WIND FARM THORNTON BANK PHASE 1

ANNUAL ENVIRONMENTAL REPORT 2009

Table of Contents

INTRODUCTION

C-Power's wind farm is located on the Thornton Bank, some 27 km to the nearest point of the coast. The project is realised in three phases.

Phase 1 or the pilot phase of the Thornton Bank project consists of the construction and exploitation of six REpower 5M wind turbine generators (WTG) on gravity base foundations.

Phase 2 and 3 will consist of the installation and exploitation of 48 Repower WTG of 6 MW on jacket foundations. The works for phase 2 and 3 are planned to start in the first quarter of 2011.

All 54 wind turbines will be fully operational by the end of 2013.

The offshore construction works of phase 1 have started in April 2008 and have been finalised at the beginning of June 2009.
The 6 WTG were commissioned from January till May 2009.
The exploitation of phase 1 started in June 2009, after the commissioning of the last wind turbine D6.

After one year from the first MWh produced and six months after the overall wind farm commissioning, this environmental annual report sums up:

- all information about the environmental permit conditions
- reporting of the monitoring activities performed by C-Power in 2009
- wind turbines data
- synthesised production data
- an overview of health, safety and environment issues

ACTIVITIES DURING 2009

Activities during the first half of 2009 consisted of finishing the construction phase and the take-over in view of the exploitation. Works for instance included the installation of the external J-tube on the 6 WTG, the post lay survey of the 150kV cable, the laying of infield cables and the interconnection between offshore and onshore cables.

As of January 2009, the wind turbines entered one by one into their exploitation phase after the signature of the "Mechanical completion test". Table 1 gives an overview of the exact starting date of operation per wind turbine.

As of that time, operation and maintenance activities are taken over by Repower under supervision of C-Power.

As of July 2009 the pilot phase of the wind farm is considered as completely operational and entered in its exploitation phase (from a technical point of view).
From July to December 2009 the principal scheduled works were the 500 hours maintenance activities.

As expected there were a lot of maintenance activities at the beginning phase due to technical or setting errors of the wind turbines.

Item	End of WTG commissioning	Substantial Completion
D1	21/01/2009	11/06/2009
D2	29/01/2009	11/06/2009
D3	29/04/2009	29/06/2009
D4	29/04/2009	29/06/2009
D5	29/05/2009	29/06/2009
D6	19/05/2009	29/06/2009
SCADA		29/06/2009
Marine installation works		06/05/2009
Inter array electrical works		03/06/2009
ABB export cable works		19/06/2009
Overall wind farm		29/06/2009

Table 1 Main dates during the commissioning phase

1 PERMIT CONDITIONS

Condition 2 Planned project adaptations

Annex IV of the building authorisation and environmental permit (Ministerial Decree (MD) of 14-04-2010, as modified by MD of 10-05-2006 and MD of 25-04-2008) stipulates in its condition 2 that every planned project adaptation needs to be notified to the administration (MUMM) and included in the annual report.

MUMM has been informed of C-Power's planned project adaptations of phase 2 and 3 in October 2008 during a meeting at MUMM's offices, just after having submitted the application for the authorisation of the project adaptations to the energy regulator CREG.

The planned project adaptations for phase 2 and 3 are:
- Adaptation of the layout of the wind farm: in order to minimise the wake effect, the WTG have been reduced in number and have been spaced out; (see figure 1)
- Reduction of number of WTG: from the initial 60 to 54 WTG;
- Use of 6 MW WTG: the WTG supplier REpower has announced that by 2012 the 5 MW WTG will be replaced by the 6 MW WTG;
- Extension of the concession area in order to adapt to the boundaries of the wind energy development zone designated by Royal Decree of 17 may 2004, which was not yet established in 2002, when C-Power applied for the concession zone at the Thornton Bank. In subarea A the extended zone will measure 10, 68 km², in subarea B 9, 23 km². The total concession area of C-Power will measure 19, 90 km²;
- Use of jacket foundations as an alternative foundation;

A full copy of the application file was sent by the CREG to all relevant administrations, among which the MUMM, as of October 2008.
The MUMM, being informed of the planned project adaptations, requested C-Power to prepare an addendum Environmental Impact Analysis (EIA) describing and analysing the effects on the marine environment of the planned project adaptations as well as analysing the cumulative effects of the authorised wind farms in the Belgian part of the North Sea, i.e. C-Power, Belwind and Eldepasco.

