Base Load Power Hub (BLPH)

Decommissioning and Abandonment Philosophy

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.1.1 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.

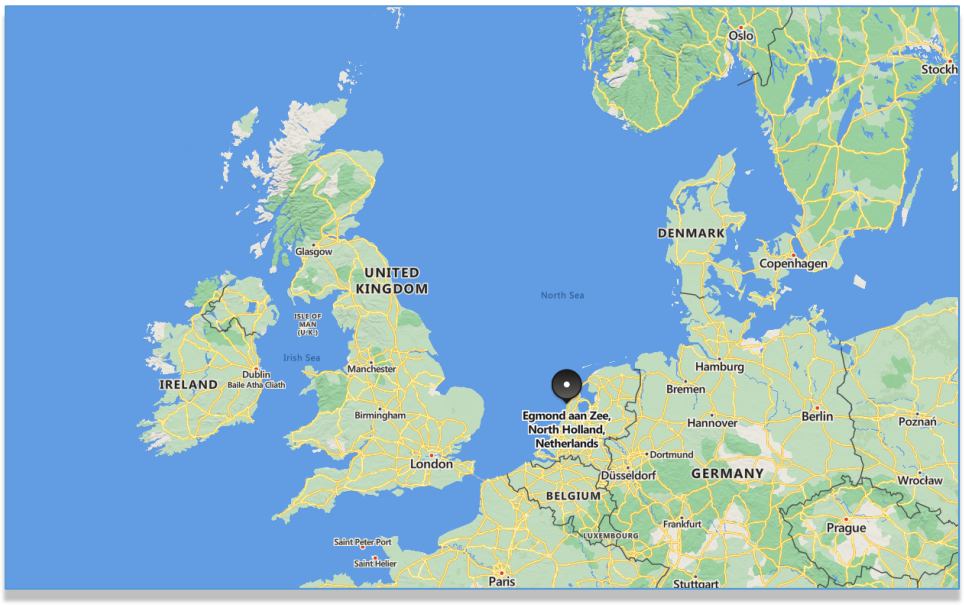


Figure 1.1 HOLLANDSE KUST NOORD WIND PARK Location Map

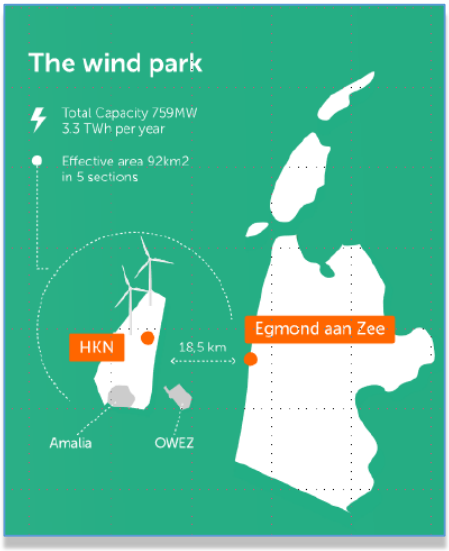


Figure 1.2 - Wind Park Details

The wind farm consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile located on coordinates E 590719.1, N 5841602.3 is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

1.1.2 Project Concept

All components included in the BLPH will be integrated onshore on a topsides and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

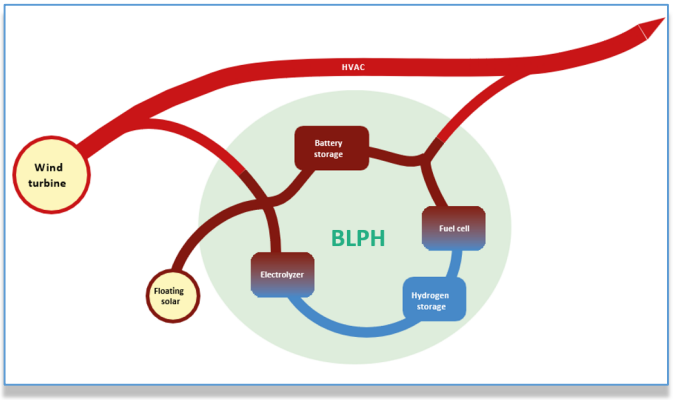


Figure 1.3 – BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining power output. This will be by discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.

The purpose of the BLPH s to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

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2 DOCUMENT SCOPE

The purpose of this document is to demonstrate the feasibility of the decommissioning of BLPH platform, including TP and caisson frame, with focus on structure removal and does not cover the Monopile.

It is to be noted that several activities could be carried out in different ways and with different technologies and operational sequences. This document will not detail all the studies that will have to be performed when the platform decommissioning project is launched.

The reference code for offshore platform removal is DNV-ST-N001 and DNV-RP-N102.

Description of the BLPH platform is given in the figure 2.1 and in the next section.

