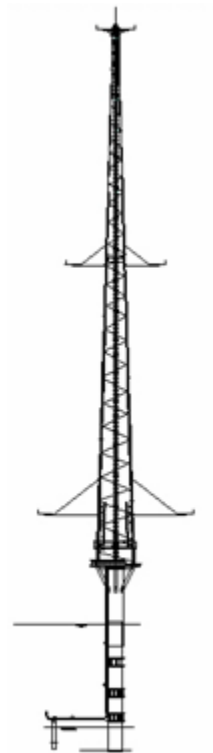




User manual data files meteorological mast NoordzeeWind



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Introduction

NoordzeeWind (NZW) is a 50/50 joint venture of Shell Wind Energy and Nuon Duurzame Energie. The company has entered an EPC contract with BCE (a consortium of Ballast Nedam and Vestas) to install a wind farm off the Dutch coast near Egmond aan Zee in 2006.

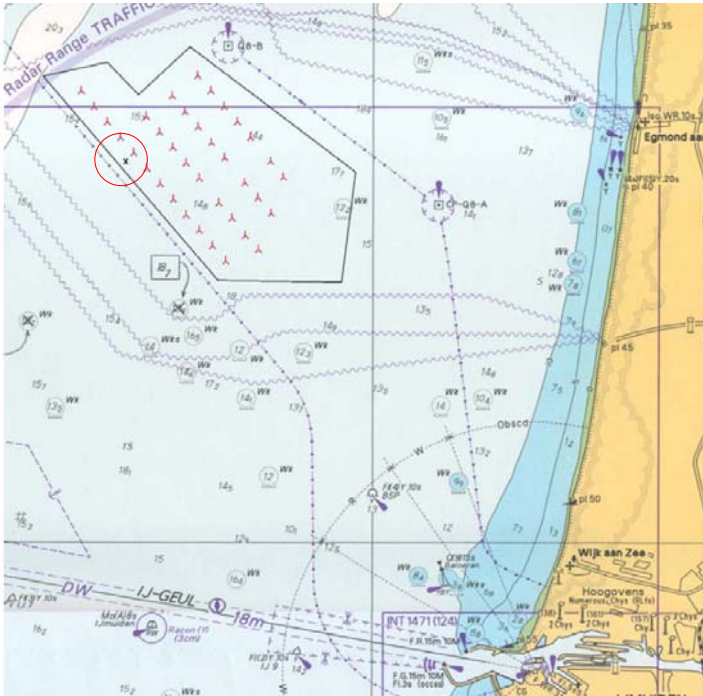
The project comprises 36 Vestas V90 wind turbines and associated support systems in the Dutch territorial waters of the North Sea, between 10 and 18km off the coast. Each turbine has a steel monopile foundation, piled to a depth of about 30m, and a transition piece connected to the

monopile via a grouted joint. Hub height is 70 meters above Mean Sea level (MSL). The produced power will be transmitted through three 34kV cables to shore, which land north of IJmuiden harbour. In a substation located near Wijk aan Zee the voltage is stepped up from 34kV to 150kV and the power is transported to the public grid by means of a 150kV underground cable.

Operations of the wind farm commenced on 1 January 2007.

At the site of the Offshore Wind farm Egmond aan Zee (OWEZ) a met mast was erected in 2003, capable of measuring the actual weather and wave conditions. The data gathered is logged into two data loggers and are subsequently sent to the shore by means of a GSM connection.

A cable connection between the met mast and the wind farm provides power



and data transport capacity.

To achieve sufficient stability for the instruments the met mast is constructed as a triangular lattice tower, mounted on a monopile foundation, driven in the sea bed. The distance between the instruments and the body of the met mast is sufficient to limit the inaccuracy of wind speed measurements to 5% (except wake effects).

Instrumentation

The site of the met mast is in WGS 84 coordinates $52^{\circ} 36' 22.9''$ N, $4^{\circ} 23' 22.7''$ E, (in UTM31 ED 50 coordinates X = 594194.830, Y = 5829600.084) at the south western side of the wind farm, indicated on the map as a little black star in the red circle. Please refer to appendices 4 and 5 for a detailed site lay out and coordinates. Instruments are installed at three levels: 70 meters above mean sea level, which equals hub height of the wind turbines, at 21,6 m and at 116 m.

The latter two heights are enabling determination of the wind speed profile over the entire rotor diameter of 90 meters. At each level wind speed and wind direction are measured at three booms situated at 300° (NW), 60° (NE) and at 180° (S), respectively. As North is 0° , the south boom is directed pure south. By using three booms per measurement level, wind flows that are disturbed by the wake of the mast can be filtered out while undisturbed wind speed and wind direction data can be derived from (one of) the other booms.

As can be seen from appendix 4, the chosen position of the met mast is enabling (multiple) wake measurements as well.

At each level the wind speed is measured by cup anemometers and by an acoustic (3D sonic, brand “Gill”) instrument. The acoustic instrument is capable of measuring detailed horizontal and vertical wind speed and direction variations.

Additional instruments like rain sensors, temperature sensors, air pressure and an Acoustic Doppler Current Profiler (ADCP) are installed as well. The complete list of instruments and specifications of the most important instruments is added as appendix 1. A drawing showing where the instruments are placed on the met mast is attached as appendix 2.

Process of data handling

The instruments in the met mast are delivering their signals to a data acquisition system in the met mast, comprising of two data loggers working in parallel to create redundancy. Each instrument is delivering its output signal to both loggers. Before storage the data are converted to 10 minute average values. On a daily basis, the supplier of the system reads the data by use of the glass fibre network in the wind farm. After a quality check by the supplier the data are sent on a monthly basis to the data acquisition system of ECN in Petten.

Description of the data files

Each sensor signal has a unique channel number in the database, see appendix 3. This channel number, combined with the systematic lay out of the database will enable easy data selection. The first six columns of each data file are used for the time stamp based on UTC. These columns are followed by the section that is containing the actual data. Each measured parameter is using five columns in the data files and the lay out of the data is identical for each parameter: channel number, maximum value, minimum value, average value, and standard deviation:

Year	Month	Day	Hour	Min	Second	Channel	Max	Min	Mean	STD	Channel	Max
2005	1	1	0	0	0	0	166	150	157.94	2.770	1	15

.....And so on...

All data are receiving a time stamp, comprising of year, month, day, hour, 10-minute block. The seconds value is present in the data files as well but for obvious reasons this value has no meaning.

