Power Technology

EN14181 Practical Experience of AST – JEP Power Industry Guidance

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E.ON UK

Integrated UK energy business

- Wholesale
  - 10,900 MW of generating capacity
  - CHP – 14 sites
  - Renewables – wind farms, hydro and biomass
  - Power Technology
- Trading
- Distribution – Central Network
- Retail - Powergen
  - 9m customers

Power Technology supplies technical support to inter
& external business

Power Technology Overview

Power Technology supplies technical support to internal (E.ON) & external business

Mission Statement

To be the leading UK based supplier of scientific and engineering expertise to the power industry worldwide, providing added value to our customers.

- Profit Centre
- Turnover £30m
- Approx 50% external income
- 50% UK Coal Market
- 25% UK Gas Market
- 250 Highly qualified staff
- Over 200 Customers across 400 sites inc JEP

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
- AST – on-going emissions compliance

Other Tests

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

Guidance on carrying out QAL2

Step 1

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

Step 2

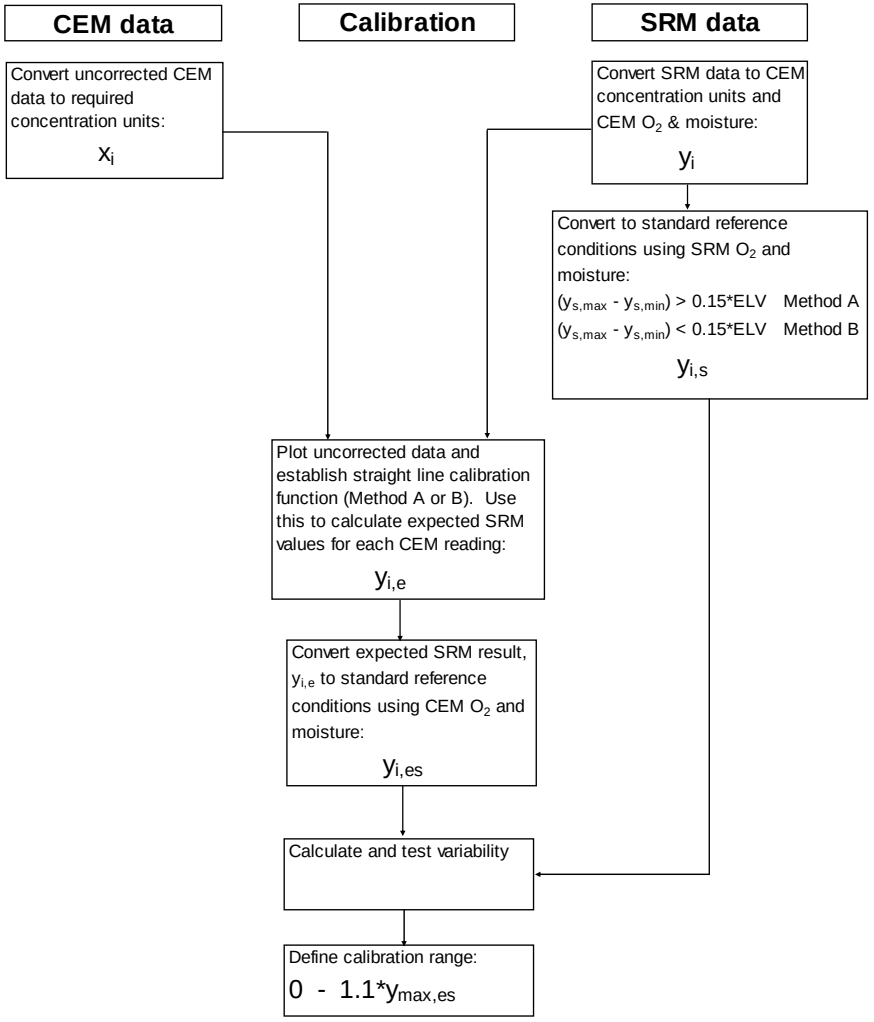
The raw SRM data are converted to the same concentration units (mg/m3) for the y-values.

