Belwind Offshore Energy

Annual work report 2016

Offshore wind energy power plant

Belwind

Subject	Author	Revision	Date
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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 (Figure 1).

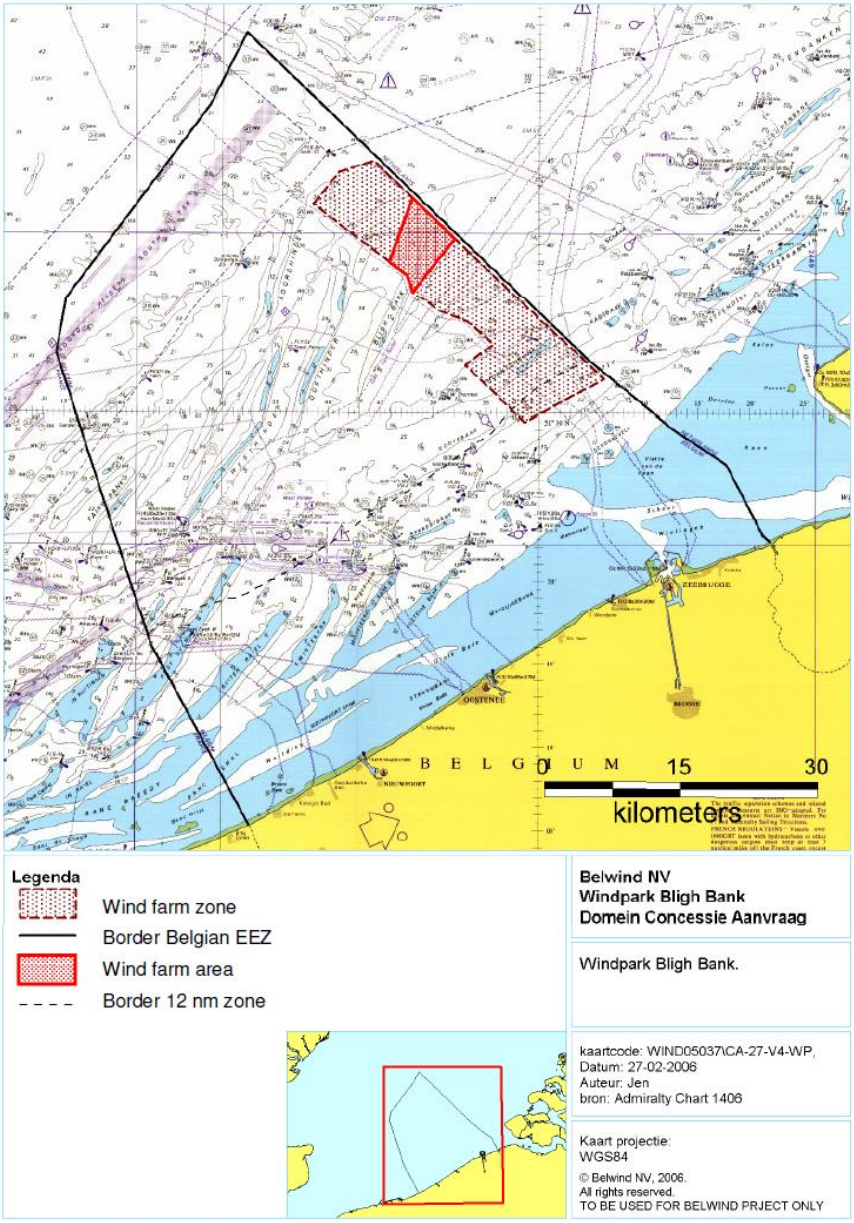


Figure 1: Location offshore wind farm Belwind

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 will be constructed in phases.
The pilot phase, Belwind 1 or Belwind phase 1, 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. Phase 1 has been erected in 2009 and 2010 and is fully operational since January 2011.

Figure 2: Locations of the wind turbines and the grid connection phase 1

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 (Alstom Haliade 6M – rotordiameter 150m) at location L01. The Belwind Demo project received its 33 kV 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, has been 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 by Belwind and Nobelwind. Nobelwind obtained in 2015 the necessary authorization for the realization of the windpark.

