0.75	0.97	1.00	1.00	1.00
4.5			0.21	0.18	0.14	0.22	0.53	0.79	1.00	1.00	1.00
5.0			0.04	0.03	0.02	0.07	0.23	0.64	0.93	0.99	1.00
5.5			0.00	0.00	0.00	0.01	0.05	0.37	0.73	0.95	0.99

TUF P99: Collinear, Dir 195˚, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.45	0.44	0.44	0.43	0.42	0.41	0.40	0.40	0.39	0.39	0.39
3.0	0.49	0.46	0.47	0.46	0.44	0.43	0.42	0.41	0.40	0.39	0.39
3.5	0.54	0.50	0.51	0.50	0.48	0.45	0.43	0.42	0.41	0.40	0.40
4.0		0.55	0.56	0.55	0.52	0.49	0.46	0.43	0.42	0.41	0.40
4.5			0.63	0.61	0.57	0.53	0.49	0.45	0.43	0.42	0.41
5.0			0.70	0.68	0.63	0.57	0.52	0.48	0.45	0.43	0.42
5.5			0.80	0.76	0.70	0.63	0.57	0.51	0.47	0.44	0.43



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom).

Go to Section Simulation Results.

E-5 Results for Floatel - Collinear

E-5.8 195° Environment, 0.7 m/s Current

PoS: Collinear, Dir 195˚, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.98	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.93	0.92	0.95	0.91	0.92	0.98	1.00	1.00	1.00	1.00
4.5			0.63	0.71	0.64	0.68	0.87	1.00	1.00	1.00	1.00
5.0			0.22	0.27	0.23	0.26	0.61	0.91	1.00	1.00	1.00
5.5			0.03	0.06	0.06	0.04	0.23	0.78	0.98	1.00	1.00

TUF P99: Collinear, Dir 195˚, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.36	0.34	0.34	0.33	0.31	0.30	0.26	0.25	0.24	0.24	0.24
3.0	0.41	0.37	0.37	0.36	0.34	0.32	0.31	0.27	0.26	0.25	0.25
3.5	0.47	0.42	0.42	0.40	0.38	0.35	0.33	0.31	0.27	0.26	0.26
4.0		0.47	0.47	0.46	0.42	0.39	0.36	0.33	0.31	0.28	0.27
4.5			0.54	0.51	0.47	0.43	0.38	0.35	0.33	0.32	0.31
5.0			0.61	0.58	0.53	0.47	0.42	0.37	0.35	0.33	0.32
5.5			0.69	0.66	0.60	0.52	0.46	0.40	0.37	0.35	0.34

PoS: Collinear, Dir 195˚, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.97	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.90	0.90	0.95	0.89	0.91	0.97	1.00	1.00	1.00	1.00
4.5			0.60	0.67	0.61	0.65	0.86	1.00	1.00	1.00	1.00
5.0			0.22	0.23	0.20	0.25	0.62	0.90	1.00	1.00	1.00
5.5			0.01	0.06	0.05	0.05	0.20	0.76	0.98	1.00	1.00

TUF P99: Collinear, Dir 195˚, Wind 10 m/s, Cur 0.7 m/s

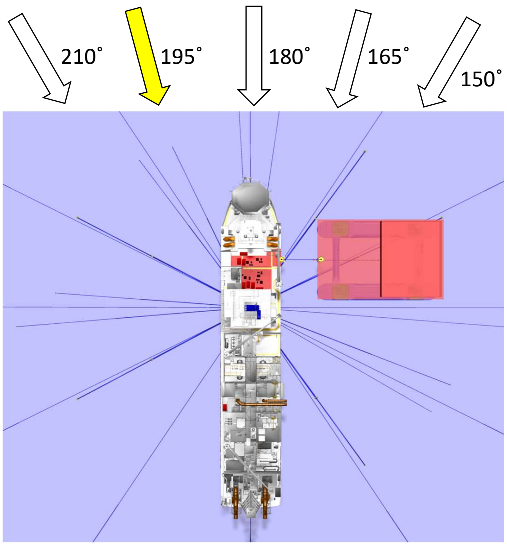
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.40	0.38	0.38	0.37	0.36	0.35	0.31	0.30	0.29	0.29	0.29
3.0	0.45	0.42	0.42	0.41	0.39	0.37	0.35	0.31	0.31	0.30	0.30
3.5	0.51	0.46	0.46	0.45	0.42	0.40	0.37	0.36	0.32	0.31	0.31
4.0		0.51	0.52	0.50	0.47	0.43	0.40	0.37	0.36	0.32	0.32
4.5			0.58	0.56	0.52	0.47	0.43	0.40	0.37	0.36	0.36
5.0			0.65	0.62	0.57	0.52	0.46	0.42	0.39	0.38	0.37
5.5			0.73	0.70	0.64	0.57	0.50	0.45	0.41	0.39	0.38

PoS: Collinear, Dir 195˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	0.98	0.97	0.98	0.99	1.00	1.00	1.00	1.00	1.00
3.5	0.91	0.96	0.92	0.93	0.87	0.93	0.97	1.00	1.00	1.00	1.00
4.0		0.66	0.64	0.67	0.64	0.72	0.86	0.99	1.00	1.00	1.00
4.5			0.27	0.33	0.32	0.44	0.69	0.91	1.00	1.00	1.00
5.0			0.09	0.05	0.07	0.12	0.40	0.74	0.97	0.99	1.00
5.5			0.00	0.00	0.00	0.02	0.09	0.58	0.86	0.98	0.98

TUF P99: Collinear, Dir 195˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.64	0.63	0.63	0.62	0.61	0.60	0.57	0.56	0.56	0.56	0.55
3.0	0.68	0.65	0.65	0.64	0.63	0.62	0.60	0.57	0.56	0.56	0.56
3.5	0.73	0.69	0.69	0.68	0.66	0.64	0.62	0.60	0.57	0.56	0.56
4.0		0.73	0.74	0.72	0.69	0.66	0.63	0.61	0.60	0.57	0.57
4.5			0.79	0.77	0.74	0.69	0.65	0.63	0.61	0.60	0.59
5.0			0.86	0.84	0.79	0.73	0.68	0.65	0.62	0.61	0.60
5.5			0.93	0.91	0.85	0.78	0.71	0.67	0.64	0.62	0.61



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom).

Go to Section Simulation Results.

E-5 Results for Floatel - Collinear

E-5.9 210° Environment, 0.2 m/s Current

PoS: Collinear, Dir 210°, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.90	0.90	0.94	0.96	0.98	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.38	0.36	0.52	0.59	0.58	0.82	1.00	1.00	1.00	1.00	1.00
3.5	0.02	0.01	0.05	0.08	0.11	0.25	0.76	0.99	1.00	1.00	1.00
4.0		0.00	0.00	0.01	0.01	0.02	0.22	0.84	1.00	1.00	1.00
4.5			0.00	0.00	0.00	0.00	0.02	0.48	0.90	0.97	1.00
5.0			0.00	0.00	0.00	0.00	0.00	0.10	0.59	0.91	0.96
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.66	0.78

TUF P99: Collinear, Dir 210°, Wind 5 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.18	0.16	0.16	0.14	0.13	0.12	0.10	0.08	0.07	0.07	0.07
3.0	0.25	0.22	0.22	0.19	0.18	0.16	0.13	0.11	0.09	0.08	0.08
3.5	0.33	0.30	0.29	0.26	0.24	0.21	0.17	0.13	0.11	0.10	0.09
4.0		0.39	0.38	0.33	0.30	0.26	0.21	0.16	0.13	0.11	0.11
4.5			0.49	0.43	0.38	0.33	0.26	0.20	0.15	0.13	0.12
5.0			0.62	0.54	0.47	0.40	0.31	0.23	0.18	0.15	0.14
5.5			0.78	0.67	0.58	0.48	0.37	0.28	0.21	0.18	0.16

PoS: Collinear, Dir 210°, Wind 10 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.84	0.88	0.96	0.96	0.96	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.27	0.35	0.50	0.56	0.54	0.80	1.00	1.00	1.00	1.00	1.00
3.5	0.02	0.02	0.02	0.06	0.10	0.21	0.74	0.99	1.00	1.00	1.00
4.0		0.00	0.00	0.01	0.02	0.02	0.22	0.84	1.00	1.00	1.00
4.5			0.00	0.00	0.00	0.00	0.02	0.38	0.88	0.99	1.00
5.0			0.00	0.00	0.00	0.00	0.00	0.09	0.60	0.91	0.98
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.57	0.71

TUF P99: Collinear, Dir 210°, Wind 10 m/s, Cur 0.2 m/s

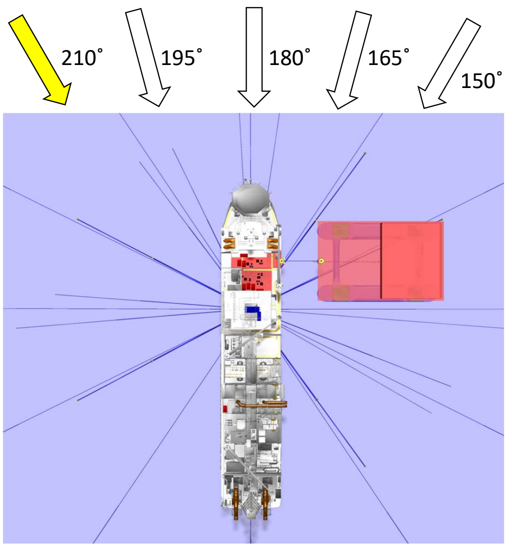
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.23	0.22	0.21	0.20	0.19	0.17	0.16	0.14	0.14	0.13	0.13
3.0	0.30	0.28	0.27	0.25	0.23	0.21	0.18	0.16	0.15	0.14	0.14
3.5	0.38	0.35	0.34	0.31	0.29	0.26	0.22	0.18	0.16	0.15	0.15
4.0		0.44	0.43	0.39	0.36	0.31	0.26	0.21	0.18	0.17	0.16
4.5			0.54	0.48	0.43	0.38	0.31	0.25	0.21	0.19	0.18
5.0			0.68	0.59	0.53	0.45	0.36	0.29	0.23	0.21	0.19
5.5			0.84	0.73	0.64	0.53	0.42	0.33	0.27	0.23	0.21

PoS: Collinear, Dir 210°, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.12	0.11	0.09	0.16	0.21	0.35	0.49	0.62	0.68	0.64	0.62
3.0	0.00	0.01	0.02	0.05	0.06	0.11	0.27	0.44	0.54	0.55	0.54
3.5	0.00	0.00	0.00	0.00	0.01	0.03	0.10	0.24	0.39	0.43	0.40
4.0		0.00	0.00	0.00	0.00	0.00	0.02	0.12	0.22	0.28	0.26
4.5			0.00	0.00	0.00	0.00	0.00	0.01	0.08	0.13	0.15
5.0			0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.04
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01

TUF P99: Collinear, Dir 210°, Wind 20 m/s, Cur 0.2 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.54	0.53	0.52	0.51	0.50	0.49	0.48	0.47	0.46	0.46	0.46
3.0	0.58	0.57	0.57	0.55	0.53	0.51	0.49	0.48	0.47	0.47	0.46
3.5	0.65	0.63	0.63	0.60	0.58	0.54	0.51	0.49	0.48	0.47	0.47
4.0		0.72	0.72	0.67	0.64	0.59	0.54	0.51	0.49	0.48	0.47
4.5			0.83	0.77	0.71	0.64	0.58	0.53	0.50	0.49	0.48
5.0			0.96	0.89	0.81	0.71	0.62	0.56	0.52	0.50	0.49
5.5			0.99	0.97	0.93	0.79	0.68	0.59	0.54	0.52	0.50



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom).

Go to Section Simulation Results.

E-5 Results for Floatel - Collinear

E-5.10 210° Environment, 0.7 m/s Current

PoS: Collinear, Dir 210°, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.93	0.95	0.96	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.46	0.48	0.63	0.77	0.77	0.92	1.00	1.00	1.00	1.00	1.00
3.5	0.05	0.07	0.15	0.21	0.22	0.47	0.91	1.00	1.00	1.00	1.00
4.0		0.00	0.00	0.01	0.04	0.07	0.54	0.91	1.00	1.00	1.00
4.5			0.00	0.00	0.00	0.00	0.09	0.72	0.95	0.99	1.00
5.0			0.00	0.00	0.00	0.00	0.00	0.30	0.78	0.96	0.99
5.5			0.00	0.00	0.00	0.00	0.00	0.05	0.47	0.74	0.85

TUF P99: Collinear, Dir 210°, Wind 5 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.37	0.35	0.35	0.33	0.32	0.31	0.27	0.26	0.25	0.25	0.25
3.0	0.43	0.40	0.40	0.37	0.35	0.33	0.31	0.27	0.26	0.26	0.26
3.5	0.50	0.47	0.45	0.42	0.40	0.37	0.34	0.31	0.28	0.27	0.27
4.0		0.55	0.53	0.49	0.45	0.41	0.37	0.33	0.32	0.29	0.28
4.5			0.62	0.56	0.52	0.46	0.40	0.36	0.33	0.32	0.31
5.0			0.73	0.66	0.60	0.52	0.44	0.39	0.35	0.34	0.33
5.5			0.86	0.78	0.69	0.59	0.49	0.42	0.38	0.35	0.34

PoS: Collinear, Dir 210°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.94	0.95	0.96	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.44	0.47	0.64	0.75	0.74	0.93	1.00	1.00	1.00	1.00	1.00
3.5	0.04	0.07	0.09	0.16	0.20	0.45	0.90	1.00	1.00	1.00	1.00
4.0		0.00	0.00	0.01	0.04	0.08	0.51	0.91	1.00	1.00	1.00
4.5			0.00	0.00	0.00	0.01	0.10	0.69	0.94	0.99	1.00
5.0			0.00	0.00	0.00	0.00	0.00	0.25	0.75	0.96	0.99
5.5			0.00	0.00	0.00	0.00	0.00	0.04	0.40	0.74	0.83

