

Report: EN14181 AST

EN 14181 AST 2014 ASSESSMENTS - UNIT 14, USKMOUTH POWER STATION

Uskmouth Power

3514067A-1

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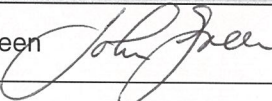
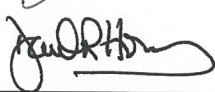
Prepared for
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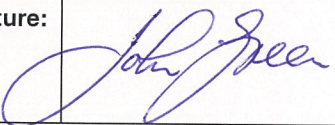
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SECTION 1

EXECUTIVE SUMMARY

COVER SHEET

 	
Report: EN14181 AST	
EN 14181 AST 2015 Assessments - Unit 14, Uskmouth Power Station	
Operator's Details:	
Permit Number:	VP3530LS
Operator Name:	Uskmouth Power Station
Installation Name:	Unit 14
Date of Monitoring Visit:	25 & 26/03/2015
Job Number:	286944E-1
Client (Primary Site Contact):	M. James
Site Address:	West Nash Road, Newport, Gwent. NP18 2PZ
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Uskmouth Power Station

Permit No.: LP3131SW

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for Uskmouth Power

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RESULTS OF THE FUNCTIONAL TESTS	45

1.1 Summary of results

Type of Test:		AST		
Emission Point Designation:		Unit 14 FGD Outlet		
Parameter		Calibration Function ($y = a x + b$)	Variability test	Calibration test
Particulate	Line 10	$y = 1.368 x + 0.00$	Passed	Passed
	Line 20	$y = 1.416 x + 0.00$	Passed	Passed
NO _x	Line 10	$y = 1.117 x - 1.98$	Passed	Passed
	Line 20	$y = 1.054 x - 3.90$	Passed	Passed
SO ₂	Line 10	$y = 1.004 x + 3.02$	Passed	Passed
	Line 20	$y = 0.644 x - 0.44$	Passed	Failed
Recommendations: During this AST both Lines NO _x and Line 10 SO ₂ values were above the valid calibration range determined at the QAL2 therefore attention is drawn to section 6.5 of EN 14181:2014.				
		Valid Calibration Range (273 °C, 101.3 kPa, 6% O ₂ , dry)	QAL2 Extrapolated Range Using Reference Materials	AST Extended Range (* indicates at this AST)
Particulate	Line 10	0 to 16.82 mg.m ⁻³	--	--
	Line 20	0 to 12.63 mg.m ⁻³	--	--
NO _x	Line 10	0 to 386.1 mg.m ⁻³	--	536 mg.m ⁻³ *
	Line 20	0 to 347.1 mg.m ⁻³	--	580 mg.m ⁻³ *
SO ₂	Line 10	0 to 804.9 mg.m-3	--	--
	Line 20	0 to 82.1 mg.m-3	0 to 527.4 mg.m ⁻³	--

Note: The determined calibration function, once applied, only remains valid, so long as the QAL3 data remains within control limits and that there are no manual adjustments made to the CEMs other than those allowed to bring the settings back within the QAL3 control limits.

1.2 Deviations**Deviations from the SRM**

Parameter	Deviation	Reason for variation	Impact on the results and actions required
Particulate	None		
NO _x	None		
SO ₂	None		

Deviations from EN 14181

Parameter	Deviation	Reason for variation	Impact on the results and actions required
Particulate	Yes	On both Lines all values were below the 95 % confidence interval of the ELV and even though the spread of results were < 15 % of the ELV, R ² values > 0.9 and the variability test indicated that the calibrations were acceptable; for completeness a Method C assessment was included in the QAL2 report and therefore also included in this report.	
NO _x	None		
SO ₂	None		

Note: No QAL3 checks carried out as the systems are optically based.

SECTION 2

INFORMATION ABOUT THE REGULATED INSTALLATION

2.1 Regulatory Information

2.1.1	Name of Installation:	Uskmouth Power Station			
2.1.2	Address of Installation:	West Nash Road, Newport, Gwent. NP18 2PZ			
2.1.3	Sector for the Installation:	LCPD			
2.1.4	Date of last QAL2/AST	30th and 31st July 2013, 1st, 2nd and 6th August 2013			
2.1.5	Regulated parameters and emission limit levels:				
	Parameter	Emission point	Short –term ELV (mg.m ⁻³)	Daily average ELV (mg.m ⁻³)	Uncertainty requirement (%)
	Particulate	Unit 14: Lines 10 & 20	50	55	30
	NO _x	Unit 14: Lines 10 & 20	500	550	20
	SO ₂	Unit 14: Lines 10 & 20	400	440	20
	O ₂	Unit 14: Lines 10 & 20	(21)	(21)	10

2.2.1	Process type and variations in emissions
	Uskmouth Power Station is a 363 MWe generating site comprising 3 x 120 MWe coal fired boilers and turbo-generator units utilising several techniques to reduce particulate and gaseous emission releases to air and comes under the Large Combustion Plant Directive 2001/80/EC (LCPD). Unit 13 was mothballed in 2013 with the other two units following in 2014; Unit 14 has been restarted early 2015. Production and therefore load is dependent on commercial demands, but can be considered continuous. Variation of the emission levels is limited but there are opportunities for at or near zero levels during periods of no production.
2.2.2	Fuel type
	Primary a coal-fired boiler.
2.2.3	Abatement
	Flue Gas Desulphurisation (FGD) for sulphur dioxide emission reduction, bag-filter system for particulate and combustion controls.

2.3 Monitoring Provisions At The Installation – Periodic Monitoring

2.3.1	Stack and sampling ports	
	Sample plane location:	Unit 14: Lines 10 & 20 sample planes are located in the inlet ducts to their respective ID Fans
	Shape:	Rectangular
	Dimensions / Diameter: (Note: for rectangular width side has ports installed)	Width (m) 2.7 Depth (m) 1.99
	Location of ports:	Sample ports are located on the side of each duct
	Number of sampling ports:	4 x 4" BSP sockets per duct
	Diagram / photographs (of emission point, platform and location)	Refer to Diagram A1 in Appendix A
2.3.2	Monitoring platform and site-provisions	
	The in-situ Opsis probes and heads are located centrally in the ID Fan inlet ducts approximately 0.75 m above the sampling plane. Access to the sampling planes and in-situ probes and heads are by way of stairways and short vertical ladders. Overall the site is compliant with TGN M1. Access to both the head and receiver of the cross-duct CEM is adequate and allows sufficient room to carry out maintenance and repairs. A service contract is in place with the instrument manufacturers / suppliers. The plant was constructed pre-CEN standards therefore the sample location is not fully compliant with them due to the proximity of the ID Fan's inlet before the CEMs and sampling locations, also a change in duct geometry upstream. The sampling planes are the best available. Homogeneity was assessed / demonstrated in December 2010 by RPS Consultants. There are no facilities to introduce reference materials to the CEMs.	
2.3.3	Sample - how representative	
	Homogeneity was assessed in December 2010 by RPS Consultants and indications are that the sampling planes are compliant. Flow measurement during the particulate measurements indicated the flow stability criteria were met on both sample planes.	

2.4 Continuous Emission Monitoring Systems (CEMs) at the Installation
2.4.1

Types of CEMs for each main determinand, oxygen and moisture			
Parameter	Particulate	Instrument Make	Durag
Type	Cross-duct forward scatter	Instrument Model	D-R800
Measurement Principle	Optical - scattered light measuring principle		
Statement of QAL1 compliance	MCERTS product conformity certificate No. Sira MC080123/00	Location of sampling / measurement	ID Fan's inlet duct
MCERTS Certified Range	0 - 15 mg.m ⁻³	Instrument Range	0 - 50mg.m ⁻³
Parameter	NO & NO ₂	Instrument Make	OPSIS
Type	Cross-duct	Instrument Model	AB AR650
Measurement Principle	Infra red (NO and NO ₂ measured separately and combined for reporting as NO _x)		
Statement of QAL1 compliance	MCERTS product conformity certificate No. Sira MC020011/04	Location of sampling / measurement	ID Fan's inlet duct
MCERTS Certified Range	NO = 0 – 150mg.m ⁻³ NO ₂ = 0 – 20mg.m ⁻³	Instrument Range	0 – 1500mg.m ⁻³ 0 – 100 mg.m ⁻³
Parameter	SO ₂	Instrument Make	OPSIS
Type	Cross-duct	Instrument Model	AB AR650
Measurement Principle	Infra red		
Statement of QAL1 compliance	MCERTS product conformity certificate No. Sira MC020011/04	Location of sampling / measurement	ID Fan's inlet duct
MCERTS Certified Range	0 – 400mg.m ⁻³	Instrument Range	0 – 700mg.m ⁻³
Parameter	Oxygen	Instrument Make	OPSIS
Type	Extractive zirconia cell	Instrument Model	AB O2000
Measurement Principle	Zirconia cell		
Statement of QAL1 compliance	MCERTS product conformity certificate No. Sira MC020012/02	Location of sampling / measurement	ID Fan's inlet duct
MCERTS Certified Range	0 – 25%	Instrument Range	25 %

2.4.2

How is the moisture determined		By measurement as part of Opsis CEM system	
Types of monitoring for peripheral determinands			
Temperature	Recorded – Yes	Comments:	
Pressure	Recorded – Yes	Comments:	

SECTION 3

INFORMATION ABOUT THE MONITORING CAMPAIGN

3.1 Test Laboratory Staff

Personnel:	J Green	 JOHN GREEN Registration no: MM 02 091 Renewal Date: JUNE 2018 Competence level: LEVEL 2 TE1, TE2, TE3, TE4 Sira Certification Service, 12 Acorn Industrial Park, Dartford, Kent DA1 4AL Tel: 01322 520500 Fax: 01322 520501 Email: mcerts@siraenvironmental.com
MCERTS Registration Number:	MM 02 091	
Expiry Date	June 2018	
Certification Level:	Level 2 (TE 1, 2, 3 & 4)	
Personnel:	R. Claydon	 Ray Claydon Registration no: MM03 363 Renewal Date: August 2018 Competence level: Level 2 TE1, TE2, TE3, TE4 Sira Certification Service, 12 Acorn Industrial Park, Dartford, Kent DA1 4AL Tel: 01322 520500 Fax: 01322 520501 Email: mcerts@siraenvironmental.com
MCERTS Registration Number:	MM 03 363	
Expiry Date	Aug 2018	
Certification Level:	Level 2 (TE 1, 2, 3 & 4)	
Personnel:	K. Norton	 KEITH NORTON Registration no: MM 07 832 Renewal Date: AUGUST 2018 Competence level: LEVEL 1 Sira Certification Service, 12 Acorn Industrial Park, Dartford, Kent DA1 4AL Tel: 01322 520500 Fax: 01322 520501 Email: mcerts@siraenvironmental.com
MCERTS Registration Number:	MM 07 832	
Expiry Date	Aug 2018	
Certification Level:	Level 1	

3.2 Standard Reference Methods (SRMs)

Substances Monitored:	Standard Method	Type and Principle	Operational Range	Certification Range (Instrumental)	Uncertainty	Accreditation Status	
						MCERTS	UKAS
Total Particulate Matter (TPM)	BS EN 13284-1	Manual gravimetric estimation	0 – 50 mg.m ³ (See note below)	N/A	Typical values: as measured - ± 10 %	Yes	Yes
Oxides of Nitrogen (NO _x)	BS EN 14792	Instrumental extractive sampling and chemiluminescence analyser	0 – 500 ppm	0 – 125 mg.m ⁻³	Typical values relative to ELV < 7 %	Yes	Yes
Sulphur Dioxide (SO ₂)	TGN M21	Instrumental extractive sampling and NDIR analyser	0 – 500 ppm	0 – 460 mg.m ⁻³	Typical values relative to ELV < 7 %	Yes	Yes
Oxygen (O ₂)	BS EN 14789	Instrumental extractive sampling and zirconia cell analyser	0 – 25 %	25 %	Typically values < 4 %	Yes	Yes
Quoted uncertainties are < the SRM requirement. <i>Note: measured values can be above the upper range of 50 mg.m-3, this is considered not to be detrimental to the uncertainty of the measured values.</i>							
Subcontracted Work Details:							
Substances Monitored:	Standard Method	Subcontractor's			Accreditation Status		
		Name		Address	MCERTS	UKAS	
N/A							

SECTION 4

MONITORING DATA AND CALCULATIONS – AST

NOTE: Numbering of subsections, Tables and Graphs in Section 4 relate to the headings given in Environment Agency's MID 14181.

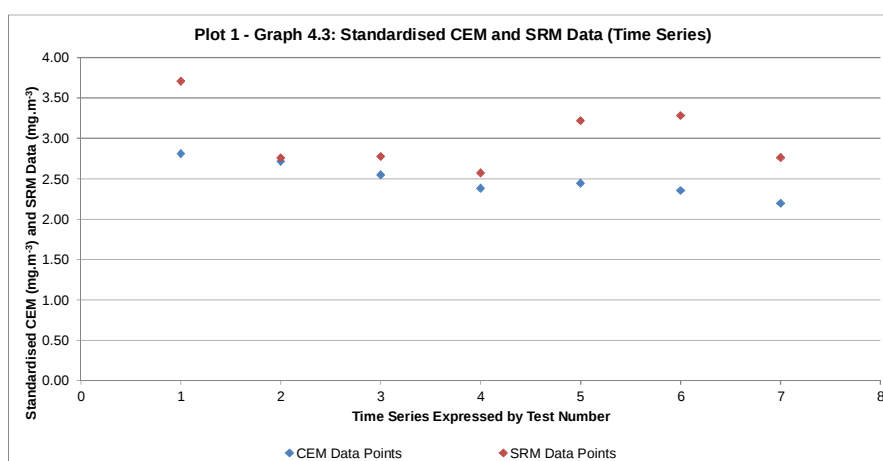
4.1 Raw monitoring data

Particulate: Unit 14 Line 10 – CEM serial No: 00432050

Table 4.1 & 4.2: Raw and Standardised Monitoring Data All Tests and Outcome of the Outliers Test.

CEM's Raw Data and Peripheral Parameters											
Sample Number <i>i</i>	Date	Time		CEM Measures the Parameter at		Duct Conditions		Oxygen	Pressure	CEM Calibrated Value At Reference Conditions	CEM Standardised Value At Reference Conditions
		Start	End	CEM Raw Value	CEM Calibrated Value at Measured Conditions (using all raw data for calibrated function)	Temperature	Moisture Content				
				x_i mg.m ⁻³	x_i mg.m ⁻³	t_i °C	h_i %				
1	25/03/15	12:15	13:10	1.49	2.04	71.8	7.15	9.44	94.67	3.84	2.81
2	25/03/15	13:35	14:29	1.38	1.89	71.6	7.10	9.90	94.48	3.71	2.72
3	25/03/15	14:39	15:35	1.32	1.81	70.8	7.07	9.70	94.52	3.49	2.55
4	25/03/15	15:47	16:41	1.25	1.71	71.2	7.01	9.59	94.53	3.26	2.38
5	25/03/15	17:05	18:04	1.28	1.76	71.1	7.11	9.52	94.31	3.34	2.44
6	25/03/15	18:16	19:13	1.23	1.68	70.7	7.13	9.61	94.34	3.22	2.35
7	26/03/15	09:36	10:31	1.16	1.58	71.1	7.19	9.55	94.87	3.00	2.19
SRM's Raw Data and Peripheral Parameters											
Sample Number <i>i</i>	Date	Time		SRM Measures the Parameter at		Extractive Dry Conditions		Oxygen	Pressure	SRM At Reference Conditions	Outliers Test Outcome
		Start	End	SRM Measured Value (at SRM conditions)	SRM Value at CEM's Raw Conditions	Temperature	Moisture Content				
				y mg.m ⁻³	y_i mg.m ⁻³	t_i °C	h_i %				
1	25/03/15	12:15	13:10	2.86	1.99	71	5.65	9.44	94.27	3.71	Valid Result
2	25/03/15	13:35	14:29	2.04	1.42	71	5.48	9.90	94.12	2.76	Valid Result
3	25/03/15	14:39	15:35	2.09	1.46	70	5.55	9.70	94.17	2.77	Valid Result
4	25/03/15	15:47	16:41	1.96	1.37	70	5.59	9.59	94.14	2.57	Valid Result
5	25/03/15	17:05	18:04	2.46	1.72	70	5.62	9.52	94.02	3.22	Valid Result
6	25/03/15	18:16	19:13	2.49	1.74	70	5.59	9.61	93.90	3.28	Valid Result
7	26/03/15	09:36	10:31	2.11	1.46	70	5.61	9.55	93.61	2.76	Valid Result

Particulate: Unit 14 Line 10 – CEM serial No: 00432050



4.4: Calculation and Procedure used for the elimination of outliers is that given in the Environment Agency's recommended procedure RM-QG14.

Table covering 4.5 to 4.9: Particulate: Unit 14 Line 10 – CEM serial No: 00432050
continued:

Continuous Emission Measuring (CEM) System Information	
Client:	Uskmouth Power Company
Site:	Uskmouth Power Station
PB Job Number:	3514067A-1
Date:	25 & 26 March 2015
Parameter:	Particulate
CEM Details:	
Instrument Make:	Durag
Model:	D-R800
Serial Number:	00432050
CEM Method:	Cross duct forward scatter
CEM Offset:	4 mA
Calibration Function:	$\hat{y}_i = \hat{a} + b x_i = 0.000 \frac{\text{mg}}{\text{m}^3} + 1.368 \frac{\text{mg/m}^3}{\text{mg/m}^3} x_i$
Valid Calibration Range:	From 0 to 16.8 mg.m ⁻³
SRM Method:	
Standard Reference No. :	EN13284-1
Method Type:	Manual gravimetric
Emissions Details:	
Emission Limit Value (ELV):	55 mg.m ⁻³
Reference Condition:	
Temperature: °C	0
Pressure: kPa	101.3
Moisture: %	0
Oxygen: %	6
Specified Uncertainty:	30 %
Uncertainty required by Authorities (σ ₀):	8.25 mg.m ⁻³

CEM Measurements Data Evaluation to Standard Conditions

Sample Number	CEM Measured Signal	CEM Calibrated Value	CEM Calibrated Value at Standard Conditions	CEM Calibrated Value at Standard Conditions
<i>i</i>	<i>x_i</i> mg.m ⁻³	<i>y_i</i> mg.m ⁻³	<i>y_{i,s}</i> mg.m ⁻³	<i>y_{i,s}</i> mg.m ⁻³
1	1.49	2.04	2.04	3.84
2	1.38	1.89	1.89	3.71
3	1.32	1.81	1.81	3.49
4	1.25	1.71	1.71	3.26
5	1.28	1.76	1.76	3.34
6	1.23	1.68	1.68	3.22

SRM Measurements Data Evaluation to Standard Conditions

Sample Number	SRM Measured Value	SRM Value at CEM Condition	SRM Value at Standard Conditions
<i>i</i>	<i>y_i</i> ppm	<i>y_i</i> mg.m ⁻³	<i>y_{i,s}</i> mg.m ⁻³
1	2.86	1.99	3.71
2	2.04	1.42	2.76
3	2.09	1.46	2.77
4	1.96	1.37	2.57
5	2.46	1.72	3.22
6	2.49	1.74	3.28

Test of Variability

Sample Number	CEM Calibrated Value at Standard Conditions	SRM Value at Standard Conditions	Difference	Difference	Squared Difference	Variability	Variability Acceptance Test	CEM Validity of Calibration Function
<i>i</i>	<i>y_{i,s}</i> mg.m ⁻³	<i>y_{i,s}</i> mg.m ⁻³	<i>D_i = y_{i,s} - y_{i,s}</i> mg.m ⁻³	<i>D_i - D̄</i> mg.m ⁻³	<i>(D_i - D̄)²</i> mg.m ⁻³	$s_D = \sqrt{1/(N-1) \times \sum (D_i - \bar{D})^2}$ (mg.m ⁻³) ²	$s_D \leq 1.5 \sigma_0 k_v$ mg.m ⁻³	$\frac{ \bar{D} }{\leq [(t_{0.95}(N-1)) (s_D / \sqrt{N})] + \sigma_0}$ mg.m ⁻³
1	3.84	3.71	-0.137	0.263	0.069	0.381	0.381 ≤ 11.683	0.400 ≤ 8.530
2	3.71	2.76	-0.958	-0.558	0.311			
3	3.49	2.77	-0.712	-0.313	0.098			
4	3.26	2.57	-0.686	-0.286	0.082			
5	3.34	3.22	-0.127	0.272	0.074			
6	3.22	3.28	0.062	0.462	0.213			
Sums Σ				0.000	0.873		Variability Test Fulfilled	Calibration of CEM Acceptable
Averages		<i>D̄</i> =	-0.400					

Refer to BS EN 14181:2004 Stationary source emissions - Quality assurance of automated measuring systems, in particular to Annex B for details and interpretation of symbols and equations.

