Power Technology

Experience of applying EN14181 in the power industry within conventional combustion and incineration plant

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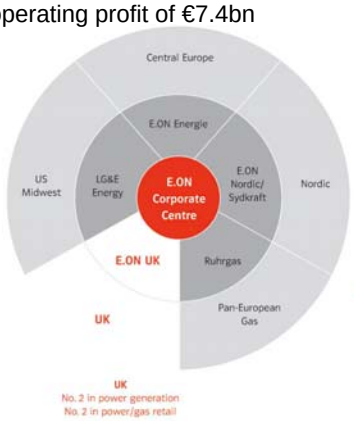
Group Structure

E.ON overview

- Europe's largest investor-owned energy service provider with roughly €49bn in sales and operating profit of €7.4bn



Emissions Monitoring Team

UKAS Accredited to ISO17025

- Particulate – total and sizing
- Gases – instrumental and wet methods
- Multi-phase – micro pollutants

MCERTS Accredited for site testing

- Up to 4 experienced test teams
- MCERTS qualifications - all competency standards

EN14181

- Broad experience, development of industry guidance
- QAL2 – in-situ, extractive, particulate, gaseous systems
- QAL3 – advice and remote QA

Other Tests

- Performance tests, combustion/fuel trials

EN14181 – QAL2 Calibration Service

We can add value by getting the correct data, with minimum inconvenience and maximum applicability to your process

- Liaison with customer/site at all times
- Optimised plant service with superior equipment and skills portfolio
- Wide knowledge of AMS design and operating techniques
- Independent of manufacturers – our advice is objective and unbiased
- Provisional test results available during site calibration regime
- Results and reports tailored to individual customer requirements

Practical Experience of EN14181 QAL2 Testing - Examples

The Good

- Passed! – Examples of AMS QAL2 data from different system types and data ranges
- Method A and Method B
- Extractive and in-situ AMS

The Bad

- Problems – during site testing e.g. sorting AMS outputs TIME = MONEY
- Problems – AMS data e.g. corrected at analyser, no output of correction values

The Ugly

- Failed! – How did that happen?

Guidance on carrying out QAL2

Step 1

The CEM data is converted to the required concentration units (mg/m3) for the x-values

Step 2

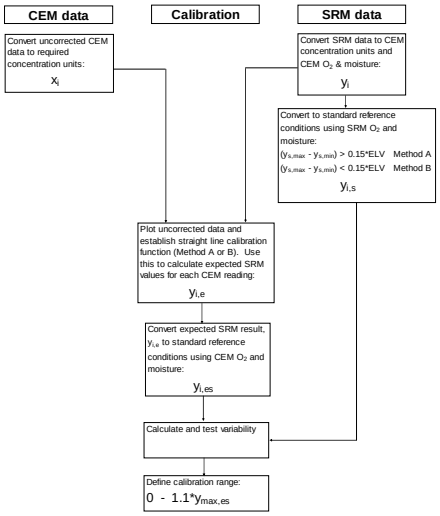
The raw SRM data is converted to the same concentration units (mg/m3) for the y-values.

Step 3

The SRM data is converted to standard reference conditions using the SRM supplementary data.

Step 4

Plot the calibration data and perform a linear fit, using the values defined in Steps 1 and 2.

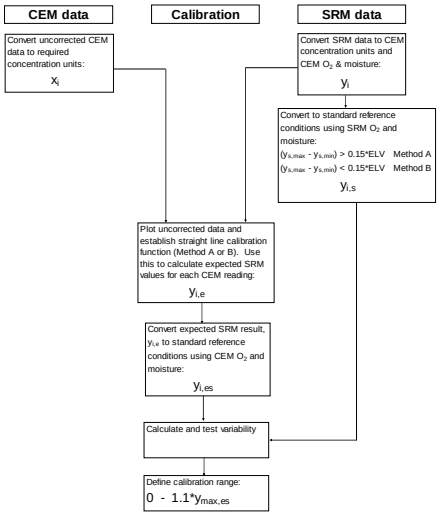


Guidance on carrying out QAL2

Step 5
Calculate the SRM expected values at standard reference conditions, using linear function.

