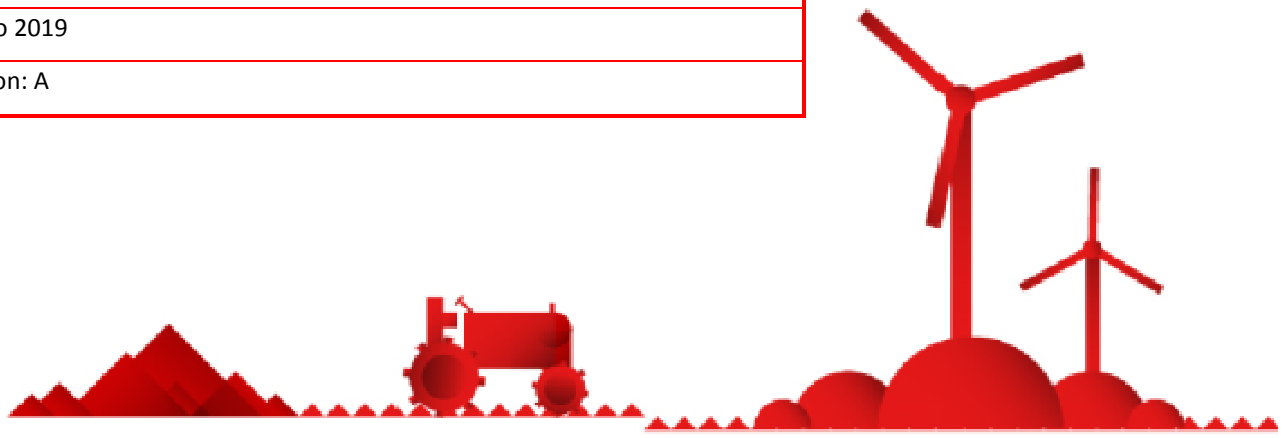
PARCO EOLICO "ROSAMARINA"

A.5 - Studio Anemologico

Lavello (Potenza)

Marzo 2019

Version: A



EDP Renewables Italia Holding S.r.l.

Via Lepetit 8/10

20124 - Milano

ORDINE DEGLI ARCHITETTI PIANIFICATORI PAESAGGISTI E CONSERVATORI PROVINCIA DI POTENZA
Donata Maria Rosaria
Margiotta
architetto
420 sez. A

MARGIOTTA [illegible]

Via Vac[illegible]37

85100 Potenza

P.IVA: 01108480763

Tel: 0971/37512

INDICE

1. INTRODUZIONE

Il presente documento è stato redatto al fine di stimare la producibilità dell'impianto eolico di Lavello (PZ) denominato "Rosamarina" di proprietà di EDP Renewables Holding Italia Srl, con sede legale a Milano in Via R. Lepetit 8/10, leader globale nel settore delle energie rinnovabili e rappresenta il quarto produttore al mondo di energia eolica.

Sul sito è stata installata una torre anemometrica di riferimento, in località Bosco delle Rose, lo studio anemologico che segue.

Lo scenario studiato nell'ambito della presente analisi è un layout di 7 aerogeneratori con potenza unitaria di 5,3 MW, pari a 37.1 MW di potenza globale, con altezza del mozzo di 121 m.

2. CARATTERISTICHE DEL PARCO EOLICO

Il parco, ubicato a nord-est dell'abitato di Lavello da cui dista circa otto Km ricadente in della frazione di Gaudiano si svilupperà in parte lungo la dorsale del "Monte Quercia" (WTG 1, WTG 2 e WTG 3) e in parte sull'altopiano immediatamente a valle del crinale verso nord-est, a sud della località la Signorella ed a nord della masseria Rosamarina (WTG 4, WTG 5 e WTG 6, e WTG 7).

Le caratteristiche del Parco eolico in esame sono le seguenti:

Scenario del progetto	**7 x GE158 5.3MW @121m**
Modello delle turbine	**GE158**
Altezza mozzo (m)	**121**
turbina (MW)	**5.3**
Numero di turbine	**7**
Capacità (MW)	**37.1**

Tabella 1 – Caratteristiche del parco eolico "Rosamarina"

La dislocazione degli aerogeneratori sul territorio è scaturita da un'attenta analisi della morfologia del territorio, da una serie di rilievi sul campo, da studi anemometrici e da una serie di elaborazioni e simulazioni informatizzate finalizzate a:

- minimizzare l'impatto visivo;
- ottemperare alle prescrizioni delle competenti autorità;
- ottimizzare la viabilità di servizio dedicata e la produzione energetica

Nella tabella sottostante si riportano le coordinate degli aerogeneratori di progetto nel sistema di coordinate UTM WGS 1984 fuso 33W.

AEROGENERATORE	EST	NORD
WTG 1	**574399**	**4546704**
WTG 2	**575499**	**4547317**
WTG 3	**575215**	**4546780**
WTG 4	**579877**	**4550531**
WTG 5	**579018**	**4550604**
WTG 6	**578131**	**4550234**
WTG 7	**578264**	**4550852**

Tabella 1 Coordinate aerogeneratori

Si riporta nell'immagine sottostante una rappresentazione della distribuzione sul territorio (Comune di Lavello) delle 7 turbine costituenti il parco eolico.

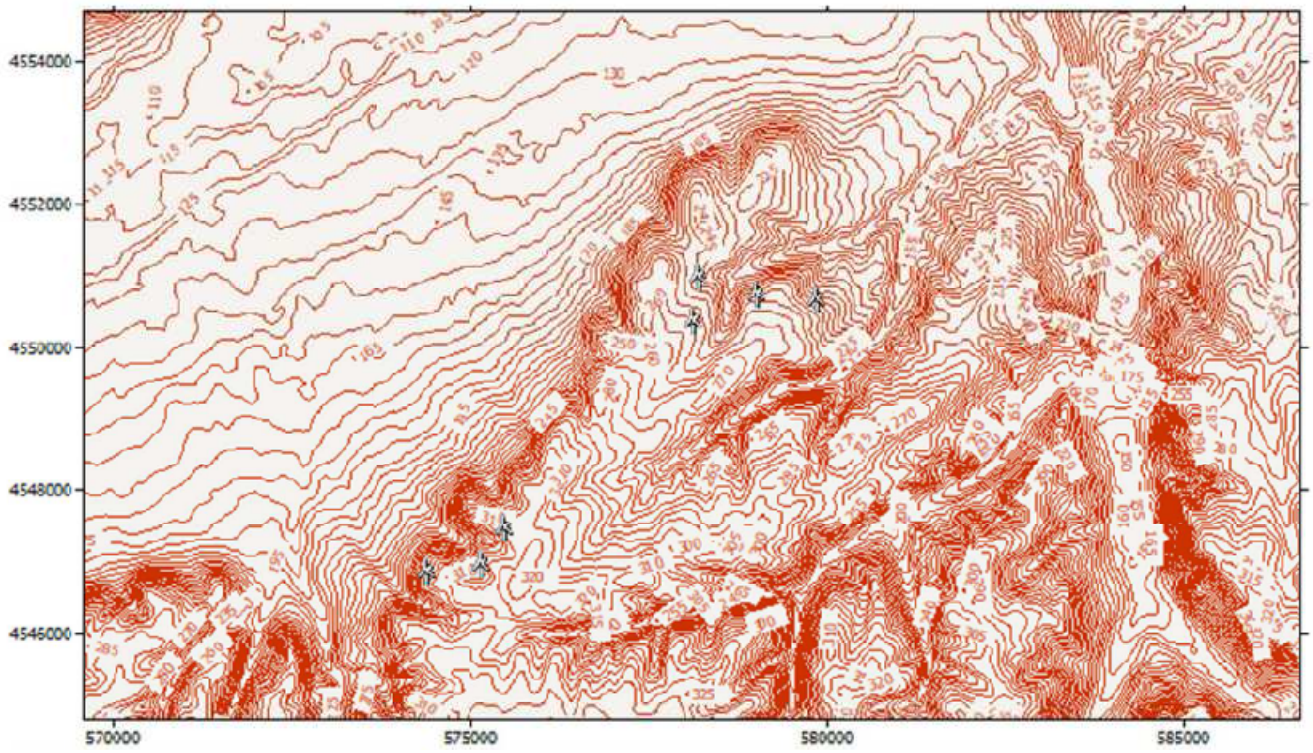


Figura 1: localizzazione delle turbine costituenti il parco eolico "Rosamarina"

3. TORRI DI MISURA INSTALLATE NELL'AREA

In prossimità dell'area in cui localizzare l'impianto è stata istallata una torre di misura in località Bosco Le Rose, con Prot. DIA 5674 del 17/04/2009 al Comune di Lavello (PZ).

Per quanto riguarda il periodo di riferimento scelto, si precisa che si definisce come periodo di riferimento quello che meglio rappresenta la natura anemometrica del sito come anche la variabilità attesa della velocità del vento. I criteri applicati per selezionare il periodo di riferimento sono così definiti:

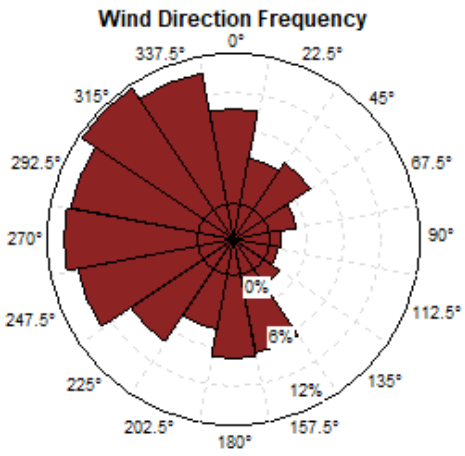
- La disponibilità dei dati durante un lungo periodo deve essere la più alta possibile;
- La rosa dei venti e la distribuzione di Weibull deve essere rappresentativa a lungo termine nei punti di installazione degli aerogeneratori;
- Il periodo di riferimento deve avere una velocità media del vento simile a quella che ci si aspetta a lungo termine.

