Nederlands Meetinstituut

Measuring systems for liquids other than water
Pattern evaluation report of a measurement transducer

Ensembles de mesurage de liquides autres que l'eau
Rapport d'essai de model d'un compteur turbine

Projectnumber: 212593
Test report N° : CVN-212593

Pattern	: A measurement transducer.
Manufacturer	: Daniel Measurement & Control, S. de R.L. de C.V. Ave. Ishikawa 1221 Parque Industrial Supra Chihuahua, Chih. 31137 Mexico
Designation	: UMB 3", UMB 4", UMB 6", UMB 8"
Issued by	: NMi Certin B.V. Hugo de Grootplein 1 3314 EG DORDRECHT
Applicant	: Daniel Europe Ltd. Logie Court Stirling University Innovation Park Stirling FK9 4NF Scotland
Date of application	: December 15, 2001
End of application	: May 7, 2002
Signature	:

W.A.C.M. van Leeuwen
manager Certification Dordrecht

OIML R117
Edition 1995 (E)

Form. 962

Nederlands Meetinstituut

Certificate

Report n°: CVN-212593
Application n°: 212593

Applicant	Daniel Europe Ltd. Logie Court Stirling University Innovation Park Stirling FK9 4NF Scotland
Submitted	Measurement transducer Manufacturer : Daniel Measurement & Control, S. de R.L. de C.V. Ave. Ishikawa 1221 Parque Industrial Supra Chihuahua, Chih. 31137 Mexico Designation : UMB 3", UMB 4", UMB 6", UMB 8"
Scope of investigation	Testing the measurement transducer for compliance with OIML International Recommendation R117 (edition 1995) "Measuring systems for liquids other than water"
Test method	As described in the applicable chapter of Testreport no. CVN-212593
Test resulsts	As described in Testreport no. CVN-212593
Documentation	See Documentation folder CVN-212593
Test period	December 15, 2001
Test place	NMi Certin B.V. Hugo de Grootplein 1 3314 EG DORDRECHT The Netherlands NMi Certin B.V. Schoemakerstraat 97 2628 VK DELFT The Netherlands
Tracability	The measurements have been executed using standards for which the traceability to primary standards, (inter)national standards and/or properties of pure substances has been demonstrated.

Dordrecht, October 25, 2002
NMi Certin B.V.

W.A.C.M. van Leeuwen
manager Certification Dordrecht

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General information concerning the pattern

Application No. : 212593 (new/~~modification~~)

Applicant :
Daniel Europe Ltd.
Logie Court
Stirling University Innovation Park
Stirling
FK9 4NF
Scotland

Manufacturer :
Daniel Measurement & Control, S. de R.L. de C.V.
Ave. Ishikawa 1221
Parque Industrial Supra
Chihuahua, Chih. 31137
Mexico

Measurement transducer

Sensor

Manufacturer : Daniel Measurement and Control
Measuring priciple : turbine meter

Pattern designation	UMB 3"	UMB 4"	UMB 6"	UMB 8"
Maximum flow rate	2460	4700	11000	20000
Minimum flow rate	246	470	1100	2000
Maximum pressure	20	20	20	20
Diameter in and outlet	75	100	150	2000

Minimum measured quantity : Depending on indication device
Environmental class : C
Accuracy class : 0.3
Nature of the liquid : Light refined oil products

Pulser

Manufacturer : Brooks Petroleum Operations
Pattern designation : B
Pattern approval mark : -
Environmental class : C (outdoor equipment)
Mains power : +10...+30 VDC, +24 VDC nominal

Note: The pulser includes an amplifier

Information concerning the test equipment used for pattern evaluation

The measurements have been executed using standards for which the traceability to primary standards, (inter)national standards and/or properties of pure substances has been demonstrated.
Using the data given below and the test date(s) the calibration data of all equipment can be traced.

NMi Number	Description	Marketing name	Type
Climate tests			
6517KG04	Climate chamber	Heraeus	VEKZ 04/220
65120116	Temperature and Humidity indicator	Novasina	MS1
RF radiated immunity testing			
14051	Compact anechoic room	Euroshield/Comtest	RFSD-F-100
15392	Signalgenerator 0.1MHz – 2048 MHz	Rohde & Schwarz	SMY02
14298	Amplifier 0.01MHz - 220MHz	SPS/Comtech	SPS7010
14307	Amplifier 200 MHz – 1100 MHz	SPS/Comtech	SPS8030
14351	Biconilog antenna 20MHz - 1100MHz	EMCO	3143
12441	Tripod	EMCO	TR3
99107	Turntable anechoic room + controller.	Heinrich Deisel	HD050
99109	Color television	Erres	S G90AE
99110	Camera	Hitachi	VM-E10E
Electro Static Discharge			
99002	ESD Simulator system	Schaffner	NSG 435-01
Electrical fast transients testing			
15110	3-phase burst simulator system 30 Amp.	Schaffner	NSG 2025-4
99001	IEC 1000-4-4 capacitive coupling clamp	Schaffner	CDN 126
99005	3-phase IEC 309 coupling adapter 32 Amp.	Schaffner	INA 250
99006	1-phase Schuko coupling adapter 16 Amp.	Schaffner	INA 252
99007	Blind cover	Schaffner	-
99014	Attenuator 30 dB for burst verification	Schaffner	INA 265
99015	Software control package	Schaffner	WIN 2025
Voltage variations and dips testing			
15354	Profline interface	Schaffner	CCN2000-3P/5, IEEE v3.0
99009	Blind cover	Schaffner	-
99030	Universal power analyzer/flicker meter	Voltech	PM 3000A
99031	Profline AC switching unit	Schaffner	888-0165-V2.30
99032	AC power source	Schaffner	3120-AMX
99033	AC power source	Schaffner	3120-AMX
99034	Magnetic module	Schaffner	134350
99035	Magnetic module	Schaffner	134350
99036	Personal computer	Dell	Dimension P133
99037	System cabinet	Schaffner	30U/He
99038	System cabinet	Schaffner	30U/He
Counters			
10E81/1101	High resolution timer/counter 120 MHz	Philips	PM 6671
10E81/1102	High resolution timer/counter 120 MHz	Philips	PM 6671
10E81/1097	High resolution timer/counter 120 MHz	Philips	PM 6671
65187016	Universal counter	HP	HP 5315A
Accuracy tests			
Testinstallation NMi, Dordrecht			
Testinstallation Brooks, Veenendaal			

Scope

Scope of investigation:

Testing the device(s) given in "General information concerning the pattern" for compliance with OIML International Recommendation R117 "Measuring systems for liquids other than water"; edition 1995 and concerns the pattern approval test of these devices / this device for application in:

- Non-interruptible measuring systems for the measurement of (petro)chemical liquids of low viscosity, excluding liquefied gases.

Conclusions:

- The devices given in "General information concerning the pattern" meet all the requirements for Accuracy class 0.3.

Check list

The symbols used in this Check List are:

+	=	Passed
-	=	Failed
mpe	=	Maximum permissible error
MMQ	=	Minimum measured quantity
MSVD	=	Minimum specified volume deviation
MSPD	=	Minimum specified price deviation

For each test, the "checklist" has been completed according to this example:

+	-	
X		The instrument fulfils the requirement or has passed the test
	X	The instrument doesn't fulfil the requirement or has failed the test
/	/	The requirement or the test is not applicable

Note: Item numbering refers to International Recommendation OIML R 117 Measuring systems for liquids other than water.

Note: Item numbering refers to International Recommendation OIML R 117 Measuring systems for liquids other than water.

