

To Whom It May Concern

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## **Vortex and Coriolis flow meters in gas applications**

Vortex and Coriolis flow meters today are commonly used for a wide variety of applications. As both meter types are based on universal measurement principles, they can be used for liquids as well as for gases. During the last decennia, a wealth of gas applications have been served by Vortex and Coriolis meters and application experience is available in abundance.

### **Vortex volume flow meters**

Vortex meters have been used for gas flow measurement since their market introduction in the early seventies. Namely steam measurement has become their standard application due to their robust mechanical construction and wide range of process temperature and pressure. Vortex meters always measure the volumetric flow; for saturated steam applications an optional integrated temperature sensor can be used to calculate mass flow within the meter transmitter. Furthermore they are commonly used for process control or cost allocation metering of utility gases like compressed air, nitrogen or oxygen.

### **Coriolis mass flow meters**

Coriolis meters are well known for the high accuracy measurement of liquid flow. They are often first choice meters especially in process industries where they offer the advantage of direct mass flow measurement. In latter years, Coriolis meters have been more and more used for gas measurement as well, covering a wide range of applications from hydrogen over natural gas to ethylene. A considerable amount of Endress+Hauser Coriolis meters Promass has been used in CNG (Compressed Natural Gas) dispensers for fuelling Natural Gas Vehicles. For these applications Promass has received a custody transfer approval from the Physikalisch-Technische Bundesanstalt (PTB).

### **Factory water calibration**

The last step in a flow meter's production process at Endress+Hauser is a wet calibration with water. During this procedure, the calibration factor (K-factor) of the individual device is determined. Using water as calibration fluid has many advantages. Due to the well known properties of water, highest calibration accuracy can be achieved. The calibration facilities of Endress+Hauser are accredited to ISO/IEC 17025 by the Swiss Accreditation Service. Overall accuracy achieved for this accreditation is better than  $\pm 0,05\%$ . Additionally the use of water enables the achievement of optimum fluid dynamic conditions which lead to a regular flow profile.

**Water calibration in gas applications**

Occasionally the question is raised if an instrument intended for use in gas applications has to be calibrated with a gas rather than with water. Attachment 1 and 2 shortly describe the Vortex and Coriolis measuring principles and the E+H meter designs. Based on that information the physical reasons for the universal validity of the K-factor are explained. In order to both test and demonstrate the feasibility of a water calibration for gas applications, a number of independent third party gas tests have been performed with Endress+Hauser's Prowirl (Vortex) and Promass (Coriolis) meters. A test overview and short description of the test facilities can be found at the end of this document. Detailed test results can be presented upon request or are to be obtained as commercially available test reports provided by the testing organization.

**Basic third party test setup**

Although the tests widely vary in fluids and process conditions, the main setup is the same for all of them:

- The meter under test is a standard production device and factory calibrated with water according to the normal procedure.
- The meter under test is installed in the gas test setup according to the manufacturer's specifications.
- Measurements against reference meters are performed without changing the K-factor determined during water calibration.
- The deviation between test meter and reference meter results is calculated in order to check if the test meter performs within its accuracy specifications for gas measurement.

**Conclusion**

Theoretical considerations as well as all attached third party tests demonstrate that a water calibrated flow meter operates within the published accuracy limits in gas applications. For this reason Endress+Hauser does not offer specific gas calibrations for their Prowirl and Promass flow meters.

**Attachments**

- Attachment 1 Vortex flow meter measuring principle and third party tests
- Attachment 2 Coriolis flow meter measuring principle and third party tests
- Attachment 3 Prowirl 77 air calibration
- Attachment 4 Promass F pigsar™ test certificate

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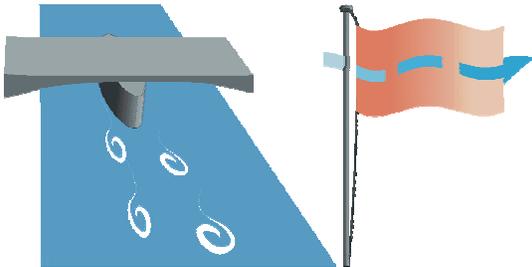
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## ATTACHMENT 1: Vortex flow meters

