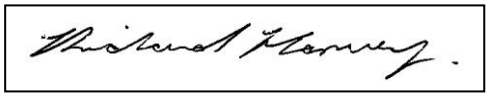
BS EN 14181 Report	
Permit Number:	**RP3133LD**
Operator:	**RWE Generation UK plc.**
Installation:	**Aberthaw Power Station**
Installation Type:	**Coal-Fired Power Station**
Emission Point:	**Unit 8**
Monitoring Dates:	**26th October – 2nd November 2016**

1709

Contract Reference:	FTBS 29312
Operator:	RWE Generation UK plc.
Address:	Aberthaw Power Plant The Leys Aberthaw, Nr Barry South Glamorgan CF62 4ZW
Client Contact:	Richard Kadim
Monitoring Organisation:	RPS Consultants
Address:	Noble House, Capital Drive, Linford Wood, Milton Keynes. MK14 6QP.
Report Date:	9th January 2017
Report Author:	Glyn Harrison
Report Approved By:	Richard Harvey
Position:	Principal Consultant
MCERTS Qualifications:	Level 2, Technical Endorsements 1, 2, 3 & 4
MCERTS Registration No.:	MM 02 020
Signature:	

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Section 1 – Executive Summary

1B.1 Result Summary – QAL2

EN 14181 Test Type		QAL2				
Stack designation		Unit 8				
Measurand	**Correlation coefficient of parallel data (R^2)**	**Derived Calibration function (y_i)** y_i= **a** + **b**x_i		**Calibrated Range**	**Extrapolated Calibrated Range**	**Variability Test**
Nitric Oxide as total NOx (Procal 1)	0.9652	2.835[1]	0.94[1]	0 – 869 mg/m^3 [2]	0 – 1869 mg/m^3 [3]	Pass
Sulphur Dioxide (Procal 1 – Low Range)	0.9562	-1.61[1]	0.96[1]	0 – 239 mg/m^3 [2]	0 – 639 mg/m^3 [3]	Pass
Sulphur Dioxide (Procal 1 – High Range)	0.9565	-1.69[1]	1.01[1]	0 – 240 mg/m^3 [2]	0 – 642 mg/m^3 [3]	Pass
Nitric Oxide as total NOx (Procal 2)	0.8555	-2.66[1]	1.14[1]	0 – 879 mg/m^3 [2]	0 – 1817 mg/m^3 [3]	Pass
Sulphur Dioxide (Procal 2 – Low Range)	0.9511	1.012[1]	1.01[1]	0 – 243 mg/m^3 [2]	0 – 643 mg/m^3 [3]	Pass
Sulphur Dioxide (Procal 2 – High Range)	0.9515	1.033[1]	1.03[1]	0 – 244 mg/m^3 [2]	0 – 643 mg/m^3 [3]	Pass

Notes

1 – Calibration function derived using Method B.
2 – Calibrated range derived using QAL2 parallel test data extended 10%.
3 – Extrapolated calibrated range derived using reference materials

Note: The calibration functions, once applied, only remain valid as long as the QAL 3 data remains within control limits, and there are no manual adjustments made to the CEMS other than those allowed to bring the settings back within the QAL 3 control limits.

1B.2 Result Summary – AST

EN 14181 Test Type	AST							
Stack designation	Unit 8							
Measurand	**Correlation coefficient of parallel data (R^2)**	**Derived Calibration function (y_i)**		**Established Calibrated Range[4]**	**AST Calibrated Range**	**Extrapolated Calibrated Range**	**Variability Test**	**Test of Calibration Function**
		y_i= a	**+ bx_i**					
Particulate Matter (Erwin SICK)	0.9852	0.6[1]	1.433[1]	0 – 55 mg/m^3	-	Not applicable	Fail	Fail

Notes

1 – Calibration function derived using Method A.
2 – Calibrated range derived using AST parallel test data extended 10%.
3 - Calibrated range derived using QAL2 parallel test data extended 100%.
4 – Established calibrated range from QAL 2 - derived using reference materials

Note: The calibration functions, once applied, only remain valid as long as the QAL 3 data remains within control limits, and there are no manual adjustments made to the CEMS other than those allowed to bring the settings back within the QAL 3 control limits.

1C Deviations

SRM deviations	None
Reason for deviation	None
EN 14181 deviations	None
Reason for deviation	N/A
Impact on results	N/A
Further actions required	None

Section 2 - Information about the Regulated Installation

2.1 Regulatory Information

Name of operator	RWE Generation UK plc.
Name of Installation	Aberthaw Power Station
Address of installation	The Leys Aberthaw, Nr Barry South Glamorgan CF62 4ZW
Sector	LCPD
Permit Number	RP3133LD
Date of last QAL 2/AST	March 2015 AST – Procal 1 & 2 & SICK OMD 41

Regulated Determinands

Determinand	Emission Point	Daily Mean	Calendar Monthly	Uncertainty Requirement
Oxides of Nitrogen	Unit 8	1080 mg/m^3 (NOx as NO_2)	1050 mg/m^3 (NOx as NO_2)	20% at the ELV
Sulphur Dioxide	Unit 8	440 mg/m^3	350 mg/m^3	20% at the ELV
Total Particulate Matter	Unit 8	35 mg/m^3	20 mg/m^3	30% at the ELV

Note: ELVs at reference conditions 273K, 101.3kPa, 6% oxygen, dry gas

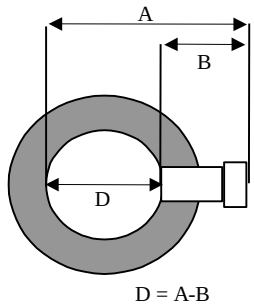
2.2 Operational Information and site monitoring provisions

2.2.1 Process type and emissions variations

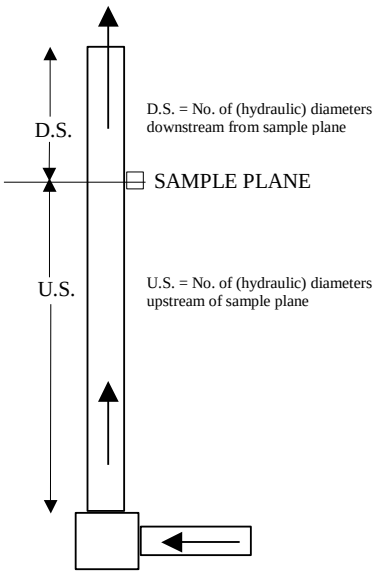
Process Type	Continuous - Coal-Fired Power Station
Process Variations	Once operational at maximum load variation is minimal
Expected emissions variations **1 Oxides of nitrogen** **2 Sulphur Dioxide** **3 Oxygen**	 640 - 775 mg/m^3 as NO_2 – variable 115 - 200 mg/m^3 – variable 6 – 8 % – constant
Possible low level emissions	Sulphur Dioxide
Provision to deal with low level emissions	Method C - Use zero and span value form functional checks, along with parallel test data to derive calibration function.
Other factors affecting monitoring results	None
Fuel type	Coal
Abatement	Flue Gas Desulphurisation & Combustion control

2.3 Monitoring Provisions at the installation

2.3.1 Stack & sampling ports



SKETCH OF SAMPLING POINT LOCATIONS, STACK GEOMETRY, MONITORING PLATFORM & SURROUNDS



A =~ 6.5m

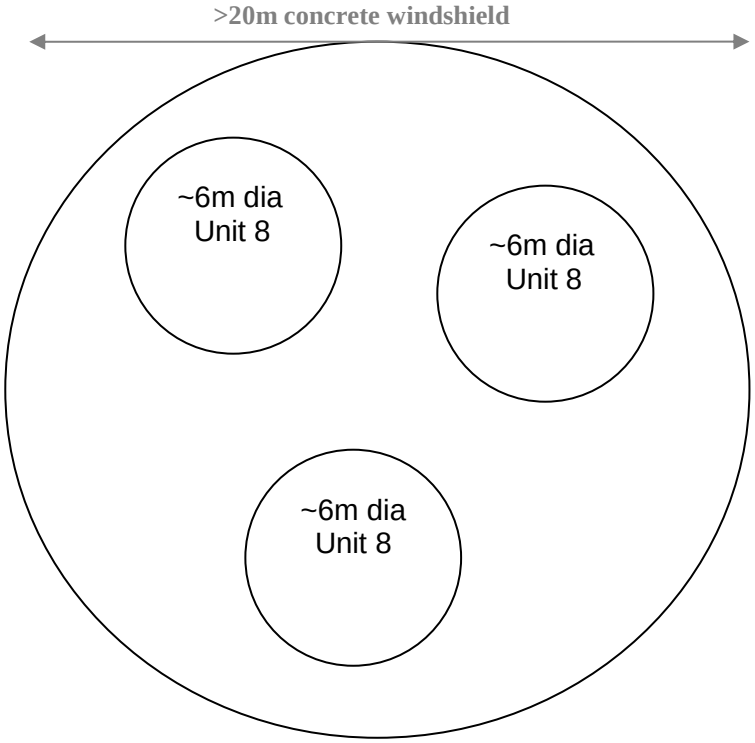
B = ~0.5m

D = ~6.00

D.S. = > 5HD

U.S. = > 5HD

Platform Diagram



Photograph of Stack

Photo of Monitoring Platform

Access was limited to ports due to the stack layout inside the windshield. The port shown is one of four.

2.3.2 Monitoring platform and site provisions

Requirement	Compliant	Notes
• A safe and clean working environment with sufficient space and weather protections.	CEMs cabinet – Monitoring probe -	Both cabinet and probe are located inside the windshield and are thus in a spacious, clean and weatherproof environment.
• Easy and safe access to the CEM.	CEMS cabinet – Monitoring probe -	Stairways to the relevant levels.
• Adequate supplies of reference materials, tools and spare parts.	Yes	
• Facilities to introduce the reference materials for gaseous-monitoring systems, both at the inlet of the sampling line (where present), and at the inlet of the CEM.	N/A	There is no facility to introduce reference materials to the sample line or CEM. The CEMs are cross-duct IR (NO, NO_2, SO_2) and cross-duct forward scatter (particulate).
• Compliance with TGN M1	No	Unable to access sample port B
• Compliance with EN 15259 – flow stability criteria (if applicable), Stack gas homogeneity.	 Yes Yes	 Stack gas homogeneity carried out previously by Atkins.

Temperature and Velocity Profile

Company Name: Aberthaw power station
Site Name: Aberthaw
Sampling Point Ref: unit 8
Project Reference:

Date: 26/10/16
Run: TPM

Mean Stack Temperature, oC	62.750
Traverse Stack Velocity, m/s	19.563
Stack Gas Volume Flow Rate, m3/s (acms)	553.123
Stack Gas Volume Flow Rate, m3/s. Wet, STP	447.213

Δp Measurement units (Pa or mmH2O)	mmH2O

Pitot Coeficiant	0.831

Barometric	758	mmHg	**Leak Test**		
Static			Instrument range	250	mmH2O
Port A	-25	mmH2O	Δp for leak test	187.5	mmH2O
Port B	-25	mmH2O	Positive leakage rate	0	per 15secs
Mean	**-25**	mmH2O	Negative leakage rate	0	per 15secs
			Pass/Fail	**Pass**	

Stagnation Test		
Static measurement		
Positive side	-25	mmH2O
Negative side	-25	mmH2O
Difference (Pa)	**0**	
Pass/Fail	**Pass**	

Stack Dimensions		
Rectangular A		(Width) m
Rectangular B		(Length) m
Circular diam A	6	m
Circular diam B	6	m
Circular Mean	6	m
Area	**28.27431**	m^2

Traverse Point	Distance	Port A Δ p, mmH2O				Port A Swirl	Port A Temp	Port B Δ p, mmH2O				Port B Swirl	Port B Temp
	m	Reading 1	Reading 2	Reading 3	Average	Degrees	°C	Reading 1	Reading 2	Reading 3	Average	Degrees	°C
1	0.20	28	28	28	**28**	0	61	27	27	27	**27**	0	63
2	0.63	31	31	31	**31**	0	63	33	33	33	**33**	0	63
3	1.16	32	32	32	**32**	0	63	32	32	32	**32**	0	63
4	1.94												
5	4.06												
6	4.84	32	32	32	**32**	0	63	34	34	34	**34**	0	64
7	5.37	32	32	32	**32**	0	63	33	33	33	**33**	0	63
8	5.80	29	29	29	**29**	0	62	29	29	29	**29**	0	62
9													
10													

Gas Data	
Oxygen %	6.00
CO_2 %	13.00
CO %	

Oxygen Correction	
Required Correction Value	
Actual Oxygen Factor	1.00
Leave BLANK if no O2 correction is required	

BS EN 13284-1 & M1 Sample Point Requirements	Requirement Met?
Duct gas Flow: angle with regard to duct access <15°?	Y
Duct Gas Flow: No Negative Velocity: Not Permitted	Y
Duct Gas Flow: Ratio of max to min velocity <3:1?	Y
Working Area > $5m^2$?	
Handrails with removable chains / self closing gates across the top of the ladder?	
Handrails (approx 0,5 and 1,0 m high) and vertical baseboards (approx 0,25m high)?	
Scaffold Built to 'Heavy Duty' Scafftag Rating or at least 2.5kN/m2 loading	
Handrails not restricting access to ports?	
Room opposite sampling port equal or greater than the length of the sampling probe plus 1 metre?	
Sufficient Power (Waterproof 110V BS4343 Standard) close or on the platform?	

2.4.1 Continuous Emissions Monitoring Systems at the installation

	Procal 1 & 2	SICK	ABB
Determinand	**NOx & SO_2 & H_2O**	**Particulate**	**Oxygen**
Type	In Situ IR	Cross Duct Forward Scatter	Zirconia Cell
Make	Procal	Erwin Sick	ABB
Model	Pulsi 200 series	OMD41	AZ20
MCERTS Certificate	MC990006/13	MC040042/01	MC110191/01
QAL1 Compliance?	Yes	Yes	Yes
Certification ranges	NO = 0 – 1000 ppm SO2 low = 0 – 250 ppm SO2 high = 0 – 1000 ppm H_2O = 0 – 30 %	0 – 0.3 extinction	0 to 25% 0 to 5%
Operational ranges	As Above	0 – 50 mg/m^3	0 to 25%vol
Principle	Dual wavelength infra-red	Opacity	Zirconia Cell
Raw data units	SO2 & NO = ppm H_2O = %	Extinction	%
Reference condition of raw data	(SO2 & NO only) wet gas, no oxygen correction	wet gas, no oxygen, temp or pressure correction	wet gas
Signal output	4-20 mA	Fibre optics	4 – 20mA
Provision for logging of 14181 data	Data logged by DCS		
Location of sample	Measurement taken at monitoring platform. SRM sample obtained from monitoring platform.		
Moisture – Measurement or calculated	Measured	Measured	Measured

Section 3 – Information about the Monitoring campaign

Table 3.1 - Monitoring Organisation Staff Details

Project Manager	Position	MCERTS Level	Technical Endorsements	Expiry Dates	MCERTS Registration Number
Glyn Harrison	Operations Manager (Stack Emissions)	2	1	10/19	MM 03 228
			2	06/17	
			3	12/21	
			4	07/20	

Site Team	Position	MCERTS Level	Technical Endorsements	Expiry Dates	MCERTS Registration Number
Edwin Powell	Consultant	2	1	12/17	MM 05 621
			2	12/17	
			3	12/17	
			4	12/17	
Daniel Lewis	Technician	1	--	-	MM 14 1291

Report Author	Position	MCERTS Level	Technical Endorsements	Expiry Dates	MCERTS Registration Number
Glyn Harrison	Operations Manager (Stack Emissions)	2	1	10/19	MM 03 228
			2	06/17	
			3	12/21	
			4	07/20	

Report Reviewer	Position	MCERTS Level	Technical Endorsements	Expiry Dates	MCERTS Registration Number
Richard Harvey	Principal Consultant	2	1	11/17	MM 02 020
			2	03/20	
			3	03/21	
			4	12/20	

3.2 - Monitoring Organisation Method Details

Emission Parameter	Standard Method	Monitoring Procedure No.	Monitoring Accreditation Status	Analysis Technique	Expected Uncertainty (%)	Analysis Procedure No.	Analytical Laboratory	Analysis Accreditation Status
Oxides of Nitrogen (as NO_2)	BS EN 14792:2005	RPSCE/1/21f	MCERTS	Chemiluminescence	6	N/A	N/A	N/A
Oxygen	BS EN 14789:2005	RPSCE/1/21g	MCERTS	Zirconia Cell	5	N/A	N/A	N/A
Sulphur Dioxide	TGN M22	RPSCE/1/24	MCERTS	FTIR	10	N/A	N/A	N/A
Total particulate Matter	BS EN 13284:2002	RPSCE/1/7c	MCERTS	Gravimetric	10 - 30	D9	RPS	UKAS

Equipment details

Emission Parameter	Analysis Technique	Analyser	Analyser Certification Status	Certified Ranges	Operational Ranges	Operating Principle
Oxygen	Zirconia Cell	Horiba PG 250	MCERTs certificate No MC 050056/04	0 – 25%	0-25%	Extractive, multicomponent dry gas analyser. Sample extracted through sample probe and 5metre heated sample line (with integral heated filter) – line temperature 180^{o}C. Sample line connected directly to a gas conditioner (peltier cooler) set at 3^{o}C. Cold dry sample then passes to analyser. Sample is drawn through system by integral pump built into analyser.
Oxides of Nitrogen	Chemiluminescence	Horiba PG 250	0 – 125 mg/m^3 NO/NOx	0 – 125 mg/m^3 NO/NOx	0 – 500ppm	
Sulphur Dioxide	FTIR	Gasmet DX4000	MCERTs certificate No MC30014/05	0 – 75mg/m^3	0 – 500 ppm	Extractive wet gas analyser. Sample obtained non-isokinetically. Sample extracted through sample probe and filtered before passing through 5metre heated sample line (with integral heated filter) – line temperature 180^{o}C. Sample line connected directly to a heated sample pump which in turn was connected to the FTIR. Hot, wet sample then passes to analyser.
Stack Gas Moisture	FTIR	Gasmet DX4000	MCERTs certificate No MC30014/05	0-40%	0-40%	
Total Particulate Matter	Multipoint isokinetic sampling with in stack filtration	N/A	N/A	0 – 50mg/m^3	-	Extractive manual test. Sample obtained isokinetically through sharp edged nozzle. Sample gas passed through a pre weighed, pre blown filter. Filter holder mounted in-stack.

Section 4A1: Data & calculations – QAL2 – Unit 8, Procal 1

4A1.1 Table 4.1.1 – Raw monitoring Data – Oxides of Nitrogen

Test No	Date	Test Start Time	Test End Time	CEMS Raw Value (Wet)	CEMS Oxygen (dry)	CEMS Moisture	SRM Raw Value (dry)	SRM Oxygen (Dry)	SRM Moisture	SRM at CEMs Raw conditions
		hr:min		NO (ppm)	(%)	(%)	NOx (ppm)	(%)	(%)	NOx (ppm)
1	26-Oct-16	11:23	12:23	337.44	6.79	2.21	328.17	6.61	3.02	318.3
2	26-Oct-16	12:34	13:34	360.61	6.74	2.15	348.55	6.58	2.78	338.9
3	26-Oct-16	13:35	14:35	331.62	6.44	2.07	318.06	6.33	2.69	309.5
4	26-Oct-16	14:36	15:36	365.07	6.51	2.12	355.64	6.37	2.73	345.9
5	26-Oct-16	15:37	16:37	378.05	6.63	2.19	365.76	6.48	2.80	355.5
6	26-Oct-16	16:38	17:38	344.15	6.93	2.25	337.30	6.72	2.89	327.5
7	26-Oct-16	17:39	18:39	346.13	7.00	2.26	339.06	6.77	2.90	329.2
8	26-Oct-16	18:40	19:40	352.52	7.01	2.22	344.91	6.83	2.84	335.1
9	26-Oct-16	19:41	20:41	351.42	7.04	2.19	344.92	6.81	2.76	335.4
10	26-Oct-16	20:42	21:42	343.51	6.93	2.14	334.97	6.80	2.66	326.1
11	26-Oct-16	21:53	22:53	336.24	6.92	2.15	333.39	6.69	2.65	324.6
12	26-Oct-16	22:54	23:54	330.84	6.88	2.23	331.21	6.68	2.72	322.2
13	26-27/10/2016	23:55	0:55	330.27	7.01	2.19	331.05	6.78	2.66	322.2
14	27-Oct-16	0:56	1:56	332.76	7.15	2.12	331.55	6.93	2.59	323.0
15	27-Oct-16	1:57	2:57	332.48	7.01	2.13	326.22	6.83	2.62	317.7
16	27-Oct-16	2:58	3:58	331.60	7.08	2.21	326.35	6.85	2.73	317.5
17	27-Oct-16	3:59	4:59	333.34	7.01	2.27	329.32	6.79	2.80	320.1
18	27-Oct-16	5:00	6:00	340.56	7.01	2.24	335.27	6.79	2.74	326.1
19	27-Oct-16	6:01	7:01	342.75	6.99	2.26	337.56	6.77	2.73	328.4
20	27-Oct-16	7:12	8:12	334.69	6.93	2.26	329.93	6.71	2.73	320.9
21	27-Oct-16	8:13	9:13	336.57	7.00	2.21	330.14	6.78	2.67	321.3
22	27-Oct-16	9:14	10:14	322.59	7.16	2.22	316.48	6.93	2.68	308.0
23	27-Oct-16	10:50	11:50	317.85	6.79	2.06	313.70	6.68	2.58	305.6
24	27-Oct-16	11:51	12:51	330.36	6.78	2.11	324.34	6.58	2.84	315.1
25	27-Oct-16	13:02	14:02	313.56	6.96	1.99	302.95	6.75	2.63	295.0
26	27-Oct-16	14:03	15:03	318.95	7.00	1.95	307.08	6.78	2.63	299.0
27	27-Oct-16	15:04	16:04	320.81	6.99	1.99	312.45	6.78	2.62	304.3
28	27-Oct-16	16:05	17:05	319.73	7.18	2.18	314.18	6.95	2.80	305.4
29	27-Oct-16	17:06	18:06	322.33	7.26	2.17	317.90	7.03	2.84	308.9
30	27-Oct-16	18:07	19:07	318.47	7.05	2.18	313.87	6.84	2.83	305.0
31	27-Oct-16	19:08	20:08	316.93	7.02	2.17	312.16	6.80	2.85	303.3
32	27-Oct-16	20:09	21:09	326.56	6.95	2.16	322.07	6.74	2.82	313.0
33	27-Oct-16	21:10	22:10	330.99	6.91	2.19	326.00	6.72	2.86	316.7
34	27-Oct-16	22:21	23:21	315.23	6.84	2.24	309.61	6.63	2.93	300.5
35	27-28/10/2016	23:22	0:22	274.39	8.32	2.18	266.90	8.15	2.87	259.2
36	02-Nov-16	11:26	12:26	337.71	6.55	2.54	331.91	6.39	2.67	323.1
37	02-Nov-16	12:27	13:27	345.47	6.51	2.49	337.10	6.32	2.77	327.8

Note:

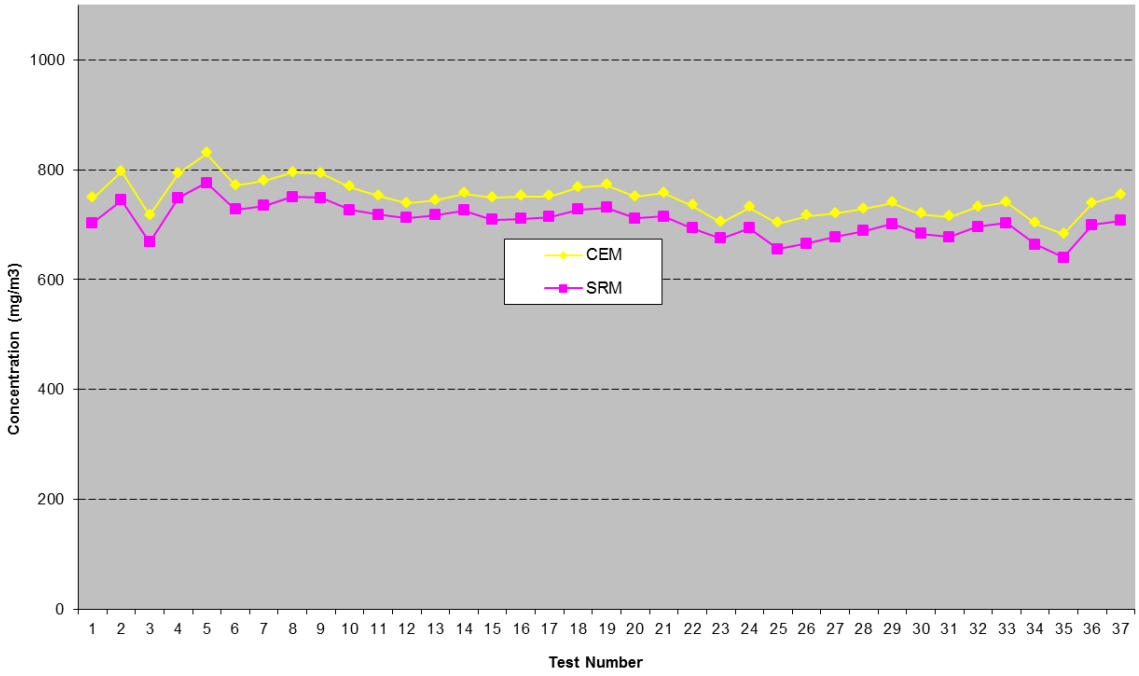
Emission concentrations expresed at reference conditions 273K, 101.3kPa

4A1.2 Table 4.2.1 - Standardised monitoring Data – Oxides of Nitrogen

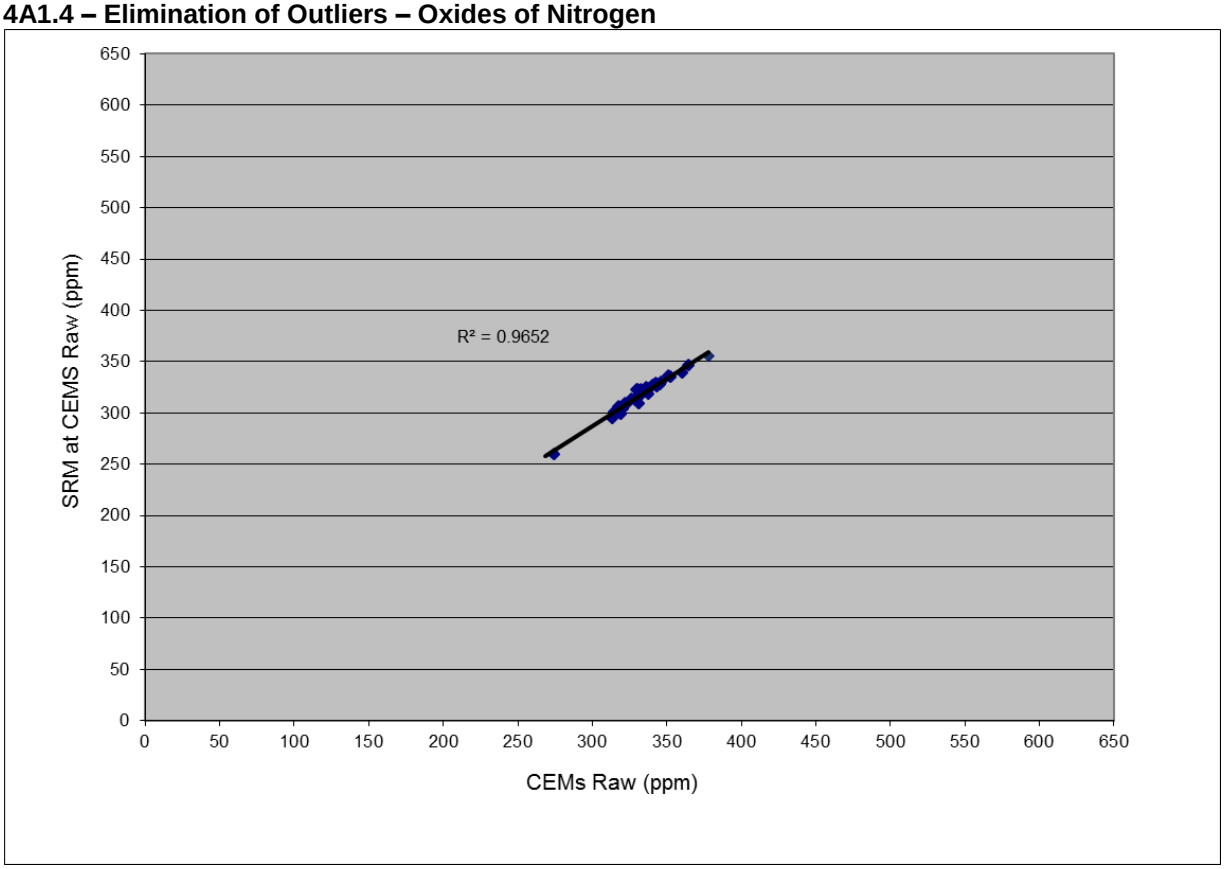
Test No	Date	Test Start Time	Test End Time	CEMS Standardised	SRM Standardised	SRM Uncertainty
		hr:min		(NOx as NO2 mg/m3)	(NOx as NO2 mg/m3)	(mg/m3)
1	26-Oct-16	11:23	12:23	748.1	702.6	23
2	26-Oct-16	12:34	13:34	796.5	744.7	24
3	26-Oct-16	13:35	14:35	716.7	667.9	22
4	26-Oct-16	14:36	15:36	793.2	749.0	25
5	26-Oct-16	15:37	16:37	829.0	776.3	25
6	26-Oct-16	16:38	17:38	771.0	727.6	24
7	26-Oct-16	17:39	18:39	779.3	734.1	24
8	26-Oct-16	18:40	19:40	794.3	750.2	25
9	26-Oct-16	19:41	20:41	793.0	749.1	25
10	26-Oct-16	20:42	21:42	768.7	727.0	24
11	26-Oct-16	21:53	22:53	752.1	718.0	24
12	26-Oct-16	22:54	23:54	738.4	712.7	23
13	26-27/10/2016	23:55	0:55	743.7	717.6	24
14	27-Oct-16	0:56	1:56	756.4	726.2	24
15	27-Oct-16	1:57	2:57	748.4	709.2	23
16	27-Oct-16	2:58	3:58	751.1	710.8	23
17	27-Oct-16	3:59	4:59	751.6	713.9	23
18	27-Oct-16	5:00	6:00	767.6	727.1	24
19	27-Oct-16	6:01	7:01	771.6	730.8	24
20	27-Oct-16	7:12	8:12	750.0	711.5	23
21	27-Oct-16	8:13	9:13	757.5	715.2	24
22	27-Oct-16	9:14	10:14	734.6	693.3	23
23	27-Oct-16	10:50	11:50	703.7	675.2	22
24	27-Oct-16	11:51	12:51	731.2	693.2	23
25	27-Oct-16	13:02	14:02	702.3	655.3	21
26	27-Oct-16	14:03	15:03	716.0	665.3	22
27	27-Oct-16	15:04	16:04	720.3	677.3	22
28	27-Oct-16	16:05	17:05	728.8	688.9	23
29	27-Oct-16	17:06	18:06	739.1	701.2	23
30	27-Oct-16	18:07	19:07	719.4	683.1	23
31	27-Oct-16	19:08	20:08	714.4	677.6	22
32	27-Oct-16	20:09	21:09	732.1	695.8	23
33	27-Oct-16	21:10	22:10	740.2	703.4	23
34	27-Oct-16	22:21	23:21	701.8	664.0	22
35	27-28/10/2016	23:22	0:22	682.4	640.4	21
36	02-Nov-16	11:26	12:26	738.9	699.7	23
37	02-Nov-16	12:27	13:27	753.5	707.3	23

Note:
Emission concentrations expresed at reference conditions 273K, 6 % Oxygen, dry gas

4A1.3 – Plot 1.1 - Time Series of Standardised CEM versus Standardised SRM data – Oxides of Nitrogen, (Expressed at reference conditions 273K, 101.3kPa, dry gas, 6% oxygen)



4A1.4 – Elimination of Outliers – Oxides of Nitrogen



Guidance on performing tests for outliers in MID 14181 section 6.3, states the following:

'As a general guide, when plotting the raw SRM and raw CEM data, if the R^2 value for the linear regression line is equal or more than 0.9, then it is not ordinarily necessary to perform an outlier test.
Additionally, any data points are not likely to be outliers unless they are more than three standard deviations from the regression line'

As the R^2 value for this determinand was 0.9652, an outlier test has not been undertaken.

4A1.5.1 Determination of Method A, B or C - Oxides of Nitrogen

Test No	Test Start Time	Test End Time	SRM measured value (y)	SRM O2	SRM Standardised
	hr:min		(ppm)	(%)	(mg/m3)
1	11:23	12:23	328.2	6.6	702.6
2	12:34	13:34	348.6	6.6	744.7
3	13:35	14:35	318.1	6.3	667.9
4	14:36	15:36	355.6	6.4	749.0
5	15:37	16:37	365.8	6.5	776.3
6	16:38	17:38	337.3	6.7	727.6
7	17:39	18:39	339.1	6.8	734.1
8	18:40	19:40	344.9	6.8	750.2
9	19:41	20:41	344.9	6.8	749.1
10	20:42	21:42	335.0	6.8	727.0
11	21:53	22:53	333.4	6.7	718.0
12	22:54	23:54	331.2	6.7	712.7
13	23:55	0:55	331.0	6.8	717.6
14	0:56	1:56	331.6	6.9	726.2
15	1:57	2:57	326.2	6.8	709.2
16	2:58	3:58	326.4	6.9	710.8
17	3:59	4:59	329.3	6.8	713.9
18	5:00	6:00	335.3	6.8	727.1
19	6:01	7:01	337.6	6.8	730.8
20	7:12	8:12	329.9	6.7	711.5
21	8:13	9:13	330.1	6.8	715.2
22	9:14	10:14	316.5	6.9	693.3
23	10:50	11:50	313.7	6.7	675.2
24	11:51	12:51	324.3	6.6	693.2
25	13:02	14:02	303.0	6.8	655.3
26	14:03	15:03	307.1	6.8	665.3
27	15:04	16:04	312.5	6.8	677.3
28	16:05	17:05	314.2	6.9	688.9
29	17:06	18:06	317.9	7.0	701.2
30	18:07	19:07	313.9	6.8	683.1
31	19:08	20:08	312.2	6.8	677.6
32	20:09	21:09	322.1	6.7	695.8
33	21:10	22:10	326.0	6.7	703.4
34	22:21	23:21	309.6	6.6	664.0
35	23:22	0:22	266.9	8.1	640.4
36	11:26	12:26	331.9	6.4	699.7
37	12:27	13:27	337.1	6.3	707.3
Sum			12088.07		

Emission Limit Value (ELV) =	1080	mg/Nm^3	Y_{max}	776.29
Maximum Permissable uncertainty =	20	%	Y_{min}	640.38
Maximum Permissable uncertainty (at E	216	mg/Nm^3		
15% of the ELV =	162	mg/Nm^3		
Is Ymax - Ymin > MPU at ELV?	No		$Y_{max - Ymin}$	135.91
Is Ymin > 15% of ELV?	Yes			

Derivation of Calibration Function	**Method B**

4A1.6.1 Table 4.3.1 - Data used to derive calibration function - Oxides of Nitrogen,

Test No	Test Start Time	Test End Time	SRM measured value (y)	CEMS measured signal (x)
	hr:min		(ppm)	(ppm)
1	Reference		0.0	-3.0
2	11:23	12:23	318.3	337.4
3	12:34	13:34	338.9	360.6
4	13:35	14:35	309.5	331.6
5	14:36	15:36	345.9	365.1
6	15:37	16:37	355.5	378.1
7	16:38	17:38	327.5	344.2
8	17:39	18:39	329.2	346.1
9	18:40	19:40	335.1	352.5
10	19:41	20:41	335.4	351.4
11	20:42	21:42	326.1	343.5
12	21:53	22:53	324.6	336.2
13	22:54	23:54	322.2	330.8
14	23:55	0:55	322.2	330.3
15	0:56	1:56	323.0	332.8
16	1:57	2:57	317.7	332.5
17	2:58	3:58	317.5	331.6
18	3:59	4:59	320.1	333.3
19	5:00	6:00	326.1	340.6
20	6:01	7:01	328.4	342.8
21	7:12	8:12	320.9	334.7
22	8:13	9:13	321.3	336.6
23	9:14	10:14	308.0	322.6
24	10:50	11:50	305.6	317.8
25	11:51	12:51	315.1	330.4
26	13:02	14:02	295.0	313.6
27	14:03	15:03	299.0	318.9
28	15:04	16:04	304.3	320.8
29	16:05	17:05	305.4	319.7
30	17:06	18:06	308.9	322.3
31	18:07	19:07	305.0	318.5
32	19:08	20:08	303.3	316.9
33	20:09	21:09	313.0	326.6
34	21:10	22:10	316.7	331.0
35	22:21	23:21	300.5	315.2
36	23:22	0:22	259.2	274.4
37	11:26	12:26	323.1	337.7
38	12:27	13:27	327.8	345.5
Sum			11755.10	12321.57

4A1.7.1 Determination of Calibration Function - Oxides of Nitrogen

Method B

Formulae:-	**Number of tests conducted =**		**N**	**38**
If Ymax-Ymin <15% of the ELV, the following formulae are used:				
b=(y/(x-Z))	**x=(1/No. AMS Tests) * Total AMS**			
	x=(1/ 38)*12321.	**or -**	**x=**	**324.25**
a=(-β.Z)	**y=(1/No. SRM Tests) * Total SRM**			
	y=(1/ 38)*11755	**or -**	**y=**	**309.34**
The Slope is calculated by :				
β=y/(x-Z)	**309.3 /(324.2--3)**		**β=**	**0.945**
The offset is calculated by:				
α=-β.Z	**-0.94*-3**		**α=**	**2.84**
The calibration is function $y_{im} = \alpha + \beta_{xi,m}$ or		**yi =**	**2.835 + 0.94 * Xi**	

