English Version

IGTM – CT
IGTM – IM

GAS TURBINE METER

Installation, Operation and Maintenance Manual (IOM)

vemm tec
Messtechnik GmbH

Installation, Operation and Maintenance Manual (IOM)

CONTENTS

LIST OF FIGURES

LIST OF FORMULAS

LIST OF TABLES

1 INTRODUCTION

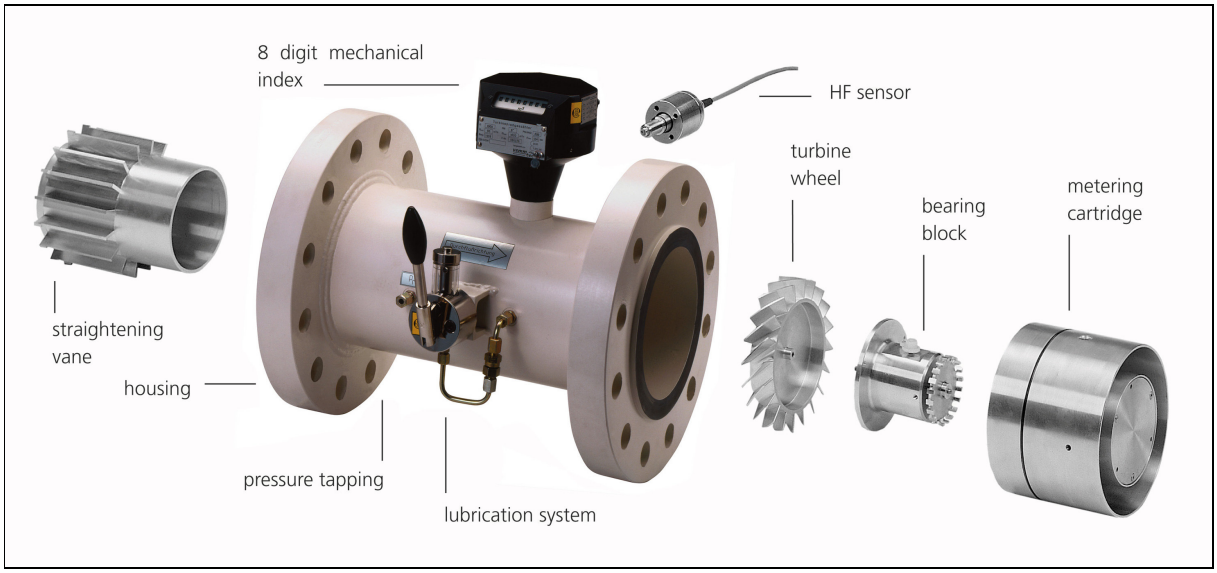
1.1 Dear customer

Congratulations on your new purchase of a high quality measurement device, the IGTM Gas Turbine Meter. To take full advantage of the potential of your metering equipment we advise you to thoroughly read this manual and follow the recommendations and warnings.

This manual makes recommendations to enable you to obtain high accurate metering results and prescribes the handling, installation and maintenance of your turbine meter. It is very important that you follow the safety recommendations at installation, hook up, and the maintenance guidelines.

This document also contains the unit dimensions and operational ranges and describes performance, calibration and outputs of the instrument.

Figure 1: Exploded view of main parts



1.2 Notice

vemm tec Messtechnik GmbH ("***vemm tec***") shall not be liable for technical or editorial errors in this manual or omissions from this manual. ***vemm tec*** makes no warranties, express or implied, including the implied warranties of merchantability and fitness for a particular purpose with respect to this manual and, in no event, shall ***vemm tec*** be liable for any special or consequential damages including, but not limited to, loss of production, loss of profits, etc.

Product names used herein are for manufacturer or supplier identification only and may be trademarks / registered trademarks of these companies.

1.3 Brief description

The ***vemm tec*** IGTM (International Gas Turbine Meter) is designed in accordance with all major international standards. The CT-model is approved for custody transfer in the European Community and other countries and provides a high-accuracy turbine meter with a mechanical counter and electronic pulse outputs.

The IGTM counts the increment of gas volume flowing through an annular passage in the meter. The gas volume is totalized on a local mechanical counter. In addition, pulse signals are generated to infer the gas flow and volume. The indicated gas volume is the actual volume that passed the meter at the actual temperature and pressure. The IGTM is available in two models; CT and IM. The IGTM-CT is used for high-accuracy custody transfer applications and has a body length of three times the nominal diameter, 3 DN. The IM (Industrial Meter) is an economically priced accurate meter and has a shorter body.

1.4 Principle of operation

The operation of the IGTM is based on the measurement of the velocity of gas. The flowing gas is accelerated and conditioned by the meter's straightening section. The integrated straightening vanes prepare the gas flow profile by removing undesirable swirl, turbulence and asymmetry before the gas reaches the rotating turbine wheel. The dynamic forces of the flowing fluid cause the rotor to rotate. The turbine wheel is mounted on the main shaft, with special high-precision, low-friction ball bearings. The turbine wheel has helical blades that have a known angle relative to the gas flow. The conditioned and accelerated gas drives the turbine wheel with an angular velocity that is proportional with the gas velocity. The rotation of the turbine wheel and the main shaft eventually drive the eight digit mechanical counter in the index head. The rotating turbine wheel can also generate pulses directly by proximity sensors that create a pulse for each passing turbine blade. By accumulating the pulses the total passed volume and gas flow rate can be calculated.

1.5 Parts and documents supplied with the IGTM

Your package contains:
- IGTM – Gas Turbine Meter
- Bottle with lubricant for initial lubrication and two years operation
- Male connectors (number depends on the number of pulse transmitters to be connected, the female plugs are mounted in the meter, the male plugs are delivered unassembled for connection on site)
- Copies of calibration documents
- Copies of pressure test documents (if applicable)
- “Instructions for Installation” (the leaflet should stay in close proximity of the meter)
- “Instructions for Storage” (a leaflet)
- “Installation, Operation and Maintenance Manual” (this manual)

The complete original certificates ordered will be shipped separately. If applicable (and if ordered) the documents supplied are:
- Inspection Certificate EN 10204 - 3.1.B
- Pressure test certificates (hydro test and air seal test)
- Verification certificate (of legal calibration) or Certificate of Conformity
- Calibration results (data and error curve)
- High pressure calibration certificate
- Applicable CE documentation (ATEX, PED)
- Material certificates of pressure containing parts
- Welding certificates
- Non destructive test: Radiographic Examination Record
- Others on request

Each shipment is checked for completeness and released by Quality Assurance Staff prior to shipment.

You should check the meter and accessories by means of the order acknowledgement and the delivery note for completeness and for any damages caused during transport. Please immediately contact your sales agent, if the goods are incomplete or damaged.

1.6 Instructions for storage and conservation

A gas turbine meter is a high precision instrument; it should be handled with care.
Never use the index head or the oil pump to lift the meter.

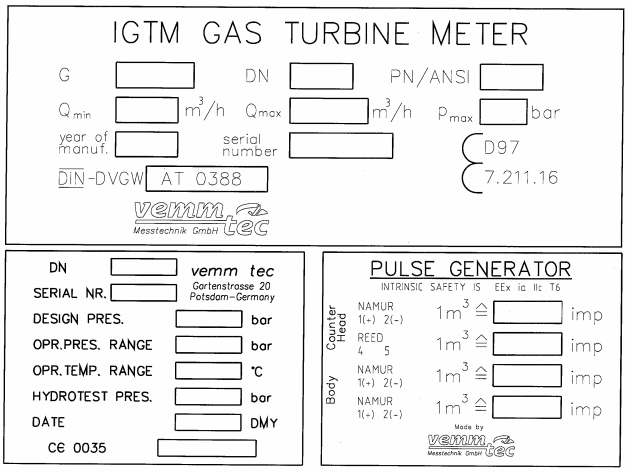
vemm tec suggests to store IGTMs in the original crating/packing to avoid damage during storage. IGTM gas turbine meters must be stored in a non-condensing atmosphere in a temperature range from -30 to +70 °C. If a meter is stored longer than 3 months or under alternative conditions the meter needs to be conserved properly.

vemm tec suggests to keep in store the original crating/packing of your IGTM gas turbine meter for later use. Please use the original crating/packing and fixing materials to secure your IGTM during all further transports, and to avoid damage during transport.

1.7 Nameplate details

Your meter is equipped with a main label. Figure 2 shows the English version. Alternatively, labels are available in German or other languages. The label contains information such as size, pressure rating and flow rate, valid for this meter. Please refer to Table 14 to check size and G-rating. Flange ratings and maximum operating pressures are listed in Table 5. Only use the meter in the indicated ranges for flow, pressure and temperature.

Figure 2: Name plate (English version), CE/PED label and pulse label



1.8 Documentation

1.8.1 Approvals

The IGTM was specifically designed to be in accordance with all relevant international standards, including EC (European Community) directives and the rigid German regulations for custody transfer. Please refer to Table 9 for a list of technical standards, rules and guidelines.

The IGTM-CT meter is approved for custody transfer in all EC countries. Please refer to Figure 17 for the EC type approval certificate. Metrological type approvals are also available for Algeria, Bulgaria, China, Czech Republic, Hungary, Malaysia, and Romania. Other approvals are pending. Please contact ***vemm tec*** for a complete list.

If your meter was ordered to be in accordance with a specific (country) approval the main label should be in accordance with that approval. If no specific approval was specified at the time of order, the standard EC label in English language will be applied.

1.8.2 Inspection certificate EN 10204 - 3.1.B

Every meter can be delivered with an “Inspection Certificate EN 10204 - 3.1.B” (see Figure 3).

Optionally you may order the complete Material Certification Package 3.1.B, including
- ”Hydro Test Protocol” and “Air Seal Test Protocol”
- Material certificates of pressure containing parts
- ATEX / EEx (intrinsically safe) certification of the proximity probes
- Welding certificates (if applicable)
- Non destructive test reports (X-ray) (if applicable)

Additional certification must be ordered separately, like other non destructive test reports or third party inspection certificates, for example.

1.8.3 Hydro test and air seal test

All IGTMs are statically pressure tested in accordance with the flange rating and with the appropriate standards and customer requirements. Flange ratings and maximum operating pressures of IGTM are mentioned in Section 3.4 and on the CE label.
- Hydro test of the meter housing at 1.5 x maximum operating pressure
- Air seal test of the completely assembled meter at 1.1 x maximum operating pressure

Certificates of these tests are included in the optional Material Certification Package 3.1.B. (This must be requested at the time of your order.)

Each meter is marked with **Wx Lx** on the meter flange, where x is a single digit number, to indicate that the test is passed.

1.8.4 Initial verification and calibration

Gas flow meters for custody transfer purposes usually have an initial verification (legal calibration). This initial verification can be performed at our factory with air at ambient conditions. The calibration facility is listed as "Accredited Test Centre for Gas Meters GN 5 at ***vemm tec*** Messtechnik GmbH". Accreditation is performed and supervised by the "Landesamt für Mess- und Eichwesen, Land Brandenburg (Eichamt)", that is the German State Verification Authority, State Brandenburg (Weights & Measures). The reference meters used for the calibrations are traceable to the national standards of the Federal Republic of Germany at the Physikalisch-Technische Bundesanstalt (PTB). The calibration managers of GN 5 are certified verification officers. After having passed the calibration, a "Verification certificate" is issued. It is signed and stamped by "GN 5".

If a legal verification certificate is not required, a factory calibration with air at ambient conditions is performed at above mentioned calibration facility. The "Certificate of Conformity" proves that the meter has been tested and complies with the stated error limits. It is signed and stamped by "***vemm tec*** Messtechnik GmbH".

In both cases (initial verification or factory calibration) a two page certificate with the measured data and curve can be issued at additional cost.

The K-factors [Imp/m³] for the HF sensors of each IGTM are determined during calibration and are shown on a label on the index head and on the calibration certificate with 6 significant digits. The K-factors are specific for each meter and correspond with specific gears in the index head. The factor determined by the calibration is the one that should be used in your calculations and flow correcting devices.

If at any time the meter is re-calibrated and the correction gears in the index head are changed, the K-factor for the HF sensors must also be adjusted.

Each IGTM has been flow tested, quality checked, and sealed:

- After initial verification, the meter is lead sealed according to the legal (EC) requirements.
- If the meter is factory calibrated, it is lead sealed with factory seals.

Please verify that all seals are present before mounting the meter in the pipeline (refer to Figure 23 for seal locations). If any of the legal seals are broken, removed or damaged, the meter may not be used for custody transfer measurements in most countries. The seals must not be painted. Your warranty will become void, if any lead seal with the original stamp is damaged.

If requested, high pressure calibrations with natural gas will be performed at external High Pressure Test Facilities, such as PIGSAR Dorsten (Germany), EnBW Stuttgart (Germany), NMi Bergum or Westerbork (The Netherlands), or ADVANTICA – former British Gas – Bishop Auckland (United Kingdom). Most of these facilities are approved for legal verifications in the respective countries. Please enquire.

1.8.5 Example certificates

Figure 3: Inspection certificate EN 10204 – 3.1.B (example)

Inspection Certificate EN 10204 - 3.1.B

vemm tec Messtechnik GmbH

Fomblatt 08-15, Revision 3 - Oktober 03
Page 1 of 1, file: .xls

vemm tec - Messtechnik GmbH
Haus- und Lieferadresse: Gartenstraße 20 • D-14484 Potsdam/Germany

DANIEL

Order date
Reference no.
Customer name

Inspected device	**IGTM Gas Turbine Meter**		
Manufactured by	**vemm tec Messtechnik GmbH, Germany, ref.**		
Selection code		Serial number	
Model	IGTM-CT	Year of manuf.	
G size rating		Range: Qmin	m3/h
Diameter		Range: Qmax	m3/h
Flanges		Max. oper. press.	bar (g)
Body material			
Temp. range	-10 to +60 °C	(Gas temperature and ambient temperature)	
Medium	Non-corrosive gases	(According to DVGW G 260)	
Approval	EEC type-approval D97 / 7.211.16		

Technical standards
EN 12261 / ASME B 16.5; DIN 30690-1; DVGW G 469; DVGW G 492 II.
vemm tec PA 10-03; vemm tec PA 10-02.

Strength and leak tests
Hydrostatic test performed with water at bar (g), duration: 5 minutes minimum
Air seal test performed with air at bar (g), duration: 5 minutes minimum

Calibration
The calibration was performed according to 71/318/EEC at the vemm tec calibration facility with air at ambient conditions. This facility is listed as Accredited Test Centre GN 5 in the Federal Republic of Germany. The standards used for the measurements are traceable to the national standards at the Physikalisch-Technische Bundesanstalt (PTB).

Declaration of conformity
This certifies that the measuring device has been designed, manufactured, tested, and inspected in accordance with the standards and technical specifications of above mentioned contract.
The requirements in the standards refered to are fulfilled. All tests have been passed.
The unit was found in perfect condition before despatching.

Place	Date	Signature	Inspector´s stamp	Company´s stamp
Potsdam, Germany				

vt 3 / Inspector
vt 4 / Deputy Inspector

fb081503

Telefon +49(0)331 / 70 96-0
Telefax: +49(0)331 / 70 96-201 und 70 96-270
E-Mail: info@vemmtec.com
Internet: www.vemmtec.com

Bankverbindung:
Mittelbrandenburgische Sparkasse (MBS)
Kto.-Nr.: 35 12 001 440
BLZ: 160 500 00
IBAN: DE34 1605 0000 3512 0014 40
BIC: WELADED1PMB

Geschäftsführer: Karst van Dellen
Michael Lenz
Registergericht: Kreisgericht Potsdam
Handelregister: HRB 3559
Steuernummer: 046/121/01774

Figure 4: ATEX certificate for IGTM sensors HF1 and HF2 (example: vem 949/03)

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

(1) **EG-Baumusterprüfbescheinigung**

(2) Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen - **Richtlinie 94/9/EG**

(3) EG-Baumusterprüfbescheinigungsnummer

PTB 00 ATEX 2048 X

(4) Gerät: Zylinderförmige induktive Sensoren Typen NC... und NJ...

(5) Hersteller: Pepperl + Fuchs GmbH

(6) Anschrift: D-68307 Mannheim

(7) Die Bauart dieses Gerätes sowie die verschiedenen zulässigen Ausführungen sind in der Anlage zu dieser Baumusterprüfbescheinigung festgelegt.

(8) Die Physikalisch-Technische Bundesanstalt bescheinigt als benannte Stelle Nr. 0102 nach Artikel 9 der Richtlinie des Rates der Europäischen Gemeinschaften vom 23. März 1994 (94/9/EG) die Erfüllung der grundlegenden Sicherheits- und Gesundheitsanforderungen für die Konzeption und den Bau von Geräten und Schutzsystemen zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen gemäß Anhang II der Richtlinie.

Die Ergebnisse der Prüfung sind in dem vertraulichen Prüfbericht PTB Ex 00-29206 festgelegt.

(9) Die grundlegenden Sicherheits- und Gesundheitsanforderungen werden erfüllt durch Übereinstimmung mit

EN 50014:1997 **EN 50020:1994**

(10) Falls das Zeichen „X" hinter der Bescheinigungsnummer steht, wird auf besondere Bedingungen für die sichere Anwendung des Gerätes in der Anlage zu dieser Bescheinigung hingewiesen.

(11) Diese EG-Baumusterprüfbescheinigung bezieht sich nur auf Konzeption und Bau des festgelegten Gerätes gemäß Richtlinie 94/9/EG. Weitere Anforderungen dieser Richtlinie gelten für die Herstellung und das Inverkehrbringen dieses Gerätes.

(12) Die Kennzeichnung des Gerätes muß die folgenden Angaben enthalten:

Ex II 2 G EEx ia IIC T6

Zertifizierungsstelle Explosionsschutz
Im Auftrag
Dr.-Ing. U. Johannsmeyer
Regierungsdirektor

Braunschweig, 26. September 2000

Seite 1/5

EG-Baumusterprüfbescheinigungen ohne Unterschrift und ohne Siegel haben keine Gültigkeit.
Diese EG-Baumusterprüfbescheinigung darf nur unverändert weiterverbreitet werden.
Auszüge oder Änderungen bedürfen der Genehmigung der Physikalisch-Technischen Bundesanstalt.
Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

(1) **EC-TYPE-EXAMINATION CERTIFICATE**
(Translation)

(2) Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres - **Directive 94/9/EC**

(3) EC-type-examination Certificate Number:

PTB 00 ATEX 2048 X

(4) Equipment: Cylindrical inductive sensors, types NC... and NJ...

(5) Manufacturer: Pepperl + Fuchs GmbH

(6) Address: D-68307 Mannheim

(7) This equipment and any acceptable variation thereto are specified in the schedule to this certificate and the documents therein referred to.

(8) The Physikalisch-Technische Bundesanstalt, notified body No. 0102 in accordance with Article 9 of the Council Directive 94/9/EC of 23 March 1994, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres, given in Annex II to the Directive.

The examination and test results are recorded in the confidential report PTB Ex 00-29206.

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN 50014:1997 **EN 50020:1994**

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This EC-type-examination Certificate relates only to the design and construction of the specified equipment in accordance with Directive 94/9/EC. Further requirements of this Directive apply to the manufacture and supply of this equipment.

(12) The marking of the equipment shall include the following:

Ex II 2 G EEx ia IIC T6

Zertifizierungsstelle Explosionsschutz
By order:
Dr.-Ing. U. Johannsmeyer
Regierungsdirektor

Braunschweig, September 26, 2000

sheet 1/5

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt.
In case of dispute, the German text shall prevail.
Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig

Figure 5: ATEX certificate for IGTM sensors HF3 and HF4 (example: vem 847/02)

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

(1) **EG-Baumusterprüfbescheinigung**

(2) Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen - **Richtlinie 94/9/EG**

(3) EG-Baumusterprüfbescheinigungsnummer

PTB 99 ATEX 2219 X

(4) Gerät: Schlitzinitiatoren Typen SJ... und SC...

(5) Hersteller: Pepperl + Fuchs GmbH

(6) Anschrift: D-68307 Mannheim

(7) Die Bauart dieses Gerätes sowie die verschiedenen zulässigen Ausführungen sind in der Anlage zu dieser Baumusterprüfbescheinigung festgelegt.

(8) Die Physikalisch-Technische Bundesanstalt bescheinigt als benannte Stelle Nr. 0102 nach Artikel 9 der Richtlinie des Rates der Europäischen Gemeinschaften vom 23. März 1994 (94/9/EG) die Erfüllung der grundlegenden Sicherheits- und Gesundheitsanforderungen für die Konzeption und den Bau von Geräten und Schutzsystemen zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen gemäß Anhang II der Richtlinie.

Die Ergebnisse der Prüfung sind in dem vertraulichen Prüfbericht PTB Ex 99-29175 festgelegt.

(9) Die grundlegenden Sicherheits- und Gesundheitsanforderungen werden erfüllt durch Übereinstimmung mit

EN 50014:1997 **EN 50020:1994**

(10) Falls das Zeichen „X" hinter der Bescheinigungsnummer steht, wird auf besondere Bedingungen für die sichere Anwendung des Gerätes in der Anlage zu dieser Bescheinigung hingewiesen.