§ (R117)	Description	+	-	Remarks
2	**General requirements**			
2.1	Constituents of a measuring system	/	/	
2.2	Ancillary devices	/	/	
2.3	Field of operation	/	/	
2.4	Accuracy classes	/	/	
2.5	Maximum permissible errors	/	/	
2.6	Conditions for applying maximum permissible errors	/	/	
2.7	Provisions for converted indications	/	/	
2.8	Maximum permissible errors on calculators	/	/	
2.9	Indications	/	/	
2.10	Elimination of air or gases	/	/	
2.11	Gas indicator	/	/	
2.12	Transfer point	/	/	
2.13	Complete filling of the measuring system	/	/	
2.14	Draining	/	/	
2.15	Variation in the internal volume of full hoses	/	/	
2.16	Branches and bypasses	/	/	
2.17	Control and closing mechanisms	/	/	
2.18	Various provisions	/	/	
2.19	Markings	/	/	
2.19.1	Each measuring system, component or subsystem shall bear, on the dial of the indicating device or on a special data plate, the following information: a) Pattern approval sign b) Manufacturer's identification or trademark c) Designation selected by the manufacturer, if appropriate d) serial number and year of manufacture e) characteristics as defined in 2.3.1, 3.1.1.1, 2.10.7.2 or 3.1.7.1 f) accuracy class, if other than 0.5. Note: the indicated characteristics should be the actual characteristics of use, if they are known when the plate is affixed. When they are not known, the indicated characteristics are those allowed by the pattern approval certificate.	**X**		
	However, the min. and the max. temperatures of the liquids shall appear on the data plate only when they differ from -10 °C and +50 °C respectively.	/	/	
	The V_{min} of the measuring system shall in all cases be clearly visible on the dial on any indicating device visible to the user during the measurement.	/	/	
	If several meters operate in a single system using common components, the marking required for each part of the system may be combined on a single plate.	/	/	

§ (R117)	Description	+	-	Remarks
	When a measuring system can be transported without being dismantled, the markings required for each component may also be combined on a single plate.	/	/	
2.20	Sealing devices and stamping plate			
2.20.1	General			
	Sealing is preferably carried out by means of lead seals.	**X**		Up to national regulations
	However, other types of sealing are permitted on fragile instruments or when these seals provide sufficient integrity, electronic seals for instance.	/	/	
	The seals shall, in all cases, be easily accessible.	/	/	
	Sealing should be provided on all parts of the measuring system that cannot be materially protected in any other way against operation liable to affect the measurement accuracy.	/	/	
	It must be prohibited to change parameters that participate in the determination of the measurement results by means of sealing devices.	/	/	
	Except for direct selling to the public, it may be acceptable that the nature of the measured liquid or its viscosity be entered into the calculator at the beginning of the measurement (see 3.1.5, 4th paragraph) even when this data participates in the correction. This data and a note explaining that this quantity has been entered manually shall be printed at the same time as the measurement results.	/	/	
	A stamping plate aimed at receiving the control marks, shall be sealed or permanently attached on a support of the measuring system. It may be combined with the data plate of the measuring system referred to in 2.19.	/	/	
	In the case of a measuring system used for potable liquids, sealing shall be applied such that the equipment may be dismantled for cleaning purposes.	/	/	
2.20.2	Electronic sealing devices	/	/	
3	**Requirements for meters and ancillary devices of a measuring device**			
3.1	Meter			
The meter(s) of a measuring system shall meet the following requirements, whether or not it (they) is (are) subject to a separate pattern approval:				
3.1.1	Field of operation			

§ (R117)	Description	+	-	Remarks
3.1.1.1	The field of operation of a meter is determined at least by the following characteristics: • minimum measured quantity, • measuring range limited by the minimum flow rate, Qmin, and the maximum flow rate, Qmax, • maximum pressure of the liquid, Pmax, • nature of the liquid(s) to be measured and limits of kinematic or dynamic viscosity when the indication of the nature of the liquid alone is not sufficient for characterising its viscosity, • maximum temperature of the liquid, Tmax, • minimum temperature of the liquid, Tmin.	X		The minimum measured quantity is depending on the resolution of the indication device
3.1.1.2	The value of the minimum measured quantity shall be in the form: $1x10^n$, 2×10^n or 5×10^n authorised units of volume, n being a positive or negative whole number, or zero.	/		
3.1.1.3	In general, the ratio between the maximum and the minimum flow rate of the meter shall be: • at least equal to ten for meters for liquids having a viscosity less than 20 mPa.s at measurement temperature, other than liquefied gases, • at least equal to five for meters for liquids having a viscosity equal to or greater than 20 mPa.s and for meters for liquefied gases. However, when the requirements applicable to a particular measuring system specify a lower ratio for that system or its meter, the ratio for the meter may be less than specified above, without being lower than two in application of 2.3.3, 3rd paragraph.	X		
3.1.2	Metrological requirements			
3.1.2.1	The maximum permissible errors for a meter, within its field of operation, are equal to those specified in line B of Table 2.	X		
3.1.2.2	For any quantity equal to or greater than five times the minimum measured quantity, the repeatability error of the meter shall not be higher than two-fifths of the value specified in line A of Table 2.	X		
3.1.2.3	For a given liquid within their fields of operation, meters shall present a magnitude of the difference between the initial intrinsic error and the error after the endurance test equal to or less than the value specified in line B in Table 2.	X		

§ (R117)	Description	+	-	Remarks
3.1.3	Connections between the flow sensor and the indicating device			
3.1.3	In the text, the expression "flow sensor" also means volume sensor.	**X**		
	The connections between the flow sensor and the indicating device shall be reliable and, for electronic devices, durable, in accordance with 4.1.3 and 4.3.2.	**X**		Connections between sensor and pulser are reliable
	This provision also applies to connections between primary and secondary devices for electromagnetic meters.	/	/	
3.1.4	Adjustment device			
3.1.4	Meters may be provided with an adjustment device, which permits modification of the ratio between the indicated volume and the actual volume of liquid passing through the meter, by a simple command.	/	/	Adjustment is performed in the connected calculator / indicating device
	When this adjustment device modifies this ratio in a discontinuous manner, the consecutive values of the ratio shall not differ by more than 0.0005 for meters intended to equip measuring systems of class 0.3, and 0.001 for other meters.	/	/	
	Adjustment by means of a bypass of the meter is prohibited.	/	/	
3.1.5	Correction device			
3.1.5	Meters may be fitted with correction devices; such devices are always considered as an integral part of the meter. The whole of the requirements that apply to the meter, in particular the maximum permissible errors specified in 3.1.2.1, are therefore applicable to the corrected volume (at metering conditions).	/	/	
	In normal operation, non-corrected volume shall not be displayed.	/	/	
	The aim of a correction device is to reduce the errors as close to zero as possible. Note: National regulations should state that the use of this device for adjusting the errors of a meter to values other than as close as practical to zero is forbidden, even when these values are within the maximum permissible errors.	/	/	
	All the parameters which are not measured and which are necessary for correction shall be contained in the calculator at the beginning of the measurement operation. The pattern approval certificate may prescribe the possibility of checking parameters that are necessary for correctness at the time of verification of the correction device.	/	/	

§ (R117)	Description	+	-	Remarks
	The correction device shall not allow the correction of a pre-estimated drift in relation to time or volume flow, for example.	/	/	
	The associated measuring instruments, if any, shall comply with the applicable International Standards or Recommendations.	/	/	
	Their accuracy shall be good enough to permit that the requirements on the meter be met, as specified in 3.1.2.1.	/	/	
	Associated measuring instruments shall be fitted with checking devices, as specified in 4.3.6.	/	/	
3.1.6	Measuring systems equipped with volumetric meters			
3.1.6	The periodic variation of a volumetric meter shall be less than half the minimum specified volume deviation.	/	/	
	When a volumetric meter is approved separately, the pattern approval certificate shall indicate the value of its cyclic volume.	/	/	
3.1.7	Measuring systems equipped with turbine meters			
3.1.7.1	The pressure downstream of the meter shall satisfy the manufacturers specification. The minimum pressure shall be indicated on the data plate of the meter.	X		
3.1.7.2	Measuring systems equipped with turbine meters shall be fitted with flow straightening devices for preventing, as far as possible, the liquid from any possible rotation and for regulating the flow at the inlet of the meter. These are straight pipes, or flow straighteners, or a combination of straight pipes and a flow straightener.	X		
	The flow straightening device shall be placed immediately upstream of the meter and its internal diameter shall be equal to the diameter of the inlet of the meter. In addition, application of the provisions in ISO 2715 is recommended for this specific point.	X		
	The length of the necessary straight pipes and the characteristics of the flow straighteners are specified by the pattern approval of turbine meters.	X		
3.1.7.3	Each turbine meter shall be followed by a straight pipe having an internal diameter equal to the outlet diameter of the meter and a length of at least five times this diameter. Note: Requirements in 3.1.7.2 and 3.1.7.3 may be not fulfilled if the manufacturer's solutions ensure equivalent results.	X		
3.1.8	Measuring systems equipped with electromagnetic meters			

