Update on the Proposed Technical Changes to ISO 17089-1

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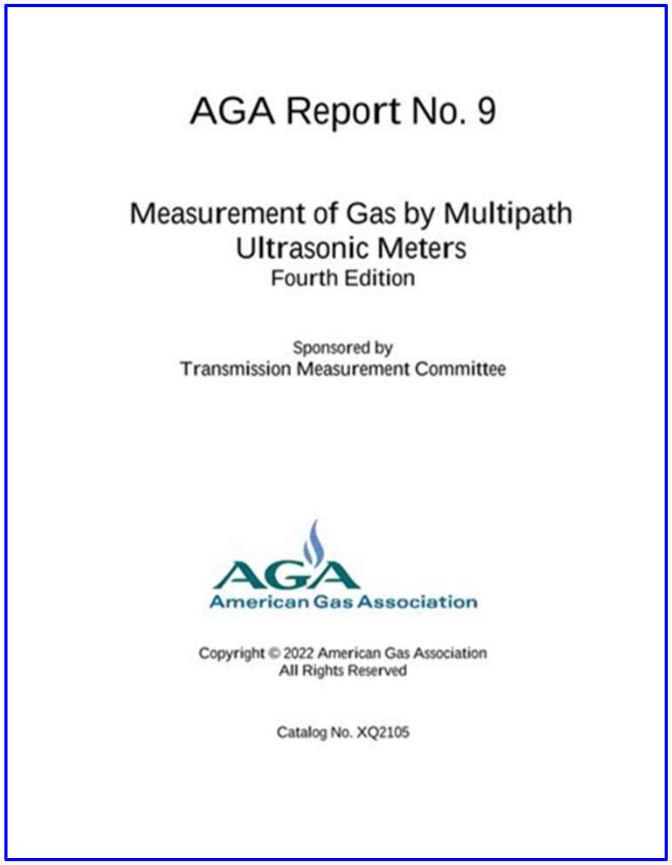
Introduction

- In all the annals of flow meter presentations, there is arguably no subject more boring than '***standards***'.

- Nevertheless, standards are important, cited in contracts, and users of a flow meter should know what that meter's standards say.

Introduction

- Two USM standards are AGA 9 (2022) & ISO 17089 (2019).



AGA Report No. 9

Measurement of Gas by Multipath Ultrasonic Meters
Fourth Edition

Sponsored by
Transmission Measurement Committee

American Gas Association

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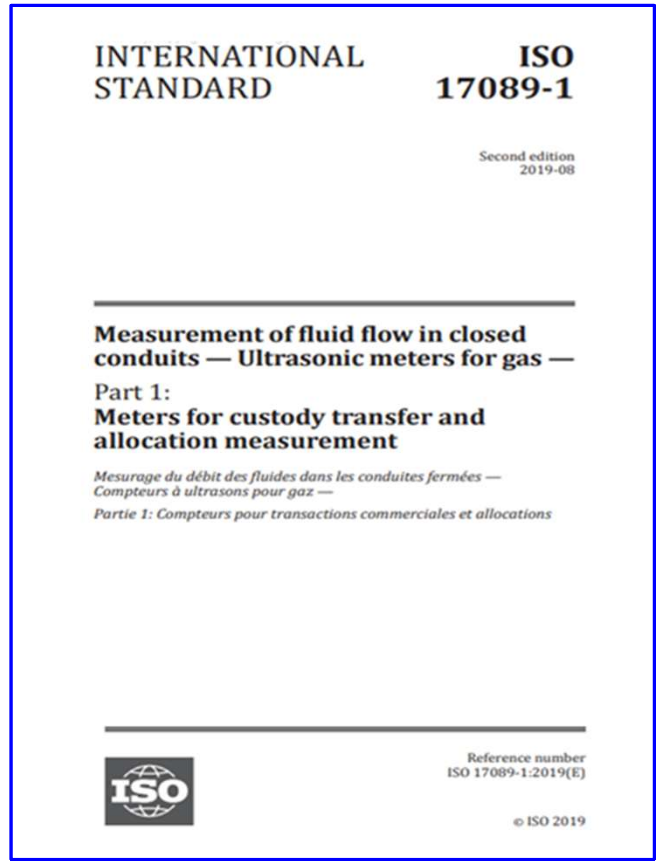
Catalog No. XQ2105



INTERNATIONAL STANDARD

ISO 17089-1

Second edition
2019-08

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 17089-1:2019(E)

