MISURE FISCALI

Milan, 25-10-2018
Auditorium TECNIMONT

Master Meter: ALL for ONE, ONE for ALL

Andrea Calo'
All custody / fiscal metering systems have **accuracy** and **repeatability targets** which must be guaranteed during their entire life cycle under **real working conditions**

**System Proving** consists in placing the **duty** meter in **series** with a **meter prover** having sufficiently better measurement accuracy and repeatability than the duty meter
Master Meter: ONE for ALL, ALL for ONE

**Metering system at factory**
- high repeatability
- high accuracy

**Metering system in operation**
(bad but possible cases)
- low repeatability
- low accuracy

**Metering system after Proving**
- high repeatability
- high accuracy

**PROVING PROCESS**

1. **Meter Factor calculation** = \[
\frac{\text{Known Volume (Prover)}}{\text{Unknown Volume (Duty Meter)}}
\]
2. **Proving Validation criteria**

- Process Conditions; fluid, P, T, air etc..
- Measurement technology limits for mechanical meters (wear out, leakages..)
Reference International Standards for Proving **MPMS Ch.4**

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

- **Open Tank Prover**
- **Small Volume Piston Prover**
- **Pipe Prover (Uni or Bi-Di)**
- **Master Meter Prover**
Focus on Master Meter Proving

- **Master meter proving** is used when proving by the direct method cannot 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¶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 to use it then on site normally uses a SVP with criteria of 0.05% repeatability in 5 runs: B+B in the table below:

<table>
<thead>
<tr>
<th>Combinations</th>
<th>Random Uncertainty (RU1) Value of First Meter</th>
<th>Random Uncertainty (RU2) Value of Second</th>
<th>MMF Range (spread) Defined in 0.2 and 0.3</th>
<th>Combined Uncertainty</th>
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<tbody>
<tr>
<td>A+B</td>
<td>0.011 %</td>
<td>0.027 %</td>
<td>0.05 %</td>
<td>0.054 %</td>
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<tr>
<td>A+C</td>
<td>0.011 %</td>
<td>0.073 %</td>
<td>0.10 %</td>
<td>0.124 %</td>
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<tr>
<td>C+B</td>
<td>0.073 %</td>
<td>0.027 %</td>
<td>0.15 %</td>
<td>0.153 %</td>
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<tr>
<td>B+B</td>
<td>0.027 %</td>
<td>0.027 %</td>
<td>0.05 %</td>
<td>0.063 %</td>
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Enable a meter to be a Master Meter

Proverdata

<table>
<thead>
<tr>
<th>Proverdata</th>
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<td>diameter cm</td>
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<td>ref. Density @15 degr.C</td>
<td>0.038</td>
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<td>flowrate tons/hr</td>
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<td>Omni report</td>
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<td>prove run</td>
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<tr>
<td>prove run</td>
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<tr>
<td>prover density kg/M3</td>
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<tr>
<td>prover density kg/M3</td>
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<tr>
<td>temp. Prover deg.C</td>
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For the reproducibility range:

- `.: repeatability range = 0.037%`
- `.: repeatability range = 0.046%`
Enable a meter to be a Master Meter

<table>
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<th>N</th>
<th>O</th>
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<th>Q</th>
<th>R</th>
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<th>T</th>
<th>U</th>
<th>V</th>
<th>W</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
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<td>818.386</td>
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</table>

- repeatability range = 0.012%
- repeatability range = 0.028%
- repeatability range = 0.023%

Endress+Hauser
People for Process Automation

Associazione Italiana Strumentisti

ISA Section

Sh.8 of 25
Operating of a Master Meter

Manual of Petroleum Measurement Standards
Chapter 4—Proving Systems

Section 8—Operation of Proving Systems

Measurement Coordination
FIRST EDITION, NOVEMBER 1996

- 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.
Coriolis Meter as best selection for Master Meter

- Best traceable **accuracy** and **repeatability** for top class products

- For top class products the traceable **water calibration** on the custody mass meter, is fully representative of the performance on oil product in the field then not affected by viscosity and density changes

- **No wear out** problems, no rotative part

- **No need for P or T compensation** for mass proving

- Suitable for mass and volume proving

- Compact and easy to be transported

- **Faster proving** than using displacement provers – and so can be used more often.