§ (R117)	Description	+	-	Remarks
3.1.8.1	Measuring systems equipped with electromagnetic meters shall be fitted with a straight pipe upstream of the meter and with a straight pipe downstream of the meter.	/	/	
	The upstream pipe shall have an internal diameter equal to the inlet diameter of the meter and a length of at least ten times this diameter.	/	/	
	The downstream pipe shall have an internal diameter equal to the outlet diameter of the meter and a length of at least five times this diameter.	/	/	
3.1.8.2	The time necessary for determining the minimum measured quantity at maximum flow rate, must be at least twenty times the duration of one complete cycle for meters using a.c. or pulsed d.c. field excitation.	/	/	
3.1.8.3	The maximum permissible cable length between primary and secondary devices, as defined in ISO/TR 6817-1980, shall be not more than 100 metres or not more than the value L expressed in metres according to the following formula, whichever is smaller: L= (kxc)l(fxC) where: k=2x10-Sm c is the conductivity of the liquid, in S/m f is the field frequency during the measuring cycle, in Hz C is the effective cable capacitance per metre, in F/m Note: Requirements in 3.1.8 may be not fulfilled if the manufacturer's solutions ensure equivalent results.	/	/	
3.2	Indicating devices	/	/	
3.3	Price indicating device	/	/	
3.4	**Printing device**	/	/	
3.5	**Memory device**	/	/	
3.6	Pre-setting device			
4	**MEASURING SYSTEMS EQUIPPED WITH ELECTRONIC DEVICES**			
4.1	General requirements			
4.1.1	Electronic measuring systems shall be designed and manufactured such that their errors do not exceed the maximum permissible errors as defined in 2.5 under rated operating conditions.	/	/	
4.1.1.1	Interruptible electronic measuring systems shall be designed and manufactured such that, when they are exposed to the disturbances specified in R117, annex A, point 4: • either a) significant faults do not occur, • or b) significant faults are detected and acted upon by means of checking facilities.	/	/	

§ (R117)	Description	+	-	Remarks
	This provision may apply separately to: • each individual cause of significant fault and/or • each part of the measuring system.	/	/	
4.1.1.2	Non-interruptible measuring systems shall be designed and manufactured in such a way that no significant faults occur when they are exposed to the disturbances specified in A.4.	/	/	
4.1.2	It is the responsibility of the manufacturer to decide whether a given pattern of measuring system is interruptible or not, taking into account the applicable rules of security. However, measuring systems for direct selling to the public shall be interruptible. When, at the time of pattern approval, it is not possible to specify the future utilisation of the instrument the requirements in 4.1.1.2 apply.	/	/	
4.1.3	The requirements in 4.1.1 shall be met durably. For this purpose electronic measuring systems shall be provided with the checking facilities specified in 4.3.	/	/	
4.1.4	A pattern of a measuring system is presumed to comply with the requirements in 4.1.1 and 4.1.3 if it passes the inspections and tests specified in 6.1.11.1 and 6.1.11.2.	/	/	
4.1.5	Measuring systems shall permit the retrieval of the information relating to the measured volume contained within the instrument when a significant fault occurred and was detected by checking facilities.	/	/	
4.2	Power supply device			
4.2.1	When the flow is not interrupted during the failure of the principal power supply, the measuring system shall be provided with an emergency power supply to safeguard all measuring functions during the failure.	/	/	
4.2.2	When the flow is interrupted during the failure of the principal power supply, the provisions in 4.2.1 shall be met, or data contained at the moment of the failure shall be saved and displayable on an indicating device subject to legal metrology control for sufficient time to permit the conclusion of the current transaction. The absolute value of the MPE for the indicated volume in this case is increased by 5% of the minimum measured quantity.	/	/	
4.3	Checking facilities			
4.3.1	Action of checking facilities The detection by the checking facilities of significant faults shall result in the following actions, according to the type.			
4.3.1.1	Checking facilities of type N: a visible or audible alarm for the attention of the operator.	/	/	

§ (R117)	Description	+	-	Remarks
4.3.1.2	CHECKING FACILITIES OF TYPES I OR P: a) for non-interruptible measuring systems: • automatic correction of the fault, or • stopping only the faulty device when the measuring system without that device continues to comply with the regulations, or • a visible or audible alarm for the operator; this alarm shall continue until the cause of the alarm is suppressed. In addition, when the measuring system transmits data to peripheral equipment, the transmission shall be accompanied by a message indicating the presence of a fault. Note: The third hyphen is not applicable for the disturbances specified in A.4. In addition, the instrument may be provided with devices to estimate the amount of liquid having passed through the installation during the occurrence of the fault. The result of this estimate shall not be capable of being mistaken for a valid indication.	/	/	
	b) for interruptible measuring systems, in particular for fuel dispensers: • automatic correction of the fault, or • stopping only the faulty device, when the measuring system without that device continues to comply with the regulations, or • stopping the flow.	/	/	
4.3.2	Checking facilities for the measurement transducer. The objective is to verify the presence of the transducer, its correct operation and the correctness of data transmission.			
4.3.2.1	When the signals generated by the flow sensor are in the form of pulses, each pulse representing an elementary volume, at least security level B defined by ISO 6551 Cable transmission of electric and/or electronic pulsed data is required.	X		The tranducer's pulser generates a double, 90° phase shifted pulse signal
	These checking facilities shall be of type P and the checking shall occur at time intervals not exceeding the duration of the measurement of an amount equal to the minimum specified volume deviation.	/	/	

§ (R117)	Description	+	-	Remarks
	It shall be possible during pattern approval and initial verification to check that these checking facilities function correctly: • by disconnecting the transducer, or • by interrupting one of the sensor's pulse generators, or by interrupting the electrical supply of the transducer.	/	/	
5.	**Requirements specific to certain types of measuring systems**			
5.1	Fuel dispensers	/	/	
5.2	Measuring systems on road tankers for the transport and delivery of liquids of low viscosity (≤ mPa.s) and stored at atmospheric pressure, with the exception of potable liquids.			
5.2.5	In conformity with national regulations on their use, each measuring system shall be allocated to a specific product or to a range of products for which the meter has been approved.	/	/	Up to national regulations
	The pipe work shall, as far as possible, be designed so that products cannot become mixed in the measuring system.	/	/	
5.3	Measuring systems for the unloading of ships' tanks and of rail and road tankers using an intermediate tank.	/	/	
5.4	Measuring systems for liquefied gases under pressure (other than LPG dispensers)	/	/	
5.5	Measuring system for milk	/	/	
5.6	**Measuring systems on pipeline and systems for loading ships**	/	/	
5.7	Fuel dispensers for liquefied gases under pressure (LPG dispensers)	/	/	
5.8	Measuring systems intended for refuelling of aircraft	/	/	
5.9	Blend dispensers	/	/	
5.10	Self-service arrangements with fuel dispensers	/	/	
5.11	Other self-service arrangements	/	/	

Information concerning the test set-up

Accuracy tests

The accuracy tests and the endurance tests were performed in February 1994 (3" and 4") an March 1996 (6" and 8"), and the results of those tests were used in this certificate.
The tests were performed by determination of the K-factor for different flow rates. The given errors are related to the nominal K-factor.

The UMB 3" and 4" meters are tested in the NMi testinstallation. The tests are performed by comparing the volume pulse-output of the meter with the volume measured in an open prover tank. The maximum errors of the standard measures are 0.03 %. The density measurements are performed with a maximum uncertainty of 0.01 % (Anton Paar density meter). Together with the extra error caused by the temperature measure-ment and density measurement, the reference method has a maximum uncertainty of about 0.05 %.

Liquid characteristics:

Liquid	Viscosity at 20 °C (mPa.s)	Density at 20 °C (kg/m^3)
Gasoline	0.47	713.9
Gas-oil	3.08	829.1

- the meter was installed in a loop which is mounted to the testbench.
- The control valve for regulating the flow, is placed behind the meter.

The UMB 3" and 4" meters are tested in the NMi testinstallation. The tests are performed by comparing the number of pulses counted with the known volume that passed through a piston prover. The turbinemeter is installed downstream of the piston prover. Due to the high flowrates the temperature and the pressure of the liquid in the piston prover and the turbinemeter is assumed to be equal. Because the maximum flowrate of the installation is limited to 3000 L/min, the UMB 4" is not tested at the highest flowrates.

