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

| |
|-------------|
| 1715150 |
| 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> | 12179350 |
| 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> | 15.12.2017 |

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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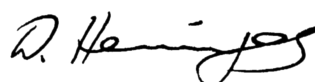
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Date
Datum

15.12.2017

Head of the calibration laboratory
Leiter des Kalibrierlaboratoriums

Dipl. Phys. Dieter Westermann

Person in charge
Bearbeiter

Techniker Dirk Henniges

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 | 20.4 °C ± 0.1 °C |
| air pressure | 994.4 hPa ± 0.3 hPa |
| relative air humidity | 34.7 % ± 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

-

Calibration result

Kalibrierergebnis

| Sensor | Tunnel Speed | Uncertainty |
|---------|--------------|-------------|
| Hz | m/s | m/s |
| 81.065 | 3.967 | 0.050 |
| 122.280 | 5.871 | 0.051 |
| 165.695 | 7.866 | 0.051 |
| 209.566 | 9.896 | 0.051 |
| 252.917 | 11.894 | 0.052 |
| 295.929 | 13.815 | 0.052 |
| 337.783 | 15.788 | 0.053 |
| 315.580 | 14.786 | 0.052 |
| 275.312 | 12.891 | 0.052 |
| 230.715 | 10.856 | 0.051 |
| 187.230 | 8.872 | 0.051 |
| 145.145 | 6.943 | 0.051 |
| 101.568 | 4.924 | 0.050 |

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Statistical analysis

| | |
|-------------------------|---|
| Slope | $0.04597 \text{ (m/s)/(Hz)} \pm 0.00006 \text{ (m/s)/(Hz)}$ |
| Offset | $0.2539 \text{ m/s} \pm 0.014 \text{ m/s}$ |
| Standard error (Y) | 0.014 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

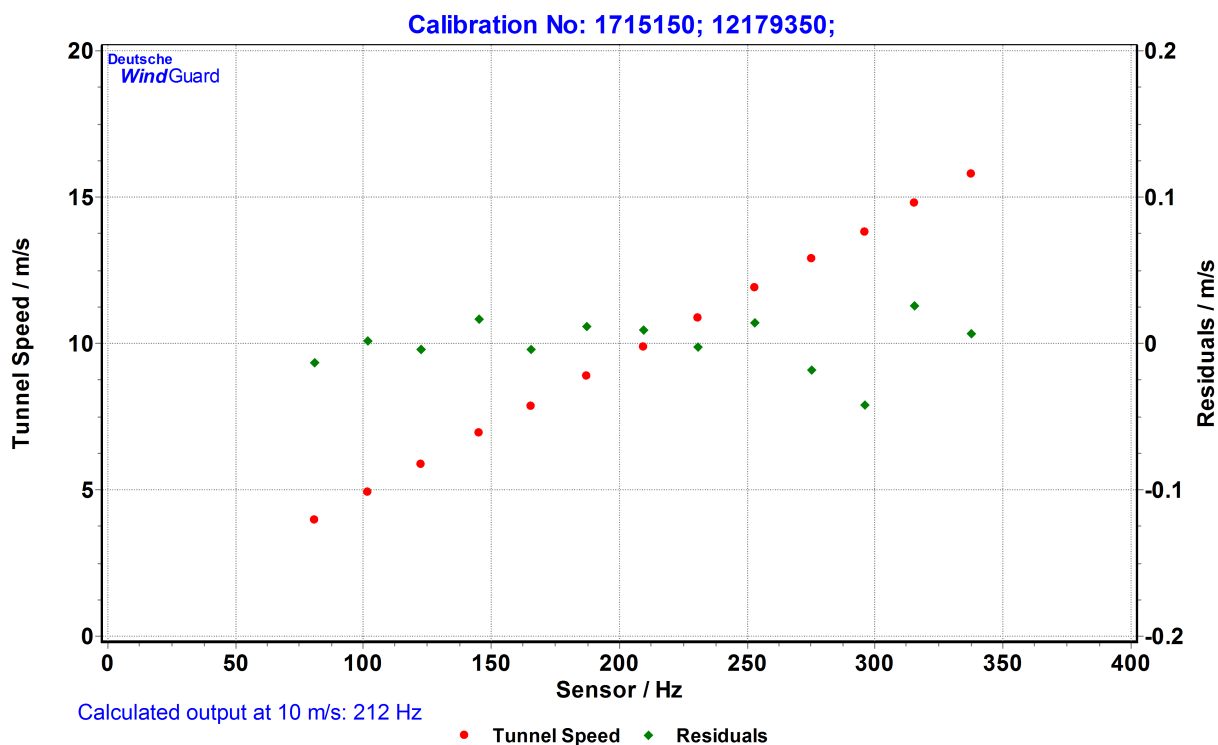
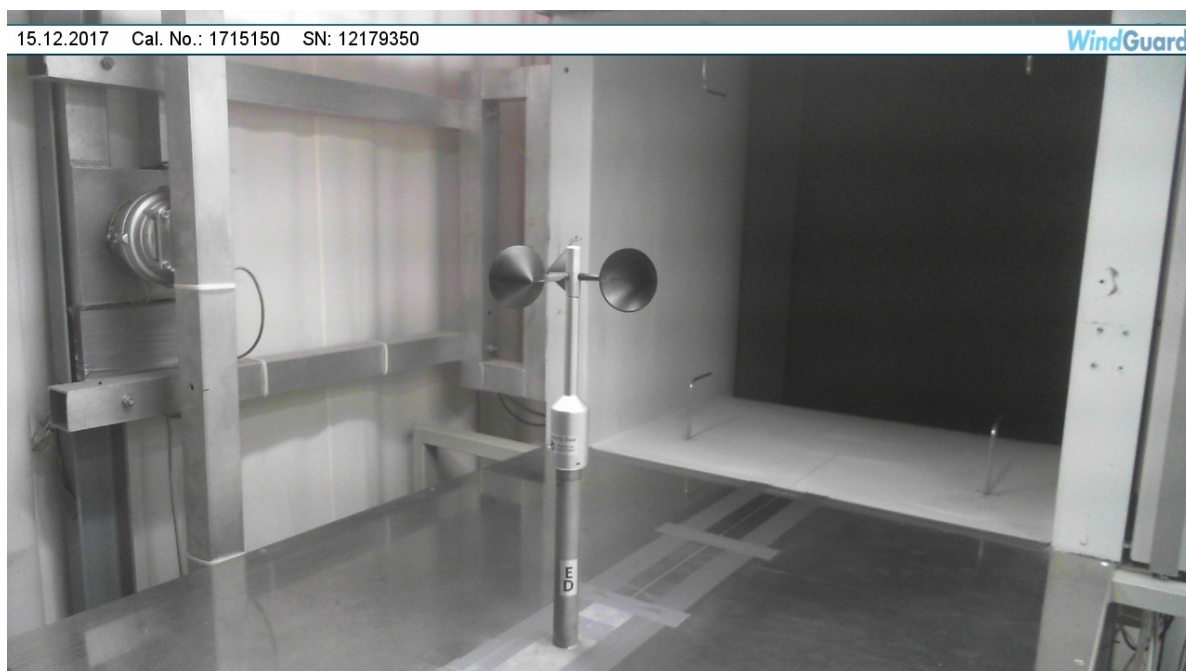


Photo of the measurement setup

Foto des Messaufbaus



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