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**Surrounding obstacles influencing
the OWEZ meteo mast
measurements**

OWEZ_R_181_T0_20070821_undisturbed wind

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1. Introduction

NoordzeeWind carries out an extensive measurement and evaluation programme (NSW-MEP) as part of the OWEZ Near Shore Wind farm project; see figure 1. The technology part of the measurement and evaluation programme considers topics as climate statistics, wind and wave loading, performance monitoring of the wind turbines, etc. Before the installation of the wind farm, a 116m high meteorological mast has been installed to measure among others the wind conditions that are not disturbed by the nearby wind farm. This meteo mast is delivering data since 2005.

To know the period during which the meteo mast has measured the undisturbed wind conditions it is necessary to investigate which wind turbine could have influenced the measurements after start-up of the normal wind turbine operation.

Furthermore the heavy lift vessel: *the Svanen*, was in the surrounding of the meteo mast and could have influenced the measurements. The possible periods of these disturbances should also be known.

To determine the significant disturbed wind direction sectors due to obstacles or neighbouring wind turbines the method prescribed in the wind turbine power performance standard [1] has been applied.

In this Memo it is reported from which wind turbine locations *the Svanen* and the wind turbines itself could have affected the meteo mast wind measurements and when this has happened. The final date when the undisturbed meteo mast measurements ended is established from this information.

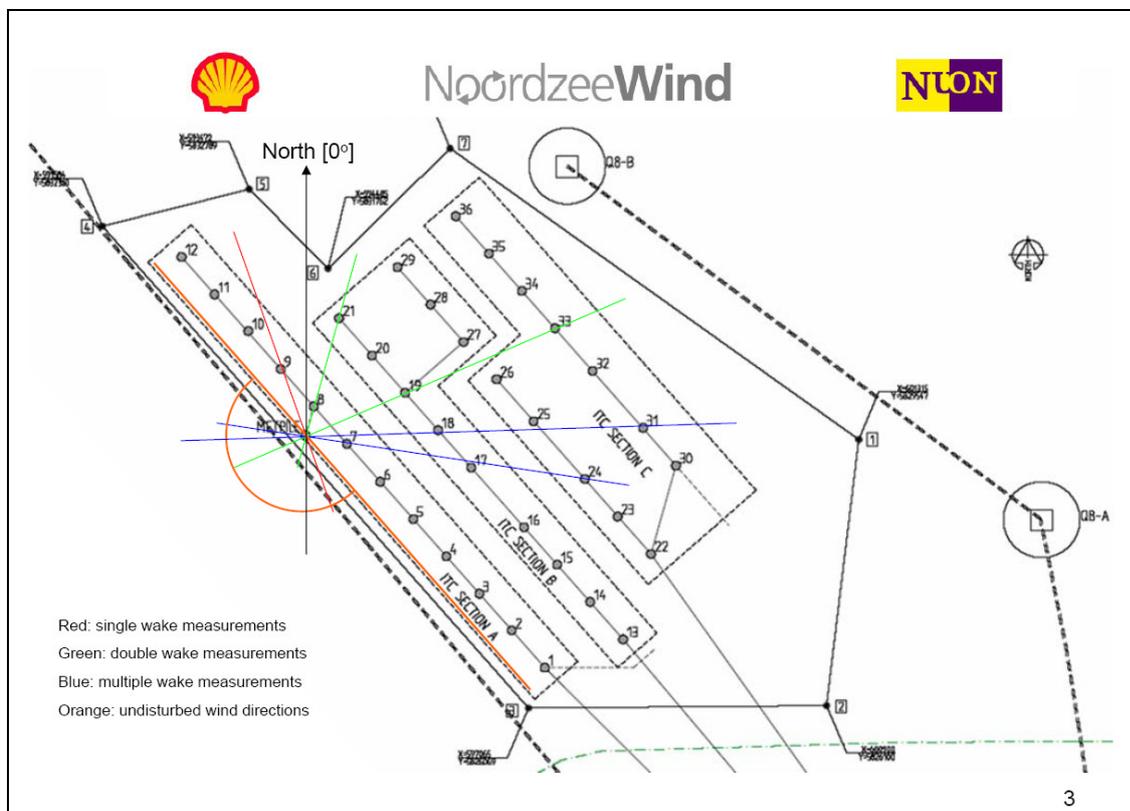


Figure 1. OWEZ wind farm lay out with the meteo mast location between turbine 7 and 8.

2. Approach

During the period 17 April up to end of June 2006 all 36 foundation piles are driven into the seabed by *the Svanen*; see figure 2. The piling dates are registered and made available by NoordzeeWind for this investigation. During piling the Svanen is fixed on the wind turbine location. During fixation of the vessel and piling this obstacle could influence the wind measurements at the meteo mast. This only counts of course for the wind turbine locations 'nearby' the meteo mast.