Uskmouth Power Station

Permit No.: LP3131SW

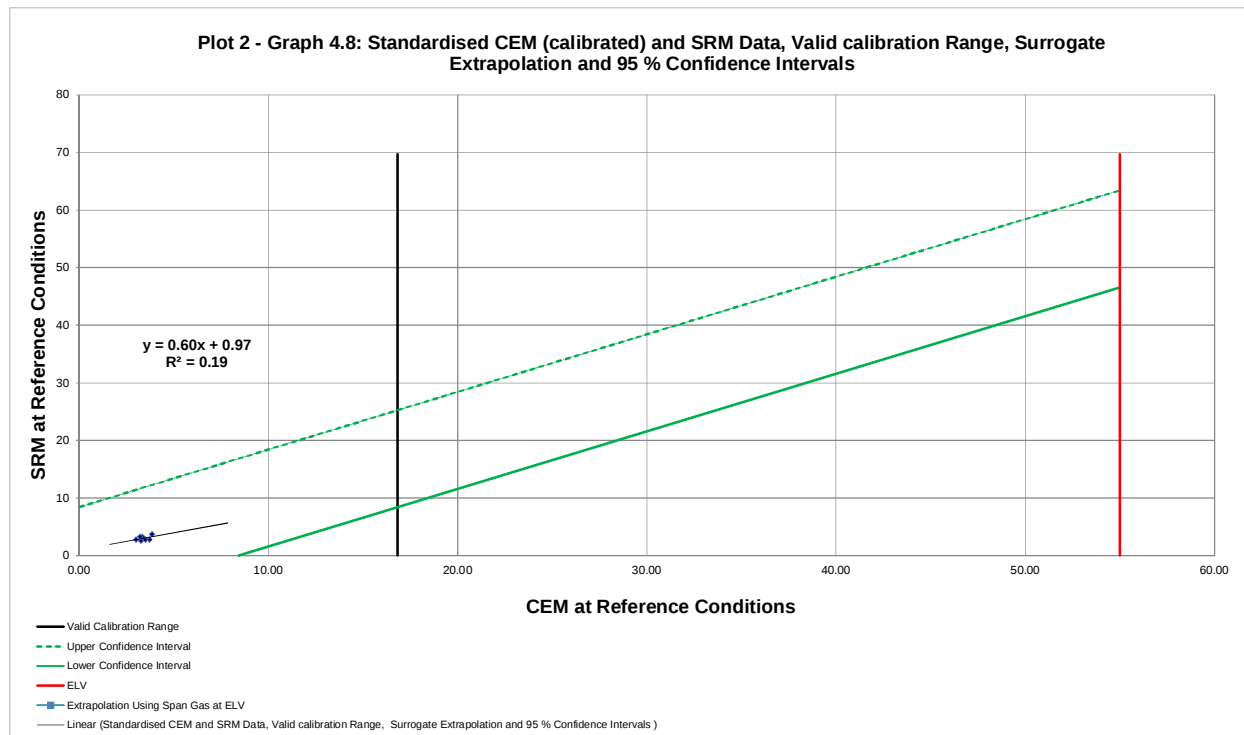
Year / visit: 2015/01

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May 2015

Prepared by Parsons Brinckerhoff
for Uskmouth Power

Particulate: Unit 14 Line 10 – CEM serial No: 00432050 continued:

X-y plot of calibrated, standardised CEM data versus standardised SRM data



Particulate: Unit 14 Line 10 – CEM serial No: 00432050 continued:

Analysis by Method C

Particulate mg.m ⁻³ CEM (Calibrated Value at Reference Conditions)	Sample Number	Particulate mg.m ⁻³ SRM (At Reference Conditions)
$\hat{y}_{i,s}$		$y_{i,s}$
3.84	1	3.71
3.71	2	2.76
3.49	3	2.77
3.26	4	2.57
3.34	5	3.22
3.22	6	3.28
3.48	Average	3.05
Difference between averages		0.43
ELV	mg.m ⁻³	55.00
95 % Confidence Interval (CI)	(%)	30.00
	mg.m ⁻³	16.50
Half of 95 % CI	mg.m ⁻³	8.25
Passes criterion		Yes

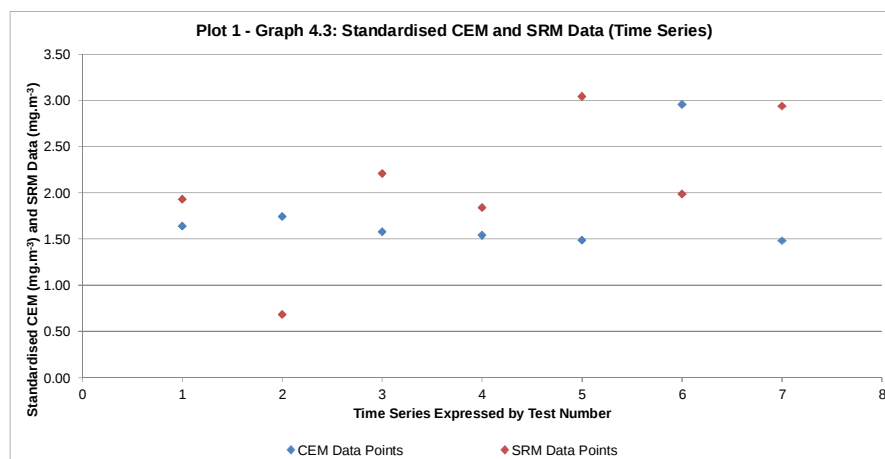
Above determined using all parallel test values.

Particulate: Unit 14 Line 20 – CEM serial No: 0432047

Table 4.1 & 4.2: Raw and Standardised Monitoring Data All Tests and Outcome of the Outliers Test.

CEM's Raw Data and Peripheral Parameters											
Sample Number	Date	Time		CEM Raw Value	CEM Calibrated Value at Measured Conditions (using all raw data for calibrated function)	Temperature	Moisture Content	Oxygen	Pressure	CEM Calibrated Value At Reference Conditions	CEM Standardised Value At Reference Conditions
		Start	End	x_i mg.m ⁻³	x_i mg.m ⁻³	t_i °C	h_i %	o_i %	P_a kPa	x_i mg.m ⁻³	x_i mg.m ⁻³
1	25/03/15	12:10	13:17	0.87	1.23	71.6	5.98	9.46	93.91	2.32	1.64
2	25/03/15	13:26	14:24	0.91	1.29	71.1	6.08	9.64	93.83	2.47	1.74
3	25/03/15	15:35	16:33	0.81	1.15	71.1	6.01	9.86	93.80	2.24	1.58
4	25/03/15	16:42	17:40	0.79	1.11	70.9	5.97	9.92	93.91	2.18	1.54
5	25/03/15	17:47	18:46	0.76	1.07	70.4	5.98	9.96	93.95	2.11	1.49
6	26/03/15	09:02	10:00	1.62	2.29	71.7	6.36	9.12	94.41	4.19	2.96
7	26/03/15	10:10	11:06	0.79	1.12	71.8	6.26	9.40	94.35	2.10	1.48
SRM Measures the Parameter at Extractive Dry Conditions											
SRM's Raw Data and Peripheral Parameters											
Sample Number	Date	Time		SRM Measured Value (at SRM conditions)	SRM Value at CEM's Raw Conditions	Temperature	Moisture Content	Oxygen	Pressure	SRM At Reference Conditions	Outliers Test Outcome
		Start	End	y mg.m ⁻³	y_i mg.m ⁻³	t_i °C	h_i %	o_i %	P_a kPa	$y_{i,s}$ mg.m ⁻³	
1	25/03/15	12:10	13:17	1.48	1.02	75	5.64	9.46	93.45	1.93	Valid Result
2	25/03/15	13:26	14:24	0.52	0.36	72	5.58	9.64	95.15	0.68	Valid Result
3	25/03/15	15:35	16:33	1.64	1.13	74	5.49	9.86	93.64	2.21	Valid Result
4	25/03/15	16:42	17:40	1.36	0.93	74	5.47	9.92	93.47	1.84	Valid Result
5	25/03/15	17:47	18:46	2.24	1.55	73	5.46	9.96	93.63	3.04	Valid Result
6	26/03/15	09:02	10:00	1.57	1.07	74	5.77	9.12	93.08	1.99	Valid Result
7	26/03/15	10:10	11:06	2.27	1.55	74	5.67	9.40	93.04	2.94	Valid Result

Particulate: Unit 14 Line 20 – CEM serial No: 0432047



4.4: Calculation and Procedure used for the elimination of outliers is that given in the Environment Agency's recommended procedure RM-QG14.

Table covering 4.5 to 4.9: Particulate: Unit 14 Line 20 – CEM serial No: 0432047
continued:

Continuous Emission Measuring (CEM) System Information	
Client:	Uskmouth Power Company
Site:	Uskmouth Power Station
PB Job Number:	3514067A-1
Date:	25 & 26 March 2015
Parameter:	Particulate
CEM Details:	Instrument Make: Durag Model: D-R800 Serial Number: 00432050 CEM Method: Cross duct forward scatter CEM Offset: mA 4 Calibration Function: $\hat{y}_i = \hat{a} + b x_i$ = 0.000 $\frac{\text{mg}}{\text{m}^3}$ + 1.416 $\frac{\text{mg}}{\text{m}^3}$ x_i Where: x_i CEM result, y_i CEM calibrated result, $\hat{a}$ intercept, b slope Valid Calibration Range: at reference conditions From 0 to 12.6 mg.m^{-3}
SRM Method:	Standard Reference No.: EN13284-1 Method Type: Manual gravimetric
Emissions Details:	Emission Limit Value (ELV): at reference conditions mg.m^{-3} 55 Reference Condition: Temperature: °C 0 Pressure: kPa 101.3 Moisture: % 0 Oxygen: % 6 Specified Uncertainty: % 30 Uncertainty required by Authorities (σ_0): mg.m^{-3} 8.25

CEM Measurements Data Evaluation to Standard Conditions

Sample Number	CEM Measured Signal	CEM Calibrated Value	CEM Calibrated Value at Stack Conditions	CEM Calibrated Value at Standard Conditions
i	x_i mg.m^{-3}	$\hat{y}_i$ mg.m^{-3}	mg.m^{-3}	$\hat{y}_{i,s}$ mg.m^{-3}
1	0.87	1.23	1.23	2.32
2	0.91	1.29	1.29	2.47
3	0.81	1.15	1.15	2.24
4	0.79	1.11	1.11	2.18
5	0.76	1.07	1.07	2.11
6	1.62	2.29	2.29	4.19
7	0.79	1.12	1.12	2.10

SRM Measurements Data Evaluation to Standard Conditions

Sample Number	SRM Measured Value	SRM Value at CEM Condition	SRM Value at Standard Conditions
i	y_i ppm	y_i mg.m^{-3}	$y_{i,s}$ mg.m^{-3}
1	1.48	1.02	1.93
2	0.52	0.36	0.68
3	1.64	1.13	2.21
4	1.36	0.93	1.84
5	2.24	1.55	3.04
6	1.57	1.07	1.99
7	2.27	1.55	2.94

Test of Variability

Sample Number	CEM Calibrated Value at Standard Conditions	SRM Value at Standard Conditions	Difference	Difference	Squared Difference	Variability	Variability Acceptance Test	CEM Validity of Calibration Function
i	$\hat{y}_{i,s}$ mg.m^{-3}	$y_{i,s}$ mg.m^{-3}	$D_i = y_{i,s} - \hat{y}_{i,s}$ mg.m^{-3}	$D_i - \bar{D}$ mg.m^{-3}	$(D_i - \bar{D})^2$ mg.m^{-3}	$s_D = \sqrt{1/(N-1) \times \sum (D_i - \bar{D})^2}$ $(\text{mg.m}^{-3})^2$	$s_D \leq 1.5 \sigma_0 k_v$ mg.m^{-3}	$ \bar{D} \leq \{ [t_{0.95}(N-1)] (\sigma_0 / \sqrt{N}) \} + \sigma_0$ mg.m^{-3}
1	2.32	1.93	-0.392	0.032	0.001	1.199	$1.199 \leq 11.683$	$0.424 \leq 9.130$
2	2.47	0.68	-1.787	-1.363	1.858			
3	2.24	2.21	-0.029	0.395	0.156			
4	2.18	1.84	-0.341	0.083	0.007			
5	2.11	3.04	0.938	1.363	1.857			
6	4.19	1.99	-2.198	-1.774	3.147			
7	2.10	2.94	0.840	1.264	1.598			
Sums Σ				0.000	8.624		Variability Test Fulfilled	Calibration of CEM Acceptable
Averages		$\bar{D} =$	-0.424					

Refer to BS EN 14181:2004 Stationary source emissions - Quality assurance of automated measuring systems, in particular to Annex B for details and interpretation of symbols and equations.

Uskmouth Power Station

Permit No.: LP3131SW

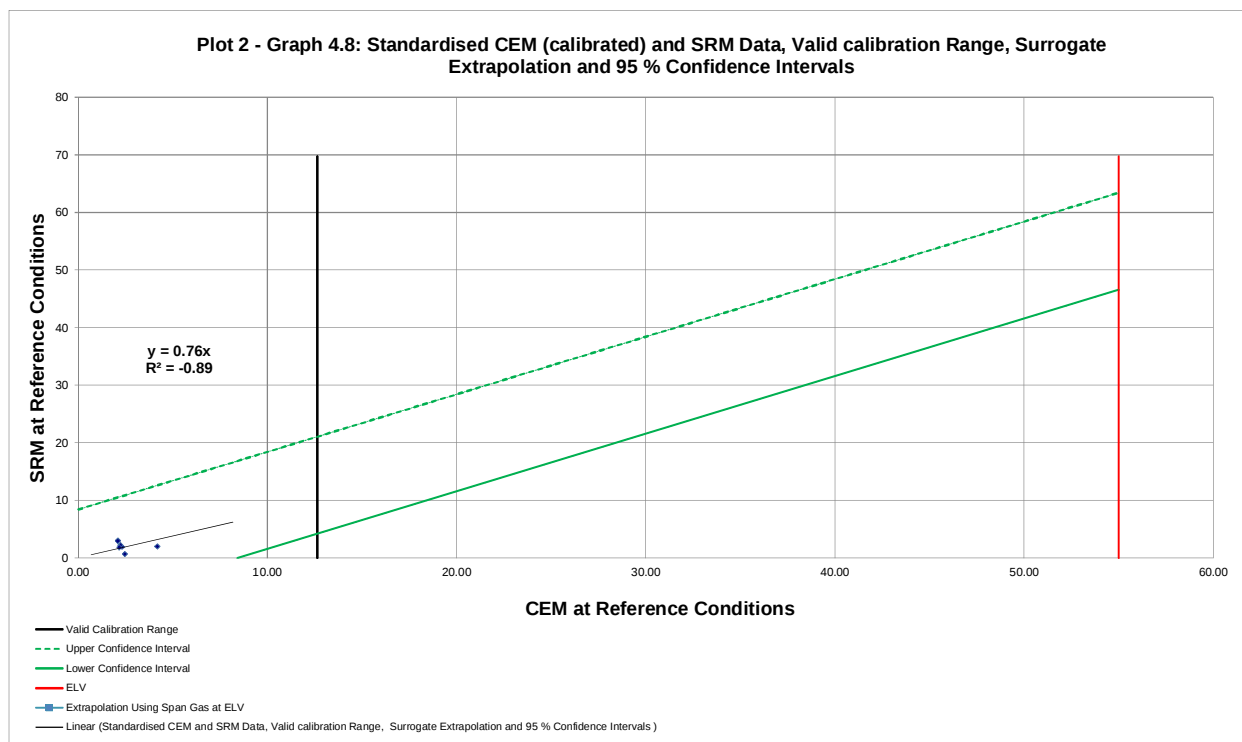
Year / visit: 2015/01

3514067A-1-U14-001R
May 2015

Prepared by Parsons Brinckerhoff
for Uskmouth Power

Particulate: Unit 14 Line 20 – CEM serial No: 0432047 continued:

X-y plot of calibrated, standardised CEM data versus standardised SRM data



Uskmouth Power Station

Permit No.: LP3131SW

Year / visit: 2015/01

3514067A-1-U14-001R
May 2015

Prepared by Parsons Brinckerhoff
for Uskmouth Power

Particulate: Unit 14 Line 20 – CEM serial No: 0432047

Analysis by Method C

Particulate mg.m^{-3} CEM (Calibrated Value at Reference Conditions)	Sample Number	Particulate mg.m^{-3} SRM (At Reference Conditions)
$\hat{y}_{i,s}$		$y_{i,s}$
2.32	1	1.93
2.47	2	0.68
2.24	3	2.21
2.18	4	1.84
2.11	5	3.04
4.19	6	1.99
2.10	7	2.94
2.51	Average	2.09
Difference between averages		0.42
ELV	mg.m^{-3}	55.00
95 % Confidence Interval (CI)	(%)	30.00
	mg.m^{-3}	16.50
Half of 95 % CI	mg.m^{-3}	8.25
Passes criterion		Yes

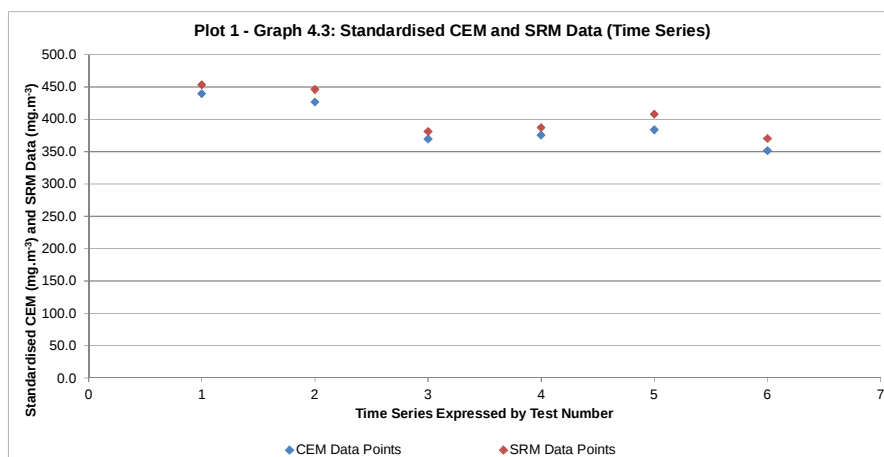
Above determined using all parallel test values.

Oxides of Nitrogen: Unit 14 Line 10 – CEM serial No. 1268

Table 4.1 & 4.2: Raw and Standardised Monitoring Data All Tests and Outcome of the Outliers Test.