(11) Diese EG-Baumusterprüfbescheinigung bezieht sich nur auf Konzeption und Bau des festgelegten Gerätes gemäß Richtlinie 94/9/EG. Weitere Anforderungen dieser Richtlinie gelten für die Herstellung und das Inverkehrbringen dieses Gerätes.

(12) Die Kennzeichnung des Gerätes muß die folgenden Angaben enthalten:

Ex II 2 G EEx ia IIC T6

Zertifizierungsstelle Explosionsschutz
Im Auftrag
Dr.-Ing. U. Johannsmeyer
Regierungsdirektor

Braunschweig, 22. Dezember 1999

Seite 1/3

EG-Baumusterprüfbescheinigungen ohne Unterschrift und ohne Siegel haben keine Gültigkeit.
Diese EG-Baumusterprüfbescheinigung darf nur unverändert weiterverbreitet werden.
Auszüge oder Änderungen bedürfen der Genehmigung der Physikalisch-Technischen Bundesanstalt.
Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

(1) **EC-TYPE-EXAMINATION CERTIFICATE**
(Translation)

(2) Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres - **Directive 94/9/EC**

(3) EC-type-examination Certificate Number:

PTB 99 ATEX 2219 X

(4) Equipment: Slot-type initiators types SJ... and SC...

(5) Manufacturer: Pepperl + Fuchs GmbH

(6) Address: D-68307 Mannheim

(7) This equipment and any acceptable variation thereto are specified in the schedule to this certificate and the documents therein referred to.

(8) The Physikalisch-Technische Bundesanstalt, notified body No. 0102 in accordance with Article 9 of the Council Directive 94/9/EC of 23 March 1994, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres, given in Annex II to the Directive.

The examination and test results are recorded in the confidential report PTB Ex 99-29175.

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN 50014:1997 **EN 50020:1994**

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This EC-type-examination Certificate relates only to the design and construction of the specified equipment in accordance with Directive 94/9/EC. Further requirements of this Directive apply to the manufacture and supply of this equipment.

(12) The marking of the equipment shall include the following:

Ex II 2 G EEx ia IIC T6

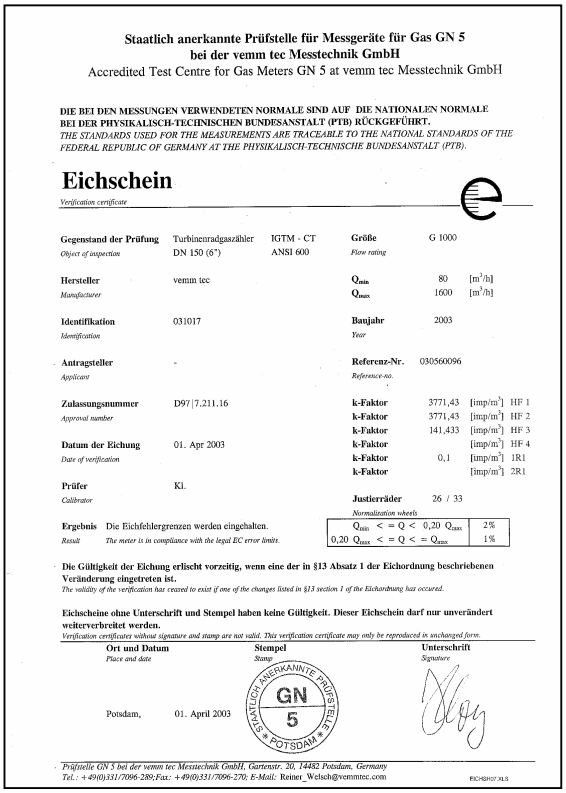
Zertifizierungsstelle Explosionsschutz
By order:
Dr.-Ing. U. Johannsmeyer
Regierungsdirektor

Braunschweig, December 22, 1999

sheet 1/3

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt.
In case of dispute, the German text shall prevail.
Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig

Figure 6: Optional calibration certificates (examples), performed with air at ambient conditions:
Initial verification – “Verification certificate”,
Factory calibration – “Certificate of conformity”,
Calibration data and error curve



Staatlich anerkannte Prüfstelle für Messgeräte für Gas GN 5
bei der vemm tec Messtechnik GmbH
Accredited Test Centre for Gas Meters GN 5 at vemm tec Messtechnik GmbH

DIE BEI DEN MESSUNGEN VERWENDETEN NORMALE SIND AUF DIE NATIONALEN NORMALE BEI DER PHYSIKALISCH-TECHNISCHEN BUNDESANSTALT (PTB) RÜCKGEFÜHRT.
THE STANDARDS USED FOR THE MEASUREMENTS ARE TRACEABLE TO THE NATIONAL STANDARDS OF THE FEDERAL REPUBLIC OF GERMANY AT THE PHYSIKALISCH-TECHNISCHE BUNDESANSTALT (PTB).

Eichschein

Verification certificate

Gegenstand der Prüfung *Object of inspection*	Turbinenradgaszähler DN 150 (6")	IGTM - CT ANSI 600	**Größe** *Flow rating*	G 1000	
Hersteller *Manufacturer*	vemm tec		Q_{min} Q_{max}	80 1600	[m³/h] [m³/h]
Identifikation *Identification*	031017		**Baujahr** *Year*	2003	
Antragsteller *Applicant*	-		**Referenz-Nr.** *Reference-no.*	030560096	
Zulassungsnummer *Approval number*	D97|7.211.16		**k-Faktor** **k-Faktor** **k-Faktor**	3771,43 3771,43 141,433	[imp/m³] HF 1 [imp/m³] HF 2 [imp/m³] HF 3
Datum der Eichung *Date of verification*	01. Apr 2003		**k-Faktor** **k-Faktor** **k-Faktor**	0,1	[imp/m³] HF 4 [imp/m³] 1R1 [imp/m³] 2R1
Prüfer *Calibrator*	Kl.		**Justierräder** *Normalization wheels*	26 / 33	

Ergebnis *Result* Die Eichfehlergrenzen werden eingehalten. *The meter is in compliance with the legal EC error limits.*

$Q_{min} <= Q < 0{,}20\ Q_{max}$	2%
$0{,}20\ Q_{max} <= Q <= Q_{max}$	1%

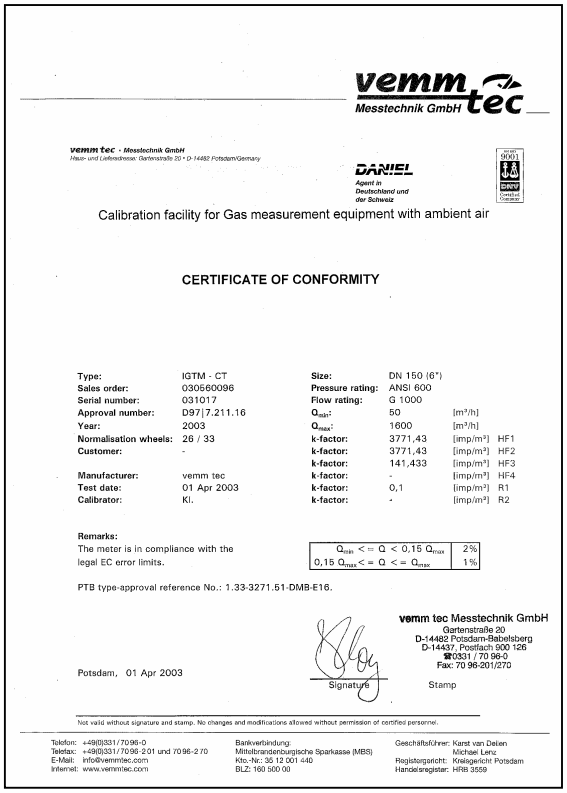
Die Gültigkeit der Eichung erlischt vorzeitig, wenn eine der in §13 Absatz 1 der Eichordnung beschriebenen Veränderung eingetreten ist.
The validity of the verification has ceased to exist if one of the changes listed in §13 section 1 of the Eichordnung has occured.

Eichscheine ohne Unterschrift und Stempel haben keine Gültigkeit. Dieser Eichschein darf nur unverändert weiterverbreitet werden.
Verification certificates without signature and stamp are not valid. This verification certificate may only be reproduced in unchanged form.

Ort und Datum *Place and date*	**Stempel** *Stamp*	**Unterschrift** *Signature*
Potsdam, 01. April 2003	STAATLICH ANERKANNTE PRÜFSTELLE GN 5 POTSDAM	

Prüfstelle GN 5 bei der vemm tec Messtechnik GmbH, Gartenstr. 20, 14482 Potsdam, Germany
Tel.: +49(0)331/7096-286;Fax: +49(0)331/7096-270; E-Mail: Reiner_Welsch@vemmtec.com

EICHSHOT.XLS



vemm tec Messtechnik GmbH

vemm tec - Messtechnik GmbH
Haus- und Lieferadresse: Gartenstraße 20 • D-14482 Potsdam/Germany

DANIEL Agent in Deutschland und der Schweiz

Calibration facility for Gas measurement equipment with ambient air

CERTIFICATE OF CONFORMITY

Type:	IGTM - CT	**Size:**	DN 150 (6")		
Sales order:	030560096	**Pressure rating:**	ANSI 600		
Serial number:	031017	**Flow rating:**	G 1000		
Approval number:	D97|7.211.16	Q_{min}:	50	[m³/h]	
Year:	2003	Q_{max}:	1600	[m³/h]	
Normalisation wheels:	26 / 33	**k-factor:**	3771,43	[imp/m³]	HF1
Customer:	-	**k-factor:**	3771,43	[imp/m³]	HF2
		k-factor:	141,433	[imp/m³]	HF3
Manufacturer:	vemm tec	**k-factor:**	-	[imp/m³]	HF4
Test date:	01 Apr 2003	**k-factor:**	0,1	[imp/m³]	R1
Calibrator:	Kl.	**k-factor:**	-	[imp/m³]	R2

Remarks:
The meter is in compliance with the legal EC error limits.

$Q_{min} <= Q < 0{,}15\ Q_{max}$	2%
$0{,}15\ Q_{max} <= Q <= Q_{max}$	1%

PTB type-approval reference No.: 1.33-3271.51-DMB-E16.

Potsdam, 01 Apr 2003

Signature

Stamp

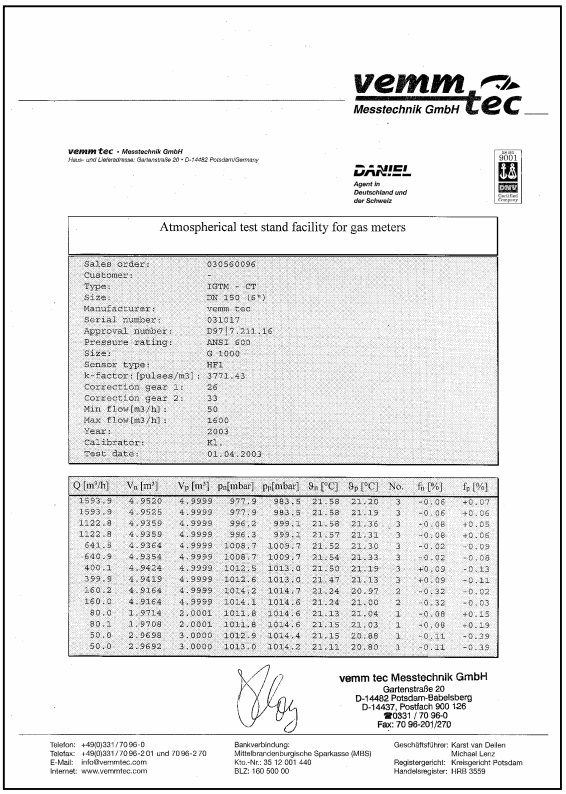
vemm tec Messtechnik GmbH
Gartenstraße 20
D-14482 Potsdam-Babelsberg
D-14437, Postfach 900 126
☎0331 / 70 96-0
Fax: 70 96-201/270

Not valid without signature and stamp. No changes and modifications allowed without permission of certified personnel.

Telefon: +49(0)331/7096-0
Telefax: +49(0)331/7096-201 und 7096-270
E-Mail: info@vemmtec.com
Internet: www.vemmtec.com

Bankverbindung:
Mittelbrandenburgische Sparkasse (MBS)
Kto.-Nr.: 35 12 001 440
BLZ: 160 500 00

Geschäftsführer: Karst van Delen
Michael Lenz
Registergericht: Kreisgericht Potsdam
Handelsregister: HRB 3559



vemm tec Messtechnik GmbH

vemm tec - Messtechnik GmbH
Haus- und Lieferadresse: Gartenstraße 20 • D-14482 Potsdam/Germany

DANIEL Agent in Deutschland und der Schweiz

Atmospherical test stand facility for gas meters

Sales order:	030560096
Customer:	-
Type:	IGTM - CT
Size:	DN 150 (6")
Manufacturer:	vemm tec
Serial number:	031017
Approval number:	D97|7.211.16
Pressure rating:	ANSI 600
Size:	G 1000
Sensor type:	HF1
k-factor:[pulses/m3]:	3771.43
Correction gear 1:	26
Correction gear 2:	33
Min flow[m3/h]:	50
Max flow[m3/h]:	1600
Year:	2003
Calibrator:	Kl.
Test date:	01.04.2003

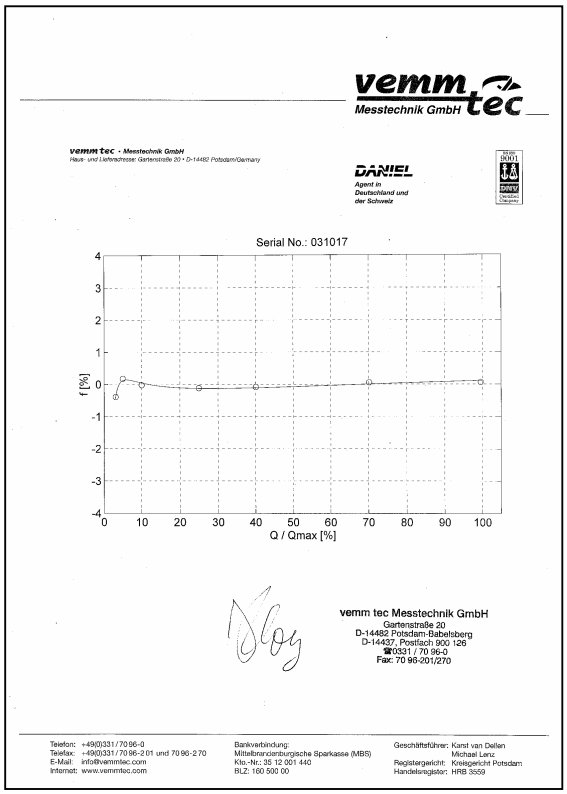
Q [m³/h]	V_n [m³]	V_p [m³]	p_n[mbar]	p_p[mbar]	ϑ_n [°C]	ϑ_p [°C]	No.	f_n [%]	f_p [%]
1593.9	4.9520	4.9999	977.9	983.5	21.58	21.20	3	-0.06	+0.07
1593.9	4.9525	4.9999	977.9	983.5	21.58	21.19	3	-0.06	+0.06
1122.8	4.9359	4.9999	996.2	999.1	21.58	21.36	3	-0.08	+0.05
1122.8	4.9359	4.9999	996.3	999.1	21.57	21.31	3	-0.08	+0.06
641.8	4.9364	4.9999	1008.7	1009.7	21.52	21.30	3	-0.02	-0.09
640.9	4.9354	4.9999	1008.7	1009.7	21.54	21.33	3	-0.02	-0.08
400.1	4.9424	4.9999	1012.5	1013.0	21.50	21.19	3	+0.09	-0.13
399.9	4.9419	4.9999	1012.6	1013.0	21.47	21.13	3	+0.09	-0.11
160.2	4.9164	4.9999	1014.2	1014.7	21.24	20.97	2	-0.32	-0.02
160.0	4.9164	4.9999	1014.1	1014.6	21.24	21.00	2	-0.32	-0.03
80.0	1.9714	2.0001	1011.8	1014.6	21.13	21.04	1	-0.08	+0.15
80.1	1.9708	2.0001	1011.8	1014.6	21.15	21.03	1	-0.09	+0.19
50.0	2.9698	3.0000	1012.9	1014.4	21.15	20.88	1	-0.11	-0.39
50.0	2.9692	3.0000	1013.0	1014.2	21.11	20.80	1	-0.11	-0.39

vemm tec Messtechnik GmbH
Gartenstraße 20
D-14482 Potsdam-Babelsberg
D-14437, Postfach 900 126
☎0331 / 70 96-0
Fax: 70 96-201/270

Telefon: +49(0)331/7096-0
Telefax: +49(0)331/7096-201 und 7096-270
E-Mail: info@vemmtec.com
Internet: www.vemmtec.com

Bankverbindung:
Mittelbrandenburgische Sparkasse (MBS)
Kto.-Nr.: 35 12 001 440
BLZ: 160 500 00

Geschäftsführer: Karst van Delen
Michael Lenz
Registergericht: Kreisgericht Potsdam
Handelsregister: HRB 3559



vemm tec Messtechnik GmbH

vemm tec - Messtechnik GmbH
Haus- und Lieferadresse: Gartenstraße 20 • D-14482 Potsdam/Germany

DANIEL Agent in Deutschland und der Schweiz

Serial No.: 031017

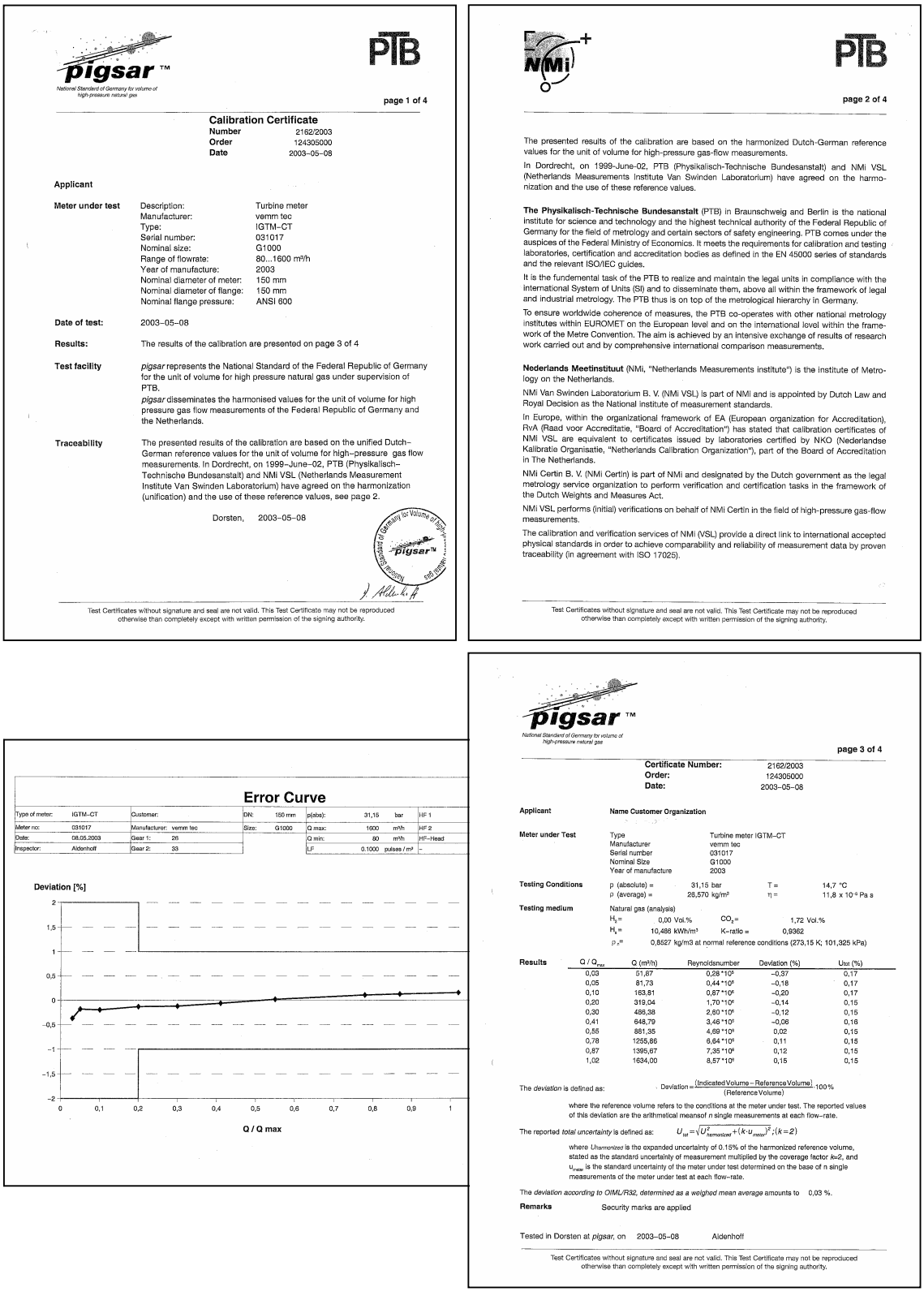
vemm tec Messtechnik GmbH
Gartenstraße 20
D-14482 Potsdam-Babelsberg
D-14437, Postfach 900 126
☎0331 / 70 96-0
Fax: 70 96-201/270

Telefon: +49(0)331/7096-0
Telefax: +49(0)331/7096-201 und 7096-270
E-Mail: info@vemmtec.com
Internet: www.vemmtec.com

Bankverbindung:
Mittelbrandenburgische Sparkasse (MBS)
Kto.-Nr.: 35 12 001 440
BLZ: 160 500 00

Geschäftsführer: Karst van Delen
Michael Lenz
Registergericht: Kreisgericht Potsdam
Handelsregister: HRB 3559

Figure 7: Optional calibration certificate (example), performed with high pressure gas



pigsar ™
National Standard of Germany for volume of high-pressure natural gas

PTB

page 1 of 4

Calibration Certificate

Number 2162/2003
Order 124305000
Date 2003-05-08

Applicant

Meter under test

Description:	Turbine meter
Manufacturer:	vemm tec
Type:	IGTM-CT
Serial number:	031017
Nominal size:	G1000
Range of flowrate:	80...1600 m³/h
Year of manufacture:	2003
Nominal diameter of meter:	150 mm
Nominal diameter of flange:	150 mm
Nominal flange pressure:	ANSI 600

Date of test: 2003-05-08

Results: The results of the calibration are presented on page 3 of 4

Test facility *pigsar* represents the National Standard of the Federal Republic of Germany for the unit of volume for high pressure natural gas under supervision of PTB.
pigsar disseminates the harmonised values for the unit of volume for high pressure gas flow measurements of the Federal Republic of Germany and the Netherlands.

