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EN 14181 QAL2 Report Commissioned by
B&W Volund

Installation Name & Address
B&W Volund
Margam Green Energy Plant
Land Off Longlands Lane (Heol Cae'r Bont)
Margam
Port Talbot
SA13 2NW

Primary Site Contact: Alex A. Nelson III

EPR Permit: EPR/DP3137EG

Stack Reference
A1 - Main Stack (H001)

Dates of the Monitoring Campaign
23rd - 26th October 2018

Job Reference Number
CAT-4504

Report Written by
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Report Approved by
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Report Date
22nd November 2018

Report Version
Version 1

Signature of Report Approver

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Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's UKAS accreditation.

This test report shall not be reproduced, except in full, without the written approval of Exova Catalyst.

This test report has been written to fully comply with the requirements in EN 14181:2014 and the Environment Agency's Technical Guidance Note TGN M20, Version 3 (incorporating MID 14181 as Annex A) which was published in June 2015.

Executive Summary (Page 1 of 2)

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)
23rd - 26th October 2018

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by B&W Volund to carry out stack emissions testing on the A1 - Main Stack (H001) Stack at Margam Green Energy Plant.

The aim of the monitoring campaign was to perform a QAL2 Calibration Exercise on the Continuous Emissions Monitor (CEM), which is installed on the Plant, following the requirements of EN 14181.

Special Requirements

There were no special requirements.

QAL2 CALIBRATION SUMMARY

Parameter	Calibration Function derived from QAL2?	EN 14181 Procedure used to Derive the Calibration Function	Calibration Function Derived	Result of Variability Test	Valid Calibration Range @ REF Conditions	Range after Surrogate Extension @ REF Conditions	Calibration Function to Apply to the Data Acquisition Handling Software (See Conclusions)
Total Particulate Matter (H001)	No	Not Derived	N/A	N/A	N/A	N/A	$y = x$
Total VOCs	Yes	Procedure A	$y = 0.9992x - 0.3120$	Pass	0 to 34.8 mg/m ³	N/A	$y = 0.9992x - 0.3120$
Oxides of Nitrogen (as NO ₂)	Yes	Procedure B	$y = 0.9845x - 0.1969$	Pass	0 to 307 mg/m ³	N/A	$y = 0.9845x - 0.1969$
Sulphur Dioxide	Yes	Procedure C	$y = 1.0208x - 0.5384$	Pass	0 to 15.0 mg/m ³	N/A	$y = 1.0208x - 0.5384$
Carbon Monoxide	Yes	Procedure A	$y = 1.0022x - 1.3791$	Pass	0 to 1096 mg/m ³	N/A	$y = 1.0022x - 1.3791$
Hydrogen Chloride	Yes	Procedure C	$y = 0.9951x - 1.2841$	Pass	0 to 3.0 mg/m ³	N/A	$y = 0.9951x - 1.2841$
Hydrogen Fluoride	Yes	Procedure C	$y = 0.9943x - 0.1411$	Pass	0 to 0.30 mg/m ³	N/A	$y = 0.9943x - 0.1411$
Ammonia	Yes	Procedure C	$y = 0.8716x - 0.4274$	Pass	0 to 18.3 mg/m ³	N/A	$y = 0.8716x - 0.4274$
Water Vapour (% v/v)	Yes	Procedure B	$y = 0.9699x + 0.0000$	Pass	0 to 17.5 % v/v	N/A	$y = 0.9699x + 0.0000$
Oxygen (H001) (% v/v)	Yes	Procedure B	$y = 1.0171x - 0.0407$	Pass	0 to 7.3 % v/v	N/A	$y = 1.0171x - 0.0407$
Carbon Dioxide (% v/v)	Yes	Procedure A	$y = 1.0714x + 0.0097$	Pass	0 to 16.9 % v/v	N/A	$y = 1.0714x + 0.0097$

The calibration functions, once applied, only remain valid as 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 limit.

All calibration functions throughout this report are given in the form $y = bx + a$, where b is the gradient and a is the intercept.

All calibration functions relate to mg/m³, unless otherwise stated.

LINEARITY SUMMARY

Parameter	Linearity Performed?	Linearity Calibration Function	R ² Value	Maximum ABS %, d _{c,rel}	Allowable ABS %, d _{c,rel}	Result of Residuals Test	Range Linearity Performed Over
Total Particulate Matter (H001)	Yes	$y = 1.0088x + 0.1901$	0.9999	0.68	5	Pass	0 to 78.6 mg/m ³
Total VOCs	Yes	$y = 1.0040x - 0.0544$	0.9999	0.41	5	Pass	0 to 30.0 mg/m ³
Nitrogen Monoxide (as NO ₂)	Yes	$y = 1.0012x - 0.2736$	1.0000	0.28	5	Pass	0 to 616 mg/m ³
Nitrogen Dioxide	Yes	$y = 1.0483x - 0.0337$	0.9969	2.62	5	Pass	0 to 60.4 mg/m ³
Sulphur Dioxide	Yes	$y = 1.0071x + 0.4369$	0.9998	0.76	5	Pass	0 to 142 mg/m ³
Carbon Monoxide	Yes	$y = 1.0060x + 1.0598$	0.9993	1.20	5	Pass	0 to 152 mg/m ³
Hydrogen Chloride	Yes	$y = 0.9906x + 0.3516$	0.9993	1.30	5	Pass	0 to 81.6 mg/m ³
Hydrogen Fluoride	Yes	$y = 0.9716x - 0.0769$	0.9990	1.71	5	Pass	0 to 8.2 mg/m ³
Water Vapour (% v/v)	Yes	$y = 0.9967x - 0.0734$	0.9995	1.61	5	Pass	0 to 30.1 % v/v
Oxygen (H001) (% v/v)	Yes	$y = 1.0016x - 0.0060$	1.0000	0.24	5	Pass	0 to 21.0 % v/v

All calibration functions relate to mg/m³, unless otherwise stated.

Executive Summary (Page 2 of 2)

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)
23rd - 26th October 2018

CONCLUSIONS, DISCUSSIONS & ACTIONS FROM THE SAMPLING EXERCISE

QAL2 Calibration Summary - Total Particulate Matter

As the Total Particulate Matter emissions are of a low order (less than the 95% Confidence Interval [CI] of the Daily ELV, which is 30%) TGN M20 suggests calibrating the CEM using a calibration factor calculated by dividing the average of the SRM data pairs by the average of the CEM data pairs. This is as opposed to using linear regression. A valid calibration function has been derived in this manner. This calibration function should be used and entered into the Data Acquisition Handling Software (DAHS).

QAL2 Calibration Summary - All Parameters except Total Particulate Matter

A valid calibration function has been derived from the parallel tests which passes the variability test. This calibration function should be used and entered into the Data Acquisition Handling Software (DAHS).

SUMMARY OF STANDARD REFERENCE METHOD & EN 14181 DEVIATIONS

Parameter	Run	Deviation
All Parameters	All Runs	There are no deviations associated with the sampling employed.

REGULATORY INFORMATION

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)
23rd - 26th October 2018

Parameter	Value
Name of the Installation	Margam Green Energy Plant
Address of the Installation	See Title Page
Sector of the Installation	Incineration
Permit Number	EPR/DP3137EG
Date of the Last QAL2 / AST Campaign	N/A
Date CEMs Data Obtained by Exova Catalyst	1st November 2018

Regulated Determinands and Emission Limit Values (ELVs)

Determinand	Short-Term ELV (mg/m ³)	Daily or 48hr Average ELV (mg/m ³)	Uncertainty Requirement (%)
Total Particulate Matter (H001)	45	15	30
Total VOCs	30	15	30
Oxides of Nitrogen (as NO ₂)	600	300	20
Nitrogen Monoxide	-	-	20
Nitrogen Dioxide	-	-	20
Sulphur Dioxide	300	75	20
Carbon Monoxide	150	75	20 ¹
Hydrogen Chloride	90	15	40
Hydrogen Fluoride	6	2	40
Ammonia	-	50 (Daily / Virtual)	40

¹ TGN M20, Version 3

OPERATIONAL INFORMATION AND SITE MONITORING PROVISIONS

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

23rd - 26th October 2018

Process Type and Variations in Emissions

Parameter	Value
Continuous or batch process	Continuous
Were there any variations in emissions during the EN 14181 test (e.g. Load changes)	No
Will these variations affect the representative nature of the collected data?	No
Are there any factors that may affect the collected data (e.g. auto-calibrations, plant start up and shut down)	Yes - periods of auto-calibration removed from the data
Reviewing historical Plant data, were low emissions expected for any determinands?	Yes - Total Particulate Matter
Was the CEM reading zero for any determinands, if so, was this investigated to ensure it was working?	No
What product was being processed during the tests?	Biomass

Type of Fuel

Parameter	Value
Fuel type used during the EN 14181 test (include proportions for co-incineration)	Biomass
Are multiple calibration functions required if the emissions vary due to different fuel types being used?	No

Abatement

Parameter	Value
Type of Abatement System	N/A
Running Status	N/A

MONITORING PROVISIONS AT THE INSTALLATION - PERIODIC MONITORING

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B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

23rd - 26th October 2018

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	2.20
Width	m	-
Area	m ²	3.80
Port Depth	cm	24
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	5" Flange

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	Permanent
Inside / Outside	Outside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	Yes
Access to sample ports unhindered by obstructions	Yes
Safe access available	Yes
Easy access available	Yes

Sampling Location / Platform Improvement Recommendations

The sampling location meets all the requirements specified in EA Guidance Note M1 and EN 15259, and therefore there are no improvement recommendations.

EN 15259 Homogeneity Test Requirements

A valid EN 15259 Homogeneity test was performed by Exova Catalyst on this Stack on 23rd October 2108, Report ID: CAT-4504-15259, and the stack gas profile was found to be homogenous.

Sampling Plane Validation Criteria (EN 15259)

Criteria in M1	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	114	> 5 Pa	Yes
Mean Velocity	m/s	13.5		
Lowest Gas Velocity	m/s	13.0		
Highest Gas Velocity	m/s	14.1		
Ratio of Above	: 1	1.08	< 3 : 1	Yes
Maximum Angle of Swirl	°	4	< 15°	Yes
No Local Negative Flow	-	Yes		Yes

MONITORING PROVISIONS AT THE INSTALLATION - PERIODIC MONITORING

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B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)
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Pro-forma for Site Provisions for Monitoring

Requirement	Compliant	Notes
A safe and clean working environment with sufficient space and weather protection.	Yes	
Easy and safe access to the CEM.	Yes	
Adequate supplies of reference materials, tools and spare parts.	Yes	
Facilities to introduce the reference materials for gaseous-monitoring systems, both at the inlet of the sampling line (where present), and at the inlet of the CEM.	Yes	
Compliance with MID 15259	Yes	See the Sampling Plane Validation Criteria table on the previous page.

Plant Photos

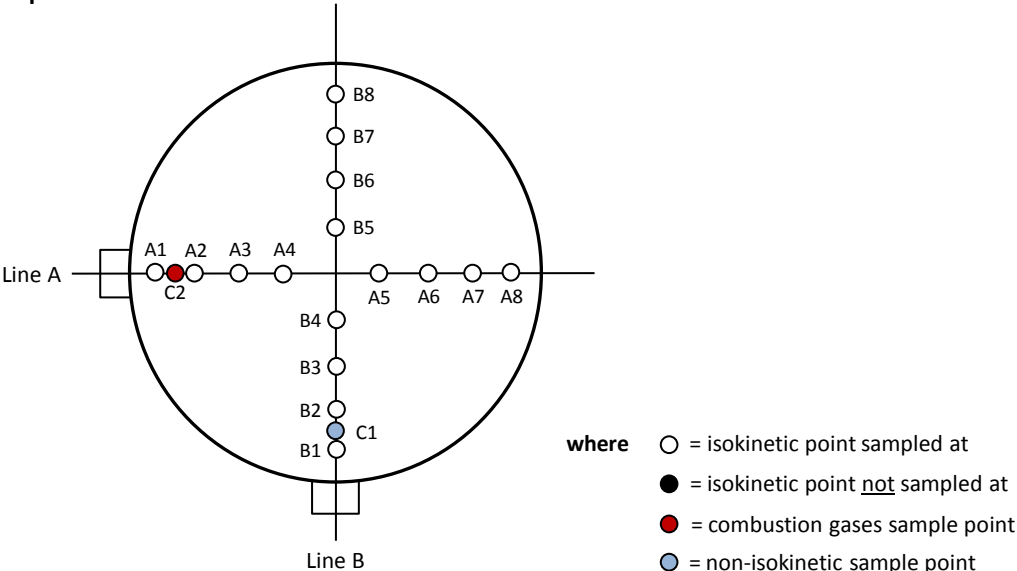
Photo 1



Photo 2



Sample Points



CONTINUOUS EMISSION MONITORs (CEMs) AT THE INSTALLATION

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

23rd - 26th October 2018

Main Determinand	Type	Instrument Name	Instrument Serial Number	Measurement Principle	Certified Range (mg/m ³)	QAL1 Compliant	MCERTS Number
Total Particulate Matter (H001)	In-Situ	SICK Dusthunter SB100	16278692	Light Scatter	0 - 15	Yes	MC 090144/03
Total VOCs	Extractive	-	-	FID	-	Yes	-
Oxides of Nitrogen (as NO ₂)	Extractive	SICK MCS 100 FT	16280511	FTIR	0 - 200	Yes	MC 100184/06
Sulphur Dioxide	Extractive	SICK MCS 100 FT	16280511	FTIR	0 - 75	Yes	MC 100184/06
Carbon Monoxide	Extractive	SICK MCS 100 FT	16280511	FTIR	0 - 75	Yes	MC 100184/06
Hydrogen Chloride	Extractive	SICK MCS 100 FT	16280511	FTIR	0 - 15	Yes	MC 100184/06
Hydrogen Fluoride	Extractive	SICK MCS 100 FT	16280511	FTIR	0 - 3	Yes	MC 100184/06
Ammonia	Extractive	SICK MCS 100 FT	16280511	FTIR	0 - 10	Yes	MC 100184/06
Water Vapour	Extractive	SICK MCS 100 FT	16280511	FTIR	0 - 40	Yes	MC 100184/06
Oxygen (H001) (Dry)	Extractive	SICK MCS 100 FT	16280511	Zirconia Cell	0 - 21	Yes	MC 100184/06
Carbon Dioxide	Extractive	SICK MCS 100 FT	16280511	FTIR	0 - 30	Yes	MC 100184/06

TEST LABORATORY STAFF

Position	Name	MCERTS Accreditation	MCERTS Number & Expiry Date	Technical Endorsements
Team Leader	David Burns	MCERTS Level 2	MM 05 579, Expiry: March 2021	TE1 TE2 TE3 TE4
Technician	Lee Heaton	MCERTS Level 1	MM 18 1433, Expiry: November 2020	None
Trainee	Luke Williams	MCERTS Trainee	TBC	N/A

STANDARD REFERENCE METHODS (SRMs)

Exova Catalyst hold UKAS and MCERTS Accreditation for performing QAL2 and ASTs, to EN 14181.

Determinand	Instrument Name	Measurement Principle	Instrumental Ranges		MCERTS Number	Reference Method	MU ² (%)
			Certified (mg/m ³)	Operational (mg/m ³)			
Total Particulate Matter (H001)	MST	Gravimetric	N/A - SRM	N/A - SRM	N/A	EN 13284-1	50
Total VOCs	Sick Maihak 3006	FID	0 - 15	0 - 160	MC 040036	EN 12619	50
Oxides of Nitrogen (as NO ₂)	Gasmet DX4000	FTIR	0 - 200	0 - 200	MC 030014	TGN M22	10
Sulphur Dioxide	Gasmet DX4000	FTIR	0 - 75	0 - 75	MC 030014	TGN M22	10
Carbon Monoxide	Gasmet DX4000	FTIR	0 - 75	0 - 75	MC 030014	TGN M22	10
Hydrogen Chloride	Gasmet DX4000	FTIR	0 - 15	0 - 15	MC 030014	TGN M22	10
Hydrogen Fluoride	Gasmet DX4000	FTIR	N/A	0 - 10	MC 030014	TGN M22	10
Ammonia	Gasmet DX4000	FTIR	N/A	0 - 10	MC 030014	TGN M22	10
Water Vapour	Gasmet DX4000	FTIR	0 - 30%	0 - 30%	MC 030014	TGN M22	5
Oxygen (H001) (Dry)	Horiba PG-250	Zirconia Cell	0 - 25%	0 - 25%	MC 050056	EN 14789	3
Carbon Dioxide	Gasmet DX4000	FTIR	0 - 25%	0 - 25%	MC 030014	TGN M22	3

NOTE 1: Exova Catalyst hold UKAS and MCERTS Accreditation for all Standard Reference Method Tests performed.

NOTE 2: The MU specified in this column is reported as the MU at the Daily ELV (not the MU percentage of concentration measured.)

where: MST stands for Manual Sampling Train

LIST OF EQUIPMENT

Extractive Sampling		Instrumental Analysers		Miscellaneous Items	
Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.
Control Box DGM (1)	CAT 7.58	Horiba PG-350E	CAT 39.11	Digital Manometer (1)	CAT 3.143
Control Box DGM (2)	-	Horiba PG-250	-	Digital Manometer (2)	CAT 3.145
Box Thermocouples (1)	CAT 3.148	Servomex 4900	-	Digital Temperature Meter	-
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	CAT 14.86
Umbilical (1)	CAT 3.148	ABB AO2020-URAS26	-	Barometer	CAT 13.41
Umbilical (2)	-	Servomex 5200MP	-	Stack Thermocouple (1)	CAT 4.1014
Oven Box (1)	CAT 12.201	Ankersmid APS 313	CAT 4.848	Stack Thermocouple (2)	CAT 4.1041
Oven Box (2)	-	Gasmet DX4000	-	Stack Thermocouple (3)	CAT 4.0014
Heated Probe (1)	CAT 5.129	Gasmet Sampling System	CAT 19.4	1m Heated Line (1)	-
Heated Probe (2)	CAT 5.130	Bernath 3006 FID	CAT 8.32	1m Heated Line (2)	-
Heated Probe (3)	CAT 5.131	M&C PSS	CAT 12.108	1m Heated Line (3)	-
S-Pitot (1)	CAT 21P.97	Mass Flow Controller (1)	CAT 6.63	5m Heated Line (1)	-
S-Pitot (2)	CAT 21S.56	Mass Flow Controller (2)	CAT 6.64	15m Heated Line (1)	-
L-Pitot	CAT 21L.41	Mass View (1)	CAT 25.61	20m Heated Line (1)	CAT 20.119
500g Check Weight	CAT 17.38	Mass View (2)	CAT 25.62	20m Heated Line (2)	-
1Kg Check Weight	CAT 17.38	Hioki 5043 (V)	CAT 11.70	Dual Channel Heater Controller	CAT 3.002
Last Impinger Arm	CAT 4.902/4.903	Easylogger EN-EL-12 Bit	-	Single Channel Heater Controller	CAT 20.119
Callipers	CAT 23.41			Laboratory Balance	CAT 1.18 / 1.18a
Tubes Kit Thermocouple	-			Tape Measure	CAT 16.49

Section 4A - Data and Calculations - QAL2

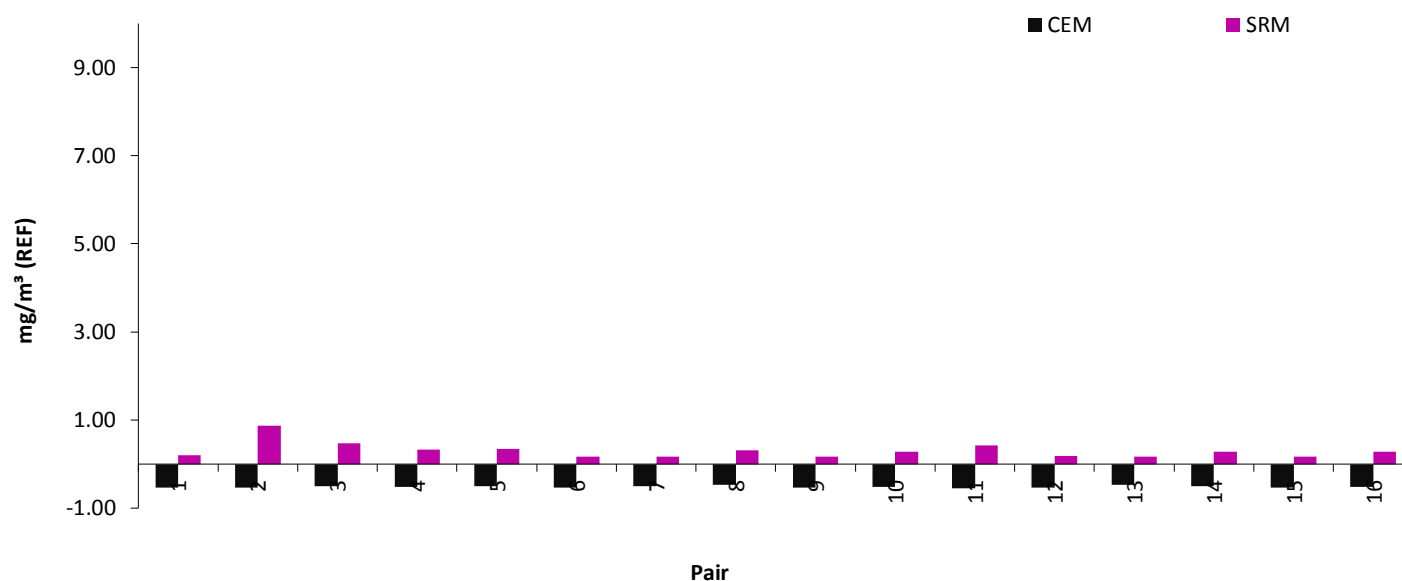
TOTAL PARTICULATE MATTER: QAL2 CALCULATIONS (HNA03GH001)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Pair	Date	Times	x, CEM (ACTUAL) mg/m ³	y, SRM (ACTUAL) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	Filter ID Number (47-XXXX)
1	24/10/2018	11:10 - 11:59	-0.30	0.12	-0.53	0.20	47-45644
2	24/10/2018	12:18 - 13:07	-0.29	0.51	-0.54	0.87	47-37837
3	24/10/2018	13:18 - 14:07	-0.27	0.28	-0.50	0.47	47-39507
4	24/10/2018	14:19 - 15:08	-0.29	0.20	-0.52	0.33	47-44103
5	24/10/2018	15:20 - 16:09	-0.28	0.21	-0.50	0.34	47-43074
6	24/10/2018	16:21 - 17:10	-0.29	0.10	-0.54	0.17	47-55140
7	25/10/2018	08:44 - 09:33	-0.28	0.10	-0.50	0.16	47-44101
8	25/10/2018	09:45 - 10:34	-0.28	0.20	-0.47	0.31	47-39496
9	25/10/2018	10:46 - 11:35	-0.29	0.10	-0.54	0.17	47-34241
10	25/10/2018	11:47 - 12:36	-0.28	0.17	-0.52	0.29	47-45648
11	25/10/2018	12:48 - 13:37	-0.29	0.26	-0.54	0.43	47-37854
12	25/10/2018	13:49 - 14:38	-0.28	0.11	-0.53	0.19	47-45642
13	25/10/2018	14:50 - 15:39	-0.25	0.11	-0.47	0.18	47-44102
14	25/10/2018	15:51 - 16:40	-0.27	0.17	-0.50	0.28	47-45647
15	26/10/2018	08:19 - 09:08	-0.29	0.10	-0.54	0.17	47-45596
16	26/10/2018	09:25 - 10:14	-0.28	0.17	-0.52	0.28	47-45671
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
DAILY ELV	-	-	-	-	-	15	

PLOT 1: BAR CHART FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED)



It can be seen from the table and graphical representation of data (above) that the emissions are of a low order (less than the 95% Confidence Interval, which is 30% of the Daily ELV) and the spread of data is poor. In these circumstances, EA document TGN M20, Version 3 allows an alternative approach to be taken. A minimum of 5 x Total Particulate Matter runs may be performed, ensuring that the total sampling time is >7.5hrs. These results should verify that the emissions are low. Surrogates should be used to check the linearity, zero and span settings of the monitor, and finally the monitor should be set on its most sensitive range in order to alert the operator that the control devices for particulates (i.e. the abatement system) may need attention if an increase in the emissions is observed.

Section 4A - Data and Calculations - QAL2

TOTAL VOCs: QAL2 CALCULATIONS

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B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
L1	Surrogate	Near Zero	-0.01	0.00	0.00	-1.93	-1.60	3.09	3.71	-0.32
L2	Surrogate	Near Zero	-0.01	0.00	0.00	-1.93	-1.60	3.09	3.71	-0.32
L3	Surrogate	Near Zero	-0.01	0.00	0.00	-1.93	-1.60	3.09	3.71	-0.32
1	24/10/2018	18:32 - 19:02	2.13	1.90	2.30	0.21	0.29	0.06	0.05	1.82
2	24/10/2018	19:32 - 20:02	1.59	1.30	1.58	-0.33	-0.30	0.10	0.11	1.28
3	24/10/2018	20:32 - 21:02	0.99	0.68	0.82	-0.92	-0.92	0.85	0.85	0.68
4	24/10/2018	21:32 - 22:02	0.92	0.66	0.80	-1.00	-0.94	0.94	0.99	0.61
5	24/10/2018	22:32 - 23:02	0.87	0.60	0.72	-1.05	-1.01	1.06	1.10	0.56
6	25/10/2018	23:32 - 00:02	1.05	0.68	0.81	-0.87	-0.92	0.80	0.75	0.74
7	25/10/2018	00:32 - 01:02	1.28	0.80	0.94	-0.64	-0.80	0.51	0.40	0.97
8	25/10/2018	01:32 - 02:02	1.63	1.33	1.60	-0.28	-0.27	0.08	0.08	1.32
9	25/10/2018	03:32 - 04:02	1.00	0.63	0.77	-0.91	-0.97	0.89	0.83	0.69
10	25/10/2018	04:32 - 05:02	2.52	2.35	2.85	0.60	0.75	0.45	0.36	2.20
11	25/10/2018	05:32 - 06:02	1.34	1.01	1.25	-0.58	-0.59	0.34	0.34	1.02
12	25/10/2018	06:32 - 07:02	0.95	0.51	0.63	-0.96	-1.09	1.05	0.92	0.64
13	25/10/2018	07:32 - 08:02	0.96	0.88	1.08	-0.95	-0.72	0.69	0.91	0.65
14	25/10/2018	09:35 - 10:05	28.65	28.35	31.64	26.73	26.75	714.90	714.45	28.31
15	25/10/2018	11:35 - 12:05	0.88	0.59	0.73	-1.04	-1.01	1.05	1.07	0.57
16	25/10/2018	12:35 - 13:05	0.87	0.52	0.63	-1.05	-1.08	1.13	1.10	0.56
17	25/10/2018	13:35 - 14:05	0.77	0.43	0.52	-1.14	-1.17	1.34	1.30	0.46
18	25/10/2018	14:35 - 15:05	1.10	0.77	0.94	-0.82	-0.83	0.68	0.67	0.78
19	25/10/2018	15:35 - 16:05	1.99	1.53	1.81	0.07	-0.07	-0.01	0.01	1.67
20	25/10/2018	16:35 - 17:05	0.89	0.52	0.64	-1.03	-1.08	1.11	1.05	0.58
21	25/10/2018	17:35 - 18:05	1.32	0.93	1.14	-0.60	-0.67	0.40	0.36	1.01
22	25/10/2018	18:35 - 19:05	1.34	0.98	1.17	-0.57	-0.62	0.36	0.33	1.03
23	25/10/2018	19:35 - 20:05	1.00	0.54	0.67	-0.91	-1.06	0.97	0.83	0.69
24	25/10/2018	20:35 - 21:05	0.87	0.45	0.55	-1.05	-1.15	1.21	1.10	0.56
25	25/10/2018	21:35 - 22:05	0.80	0.58	0.69	-1.12	-1.03	1.15	1.25	0.49
26	25/10/2018	22:35 - 23:05	1.40	1.08	1.27	-0.51	-0.52	0.27	0.26	1.09
27	26/10/2018	23:35 - 00:05	1.35	0.87	1.02	-0.57	-0.73	0.42	0.33	1.03
28	26/10/2018	00:35 - 01:05	0.90	0.50	0.60	-1.02	-1.10	1.12	1.03	0.59
29	26/10/2018	01:35 - 02:05	1.32	0.90	1.06	-0.59	-0.71	0.42	0.35	1.01
30	26/10/2018	02:35 - 03:05	0.85	0.42	0.50	-1.06	-1.18	1.26	1.13	0.54
31	26/10/2018	03:35 - 04:05	1.64	1.19	1.40	-0.27	-0.41	0.11	0.08	1.33
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Section 4A - Data and Calculations - QAL2

TOTAL VOCs: QAL2 CALCULATIONS

(Page 2 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
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					MAX SRM - MIN SRM	31.14		SUM	744.94	745.51
					(DAILY) DELV (mg/m ³)	15				
					95% CI MU (%)	30				
					95% CI at DELV (mg/m ³)	4.5				
					15% of ELV	2.3				
					PROCEDURE (A, B, C)	A				
							PROCEDURE A	If (MAX SRM - MIN SRM) > 95% CI at Daily ELV		
							PROCEDURE B	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV		
							PROCEDURE C	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV		

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
1	25/10/2018	08:32 - 09:05			Instrument performing an auto-zero
2	25/10/2018	02:32 - 03:02	1.69	0.96	Statistical outlier (as defined in TGN M20 - V3)
3	25/10/2018	10:35 - 11:05	1.95	1.00	Statistical outlier (as defined in TGN M20 - V3)
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TOTAL VOCs: QAL2 CALCULATIONS

(Page 3 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Derivation of Calibration Function

b =	0.9992	a =	-0.3120	CALIBRATION FUNCTION =	y = 0.9992x - 0.3120
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where

For Procedure A / C

$$b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$$

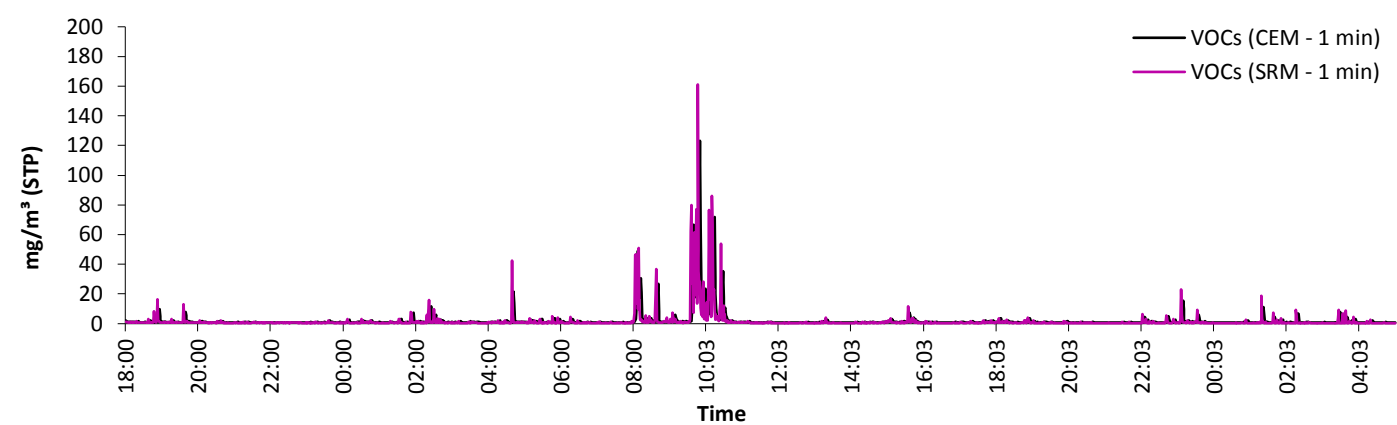
$$\text{and } a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$$