C-Power's project adaptations in phase 2 and 3, including the extension of the concession area, have been authorised by Ministerial Decree of 3 February 2010.

By its letter of 15 March 2010 to the MUMM, C-Power has notified the addendum EIA (Arcadis, March 2010) This addendum EIA describes and analyses all expected effects on the marine environment generated by the project adaptations, as well as the cumulative effects of the three authorised wind farms in the Belgian part of the North Sea.

The addendum EIA concludes that the effects on the marine environment caused by the project adaptations are not larger nor of a different kind than those of the initial project. On the contrary, given

the reduced number of wind turbines, the impact on the marine environment of the adapted project is expected to be slightly smaller than the impact of the authorised project.

The MUMM subsequently adopted the legal provisions of art. 1, 9° *juncto* art. 3, §2 of the Royal Decree of 7 September 2003 on Permits and Authorisations and stated, by its letter to C-Power of 6 May 2010, that the project adaptations of phase 2 and 3 are to be considered as adjustments *("ingrepen").* Therefore the project adaptations are still covered by the building authorisation and environmental permit of 14-04-2004, as modified by MD of 10-05-2006 and MD of 25-04-2008.

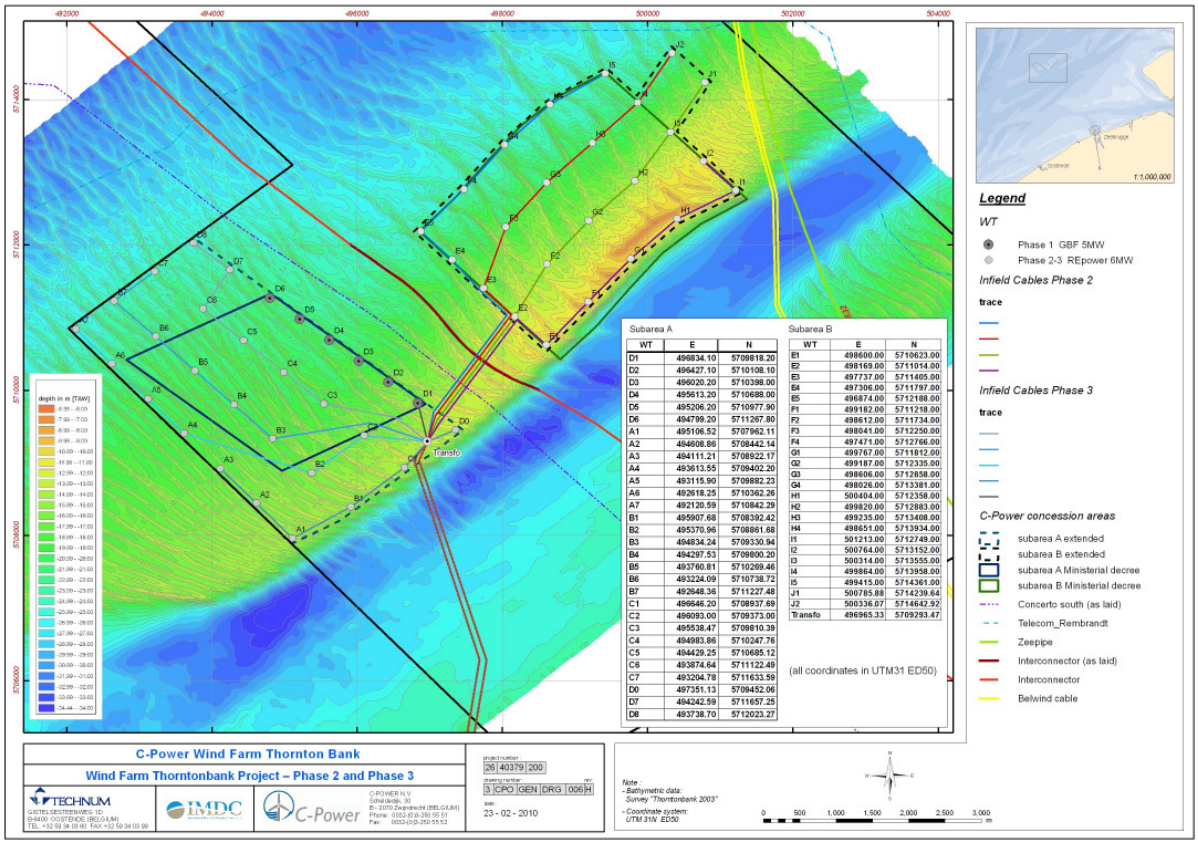

Figure 1: Map of adapted Thornton Bank project

Condition 3 Works in or around the Seaway (Vaargeul)

