Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Precision for the real world
Our calibration facilities at your service

We calibrate your flowmeters on the world's most advanced rigs – in our factory or onsite

Endress+Hauser

People for Process Automation

Endress+Hauser – Your Partner

Endress+Hauser is a global provider of solutions for instrumentation and automation. Supplying the production and logistic sectors of the process industry, the company develops sensors and systems that obtain information from the process, transmit this data and process it. High-quality products and cutting-edge services support our customers' competitiveness with top-notch quality, dependability and efficiency.

Endress+Hauser works closely with universities and research institutes, and also cooperates with business partners and competitors. The company is committed to continuously expanding its industry-specific know-how and ensuring the competence of its sales, marketing and service. The closely knit network of affiliated production and marketing companies as well as regional representatives establishes and maintains the group's powerful presence in all the world's markets – in other words right on your doorstep.

Endress+Hauser is a byword for independence, continuity and long-term customer relationships. Our 50-plus years of application experience are the foundation on which we have built our enormously wide range of products for metering flow, level, pressure and temperature, complete with fluid analysis, recording and system components.

Endress+Hauser is a single-source supplier, so you can always be confident that we will have the optimum solution for your measurement requirements.

Contents

Single-source calibration technology

For level, pressure, flow, temperature and analysis – as a single-source supplier Endress+Hauser manufactures premium equipment and offers its customers all the support of a comprehensive calibration service. Only meters calibrated correctly and to the applicable standards can be relied on to return sustainably accurate and dependable measured values.

Your benefit: cost savings accruing from reliable process control and high product quality.


Level


Pressure


Flow


Temperature


Liquid Analysis

Flow measurement as a core competence

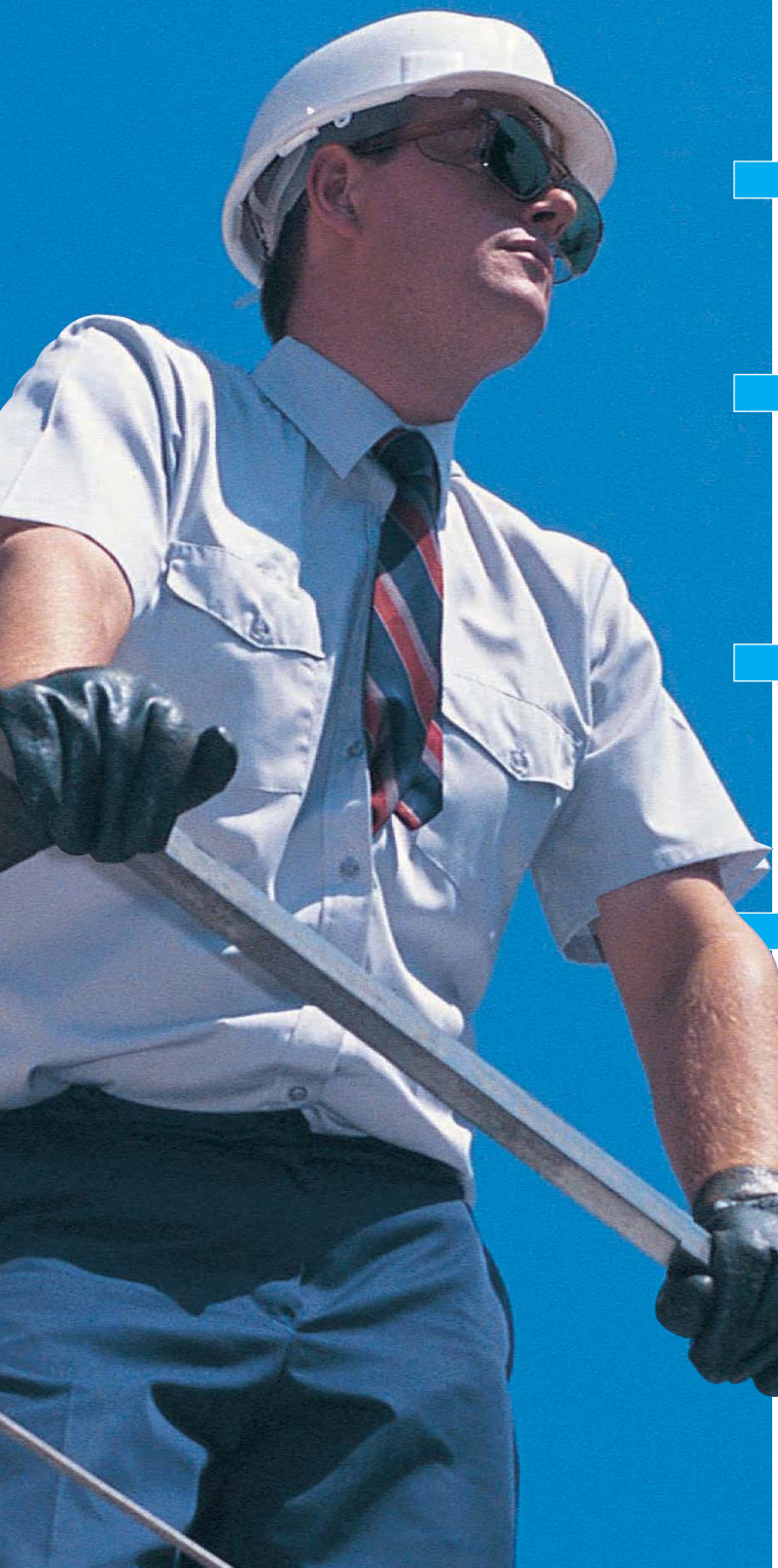
Endress+Hauser and its customers speak the same language in the field of flow measurement as elsewhere. We have 30-plus years of experience in developing and building high-tech calibration rigs for correctly and traceably verifying the accuracy of meters. Our maxim is: "Consistently high measurement quality for our customers all around the world."

From that baseline we have developed a global calibration concept that offers you, our customer, maximum confidence and maximum security:

- Worldwide accreditation of all flow calibration rigs
- Periodic inspection by national standard authorities
- Complete traceability back to national standards (e.g. METAS, PTB, NPL, LNE, NIST, CN), as laid down in ISO/IEC 17025
- Calibration service in more than 40 countries
- Permanent knowledge transfer through internal and external training
- High-tech calibration rigs based on a common design platform

Your expectations benchmark

Increasingly stringent requirements for dependability and product quality are a given in many industry sectors. In pharmaceuticals and in the oil and gas sector, for balancing material flows and metering costly additives – process control invariably needs accurate and endurably stable flowmeters. Then again, there are other fields in which legislation requires regular onsite calibration because reproducibility in processes is a crucial necessity.



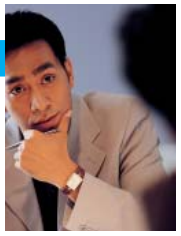
our endeavors

Whichever the profile. As a customer of Endress+Hauser you can be sure that we are thoroughly familiar with all your needs regarding every aspect of calibration and measuring accuracy. Experience amassed over many years and in many different industries is reflected in our calibration service, a service we tailor to your needs and your preferences. Taking flow metering as an example, this brochure details the capabilities and calibration solutions you can expect from us.

Try it out for yourself

Certified measuring accuracy

"It is absolutely crucial for us to keep exactly to the recipe, so that we make optimum use of what are very costly raw materials."



Competent calibration management

"There is a constant need to save on personnel and general costs. That's why we are working with an external supplier with specially trained experts who use Standard Operating Procedures (SOP) and with whom we know our calibration management is in safe hands."

High plant availability

"Our customers expect us to meet the agreed delivery deadlines. We need high plant availability in order to do so. That's why short calibration times without lengthy process interruptions are so important to us."

Long-term stability of meters

"In quality-critical applications we have to be absolutely sure that any given meter will maintain the specified measuring accuracy even at high pressures or despite quick changes in the fluid's temperature."

Complete traceability

"The legislation is very clear on this point, so 100% reproducibility across our production processes is very, very important for us."

Our calibration capability – your competitive edge

"Consistently high measurement quality for our customers worldwide."

Endress+Hauser has long adhered to this principle and repeatably sets new standards in calibration metrology. That means we can sustainably safeguard your edge over the competition.

- More than 30 years of experience in building flow calibration rigs
- More than 1.5 million flowmeters successfully calibrated since 1977
- High-tech calibration facilities designed and built to the state of the art
- Global calibration concept:
  – All calibration rigs are accredited to ISO/IEC 17025 (unique achievement)
  – All test equipment fully traceable to national and international standards
- Worldwide onsite calibration service by qualified specialists
- World's best production calibration facility (±0.015% measuring uncertainty)
- Comprehensive and traceable calibration tools, e.g. factory and onsite calibration, software packages, test equipment or documentations

It's reality that counts

Is compliance with quality standards a crunch factor for you?
Is competition forcing you to cut costs and keep them low?
Do you want to be completely sure that your investments in metering infrastructure pay off in the long term?

