NFOGM Temadag 19.3.2015

- **Challenges with calibration and adjustment of liquid USM`s**
- **Standards for Gas USM`s**
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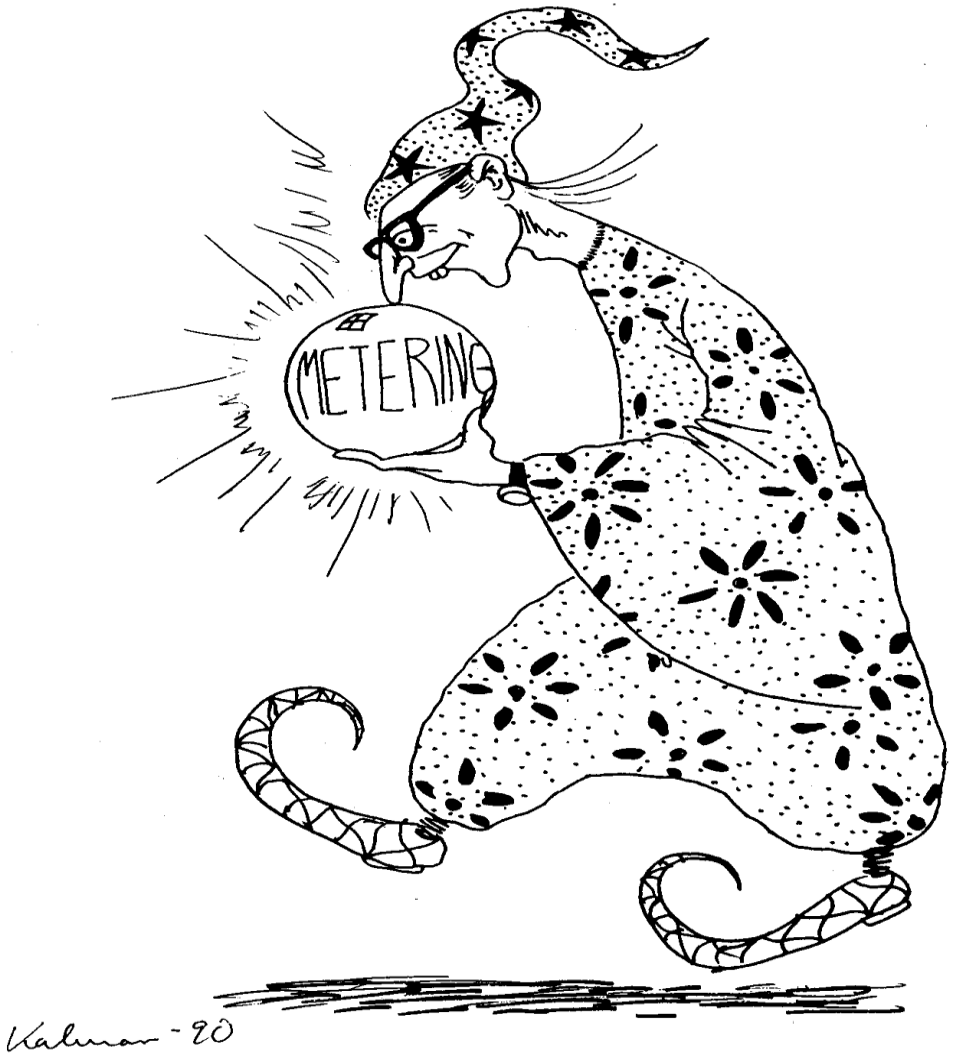
Challenges with calibration and adjustment of liquid USM`s

- The challenge is mainly related to systems which is designed without a permanent proving device and the fact that calibration stations are not capable of reproducing the relevant flow rates. To compensate for this testing with various Re No (various liquids) are used to create a concept of dynamic similitude.
- Upstream pipe configuration and conditioning device should be as in the field.
- Normal way forward during testing: Testing of meter without correction – Develop an algorithm to correct for viscous effects – Retest the meter to validate the performance with correction.
- The documentation of the correction algorithms and the precise definition of the look up tables is important. It is for NPD/Oil company/Vendor important that this baseline is correctly established and maintained at this level for the life of the meter. Each vendor has a vendor specific way to derive the corrections. Also confidentiality issues may be on the table.
- The look up table should have a resolution which makes error related to this less than 0,0X% of measured volume (in the measuring range).
- All meters for important services will require individual calibrations.

Challenges with calibration and adjustment of liquid USM`s

- A «check sum» follow up to keep track of any changes being done after calibration has taken place. We had the opportunity to test it in week 10. It did not work, the «check sum» was changed and no answers were available. Investigation ongoing.
- It is not so that the «Check sum» always will have to be the same, but any changes will have to be well documented.
- We do have to bear in mind that we always will increase the uncertainty of the measurement system when we design a system without a premanent proving device. A laboratory calibration will never be able to reproduce the actual values for P,T and flow conditions as you see in the field. A typical difference as we have experienced recently is between 0,3-0,4%.
- Both pulse and digital signal transmission possibility should be available on the meter. As this simplify the testing of the meter.
- A hollow plate (HP) + at least 5 D upstream is normally recommended as upstream configuration.