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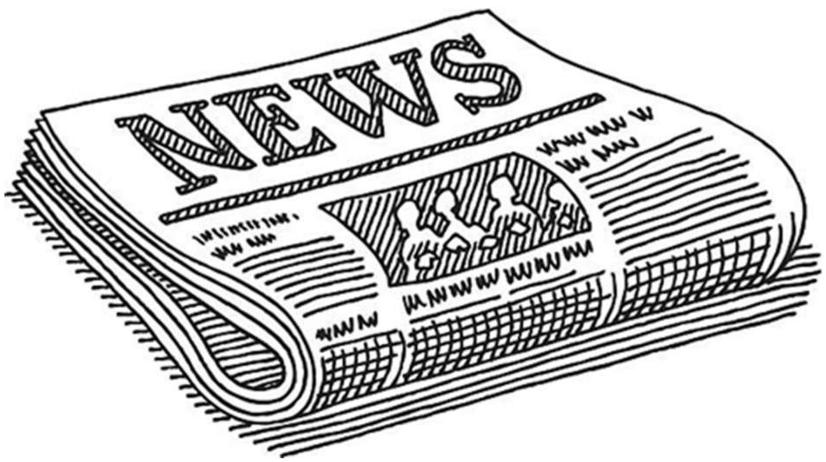
Introduction

- AGA 9 holds sway over the US industry. However …
- AGA 9 and ISO 17089 share citations across the world.
- As global energy metering equipment must satisfy international specifications, USM manufacturers and calibration labs must comply to ***both*** AGA 9 and ISO 17089.
- Hence, ISO 17089 updates are relevant to the US USM community.
- ISO 17089-1 is currently being updated…

Introduction

- The primary objective of this presentation is to inform the US USM community that ISO 17089-1 is currently being updated.



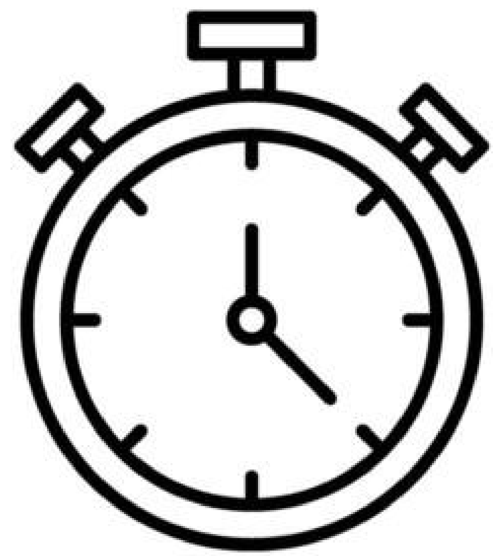
- *All USM subject matter specialists are invited to comment through your national standards body.*
- There is no point complaining about some content after its published.

- This message is the main point of this presentation.
- And now for some filler…

ISO 17089-1

- In these 20 mins, let’s discuss select topics being reviewed by ISO:

  - Uncertainty
  - Calibration
  - Diagnostics



1. Uncertainty

- ISO 17089-1 (2010) gave gas USM uncertainty examples:

EXAMPLE 1

optimistic

a) USM: 0,2 %
b) CMC: 0,2 %
c) Operational
   1) l_{min} is "respected": 0 %
   2) calibration curve correction "on": 0 %
   3) handling: 0,1 %

Total uncertainty on volume is equal to

$\sqrt{(0,2^2 + 0,2^2 + 0,1^2)} = 0,3$ %

EXAMPLE 2

pessimistic

a) USM: 0,3 %
b) CMC: 0,3 %
c) Operational
   1) l_{min} needs "detailed research": 0,3 %
   2) calibration curve correction "off": 0,3 %
   3) handling: 0,1 %

Total uncertainty on volume is equal to

$\sqrt{[(4 \times 0,3^2) + 0,1^2]} = 0,6$ %

- Comments for the Ed 3. technical committee:
  - Why not have one realistic example?
  - You can't say a calibration fit is perfect!?
  - Where is the MMSCFD uncertainty (as AGA 9 gives)?