### Vortex measuring principle



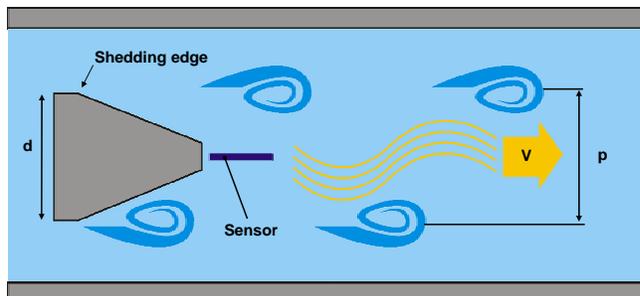
The Vortex measuring principle is based on the fact that in a fluid flow downstream of an obstacle vortices are formed. This phenomenon can be observed by looking at eddies formed downstream of a bridge pillar. An example for the formation of a vortex street in air flow is a flag; it flutters in the wind due to the shedding of the vortices at the flag pole.

The flow reaches its maximum velocity at the widest part of the obstacle which according to Bernoulli's law goes along with low pressure. Behind the bluff body the velocity slows down which corresponds to a higher pressure. This effect causes a pressure drop from the end to the side of the obstacle, consequently a backflow and, ultimately, vortices. The vortices are shed alternately on each side of the obstacle and are carried away by the fluid, thereby moving ahead with fluid velocity.

It has been shown by the physicists Strouhal and von Kármán that with a uniform pipe diameter, the volume of the vortices formed behind an obstacle is constant over a wide range of fluid conditions. It only depends on the geometry of the obstacle. Volumetric flow can therefore be derived directly from the number of vortices counted per unit of time. This is the principle of operation of any commercially available Vortex flow meter.

### E+H design Prowirl Vortex meter

Bluff body designs vary in shape from manufacturer to manufacturer. They can be rectangular, triangular, round, delta-shaped or one of several proprietary and patented designs. The main objective is to feature high linearity (meaning a constant vortex volume) over the whole measuring range, independent of the fluid conditions.



Endress+Hauser's Vortex flow meters Prowirl are using delta-shaped bluff bodies. NASA engineers have subjected these bluff body designs to exhaustive studies; they exhibit almost ideal linearity and have proved particularly reliable. The shedding edge is sheltered from abrasion and plugging and therefore provides exceptional long-term stability.

The K-factor determined during water calibration is a measure of the vortex volume. The ideal linearity of the delta-shaped bluff body means that the K-factor depends only on the geometry of the individual meter. As the meter geometry is not influenced by fluid type (liquid or gas) or

process conditions like fluid pressure or density, the K-factor determined with water can be used for any fluid including for gas flow measurement.

Due to the effect that the meter body expands with increasing temperature, the fluid temperature has a small effect on the K-factor which for stainless steel meter is about 0,5% per 100K. By entering the fluid temperature into the Prowirl 72 transmitter, this effect is compensated automatically. For Prowirl 73 the compensation is calculated automatically based on the integrated temperature measurement.

### Third party gas tests Prowirl

Independent third party gas tests of Prowirl flow meters have been performed for different nominal diameters. As test gases natural gas at various pressures and air at ambient condition were available. By this means tests on both a wide pressure range as well as on different gases are available.

An overview of the tests can be found in the following table:

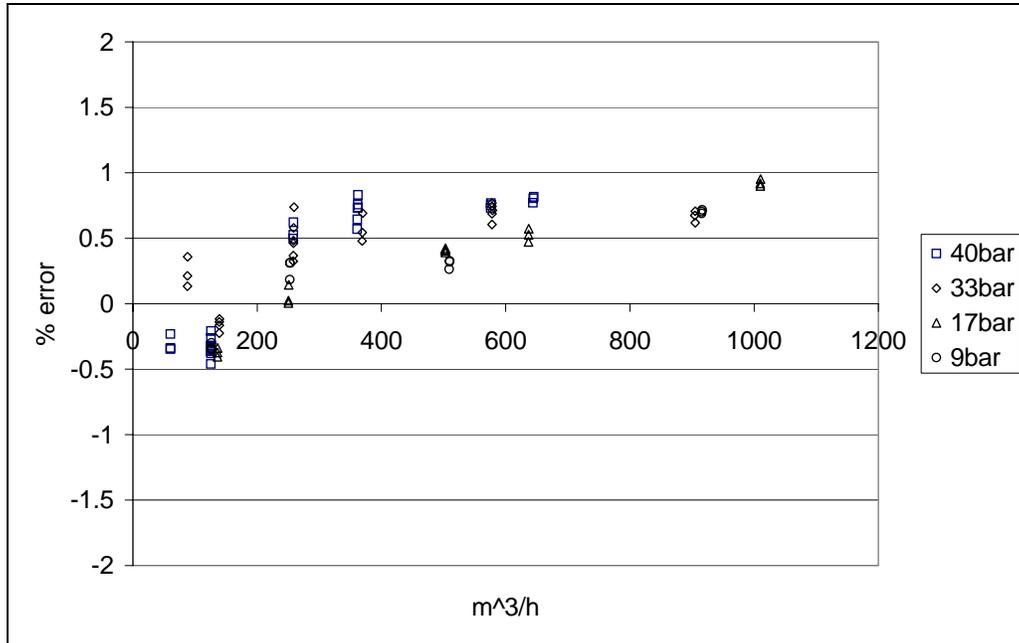
Test site	Flow meter	Test fluid	Flow	Pressure	Temperature	Reference
Gasunie, NL	Prowirl 72 DN 100 / 4", ANSI Cl. 300 Sch. 40	Natural gas	up to 20 m/s	9 bar a 17 bar a 33 bar a 40 bar a	20°C ± 1°C	mass flow measurement, density from gas analysis, measured pressure and temperature
EAM Bern, CH	Prowirl 77F DN 40 / 1,5"	Air	41 - 156 m3/h	0,93 bar a	20°C ± 1°C	
EAM Bern, CH	Prowirl 70W DN 25 / 1"	Air	15 - 95 m3/h	0,96 bar a	20°C ± 1°C	

#### *Gasunie, the Netherlands*

Gasunie is the Dutch national gas distribution company and gas supplier for the total Dutch market. They operate various gas metrology facilities. The Prowirl tests were performed on the high pressure flow test facility which operates on natural gas with pressures from 9 to 41 bar in pipes from DN 50 to DN 300. The following graphic shows the test results (error vs. flow rate) and a sample calibration printout from Gasunie.

#### *EAM (Eidgenössisches Amt für Messwesen), Switzerland*

EAM is the Swiss Federal Office of Metrology. The Prowirl vortex meter tests have been performed on air at ambient conditions with two different nominal diameters (DN 25 and DN 40). The test results have been confirmed by EAM with an official calibration certificate which can be found in attachment 3. For additional information, the certificates of the factory water calibration have been included in the file as well.



ANALYSIS

DATE: 10/12/02      ANALYSIS TIME: 850      STREAM SEQUENCE: 2  
 TIME: 16:20      CYCLE TIME: 860      STREAM#: 2  
 GCID : 7390      MODE: RUN      CYCLE START TIME: 16:20

COMP NAME	COMP CODE	MOLE %	SupDry	InfDry	Rel Den
METHANE	100	81.717	32.4704	29.2610	0.4526
ETHANE	101	2.971	2.0689	1.8939	0.0308
PROPANE	102	0.426	0.4223	0.3888	0.0065
I-BUTANE	103	0.070	0.0898	0.0829	0.0014
N-BUTANE	104	0.082	0.1046	0.0966	0.0016
NITROGEN	114	13.585	0.0000	0.0000	0.1314
C O 2	117	0.989	0.0000	0.0000	0.0150
NEO-C5	107	0.008	0.0121	0.0112	0.0002
IPENTANE	105	0.020	0.0316	0.0293	0.0005
NPENTANE	106	0.019	0.0300	0.0277	0.0005
C6+	111	0.063	0.1162	0.1087	0.0019
HELIUM	113	0.050	0.0000	0.0000	0.0001
TOTALS :		100.000	35.3459	31.9000	0.6426
DRY SUPERIOR C.V	:		35.4280		
SAT SUPERIOR C.V	:		35.2143		
DRY INFERIOR C.V	:		31.9741		
SAT INFERIOR C.V	:		31.7813		
COMPRESSIBILITY FACTOR Z	:		0.9977		
REAL RELATIVE DENSITY	:		0.6437		
REAL DENSITY	:		0.8323		
WOBBE SUPERIOR INDEX	:		44.1567		
WOBBE INFERIOR INDEX	:		39.8519		
UnNormal SUM	:		99.583		
NORMALISATION TOLERANCE	:		5.000		

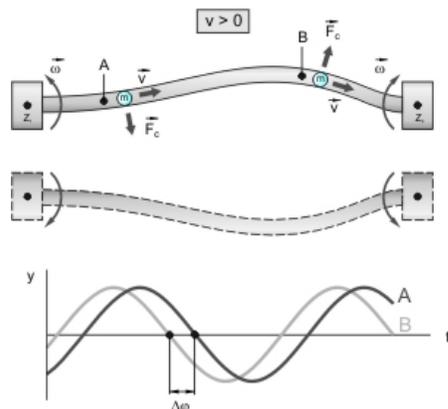
## ATTACHMENT 2: Coriolis flow meters

### Coriolis measuring principle

The Coriolis flow measuring principle is based on the Coriolis effect which occurs when both rotational and translational movements are superimposed in a system.

