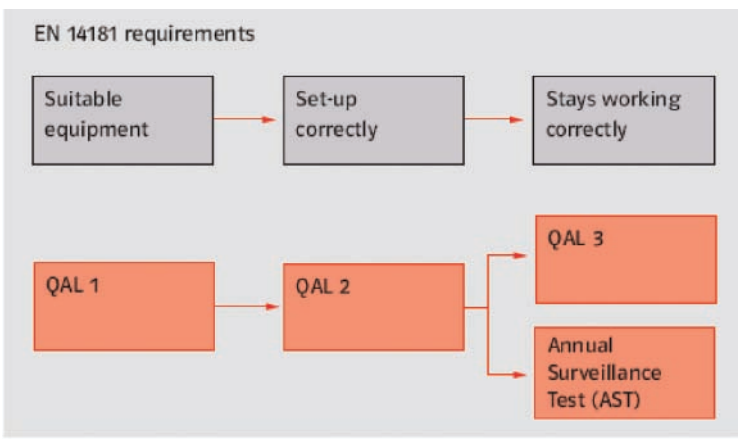
Continuous Emission Monitoring

EN14181 - Quality *and* Quantity in Emissions Monitoring?

If you are an industrial process operator with an environmental permit, then you will be aware of the requirement to ensure that any continuous emissions monitoring systems (CEMs) that are installed at emission points to air are functioning correctly. Five years ago a new European standard (BS EN 14181) was introduced to provide formal quality assurance procedures to be applied to CEMs on all processes falling under the Waste Incineration (WID) and Large Combustion Plant (LCPD) Directives.

The principles of BS EN 14181 are relatively simple in that suitable monitoring equipment is installed; it is set up correctly, calibrated effectively and monitored over time to ensure the derived calibration function maintains its validity and suitable checks are made. The outcome of this is to increase both the accuracy and precision of the installed instrument, thus increasing the confidence in the results it reports and ultimately reducing the potential requirement for additional specialist monitoring to verify the performance of the process.

In short, EN14181 defines three Quality Assurance Levels - QAL1, QAL2 and QAL3 - and an Annual Surveillance Test (AST). The basic structure of the QA process is shown in the flow diagram.



The Operator has the following general responsibilities:

- Installation of compliant equipment (QAL1)
- In-situ calibration of CEMs using an accredited test organisation (QAL2)
- Annual check of the in-situ calibration using an accredited test organisation (AST)
- Performing ongoing Quality Assurance based on regular zero and span checks (QAL3)
- Submission of QAL2, QAL3 and AST reports and ongoing maintenance of records

- Checking of hourly averages against the valid calibration range (weekly)

QAL1 requires an assessment of the suitability of the CEM equipment. New analysers should be certified, for a suitable measurement range, under the Environment Agency's MCERTS scheme. A simplified means of assessing the suitability of the CEMs has been agreed - the certification range must be less than 2.5 times the Emission Limit Value (ELV) as illustrated below for a new gas turbine.

Table: Required certification ranges for new gas turbine plant

Species	ELV $_{24h}$ (mg/m^3)	Required certification range (mg/m^3)
NOx	50	< 125
O_2	10%	< 25%
H_20	6%	< 15%

This approach has worked well for the regulated gases with assigned ELVs, such as NO_x and SO_2, but there has been difficulty with oxygen and water vapour measurement which are used to correct the main gas concentrations to dry reference conditions for reporting purposes. In the power industry, the 'ELV' assigned to these peripheral measurements should reflect the process concentration. For example, a coal fired power station has a base load oxygen content of 6% (dry). Ideally, the instrument certification range should therefore be less than 15% O_2 with a span gas concentration of 12% O_2. For gas turbines, the process oxygen content is higher than this and an 'ELV' of 10% would be appropriate.

Moisture measurement is only required when the other gas concentrations are measured on a 'wet' basis, that is, when the process water is not removed from the sample prior to analysis. Given that the measurement of moisture vapour, and the associated Quality Assurance, is problematic - since it is more difficult to challenge an instrument with a 'wet' gas - a combination of instrument functional checks and calculation of the moisture content is often sufficient for large combustion plant.

QAL2 requires calibration of the monitors against analytical methods - standard reference methods - applied by a test organisation accredited to ISO 17025. The straight line calibration relationship between the CEM and the test data is established by taking at least 15 pairs of measurements obtained across at least 3 days of normal plant operation. Any scatter in the data comparison is assumed to be caused by the plant monitor and this scatter must be below a threshold in order to pass. QAL2 is intended to take account of any bias caused by the particular monitoring equipment or the sampling location and must be conducted every 5 years or following a significant change to the process, the fuel mix or the CEMs.