Procedure B

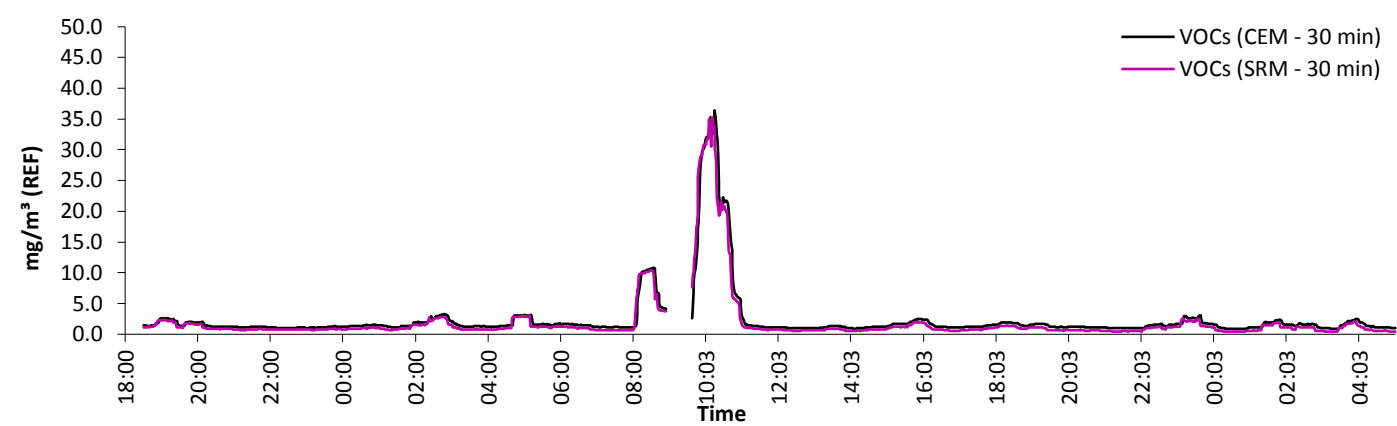
$$b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$$

$$\text{and } a = -b \times \text{OFFSET}$$

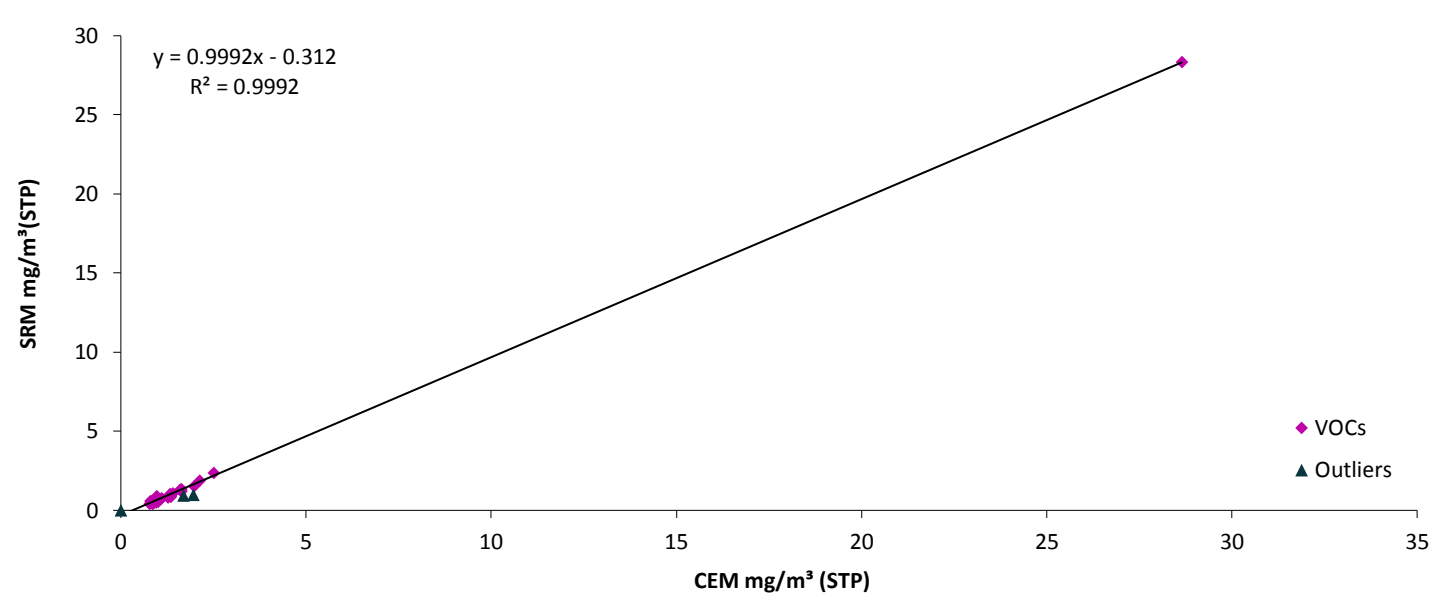
PLOT 1a: GRAPH FOR STP SRM vs STP CEMS (NON-STANDARDISED) (1 minute readings)



PLOT 1: GRAPH FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED) (30 minute rolling averages)



PLOT 2: Calibration Graph for Procedure A



Section 4A - Data and Calculations - QAL2

TOTAL VOCs: QAL2 CALCULATIONS

(Page 4 of 6)

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CEM Oxygen (DRY) % v/v	CAL		SRM Oxygen (DRY) % v/v	where CAL = Calibrated using QAL2 calibration functions			ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v		CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	
L1	Surrogate	Near Zero	-0.32	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-0.32	0.00	-0.01	0.32
L2	Surrogate	Near Zero	-0.32	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-0.32	0.00	-0.01	0.32
L3	Surrogate	Near Zero	-0.32	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-0.32	0.00	-0.01	0.32
1	24/10/2018	18:32 - 19:02	1.82	14.86	14.41	14.51	6.50	6.57	6.57	6.57	2.20	2.30	2.59	0.10
2	24/10/2018	19:32 - 20:02	1.28	14.73	14.28	14.35	6.54	6.61	6.62	6.62	1.55	1.58	1.93	0.03
3	24/10/2018	20:32 - 21:02	0.68	14.54	14.10	14.14	6.52	6.59	6.59	6.59	0.83	0.82	1.20	0.00
4	24/10/2018	21:32 - 22:02	0.61	14.50	14.06	14.11	6.48	6.55	6.62	6.62	0.73	0.80	1.11	0.07
5	24/10/2018	22:32 - 23:02	0.56	15.47	15.01	15.04	6.35	6.42	6.45	6.45	0.67	0.72	1.05	0.05
6	25/10/2018	23:32 - 00:02	0.74	15.65	15.18	15.10	6.05	6.11	6.08	6.08	0.87	0.81	1.25	-0.06
7	25/10/2018	00:32 - 01:02	0.97	15.87	15.39	15.30	5.88	5.94	5.96	5.96	1.14	0.94	1.51	-0.20
8	25/10/2018	01:32 - 02:02	1.32	15.70	15.23	15.21	6.16	6.23	6.25	6.25	1.58	1.60	1.96	0.02
9	25/10/2018	03:32 - 04:02	0.69	15.79	15.32	15.23	6.33	6.40	6.46	6.46	0.84	0.77	1.22	-0.07
10	25/10/2018	04:32 - 05:02	2.20	15.77	15.30	15.22	6.34	6.41	6.41	6.41	2.67	2.85	3.05	0.18
11	25/10/2018	05:32 - 06:02	1.02	15.82	15.35	15.32	6.39	6.46	6.59	6.59	1.25	1.25	1.63	0.00
12	25/10/2018	06:32 - 07:02	0.64	15.67	15.20	15.14	6.54	6.61	6.64	6.64	0.79	0.63	1.17	-0.16
13	25/10/2018	07:32 - 08:02	0.65	15.99	15.51	15.60	6.22	6.29	6.42	6.42	0.78	1.08	1.16	0.29
14	25/10/2018	09:35 - 10:05	28.31	17.54	17.01	16.29	4.81	4.85	4.94	4.94	31.68	31.64	32.05	-0.04
15	25/10/2018	11:35 - 12:05	0.57	15.56	15.09	15.25	6.61	6.68	6.59	6.59	0.70	0.73	1.09	0.03
16	25/10/2018	12:35 - 13:05	0.56	15.35	14.89	14.95	6.37	6.44	6.38	6.38	0.67	0.63	1.05	-0.04
17	25/10/2018	13:35 - 14:05	0.46	15.25	14.79	14.86	6.54	6.61	6.45	6.45	0.56	0.52	0.95	-0.05
18	25/10/2018	14:35 - 15:05	0.78	15.77	15.30	15.28	6.44	6.51	6.47	6.47	0.96	0.94	1.34	-0.01
19	25/10/2018	15:35 - 16:05	1.67	15.62	15.15	15.10	6.13	6.19	6.12	6.12	2.00	1.81	2.37	-0.18
20	25/10/2018	16:35 - 17:05	0.58	15.54	15.07	15.15	6.58	6.66	6.62	6.62	0.71	0.64	1.10	-0.07
21	25/10/2018	17:35 - 18:05	1.01	15.88	15.40	15.23	6.48	6.55	6.54	6.54	1.23	1.14	1.62	-0.09
22	25/10/2018	18:35 - 19:05	1.03	15.79	15.32	15.26	6.01	6.07	6.13	6.13	1.22	1.17	1.59	-0.05
23	25/10/2018	19:35 - 20:05	0.69	15.36	14.90	14.90	6.52	6.59	6.62	6.62	0.84	0.67	1.23	-0.18
24	25/10/2018	20:35 - 21:05	0.56	15.44	14.98	14.94	6.54	6.61	6.63	6.63	0.68	0.55	1.06	-0.13
25	25/10/2018	21:35 - 22:05	0.49	15.78	15.31	15.47	6.18	6.24	6.24	6.24	0.58	0.69	0.96	0.11
26	25/10/2018	22:35 - 23:05	1.09	15.88	15.41	15.38	5.99	6.05	5.99	5.99	1.29	1.27	1.66	-0.02
27	26/10/2018	23:35 - 00:05	1.03	15.79	15.31	15.28	5.84	5.90	5.84	5.84	1.21	1.02	1.58	-0.20
28	26/10/2018	00:35 - 01:05	0.59	15.96	15.48	15.52	6.10	6.17	6.16	6.16	0.70	0.60	1.08	-0.11
29	26/10/2018	01:35 - 02:05	1.01	16.10	15.61	15.60	6.02	6.08	6.05	6.05	1.20	1.06	1.58	-0.14
30	26/10/2018	02:35 - 03:05	0.54	16.10	15.62	15.61	6.07	6.13	6.10	6.10	0.65	0.50	1.02	-0.15
31	26/10/2018	03:35 - 04:05	1.33	16.42	15.92	15.89	5.86	5.91	5.84	5.84	1.57	1.40	1.94	-0.17
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Section 4A - Data and Calculations - QAL2

TOTAL VOCs: QAL2 CALCULATIONS

(Page 5 of 6)

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CEM Oxygen (DRY) % v/v	CAL		SRM Oxygen (DRY) % v/v	where CAL = Calibrated using QAL2 calibration functions			ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v		CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	
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											MAX	AVERAGE	AVERAGE	Sd
											31.68	2.04	2.45	0.11

Test of Variability

$Q_o = ELV \times (MU / 100) / 1.96$	2.30
Kv for 31 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_o \times Kv$.

Parameter	Value
Standard Deviation (Sd)	0.11
$Q_o \times Kv$	2.27
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	31.7
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The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 34.8
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 3.0

Greater of (a) or (b)	0 to 34.8
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Surrogate Extension Applied?	No
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Valid Calibration Range (at REF conditions)	0 to 34.8 mg/m³
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Section 4A - Data and Calculations - QAL2

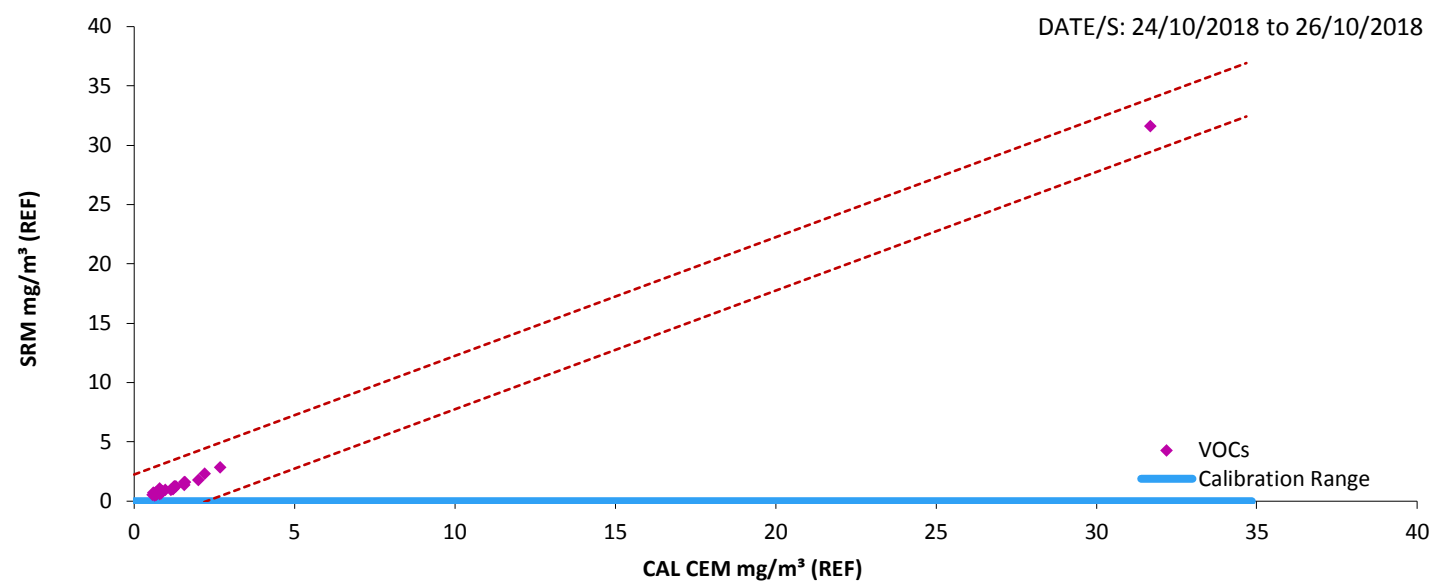
TOTAL VOCs: QAL2 CALCULATIONS

(Page 6 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

(Page 1 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
L1	Surrogate	Near Zero	0.20	0.00	0.00	-199.82	-196.72	39309.91	39929.98	0.00
L2	Surrogate	Near Zero	0.20	0.00	0.00	-199.82	-196.72	39309.91	39929.98	0.00
L3	Surrogate	Near Zero	0.20	0.00	0.00	-199.82	-196.72	39309.91	39929.98	0.00
1	24/10/2018	18:32 - 19:02	233.45	227.64	276.78	33.43	30.91	1033.35	1117.35	229.63
2	24/10/2018	19:32 - 20:02	232.00	227.31	276.94	31.98	30.59	978.14	1022.41	228.20
3	24/10/2018	20:32 - 21:02	219.15	214.06	259.61	19.13	17.34	331.75	365.96	215.55
4	24/10/2018	21:32 - 22:02	212.74	209.65	254.65	12.72	12.93	164.46	161.72	209.24
5	24/10/2018	22:32 - 23:02	213.64	209.34	253.98	13.61	12.62	171.80	185.34	210.12
6	25/10/2018	23:32 - 00:02	212.33	206.15	244.20	12.30	9.43	116.00	151.31	208.83
7	25/10/2018	00:32 - 01:02	218.70	212.19	249.88	18.67	15.47	288.78	348.64	215.10
8	25/10/2018	01:32 - 02:02	224.82	218.47	261.98	24.79	21.75	539.24	614.77	221.13
9	25/10/2018	02:32 - 03:02	219.03	212.27	256.91	19.00	15.55	295.46	361.16	215.43
10	25/10/2018	03:32 - 04:02	212.69	208.95	254.24	12.67	12.23	154.95	160.50	209.19
11	25/10/2018	04:32 - 05:02	223.12	216.25	262.15	23.09	19.53	451.06	533.35	219.46
12	25/10/2018	05:32 - 06:02	218.54	219.76	270.09	18.51	23.04	426.59	342.76	214.95
13	25/10/2018	06:32 - 07:02	222.27	215.74	265.54	22.24	19.02	423.07	494.74	218.62
14	25/10/2018	07:32 - 08:02	216.55	215.64	262.83	16.52	18.91	312.46	272.92	212.99
15	25/10/2018	10:35 - 11:05	237.88	231.83	273.60	37.85	35.11	1328.85	1432.81	233.99
16	25/10/2018	11:35 - 12:05	215.31	215.10	264.25	15.29	18.38	280.99	233.72	211.77
17	25/10/2018	12:35 - 13:05	219.31	219.28	264.53	19.28	22.55	434.87	371.78	215.70
18	25/10/2018	13:35 - 14:05	217.31	210.46	254.84	17.28	13.74	237.48	298.65	213.73
19	25/10/2018	14:35 - 15:05	197.00	195.81	238.57	-3.02	-0.91	2.76	9.13	193.75
20	25/10/2018	15:35 - 16:05	216.89	213.34	253.22	16.87	16.62	280.32	284.55	213.33
21	25/10/2018	16:35 - 17:05	202.49	200.68	246.80	2.46	3.96	9.76	6.06	199.15
22	25/10/2018	17:35 - 18:05	208.67	207.78	254.19	8.65	11.06	95.64	74.75	205.23
23	25/10/2018	18:35 - 19:05	211.57	211.76	252.01	11.55	15.03	173.59	133.31	208.09
24	25/10/2018	19:35 - 20:05	215.15	214.90	263.44	15.13	18.18	274.93	228.82	211.61
25	25/10/2018	20:35 - 21:05	220.43	220.38	270.40	20.40	23.66	482.80	416.33	216.81
26	25/10/2018	21:35 - 22:05	223.12	219.01	263.28	23.09	22.29	514.83	533.35	219.46
27	25/10/2018	22:35 - 23:05	219.87	216.41	255.61	19.85	19.69	390.81	393.87	216.26
28	26/10/2018	23:35 - 00:05	227.75	223.71	261.27	27.72	26.99	748.26	768.59	224.01
29	26/10/2018	00:35 - 01:05	215.18	213.06	254.92	15.16	16.34	247.66	229.70	211.64
30	26/10/2018	01:35 - 02:05	225.51	220.84	262.44	25.49	24.12	614.67	649.64	221.81
31	26/10/2018	02:35 - 03:05	228.27	225.57	269.08	28.25	28.85	814.94	798.02	224.53
32	26/10/2018	03:35 - 04:05	219.53	211.90	249.30	19.51	15.18	296.07	380.54	215.93
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Section 4A - Data and Calculations - QAL2

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

(Page 2 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
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89										
90										
					MAX SRM - MIN SRM	38.37				
					(DAILY) DELV (mg/m ³)	300				
					95% CI MU (%)	20				
					95% CI at DELV (mg/m ³)	60.0				
					15% of ELV	45.0				
					PROCEDURE (A, B, C)	B				
							SUM	130846.03	133166.51	
							PROCEDURE A		If (MAX SRM - MIN SRM) > 95% CI at Daily ELV	
							PROCEDURE B		If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV	
							PROCEDURE C		If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV	

WHERE OFFSET = 0.2

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
1	25/10/2018	08:32 - 09:05	138.24	143.68	Instrument performing an auto-zero Statistical outlier (as defined in TGN M20 - V3)
2	25/10/2018	09:35 - 10:05			
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25					

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

(Page 3 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Derivation of Calibration Function

b =	0.9845	a =	-0.1969	CALIBRATION FUNCTION =	y = 0.9845x - 0.1969
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where

For Procedure A / C

$$b = \frac{[(x - x_{av}) \times (y - y_{av})]}{(x - x_{av})^2}$$

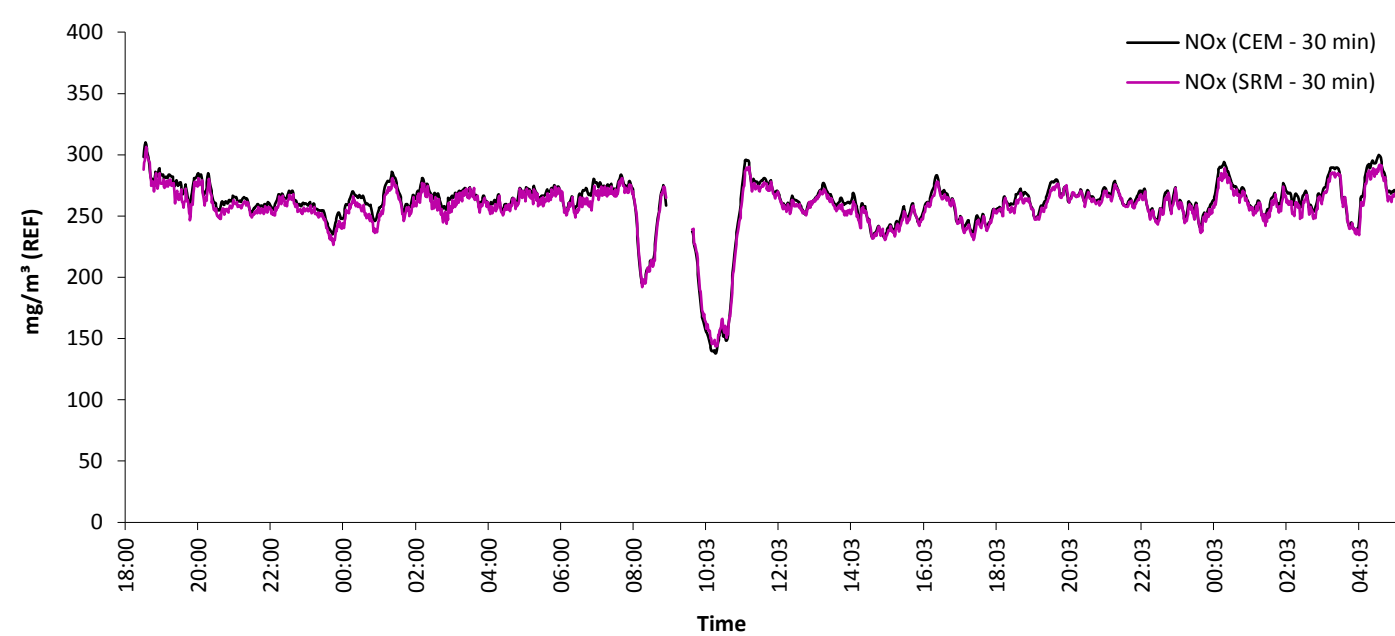
$$\text{and } a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$$

Procedure B

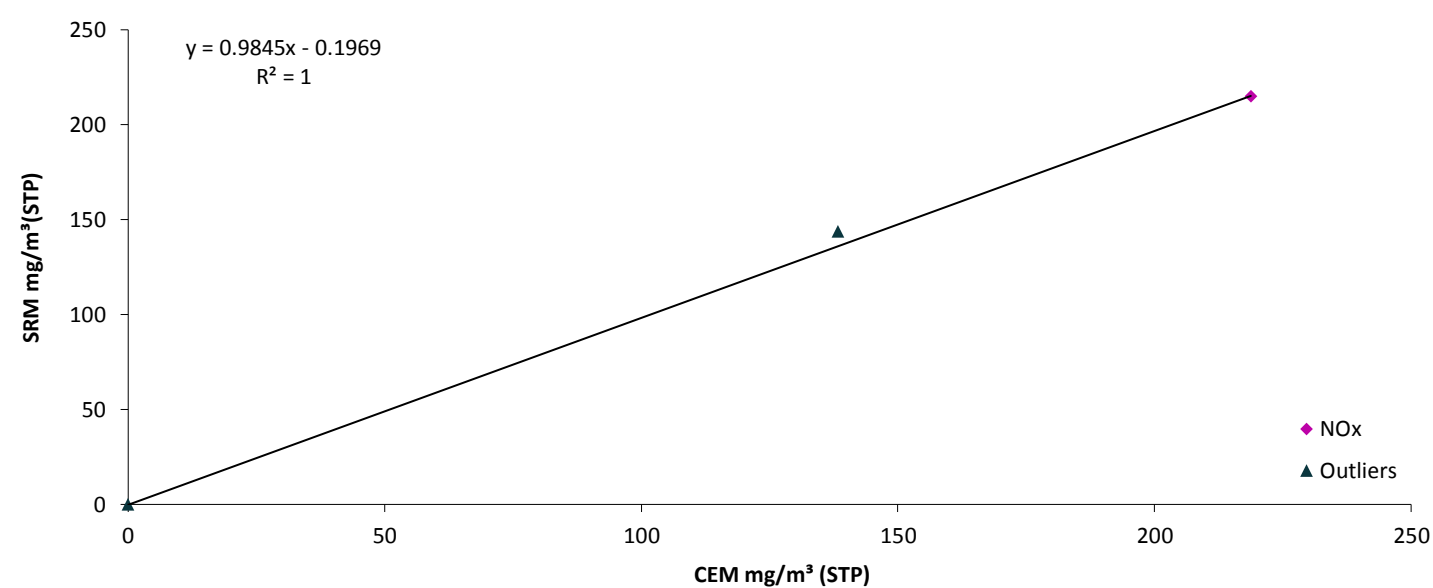
$$b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$$

$$\text{and } a = -b \times \text{OFFSET}$$

PLOT 1: GRAPH FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED) (30 minute rolling averages)



PLOT 2: Calibration Graph for Procedure B



Section 4A - Data and Calculations - QAL2

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

(Page 4 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	CEM Oxygen (DRY) % v/v			CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
					N/A				N/A						
L1	Surrogate	Near Zero	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00	0.00	0.00	0.20	0.00
L2	Surrogate	Near Zero	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00	0.00	0.00	0.20	0.00
L3	Surrogate	Near Zero	0.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00	0.00	0.00	0.20	0.00
1	24/10/2018	18:32 - 19:02	229.63	14.86	14.41	14.51	6.50	6.57	6.57	6.57	278.89	276.78	283.53	-2.10	
2	24/10/2018	19:32 - 20:02	228.20	14.73	14.28	14.35	6.54	6.61	6.62	6.62	277.57	276.94	282.20	-0.63	
3	24/10/2018	20:32 - 21:02	215.55	14.54	14.10	14.14	6.52	6.59	6.59	6.59	261.25	259.61	265.62	-1.64	
4	24/10/2018	21:32 - 22:02	209.24	14.50	14.06	14.11	6.48	6.55	6.62	6.62	252.83	254.65	257.06	1.83	
5	24/10/2018	22:32 - 23:02	210.12	15.47	15.01	15.04	6.35	6.42	6.45	6.45	254.33	253.98	258.58	-0.35	
6	25/10/2018	23:32 - 00:02	208.83	15.65	15.18	15.10	6.05	6.11	6.08	6.08	248.02	244.20	252.16	-3.81	
7	25/10/2018	00:32 - 01:02	215.10	15.87	15.39	15.30	5.88	5.94	5.96	5.96	253.21	249.88	257.44	-3.34	
8	25/10/2018	01:32 - 02:02	221.13	15.70	15.23	15.21	6.16	6.23	6.25	6.25	264.89	261.98	269.31	-2.91	
9	25/10/2018	02:32 - 03:02	215.43	15.73	15.26	15.18	6.28	6.35	6.39	6.39	260.24	256.91	264.59	-3.33	
10	25/10/2018	03:32 - 04:02	209.19	15.79	15.32	15.23	6.33	6.40	6.46	6.46	253.79	254.24	258.04	0.45	
11	25/10/2018	04:32 - 05:02	219.46	15.77	15.30	15.22	6.34	6.41	6.41	6.41	266.33	262.15	270.78	-4.18	
12	25/10/2018	05:32 - 06:02	214.95	15.82	15.35	15.32	6.39	6.46	6.59	6.59	261.87	270.09	266.25	8.22	
13	25/10/2018	06:32 - 07:02	218.62	15.67	15.20	15.14	6.54	6.61	6.64	6.64	268.67	265.54	273.16	-3.13	
14	25/10/2018	07:32 - 08:02	212.99	15.99	15.51	15.60	6.22	6.29	6.42	6.42	257.05	262.83	261.34	5.78	
15	25/10/2018	10:35 - 11:05	233.99	15.50	15.04	15.05	6.15	6.21	6.04	6.04	279.30	273.60	283.95	-5.70	
16	25/10/2018	11:35 - 12:05	211.77	15.56	15.09	15.25	6.61	6.68	6.59	6.59	261.24	264.25	265.60	3.01	
17	25/10/2018	12:35 - 13:05	215.70	15.35	14.89	14.95	6.37	6.44	6.38	6.38	261.14	264.53	265.50	3.39	
18	25/10/2018	13:35 - 14:05	213.73	15.25	14.79	14.86	6.54	6.61	6.45	6.45	261.54	254.84	265.91	-6.69	
19	25/10/2018	14:35 - 15:05	193.75	15.77	15.30	15.28	6.44	6.51	6.47	6.47	236.79	238.57	240.77	1.79	
20	25/10/2018	15:35 - 16:05	213.33	15.62	15.15	15.10	6.13	6.19	6.12	6.12	254.68	253.22	258.93	-1.46	
21	25/10/2018	16:35 - 17:05	199.15	15.54	15.07	15.15	6.58	6.66	6.62	6.62	245.21	246.80	249.33	1.58	
22	25/10/2018	17:35 - 18:05	205.23	15.88	15.40	15.23	6.48	6.55	6.54	6.54	251.80	254.19	256.02	2.39	
23	25/10/2018	18:35 - 19:05	208.09	15.79	15.32	15.26	6.01	6.07	6.13	6.13	246.93	252.01	251.06	5.08	
24	25/10/2018	19:35 - 20:05	211.61	15.36	14.90	14.90	6.52	6.59	6.62	6.62	258.79	263.44	263.12	4.65	
25	25/10/2018	20:35 - 21:05	216.81	15.44	14.98	14.94	6.54	6.61	6.63	6.63	265.77	270.40	270.21	4.63	
26	25/10/2018	21:35 - 22:05	219.46	15.78	15.31	15.47	6.18	6.24	6.24	6.24	263.40	263.28	267.80	-0.12	
27	25/10/2018	22:35 - 23:05	216.26	15.88	15.41	15.38	5.99	6.05	5.99	5.99	256.47	255.61	260.76	-0.87	
28	26/10/2018	23:35 - 00:05	224.01	15.79	15.31	15.28	5.84	5.90	5.84	5.84	262.81	261.27	267.19	-1.55	
29	26/10/2018	00:35 - 01:05	211.64	15.96	15.48	15.52	6.10	6.17	6.16	6.16	253.20	254.92	257.44	1.71	
30	26/10/2018	01:35 - 02:05	221.81	16.10	15.61	15.60	6.02	6.08	6.05	6.05	264.29	262.44	268.70	-1.85	
31	26/10/2018	02:35 - 03:05	224.53	16.10	15.62	15.61	6.07	6.13	6.10	6.10	268.47	269.08	272.94	0.61	
32	26/10/2018	03:35 - 04:05	215.93	16.42	15.92	15.89	5.86	5.91	5.84	5.84	255.37	249.30	259.63	-6.07	
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Section 4A - Data and Calculations - QAL2

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

(Page 5 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CEM Oxygen (DRY) % v/v	CAL		CEM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 6% O ₂) mg/m ³		SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v		SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³			
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											MAX	AVERAGE	AVERAGE	Sd	
											279.30	259.42	263.90	3.64	

where CAL = Calibrated using QAL2 calibration functions

Test of Variability

$Q_o = ELV \times (MU / 100) / 1.96$	30.61
Kv for 32 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_o \times Kv$.