Yes? Then you have come to the right place. Because high-quality flowmeters – adjusted on cutting-edge calibration rigs – add crucial value to your plant. It is this combination of meters and calibration which means that our specified accuracy is also applicable in your process. Certainly one reason why the Promass F Coriolis mass flowmeter is used more and more commonly as the reference for onsite calibrations whenever stringent requirements apply.

What our

"Promass F is our standard meter for process control in the manufacture of pharmaceutical products from human plasma, and in our experience this meter is very good. In terms of day-to-day operability and maintenance, Promass F has proved extremely robust and suitable for the job. And what's more, when we had the flowmeters in a new production facility calibrated for the first time we had on-the-spot, expert support from Endress+Hauser to rely on."

Beat Meyer / Rainer Kraus
Director, Technical Services / Quality Engineer
CSL Bering AG (Switzerland)

"When it comes to calibrating process-critical measuring points, we have complete faith in Endress+Hauser. I was really relieved as I held the calibration certificates in my hands. Now we can record the results of the calibrations over the years and thus demonstrate the stability of the cough lozenge production as well as the production of the vitamin-enriched gummy bears in one document."

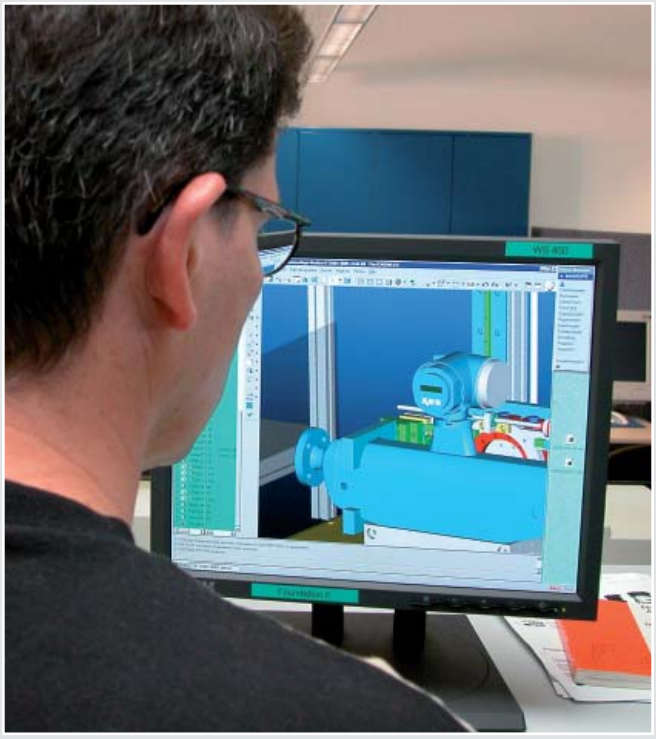
Sonja Häfelfinger
Quality Engineer
Fritz Hunziker + Co AG (Switzerland)

Our flowmeters – your process dependability

In the real world of day-to-day metering, conditions are rarely ideal. Pipe-borne vibrations, high pressures, rapid temperature transients, extended operability and increasing expectations with regard to long-term stability are crunch factors that have to be taken into account right from the beginning.

For example, our development engineers use special simulation programs to determine which design will ensure the best possible immunity to external influences. Extensive field tests then serve to verify these results and optimize existing designs. That is why all Endress+Hauser Proline flowmeters have been able to meet the industry-specific requirements for over 15 years – without any ifs and buts.

Promass Promag Prosonic Flow Prowirl t-mass



Promass F – precision for the real world

Promass F is established as the standard device for measuring flow in many industries.

- The excellent measuring accuracy (±0.05%) ensures energy and product savings.
- The optimized measuring-tube geometry is the key to outstanding process stability despite changes in pressure and temperature.
- The robust design dependably dissipates external pipe-borne forces.
- The high oscillation frequency of the measuring tube suppresses even strong pipe-borne vibrations.
- Use as a traceable reference meter permits precise onsite calibration.

customers say

"On my recent visit to Endress+Hauser's production plants I had the opportunity to talk to some technicians about these and many other measurement tasks in a refinery. I was impressed with the encompassing competence and know-how and the broad range of process automation instrumentation from Endress+Hauser especially developed for the oil and gas industry. As a result, we are now able to execute start-ups faster and safer."

Claus Roeseler
Technical Director
NOREAST PETROLEUM NIGERIA Ltd.
(Nigeria)

"In the final analysis, we have to decide what we can do with our own staffing resources and what services have to be subcontracted. So our Technical Director Kurt Pfäffli arranged for onsite calibration by Endress+Hauser. That kind of work should be undertaken by specialists as our own people are too involved in the day-to-day running of the business."

Peter Roth
Production Manager KNF
Wander / Associated British Foods ABF
(Switzerland)

Global calibration concept

Consistently high measurement quality for all customers around the world

As a global player, Endress+Hauser acts on the basis of internationally valid standards for recognition of its products and test methods.

One unique facet of our company's operations is that all flow calibration rigs are accredited by different national metrology authorities in accordance with ISO/IEC 17025 – e.g. by SAS (Switzerland), A2LA (USA), and CNAS (China). At the same time, these accreditations guarantee that all the equipment used for calibration can be traced back through an uninterrupted chain of reference to the respective national standard.

Our global calibration concept is based on identical high-tech calibration rigs that ensure a uniformly high level of measuring quality for customers all around the world.

And when time is of the essence we are always in your area – for the stipulated factory calibration or onsite calibration directly in your plant. This saves both time and costs.

Matthias Aschberger

Plant Director

Cernay (France)

“Our flow calibration facilities in Cernay cover an enormous range of measurement. We can deal with anything from less than one liter up to six million liters per hour. That is the range covered by meters with tube diameters from 2 millimeters to 2 meters.”

Jürg Honegger

Director
Calibration Facilities

Reinach (Switzerland)

“Transparency and the trust placed in us by our customers are of key importance. That is why we have all the flow calibration rigs in our production facilities all over the world accredited by national metrology institutes.”

Dr. Wei Qinxue

General Manager

Suzhou (China)

“Precision-calibrated flowmeters are a must for China’s industry. The new calibration facility with CNAS accreditation now lets us demonstrate clearly the traceability of all calibration measurements to our customers.”

Hans-Peter Blaser

General Manager

Greenwood (USA)

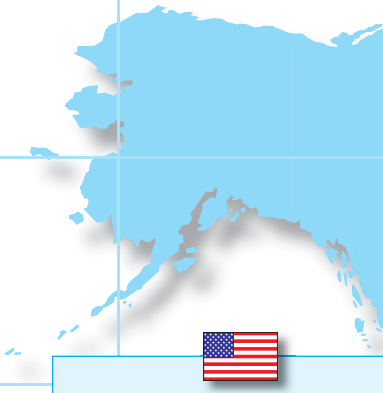
“The demand for dependable, highly accurate flowmeters is increasing at a tremendous rate, especially in the oil, gas and pharmaceuticals sectors. In order to supply our markets in North and South America accordingly, we have now commissioned a PremiumCal calibration facility in our US plant.”

Krishnakumar Srinivasan

General Manager

Aurangabad (India)

“Our latest calibration rig is the response to the huge growth recently experienced in the Indian water and wastewater sector. We can now calibrate flowmeters for large-bore pipes.”



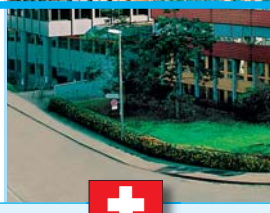
Endress+Hauser Flowtec Greenwood (USA)

- Calibration rigs DN 2 to 1200
- Maximum measuring uncertainty: ±0.015%
- Accredited by the American Association for Laboratory Accreditation (A2LA)

Round-robin tests for higher safeguards

Regular “round-robin tests” are conducted between the individual Endress+Hauser flow calibration rigs worldwide to compare their performance and measurement accuracy.

Promass F flowmeters calibrated to a high level of accuracy are used as “transfer standards” in these comparison and control measurements.