ISO USM uncertainty (k=2)	ISO Ed 1	ISO Ed 1	ISO Ed 3
	example 1	example 2	proposed
	(optimistic)	(pessimistic)	realistic ?
reproducibility	0.2	0.3	0.25
calibration facility uncertainty	0.2	0.3	0.2
installation influences	0	0.3	0.15
calibration data 'K' fitting	0	0.3	0.2
handling (other extrinsic factors)	0.1	0.1	0.1
RSS% volume flow uncertainty	0.30	0.61	0.42
P	0.2	0.2	0.2
T	0.34	0.34	0.34
Z	0.1	0.1	0.1
RSS% density uncertainty	0.41	0.41	0.41
RSS% MMSCFD	0.51	0.73	0.58

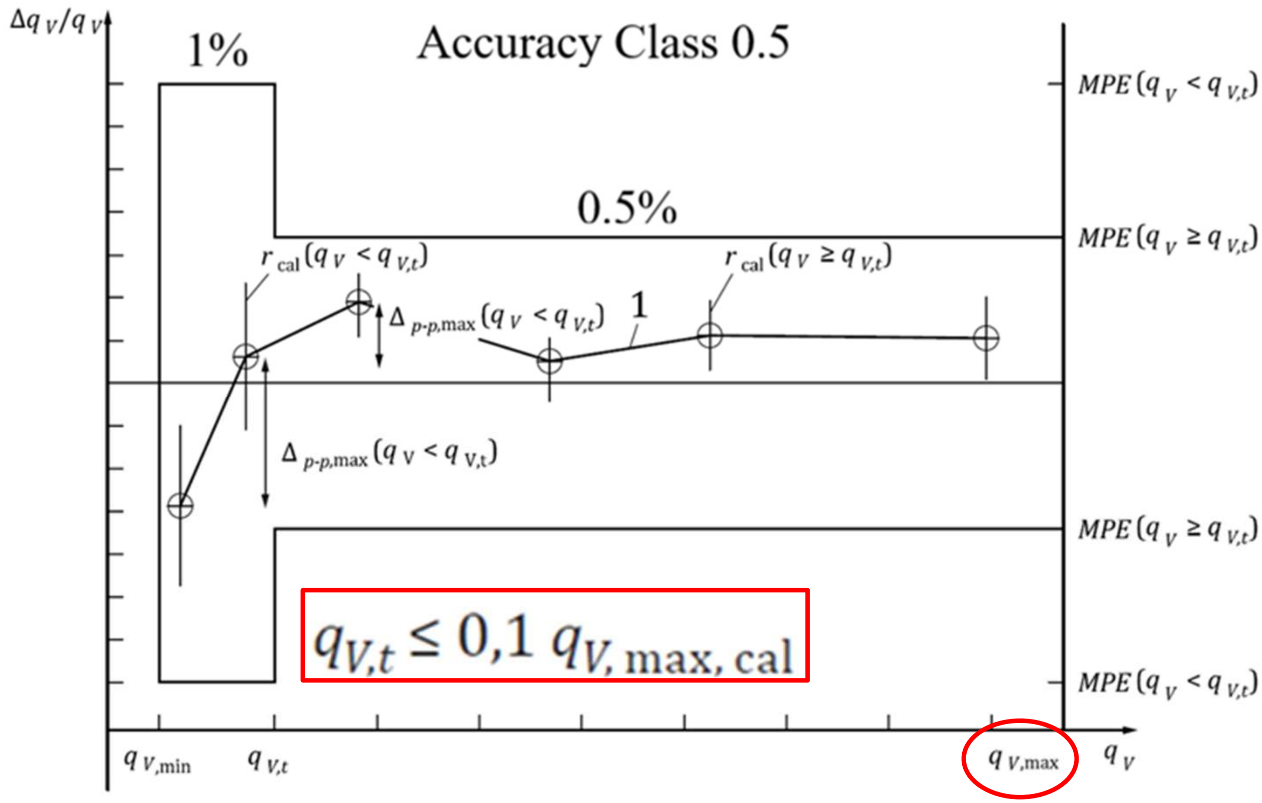
ISO 17089 vs. AGA 9 (2022) Uncertainty Examples

ISO USM uncertainty (k=2)		ISO Ed 3 proposed	AGA 9 (k=2)	AGA 9
calibration facility uncertainty	0.28	0.2	calibration	0.3
calibration data 'K' fitting		0.2		
reproducibility		0.25		
installation influences	0.31	0.15	field effects	0.3
handling (other extrinsic factors)		0.1		
RSS%volume flow uncertainty		0.42	RSS%volume flow uncertainty	0.42
P		0.2	P	0.2
T		0.34	T	0.34
Z		0.1	Z	0.1
RSS% density uncertainty		0.41	RSS% density uncertainty	0.41
RSS% MMSCFD		0.58	RSS% MMSCFD	0.58