Step 6
Calculate and test the variability of the calibration. The variability is a measure of the scatter of the data points about the straight line fit.

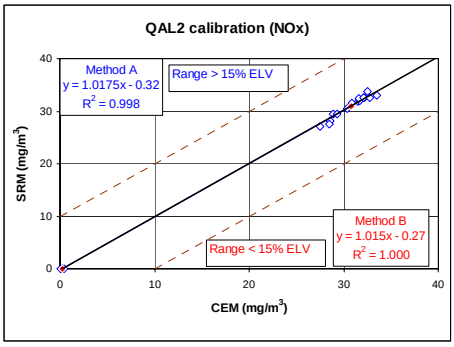
Step 7
Define the valid calibration range. This is nominally taken to be 110% of the maximum expected SRM concentration (calibrated CEM reading) obtained from the QAL2 AMS data



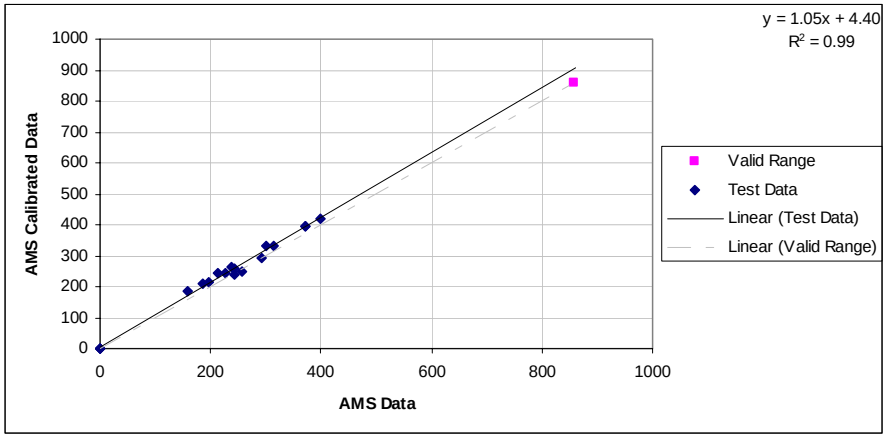
Example Method A and Method B

Defined by range of data set

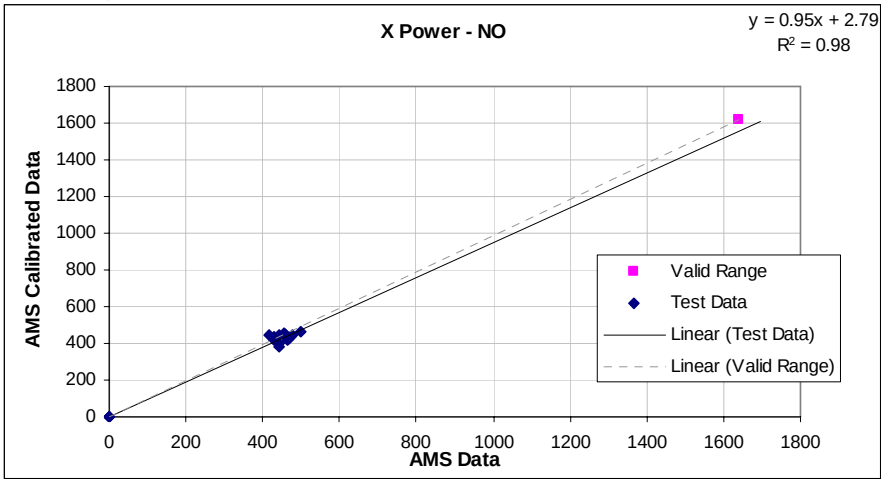
- Not allowed to degrade process
- Range of SRM values>15% ELV = A
- Range of SRM values<15% ELV = B
- Maximum of SRM values<30% ELV = use zero & span data for calibration
- Zero data can be included in data sets
- QAL2 not required for O2 and H2O
- Extend valid range by 10% from max SRM value - Extend further with reference span (if within conf



