Sustaining Quality Flow Measurement in Critical Applications

The offshore oil and gas industry needs good measurement repeatability and low uncertainty to meet its engineering assessment, review, and audits. Jason Laidlaw, Oil and Gas Consultant at Emerson Process Management, looks at how standards and guidelines provide key components of reference for producers when flow measurement systems or devices are reviewed and inspected.

In flow measurement, good device and instrument repeatability is the fundamental building block for devices and systems that will exhibit low uncertainty and good accuracy when compared to a reference standard. How do you ensure that same repeatability when it comes to the on-going review and assessment of the system?

For engineering assessment, review or audit, good repeatability and low uncertainty are the result of having trained, skilled and competent personnel. Good accuracy comes from having consistent reference sources such as a standard, best practice or technical guidance note. Therefore, having standards and guidelines are key components of reference when flow measurement systems or devices are reviewed and inspected. Having a standard, whether an internal criteria or international reference, is essential if similar systems are to be compared and benchmarked across common facilities and installations, pipelines or even differing world areas.

If you specify the right equipment, have it calibrated, correctly installed and are following the appropriate standard, flow measurement systems are at their optimal level of performance right up to the moment you expose them to product. After this, the rate at which the level of performance declines will be subject to how well the system is managed and sustained and whether the original design decisions made are valid for the continued and future process conditions.

Measurement Management

To demonstrate measurement control, a management process with a means of periodically verifying the measurement processes is key and should be considered an essential component of the overall flow system. The purpose of implementing such a system is to ensure sustainability and close the loop on ongoing performance using a quality based approach to identify options for improvement.

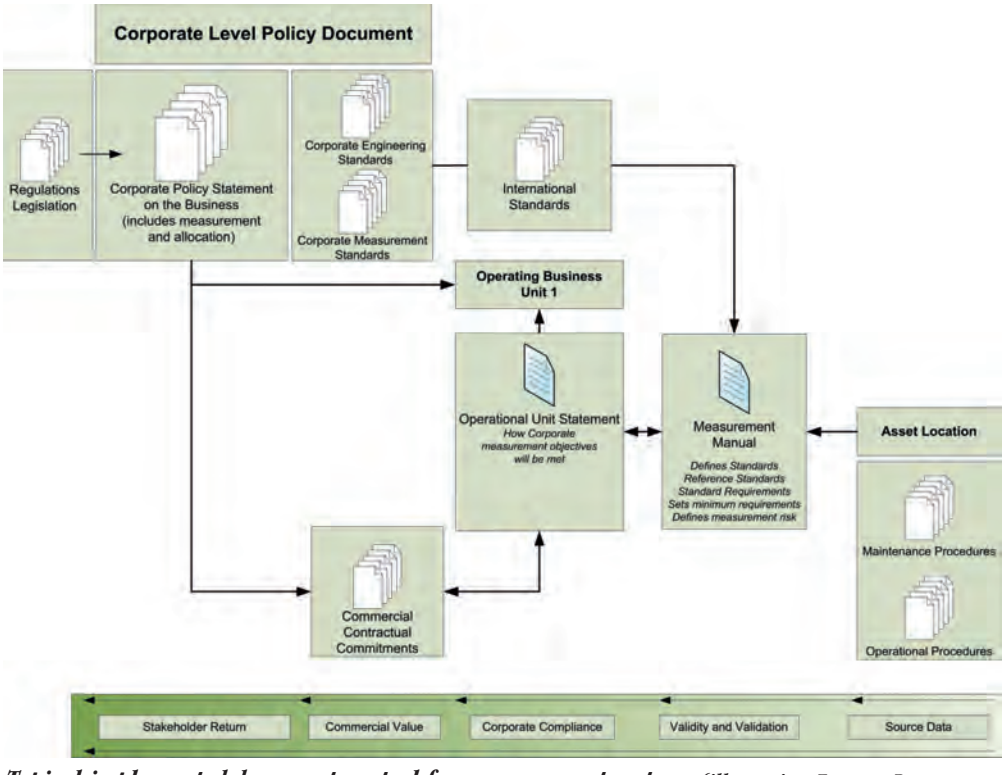
For example, if you consider what can physically cause measurement deviation these broadly fall into three categories:

- Physical and mechanical (damage, deterioration, output shift).
- Inappropriate usage (range, scale, calibration etc.).
- Current operating conditions (original design, changing process).

