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GOW03+04 Offshore Substation Assessment of Ship collision friendliness Preliminary design

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Change Log

Change log			
Revision	**Date**	**Initials**	**Description**
A	23-02-2019	XLAOM	First edition for BSH 1st release

1 Introduction

1.1 Definitions

In this document, the following definitions apply:

GOW03+04 refers to the Gode Wind 03 + 04 offshore wind farm projects.

1.1.1 List of abbreviations

BSH	Bundesamt für Seeschifffahrt und Hydrographie
LAT	Lowest Astronomic Tide
OSS	Offshore Substation
WTG	Wind Turbine Generator

1.2 Project description

Ørsted is developing the Gode Wind 03+04 Offshore Wind Farm (GOW03+04) located in the DolWin grid cluster in the German bight, within the German Exclusive Economic Zone. The GOW03+04 offshore wind farm is located nearby the Gode Wind 01 and 02 (GOW01 and GOW02 respectively) offshore windfarms with very similar environmental and geotechnical conditions.
The GOW03+04 and neighboring windfarms GOW01 and GOW02 is outlined in the figure 1-1 below.

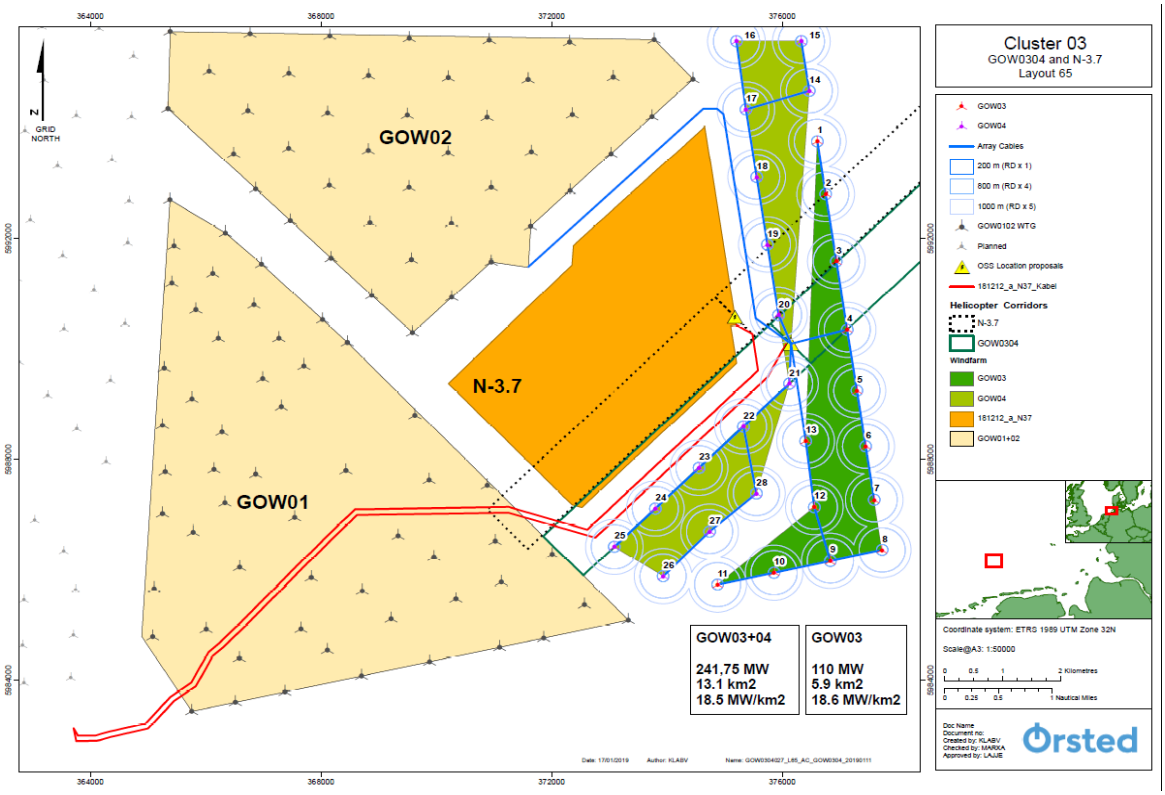


Figure 1-1: Location of the Gode Wind 03+04 Offshore Wind Farm.

In relation to the wind farm, an offshore substation (OSS) shall be installed. The OSS shall consist of a topside installed on a substructure. A four (4) legged bottom fixed steel jacket is the base case. Optionally the substructure may consist of a monopile and transition piece.
The position of the OSS is planned to be in the center of the wind farm. The water depth in the area is approximately -31m LAT.
The initial design basis for the substructure is presented in [Ref. 2] and a preliminary design is presented in [Ref. 3].

This document assesses on a comparative basis the compliance of the OSS preliminary substructure design with the BSH requirements for ship collision friendliness design.

The document is prepared for the 1st BSH release.

2 Design regulations and codes

Refences to design regulations and codes are defined in [Ref. 4] and [Ref. 2].

