Uncertainty in Gas Measurement,

How does it affect me?

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AGIT Gas Speak Colloquium 2016

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Who is MetSolv?

MetSolv is an Australian specialist metering company for the Energy, Resources and Utilities industry.

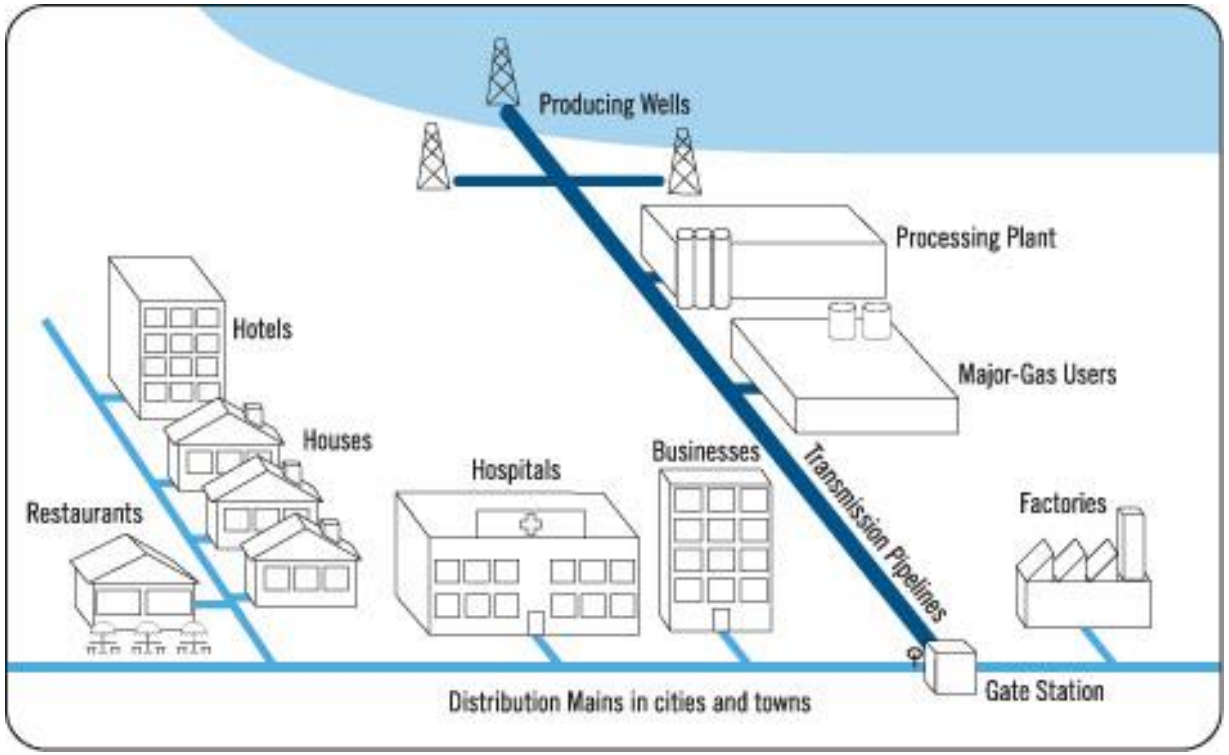
Independent of metering system providers and vendors, we are able to offer a unique combination of services and expertise.

Gas Measurement?

- What is uncertainty when we talk about gas measurement, why is it important and why do we care when the flow meter is providing us a flow value?

- In gas transmission networks accurate flow data is important for a range of financial, operational and regulatory reasons.

- However, the value of this data to the operator may be undermined by the meter uncertainty.

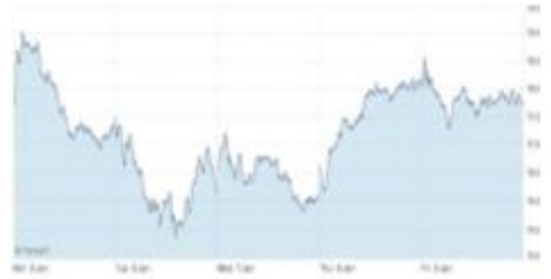


Importance of Accurate Measurement?