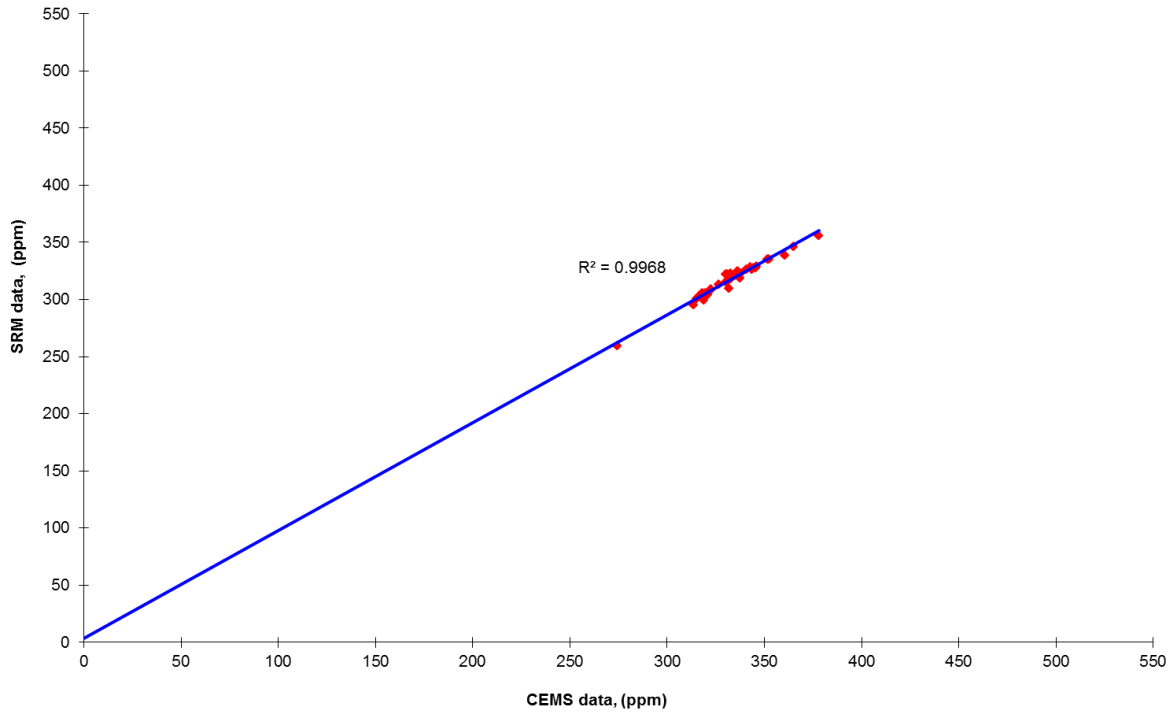
4A1.8.1 Table 4.4.1 - Calculation of calibrated CEMS values - Oxides of Nitrogen

Test No	Test Start Time	Test End Time	CEMS Raw Value (x)	CEMS Calibrated signal	CEMS Dry Oxygen	CEMS Moisture	CEMS Standardised Value (dry)	CEMS Calibrated Standardised Value	SRM Standardised
	hr:min		(ppm)	(ppm)	(%)	(%)	(mg/Nm^3)	(mg/Nm^3)	(mg/Nm3)
1	Reference		-3.0	0.0	N/A	N/A	-3.0	0.0	0.0
2	11:23	12:23	337.4	321.8	6.8	2.2	748.1	713.4	702.6
3	12:34	13:34	360.6	343.7	6.7	2.1	796.5	759.2	744.7
4	13:35	14:35	331.6	316.3	6.4	2.1	716.7	683.6	667.9
5	14:36	15:36	365.1	347.9	6.5	2.1	793.2	756.0	749.0
6	15:37	16:37	378.1	360.2	6.6	2.2	829.0	789.9	776.3
7	16:38	17:38	344.2	328.2	6.9	2.2	771.0	735.1	727.6
8	17:39	18:39	346.1	330.0	7.0	2.3	779.3	743.0	734.1
9	18:40	19:40	352.5	336.1	7.0	2.2	794.3	757.3	750.2
10	19:41	20:41	351.4	335.0	7.0	2.2	793.0	756.0	749.1
11	20:42	21:42	343.5	327.5	6.9	2.1	768.7	733.0	727.0
12	21:53	22:53	336.2	320.7	6.9	2.2	752.1	717.3	718.0
13	22:54	23:54	330.8	315.6	6.9	2.2	738.4	704.3	712.7
14	23:55	00:55	330.3	315.0	7.0	2.2	743.7	709.4	717.6
15	00:56	01:56	332.8	317.4	7.1	2.1	756.4	721.5	726.2
16	01:57	02:57	332.5	317.1	7.0	2.1	748.4	713.9	709.2
17	02:58	03:58	331.6	316.3	7.1	2.2	751.1	716.4	710.8
18	03:59	04:59	333.3	317.9	7.0	2.3	751.6	716.9	713.9
19	05:00	06:00	340.6	324.8	7.0	2.2	767.6	732.0	727.1
20	06:01	07:01	342.8	326.8	7.0	2.3	771.6	735.8	730.8
21	07:12	08:12	334.7	319.2	6.9	2.3	750.0	715.4	711.5
22	08:13	09:13	336.6	321.0	7.0	2.2	757.5	722.5	715.2
23	09:14	10:14	322.6	307.8	7.2	2.2	734.6	700.9	693.3
24	10:50	11:50	317.8	303.3	6.8	2.1	703.7	671.5	675.2
25	11:51	12:51	330.4	315.1	6.8	2.1	731.2	697.5	693.2
26	13:02	14:02	313.6	299.2	7.0	2.0	702.3	670.2	655.3
27	14:03	15:03	318.9	304.3	7.0	2.0	716.0	683.2	665.3
28	15:04	16:04	320.8	306.1	7.0	2.0	720.3	687.2	677.3
29	16:05	17:05	319.7	305.1	7.2	2.2	728.8	695.4	688.9
30	17:06	18:06	322.3	307.5	7.3	2.2	739.1	705.2	701.2
31	18:07	19:07	318.5	303.9	7.1	2.2	719.4	686.5	683.1
32	19:08	20:08	316.9	302.4	7.0	2.2	714.4	681.7	677.6
33	20:09	21:09	326.6	311.5	6.9	2.2	732.1	698.4	695.8
34	21:10	22:10	331.0	315.7	6.9	2.2	740.2	706.1	703.4
35	22:21	23:21	315.2	300.8	6.8	2.2	701.8	669.7	664.0
36	23:22	00:22	274.4	262.2	8.3	2.2	682.4	652.1	640.4
37	11:26	12:26	337.7	322.1	6.6	2.5	738.9	704.7	699.7
38	12:27	13:27	345.5	329.4	6.5	2.5	753.5	718.4	707.3
				Sum			27634.16		

Emission Limit Value (ELV) = 1080 mg/Nm^3

Reference Oxygen 6 %

4A1.9.1 Plot 2.1 CEM versus SRM Parallel Test Data at CEM measurement conditions –NOx ppm, wet gas.



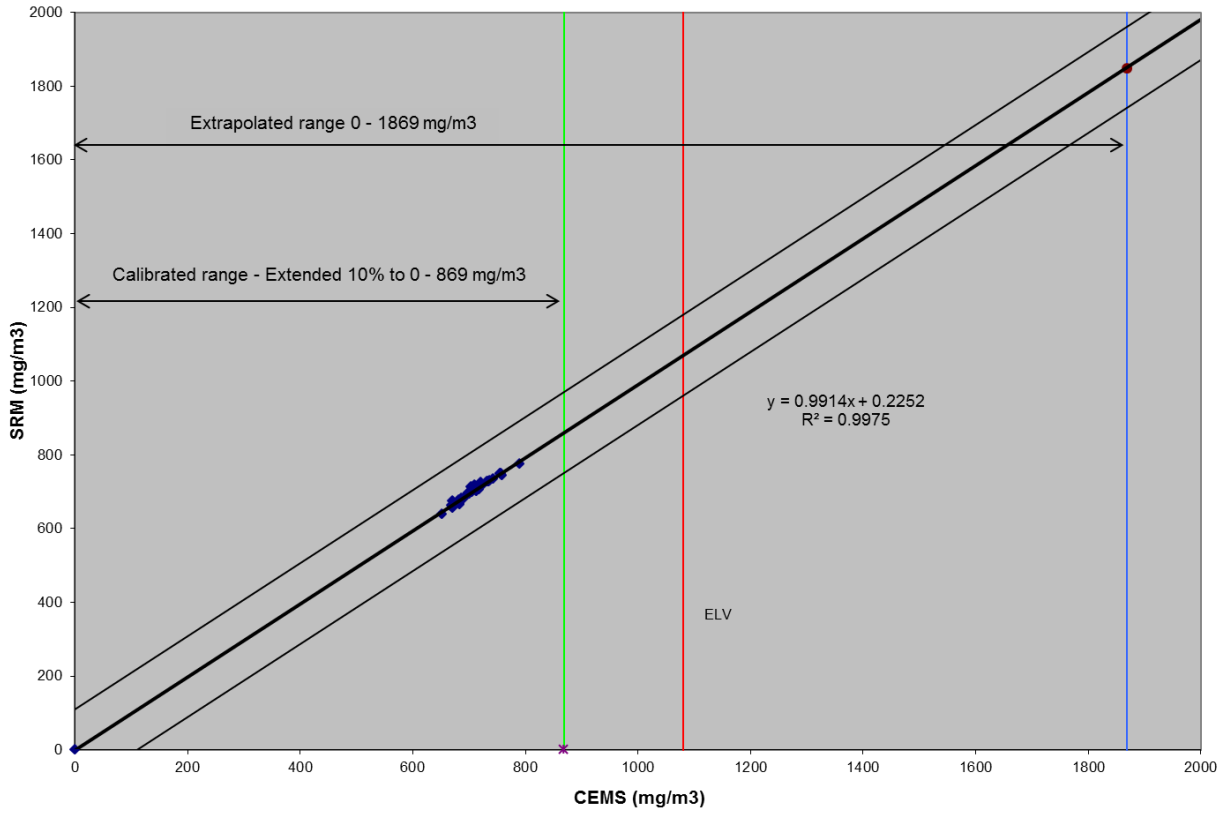
4A1.10.1 Table 4.5.1 – Data used for the Variability Test – Oxides of Nitrogen

Test No	Test Start Time	Test End Time	CEMS Calibrated Standardised value	SRM Standardised value	Difference D1	Difference D1 - D	Squared Difference D1 - D
	hr:min		mg/m3	mg/m3			
2	11:23	12:23	713.4	702.6	-10.82	-4.93	24.32
3	12:34	13:34	759.2	744.7	-14.52	-8.63	74.53
4	13:35	14:35	683.6	667.9	-15.68	-9.79	95.82
5	14:36	15:36	756.0	749.0	-6.99	-1.10	1.22
6	15:37	16:37	789.9	776.3	-13.59	-7.71	59.38
7	16:38	17:38	735.1	727.6	-7.49	-1.60	2.57
8	17:39	18:39	743.0	734.1	-8.92	-3.04	9.22
9	18:40	19:40	757.3	750.2	-7.03	-1.15	1.32
10	19:41	20:41	756.0	749.1	-6.90	-1.02	1.03
11	20:42	21:42	733.0	727.0	-5.98	-0.09	0.01
12	21:53	22:53	717.3	718.0	0.67	6.55	42.93
13	22:54	23:54	704.3	712.7	8.41	14.30	204.43
14	23:55	00:55	709.4	717.6	8.16	14.04	197.21
15	00:56	01:56	721.5	726.2	4.68	10.57	111.72
16	01:57	02:57	713.9	709.2	-4.64	1.24	1.54
17	02:58	03:58	716.4	710.8	-5.58	0.30	0.09
18	03:59	04:59	716.9	713.9	-2.99	2.90	8.42
19	05:00	06:00	732.0	727.1	-4.87	1.01	1.03
20	06:01	07:01	735.8	730.8	-5.02	0.86	0.74
21	07:12	08:12	715.4	711.5	-3.83	2.05	4.21
22	08:13	09:13	722.5	715.2	-7.21	-1.32	1.74
23	09:14	10:14	700.9	693.3	-7.60	-1.72	2.95
24	10:50	11:50	671.5	675.2	3.73	9.61	92.43
25	11:51	12:51	697.5	693.2	-4.25	1.64	2.68
26	13:02	14:02	670.2	655.3	-14.97	-9.08	82.43
27	14:03	15:03	683.2	665.3	-17.90	-12.01	144.29
28	15:04	16:04	687.2	677.3	-9.98	-4.09	16.72
29	16:05	17:05	695.4	688.9	-6.49	-0.61	0.37
30	17:06	18:06	705.2	701.2	-3.95	1.94	3.77
31	18:07	19:07	686.5	683.1	-3.43	2.46	6.05
32	19:08	20:08	681.7	677.6	-4.06	1.83	3.34
33	20:09	21:09	698.4	695.8	-2.57	3.31	10.97
34	21:10	22:10	706.1	703.4	-2.70	3.18	10.13
35	22:21	23:21	669.7	664.0	-5.70	0.19	0.04
36	23:22	00:22	652.1	640.4	-11.72	-5.83	34.04
37	11:26	12:26	704.7	699.7	-4.92	0.97	0.94
38	12:27	13:27	718.4	707.3	-11.15	-5.26	27.66
37 Tests		Mean			-5.89		
Sum							1282.27

4A1.11.1 - Variability Test Calculation – Oxides of Nitrogen

SD=	Root(1-Number).Integral(D1-D)^2	5.97	mg/m3(s,d),6%O2
The uncertainty laid down by the authorities is 20% ELV as a 95% confidence interval. O_0 is therefore calculated as:-			
O_0=	0.2*1080 mg/m3 (s,d,6%O2)/1.96	110.20	mg/m3(s,d),6%O2
For 37 tests, kv =	0.9885		
Therefore variability=	5.97 <= 110.2 * 0.9885		
	or 5.97 <= 108.94		
Which is TRUE therefore the CEMS passes the test			

4A1.12.1 Plot 3.1 –Standardised CEM data versus standardised SRM - Oxides of Nitrogen (as NO_2) – Reference conditions 273K, 101.3kPa, dry gas, 6% oxygen



4A1.1.2 Table 4.1.2 – Raw monitoring Data – Sulphur Dioxide, Low Range

Test No	Date	Test Start Time	Test End Time	CEMS Raw Value (wet)	CEMS Oxygen (dry)	CEMS Moisture	SRM Raw value (wet)	SRM Oxygen (dry)	SRM Moisture	SRM at CEMs Raw conditions
		hr:min		(ppm)	(%)	(%)	(ppm)	(%)	(%)	(ppm)
1	26-Oct-16	11:23	12:23	65.40	6.79	2.21	63.35	6.61	3.02	63.3
2	26-Oct-16	12:34	13:34	66.36	6.74	2.15	66.31	6.58	2.78	66.3
3	26-Oct-16	13:35	14:35	66.20	6.44	2.07	67.20	6.33	2.69	67.2
4	26-Oct-16	14:36	15:36	66.60	6.51	2.12	67.39	6.37	2.73	67.4
5	26-Oct-16	15:37	16:37	66.54	6.63	2.19	66.68	6.48	2.80	66.7
6	26-Oct-16	16:38	17:38	65.50	6.93	2.25	64.88	6.72	2.89	64.9
7	26-Oct-16	17:39	18:39	65.06	7.00	2.26	64.58	6.77	2.90	64.6
8	26-Oct-16	18:40	19:40	63.62	7.01	2.22	59.98	6.83	2.84	60.0
9	26-Oct-16	19:41	20:41	61.07	7.04	2.19	55.61	6.81	2.76	55.6
10	26-Oct-16	20:42	21:42	59.08	6.93	2.14	54.14	6.80	2.66	54.1
11	26-Oct-16	21:53	22:53	58.16	6.92	2.15	52.98	6.69	2.65	53.0
12	26-Oct-16	22:54	23:54	57.66	6.88	2.23	52.03	6.68	2.72	52.0
13	26-27/10/2016	23:55	0:55	55.09	7.01	2.19	49.45	6.78	2.66	49.4
14	27-Oct-16	0:56	1:56	52.96	7.15	2.12	47.16	6.93	2.59	47.2
15	27-Oct-16	1:57	2:57	53.68	7.01	2.13	48.38	6.83	2.62	48.4
16	27-Oct-16	2:58	3:58	54.80	7.08	2.21	49.52	6.85	2.73	49.5
17	27-Oct-16	3:59	4:59	55.21	7.01	2.27	50.03	6.79	2.80	50.0
18	27-Oct-16	5:00	6:00	52.96	7.01	2.24	47.23	6.79	2.74	47.2
19	27-Oct-16	6:01	7:01	51.65	6.99	2.26	45.39	6.77	2.73	45.4
20	27-Oct-16	7:12	8:12	52.71	6.93	2.26	46.08	6.71	2.73	46.1
21	27-Oct-16	8:13	9:13	52.21	7.00	2.21	45.45	6.78	2.67	45.5
22	27-Oct-16	9:14	10:14	52.38	7.16	2.22	44.75	6.93	2.68	44.8
23	27-Oct-16	10:50	11:50	56.08	6.79	2.06	53.11	6.68	2.58	53.1
24	27-Oct-16	11:51	12:51	59.48	6.78	2.11	56.52	6.58	2.84	56.5
25	27-Oct-16	13:02	14:02	62.32	6.96	1.99	58.67	6.75	2.63	58.7
26	27-Oct-16	14:03	15:03	63.59	7.00	1.95	60.69	6.78	2.63	60.7
27	27-Oct-16	15:04	16:04	64.84	6.99	1.99	63.57	6.78	2.62	63.6
28	27-Oct-16	16:05	17:05	62.66	7.18	2.18	59.02	6.95	2.80	59.0
29	27-Oct-16	17:06	18:06	60.21	7.26	2.17	56.66	7.03	2.84	56.7
30	27-Oct-16	18:07	19:07	57.10	7.05	2.18	53.37	6.84	2.83	53.4
31	27-Oct-16	19:08	20:08	52.29	7.02	2.17	49.14	6.80	2.85	49.1
32	27-Oct-16	20:09	21:09	51.76	6.95	2.16	48.63	6.74	2.82	48.6
33	27-Oct-16	21:10	22:10	49.63	6.91	2.19	46.83	6.72	2.86	46.8
34	27-Oct-16	22:21	23:21	47.46	6.84	2.24	44.76	6.63	2.93	44.8
35	27-28/10/2016	23:22	0:22	41.88	8.32	2.18	39.04	8.15	2.87	39.0
36	02-Nov-16	11:26	12:26	75.34	6.55	2.54	73.06	6.39	2.67	73.1
37	02-Nov-16	12:27	13:27	70.15	6.51	2.49	70.17	6.32	2.77	70.2

Note:

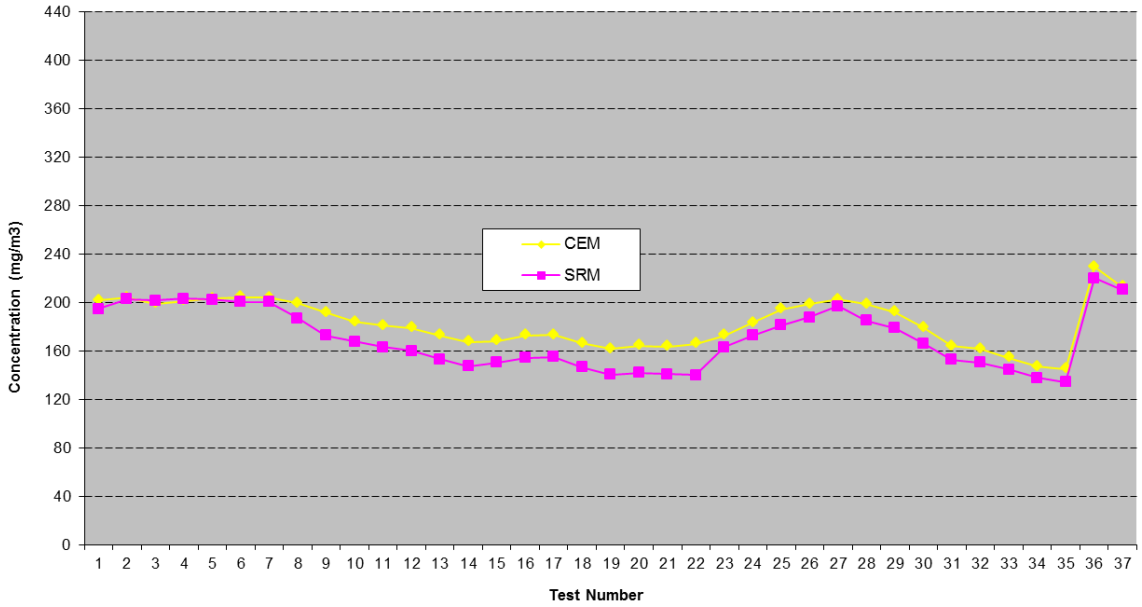
Emission concentrations expresed at reference conditions 273K, 101.3kPa

4A1.2.2 Table 4.2.2 -Standardised monitoring Data – Sulphur Dioxide, Low Range

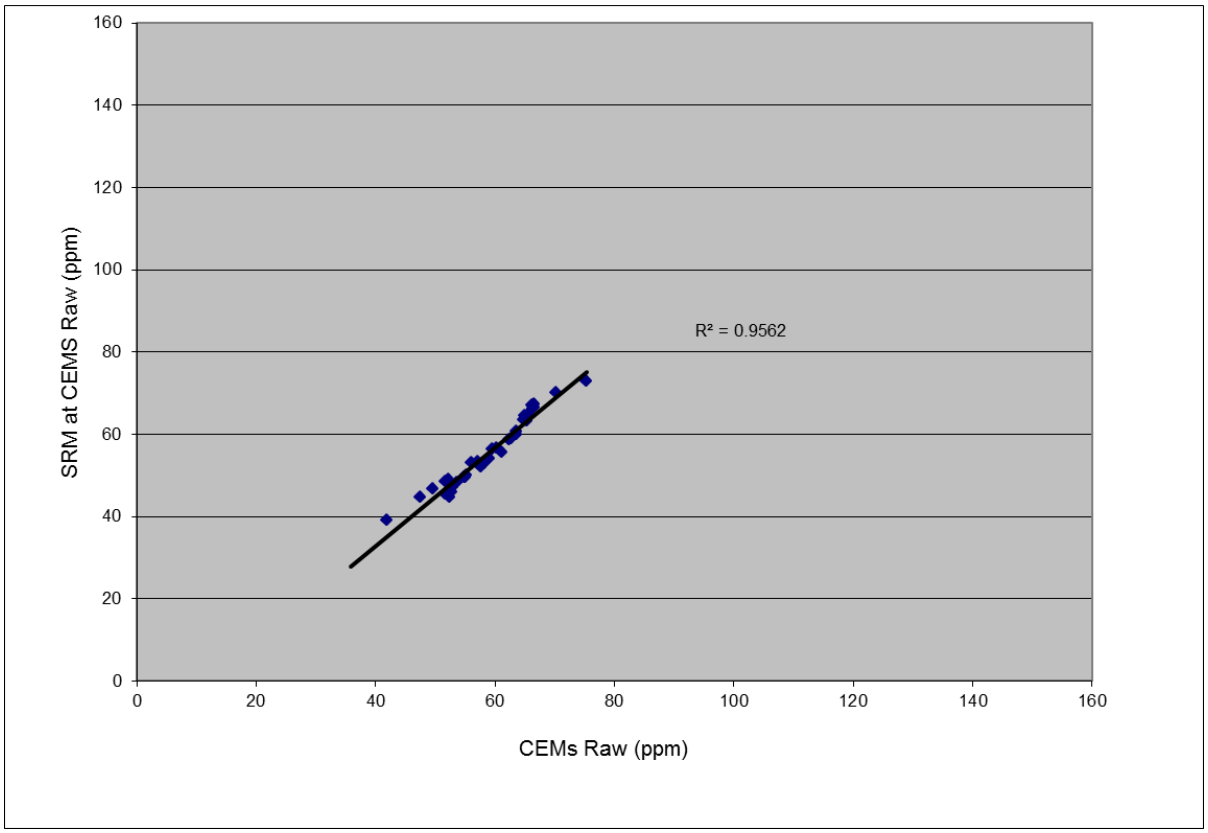
Test No	Date	Test Start Time	Test End Time	CEMS Standardised	SRM Standardised	SRM Uncertainty
		hr:min		(SO2 mg/m3)	(SO2 mg/m3)	(mg/m3)
1	26-Oct-16	11:23	12:23	201.7	194.6	8.7
2	26-Oct-16	12:34	13:34	203.9	202.7	9.1
3	26-Oct-16	13:35	14:35	199.0	201.8	9.1
4	26-Oct-16	14:36	15:36	201.3	203.0	9.1
5	26-Oct-16	15:37	16:37	203.0	202.6	9.1
6	26-Oct-16	16:38	17:38	204.1	200.5	9.0
7	26-Oct-16	17:39	18:39	203.8	200.4	9.0
8	26-Oct-16	18:40	19:40	199.5	186.8	8.4
9	26-Oct-16	19:41	20:41	191.7	172.8	7.8
10	26-Oct-16	20:42	21:42	183.9	168.0	7.6
11	26-Oct-16	21:53	22:53	181.0	163.1	7.3
12	26-Oct-16	22:54	23:54	179.0	160.1	7.2
13	26-27/10/2016	23:55	0:55	172.6	153.2	6.9
14	27-Oct-16	0:56	1:56	167.5	147.5	6.6
15	27-Oct-16	1:57	2:57	168.1	150.3	6.7
16	27-Oct-16	2:58	3:58	172.7	154.3	6.9
17	27-Oct-16	3:59	4:59	173.2	155.2	7.0
18	27-Oct-16	5:00	6:00	166.1	146.5	6.6
19	27-Oct-16	6:01	7:01	161.8	140.5	6.3
20	27-Oct-16	7:12	8:12	164.4	142.1	6.4
21	27-Oct-16	8:13	9:13	163.5	140.8	6.3
22	27-Oct-16	9:14	10:14	166.0	140.2	6.3
23	27-Oct-16	10:50	11:50	172.8	163.2	7.3
24	27-Oct-16	11:51	12:51	183.2	173.0	7.8
25	27-Oct-16	13:02	14:02	194.2	181.3	8.2
26	27-Oct-16	14:03	15:03	198.6	187.9	8.4
27	27-Oct-16	15:04	16:04	202.5	196.9	8.8
28	27-Oct-16	16:05	17:05	198.7	185.2	8.3
29	27-Oct-16	17:06	18:06	192.1	179.0	8.0
30	27-Oct-16	18:07	19:07	179.5	166.3	7.5
31	27-Oct-16	19:08	20:08	164.0	152.8	6.9
32	27-Oct-16	20:09	21:09	161.5	150.4	6.7
33	27-Oct-16	21:10	22:10	154.4	144.7	6.5
34	27-Oct-16	22:21	23:21	147.0	137.6	6.2
35	27-28/10/2016	23:22	0:22	144.9	134.2	6.0
36	02-Nov-16	11:26	12:26	229.3	220.2	9.9
37	02-Nov-16	12:27	13:27	212.9	210.7	9.4

Note:
Emission concentrations expresed at reference conditions 273K, 6 % Oxygen, dry gas

4A1.3.2 – Plot 1.2 - Time Series of Standardised CEM versus Standardised SRM data – Sulphur Dioxide, Low Range (Expressed at reference conditions 273K, 101.3kPa, dry gas, 6% oxygen)



4A1.4.2 – Elimination of Outliers – Sulphur Dioxide, Low Range.



Guidance on performing tests for outliers in MID 14181 section 6.3, states the following:

'As a general guide, when plotting the raw SRM and raw CEM data, if the R^2 value for the linear regression line is equal or more than 0.9, then it is not ordinarily necessary to perform an outlier test.
Additionally, any data points are not likely to be outliers unless they are more than two standard deviations from the regression line'

As the R^2 value for this determinand was 0.9562, an outlier test has not been undertaken.

4A1.5.2 Determination of Method A, B or C - Sulphur Dioxide, Low Range.

Test No	Test Start Time	Test End Time	SRM measured value (y)	SRM O2	SRM Standardised
	hr:min		(ppm)	(%)	(mg/m3)
1	11:23	12:23	63.3	6.6	194.6
2	12:34	13:34	66.3	6.6	202.7
3	13:35	14:35	67.2	6.3	201.8
4	14:36	15:36	67.4	6.4	203.0
5	15:37	16:37	66.7	6.5	202.6
6	16:38	17:38	64.9	6.7	200.5
7	17:39	18:39	64.6	6.8	200.4
8	18:40	19:40	60.0	6.8	186.8
9	19:41	20:41	55.6	6.8	172.8
10	20:42	21:42	54.1	6.8	168.0
11	21:53	22:53	53.0	6.7	163.1
12	22:54	23:54	52.0	6.7	160.1
13	23:55	0:55	49.4	6.8	153.2
14	0:56	1:56	47.2	6.9	147.5
15	1:57	2:57	48.4	6.8	150.3
16	2:58	3:58	49.5	6.9	154.3
17	3:59	4:59	50.0	6.8	155.2
18	5:00	6:00	47.2	6.8	146.5
19	6:01	7:01	45.4	6.8	140.5
20	7:12	8:12	46.1	6.7	142.1
21	8:13	9:13	45.5	6.8	140.8
22	9:14	10:14	44.8	6.9	140.2
23	10:50	11:50	53.1	6.7	163.2
24	11:51	12:51	56.5	6.6	173.0
25	13:02	14:02	58.7	6.8	181.3
26	14:03	15:03	60.7	6.8	187.9
27	15:04	16:04	63.6	6.8	196.9
28	16:05	17:05	59.0	6.9	185.2
29	17:06	18:06	56.7	7.0	179.0
30	18:07	19:07	53.4	6.8	166.3
31	19:08	20:08	49.1	6.8	152.8
32	20:09	21:09	48.6	6.7	150.4
33	21:10	22:10	46.8	6.7	144.7
34	22:21	23:21	44.8	6.6	137.6
35	23:22	0:22	39.0	8.1	134.2
36	11:26	12:26	73.1	6.4	220.2
37	12:27	13:27	70.2	6.3	210.7
Sum			2041.79		

Emission Limit Value (ELV) =	440	mg/Nm^3	Y_{max}	220.18
Maximum Permissable uncertainty =	20	%	Y_{min}	134.18
Maximum Permissable uncertainty (at I	88	mg/Nm^3		
15% of the ELV =	66	mg/Nm^3		
Is Ymax - Ymin > MPU at ELV?	No		$Y_{max - Ymin}$	86.00
Is Ymin > 15% of ELV?	Yes			

Derivation of Calibration Function	**Method B**

4A1.6.2 Table 4.3.2 - Data used to derive calibration function - Sulphur Dioxide, Low Range.

Test No	Test Start Time	Test End Time	SRM measured value (y)	CEMS measured signal (x)
	hr:min		(ppm)	(ppm)
1	Reference Zero		0.0	1.7
2	11:23	12:23	63.3	65.4
3	12:34	13:34	66.3	66.4
4	13:35	14:35	67.2	66.2
5	14:36	15:36	67.4	66.6
6	15:37	16:37	66.7	66.5
7	16:38	17:38	64.9	65.5
8	17:39	18:39	64.6	65.1
9	18:40	19:40	60.0	63.6
10	19:41	20:41	55.6	61.1
11	20:42	21:42	54.1	59.1
12	21:53	22:53	53.0	58.2
13	22:54	23:54	52.0	57.7
14	23:55	0:55	49.4	55.1
15	0:56	1:56	47.2	53.0
16	1:57	2:57	48.4	53.7
17	2:58	3:58	49.5	54.8
18	3:59	4:59	50.0	55.2
19	5:00	6:00	47.2	53.0
20	6:01	7:01	45.4	51.6
21	7:12	8:12	46.1	52.7
22	8:13	9:13	45.5	52.2
23	9:14	10:14	44.8	52.4
24	10:50	11:50	53.1	56.1
25	11:51	12:51	56.5	59.5
26	13:02	14:02	58.7	62.3
27	14:03	15:03	60.7	63.6
28	15:04	16:04	63.6	64.8
29	16:05	17:05	59.0	62.7
30	17:06	18:06	56.7	60.2
31	18:07	19:07	53.4	57.1
32	19:08	20:08	49.1	52.3
33	20:09	21:09	48.6	51.8
34	21:10	22:10	46.8	49.6
35	22:21	23:21	44.8	47.5
36	23:22	0:22	39.0	41.9
37	11:26	12:26	73.1	75.3
38	12:27	13:27	70.2	70.2
Sum			2041.79	2171.38

4A1.7.2 Determination of Calibration Function - Sulphur Dioxide, Low Range.

Method B

Formulae:-	**Number of tests conducted =**		**N**	**38**
If Ymax-Ymin <15% of the ELV, the following formulae are used:				
b=(y/(x-Z))	**x=(1/No. AMS Tests) * Total AMS**			
	x=(1/ 38)*2171.3	**or -**	**x=**	**57.14**
a=(-β.Z)	**y=(1/No. SRM Tests) * Total SRM**			
	y=(1/ 38)*2041.	**or -**	**y=**	**53.73**
The Slope is calculated by :				
β=y/(x-Z)	**53.73 /(57.14-1.67)**		**β=**	**0.969**
The offset is calculated by:				
α=-β.Z	**-0.96*1.67**		**α=**	**-1.62**
The calibration is function $y_{im} = \alpha + \beta_{xi,m}$ or		**yi =**	**-1.61 + 0.96 * Xi**	

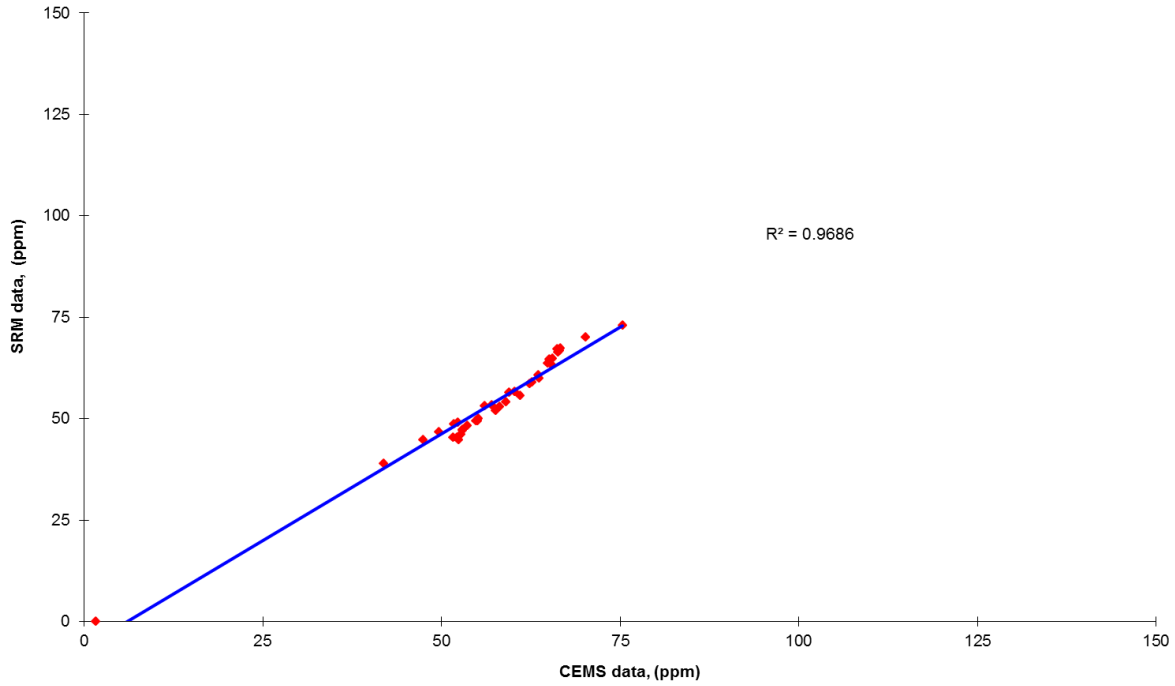
4A1.8.2 Table A.4.4.2 - Calculation of calibrated CEMS values - Sulphur Dioxide, Low Range

Test No	Test Start Time	Test End Time	CEMS Raw Value (x)	CEMS Calibrated signal	CEMS Dry Oxygen	CEMS Moisture	CEMS Standardised Value (dry)	CEMS Calibrated Standardised Value	SRM Standardised
	hr:min		(ppm)	(ppm)	(%)	(%)	(mg/Nm^3)	(mg/Nm^3)	(mg/m3)
1	Reference Zero		1.7	0.0	N/A	N/A	1.7	0.0	0.0
2	11:23	12:23	65.4	61.7	6.8	2.2	201.7	190.4	194.6
3	12:34	13:34	66.4	62.7	6.7	2.1	203.9	192.6	202.7
4	13:35	14:35	66.2	62.5	6.4	2.1	199.0	187.9	201.8
5	14:36	15:36	66.6	62.9	6.5	2.1	201.3	190.1	203.0
6	15:37	16:37	66.5	62.8	6.6	2.2	203.0	191.7	202.6
7	16:38	17:38	65.5	61.8	6.9	2.2	204.1	192.7	200.5
8	17:39	18:39	65.1	61.4	7.0	2.3	203.8	192.3	200.4
9	18:40	19:40	63.6	60.0	7.0	2.2	199.5	188.1	186.8
10	19:41	20:41	61.1	57.5	7.0	2.2	191.7	180.6	172.8
11	20:42	21:42	59.1	55.6	6.9	2.1	183.9	173.1	168.0
12	21:53	22:53	58.2	54.7	6.9	2.2	181.0	170.3	163.1
13	22:54	23:54	57.7	54.2	6.9	2.2	179.0	168.4	160.1
14	23:55	00:55	55.1	51.7	7.0	2.2	172.6	162.1	153.2
15	00:56	01:56	53.0	49.7	7.1	2.1	167.5	157.1	147.5
16	01:57	02:57	53.7	50.4	7.0	2.1	168.1	157.8	150.3
17	02:58	03:58	54.8	51.5	7.1	2.2	172.7	162.2	154.3
18	03:59	04:59	55.2	51.9	7.0	2.3	173.2	162.7	155.2
19	05:00	06:00	53.0	49.7	7.0	2.2	166.1	155.8	146.5
20	06:01	07:01	51.6	48.4	7.0	2.3	161.8	151.6	140.5
21	07:12	08:12	52.7	49.4	6.9	2.3	164.4	154.2	142.1
22	08:13	09:13	52.2	49.0	7.0	2.2	163.5	153.3	140.8
23	09:14	10:14	52.4	49.1	7.2	2.2	166.0	155.6	140.2
24	10:50	11:50	56.1	52.7	6.8	2.1	172.8	162.4	163.2
25	11:51	12:51	59.5	56.0	6.8	2.1	183.2	172.4	173.0
26	13:02	14:02	62.3	58.7	7.0	2.0	194.2	183.1	181.3
27	14:03	15:03	63.6	60.0	7.0	2.0	198.6	187.3	187.9
28	15:04	16:04	64.8	61.2	7.0	2.0	202.5	191.1	196.9
29	16:05	17:05	62.7	59.1	7.2	2.2	198.7	187.4	185.2
30	17:06	18:06	60.2	56.7	7.3	2.2	192.1	180.9	179.0
31	18:07	19:07	57.1	53.7	7.1	2.2	179.5	168.8	166.3
32	19:08	20:08	52.3	49.0	7.0	2.2	164.0	153.8	152.8
33	20:09	21:09	51.8	48.5	6.9	2.2	161.5	151.3	150.4
34	21:10	22:10	49.6	46.5	6.9	2.2	154.4	144.5	144.7
35	22:21	23:21	47.5	44.4	6.8	2.2	147.0	137.4	137.6
36	23:22	00:22	41.9	39.0	8.3	2.2	144.9	134.8	134.2
37	11:26	12:26	75.3	71.4	6.6	2.5	229.3	217.2	220.2
38	12:27	13:27	70.2	66.3	6.5	2.5	212.9	201.3	210.7
				Sum			6765.18		

Emission Limit Value (ELV) = 440 mg/Nm^3

Reference Oxygen 6 %

4A1.9.2 Plot 2.2 CEM versus SRM Parallel Test Data at CEM measurement conditions –Sulphur dioxide, wet gas



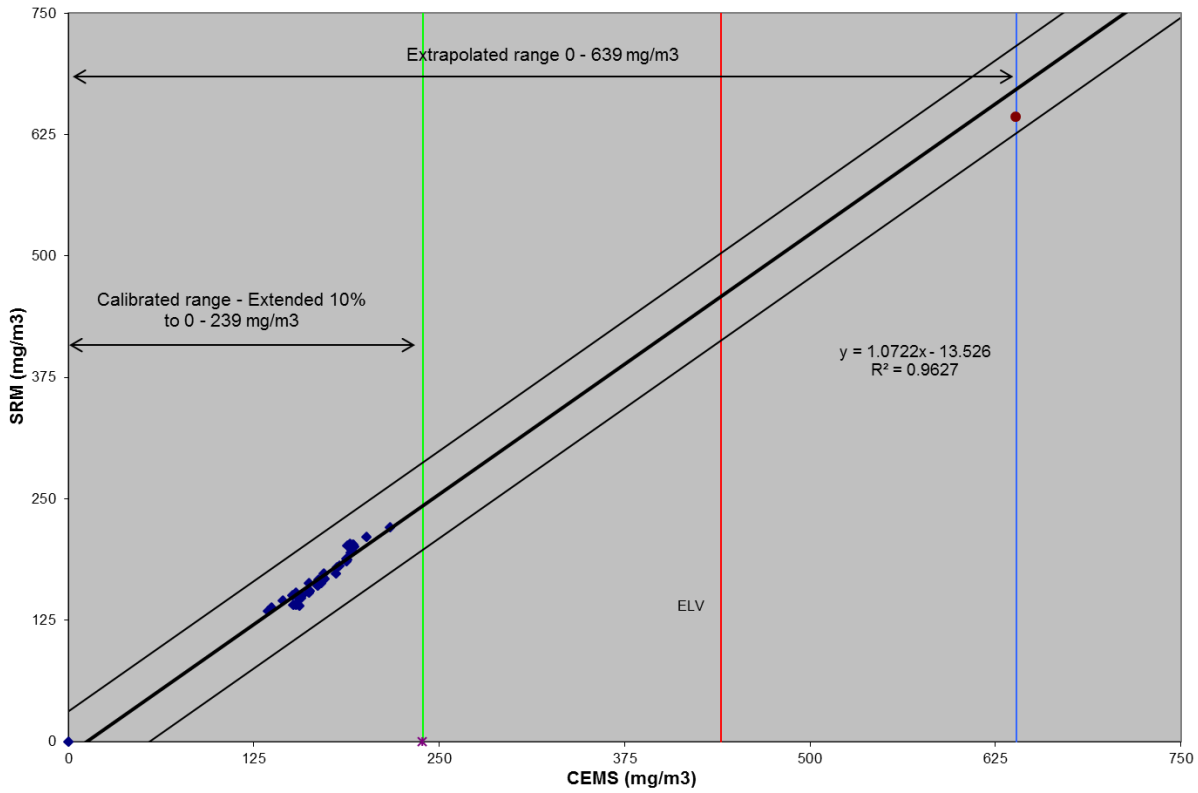
4A1.10.2 Table 4.5.2 – Data used for the Variability Test – Sulphur Dioxide, Low Range.