The BSH code stating the requirement for ship collision friendliness design is:

[1] BSH Standard 7005: Standard Design, Minimum requirements concerning the constructive design of offshore structures within the Exclusive Economic Zone (EEZ). English edition: 28 July 2015 – Corrected 1 December 2015 (German edition; 28 July 2015 – Corrected 1 December 2015)

3 References

Ørsted document reference number and revision are listed after the title in brackets (number_revision).

[2] GOW03+04 Design Basis for Substructure (00587961_C)
[3] GOW03+04 Offshore Wind Farm Gode Wind 03+04 - Offshore Substation (00804118_C)
[4] GOW03 +04 Norm Hierarchy (00587968_C)
[5] GOW03+04 Comparison of soil conditions at OSS position at GOW0304 and GOW02 (00980770_A)
[6] Memo on GOW0304 ULS loads (01022390_B)
[7] Analysis of Vessel Friendliness of Substructure Jacket for OSS OWP Gode Wind 01, CA_P40_GOW01-OSS-01 (1736626_A)
[8] Analysis of Vessel Friendliness of Substructure Jacket for OSS OWP Gode Wind 02, CA_P40_GOW01-OSS-02 (1736645_A)
[9] Analysis of Vessel Friendliness of Substructure Monopile for WEP OWP GOW03+04, P156_ORSGOW0304_MP_DE_R01-1 (01569237_A)
[10] Analysis of Vessel Friendliness of Substructure Monopile for WEP OWP Borkum-Riffgrund II, CA_P65_BKR02-MP-04 (01569236_A)
[11] GOW03+04 Design Basis part C – Conceptual Design (00551517_E)

4 Preliminary design BSH 1st release

4.1 OSS Jacket substructure option

For the OSS jacket option, the preliminary design is based upon the jacket design of GOW01 and GOW02 OSS.

The water depth at the GOW03+04 offshore substation site is in the order of -31 m LAT. Comparing with the water depths at GOW01, -30.3m LAT, GOW02 -32.7m LAT the water depth for GOW03+04 is very comparable and range between the two reference sites.

Hence the jacket proposed for the GOW03+04 OSS site would be very similar when it comes to the seabed footprint, geometrical dimensions, jacket configuration and hydrodynamic loadings, marine growth, air/sea temperatures etc. Further the soil conditions at the GOW03+04 site are also like the GOW01 and GOW02 sites.

[Ref 2, 3, 4 and 5].

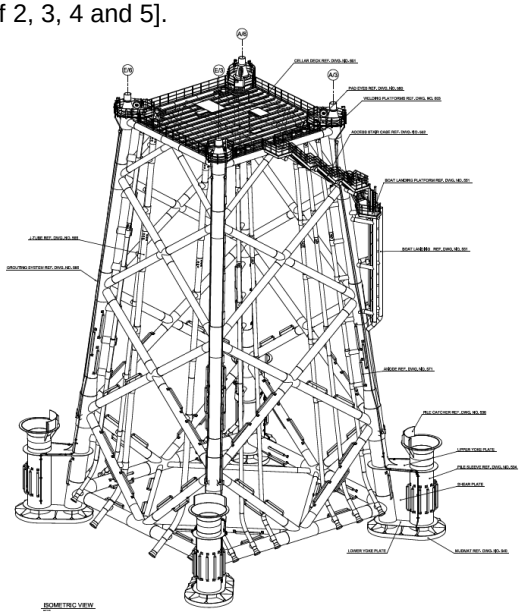


Figure 4-1: Principle layout of the jacket substructure

4.1.1 Ship collision friendliness

The similar vessel sizes for collision analysis are specified to GOW01, GOW02 as for GOW0304 (Tanker 75.000 DWT and containership 80.000 DWT). As the preliminary design for GOW0304 jacket and the environmental and soil conditions are very similar to the GOW01 and GOW02 jacket design and soil conditions, the ship collision friendliness studies of GOW01 and GOW02 can be applied to the GOW0304 preliminary jacket design and a similar outcome can be expected.

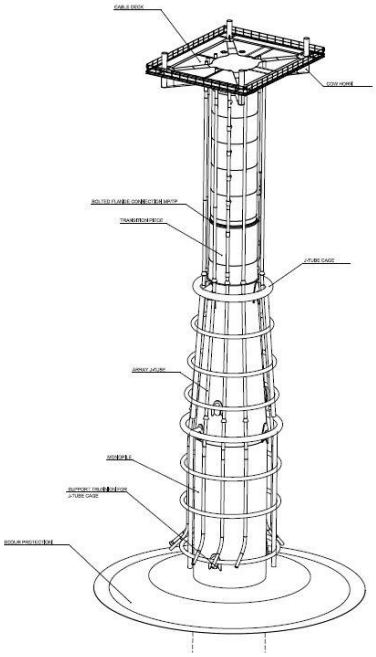
For both GOW01 and GOW02 the design has proven to comply with the requirements for ship collision friendliness and hence it can be expected also to be valid for the GOW0304 preliminary jacket design option.