Traceability The presented results of the calibration are based on the unified Dutch-German reference values for the unit of volume for high-pressure gas flow measurements. In Dordrecht, on 1999-June-02, PTB (Physikalisch-Technische Bundesanstalt) and NMi VSL (Netherlands Measurement Institute Van Swinden Laboratorium) have agreed on the harmonization (unification) and the use of these reference values, see page 2.

Dorsten, 2003-05-08

Test Certificates without signature and seal are not valid. This Test Certificate may not be reproduced otherwise than completely except with written permission of the signing authority.

NMi

PTB

page 2 of 4

The presented results of the calibration are based on the harmonized Dutch-German reference values for the unit of volume for high-pressure gas-flow measurements.

In Dordrecht, on 1999-June-02, PTB (Physikalisch-Technische Bundesanstalt) and NMi VSL (Netherlands Measurements Institute Van Swinden Laboratorium) have agreed on the harmonization and the use of these reference values.

The Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig and Berlin is the national institute for science and technology and the highest technical authority of the Federal Republic of Germany for the field of metrology and certain sectors of safety engineering. PTB comes under the auspices of the Federal Ministry of Economics. It meets the requirements for calibration and testing laboratories, certification and accreditation bodies as defined in the EN 45000 series of standards and the relevant ISO/IEC guides.

It is the fundemental task of the PTB to realize and maintain the legal units in compliance with the international System of Units (SI) and to disseminate them, above all within the framework of legal and industrial metrology. The PTB thus is on top of the metrological hierarchy in Germany.

To ensure worldwide coherence of measures, the PTB co-operates with other national metrology institutes within EUROMET on the European level and on the international level within the framework of the Metre Convention. The aim is achieved by an intensive exchange of results of research work carried out and by comprehensive international comparison measurements.

Nederlands Meetinstituut (NMi, "Netherlands Measurements institute") is the institute of Metrology on the Netherlands.

NMi Van Swinden Laboratorium B. V. (NMi VSL) is part of NMi and is appointed by Dutch Law and Royal Decision as the National institute of measurement standards.

In Europe, within the organizational framework of EA (European organization for Accreditation), RvA (Raad voor Accreditatie, "Board of Accreditation") has stated that calibration certificates of NMi VSL are equivalent to certificates issued by laboratories certified by NKO (Nederlandse Kalibratie Organisatie, "Netherlands Calibration Organization"), part of the Board of Accreditation in The Netherlands.

NMi Certin B. V. (NMi Certin) is part of NMi and designated by the Dutch government as the legal metrology service organization to perform verification and certification tasks in the framework of the Dutch Weights and Measures Act.

NMi VSL performs (initial) verifications on behalf of NMi Certin in the field of high-pressure gas-flow measurements.

The calibration and verification services of NMi (VSL) provide a direct link to international accepted physical standards in order to achieve comparability and reliability of measurement data by proven traceability (in agreement with ISO 17025).

Test Certificates without signature and seal are not valid. This Test Certificate may not be reproduced otherwise than completely except with written permission of the signing authority.

Error Curve

Type of meter:	IGTM-CT	Customer:		DN:	150 mm	p(abs):	31,15 bar	HF 1
Meter no:	031017	Manufacturer:	vemm tec	Size:	G1000	Q max:	1600 m³/h	HF 2
Date:	08.05.2003	Gear 1:	26			Q min:	80 m³/h	HF-Head
Inspector:	Aldenhoff	Gear 2:	33			LF	0.1000 pulses / m³	-

pigsar ™
National Standard of Germany for volume of high-pressure natural gas

page 3 of 4

Certificate Number: 2162/2003
Order: 124305000
Date: 2003-05-08

Applicant **Name Customer Organization**

Meter under Test

Type	Turbine meter IGTM-CT
Manufacturer	vemm tec
Serial number	031017
Nominal Size	G1000
Year of manufacture	2003

Testing Conditions

p (absolute) =	31,15 bar	T =	14,7 °C
ρ (average) =	26,570 kg/m³	η =	11,8 x 10⁻⁶ Pa s

Testing medium Natural gas (analysis)

H_i =	0,00 Vol.%	CO_2 =	1,72 Vol.%
H_s =	10,486 kWh/m³	K-ratio =	0,9362
ρ_n =	0,8527 kg/m3 at normal reference conditions (273,15 K; 101,325 kPa)		

Results

Q / Q_{max}	Q (m³/h)	Reynoldsnumber	Deviation (%)	U_{tot} (%)
0,03	51,67	0,28 *10⁶	-0,37	0,17
0,05	81,73	0,44 *10⁶	-0,18	0,17
0,10	163,81	0,87 *10⁶	-0,20	0,17
0,20	319,04	1,70 *10⁶	-0,14	0,15
0,30	486,38	2,60 *10⁶	-0,12	0,15
0,41	648,79	3,46 *10⁶	-0,06	0,16
0,55	881,35	4,69 *10⁶	0,02	0,15
0,78	1255,86	6,64 *10⁶	0,11	0,15
0,87	1395,67	7,35 *10⁶	0,12	0,15
1,02	1634,00	8,57 *10⁶	0,15	0,15

The *deviation* is defined as: $\text{Deviation} = \frac{(\text{Indicated Volume} - \text{Reference Volume})}{(\text{Reference Volume})} \cdot 100\%$

where the reference volume refers to the conditions at the meter under test. The reported values of this deviation are the arithmetical meansof *n* single measurements at each flow-rate.

The reported *total uncertainty* is defined as: $U_{tot} = \sqrt{U^2_{harmonized} + (k \cdot u_{meter})^2}; (k = 2)$

where $U_{harmonized}$ is the expanded uncertainty of 0.15% of the harmonized reference volume, stated as the standard uncertainty of measurement multiplied by the coverage factor *k*=2, and u_{meter} is the standard uncertainty of the meter under test determined on the base of n single measurements of the meter under test at each flow-rate.

The *deviation according to OIML/R32, determined as a weighed mean average* amounts to 0,03 %.

Remarks Security marks are applied

Tested in Dorsten at *pigsar*, on 2003-05-08 Aldenhoff

Test Certificates without signature and seal are not valid. This Test Certificate may not be reproduced otherwise than completely except with written permission of the signing authority.

2 INSTALLATION

2.1 Safety instructions and warnings: See back page

2.2 Instructions specific to the EC Pressure Equipment Directive (PED)

This chapter identifies specific installation and operation instructions necessary to ensure compliance with the Essential Safety Requirements (ESR) of the European Economic Area Pressure Equipment Directive (PED) 97/23/EC.

This document applies to IGTM Gas Turbine Meters manufactured by ***vemm tec*** Messtechnik GmbH (Potsdam-Babelsberg, Germany).

vemm tec Messtechnik GmbH's IGTM Gas Turbine Meters are supplied as components to be installed in the end users piping system. It is therefore the responsibility of the end user to ensure compliance with the requirements of the directive and regulations quoted in this section. Guidance for compliance of the relevant Essential Safety Requirements of the Pressure Equipment Directive 97/23/EC is given below.

Table 1: Essential Safety Requirements (ESR) of the Pressure Equipment Directive (PED)
(Part 1, continued on next page)

PED ESR Ref.	Essential Safety Requirements (ESR)	Compliance Requirement
2.3	**Provisions to ensure safe handling and operation.** The method of operation specified for pressure equipment must be such as to preclude any reasonably foreseen risk in operation of the equipment. Particular attention must be paid, where appropriate to the following.	
	Closures & openings	During removal and replacement of any parts such as the index head, the lubrication system, high frequency sensors or thermo-wells the end user shall ensure that the meter has been properly isolated and the internal pressure has been safely vented.
	Devices to prevent physical access whilst pressure or a vacuum exists	The end user shall ensure that the IGTM's are installed in a properly designed system with access limitation in place if required.
	Surface temperature.	It is the responsibility of the end user to assess the expected surface temperature in service and, if necessary, take precautions to avoid personnel coming into contact with the equipment.
	Decomposition of unstable fluids	It is not envisaged that, for the designed service, the equipment shall come into contact with unstable fluids; however the end user should assess the risk and take any steps considered necessary.

Table 1: Essential Safety Requirements (ESR) of the Pressure Equipment Directive (PED) (Part 2)

2.4	**Means of examination** Pressure equipment must be designed and constructed so that all necessary examinations to ensure safety can be carried out.	For the examination of all pressure containing parts of the IGTM the meter needs to be removed from the line. It is the responsibility of the end user to ensure that the internal pressure has been safely vented before the meter is removed from the line. It is also the responsibility of the end user to use suitable material and that the employees performing the removal are well trained in assembling and disassembling high pressure gas lines. The end user should refer to this "Installation, Operation and Maintenance Manual" supplied with each meter. It is not considered that the process medium for which the equipment is designed will give rise to severe corrosion/erosion problems. It is the end user's responsibility to monitor any change in the process medium that may cause concern.
2.5	**Means of draining and venting** Harmful effects such as vacuum collapse, corrosion and uncontrolled chemical reactions must be avoided.	It is the responsibility of the end user to ensure that the equipment is installed in a well designed piping system to avoid such hazards.
2.6	**Corrosion or other chemical attack**	It is not considered that the process medium for which the equipment is designed will give rise to severe corrosion problems. It is the end user's responsibility to monitor any change in the process medium that may cause concern.
2.7	**Wear**	It is not considered that the use of the IGTM for fluid metering will give rise to any abnormal wear problems. It is the responsibility of the end user to install any necessary filtration upstream of the IGTM to maintain the condition of the process medium and to take care that no moisture or particles larger than 5 µm can enter the meter.
2.10	**Protection against exceeding the allowable limits of the pressure equipment**	The IGTM must be installed in a well designed piping system with adequate protection against excessive pressure.
2.12	**External fire**	The IGTM has no special accessories for fire damage limitation. It is the responsibility of the end user to provide adequate fire fighting facilities on site.
7.3	**Pressure limiting devices, particularly for pressure vessels**	The IGTM is not a pressure vessel and has no integral pressure limiting devices. It is the responsibility of the end user to ensure that the IGTM is installed in a well designed system so that momentary pressure surges are limited to fewer than 10 % of the IGTM's maximum operating pressure.

You will find an example PED Certificate in Figure 20.

2.3 Installation

Your IGTM is a high precision metering instrument that can only perform efficiently when the following installation guidelines are followed.

NOTE: Install the meter preferably indoors. If installed outdoors, the meter must be protected from direct sunlight and rain.

2.3.1 Lubrication system and lubrication before start up

Each standard IGTM is equipped with an oil system and lubrication pump. The oil pump is dimensioned according to the size of the meter, as mentioned in Table 2.

- The small oil pump is operated by a push button: Remove the hex-cap before operating.
- The larger pumps have an operating lever: One stroke is to move the lever forward and back to its original position.

As an option, your IGTM up to DN 250 (10") can be provided with permanently lubricated bearings. No oil pump is supplied with this kind of meters.

CAUTION: Before the initial start up the meter must be lubricated as described in this section.

To achieve a very long meter life, regular lubrication is required. Typically, for a clean, dry-gas application, lubrication is recommended every 3 months. For dirty gas, more frequent lubrication is required. Specification of the lubrication oil and quantities follow.

Table 2: Oil pumps

Meter size	Oil pump size	Volume / Stroke	Container
DN 50 (2") / DN 80 (3") / DN 100 (4")	Small	0.14 cm^3/Stroke	1 cm^3
DN 150 (6") / DN 200 (8") / DN 250 (10")	Medium	0.5 cm^3/Stroke	10 cm^3
DN 300 (12") / DN 400 (16")	Large	1.0 cm^3/Stroke	120 cm^3

The lubrication system is specially designed for high-pressure applications. The force to operate the pump is minimal. The lubrication system is exposed to the full gas pressure. To prevent gas leakage, the pump is equipped with an internal non-return valve. A second non-return valve is installed in the lubrication line that goes into the meter body.

The lubrication system is designed to allow lubrication even under hostile environment conditions. An internal anti-freeze feature counteracts the small amounts of moisture that may be present either in the oil or the reservoir. The turbine is shipped with a small amount of oil in each bearing. This amount is only sufficient for initial operation at the factory and calibration.

Lubrication before start-up

It is recommended to use Shell Morlina 10 (Tellus 10), Anderol 401D, LO2 or equivalent, or Aero Shell Fluid 12 complying with MIL-L-6085 A. ***vemm tec*** supplies an amount of bearing lubrication oil with each IGTM. This initial quantity is sufficient to cover two years of operation for normal applications. For transporting and handling purposes, each turbine is supplied without any oil in the pump and lubrication system. Before start up operation you must proceed as follows.

Step 1: Fill the reservoir with oil. Close the cover of the reservoir after filling to avoid polluting the oil.

Step 2: Apply the initial amount of oil to the lubrication system with the number of strokes of the oil pump shown in the table below. One stroke is forward and back to the original position. The push button of the small oil pump can be accessed by removing the hex-cap of the pump.

Step 3: Check the oil level (during initial lubrication it will be necessary to re-fill the reservoir). Close the cover of the reservoir after filling to avoid polluting the oil.

Table 3: Lubrication quantity at start up

Meter Size	Initial lubrication (before first use)
DN 50 (2“)	43 Strokes = 6 cm³
DN 80 (3“)	50 Strokes = 7 cm³
DN 100 (4“)	57 Strokes = 8 cm³
DN 150 (6“)	18 Strokes = 9 cm³
DN 200 (8“)	20 Strokes = 10 cm³
DN 250 (10“)	20 Strokes = 10 cm³
DN 300 (12“)	6 Strokes = 6 cm³
DN 400 (16”)	12 Strokes = 12 cm³

After the initial lubrication the bearings must be lubricated at regular intervals as described in Section 4.1. Lubrication not only reduces the friction of the bearings, it also flushes small particles that may have collected around the bearings over time.

2.3.2 Required upstream and downstream length

For best metering results the IGTM should be installed in a straight pipe section of equal nominal diameter to the meter. The meter axis should be concentric and identical to the piping axis. Gaskets immediately upstream and downstream of the meter should not protrude into the stream.

The IGTM requires a minimum upstream length of 2 meter diameters for custody transfer accuracy. (The IGTM meets the requirements of ISO 9951 and OIML R32.) For best results, however, we recommend a 5 diameters long straight inlet section.

Fittings like valves, filters, control valves, reducers, T-pieces, bends, and safety shut-off valves in the upstream section are recommended to be a minimum of 5 diameters from the meter inlet.

The straight downstream section should be at least 1 meter diameter long, preferably 3 diameters. The temperature transmitter should be installed in this section. (See Section 2.3.6 in this manual.)

For customer specific meter applications, other upstream and downstream lengths may be required.

2.3.3 Flow direction and orientation

The flow direction of the meter is indicated on the meter with an arrow. The index head is standard mounted for flow direction from left to right, unless specified differently at the time of your order.

CAUTION: Reverse flow will damage the meter.

The meter is equipped for horizontal installation as standard. However, meters up to DN 150 (6“) can also be operated vertically. In this case the oil pump must be equipped with an adapter for vertical operation. The flow direction needs to be indicated when ordering an IGTM. For options please consult your sales agent.

2.3.4 Volume conversion

vemm tec can provide you with flow conversion devices, ranging from a converter with only basic features to a sophisticated flow computer. The latter has features like curve correction, valve control, gas chromatograph readout, and other customer specified functions.
We offer such devices on your request. Please enquire for more details.

A flow conversion device connected with the IGTM will convert the volume measured at actual conditions to volume at base conditions with the following formula (nomenclature according to EN 12405).

Formula 1: Volume conversion

$$V_b = \frac{p}{p_b} \bullet \frac{T_b}{T} \bullet \frac{Z_b}{Z} \bullet V_m$$

V_b	=	Volume at base conditions	[m³] (converted volume)
V_m	=	Volume at measurement conditions	[m³] (unconverted volume)
		(pulses from the gas meter multiplied with the gas meter's K-factor)	
p	=	Absolute gas pressure at measurement conditions	[bar abs] (actual pressure)
p_b	=	Absolute pressure at base conditions	[1.01325 bar] (or other specified pressure)
T_b	=	Absolute temperature at base conditions	[273.15 K] (or other specified temperature)
T	=	Absolute gas temperature at measurement conditions	[K]
Z_b	=	Compressibility factor of the gas at base conditions	
Z	=	Compressibility factor of the gas at measurement conditions	

2.3.5 Connection pressure transmitter at Pm-point

A pressure tap is located on the meter housing to enable the measurement of the static pressure upstream of the turbine wheel. It must be shut before start up and during operation, either with a screw plug or with connection to a pressure transmitter.

The pressure measurement point is marked as p_r or p_m (pressure at metering conditions). The bore is 3 mm and perpendicular to the wall. It has a G 1/8 cylindrical female thread and a bolting for tubing with 6 mm diameter. Connection with 6 mm stainless steel tubing (standard) or larger is recommended. If the pressure tap is not needed, it must be sealed with a G 1/8 dummy plug.

NOTE: The tubing connection of 6 mm diameter is NOT identical with 1/4" diameter tubing (6.35 mm). Replace the inner ring or the connector if the tubing is non-metric.

The pressure reference point should be used for connecting the pressure transmitter of the flow converter or flow computer in order to convert the measured volume to base conditions, in some countries called standard or normal conditions. The $p_m(p_r)$-point is used during the determination of the meter calibration curve and this $p_m(p_r)$-point should be used for custody transfer applications. Using a different pressure point may cause small errors in the flow measurement and the conversion to base conditions.

2.3.6 Temperature measurement

The temperature transmitter is required when a flow converter or flow computer is used to convert the measured volume to base conditions, in some countries called standard or normal conditions. The temperature sensor should be installed in a thermo-well.

As an option, your IGTM can be equipped with an integrated thermo-well. Alternatively, the temperature measurement shall be located downstream of the meter. ***vemm tec*** recommends 1 to 3 meter diameters distance downstream from the meter, but not more than 600 mm. No pressure drop should occur between the temperature device and the meter. The temperature sensor is recommended to be within the center third of the pipe and be protected from heat transfer from the external environment.

A second thermo-well close to the other one may be added to allow in-line checking of the main temperature sensor.

Some specific models of the IGTM are equipped with thermo-wells integrated in the meter body. Do not replace these thermo-wells by other models and do not remove these thermo-wells when the meter is pressurized.

2.3.7 Density measurement

When a line density meter is used, the above mentioned requirements for pressure and temperature should be followed for the location of the density meter. Most density meters will be installed in a separate pocket, welded into the pipeline. The density meter will typically be installed in the downstream section of the IGTM (3 – 5 meter diameters), to measure the density at operating temperature conditions. The sample gas flowing through the density meter should be taken from the $p_m(p_r)$-point of the IGTM to ensure the density is measured at the correct line pressure.
Please refer to the recommendations of the density meter manufacturer for optimal results.

Base density can be measured at any point in the installation, as long as the gas sample flowing through the density meter is representative of the actual flowing gas.