Endress+Hauser Flowtec Cernay (France)

- Calibration rigs DN 2 to 2000
- Maximum measuring uncertainty: ±0.05%
- Accredited by the Swiss Accreditation Service (SAS)

Endress+Hauser Flowtec Reinach (Switzerland)

- Calibration rigs DN 1 to 250
- Maximum measuring uncertainty: ±0.015%
- Accredited by the Swiss Accreditation Service (SAS)

Production Center
for flowmeters

Stationary calibration facilities, accredited to ISO/IEC 17025

Sales Center

- With full range of services: maintenance, consulting, commissioning, servicing, onsite calibration
- Equipped with additional stationary calibration rigs (DN 8 to 100)

Endress+Hauser Flowtec Suzhou (China)

- Calibration rigs DN 2 to 1200
- Maximum measuring uncertainty: ±0.05%
- Accredited by the China National Accreditation Service for Conformity Assessment (CNAS)

Endress+Hauser Flowtec Aurangabad (India)

- Calibration rigs DN 2 to 1200
- Maximum measuring uncertainty: ±0.05%
- Accredited by the Swiss Accreditation Service (SAS)

The calibration of flowmeters

Our services at a glance

In many production facilities flowmeters are in permanent operation under the severest of conditions. Often these meters are quality-relevant and thus have to be periodically checked or recalibrated. The frequency of these checks depends on the application, required accuracy, industry-specific best practice, or statutory requirements. To meet this demand, Endress+Hauser has built high-precision calibration facilities all round the world. Many of our service organizations also offer onsite verification and calibration, thereby eliminating the need to remove the meter and reducing unnecessary costs.

In-situ calibration, moreover, ensures that the meter is tested under the prevailing operating conditions.

Test-equipment monitoring (ISO 9000)

Under ISO 9000, measuring devices used to measure volume or mass flow are subject to test-equipment monitoring. Since we have accreditation as a calibration provider, Endress+Hauser is able to carry out certified calibration for you within the framework of ISO 9000 or in accordance with the FDA rules, as applicable, for the meters we manufacture and for other makes as well.

	Onsite control measurement		Onsite calibration
Method Test equipment	Control measurement from the outside (clamp-on ultrasonic flow measurement)	Verification with Fieldcheck (tester and simulator)	Comparison with special, in series reference meter. Mobile test rigs with flowmeters as reference (mass, volume).
Traceability	Not traceable (measuring point cannot be calibrated as a unit)	Traceable test instrument	To national standards (accredited or accreditation is in progress)
Calibration range	Plant dependent	Depends on the device under test	0.3 to 200 m^3/h (DN 4 to 125) (others on request)
Max. measuring uncertainty	±2%	±1%	±0.25 to 1% (depending on the calibration rig)
Calibration points Test points	Freely selectable	5 points	3 or 5 points (others on request)
Certificates issued	Measurement protocol	Measurement protocol	Calibration protocol or certificate
Time required	Approx. 1 hour per meter	Approx. 15 minutes per meter	2 to 4 hours per measuring point (depending on: plant type, with/ without bypass, nominal diameter, etc.)
Benefit Possibilities	■ Meter is not removed for testing ■ Measurement from outside, directly on the pipe ■ Particularly suitable for – large-bore pipes – chemically aggressive fluids	■ Meter is not removed for testing ■ Results automatically logged ■ Traceable instrument ■ Conclusions can be drawn in regards to stability and operability of the device under test	■ Meter is not removed for testing ■ Calibration in the field under real-life conditions

Workshop calibration	Factory calibration
Stationary calibration facilities: ■ Gravimetric measurements with weighing containers ■ Volumetric measurements with pipe provers ■ Master-slave method (reference: Coriolis flowmeters)	Stationary calibration facilities: ■ Gravimetric measurements with weighing containers ■ Volumetric measurements with pipe provers ■ Master-slave method (reference: Coriolis flowmeters or magmeters)
To national standards (accredited or accreditation is in progress)	To national standards (accreditation to ISO/IEC 17025)
36 dm^3/h to 100 m^3/h (DN 8 to 100) (depending on facility)	4 dm^3/h to 5760 m^3/h (DN 2 to 2000) (depending on facility)
±0.15% / ±0.25% (volumetric or gravimetric)	Standard: ±0.05% Option: ±0.015% (PremiumCal)
3 or 5 points (others on request)	3 or 5 points (others on request)
Calibration protocol or certificate	Standard: calibration protocol Option: SCS, A2LA or CNAS calibration certificate (ISO/IEC 17025)
2 to 5 days inhouse (depending on nominal diameter)	2 to 5 days inhouse (depending on nominal diameter)
■ Securing local presence in America, Europe and Asia ■ Shorter turnaround time	■ Precision calibration ■ Accredited to ISO/IEC 17025 ■ Calibration over a wide range of nominal diameters ■ Calibration of reference meters possible

What is accreditation?

Accreditation means the formal recognition of a body's technical competence in performing specific services such as calibration, for example. This recognition is issued by authorized bodies, often a national metrology authority working in strict compliance with comprehensive international codes of practice.

ISO/IEC 17025

ISO/IEC 17025 is an internationally accepted standard covering "general requirements for the competence of testing and calibration laboratories". ISO/IEC 17025 lays down all the requirements that calibration facilities have to meet if they wish to demonstrate that they operate a quality system, are technically competent, and are able to generate technically valid results. A company has to meet very stringent requirements in order to obtain and keep ISO/IEC 17025 accreditation.

Advantages of accredited calibration facilities

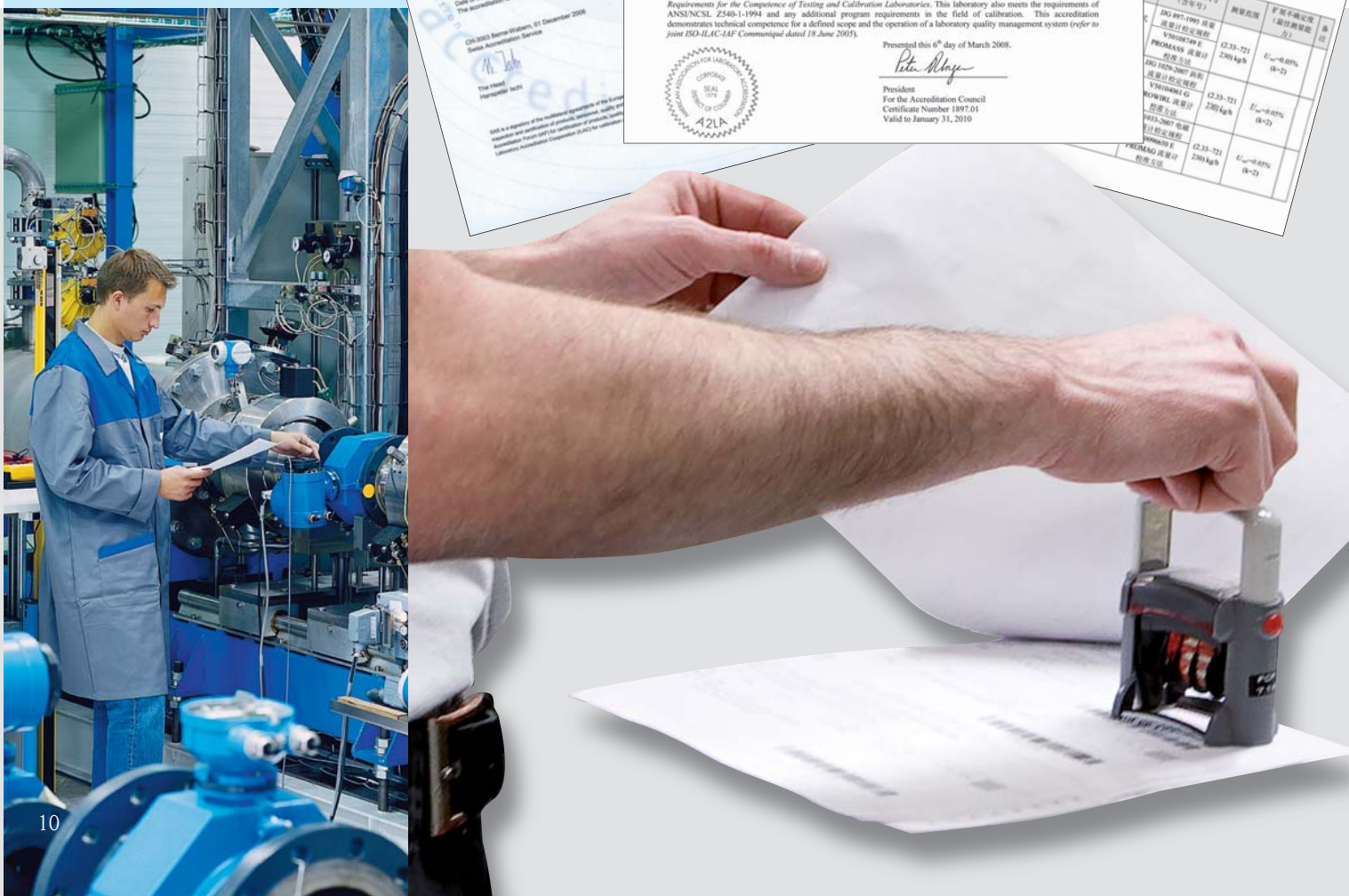
- Traceability back to national standards (e.g. METAS, PTB, NPL, LNE, NIST, CN)
- Worldwide acceptance
- Periodic inspection by national standard authorities
- Secure measuring results

