# Field Standard Meters

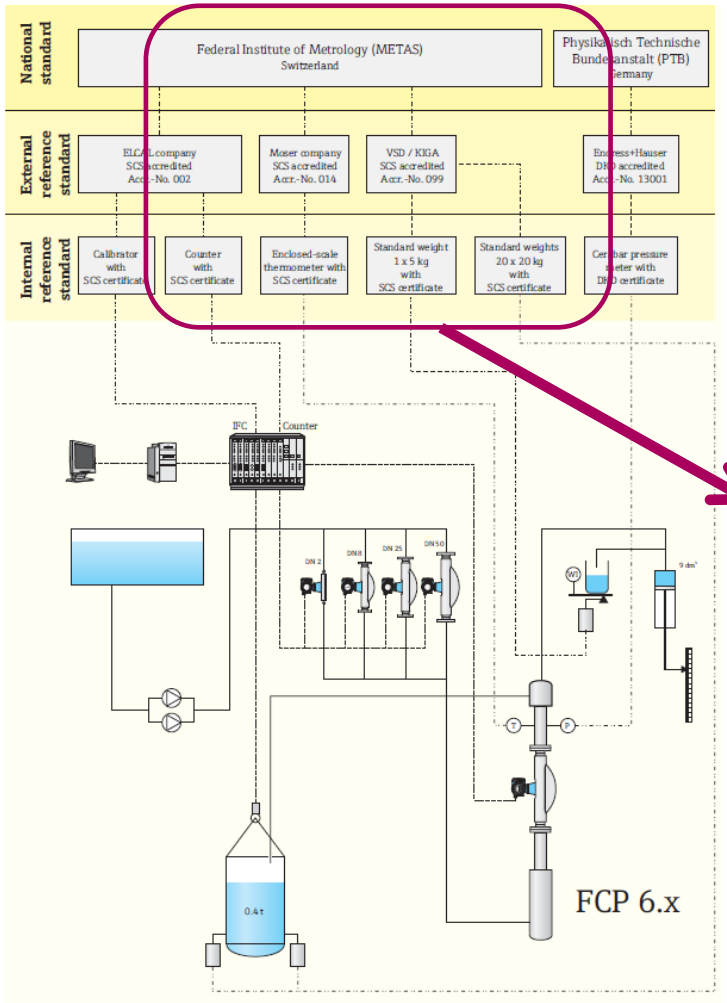


Endress+Hauser

# Field Standard Meters – Presentation Goals

- Describe - initial calibration traceability
  - Duty meters
  - Field Standard Meters
- Show - additional traceable verification data for Field Standard Meters
  - Gravimetric
  - Volume Proving
- Compare - OIML vs NIST Handbook 44 Tolerances
- Describe - American Petroleum Institute Recommendations
  - Proving and Master Meter
- Describe - Added benefit: Calibration vs Electronic Diagnostic Verification
- Show - Global Field Standard Meter Examples

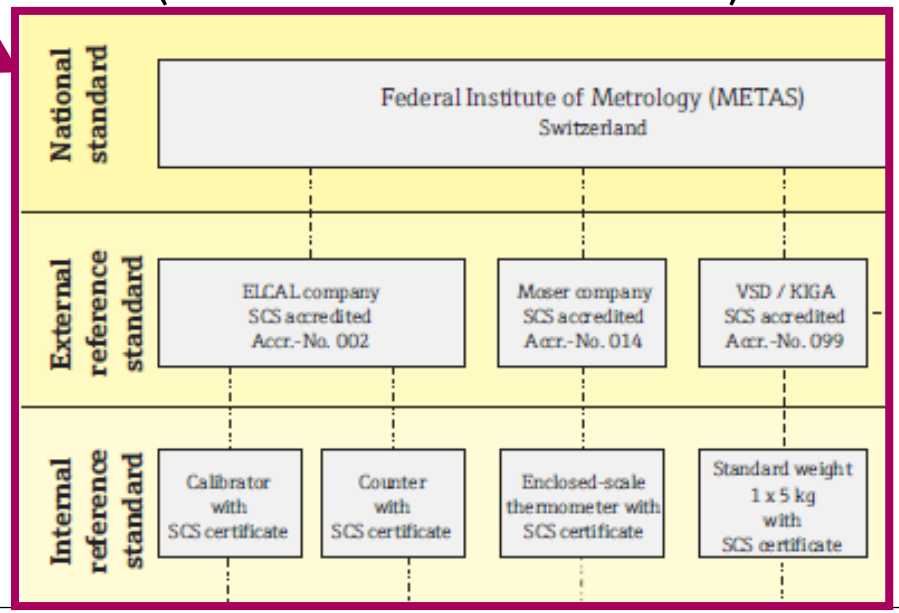
# All Mass Flow Meters Are Calibrated - Metrological Chain For Calibration




Traceable calibration means…

Property of a measurement result to be related to a reference through a documented and unbroken chain of calibrations

(99.5% Confidence Level)