Step 3

The SRM data are 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

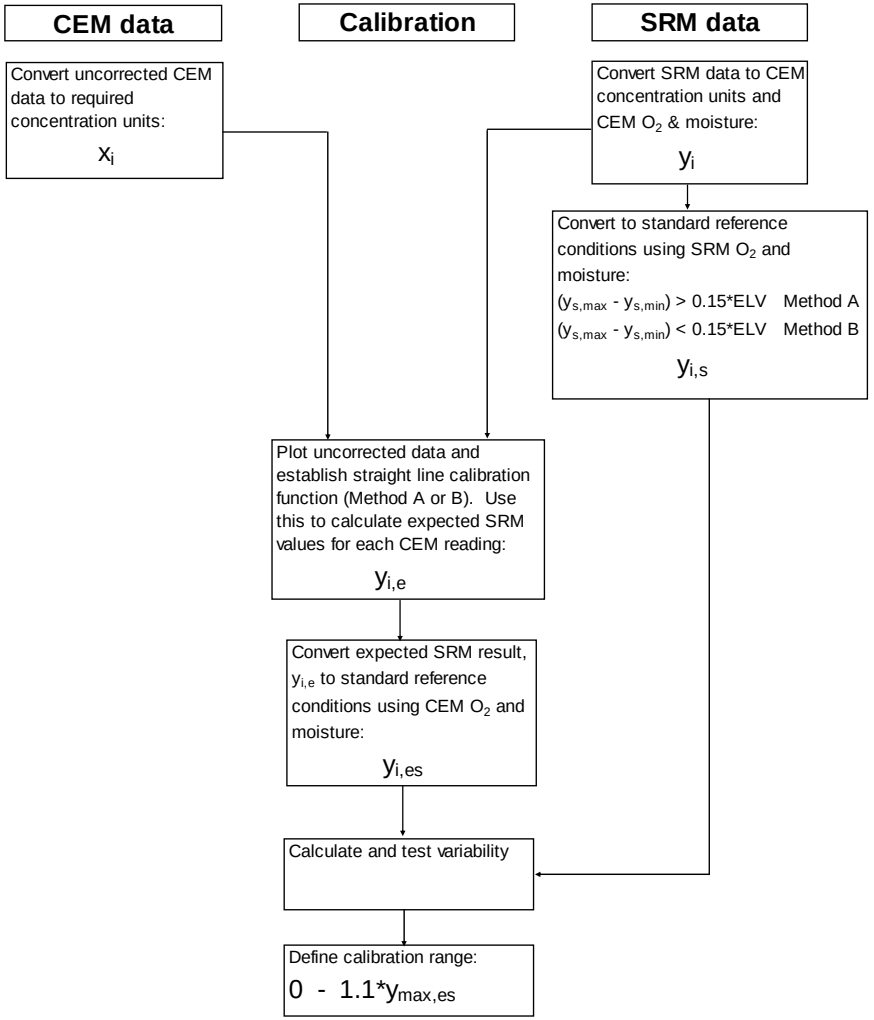
Calculate the SRM expected values at standard reference conditions, using linear function.