The first category can most certainly be picked up during planned maintenance; the second could actually be caused by planned maintenance due to unfamiliarity or user inexperience; and the third category has to be looked at in a wider context and may not be immediately obvious at the individual measurement location.

While each of these conditions can happen during the normal operation and life of the measurement system, the important part is to have a system in place and an ability to detect or determine a deviation. Detecting measurement deviation is possible from a number of different procedures:

- Calibration, verification and inspection.
- Statistical analysis of key data



Typical implemented document control for measurement systems *(illustration: Emerson Process Management)*

and validating, establishing performance baselines.
- Using specific equipment diagnostics, process simulation, sampling.

ISO 10012 [1] describes four key areas of focus to ensure effective measurement management. These are 5.0 Management responsibility; 6.0 Resource management; 7.0 Metrological confirmation and realisation of the measurement process; and 8.0 Measurement management system analysis and improvement. These are the initial steps to establish the quality objectives of the overall process and the risk of incorrect measurement results.

Taking the principles outlined within this standard is one step to developing a longer term, sustainable measurement system as BP Azerbaijan [2] has developed in that region. HM 54 [3] takes mainly sections 7.0 and 8.0 outlined within ISO 10012 and develops a more detailed specific view of the overall process for the UK upstream measurement industry.

Detecting Measurement Deviation

Inspection or audit is one aspect of monitoring the measurement system and is a quality-based review process. It is used to identify non-conformances and areas for improvement. While there is a great deal of information and standards available on the process of auditing, there are very few standards or guidance notes that can be applied directly to complete upstream oil and gas measurement systems. HM 60 [4] could be considered one reference document but this primarily focuses on the audit process, not the measurement critical content of the review. In most cases the method and procedures have to be constructed by an experienced, competent person from a combination of standards, guidance notes, regulations, commercial agreements and "good oil-field practice", which is "catch all" for what may be left unwritten elsewhere.

Quality-based review process – Emerson meter inspection
(photo: Emerson Process Management)

The same cannot be said for measurement system construction and design where there are many standards governing physical design and requirements. However, in almost all cases, prior specialist measurement knowledge and experience are required to bridge the gap between the reference standard and the actual measurement application.

Without prior knowledge, you could assume all that is required for a successful review of a measurement system is to check for conformance to the applicable standard. This is partly true but, for the reasons outlined earlier, this may not cover the full range and applicability of the system and does not address management and control. Certainly, design would form part of the general audit criteria but there are other parts of the quality measurement system that require criteria, for example the monitoring of proving results, frequency of calibration checks and actual reporting chain of measured results.

Another important factor for consideration when developing a base criteria, is what is required for regulatory compliance, for example DECC Measurement Guidelines [5] or the NPD Statement of Requirement [6] or from a European Legal metrology perspective for example MID [7].

All inspections are performed looking for compliance with the appropriate reference. Irrespective of the audit or review performed, in general, the pure metrological measurement criteria will roughly follow the same format and cover the same scope. The differences will start to appear in specific criteria based on the focus areas for each audit type, for example the measurement system may be the same but an inspection by a regulator will differ in parts from an inspection by a pipeline operator.

An organisation has to consider audit as necessary to demonstrate compliance with regulations or commercial agreements and may consider audit an early warning system for future problems or issues that could require intervention. Either way, audit is a feedback loop for the management system where consistency of findings and an understanding in the significance of the deviation, will determine the level of potential exposure and appropriate action. ISO 17020 [8] can be used to ensure consistency in the approach of inspection bodies, both internally and externally from the organisation, as it outlines the specific requirements that are required of that type of management system.