Metering stations provide indication of the Volume and Energy produced, sold and exported.

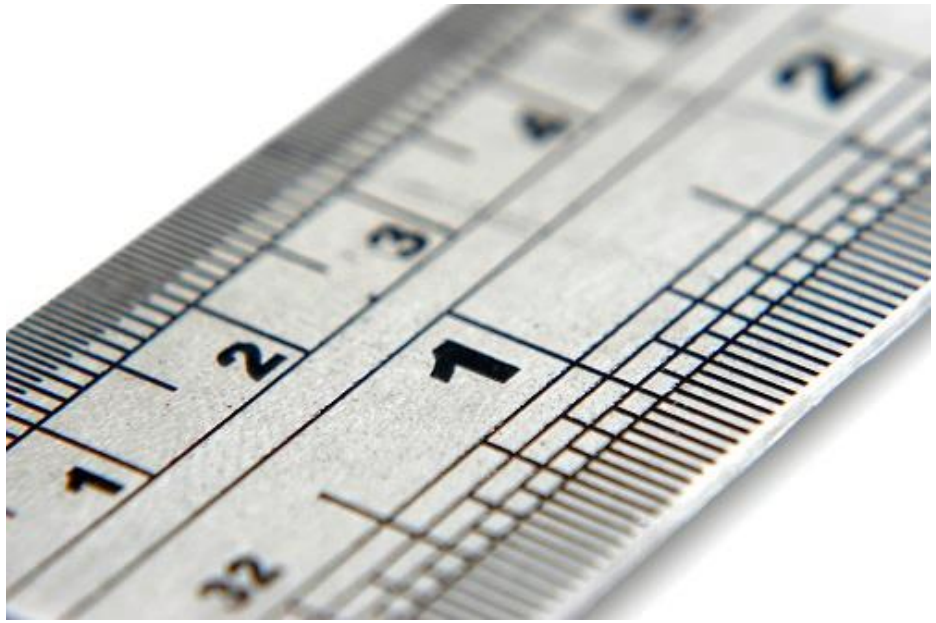
The recorded data from the Metering stations is used to develop Asset Reports.

Asset performance is collected and reported, the group performance can be determined.



Group performance will influence share price.

Measurements?



- It is a misconception that measurement is an exact science.
- All measurements are merely estimates of the true value being measured and the true value can never be known.
- **Uncertainty** is the doubt that exists about the result of any measurement.

- The uncertainty of a measurement tells us something about its quality.
- The degree of doubt about the measurement becomes increasingly important with the requirement for increased accuracy.

What is Uncertainty of Measurement?

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- In everyday use, “uncertainty” is a sort of “who knows what’s going to happen?”
- In a scientific measurement, it’s less an admission of ignorance than an expression of confidence.
- All measurements have some degree of uncertainty that may come from a variety of sources.
- In a metering station a number of instruments make up the uncertainty analysis calculation.

Measurement = (Best Estimate ± Uncertainty) Units

The normal distribution function (“bell curve”) from statistics. Image from Wikimedia

Uncertainty Analysis

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- It should be appreciated that “Uncertainty Calculations” represent the “worst case uncertainty” under the normal operating conditions.

- Under normal operating conditions the uncertainty should be within (i.e. less than) the calculated uncertainties.

- However, under fault conditions the uncertainty could be greater than the calculated Uncertainty.

Accuracy & Repeatability

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- Uncertainty is related to Accuracy, in that high accuracy has a low uncertainty.

- **Good Accuracy** means **Good Repeatability**

Accuracy & Repeatability

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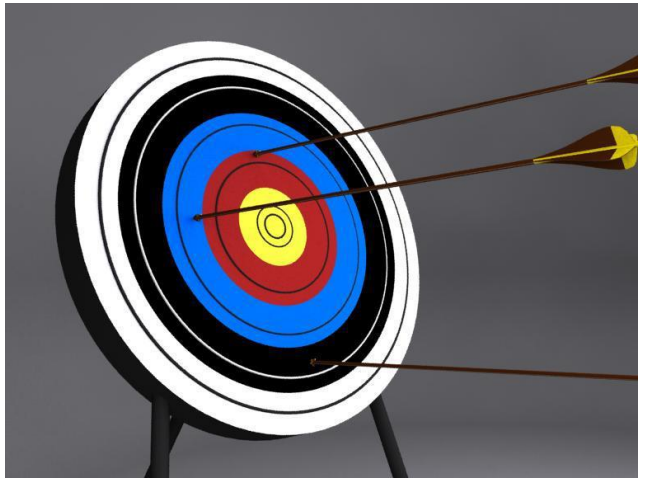
- **Poor Repeatability** means **Poor Accuracy**



