Belwind Offshore Energy

Annual work report 2018

Offshore wind energy power plant

Belwind

Subject	Author	Reviewer	Approver	Date
Draft report	O&M	CSU/DVA	KVE	08/05/2019
Final report	O&M	CSU/DVA	KVE	10/05/2019

PUBLIC VERSION

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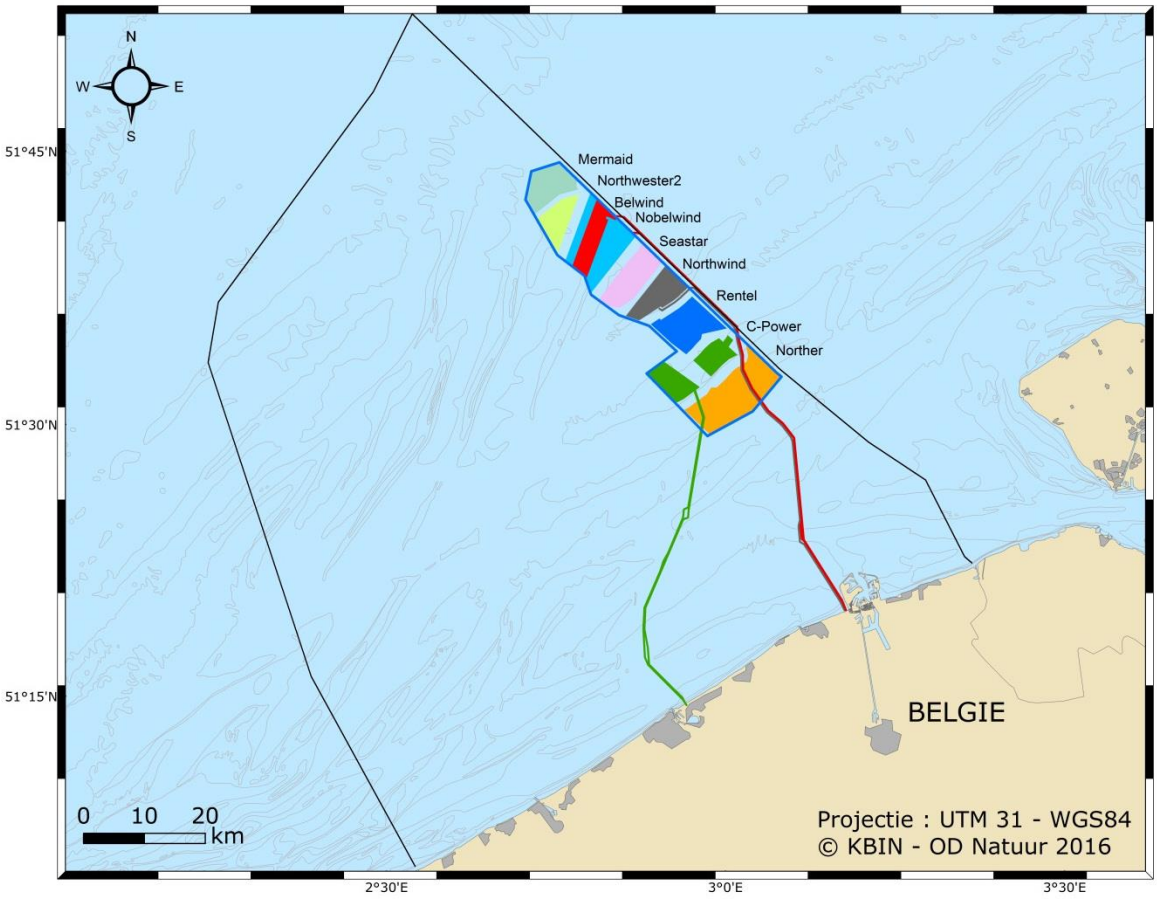
1 Introduction

The Belwind offshore wind farm is located on the Belgian Continental Shelf, within the Belgian Exclusive Economic zone. The distance from the wind farm to the nearest point at the shore (Zeebrugge) is approximately 46 km.