Fuel characteristics:

Liquid	Viscosity [mm^2/s] @ (20 °C)	Thermal expansion coefficient [$°C^{-1}$]	Compressibility [kPa^{-1}]
Isopar J	1.5	0.000776	$5.7@10^{-7}$
Flexon 832	12.6	0.000728	$5.4@10^{-7}$

Remarks:

- The control valve for regulating the flow, is placed downstream of the meter.
- The maximum uncertainty in each measurement is less than 0.04%. This uncertainty includes the error made by the temperature effect.
- The maximum flowrate of the compact prover is about 850 m^3/h. The 8" turbinemeter could not be tested on all flowrates.
- The net prover volume (volume at 15 °C) is calculated back to what this volume was at metering conditions

For the accuracy tests the error is defined as:

Error = (K-faktor – 18,7) / 18,7 * 100%

Performance tests

The test prescribed by OIML International Recommendation, regarding electronic devices, as given in Annex A, have been performed on the pulser. Because the pulser is integrated in the measurement sensor, tests were performed in the following way:

- the measurements sensor's inner part were rotated using an electro motor
- a second, check pulser was attached to the measurement sensor's inner part
- the number of pulses generated by the transducer's own pulser was compared with the number of pulses generated by the check pulser.

The output of the check pulser generated 33.33333 times more pulses per revolution than the pulser under test.
The tests were carried out at a simulated flowrate of approximately 2998.5 l/min equal to 315.9 Hz (2998.5/60 sec * 6.3212 nom puls/l value)

Conclusion of the tests

N°	Test description	+	-	Remarks
Tests on the UMB turbine meter 3"				
1	Dry Heat	X		
2	Cold	X		
3	Damp Heat	X		
4	Power voltage variation	X		
5	Electrical burst	X		
6	Electro static discharges			
7	Electromagnetic suspectibility, Orientation 1, 26 – 1000 MHz, Vertical and Horizontal polarisation	X		
8	Before endurance gasoline	X		
9	After endurance gasoline	X		
10	Accuracy test petroleum	X		
11	Accuracy test gasoil	X		

SYMBOLS

Symbols, units and equations:

t	Time (s)
Q	Flowrate (L/min)
F	Frequency (Hz)
V_i	Volume indication (L)
V_n	Calculated volume from simulated pulses
Np in	Number of pulses from reference
Nn	Number of pulses from reference calculated with pulse value
Ni	Number of pulses from primary indicator
T	Temperature of liquid in test measure (°C)
T_r	Reference temperature of test measure (°C)
T_m	Temperature of liquid passed through the meter (°C)
p_m	Pressure of liquid passed through the meter (bar gauge)
E_v	Error of volume indication (%)
E_p	Error of price indication (price)
E_{ni}	Error of pulses (%)
α	Cubic expansion coefficient of test liquid due to temperature ($°C^{-1}$)
χ	Cubic expansion coefficient of test liquid due to pressure (bar^{-1})
β	Cubic expansion coefficient of test measure due to temperature ($°C^{-1}$)
V_{nc}	Volume of test measure, compensated for deviation from reference temperature (L)
V_{mc}	Volume passing through the meter corrected for the temperature and pressure difference between temperature of liquid in test measure and temperature and pressure of liquid passing through the meter (L)
$\bar{E}$	Mean value of error of indication (% or price)
n	Number of tests at the same condition
S.F.	Significant Fault (%)
U	Mains Voltage
U_i	Indicated mains voltage
P_c	$= V_i \times P_u$
E_v	$= \frac{Kfaktor - Nom.pulseV}{Nom.pulseV} \times 100$
f in	Frequentie pule output
n_{ref}	Number of reference pulses
nn_{ref}	Number of reference pulses devided by the pulse ratio
ni	Number of pulses UET

Pulse ratio: (pulse value reference) / (pulse value EUT)

Testresults

1. Dry heat (non condensing)
   Test place: NMi Certin B.V., Hugo de Grootplein 1, 3314 EG Dordrecht
   Test date: January 11, 2002 – Februari 14, 2002
   Observer: P. van Rooy

	Reference values					Primary indicator		
Test No. / Condition	f in	Q	n_{ref}	Pulse ratio	nn_{ref}	ni	Eni	MPE Eni
	Hz	L/min	pulses		pulses	pulses	%	%
1	temperature [°C]: 20; relative humidity [%RH]: 50							
1A	315.9	2998.5	682165	33.33333	20465	20475	0.05	0.06
1B	315.9	2998.5	679450	33.33333	20384	20388	0.02	0.06
1C	315.9	2998.5	675513	33.33333	20265	20276	0.05	0.06
2	temperature [°C]: 55; relative humidity [%RH]: 19; EUT switched on							
2A	315.9	2998.5	693685	33.33333	20811	20815	0.02	0.06
2B	315.9	2998.5	693255	33.33333	20798	20799	0.01	0.06
2C	315.9	2998.5	710583	33.33333	21317	21318	0.00	0.06
3	temperature [°C]: 20; relative humidity [%RH]: 50							
3A	315.9	2998.5	687222	33.33333	20617	20625	0.04	0.06
3B	315.9	2998.5	685146	33.33333	20554	20558	0.02	0.06
3C	315.9	2998.5	691750	33.33333	20753	20759	0.03	0.06

Environmental conditions:

Ambient :	Temperature :	55 °C
	Relative Humidity :	19 %
	Pressure :	1022 hPa

2. Cold
Test place: NMi Certin B.V., Hugo de Grootplein 1, 3314 EG Dordrecht
Test date: January 11, 2002 – Februari 14, 2002
Observer: P. van Rooy

	Reference values					Primary indicator		
Test No. / Condition	f in	Q	nref	Pulse ratio	nnref	ni	Eni	MPE Eni
	Hz	L/min	pulses		pulses	pulses	%	%
1	temperature [°C]: 20; relative humidity [%RH]: 50							
1A	315.9	2998.5	644079	33.33333	19322	19327	0.02	0.06
1B	315.9	2998.5	642091	33.33333	19263	19262	0.00	0.06
1C	315.9	2998.5	646730	33.33333	19402	19406	0.02	0.06
2	temperature [°C]: -25; relative humidity [%RH]: not measured; EUT switched on							
2A	315.9	2998.5	1699084	33.33333	50973	50986	0.03	0.06
2B	315.9	2998.5	1687593	33.33333	50628	50655	0.05	0.06
2C	315.9	2998.5	1688686	33.33333	50661	50677	0.03	0.06
3	temperature [°C]: 20; relative humidity [%RH]: 50							
3A	315.9	2998.5	682165	33.33333	20465	20475	0.05	0.06
3B	315.9	2998.5	679450	33.33333	20384	20388	0.02	0.06
3C	315.9	2998.5	675513	33.33333	20265	20276	0.05	0.06

Environmental conditions:
Ambient : Temperature : -25 °C
Pressure : 1026 hPa

3. Damp heat cyclic
Test place: NMi Certin B.V., Hugo de Grootplein 1, 3314 EG Dordrecht
Test date: January 11, 2002 – Februari 14, 2002
Observer: P. van Rooy

	Reference values					Primary indicator		
Test No. / Condition	f in	Q	n_{ref}	Pulse ratio	nn_{ref}	ni	Eni	MPE Eni
	Hz	L/min	pulses		pulses	pulses	%	%
1	temperature [°C]: 20; relative humidity [%RH]: 50							
1A	315.9	2998.5	687222	33.33333	20617	20625	0.04	0.06
1B	315.9	2998.5	685146	33.33333	20554	20558	0.02	0.06
1C	315.9	2998.5	691750	33.33333	20753	20759	0.03	0.06
2	2 cycles at temperature [°C]: 25 - 55 - 25 - 55 °C; relative humidity [%RH]: 96; EUT switched off							
3	temperature [°C]: 20; relative humidity [%RH]: 50							
3A	315.9	2998.5	682228	33.33333	20467	20466	0.00	0.06
3B	315.9	2998.5	693475	33.33333	20804	20803	-0.01	0.06
3C	315.9	2998.5	712538	33.33333	21376	21375	-0.01	0.06

Environmental conditions:

Ambient :	Temperature :	25 – 55 – 25 - 55 °C
	Relative Humidity :	50 %
	Pressure :	1016 hPa

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4. Power voltage variations
Test place: NMi Certin B.V., Hugo de Grootplein 1, 3314 EG Dordrecht
Test date: January 11, 2002 – Februari 14, 2002
Observer: R. van Horssen

