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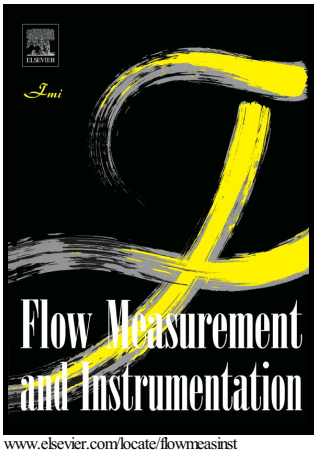

www.elsevier.com/locate/flowmeasinst

PII: S0955-5986(17)30298-4
DOI: https://doi.org/10.1016/j.flowmeasinst.2018.02.001
Reference: JFMI1402

To appear in: *Flow Measurement and Instrumentation*

Received date: 18 July 2017
Revised date: 28 November 2017
Accepted date: 7 February 2018

Cite this article as: Nadezhda Pashnina, Determination of Optimal Calibration Intervals by balancing Financial Exposure against Measurement Costs, *Flow Measurement and Instrumentation,* https://doi.org/10.1016/j.flowmeasinst.2018.02.001

Determination of Optimal Calibration Intervals by balancing Financial Exposure against Measurement Costs

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ABSTRACT

Maintenance strategies associated with fiscal measurement systems have traditionally been based on time-based approach when calibration activities are scheduled at fixed intervals without much consideration to the previous performance of measuring instruments. The current economic challenges encourage abandoning the time-based maintenance in favour of other strategies, such as risk-based approach to maintenance. This approach is used to determine an appropriate calibration frequency by balancing financial exposure against measurement costs.

There is not a universally applicable single best practice for determination of calibration intervals, this is reflected in a few officially published documents which provide only a general guidance. Addressing the need for better understanding of the mechanism required for determination of the optimal calibration intervals the detailed calculation algorithm suitable for practical use is developed based on the general guidance on risk-based approach to maintenance.

The calculation algorithm is based on statistical analysis of calibration data of an individual measuring instrument which defines the progressive change of a measurement error as a nonstationary random process. The measurement error together with the selected loss function defines the financial exposure which forms the 'total cost' function by summation with the measurement costs, determined as the cost of ownership of the measurement instrument. A minimum of the total costs function determines the optimal calibration interval of the measuring instrument.

The case study of the ultrasonic flow meters, operating in the custody-transfer gas flow measurement system, are used to illustrate the calculation algorithm. It has been shown that the determination of calibration intervals is a complex mathematical and statistical process requiring accurate and sufficient data including calibration results and registered costs. Application of the suggested calculation algorithm can be beneficial in assessment and minimisation of financial risks associated with currently implemented maintenance strategies as well as in review of calibration intervals to balance financial exposure and measurement costs.

Keywords: optimal calibration interval, risk-based approach, measurement error, expected loss, financial exposure, measurement costs

1 Introduction

The current economic challenges facing the upstream oil and gas sector has driven a need to reduce costs and improve efficiency. A reduction of operating costs may be achieved through the extension of calibration intervals. The maintenance strategies associated with fiscal measurement systems have traditionally been based on a time-based approach, without much consideration to the previous performance of measuring instruments and to the introduction of intelligent diagnostic capabilities of modern instrumentation. However, custody transfer and allocation measurement are essentially the cash registers and their performance must be assured to minimise financial exposure (just another name for risk and means the amount that can be lost due to unknown measurement error). Similarly, complying with EU regulation for the monitoring, reporting and verification of greenhouse gas emissions requires operators to define a calibration and maintenance regime to meet the uncertainty thresholds specified by the applied tiers.

It is this drive, to reduce costs, whilst maintaining control of the measurement uncertainty that has resulted in the Oil & Gas Authority (UK) to strongly urge operators to consider abandoning the traditional time-based maintenance in favour of risk-based maintenance, condition-based maintenance, or combination of both [1]. It is suggested that the risk-based approach to maintenance, as outlined in section 5.2.5 of the OGA Measurement Guidelines [2], should be the default methodology.

Time-based maintenance activities are scheduled at fixed intervals with the possibility to relax the frequency for any measuring instrument demonstrating a satisfactory level of stability. The basic principle of **condition-**