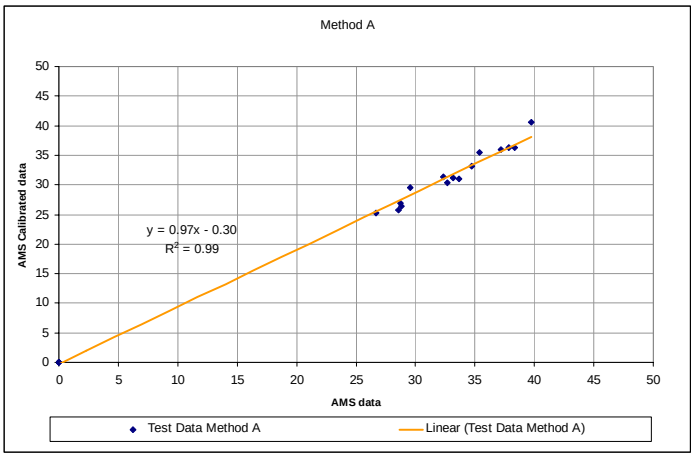
Example – Coal SO2



Example – Coal NOx



Example extractive (CCGT – NOx)



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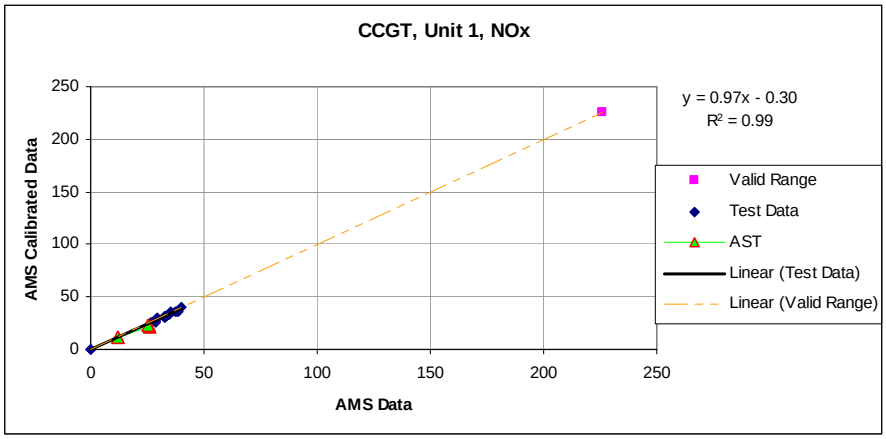
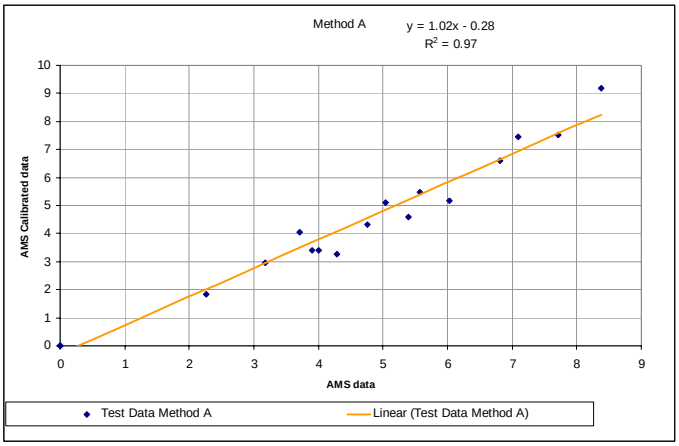
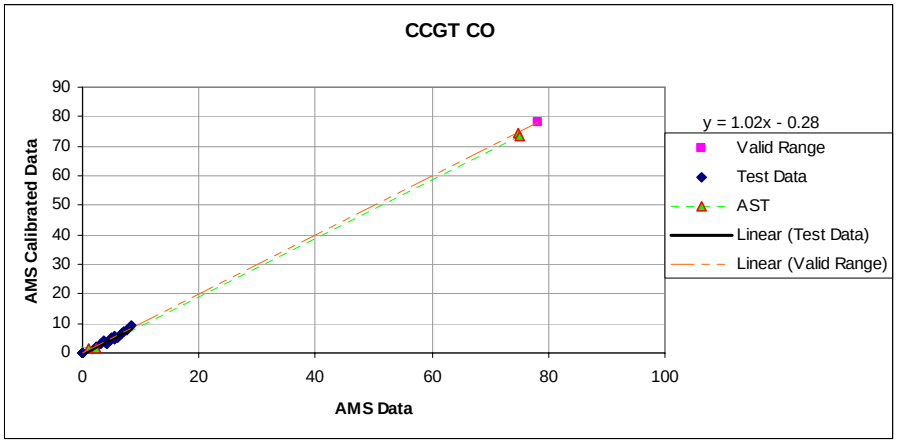