A common communication practice between MUMM, the nautical authorities and C-Power has been established and applied in order to inform all parties in advance of the time and place of all offshore works and wind farm related activities in the concession area and near the seaway (Vaargeul).

Condition 4 Sunken or driving objects

On 23 October 2009, a stainless steel plate of approximately 1,5 m² was unintentionally dropped in the sea by subcontractor IBO. The plate was fastened according to regulations. Due to a severe wind gust the pressure on the wire ring and connection was too high. The plate was hoisted by the Pallfinger crane on the GBF by Repower. The plate hit the water about 15 meters away from the GBF.
No boats nor divers were in the neighbourhood so it was not possible to recuperate the plate immediately. Given the light weight of the plate, it drove away quickly with the current and sank down at an unidentifiable place so attempts to recuperate the plate later were considered as unrealistic.
Subcontractor IBO was requested to investigate if smaller stainless steel plates can be used in order to complete works.

On 6 November 2009, while lifting down gas bottles from the fire extinguishing on D6 on Thornton Bank to the Windcat, 5 of the 7 bottles have sunken on the seabed and could not be recuperated while sinking down. The bottles are in steel and can contain 40kg of N2, but were empty at the time of the incident. The unintentional dropping happened from low height. The 2 other empty gas bottles fell from the pallet onto the platform of the Windcat. No other damage was caused by this incident.
C-Power has requested Repower to recuperate the 5 sunken bottles. Repower has engaged to perform the recuperation of the bottles during the summer season (2010). The search action and diving inspection was performed on 23-05-2010. Although the diving and search conditions were optimal (3 meter visibility, hardly any current,..), no bottle was found on the sea bed in a perimeter of 12 meter around the foundations. However, the diving report mentioned the cleanliness on and around the scour protection: neither litter nor other objects were found.
In order to prevent the loss of bottles during transport between the WTG and the boat, REpower will use from now on a special cage to transport these bottles. This cage is kept at the REpower premises in Ostend.

Condition 5 & 25 &35 Annual execution report & survey export cable

This report implements condition 5.

A post lay survey of the export 150 kV cable has been performed in January, July and September 2009. The as laid coordinates of the cable have been communicated to the federal department of Energy and to MUMM during a meeting in Ostend in June 2009. Further official reporting was provided during the follow up committee in September 2009 in MUMM's offices.
Twenty copies of the as laid plans have been transferred in October 2009 to the federal department of Energy, who has dispatched a copy of the as laid plans to the MUMM.

A bathymetric survey of infield and export cable routes as well as the sand dumping locations L1, L2 and L3 on the Thornton bank was executed on 24-09-2009 in order to control the burial depth of the cables and the follow up of the scour protection and morphology around the substructures.

The data of these surveys have been put on C-Power's data storage system (Buzzsaw) to which the MUMM has a password protected access.

With regard to the monitoring of the sea cable, it is noticed that the burial depth of the sea cable is changing in the areas with the moving dunes. The burial depth can become more or less profound then the burial depth during the laying of the cable.

However, in general, the depth of the sea cable is not less than 1 meter, except at a few locations due to moving sand dunes where the burial depth is between 0, 5 m and 1 m. This area will be monitored in detail during the next survey campaigns.

At some specific points of the cable route, where other burial depths have been executed according to the permit conditions, the following observations were made:
- at the beach between low and high tide line: between 4 and 1,5 meter burial depth
- at the crossing of Vaargeul 1: between 6 and 4,5 meter under the future depth of the Vaargeul 1
- at the run up of Scheur: between 1 and 2 meter burial depth.