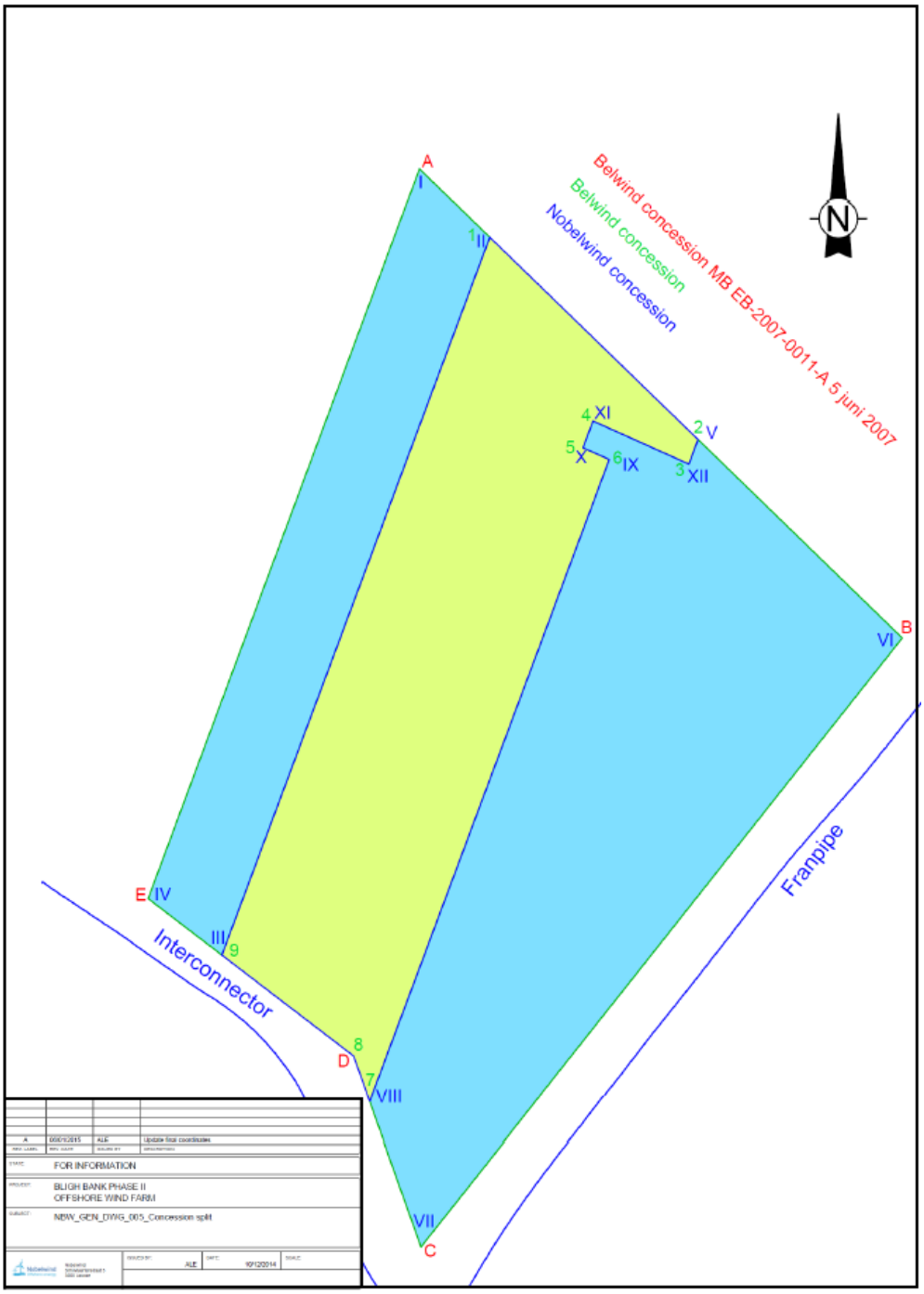


Figure 3: Location of Nobelwind build around Belwind (open field).

