Just what are we Calibrating?

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Just what are we calibrating

- Remote operation and reporting by sensors with built in intelligence is a massive growth industry.
- To meet this demand many instrument manufacturers now supply intelligent systems which can be interrogated /controlled by hand held or remotely operated equipment.
- These interrogate the signal conditioning modules mounted on the primary measuring elements.
- Gathered information from the circuitry in the sensor can be compared and verified against the original calibration data produced at the time of manufacture.
- Does this simple verification imply that since installation /calibration, that some deterioration of the actual measuring elements has not taken place,
- If deterioration has taken place , the magnitude of the calibration shift and by definition the integrity of the instruments readings will not be made manifest
- That this deterioration will not necessarily affect the integrity of the last or original calibration or that it does not affect the calibration or can be monitored and corrected for.
- Environmental conditions at the sensor location, can cause the loss of integrity and have serious implications in that any damage, obstruction, corrosion, erosion, buildup of lime scale, fatigue etc. will affect the results from the sensor.
- Equally the difference of calibration conditions from lab to site and the installation itself.

Just what are we calibrating contd.

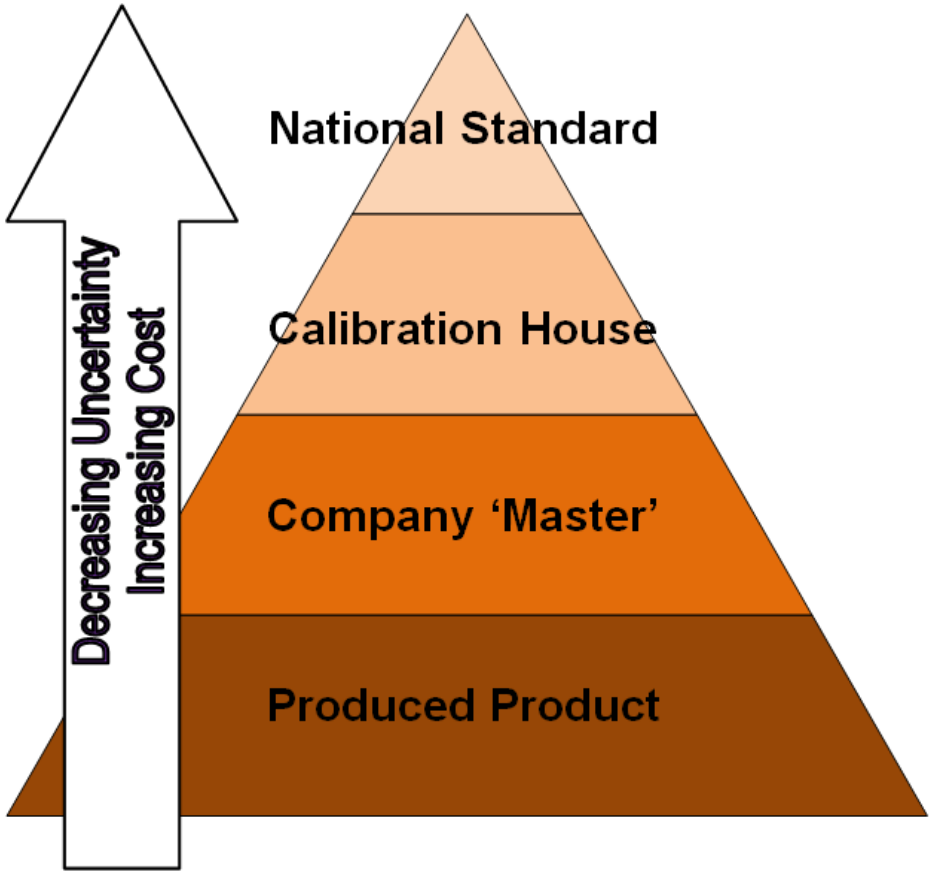
- This begs the question regarding **what is being verified or calibrated by** remote interrogation. Is it the electronics with its programmed algorithms or is it the complete measuring system.
- What about the sensor itself.
- Care has to be exercised in making this distinction.
- Is there a real alternative to the physical inspection of the primary elements and full re-calibration using accredited standards.
- This presentation raises the issues regarding the uncertainties associated with the philosophy of Verification and Calibration by exception (condition monitoring) rather than time based Preventative Maintenance and of remote operation considerations.

What is a Calibration?

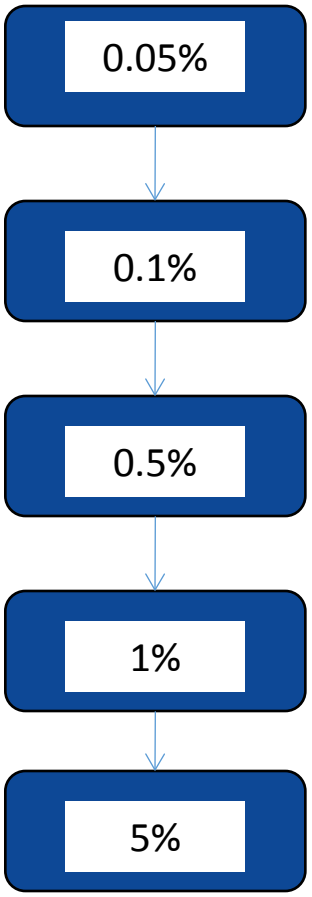
- “A set of operations that establish,
- **under specified conditions**;
- the relationship between values of quantities indicated by a measuring instrument or measuring system,
- and the corresponding values realised by **standards**.”