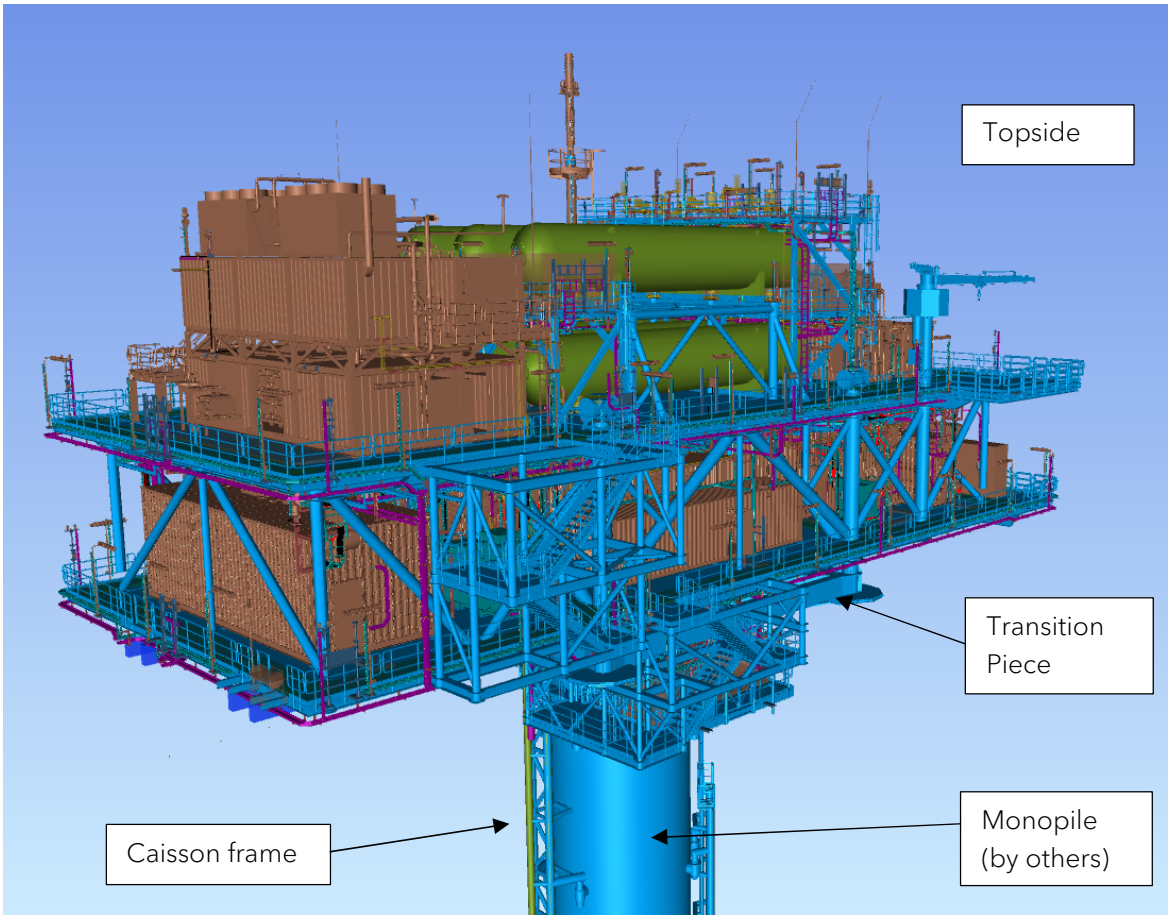


Figure 2.1 – BLPH Topside

3 REFERENCES

3.1 CODES AND STANDARDS

Doc. No.	Description
/1/ BS EN ISO 19900	General requirements for offshore structures - 2019
/2/ BS EN ISO 19901-1	Specific requirements for offshore structures - Part 1: Metocean design and operating considerations - 2015
/3/ BS EN ISO 19901-3	Specific requirements for offshore structures – Part 3: Topsides structure - 2014
/4/ BS EN ISO 19901-5	Specific requirements for offshore structures – Part 5: Weight Management - 2021
/5/ BS EN ISO 19901-6	Specific requirements for offshore structures – Part 6: Marine Operations – 2009
/6/ BS EN ISO 19902	Petroleum and natural gas industries - Fixed steel offshore structures – 2020
/7/ DNV-ST-N001	DNV - Marine operation and marine warranty - 2023
/8/ DNV-RP-N102	DNV-RP-N102 Marine operations during removal of offshore installations - Recommended practice. 2021
/9/ DNV-ST-0145	DNV, Offshore substations
/10/ DNV-RP-C205	DNV - Environmental conditions and environmental loads - September 2019, amended September 2021.
/11/ DNV-OS-C101	Design of offshore steel structures, general- LRFD method, 2021
/12/ DNV-ST-0126	Support structures for wind turbine, 2018

3.2 COMPANY SPECIFICATIONS

Doc. No.	Description
/13/ DEP 37.19.00.12	Gen - Offshore Topsides Structures
/14/ DEP 37.19.00.30	Gen - Fixed Steel Offshore Structures (Adoption of IOGP S-631-11, Amendments / Supplements to ISO 19902:2020).
/15/ DEP 37.81.10.19	Gen - Marine Operations Requirements – Loadout, Transportation and Installation of Offshore Structures (Amendments / Supplements to ISO 19901-6)
/16/ DEP 37.91.10.11	Mobile Mooring Systems (Amendments / Supplements to API RP 2SK, API RP 2SM AND API RP 2I)

3.3 PROJECT DOCUMENTS

Doc. No.	Description
/17/ 123A90-DDL-MD-RE-01006	Monthly Weight Report
/18/ 123A90-PML-MD-PRO-01002	Weight Control Procedure
/19/ 123A90-DDL-PP-DS-70070	Plot Plans
/20/ 123A90-DDL-ST-SP-90018	Structural Material Specification for Topside & TP
/21/ 123A90-DDL-ST-SP-90118	Structural Material Specification for Flange & Bolts
/22/ 123A90-DDL-ST-SP-90017	Structural Design Basis
/23/ 123A90-DDL-ST-RE-90000	In-service Analysis
/24/ 123A90-DDL-ST-RE-90005	BLPH Platform joint check Design Report
/25/ 123A90-DDL-ST-RE-90120	Structural verification against accidental loads
/26/ 123A90-DDL-ST-RE-90007	BLPH Platform - FE analysis
/27/ 123A90-DDL-TI-SP-99014	Specification for TP, Topside and Caissons Transportation and Installation
/28/ 123A90-DDL-ST-TN-90119	Evaluating ISO and DNV approaches

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4 DEFINITIONS AND ABBREVIATIONS

COMPANY or Client (CPY)	Crosswind
CONTRACTOR (CTR)	ROSETTI MARINO S.p.A.
PROJECT	HOLLANDSE KUST NOORD WIND PARK Project
BESS	BATTERY ENERGY STORAGE SYSTEM
BG	Box Girder
BLPH	Base Load Power Hub
CF	Caisson Frame
CL	Concentrated Load
CoG	Centre of Gravity
CTV	Crew Transfer Vessel
CW	CrossWind
DAF	Dynamic Amplification Factor
DNV	Det Norske Veritas
DP	Dynamic Positioning
El.	Elevation
EPCI	Engineering Procurement Construction and Installation
HAT	Highest Astronomical Tide
HKN	Hollandse Kust Noord
LAT	Lowest Astronomical Tide
LRFD	Load and Resistance Factor Design
MSL	Mean Sea Level
NTE	Not-to-Exceed
OD	Outside Diameter
PAU	Pre-Assembled Unit (H2 Vessels)
PG	Plate Girder
SHL	Static Hook Load
T&I	Transport & Installation
ToS	Top of Steel

TP	Transition Piece
UC	Unity Check
UDL	Uniformly Distributed Load
WTG	Wind Turbine Generator
W2W	Walk to Work

Table 4.1 - Definitions and Abbreviations

5 PLATFORM DESCRIPTION

5.1 LOCATION AND ORIENTATION

The wind farm consists of 69 x 11.5 MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile, located on coordinates E 590719.1, N 5841602.3, will be reserved for installing the platform accommodating the BLPH.

The above co-ordinates are referenced to ETRS89 / UTM zone 31N global coordinate system.

Platform (Topsides) North is rotated 25° towards west with reference to True North so that the monopile main access platform is orthogonal to the Topsides, as per Figure 5.1.

5.2 BLPH TOPSIDES LAYOUT BASIS

The BLPH comprises of two main deck levels with overall deck plan dimensions of 40 m x 16 m, excluding external walkways, laydown areas and stairs, with an overall deck height of 7 m between decks. There are currently 6 hydrogen storage vessels which lie horizontally, aligned North - South, within the PAU structure located above the upper deck.

The Topsides layout is shown in Figure 5.1.

The Topsides is unmanned and there is no helideck. Main access is via Ladder access to sea for small Crew Transfer Vessel (CTV). Walk to Work (W2W) access is an alternative to W2W platforms provided on the lower deck, via Ampelmann.

Deck elevations are:

- Target top of TP, El. + 22.310 m;
- Lower Deck, El. + 23.310 m ToS;
- Upper Deck, El. + 30.310 m ToS.