Nobelwind will consist of 165MW (50 WTG's of 3,3 MW – Vestas V112), with its own OHVS and 220 kV submarine power cable to the Northwind OHVS.

Construction of Nobelwind started in 2016. From May to September the Vole Au Vent installed the monopiles and transition pieces. After installing the 51 foundations the Vole Au Vent started the installation of the wind turbines. By the 31st of December 2016 22 WTGs were already installed in the Nobelwind concession.

3 Construction works on the Belwind concession

The Nobelwind activities have mostly been performed on the outside of the Belwind concession boundaries. However, the installation of the Nobelwind OHVS with its foundation has been located inside the Belwind concession. For these works a temporary Nobelwind work zone was defined in agreement with the Belwind operations. The Nobelwind OHVS is connected with the already pre-installed 220kV interconnector cable which leads the High Voltage energy via the OHVS of Northwind and a shared Cableco 220kV export cable to shore (Elia substation located in Zeebrugge).

Also, the cables leading to the NBW concession Wind Turbine Generators (WTG`s) have partially been installed in the Belwind concession. These infield cables have been buried by jetting technique and do cross other cables at few locations. These cable crossings are designed with matrasses separating both cables. Between the Belwind and the Nobelwind OHVS a 33kV cable was installed as a purpose to be able to back-feed either of the windfarm assets in case of a major export cable damage. This seriously mitigates the risk of the WTG`s deteriorating under offshore conditions when not powered. The 33kV coupling cable has been pulled in on the BW OHVS via the spare J-tube which received a new adapted bellmouth for this purpose as the bellmouth was buried under scour protection. Mattresses were installed to prevent damage on the cable during pull-in and the cable was trenched and stone buried near the OHVS. The connection will be finalized in 2017 under the Nobelwind project.

4 O&M Belwind 1

4.1 Environmental research activities:

Also in 2016 the MUMM coordinated all the foreseen standard monitoring activities in the field. There was a continuation of the bird assessments, the fish assessments by line fishing and trawl net fishing as were there were further research activities on the substrate on the foundations and the seabed. In collaboration with some scientific organizations, some dedicated programs were also started-up in 2016 (for ex corrosion, grout, …).

4.1.1 Bat Monitoring

As last year, Belwind facilitated the installation of a bat monitoring equipment on the BW1 OHVS. The installation was installed in March well before the spring migration of certain bat species. The recorded ultrasonic signals allow for the researchers to diversify the different species and note their presence as passing by or as more local.

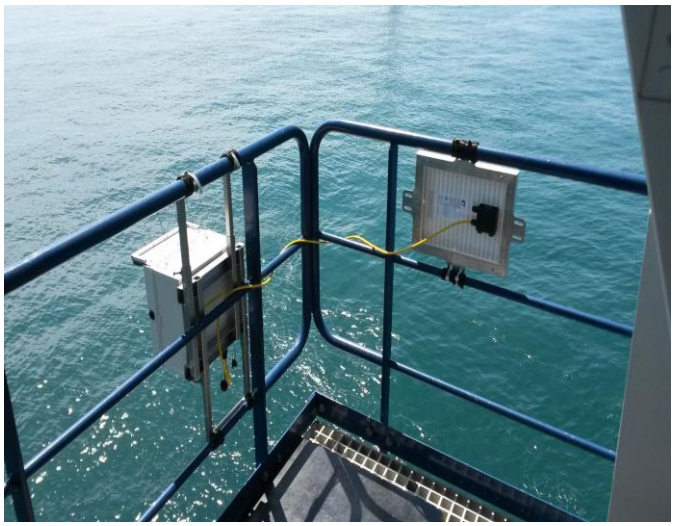


Figure 4: Installation of Bat recorder system on BW1 OHVS Cable deck

4.1.2 Seismic campaign

A seismic campaign was launched in the framework of the Search and TILES research projects. A complex interface was spotted to align windfarm constraints with the research goals. Belwind proposed to the MUMM to release within this campaign the already available windfarm data at the MUMM as shared under other frameworks. This created a win-win where no coordination needed to be set-up and the research party got the data with less effort.

