



GdS - Misure Fiscali

Milan, October, 25 2018

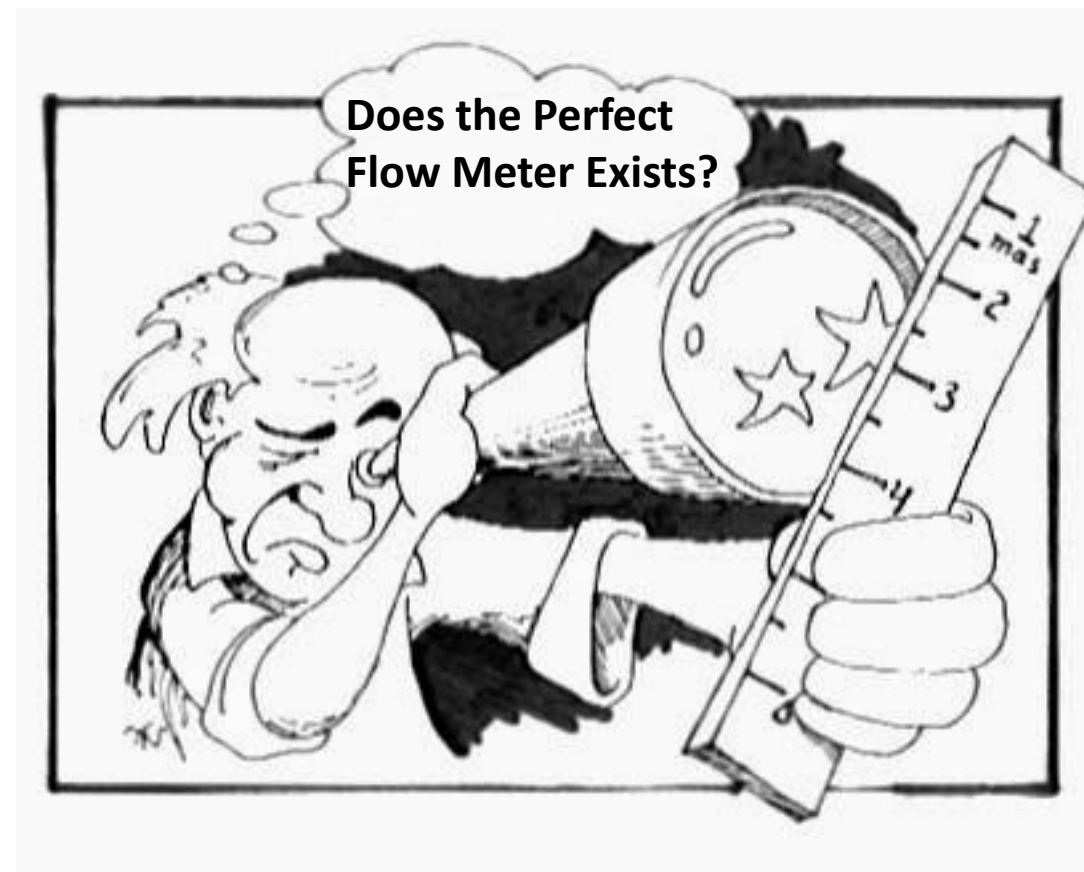
Auditorium TECNIMONT

Meters – Metrological Conformity Assessment

The **Perfect Flow Meter**,

as described by **George Mattingly**, Ph.D., of the **National Institute of Standards and Technology** (now retired)

- never drifts or wears;
- measure in mass units;
- never needs zeroing;
- is immune to the effects of changing fluid properties and fluid dynamics, density, viscosity, Reynolds number, speed of sound, swirl and irregular flow profile.





Verification Addresses Challenges of Calibration and Proving

Calibration

- Establish relationship between flow rate and signal produced by sensor
- Should be traceable and accredited



Validation

- Compare meter to a reference to confirm performance
- Example: Prover or master meter



Verification

- Correlate diagnostics, secondary variables to primary variables
- Example: Meter Structural integrity



Define the Legal approvals and standards



- Organisation Internationale de Metrologie Legale (OIML)
- Directive from the European Parliament and of the council
- National Conference on Weights and Measures (NCWM)
- International Standards Organization (ISO)
- American Petroleum Institute (API)
- European Standard (EN)





**Paving the
way towards
a global
metrology
system since
1955**

OIML International Organization of Legal Metrology

What is the OIML?

“The mission of the OIML is to **enable economies** to put in place effective **legal metrology infrastructures that are mutually compatible and internationally recognized**, for all areas for which governments take responsibility, such as those which facilitate trade, establish mutual confidence and harmonize the level of consumer protection worldwide.” - [OIML B 15:2011](#)

The International Organization of Legal Metrology is an intergovernmental treaty organization which

- develops model regulations, standards and related documents for use by legal metrology authorities and industry,
- provides mutual recognition systems which reduce trade barriers and costs in a global market,
- represents the interests of the legal metrology community within international organizations and forums concerned with metrology, standardization, testing, certification and accreditation,
- promotes and facilitates the exchange of knowledge and competencies within the legal metrology community worldwide,
- cooperates with other metrology bodies to raise awareness of the contribution that a sound legal metrology infrastructure can make to a modern economy.

The OIML issues several categories of publications:

- **International [Recommendations](#)**, which are **intended as model regulations** for a number of categories of **measuring instruments**, and which **OIML Member States are morally obliged to implement as far as possible**;
- International [Documents](#), which are informative and are intended for guidance purposes; and
- other publications such as [Vocabularies](#), [Guides](#), [Basic Publications](#) and [Expert Reports](#).



From: www.oiml.org

International Organization for Standardization



ISO has
published
22362
International
standards

We're ISO,
the **International Organization for Standardization**. We develop and publish International Standards.

ISO is an **independent, non-governmental international organization** with a membership of **162 National Standards bodies**.

Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards that support innovation and provide solutions to global challenges.

You'll find our Central Secretariat in Geneva, Switzerland.

What are standards?

International Standards make things work. They give world-class specifications for products, services and systems, to ensure quality, safety and efficiency. They are instrumental in facilitating **international trade**.

ISO has published 22362 International Standards and related documents, covering almost every industry, from technology, to food safety, to agriculture and healthcare.

ISO International Standards impact everyone, everywhere.



London 1946, 65 delegates from 25 countries meet to discuss the future of International Standardization

From: www.iso.org

API American Petroleum Institute



Today API
maintains
nearly 700
standards and
recommended
practices

Who is API ?

Who We Are

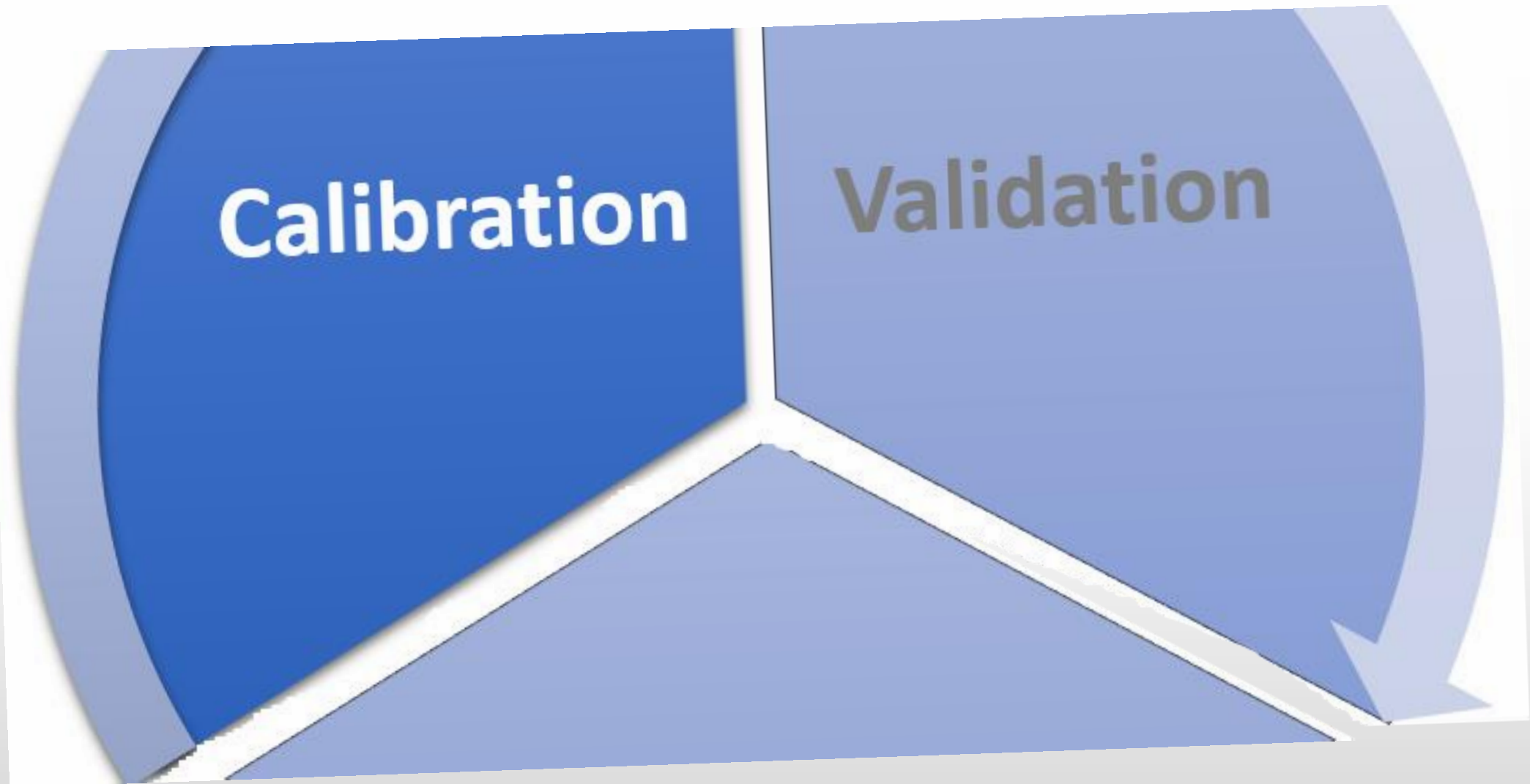
API is the only national trade association representing all facets of the natural gas and oil industry, which supports 10.3 million U.S. jobs and nearly 8 percent of the U.S. economy. API's more than 600 members include large integrated companies, as well as exploration and production, refining, marketing, pipeline, and marine businesses, and service and supply firms.