[Ref. 2, 7, 8].

4.2 OSS Monopile substructure option

For the OSS monopile option the preliminary design is similar and based on the GOW0304 conceptual WTG substructure design.

The interface footprint towards the topside is envisaged to be in the rage of 15 m x 15m at elevation +26m LAT (+/- 3m). The top of the helideck is envisaged to be in elevation +46 m LAT (+/- 3m). The total height of the OSS above water (transition piece + topside) is shorter than the WTG transition piece, tower and turbine and the envisaged weight of the OSS topside is higher (2200mT compared to 480mT or 620mT) than the WTG transition piece, tower and turbine.
The outer diameter of the monopile at seabed elevation is envisaged to be in the order of 8.5m and the outer diameter at the top of the transition piece is expected in the order of 7m. I/J-tubes for array and export cables are envisaged on the outside of the monopile and transition piece. The embedment length is roughly estimated to be in the order of 35-40 meter. The lay-out with expected dimension and thicknesses are presented in figure 4-2.
[Ref. 2, 3, 5, 9 and 11].



Item	Expected Outer diameter (mm)	Expected thickness range (mm)
Transition piece (TP)	7000	60-150
Monopile (MP)	8500	60-130
Conical part	7000-to-8500	60-130
Cable deck profiles	n/a	16-50
Module Support Frame (MSF)	n/a	20-80
Boat landing primary bumpers	410-450	12-50
Boat landing secondary verticals	250-360	12-50
Boat landing supports	400-600	20-40
I/J-tubes	450-750	12-25

Figure 4-2: Principle layout, dimension and thicknesses of the monopile, transition piece and module support frame, external structures for I/J-tubes and sacrificial anodes. The boat landing and escape ways are not shown on the figure.

4.2.1 Ship collision friendliness

Since the monopile preliminary design for the GOW0304 OSS is based upon the WTG monopile concept design, the WTG ship collision friendliness study can be applied to the GOW0304 OSS monopile preliminary design and a similar outcome can be expected.
A ship collision proof has been carried out for the GOW0304 WTG monopile and transition piece concept design. The proof has confirmed to comply with requirements for ship collision friendliness and with a certain margin and rated “2”, see table 4-1.

		1	2	3	4
1	Katastrophal	4	5	6	7
2	Schwerwiegend	3	4	5	6
3	Beträchtlich	2	3	4	5
4	Unbedeutend	1	2	3	4
	Konsequenz/ Eintrittshäufigkeit	Äußerst selten	Selten	Gelegentlich	häufig

Table 4-1: Ship collision risk matrix for GOW0304 WTG monopile and transition piece [Ref. 9].

The OSS monopile preliminary design has external installed j-tubes and could be expected to have a negative effect on the collision result compared to the result of [Ref. 9]. For the ship collision analysis though, secondary structures like j-tubes are not part of the collision analysis and are therefore neglected here.

The OSS monopile preliminary design system differs to the system of the WTG in height and mass.
The OSS monopile system is shorter and with more mass than the WTG system. The effect of this is not possible to foresee and can have both positive or a negative effect.

The position of the OSS compared to the WTG's in the windfarm can be argued as more favourable as the OSS is positioned in the middle of the windfarm and thereby resulting in a lower likelihood of occurrence "Eintrittshäufigkeit".

The results of [Ref. 9] allow for a certain more negative consequence, "Beträchtlich" compared to "Unbedeutend" when likelihood of occurrence remains in the "Selten" class. The likelihood of occurrence for the OSS though, can with respect to a more favourable position than a WTG be argued classed more favourable "Äußerst selten" compared to "Selten" in the ship collision risk matrix, see table 4-1. This will leave room for a considerable higher consequence classification.
The GOW0304 monopile preliminary design option is therefore expected to comply with the requirements of ship collision friendliness, as an eventual negative consequence of the height and mass system differences compared to the WTG, can be either accommodated inside the available acceptance margin of the GOW0304 WTG result, or accommodated by classing a more favorable position of the OSS.
[Ref. 9, 10, 11].

5 Conclusion

An assessment for ship collision friendliness at the early design stage, BSH 1st release, is conducted on a comparative basis. The results are that both the jacket and the monopile preliminary design options for OSS substructure are expected to comply with the requirements for ship collision friendliness as regulated by the German authorities BSH.

In the design stage for BSH 2nd release, when the OSS substructure selection has taken place and the design is completed, the final design shall be proven in line with the BSH requirements for ship collision friendliness.

To apply a layer of contingency to this conclusion, a second opinion shall be obtained from a recognized expert on the matter subject. The expert shall validate the arguments and conclusions of this document. The expert shall issue a statement, based on a discussion and conclusion leading to his result concerning the ship collision friendliness of design for BSH 1st release for GOW0304 OSS foundation, jacket and mono pile / transition piece.