Calibration Report - MEASNET-annex

Ammonit Wind Tunnel GmbH
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www.ammonit-windtunnel.com

25.11.2019

Dipl.Geoök. S. Müller

Dipl.-Ing. D. Wüstenberg
(signed electronically)

Object:	Cup-Anemometer	Type:	Thies fc advanced II / 4.3352.10.000
Manufacturer:	Thies GmbH Göttingen	Serial number:	11195021 / -
Customer:	Ammonit Measurement GmbH, Berlin	Inventory number:	-
Order number/date:	099AKB19, 2019/09/26	Report number:	193673_D-K-20511-01-00_2019-11

Calibration

- Date and Time:	25.11.2019 13:09
- Wind tunnel:	AWT Bargeshagen
- Software version:	anemo_aus_awt_05_01_rev5.VBS
- Campaign report:	004AK119
- Date of campaign report:	31.12.2019

Ambient conditions

- Air temperature:	19.4 °C
- Rel. Humidity of air:	38 %
- Air pressure:	1011 hPa

Regression curve:

- Range of regression:	4 m/s to 16 m/s
- Slope:	0.045786 [m/s] / [Hz]
- Offset:	0.256968 [m/s]
- Correlation coefficient:	0.999988 [-]
- Standard error in y:	0.019430 [m/s]
- Mean deviation:	-

calculated values at given flow speed

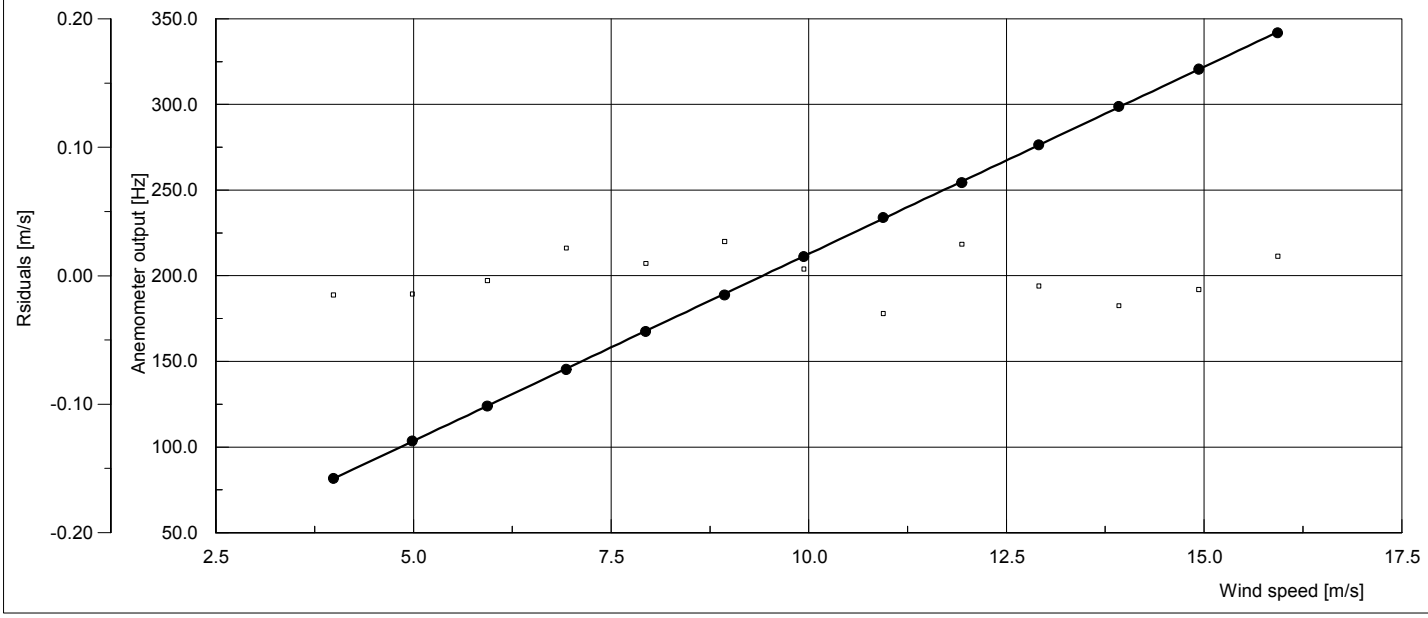
m/s	Hz
10.00	212.79
16.00	343.84

MEASNET is an association of companies which are engaged in the field of wind energy and want to ensure high quality measurements, the uniform interpretation of standards and recommendations as well as the interchangeability of results.