Parameter	Value
Standard Deviation (Sd)	3.64
$Q_o \times Kv$	30.26
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	279.3
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The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 307
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 60.0

Greater of (a) or (b)	0 to 307
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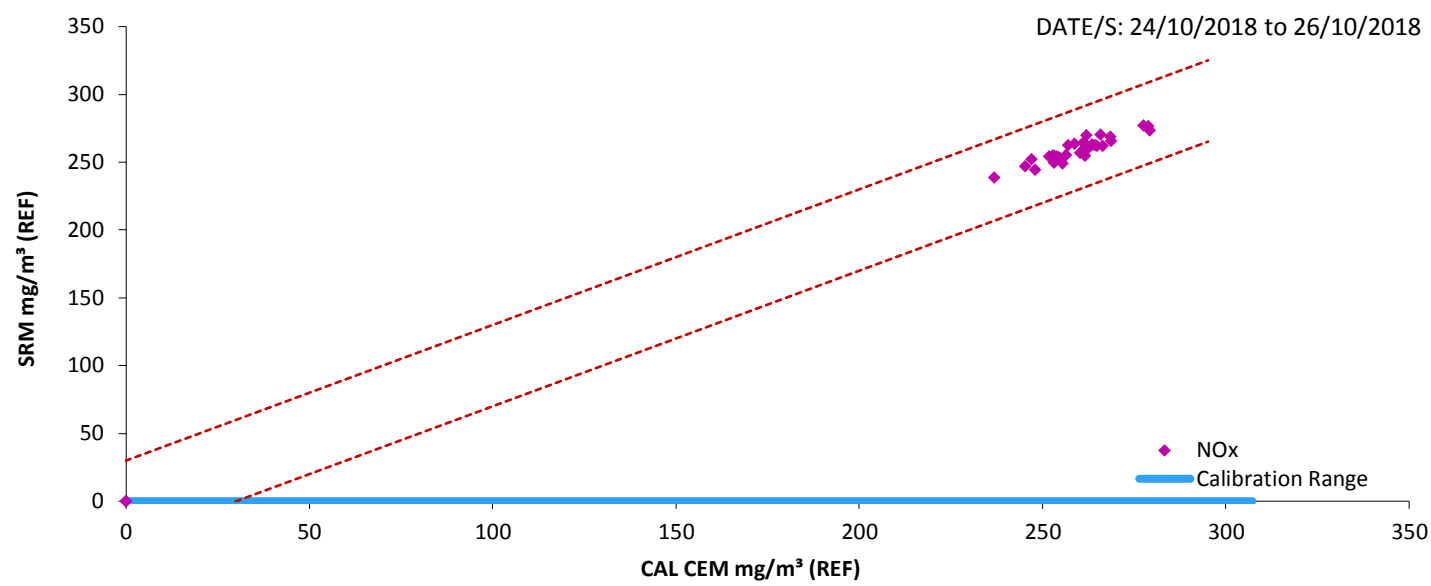
Surrogate Extension Applied?	No
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Valid Calibration Range (at REF conditions)	0 to 307 mg/m³
--	----------------------------------

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS
(Page 6 of 6)

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 1 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data

Pair	Date	Time (48-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
H1	Surrogate	High	139.60	142.00	142.00	131.91	134.69	17767.80	17401.25	141.96
L1	Surrogate	Near Zero	0.50	0.00	0.00	-7.19	-7.31	52.51	51.64	-0.03
L2	Surrogate	Near Zero	0.50	0.00	0.00	-7.19	-7.31	52.51	51.64	-0.03
L3	Surrogate	Near Zero	0.50	0.00	0.00	-7.19	-7.31	52.51	51.64	-0.03
1	24/10/2018	09:07 - 09:56	0.80	0.45	0.53	-6.89	-6.86	47.22	47.42	0.28
2	24/10/2018	10:11 - 11:00	0.89	0.45	0.54	-6.80	-6.86	46.60	46.19	0.37
3	24/10/2018	11:10 - 11:59	0.79	0.36	0.43	-6.90	-6.94	47.88	47.56	0.27
4	24/10/2018	12:18 - 13:07	0.67	0.37	0.45	-7.02	-6.94	48.70	49.23	0.15
5	24/10/2018	13:18 - 14:07	0.73	0.29	0.35	-6.96	-7.02	48.80	48.39	0.21
6	24/10/2018	14:19 - 15:08	0.62	0.19	0.22	-7.07	-7.12	50.29	49.93	0.09
7	24/10/2018	15:20 - 16:09	0.56	0.26	0.31	-7.13	-7.04	50.19	50.78	0.03
8	24/10/2018	16:21 - 17:10	0.56	0.21	0.25	-7.13	-7.10	50.58	50.78	0.03
9	25/10/2018	08:44 - 09:33	2.09	0.92	1.05	-5.60	-6.39	35.77	31.32	1.60
10	25/10/2018	10:46 - 11:35	1.64	0.67	0.83	-6.05	-6.64	40.12	36.56	1.14
11	25/10/2018	11:47 - 12:36	1.11	0.99	1.20	-6.58	-6.32	41.55	43.25	0.59
12	25/10/2018	12:48 - 13:37	0.88	0.76	0.92	-6.81	-6.55	44.56	46.32	0.36
13	25/10/2018	13:49 - 14:38	0.68	0.50	0.61	-7.01	-6.81	47.68	49.09	0.16
14	25/10/2018	14:50 - 15:39	2.32	0.97	1.17	-5.37	-6.34	34.03	28.80	1.83
15	25/10/2018	15:51 - 16:40	3.17	1.29	1.56	-4.52	-6.02	27.19	20.40	2.70
16	26/10/2018	08:19 - 09:08	1.29	1.08	1.35	-6.40	-6.23	39.83	40.91	0.78
17	26/10/2018	09:25 - 10:14	1.51	1.70	2.03	-6.18	-5.61	34.66	38.15	1.00
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Section 4A - Data and Calculations - QAL2

SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 2 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data (continued)

Pair	Date	Time (48-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
64										
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			MAX SRM - MIN SRM		1.81			SUM	18660.99	18281.23
			(DAILY) DELV (mg/m ³)		75					
			95% CI MU (%)		20					
			95% CI at DELV (mg/m ³)		15.0					
			15% of ELV		11.3					
			PROCEDURE (A, B, C)		C					
								PROCEDURE A	If (MAX SRM - MIN SRM) > 95% CI at Daily ELV	
								PROCEDURE B	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV	
								PROCEDURE C	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV	

Outliers Data

Pair	Date	Time (48-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
1	25/10/2018	09:45 - 10:34	3.50	0.60	Statistical outlier (as defined in TGN M20 - V3)
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3					
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Section 4A - Data and Calculations - QAL2

SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 3 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Derivation of Calibration Function

b =	1.0208	a =	-0.5384	CALIBRATION FUNCTION =	y = 1.0208x - 0.5384
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where

For Procedure A / C

$$b = \frac{[(x - x_{av}) \times (y - y_{av})]}{(x - x_{av})^2}$$

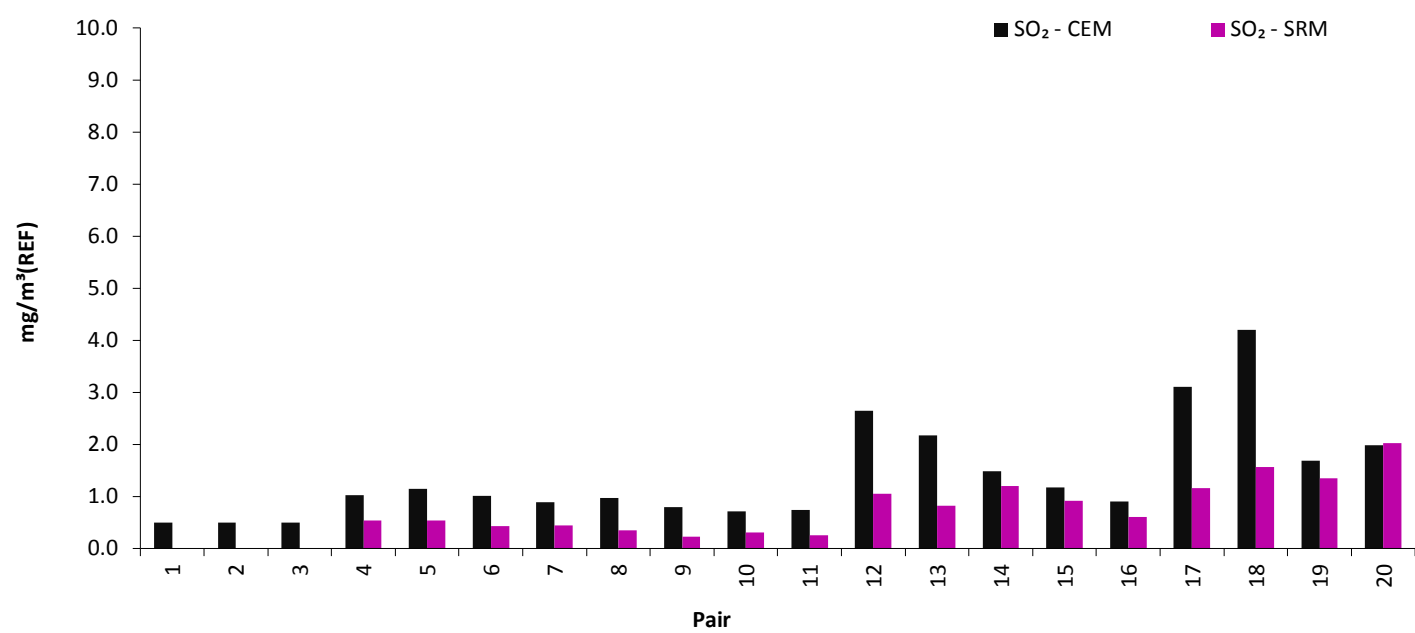
$$\text{and } a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$$

Procedure B

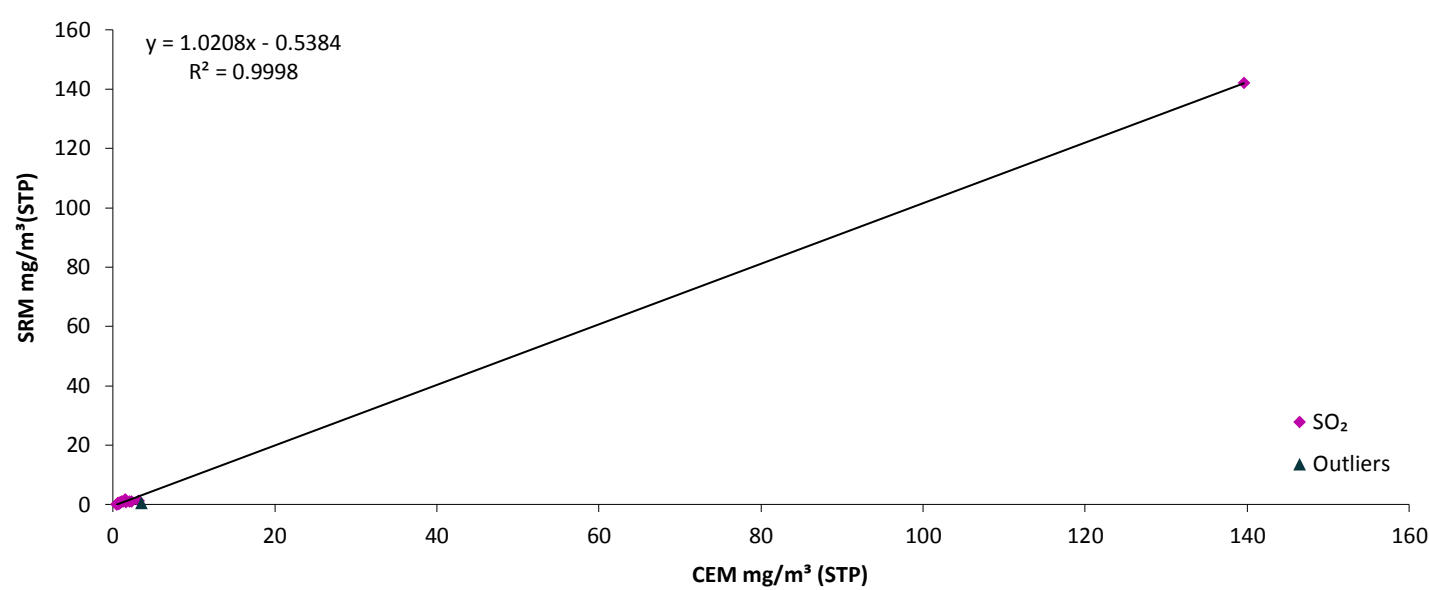
$$b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$$

$$\text{and } a = -b \times \text{OFFSET}$$

PLOT 1: BAR CHART FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED)



PLOT 2: Calibration Graph for Procedure C



Section 4A - Data and Calculations - QAL2

SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 4 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data

Pair	Date	Time (48-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CEM Oxygen (DRY) % v/v	CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
H1	Surrogate	High	141.96	N/A	N/A	N/A	N/A	N/A	N/A	N/A	141.96	142.00	139.60	0.04
L1	Surrogate	Near Zero	-0.03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-0.03	0.00	0.50	0.03
L2	Surrogate	Near Zero	-0.03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-0.03	0.00	0.50	0.03
L3	Surrogate	Near Zero	-0.03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-0.03	0.00	0.50	0.03
1	24/10/2018	09:07 - 09:56	0.28	13.67	13.26	13.19	7.37	7.46	6.43	0.36	0.53	1.02	0.18	
2	24/10/2018	10:11 - 11:00	0.37	13.76	13.35	13.34	7.40	7.49	6.54	0.47	0.54	1.14	0.07	
3	24/10/2018	11:10 - 11:59	0.27	14.88	14.43	13.78	7.22	7.30	6.12	0.34	0.43	1.01	0.08	
4	24/10/2018	12:18 - 13:07	0.15	15.06	14.61	15.01	7.68	7.77	6.53	0.19	0.45	0.89	0.25	
5	24/10/2018	13:18 - 14:07	0.21	15.11	14.66	13.71	7.70	7.79	6.50	0.28	0.35	0.97	0.07	
6	24/10/2018	14:19 - 15:08	0.09	14.52	14.08	12.78	7.35	7.43	6.27	0.12	0.22	0.80	0.10	
7	24/10/2018	15:20 - 16:09	0.03	14.46	14.03	12.79	7.31	7.39	6.16	0.04	0.31	0.72	0.26	
8	24/10/2018	16:21 - 17:10	0.03	15.48	15.01	13.67	7.59	7.68	6.28	0.04	0.25	0.74	0.20	
9	25/10/2018	08:44 - 09:33	1.60	16.50	16.00	14.35	6.79	6.87	5.77	2.02	1.05	2.64	-0.96	
10	25/10/2018	10:46 - 11:35	1.14	15.47	15.00	16.17	7.58	7.67	6.43	1.50	0.83	2.17	-0.68	
11	25/10/2018	11:47 - 12:36	0.59	15.54	15.07	15.24	7.66	7.75	6.46	0.79	1.20	1.48	0.41	
12	25/10/2018	12:48 - 13:37	0.36	15.26	14.80	14.39	7.70	7.79	6.52	0.48	0.92	1.17	0.44	
13	25/10/2018	13:49 - 14:38	0.16	15.37	14.91	14.45	7.72	7.81	6.55	0.21	0.61	0.91	0.40	
14	25/10/2018	14:50 - 15:39	1.83	15.58	15.11	14.65	7.68	7.77	6.44	2.44	1.17	3.10	-1.28	
15	25/10/2018	15:51 - 16:40	2.70	15.06	14.61	14.21	7.65	7.74	6.60	3.57	1.56	4.20	-2.01	
16	26/10/2018	08:19 - 09:08	0.78	15.76	15.29	14.96	7.33	7.41	6.85	1.01	1.35	1.68	0.33	
17	26/10/2018	09:25 - 10:14	1.00	15.86	15.38	14.77	7.38	7.47	6.28	1.31	2.03	1.98	0.71	
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Section 4A - Data and Calculations - QAL2

SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 5 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data (continued)

Pair	Date	Time (48-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		SRM Water Vapour % v/v	CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Oxygen (DRY) % v/v		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
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											MAX	AVERAGE	AVERAGE	Sd
											3.57	0.81	1.57	0.72

where CAL = Calibrated using QAL2 calibration functions

Test of Variability

$Q_o = ELV \times (MU / 100) / 1.96$	7.65
Kv for 17 Pairs of Data	0.9791

The variability is accepted if $Sd \leq Q_o \times Kv$.

Parameter	Value
Standard Deviation (Sd)	0.72
$Q_o \times Kv$	7.49
Outcome of Variability Test	Pass

Procedure C Acceptability Test

Average of UNCAL CEM (1)	1.57
Average of SRM (2)	0.81
ABS Difference (1) & (2)	0.75

Outcome of Procedure C Acceptability Test	Pass
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Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	3.6
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The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 3.9
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 15.0

Greater of (a) or (b)	0 to 15.0
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Surrogate Extension Applied?	NOT PERMISSIBLE
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Valid Calibration Range (at REF conditions)	0 to 15.0 mg/m³
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Section 4A - Data and Calculations - QAL2

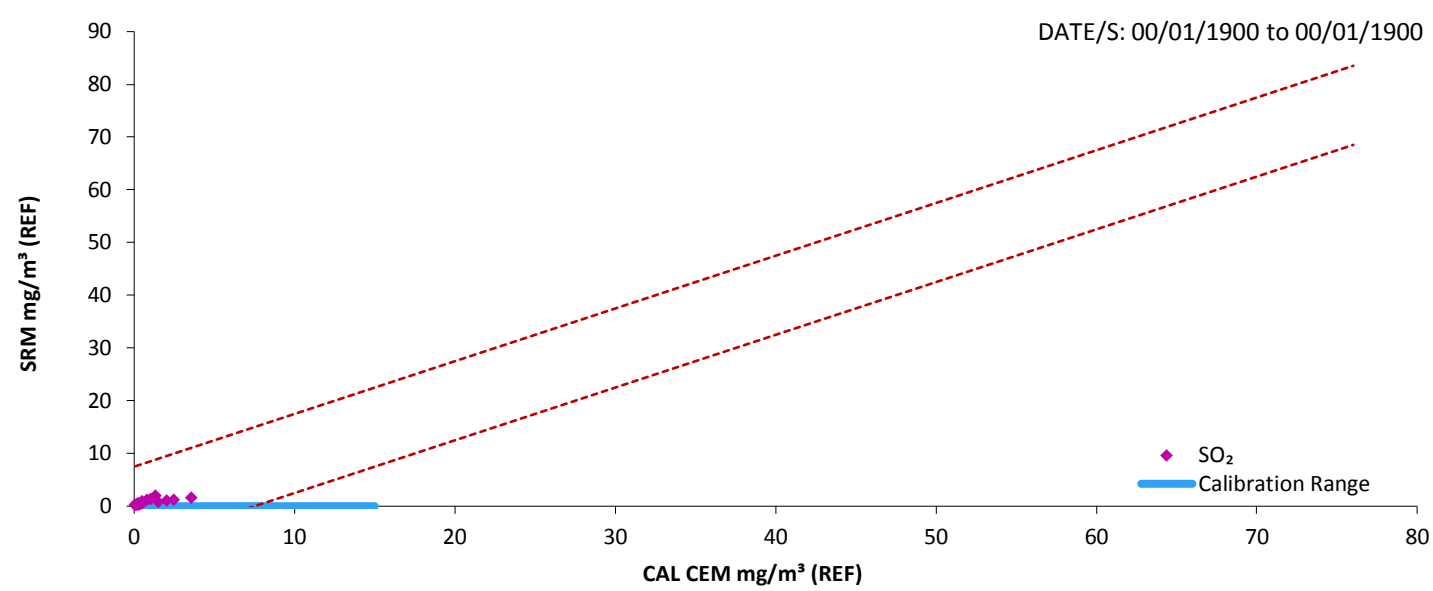
SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 6 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

CARBON MONOXIDE: QAL2 CALCULATIONS

(Page 1 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
L1	Surrogate	Near Zero	0.00	0.00	0.00	-69.82	-68.59	4788.95	4874.66	-1.38
L2	Surrogate	Near Zero	0.00	0.00	0.00	-69.82	-68.59	4788.95	4874.66	-1.38
L3	Surrogate	Near Zero	0.00	0.00	0.00	-69.82	-68.59	4788.95	4874.66	-1.38
1	24/10/2018	18:32 - 19:02	84.14	81.80	99.46	14.32	13.21	189.17	205.06	82.94
2	24/10/2018	19:32 - 20:02	54.95	55.40	67.50	-14.87	-13.19	196.13	221.03	53.69
3	24/10/2018	20:32 - 21:02	22.65	24.73	29.99	-47.17	-43.86	2069.04	2225.35	21.32
4	24/10/2018	21:32 - 22:02	23.26	23.04	27.98	-46.56	-45.55	2120.99	2167.90	21.93
5	24/10/2018	22:32 - 23:02	15.40	14.32	17.37	-54.42	-54.27	2953.72	2961.75	14.05
6	25/10/2018	23:32 - 00:02	43.30	42.49	50.33	-26.52	-26.10	692.15	703.25	42.01
7	25/10/2018	00:32 - 01:02	67.01	57.57	67.79	-2.81	-11.02	30.93	7.87	65.78
8	25/10/2018	01:32 - 02:02	63.06	64.02	76.77	-6.76	-4.57	30.89	45.71	61.82
9	25/10/2018	03:32 - 04:02	35.40	34.53	42.02	-34.42	-34.06	1172.28	1184.65	34.10
10	25/10/2018	04:32 - 05:02	85.64	83.59	101.33	15.82	15.00	237.24	250.17	84.44
11	25/10/2018	05:32 - 06:02	51.28	52.32	64.30	-18.53	-16.27	301.54	343.54	50.02
12	25/10/2018	06:32 - 07:02	24.85	19.66	24.19	-44.97	-48.93	2200.77	2022.63	23.52
13	25/10/2018	09:35 - 10:05	889.98	891.94	995.35	820.17	823.35	675283.40	672670.80	890.54
14	25/10/2018	11:35 - 12:05	19.42	19.29	23.70	-50.40	-49.30	2484.56	2540.10	18.08
15	25/10/2018	12:35 - 13:05	24.80	24.95	30.09	-45.02	-43.65	1964.74	2026.40	23.48
16	25/10/2018	13:35 - 14:05	16.14	17.06	20.65	-53.68	-51.53	2766.55	2881.90	14.79
17	25/10/2018	14:35 - 15:05	63.89	62.79	76.50	-5.93	-5.80	34.39	35.11	62.65
18	25/10/2018	15:35 - 16:05	97.23	87.38	103.71	27.41	18.79	514.94	751.32	96.06
19	25/10/2018	16:35 - 17:05	29.54	37.78	46.46	-40.28	-30.81	1241.11	1622.22	28.23
20	25/10/2018	17:35 - 18:05	79.85	79.18	96.86	10.04	10.59	106.27	100.72	78.65
21	25/10/2018	18:35 - 19:05	73.80	79.99	95.19	3.98	11.40	45.34	15.82	72.58
22	25/10/2018	19:35 - 20:05	45.10	40.98	50.23	-24.72	-27.61	682.48	610.86	43.82
23	25/10/2018	20:35 - 21:05	32.30	32.09	39.37	-37.52	-36.50	1369.50	1407.66	30.99
24	25/10/2018	21:35 - 22:05	22.97	19.88	23.90	-46.85	-48.71	2281.99	2195.02	21.64
25	25/10/2018	22:35 - 23:05	67.79	65.53	77.39	-2.03	-3.06	6.21	4.10	66.56
26	26/10/2018	23:35 - 00:05	66.07	55.32	64.61	-3.75	-13.27	49.73	14.05	64.84
27	26/10/2018	00:35 - 01:05	38.97	39.36	47.09	-30.84	-29.23	901.69	951.39	37.68
28	26/10/2018	01:35 - 02:05	63.69	59.99	71.29	-6.13	-8.61	52.77	37.60	62.45
29	26/10/2018	02:35 - 03:05	33.42	31.31	37.35	-36.40	-37.28	1357.02	1325.15	32.11
30	26/10/2018	03:35 - 04:05	68.12	65.24	76.76	-1.70	-3.35	5.68	2.88	66.89
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Section 4A - Data and Calculations - QAL2

CARBON MONOXIDE: QAL2 CALCULATIONS

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B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
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					MAX SRM - MIN SRM			SUM	717710.06	716155.98
					(DAILY) DELV (mg/m ³)					
					95% CI MU (%)					
					95% CI at DELV (mg/m ³)					
					15% of ELV					
					PROCEDURE (A, B, C)					
							PROCEDURE A	If (MAX SRM - MIN SRM) > 95% CI at Daily ELV		
							PROCEDURE B	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV		
							PROCEDURE C	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV		

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
1	25/10/2018	08:32 - 09:05			Instrument performing an auto-zero
2	25/10/2018	02:32 - 03:02	71.23	45.76	Statistical outlier (as defined in TGN M20 - V3)
3	25/10/2018	07:32 - 08:02	30.19	44.63	Statistical outlier (as defined in TGN M20 - V3)
4	25/10/2018	10:35 - 11:05	74.37	47.75	Statistical outlier (as defined in TGN M20 - V3)
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CARBON MONOXIDE: QAL2 CALCULATIONS

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B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)

Derivation of Calibration Function

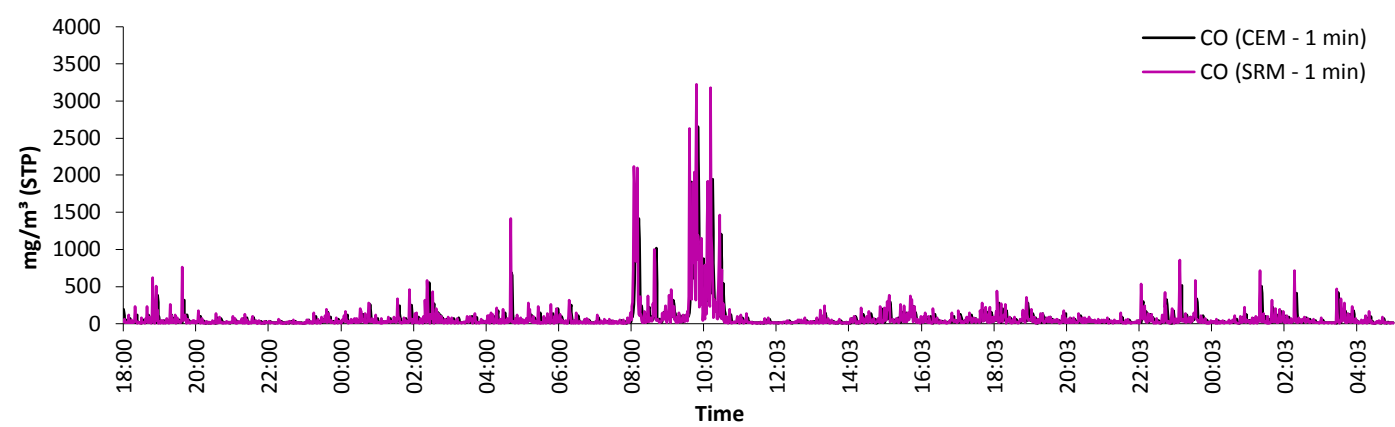
b =	1.0022	a =	-1.3791	CALIBRATION FUNCTION =	y = 1.0022x - 1.3791
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where

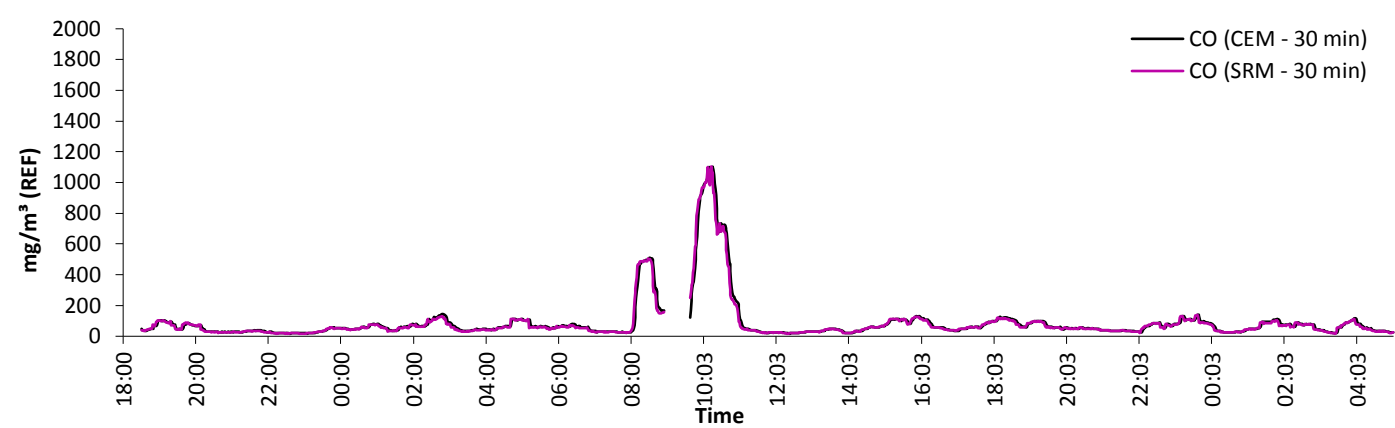
For Procedure A / C $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$

Procedure B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

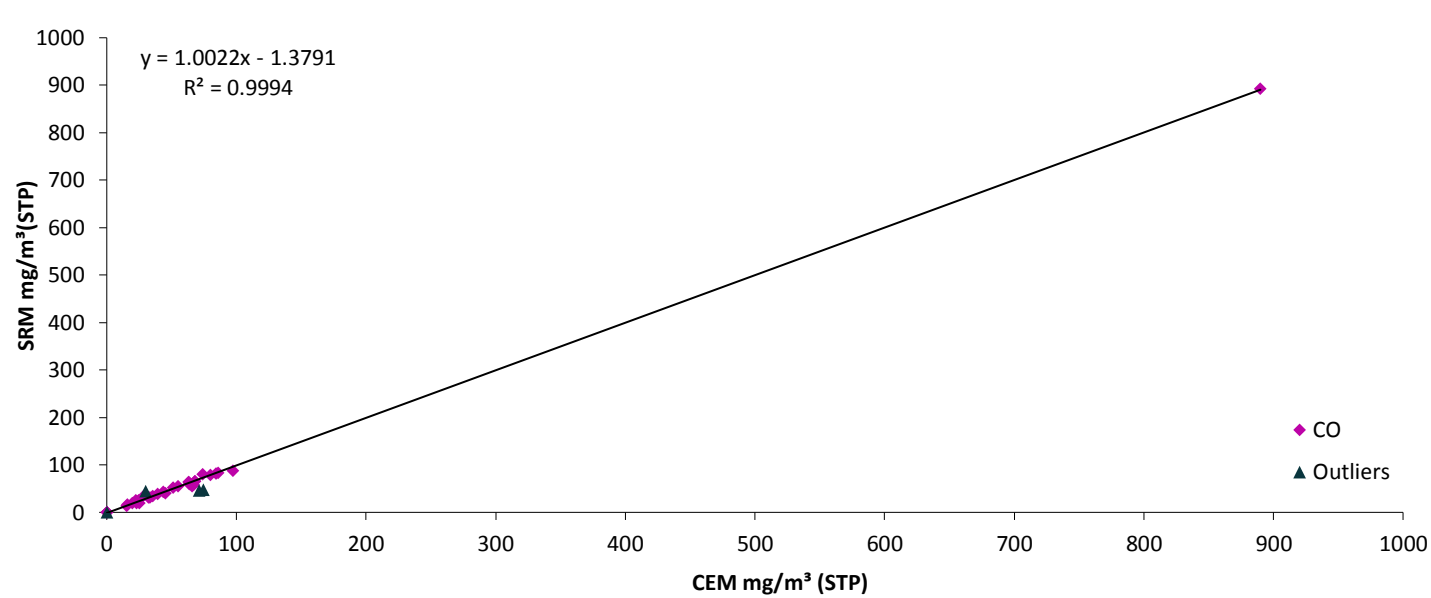
PLOT 1a: GRAPH FOR STP SRM vs STP CEMS (NON-STANDARDISED) (1 minute readings)



PLOT 1: GRAPH FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED) (30 minute rolling averages)