4.1.3 Fish telemetry installation

Following previous year campaigns where the presence of cod was monitored in the Belwind windfarm a follow-up campaign was set-up that would focus on the behavior of the cod under the influence of piling noise nearby. In the spring of 2016, a network of 14 fish telemetry receivers was placed around BB-C05.The deployment and retrieval of these receivers have been optimized over the last campaigns. During several occasions line fishing was done and cod was implanted with a small telemetric device in order to track their movements.

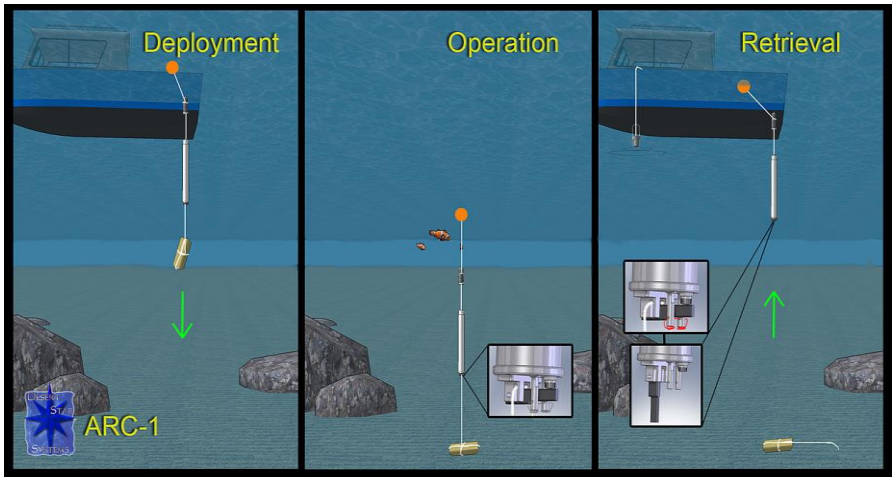


Figure 5: deployment and retrieval of Fish telemetry devises

During the piling activities, several noise measurements were executed in order to be able to make conclusions on the effects noted. Some of them where located as a reference measurement near BB-C05 and some others also fell into Belwind as a certain distance needed to be kept between the measurement vessel and the piling vessel. In all this, a very close cooperation needed to be present between the research parties and the windfarm operator.

Most of the telemetric devices could be perfectly retrieved but some of them did seem to have moved in the current and needed some research diving activities to retrieve them from the seabed.

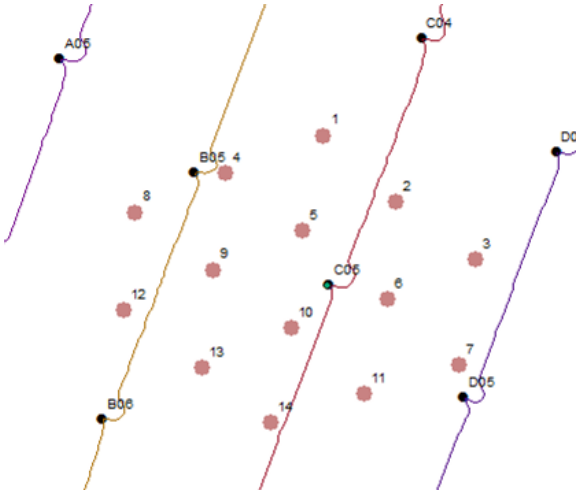


Figure 6: 14 locations around BB-C05 equipped with receivers

4.1.4 C-POD installations

3 CPOD underwater noise detectors were installed in the Belwind windfarm to measure the effect of the NBW piling noise on the behavior of Sea mammals in the area. By detecting the specific ultrasonic underwater sounds, an evaluation of the presence of sea mammals can be done. No results are known yet but it is visually very clear that sea mammals have repopulated the windfarm since piling operations as they are spotted at multiple occasions.