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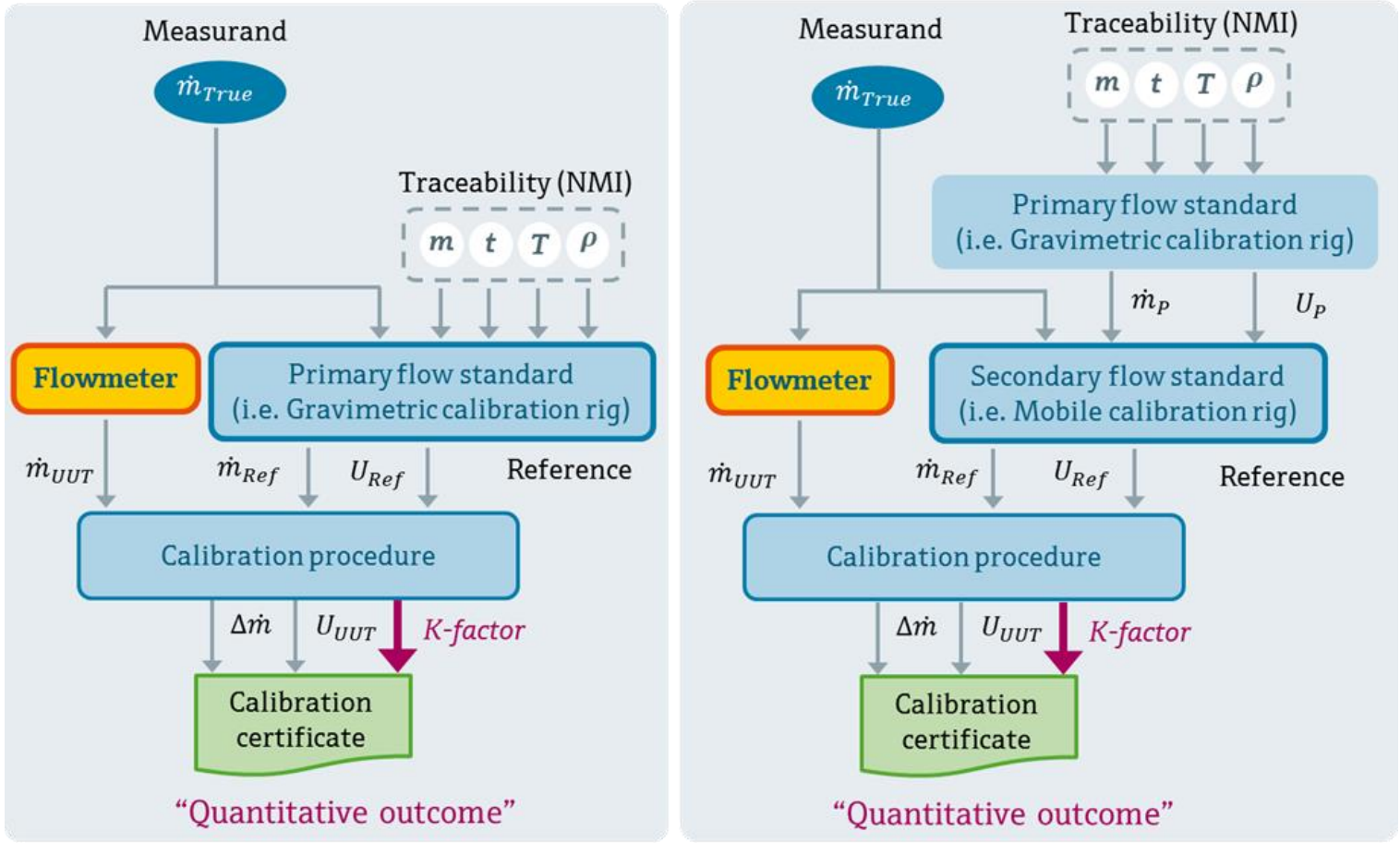
# Mass Flow Meters Are Calibrated Using Primary and Secondary Standards




Flow calibration via primary (a) and secondary flow standard (b)

# OIML Accuracy Class Compared to NIST Handbook 44 3.37 Mass Flow Meter

**Table 1**

| Class | Type of measuring system |
|---|---|
| 0.3 | - Measuring systems on pipelines (see 5.7 )<br>(With exemption for what is stated for accuracy class 1.0 and 1.5) |
| 0.5 | All measuring systems, if not differently stated elsewhere in this table, in particular:<br>- fuel dispensers for motor vehicles (other than LPG dispensers) (see 5.1, 5.9, and 5.10 )<br>- measuring systems on road tankers for liquids of low viscosity (see 5.2)<br>- measuring systems for the unloading of ships' tanks and rail and road tankers (see 5.3)<br>- measuring systems for milk, beer, and other foaming liquids (see 5.6 )<br>- measuring systems for loading ships (see 5.7 )<br>- measuring systems for refuelling aircraft (see 5.8) |
| 1.0 | - Measuring systems for liquefied gases under pressure measured at a temperature equal to or above – 10 °C (see 5.4)<br>- LPG dispensers for motor vehicles (see 5.5 )<br>- Measuring systems:<br>• used for liquids whose dynamic viscosity is higher than 1000 mPa·s, or<br>• whose maximum flowrate is not higher than 20 L/h or 20 kg/h |
| 1.5 | - Measuring systems for liquefied carbon dioxide (see 5.4.9 ),<br>- Measuring systems (other than LPG dispensers) for liquefied gases under pressure measured at a temperature below – 10 °C (see 5.4) |

A better accuracy for a certain type of measuring system may be specified.