Location offshore wind farm Belwind

2 Project overview

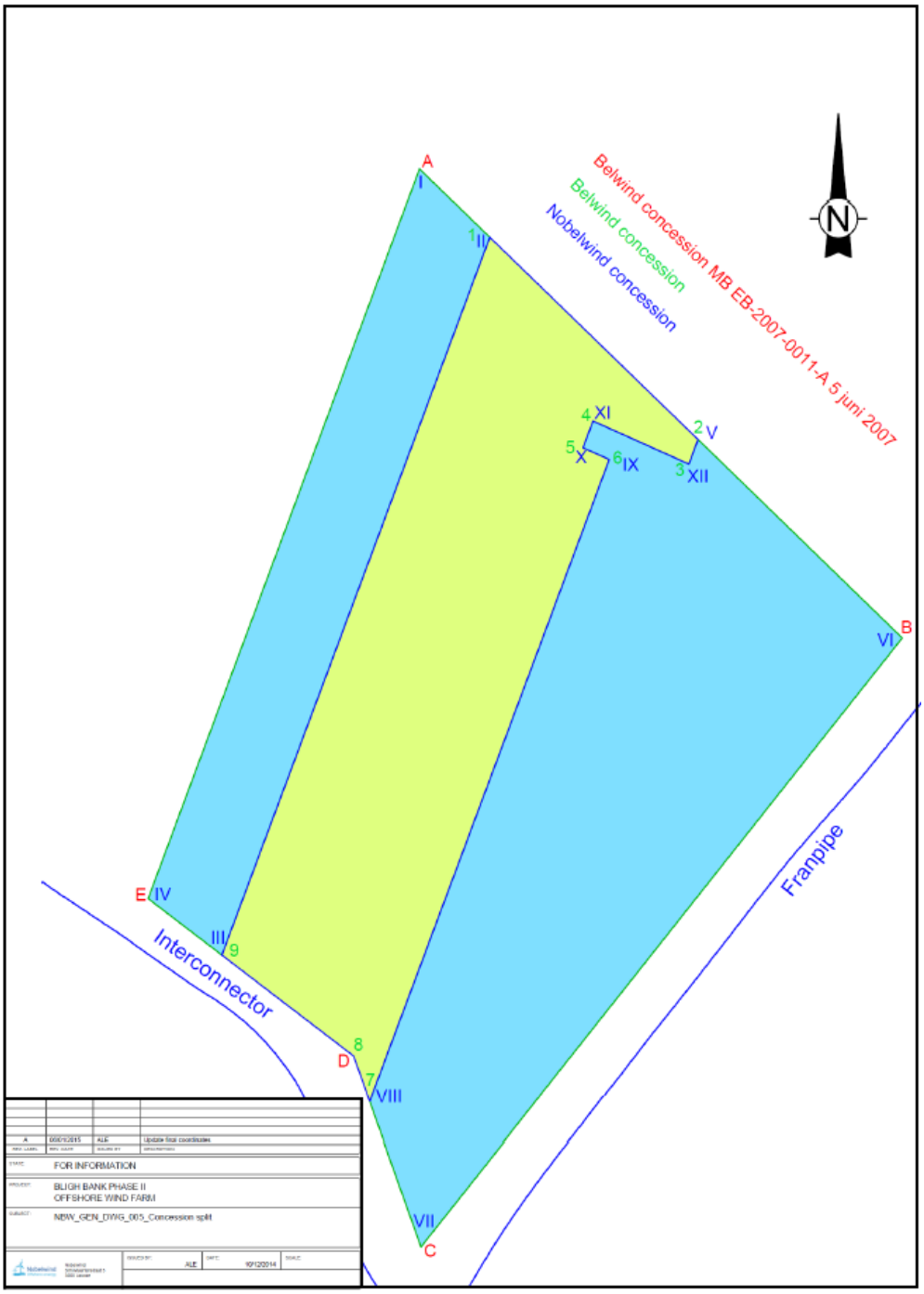
According the authorization for the construction and a license for the operation of a wind farm on the Bligh Bank in the Belgian sea areas article, the wind farm should be constructed in two phases.

Belwind consists of 55 wind turbines of 3 MW each (Vestas V90) and an Offshore High Voltage Station (OHVS). Via a local grid (33 kV) the wind turbines are connected to the OHVS. The energy is transported to shore by a 150 kV submarine cable. Belwind has been erected in 2009 and 2010 and is fully operational since January 2011.

Locations of the wind turbines and the grid connection of Belwind

In 2013 and 2014, the realization of the Belwind Demo project was started. This project consists of the installation of a jacket foundation and a 6 MW windturbine (GE Haliade 6M – rotordiameter 150m) at location L01. The Belwind Demo project received its 33kV cable installation in 2014 during the summer. Once the cable was connected the commissioning of the Haliade 150 Turbine got on its way. The WTG produces since 2015 green energy via a direct drive concept and had at time of erection the biggest blade rotor size in operation.
In November 2015 the division of Alstom Power has been taking over by GE Renewables.