PLOT 2: Calibration Graph for Procedure A



Section 4A - Data and Calculations - QAL2

CARBON MONOXIDE: QAL2 CALCULATIONS

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B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CEM Oxygen (DRY) % v/v	CAL		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v						
					N/A			N/A							
L1	Surrogate	Near Zero	-1.38	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-1.38	0.00	0.00	1.38
L2	Surrogate	Near Zero	-1.38	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-1.38	0.00	0.00	1.38
L3	Surrogate	Near Zero	-1.38	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-1.38	0.00	0.00	1.38
1	24/10/2018	18:32 - 19:02	82.94	14.86	14.41	14.51	6.50	6.57	6.57	6.57	100.73	99.46	102.19	-1.27	
2	24/10/2018	19:32 - 20:02	53.69	14.73	14.28	14.35	6.54	6.61	6.62	6.62	65.31	67.50	66.84	2.19	
3	24/10/2018	20:32 - 21:02	21.32	14.54	14.10	14.14	6.52	6.59	6.59	6.59	25.83	29.99	27.45	4.16	
4	24/10/2018	21:32 - 22:02	21.93	14.50	14.06	14.11	6.48	6.55	6.62	6.62	26.50	27.98	28.10	1.49	
5	24/10/2018	22:32 - 23:02	14.05	15.47	15.01	15.04	6.35	6.42	6.45	6.45	17.01	17.37	18.64	0.36	
6	25/10/2018	23:32 - 00:02	42.01	15.65	15.18	15.10	6.05	6.11	6.08	6.08	49.90	50.33	51.42	0.44	
7	25/10/2018	00:32 - 01:02	65.78	15.87	15.39	15.30	5.88	5.94	5.96	5.96	77.43	67.79	78.89	-9.64	
8	25/10/2018	01:32 - 02:02	61.82	15.70	15.23	15.21	6.16	6.23	6.25	6.25	74.05	76.77	75.54	2.72	
9	25/10/2018	03:32 - 04:02	34.10	15.79	15.32	15.23	6.33	6.40	6.46	6.46	41.37	42.02	42.95	0.65	
10	25/10/2018	04:32 - 05:02	84.44	15.77	15.30	15.22	6.34	6.41	6.41	6.41	102.48	101.33	103.93	-1.15	
11	25/10/2018	05:32 - 06:02	50.02	15.82	15.35	15.32	6.39	6.46	6.59	6.59	60.93	64.30	62.48	3.37	
12	25/10/2018	06:32 - 07:02	23.52	15.67	15.20	15.14	6.54	6.61	6.64	6.64	28.90	24.19	30.53	-4.71	
13	25/10/2018	09:35 - 10:05	890.54	17.54	17.01	16.29	4.81	4.85	4.94	4.94	996.43	995.35	995.81	-1.08	
14	25/10/2018	11:35 - 12:05	18.08	15.56	15.09	15.25	6.61	6.68	6.59	6.59	22.31	23.70	23.96	1.40	
15	25/10/2018	12:35 - 13:05	23.48	15.35	14.89	14.95	6.37	6.44	6.38	6.38	28.42	30.09	30.03	1.67	
16	25/10/2018	13:35 - 14:05	14.79	15.25	14.79	14.86	6.54	6.61	6.45	6.45	18.10	20.65	19.74	2.55	
17	25/10/2018	14:35 - 15:05	62.65	15.77	15.30	15.28	6.44	6.51	6.47	6.47	76.57	76.50	78.09	-0.07	
18	25/10/2018	15:35 - 16:05	96.06	15.62	15.15	15.10	6.13	6.19	6.12	6.12	114.68	103.71	116.07	-10.97	
19	25/10/2018	16:35 - 17:05	28.23	15.54	15.07	15.15	6.58	6.66	6.62	6.62	34.76	46.46	36.38	11.70	
20	25/10/2018	17:35 - 18:05	78.65	15.88	15.40	15.23	6.48	6.55	6.54	6.54	96.50	96.86	97.98	0.37	
21	25/10/2018	18:35 - 19:05	72.58	15.79	15.32	15.26	6.01	6.07	6.13	6.13	86.12	95.19	87.57	9.07	
22	25/10/2018	19:35 - 20:05	43.82	15.36	14.90	14.90	6.52	6.59	6.62	6.62	53.59	50.23	55.16	-3.36	
23	25/10/2018	20:35 - 21:05	30.99	15.44	14.98	14.94	6.54	6.61	6.63	6.63	37.99	39.37	39.59	1.38	
24	25/10/2018	21:35 - 22:05	21.64	15.78	15.31	15.47	6.18	6.24	6.24	6.24	25.97	23.90	27.57	-2.07	
25	25/10/2018	22:35 - 23:05	66.56	15.88	15.41	15.38	5.99	6.05	5.99	5.99	78.94	77.39	80.40	-1.55	
26	26/10/2018	23:35 - 00:05	64.84	15.79	15.31	15.28	5.84	5.90	5.84	5.84	76.06	64.61	77.51	-11.46	
27	26/10/2018	00:35 - 01:05	37.68	15.96	15.48	15.52	6.10	6.17	6.16	6.16	45.08	47.09	46.63	2.01	
28	26/10/2018	01:35 - 02:05	62.45	16.10	15.61	15.60	6.02	6.08	6.05	6.05	74.41	71.29	75.88	-3.12	
29	26/10/2018	02:35 - 03:05	32.11	16.10	15.62	15.61	6.07	6.13	6.10	6.10	38.39	37.35	39.96	-1.04	
30	26/10/2018	03:35 - 04:05	66.89	16.42	15.92	15.89	5.86	5.91	5.84	5.84	79.11	76.76	80.57	-2.35	
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Section 4A - Data and Calculations - QAL2

CARBON MONOXIDE: QAL2 CALCULATIONS

(Page 5 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CEM Oxygen (DRY) % v/v	CAL		SRM Oxygen (DRY) % v/v	where CAL = Calibrated using QAL2 calibration functions			ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v		CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	
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											MAX	AVERAGE	AVERAGE	Sd
											996.43	88.19	89.93	4.85

Test of Variability

$Q_o = ELV \times (MU / 100) / 1.96$	7.65
Kv for 30 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_o \times Kv$.

Parameter	Value
Standard Deviation (Sd)	4.85
$Q_o \times Kv$	7.57
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	996.4
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The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 1096
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 15.0

Greater of (a) or (b)	0 to 1096
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Surrogate Extension Applied?	No
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Valid Calibration Range (at REF conditions)	0 to 1096 mg/m³
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Section 4A - Data and Calculations - QAL2

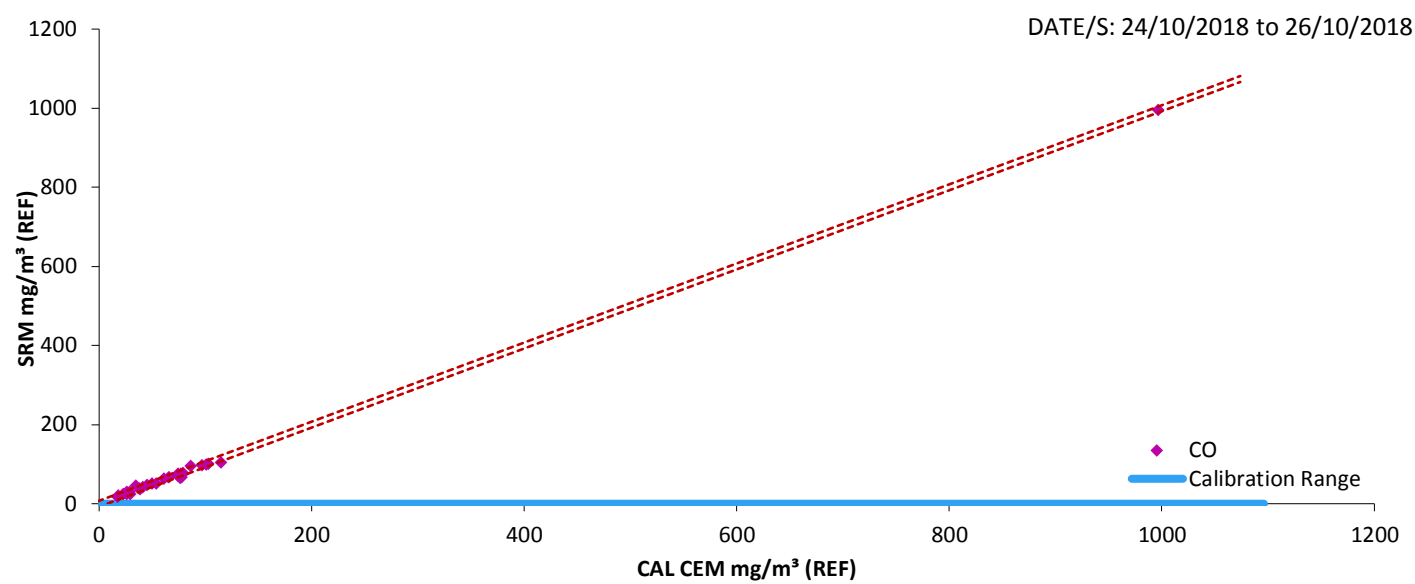
CARBON MONOXIDE: QAL2 CALCULATIONS

(Page 6 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

HYDROGEN CHLORIDE: QAL2 CALCULATIONS

(Page 1 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
H1	Surrogate	High	81.60	80.00	80.00	77.68	77.38	6010.50	6033.53	79.91
L1	Surrogate	Near Zero	0.07	0.00	0.00	-3.85	-2.62	10.10	14.85	-1.21
L2	Surrogate	Near Zero	0.07	0.00	0.00	-3.85	-2.62	10.10	14.85	-1.21
L3	Surrogate	Near Zero	0.07	0.00	0.00	-3.85	-2.62	10.10	14.85	-1.21
1	24/10/2018	18:32 - 19:02	2.36	0.84	1.02	-1.56	-1.78	2.79	2.44	1.07
2	24/10/2018	20:32 - 21:02	2.08	0.37	0.45	-1.85	-2.25	4.16	3.41	0.78
3	24/10/2018	21:32 - 22:02	1.98	0.37	0.45	-1.94	-2.25	4.38	3.78	0.69
4	24/10/2018	22:32 - 23:02	2.02	0.38	0.46	-1.90	-2.24	4.27	3.62	0.73
5	25/10/2018	23:32 - 00:02	1.93	0.42	0.50	-1.99	-2.20	4.39	3.97	0.64
6	25/10/2018	00:32 - 01:02	1.97	0.73	0.86	-1.95	-1.89	3.69	3.80	0.68
7	25/10/2018	01:32 - 02:02	1.98	0.76	0.91	-1.94	-1.87	3.62	3.76	0.69
8	25/10/2018	02:32 - 03:02	1.96	0.57	0.69	-1.96	-2.05	4.03	3.84	0.67
9	25/10/2018	03:32 - 04:02	1.94	0.60	0.74	-1.98	-2.02	4.00	3.93	0.65
10	25/10/2018	04:32 - 05:02	1.97	0.50	0.61	-1.95	-2.12	4.13	3.80	0.68
11	25/10/2018	05:32 - 06:02	1.97	0.47	0.57	-1.96	-2.15	4.22	3.83	0.67
12	25/10/2018	06:32 - 07:02	1.89	0.49	0.60	-2.03	-2.14	4.34	4.14	0.60
13	25/10/2018	07:32 - 08:02	1.96	0.60	0.73	-1.96	-2.02	3.97	3.85	0.67
14	25/10/2018	09:35 - 10:05	2.15	0.46	0.52	-1.77	-2.16	3.82	3.14	0.86
15	25/10/2018	10:35 - 11:05	1.97	0.44	0.52	-1.96	-2.18	4.26	3.83	0.67
16	25/10/2018	11:35 - 12:05	1.93	0.37	0.45	-2.00	-2.25	4.50	3.99	0.63
17	25/10/2018	12:35 - 13:05	1.85	0.37	0.45	-2.08	-2.25	4.67	4.31	0.56
18	25/10/2018	13:35 - 14:05	1.70	0.37	0.45	-2.23	-2.25	5.02	4.96	0.40
19	25/10/2018	14:35 - 15:05	1.86	0.37	0.45	-2.07	-2.25	4.65	4.27	0.56
20	25/10/2018	15:35 - 16:05	1.72	0.37	0.44	-2.21	-2.25	4.97	4.88	0.42
21	25/10/2018	16:35 - 17:05	1.66	0.37	0.45	-2.27	-2.25	5.11	5.14	0.37
22	25/10/2018	17:35 - 18:05	1.65	0.37	0.45	-2.27	-2.25	5.12	5.16	0.36
23	25/10/2018	18:35 - 19:05	1.68	0.37	0.44	-2.24	-2.25	5.05	5.03	0.39
24	25/10/2018	19:35 - 20:05	1.71	0.37	0.45	-2.22	-2.25	5.00	4.92	0.41
25	25/10/2018	20:35 - 21:05	1.70	0.38	0.46	-2.23	-2.24	5.00	4.96	0.40
26	25/10/2018	21:35 - 22:05	1.68	0.38	0.45	-2.24	-2.24	5.03	5.03	0.39
27	25/10/2018	22:35 - 23:05	1.68	0.45	0.53	-2.24	-2.17	4.86	5.02	0.39
28	26/10/2018	23:35 - 00:05	1.69	0.37	0.43	-2.23	-2.25	5.02	4.98	0.40
29	26/10/2018	00:35 - 01:05	1.74	0.37	0.44	-2.19	-2.25	4.92	4.78	0.45
30	26/10/2018	01:35 - 02:05	1.71	0.37	0.44	-2.22	-2.25	5.00	4.92	0.41
31	26/10/2018	02:35 - 03:05	1.71	0.37	0.44	-2.21	-2.25	4.99	4.90	0.42
32	26/10/2018	03:35 - 04:05	1.66	0.37	0.43	-2.27	-2.25	5.11	5.14	0.37
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Section 4A - Data and Calculations - QAL2

HYDROGEN CHLORIDE: QAL2 CALCULATIONS

(Page 2 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
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			MAX SRM - MIN SRM		0.59			SUM	6184.87	6215.62
			(DAILY) DELV (mg/m ³)		15					
			95% CI MU (%)		40					
			95% CI at DELV (mg/m ³)		6.0					
			15% of ELV		2.3					
			PROCEDURE (A, B, C)		C					
								PROCEDURE A	If (MAX SRM - MIN SRM) > 95% CI at Daily ELV	
								PROCEDURE B	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV	
								PROCEDURE C	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV	

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
1	25/10/2018	08:32 - 09:05			Instrument performing an auto-zero Statistical outlier (as defined in TGN M20 - V3)
2	24/10/2018	19:32 - 20:02	2.21	0.40	
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HYDROGEN CHLORIDE: QAL2 CALCULATIONS

(Page 3 of 6)

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)

Derivation of Calibration Function

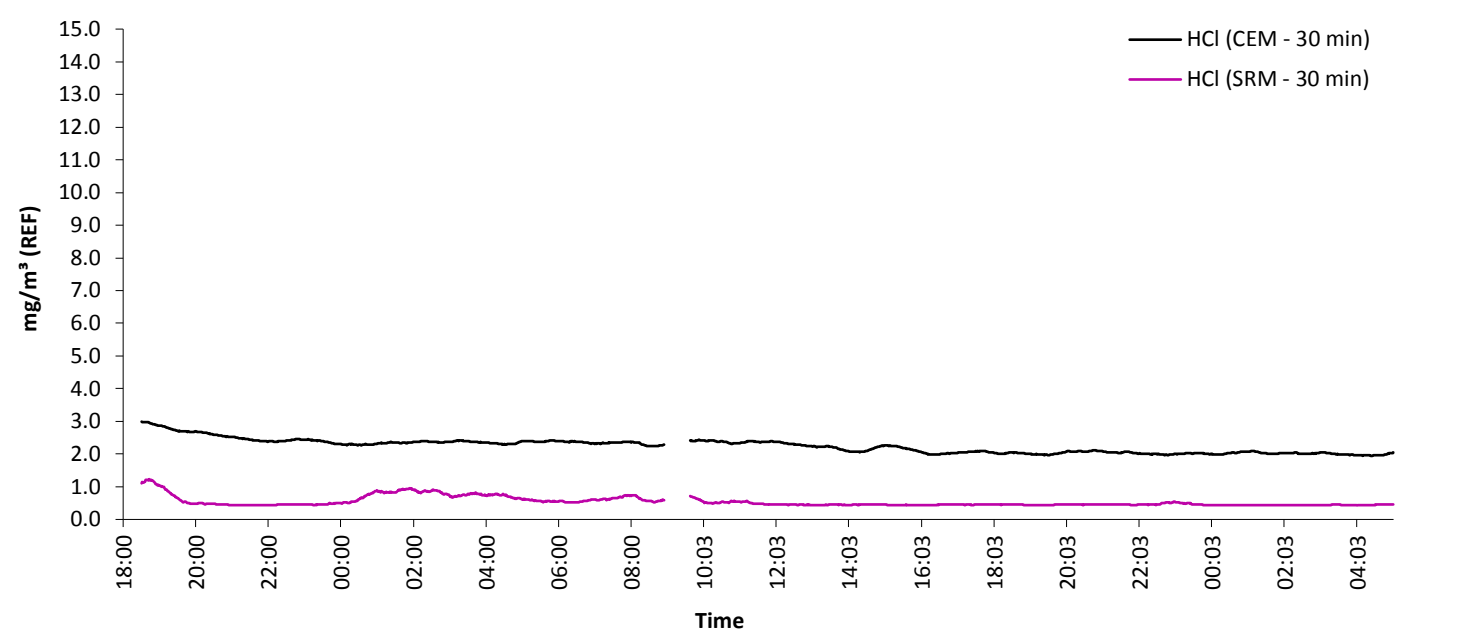
b =	0.9951	a =	-1.2841	CALIBRATION FUNCTION =	y = 0.9951x - 1.2841
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where

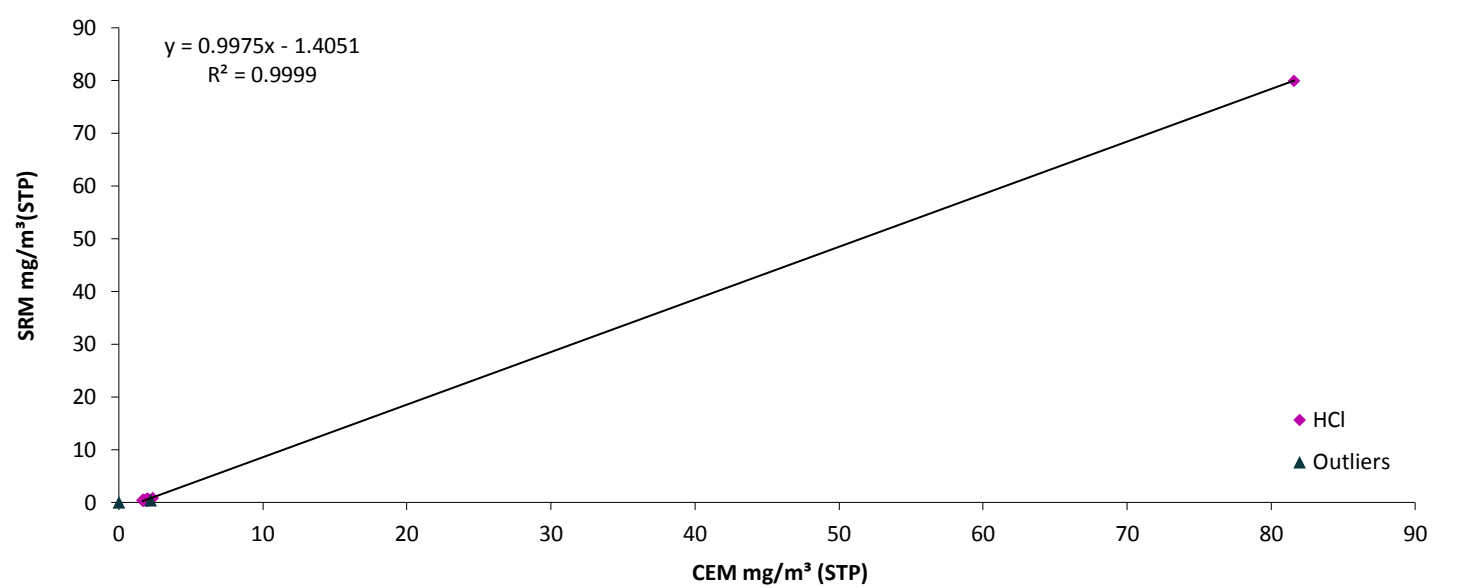
For Procedure A / C $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$

Procedure B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

PLOT 1: GRAPH FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED) (30 minute rolling averages)



PLOT 2: Calibration Graph for Procedure C



Section 4A - Data and Calculations - QAL2

HYDROGEN CHLORIDE: QAL2 CALCULATIONS

(Page 4 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CEM Oxygen (DRY) % v/v	CAL		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	where CAL = Calibrated using QAL2 calibration functions			ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v			CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	
H1	Surrogate	High	79.91	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	79.91	80.00	81.60	0.09
L1	Surrogate	Near Zero	-1.21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-1.21	0.00	0.07	1.21
L2	Surrogate	Near Zero	-1.21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-1.21	0.00	0.07	1.21
L3	Surrogate	Near Zero	-1.21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-1.21	0.00	0.07	1.21
1	24/10/2018	18:32 - 19:02	1.07	14.86	14.41	14.51	6.50	6.57	6.57	6.57	1.29	1.02	1.02	2.87	-0.27
2	24/10/2018	20:32 - 21:02	0.78	14.54	14.10	14.14	6.52	6.59	6.59	6.59	0.95	0.45	0.45	2.52	-0.50
3	24/10/2018	21:32 - 22:02	0.69	14.50	14.06	14.11	6.48	6.55	6.62	6.62	0.83	0.45	0.45	2.39	-0.38
4	24/10/2018	22:32 - 23:02	0.73	15.47	15.01	15.04	6.35	6.42	6.45	6.45	0.88	0.46	0.46	2.45	-0.43
5	25/10/2018	23:32 - 00:02	0.64	15.65	15.18	15.10	6.05	6.11	6.08	6.08	0.76	0.50	0.50	2.29	-0.26
6	25/10/2018	00:32 - 01:02	0.68	15.87	15.39	15.30	5.88	5.94	5.96	5.96	0.80	0.86	0.86	2.32	0.05
7	25/10/2018	01:32 - 02:02	0.69	15.70	15.23	15.21	6.16	6.23	6.25	6.25	0.83	0.91	0.91	2.38	0.08
8	25/10/2018	02:32 - 03:02	0.67	15.73	15.26	15.18	6.28	6.35	6.39	6.39	0.81	0.69	0.69	2.37	-0.12
9	25/10/2018	03:32 - 04:02	0.65	15.79	15.32	15.23	6.33	6.40	6.46	6.46	0.79	0.74	0.74	2.36	-0.05
10	25/10/2018	04:32 - 05:02	0.68	15.77	15.30	15.22	6.34	6.41	6.41	6.41	0.83	0.61	0.61	2.40	-0.21
11	25/10/2018	05:32 - 06:02	0.67	15.82	15.35	15.32	6.39	6.46	6.59	6.59	0.82	0.57	0.57	2.40	-0.25
12	25/10/2018	06:32 - 07:02	0.60	15.67	15.20	15.14	6.54	6.61	6.64	6.64	0.73	0.60	0.60	2.32	-0.14
13	25/10/2018	07:32 - 08:02	0.67	15.99	15.51	15.60	6.22	6.29	6.42	6.42	0.81	0.73	0.73	2.37	-0.08
14	25/10/2018	09:35 - 10:05	0.86	17.54	17.01	16.29	4.81	4.85	4.94	4.94	0.96	0.52	0.52	2.41	-0.44
15	25/10/2018	10:35 - 11:05	0.67	15.50	15.04	15.05	6.15	6.21	6.04	6.04	0.80	0.52	0.52	2.35	-0.28
16	25/10/2018	11:35 - 12:05	0.63	15.56	15.09	15.25	6.61	6.68	6.59	6.59	0.78	0.45	0.45	2.38	-0.33
17	25/10/2018	12:35 - 13:05	0.56	15.35	14.89	14.95	6.37	6.44	6.38	6.38	0.67	0.45	0.45	2.24	-0.22
18	25/10/2018	13:35 - 14:05	0.40	15.25	14.79	14.86	6.54	6.61	6.45	6.45	0.49	0.45	0.45	2.08	-0.05
19	25/10/2018	14:35 - 15:05	0.56	15.77	15.30	15.28	6.44	6.51	6.47	6.47	0.69	0.45	0.45	2.27	-0.24
20	25/10/2018	15:35 - 16:05	0.42	15.62	15.15	15.10	6.13	6.19	6.12	6.12	0.51	0.44	0.44	2.05	-0.07
21	25/10/2018	16:35 - 17:05	0.37	15.54	15.07	15.15	6.58	6.66	6.62	6.62	0.45	0.45	0.45	2.04	0.00
22	25/10/2018	17:35 - 18:05	0.36	15.88	15.40	15.23	6.48	6.55	6.54	6.54	0.44	0.45	0.45	2.03	0.01
23	25/10/2018	18:35 - 19:05	0.39	15.79	15.32	15.26	6.01	6.07	6.13	6.13	0.46	0.44	0.44	1.99	-0.02
24	25/10/2018	19:35 - 20:05	0.41	15.36	14.90	14.90	6.52	6.59	6.62	6.62	0.51	0.45	0.45	2.09	-0.06
25	25/10/2018	20:35 - 21:05	0.40	15.44	14.98	14.94	6.54	6.61	6.63	6.63	0.50	0.46	0.46	2.08	-0.03
26	25/10/2018	21:35 - 22:05	0.39	15.78	15.31	15.47	6.18	6.24	6.24	6.24	0.47	0.45	0.45	2.02	-0.01
27	25/10/2018	22:35 - 23:05	0.39	15.88	15.41	15.38	5.99	6.05	5.99	5.99	0.46	0.53	0.53	2.00	0.07
28	26/10/2018	23:35 - 00:05	0.40	15.79	15.31	15.28	5.84	5.90	5.84	5.84	0.47	0.43	0.43	1.99	-0.04
29	26/10/2018	00:35 - 01:05	0.45	15.96	15.48	15.52	6.10	6.17	6.16	6.16	0.53	0.44	0.44	2.08	-0.09
30	26/10/2018	01:35 - 02:05	0.41	16.10	15.61	15.60	6.02	6.08	6.05	6.05	0.49	0.44	0.44	2.03	-0.06
31	26/10/2018	02:35 - 03:05	0.42	16.10	15.62	15.61	6.07	6.13	6.10	6.10	0.50	0.44	0.44	2.04	-0.06
32	26/10/2018	03:35 - 04:05	0.37	16.42	15.92	15.89	5.86	5.91	5.84	5.84	0.43	0.43	0.43	1.96	0.00
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HYDROGEN CHLORIDE: QAL2 CALCULATIONS

(Page 5 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CEM Oxygen (DRY) % v/v	CAL		SRM Oxygen (DRY) % v/v	where CAL = Calibrated using QAL2 calibration functions			ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v		CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	
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											MAX	AVERAGE	AVERAGE	Sd
											1.29	0.54	2.24	0.16

Test of Variability

$Q_o = ELV \times (MU / 100) / 1.96$	3.06
Kv for 32 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_o \times Kv$.

Parameter	Value
Standard Deviation (Sd)	0.16
$Q_o \times Kv$	3.03
Outcome of Variability Test	Pass

Procedure C Acceptability Test

Average of UNCAL CEM (1)	2.24
Average of SRM (2)	0.54
ABS Difference (1) & (2)	1.70

Outcome of Procedure C Acceptability Test	Pass
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Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	1.3
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The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 1.4
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 3.0

Greater of (a) or (b)	0 to 3.0
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Surrogate Extension Applied?	NOT PERMISSIBLE
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Valid Calibration Range (at REF conditions)	0 to 3.0 mg/m³
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Section 4A - Data and Calculations - QAL2

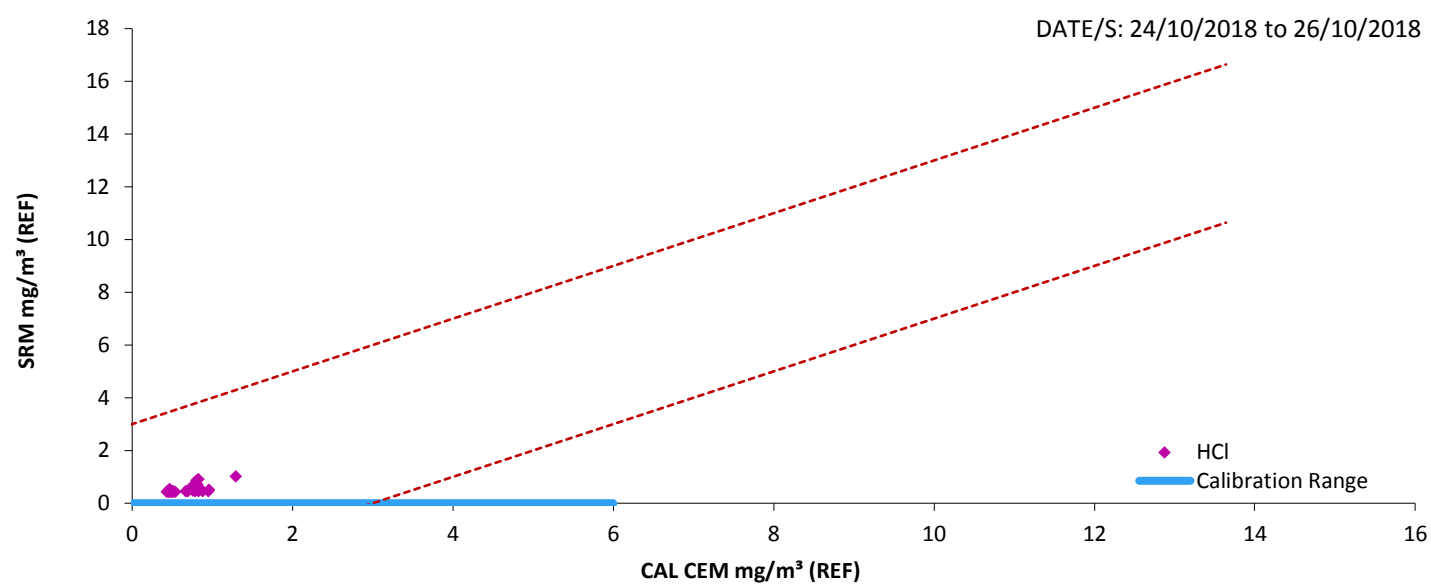
HYDROGEN CHLORIDE: QAL2 CALCULATIONS

(Page 6 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

HYDROGEN FLUORIDE: QAL2 CALCULATIONS

(Page 1 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
H1	Surrogate	High	8.17	8.00	8.00	7.66	7.64	58.50	58.70	7.98
L1	Surrogate	Near Zero	0.00	0.00	0.00	-0.51	-0.36	0.19	0.26	-0.14
L2	Surrogate	Near Zero	0.00	0.00	0.00	-0.51	-0.36	0.19	0.26	-0.14
L3	Surrogate	Near Zero	0.00	0.00	0.00	-0.51	-0.36	0.19	0.26	-0.14
1	24/10/2018	18:32 - 19:02	0.31	0.16	0.19	-0.20	-0.20	0.04	0.04	0.17
2	24/10/2018	19:32 - 20:02	0.33	0.16	0.19	-0.18	-0.20	0.04	0.03	0.19
3	24/10/2018	20:32 - 21:02	0.32	0.16	0.19	-0.19	-0.20	0.04	0.04	0.17
4	24/10/2018	21:32 - 22:02	0.31	0.16	0.19	-0.20	-0.20	0.04	0.04	0.17
5	24/10/2018	22:32 - 23:02	0.32	0.16	0.19	-0.19	-0.20	0.04	0.04	0.18
6	25/10/2018	23:32 - 00:02	0.33	0.16	0.19	-0.18	-0.20	0.04	0.03	0.19
7	25/10/2018	00:32 - 01:02	0.33	0.16	0.19	-0.18	-0.20	0.04	0.03	0.19
8	25/10/2018	01:32 - 02:02	0.31	0.16	0.19	-0.20	-0.20	0.04	0.04	0.16
9	25/10/2018	02:32 - 03:02	0.32	0.16	0.19	-0.19	-0.20	0.04	0.03	0.18
10	25/10/2018	04:32 - 05:02	0.30	0.16	0.19	-0.21	-0.20	0.04	0.04	0.16
11	25/10/2018	05:32 - 06:02	0.31	0.16	0.20	-0.20	-0.20	0.04	0.04	0.17
12	25/10/2018	06:32 - 07:02	0.31	0.16	0.20	-0.20	-0.20	0.04	0.04	0.17
13	25/10/2018	07:32 - 08:02	0.34	0.16	0.20	-0.17	-0.20	0.03	0.03	0.20
14	25/10/2018	09:35 - 10:05	0.30	0.16	0.18	-0.21	-0.20	0.04	0.04	0.16
15	25/10/2018	10:35 - 11:05	0.33	0.16	0.19	-0.18	-0.20	0.04	0.03	0.19
16	25/10/2018	11:35 - 12:05	0.31	0.16	0.20	-0.20	-0.20	0.04	0.04	0.16
17	25/10/2018	12:35 - 13:05	0.32	0.16	0.19	-0.19	-0.20	0.04	0.03	0.18
18	25/10/2018	13:35 - 14:05	0.33	0.16	0.19	-0.18	-0.20	0.04	0.03	0.18
19	25/10/2018	14:35 - 15:05	0.32	0.16	0.19	-0.19	-0.20	0.04	0.04	0.18
20	25/10/2018	15:35 - 16:05	0.31	0.16	0.19	-0.20	-0.20	0.04	0.04	0.17
21	25/10/2018	16:35 - 17:05	0.33	0.16	0.20	-0.18	-0.20	0.04	0.03	0.18
22	25/10/2018	17:35 - 18:05	0.32	0.16	0.20	-0.19	-0.20	0.04	0.04	0.17
23	25/10/2018	18:35 - 19:05	0.31	0.16	0.19	-0.20	-0.20	0.04	0.04	0.16
24	25/10/2018	19:35 - 20:05	0.31	0.16	0.20	-0.20	-0.20	0.04	0.04	0.16
25	25/10/2018	20:35 - 21:05	0.31	0.16	0.20	-0.20	-0.20	0.04	0.04	0.17
26	25/10/2018	21:35 - 22:05	0.34	0.16	0.19	-0.17	-0.20	0.04	0.03	0.19
27	25/10/2018	22:35 - 23:05	0.31	0.16	0.19	-0.20	-0.20	0.04	0.04	0.16
28	26/10/2018	23:35 - 00:05	0.32	0.16	0.19	-0.19	-0.20	0.04	0.04	0.17
29	26/10/2018	00:35 - 01:05	0.31	0.16	0.19	-0.20	-0.20	0.04	0.04	0.17
30	26/10/2018	01:35 - 02:05	0.31	0.16	0.19	-0.20	-0.20	0.04	0.04	0.17
31	26/10/2018	02:35 - 03:05	0.31	0.16	0.19	-0.20	-0.20	0.04	0.04	0.16
32	26/10/2018	03:35 - 04:05	0.31	0.16	0.19	-0.20	-0.20	0.04	0.04	0.17
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Section 4A - Data and Calculations - QAL2