Di seguito si riportano le coordinate dell' anemometro utilizzato nel sistema di coordinate Gauss Boaga Roma 40 fuso est.

Località	Coordinate GAUSS BOAGA - ROMA 40 (m)		Data di installazione
	est	nord	
Bosco delle Rose	2590801	4544068	04/2009

Tabella 2 – Ubicazione anemometro

Dalla campagna anemologica effettuata, sono stati ricavati i dati della velocità e direzione predominante dei venti rappresentati dalla Rosa dei Venti di seguito riportata:



4. CURVA DI POTENZA

La curva di potenza considerata nella presente analisi, corrispondente ad una densità dell'aria di 1,17 kg/m^3, è la seguente:

WGT	**GE 158 5.3 MW 1,17 Kg/m^3**
VELOCITA' (m/s)	POTENZA (KW)
0	0
1	0
2	0
3	68
4	277
5	603
6	1081
7	1747
8	2618
9	3574
10	4403
11	5032
12	5292
13	5300
14	5300
15	5300
16	5300
17	5300
18	5300
19	5300
20	5300
21	5300
22	5300

Tabella 3 – Curva di potenza considerata nella presente analisi

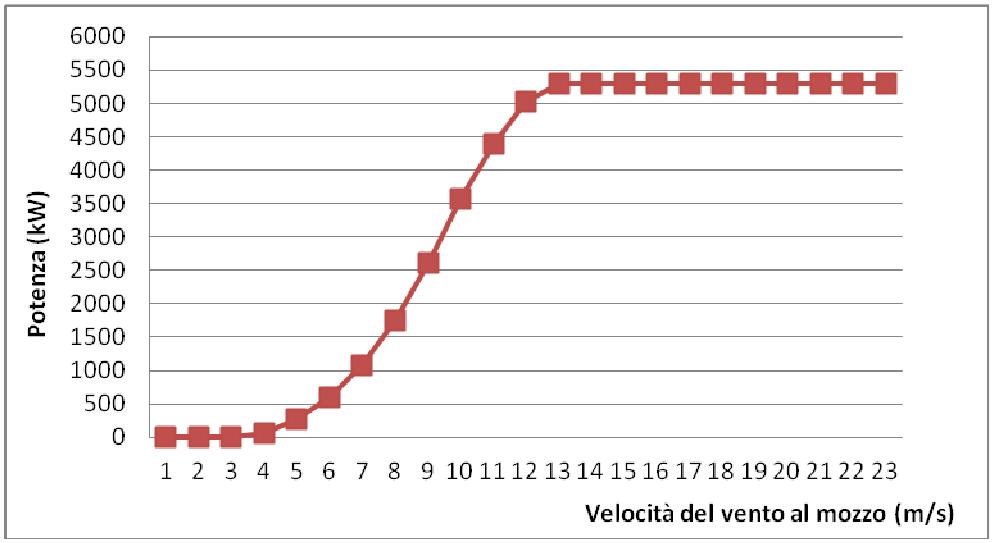


Figura 2: Curva di potenza

La Società EDPR, contestualmente alla realizzazione del parco, ha intenzione di installare un ulteriore torre anemometrica in Località Coppa Fenocchio, a circa 420,00 metri dalla WTG06 e a circa 660,00 metri dalla WTG07.

Località	Coordinate UTM – WGS84 33T (m)		Data di installazione
	est	nord	
Coppa Fenocchio	577780	4550434	**In fase esecutiva**

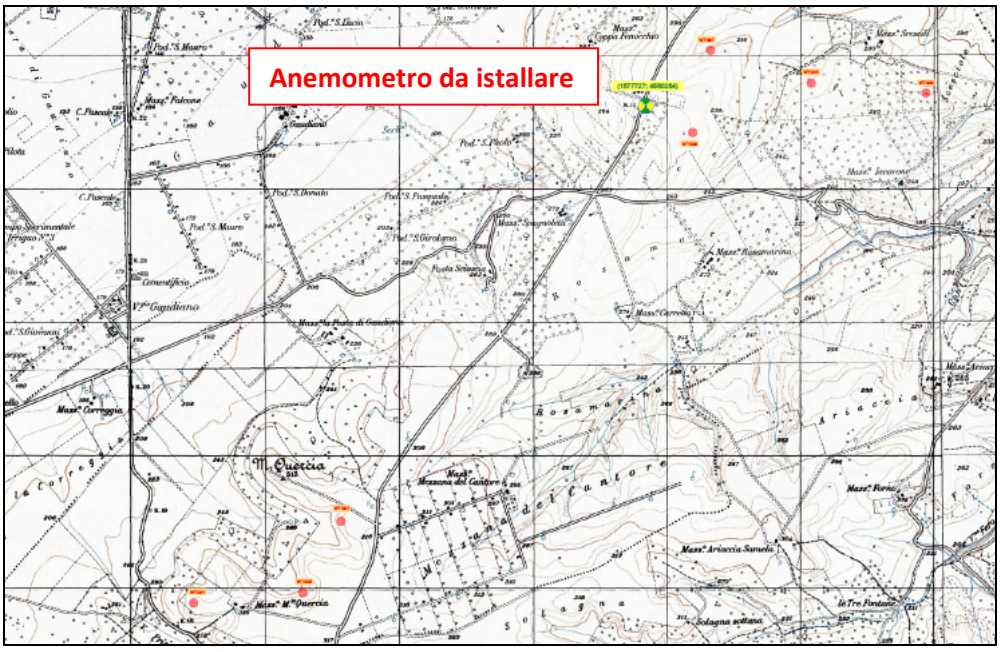


Figura 3: Localizzazione dell'anemometro da istallare in fase esecutiva

5. DENSITA' VOLUMENTRICA

La produzione annuale stimata per il parco eolico di Lavello "Rosamarina" è di **100.360MWh**.

Per il calcolo della densità volumetrica di energia annua unitaria si ha:

$$Ev = \frac{E}{18D^2H}$$

dove D e H rappresentano rispettivamente il diametro del rotore e l'altezza totale dell'aerogeneratore (somma del raggio del rotore e dell'altezza da terra del mozzo) espressi in metri, mentre E rappresenta l'energia prodotta dalla turbina (espressa in kWh/anno).

Nel caso in esame, considerando un aerogeneratore avente un rotore di diametro pari a 158 m ed altezza totale di 199.90 m risulta:

***Ev** = (100.360.000/7)/18x158^{2}x199.9= 0.16 (KWh/(anno*m^3)*

6. DOCUMENTI COMPROVANTI L'INSTALLAZIONE DELL'ANEMOMETRO "BOSCO DELLE ROSE"

LNSalv.....l662

CITTA' DI LAVELLO

Provincia di Potenza

UFFICIO TECNICO COMUNALE

Via Cavour - 85024 LAVELLO (Pz)

Cod. Fisc. 85000470766 P. I.V.A. 007899800760 Telefono 0972/80111 (centralino) Fax. 097288643

Prot. n° 5674 Lavello, lì 18 maggio 2009

Al Sig. DELLI GUANTI Gianfranco
Via Sorboli n° 14
Vico del Gargano (Fg)

e.p.c. Al Progettista
Geom. Valentino GIAMBELLI
Via Trento n° 64
Vimercate (Mi)

Al Comando di Polizia Municipale
S E D E

OGGETTO: **Denuncia Inizio Attività edilizia . Art. 22 comma 3 del D.P.R. 380/2001-.**
Installazione temporanea di una torre anemometrica (Ditta WINDERG srl) in agro di Lavello Foglio di mappa n° 60 particella n° 286.

Con la presente, si restituisce una copia della denuncia di cui all'oggetto, significando che la stessa è stata acquisita agli atti del Comune in data **17 aprile 2009** col n° **2061** d'ordine, la stessa viene depositata con provvedimento **n° 70 del 15 maggio 2009** nell'apposito registro dell'Ufficio Tecnico Comunale.

Con la comunicazione di effettivo inizio dei lavori dovrà essere presentato:

1. **DURC** (documento unico di regolarità contributiva), ai sensi del D.L.vo 251/2004, relativo all'impresa esecutrice dei lavori. In caso di assenza della certificazione di regolarità contributiva l'efficacia della validità della denuncia di inizio di attività si intende sospesa.

Il progettista, ad ultimazione dei lavori, ha l'obbligo di emettere certificato di collaudo finale attestante la congruità dell'opera al progetto di cui al presente deposito.

Tutti i materiali provenienti dagli scavi o dalle demolizioni dovranno essere trasportati in giornata presso discariche autorizzate a tal fine o impianti autorizzati per il recupero. Tanto al fine di non incorrere nella violazione degli articoli 14 – 50 – 51 del Decreto Legislativo 5 febbraio 1997 n° 22 e successive modifiche ed integrazioni. Con la comunicazione di ultimazione dei lavori, nonché la richiesta di agibilità / abitabilità dovrà essere dimostrata la destinazione dei rifiuti.

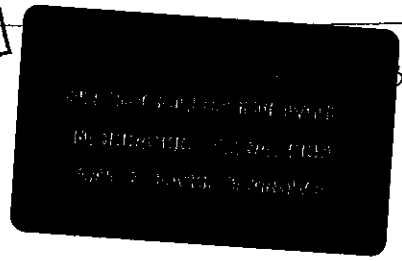
IL RESPONSABILE DEL SETTORE TECNICO
Arch. Sabina COLAIANNI

17/4/09
modello DIA/1.2 UTC

CITTA' DI LAVELLO
Segreteria Generale
16 APR. 2009
Arrivo /consegnato a mano

protocollo

bollo



AL SIGNOR SINDACO
DEL COMUNE DI LAVELLO (PZ)
via Cavour 85024 LAVELLO

COMUNICAZIONE DI INIZIO ATTIVITA' EDILIZIA

Il sottoscritto olelli GUANTI GIANFRANCO nato a MILANO IL 27/4/1964

residente in VICO DEL GARGANO alla via SORBOLI N. 14 C.A.P. 71018

codice fiscale D L L G F R 6 4 D 2 7 F 2 0 5 W

con domicilio in VICO DEL GARGANO alla via SORBOLI N. 14

nella qualità di

proprietario ☐

comproprietario (1) ☐

avente titolo ☒ MANDATARIO RAPPRESENTANTE DI WINDORG SRL
mediante delega con firma autenticata in data .....

dal proprietario ..... nato a .....

residente in ..... alla via .....