	Reference values					Primary indicator		
Test No. / Condition	f in	Q	np in	Pulse ratio	nn	ni	Eni	MPE Eni
	Hz	L/min	pulses		pulses	pulses	%	%
1	power supply voltage: 24 Vdc							
1A	315.9	2998.5	1344218	33.33333	40327	40326	0.00	0.06
1B								
1C								
2	maximum power supply voltage: 30 Vdc							
2A	315.9	2998.5	2165857	33.33333	64976	64975	0.00	0.06
2B	315.9	2998.5	1992590	33.33333	59778	59777	0.00	0.06
2C								
3	minimum power supply voltage: 10 Vdc							
3A	315.9	2998.5	1994630	33.33333	59839	59838	0.00	0.06
3B	315.9	2998.5	2080217	33.33333	62407	62406	0.00	0.06
3C								
4	power supply voltage: 24 Vdc							
4A	315.9	2998.5	1355533	33.33333	40666	40664	0.00	0.06
4B								
4C								

Remarks: Ui nominal voltage = 10-30 Vdc

Environmental conditions:

Ambient:	Temperature:	21 °C
	Humidity:	52 %
	Pressure :	1026.0 hPa

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Electrical burst
Test place: NMi Certin B.V., Schoemakerstraat 97 2628 VK DELFT
Test date: January 11, 2002 – Februari 14, 2002
Observer: M.P. Mergler

	Reference values					**Primary indicator**				
Test No. / Condition	f in	Q	np in	Pulse ratio	nn	ni	Eni	SF	Checking facility	
	Hz	L/min	pulses		pulses	pulses	%	%	yes	no
1	nominal power supply voltage: 230 Vac at 50 Hz									no
1A	315.9	2998.5	1344218	33.33333	40327	40326	0.00	0.10		no
1B	315.9	2998.5	1356733	33.33333	40702	40701	0.00	0.10		no
1C	315.9	2998.5	1378168	33.33333	41345	41344	0.00	0.10		no
2	line 1 positive									
2A	315.9	2998.5	879331	33.33333	26380	26379	0.00	0.10		no
2B										
2C										
3	line 1 negative									
3A	315.9	2998.5	762696	33.33333	22881	22880	0.00	0.10		no
3B										
3C										
4	line 2 positive									
4A	315.9	2998.5	1166668	33.33333	35000	34999	0.00	0.10		no
4B										
4C										
5	line 2 negative									
5A	315.9	2998.5	794368	33.33333	23831	23830	0.00	0.10		no
5B										
5C										

Environmental conditions:

Ambient :	Temperature :	22 °C
	Relative Humidity :	52 %
	Pressure :	1018 hPa

6. Electro Static Discharges (ESD)
Test place: NMi Certin B.V., Schoemakerstraat 97 2628 VK DELFT
Test date: January 11, 2002 – Februari 14, 2002
Observer: M.P. Mergler

	Reference values					Primary indicator				
Test No. / Condition	f in	Q	np in	Pulse ratio	nn	ni	Eni	SF	Checking facility	
	Hz	L/min	pulses		pulses	pulses	%	%	yes	no
1	reference condition									
1A	315.9	2998.5	1355533	33.33333	40666	40664	0.00	0.10		no
1B										
1C										
2	positive discharge on			pulser						
2A	315.9	2998.5	2523733	33.33333	75712	75725	0.02	0.10		no
2B										
2C										
3	negative discharge on			pulser						
3A	315.9	2998.5	2202211	33.33333	66066	66073	0.01	0.10		no
3B										
3C										
4	reference condition									
4A	315.9	2998.5	1344218	33.33333	40327	40326	0.00	0.10		no
4B										
4C										

Environmental conditions:
Ambient : Temperature : 22 °C
Relative Humidity : 52 %
Pressure : 1018 hPa

7. Electromagnetic Susceptibility
Test place: NMi Certin B.V., Schoemakerstraat 97 2628 VK DELFT
Test date: January 11, 2002 – Februari 14, 2002
Observer: M.P. Mergler

	Reference values						Primary indicator				
Test condition	S.V.	f in	Q	np in	Puls ratio	nn	ni	Eni	SF	Checking facility	
Method	decade/s	Hz	L/min	pulses		pulses	pulses	%	%	yes	no
non disturbed		315.9	2998.5	1340905	33.3333	40227	40227	0.00	0.10		no
non disturbed		315.9	2998.5	1804519	33.3333	54136	54136	0.00	0.10		no
antenna H; side 1; 26 - 35.045 MHz	1% steps	315.9	2998.5	1772375	33.3333	53171	53170	0.00	0.10		no
35.045 - 51.659 MHz	1% steps	315.9	2998.5	1750513	33.3333	52515	52514	0.00	0.10		no
51.659 - 79.244 MHz	1% steps	315.9	2998.5	1915254	33.3333	57458	57457	0.00	0.10		no
antenna V; side 1; 26 - 35.045 MHz	1% steps	315.9	2998.5	1375550	33.3333	41267	41266	0.00	0.10		no
35.045 - 51.659 MHz	1% steps	315.9	2998.5	1702304	33.3333	51069	51069	0.00	0.10		no
51.659 - 79.244 MHz	1% steps	315.9	2998.5	1865609	33.3333	55968	55967	0.00	0.10		no

	Reference values						Primary indicator				
Test condition	S.V.	f in	Q	np in	Pulse ratio	nn	ni	Eni	SF	Checking facility	
Method	decade/s	Hz	L/min	pulses		pulses	pulses	%	%	yes	no
80.037 - 119.164 MHz	1% steps	315.9	2998.5	1700545	33.3333	51016	51015	0.00	0.10		no
119.164 -173.923 MHz	1% steps	315.9	2998.5	1650447	33.3333	49513	49513	0.00	0.10		no
173.923 - 258.946 MHz	1% steps	315.9	2998.5	1707206	33.3333	51216	51215	0.00	0.10		no
258.946 - 385.536 MHz	1% steps	315.9	2998.5	1689569	33.3333	50687	50687	0.00	0.10		no
385.536 -574.01 MHz	1% steps	315.9	2998.5	1728076	33.3333	51842	51841	0.00	0.10		no
574.01 -982.368 MHz	1% steps	315.9	2998.5	2255381	33.3333	67661	67660	0.00	0.10		no

	Reference values						Primary indicator				
Test condition	S.V.	f in	Q	np in	Pulse ratio	nn	ni	Eni	SF	Checking facility	
Method	decade/s	Hz	L/min	pulses		pulses	pulses	%	%	yes	no
80.037 - 119.164 MHz	1% steps	315.9	2998.5	1767151	33.3333	53015	53014	0.00	0.10		no
119.164 - 173.923 MHz	1% steps	315.9	2998.5	1728841	33.3333	51865	51864	0.00	0.10		no
173.923 - 258.946 MHz	1% steps	315.9	2998.5	1750060	33.3333	52502	52501	0.00	0.10		no
258.946 - 385.536 MHz	1% steps	315.9	2998.5	1725431	33.3333	51763	51762	0.00	0.10		no
385.536 - 574.01 MHz	1% steps	315.9	2998.5	1738811	33.3333	52164	52164	0.00	0.10		no
574.01 - 1000.00 MHz	1% steps	315.9	2998.5	2362234	33.3333	70867	70866	0.00	0.10		no
non disturbed		315.9	2998.5	1344618	33.3333	40339	40338	0.00	0.10		no
non disturbed		315.9	2998.5	1356733	33.3333	40702	40701	0.00	0.10		no
non disturbed		315.9	2998.5	1378168	33.3333	41345	41344	0.00	0.10		no

Environmental conditions:

Ambient :	Temperature :	22 °C
	Relative Humidity :	52 %
	Pressure :	1016 hPa

8. Before Endurance test **(UMB 3")**
Test place: NMi Certin B.V., Hugo de Grootplein 1, 3314 EG Dordrecht
Test date: February 1994; nominal k-factor: 29.2 p/L