2.3.8 Energy measurement

In order to calculate the energy content of the passed gas, the converted volume is to be multiplied by the heating value. The volume conversion is described in Section 2.3.4. The heating value of the gas can be determined in several ways. The mostly used methods are:

- On-line analysis with a process gas chromatograph
- On-line analysis with a calorimeter
- Laboratory analysis of a collected sample
- Calculation by pipeline simulation

2.3.9 Index head and pulse transmitters

The IGTM index head is available in three versions:

- The standard IGTM index head is rated IP 65 after EN 60529, that is dust-tight and hose-proof. The IP 65 index head also conforms to NEMA 4 and NEMA 4X.
- A tropical version index head with vented holes and bugscreen cannot meet IP 65.
- Very humid environment requires IP 67, that is dust-tight and high sea proof. In this case, the index head contains a silicagel drying unit.

All IGTM sockets with connectors for pulse transmitters are rated IP 67 and NEMA 6.

Every index head is equipped with high-quality bearings and polished gears for low-friction. To ensure that each revolution of the mechanical counter corresponds with a known volume, a final factory flow test is performed. As part of this test, the ratio of the gears is checked and if necessary adjusted. These gears are inside the index head and the head is lead-sealed to prevent unauthorized access.

The mechanical counter totalizes the actual volume passing through the meter. A large eight-digit (non-resettable) display shows the totalized volume.

For easy reading of the volume indicated at the display, the index head can be turned through 350° without violating the lead seal (refer to Figure 8 and Figure 9). To turn the index head loosen the two inner hex nuts, located left and right from the front (1 and 2) and the screw at the back (3) (all on the upper cover), and turn the upper cover carefully with two hands, without lifting it. Tighten the nuts after positioning.

CAUTION: Do not break the seals when turning the index head.

Your IGTM gas turbine meter is supplied with two or more pulse transmitters. The pulse signals can be connected to a flow computer or a flow converter. Two types of pulse transmitters are available: LF (low frequency) reed switches and HF (high frequency) proximity sensors. Both reed switches and /or proximity sensors can be fitted in the index head if specified as part of the order. If your meter is supplied with pulse transmitters at the meter body these transmitters are proximity sensors.

Figure 8: Mechanical counter reading at the index head display

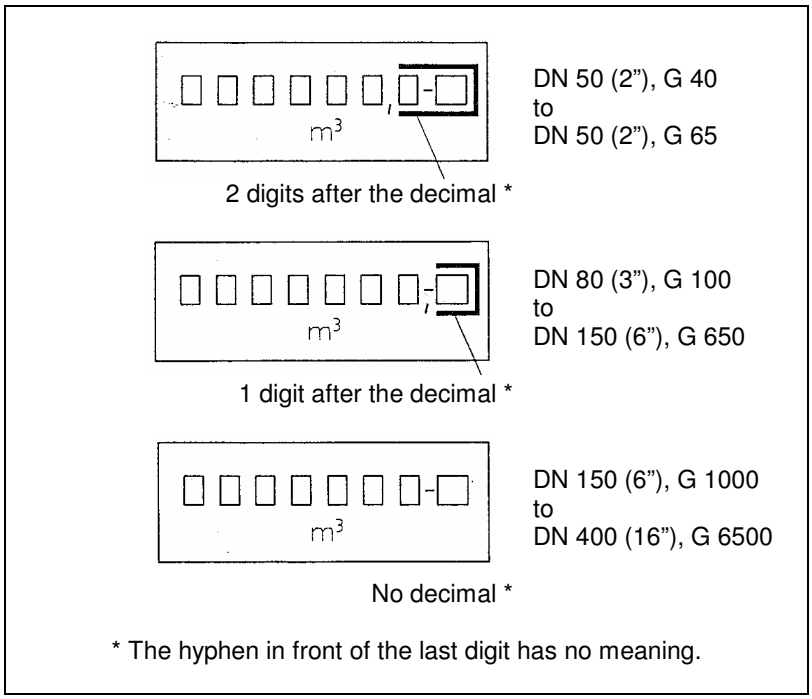


Figure 9: Orientation change of the index head

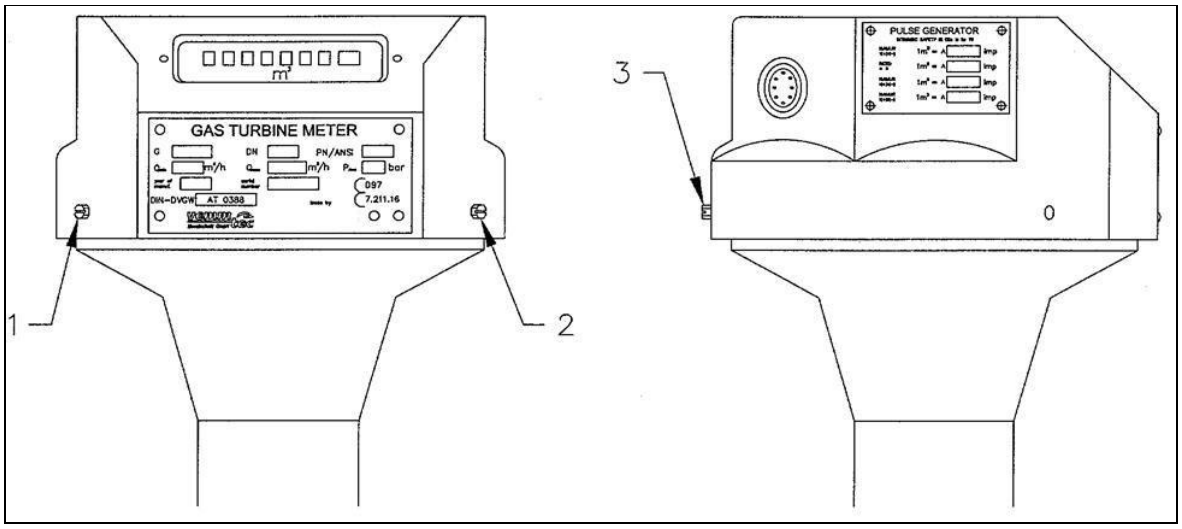


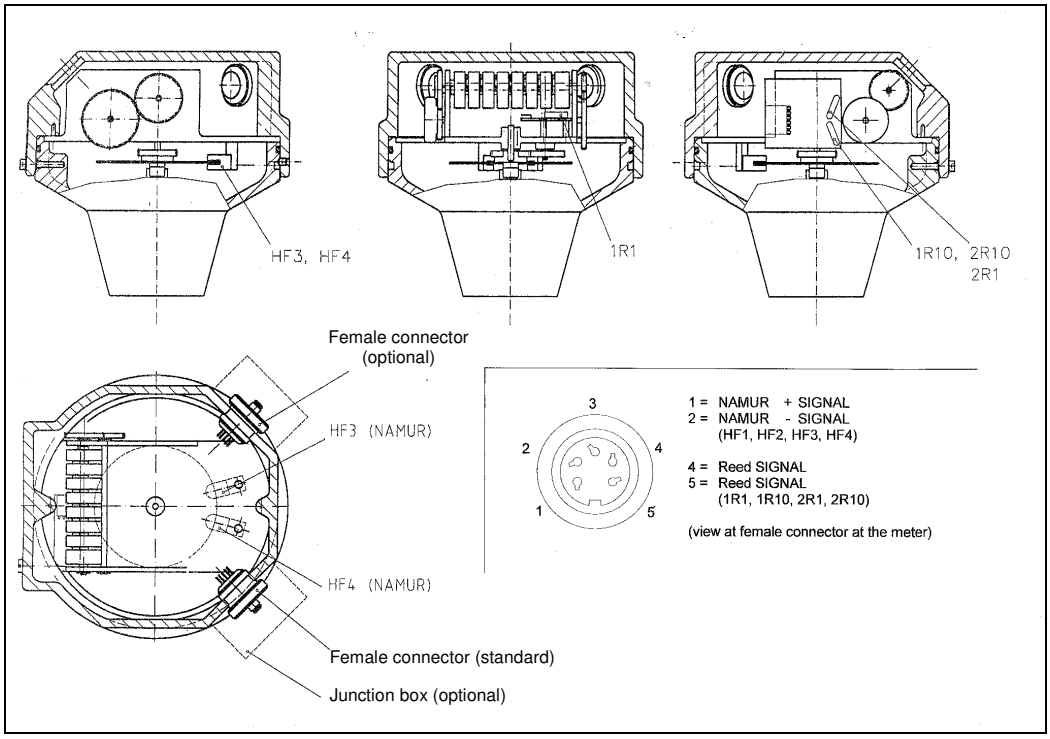
Table 4: Available pulse transmitters

Code	Description	Maximum frequency *	Remarks
1R1, 2R1	Reed switch	< 1 Hz	1R1 standard, 2R1 optional **
1R10, 2R10	Reed switch, frequency x 10	< 10 Hz	1R10 and/or 2R10 optional **
HF3, HF4	HF NAMUR sensor (at the index head)	< 200 Hz	HF3 standard, HF4 optional
HF1	HF NAMUR sensor (at the turbine wheel)	< 4.5 kHz	optional
HF2	HF NAMUR sensor (at the reference wheel)	< 4.5 kHz (equal to HF1)	optional (only IGTM-CT sizes DN 100 (4") and up)

* The maximum pulse frequency depends on meter size: Please refer to Table 14 for typical values.

** A maximum of two reed switches can be supplied per meter.

Figure 10: Drawing of index head internals with connector diagram



Sockets for the pulse transmitters in the index head are located at the back of the index head. A label is located alongside each of the socket(s), which indicates the type of pulse transmitter, the K-factor (number of pulses per cubic meter) and the connecting pins and their polarity. The details of the pulse transmitters in the meter body are also shown on the nameplate at the index head.

All sockets at the meter are female connectors. For each connector the corresponding male connector is supplied with your meter. The male connector is shipped unassembled, for your choice of cable and length to make the field connections.

You will find more information about the sensor types and electrical connection schematics in the following sections of this manual.

2.3.10 Specification of reed switches (R1 or R10 in the index head)

As standard the index head is equipped with one low frequency reed contact closure switch (1R1) which gives one pulse per revolution of the last digit roll of the counter. Depending on the meter size the volume per pulse can be 0.1, 1, or 10 m³ (see Table 14). Optionally, a second reed switch (2R1) can be provided.

Alternatively, the meter can be equipped with one or two reed switches that give 10 pulses per revolution of the last digit roll of the counter (1R10, 2R10).

A maximum of two low frequency switches can be mounted in the index head.

A reed switch generates a low frequency contact closure signal. This signal can be used to connect to a flow converter (often battery powered) which may be located beside the meter in the hazardous area. Reed switches require no power for the circuit to generate pulses.

A 100 Ohm resistor is connected in series with the reed switch. If the reed switches are connected to non-intrinsically safe devices, a barrier should be used.

Please refer to the connector diagram in Figure 10 and electrical connection schematics in Section 2.3.12.

2.3.11 Specifications of high frequency sensors (HF1 to HF4)

A proximity sensor generates a high frequency signal according to NAMUR EN 60947-5/6 standard (8.2 V, direct current switching between 1.2 and 2.1 mA). These sensors require external power and therefore can not be used with battery powered devices.

The sensors HF1, HF2, HF3, HF4 are electrically identical. You will find the connector diagram Figure 10 and electrical connection schematics in Section 2.3.12.

One high frequency proximity sensor (HF3) is provided as standard in the index head. This sensor provides a middle range frequency signal (< 200 Hz) based on a rotating impulse disk. The detection is based on standard proximity switches. The signal is intrinsically safe and complies with the NAMUR standard (EN 60947-5/6) for intrinsically safe signals. A second high frequency sensor (HF4) can optionally be installed in the index head. The HF4 sensor generates pulses with equal frequency as the HF3 sensor.

In addition, your gas turbine meter may be equipped with one or two high frequency sensors located in the body of the turbine meter (HF1, HF2). The HF1 sensor directly generates a pulse for each passing blade of the turbine wheel, the HF2 sensor works with a reference wheel. These high frequency sensors are mainly used for high accuracy applications.

The following checks can be done with the HF pulses.

- For a check on signal integrity both HF1/HF2 combined, or HF3/HF4 combined, can be connected to your flow computer. The number of HF3 and HF4 pulses must be identical. In the standard application the HF2 generates the same number of pulses as the HF1.
- For checking that no turbine wheel blade is missing, the combination of HF1 and HF2 must be used. The number of pulses is identical in the standard application.
- Optionally, your meter can be specially equipped for HF1 and HF2 pulses with 90° phase shift. This allows recognition of the gas flow direction, and thus detection of reverse flow.

The pulse frequency at maximum flow of HF sensors depends on the meter size. Typical values are shown in Table 14. The K-factor [Imp/m³] for your gas turbine meter is determined during calibration and is shown on a label on the index head and on the calibration certificate. This K-factor is specific for each meter and corresponds with specific gears in the index head. The factor determined by the calibration is the one that should be used in your calculations and flow correcting devices.

2.3.12 Electrical connection schematics for pulse transmitters

The pulse transmitters used are indicated at the labels beside the connectors. Please refer to Table 4 with the available pulse transmitters and to the connector diagram in Figure 10. Examples of connections are given in the following drawings.

CAUTION: For use with hazardous gas in potentially hazardous area never hook up the meter to non-intrinsically-safe circuits.

The interface/barrier between hazardous and safe area operations must be suitable and can be purchased from ***vemm tec***. Please refer to the recommended safety barriers in Table 13 for connecting the HF sensors to non-intrinsically safe equipment.

An analogue signal (4 – 20 mA) can be generated by using an IS frequency-current-(F/I)-converter connected to the sensor. Please refer to Table 13.

Figure 11: IGTM scheme with location of pulse transmitters

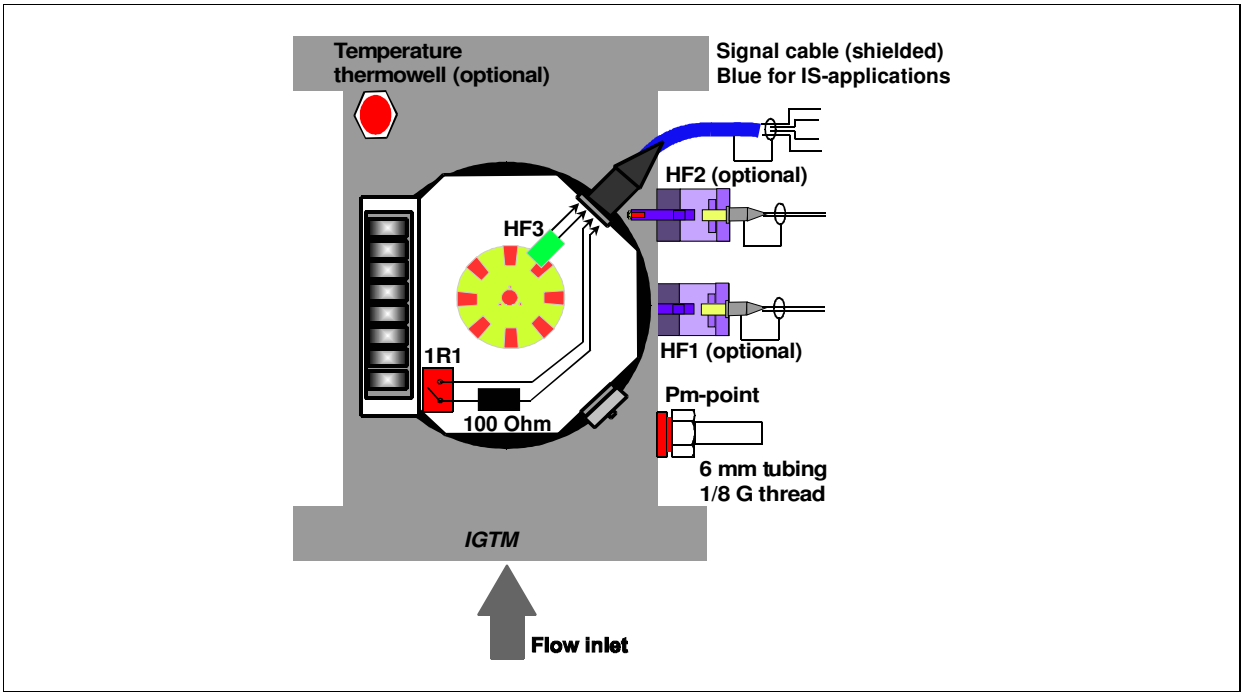


Figure 12: Connection diagram for low frequency reed switch

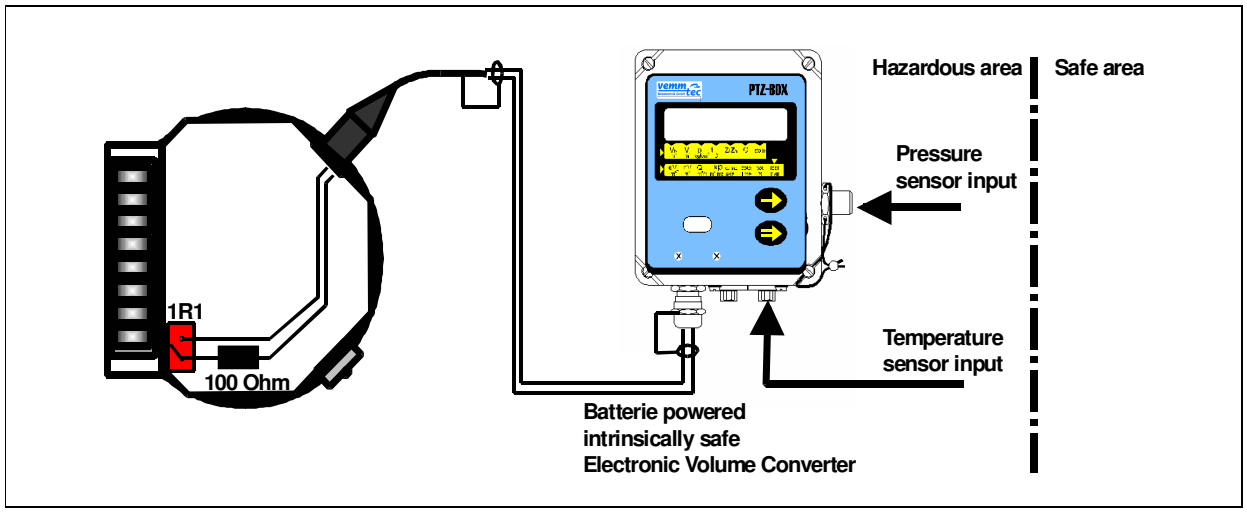
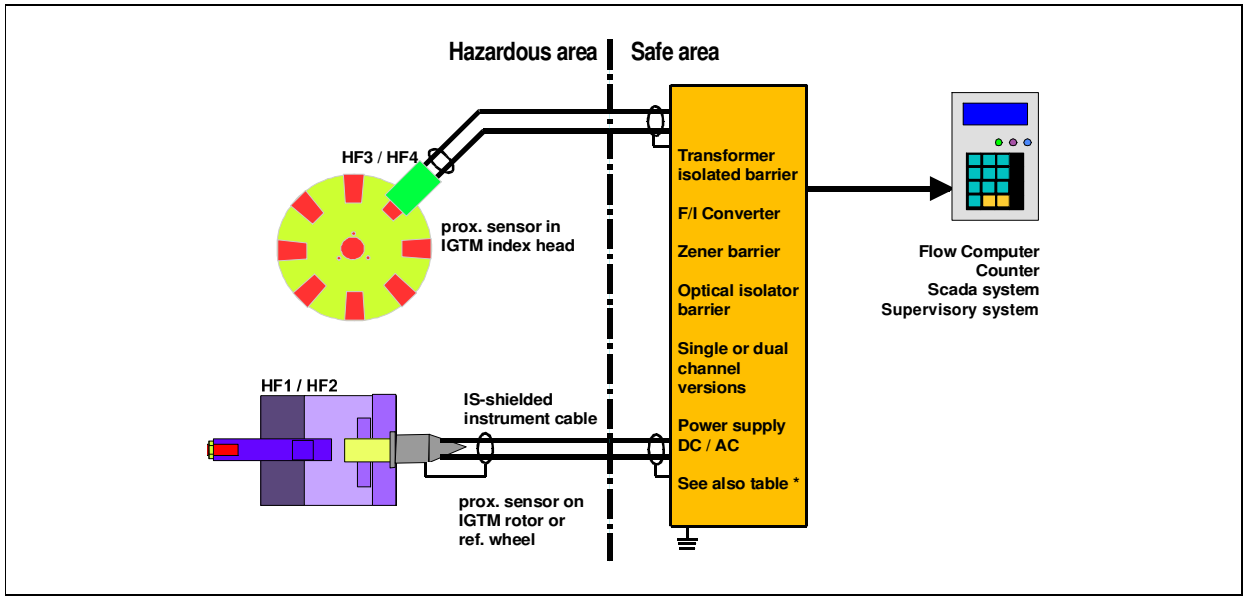


Figure 13: Connection diagram for high frequency sensors
(* See also Table 13)



2.3.13 Required settings for flow computers and flow converters

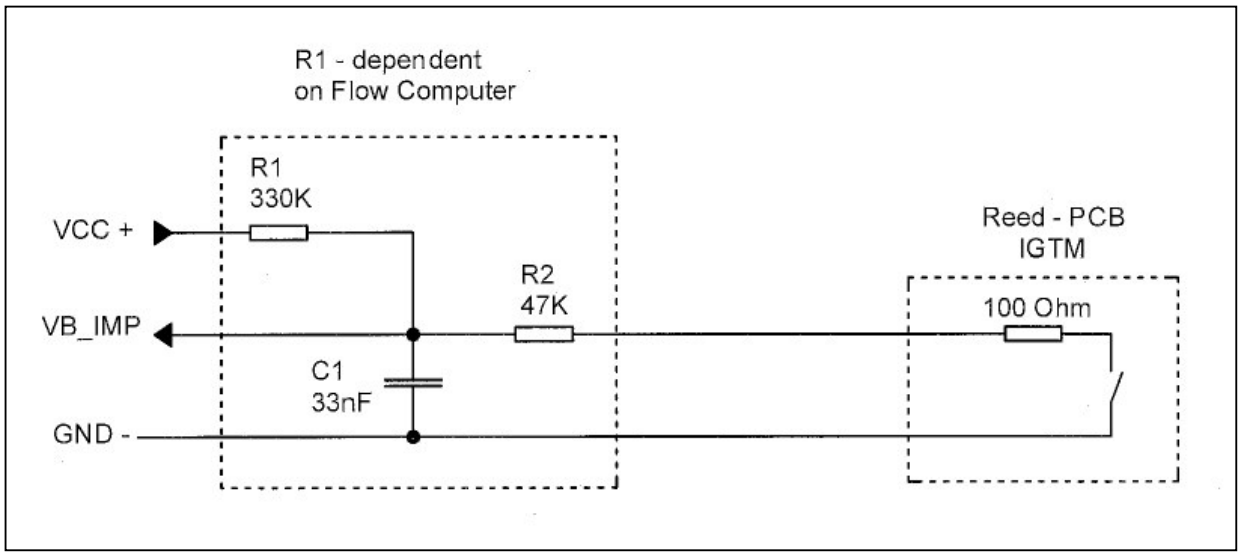
The K-factor setting for your flow computer/flow converter is shown on the label beside the appropriate connector. These impulse values are the same as the values shown on the calibration certificate/initial verification sheet. The values given on the label are the results of calibration and these values should be used in any volume converting device connected to the turbine meter.