Uncertainty

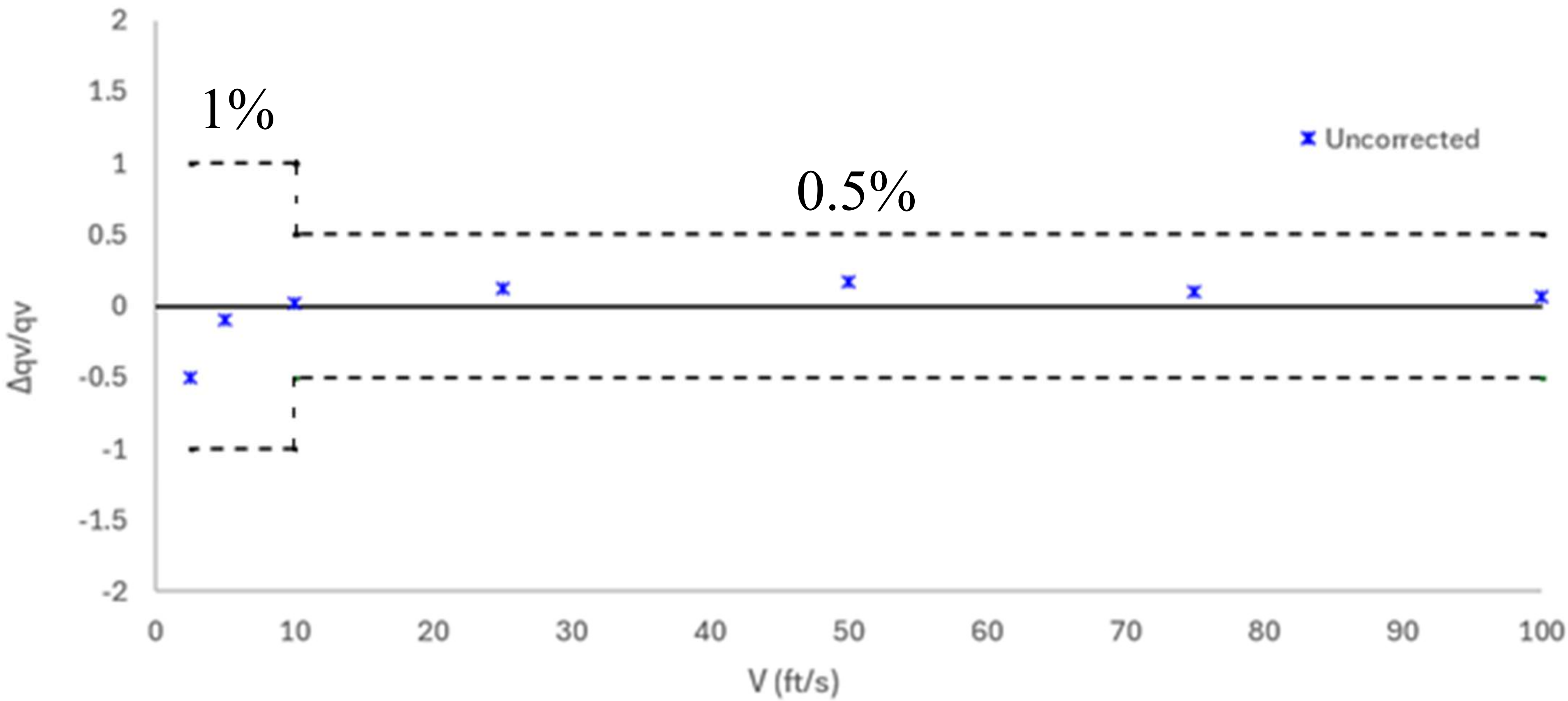
- ISO TC 30 SC 5 WG1 hasn't yet decided on the uncertainty example.
- There is consensus that it should be more thorough including probability distribution, coverage factors, sensitivity coefficients etc.
- Perhaps align with API?
- There is a proposal to make the example's $U_{Qs} < 0.58\%$ (*i.e. different to AGA 9*), e.g. $U_{Qs} = 0.5\%$.
- Regardless of the numbers used, an uncertainty analysis is very useful for understanding what aspects of USM operation are most critical for low uncertainty flow metering.