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

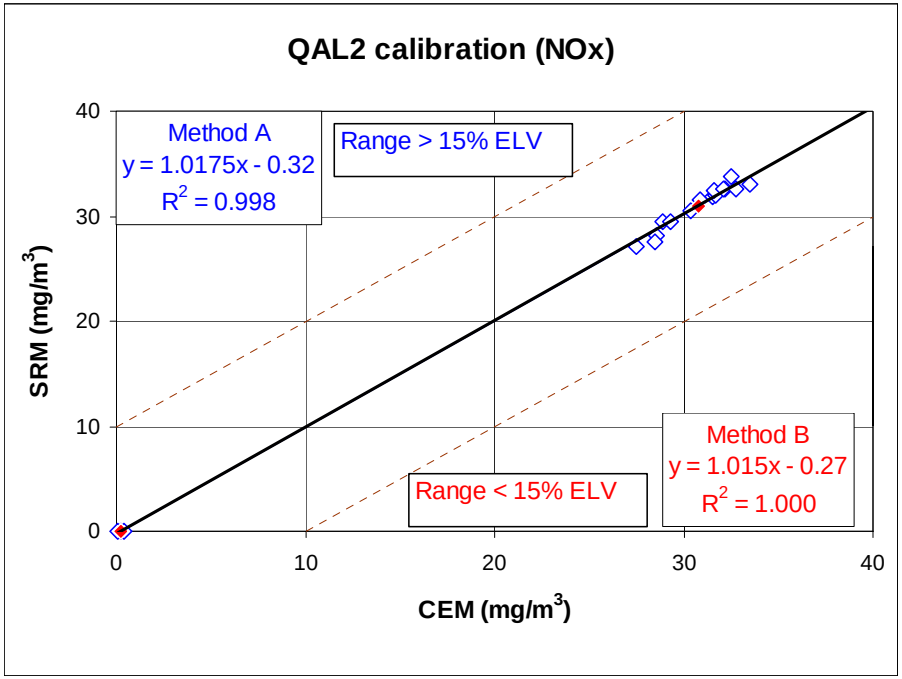
Define the valid calibration range. This is nominally taken to be 110% of the maximum expected SRM concentration (calibrated CEM reading) obtained from the QAL2 AMS data



QAL2 Calibration - 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
- Reference span data only used if max SRM<30% ELV
- QAL2 not required for O2 and H2O
- Extend valid range by 10% from