TUF P99: Collinear, Dir 210°, Wind 10 m/s, Cur 0.7 m/s

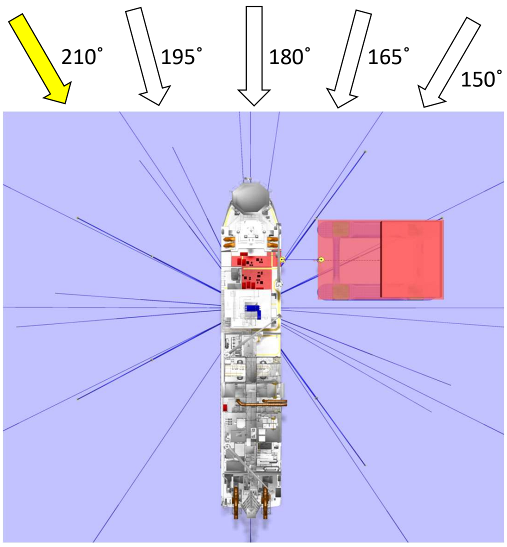
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.42	0.41	0.40	0.38	0.37	0.36	0.33	0.31	0.31	0.31	0.31
3.0	0.48	0.46	0.45	0.42	0.41	0.39	0.37	0.33	0.32	0.32	0.31
3.5	0.55	0.52	0.51	0.47	0.45	0.42	0.39	0.37	0.33	0.33	0.32
4.0		0.60	0.58	0.54	0.51	0.46	0.42	0.39	0.37	0.34	0.33
4.5			0.67	0.62	0.57	0.51	0.45	0.41	0.39	0.37	0.37
5.0			0.79	0.71	0.65	0.57	0.49	0.44	0.40	0.39	0.38
5.5			0.91	0.83	0.75	0.64	0.54	0.47	0.43	0.41	0.40

PoS: Collinear, Dir 210°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.23	0.25	0.24	0.33	0.39	0.58	0.72	0.82	0.87	0.87	0.86
3.0	0.00	0.03	0.02	0.10	0.16	0.24	0.51	0.67	0.74	0.78	0.73
3.5	0.00	0.00	0.01	0.02	0.02	0.09	0.27	0.43	0.63	0.67	0.66
4.0		0.00	0.00	0.00	0.00	0.00	0.08	0.23	0.39	0.51	0.51
4.5			0.00	0.00	0.00	0.00	0.00	0.11	0.23	0.30	0.33
5.0			0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.15	0.13
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.02

TUF P99: Collinear, Dir 210°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.71	0.70	0.70	0.68	0.67	0.66	0.63	0.63	0.62	0.62	0.61
3.0	0.76	0.74	0.74	0.71	0.70	0.68	0.66	0.63	0.63	0.62	0.62
3.5	0.83	0.80	0.79	0.76	0.73	0.70	0.67	0.66	0.63	0.63	0.62
4.0		0.87	0.86	0.82	0.78	0.74	0.70	0.67	0.66	0.63	0.63
4.5			0.94	0.90	0.84	0.78	0.72	0.69	0.67	0.66	0.65
5.0			0.98	0.96	0.92	0.84	0.76	0.71	0.68	0.67	0.66
5.5			0.99	0.99	0.98	0.90	0.80	0.74	0.70	0.68	0.67



Results are shown for the reduced H_s–T_p matrix under collinear conditions (waves, wind, and current aligned). Left panels show the probability of success per bin; right panels show the P99 TUF, i.e., the 99th percentile of utilised thrust relative to installed capacity. Rows correspond to wind speeds: 5 m/s (top), 10 m/s (middle), 20 m/s (bottom).

Go to Section Simulation Results.

E-6 Results for Floatel - Non-Collinear

E-6.1 150° Primary and 210° Secondary Wave, 10 m/s Wind

PoS: Coll., Dir: 150˚, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.93	0.96	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.46	0.49	0.75	0.84	0.88	0.99	1.00	1.00	1.00	1.00	1.00
3.5	0.02	0.06	0.15	0.26	0.26	0.57	0.96	1.00	1.00	1.00	1.00
4.0		0.00	0.00	0.04	0.04	0.08	0.59	0.94	1.00	1.00	1.00
4.5			0.00	0.00	0.00	0.00	0.10	0.64	0.93	0.98	0.99
5.0			0.00	0.00	0.00	0.00	0.00	0.17	0.55	0.78	0.83
5.5			0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.33	0.45

TUF P99: Coll., Dir: 150˚, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.43	0.41	0.40	0.37	0.36	0.34	0.32	0.31	0.31	0.31	0.30
3.0	0.49	0.47	0.45	0.41	0.38	0.37	0.35	0.32	0.32	0.31	0.31
3.5	0.57	0.53	0.52	0.45	0.42	0.39	0.37	0.35	0.33	0.32	0.32
4.0		0.61	0.59	0.51	0.46	0.43	0.39	0.37	0.36	0.33	0.33
4.5			0.68	0.57	0.51	0.46	0.42	0.39	0.37	0.36	0.36
5.0			0.78	0.65	0.57	0.51	0.45	0.41	0.39	0.38	0.37
5.5			0.89	0.74	0.64	0.56	0.49	0.44	0.41	0.39	0.38

PoS: Non-coll., Dir: 150˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 210˚, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.95	0.96	0.99	1.00	1.00	1.00					
3.0	0.48	0.52	0.74	0.85	0.86	0.99	1.00				
3.5	0.02	0.05	0.17	0.26	0.30	0.57	0.95	1.00			
4.0		0.00	0.00	0.02	0.02	0.06	0.56	0.94	1.00		
4.5			0.00	0.00	0.00	0.00	0.08	0.64	0.92	0.98	0.99
5.0			0.00	0.00	0.00	0.00	0.00	0.16	0.55	0.76	0.84
5.5			0.00	0.00	0.00	0.00	0.00	0.01	0.12	0.35	0.39

TUF P99: Non-coll., Dir: 150˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 210˚, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.41	0.40	0.39	0.36	0.34	0.33					
3.0	0.48	0.46	0.44	0.40	0.37	0.35	0.34				
3.5	0.56	0.52	0.51	0.45	0.41	0.38	0.36	0.34			
4.0		0.60	0.58	0.50	0.45	0.41	0.38	0.36	0.34		
4.5			0.67	0.57	0.50	0.45	0.41	0.38	0.36	0.35	0.34
5.0			0.78	0.64	0.56	0.50	0.44	0.40	0.38	0.36	0.36
5.5			0.88	0.74	0.63	0.55	0.48	0.43	0.40	0.38	0.37

PoS: Non-coll., Dir: 150˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 210˚, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.91	0.95	0.99	1.00	1.00	1.00					
3.0	0.32	0.48	0.71	0.76	0.84	0.98	1.00				
3.5	0.00	0.04	0.10	0.20	0.22	0.52	0.93	1.00			
4.0		0.00	0.00	0.02	0.01	0.09	0.49	0.91	1.00		
4.5			0.00	0.00	0.00	0.00	0.04	0.61	0.90	0.94	0.98
5.0			0.00	0.00	0.00	0.00	0.00	0.11	0.50	0.68	0.78
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.28	0.31

TUF P99: Non-coll., Dir: 150˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 210˚, 1.5 m

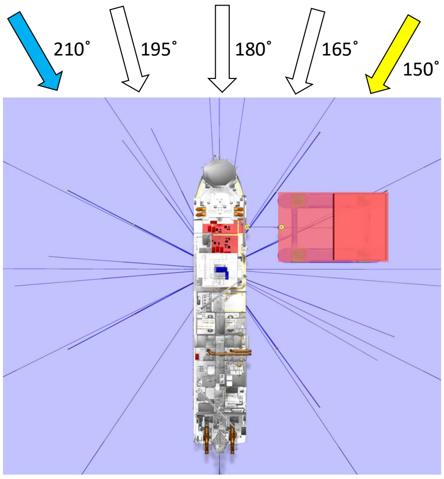
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.42	0.40	0.39	0.36	0.35	0.33					
3.0	0.49	0.46	0.45	0.40	0.38	0.36	0.34				
3.5	0.56	0.53	0.51	0.45	0.41	0.38	0.36	0.34			
4.0		0.61	0.59	0.51	0.46	0.42	0.39	0.37	0.35		
4.5			0.67	0.57	0.51	0.46	0.41	0.38	0.36	0.35	0.35
5.0			0.78	0.65	0.57	0.50	0.45	0.41	0.38	0.37	0.36
5.5			0.88	0.74	0.63	0.55	0.48	0.43	0.40	0.38	0.37

PoS: Non-coll., Dir: 150˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 210˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.37	0.49	0.68	0.75	0.83	0.84					
3.0	0.04	0.10	0.17	0.32	0.40	0.63	0.80				
3.5	0.00	0.01	0.03	0.06	0.02	0.17	0.50	0.72			
4.0		0.00	0.00	0.00	0.01	0.01	0.14	0.44	0.75		
4.5			0.00	0.00	0.00	0.00	0.03	0.10	0.44	0.48	0.42
5.0			0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.15	0.20
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.05

TUF P99: Non-coll., Dir: 150˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 210˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.43	0.42	0.39	0.38	0.37					
3.0	0.50	0.48	0.47	0.42	0.40	0.39	0.37				
3.5	0.57	0.54	0.52	0.47	0.44	0.41	0.39	0.38			
4.0		0.62	0.60	0.52	0.47	0.44	0.41	0.39	0.37		
4.5			0.68	0.58	0.52	0.47	0.43	0.41	0.39	0.38	0.38
5.0			0.79	0.66	0.58	0.51	0.46	0.43	0.41	0.40	0.39
5.5			0.89	0.75	0.64	0.56	0.49	0.45	0.42	0.41	0.40



Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

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E-6 Results for Floatel - Non-Collinear

E-6.2 150° Primary and 210° Secondary Wave, 20 m/s Wind

PoS: Coll., Dir: 150°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.38	0.51	0.64	0.57	0.63	0.79	0.88	0.91	0.90	0.90	0.90
3.0	0.03	0.10	0.11	0.24	0.28	0.44	0.74	0.83	0.87	0.84	0.78
3.5	0.00	0.00	0.01	0.04	0.02	0.10	0.35	0.60	0.75	0.75	0.63
4.0		0.00	0.00	0.00	0.00	0.02	0.10	0.30	0.50	0.55	0.44
4.5			0.00	0.00	0.00	0.00	0.01	0.09	0.22	0.27	0.28
5.0			0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.08	0.08
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02

TUF P99: Coll., Dir: 150°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.51	0.50	0.50	0.49	0.48	0.48	0.47	0.46	0.46	0.46	0.46
3.0	0.52	0.51	0.51	0.50	0.49	0.48	0.48	0.47	0.47	0.46	0.46
3.5	0.54	0.53	0.53	0.51	0.50	0.49	0.49	0.48	0.47	0.47	0.47
4.0		0.55	0.55	0.53	0.51	0.50	0.49	0.49	0.48	0.47	0.47
4.5			0.57	0.54	0.52	0.51	0.50	0.49	0.48	0.48	0.48
5.0			0.60	0.57	0.54	0.52	0.51	0.50	0.49	0.48	0.48
5.5			0.63	0.59	0.56	0.53	0.52	0.50	0.50	0.49	0.49

PoS: Non-coll., Dir: 150°, Wind 20 m/s, Cur 0.7 m/s, Sec: 210°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.35	0.47	0.62	0.57	0.63	0.80					
3.0	0.03	0.07	0.10	0.21	0.24	0.43	0.67				
3.5	0.00	0.00	0.01	0.03	0.03	0.08	0.34	0.59			
4.0		0.00	0.00	0.00	0.00	0.01	0.11	0.29	0.48		
4.5			0.00	0.00	0.00	0.00	0.00	0.08	0.19	0.20	0.25
5.0			0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.00	0.00
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TUF P99: Non-coll., Dir: 150°, Wind 20 m/s, Cur 0.7 m/s, Sec: 210°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.69	0.68	0.67	0.65	0.64	0.63					
3.0	0.73	0.72	0.71	0.68	0.66	0.64	0.63				
3.5	0.80	0.77	0.76	0.71	0.68	0.66	0.64	0.63			
4.0		0.84	0.83	0.76	0.72	0.69	0.66	0.64	0.63		
4.5			0.91	0.81	0.76	0.72	0.68	0.66	0.64	0.63	0.63
5.0			0.97	0.89	0.81	0.76	0.71	0.67	0.65	0.64	0.63
5.5			0.99	0.96	0.88	0.80	0.74	0.70	0.67	0.65	0.64

PoS: Non-coll., Dir: 150°, Wind 20 m/s, Cur 0.7 m/s, Sec: 210°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.27	0.32	0.46	0.45	0.60	0.62					
3.0	0.01	0.06	0.07	0.13	0.17	0.31	0.57				
3.5	0.00	0.00	0.01	0.02	0.00	0.10	0.26	0.50			
4.0		0.00	0.00	0.00	0.00	0.01	0.07	0.25	0.37		
4.5			0.00	0.00	0.00	0.00	0.01	0.06	0.16	0.17	0.20
5.0			0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.05
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01