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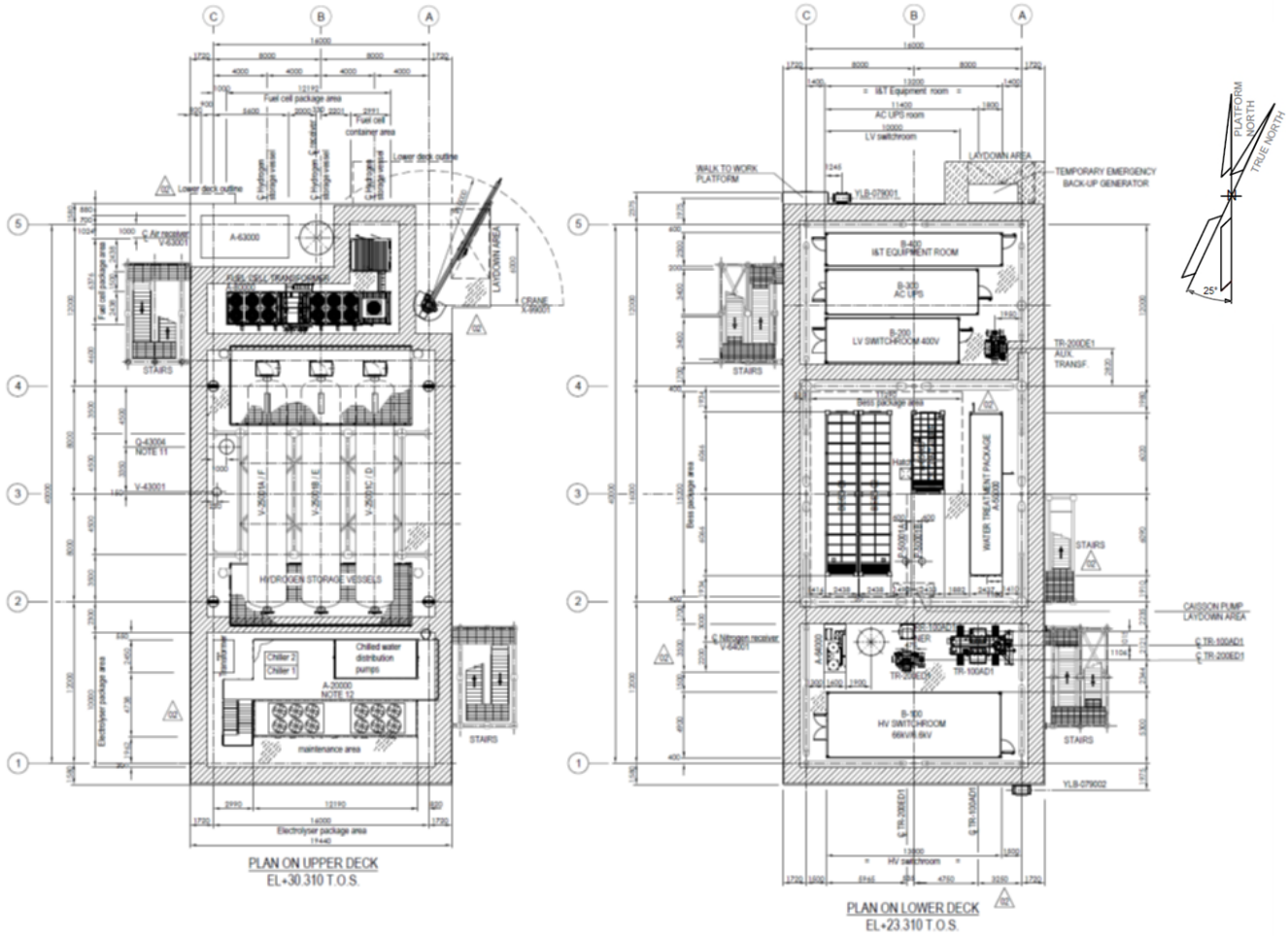


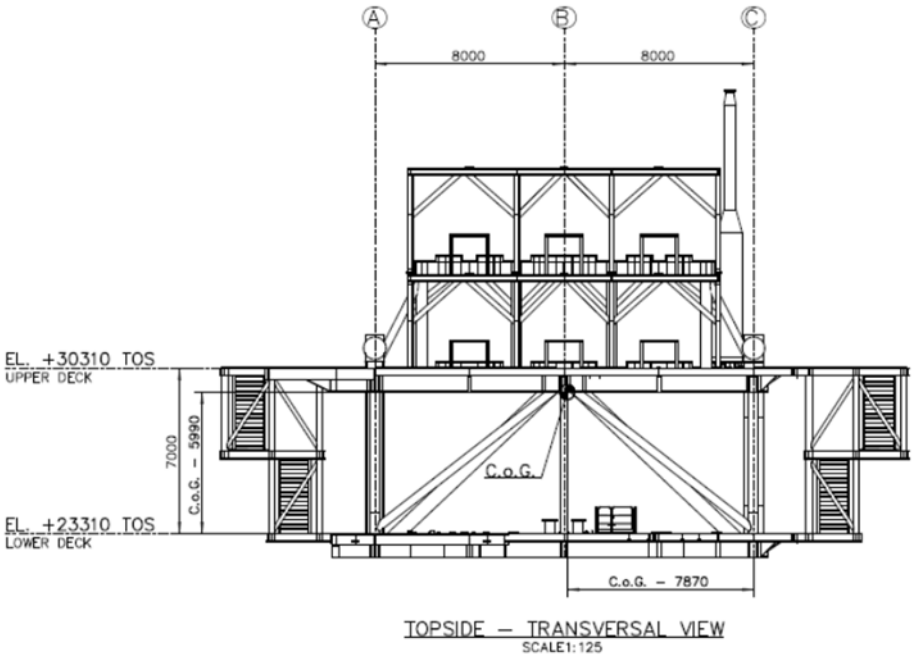
Figure 5.1 - Base Load Power Hub Plot Plan

5.2.1 COG position

According to the physical weighing operation carried out at Rosetti Marino Yard, Topside has the following CoG and weight position (from A1 and LAT) relevant to load-in condition:

- Weight 1695 ton (including 3% cont.);
- X_G = 19.87 m;
- Y_G = 7.87m;

BLPH load-in scheme with CoG position is shown in the next figure.



TOPSIDE – TRANSVERSAL VIEW
SCALE1:125

TOPSIDE WEIGHED WEIGHT = 1695 t
(3% CONTINGENCY INCLUDED)