Example extractive (CCGT – CO)



Example extractive (CCGT – CO)



Example – Low cluster

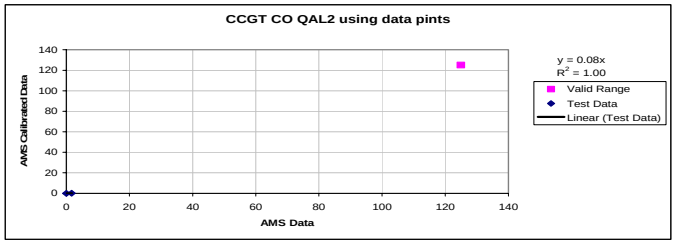
Table 1: Calibration Function (mg/Nm^3, dry gas)

Species	*a*	*b*	Uncertainty	Allowable	Validity Range
CO	0.00	0.08	0.0	3.0	125.0 mg/Nm^3 dry gas @ % O_2

Table 2:

The diference of the reference material value from the calibration line is:	1087.31%

Calibration Method used: Method B



The data points on the chart above are shown in blue, the valid calibration range is shown (in mg/m3 wet gas @ duct O2) in red

Example – Low cluster, calibrated with reference materials

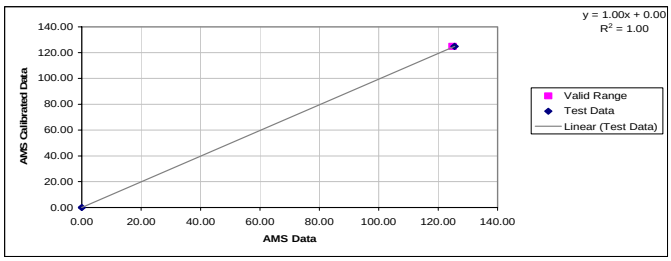
Table 1: Calibration Function (mg/Nm^3, dry gas)

Species	*a*	*b*	Uncertainty	Allowable	Validity Range
CO	0.00	1.00	1.7	3.0	124.9 mg/Nm^3 dry gas @ % O_2

Table 2:

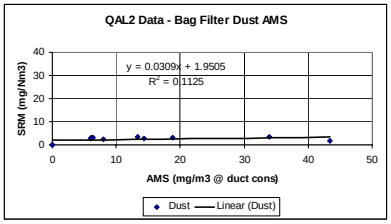
The diference of the reference material value from the calibration line is:	0.49%