- **Good Repeatability** does not necessarily mean **Good Accuracy**

Cost of Gas Measurement Uncertainty

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- In 2013 Australia Produced approximately 2,467 Peta Joules of gas and the average price was $4.22 per Giga Joule.
- The total Annual cost was approximately **$10,410,740,000**.
- The Industry standard uncertainty limit when measuring gas is 1%.
- The financial uncertainty to this trading was approximately:

$104,107,400 for the year….!!!!

Statistics taken from Australia Bureau of Resources Gas Market Report 2014

Uncertainty Analysis

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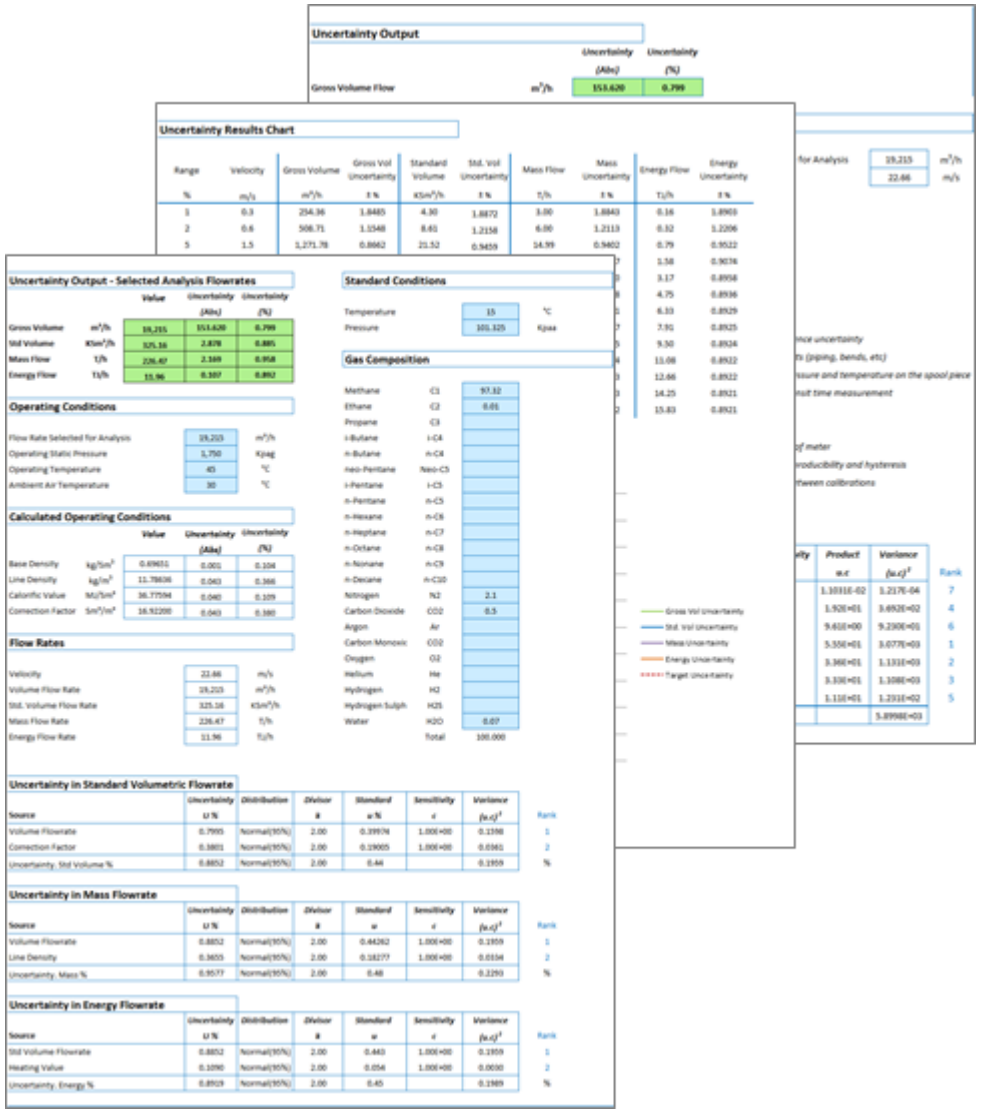
- The uncertainty analysis specifies the performance of each element in the metering system that contributes to the overall system uncertainty of the measurement.
- Provides an uncertainty profile covering the operating range of the meter.
- Each element may be tuneable to assess equipment selections and calibration / verification procedures.