Practical Experience of EN14181 AST - Examples

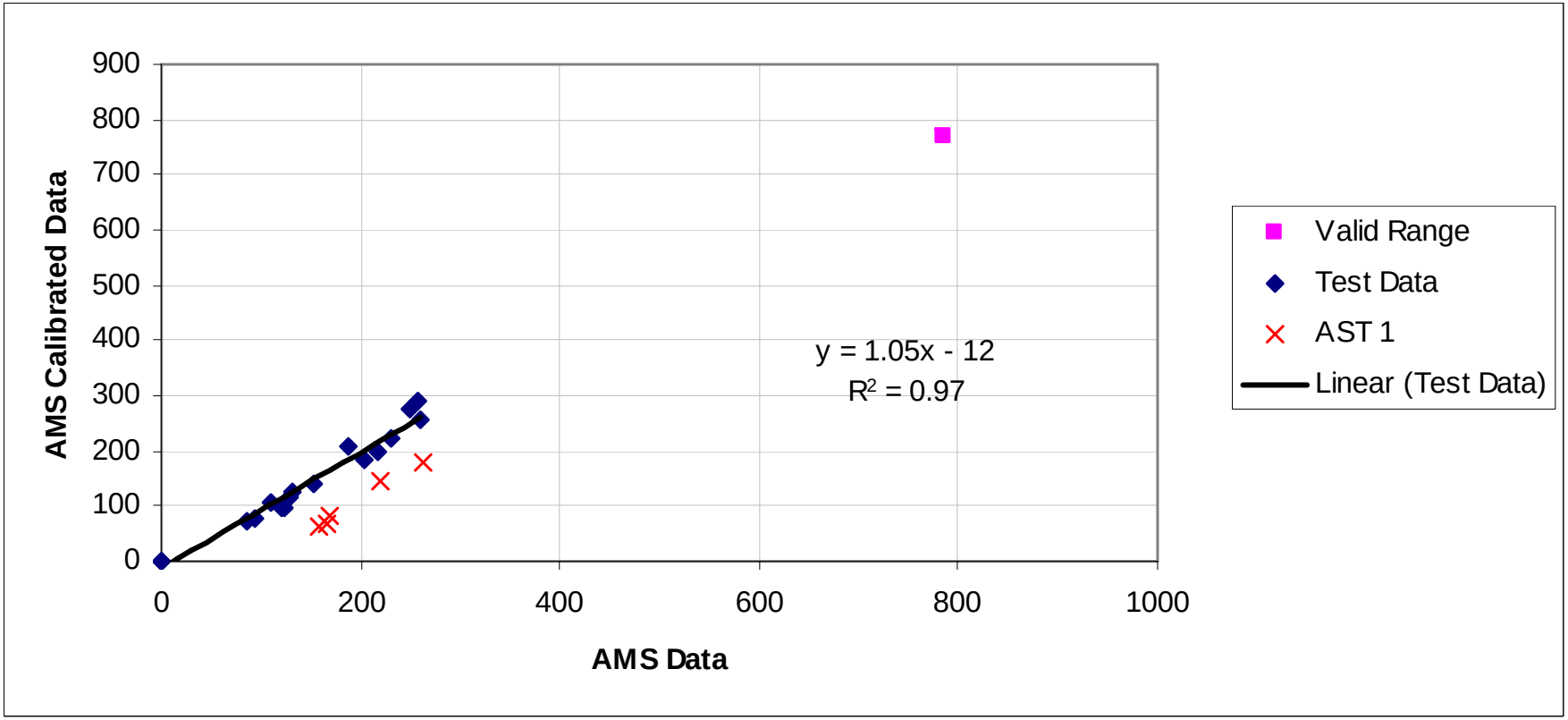
AST

- Test to Validate QAL2 calibration
- Scaled down QAL2 (5 data pairs – min 1 day)
- Variability test (inc calibration function)
- Functional checks on AMS are required