To determine which wind turbine locations could influence these measurements and over what wind direction sector, the method has been applied as described in Annex A of the Wind Turbine Power Performance standard IEC 61400-12-1:2005 [1]. ECN Wind Energy has put this method in an Excel sheet 'MeasSector' for their normal wind turbine testing practice.

Input for this sheet are:

- the coordinates of the meteo mast and wind turbine locations [2];
- the dimensions of the obstacle: (Svanen) height: 100 m and width: 60 m.
- the obstacle (Svanen) is considered a 'building'.



Figure 2. The heavy lift vessel *Svanen* during piling.

The calculation result is shown in Annex A.

These locations and accompanying wind direction sectors are combined with the dates of piling.

The same approach has been used to determine the relevant wind turbine locations plus accompanying sectors affecting the meteo mast in case of normal operating wind turbines. The applied relevant obstacle dimension of a wind turbine is its rotor diameter i.e. 90 m. The wind turbines were installed during the period: mid September until the end of 2006.

The calculation result is in Annex B and these results were combined with the trial runs and start-up dates of the wind turbines.

3. Results

Annex A shows the wind turbine locations that can disturb the wind measurements at the meteo mast in case the wind direction is within the given sectors. The disturbance is due to the vessel *Svanen* positioned on the wind turbine location. The relevant locations are summarised in following table 1.

Table 1. *Wind turbine locations, sectors en periods of disturbance due to piling*

| Wind turbine location | Disturbing sector (dgr) | Date and time (round figures) of piling | Measurements disturbed [Y/N] |
|-----------------------|-------------------------|-----------------------------------------|------------------------------|
| 6 | 106 - 139 | 04-06-'06, 22:00 – 24:00 | No |
| 7 | 80 - 124 | 02-06-'06, 18:00 – 20:00 | No |
| 8 | 350 - 42 | 07-06-'06, 11:00 – 14:00 | no data available |
| 9 | 322 - 358 | 09-06-'06, 07:00 – 09:00 | no data available |
| 19 | 52 - 83 | 03-07-'06, 02:00 – 04:00 | Yes |
| 20 | 24 - 56 | 04-07-'06, 17:00 – 19:00 | Yes |

In table 1 only the piling time is given, but the hours necessary to position the *Svanen* and breaking up, should also be taken into account. A margin of eight hours before and after piling should be taken into account for these activities.

The given sectors are only relevant in case the measured wind direction was in that sector during the number of hours that the *Svanen* was present at that site. A check whether the actual measured wind direction was within the disturbed sector shows that this was the case for the location 19 and 20; as indicated in the last column of table 1.

Annex B summarises the wind turbines influencing the meteo mast after their trial runs and start for normal operations. From the date of trial runs onwards it must be assumed that wind coming from that sector will disturb the meteo mast measurements. These dates are given in table 2.

Table 2. *Dates since when the wind measurements might be disturbed by the wind turbine.*

| Wind turbine number | Excluded sector (dgr) | Date of first trial run |
|---------------------|-----------------------|-------------------------|
| 5 | 112 - 143 | 17-10-'06* |
| 6 | 104 - 140 | 29-09-'06 |
| 7 | 77 - 126 | 29-09-'06* |
| 8 | 347 - 45 | 03-10-'06 |
| 9 | 320 - 359 | 29-09-'06 |
| 10 | 315 - 348 | 03-10-'06* |
| 18 | 72 - 103 | 18-10-'06 |
| 19 | 50 - 83 | 17-10-'06 |
| 20 | 23 - 57 | 03-11-'06 |
| 21 | 0 - 32 | 18-10-'06 |

*: exact date not logged, most likely date is given

It is assumed here that non-operating wind turbines with feathered rotor blades are not influencing the meteo mast measurements. Furthermore the A2SEA wind turbine installation activities are not taken into account.

The remaining meteo mast undisturbed sector after all wind turbines went into operation (end of 2006) is established between 143 and 316 degrees.

4. Conclusion

The MEP - NSW period to gather undisturbed meteorological data with the NoordzeeWind meteo mast is from 2005-07-01 until 2006-06-30. The construction work of the wind farm started April 2006.

During the construction period nearby operations with the heavy lift vessel *Svanen* could have influenced the measurements. The wind turbine positions, dates and wind direction sectors relevant for these disturbances are determined. From a first check it appeared that the actual meteo mast measurements are within the disturbed sector when the *Svanen* was at the wind turbine locations 19 and 20.

On the 29th of September 2006 the first meteo mast surrounding wind turbines made their trial runs for start-up to normal operation. With the exception of a limited number of days where piling activities took place the meteo mast wind measurements were undisturbed by the wind farm itself until 2006-09-29.