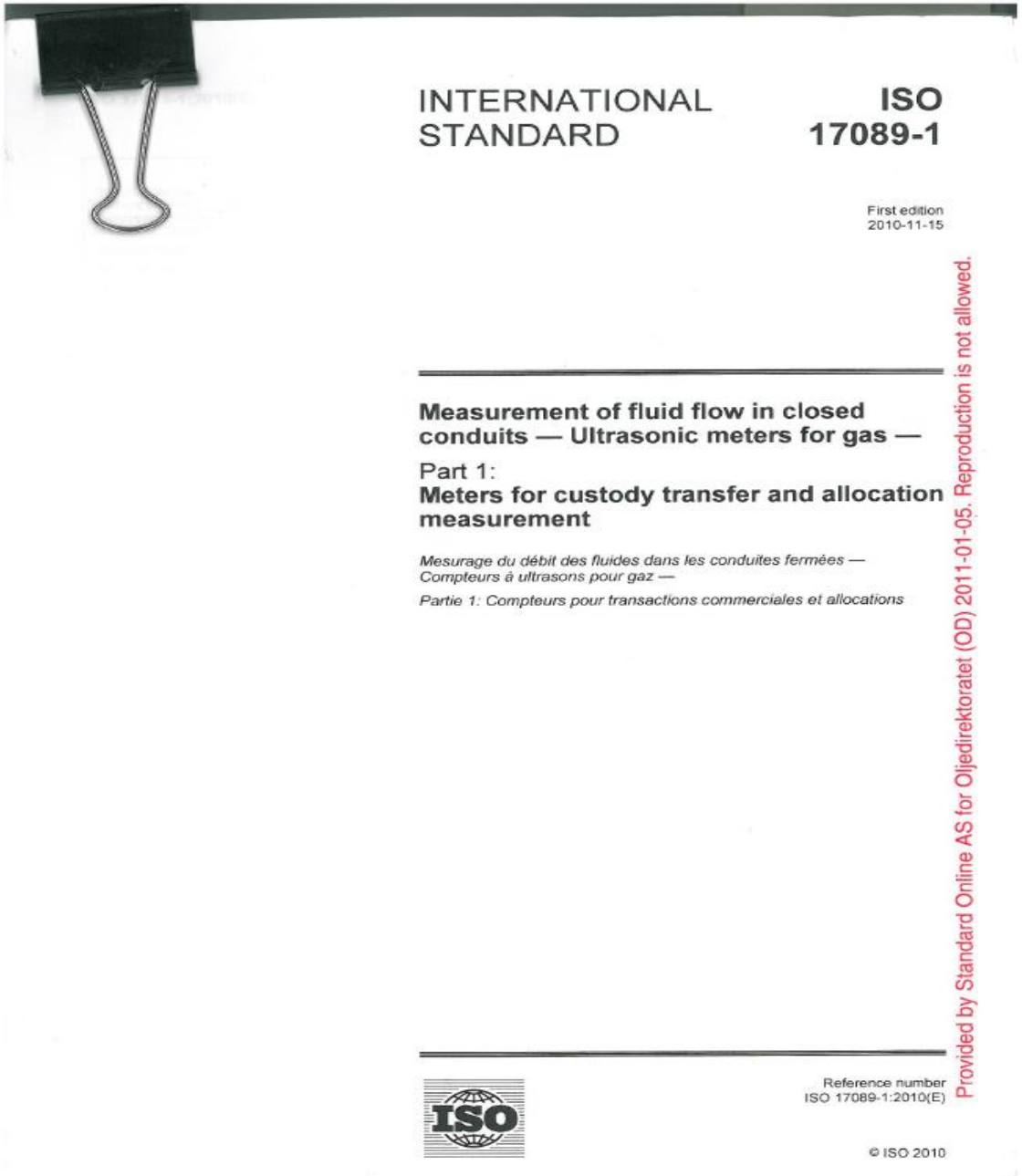
We do not like to look for anwers in obscure crystal spheres



We wish to be the Kings/Masters of the situation

Norway. Standards for Gas USM`s

- Our main reference should always be the Norwegian Petroleum Directorate Regulations relating to measurement of petroleum for fiscal purposes and for calculation of CO_2 tax. We would like to think of this as «Hakkespettboken» which we remember from Huey, Luey and Dewey. The book that could give answer to all challenges. When it comes to Gas USM`s we will have to seek information also from other documents.
- First the new NORSOK-I-106, which was released in November 2014. It is also just giving brief information about the subject (section 7.3). We have to go to the international statandards to dive deeper. Reference is made to NPD Measurement Regulations preface last paragraph. (Reckognized standards and Industry standards)