The files are labeled systematic: OWEZ_M_181_YYYYMMDD-YYYYMMDD.xls

In general each data file is containing data of one calendar month, the actual period is specified in the name of the file.

Quality of data

All sensors are calibrated according to MEASNET. General accuracy of wind data that is not influenced by the wake of the mast itself is better than 95%. For scientific users of the data only, the actual calibration certificates are available at NoordzeeWind upon request.

Before the data is made available on the internet, quality checks have been carried out.

Calibration factors of the instruments are applied on the data. Wind direction data are corrected where appropriate to secure values between 0 and 360 degrees. Corrupt and/or missing data fields are marked by replacing those invalid data by error values (-999999).

Validity of this manual

This version of the manual is suitable for data files from July/August 2005 and further. It supersedes version 1.1 dated 8 June 2006 and is valid until a new version will be issued and made available on the internet.

Contact details and questions

Questions about this user manual or the data files can be addressed by sending an E mail to:

mep-manager@noordzeewind.nl

Questions about the user manual can only be answered if the version of the user manual (see title sheet) is specified. In case of questions about data file(s) please include the name of the file(s), the channel numbers of the instruments (see appendix 3) if applicable to the question, the measuring period and the month of the data file.

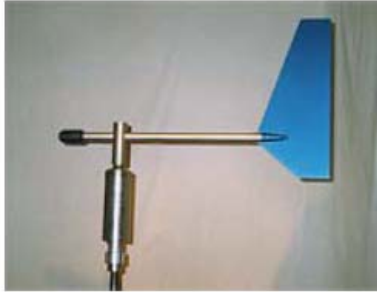


Disclaimer: This manual has been prepared by NoordzeeWind [Investor I] B.V. (NZWBV) No representation or warranty is provided by NZWBV in respect of the completeness or accuracy of the information contained herein, or in respect of the accuracy of the wind met mast data made available on this website. NZWBV reserves the right to change the lay out and/or content of the data files and accepts no liability whatsoever in respect of the use of this manual or the wind met mast data.

Appendix 1: list of instruments

Position at drawing:	Location / Height (meters above MSL):	Instrument:	Instrument make and type:	Instrument code:
1	S/21	Wind direction vane	Mierij Meteo 524	WD 524/S/21
2	S/21	Cup anemometer	Mierij Meteo 018	WS 018/S/21
3	S/21	Temperature/humidity	Vaisala Oyj HMP 233	RHTT 261/S/21
4	NE/21	Wind direction vane	Mierij Meteo 524	WD 524/NE/21
5	NE/21	Cup anemometer	Mierij Meteo 018	WS 018/NE/21
6	NW/21	Wind direction vane	Mierij Meteo 524	WD 524/NW/21
7	NW/21	Cup anemometer	Mierij Meteo 018	WS 018/NW/21
8	NW/21	Sonic windmeter	Gill 1086M	3DWM4/NW/21
9	S/70	Wind direction vane	Mierij Meteo 524	WD 524/S/70
10	S/70	Cup anemometer	Mierij Meteo 018	WS 018/S/70
11	S/70	Temperature/humidity	Vaisala Oyj HMP 233	RHTT 261/S/70
12	NE/70	Wind direction vane	Mierij Meteo 524	WD 524/NE/70
13	NE/70	Cup anemometer	Mierij Meteo 018	WS 018/NE/70
14	NE/70	Precipitation sensor	Mierij Meteo PD 205	PD 205/NE/70
15	NW/70	Wind direction vane	Mierij Meteo 524	WD 524/NW/70
16	NW/70	Cup anemometer	Mierij Meteo 018	WS 018/NW/70
17	NW/70	Sonic windmeter	Gill 1086M	3DWM4/NW/70
18	NW/70	Precipitation sensor	Mierij Meteo PD 205	PD 205/NW/70
19	S/116	Wind direction vane	Mierij Meteo 524	WD 524/S/116
20	S/116	Cup anemometer	Mierij Meteo 018	WS 018/S/116
21	S/116	Temperature/humidity	Vaisala Oyj HMP 233	RHTT 261/S/116
22	NE/116	Wind direction vane	Mierij Meteo 524	WD 524/NE/116
23	NE/116	Cup anemometer	Mierij Meteo 018	WS 018/NE/116
24	NW/116	Wind direction vane	Mierij Meteo 524	WD 524/NW/116
25	NW/116	Cup anemometer	Mierij Meteo 018	WS 018/NW/116
26	NW/116	Sonic windmeter	Gill 1086M	3DWM4/NW/116
27	116	Acceleration sensor	Seika XB2i	AC SB2i/T/116
32	20	Air pressure	Druck RPT 410V	DP910
42	-3.8	SeaWater Temperature Sensor	Mierij Meteo Pt100	ST 808/NW/-3.8
43	-17	Acoustic Doppler Current Profiler	Nortek-as AWAC	ADCP

Note: position numbers 28 until 42 (except pos. 32) are for auxiliaries and not used for instruments. Refer to appendix 2 for a drawing of the positions of the instruments on the meteo mast.



The overshoot ratio of the model 524 Mierij Meteo wind vane is low. This ratio depends on the moment of force, the friction and the moment of inertia.

The lightweight materials, the relatively high blade, the contactless determination of the blade position and the excellent counterbalancing of the vane assembly help to minimize this ratio. Being well-balanced, Mierij Meteo wind vane does not have any preferred position.

The wind vane has a range of 0 to 360 degrees. As the instrument can identify 256 directions, its resolution is 1,4°. The wind vane is protected against inductive interference in accordance with prevailing international standards. The sensor can easily be connected to peripheral equipment, which is also available from Mierij Meteo.

Performance Specifications

Operating range: 0..360°
Resolution: 1.4°
Code disc error: 0.3° maximum

Physical specifications

Dimensions: 710 x 625 mm, housing Ø 70mm
Weight: 2.2kg.
Material: Anodized aluminium
Operating temperature: -25 ..+60°C
Static discharge: The instrument is protected against outside inductive interference up to a discharge power of 1500Watt
Watertightness: IP-65

Installation

Installation: Vertically, free-standing
Mounting: 5-pole KNMI instrument plug
Connection: 5-pole KNMI instrument plug

Electrical specifications

Supply voltage: 18.. 30VDC
Power consumption: 80 mA
Output signal: Digital differential
Output impedance: 400 Ohm/ 10nF

General

Maintenance: At 1 to 2-year intervals, depending on local conditions
Calibration certificate: A calibration certificate with a validity of 1 year is available on request
Guarantee: 2 years

Cup Anemometer

KNMI Anemometer Model 018

[C Previous page](#)



This rotary anemometer has three cups, which are mounted on a freely rotating axis. The low weight and the special design of the cups enable the anemometer to respond quickly to changing wind speeds. The absence of contacting devices also ensures fast response. These features allow a response length of 2.9 metres. The anemometer is able to measure wind speeds from 0.5 to 50 m/s.

