

EN14181 Stationary Source Emissions - Quality Assurance of Automated Measuring Systems

EN14181 has now been in operation for 10 years and has had far-reaching consequences for Regulators, Equipment Manufactures, Test Houses and, most importantly, Process Operators. The Standard describes the quality assurance procedures needed to assure that Automated Measurement Systems (AMS) installed to measure emissions to air are capable of meeting the uncertainty requirements on measured values given by legislation; e.g. EU Directives and BREF documents. The standard is currently under review and a revised version should be published this year.

“By planning the project carefully, with all parties involved from the outset, good consistent results from the AMS can be achieved.”

Three different Quality Assurance Levels (QAL 1, QAL 2, and QAL 3) are described. These cover the suitability of an AMS for its measuring task (e.g. before or during the purchase period of the AMS) QAL 1 (EN 15267), the validation of the AMS following its installation QAL 2, and the control of the AMS during its ongoing operation on an industrial plant QAL 3. An Annual Surveillance Test (AST) is also defined.

The suitability evaluation of the AMS and its measuring procedure are described in EN15267 (QAL 1) where a methodology is given for calculating the total uncertainty of AMS measured values. This total uncertainty is calculated from the evaluation of all the uncertainty contributions arising from its individual performance characteristics.

EN14181 specifies procedures for establishing quality assurance levels QAL 2, QAL 3 and AST for an AMS installed on industrial plants for the determination of the flue gas components and other flue gas parameters. It supports requirements in the EU Industrial Emission Directive 2010/75/EU and the related BREF documents.

This standard specifies:

- A procedure (QAL 2) to calibrate the AMS, following its installation, and to determine the 'variability' of the measured values obtained by the AMS. Various functional checks must be performed before the QAL2 is undertaken.
- A procedure (QAL 3) to maintain and demonstrate the required quality of the measurement results during the normal operation of an AMS, by checking that the zero and span characteristics are consistent with those determined during QAL 1 (drift checking).
- A procedure for the annual surveillance tests (AST) of the AMS in order to evaluate (i) that it functions correctly and its performance remains valid and (ii) that its calibration function and variability remain as previously determined. Functional checks are, again, required before the QAL2 is undertaken.

This standard is designed to be used after the AMS has been accepted according to the procedures specified in EN15267.

This standard is restricted to quality assurance (QA) of the AMS, and does not include QA of the data collection and recording system of the plant.

Tests in detail

The QAL 2 and AST procedures involve the testing laboratories who have to have ISO 17025 accreditation (UKAS in the UK), whereas the QAL 3 procedures involve the plant operators.

QAL 2 is a procedure for the determination of the calibration function and its 'variability', and a test of the 'variability' of the measured values of the AMS compared with the uncertainty

Roles and responsibilities of carrying out EN141818 tests

Organisation	Roles and requirements
CEMs manufacturers and suppliers	<ul style="list-style-type: none"> • Achieving and maintaining certification of CEMs to the applicable MCERTS performance standards • Supplying, correctly installing, commissioning and maintaining appropriate, MCERTS certified CEMs to applicable installations • Installing CEMs in a manner which assures their integrity and correct operation to the required performance standards • When appropriate, co-operating with process operators and test laboratories to perform the functional tests and calibrate CEMs
Test laboratories	<ul style="list-style-type: none"> • Achieving and maintaining accreditation to ISO 17025 and the MCERTS performance standards, for the applicable SRMs • Performing the SRMs for the QAL2 and AST procedures • Reporting the results of the functional tests specified for the QAL2 and AST procedures • From the beginning of 2011, test laboratories must also be accredited to EN 14181. • Notifying the operator that the operator is responsible for ensuring that the functional tests are performed before each QAL2 and AST, regardless of who subsequently performs the functional tests
Process operators	<ul style="list-style-type: none"> • Using CEMs certified to the appropriate MCERTS performance standards • Performing the QAL3 procedures • Ensuring that the functional tests are performed before each QAL2 and AST. • Submission of QAL2, QAL3 and AST reports as required by the regulator • Applying a procedure for QAL3; maintaining QAL3 records, other records and information as specified within EN 14181, and retaining QAL2 and AST reports for periods specified by the regulator
Regulators	<ul style="list-style-type: none"> • Specifying EN 14181 requirements within permits or variations to permits • Assessing operator compliance • Assessing test laboratories for compliance with the MID for EN 14181 • Providing guidance on EN 14181

given by legislation. The 'variability' is a measure of the scatter of data around the calibration line. The QAL 2 tests are performed on suitable AMS that have been correctly installed and commissioned. A calibration function is established from the results of a number of parallel measurements performed with a Standard Reference Method (SRM) these methods are

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stated in the various CEN and ISO standards. The variability of the measured values obtained with the AMS is then evaluated against the required uncertainty.

The QAL 2 procedures are repeated either: periodically; after a major change of plant operation; after a failure of the AMS or as required by legislation.