Since 1924, the American Petroleum Institute has been a cornerstone in establishing and maintaining standards for the worldwide oil and natural gas industry. **Our work helps the industry invent and manufacture superior products** consistently, provide critical services, ensure fairness in the marketplace for businesses and consumers alike, and promotes the acceptance of products and practices globally.

Standards enhance the safety of industry operations, assure quality, help keep costs down, reduce waste, and minimize confusion. They help speed acceptance, bring products to market quicker, and avoid having to reinvent the wheel every time a product is manufactured.

The second effort was the standardization of oil field equipment. During World War I, drilling delays resulted from shortages of equipment at the drill site, and the industry attempted to overcome that problem by pooling equipment. The program reportedly failed because there was no uniformity of pipe sizes, threads and coupling. Thus, the new association took up the challenge of developing industry-wide standards and the first standards were published in 1924.

From: www.api.org



Calibration Laboratory

- Quality Management System globally consistent
- Calibration methods approved and accepted globally by National Metrology Institutes
- Calibration and Measurement Capability (CMC) verified by multiple accrediting bodies.
- Inter-laboratory test program
 - Agreements between multiple national labs.

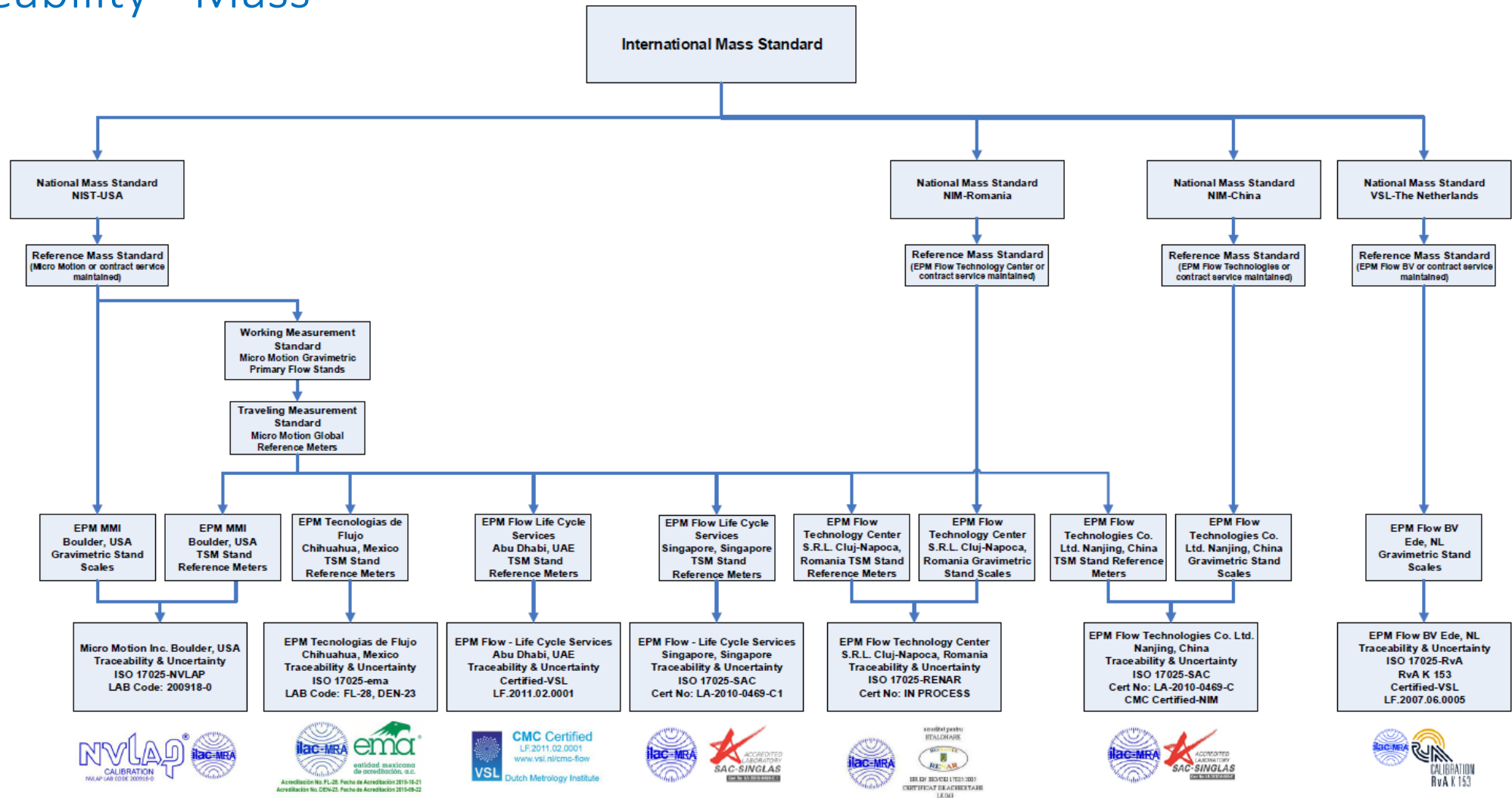


Global Traceability - Mass

Traceable through countries to the international kilogram



Uncertainty values verified by accrediting bodies and accepted through mutual recognition programs