An object in a rotating system which is moving straight forward from the center of rotation to the outward encounters steadily increasing rotational speed. As inertia comes into play, it has to overcome a force known as the Coriolis force. This force acts to deflect the object from its straight route. The heavier the object and the faster it moves, the more inertia is perceptible and the more powerful is the effect of the Coriolis force. In mathematical terms this means that the Coriolis force is proportional to the object's mass flow, and the mass flow only. The force is not influenced by other object properties like fluid type, density or flow profile.

In a Coriolis mass flow meter, the rotary motion described above that generates the Coriolis force is replaced by exciting the measuring tubes to oscillate at their resonance frequency. The individual mass particles of the measured fluid are influenced by the Coriolis force in the following manner:



- At zero flow, when the fluid is at a standstill, there is no linear movement. Consequently, no Coriolis force occurs.
- Once the mass is flowing, the Coriolis force induced by the oscillation in the measuring tubes causes the fluid particles and eventually the measuring tubes to move to the side.
- This additional movement has the opposite direction at the inlet section than at the outlet section of the measuring tubes. This means that the Coriolis force causes the measuring tubes to “twist” a few micrometers.
- This twist movement causes a time shift of the original oscillation movement which is proportional to the mass flow. Sensors at the inflow and outflow section register the time shift as a phase difference.

The phase difference is directly proportional to the fluid mass flow. It does not depend on other fluid characteristics such as fluid type or density. For that reason the Coriolis measurement principle can be applied for liquid as well as for gaseous fluids. During water calibration of a Coriolis flow meter, the factor between phase shift and fluid mass flow is determined. This factor is the calibration factor of the individual meter. It depends only on the dynamic characteristics of the meter tubes as this defines the additional movement of the tubes caused by the Coriolis force.

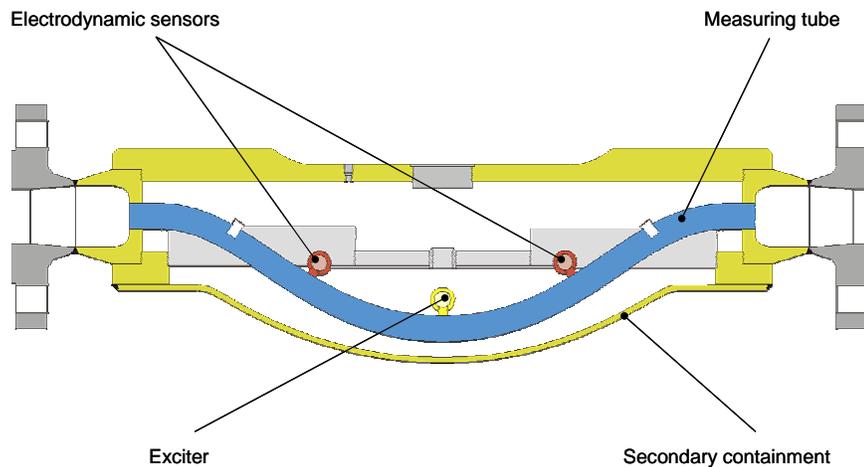
Process parameters like temperature and pressure can have a small effect on the dynamic behavior and thereby on the K-factor and therefore are compensated for in the meter electronics. An internal temperature measurement is made to compensate the dynamic changes to the tubes due to expansion and contraction. Very high fluid pressures can have a small effect on the K-factor as the tubes stiffen and therefore influence the dynamic behavior. By entering the fluid pressure into the transmitter, this effect is compensated automatically as well. If the fluid

pressure shows extreme variations, Prowirl 83 offers an optional current input to perform variable pressure compensation.