Figure 7: Sea mammals roaming at the Belwind Windfarm

4.1.5 Risk Assessment Fish-track trawler fishing

As the MUMM had the opportunity to use the research vessel Simon Stevin for their yearly planned fish track monitoring campaign, the need for a correct risk evaluation was detected. All parties together performed a HAZOP and correct mitigation measures were launched to assure the highest levels of safety during such high risk activities in the windfarm for both the research vessel and its personnel as the windfarm assets.

5 Wind farm annual operations information

5.1 Production

5.1.1 Performance of the wind farm

Output and Capacity factor

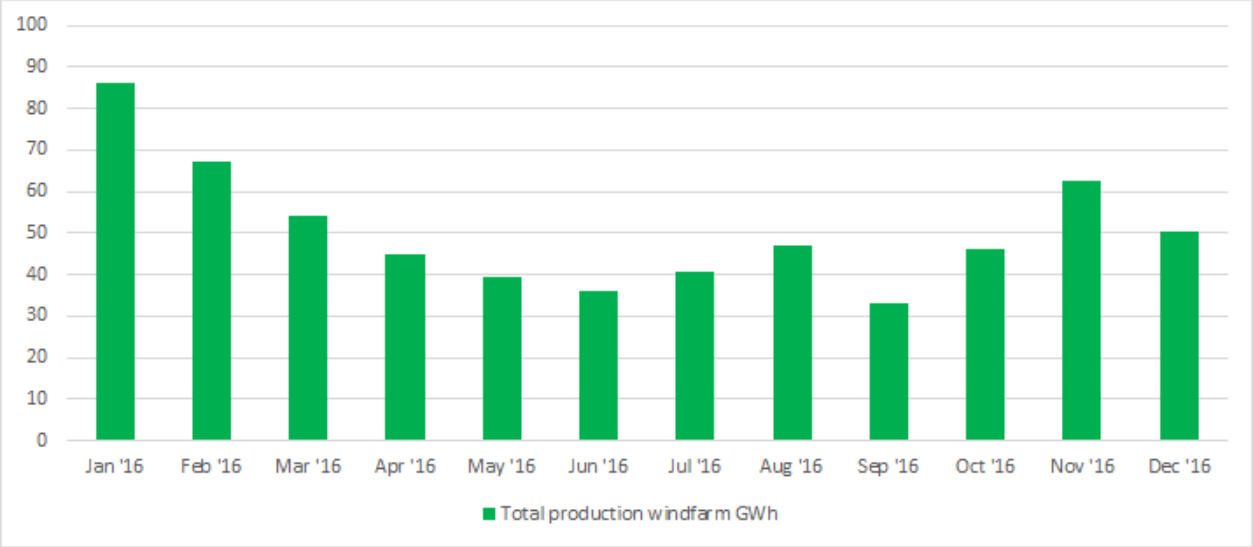
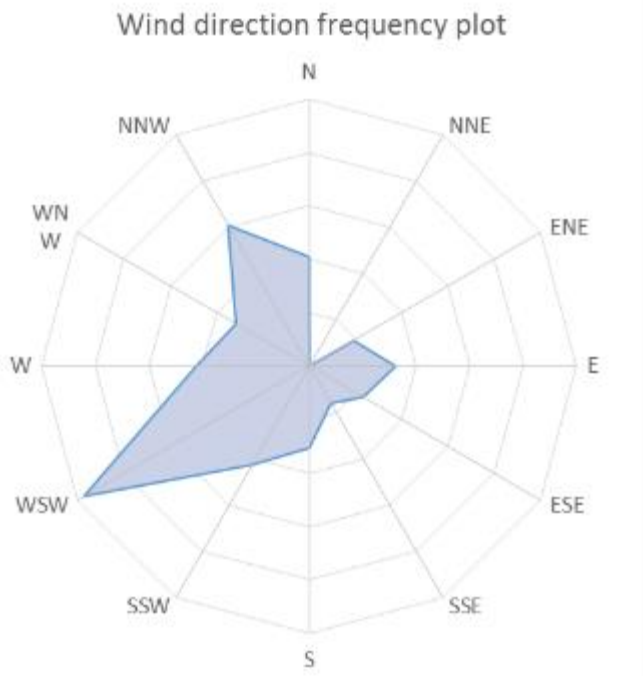