TUF P99: Non-coll., Dir: 150°, Wind 20 m/s, Cur 0.7 m/s, Sec: 210°, 1.5 m

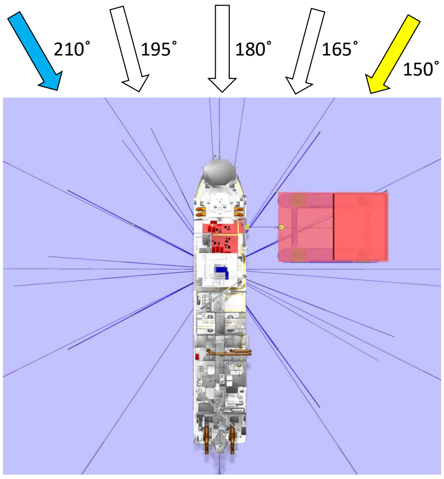
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.69	0.68	0.67	0.66	0.64	0.63					
3.0	0.74	0.72	0.71	0.68	0.66	0.65	0.63				
3.5	0.80	0.78	0.76	0.71	0.69	0.67	0.65	0.64			
4.0		0.85	0.83	0.76	0.72	0.69	0.66	0.65	0.64		
4.5			0.91	0.82	0.76	0.72	0.68	0.66	0.64	0.64	0.63
5.0			0.97	0.89	0.82	0.76	0.71	0.68	0.66	0.64	0.64
5.5			0.99	0.96	0.88	0.80	0.74	0.70	0.67	0.65	0.65

PoS: Non-coll., Dir: 150°, Wind 20 m/s, Cur 0.7 m/s, Sec: 210°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.03	0.06	0.05	0.16	0.16	0.19					
3.0	0.01	0.02	0.05	0.04	0.03	0.11	0.11				
3.5	0.00	0.00	0.01	0.02	0.00	0.05	0.06	0.09			
4.0		0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.06		
4.5			0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.08	0.05
5.0			0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TUF P99: Non-coll., Dir: 150°, Wind 20 m/s, Cur 0.7 m/s, Sec: 210°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.70	0.69	0.69	0.67	0.66	0.64					
3.0	0.75	0.73	0.72	0.69	0.67	0.66	0.65				
3.5	0.81	0.78	0.77	0.72	0.69	0.67	0.66	0.65			
4.0		0.86	0.84	0.77	0.73	0.70	0.67	0.66	0.65		
4.5			0.92	0.82	0.77	0.73	0.69	0.67	0.65	0.64	0.64
5.0			0.97	0.90	0.82	0.76	0.72	0.69	0.67	0.65	0.65
5.5			0.99	0.96	0.89	0.81	0.75	0.71	0.68	0.66	0.66



Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

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E-6 Results for Floatel - Non-Collinear

E-6.3 165° Primary and 195° Secondary Wave, 10 m/s Wind

PoS: Coll., Dir: 165°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.94	0.95	0.94	0.93	0.99	1.00	1.00	1.00	1.00	1.00
4.5			0.72	0.71	0.65	0.83	0.97	1.00	1.00	1.00	1.00
5.0			0.34	0.31	0.22	0.41	0.83	0.97	1.00	1.00	1.00
5.5			0.07	0.02	0.01	0.12	0.39	0.89	0.99	1.00	1.00

TUF P99: Coll., Dir: 165°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.40	0.37	0.38	0.37	0.35	0.34	0.31	0.30	0.29	0.29	0.29
3.0	0.45	0.41	0.42	0.40	0.38	0.36	0.34	0.31	0.30	0.30	0.30
3.5	0.51	0.46	0.47	0.45	0.41	0.38	0.36	0.35	0.32	0.31	0.31
4.0		0.51	0.53	0.50	0.45	0.41	0.38	0.36	0.35	0.32	0.32
4.5			0.60	0.56	0.50	0.44	0.41	0.38	0.36	0.35	0.35
5.0			0.68	0.64	0.55	0.48	0.44	0.40	0.38	0.36	0.36
5.5			0.77	0.72	0.61	0.53	0.47	0.43	0.40	0.38	0.37

PoS: Non-coll., Dir: 165°, Wind 10 m/s, Cur 0.7 m/s, Sec: 195°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
4.0		0.94	0.97	0.95	0.95	0.99	1.00	1.00	1.00		
4.5			0.73	0.75	0.71	0.85	0.97	1.00	1.00	1.00	1.00
5.0			0.35	0.37	0.25	0.41	0.83	0.97	1.00	1.00	1.00
5.5			0.08	0.06	0.01	0.12	0.38	0.87	0.98	1.00	1.00

TUF P99: Non-coll., Dir: 165°, Wind 10 m/s, Cur 0.7 m/s, Sec: 195°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.38	0.35	0.36	0.35	0.33	0.32					
3.0	0.43	0.39	0.40	0.39	0.36	0.34	0.32				
3.5	0.50	0.44	0.46	0.43	0.39	0.36	0.34	0.33			
4.0		0.50	0.52	0.49	0.44	0.39	0.36	0.34	0.33		
4.5			0.59	0.55	0.48	0.43	0.39	0.36	0.35	0.33	0.33
5.0			0.67	0.63	0.54	0.47	0.42	0.39	0.36	0.35	0.34
5.5			0.76	0.71	0.60	0.52	0.46	0.41	0.38	0.36	0.35

PoS: Non-coll., Dir: 165°, Wind 10 m/s, Cur 0.7 m/s, Sec: 195°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.99	1.00	0.99	1.00	1.00	1.00	1.00	1.00			
4.0		0.93	0.96	0.94	0.94	0.99	1.00	1.00	1.00		
4.5			0.69	0.70	0.71	0.81	0.96	1.00	1.00	1.00	1.00
5.0			0.30	0.33	0.23	0.42	0.79	0.97	1.00	1.00	1.00
5.5			0.05	0.05	0.00	0.08	0.35	0.75	0.95	0.95	0.99

TUF P99: Non-coll., Dir: 165°, Wind 10 m/s, Cur 0.7 m/s, Sec: 195°, 1.5 m

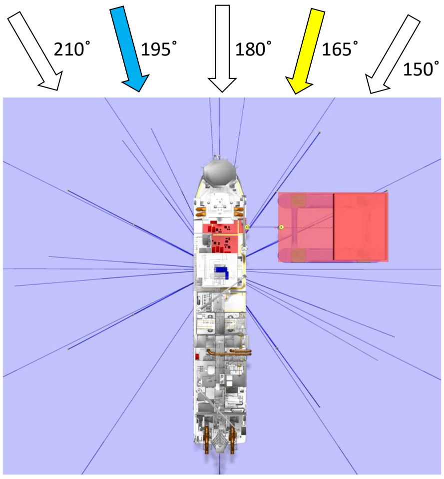
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.39	0.37	0.37	0.36	0.34	0.32					
3.0	0.45	0.41	0.41	0.40	0.37	0.35	0.33				
3.5	0.51	0.45	0.47	0.44	0.40	0.37	0.35	0.33			
4.0		0.51	0.53	0.50	0.44	0.40	0.37	0.35	0.34		
4.5			0.60	0.56	0.49	0.44	0.40	0.37	0.35	0.34	0.34
5.0			0.68	0.63	0.55	0.48	0.43	0.39	0.37	0.36	0.35
5.5			0.77	0.72	0.61	0.53	0.47	0.42	0.39	0.37	0.36

PoS: Non-coll., Dir: 165°, Wind 10 m/s, Cur 0.7 m/s, Sec: 195°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	0.99	1.00	1.00	1.00	1.00	1.00				
3.5	0.98	0.99	1.00	1.00	0.99	1.00	1.00	1.00			
4.0		0.81	0.92	0.91	0.93	0.98	1.00	1.00	1.00		
4.5			0.58	0.62	0.61	0.73	0.95	0.99	1.00	1.00	1.00
5.0			0.22	0.22	0.19	0.32	0.67	0.95	0.99	0.99	1.00
5.5			0.03	0.02	0.00	0.04	0.23	0.83	0.97	0.98	0.95

TUF P99: Non-coll., Dir: 165°, Wind 10 m/s, Cur 0.7 m/s, Sec: 195°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.43	0.41	0.41	0.39	0.38	0.37					
3.0	0.47	0.44	0.43	0.41	0.39	0.37	0.35				
3.5	0.53	0.48	0.48	0.46	0.42	0.41	0.38	0.37			
4.0		0.54	0.55	0.52	0.47	0.43	0.40	0.39	0.38		
4.5			0.62	0.58	0.52	0.47	0.43	0.40	0.39	0.38	0.37
5.0			0.70	0.66	0.57	0.50	0.46	0.42	0.39	0.37	0.37
5.5			0.78	0.73	0.62	0.54	0.49	0.44	0.41	0.40	0.39



Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

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E-6 Results for Floatel - Non-Collinear

E-6.4 165° Primary and 195° Secondary Wave, 20 m/s Wind

PoS: Coll., Dir: 165˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.98	0.99	0.98	0.96	0.94	0.99	1.00	1.00	1.00	1.00	1.00
4.0		0.86	0.88	0.81	0.79	0.89	0.98	1.00	1.00	1.00	1.00
4.5			0.46	0.43	0.38	0.64	0.83	0.99	1.00	1.00	1.00
5.0			0.15	0.10	0.06	0.24	0.63	0.90	0.99	0.99	1.00
5.5			0.01	0.01	0.00	0.04	0.22	0.73	0.93	0.97	0.97

TUF P99: Coll., Dir: 165˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.63	0.61	0.61	0.60	0.59	0.58	0.56	0.56	0.56	0.55	0.55
3.0	0.67	0.64	0.64	0.63	0.61	0.59	0.58	0.57	0.56	0.56	0.55
3.5	0.72	0.68	0.68	0.66	0.63	0.61	0.60	0.58	0.57	0.56	0.56
4.0		0.72	0.73	0.71	0.67	0.63	0.61	0.59	0.58	0.57	0.56
4.5			0.80	0.76	0.71	0.66	0.63	0.61	0.59	0.59	0.58
5.0			0.88	0.83	0.75	0.69	0.65	0.62	0.61	0.59	0.59
5.5			0.95	0.91	0.81	0.73	0.68	0.64	0.62	0.61	0.60

PoS: Non-coll., Dir: 165˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 195˚, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	0.99	0.99	1.00	1.00				
3.5	0.93	0.94	0.97	0.89	0.94	0.99	1.00	1.00			
4.0		0.68	0.78	0.75	0.70	0.81	0.93	1.00	1.00		
4.5			0.33	0.38	0.32	0.45	0.78	0.95	1.00	1.00	1.00
5.0			0.05	0.05	0.07	0.13	0.51	0.85	0.95	0.99	0.99
5.5			0.01	0.00	0.00	0.02	0.20	0.56	0.88	0.94	0.94

TUF P99: Non-coll., Dir: 165˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 195˚, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.65	0.64	0.63	0.62	0.60	0.60					
3.0	0.69	0.66	0.66	0.64	0.62	0.61	0.60				
3.5	0.74	0.70	0.70	0.68	0.65	0.62	0.61	0.60			
4.0		0.74	0.75	0.73	0.69	0.65	0.63	0.61	0.60		
4.5			0.82	0.78	0.72	0.68	0.64	0.63	0.61	0.60	0.59
5.0			0.90	0.85	0.77	0.71	0.67	0.64	0.62	0.61	0.60
5.5			0.96	0.93	0.82	0.75	0.69	0.66	0.64	0.62	0.61

PoS: Non-coll., Dir: 165˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 195˚, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.97	0.99	0.98	0.96	0.95	0.99	1.00	1.00			
4.0		0.81	0.86	0.86	0.83	0.88	0.98	1.00	1.00		
4.5			0.47	0.52	0.42	0.65	0.82	0.98	1.00	1.00	1.00
5.0			0.12	0.10	0.08	0.23	0.64	0.89	0.99	0.98	1.00
5.5			0.02	0.01	0.00	0.04	0.22	0.68	0.91	0.94	0.94

TUF P99: Non-coll., Dir: 165˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 195˚, 1.5 m

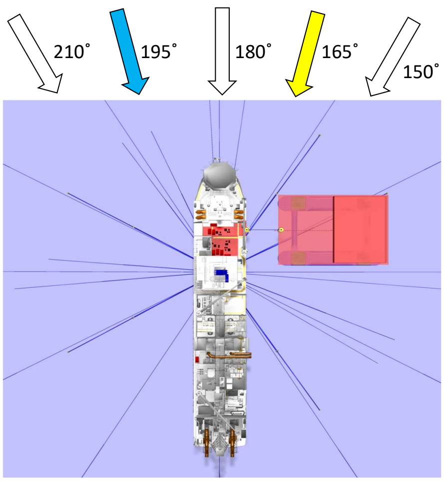
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.63	0.61	0.61	0.60	0.59	0.58					
3.0	0.67	0.64	0.64	0.63	0.61	0.59	0.58				
3.5	0.72	0.68	0.68	0.66	0.63	0.61	0.59	0.58			
4.0		0.72	0.73	0.71	0.66	0.63	0.61	0.59	0.58		
4.5			0.80	0.76	0.70	0.66	0.63	0.61	0.59	0.58	0.58
5.0			0.88	0.83	0.75	0.69	0.65	0.62	0.60	0.59	0.59
5.5			0.95	0.91	0.81	0.73	0.68	0.64	0.62	0.60	0.59

PoS: Non-coll., Dir: 165˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 195˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	0.99	0.99	1.00	1.00				
3.5	0.93	0.94	0.97	0.89	0.94	0.99	1.00	1.00			
4.0		0.68	0.78	0.75	0.70	0.81	0.93	1.00	1.00		
4.5			0.33	0.38	0.32	0.45	0.78	0.95	1.00	1.00	1.00
5.0			0.05	0.05	0.07	0.13	0.51	0.85	0.95	0.99	0.99
5.5			0.01	0.00	0.00	0.02	0.20	0.56	0.88	0.94	0.94

TUF P99: Non-coll., Dir: 165˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 195˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.65	0.64	0.63	0.62	0.60	0.60					
3.0	0.69	0.66	0.66	0.64	0.62	0.61	0.60				
3.5	0.74	0.70	0.70	0.68	0.65	0.62	0.61	0.60			
4.0		0.74	0.75	0.73	0.69	0.65	0.63	0.61	0.60		
4.5			0.82	0.78	0.72	0.68	0.64	0.63	0.61	0.60	0.59
5.0			0.90	0.85	0.77	0.71	0.67	0.64	0.62	0.61	0.60
5.5			0.96	0.93	0.82	0.75	0.69	0.66	0.64	0.62	0.61



Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

E-6 Results for Floatel - Non-Collinear

E-6.5 180° Primary and 150° Secondary Wave, 10 m/s Wind

PoS: Coll., Dir: 180°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.97	0.91	0.96	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.87	0.69	0.72	0.89	0.99	1.00	1.00	1.00	1.00
5.5			0.61	0.36	0.42	0.59	0.87	1.00	1.00	1.00	1.00

TUF P99: Coll., Dir: 180°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.38	0.38	0.38	0.36	0.34	0.30	0.29	0.29	0.29	0.29
3.0	0.51	0.42	0.42	0.42	0.39	0.36	0.34	0.31	0.30	0.30	0.29
3.5	0.60	0.47	0.47	0.47	0.42	0.39	0.36	0.35	0.31	0.31	0.30
4.0		0.53	0.53	0.53	0.47	0.42	0.39	0.37	0.35	0.32	0.31
4.5			0.60	0.59	0.52	0.46	0.42	0.39	0.37	0.36	0.35
5.0			0.68	0.67	0.58	0.50	0.45	0.41	0.38	0.37	0.36
5.5			0.77	0.76	0.65	0.55	0.48	0.44	0.40	0.38	0.37

PoS: Non-coll., Dir: 180°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	0.95	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
4.0		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00		
4.5			0.98	0.93	0.97	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.88	0.71	0.74	0.94	0.99	1.00	1.00	1.00	1.00
5.5			0.63	0.40	0.45	0.63	0.88	1.00	1.00	1.00	1.00

TUF P99: Non-coll., Dir: 180°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.42	0.36	0.36	0.36	0.33	0.31					
3.0	0.50	0.40	0.40	0.40	0.37	0.34	0.32				
3.5	0.59	0.45	0.46	0.45	0.41	0.37	0.34	0.33			
4.0		0.51	0.52	0.52	0.46	0.40	0.37	0.34	0.33		
4.5			0.59	0.59	0.51	0.44	0.40	0.37	0.35	0.33	0.33
5.0			0.68	0.67	0.57	0.49	0.43	0.39	0.36	0.35	0.34
5.5			0.77	0.76	0.64	0.54	0.47	0.42	0.39	0.36	0.35

PoS: Non-coll., Dir: 180°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	0.95	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
4.0		0.95	1.00	0.99	1.00	1.00	1.00	1.00	1.00		
4.5			0.97	0.93	0.96	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.87	0.70	0.73	0.91	0.99	1.00	1.00	0.99	1.00
5.5			0.58	0.38	0.46	0.59	0.88	0.95	1.00	0.99	1.00

TUF P99: Non-coll., Dir: 180°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 1.5 m

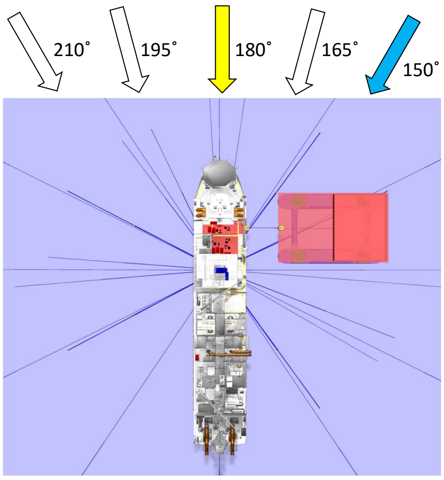
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.37	0.37	0.36	0.34	0.32					
3.0	0.51	0.41	0.41	0.41	0.37	0.35	0.33				
3.5	0.60	0.46	0.47	0.46	0.41	0.38	0.35	0.33			
4.0		0.52	0.53	0.52	0.46	0.41	0.38	0.35	0.34		
4.5			0.60	0.59	0.52	0.45	0.41	0.37	0.35	0.34	0.33
5.0			0.68	0.67	0.58	0.49	0.44	0.40	0.37	0.36	0.35
5.5			0.77	0.76	0.65	0.54	0.48	0.43	0.39	0.37	0.36

PoS: Non-coll., Dir: 180°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.85	0.82	0.85	0.79	0.80	0.84					
3.0	0.80	0.81	0.84	0.78	0.92	0.84	0.75				
3.5	0.75	0.78	0.83	0.77	0.92	0.84	0.80	0.86			
4.0		0.77	0.81	0.75	0.79	0.83	0.81	0.85	0.84		
4.5			0.74	0.63	0.70	0.79	0.81	0.85	0.84	0.87	0.92
5.0			0.61	0.48	0.47	0.65	0.74	0.84	0.83	0.93	0.90
5.5			0.37	0.19	0.20	0.42	0.68	0.84	0.82	0.92	0.93

TUF P99: Non-coll., Dir: 180°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°,2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.47	0.42	0.42	0.41	0.39	0.38					
3.0	0.54	0.45	0.45	0.45	0.42	0.40	0.38				
3.5	0.62	0.50	0.50	0.49	0.45	0.42	0.40	0.39			
4.0		0.55	0.56	0.55	0.49	0.45	0.42	0.40	0.39		
4.5			0.63	0.62	0.54	0.48	0.44	0.42	0.40	0.39	0.39
5.0			0.71	0.70	0.60	0.53	0.47	0.44	0.42	0.39	0.39
5.5			0.79	0.78	0.66	0.56	0.51	0.46	0.43	0.41	0.41



Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

E-6 Results for Floatel - Non-Collinear

E-6.6 180° Primary and 150° Secondary Wave, 20 m/s Wind

PoS: Coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	0.98	0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.95	0.84	0.89	0.96	0.99	1.00	1.00	1.00	1.00
5.0			0.78	0.61	0.67	0.85	0.95	1.00	1.00	1.00	1.00
5.5			0.49	0.29	0.27	0.50	0.82	0.96	1.00	1.00	1.00

TUF P99: Coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.62	0.58	0.58	0.58	0.56	0.55	0.52	0.51	0.51	0.51	0.51
3.0	0.69	0.61	0.61	0.61	0.58	0.56	0.55	0.52	0.52	0.51	0.51
3.5	0.77	0.65	0.66	0.65	0.61	0.58	0.56	0.55	0.52	0.52	0.52
4.0		0.70	0.71	0.70	0.65	0.61	0.58	0.56	0.55	0.53	0.52
4.5			0.77	0.76	0.70	0.64	0.60	0.58	0.56	0.55	0.55
5.0			0.85	0.84	0.75	0.67	0.63	0.60	0.58	0.56	0.56
5.5			0.93	0.92	0.81	0.72	0.66	0.62	0.59	0.58	0.57

PoS: Non-coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 150˚, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
4.0		1.00	0.99	0.98	0.99	1.00	1.00	1.00	1.00		
4.5			0.96	0.87	0.91	0.96	0.99	1.00	1.00	1.00	1.00
5.0			0.81	0.64	0.73	0.85	0.96	1.00	1.00	1.00	1.00
5.5			0.55	0.35	0.31	0.56	0.83	0.97	1.00	1.00	1.00

TUF P99: Non-coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 150˚, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.61	0.56	0.56	0.56	0.54	0.53					
3.0	0.67	0.60	0.60	0.59	0.57	0.55	0.53				
3.5	0.76	0.64	0.64	0.64	0.60	0.57	0.55	0.53			
4.0		0.69	0.70	0.69	0.64	0.59	0.57	0.55	0.53		
4.5			0.76	0.76	0.69	0.62	0.59	0.56	0.55	0.54	0.53
5.0			0.84	0.83	0.74	0.66	0.61	0.58	0.56	0.55	0.54
5.5			0.93	0.92	0.81	0.71	0.65	0.60	0.58	0.56	0.55

PoS: Non-coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 150˚, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
4.0		1.00	0.99	0.98	0.99	1.00	1.00	1.00	1.00		
4.5			0.96	0.85	0.92	0.94	0.99	1.00	1.00	1.00	1.00
5.0			0.80	0.63	0.71	0.86	0.95	1.00	1.00	0.99	1.00
5.5			0.51	0.29	0.28	0.58	0.82	0.97	1.00	0.99	0.95

TUF P99: Non-coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 150˚, 1.5 m

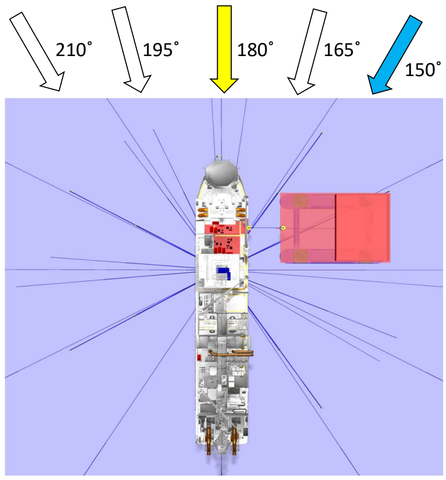
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.62	0.58	0.57	0.57	0.55	0.54					
3.0	0.68	0.61	0.61	0.60	0.57	0.55	0.54				
3.5	0.77	0.65	0.65	0.64	0.60	0.57	0.55	0.54			
4.0		0.70	0.70	0.70	0.64	0.60	0.57	0.55	0.54		
4.5			0.77	0.76	0.69	0.63	0.59	0.57	0.55	0.54	0.54
5.0			0.85	0.84	0.75	0.67	0.62	0.59	0.57	0.55	0.55
5.5			0.93	0.93	0.81	0.71	0.65	0.61	0.58	0.57	0.56

PoS: Non-coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 150˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.76	0.65	0.77	0.75	0.76	0.81					
3.0	0.72	0.60	0.76	0.75	0.73	0.94	0.60				
3.5	0.65	0.55	0.65	0.73	0.70	0.85	0.60	0.85			
4.0		0.59	0.60	0.71	0.63	0.82	0.60	0.79	0.78		
4.5			0.64	0.57	0.68	0.81	0.60	0.79	0.78	0.92	0.70
5.0			0.35	0.34	0.40	0.65	0.67	0.77	0.77	0.89	0.70
5.5			0.23	0.19	0.18	0.30	0.46	0.70	0.72	0.85	0.70

TUF P99: Non-coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 150˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.65	0.61	0.61	0.60	0.59	0.58					
3.0	0.71	0.64	0.64	0.63	0.61	0.58	0.57				
3.5	0.78	0.68	0.68	0.67	0.64	0.60	0.59	0.58			
4.0		0.73	0.73	0.72	0.67	0.63	0.60	0.59	0.58		
4.5			0.79	0.79	0.72	0.65	0.63	0.61	0.59	0.58	0.58
5.0			0.87	0.86	0.77	0.69	0.65	0.62	0.60	0.59	0.58
5.5			0.95	0.94	0.83	0.74	0.68	0.64	0.62	0.60	0.59



Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

E-6 Results for Floatel - Non-Collinear

E-6.7 180° Primary and 210° Secondary Wave, 10 m/s Wind

PoS: Coll., Dir: 180˚, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.97	0.91	0.96	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.87	0.69	0.72	0.89	0.99	1.00	1.00	1.00	1.00
5.5			0.61	0.36	0.42	0.59	0.87	1.00	1.00	1.00	1.00

TUF P99: Coll., Dir: 180˚, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.38	0.38	0.38	0.36	0.34	0.30	0.29	0.29	0.29	0.29
3.0	0.51	0.42	0.42	0.42	0.39	0.36	0.34	0.31	0.30	0.30	0.29
3.5	0.60	0.47	0.47	0.47	0.42	0.39	0.36	0.35	0.31	0.31	0.30
4.0		0.53	0.53	0.53	0.47	0.42	0.39	0.37	0.35	0.32	0.31
4.5			0.60	0.59	0.52	0.46	0.42	0.39	0.37	0.36	0.35
5.0			0.68	0.67	0.58	0.50	0.45	0.41	0.38	0.37	0.36
5.5			0.77	0.76	0.65	0.55	0.48	0.44	0.40	0.38	0.37

PoS: Non-coll., Dir: 180˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 210˚, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	0.95	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
4.0		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00		
4.5			0.98	0.93	0.97	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.88	0.71	0.74	0.94	0.99	1.00	1.00	1.00	1.00
5.5			0.63	0.40	0.45	0.63	0.88	1.00	1.00	1.00	1.00

TUF P99: Non-coll., Dir: 180˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 210˚, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.42	0.36	0.36	0.35	0.33	0.31					
3.0	0.50	0.40	0.40	0.40	0.37	0.34	0.32				
3.5	0.59	0.45	0.46	0.45	0.41	0.37	0.34	0.33			
4.0		0.51	0.52	0.52	0.46	0.40	0.37	0.34	0.33		
4.5			0.59	0.59	0.51	0.44	0.40	0.37	0.35	0.33	0.33
5.0			0.68	0.67	0.57	0.49	0.43	0.39	0.36	0.35	0.34
5.5			0.77	0.76	0.64	0.54	0.47	0.42	0.39	0.36	0.35

PoS: Non-coll., Dir: 180˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 210˚, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	0.99	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
4.0		1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00		
4.5			0.97	0.92	0.96	0.99	1.00	1.00	1.00	1.00	1.00
5.0			0.88	0.70	0.76	0.89	0.99	1.00	1.00	1.00	1.00
5.5			0.65	0.40	0.44	0.65	0.86	1.00	1.00	1.00	1.00

TUF P99: Non-coll., Dir: 180˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 210˚, 1.5 m