Test No	Test Start Time	Test End Time	CEMS Calibrated Standardised value	SRM Standardised value	Difference D1	Difference D1 - D	Squared Difference D1 - D
	hr:min		mg/m3	mg/m3			
2	11:23	12:23	190.4	194.6	4.18	5.64	31.83
3	12:34	13:34	192.6	202.7	10.16	11.63	135.28
4	13:35	14:35	187.9	201.8	13.84	15.31	234.27
5	14:36	15:36	190.1	203.0	12.87	14.33	205.42
6	15:37	16:37	191.7	202.6	10.88	12.35	152.44
7	16:38	17:38	192.7	200.5	7.81	9.28	86.14
8	17:39	18:39	192.3	200.4	8.04	9.50	90.31
9	18:40	19:40	188.1	186.8	-1.30	0.17	0.03
10	19:41	20:41	180.6	172.8	-7.84	-6.37	40.59
11	20:42	21:42	173.1	168.0	-5.18	-3.72	13.81
12	21:53	22:53	170.3	163.1	-7.25	-5.78	33.45
13	22:54	23:54	168.4	160.1	-8.26	-6.79	46.11
14	23:55	00:55	162.1	153.2	-8.92	-7.45	55.56
15	00:56	01:56	157.1	147.5	-9.59	-8.12	65.98
16	01:57	02:57	157.8	150.3	-7.51	-6.04	36.49
17	02:58	03:58	162.2	154.3	-7.92	-6.46	41.71
18	03:59	04:59	162.7	155.2	-7.46	-5.99	35.91
19	05:00	06:00	155.8	146.5	-9.29	-7.82	61.20
20	06:01	07:01	151.6	140.5	-11.10	-9.63	92.75
21	07:12	08:12	154.2	142.1	-12.01	-10.54	111.18
22	08:13	09:13	153.3	140.8	-12.54	-11.08	122.71
23	09:14	10:14	155.6	140.2	-15.48	-14.01	196.23
24	10:50	11:50	162.4	163.2	0.90	2.36	5.58
25	11:51	12:51	172.4	173.0	0.54	2.01	4.03
26	13:02	14:02	183.1	181.3	-1.74	-0.27	0.08
27	14:03	15:03	187.3	187.9	0.54	2.00	4.02
28	15:04	16:04	191.1	196.9	5.74	7.20	51.88
29	16:05	17:05	187.4	185.2	-2.15	-0.68	0.46
30	17:06	18:06	180.9	179.0	-1.95	-0.48	0.23
31	18:07	19:07	168.8	166.3	-2.44	-0.97	0.95
32	19:08	20:08	153.8	152.8	-1.01	0.46	0.21
33	20:09	21:09	151.3	150.4	-0.92	0.55	0.30
34	21:10	22:10	144.5	144.7	0.16	1.63	2.66
35	22:21	23:21	137.4	137.6	0.22	1.68	2.84
36	23:22	00:22	134.8	134.2	-0.59	0.87	0.76
37	11:26	12:26	217.2	220.2	2.95	4.42	19.53
38	12:27	13:27	201.3	210.7	9.36	10.83	117.32
37 Tests		Mean			-1.47		
Sum							2100.25

4A1.11.2 - Variability Test Calculation – Sulphur Dioxide, Low Range.

SD=	Root(1-Number).Integral(D1-D)^2	7.64	mg/m3(s,d),6%O2
The uncertainty laid down by the authorities is 20% ELV as a 95% confidence interval. O_0 is therefore calculated as:-			
O_0=	0.2*440 mg/m3 (s,d,6%O2)/1.96	44.90	mg/m3(s,d),6%O2
For 37 tests, kv =	0.9885		
Therefore variability=	7.64 <= 44.9 * 0.9885		
or	7.64 <=	44.38	
Which is TRUE therefore the CEMS passes the test			

4A1.12.2 Plot 3.2 –Standardised CEM data versus standardised SRM - Sulphur dioxide, Low Range – Reference conditions 273K, 101.3kPa 6% oxygen, dry gas.



4A1.1.3 Table 4.1.3– Raw monitoring Data – Sulphur Dioxide, High Range

Test No	Date	Test Start Time	Test End Time	CEMS Raw Value (wet)	CEMS Oxygen (dry)	CEMS Moisture	SRM Raw value (wet)	SRM Oxygen (dry)	SRM Moisture	SRM at CEMs Raw conditions
		hr:min		(ppm)	(%)	(%)	(ppm)	(%)	(%)	(ppm)
1	26-Oct-16	11:23	12:23	62.50	6.79	2.21	63.35	6.61	3.02	63.3
2	26-Oct-16	12:34	13:34	63.45	6.74	2.15	66.31	6.58	2.78	66.3
3	26-Oct-16	13:35	14:35	63.28	6.44	2.07	67.20	6.33	2.69	67.2
4	26-Oct-16	14:36	15:36	63.67	6.51	2.12	67.39	6.37	2.73	67.4
5	26-Oct-16	15:37	16:37	63.61	6.63	2.19	66.68	6.48	2.80	66.7
6	26-Oct-16	16:38	17:38	62.61	6.93	2.25	64.88	6.72	2.89	64.9
7	26-Oct-16	17:39	18:39	62.17	7.00	2.26	64.58	6.77	2.90	64.6
8	26-Oct-16	18:40	19:40	60.79	7.01	2.22	59.98	6.83	2.84	60.0
9	26-Oct-16	19:41	20:41	58.32	7.04	2.19	55.61	6.81	2.76	55.6
10	26-Oct-16	20:42	21:42	56.40	6.93	2.14	54.14	6.80	2.66	54.1
11	26-Oct-16	21:53	22:53	55.51	6.92	2.15	52.98	6.69	2.65	53.0
12	26-Oct-16	22:54	23:54	55.02	6.88	2.23	52.03	6.68	2.72	52.0
13	26-27/10/2016	23:55	0:55	52.54	7.01	2.19	49.45	6.78	2.66	49.4
14	27-Oct-16	0:56	1:56	50.49	7.15	2.12	47.16	6.93	2.59	47.2
15	27-Oct-16	1:57	2:57	51.19	7.01	2.13	48.38	6.83	2.62	48.4
16	27-Oct-16	2:58	3:58	52.26	7.08	2.21	49.52	6.85	2.73	49.5
17	27-Oct-16	3:59	4:59	52.66	7.01	2.27	50.03	6.79	2.80	50.0
18	27-Oct-16	5:00	6:00	50.50	7.01	2.24	47.23	6.79	2.74	47.2
19	27-Oct-16	6:01	7:01	49.23	6.99	2.26	45.39	6.77	2.73	45.4
20	27-Oct-16	7:12	8:12	50.25	6.93	2.26	46.08	6.71	2.73	46.1
21	27-Oct-16	8:13	9:13	49.78	7.00	2.21	45.45	6.78	2.67	45.5
22	27-Oct-16	9:14	10:14	49.93	7.16	2.22	44.75	6.93	2.68	44.8
23	27-Oct-16	10:50	11:50	53.51	6.79	2.06	53.11	6.68	2.58	53.1
24	27-Oct-16	11:51	12:51	56.79	6.78	2.11	56.52	6.58	2.84	56.5
25	27-Oct-16	13:02	14:02	59.54	6.96	1.99	58.67	6.75	2.63	58.7
26	27-Oct-16	14:03	15:03	60.77	7.00	1.95	60.69	6.78	2.63	60.7
27	27-Oct-16	15:04	16:04	61.97	6.99	1.99	63.57	6.78	2.62	63.6
28	27-Oct-16	16:05	17:05	59.86	7.18	2.18	59.02	6.95	2.80	59.0
29	27-Oct-16	17:06	18:06	57.49	7.26	2.17	56.66	7.03	2.84	56.7
30	27-Oct-16	18:07	19:07	54.49	7.05	2.18	53.37	6.84	2.83	53.4
31	27-Oct-16	19:08	20:08	49.85	7.02	2.17	49.14	6.80	2.85	49.1
32	27-Oct-16	20:09	21:09	49.34	6.95	2.16	48.63	6.74	2.82	48.6
33	27-Oct-16	21:10	22:10	47.28	6.91	2.19	46.83	6.72	2.86	46.8
34	27-Oct-16	22:21	23:21	45.20	6.84	2.24	44.76	6.63	2.93	44.8
35	27-28/10/2016	23:22	0:22	39.84	8.32	2.18	39.04	8.15	2.87	39.0
36	02-Nov-16	11:26	12:26	72.15	6.55	2.54	73.06	6.39	2.67	73.1
37	02-Nov-16	12:27	13:27	67.11	6.51	2.49	70.17	6.32	2.77	70.2

Note:

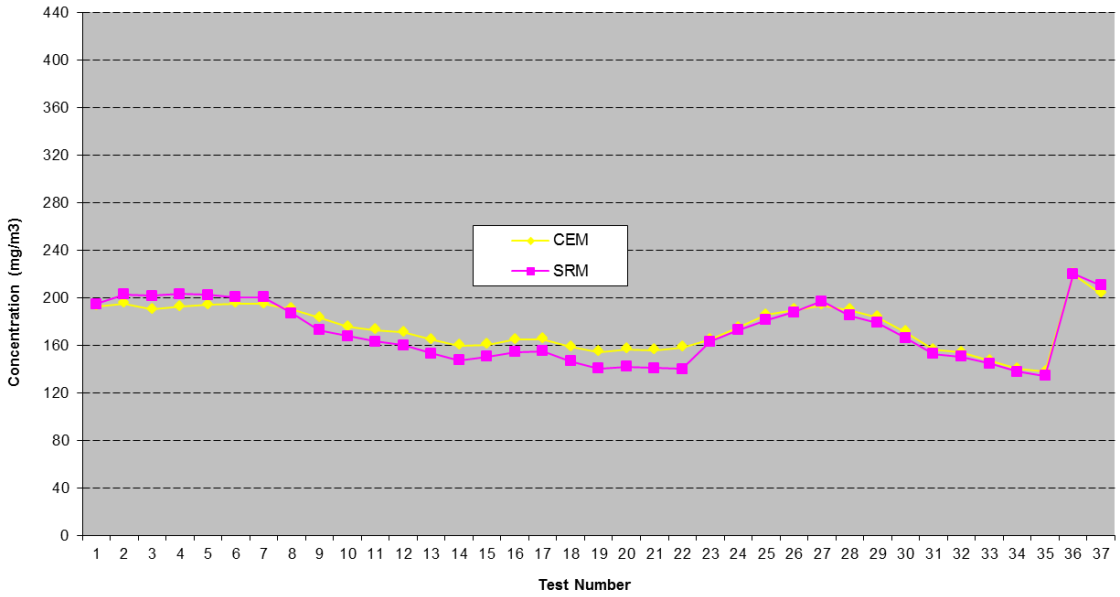
Emission concentrations expresed at reference conditions 273K, 101.3kPa

4A1.2.3 Table 4.2.3 -Standardised monitoring Data – Sulphur Dioxide, High Range

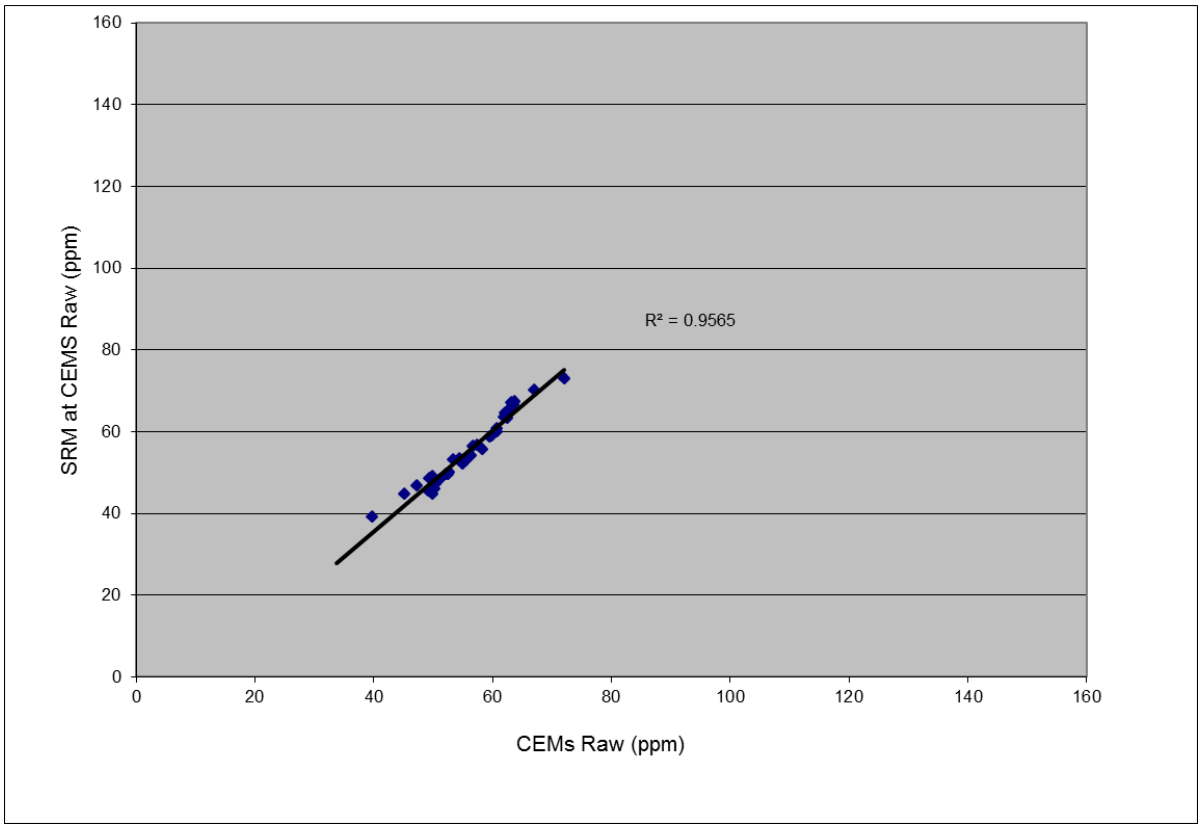
Test No	Date	Test Start Time	Test End Time	CEMS Standardised	SRM Standardised	SRM Uncertainty
		hr:min		(SO2 mg/m3)	(SO2 mg/m3)	(mg/m3)
1	26-Oct-16	11:23	12:23	192.8	194.6	8.7
2	26-Oct-16	12:34	13:34	195.0	202.7	9.1
3	26-Oct-16	13:35	14:35	190.3	201.8	9.1
4	26-Oct-16	14:36	15:36	192.5	203.0	9.1
5	26-Oct-16	15:37	16:37	194.1	202.6	9.1
6	26-Oct-16	16:38	17:38	195.1	200.5	9.0
7	26-Oct-16	17:39	18:39	194.8	200.4	9.0
8	26-Oct-16	18:40	19:40	190.6	186.8	8.4
9	26-Oct-16	19:41	20:41	183.1	172.8	7.8
10	26-Oct-16	20:42	21:42	175.6	168.0	7.6
11	26-Oct-16	21:53	22:53	172.8	163.1	7.3
12	26-Oct-16	22:54	23:54	170.8	160.1	7.2
13	26-27/10/2016	23:55	0:55	164.6	153.2	6.9
14	27-Oct-16	0:56	1:56	159.7	147.5	6.6
15	27-Oct-16	1:57	2:57	160.3	150.3	6.7
16	27-Oct-16	2:58	3:58	164.7	154.3	6.9
17	27-Oct-16	3:59	4:59	165.2	155.2	7.0
18	27-Oct-16	5:00	6:00	158.4	146.5	6.6
19	27-Oct-16	6:01	7:01	154.2	140.5	6.3
20	27-Oct-16	7:12	8:12	156.7	142.1	6.4
21	27-Oct-16	8:13	9:13	155.9	140.8	6.3
22	27-Oct-16	9:14	10:14	158.2	140.2	6.3
23	27-Oct-16	10:50	11:50	164.8	163.2	7.3
24	27-Oct-16	11:51	12:51	174.9	173.0	7.8
25	27-Oct-16	13:02	14:02	185.5	181.3	8.2
26	27-Oct-16	14:03	15:03	189.8	187.9	8.4
27	27-Oct-16	15:04	16:04	193.6	196.9	8.8
28	27-Oct-16	16:05	17:05	189.8	185.2	8.3
29	27-Oct-16	17:06	18:06	183.4	179.0	8.0
30	27-Oct-16	18:07	19:07	171.3	166.3	7.5
31	27-Oct-16	19:08	20:08	156.3	152.8	6.9
32	27-Oct-16	20:09	21:09	153.9	150.4	6.7
33	27-Oct-16	21:10	22:10	147.1	144.7	6.5
34	27-Oct-16	22:21	23:21	140.0	137.6	6.2
35	27-28/10/2016	23:22	0:22	137.8	134.2	6.0
36	02-Nov-16	11:26	12:26	219.6	220.2	9.9
37	02-Nov-16	12:27	13:27	203.6	210.7	9.4

Note:
Emission concentrations expresed at reference conditions 273K, 6 % Oxygen, dry gas

4A1.3.3 – Plot 1.3 - Time Series of Standardised CEM versus Standardised SRM data – Sulphur Dioxide, High Range (Expressed at reference conditions 273K, 101.3kPa, dry gas, 6% oxygen)



4A1.4.3 – Elimination of Outliers – Sulphur Dioxide, High Range.



Guidance on performing tests for outliers in MID 14181 section 6.3, states the following:

'As a general guide, when plotting the raw SRM and raw CEM data, if the R^2 value for the linear regression line is equal or more than 0.9, then it is not ordinarily necessary to perform an outlier test.
Additionally, any data points are not likely to be outliers unless they are more than two standard deviations from the regression line'

As the R^2 value for this determinand was 0.9565, an outlier test has not been undertaken.

4A1.5.3 Determination of Method A, B or C - Sulphur Dioxide, High Range.

Test No	Test Start Time	Test End Time	SRM measured value (y)	SRM O2	SRM Standardised
	hr:min		(ppm)	(%)	(mg/m3)
1	11:23	12:23	63.3	6.6	194.6
2	12:34	13:34	66.3	6.6	202.7
3	13:35	14:35	67.2	6.3	201.8
4	14:36	15:36	67.4	6.4	203.0
5	15:37	16:37	66.7	6.5	202.6
6	16:38	17:38	64.9	6.7	200.5
7	17:39	18:39	64.6	6.8	200.4
8	18:40	19:40	60.0	6.8	186.8
9	19:41	20:41	55.6	6.8	172.8
10	20:42	21:42	54.1	6.8	168.0
11	21:53	22:53	53.0	6.7	163.1
12	22:54	23:54	52.0	6.7	160.1
13	23:55	0:55	49.4	6.8	153.2
14	0:56	1:56	47.2	6.9	147.5
15	1:57	2:57	48.4	6.8	150.3
16	2:58	3:58	49.5	6.9	154.3
17	3:59	4:59	50.0	6.8	155.2
18	5:00	6:00	47.2	6.8	146.5
19	6:01	7:01	45.4	6.8	140.5
20	7:12	8:12	46.1	6.7	142.1
21	8:13	9:13	45.5	6.8	140.8
22	9:14	10:14	44.8	6.9	140.2
23	10:50	11:50	53.1	6.7	163.2
24	11:51	12:51	56.5	6.6	173.0
25	13:02	14:02	58.7	6.8	181.3
26	14:03	15:03	60.7	6.8	187.9
27	15:04	16:04	63.6	6.8	196.9
28	16:05	17:05	59.0	6.9	185.2
29	17:06	18:06	56.7	7.0	179.0
30	18:07	19:07	53.4	6.8	166.3
31	19:08	20:08	49.1	6.8	152.8
32	20:09	21:09	48.6	6.7	150.4
33	21:10	22:10	46.8	6.7	144.7
34	22:21	23:21	44.8	6.6	137.6
35	23:22	0:22	39.0	8.1	134.2
36	11:26	12:26	73.1	6.4	220.2
37	12:27	13:27	70.2	6.3	210.7
Sum			2041.79		

Emission Limit Value (ELV) =	440	mg/Nm^3	Y_{max}	220.18
Maximum Permissable uncertainty =	20	%	Y_{min}	134.18
Maximum Permissable uncertainty (at I	88	mg/Nm^3		
15% of the ELV =	66	mg/Nm^3		
Is Ymax - Ymin > MPU at ELV?	No		$Y_{max - Ymin}$	86.00
Is Ymin > 15% of ELV?	Yes			

Derivation of Calibration Function	**Method B**

4A1.6.3 Table 4.3.3 - Data used to derive calibration function - Sulphur Dioxide, High Range.

Test No	Test Start Time	Test End Time	SRM measured value (y)	CEMS measured signal (x)
	hr:min		(ppm)	(ppm)
1	Reference Zero		0.0	1.7
2	11:23	12:23	63.3	62.5
3	12:34	13:34	66.3	63.4
4	13:35	14:35	67.2	63.3
5	14:36	15:36	67.4	63.7
6	15:37	16:37	66.7	63.6
7	16:38	17:38	64.9	62.6
8	17:39	18:39	64.6	62.2
9	18:40	19:40	60.0	60.8
10	19:41	20:41	55.6	58.3
11	20:42	21:42	54.1	56.4
12	21:53	22:53	53.0	55.5
13	22:54	23:54	52.0	55.0
14	23:55	0:55	49.4	52.5
15	0:56	1:56	47.2	50.5
16	1:57	2:57	48.4	51.2
17	2:58	3:58	49.5	52.3
18	3:59	4:59	50.0	52.7
19	5:00	6:00	47.2	50.5
20	6:01	7:01	45.4	49.2
21	7:12	8:12	46.1	50.3
22	8:13	9:13	45.5	49.8
23	9:14	10:14	44.8	49.9
24	10:50	11:50	53.1	53.5
25	11:51	12:51	56.5	56.8
26	13:02	14:02	58.7	59.5
27	14:03	15:03	60.7	60.8
28	15:04	16:04	63.6	62.0
29	16:05	17:05	59.0	59.9
30	17:06	18:06	56.7	57.5
31	18:07	19:07	53.4	54.5
32	19:08	20:08	49.1	49.8
33	20:09	21:09	48.6	49.3
34	21:10	22:10	46.8	47.3
35	22:21	23:21	44.8	45.2
36	23:22	0:22	39.0	39.8
37	11:26	12:26	73.1	72.1
38	12:27	13:27	70.2	67.1
Sum			2041.79	2073.04

4A1.7.3 Determination of Calibration Function - Sulphur Dioxide, High Range.

Method B

Formulae:-	**Number of tests conducted =**		**N**	**38**
If Ymax-Ymin <15% of the ELV, the following formulae are used:				
b=(y/(x-Z))	**x=(1/No. AMS Tests) * Total AMS**			
	x=(1/ 38)*2073.0	**or -**	**x=**	**54.55**
a=(-β.Z)	**y=(1/No. SRM Tests) * Total SRM**			
	y=(1/ 38)*2041.	**or -**	**y=**	**53.73**
The Slope is calculated by :				
β=y/(x-Z)	**53.73 /(54.55-1.67)**		**β=**	**1.016**
The offset is calculated by:				
α=-β.Z	**-1.01*1.67**		**α=**	**-1.70**
The calibration is function $y_{im} = \alpha + \beta_{xi,m}$ or		**yi =**	**-1.69 + 1.01 * Xi**	

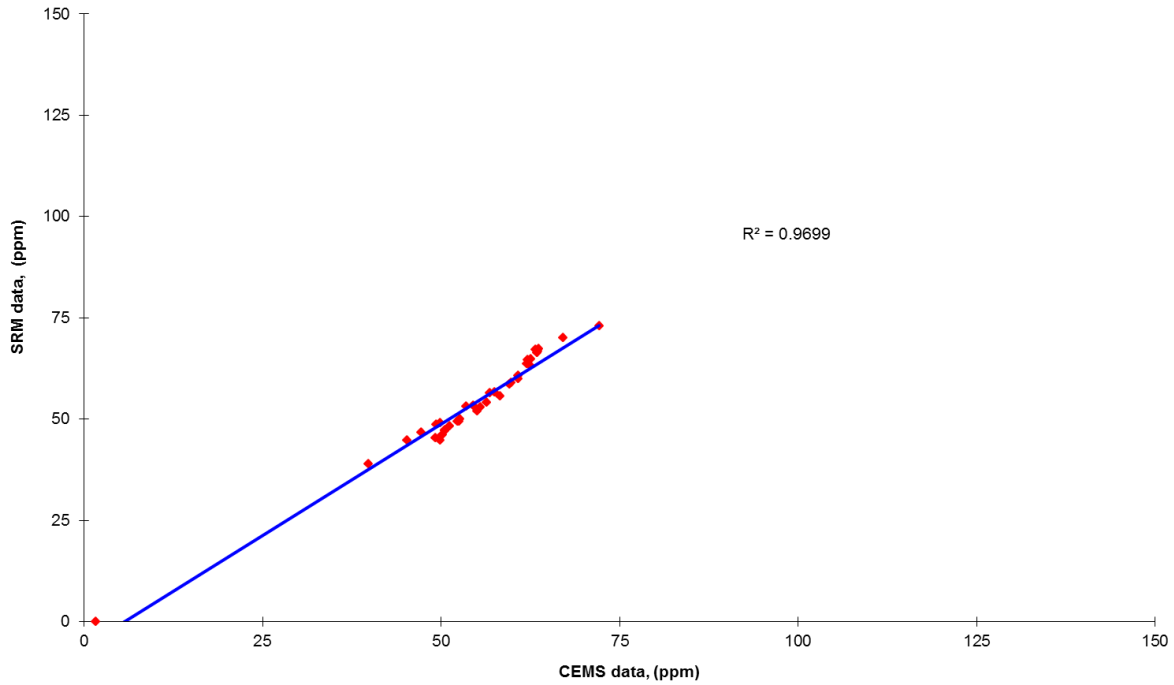
4A1.8.3 Table A.4.4.3 - Calculation of calibrated CEMS values - Sulphur Dioxide, High Range.

Test No	Test Start Time	Test End Time	CEMS Raw Value (x)	CEMS Calibrated signal	CEMS Dry Oxygen	CEMS Moisture	CEMS Standardised Value (dry)	CEMS Calibrated Standardised Value	SRM Standardised
	hr:min		(ppm)	(ppm)	(%)	(%)	(mg/Nm^3)	(mg/Nm^3)	(mg/m3)
1	Reference Zero		1.7	0.0	N/A	N/A	1.7	0.0	0.0
2	11:23	12:23	62.5	61.8	6.8	2.2	192.8	190.6	194.6
3	12:34	13:34	63.4	62.8	6.7	2.1	195.0	192.9	202.7
4	13:35	14:35	63.3	62.6	6.4	2.1	190.3	188.2	201.8
5	14:36	15:36	63.7	63.0	6.5	2.1	192.5	190.4	203.0
6	15:37	16:37	63.6	62.9	6.6	2.2	194.1	192.0	202.6
7	16:38	17:38	62.6	61.9	6.9	2.2	195.1	193.0	200.5
8	17:39	18:39	62.2	61.5	7.0	2.3	194.8	192.6	200.4
9	18:40	19:40	60.8	60.1	7.0	2.2	190.6	188.3	186.8
10	19:41	20:41	58.3	57.6	7.0	2.2	183.1	180.7	172.8
11	20:42	21:42	56.4	55.6	6.9	2.1	175.6	173.1	168.0
12	21:53	22:53	55.5	54.7	6.9	2.2	172.8	170.2	163.1
13	22:54	23:54	55.0	54.2	6.9	2.2	170.8	168.3	160.1
14	23:55	00:55	52.5	51.7	7.0	2.2	164.6	161.9	153.2
15	00:56	01:56	50.5	49.6	7.1	2.1	159.7	156.9	147.5
16	01:57	02:57	51.2	50.3	7.0	2.1	160.3	157.6	150.3
17	02:58	03:58	52.3	51.4	7.1	2.2	164.7	162.0	154.3
18	03:59	04:59	52.7	51.8	7.0	2.3	165.2	162.5	155.2
19	05:00	06:00	50.5	49.6	7.0	2.2	158.4	155.6	146.5
20	06:01	07:01	49.2	48.3	7.0	2.3	154.2	151.4	140.5
21	07:12	08:12	50.3	49.4	6.9	2.3	156.7	153.9	142.1
22	08:13	09:13	49.8	48.9	7.0	2.2	155.9	153.1	140.8
23	09:14	10:14	49.9	49.0	7.2	2.2	158.2	155.4	140.2
24	10:50	11:50	53.5	52.7	6.8	2.1	164.8	162.3	163.2
25	11:51	12:51	56.8	56.0	6.8	2.1	174.9	172.5	173.0
26	13:02	14:02	59.5	58.8	7.0	2.0	185.5	183.2	181.3
27	14:03	15:03	60.8	60.0	7.0	2.0	189.8	187.5	187.9
28	15:04	16:04	62.0	61.3	7.0	2.0	193.6	191.4	196.9
29	16:05	17:05	59.9	59.1	7.2	2.2	189.8	187.5	185.2
30	17:06	18:06	57.5	56.7	7.3	2.2	183.4	180.9	179.0
31	18:07	19:07	54.5	53.7	7.1	2.2	171.3	168.7	166.3
32	19:08	20:08	49.8	49.0	7.0	2.2	156.3	153.5	152.8
33	20:09	21:09	49.3	48.4	6.9	2.2	153.9	151.1	150.4
34	21:10	22:10	47.3	46.3	6.9	2.2	147.1	144.2	144.7
35	22:21	23:21	45.2	44.2	6.8	2.2	140.0	137.0	137.6
36	23:22	00:22	39.8	38.8	8.3	2.2	137.8	134.2	134.2
37	11:26	12:26	72.1	71.6	6.6	2.5	219.6	218.0	220.2
38	12:27	13:27	67.1	66.5	6.5	2.5	203.6	201.8	210.7
				Sum			6458.51		

Emission Limit Value (ELV) = 440 mg/Nm^3

Reference Oxygen 6 %

4A1.9.3 Plot 2.3 CEM versus SRM Parallel Test Data at CEM measurement conditions –Sulphur dioxide, wet gas.



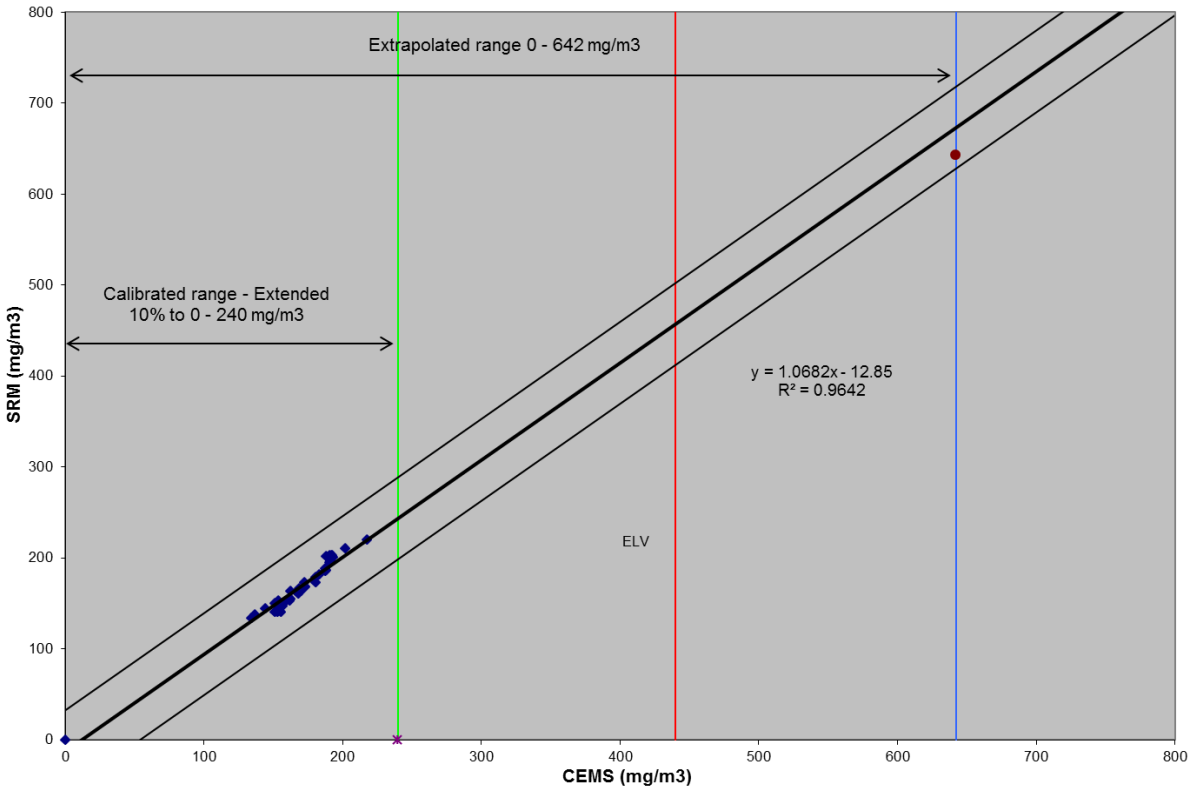
4A1.10.3 Table 4.5.3 – Data used for the Variability Test – Sulphur Dioxide, High Range.

Test No	Test Start Time	Test End Time	CEMS Calibrated Standardised value	SRM Standardised value	Difference D1	Difference D1 - D	Squared Difference D1 - D
	hr:min		mg/m3	mg/m3			
2	11:23	12:23	190.6	194.6	3.93	5.39	29.06
3	12:34	13:34	192.9	202.7	9.85	11.31	127.95
4	13:35	14:35	188.2	201.8	13.54	15.01	225.17
5	14:36	15:36	190.4	203.0	12.56	14.02	196.67
6	15:37	16:37	192.0	202.6	10.57	12.03	144.77
7	16:38	17:38	193.0	200.5	7.53	9.00	80.96
8	17:39	18:39	192.6	200.4	7.79	9.26	85.68
9	18:40	19:40	188.3	186.8	-1.49	-0.03	0.00
10	19:41	20:41	180.7	172.8	-7.91	-6.45	41.57
11	20:42	21:42	173.1	168.0	-5.17	-3.71	13.75
12	21:53	22:53	170.2	163.1	-7.19	-5.73	32.84
13	22:54	23:54	168.3	160.1	-8.18	-6.72	45.09
14	23:55	00:55	161.9	153.2	-8.75	-7.29	53.09
15	00:56	01:56	156.9	147.5	-9.36	-7.90	62.43
16	01:57	02:57	157.6	150.3	-7.30	-5.84	34.08
17	02:58	03:58	162.0	154.3	-7.74	-6.27	39.35
18	03:59	04:59	162.5	155.2	-7.30	-5.83	34.02
19	05:00	06:00	155.6	146.5	-9.05	-7.59	57.62
20	06:01	07:01	151.4	140.5	-10.82	-9.36	87.58
21	07:12	08:12	153.9	142.1	-11.76	-10.30	106.01
22	08:13	09:13	153.1	140.8	-12.30	-10.83	117.33
23	09:14	10:14	155.4	140.2	-15.22	-13.75	189.12
24	10:50	11:50	162.3	163.2	0.99	2.45	6.02
25	11:51	12:51	172.5	173.0	0.51	1.97	3.90
26	13:02	14:02	183.2	181.3	-1.90	-0.44	0.19
27	14:03	15:03	187.5	187.9	0.34	1.80	3.24
28	15:04	16:04	191.4	196.9	5.49	6.95	48.33
29	16:05	17:05	187.5	185.2	-2.29	-0.82	0.68
30	17:06	18:06	180.9	179.0	-1.97	-0.51	0.26
31	18:07	19:07	168.7	166.3	-2.37	-0.90	0.82
32	19:08	20:08	153.5	152.8	-0.75	0.72	0.51
33	20:09	21:09	151.1	150.4	-0.65	0.82	0.67
34	21:10	22:10	144.2	144.7	0.50	1.97	3.86
35	22:21	23:21	137.0	137.6	0.61	2.08	4.32
36	23:22	00:22	134.2	134.2	0.00	1.46	2.14
37	11:26	12:26	218.0	220.2	2.20	3.67	13.44
38	12:27	13:27	201.8	210.7	8.90	10.36	107.40
37 Tests		Mean			-1.46		
Sum							1999.90

4A1.11.3 - Variability Test Calculation – Sulphur Dioxide, High Range.