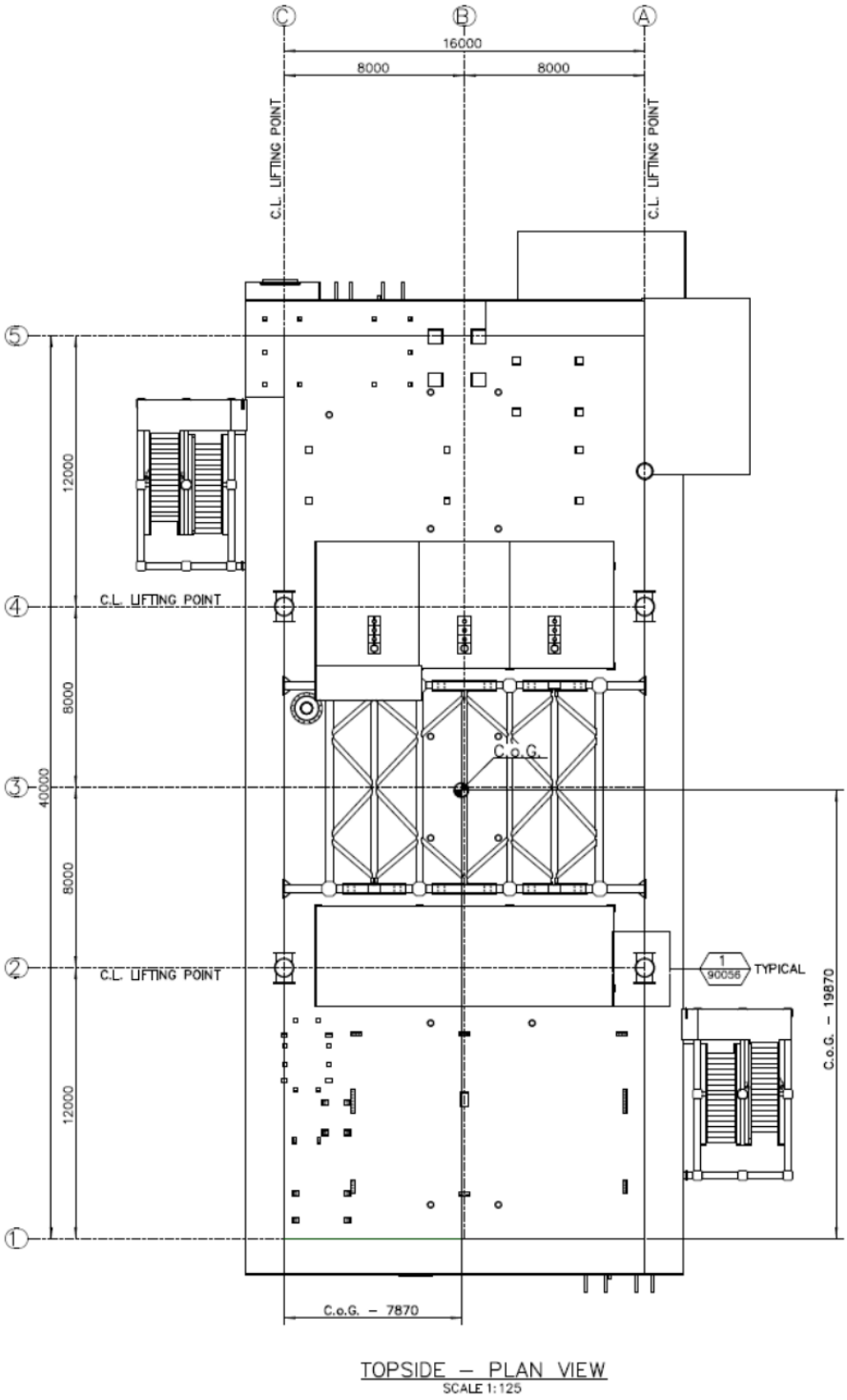


Figure 5.2 - Base Load Power Hub – CoG position

5.3 MONOPILE-TOPSIDES INTERFACE – TRANSITION PIECE

The interface level between Monopile and Topsides is at El.+17.050 m relative to LAT and reported in Figure 5.4. TP is composed by a central column with an outer diameter of 7m and Four (4) boxed girders with height ranging from 2.5 m to 1.4 m, oriented along the main diagonals of the TP.

TP main dimensions are 16m x 16m with height 7.9m

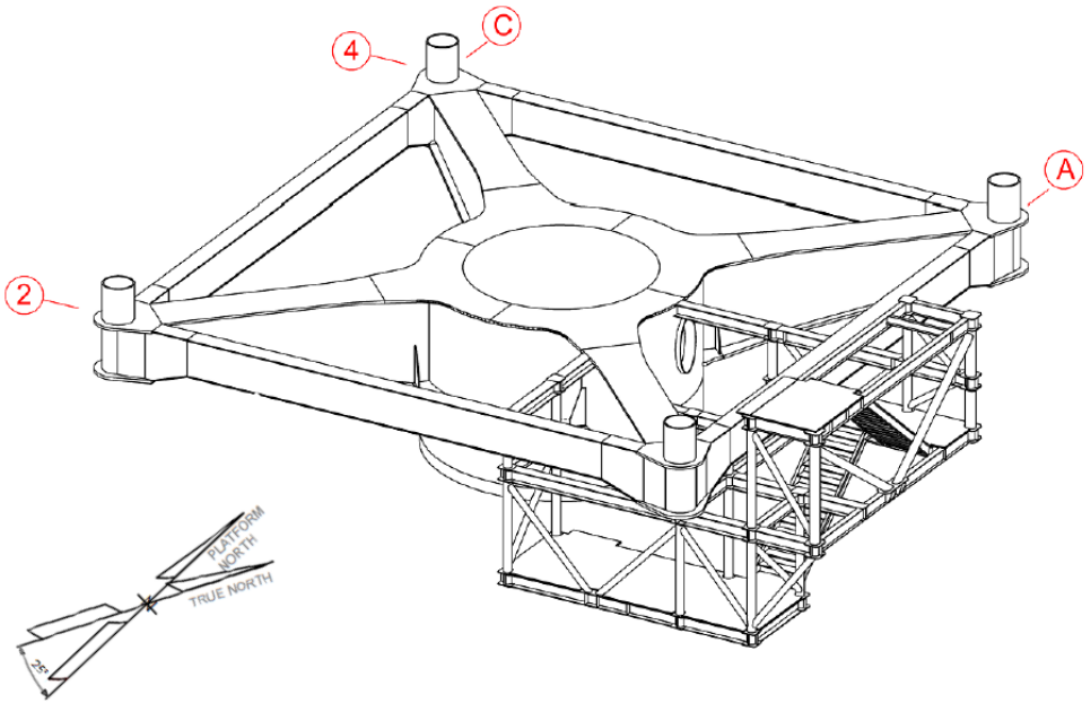


Figure 5.3 - Base Load Power Hub Plot Plan

Connection of the two flanges is made by n. 156 bolt M64 class 10.9.