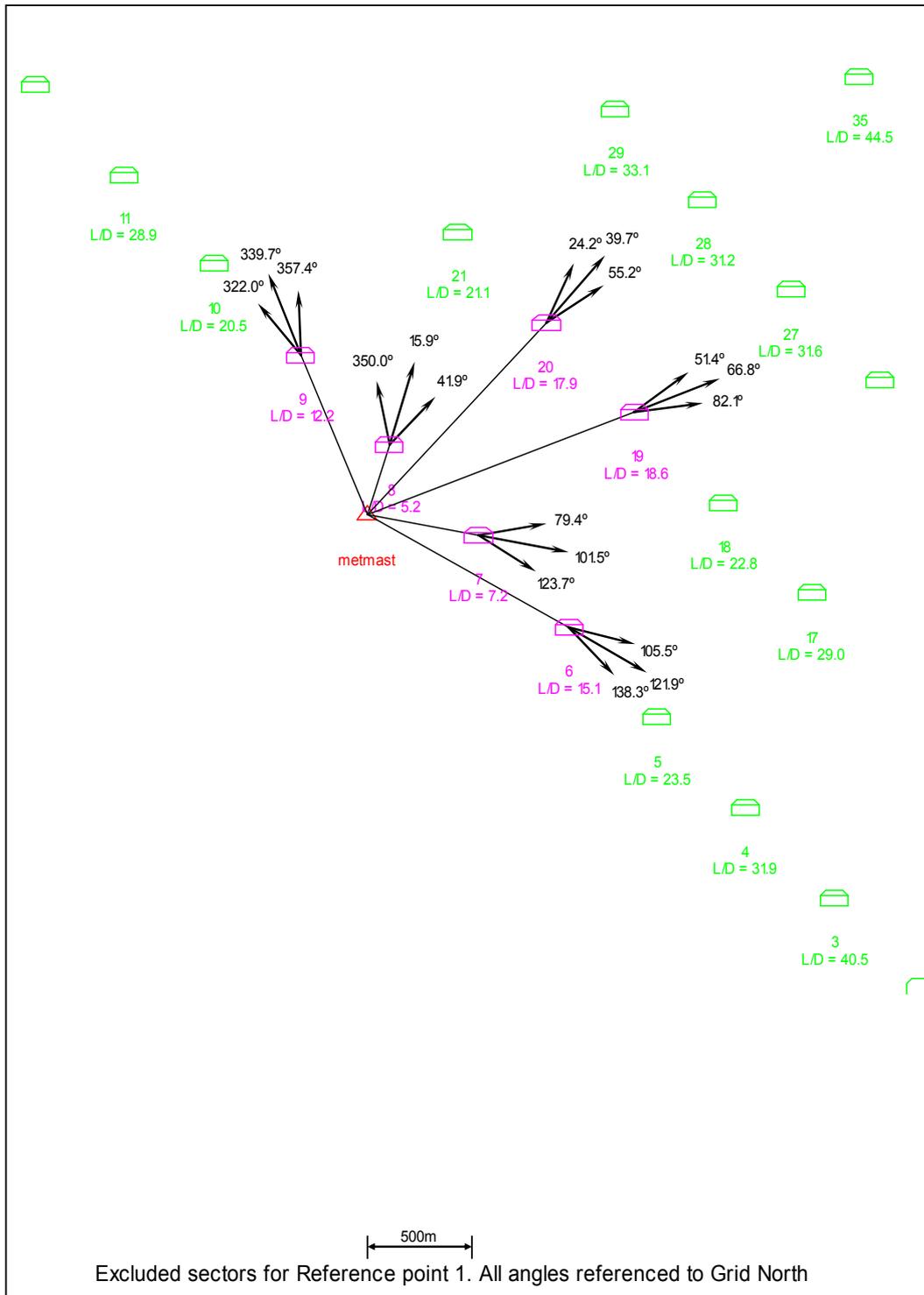
The results are fixed in the timeline below.

| | | | | | |
|------------|-----------------------------------------------------------------------------------------------------------------------------------|------------|------------------------------------------------------------|------------|-------------------------------------------------------------|
| 2005-07-01 | | 2006-06-30 | | 2006-09-29 | |
| | MEP-NSW period: Undisturbed wind | | Additional period with undisturbed wind measurements | | Wind measurements disturbed in: sector 316 → 143 dgr. |
| | Measurements disturbed occasionally during construction activities; see table 1 for periods and relevant direction sectors. | | | | |

References

- [1] IEC 61400-12-1:2005, Power performance measurements of electricity producing wind turbines, first edition, 2005-12.
- [2] H.J. Kouwenhoven, Offshore Windpark Egmond aan Zee; Turbine siting and met mast position w.r.t. wake measurements, Doc.: NZW-16-M-12-R01, 26-11-2006.

ANNEX A. Piling positions influencing the meteo mast



ANNEX B. Surrounding operating wind turbines influencing the meteo mast