The assumption that the manual test reading is 'correct' and that the plant monitor is at fault has caused a number of poor calibrations related to poor application of the manual method or very low process concentration levels (less than 30% of the limit value). To an extent, these issues have been addressed by national guidance documents and by working closely with the national regulators. However, there remains a need for the Operator to conduct a 'sanity check' to ensure that a meaningful calibration is obtained.

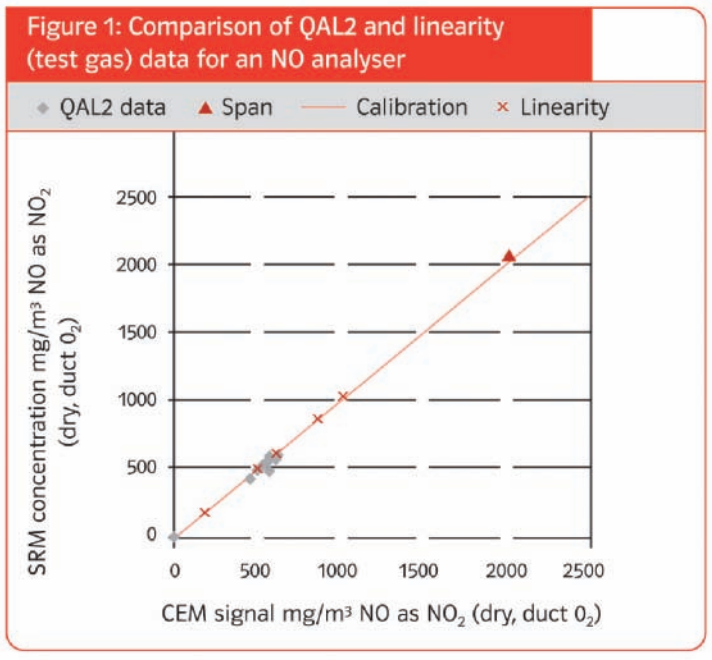
In the power industry, it is considered best practice is to resolve differences between the plant monitor and the manual test method to ensure a level of agreement of better than 10% so that the QAL2 can be regarded as a verification check of the instrument.

Weekly data check

The chief remaining problem is the weekly data check that the Operator must perform in order to confirm that the reported emissions data are within the 'Valid Calibration Range' of the continuous monitoring system. This valid concentration range is defined as being 10% greater than the highest concentration measured during the three day QAL2 test campaign. This is far too restrictive for many power plant since the variability in average emissions across a year of operation is generally much higher than 10% resulting in multiple breaches of this requirement. Strictly, a breach requires that the costly test campaign is repeated, in many cases without significant improvement in the overall calibration.

Conversely, it is clear that challenging the continuous monitors with reference gases and optical filters can give an equivalent level of confidence in the calibration, over a much wider measurement range, as shown in Figure 1 which compares data obtained with test gases with in-situ test results from a QAL2. Provided that acceptable safeguards are in place, it is recommended within the power industry that this method should be used for valid range extension for power plant, rather than the more restrictive approach based on short term test results.

Figure 1: Comparison of QAL2 and linearity (test gas) data for an NO analyser

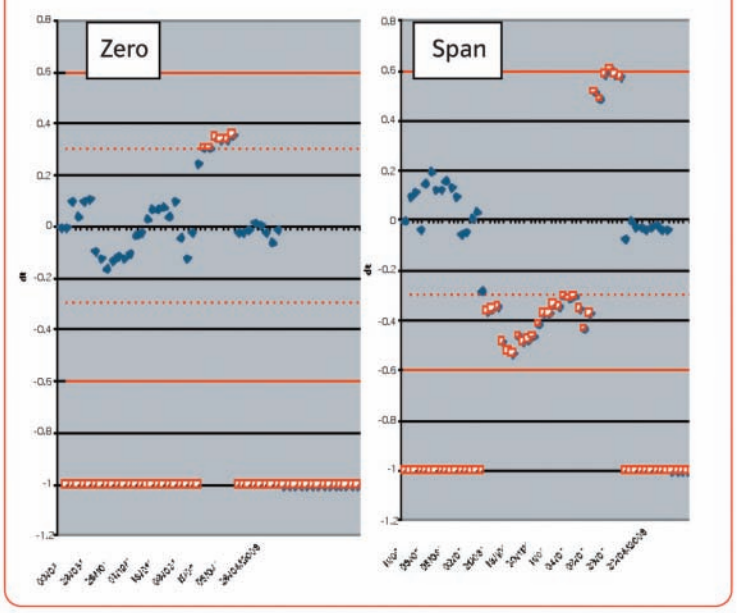


QAL3 is intended to provide an audited check of ongoing performance by conducting regular zero and span checks of the monitors and comparing the measured drift against pre-defined warning and action limits, as shown in Figure 2. The red symbols indicate that the instrument drift is becoming unacceptably high and attention the instrument requires attention. Operators of large combustion plant generally prefer this Shewhart chart approach in which the control limits are based on Emission Limit Values since the approach recommended in the standard for setting control limits is considered to be too complicated for routine use.