INTERNATIONAL STANDARD

ISO 17089-1

First edition
2010-11-15

Measurement of fluid flow in closed conduits — Ultrasonic meters for gas —

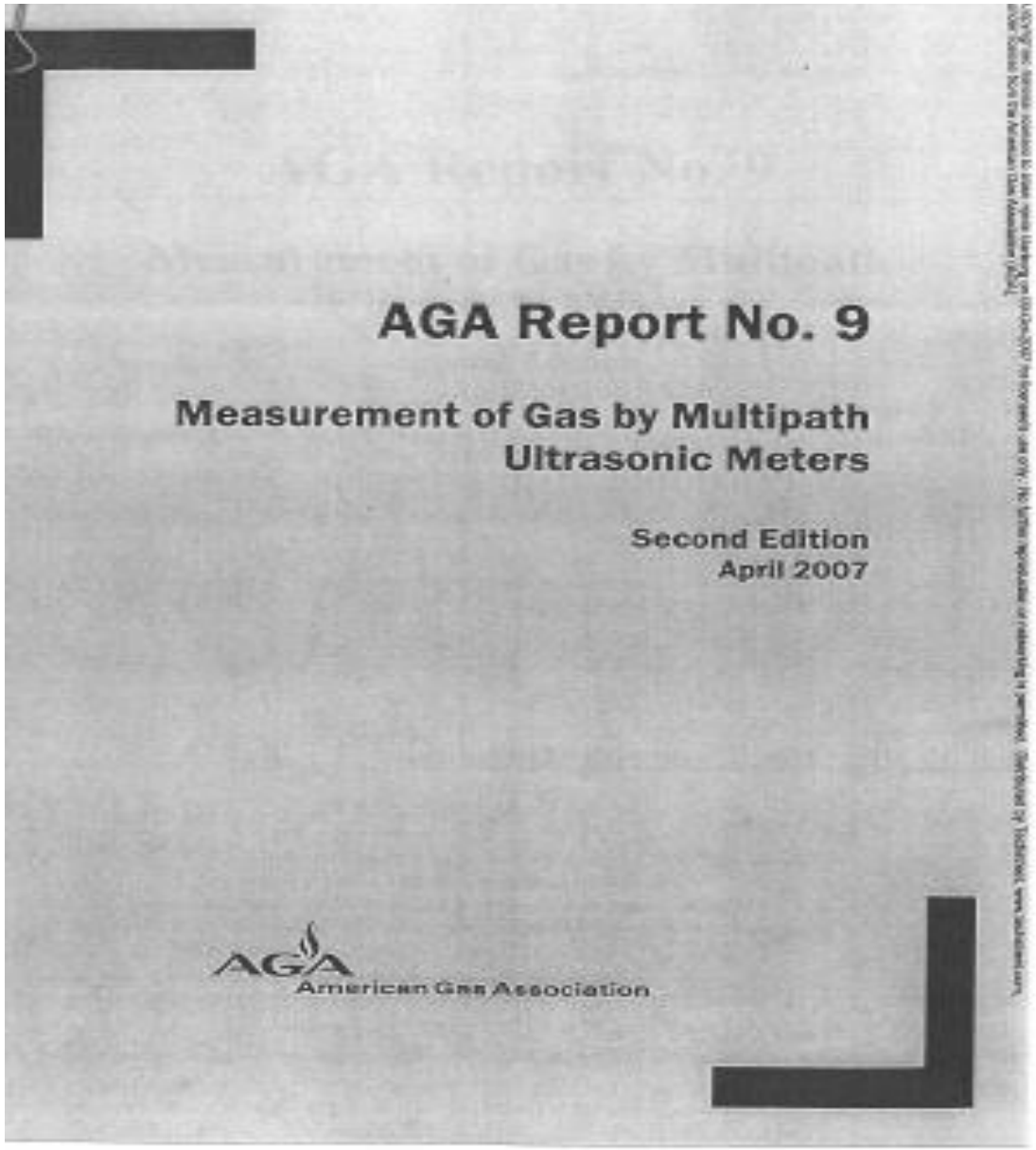
Part 1: Meters for custody transfer and allocation measurement

Mesurage du débit des fluides dans les conduites fermées — Compteurs à ultrasons pour gaz —

Partie 1: Compteurs pour transactions commerciales et allocations

Reference number
ISO 17089-1:2010(E)

Who`s next


AGA Report No. 9
Measurement of Gas by Multipath Ultrasonic Meters
Second Edition
April 2007
AGA
American Gas Association

BS 7965:2013

BSI Standards Publication

Guide to the selection, installation, operation and calibration of diagonal path transit time ultrasonic flowmeters for industrial gas applications

bsi.