Potential Effects

Exposure is an interesting concept in understanding the significance of the deviation as it may, or may not be, an actual measurement error that can be clearly identified which is what you may expect. Actual errors are relativity easy to identify, correct and manage. Exposure on the other hand could be a perceived increase in the level of overall system uncertainty, it could be a legal risk, it could be tax risk, it could be a production risk, it could be a reputation risk and it could be any combination of all of the previous.

Every operator will have internal processes and procedures that will define their acceptable level of exposure and what type of response do any findings warrant. These are normally not as easy to correct and this is where the level of internal action and focus applied determines the future sustainability of the measurement system.

Dealing with Non-Conformances

Future sustainability can then be described as a plan to correct the exposure non-conformance or a plan to control and manage the non-conformance. Regulators normally have very clear guidelines as to what is expected from the measurement system and what they would expect as a method of correction. Other types of audit or inspection by partner or pipeline representatives and internal departments may, within the terms of the agreement, have some flexibility in dealing with exposure non-conformances based on current or future business needs and investments.

In large national or international organisations, having consistency with the inspection or audit of measurement systems and having consistent measurement or reference standards, enables the intercomparison of facilities, installations, pipelines and world areas. The outcome from the audit can then become a key input into the management decision process on how, and where, to deploy funds and resources to mitigate non-conformances.

Traceable Management System

On the whole, a measurement management system won't generate the actual revenue. This will be determined by the type of product, availability and trading price. It will almost certainly be part of the quantification process of what the initial expected revenue should be. Therefore having a traceable quality measurement management system in place, that can stand up to scrutiny to audit and inspection, can only serve to sustain the system and aid/improve future and ongoing measurement system performance.

The repeatability condition of a measurement method is a quantitative measure of the random error, out of a set of conditions that includes the same measurement procedure, same operators, same measuring system, same operating conditions and same location, and replicate measurements on the same or similar objects over a short period of time VIM [9]. This is not something that can generally be adhered to when we consider audit or inspection.
Therefore the term "reproducibility of a method of measurement" – which is a quantitative expression of the random error associated condition of measurement out of a set of conditions that includes different locations, operators, measuring systems, and replicate measurements on the same or similar objects VIM [9] – is more appropriate.

In summary, the same type of measurement system can have differences in design and measuring procedures within the same operator dependant on the service and regulatory environment across the world. To ensure consistency and reproducibility of the audit or inspection requires common standards to be adopted and implemented. ■

References

[1] International Standards Organisation, EN ISO 10012:2003 Measurement management systems – Requirements for measurement processes and measuring equipment, 1st Ed, ISO, ISBN 0 580 41654 2, 2003.
[2] B Pearson; F Nasirov; I Gurbanov, Developing Measurement Infrastructure in BP Azerbaijan, Paper 2.1, 28th North Sea Flow Measurement Workshop, St Andrews, 2010.
[3] Energy Institute, HM 54 Guidelines for the management of measurement for the UK upstream oil and gas industry, London: Energy Institute, 2007.
[4] Energy Institute, HM 60 Guidelines for the auditing of measurement systems for the UK upstream oil and gas industry, London: Energy Institute, 2007.
[5] Department of Energy & Climate Change (DECC), Licensing, Exploration & Development, Guidance Notes for Petroleum Measurement for system operating under the Petroleum (Production) Regulations, Issue 9, DECC, July 2014.
[6] Norwegian Petroleum Directorate (NPD), Regulations Relating to Measurement of Petroleum for Fiscal Purposes and for Calculation of CO2-Tax (The Measurement Regulations), NPD, November 2001.
[7] The European Parliament and of the Council the European Union, DIRECTIVE 2004/22/EC Measuring Instruments (MID), European Parliament, March 2004.
[8] International Standards Organisation, EN ISO 17020:2004 General criteria for the operation of various types of bodies performing inspection, 1st Ed, ISO, ISBN 0 580 44683 2, 2004.
[9] Joint Committee for Guides in Metrology, JCGM 100 International vocabulary of metrology – Basic and general concepts and associated terms (VIM), 3rd Ed, 2012.

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