The AST is a procedure designed to evaluate whether the measured values obtained from the AMS still meet the required uncertainty criteria – as demonstrated in the previous QAL 2 test. It also determines whether the calibration function obtained during the previous QAL 2 test is still valid. The validity of the measured values obtained with the AMS is checked by means of a series of functional tests as well as by the performance of a limited number of parallel measurements using an appropriate SRM. Refer Figure 1.

Figure 1 Quality Assurance Flowchart

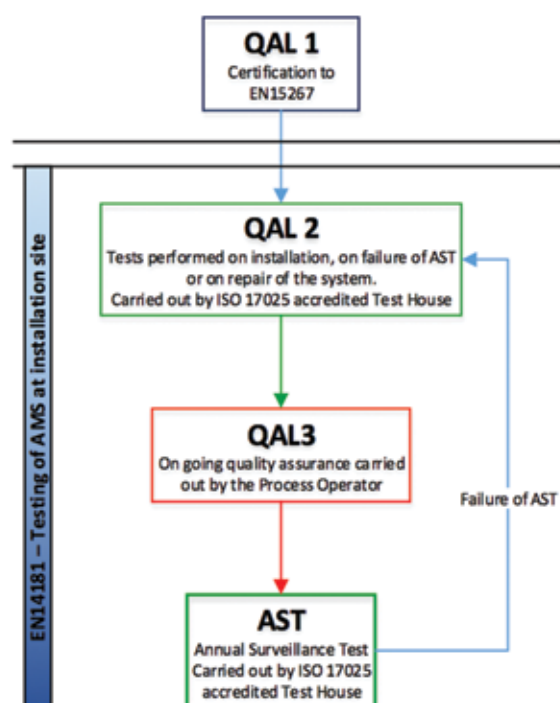


Figure 1: Quality Assurance Flowchart

Tests required by QAL 2 & AST

Testing shall cover the following items:

- Installation of the AMS;
- Calibration of the AMS by means of parallel measurements with a SRM;
- Determination of the variability of the AMS, and the check of compliance with the required uncertainty.

The sequence of the combined tests is shown in figure 2.

Figure 2 Sequence of testing for QAL2 & AST

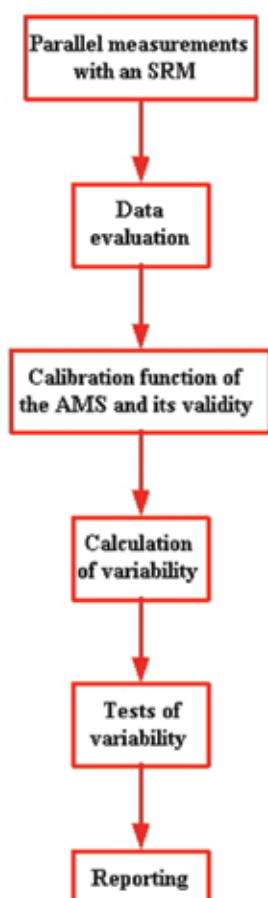


Figure 2: Sequence of testing for QAL2 & AST

Frequency of tests

A full QAL 2 procedure shall be performed at least every 5 years for every AMS and more frequently if so required by legislation (Incineration of Waste specifies parallel measurements every 3 years). In addition, after each major change in plant operation (e.g. change in flue gas abatement system or change of fuel) or major changes in the set-up of the AMS, a full QAL 2 for the components influenced by the change shall be performed and reported within 6 months after the changes. During the period before a new calibration function has been established the previous calibration function (where necessary with extrapolation) shall be used.

A Standard Reference Method (SRM) is used to sample the emissions at a point in the duct that is as close as possible to the AMS, without interfering with its operation, having demonstrated that the sampling location is representative by means of duct surveys performed according to EN 15259. The duration of the SRM sampling shall be identical to the duration of measurement made by the AMS.

The AST is carried out on the anniversary of the first QAL2 tests and subsequently every year up until a new QAL2 is required.

Functional tests of the AMS required by QAL2 and AST

One of the major challenges in carrying out successful QAL2 and AST is the organising of the functional tests, usually carried out by the AMS supplier.

Table 3 shows the function tests that must be carried out for QAL2 and AST.

Activity	Extractive AMS	In-situ AMS
Service of the analyser/system	X	X
Alignment and cleanliness		X
Sampling system	X	
Documentation and records	X	X
Serviceability	X	X
Leak test	X	
Zero and span check	X	X
Linearity	X	X
Interferences	X	X
Zero & span drift (QAL3 audit)	X	X
Response time	X	X
Report	X	X

Table 3: Function tests for QAL2 and AST tests

The details of the tests are as follows.