The instrument is protected against inductive interference in accordance with prevailing international standards.

The sensor should be installed at a location which permits free wind access. Meteorological advice regarding suitable locations can be obtained from Mierij Meteo.

Performance Specifications

Operating range:	0..50 m/s
Resolution:	0.06 m wind run
Response length:	2.9 m
Average gradient:	0.062 m/pulse
Standard Deviation:	0.0004 m/pulse
Starting speed:	< 0.5 m/s
Maximum wind load:	Cup assembly tested up to 75 m/s

Physical specifications

Dimensions:	330 x 225 mm, housing Ø 70mm
Weight:	1kg.
Material:	Housing: Anodized aluminium Cups: Glass-fibre reinforced
Operating temperature:	-25 ..+60°C
Static discharge:	The instrument is protected against outside inductive interference up to a discharge power of 1500Watt
Watertightness:	IP-65

Installation

Installation:	Vertically, free-standing
Mounting:	5-pole KNMI instrument plug
Connection:	5-pole KNMI instrument plug

Electrical specifications

Supply voltage:	18.. 30VDC
Power consumption:	25 mA
Output signal:	Digital differential ± 8V
Output impedance:	400 Ohm/ 10nF

General

Maintenance:	At 1 to 2-year intervals, depending on local conditions
Calibration certificate:	A calibration certificate with a validity of 1 year is available on request
Guarantee:	2 years; 5 years on the KNMI cup assembly

GILL
INSTRUMENTS

WindMaster / WindMaster Pro

SOLENT

3 Axis Ultrasonic Meteorological Anemometer

- High reliability, zero maintenance - decreased down time and service costs.
- Software configurable - reduces set up and installation time.
- 8 measurement modes - flexible and easy to use.

From the world leader, Gill Instruments Ltd, the WindMaster range of speed and direction sensors, provide the best solution on the market for serious 3 axis wind measurement. With a simplified mounting arrangement and fully software configurable operation, both the WindMaster and WindMaster Pro are ideal for the measurement of wind turbulence and wind loading. The anemometers can be driven by the users own software, a commercial communications package or via WindCom - a communications package developed by Gill and supplied free of charge with every WindMaster. This allows the user to operate the anemometers in various modes enabling the measurements of U,V and W vectors or wind speed plus direction and W in NMEA configuration. Communication is via a RS422 bi-directional link, which allows up to 26 units to be networked and data to be logged on demand (polled). The WindMaster has 4 analogue outputs, which can be configured to allow 1-5V, $\pm 2.5V$ or 4-20mA operation and 3 analogue inputs. The WindMaster Pro has speed of sound output as standard and user selectable output rate up to 10Hz. Eight single ended or four differential analogue input channels are available to provide the ability to synchronise analogue signals with wind data.



WindMaster

APPLICATIONS

- Meteorological
- Transport
- Building research
- Tunnels
- Marine
- Military
- Aviation

FEATURES

- NMEA output format
- Self diagnostics
- Free communications software
- WindMaster**
 - 1 or 4 outputs/sec, user selectable
 - 3 analogue inputs
 - 4 analogue outputs
 - RS422 output
- WindMaster Pro**
 - 1, 2, 4, 5, 8 or 10 outputs/sec, user selectable
 - Speed of sound output
 - Full and half duplex RS422 output
 - Low power
 - Analogue inputs

3 Axis Ultrasonic Meteorological Anemometer

SPECIFICATION	WindMaster	WindMaster Pro
Measurement		
Ultrasonic sampling rate	39/sec	39/sec
Parameters	UVW, Polar, NMEA, Tunnel	UVW, Polar, NMEA
Units	m/s, Knots, MPH, KPH	m/s, Knots, MPH, KPH
Averaging	3 sec, 5 sec, 10 sec	3 sec, 5 sec, 10 sec
Windspeed		
Range	0 - 60m/s (0 - 134 mph)	0 - 60m/s (0 - 134 mph)
Accuracy	1.5%RMS (0 - 20m/s)	1.5%RMS (0 - 20m/s)
Resolution	0.01 m/s	0.01 m/s
Offset	±0.01 m/s	±0.01 m/s
Direction		
Range	0 - 359°	0 - 359°
Accuracy	<25m/s ± 2°	<25m/s ± 2°
Resolution	1°	1°
Power requirement		
Anemometer only	9 - 30Vdc at 150mA max	9 - 30Vdc at 60mA average at 12Vdc
Digital Output		
Communication	RS422 full duplex, network up to 26 anemometers	RS422 full duplex, network up to 26 anemometers
Baud rates	1200, 2400, 4800, 9600, 19200, 38400	300, 1200, 2400, 4800, 9600, 19200, 38400
Output rates	1 or 4 outputs/sec	1, 2, 4, 5, 8 or 10 outputs/sec
Formats	8 data, odd, even or no parity	7 or 8 data, odd, even or no parity
Analogue Outputs		
Quantity	4	n/a
Scale	Multiples of ±10m/s up to ±70m/s	n/a
Type	±2.5V, 5V or 4 - 20mA	n/a
Frequency response	0.5Hz (1 output/sec), 2Hz (4 outputs/sec)	n/a
Impedance	470 Ohms	n/a
Analogue Inputs		
Quantity	3	8 single ended or 4 differential
Type	-2.5V to 5V	-5V to +5V
Resolution	11 bits over 5V	14 bits over 5V
Speed of Sound		
Range	n/a	300 to 370m/s
Accuracy	n/a	<20m/s 3%RMS
Resolution	n/a	0.01m/s
Dimensions		
Size	750mm x 240mm	750mm x 240mm
Weight	1kg	1kg
Environmental		
Moisture protection	IP65	IP65
Operating temperature	-40°C to +60°C	-40°C to +60°C
Humidity	5% to 100% RH	5% to 100% RH
Precipitation	Operation maintained to 300mm/Hr	Operation maintained to 300mm/Hr
EMC	BS EN 50081-1: 1992 (Emissions class B) BS EN 50082-1: 1992 (Immunity) FCC class A	BS EN 50081-1: 1992 (Emissions class B) BS EN 50082-1: 1992 (Immunity) FCC class A
General	Suitable for exposure to a marine environment	Suitable for exposure to a marine environment