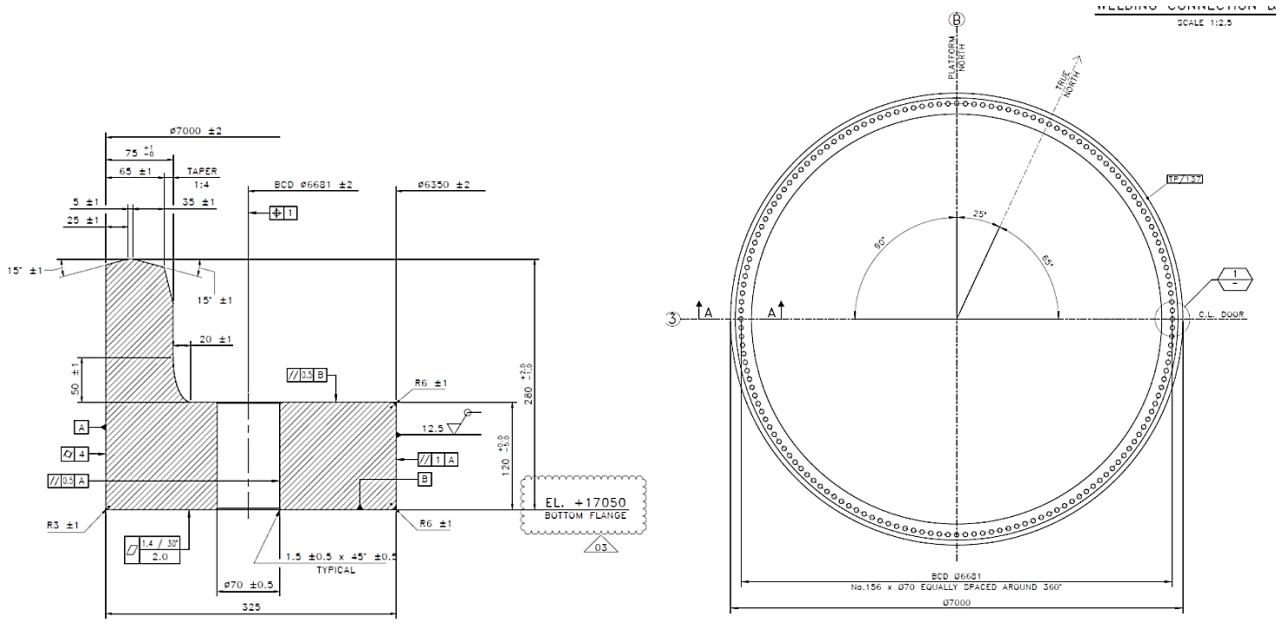


Figure 5.4– Monopile-to-Transition Piece Flange

5.3.1 COG Position

According to the physical weighing operation carried out at Rosetti Marino Yard, TP has the following CoG and weight position (from A1 and LAT) relevant to load-in condition:

- Load-in weight 254.4 ton (including 3% cont.);
- X_G = 19.663 m;
- Y_G = 8.774 m;

TP load-in scheme with CoG position is shown in the next figure.

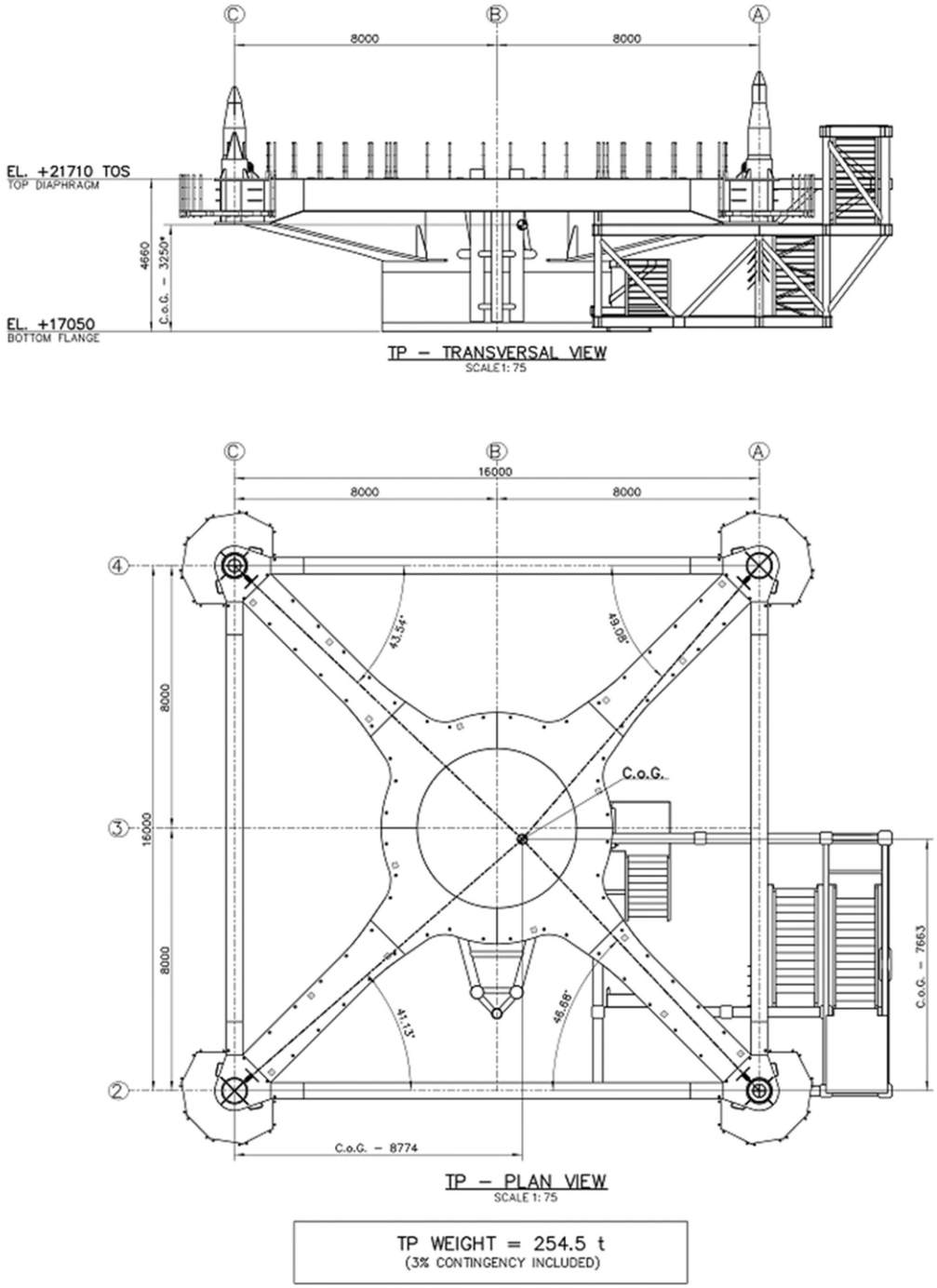


Figure 5.5 – Transition Piece – CoG position

5.4 CAISSON FRAME

The caisson frame is designed to structurally connect n.2 seawater lift caissons and n.1 brine discharge caisson to the Monopile CW70.

The brine caisson is "piggy-backed" off the CF. it is positioned on the outside of the CF and terminates 6m above the inlet to the seawater lift pump caissons. This to avoid, as far as possible, cross-contamination of waste brine water being dumped overboard with fresh seawater drawn for electrolysis.