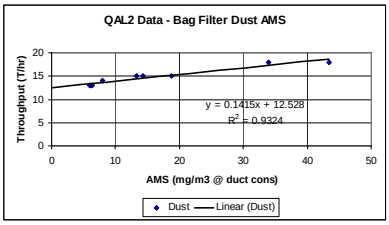
Calibration Method used: Method B



Example failed

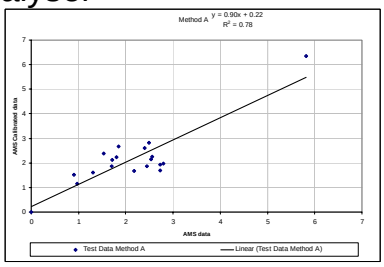
- MCERTS certified AMS Dust analyser
- Fit for purpose (bag filter) on paper
- Installed new 2002
- Set-up & calibrated on site by manufacturer
- Passed functionality tests
- QAL2 planned to cover range of loads and fuel types
- SRM tests showed no variation in emission
- Provisional results available on test day
- Postponed QAL2 to investigate
- Bag filters were sound
- Test results bought into question
- AMS was responding to load / flow

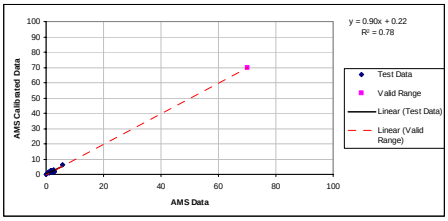




Passed QAL2 with new analyser

- MCERTS certified AMS Dust analyser
- Fit for purpose (bag filter)
- Installed 2004
- Set-up on site by manufacturer
- Passed functionality tests
- QAL2 planned to cover range of loads and fuel types
- SRM tests showed no variation in emission – scatter at low level
- AMS was spanned with reference material to produce calibration





In Conclusion

An efficient and successful QAL2 calibration exercise requires:

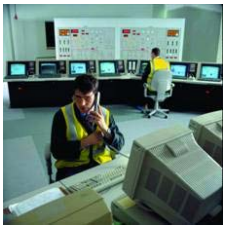
- Thorough planning
- Site preparation in advance of testing
- Communication with test house at all stages of the calibration regime
- Clear and concise reporting

EN14181 does not have to mean:

- New AMS equipment
- Extra testing for no return

EN14181 can mean:

- Confidence in existing AMS equipment
- Valuable test data at varying plant conditions
- More reliable emissions and compliance data



LCPD Definitions

Flue

A discrete pipe through which the exhaust gases from a boiler are vented to the atmosphere. There may be more than one flue within a stack.

Stack

A chimney or a windshield. A windshield can wrap around flues, providing support to the flues and protection from the weather.

Large Combustion Plant (LCP)

A boiler, or group of boilers, discharging waste gases through a common stack where the total thermal input is 50 MWth or more, based on gross calorific value.

QAL1 – Fitness for purpose

- Instruments with a certified range below 2.5*ELV and field tested on a suitable process

Coal fired plant	NOx mg/m^3	SO_2 mg/m^3	Dust mg/m^3
Emission Limit Value (48h)	550	440	55
QAL1 certification range	<1375	<1100	<140 [<0.4 OD units]

Gas fired plant	Natural Gas	Liquid fuel	Both
	NOx mg/m^3	NOx mg/m^3	CO mg/m^3
Emission Limit Value (24h)	50	120	100
QAL1 certification range	<125	<300	<250

- Existing uncertified CEMs are deemed fit for purpose if they pass QAL2

Operators Check list I

QAL1

- Ensure that instruments have MCERTS certification – including O_2 and H_2O (if applicable)
- Install temp. and absolute pressure for dust correction
- Ensure that the range quoted on the certificate is less than 2.5*ELV. Take care with NO_2
- Demonstrate that the CEM gives representative readings

Operators Check list II

QAL2

- Review instrument ranges and span gas values and adjust if necessary (Range 2.5*ELV, Span 2*ELV)
- Review the DACS and the correction of CEM results. Ensure that the raw uncorrected data is available. Record O_2, H_2O (if app.), T & P. {The QAL2 calibration must be applied to uncorrected data.}
- Default water values are available for dust correction.
- Employ a UKAS / MCERTS accredited test organisation

Operators Check list III

QAL2

- Agree reference gases/filters
- Agree data collection method - analogue outputs should be provided for the test organisation – also DACS info ensuring that this matches the local readout
- Ensure that functional checks performed by test house (or manufacturer or yourself). The test house must approve and audit the approach.