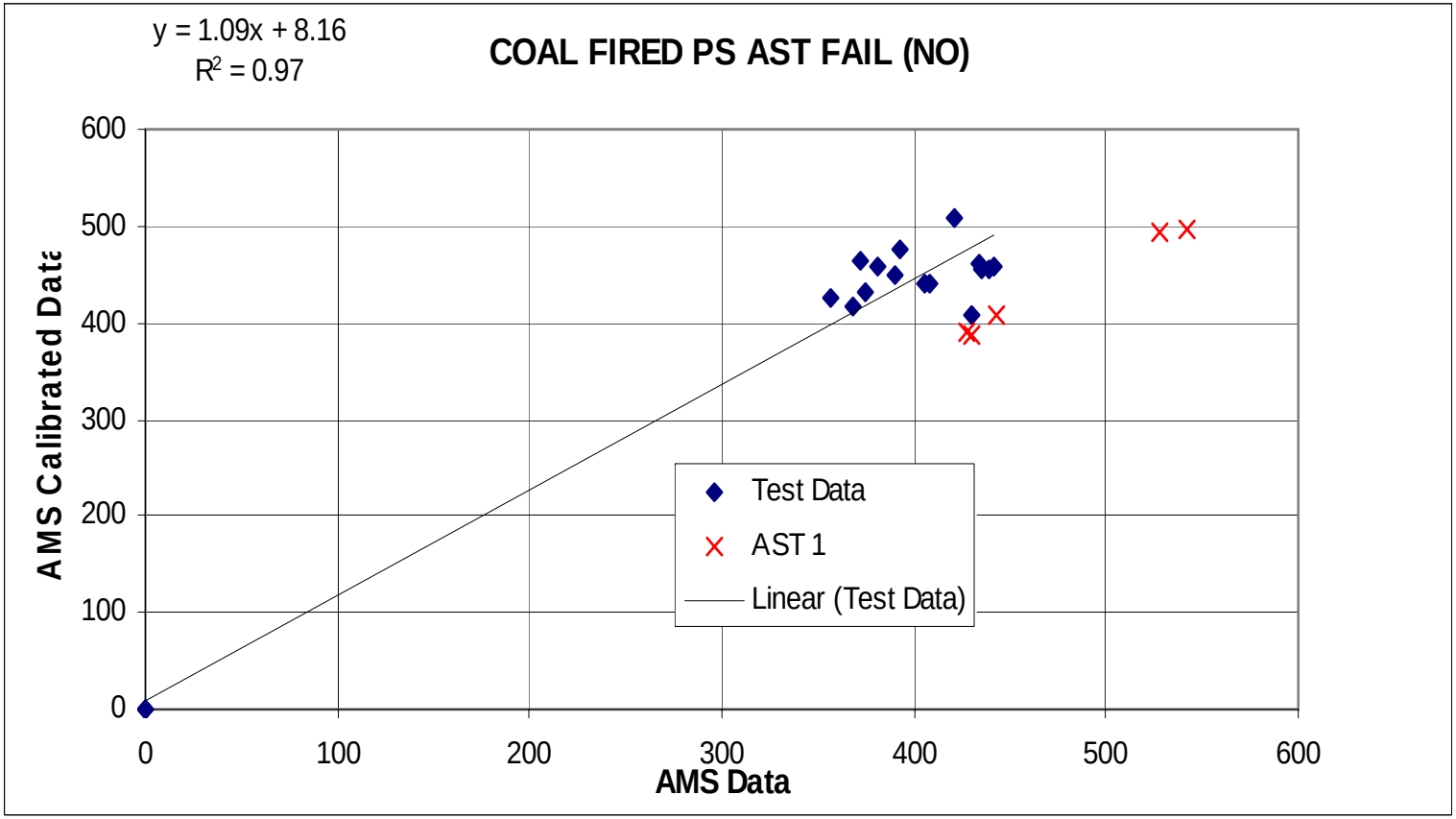
Examples

- AMS AST data from different system types
- Problems – during site testing e.g. sorting AMS outputs TIME = MONEY
- Problems – AMS data e.g. corrected at analyser, no output of correction values
- Failed! – How did that happen?