The development of Phase 2, Belwind 2 or Belwind phase 2, was started in 2014. For the development, a new company was created, named Nobelwind in which funds was found for the pre-development. The shareholders of the Nobelwind are the same shareholders as in Belwind. In line with the Royal Decrees 20/12/2000 (Domain concession), 12/03/2002 (Sea-cable) and 07/09/2003 (Marine Environmental permit), the partial split of the initial domain concession, sea-cable permit and Marine Environmental permit, has been applied for by Belwind and Nobelwind. Nobelwind obtained in 2015 the necessary authorization for the realization of the windfarm.



Domain concessions Belwind and Nobelwind

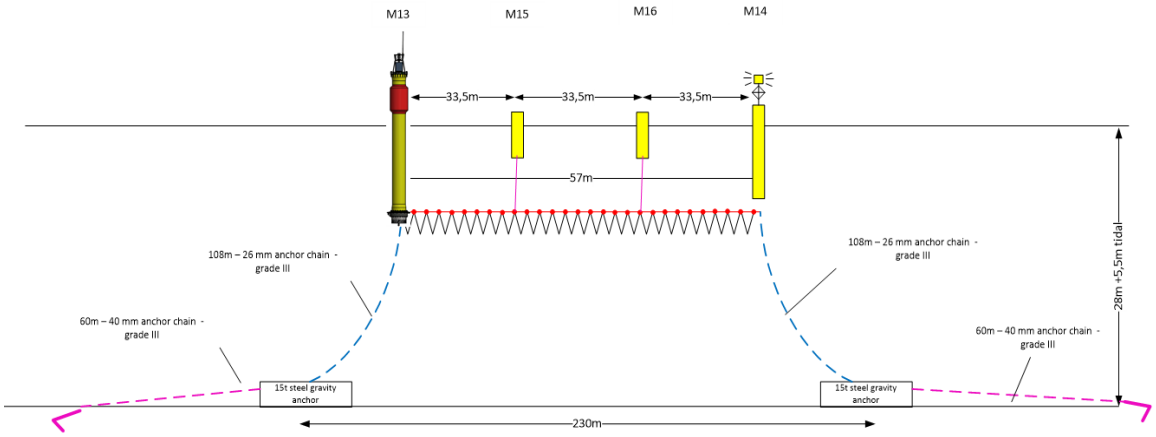
Nobelwind consists of 50 WTG's, type Vestas V112 3,3 MW, total of 165 MW and one OHVS. A 220kV interconnector cable connects this OHVS with the Northwind OHVS. Energy is transported to land via the existing 220 kV export cable, named Cableco. Construction of Nobelwind started in 2016. The first energy has been produced since January 2017 and Nobelwind is fully operational as of May 2017.

3 Construction works on the Belwind concession

No construction works took place in the Belwind concession.

The Nobelwind activities were mostly finished in 2017.

In 2017 Belwind agreed to participate in the Edulis project (Installation of a long line, already with full growth mussels, equipped with sensors for monitoring of the forces in the line and anchors, dynamic position of the anchoring and lines, in order to be able to design a optimal mussel farm offshore). The long line was installed in December 2017 and during 2018 Belwind supported the Edulis-project with the visual inspections of equipment in the concession:

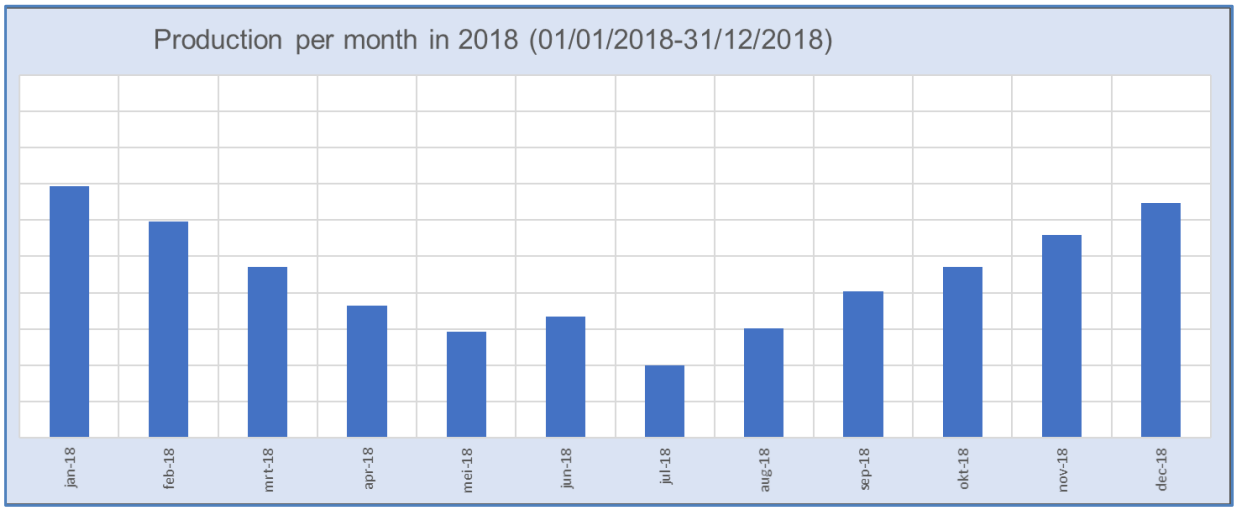


4 Wind farm annual operations information

Below figures cover the 55 MVOW V90 turbines. The GE Haliade demo project is covered in chapter 5.

4.1 Production

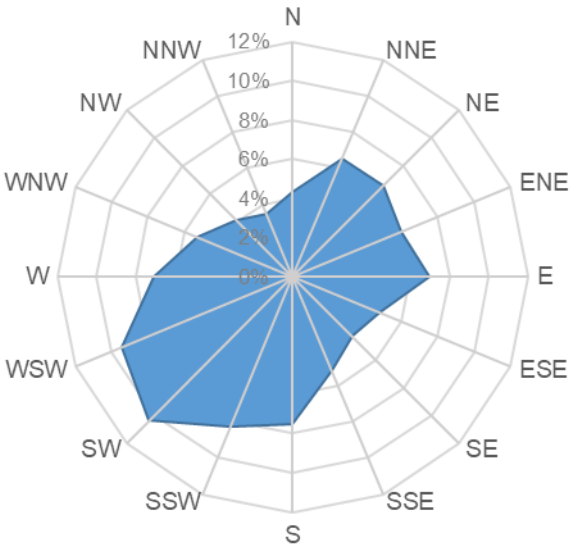
4.1.1 Performance of the wind farm



Monthly production V90 2018

4.1.2 Wind rose

The displayed wind rose is a graphical representation of the wind speed and direction measured all over the wind farm.



Wind-rose

For all wind speed categories, the wind direction WSW prevails.

4.2 Planned maintenance :

MVOW, the service contractor for the Belwind **V90 WTG's**, performed the following planned maintenance and inspections in 2018:

- **8-yearly service:** Yearly, an annual service is done on all the turbines. Every component is carefully inspected and made sure it will operate correctly for the next year. On 16th December MVOW should have finished the 8-yearly-maintenance on BW, which takes 4days/turbine. MVOW however experienced a delay of several months. This is mainly due to the allocation of people on other campaigns (e.g. oil exchange campaign). MVOW has finished the campaign on 30th April 2019.
- **Statutory inspections:** on regular intervals, the service elevator (3 months), the Acta crane on the transition piece (1year) and the hook-on points (1 year) are inspected and certified by a 3rd party;
- **HV inspections:** every year, MVOW skilled technicians and a third party inspect and certifies the HV installation. Both the switchgear and the transformer are inspected. The switchgear in the turbines is inspected with ultra-sonic equipment;
- **Blade inspections:** All blades from all WTG's were inspected by the use of drones. As the drones and the cameras are constantly evolving and more detailed analyses can be done, MVOW concluded that there was a big amount of blade damages in different categories.
- **Oil exchange campaign:** On 15/08/2018 MVOW initiated a campaign to change hydraulic and gearbox oil on the turbines in the windfarm. For this campaign a subcontractor was hired by MVOW to assist. The company OceanTeam has a SOCOT-unit available that is designed for these operations.

OceanTeam SOCOT unit

The maintenance contract of the **electrical installation** with CG is still actual.

Booster station:

CG Holding and Parkwind performed all planned maintenance:

- Yearly mandatory statutory inspections of high voltage installation;
- Yearly maintenance on all low voltage parts of the installation;
- 3 Monthly visual inspection of the high voltage parts of the installation;
- Annual maintenance of Fire detection & Fire Fighting;
- 3 Monthly maintenance on all SCADA systems and IT infrastructure.