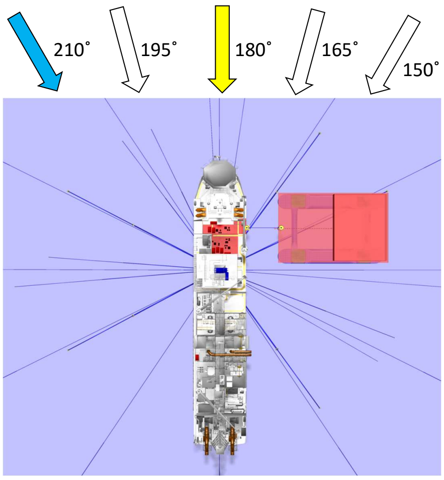
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.37	0.37	0.36	0.34	0.32					
3.0	0.51	0.41	0.41	0.41	0.37	0.35	0.33				
3.5	0.60	0.46	0.47	0.46	0.41	0.38	0.35	0.33			
4.0		0.52	0.53	0.52	0.46	0.41	0.38	0.35	0.34		
4.5			0.60	0.59	0.52	0.45	0.41	0.37	0.35	0.34	0.33
5.0			0.68	0.67	0.58	0.49	0.44	0.40	0.37	0.36	0.35
5.5			0.77	0.76	0.65	0.54	0.48	0.43	0.39	0.37	0.36

PoS: Non-coll., Dir: 180˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 210˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.84	0.79	0.87	0.84	0.87	0.88					
3.0	0.83	0.79	0.86	0.82	0.92	0.88	0.93				
3.5	0.80	0.79	0.83	0.82	0.91	0.88	0.86	0.90			
4.0		0.77	0.80	0.77	0.83	0.86	0.85	0.89	0.91		
4.5			0.77	0.67	0.74	0.83	0.82	0.80	0.88	0.93	0.94
5.0			0.62	0.46	0.55	0.70	0.76	0.75	0.87	0.94	0.96
5.5			0.39	0.17	0.22	0.39	0.63	0.74	0.85	0.94	0.94

TUF P99: Non-coll., Dir: 180˚, Wind 10 m/s, Cur 0.7 m/s, Sec: 210˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.47	0.42	0.41	0.41	0.39	0.38					
3.0	0.54	0.45	0.45	0.44	0.41	0.40	0.38				
3.5	0.62	0.50	0.50	0.49	0.45	0.42	0.40	0.38			
4.0		0.55	0.56	0.55	0.49	0.45	0.42	0.40	0.39		
4.5			0.63	0.62	0.54	0.48	0.44	0.41	0.40	0.39	0.38
5.0			0.71	0.70	0.60	0.53	0.47	0.44	0.41	0.39	0.39
5.5			0.80	0.79	0.67	0.57	0.50	0.46	0.43	0.41	0.40



Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

E-6 Results for Floatel - Non-Collinear

E-6.8 180° Primary and 210° Secondary Wave, 20 m/s Wind

PoS: Coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		1.00	0.98	0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.00
4.5			0.95	0.84	0.89	0.96	0.99	1.00	1.00	1.00	1.00
5.0			0.78	0.61	0.67	0.85	0.95	1.00	1.00	1.00	1.00
5.5			0.49	0.29	0.27	0.50	0.82	0.96	1.00	1.00	1.00

TUF P99: Coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.62	0.58	0.58	0.58	0.56	0.55	0.52	0.52	0.51	0.51	0.51
3.0	0.69	0.61	0.61	0.61	0.58	0.56	0.55	0.52	0.52	0.51	0.51
3.5	0.77	0.65	0.66	0.65	0.61	0.58	0.56	0.55	0.52	0.52	0.52
4.0		0.70	0.71	0.70	0.65	0.61	0.58	0.56	0.55	0.53	0.52
4.5			0.77	0.76	0.70	0.64	0.60	0.58	0.56	0.55	0.55
5.0			0.85	0.84	0.75	0.67	0.63	0.60	0.58	0.56	0.56
5.5			0.93	0.92	0.81	0.72	0.66	0.62	0.59	0.58	0.57

PoS: Non-coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 210˚, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
4.0		1.00	0.99	0.98	0.99	1.00	1.00	1.00	1.00		
4.5			0.96	0.88	0.90	0.96	0.99	1.00	1.00	1.00	1.00
5.0			0.81	0.63	0.71	0.85	0.95	1.00	1.00	1.00	1.00
5.5			0.55	0.32	0.31	0.58	0.83	0.97	1.00	1.00	1.00

TUF P99: Non-coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 210˚, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.61	0.56	0.56	0.56	0.54	0.53					
3.0	0.67	0.60	0.60	0.59	0.57	0.55	0.53				
3.5	0.76	0.64	0.64	0.63	0.60	0.57	0.55	0.53			
4.0		0.69	0.70	0.69	0.64	0.59	0.57	0.55	0.53		
4.5			0.76	0.76	0.69	0.62	0.59	0.56	0.55	0.54	0.53
5.0			0.84	0.83	0.74	0.66	0.61	0.58	0.56	0.55	0.54
5.5			0.93	0.92	0.81	0.71	0.65	0.60	0.58	0.56	0.55

PoS: Non-coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 210˚, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
4.0		1.00	0.98	0.97	1.00	1.00	1.00	1.00	1.00		
4.5			0.95	0.85	0.92	0.96	0.99	1.00	1.00	1.00	1.00
5.0			0.79	0.63	0.72	0.86	0.94	1.00	1.00	1.00	1.00
5.5			0.53	0.30	0.27	0.53	0.83	0.98	1.00	1.00	1.00

TUF P99: Non-coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 210˚, 1.5 m

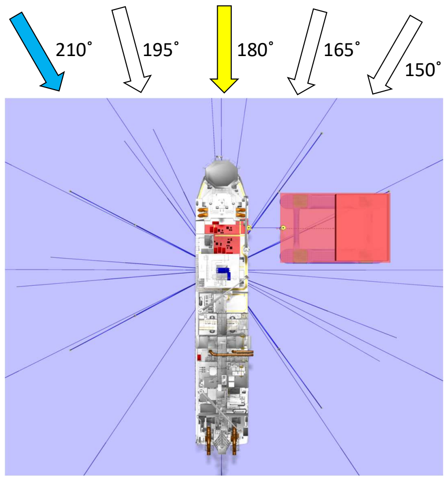
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.62	0.57	0.57	0.57	0.55	0.54					
3.0	0.68	0.61	0.60	0.60	0.57	0.55	0.54				
3.5	0.76	0.65	0.65	0.64	0.60	0.57	0.55	0.54			
4.0		0.70	0.70	0.70	0.64	0.60	0.57	0.55	0.54		
4.5			0.77	0.76	0.69	0.63	0.59	0.57	0.55	0.54	0.54
5.0			0.85	0.84	0.75	0.67	0.62	0.59	0.57	0.55	0.55
5.5			0.93	0.93	0.81	0.72	0.65	0.61	0.58	0.57	0.56

PoS: Non-coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 210˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.81	0.83	0.79	0.76	0.80	0.84					
3.0	0.77	0.82	0.77	0.73	0.80	0.93	0.92				
3.5	0.73	0.82	0.83	0.72	0.78	0.95	0.91	0.86			
4.0		0.66	0.79	0.64	0.74	0.83	0.88	0.84	0.83		
4.5			0.73	0.51	0.67	0.78	0.83	0.83	0.78	0.92	0.88
5.0			0.49	0.31	0.39	0.61	0.72	0.80	0.78	0.90	0.86
5.5			0.24	0.14	0.15	0.34	0.52	0.71	0.75	0.90	0.85

TUF P99: Non-coll., Dir: 180˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 210˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.65	0.61	0.61	0.60	0.59	0.58					
3.0	0.71	0.64	0.64	0.63	0.61	0.58	0.57				
3.5	0.78	0.68	0.68	0.67	0.64	0.60	0.59	0.57			
4.0		0.73	0.73	0.72	0.67	0.63	0.60	0.59	0.58		
4.5			0.80	0.79	0.72	0.66	0.63	0.60	0.59	0.58	0.57
5.0			0.87	0.86	0.77	0.69	0.65	0.62	0.60	0.59	0.58
5.5			0.95	0.94	0.84	0.74	0.68	0.64	0.62	0.60	0.59



Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

E-6 Results for Floatel - Non-Collinear

E-6.9 195° Primary and 165° Secondary Wave, 10 m/s Wind

PoS: Coll., Dir: 195°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.5	0.97	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.0		0.90	0.90	0.95	0.89	0.91	0.97	1.00	1.00	1.00	1.00
4.5			0.60	0.67	0.61	0.65	0.86	1.00	1.00	1.00	1.00
5.0			0.22	0.23	0.20	0.25	0.62	0.90	1.00	1.00	1.00
5.5			0.01	0.06	0.05	0.05	0.20	0.76	0.98	1.00	1.00

TUF P99: Coll., Dir: 195°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.40	0.38	0.38	0.37	0.36	0.35	0.31	0.30	0.29	0.29	0.29
3.0	0.45	0.42	0.42	0.41	0.39	0.37	0.35	0.31	0.31	0.30	0.30
3.5	0.51	0.46	0.46	0.45	0.42	0.40	0.37	0.36	0.32	0.31	0.31
4.0		0.51	0.52	0.50	0.47	0.43	0.40	0.37	0.36	0.32	0.32
4.5			0.58	0.56	0.52	0.47	0.43	0.40	0.37	0.36	0.36
5.0			0.65	0.62	0.57	0.52	0.46	0.42	0.39	0.38	0.37
5.5			0.73	0.70	0.64	0.57	0.50	0.45	0.41	0.39	0.38

PoS: Non-coll., Dir: 195°, Wind 10 m/s, Cur 0.7 m/s, Sec: 165°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.97	0.99	0.99	0.99	1.00	1.00	1.00	1.00			
4.0		0.91	0.91	0.96	0.90	0.91	0.98	1.00	1.00		
4.5			0.60	0.68	0.62	0.68	0.88	1.00	1.00	1.00	1.00
5.0			0.23	0.24	0.21	0.27	0.63	0.90	1.00	1.00	1.00
5.5			0.01	0.06	0.05	0.05	0.21	0.76	0.98	1.00	1.00

TUF P99: Non-coll., Dir: 195°, Wind 10 m/s, Cur 0.7 m/s, Sec: 165°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.38	0.35	0.35	0.35	0.33	0.32					
3.0	0.43	0.39	0.39	0.38	0.36	0.34	0.33				
3.5	0.49	0.44	0.44	0.43	0.40	0.37	0.35	0.33			
4.0		0.49	0.50	0.48	0.45	0.41	0.38	0.35	0.33		
4.5			0.56	0.54	0.50	0.45	0.41	0.37	0.35	0.34	0.33
5.0			0.64	0.61	0.56	0.50	0.45	0.40	0.37	0.35	0.34
5.5			0.72	0.69	0.63	0.55	0.49	0.43	0.39	0.37	0.36

PoS: Non-coll., Dir: 195°, Wind 10 m/s, Cur 0.7 m/s, Sec: 165°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.97	0.99	0.99	0.99	0.99	1.00	1.00	1.00			
4.0		0.90	0.89	0.93	0.88	0.92	0.95	1.00	1.00		
4.5			0.62	0.68	0.60	0.64	0.87	1.00	1.00	1.00	1.00
5.0			0.22	0.23	0.20	0.25	0.58	0.90	1.00	1.00	1.00
5.5			0.03	0.06	0.05	0.06	0.20	0.76	0.98	0.99	0.95

TUF P99: Non-coll., Dir: 195°, Wind 10 m/s, Cur 0.7 m/s, Sec: 165°, 1.5 m

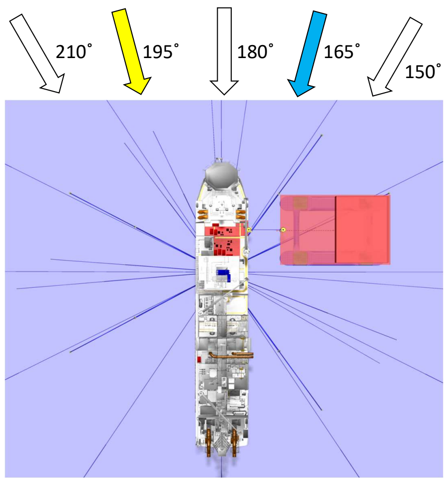
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.39	0.37	0.36	0.35	0.34	0.33					
3.0	0.44	0.40	0.40	0.39	0.37	0.35	0.34				
3.5	0.50	0.45	0.45	0.43	0.41	0.38	0.36	0.34			
4.0		0.50	0.51	0.49	0.46	0.42	0.39	0.36	0.34		
4.5			0.57	0.55	0.51	0.46	0.42	0.38	0.36	0.34	0.34
5.0			0.65	0.62	0.56	0.51	0.46	0.41	0.38	0.36	0.35
5.5			0.73	0.70	0.63	0.56	0.49	0.44	0.40	0.38	0.37

PoS: Non-coll., Dir: 195°, Wind 10 m/s, Cur 0.7 m/s, Sec: 165°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00				
3.5	0.97	0.98	0.98	0.98	0.98	1.00	1.00	1.00			
4.0		0.79	0.85	0.88	0.84	0.89	0.95	1.00	1.00		
4.5			0.55	0.55	0.50	0.56	0.83	0.98	1.00	1.00	1.00
5.0			0.17	0.15	0.20	0.20	0.53	0.90	1.00	1.00	1.00
5.5			0.02	0.04	0.04	0.03	0.17	0.73	0.96	1.00	0.95

TUF P99: Non-coll., Dir: 195°, Wind 10 m/s, Cur 0.7 m/s, Sec: 165°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.42	0.40	0.39	0.39	0.38	0.36					
3.0	0.47	0.43	0.43	0.42	0.40	0.38	0.37				
3.5	0.53	0.47	0.47	0.46	0.44	0.41	0.39	0.37			
4.0		0.53	0.53	0.51	0.48	0.44	0.41	0.39	0.38		
4.5			0.59	0.57	0.53	0.48	0.44	0.41	0.39	0.38	0.37
5.0			0.66	0.64	0.58	0.53	0.47	0.43	0.40	0.39	0.38
5.5			0.74	0.71	0.64	0.57	0.51	0.46	0.42	0.40	0.39



Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

E-6 Results for Floatel - Non-Collinear

ENCLOSURE	6
REPORT NUMBER	OC2025 F-073
DATE	2026-06-03
REFERENCE	2025/720

E-6.10 195° Primary and 165° Secondary Wave, 20 m/s Wind

PoS: Coll., Dir: 195°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.0	1.00	1.00	0.98	0.97	0.98	0.99	1.00	1.00	1.00	1.00	1.00
3.5	0.91	0.96	0.92	0.93	0.87	0.93	0.97	1.00	1.00	1.00	1.00
4.0		0.66	0.64	0.67	0.64	0.72	0.86	0.99	1.00	1.00	1.00
4.5			0.27	0.33	0.32	0.44	0.69	0.91	1.00	1.00	1.00
5.0			0.09	0.05	0.07	0.12	0.40	0.74	0.97	0.99	1.00
5.5			0.00	0.00	0.00	0.02	0.09	0.58	0.86	0.98	0.98

TUF P99: Coll., Dir: 195°, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.64	0.63	0.63	0.62	0.61	0.60	0.57	0.56	0.56	0.56	0.55
3.0	0.68	0.65	0.65	0.64	0.63	0.62	0.60	0.57	0.56	0.56	0.56
3.5	0.73	0.69	0.69	0.68	0.66	0.64	0.62	0.60	0.57	0.56	0.56
4.0		0.73	0.74	0.72	0.69	0.66	0.63	0.61	0.60	0.57	0.57
4.5			0.79	0.77	0.74	0.69	0.65	0.63	0.61	0.60	0.59
5.0			0.86	0.84	0.79	0.73	0.68	0.65	0.62	0.61	0.60
5.5			0.93	0.91	0.85	0.78	0.71	0.67	0.64	0.62	0.61

PoS: Non-coll., Dir: 195°, Wind 20 m/s, Cur 0.7 m/s, Sec: 165°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	0.99	0.97	0.98	0.99	1.00				
3.5	0.93	0.98	0.92	0.94	0.88	0.93	0.97	1.00			
4.0		0.67	0.69	0.70	0.67	0.73	0.87	0.99	1.00		
4.5			0.29	0.35	0.35	0.45	0.69	0.92	1.00	1.00	1.00
5.0			0.10	0.06	0.07	0.16	0.41	0.74	0.98	1.00	1.00
5.5			0.00	0.00	0.00	0.02	0.11	0.58	0.86	0.98	0.95

TUF P99: Non-coll., Dir: 195°, Wind 20 m/s, Cur 0.7 m/s, Sec: 165°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.62	0.61	0.60	0.60	0.59	0.58					
3.0	0.66	0.63	0.63	0.62	0.61	0.59	0.58				
3.5	0.71	0.67	0.67	0.66	0.64	0.61	0.60	0.58			
4.0		0.71	0.72	0.70	0.67	0.64	0.61	0.59	0.58		
4.5			0.77	0.76	0.72	0.67	0.64	0.61	0.59	0.58	0.58
5.0			0.84	0.82	0.77	0.71	0.67	0.63	0.61	0.59	0.58
5.5			0.92	0.90	0.83	0.76	0.70	0.65	0.62	0.60	0.59

PoS: Non-coll., Dir: 180°, Wind 20 m/s, Cur 0.7 m/s, Sec: 165°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	1.00	1.00	1.00	1.00					
3.0	1.00	1.00	0.95	0.97	0.98	0.99	1.00				
3.5	0.85	0.93	0.92	0.93	0.86	0.85	0.90	1.00			
4.0		0.67	0.62	0.66	0.62	0.72	0.88	1.00	1.00		
4.5			0.27	0.31	0.35	0.46	0.67	0.89	1.00	1.00	1.00
5.0			0.07	0.05	0.08	0.14	0.43	0.74	0.94	1.00	1.00
5.5			0.00	0.00	0.00	0.01	0.09	0.59	0.86	0.98	0.96

TUF P99: Non-coll., Dir: 180°, Wind 20 m/s, Cur 0.7 m/s, Sec: 165°, 1.5 m

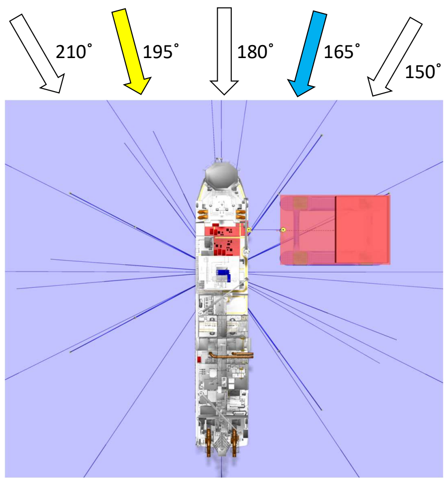
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.63	0.62	0.61	0.61	0.60	0.59					
3.0	0.67	0.64	0.64	0.63	0.62	0.60	0.59				
3.5	0.72	0.68	0.68	0.67	0.65	0.62	0.60	0.59			
4.0		0.72	0.73	0.71	0.68	0.65	0.62	0.60	0.59		
4.5			0.78	0.76	0.72	0.68	0.64	0.62	0.60	0.59	0.58
5.0			0.85	0.83	0.78	0.72	0.67	0.64	0.61	0.60	0.59
5.5			0.92	0.90	0.84	0.77	0.71	0.66	0.63	0.61	0.60

PoS: Non-coll., Dir: 180°, Wind 20 m/s, Cur 0.7 m/s, Sec: 165°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	1.00	1.00	0.99	0.95	1.00	1.00					
3.0	0.96	0.98	0.95	0.95	0.97	0.99	0.90				
3.5	0.70	0.75	0.80	0.84	0.82	0.91	0.80	0.95			
4.0		0.52	0.56	0.40	0.55	0.64	0.70	0.85	1.00		
4.5			0.23	0.26	0.23	0.37	0.60	0.85	0.95	1.00	1.00
5.0			0.07	0.04	0.07	0.13	0.36	0.70	0.93	0.95	0.99
5.5			0.00	0.00	0.00	0.01	0.09	0.51	0.82	0.92	0.95

TUF P99: Non-coll., Dir: 180°, Wind 20 m/s, Cur 0.7 m/s, Sec: 165°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.66	0.64	0.64	0.63	0.62	0.61					
3.0	0.69	0.66	0.66	0.65	0.64	0.62	0.61				
3.5	0.74	0.70	0.70	0.68	0.66	0.64	0.63	0.61			
4.0		0.74	0.74	0.72	0.70	0.67	0.64	0.62	0.61		
4.5			0.80	0.78	0.74	0.70	0.66	0.64	0.62	0.61	0.61
5.0			0.87	0.84	0.79	0.73	0.69	0.66	0.63	0.62	0.61
5.5			0.93	0.91	0.85	0.78	0.72	0.68	0.65	0.63	0.62



Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

E-6 Results for Floatel - Non-Collinear

E-6.11 210° Primary and 150° Secondary Wave, 10 m/s Wind

PoS: Coll., Dir: 210°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.94	0.95	0.96	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00
3.0	0.44	0.47	0.64	0.75	0.74	0.93	1.00	1.00	1.00	1.00	1.00
3.5	0.04	0.07	0.09	0.16	0.20	0.45	0.90	1.00	1.00	1.00	1.00
4.0		0.00	0.00	0.01	0.04	0.08	0.51	0.91	1.00	1.00	1.00
4.5			0.00	0.00	0.00	0.01	0.10	0.69	0.94	0.99	1.00
5.0			0.00	0.00	0.00	0.00	0.00	0.25	0.75	0.96	0.99
5.5			0.00	0.00	0.00	0.00	0.00	0.04	0.40	0.74	0.83

TUF P99: Coll., Dir: 210°, Wind 10 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.42	0.41	0.40	0.38	0.37	0.36	0.33	0.31	0.31	0.31	0.31
3.0	0.48	0.46	0.45	0.42	0.41	0.39	0.37	0.33	0.32	0.32	0.31
3.5	0.55	0.52	0.51	0.47	0.45	0.42	0.39	0.37	0.33	0.33	0.32
4.0		0.60	0.58	0.54	0.51	0.46	0.42	0.39	0.37	0.34	0.33
4.5			0.67	0.62	0.57	0.51	0.45	0.41	0.39	0.37	0.37
5.0			0.79	0.71	0.65	0.57	0.49	0.44	0.40	0.39	0.38
5.5			0.91	0.83	0.75	0.64	0.54	0.47	0.43	0.41	0.40

PoS: Non-coll., Dir: 210°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.95	0.95	0.96	0.96	0.99	1.00					
3.0	0.46	0.48	0.62	0.61	0.70	0.93	1.00				
3.5	0.04	0.06	0.08	0.07	0.14	0.46	0.89	1.00			
4.0		0.00	0.00	0.01	0.02	0.05	0.50	0.92	1.00		
4.5			0.00	0.00	0.00	0.00	0.07	0.69	0.93	0.99	1.00
5.0			0.00	0.00	0.00	0.00	0.00	0.19	0.76	0.97	1.00
5.5			0.00	0.00	0.00	0.00	0.00	0.01	0.36	0.73	0.85

TUF P99: Non-coll., Dir: 210°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.40	0.38	0.38	0.36	0.35	0.34					
3.0	0.46	0.44	0.43	0.41	0.39	0.37	0.35				
3.5	0.54	0.51	0.49	0.46	0.44	0.40	0.37	0.35			
4.0		0.59	0.56	0.53	0.49	0.45	0.40	0.37	0.35		
4.5			0.65	0.60	0.56	0.50	0.44	0.39	0.37	0.35	0.35
5.0			0.77	0.70	0.64	0.55	0.48	0.42	0.39	0.37	0.36
5.5			0.90	0.82	0.73	0.62	0.53	0.46	0.41	0.39	0.38

PoS: Non-coll., Dir: 210°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.92	0.87	0.96	0.95	0.99	1.00					
3.0	0.36	0.42	0.52	0.54	0.68	0.89	0.99				
3.5	0.02	0.01	0.06	0.06	0.12	0.34	0.87	1.00			
4.0		0.00	0.00	0.00	0.01	0.06	0.45	0.89	0.99		
4.5			0.00	0.00	0.00	0.00	0.05	0.53	0.93	0.99	1.00
5.0			0.00	0.00	0.00	0.00	0.00	0.14	0.67	0.95	0.98
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.60	0.77

TUF P99: Non-coll., Dir: 210°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 1.5 m

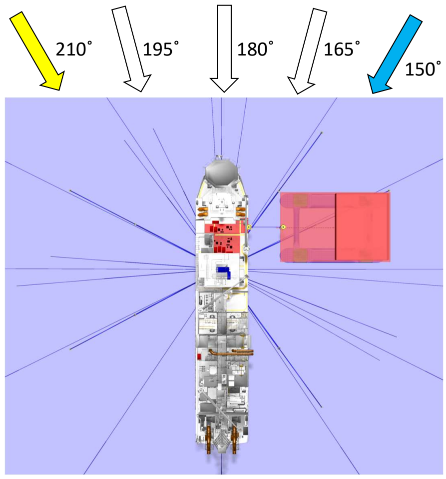
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.41	0.39	0.38	0.37	0.36	0.35					
3.0	0.47	0.44	0.44	0.41	0.39	0.37	0.35				
3.5	0.54	0.51	0.50	0.47	0.44	0.41	0.38	0.35			
4.0		0.59	0.57	0.54	0.50	0.45	0.41	0.38	0.36		
4.5			0.66	0.61	0.56	0.50	0.44	0.40	0.37	0.36	0.35
5.0			0.77	0.70	0.64	0.56	0.48	0.43	0.40	0.38	0.37
5.5			0.91	0.82	0.74	0.63	0.53	0.46	0.42	0.40	0.38

PoS: Non-coll., Dir: 210°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.24	0.40	0.45	0.53	0.64	0.75					
3.0	0.03	0.07	0.09	0.16	0.18	0.46	0.60				
3.5	0.00	0.00	0.01	0.01	0.00	0.05	0.33	0.59			
4.0		0.00	0.00	0.00	0.00	0.02	0.24	0.43	0.58		
4.5			0.00	0.00	0.00	0.00	0.00	0.11	0.34	0.48	0.44
5.0			0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.29	0.27
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09	0.11

TUF P99: Non-coll., Dir: 210°, Wind 10 m/s, Cur 0.7 m/s, Sec: 150°, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.44	0.43	0.42	0.41	0.40	0.38					
3.0	0.49	0.47	0.47	0.44	0.43	0.40	0.39				
3.5	0.56	0.52	0.51	0.49	0.47	0.44	0.41	0.39			
4.0		0.61	0.58	0.55	0.52	0.47	0.42	0.41	0.39		
4.5			0.67	0.62	0.58	0.51	0.46	0.43	0.41	0.40	0.39
5.0			0.79	0.72	0.66	0.57	0.50	0.45	0.43	0.41	0.40
5.5			0.92	0.84	0.75	0.64	0.55	0.48	0.45	0.43	0.41



Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

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E-6 Results for Floatel - Non-Collinear

E-6.12 210° Primary and 150° Secondary Wave, 20 m/s Wind

PoS: Coll., Dir: 210˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.23	0.25	0.24	0.33	0.39	0.58	0.72	0.82	0.87	0.87	0.86
3.0	0.00	0.03	0.02	0.10	0.16	0.24	0.51	0.67	0.74	0.78	0.73
3.5	0.00	0.00	0.01	0.02	0.02	0.09	0.27	0.43	0.63	0.67	0.66
4.0		0.00	0.00	0.00	0.00	0.00	0.08	0.23	0.39	0.51	0.51
4.5			0.00	0.00	0.00	0.00	0.00	0.11	0.23	0.30	0.33
5.0			0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.15	0.13
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.02