All MEASNET members must be accredited according to ISO/IEC 17025 for the MEASNET approved measurements and have to demonstrate their ability in an individual assessment. In addition the participation in regular round robin tests is mandatory (compliance factor < 1 %). For further details see www.measnet.com.

Only test reports for anemometer calibration with a correlation coefficient >= 0.99995 fulfill the MEASNET criteria for linearity and obtain the MEASNET stamp.

The anemometer under test fulfills the MEASNET requirement for linearity.



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Measurements

Measurements were made according to the guidelines set by the MEASNET network at the Wind Tunnel of Ammonit WindTunnel GmbH in Bargeshagen. The reference velocity was measured using a Prandtl Tube. The anemometer was placed on the standard mounting tube of the test section (a steel tube with the diameter 34,0 mm). The anemometer has run in for minimum 5 min at about 10 m/s before the calibration procedure begins.

The calibration was performed under both, rising and falling wind speed in the range mentioned in page 1.The sampling frequency was 1 Hz an the sampling intervall 30 sec. Before collecting data at each wind speed, one minute delay was allowed for stable conditions to become established.

Remarks

Correlation Coefficient >= 0.99995
The anemometer under test fulfills the MEASNET requirement for linearity.

Uncertainties

- Standard uncertainty of slope (A): 0.000066 [m/s] / [Hz]
- Standard uncertainty of offset (B): 0.014999 [m/s]

Reference Wind Speed [m/s]	Standard deviation Ref. wind speed [m/s]	Anemometer output [Hz]	Residuals [m/s]	Uncertainties Type A [m/s]	Uncertainties Type B [m/s]	Uncertainties total [m/s]
3.98	0.01	81.73	-0.01	0.00	0.05	0.10
5.93	0.01	124.03	-0.00	0.00	0.05	0.10
7.93	0.01	167.42	0.01	0.01	0.05	0.10
9.93	0.01	211.24	0.01	0.01	0.06	0.10
11.93	0.01	254.42	0.02	0.01	0.08	0.10
13.92	0.02	298.86	-0.02	0.01	0.08	0.10
15.93	0.02	341.87	0.02	0.01	0.09	0.10
14.93	0.01	320.68	-0.01	0.01	0.09	0.10
12.91	0.02	276.44	-0.01	0.01	0.08	0.10
10.94	0.01	233.93	-0.03	0.01	0.07	0.10
8.93	0.01	188.84	0.03	0.01	0.06	0.10
6.93	0.01	145.27	0.02	0.01	0.05	0.10
4.98	0.01	103.49	-0.01	0.00	0.05	0.10

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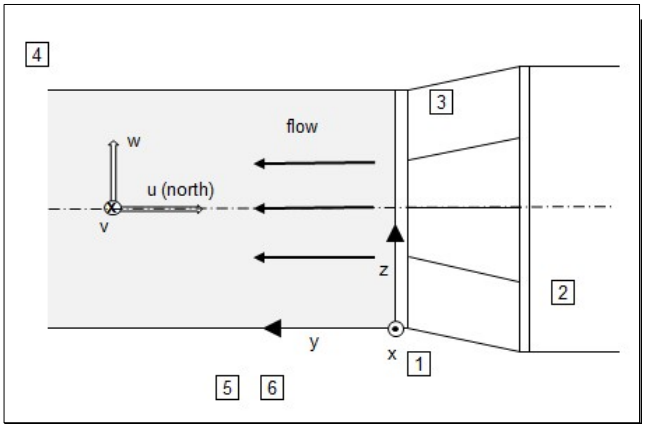
Manufacturer:	Thies GmbH Göttingen	Serialnumber:	11195021 / -
Customer:	Ammonit Measurement GmbH, Berlin	Inventory number:	-
Order number/date:	099AKB19, 2019/09/26	Report number:	193673_D-K-20511-01-00_2019-11