CEM's Raw Data and Peripheral Parameters											
CEM Measures the Parameter at						Duct	Conditions				
Sample Number	Date	Time		CEM Raw Value	CEM Calibrated Value at Measured Conditions (using all raw data for calibrated function)	Temperature	Moisture Content	Oxygen	Pressure	CEM Calibrated Value At Reference Conditions	CEM Standardised Value At Reference Conditions
<i>i</i>		Start	End	x_i		t_i	h_i	o_i	P_a	x_i	
				mg.m ⁻³							
1	25/03/15	11:50	12:50	224.6	248.8	72.7	7.00	9.85	94.74	487.3	439.8
2	25/03/15	13:50	14:50	216.5	239.8	71.1	7.11	9.93	94.47	472.8	426.9
3	25/03/15	15:50	16:50	193.2	213.8	71.2	6.99	9.61	94.53	408.9	369.6
4	25/03/15	17:50	18:50	196.7	217.6	70.8	7.13	9.57	94.34	415.7	375.6
5	26/03/15	10:15	11:15	201.6	223.1	71.6	7.12	9.56	94.84	424.7	383.7
6	26/03/15	12:15	13:15	188.0	208.0	71.7	7.09	9.35	94.83	388.6	351.3
SRM Measures the Parameter at Extractive Dry Conditions											
SRM's Raw Data and Peripheral Parameters											
Sample Number	Date	Time		SRM Measured Value (at SRM conditions)	SRM Value at CEM's Raw Conditions	Temperature	Moisture Content	Oxygen	Pressure	SRM At Reference Conditions	Outliers Test Outcome
<i>i</i>		Start	End	y	y_i	t_i	h_i	o_i	P_a	$y_{i,s}$	
				ppm							
1	25/03/15	11:50	12:50	164.1	235.2	71	5.50	9.85	94.3	453.4	Valid Result
2	25/03/15	13:50	14:50	160.3	229.5	71	5.47	9.93	94.1	446.0	Valid Result
3	25/03/15	15:50	16:50	140.9	202.1	70	5.59	9.61	94.1	381.2	Valid Result
4	25/03/15	17:50	18:50	143.8	205.6	70	5.60	9.57	93.9	387.3	Valid Result
5	26/03/15	10:15	11:15	151.4	215.9	70	5.61	9.56	93.6	407.9	Valid Result
6	26/03/15	12:15	13:15	140.2	199.7	70	5.69	9.35	93.6	370.6	Valid Result

Oxides of Nitrogen: Unit 14 Line 10 – CEM serial No. 1268



4.4: Calculation and Procedure used for the elimination of outliers is that given in the Environment Agency's recommended procedure RM-QG14.

Table covering 4.5 to 4.7: Oxides of Nitrogen: Unit 14 Line 10 – CEM serial No. 1268
continued:

Continuous Emission Measuring (CEM) System Information	
Client:	Uskmouth Power Company
Site:	Uskmouth Power Station
PB Job Number:	3514067A-1
Date:	25 & 26 March 2015
Parameter:	Oxides of Nitrogen
CEM Details:	
Instrument Make:	Opsis
Model:	AB AR650
Serial Number:	1268
CEM Method:	Cross duct IR
CEM Offset:	4 mA
Calibration Function:	$\hat{y}_i = \hat{a} + b x_i = -1.976 \frac{\text{mg}}{\text{m}^3} + 1.117 \frac{\text{mg}}{\text{m}^3} x_i$
Valid Calibration Range: at reference conditions	From 0 to 386.1 mg.m ⁻³
SRM Method:	
Standard Reference No. :	EN14792
Method Type:	Extractive sampling and Chemiluminescence
Emissions Details:	
Emission Limit Value (ELV): at reference conditions	550 mg.m ⁻³
Reference Condition:	
Temperature: °C	0
Pressure: kPa	101.3
Moisture: %	0
Oxygen: %	6
Specified Uncertainty:	20 %
Uncertainty required by Authorities (σ ₀):	55 mg.m ⁻³

CEM Measurements Data Evaluation to Standard Conditions

Sample Number	CEM Measured Signal	CEM Calibrated Value	CEM Calibrated Value at Stack Conditions	CEM Calibrated Value at Standard Conditions
<i>i</i>	<i>x_i</i> mg.m ⁻³	<i>y_i</i> mg.m ⁻³	mg.m ⁻³	<i>y_{i,s}</i> mg.m ⁻³
1	224.6	248.8	248.8	487.3
2	216.5	239.8	239.8	472.8
3	193.2	213.8	213.8	408.9
4	196.7	217.6	217.6	415.7
5	201.6	223.1	223.1	424.7
6	188.0	208.0	208.0	388.6

SRM Measurements Data Evaluation to Standard Conditions

Sample Number	SRM Measured Value	SRM Value at CEM Condition	SRM Value at Standard Conditions
<i>i</i>	<i>y_i</i> ppm	<i>y_i</i> mg.m ⁻³	<i>y_{i,s}</i> mg.m ⁻³
1	164.1	235.2	453.4
2	160.3	229.5	446.0
3	140.9	202.1	381.2
4	143.8	205.6	387.3
5	151.4	215.9	407.9
6	140.2	199.7	370.6

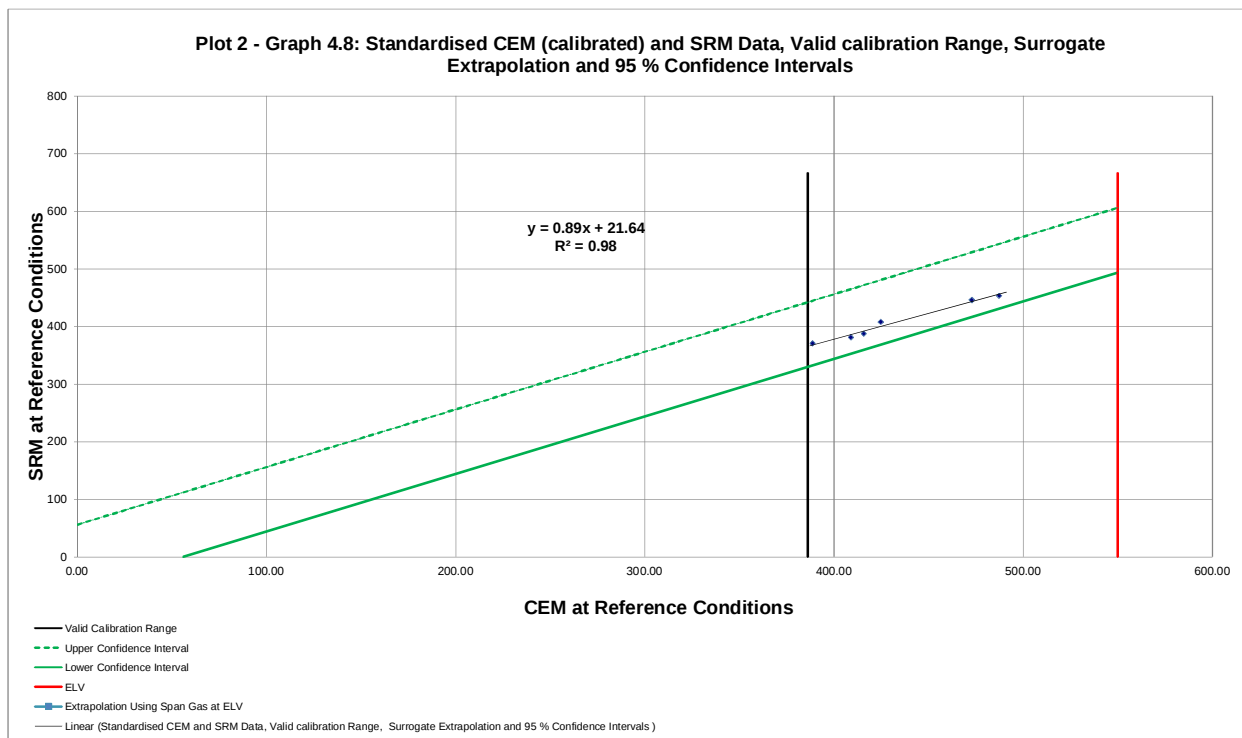
Test of Variability

Sample Number	CEM Calibrated Value at Standard Conditions	SRM Value at Standard Conditions	Difference	Difference	Squared Difference	Variability	Variability Acceptance Test	CEM Validity of Calibration Function
<i>i</i>	<i>y_{i,s}</i> mg.m ⁻³	<i>y_{i,s}</i> mg.m ⁻³	<i>D_i = y_{i,s} - y_{i,s}</i> mg.m ⁻³	<i>D_i - D̄</i> mg.m ⁻³	<i>(D_i - D̄)²</i> mg.m ⁻³	$s_D = \sqrt{1/(N-1) \times \sum (D_i - \bar{D})^2}$ (mg.m ⁻³) ²	$s_D \leq 1.5 \sigma_0 k_v$ mg.m ⁻³	$\frac{ \bar{D} }{\leq \{ [t_{0.95}(N-1)] (s_D / \sqrt{N}) \} + \sigma_0}$ mg.m ⁻³
1	487.3	453.4	-33.897	-8.631	74.498	6.577	6.577 ≤ 76.964	25.27 ≤ 60.410
2	472.8	446.0	-26.759	-1.494	2.231			
3	408.9	381.2	-27.751	-2.485	6.178			
4	415.7	387.3	-28.349	-3.083	9.506			
5	424.7	407.9	-16.826	8.439	71.224			
6	388.6	370.6	-18.012	7.254	52.620			
Sums Σ				0.000	216.257		Variability Test Fulfilled	Calibration of CEM Acceptable
Averages			<i>D̄</i> = -25.266					

Refer to BS EN 14181:2004 Stationary source emissions - Quality assurance of automated measuring systems, in particular to Annex B for details and interpretation of symbols and equations.

Oxides of Nitrogen: Unit 14 Line 10 – CEM serial No. 1268 continued:

X-y plot of calibrated, standardised CEM data versus standardised SRM data

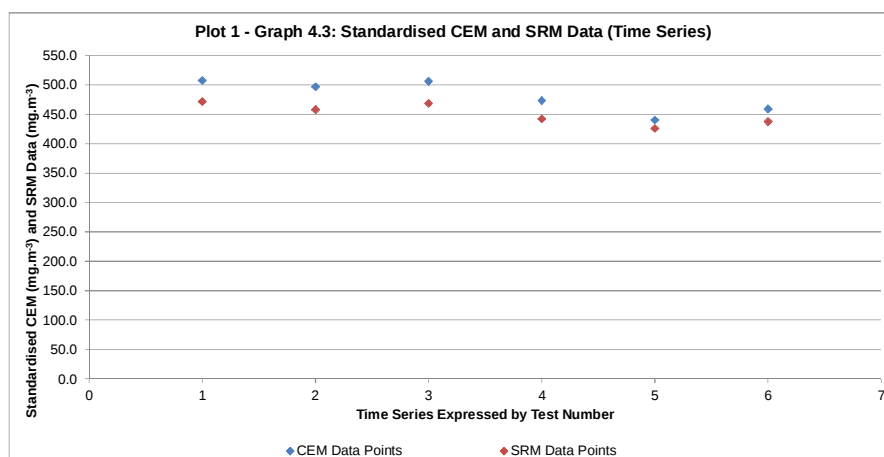


Oxides of Nitrogen: Unit 14 Line 20 – CEM serial No. 1266

Table 4.1 & 4.2: Raw and Standardised Monitoring Data All Tests and Outcome of the Outliers Test.

CEM's Raw Data and Peripheral Parameters											
CEM Measures the Parameter at Duct Conditions											
Sample Number	Date	Time		CEM Raw Value	CEM Calibrated Value at Measured Conditions (using all raw data for calibrated function)	Temperature	Moisture Content	Oxygen	Pressure	CEM Calibrated Value At Reference Conditions	CEM Standardised Value At Reference Conditions
i		Start	End	x_i mg.m ⁻³		t_i °C	h_i %	o_i %	P_a kPa	x_i mg.m ⁻³	
1	25/03/15	12:50	13:50	266.9	277.4	71.4	5.99	9.58	93.87	527.3	507.4
2	25/03/15	14:50	15:50	256.0	266.0	71.1	6.03	9.81	93.82	516.2	496.9
3	25/03/15	16:50	17:50	260.0	270.1	70.8	5.98	9.87	93.93	525.9	506.1
4	25/03/15	18:50	19:50	242.5	251.7	71.3	6.27	9.85	93.90	491.3	473.4
5	26/03/15	09:15	10:15	240.4	249.4	71.7	6.33	9.16	94.40	456.9	440.3
6	26/03/15	11:15	12:15	242.7	251.9	72.3	6.18	9.53	94.42	476.5	459.1
SRM Measures the Parameter at Extractive Dry Conditions											
SRM's Raw Data and Peripheral Parameters											
Sample Number	Date	Time		SRM Measured Value (at SRM conditions)	SRM Value at CEM's Raw Conditions	Temperature	Moisture Content	Oxygen	Pressure	SRM At Reference Conditions	Outliers Test Outcome
i		Start	End	y ppm	y_i mg.m ⁻³	t_i °C	h_i %	o_i %	P_a kPa	$y_{i,s}$ mg.m ⁻³	
1	25/03/15	12:50	13:50	174.8	247.1	73	5.60	9.58	93.6	471.4	Valid Result
2	25/03/15	14:50	15:50	166.4	235.4	73	5.51	9.81	93.6	457.9	Valid Result
3	25/03/15	16:50	17:50	169.3	238.6	74	5.49	9.87	93.5	468.7	Valid Result
4	25/03/15	18:50	19:50	160.0	226.5	73	5.50	9.85	93.6	442.0	Valid Result
5	26/03/15	09:15	10:15	163.7	229.1	74	5.76	9.16	93.1	425.8	Valid Result
6	26/03/15	11:15	12:15	162.9	228.2	74	5.62	9.53	93.0	437.5	Valid Result

Oxides of Nitrogen: Unit 14 Line 20 – CEM serial No. 1266



4.4: Calculation and Procedure used for the elimination of outliers is that given in the Environment Agency's recommended procedure RM-QG14.

Table covering 4.5 to 4.7: Oxides of Nitrogen: Unit 14 Line 20 – CEM serial No. 1266
continued:

Continuous Emission Measuring (CEM) System Information	
Client:	Uskmouth Power Company
Site:	Uskmouth Power Station
PB Job Number:	3514067A-1
Date:	25 & 26 March 2015
Parameter:	Oxides of Nitrogen
CEM Details:	
Instrument Make:	Opsis
Model:	AB AR650
Serial Number:	1266
CEM Method:	Cross duct IR
CEM Offset:	4 mA
Calibration Function:	$\hat{y}_i = \hat{a} + b x_i = -3.899 \frac{\text{mg}}{\text{m}^3} + 1.054 \frac{\text{mg/m}^3}{\text{mg/m}^3} x_i$
Valid Calibration Range:	From 0 to 347.1 mg.m ⁻³
SRM Method:	
Standard Reference No. :	EN14792
Method Type:	Extractive sampling and Chemiluminescence
Emissions Details:	
Emission Limit Value (ELV):	550 mg.m ⁻³
Reference Condition:	
Temperature:	0 °C
Pressure:	101.3 kPa
Moisture:	0 %
Oxygen:	6 %
Specified Uncertainty:	20 %
Uncertainty required by Authorities (σ ₀):	55 mg.m ⁻³

CEM Measurements Data Evaluation to Standard Conditions

Sample Number	CEM Measured Signal	CEM Calibrated Value	CEM Calibrated Value at Standard Conditions	CEM Calibrated Value at Standard Conditions
<i>i</i>	x_i mg.m ⁻³	$\hat{y}_i$ mg.m ⁻³	$y_{i,s}$ mg.m ⁻³	$\hat{y}_{i,s}$ mg.m ⁻³
1	266.9	277.4	277.4	527.3
2	256.0	266.0	266.0	516.2
3	260.0	270.1	270.1	525.9
4	242.5	251.7	251.7	491.3
5	240.4	249.4	249.4	456.9
6	242.7	251.9	251.9	476.5

SRM Measurements Data Evaluation to Standard Conditions

Sample Number	SRM Measured Value	SRM Value at CEM Condition	SRM Value at Standard Conditions
<i>i</i>	y_i ppm	y_i mg.m ⁻³	$y_{i,s}$ mg.m ⁻³
1	174.8	247.1	471.4
2	166.4	235.4	457.9
3	169.3	238.6	468.7
4	160.0	226.5	442.0
5	163.7	229.1	425.8
6	162.9	228.2	437.5

Test of Variability

Sample Number	CEM Calibrated Value at Standard Conditions	SRM Value at Standard Conditions	Difference	Difference	Squared Difference	Variability	Variability Acceptance Test	CEM Validity of Calibration Function
<i>i</i>	$\hat{y}_{i,s}$ mg.m ⁻³	$y_{i,s}$ mg.m ⁻³	$D_i = y_{i,s} - \hat{y}_{i,s}$ mg.m ⁻³	$D_i - \bar{D}$ mg.m ⁻³	$(D_i - \bar{D})^2$ mg.m ⁻³	$s_D = \sqrt{1/(N-1) \times \sum (D_i - \bar{D})^2}$ (mg.m ⁻³) ²	$s_D \leq 1.5 \sigma_0 k_v$ mg.m ⁻³	$\frac{ \bar{D} }{\leq \{t_{0.95}(N-1)\}(s_D / \sqrt{N})\} + \sigma_0}$ mg.m ⁻³
1	527.3	471.4	-55.897	-7.446	55.445	11.123	11.123 ≤ 76.964	48.45 ≤ 64.150
2	516.2	457.9	-58.259	-9.808	96.187			
3	525.9	468.7	-57.144	-8.693	75.569			
4	491.3	442.0	-49.301	-0.850	0.722			
5	456.9	425.8	-31.075	17.376	301.925			
6	476.5	437.5	-39.031	9.420	88.745			
Sums Σ				0.000	618.593		Variability Test Fulfilled	Calibration of CEM Acceptable
Averages		$\bar{D} =$	-48.451					

Refer to BS EN 14181:2004 Stationary source emissions - Quality assurance of automated measuring systems; in particular to Annex B for details and interpretation of symbols and equations.