WARNING: Some devices use the K-factor [Imp/m³]. Other devices use the reciprocal value [m³/Imp]. Please check carefully which value should be used in your device.

In case your computer provides curve correction, K-factors should be set for several flow rates. Please refer to the manual of your flow computer for applying these factors.

For reed switches, the pulse length is factory set to switch high between the digit 6 and 9 on the last digit roll of the counter. Your flow convertor should be equipped with a debouncing feature or have a low pass filter so that it is not affected by a slightly bouncing signal. A simple debouncing filter circuit is shown in Figure 14.

Figure 14: Debouncing filter circuit diagram



3 OPERATION

3.1 Accuracy

Standard accuracy limits for all IGTM models are in accordance with the EC directives and many other countries regulations:

± 1 % for 0.2 Q_{max} to Q_{max}
± 2 % for Q_{min} to 0.2 Q_{max}

As an option for the CT model the accuracy limits can be improved:

± 0.5 % for 0.2 Q_{max} to Q_{max}
± 1.0 % for Q_{min} to 0.2 Q_{max}

If specified in your order, other accuracy limits or a special linearity will be applicable.

The repeatability of the IGTM is ± 0.1 %.

These limits are valid for the meter performance in ambient air. For high pressure applications, the linearity is generally better and the turn down ratio improves.

3.2 Operating flow range

The flow range of the IGTM, as defined per the EC approvals, is 1:20 (Q_{min} to Q_{max}). This range is the standard performance under ambient air conditions.

With small meter sizes DN 50 (2") and DN 80 (3"), with special designs, or with low relative density gases (relative density < 0.6), the range may be restricted to 1:10 or 1:5. Meters with improved ranges (up to 1:50) are available in certain sizes. These meters are specially prepared and equipped with special low friction bearings. Please refer to Table 15.

The turbine meter still operates properly far below Q_{min}, however the accuracy at these low flow rates decreases.

3.2.1 Flow range at elevated pressure

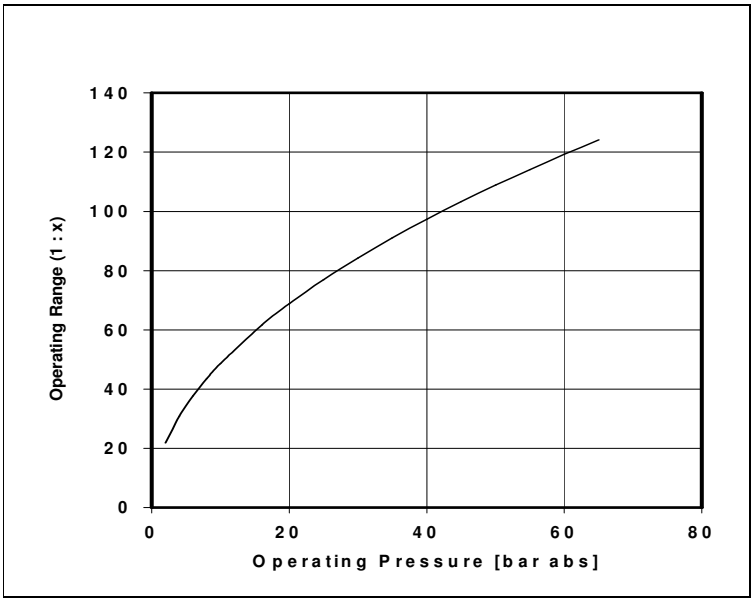
At higher operating pressure, the density of the gas increases. With increasing density the available driving force increases. The increased momentum reduces the relative influence of the bearing friction. The additional momentum increases the rotor drive, which in turn decreases the minimum flow rate at which the meter will remain within legal error limits at low flow rates. Effectively, the range of the IGTM increases; Q_{max} remains the same, Q_{min} reduces. The new Q_{min} ($Q_{min,m}$) can be determined with the following formula (see also Figure 15).

Formula 2: Flow range at elevated pressure

$$Q_{\min,m} = Q_{\min} \sqrt{\frac{\rho_{air,b} \cdot p_b}{\rho_b \cdot p_m}}$$

$Q_{min,m}$	=	Minimum flow rate at actual pressure	[m³/h]
Q_{min}	=	Minimum flow rate as specified	[m³/h] (see Table 14)
$\rho_{air,b}$	=	Density of air at base conditions	[1.293 kg/m³]
ρ_b	=	Gas density at base conditions	[kg/m³] (see Table 11)
p_b	=	Absolute pressure at base conditions	[1.013 bar abs]
p_m	=	Absolute gas pressure at measurement conditions	[bar abs] (actual pressure)

Figure 15: Turn down ratio at elevated pressure



3.2.2 Overload

The IGTM is designed to compensate for a limited time of operation with a flow rate overload of maximum 20 % above Q_{max}. The overload must occur gradually and without pulsations.

3.3 Temperature range

The standard temperature range is between -10 °C and +60 °C gas temperature and ambient temperature. For customer specific applications, other temperature ranges may apply.

3.4 Maximum pressure

Flange rating and maximum operating pressure of your meter are indicated on the main label at the meter and in the calibration certificate. IGTM gas turbine meters are available for the following maximum pressures.

Table 5: Flange rating and maximum operating pressure

Flange rating	Maximum operating pressure [bar abs]
ANSI 150#	20
ANSI 300#	52
ANSI 600#	104
PN 10	10
PN 16	16
PN 25	25
PN 40	40
PN 64	64
PN 100	100

3.5 Pressure loss under operating conditions

The pressure loss at actual pressure and actual flow can roughly be calculated using the values from Table 16 and the following formula. This formula assumes a purely quadratic behavior which is not exactly the case due to fluid dynamic effects.

Formula 3: Pressure loss under operating conditions

$$\Delta p \approx \Delta p_r \bullet \frac{\rho}{\rho_r} \bullet \left(\frac{Q}{Q_{\max}} \right)^2$$

Δp	=	Pressure loss at measurement conditions	[mbar]	(with the measured gas)
Δp_r	=	Pressure loss at reference conditions	[mbar]	(see Table 16 at 100 % flow)
ρ	=	Density at measurement conditions	[kg/m³]	(actual density of the measured gas)
ρ_r	=	Density at reference conditions	[0.8 kg/m³]	(with natural gas)
Q	=	Actual flow rate of the measured gas	[m³/h]	
Q_{max}	=	Maximum flow rate of the gas meter	[m³/h]	(see Table 16)

3.6 Material of construction

The standard materials of construction are listed below. Some gas types require special materials, please check the material compatibility or enquire at ***vemm tec*** (see Table 11).

Table 6: Standard material specification

Part description	**Material description**
Housing	Ductile Iron (EN-GJS-400-18-LT) or Carbon Steel (cast or welded) or Stainless Steel (on request)
Straightening Vane	Aluminium
Turbine Wheel	Aluminium
Metering Insert	Aluminium
Bearing block	Aluminium
Bearings	Stainless steel
Shafts	Stainless steel
Gears	Stainless steel or synthetic material
Magnetic Coupling	Stainless steel
Index Head	Aluminium
Counter	Synthetic material
Counter Plate	Aluminium

3.7 Gas composition and flow conditions

The standard IGTM can be used for all non-aggressive gases, like natural gas, methane, propane, butane, city and fabricated gas, air, nitrogen, etc.

Special designs are available for aggressive gases like sour gas, biogas and oxygen. Never use a standard meter for these applications without a ***vemm tec*** confirmation. In Table 11 you will find a listing of gases and their (special) material requirements for the IGTM.

The IGTM reaches its full potential when the turbine rotor is subjected to uniform and undisturbed gas velocity within the meter housing. The integrated flow conditioner is designed to comply with EN 12261, ISO 9951, and OILM R32 perturbation test conditions and creates stable flow conditions for the turbine rotor. In practice, the performance of the IGTM will also slightly depend on the installation. The IGTM is substantially less sensitive for effect from flow disturbances than other devices. In poorly designed gas-metering installations, some conditions can lead to increased error of the meter.

Pulsating gas flow and intermittent flows should be avoided. Large and fast pressure fluctuations should also be avoided. When filling a piping section, always let the pressure and flow increase slowly to avoid overloading. Open valves very carefully and slowly. Preferably install bypass lines over ball valves to fill the line before opening the valve. Pulsating or intermittent flow leads to under or over registration due to rotor inertia. Both effects do not fully compensate, so typically a positive measurement error remains.

Heavy vibrations must be avoided.

The gas flow must be free from contaminants, water, condensates, dust and particles. These can damage the delicate bearings and the rotor. When dust collects over time, it has an adverse effect on the metering accuracy. Dirty gases should be filtered with a 5 micron particle filter.

Lubricate your IGTM before start up and at regular intervals during operation (see Sections 2.3.1 and 4.1).

Turbine meters are occasionally over-dimensioned or oversized. This may be due to higher future flow rates or seasonal fluctuations. When a gas turbine meter operates below its stated minimum flow rate, this typically results in a negative error. Under high pressure conditions this effect is partially compensated (Section 3.2.1).

4 MAINTENANCE

4.1 Regular lubrication

On request, IGTM up to DN 250 (10") are available with permanently lubricated bearings that need no lubrication.

Each standard IGTM is equipped with an oil pump. For details about the lubrication system, please refer to Section 2.3.1. The meter must be regularly lubricated with the oil quantities detailed in Table 7. For lubrication, the cap on the oil pump should be unscrewed and the reservoir can be carefully filled with oil. The reservoir may need refilling during the lubrication session. Always close the cap of the reservoir to avoid contaminating the oil with dirt and moisture.

In standard applications (clean and dry gas, nominal meter usage), the lubrication interval is every 3 months. When the gas is dirty or when the meter is operated at design extremes more frequent lubrication is recommended.

Table 7: Periodical lubrication quantities

Meter size	Periodical lubrication
DN 50 (2")	7 Strokes = 1 cm³
DN 80 (3")	7 Strokes = 1 cm³
DN 100 (4")	14 Strokes = 2 cm³
DN 150 (6")	6 Strokes = 3 cm³
DN 200 (8")	8 Strokes = 4 cm³
DN 250 (10")	10 Strokes = 5 cm³
DN 300 (12")	6 Strokes = 6 cm³
DN 400 (16")	6 Strokes = 6 cm³

WARNING: Over-lubrication (interval frequency and quantity) may cause dirt accumulation in the downstream path of the oil. Excessive lubrication may cause metering inaccuracy at very low flow rates.

4.2 Spare parts

No commissioning spare parts are required. Under normal operating conditions no operational spare parts are required. Under extreme operating/environmental conditions or where meters are situated in less accessible areas, spare part storage as mentioned in Table 12 can be considered. For special circumstances, dedicated spare parts lists may be applicable.

The following 2 years operation spare parts might come into consideration (part.-nos. depending on diameter and G-rate):

- Lubrication oil 50 ml
- Set of O-rings
- Connector for pulse sensors (male)
- Electronic revision set for index head

A repair of defective meters is preferrably performed by the manufacturer, a new calibration is needed afterwards. Spare parts and labour hours will be quoted after inspection. The following spare parts might apply for repair:

- Index head complete
- Spare turbine wheel or metering cartridge (internals) complete with turbine wheel
- Flow straightener
- HF1 and/or HF2 high frequency sensor
- Lubrication pump

For custody transfer purposes and for best performance after repair, gas turbine meters should be calibrated at an approved calibration facility. See Section 4.4 in this manual.

4.3 Spin test

For a fast, limited test of the meter condition, a spin test can be performed.

Please allow the meter to reach ambient temperature, and ensure a relatively draft-free environment to conduct the test. Do not lubricate the meter before performing a spin test.

With the meter out of the line, the meter rotor can be blown to rotate at close to maximum speed by applying compressed air (with an air gun) from the inlet side of the meter. The air will rotate the rotor. Exposure time minimum is 10 – 15 seconds.

At a time t = 0 the flow of air should be stopped. At the same time, a stopwatch is activated. The rotor should be left to spin freely until it comes to a complete stop: No more forward rotation. The time in seconds required for the rotor to come to a complete standstill is called the spin-down time.

A significant decrease of spin-down time indicates either a bearing problem or significant build up of dirt or sludge in the bearings. The spin-down time gives a rough indication of the meter bearing condition. If the time has dropped more than 50 % from the indicated values in the table below, bearing replacement is required. The spin test gives an indication of the meter performance and accuracy at the low flow rates. A reduced spin down does not necessarily indicate a loss of accuracy. It indicates a loss of range and accuracy at low flow rates.

Table 8: Nominal spin-down times (with mechanical index head and standard bearings)

Meter Size	Nominal spin-down time
DN 50 (2“)	50 seconds
DN 80 (3“)	120 seconds
DN 100 (4“)	240 seconds
DN 150 (6“)	> 360 seconds
DN 200 (8“)	> 360 seconds
DN 250 (10“)	> 360 seconds
DN 300 (12“)	> 360 seconds
DN 400 (16“)	> 360 seconds

4.4 Recalibration

Legal requirements for recalibration are different in each country. If no recalibration requirements apply, ***vemm tec*** suggests a recalibration period of 6 – 12 years. This period should be more frequent when operating in harsh conditions, such as dirty gas or pulsating flow. ***vemm tec*** can perform legal verifications or factory calibrations with ambient air. When the meter is checked or reconditioned, a new calibration should also be performed.

In addition, you can recalibrate the meter with high pressure gas.

Please refer to section “Initial verification and calibration”.

NOTE: If at any time the meter is recalibrated and the correction gears in the index head are changed, the K-factor for the HF sensors must also be adjusted.

Example

Under German law, a standard IGTM with oil pump may be used for a 12-year period without recalibration. A permanently lubricated IGTM without oil pump may be used for 8 years without recalibration. However, depending on the size of the turbine meter or the gas flow through the station; the German gas industry practice is to install two or more meters in parallel which can be periodically checked against each other due to a special configuration in the piping. This configuration is installed in stations with a flow rate above 5,000 m^3/h at base conditions. Some companies, as standard operating procedure, install permanent check meters in series with a gas turbine meter for stations supplying a flow rate above 10,000 m^3/h at base conditions.

5 WARRANTY

IGTM Gas Turbine Meters supplied by ***vemm tec*** are guaranteed against defects due to faulty material or workmanship for a period of 12 months from the date of placing into operation, but not more than 18 months from the date of dispatch for Goods, according to the "General Terms and Conditions" of ***vemm tec*** Messtechnik GmbH, unless otherwise agreed in writing.

Replacement parts provided under the terms of this warranty are warranted for the remainder of the warranty period applicable to the Goods, as if such parts were original components of the Goods.
This warranty does not extend

(i) to damages caused by unsuitable or improper use, faulty installation or operation by the Customer or third parties, natural wear and tear, faulty or negligient treatment or maintenance, the use of unsuitable operating or substitutional materials, deficient assembly and damages caused by chemical, electronic or electric influence,
(ii) to equipment, materials, parts and accessories manufactured by others,
(iii) to correctness of any externally performed calibrations, either at ambient conditions or at elevated pressure.

Improper use also includes breaking the seals of the meter and non-compliance to this "Installation, Operation and Maintenance Manual".

vemm tec accepts no liability for Goods being fit for the purpose required by the Customer unless it shall have been given full and accurate particulars of the Customer's requirements and of the conditions under which the Goods are required to be used.

Upon written notification received by ***vemm tec*** within the above-stated warranty period of any failure to conform to the above warranty, upon return prepaid to the address specified by ***vemm tec*** of any non-conforming original part or component, and upon inspection by ***vemm tec*** to verify said non-conformity, ***vemm tec*** at its sole option either shall repair or replace said original part or component without charge to the Customer, or shall refund to the Customer the price thereof. Externally performed calibrations are not covered by warranty. However, if ***vemm tec***'s inspection fails to verify the claimed non-conformity the Customer will be liable for any costs incurred by vemm tec in investigating the claimed non-conformity. The remedies set forth herein are exclusive without regard to whether any defect was discoverable or latent at the time of delivery of the Goods to the Customer.

Goods, once delivered, may be returned to ***vemm tec*** only with prior written authority from ***vemm tec*** unless those Goods are accepted by ***vemm tec*** as being defective as to material or workmanship. In the event of a return being authorized by ***vemm tec***, ***vemm tec*** shall have the right to charge carriage to and from the delivery location and the costs involved in the removal of the Goods from the Customer's premises.

All further claims of the Customer against ***vemm tec*** as well as our subcontractors are – in accordance with the law – excluded, including compensation for consequential damages and damages based on repairs and replacements, except in the case of conscious negligience or compulsory liability for the lack of guaranteed qualities.

Claims for warranty and service need to be addressed to the ***vemm tec*** office or to the ***vemm tec*** agent where the meters originally are ordered.

6 APPENDIX WITH TABLES AND FIGURES

Table 9: Technical standards, rules and guidelines

International and German standards	
ISO 9951	Measurement of gas flow in closed conduits – Turbine meters
AGA 7	Measurement of gas by turbine meters
EN 12261	Gas meters – Turbine gas meters
EN 50014 to 20	Electrical apparatus for potentially explosive atmospheres
DIN 30690-1	Construction elements in the gas supply system – part 1: Requirements for construction elements in gas supply systems
DIN 33800	Gas Turbine Meters
EO-AV, Appendix 7, Part 1	Eichordnung (German regulations for custody transfer): Volume gas meters
EC (European Community) guidelines	
71/318/EEC 26.07.1971	EEC-Guideline: Volume Gas meters
74/331/EEC 16.06.1974	1. Amendment
78/365/EEC 31.03.1978	2. Amendment
82/623/EEC 01.07.1982	3. Amendment
PTB (Germany) guidelines	
PTB-A 7.1	Volume gas meters
PTB-Prüfregeln Band 29	Gas meters: Testing of volume gas meters with air at atmospheric pressure
PTB-Prüfregeln Band 30	Measurement devices for gas: High pressure test of gas meters
TR G 13	Installation and operation of gas turbine meters
DVGW (Germany) regulations	
G 260/I	Gas quality
G 260/II	Supplementary rules for gases of the second gas family
G 261	Measuring gas quality
G 285	Hydrate inhibition in natural gas with methanol
G 469	Pressure testing for piping and systems in gas supply
G 486	Gas law deviation factors and natural gas compressibility factors – calculation and application
G 491	Gas pressure regulating stations with inlet pressures exceeding 4 bar up to 100 bar – design, construction, montage, testing and start up
G 492/II	Systems for large quantities gas measurement with an operating pressure above 4 bar up to 100 bar
G 493	Procedure for granting DVGW certification for manufacturers of pressure control and gas measurement equipment
G 495	Gas pressure control systems and systems for large-quantity gas measurement, monitoring and servicing
OIML	
IR 6	General provisions for gas volume meters
IR 32	Rotary piston gas meters and turbine gas meters

Many national standards and laws are based on the above.