Operators Check list IV

QAL2

- Plan the test campaign, with the test house - request that the linearity data/test gases are used to extend the declared valid calibration range. This is very important.
- Review the test data/QAL2 analysis with the test house. Submit a one page summary report to the EA. It is preferable to include the calibration plot with the summary page.
- Apply the QAL2 calibration factor in the DACS, also record the raw data. Then correct to standard reference conditions (X% O_2, dry at 0°C, 1013.25 mbar absolute).

Check list V

QAL3

- Commence weekly emissions data checks
- Commence weekly checks of zero and span drift. Don't adjust if within 2.5% of the span value. Keep a log of the measured drift and whether or not the instrument was adjusted (log sheets are available on request).
- Plot the new point on the control chart and decide whether or not any adjustment or maintenance of the analyser is required. Maintenance/service records are required for the annual audit.

QAL2 In-situ calibration – key points

- **When required:** Every 5 (3 years for WID) years & after any significant change. Justify no change– may need an AST. CEM can be changed without QAL2.
- **Parallel** measurements: ≥15 valid pairs across ≥ 3 days within 4 weeks. 30-60 min. sampling (minimum). Dust can be 5 tests if < 16.5 mg/m^3 on coal plant– can then extrapolate up to this point.
  If <30% of ELV – base calibration on ref. materials, e.g., GT CO, FGD dust.
  Use linearity test or span values to extend calibration range.
  Dust span value from manufacturer's recommendation or historic values.
- **Based on** uncorrected data (duct conditions) – need water content, temperature and pressure for dust correction. Need to pass statistical tests.
- **Standard** Reference Methods defined by CEN standards (assumed

Practical Experience of EN14181 QAL2 Testing - Advice

Advance planning

- Test schedule – vary plant conditions
- AMS preparation – maintenance
- AMS preparation – AST, zero/span
- AMS preparation – analysis conditions
- AMS Outputs – decide how to record

Supplementary parameters

– H2O, O2, temp, pressure

- Data correction? – where/when

Functional checks

- AMS equipment maintenance/service records
- Access to AMS sample location

Reporting

- ELVs and appropriate legislation for ranges
- Extending validity ranges with reference material

Activity	QAL2 & AST	
	Extractive	In-situ
Alignment & cleanliness		X
Sampling system	X	
Leak test	X	
Zero & span check	X	X
Linearity	X	X
Response time	X	X
Cross-intereference*	X	X

*May be required for SCR systems

Practical Experience of EN14181 QAL2 Testing - Advice

AMS Data - Must ensure that AMS Data is recorded and interpreted correctly

- Log AMS outputs directly
- Check AMS output, AMS display and DCS reading
- Operators must understand corrections taking place to AMS data, we have encountered correction errors at sites

Useful Info

- When carrying out a QAL2 where the SRM is a direct reading instrument the data can be manipulate on site, the site team can establish if the variability test will be passed
- When carrying out a QAL2 where the SRM is not direct reading instrument (eg Particulate / HCl) the results will not be available on site therefore the test team will not be able to plot the results on site. Strongly advise to carry out >15 tests.
- If the emissions are <30% of the ELV and the scatter of points means that it is not possible to derive a valid calibration function the AMS may be calibrated using a reference material (M20)
- If the particulate emissions are <30% of the ELV the number of tests may be reduced to 5, but must still be over 3 days and the test durations must total >7.5 hours (MID 13284-2)