SD=	Root(1-Number).Integral(D1-D)^2		7.45	mg/m3(s,d),6%O2
The uncertainty laid down by the authorities is 20% ELV as a 95% confidence interval. O_0 is therefore calculated as:-				
O_0=	0.2*440 mg/m3 (s,d,6%O2)/1.96		44.90	mg/m3(s,d),6%O2
For 37 tests, kv =	0.9885			
Therefore variability=		7.45 <= 44.9 * 0.9885		
	or	7.45 <=	44.38	
Which is TRUE therefore the CEMS passes the test				

4A1.12.3 Plot 3.3 –Standardised CEM data versus standardised SRM - Sulphur dioxide, High Range – Reference conditions 273K, 101.3kPa., 6% oxygen, dry gas.



Section 4A2: Data & calculations – QAL2 – Unit 8, Procal 2

4A2.1 Table 4.1.1 – Raw monitoring Data – Oxides of Nitrogen

Test No	Date	Test Start Time	Test End Time	CEMS Raw Value (Wet)	CEMS Oxygen (dry)	CEMS Moisture	SRM Raw Value (dry)	SRM Oxygen (Dry)	SRM Moisture	SRM at CEMs Raw conditions
		hr:min		NO (ppm)	(%)	(%)	NOx (ppm)	(%)	(%)	NOx (ppm)
1	26-Oct-16	11:23	12:23	287.44	6.79	2.60	328.17	6.61	3.02	318.3
2	26-Oct-16	12:34	13:34	309.68	6.74	2.49	348.55	6.58	2.78	338.9
3	26-Oct-16	13:35	14:35	240.89	6.44	2.10	318.06	6.33	2.69	309.5
4	26-Oct-16	14:36	15:36	306.47	6.51	2.48	355.64	6.37	2.73	345.9
5	26-Oct-16	15:37	16:37	319.20	6.63	2.54	365.76	6.48	2.80	355.5
6	26-Oct-16	16:38	17:38	287.99	6.93	2.60	337.30	6.72	2.89	327.5
7	26-Oct-16	17:39	18:39	288.85	7.00	2.66	339.06	6.77	2.90	329.2
8	26-Oct-16	18:40	19:40	295.72	7.01	2.71	344.91	6.83	2.84	335.1
9	26-Oct-16	19:41	20:41	293.82	7.04	2.76	344.92	6.81	2.76	335.4
10	26-Oct-16	20:42	21:42	288.00	6.93	2.78	334.97	6.80	2.66	326.1
11	26-Oct-16	21:53	22:53	280.16	6.92	2.79	333.39	6.69	2.65	324.6
12	26-Oct-16	22:54	23:54	277.76	6.88	2.79	331.21	6.68	2.72	322.2
13	26-27/10/2016	23:55	0:55	273.58	7.01	2.73	331.05	6.78	2.66	322.2
14	27-Oct-16	0:56	1:56	280.66	7.15	2.66	331.55	6.93	2.59	323.0
15	27-Oct-16	1:57	2:57	280.74	7.01	2.44	326.22	6.83	2.62	317.7
16	27-Oct-16	2:58	3:58	278.98	7.08	2.35	326.35	6.85	2.73	317.5
17	27-Oct-16	3:59	4:59	282.66	7.01	2.40	329.32	6.79	2.80	320.1
18	27-Oct-16	5:00	6:00	286.19	7.01	2.45	335.27	6.79	2.74	326.1
19	27-Oct-16	6:01	7:01	292.48	6.99	2.50	337.56	6.77	2.73	328.4
20	27-Oct-16	7:12	8:12	280.62	6.93	2.54	329.93	6.71	2.73	320.9
21	27-Oct-16	8:13	9:13	284.77	7.00	2.55	330.14	6.78	2.67	321.3
22	27-Oct-16	9:14	10:14	271.92	7.16	2.56	316.48	6.93	2.68	308.0
23	27-Oct-16	10:50	11:50	273.91	6.79	2.57	313.70	6.68	2.58	305.6
24	27-Oct-16	11:51	12:51	279.28	6.78	2.53	324.34	6.58	2.84	315.1
25	27-Oct-16	13:02	14:02	265.67	6.96	2.43	302.95	6.75	2.63	295.0
26	27-Oct-16	14:03	15:03	266.19	7.00	2.15	307.08	6.78	2.63	299.0
27	27-Oct-16	15:04	16:04	267.87	6.99	2.12	312.45	6.78	2.62	304.3
28	27-Oct-16	16:05	17:05	265.10	7.18	2.19	314.18	6.95	2.80	305.4
29	27-Oct-16	17:06	18:06	269.37	7.26	2.27	317.90	7.03	2.84	308.9
30	27-Oct-16	18:07	19:07	264.62	7.05	2.34	313.87	6.84	2.83	305.0
31	27-Oct-16	19:08	20:08	261.75	7.02	2.38	312.16	6.80	2.85	303.3
32	27-Oct-16	20:09	21:09	272.19	6.95	2.40	322.07	6.74	2.82	313.0
33	27-Oct-16	21:10	22:10	274.67	6.91	2.42	326.00	6.72	2.86	316.7
34	27-Oct-16	22:21	23:21	259.82	6.84	2.45	309.61	6.63	2.93	300.5
35	27-28/10/2016	23:22	0:22	226.89	8.32	2.47	266.90	8.15	2.87	259.2
36	02-Nov-16	11:26	12:26	286.11	6.55	2.74	331.91	6.39	2.67	323.1
37	02-Nov-16	12:27	13:27	292.84	6.51	2.73	337.10	6.32	2.77	327.8

Note:

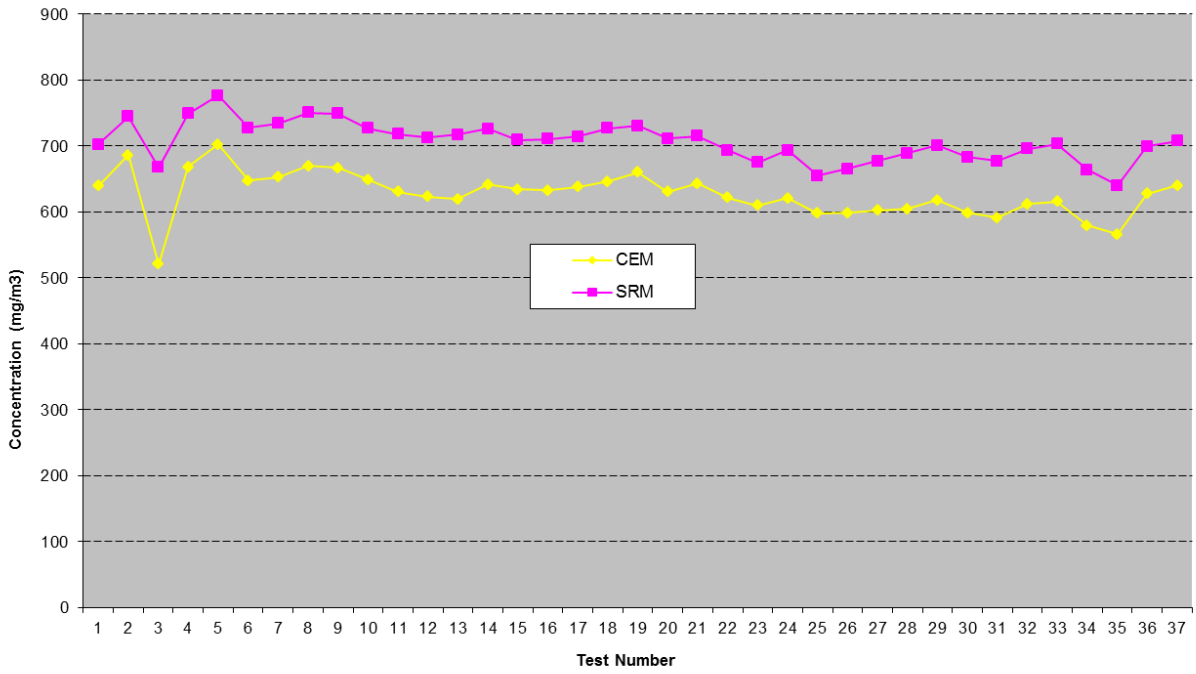
Emission concentrations expresed at reference conditions 273K, 101.3kPa

4A2.2 Table 4.2.1 - Standardised monitoring Data – Oxides of Nitrogen

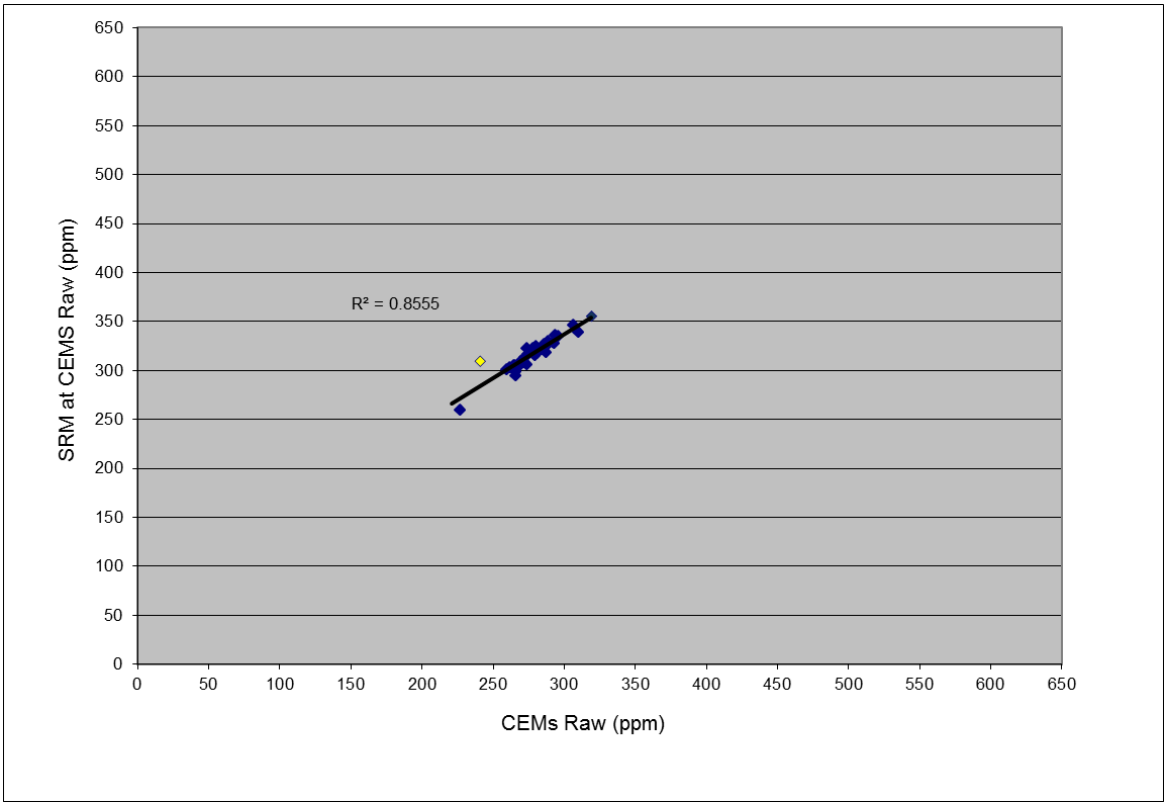
Test No	Date	Test Start Time	Test End Time	CEMS Standardised	SRM Standardised	SRM Uncertainty
		hr:min		(NOx as NO2 mg/m3)	(NOx as NO2 mg/m3)	(mg/m3)
1	26-Oct-16	11:23	12:23	639.7	702.6	23
2	26-Oct-16	12:34	13:34	686.4	744.7	24
3	26-Oct-16	13:35	14:35	520.8	667.9	22
4	26-Oct-16	14:36	15:36	668.4	749.0	25
5	26-Oct-16	15:37	16:37	702.5	776.3	25
6	26-Oct-16	16:38	17:38	647.5	727.6	24
7	26-Oct-16	17:39	18:39	653.0	734.1	24
8	26-Oct-16	18:40	19:40	669.7	750.2	25
9	26-Oct-16	19:41	20:41	666.9	749.1	25
10	26-Oct-16	20:42	21:42	648.7	727.0	24
11	26-Oct-16	21:53	22:53	630.8	718.0	24
12	26-Oct-16	22:54	23:54	623.4	712.7	23
13	26-27/10/2016	23:55	0:55	619.5	717.6	24
14	27-Oct-16	0:56	1:56	641.5	726.2	24
15	27-Oct-16	1:57	2:57	634.0	709.2	23
16	27-Oct-16	2:58	3:58	632.8	710.8	23
17	27-Oct-16	3:59	4:59	638.2	713.9	23
18	27-Oct-16	5:00	6:00	646.5	727.1	24
19	27-Oct-16	6:01	7:01	660.1	730.8	24
20	27-Oct-16	7:12	8:12	630.7	711.5	23
21	27-Oct-16	8:13	9:13	643.2	715.2	24
22	27-Oct-16	9:14	10:14	621.4	693.3	23
23	27-Oct-16	10:50	11:50	609.6	675.2	22
24	27-Oct-16	11:51	12:51	620.8	693.2	23
25	27-Oct-16	13:02	14:02	597.7	655.3	21
26	27-Oct-16	14:03	15:03	598.8	665.3	22
27	27-Oct-16	15:04	16:04	602.2	677.3	22
28	27-Oct-16	16:05	17:05	604.4	688.9	23
29	27-Oct-16	17:06	18:06	618.2	701.2	23
30	27-Oct-16	18:07	19:07	598.8	683.1	23
31	27-Oct-16	19:08	20:08	591.2	677.6	22
32	27-Oct-16	20:09	21:09	611.7	695.8	23
33	27-Oct-16	21:10	22:10	615.8	703.4	23
34	27-Oct-16	22:21	23:21	579.7	664.0	22
35	27-28/10/2016	23:22	0:22	565.9	640.4	21
36	02-Nov-16	11:26	12:26	627.3	699.7	23
37	02-Nov-16	12:27	13:27	640.3	707.3	23

Note:
Emission concentrations expresed at reference conditions 273K, 6 % Oxygen, dry gas

4A2.3 – Plot 1.1 - Time Series of Standardised CEM versus Standardised SRM data – Oxides of Nitrogen, (Expressed at reference conditions 273K, 101.3kPa, dry gas, 6% oxygen)



4A2.4 – Elimination of Outliers – Oxides of Nitrogen



4A2.4 (Cont…) – Elimination of Outliers – Oxides of Nitrogen

Test No	Test Start Time	Test End Time	CEMS Raw Value	SRM Value at CEMS Raw conditions	Difference Di	Difference Di - $\bar{D}i$	Is Result an Outlier - Di-$\bar{D}i$> 2SD
	hr:min		(ppm)	(ppm)			
1	11:23	12:23	287.4	318.3	30.83	-8.10	No
2	12:34	13:34	309.7	338.9	29.18	-9.75	No
3	13:35	14:35	240.9	309.5	68.62	29.69	Yes
4	14:36	15:36	306.5	345.9	39.47	0.54	No
5	15:37	16:37	319.2	355.5	36.30	-2.63	No
6	16:38	17:38	288.0	327.5	39.56	0.63	No
7	17:39	18:39	288.8	329.2	40.39	1.46	No
8	18:40	19:40	295.7	335.1	39.39	0.47	No
9	19:41	20:41	293.8	335.4	41.58	2.65	No
10	20:42	21:42	288.0	326.1	38.06	-0.86	No
11	21:53	22:53	280.2	324.6	44.42	5.49	No
12	22:54	23:54	277.8	322.2	44.44	5.51	No
13	23:55	00:55	273.6	322.2	48.66	9.74	No
14	00:56	01:56	280.7	323.0	42.30	3.38	No
15	01:57	02:57	280.7	317.7	36.92	-2.01	No
16	02:58	03:58	279.0	317.5	38.47	-0.45	No
17	03:59	04:59	282.7	320.1	37.44	-1.48	No
18	05:00	06:00	286.2	326.1	39.91	0.98	No
19	06:01	07:01	292.5	328.4	35.88	-3.04	No
20	07:12	08:12	280.6	320.9	40.31	1.38	No
21	08:13	09:13	284.8	321.3	36.57	-2.36	No
22	09:14	10:14	271.9	308.0	36.08	-2.85	No
23	10:50	11:50	273.9	305.6	31.69	-7.23	No
24	11:51	12:51	279.3	315.1	35.87	-3.06	No
25	13:02	14:02	265.7	295.0	29.30	-9.62	No
26	14:03	15:03	266.2	299.0	32.81	-6.12	No
27	15:04	16:04	267.9	304.3	36.39	-2.53	No
28	16:05	17:05	265.1	305.4	40.29	1.37	No
29	17:06	18:06	269.4	308.9	39.50	0.57	No
30	18:07	19:07	264.6	305.0	40.35	1.43	No
31	19:08	20:08	261.8	303.3	41.51	2.59	No
32	20:09	21:09	272.2	313.0	40.80	1.87	No
33	21:10	22:10	274.7	316.7	42.02	3.09	No
34	22:21	23:21	259.8	300.5	40.73	1.80	No
35	23:22	00:22	226.9	259.2	32.34	-6.59	No
36	11:26	12:26	286.1	323.1	36.94	-1.98	No
37	12:27	13:27	292.8	327.8	34.93	-3.99	No
				Average $\bar{D}i$	38.93		
			Standard Deviation		6.56		
			Standard Deviation x2		13.11		

4A2.5.1 Determination of Method A, B or C - Oxides of Nitrogen

Test No	Test Start Time	Test End Time	SRM measured value (y)	SRM O2	SRM Standardised
	hr:min		(ppm)	(%)	(mg/m3)
1	11:23	12:23	328.2	6.6	702.6
2	12:34	13:34	348.6	6.6	744.7
4	14:36	15:36	355.6	6.4	749.0
5	15:37	16:37	365.8	6.5	776.3
6	16:38	17:38	337.3	6.7	727.6
7	17:39	18:39	339.1	6.8	734.1
8	18:40	19:40	344.9	6.8	750.2
9	19:41	20:41	344.9	6.8	749.1
10	20:42	21:42	335.0	6.8	727.0
11	21:53	22:53	333.4	6.7	718.0
12	22:54	23:54	331.2	6.7	712.7
13	23:55	0:55	331.0	6.8	717.6
14	0:56	1:56	331.6	6.9	726.2
15	1:57	2:57	326.2	6.8	709.2
16	2:58	3:58	326.4	6.9	710.8
17	3:59	4:59	329.3	6.8	713.9
18	5:00	6:00	335.3	6.8	727.1
19	6:01	7:01	337.6	6.8	730.8
20	7:12	8:12	329.9	6.7	711.5
21	8:13	9:13	330.1	6.8	715.2
22	9:14	10:14	316.5	6.9	693.3
23	10:50	11:50	313.7	6.7	675.2
24	11:51	12:51	324.3	6.6	693.2
25	13:02	14:02	303.0	6.8	655.3
26	14:03	15:03	307.1	6.8	665.3
27	15:04	16:04	312.5	6.8	677.3
28	16:05	17:05	314.2	6.9	688.9
29	17:06	18:06	317.9	7.0	701.2
30	18:07	19:07	313.9	6.8	683.1
31	19:08	20:08	312.2	6.8	677.6
32	20:09	21:09	322.1	6.7	695.8
33	21:10	22:10	326.0	6.7	703.4
34	22:21	23:21	309.6	6.6	664.0
35	23:22	0:22	266.9	8.1	640.4
36	11:26	12:26	331.9	6.4	699.7
37	12:27	13:27	337.1	6.3	707.3
Sum			11770.01		

Emission Limit Value (ELV) =	1080	mg/Nm^3	Y_{max}	776.29
Maximum Permissable uncertainty =	20	%	Y_{min}	640.38
Maximum Permissable uncertainty (at I	216	mg/Nm^3		
15% of the ELV =	162	mg/Nm^3		
Is Ymax - Ymin > MPU at ELV?	No		$Y_{max - Ymin}$	135.91
Is Ymin > 15% of ELV?	Yes			

Derivation of Calibration Function	**Method B**

4A2.6.1 Table 4.3.1 - Data used to derive calibration function - Oxides of Nitrogen,

Test No	Test Start Time	Test End Time	SRM measured value (y)	CEMS measured signal (x)
	hr:min		(ppm)	(ppm)
1	Reference		0.0	2.3
2	11:23	12:23	318.3	287.4
3	12:34	13:34	338.9	309.7
5	14:36	15:36	345.9	306.5
6	15:37	16:37	355.5	319.2
7	16:38	17:38	327.5	288.0
8	17:39	18:39	329.2	288.8
9	18:40	19:40	335.1	295.7
10	19:41	20:41	335.4	293.8
11	20:42	21:42	326.1	288.0
12	21:53	22:53	324.6	280.2
13	22:54	23:54	322.2	277.8
14	23:55	0:55	322.2	273.6
15	0:56	1:56	323.0	280.7
16	1:57	2:57	317.7	280.7
17	2:58	3:58	317.5	279.0
18	3:59	4:59	320.1	282.7
19	5:00	6:00	326.1	286.2
20	6:01	7:01	328.4	292.5
21	7:12	8:12	320.9	280.6
22	8:13	9:13	321.3	284.8
23	9:14	10:14	308.0	271.9
24	10:50	11:50	305.6	273.9
25	11:51	12:51	315.1	279.3
26	13:02	14:02	295.0	265.7
27	14:03	15:03	299.0	266.2
28	15:04	16:04	304.3	267.9
29	16:05	17:05	305.4	265.1
30	17:06	18:06	308.9	269.4
31	18:07	19:07	305.0	264.6
32	19:08	20:08	303.3	261.8
33	20:09	21:09	313.0	272.2
34	21:10	22:10	316.7	274.7
35	22:21	23:21	300.5	259.8
36	23:22	0:22	259.2	226.9
37	11:26	12:26	323.1	286.1
38	12:27	13:27	327.8	292.8
Sum			11445.59	10076.30

4A2.7.1 Determination of Calibration Function - Oxides of Nitrogen

Method B

Formulae:-	**Number of tests conducted =**		**N**	**37**
If Ymax-Ymin <15% of the ELV, the following formulae are used:				
b=(y/(x-Z))	**x=(1/No. AMS Tests) * Total AMS**			
	x=(1/ 37)*10076.	**or -**	**x=**	**272.33**
a=(-β.Z)	**y=(1/No. SRM Tests) * Total SRM**			
	y=(1/ 37)*11445	**or -**	**y=**	**309.34**
The Slope is calculated by :				
β=y/(x-Z)	**309.3 /(272.3-2.33)**		**β=**	**1.146**
The offset is calculated by:				
α=-β.Z	**-1.14*2.33**		**α=**	**-2.67**
The calibration is function $y_{im} = \alpha + \beta_{xi,m}$ or		**yi =**	**-2.66 + 1.14 * Xi**	

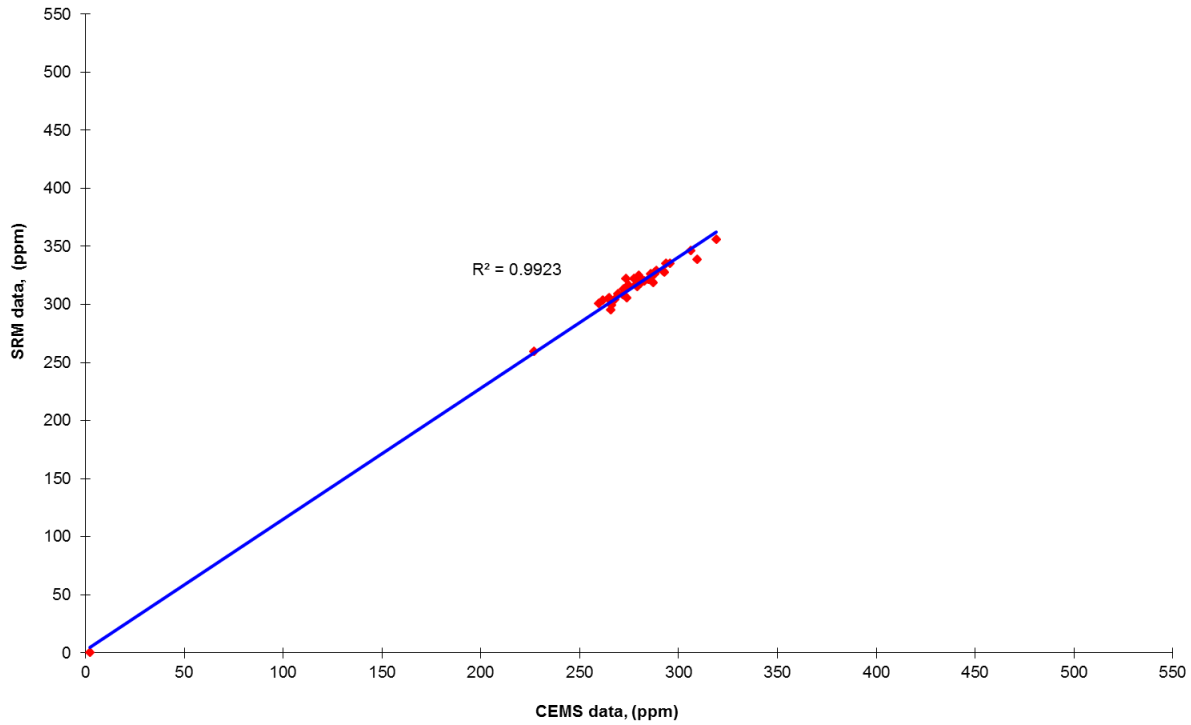
4A2.8.1 Table 4.4.1 - Calculation of calibrated CEMS values - Oxides of Nitrogen

Test No	Test Start Time	Test End Time	CEMS Raw Value (x)	CEMS Calibrated signal	CEMS Dry Oxygen	CEMS Moisture	CEMS Standardised Value (dry)	CEMS Calibrated Standardised Value	SRM Standardised
	hr:min		(ppm)	(ppm)	(%)	(%)	(mg/Nm^3)	(mg/Nm^3)	(mg/Nm3)
1	Reference		2.3	0.0	N/A	N/A	2.3	0.0	0.0
2	11:23	12:23	287.4	326.6	6.8	2.6	639.7	727.0	702.6
3	12:34	13:34	309.7	352.1	6.7	2.5	686.4	780.5	744.7
5	14:36	15:36	306.5	348.5	6.5	2.5	668.4	760.0	749.0
6	15:37	16:37	319.2	363.0	6.6	2.5	702.5	799.0	776.3
7	16:38	17:38	288.0	327.3	6.9	2.6	647.5	735.8	727.6
8	17:39	18:39	288.8	328.3	7.0	2.7	653.0	742.1	734.1
9	18:40	19:40	295.7	336.1	7.0	2.7	669.7	761.3	750.2
10	19:41	20:41	293.8	334.0	7.0	2.8	666.9	758.0	749.1
11	20:42	21:42	288.0	327.3	6.9	2.8	648.7	737.2	727.0
12	21:53	22:53	280.2	318.3	6.9	2.8	630.8	716.7	718.0
13	22:54	23:54	277.8	315.6	6.9	2.8	623.4	708.3	712.7
14	23:55	00:55	273.6	310.8	7.0	2.7	619.5	703.7	717.6
15	00:56	01:56	280.7	318.9	7.1	2.7	641.5	728.8	726.2
16	01:57	02:57	280.7	319.0	7.0	2.4	634.0	720.3	709.2
17	02:58	03:58	279.0	317.0	7.1	2.4	632.8	718.9	710.8
18	03:59	04:59	282.7	321.2	7.0	2.4	638.2	725.2	713.9
19	05:00	06:00	286.2	325.2	7.0	2.5	646.5	734.6	727.1
20	06:01	07:01	292.5	332.4	7.0	2.5	660.1	750.2	730.8
21	07:12	08:12	280.6	318.8	6.9	2.5	630.7	716.6	711.5
22	08:13	09:13	284.8	323.6	7.0	2.6	643.2	730.9	715.2
23	09:14	10:14	271.9	308.9	7.2	2.6	621.4	705.8	693.3
24	10:50	11:50	273.9	311.1	6.8	2.6	609.6	692.5	675.2
25	11:51	12:51	279.3	317.3	6.8	2.5	620.8	705.3	693.2
26	13:02	14:02	265.7	301.7	7.0	2.4	597.7	678.8	655.3
27	14:03	15:03	266.2	302.3	7.0	2.2	598.8	680.0	665.3
28	15:04	16:04	267.9	304.2	7.0	2.1	602.2	683.9	677.3
29	16:05	17:05	265.1	301.1	7.2	2.2	604.4	686.4	688.9
30	17:06	18:06	269.4	305.9	7.3	2.3	618.2	702.2	701.2
31	18:07	19:07	264.6	300.5	7.1	2.3	598.8	680.0	683.1
32	19:08	20:08	261.8	297.2	7.0	2.4	591.2	671.3	677.6
33	20:09	21:09	272.2	309.2	6.9	2.4	611.7	694.8	695.8
34	21:10	22:10	274.7	312.0	6.9	2.4	615.8	699.5	703.4
35	22:21	23:21	259.8	295.0	6.8	2.4	579.7	658.2	664.0
36	23:22	00:22	226.9	257.3	8.3	2.5	565.9	641.7	640.4
37	11:26	12:26	286.1	325.1	6.6	2.7	627.3	712.8	699.7
38	12:27	13:27	292.8	332.8	6.5	2.7	640.3	727.8	707.3
				Sum			22689.78		

Emission Limit Value (ELV) = 1080 mg/Nm^3

Reference Oxygen 6 %

4A2.9.1 Plot 2.1 CEM versus SRM Parallel Test Data at CEM measurement conditions –NOx ppm, wet gas.



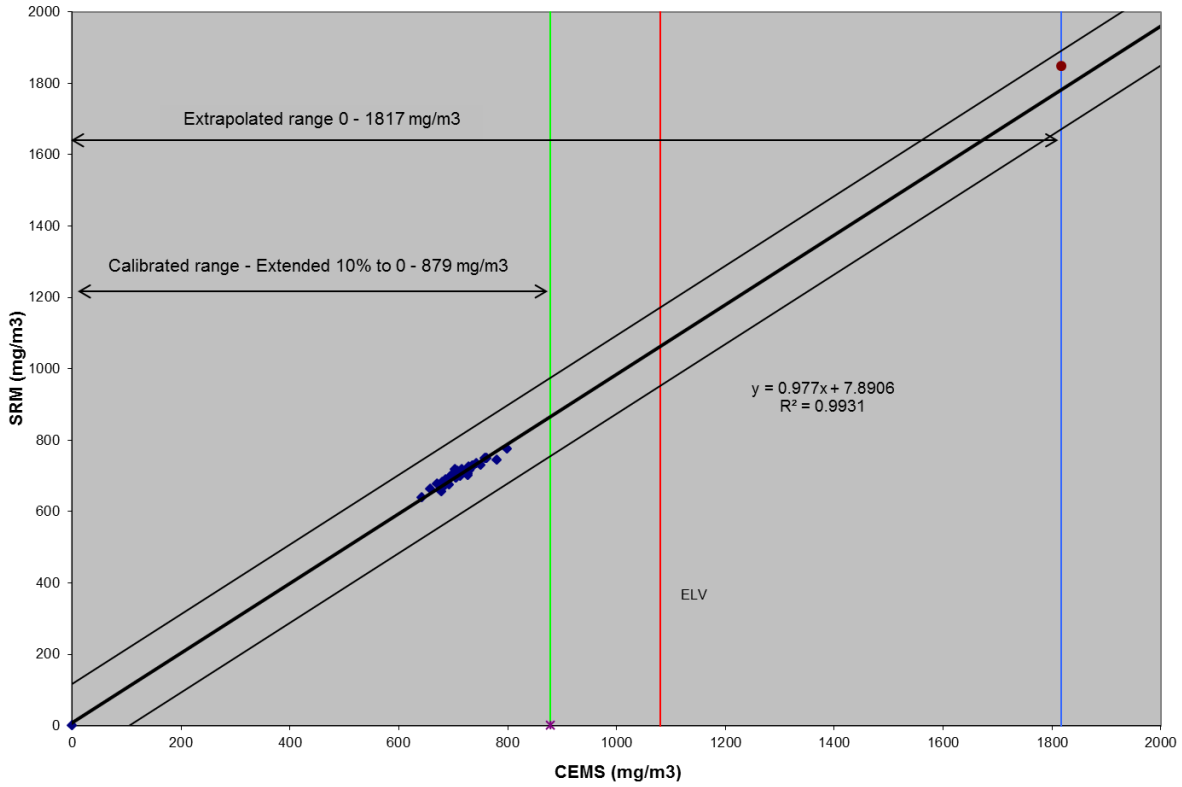
4A2.10.1 Table 4.5.1 – Data used for the Variability Test – Oxides of Nitrogen

Test No	Test Start Time	Test End Time	CEMS Calibrated Standardised value	SRM Standardised value	Difference D1	Difference D1 - D	Squared Difference D1 - D
	hr:min		mg/m3	mg/m3			
2	11:23	12:23	727.0	702.6	-24.40	-16.02	256.55
3	12:34	13:34	780.5	744.7	-35.85	-27.48	754.91
5	14:36	15:36	760.0	749.0	-10.97	-2.59	6.72
6	15:37	16:37	799.0	776.3	-22.70	-14.32	205.09
7	16:38	17:38	735.8	727.6	-8.15	0.22	0.05
8	17:39	18:39	742.1	734.1	-7.99	0.39	0.15
9	18:40	19:40	761.3	750.2	-11.03	-2.66	7.05
10	19:41	20:41	758.0	749.1	-8.95	-0.57	0.33
11	20:42	21:42	737.2	727.0	-10.24	-1.86	3.46
12	21:53	22:53	716.7	718.0	1.33	9.71	94.31
13	22:54	23:54	708.3	712.7	4.43	12.81	163.97
14	23:55	00:55	703.7	717.6	13.89	22.27	496.04
15	00:56	01:56	728.8	726.2	-2.66	5.72	32.68
16	01:57	02:57	720.3	709.2	-11.10	-2.72	7.39
17	02:58	03:58	718.9	710.8	-8.12	0.26	0.07
18	03:59	04:59	725.2	713.9	-11.26	-2.88	8.31
19	05:00	06:00	734.6	727.1	-7.47	0.91	0.83
20	06:01	07:01	750.2	730.8	-19.47	-11.09	123.02
21	07:12	08:12	716.6	711.5	-5.05	3.33	11.07
22	08:13	09:13	730.9	715.2	-15.63	-7.25	52.60
23	09:14	10:14	705.8	693.3	-12.52	-4.14	17.15
24	10:50	11:50	692.5	675.2	-17.28	-8.90	79.22
25	11:51	12:51	705.3	693.2	-12.12	-3.74	14.00
26	13:02	14:02	678.8	655.3	-23.56	-15.19	230.61
27	14:03	15:03	680.0	665.3	-14.72	-6.34	40.18
28	15:04	16:04	683.9	677.3	-6.66	1.72	2.97
29	16:05	17:05	686.4	688.9	2.56	10.94	119.58
30	17:06	18:06	702.2	701.2	-0.98	7.40	54.70
31	18:07	19:07	680.0	683.1	3.06	11.44	130.76
32	19:08	20:08	671.3	677.6	6.26	14.64	214.21
33	20:09	21:09	694.8	695.8	0.96	9.34	87.24
34	21:10	22:10	699.5	703.4	3.87	12.25	150.14
35	22:21	23:21	658.2	664.0	5.82	14.20	201.60
36	23:22	00:22	641.7	640.4	-1.36	7.02	49.32
37	11:26	12:26	712.8	699.7	-13.08	-4.70	22.07
38	12:27	13:27	727.8	707.3	-20.49	-12.11	146.71
36 Tests		Mean			-8.38		
Sum							3785.05

4A2.11.1 - Variability Test Calculation – Oxides of Nitrogen

SD=	Root(1-Number).Integral(D1-D)^2	10.40	mg/m3(s,d),6%O2
The uncertainty laid down by the authorities is 20% ELV as a 95% confidence interval. O_0 is therefore calculated as:-			
O_0=	0.2*1080 mg/m3 (s,d,6%O2)/1.96	110.20	mg/m3(s,d),6%O2
For 36 tests, kv =	0.9885		
Therefore variability=	10.4 <= 110.2 * 0.9885		
	or 10.40 <= 108.94		
Which is TRUE therefore the CEMS passes the test			

4A2.12.1 Plot 3.1 –Standardised CEM data versus standardised SRM - Oxides of Nitrogen (as NO_2) – Reference conditions 273K, 101.3kPa, dry gas, 6% oxygen