## E+H design Promass Coriolis meter

When monitoring gas flows, the operating densities are generally a factor of 30 – 40 lower than that of a liquid and as a consequence, the mass flow-rates are comparably lower, hence the meter tends to be working in the lower operating region of its range and zero stability becomes of paramount importance. The Promass design is especially devoted to providing an exceptional zero stability by implementing the following points:

- A high resonance frequency of 400-1000 Hz ensures immunity to external pipe vibrations due to pumps or compressors (typically 100-150 Hz).
- A rigid carrier tube design prevents influences from external mechanical forces on the pipeline.
- Highly sophisticated welding techniques (electron beam welding, laser welding) ensure highest accuracy in welding tolerances and therefore lowest impact on zero point stability.
- The measuring tube material must be from the same batch of raw material to ensure the absence of differences in material composition and tolerances. This results in an equal thermal expansion of the measuring tubes and therefore smallest impact on zero point stability.



## Third party gas tests Promass (Coriolis measuring principle)

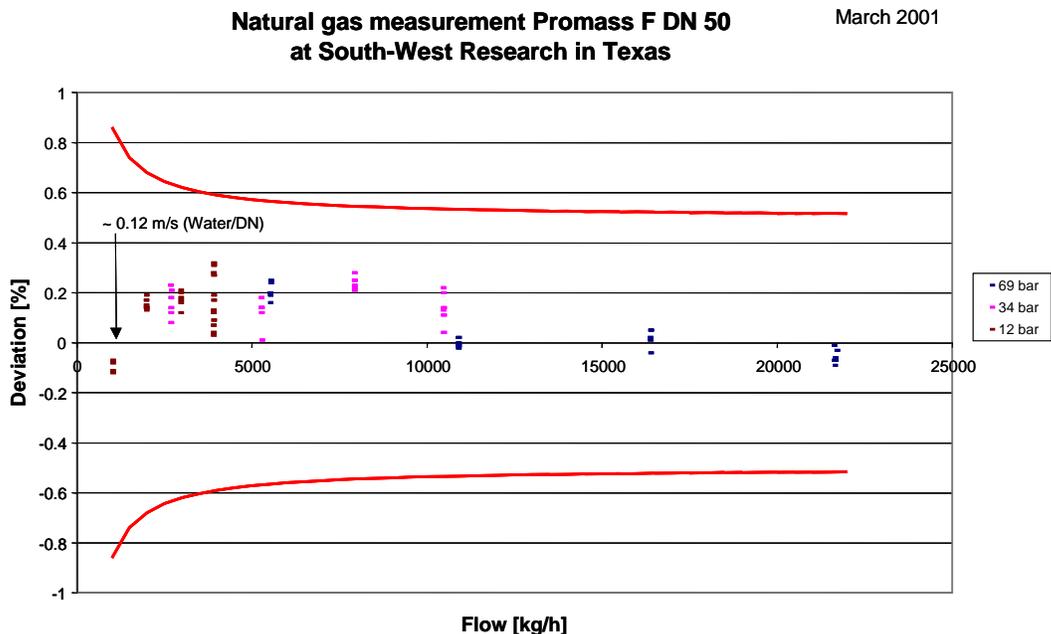
Third party gas tests on Coriolis flow meters have been performed on natural gas between 12 and 70 bar, on air at 5 bar and on industrial gases like ethylene and propylene. For Promass as well as for Prowirl different nominal diameters have been tested.

The following table shows a third party test overview:

Test site	Flow meter	Test fluid	Flow	Pressure	Temperature	Remarks
PIGSAR™, Germany	Promass 83F DN 150	Natural gas	5'000-50'000 kg/h	20, 63 bar	14,68 °C	
			10'000-100'000 kg/h	48,76 bar	15,28 °C	
PIGSAR™, Germany	Promass 83F DN 100	Natural gas	10'000-100'000 kg/h	50,4 bar	15,28 °C	
PIGSAR™, Germany	Promass 83F DN 80	Natural gas		50,3 bar		
				21,1 bar		
PIGSAR™, Germany	Promass 83F DN 50	Natural gas		51,3 bar		
				21,4 bar		
PIGSAR™, Germany	Promass 83F DN 40	Natural gas		48,5 bar		
PIGSAR™, Germany	Promass 83F DN 25	Natural gas		45,1 bar		
SwRI, Texas, USA	Promass F, DN 50	Natural gas		69 bar		Tests organized by Gas Research Institute, Test report GRI-01/0222 [2002]
				34 bar		
				12 bar		
SwRI, Texas, USA	Promass F, DN 100	Natural gas		69 bar		Tests organized by Gas Research Institute, Test report GRI-01/0222 [2002]
				34 bar		
				12 bar		
CEESI, Colorado, USA		water, air, dry gas and wet gas				Tests organized by Gas Research Institute, Test report GRI-04/0172 [2004]
CEESI, Iowa, USA	Promass 83F DN 250	Natural gas				Straight run tests and tests of flow disturbances (show no influence on measurement accuracy)
Cetiat, France	Promass F, DN 15	Air	50-250 kg/h	5 bar a		
DOW, NL	Promass F, DN 80	Ethylene	10'000-40'000 kg/h	75-95 bar	10°C	
		Propylene	40'000-45'000 kg/h	60 bar	10-15°C	

