Base Load Power Hub (BLPH)

SIMOPS FOR COMMISSIONING ACTIVITIES

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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.

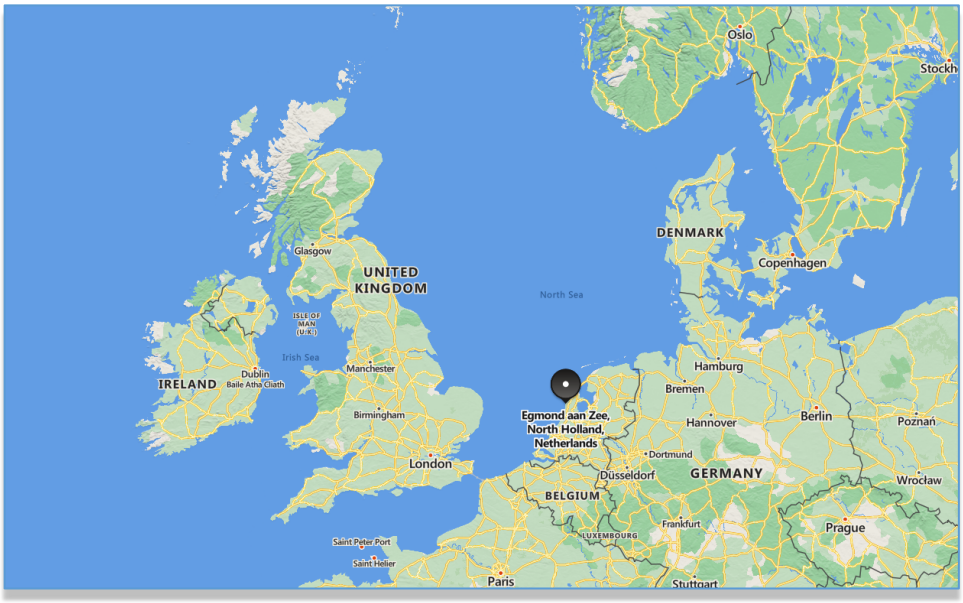


Figure 1 HOLLANDSE KUST NOORD WIND PARK Location Map

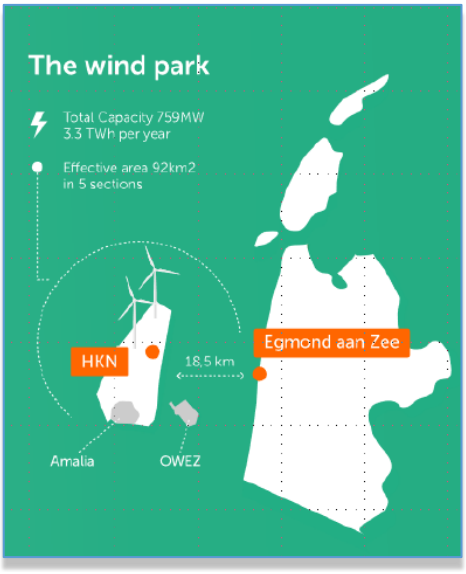


Figure 2 - Wind Park Details

The wind farm will 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.

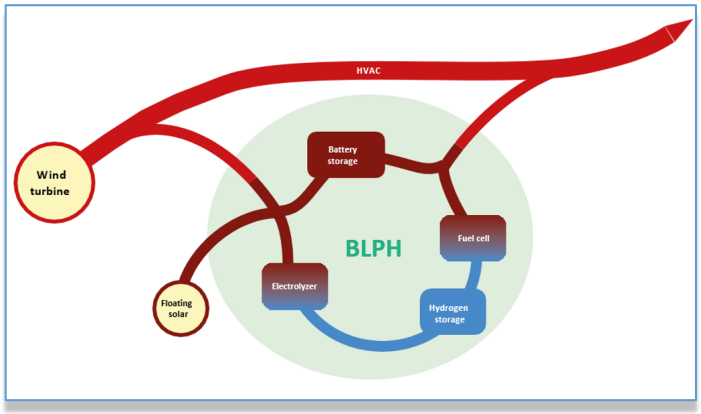


Figure 3 – BLPH Concept

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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 EXECUTIVE SUMMARY

This document has the purpose of detailing the results of the SIMOPS Workshop dedicated to Commissioning Activities for the new Base Load Power Hub (BLPH) which will be installed in the framework of HOLLANDSE KUST NOORD WIND PARK Project. The scope of this document is limited to the topsides structure and associated facilities up until connection with the monopile.

Project development foresees the construction and first commissioning of the platform in the on-shore yard of Rosetti Marino, in order to complete all checks before shipping the platform in the North Sea.

After installation of the platform, it is foreseen to perform a further commissioning step on selected circuit of the platform.

In consideration of the fact that detailed SIMOPS analysis will be developed during the on field activities both on-shore and off-shore, on daily basis, the present study is focused on the analysis of the general main activities and the identification of potential risks of interference between them.

Following objectives are included in the scope of the study:

- Apply SIMOPS analysis for main commission activities to be carried out in the on-shore construction yard.
- Apply MOPO and SIMOPS analysis for commission activities to be carried out in the off-shore platform.
- Verify eventual constraints for the planned maintenance activities on the off-shore platform.

Analysis of interferences during commissioning activities was based on the available documentation:

- commissioning schedules both for on shore yard and for off-shore platform;
- 3D model and detailed lay-outs of the platform;
- general lay-out of the on-shore yard.