Uskmouth Power Station

Permit No.: LP3131SW

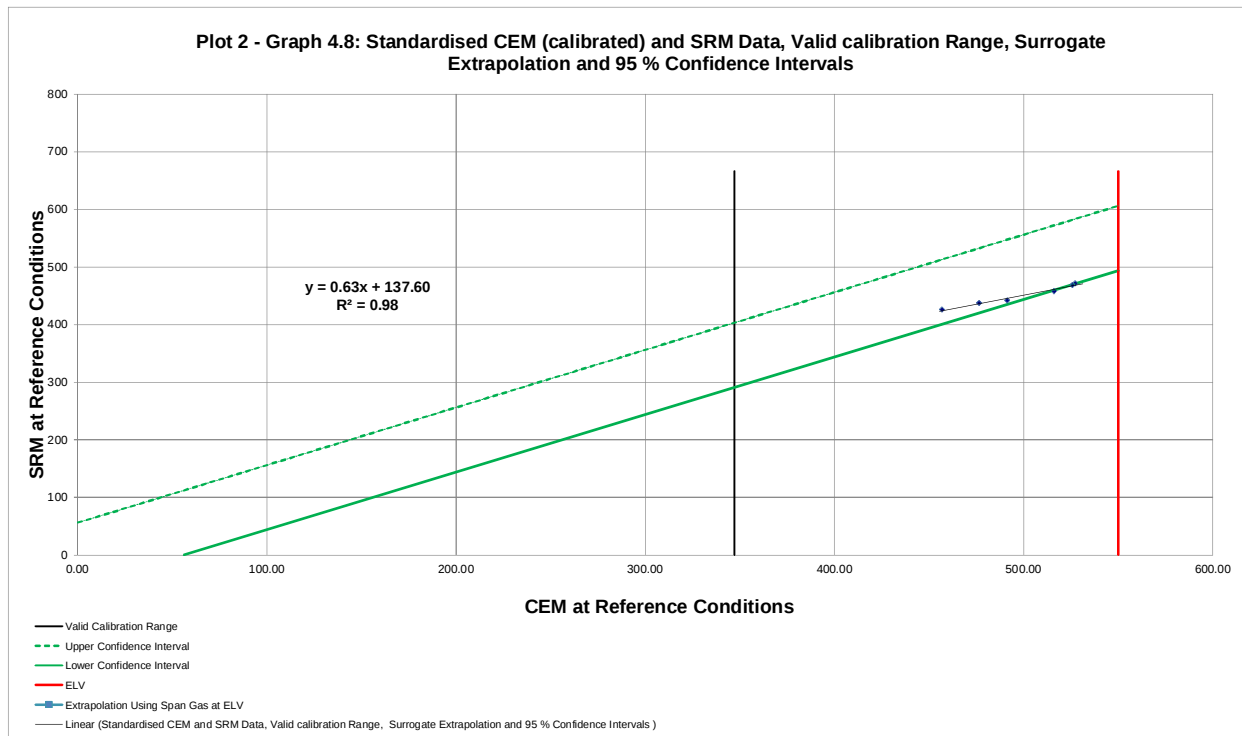
Year / visit: 2015/01

3514067A-1-U14-001R
May 2015

Prepared by Parsons Brinckerhoff
for Uskmouth Power

Oxides of Nitrogen: Unit 14 Line 20 – CEM serial No. 1266 continued:

X-y plot of calibrated, standardised CEM data versus standardised SRM data

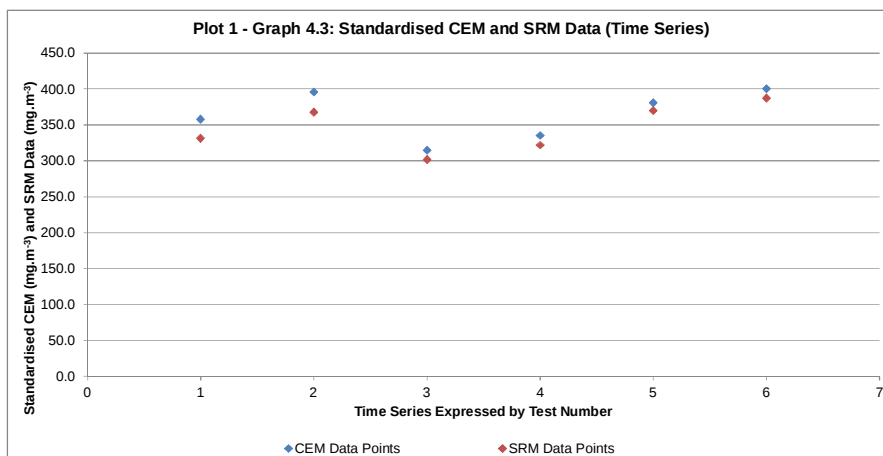


Sulphur Dioxide: Unit 14 Line 10 – CEM serial No. 1268

Table 4.1 & 4.2: Raw and Standardised Monitoring Data All Tests and Outcome of the Outliers Test.

CEM's Raw Data and Peripheral Parameters											
Sample Number	Date	Time		CEM Raw Value	CEM Calibrated Value at Measured Conditions (using all raw data for calibrated function)	Duct Temperature	Moisture Content	Oxygen	Pressure	CEM Calibrated Value At Reference Conditions	CEM Standardised Value At Reference Conditions
		Start	End	x_i mg.m ⁻³	x_i mg.m ⁻³	t_i °C	h_i %	o_i %	P_a kPa	x_i mg.m ⁻³	x_i mg.m ⁻³
1	25/03/15	11:50	12:50	182.7	186.4	72.7	7.00	9.85	94.74	364.9	357.7
2	25/03/15	13:50	14:50	200.6	204.4	71.1	7.11	9.93	94.47	402.9	395.5
3	25/03/15	15:50	16:50	164.4	168.1	71.2	6.99	9.61	94.53	321.4	314.5
4	25/03/15	17:50	18:50	175.3	179.0	70.8	7.13	9.57	94.34	341.8	334.9
5	26/03/15	10:15	11:15	200.1	203.8	71.6	7.12	9.56	94.84	388.0	380.9
6	26/03/15	12:15	13:15	214.3	218.1	71.7	7.09	9.35	94.83	407.5	400.4
SRM Measures the Parameter at Extractive Dry Conditions											
Sample Number	Date	Time		SRM Measured Value (at SRM conditions)	SRM Value at CEM's Raw Conditions	Duct Temperature	Moisture Content	Oxygen	Pressure	SRM At Reference Conditions	Outliers Test Outcome
		Start	End	y ppm	y_i mg.m ⁻³	t_i °C	h_i %	o_i %	P_a kPa	$y_{i,s}$ mg.m ⁻³	
1	25/03/15	11:50	12:50	86.2	171.9	71	5.50	9.85	94.3	331.4	Valid Result
2	25/03/15	13:50	14:50	94.9	189.1	71	5.47	9.93	94.1	367.5	Valid Result
3	25/03/15	15:50	16:50	80.2	160.0	70	5.59	9.61	94.1	301.7	Valid Result
4	25/03/15	17:50	18:50	85.8	170.7	70	5.60	9.57	93.9	321.6	Valid Result
5	26/03/15	10:15	11:15	98.7	195.7	70	5.61	9.56	93.6	369.7	Valid Result
6	26/03/15	12:15	13:15	105.3	208.8	70	5.69	9.35	93.6	387.3	Valid Result

Sulphur Dioxide: Unit 14 Line 10 – CEM serial No. 1268continued:



4.4: Calculation and Procedure used for the elimination of outliers is that given in the Environment Agency's recommended procedure RM-QG14.

Table covering 4.5 to 4.7: Sulphur Dioxide: Unit 14 Line 10 – CEM serial No. 1268
continued:

Continuous Emission Measuring (CEM) System Information			
Client:	Uskmouth Power Company		
Site:	Uskmouth Power Station		
PB Job Number:	3514067A-1		
Date:	25 & 26 March 2015		
Parameter:	Sulphur Dioxide		
CEM Details:			
Instrument Make:	Opsis		
Model:	AB AR650		
Serial Number:	1268		
CEM Method:	Cross duct IR		
CEM Offset:	4		
Calibration Function:	$\hat{y}_i = \hat{a} + b x_i = 3.011 \frac{\text{mg}}{\text{m}^3} + 1.004 \frac{\text{mg/m}^3}{\text{mg/m}^3} x_i$		
Valid Calibration Range:	From 0 to 804.9 mg.m^{-3}		
SRM Method:			
Standard Reference No. :	TGM M21		
Method Type:	Extractive sampling and Non-dispersive Infrared		
Emissions Details:			
Emission Limit Value (ELV):	440		
Reference Condition:			
Temperature:	0		
Pressure:	101.3		
Moisture:	0		
Oxygen:	6		
Specified Uncertainty:	20		
Uncertainty required by Authorities (σ_0):	44		

CEM Measurements Data Evaluation to Standard Conditions

Sample Number	CEM Measured Signal	CEM Calibrated Value	CEM Calibrated Value at Standard Conditions	CEM Calibrated Value at Standard Conditions
i	x_i	$\hat{y}_i$	$\hat{y}_{i,s}$	$\hat{y}_{i,s}$
	mg.m^{-3}	mg.m^{-3}	mg.m^{-3}	mg.m^{-3}
1	182.7	186.4	186.4	364.9
2	200.6	204.4	204.4	402.9
3	164.4	168.1	168.1	321.4
4	175.3	179.0	179.0	341.8
5	200.1	203.8	203.8	388.0
6	214.3	218.1	218.1	407.5

SRM Measurements Data Evaluation to Standard Conditions

Sample Number	SRM Measured Value	SRM Value at CEM Condition	SRM Value at Standard Conditions
i	y_i	y_i	$y_{i,s}$
	ppm	mg.m^{-3}	mg.m^{-3}
1	86.2	171.9	331.4
2	94.9	189.1	367.5
3	80.2	160.0	301.7
4	85.8	170.7	321.6
5	98.7	195.7	369.7
6	105.3	208.8	387.3

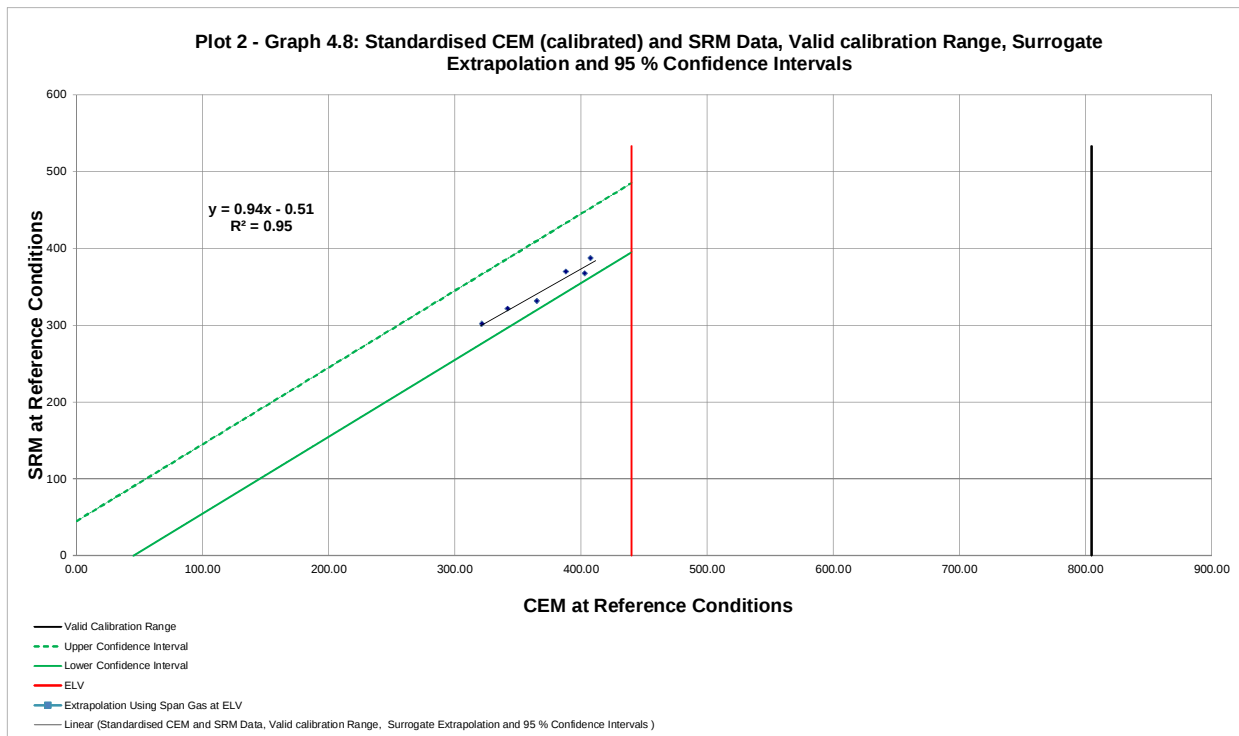
Test of Variability

Sample Number	CEM Calibrated Value at Standard Conditions	SRM Value at Standard Conditions	Difference	Difference	Squared Difference	Variability	Variability Acceptance Test	CEM Validity of Calibration Function
i	$\hat{y}_{i,s}$	$y_{i,s}$	$D_i = y_{i,s} - \hat{y}_{i,s}$	$D_i - \bar{D}$	$(D_i - \bar{D})^2$	$s_D = \sqrt{1/(N-1) \times \sum (D_i - \bar{D})^2}$	$s_D \leq 1.5 \sigma_0 k_v$	$\frac{ \bar{D} }{\leq \{ [t_{0.95}(N-1)] (s_D / \sqrt{N}) \} + \sigma_0}$
	mg.m^{-3}	mg.m^{-3}	mg.m^{-3}	mg.m^{-3}	mg.m^{-3}	$(\text{mg.m}^{-3})^2$	mg.m^{-3}	mg.m^{-3}
1	364.9	331.4	-33.533	-8.979	80.621	7.743	7.743 ≤ 61.571	24.55 ≤ 50.370
2	402.9	367.5	-35.424	-10.870	118.166			
3	321.4	301.7	-19.747	4.806	23.102			
4	341.8	321.6	-20.244	4.310	18.572			
5	388.0	369.7	-18.254	6.300	39.691			
6	407.5	387.3	-20.121	4.433	19.653			
Sums Σ				0.000	299.805		Variability Test Fulfilled	Calibration of CEM Acceptable
Averages		$\bar{D} =$	-24.554					

Refer to BS EN 14181:2004 Stationary source emissions - Quality assurance of automated measuring systems, in particular to Annex B for details and interpretation of symbols and equations.

Sulphur Dioxide: Unit 14 Line 10 – CEM serial 1268 continued:

X-y plot of calibrated, standardised CEM data versus standardised SRM data

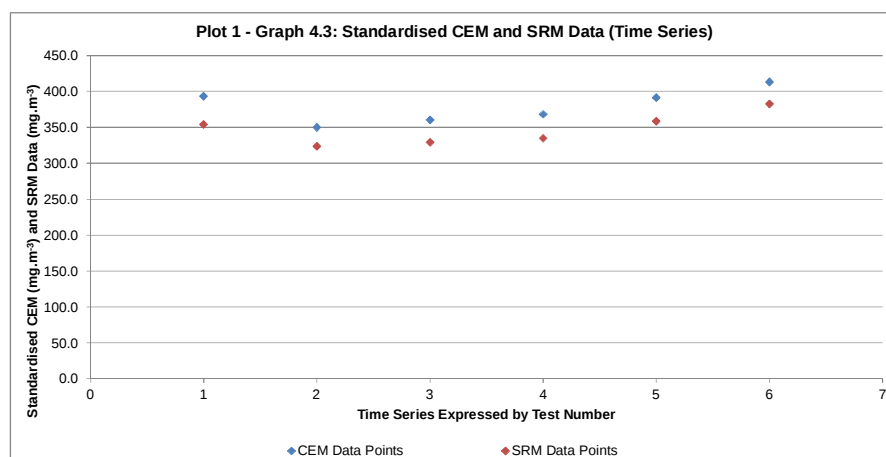


Sulphur Dioxide: Unit 14 Line 20 – CEM serial No. 1266

Table 4.1 & 4.2: Raw and Standardised Monitoring Data All Tests and Outcome of the Outliers Test.

CEM's Raw Data and Peripheral Parameters											
Sample Number <i>i</i>	Date	Time		CEM Measures the Parameter at		Duct Conditions		Oxygen	Pressure	CEM Calibrated Value At Reference Conditions x_i mg.m^{-3}	CEM Standardised Value At Reference Conditions mg.m^{-3}
		Start	End	CEM Raw Value x_i mg.m^{-3}	CEM Calibrated Value at Measured Conditions (using all raw data for calibrated function) mg.m^{-3}	Temperature t_i $^{\circ}\text{C}$	Moisture Content h_i $\%$				
1	25/03/15	12:50	13:50	206.9	132.7	71.4	5.99	9.58	93.87	252.3	393.2
2	25/03/15	14:50	15:50	180.3	115.6	71.1	6.03	9.81	93.82	224.4	350.0
3	25/03/15	16:50	17:50	185.0	118.7	70.8	5.98	9.87	93.93	231.1	360.2
4	25/03/15	18:50	19:50	188.5	120.9	71.3	6.27	9.85	93.90	236.1	368.0
5	26/03/15	09:15	10:15	213.7	137.1	71.7	6.33	9.16	94.40	251.1	391.4
6	26/03/15	11:15	12:15	218.4	140.2	72.3	6.18	9.53	94.42	265.2	413.2
SRM Measures the Parameter at Extractive Dry Conditions											
SRM's Raw Data and Peripheral Parameters											
Sample Number <i>i</i>	Date	Time		SRM Measured Value (at SRM conditions) y ppm	SRM Value at CEM's Raw Conditions y_i mg.m^{-3}	Temperature t_i $^{\circ}\text{C}$	Moisture Content h_i $\%$	Oxygen o_i $\%$	Pressure P_a kPa	SRM At Reference Conditions $y_{i,s}$ mg.m^{-3}	Outliers Test Outcome
		Start	End								
1	25/03/15	12:50	13:50	94.3	185.5	73	5.60	9.58	93.6	353.9	Valid Result
2	25/03/15	14:50	15:50	84.5	166.3	73	5.51	9.81	93.6	323.5	Valid Result
3	25/03/15	16:50	17:50	85.5	167.6	74	5.49	9.87	93.5	329.2	Valid Result
4	25/03/15	18:50	19:50	87.1	171.6	73	5.50	9.85	93.6	334.9	Valid Result
5	26/03/15	09:15	10:15	99.1	192.9	74	5.76	9.16	93.1	358.6	Valid Result
6	26/03/15	11:15	12:15	102.4	199.5	74	5.62	9.53	93.0	382.5	Valid Result

Sulphur Dioxide: Unit 14 Line 20 – CEM serial No. 1266continued:



4.4: Calculation and Procedure used for the elimination of outliers is that given in the Environment Agency's recommended procedure RM-QG14.

Table covering 4.5 to 4.7: Sulphur Dioxide: Unit 14 Line 20 – CEM serial No. 1266
continued:

Continuous Emission Measuring (CEM) System Information			
Client:	Uskmouth Power Company		
Site:	Uskmouth Power Station		
PB Job Number:	3514067A-1		
Date:	25 & 26 March 2015		
Parameter:	Sulphur Dioxide		
CEM Details:	Instrument Make: Opsis Model: AB AR650 Serial Number: 1266 CEM Method: Cross duct IR CEM Offset: mA 4 Calibration Function: $y_i = \hat{a} + b x_i = -0.442 \frac{\text{mg}}{\text{m}^3} + 0.644 \frac{\text{mg}}{\text{m}^3} x_i$ Where: x_i CEM result y_i CEM calibrated result $\hat{a}$ intercept b slope Valid Calibration Range: From 0 to 82.1 mg.m^{-3} at reference conditions		
SRM Method:	Standard Reference No. : TGM M21 Method Type: Extractive sampling and Non-dispersive Infrared		
Emissions Details:	Emission Limit Value (ELV): mg.m^{-3} 440 at reference conditions Reference Condition: Temperature: °C 0 Pressure: kPa 101.3 Moisture: % 0 Oxygen: % 6 Specified Uncertainty: % 20 Uncertainty required by Authorities (σ_0): mg.m^{-3} 44		

CEM Measurements Data Evaluation to Standard Conditions

Sample Number	CEM Measured Signal	CEM Calibrated Value	CEM Calibrated Value at Stack Conditions	CEM Calibrated Value at Standard Conditions
i	x_i mg.m^{-3}	$\hat{y}_i$ mg.m^{-3}	mg.m^{-3}	$\hat{y}_{i,s}$ mg.m^{-3}
1	206.9	132.7	132.7	252.3
2	180.3	115.6	115.6	224.4
3	185.0	118.7	118.7	231.1
4	188.5	120.9	120.9	236.1
5	213.7	137.1	137.1	251.1
6	218.4	140.2	140.2	265.2

SRM Measurements Data Evaluation to Standard Conditions

Sample Number	SRM Measured Value	SRM Value at CEM Condition	SRM Value at Standard Conditions
i	y_i ppm	y_i mg.m^{-3}	$y_{i,s}$ mg.m^{-3}
1	94.3	185.5	353.9
2	84.5	166.3	323.5
3	85.5	167.6	329.2
4	87.1	171.6	334.9
5	99.1	192.9	358.6
6	102.4	199.5	382.5

Test of Variability

Sample Number	CEM Calibrated Value at Standard Conditions	SRM Value at Standard Conditions	Difference	Difference	Squared Difference	Variability	Variability Acceptance Test	CEM Validity of Calibration Function
i	$\hat{y}_{i,s}$ mg.m^{-3}	$y_{i,s}$ mg.m^{-3}	$D_i = y_{i,s} - \hat{y}_{i,s}$ mg.m^{-3}	$D_i - \bar{D}$ mg.m^{-3}	$(D_i - \bar{D})^2$ mg.m^{-3}	$s_D = \sqrt{1/(N-1) \times \sum (D_i - \bar{D})^2}$ $(\text{mg.m}^{-3})^2$	$s_D \leq 1.5 \sigma_0 k_v$ mg.m^{-3}	$ \bar{D} \leq \{ [t_{0.95}(N-1)] (s_D / \sqrt{N}) \} + \sigma_0$ mg.m^{-3}
1	252.3	353.9	101.538	-2.194	4.813	7.486	$7.486 \leq 61.571$	$103.73 \leq 50.158$
2	224.4	323.5	99.103	-4.629	21.431			
3	231.1	329.2	98.168	-5.564	30.963			
4	236.1	334.9	98.824	-4.908	24.085			
5	251.1	358.6	107.414	3.682	13.558			
6	265.2	382.5	117.345	13.613	185.321			
Sums Σ				0.000	280.172		Variability Test Fulfilled	Calibration of CEM Unacceptable
Averages		$\bar{D} =$	103.732					

Refer to BS EN 14181:2004 Stationary source emissions - Quality assurance of automated measuring systems, in particular to Annex B for details and interpretation of symbols and equations.