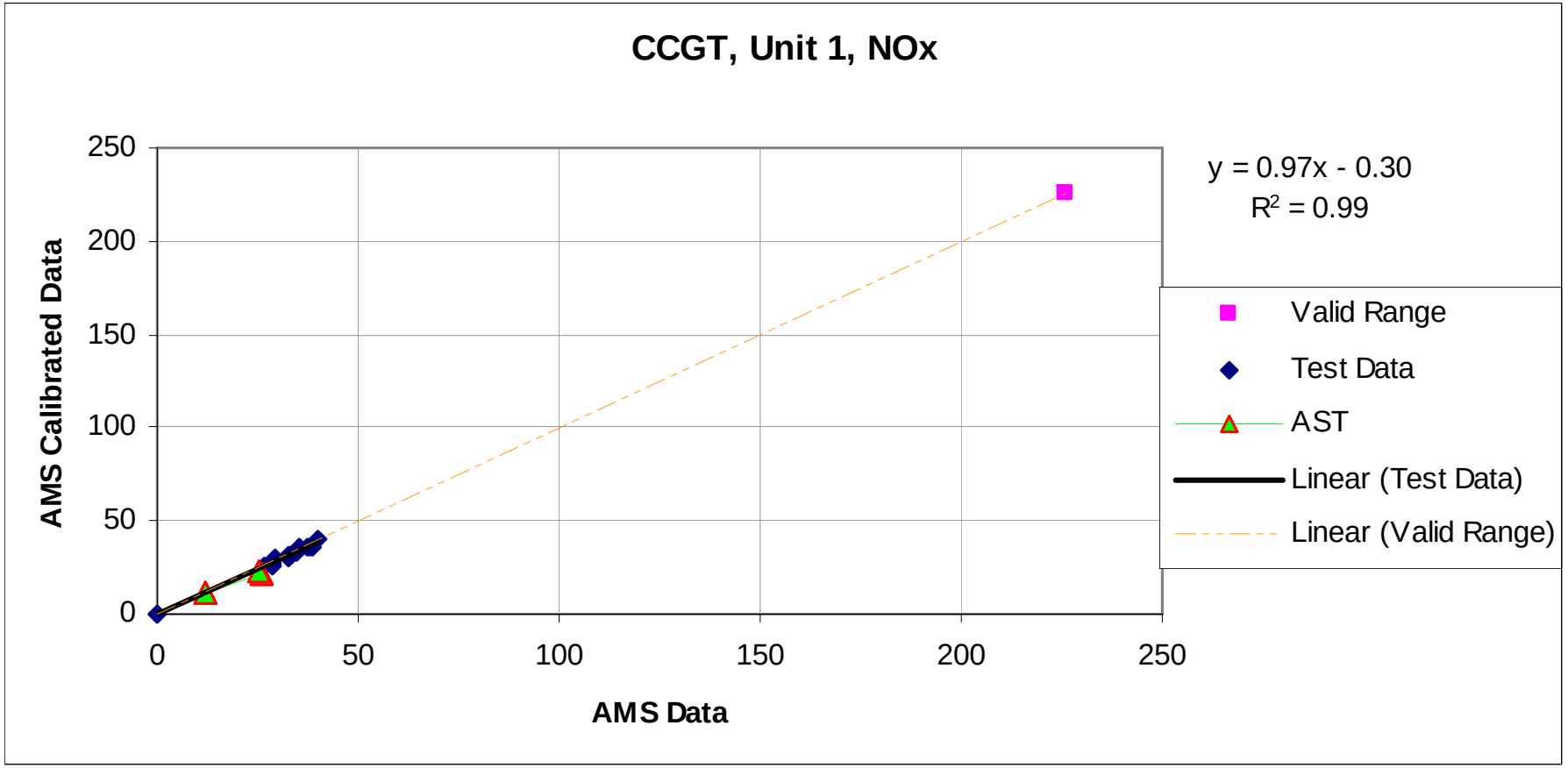
Example in-situ – Coal SO2



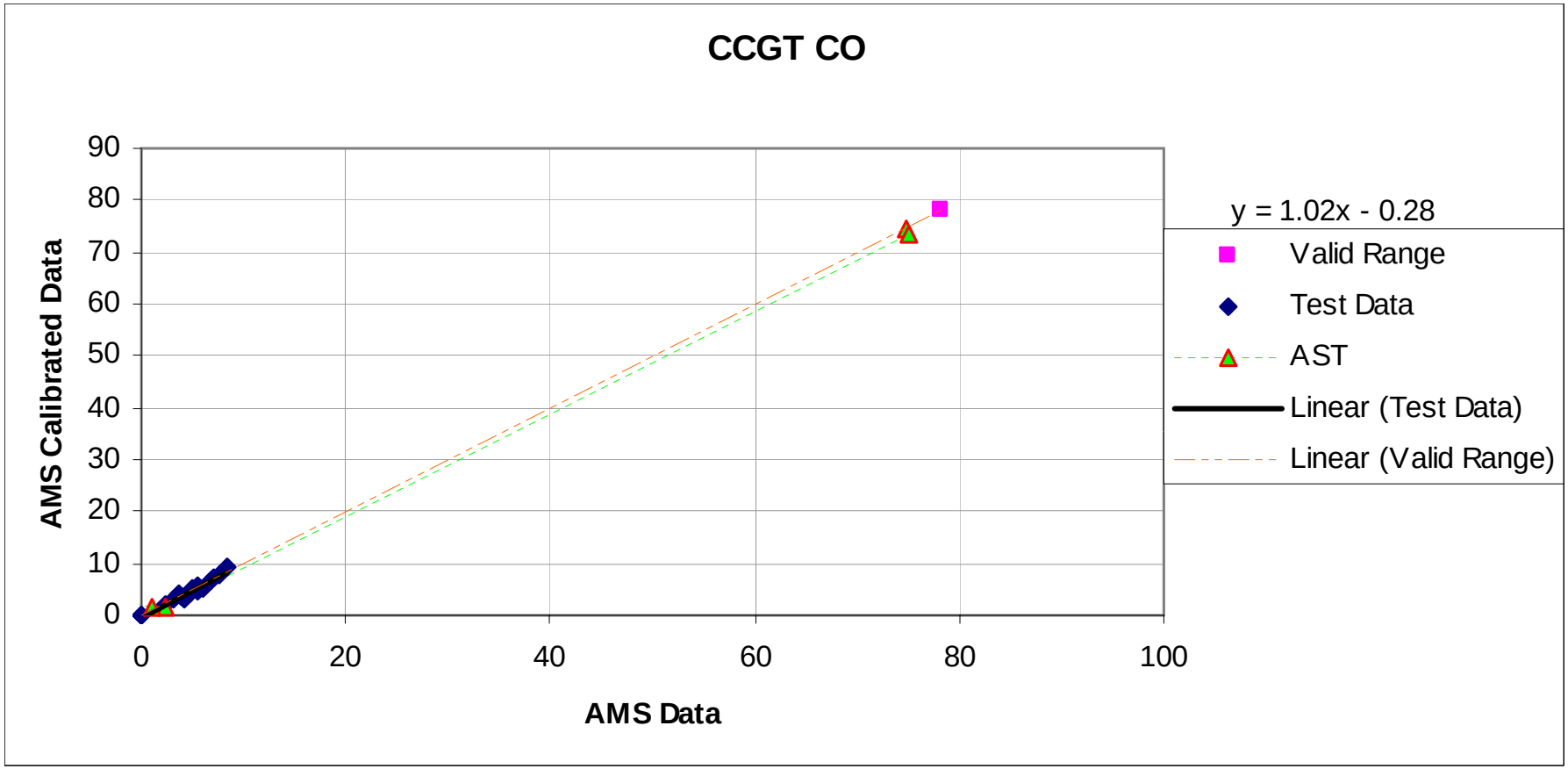
Example in-situ – Coal NOx



Example extractive (CCGT – NOx)



Example extractive (CCGT – CO)



Example data correction problems

	SRM	SRM	AMS	AMS	AMS	AMS
	mg/Nm3	mg/m3	mA	mg/Nm3	O2 (dry)	H2O
14:29:00	7.50	6.89	11.030	4.394	5.614	10.610
15:56:00	9.05	8.45	13.820	6.138	5.500	10.230
10:47:00	5.82	5.21	6.852	1.783	5.980	9.220
12:07:00	4.77	4.39	7.620	2.263	5.570	9.070

SRM data must be compared @ AMS measuring conditions

If AMS data is corrected, calibration must be @ AMS measuring conditions

Need to record supplementary data @ AMS e.g. O2, H2O, temp. & pressure

SRM data corrected using AMS supplementary data

Check AMS readings against DCS readings

Need data measured at AMS e.g. extractive dust needs temp/pressure

JEP guidance has calculation for H2O from oxygen content

Practical Experience of EN14181 AST Testing - Advice

Advance planning

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

Supplementary parameters

- What? – H2O, O2, temp, pressure
- Data correction? – where/when

Functional checks

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

Reporting

- Current AMS QAL2 calibration available
- Apply to AST data – Pass / Fail?

	AST	
Activity	**Extractive**	**In-situ**
Alignment & cleanliness		✓
Sampling system	✓	
Records	✓	✓
Serviceability	✓	✓
Leak test	✓	
Zero & span check	✓	✓
Linearity	✓	✓
Interferences	✓	✓
Zero & span drift (audit)	✓	✓
Response time	✓	✓
Report	✓	✓

Practical Experience of EN14181 AST Testing - Advice

AMS Data - AMS Data must be recorded and interpreted correctly

Good QAL2 and understand report / results