### PIGSAR™, Germany:

The pigsar™ laboratory belongs to Ruhrgas AG. It is the officially recognized test facility for proving gas meters. As such pigsar™ is the National Standard of the Federal Republic of Germany for High-pressure Natural Gas. Pigsar™ represents the international joint standard between Germany and the Netherlands; these two countries have harmonized the national measuring chains for high pressure natural gas under the Dordrecht agreement of June 1999. The Endress+Hauser Coriolis flow meter Promass F has been tested in different nominal diameters between DN 25 (1") and DN 150 (6") and at different test pressures. The test results of Promass F DN 50 are represented in the following graphic. The pigsar™ test certificate for a Promass F DN 80 (3") is attached as example (attachment 4).



### SwRI, Texas, USA:

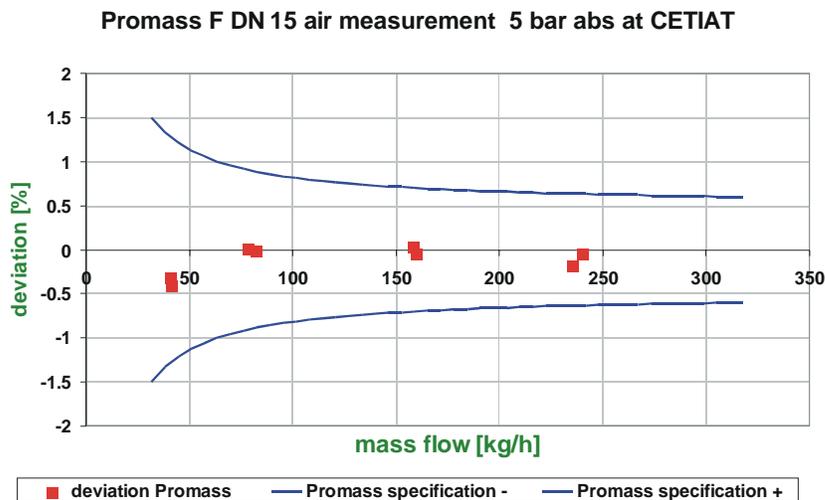
Southwest Research Institute is an independent, nonprofit applied research and development organization. The SwRI Metering Research Facility (MRF) is a high-accuracy natural gas flow laboratory used for meter research, calibration, and testing. Using a test medium of either natural gas or nitrogen, the MRF provides a broad range of test conditions similar to those experienced in the field. The Coriolis gas tests have been organized by the Gas Research Institute.

### CEESI, USA:

Colorado Engineering Experiment Station, Inc. The corporation operates as an independent commercial calibration facility. The calibration capabilities of the Colorado test facility include water calibration as well as a wide range of flow rates, temperatures, and pressures utilizing numerous test gasses including air. The CEESI facility in Iowa provides natural gas calibration for ultrasonic flow meters, turbines, large diameter orifice meters and other meters requiring high Reynolds number ranges. Flow meter calibrations at CEESI are accredited by NVLAP and traceable to NIST. The Promass F DN 250 test has been presented on the 2005 AGA Operations Conference and Biennial Exhibition as joint contribution by Endress+Hauser and CEESI.

### Cetiat, France and DOW, the Netherlands:

These are tests which have been performed by the customers in order to convince themselves from the feasibility of Promass for their respective applications. Results from the air test are shown in the following graphic.