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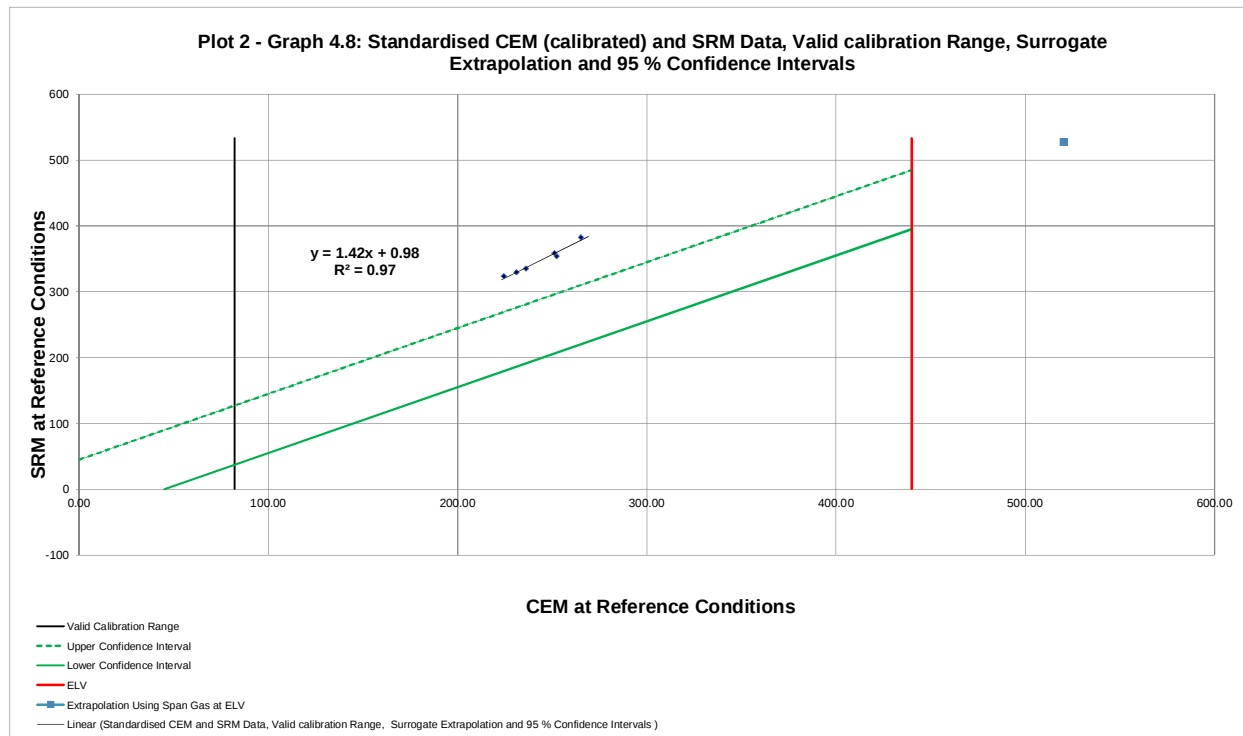
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May 2015

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for Uskmouth Power

Sulphur Dioxide: Unit 14 Line 20 – CEM serial 1266 continued:

X-y plot of calibrated, standardised CEM data versus standardised SRM data



SECTION 5

RESULTS OF THE FUNCTIONAL TESTS

Requirement	✓	Notes
5.1. Alignment and cleanliness The checks required by BS EN 14181 were: Durag particulate CEM by CES Environmental Instruments Ltd. (CES) during their annual service visit. Tables A1a to c and A2a to c in Appendix A displays Line 10 and 20's Service Engineer's Report and show whether any adjustments or changes were required. Opolis gaseous system the Service Engineer from Enviro Technology Services plc (ETS) during their annual service visit. Tables A3a to d and A8a to d in Appendix A displays Line 10 and 20's Service Engineer's Report and show whether any adjustments or changes were required.		
• Internal check of the CEM	✓	Carried out by ETS
	✓	Carried out by CES
• Cleanliness of the optical components	✓	Carried out by ETS
	✓	Carried out by CES
• Flushing air supply	✓	Carried out by ETS
	✓	Carried out by CES
• Obstructions in the optical path	✓	Carried out by ETS
	✓	Carried out by CES
• After re-assembly at the measurement location at least the following shall be checked	✓	Carried out by ETS
	✓	Carried out by CES
• Alignment of the measuring system	✓	Carried out by ETS
	✓	Carried out by CES
• Contamination control (internal check of optical surfaces)	✓	Carried out by ETS
	✓	Carried out by CES
5.2. Sampling systems Refer to the service reports in Appendix 2 Parsons Brinckerhoff's Team Leader visually inspected the CEMs during the AST exercise and observed no obvious sign of faults or potential flaws that would decrease the quality of the data produced.		
• Sampling probe	✓	In situ cross-duct
	✓	In situ cross-duct
• Gas conditioning systems	N/A	In situ cross-duct
	N/A	
• Pumps	✓	Carried out by ETS
	✓	Carried out by CES
• All connections	✓	Carried out by ETS
	✓	Carried out by CES
• Sample lines	N/A	In situ cross-duct
	N/A	In situ cross-duct
• Power supplies	✓	
	✓	
• Filters	N/A	

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Requirement	✓	Notes
		Visual inspection
NOx converters – if installed: Date of last efficiency-test The result of this test.	N/A	Visual inspection
	N/A	In situ cross-duct
The sampling system shall be in good condition and free of any visible faults, which may decrease the quality of data	✓	In situ cross-duct
	✓	In situ cross-duct
5.3. Documentation and Records The CEMs' data outputs are transmitted to a dedicated PC located in the DSC room. The PC performs various analyses, records storage and outputs to various information terminals around the site. Relevant manuals, plan of the CEMs, log books, service reports and training records/certificates are kept in the Process Support Manager's office. There are no QAL3 checks in place as the systems are calibrated every six months by ETS. No routine calibration checks are undertaken and hence no analyser analysis is performed. There is evidence the operator includes procedures for the management of the CEMs in the sites auditing and management system.		
5.4. Serviceability Annual and interim service contracts are in place with ETS and CES. CEMs are adequately protected from the elements and access is easy and safe by a combination of stairways and gantries with sufficient platform area at the CEMs' locations.		
5.5. Leak testing Not applicable for non-extractive analysers.		
5.6. Zero and Span check All CEMs are subjected to zero and span checks during the annual and interim service and calibration by the respective service contract.		
5.7. Linearity		
TPM CEM A six point linearity check, inclusive of zero, was included in the annual service and calibration: refer to Appendix A: Table A1b page iv for Line 10 and Table A2b page iv for Line 20.		
NOX CEM Linearity check was undertaken during the annual service by the ETS, the results for both NO and NO ₂ are given in the linearisation certificate in Appendix A Table A4a & b and A9a & b for Line 10 and 20 respectively. ETS perform a test of linearity as required in Annex B of EN 1418, but do not plot or calculate the test of residual; for completeness WSP Parsons Brinckerhoff has undertaken this and the results are given in Appendix A Tables A5 & 6 for Line 10 and A10 & 11 for Line 20.		
SO2 CEM Linearity check was undertaken during the annual service by the ETS, the results are given in the linearisation certificate in Appendix A Table A4b and A9b for Line 10 and 20 respectively. ETS perform a test of linearity as required in Annex B of EN 1418, but do not plot or calculate the test of residual; for completeness WSP Parsons Brinckerhoff has undertaken this and the results are given in Appendix A Tables A7 for Line 10 and A12 for Line 20.		

Requirement	✓	Notes																								
5.8. Interferences Not applicable																										
5.9. Zero and Span Drift (Audit) Yes during services.																										
5.10. Response Time <table border="1" style="margin: 10px auto; width: 80%;"> <thead> <tr> <th>Determinant</th> <th>CEM's Set Range</th> <th>Concentration of Determinant Used</th> <th>Measured Response (Time to reach 90 % of concentration)</th> </tr> <tr> <th></th> <th>(ppm,mg.m⁻³)</th> <th>(mg.m⁻³)</th> <th>(s)</th> </tr> </thead> <tbody> <tr> <td>TPM</td> <td></td> <td></td> <td>20</td> </tr> <tr> <td>NO</td> <td></td> <td></td> <td>No data supplied</td> </tr> <tr> <td>NO₂</td> <td></td> <td></td> <td>No data supplied</td> </tr> <tr> <td>SO₂</td> <td></td> <td></td> <td>No data supplied</td> </tr> </tbody> </table>	Determinant	CEM's Set Range	Concentration of Determinant Used	Measured Response (Time to reach 90 % of concentration)		(ppm,mg.m ⁻³)	(mg.m ⁻³)	(s)	TPM			20	NO			No data supplied	NO ₂			No data supplied	SO ₂			No data supplied		
Determinant	CEM's Set Range	Concentration of Determinant Used	Measured Response (Time to reach 90 % of concentration)																							
	(ppm,mg.m ⁻³)	(mg.m ⁻³)	(s)																							
TPM			20																							
NO			No data supplied																							
NO ₂			No data supplied																							
SO ₂			No data supplied																							
5.11. Service Reports The service reports meet the minimum requirements of Appendix 2 section 9 of the pro-forma given in MID 14181, any deviations or exceptions are detailed below.																										
As a minimum requirement the service report should include the following:																										
Document reference for work instruction for the type of work being undertaken	✓																									
Instrument manufacturer	✓	Inferred in the ETS report																								
Instrument type	✓	ETS yes CES yes																								
Instrument model	✓																									
Instrument Serial No. (compare with recorded reading at start)	✓																									
Instrument configuration including computer file and name if available	✓	Details of settings are given in the service reports																								
Operating principle	✓	Inferred but not specifically noted																								
Operating range	✓	ETS no reference																								
Measuring condition	✓	ETS no reference CES yes																								
Certification details	✓	ETS no CES yes																								
Compliance with MCERTS (including certificate no.)	✓	ETS no CES yes																								
Location	✓																									
Date and time work was undertaken	✓																									
Equipment used – type, serial no's, calibration dates	✓	ETS N/A																								

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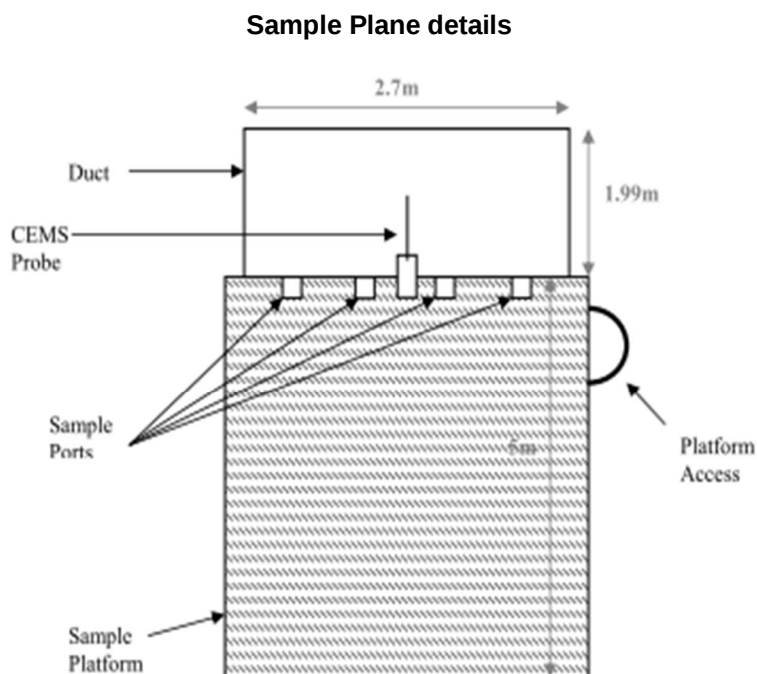
Requirement	✓	Notes
Gases used – certificate numbers, expiry dates, binary / mix	✓	ETS gas certificates numbers CES filter set numbers
Calibration and linearity data as required by EN14181	✓	The CES reports indicate that the requirements are met. ETS reports do not include a graph with the calculation of the regression line; there is no calculation of the residuals of the average concentration or the test of the residuals. WSP Parsons Brinckerhoff has taken ETS's data and calculated the missing items. Refer to Tables A5 to A7 for Line 10 and A10 to 12 for Line 20 for details.
Logged data for period of calibration and linearity	✓	
Name and signature of service engineer	✓	ETS name only CES name only

APPENDIX A

RESULTS OF THE FUNCTIONAL TESTS

Diagram A1

Uskmouth Power
Uskmouth Power Station
Diagrams and pictures of the sampling location, platforms and CEMs location



**Photograph of monitoring platform and
sample ports**



Photograph of a sample port



Note: CEM can just be seen at the top of the picture

Table A1a

Uskmouth Power

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CES Environmental Instruments Ltd: Durag D-R800 Functional test report for Unit 14 Line 10 – service report, linearity data sheets and base light settings (5 pages)

Page i of v

[illegible]

Page 1 of 5

462-UNE 14-10-DURAG D-8800V6-29-01-14

Page ii of v

Universal Settings (on Board)	
Range Low Zero mA	4.0
Range End mA	20.0
Output type	mA
Range Start	0.0
Range Stop	50.0
Adjustment Factor (E01)	0.0750E-1
Adjustment Offset (E02)	0.0
Range 0, 1, 2, 3	Linear
Characteristic Curve (E03)	
Integration	20 Seconds
Output 1	
Mod Bus Address	0
Ref point	0
Contamination	0
Check Cycle hrs	0
Manufacture date	
Firm Ware	V07.71
Output 2	
Mod Bus Address	0
Ref point	0
Contamination	0
Check Cycle hrs	0
Manufacture date	
Firm Ware	V07.71
4 x 700 = 80	

Universal Settings (on Left)	
Range Low Zero mA	4.0
Range End mA	20.0
Output type	mA
Range Start	0.0
Range Stop	50.0
Adjustment Factor (E01)	0.0750E-1
Adjustment Offset (E02)	0.0
Range 0, 1, 2, 3	Linear
Characteristic Curve (E03)	
Integration	20 Seconds
Output 1	
Mod Bus Address	0
Ref point	0
Contamination	0
Check Cycle hrs	0
Manufacture date	
Firm Ware	V07.71
Output 2	
Mod Bus Address	0
Ref point	0
Contamination	0
Check Cycle hrs	0
Manufacture date	
Firm Ware	V07.71
4 x 700 = 80	

Common Actions required	
Serial Number	C263
Order Qty No.	12=
Date required	12/04
Warranty Specification	12=
White specification	20=
Ken Check	
Open Check	
After probe lifting beginning to corrode with some pitting	
Signature	
Date	14/02/2013

Page 2 of 5

4462-Unit 14-10-CURAG D-RB00V6-29-01-14

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Table A1b

Uskmouth Power
UskmouthPower Station
CES Environmental Instruments Ltd: Durag D-R800 Functional test report for Unit 14 Line 10 –
service report, linearity data sheets and base light settings (5 pages) cont'd

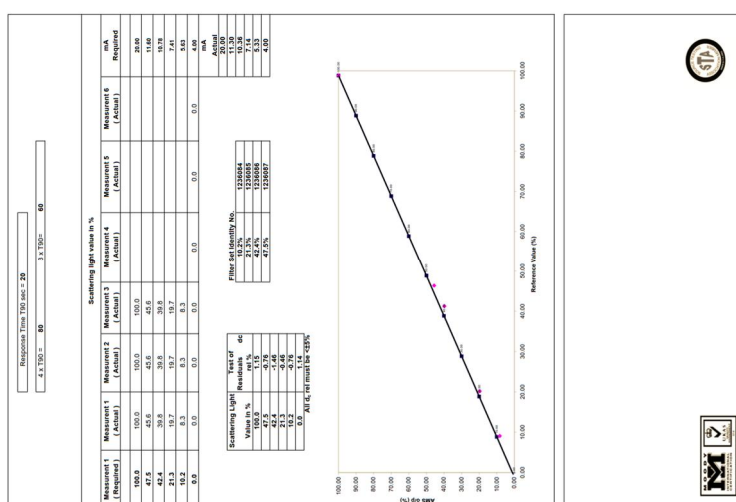
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[illegible]

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162 Unit 14-16 COURAGE COURTESY 20-01-14

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462-Unit 14-10 COURAG D-R000V6-29-01-14

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Table A1c

Uskmouth Power

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CES Environmental Instruments Ltd: Durag D-R800 Functional test report for Unit 14 Line 10 – service report, linearity data sheets and base light settings (5 pages) cont'd

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CES Environmental Instruments Ltd
Breiby Business park
Ashby Road
Staffordshire
Burton on trent
DE13 0TZ
Tel: 01283 216334
Email: info@cesel.co.uk



CES Environmental Instruments Ltd
Specialist in Environmental Monitoring and Data Systems

Base Light Settings
Unit 14-10

Site Address

Uskmouth Power Station
Unit 14, Nash Road
Nash
Newport
NP18 2BZ

Client Contact name's: John Gregory

CES Engineer D Harvey

Purchase Order No: na

Job No: 124609

Instrument Manufacture: Durag SMBH

MCERTS Compliance cert No: SIRA-MC-0812302-DR 800

Serial No: 0442050

Work Instruction Ref:

Service Date: 11-Feb-15

Instrument: Durag D-R800 (Forward Scattered Li)

Probe type: 80mm

Probe length: 80mm

Orientation: Vertical

Plant: Unit 14-10

Parameter	Set point	Scattered light value	
0	4375.4	4235	Pass
1	4553.3	4248	Pass
3	4853.8	4304	Pass
4	591.2	4333	Pass

Laser adjust

Base Light

Pollution light level

Filter Set Identity No.