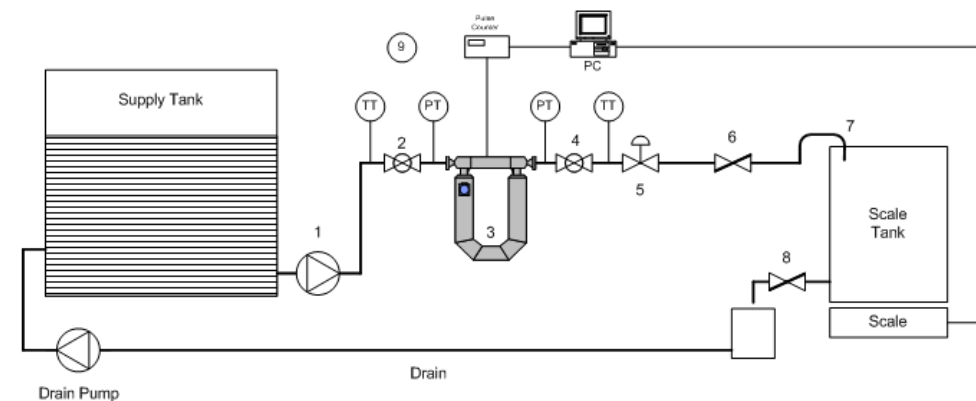


The Emerson's way: Coriolis Factory Calibration stand



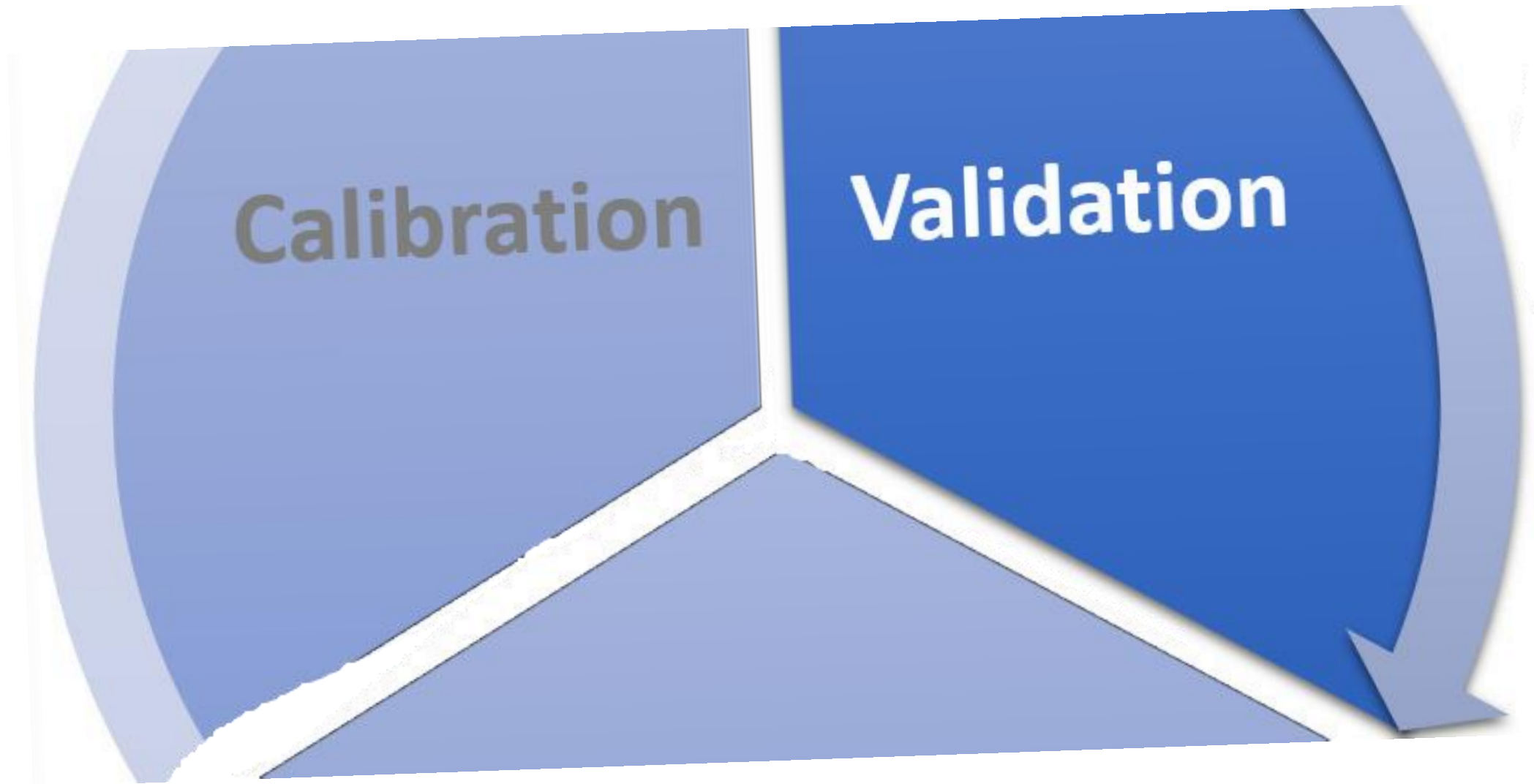
Three **ISO/IEC 17025** accredited Flow Loops, includes additional Coriolis product calibration processes with confirmed best **measurement uncertainties to 0.017%** for mass flow and **0.07 kg/m³** for density.

Up to 14" Meters.
ISO9001:2008 certified for quality management systems.

A screenshot of an Emerson ISO/IEC 17025 Accredited Calibration Certificate. The certificate includes fields for Object, Manufacturer, Type, Serial number, Customer, Order number, Date of calibration, Calibration fluid, Calibration standard, Reference conditions, Environmental conditions, and Measurement uncertainty. It also features the Emerson logo and the RINA Calibration RvA K 153 logo.

The Emerson's way: Coriolis Global Calibration network





What is Validation?

Purposes of Validation/Proving

- **Confirm or correct meter factors**
- Determine whether or not different meter factors are needed for changing operating conditions
- **Meet contractual and regulatory requirements**
OIML, API, MID, GOST
- Verify meter accuracy and repeatability
- Reduce uncertainty
- Establish meter reliability and reproducibility
- Anticipate meter failures



Early Proving

Historic Proving Methods

- **Displacement Prover**

Small Volume / Compact

- Portable

Pipe / Ball

- Stationary



- **Tank Prover**

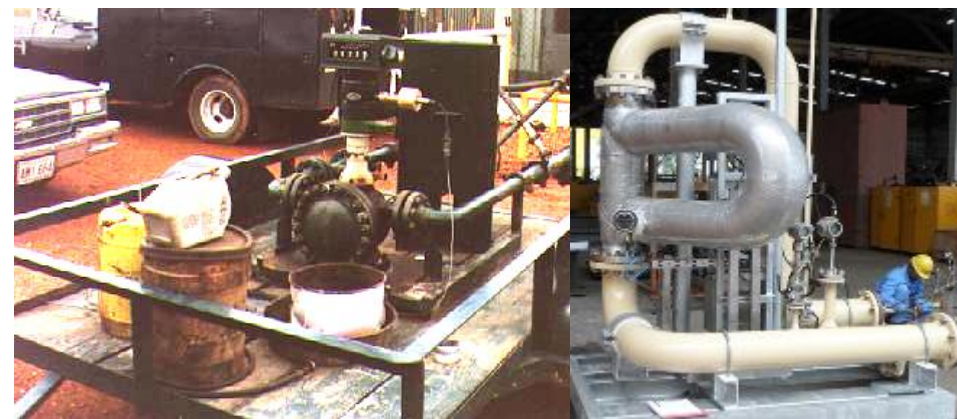
Portable or Stationary

- **Master Meter**

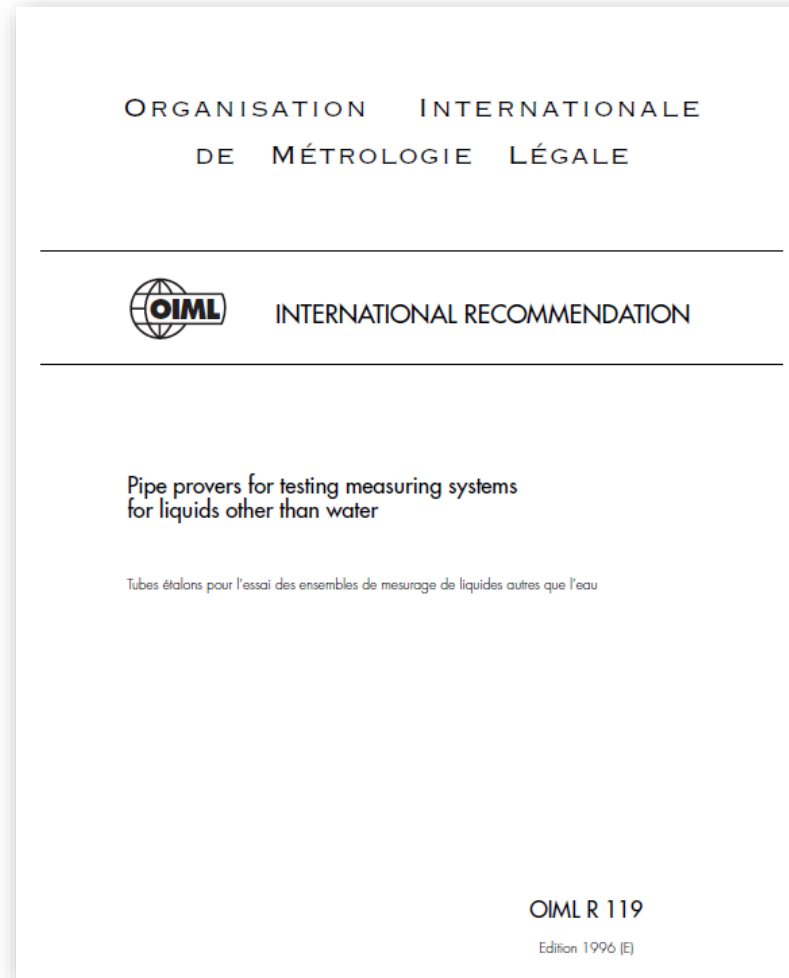
Turbine & PD

Mass Meters

- Flexible



Pipe Provers for testing measuring systems for liquid other than water



This Recommendation deals with pipe provers and with their use for testing measuring systems for liquids other than water (hereinafter called «measuring systems»), in order to verify that they comply with the relevant metrological requirements in the International Recommendation OIML R 117.