- Start of SCADA upgrade/ replacement

Offshore High Voltage Station:

CG Holding and Parkwind performed all planned maintenance:

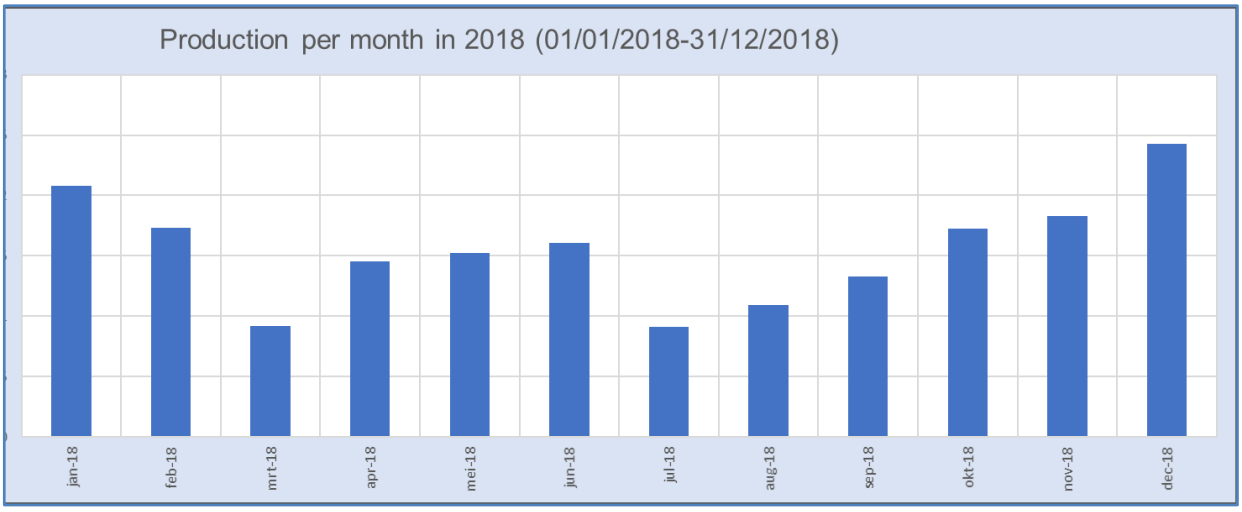
- Yearly mandatory statutory inspections of high voltage installation carried out by supplier: this inspection was carried out according to legal criteria (AREI) and no major observations were made;
- 3-monthly mandatory statutory inspections of all lifting equipment by supplier: all secondary equipment, cables, chains, slings, hooks and the cranes mechanisms are inspected to see if any aging or damage has occurred to the equipment;
- 3-monthly mandatory statutory inspections of all personal protective equipment by supplier: the inspection focuses on the state of all PPE's used and verifies if all PPE are maintained and used as intended by the manufacturer;
- Yearly inspection and maintenance of the fire detection system this maintenance campaign focuses on testing of the fire detection equipment and fire control cabinet functions;
- Yearly inspection and maintenance of the firefighting this maintenance campaign focuses on the firefighting equipment, e.g. pressure on the firefighting gas and portable fire bottles and test of the release valves and activation push buttons;
- Yearly maintenance of HVAC installation: annual replacement of filters, functional tests of all valves & sensors, inspection of the ice water machine and cleaning of the heat exchange condensers is performed;
- Yearly inspection of diesel fuel system: general inspection of the diesel generator, pumps and valves are focused during this yearly maintenance. The diesel tank and its leak detection is also checked;
- Yearly inspection of life saving equipment (life jackets, life raft, immersion suits and portable fire extinguisher) by supplier;
- Thermal Imaging LV, MV and HV equipment: CG carried out regular inspection using thermal imaging camera;
- Ultrasonic inspection of MV and HV equipment: CG carried out regular inspection using ultra sonic measuring equipment;

On the **foundations**, the following tasks have been performed in 2018 as part of the routine maintenance:

- Inspection, maintenance and recertification of the fall arrest systems: the complete fall arrest system is inspected and recertified by qualified technicians. If any system is non-compliant it gets replaced as soon as possible;
- Inspection of cathodic protection: the cathodic protection needs to prevent/limit the corrosion on the primary and secondary submerged steel. During this campaign the protection is measured and evaluated if the protection grade is still enough compared to design values. The measurement of the actual cathodic protection was done by handheld drop cell Ag/AgCl reference electrode and with an ROV mounted stab probe;
- Survey of inter-array cables: this multibeam survey takes a snapshot of the sea bottom condition and the results are used to determine the depth of burial of the cable assets;
- Survey scour protection: This multibeam survey measures the level of scour protection compared to the level during as-built, design and earlier years; internal foundation inspection, especially focused on corrosion in fall;
- Internal and external NDT-inspections of welds, bearings and boat landing studs;
- ROV inspection of outer submerged foundation to evaluate the marine growth and presence of ropes, fishing nets, rocks or other debris;
- Inspection of paint by qualified paint inspector and subsequent touch-up, especially on the ladders and top platforms;
- Paint repairs if necessary: on some foundations, some of the circumferential welds have been repaired. Smaller repairs were done on the ladders and railing on the topside.
- Smart foundation monitoring: the WTG C01 is equipped with several sensors in order to monitor the grout, loads, and vibrations.