The workshop was held on September 6th, 2024, in Rosetti Marino's premises in Milan, with availability of technicians connected via video conference meeting.

Main results of the discussion are reported in following paragraphs.

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SIMOPS for on-shore activities

Risk assessment of commissioning activities in the on-shore yard has identified two specific phases in terms of risk:

- activities without presence of hydrogen (before electrolyser circuit commissioning);
- activities with presence of hydrogen (after electrolyser circuit commissioning).

The first part of the commissioning activities foresees specific risks linked to following phases:

- mechanical completion (including possible hot work activities and radiography of the weldings);
- electrical energization of the platform;
- commissioning of the nitrogen generation package.

These activities (in absence of flammable substances) pose specific risks for workers which will be managed with dedicated permit to work procedures (and use of relevant PPEs) and definition of restricted areas, where necessary.

Commissioning of the hydrogen circuit is planned to be started when all other hot works activities are completed. Commissioning of the circuit requires following activities:

- Hydrogen production in the electrolyser until reaching the correct composition specification;
- Hydrogen vessel pressurization and leak test performance;
- Fuel cell commissioning by feeding the cells with hydrogen provided by a road trailer and connection by a flexible hose or produced by the elecrolysers.

The above described activities require a prolonged phase of venting of hydrogen by main vent (or by local vents) located on top of the platform. Venting is performed during the initial phase of hydrogen production (until the correct specification is reached) and during activities of testing of hydrogen vessels.

SIMOPS analysis was carried out by assuming the following:

- commissioning of hydrogen circuit is carried out after commissioning of electrical and instrumental circuit, thus with availability of the full functionality of F&G system of the platform which will activate the established safety action in case of revealed leak/fire;
- commissioning of hydrogen circuit is carried out with local fire-fighting system fully available which includes the hydrants directed connected to the local fire-fighting network covering the East side of the platform and the fire trucks located on the opposite side of the platform, both sized to provide suitable fire water to complete the actions of cooling down in case of fire.

On basis of the discussion, the recommended actions are here below described.

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No.	Phase	Action
1.1	Hydrogen feed by means of a road trailer and flexible hose – THIS SCENARIO IS NOT MORE APPLICABLE.	Determine a restricted area around the hydrogen trailer and relevant unloading and connection station, dimensioned in such way to prevent any potential source of ignition in case of unexpected leakage from the flexible hose/connection, according to following possibilities: - Establish maximum radiation level by performing consequences assessment due to a leak of hydrogen from the flexible hose; - Adopt the restricted distances proposed by Italian Decree DM 23.10.2018 relevant to hydrogen road distributors (15 m) Accessibility to BLPH and to the restricted area of hydrogen feed from road trailer shall be strictly managed to reduce the risk associated to the activity
1.2		Include in the restricted area the portion of marine channel positioned immediately on the West Side of Rosetti Marino's yard
1.3		Guarantee the presence of specialized personnel inside the construction yard during the whole duration of fuel cell feed from the hydrogen trailer, with capability to manage eventual emergency situations associated to potential hydrogen leak
2.1	Hydrogen venting during hydrogen circuit commissioning	Define a respect zone around the BLPH on basis of the potential distance of hydrogen distance to LFL/2 concentration. This area can be determined in following ways: - Adopt the calculated values in the Vent Gas Dispersion and Potential Radiation Study of the plat form, document no. 123A90-DDL-SAF-RE-30021); - Perform a more specific dispersion simulation corresponding to the effective maximum venting flow rate of the venting activities in the yard
2.2		In the defined area of respect, specific assessment shall be carried out considering the possible activities on the adjacent construction yards which might determine ignition sources to the cloud. The activities in such yards shall be managed in order to prevent/manage risk of ignition

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In addition of above-indicated measures, it is clearly stated that this analysis does not cover/substitute the detailed SIMOPS analysis that shall be carried out on daily basis with reference to effective progress of the job.

Further details are given in paragraph 6 "Conclusions and recommendations".

SIMOPS for off-shore activities

Risk assessment of commissioning activities in the off-shore platform has identified two specific phases in terms of risk:

- activities without presence of hydrogen (before electrolyser circuit commissioning);
- activities with presence of hydrogen (after electrolyser circuit commissioning).

The first part of the commissioning activities foresees specific risks linked to following phases:

- electrical energization of the platform;
- hook up of specific mechanical circuit (as the sea water pump circuit).

These activities (in absence of flammable substances) pose specific risks for workers which will be managed with dedicated permit to work procedures (and use of relevant PPEs) and definition of restricted areas, where necessary.

Commissioning of the hydrogen circuit is planned to be started when all other hot works activities are completed. Commissioning of the circuit requires following activities:

- Hydrogen production in the electrolyser until reaching the correct composition specification;
- Hydrogen vessel pressurization and leak test performance;
- Fuel cell commissioning by feeding the cells with produced hydrogen.

The above described activities require a prolonged phase of venting of hydrogen by main vent located on top of the platform.

The BLPH blow down report identifies a restricted area located in the top parts of the platform (access platform of the hydrogen vessels and fuel cells' roof). This area is generally prohibited to personnel in any phases in which the hydrogen plant is pressurized.

SIMOPS analysis was carried out by assuming the following:

- commissioning of hydrogen circuit is carried out after commissioning of electrical and instrumental circuit, thus with availability of the full functionality of F&G system of the platform which will activate the established safety action in case of revealed leak/fire;
- commissioning of hydrogen circuit is carried out with restriction of the accessibility to the top part of the platform (as specified in the blow down report, document no. 123A90-DDL-PR-RE-80030).