OIML R-119



OIML R-119: in clauses 2 and 3, **metrological characteristics of pipe provers are summarized, including their calibration.**

OIML R-119: in clauses 4 to 8, **methods are given for testing the following measuring systems:**

- measuring systems on **road tankers**;
- measuring systems for the **unloading** of road and rail tankers, ships' tanks and tank containers;
- measuring systems for the **loading** of road and rail tankers, ships' tanks and tank containers;
- measuring systems on **pipelines**;
- measuring systems for liquefied petroleum gas (**LPG**) under pressure;
- **LPG dispensers** and **fuel dispensers**.

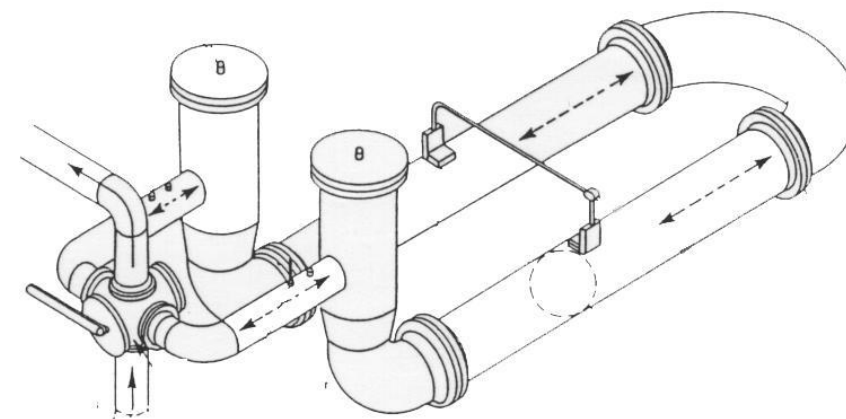
Many of the descriptions in this Recommendation are referred to in the International Standards listed below in which more detailed information is found.

- **ISO 7278-1** *Liquid hydrocarbons - Dynamic measurement - Proving systems for volumetric Meters*
- **ISO 8222** *Petroleum measurement systems - Calibration - Temperature corrections for use with volumetric reference measuring systems*
- **ISO 4267-2** *Petroleum and liquid petroleum products - Calculation of oil quantities - Part 2: Dynamic measurement*

Pipe Provers

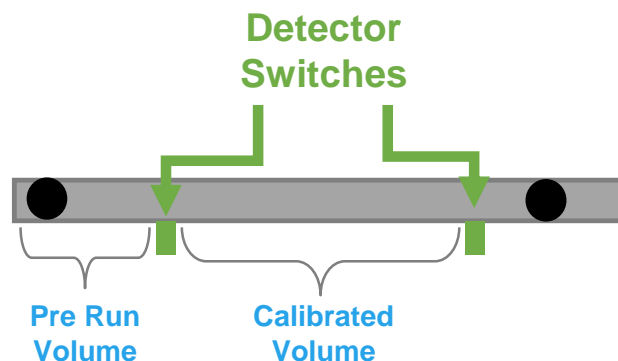


A pipe prover is a pipe or cylinder whose measured volume is used to calibrate or «prove» a flow meter. Proving the meter is accomplished by passing through the pipe a displacer (usually a sphere or piston) which actuates detectors delimiting the calibrated section. The known volume in this section is corrected for temperature and pressure and compared to the reading of the meter to determine the meter error.

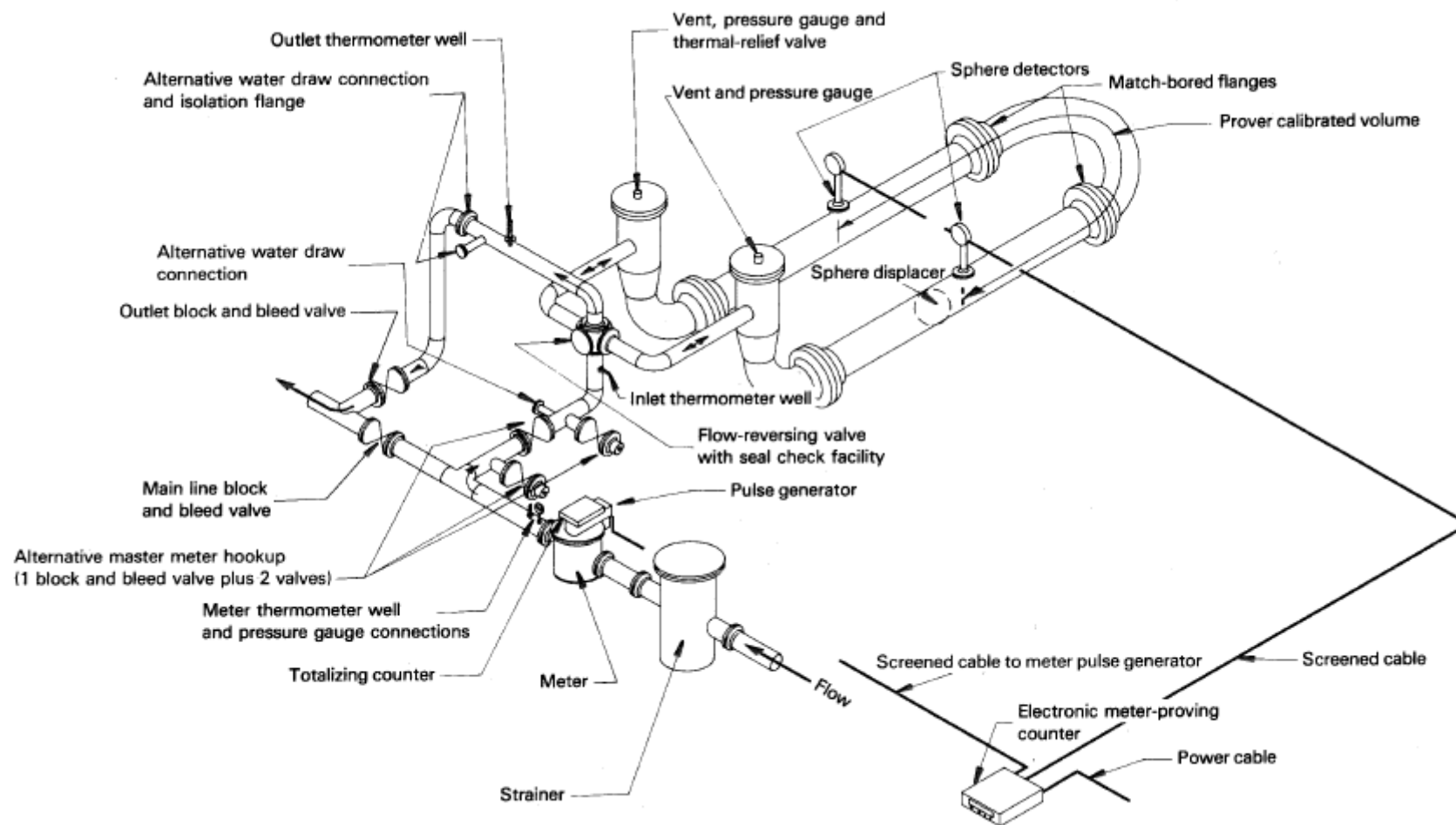


Also referred to as:

- Ball Provers
- Bi-Directional Provers

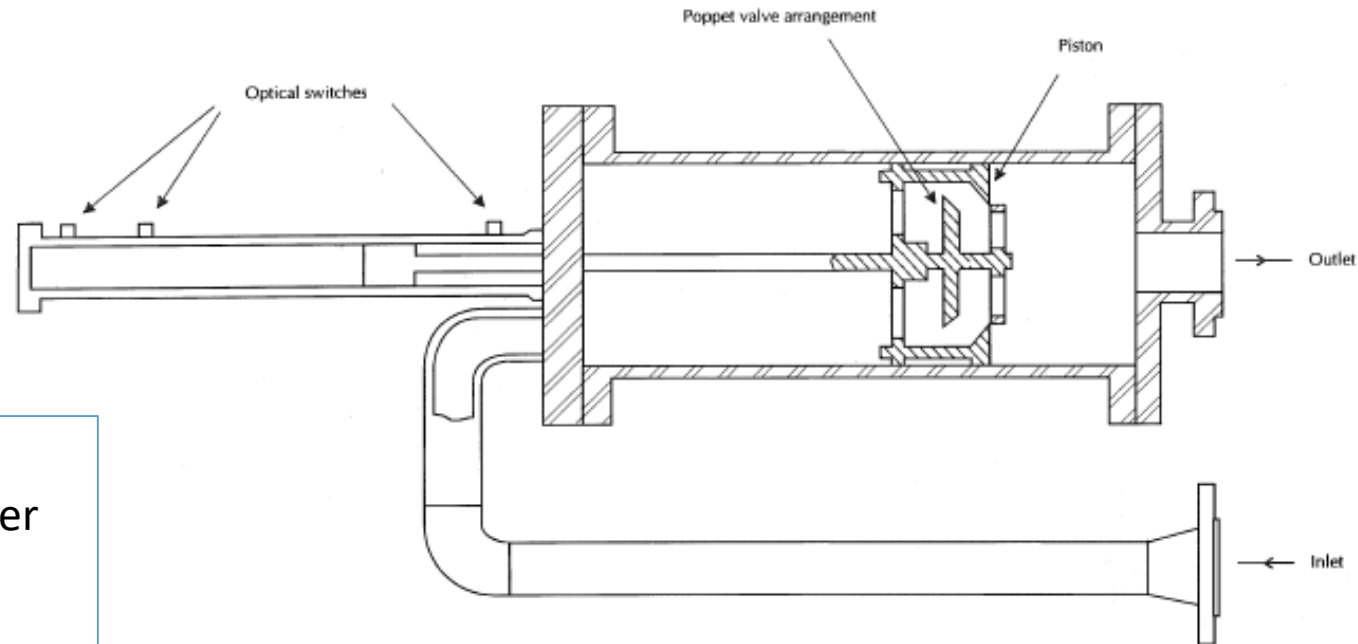


Pipe Provers



Typical Bidirectional U-type pipe prover (Extracted from ISO 7278)

Piston Provers

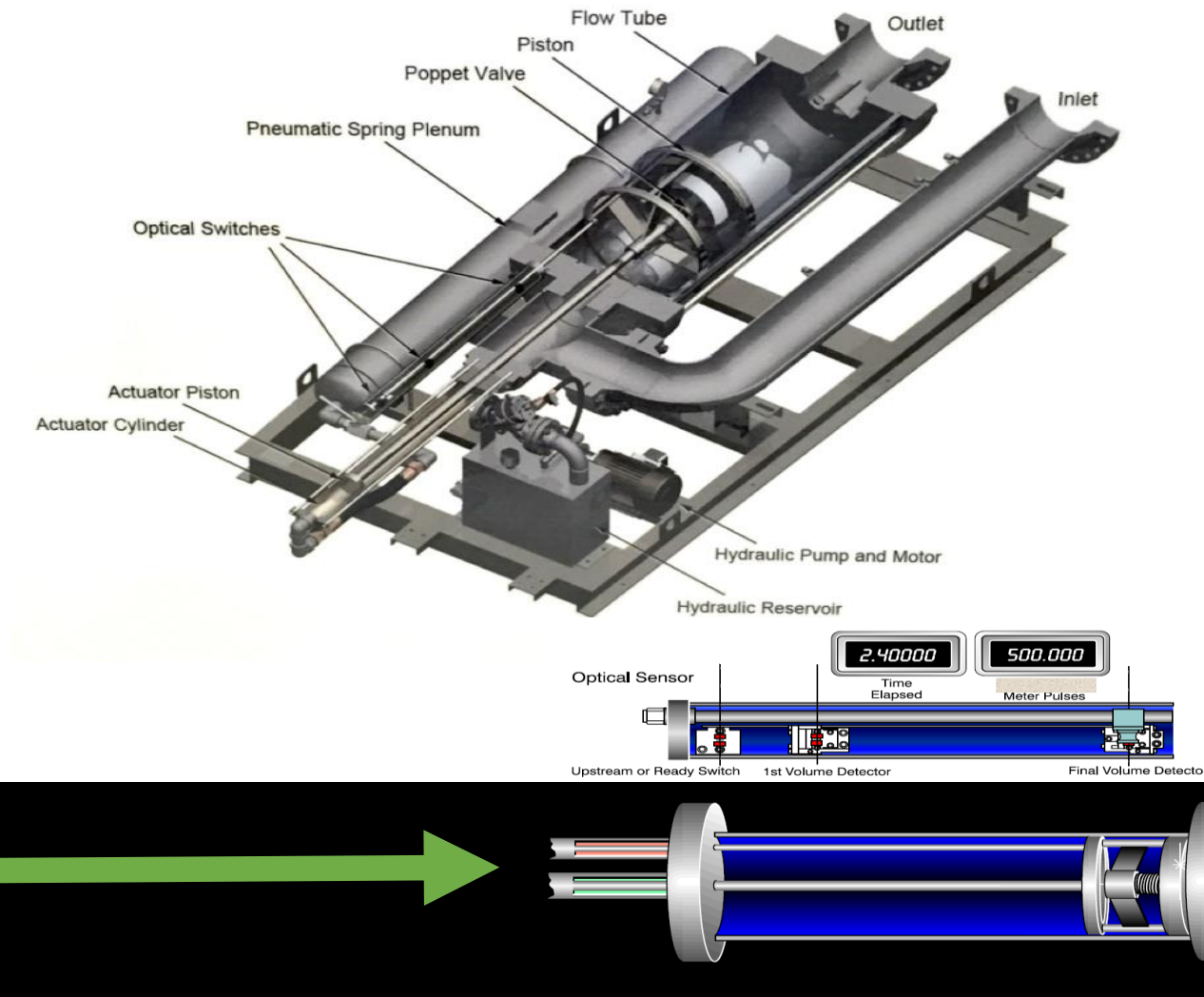


Also referred to as:

- Captive-Displacement Prover
- Compact Prover
- Piston-type Prover

Typical Small volume pipe prover with internal valve (Extracted from ISO 7278)

Pipe Provers – Small Volume



The Emerson's way: Pipe Provers – Compact Piston Prover

Compact Prover Range

- Flow Rate: 0.057 m³/h to 3'972 m³/h
- Nominal Flow tube diameter: 8" to 40"
- Nominal Prover Base volume: 20 liters to 650 liters
- Temperature: - 43° C to 260° C - Pressure: 150 to 1,500 ANSI Class
- Rangeability 1000 : 1
- Repeatability: 0.02 or better (water draw)