Ai sensi e per gli effetti dalla legge 4 dicembre 1993, n°493 e successive modificazioni;

DENUNCIA

L'INIZIO DELLA ESECUZIONE DI OPERE EDILIZIE NEL FABBRICATO UBICATO IN TERRITORIO DI LAVELLO

VIA /CONTRADA/PIAZZA/CORSO BOSCO DELLE ROSE

N° ..... piano .....

FG. 60 PART. 286

come da progetto allegato e relativa relazione asseverata dal progettista abilitato GEOM./ARCH./ING.

VALENTINO GIAMBELLI

COMUNICA

- ☐ le opere previste ed illustrate nella allegata relazione asseverata rispondono alla casistica del citato articolo 4, comma 7, lettera ....., della legge 493/93 e successive modifiche;
- ☐ le opere comportano modifiche in locali NON interessati da domanda di CONDONO edilizio ex legge 47/85 e successive modifiche;
- ☐ le opere comportano modifiche in locali interessati da domanda di CONDONO edilizio ex legge 47/85 e successive modifiche, ultimate nell'anno ..... come da domanda di condono inoltrata in data ..... a nome di .....;
- ☐ le opere richieste comportano modifiche dei locali oggetto di concessione a sanatoria ex legge 47/85 inoltrata in data ..... a nome di .....;

INSTALLAZIONE TEMPORANEA DI TORRE ANEMOMETRICA

~~firma del proprietario~~ / avente tittolo .....

data, ...

spazio riservato alla autentica della firma

(1) indicare per esteso le generalità complete degli altri comproprietari

.....

.....

.....

.....

.....

7. CALIBRAZIONE ANEMOMETRO “BOSCO LE ROSE”

WINDERO

DEUTSCHER KALIBRIERDIENST DKD

Kalibrierlaboratorium für Strömungsgeschwindigkeit von Luft
Calibration laboratory for velocity of air flow
Akkreditiert durch die */ accredited by the*
Akkreditierungsstelle des DKD bei der
PHYSIKALISCH-TECHNISCHEN BUNDESANSTALT (PTB)

DEWI GmbH
Deutsches Windenergie-Institut
138807

Deutscher Akkreditierungs Rat
DAR
DKD-K-28901

Kalibrierschein
Calibration certificate

Kalibrierzeichen
Calibration label

1388_07
DKD-K-28901
10.09.07

Gegenstand *Object*	Cup Anemometer
Hersteller *Manufacturer*	NRG systems Hinesburg VT 05461 USA
Typ *Type*	Max 40 (S)
Fabrikat/Serien-Nr. *Serial number*	body: 1388_07 cup: -
Auftraggeber *Customer*	SARTELCO SISTEMI SRL 20059 Vimercate (MI), IT
Auftragsnummer *Order No.*	1388_07
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	3+3
Datum der Kalibrierung *Date of calibration*	10.09.07

Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Der DKD 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 DKD 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.

Stempel *Seal*	Datum *Date*	Stellv. Leiter des Kalibrierlaboratoriums *Deputy head of the calibration laboratory*	Bearbeiter *Person in charge*
Deutscher Kalibrierdienst DKD-K-28901	10.09.07	P. Busche Dipl.-Ing. (FH) P. Busche	R.Kluin

DEWI GmbH DEUTSCHES WINDENERGIE - INSTITUT
Ebertstr. 96, D-26382 Wilhelmshaven
Tel. +49 (0)4421 4808-0, Fax. +49 (0)4421 4808-43

1388_07
DKD-K-28901
10.09.07

Kalibrierzeichen
Calibration label

Kalibriergegenstand *Object*	Cup Anemometer	
Kalibrierverfahren *Calibration procedure*	MEASNET - Cup Anemometer Calibration Procedure - 9/1997 ISO 3966 – Measurement of fluid in closed conduits – 1977	
Ort der Kalibration *Place of calibration*	Windtunnel of the University of Oldenburg	
Meßbedingungen *Test conditions*	wind tunnel area [1]	8000 cm²
	anemometer frontal area [2]	150 cm²
	diameter of mounting pipe [3]	16 mm
	blockage ratio [4]	0.019 [-]
	blockage correction [5]	0.999 [-]
	tunnel calibration [6]	0.999 [-]
	average DEWI reference [7]	Risoe 2084 : 10.22 m/s
	present DEWI reference [8]	10.22 m/s
Umgebungsbedingungen *Ambient conditions*	air temperature	22.0 °C
	air pressure	1007.2 hPa
	relative air humidity	50.2 %
Dateiinformation *File information*		c:\AK\Kalibrierdaten\Doc\2007\09_2007\1388_07.doc
Anmerkungen *Remarks*	-	
Auswertesoftware *Software version*	LV_Rev.1.6	

[1] Nozzle area of the wind tunnel

[2] Projected cross sectional area of the anemometer

[3] Diameter of the mounting pipe

[4] Ratio [2] to [1]

[5] Correction in wind speed due to the blockage effect of the anemometer

[6] Ratio of wind speed at the anemometer position relative to the wind speed measuring plane

[7] Long term average value of the reference anemometer

[8] Current value of the reference anemometer

DEWI GmbH DEUTSCHES WINDENERGIE - INSTITUT
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Tel. +49 (0)4421 4808-0, Fax. +49 (0)4421 4808-43

1388_07
DKD-K-28901
10.09.07

Kalibrierzeichen
Calibration label

Messergebnis:
Result:

Strömungs-geschwindigkeit Luft (speed of air flow) m/s	Anzeige Anemometer (anemometer signal) 1/s	Erweiterte Messunsicherheit (expanded uncertainty)* m/s
4.124	5.090	0.10
6.169	7.705	0.10
8.189	10.286	0.10
10.358	13.091	0.10
12.413	15.772	0.10
14.481	18.491	0.10
16.079	20.559	0.10
15.557	19.883	0.10
13.472	17.073	0.10
11.418	14.440	0.10
9.301	11.707	0.10
7.242	9.062	0.10
5.143	6.364	0.10

*) Angegeben ist die erweiterte Messunsicherheit, die sich aus der Standardmessunsicherheit durch Multiplikation mit dem Erweiterungsfaktor k=2 ergibt, wobei die kleinste angebbare Messunsicherheit gemäß DKD-Akkreditierung 0.10 m/s beträgt. Die erweiterte Messunsicherheit wurde gemäß DKD-3 ermittelt. Der Wert liegt mit einer Wahrscheinlichkeit von 95% im zugeordneten Wertintervall.

Der Deutsche Kalibrierdienst 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.

**) The expanded uncertainty assigned to the measurement results is obtained by multiplying the standard uncertainty by the coverage factor k=2. According to the DKD-accreditation the value for the best measurement capability shall not be smaller than 0.10 m/s. The expanded uncertainty has been determined in accordance with DKD-3. The value of the measurand lies within the assigned range of values with a probability of 95%.*

The DKD 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. Further signatory members within Europe and outside of Europe may be extracted from the EA-internet page (www.european-accreditation.org) and the ILAC-internet page (www.ilac.org)

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DEWI

MEASNET Appendix

1. Results

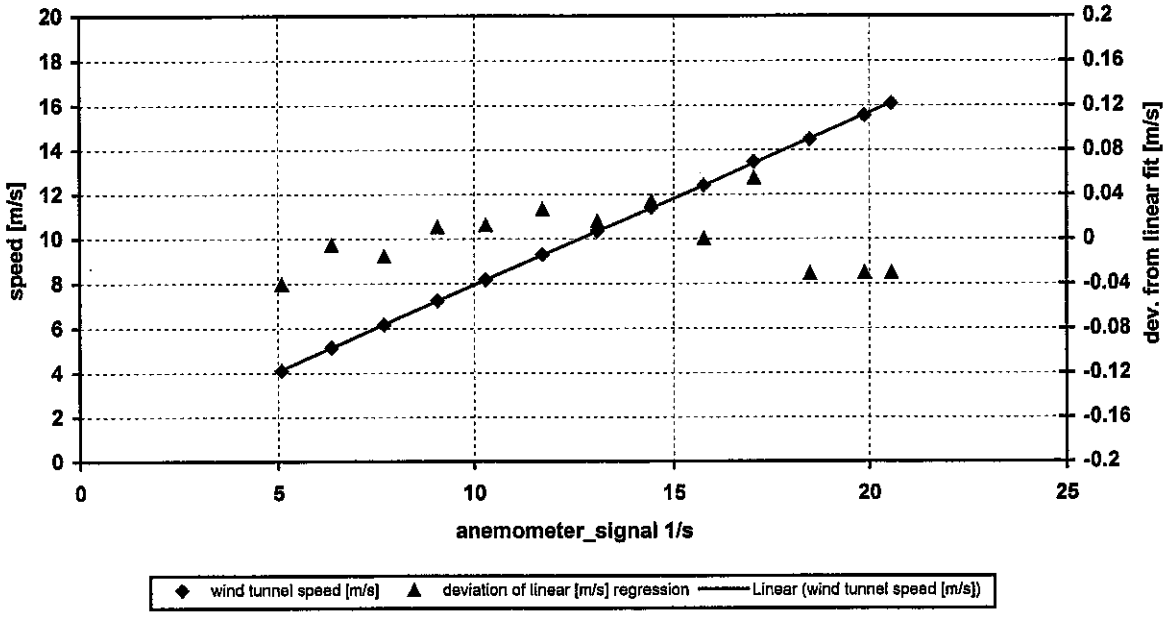
DKD calibration no.	1388_07
type	Max 40 (S)
serial number	1388_07
cup number	-
date	10.09.07
file	c:\AK\Kalibrierdaten\Doc\2007\09_2007\1388_07.doc
DEWI Version	LV_Rev.1.6
air temperature	22.0 °C
air pressure	1007.2 hPa
air humidity	50.2 %