4A2.1.2 Table 4.1.2 – Raw monitoring Data – Sulphur Dioxide, Low Range

Test No	Date	Test Start Time	Test End Time	CEMS Raw Value (wet)	CEMS Oxygen (dry)	CEMS Moisture	SRM Raw value (wet)	SRM Oxygen (dry)	SRM Moisture	SRM at CEMs Raw conditions
		hr:min		(ppm)	(%)	(%)	(ppm)	(%)	(%)	(ppm)
1	26-Oct-16	11:23	12:23	60.41	6.79	2.60	63.35	6.61	3.02	63.3
2	26-Oct-16	12:34	13:34	60.92	6.74	2.49	66.31	6.58	2.78	66.3
3	26-Oct-16	13:35	14:35	60.93	6.44	2.42	67.20	6.33	2.69	67.2
4	26-Oct-16	14:36	15:36	61.47	6.51	2.48	67.39	6.37	2.73	67.4
5	26-Oct-16	15:37	16:37	61.17	6.63	2.54	66.68	6.48	2.80	66.7
6	26-Oct-16	16:38	17:38	60.47	6.93	2.60	64.88	6.72	2.89	64.9
7	26-Oct-16	17:39	18:39	60.17	7.00	2.66	64.58	6.77	2.90	64.6
8	26-Oct-16	18:40	19:40	58.63	7.01	2.71	59.98	6.83	2.84	60.0
9	26-Oct-16	19:41	20:41	56.50	7.04	2.76	55.61	6.81	2.76	55.6
10	26-Oct-16	20:42	21:42	54.15	6.93	2.78	54.14	6.80	2.66	54.1
11	26-Oct-16	21:53	22:53	53.27	6.92	2.79	52.98	6.69	2.65	53.0
12	26-Oct-16	22:54	23:54	52.62	6.88	2.79	52.03	6.68	2.72	52.0
13	26-27/10/2016	23:55	0:55	50.63	7.01	2.73	49.45	6.78	2.66	49.4
14	27-Oct-16	0:56	1:56	49.60	7.15	2.66	47.16	6.93	2.59	47.2
15	27-Oct-16	1:57	2:57	48.29	7.01	2.44	48.38	6.83	2.62	48.4
16	27-Oct-16	2:58	3:58	49.78	7.08	2.35	49.52	6.85	2.73	49.5
17	27-Oct-16	3:59	4:59	48.93	7.01	2.40	50.03	6.79	2.80	50.0
18	27-Oct-16	5:00	6:00	47.63	7.01	2.45	47.23	6.79	2.74	47.2
19	27-Oct-16	6:01	7:01	45.47	6.99	2.50	45.39	6.77	2.73	45.4
20	27-Oct-16	7:12	8:12	46.44	6.93	2.54	46.08	6.71	2.73	46.1
21	27-Oct-16	8:13	9:13	46.93	7.00	2.55	45.45	6.78	2.67	45.5
22	27-Oct-16	9:14	10:14	46.00	7.16	2.56	44.75	6.93	2.68	44.8
23	27-Oct-16	10:50	11:50	50.19	6.79	2.57	53.11	6.68	2.58	53.1
24	27-Oct-16	11:51	12:51	53.35	6.78	2.53	56.52	6.58	2.84	56.5
25	27-Oct-16	13:02	14:02	55.44	6.96	2.43	58.67	6.75	2.63	58.7
26	27-Oct-16	14:03	15:03	57.72	7.00	2.15	60.69	6.78	2.63	60.7
27	27-Oct-16	15:04	16:04	60.30	6.99	2.12	63.57	6.78	2.62	63.6
28	27-Oct-16	16:05	17:05	58.02	7.18	2.19	59.02	6.95	2.80	59.0
29	27-Oct-16	17:06	18:06	56.06	7.26	2.27	56.66	7.03	2.84	56.7
30	27-Oct-16	18:07	19:07	52.75	7.05	2.34	53.37	6.84	2.83	53.4
31	27-Oct-16	19:08	20:08	47.71	7.02	2.38	49.14	6.80	2.85	49.1
32	27-Oct-16	20:09	21:09	46.91	6.95	2.40	48.63	6.74	2.82	48.6
33	27-Oct-16	21:10	22:10	44.58	6.91	2.42	46.83	6.72	2.86	46.8
34	27-Oct-16	22:21	23:21	42.31	6.84	2.45	44.76	6.63	2.93	44.8
35	27-28/10/2016	23:22	0:22	36.68	8.32	2.47	39.04	8.15	2.87	39.0
36	02-Nov-16	11:26	12:26	70.64	6.55	2.74	73.06	6.39	2.67	73.1
37	02-Nov-16	12:27	13:27	66.03	6.51	2.73	70.17	6.32	2.77	70.2

Note:

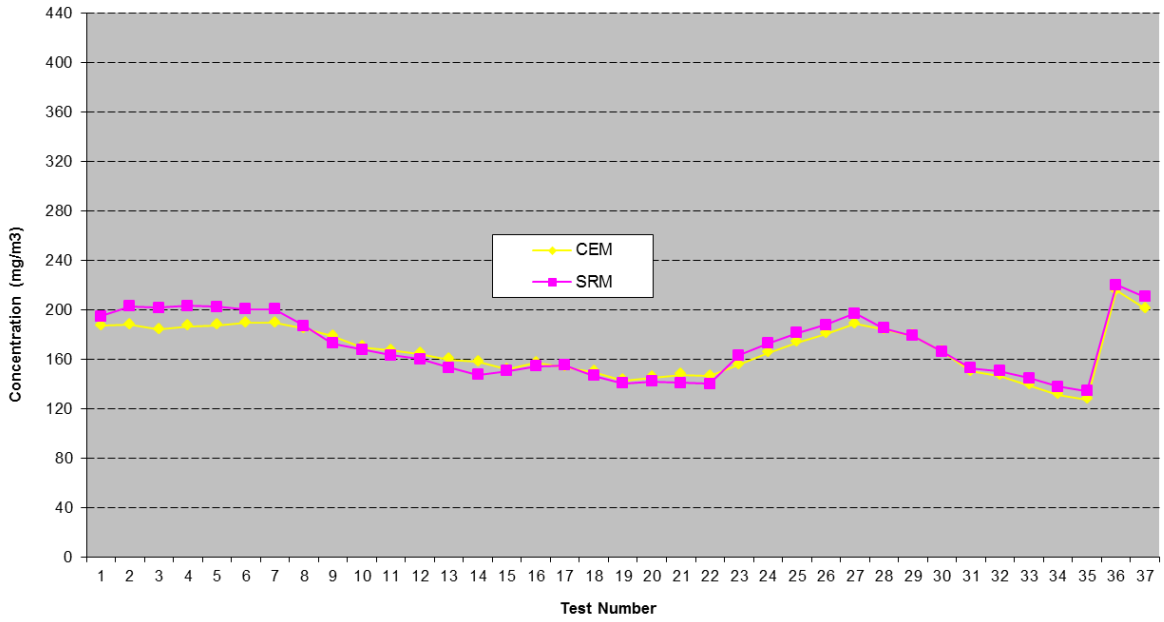
Emission concentrations expresed at reference conditions 273K, 101.3kPa

4A2.2.2 Table 4.2.2 -Standardised monitoring Data – Sulphur Dioxide, Low Range

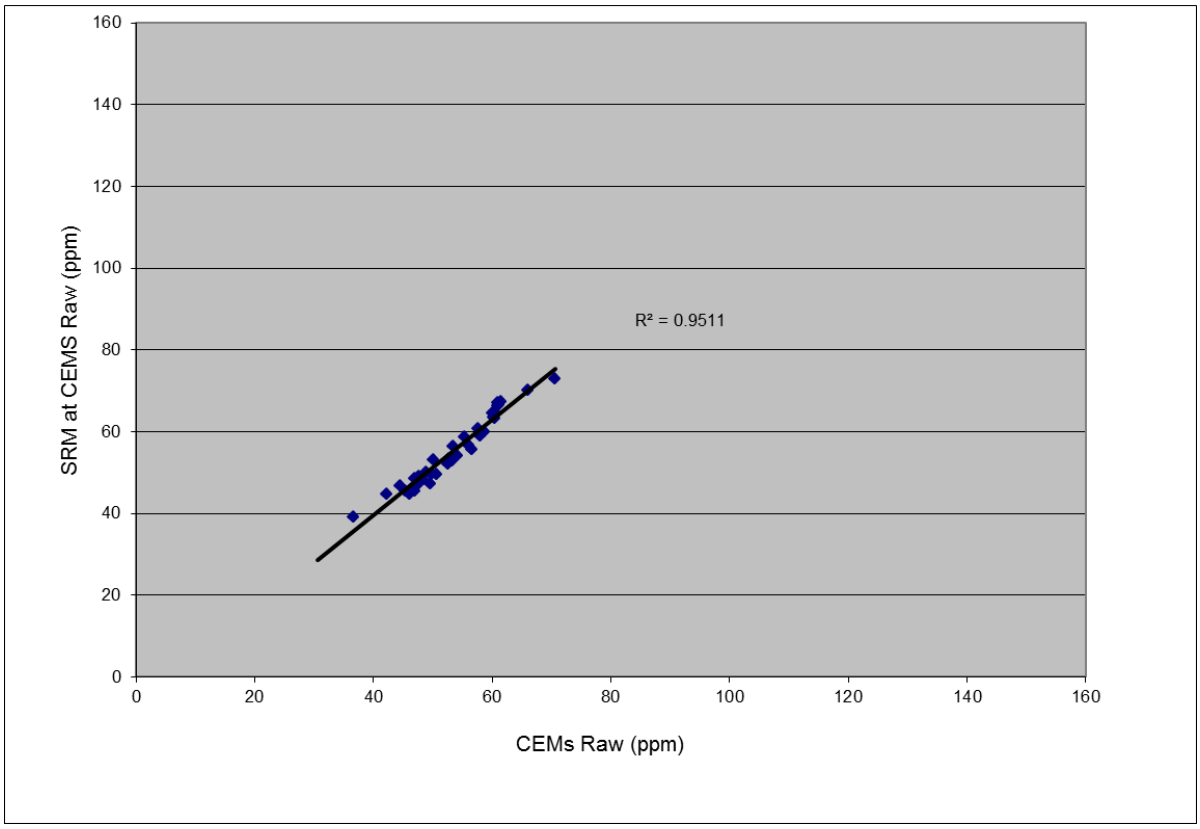
Test No	Date	Test Start Time	Test End Time	CEMS Standardised	SRM Standardised	SRM Uncertainty
		hr:min		(SO2 mg/m3)	(SO2 mg/m3)	(mg/m3)
1	26-Oct-16	11:23	12:23	187.1	194.6	8.7
2	26-Oct-16	12:34	13:34	187.9	202.7	9.1
3	26-Oct-16	13:35	14:35	183.9	201.8	9.1
4	26-Oct-16	14:36	15:36	186.5	203.0	9.1
5	26-Oct-16	15:37	16:37	187.3	202.6	9.1
6	26-Oct-16	16:38	17:38	189.2	200.5	9.0
7	26-Oct-16	17:39	18:39	189.2	200.4	9.0
8	26-Oct-16	18:40	19:40	184.8	186.8	8.4
9	26-Oct-16	19:41	20:41	178.4	172.8	7.8
10	26-Oct-16	20:42	21:42	169.7	168.0	7.6
11	26-Oct-16	21:53	22:53	166.9	163.1	7.3
12	26-Oct-16	22:54	23:54	164.3	160.1	7.2
13	26-27/10/2016	23:55	0:55	159.5	153.2	6.9
14	27-Oct-16	0:56	1:56	157.7	147.5	6.6
15	27-Oct-16	1:57	2:57	151.7	150.3	6.7
16	27-Oct-16	2:58	3:58	157.1	154.3	6.9
17	27-Oct-16	3:59	4:59	153.7	155.2	7.0
18	27-Oct-16	5:00	6:00	149.7	146.5	6.6
19	27-Oct-16	6:01	7:01	142.8	140.5	6.3
20	27-Oct-16	7:12	8:12	145.2	142.1	6.4
21	27-Oct-16	8:13	9:13	147.5	140.8	6.3
22	27-Oct-16	9:14	10:14	146.3	140.2	6.3
23	27-Oct-16	10:50	11:50	155.4	163.2	7.3
24	27-Oct-16	11:51	12:51	165.0	173.0	7.8
25	27-Oct-16	13:02	14:02	173.6	181.3	8.2
26	27-Oct-16	14:03	15:03	180.6	187.9	8.4
27	27-Oct-16	15:04	16:04	188.6	196.9	8.8
28	27-Oct-16	16:05	17:05	184.0	185.2	8.3
29	27-Oct-16	17:06	18:06	179.0	179.0	8.0
30	27-Oct-16	18:07	19:07	166.1	166.3	7.5
31	27-Oct-16	19:08	20:08	149.9	152.8	6.9
32	27-Oct-16	20:09	21:09	146.7	150.4	6.7
33	27-Oct-16	21:10	22:10	139.0	144.7	6.5
34	27-Oct-16	22:21	23:21	131.4	137.6	6.2
35	27-28/10/2016	23:22	0:22	127.3	134.2	6.0
36	02-Nov-16	11:26	12:26	215.5	220.2	9.9
37	02-Nov-16	12:27	13:27	200.9	210.7	9.4

Note:
Emission concentrations expresed at reference conditions 273K, 6 % Oxygen, dry gas

4A2.3.2 – Plot 1.2 - Time Series of Standardised CEM versus Standardised SRM data – Sulphur Dioxide, Low Range (Expressed at reference conditions 273K, 101.3kPa, dry gas, 6% oxygen)



4A2.4.2 – Elimination of Outliers – Sulphur Dioxide, Low Range.



Guidance on performing tests for outliers in MID 14181 section 6.3, states the following:

'As a general guide, when plotting the raw SRM and raw CEM data, if the R^2 value for the linear regression line is equal or more than 0.9, then it is not ordinarily necessary to perform an outlier test.
Additionally, any data points are not likely to be outliers unless they are more than two standard deviations from the regression line'

As the R^2 value for this determinand was 0.9511, an outlier test has not been undertaken.

4A2.5.2 Determination of Method A, B or C - Sulphur Dioxide, Low Range.

Test No	Test Start Time	Test End Time	SRM measured value (y)	SRM O2	SRM Standardised
	hr:min		(ppm)	(%)	(mg/m3)
1	11:23	12:23	63.3	6.6	194.6
2	12:34	13:34	66.3	6.6	202.7
3	13:35	14:35	67.2	6.3	201.8
4	14:36	15:36	67.4	6.4	203.0
5	15:37	16:37	66.7	6.5	202.6
6	16:38	17:38	64.9	6.7	200.5
7	17:39	18:39	64.6	6.8	200.4
8	18:40	19:40	60.0	6.8	186.8
9	19:41	20:41	55.6	6.8	172.8
10	20:42	21:42	54.1	6.8	168.0
11	21:53	22:53	53.0	6.7	163.1
12	22:54	23:54	52.0	6.7	160.1
13	23:55	0:55	49.4	6.8	153.2
14	0:56	1:56	47.2	6.9	147.5
15	1:57	2:57	48.4	6.8	150.3
16	2:58	3:58	49.5	6.9	154.3
17	3:59	4:59	50.0	6.8	155.2
18	5:00	6:00	47.2	6.8	146.5
19	6:01	7:01	45.4	6.8	140.5
20	7:12	8:12	46.1	6.7	142.1
21	8:13	9:13	45.5	6.8	140.8
22	9:14	10:14	44.8	6.9	140.2
23	10:50	11:50	53.1	6.7	163.2
24	11:51	12:51	56.5	6.6	173.0
25	13:02	14:02	58.7	6.8	181.3
26	14:03	15:03	60.7	6.8	187.9
27	15:04	16:04	63.6	6.8	196.9
28	16:05	17:05	59.0	6.9	185.2
29	17:06	18:06	56.7	7.0	179.0
30	18:07	19:07	53.4	6.8	166.3
31	19:08	20:08	49.1	6.8	152.8
32	20:09	21:09	48.6	6.7	150.4
33	21:10	22:10	46.8	6.7	144.7
34	22:21	23:21	44.8	6.6	137.6
35	23:22	0:22	39.0	8.1	134.2
36	11:26	12:26	73.1	6.4	220.2
37	12:27	13:27	70.2	6.3	210.7
Sum			2041.79		

Emission Limit Value (ELV) =	440	mg/Nm^3	Y_{max}	220.18
Maximum Permissable uncertainty =	20	%	Y_{min}	134.18
Maximum Permissable uncertainty (at I	88	mg/Nm^3		
15% of the ELV =	66	mg/Nm^3		
Is Ymax - Ymin > MPU at ELV?	No		$Y_{max - Ymin}$	86.00
Is Ymin > 15% of ELV?	Yes			

Derivation of Calibration Function	**Method B**

4A2.6.2 Table 4.3.2 - Data used to derive calibration function - Sulphur Dioxide, Low Range.

Test No	Test Start Time	Test End Time	SRM measured value (y)	CEMS measured signal (x)
	hr:min		(ppm)	(ppm)
1	Reference Zero		0.0	-1.0
2	11:23	12:23	63.3	60.4
3	12:34	13:34	66.3	60.9
4	13:35	14:35	67.2	60.9
5	14:36	15:36	67.4	61.5
6	15:37	16:37	66.7	61.2
7	16:38	17:38	64.9	60.5
8	17:39	18:39	64.6	60.2
9	18:40	19:40	60.0	58.6
10	19:41	20:41	55.6	56.5
11	20:42	21:42	54.1	54.2
12	21:53	22:53	53.0	53.3
13	22:54	23:54	52.0	52.6
14	23:55	0:55	49.4	50.6
15	0:56	1:56	47.2	49.6
16	1:57	2:57	48.4	48.3
17	2:58	3:58	49.5	49.8
18	3:59	4:59	50.0	48.9
19	5:00	6:00	47.2	47.6
20	6:01	7:01	45.4	45.5
21	7:12	8:12	46.1	46.4
22	8:13	9:13	45.5	46.9
23	9:14	10:14	44.8	46.0
24	10:50	11:50	53.1	50.2
25	11:51	12:51	56.5	53.4
26	13:02	14:02	58.7	55.4
27	14:03	15:03	60.7	57.7
28	15:04	16:04	63.6	60.3
29	16:05	17:05	59.0	58.0
30	17:06	18:06	56.7	56.1
31	18:07	19:07	53.4	52.7
32	19:08	20:08	49.1	47.7
33	20:09	21:09	48.6	46.9
34	21:10	22:10	46.8	44.6
35	22:21	23:21	44.8	42.3
36	23:22	0:22	39.0	36.7
37	11:26	12:26	73.1	70.6
38	12:27	13:27	70.2	66.0
Sum			2041.79	1978.13

4A2.7.2 Determination of Calibration Function - Sulphur Dioxide, Low Range.

Method B

Formulae:-	**Number of tests conducted =**		**N**	**38**
If Ymax-Ymin <15% of the ELV, the following formulae are used:				
b=(y/(x-Z))	**x=(1/No. AMS Tests) * Total AMS**			
	x=(1/ 38)*1978.1	**or -**	**x=**	**52.06**
a=(-β.Z)	**y=(1/No. SRM Tests) * Total SRM**			
	y=(1/ 38)*2041.	**or -**	**y=**	**53.73**
The Slope is calculated by :				
β=y/(x-Z)	**53.73 /(52.05--1)**		**β=**	**1.013**
The offset is calculated by:				
α=-β.Z	**-1.01*-1**		**α=**	**1.01**
The calibration is function $y_{im} = \alpha + \beta_{xi,m}$ or		**yi =**	**1.012 + 1.01 * Xi**	

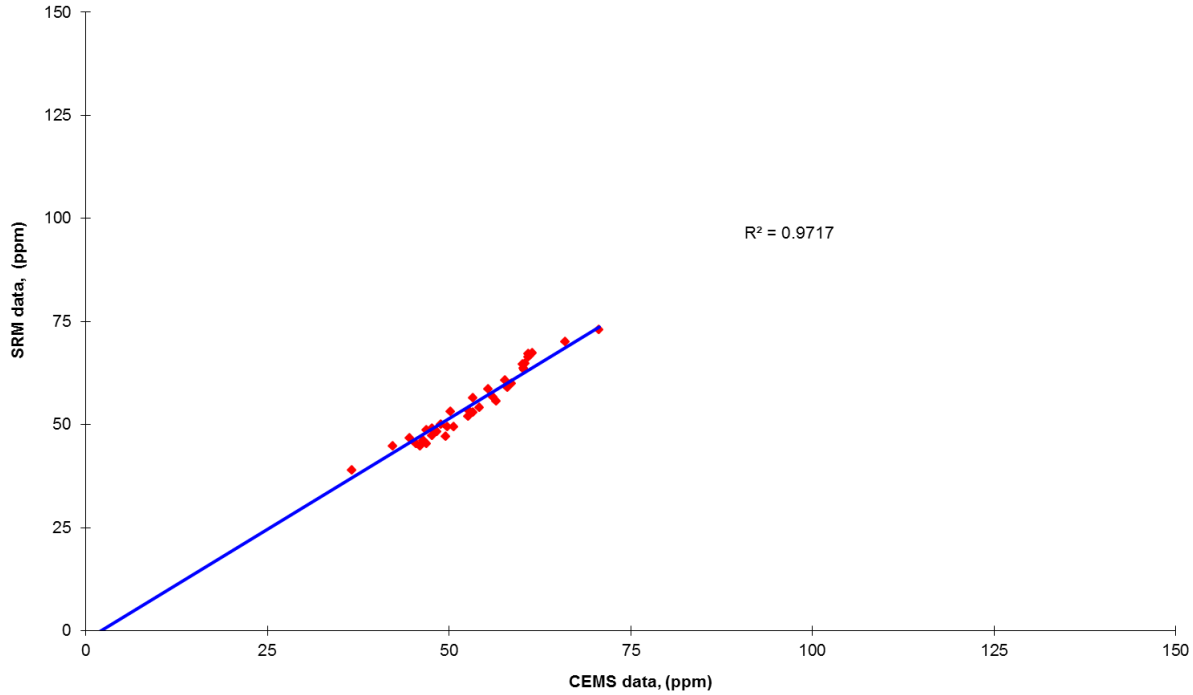
4A2.8.2 Table A.4.4.2 - Calculation of calibrated CEMS values - Sulphur Dioxide, Low Range

Test No	Test Start Time	Test End Time	CEMS Raw Value (x)	CEMS Calibrated signal	CEMS Dry Oxygen	CEMS Moisture	CEMS Standardised Value (dry)	CEMS Calibrated Standardised Value	SRM Standardised
	hr:min		(ppm)	(ppm)	(%)	(%)	(mg/Nm^3)	(mg/Nm^3)	(mg/m3)
1	Reference Zero		-1.0	0.0	N/A	N/A	-1.0	0.0	0.0
2	11:23	12:23	60.4	62.2	6.8	2.6	187.1	192.6	194.6
3	12:34	13:34	60.9	62.7	6.7	2.5	187.9	193.4	202.7
4	13:35	14:35	60.9	62.7	6.4	2.4	183.9	189.3	201.8
5	14:36	15:36	61.5	63.3	6.5	2.5	186.5	192.0	203.0
6	15:37	16:37	61.2	63.0	6.6	2.5	187.3	192.8	202.6
7	16:38	17:38	60.5	62.3	6.9	2.6	189.2	194.7	200.5
8	17:39	18:39	60.2	61.9	7.0	2.7	189.2	194.8	200.4
9	18:40	19:40	58.6	60.4	7.0	2.7	184.8	190.3	186.8
10	19:41	20:41	56.5	58.2	7.0	2.8	178.4	183.9	172.8
11	20:42	21:42	54.2	55.9	6.9	2.8	169.7	175.1	168.0
12	21:53	22:53	53.3	55.0	6.9	2.8	166.9	172.2	163.1
13	22:54	23:54	52.6	54.3	6.9	2.8	164.3	169.6	160.1
14	23:55	00:55	50.6	52.3	7.0	2.7	159.5	164.7	153.2
15	00:56	01:56	49.6	51.2	7.1	2.7	157.7	163.0	147.5
16	01:57	02:57	48.3	49.9	7.0	2.4	151.7	156.8	150.3
17	02:58	03:58	49.8	51.4	7.1	2.4	157.1	162.3	154.3
18	03:59	04:59	48.9	50.6	7.0	2.4	153.7	158.9	155.2
19	05:00	06:00	47.6	49.3	7.0	2.5	149.7	154.8	146.5
20	06:01	07:01	45.5	47.1	7.0	2.5	142.8	147.8	140.5
21	07:12	08:12	46.4	48.0	6.9	2.5	145.2	150.2	142.1
22	08:13	09:13	46.9	48.5	7.0	2.6	147.5	152.6	140.8
23	09:14	10:14	46.0	47.6	7.2	2.6	146.3	151.3	140.2
24	10:50	11:50	50.2	51.8	6.8	2.6	155.4	160.5	163.2
25	11:51	12:51	53.4	55.0	6.8	2.5	165.0	170.2	173.0
26	13:02	14:02	55.4	57.2	7.0	2.4	173.6	178.9	181.3
27	14:03	15:03	57.7	59.5	7.0	2.2	180.6	186.1	187.9
28	15:04	16:04	60.3	62.1	7.0	2.1	188.6	194.2	196.9
29	16:05	17:05	58.0	59.8	7.2	2.2	184.0	189.6	185.2
30	17:06	18:06	56.1	57.8	7.3	2.3	179.0	184.5	179.0
31	18:07	19:07	52.7	54.4	7.1	2.3	166.1	171.4	166.3
32	19:08	20:08	47.7	49.3	7.0	2.4	149.9	155.0	152.8
33	20:09	21:09	46.9	48.5	6.9	2.4	146.7	151.7	150.4
34	21:10	22:10	44.6	46.2	6.9	2.4	139.0	144.0	144.7
35	22:21	23:21	42.3	43.9	6.8	2.4	131.4	136.2	137.6
36	23:22	00:22	36.7	38.2	8.3	2.5	127.3	132.4	134.2
37	11:26	12:26	70.6	72.5	6.6	2.7	215.5	221.3	220.2
38	12:27	13:27	66.0	67.9	6.5	2.7	200.9	206.5	210.7
				Sum			6188.32		

Emission Limit Value (ELV) = 440 mg/Nm^3

Reference Oxygen 6 %

4A2.9.2 Plot 2.2 CEM versus SRM Parallel Test Data at CEM measurement conditions –Sulphur dioxide, wet gas



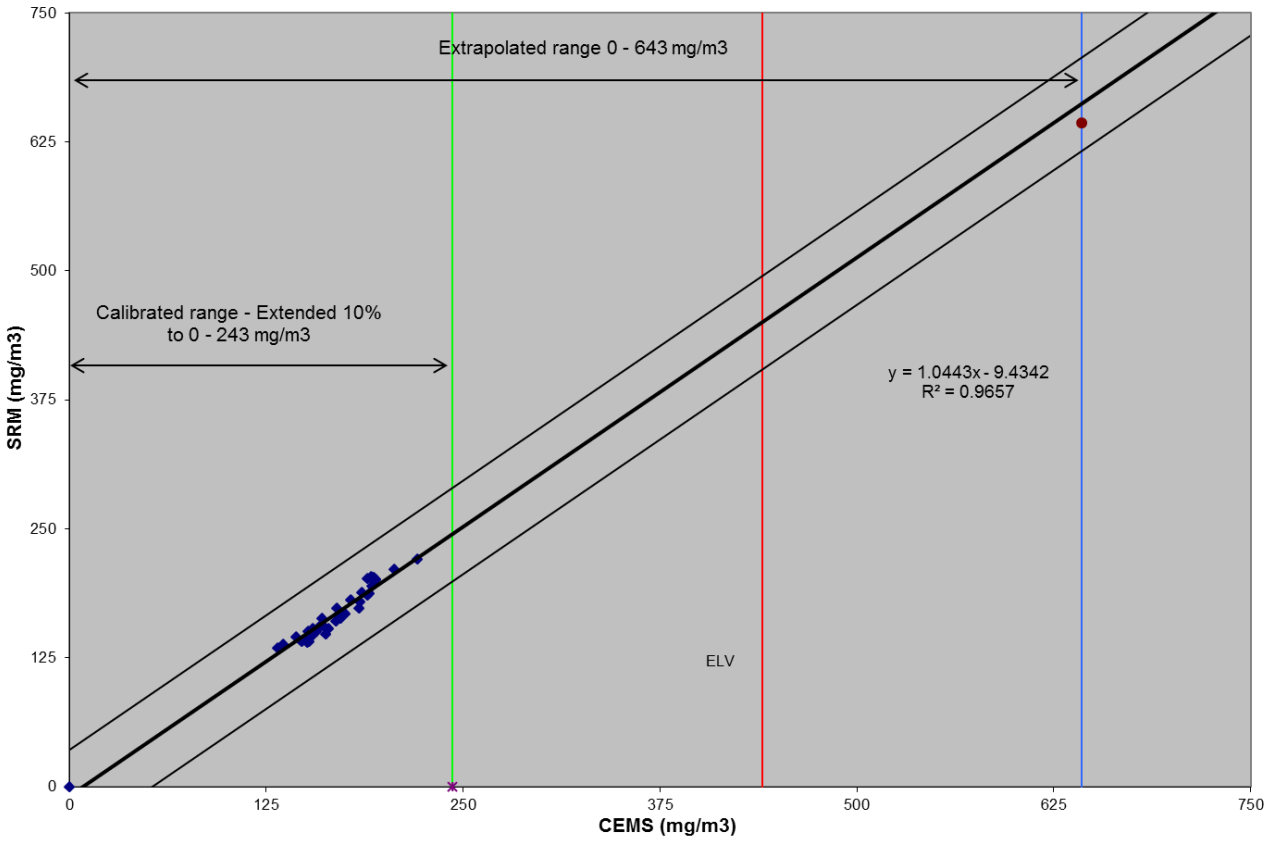
4A2.10.2 Table 4.5.2 – Data used for the Variability Test – Sulphur Dioxide, Low Range.

Test No	Test Start Time	Test End Time	CEMS Calibrated Standardised value	SRM Standardised value	Difference D1	Difference D1 - D	Squared Difference D1 - D
	hr:min		mg/m3	mg/m3			
2	11:23	12:23	192.6	194.6	2.00	4.03	16.28
3	12:34	13:34	193.4	202.7	9.34	11.37	129.33
4	13:35	14:35	189.3	201.8	12.51	14.54	211.49
5	14:36	15:36	192.0	203.0	11.01	13.05	170.22
6	15:37	16:37	192.8	202.6	9.80	11.84	140.07
7	16:38	17:38	194.7	200.5	5.79	7.83	61.24
8	17:39	18:39	194.8	200.4	5.53	7.56	57.16
9	18:40	19:40	190.3	186.8	-3.47	-1.43	2.05
10	19:41	20:41	183.9	172.8	-11.13	-9.09	82.65
11	20:42	21:42	175.1	168.0	-7.09	-5.06	25.60
12	21:53	22:53	172.2	163.1	-9.11	-7.08	50.10
13	22:54	23:54	169.6	160.1	-9.46	-7.42	55.10
14	23:55	00:55	164.7	153.2	-11.54	-9.50	90.31
15	00:56	01:56	163.0	147.5	-15.44	-13.40	179.59
16	01:57	02:57	156.8	150.3	-6.54	-4.50	20.27
17	02:58	03:58	162.3	154.3	-8.04	-6.00	36.00
18	03:59	04:59	158.9	155.2	-3.60	-1.57	2.46
19	05:00	06:00	154.8	146.5	-8.26	-6.22	38.73
20	06:01	07:01	147.8	140.5	-7.25	-5.21	27.15
21	07:12	08:12	150.2	142.1	-8.09	-6.06	36.69
22	08:13	09:13	152.6	140.8	-11.79	-9.75	95.10
23	09:14	10:14	151.3	140.2	-11.18	-9.14	83.57
24	10:50	11:50	160.5	163.2	2.73	4.77	22.72
25	11:51	12:51	170.2	173.0	2.73	4.76	22.70
26	13:02	14:02	178.9	181.3	2.37	4.41	19.45
27	14:03	15:03	186.1	187.9	1.77	3.81	14.49
28	15:04	16:04	194.2	196.9	2.70	4.73	22.41
29	16:05	17:05	189.6	185.2	-4.37	-2.33	5.45
30	17:06	18:06	184.5	179.0	-5.56	-3.52	12.42
31	18:07	19:07	171.4	166.3	-5.05	-3.01	9.09
32	19:08	20:08	155.0	152.8	-2.25	-0.22	0.05
33	20:09	21:09	151.7	150.4	-1.30	0.73	0.54
34	21:10	22:10	144.0	144.7	0.72	2.76	7.62
35	22:21	23:21	136.2	137.6	1.43	3.47	12.02
36	23:22	00:22	132.4	134.2	1.75	3.79	14.35
37	11:26	12:26	221.3	220.2	-1.12	0.92	0.85
38	12:27	13:27	206.5	210.7	4.13	6.17	38.07
37 Tests		Mean			-2.04		
Sum							1813.38

4A2.11.2 - Variability Test Calculation – Sulphur Dioxide, Low Range.

SD=	Root(1-Number).Integral(D1-D)^2		7.10	mg/m3(s,d),6%O2
The uncertainty laid down by the authorities is 20% ELV as a 95% confidence interval. O_0 is therefore calculated as:-				
O_0=	0.2*440 mg/m3 (s,d,6%O2)/1.96		44.90	mg/m3(s,d),6%O2
For 37 tests, kv =	0.9885			
Therefore variability=		7.1 <= 44.9 * 0.9885		
	or 7.10	<=	44.38	
Which is TRUE therefore the CEMS passes the test				

4A2.12.2 Plot 3.2 –Standardised CEM data versus standardised SRM - Sulphur dioxide, Low Range – Reference conditions 273K, 101.3kPa 6% oxygen, dry gas.



4A2.1.3 Table 4.1.3– Raw monitoring Data – Sulphur Dioxide, High Range

Test No	Date	Test Start Time	Test End Time	CEMS Raw Value (wet)	CEMS Oxygen (dry)	CEMS Moisture	SRM Raw value (wet)	SRM Oxygen (dry)	SRM Moisture	SRM at CEMs Raw conditions
		hr:min		(ppm)	(%)	(%)	(ppm)	(%)	(%)	(ppm)
1	26-Oct-16	11:23	12:23	59.23	6.79	2.60	63.35	6.61	3.02	63.3
2	26-Oct-16	12:34	13:34	59.68	6.74	2.49	66.31	6.58	2.78	66.3
3	26-Oct-16	13:35	14:35	59.78	6.44	2.42	67.20	6.33	2.69	67.2
4	26-Oct-16	14:36	15:36	60.25	6.51	2.48	67.39	6.37	2.73	67.4
5	26-Oct-16	15:37	16:37	59.94	6.63	2.54	66.68	6.48	2.80	66.7
6	26-Oct-16	16:38	17:38	59.37	6.93	2.60	64.88	6.72	2.89	64.9
7	26-Oct-16	17:39	18:39	59.06	7.00	2.66	64.58	6.77	2.90	64.6
8	26-Oct-16	18:40	19:40	57.45	7.01	2.71	59.98	6.83	2.84	60.0
9	26-Oct-16	19:41	20:41	55.36	7.04	2.76	55.61	6.81	2.76	55.6
10	26-Oct-16	20:42	21:42	52.98	6.93	2.78	54.14	6.80	2.66	54.1
11	26-Oct-16	21:53	22:53	52.15	6.92	2.79	52.98	6.69	2.65	53.0
12	26-Oct-16	22:54	23:54	51.47	6.88	2.79	52.03	6.68	2.72	52.0
13	26-27/10/2016	23:55	0:55	49.62	7.01	2.73	49.45	6.78	2.66	49.4
14	27-Oct-16	0:56	1:56	48.46	7.15	2.66	47.16	6.93	2.59	47.2
15	27-Oct-16	1:57	2:57	47.16	7.01	2.44	48.38	6.83	2.62	48.4
16	27-Oct-16	2:58	3:58	48.80	7.08	2.35	49.52	6.85	2.73	49.5
17	27-Oct-16	3:59	4:59	47.87	7.01	2.40	50.03	6.79	2.80	50.0
18	27-Oct-16	5:00	6:00	46.64	7.01	2.45	47.23	6.79	2.74	47.2
19	27-Oct-16	6:01	7:01	44.44	6.99	2.50	45.39	6.77	2.73	45.4
20	27-Oct-16	7:12	8:12	45.44	6.93	2.54	46.08	6.71	2.73	46.1
21	27-Oct-16	8:13	9:13	46.03	7.00	2.55	45.45	6.78	2.67	45.5
22	27-Oct-16	9:14	10:14	44.97	7.16	2.56	44.75	6.93	2.68	44.8
23	27-Oct-16	10:50	11:50	49.21	6.79	2.57	53.11	6.68	2.58	53.1
24	27-Oct-16	11:51	12:51	52.32	6.78	2.53	56.52	6.58	2.84	56.5
25	27-Oct-16	13:02	14:02	54.38	6.96	2.43	58.67	6.75	2.63	58.7
26	27-Oct-16	14:03	15:03	56.43	7.00	2.15	60.69	6.78	2.63	60.7
27	27-Oct-16	15:04	16:04	59.22	6.99	2.12	63.57	6.78	2.62	63.6
28	27-Oct-16	16:05	17:05	56.78	7.18	2.19	59.02	6.95	2.80	59.0
29	27-Oct-16	17:06	18:06	54.89	7.26	2.27	56.66	7.03	2.84	56.7
30	27-Oct-16	18:07	19:07	51.72	7.05	2.34	53.37	6.84	2.83	53.4
31	27-Oct-16	19:08	20:08	46.69	7.02	2.38	49.14	6.80	2.85	49.1
32	27-Oct-16	20:09	21:09	45.92	6.95	2.40	48.63	6.74	2.82	48.6
33	27-Oct-16	21:10	22:10	43.60	6.91	2.42	46.83	6.72	2.86	46.8
34	27-Oct-16	22:21	23:21	41.37	6.84	2.45	44.76	6.63	2.93	44.8
35	27-28/10/2016	23:22	0:22	35.75	8.32	2.47	39.04	8.15	2.87	39.0
36	02-Nov-16	11:26	12:26	69.40	6.55	2.74	73.06	6.39	2.67	73.1
37	02-Nov-16	12:27	13:27	64.70	6.51	2.73	70.17	6.32	2.77	70.2

Note:

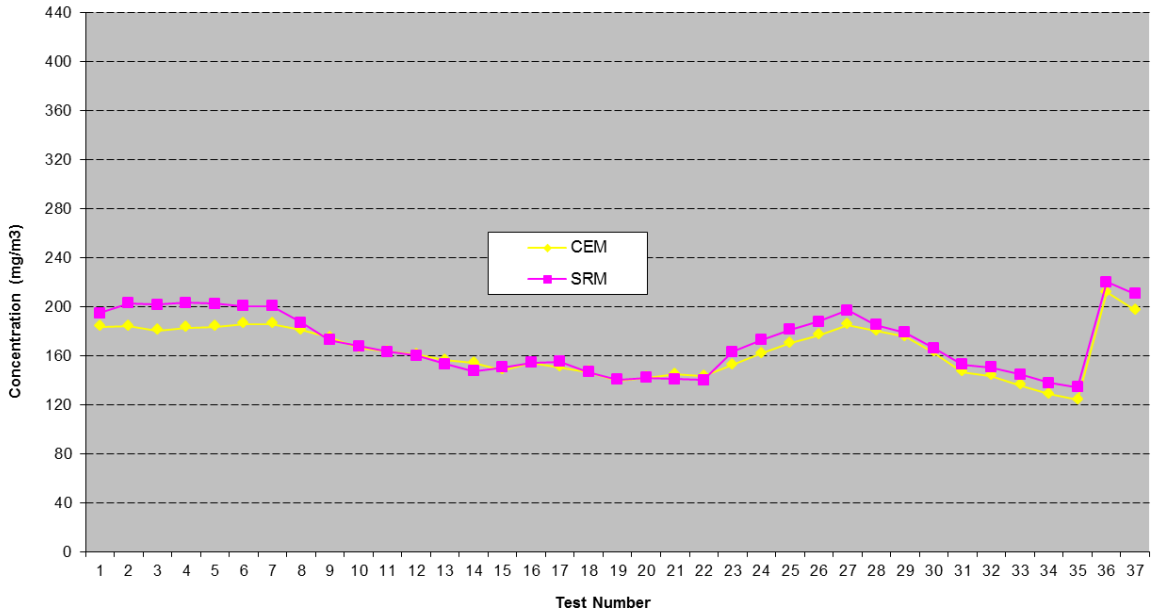
Emission concentrations expresed at reference conditions 273K, 101.3kPa