5.4.1 COG Position

CoG position is taken from ref. /17/, and compared with TEKLA model:

- Loadout Expected Weight 32.5 ton (16% cont. included)

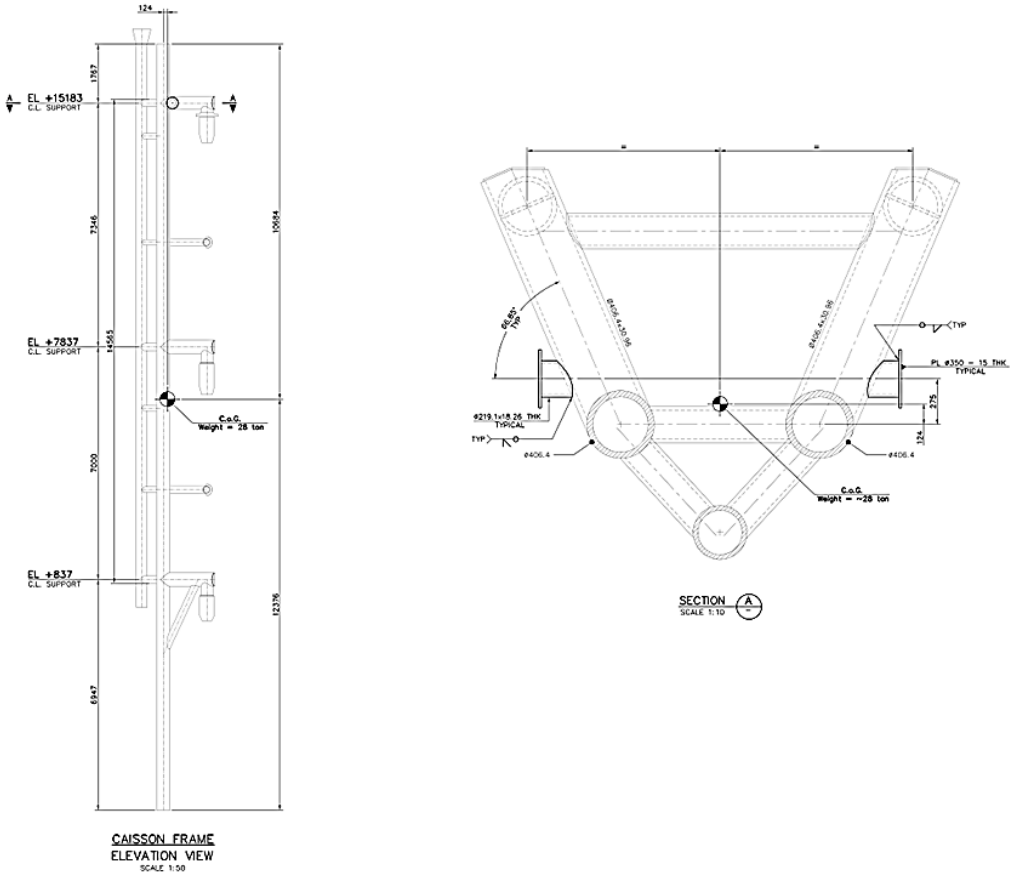


Figure 5.6 – CF COG position

6 BLPH PLATFORM, TP AND CF INSTALLATON PROCEDURE

This section outlines the installation of the platform that could be useful for dismantling design.

BLPH topside, TP and CF were transported on 300ft cargo barge VERVECE. Topside will be transported with Rows A and C aligned with barge long. axis.

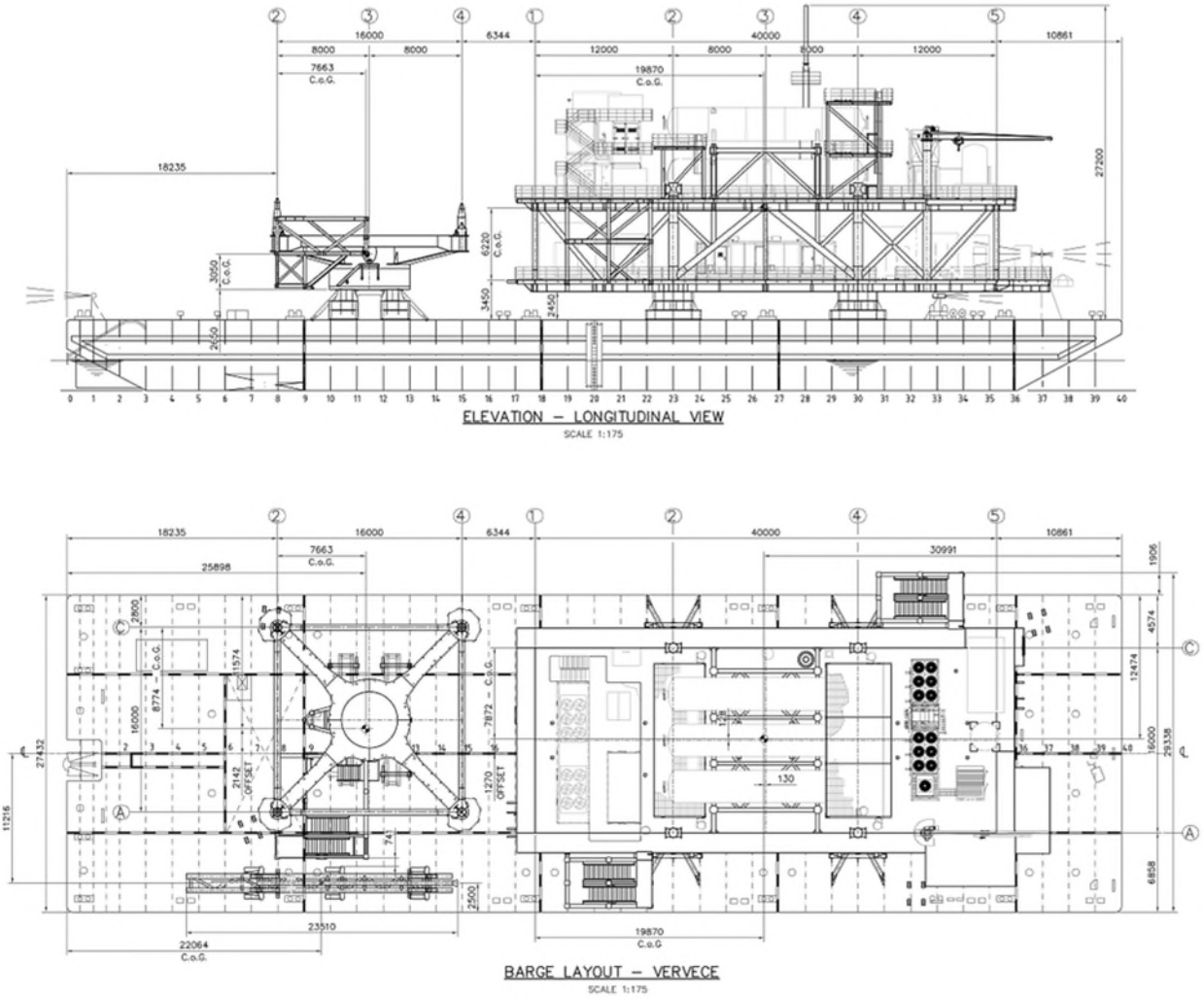


Figure 6.1 – 300 ft barge layout

The offshore operations shall be performed according to DNV-ST-N001 code, Ref./7/, considering the Company DEP 37.81.10.19-Gen and DEP 37.91.10.11 respectively for installation and mooring as additional guidelines, Ref./15/ and /16/.

The installation sequence is TP, caisson frame and topside.

6.1 TRANSITION PIECE

A lift assessment of the TP shall be performed using the Heavy Lift Vessels (HLVs) sheerlegs type using PS crane, with 4 slings running in a single hook configuration.