linear regression analysis

slope	0.7721 m ± 0.00169 m
offset	0.235 m/s ± 0.024 m/s
correlation coefficient	0.999974
standard error (v)	0.030 m/s
COV(A,B)	-37.450E-6

remarks -

DEWI Calibration No. 1388_07



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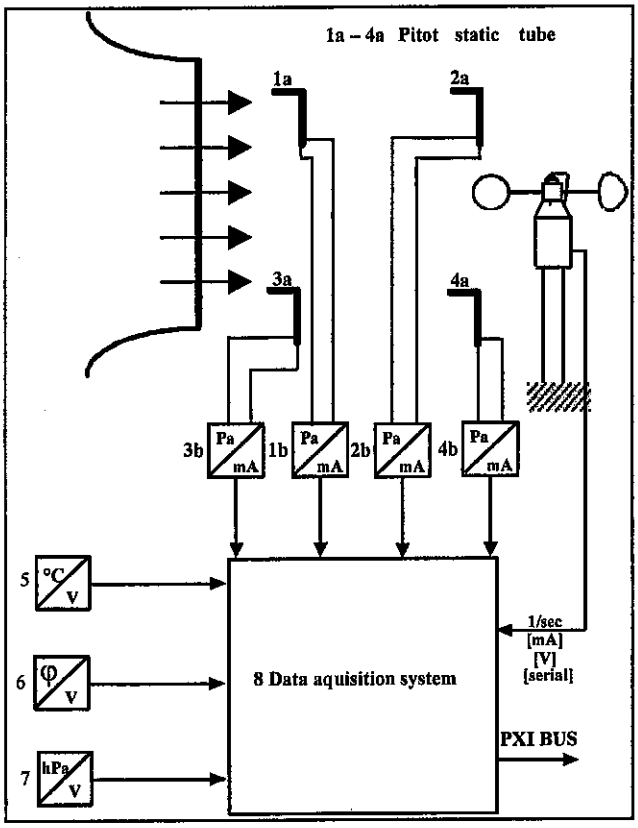
Tel. +49 (0)4421 4808-0, Fax. +49 (0)4421 4808-43

2. Instrumentation



Description of the data acquisition system

1a – 4a Pitot tube

Type:	Airflow (ISO 3966)
Year:	2005
Calibration:	No; ISO 3966 [1]

1b Pressure Transducer

Type:	ASHCROFT XLdp
Year:	1993
Calibration:	recalibration DEWI

2b Pressure Transducer

Type:	ASHCROFT XLdp
Year:	1993
Calibration:	recalibration DEWI

3b Pressure Transducer

Type:	Setra 239
Year:	2003
Calibration:	recalibration DEWI

4b Pressure Transducer

Type:	Setra 239
Year:	2001
Calibration:	recalibration DEWI

5 Thermometer

Type:	Galtec KRC2/5-ME
Serial no.	48448
Calibration:	2928/2007_01

6 Humidity Sensor

Type:	Galtec KRC2/5-ME
Serial no.	48448
Calibration:	2928/2007_01

7 Barometer

Type:	Vaisala PTB 100A
Serial no.	U5030013
Calibration:	P01664/Nov. 2006

8 Data aquisition system

Type:	NI 1042
Year:	2003
Calibration:	checked with calibrated current, voltage and frequency standard

Reference Pressure transducer

Type:	Ashcroft XLDP2
Year:	2004
Calibration:	A 5662 /07-01

Wind Tunnel: University of Oldenburg

Remark: Ambient pressure standard is calibrated by DKD in 02/2006
Combined temperature and humidity standard is calibrated by the German 'Eichamt' in 4/2000
The multimeter is calibrated by 'DKD' in 06/2006
The frequency counter is calibrated by the German 'DKD' in 06/2005

3 Deviation to MEASNET Procedure

1. The time to get stable flow conditions between two speed settings is approx. 30 seconds (it has been proven for this tunnel that 30 seconds are sufficient enough to establish a stable flow).
2. The expanded uncertainty from page 3 shows only values ≥ 0.10 m/s due to the *best measurement capability* of 0.10 m/s as defined by the DKD accreditation.

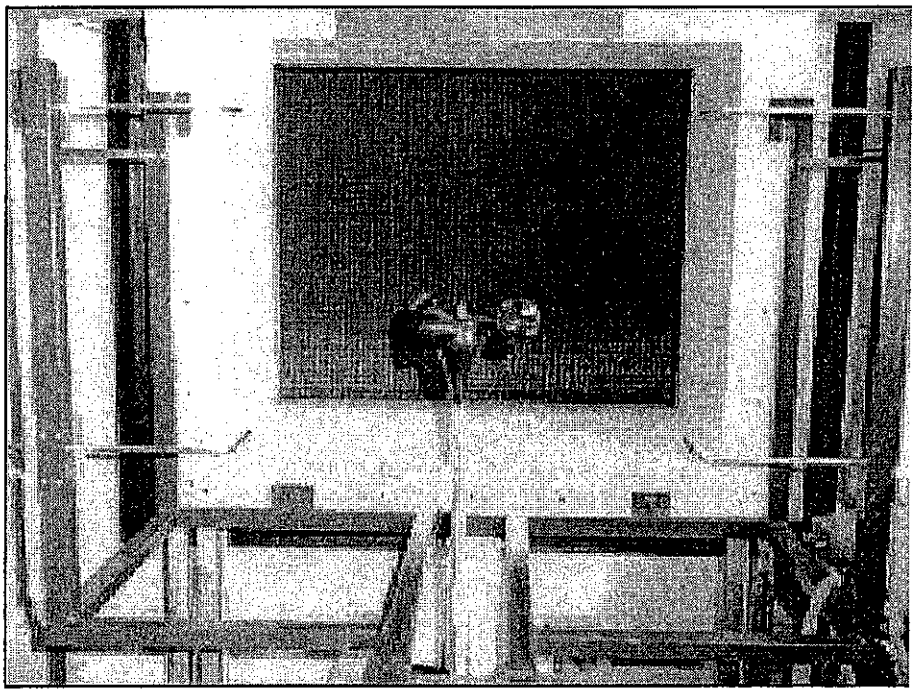


Photo showing the anemometer and the mounting system in the wind tunnel.
The anemometer shown in the photo is not the actual calibrated one but it is identical with the calibrated anemometer.
Remark: The photo does not show the real proportions, it is distorted by the lens of the camera.

4 References

[1] MEASNET
Cup Anemometer Calibration Procedure
September 1997

[2] ISO 3966 1977
Measurement of fluid flow in closed conduits.

[3] H.Klug, P.Busche, K.Nolopp 2005
DEWI QMH-AKL Rev.05

DEUTSCHER KALIBRIERDIENST DKD

Kalibrierlaboratorium für Strömungsgeschwindigkeit von Luft
Calibration laboratory for velocity of air flow
Akkreditiert durch die / *accredited by the*
Akkreditierungsstelle des DKD bei der
PHYSIKALISCH-TECHNISCHEN BUNDESANSTALT (PTB)

DEWI GmbH
Deutsches Windenergie-Institut
138807

Deutscher Akkreditierungs Rat
DAR
DKD-K-28901

Kalibrierschein
Calibration certificate

Kalibrierzeichen *Calibration label*
1389_07
DKD-K-28901
10.09.07

Gegenstand *Object*	Cup Anemometer
Hersteller *Manufacturer*	NRG systems Hinesburg VT 05461 USA
Typ *Type*	Max 40 (S)
Fabrikat/Serien-Nr. *Serial number*	body: 1389_07 cup: -
Auftraggeber *Customer*	SARTELCO SISTEMI SRL 20059 Vimercate (MI), IT
Auftragsnummer *Order No.*	1389_07
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	3+3
Datum der Kalibrierung *Date of calibration*	10.09.07

Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Der DKD 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 DKD 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.

Stempel *Seal*	Datum *Date*	Stellv. Leiter des Kalibrierlaboratoriums *Deputy head of the calibration laboratory*	Bearbeiter *Person in charge*
Deutscher DKD-K-28901 Kalibrierdienst	10.09.07	Dipl.-Ing. (FH) P. Busche	R.Kluin

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Ebertstr. 96, D-26382 Wilhelmshaven
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1389_07
DKD-K-28901
10.09.07

Kalibrierzeichen
Calibration label

Kalibriergegenstand *Object*	Cup Anemometer	
Kalibrierverfahren *Calibration procedure*	MEASNET - Cup Anemometer Calibration Procedure - 9/1997 ISO 3966 – Measurement of fluid in closed conduits – 1977	
Ort der Kalibration *Place of calibration*	Windtunnel of the University of Oldenburg	
Meßbedingungen *Test conditions*	wind tunnel area [1]	8000 cm²
	anemometer frontal area [2]	150 cm²
	diameter of mounting pipe [3]	16 mm
	blockage ratio [4]	0.019 [-]
	blockage correction [5]	0.999 [-]
	tunnel calibration [6]	0.999 [-]
	average DEWI reference [7]	Risoe 2084 : 10.22 m/s
	present DEWI reference [8]	10.22 m/s
Umgebungsbedingungen *Ambient conditions*	air temperature	22.1 °C
	air pressure	1007.2 hPa
	relative air humidity	50.1 %
Dateiinformation *File information*		c:\AK\Kalibrierdaten\Doc\2007\09_2007\1389_07.doc
Anmerkungen *Remarks*	-	
Auswertesoftware *Software version*	LV_Rev.1.6	