Table 10: List of approvals

ISO 9000

vemm tec Messtechnik GmbH is certified according to ISO 9001, see Figure 16.

Metrological approvals

IGTM Gas Turbine Meters are legally approved for custody transfer within the European Economic Community with the EC type-approval, issued by Physikalisch-Technische Bundesanstalt (PTB):
PTB 1.33-3271.51-DMB-E16 with sign E-D97 7.211.16 (see Figure 17)

In addition, approvals in several countries have been granted and are in process as a continuing effort. Approvals are currently available (August 2002) for the following countries:
Algeria (ONML)
Bulgaria (NCM)
China (NIM)
Czech Republic (CMI)
Germany (PTB)
Hungary (NOM)
Malaysia (SIRIM)
Romania (BRML)
Others are in progress.

Figure 16: ***vemm tec*** ISO 9001 Certificate

DNV

CERTIFICATE

DNV ZERTIFIZIERUNG UND UMWELTGUTACHTER GMBH

certifies that the company

vemm tec Messtechnik GmbH

vemm tec Messtechnik GmbH
Gartenstr. 20
D- 14482 Potsdam

has established a

quality management system
in conformity with

EN ISO 9001 : 2000

This Certificate is valid for:

Design, engineering, Manufacturing, Calibration, Sales, Installation, Repair of Equipment, Components and Systems for Gas- and Fluid Measurement Technology
Sales, Distribution and Trade of Equipment and Systems

Further clarifications regarding the scope of this certificate and the applicability of ISO 9001 : 2000 requirements may be obtained by consulting the certified company.

This Certificate is valid until:
2007-02-28

Certificate-Registration-No.:
14104-2004-AQ-ESN-TGA

Essen, 2004-03-16
N. Kim
Manager

Deutscher Akkreditierungs Rat
DAR
TGA-ZM-004/92-00

Essen, 2004-03-16
H.-J. Kinter
Lead-Auditor

This Certificate is only valid in connection with the original Certificate 14104-2004-AQ-ESN-TGA.
Stand 08/01 E DNV 14020/1.1

Design and compliance certification

CE	EC-Conformity declaration, Notified Body TÜV 0035 (see Figure 20)
PED 97/23/EC	Certificate of Notified Body TÜV 0035
DIN-DVGW	German Registration Number: NG-4702AT0388 (see Figure 19)

The Reed switch sensors are considered to be simple apparatus and as such do not require ATEX approval. The pulse generators applied in HF1 to HF4 are approved according to ATEX for the use in hazardous areas subject to explosive gases. In all cases the sensors should be connected to an intrinsically safe circuit after NAMUR (EN 60947-5/6). The following certificates for our sensors have been obtained (May 2004, subject to change without notice):

HF1/HF2:	PTB 00 ATEX 2048 X (see Figure 4)
HF3/HF4:	PTB 99 ATEX 2219 X (see Figure 5)

Figure 17: EC type-approval certificate (German original and English translation)

Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

EWG-Bauartzulassung vom 25.04.1997
EEC type-approval certificate, dated

2. Nachtrag
Supplement

D 97
7.211.16

Seite 1 von 2 Seiten
Page 1 of 2 pages

Zulassungsinhaber: *Issued to:* vemm tec Messtechnik GmbH
14482 Potsdam

Bauart: *In respect of:* Turbinenradgaszähler
Typ IGTM

Die oben genannte Bauartzulassung wird gemäß § 27 der Eichordnung mit allen Rechten und Pflichten auf den Zulassungsinhaber

vemm tec Messtechnik GmbH
14482 Potsdam

übertragen.

Die Bauartzulassung mit dem oben genannten Zulassungszeichen zugunsten des im Zulassungsschein bzw. im 1. Nachtrag dazu eingetragenen Inhabers

Daniel Europe Ltd.
2280 AE Rijswijk
Niederlande

erlischt mit dem Zeitpunkt der Zulassungsübertragung.

Auf Meßgeräten, die nach dem Zeitpunkt dieser Änderung mit dem oben genannten Zulassungszeichen versehen werden, sind nach § 42 Abs. 1 der Eichordnung vom 21. Juni 1994 (BGBl. I, S. 1293) geforderten Aufschriften entsprechend zu ändern.

Hinweise und Rechtsbehelfsbelehrung:
Nachträge ohne Unterschrift und Siegel haben keine Gültigkeit. Nachträge sind Bestandteil der Bauartzulassung und dürfen nur unverändert weiterverbreitet werden. Auszüge bedürfen der Genehmigung der Physikalisch-Technischen Bundesanstalt.
Gegen diesen Bescheid kann innerhalb eines Monats nach Bekanntgabe schriftlich oder zur Niederschrift Widerspruch bei der Physikalisch-Technischen Bundesanstalt unter einer der nachstehenden Adressen eingelegt werden.
Note and information on legal remedies available:
Supplements without signature and seal are not valid. Supplements are part of the type approval certificate and may not be reproduced other than in full. Extracts may be taken only with the permission of the Physikalisch-Technische Bundesanstalt. Objection may be made to this notification within one month of its receipt either in writing or orally recorded, to the Physikalisch-Technische Bundesanstalt at one of the following addresses.

Physikalisch-Technische Bundesanstalt
Bundesallee 100, D-38116 Braunschweig
Abbestraße 2-12, D-10587 Berlin
Fürstenwalder Damm 388, D-12587 Berlin

394.04.s

Physikalisch-Technische Bundesanstalt

2. Nachtrag
Supplement

zur EWG-Bauartzulassung
to the EEC type-approval certificate

D 97
7.211.16

Seite 2 von 2 Seiten
Page 2 of 2 pages

Auf Grund des § 26 der Eichordnung vom 21.06.1994 (BGBl I, S. 1293) wird die EWG-Bauartzulassung für die vorstehend gekennzeichnete Bauart hiermit wie folgt geändert.

4. Zulassungsunterlagen

4.1 Zeichnungen und Beschreibungen

Zusätzlich zu den in der Anlage zum Zulassungsschein und im 1. Nachtrag dazu aufgeführten Unterlagen gelten die folgenden Zulassungsunterlagen:

Zeichnungs-Nr.	letzter Stand	Gegenstand der Zeichnung
76850.0011	23.10.02	Hauptschild
76850.0012	06.03.01	Impulsgeberschild
76850.0026	23.10.02	Hauptschild englisch

Im Auftrag
By order
H. Krebs

Braunschweig, 14.11.2002

Geschäftszeichen: 1.33-3271.51-DMB-E16
1.33 - 02001578

Siegel
Seal

Translation of the original German version

Physikalisch-Technische Bundesanstalt

Braunschweig and Berlin

EEC type-approval certificate, dated 25.04.1997

2nd Supplement

D 97
7.211.16

Page 1 of 2 pages

Issued to: vemm tec Messtechnik GmbH
14482 Potsdam

In respect of: Gas Turbine Meters
Model: IGTM

According to § 27 of the "Eichordnung" the type approval as mentioned above is transferred with all rights and obligations to the owner of the approval:

vemm tec Messtechnik GmbH
14482 Potsdam.

The change of the transfer of the approval as mentioned in the 1st supplement under the above mentioned approval mark to the company:

Daniel Europe Ltd.
2280 AE Rijswijk
The Netherlands

is herewith cancelled.

According to § 42 Chapter 1 of the "Eichordnung" of 21 June 1994 (BGBl. I, S. 1293) all measurement devices that will be supplied after the date of this supplement under the above mentioned approval mark need to be provided with modified nameplates.

Note and information on legal remedies available:
Supplements without signature and seal are not valid. Supplements are parts of the type approval and may not be reproduced other than in full. Extracts may taken only with the permission of the Physikalisch-Technische Bundesanstalt. Objection may be made to this notification within one month of its receipt either in writing or orally recorded, to the Physikalish-Technische Bundesanstalt at one of the following addresses.

Physykalisch-Technische Bundesanstalt
Bundesallee 100, D-38116 Braunschweig
Abbestrasse 2-12, D-10587 Berlin
Fürstenwalder Damm 388, D-12587 Berlin

Translation of the original German version

Physikalisch-Technische Bundesanstalt

2nd Supplement
to EEC-Type Approval

D 97
7.211.16

Page 2 of 2 pages

According to § 26 of the Eichordnung" of 21 June 1994 (BGBl. I, S. 1293) the EEC Type Approval for the type as mentioned before is changed as follows.

4. Approval documentation

4.1 Drawings and descriptions

Additional to the documentation in the Type Approval Certificate and the 1st Supplement to it the following documents are applicable.

Drawing No.	Last issue	Description
76850.0011	23/10/2002	Main name plate
76850.0012	6/3/2001	Impulse name plate
76850.0026	23/10/2002	Main name plate (English)

By order

[Signature]

H. Krebs

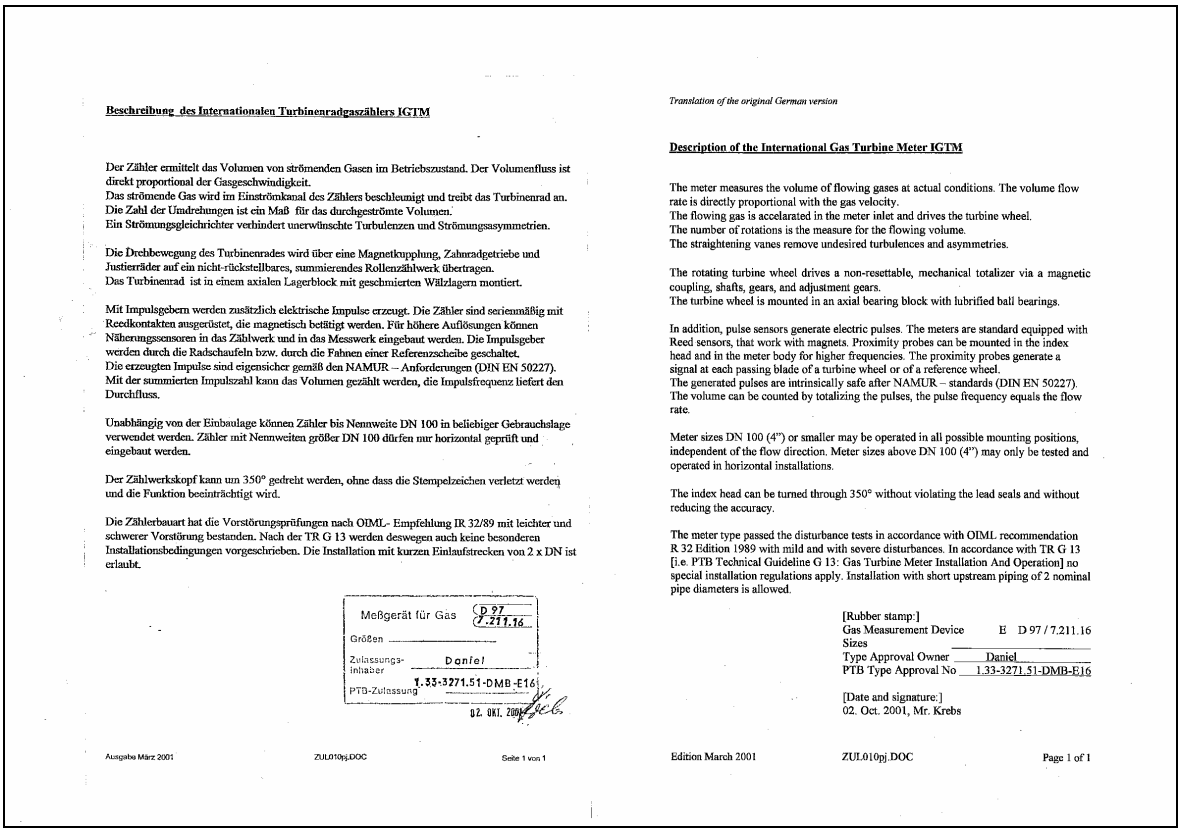
[PTB Stamp]

Braunschweig, 14/11/2002

Reference 1.33-3271.51-DMB-E16
1.33 - 02001578

Seal

Figure 18: PTB confirmation of OIML tests (German original and English translation)



Beschreibung des Internationalen Turbinenradgaszählers IGTM

Der Zähler ermittelt das Volumen von strömenden Gasen im Betriebszustand. Der Volumenfluss ist direkt proportional der Gasgeschwindigkeit.
Das strömende Gas wird im Einströmkanal des Zählers beschleunigt und treibt das Turbinenrad an.
Die Zahl der Umdrehungen ist ein Maß für das durchgeströmte Volumen.
Ein Strömungsgleichrichter verhindert unerwünschte Turbulenzen und Strömungsasymmetrien.

Die Drehbewegung des Turbinenrades wird über eine Magnetkupplung, Zahnradgetriebe und Justierräder auf ein nicht-rückstellbares, summierendes Rollenzählwerk übertragen.
Das Turbinenrad ist in einem axialen Lagerblock mit geschmierten Wälzlagern montiert.

Mit Impulsgebern werden zusätzlich elektrische Impulse erzeugt. Die Zähler sind serienmäßig mit Reedkontakten ausgerüstet, die magnetisch betätigt werden. Für höhere Auflösungen können Näherungssensoren in das Zählwerk und in das Messwerk eingebaut werden. Die Impulsgeber werden durch die Radschaufeln bzw. durch die Fahnen einer Referenzscheibe geschaltet.
Die erzeugten Impulse sind eigensicher gemäß den NAMUR – Anforderungen (DIN EN 50227).
Mit der summierten Impulszahl kann das Volumen gezählt werden, die Impulsfrequenz liefert den Durchfluss.

Unabhängig von der Einbaulage können Zähler bis Nennweite DN 100 in beliebiger Gebrauchslage verwendet werden. Zähler mit Nennweiten größer DN 100 dürfen nur horizontal geprüft und eingebaut werden.

Der Zählwerkskopf kann um 350° gedreht werden, ohne dass die Stempelzeichen verletzt werden und die Funktion beeinträchtigt wird.

Die Zählerbauart hat die Vorstörungsprüfungen nach OIML- Empfehlung IR 32/89 mit leichter und schwerer Vorstörung bestanden. Nach der TR G 13 werden deswegen auch keine besonderen Installationsbedingungen vorgeschrieben. Die Installation mit kurzen Einlaufstrecken von 2 x DN ist erlaubt.

Meßgerät für Gas D 97 / 7.211.16
Größen
Zulassungs-inhaber Daniel
PTB-Zulassung 1.33-3271.51-DMB-E16
02. Okt. 2001

Ausgabe März 2001 ZUL010pj.DOC Seite 1 von 1

Translation of the original German version

Description of the International Gas Turbine Meter IGTM

The meter measures the volume of flowing gases at actual conditions. The volume flow rate is directly proportional with the gas velocity.
The flowing gas is accelarated in the meter inlet and drives the turbine wheel.
The number of rotations is the measure for the flowing volume.
The straightening vanes remove undesired turbulences and asymmetries.

The rotating turbine wheel drives a non-resettable, mechanical totalizer via a magnetic coupling, shafts, gears, and adjustment gears.
The turbine wheel is mounted in an axial bearing block with lubrified ball bearings.

In addition, pulse sensors generate electric pulses. The meters are standard equipped with Reed sensors, that work with magnets. Proximity probes can be mounted in the index head and in the meter body for higher frequencies. The proximity probes generate a signal at each passing blade of a turbine wheel or of a reference wheel.
The generated pulses are intrinsically safe after NAMUR – standards (DIN EN 50227).
The volume can be counted by totalizing the pulses, the pulse frequency equals the flow rate.

Meter sizes DN 100 (4") or smaller may be operated in all possible mounting positions, independent of the flow direction. Meter sizes above DN 100 (4") may only be tested and operated in horizontal installations.

The index head can be turned through 350° without violating the lead seals and without reducing the accuracy.

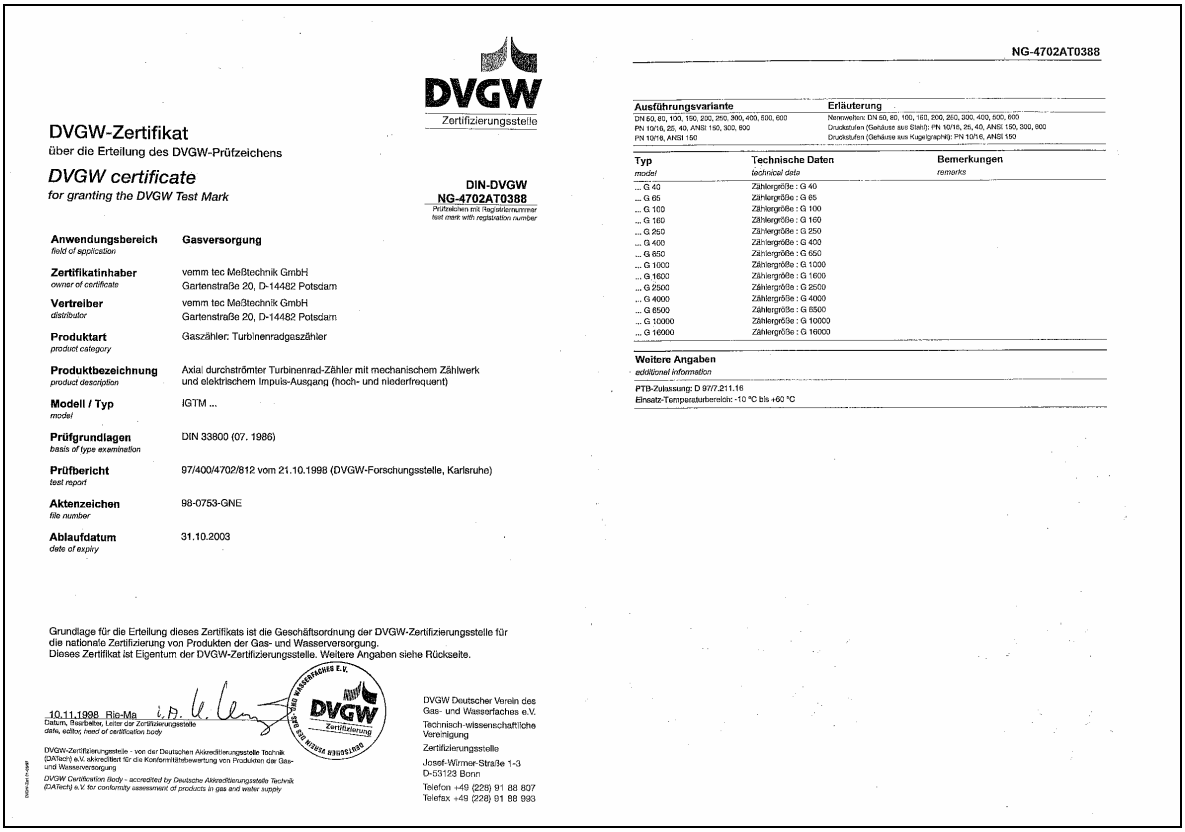
The meter type passed the disturbance tests in accordance with OIML recommendation R 32 Edition 1989 with mild and with severe disturbances. In accordance with TR G 13 [i.e. PTB Technical Guideline G 13: Gas Turbine Meter Installation And Operation] no special installation regulations apply. Installation with short upstream piping of 2 nominal pipe diameters is allowed.

[Rubber stamp:]
Gas Measurement Device E D 97 / 7.211.16
Sizes
Type Approval Owner Daniel
PTB Type Approval No 1.33-3271.51-DMB-E16

[Date and signature:]
02. Oct. 2001, Mr. Krebs

Edition March 2001 ZUL010pj.DOC Page 1 of 1

Figure 19: German DVGW approval



DVGW
Zertifizierungsstelle

DVGW-Zertifikat
über die Erteilung des DVGW-Prüfzeichens

DVGW certificate
for granting the DVGW Test Mark

DIN-DVGW
NG-4702AT0388
Prüfzeichen mit Registriernummer
Test mark with registration number

Anwendungsbereich *field of application*	**Gasversorgung**
Zertifikatinhaber *owner of certificate*	vemm tec Meßtechnik GmbH Gartenstraße 20, D-14482 Potsdam
Vertreiber *distributor*	vemm tec Meßtechnik GmbH Gartenstraße 20, D-14482 Potsdam
Produktart *product category*	Gaszähler: Turbinenradgaszähler
Produktbezeichnung *product description*	Axial durchströmter Turbinenrad-Zähler mit mechanischem Zählwerk und elektrischem Impuls-Ausgang (hoch- und niederfrequent)
Modell / Typ *model*	IGTM ...
Prüfgrundlagen *basis of type examination*	DIN 33800 (07. 1986)
Prüfbericht *test report*	97/400/4702/812 vom 21.10.1998 (DVGW-Forschungsstelle, Karlsruhe)
Aktenzeichen *file number*	98-0753-GNE
Ablaufdatum *date of expiry*	31.10.2003

Grundlage für die Erteilung dieses Zertifikats ist die Geschäftsordnung der DVGW-Zertifizierungsstelle für die nationale Zertifizierung von Produkten der Gas- und Wasserversorgung.
Dieses Zertifikat ist Eigentum der DVGW-Zertifizierungsstelle. Weitere Angaben siehe Rückseite.