Table 1: Monthly production 2016

5.1.2 Wind rose & energetic wind rose



Graph 2: Energetic wind rose

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

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

5.2 Maintenance

5.2.1 Planned Maintenance

MVOW and GE, the service contractors for the BELWIND1 **WTG's**, performed the following planned maintenance and inspections in 2016:

- Annual service: yearly an annual service is done on all the turbines. The annual service takes three full days per turbine. Every component is carefully inspected and made sure it will operate correctly for the next year.
- 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 3th party [Vincotte].
- MVOW HV inspections: every year, all the HV equipment on the turbines (transformer and switchgears) is inspected by MVOW.
- Vincotte HV inspections: every year, MVOW skilled technicians and a third party [Vincotte] inspect and certifies the HV installation. 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 evaluating, and detailed more detailed analyses can be done, MVOW concluded that there was a big amount of blade damages in different categories.

As soon as the results were available, BW and MVOW took immediate actions. A blade repair team was created, vessels were arranged and all equipment was ordered.
Repairs were executed by:
Rope workers: Rope workers are working on rather small damages and all lightning damages.

Sky climbers: Sky climbers are used for the bigger damages

Figure 8: Rope workers at work on BW.

Figure 9: Sky climbers in use

As immediate actions were taken, all blade damages are under control and all blades are monitored yearly.

The maintenance contract of the **electrical installation** with CG is still actual.
The maintenance + helpdesk contract with EBO-enterprises for the industrial networking is still actual.
In 2016, the maintenance contract with Siemens fire-fighting has been signed.

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, in 2016 the batteries in each control cubicle have been replaced
- 3 monthly maintenance on all SCADA systems and IT infrastructure.

Offshore High Voltage Station:
CG Holding and Parkwind performed all planned maintenance.

- Yearly mandatory statutory inspections of high voltage installation carried out by SGS: this inspection was carried out by SGS according to legal criteria (AREI) and no major observations were made.

- 5 yearly SGS electrical inspections has been done in 2016, next inspection will be foreseen in 2021.
- 3 Monthly mandatory statutory inspections of all lifting equipment by SGS: 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 SGS: 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. In 2016 Siemens has replaced the batteries in their control cubicles on the OHVS.
- 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. Also the diesel tank and its leak detection is checked.

- Yearly inspection of life saving equipment (life jackets, life raft, immersion suits and portable fire extinguisher) by Survitec Group
- 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.
- A campaign to replace lights bulbs damaged by corrosion started in 2015 continued in 2016. 88 Pieces have been already replaced.
- No extra maintenance has been done during 2016 on the bilge water separator, filters will be replaced during de first semester of 2017.

On the **foundations**, the following tasks have been performed in 2016 as part of the routine maintenance:

- Inspection, maintenance and recertification of the fall arrest systems in spring
- Inspection of cathodic protection by several techniques such as drop-cell, proximity probes or ROV stab measurements
- Survey of cables and scour protection by multi-beam survey
- 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
- Cleaning of the ladders on the foundations (high pressure water jet) and installation of a anti-fouling scrapper
- 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 as paint was flaking and not adhered any longer. Also smaller repairs were done on the ladders and railing on the topside.

Figure 10: paint repairs foundation

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.