HYDROGEN FLUORIDE: QAL2 CALCULATIONS

(Page 2 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
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			MAX SRM - MIN SRM		0.02			SUM	60.31	60.65
			(DAILY) DELV (mg/m ³)		2					
			95% CI MU (%)		40					
			95% CI at DELV (mg/m ³)		0.6					
			15% of ELV		0.2					
			PROCEDURE (A, B, C)		C					
								PROCEDURE A	If (MAX SRM - MIN SRM) > 95% CI at Daily ELV	
								PROCEDURE B	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV	
								PROCEDURE C	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV	

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
1	25/10/2018	08:32 - 09:05	0.34	0.16	Instrument performing an auto-zero Statistical outlier (as defined in TGN M20 - V3)
2	25/10/2018	03:32 - 04:02			
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HYDROGEN FLUORIDE: QAL2 CALCULATIONS

(Page 3 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Derivation of Calibration Function

b =	0.9943	a =	-0.1411	CALIBRATION FUNCTION =	y = 0.9943x - 0.1411
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where

For Procedure A / C

$$b = \frac{[(x - x_{av}) \times (y - y_{av})]}{(x - x_{av})^2}$$

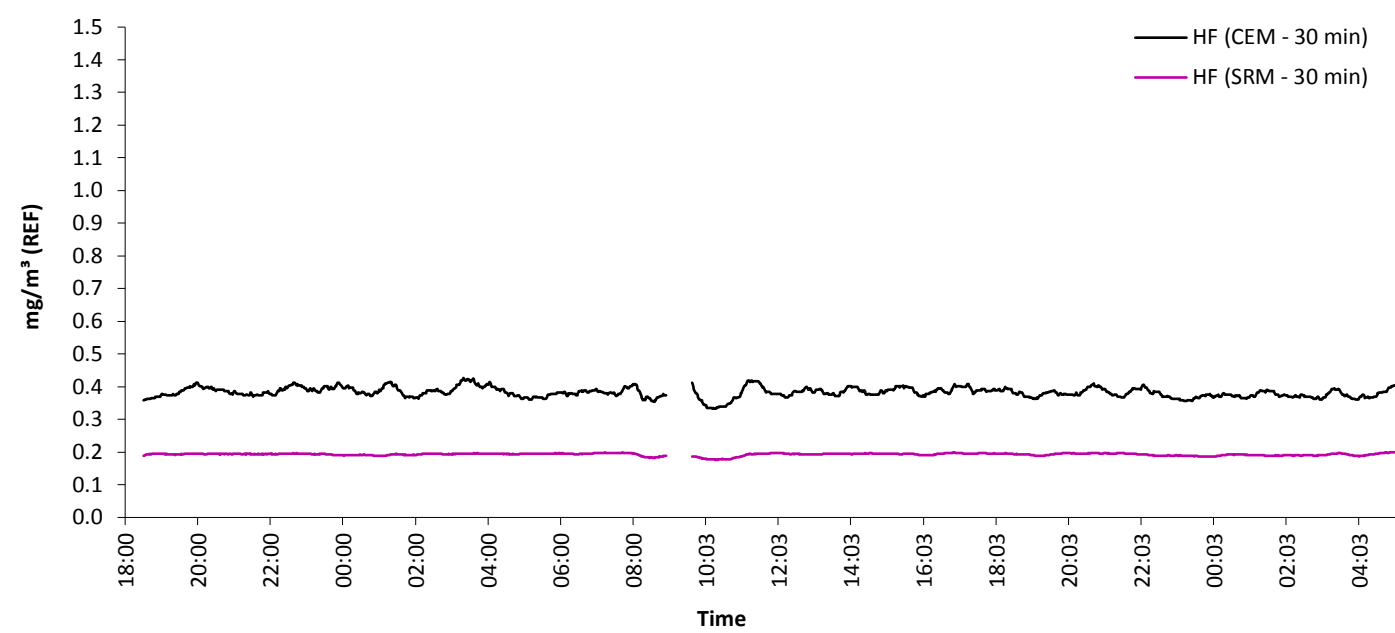
and a = MEAN(y) - [MEAN(x) x b]

Procedure B

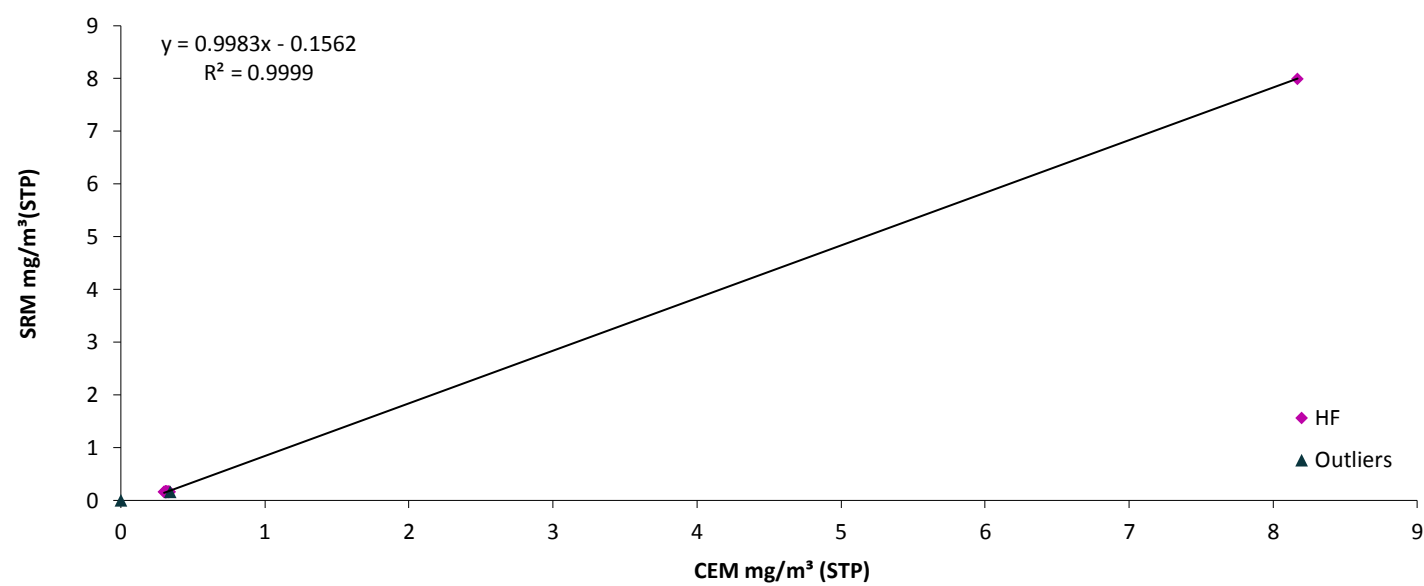
$$b = \frac{\text{MEAN}(y)}{[\text{MEAN}(x) - \text{OFFSET}]}$$

and a = -b x OFFSET

PLOT 1: GRAPH FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED) (30 minute rolling averages)



PLOT 2: Calibration Graph for Procedure C



Section 4A - Data and Calculations - QAL2

HYDROGEN FLUORIDE: QAL2 CALCULATIONS

(Page 4 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CEM Oxygen (DRY) % v/v	CAL		CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v				
H1	Surrogate	High	7.98	N/A	N/A	N/A	N/A	N/A	N/A	7.98	8.00	8.17	0.02
L1	Surrogate	Near Zero	-0.14	N/A	N/A	N/A	N/A	N/A	N/A	-0.14	0.00	0.00	0.14
L2	Surrogate	Near Zero	-0.14	N/A	N/A	N/A	N/A	N/A	N/A	-0.14	0.00	0.00	0.14
L3	Surrogate	Near Zero	-0.14	N/A	N/A	N/A	N/A	N/A	N/A	-0.14	0.00	0.00	0.14
1	24/10/2018	18:32 - 19:02	0.17	14.86	14.41	14.51	6.50	6.57	6.57	0.20	0.19	0.38	-0.01
2	24/10/2018	19:32 - 20:02	0.19	14.73	14.28	14.35	6.54	6.61	6.62	0.23	0.19	0.40	-0.04
3	24/10/2018	20:32 - 21:02	0.17	14.54	14.10	14.14	6.52	6.59	6.59	0.21	0.19	0.38	-0.02
4	24/10/2018	21:32 - 22:02	0.17	14.50	14.06	14.11	6.48	6.55	6.62	0.21	0.19	0.38	-0.01
5	24/10/2018	22:32 - 23:02	0.18	15.47	15.01	15.04	6.35	6.42	6.45	0.21	0.19	0.39	-0.02
6	25/10/2018	23:32 - 00:02	0.19	15.65	15.18	15.10	6.05	6.11	6.08	0.22	0.19	0.39	-0.04
7	25/10/2018	00:32 - 01:02	0.19	15.87	15.39	15.30	5.88	5.94	5.96	0.22	0.19	0.39	-0.03
8	25/10/2018	01:32 - 02:02	0.16	15.70	15.23	15.21	6.16	6.23	6.25	0.20	0.19	0.37	0.00
9	25/10/2018	02:32 - 03:02	0.18	15.73	15.26	15.18	6.28	6.35	6.39	0.22	0.19	0.39	-0.02
10	25/10/2018	04:32 - 05:02	0.16	15.77	15.30	15.22	6.34	6.41	6.41	0.19	0.19	0.37	0.00
11	25/10/2018	05:32 - 06:02	0.17	15.82	15.35	15.32	6.39	6.46	6.59	0.21	0.20	0.38	-0.01
12	25/10/2018	06:32 - 07:02	0.17	15.67	15.20	15.14	6.54	6.61	6.64	0.21	0.20	0.38	-0.01
13	25/10/2018	07:32 - 08:02	0.20	15.99	15.51	15.60	6.22	6.29	6.42	0.24	0.20	0.41	-0.04
14	25/10/2018	09:35 - 10:05	0.16	17.54	17.01	16.29	4.81	4.85	4.94	0.18	0.18	0.34	0.00
15	25/10/2018	10:35 - 11:05	0.19	15.50	15.04	15.05	6.15	6.21	6.04	0.23	0.19	0.40	-0.04
16	25/10/2018	11:35 - 12:05	0.16	15.56	15.09	15.25	6.61	6.68	6.59	0.20	0.20	0.38	-0.01
17	25/10/2018	12:35 - 13:05	0.18	15.35	14.89	14.95	6.37	6.44	6.38	0.22	0.19	0.39	-0.02
18	25/10/2018	13:35 - 14:05	0.18	15.25	14.79	14.86	6.54	6.61	6.45	0.22	0.19	0.40	-0.03
19	25/10/2018	14:35 - 15:05	0.18	15.77	15.30	15.28	6.44	6.51	6.47	0.22	0.19	0.39	-0.02
20	25/10/2018	15:35 - 16:05	0.17	15.62	15.15	15.10	6.13	6.19	6.12	0.20	0.19	0.37	-0.01
21	25/10/2018	16:35 - 17:05	0.18	15.54	15.07	15.15	6.58	6.66	6.62	0.23	0.20	0.40	-0.03
22	25/10/2018	17:35 - 18:05	0.17	15.88	15.40	15.23	6.48	6.55	6.54	0.21	0.20	0.39	-0.02
23	25/10/2018	18:35 - 19:05	0.16	15.79	15.32	15.26	6.01	6.07	6.13	0.19	0.19	0.36	0.00
24	25/10/2018	19:35 - 20:05	0.16	15.36	14.90	14.90	6.52	6.59	6.62	0.20	0.20	0.37	0.00
25	25/10/2018	20:35 - 21:05	0.17	15.44	14.98	14.94	6.54	6.61	6.63	0.21	0.20	0.38	-0.01
26	25/10/2018	21:35 - 22:05	0.19	15.78	15.31	15.47	6.18	6.24	6.24	0.23	0.19	0.40	-0.04
27	25/10/2018	22:35 - 23:05	0.16	15.88	15.41	15.38	5.99	6.05	5.99	0.19	0.19	0.36	0.00
28	26/10/2018	23:35 - 00:05	0.17	15.79	15.31	15.28	5.84	5.90	5.84	0.20	0.19	0.37	-0.02
29	26/10/2018	00:35 - 01:05	0.17	15.96	15.48	15.52	6.10	6.17	6.16	0.20	0.19	0.37	-0.01
30	26/10/2018	01:35 - 02:05	0.17	16.10	15.61	15.60	6.02	6.08	6.05	0.20	0.19	0.37	-0.01
31	26/10/2018	02:35 - 03:05	0.16	16.10	15.62	15.61	6.07	6.13	6.10	0.20	0.19	0.37	0.00
32	26/10/2018	03:35 - 04:05	0.17	16.42	15.92	15.89	5.86	5.91	5.84	0.20	0.19	0.37	-0.01
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HYDROGEN FLUORIDE: QAL2 CALCULATIONS

(Page 5 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CAL		CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v			CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v				
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											MAX	AVERAGE	AVERAGE	Sd
											0.24	0.19	0.38	0.01

where CAL = Calibrated using QAL2 calibration functions

Test of Variability

$Q_o = ELV \times (MU / 100) / 1.96$	0.31
Kv for 32 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_o \times Kv$.

Parameter	Value
Standard Deviation (Sd)	0.01
$Q_o \times Kv$	0.30
Outcome of Variability Test	Pass

Procedure C Acceptability Test

Average of UNCAL CEM (1)	0.38
Average of SRM (2)	0.19
ABS Difference (1) & (2)	0.19

Outcome of Procedure C Acceptability Test	Pass
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Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	0.24
--	------

The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 0.26
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 0.30

Greater of (a) or (b)	0 to 0.30
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Surrogate Extension Applied?	NOT PERMISSIBLE
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Valid Calibration Range (at REF conditions)	0 to 0.30 mg/m ³
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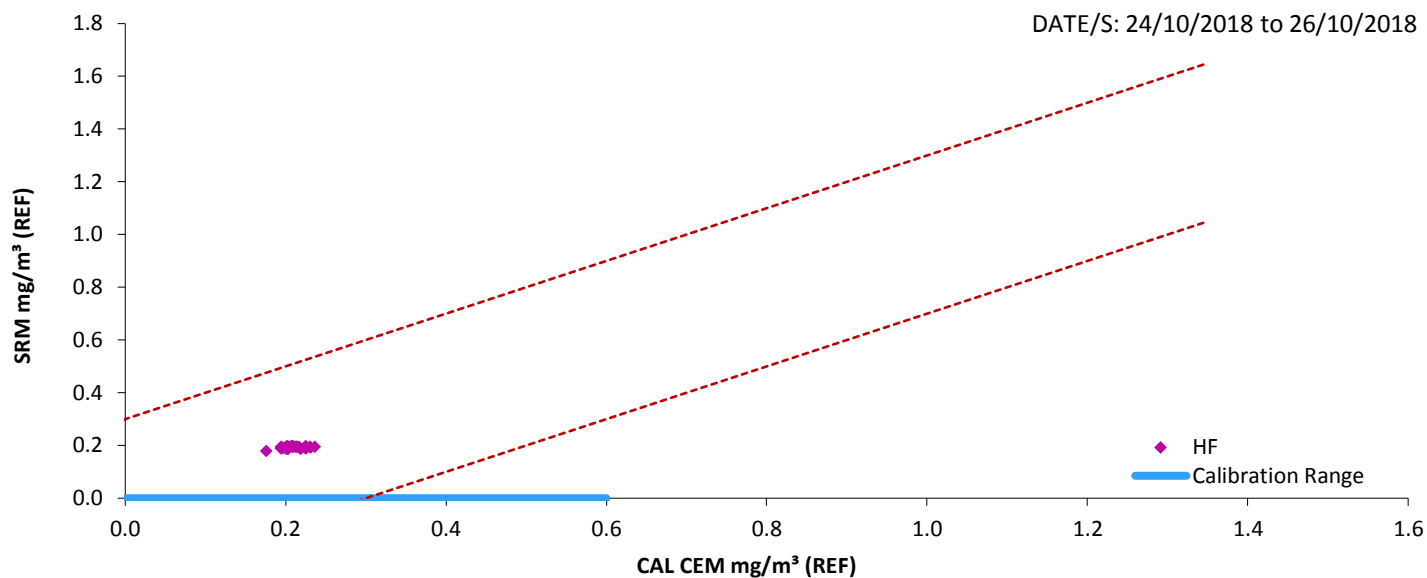
HYDROGEN FLUORIDE: QAL2 CALCULATIONS

(Page 6 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

AMMONIA: QAL2 CALCULATIONS

(Page 1 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
H1	Surrogate	High	18.93	19.15	19.15	9.09	11.00	100.04	82.68	16.07
L1	Surrogate	Near Zero	0.03	0.00	0.00	-9.81	-8.15	79.90	96.18	-0.40
L2	Surrogate	Near Zero	0.03	0.00	0.00	-9.81	-8.15	79.90	96.18	-0.40
L3	Surrogate	Near Zero	0.03	0.00	0.00	-9.81	-8.15	79.90	96.18	-0.40
1	24/10/2018	20:32 - 21:02	10.63	7.01	8.51	0.79	-1.13	-0.90	0.63	8.84
2	24/10/2018	21:32 - 22:02	11.53	8.95	10.87	1.69	0.80	1.35	2.85	9.62
3	24/10/2018	22:32 - 23:02	13.41	10.36	12.56	3.57	2.21	7.88	12.74	11.26
4	25/10/2018	23:32 - 00:02	13.49	11.02	13.05	3.65	2.87	10.47	13.32	11.33
5	25/10/2018	00:32 - 01:02	11.23	10.50	12.36	1.39	2.35	3.28	1.95	9.36
6	25/10/2018	01:32 - 02:02	10.00	8.59	10.30	0.17	0.44	0.07	0.03	8.29
7	25/10/2018	02:32 - 03:02	10.22	8.70	10.53	0.38	0.55	0.21	0.15	8.48
8	25/10/2018	03:32 - 04:02	10.28	8.76	10.66	0.44	0.61	0.27	0.19	8.53
9	25/10/2018	04:32 - 05:02	9.82	7.92	9.60	-0.02	-0.23	0.00	0.00	8.13
10	25/10/2018	05:32 - 06:02	9.74	8.33	10.24	-0.10	0.18	-0.02	0.01	8.06
11	25/10/2018	06:32 - 07:02	10.16	8.79	10.82	0.32	0.65	0.21	0.10	8.43
12	25/10/2018	07:32 - 08:02	10.09	8.66	10.55	0.25	0.51	0.13	0.06	8.37
13	25/10/2018	09:35 - 10:05	11.28	9.56	10.67	1.44	1.41	2.04	2.07	9.40
14	25/10/2018	10:35 - 11:05	10.94	8.87	10.46	1.10	0.72	0.80	1.22	9.11
15	25/10/2018	11:35 - 12:05	11.61	9.67	11.88	1.78	1.53	2.71	3.15	9.69
16	25/10/2018	12:35 - 13:05	13.45	10.58	12.77	3.61	2.43	8.80	13.06	11.30
17	25/10/2018	13:35 - 14:05	13.19	10.45	12.66	3.36	2.30	7.73	11.26	11.07
18	25/10/2018	14:35 - 15:05	16.10	12.42	15.13	6.27	4.27	26.78	39.26	13.61
19	25/10/2018	15:35 - 16:05	12.33	10.30	12.23	2.49	2.15	5.37	6.22	10.32
20	25/10/2018	16:35 - 17:05	10.84	9.36	11.51	1.00	1.21	1.21	1.00	9.02
21	25/10/2018	17:35 - 18:05	10.53	8.83	10.80	0.69	0.68	0.47	0.48	8.75
22	25/10/2018	18:35 - 19:05	9.51	7.56	8.99	-0.32	-0.59	0.19	0.11	7.86
23	25/10/2018	19:35 - 20:05	8.74	7.12	8.73	-1.10	-1.02	1.12	1.20	7.19
24	25/10/2018	20:35 - 21:05	8.56	7.19	8.82	-1.27	-0.96	1.22	1.62	7.04
25	25/10/2018	21:35 - 22:05	8.35	7.00	8.42	-1.49	-1.14	1.70	2.21	6.85
26	25/10/2018	22:35 - 23:05	8.03	7.24	8.55	-1.81	-0.91	1.64	3.26	6.57
27	26/10/2018	23:35 - 00:05	7.77	6.67	7.79	-2.06	-1.48	3.05	4.26	6.35
28	26/10/2018	00:35 - 01:05	8.02	6.04	7.22	-1.82	-2.11	3.83	3.31	6.56
29	26/10/2018	01:35 - 02:05	8.35	6.43	7.65	-1.49	-1.71	2.55	2.22	6.85
30	26/10/2018	02:35 - 03:05	8.35	6.42	7.66	-1.49	-1.73	2.57	2.22	6.85
31	26/10/2018	03:35 - 04:05	8.73	6.71	7.90	-1.11	-1.43	1.59	1.24	7.18
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AMMONIA: QAL2 CALCULATIONS
(Page 2 of 6)

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 6% O₂) mg/m³	$x - x_{av}$ (A)	$y - y_{av}$ (B)	(A) x (B)	$(x - x_{av})^2$	CAL CEM (STP, WET) mg/m³
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			MAX SRM - MIN SRM		7.91			SUM	438.10	502.62
			(DAILY) DELV (mg/m³)		50					
			95% CI MU (%)		40					
			95% CI at ELV (mg/m³)		20.0					
			15% of ELV		7.5					
			PROCEDURE (A, B, C)		C					
			Virtual							

Section 4A - Data and Calculations - QAL2

AMMONIA: QAL2 CALCULATIONS

(Page 3 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Derivation of Calibration Function

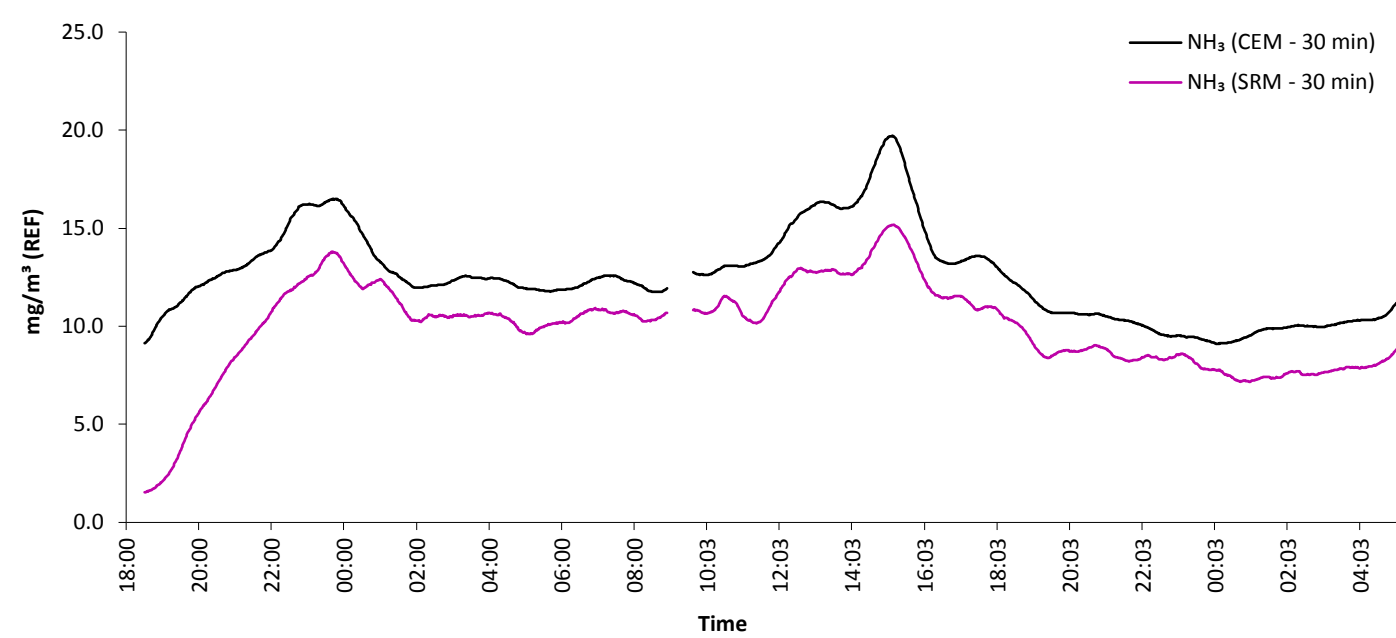
b =	0.8716	a =	-0.4274	CALIBRATION FUNCTION =	y = 0.8716x - 0.4274
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where

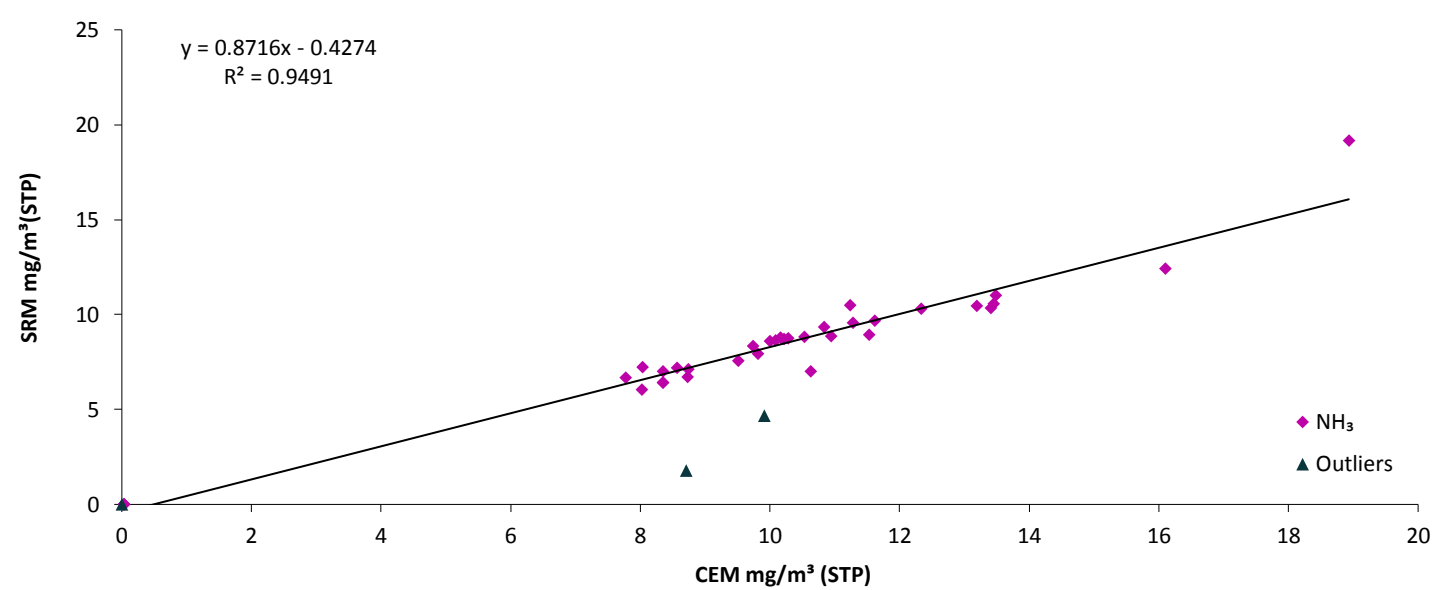
For Procedure A / C $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$

Procedure B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

PLOT 1: GRAPH FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED) (30 minute rolling averages)



PLOT 2: Calibration Graph for Procedure C



Section 4A - Data and Calculations - QAL2

AMMONIA: QAL2 CALCULATIONS

(Page 4 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CEM Oxygen (DRY) % v/v	CAL		SRM Oxygen (DRY) % v/v	where CAL = Calibrated using QAL2 calibration functions			ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v		CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v		CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	
H1	Surrogate	High	16.07	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16.07	19.15	18.93	3.08
L1	Surrogate	Near Zero	-0.40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-0.40	0.00	0.03	0.40
L2	Surrogate	Near Zero	-0.40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-0.40	0.00	0.03	0.40
L3	Surrogate	Near Zero	-0.40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	-0.40	0.00	0.03	0.40
1	24/10/2018	20:32 - 21:02	8.84	14.54	14.10	14.14	6.52	6.59	6.59	10.71	8.51	12.88	-2.21	
2	24/10/2018	21:32 - 22:02	9.62	14.50	14.06	14.11	6.48	6.55	6.62	11.62	10.87	13.93	-0.75	
3	24/10/2018	22:32 - 23:02	11.26	15.47	15.01	15.04	6.35	6.42	6.45	13.63	12.56	16.23	-1.06	
4	25/10/2018	23:32 - 00:02	11.33	15.65	15.18	15.10	6.05	6.11	6.08	13.45	13.05	16.02	-0.41	
5	25/10/2018	00:32 - 01:02	9.36	15.87	15.39	15.30	5.88	5.94	5.96	11.02	12.36	13.22	1.34	
6	25/10/2018	01:32 - 02:02	8.29	15.70	15.23	15.21	6.16	6.23	6.25	9.93	10.30	11.98	0.36	
7	25/10/2018	02:32 - 03:02	8.48	15.73	15.26	15.18	6.28	6.35	6.39	10.24	10.53	12.34	0.28	
8	25/10/2018	03:32 - 04:02	8.53	15.79	15.32	15.23	6.33	6.40	6.46	10.35	10.66	12.47	0.31	
9	25/10/2018	04:32 - 05:02	8.13	15.77	15.30	15.22	6.34	6.41	6.41	9.86	9.60	11.91	-0.26	
10	25/10/2018	05:32 - 06:02	8.06	15.82	15.35	15.32	6.39	6.46	6.59	9.82	10.24	11.87	0.41	
11	25/10/2018	06:32 - 07:02	8.43	15.67	15.20	15.14	6.54	6.61	6.64	10.36	10.82	12.48	0.47	
12	25/10/2018	07:32 - 08:02	8.37	15.99	15.51	15.60	6.22	6.29	6.42	10.10	10.55	12.18	0.46	
13	25/10/2018	09:35 - 10:05	9.40	17.54	17.01	16.29	4.81	4.85	4.94	10.52	10.67	12.62	0.15	
14	25/10/2018	10:35 - 11:05	9.11	15.50	15.04	15.05	6.15	6.21	6.04	10.87	10.46	13.06	-0.41	
15	25/10/2018	11:35 - 12:05	9.69	15.56	15.09	15.25	6.61	6.68	6.59	11.96	11.88	14.33	-0.07	
16	25/10/2018	12:35 - 13:05	11.30	15.35	14.89	14.95	6.37	6.44	6.38	13.68	12.77	16.29	-0.91	
17	25/10/2018	13:35 - 14:05	11.07	15.25	14.79	14.86	6.54	6.61	6.45	13.55	12.66	16.14	-0.89	
18	25/10/2018	14:35 - 15:05	13.61	15.77	15.30	15.28	6.44	6.51	6.47	16.63	15.13	19.68	-1.50	
19	25/10/2018	15:35 - 16:05	10.32	15.62	15.15	15.10	6.13	6.19	6.12	12.32	12.23	14.72	-0.10	
20	25/10/2018	16:35 - 17:05	9.02	15.54	15.07	15.15	6.58	6.66	6.62	11.10	11.51	13.34	0.40	
21	25/10/2018	17:35 - 18:05	8.75	15.88	15.40	15.23	6.48	6.55	6.54	10.74	10.80	12.92	0.06	
22	25/10/2018	18:35 - 19:05	7.86	15.79	15.32	15.26	6.01	6.07	6.13	9.33	8.99	11.29	-0.34	
23	25/10/2018	19:35 - 20:05	7.19	15.36	14.90	14.90	6.52	6.59	6.62	8.80	8.73	10.69	-0.06	
24	25/10/2018	20:35 - 21:05	7.04	15.44	14.98	14.94	6.54	6.61	6.63	8.63	8.82	10.50	0.19	
25	25/10/2018	21:35 - 22:05	6.85	15.78	15.31	15.47	6.18	6.24	6.24	8.22	8.42	10.02	0.19	
26	25/10/2018	22:35 - 23:05	6.57	15.88	15.41	15.38	5.99	6.05	5.99	7.80	8.55	9.53	0.75	
27	26/10/2018	23:35 - 00:05	6.35	15.79	15.31	15.28	5.84	5.90	5.84	7.45	7.79	9.12	0.34	
28	26/10/2018	00:35 - 01:05	6.56	15.96	15.48	15.52	6.10	6.17	6.16	7.85	7.22	9.59	-0.63	
29	26/10/2018	01:35 - 02:05	6.85	16.10	15.61	15.60	6.02	6.08	6.05	8.16	7.65	9.95	-0.52	
30	26/10/2018	02:35 - 03:05	6.85	16.10	15.62	15.61	6.07	6.13	6.10	8.19	7.66	9.98	-0.53	
31	26/10/2018	03:35 - 04:05	7.18	16.42	15.92	15.89	5.86	5.91	5.84	8.49	7.90	10.32	-0.59	
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Section 4A - Data and Calculations - QAL2

AMMONIA: QAL2 CALCULATIONS

(Page 5 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 6% O ₂) mg/m ³	SRM (STP, DRY, 6% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 6% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v			CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
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												MAX	AVERAGE	AVERAGE	Sd
												16.63	10.32	12.63	0.71

where CAL = Calibrated using QAL2 calibration functions

Test of Variability

$Q_o = ELV \times (MU / 100) / 1.96$	10.20
Kv for 31 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_o \times Kv$.

