

Performance Analysis of an Operational Metering Station using Ultrasonic Flowmeters

2009 Operations Conference & Exhibition
David L. Lawrence Convention Centre
Pittsburgh, May 19 to 21



AGENDA

➤ **The Metering System**

➤ **Present Phase**

➤ **Methods**

➤ **Results**

➤ **Measurement Uncertainty**

➤ **Summary and Conclusions**

The Metering System

- Reference to the standards & recommendations documentation:
 - 1988 AGA 'Gas Measurement Manual, Design of Meter Regulator Stations, Part Nine'
 - 1999 NEN-EN 1776 'Gas supply systems - Natural gas measuring stations - Functional requirements'
- Address both axial and non-axial components of flow
- Multipath Metering configurations
- A FC may be used, but consideration to swirl should be given during the design phase
- Cross-over deployed (i) L-config., and (ii) Z-config.



The Metering System

- AGA manual does not address USM, FC, measurement uncertainty, or bypass configurations
- 1999 NEN-EN 1776 'Gas supply systems - Natural gas measuring stations - Functional requirements':
 - USM reference to an ISO document; 12765 now at status 'withdrawn'
 - Use of FC
 - Measurement uncertainty
 - Bypass configurations (maintenance)
- No document references the 'Cross-over series meter check' using either the L or Z-configuration



The Metering System

- Recent project based on 'real-life' metering systems and 'Computational Fluid Dynamics' (CFD) where the individual meter transit-times are compared to the CFD modelling to increase confidence of the data and further reduce the uncertainty
- Component parts standards:

GAS METER	STANDARD		GAS PROPERTY	STANDARD
Turbine Meter	AGA 7		Compressibility	SGERG88
	ISO 9951			SGERG91
	EN 12261			MGERG
Ultrasonic Meter	AGA 9			AGA NX 19
	ISO 17089 (DIS)			AGA 8
	EN 14236		Base Conditions	ISO 6976
Orifice Plate	AGA 3		Composition	ISO 6974
	ISO 5167			ISO 10723
Conversion Device	EN 12405			ASTM 1945
			Calorific Value	ISO 6976
				GPA 2145
				GPA 2172
			Speed-of-sound	AGA 10
			Specific Heat	AGA 10

Field Verification and Validation of an Energy Measurement System after: Herwijn, 2008.

The Metering System

- In summary it can be shown that:
 - Manuals & standards do not totally reflect what is current within the gas industry
 - Metering systems employing the 'cross-over series check' configuration are growing in number
 - A standard uncertainty budget has not been proposed specifically written for the above

Present Phase

- Analysed a metering system in:
 - Normal operating conditions
 - 'Cross-over series meter check'
 - Meter run with and without a FC
- Identify significant events
- Derive recommendations for metering station designs:
 - Identify future project work