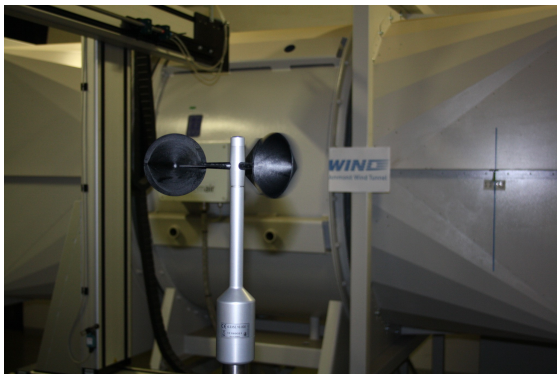
Equipment used	Type	Manufacturer	Inv.-No	Calibration
Prandtl tube	06565	Airflow	0008WT16	14141 PTB 17
Diff. press. sensor	Setra 239	Setra Systems, Inc.	0041WT15	S10350-D-K-15055-01-00-2019-01
Temp. sensor	KRC2/5	Galltec GmbH	0005WT16	14-0164-D-K-15186-01-00-2019-02
Humidity sensor	KRC2/5	Galltec GmbH	0005WT16	14-0164-D-K-15186-01-00-2019-02
Barometer	PTB110	Vaisala GmbH	0039WT15	081-D-K-15157-01-00-2019-01
A to D card	PCI-6033E	Nat. Instr. GmbH	0011WT15	0001 AWT 2019-10
Counter card	PCI-6033E	Nat. Instr. GmbH	0011WT15	0028 AWT 2019-06
Calibrator	METRACAL MC	GMV-I GmbH	0037WT15	QC109-D-K-15080-01-01-2019-09
Tilt sensor	QG65-KD-030H	Distrelec GmbH	0011WT17	10713560 D-K-15118-01-00-2019-03
Angle encoder	8.5883.5324	Kübler GmbH	0012WT17	11115 D-K-15001-01-00-2018-06

Sketch of the wind tunnel:



Origin of Coordinates (1): Lower left Edge of the Nozzle
Centre of Cups (Anemometer): x=600, y=600, z=600 [mm]
Prandtl Tube Position (3): 4 Tubes at the Corners of the Nozzle
Pre-Chamber Pressure (2)
Temperature- and Humidity Sensor (4): At the edge of the Wind-Tunnel Cross-Section Leaving Jet
Barometric Pressure (5): next to the Leaving Jet
Data Acquisition (6)
Different Calibration Position: See Remarks Page 2

Photo of the anemometer:



Summary:

- Report number:	193673_D-K-20511-01-00_2019-11
- Type:	Thies fc advanced II / 4.3352.10.000
- Serial-/Cup number:	11195021 / -
- Slope:	0.045786 [m/s] / [Hz]
- Offset:	0.256968 [m/s]
- Correlation coefficient:	0.999988 [-]

The anemometer under test fulfills the MEASNET requirement for linearity.

Ammonit Wind Tunnel GmbH

Bargeshagen, Germany

akkreditiert durch die / accredited by the

Deutsche Akkreditierungsstelle GmbH

als Kalibrierlaboratorium im / as calibration laboratory

Deutschen Kalibrierdienst

193673	
D-K-20511-01-00	
2019-11	

Kalibrierschein
Calibration certificate

Kalibrierschein
Calibration certificate

Gegenstand *Object*	Cup-Anemometer
Hersteller *Manufacturer*	Thies GmbH Göttingen
Typ *Type*	Thies fc advanced II / 4.3352.10.000
Fabrikat/Serien-Nr. *Serial number*	11195021
Auftraggeber *Customer*	Ammonit Measurement GmbH, Berlin
Auftragsnummer *Order No.*	099AKB19, 2019/09/26
Anzahl der Seiten des Kalibrierscheines *Number of Pages of the certificate*	3
Datum der Kalibrierung *Date of calibration*	25.11.19

Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Die DAkkS ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine.
Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI). The DAkkS is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.
The user is obliged to have the object recalibrated at appropriate intervals.

