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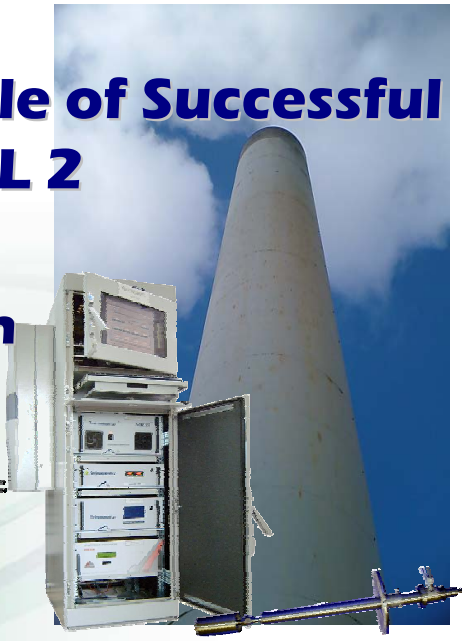
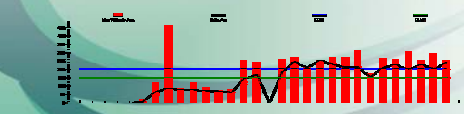
Practical Example of Successful QAL 2

Mark Davidson
TTS Presentation





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EN 14181 – The QAL's

Quality Assurance of Automated Measuring Systems

"***(QAL1)*** *to demonstrate that the AMS is suitable for the intended purpose before installation, by meeting required performance standards and the uncertainty budgets specified in the EU directives;"*

"***(QAL2)*** *to calibrate the AMS and determine the variability of the measured values obtained by it; so as to demonstrate the suitability of the AMS for its application, following installation;"*

"***(QAL 3)*** *to maintain and demonstrate the required quality of the measurement results during the normal operation of the AMS, by checking that the zero and span characteristics are consistent with those determined during QAL 1;*"

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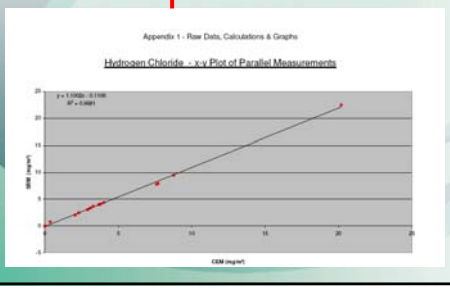
EN 14181 – QAL 2



- Instrument Compared to Standard Reference Method (SRM) in a Parallel Test.
- Results From Two Instruments Compared and Linear Calibration Function Generated
- All Data from the AMS is now Calibrated in Software Against This Function.
- Range of Data used to Generate Function Provides Valid Instrument Range. Emissions Should Remain Within This Range or New QAL 2 Performed.

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Traditionally

- End users would usually have existing relationships with stack testing houses
- The same companies who carry out periodic testing would be approached for the QAL 2 test
- Site specific experience, existing account info, trusted engineers & fully inducted etc
- As long as the company has the correct certification of personnel, equipment and procedure then, this option is not always a bad one.

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The Danger Of Separation

It may seen sensible for an operator to Order a AMS systems from a AMS supplier, and order a Stack test from a Stack tester.

This can and has caused problems in the past eg

- **Results From Stack test compared to wrong data**
- **Results from stack tests not corrected in the same way as CEMS , (moisture O2 etc)**
- **Analyser (s) offline/in fault for part of tests**
- **Analyser Calibration / zero ref not adjusted**
- **Test carried out when analyser is due for calibration / service**
- **Usually results in tests having to be repeated at a cost and contractual disputes**

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AMS Provider Involved In QAL 2

Due to our previous experience with stack testing we recommend to our customers that we are **involved** in all QAL 2 testing.

The majority of systems we are installing today include the QAL 2 test as our scope of supply. For today's example CBISS hired an qualified Test House (Scientifics) to do this work with our assistance.

On reviewing the Standard we found that it was essential that the Stack tester and CBISS understood the standard, and the AMS equipment.

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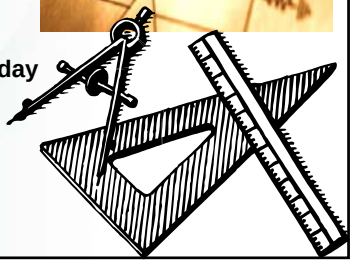
Working Relationship

- **Initial meeting to discuss Standard and equipment tests**
- **Produce test document specific to equipment and site**
- **Stack tester is trained to be able to view analyser error messages make simple analyser checks and be able to take data from AMS reporting software**
- **CBISS perform service & calibration visit on site prior to Stack tests**
- **CBISS engineer & Stack tester visit site for first day of testing**
- **Report completed and passed to customer.**

Usually results in tests <u>not</u> repeated.