D Harvey

Uskmouth Power Station

Permit No.: LP3131SW

Year / visit: 2015/01

3514067A-1-U14-001R
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Table A2a

Uskmouth Power
UskmouthPower Station
CES Environmental Instruments Ltd: Durag D-R800 Functional test report for Unit 14 Line 20 – service report, linearity data sheets and base light settings (5 pages)

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CES
Environmental Instruments
Instruments • Environmental Monitoring and Data Systems

CES Environmental Instruments Ltd
Bobby Business park
Ashtly Road
Drogheda
Bulbin on trent
DU15 0YZ

Tel: 01283 216334
Email: info@cesni.co.uk

Service Report Durag D-R800

Unit 14-20

Site Address Unknown Power Station West Main Road Drogheda Newport NP18 2EE		John Gregory	
Client Contact Name: CES Customer Purchase Order No: Job Ref:	Job Chamber Job ID: Durag CM8H Serial No:	Service Date Time: Device Type Range Page	11/02/2011 10:25:11:20 DR 800 (Forward Scatter Light) Unit 14-20 Newport
Instrument Manufacturer: Serial No:		Certified Range	
MCPHYS Compliance test No: Work Instruction Ref:		S80-MC-38912302-DR 800 WT 455	

Checklist	Comments
☐ Internal inspection	
☒ If there was a reported fault was it confirmed	
☒ The equipment has been removed for the necessary test equipment	Not required
☒ Visual cleaning, optical adjustment necessary	
☒ Visual inspection of internal components and connections have been checked and verified	
☒ Unit inspected externally and verified to be in good condition	
☒ Check cycle confirmed	
☒ We are satisfied that the Durag Products are working to specification	
☒ The equipment has been returned to the customer in good condition	
☒ Check wiring and power supply	
☒ Check for general damage	
☒ Check purge air equipment	
☒ Check for leaks	
☒ Clean per other	
☒ APV Filter changed	
☒ APV Filter alarm check	
☒	Not required
☒	Not required
☒	Not required



MCPHYS
Environmental Instruments Ltd
Drogheda, Co. Dublin
Tel: 01283 216334
Email: info@cesni.co.uk



STP
Sewer Treatment Plant
Drogheda, Co. Dublin
Tel: 01283 216334
Email: info@cesni.co.uk

Page 1 of 5

1462107 14:20 DURAG D R8000V6 29.01.14

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Instrument Settings (as found)		Output 1		Output 2	
Range Low mA	4.0	Range Low mA	0	Mod Bus Address	
Range End mA	20.0	Range End mA	0	Ref point	15.26 mA
Output type	mA ²	Output type	mA ²	Ref point	75.1 %
Range end	50.0	Range end	0	Contamination	85.1 %
Adjustment factor (E01)	0.0558E-1	Adjustment factor (E01)	0	Check Cycle hrs	24.0
Adjustment Offset (E02)	0.0	Adjustment Offset (E02)	0	Manufacture date	30072007
Range 0, 1, 2, 3	0	Range 0, 1, 2, 3	0	Firm Ware	V07.71
Characteristic Curve (E03)	Linear	Characteristic Curve (E03)	Linear		
Integration	20 Seconds	Integration	20 Seconds		

Instrument Settings (as Left)		Output 1		Output 2	
Range Low Zero mA	4.0	Range Low Zero mA	0	Mod Bus Address	
Range End mA	20.0	Range End mA	0	Ref point	15.17 mA
Output type	mA ²	Output type	mA ²	Ref point	69.8 %
Range end	50.0	Range Start	0	Contamination	69 %
Adjustment factor (E01)	0.0558E-1	Adjustment factor (E01)	0	Check Cycle hrs	24.0
Adjustment Offset (E02)	0.0	Adjustment Offset (E02)	0	Manufacture date	30072007
Range 0, 1, 2, 3	0	Range 0, 1, 2, 3	0	Firm Ware	V07.71
Characteristic Curve (E03)	Linear	Characteristic Curve (E03)	Linear		
Integration	20 Seconds	Integration	20 Seconds		

Common Settings		Within Specification	
Item Check	Item Check	Within Specification	Within Specification
mA output	4 =	4.10	12 =
Alarm Quality No.	C253	Call Date required	12/05/2015

Comments / Actions required

Instrument returned by service and confirmed	
Engineer	11/03/2015
Signature	

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2025 JUN 14 20:00 RAG O BARNES 29.03.14

Uskmouth Power Station

Permit No.: LP3131SW

Year / visit: 2015/01

3514067A-1-U14-001R
May 2015

Prepared by Parsons Brinckerhoff
for Uskmouth Power

Table A2b

Uskmouth Power
UskmouthPower Station
CES Environmental Instruments Ltd: Durag D-R800 Functional test report for Unit 14 Line 20 –
service report, linearity data sheets and base light settings (5 pages) cont'd

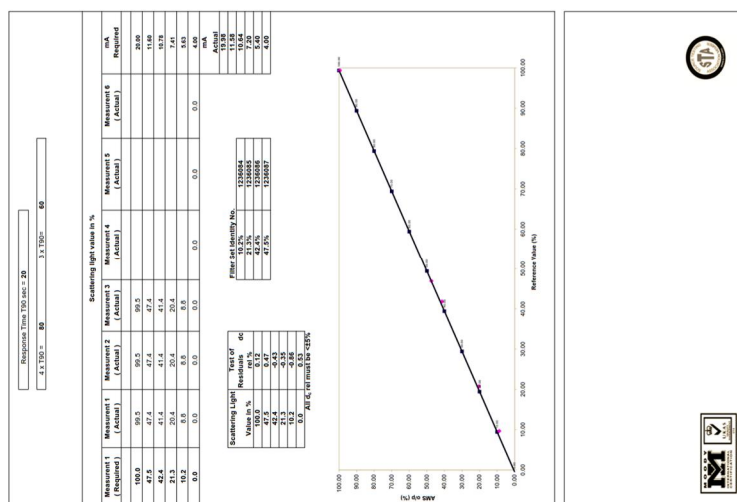
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ms2-Unit 14-20 COURAG COURAGE 29-01-14

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14-00000-29-01-14

Uskmouth Power Station

Permit No.: LP3131SW

Year / visit: 2015/01

3514067A-1-U14-001R
May 2015

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Table A2c

Uskmouth Power

UskmouthPower Station

CES Environmental Instruments Ltd: Durag D-R800 Functional test report for Unit 14 Line 20 – service report, linearity data sheets and base light settings (5 pages) cont'd

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CES Environmental Instruments Ltd
Brebby Business park
Ashby Road
Staffordshire
Burton on trent
DE15 0YZ
Tel: 01283 216334
Email: info@cesei.co.uk



CES
Environmental Instruments Ltd
Specialists in Environmental Monitoring and Data Acquisition

Base Light Settings
Unit 14-20

Site Address
Uskmouth Power Station
West Nash Road
Nash
Northampton
NN16 2BZ

Client Contact name's: John Gregory

CES Engineer: K Chawner

Purchase Order No: n/a

Job Ref: E044822MSH

Work Instruction Ref: SIRA-MC-080123002-DR R800

MCERTS Compliance cert No: 00432047

Serial No:

Work Instruction Ref:

Service Date: 11-Feb-15

Device Type: DR 800 (Forward Scattered Li

Device ID: 11111111

Orientation: Vertical

Plant: Unit 14-20

Parameter	Set point	Scattered light value	
0	823.4	4225	Pass
1	635.3	4258	Pass
2	457.2	4267	Pass
4	591.2	4333	Pass

Laser adjust

Pass

Base Light

Pass

Pollution light level

Pass

Filter Set Identity No. 1235120

K Chawner

Uskmouth Power Station

Permit No.: LP3131SW

Year / visit: 2015/01

3514067A-1-U14-001R
May 2015

Prepared by Parsons Brinckerhoff
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Table A3a

Uskmouth Power
UskmouthPower Station
ETS Ltd: Opsis service report for Unit 14 Line 10 (7 pages)

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Enviro Technology Services plc Kindfisher Business Park, London Road, Stroud, Gloucestershire GL5 2BY, UK Tel: +44 (0)1453 733200 Fax: +44 (0)1453 733201 Web: www.et.co.uk	
Please consider the environment before printing this report	
ENGINEER'S REPORT	
CRN No:	Customer Order No:
Engineer Name:	Russell Cook
Enviro Client / Database Name:	Visit Type: Routine Service
Official Defra Site Name (if applicable):	Lakemouth 14-10
Site Visit Start Date:	Time: 08:00 GMT
Site Visit End Date:	Time: 15:00 GMT
Reported Fault / Task:	(Data Elimination)
Routine service	
Engineer's Comments: Completed plant inspection reported to techs office and obtained W.O permit. Moved equipment to analyser area O2 probe checked and found OK. All apparatus checked OK. On arrival at site found no problems. Checked noise levels require reporting on next service visit. NO filter requires replacing on next service visit. Analysers require removing and cleaning.	

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[illegible]

Uskmouth Power Station

Permit No.: LP3131SW

Year / visit: 2015/01

3514067A-1-U14-001R
May 2015

Prepared by Parsons Brinckerhoff
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Table A3b

Uskmouth Power
UskmouthPower Station
ETS Ltd: Opsis service report for Unit 14 Line 10 (7 pages) cont'd

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[illegible]

Page iv of vii



System check (test)		Find checks		Page 3 of 3		Page	
Disk Card		Find no		Type		N/A	
Check speed deviation (1 top)		1	0.27				
Check speed deviation (10 tops)		2	0.07				
Check speed deviation (10 tops)		3	0.07				
Check speed deviation (10 tops)		4	-13	No change		Use level	
Check speed deviation (10 tops)		5	0	6 months			
Check speed deviation (10 tops)		6	0				
Check speed deviation (10 tops)		7	4.97				
Check speed deviation (10 tops)		8	3.7	Transfer solid no.		N/A	
Check speed deviation (10 tops)		9	2	Receiver solid no.		N/A	
Check speed deviation (10 tops)		10	-2	Power supply solid no.		N/A	
Check speed deviation (10 tops)		11	50.07	Exhaust			
Find measure ment readings		12	50.07	Exhaust			
Find measure ment readings		13	50.07	Exhaust			
Find measure ment readings		14	50.07	Exhaust			
Find measure ment readings		15	50.07	Exhaust			
Find measure ment readings		16	50.07	Exhaust			
Find measure ment readings		17	50.07	Exhaust			
Find measure ment readings		18	50.07	Exhaust			
Find measure ment readings		19	50.07	Exhaust			
Find measure ment readings		20	50.07	Exhaust			
Find measure ment readings		21	50.07	Exhaust			
Find measure ment readings		22	50.07	Exhaust			
Find measure ment readings		23	50.07	Exhaust			
Find measure ment readings		24	50.07	Exhaust			
Find measure ment readings		25	50.07	Exhaust			
Find measure ment readings		26	50.07	Exhaust			
Find measure ment readings		27	50.07	Exhaust			
Find measure ment readings		28	50.07	Exhaust			
Find measure ment readings		29	50.07	Exhaust			
Find measure ment readings		30	50.07	Exhaust			
Find measure ment readings		31	50.07	Exhaust			
Find measure ment readings		32	50.07	Exhaust			
Find measure ment readings		33	50.07	Exhaust			
Find measure ment readings		34	50.07	Exhaust			
Find measure ment readings		35	50.07	Exhaust			
Find measure ment readings		36	50.07	Exhaust			
Find measure ment readings		37	50.07	Exhaust			
Find measure ment readings		38	50.07	Exhaust			
Find measure ment readings		39	50.07	Exhaust			
Find measure ment readings		40	50.07	Exhaust			
Find measure ment readings		41	50.07	Exhaust			
Find measure ment readings		42	50.07	Exhaust			
Find measure ment readings		43	50.07	Exhaust			
Find measure ment readings		44	50.07	Exhaust			
Find measure ment readings		45	50.07	Exhaust			
Find measure ment readings		46	50.07	Exhaust			
Find measure ment readings		47	50.07	Exhaust			
Find measure ment readings		48	50.07	Exhaust			
Find measure ment readings		49	50.07	Exhaust			
Find measure ment readings		50	50.07	Exhaust			
Find measure ment readings		51	50.07	Exhaust			
Find measure ment readings		52	50.07	Exhaust			
Find measure ment readings		53	50.07	Exhaust			
Find measure ment readings		54	50.07	Exhaust			
Find measure ment readings		55	50.07	Exhaust			
Find measure ment readings		56	50.07	Exhaust			
Find measure ment readings		57	50.07	Exhaust			
Find measure ment readings		58	50.07	Exhaust			
Find measure ment readings		59	50.07	Exhaust			
Find measure ment readings		60	50.07	Exhaust			
Find measure ment readings		61	50.07	Exhaust			
Find measure ment readings		62	50.07	Exhaust			
Find measure ment readings		63	50.07	Exhaust			
Find measure ment readings		64	50.07	Exhaust			
Find measure ment readings		65	50.07	Exhaust			
Find measure ment readings		66	50.07	Exhaust			
Find measure ment readings		67	50.07	Exhaust			
Find measure ment readings		68	50.07	Exhaust			
Find measure ment readings		69	50.07	Exhaust			
Find measure ment readings		70	50.07	Exhaust			
Find measure ment readings		71	50.07	Exhaust			
Find measure ment readings		72	50.07	Exhaust			
Find measure ment readings		73	50.07	Exhaust			
Find measure ment readings		74	50.07	Exhaust			
Find measure ment readings		75	50.07	Exhaust			
Find measure ment readings		76	50.07	Exhaust			
Find measure ment readings		77	50.07	Exhaust			
Find measure ment readings		78	50.07	Exhaust			
Find measure ment readings		79	50.07	Exhaust			
Find measure ment readings		80	50.07	Exhaust			
Find measure ment readings		81	50.07	Exhaust			
Find measure ment readings		82	50.07	Exhaust			
Find measure ment readings		83	50.07	Exhaust			
Find measure ment readings		84	50.07	Exhaust			
Find measure ment readings		85	50.07	Exhaust			
Find measure ment readings		86	50.07	Exhaust			
Find measure ment readings		87	50.07	Exhaust			
Find measure ment readings		88	50.07	Exhaust			
Find measure ment readings		89	50.07	Exhaust			
Find measure ment readings		90	50.07	Exhaust			
Find measure ment readings		91	50.07	Exhaust			
Find measure ment readings		92	50.07	Exhaust			
Find measure ment readings		93	50.07	Exhaust			
Find measure ment readings		94	50.07	Exhaust			
Find measure ment readings		95	50.07	Exhaust			
Find measure ment readings		96	50.07	Exhaust			
Find measure ment readings		97	50.07	Exhaust			
Find measure ment readings		98	50.07	Exhaust			
Find measure ment readings		99	50.07	Exhaust			
Find measure ment readings		100	50.07	Exhaust			

System line connected		Find checks	
disk space		n/a	
memory		286	
file name		172	
line		UNAK005	

See Engineers Note sheet 02.51 N 1885

Comments:

Uskmouth Power Station

Permit No.: LP3131SW

Year / visit: 2015/01

3514067A-1-U14-001R
May 2015

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Table A3c

Uskmouth Power
UskmouthPower Station
ETS Ltd: Opsis service report for Unit 14 Line 10 (7 pages) cont'd

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Opsis Analyser Gas Calibration Sheet									
Gas	NO	NO2	SO2	CO					
Path Length (m)	1.65	1.65	1.65	1.65					
Cell Length (mm)	104.80	39.96	488	10.02	1.00				19.98
Cylinder Concentration (ppm)	5103	1050	995	8720					
Conversion Factor (ppm to mg/m3)	1.34	2.05	2.86	1.25					
Recorded Span Readings									
Reading 1	421.00	48.90	916.00	63.90					
Reading 2	421.00	48.90	923.00	63.90					
Reading 3	421.00	47.70	921.00	63.60					
Reading 4	421.60	47.80	935.00	66.10					
Reading 5									
Reading 6									
Reading 7									
Reading 8									
Reading 9									
Reading 10									
Reading 11									
Reading 12									
Reading 13									
Reading 14									
Reading 15									
Actual Concentration =	mg/m3	421.55	48.60	923.55	67.45	#DIV/0!	67.45	#DIV/0!	#DIV/0!
Expected Concentration =	mg/m3	434.32	52.23	858.88	66.19	#DIV/0!	66.19	#DIV/0!	71.90
Readings Taken		4	4	4	4		4		
Minimum Concentration =	mg/m3	421.00	47.70	916.00	63.90		63.90		
Maximum Concentration =	mg/m3	421.90	49.90	935.00	69.60		69.60		
Average Concentration =	mg/m3	421.55	48.60	923.55	67.45		67.45		
Standard Deviation		0.38730	1.04881	8.08352	2.46374		2.46374		
95% Confidence Levels		0.37955	1.02781	7.92171	2.41442		2.41442		
95% Confidence Range Maximum		421.92955	49.62781	931.47171	69.86442		69.86442		
95% Confidence Range Minimum		421.17045	47.57219	915.62829	65.03556		65.03556		
Previous Instrument Span Factor		0.95	1.20	0.92	1.03		1.03		
New Instrument Span Factor		0.98	1.29	0.86	1.01		1.01		

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Enviro Technology Services plc
SOURCING FOR LIFE

Opsis O₂ Analyser
Data Sheet

Model No: Q2020 Serial No: 1865 Eff No:

PRE TEST DATA

Start Date: 17/02/2015
Start Time: 14:00

Current Reading: 20.9 %
Status: normal
O₂ Cell: -8.0 mV

POST TEST DATA

Finish Date: 17/02/2015
Finish Time: 14:00

CALIBRATION SOURCE DETAILS

Zero Cylinder No: 221335
Cylinder Conc: 2 %
Cylinder Press: 150 Bar
Exp. Date: 22/07/2020

Span Cylinder No: ambient
Cylinder Conc: n/a
Cylinder Press: n/a Bar
Exp. Date: n/a

CALIBRATION RESULTS

Zero: 20.0 %
Span: 20.9 %

Please consider the environment before printing this data sheet

Uskmouth Power
UskmouthPower Station
ETS Ltd: Opsis service report for Unit 14 Line 10 (7 pages) cont'd

Page vii of vii



Calibration Certificate

Analyser Settings

Serial Number: 1885
14=10
Date: 17.02.15
Sign: R Cook

[illegible]

Remarks:

Table A4a

Uskmouth Power
UskmouthPower Station
ETS Ltd.: Opcsis linearisation data for Unit 14 Line 10 (4 pages)

Page i of iv

[illegible]

Page ii of iv

Opsis Analyzer Gas Calibration Sheet unit 14-10 s/n 1268					
Gas	NO	NO	NO	NO	
Path Length (m)	1.65	1.65	1.65	1.65	
Cell Length (mm)	39.96	69.9	124.8	174	
Cylinder Concentration (ppm)	5103	5103	5103	5103	
Conversion factor (ppm to mg/m ³)	1.34	1.34	1.34	1.34	

Recorded Span Readings					
Reading 1	164.00	285.00	511.00	718.20	0.10
Reading 2	163.10	284.00	511.20	717.20	-0.10
Reading 3	163.20	284.00	511.20	718.20	0.10
Reading 4	163.20	283.20	511.90	718.10	0.20
Reading 5	163.00	283.90	512.00	718.00	0.10
Reading 6					
Reading 7					
Reading 8					
Reading 9					
Reading 10					
Reading 11					
Reading 12					
Reading 13					
Reading 14					
Reading 15					

Actual Concentration =	mg/m ³	163.33	283.88	511.53	717.88
Expected Concentration =	mg/m ³	166.40	289.48	517.20	721.10
Readings Taken		4	4	4	4
Minimum Concentration =	ug/m ³	163.00	283.20	511.00	717.20
Maximum Concentration =	ug/m ³	164.00	285.00	512.00	718.20
Average Concentration =	ug/m ³	163.33	283.88	511.53	717.88
Standard Deviation		0.45735	0.80571	0.49917	0.45735
95% Confidence Levels		0.44819	0.78958	0.48817	0.44819
95% Confidence Range Maximum		163.77319	284.66458	512.01417	718.32319
95% Confidence Range Minimum		162.87481	283.08542	511.03583	717.42681
Previous Instrument Span Factor		1.00	1.00	1.00	1.00
New Instrument Span Factor		1.01	1.02	1.01	1.00

Uskmouth Power Station

Permit No.: LP3131SW

Year / visit: 2015/01

3514067A-1-U14-001R
May 2015

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Table A4b

Uskmouth Power
UskmouthPower Station
ETS Ltd.: Opsis linearisation data for Unit 14 Line 10 (4 pages) cont'd