Use CFD to model flow

Determine the basis of an enhanced uncertainty calculation model

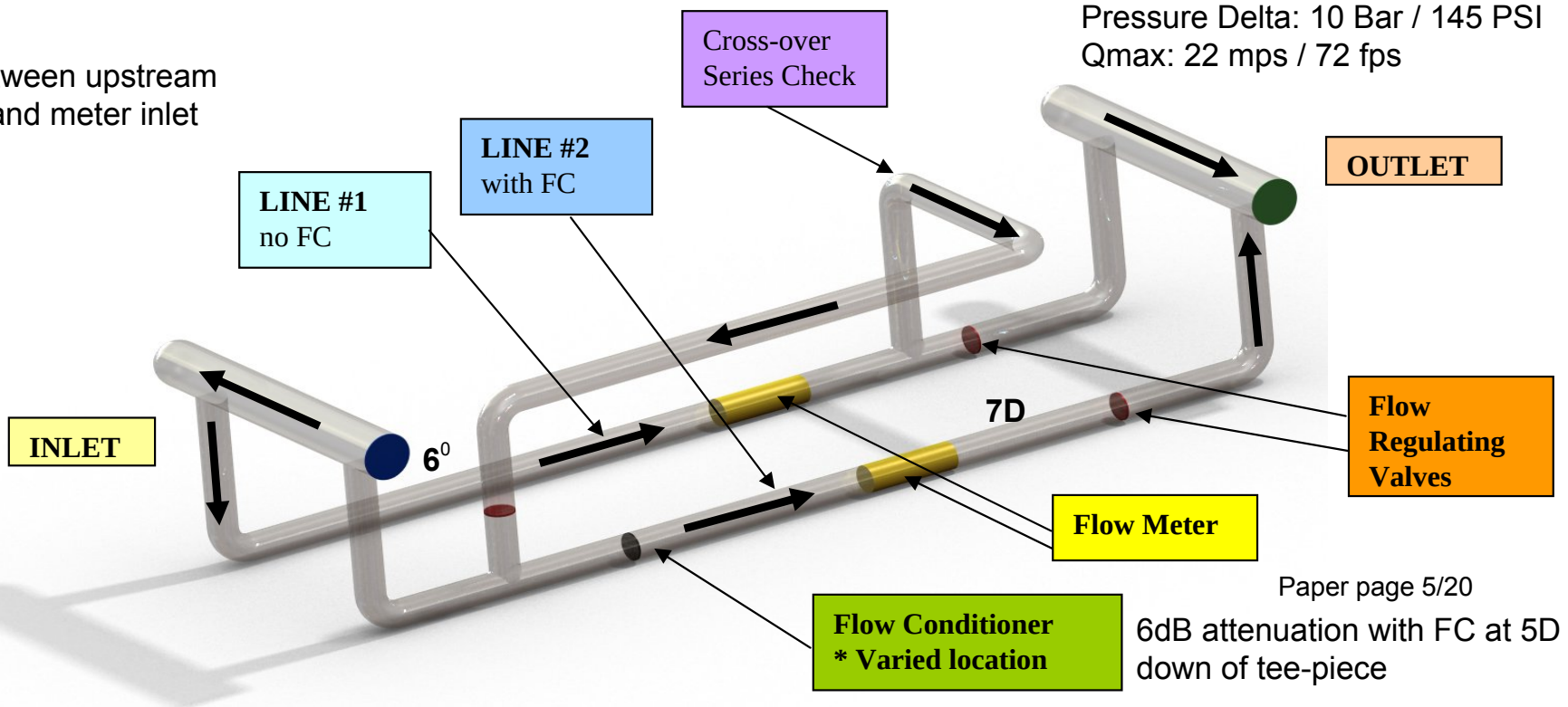
Methods

2 Microphones in Line # 2 - UP / DN of USM

1 Microphone in Line # 1 - DN of USM in cross-over tee-piece

15D between upstream valves and meter inlet

Pressure Delta: 10 Bar / 145 PSI
Qmax: 22 mps / 72 fps



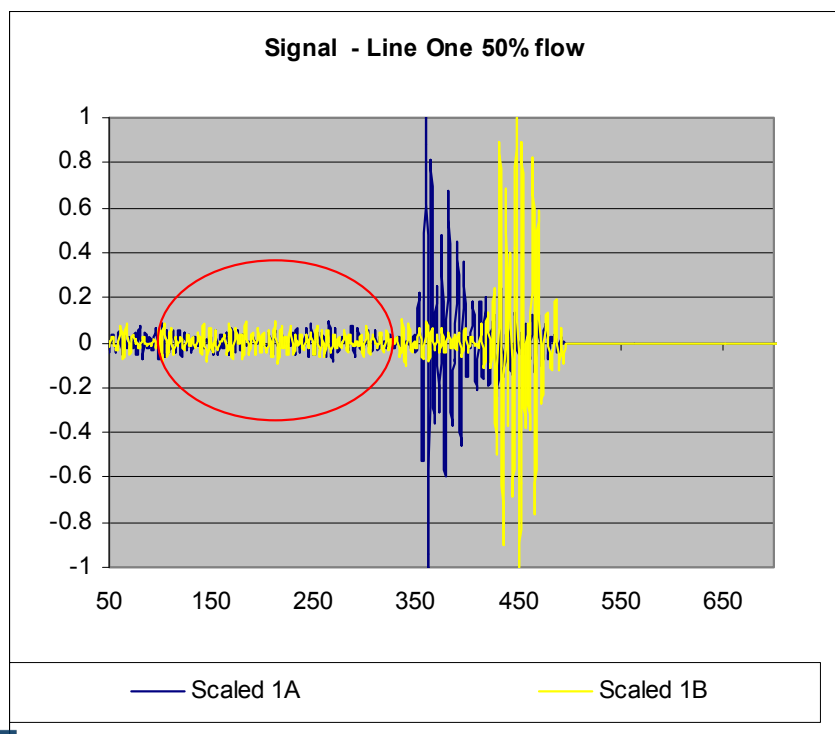
Paper page 5/20

6dB attenuation with FC at 5D
down of tee-piece

Readings from Microphones used for 'Valve Weighting Factor N_v '
+T and Flow readings connected remotely to a flow computer

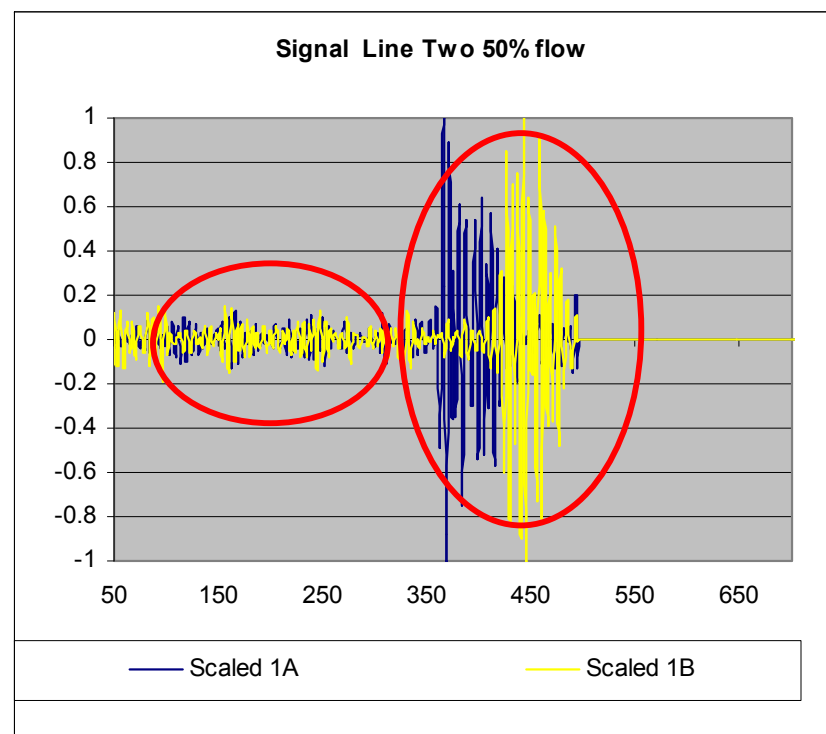
Results

- Metering system at 50% flow through Lines # 1 and 2 at 6 Barg Delta:
 - Typical 'normal' conditions



SNR 9.90:1

Swirl



SNR 8.68:1