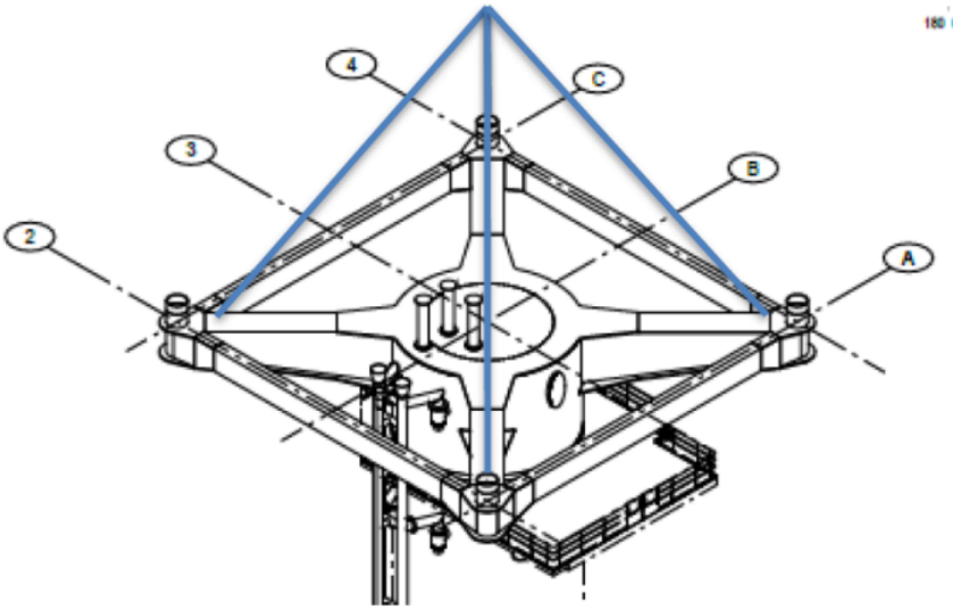


Figure 6.2– TP Offshore Lift Rigging Arrangement

On top of TP 4 padeyes will be used for slings connection.

6.2 CAISSONS

The caisson frame will be installed after the TP and before the Topsides using single hook lift point configuration in combination with steering lines. Two slings will be wrapped around top elevation braces, and the third one will be connected to the piggy-backed pipe providing stability to the lifted object.

CF is equipped with 6 stabbing guides, with different length able to assist the engagement in the 6 monopile sleeves.

6.3 TOPSIDE

HLV will make use of its lifting beam in a dual crane lift configuration. The Topsides is lifted with sheerleg crane on single vessel, using spreader beams.

Lifting trunnion will remain on structure for decommissioning.