QAL3 checks in place, AMS in control
All maintenance / service of AMS carried out
Functional checks of AMS carried out
Arrange AST
Log AMS outputs directly (reduces confusion)
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 an AST 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 an AST 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 >5 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)

Clarify reporting requirements with Test House

Report

QAL2 Summary Report

Client: EON-UK
Site: X Power Station
Process: Unit 1
Location: A Side
Dates: 13th-16th Feb 2007
Test Laboratory Details: EON-UK, Power Technology (UKAS Lab 2200)
Type of Test: QAL2
AMS Details: SICK OMD 41

Analysis Component: Dust

Type of test - QAL2 or AST

Component being tested

The actual uncertainty is the standard deviation of the differences between the measured SRM value and the calibrated CEM value. This part of the QAL2 is the variability test, full details can be found in EA TGN M20

Calibration Function: The data contained in Table 3 represents the Input to the calibration and variability test calculations. The results of the calculation are summarised in Table 1 below, the calibration takes the form:

$$y_i = bx_i + a$$

Slope

Offset

y_i is the AMS calibrated value
x_i is the AMS measured signal

Valid calibration range - This can be:

The highest corrected SRM measured value + 10% (gases)
The highest corrected SRM measured value + 100% (particulate)
TGN M20 (Section 3.5.11) states that the calibration range may be extended further using reference materials so long as the resulting data points are within the 95% confidence intervals of the calibration function

