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Akkreditierungsstelle
D-K-15140-01-00Calibration certificate
*Kalibrierschein*Calibration mark
Kalibrierzeichen

1715128
D-K-
15140-01-00
12/2017

Object <i>Gegenstand</i>	Cup Anemometer
Manufacturer <i>Hersteller</i>	Thies Clima D-37083 Göttingen
Type <i>Typ</i>	4.3351.10.000
Serial number <i>Fabrikat/Serien-Nr.</i>	12179378
Customer <i>Auftraggeber</i>	HydroWind BVBA B-1850 Grimbergen (Brussels)
Order No. <i>Auftragsnummer</i>	Email 2017-11-20, Wery
Project No. <i>Projektnummer</i>	VT171188
Number of pages <i>Anzahl der Seiten</i>	4
Date of Calibration <i>Datum der Kalibrierung</i>	14.12.2017

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI).

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Date
Datum

14.12.2017

Head of the calibration laboratory
Leiter des Kalibrierlaboratoriums

Dipl. Phys. Dieter Westermann

Person in charge
Bearbeiter

Hendrik Jansen, B. Eng.

Calibration object
Kalibriergegenstand

Cup Anemometer

Calibration procedure
Kalibrierverfahren

- Deutsche WindGuard Wind Tunnel Services: VA Anemometerkalibrierung
- Based on following standards:
- MEASNET ANEMOMETER CALIBRATION PROCEDURE Version 2 / 2009
- IEC 61400-12-1:2017 Power performance measurements of electricity producing wind turbines
- IEC 61400-12-2:2013 Power performance of electricity producing wind turbines based on nacelle anemometry
- ISO 3966:2008 Measurement of fluid in closed conduits
- ISO 16622:2002 Meteorology - Sonic anemometers/thermometers

Place of calibration
Ort der Kalibrierung

Wind tunnel of Deutsche WindGuard WindTunnel Services GmbH, Varel

Test conditions
Messbedingungen

wind tunnel area	10000 cm ²
anemometer frontal area	230 cm ²
diameter of mounting pipe	34 mm
blockage ratio ¹⁾	0.023 [-]
software version	7.7

¹⁾ Due to the special construction of the test section no blockage correction is necessary.

Ambient conditions
Umgebungsbedingungen

air temperature	20.9 °C ± 0.1 °C
air pressure	987.4 hPa ± 0.3 hPa
relative air humidity	34.8 % ± 2.0 %

Measurement uncertainty
Messunsicherheit

The expanded uncertainty assigned to the measurement results is obtained by multiplying the standard uncertainty by the coverage factor $k=2$. It has been determined in accordance with DAkkS-DKD-3. The value of the measurand lies within the assigned range of values with a probability of 95%.
The reference flow speed measurement is traceable to the German NMI (Physikalisch-Technische Bundesanstalt) standard for flow speed. It is realized by using a PTB owned and calibrated Laser Doppler Anemometer (Standard Uncertainty 0.2 %, $k=2$)

Additional remarks
Zusätzliche Anmerkungen

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Calibration result

Kalibrierergebnis

Sensor	Tunnel Speed	Uncertainty
Hz	m/s	m/s
80.970	3.965	0.050
122.674	5.882	0.051
165.892	7.886	0.051
209.590	9.886	0.051
253.188	11.901	0.052
295.178	13.824	0.053
337.414	15.795	0.052
316.152	14.791	0.052
275.006	12.895	0.052
229.791	10.855	0.051
187.253	8.861	0.051
145.157	6.933	0.051
100.876	4.913	0.050

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Statistical analysis

Slope	$0.04603 \text{ (m/s)/(Hz)} \pm 0.00005 \text{ (m/s)/(Hz)}$
Offset	$0.2488 \text{ m/s} \pm 0.011 \text{ m/s}$
Standard error (Y)	0.011 m/s
Correlation coefficient	0.99999