Kalibrierprotokoll  
Calibration - Protocol

Endress+Hauser  
Flowtec



PROWIRL 77 F

Fabrikations-Nr. / Serial Number : 432032 Index :  
 Nenndurchmesser / Nominal diameter : 1 1/2"  
 Messbereich / Flowrange : 10.260dm<sup>3</sup>/s= 10.26000 dm<sup>3</sup>/s  
 Geschwindigkeit / Flowspeed : 8.999 m/s  
 Frequenz Ausgang / frequency output : 198.1570 Hz  
 Wassertemperatur / Water temp. : 31.03 °C

Mess- Nr.	RG Nr.	RV- Nr.	F- Nr.	Durchfluss flowrate %	Vol. ist vol. meas. dm <sup>3</sup>	Vol. soll vol. rated dm <sup>3</sup>	Abweichung deviation %	Abw.RefGer dev.RefDev %	K.-Faktor K.-factor P/dm <sup>3</sup>	Messzeit meas. time s	Temperatur temp. °C
	0	1	1	64.9	201.1024	202.2185	-0.55	0.12	19.3136	30.36	30.91
K c	1	1	1	64.9	200.6364	201.5931	-0.47	0.14	19.3136	30.26	30.95
	2	1	1	53.2	165.7903	165.8724	-0.05	0.14	19.3136	30.36	30.98
K c	3	1	1	39.8	124.2133	123.9371	0.22	0.16	19.3136	30.36	31.01
	4	1	1	29.6	92.57749	92.31681	0.28	0.18	19.3136	30.36	31.07
K c	5	2	1	20.0	83.15406	82.94542	0.25	0.07	19.3136	40.38	31.11

K.-Factor : 19.31355 P/dm<sup>3</sup>

kalibriert / calibrated : 25.11.97

Anlage / calibration rig : FCP-6.1

L. Banyay

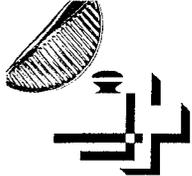
Bemerkungen :

Mit EAM-Ring

Fabr.-Nr. 432032.  
PSTK-Code:

00-00-00  
F.Faktor = 80.0 %

25.11.97 11:38:06  
Soft-Version : 2.02.01/2.0



Nr. 136-2181

# Kalibrierzertifikat

*Gegenstand:* Wirbelstrom-Gaszähler  
Fabrik-Nr.: 432032  
Typ: Prowirl 77 F  
Hersteller: Flowtec AG

*Auftraggeber:* Endress und Hauser, Flowtec AG, Reinach

## Umfang der Kalibrierung

Der Wirbelstrom-Gaszähler (Prüfling) wurde im Messbereich von 41 m<sup>3</sup>/h bis 156 m<sup>3</sup>/h bei 6 Durchflussstärken geprüft.

## Messverfahren

Im Saugbetrieb wurde die Luft des Prüfraumes mit einem Ventilator zuerst durch den Prüfling und anschliessend durch den Normalgaszähler gesogen.

Die angegebenen Werte beziehen sich auf den beim Druckmessstutzen gemessenen Luftdruck, am Auslass des Prüflings.

Unter Berücksichtigung von Messzeit, Druck- und Temperaturunterschieden sowie des Luftdrucks wurde aus dem Volumen des Normalgaszählers das Volumen beim Druckmessstutzen berechnet.

## Messbedingungen

Barometrischer Luftdruck: 939.0 mbar bis 939.3 mbar  
Unterdruck: -2.8 mbar bis -34.1 mbar  
Raumtemperatur: 21.1 °C bis 21.3 °C  
Raumlufffeuchte: 23 % bis 24 %


**Kalibrierzertifikat (Fortsetzung)**
**Nr. 136-2181**
**Resultate**

Die angegebenen Werte sind Mittelwerte aus 2 Messungen.

*Angezeigtes Volumen*

Volumen basierend auf der Impulswertigkeit des Prüflings von 19313.55 Imp/m<sup>3</sup>.

Durchfluss- stärke	Tatsächliches Volumen	Angezeigtes Volumen	Messabw.	$U_{95}$ Messabw.	P abs Luftdruck	Temperatur
m <sup>3</sup> /h	m <sup>3</sup>	m <sup>3</sup>	%	%	mbar	°C
40.8	0.6072	0.6014	-0.97	± 0.2	939.5	20.23
49.6	0.8057	0.8014	-0.53	± 0.2	935.2	20.19
75.4	1.206	1.201	-0.37	± 0.2	930.4	20.13
99.5	1.605	1.601	-0.23	± 0.2	924.4	20.11
124.9	2.001	2.003	+0.10	± 0.2	916.6	20.07
156.3	2.494	2.504	+0.41	± 0.2	904.9	20.04

**Messunsicherheit**

Der angegebene Messwert und die zugehörige Unsicherheit geben den Bereich an, der den Wert der gemessenen Grössen mit einer Wahrscheinlichkeit von 95 % enthält.

