Fact Sheet 4 of 4 - Project 1075

Optimising Instrumentation for Better Process Performance Module 4: Using Standards and Regulatory Practices to Support Online Sensors in the Water Industry

Background

Australia does not presently have any formal health or environmental regulation governing the measurement performance of online water quality monitoring systems - because output from these devices may be used for operational control without being utilised for compliance purposes. As a result, performance of online instruments is managed and assessed on an individual basis by each utility, according to criteria that may vary across different organisations and applications.

Existing standards and regulatory practices were considered in this module to assess whether they could be adapted to increase the reliability of online water sensors and assist utility staff in managing water quality. Industry partners identified a range of concerns linked with measurement performance and regulation of online monitoring instruments, spanning issues such as instrument selection, prediction of field performance, installation, implementation and lack of harmonisation of guidance and practices.

In our two case studies, data from a major water utility were used to illustrate the way conventional laboratory QA/QC principles can be applied to optimising the performance and use of online sensors; and the concepts underlying an international regulatory framework presently applied to water flow meters were explored for applicability to online water quality measurement.

Suggestions regarding information sharing, instrument performance testing capability, certification and training were proposed for industry consideration.

Regulation and Standards relevant to Online Water Meters

In some countries, advice on online monitoring is partly incorporated in the drinking water guidelines. The overarching Australian regulatory guidelines applicable to drinking water are the Australian Drinking Water Guidelines (ADWG). The ADWG touches only briefly on online monitoring instruments and then only in general terms, highlighting the need for appropriate accuracy and sensitivity, and recommending online continuous monitoring where possible.

International standards for online sensors are available, in particular ISO 15839:2003 “Water quality -- online sensors/analysing equipment for water -- specifications and performance tests” and ISO 17381:2003 “Water quality – selection and application of ready-to-use test kit methods in water quality”. Both standards were reviewed and confirmed by ISO in 2014. At this stage these standards do not address all the issues raised by industry participants during this project, in particular the availability of objective and independent performance data directly applicable to individual plant requirements. Standards Australia is Australia’s primary standards organisation and the member of the national standards and conformance network with responsibility for development and adoption of standards in Australia. At the time of writing, it does not appear to have a standard for online water sensors; however, committee EV-008 acts as an Australian mirror committee to ISO TC 147, the ISO Technical Committee for water quality, and could be approached with any industry requests.

Many online instruments are calibrated using laboratory measurements of reference samples, and in some cases the instruments themselves are essentially laboratory equipment with an automated sampling/sample presentation system. It is generally well understood that this inherent reliance on laboratory measurements can be at least partly addressed by use of conventional laboratory-style QA/QC protocols and structures, potentially with some form of adaptation to accommodate instruments in the field. These protocols tend to be very well-established and there is a considerable store of guidance available from regulators or industry on topics such as calibration, verification and sampling techniques. However, it is important to consider the impact of transferring protocols developed for laboratory use into the field, where ambient conditions are far more variable and less controlled, and storage and handling requirements more complex.

Conventional QA/QC protocols were developed to support laboratory analyses, which are generally performed under well-controlled and reproducible conditions. Many online sensors operate in circumstances where ambient conditions, matrix and sample presentation (in particular with flowing streams) are difficult to control and in some cases may be difficult to monitor. The sheer variability of field conditions makes it impractical for most instrument suppliers to test their products against every possible application. However, by considering the science of the underlying technology

and the principles of the engineering design, it is often possible to identify the factors most likely to influence the measurement result. The way these influence factors can be used in regulation and standards is illustrated by the approach of the International Organisation of Legal Metrology (OIML), which provides internationally adopted performance-based standards for measuring instruments used for trade or legal purposes. OIML standards are designed to address key influence factors such as ambient temperature and pressure, vibration and electromagnetic interference.

Case studies

Two case studies were conducted to illustrate the way in which well-established QA/QC protocols and structures developed for laboratory and field instruments can be applied to the water industry.

Case Study 1 examined the status and impact of QA/QC practices in the water industry, and demonstrated how these can be applied effectively to monitor reproducibility, repeatability and other contributions to the overall measurement uncertainty. The case study also illustrated the use of QC data in situations where systemic changes (e.g. replacement of instruments or standards) had occurred.

Operational monitoring data was provided by an Australian ground water treatment plant for four key parameters: chlorine, fluoride, pH and turbidity. For each of these, the plant provided online sensor (SCADA) data, laboratory analysis results for daily samples collected at the plant, and analyser verification results using a range of standards, some used repeatedly over a period of time and others freshly-prepared. Examination of the data clearly illustrated that the QA/QC calibration standards and protocols were well chosen, so that there was good consistency in test results for standards over time, and the few exceptions were easily identified and explained. This helps operational staff discern whether a change in instrument reading has been triggered by an actual change in water quality or is related to a different cause, such as equipment maintenance.

The QA/QC protocols discussed in Case Study 1 are based on those developed for use with instruments used in a laboratory environment. However, most online instruments are operated in a field environment which is far less controlled in terms of ambient conditions and sample presentation.

Case Study 2 summarised the technical concepts and principles of the internationally adopted legal metrology framework, which has been applied extensively to support measurement instruments used in a field environment, and explained the way these are applied in Australia to water (flow) metering.

This international system has been used in Australia and many other countries around the world since 1955. The four primary components of this system are:

- An internationally and/or nationally agreed performance-based standard
- Testing and certification of instrument design against performance criteria specified in the standard
- Testing at the time of manufacture or installation of a randomised sample of individual instruments manufactured to an approved design
- In-situ testing of individual instruments after installation.

Each of these components contain elements which could be used to better enable industry to predict and manage performance of on-line instruments. For example, identifying and agreeing upon a set of influence factors helps instrument manufacturers and instrument users decide where to focus their efforts in both instrument development and instrument assessment. Similarly, having an agreed approach to in-field testing would make it easier to compare different instruments or check for changes in performance over time.

Summary

A wide variety of concerns about instrument selection, prediction of field performance, installation and implementation, and lack of harmonisation have been raised by project industry partners. In identifying alternatives which could be used to address these concerns, existing standards and guidance, current water industry knowledge of QA/QC protocols and the international legal metrology framework have been considered. Some of the desired information is already well-understood and used effectively by at least part of the Australian water industry. This could be further enhanced by information on instrument performance in the field, such as that generated by the approach of the international legal metrology framework.

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