5 The Belwind DEMO project 'Haliade' GE

Production



Monthly production GE-Haliade 2018

6 Environmental Research

The MUMM coordinated all the foreseen standard environmental monitoring activities in the field. There was a continuation of the bird assessments, the fish assessments by line fishing and trawl net fishing as further research activities on the fouling organisms on the foundations and scour protection, the seabed and the fauna at the reef balls. In collaboration with scientific organizations, some dedicated programs were also started-up in 2017 and further executed by the MUMM whereby Belwind cooperates where relevant (Bat-monitoring, fisch campaign, fish-tracks, diving operation, …).

7 Permit conditions

In compliance with the authorization for the construction and a license for the operation of a wind farm on the Bligh Bank in the Belgian sea areas article, we give an overview of the environmental permit conditions as mentioned in the appendix 1 of the authorization for the construction and a license for the operation of a wind farm (see Table 1).

Table 1: Permit conditions overview

Condition Number	Condition Summary	Current Status
2	Each planned modification must be reported to the Board and will be included in the annual work report.	No modifications in 2018.
4	The holder undertakes to find and recover all floating or sunken objects used for its activities which, for any reason, have ended up in the sea during the construction, operation or dismantling stages.	All dropped objects related to Belwind offshore activities (#4) are recorded in the online reporting tool, the SOS system, and notified to the Board.
14	During construction, all foundations and structures already finished must have a temporary warning light (at the highest point) for shipping and aviation traffic.	No new foundations installed in 2018.
15	The holder must set up the necessary safety systems to assure the signalling of the wind farm and structures at all times.	Since 8 February 2011 all navigation and aviation signalisation are fully operational. All cases of defects or malfunctioning (only Tier 1 events) were reported to the relevant authorities and repaired as soon as possible.
16	All WTG's must be numbered individually at the base of the mast and at the top of the nacelle.	The foundation and the WTGs have been numbered in accordance with the requirements of this condition.
17	All WTGs and transformers must be provided with collection receptacles to prevent liquids from being released in the environment.	The design of the WTG is such that in case of leakage in the nacelle, all fluids are collected in the central part of the nacelle. From here, collection receptacles are installed under the oil pumps and hydraulic systems as standard.
20	During the operation stage, the availability must be facilitated of a specially equipped intervention vessel (or combination of vessels) for assignments concerning the prevention of shipping traffic accidents and cleaning up sea pollution around and in the wind farm	On 22 January 2011, an agreement was signed with Federal authority responsible for the marine environment. Further clarification regarding the practicalities of the agreement have been clarified in vision text signed by the Secretary of State, DG Environment, MUMM and wind farms C-power, Belwind and Northwind.
21	Once or twice a year, the holder must take part in simulated nautical accidents, emergency towing exercises and pollution combating exercises.	On a regular base Belwind MVOW execute internal emergency exercises (see 8.1.3 of this report).

Condition Number	Condition Summary	Current Status
24	Before laying protective mattresses or other artificial erosion protection on the seabed, the holder must verify and certify that all components chosen can be used without any danger of leaching into the marine environment. The composition of the erosion protection must be presented to the Board for approval. The use of monoliths and slag is hereby prohibited.	No new construction material to be approved in 2018.
29.1	The construction materials and rip-rap must be made of natural materials and must not contain any waste materials or a secondary raw material… the use of slag is prohibited.	No new construction material to be approved in 2018.
31.2	Pile driving activity between 1 January and 30 April will be subject to additional, special monitoring in the amount of EUR 50,000 at most, which is not included in the estimated budget and is completely at the expense of the holder	No piling activities have been performed in 2018.
33.1	The lighting of the turbines for the benefit of shipping and aviation traffic must comply with the conditions set by the competent authorities.	Lights are installed according to the Navigational Aids plan and have been fully operational in the O&M reporting period. Since Nobelwind is built around Belwind, the Navigational Aids Plan of Belwind has been changed into a Navigational Aids Plan of the Bligh Bank, considering the whole zone of Belwind and Nobelwind as one zone.
33.2	Foghorns, which come into operation automatically in the event of a meteorological visibility of less than 2 sea miles, must be placed on the corner turbines.	Fog horns are installed according to the Navigational Aids plan and have been fully operational in the O&M reporting period. See also 33.1.
34	The holder must maintain the farm on a regular basis.	All installations are maintained on a regular basis.
48	A logbook must be kept in which the following is specified for each turbine: ➢ Date, time and all relevant data of incidents that occur which have an impact of the environment, stating the measures taken; and ➢ The recording of hazardous waste materials, the date of removal of the relevant batch of waste, the quantity and the name of the carrier and the recognised waste processor must also be recorded.	We confirm that logbooks have been kept for all turbines since start-up of the first WTG and this has continued during operation.