On basis of these assumptions and of the available commissioning schedule, the team was able to define a MOPO matrix inside which all the activities are classified as "allowable".

This result provides a general confirmation that the commissioning activity is correctly scheduled.

Nevertheless, it is clearly stated that this analysis does not cover/substitute the detailed SIMOPS analysis that shall be carried out on daily basis with reference to effective progress of the job and relevant schedule.

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2.1 MAIN REFERENCES

Ref.	Description
1	Crosswind BLPH Offshore Commissioning schedule
2	Crosswind BLPH Subsystem Construction and Commissioning Schedule
3	123A90-DDL-PR-RE-80030 – Relief, Vent and Blow Down Report
4	123A90-DDL-PP-DL-70070 – BLPH Plot plan – Lower and upper deck
5	123A90-DDL-PP-DL-70071 – BLPH Plot plan – Below Lower deck
6	123A90-DDL-PP-DL-70072 – BLPH Plot plan – Elevation looking North & East
7	123A90-DDL-SAF-DL-30022 – BLPH – Hazardous Area Classification – Lower and upper deck
8	123A90-DDL-SAF-DL-30024 – BLPH – Hazardous Area Classification – Elevation looking North & East
9	123A90-DDL-SAF-DL-30013 – BLPH – Hazardous Area Classification Schedule
10	BLPH_MODEL_26-02-24 (3D model of platform)
11	123A90-DDL-PR-RE-80040 – Process Design Philosophy
12	123A90-DDL-SAF-RE-30046 – HSE Design Philosophy
13	123A90-DDL-SAF-RE-30037 – SIMOPS/MOPO Terms of Reference
14	PI-01.0 "Planimetria Generale e Piante" (On shore construction yard lay-out)

Table 1 - Reference Documents

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2.2 DEFINITIONS AND ABBREVIATIONS

2.2.1 Definitions

ALARP	is short for "as low as reasonably practicable, s the concept of "reasonably practicable"; this involves weighing a risk against the trouble, time and money needed to control it. Thus, ALARP describes the level to which we expect to see workplace risks controlled.
COMPANY or Client (CPY)	Crosswind
CONSEQUENCES	The outcome of an event. For the purpose of this project, the outcome is identified in terms of harm to exposed persons and assets.
EPC CONTRACTOR (CTR)	ROSETTI MARINO S.p.A.
EVENT	Occurrence or change of a particular set of circumstances.
FREQUENCY	The estimated number of events per defined unit of time (normally refereed to one-year time).
PROJECT	HOLLANDSE KUST NOORD WIND PARK Project
RISK	Combination of frequency and consequence of scenarios. For the purpose of the present project, the risk is evaluated on exposed persons and on project equipment, due to the effects of events caused by LOC of hazardous substances
RECOMMENDATIONS	Improvements /actions required to reduce the identified risk.

Table 2 - Definitions

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2.2.2 Abbreviations

ALARP	As Low As Reasonably Practicable
BESS	Battery Energy Storage System
BLPH	Base Load Power Hub
CPI	Company Provided Item
HFE	Human Factor Engineering
HKN	Hollandse Kust Noord
HSE	Health, Safety and Environment
IOGP	International Association of Oil & Gas Producers
TOR	Terms of Reference
TP	Transition piece

Table 3 - Abbreviations

3 SIMOPS STUDY

3.1 GENERAL ASPECTS

Simultaneous Operations (SIMOPS) involve the concurrent execution of two or more activities, significantly increasing operational complexity and associated risk levels. This complexity is especially apparent when these activities occur in the same location at the same time, potentially leading to a compounded risk due to the possible failure of controls designed for each individual activity.

SIMOPS is characterized as any combination of two or more distinct sets of macro-activities executed concurrently within a defined area. These activities, possibly undertaken by different organizations or under varied management systems, can adversely interact due to their proximity or other critical factors. This interaction may result in undesirable events impacting health, safety, environment, asset integrity, production continuity, and consequently causing economic losses.

SIMOPS study is typically conducted as a multidisciplinary endeavour in a workshop setting, focusing on identifying potential hazards arising from simultaneous operations in a shared area.

The BLPH project foresees the construction and commissioning of the module directly in the construction yard at Rosetti Marino's premises. This activity foresees also the realization of the entire hydrogen circuit, and the associated packages for instrumentation and nitrogen distribution. These activities require also welding and all necessary hot work to complete the circuits. Once the module is fully commissioned, it will be shipped to the North Sea, for the installation on to the offshore monopile.

After the installation of the platform, no mechanical activities are foreseen for hydrogen circuit. The only mechanical activities are linked to the hook up of sea water pumps and Wastewater pump, for the necessary on-site connections.

On the other hand, it will be necessary to perform commissioning of all circuits again the in order to verify the functionality of the equipment and instrumentation after transport and installation on monopile.

The present analysis has been divided into two distinct studies:

- SIMOPS for onshore commissioning activities;
- SIMOPS for offshore commissioning activities.

The first part of the study is focused on the activities which will be performed in the construction and commissioning yard at Rosetti Marino's premises.

The second part of the study is focused on the activity which will be performed on BLPH after installation of the module in the offshore monopile.