Accuracy specification applies between 5°C and 35°C and wind incidence +10° to the horizontal in unobstructed air with respect to the anemometer. The SOLENT range is in continuous development and so specifications may be subject to change without prior notice.
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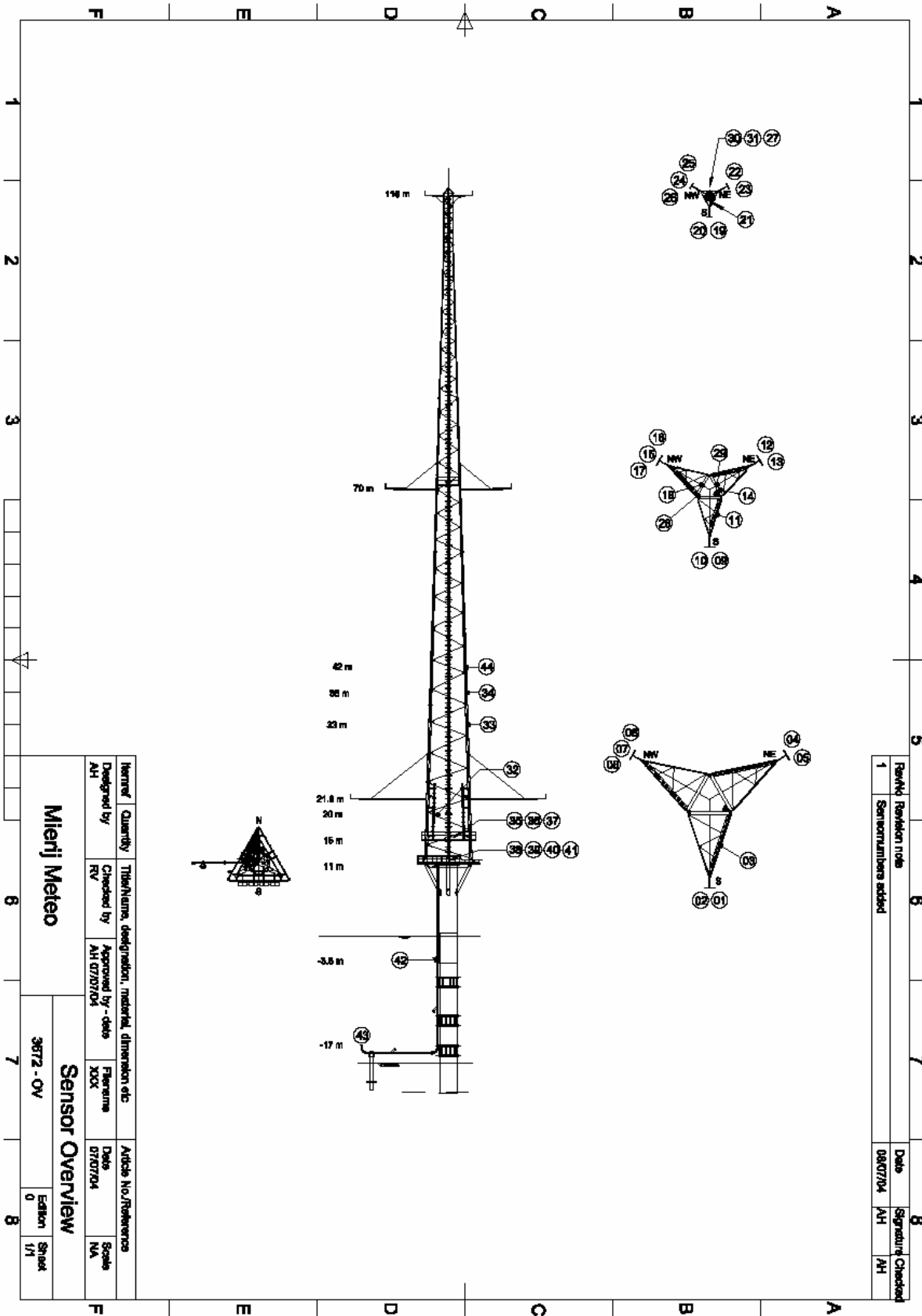
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Appendix 2: instrumentation drawings

Overview:

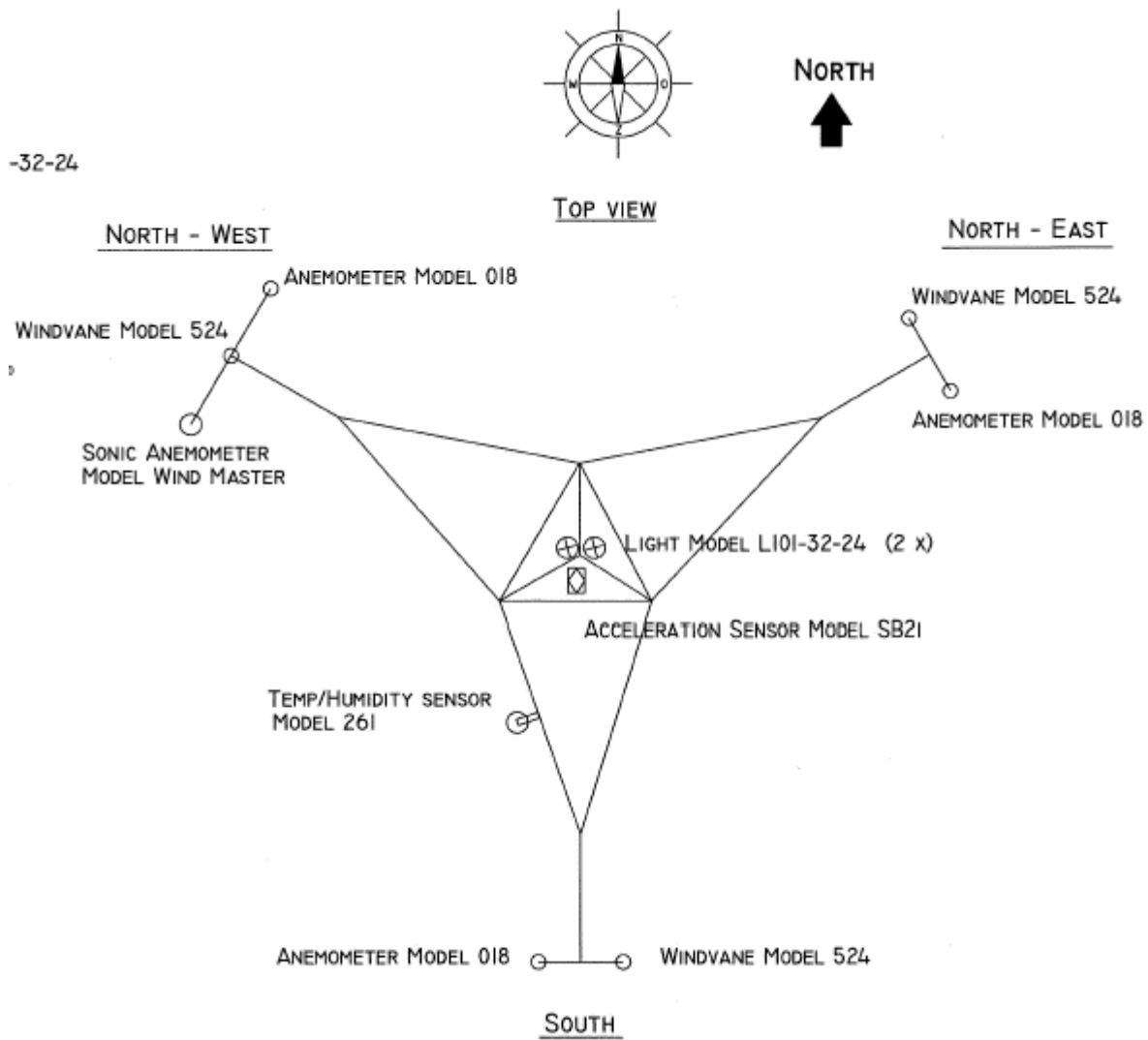


Note: position numbers 28 until 42 (except pos. 32) and 44 are for auxiliaries and not used for measurements.

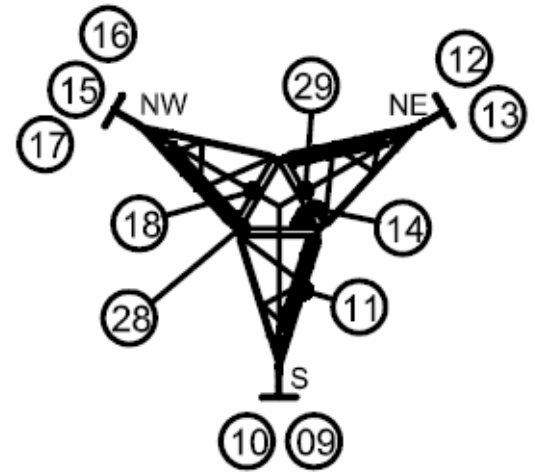
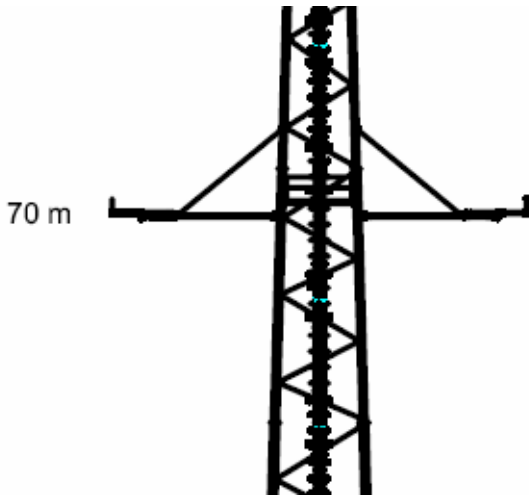
Instruments at top section of the met mast:



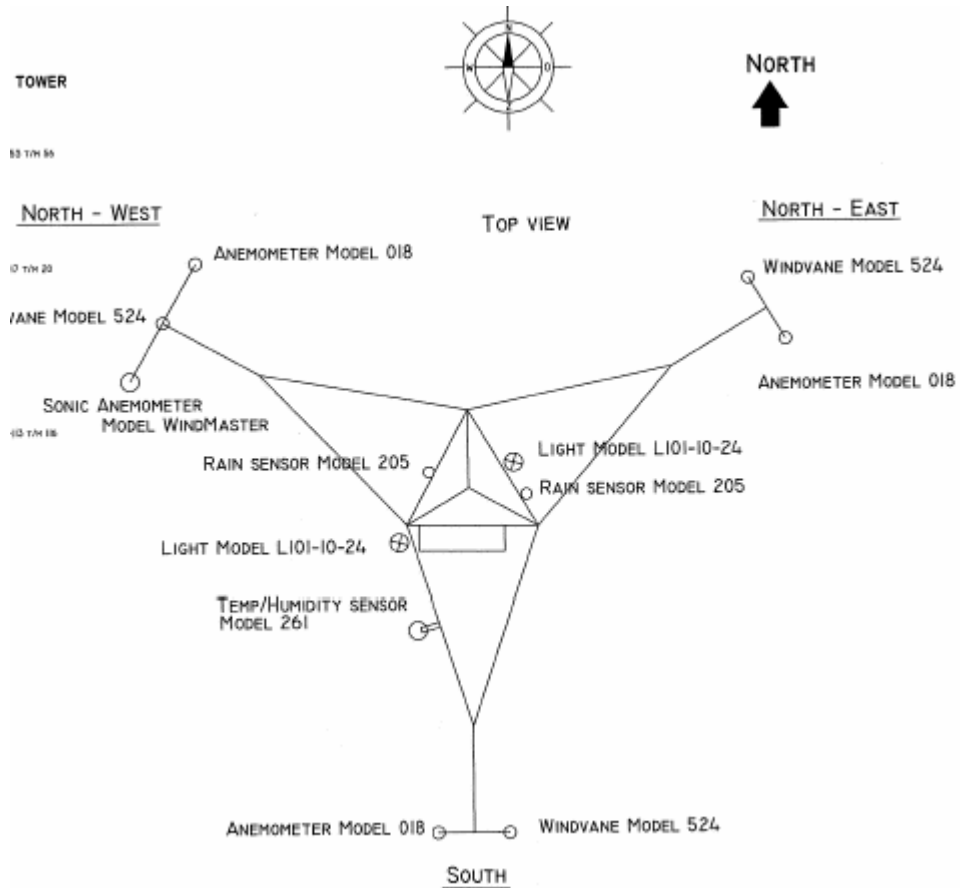
Note: position numbers 28 until 42 (except pos. 32) and 44 are for auxiliaries and not used for measurements.