Parameter	Value
Standard Deviation (Sd)	0.71
$Q_o \times Kv$	10.09
Outcome of Variability Test	Pass

Procedure C Acceptability Test

Average of UNCAL CEM (1)	12.63
Average of SRM (2)	10.32
ABS Difference (1) & (2)	2.31

Outcome of Procedure C Acceptability Test	Pass
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Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	16.6
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The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 18.3
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 10.0

Greater of (a) or (b)	0 to 18.3
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Surrogate Extension Applied?	NOT PERMISSIBLE
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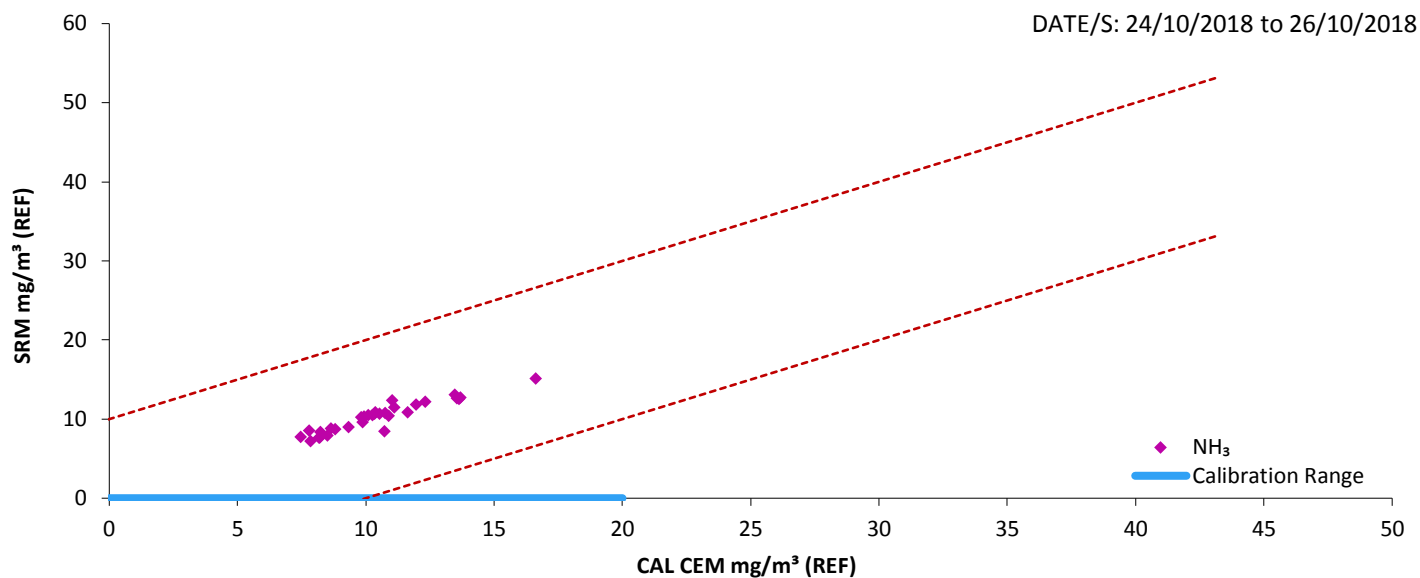
Valid Calibration Range (at REF conditions)	0 to 18.3 mg/m ³
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AMMONIA: QAL2 CALCULATIONS

(Page 6 of 6)

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

WATER VAPOUR: QAL2 CALCULATIONS

(Page 1 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (ACTUAL) % v/v	y, SRM (ACTUAL) % v/v	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (ACTUAL) % v/v
L1	Surrogate	Near Zero	0.00	0.00	-14.26	-13.83	197.30	203.42	0.00
L2	Surrogate	Near Zero	0.00	0.00	-14.26	-13.83	197.30	203.42	0.00
L3	Surrogate	Near Zero	0.00	0.00	-14.26	-13.83	197.30	203.42	0.00
1	24/10/2018	18:32 - 19:02	14.86	14.51	0.60	0.68	0.41	0.36	14.41
2	24/10/2018	19:32 - 20:02	14.73	14.35	0.46	0.52	0.24	0.22	14.28
3	24/10/2018	20:32 - 21:02	14.54	14.14	0.28	0.31	0.09	0.08	14.10
4	24/10/2018	21:32 - 22:02	14.50	14.11	0.24	0.28	0.07	0.06	14.06
5	24/10/2018	22:32 - 23:02	15.47	15.04	1.21	1.20	1.46	1.47	15.01
6	25/10/2018	23:32 - 00:02	15.65	15.10	1.39	1.27	1.76	1.92	15.18
7	25/10/2018	00:32 - 01:02	15.87	15.30	1.61	1.46	2.35	2.58	15.39
8	25/10/2018	01:32 - 02:02	15.70	15.21	1.44	1.38	1.98	2.07	15.23
9	25/10/2018	02:32 - 03:02	15.73	15.18	1.47	1.35	1.98	2.15	15.26
10	25/10/2018	03:32 - 04:02	15.79	15.23	1.53	1.40	2.14	2.35	15.32
11	25/10/2018	04:32 - 05:02	15.77	15.22	1.51	1.38	2.08	2.27	15.30
12	25/10/2018	05:32 - 06:02	15.82	15.32	1.56	1.48	2.32	2.44	15.35
13	25/10/2018	06:32 - 07:02	15.67	15.14	1.41	1.31	1.84	1.99	15.20
14	25/10/2018	07:32 - 08:02	15.99	15.60	1.73	1.77	3.06	3.00	15.51
15	25/10/2018	10:32 - 11:02	15.50	15.05	1.24	1.21	1.51	1.54	15.04
16	25/10/2018	11:32 - 12:02	15.56	15.25	1.29	1.42	1.83	1.67	15.09
17	25/10/2018	12:32 - 13:02	15.35	14.95	1.09	1.11	1.21	1.18	14.89
18	25/10/2018	13:32 - 14:02	15.25	14.86	0.98	1.03	1.01	0.97	14.79
19	25/10/2018	14:32 - 15:02	15.77	15.28	1.51	1.45	2.19	2.27	15.30
20	25/10/2018	15:32 - 16:02	15.62	15.10	1.36	1.26	1.72	1.85	15.15
21	25/10/2018	16:32 - 17:02	15.54	15.15	1.27	1.32	1.68	1.62	15.07
22	25/10/2018	17:32 - 18:02	15.88	15.23	1.62	1.40	2.26	2.61	15.40
23	25/10/2018	18:32 - 19:02	15.79	15.26	1.53	1.43	2.18	2.33	15.32
24	25/10/2018	19:32 - 20:02	15.36	14.90	1.10	1.07	1.18	1.21	14.90
25	25/10/2018	20:32 - 21:02	15.44	14.94	1.18	1.10	1.30	1.39	14.98
26	25/10/2018	21:32 - 22:02	15.78	15.47	1.52	1.63	2.48	2.31	15.31
27	25/10/2018	22:32 - 23:02	15.88	15.38	1.62	1.54	2.50	2.63	15.41
28	26/10/2018	23:32 - 00:02	15.79	15.28	1.53	1.45	2.21	2.33	15.31
29	26/10/2018	00:32 - 01:02	15.96	15.52	1.70	1.68	2.86	2.89	15.48
30	26/10/2018	01:32 - 02:02	16.10	15.60	1.83	1.76	3.23	3.36	15.61
31	26/10/2018	02:32 - 03:02	16.10	15.61	1.84	1.78	3.28	3.39	15.62
32	26/10/2018	03:32 - 04:02	16.42	15.89	2.16	2.05	4.43	4.64	15.92
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Section 4A - Data and Calculations - QAL2

WATER VAPOUR: QAL2 CALCULATIONS

(Page 2 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (ACTUAL) % v/v	y, SRM (ACTUAL) % v/v	$x - x_{av}$ (A)	$y - y_{av}$ (B)	(A) x (B)	$(x - x_{av})^2$	CAL CEM (ACTUAL) % v/v
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67									
68									
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MAX SRM - MIN SRM				1.78			SUM	652.73	673.38
(DAILY) DELV (% v/v)				30					
95% CI MU (%)				30					
95% CI at DELV (% v/v)				9.0					
PROCEDURE (A OR B)				B					

PROCEDURE A If (MAX SRM - MIN SRM) > 95% CI at Daily ELV
PROCEDURE B If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and
 MIN SRM ≥ 15% of Daily ELV

WHERE OFFSET = 0

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (ACTUAL) % v/v	y, SRM (ACTUAL) % v/v	Reason for Data Pair Removal
1	25/10/2018	08:32 - 09:02			Instrument performing an auto-zero Statistical outlier (as defined in TGN M20 - V3)
2	25/10/2018	09:32 - 10:02	17.54	16.29	
3					
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Section 4A - Data and Calculations - QAL2

WATER VAPOUR: QAL2 CALCULATIONS

(Page 3 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Derivation of Calibration Function

b =	0.9699	a =	0.0000	CALIBRATION FUNCTION =	y = 0.9699x + 0.0000
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where

For Method A

$$b = \frac{[(x - x_{av}) \times (y - y_{av})]}{(x - x_{av})^2}$$

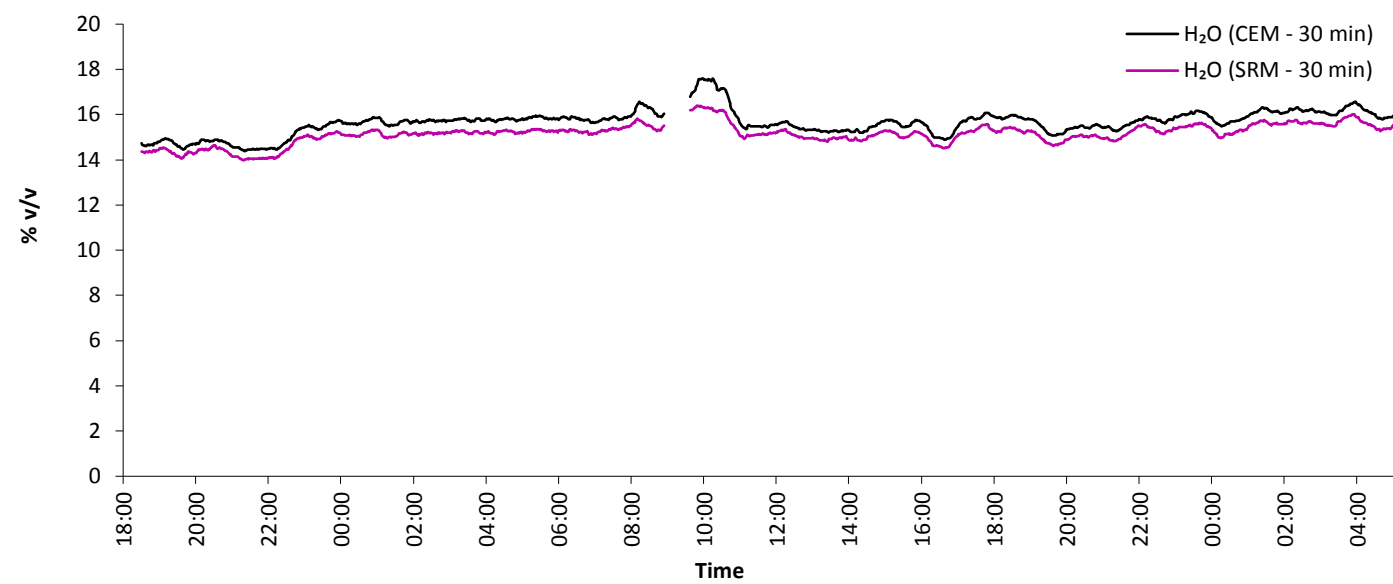
$$\text{and } a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$$

Method B

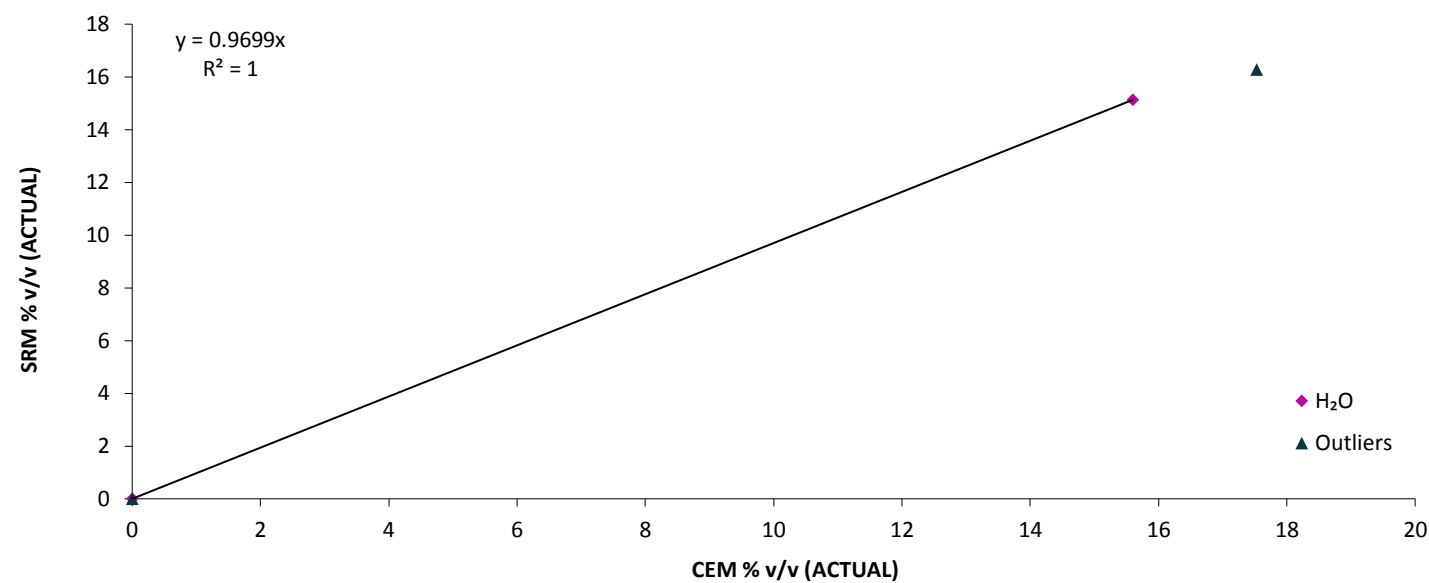
$$b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$$

$$\text{and } a = -b \times \text{OFFSET}$$

PLOT 1: GRAPH FOR STP SRM vs STP CEM (30 minute rolling averages)



PLOT 2: Calibration Graph for Method B



Section 4A - Data and Calculations - QAL2

WATER VAPOUR: QAL2 CALCULATIONS

(Page 4 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (ACTUAL) % v/v	ys, SRM (ACTUAL) % v/v	UNCAL CEM (ACTUAL) % v/v	ys, SRM - CAL CEM
L1	Surrogate	Near Zero	0.00	0.00	0.00	0.00
L2	Surrogate	Near Zero	0.00	0.00	0.00	0.00
L3	Surrogate	Near Zero	0.00	0.00	0.00	0.00
1	24/10/2018	18:32 - 19:02	14.41	14.51	14.86	0.10
2	24/10/2018	19:32 - 20:02	14.28	14.35	14.73	0.07
3	24/10/2018	20:32 - 21:02	14.10	14.14	14.54	0.04
4	24/10/2018	21:32 - 22:02	14.06	14.11	14.50	0.05
5	24/10/2018	22:32 - 23:02	15.01	15.04	15.47	0.03
6	25/10/2018	23:32 - 00:02	15.18	15.10	15.65	-0.07
7	25/10/2018	00:32 - 01:02	15.39	15.30	15.87	-0.10
8	25/10/2018	01:32 - 02:02	15.23	15.21	15.70	-0.02
9	25/10/2018	02:32 - 03:02	15.26	15.18	15.73	-0.07
10	25/10/2018	03:32 - 04:02	15.32	15.23	15.79	-0.09
11	25/10/2018	04:32 - 05:02	15.30	15.22	15.77	-0.08
12	25/10/2018	05:32 - 06:02	15.35	15.32	15.82	-0.03
13	25/10/2018	06:32 - 07:02	15.20	15.14	15.67	-0.06
14	25/10/2018	07:32 - 08:02	15.51	15.60	15.99	0.09
15	25/10/2018	10:32 - 11:02	15.04	15.05	15.50	0.01
16	25/10/2018	11:32 - 12:02	15.09	15.25	15.56	0.16
17	25/10/2018	12:32 - 13:02	14.89	14.95	15.35	0.06
18	25/10/2018	13:32 - 14:02	14.79	14.86	15.25	0.07
19	25/10/2018	14:32 - 15:02	15.30	15.28	15.77	-0.01
20	25/10/2018	15:32 - 16:02	15.15	15.10	15.62	-0.06
21	25/10/2018	16:32 - 17:02	15.07	15.15	15.54	0.08
22	25/10/2018	17:32 - 18:02	15.40	15.23	15.88	-0.17
23	25/10/2018	18:32 - 19:02	15.32	15.26	15.79	-0.05
24	25/10/2018	19:32 - 20:02	14.90	14.90	15.36	0.00
25	25/10/2018	20:32 - 21:02	14.98	14.94	15.44	-0.04
26	25/10/2018	21:32 - 22:02	15.31	15.47	15.78	0.16
27	25/10/2018	22:32 - 23:02	15.41	15.38	15.88	-0.03
28	26/10/2018	23:32 - 00:02	15.31	15.28	15.79	-0.03
29	26/10/2018	00:32 - 01:02	15.48	15.52	15.96	0.04
30	26/10/2018	01:32 - 02:02	15.61	15.60	16.10	-0.01
31	26/10/2018	02:32 - 03:02	15.62	15.61	16.10	0.00
32	26/10/2018	03:32 - 04:02	15.92	15.89	16.42	-0.04
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Section 4A - Data and Calculations - QAL2

WATER VAPOUR: QAL2 CALCULATIONS

(Page 5 of 6)

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (ACTUAL) % v/v	ys, SRM (ACTUAL) % v/v	UNCAL CEM (ACTUAL) % v/v	ys, SRM - CAL CEM
66						
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90						
			MAX	AVERAGE	AVERAGE	Sd
			15.92	15.13	15.60	0.08

Test of Variability

$Q_o = ELV \times (MU / 100) / 1.96$	4.59
Kv for 32 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_o \times Kv$

Parameter	Value
Standard Deviation (Sd)	0.08
$Q_o \times Kv$	4.54
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (% v/v)	15.9
Allowable Extension (%)	10

Valid Calibration Range	0 to 17.5 % v/v
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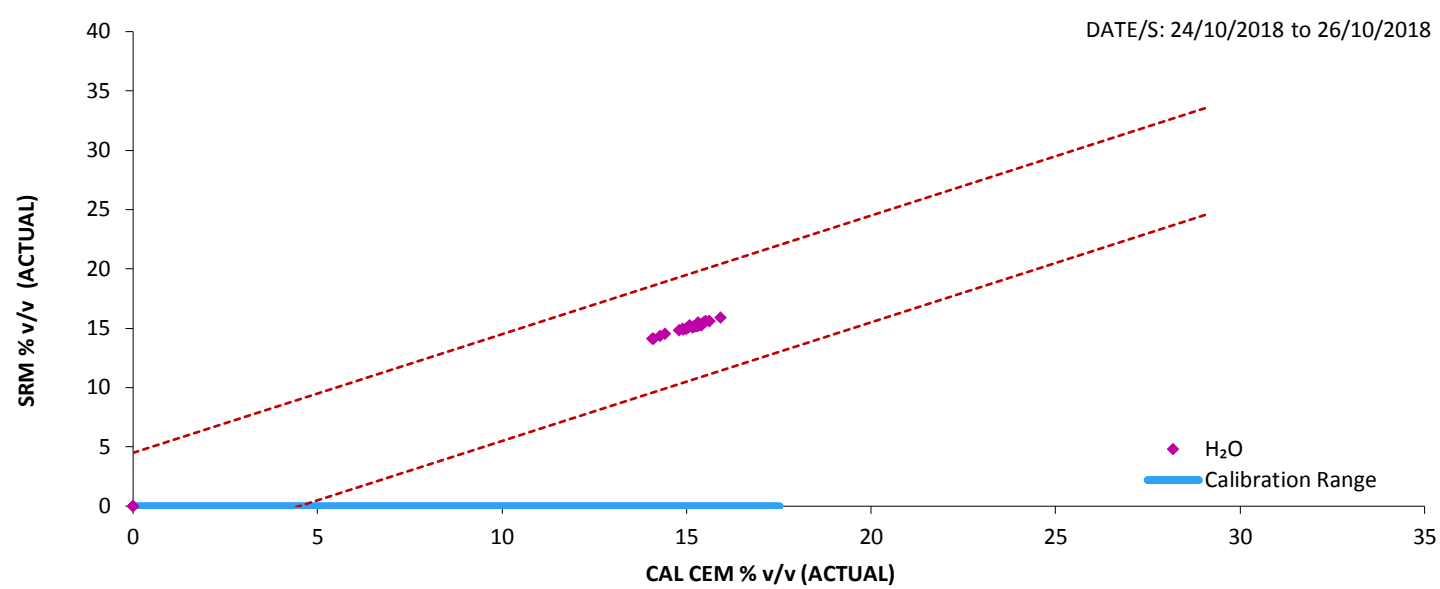
Section 4A - Data and Calculations - QAL2

WATER VAPOUR: QAL2 CALCULATIONS
 (Page 6 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

PLOT 3: X-Y Plot - ACTUAL CAL CEM vs ACTUAL SRM Values



Section 4A - Data and Calculations - QAL2

OXYGEN: QAL2 CALCULATIONS (HNA03GH001)

(Page 1 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (DRY) % v/v	y, SRM (DRY) % v/v	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (DRY) % v/v
L1	Surrogate	Near Zero	0.04	0.00	-5.62	-5.72	32.15	31.61	0.00
L2	Surrogate	Near Zero	0.04	0.00	-5.62	-5.72	32.15	31.61	0.00
L3	Surrogate	Near Zero	0.04	0.00	-5.62	-5.72	32.15	31.61	0.00
1	24/10/2018	18:32 - 19:02	6.50	6.57	0.84	0.85	0.71	0.70	6.57
2	24/10/2018	19:32 - 20:02	6.54	6.62	0.88	0.91	0.80	0.77	6.61
3	24/10/2018	20:32 - 21:02	6.52	6.59	0.86	0.88	0.75	0.74	6.59
4	24/10/2018	21:32 - 22:02	6.48	6.62	0.82	0.90	0.74	0.68	6.55
5	24/10/2018	22:32 - 23:02	6.35	6.45	0.69	0.73	0.50	0.47	6.42
6	25/10/2018	23:32 - 00:02	6.05	6.08	0.38	0.37	0.14	0.15	6.11
7	25/10/2018	00:32 - 01:02	5.88	5.96	0.22	0.24	0.05	0.05	5.94
8	25/10/2018	01:32 - 02:02	6.16	6.25	0.50	0.53	0.27	0.25	6.23
9	25/10/2018	02:32 - 03:02	6.28	6.39	0.62	0.67	0.41	0.38	6.35
10	25/10/2018	03:32 - 04:02	6.33	6.46	0.67	0.74	0.49	0.45	6.40
11	25/10/2018	04:32 - 05:02	6.34	6.41	0.68	0.69	0.47	0.46	6.41
12	25/10/2018	06:32 - 07:02	6.54	6.64	0.87	0.92	0.80	0.76	6.61
13	25/10/2018	07:32 - 08:02	6.22	6.42	0.56	0.70	0.39	0.31	6.29
14	25/10/2018	09:32 - 10:02	4.81	4.94	-0.86	-0.78	0.66	0.73	4.85
15	25/10/2018	11:32 - 12:02	6.61	6.59	0.94	0.87	0.83	0.89	6.68
16	25/10/2018	12:32 - 13:02	6.37	6.38	0.71	0.66	0.47	0.51	6.44
17	25/10/2018	14:32 - 15:02	6.44	6.47	0.78	0.75	0.58	0.61	6.51
18	25/10/2018	15:32 - 16:02	6.13	6.12	0.46	0.40	0.18	0.22	6.19
19	25/10/2018	16:32 - 17:02	6.58	6.62	0.92	0.91	0.84	0.85	6.66
20	25/10/2018	17:32 - 18:02	6.48	6.54	0.82	0.82	0.67	0.67	6.55
21	25/10/2018	18:32 - 19:02	6.01	6.13	0.35	0.41	0.14	0.12	6.07
22	25/10/2018	19:32 - 20:02	6.52	6.62	0.85	0.90	0.77	0.73	6.59
23	25/10/2018	20:32 - 21:02	6.54	6.63	0.87	0.91	0.80	0.76	6.61
24	25/10/2018	21:32 - 22:02	6.18	6.24	0.52	0.52	0.27	0.27	6.24
25	25/10/2018	22:32 - 23:02	5.99	5.99	0.32	0.27	0.09	0.11	6.05
26	26/10/2018	23:32 - 00:02	5.84	5.84	0.18	0.12	0.02	0.03	5.90
27	26/10/2018	00:32 - 01:02	6.10	6.16	0.44	0.44	0.19	0.19	6.17
28	26/10/2018	01:32 - 02:02	6.02	6.05	0.36	0.33	0.12	0.13	6.08
29	26/10/2018	02:32 - 03:02	6.07	6.10	0.41	0.38	0.15	0.17	6.13
30	26/10/2018	03:32 - 04:02	5.86	5.84	0.19	0.12	0.02	0.04	5.91
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Section 4A - Data and Calculations - QAL2

OXYGEN: QAL2 CALCULATIONS (HNA03GH001)

(Page 2 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (DRY) % v/v	y, SRM (DRY) % v/v	$x - x_{av}$ (A)	$y - y_{av}$ (B)	(A) x (B)	$(x - x_{av})^2$	CAL CEM (DRY) % v/v
66									
67									
68									
69									
70									
71									
72									
73									
74									
75									
76									
77									
78									
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80									
81									
82									
83									
84									
85									
86									
87									
88									
89									
90									
MAX SRM - MIN SRM				1.70			SUM	109.80	108.03
(DAILY) DELV (% v/v)				21					
95% CI MU (%)				10					
95% CI at DELV (% v/v)				2.1					
PROCEDURE (A OR B)				B					

PROCEDURE A If (MAX SRM - MIN SRM) > 95% CI at Daily ELV
PROCEDURE B If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and
 MIN SRM ≥ 15% of Daily ELV

WHERE OFFSET = 0.04

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (DRY) % v/v	y, SRM (DRY) % v/v	Reason for Data Pair Removal
1	25/10/2018	08:32 - 09:02			Instrument performing an auto-zero
2	25/10/2018	05:32 - 06:02	6.39	6.59	Statistical outlier (as defined in TGN M20 - V3)
3	25/10/2018	10:32 - 11:02	6.15	6.04	Statistical outlier (as defined in TGN M20 - V3)
4	25/10/2018	13:32 - 14:02	6.54	6.45	Statistical outlier (as defined in TGN M20 - V3)
5					
6					
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OXYGEN: QAL2 CALCULATIONS (HNA03GH001)

(Page 3 of 6)

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)