Table T.2.
Accuracy Classes and Tolerances for Mass Flow Meters

| Accuracy Class | Application or Commodity Being Measured | Acceptance Tolerance | Maintenance Tolerance | Special Tolerance |
|---|---|---|---|---|
| 0.3 | - Large capacity motor-fuel dispensers (maximum discharge flow rates greater than 100 L/min or 25 gal/min)<br>- Heated products (other than asphalt) at temperatures greater than 50 °C (122 °F)<br>- Asphalt at temperatures equal to or below 50 °C (122 °F)<br>- Loading rack meters<br>- Vehicle-tank meters<br>- Home heating oil<br>- Milk and other food products<br>- All other liquid applications not shown in the table where the minimum delivery is at least 700 kg (1500 lb) | 0.2 % | 0.3 % | 0.5 % |
| 0.3A | - Asphalt at temperatures greater than 50 °C (122 °F) | 0.3 % | 0.3 % | 0.5 % |
| 0.5 | - Small capacity (retail) motor-fuel dispensers<br>- Agri-chemical liquids<br>- All other liquid applications not shown in the table where the minimum delivery is less than 700 kg or 1500 lb | 0.3 % | 0.5 % | 0.5 % |
| 1.0 | - Anhydrous ammonia<br>- LP Gas (including vehicle-tank meters) | 0.6 % | 1.0 % | 1.0 % |
| 2.0 | - Compressed natural gas as a motor-fuel | 1.5 % | 2.0 % | 2.0 % |
| 2.5 | - Cryogenic liquid meters<br>- Liquefied compressed gases other than LP Gas | 1.5 % | 2.5 % | 2.5 % |

(Added 1994) (Amended 1999, 2001, and 2013)

# OIML System “A” versus Meter “B” Tolerance

**Table 2**

| | Accuracy class | | | |
|---|---|---|---|---|
| **Line** | 0.3 | 0.5 | 1.0 | 1.5 |
| A (*) | 0.3 % | 0.5 % | 1.0 % | 1.5 % |
| B (*) | 0.2 % | 0.3 % | 0.6 % | 1.0 % |
| C (equal to Line A – Line B) | 0.1 % | 0.2 % | 0.4 % | 0.5 % |

(*) see 2.6 for application of line A or line B.

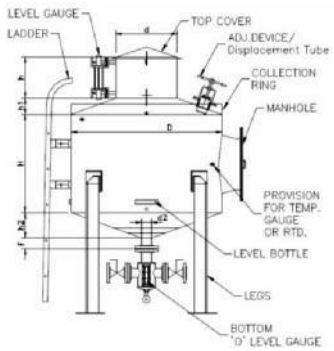
Line A: Complete Measuring System

Line B: Accuracy of one meter

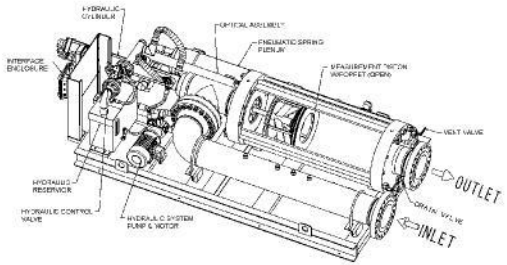
# American Petroleum Institute – Manual on Petroleum Measurement Standards

## Manual of Petroleum Measurement Standards Chapter 4—Proving Systems

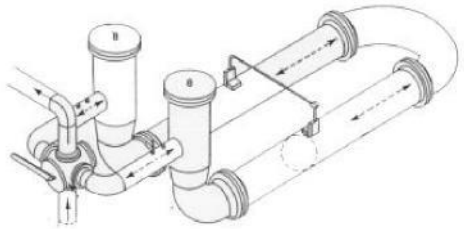
**Open Tank**



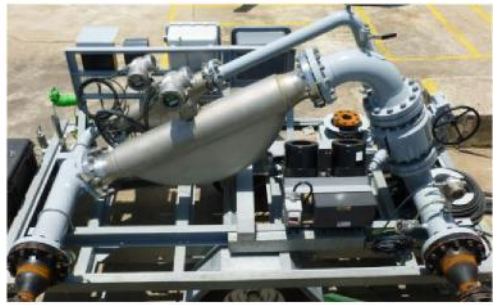

**Small Volume Pipe Prover**




**Piston Prover (Uni or Bi-Di) Prover**



**Master Meter Prover**





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# American Petroleum Institute – Master Meter Provers

**Manual of Petroleum Measurement Standards**
**Chapter 4—Proving Systems**

**Section 5—Master-Meter Provers**

**Measurement Coordination Department**

FIRST EDITION, OCTOBER 1988

- Third Edition, June 2011

- Note: Latest issue is:
- Fourth Edition, June 2016

- **Master meter proving** is used when proving by the direct method can not be accomplished because of meter characteristics, logistics, time, space, safety, ***and cost considerations*.**

- The terminology for this type of proving is "**Indirect master meter proving**"; according to MPMS Ch.4.5 clause 6.5 ,to establish a master meter factor (and this meter could be used for that duty), **a proving against a conventional prover on site or accredited calibration shall be performed** with a repeatability that results in a demonstrated random uncertainty of ±0.029 % or better, at a 95% confidence level.