A monitoring campaign of the gravity base foundations (GBF) by ROV and divers was executed in the period between 25-05-2009 and 29-07-2009. Compared with the previous campaign in 2008, no major changes were observed for the scour protection. Videotapes of this monitoring campaign are available on DVD in the site offices of C-Power.

The monitoring of the electro-magnetic fields of the electricity cables has been performed on 21 and 22 May 2010. The results of this research will be transmitted to MUMM as soon as available and will also be reported in the annual report of 2010.

Condition 6 Retribution monitoring activities

The cost of the monitoring activities performed by the MUMM in the year 2009 amounts to 361.263 EUR. C-Power has paid the invoice that was sent in March 2010.

Condition 8 Parameters of the measurement masts

The permit says in annex II that a cumulative monitoring with 1 meteorological mast for the 3 wind farms will be foreseen.

In 2005 the federal government had engaged into the investment of 1 meteorological mast for academic and applied research in marine environment in or nearby the wind farm concession zone.

Therefore, no meteorological mast has been installed in phase 1 and no installation of a measurement mast has been planned for phase 2 and 3 of the Thornton Bank project.

Nonetheless, C-Power will install, instead of the masts, a LIDAR device on the transformer station, which will be built in 2012. By that time, a meteorological data transfer method will be discussed with the MUMM so that the relevant measurement data can be transmitted to the Belgian Marine Data Centre.

However, in the mean time, the meteorological data available from the REguard system of Repower have been transmitted to the MUMM during a trial period. Unfortunately, the north wind direction was not entirely registered, therefore the meteorological data were considered as inaccurate and therefore useless for the Belgian Marine Data Centre.

C-Power has signalled this lacuna to wind turbine manufacturer REpower. According to REpower, a software problem is at the basis of this problem and the possibility that it can still be remedied for the existing WTG is very remote.

Based upon this experience and in accordance with the permit condition, an initiative from the federal research department for a common measurement mast, as promised in 2005, still seems to be the most efficient solution.

Condition 10 &13 &18 & 22.1 & 22.3 Risks & safety

A draft copy of the emergency plan of the exploitation phase was submitted by C-Power to MUMM at the end of November 2008. This emergency plan was subsequently amended, revised and merged with the emergency plan of the construction phase. The final and consolidated version of the emergency plan of C-Power of both the construction and exploitation phase was submitted in September 2009 to the MUMM and to the federal environment department.

The emergency plan contains a list of all vessels of construction phase 1 and of the operation and maintenance phase 1.
The risks related to oils and dangerous substances in the WTG are listed in the annexes of the emergency plan. Among others, procedures describing how to react to the incidental release of oil and dangerous substances in case of fire or collision from a vessel are described in the emergency plan.
A list with the features and the quantities of hazardous and noxious substances (HNS) is annexed at the emergency plan.

The emergency plan for construction and exploitation phase 1 and its annexes is available and regularly updated on the data management system of C-Power (Buzzsaw)

Condition 14

During the first quarter of 2009 problems with temporary warning lights have occurred due to a delay in the energising of the sea cable. C-Power has purchased a stock of solar warning lights and has used these until the connection with the sea cable was realised.

Condition 16

Due to some incidents during construction, two towers had to be switched on the foundations D3 and D5. That is why in 2009 the numbers of the towers on D3 and D5 did not correspond with the foundations during some time. C-Power asked REpower to remediate this problem as soon as was possible. The right numbers have been put on the towers; since then, all 6 WTG are correctly numbered

Condition 20

An agreement for the compensation in environmental advantage has been signed between the Federal Department of Environment, the MUMM and C-Power in January 2009.
This agreement stipulates a yearly financial or material compensation of 70.000 EUR to be paid by C-Power in order to compensate for the potential environmental risk of oil pollution by collision incidents within the wind farm.

Condition 21

Given the fact that construction works were executed till June 2009 and given the first experience of the exploitation phase in the second half of the year, no nautical emergency exercise on sea has been taken place at the Thornton Bank in 2009.
The first emergency exercise with the deployment of the oil control equipment on sea under the coordination of the Federal Department of Environment and in collaboration with the nautical authorities has been successfully organised in April 2010.

Condition 33

All WTG dispose of lighting according to international IALA and ICAO standards. The corner wind turbines D1 and D6 dispose of fog horns that automatically operate at weather conditions of -2 miles visibility.