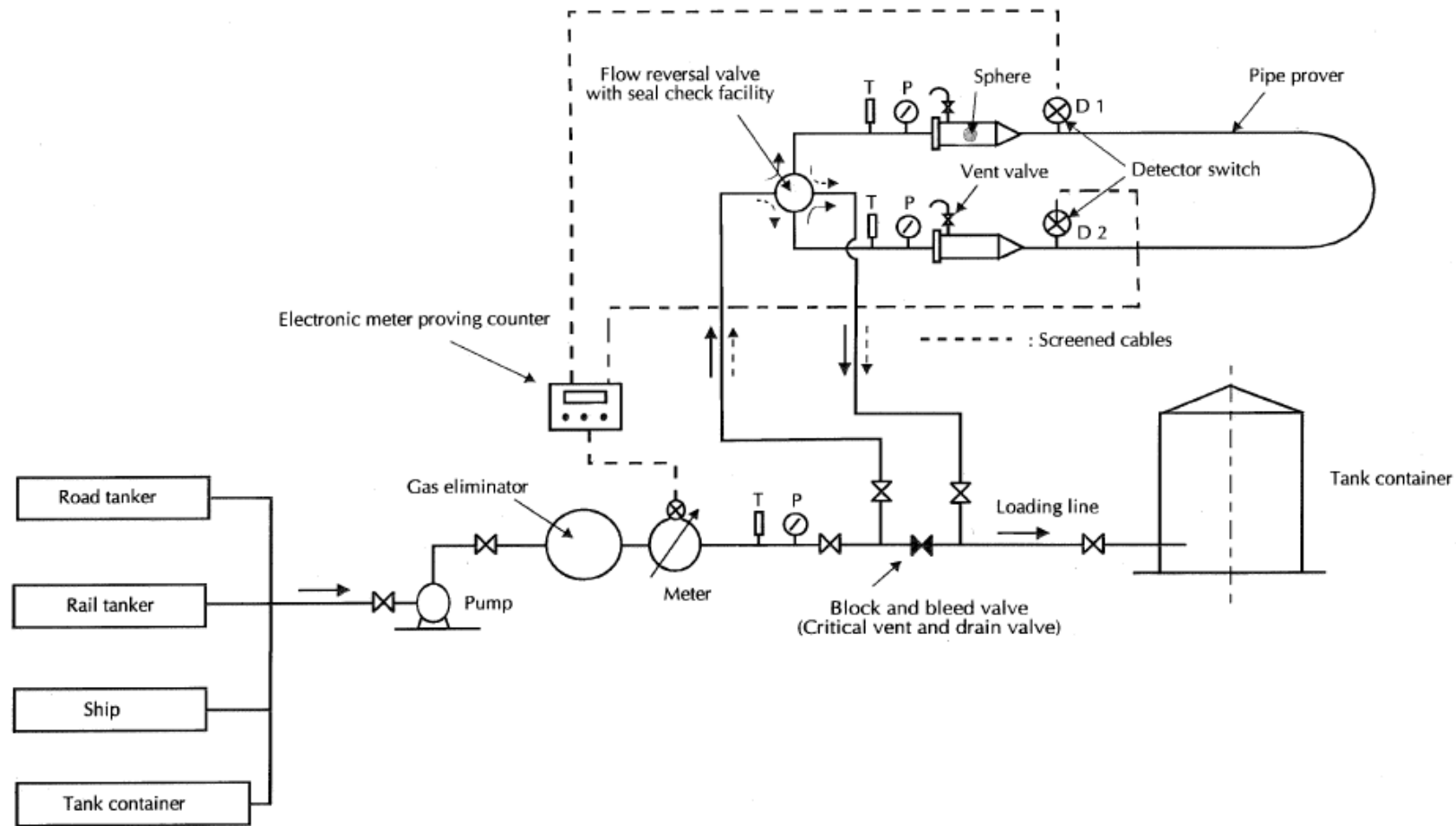


energy **API** Chapter 4.2
Chapter 4.6



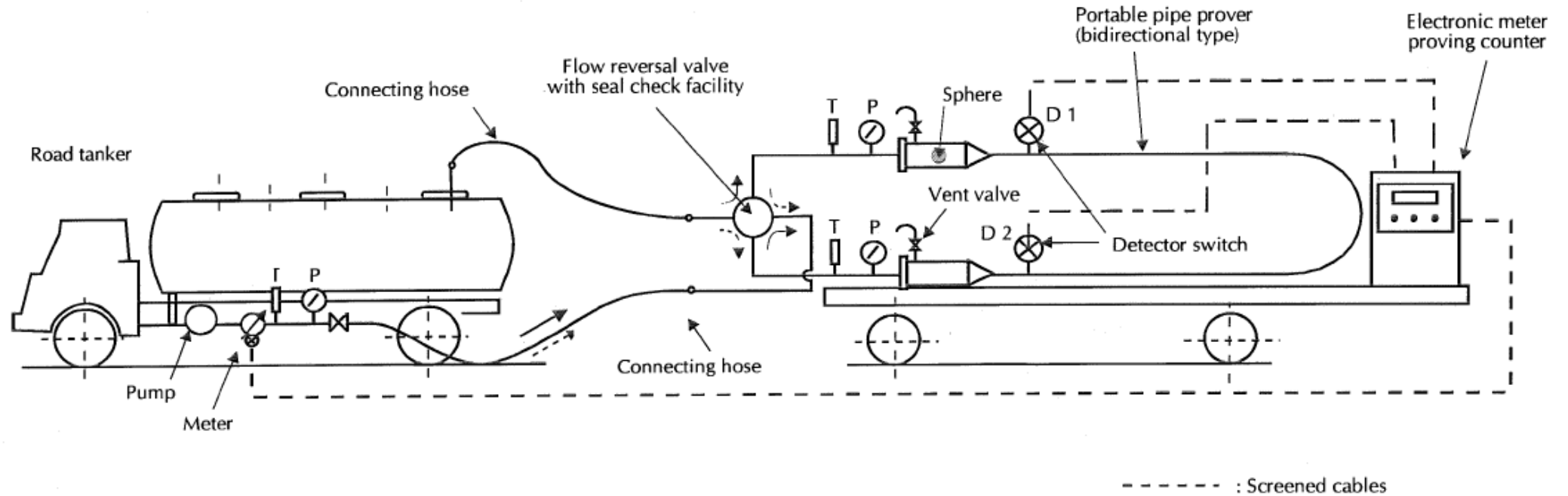
Daniel Compact Prover: High accuracy, rapid operation and continuous flow for proving a flow meter in an operational line. Operated without interrupting normal flow and without the use of manually operated bypass valves.

Verification Layout tanker unloading



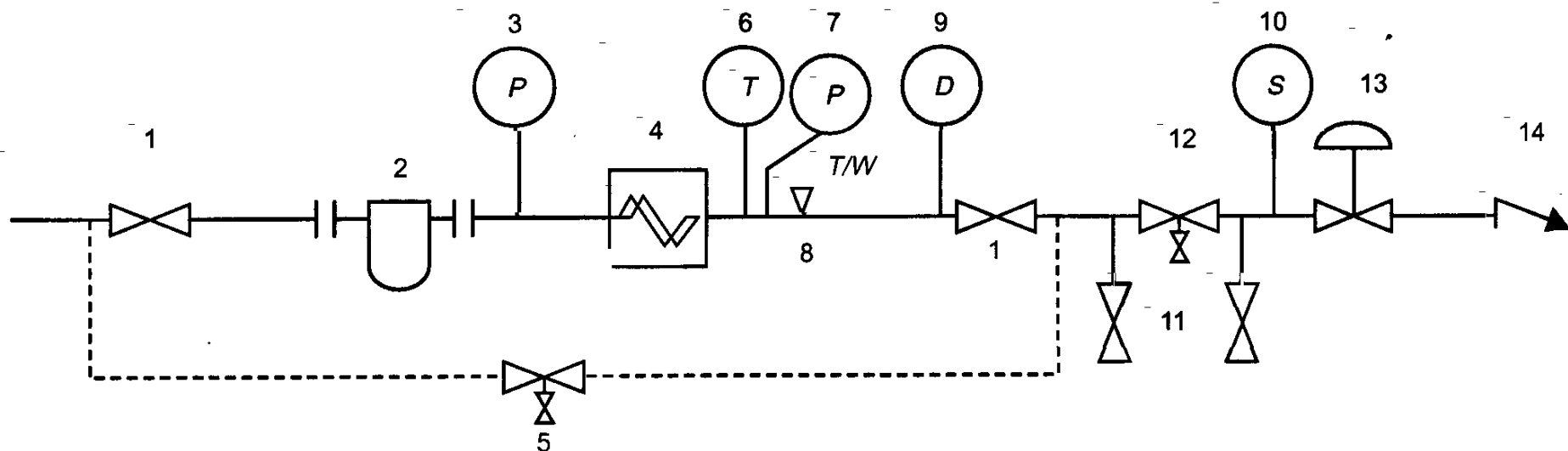
OIML R119 – Verification of measuring systems for unloading of road and rail tankers, ship's tanks and tank containers