Scenario: Meter transfer station with daily throughput of 100 TJ per day.

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Assume Production :-	36.5	PJ / year
Assume a Market Value of :-	4.22	$ / GJ

Meter Station Uncertainty %	Daily Flow Uncertainty TJ / day	Daily Cost Uncertainty $ / day	Annual Flow Uncertainty TJ / year	**Annual Uncertainty $ / year**
0.6	0.6	2,532	219	924,180
0.7	0.7	2,954	256	1,078,210
0.8	0.8	3,376	292	1,232,240
1.0	1.0	4,220	365	1,540,300
1.5	1.5	6,330	548	2,310,450

- In practice uncertainty calculations can demonstrate an uncertainty of about 0.7%.
- Station design, flow meter calibration and the operating procedure being critical.

Design Implications

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Using Uncertainty Analysis in a Pipeline Balance

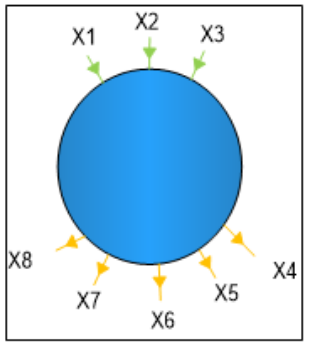
- In a gas transmission network with multiple transfer points and flow meters it is possible to check the balance across the system.

- The uncertainty can be used to help manage the lost and unaccounted for gas.

Balance Uncertainties

- Pipeline has 8 transfer points.
- Transfer points have a measurement and an uncertainty associated.
- Input/output balance is calculated.
- Standard uncertainty in the balance is calculated.
- Expanded uncertainty in the balance is calculated to provide an increased confidence level of 95%.

Uncertainty Output



System Balance = 5 TJ ± 3.93 TJ (95% confidence)

That means that the true value of the measurement lies between 1.07 TJ's and 8.93 TJ's 95% of the time.

Inlet Total	560 TJ		
Outlet Total	555 TJ		
Balance = Inlet - Outlet	5 TJ	0.89%	Difference

Input Data

Inlet

	X (TJ)	U %	U (TJ)	Distribution	Divisor k	Standard u	Sensitivity c	Variance (u.c)²
X1	120	0.79	0.95	Normal(95%)	1.96	0.484	1.00	2.34E-01
X2	140	0.85	1.19	Normal(95%)	1.96	0.607	1.00	3.69E-01
X3	300	0.94	2.82	Normal(95%)	1.96	1.439	1.00	2.07E+00
Total TJ	560					Combined Standard Uncertainty		1.63 TJ

Outlet

	X (TJ)	U%	U (TJ)	Distribution	Divisor k	Standard u	Sensitivity c	Variance (u.c)²
X4	95	0.85	0.81	Normal(95%)	1.96	0.412	1.00	1.70E-01
X5	100	0.75	0.75	Normal(95%)	1.96	0.383	1.00	1.46E-01
X6	200	0.81	1.62	Normal(95%)	1.96	0.827	1.00	6.83E-01
X7	50	1.1	0.55	Normal(95%)	1.96	0.281	1.00	7.87E-02
X8	110	0.92	1.01	Normal(95%)	1.96	0.516	1.00	2.67E-01
Total TJ	555					Combined Standard Uncertainty		1.16 TJ

How Healthy Is Your Metering System?

THANK YOU

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