Alignment and cleanliness

A visual inspection, with reference to the AMS manuals, shall be carried out on the following when applicable:

- internal control of analyser
- cleanliness of the optical components



- flushing-air supply
- obstructions in the optical path

After re-assembly at the measurement location at least the following shall be checked:

- alignment of the measuring instrument
- contamination control (internal control of optical surfaces)
- flushing air supply

Sampling system

A visual inspection of the sampling system shall be performed, noting the condition of the following components, when fitted:

- sampling probe
- gas conditioning systems
- pumps
- all connections
- sample lines
- power supplies
- filters

The sampling system shall be in good condition and free of any visible faults, which would decrease the quality of data.

Documentation and records

The following documentation shall be controlled, readily accessible and up to date:

- General arrangement and schematic of the AMS
- All manuals (maintenance, users, etc.)
- Log books
- Possible malfunctions and action taken
- Service reports
- QAL 3 documentation
- Actions taken as a result of out of control situations
- Management system procedures for maintenance, calibration and training
- Training records
- Maintenance schedules
- Auditing plans and records

Serviceability

There shall be provisions for the effective management and maintenance of the AMS, in order to ensure the maintenance of the quality of data. Such provisions include at least the following:

- Safe and clean working environment with sufficient space and weather protections
- Easy and safe access to the AMS itself
- Adequate supplies of calibration materials, tools and spare parts

Leak test

Leak testing shall be performed according to the AMS manuals. The test shall cover the entire sampling system.

Zero and span check

Reference zero and span materials shall be used to verify the corresponding readings of the AMS.

In case of non-extractive AMS zero and span checks shall be performed on a waste gas free reference path before and after the readjustment and after re-assembly of the AMS at the measurement location.



Linearity

The linearity of the analyser's response shall be checked using five different reference materials, including a zero concentration.

The reference material with zero concentration, as well as the reference materials with four different concentrations, shall be traceable.

In case of gaseous reference materials, these four reference materials can be obtained from different gas cylinders or can be prepared by means of a calibrated dilution system from one single gas concentration.

The reference material concentrations shall be selected such that the measured values are at approximately 20%, 40%, 60% and 80% of the range of two times the emission limit. It is necessary to know the values of the ratios of their concentrations precisely enough so that an incorrect failure of the linearity test does not occur. The dry test reference material shall be applied to the inlet of the AMS.

The individual analysers are tested using the following concentrations applied in a randomised sequence:

- reference material with zero concentration
- reference material concentration approximately 20% of 2 times the emission limit
- reference material concentration approximately 40% of 2 times the emission limit
- reference material concentration approximately 60% of 2

times the emission limit

- reference material concentration approximately 80% of 2 times the emission limit
- reference material with zero concentration

After each change in concentration, the first instrument reading shall be taken after at least three times the response time of the AMS. At each reference material concentration, at least three readings shall be made. The time period between the start of each of the three readings shall be separated by at least four times the response time.

The linearity shall be calculated and tested using the procedure given in annex B of the standard. If the AMS does not pass this test, then the problem shall be identified and solved.

Interferences

A test shall be undertaken if the process gases to be monitored contain components that are known interferences, as identified during QAL 1. This may not be required if the process concentration of the interferents are within those tested during certification.

Zero & span drift (audit)

The zero point and span drift shall be obtained from and evaluated on the basis of the records of QAL 3.

Response time

The response time of the AMS shall be checked. This can be performed, if appropriate, by feeding of the reference material at the end of the sampling probe. The response time shall not exceed the measured value that has been identified during QAL 1.

Report

The results of the functional test shall be reported. Any faults shall be recorded. If the faults are judged to have an effect on the quality of data, then the operator shall carry out the necessary corrective and preventive action.

Conclusion

EN 14181 is a complex standard with far reaching consequence it relies on a high degree of co-operation by all parties involved i.e. Process Operator, Test House, AMS supplier's service department and the regulator. We have seen that when corners are cut additional costs are incurred. By planning the project carefully, with all parties involved from the outset, good consistent results from the AMS can be achieved.

References

Industrial Emission Directive 2010/75/EU

BREF Documents available from <http://eippcb.jrc.ec.europa.eu/reference/>

EN 14181 - Stationary source emissions - Quality assurance of automated measuring systems

EN15267 parts 1 to 3 Air Quality – Certification of automated measuring systems

PD CEN TR 15983 2010 Stationary source emissions - Guidance on the application of EN14181

Environment Agency Technical Guidance Note M1

Environment Agency Technical Guidance Note M2

Environment Agency Technical Guidance Note M20

All Environment Agency Documents are available from www.mcerts.net

The Source Testing Association



The Source Testing Association (STA) was established in 1995 the membership comprises representation 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.

Its aims and objectives are to:

- contribute to the development of industry standards, codes, safety procedures and operating principles;
- encourage the personal and professional development of practicing source testers and students;
- maintain a body of current sampling knowledge;
- assist in maintenance of a high level of ethical conduct;
- seek co-operative endeavours with other professional organisations, institutions and regulatory bodies, nationally and internationally, that are engaged in source emissions testing.

The Association's 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.

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