8 Operations Management

8.1 Health Safety and environment

8.1.1 Unwanted events over the reporting period

Hereunder the most important unwanted (LTI) events are elucidated:

Accident with LTI [04/10/2018]: While climbing up, the victim bumped into the ladder, hurting the knee.

8.1.2 Proactive safety initiatives

In 2018 some proactive safety initiatives, to avoid unwanted events from happening, were initiated:

To stimulate the reporting of near misses, hazard observations and opportunities for improvement in the online 'SOS' reporting system, a KPI was set for all O&M personnel of at least one notification per offshore day. This KPI stimulated the reporting and use of the SOS system, making sure people are more familiar with the system and ensuring a process of continuous improvement. The KPI had a big impact on the amount of reported event.

Offshore workplace inspections, on both the OHVS and turbines, were executed by the External Service for Prevention and Protection at Work. All remarks were logged into an action list with Responsibles assigned. In this framework Legionella testing was performed.

The Employer Requirements for HSSE Assurance for Contractors were finalized. These HSSE Employer Requirements provide a clear overview of the requirements Contractors are expected to meet regarding training, Work Vessel Coordination, Emergency Response, risk assessments, method statements, management of change, environmental requirements regarding hazardous substances, waste, … The HSSE Employer requirements were also translated in a HSSE Questionnaire for Contractors which is to be used to compare Contractors during tender phase.

The HSSE Inductions were updated conform new and revised safety procedures. The first steps were taken to transform the current inductions, in PowerPoint format, to an online induction system coupled to the SOS system for follow up of training certificates.

Several Risk Assessments were created or reviewed, such as:

- Risk Assessment First Aid
- Risk Assessment Confined spaces
- Risk Assessment Environmental strain / influence
- Risk Assessment Security
- Risk Assessment Night Work
- Risk Assessment Helicopter operations

Existing work procedures were updated, and new procedures were implemented. Some examples include:

- Work Vessel Coordination procedure
- Working with drones
- Organization of Safety Exercises
- SF6 procedure
- Alcohol and drug procedure (under final revision)
- Exploitation procedure
- Night Work