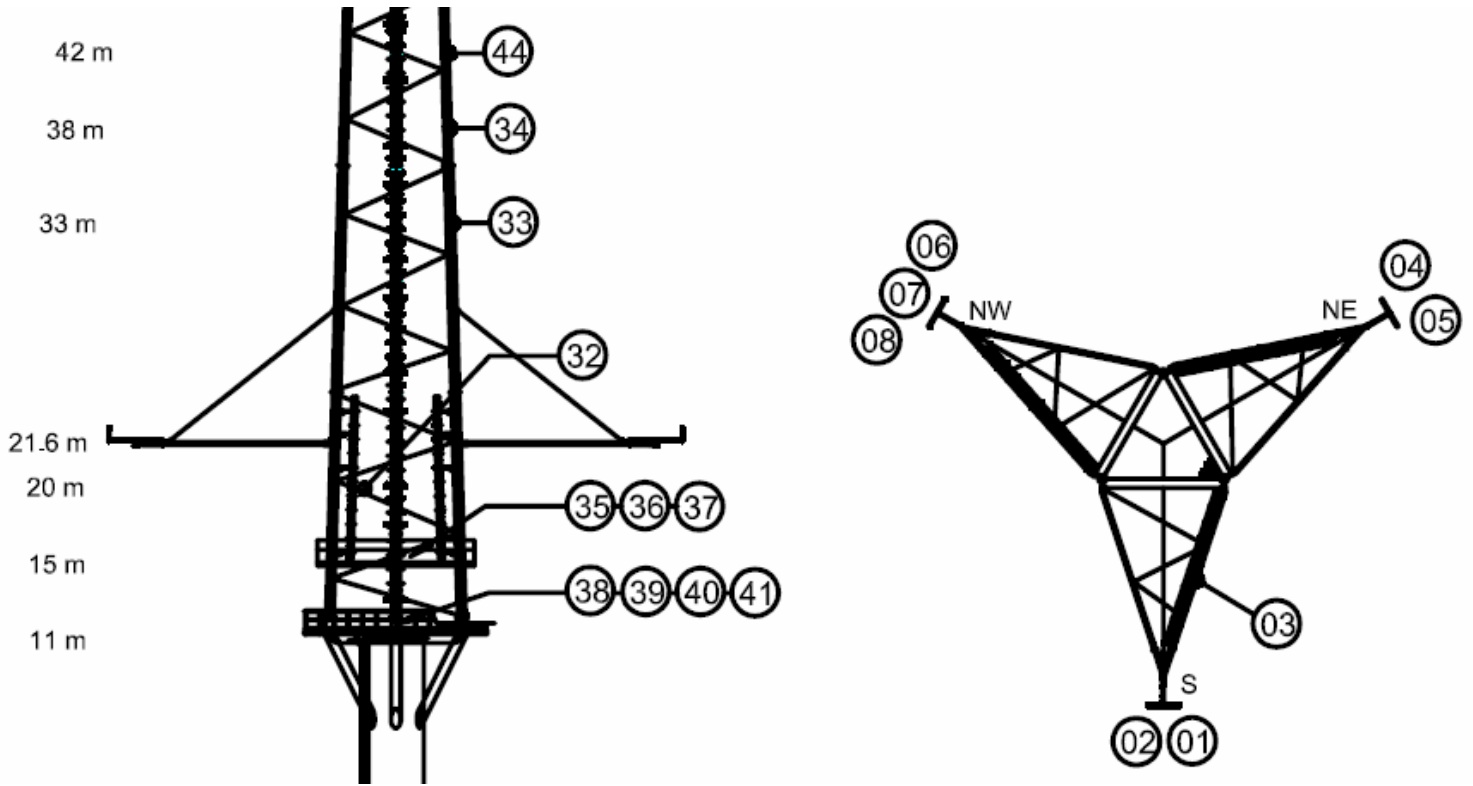
Instruments at middle section of the met mast:



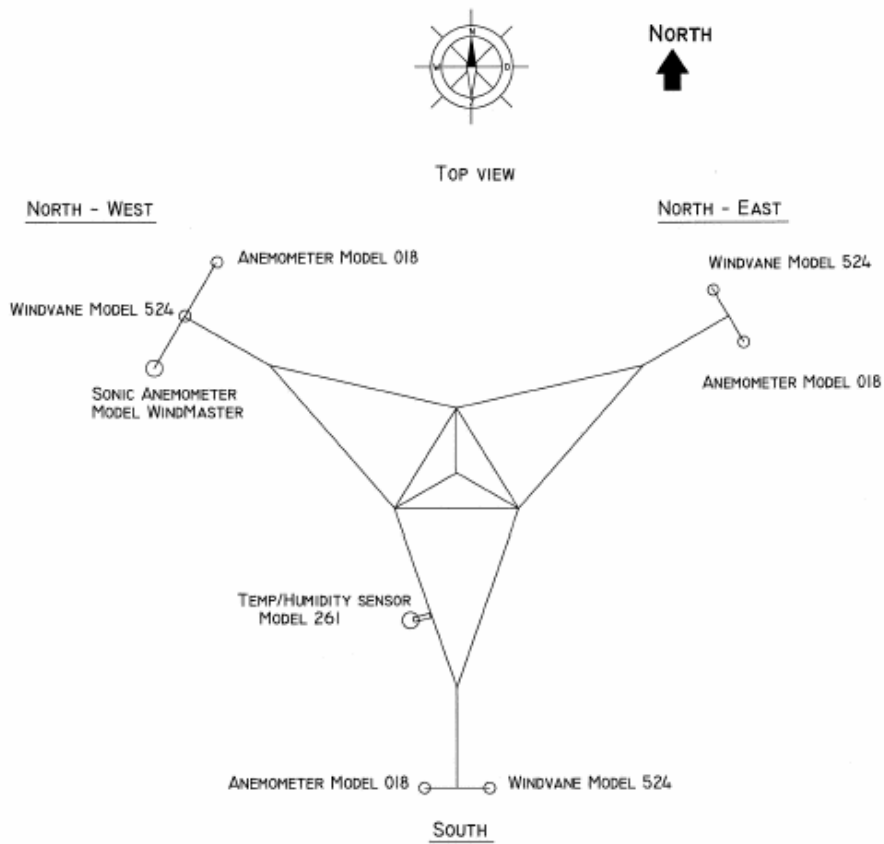
Note: position numbers 28 until 42 (except pos. 32) and 44 are for auxiliaries and not used for measurements.