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QAL 2 Report

- Once the tests have taken place and the successful report has been issued, the data is utilised by the software package
- The AMS must be calibrated to the SRM results
- Various software packages are available with an additional upgrade specifically for the EN14181 standard

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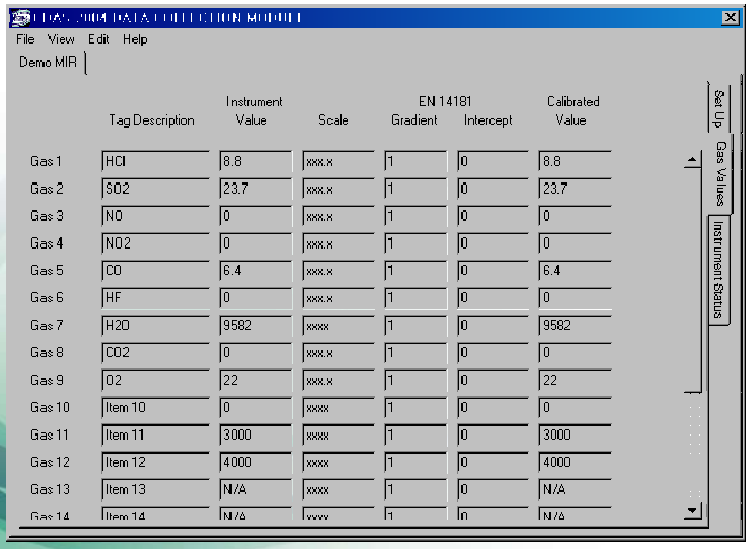
Example QAL 2 software



	Tag Description	Instrument Value	Scale	EN 14181 Gradient	EN 14181 Intercept	Calibrated Value
Gas 1	HCl	8.8	xxx.x	1	0	8.8
Gas 2	SO2	23.7	xxx.x	1	0	23.7
Gas 3	NO	0	xxx.x	1	0	0
Gas 4	NO2	0	xxx.x	1	0	0
Gas 5	CO	6.4	xxx.x	1	0	6.4
Gas 6	HF	0	xxx.x	1	0	0
Gas 7	H2O	9582	xxxx	1	0	9582
Gas 8	CO2	0	xxx.x	1	0	0
Gas 9	O2	22	xxx.x	1	0	22
Gas 10	Item 10	0	xxxx	1	0	0
Gas 11	Item 11	3000	xxxx	1	0	3000
Gas 12	Item 12	4000	xxxx	1	0	4000
Gas 13	Item 13	N/A	xxxx	1	0	N/A
Gas 14	Item 14	N/A	xxxx	1	0	N/A

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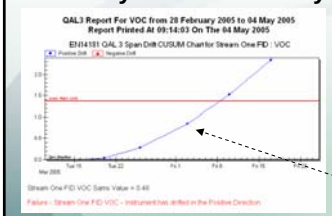
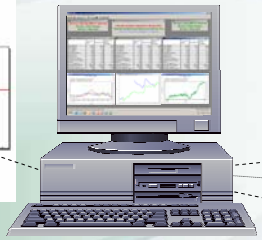
EN 14181 – QAL 3

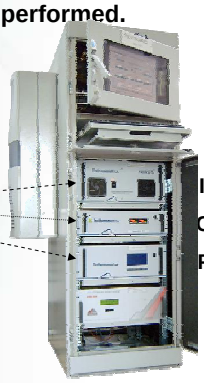
- When a QAL 2 is completed the AMS should be QAL 3 “ready”.
- Analysers need to carry out calibration checks against span gas and zero readings at regular intervals.
- Results of these measurements need to be recorded.
- Analysis of all recently recorded results must be performed.