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3.2 SIMOPS WORKSHOP

SIMOPS workshop was held on September 6th, 2024, in Rosetti Marino's premises in Milano.

It was developed according to two distinct sessions:

- Morning session: Offshore commissioning SIMOPS;
- Afternoon session: Onshore commissioning SIMOPS.

List of participants for the two sessions are reported in following table.

No.	Name	Company	Role
1	Neil Carlo Manning	ICARO	Facilitator
2	Alberto Baldassarri	ICARO	Scribe
3	Claudia Giunchi	Rosetti Marino	Project Engineer
4	Carolina Caracciolo	Rosetti Marino	Technical Safety Lead
5	Daniele Ricci Picciloni	Rosetti Marino	HSSE Manager
6	Anthony Iveson	Rosetti Marino	Commissioning Manager
7	Wolmer Borghi	Rosetti Marino	Construction Manager
8	Massimiliano Brunelli	Rosetti Marino	Project Manager
9	Paul Van Rossum	Crosswind	Technical Safety Lead
10	Eunice Liow	Crosswind	Operations Lead
11	Nicholas Le Brun	Crosswind	HSSE Manager
12	Martin Taylor	Crosswind	Commissioning Manager
13	Richard Brocx	Crosswind	HSSE Supervisor
14	Johan Van Sprunsen	Crosswind	Operations Lead
15	Jeroen Van Loon	Crosswind	Construction Manager

Table 4 – List of participants

The application of the methodology is reported in the following paragraphs.

4 SIMOPS FOR ON SHORE COMMISSIONING

4.1 IDENTIFICATION OF ON SHORE COMMISSIONING ACTIVITIES

The working team analysed the different programmed activities for the on shore BLPH module, according to the project schedule as illustrated in document [2] and clearly limited to the commission activities.

With reference to the scheduled activities of commissioning, following considerations are applicable:

1. First circuits to be commissioned are associated to Electrical distribution, lighting (both normal and emergency), process control, emergency shut down, F&G network and HVAC;
2. Instrument air package and nitrogen package will be commissioned before hydrogen circuit commissioning;
3. In the schedule it is foreseen that a part of commissioning activities of electrical and instrumental circuits will be concurrent with the mechanical completion of the hydrogen circuit (including welding of the piping and possibility for hot works and radiographic activities which shall be defined and programmed during the detailed SIMOPS study of the construction and commissioning phases).
4. Hydrogen circuit commissioning, including electrolyser, storage vessel and fuel cells (with direct charge of hydrogen), will be performed once all the electrical power and instrument air distribution networks are in operation (in order to guarantee correct process control of hydrogen circuit);
5. Hydrogen circuit commissioning, including electrolyser, storage vessel and fuel cells (with direct charge of hydrogen), will be performed once the F&G network and the emergency shut down network are fully in operation (in order to guarantee safe and fast shut down of the hydrogen circuit in case of revealed leak/fire);
6. Hydrogen circuit commissioning, including electrolyser, storage vessel and fuel cells (with direct charge of hydrogen), will be performed with the availability of fire fighting devices of the yard, being constituted by following elements:
    - Fire hydrants directly connected to the existing fire-fighting network of the yard, located on the East side of the platform;
    - Fire trucks, positioned on the West side of the module, to guarantee fire protection on that side in case of need.
7. First commissioning of fuel cell is performed either by means of a hydrogen road tanker which will be provided by external supplier and positioned in a dedicated area in the yard or hydrogen produced from the electrolysers. Connection between road trailer and fuel cells will be realized with installation of a flexible hose (suitable for high pressure hydrogen installation), whose length is estimated about 50 m. Position of the trailer with respect to BLPH module is reported in figure 5.
8. Commissioning of hydrogen electrolysers foresees the production of hydrogen until the specified purity is reached; this aspect will require routing the initially produced hydrogen to the vent of the module with continuity for an expected period of some days. Vent is designed for marine configuration of the platform, therefore, in these circumstances vent will determine hydrogen

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dispersion in the yard area, which include installation yards for other modules and consequently a potential situation of interference non applicable once the platform is installed in the North Sea.

9. Commissioning of hydrogen storage vessels foresees the execution of pressurization with produced gas from electrolysers in order to make leak tests, followed by subsequent depressurization. The activity on no. 6 storage vessels will therefore determines the need of continuously routing the produced hydrogen to the vent of the module with continuity for an expected period of some days, posing the interference risk already illustrated in bullet no. 8.

The discussion was generated on the arguments highlighted in the above reported bullets.

4.2 DISCUSSION ON IDENTIFIED INTERFERENCES

The analysis was performed taking into consideration the following two distinct phases:

- activities which are developed in absence of hydrogen in the module;
- activities which are developed in presence of hydrogen in the module.

The analysis was performed with reference to the yard lay-out as reported in following figure (selected from document [14]).