Table 1: Calibration function based on data points (mg/Nm3, wet gas)

Species	a	b	Uncertainty	Allowable	Validity Range
Dust	0.10	0.99	4.8 mg/m3	8.3 mg/m3	192.0 mg/Nm^3 dry gas @ ref% O_2

Table 2:

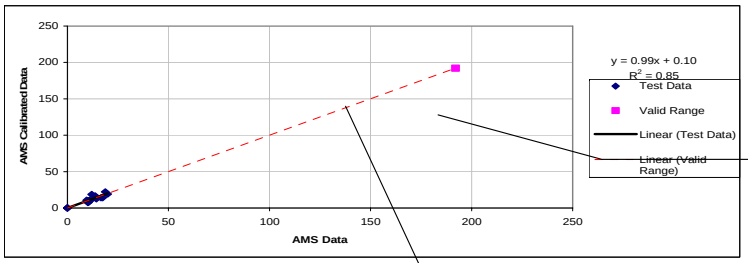
The difference of the reference material value from the calibration line is:	0.64%

To extend valid range should be <20% (NOx, CO, SO2), <30% (dust, TOCs), <40% (HCl, NH3)

Calibration Method used: Method A

The allowable uncertainty is the uncertainty laid down by the authorities (20% ELV for NOx, CO, SO2, 30% ELV for TOCs & Dust, 40% ELV for HCl & NH3) as a 95% CI. It is calculated by

(0.2 x ELV) / 1.96 for NOx, CO, SO2
(0.3 x ELV) / 1.96 for Dust & TOCs
(0.4 x ELV) / 1.96 for HCl & NH3



The data points plotted on the chart are at AMS conditions, I.e if the AMS is an FTIR the data points would be plotted wet gas, uncorrected for O2. If the AMS were an extractive IR analyser the data points would be dry gas, no correction for O2. If the AMS were cross duct Dust analyser the data points would be wet gas, duct temperature, duct pressure & no O2 correction

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

The valid calibration range has been extended using a reference material (as allowed in M20 3.5.11)

Table 3: Monitoring Results

Date	Time Start	Time End	SRM Value mg/m3	SRM O_2 %	AMS Value mg/m3	AMS O_2 %
13/02/2007	10:42:00	11:51:00	11.2	6.9	9.6	7.9
13/02/2007	12:53:00	14:47:00	7.9	7.2	10.2	7.9
13/02/2007	14:02:00	14:55:00	10.4	7.2	10.2	7.9
14/02/2007	09:46:00	10:39:00	17.8	7.1	13.7	7.9
14/02/2007	10:57:00	11:50:00	15.5	6.9	12.8	7.9
14/02/2007	12:46:00	13:37:00	20.7	6.6	19.9	7.7
14/02/2007	13:48:00	14:40:00	23.1	7.3	18.8	8.0
14/02/2007	14:55:00	15:46:00	16.3	7.5	13.8	8.3
15/02/2007	09:30:00	10:21:00	11.1	7.8	11.3	8.6
15/02/2007	10:33:00	11:25:00	8.9	7.4	10.5	8.6
15/02/2007	12:35:00	13:24:00	10.7	7.7	10.8	8.5
15/02/2007	13:37:00	14:28:00	19.8	7.7	12.0	8.5
16/02/2007	09:31:00	10:22:00	14.8	8.5	16.6	9.3
16/02/2007	10:37:00	11:27:00	14.8	8.4	17.5	9.1
16/02/2007	11:51:00	12:42:00	13.0	8.3	14.4	9.0
SPAN	-	-	192.04	-	192.04	-

Raw Data used in the calculations

Note: The calibrated range of the analyser was extended using reference material

In Conclusion

Efficient and successful EN14181 calibration requires:

- Thorough planning
- Site preparation in advance of testing
- Communication with test house at all stages of the calibration regime
- Clear and concise reporting of QAL2

Ongoing EN14181 compliance requires:

- Regular QAL3 quality checks
- Good AMS service/maintenance records
- AST to prove consistency of QAL2

A successful AST requires:

- Correctly operating AMS equipment
- Details of any AMS alterations since QAL2
- Consistent & accurate SRM testing