Figure 2 Fog horn on D6

Condition 44

15 March 2008 is the start date of the validity of the building authorisation, which has been notified to the MUMM.

Condition 45

21 April 2009 is the start date of the validity of the exploitation permit, which has been notified to the MUMM.

Condition 46 & 47

The planning of the construction works have been communicated on a weekly basis to the MUMM, the '*Kustwachtcentrale'* and '*MIK'* .

Condition 48

A log book of the marine works contractor and the wind turbine contractor of C-Power is kept and at the disposal of the supervisory authorities on simple request.
2 incidents with a possible impact on the marine environment have occurred in 2009. They are listed under chapter 6.

Condition 49

A safety area around the 6 WTG of the pilot phase has been established with cardinal buoys. These buoys are located at more than 500 m from the wind turbines. In accordance with the nautical authorities (Scheepvaartpolitie and MRCC), it was agreed to leave these cardinal buoys until they have to be repositioned for the next phase of the construction works.

2 RESULTS MONITORING MARINE ENVIRONMENT

The building authorisation and environmental permit stipulates that C-Power has the following monitoring obligations:

- Hydro dynamics: before, during and after the works at the Goote Bank and the Thornton Bank
- Sedimentation and erosion foundations: before and 1 month after the installation of the foundations; after the first heavy storm and 1 month after the heavy storm
- Sedimentation and erosion cable: after the cable laying works (regular surveys)
- Movement of dumped sand: before, during and after the works, after the first heavy storm and 1 month after the heavy storm.
- Noise and vibrations: measurement of noise above sea level during construction works and at the beginning of the exploitation phase; measurements of vibrations as of year 1 at 3 WTG.
- Risks: meteorological data
- Electromagnetical fields: after the full operation of the pilot phase and after the full operation of the complete wind farm

Hydro dynamics

C-Power has executed measurements of the turbidity, current, wave height and water level at the Gootebank and the Thornton Bank:
- before the works, in February and March 2008
- during the works, in June and July 2008 and
- after the works, in June and July 2009.

The Gootebank was used as a reference location, in order to be able to compensate for hydro meteorological influences.

The analysis of the measurement data has been presented at the offices of MUMM in September 2009. Detailed monitoring data as well as the synthetic monitoring report have been uploaded at the Buzzsaw data management system, to which MUMM has access via a pass word.

The synthetic report analyses the measurement data at the Gootebank and Thornton Bank before, during and after the works with the objective to investigate whether the sediment concentrations at the Thornton bank have changed due to the construction of the wind farm at that location.

The measurements consisted of flow measurements with an ADCP and a RCM-9, wave measurements with an ADCP and turbidity measurements with an OBS3A and a RCM-9.

From the analysis of the data, it appeared that the sediment concentrations occurring at the Thornton bank did not change during the works compared to the reference situation, which was measured before the works had started. Furthermore, it appeared that the concentrations occurring at the Thornton Bank were not changed after the works at the Thornton Bank had ended.

The highest sediment concentrations were found in the reference situation before the works, which is due to the fact that this was the only measurement period that was performed in the winter season.

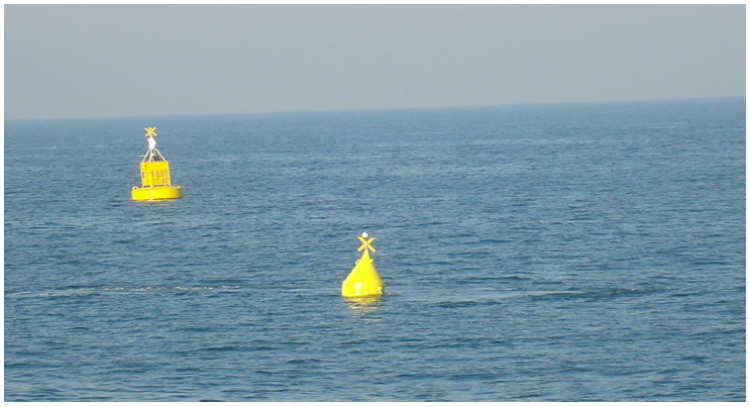

Figure 3 Measurement buoy of ADCP at Thornton Bank

Sedimentation and erosion foundations

In addition to a monitoring campaign of the gravity base foundations (GBF), executed in the period between 25-05-2009 and 29-07-2009, a multibeam bathymetric survey around the foundations was performed on 24-09-2009.