	Reference values					**Primary indicator**			
Test No. / Condition	f in	Q	Tr	Pr	Vnc	n_i	K-factor	Ev	mpe
	Hz	L/min	°C	bar	L	pulses	pulses/L	%	%
1	1144	2350	14.8	1.0	5016.5	146727	29.249	0.17	0.30
2	1144	2350	14.9	1.0	4996.5	146178	29.256	0.19	0.30
	Average EV		0.18	%	Range	0.02	%		
3	960	1973	15.5	2.0	4995.5	146094	29.245	0.15	0.30
4	960	1973	15.8	2.0	4996.5	146102	29.241	0.14	0.30
	Average EV		0.15	%	Range	0.01	%		
5	720	1480	16.2	2.9	4995.5	146079	29.242	0.14	0.30
6	720	1480	16.4	2.9	4995.5	146079	29.242	0.14	0.30
	Average EV		0.14	%	Range	0.00	%		
7	480	987	16.7	1.4	1995.8	58356	29.239	0.13	0.30
8	480	987	16.7	1.4	1995.4	58352	29.243	0.15	0.30
	Average EV		0.14	%	Range	0.01	%		
9	360	740	16.8	1.4	1994.8	58272	29.212	0.04	0.30
10	360	740	16.8	1.4	1995.0	58277	29.212	0.04	0.30
	Average EV		0.04	%	Range	0.00	%		
11	240	493	17.0	1.2	1994.0	58225	29.200	0.00	0.30
12	240	493	17.0	1.2	1994.2	58235	29.202	0.01	0.30
	Average EV		0.01	%	Range	0.01	%		
13	120	247	17.3	1.4	1997.0	58295	29.191	-0.03	0.30

Product : gasoline

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8. After Endurance test **(UMB 3")**

Test place: NMi Certin B.V., Hugo de Grootplein 1, 3314 EG Dordrecht

Test date: February 1994; nominal k-factor: 29.2 p/L

	Reference values					**Primary indicator**			
Test No. / Condition	f in Hz	Q L/min	Tr °C	Pr bar	Vnc L	n_i pulses	K-factor pulses/L	Ev %	MPE %
1	1201	2467	18.60	1.0	5043.0	147450	29.239	0.13	0.30
2	1201	2467	18.60	1.0	5062.0	148090	29.255	0.19	0.30
3	1201	2467	19.40	1.0	5061.0	147977	29.239	0.13	0.30
	Average EV		0.15	%	Range	0.06	%		
4	9574	19673	19.60	2.2	5068.0	148005	29.204	0.01	0.30
5	9574	19673	19.70	2.2	5047.0	147406	29.207	0.02	0.30
	Average EV		0.02	%	Range	0.01	%		
6	720	1480	20.20	3.1	5048.0	147439	29.207	0.03	0.30
	Average EV		0.03	%	Range	0.00	%		
7	480	987	20.70	3.7	5044.5	147366	29.213	0.05	0.30
8	480	987	21.00	3.7	5051.5	147447	29.189	-0.04	0.30
	Average EV		0.00	%	Range	0.08	%		
9	240	493	21.40	1.8	2030.4	59352	29.232	0.11	0.30
10	240	493	21.50	1.8	2034.4	59471	29.233	0.11	0.30
	Average EV		0.11	%	Range	0.00	%		
11	120	247	21.50	1.9	2011.6	58784	29.223	0.08	0.30
12	120	247	21.50	1.9	2017.0	58951	29.227	0.09	0.30
	Average EV		0.08	%	Range	0.02	%		

Product : gasoline

10. Accuracy of the Meter (UMT 3")
Test place: NMi Certin B.V., Hugo de Grootplein 1, 3314 EG Dordrecht
Test date: February 1994; nominal k-factor: 29.2 p/L

	Reference values				Primary indicator				
Test No. / Condition	f in Hz	Q L/min	Tr °C	Pr bar	Vnc L	n_i pulses	K-factor pulses/L	Ev %	mpe %
1	1201	2467	13.80	1.1	4977.0	145692	29.273	0.25	0.30
2	1201	2467	14.10	1.1	4977.0	145699	29.274	0.26	0.30
Average EV			0.25	%	Range	0.00	%		
3	960	1973	14.60	1.6	4975.5	145403	29.224	0.08	0.30
4	960	1973	14.80	1.6	4976.5	145484	29.234	0.12	0.30
Average EV			0.10	%	Range	0.04	%		
5	720	1480	15.40	1.8	4972.0	145240	29.212	0.04	0.30
6	720	1480	15.60	1.8	4972.5	145256	29.212	0.04	0.30
Average EV			0.04	%	Range	0.00	%		
7	480	987	15.90	1.4	1987.6	58009	29.185	-0.05	0.30
8	480	987	16.00	1.4	1987.2	58019	29.196	-0.01	0.30
Average EV			-0.03	%	Range	0.04	%		
9	360	740	16.10	1.3	1985.4	57972	29.199	0.00	0.30
10	360	740	16.20	1.3	1986.0	57979	29.194	-0.02	0.30
Average EV			-0.01	%	Range	0.02	%		
11	240	493	16.30	1.4	1986.0	58000	29.204	0.02	0.30
12	240	493	16.40	1.4	1986.6	58010	29.201	0.00	0.30
Average EV			0.01	%	Range	0.01	%		
13	120	247	16.50	1.4	1994.4	58328	29.246	0.16	0.30
14	120	247	16.80	1.4	1992.2	58256	29.242	0.14	0.30
Average EV			0.15	%	Range	0.01	%		

Product : petroleum

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11. Accuracy test gasoil **(UMB 3")**

Test place: NMi Certin B.V., Hugo de Grootplein 1, 3314 EG Dordrecht

Test date: February 1994; nominal k-factor: 29.2 p/L

	Reference values					Primary indicator			
Test No. / Condition	f in Hz	Q L/min	Tr °C	Pr bar	Vnc L	n_i pulses	K-factor pulses/L	Ev %	mpe %
1	1201	2467	14.40	1.00	4953.00	144851	29.245	0.15	0.30
2	1201	2467	14.60	1.00	4953.50	144857	29.243	0.15	0.30
3									
Average EV			0.15	%	Range	0.01	%		
4	960	1973	15.20	2.20	1981.80	57909	29.220	0.07	0.30
5	960	1973	15.30	2.20	1981.60	57914	29.226	0.09	0.30
6									
Average EV			0.08	%	Range	0.02	%		
7	720	1480	15.50	1.60	1980.40	57872	29.222	0.08	0.30
8	720	1480	15.60	1.60	1980.00	57864	29.224	0.08	0.30
9									
Average EV			0.08	%	Range	0.01	%		
10	480	987	15.90	1.70	1979.40	57821	29.211	0.04	0.30
11	480	987	15.90	1.70	1979.40	57807	29.204	0.01	0.30
12									
Average EV			0.03	%	Range	0.02	%		
13	360	740	16.00	1.40	1978.00	57767	29.205	0.02	0.30
14	360	740	16.10	1.40	1978.00	57766	29.204	0.01	0.30
15									
Average EV			0.02	%	Range	0.00	%		
16	240	493	16.30	1.40	1978.20	57771	29.204	0.01	0.30
17	240	493	16.40	1.40	1977.20	57734	29.200	0.00	0.30
18									
Average EV			0.01	%	Range	0.01	%		
19	120	247	16.80	1.60	1979.40	57775	29.188	-0.04	0.30
20	120	247	16.90	1.60	1978.80	57749	29.184	-0.06	0.30
21									
Average EV			-0.05	%	Range	0.01	%		

Product : gasoil

12. Before Endurance test **(UMB 4")**
Test place: NMi Certin B.V., Hugo de Grootplein 1, 3314 EG Dordrecht
Test date: February 1994

	Reference values					Primary indicator			
Test No. / Condition	f in	Q	Tr	Pr	Vnc	n_i	K-factor	Ev	MPE
	Hz	L/min	°C	bar	L	pulses	pulses/L	%	%
1	811	2595	20.70	1.30	5072.18	94932	18.716	-0.18	0.30
2	811	2595	20.80	1.30	5067.55	94851	18.717	-0.17	0.30
3	811	2595	20.80	1.30	5065.34	94799	18.715	-0.19	0.30
Average EV			-0.18	%	Range	0.02	%		
4	591	1890	20.90	2.70	5069.76	94835	18.706	-0.23	0.30
5	591	1890	21.00	2.70	5068.22	94806	18.706	-0.23	0.30
6	591	1890	21.10	2.70	5070.63	94865	18.709	-0.22	0.30
Average EV			-0.23	%	Range	0.01	%		
7	408	1307	21.20	3.40	2067.53	38726	18.731	-0.10	0.30
8	408	1307	21.30	3.40	2054.36	38486	18.734	-0.09	0.30
9	408	1307	21.20	3.40	1996.33	37405	18.737	-0.07	0.30
Average EV			-0.09	%	Range	0.03	%		
10	251	804	21.30	3.80	1969.32	36949	18.762	0.07	0.30
11	251	804	21.30	3.80	1985.55	37263	18.767	0.09	0.30
12	251	804	21.60	3.80	1992.27	37378	18.762	0.06	0.30
Average EV			0.07	%	Range	0.03	%		
13	144	460	20.80	4.00	2012.48	37753	18.759	0.05	0.30
14	144	460	20.90	4.00	2010.86	37716	18.756	0.03	0.30
15	144	460	21.00	4.00	2012.07	37746	18.760	0.05	0.30
Average EV			0.05	%	Range	0.02	%		
16	100	320	21.30	4.00	2019.79	37868	18.748	-0.01	0.30
17	100	320	21.50	4.00	2010.66	37710	18.755	0.03	0.30
18	100	320	21.70	4.00	2013.09	37736	18.745	-0.03	0.30
Average EV			0.00	%	Range	0.04	%		