[1] Nozzle area of the wind tunnel

[2] Projected cross sectional area of the anemometer

[3] Diameter of the mounting pipe

[4] Ratio [2] to [1]

[5] Correction in wind speed due to the blockage effect of the anemometer

[6] Ratio of wind speed at the anemometer position relative to the wind speed measuring plane

[7] Long term average value of the reference anemometer

[8] Current value of the reference anemometer

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1389_07
DKD-K-28901
10.09.07

Kalibrierzeichen
Calibration label

Messergebnis:
Result:

Strömungs-geschwindigkeit Luft (speed of air flow) m/s	Anzeige Anemometer (anemometer signal) 1/s	Erweiterte Messunsicherheit (expanded uncertainty)* m/s
4.117	5.071	0.10
6.169	7.710	0.10
8.196	10.285	0.10
10.352	13.065	0.10
12.408	15.744	0.10
14.490	18.379	0.10
16.104	20.595	0.10
15.568	19.897	0.10
13.458	17.070	0.10
11.420	14.455	0.10
9.301	11.692	0.10
7.240	9.051	0.10
5.148	6.347	0.10

*) Angegeben ist die erweiterte Messunsicherheit, die sich aus der Standardmessunsicherheit durch Multiplikation mit dem Erweiterungsfaktor k=2 ergibt, wobei die kleinste angebbare Messunsicherheit gemäß DKD-Akkreditierung 0.10 m/s beträgt. Die erweiterte Messunsicherheit wurde gemäß DKD-3 ermittelt. Der Wert liegt mit einer Wahrscheinlichkeit von 95% im zugeordneten Wertintervall.

Der Deutsche Kalibrierdienst 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.

**) The expanded uncertainty assigned to the measurement results is obtained by multiplying the standard uncertainty by the coverage factor k=2. According to the DKD-accreditation the value for the best measurement capability shall not be smaller than 0.10 m/s. The expanded uncertainty has been determined in accordance with DKD-3. The value of the measurand lies within the assigned range of values with a probability of 95%.*

The DKD 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. Further signatory members within Europe and outside of Europe may be extracted from the EA-internet page (www.european-accreditation.org) and the ILAC-internet page (www.ilac.org)

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DEWI

MEASNET Appendix

1. Results

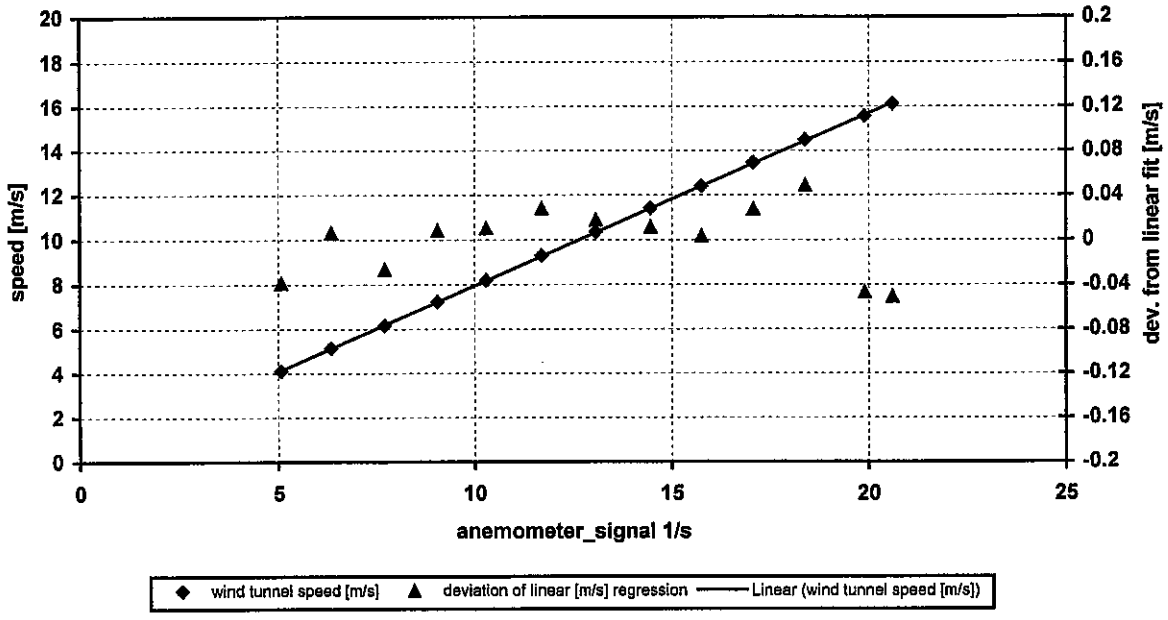
DKD calibration no.	1389_07
type	Max 40 (S)
serial number	1389_07
cup number	-
date	10.09.07
file	c:\AK\Kalibrierdaten\Doc\2007\09_2007\1389_07.doc
DEWI Version	LV_Rev.1.6
air temperature	22.1 °C
air pressure	1007.2 hPa
air humidity	50.1 %

linear regression analysis

slope	0.7729 m ± 0.00181 m
offset	0.236 m/s ± 0.025 m/s
correlation coefficient	0.999970
standard error (v)	0.032 m/s
COV(A,B)	-42.627E-6

remarks -

DEWI Calibration No. 1389_07



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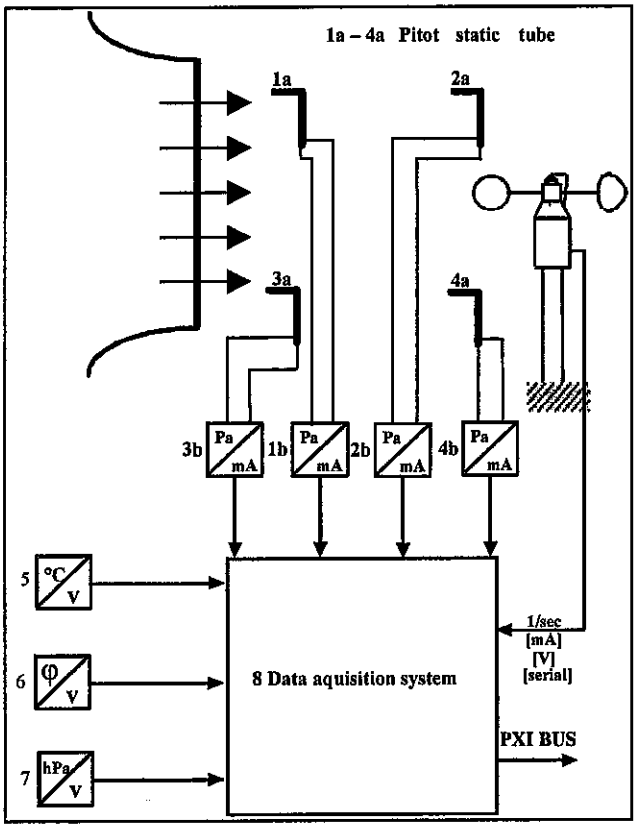
2. Instrumentation



Description of the data acquisition system

1a – 4a Pitot tube

Type:	Airflow (ISO 3966)
Year:	2005
Calibration:	No; ISO 3966 [1]

1b Pressure Transducer

Type:	ASHCROFT XLdp
Year:	1993
Calibration:	recalibration DEWI

2b Pressure Transducer

Type:	ASHCROFT XLdp
Year:	1993
Calibration:	recalibration DEWI

3b Pressure Transducer

Type:	Setra 239
Year:	2003
Calibration:	recalibration DEWI

4b Pressure Transducer

Type:	Setra 239
Year:	2001
Calibration:	recalibration DEWI

5 Thermometer

Type:	Galtec KRC2/5-ME
Serial no.	48448
Calibration:	2928/2007_01

6 Humidity Sensor

Type:	Galtec KRC2/5-ME
Serial no.	48448
Calibration:	2928/2007_01

7 Barometer

Type:	Vaisala PTB 100A
Serial no.	U5030013
Calibration:	P01664/Nov. 2006

8 Data aquisition system

Type:	NI 1042
Year:	2003
Calibration:	checked with calibrated current, voltage and frequency standard

Reference Pressure transducer

Type:	Ashcroft XLDP2
Year:	2004
Calibration:	A 5662 /07-01

Wind Tunnel: University of Oldenburg

Remark: Ambient pressure standard is calibrated by DKD in 02/2006
Combined temperature and humidity standard is calibrated by the German 'Eichamt' in 4/2000
The multimeter is calibrated by 'DKD' in 06/2006
The frequency counter is calibrated by the German 'DKD' in 06/2005

3 Deviation to MEASNET Procedure

1. The time to get stable flow conditions between two speed settings is approx. 30 seconds (it has been proven for this tunnel that 30 seconds are sufficient enough to establish a stable flow).
2. The expanded uncertainty from page 3 shows only values ≥ 0.10 m/s due to the *best measurement capability* of 0.10 m/s as defined by the DKD accreditation.