QAL 3 REPORTS
Cusum or Shewhart



Data logging & Control of Gas injection



IR analyser
Cal Gas BOX
FID Analyser

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Practical Example of Successful QAL 2

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James Bealing
Scientifics Limited

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BS EN 14181 Approach

- BS EN 14181 & BS EN 13284-2
- MID 14181 & MID 13284-2
- EA TGN M20
- EA M2 - SRMs

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QAL 2 AIMS & REQUIREMENTS

- Verify correct installation of CEMS
- Correct functionality
- Calibrate using SRMs
- Calibration function

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SRM – KEY POINTS

- Accurate & Precise
- MCERTS Certification for Instrumental Analyser used in SRM and over appropriate ranges
- Adequate spread over measurement range, low scatter & linear response

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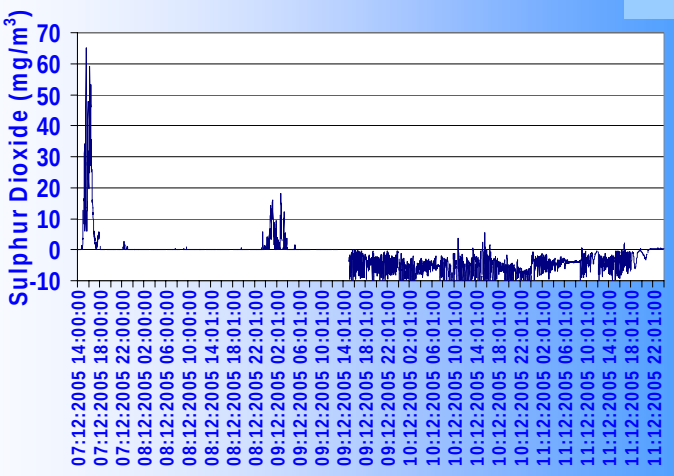
SO_2 CEMS Data (4-5 Days)



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x SO2 cem	y SO2 srm
28.08	54.49
36.60	61.98
0.00	15.34
0.00	15.07
0.00	15.20
0.00	15.02
0.00	15.01
0.00	15.13
9.28	25.96
3.45	20.95
1.35	18.24
1.01	17.14
-3.93	10.15
-4.77	8.55
-4.21	9.36

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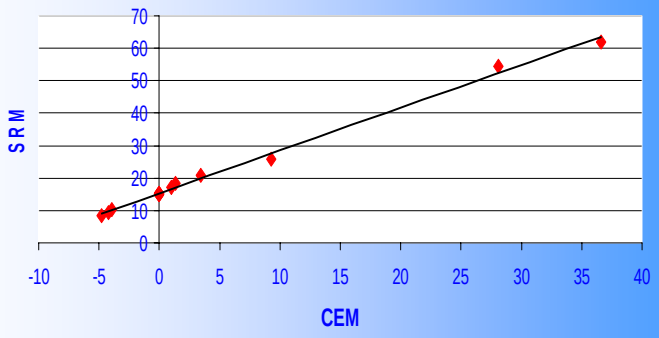
Sulphur Dioxide

y = 1.3176x + 15.301

R^2 = 0.9962



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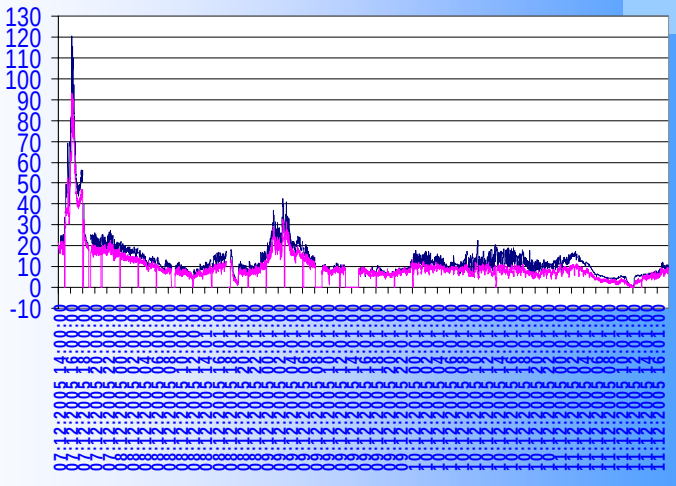
– CEM HCl – SRM HCl



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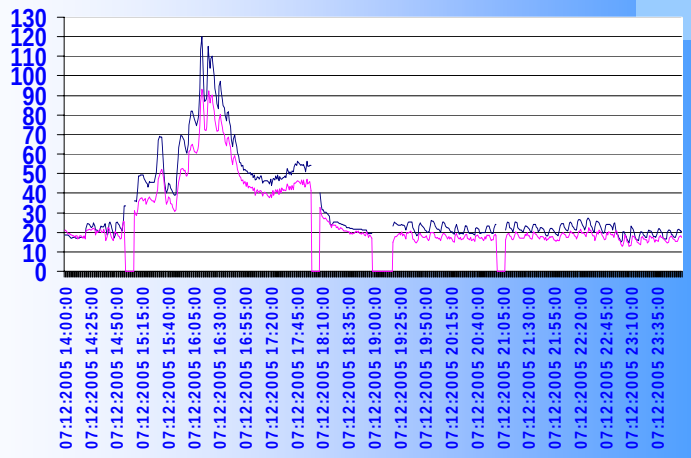
– CEM HCl – SRM HCl