10.11.1998 Ric-Ma i.A.
Datum, Aussteller, Leiter der Zertifizierungsstelle
date, editor, head of certification body

DVGW-Zertifizierungsstelle - von der Deutschen Akkreditierungsstelle Technik (DATech) e.V. akkreditiert für die Konformitätsbewertung von Produkten der Gas- und Wasserversorgung
DVGW Certification Body - accredited by Deutsche Akkreditierungsstelle Technik (DATech) e.V. for conformity assessment of products in gas and water supply

DVGW Deutscher Verein des Gas- und Wasserfaches e.V.
Technisch-wissenschaftliche Vereinigung
Zertifizierungsstelle
Josef-Wirmer-Straße 1-3
D-53123 Bonn
Telefon +49 (228) 91 88 807
Telefax +49 (228) 91 88 993

NG-4702AT0388

Ausführungsvariante	Erläuterung
DN 50, 80, 100, 150, 200, 250, 300, 400, 500, 600 PN 10/16, 25, 40, ANSI 150, 300, 600 PN 10/16, ANSI 150	Nennweiten: DN 50, 80, 100, 150, 200, 250, 300, 400, 500, 600 Druckstufen (Gehäuse aus Stahl): PN 10/16, 25, 40, ANSI 150, 300, 600 Druckstufen (Gehäuse aus Kugelgraphit): PN 10/16, ANSI 150

Typ *model*	Technische Daten *technical data*	Bemerkungen *remarks*
... G 40	Zählergröße : G 40	
... G 65	Zählergröße : G 65	
... G 100	Zählergröße : G 100	
... G 160	Zählergröße : G 160	
... G 250	Zählergröße : G 250	
... G 400	Zählergröße : G 400	
... G 650	Zählergröße : G 650	
... G 1000	Zählergröße : G 1000	
... G 1600	Zählergröße : G 1600	
... G 2500	Zählergröße : G 2500	
... G 4000	Zählergröße : G 4000	
... G 6500	Zählergröße : G 6500	
... G 10000	Zählergröße : G 10000	
... G 16000	Zählergröße : G 16000	

Weitere Angaben
additional information

PTB-Zulassung: D 97/7.211.16
Einsatz-Temperaturbereich: -10 °C bis +60 °C

Figure 20: EC-Conformity declaration (example)

COPY

vemm tec Messtechnik GmbH	**Konformitätserklärung** Im Sinne der Druckgeräte-Richtlinie 97/23/EG **EC-Conformity declaration** According to the Pressure equipment directive 97/23/EC	Ref.-Nr. 030760128 23.Juli 2003 Seite 1 von 1 (B1uF_DN300_Mitgas_80bar)

1. **Hiermit erklären wir, vemm tec Messtechnik GmbH, Gartenstr. 20, D - 14482 Potsdam, in eigener Verantwortung, dass die nachfolgend bezeichneten Erzeugnisse nach ihrer Konzipierung und Bauart in der von uns in Verkehr gebrachten Ausführung den einschlägigen grundlegenden Sicherheitsanforderungen der EG-Richtlinie entsprechen. Diese Erklärung verliert ihre Gültigkeit bei nicht mit uns abgestimmten Änderungen der Bauarten.**
We vemm tec Messtechnik GmbH, Gartenstr. 20, D - 14482 Potsdam herewith declare that the gas meters described below comply with the basic safety requirements of the EC directive concerning design, construction and putting the model into circulation. This declaration is no longer valid if the unit is modified without our agreement.

2. **Beschreibung der Erzeugnisse /** Description of the units

- **Referenznummer des Auftrags /** Reference- Nr.	**030760128**
- **Bezeichnung der Erzeugnisse /** Description of the unit	**Turbinenradzähler**/Turbine gas meter
- **Bauart /** Types of unit	**IGTM**
- **Nennweite DN /** Nominal size DN	**300**
- **Max. zulässiger Druck PS /** Max. allowable pressure PS (bar)	**80**
- **Klassifizierung /** Classification	**Rohrleitungsteil/** Pipe
- **Fluid Kategorie /** Fluid category	**Gruppe 1/** Group 1
- **Diagramm /** Chart	**6** / 6
- **Angewandte Kategorie /** Category being used	**Kategorie III /** Category III

3. **Die oben bezeichneten Erzeugnisse entsprechen der Richtlinie 97/23/EG vom 29.05.97 über Druckgeräte. Als Konformitätsbewertungsverfahren wurden entsprechend der Kategorie III die Module B1 und F angewendet.**
The above mentioned units fullfill the requirement of the directive 97/23/EC about pressure equipment. For the conformity assessment procedure the modules B1 and F according to category III have been used.

4. **Module B1 und F /** Modules B1 and F

Modul/ Module	**Konformitätsbewertungsverfahren/** Conformity assessment procedure	**Zertifikat/** Certificate
B 1	EG-Entwurfsprüfung / EC design-examination	**Nr. Wo 03 06 27**
F	Prüfung der Produkte / Product verification	**Nr. 01 202 832-F-03 0001 bis 01 202 832-F-03 0007**

5. **Name und Anschrift der benannten Stelle /** Name and address of the Notified body:
TÜV Anlagentechnik GmbH; Unternehmensgruppe TÜV Rheinland/Berlin-Brandenburg
Max-Eyth-Allee 2; 14469 Potsdam
6. **Identifikations-Nummer /** Identification number: 0035

7. **Aufgaben des Herstellers /** Manufacturer to ensure and to declare
- Antrag auf Entwurfsprüfung/ Application for EC design - examination
- Bereitstellung eines Baumusters/ Provide a representative example of production to the Notified body
- Information zu Baumusteränderungen/ Inform Notified Body of any modifications
- Erklärung der Konformität / Draw up written Declaration of conformity
- CE- Kennzeichnung/ must affix CE-Marking
- Aufbewahrung der technischen Dokumentation, Kopien der Baumusterprüfbescheinigung und der Konformitätserklärung für 10 Jahre/ Keep technical documentation, copies of EC type-examination certificate and of declaration of conformity for 10 years

8. **Aufgaben der Benannten Stelle /** Notified Body to ensure
- EG-Entwurfsprüfung/ EC design-examination
- Untersuchungen und Prüfungen durch Kontrolle und Erprobung jeden einzelnen Druckgeräts/ Must perform the appropriate examinations and tests by examination of each item of pressure equipment

9. **Angewandte Normen oder technische Spezifikationen/** Applied standards or technical rules:
DIN EN 10213-1, EN 1092-1, AD- Merkblätter

Karst van Dellen
Geschäftsführer/ Managing Director

vemm tec Messtechnik GmbH
Gartenstraße 20
D-14482 Potsdam-Babelsberg
D-14437, Postfach 900 126
☎ 0331 / 70 96-0
Fax: 70 96-201/270

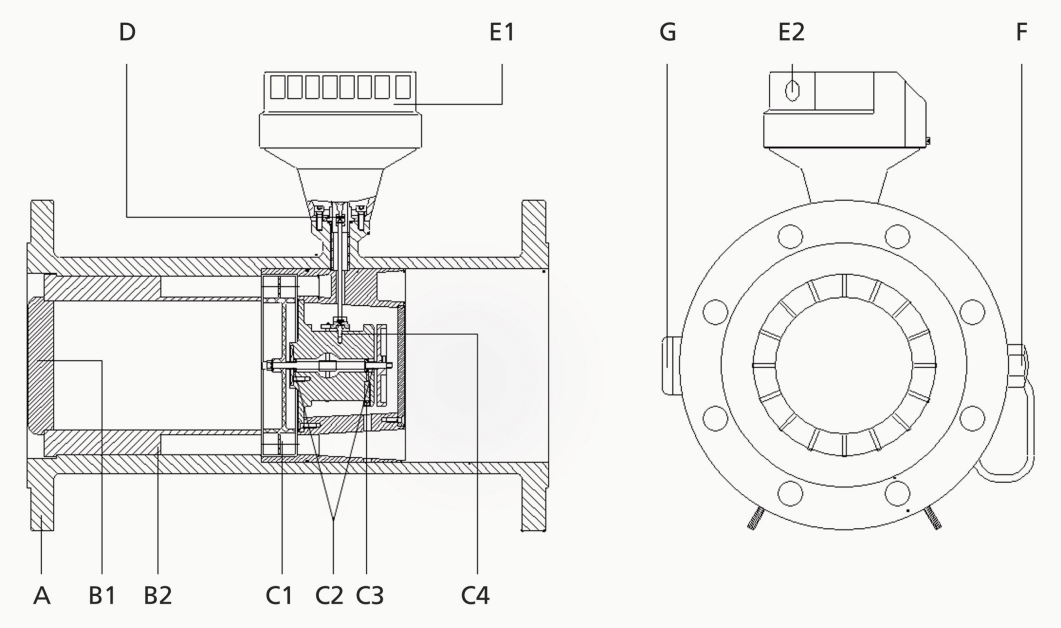
vemm tec Messtechnik GmbH - Gartenstr. 20 - 14482 Potsdam
Zertifiziert nach ISO 9001 von DNV Zertifikats-Nummer: CERT-10915-2001-AQ-ESN-TGA

Table 11: Gas types

Gas type	**Symbol**	**Density at base conditions (1.013 bar abs.) [kg/m³]**	**Meter housing**	**Notes**
Acetylene	C_2H_4	1.17	Special	Aluminium parts teflon coated
Air		1.29	Standard	
Ammonia	NH_3	0.77	Standard	O-rings / lubrication
Argon	Ar	1.78	Standard	
Biogas			Special	Special internal
Butane	C_4H_{10}	2.70	Standard	
Carbon dioxide	CO_2	1.98	Standard	Except foodstuff industry
Carbon monoxide	CO	1.25	Standard	
City gas		0.90	Standard	
Ethane	C_2H_6	1.36	Standard	
Ethylene (gas phase)	C_2H_4	1.26	Standard	Special internal
Flue gases			Special	O-rings / lubrication
Freon (gas phase)	CCl_2F_2	5.66	Standard	O-rings / lubrication
Helium	He	0.18	Standard	Special internal
Hydrogen	H_2	0.09	Special	Special flow range
Hydrogen sulphide (0.2 %)	H_2S	1.54	Special	Special internal
Methane	CH_4	0.72	Standard	
Natural Gas		0.83	Standard	
Nitrogen	N_2	1.25	Standard	
Oxygen (pure)	O_2	1.43	Standard	Special internal
Pentane	C_5H_{12}	3.46	Standard	
Propane	C_3H_8	2.02	Standard	
Propylene (gas phase)	C_3H_6	1.92	Standard	Special internal
Sour gas			Special	O-rings / lubrication
Sulphur dioxide (0.2 %)	SO_2	2.93	Special	Special internal

For all specials, please enquire at ***vemm tec***.

Figure 21: Main parts of the IGTM



A Pressure containing meter housing with end-flanges

B Flow deflector (straightening vane)
- **B1** Central cone
- **B2** Guiding vanes

C Metering insert cartridge with turbine wheel
- **C1** Turbine wheel
- **C2** Precision Bearings
- **C3** Bearing Block
- **C4** Internal gears, shafts and axis

D Magnetic coupling (gas tight sealed)

E Index head with nameplates
- **E1** Mechanical counter
- **E2** Connector for pulse transmitters [1R1; HF3 + options]

F Oil pump

G High frequency pulse transmitters [HF1; HF2]

Figure 22: Gear drawing

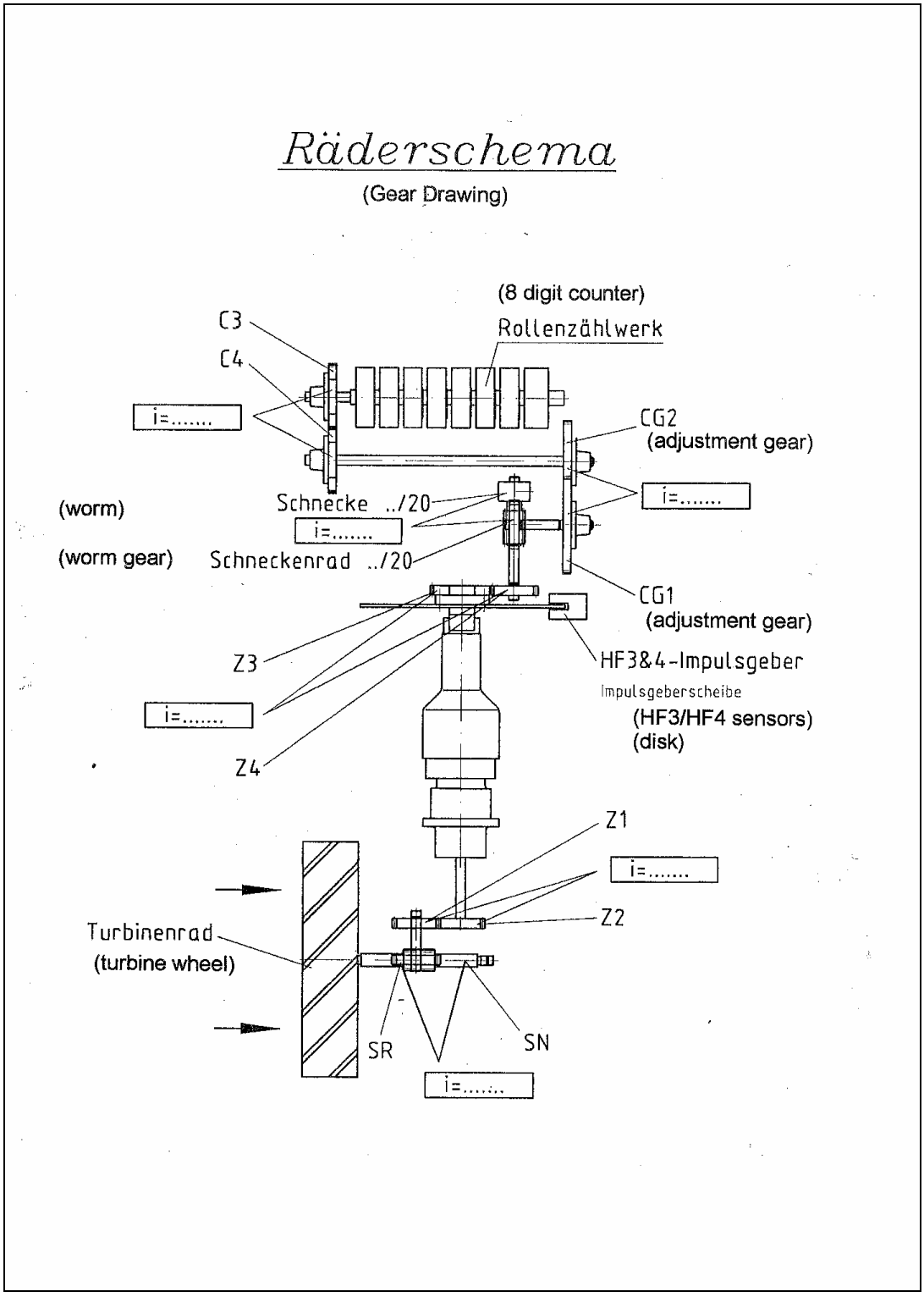


Table 12: Spare parts listing

Description	**Part-number**							
Spare parts per meter diameter	**DN 50 (2")**	**DN 80 (3")**	**DN 100 (4")**	**DN 150 (6")**	**DN 200 (8")**	**DN 250 (10")**	**DN 300 (12")**	**DN 400 (16")**
Index head internals	Please enquire (Completely fitted for the requested meter. Please note serial number of your meter.)							
Index head complete	Please enquire (Completely mounted with counter for a particular size, G-rate and serial number.)							
Electronic revision set for index head (1R1, HF3)	76850.0280 (Consisting of PCB for Reed switch 1R1 as well as proximity switch including mounting set for HF3.)							
Electronic revision set for index head (1R1, 1R10, HF3, HF4)	76850.0281 (Consisting of PCB for 2 Reed switches (1R1/2R1/1R10/2R10) as well as proximity switch including mounting set for HF3 and HF4.)							
HF1 assembly HF2 assembly Connector for pulse sensors (male)	Please enquire (Please indicate meter type CT or IM, diameter, flange rating.) 76850.0272							
Magnetic coupling	76850.0100							
Set of internals	(Including aluminium turbine wheel, bearing block, bearings, shafts, completely assembled and tested. Please indicate meter size and G-rate.)							
with turbine wheel 30 deg.		76842.3000	76843.3000	76844.3000	76845.3000	76846.3000	76847.3000	76848.3000
with turbine wheel 45 deg.	76841.2000	76842.2000	76843.2000	76844.2000	76845.2000	76846.2000	76847.2000	76848.2000
Spare turbine wheel 30 deg.		76842.1023	76843.1023	76844.1023	76845.1023	76846.1023	76847.1023	76848.1023
Spare turbine wheel 45 deg.	76841.1003	76842.1003	76843.1003	76844.1003	76845.1003	76846.1003	76847.1003	76848.1003
Flow straightener IGTM-CT	76821.1000	76822.1000	76823.1000	76824.1000	76825.1000	76826.1000	76827.1000	76828.1000
Flow straightener IGTM-IM	76821.1000	76822.1600	76823.1600	76824.1600	76825.1600	76826.1600	76827.1600	76828.1600
Set of O-rings (for internals, index head, sensors, coupling)	76850.0291	76850.0292	76850.0293	76850.0294	76850.0295	76850.0296	76850.0297	76850.0298
Lubrication oil for oil system Bottle with 30 ml oil Bottle with 50 ml oil Bottle with 100 ml oil Bottle with 500 ml oil Bottle with 1000 ml oil	76850.1001 76850.1003 76850.1004 76805.1007 76850.1005							
Oil pump (piping not included)	76540.0030			76863.1102			76866.1101	
Non-return valve for oiler piping	76540.0031							

Table 13: Intrinsically safe equipment

(Please find more information in the internet at www.pepperl-fuchs.com and www.turck.de)

Function	Input channels			Output			Power	Serial number			Maximum frequency (if < 5 kHz)
	Number	Reed switch	HF Namur	Number	Transistor	Analogue 0/4 - 20 mA	VAC/VDC	Make: Turck	Make: Pepperl + Fuchs	Make: MTL	
Transformer Isolated Barrier	1	X	X	2	active	-	24 VDC	MK13-12 Ex0-T/24VDC	KFD2-ST2-Ex1.LB		Turck max freq. 3 kHz
Transformer Isolated Barrier	2	X	X	2	active	-	24 VDC	MK13-22 Ex0-T/24VDC	KFD2-ST2-Ex2		Turck max freq. 3 kHz
Transformer Isolated Barrier	1	X	X	2	passive	-	24 VDC	MK15-RPN-Ex0/24VDC	KFD2-SOT2-Ex1.LB	MTL 5014	
Transformer Isolated Barrier	2	X	X	2	passive	-	24 VDC	MK13-22 Ex0-T/24VDC	KFD2-SOT2-Ex2	MTL 5015	Turck max freq. 3 kHz
Transformer Isolated Barrier	2	X	X	2	passive	-	115 VAC	MK13-22 Ex0-T/115VAC	KFA5-SOT-Ex2		Turck max freq. 3 kHz
Transformer Isolated Barrier	2	X	X	2	passive	-	230 VAC	MK13-22 Ex0-T/230VAC	KFA6-SOT2-EX2		Turck max freq. 3 kHz
Transformer Isolated Barrier	2		X	2 x 2	passive	-	24 VDC	MC13-241 Ex0-T/24VDC S276			
Frequency-Current Converter	1	X	X	1		X	24 VDC	MK21-12Ex0-Ri/24VDC	KFD2-UFC-Ex1.D	MTL 5521-11-24	
Frequency-Current Converter	1	X	X	1		X	85-253 VAC	MK21-12Ex0-Ri/230VAC	KFU8-UFC-Ex1.D	MTL 5521-11-230	
Frequency divider	1	X	X	1	passive		24 VDC		KFD2-UFC-Ex1.D	MTL 5031	
Frequency divider	1	X	X	1	passive		85-253 VAC		KFU8-UFC-Ex1.D		
Frequency monitor switch	1	X	X	1	passive		24 VDC	MK21-12Ex0-Ri/24VDC	KFD2-UFC-Ex1.D		
Frequency monitor switch	1	X	X	1	passive		85-253 VAC	MK21-12Ex0-Ri/230VAC	KFU8-UFC-Ex1.D		

The indicated models are suggested by the applicable manufacturers. In case the devices are not delivered by ***vemm tec***, ***vemm tec*** *cannot be hold responsible for unproper operation.*