- Our procedure for proving of the master meter uses an SVP with criteria of 0.05% repeatability in 5 runs : B+B in the table B.2 examples below:

| Combinations | Random Uncertainty (RU1) Value of First Meter | Random Uncertainty (RU2) Value of Second | MMF Range (spread) Defined in 6.2 and 6.3 | Combined Uncertainty MMF Uncertainty = $\sqrt{RU_1^2 + RU_2^2 + (0.5 \times \text{MMF Range})}$ |
|---|---|---|---|---|
| A+B | 0.011 % | 0.027 % | 0.05 % | 0.054 % |
| A+C | 0.011 % | 0.073 % | 0.10 % | 0.124 % |
| C+B | 0.073 % | 0.027 % | 0.15 % | 0.153 % |
| B+B | 0.027 % | 0.027 % | 0.05 % | 0.063 % |

# American Petroleum Institute – Operation of Proving Systems

**Manual of Petroleum Measurement Standards**
**Chapter 4—Proving Systems**

**Section 8—Operation of Proving Systems**

**Measurement Coordination**
FIRST EDITION, NOVEMBER 1995

- Note: Latest issue is:
- 2nd edition, September 2013

**4.8.2.11 PROVER RECALIBRATION FREQUENCY**

c. The maximum interval indicated below has elapsed.
1. Three years for small volume provers and mobile provers.
2. Five years for permanently installed pipe provers.
3. Five years for permanently installed tank provers.
4. Three months for master meter provers.

**4.8.2.10 FREQUENCY OF METER PROVING**

The frequency required for proving varies from several times a day to twice a year or even longer depending upon the value of the liquid, cost/benefit to prove, meter proving history, meter system stability, and variations of operating systems.

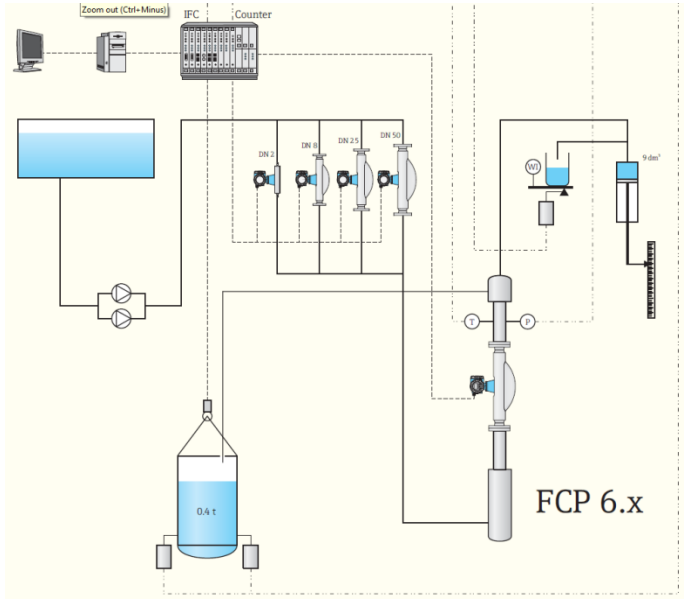
For large volumes or different liquids, a permanently installed prover is normally used. The meters should be proved whenever the flow rate, temperature, pressure, API Gravity (relative density), or viscosity changes significantly. Normally, time or volume is used to determine when the meter should be proved.

The proving frequency for new systems should start at short intervals and be extended to longer intervals as confidence increases in the system.

# Calibration or Proving Supported By Electronic Diagnostic Verification

What is the relation between calibration and verification results?