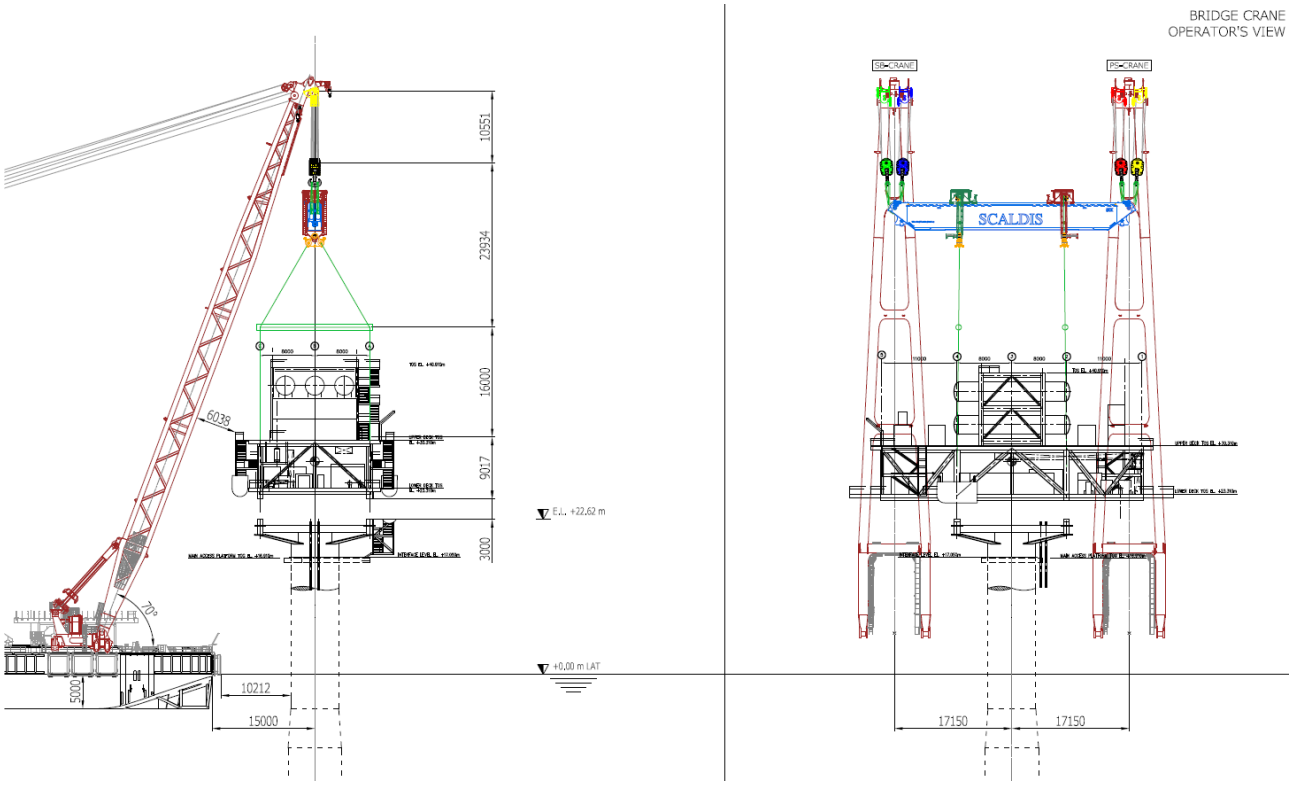


Figure 6.3- Topside Offshore Lift Rigging Arrangement

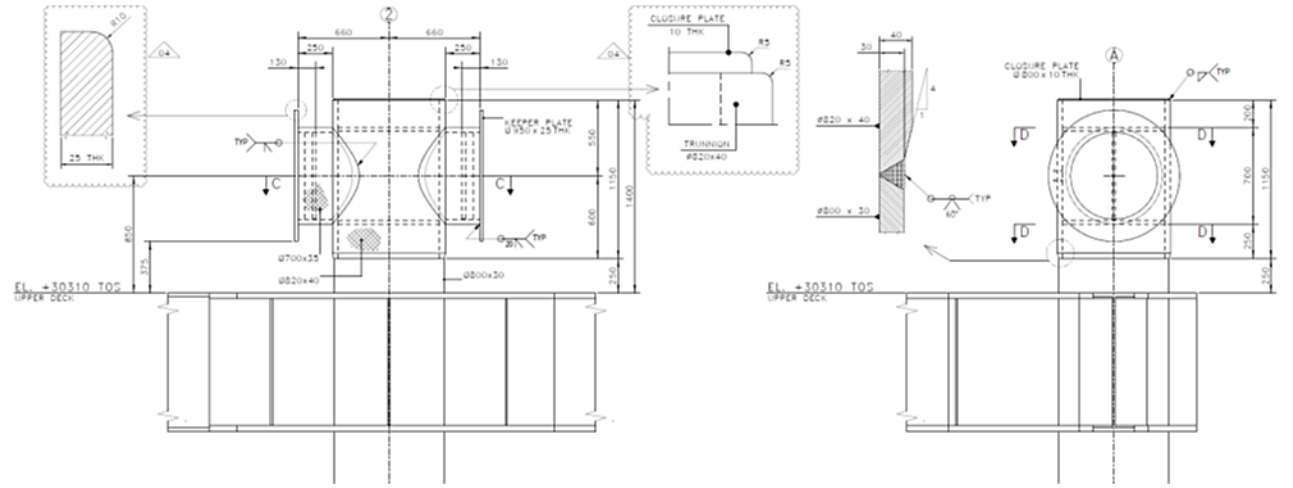


Figure 6.4- Topside Offshore Lifting trunnions

7 PLATFORM DECOMMISSIONING DESIGN

Decommissioning of the platform shall be based on a dedicated design that shall comply with DNV–ST-N001 code, Ref./7/, DNV-RP-N102 and considering the Company DEP 37.81.10.19-Gen and DEP 37.91.10.11, respectively for installation and mooring, as additional guidelines, Ref./15/ and /16/.

According to the requirement of CW project, platform shall be completely removed, allowing the installation of the original wind blade on monopile.

7.1 TOPSIDE AND TP

The topside, together with the TP, is planned to be removed in a single lift using the double trunnions located on top of BLPH, following the same methodology adopted for installation, hence with double hook and spreader beams.

The disconnection of topside, including TP, from the monopile, will be carried out by removing or cutting the n. 156 M64 bolts.

7.1.1 Removal operation

Once the preparatory activities are completed, the lifting slings will be connected to the lifting points on the BLPH upper deck, which were intentionally left in place after installation.

The lifting points were designed for a topside weight of 2000 t. The weighed weight of BLPH is 1695 ton, plus 254.5 t of TP, resulting in a total of 1950 ton < 2000 t, with the CoG showing a minimum offset from the platform physical center.

The ULS lift point design load is 1282 t (12577 kN), including a consequence factor (CF) = 1.30, ref. /24/.

Tugger lines will be connected to relevant attached point to assist and control the structure during lifting and setting down on barge operations.

The unbolting operation will start after the slings will be tensioned and once unbolting will be completed the lifting can start.

Structure will be based on barge grillage and sea fastening installed and welded to secure the topside during sea transport.

7.2 CAISSON FRAME

CF is planned to be removed using the same slings arrangement that has been designed for the offshore installation.

7.2.1 Removal operation

The lift-off from monopile requests as first activity the removal of the two safety pins located at elevation +14.500m.

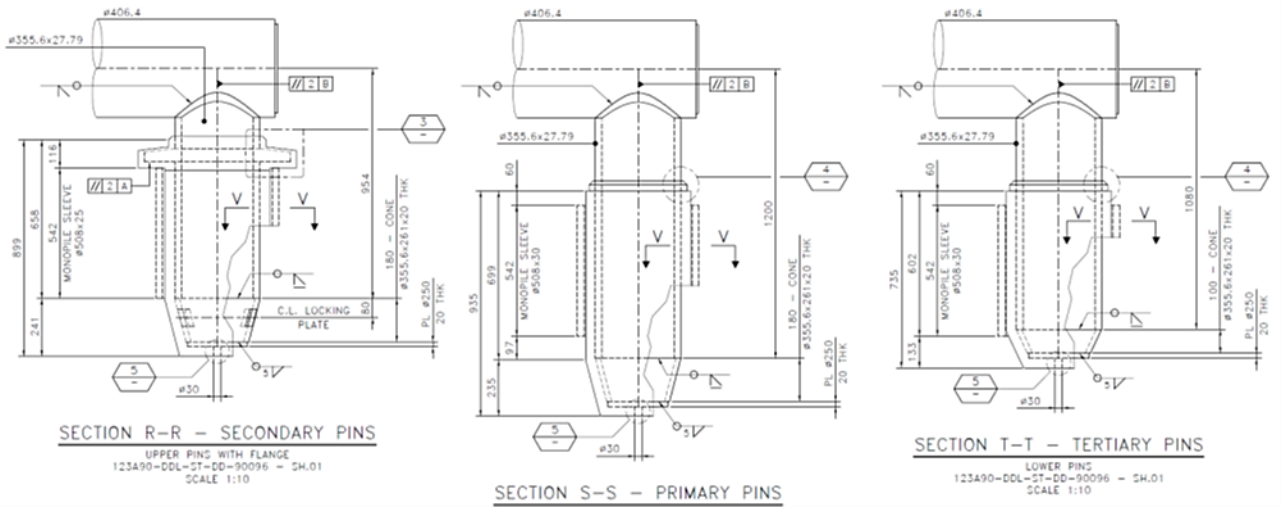


Figure 7.1– CF primary, secondary and tertiary pins

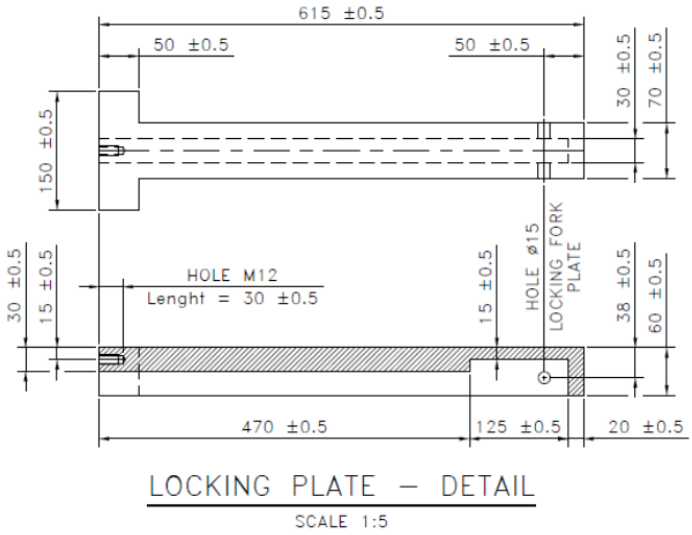


Figure 7.2– CF locking plates for the primary pins

Once the preparatory activities are completed, the lifting slings will be connected to the main braces at upper elevation. Tugger lines will be connected to relevant attached point to the designated connection points to assist and control the structure during the lifting and setting-down operations onto the barge. The structure will be landed on barge deck and rotated from the vertical to the horizontal position. Then, sea fastening or stoppers installed to secure the cargo during sea transport.

7.3 MARINE SPREAD AND EQUIPMENT

The Minimum Required Marine Spread is listed in the following. The selection of the most appropriate marine spread is based on the studies and methodologies defined in the removal detail design phase.

- N. 1 revolving or sheerleg heavy lift vessel fully equipped for platform removal
- N. 1 tug for anchor handling in case off HLV anchored or mooring assistance
- N. 1 tug and transportation barge
- N. 1 supply vessel

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