Figure 23: Lead seals

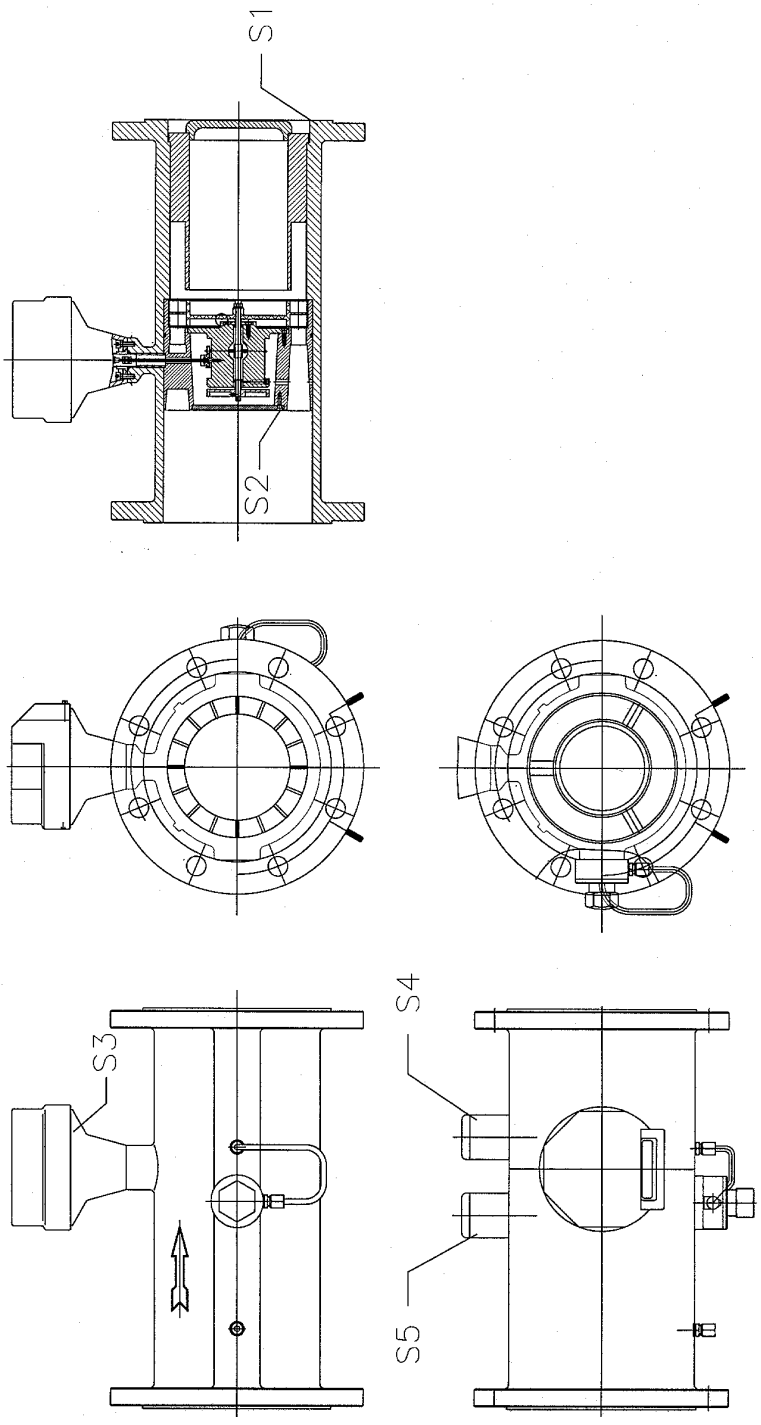


Table 14: Size dependent data and k-factors

Nominal diameter	Size rating	Q_{max}	Q_{min} (standard flow range)	Rotating speed turbine wheel at Q_{max}	Turbine wheel		Maximum frequency			k-factor		
					blade angle	number of blades	HF1/HF2 approx.	HF3/HF4 approx.	1R1 Reed	HF1/HF2 approx.	HF3/HF4 approx.	1R1 Reed
[mm]	G	[m³/h]	[m³/h]	[min⁻¹]			[Hz]	[Hz]	[Hz]	[Imp/m³]	[Imp/m³]	[Imp/m³]
DN 50	G 40	65	13	8900	45	16	2800	80	0,18	155000	4400	10
(2")	G 65	100	10	13700	45	16	4300	120	0,28	155000	4400	10
DN 80	G 100	160	16	6200	45	16	1900	50	0,04	42200	1200	1
(3")	G 160	250	13	9600	45	16	2900	80	0,07	42200	1200	1
	G 250	400	20	8900	30	16	2600	70	0,11	23500	670	1
DN 100	G 160	250	13	4300	45	16	1200	60	0,07	17000	800	1
(4")	G 250	400	20	6900	45	16	1900	90	0,11	17000	800	1
	G 400	650	32	6500	30	16	1700	80	0,18	9400	440	1
DN 150	G 400	650	32	3400	45	20	1100	70	0,18	6280	360	1
(6")	G 650	1000	50	5200	45	20	1700	100	0,28	6280	360	1
	G 1000	1600	80	4800	30	20	1600	60	0,04	3570	135	0,1
DN 200	G 650	1000	50	2200	45	20	790	40	0,03	2840	150	0,1
(8")	G 1000	1600	80	3500	45	20	1300	70	0,04	2840	150	0,1
	G 1600	2500	130	3100	30	20	1100	60	0,07	1510	80	0,1
DN 250	G 1000	1600	80	2000	45	24	830	60	0,04	1870	135	0,1
(10")	G 1600	2500	130	3100	45	24	1300	90	0,07	1870	135	0,1
	G 2500	4000	200	2900	30	24	1200	90	0,11	1110	80	0,1
DN 300	G 1600	2500	130	1900	45	24	780	60	0,07	1120	80	0,1
(12")	G 2500	4000	200	3000	45	24	1300	90	0,11	1120	80	0,1
	G 4000	6500	320	2800	30	24	1200	130	0,18	660	75	0,1
DN 400	G 2500	4000	200	1600	45	24	610	60	0,11	550	55	0,1
(16")	G 4000	6500	320	2600	45	24	990	100	0,18	550	55	0,1
	G 6500	10000	500	2300	30	24	1300	130	0,28	470	50	0,1

The indicated frequency values and k-factors of HF1/HF2 and HF3/HF4 are for information only.
The final values will be mentioned at the meter´s nameplate and in the calibration certificate.

Table 15: Diameter and flow rate combinations

Nominal diameter [mm] [Inch]	**Size rating**	**Qmax** [m³/h]	**Standard flow range 1 : 20** Qmin [m³/h]	**Improved [1] flow range 1 : 30** Qmin [m³/h]	**Best possible [1] flow range** Qmin [m³/h]	(rounded)
DN 50 (2")	G 40	65	**13** [2]	7 [3]	6	1 : 10
	G 65	100	**10** [4]	7 [5]	6	1 : 16
DN 80 (3")	G 100	160	**16** [4]	8 [6]	6	1 : 25
	G 160	250	**13**	8	6	1 : 40
	G 250	400	**20**	13	-	-
DN 100 (4")	G 160	250	**13**	**8**	-	-
	G 250	400	**20**	**13**	9	1 : 45
	G 400	650	**32**	**20**	16	1 : 40
DN 150 (6")	G 400	650	**32**	**20**	-	-
	G 650	1000	**50**	**32**	20	1 : 50
	G 1000	1600	**80**	**50**	40	1 : 40
DN 200 (8")	G 650	1000	**50**	**32**	-	-
	G 1000	1600	**80**	**50**	32	1 : 50
	G 1600	2500	**130**	**80**	60	1 : 40
DN 250 (10")	G 1000	1600	**80**	**50**	-	-
	G 1600	2500	**130**	**80**	50	1 : 50
	G 2500	4000	**200**	**130**	100	1 : 40
DN 300 (12")	G 1600	2500	**130**	**80**	-	-
	G 2500	4000	**200**	**130**	80	1 : 50
	G 4000	6500	**320**	**200**	160	1 : 40
DN 400 (16")	G 2500	4000	**200**	**130**	-	-
	G 4000	6500	**320**	**200**	130	1 : 50
	G 6500	10000	**500**	**320**	250	1 : 40

[1] Available for IGTM-CT only
[2] Flow range 1 : 5
[3] Flow range 1 : 9
[4] Flow range 1 : 10
[5] Flow range 1 : 15
[6] Flow range 1 : 20

All combinations are available in the standard accuracy:
± 1 % for 0.2 Q_{max} to Q_{max}
± 2 % for Q_{min} to 0.2 Q_{max}

The bold printed combinations are also available with improved accuracy (for CT-models only):
± 0.5 % for 0.2 Q_{max} to Q_{max}
± 1.0 % for Q_{min} to 0.2 Q_{max}

Table 16: Gas velocity and pressure loss

Nominal diameter [mm] [inch]	Size rating	Qmax [m³/h]	Qmin (standard flow range) [m³/h]	Gas velocity at Qmax (in standard piping Schedule 40) [m/s]	Pressure loss with natural gas of 1.0 bar abs at specified flow rate [mbar]		
					50 % Qmax	80 % Qmax	100 % Qmax
DN 50 (2")	G 40	65	13	8,3	1,4	3,5	5,5
	G 65	100	10	12,8	2,9	7,5	11,7
DN 80 (3")	G 100	160	16	8,3	0,9	2,4	3,7
	G 160	250	13	13,0	2,2	5,5	8,6
	G 250	400	20	20,7	3,4	8,8	13,8
DN 100 (4")	G 160	250	13	8,4	0,8	2,0	3,1
	G 250	400	20	13,5	1,7	4,3	6,8
	G 400	650	32	22,0	2,7	6,9	10,8
DN 150 (6")	G 400	650	32	9,7	0,8	2,0	3,1
	G 650	1000	50	14,9	1,8	4,5	7,1
	G 1000	1600	80	23,8	2,8	7,2	11,3
DN 200 (8")	G 650	1000	50	8,6	0,6	1,6	2,5
	G 1000	1600	80	13,8	1,1	2,8	4,3
	G 1600	2500	130	21,5	2,5	6,5	10,2
DN 250 (10")	G 1000	1600	80	8,7	0,6	1,6	2,5
	G 1600	2500	130	13,7	1,2	3,2	4,9
	G 2500	4000	200	21,8	2,0	5,0	7,9
DN 300 (12")	G 1600	2500	130	9,5	0,6	1,6	2,5
	G 2500	4000	200	15,2	1,2	3,2	4,9
	G 4000	6500	320	24,7	2,0	5,0	7,9
DN 400 (16")	G 2500	4000	200	9,4	0,6	1,6	2,5
	G 4000	6500	320	15,4	1,2	3,2	4,9
	G 6500	10000	500	23,6	2,2	5,5	8,6

Figure 24: Dimensional drawing

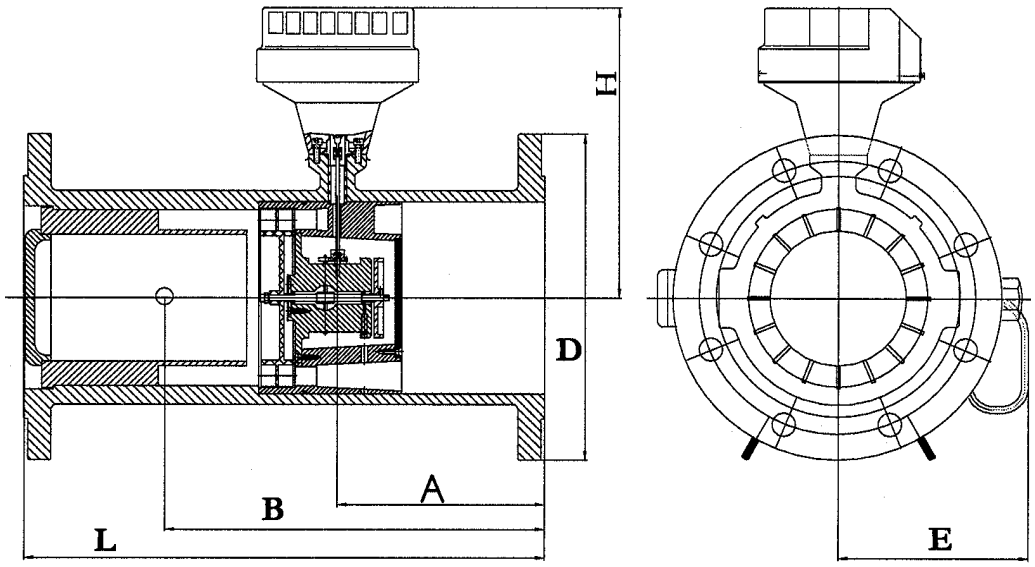


Table 17: Dimensions and weights
(Part 1, continued on next page)

DN [mm] [Inch]	Size G	A [mm] CT	A [mm] IM	B [mm] CT	B [mm] IM	E [mm] CT	E [mm] IM	D [mm]	Height H [mm] CT	Height H [mm] IM	Total length L [mm] CT	Total length L [mm] IM	Pressure class PN or ANSI	Body material	Weight [kg] CT	Weight [kg] IM
DN 50 (2")	40 or 65	62	62	70	70	102	102	165	215	215	150	150	PN 10/16	Ductile Iron	11	11
						127	127	165	200	200			PN 10/16	Steel	24	24
						127	127	165	200	200			PN 25/40	Steel	24	24
						127	127	180	205	205			PN 64	Steel	24	24
						140	140	195	215	215			PN 100	Steel	33	33
						102	102	152	215	215			ANSI 150	Ductile Iron	11	11
						127	127	152	200	200			ANSI 150	Steel	24	24
						127	127	165	200	200			ANSI 300	Steel	24	24
						127	127	165	200	200			ANSI 400	Steel	24	24
						127	127	165	200	200			ANSI 600	Steel	24	24
DN 80 (3")	100 or 160 or 250	92	42	108	56	120	115	200	205	230	240	120	PN 10/16	Ductile Iron	16	15
						120	145	200	192	220			PN 10/16	Steel	26	28
						120	145	200	192	220			PN 25/40	Steel	26	32
						120	150	215	192	225			PN 64	Steel	32	37
						120	155	230	192	230			PN 100	Steel	35	37
						120	150	191	205	230			ANSI 150	Ductile Iron	25	15
						120	145	191	192	215			ANSI 150	Steel	25	25
						120	150	210	192	220			ANSI 300	Steel	29	30
						120	150	210	192	220			ANSI 400	Steel	29	30
						120	150	210	192	220			ANSI 600	Steel	29	30
DN 100 (4")	160 or 250 or 400	120	50	154	75	135	135	220	230	245	300	150	PN 10/16	Ductile Iron	27	24
						140	160	220	215	230			PN 10/16	Steel	31	42
						140	165	235	215	235			PN 25/40	Steel	39	48
						140	170	250	215	240			PN 64	Steel	42	55
						140	180	265	215	250			PN 100	Steel	48	62
						135	135	229	230	235			ANSI 150	Ductile Iron	36	24
						140	165	229	215	235			ANSI 150	Steel	36	48
						140	170	254	215	240			ANSI 300	Steel	43	57
						140	170	254	215	240			ANSI 400	Steel	43	57
						140	180	273	215	255			ANSI 600	Steel	50	60

Table 17: Dimensions and weights
(Part 2)

DN [mm] [Inch]	Size G	A [mm] CT	A [mm] IM	B [mm] CT	B [mm] IM	E [mm] CT	E [mm] IM	D [mm]	Height H [mm] CT	Height H [mm] IM	Total length L [mm] CT	Total length L [mm] IM	Pressure class PN or ANSI	Body material	Weight [kg] CT	Weight [kg] IM
DN 150 (6")	400 or 650 or 1000	182	56	218	85	198	235	285	255	275	450	175	PN 10/16	Ductile Iron	45	30
						215	230	285	250	260			PN 10/16	Steel	45	62
						215	240	300	250	270			PN 25/40	Steel	40	70
						215	250	345	250	290			PN 64	Steel	74	102
						215	250	355	250	290			PN 100	Steel	90	110
						198	235	279	255	275			ANSI 150	Ductile Iron	50	30
						215	225	279	250	260			ANSI 150	Steel	50	60
						215	240	318	250	275			ANSI 300	Steel	70	84
						215	240	318	250	275			ANSI 400	Steel	80	84
						215	255	356	250	290			ANSI 600	Steel	100	110
DN 200 (8")	650 or 1000 or 1600	240	69	278	160	250	255	340	270	290	600	200	PN 10	Ductile Iron	75	92
							255	340		290			PN 10	Steel	75	92
							255	340		290			PN 16	Ductile Iron	75	92
							255	340		290			PN 16	Steel	75	92
							265	360		298			PN 25	Steel	90	108
							275	375		308			PN 40	Steel	100	122
							285	415		320			PN 64	Steel	125	163
							290	430		330			PN 100	Steel	160	176
							255	343		290			ANSI 150	Ductile Iron	96	96
							255	343		290			ANSI 150	Steel	96	96
							275	381		308			ANSI 300	Steel	120	128
							275	381		308			ANSI 400	Steel	135	128
							285	419		320			ANSI 600	Steel	155	190
DN 250 (10")	1000 or 1600 or 2500	300	125	353	168	270	270	395	285	285	750	300	PN 10	Steel	90	70
								405					PN 16	Steel	95	72
								425					PN 25	Steel	110	90
								450					PN 40	Steel	130	108
								470					PN 64	Steel	155	140
								505					PN 100	Steel	220	205
								406					ANSI 150	Steel	110	72
								445					ANSI 300	Steel	150	110
								445					ANSI 400	Steel	170	122
								508					ANSI 600	Steel	240	210
DN 300 12"	1600 or 2500 or 4000	360	130	358	130	315	315	445	320	320	900	320	PN 10	Steel	120	90
								460					PN 16	Steel	130	100
								485					PN 25	Steel	150	124
								515					PN 40	Steel	180	160
								530					PN 64	Steel	240	180
								585					PN100	Steel	345	280
								483					ANSI 150	Steel	160	160
								521					ANSI 300	Steel	210	212
								521					ANSI 400	Steel	240	235
								559					ANSI 600	Steel	290	300
DN 400 16"	2500 or 4000 or 6500	480	150	480	150	350	350	565	355	355	1200	400	PN 10	Steel	355	225
								580					PN 16	Steel	380	250
								620					PN 25	Steel	415	285
								660					PN 40	Steel	455	325
								670					PN 64	Steel	500	370
								715					PN100	Steel	600	470
								597					ANSI 150	Steel	410	280
								648					ANSI 300	Steel	450	320
								648					ANSI 400	Steel	500	370
								686					ANSI 600	Steel	590	460

7 SAFETY INSTRUCTIONS AND WARNINGS

Please refer to section 2.2 for specific warnings in the EC Pressure Equipment Directive.

The IGTM gas turbine meter supplied to you is a sensitive, high-quality metering instrument and should be handled with care. The smaller meters (DN 50 (2") to DN 100 (4")) should be lifted or transported with a strap. Larger meters (DN 150 (6") and up) are equipped with lifting lug holes in the flanges.
The meter should only be lifted with straps or with lifting lugs.

Never use the index (counter) head or the HF sensors as a handle bar or lifting handle.
The index head contains delicate shafts and gears that may be damaged with inappropriate handling. Improper use may cause inaccurate measurements.

Your meter may be equipped with electronic sensors. The electrical circuits are designed to be intrinsically safe (after EN 60947-5/6 NAMUR). **For use with hazardous gas in potentially hazardous area never hook up the meter to non-intrinsically-safe circuits.** Refer to hook-up diagrams for all sensor types later in this section.

Use only studs and nuts appropriate for the application and pressure class of the meter. Use new and correct size gaskets only. Ensure that flange faces are free from dirt and sharp metal filings. Gaskets should not protrude into the piping.

Do not hydro test the meter.
This was done in the factory. Water or any other liquid media will damage the meter.

Before disassembly of the meter, please observe the following rules:

- **For safety reasons NEVER disassemble a gas turbine meter under pressure.**
- **Do not remove, break, or paint any of the markings and lead seals** on a custody transfer meter, because in most countries the legal status of the meter for custody transfer measurement will become invalid. The meter must be re-calibrated at an approved test facility to regain legal status. The warranty as mentioned in this manual is only applicable if all of the markings and lead seals are undamaged and in place with the original seal stamp.
- If you replace critical internal parts (rotor, bearings, gears or complete internal components) **the meter should be recalibrated at a flow test facility** for the best accuracy. If the meter is to be used in a custody transfer application, the flow laboratory must be approved for custody transfer calibration.

Slowly and carefully fill your gas pipeline and meter-run. **Always fill** the meter pipeline section **from the upstream side** of your meter. Reverse flow and/or over load may damage the meter. Rapid gas expansion causes temperature extremes. Initial flow may cause collected dust and particles to travel and damage your meter. To **empty** a gas filled metering section, a vent **downstream** of the meter should be used, to avoid reverse flow through your IGTM.

Lubricate your IGTM before the first use and at regular intervals during operation.

Please report any problems to the manufacturer.

vemm tec Messtechnik GmbH
Gartenstrasse 20
14482 Potsdam-Babelsberg
Germany
Tel. +49 (0) 3 31 / 70 96 274
Fax +49 (0) 3 31 / 70 96 270
E mail: info@vemmtec.com
Internet: http://www.vemmtec.com