Verification of measuring system on road tankers



OIML R119 – Verification of measuring systems on road tankers

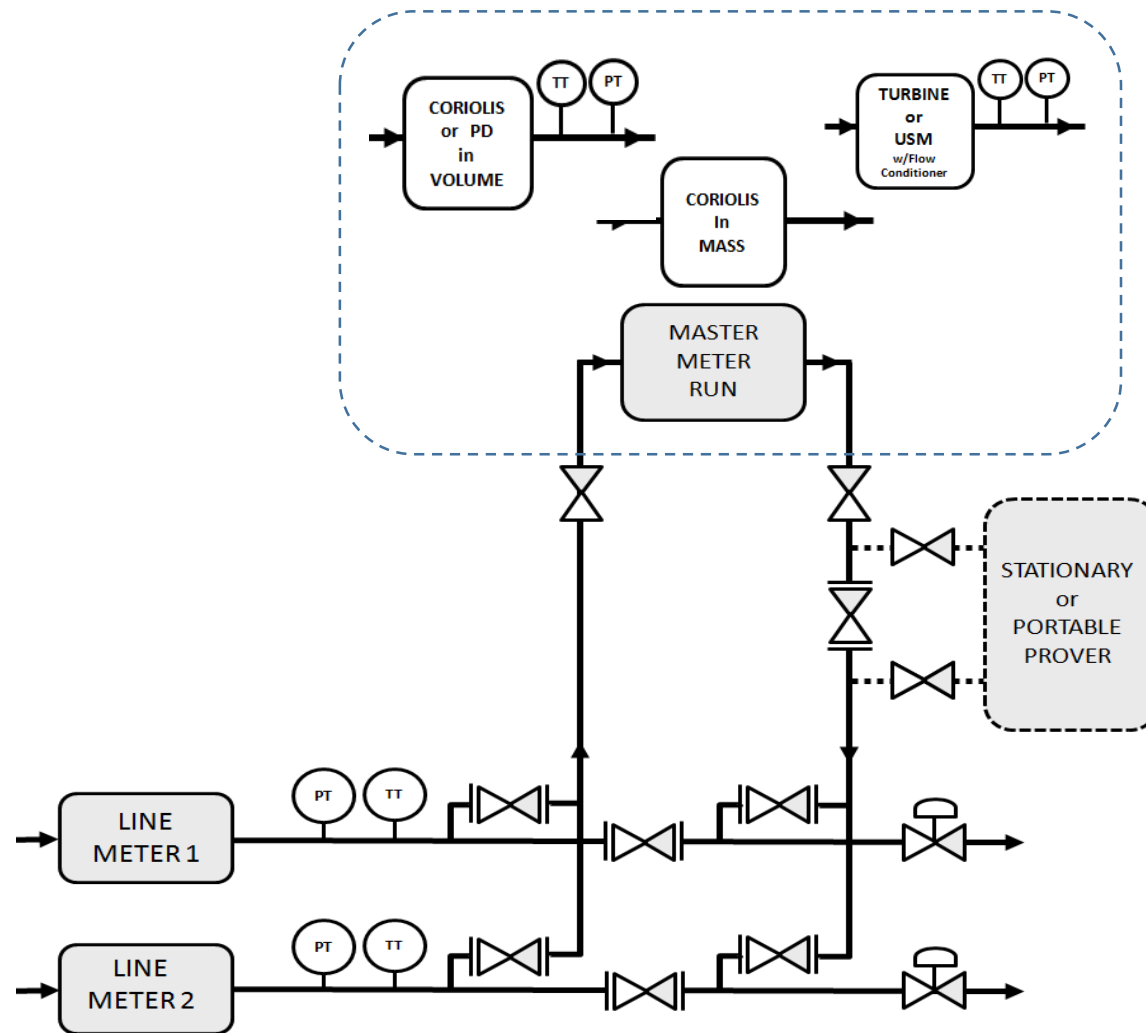
API Chapter 5.6



- | | |
|--|--|
| 1. Block valve | 8. Test thermowell (optional) |
| 2. Strainer/air eliminator (optional) | 9. Density measurement/verification point |
| 3. Pressure indicating device (optional) | 10. Manual sample point or autosampler (optional) with probe |
| 4. Coriolis meter | 11. Proving connection, block valves |
| 5. Meter bypass (optional) with block and bleed valve or blind | 12. Block and bleed isolation valve for proving/zeroing |
| 6. Temperature indicating device | 13. Control valve (as required) |
| 7. Pressure indicating device | 14. Check valve (as required) |

Note: All sections of line that may be blocked in must have provisions for pressure relief.

API 4.5 Master Meter Provers configuration



The Emerson's way: Mobile Master Meters



Not only...The Emerson's way: Mobile Master Meters



CMF HC4 12inch



Outdoor road master meter truck



CMF 200 2inch

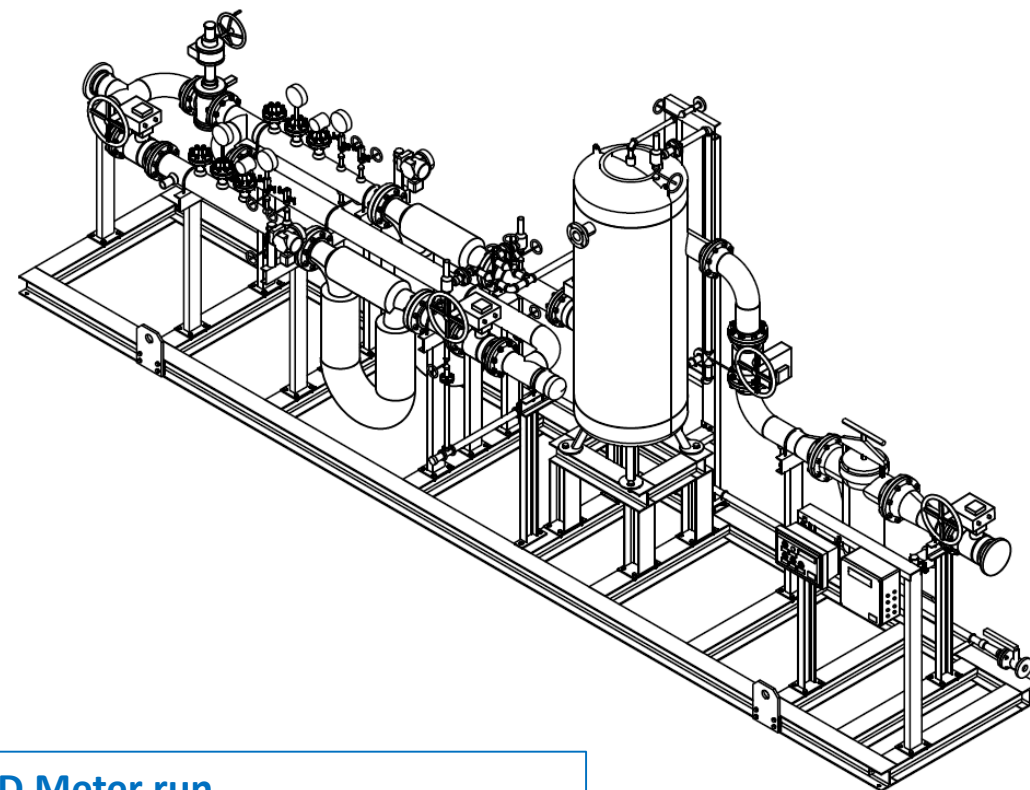
The Emerson's way: Coriolis Flow master metering skid

- Three independent streams, each having one thermal insulated Emerson Coriolis flow meter, varying in size. Flow rate range: 4'790 to 1'340'000 kg/h
- Suitable for MID Initiation Verification on actual customer fluid and process conditions.
- Liquid measuring system assessment by an Emerson MID Verification Officer (mod. D) or Notified Body (mod. F).
- All master meter CMC's (Calibration & Measurement Capabilities) and corresponding master meter MPE's (Maximum Permissible Errors/Acceptance Criteria), as well as the skid operating procedure have been approved independently by the Dutch NMi.
- ATEX Zone 1 compliant



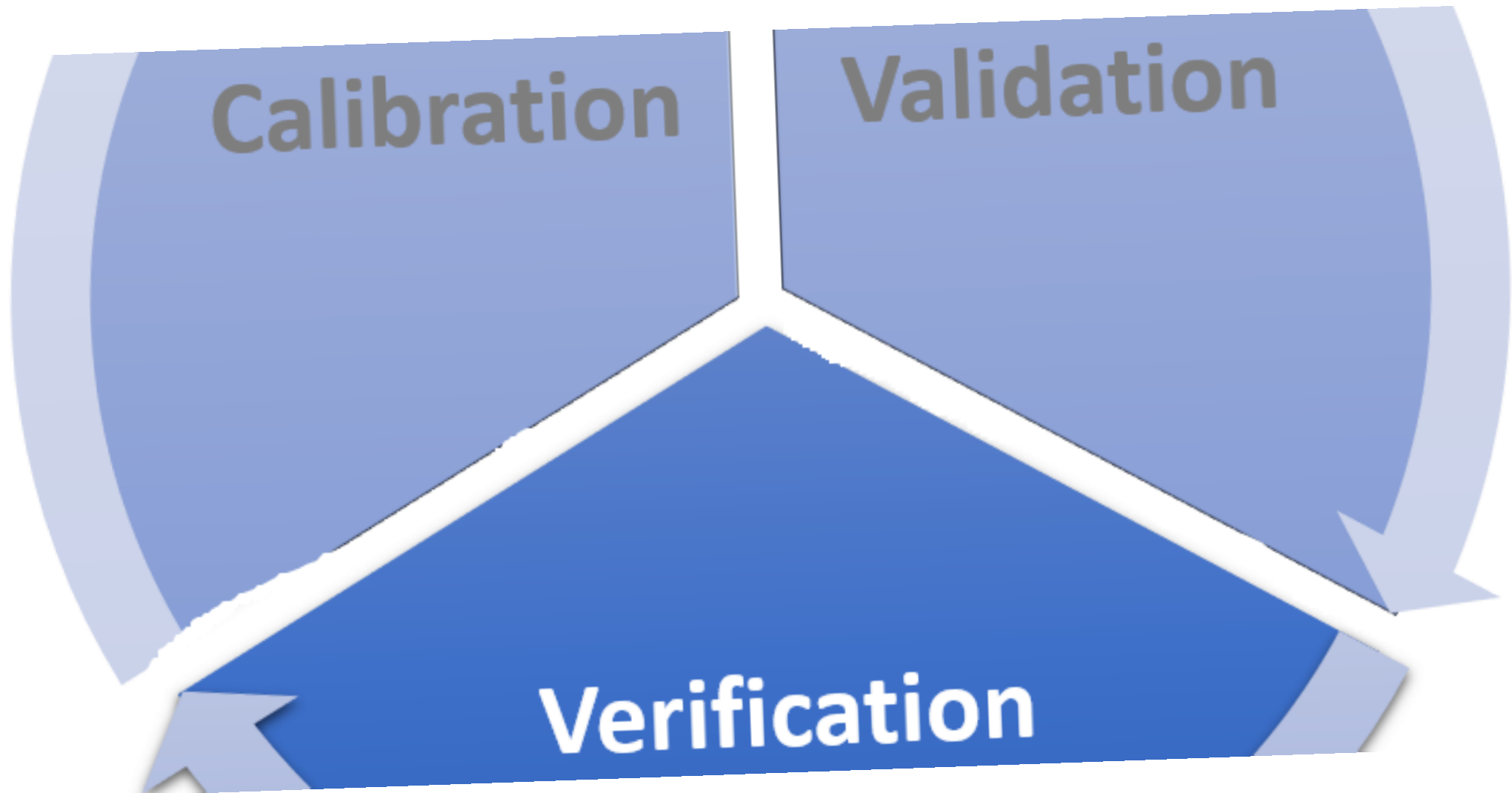
The skid allows for mass flow based Emerson Coriolis MID flow meter assessment.