Accreditation

The key to transparency and comparability

As far as meter calibration is concerned, trustworthiness and the acceptance of certificates depend directly on the verifiable capabilities of the calibration centers concerned. That is why all Endress+Hauser's flow calibration rigs are accredited by national authorities in accordance with ISO/IEC 17025. This is unique and a confirmation of the high confidence placed in us by the respective national authorities in different countries. No other manufacturer of flowmeters can lay claim to this ultimate proof of quality. And what is more, official accreditation is a must for verifiably establishing that the measuring accuracy specified by the manufacturer is fully traceable back to national standards. The audits and field tests conducted by the accreditation body are comprehensive and stringent. The range of testing includes, for example:

- Training levels of the operating personnel
- Technical infrastructure (operating procedures, methods used, e.g. for calculating the measuring uncertainty of the facility as a whole)
- Organizational structures (independence, quality management)



100% traceability = 100% confidence

Laying all the cards on the table

"Only fully traceable calibration rigs to ISO/IEC 17025 can really be trusted." Is that true? Yes, because verification comparisons between device under test, calibration rig, test equipment and a country's hierarchically highest "national standard" are the only way of conclusively establishing the end-to-end traceability of measured values – and consequently of the measuring uncertainty stated by the device manufacturer. This is one of the main reasons why Endress+Hauser has had all flow calibration rigs accredited by official bodies.

The International Prototype Kilogram (at BIPM, France)

- International Prototype Kilogram (IPK) = global reference and basic unit of mass. The Bureau International des Poids et Mesures (BIPM), founded in 1875, keeps the IPK under lock and key in a vault on its premises in Sèvres near Paris (France).
- In 1950, 1991 and 2003 comparison measurements for verification took place between the IPK and Switzerland's replica No. 38.
- Measuring uncertainty of the verification: ±0.000001% (±10 micrograms)

±0.000001%

The national standard (national institute of metrology)

- Verification of the standard weights used by Endress+Hauser every 5 years by the Swiss Federal Office of Metrology METAS, using a mass comparator and national reference weights (national reference standards)
- Measuring uncertainty of the METAS 500 kg reference weight (set 502, class E2): ±0.0001% (0.5 gram to 500 kg)
- Regular verification of the reference weights against Switzerland's replica No. 38 of the IPK every 10 years

±0.0001%

The gravimetric scales (Endress+Hauser)

- Gravimetric scales of the PremiumCal calibration rig for measuring the reference flow values
- Regular verification of the scales every 2 weeks with standard weights (= internal reference standard)
- Measuring uncertainty of the standard weights (class F2): ±0.0016%

±0.0016%

The calibration rig (Endress+Hauser)

- PremiumCal calibration rig for testing Promass 83F/84F
- Measuring uncertainty: ±0.015%
- Accredited to ISO/IEC 17025 by the Swiss Accreditation Service (SAS)
- Annual SAS audits of the facility

±0.015%

The meter (in customer's production plant)

- Promass 83F/84F for metering mass flow:
  – Exact balancing of material flows
  – Precise dosing of costly active ingredients
- Measuring accuracy: ±0.05%
- Reference meter for onsite calibration (measuring uncertainty of mobile calibration rigs: ±0.25 to 0.5%)

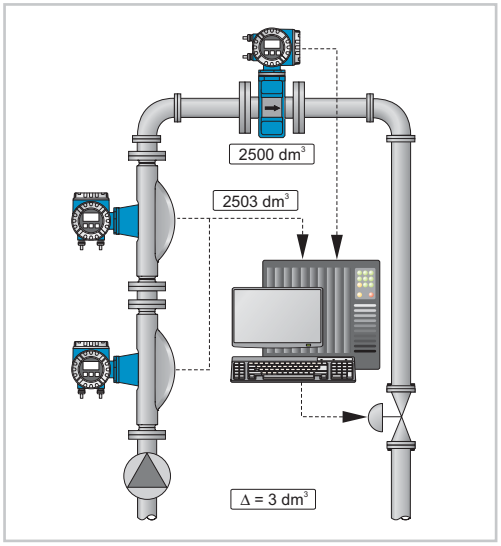
±0.05%

(Measuring uncertainty conforming to k = 2)

Methods of wet calibration

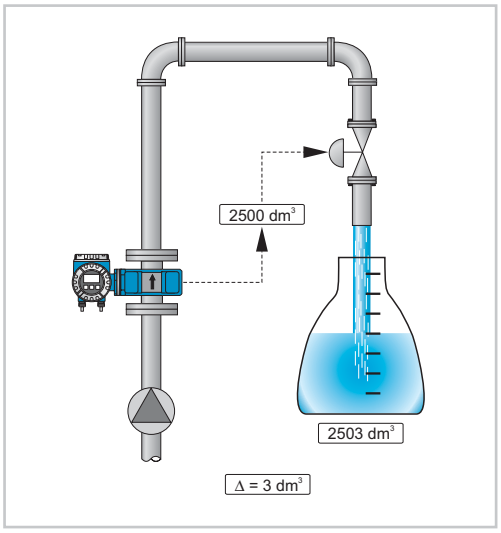
Diversity is our best card

Volume or mass comparison can be used in calibrating flowmeters. The fluid flowing through the meter is measured either volumetrically with the aid of calibrated vessels, or determined gravimetrically with high-precision weighing scales, and compared with the reading shown by the device under test. Comparative measurements between the various calibration methods are possible at any time.



Master-slave method

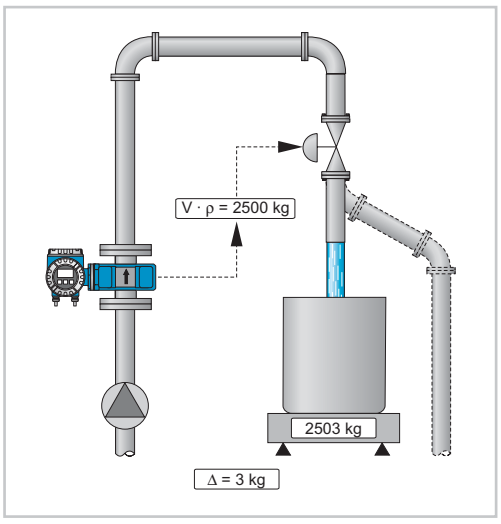
The accuracy attainable by certain types of flowmeter is almost on a par with that of the calibration facilities and laboratory rigs on which they are calibrated. Coriolis mass flowmeters in particular can achieve measuring uncertainties better than ±0.1%. They are so accurate that they are often employed as secondary standards for gauging less accurate flowmeters. If reference meters evincing sufficient long-term stability and precision are available, they can be utilized in master-slave calibration configurations. The reference signal for the device under test is the mean of the value measured by two Coriolis master meters, set up for the corresponding diameter of the device under test. Measuring uncertainty is ±0.08%.



Volumetric method

A container of precisely known capacity is used for volumetric comparison. This container can have a scale for reading the volume, or it can be fitted with one or more limit switches that start, stop or divert the flow of fluid. Although modern wet-calibration techniques make increasing use of gravimetric methods, the volumetric method using pipe provers, however, offers some advantages in certain instances:

- No losses whatsoever for precision metering of very small quantities due to the closed loop. Residual amounts of fluid in the apparatus have no effect on the result.
- At low flow rates and correspondingly long measuring times, the sealed system of a pipe prover prevents errors due to evaporation.



Gravimetric method

Water from a tank of adequate capacity is circulated through the device under test until the system settles to the desired measuring range. Once this status has been achieved, a flow diverter (with flying start/stop) switches reproducibly at a very high speed and the diverted quantity of fluid flows to the weighing tank. An electronic switch is tripped at the same time to start a frequency or pulse counter. As soon as the desired quantity of water is in the tank, the flow diverter switches back to its initial position and the switch for the frequency counter is closed. The results obtained by the weighing tank and the frequency counter are subsequently compared.

Calibration certificates (SCS, A2LA, CNAS)

The dictates of quality are often such that a meter needs an official calibration certificate, e.g. flow metering in regulated industries or for volume measurement in large-bore water pipelines.