The data obtained from the monitoring campaign in September 2009 were analysed. A general sedimentation tendency is observed with, at one location of GBF 4 and 5, some minor edge scour. However, the limited erosion that took place did not occur at critical locations, i.e. locations at which the difference between the out survey and alarm line are small. Levels remain situated above the alarm line everywhere and no action needs to be undertaken.

The monitoring report is available on C-Power's data management system (Buzzsaw).

Sedimentation and erosion cable

See also under chapter 1 p.9 and p.10

A post lay bathymetric survey of the export 150 kV cable has been performed in January and further follow up surveys were performed in July and September 2009.

A bathymetric survey of infield and export cable routes as well as the sand dumping locations L1, L2 and L3 on the Thornton bank was executed on 24-09-2009 in order to control the burial depth of the cables and the follow up of the scour protection and morphology around the substructures.

All survey data of the 150 kV cable as well as the 33 kV infield cables are kept on C-Power's data storage and management system (Buzzsaw), to which the MUMM has password protected access.

20 hard copies, as well as 5 dvd's, of the as laid charts of the 150 kV, have been transmitted to the supervisory authority (Federal Department of Energy).

As a general conclusion, between September 2009 and previous surveys, the results show very limited changes in seabed level (order of 0,05 and 0,20 m) at most parts of the 150 kV cable trajectory

Movement of dumped sand

A bathymetric survey of the sand locations L&, L2 and L3 on the Thornton Bank has been performed on 24-09-2009.

The depth of the pits on the sand dumping locations as observed during the phase 1 execution works, were confirmed during the survey executed on 24-09-2009.

Survey results and synthetic reports are available on C-Power's data management system (Buzzsaw).

Noise and vibrations

Upon common agreement between the MUMM and C-Power, this part of the monitoring program has been transferred to the MUMM.

Risks: meteorological data

See also under chapter 1, p 10

The permit stipulates that this part of the monitoring will be cumulative monitoring with 1 meteorological mast for the 3 wind farms. As mentioned above, this common measurement mast has not been installed despite the engagement of the Minister in charge of the North Sea in 2005.

However, in the mean time and upon common agreement between C-Power and MUMM, the meteorological data available from C-Power's WTG have been transmitted during a trial period (April 2009): air temperature, wind force and wind direction.

The MUMM has signalled a lacuna in the measurements (North wind was not fully registered). Since the data were considered incomplete and thus of no use to the Belgian Marine Data Centre, C-Power has stopped the transmission of these meteorological data.

C-Power has signalled this lacuna to wind turbine manufacturer REpower. According to REpower, a software problem is at the basis of this problem and the possibility that it can still be remedied for the existing WTG is very remote.

Nonetheless, C-Power will install, instead of the masts, a LIDAR device on the transformer station, which will be built in 2012.

By that time, a meteorological data transfer mode with MUMM will be discussed so that the relevant measurement data can be transmitted to the Belgian Marine Data Centre.

Electro-magnetical fields

The first measurements of the electromagnetic fields of the export cable have been performed on 20 and 21-05-2010. The results will be transmitted to the MUMM as soon as they are available.

3 WIND TURBINES DATA

In table 2, the average rotor speed and pitch angle are compared to the wind direction for the Repower 5M WTG in 2009.

Rotor Speed [rpm]	Pitch Angle (°)	Wind Dir
10,0	7	North
10,6	5	
10,0	6	
10,6	7	30°
10,3	7	
10,3	8	
10,2	6	60°
9,8	5	
8,5	8	
8,7	6	East
9,0	4	
9,1	5	
9,6	4	120°
9,9	3	
9,7	4	
9,4	5	150°
10,0	7	
10,5	6	
10,6	7	South
10,0	9	
10,2	8	
10,5	8	210°
10,5	8	
11,1	8	
10,9	8	240°
10,3	8	
10,1	8	
9,6	9	West
10,3	6	
10,0	6	
9,0	8	300°
9,6	7	
9,7	7	
9,5	9	330°
10,0	9	
9,6	10	