2. Calibration

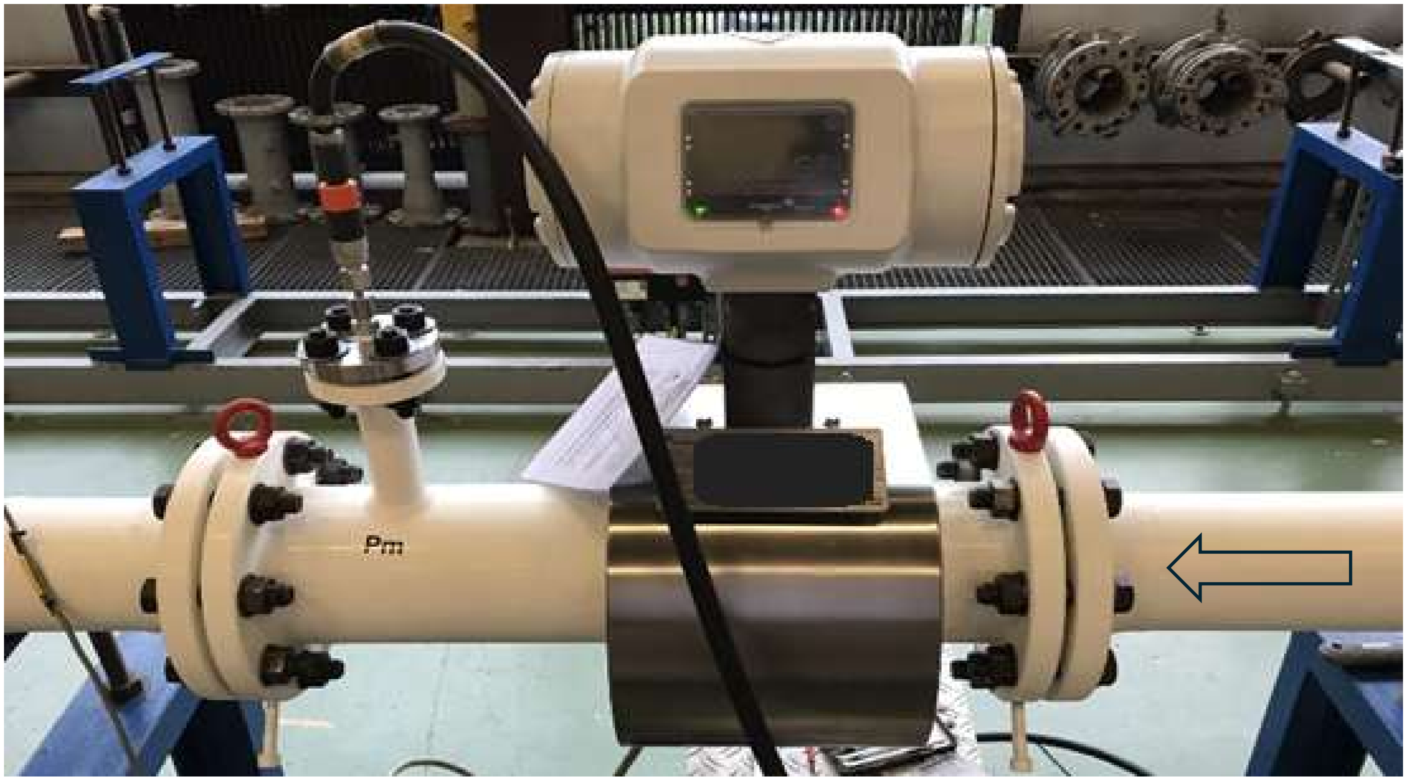


Symbol	Meaning
$q_{V,\max,20}$	Designed maximum flow rate, designed for maximum gas speed of 20 m/s
$q_{V,\max,x}$	Designed maximum flow rate, designed for maximum gas speed of *x* m/s
$q_{V,\max,\mathrm{op}}$	Operational maximum flow rate; defined only when smaller than designed maximum
$q_{V,\max,\mathrm{cal}}$	Highest flow rate calibrated; defined only when smaller than operational maximum

Expected Typical Calibration for 2.5 ft/s < V < 100 ft/s:

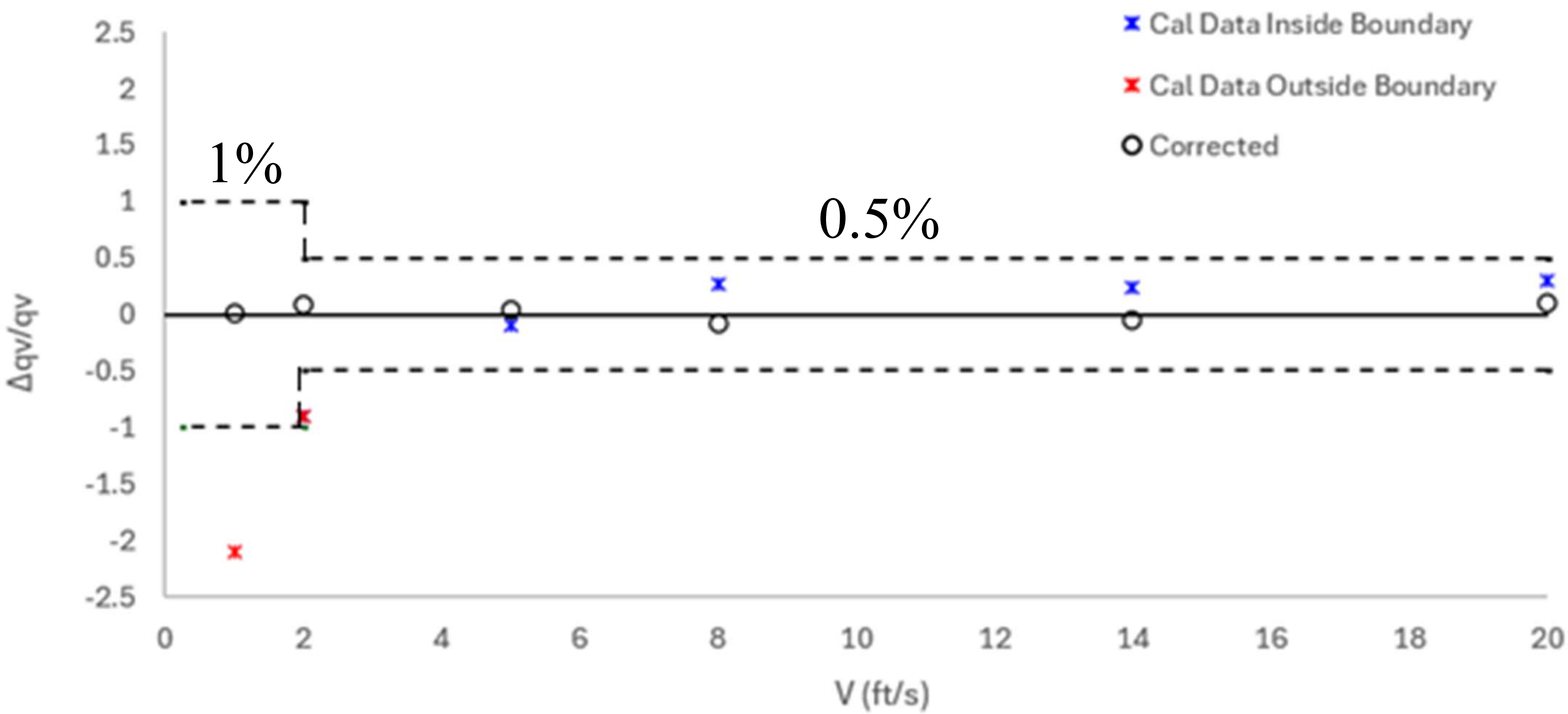


Calibration In Accordance with ISO 17089 (2010)



- 3" USM calibrated for application with max 250 psia and a max 20 ft/s.
  - USM designed for ≤ 100 ft/s, calibrated at ≤ 20 ft/s.

But for max 10 ft/s, ISO 17089-1 says: $q_{V,t} \leq 0{,}1\ q_{V,\max,\text{cal}}$



Calibration Issue Comments

- ISO 17089-1 text inherently assumes USM calibrations have V_{max} ≈100 ft/s, hence, $q_{vt} = 0.1 q_{v,max,cal}$ makes sense.

- *Try being a USM manufacturer attempting to convince a Middle East operator that it's the standards that are flawed, and your USM is correct!*

- ISO TC 30 SC5 will correct this ambiguity in ISO 17089-1 Ed 3.
- A possible fix is to change from:

$$q_{V,t} = 0.1\ q_{V,max,cal}$$

to:

$$q_{V,t} = 0.1\ q_{V,max,100\ ft/s}$$

3. Diagnostics

"It is always the novice who exaggerates"
C.S. Lewis

- USM's have a comprehensive diagnostics suite.
- 1st generation USM's offered novelty of diagnostic abilities.

- 1st generation novice USM proponents envisioned no re-calibration, malfunction pattern recognition & self-correcting USMs.
- Experience has taught the road to that utopia is slow.