Product : gasoline

13. After Endurance test **(UMB 4")**
Test place: NMi Certin B.V., Hugo de Grootplein 1, 3314 EG Dordrecht
Test date: February 1994

	Reference values					Primary indicator			
Test No. / Condition	f in	Q	Tr	Pr	Vnc	n_i	K-factor	Ev	MPE
	Hz	L/min	°C	bar	L	pulses	pulses/L	%	%
1	826	2644	21.00	1.00	5024.01	94119	18.734	-0.09	0.30
2	826	2644	21.00	1.00	5028.87	94214	18.735	-0.08	0.30
3	826	2644	22.00	1.00	5034.74	94290	18.728	-0.12	0.30
Average EV			-0.10	%	Range	0.04	%		
4	596	1906	22.00	4.00	5043.68	94436	18.724	-0.14	0.30
5	596	1906	22.00	4.00	5028.97	94177	18.727	-0.12	0.30
6	596	1906	22.00	4.00	5030.99	94210	18.726	-0.13	0.30
Average EV			-0.13	%	Range	0.02	%		
7	410	1313	22.00	3.00	2042.65	38296	18.748	-0.01	0.30
8	410	1313	22.00	3.00	2037.80	38226	18.758	0.05	0.30
9	410	1313	23.00	3.00	2035.93	38177	18.752	0.01	0.30
Average EV			0.01	%	Range	0.06	%		
10	253	808	23.00	4.00	2032.95	38164	18.773	0.12	0.30
11	253	808	22.00	4.00	2039.53	38327	18.792	0.22	0.30
12	253	808	23.00	4.00	2029.45	38105	18.776	0.14	0.30
13	253	808	23.00	4.00	2027.92	38091	18.783	0.18	0.30
Average EV			0.18	%	Range	0.1	%		
14	147	470	23.00	4.00	2028.19	38076	18.773	0.12	0.30
15	147	470	23.00	4.00	2031.08	38153	18.785	0.18	0.30
16	147	470	23.00	4.00	2029.84	38119	18.779	0.16	0.30
Average EV			0.16	%	Range	0.06	%		

Product : gasoline

14. Accuracy test petroleum **(UMB 4")**
Test place: NMi Certin B.V., Hugo de Grootplein 1, 3314 EG Dordrecht
Test date: February 1994

	Reference values					Primary indicator			
Test No. / Condition	f in	Q	Tr	Pr	Vnc	n_i	K-factor	Ev	mpe
	Hz	L/min	°C	bar	L	pulses	pulses/L	%	%
1	919	2940	14.20	1.20	5061.24	94889	18.748	-0.01	0.30
2	919	2940	14.50	1.20	5010.52	94012	18.763	0.07	0.30
3	919	2940	14.60	1.20	5059.70	94942	18.764	0.08	0.30
Average EV			0.05	%	Range	0.09	%		
4	600	1920	14.90	3.20	5005.51	93987	18.777	0.14	0.30
5	600	1920	15.20	3.20	5001.00	93895	18.775	0.13	0.30
6	600	1920	15.20	3.20	5001.00	93865	18.769	0.10	0.30
Average EV			0.13	%	Range	0.04	%		
7	404	1294	15.90	3.60	2032.11	38119	18.758	0.04	0.30
8	404	1294	16.00	3.60	2019.59	37887	18.760	0.05	0.30
9	404	1294	16.30	3.60	2024.50	37938	18.739	-0.06	0.30
Average EV			0.01	%	Range	0.11	%		
10	255	815	16.40	3.90	2026.96	38011	18.753	0.01	0.30
11	255	815	16.60	3.90	2026.96	38033	18.764	0.07	0.30
12	255	815	16.70	3.90	2027.37	38013	18.750	0.00	0.30
Average EV			0.03	%	Range	0.07	%		
13	150	480	16.80	4.00	2029.84	38088	18.764	0.07	0.30
14	150	480	17.00	4.00	2029.84	38103	18.771	0.11	0.30
15	150	480	17.20	4.00	2030.87	38131	18.776	0.14	0.30
Average EV			0.11	%	Range	0.08	%		

Product : petroleum

15. Accuracy test gasoil **(UMB 4")**
Test place: NMi Certin B.V., Hugo de Grootplein 1, 3314 EG Dordrecht
Test date: February 1994

	Reference values					Primary indicator			
Test No. / Condition	f in	Q	Tr	Pr	Vnc	n_i	K-factor	Ev	mpe
	Hz	L/min	°C	bar	L	pulses	pulses/L	%	%
1	836	2665	18.90	1.50	5001.75	94010	18.795	-0.18	0.30
2	836	2665	19.30	1.50	5008.77	94136	18.794	-0.19	0.30
3	836	2665	19.50	1.50	5005.26	94036	18.787	-0.23	0.30
Average EV			-0.20	%	Range	0.05	%		
4	601	1915	19.70	3.20	5018.47	94335	18.798	-0.17	0.30
5	601	1915	20.00	3.20	5005.41	94038	18.787	-0.23	0.30
6	601	1915	20.90	3.20	2031.45	38161	18.785	-0.24	0.30
Average EV			-0.21	%	Range	0.07	%		
7	410	1308	20.60	4.00	2037.07	38315	18.809	-0.11	0.30
8	410	1308	20.60	4.00	2040.82	38370	18.801	-0.15	0.30
9	410	1308	20.60	4.00	2035.00	38274	18.808	-0.12	0.30
Average EV			-0.13	%	Range	0.04	%		
10	254	810	20.10	4.30	4985.89	94068	18.867	0.20	0.30
11	254	810	20.10	4.30	2017.29	38055	18.864	0.18	0.30
12	254	810	20.20	4.30	2020.14	38098	18.859	0.15	0.30
Average EV			0.18	%	Range	0.05	%		
13	150	477	20.40	4.30	2023.21	38194	18.878	0.25	0.30
14	150	477	20.60	4.30	2019.53	38128	18.880	0.26	0.30
15	150	477	20.60	4.30	2020.75	38143	18.876	0.24	0.30
Average EV			0.25	%	Range	0.02	%		
16	330	1050	20.40	4.20	2030.83	38231	18.825	-0.02	0.30
17	330	1050	20.40	4.20	2028.97	38199	18.827	-0.02	0.30
18	330	1050	20.50	4.20	2021.18	38047	18.824	-0.03	0.30
Average EV			-0.02	%	Range	0.01	%		

Product : gasoil

16. Accuracy test Isopar J **(UMB 6")**
Test place: Brooks Instrument B.V., Veenendaal
Test date: 20 March 1996

Nominale K-faktor 5.8 pulses/L

	Reference values					**Primary indicator**			
Test No. / Condition	f in	Q	Tr	Pr	Vnc	n_i	K-factor	Ev	mpe
	Hz	L/min	°C	bar	L	pulses	pulses/L	%	%
1	1108	11467	24.00	2.74	120.32	699.35	5.812	0.21	0.30
2	1106	11439	24.10	2.74	120.32	699.46	5.813	0.23	0.30
3	1104	11418	24.10	2.73	120.32	699.35	5.812	0.21	0.30
	Average EV		0.22	%	Range	0.02	%		
4	883	9134	24.00	3.42	120.32	699.34	5.812	0.21	0.30
5	881	9114	24.00	3.41	120.32	699.17	5.811	0.19	0.30
6	879	9094	24.00	3.43	120.32	699.28	5.812	0.20	0.30
	Average EV		0.20	%	Range	0.02	%		
7	656	6790	24.10	2.97	120.32	699.08	5.810	0.18	0.30
8	657	6794	24.10	2.96	120.32	699.18	5.811	0.19	0.30
9	657	6793	24.10	2.95	120.32	699.34	5.812	0.21	0.30
	Average EV		0.19	%	Range	0.04	%		
10	432	4473	24.00	3.92	120.32	699.23	5.811	0.20	0.30
11	432	4471	24.00	3.92	120.32	699.24	5.812	0.20	0.30
12	431	4461	24.00	3.92	120.32	699.19	5.811	0.19	0.30
	Average EV		0.20	%	Range	0.01	%		
13	215	2228	24.00	4.39	120.32	699.35	5.812	0.21	0.30
14	215	2222	24.00	4.40	120.32	699.32	5.812	0.21	0.30
15	215	2226	24.00	4.40	120.32	699.23	5.811	0.20	0.30
	Average EV		0.21	%	Range	0.02	%		
16	110	1137	24.00	4.50	120.32	698.56	5.806	0.10	0.30
17	110	1134	24.00	4.51	120.32	698.48	5.805	0.09	0.30
18	110	1134	24.00	4.51	120.32	698.42	5.805	0.08	0.30
	Average EV		0.09	%	Range	0.02	%		