Derivation of Calibration Function

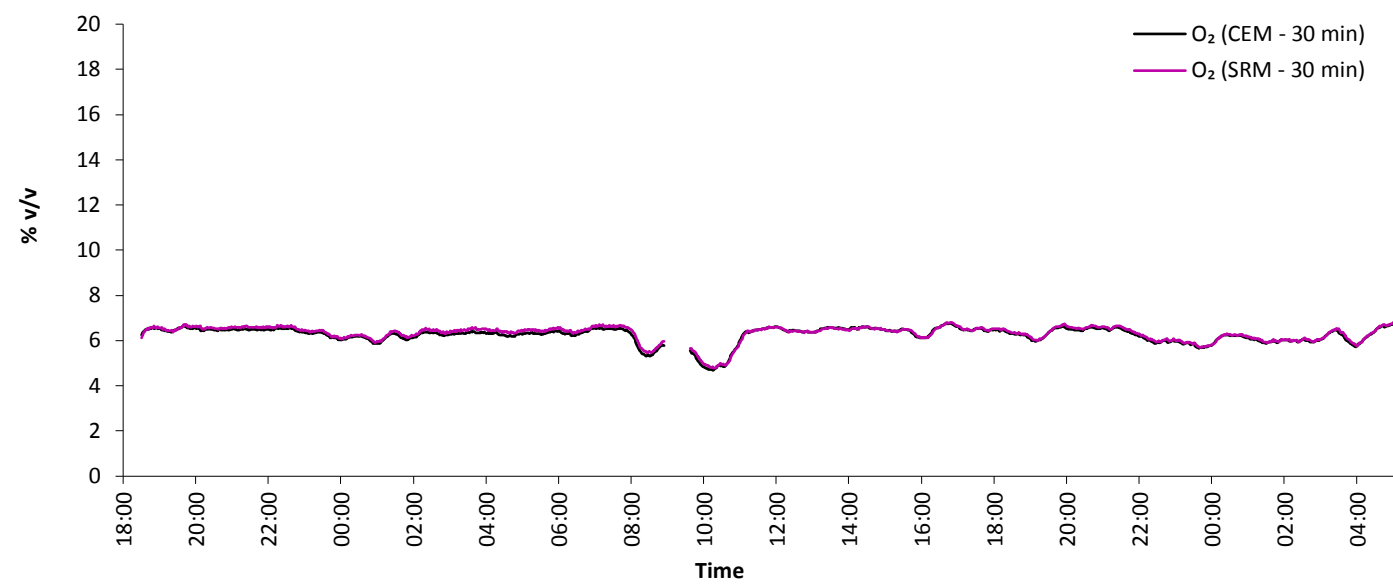
b =	1.0171	a =	-0.0407	CALIBRATION FUNCTION =	y = 1.0171x - 0.0407
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where

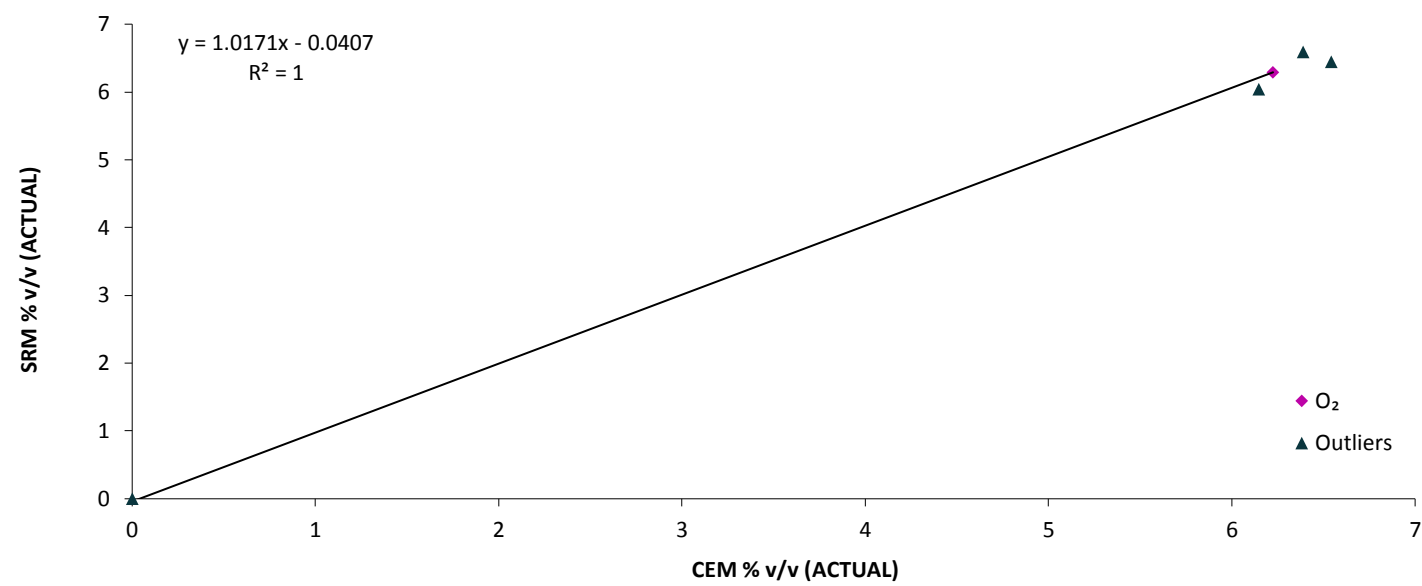
For Method A $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$

Method B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

PLOT 1: GRAPH FOR STP SRM (DRY) vs STP CEMS (DRY) (30 minute rolling averages)



PLOT 2: Calibration Graph for Method B



Section 4A - Data and Calculations - QAL2

OXYGEN: QAL2 CALCULATIONS (HNA03GH001)

(Page 4 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (DRY) % v/v	ys, SRM (DRY) % v/v	UNCAL CEM (DRY) % v/v	ys, SRM - CAL CEM
L1	Surrogate	Near Zero	0.00	0.00	0.04	0.00
L2	Surrogate	Near Zero	0.00	0.00	0.04	0.00
L3	Surrogate	Near Zero	0.00	0.00	0.04	0.00
1	24/10/2018	18:32 - 19:02	6.57	6.57	6.50	0.00
2	24/10/2018	19:32 - 20:02	6.61	6.62	6.54	0.01
3	24/10/2018	20:32 - 21:02	6.59	6.59	6.52	0.00
4	24/10/2018	21:32 - 22:02	6.55	6.62	6.48	0.07
5	24/10/2018	22:32 - 23:02	6.42	6.45	6.35	0.03
6	25/10/2018	23:32 - 00:02	6.11	6.08	6.05	-0.03
7	25/10/2018	00:32 - 01:02	5.94	5.96	5.88	0.02
8	25/10/2018	01:32 - 02:02	6.23	6.25	6.16	0.02
9	25/10/2018	02:32 - 03:02	6.35	6.39	6.28	0.04
10	25/10/2018	03:32 - 04:02	6.40	6.46	6.33	0.06
11	25/10/2018	04:32 - 05:02	6.41	6.41	6.34	0.00
12	25/10/2018	06:32 - 07:02	6.61	6.64	6.54	0.03
13	25/10/2018	07:32 - 08:02	6.29	6.42	6.22	0.13
14	25/10/2018	09:32 - 10:02	4.85	4.94	4.81	0.10
15	25/10/2018	11:32 - 12:02	6.68	6.59	6.61	-0.09
16	25/10/2018	12:32 - 13:02	6.44	6.38	6.37	-0.06
17	25/10/2018	14:32 - 15:02	6.51	6.47	6.44	-0.04
18	25/10/2018	15:32 - 16:02	6.19	6.12	6.13	-0.08
19	25/10/2018	16:32 - 17:02	6.66	6.62	6.58	-0.03
20	25/10/2018	17:32 - 18:02	6.55	6.54	6.48	-0.01
21	25/10/2018	18:32 - 19:02	6.07	6.13	6.01	0.05
22	25/10/2018	19:32 - 20:02	6.59	6.62	6.52	0.03
23	25/10/2018	20:32 - 21:02	6.61	6.63	6.54	0.02
24	25/10/2018	21:32 - 22:02	6.24	6.24	6.18	0.00
25	25/10/2018	22:32 - 23:02	6.05	5.99	5.99	-0.06
26	26/10/2018	23:32 - 00:02	5.90	5.84	5.84	-0.06
27	26/10/2018	00:32 - 01:02	6.17	6.16	6.10	-0.01
28	26/10/2018	01:32 - 02:02	6.08	6.05	6.02	-0.04
29	26/10/2018	02:32 - 03:02	6.13	6.10	6.07	-0.03
30	26/10/2018	03:32 - 04:02	5.91	5.84	5.86	-0.07
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Section 4A - Data and Calculations - QAL2

OXYGEN: QAL2 CALCULATIONS (HNA03GH001)

(Page 5 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (DRY) % v/v	ys, SRM (DRY) % v/v	UNCAL CEM (DRY) % v/v	ys, SRM - CAL CEM
66						
67						
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90						
			MAX	AVERAGE	AVERAGE	Sd
			6.68	6.29	6.22	0.05

Test of Variability

$Q_o = ELV \times (MU / 100) / 1.96$	1.07
Kv for 30 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_o \times Kv$

Parameter	Value
Standard Deviation (Sd)	0.05
$Q_o \times Kv$	1.06
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (% v/v)	6.7
Allowable Extension (%)	10

Valid Calibration Range	0 to 7.3 % v/v
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Section 4A - Data and Calculations - QAL2

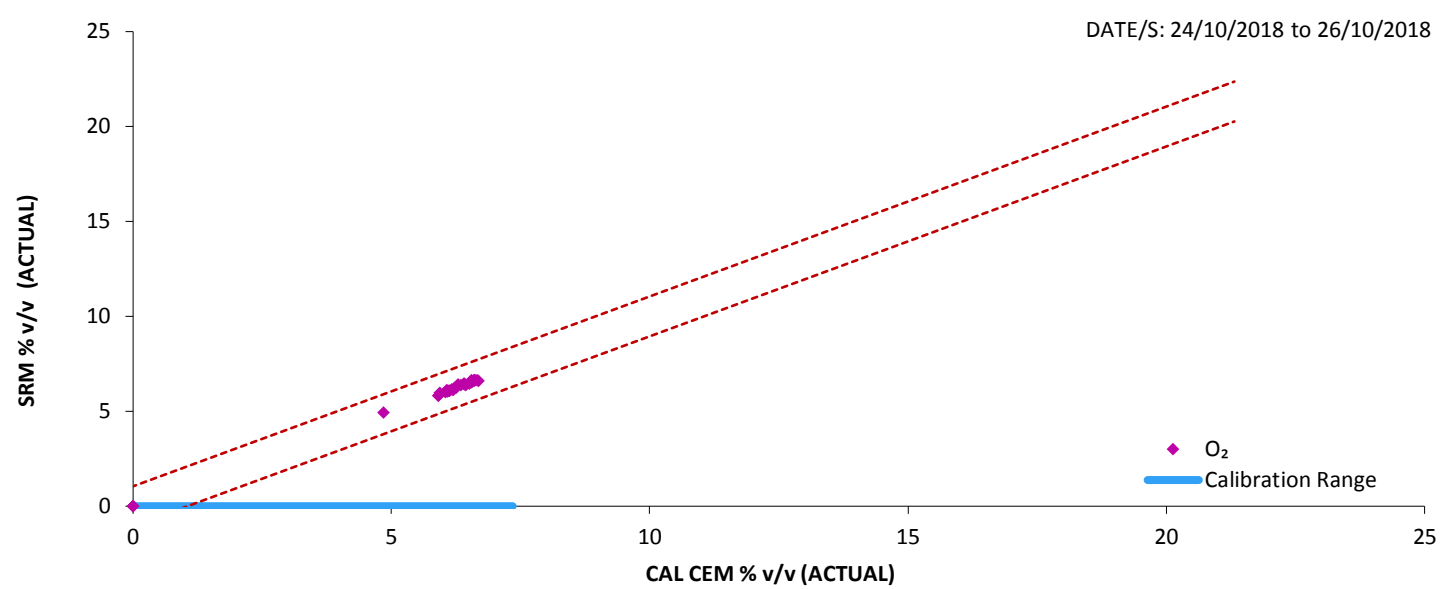
OXYGEN: QAL2 CALCULATIONS (HNA03GH001)

(Page 6 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

PLOT 3: X-Y Plot - ACTUAL CAL CEM vs ACTUAL SRM Values



Section 4A - Data and Calculations - QAL2

CARBON DIOXIDE: QAL2 CALCULATIONS

(Page 1 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (DRY) % v/v	y, SRM (DRY) % v/v	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (DRY) % v/v
L1	Surrogate	Near Zero	-0.01	0.00	-11.89	-12.74	151.38	141.30	0.00
L2	Surrogate	Near Zero	-0.01	0.00	-11.89	-12.74	151.38	141.30	0.00
L3	Surrogate	Near Zero	-0.01	0.00	-11.89	-12.74	151.38	141.30	0.00
1	24/10/2018	18:32 - 19:02	12.74	13.71	0.86	0.97	0.84	0.74	13.66
2	24/10/2018	19:32 - 20:02	12.71	13.62	0.83	0.89	0.74	0.70	13.63
3	24/10/2018	20:32 - 21:02	12.77	13.67	0.89	0.93	0.83	0.79	13.69
4	24/10/2018	21:32 - 22:02	12.78	13.74	0.91	1.00	0.91	0.82	13.71
5	24/10/2018	22:32 - 23:02	12.89	13.87	1.01	1.13	1.15	1.03	13.82
6	25/10/2018	23:32 - 00:02	13.18	14.18	1.30	1.44	1.88	1.69	14.13
7	25/10/2018	00:32 - 01:02	13.32	14.38	1.44	1.65	2.38	2.08	14.28
8	25/10/2018	01:32 - 02:02	13.09	14.15	1.22	1.41	1.72	1.48	14.04
9	25/10/2018	02:32 - 03:02	12.96	13.95	1.08	1.22	1.32	1.17	13.89
10	25/10/2018	03:32 - 04:02	12.96	13.94	1.08	1.21	1.30	1.17	13.89
11	25/10/2018	04:32 - 05:02	12.97	13.91	1.09	1.17	1.28	1.20	13.91
12	25/10/2018	05:32 - 06:02	12.92	13.92	1.04	1.19	1.24	1.08	13.85
13	25/10/2018	06:32 - 07:02	12.74	13.70	0.86	0.97	0.83	0.74	13.66
14	25/10/2018	09:32 - 10:02	14.29	15.37	2.41	2.63	6.36	5.82	15.32
15	25/10/2018	10:32 - 11:02	13.09	13.97	1.21	1.23	1.49	1.47	14.03
16	25/10/2018	11:32 - 12:02	12.65	13.61	0.77	0.88	0.68	0.59	13.56
17	25/10/2018	12:32 - 13:02	12.86	13.71	0.98	0.97	0.95	0.96	13.78
18	25/10/2018	13:32 - 14:02	12.68	13.52	0.81	0.79	0.63	0.65	13.60
19	25/10/2018	14:32 - 15:02	12.78	13.63	0.91	0.90	0.81	0.82	13.71
20	25/10/2018	15:32 - 16:02	13.08	13.93	1.20	1.20	1.44	1.44	14.02
21	25/10/2018	16:32 - 17:02	12.65	13.61	0.77	0.88	0.67	0.59	13.56
22	25/10/2018	17:32 - 18:02	12.74	13.65	0.86	0.91	0.79	0.75	13.66
23	25/10/2018	18:32 - 19:02	13.17	14.12	1.29	1.38	1.79	1.68	14.12
24	25/10/2018	19:32 - 20:02	12.73	13.63	0.86	0.89	0.76	0.73	13.65
25	25/10/2018	20:32 - 21:02	12.71	13.59	0.83	0.85	0.71	0.69	13.63
26	25/10/2018	21:32 - 22:02	13.02	13.91	1.15	1.18	1.35	1.31	13.96
27	25/10/2018	22:32 - 23:02	13.21	14.16	1.33	1.42	1.89	1.77	14.16
28	26/10/2018	23:32 - 00:02	13.31	14.18	1.44	1.45	2.08	2.06	14.27
29	26/10/2018	00:32 - 01:02	13.10	14.07	1.22	1.33	1.62	1.49	14.04
30	26/10/2018	01:32 - 02:02	13.18	14.08	1.30	1.35	1.75	1.69	14.13
31	26/10/2018	02:32 - 03:02	13.14	13.99	1.26	1.26	1.59	1.58	14.08
32	26/10/2018	03:32 - 04:02	13.32	14.26	1.44	1.52	2.19	2.07	14.28
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Section 4A - Data and Calculations - QAL2

CARBON DIOXIDE: QAL2 CALCULATIONS

(Page 2 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (DRY) % v/v	y, SRM (DRY) % v/v	$x - x_{av}$ (A)	$y - y_{av}$ (B)	(A) x (B)	$(x - x_{av})^2$	CAL CEM (DRY) % v/v
66									
67									
68									
69									
70									
71									
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86									
87									
88									
89									
90									
MAX SRM - MIN SRM				1.85			SUM	500.12	466.78
(DAILY) DELV (% v/v)				16					
95% CI MU (%)				10					
95% CI at DELV (% v/v)				1.6					
PROCEDURE (A OR B)				A					

PROCEDURE A If (MAX SRM - MIN SRM) > 95% CI at Daily ELV
PROCEDURE B If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and
 MIN SRM ≥ 15% of Daily ELV

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (DRY) % v/v	y, SRM (DRY) % v/v	Reason for Data Pair Removal
1	25/10/2018	08:32 - 09:02			Instrument performing an auto-zero
2	25/10/2018	07:32 - 08:02	13.03	14.17	Statistical outlier (as defined in TGN M20 - V3)
3					
4					
5					
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24					
25					

Section 4A - Data and Calculations - QAL2

CARBON DIOXIDE: QAL2 CALCULATIONS

(Page 3 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Derivation of Calibration Function

b =	1.0714	a =	0.0097	CALIBRATION FUNCTION =	y = 1.0714x + 0.0097
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where

For Method A

$$b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$$

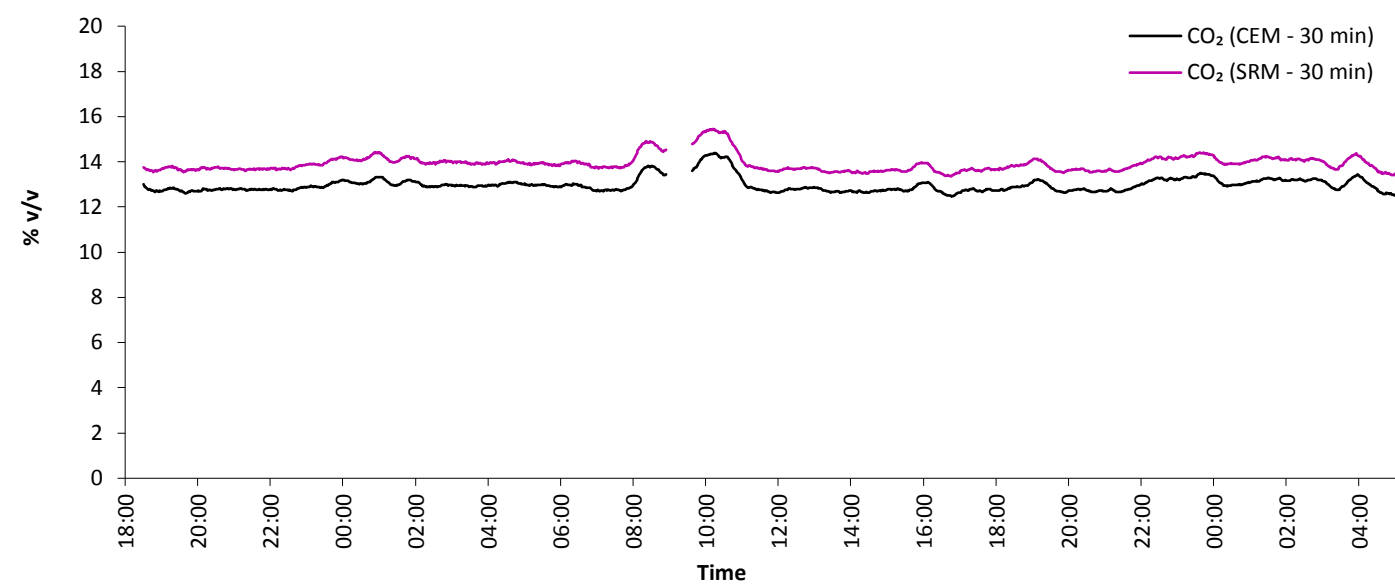
$$\text{and } a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$$

Method B

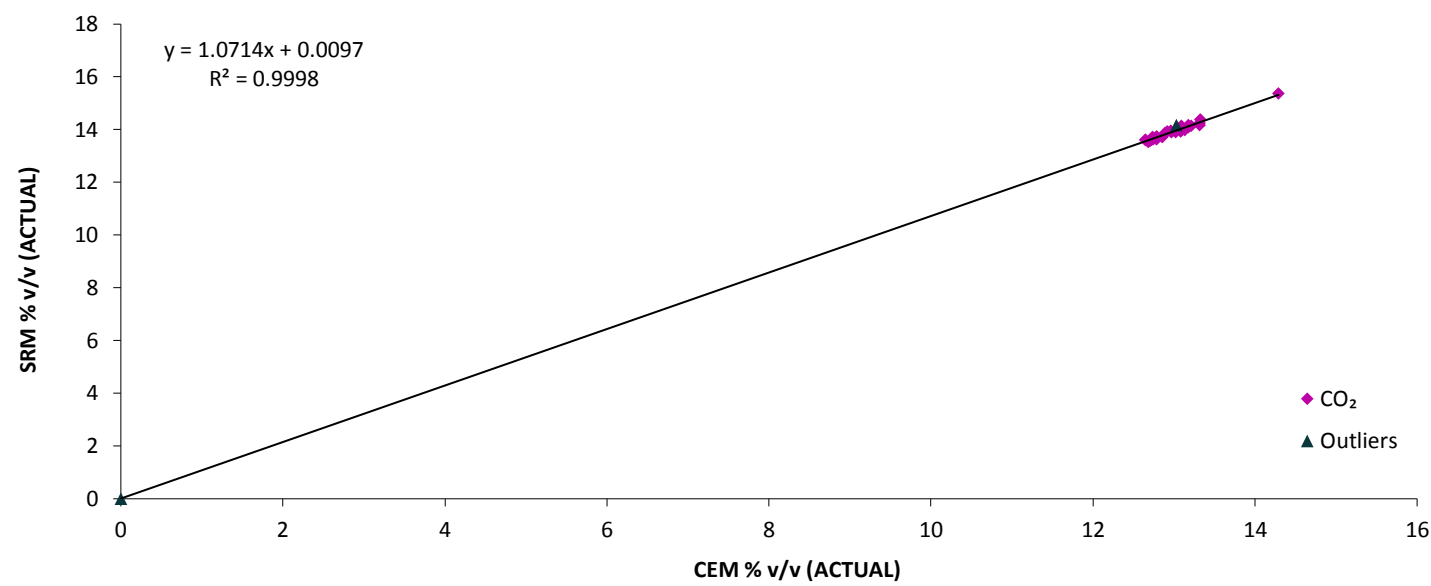
$$b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$$

$$\text{and } a = -b \times \text{OFFSET}$$

PLOT 1: GRAPH FOR STP SRM (DRY) vs STP CEMS (DRY) (30 minute rolling averages)



PLOT 2: Calibration Graph for Method A



Section 4A - Data and Calculations - QAL2

CARBON DIOXIDE: QAL2 CALCULATIONS

(Page 4 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (DRY) % v/v	ys, SRM (DRY) % v/v	UNCAL CEM (DRY) % v/v	ys, SRM - CAL CEM
L1	Surrogate	Near Zero	0.00	0.00	-0.01	0.00
L2	Surrogate	Near Zero	0.00	0.00	-0.01	0.00
L3	Surrogate	Near Zero	0.00	0.00	-0.01	0.00
1	24/10/2018	18:32 - 19:02	13.66	13.71	12.74	0.05
2	24/10/2018	19:32 - 20:02	13.63	13.62	12.71	-0.01
3	24/10/2018	20:32 - 21:02	13.69	13.67	12.77	-0.02
4	24/10/2018	21:32 - 22:02	13.71	13.74	12.78	0.03
5	24/10/2018	22:32 - 23:02	13.82	13.87	12.89	0.05
6	25/10/2018	23:32 - 00:02	14.13	14.18	13.18	0.05
7	25/10/2018	00:32 - 01:02	14.28	14.38	13.32	0.10
8	25/10/2018	01:32 - 02:02	14.04	14.15	13.09	0.11
9	25/10/2018	02:32 - 03:02	13.89	13.95	12.96	0.06
10	25/10/2018	03:32 - 04:02	13.89	13.94	12.96	0.05
11	25/10/2018	04:32 - 05:02	13.91	13.91	12.97	0.00
12	25/10/2018	05:32 - 06:02	13.85	13.92	12.92	0.07
13	25/10/2018	06:32 - 07:02	13.66	13.70	12.74	0.04
14	25/10/2018	09:32 - 10:02	15.32	15.37	14.29	0.05
15	25/10/2018	10:32 - 11:02	14.03	13.97	13.09	-0.07
16	25/10/2018	11:32 - 12:02	13.56	13.61	12.65	0.05
17	25/10/2018	12:32 - 13:02	13.78	13.71	12.86	-0.08
18	25/10/2018	13:32 - 14:02	13.60	13.52	12.68	-0.08
19	25/10/2018	14:32 - 15:02	13.71	13.63	12.78	-0.07
20	25/10/2018	15:32 - 16:02	14.02	13.93	13.08	-0.09
21	25/10/2018	16:32 - 17:02	13.56	13.61	12.65	0.05
22	25/10/2018	17:32 - 18:02	13.66	13.65	12.74	-0.01
23	25/10/2018	18:32 - 19:02	14.12	14.12	13.17	0.00
24	25/10/2018	19:32 - 20:02	13.65	13.63	12.73	-0.02
25	25/10/2018	20:32 - 21:02	13.63	13.59	12.71	-0.04
26	25/10/2018	21:32 - 22:02	13.96	13.91	13.02	-0.05
27	25/10/2018	22:32 - 23:02	14.16	14.16	13.21	-0.01
28	26/10/2018	23:32 - 00:02	14.27	14.18	13.31	-0.09
29	26/10/2018	00:32 - 01:02	14.04	14.07	13.10	0.02
30	26/10/2018	01:32 - 02:02	14.13	14.08	13.18	-0.05
31	26/10/2018	02:32 - 03:02	14.08	13.99	13.14	-0.09
32	26/10/2018	03:32 - 04:02	14.28	14.26	13.32	-0.02
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Section 4A - Data and Calculations - QAL2

CARBON DIOXIDE: QAL2 CALCULATIONS

(Page 5 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (DRY) % v/v	ys, SRM (DRY) % v/v	UNCAL CEM (DRY) % v/v	ys, SRM - CAL CEM
66						
67						
68						
69						
70						
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72						
73						
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75						
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86						
87						
88						
89						
90						
			MAX	AVERAGE	AVERAGE	Sd
			15.32	13.93	12.99	0.06

Test of Variability

$Q_o = ELV \times (MU / 100) / 1.96$	0.82
Kv for 32 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_o \times Kv$

Parameter	Value
Standard Deviation (Sd)	0.06
$Q_o \times Kv$	0.81
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (% v/v)	15.3
Allowable Extension (%)	10

Valid Calibration Range	0 to 16.9 % v/v
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Section 4A - Data and Calculations - QAL2

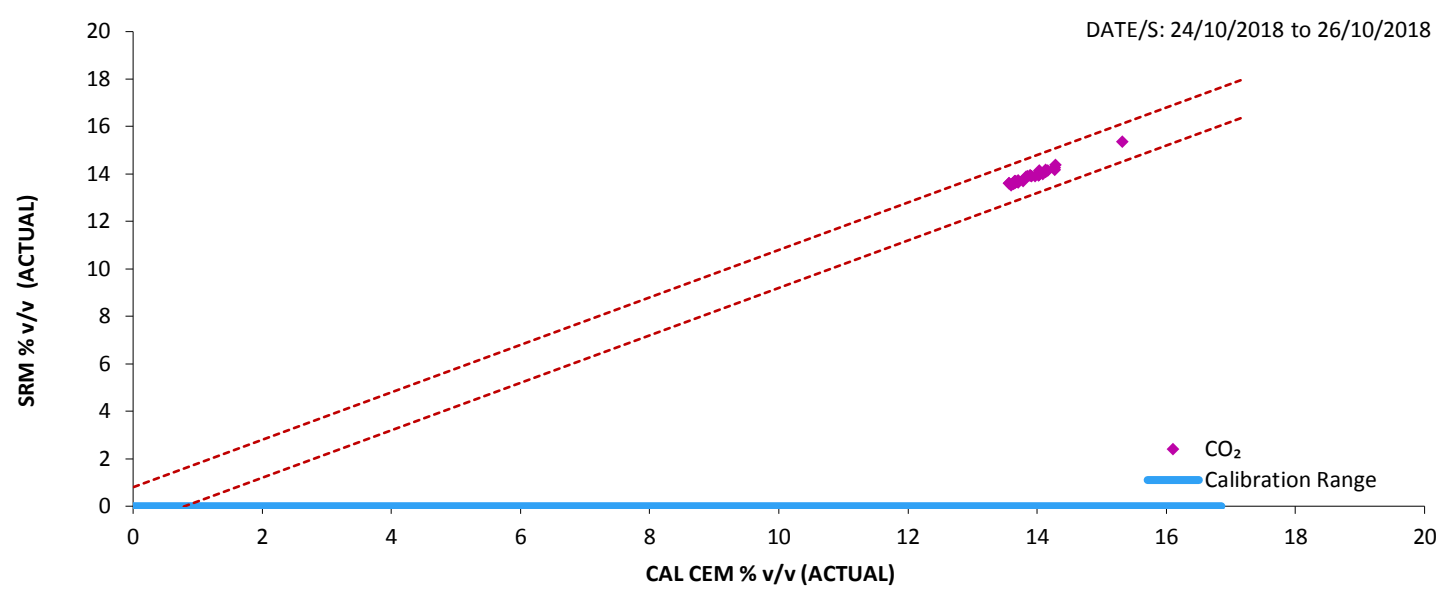
CARBON DIOXIDE: QAL2 CALCULATIONS

(Page 6 of 6)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

PLOT 3: X-Y Plot - ACTUAL CAL CEM vs ACTUAL SRM Values



Section 5 - Results of the Functional Checks

FUNCTIONAL CHECKS OF CEM

(Page 1 of 2)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

Description of Functional Checks / Equipment Used for Linearity of Total Particulate Matter CEM

Before performing the parallel measurements, Exova Catalyst's Engineer checked the Data Acquisition Handling Software (DAHS) PC and noted that the readings looked "sensible" and no flatlining or repeating zeros were being output, giving an added confidence that the analyser was working correctly.