ISO 17089-1 (2019)

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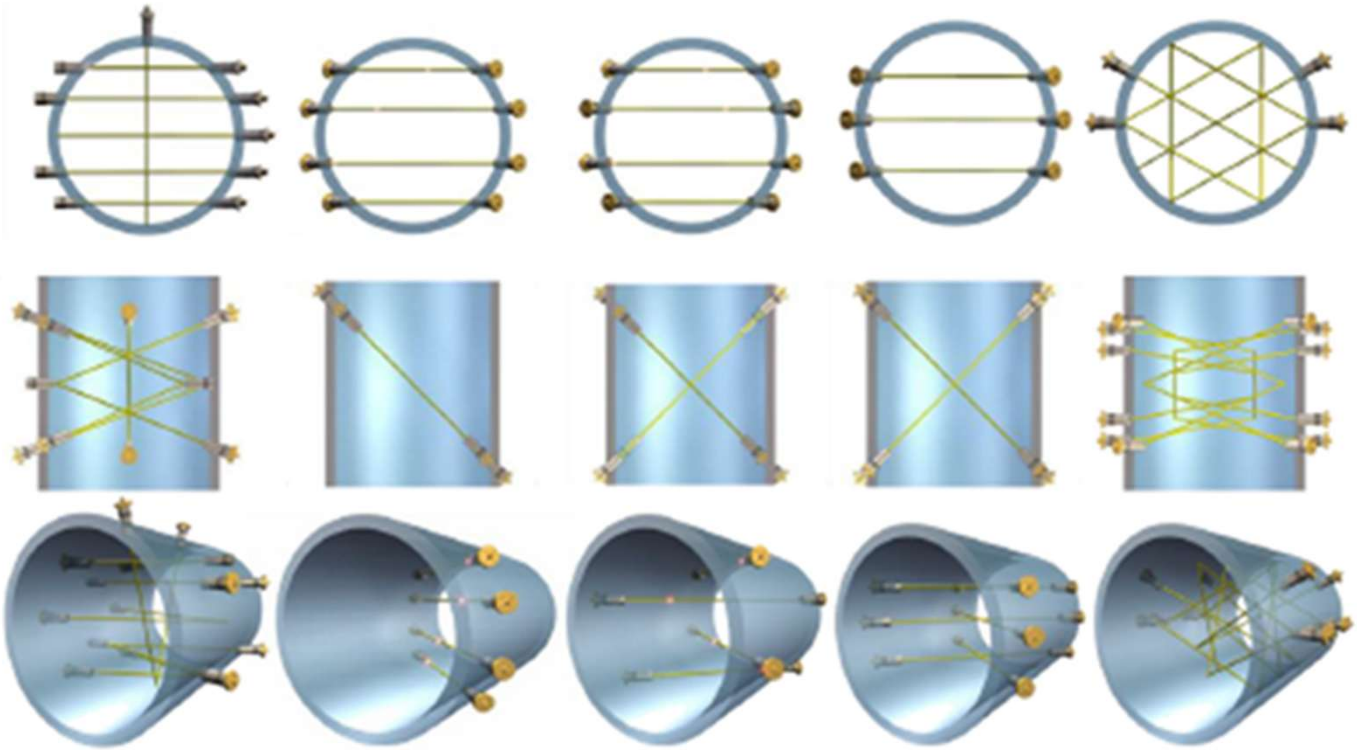
- 2nd Ed. ISO 17089 Section 8: "*Audit Trail and Diagnostics for Meter Verification*".
- It discusses logging diagnostic data at FAT, calibration, SAT & operation.
- It gives ***quantifiable*** SoS alarm thresholds.
- An end user consensus is: "*state all USM diagnostic alarm thresholds!*"
- Alarm thresholds are required to make sense of pattern recognition advice…

USM alarm thresholds facilitate pattern recognition:

Relational diagnostic	Per path					
	Signal Acceptance	Automatic gain control	S/N	MSOS	Flow velocity	Standard Deviation
Transducer failure	×	×	—	×	×	×
Detection problems	×	×	×	×	×	×
Ultrasonic noise	×	×	×	—	—	—
Process conditions pressure	—	×	×	—	—	—
Process conditions temper-ature	—	—	—	×	—	—
Fouling	×	×	×	×	×	×
Changes in the flow profile	—	—	—	—	×	×
High velocity	×	×	×	—	—	×

ISO 17089-1 (2019) Table 6

Why no generic USM alarm thresholds?