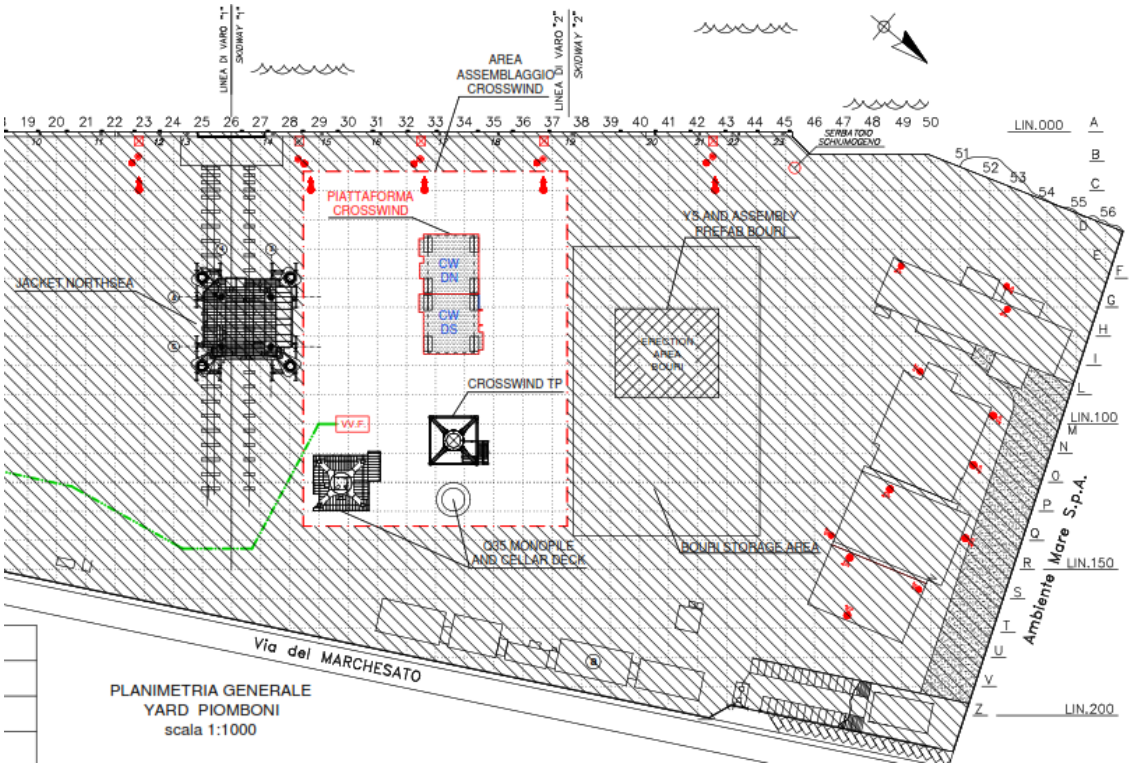


Figure 4 – On shore construction yard lay-out

The BLPH construction yard is highlighted in white field. The area is located between other construction yards on responsibility of Rosetti Marino. Minimum distance between BLPH area and the other construction yards is about 30 m.

On the West side the yard is adjacent to the marine channel of Ravenna.

Inside the construction yard, on West side, it is evident the availability of the hydrants connected to the firewater network. On the East side, there will be the availability of fire trucks capable to fight eventual fire principles in the yard.

On the East side, close to site fence, there is the building dedicated to management of the activities and the emergency on the yard.

In Southwest corner of BLPH yard, it is foreseen the temporary connection with (high pressure) hydrogen road trailer. The connection will be made by a suitable flexible hose that will route hydrogen from the trailer to the fuel cells, located on upper deck of the module, potentially crossing the working area.

The BLPH construction area will be located inside Rosetti Marino's plant which will be continuously manned during the commission activities requiring the presence of hydrogen.

4.2.1 Activities to be developed in absence of hydrogen in the module

These activities include:

- Energy distribution network activation;
- Commissioning of control and safety circuits of the module;
- Commissioning of instrument air and nitrogen circuits.

With reference to the commissioning of electrical circuit, specific risk associated to setting the circuit under tension are clearly present (e.g.: the electrocution).

It is assumed that each activity will be scheduled according to relevant risk and during the daily SIMOPS study for the on-shore construction and commissioning, and on basis of those detailed studies, the working team will apply the required measures and barriers to protect the personnel responsible for such activity and the personnel responsible for concurrent activity.

As an example, whenever a restriction/respect area is required, the necessary actions to make it effective will be put in force by the plant organization. Clearly, the appropriate measures will be selected in consideration of the fact that there are no dangerous (flammable) substances in the module.

Same concept applies for the installation of measures dedicated to potential interference with concurrent activities for mechanical completion of the hydrogen circuit.

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With such assumptions, the team agreed that the simultaneous operations can be managed by the plant organization by means of detailed SIMOPS analysis, based on best practice for commissioning and in coherence with law requirements.

4.2.2 Activities to be developed in presence of hydrogen in the module

These activities include:

a) Commissioning of fuel cells by external hydrogen supply;

b) Commissioning of electrolyzation modules and hydrogen storage vessels.

Discussions held during the meeting are detailed in following paragraphs.

a) Commissioning of fuel cells by external hydrogen supply

The activity will be carried out either with external supply of hydrogen by a road trailer or with hydrogen produced by the electrolysers. It will be performed by determination of a temporary connection between the trailer and the fuel cells on the higher level of the module. The basic position of the trailer is illustrated in the yard plot plan included in Figure 4.

This temporary operation (including characteristics of vehicle, types of connections and selection of suitable flexible hose) is designed with the support of specialized company in the production and management of highly pressurized hydrogen.

This type of risk is specific for the on-shore commissioning and it is limited in time only during the fuel cell pre-commissioning. From the discussion in the meeting, it is expected this phase to last from three to five consecutive days.

For the development of this commissioning activity, Rosetti Marino has already agreed with local Fire Fighting authority the definition of an area of respect in accordance with Italian decree of 03/02/2016.