Calibration rig

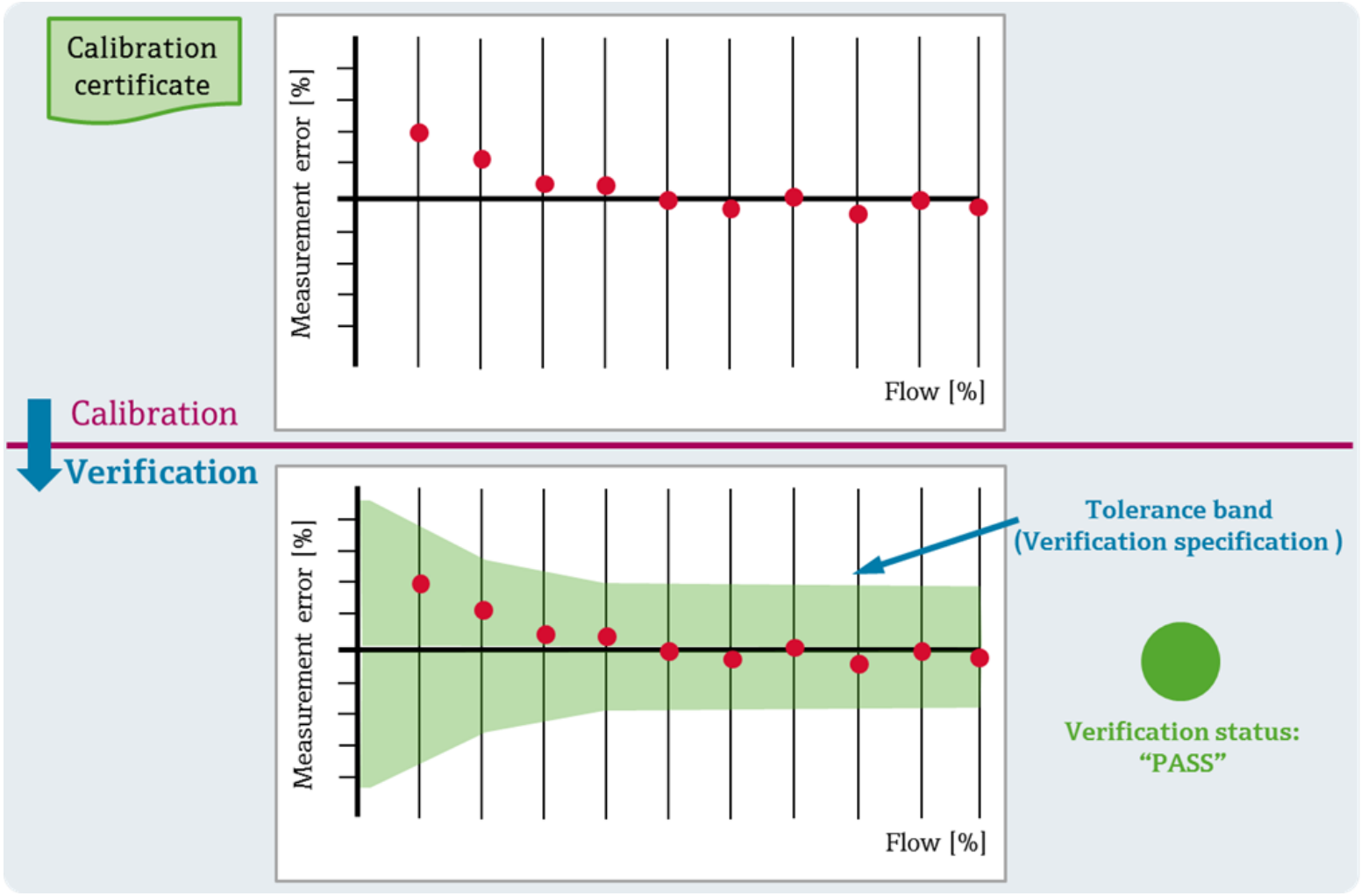



Calibration report

Field Standard Meter

Verification report

# Calibration vs Electronic Diagnostic Verification Comparison



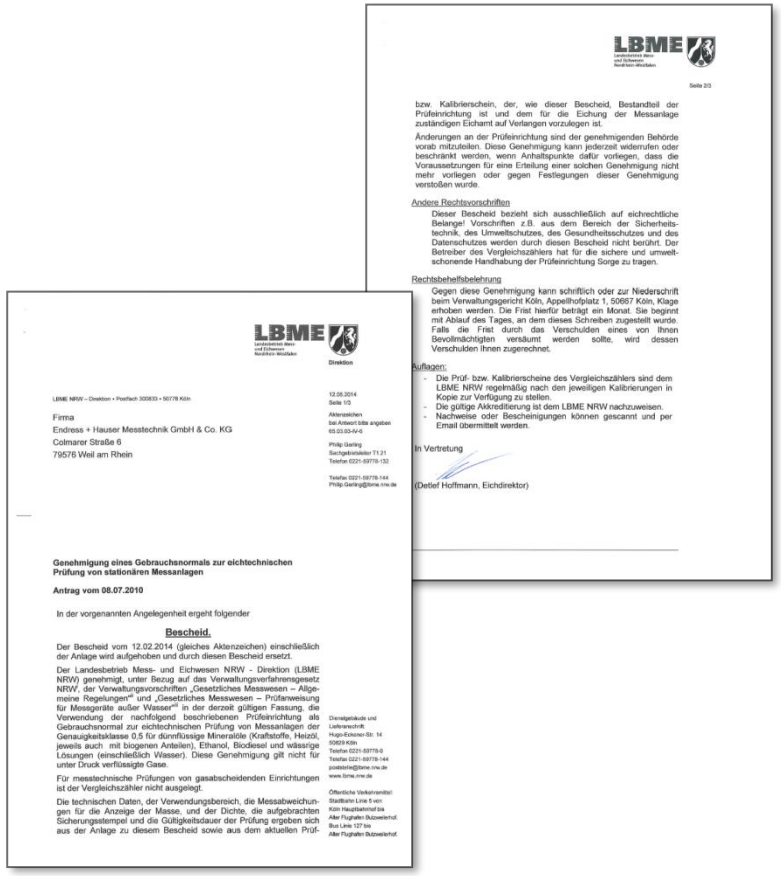

Example: A verification task based on the flowmeter measurement error



Endress+Hauser

# Germany Approval for Field Standard Meters

- Approval for use as a field standard of use for testing of measuring systems of accuracy class 0.5*.
- Valid for:
  - Low-viscosity mineral oils (fuels, heating oil, each also with biogenic proportions)
  - Ethanol, Biodiesel
  - Aqueous solutions (including water)
- Approval granted by LBME (Landesbetrieb Mess-und Eichwesen Nordrhein-Westfalen) 12 May 2014


LBME

bzw. Kalibrierschein, der, wie dieser Bescheid, Bestandteil der Prüfeinrichtung ist und dem für die Eichung der Messanlage zuständigen Eichamt auf Verlangen vorzulegen ist.

Änderungen an der Prüfeinrichtung sind der genehmigenden Behörde vorab mitzuteilen. Diese Genehmigung kann jederzeit widerrufen oder beschränkt werden, wenn Anhaltspunkte dafür vorliegen, dass die Voraussetzungen für eine Erteilung einer solchen Genehmigung nicht mehr vorliegen oder gegen Festlegungen dieser Genehmigung verstoßen wurde.

Andere Rechtsvorschriften

Dieser Bescheid bezieht sich ausschließlich auf eichrechtliche Belange! Vorschriften z.B. aus dem Bereich der Sicherheitstechnik, des Umweltschutzes, des Gesundheitsschutzes und des Datenschutzes werden durch diesen Bescheid nicht berührt. Der Betreiber des Vergleichszählers hat für die sichere und umweltschonende Handhabung der Prüfeinrichtung Sorge zu tragen.