The Emerson's way: Coriolis Flow pay&check metering skid



MID Meter run

- Flow Rate: 1'136 to 12'600 kg/min
- Nominal Flow tube diameter: 6" #150"
- MID B+D certified



Meter Verification

The perfect Flow Meter does not, yet, exist.

Coriolis flow meters, however, are largely insensitive to fluid properties.

Maybe in the future, on-board meter verification diagnostics will be a standard Metrological Supplement in Coriolis technology.

Verification will not replace proving or calibration, but it can and is already, extending intervals.

Proving and calibration are regulated by legal and contractual arrangements.

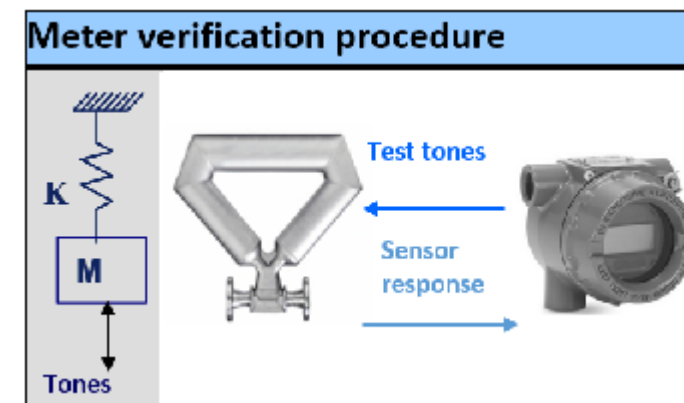
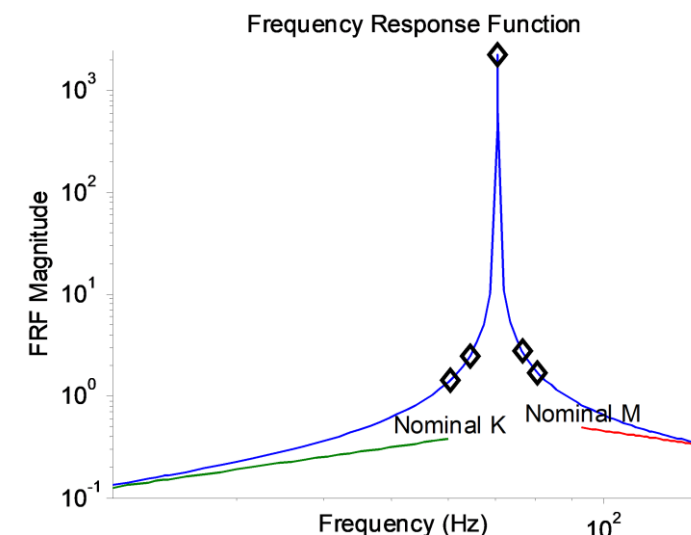
Verification is recognized by a growing number of agencies.



Meter Verification

Verification methodologies can include measuring and trending process measurements, **looking at internal parameters** such as **drive gain** and **pickoff amplitude**, and using additional hardware internal or external to the transmitter to verify flow measurement. The user can perform many of these techniques, and others require a service technician visit by the vendor.

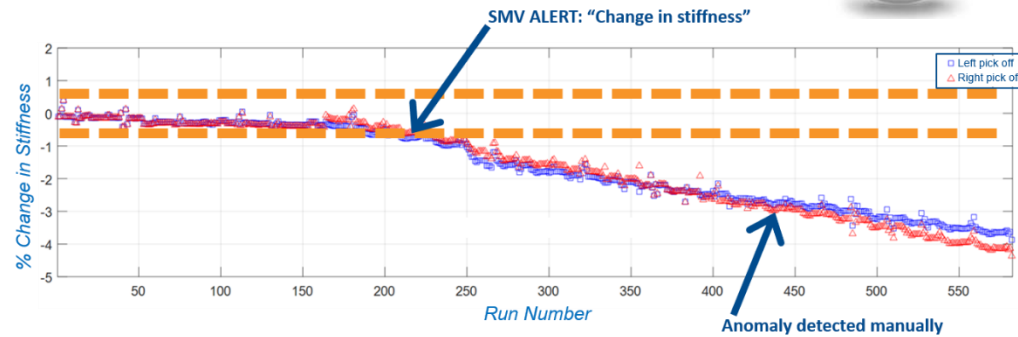
Different stiffness-based verification techniques are available in the market. The focus on stiffness based techniques is important because the relationship between the flow calibration factor and stiffness.



The Emerson's way: Meter Verification



- Measurement confidence
- Audit trail of measurement performance
- Instrument performance audit trail
- Preventative maintenance information
- Coating detection
- Installation verification
- Electronics verification
- Automatic schedule
- Digital Alarm transmission
- Verification is recognized by a growing number of agencies.



NMI+ TRUE VALUE

Coriolis Smart Meter Verification
Structural Integrity Method
Micro Motion

To whom it :
Date : 29 July 2016
Subject : SMV diagno

Pass
Next Scheduled Test : 05/10/2017 17:03:33

Instrument Owner : Emerson PMs
Company : Emerson Process
Location : Seregno
Note : Note.....di notte

Contact Name/ Tested By : Landolo
Telephone : 0362-2285223
Application/Service : Scrivania

Meter Information

Transmitter Tag :
Transmitter Model : 5700
Transmitter Serial Number : 1211
Core Processor Serial Number : 0

Test Conditions and Meter Configuration

Flow Configuration
Flow Damping : 0.80000 Sec
Flow Calibration Factor : 3.32234.88
Mass Factor : 1.00000
Density Meter Factor : 1.00000
Volume Factor : 1.00449
Factory Zero : 0.00000 µsec
DT or TC : 4.49000
FT : 4.88000

Sensor Operating Conditions
Mass Flow Rate : 0.00000 kg/min
Volume Flow Rate : 0.00000 l/min
Density : 0.00000 kg/m3
Temperature : 25.84200 °C
External Pressure : 0.00000 Kilopascals
Current Zero : 0.03982 µsec

Density Configuration
Density Damping : 0.80000 Sec
K1 : 6684.85400 µsec
K2 : 7326.08691 µsec
D1 : 0.00000 g/cm3
D2 : 1.00000 g/cm3
FD : 1600.00000

Version Information
Transmitter Revision : 1.30
Core Processor Revision : 4.20
ProLink III Revision : 4.0.320.2

Meter Verification
Tube Stiffness
Transmitter/RI
Sensor
Critical Alarms
Maintenance A
Other Alarms
Configuration
Zero Changed

Dear Sir or M
On request :
investigated Micro Motion
Meter Verifi
specification
In that fram
Meter Verifi
mass flow sp
From this im
confirm that
it is advised
can therefore
proving inte
* Reference
I trust to hav
With kind regards,
NMI Certin B.V.
M.Ph.D. Schmidt
Approvals Expert

Structural Integrity Normalized Stiffness
Transmitter Serial Number: 1211, 0495, Transmitter Model: 5700 Configurable I/O, Sensor Model: CCM 5015
Sensor Serial Number: 15006034, Core Processor Serial Number: 0
Left Stiffness (Device-Initiated) / Right Stiffness (Device-Initiated) / Inlet Stiffness (ProLink III-Initiated) / Outlet Stiffness (ProLink III-Initiated)

Acceptance Bar

**THANK
YOU!**

Calibration

Validation

Verification

giuseppe.iandolo@emerson.com