The area of respect around hydrogen trailer is defined in blue colour in figure 5.

The area is sized to guarantee 20 m of area of respect around the trailer.

Accessibility to BLPH and to the restricted area of hydrogen feed from road trailer will be strictly managed to reduce the risk associated to the activity marine channel. Activities close to the yard and mooring to the yard quay in the proximity of the platform will be interrupted during H2 production.

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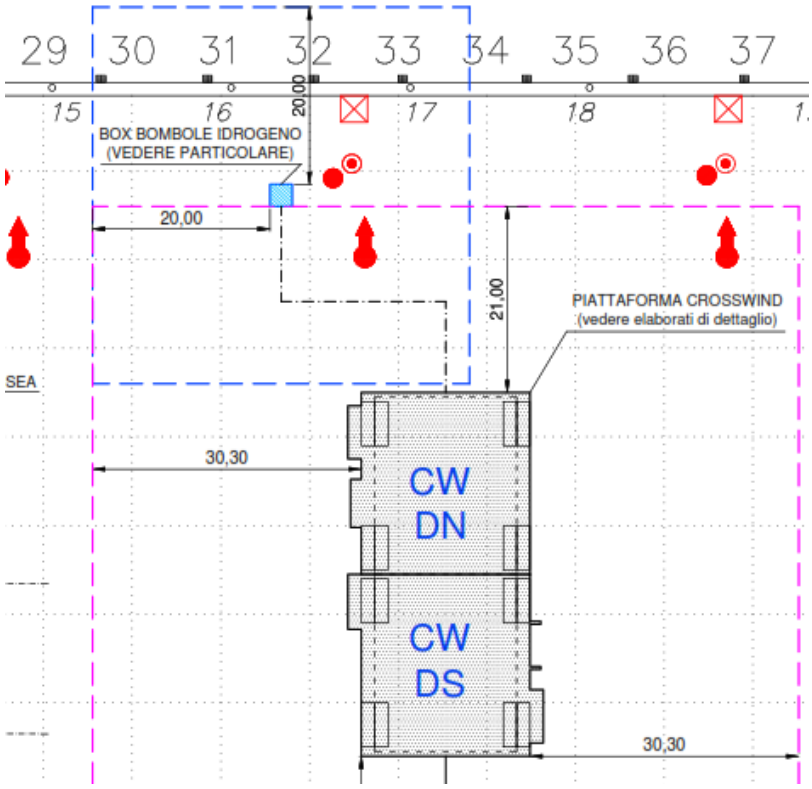


Figure 5 – Area of respect for the hydrogen trailer

b) Commissioning of electrolyzation modules and hydrogen storage vessels

It is foreseen to put in service the electrolysers with the aim of reaching the correct hydrogen specification in terms of composition. Therefore, it is planned to keep the electrolysers in operation for some days until the desired specification is reached. During this period of time, the produced hydrogen is continuously vented to atmosphere, thus creating a potential risk of ignition associated to the dispersion of hydrogen cloud.

In terms of risk assessment, the case was analyzed taking into consideration the results of the BLPH Vent Gas Dispersion and Potential Radiation Study, document no. 123A90-DDL-SAF-RE-30021.

The design of BLPH vent system is such to guarantee a sterile area in the module in case of ignition of released vent, with exception of the following:

- fixed platform for accessibility to the top side of hydrogen storage vessels;
- roof of the fuel cells module.

For the present analysis, following assumptions are made:

- during commissioning of hydrogen circuit in general, only authorized personnel, involved in the development of the commissioning activities, will be allowed to stand on the platform;
- the accessibility to top side of hydrogen vessel and to roof of fuel cells module will be restricted and managed, in case of need, by means of rigorous authorization system.

These assumptions will limit the risk associated to the personnel involved in the commissioning phase of the BLPH.

The second analyzed aspect is associated to potential interference with other surrounding activities. Vent gas dispersion report identifies, as maximum value, a dispersion distance of 50 m at a height between 15 and 20 m from the platform vent. This result, allocated inside the construction yard, can pose specific issues.

Inside the yard, the module's vent is installed at about 15 m of height; therefore, the impact of the cloud can reach a distance of 50 m at a height between 30 m and 35 m.

In consideration of the presence of other construction yards for other platforms in the area surrounding the BLPH construction yard, it is required to define carefully a respect area around the hydrogen vent and establish whether the adjacent yards might be reached by the hydrogen dispersion cloud.

In case a yard is potentially reached by the flammable cloud, activities on this yard shall be managed and programmed in order to carefully manage the risk of ignition. Possible actions to be put in place are the following:

- minimized or postpone hot works activities during the phases involving hydrogen continuous emission from vent of BLPH module;
- manage the F&G alarm systems of BLPH module to rapidly alert the personnel of the adjacent yard of the potential incoming risk.

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As final consideration of the discussion, it is suggested to evaluate the possibility to perform a vent dispersion study associated to on shore commissioning activities, which shall take into consideration:

- Local atmospheric data and prevailing wind directions;
- Effective flow rate of hydrogen, which is continuously vented during commissioning activities, considering the worst expected case between the electrolysers and the storage vessel.

The development of a specific case study tailored to effective condition of the construction yard, could lead to more detailed results and consequently could provide more efficient actions to be applied.