Rechtsbehelfsbelehrung

Gegen diese Genehmigung kann schriftlich oder zur Niederschrift beim Verwaltungsgericht Köln, Appellhofplatz 1, 50667 Köln, Klage erhoben werden. Die Frist hierfür beträgt ein Monat. Sie beginnt mit Ablauf des Tages, an dem dieses Schreiben zugestellt wurde. Falls die Frist durch das Verschulden eines von Ihnen Bevollmächtigten versäumt werden sollte, wird dessen Verschulden Ihnen zugerechnet.

Auflagen:

- Die Prüf- bzw. Kalibrierscheine des Vergleichszählers sind dem LBME NRW regelmäßig nach den jeweiligen Kalibrierungen in Kopie zur Verfügung zu stellen.
- Die gültige Akkreditierung ist dem LBME NRW nachzuweisen.
- Nachweise oder Bescheinigungen können gescannt und per Email übermittelt werden.

In Vertretung

(Detlef Hoffmann, Eichdirektor)

LBME

Direktion

Firma
Endress + Hauser Messtechnik GmbH & Co. KG
Colmarer Straße 6
79576 Weil am Rhein

**Genehmigung eines Gebrauchsnormals zur eichtechnischen Prüfung von stationären Messanlagen**

**Antrag vom 08.07.2010**

In der vorgenannten Angelegenheit ergeht folgender

**Bescheid.**

Der Bescheid vom 12.02.2014 (gleiches Aktenzeichen) einschließlich der Anlage wird aufgehoben und durch diesen Bescheid ersetzt.

Der Landesbetrieb Mess- und Eichwesen NRW - Direktion (LBME NRW) genehmigt, unter Bezug auf das Verwaltungsverfahrensgesetz NRW, der Verwaltungsvorschriften „Gesetzliches Messwesen – Allgemeine Regelungen“ und „Gesetzliches Messwesen – Prüfanweisung für Messgeräte außer Wasser“ in der derzeit gültigen Fassung, die Verwendung der nachfolgend beschriebenen Prüfeinrichtung als Gebrauchsnormal zur eichtechnischen Prüfung von Messanlagen der Genauigkeitsklasse 0,5 für dünnflüssige Mineralöle (Kraftstoffe, Heizöl, jeweils auch mit biogenen Anteilen), Ethanol, Biodiesel und wässrige Lösungen (einschließlich Wasser). Diese Genehmigung gilt nicht für unter Druck verflüssigte Gase.

Für messtechnische Prüfungen von gasabscheidenden Einrichtungen ist der Vergleichszähler nicht ausgelegt.

Die technischen Daten, der Verwendungsbereich, die Messabweichungen für die Anzeige der Masse, und der Dichte, die aufgebrachten Sicherungsstempel und die Gültigkeitsdauer der Prüfung ergeben sich aus der Anlage zu diesem Bescheid sowie aus dem aktuellen Prüf-

* Compliance with the administrative regulation "Gesetzliches Messwesen – General test instructions for measuring instruments for flowing Liquids other than water (GM-P5)



Endress+Hauser

# France Approvals for Field Standard Meters

- Approval for use as a field standard of use for testing of measuring systems
- Valid for:
  - Refined hydrocarbons
  - LPG
- Approval granted by LNE (Laboratorie National De Metrologie Et D'Essaia 11 March 2019

Organisme désigné par
le Ministère chargé de l'industrie

LABORATOIRE NATIONAL DE MÉTROLOGIE ET D'ESSAIS

**CERTIFICAT D'APPROBATION DE MOYENS D'ESSAIS**

**N° LNE-33723 rév. 2 du 11 mars 2019**

Modifie le certificat 33723-1

**Délivré par** : Laboratoire national de métrologie et d'essais

**En application** : Décret n° 2001-387 du 3 mai 2001 modifié, de l'arrêté du 31 décembre 2001 et de la décision n° 09.00.110.003.1 du 21 octobre 2009 relative aux moyens d'étalonnage dans le domaine du mesurage statique et dynamique des liquides.

**Délivré à** : SOCIETE GENERALE DE METROLOGIE (SGM) - ZA Bastide Blanche Bâtiment E1
FRANCE 13127 VITROLLES

**Concernant** : Moyen d'essais SGM type MASS PROVER DEPOT.

**Caractéristiques** : Les caractéristiques du moyen d'essais sont détaillées en annexe du présent certificat.

**Valable jusqu'au** : Le présent certificat reste valable tant qu'aucune modification ou évolution susceptible de modifier les caractéristiques du moyen d'essais n'est apportée et sous réserve que l'incertitude globale reste inférieure aux critères fixés pour la catégorie d'instruments concernés. Par ailleurs, toute modification des procédures citées dans le présent certificat doit être portée à la connaissance du LNE.

Les principales caractéristiques et conditions d'approbation figurent dans l'annexe ci-jointe qui fait partie intégrante du certificat d'approbation et comprend 10 pages.
Tous les plans, schémas et notices sont déposés au Laboratoire national de métrologie et d'essais sous la référence de dossier P190168 -1.