4A2.2.3 Table 4.2.3 -Standardised monitoring Data – Sulphur Dioxide, High Range

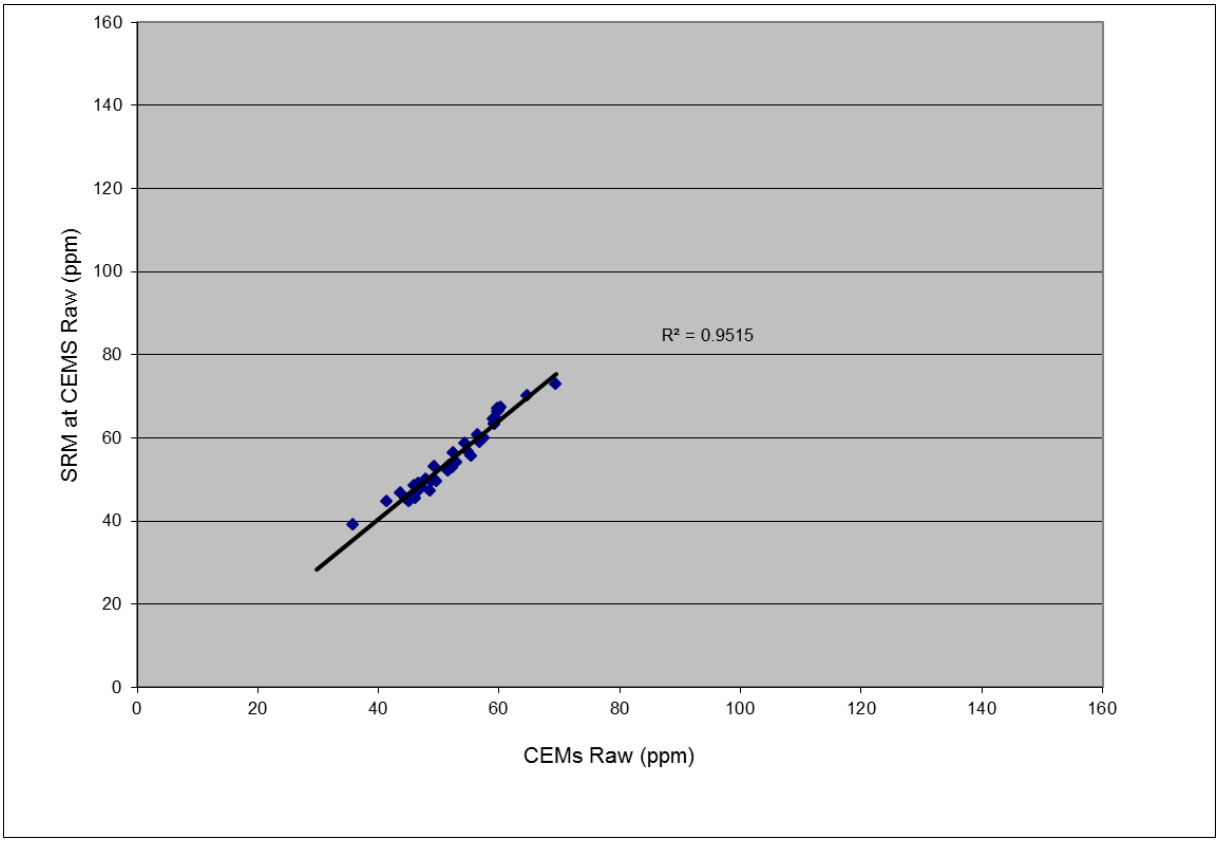
Test No	Date	Test Start Time	Test End Time	CEMS Standardised	SRM Standardised	SRM Uncertainty
		hr:min		(SO2 mg/m3)	(SO2 mg/m3)	(mg/m3)
1	26-Oct-16	11:23	12:23	183.4	194.6	8.7
2	26-Oct-16	12:34	13:34	184.0	202.7	9.1
3	26-Oct-16	13:35	14:35	180.4	201.8	9.1
4	26-Oct-16	14:36	15:36	182.8	203.0	9.1
5	26-Oct-16	15:37	16:37	183.5	202.6	9.1
6	26-Oct-16	16:38	17:38	185.7	200.5	9.0
7	26-Oct-16	17:39	18:39	185.8	200.4	9.0
8	26-Oct-16	18:40	19:40	181.0	186.8	8.4
9	26-Oct-16	19:41	20:41	174.8	172.8	7.8
10	26-Oct-16	20:42	21:42	166.0	168.0	7.6
11	26-Oct-16	21:53	22:53	163.4	163.1	7.3
12	26-Oct-16	22:54	23:54	160.7	160.1	7.2
13	26-27/10/2016	23:55	0:55	156.3	153.2	6.9
14	27-Oct-16	0:56	1:56	154.1	147.5	6.6
15	27-Oct-16	1:57	2:57	148.2	150.3	6.7
16	27-Oct-16	2:58	3:58	154.0	154.3	6.9
17	27-Oct-16	3:59	4:59	150.4	155.2	7.0
18	27-Oct-16	5:00	6:00	146.6	146.5	6.6
19	27-Oct-16	6:01	7:01	139.6	140.5	6.3
20	27-Oct-16	7:12	8:12	142.1	142.1	6.4
21	27-Oct-16	8:13	9:13	144.6	140.8	6.3
22	27-Oct-16	9:14	10:14	143.0	140.2	6.3
23	27-Oct-16	10:50	11:50	152.4	163.2	7.3
24	27-Oct-16	11:51	12:51	161.8	173.0	7.8
25	27-Oct-16	13:02	14:02	170.2	181.3	8.2
26	27-Oct-16	14:03	15:03	176.6	187.9	8.4
27	27-Oct-16	15:04	16:04	185.2	196.9	8.8
28	27-Oct-16	16:05	17:05	180.1	185.2	8.3
29	27-Oct-16	17:06	18:06	175.3	179.0	8.0
30	27-Oct-16	18:07	19:07	162.8	166.3	7.5
31	27-Oct-16	19:08	20:08	146.7	152.8	6.9
32	27-Oct-16	20:09	21:09	143.6	150.4	6.7
33	27-Oct-16	21:10	22:10	136.0	144.7	6.5
34	27-Oct-16	22:21	23:21	128.4	137.6	6.2
35	27-28/10/2016	23:22	0:22	124.1	134.2	6.0
36	02-Nov-16	11:26	12:26	211.7	220.2	9.9
37	02-Nov-16	12:27	13:27	196.8	210.7	9.4

Note:
Emission concentrations expresed at reference conditions 273K, 6 % Oxygen, dry gas

4A2.3.3 – Plot 1.3 - Time Series of Standardised CEM versus Standardised SRM data – Sulphur Dioxide, High Range (Expressed at reference conditions 273K, 101.3kPa, dry gas, 6% oxygen)



4A2.4.3 – Elimination of Outliers – Sulphur Dioxide, High Range.



Guidance on performing tests for outliers in MID 14181 section 6.3, states the following:

'As a general guide, when plotting the raw SRM and raw CEM data, if the R^2 value for the linear regression line is equal or more than 0.9, then it is not ordinarily necessary to perform an outlier test.
Additionally, any data points are not likely to be outliers unless they are more than two standard deviations from the regression line'

As the R^2 value for this determinand was 0.9515, an outlier test has not been undertaken.

4A2.5.3 Determination of Method A, B or C - Sulphur Dioxide, High Range.

Test No	Test Start Time	Test End Time	SRM measured value (y)	SRM O2	SRM Standardised
	hr:min		(ppm)	(%)	(mg/m3)
1	11:23	12:23	63.3	6.6	194.6
2	12:34	13:34	66.3	6.6	202.7
3	13:35	14:35	67.2	6.3	201.8
4	14:36	15:36	67.4	6.4	203.0
5	15:37	16:37	66.7	6.5	202.6
6	16:38	17:38	64.9	6.7	200.5
7	17:39	18:39	64.6	6.8	200.4
8	18:40	19:40	60.0	6.8	186.8
9	19:41	20:41	55.6	6.8	172.8
10	20:42	21:42	54.1	6.8	168.0
11	21:53	22:53	53.0	6.7	163.1
12	22:54	23:54	52.0	6.7	160.1
13	23:55	0:55	49.4	6.8	153.2
14	0:56	1:56	47.2	6.9	147.5
15	1:57	2:57	48.4	6.8	150.3
16	2:58	3:58	49.5	6.9	154.3
17	3:59	4:59	50.0	6.8	155.2
18	5:00	6:00	47.2	6.8	146.5
19	6:01	7:01	45.4	6.8	140.5
20	7:12	8:12	46.1	6.7	142.1
21	8:13	9:13	45.5	6.8	140.8
22	9:14	10:14	44.8	6.9	140.2
23	10:50	11:50	53.1	6.7	163.2
24	11:51	12:51	56.5	6.6	173.0
25	13:02	14:02	58.7	6.8	181.3
26	14:03	15:03	60.7	6.8	187.9
27	15:04	16:04	63.6	6.8	196.9
28	16:05	17:05	59.0	6.9	185.2
29	17:06	18:06	56.7	7.0	179.0
30	18:07	19:07	53.4	6.8	166.3
31	19:08	20:08	49.1	6.8	152.8
32	20:09	21:09	48.6	6.7	150.4
33	21:10	22:10	46.8	6.7	144.7
34	22:21	23:21	44.8	6.6	137.6
35	23:22	0:22	39.0	8.1	134.2
36	11:26	12:26	73.1	6.4	220.2
37	12:27	13:27	70.2	6.3	210.7
Sum			2041.79		

Emission Limit Value (ELV) =	440	mg/Nm^3	Y_{max}	220.18
Maximum Permissable uncertainty =	20	%	Y_{min}	134.18
Maximum Permissable uncertainty (at I	88	mg/Nm^3		
15% of the ELV =	66	mg/Nm^3		
Is Ymax - Ymin > MPU at ELV?	No		$Y_{max - Ymin}$	86.00
Is Ymin > 15% of ELV?	Yes			

Derivation of Calibration Function	**Method B**

4A2.6.3 Table 4.3.3 - Data used to derive calibration function - Sulphur Dioxide, High Range.

Test No	Test Start Time	Test End Time	SRM measured value (y)	CEMS measured signal (x)
	hr:min		(ppm)	(ppm)
1	Reference Zero		0.0	-1.0
2	11:23	12:23	63.3	59.2
3	12:34	13:34	66.3	59.7
4	13:35	14:35	67.2	59.8
5	14:36	15:36	67.4	60.3
6	15:37	16:37	66.7	59.9
7	16:38	17:38	64.9	59.4
8	17:39	18:39	64.6	59.1
9	18:40	19:40	60.0	57.4
10	19:41	20:41	55.6	55.4
11	20:42	21:42	54.1	53.0
12	21:53	22:53	53.0	52.1
13	22:54	23:54	52.0	51.5
14	23:55	0:55	49.4	49.6
15	0:56	1:56	47.2	48.5
16	1:57	2:57	48.4	47.2
17	2:58	3:58	49.5	48.8
18	3:59	4:59	50.0	47.9
19	5:00	6:00	47.2	46.6
20	6:01	7:01	45.4	44.4
21	7:12	8:12	46.1	45.4
22	8:13	9:13	45.5	46.0
23	9:14	10:14	44.8	45.0
24	10:50	11:50	53.1	49.2
25	11:51	12:51	56.5	52.3
26	13:02	14:02	58.7	54.4
27	14:03	15:03	60.7	56.4
28	15:04	16:04	63.6	59.2
29	16:05	17:05	59.0	56.8
30	17:06	18:06	56.7	54.9
31	18:07	19:07	53.4	51.7
32	19:08	20:08	49.1	46.7
33	20:09	21:09	48.6	45.9
34	21:10	22:10	46.8	43.6
35	22:21	23:21	44.8	41.4
36	23:22	0:22	39.0	35.8
37	11:26	12:26	73.1	69.4
38	12:27	13:27	70.2	64.7
Sum			2041.79	1937.54

4A2.7.3 Determination of Calibration Function - Sulphur Dioxide, High Range.

Method B

Formulae:-	**Number of tests conducted =**		**N**	**38**
If Ymax-Ymin <15% of the ELV, the following formulae are used:				
b=(y/(x-Z))	**x=(1/No. AMS Tests) * Total AMS**			
	x=(1/ 38)*1937.5	**or -**	**x=**	**50.99**
a=(-β.Z)	**y=(1/No. SRM Tests) * Total SRM**			
	y=(1/ 38)*2041.	**or -**	**y=**	**53.73**
The Slope is calculated by :				
β=y/(x-Z)	**53.73 /(50.98--1)**		**β=**	**1.034**
The offset is calculated by:				
α=-β.Z	**-1.03*-1**		**α=**	**1.03**
The calibration is function $y_{im} = \alpha + \beta_{xi,m}$ or		**yi =**	**1.033 + 1.03 * Xi**	

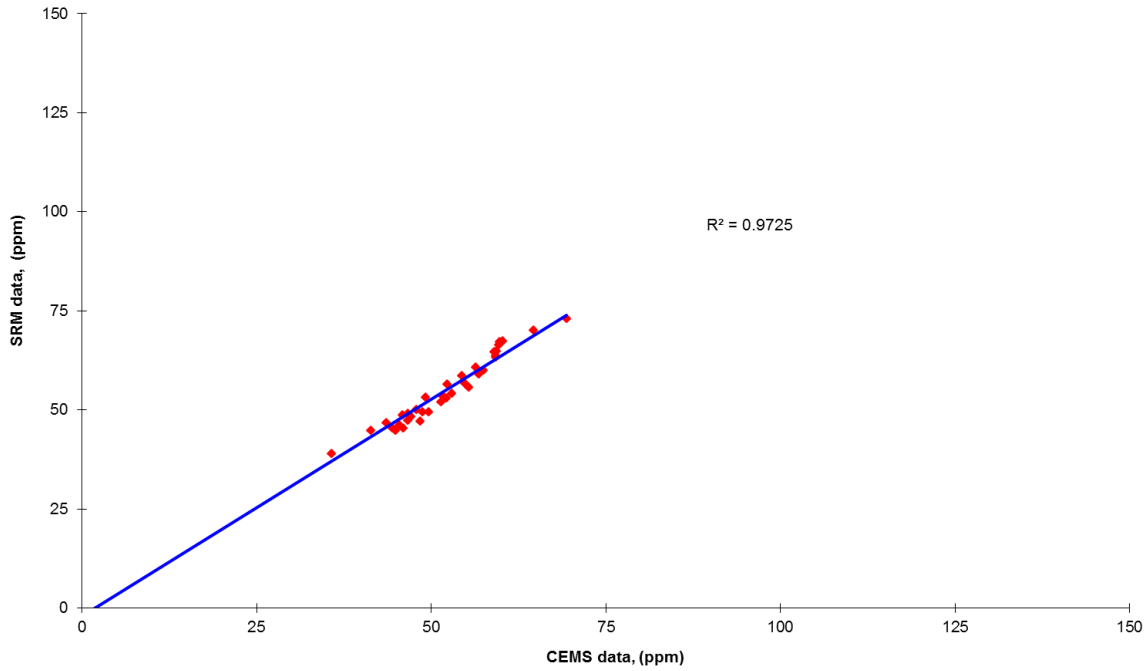
4A2.8.3 Table A.4.4.3 - Calculation of calibrated CEMS values - Sulphur Dioxide, High Range.

Test No	Test Start Time	Test End Time	CEMS Raw Value (x)	CEMS Calibrated signal	CEMS Dry Oxygen	CEMS Moisture	CEMS Standardised Value (dry)	CEMS Calibrated Standardised Value	SRM Standardised
	hr:min		(ppm)	(ppm)	(%)	(%)	(mg/Nm^3)	(mg/Nm^3)	(mg/m3)
1	Reference Zero		-1.0	0.0	N/A	N/A	-1.0	0.0	0.0
2	11:23	12:23	59.2	62.2	6.8	2.6	183.4	192.8	194.6
3	12:34	13:34	59.7	62.7	6.7	2.5	184.0	193.4	202.7
4	13:35	14:35	59.8	62.8	6.4	2.4	180.4	189.6	201.8
5	14:36	15:36	60.3	63.3	6.5	2.5	182.8	192.1	203.0
6	15:37	16:37	59.9	63.0	6.6	2.5	183.5	192.9	202.6
7	16:38	17:38	59.4	62.4	6.9	2.6	185.7	195.2	200.5
8	17:39	18:39	59.1	62.1	7.0	2.7	185.8	195.3	200.4
9	18:40	19:40	57.4	60.4	7.0	2.7	181.0	190.3	186.8
10	19:41	20:41	55.4	58.3	7.0	2.8	174.8	184.0	172.8
11	20:42	21:42	53.0	55.8	6.9	2.8	166.0	174.9	168.0
12	21:53	22:53	52.1	54.9	6.9	2.8	163.4	172.1	163.1
13	22:54	23:54	51.5	54.2	6.9	2.8	160.7	169.3	160.1
14	23:55	00:55	49.6	52.3	7.0	2.7	156.3	164.8	153.2
15	00:56	01:56	48.5	51.1	7.1	2.7	154.1	162.6	147.5
16	01:57	02:57	47.2	49.8	7.0	2.4	148.2	156.4	150.3
17	02:58	03:58	48.8	51.5	7.1	2.4	154.0	162.4	154.3
18	03:59	04:59	47.9	50.5	7.0	2.4	150.4	158.7	155.2
19	05:00	06:00	46.6	49.2	7.0	2.5	146.6	154.7	146.5
20	06:01	07:01	44.4	47.0	7.0	2.5	139.6	147.5	140.5
21	07:12	08:12	45.4	48.0	6.9	2.5	142.1	150.1	142.1
22	08:13	09:13	46.0	48.6	7.0	2.6	144.6	152.7	140.8
23	09:14	10:14	45.0	47.5	7.2	2.6	143.0	151.1	140.2
24	10:50	11:50	49.2	51.9	6.8	2.6	152.4	160.7	163.2
25	11:51	12:51	52.3	55.1	6.8	2.5	161.8	170.4	173.0
26	13:02	14:02	54.4	57.2	7.0	2.4	170.2	179.2	181.3
27	14:03	15:03	56.4	59.4	7.0	2.2	176.6	185.8	187.9
28	15:04	16:04	59.2	62.2	7.0	2.1	185.2	194.7	196.9
29	16:05	17:05	56.8	59.7	7.2	2.2	180.1	189.4	185.2
30	17:06	18:06	54.9	57.8	7.3	2.3	175.3	184.5	179.0
31	18:07	19:07	51.7	54.5	7.1	2.3	162.8	171.5	166.3
32	19:08	20:08	46.7	49.3	7.0	2.4	146.7	154.9	152.8
33	20:09	21:09	45.9	48.5	6.9	2.4	143.6	151.6	150.4
34	21:10	22:10	43.6	46.1	6.9	2.4	136.0	143.8	144.7
35	22:21	23:21	41.4	43.8	6.8	2.4	128.4	135.9	137.6
36	23:22	00:22	35.8	38.0	8.3	2.5	124.1	131.8	134.2
37	11:26	12:26	69.4	72.8	6.6	2.7	211.7	222.0	220.2
38	12:27	13:27	64.7	67.9	6.5	2.7	196.8	206.6	210.7
				Sum			6061.29		

Emission Limit Value (ELV) = 440 mg/Nm^3

Reference Oxygen 6 %

4A2.9.3 Plot 2.3 CEM versus SRM Parallel Test Data at CEM measurement conditions –Sulphur dioxide, wet gas.



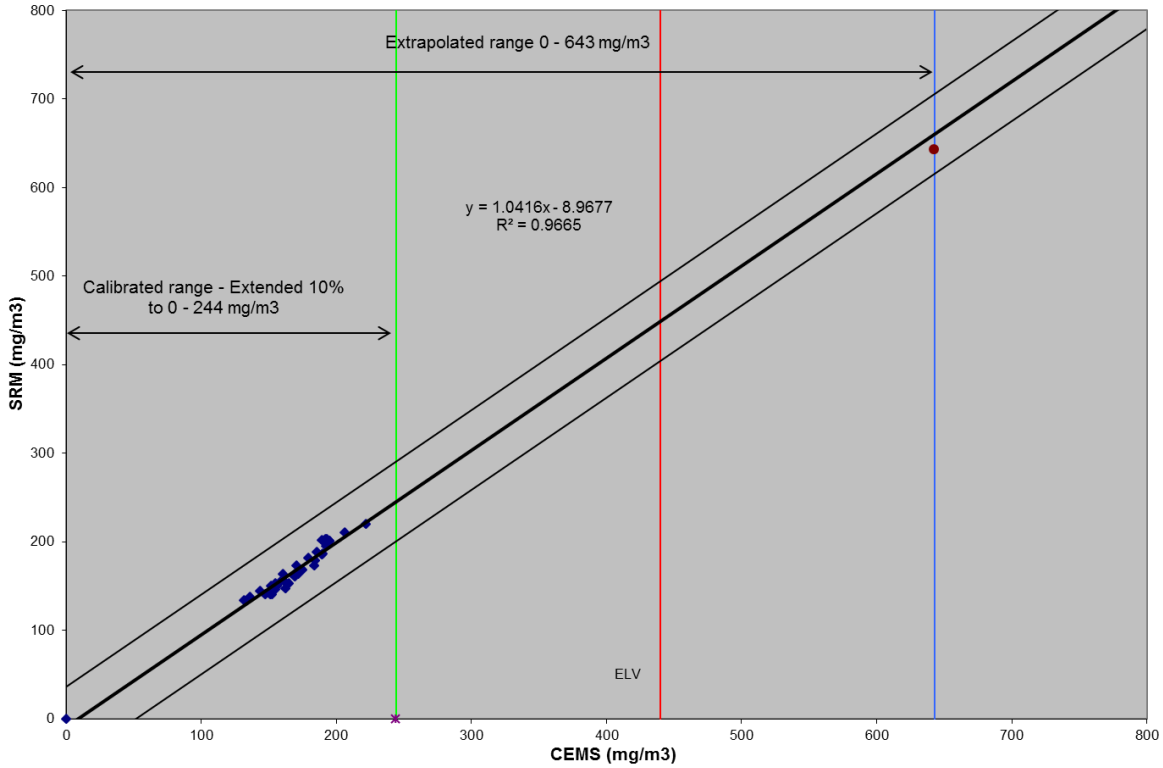
4A2.10.3 Table 4.5.3 – Data used for the Variability Test – Sulphur Dioxide, High Range.

Test No	Test Start Time	Test End Time	CEMS Calibrated Standardised value	SRM Standardised value	Difference D1	Difference D1 - D	Squared Difference D1 - D
	hr:min		mg/m3	mg/m3			
2	11:23	12:23	192.8	194.6	1.82	3.85	14.82
3	12:34	13:34	193.4	202.7	9.34	11.37	129.26
4	13:35	14:35	189.6	201.8	12.20	14.23	202.50
5	14:36	15:36	192.1	203.0	10.90	12.93	167.25
6	15:37	16:37	192.9	202.6	9.72	11.75	138.04
7	16:38	17:38	195.2	200.5	5.34	7.37	54.29
8	17:39	18:39	195.3	200.4	5.11	7.14	50.95
9	18:40	19:40	190.3	186.8	-3.51	-1.48	2.19
10	19:41	20:41	184.0	172.8	-11.17	-9.14	83.50
11	20:42	21:42	174.9	168.0	-6.90	-4.87	23.67
12	21:53	22:53	172.1	163.1	-9.02	-6.98	48.76
13	22:54	23:54	169.3	160.1	-9.21	-7.18	51.51
14	23:55	00:55	164.8	153.2	-11.62	-9.59	91.92
15	00:56	01:56	162.6	147.5	-15.03	-13.00	169.02
16	01:57	02:57	156.4	150.3	-6.10	-4.07	16.57
17	02:58	03:58	162.4	154.3	-8.18	-6.15	37.77
18	03:59	04:59	158.7	155.2	-3.42	-1.39	1.94
19	05:00	06:00	154.7	146.5	-8.22	-6.18	38.25
20	06:01	07:01	147.5	140.5	-6.94	-4.91	24.09
21	07:12	08:12	150.1	142.1	-7.93	-5.90	34.78
22	08:13	09:13	152.7	140.8	-11.97	-9.94	98.81
23	09:14	10:14	151.1	140.2	-10.90	-8.86	78.57
24	10:50	11:50	160.7	163.2	2.57	4.60	21.16
25	11:51	12:51	170.4	173.0	2.54	4.57	20.91
26	13:02	14:02	179.2	181.3	2.13	4.16	17.33
27	14:03	15:03	185.8	187.9	2.10	4.13	17.06
28	15:04	16:04	194.7	196.9	2.19	4.22	17.83
29	16:05	17:05	189.4	185.2	-4.20	-2.17	4.72
30	17:06	18:06	184.5	179.0	-5.51	-3.48	12.10
31	18:07	19:07	171.5	166.3	-5.21	-3.18	10.10
32	19:08	20:08	154.9	152.8	-2.14	-0.11	0.01
33	20:09	21:09	151.6	150.4	-1.20	0.83	0.69
34	21:10	22:10	143.8	144.7	0.93	2.96	8.79
35	22:21	23:21	135.9	137.6	1.66	3.69	13.64
36	23:22	00:22	131.8	134.2	2.36	4.39	19.27
37	11:26	12:26	222.0	220.2	-1.77	0.26	0.07
38	12:27	13:27	206.6	210.7	4.07	6.10	37.22
37 Tests		Mean			-2.03		
Sum							1759.36

4A2.11.3 - Variability Test Calculation – Sulphur Dioxide, High Range.

SD=	Root(1-Number).Integral(D1-D)^2		6.99	mg/m3(s,d),6%O2
The uncertainty laid down by the authorities is 20% ELV as a 95% confidence interval. O_0 is therefore calculated as:-				
O_0=	0.2*440 mg/m3 (s,d,6%O2)/1.96		44.90	mg/m3(s,d),6%O2
For 37 tests, kv =	0.9885			
Therefore variability=		6.99 <= 44.9 * 0.9885		
	or	6.99 <=	44.38	
Which is TRUE therefore the CEMS passes the test				

4A2.12.3 Plot 3.3 –Standardised CEM data versus standardised SRM - Sulphur dioxide, High Range – Reference conditions 273K, 101.3kPa., 6% oxygen, dry gas.



Section 4B1: Data & Calculations – AST – Unit 8, SICK OMD 41

4B3 4.1 Table 4.1 – Raw monitoring Data – Total Particulate Matter

Test No	Date	Test Start Time	Test End Time	CEMS Raw Value (Extinction)	CEMS Oxygen (Wet)	CEMS Moisture (Wet)	CEM Stack Temp	CEM Stack Press	SRM Raw value (dry)	SRM Moisture (Wet FT)	SRM Oxygen (Dry)	SRM Stack Temp	SRM Stack Press	SRM at CEMs Raw conditions
		hr:min		%	(%)	(%)	C	kpa	(mg/m3)	(%)	(%)	C	kpa	(mg/m3)
1	26-Oct-16	10:43	11:43	18.2	6.5	2.60	65.1	101.7	117.9	2.9	6.6	63.0	100.8	92.6
2	26-Oct-16	14:13	15:13	22.6	6.3	2.46	64.5	101.8	106.4	2.7	6.3	64.0	100.8	83.5
3	27-Oct-16	10:47	11:47	12.0	6.9	2.56	64.6	102.1	118.4	2.6	6.7	65.0	100.8	92.8
4	27-Oct-16	11:55	12:55	12.6	6.6	2.52	64.3	102.1	56.1	2.8	6.6	64.0	100.8	44.0
5	27-Oct-16	13:03	14:03	13.4	6.8	2.43	63.8	102.2	73.5	2.6	6.8	63.0	100.8	57.8
6	27-Oct-16	14:10	15:10	14.8	6.8	2.11	63.3	102.2	87.9	2.6	6.8	64.0	100.8	69.0

Note:

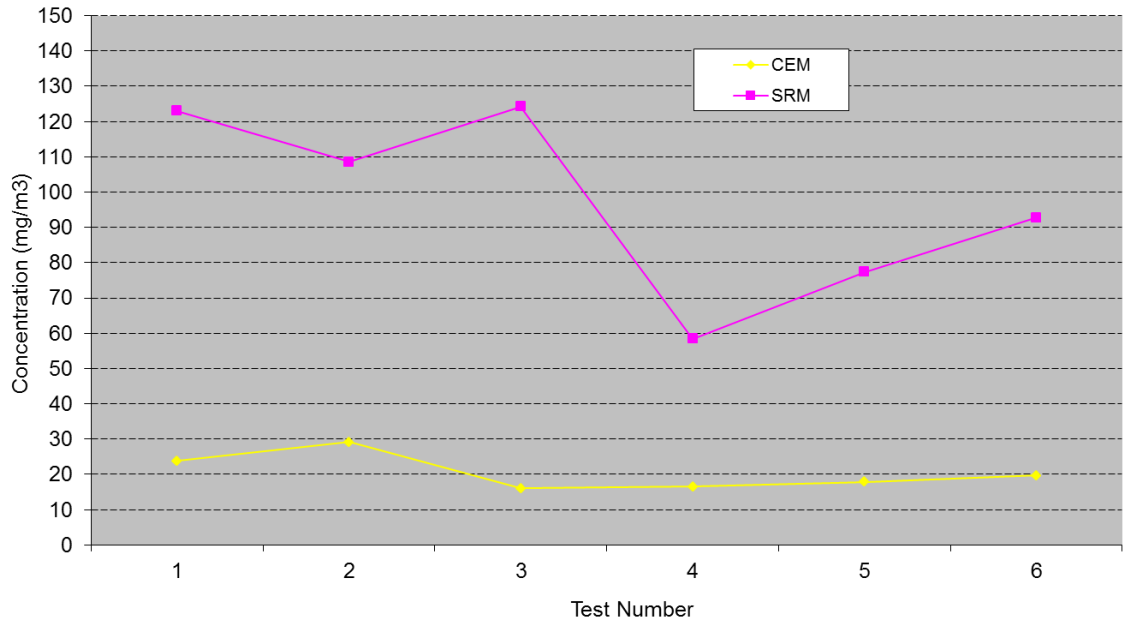
Emission concentrations expresed at reference conditions 273K, 101.3kPa

4B3 4.2 Table 4.2 – Standardised monitoring Data – Total Particulate Matter

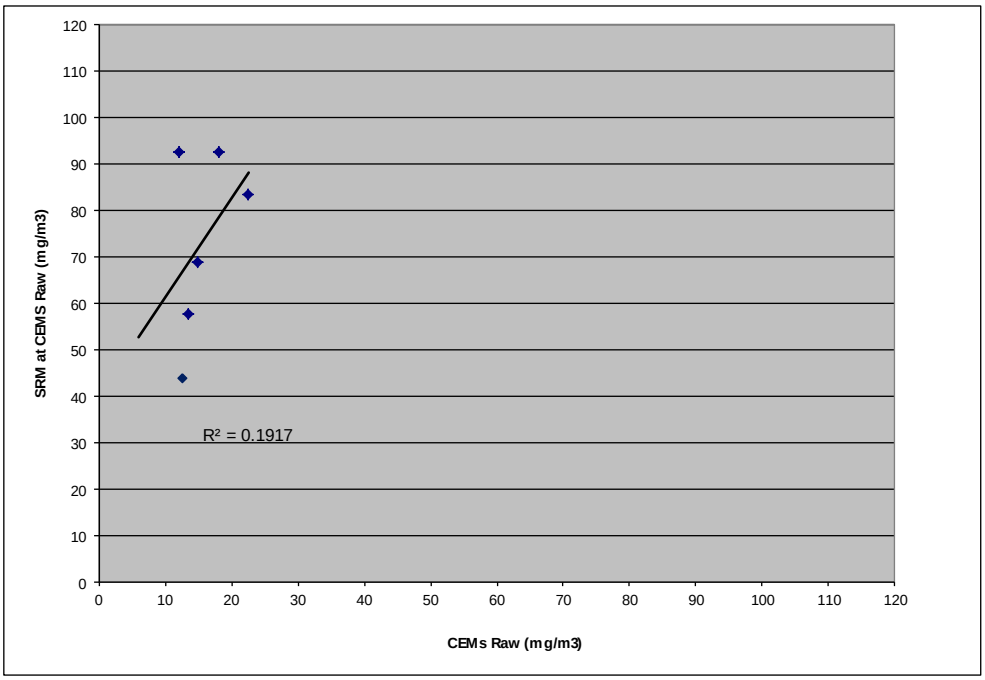
Test No	Date	Test Start Time	Test End Time	CEMS Standardised Value	SRM Standardised Value	SRM Uncertainty
		hr:min		(mg/m3)	mg/m3)	(mg/m3)
1	26-Oct-16	10:43	11:43	23.9	123.0	0.33
2	26-Oct-16	14:13	15:13	29.1	108.5	0.30
3	27-Oct-16	10:47	11:47	16.1	124.2	0.21
4	27-Oct-16	11:55	12:55	16.5	58.4	0.18
5	27-Oct-16	13:03	14:03	17.8	77.3	0.22
6	27-Oct-16	14:10	15:10	19.6	92.8	0.21

Note:
Emission concentrations expresed at reference conditions 273K, 101.3kPa 6 % Oxygen, dry gas

4B3 4.3 Plot 1.1 –Time Series of Standardised CEM versus Standardised SRM data – Total Particulate Matter. Reference conditions: 273K, 101.3kPa, dry gas, 6% oxygen.



4B3 4.4 – Elimination of Outliers – Total Particulate Matter.



Test No	Date	Test Start Time	Test End Time	CEMS Raw Value (Extinction)	SRM Value at CEMS Raw conditions	Difference Di	Difference Di - $\bar{D}i$	Is Result an Outlier - Di-$\bar{D}i$> 2SD
		hr:min		%	(mg/m3)			
1	26-Oct-16	10:43	11:43	18.2	92.6	74.45	16.78	No
2	26-Oct-16	14:13	15:13	22.6	83.5	60.90	3.23	No
3	27-Oct-16	10:47	11:47	12.0	92.8	80.72	23.06	No
4	27-Oct-16	11:55	12:55	12.6	44.0	31.39	-26.27	No
5	27-Oct-16	13:03	14:03	13.4	57.8	44.38	-13.28	No
6	27-Oct-16	14:10	15:10	14.8	69.0	54.15	-3.52	No
					Average $\bar{D}i$	57.66		
				Standard Deviation		18.45		
				Standard Deviation x2		36.91		

4B3 4.5 Table 4.3 - Data used to Calculate Calibrated Values – Total Particulate Matter.

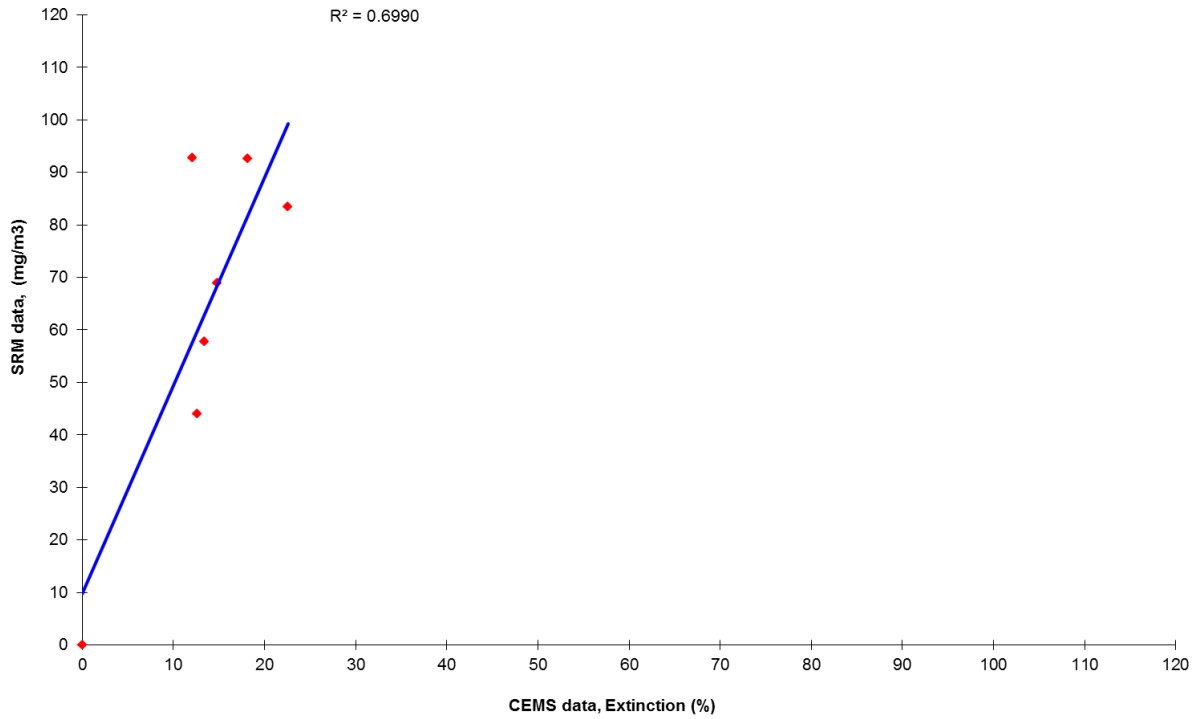
Test No	Date	Test Start Time	Test End Time	CEMS Raw Value (Extinction)	CEMS Calibrated signal	CEMS Moisture	CEMS Temp	CEMS Pressure	CEMS Dry Oxygen	CEMS Standardised Value (dry)	CEMS Calibrated Standardised Value	SRM Standardised
		hr:min		%	(mg/m3)	(%)	(^{o}C)	(kPa)	(%)	(mg/Nm^{3})	(mg/Nm^{3})	(mg/m3)
1	17-Feb-16	Reference		0.0	-0.3	N/A	N/A	N/A	0.0	0.0	-0.2	0.0
2	26-Oct-16	10:43	11:43	18.2	21.7	2.6	65.1	101.7	6.5	23.9	28.4	123.0
3	26-Oct-16	14:13	15:13	22.6	27.0	2.5	64.5	101.8	6.3	29.1	34.8	108.5
4	27-Oct-16	10:47	11:47	12.0	14.2	2.6	64.6	102.1	6.9	16.1	19.0	124.2
5	27-Oct-16	11:55	12:55	12.6	14.9	2.5	64.3	102.1	6.6	16.5	19.5	58.4
6	27-Oct-16	13:03	14:03	13.4	15.9	2.4	63.8	102.2	6.8	17.8	21.2	77.3
7	27-Oct-16	14:10	15:10	14.8	17.6	2.1	63.3	102.2	6.8	19.6	23.3	92.8
					Sum					**123.04**		

Emission Limit Value (ELV) = **35** mg/Nm^{3}

Reference Oxygen **6 %**

Established Calibration Function y_i= -0.303 + 1.208xi

Plot of CEM versus SRM Data at CEM measurement conditions– Total Particulate Matter, at stack temperature, pressure and moisture conditions.