4.2.3 Summary of On shore commissioning activities safeguards

The activities relevant to on shore module commissioning will be performed with availability of following safeguards:

1. Hydrogen feed by means of a road trailer and flexible hose:
   1.1. A restricted area around the hydrogen trailer and relevant unloading and connection station has been determined to prevent any potential source of ignition in case of unexpected leakage from the flexible hose/connection according to the Italian regulation D.M.03/02/2016.
   1.2. Accessibility to BLPH and to the restricted area of hydrogen feed from road trailer will be strictly managed to reduce the risk associated to the activity. Marine channel activities close to the yard and mooring to the yard quay in the proximity of the platform will be interrupted during H_2 production.
   1.3. Only trained personnel for emergency situation associated with potential hydrogen leak will be present for the whole duration of fuel cell feed from the hydrogen trailer.

2. Hydrogen venting during hydrogen circuit commissioning:
   2.1. A respect zone around the BLPH on basis of the potential distance of hydrogen distance to LFL/2 concentration will be defined.
   2.2. In the defined area of respect, a specific assessment will be carried out considering the possible activities on the adjacent construction in the yard which might determine ignition sources to the cloud. The activities in adjacent projects will be managed in order to prevent/manage risk of ignition

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5 SIMOPS FOR OFF-SHORE COMMISSIONING

5.1 IDENTIFICATION OF OFF SHORE COMMISSIONING ACTIVITIES

The working team analysed the different programmed activities for the offshore BLPH module, according to the project schedule as illustrated in document [3] and clearly limited to the commission activities.

With reference to the scheduled activities of commissioning, following considerations are applicable:

1. First circuits to be commissioned are associated to Electrical distribution, energization of switchboard (to guarantee lighting and all other services for the platform), process control, emergency shut down, F&G network and HVAC;
2. Sea water package and BESS will be commissioned before hydrogen circuit commissioning;
3. In the schedule it is foreseen that a part of commissioning activities of electrical and instrumental circuits will be concurrent with hook up of the sea water and wastewater circuits (only hook up with no hot works foreseen).
4. Hydrogen circuit commissioning (including electrolyser, storage vessel and fuel cells (with direct charge of hydrogen) will be performed once all the electrical power and instrument air distribution networks are in operation (in order to guarantee correct process control of hydrogen circuit);
5. Hydrogen circuit commissioning (including electrolyser, storage vessel and fuel cells (fed directly by the produced hydrogen) will be performed once the F&G network and the emergency shut down network are fully in operation (in order to guarantee safe and fast shut down of the hydrogen circuit in case of revealed leak/fire);
6. Commissioning of hydrogen electrolysers foresees the production of hydrogen until the specified purity is reached; this aspect will require routing the initially produced hydrogen to the vent of the module with continuity for an expected period of some days. Vent is designed to minimize the impact of the potential radiation onto the platform, in case of ignition.
7. Commissioning of hydrogen storage vessels foresees the execution of pressurization with produced gas from electrolysers in order to make leak tests, followed by subsequent depressurization. The activity on no. 6 storage vessels will therefore determine the need of continuous routing the produced hydrogen to the vent of the module with continuity for an expected period of some days, posing the interference risk already illustrated in bullet no. 6.

5.2 DEFINITION OF MOPO

For this part of commissioning, the team was focused on the definition of MOPO Matrix for the identification of these activities that shall not be performed concurrently. The analysis was carried out with specific reference to the available schedule as reported in document [3], considering exclusively the commissioning activities.

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The Matrix has the purpose to preliminary identify the typology of activities that shall not be performed concurrently on the module, due to fact that the interference might cause potential risk to exposed personnel, the environment or the asset.

The results of the MOPO analysis is illustrated in the following figure.