TUF P99: Coll., Dir: 210˚, Wind 20 m/s, Cur 0.7 m/s

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.71	0.70	0.70	0.68	0.67	0.66	0.63	0.63	0.62	0.62	0.61
3.0	0.76	0.74	0.74	0.71	0.70	0.68	0.66	0.63	0.63	0.62	0.62
3.5	0.83	0.80	0.79	0.76	0.73	0.70	0.67	0.66	0.63	0.63	0.62
4.0		0.87	0.86	0.82	0.78	0.74	0.70	0.67	0.66	0.63	0.63
4.5			0.94	0.90	0.84	0.78	0.72	0.69	0.67	0.66	0.65
5.0			0.98	0.96	0.92	0.84	0.76	0.71	0.68	0.67	0.66
5.5			0.99	0.99	0.98	0.90	0.80	0.74	0.70	0.68	0.67

PoS: Non-coll., Dir: 210˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 150˚, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.24	0.22	0.21	0.28	0.36	0.56					
3.0	0.00	0.02	0.04	0.09	0.13	0.24	0.54				
3.5	0.00	0.00	0.01	0.02	0.00	0.05	0.26	0.44			
4.0		0.00	0.00	0.00	0.00	0.00	0.05	0.24	0.43		
4.5			0.00	0.00	0.00	0.00	0.00	0.10	0.21	0.28	0.34
5.0			0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.15	0.13
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.02

TUF P99: Non-coll., Dir: 210˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 150˚, 0.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.70	0.69	0.68	0.67	0.66	0.64					
3.0	0.75	0.73	0.72	0.70	0.68	0.66	0.64				
3.5	0.81	0.78	0.77	0.74	0.72	0.69	0.66	0.64			
4.0		0.86	0.84	0.80	0.76	0.72	0.68	0.66	0.64		
4.5			0.93	0.88	0.83	0.76	0.71	0.67	0.65	0.64	0.64
5.0			0.98	0.96	0.91	0.82	0.74	0.70	0.67	0.65	0.64
5.5			0.99	0.99	0.97	0.89	0.78	0.72	0.69	0.67	0.66

PoS: Non-coll., Dir: 210˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 150˚, 1.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.11	0.19	0.15	0.21	0.27	0.41					
3.0	0.00	0.02	0.04	0.07	0.11	0.20	0.42				
3.5	0.00	0.00	0.00	0.00	0.00	0.07	0.21	0.38			
4.0		0.00	0.00	0.00	0.00	0.00	0.04	0.23	0.37		
4.5			0.00	0.00	0.00	0.00	0.00	0.07	0.17	0.24	0.25
5.0			0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.08	0.13
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.00

TUF P99: Non-coll., Dir: 210˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 150˚, 1.5 m

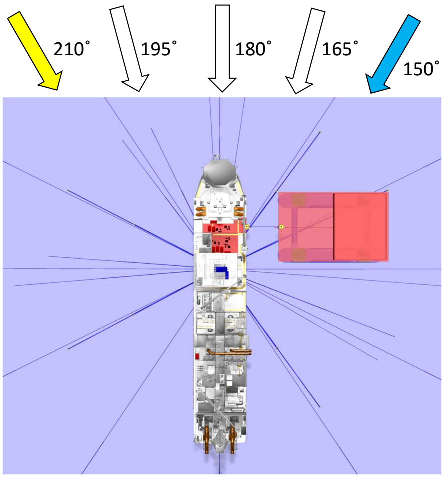
Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.71	0.69	0.69	0.67	0.66	0.65					
3.0	0.75	0.73	0.73	0.71	0.69	0.67	0.65				
3.5	0.82	0.79	0.78	0.75	0.72	0.69	0.67	0.65			
4.0		0.86	0.85	0.81	0.77	0.72	0.69	0.66	0.65		
4.5			0.93	0.89	0.83	0.77	0.72	0.68	0.66	0.65	0.64
5.0			0.98	0.96	0.92	0.82	0.75	0.70	0.67	0.66	0.65
5.5			0.99	0.99	0.97	0.89	0.79	0.73	0.69	0.67	0.66

PoS: Non-coll., Dir: 210˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 150˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.02	0.03	0.03	0.04	0.04	0.06					
3.0	0.00	0.02	0.01	0.00	0.01	0.02	0.07				
3.5	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.07			
4.0		0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.03		
4.5			0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.00	0.04
5.0			0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.03
5.5			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00

TUF P99: Non-coll., Dir: 210˚, Wind 20 m/s, Cur 0.7 m/s, Sec: 150˚, 2.5 m

Hs\Tp	6	7	8	9	10	11	12	13	14	15	16
2.5	0.72	0.71	0.71	0.69	0.68	0.67					
3.0	0.77	0.74	0.74	0.72	0.70	0.68	0.67				
3.5	0.83	0.80	0.79	0.76	0.73	0.70	0.69	0.67			
4.0		0.88	0.87	0.83	0.78	0.74	0.70	0.68	0.67		
4.5			0.95	0.91	0.85	0.78	0.73	0.69	0.67	0.67	0.66
5.0			0.99	0.97	0.93	0.84	0.76	0.71	0.69	0.67	0.67
5.5			1.00	0.99	0.98	0.91	0.81	0.74	0.70	0.69	0.67



Results are shown for the reduced H_s–T_p matrix under collinear conditions (top), and non-collinear conditions with a secondary wave H_s of 0.5 m, 1.5 m, 2.5 m (below). Left panels show the probability of success per bin; right panels show the P99 TUF.

Go to Section Simulation Results.

Appendices

A Terminology

This appendix provides detailed definitions of the operational, environmental, and hydrodynamic terms used throughout this report. These definitions are intended to support a consistent interpretation of the numerical framework and the risk-based results presented.

Operability and Risk Metrics

Activity-Specific Operating Guidelines (ASOG)
A decision-support document defining activity-specific limits, watch circles, and escalation triggers. It serves as the primary guidance for the crew to conduct operations safely under specific environmental and system constraints.

Adaptive Sampling (Fail-Fast Loop)
A computational strategy for optimising simulation effort. It involves executing an initial screening batch of seeds; if the majority of these exceed the operational limit, the condition is flagged as non-operable, and the remaining simulations are terminated early.

Mode A (Forecast-Driven Operability)
The preferred operational mode in which time-domain simulations are run against a specific forecast time window for the planned operation, including ensemble forecast uncertainty. The output is a forecast-specific PoS timeline tailored to the planned heading, operational configuration, and sea-state evolution. (See Section 3.1.1.)

Mode B (Hindcast-Driven Database)
A fallback operational mode used during early planning or where on-the-fly simulation capacity is not available during execution. Simulations are performed on a representative set of sea-state matrices derived from site hindcast statistics. The output is a generic operability envelope used as a decision-support database within the ASOG. (See Section 3.1.2.)

Go/No-Go Decision
A binary operational decision based on whether the predicted risk (expressed through PoS or response quantiles) remains within the accepted threshold for the planned task.

Operability
The capacity to execute a planned operation within defined safety criteria for a specified duration and environmental state. It is expressed through response levels or the Probability of Success (PoS).

Operability Gradient Profile
The rate at which PoS degrades along the H_s axis at a fixed T_p, heading, and environmental forcing. The profile takes two characteristic shapes: a *gradual* gradient, in which PoS declines slowly over a wide H_s span (of the order of 1–2 m between the median and high-quantile thresholds); and a *steep* gradient, in which PoS declines rapidly over a narrow H_s span (less than approximately 1 m). The steepness depends not only on H_s but also on heading and on the spectral composition of the sea state. The gradient profile governs both the choice of statistical metric for acceptance criteria (a non-conservative metric is most consequential on a steep gradient) and the sensitivity of the operability decision to forecast error in H_s. (See Sections 5.1 and 5.2.)

Operational Limit / Criterion

A response threshold (e.g., maximum relative motion, acceleration, force, or DP capability) beyond which an operation is deemed unsafe. An exceedance of any single criterion typically results in an operational ”No-Go”.

Probability of Success (PoS)

The statistical likelihood that all relevant criteria remain within limits over the evaluation duration. In this framework, it is estimated as the fraction of independent simulation realisations (seeds) that do not violate any limit state.

Probability of Exceedance (p_{exc})

The likelihood that one or more criteria are breached during the evaluation duration. Numerically, $p_{\text{exc}} = 1 - \text{PoS}$.

Quantile / Percentile (P_{50}, P_{90}, P_{99})

A response level derived from the short-term maxima distribution. For instance, P_{50} is the median of the maxima, while P_{99} is the response value that is not exceeded in 99% of the observed cases for a given sea state.

Short-Term Maxima Distribution

The distribution of maximum responses obtained from multiple stochastic realisations over a set duration. This distribution is typically right-skewed, meaning extreme maxima occur with low probability but are critical for risk-critical decision-making.

Most Probable Maximum (MPM)

The mode (most likely value) of the short-term maxima distribution. It represents a typical maximum encounter rather than a conservative upper bound.

Expected Maximum (E_{max})

The mean of the extreme value distribution. Like MPM, it is a measure of the typical maximum and is generally lower than high-quantile targets such as P_{99}.

Stochastic Realisation (Seed)

A single time-domain simulation run for the same sea-state parameters but with a different random phase realisation. Multiple seeds are required to robustly estimate the distribution of short-term maxima and derived risk metrics.

Simulation Duration

The time interval (e.g., 1–3 hours) over which the operation is assessed. The maximum response over this duration is treated as a random variable forming the basis for statistical quantiles.

Transition Zone

The specific, targeted band of environmental conditions (e.g., wave heights) where a vessel's capability is uncertain, transitioning from a clearly safe zone to a clearly unsafe zone.

Wave and Environmental Terminology

α-factor (Forecast Safety Factor)

A multiplicative factor applied to weather parameters (typically H_s) to account for forecast uncertainty. For sensitive operations, spectral perturbations or component-wise factors for wind sea and swell may be more informative than a single factor applied to the total sea.

Capacity-Limited Regime

An operational regime governed by global station-keeping force generation. Limit exceedance is typically driven by thruster saturation under high mean drift forces in severe, often collinear, weather conditions.

Collinear Conditions
Environmental scenarios where waves, wind, and current are assumed to propagate in the same direction, typically maximising additive mean loads.

Non-Collinear Conditions
Multi-directional scenarios where external loads do not align, such as crossing swells or wind acting at an angle to the primary wave system.

Precision-Limited Regime
A regime governed by station-keeping accuracy and relative-motion tolerances. Limit exceedance is typically driven by wave-induced vessel oscillations or control dynamics rather than a lack of power.

Multi-modal Sea State
A sea state characterised by multiple distinct energy peaks in the wave spectrum, typically associated with multiple wave systems (e.g., wind sea plus one or more swells) with different periods and directions.

Secondary Wave System
The non-dominant wave component in a multi-modal sea (e.g., swell). Secondary systems can significantly affect operability if they fall within sensitive response bands or introduce directionally separated loads.

Wave Spectrum (Directional)
A frequency-domain description of wave energy distribution. Directional spectra distribute energy across both frequency and direction, which is essential when a vessel's response is direction-sensitive.

Vessel Hydrodynamics and DP Terminology

Azimuth Strategy / Thruster Allocation
The control logic that distributes commanded forces and moments to individual thrusters. Strategies include ”free-rotating” (maximising available force) or ”biased/star” (improving responsiveness by reducing rotation).

Free-Rotating Mode
An allocation mode where azimuth thrusters are allowed to rotate freely 360 degrees to align with the demanded force direction. This framework recommends explicitly modelling mechanical rotation delays, ramp-up times, and interaction effects associated with this mode.

Rotational Hunting
The continuous adjustment of free-rotating thruster azimuths under indifferent or stochastic rotational loading, particularly when the mean environmental moment is small relative to the wave-induced and turbulent components. Hunting consumes thrust capacity that would otherwise be available for surge and sway control and is most pronounced in symmetric loading conditions (e.g., the drilling rig at 0°/180° headings, Section 5.1).

DP-Stabilisation Mechanism
The phenomenon, observed in both case studies, whereby a steady environmental load (typically a steady current aligned with the drift demand) provides a constant directional bias for the free-rotating thruster allocation, reducing rotational hunting and improving station-keeping accuracy. The mechanism explains why a higher current may improve PoS in marginal cells of the floatel case despite increasing the steady drift load. (See Sections 5.1 and 5.2.)

Low-Frequency Motions
Slow oscillations driven by second-order wave drift, wind gusts, and DP control dynamics. These are critical for station-keeping and offset-related operational limits.

Wave-Frequency (First-Order) Motions
Motions occurring at wave-encounter frequencies, commonly represented by linear Response Amplitude Operators (RAOs).

Relative Motion
The motion of one point or body relative to another (e.g., a floatel relative to an FPSO). Relative motions are often the governing metric for gangway-to-moving-target connections.

RAO (Response Amplitude Operator)
A linear transfer function relating wave input to wave-frequency vessel response as a function of wave period and direction.

Surrogate Model
A computationally efficient predictive model trained on high-fidelity simulation results to provide rapid, on-the-fly estimates of operability for specific weather forecast scenarios.

Thruster Utilisation Factor (TUF)
A dimensionless measure expressing the demanded thrust relative to the available thrust capacity. High TUF values indicate low remaining station-keeping margins.

Viscous Damping
Damping due to fluid viscosity (e.g., bilge effects or flow separation) is not captured by potential theory. Calibrating these coefficients against model tests is critical for predicting accurate resonant responses, particularly in roll.