For this reason, Endress+Hauser as officially accredited calibration provider for the measured variable "flow" also performs calibration with SCS, A2LA or CNAS certification. These certificates are accepted in all ISO member states and consequently they are invariably recognized and accepted by national authorities and in quality audits.

The calibration certificate/protocol

Accuracy certified in black and white

Endress+Hauser subjects all its flowmeters to continuous quality checks throughout production and tests, calibrates and adjusts them on the world's most advanced calibration rigs. As proof of successful standards-compliant calibration, a protocol is completed for each meter. This protocol states the measuring accuracy achieved by the meter and contains information on the calibration factors determined by testing. The standard calibration procedure calls for testing at two or three measuring points; if an official calibration certificate is required this number is increased to five measuring points within a measuring range specified by the customer. All production and calibration data are saved to optical disks and archived for a minimum of 10 years.

Official stamp of the national authority / calibration service. Proof that Endress+Hauser is accredited as a calibration provider in accordance with ISO/IEC 17025 and undertakes calibration in compliance with the applicable standards.

SAS is a member of ILAC (International Laboratory Accreditation Cooperation)

Details of the meter / customer

Initial calibration or recalibration

All results of measurement

Additional information about the rig, traceability and measuring uncertainty

Stamp / Signature Calibration provider / Operator

Full scale value (standard or customer-specific)

Details on calibration measurement

Measuring uncertainty of calibration rig plus reproducibility of the meter tested

Endress+Hauser
People for Process Automation

Certificate
Flow Calibration with Adjustment
N° 12345678

ilac-MRA SWISS CALIBRATION S C S

Swiss Calibration Service, Accreditation N° SCS 052
Calibration Laboratory accredited by the Swiss Accreditation Service (SAS) according to ISO/IEC 17025

12341234 (Purchase order number)	FCP-7.1.5 / gravimetric (Reference: Calibration rig/Method)
Customer	15000.0 kg/hr (≙ 100%) (Calibrated full scale)
NL-533272-10 / Endress+Hauser Flowtec AG (Order N°/Manufacturer)	Service interface (Calibrated output)
PROMASS 83 F DN50 / 2" (Transmitter/Sensor)	1.8448 (Calibration factor)
AAxxxxxxxxxx / AAxxxxxxxxx (Serial N°)	44 (Zero point)
– (Tag N°)	24.5 °C (Water temperature)
New (Condition)	0.025 % (Expanded uncertainty of measurement)

Flow [%]	Flow [kg/hr]	Duration [s]	m target [kg]	m meas. [kg]	Δ o.r.* [%]	Outp.** [mA]
19.9	2982.0	60.4	49.992	50.008	0.032	7.18
34.9	5233.5	34.5	50.136	50.130	-0.012	9.58
50.1	7516.5	71.9	150.204	150.167	-0.025	12.02
74.9	11234	48.2	150.421	150.375	-0.031	15.98
99.9	14991	36.2	150.611	150.585	-0.017	19.99
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*o.r.: of rate
**Calculated value (4 - 20 mA)

Measured error % o.r.
Tolerance limit: ±0.05% o.r.* ± Zero stability
1.5 1 0.5 0 -0.5 -1 -1.5
0 10 20 30 40 50 60 70 80 90 100 [%] Flow

For detailed data concerning output specifications of the unit under test, see technical informations (TI), chapter Performance characteristics.

This calibration certificate was generated electronically. It documents the traceability to national standards, which realize the physical units of measurements (SI).

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approx. 95%. The measuring uncertainty includes uncertainty components of the reference, the calibration method, the environment and of the device under test.

Flow Endress+Hauser
Stamp

23.10.2008
Date of calibration

R. Bächler
Operator

M. Wenger
Head

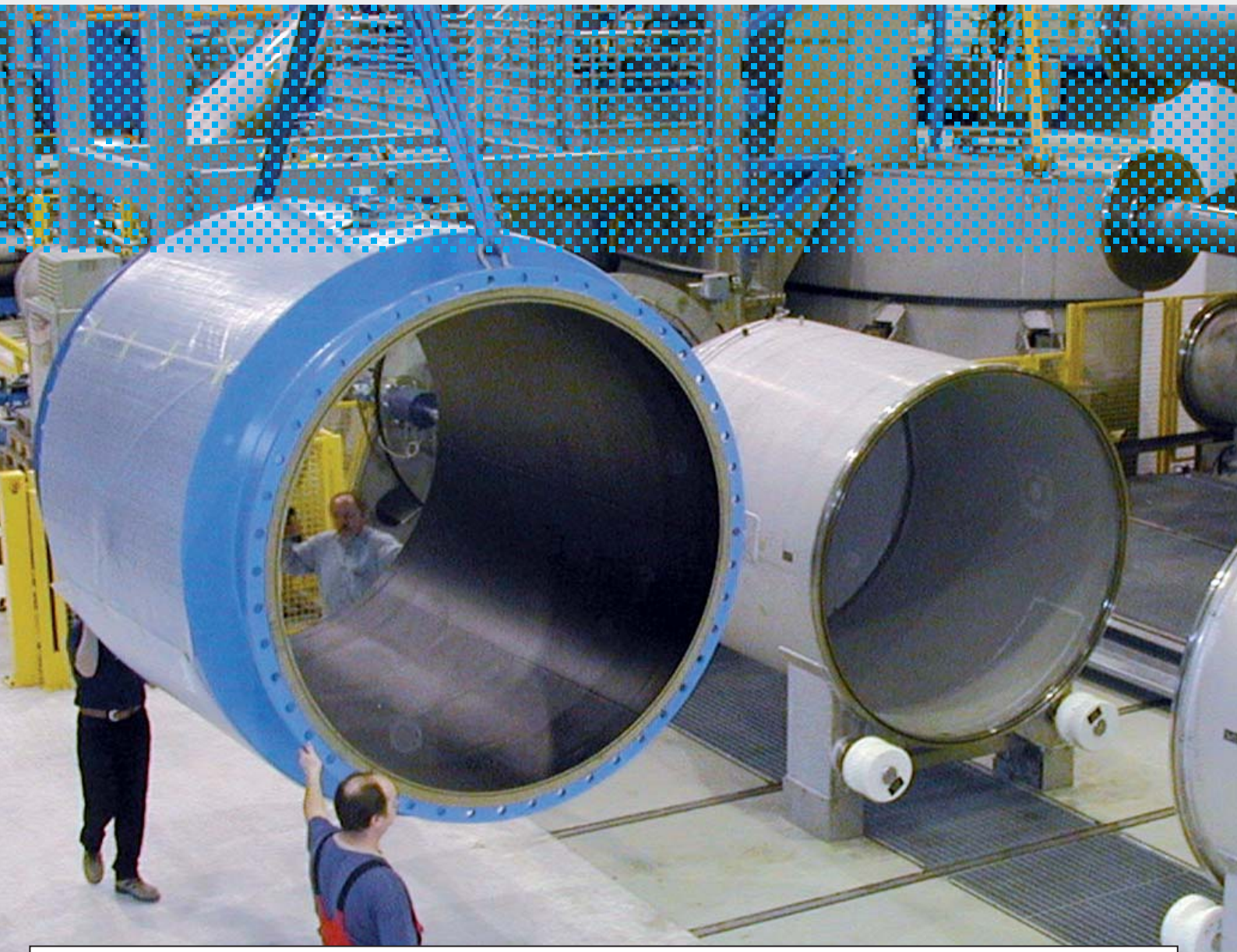
This certificate shall not be published or reproduced other than in full, except with the prior written approval of the issuing laboratory.

Endress+Hauser Flowtec AG
Kägenstrasse 7 / Rue de l'Europe 35
CH-4153 Reinach / F-68700 Cernay

Example of a calibration certificate (SCS 052)

Calibration metrology at its finest

Precision that pays

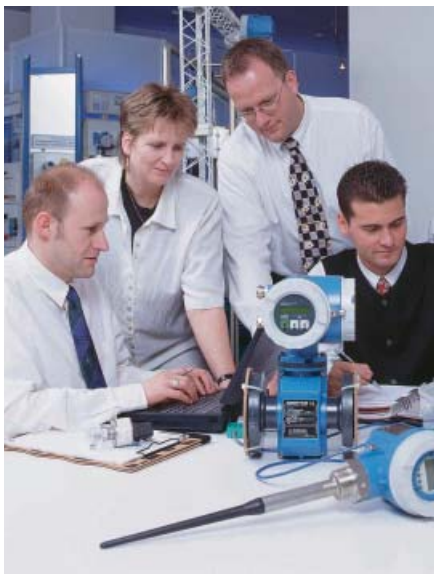


More than 30 years of experience

No other manufacturer of flowmeters operates more calibration rigs than Endress+Hauser. For more than 30 years we have been planning, building and installing these high-tech rigs with our own dedicated specialists, engineers, software developers, technicians and designers.