- Diagnostics are either USM design dependent or independent.
- Diagnostic values can be process dependent.

Why no generic USM alarm thresholds?

- Stating USM diagnostic alarm thresholds would mean being precise about unspecified
  - USM designs,
  - process conditions, and
  - end user requirements.

"There's no sense in being precise when you don't even know what you're talking about."
— **John von Neumann**

- The ISO committee *cannot* be precise about diagnostic thresholds.

ISO USM Diagnostics Pragmatism

Terry Cousins

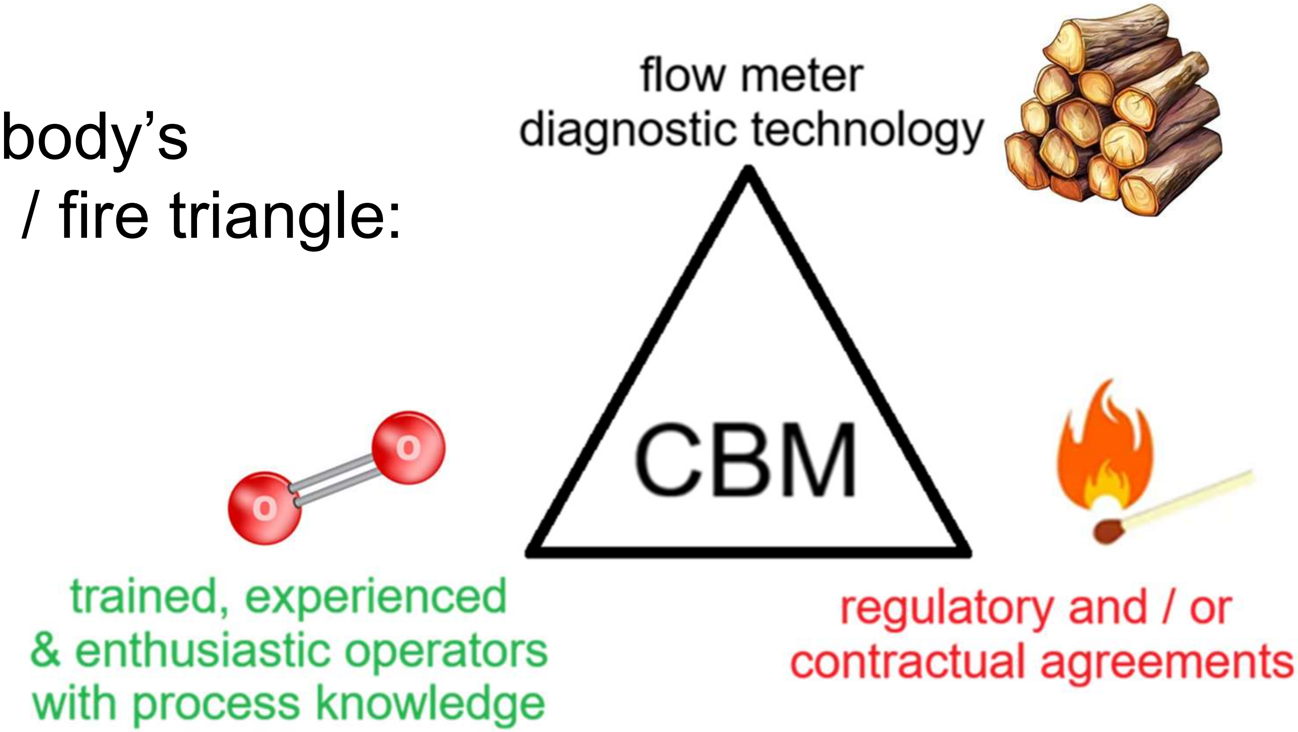
"You cannot divorce diagnostic analysis from knowledge of the process.

USM diagnostic systems don't identify the problem on their own.

A competent operator needs to combine USM diagnostic results with process knowledge to identify the problem."

Which leads to…

Lightbody's
CBM / fire triangle:



- Trained operators, with USM design & process conditions knowledge, and their specific appetite for risk, choose alarm thresholds.
- *ISO is leaning towards promoting this view.*

Conclusions

- Both AGA 9 and ISO 17089 can be important to USM manufacturers and calibration facilities.
- ISO 17089-1 is currently undergoing a comprehensive review.
- There is no point complaining about any content ***after*** its published…
- Interested parties are encouraged to respond when it goes out for industry comment (probably 2027).

Questions!?

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