Remarks

The calibrated sensor complies with the demanded linearity of MEASNET



Graphical representation of the result *Grafische Darstellung des Ergebnisses*

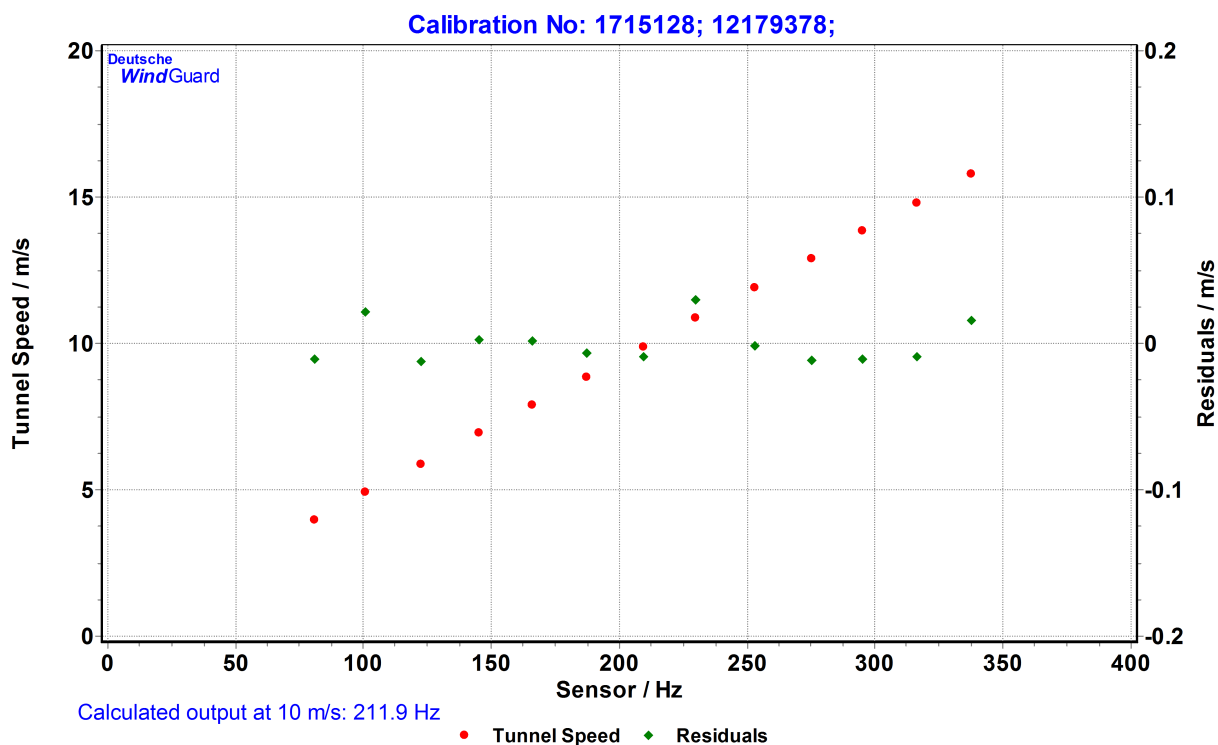
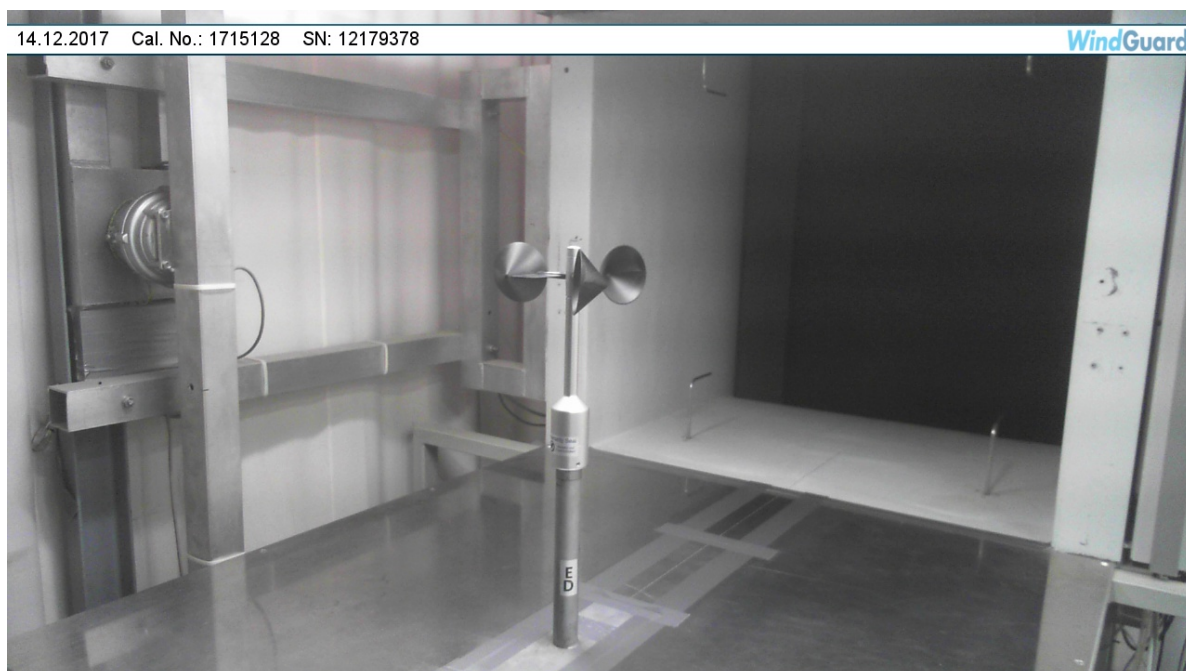


Photo of the measurement setup *Foto des Messaufbaus*



Remark: The proportions of the set-up may not be true to scale due to imaging geometry.