The need for control charts is less obvious when the CEM certification includes automatic checks and adjustments of the zero and/or span point and automatically generates an alarm when the drift is higher than a pre-set value.

Many different control chart approaches can be used.

Figure 2: Example of a Shewhart control chart



The way forward

To increase the confidence in this work the United Kingdom Accreditation Service (UKAS) is working in partnership with the Environment Agency under the MCERTS scheme to define accreditation criteria to ISO/IEC 17025 for stack emissions monitoring organisations that perform and offer a service to verify and calibrate CEMS in accordance with BS EN 14181. Since this is a new area the accreditation scheme is currently being run as a pilot project, focusing on the key requirements to ensure that consistency in the application of the assessment criteria and ultimately confidence can be assured in the future.

The stack emission monitoring organisation will be expected to verify that the continuous emission monitoring equipment installed at the release point meets the performance requirements (both operational and legislative) for the process (Quality Assurance Level (QAL) 1). Additionally as part of the pre-visit assessment (contract review) any adjustments required to the plant/process will need to be agreed in advance, such that these can be performed within operational parameters as part of the paired measurement exercise (in accordance to both QAL2 and AST). Much of this information, including sampling protocols, and analysis methods, is captured by the Site Specific Protocol that the stack emissions organisation must prepare before testing begins, in accordance with a relatively new European standard BS EN 15259:2007. The contract review process will also include an assessment of the on-going performance checks of current installed equipment, where applicable verifying that any zero and span drifts including maintenance outages are suitably controlled (in accordance to QAL3).

QAL3 – This is causing much confusion within the industry as to how it to works, when to apply QAL3 and what adjustment can be made.

The aim of the procedure is to maintain and demonstrate the quality of the AMS, so that requirement for the stated zero and span repeatability and drift values are met during ongoing operation and the AMS is maintained in the same operational condition as when installed. This shall be achieved by confirming that the drift and precision determined during the QAL1 remain under control.

The Source Testing Association (STA) will be holding series of Technical Transfer Seminars on the QAL3 procedures from May 2010, see www.s-t-a.org/events for more details.

The STA was established in 1995 and has a corporate membership of over 200 companies from process operators, regulators, equipment suppliers and test laboratories. The STA is a non-profit making organisation.

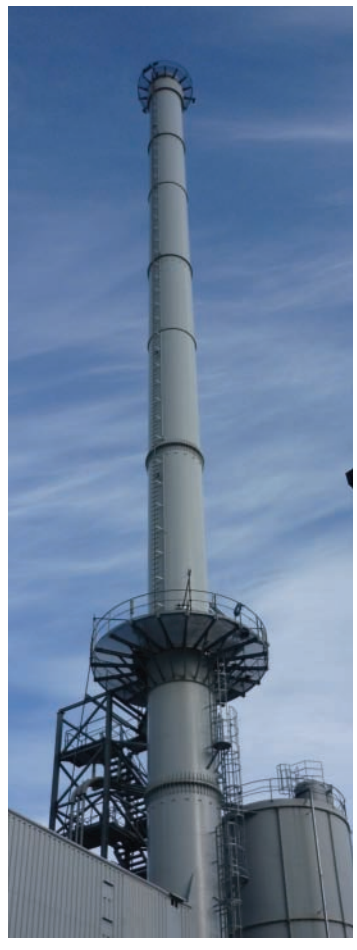
The STA is committed to the advancement of the science and practice of emission monitoring and to develop and maintain a high quality of service to customers.

The Associations headquarters are based in Hitchin, Hertfordshire with meeting rooms, library and administration offices.

The Association offers a package of benefits to its members which include:

- Technical advice relating to emission monitoring
- Conference and exhibition opportunities
- Seminars and training on a variety of related activities
- Representation on National, European and International standards organisations
- Training in relation to many aspects of emission monitoring
- Liaison with regulators, UK and International, many of whom are members.

For more information visit www.s-t-a.org



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