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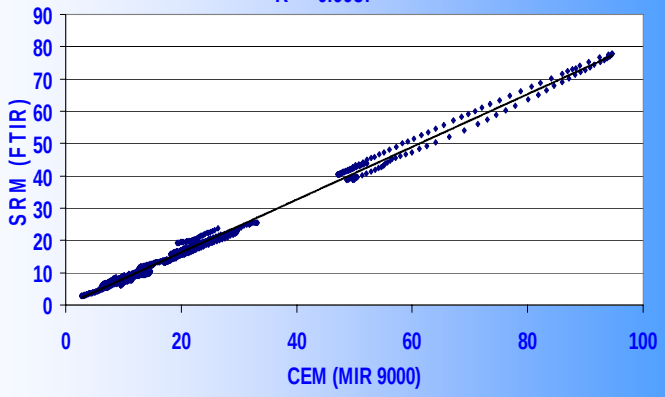
Hydrogen Chloride

y = 0.8167x - 0.0234

R^2 = 0.9937



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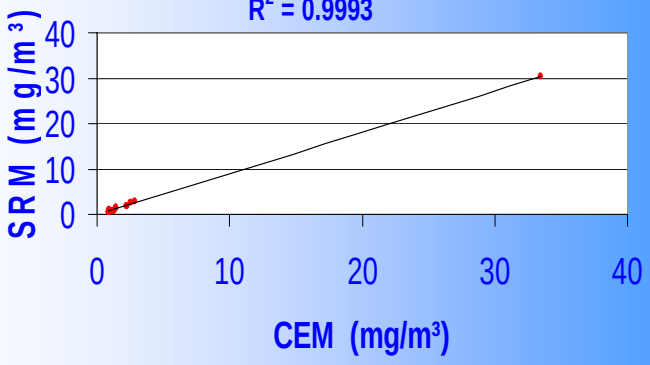
VOCs

y = 0.911x - 0.1392

R^2 = 0.9993



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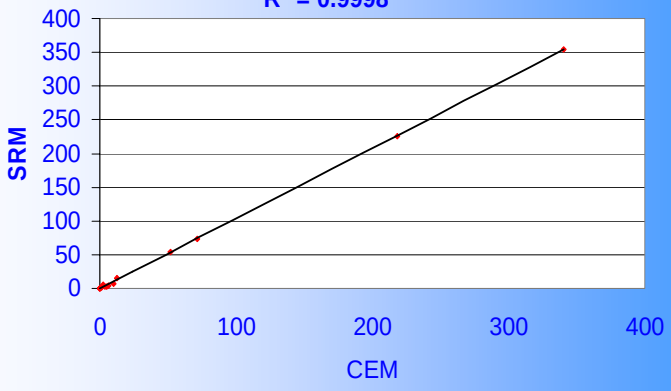
CO

y = 1.0405x - 0.3722

R^2 = 0.9998



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Parameter	Calibration Function	Valid Calibration Range STP (mg/m³)	Valid Calibration Range @ STP, 11% O_2, dry (mg/Sm³)
Total Particulate Matter	Y = 0.9289x + 0.149	0.5 to 2.5	1.5 to 11.5
Hydrogen Chloride	Y = 0.7491x -0.2423	0 to 77.3	0 to 119.3
Volatile Organic Compounds (as C)	Y = 0.911x -0.1392	0.5 to 33.3	1 to 71.4
Nitrogen Monoxide	Y = 1x -0.171	0 to 68	0 to 120.5 as NO 0 to 184.4 as NO_2
Nitrogen Dioxide	Not Determined, Insufficient Spread of Data	Refer to Instrument Linearity Data	Refer to Instrument Linearity Data
Sulphur Dioxide	Y = 1.3176x + 15.301	8.5 to 68	15.1 to 107.7
Carbon Monoxide	Y = 1.0405x -0.3722	0 to 390.3	0 to 465.3

