OPTIMIZING THE RULES

SENSITIVITY STUDIES

TO AVOID UNNECESSARY AND COMPLEX COMPUTATIONS FOR FOWT DESIGN

OptiFOWT

The international standards for Floating Offshore Wind Turbine (FOWT) are calling for a high number of Design Load Cases (DLC). However, they often don't describe the FOWT element to be targeted. Furthermore, to cover wind turbulence, tower and blade vibrations, and the dynamic response of mooring lines, the most sophisticated models are necessary, requiring a huge amount of processing time.

Designers are left with two choices:

• Running thousands of cases with a high-fidelity model, making the process both heavy and costly.

• Simplifying the model or reducing the number of load cases for the preliminary design loops, without the necessary explanations.

Bureau Veritas' joint industry project (JIP) proposes to launch thorough investigations, based on sensitivity studies, to identify critical DLC for different FOWT floater and mooring arrangements. Its conclusions will help contextualize model simplifications while minimizing the impact on results.

OBJECTIVE

The proposed JIP will:

• Optimize the number of calculations by identifying useless and non-dimensioning DLC.

• Determine model simplifications that can be implemented according to the design objective.

To achieve this, the sensitivity study will run the required DLC for several FOWT floater and mooring arrangements, focusing only on extreme values (no planned fatigue calculations). The results of each family of floater and mooring arrangements will be compared to inform an appropriate design methodology.

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SCOPE OF WORK

WORK PACKAGE (WP) I: COLLECTION OF INPUT DATA AND VALIDATION OF HYPOTHESES

Designers will provide data on the floater, mooring and associated environments. For the purpose of this study, BV will assume a single 15 MW generic turbine for each floater and adapt the controller accordingly. However, if specified and requested by designers, the turbine setup associated to their floater could be taken into account in the calculation. The models will be built on a single tool (Opera) and validated in collaboration with designers.

This will be followed by collective feedback from BV and its collaborators on the number of environmental cases per DLC. The idea is to set a selected number of critical metocean cases per DLC, in order to test only dimensioning environmental conditions. Each FOWT model will be analyzed in relation to the environment it has been designed for.

All participants will decide the desired design output for station keeping systems, nautical performances, structural design and rotor nacelle assembly integration. This includes mooring lines tensions, floater motions, pressures, etc.

WP II: IDENTIFICATION OF CRITICAL DLC

For these calculations, the model will not be simplified (except for the floater, which is considered rigid). All environmental cases identified in WP I will be run to obtain a comprehensive simulation database and identify the typical DLC for the design output defined in WP I.

WP III: ACCEPTABLE MODEL SIMPLIFICATIONS

This phase will focus on critical load cases. Sensitivity analysis will be performed for model simplifications such as mooring lines modelization, blades and tower flexibility or wind turbulences. The objective is to:

- Identify the model assumptions that maintain a reliable level of precision according to the given design output.

- Find the best compromise between model accuracy and required CPU time.

WP IV: STATISTICAL CONVERGENCE

Some technical standards requires six seeds to be run for each simulation case. This is very different from the offshore oil and gas practice, where 20 to 30 seeds are used for governing load cases.

BV will examine the variability of results to determine the minimum number of seeds to reach statistical convergence.

WP V: GUIDANCE NOTE

Based on the findings of WP II, III and IV, BV will take the lead in defining recommendations for reliable design methodologies for FOWT.

DELIVERABLES

Detailed reports containing findings from each WP and a separate report outlining the main conclusions and recommendations.

All design data (inputs and outputs) will be anonymous to ensure the confidentiality of each concept.

The design outputs will, however, be communicated to each designer in a database for their own design.

BASED ON THE FINDINGS OF SENSITIVITY STUDIES DONE IN THIS JIP, BV WILL MAKE RECOMMENDATIONS FOR RELIABLE DESIGN METHODOLOGIES FOR FOWT.

SCHEDULE

The JIP will start during the third quarter of 2023, for a duration of three years and with the present minimum budget.

PARTICIPATION FEES

Tentative participation fees:

- Operators: €75,000 payable over two financial years.

- Others: €50,000 payable over two financial years.

Participants will initially have to commit to a fee of €500,000 for the JIP. This amount will cover the entire proposal in this flyer for up to eight test cases. Any extra funding will allow for more models, load cases and sensitivities according to sponsors' requirements.

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TOOLS AND EXPERTISE

- **Research projects using Opera:** JIPs OC6 and Dionysos, European Project Fibergy.

- **FOWT Projects reviewed by BV:** PGL, Eolmed, EREBUS, BADA.

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