Page iii of iv

Opsis Analyser Gas Calibration Sheet 14-20 s/n 1268									
Gas	NO2	NO2	NO2	NO2	NO2	NO2	NO2	NO2	NO2
Path Length (m)	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65
Cell Length (mm)	9.9	18.9	29.9	39.96					
Cylinder Concentration (ppm)	1050	1050	1050	1050	1050	1050	1050	1050	1050
Conversion factor (ppm to mg/m ³)	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05
Recorded Span Readings									
Reading 1	13.50	27.90	41.90	57.20	66.80	75.20	83.60	92.00	100.40
Reading 2	13.80	27.60	41.70	56.60	66.00	74.60	83.00	91.40	99.80
Reading 3	13.80	27.60	41.70	56.60	66.00	74.60	83.00	91.40	99.80
Reading 4	13.70	27.90	41.70	56.00	65.00	73.00	81.00	89.00	97.00
Reading 5	13.80	27.90	41.70	56.10	65.10	73.10	81.10	89.10	97.10
Reading 6									
Reading 7									
Reading 8									
Reading 9									
Reading 10									
Reading 11									
Reading 12									
Reading 13									
Reading 14									
Reading 15									
Actual Concentration =	mg/m ³	13.72	27.42	41.74	56.38	66.00	75.20	83.60	92.00
Expected Concentration =	mg/m ³	12.94	26.01	39.03	52.28	61.00	69.80	78.60	87.40
Readings Taken		5	5	5	5	5	5	5	5
Minimum Concentration =	ug/m ³	13.50	27.40	41.70	56.00	65.00	73.00	81.00	89.00
Maximum Concentration =	ug/m ³	13.80	27.90	41.90	57.20	66.80	75.20	83.60	92.00
Average Concentration =	ug/m ³	13.72	27.82	41.74	56.38	66.00	75.20	83.60	92.00
Standard Deviation		0.13038	0.13038	0.08944	0.08254	0.08347	0.08347	0.08347	0.08347
95% Confidence Levels		0.11428	0.11428	0.07840	0.07114	0.07114	0.07114	0.07114	0.07114
95% Confidence Range Maximum		13.83428	27.93428	41.83428	56.83714	66.83714	75.83714	83.83714	92.83714
95% Confidence Range Minimum		13.60572	27.76572	41.66572	55.92286	65.16286	74.36286	82.36286	91.16286
Previous Instrument Span Factor		1.20	1.20	1.12	1.20	1.20	1.20	1.20	1.20
New Instrument Span Factor		1.13	1.12	1.12	1.11	1.11	1.11	1.11	1.11

Page iv of iv

Opsis Analyser Gas Calibration Sheet 15-20 s/n 1268									
Gas	SO2	SO2	SO2	SO2	SO2	SO2	SO2	SO2	SO2
Path Length (m)	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65
Cell Length (mm)	19.9	49.8	68.7	104.8					
Cylinder Concentration (ppm)	7250	7250	7250	7250	7250	7250	7250	7250	7250
Conversion factor (ppm to mg/m ³)	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86	2.86
Recorded Span Readings									
Reading 1	238.50	622.00	870.00	1250.00	0.20	0.20	0.20	0.20	0.20
Reading 2	241.90	622.20	870.10	1250.00	0.10	0.10	0.10	0.10	0.10
Reading 3	242.10	623.00	868.10	1253.00	0.20	0.20	0.20	0.20	0.20
Reading 4	244.70	623.10	868.10	1251.00	0.20	0.20	0.20	0.20	0.20
Reading 5									
Reading 6									
Reading 7									
Reading 8									
Reading 9									
Reading 10									
Reading 11									
Reading 12									
Reading 13									
Reading 14									
Reading 15									
Actual Concentration =	mg/m ³	241.80	623.08	869.33	1258.25	0.18	0.18	0.18	0.18
Expected Concentration =	mg/m ³	250.08	625.82	875.90	1316.99	0.18	0.18	0.18	0.18
Readings Taken		4	4	4	4	4	4	4	4
Minimum Concentration =	ug/m ³	238.50	622.00	868.10	1255.00	0.10	0.10	0.10	0.10
Maximum Concentration =	ug/m ³	244.70	625.10	870.10	1261.00	0.20	0.20	0.20	0.20
Average Concentration =	ug/m ³	241.80	623.08	869.33	1258.25	0.18	0.18	0.18	0.18
Standard Deviation		2.54296	1.41745	0.93229	2.78379	0.05000	0.05000	0.05000	0.05000
95% Confidence Levels		2.49206	1.38908	0.91343	2.69844	0.04900	0.04900	0.04900	0.04900
95% Confidence Range Maximum		244.29206	624.44608	870.23643	1260.94844	0.22400	0.22400	0.22400	0.22400
95% Confidence Range Minimum		239.30794	621.65392	868.41357	1255.55156	0.13600	0.13600	0.13600	0.13600
Previous Instrument Span Factor		0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
New Instrument Span Factor		0.95	0.92	0.93	0.94	0.94	0.94	0.94	0.94

Table A5

**Uskmouth Power
Uskmouth Power Station
Parsons Brinckerhoff's calculation of linearity using ETS Ltd. linearisation data for Unit 14
Line 10 - NO**

Client:	Uskmouth Power		
Site:	Uskmouth Power Station		
PB Job Number:	3514067A-1		
Instrument Make:	Opsis		
Model:	ABAR650		
Serial Number:	1268		
Component:	Nitrogen monoxide		
Purpose of Test:	Test of Linearity - to BS EN 14181: 2014 Annex B		
Date of Test Period:	23/02/15		
Reference Material concentration:	mg.m ⁻³	721	
Measurement Range - Upper Limit (c _u)	mg.m ⁻³	1100	Twice the ELV
Test Site ELV	mg.m ⁻³	550	

Test No.	Measured Concentration of Nitrogen monoxide mg.m ⁻³ AMS	Presented Concentration of Nitrogen monoxide mg.m ⁻³ Reference Material	(y _i -y _z)	(y _i -y _z) ²	x _i (y _i -y _z)	Average x _i Values at Each Presented Concentration Level c	Calculation of the Residual d _c	Calculation of the Relative Residual d _{c,rel} %
	x _i	y _i	(y _i -y _z)	(y _i -y _z) ²	x _i (y _i -y _z)	x _c	d _c = x _c - (A+Bc)	d _{c,rel} = (d _c / c _u) * 100
1	0.10	0.00	-282.27	79673.57	-28.23			
2	0.10	0.00	-282.27	79673.57	-28.23	0.10	1.28	0.12
3	0.10	0.00	-282.27	79673.57	-28.23			
4	-0.10	0.00	-282.27	79673.57	28.23			
5	0.20	0.00	-282.27	79673.57	-56.45	0.07	1.24	0.11
6	0.10	0.00	-282.27	79673.57	-28.23			
7	163.10	165.60	-116.66	13609.72	-19027.36			
8	163.20	165.60	-116.66	13609.72	-19039.03	163.10	-0.32	-0.03
9	163.00	165.60	-116.66	13609.72	-19015.70			
10	283.40	289.68	7.42	55.03	2102.32			
11	283.20	289.68	7.42	55.03	2100.84	283.50	-3.25	-0.30
12	283.90	289.68	7.42	55.03	2106.03			
13	511.20	517.20	234.94	55195.72	120100.15			
14	511.90	517.20	234.94	55195.72	120264.61	511.70	-1.18	-0.11
15	512.00	517.20	234.94	55195.72	120288.10			
16	717.20	721.10	438.83	192576.10	314732.42			
17	718.10	721.10	438.83	192576.10	315127.37	717.77	2.23	0.20
18	718.00	721.10	438.83	192576.10	315083.48			
	Sum = (Σx _i)	Sum = (Σy _i)	Sum = (Σ(y _i -y _z))	Sum = (Σ(y _i -y _z) ²)	Sum = (Σx _i (y _i -y _z))	Sum = (Σx _c)		
	5028.70	5080.77	0.00	1262351.12	1254682.09	1676.23		
	A' = (average of x -values)	y _z = (average of y -values)	Average	Average	Average	Average Value of x _c (x _c)		
	279.37	282.27	0.00	70130.62	69704.56	279.37		

Establishment of the Regression Line:

Linear regression:

$$x_i = A' + B (y_i - y_z)$$

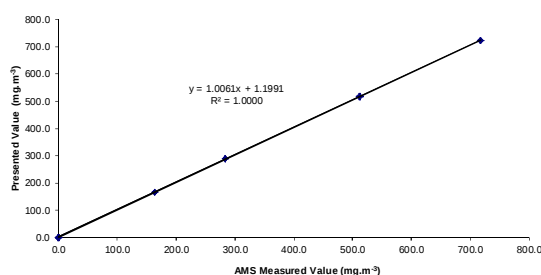
$$B = \frac{\sum x_i (y_i - y_z)}{\sum (y_i - y_z)^2}$$

$$B = 0.99$$

$$A = A' - B y_z$$

$$A = -1.18$$

Linearity



Calculation of the Residuals of the Average Concentrations

$$\bar{x}_c = \frac{\sum x_{c,i}}{m_c}$$

$$d_c = \bar{x}_c - (A + Bc)$$

$$d_{c,rel} = (d_c / c_u) * 100$$

Test of Residuals:

Linearity acceptable if: **All $d_{c,rel} \leq 5\%$**

Therefore: AMS passes linearity criteria of BS EN 14181:2014

Refer to BS EN 14181:2014 Stationary source emissions - Quality assurance of automated measuring systems, in particular to Annex B for details and interpretation of symbols and equations.

Uskmouth Power Station

Permit No.: LP3131SW

Year / visit: 2015/01

3514067A-1-U14-001R
May 2015

Prepared by Parsons Brinckerhoff
for Uskmouth Power

Table A6

**Uskmouth Power
Uskmouth Power Station
Parsons Brinckerhoff's calculation of linearity using ETS Ltd. linearisation data for Unit 14
Line 10 – NO₂**

Client:	Uskmouth Power
Site:	Uskmouth Power Station
PB Job Number:	3514067A-1
Instrument Make:	Opsis
Model:	ABAR650
Serial Number:	1268
Component:	Nitrogen dioxide
Purpose of Test:	Test of Linearity - to BS EN 14181: 2014 Annex B
Date of Test Period:	23/02/15
Reference Material concentration:	mg.m ⁻³ 52
Measurement Range - Upper Limit (c _u)	mg.m ⁻³ 100
Test Site ELV	mg.m ⁻³ 550
	Range of analyser

Test No.	Measured Concentration of Nitrogen dioxide mg.m ⁻³ AMS	Presented Concentration of Nitrogen dioxide mg.m ⁻³ Reference Material	(y _i -y _z)	(y _i -y _z) ²	x _i (y _i -y _z)	Average x _i Values at Each Presented Concentration Level c	Calculation of the Residual d _c	Calculation of the Relative Residual d _{c,rel} %
	x _i	y _i	(y _i -y _z)	(y _i -y _z) ²	x _i (y _i -y _z)	x _c	d _c = x _c - (A+Bc)	d _{c,rel} = (d _c / c _u) * 100
1	-0.50	0.00	-21.71	471.33	10.86			
2	-0.50	0.00	-21.71	471.33	10.86			
3	-0.40	0.00	-21.71	471.33	8.68	-0.47	-0.07	-0.07
4	-0.50	0.00	-21.71	471.33	10.86			
5	-0.50	0.00	-21.71	471.33	10.86	-0.50	-0.10	-0.10
6	-0.50	0.00	-21.71	471.33	10.86			
7	13.80	12.94	-8.77	76.92	-121.03			
8	13.70	12.94	-8.77	76.92	-120.15	13.77	0.18	0.18
9	13.80	12.94	-8.77	76.92	-121.03			
10	27.80	26.01	4.30	18.49	119.55			
11	27.90	26.01	4.30	18.49	119.98	27.87	0.15	0.15
12	27.90	26.01	4.30	18.49	119.98			
13	41.70	39.08	17.37	301.74	724.36			
14	41.70	39.08	17.37	301.74	724.36	41.70	-0.14	-0.14
15	41.70	39.08	17.37	301.74	724.36			
16	56.00	52.23	30.52	931.46	1709.11			
17	56.00	52.23	30.52	931.46	1709.11	56.03	-0.02	-0.02
18	56.10	52.23	30.52	931.46	1712.16			
	Sum = (Σx _i)	Sum = (Σy _i)	Sum = (Σ(y _i -y _z))	Sum = (Σ(y _i -y _z) ²)	Sum = (Σx _i (y _i -y _z))	Sum = (Σx _c)		
	415.20	390.78	0.00	6813.84	7363.70	138.40		
	A' = (average of x-values)	y _z = (average of y-values)	Average	Average	Average	Average Value of x _c (x _c)		
	23.07	21.71	0.00	378.55	409.09	23.07		

Establishment of the Regression Line:

Linear regression:

$$x_i = A' + B(y_i - y_z)$$

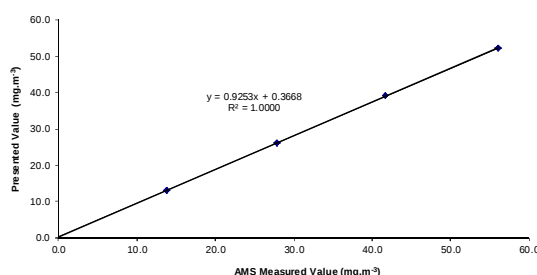
$$B = \frac{\sum x_i (y_i - y_z)}{\sum (y_i - y_z)^2}$$

$$B = 1.08$$

$$A = A' - B y_z$$

$$A = -0.40$$

Linearity



Calculation of the Residuals of the Average Concentrations

$$\bar{x}_c = \frac{\sum x_{c,i}}{m_c}$$

$$d_c = \bar{x}_c - (A + Bc)$$

$$d_{c,rel} = (d_c / c_u) * 100$$

Test of Residuals:

Linearity acceptable if: **All d_{c,rel} ≤ 5%**

Therefore: AMS passes linearity criteria of BS EN 14181:2014

Refer to BS EN 14181:2014 Stationary source emissions - Quality assurance of automated measuring systems, in particular to Annex B for details and interpretation of symbols and equations.

Uskmouth Power Station

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Year / visit: 2015/01

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Prepared by Parsons Brinckerhoff
for Uskmouth Power

Table A7

**Uskmouth Power
UskmouthPower Station
Parsons Brinckerhoff's calculation of linearity using ETS Ltd. linearisation data for Unit 14
Line 10 – SO₂**

Client:	Uskmouth Power
Site:	Uskmouth Power Station
PB Job Number:	3514067A-1
Instrument Make:	Opsis
Model:	ABAR650
Serial Number:	1268
Component:	Sulphur dioxide
Purpose of Test:	Test of Linearity - to BS EN 14181: 2014 Annex B
Date of Test Period:	23/02/15
Reference Material concentration:	mg.m ⁻³ 1317
Measurement Range - Upper Limit (c _u)	mg.m ⁻³ 700
Test Site ELV	mg.m ⁻³ 440

Test No.	Measured Concentration of Sulphur dioxide mg.m ⁻³ AMS	Presented Concentration of Sulphur dioxide mg.m ⁻³ Reference Material				Average x _i Values at Each Presented Concentration Level c	Calculation of the Residual d _c	Calculation of the Relative Residual d _{c,rel} %
	x _i	y _i	(y _i -y _z)	(y _i -y _z) ²	x _i (y _i -y _z)	x _c	d _c = x _c - (A+Bc)	d _{c,rel} = (d _c / c _u) * 100
1	0.10	0.00	-511.46	261596.07	-51.15			
2	0.20	0.00	-511.46	261596.07	-102.29	0.17	-5.29	-0.76
3	0.20	0.00	-511.46	261596.07	-102.29			
4	0.20	0.00	-511.46	261596.07	-102.29			
5	0.10	0.00	-511.46	261596.07	-51.15	0.17	-5.29	-0.76
6	0.20	0.00	-511.46	261596.07	-102.29			
7	241.90	250.08	-261.39	68323.34	-63229.59			
8	242.10	250.08	-261.39	68323.34	-63281.87	242.90	-3.83	-0.55
9	244.70	250.08	-261.39	68323.34	-63961.48			
10	622.20	625.82	114.36	13077.51	71152.90			
11	623.00	625.82	114.36	13077.51	71244.38	623.43	14.20	2.03
12	625.10	625.82	114.36	13077.51	71484.53			
13	870.10	875.90	364.43	132812.33	317094.25			
14	868.10	875.90	364.43	132812.33	316365.38	869.10	18.60	2.66
15	869.10	875.90	364.43	132812.33	316729.81			
16	1255.00	1316.99	805.53	648871.13	1010934.34			
17	1257.00	1316.99	805.53	648871.13	1012545.39	1257.67	-18.39	-2.63
18	1261.00	1316.99	805.53	648871.13	1015767.49			
	Sum = (Σx _i)	Sum = (Σy _i)	Sum = (Σ(y _i -y _z))	Sum = (Σ(y _i -y _z) ²)	Sum = (Σx _i (y _i -y _z))	Sum = (Σx _c)		
	8980.30	9206.36	0.00	4158829.30	4012334.07	2993.43		
	A' = (average of x -values)	y _z = (average of y -values)	Average	Average	Average	Average Value of x _c (x _c)		
	498.91	511.46	0.00	231046.07	222907.45	498.91		

Establishment of the Regression Line:

Linear regression:

$$x_i = A' + B (y_i - y_z)$$

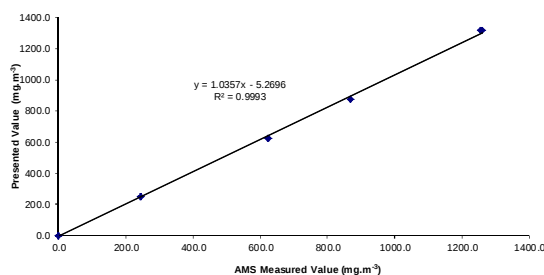
$$B = \frac{\sum x_i (y_i - y_z)}{\sum (y_i - y_z)^2}$$

$$B = 0.96$$

$$A = A' - B y_z$$

$$A = 5.46$$

Linearity



Calculation of the Residuals of the Average Concentrations

$$\bar{x}_c = \frac{\sum x_{c,i}}{m_c}$$

$$d_c = \bar{x}_c - (A + Bc)$$

$$d_{c,rel} = (d_c / c_u) * 100$$

Test of Residuals:

Linearity acceptable if:

All d_{c,rel} ≤ 5%

Therefore: AMS passes linearity criteria of BS EN 14181:2014

Refer to BS EN 14181:2014 Stationary source emissions - Quality assurance of automated measuring systems, in particular to Annex B for details and interpretation of symbols and equations.