Product : Isopar J; viscosity 1.5 mm^2/s at 20 °C

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17. Accuracy test Flexon **(UMB 6")**
Test place: Brooks Instrument B.V., Veenendaal
Test date: 22 March 1996

Nominale K-faktor 5.8

	Reference values					Primary indicator			
Test No. / Condition	f in Hz	Q L/min	Tr °C	Pr bar	Vnc L	n_i pulses	K-factor pulses/L	Ev %	mpe %
1	1111	11492	22.30	2.96	120.31	699.837	5.817	0.29	0.30
2	1110	11478	22.50	2.95	120.31	699.803	5.817	0.29	0.30
3	1109	11473	22.60	2.99	120.31	699.76	5.816	0.28	0.30
Average EV			0.29	%	Range	0.01	%		
4	887	9175	23.60	3.71	120.31	699.936	5.818	0.31	0.30
5	888	9185	23.70	3.69	120.32	699.907	5.817	0.29	0.30
6	888	9183	23.80	3.69	120.32	699.692	5.815	0.26	0.30
Average EV			0.29	%	Range	0.04	%		
7	649	6713	23.90	4.24	120.32	699.688	5.815	0.26	0.30
8	648	6706	24.00	4.24	120.32	699.798	5.816	0.28	0.30
9	649	6712	23.90	4.24	120.31	699.791	5.817	0.29	0.30
Average EV			0.28	%	Range	0.02	%		
10	436	4510	23.90	4.20	120.31	699.342	5.813	0.22	0.30
11	436	4508	24.00	4.20	120.32	699.301	5.812	0.21	0.30
12	435	4503	24.00	4.20	120.32	699.272	5.812	0.20	0.30
Average EV			0.21	%	Range	0.02	%		
13	221	2289	23.90	4.67	120.32	698.76	5.808	0.13	0.30
14	222	2293	23.90	4.66	120.31	698.829	5.809	0.15	0.30
15	215	2227	23.90	4.66	120.31	698.831	5.809	0.15	0.30
Average EV			0.14	%	Range	0.02	%		
16	107	1105	24.00	4.44	120.32	693.883	5.767	-0.57	0.30
17	107	1107	24.00	4.44	120.32	693.882	5.767	-0.57	0.30
18	107	1107	24.00	4.44	120.32	693.928	5.767	-0.56	0.30
Average EV			-0.57	%	Range	0.01	%		

Product : Flexon 832; viscosity 12.6 mm^2/s at 20 °C

18. Accuracy test Isopar J **(UMB 8")**
Test place: Brooks Instrument B.V., Veenendaal
Test date: 21 March 1996

Nominale K-faktor 3.2 pulses/L

	Reference values					**Primary indicator**			
Test No. / Condition	f in	Q	Tr	Pr	Vnc	n_i	K-factor	Ev	mpe
	Hz	L/min	°C	bar	L	pulses	pulses/L	%	%
1	754	14133	23.30	1.75	120.31	384.2	3.193	-0.20	0.30
2	752	14109	24.10	1.68	120.32	384.05	3.192	-0.25	0.30
3	752	14098	24.70	1.71	120.32	384.06	3.192	-0.25	0.30
	Average EV		-0.24	%	Range	0.05	%		
4	623	11689	25.40	2.65	120.32	384.26	3.194	-0.20	0.30
5	623	11684	25.70	2.68	120.32	384.16	3.193	-0.23	0.30
6	623	11681	26.10	2.65	120.32	384.18	3.193	-0.22	0.30
	Average EV		-0.21	%	Range	0.03	%		
7	494	9271	26.60	3.42	120.32	384.38	3.195	-0.17	0.30
8	494	9254	26.90	3.42	120.32	384.39	3.195	-0.17	0.30
9	492	9228	27.20	3.42	120.32	384.32	3.194	-0.18	0.30
	Average EV		-0.17	%	Range	0.00	%		
10	512	9609	27.60	3.93	120.32	384.62	3.197	-0.11	0.30
11	513	9624	27.90	3.93	120.33	384.63	3.196	-0.11	0.30
12	368	6898	28.20	3.92	120.33	384.59	3.196	-0.12	0.30
	Average EV		-0.11	%	Range	0.02	%		
13	244	4582	28.20	3.95	120.33	384.99	3.199	-0.02	0.30
14	244	4580	28.30	3.94	120.33	384.9	3.199	-0.04	0.30
15	244	4582	28.50	3.94	120.33	384.95	3.199	-0.03	0.30
	Average EV		-0.03	%	Range	0.02	%		
16	123	2306	28.50	4.48	120.33	385.28	3.202	0.06	0.30
17	124	2327	28.70	4.48	120.33	385.35	3.202	0.08	0.30
18	122	2296	28.80	4.48	120.33	385.21	3.201	0.04	0.30
	Average EV		0.06	%	Range	0.04	%		

Product : Isopar J; viscosity 1.5 mm^2/s at 20 °C

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19. Accuracy test Flexon **(UMB 8")**
Test place: Brooks Instrument B.V., Veenendaal
Test date: 22 March 1996

Nominale K-faktor 3.2 pulses/L

	Reference values					Primary indicator			
Test No. / Condition	f in	Q	Tr	Pr	Vnc	n_i	K-factor	Ev	mpe
	Hz	L/min	°C	bar	L	pulses	pulses/L	%	%
1	754	14140	30.70	1.97	120.34	385.303	3.202	0.06	0.30
2	754	14132	31.20	1.98	120.34	385.325	3.202	0.06	0.30
3	754	14130	31.60	1.93	120.33	385.252	3.202	0.05	0.30
Average EV			0.06	%	Range	0.01	%		
4	624	11691	27.30	2.99	120.33	385.463	3.203	0.11	0.30
5	622	11659	27.70	2.97	120.32	385.433	3.203	0.11	0.30
6	623	11672	28.10	2.98	120.32	385.438	3.203	0.11	0.30
Average EV			0.11	%	Range	0.00	%		
7	494	9255	28.30	3.79	120.33	385.623	3.205	0.15	0.30
8	494	9255	28.60	3.77	120.32	385.626	3.205	0.16	0.30
9	493	9247	29.00	3.75	120.33	385.613	3.205	0.14	0.30
Average EV			0.15	%	Range	0.01	%		
10	368	6905	29.10	4.31	120.33	385.727	3.206	0.17	0.30
11	369	6920	29.40	4.30	120.33	385.688	3.205	0.16	0.30
12	369	6918	29.60	4.30	120.33	385.732	3.206	0.18	0.30
Average EV			0.17	%	Range	0.01	%		
13	244	4568	29.60	4.25	120.33	385.677	3.205	0.16	0.30
14	243	4563	29.70	4.26	120.33	385.605	3.205	0.14	0.30
15	243	4564	29.80	4.26	120.33	385.618	3.205	0.15	0.30
Average EV			0.15	%	Range	0.02	%		
16	122	2289	29.90	4.83	120.34	384.748	3.197	-0.09	0.30
17	122	2284	30.00	4.84	120.33	384.852	3.198	-0.05	0.30
18	122	2285	30.10	4.83	120.33	384.868	3.198	-0.05	0.30
Average EV			-0.06	%	Range	0.04	%		

Product : Flexon 832; viscosity 12.6 mm^2/s at 20 °C