- **Easier proving** than using displacement provers – extremely easy to automate and so requires fewer skilled staff in the field.
Operating of a Coriolis Master Meter

• Coriolis meters shall comply with API MPMS Chapter 5.6.

• Prover meter factor for master meter proving of a mass meter using a mass master meter is calculated as below:

\[
MF_P = \frac{M_{MM} \times MF_{MM}}{M_M}
\]

- \(MF_P\): Meter factor calculated from proving
- \(M_{MM}\): Master meter (uncorrected) mass
- \(MF_{MM}\): Meter factor of the master meter (at the proving flow rate)
- \(M_M\): Meter on prove (uncorrected) mass

• Process conditions must ensure a single, homogenous fluid

• The meter factor that is determined during proving includes any error the zero value may be contributing. Prior to proving the line meter, but at the operating conditions (pressure and temperature) of the line meter, the master meter observed zero value should be verified.
Case study 1

Region: Far East Asia
Customer Type: Refining
Application: LPG pipeline

Scope of supply:
- N’1 Custody Transfer LPG Pipeline Metering System class
- Z pattern configuration for master meter
- Fully automated proving process
- Fluid: LPG
Master Meter: ONE for ALL, ALL for ONE

Manual of Petroleum Measurement Standards
Chapter 4.5 Master Meter Provers

Z pattern / Pay & Check configuration

Standby/master meter

Permanent external prover connection – for master meter

Duty mass meter

Displacement or Coriolis in Volume Meter Run Detail
Approval of Weights & Measures on Site

- Various master-meter verifications at site initiated from control room – fully automated
- Then visit of SIRIM Berhad (wholly-owned company of the Malaysia Government), effectively, the weights & measures agency for Malaysia
- Validation also from NGC the end-customer
Case study 2

Region: Europe
Customer Type: Market Terminal
Application: Ship Loading

Scope of supply:
- 9 off Custody Transfer MID 0.5 approved systems with Coriolis 12"
- 1 off Coriolis-12” Master Meter MID approved on portable trailer
- Fluid: Gasoil, Heavy & Mid Bunker Fuel Oil – MGO IFO HFO
Master Meter: ONE for ALL, ALL for ONE

Duty meter

Master meter
• 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 our accredited water calibration rig
Case study 3

Region: Middle East
Customer Type: LPG production
Application: LPG pipeline

Scope of supply:
- 1 redundant custody transfer metering system
- 1 installed master meter
- Fully automated process including sampling and proving
- Fluid: LPG
Master Mass Meter: ONE for ALL, ALL for ONE

- Stand By mass meter
- Master mass meter
- Duty mass meter
- Permanent external prover connection – for master meter
- Automatic LPG sample grabber
Case study 4

Region: Africa
Customer Type: Distribution Terminal
Application: truck loading and pipeline metering

Scope of supply:
- 7 – Metering streams for LPG
- 3 – Metering streams for JET FUEL
- 3 – Metering streams for HEAVY GAS OIL
- 23 – Metering streams for GASOLINE
- 23 – Metering streams for GAS OIL
- 1 – Master meter
Case study 5

Region: Turkey
Customer Type: Terminals and Refinery
Application: Various, pipeline and ship loading/unloading

Scope of supply Project:
- Various custody transfer systems for different locations, applications and fluids
- 1 common master meter mounted on truck
- Fluid: Diesel, Gasoil, LPG, HFO
Test of connection between master meter and metering skid with flexi pipes

Connection test

Grounding plug

Fast plug for signals
Easy to operate as first target in our design
Master Metering is a practical and recognized procedure for proving of custody transfer metering systems.

Coriolis meter new generation represent the most indicate and performant technologies for master metering:

- Full independence from process conditions
- Highest accuracy both for mass and volume measurement
- Highest metering stability and repeatability
- High turndown ratio in order to allow the multiple meter sizes proving with one common device
- Compact footprint for easy installation on mobile provers
ONE Coriolis master meter
for
ALL proving needs

(....questions?)