8.1.3 Safety Exercises

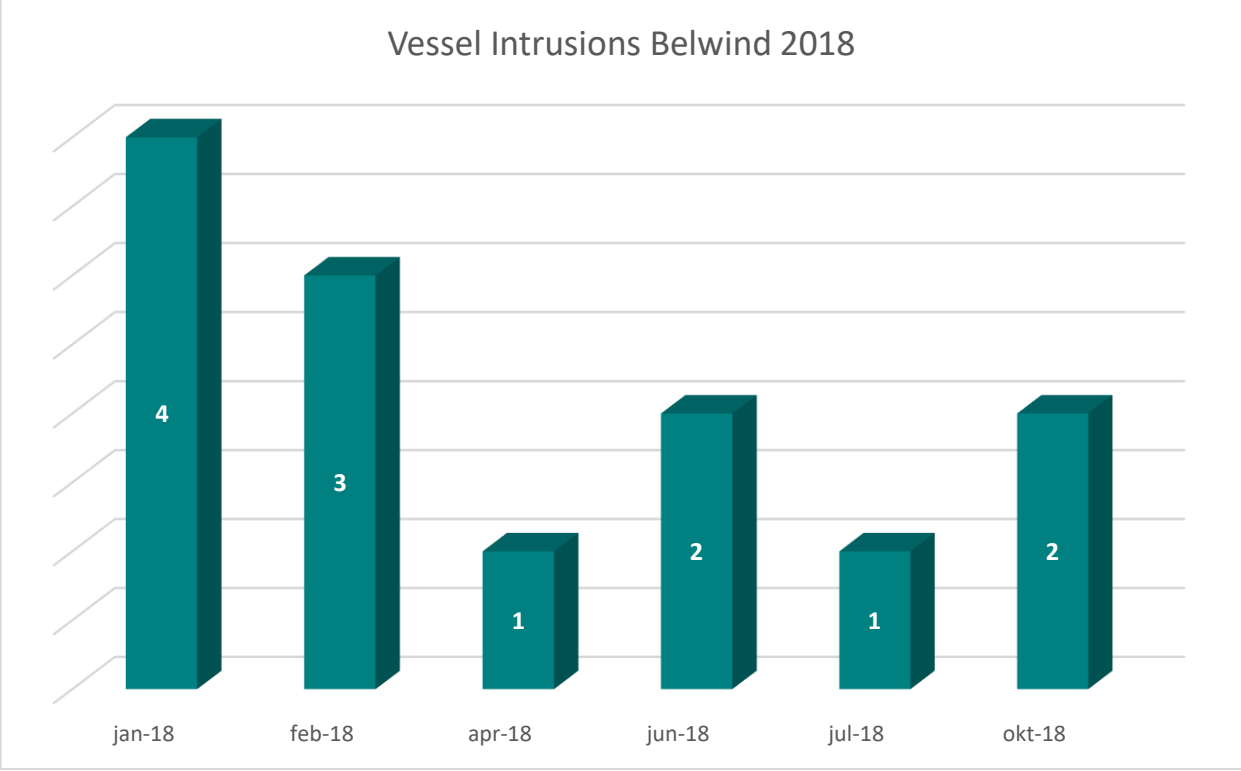
Overview emergency exercises 2018	
WTG	03/07/2018: Contractor – Evacuation unconscious victim in TP basement
	15/10/2018: Contractor – Evacuation from elevator to tower ladder
	16/10/2018: Contractor – Evacuation from elevator to tower ladder
	16/10/ 2018: Contractor - Eye injury in nacelle due to hydraulic oil
	16/10/2018: Contractor - Shoulder fracture in HUB
	17/10/2018: Contractor - Crushed finger in HUB
	21/11/2018: Contractor – BlighSar Evacuation of victim with Crushed foot out of HUB
OHVS	13/07/2018: BW Elec- Rescue of injured victim from below the meteo tower.
Vessel	25/07/2018: BW WVC – MOB GEO XIV outside windfarm boundaries

8.1.4 Emergency actions (TIER2)

No TIER 2 situations, that need external assistance, were reported in 2018.

8.1.5 Intrusions

In 2018 we had 13 intrusions reported on the Belwind concession. A good monitoring of the wind park will be executed as a direct action.



8.2 Vessel & accessibility

For maintenance on the turbines the Esvagt Supporter (in December 2017 replaced by the Esvagt Mercator) is used as hotel/mother ship. Small crew transfer crafts, FRC's, are being used for transfer of personal, tools and equipment on the wind turbines, as well asfor maintenance on the OHVS and the foundations, for delivery of parts and equipment to the wind farm, and for carrying out surveys and measurement campaigns.

8.3 O&M office Parkwind

O&M team offices are located in the harbor of Ostend.
Esplanadestraat 10B
8400 Oostende

9 Conclusion and outlook

2018 was not the most productive year since the beginning of Belwind, mainly due to less wind than predicted in combination with the major blade repair campaign. Where unplanned downtime occurred, the teams managed to keep the unavailability of the turbine to its minimum.

The maintenance routine on all aspects (WTG, civil and electrical) was carried out. Belwind and contractors were challenged a few times with unexpected issues, such as the blade damages and generator and bearing issues. With the correct lessons learned implemented in both scheduled and unscheduled tasks, it is expected that in 2019 the maintenance routine can continue without any major surprises to overcome.

No big HSSE incidents were recorded and all tasks as mentioned under the operational permits are well managed. The monitoring results of the installed infrastructure show no significant observations for 2018.

Belwind, captured under the Parkwind organization, will keep striving for innovation in terms of maintenance procedures, preventive actions, O&M inspection tools, etc. as it has been doing in the past. This smarter maintenance shall allow Belwind to enlarge its maintenance scope without running the risk of needing a larger OPEX budget. Next to the standard maintenance, it is expected that some issues start showing off after 8 years in operation which might need some more dedicated attention. However, with a strong team as Parkwind, we are confident that any concerning progress can be tackled adequately and preferably in a proactive matter.