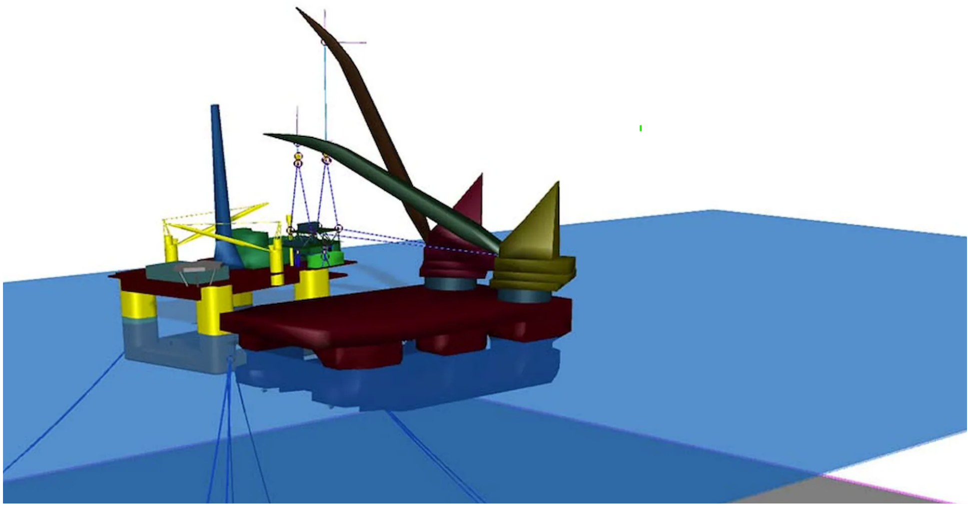
B SIMA

Overview. SIMA (Simulation Workbench for Marine Applications) is a simulation and analysis workbench developed by SINTEF Ocean. It provides a graphical environment for modelling, executing, and post-processing time-domain simulations of marine operations and floating systems. SIMA integrates the SIMO and RIFLEX physics solvers, enabling fully coupled analysis of vessels, mooring systems, risers, umbilicals, and dynamic-positioning systems within a single workflow.

Main capabilities.

- **Modelling environment:** graphical editors for vessels, mooring lines, fenders, cranes, winches, and coupling elements; supported import of standard hydrodynamic data formats (e.g., WAMIT, WADAM).
- **Time-domain solvers:** SIMO for non-linear motions and station-keeping of multibody systems; RIFLEX for finite-element analysis of mooring lines, risers, and umbilicals.
- **Supported analyses:** static analysis, non-linear time-domain analysis, fully coupled vessel-mooring-riser analysis, eigenvalue analysis, and vortex-induced vibration (VIV) analysis.
- **Post-processor:** chained data manipulations and filters, statistical post-processing, spectral and fatigue analysis, and visualisation of time-series, distributions, and 3D motions.
- **Workflow engine:** hierarchical workflows for parametric studies and large simulation campaigns; supports interaction with external programs and automated execution of multiple simulations with parameter sweeps.
- **Report generation:** automated assembly of analysis results into structured technical reports with text, formulas, tables, and plots.

Typical applications. Stationkeeping with mooring systems and dynamic positioning; lifting of topsides, modules, and subsea equipment; float-over installation; tandem and side-by-side offloading; transportation and towing; global response analysis of risers and umbilicals; up-ending of SPAR platforms; crane operations; and offshore wind turbine analysis.



Resources. The SIMA workbench is developed and maintained by SINTEF Ocean. Further information, including the user guide, factsheet, and software documentation, is available at:

- SIMA factsheet: `https://simasite.azurewebsites.net/index.html`
- SIMA user guide: `https://sima.sintef.no/doc/4.8.0/userguide/index.html`
- RIFLEX user and theory manual: `https://sima.sintef.no/doc/4.8.0/riflex/index.html`

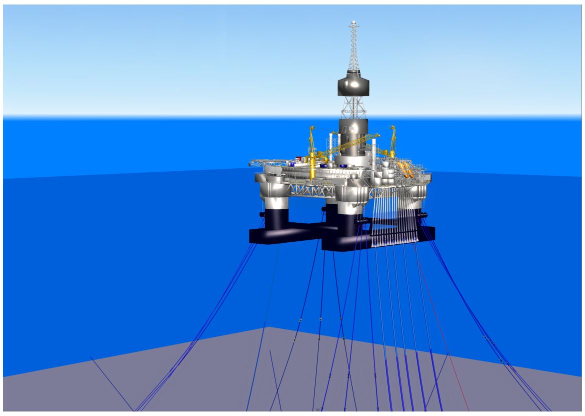
C SIMO

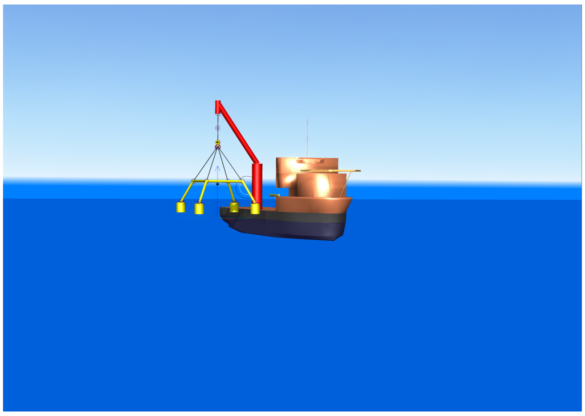
Overview. SIMO (Simulation of Marine Operations) is a time-domain simulation program for the study of motions and station-keeping of multibody systems, developed and maintained by SINTEF Ocean. SIMO is the physics solver underlying station-keeping analyses within the SIMA workbench (Appendix B). It supports non-linear effects in the wave-frequency range and provides flexible modelling of station-keeping forces, connecting force mechanisms (anchor lines, ropes, thrusters, fenders, bumpers, and docking guide piles), and dynamic-positioning systems.

Main capabilities.

- **Environment modelling:** regular and irregular waves with several model spectra; constant and gust wind; current with depth-varying speed and direction.
- **Body types:** arbitrary number of bodies, modelled as large-volume bodies in 6-DOF, large-volume bodies with separated wave-frequency (RAO) and low-frequency response, or small-volume bodies in 3-DOF.
- **Body-force models:** hydrostatic stiffness, linear and quadratic damping, wind and current forces (linear and quadratic), first-order wave excitation forces, frequency-dependent added mass and damping (modelled as retardation functions), slow-drift forces (Newman approximation), full second-order wave forces (QTF), wave-drift damping forces, ringing forces, slender-element forces (Morison model), and small-body hydrodynamic forces including slamming.
- **Hydrodynamic input:** import of frequency-domain hydrodynamic coefficients (added mass, damping, first- and second-order wave excitation) from external solvers such as WAMIT and WADAM.
- **Positioning systems:** mooring lines and hawsers via general tension-elongation relationships, anchor lines composed of segments, branches, buoys and clump-weights; thrusters with constant force or controlled by a dynamic-positioning module (Kalman filtering or PID regulation).
- **Mechanical coupling:** coupling between bodies through tension-elongation relationships, with optional hysteresis; contact elements modelled as fenders, bumpers, guide posts, and docking cones.

Typical applications. Station-keeping of mono-hull vessels, semi-submersibles, tension-leg platforms, and SPAR-buoys; turret-moored, spread-moored, dynamically positioned, and tension-leg systems; offloading operations (tandem and side-by-side); offshore crane operations; subsea installations; jacket and deck installation and removal (float-over); installation and up-ending of TLP, GBS, and SPAR platforms.





Resources. The SIMO solver is developed and maintained by SINTEF Ocean. The user manual and supporting documentation are available at:

- SIMO user manual: `https://sima.sintef.no/doc/4.8.0/userguide/index.html`
- SIMA factsheet: `https://simasite.azurewebsites.net/index.html`

D Gangway response definitions and conventions

For the assessment of gangway operability, an additional set of responses and acceptance criteria are required. General terminology is summarised in Appendix A. In the expressions below, $\eta_1, \dots, \eta_6$ denote the vessel 6-DOF motions (surge, sway, heave, roll, pitch, yaw), and the subscript $(\cdot)_p$ indicates that the corresponding translatory motion is evaluated at the gangway pedestal position.

The following gangway response components are typically of interest:

- **Telescoping (axial motion), η_L:** positive values indicate elongation:

$$\eta_L = \eta_{1p} \cos(\bar{\psi}) \cos(\bar{\theta}) - \eta_{2p} \sin(\bar{\psi}) \cos(\bar{\theta}) - \eta_{3p} \sin(\bar{\theta}), \tag{5}$$

  where $\bar{\psi}$ is the mean slew angle and $\bar{\theta}$ is the mean boom (luffing) angle.

- **Luffing (vertical angular motion), η_θ:** rotation in the vertical plane of the gangway centreplane (angle relative to BL):

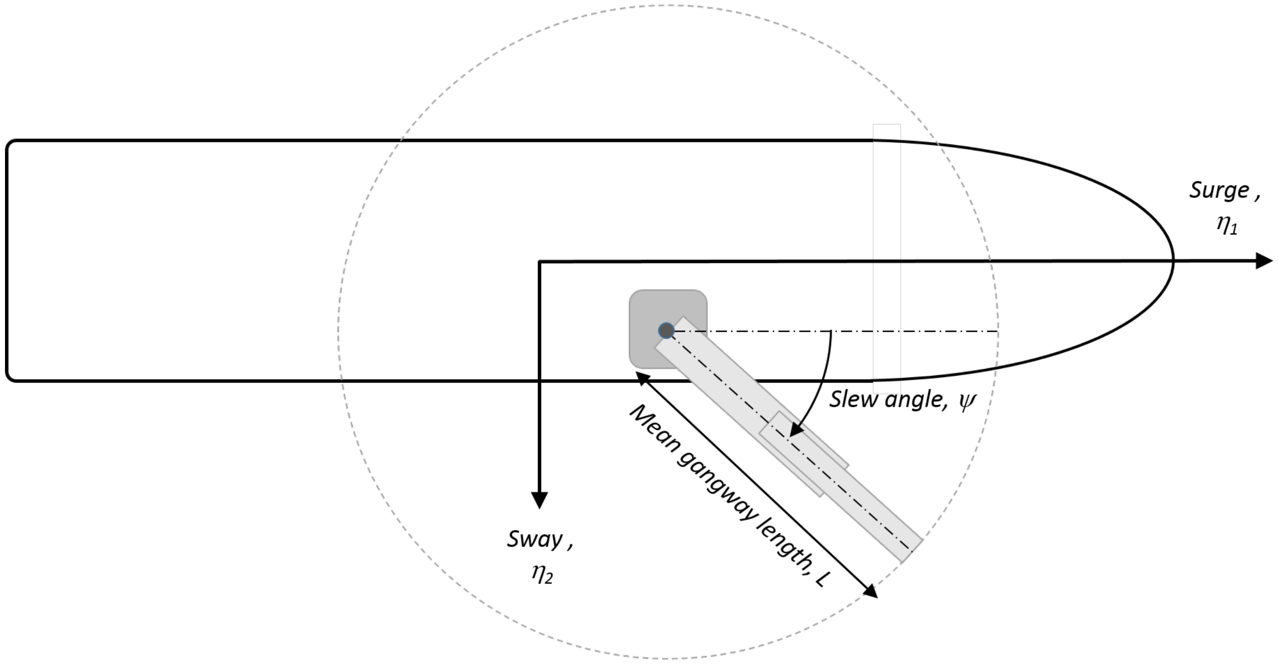
$$\eta_\theta = -\frac{\eta_{1p}}{L} \cos(\bar{\psi}) \sin(\bar{\theta}) + \frac{\eta_{2p}}{L} \sin(\bar{\psi}) \sin(\bar{\theta}) - \frac{\eta_{3p}}{L} \cos(\bar{\theta}) - \eta_4 \sin(\bar{\psi}) - \eta_5 \cos(\bar{\psi}). \tag{6}$$

- **Slewing (horizontal angular motion), η_ψ:** rotation about the vertical axis (angle relative to CL):

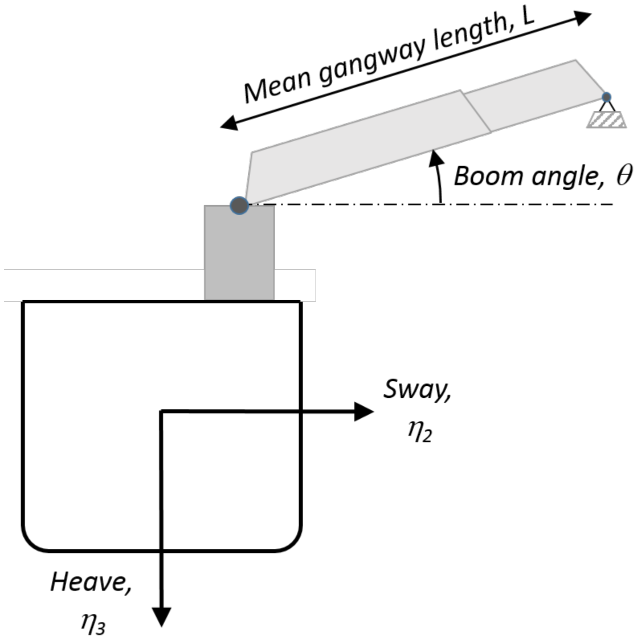
$$\eta_\psi = -\frac{\eta_{1p}}{L \cos(\bar{\theta})} \sin(\bar{\psi}) - \frac{\eta_{2p}}{L \cos(\bar{\theta})} \cos(\bar{\psi}) + \eta_6. \tag{7}$$

The following definitions apply (see Figure 9):

- **Mean gangway length, L:** mean length in the operating position; telescoping occurs about this position.
- **Pedestal (gangway base) position:** ship location about which the gangway rotates in vertical and horizontal planes.
- **Slew angle, ψ:** gangway heading relative to the ship centreline (CL). Zero slew angle corresponds to the gangway aligned with the vessel centreline.
- **Boom/luffing angle, θ:** gangway elevation angle relative to the horizontal. A positive boom angle means the gangway points upwards; η_θ is the corresponding motion.



(a) Top view



(b) Cross-section view

Figure 9: Definition of gangway parameters.