Regular contacts to national metrology institutes such as Germany's Physikalisch-Technische Bundesanstalt (PTB) and the Swiss Federal Office of Metrology (METAS) maintain the exchange of specialist know-how. This knowledge, in turn, ensures that our calibration rigs always represent the state of the art in metrology.

Our customers benefit in a number of ways: they can dependably measure and process costly raw materials and intermediate products, comply with what are often extremely stringent quality specifications, and implement optimum process automation to minimize their costs.



Outstanding metrology

Only the best is good enough for our customers. So when it comes to precision, we leave absolutely nothing to chance. The many parts needed for a calibration rig are designed, built and tested by Endress+Hauser's own development departments.

A perfect fit every time
Every meter to be calibrated has to slot perfectly into the rig, because a perfect fit is essential for perfect measurements. We use special adapter systems to achieve this fit. The biggest Endress+Hauser calibration facility in Cernay (France), for example, is built around an impressively huge adapter revolver that rotates to bring exactly the right nominal diameter into position (see page 9). Hydraulic rams hold the device under test in position; no fasteners are needed.

Unique weighing technology
Highly sophisticated weighing systems – of the kind used in gravimetry – are essential for obtaining the "true" reference value for a calibration run. PremiumCal, the world's best calibration facility under production conditions, has two weighing tanks for this purpose; the capacities of these vessels are 400 and 4000 kg. High-precision weighing cells of the latest generation (class 6/5) are perfectly capable of detecting differences of less than one gram in 400 kilos – that is unparalleled peak performance on the international stage.

Highly advanced system control

Day in, day out, Endress+Hauser tests and calibrates hundreds of flowmeters – mostly in three shifts working round the clock. Many of the operating procedures and measurements are fully automatic:

- Test and calibration measurements
- Download of the calibration factors to the device under test
- Storage of the calibration data in databases

Calibrating with this high degree of rationalization and to an uncompromising standard of precision is only possible with extremely effective system control. The programs used for this purpose are developed and tested by our in-house software department. The software is validated and it is documented in accordance with ISO/IEC 17025. The regular monitoring of equipment, measuring points and climatic boundary conditions is also fully automatic under higher-level process control. Air pressure, relative humidity, air temperature, water temperature, leakage, flow rate and many other test parameters are constantly monitored and evaluated.

Maximum precision under constant measuring conditions

Only stable measuring conditions ensure dependable calibration accuracy. This is particularly true when large flowmeters with nominal diameters up to 2000 mm are calibrated. Consequently, the largest calibration facility that Endress+Hauser operates in Cernay (France) has a water tower 28 meters high. The huge tank that this tower supports ensures a uniform supply of water throughout the entire cycle of measurement.

- Constant pressure at the meter being tested
- No pumping pulsations in the flow
- No level measurement overlaying additional measuring uncertainties
- Measurements of any duration are possible, for example to verify the long-term behavior of flowmeters at certain calibration points

Flow rates from a few liters up to six million liters per hour can be measured for calibration and always with the same, uniformly high level of precision.

"PremiumCal"
The world's best production calibration facility

Highly accurate flowmeters are being used more and more frequently in process control. In order to verify the excellent accuracy of modern Coriolis flowmeters in accordance with internationally accepted standards, a team of 26 engineers, technicians and designers got together at Endress+Hauser with the declared aim of evolving the design of an existing production calibration rig to make it the best in the world. The measurement results achieved with the new calibration rig deviate no more than ±0.015% from the reference value – equivalent to the contents of a single champagne glass per one thousand liters of water!

- Excellent measuring accuracy (uncertainty):
  – Standard weights (for testing scales): ±0.0016%
  – Calibration rig: ±0.015% (gravimetric); ±0.021% (volumetric)
  – Traceable accuracy of the device under test: ±0.05%
- Total measuring uncertainty calculated as per the Guide to the Expression of Uncertainty in Measurement (GUM) with up to 60 influencing factors
- Fully automatic testing, calibration and linearization of the two high-precision scales with stationary standard weights

Special density calibration

Direct registration of fluid density by Coriolis flowmeters is becoming increasingly important in process monitoring. Some industries have their own specific density and concentration units, such as °Brix, °Baumé, °Plato, °API, alcohol content or mass%.

Substandard product invariably generates high costs, so the requirements for accuracy in inline density measurement can be very high indeed. Consequently, Endress+Hauser offers the option of special density calibration, undertaken in a special laboratory. The fluids used for the purpose vary in their density and include ethanol, molasses and polytungstate (0.8 to 1.8 g/cc).

Additional calibration measurements with water are conducted at different temperatures between 5 and 80 °C. Following density adjustment in the field, the meters are then capable of attaining an accuracy of up to ±0.0005 g/cc.

Calibrating with air

By the same token, Endress+Hauser sets the bar very high for calibrating mass flowmeters for gas. The air calibration rig installed for this purpose in 2005 in Reinach (Switzerland) is one of the few that operates with such a high degree of automation. Multiple adapter revolvers enable the devices under test to be slotted in neatly and fully automatically into the rig (DN 15 to 100). The system is also capable of running fully automated leak tests. The air flow rate can be varied between 50 grams and 10 metric tons per hour.

An array of three reference gasmeters – nozzle, rotary piston and turbine – ensure that the calibration results are accurate to ±0.3% over the entire measuring range. A special climate control system system keeps the air inside the calibration chamber at a constant 24 °C and 40% humidity day and night.

What the SAS says

August Schaub

Chief Assessor

Swiss Accreditation Service SAS
(Switzerland)

"Since 1994, Endress+Hauser has been accredited in accordance with ISO/IEC 17025 as a calibration provider for flowmeters by the Swiss Accreditation Service (SAS). The very good results of the comparative verification measurements between the Swiss Federal Office of Metrology (METAS) and Endress+Hauser confirm the high reliability of the flow calibration rigs that we test at Endress+Hauser. I can safely say that in all these years, cooperation and the exchange of information with Endress+Hauser have been very agreeable and competent. The efforts of the well-trained and committed people who work for the company continuously further the groundbreaking role in the calibration of flowmeters.

The high technological standard of the calibration rigs and their constant improvement ensure that customer requirements are met on a very high level. The reference meters calibrated by METAS establish the baseline. In the audits I have conducted to date, the Endress+Hauser calibration rigs have always been in very good condition."

Calibration solutions

The key to monitoring your quality standards

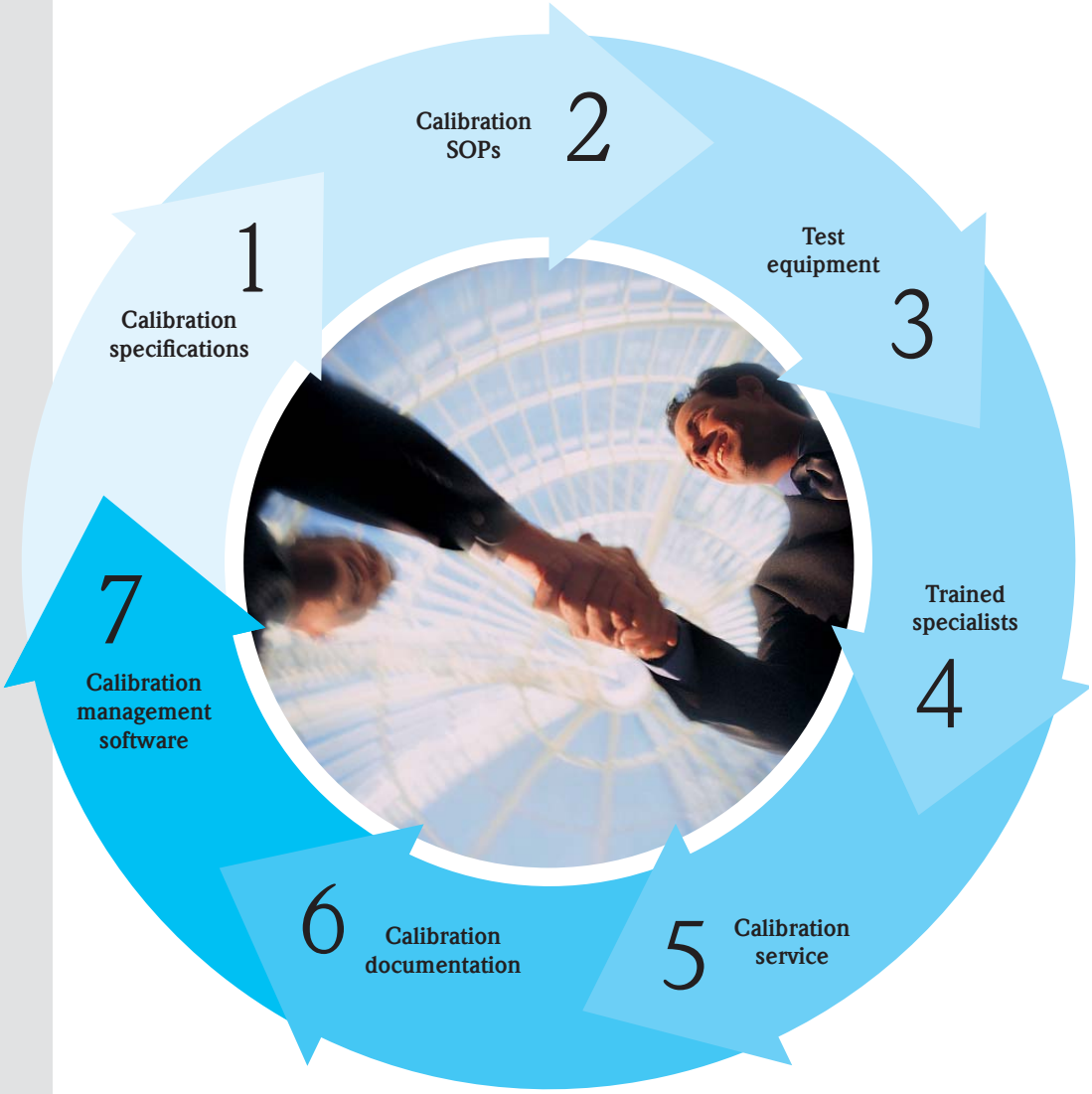
Are these your questions?