Table 2 Average rotor speed and pitch angle vs. wind direction for a 5M in 2009

In figure 4 a diagram represents the average rotor speed and pitch angle of D1 in 2009

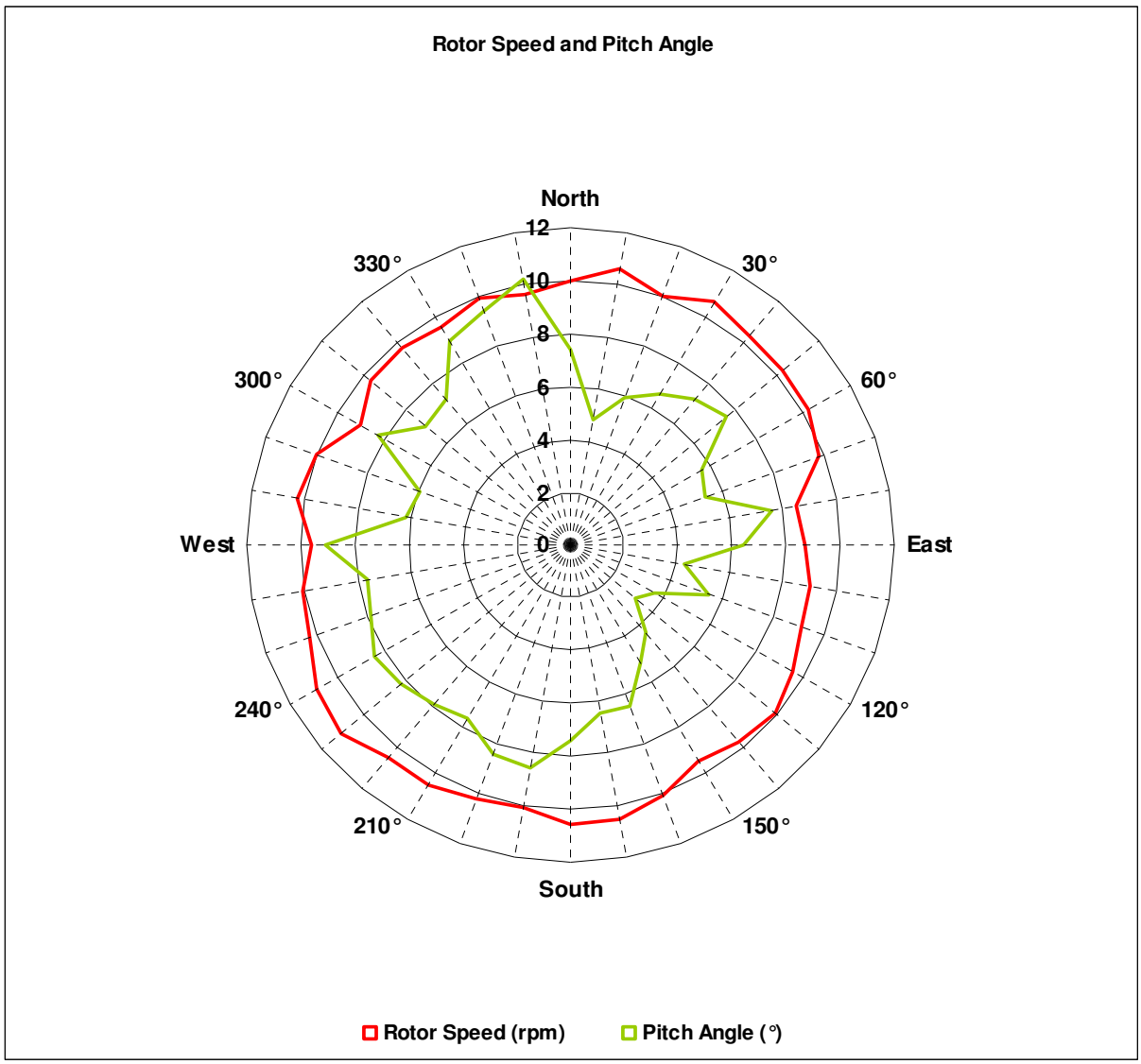

Figure 4 Rotor speed and pitch angle of D1 in 2009

4 HEALTH, SAFETY AND ENVIRONMENT (HSE)

The health, safety and environment standards at the Thornton Bank are considered to be very good, which is reflected in the low occurrence of incidents during 2009 and before. No deaths, heavy or minor injuries occurred in 2009.