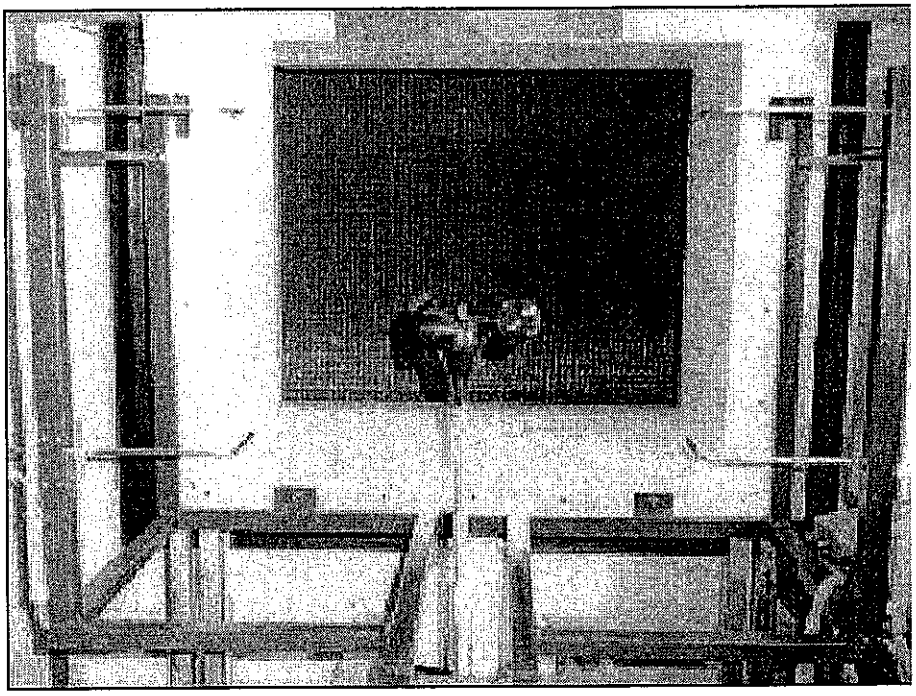


Photo showing the anemometer and the mounting system in the wind tunnel.
The anemometer shown in the photo is not the actual calibrated one but it is identical with the calibrated anemometer.
Remark: The photo does not show the real proportions, it is distorted by the lens of the camera.

4 References

[1] MEASNET
Cup Anemometer Calibration Procedure
September 1997

[2] ISO 3966 1977
Measurement of fluid flow in closed conduits.

[3] H.Klug, P.Busche, K.Nolopp 2005
DEWI QMH-AKL Rev.05

DEUTSCHER KALIBRIERDIENST DKD

Kalibrierlaboratorium für Strömungsgeschwindigkeit von Luft
Calibration laboratory for velocity of air flow

Akkreditiert durch die */ accredited by the*
Akkreditierungsstelle des DKD bei der
PHYSIKALISCH-TECHNISCHEN BUNDESANSTALT (PTB)

DEWI GmbH
Deutsches Windenergie-Institut
139007

Deutscher Akkreditierungs Rat
DAR
DKD-K-28901

Kalibrierschein
Calibration certificate

Kalibrierzeichen
Calibration label

1390_07
DKD-K-28901
10.09.07

Gegenstand *Object*	Cup Anemometer
Hersteller *Manufacturer*	NRG systems Hinesburg VT 05461 USA
Typ *Type*	Max 40 (S)
Fabrikat/Serien-Nr. *Serial number*	body: 1390_07 cup: -
Auftraggeber *Customer*	SARTELCO SISTEMI SRL 20059 Vimercate (MI), IT
Auftragsnummer *Order No.*	1390_07
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	3+3
Datum der Kalibrierung *Date of calibration*	10.09.07

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Stempel *Seal*	Datum *Date*	Stellv. Leiter des Kalibrierlaboratoriums *Deputy head of the calibration laboratory*	Bearbeiter *Person in charge*
Deutscher Kalibrierdienst DKD-K-28901	10.09.07	Dipl.-Ing. (FH) P. Busche	R.Kluin

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1390_07
DKD-K-28901
10.09.07

Kalibrierzeichen
Calibration label

Kalibriergegenstand *Object*	Cup Anemometer	
Kalibrierverfahren *Calibration procedure*	MEASNET - Cup Anemometer Calibration Procedure - 9/1997 ISO 3966 – Measurement of fluid in closed conduits – 1977	
Ort der Kalibration *Place of calibration*	Windtunnel of the University of Oldenburg	
Meßbedingungen *Test conditions*	wind tunnel area [1]	8000 cm²
	anemometer frontal area [2]	150 cm²
	diameter of mounting pipe [3]	16 mm
	blockage ratio [4]	0.019 [-]
	blockage correction [5]	0.999 [-]
	tunnel calibration [6]	0.999 [-]
	average DEWI reference [7]	Risoe 2084 : 10.22 m/s
	present DEWI reference [8]	10.22 m/s
Umgebungsbedingungen *Ambient conditions*	air temperature	22.2 °C
	air pressure	1007.2 hPa
	relative air humidity	50.2 %
Dateiinformation *File information*		c:\AK\Kalibrierdaten\Doc\2007\09_2007\1390_07.doc
Anmerkungen *Remarks*	-	
Auswertesoftware *Software version*	LV_Rev.1.6	

[1] Nozzle area of the wind tunnel

[2] Projected cross sectional area of the anemometer

[3] Diameter of the mounting pipe

[4] Ratio [2] to [1]

[5] Correction in wind speed due to the blockage effect of the anemometer

[6] Ratio of wind speed at the anemometer position relative to the wind speed measuring plane

[7] Long term average value of the reference anemometer

[8] Current value of the reference anemometer

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DEWI

1390_07
DKD-K-28901
10.09.07

Kalibrierzeichen
Calibration label

Messergebnis:
Result:

Strömungs-geschwindigkeit Luft (speed of air flow) m/s	Anzeige Anemometer (anemometer signal) 1/s	Erweiterte Messunsicherheit (expanded uncertainty)* m/s
4.124	5.041	0.10
6.166	7.681	0.10
8.186	10.238	0.10
10.355	13.098	0.10
12.415	15.749	0.10
14.486	18.373	0.10
16.089	20.550	0.10
15.567	19.838	0.10
13.471	17.060	0.10
11.416	14.427	0.10
9.311	11.691	0.10
7.238	8.987	0.10
5.142	6.322	0.10

*) Angegeben ist die erweiterte Messunsicherheit, die sich aus der Standardmessunsicherheit durch Multiplikation mit dem Erweiterungsfaktor k=2 ergibt, wobei die kleinste angebbare Messunsicherheit gemäß DKD-Akkreditierung 0.10 m/s beträgt. Die erweiterte Messunsicherheit wurde gemäß DKD-3 ermittelt. Der Wert liegt mit einer Wahrscheinlichkeit von 95% im zugeordneten Wertintervall.

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MEASNET Appendix

1. Results

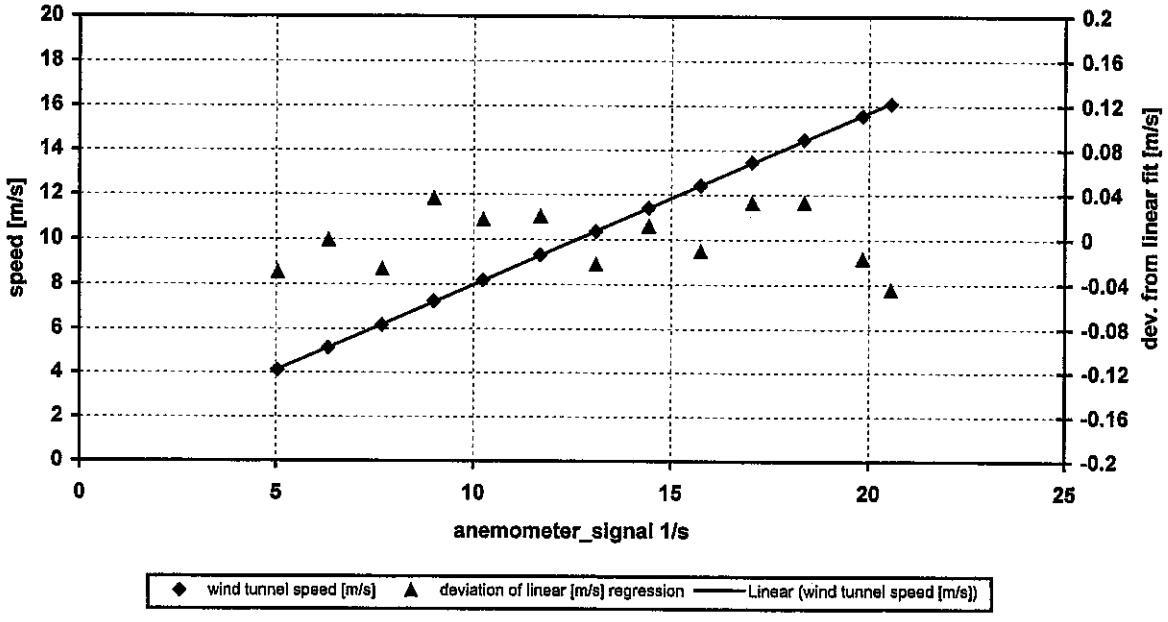
DKD calibration no.	1390_07
type	Max 40 (S)
serial number	1390_07
cup number	-
date	10.09.07
file	c:\AK\Kalibrierdaten\Doc\2007\09_2007\1390_07.doc
DEWI Version	LV_Rev.1.6
air temperature	22.2 °C
air pressure	1007.2 hPa
air humidity	50.2 %

linear regression analysis

slope	0.7725 m ± 0.00158 m
offset	0.259 m/s ± 0.022 m/s
correlation coefficient	0.999977
standard error (v)	0.028 m/s
COV(A,B)	-32.492E-6

remarks -

DEWI Calibration No. 1390_07



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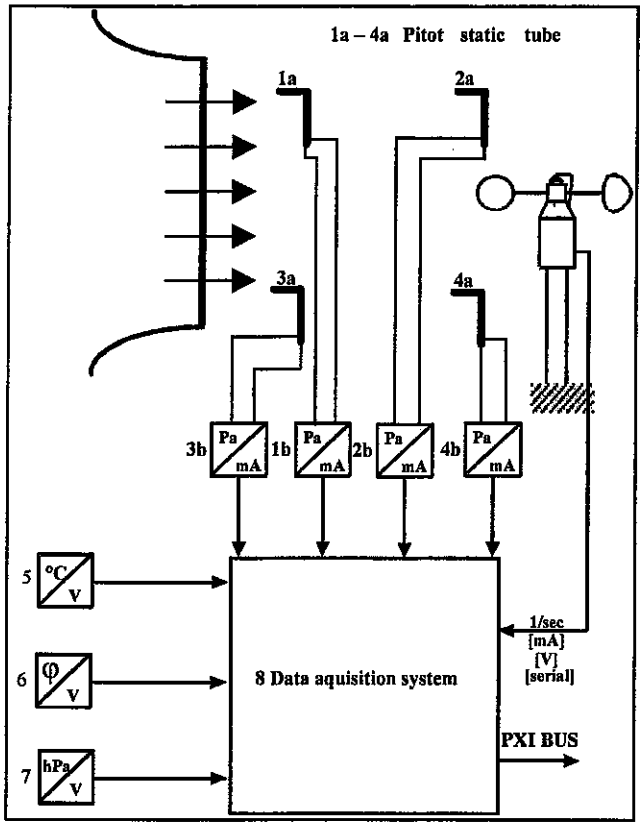
2. Instrumentation