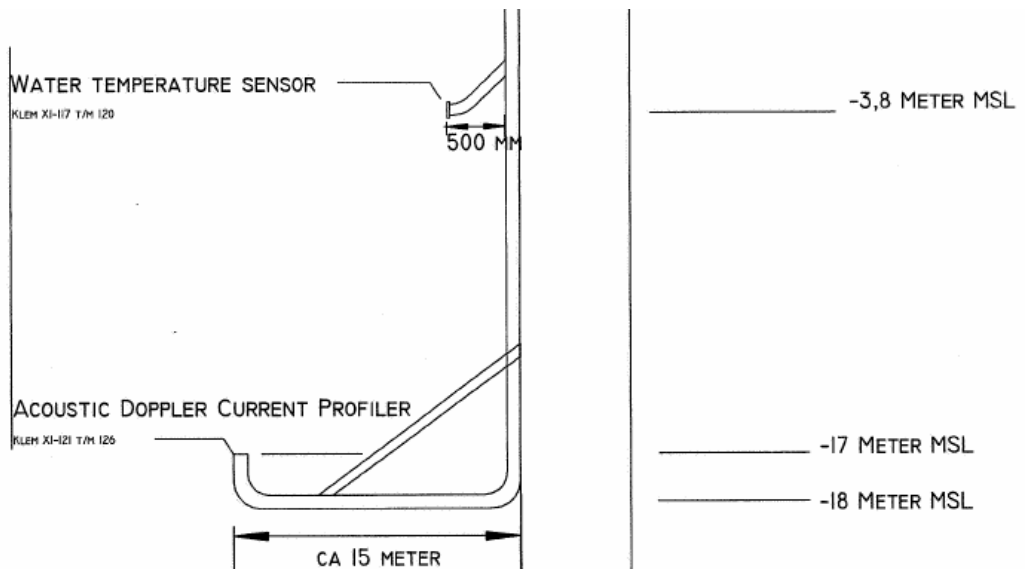
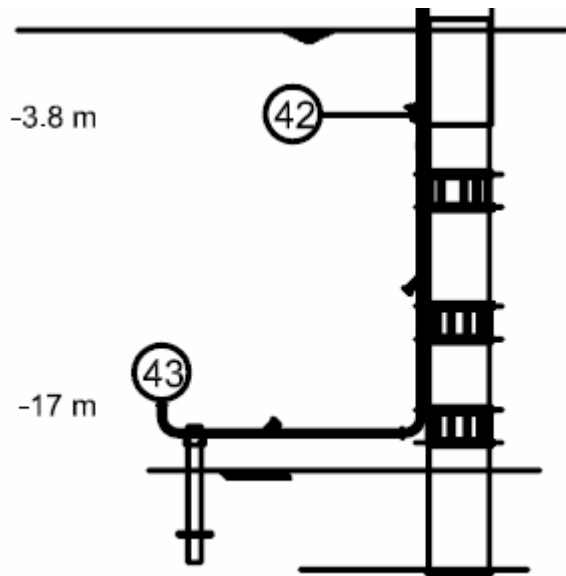
Instruments at lower section of the met mast:



Note: position numbers 28 until 42 (except pos. 32) and 44 are for auxiliaries and not used for measurements.



Instruments at under water section of the met mast:



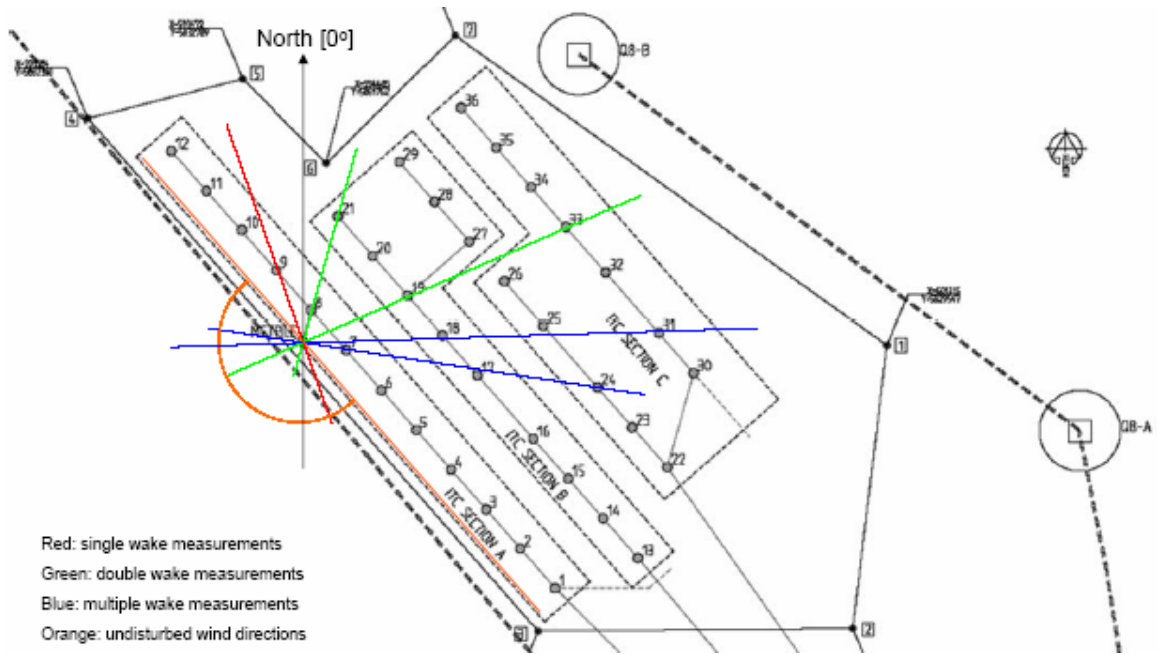
Appendix 3: list of channels and data

Overview of data base channels and instruments		
Channel	Instrument code	Parameter and Unit
0	3D WM4/NW/21	wind direction [°]
1	3D WM4/NW/21	horizontal wind speed [m/s]
2	3D WM4/NW/21	vertical wind speed [m/s]
3	3D WM4/NW/116	wind direction [°]
4	3D WM4/NW/116	horizontal wind speed [m/s]
5	3D WM4/NW/116	vertical wind speed [m/s]
6	3D WM4/NW/70	wind direction [°]
7	3D WM4/NW/70	horizontal wind speed [m/s]
8	3D WM4/NW/70	vertical wind speed [m/s]
9	WS 018/NW/116	wind speed [m/s]
10	WS 018/NE/116	wind speed [m/s]
11	WS 018/S/116	wind speed [m/s]
12	WS 018/NW/70	wind speed [m/s]
13	WS 018/NE/70	wind speed [m/s]
14	WS 018/S/70	wind speed [m/s]
15	WS 018/NW/21	wind speed [m/s]
16	WS 018/NE/21	wind speed [m/s]
17	WS 018/S/21	wind speed [m/s]
18	RHTT 261/S/116	ambient temp. [°C]
19	RHTT 261/S/70	ambient temp. [°C]
20	RHTT 261/S/21	ambient temp. [°C]
21	RHTT 261/S/116	relative humidity [%]
22	RHTT 261/S/70	relative humidity [%]
23	RHTT 261/S/21	relative humidity [%]
24	DP910	ambient air pressure [mbar]
25	PD 205/NW/70	precipitation [yes/no]
26	PD 205/NE/70	precipitation [yes/no]
27	ST 808/NW/-3.8	sea water temperature [°C]
28	AC SB2i/T/116	X (north – south) acceleration [m/s ²]
29	AC SB2i/T/116	Y (west – east) acceleration [m/s ²]
30	WD 524/NW/116	wind direction [°]
31	WD 524/NE/116	wind direction [°]
32	WD 524/S/116	wind direction [°]
33	WD 524/NW/70	wind direction [°]
34	WD 524/NE/70	wind direction [°]
35	WD 524/S/70	wind direction [°]
36	WD 524/NW/21	wind direction [°]
37	WD 524/NE/21	wind direction [°]
38	WD 524/S/21	wind direction [°]

Overview of data base channels and instruments		
Channel	Instrument code	Parameter and Unit
50	ADCP	Water level [m]
51	ADCP	Water temperature [°C]
52	ADCP	Wave height [m]
53	ADCP	Wave period [s]
54	ADCP	Wave direction [°]
55	ADCP	Current velocity 7 m [m/s]
56	ADCP	Current velocity 11 m [m/s]
57	ADCP	Current direction 7 m [°]
58	ADCP	Current direction 11 m [°]

Note: Channel numbers are referring to the data files.

Appendix 4: site lay out



Appendix 5: positions of met mast and wind turbines

PILENUMBER	UTM31 ED50		WGS 84					
	X (M)	Y (M)	NB			DL		
			DEGR.	MIN.	SEC.	DEGR.	MIN.	SEC.
METPILE	594194.830	5829600.084	52	36	22.9	4	23	22.7
1	597274.725	5826591.268	52	34	43.6	4	26	3.2
2	596850.298	5827074.412	52	34	59.5	4	25	41.2
3	596433.082	5827549.346	52	35	15.1	4	25	19.5
4	596007.871	5828033.381	52	35	31.1	4	24	57.4
5	595583.564	5828516.388	52	35	47.0	4	24	35.4
6	595158.536	5829000.215	52	36	2.9	4	24	13.3
7	594726.899	5829491.566	52	36	19.1	4	23	50.9
8	594301.872	5829975.392	52	36	35.0	4	23	28.8
9	593876.844	5830459.219	52	36	50.9	4	23	6.7
10	593459.780	5830949.925	52	37	7.0	4	22	45.0
11	593026.907	5831426.739	52	37	22.7	4	22	22.5
12	592601.760	5831910.701	52	37	38.7	4	22	0.4
13	592182.906	5826958.656	52	34	54.9	4	26	57.1
14	597857.945	5827442.541	52	35	10.8	4	26	35.1
15	597432.893	5827926.345	52	35	26.7	4	26	13.0
16	597007.841	5828410.149	52	35	42.6	4	25	51.0
17	596528.400	5829183.640	52	36	8.1	4	25	15.6
18	595903.175	5829667.506	52	36	24.0	4	24	53.6
19	595478.123	5830151.311	52	36	39.9	4	24	31.5
20	595053.071	5830635.115	52	36	55.9	4	24	9.4
21	594628.019	5831118.920	52	37	11.8	4	23	47.3
22	598641.617	5828064.237	52	35	30.4	4	27	17.4
23	598213.001	5828548.830	52	35	46.3	4	26	55.1
24	597789.303	5829036.888	52	36	2.4	4	26	33.1
25	597131.999	5829783.176	52	36	27.0	4	25	59.0
26	596654.274	5830327.142	52	36	44.9	4	25	34.2
27	596229.314	5830811.026	52	37	0.8	4	25	12.1
28	595804.353	5831294.911	52	37	16.7	4	24	50.0
29	595379.393	5831778.796	52	37	32.7	4	24	27.9
30	598962.251	5829209.049	52	36	7.2	4	27	35.6
31	598540.161	5829696.571	52	36	23.3	4	27	13.7
32	597889.576	5830435.234	52	36	47.6	4	26	40.0
33	597405.648	5830987.018	52	37	5.8	4	26	14.8
34	596980.688	5831470.903	52	37	21.7	4	25	52.7
35	596555.727	5831954.788	52	37	37.6	4	25	30.7
36	596130.767	5832438.673	52	37	53.5	4	25	8.6

Appendix 6: distances between met mast and wind turbines suitable for wake measurements

Distance between:	Distance: (m)	Wind direction: (°)
Met mast - WT #9	916	340
Met mast - WT #8	390	
WT #8 - WT #21	1189	16
Total distance	1579	
Met mast - WT #19	1397	
WT #19 - WT #33	2101	67
Total distance	3498	
Met mast - WT #18	1710	
WT #18 - WT #25	1234	88
WT #25 - WT #31	1411	
Total distance	4355	
Met mast - WT #7	543	
WT #7 - WT #17	1631	102
WT #17 - WT #24	1468	
Total distance	3642	
Undisturbed		135 - 315