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.	1. Since the development of the second phase of the Bligh Bank project (Nobelwind) and the design of the shared grid connection Nobelwind and Northwind, it was decided by Belwind (for financial and technical reasons) to transfer a part of the owner ship of the domain concession to a new company, namely Nobelwind NV. Therefor the construction and operation licence is transferred partial to Nobelwind NV. The modalities of this transfer to Nobelwind have been confirmed by a Ministerial Decree of October 7th 2015. 2. The validity of the construction and operation licence of Belwind has been extended till January 22th 2038.
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.	No floating of sunken objects has been established.
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 2016
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 is fully operational
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
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, Vestas and Seahopper execute internal emergency exercises.
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.	For the installation of the IA (Inter Array) cables for the Nobelwind project in the Belwind concession zone, the approval from the MUMM has been obtained regarding the components of the installed protective mattresses.

Condition Number	Condition Summary	Current Status
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.	Certificates of Origin supplied for all scour protection materials have been transmitted to the MUMM. See also 24.
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 has been performed in 2016.
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 the Nobelwind windpark is built around the Belwind windpark, the Navigation Aids Plan of Belwind will be adopted and will consider the whole zone of Belwind and Nobelwind as 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.

Table2: Permit conditions overview

9 Operations Management

9.1 Health Safety and environment

9.1.1 Proactive safety initiatives

In 2016 some proactive safety initiatives, to avoid unwanted events from happening, were initiated:

The implementation of an online full near miss and hazard observation reporting system. Personnel is encouraged to report all unwanted events using the online reporting tool that was developed in 2016, the 'SoS' [SafeOffshoreOperations] system. The system facilitates the notification, reporting and follow-up of events.

The SoS system also includes a track and trace and work permit system. Safety critical tasks, such as lifting activities and working on high voltage installations, are to be approved by the QHSSE department before being executed.

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

- *Working with third parties*
- *Diving procedure (ongoing)*
- *Drones*
- *Asbestos procedure*
- *Legionella procedure (ongoing)*
- *Ergonomics procedure*
- *Evacuation procedure*
- *Lifting procedure*
- *Method statement procedure*
- *Mobile working means procedure*
- *PPE procedure*
- *Procurement procedure*
- *Risk assessment procedure (ongoing)*
- *Training procedure*
- *Youngsters, interns and temporary employees*
- *Working hours, night and shift work*
- *Working at height*

Several trainings were prepared and developed such as a VCA-VOL training, ISM / ISPS course, Confined space training, etc.

The ERP BW was revised. Changes in comparison to the previous version include: integration of the NBW project (previous Belwind phase II), a decrease of the amount of emergency scenarios to facilitate the use, a more clear definition of TIER events, an update of the contact details, a clear overview of the expected safety drills, etc.

9.1.2 Emergency exercises

Overview emergency exercises 2016	
OHVS	First aid and evacuation of victim from OHVS to vessel
	Man overboard exercise Windcat 8
WTG	Injured person – stretcher casualty WTG
	Hotel vessel injured person – walking casualty CTV
	Hotel vessel fire – personnel onboard CTV
	Hotel vessel man overboard
	Hotel vessel collision drill
	Hotel vessel stranded / drifting vessel
	Hotel vessel emergency evacuation to second vessel
	Rescue – ladder, internal tower, external TP
	Rescue HUB to nacelle
	Rescue- nose cone evacuation

9.1.3 Emergency actions (TIER2)

Tier 2 event: On SCADA several errors on the aviation lights, navigation lights and foghorns were discovered. As less than 80% of the lights was operational a TIER 2 situation was raised conform the ERP.
MRCC was informed and all lights were replaced as soon as possible. As a mitigation, the WTG package manager took this topic up on the weekly toolbox. On this toolbox the importance was explained and a request was given to take the online monitoring serious.

9.2 O&M office Parkwind

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

10 Conclusion and outlook

2016 was not the most productive year since Belwind was built in terms of Energy, mainly due to the low winds in combination with the blade repairs. Where unplanned downtime occurred, the teams managed to keep the unavailability of the turbine to its minimum.

We are happy to report that no big QHSSE incidents were recorded and that all tasks as mentioned under the operational permits are well managed.

Belwind, captured under the bigger 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 we do foresee some issues to start showing after 6 years in operation which might need some more dedicated attention but with the strong team we are confident that any concerning progress can be tackled adequately and preferably in a proactive matter.