4B3 4.6 Table 4.4 – Data used for the Variability Test – Total Particulate Matter.

Test No	Test Start Time	Test End Time	CEMS Calibrated Standardised value	SRM Standardised value	Difference D1	Difference D1 - D	Squared Difference D1 - D
	hr:min		mg/m3	mg/m3			
1	Reference		-0.2	0.0	0.22	-62.38	3891.17
2	10:43	11:43	28.4	123.0	94.56	31.96	1021.45
3	14:13	15:13	34.8	108.5	73.74	11.14	124.17
4	10:47	11:47	19.0	124.2	105.15	42.56	1811.02
5	11:55	12:55	19.5	58.4	38.87	-23.73	562.94
6	13:03	14:03	21.2	77.3	56.19	-6.40	41.01
7	14:10	15:10	23.3	92.8	69.45	6.85	46.92
7 Tests		Mean			62.60		
Sum							7498.70

4B3 4.7 - Variability Test and Test of Calibration Function Calculations – Total Particulate Matter.

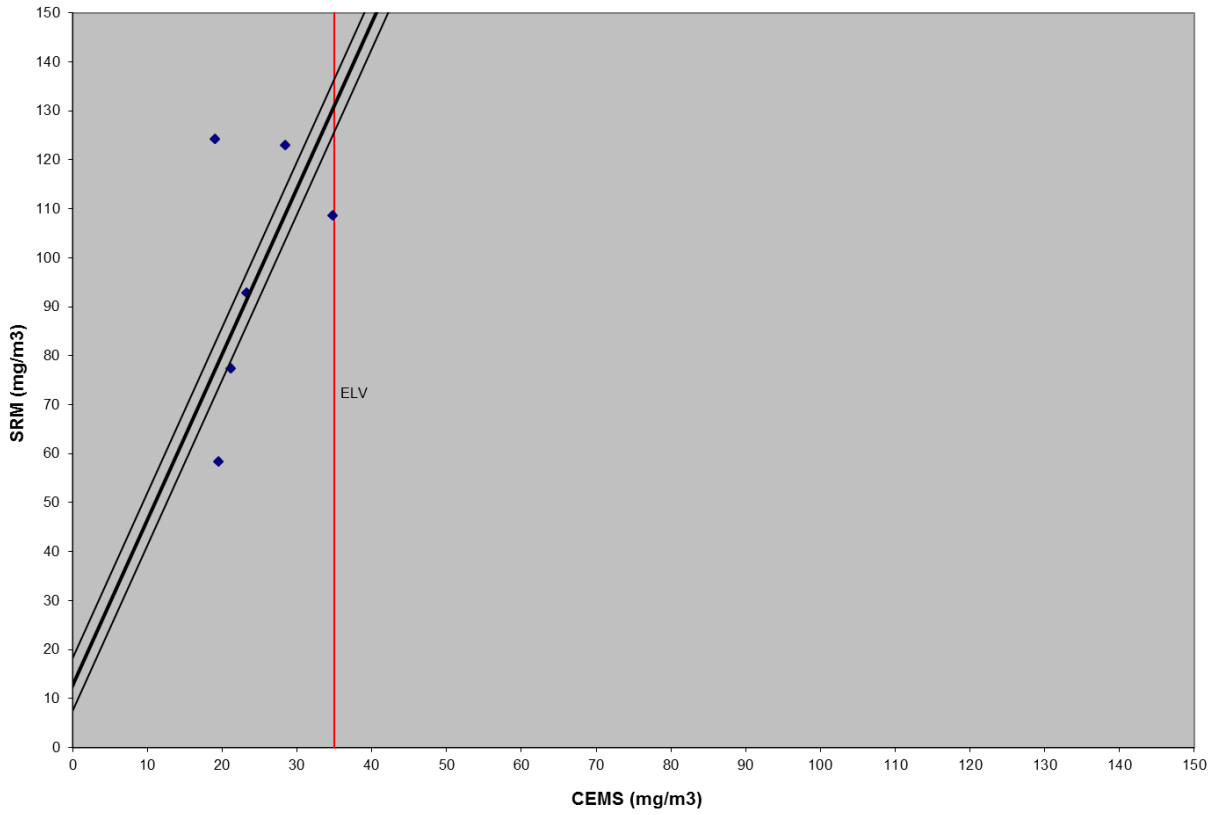
Variability Test

SD=	Root(1-Number).Integral(D1-D)^2		35.35	mg/m3(s,d),6%O_2
The uncertainty laid down by the authorities is 30% ELV as a 95% confidence interval. O_0 is therefore calculated as:-				
O_0=	0.3*35 mg/m3 (s,d,6%O2)/1.96		5.36	mg/m3(s,d),6%O_2
For 8 tests, k_v =	0.9521			
Therefore variability=		35.35 <= 5.36 * 0.9521 * 1.5		
	or	35.35 <=	7.65	
Which is FALSE therefore the CEMS fails the test				

Test of Calibration Function

The calibration of the AMS is accepted if:			D1<= $t_{0.95}$(*N*-1)*(s,d/root *N*)+O_0	
		D1=	62.60	
For 7 tests, t0.95(N-1) =	1.895			
Therefore test of calibration =		62.6 <=1.895*(35.35/root 7)+5.36		
	or	62.60 <=	30.68	
Which is FALSE therefore the calibration function is INVALID				

4B3 4.8 Plot 2 – Standardised CEM data versus standardised SRM - Total Particulate Matter – Reference conditions 273K, 101.3kPa, dry gas, 6% oxygen.



Section 5 – Results of Functional tests

Table 5.1 - Audit of functional tests

Operator	RWE Generation UK plc.	
Site	Aberthaw Power Plant	
Stack	Unit 8	
Process Sector	LCPD	
Analyser A - Make Model **MCERTs Certificate Number**	Procal 1 - Pulsi 2000, In Situ IR MC990006/07	
Analyser B - Make Model **MCERTs Certificate Number**	Procal 2 - Pulsi 2000, In Situ IR MC990006/07	
Analyser C - Make Model **MCERTs Certificate Number**	Erwin SICK OMD41, Cross Duct Forward Scatter MC040042/01	
Parameters Tested	**Daily ELV**	**Certified range**
NO & NO_2	1080 mg/m^3 (NO_x as NO_2)	PROCAL: NO = 0 – 1000 ppm
Total Particulate Matter	35 mg/m^3	Erwin SICK: TPM = 0 – 200 mg/m3
SO_2	440 mg/m^3	PROCAL = SO2 low = 0 – 250 ppm SO2 high = 0 – 1000 ppm

Analysers A & B	
Organisation carrying out tests -	Parker/Procal
Status of organisation – CEMS manufacturer/operator/service contractor	CEMS OEM
Test engineer	M Findley
Date of tests	1st – 11th October 2016

Analyser C	
Organisation carrying out tests -	SICK
Status of organisation – CEMS manufacturer/operator/service contractor	CEMS OEM
Test engineer	P Burgess
Date of tests	5th - 10th October 2016

Functional Test compliance with EN 14181

Requirement	Compliance Y/N	Notes
1 – Alignment and cleanliness All checks specified in MID 14181 carried out ? – 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 lines; - filters. The sampling system shall be in good condition and free of any visible faults, which may decrease the quality of the testing.	Yes Yes	**Procal** – Yes **SICK (OMD)** – Yes – Optics cleaned
2 - Leak Test Leak testing shall be performed according to the AMS manuals. The test shall cover the entire sampling system.	N/A	**Procal** – N/A although differential pressure noted as OK
Results of leak check compliant with requirements of relevant standards	N/A	
3 - Zero and Span Check Analyser Reference zero and span materials shall be used to verify the corresponding readings of the AMS.	Yes	**Procal** – Yes **SICK (OMD 41)** – Yes – although based on the use of filters
Results compliant with requirements of relevant standards Parameter:		
NO SO_2 TPM	Yes (Procal) Yes (Procal) Yes	**SICK (OMD41)** - Span values recorded as mA signals

Requirement	Compliance Y/N	Notes
4 - Zero and Span Check Full System Reference zero and span materials shall be used to verify the corresponding readings of the AMS.	N/A	Procal analysers are in situ type and therefore there is as such, no 'full system'.
5 – NOx converter efficiency check	N/A	
6 - Linearity The linearity of the analysers shall be checked using five different reference materials, including zero concentration.	Yes – Procal, SICK OMD 41	**Procal** – Yes **SICK (OMD)** – Yes – although based on the use of filters
The reference material with zero concentration, as well as the reference materials with four different concentrations, shall have a verifiable quantity and quality.	Yes	**Procal** – Yes **SICK** – Yes – although based on the use of filters
The reference material concentrations shall be selected such that the measured values are approximately 20%, 40%, 60% and 80% of two times the emission limit.	See note	**Procal** – Yes **SICK** – Used 8 points using filters
The dry test reference material shall be applied to the inlet of the AMS. Reference materials can be introduced directly into the analyser as long as the integrity of the sample system has been proved	N/A	N/A

Requirement	Compliance Y/N	Notes
6 – Linearity (continued) After each change in concentration, the first instrument readings shall be taken after a time period equal to 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. A risk based approach may be adopted in order to reduce the time for the linearity tests	No N/A	**Procal** – No times stated in report **SICK (OMD)** – No times stated in report
Linearity Test Pass Parameter		**Procal** – Yes **SICK (OMD)** – Yes
NO, SO_2 & TPM	Yes	
6 – Interferences (only required in the event of a failure of the QAL 2/AST)	N/A	
7 – Zero and Span Drift (Audit)	Yes	
8- Response time The response of the AMS shall be checked. This can be performed, if appropriate, by feeding the reference material at the end of the sampling probe. The response time shall not exceed the measured value as identified during QAL 1.	See Note	**Procal** – Yes **SICK (OMD 41)** – Yes

Requirement	Compliance Y/N	Notes
9a – Service Report - **PROCAL**		
• Document reference	Yes	
• Instrument manufacturer	Yes	Procal
• Instrument Type	Yes	In-situ
• Instrument model	Yes	PULSI 200
• Instrument Serial No's	Yes	
• Operating principal	Yes	
• Operating range	Yes	
• Certification details	Yes	
• Compliance with MCERTS	Yes	
• Location	Yes	
• Date and time of work	Yes	Date only
• Equipment used - Type serial no's etc	Yes	Gas divider
• Gases used – certificate numbers, expiry dates, type	No	Copy of gas certificates offered to customer
• NOx converter efficiency check	N/A	
• Calibration and linearity data	Yes	
• Logged data for period of calibration/linearity	No	
• Name & signature of test engineer	Yes	

Requirement	Compliance Y/N	Notes
9b – Service Report – **SICK OMD**		
• Document reference	Yes	
• Instrument manufacturer	Yes	
• Instrument Type	Yes	
• Instrument model	Yes	
• Instrument Serial No's	Yes	
• Operating principal	Yes	
• Operating range	Yes	
• Certification details	Yes	
• Compliance with MCERTS	Yes	
• Location	Yes	
• Date and time of work	Yes	Date Only
• Equipment used - Type serial no's etc	Yes	On Linearity Sheet
• Gases used – certificate numbers, expiry dates, type	N/A	Linearity carried out using filters. Filter set serial no stated.
• NOx converter efficiency check	N/A	
• Calibration and linearity data	Yes	
• Logged data for period of calibration/linearity	Yes	Data supplied separately by client
• Name & signature of test engineer	Yes	

OMD41- Particulate Linearity Report

Customer	ABERTHAW
Site	ABERTHAW
Permit Ref	
Contact	DAN PETERS
Service Ref No.	19128
Survey Date	10/10/2016
Device Type	OMD41
Serial Number	98078002
MCERTS Cert No	MC 040042/01
Certification Details	See Certificate
Measurement Principle	OPACITY
Gas Box Serial Number	91148002
SICK Engineer	P BURGESS
Signature	 P BURGESS

Sick (UK) Ltd
Waldkirch House
39 Hedley Road
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Hertfordshire
AL1 5BN

Tel: +44 (0) 1727 831121
Fax: +44 (0) 1727 855332
E-Mail: info@sick.co.uk

Particulate Linearity

Customer	ABERTHAW
Plant	ABERTHAW
Site Contact	DAN PETERS
Product	OMD41
MCERTS Certificate Number	MC 040042/01
Location	Stack

Site Permit Ref	0
SVDN No	19128
Order Number	
QAL2/AST/Routine	QAL2
Date	19/10/2016
Engineer	P BURGESS

Filter Set S/N	17103386
Calibration Date	26/10/2016
Results Visible on DCS?	Not possible disconnected from stack
Corrections Applied?	NA

Response time (T_{90}) seconds	2
Permit Daily ELV for Dust mg.m^{-3}	200
Plant ELV x 2, mg.m^{-3} (c_{ELV})	400
Analyser Range mg.m^{-3}	500

Component 1	Particulate
Set pt time ($4xT_{90}$) sec	8
Log time ($3xT_{90}$) sec	6

Linearity Results

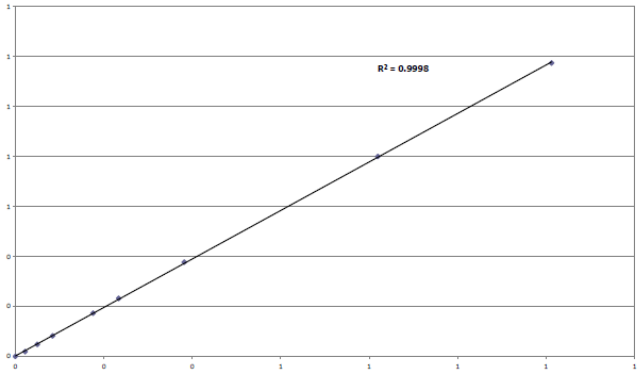
Expected Extinction	Reading 1	Reading 2	Reading 3	Average Reading	DCS	DCS Time
0.0220	0.0190	0.0190	0.0190	0.0190	NA	NA
0.0496	0.0480	0.0480	0.0480	0.0480	NA	NA
0.0841	0.0820	0.0820	0.0821	0.0820	NA	NA
0.1755	0.1730	0.1731	0.1730	0.1730	NA	NA
0.2334	0.2320	0.2320	0.2320	0.2320	NA	NA
0.3818	0.3770	0.3770	0.3770	0.3770	NA	NA
0.8195	0.8000	0.8000	0.8000	0.8000	NA	NA
1.2124	1.1750	1.1730	1.1750	1.1743	NA	NA

Zero Results

ZERO	Expected Transmission	Analyser Reading mg.m^{-3}	DCS mg.m^{-3}	DCS Time
Zero Reading 1	0.00	0.00	NA	NA
Zero Reading 2	0.00	0.00	NA	NA
Zero Reading 3	0.00	0.00	NA	NA
Zero Reading 4	0.00	0.00	NA	NA
Zero Reading 5	0.00	0.00	NA	NA
Zero Reading 6	0.00	0.00	NA	NA
AVERAGE		0.00		

Actual Extinction	Average CEM Reading (Ex)	$d_{Ex/ref}$	$d_{Ex/ref}$ <5% (EN 14181)
0.0000	0.0000	-0.03%	PASS
0.0220	0.0190	-0.09%	PASS
0.0496	0.0480	-0.04%	PASS
0.0841	0.0820	0.03%	PASS
0.1755	0.1730	-0.02%	PASS
0.2334	0.2320	-0.09%	PASS
0.3818	0.3770	-0.04%	PASS
0.8195	0.8000	0.03%	PASS
1.2124	1.1743	-0.02%	PASS

Actual Extinction v CEM Reading (Ex)



Engineer	P BURGESS
Signature	
Comments	Analyser exhibiting a linear response

Version 2016 - Uncontrolled when printed

Filter Extinction i %	Reference value x_i %	CEM value y_i $mg.m^{-3}$	Difference X_i-X_z	Product $Y_i(X_i$-$X_z)$	Squared difference $(X_i$-$X_z)^2$
0%	0.00	0.00	-0.30	0.00	0.09
0%	0.00	0.00	-0.30	0.00	0.09
0%	0.00	0.00	-0.30	0.00	0.09
0.022	0.02	0.02	-0.28	-0.01	0.08
0.022	0.02	0.02	-0.28	-0.01	0.08
0.022	0.02	0.02	-0.28	-0.01	0.08
0.0496	0.05	0.05	-0.25	-0.01	0.06
0.0496	0.05	0.05	-0.25	-0.01	0.06
0.0496	0.05	0.05	-0.25	-0.01	0.06
0.0841	0.18	0.17	-0.12	-0.02	0.01
0.0841	0.18	0.17	-0.12	-0.02	0.01
0.0841	0.18	0.17	-0.12	-0.02	0.01
0.1755	0.08	0.08	-0.21	-0.02	0.05
0.1755	0.08	0.08	-0.21	-0.02	0.05
0.1755	0.08	0.08	-0.21	-0.02	0.05
0.2334	0.23	0.23	-0.06	-0.01	0.00
0.2334	0.23	0.23	-0.06	-0.01	0.00
0.2334	0.23	0.23	-0.06	-0.01	0.00
0.3818	0.38	0.38	0.08	0.03	0.01
0.3818	0.38	0.38	0.08	0.03	0.01
0.3818	0.38	0.38	0.08	0.03	0.01
0.8195	0.82	0.80	0.52	0.42	0.27
0.8195	0.82	0.80	0.52	0.42	0.27
0.8195	0.82	0.80	0.52	0.42	0.27
1.2124	1.21	1.18	0.91	1.07	0.84
1.2124	1.21	1.17	0.91	1.07	0.84
1.2124	1.21	1.18	0.91	1.07	0.84
0%	0.00	0.00	-0.30	0.00	0.09
0%	0.00	0.00	-0.30	0.00	0.09
0%	0.00	0.00	-0.30	0.00	0.09
Average	0.30	0.29			
Sum	8.93	8.72	0.00	4.36	4.49

a =	0.29
B =	0.97
A =	0.00

Residuals				
Averages	c %	Average Y_c	d_c	$d_{c,rel}$
0	0.00	0.00	0.00	-0.03%
0.022	0.02	0.02	0.00	-0.09%
0.0496	0.05	0.05	0.00	-0.04%
0.0841	0.18	0.17	0.00	0.03%
0.1755	0.08	0.08	0.00	-0.02%
0.2334	**0.23**	**0.23**	0.00	0.10%

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SICK

Maintenance Report OMD41 Stack UNIT 8

☒ Maintenance ☐ Repair

Customer:	RWE Aberthaw	Customer no:	SVON 019128
Country:	UK	Location:	Aberthaw PS
Receiver:	1012184	Serial no.:	98078002
Reflector:	1012385	Serial no.:	98078002
Eval.Unit:	n/a	Serial no.:	n/a

Plant operating status:	**Stack UNIT 8 unit not running**

	done	Remarks:
Check weekly/monthly/ quarterly log files: Log files ok?	☐	Not available
Training recommended:	☐	Not required

Dust reading before check

	Opacity or Extinction		NA Removed by RWE Staff.
	Dust in Ex	Ex	0.065
	Contamination	mA	
	Dust reading, measured values	mA	4.7
	Control cycle, Zero point values	mA	0
	Control cycle, Span value	mA	70

1. Visual Inspection

1.1	Check if measured values are plausible in the control room	☒	OK
1.2	Check if control cycle is (zero/span) valid (control room or recorder or evaluation unit)	☒	O.K.
1.3	Check if there is any error message	☒	None
1.4	Check for mechanical or electrical connection damage	☒	OK
1.5	Check mechanical mounting	☒	O.K.

2. Purge Air Unit

2.1	Check the hoses and ring nozzles	☒	NA RWE STAFF
2.2	Clean the pre-filter	☐	
2.3	Replace the filter insert, part no. 5306091 for OMD41 SN > 97xxxxxxx, or part no.6700149 for OMD41 SN <96xxxxxx	☐	
2.4	Check function of filter monitor purge switch.	☐	

3. Fail Safe Shutter (FSS Optional)

3.1	Check function of fail-safe shutter	☐	NA

4. Optical unit

4.1	Clean housing	☒	O.K.
4.2	Check and, if necessary readjust optical axis	☒	O.K.

4.3	Clean optical boundary surfaces for sender/receiver and reflector, 2 x part no. 4003353	☒	O.K.
4.4	Check and replace desiccant cartridge, part no. 2008475	☒	Not required Still blue.
4.5.	Check the transmitter diode	☒	O.K.
4.6	Check the stepper motor	☒	O.K.
4.7	Check zero point, re-calibrate at smoke-free measurement point if it deviates	☒	O.K.
4.8	Check function of control cycle	☒	O.K.
4.9	Linearity check	☒	OK

Linearity Measurement	**Set value**	**Actual Value**	**Deviation in %**		< 2% OK?
Zero	0.0 mA	0.0	mA	0.00	0.0%	OK
Span 1 (aprox. 30%)	14.06 mA	14.06	mA	0.02	0.0%	OK
Span 2 (aprox. 70%)	16.80 mA	16.80	mA	0.00	0%	OK
Span 3 (100%)	20.00 mA	20.00	mA	0.00	0.0%	OK

5. Connection unit

	Check the analogue and digital input and output signals	☐	n/a

6. Final check

6.1	Check function of complete measurement system	☒	OK
6.2	Check the availability of the system	☒	Not available
6.3	Write device data into the report file	☒	OK
6.4	Complete Service Report and Measurement Log-file	☒	OK

7. Report in writing to the plant manager as follows:

Quality of maintenance work by plant personnel: OK
Cleanliness of measuring station and devices: OK
Maintenance work done(in addition to Annex 1): None
Problems found, solution applied: None
Recommendation for repair, changes: None
Availability of the unit: Off line
Proposal how to reach higher availability and better emission data quality: None
Training provided to plant personnel, proposal for settlement: None
Training requirements detected: None
Others:

Dust reading after check

	Opacity or Extinction	EX	0.0047
	Dust in mg / m³	mg/m³	0.0
	Contamination	mA	0.0
	Dust reading, measured values	mA	4.5
	Control cycle, Zero point values	mA	4.00
	Control cycle, Span value	mA	16.80

Remarks :

	Name Plant person: Dan Peters

13.12.16 Maintenance check list OMD 41 2 / 3

Date : 10-10-16	Technician: Paul Burgess

CALIBRATION CERTIFICATE

Site	**Aberthaw**
Date	**11/10/2016**
Instrument	**Unit 8 Primary**
Instrument Ref	**8800539** **8500916**
Engineer	**Michael Findley**

Results:

Component	Units	Range FSD	Gas conc	Cert ref	Results		% error FSD
					pre cal	post cal	
H2O	%	10	n/a				
CO2	mAU	400	n/a				
CO	PPM	500	336	site gas	316	319	-3.4
NO	PPM	1000	659		336	662	0.3
SO2-H	PPM	1000	674	site gas	700	678	0.4
SO2-L	PPM	250	207.9	936352001	211	213	2.0

Cross sensitivity tests:

Test/	Response			% Error FSD		
	CO	NO	SO2-H	CO	NO	SO2-H
CO2 15%	1	24	4	0.2	2.4	0.4
H2O 4%	8	-2	4	1.6	-0.2	0.4
CO2 15% + H2O 3%	4	-3	7	0.8	-0.3	0.7

Test/	Response			% Error FSD		
	SO2-L			SO2-L		
CO2 15%	4			1.6		
H2O 4%	4			1.6		
CO2 15% + H2O 3%	7			2.8		

Signature: M.Findley

M.Findley
Procal Customer Support Engineer

Parker Procal, 5 Maxwell Road, Woodston, Peterborough, PE2 7HU, UK
Tel: +44 (0) 17336 232495 Email: procalsales@parker.com Website: www.procal.com

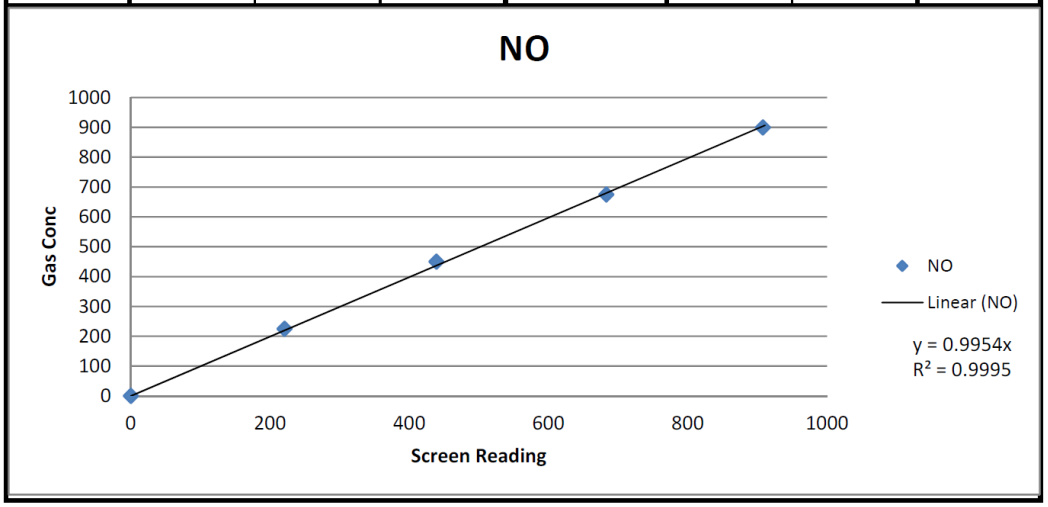
7-7853-02 cal cert site visit general use Change note: 7007110 Date: 17/03/09

LINEARISATION RESULTS

Site	Aberthaw
Date	11/10/2016
Instrument	Unit 8 Primary
Instrument Ref	8800539 8500916M
Engineer	Michael Findley

The above analyser has undergone a linearisation check and calibration, if required, in accordance with the company's quality system. The following results were obtained.

Component	Units	Range FSD	Gas conc	Cert ref	Results		% error
					pre cal	post cal	FSD
NO	PPM	1000	900	4000619281	908	908	0.8
					911	911	1.1
					911	911	1.1
NO	PPM	1000	675	4000619281	683	683	0.8
					684	684	0.9
					683	683	0.8
NO	PPM	1000	450	4000619281	439	439	-1.1
					452	452	0.2
					454	454	0.4
NO	PPM	1000	225	4000619281	221	221	-0.4
					230	230	0.5
					231	231	0.6



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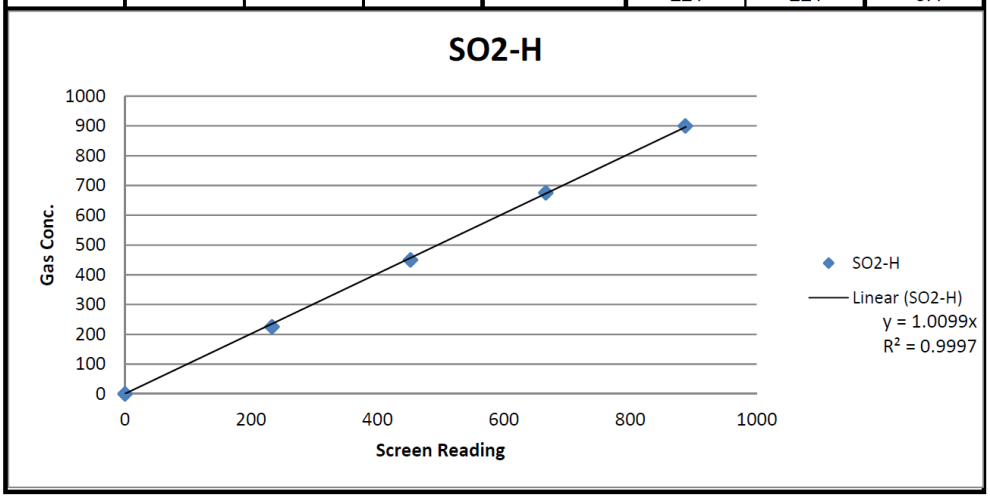
Tel: +44 (0) 17336 232495 Email: procalsales@parker.com Website: www.procal.com

7-7862-04 Linearisation Certificate Change note: 7009251 Date: 30/07/12

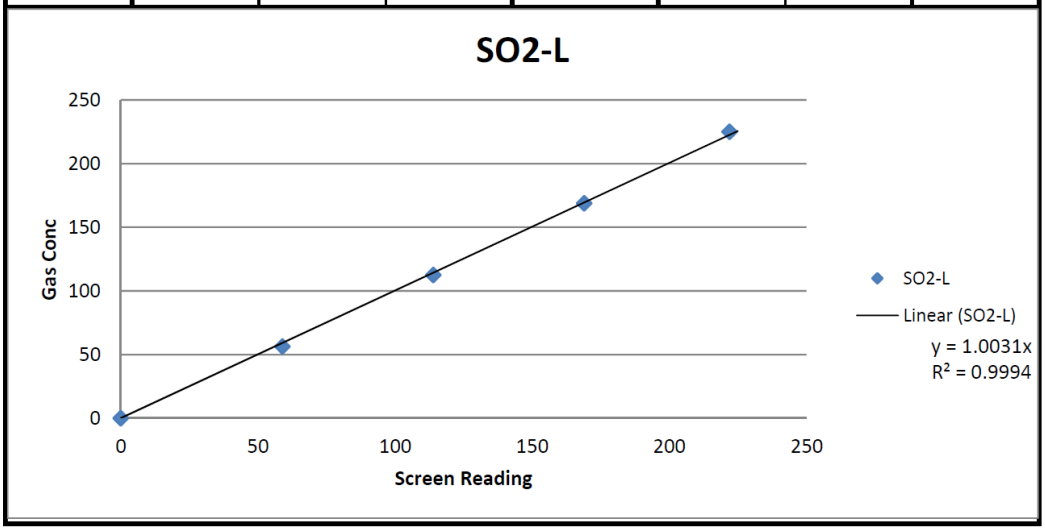
Component	Units	Range FSD	Gas conc	Cert ref	Results		% error FSD
					pre cal	post cal	
SO2-H	PPM	1000	900	40006192554	887	887	-1.3
					887	887	-1.3
					888	888	-1.2
SO2-H	PPM	1000	675	40006192555	666	666	-0.9
					664	664	-1.1
					664	664	-1.1
SO2-H	PPM	1000	450	40006192556	452	452	0.2
					440	440	-1.0
					442	442	-0.8
SO2-H	PPM	1000	225	40006192557	233	233	0.8
					220	220	-0.5
					221	221	-0.4



Kittiwake Procal Ltd, 5 Maxwell Road, Woodston, Peterborough, PE2 7HU, UK TEL:+44(0)1733 23495 FAX:+44(0)1733 235255
E-mail: asampson@procal.com Website: www.procal.com

7-7862-04 Linearisation Certificate Change note: 7009251 Date: 30/07/12

Component	Units	Range FSD	Gas conc	Cert ref	Results		% error
					pre cal	post cal	FSD
SO2-L	PPM	250	225	4006192686	222	222	-1.2
					224	224	-0.4
					225	225	0.0
SO2-L	PPM	250	168.75	4006192687	169	169	0.1
					169	169	0.1
					169	169	0.1
SO2-L	PPM	250	112.5	4006192688	114	114	0.6
					115	115	1.0
					115	115	1.0
SO2-L	PPM	250	56.25	4006192689	59	59	1.1
					58	58	0.7
					58	58	0.7



Zero	H2O	CO2	CO	NO	SO2-H	SO2-L
#1	0	0	-1	-1	1	1
#2	0	0	-1	-4	0	0
#3	0	0	-1	-6	3	3
#4	0	0	0	-4	2	2
#5	0	0	0	-3	1	1
#6	0	0	-3	0	3	3

Signature:

M.Findley
Procal Customer Support Engineer

Kittiwake Procal Ltd, 5 Maxwell Road, Woodston, Peterborough, PE2 7HU, UK TEL:+44(0)1733 23495 FAX:+44(0)1733 235255
E-mail: asampson@procal.com Website: www.procal.com

7-7862-04 Linearisation Certificate Change note: 7009251 Date: 30/07/12

Functionality Test Results

DECLARATION OF CONFORMITY

We,

Kittiwake Procal Ltd
5 Maxwell Road
Woodston
Peterborough
Cambridgeshire
PE2 7HU
United Kingdom

Tel: (+44) (0) 1733 232495
Fax: (+44) (0) 1733 235255
e-mail: post@procal.com
Web site: www.procal.com

declare that the product: **Type PULSI 200 Analyser** ***installed at***

Customer	**Aberthaw Power Station**
Control Unit Serial Number	**8800539**
P200 Serial Number	**8500916M**
Site Identification	**Unit 8 Primary**

to which this declaration relates is in conformance with the MCERTs Performance Standard for Continuous Emission Monitoring Systems: Version 2. Revision 1 (April 2003).

MCERTS Product Conformance Certificates:

Licence	Certificate Number	Variation	Dated
ACU	SIRA MC 990006/	8	02/10/09
ACWn	SIRA MC 050060/	6	02/10/09

MCERTs Certification Body:

Sira Certification Service	
12 Acorn Industrial Park	Tel: (+44) (0) 1322 520500
Crayford Road	
Crayford	Fax: (+44) (0) 1322 520501
Dartford	
Kent	
DA1 4AL	e-mail: info@siraenvironmental.com
United Kingdom	Web site: www.siracertification.com

Quality System:

ISO 9001:2008	Certificate Nr: 062043	Dated: 11/06/09

Technical Standards Used:

EN 15267-2	Dated:	2009
EN 15267-3	Dated:	2007

All tests carried out to Kittiwake Procal's working procedures and those within Annex A of EN14181, Version 2.3 June 2010, relating to functionality testing by CEMs' manufacturers.

Signed:…… ***Date:…11/10/2016……***

1.0 Alignment and Cleanliness.

1.1 Internal Check of Analyser

Analyser under test	Status	Notes
Optical path clear	Yes	
Optics clean	Yes	
Internal wiring ok	Yes	
Air supply on	Yes	
Purge flow >300 ltrs/hr	Yes	
Pressure differential <80mBar	Yes	36mbar

2.0 Zero and Span Checks.

2.1 Zero Check

Component:	H2O	CO2	CO	NO	SO2-H	SO2-L	Ta	Ts	Ps
Units:	%	mAU	ppm	ppm	ppm	ppm			
Process conc	3.5	64	49	65	115	103	23	132	1021
Zero conc	0	0	-2	3	3	3	23.2	129	1057
% error	<2	<2	<2	<2	<2	<2			
Pass/Fail	Pass	Pass	Pass	Pass	Pass	Pass			
T90 recovery									

2.2 Span Check

Component:	H2O	CO2	CO	NO	SO2-H	SO2-L	Ta	Ts	Ps
Units:	%	mAU	ppm	ppm	ppm	ppm			
Full range	10	-	500	1000	1000	250			
Zero Conc	0	0	-3	0	3	3	23.2	130	1057
Test Gas Conc			336	659	674	207.9			
Cert number			Site gas		Site gas	936352001			
Response Conc			336	662	678	207			
% Error			<2	<2	<2	<2			
Pass/Fail			Pass	Pass	Pass	Pass			
T90 time				80	80	85			

2.3 Filter Level Checks

All on zero air	F6	F2	F7	F5G	F3	F1G	F4	F8	
Factory	2822	4446	4654	2684	3487	2294	536	3053	
Last visit	2313	3028	3379	1981	2784	2036	457	2485	
This visit	1926	2643	2903	1678	2329	1696	401	2153	

2.4 Interference Checks

Component:	H2O	CO2	CO	NO	SO2-H	SO2-L
Units:	%	mAU	ppm	ppm	ppm	ppm
ZERO	0	0	3	-1	2	2
CO2 15%	0	186	1	24	4	4
H2O 4%	4	3	8	-2	4	4
H2O 3% & CO2 15%	3.5	186	7	41	7	7

3.0 Data Acquisition.

Displayed \ Component							
Zero	Analyser						
	DCS						
	4-20mA						
Span	Analyser						
	DCS						
	4-20mA						

4.0 Linear coefficient record.

Coefficient \ Component		H2O	CO2	CO	NO	SO2-H	SO2-L
Last test	Linear	2.200E-2	1	9.590E0	1.285E1	5.947E0	5.944E0
	Squared	5.980E-5	0	9.496E-2	3.673E-2	-2.800E-3	-7.300E0
	Cubed						
This test	Linear	2.200E-2	1	1.019E+01	1.285E+01	6.300E+00	6.324E+00
	Squared	5.980E-5	0	1.009E-01	3.673E-02	-2.967E-03	-7.766E-03
	Cubed						

5.0 Test Information

5.1 Procal Engineer: **Michael Findley**

5.2 Test House:

5.3 Test House Engineer:

Appendix 1. Pro-forma for assessing and reporting the results of the functional tests

Requirement		Notes
1. Alignment and Cleanliness		
A visual inspection, with reference to the CEMs manuals, shall be carried out on the following when applicable:		
• Internal check of the CEM	√	All functions ok
• Cleanliness of the optical components	√	
• Flushing air supply	√	Ok
• Obstructions in the optical path	√	None
• After re-assembly at the measurement location at least the following shall be checked	√	No re-alignment required
• Alignment of the measuring system	√	No alignment required
• Contamination control (internal check of optical surfaces)	√	
2. Sampling Systems		
A visual inspection of the sampling system shall be performed, noting the condition of the following components, when fitted:		
• Sampling probe	n/a	
• Gas conditioning systems	n/a	
• Pumps	n/a	
• All connections	√	Ok
• Sample lines	n/a	
• Power supplies	√	Ok
• Filters	√	Ok
• NOx converters - if the sampling system contains a NOx converter, then the test laboratory shall record when the last efficiency-test was performed, and the result of this test.	n/a	
• The sampling system shall be in good condition and free of any visible faults, which may decrease the quality of data	√	Ok
3. Leak testing		
• Leak testing shall be performed according to the CEMs manuals. The tests shall cover the entire sampling system.	n/a	
4. Zero and Span check		
• Reference zero and span materials shall be used to verify the corresponding readings of the CEM.	√	Ok
• In case of non-extractive CEM, zero and span checks shall be performed using a reference-path free of flue gas before and after readjustment and after re-assembly of the CEM at the measurement location.	√	Ok
5. Linearity		
• During the calibration/linearity tests the applied concentrations should be logged onto the DCS to prove the complete system i.e. concentration applied to the instrument is represented by the instrument output and identical to the value logged on the DCS.	√	Data collected on ACU MK3 customer DCS during testing

Requirement		Notes
DCS logged values should be included in the instrument service report.	√	Data collected on ACU MK3 & customer DCS during testing
• The linearity of the CEM's response shall be checked using five different reference materials, including a zero concentration.	√	See linearity Cert
• The reference material with zero concentration, as well as the reference materials with four different concentrations, shall have a verifiable quantity and quality.	√	See gas certs
• 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.	√	Gas points derived from blending full gas range using a Procal P9000, a water generator/gas blender
• 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 CEM.	√	See linearity cert
The individual CEMs are tested using the following concentrations applied in a randomised sequence:		
• Reference material with zero concentration;	√	See linearity cert
Reference material concentration approximately 20 % of 2 times the emission limit;	√	See linearity cert
• Reference material concentration approximately 40 % of 2 times the emission limit;	√	See linearity cert
• Reference material concentration approximately 60 % of 2 times the emission limit;	√	See linearity cert
• Reference material concentration approximately 80 % of 2 times the emission limit;	√	See linearity cert
• Reference material with zero concentration;	√	See linearity cert
After each change in concentration, the first instrument reading shall ordinarily be taken after a time period equal to at least three times the response time of the CEM. At each reference material concentration, at least three readings shall be made, six readings shall be taken at zero. The time period between the start of each of the three readings shall be separated by at least four times the response time. The test-laboratory may apply a risk-based approach to linearity testing in order to reduce the time for the tests. For example, the readings may be taken after less than 3x the response time; however, if the CEM fails the linearity test, then the test laboratory shall repeat the linearity test and wait at least 3x the response time as stated above. Alternatively, the number of repetitions of the test may be reduced if the CEM passes the required performance criteria by a factor of at least 2 (i.e. half the allowable residual). Increasing the waiting time to 5x the response time, for example, may be a means of meeting this requirement. Where no other method is possible, the linearity can also be performed with the aid of reference materials such as grating filters or gas filters.		