*Etabli le 11 mars 2019*

cofrac
CERTIFICATION DE PRODUITS ET SERVICES

Pour le Directeur Général
Signature numérique de THOMAS LOMMATZSCH ID
Date : 2019.03.11 [illegible] +01'00'
Thomas LOMMATZSCH
Responsable du Pôle Certification
Instrumentation et Technologies de l'Information

**Laboratoire national de métrologie et d'essais** • Etablissement public à caractère industriel et commercial
Siège social : 1, rue Gaston Boissier - 75724 Paris Cedex 15 • Tél. : 01 40 43 37 00 - Fax : 01 40 43 37 37
info@lne.fr • lne.fr • RCS Paris 313 320 244 - NAF : 7120B - TVA : FR 92 313 320 244



Endress+Hauser

# Netherland Uncertainty Declaration for 10” Field Standard Meter

- Conclusion:
  - The expanded uncertainty of the flowmeter for measuring the quantity of mass flow is 0.064% (bidirectional use) and 0.059% (unidirectional use) with a coverage factor k=2 (confidence level of 95%).
  - Approval for use as a field standard of use for testing of measuring systems
- NMi Certain BV, 24 March 2020

**Declaration**

Number NMi-2400577-EB-02
Project number: 2400577
Page 1 of 1

| | |
|---|---|
| Issued by | NMi Certin B.V. |
| Applicant | Endress+Hauser Flowtec AG<br>Kägenstrasse 7<br>CH-4153 Reinach (BL)<br>Switzerland |
| Submitted | A **flow meter** intended to be used as master meter for measuring the quantity of mass flow rate.<br>Manufacturer's identification : Endress+Hauser<br>Type designation : Promass F300 |
| Scope of assessment | The expanded uncertainty of a master flow meter is determined based on the flow calibration on water and oil products.<br>This review is solely performed based on water calibration certificates issued by Endress+Hauser under ISO 17025 accreditation no. SCS 0052 by Swiss Accreditation Service (SAS) and the oil product calibration certificates issued by SPSE under ISO 17025 accreditation no. 2.1340 by Cofrac.<br>Only the determination of the mass flow is in the scope of this assessment. |
| In accordance with | JCGM 100: 2008<br>“Evaluation of measurement data — Guide to the expression of uncertainty in measurement”. |
| Annexes | The complete declaration consists of the following annexes:<br>– Annex 1: General information and uncertainty calculation<br>– Annex 2: Graphs of calibration results<br>– Annex 3: Water calibration certificates<br>– Annex 4: Oil products calibration certificates |
| Conclusion | The expanded uncertainy of the flow meter for the measuring the quantity of mass flow is 0,064 % (bidirectional use) and 0,059 % (unidirectional use) with coverage factor k=2 (confidence level of 95%). |

Issuing Authority **NMi Certin B.V.**
24 March 2020

E.D. Beumer
Senior Approval Expert

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certin@nmi.nl
www.nmi.nl





Endress+Hauser

# France

LPG Field Standard Meter


Hydrocarbon  Field Standard Meter

# France

Hydrocarbon  Field Standard Meter

# Liquefied Petroleum Gas Meter Proving

Slovenia

Meters used to test Liquefied Petroleum Gas  truck mounted delivery system.

Turkey

# Trailer Mounted Meter Systems

3” Coriolis Turkey

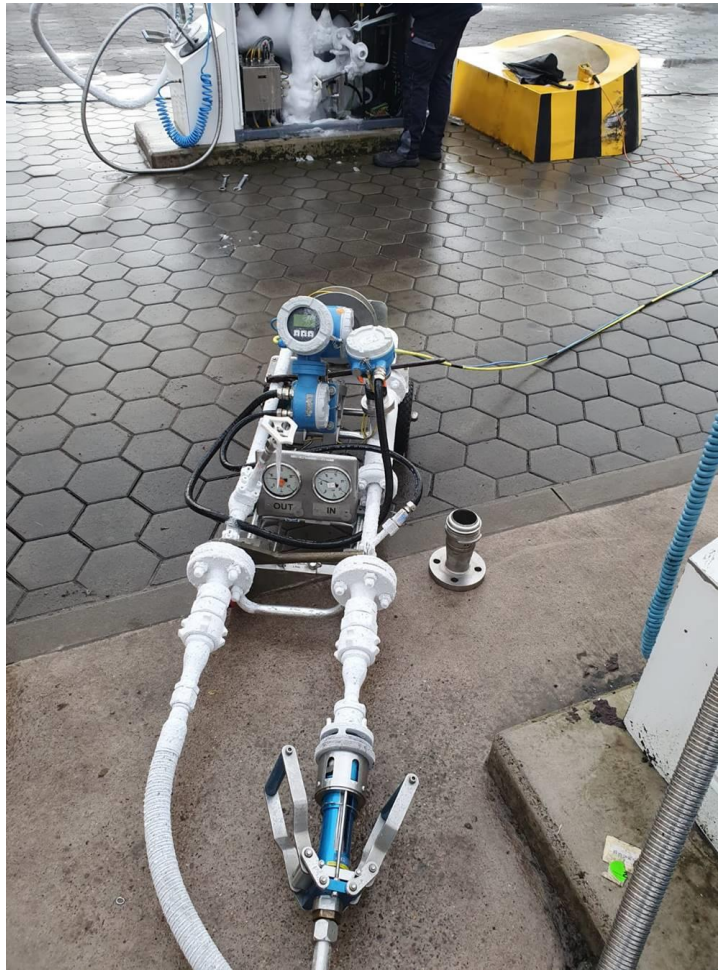
10” Coriolis South Africa

4” Coriolis Pascagoula MS

# Cuba – mobile master meter

# Mobile Calibration System in Vietnam


# Liquefied Natural Gas Master Meter in Germany




Liquefied Natural Gas Master Meter in Germany


Liquefied Petroleum Gas Master Meter in Slovenia.