Description of the data acquisition system

1a – 4a Pitot tube

Type:	Airflow (ISO 3966)
Year:	2005
Calibration:	No; ISO 3966 [1]

1b Pressure Transducer

Type:	ASHCROFT XLdp
Year:	1993
Calibration:	recalibration DEWI

2b Pressure Transducer

Type:	ASHCROFT XLdp
Year:	1993
Calibration:	recalibration DEWI

3b Pressure Transducer

Type:	Setra 239
Year:	2003
Calibration:	recalibration DEWI

4b Pressure Transducer

Type:	Setra 239
Year:	2001
Calibration:	recalibration DEWI

5 Thermometer

Type:	Galtec KRC2/5-ME
Serial no.	48448
Calibration:	2928/2007_01

6 Humidity Sensor

Type:	Galtec KRC2/5-ME
Serial no.	48448
Calibration:	2928/2007_01

7 Barometer

Type:	Vaisala PTB 100A
Serial no.	U5030013
Calibration:	P01664/Nov. 2006

8 Data aquisition system

Type:	NI 1042
Year:	2003
Calibration:	checked with calibrated current, voltage and frequency standard

Reference Pressure transducer

Type:	Ashcroft XLDP2
Year:	2004
Calibration:	A 5662 /07-01

Wind Tunnel: University of Oldenburg

Remark: Ambient pressure standard is calibrated by DKD in 02/2006
Combined temperature and humidity standard is calibrated by the German 'Eichamt' in 4/2000
The multimeter is calibrated by 'DKD' in 06/2006
The frequency counter is calibrated by the German 'DKD' in 06/2005

3 Deviation to MEASNET Procedure

1. The time to get stable flow conditions between two speed settings is approx. 30 seconds (it has been proven for this tunnel that 30 seconds are sufficient enough to establish a stable flow).
2. The expanded uncertainty from page 3 shows only values ≥ 0.10 m/s due to the *best measurement capability* of 0.10 m/s as defined by the DKD accreditation.

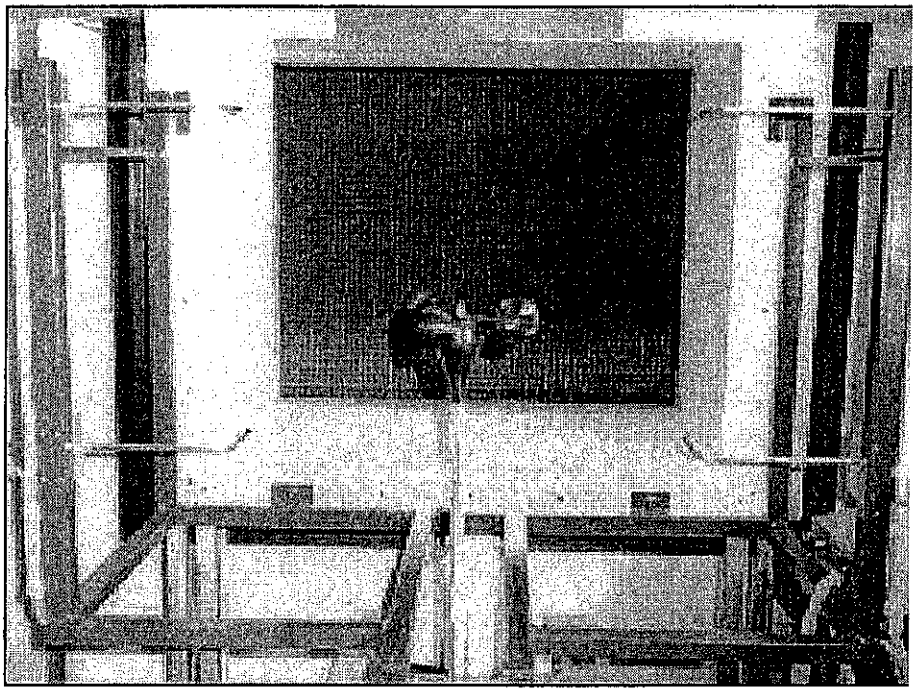


Photo showing the anemometer and the mounting system in the wind tunnel.
The anemometer shown in the photo is not the actual calibrated one but it is identical with the calibrated anemometer.
Remark: The photo does not show the real proportions, it is distorted by the lens of the camera.

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[1] MEASNET
Cup Anemometer Calibration Procedure
September 1997

[2] ISO 3966 1977
Measurement of fluid flow in closed conduits.

[3] H.Klug, P.Busche, K.Nolopp 2005
DEWI QMH-AKL Rev.05

DEUTSCHER KALIBRIERDIENST DKD

Kalibrierlaboratorium für Strömungsgeschwindigkeit von Luft
Calibration laboratory for velocity of air flow
Akkreditiert durch die */ accredited by the*
Akkreditierungsstelle des DKD bei der
PHYSIKALISCH-TECHNISCHEN BUNDESANSTALT (PTB)

DEWI GmbH
Deutsches Windenergie-Institut

140307

Deutscher Akkreditierungs Rat
DAR
DKD-K-28901

Kalibrierschein
Calibration certificate

Kalibrierzeichen *Calibration label*
1403_07
DKD-K-28901
11.09.07

Gegenstand *Object*	Cup Anemometer
Hersteller *Manufacturer*	NRG systems Hinesburg VT 05461 USA
Typ *Type*	Max 40 (S)
Fabrikat/Serien-Nr. *Serial number*	body: 1403_07 cup: -
Auftraggeber *Customer*	SARTELCO SISTEMI SRL 20059 Vimercate (MI), IT
Auftragsnummer *Order No.*	1403_07
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	3+3
Datum der Kalibrierung *Date of calibration*	11.09.07

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The user is obliged to have the object recalibrated at appropriate intervals.

Stempel *Seal*	Datum *Date*	Stellv. Leiter des Kalibrierlaboratoriums *Deputy head of the calibration laboratory*	Bearbeiter *Person in charge*
Deutscher DKD-K-28901 Kalibrierdienst	11.09.07	Dipl.-Ing. (FH) P. Busche	R.Kluin

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1403_07
DKD-K-28901
11.09.07

Kalibrierzeichen
Calibration label

Kalibriergegenstand *Object*	Cup Anemometer	
Kalibrierverfahren *Calibration procedure*	MEASNET - Cup Anemometer Calibration Procedure - 9/1997 ISO 3966 – Measurement of fluid in closed conduits – 1977	
Ort der Kalibration *Place of calibration*	Windtunnel of the University of Oldenburg	
Meßbedingungen *Test conditions*	wind tunnel area [1]	8000 cm²
	anemometer frontal area [2]	150 cm²
	diameter of mounting pipe [3]	16 mm
	blockage ratio [4]	0.019 [-]
	blockage correction [5]	0.999 [-]
	tunnel calibration [6]	0.999 [-]
	average DEWI reference [7]	Risoe 2084 : 10.22 m/s
	present DEWI reference [8]	10.22 m/s
Umgebungsbedingungen *Ambient conditions*	air temperature	22.1 °C
	air pressure	1017.6 hPa
	relative air humidity	53.8 %
Dateiinformation *File information*		c:\AK\Kalibrierdaten\Doc\2007\09_2007\1403_07.doc
Anmerkungen *Remarks*	-	
Auswertesoftware *Software version*	LV_Rev.1.6	

[1] Nozzle area of the wind tunnel

[2] Projected cross sectional area of the anemometer

[3] Diameter of the mounting pipe

[4] Ratio [2] to [1]

[5] Correction in wind speed due to the blockage effect of the anemometer

[6] Ratio of wind speed at the anemometer position relative to the wind speed measuring plane

[7] Long term average value of the reference anemometer

[8] Current value of the reference anemometer

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DEWI

1403_07
DKD-K-28901
11.09.07

Kalibrierzeichen
Calibration label

Messergebnis:
Result:

Strömungs-geschwindigkeit Luft (speed of air flow) m/s	Anzeige Anemometer (anemometer signal) 1/s	Erweiterte Messunsicherheit (expanded uncertainty)* m/s
4.125	5.079	0.10
6.180	7.712	0.10
8.229	10.342	0.10
10.367	13.090	0.10
12.415	15.742	0.10
14.493	18.486	0.10
16.111	20.567	0.10
15.577	19.860	0.10
13.472	17.038	0.10
11.429	14.457	0.10
9.313	11.755	0.10
7.252	9.067	0.10
5.149	6.383	0.10

*) Angegeben ist die erweiterte Messunsicherheit, die sich aus der Standardmessunsicherheit durch Multiplikation mit dem Erweiterungsfaktor k=2 ergibt, wobei die kleinste angebbare Messunsicherheit gemäß DKD-Akkreditierung 0.10 m/s beträgt. Die erweiterte Messunsicherheit wurde gemäß DKD-3 ermittelt. Der Wert liegt mit einer Wahrscheinlichkeit von 95% im zugeordneten Wertintervall.