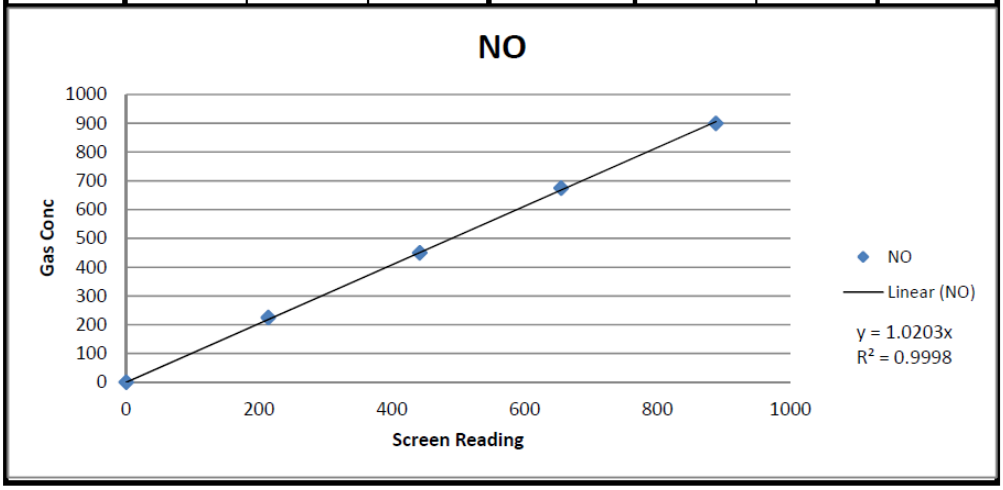
Requirement		Notes
The linearity shall be calculated and tested using the procedure as given in EN 14181 annex B. If the CEM does not pass this test; then the problem shall be identified and rectified.		
6. Interferences		
• A test shall be undertaken if the process gases to be monitored contain components that are known interferences, as identified during QAL1 and there is a failure of the QAL2 or AST which could be due to interferents.	√	Interference checks made with Water vapour, CO2 and each gas species
7. Zero and Span drift (Audit)		
• The test laboratory shall assess whether the operator has a QAL3 procedure in place, and whether the operator has applied this procedure. The evidence would comprise (i) a documented procedure, (ii) zero and span data, (iii) control charts.	√	Customer has procedure in place and has documented evidence
. Response Time		
• The response time of the CEM 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 performance requirement applied during the QAL1 tests.	√	Response time recorded on test sheet and this test sheet
9. Service Report		
As a minimum requirement the service report should include the following:		
• Document reference for work instruction for the type of work being undertaken	√	Procal Method Statement
• Instrument manufacturer	√	Procal
• Instrument type	√	Pulsi 2000
• Instrument model	√	P2000
• Instrument Serial No	√	8500916M
• Operating principle	√	GFCIR & NIR
• Operating range	√	Recorded on this report
• Certification details	√	Mcerted
• Compliance with MCERTS (including certificate no.)	√	SIRA MC 990006/08
• Location	√	Unit 8 Primary
• Date and time work was undertaken	√	11/06/2016
• Equipment used - type, serial no's, calibration dates	√	Procal Water Generator/Gas divider Pcal #6
• Gases used - certificate numbers, expiry dates, binary / mix	√	Copy of Gas Certs at customer request can be emailed
• NOx converter efficiency test, if applicable	n/a	
• Calibration and linearity data as required by EN14181	√	See Linearity & (Calcert Data)
• **Logged** data for period of calibration and linearity. Note there may be gaps in the data, in such cases, the test laboratory shall state why there are gaps in the data	√	See Linearity & (Calcert Data)

LINEARISATION RESULTS

Site	Matthew Gosling
Date	11/10/2016
Instrument	Unit 8 back up
Instrument Ref	8800624 8500726
Engineer	Matthew Gosling

The above analyser has undergone a linearisation check and calibration, if required, in accordance with the company's quality system. The following results were obtained.

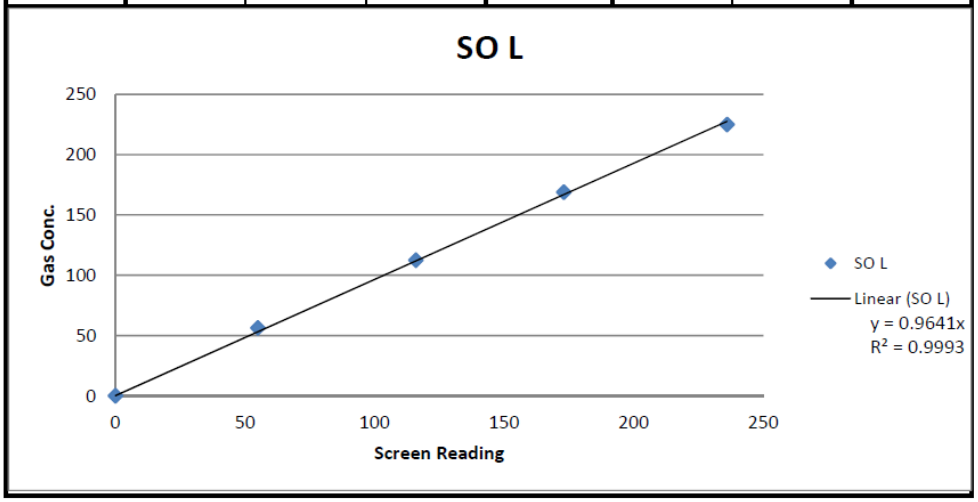
Component	Units	Range FSD	Gas conc	Cert ref	Results		% error
					pre cal	post cal	FSD
NO	ppm	1000	675	4000619281	655	655	-2.0
					655	655	-2.0
					658	658	-1.7
NO	ppm	1000	225	4000619281	214	214	-1.1
					210	210	-1.5
					218	218	-0.7
NO	ppm	1000	900	4000619282	888	888	-1.2
					885	885	-1.5
					883	883	-1.7
NO	ppm	1000	450	4000619283	442	442	-0.8
					432	432	-1.8
					433	433	-1.7



Kittiwake Procal Ltd, 5 Maxwell Road, Woodston, Peterborough, PE2 7HU, UK
Tel: +44 (0) 17336 232495 Email: procalsales@parker.com Website: www.procal.com

7-7862-04 Linearisation Certificate Change note: 7009251 Date: 30/07/12

Component	Units	Range FSD	Gas conc	Cert ref	Results		% error
					pre cal	post cal	FSD
SO L	ppm	1000	168.75	4006192686	173	173	0.4
					167	167	-0.2
					172	172	0.3
SO L	ppm	1000	56.25	4006192686	55	55	-0.1
					57	57	0.1
					57	57	0.1
SO L	ppm	1000	225	4006192686	236	236	1.1
					226	226	0.1
					225	225	0.0
SO L	ppm	1000	112.5	4006192686	116	116	0.4
					114	114	0.2
					112	112	-0.1



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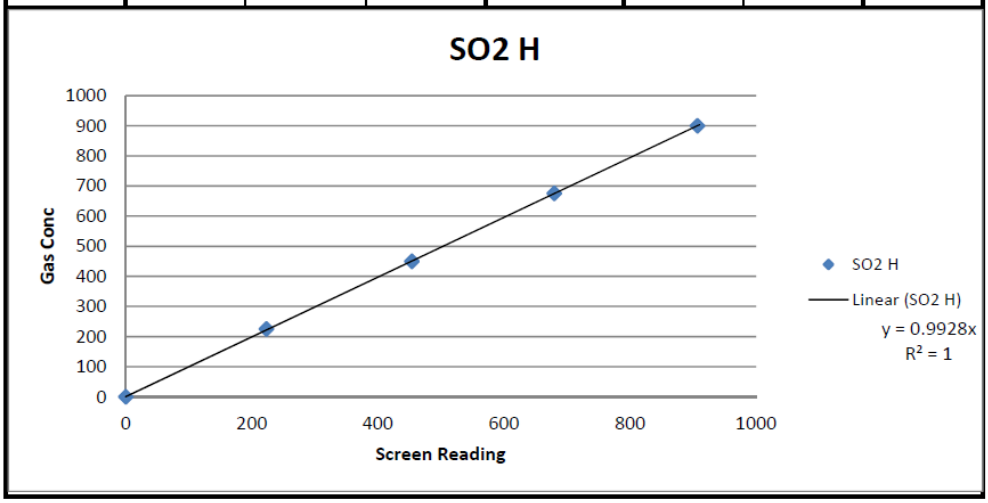
E-mail: asampson@procal.com Website: www.procal.com

7-7862-04 Linearisation Certificate Change note: 7009251 Date: 30/07/12

Component	Units	Range FSD	Gas conc	Cert ref	Results		% error
					pre cal	post cal	FSD
SO2 H	ppm	250	675	40006192554	680	680	2.0
					681	681	2.4
					682	682	2.8
SO2 H	ppm	250	225	40006192554	223	223	-0.8
					226	226	0.4
					226	226	0.4
SO2 H	ppm	250	900	40006192554	907	907	2.8
					910	910	4.0
					910	910	4.0
SO2 H	ppm	250	450	40006192554	454	454	1.6
					456	456	2.4
					455	455	2.0



Zero	H2O	CO2	CO	NO	SO2 - H	SO2 - L
#1	0	0	3	6	1	1
#2	0	-1	1	0	-2	-2
#3	0	0	3	3	-3	-3
#4	0	0	3	2	0	0
#5	0	-1	1	2	-2	-2
#6	0	0	2	1	0	0

Signature:

Procal Customer Support Engineer

Kittiwake Procal Ltd, 5 Maxwell Road, Woodston, Peterborough, PE2 7HU, UK TEL:+44(0)1733 23495 FAX:+44(0)1733 235255
E-mail: asampson@procal.com Website: www.procal.com

7-7862-04 Linearisation Certificate Change note: 7009251 Date: 30/07/12

CALIBRATION CERTIFICATE

Site	**Aberthaw**
Date	**01/10/2016**
Instrument	**Unit 8 Back Up**
Instrument Ref	**8800624** **8500726**
Engineer	**Matthew Gosling**

Results:

Component	Units	Range FSD	Gas conc	Cert ref	Results		% error FSD
					pre cal	post cal	
H2O	%	10	p9000				
CO2	mAU	400	14.9				
CO	PPM	500	336	site gas	327	327	-1.8
NO	PPM	1000	659		671	671	1.2
SO2-H	PPM	1000	674	site gas	607	679	0.5
SO2-L	PPM	250	207.9	6192686	191	209	0.4

Cross sensitivity tests:

Test/	Response			% Error FSD		
	CO	NO	SO2-H	CO	NO	SO2-H
CO2 15%	0	14	-12	0.0	1.4	-1.2
H2O 3%	-5	6	5	-1.0	0.6	0.5
CO2 15% + H2O 3%	4	-3	7	0.8	-0.3	0.7

Test/	Response			% Error FSD		
	SO2-L			SO2-L		
CO2 15%	6			2.4		
H2O 3%	3			1.2		
CO2 15% + H2O 3%	7			2.8		

Signature:

M.Gosling
Procal Customer Support Engineer

Parker Procal, 5 Maxwell Road, Woodston, Peterborough, PE2 7HU, UK
Tel: +44 (0) 17336 232495 Email: procalsales@parker.com Website: www.procal.com

7-7853-02 cal cert site visit general use Change note: 7007110 Date: 17/03/09

Functionality Test Results

DECLARATION OF CONFORMITY

We,

Kittiwake Procal Ltd
5 Maxwell Road
Woodston
Peterborough
Cambridgeshire
PE2 7HU
United Kingdom

Tel: (+44) (0) 1733 232495
Fax: (+44) (0) 1733 235255
e-mail: post@procal.com
Web site: www.procal.com

declare that the product: **Type PULSI 200 Analyser** ***installed at***

Customer	**Aberthaw Power Station**
Control Unit Serial Number	**8800624**
P200 Serial Number	**8500726M**
Site Identification	**Unit 8 back up**

to which this declaration relates is in conformance with the MCERTs Performance Standard for Continuous Emission Monitoring Systems: Version 2. Revision 1 (April 2003).

MCERTS Product Conformance Certificates:

Licence	Certificate Number	Variation	Dated
ACU	SIRA MC 990006/	8	02/10/09
ACWn	SIRA MC 050060/	6	02/10/09

MCERTs Certification Body:

Sira Certification Service	
12 Acorn Industrial Park	Tel: (+44) (0) 1322 520500
Crayford Road	
Crayford	Fax: (+44) (0) 1322 520501
Dartford	
Kent	
DA1 4AL	e-mail: info@siraenvironmental.com
United Kingdom	Web site: www.siracertification.com

Quality System:

ISO 9001:2008	Certificate Nr: 062043	Dated: 11/06/09

Technical Standards Used:

EN 15267-2	Dated:	2009
EN 15267-3	Dated:	2007

All tests carried out to Kittiwake Procal's working procedures and those within Annex A of EN14181, Version 2.3 June 2010, relating to functionality testing by CEMs' manufacturers.

Signed:…… ***Date:…11/09/2016……***

1.0 Alignment and Cleanliness.

1.1 Internal Check of Analyser

Analyser under test	Status	Notes
Optical path clear	Yes	
Optics clean	Yes	
Internal wiring ok	Yes	
Air supply on	Yes	
Purge flow >300 ltrs/hr	Yes	
Pressure differential <80mBar	Yes	24mbar

2.0 Zero and Span Checks.

2.1 Zero Check

Component:	H2O	CO2	CO	NO	SO2-H	SO2-L	Ta	Ts	Ps
Units:	%	mAU	ppm	ppm	ppm	ppm			
Process conc	4.4	71	39	7.1	120	127	25.2	130.5	1009
Zero conc	0	-1	1	0	0	0	25.3	130.1	1033
% error	<2	<2	<2	<2	<2	<2			
Pass/Fail	Pass	Pass	Pass	Pass	Pass	Pass			
T90 recovery									

2.2 Span Check

Component:	H2O	CO2	CO	NO	SO2-H	SO2-L	Ta	Ts	Ps
Units:	%	mAU	ppm	ppm	ppm	ppm			
Full range	10	-	500	1000	1000	250			
Zero Conc	0	-1	1	0	0	0	25.3	130.1	1033
Test Gas Conc			336	659	674	207.9			
Cert number			Site Gas		Site Gas	936352001			
Response Conc			327	671	672	209			
% Error			<2	<2	<2	<2			
Pass/Fail			Pass	Pass	Pass	Pass			
T90 time				82	60	106			

2.3 Filter Level Checks

All on zero air	F6	F2	F7	F5G	F3	F1G	F4	F8	
Factory	3254	4455	3769	2280	3242	1962	556	3716	
Last visit	2007	2717	3007	1767	2444	1773	395	2144	
This visit	2203	2964	2534	1544	2205	1535	417	2866	

2.4 Interference Checks

Component:	H2O	CO2	CO	NO	SO2-H	SO2-L
Units:	%	mAU	ppm	ppm	ppm	ppm
ZERO	0	-1	-3	2	-3	-3
CO2 14.9%	0	198	0	14	-12	-12
H2O 2%	2.2	-1	-5	6	5	5
H2O 4% & CO2 14.9%	4.4	195	-2	26	15	15

3.0 Data Acquisition.

Displayed \ Component							
Zero	Analyser						
	DCS						
	4-20mA						
Span	Analyser						
	DCS						
	4-20mA						

4.0 Linear coefficient record.

Coefficient \ Component		H2O	CO2	CO	NO	SO2-H	SO2-L
	Linear	1.860E-02	1	9.603E0	1.285E1	5.947E0	5.944E0
Last test	Squared	4.760E-05	0	9.509E-2	3.673E-2	-2.800E-3	-7.300E0
	Cubed						
	Linear	1.860E-02	1	6.858E+00	1.064E+01	4.714E+00	4.8467
This test	Squared	4.760E-05	0	9.144E-02	4.890E-02	4.000E-04	-2.800E-03
	Cubed						

5.0 Test Information

5.1 Procal Engineer: **M Gosling**

5.2 Test House:

5.3 Test House Engineer:

Appendix 1. Pro-forma for assessing and reporting the results of the functional tests

Requirement		Notes
1. Alignment and Cleanliness		
A visual inspection, with reference to the CEMs manuals, shall be carried out on the following when applicable:		
• Internal check of the CEM	√	All functions ok
• Cleanliness of the optical components	√	
• Flushing air supply	√	Ok
• Obstructions in the optical path	√	None
• After re-assembly at the measurement location at least the following shall be checked	√	No re-alignment required
• Alignment of the measuring system	√	No alignment required
• Contamination control (internal check of optical surfaces)	√	
2. Sampling Systems		
A visual inspection of the sampling system shall be performed, noting the condition of the following components, when fitted:		
• Sampling probe	n/a	
• Gas conditioning systems	n/a	
• Pumps	n/a	
• All connections	√	Ok
• Sample lines	n/a	
• Power supplies	√	Ok
• Filters	√	Ok
• NOx converters - if the sampling system contains a NOx converter, then the test laboratory shall record when the last efficiency-test was performed, and the result of this test.	n/a	
• The sampling system shall be in good condition and free of any visible faults, which may decrease the quality of data	√	Ok
3. Leak testing		
• Leak testing shall be performed according to the CEMs manuals. The tests shall cover the entire sampling system.	n/a	
4. Zero and Span check		
• Reference zero and span materials shall be used to verify the corresponding readings of the CEM.	√	Ok
• In case of non-extractive CEM, zero and span checks shall be performed using a reference-path free of flue gas before and after readjustment and after re-assembly of the CEM at the measurement location.	√	Ok
5. Linearity		
• During the calibration/linearity tests the applied concentrations should be logged onto the DCS to prove the complete system i.e. concentration applied to the instrument is represented by the instrument output and identical to the value logged on the DCS.	√	Data collected on ACU MK4

Requirement		**Notes**

DCS logged values should be included in the instrument service report.	√	Data collected on ACU MK4
• The linearity of the CEM's response shall be checked using five different reference materials, including a zero concentration.	√	See linearity Cert
• The reference material with zero concentration, as well as the reference materials with four different concentrations, shall have a verifiable quantity and quality.	√	See gas certs
• 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.	√	Gas points derived from blending full gas range using a Procal P9000, a water generator/gas blender
• 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 CEM.	√	See linearity cert
The individual CEMs are tested using the following concentrations applied in a randomised sequence:		
• Reference material with zero concentration;	√	See linearity cert
Reference material concentration approximately 20 % of 2 times the emission limit;	√	See linearity cert
• Reference material concentration approximately 40 % of 2 times the emission limit;	√	See linearity cert
• Reference material concentration approximately 60 % of 2 times the emission limit;	√	See linearity cert
• Reference material concentration approximately 80 % of 2 times the emission limit;	√	See linearity cert
• Reference material with zero concentration;	√	See linearity cert
After each change in concentration, the first instrument reading shall ordinarily be taken after a time period equal to at least three times the response time of the CEM. At each reference material concentration, at least three readings shall be made, six readings shall be taken at zero. The time period between the start of each of the three readings shall be separated by at least four times the response time. The test-laboratory may apply a risk-based approach to linearity testing in order to reduce the time for the tests. For example, the readings may be taken after less than 3x the response time; however, if the CEM fails the linearity test, then the test laboratory shall repeat the linearity test and wait at least 3x the response time as stated above. Alternatively, the number of repetitions of the test may be reduced if the CEM passes the required performance criteria by a factor of at least 2 (i.e. half the allowable residual). Increasing the waiting time to 5x the response time, for example, may be a means of meeting this requirement. Where no other method is possible, the linearity can also be performed with the aid of reference materials such as grating filters or gas filters.		

Requirement	**Notes**

The linearity shall be calculated and tested using the procedure as given in EN 14181 annex B. If the CEM does not pass this test; then the problem shall be identified and rectified.		
6. Interferences		
• A test shall be undertaken if the process gases to be monitored contain components that are known interferences, as identified during QAL1 and there is a failure of the QAL2 or AST which could be due to interferents.	√	Interference checks made with Water vapour, CO2 and each gas species
7. Zero and Span drift (Audit)		
• The test laboratory shall assess whether the operator has a QAL3 procedure in place, and whether the operator has applied this procedure. The evidence would comprise (i) a documented procedure, (ii) zero and span data, (iii) control charts.	√	Customer has procedure in place and has documented evidence
. Response Time		
• The response time of the CEM 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 performance requirement applied during the QAL1 tests.	√	Response time recorded on test sheet and this test sheet
9. Service Report		
As a minimum requirement the service report should include the following:		
• Document reference for work instruction for the type of work being undertaken	√	Procal Method Statement
• Instrument manufacturer	√	Procal
• Instrument type	√	Pulsi 2000
• Instrument model	√	P2000
• Instrument Serial No	√	8500726M
• Operating principle	√	GFCIR & NIR
• Operating range	√	Recorded on this report
• Certification details	√	Mcerted
• Compliance with MCERTS (including certificate [illegible])	√	SIRA MC 990006/08
• Location	√	Unit 8 Back up
• Date and time work was undertaken	√	11/09/2016
• Equipment used - type, serial no's, calibration dates	√	Procal Water Generator/Gas divider Pcal #6
• Gases used - certificate numbers, expiry dates, binary / mix	√	Copy of Gas Certs at customer request can be emailed
• NOx converter efficiency test, if applicable	n/a	
• Calibration and linearity data as required by EN14181	√	See Linearity & (Calcert Data)
• **Logged** data for period of calibration and linearity. Note there may be gaps in the data, in such cases, the test laboratory shall state why there are gaps in the data	√	See Linearity & (Calcert Data)

CERTIFICATE OF CALIBRATION

Unit No	**U 7**
Application	**Stack Flue Gas Oxygen Analyser**
Probe Serial No	**3K220000139813**
WOC No	**3-16-513044-00**

TESTED AGAINST		
Calibration Meter	**Type**	**Beamex**
	Serial No	**25514526**
	Calibration Date	**05-02-16**
2 % Oxygen	**Certified Input Valve**	**1.98 %**
	Cylinder No	**S1358263**
	Expiry Date	**04/10/2017**
	Theoretical Output	**7.168mA**
8 % Oxygen	**Certified Input Valve**	**8.04 %**
	Cylinder No	**S1144548**
	Expiry Date	**19/06/2019**
	Theoretical Output	**16.864mA**

Results

		Local Display	**Current**	**Procal ACU Display**
1.98 % Oxygen (7.168 mA)	**Before**	**1.97%**	**7.133mA**	**2%**
	After			
8.04 % Oxygen (16.864 mA)	**Before**	**7.94%**	**16.7mA**	**8%**
	After			

Signed – Ian Jauncey

Date – 16/02 /16

RWE Npower
C & I Department
Aberthaw Power Station
West Aberthaw
The Leys
Barry
CF62 4ZW

Table 5.2 - Functional Tests carried out by RPS

Requirement	Compliance	Notes
10 Documentation of Records The following documentation shall be controlled, readily accessible and up to date: - a plan of the CEMS; - all manuals (maintenance, users, etc.);	Yes Yes	A plan of the AMS resides in the Electrical Control & Instrumentation section offices and at the analyser. .
- log books to document possible malfunctions and action taken; - service reports;	Yes Yes	All service reports are filed.
- QAL 3 documentation including actions taken as a result of out of control situations	Yes	There is a well established QAL3 system in place and analyser drift is routinely monitored using shewart charts. Evidence was provided to RPS.
Management system procedures for maintenance, calibration and training;	Yes	The Performance dept manage and review maintenance and calibration and training carried out by the EC&I team.
Training records/certificates	Yes	Evidence was provided to RPS

Requirement	Compliance	Notes
Maintenance schedules.	Yes	Maintenance scheduled by Performance.
Auditing Plans & Records – Evidence that the operator includes procedures for the management of the CEMS within the auditing cycle of the management system.	Yes	Carried out using dedicated Technical Team from Swindon Head Office. An auditor witnessed the parallel tests, which suggest a good level of organisation.

APPENDIX 1: SRM Calibration Data

Table A1.1– SRM On-Site Calibrations

Sample Date	Equipment Name	Equipment ID Number	Span Gas Type	ID Number	Span Gas Concentration	Pre-Sampling Result*		Post-Sampling Result*	
						Zero	Span	Zero	Span
26-27/10/16	Horiba PG 250	955	NO (V.U)	222094	405.7 ppm	2.3 ppm	405.6 ppm	1.6 ppm	404.1 ppm
			O_2 (V.U.)	216463	14.63 %	0.10 %	14.55 %	0.06 %	14.52 %
	Gasmet DX4000	1610	SO_2 (V.U.)	237324	201 ppm	0.1 ppm	197.8 ppm	0.0 ppm	197.6 ppm
27-28/10/16	Horiba PG 250	955	NO (17025)	83649	405.7 ppm	1.6 ppm	404.1 ppm	0.8 ppm	405.1 ppm
			O_2 (V.U.)	216463	14.63 %	0.06 %	14.52 %	0.05 %	14.53 %
	Gasmet DX4000	1610	SO_2 (17025)	237324	201 ppm	0.0 ppm	197.6 ppm	0.0 ppm	196.7 ppm
2/11/16	Horiba PG 250	955	NO (17025)	83649	405.7 ppm	0.0 ppm	407.8 ppm	1.3 ppm	404.4 ppm
			O_2 (V.U.)	216463	14.63 %	0.19 %	14.60 %	0.20 %	14.50 %
	Gasmet DX4000	1610	SO_2 (17025)	237324	201 ppm	0.0 ppm	196.9 ppm	0.0 ppm	192.9 ppm

Notes

- **- Calibration values are those for the entire sample system.*
- *- Zero gas 99.999% N_2*

APPENDIX 2 – Accreditation Schedule

Schedule of Accreditation

issued by

United Kingdom Accreditation Service

2 Pine Trees, Chertsey Lane, Staines-upon-Thames, TW18 3HR, UK

UKAS TESTING

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Issue No: 066 **Issue date:** 15 April 2016

35 New Bridge Street, London EC4V 6BW	Contact: Mr S Hurst Tel: +44 (0) 20 7280 3200 Fax: +44 (0) 20 7283 9248 E-Mail: hursts@rpsgroup.com Website: www.rpsgroup.com

Testing performed by the Organisation at the locations specified below

Locations covered by the organisation and their relevant activities

Laboratory locations:

Location details		Activity	Location code
Address 35 New Bridge Street London EC4V 6BW United Kingdom	Local contact Mr D Blyton Tel: +44 (0)20 7280 3200 Fax: +44 (0) 20 7283 9248 Email: rpslo@rpsgroup.com	Health and Hygiene Support Functions: Quality Management, including contract review, document control, auditing and quality control	D
Address Noble House Capital Drive Linford Wood Milton Keynes MK14 6QP	Local contact Mr M Bates Tel: +44 (0)1235 437 100 Fax: +44 (0)1908 669899 Email: rpsmk@rpsgroup.com	Health and Hygiene	E
Address Suite 4C Rhodes Business Park Silburn Way Middleton Manchester M24 4NE	Local contact Mr S Pepper Tel: +44 (0) 161 6549069 Fax: +44 (0)161 6436495 Email: rpswn@rpsgroup.com	Health and Hygiene	F

Site activities performed away from the locations listed above:

Location details	Activity	Location code
Premises including domestic, commercial and industrial	Health and Hygiene Environmental Sampling and Testing	London - K Milton Keynes - L Middleton - M
Customers sites requiring Stack Emissions Testing	Stack emissions Testing	Milton Keynes - L
Mobile Laboratories	Health and Hygiene	London - J

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Issue No: 066 **Issue date:** 15 April 2016

Testing performed by the Organisation at the locations specified

DETAIL OF ACCREDITATION

Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used	Location Code
	Health and Hygiene	Health and Safety Executive Asbestos: The analysts' guide for sampling, analysis and clearance procedures (HSG 248)	
ASBESTOS FIBRES IN AIR	Sampling of air for fibre counting	HSG 248:February 2005 (Documented In-House Procedure)	K, L, M
	Fibre counting	HSG 248:February 2005 (Documented In-House Procedure)	E, F, J, K, L, M
	4 Stage Clearance Process	HSG 248:February 2005 (Documented In-House Procedure)	K,L, M
ASBESTOS IN BULK MATERIALS including materials and products suspected of containing asbestos	Sampling of bulk materials for asbestos identification	HSG 248:February 2005 (Documented In-House Procedure)	K, L, M
	Identification of: Amosite Chrysotile Crocidolite Fibrous Actinolite Fibrous Anthophyllite Fibrous Tremolite	HSG 248:February 2005 (Documented In-House Procedure using stereo-microscopy, polarised light microscopy and dispersion staining)	F

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Testing performed by the Organisation at the locations specified

Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used	Location Code
Testing of Stack Emissions to Atmosphere	Sampling with subsequent analysis by an ISO/IEC 17025 accredited laboratory	National, International and other recognised standards using documented in-house work instructions to meet the requirements of DD CEN/TS 15675:2007/ BS EN 15259:2007	
	Gaseous Organic Compounds - sorbent tube method	USEPA Method 18 (RPSCE/1/19a)	L
	Total Particulate Matter (20 to 1000 mg/m^3)	BS ISO 9096:2003 (RPSCE/1/7/d)	L
Testing of Stack Emissions to Atmosphere	Sampling and On-Line Analysis		
	Pressure, Temperature and Velocity	BS EN 13284-1:2002 BS ISO 9096:2003 (RPSCE/1/2)	L
Testing of Stack Emissions to Atmosphere	Sampling with subsequent analysis by an ISO/IEC 17025 accredited laboratory	National, European, International and Environment Agency specified standards including MIDs and documented in-house work instructions to meet the requirements of the Environment Agency (MCERTS) Performance Standard and DD CEN/TS 15675:2007/ BS EN 15259:2007	
	Total Particulate Matter	BS EN 13284-1:2002 (RPSCE/1/7c)	L
	Hydrogen Chloride	BS EN 1911:2010 (RPSCE/1/8b)	L
	Halides and Halogens: Hydrogen Bromide Chlorine Bromine	US EPA Method 26 and 26A (RPSCE/1/8a)	L

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Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used	Location Code
Testing of Stack Emissions to Atmosphere (cont'd)	Sampling with subsequent analysis by an ISO/IEC 17025 accredited laboratory (cont'd)	National, European, International and Environment Agency specified standards including MIDs and documented in-house work instructions to meet the requirements of the Environment Agency (MCERTS) Performance Standard and DD CEN/TS 15675:2007/ BS EN 15259:2007	
	Sulphur dioxide	BS EN 14791:2005 (RPSCE/1/23)	L
	Hydrogen Fluoride	BS ISO 15713:2006 (RPSCE/1/8c)	L
	Mercury	BS EN 13211:2002 (RPSCE/1/9b)	L
	Metals	BS EN 14385:2004 (RPSCE/1/9c)	L
	Dioxins and furans	BS EN 1948-1:2006 (RPSCE/1/10b)	L
	Dioxin-like Polychlorinated Biphenyls (PCBs)	BS EN 1948-4:2010 (RPSCE/1/10b)	L
	Polycyclic Aromatic hydrocarbons (PAH's)	BS ISO 11338-1:2003 (RPSCE/1/10c)	L
	Formaldehyde	US EPA Method 316 (RPSCE/1/22)	L
	Formaldehyde – sorbent tube method	PD CEN/TS 13649:2014 RPSCE/1/19b Rev D	L

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Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used	Location Code
Testing of Stack Emissions to Atmosphere (cont'd)	Sampling with subsequent analysis by an ISO/IEC 17025 accredited laboratory (cont'd)	National, European, International and Environment Agency specified standards including MIDs and documented in-house work instructions to meet the requirements of the Environment Agency (MCERTS) Performance Standard and DD CEN/TS 15675:2007/ BS EN 15259:2007	
	Speciated VOCs (carbon and other suitable tubes) (Dry stacks only): Aliphatic VOCs Aromatic VOCs Aliphatic amines Aromatic amines Cresols Phenols Acetic acid	PD CEN/TS 13649:2014 (RPSCE/1/19b)	L
	Amines (Total aromatic and aliphatic)	PD CEN/TS 13649:2014, NIOSH method 2010 + 2002 (RPSCE/1/19c)	L
	Isocyanates	USEPA Method 207-1 (documented in-house method RPSCE/1/18C)	L
	Isocyanates	USEPA CTM 036 (documented in-house method RPSCE/1/18D Rev A)	L
	Hydrogen cyanide	US EPA OTM 29 (RPSCE/1/16a)	L
	Hydrogen sulphide	US EPA Method 11 (RPSCE/1/17)	L
	Ammonia	BS EN 14791:2005 (RPSCE/1/14b)	L

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Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used	Location Code
Testing of Stack Emissions to Atmosphere (cont'd)	Sampling with subsequent analysis by an ISO/IEC 17025 accredited laboratory (cont'd)	National, European, International and Environment Agency specified standards including MIDs and documented in-house work instructions to meet the requirements of the Environment Agency (MCERTS) Performance Standard and DD CEN/TS 15675:2007/ BS EN 15259:2007	
	$PM_{10}/PM_{2.5}$ at low concentrations (0-40 mg/m^3)	BS EN ISO 23210 (RPSCE/1/26 Rev A)	L
	Chrome VI	USEPA Method 0061 (RPSCE/1/9d Rev A)	L
Testing of Stack Emissions to Atmosphere	Sampling and On-Site Analysis	National, European, International and Environment Agency specified standards including MIDs and Documented In-House work instructions to meet the requirements of the Environment Agency (MCERTS) Performance Standard and DD CEN/TS 15675:2007/ BS EN 15259:2007	
	Water Vapour	BS EN 14790:2005 (RPSCE/1/12b)	L

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Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used	Location Code
Testing of Stack Emissions to Atmosphere (cont'd)	Sampling and On-Line Analysis	National, European, International and Environment Agency specified standards including MIDs and Documented In-House work instructions to meet the requirements of the Environment Agency (MCERTS) Performance Standard and DD CEN/TS 15675:2007/ BS EN 15259:2007	
	Pressure, Temperature and Velocity (Point Velocity Method)	BS EN 16911-1:2013 (RPSCE 1/2 – Differential Pressure Device (Pitot Tube) Method	L
	Water Vapour*	EA TGN M22 (RPSCE/1/24 - Validated FTIR analyser)	L
	Carbon Monoxide*	BS EN 15058:2006 (RPSCE/1/21h - NDIR analyser) EA TGN M22 (RPSCE/1/24 - Validated FTIR analyser)	L
	Carbon Dioxide*	ISO 12039:2001 (RPSCE/1/21e - NDIR analyser) EA TGN M22 (RPSCE/1/24 - FTIR analyser)	L
	Nitrogen Monoxide (NO)*	BS EN 14792:2005 (RPSCE/1/21f - Chemiluminescence analyser) EA TGN M22 (RPSCE/1/24 - Validated FTIR analyser)	L
	Nitrogen Dioxide (NO_2)*	EA TGN M22 (RPSCE/1/24 - Validated FTIR analyser)	L

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Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used	Location Code
Testing of Stack Emissions to Atmosphere (cont'd)	Sampling and On-Line Analysis (cont'd)	National, European, International and Environment Agency specified standards including MIDs and Documented In-House work instructions to meet the requirements of the Environment Agency (MCERTS) Performance Standard and DD CEN/TS 15675:2007/ BS EN 15259:2007	
	Oxides of Nitrogen (NOx)*	BS EN 14792:2005 (RPSCE/1/21f - Chemiluminescence analyser) EA TGN M22 (RPSCE/1/24 - Validated FTIR analyser)	L
	Nitrous Oxide (N_2O)	EA TGN M22 (RPSCE/1/24 Rev B - Validated FTIR analyser)	L
	Sulphur dioxide*	EA TGN M22 (RPSCE/1/24 - FTIR analyser)	L
	Oxygen*	BS EN 14789:2005 (RPSCE/1/21g - validated Zirconium cell analyser)	L
	Total Gaseous Organic Carbon* (TOC/VOC) (0 to 1000 mg/m³)	BS EN 12619:2013 (RPSCE/1/4b - FID analyser)	L

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Materials/Products tested	Type of test/Properties measured/Range of measurement	Standard specifications/ Equipment/Techniques used	Location Code
Stack Emissions - Continuous Emissions Monitoring Systems (CEMS)	QAL 2 and the Annual Surveillance Test (AST) for CEMS	Documented in house procedure RPSCE/1/25 to meet the requirements of BS EN 14181:2014, Environment Agency MID 14181 (TGN M20 Annex A) and other requirements of the Environment Agency (MCERTS) Performance Standard and DD CEN/TS 15675:2007/ BS EN 15259:2007	L
END			

* - The scale range of the analyser used for this test must be that detailed on its current MCERTS certificate or a range validated by the organisation to meet MCERTS requirements.

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