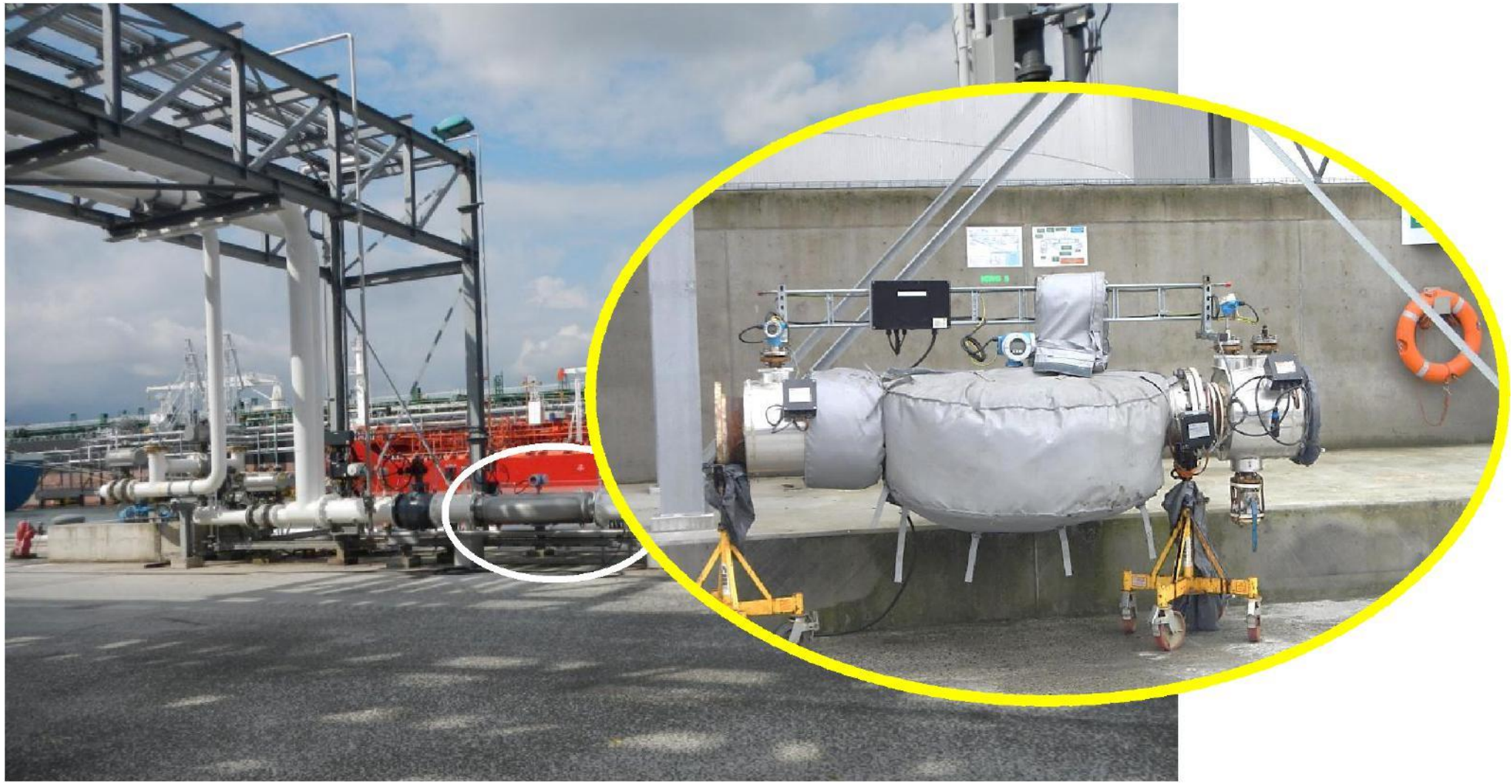
Endress+Hauser

# Denmark Marketing Terminal – Ship Loading

Application:

- 9 Custody Transfer MID 0.5 approved systems with Coriolis 12”
- 1 Coriolis- 12” Master Meter MID approved on portable trailer
- Fluid: Gasoil, Heavy & Mid Bunker Fuel Oil

# Denmark Marketing Terminal – 12” Duty Meter and 12” Master Meter



# Denmark Marketing Terminal – 12” Duty Meter and “ Master Meter


DANAK
Calibration Certificate

FORCE Certification

DANAK

Certificate of Conformity
Measuring Instrument Directive – MID, Module F

Issued to: Endress+Hauser Instruments International AG
Kaegenstrasse 2
4153 Reinach
Switzerland

Conclusion: The measuring system fulfils the requirements of the regulation.

Lars Parmo
FORCE Certifiion, Certificates Manager



SPSE

CERTIFICAT D'ETALONNAGE
CALIBRATION CERTIFICATE

N° 13377

- Calibration certificate for the duty meter for MID 0.5 application
- Certificate of conformity

- Calibration certificate from accredited laboratory using oil calibration rig with bi-directional ball prover
- Yearly verification certificate against accredited water calibration rig



Endress+Hauser

# Mass Flow Meter - Master Meter / Field Standard Meter

- Traceable, accurate and repeatable
  - Traceable water calibration and verification of mass meter is transferrable to the field
  - Suitable for mass and volume proving (P or T compensation for volume proving to standard conditions)
- Reliable
  - Faster, easier, efficient proving compared to using scales or volume provers or displacement provers – easy to automate
  - No mechanical wear, no rotating parts
  - Compact, frame mounted for easy transport
  - On-board electronic verification system ensures ongoing performance between traceable re-verifications
- Field Standard Meters are approved for use worldwide to place into service and test metering systems in contractual and legal for trade applications
- Adoption of LPG-15.1 and MFM 15.1 will lead to broader use in the US and in the future possibly Canada.