Peripheral Measurements	Calibration Function	Valid Calibration Range (%)
Oxygen (Dry Gas Basis)	Y = 1.007x + -0.2011	10.17 to 21.1
Oxygen (Wet Gas Basis)	Y = 0.9931x + 0.2148	11.79 to 20.9
Moisture (Instrumental)	Y = 0.8514x + 0.1464	0.6 to 12.8

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Determinand	Instrument	Measurement Principle	Instrument Range	Minimum Certified Range	Process Emission Limit	Reporting Confidence Interval
TPM	DT 990	Electrodynamic	0 - 30 mg/m³	0 - 30 mg/m³	10 mg/m³	30%
HCl	MIR 9000	GFC-NDIR	0 - 200 mg/m³	0 - 15 mg/m³	10 mg/m³	40%
VOCs	Graphite 52M	FID	0 - 100 mg/m³	Not Certified	10 mg/m³	30%
NO	MIR 9000	GFC-NDIR	0 - 300 mg/m³	0 - 80 mg/m³	N/A	-
NO_2	MIR 9000	GFC-NDIR	0 - 100 mg/m³	Not Certified	N/A	-
NO_x (as NO_2)	MIR 9000	GFC-NDIR	0 - 500 mg/m³	0 - 120 mg/m³	200 mg/m³	20%
SO_2	MIR 9000	GFC-NDIR	0 - 300 mg/m³	0 - 75 mg/m³	50 mg/m³	20%
CO	MIR 9000	GFC-NDIR	0 - 200 mg/m³	0 - 75 mg/m³	50 mg/m³	20%
O_2 (Dry)	MIR 9000	Paramagnetism	0 - 21%	Not Certified	N/A	10%
O_2 (Wet)	Setnag	Zirconia Cell	0 - 25%	Not Certified	N/A	10%
H_2O	MIR 9000 & Setnag	Calculation	0 - 100%	Not Certified	N/A	30%

Determinand	Instrument	Measurement Principle	Instrument Range	Minimum Certified Range	Process Emission Limit	Calculated Uncertainty at ELV
TPM	Manual Sampling Train	Gravimetric	0 - 50 mg/m³	0 - 5 mg/m³	10 mg/m³	9.7%
HCl	Temet DX-4000 FTIR	FTIR	0 - 80 mg/m³	0 - 15 mg/m³	10 mg/m³	19.7%
VOCs [1]	Sick Maihak 3006 FID	FID	0 - 15 mg/m³	0 - 15 mg/m³	10 mg/m³	2.4%
NO	Temet DX-4000 FTIR	FTIR	0 - 200 mg/m³	0 - 200 mg/m³	N/A	8.0%
NO_2	Temet DX-4000 FTIR	FTIR	0 - 10 mg/m³	Not Certified	N/A	-
NO_x (as NO_2)	Temet DX-4000 FTIR	FTIR	0 - 300 mg/m³	0 - 300 mg/m³	200 mg/m³	8.0%
SO_2	Temet DX-4000 FTIR	FTIR	0 - 150 mg/m³	0 - 75 mg/m³	50 mg/m³	13.3%
CO	Temet DX-4000 FTIR	FTIR	0 - 400 mg/m³	0 - 75 mg/m³	50 mg/m³	9.2%
O_2 (Dry)	Servomex Zentra 4900	Paramagnetism	0 - 25% v/v	0 - 25% v/v	N/A	3.3%
O_2 (Wet)	N/A	By Calculation	N/A	N/A	N/A	7.9%
H_2O	Temet DX-4000 FTIR	FT-IR	0 - 26% v/v	0 - 25% v/v	N/A	7.2%

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Appendix 2: Example Executive Summary Report

Executive Summary – BS EN14181 compliance report				
Process Operator			PPC Permit No	
Address			Contact	
			Tel No	
			Email	
Tests carried out * Delete where applicable	QAL2*	AST*	Date test carried out	
CEM System:			MCERTS reference:	
Manufacturer/Supplier			Contact	
Address			Tel No	
			Email	
Testing laboratory			UKAS Accreditation No	
Address			Contact	
			Tel No	
			Email	
Functional test audit carried out by, if elements of the tests where carried out by a third party			Name	MCERTS No
Functional test report reference			Report ref	Date
"Did the tests comply with the standard" If NO supply information on a separate sheet			YES	NO
Were there any corrective actions required If YES supply information on a separate sheet			YES	NO
Date when the QAL2 calibration was applied to the CEM				
Full report reference number				
Summary report submitted by			Name Organisation	

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