Traceability

- Property whereby a result can be related to stated references through an unbroken chain of comparisons, each having a stated uncertainty



The Traceability Chain



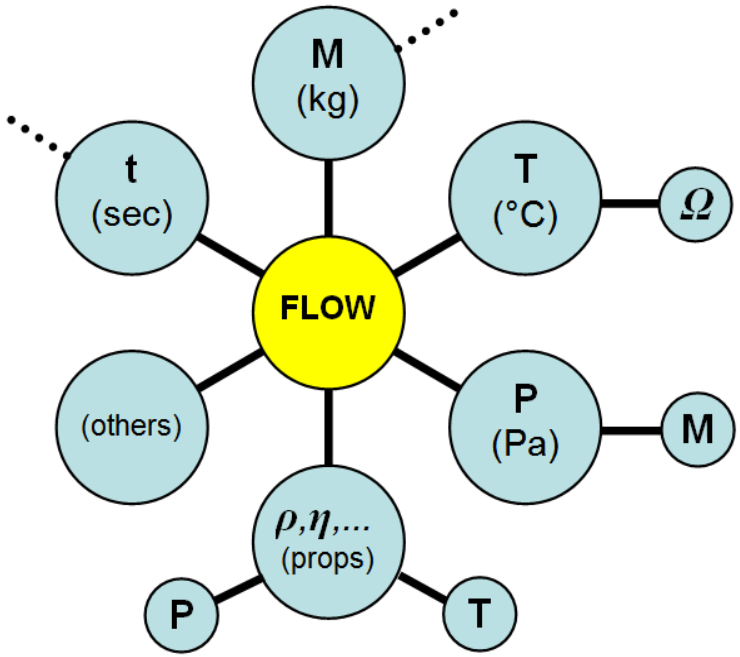
National Standards Laboratory

Calibration laboratory

Company "Master" instrument

Production instrument

End product



Regulatory position

"Unless otherwise agreed with OGA, systems designed to measured quantities exported into common transportation systems should be capable of demonstrating an uncertainty to within ***±0.25% of dry mass****."*

OGA Guidance Notes for Petroleum Measurement, Issue 9.2, October 2015

Measurements Involved

Primary

- Pressure
- Flow
- Density
- Temperature

Secondary

- Time
- Dimensional

Environment Parameters

Oil & Gas

- Temperature Range & Variation
- Pressure Range & Variation
- Chemical Content
- Density Variation

Causes of Variation

- Wax
- Humidity
- Erosion
- Corrosion
- Deposition
- Dimensional Variation
- Stress Corrosion & Fatigue

Environment Parameters

Food and Beverage Industry

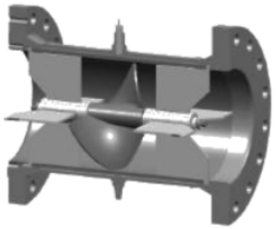
- Flow
- Temperature
- Pressure
- Mass
- *pH , Conductivity etc*

Additional Requirements

- *The need for off line calibration to maintain the strict hygienic requirements*

Densitometry Background

- Most liquid measurement systems in the North Sea still make use of volume flowmeters



- Allocation is by mass in shared transportation systems
  - fluid density is required to convert from volume to mass
  - Most common device is vibrating tube densitometer
  - **traceable calibration required**

Densitometry Background

Previous approach –

- Initial calibration at 20°C and 1 bar
  - derive corrections for other temperatures at 1 bar
  - derive corrections for other pressures at 20°C
- Annual re-calibration only at 20°C and 1 bar

but

densitometers used at non-ambient conditions!

densitometer equation is cross-coupled in period, temperature and pressure!

Typical Flow Measuring Instruments

Primary

- Coriolis
- Turbine
- Venturi
- Ultrasonic
- Multi-phase
- Orifice plate

Secondary

Water Cut

- Microwave
- Gamma beams
- Infra Red

Knowledge

- There have been many papers written on effects of a number of the for mentioned flow meter instrument techniques.
- For instance Reader Harris's book on Coriolis and Venturi metering with references to many research papers of these methods and uncertainties.
- There are software techniques applying algorithms to assist in knowing the data integrity and sensor condition.
- It is of concern however that calibrations are carried out in the lab or by first tier transfer standards having correction factors, assumed to be applicable for the use in the environment where the instruments are installed.

Knowledge Gap

To meet the Calibration by exception challenge

- Do we have the history of sensor performance in the current and upcoming new challenging environments of the sensors to meet the regulatory and fiscal requirements?
- What may be the future regulatory requirements.
- Do we have the standards and calibration facilities to meet these challenges?
- Have the risks been fully quantified?

Knowledge Gap

To meet the Calibration by exception challenge

- Modern instrumentation allows for the collection of large amounts of data which with data interrogation programs and diagnostics should allow for monitoring of meter shift.
- Some very sophisticated data collection and transmission modules have the ability to trend changes from the original Calibration data. In these cases the requirement for re-calibration can be continuously monitored
- Will we be able to know if sensors are not performing correctly by interrogating other unrelated sensors in the location?
- If we can what action can be taken
- Do we have to put in triple sensing and poll these know which are believable ?
- Will this be cost effective?
- What about future maintenance on the supposed faulty sensor to maintain the polling population?

Future

To meet the Calibration by exception challenge

- Opportunity for the U.K to accept the challenge and drive the measurement industry forward?
- This could well expand the skill levels requirements as we continue to meet the legacy requirements and the new challenges in this challenging industry.
- To sum up are we truly calibrating the whole system of the measurement instrument as needed or only part of it?
- Can we remotely calibrate the whole system?

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