Datum *Date*	Leiter des Kalibrierlaboratoriums *Head of the calibration laboratory*	Bearbeiter *Person in charge*
25.11.2019	Dipl.-Ing. D. Wüstenberg	Dipl.Geoök. S. Müller

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Kalibriergegenstand *Object*	Cup-Anemometer
Kalibrierverfahren *Calibration procedure*	IEC 61400-12-1: 2017 (DIN EN 61400-12-1 2017:03) Wind power generation systems - Power performance measurement of electricity producing wind turbines MEASNET - Anemometer Calibration Procedure - Version 2 - 10/2009
Ort der Kalibrierung *Place of calibration*	AWT Bargeshagen

Messbedingung
Test conditions

wind tunnel area [1]	14400 cm²
anemometer frontal area [2]	300 cm²
diameter of mounting pipe [3]	34,0 mm
blockage ratio [4]	0.021 [-]

Umgebungsbedingungen
Air conditions

air temperature	19.4 °C (+- 1.0 K)
air pressure	1011 hPa (+- 1.0 hPa)
relative humidity	38 % (+- 2.0 %)

Dateiinformation *File conditions*	thi-11195021 / Cup-f-mes-wind / vt-vxy
Anmerkungen *Remarks*	Correlation Coefficient >= 0.99995 The anemometer under test fulfills the MEASNET requirement for linearity.
Auswertesoftware *Software version*	anemo_aus_awt_05_01_rev5.VBS

Der Kalibrierschein wurde elektronisch unterschrieben.
The calibration certificate was signed electronically.

[1] *Querschnittsfläche der Auslassdüse des Windkanals / Cross-sectional area of the orifice of the wind tunnel*

[2] *Vereinfachte Querschnittsfläche (Schattenwurf) des Anemometers inkl. Montagerohr / Simplified cross-sectional area of the anemometer including mounting pipe*

[3] *Durchmesser des Montagerohrs / Diameter of the mounting pipe*

[4] *Verhältnis von 2) zu 1) / Ratio 2) to 1)*

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Kalibrierergebnis:
Results

Anzeige Anemometer / Indication anemometer [Hz]	Strömungsgeschwindigkeit / Air flow velocity [m/s]	Erweiterte Messunsicherheit / Expanded Uncertainty [m/s]
81.73	3.98	0.10
124.03	5.93	0.10
167.42	7.93	0.10
211.24	9.93	0.10
254.42	11.93	0.10
298.86	13.92	0.10
341.87	15.93	0.10
320.68	14.93	0.10
276.44	12.91	0.10
233.93	10.94	0.10
188.84	8.93	0.10
145.27	6.93	0.10
103.49	4.98	0.10

Angegeben ist die erweiteret Messunsicherheit, die sich aus der Standardmessunsicherheit durch Multiplikation mit dem Erweiterungsfaktor k=2 ergibt. Sie wurde gemäß DAkkS-DKD-3 ermittelt. Der Wert der Messgröße liegt mit einer Wahrscheinlichkeit von 95% im zugeordneten Wertintervall.
Reported is the expanded uncertainty which results from the standard uncertainty by multiplication with the coverage factor k = 2. It has been calculated according to DAkkS-DKD-3. The value of the measurand is found within the attributed interval with a probability of approximately 95 %.

Die Deutsche Akkreditierungsstelle GmbH ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine. Die weiteren Unterzeichner innerhalb und außerhalb Europas sind den Internetseiten von EA (www.european-accreditation.org) und ILAC (www.ilac.org) zu entnehmen.
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