- Do your quality-relevant metering instruments in your plant require regular checks, validation or calibration?
- Do you want to entrust all calibration activities to a competent service provider who not only works economically, quickly and to a high standard of quality, but is accredited and will return fully traceable results?
- Do you need unequivocal and clear calibration records?

Yes!

Then you can turn with confidence to Endress+Hauser. Having amassed years of experience in metrology, we can offer speedy competent solutions for every aspect of calibration in widely differing sectors of industry.

And it all comes from a single source.



1

Calibration specifications

We provide support and advice when you draw up metrology plans. Working jointly with your experts, we define calibration specifics for the applicable parameters, including error tolerance and calibration period for example, and onsite or factory calibration for the individual meters.

2

Calibration SOPs

Our calibration routines are always governed by Standard Operating Procedures (SOPs). SOPs ensure that the calibrations we perform can be repeated anywhere and at any time. We also offer a wide range of customer-specific SOPs.

3

Test equipment

You can always count on Endress+Hauser for anything relating to the calibration of metering devices and flowmeters. We undertake all the necessary work of calibration on your behalf. Our calibration rigs are traceable to national and international standards in accordance with ISO/IEC 17025.

4

Trained specialists

Our service technicians are GMP-trained (Good Manufacturing Practice). So only skilled specialists undertake your onsite calibrations. That shifts the burden of cost-intensive routine testing away from your maintenance team. On request we can train your stuff in every aspect of calibration and calibration management.

5

Calibration service

Our company is a global player, so our calibration service is always close at hand. All our primary calibration rigs are accredited by national authorities to ISO/IEC 17025 and are fully traceable. We operate more calibration labs than any other flowmeter manufacturer and also calibrate meters of other types and makes.

6

Calibration documentation

Certified and traceable documentation is part of our calibration service. Your meters might be calibrated in the field or in our factory, but you always receive a calibration protocol or certificate compliant with ISO/IEC 17025. This documentation satisfies the requirements of all the relevant authorities.

7

Calibration management software

CompuCal™ is a program that monitors all planning activity for your installed base, returning traceable and auditable data records. CompuCal was developed jointly with key-account customers and is used by global players in the pharmaceuticals industry (21 CFR 11 compliant).

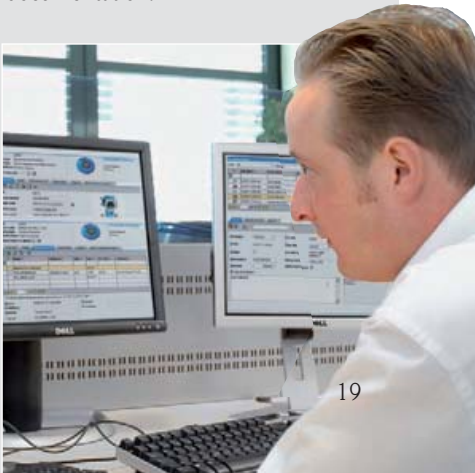
Testing and verification directly in-situ

The Fieldcheck tester and simulator makes it possible to check flowmeters directly in the piping, without interrupting your process:

- Traceable instrument
- Generation of tamperproof test certificates, e.g. for regulatory bodies or quality audits
- Long-term monitoring of meter-specific and process-specific parameters (trend analysis)
- Extension of cost-intensive calibration cycles

W@M Complete information from your plant

Web-based Asset Management W@M™ from Endress+Hauser is an open and flexible information system that builds on intranet/internet technology and interconnects all software programs, products and services from Endress+Hauser.
At every step in the cycle – from concept planning through to maintenance and service in the plant – all the available information can be accessed at any time. Consequently, the user can dependably comply with the growing requirements for product quality with traceable, certified calibration and documentation.



Life sciences industry

Calibration and verification directly in the pipe

In the closely regulated life sciences industry, quality, measuring accuracy and reproducibility are all of crucial importance. Total compliance with the industry's FDA and GMP or ASME BPE requirements is an absolute must. Every decimal percentage point knocked off measuring uncertainty means a significant reduction in costs – for example in the dosing, mixing and batching of active ingredients that can sometimes run to several million EURO per kilogram. Endress+Hauser ensures production efficiency by providing you with high-accuracy flowmeters plus the backup of a comprehensive calibration service and proven tools for verification and calibration management.

Promass P for pharmaceuticals

Promass P is a Coriolis flowmeter developed specifically for the life sciences industry. It supports you whenever you need permanent metering of quality-critical process variables.

- Compliant with ASME BPE, FDA, EHEDG and 3-A
- Can be completely drained
- High chemical resistance; fully welded sensor design
- Hygienic design with corrosion-resistant, electropolished surface
- Excellent performance under temperature change, e.g. after CIP or SIP cleaning

Calibrate with traceability – wherever you want

Transparency and traceability – two key issues that are becoming increasingly important right across the life sciences industry. And the onsite calibration of flowmeters is a closely related field. It is here that Endress+Hauser uses mobile rigs with Promass F as the high-accuracy reference meter (transfer standard). Promass F – itself tested on accredited calibration rigs compliant with ISO/IEC 17025 – is used to ensure complete traceability to the national standard. Onsite calibration is complemented by CompuCal, a program for time-saving calibration management, and by the Fieldcheck tester and simulator which enables speedy verification of meters directly in the pipe. In this way, the calibration costs and availability of the measurement are optimized.

Martin Lenz
Engineer for electronics, metrology, control and operations
Sanofi-Aventis (Germany)

"As one of the world's leading pharmaceutical companies we place enormous emphasis on high product quality, and that means 100% traceability across all our processes. So it has long been standard practice for us to use flowmeters from Endress+Hauser – for example for balancing flows of materials and to meet quality-relevant requirements, say in dosing.

Our studies over a number of years have shown that the field accuracy of Promass F evinces outstanding long-term stability. For us that translates into maximized dependability in the process, comparatively long calibration cycles, and also more economical production. Right now we are considering extending the calibration intervals for non-quality-relevant operational flowmeters from 2 to 3 years."

Chemicals industry

When process stability is a key issue

The environment is harsh and process conditions are demanding, so the chemicals industry places particularly high requirements on its metrology. Users expect reliability in registering process variables, along with high accuracy and reproducibility. All are essential for ensuring cost efficiency and constant product quality. So obviously, meters operating under these real-life process conditions have to deliver exactly what is promised on the basis of technical specifications and factory-calibration figures.

The meters installed in chemicals plants are rarely recalibrated, so precision and long-term stability are all the more important. The essentials are traceable primary accuracy and well-designed sensors. The better and more stable the accuracy of the meters, the higher the level of precision in the system as a whole. Consequently, the high field accuracy of Promass flowmeters pays off again and again over the long lifecycle of a chemicals plant. The operator has reproducible measured values and can nudge the process closer to the critical point, for example to maximize yield.