Uskmouth Power Station

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Table A8a

Uskmouth Power
UskmouthPower Station
ETS Ltd: Opsis service report for Unit 14 Line 20 (7 pages)

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Uskmouth Power Station

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Table A8b

Uskmouth Power
UskmouthPower Station
ETS Ltd: Opsis service report for Unit 14 Line 20 (7 pages) cont'd

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Page iv of vii

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Uskmouth Power Station

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Table A8c

Uskmouth Power
Uskmouth Power Station
ETS Ltd: Opsis service report for Unit 14 Line 20 (7 pages) cont'd

Page v of vii

Opsis Analyser Gas Calibration Sheet									
Gas	NO	NO2	CO	CO2					
Path Length (m)	1.65	1.65	1.65	1.65					
Cell Length (mm)	488	39.96	10.02	1.00					
Cylinder Concentration (ppm)	5103	995	1090	8720					
Conversion Factor (ppm to mg/m3)	1.34	2.86	2.05	1.25					
Recorded Span Readings									
Reading 1	390.00	958.00	51.90	72.40					
Reading 2	391.10	950.00	52.50	70.80					
Reading 3	391.20	951.00	52.60	68.50					
Reading 4	385.00	952.00	53.00	67.60					
Reading 5			53.10	70.00					
Reading 6									
Reading 7									
Reading 8									
Reading 9									
Reading 10									
Reading 11									
Reading 12									
Reading 13									
Reading 14									
Reading 15									
Actual Concentration =	mg/m3	mg/m3	mg/m3	mg/m3					
Expected Concentration =	mg/m3	mg/m3	mg/m3	mg/m3					
Readings Taken	4	4	5	5					
Minimum Concentration =	mg/m3	mg/m3	mg/m3	mg/m3					
Maximum Concentration =	mg/m3	mg/m3	mg/m3	mg/m3					
Average Concentration =	mg/m3	mg/m3	mg/m3	mg/m3					
Standard Deviation									
95% Confidence Level									
95% Confidence Range Maximum									
95% Confidence Range Minimum									
Previous Instrument Span Factor	0.92	0.93	1.21	0.96					
New Instrument Span Factor	1.02	0.94	1.20	0.91					

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Enviro Technology Services plc
MONITORING FOR LIFE

Opsis O₂ Analyser
Data Sheet

Model No: Q2020 Serial No: 1897 ET No:

PRETEST DATA

Start Date: Start Time: Finish Date: Finish Time:

Current Reading: Status: O₂ Cell: mV

POST TEST DATA

Current Reading: Status: O₂ Cell: mV

CALIBRATION SOURCE DETAILS

Zero Cylinder No: Cylinder Conc: Cylinder Press: Exp. Date:

Span Cylinder No: Cylinder Conc: Cylinder Press: Exp. Date:

CALIBRATION RESULTS

Zero: Span:

Please consider the environment before printing this data sheet

Uskmouth Power
UskmouthPower Station
ETS Ltd: Opsis service report for Unit 14 Line 20 (7 pages) cont'd

Page vii of vii

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Table A9a

Uskmouth Power
UskmouthPower Station
ETS Ltd.: Opcsis linearisation data for Unit 14 Line 20 (4 pages)

Page i of iv

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Page ii of iv

Opsis Analyser Gas Calibration Sheet unit 14-20 s/n 1266					
Gas	NO	NO	NO	NO	NO
Path Length (m)	1.65	1.65	1.65	1.65	1.65
Cell Length (mm)	38.96	69.9	124.7	174.7	
Cylinder Concentration (ppm)	5103	5103	5103	5103	
Conversion Factor (ppm to mg/m ³)	1.34	1.34	1.34	1.34	
Recorded Span Readings					
Reading 1	164.20	277.50	510.20	718.90	1.60
Reading 2	164.11	277.30	511.20	718.90	1.60
Reading 3	164.11	277.30	511.20	718.90	1.60
Reading 4	164.00	278.10	513.30	721.00	1.60
Reading 5	165.90	278.20	512.90	721.10	1.60
Reading 6					
Reading 7					
Reading 8					
Reading 9					
Reading 10					
Reading 11					
Reading 12					
Reading 13					
Reading 14					
Reading 15					
Actual Concentration = mg/m ³ 164.05 277.65 512.03 720.25 Expected Concentration = mg/m ³ 166.40 289.48 516.79 724.00					
Readings Taken 4 4 4 4 Minimum Concentration = ug/m ³ 163.90 277.30 510.20 719.00 Maximum Concentration = ug/m ³ 164.20 278.20 513.30 721.10 Average Concentration = ug/m ³ 164.05 277.85 512.03 720.25					
Standard Deviation 0.12910 0.04015 1.39374 0.99499 0.12652 0.39606 1.36584 0.97607 95% Confidence Levels 164.17652 278.24606 513.90284 721.22607 95% Confidence Range Maximum 165.92346 277.45394 510.65916 719.27493 95% Confidence Range Minimum 163.92346 277.45394 510.65916 719.27493					
Previous Instrument Span Factor 0.92 0.92 0.92 0.92 New Instrument Span Factor 0.93 0.96 0.93 0.92					

Uskmouth Power Station

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Prepared by Parsons Brinckerhoff
for Uskmouth Power

Table A9b

Uskmouth Power
Uskmouth Power Station
ETS Ltd.: Opsis linearisation data for Unit 14 Line 20 (4 pages) cont'd

Page iii of iv

Opsis Analyser Gas Calibration Sheet 14-20 s/n 1266									
Gas	NO2	NO2	NO2	NO2	NO2	NO2	NO2	NO2	NO2
Pan Length (m)	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65
Cell Length (mm)	9.9	19.9	29.9	39.96					
Cylinder Concentration (ppm)	1050	1050	1050	1050					
Conversion Factor (ppm to mg/m3)	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05
Recorded Span Readings									
Reading 1	13.10	25.10	38.60	51.50					
Reading 2	13.20	25.20	38.80	52.60					
Reading 3	13.40	25.90	39.00	52.10					
Reading 4	13.30	26.00	39.10	53.00					
Reading 5									
Reading 6									
Reading 7									
Reading 8									
Reading 9									
Reading 10									
Reading 11									
Reading 12									
Reading 13									
Reading 14									
Reading 15									
Actual Concentration =	mg/m3	13.25	25.55	38.90	52.30				
Expected Concentration =	mg/m3	12.94	24.01	39.08	52.23				
Reading Taken		4	4	4	4				
Minimum Concentration =	ug/m3	13.10	25.10	38.60	51.50				
Maximum Concentration =	ug/m3	13.40	26.00	39.10	53.00				
Average Concentration =	ug/m3	13.25	25.55	38.90	52.30				
Standard Deviation		0.12910	0.46547	0.21602	0.44807				
95% Confidence Levels		0.12452	0.45616	0.21170	0.43870				
95% Confidence Range Maximum		13.37652	26.00616	39.11170	52.93510				
95% Confidence Range Minimum		13.12348	25.09384	38.68830	51.66490				
Previous Instrument Span Factor		1.21	1.21	1.21	1.21				
New Instrument Span Factor		1.18	1.23	1.22	1.21				

Page iv of iv

Opsis Analyser Gas Calibration Sheet 14-20 s/n 1266									
Gas	SO2	SO2	SO2	SO2	SO2	SO2	SO2	SO2	SO2
Pan Length (m)	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65
Cell Length (mm)	19.9	49.8	69.7	104.8	119.8				
Cylinder Concentration (ppm)	7520	7520	7520	7520	7520				
Conversion Factor (ppm to mg/m3)	2.86	2.86	2.86	2.86	2.86				
Recorded Span Readings									
Reading 1	243.20	622.50	877.70	1261.00	-0.10	0.10			
Reading 2	243.40	621.90	876.80	1258.00	0.10	0.10			
Reading 3	244.10	622.00	877.10	1262.70	0.10	0.10			
Reading 4	244.30	622.70	877.60	1263.00	0.10	0.10			
Reading 5									
Reading 6									
Reading 7									
Reading 8									
Reading 9									
Reading 10									
Reading 11									
Reading 12									
Reading 13									
Reading 14									
Reading 15									
Actual Concentration =	mg/m3	243.75	622.28	877.30	1261.43	0.05			
Expected Concentration =	mg/m3	239.19	646.13	906.82	1344.03				
Reading Taken		4	4	4	4	4			
Minimum Concentration =	ug/m3	243.20	621.90	876.80	1258.00	-0.10			
Maximum Concentration =	ug/m3	244.30	622.70	877.70	1263.00	0.10			
Average Concentration =	ug/m3	243.75	622.28	877.30	1261.43	0.05			
Standard Deviation		0.53229	0.38622	0.42626	1.44097	0.10000			
95% Confidence Levels		0.51814	0.37616	0.41478	1.41412	0.07800			
95% Confidence Range Maximum		244.27164	622.65319	877.71577	1263.22912	0.14600			
95% Confidence Range Minimum		243.22836	621.89651	876.88423	1259.62688	-0.04600			
Previous Instrument Span Factor		0.93	0.93	0.93	0.93	0.93			
New Instrument Span Factor		0.99	0.97	0.96	1.01				

Table A10

**Uskmouth Power
Uskmouth Power Station
Parsons Brinckerhoff's calculation of linearity using ETS Ltd. linearisation data for Unit 14
Line 20 - NO**

Client:	Uskmouth Power
Site:	Uskmouth Power Station
PB Job Number:	3514067A-1
Instrument Make:	Opsis
Model:	ABAR650
Serial Number:	1268
Component:	Nitrogen monoxide
Purpose of Test:	Test of Linearity - to BS EN 14181: 2014 Annex B
Date of Test Period:	23/02/15
Reference Material concentration:	mg.m ⁻³ 724
Measurement Range - Upper Limit (c _u)	mg.m ⁻³ 1100 Twice the ELV
Test Site ELV	mg.m ⁻³ 550

Test No.	Measured Concentration of Nitrogen monoxide mg.m ⁻³ AMS	Presented Concentration of Nitrogen monoxide mg.m ⁻³ Reference Material	(y _i -y _z)	(y _i -y _z) ²	x _i (y _i -y _z)	Average x _i Values at Each Presented Concentration Level c	Calculation of the Residual d _c	Calculation of the Relative Residual d _{c,rel} %
	x _i	y _i	(y _i -y _z)	(y _i -y _z) ²	x _i (y _i -y _z)	x _c	d _c = $\bar{x}_c - (A + Bc)$	d _{c,rel} = (d _c / c _u) * 100
1	1.60	0.00	-282.68	79907.48	-452.29	1.60	2.38	0.22
2	1.60	0.00	-282.68	79907.48	-452.29			
3	1.60	0.00	-282.68	79907.48	-452.29			
4	1.60	0.00	-282.68	79907.48	-452.29			
5	1.60	0.00	-282.68	79907.48	-452.29	1.60	2.38	0.22
6	1.60	0.00	-282.68	79907.48	-452.29			
7	164.00	165.60	-117.07	13706.55	-19212.01	164.00	0.45	0.04
8	164.00	165.60	-117.07	13706.55	-19200.30			
9	163.90	165.60	-117.07	13706.55	-19188.59			
10	277.30	289.68	7.00	49.05	1942.15	277.87	-8.81	-0.80
11	278.10	289.68	7.00	49.05	1947.75			
12	278.20	289.68	7.00	49.05	1948.45			
13	511.70	516.79	234.11	54806.80	119793.33	512.63	0.59	0.05
14	513.30	516.79	234.11	54806.80	120167.91			
15	512.90	516.79	234.11	54806.80	120074.26			
16	719.90	724.00	441.32	194764.13	317706.91	720.67	3.00	0.27
17	721.00	724.00	441.32	194764.13	318192.36			
18	721.10	724.00	441.32	194764.13	318236.50			
Sum = (Σx _i)		Sum = (Σy _i)	Sum = (Σ(y _i -y _z))	Sum = (Σ(y _i -y _z) ²)	Sum = (Σx _i (y _i -y _z))	Sum = (Σx _c)		
5035.10		5088.22	0.00	1269424.48	1259695.01	1678.37		
A' = (average of x -values)		y _c = (average of y -values)	Average	Average	Average	Average Value of x _c (x _c)		
279.73		282.68	0.00	70523.58	69983.06	279.73		

Establishment of the Regression Line:

Linear regression:

$$x_i = A' + B (y_i - y_z)$$

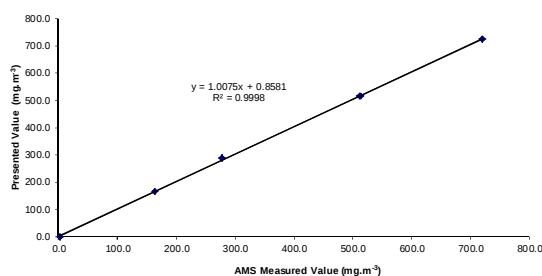
$$B = \frac{\sum x_i (y_i - y_z)}{\sum (y_i - y_z)^2}$$

$$B = 0.99$$

$$A = A' - B y_z$$

$$A = -0.78$$

Linearity



Calculation of the Residuals of the Average Concentrations

$$\bar{x}_c = \frac{\sum x_{c,i}}{m_c}$$

$$d_c = \bar{x}_c - (A + Bc)$$

$$d_{c,rel} = (d_c / c_u) * 100$$

Test of Residuals:

Linearity acceptable if: **All d_{c,rel} ≤ 5%**

Therefore: AMS passes linearity criteria of BS EN 14181:2014

Refer to BS EN 14181:2014 Stationary source emissions - Quality assurance of automated measuring systems, in particular to Annex B for details and interpretation of symbols and equations.

Uskmouth Power Station

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Prepared by Parsons Brinckerhoff
for Uskmouth Power

Table A11

**Uskmouth Power
Uskmouth Power Station
Parsons Brinckerhoff's calculation of linearity using ETS Ltd. linearisation data for Unit 14
Line 20 – NO₂**

Client:	Uskmouth Power
Site:	Uskmouth Power Station
PB Job Number:	3514067A-1
Instrument Make:	Opsis
Model:	ABAR650
Serial Number:	1268
Component:	Nitrogen dioxide
Purpose of Test:	Test of Linearity - to BS EN 14181: 2014 Annex B
Date of Test Period:	23/02/15
Reference Material concentration:	mg.m ⁻³ 52
Measurement Range - Upper Limit (c _u)	mg.m ⁻³ 100
Test Site ELV	mg.m ⁻³ 550

Range of analyser

Test No.	Measured Concentration of Nitrogen dioxide mg.m ⁻³ AMS	Presented Concentration of Nitrogen dioxide mg.m ⁻³ Reference Material				Average x _i Values at Each Presented Concentration Level c	Calculation of the Residual d _c	Calculation of the Relative Residual d _{c,rel} %
	x _i	y _i	(y _i -y _z)	(y _i -y _z) ²	x _i (y _i -y _z)	x _c	d _c = x _c - (A+Bc)	d _{c,rel} = (d _c / c _u) * 100
1	1.70	0.00	-21.71	471.33	-36.91			
2	-1.40	0.00	-21.71	471.33	30.39	-0.47	0.37	0.37
3	-1.70	0.00	-21.71	471.33	36.91			
4	-1.80	0.00	-21.71	471.33	39.08			
5	-1.80	0.00	-21.71	471.33	39.08	-1.80	-0.96	-0.96
6	-1.80	0.00	-21.71	471.33	39.08			
7	13.20	12.94	-8.77	76.92	-115.77			
8	13.40	12.94	-8.77	76.92	-117.52	13.30	0.89	0.89
9	13.30	12.94	-8.77	76.92	-116.65			
10	25.20	26.01	4.30	18.49	108.37			
11	25.90	26.01	4.30	18.49	111.38	25.70	-0.09	-0.09
12	26.00	26.01	4.30	18.49	111.81			
13	38.90	39.08	17.37	301.74	675.72			
14	39.00	39.08	17.37	301.74	677.46	39.00	-0.16	-0.16
15	39.10	39.08	17.37	301.74	679.20			
16	52.60	52.23	30.52	931.46	1605.34			
17	52.10	52.23	30.52	931.46	1590.08	52.57	-0.06	-0.06
18	53.00	52.23	30.52	931.46	1617.55			
	Sum = (Σx _i)	Sum = (Σy _i)	Sum = (Σ(y _i -y _z))	Sum = (Σ(y _i -y _z) ²)	Sum = (Σx _i (y _i -y _z))	Sum = (Σx _c)		
	384.90	390.78	0.00	6813.84	6974.59	128.30		
	A' = (average of x-values)	y _z = (average of y-values)	Average	Average	Average	Average Value of x _c (x _c)		
	21.38	21.71	0.00	378.55	387.48	21.38		

Establishment of the Regression Line:

Linear regression:

$$x_i = A' + B (y_i - y_z)$$

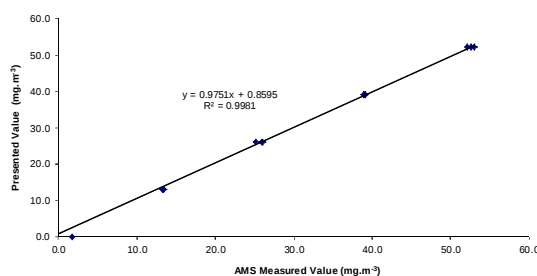
$$B = \frac{\sum x_i (y_i - y_z)}{\sum (y_i - y_z)^2}$$

$$B = 1.02$$

$$A = A' - B y_z$$

$$A = -0.84$$

Linearity



Calculation of the Residuals of the Average Concentrations

$$\bar{x}_c = \frac{\sum x_{c,i}}{m_c}$$

$$d_c = \bar{x}_c - (A + Bc)$$

$$d_{c,rel} = (d_c / c_u) * 100$$

Test of Residuals:

Linearity acceptable if: **All $d_{c,rel} < 5\%$**

Therefore: AMS passes linearity criteria of BS EN 14181:2014

Refer to BS EN 14181:2014 Stationary source emissions - Quality assurance of automated measuring systems, in particular to Annex B for details and interpretation of symbols and equations.

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for Uskmouth Power

Table A12

**Uskmouth Power
Uskmouth Power Station
Parsons Brinckerhoff's calculation of linearity using ETS Ltd. linearisation data for Unit 14
Line 20 – SO₂**

Client:	Uskmouth Power
Site:	Uskmouth Power Station
PB Job Number:	3514067A-1
Instrument Make:	Opsis
Model:	ABAR650
Serial Number:	1268
Component:	Sulphur dioxide
Purpose of Test:	Test of Linearity - to BS EN 14181: 2014 Annex B
Date of Test Period:	23/02/15
Reference Material concentration:	mg.m ⁻³ 1366
Measurement Range - Upper Limit (c _u)	mg.m ⁻³ 700
Test Site ELV	mg.m ⁻³ 440

Test No.	Measured Concentration of Sulphur dioxide mg.m ⁻³ AMS	Presented Concentration of Sulphur dioxide mg.m ⁻³ Reference Material				Average x _i Values at Each Presented Concentration Level c	Calculation of the Residual d _c	Calculation of the Relative Residual d _{c,rel} %
	x _i	y _i	(y _i -y _z)	(y _i -y _z) ²	x _i (y _i -y _z)	x _c	d _c = x _c - (A+Bc)	d _{c,rel} = (d _c / c _u) * 100
1	0.10	0.00	-530.51	281440.59	-53.05			
2	0.10	0.00	-530.51	281440.59	-53.05	0.10	-5.18	-0.74
3	0.10	0.00	-530.51	281440.59	-53.05			
4	0.10	0.00	-530.51	281440.59	-53.05			
5	0.10	0.00	-530.51	281440.59	-53.05	0.10	-5.18	-0.74
6	0.10	0.00	-530.51	281440.59	-53.05			
7	243.40	259.39	-271.12	73506.30	-65990.72			
8	244.10	259.39	-271.12	73506.30	-66180.50	243.93	-3.65	-0.52
9	244.30	259.39	-271.12	73506.30	-66234.73			
10	621.90	649.12	118.62	14069.57	73766.79			
11	622.00	649.12	118.62	14069.57	73778.65	622.20	10.55	1.51
12	622.70	649.12	118.62	14069.57	73861.69			
13	876.80	908.51	378.00	142887.39	331434.33			
14	877.10	908.51	378.00	142887.39	331547.73	877.17	23.22	3.32
15	877.60	908.51	378.00	142887.39	331736.74			
16	1259.00	1366.03	835.52	698094.10	1051920.00			
17	1262.70	1366.03	835.52	698094.10	1055011.43	1261.57	-19.76	-2.82
18	1263.00	1366.03	835.52	698094.10	1055262.09			
	Sum = (Σx _i)	Sum = (Σy _i)	Sum = (Σ(y _i -y _z))	Sum = (Σ(y _i -y _z) ²)	Sum = (Σx _i (y _i -y _z))	Sum = (Σx _c)		
	9015.20	9549.18	0.00	4474315.60	4179595.20	3005.07		
	A' = (average of x -values)	y _z = (average of y -values)	Average	Average	Average	Average Value of x _c (x _c)		
	500.84	530.51	0.00	248573.09	232199.73	500.84		

Establishment of the Regression Line:

Linear regression:

$$x_i = A' + B(y_i - y_z)$$

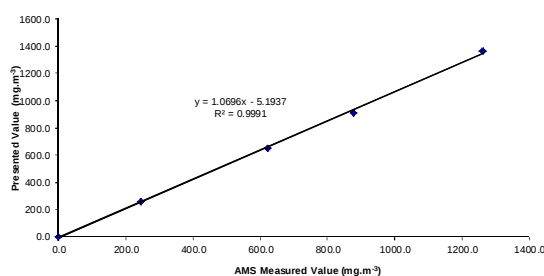
$$B = \frac{\sum x_i (y_i - y_z)}{\sum (y_i - y_z)^2}$$

$$B = 0.93$$

$$A = A' - B y_z$$

$$A = 5.28$$

Linearity



Calculation of the Residuals of the Average Concentrations

$$\bar{x}_c = \frac{\sum x_{c,i}}{m_c}$$

$$d_c = \bar{x}_c - (A + Bc)$$

$$d_{c,rel} = (d_c / c_u) * 100$$

Test of Residuals:

Linearity acceptable if: **All $d_{c,rel} \leq 5\%$**

Therefore: AMS passes linearity criteria of BS EN 14181:2014

Refer to BS EN 14181:2014 Stationary source emissions - Quality assurance of automated measuring systems, in particular to Annex B for details and interpretation of symbols and equations.

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