...making excellence a habit.

Standards

- We wish to highlight some sections from BS 7965 (2013) as that is the newest and the least known standard in Norway. We do , however, not say that NPD express any preferences, we just mention some interesting paragraphs.

Klassifisering av målere

Table 2 **Class performance criteria – Meter requirements**

Class	Total USM uncertainty (actual volume flow)	Repeatability	Reproducibility	Resolution	Error limit (plus or minus) (q_t to q_{max})		
					Large meters	Medium meters	Small meters
	%	%	%	mm/s	%	%	%
1	<±0.7	<±0.20	<±0.30	<1	0.7	1.0	2.0
2	<±1.5	<±0.25	<±0.60	<2	1.0	1.5	3.0
3	<±3.0	<±0.35	<±0.90	<4	1.5	2.0	4.5
					Error limit (plus or minus) (q_{min} to q_{max})		
4	<±7.5	<±1.0	<±1.20	<10	5.0	5.0	7.0

NOTE 1 Large meters are defined as meters with nominal bores equal to or greater than 300 mm (12 inches). Medium meters are defined as meters with a nominal bore below 300 mm (12 inches) but greater than 100 mm (4 inches). Small meters are defined to have a nominal bore equal to or less than 100 mm (4 inches).

Classification of meters (ref table 2)

- 1) Custody transfer
- 2) Allocation
- 3) Utilities/Fuel gas
- 4) Process/flare gas

- We can consentrate on item 1 and 2. In BS it is included various notes on item 3 and 4.
- We can see that BS uses a zero to limit the possibility to achieve a better result by truncation of digits.
- Also ISO differensiate between category 1 and 2 and the presenly ongoing NPD regulatury update should do the same.

Thermowell installation and Insulation (5.4.5)

- Between 2D og 5D downstream of meter (as ISO)
- Intrusion depth on T-elements is mentioned. D/10 – D/6.67.
- Isolation of pipes:
- «Where the insertion depth er larger than D/3,33 the meter run need not to be insulated. Where insertion depth is less than D/3,33 (or where surface mount technology is used) then the meter run should be insulated from the meter inlet until at least 1D downstream of the measurement point.»

Roughness in pipe criteria (5.4.2)

- $K_r/D \leq 10^{-4}$
- K_r = (pipe wall uniform roughness) is approximately equal to Ra* ¶). The requirement is very much the same as in ISO 5167 (2003) Annex B.

7.6.3 Shift between calibrations

- For meters larger than 4 inch, a typical tolerance of ± 0,3% of FWME should be allowed between subsequent calibrations. For meters less than 4 inches the allowable shift is 0,5% of FWME.

7.6.5 Path Failure Simulation and exchange of components (New in 2013)

Path failure simulation and exchange of components

Where a Class 1 or Class 2 meter remains in service in the event of path failure, the effect of the failure should be determined during meter calibration by simulating the failure of one or more paths. The test should be carried out at or around the mid-point of the expected operating range of the meter. During the test, the flow rate should be varied by 20% of the flow rate to ensure that the meter responds appropriately.

The manufacturer should demonstrate the capability of the meter to replace or relocate transducers, electronic parts and software without a significant change in meter performance. This should be demonstrated for:

the electronics; transducers of different path types.

When components are exchanged, the resulting shift in the FWME of the meter should not be more than 0.2%.

VOS checks at laboratorium calibrations (Normally done)

- The maximum variation of the VOS between the different active paths (foot print) shall not exceed 0,5 m/s.
- The maximum deviation of the VOS average (active paths only) measured by the individual meter paths versus the VOS calculated by AGA 10 shall not exceed ± 0,2 %.

- **Thank you for your attention!**

References

- Regulations relating to measurement of petroleum for fiscal purposes and for calcultations of CO_2 tax (NPD)
- ISO 17089-1: Measurement of fluid flow in closed conduits – Ultrasonic meters for gas (2010)
- AGA Report No. 9: Measurement of Gas by Multipath Ultrasonic Meters (2007)
- BS 7965: Guide to the selection, operation and calibration of diagonal path transit time ultrasonic flowmeters for industrial gas applications (2013)
- Krohne: Technical presentation, Stavanger 27.11.15
- Krohne: Technical information
- CEESI/NMi USM/Coriolis Seminar March 2014. Terry Cousins: The Reynolds Number corrections of Liquid Ultrasonic Meters and Coriolis Meters.
- NSFMW-2014: Terry Cousins: Is linearisation safe for custody transfer meters?
- NEL: South East Asia Hydrocarbon Flow measurement Workshop 2008: Brown/Cousins/Augenstein: Important considerations for traceable calibration of liquid ultrasonic meters
- NSFMW- 2013: Kalivoda/Smith/Gailey: Dynamic Testing