An updated and coordinated version of the emergency plan (with a new chapter for the exploitation phase) was submitted to the MUMM in September 2009. An information session on the emergency plan and the most current HSE procedures was organised for the REpower crew at C-Power's premises in December 2009.

A dedicated HSE engineer is integrated in the organisation chart of C-Power with missions such as the coordination of the HSE initiatives, the organisation of internal HSE emergency exercises, training and information sessions, etc...
Specific training sessions (climbing, rescuing and basic rules of accident prevention) are organised by REpower for employees and for C-Power staff. As an important safety measure, the visit or access to the WTG without a REpower employee is not authorised: a special instruction sheet with safety regulations for persons who need to visit or ascend the wind turbines, needs to be read and signed off prior to the visit.

On a regular basis, safety exercises with the Sea King helicopters are organised by C-Power: e.g. in August 2009 a doctor and diver were winched down from the Sea King on the heli-platform of a wind turbine in order to train safe access procedures in emergency cases. Safety regulations for the use of a NHV helicopter for transport to the Thornton bank turbines have also been established and strictly implemented.

Figure 6 Operational Manager of C-Power safely attached while performing a standard check of the aviation light

Remote Monitoring system

C-Power has a 24-hour SCADA (Supervisory Control and Data Acquisition) surveillance system in operation, which is located both at the operational centre of C-Power in Ostend and in the REpower offices in Ostend and Hamburg.

The daily monitoring of the SCADA system enables both the operational manager of C-Power and Repower to have a complete overview of all turbines and therefore can take action if any abnormalities occur. C-Power has linked MRCC into this SCADA system.

On each wind turbine 2 cameras are installed at the height of the boat landings.
On WTG D1, an extra third camera is installed.
On WTG D6, an extra 180° camera will be installed in 2010.

The camera images are sent through in real time to the operational centre in Ostend and Hamburg and are stored for 24 h.
These images will be also available for the nautical authorities (*Scheepvaartpolitie*) in real time as of 2010.

Environmental incidents: sunken objects

See also under chapter 1, p. 7

On 23-10-2009, a stainless steel plate of approximately 1,5 m² was unintentionally dropped in the sea by subcontractor IBO. The plate was fastened according to regulations. Due to a severe wind gust the pressure on the wire ring and connection was too high. The plate was hoisted by the Pallfinger crane on the GBF by Repower. The plate hit the water about 15 meters away from the GBF.
No boats nor divers were in the neighbourhood so it was not possible to recuperate the plate immediately. Given the light weight of the plate, it drove away quickly with the current and sank down at an unidentifiable place so attempts to recuperate the plate later were considered unrealistic.
C-Power requested subcontractor IBO to investigate if smaller stainless steel plates could be used in order to complete works.

On 02-11-2009 at 9.20 AM, a smoke warning signal went of in the nacelle of D6 (94 m height). All 7 nitrogen bottles have been spurted empty in the electrical boxes.
On 6 November 2009, while lifting down the empty gas bottles from the fire extinguishing on D6 on Thornton Bank to the Windcat, 5 of the 7 bottles have fallen into the water. Given the rough weather and the absence of divers at the moment of the incident, the bottles could not be recuperated immediately.
The bottles are in steel and can contain 40kg of N2, but were empty at the time of the incident. The unintentional dropping happened from low height. The 2 other empty gas bottles fell from the pallet onto the platform of the Windcat. No other damage was caused by this incident.

C-Power requested Repower to recuperate the 5 sunken bottles. Repower engaged to perform the recuperation of the bottles during the summer season (2010).

The search action and diving inspection was performed on 23-05-2010. Although the diving and search conditions were optimal (3 meter visibility, hardly any current,..), no bottle was found on the sea bed in a perimeter of 12 meter around the foundations. However, the diving report mentioned the cleanliness on and around the scour protection: neither litter nor other objects were found.

In order to prevent the loss of bottles during transport between the WTG and the boat, REpower will henceforth use a special cage to transport the bottles. This cage is kept at the REpower premises in Ostend.