Die abgeschätzte Messunsicherheit beinhaltet Unsicherheitsbeiträge vom benutzten Normal, vom Kalibrierverfahren und vom kalibrierten Messmittel.

**Datum der Kalibrierung/Kennzeichnung**

Die Kalibrierung erfolgte vom 12. Januar 1999.

Der Prüfling wurde mit der Kalibriermarke des Amtes, datiert Januar 99 versehen.

Für die Messung:

G. Castella

Eidgenössisches Amt für Messwesen  
 Abteilung Mechanik, Strahlung und  
 Legale Metrologie

Dr. Bruno Vaucher, Stv. Direktor

Wabern 8. Januar 1999

Zg

**Staatlich anerkannte Prüfstelle für Meßgeräte für Gas GH 45**  
(bei der Ruhrgas AG)



# Prüfschein

(Sonderprüfung mit Hochdruckerdgas)



Beglaubigungsschein-Nr.:	480 / 1999
Name (Firma) und Wohnort (Sitz) des Antragstellers:	Endress + Hauser Flowtec AG
Meßgerätebezeichnung:	Promass F
Zulassungszeichen:	keine Bauartzulassung für den geschäftlichen Verkehr
Hersteller:	Flowtec
Fabriknummer:	40577
Größenbezeichnung:	3 "
Belastungsbereich:	850 bis 20000 kg/h
Baujahr:	1999
Nennweite:	80 mm
Anschlußflanschnennweite :	80 mm
Anschlußflansche:	ANSI 600

$\frac{Q}{Q_{max}}$	$\dot{m}$ kg/h	Reynoldszahl $10^6$	Meßabweichung %
0.04	867	0.33	-0.29
0.10	1900	0.74	-0.41
0.19	3726	1.45	-0.20
0.47	9293	3.62	-0.17
0.97	19398	7.51	0.02

Meßabweichung nach OIML: -0.14 %

Die Meßabweichung ist mit einer Meßunsicherheit von 0,3 % behaftet.

p(absolut) = 21.1 bar       $\vartheta$  = 14.3 °C  
 $p_b$  = 17.063 kg/m<sup>3</sup>       $\eta$  = 11.3 x10<sup>-6</sup>Pa·s

Impulsgeber: HF  
 Bezeichnung: HF  
 Impulse/kg: 500

Seite 1  
 zum Beglaubigungsschein  
 Nr. 480 / 99

Für die Meßabweichung gilt:  $F = \frac{m_G - m}{m} \cdot 100\%$

mit F = Meßabweichung,  $m_G$  = angezeigte Masse, m = richtige Masse

Prüfmedium: Erdgas

Analyse: H <sub>2</sub>	= 0.000	Vol. %	CO <sub>2</sub>	= 1.356	Vol. %
H <sub>on</sub>	= 10.331	kWh/m <sup>3</sup>	K-Zahl	= 0.9597	
ρ <sub>n</sub>	= 0.827	kg/m <sup>3</sup>			

sonstige Angaben: keine

Die Normale sind an die nationalen Normen der Physikalisch Technischen Bundes anstalt (PTB) angeschlossen. Das Meßgerät wurde einer Sonderprüfung mit Hochdruckerdgas nach der Eichanweisung Nummer 11.5 und in Anlehnung der technischen Richtlinie G 7, in der derzeit gültigen Fassung, der PTB unterzogen. Das geprüfte Gerät darf nicht im eichpflichtigen Verkehr verwendet oder bereitgehalten werden.

Aufgebrachte Stempel: Hauptstempel **GH 45 / 99**

Dorsten, den 16.08.99

Prüfstellenleitung

*Die*



Hinweis: Ohne Unterschrift und Dienststempel hat dieser Beglaubigungsschein keine Gültigkeit. Er darf nur unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung der Prüfstelle!



# Fehlerkurve

Zählertyp : Promass F	Kunde : Endress + Hauser	DN : 80	P(abs) : 21.1 bar	HF 1 : 500 Imp/kg
Zählernr. : 40577	Fabrikat : Flowtec	Größe : 3"	m (max) : 20000 kg/h	HF :
Datum : 16.08.1999	J 1 : -		m (min) : 850 kg/h	HF :
Prüfer : Hirlehei	J 2 : -		NF 1 : -	HF :