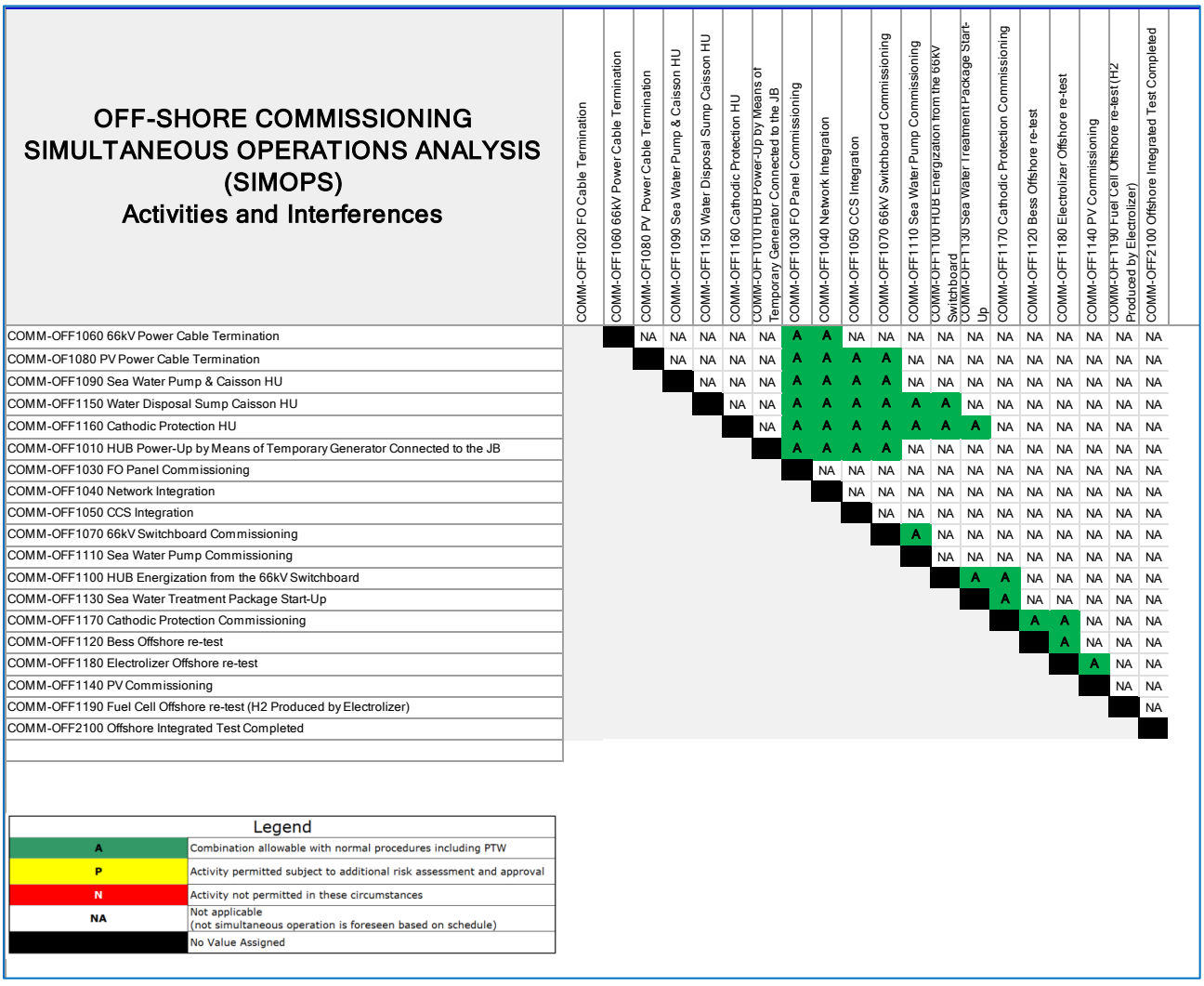


Figure 6 – MOPO Matrix

Notes to the figure:

The Matrix reports in lines and in columns the possible combination between the activities. The boxes in the diagonal line are black since they refer to the combination of same activity which is not applicable.

The matrix was based on effective possible concurrent activities on basis of the schedule of the commissioning as per document [3]. Following assumptions apply:

- The boxes indicated with "NA" refer to cases in which Simultaneous Operations are Not Applicable since the activities are not currently scheduled to be concurrent. Should the schedule change, the concurrent execution of such activities is to be considered not allowed unless a proper update of the MOPO is performed.
- For the other cases, the Team has analyzed the potential risks of interference and established the relevant color-code to be applied.
- It is assumed that each single activity is carried out according to commissioning procedure and best practices with availability of proper PPE.
- It is assumed that each activity is carried out according to the schedule and therefore all the preceding activities have been completed before going on with the new one (e.g.: it is assumed that electrolyser commissioning is performed after completion of commissioning of 66 kV Switchboard, otherwise it will be not feasible to start giving energy to electrolyser).
- The combination inside the matrix, indicating the "Allowable" configuration, does not mean that there is no risk at all in performing each single activity, but it means that the concurrent execution of both activities does not pose any additional risks of interference.
- Risk of interferences have been analyzed considering the following criteria:
    - the position of each working area and distances between the two;
    - evaluate if activities are part of same circuit or belong to different circuits without any interference;
    - presence of distances of respect to be associated to each single activity (which might interfere with the position of other working location);
    - availability of suitable PPEs in the performance of each single activity.

As can be seen in the figure 4, the evaluated interferences are all included in the "Allowable" region and therefore there are no significant risks of interferences during the offshore commissioning activities on the module.

This shall be considered as a general result which states that the proposed schedule is suitable to conduct the commissioning in safe conditions.

Clearly, when it comes to perform the evaluation on detailed daily activity, particular care shall be devoted to the evaluation of possible changes in the schedule.

In present study such changes have not been assessed ("NA" field applied) and therefore, in case of re-scheduling, a more detailed analysis for identification of eventual of additional situations of interference shall be put in place.

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6 CONCLUSIONS AND RECOMMENDATIONS

SIMOPS workshop allowed the analysis of possible interferences both in onshore and offshore commissioning phases.

The discussion involved a multidisciplinary team from the different involved stakeholder.

The analysis was carried out with the aim to identify the most effective and straightforward discussion for identification of interferences and possible actions to prevent/mitigate their potential effects.

The results of the workshop are illustrated in following paragraphs.

6.1 ON SHORE COMMISSIONING ACTIVITIES RESULTS

The on-shore commissioning activities present specific risks associated with the position of the module in the overall construction yard.

The company has foreseen the installation of a set of safeguards oriented to the management of the specific risks present in the yard.

In the availability of these specific safeguards, the overall evaluated interferences of the on shore commissioning activities are all classified as “Allowable”.

6.2 OFFSHORE COMMISSIONING ACTIVITIES RESULTS

The evaluated interferences are all included in the “Allowable” region and therefore there are no significant risks of interferences during the offshore commissioning activities on the module.

Based on the current schedule, the evaluated interferences are all included in either the “N/A” or the “Allowable” region and therefore there are no significant risks of interferences during the offshore commissioning activities on the module.

For any change in the schedule the MOPO should first be updated to confirm the activities are allowed in concurrent operation.

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