Der Deutsche Kalibrierdienst 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.

**) The expanded uncertainty assigned to the measurement results is obtained by multiplying the standard uncertainty by the coverage factor k=2. According to the DKD-accreditation the value for the best measurement capability shall not be smaller than 0.10 m/s. The expanded uncertainty has been determined in accordance with DKD-3. The value of the measurand lies within the assigned range of values with a probability of 95%.*

The DKD 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. Further signatory members within Europe and outside of Europe may be extracted from the EA-internet page (www.european-accreditation.org) and the ILAC-internet page (www.ilac.org)

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MEASNET Appendix

1. Results

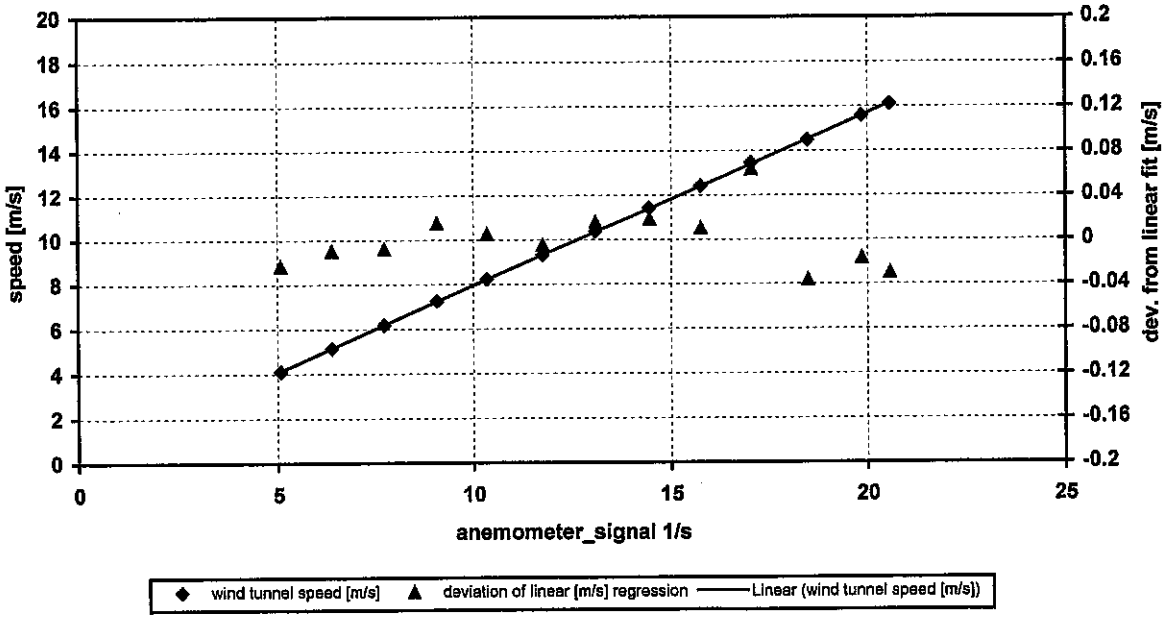
DKD calibration no.	1403_07
type	Max 40 (S)
serial number	1403_07
cup number	-
date	11.09.07
file	c:\AK\Kalibrierdaten\Doc\2007\09_2007\1403_07.doc
DEWI Version	LV_Rev.1.6
air temperature	22.1 °C
air pressure	1017.6 hPa
air humidity	53.8 %

linear regression analysis

slope	0.7742 m ± 0.00153 m
offset	0.217 m/s ± 0.021 m/s
correlation coefficient	0.999978
standard error (v)	0.027 m/s
COV(A,B)	-30.708E-6

remarks -

DEWI Calibration No. 1403_07



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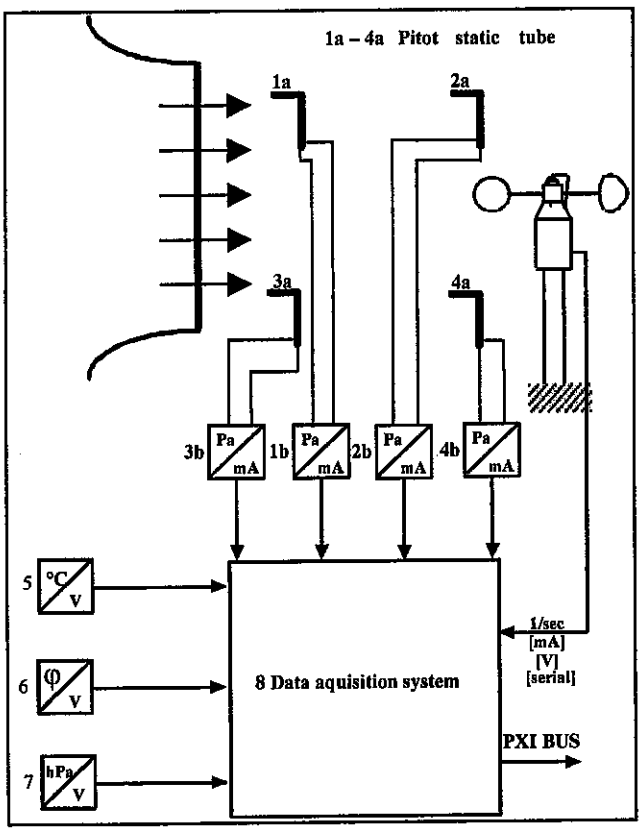
2. Instrumentation



Description of the data acquisition system

1a – 4a Pitot tube

Type:	Airflow (ISO 3966)
Year:	2005
Calibration:	No; ISO 3966 [1]

1b Pressure Transducer

Type:	ASHCROFT XLdp
Year:	1993
Calibration:	recalibration DEWI

2b Pressure Transducer

Type:	ASHCROFT XLdp
Year:	1993
Calibration:	recalibration DEWI

3b Pressure Transducer

Type:	Setra 239
Year:	2003
Calibration:	recalibration DEWI

4b Pressure Transducer

Type:	Setra 239
Year:	2001
Calibration:	recalibration DEWI

5 Thermometer

Type:	Galtec KRC2/5-ME
Serial no.	48448
Calibration:	2928/2007_01

6 Humidity Sensor

Type:	Galtec KRC2/5-ME
Serial no.	48448
Calibration:	2928/2007_01

7 Barometer

Type:	Vaisala PTB 100A
Serial no.	U5030013
Calibration:	P01664/Nov. 2006

8 Data aquisition system

Type:	NI 1042
Year:	2003
Calibration:	checked with calibrated current, voltage and frequency standard

Reference Pressure transducer

Type:	Ashcroft XLDP2
Year:	2004
Calibration:	A 5662 /07-01

Wind Tunnel: University of Oldenburg

Remark: Ambient pressure standard is calibrated by DKD in 02/2006
Combined temperature and humidity standard is calibrated by the German 'Eichamt' in 4/2000
The multimeter is calibrated by 'DKD' in 06/2006
The frequency counter is calibrated by the German 'DKD' in 06/2005

3 Deviation to MEASNET Procedure

1. The time to get stable flow conditions between two speed settings is approx. 30 seconds (it has been proven for this tunnel that 30 seconds are sufficient enough to establish a stable flow).
2. The expanded uncertainty from page 3 shows only values ≥ 0.10 m/s due to the *best measurement capability* of 0.10 m/s as defined by the DKD accreditation.

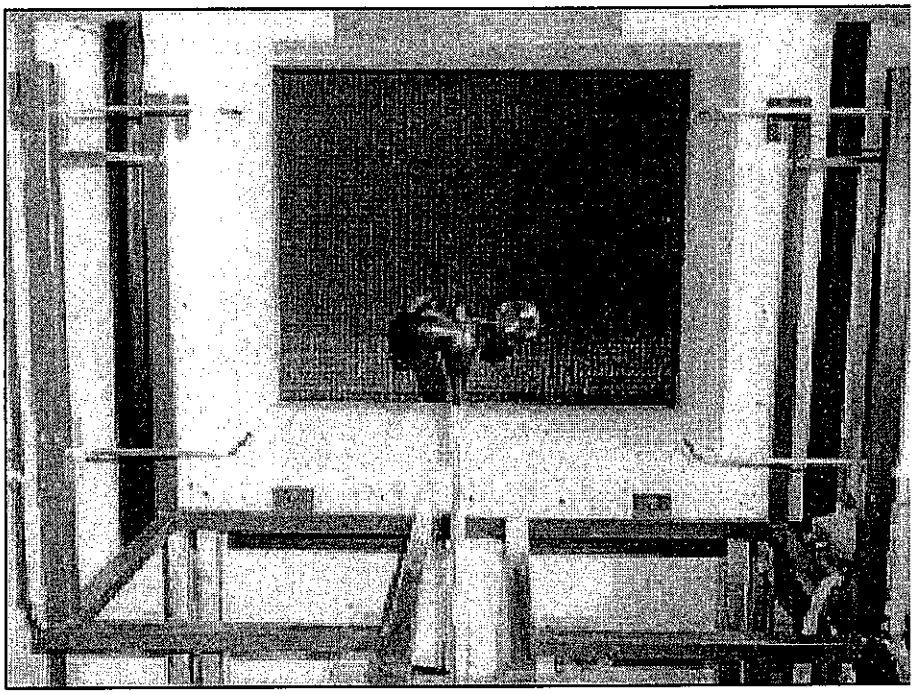


Photo showing the anemometer and the mounting system in the wind tunnel.
The anemometer shown in the photo is not the actual calibrated one but it is identical with the calibrated anemometer.
Remark: The photo does not show the real proportions, it is distorted by the lens of the camera.

4 References

[1] MEASNET
Cup Anemometer Calibration Procedure
September 1997

[2] ISO 3966 1977
Measurement of fluid flow in closed conduits.

[3] H.Klug, P.Busche, K.Nolopp 2005
DEWI QMH-AKL Rev.05