Dipl.-Ing. (FH) Anton Würzinger
Manager of EMR-Technik
VTA GmbH, Deggendorf (Germany)

"The company VTA, Verfahrenstechnische Anlagen GmbH, based in Deggendorf, Germany, is an international supplier of solutions for thin film and short-path distillation for many different sectors, including the chemical industry. We create feasibility studies right through to turn-key projects, pilot and manufacturing plants. VTA also conducts in-house toll distillation for heat sensitive or high-melting products.

We utilize the Promass F Coriolis mass flowmeter at various points in our technical processes as a proven "all-rounder". Based on our previous experience in using this device, we are able to completely rely on the stability of its measurement even with fluctuating fluids, pressures and temperatures. We greatly value the reliability and field accuracy of this flowmeter that offers high flexibility."

Onsite verification the easy way

Anyone who needs in-process proof that Endress+Hauser flowmeters are operating fully to specification can obtain the necessary data easily and quickly with the Fieldcheck tester and simulator. The use of Fieldcheck enables selective maintenance, significantly encreasing plant availability:

- Traceably calibrated tester and simulator
- Comprehensive testing of sensors and transmitters with no interruption to the process
- Time for verification: max. 15 minutes per meter
- Measurement protocol generated automatically, complete with documentation and archiving for purposes of comparison

One for all – multivariable metering

Coriolis flowmeters can measure several process variables simultaneously: mass flow, density and temperature. These figures can be used to compute other important parameters:

- Volume flow
- Standard density
- Concentrations in two-phase fluids

Promass F is the first Coriolis flowmeter to achieve standardization for measuring density in the chemicals industry. Endress+Hauser also offers a special density calibration to meet ultra-high requirements. And Promass I is the world's only flowmeter capable of measuring viscosity directly in the piping. This opens up completely new perspectives in process control and quality assurance.

Oil and gas industry

Where high-precision, robust metrology is essential

In the oil and gas business two things are vital: robust metrology and high measuring accuracy. Loading or transferring, blending or balancing – with the rising prices for crude any error, no matter how small, factors into costs. It is crucial to ensure that external influences such as vibration and pipe strain, as well as pressure and temperature fluctuations do not affect the measurement. Not a problem for the robust Coriolis flowmeter Promass F. This meter is calibrated with legendary "Swiss precision" on the world's most accurate production calibration rig. Consequently, the industry-standard accuracy can be ideally maintained in all transactions.

Save yourself 2 million dollars

Measuring accuracy is not a luxury. Take the price of crude per barrel at USD 50. If a plant operator achieves only a 0.1% improvement on error over 100,000 BOPD, annual earnings would be up about 1.8 million dollars. This is exactly where the fully traceable measuring accuracy (±0.05%) of Promass F really pays off.

Promass F as transfer standard

Many sectors of the petroindustry require Coriolis flowmeters to be calibrated with oil, not water. Promass F has provided ample proof of its abilities in these tests on the accredited pipe provers operated by the Société du Pipeline Sud Européen (SPSE) in Fos-sur-Mer, France. Calibration was performed with four fluids of different densities and viscosities: crude oil, oil condensate, heating oil and naphtha. The tests were conducted in strict compliance with the API and OIML regulations to obtain the custody-transfer approval according to OIML R117, Class 0.3. More and more frequently, metrological authorities use Promass F as a highly accurate transfer standard for onsite calibrations.

Sergio Ochoa Márquez
Head of Metrology Department (LAPEM)
Comisión Federal de Electricidad CFE (Mexico)

"As a state-owned energy company, Comisión Federal de Electricidad (CFE) generates, transports and distributes 95% of the electricity required in Mexico for around 25 million customers. About 78% of this electricity is generated in thermal power stations. The mineral oil supplied to these stations via pipeline by PEMEX (Petróleos Mexicanos) is accurately metered for billing using flowmeter-based systems. The quantities of oil billed in this way are very large, so of course maximum measuring accuracy is particularly important.
This is why our internal metrology department LAPEM (Laboratorio de Pruebas de Equipos y Materiales) checks and calibrates these measurement systems regularly onsite. The reference device we have decided to use for these onsite calibrations is Promass F, the Coriolis mass flowmeter from Endress+Hauser. Its compact and robust design and its outstanding metrological abilities assist us in guaranteeing the traceability of our measurement systems. Another key factor in our decision was that Promass F ensures perfect measurements under difficult process conditions, generally high-viscosity mineral oils at temperatures up to 80 °C. This will afford us even more reliability in future for the job of maintaining the measuring points in the system."


T1309
T1308


CFE

Food industry

Highest field accuracy for more product quality

The food industry continually raises the quality standard of its end products (IFS, BRC, ISO 22000:2005). Thick honey or fruit juices, mixing, filling and dosing – whatever the product or application, the plant operator always faces the same questions:

- How can I sustainably ensure product quality?
- How do I make my processes flexible and cost-effective at the same time?
- How can I implement tracking and tracing for product quality and origin across the various process steps?

The answer is simple: Firstly by regular calibration of quality-critical measuring points. And secondly by using only meters with high field accuracy that conserve both energy and resources and that fulfill all requirements in terms of cleanliness and hygiene. Promass, the Coriolis mass flowmeter from Endress+Hauser meets and beats all these requirements – as an endurably stable flowmeter for control or as a highly accurate and traceable reference for onsite calibration.

Promass S for food

Promass S is a Coriolis mass flowmeter developed specifically for the food industry. It supports you whenever you need permanent monitoring of quality-critical process variables.

- Robust stainless-steel single-tube meter
- Easily cleaned, can be completely drained and is piggable
- Compliant with the requirements of FDA, EHEDG and 3-A
- Excellent performance under temperature change, e.g. after CIP or SIP cleaning

Density, concentration and viscosity metering

Fluid density as measured with modern Coriolis flowmeters has become an indispensable part of efficient process control. With the determination of the fluid density other important parameters can be calculated for signal output:

- Standard density (temperature-compensated density values)
- Concentrations, mass and volume proportions in two-phase fluids
- Industry-specific units of density for recipe control (e.g. °Brix, °Baumé, alcohol content)

Endress+Hauser also offers special density calibration for its Promass meters. This enables high-precision metering across a plant's entire density and temperature range. And if that is not enough: Promass I can now also measure the viscosity of the fluid directly inline. That is a globally unique feature.

David Medlyn
Systems Integration Manager
Coopers Brewery Limited (Australia)

"Founded in the year 1862, our family-owned company Cooper's Brewery Ltd. has been successfully brewing a wide range of beers for over 145 years. As one of Australia's most modern breweries, we utilize the latest measurement technologies. For example, we use an inline density meter after the mash filter to calculate the specific gravity (°Plato) of the wort going into the kettle. The aim is to determine the efficiency of extract recovered from the spent grain in order to achieve a consistent wort quality with optimum use of sparging water and power. We rely on PROFIBUS technology and the Promass F from Endress+Hauser to achieve this process. With this flowmeter we are able to use its density measurement function to determine the strength of the filtered wort but also allows us to optimise the volume of sparge water necessary to recover most of the extract in the spent grain.

The clear benefits of Promass F were its compact and robust design and its simple installation into existing pipelines as well as its excellent measurement accuracy. Together with flow measurement, we are able to ensure optimum control of the mash filtration process allowing us to save energy during the brewing process, and to produce consistently high-quality beer."

Supplementary documentation

Flow measurement

Flow measurement for liquids, gases and steam
Products and services at a glance
FA005D/06/en

Flow measurement
Selection guide
CP001D/06/en

Metering flow the cost-optimised way
Comprehensive metering point solutions for planning, commissioning and maintenance
CP006D/06/en

Flow measurement in utilities
Energy management in your hands – customized solutions for compressed air, gas, steam and water
CP007D/06/en

Calibration management / Calibration service

Looking for competence in calibration?
10 good reasons to choose Endress+Hauser
IN102H/29/ae

Calibration services
A complete range of calibration services to suit your requirements
FA020H/29/ae

Flowmeter calibration
Conformity, the key to productivity
CP001H/29/ae

Calibration Management CompuCal™
High performance system to efficiently maintain and calibrate your onsite instrumentation
CP014H/11/ae

Calibration of level instruments
50 years' experience at your service
IN103H/29/ae

Calibration of flowmeters
When a competent supplier is essential
IN104H/29/ae

Calibration of pressure devices
Traceable and accredited calibration
IN105H/29/ae

Calibration of temperature instruments
The control of your measurement via suitable methods
IN106H/29/ae

Calibration of analysis devices
A matter for specialists
IN107H/29/ae

Link for calibration-related topics
http://www.products.endress.com/service_offering

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