Reference Materials Available on Site

Parameter	QAL3 Check Gas	Concentration (mg/m ³ / %)	QAL3 Check Gas Supplier	Cylinder Number	Cylinder Expiry Date	Certified Accuracy
Total VOCs	C ₃ H ₈	-	-	-	-	-
Nitrogen Monoxide	NO	-	-	-	-	-
Nitrogen Dioxide	NO ₂	-	-	-	-	-
Sulphur Dioxide	SO ₂	-	-	-	-	-
Carbon Monoxide	CO	-	-	-	-	-
Hydrogen Chloride	HCl	-	-	-	-	-
Hydrogen Fluoride	HF	-	-	-	-	-
Ammonia	NH ₃	-	-	-	-	-
Water Vapour	H ₂ O	-	-	-	-	-
Oxygen (H001)	O ₂	-	-	-	-	-
Carbon Dioxide	CO ₂	-	-	-	-	-
Zero Gas	N ₂	-	-	-	-	-

CEM Checks

Parameter	Analyser System Check				Sampling Line System Check			
	Gas Conc. (mg/m ³ / %)	Zero (mg/m ³ / %)	Span (mg/m ³ / %)	Response (T ₉₀ - secs)	Gas Conc. (mg/m ³ / %)	Zero (mg/m ³ / %)	Span (mg/m ³ / %)	Response (T ₉₀ - secs)
Total VOCs	-	-	-	-	-	-	-	-
Nitrogen Monoxide	-	-	-	-	-	-	-	-
Nitrogen Dioxide	-	-	-	-	-	-	-	-
Sulphur Dioxide	-	-	-	-	-	-	-	-
Carbon Monoxide	-	-	-	-	-	-	-	-
Hydrogen Chloride	-	-	-	-	-	-	-	-
Hydrogen Fluoride	-	-	-	-	-	-	-	-
Ammonia	-	-	-	-	-	-	-	-
Water Vapour	-	-	-	-	-	-	-	-
Oxygen (H001)	-	-	-	-	-	-	-	-
Carbon Dioxide	-	-	-	-	-	-	-	-

PRO-FORMA FOR ASSESSING AND REPORTING THE RESULTS OF THE FUNCTIONAL TESTS

(Page 1 of 4)

Functional Checks Performed By	-
Date/s Functional Checks Performed	17th October 2018

1. Alignment and Cleanliness (Non-Extractive CEMs Only)

Requirement	Performed	Notes
A visual inspection, with reference to the CEMs manuals, shall be carried out on the following when applicable:		
Internal check of the CEM.	N/A	see appended report
Cleanliness of the optical components.	N/A	see appended report
Flushing air supply.	N/A	see appended report
Optical path free from obstructions.	N/A	see appended report
After re-assembly at the measurement location, at least the following shall be checked:		
Alignment of the measuring system.	N/A	see appended report
Contamination control (internal check of optical surfaces).	N/A	see appended report

2. Sampling System (Extractive CEMs Only)

Requirement	Performed	Notes
A visual inspection of the sampling system shall be performed, noting the condition of the following components, when fitted:		
Sampling probe.	N/A	see appended report
Gas conditioning systems.	N/A	see appended report
Pumps.	N/A	see appended report
All connections.	N/A	see appended report
Sample lines.	N/A	see appended report
Power supplies.	N/A	see appended report
Filters.	N/A	see appended report
NOx converters – if the sampling system contains a NOx converter, then the test laboratory shall record when the last efficiency-test was performed, and the result of this test.	N/A	see appended report
The sampling system shall be in good condition and free of any visible faults, which may decrease the quality of the data.	N/A	see appended report

3. Leak testing

Requirement	Performed	Notes
Leak Testing shall be performed according to the CEMs manuals. The test shall cover the entire sampling system.	N/A	see appended report

4. Zero and Span Check

Requirement	Performed	Notes
Reference zero and span materials shall be used to verify the corresponding readings of the CEMs. Ensure the reading on the DAHS Computer reflects the reading on the screen of the CEMs Analyser/s.	N/A	see appended report

PRO-FORMA FOR ASSESSING AND REPORTING THE RESULTS OF THE FUNCTIONAL TESTS

(Page 2 of 4)

4. Zero and Span Check (continued)

Requirement	Performed	Notes
For non-extractive CEMs, zero and span checks shall be performed using a reference-path free of flue gas before and after readjustment and after re-assembly of the CEM at the measurement location.	N/A	see appended report

5. Linearity

Requirement	Performed	Notes
During the calibration / linearity tests the applied concentrations should be logged onto the DAHS to prove the complete system. i.e. Concentration applied to the instrument is represented by the instrument output and identical to the value logged on the DAHS. DAHS logged values should be included in the instrument service report.	N/A	see appended report
The linearity of the CEM response shall be checked using five different reference materials, including a zero concentration.	N/A	see appended report
The reference material with zero concentration, as well as the reference materials with four different concentrations, shall have a verifiable quantity and quality.	N/A	see appended report
In case of gaseous reference materials, these four reference materials can be obtained from different gas cylinders or can be prepared by means of a calibrated dilution system from one single gas concentration. The uncertainty must be $\leq 2\%$ and where they	N/A	see appended report
The reference material concentrations shall be selected such that the measured values are at approximately 20%, 40%, 60% and 80% of the range that is at least the short-term ELV. It is necessary to know the values of the ratios of their concentrations precisely enough so that an incorrect failure of the linearity test does not occur. The dry test reference material shall be applied to the inlet of the CEM. (i.e. not down the line)	N/A	see appended report
The individual CEMs are tested using the following concentrations applied in a randomised sequence:		
Reference material with zero concentration	N/A	see appended report
Reference material concentration approximately 20% of the range (i.e. the short-term ELV)	N/A	see appended report
Reference material concentration approximately 40% of the range (i.e. the short-term ELV)	N/A	see appended report
Reference material concentration approximately 60% of the range (i.e. the short-term ELV)	N/A	see appended report
Reference material concentration approximately 80% of the range (i.e. the short-term ELV)	N/A	see appended report
Reference material with zero concentration	N/A	see appended report

6. Interferences

Requirement	Performed	Notes
A test shall be undertaken if the process gases to be monitored contain components that are known interferences, as identified during QAL1 and there is a failure of the QAL2 or AST which could be due to interferences.	N/A	see appended report

PRO-FORMA FOR ASSESSING AND REPORTING THE RESULTS OF THE FUNCTIONAL TESTS

(Page 3 of 4)

7. Zero and Span Drift Audit		
Requirement	Performed	Notes
The test laboratory shall assess whether the operator has a QAL3 procedure in place, and whether the operator has applied this procedure. The evidence would comprise (i) a documented procedure, (ii) zero and span data, (iii) control charts.	N/A	see appended report

8. Response Time		
Requirement	Performed	Notes
The response time of the CEM shall be checked. This can be performed, if appropriate, by feeding of the reference material at the end of the sampling probe. The response time shall not exceed the performance requirement applied during the QAL1 tests. (i.e. 200 seconds)	N/A	see appended report

9. Service Report (THIS IS AN AUDIT OF THE SERVICE REPORT, STATE IF THE REQUIRED INFO IS PRESENT OR NOT IN THE SERVICE REPORT)		
Requirement	Performed	Notes
As a minimum requirement the service report should include the following:		
Document reference for work instruction for the type of work being undertaken.	No	Not listed
Instrument manufacturer.	No	Not listed
Instrument type.	No	Not listed
Instrument model.	Yes	MCS100FT
Instrument serial no.	Yes	1632 0575
Operating principle.	No	Not listed
Operating range.	Yes	see appended report
Certification details.	Yes	see appended report
Compliance with MCERTS. (including certificate no.)	No	Not listed
Location.	Yes	see appended report
Date and time work was undertaken.	No	Not listed
Equipment used - type, serial no's, calibration dates.	Yes	see appended report
Gases used - certificate no's, expiry dates, binary or mixture.	Yes	Expiry dates not listed
Calibration and linearity data as required by EN14181.	No	Not listed
Logged data for the period of calibration and linearity. NOTE: There may be gaps in the data, for example, if the CEMs are removed from the stack for the linearity test. In such cases, the test laboratory shall state why there are gaps in the data.	No	Not listed
Name and signature of the service engineer present on the service report?	No	Not listed

PRO-FORMA FOR ASSESSING AND REPORTING THE RESULTS OF THE FUNCTIONAL TESTS

(Page 4 of 4)

10. Documentation and Records		
Requirement	Available	Notes
A plan of the CEM.	N/A	See appended report
All manuals (maintenance, users, etc).	N/A	See appended report
Log books to document possible malfunctions and action taken.	N/A	See appended report
Service reports.	N/A	See appended report
QAL3 documentation including actions taken as a result of out of control situations.	N/A	See appended report
Management system procedures for maintenance, calibration and training.	N/A	See appended report
Training records.	N/A	See appended report
Maintenance schedules.	N/A	See appended report
Auditing plans and records - evidence that the operator includes the procedures for the management of the CEMs within the auditing cycle of the management system.	N/A	See appended report
Existing instrument calibration functions / gain factors.	N/A	See appended report
Documentation and records audit completed and validated prior to commencing SRM testing.	N/A	See appended report

TOTAL PARTICULATE MATTER: LINEARITY CHECK CALCULATIONS (HNA03GH001)

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)
17/10/2018

Linearity Tests performed by	-
100% value taken for Linearity Tests	100

Linearity Readings on CEM

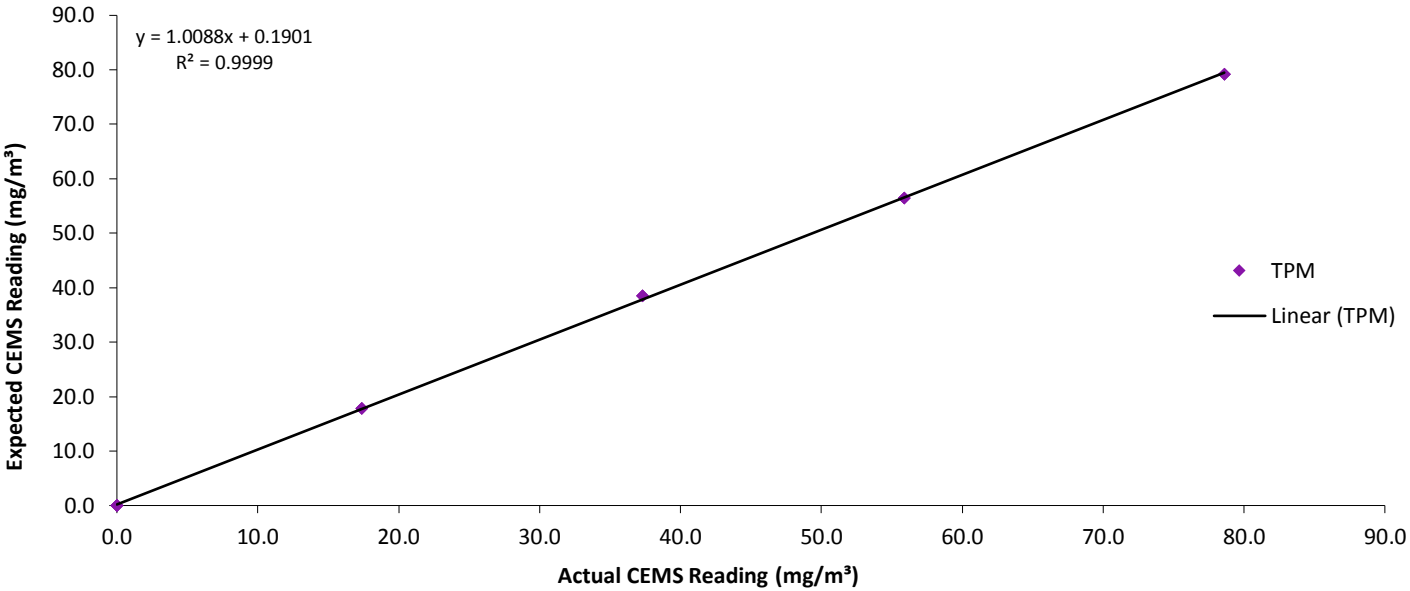
Linearity Point	Time of Readings	Linearity % Point	Expected Reading (mg/m³)	Reading 1 (mg/m³)	Reading 2 (mg/m³)	Reading 3 (mg/m³)	Average CEM Reading (mg/m³)
1	-	0.00	0.00	0.00	0.00	0.00	0.00
2	-	56.50	56.50	55.90	55.90	55.90	55.90
3	-	17.80	17.80	17.40	17.40	17.40	17.40
4	-	79.20	79.20	78.60	78.60	78.60	78.60
5	-	0.00	0.00	0.00	0.00	0.00	0.00
6	-	38.50	38.50	37.30	37.30	37.30	37.30

NOTE: Concentrations obtained using -

Test of Residuals

Linearity Point	Average x_c	d_c	% $d_{c,rel}$	ABS % $d_{c,rel}$	MAX ABS % $d_{c,rel}$	Limit	Outcome
1	0.00	0.18	0.18	0.18	0.68	5	Pass
2	55.90	0.08	0.08	0.08			
3	17.40	-0.06	-0.06	0.06			
4	78.60	0.28	0.28	0.28			
5	0.00	0.18	0.18	0.18			
6	37.30	-0.68	-0.68	0.68			

Graphical Representation of Linearity Data



Section 5 - Results of the Functional Tests

TOTAL VOCs: LINEARITY CHECK CALCULATIONS

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

17/10/2018

Linearity Tests performed by	-
100% value taken for Linearity Tests	37.5875

Linearity Readings on CEM

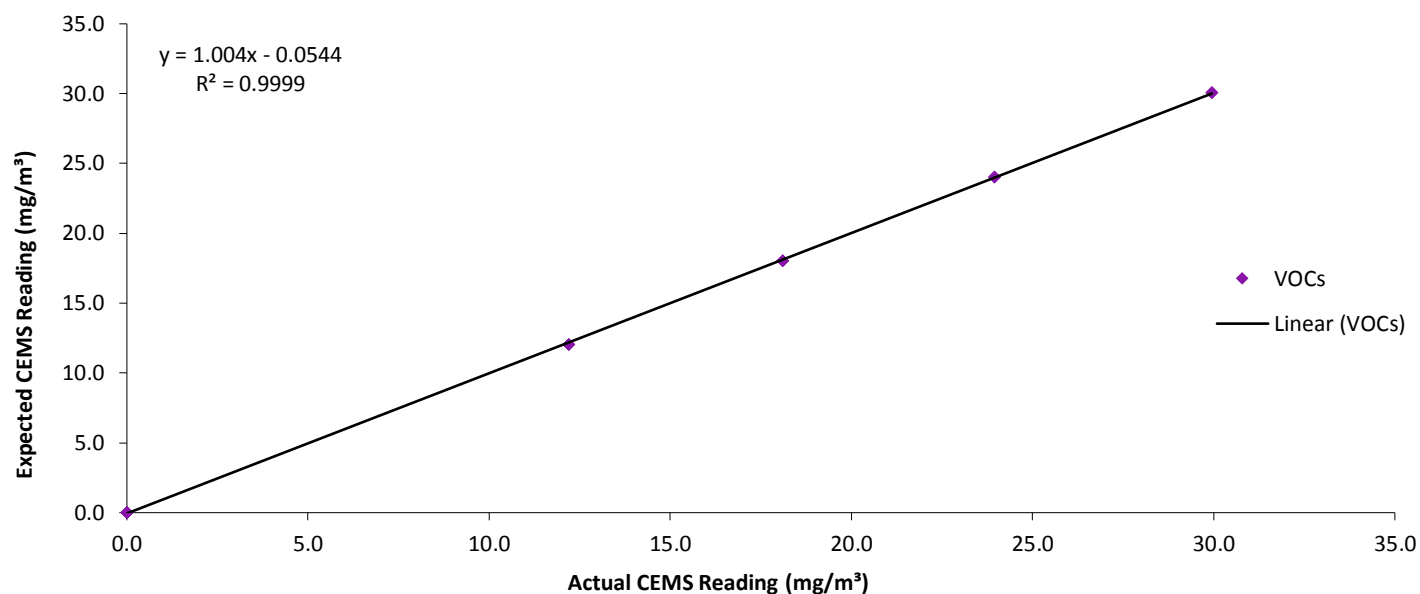
Linearity Point	Time of Readings	Linearity % Point	Expected Reading (mg/m ³)	Reading 1 4 x Response (mg/m ³)	Reading 2 1 x Response (mg/m ³)	Reading 3 1 x Response (mg/m ³)	Average CEM Reading (mg/m ³)
1	-	0.00	0.00	0.00	0.00	0.00	0.00
2	-	64.00	24.06	23.95	23.95	23.95	23.95
3	-	32.00	12.03	12.19	12.19	12.19	12.19
4	-	80.00	30.07	29.95	29.95	29.95	29.95
5	-	0.00	0.00	0.00	0.00	0.00	0.00
6	-	48.00	18.04	18.10	18.10	18.10	18.10

NOTE: Concentrations obtained using -

Test of Residuals

Linearity Point	Average x_c	d_c	%, $d_{c,rel}$	ABS %, $d_{c,rel}$	MAX ABS %, $d_{c,rel}$	Limit	Outcome
1	0.00	-0.05	-0.15	0.15	0.41	5	Pass
2	23.95	-0.06	-0.17	0.17			
3	12.19	0.16	0.41	0.41			
4	29.95	-0.05	-0.15	0.15			
5	0.00	-0.05	-0.15	0.15			
6	18.10	0.08	0.20	0.20			

Graphical Representation of Linearity Data



Section 5 - Results of the Functional Tests

NITROGEN MONOXIDE: LINEARITY CHECK CALCULATIONS

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

17/10/2018

Linearity Tests performed by	-
100% value taken for Linearity Tests	502.25

Linearity Readings on CEM [As Read on Analyser] (as NO)

Linearity Point	Time of Readings	Linearity % Point	Expected Reading (mg/m ³)	Reading 1 4 x Response (mg/m ³)	Reading 2 1 x Response (mg/m ³)	Reading 3 1 x Response (mg/m ³)	Average CEM Reading (mg/m ³)
1	-	0.00	0.00	0.00	0.00	0.00	0.00
2	-	64.00	321.44	320.60	320.60	320.60	320.60
3	-	32.00	160.72	162.10	162.10	162.10	162.10
4	-	80.00	401.80	401.95	401.95	401.95	401.95
5	-	0.00	0.00	0.00	0.00	0.00	0.00
6	-	48.00	241.08	240.10	240.10	240.10	240.10

NOTE: Concentrations obtained using -

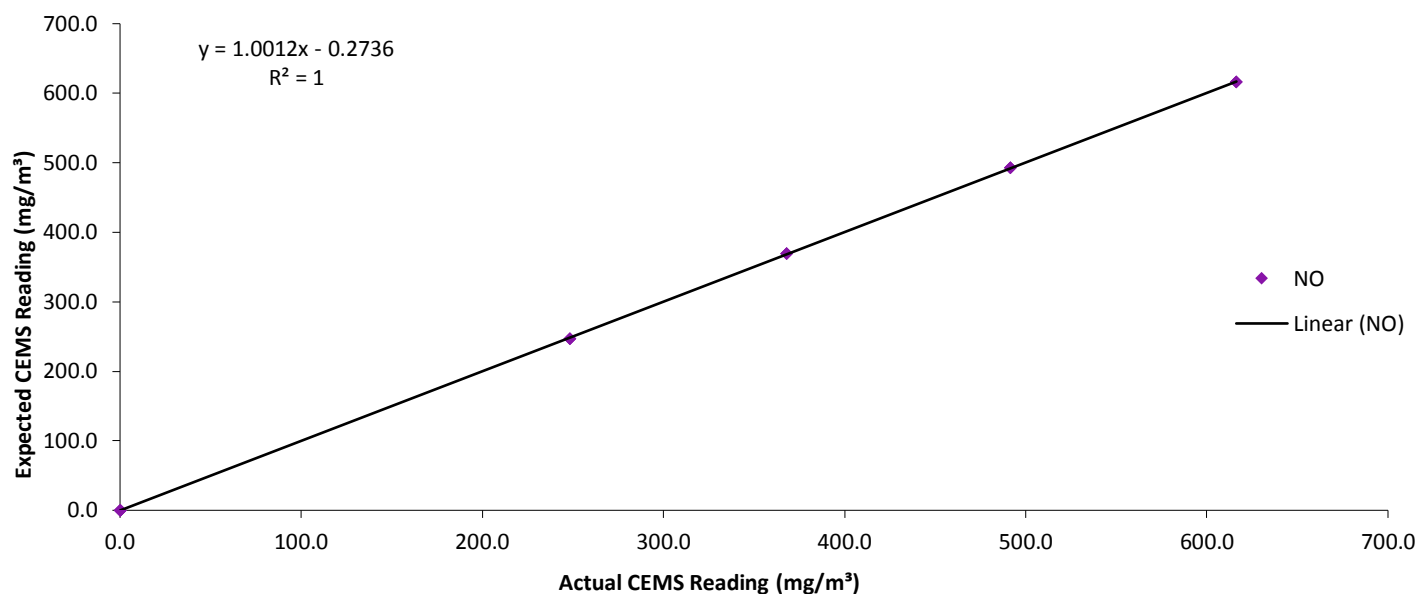
Linearity Readings on CEM (as NO₂)

Linearity Point	Time of Readings	Linearity % Point	Expected Reading (mg/m ³)	Reading 1 4 x Response (mg/m ³)	Reading 2 1 x Response (mg/m ³)	Reading 3 1 x Response (mg/m ³)	Average CEM Reading (mg/m ³)
1	-	0.00	0.00	0.00	0.00	0.00	0.00
2	-	64.00	492.87	491.59	491.59	491.59	491.59
3	-	32.00	246.44	248.55	248.55	248.55	248.55
4	-	80.00	616.09	616.32	616.32	616.32	616.32
5	-	0.00	0.00	0.00	0.00	0.00	0.00
6	-	48.00	369.66	368.15	368.15	368.15	368.15

Test of Residuals (as NO₂)

Linearity Point	Average x _c	d _c	%, d _{c,rel}	ABS %, d _{c,rel}	MAX ABS %, d _{c,rel}	Limit	Outcome
1	0.00	-0.28	-0.04	0.04	0.28	5	Pass
2	491.59	-0.96	-0.12	0.12			
3	248.55	2.14	0.28	0.28			
4	616.32	0.71	0.09	0.09			
5	0.00	-0.28	-0.04	0.04			
6	368.15	-1.33	-0.17	0.17			

Graphical Representation of Linearity Data (as NO₂)



Section 5 - Results of the Functional Tests

NITROGEN DIOXIDE: LINEARITY CHECK CALCULATIONS

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)
17/10/2018

Linearity Tests performed by	-
100% value taken for Linearity Tests	77.9

Linearity Readings on CEM

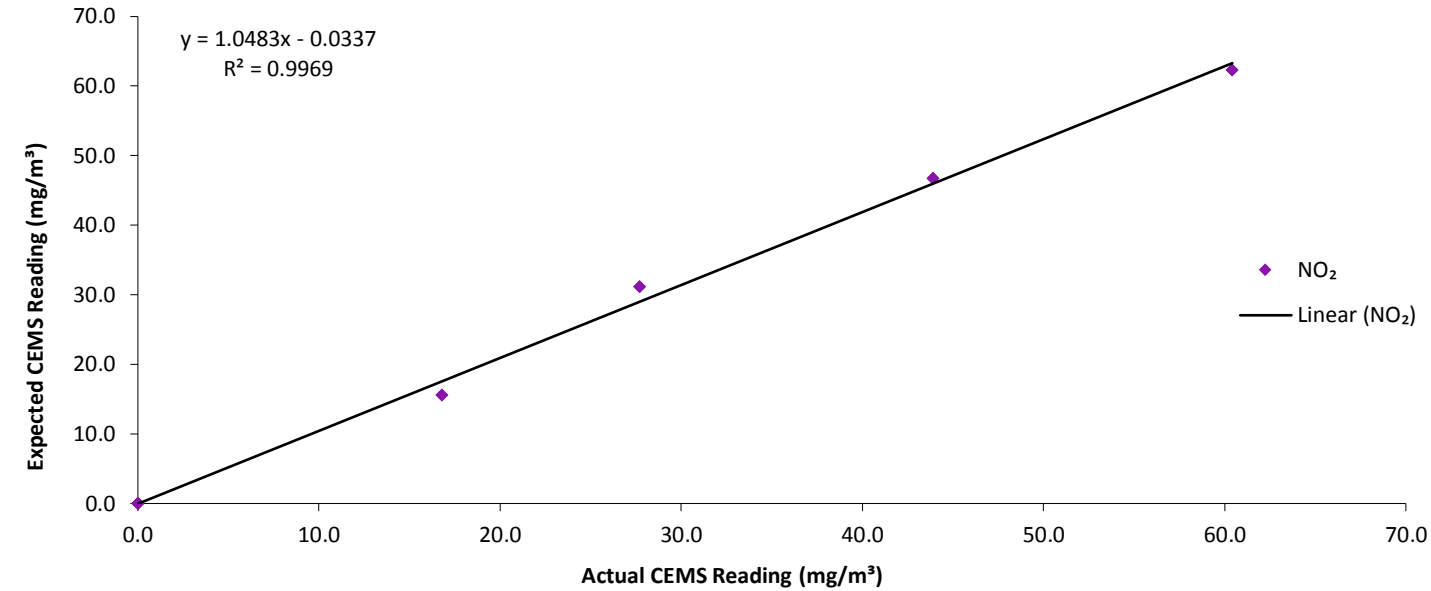
Linearity Point	Time of Readings	Linearity % Point	Expected Reading (mg/m ³)	Reading 1 4 x Response (mg/m ³)	Reading 2 1 x Response (mg/m ³)	Reading 3 1 x Response (mg/m ³)	Average CEM Reading (mg/m ³)
1	-	0.00	0.00	0.00	0.00	0.00	0.00
2	-	60.00	46.74	43.90	43.90	43.90	43.90
3	-	20.00	15.58	16.80	16.80	16.80	16.80
4	-	80.00	62.32	60.42	60.42	60.42	60.42
5	-	0.00	0.00	0.00	0.00	0.00	0.00
6	-	40.00	31.16	27.70	27.70	27.70	27.70

NOTE: Concentrations obtained using -

Test of Residuals

Linearity Point	Average x_c	d_c	% $d_{c,rel}$	ABS % $d_{c,rel}$	MAX ABS % $d_{c,rel}$	Limit	Outcome
1	0.00	-0.11	-0.14	0.14	2.62	5	Pass
2	43.90	-0.66	-0.84	0.84			
3	16.80	1.87	2.41	2.41			
4	60.42	1.05	1.34	1.34			
5	0.00	-0.11	-0.14	0.14			
6	27.70	-2.04	-2.62	2.62			

Graphical Representation of Linearity Data



Section 5 - Results of the Functional Tests

SULPHUR DIOXIDE: LINEARITY CHECK CALCULATIONS

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

17/10/2018

Linearity Tests performed by	-
100% value taken for Linearity Tests	177.5

Linearity Readings on CEM

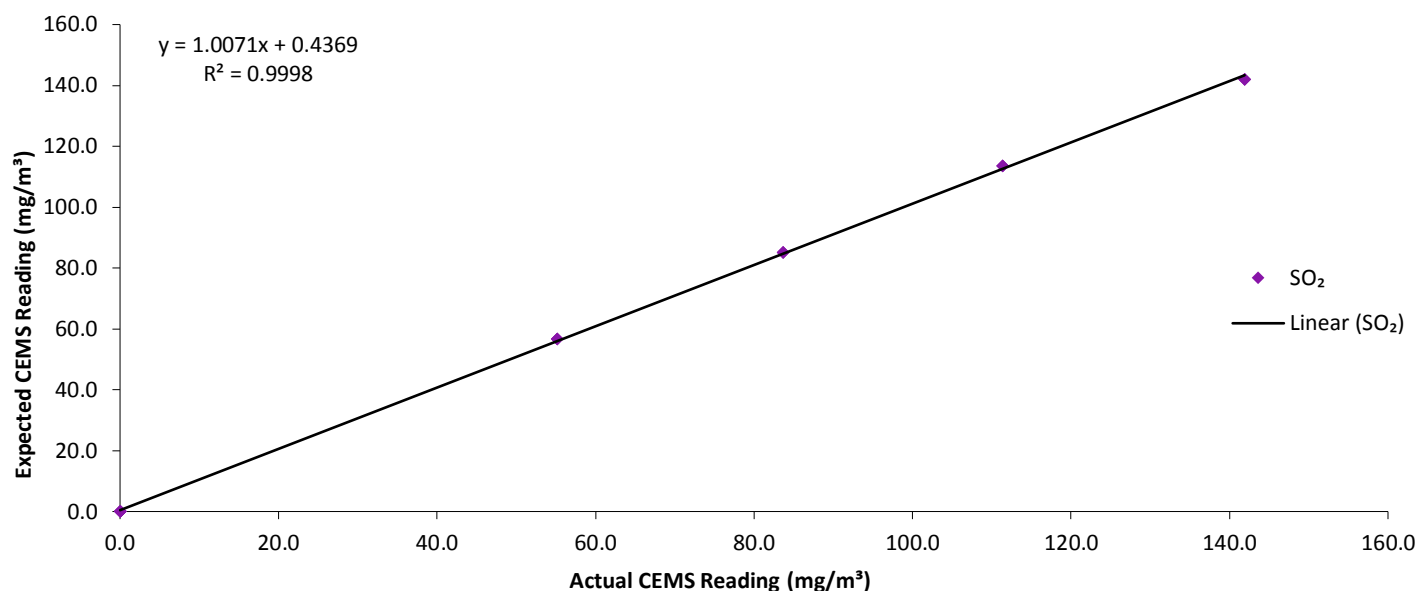
Linearity Point	Time of Readings	Linearity % Point	Expected Reading (mg/m ³)	Reading 1 4 x Response (mg/m ³)	Reading 2 1 x Response (mg/m ³)	Reading 3 1 x Response (mg/m ³)	Average CEM Reading (mg/m ³)
1	-	0.00	0.00	0.00	0.00	0.00	0.00
2	-	64.00	113.60	111.40	111.40	111.40	111.40
3	-	32.00	56.80	55.20	55.20	55.20	55.20
4	-	80.00	142.00	141.90	141.90	141.90	141.90
5	-	0.00	0.00	0.00	0.00	0.00	0.00
6	-	48.00	85.20	83.70	83.70	83.70	83.70

NOTE: Concentrations obtained using -

Test of Residuals

Linearity Point	Average x_c	d_c	% $d_{c,rel}$	ABS % $d_{c,rel}$	MAX ABS % $d_{c,rel}$	Limit	Outcome
1	0.00	0.42	0.24	0.24	0.76	5	Pass
2	111.40	-0.96	-0.54	0.54			
3	55.20	-0.77	-0.43	0.43			
4	141.90	1.35	0.76	0.76			
5	0.00	0.42	0.24	0.24			
6	83.70	-0.46	-0.26	0.26			

Graphical Representation of Linearity Data



Section 5 - Results of the Functional Tests

CARBON MONOXIDE: LINEARITY CHECK CALCULATIONS

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)
17/10/2018

Linearity Tests performed by	-
100% value taken for Linearity Tests	190

Linearity Readings on CEM

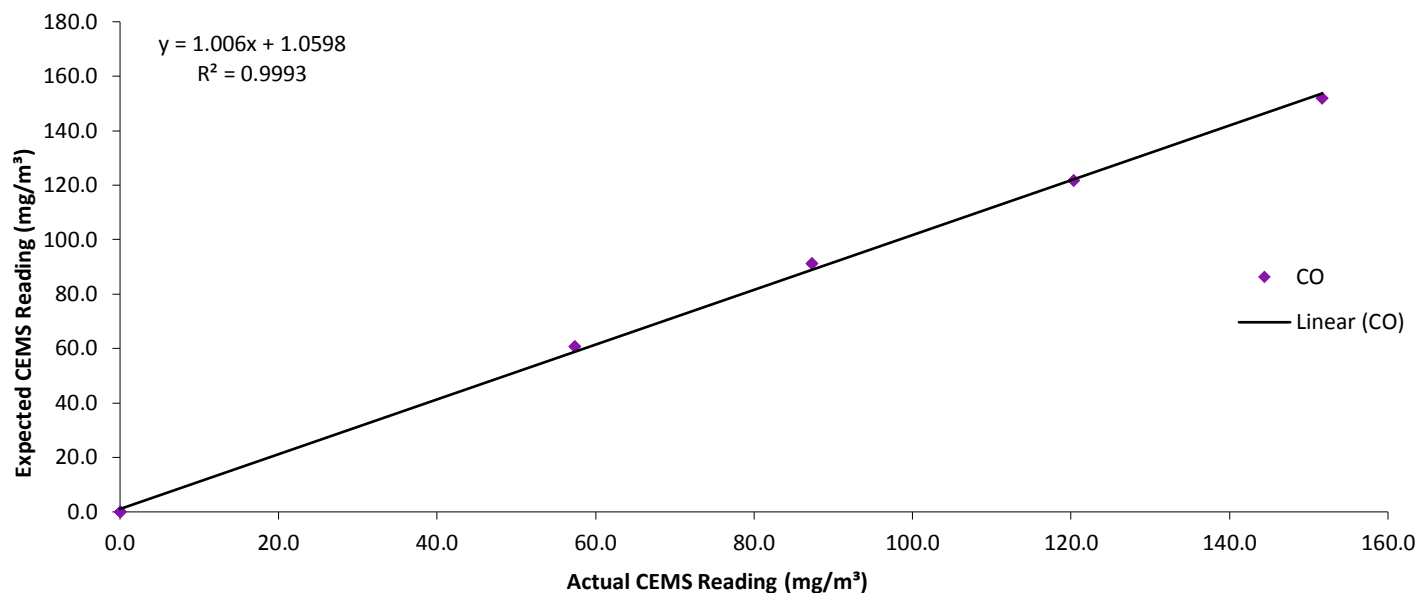
Linearity Point	Time of Readings	Linearity % Point	Expected Reading (mg/m³)	Reading 1 4 x Response (mg/m³)	Reading 2 1 x Response (mg/m³)	Reading 3 1 x Response (mg/m³)	Average CEM Reading (mg/m³)
1	-	0.00	0.00	0.00	0.00	0.00	0.00
2	-	64.00	121.60	120.30	120.30	120.30	120.30
3	-	32.00	60.80	57.40	57.40	57.40	57.40
4	-	80.00	152.00	151.72	151.72	151.72	151.72
5	-	0.00	0.00	0.00	0.00	0.00	0.00
6	-	48.00	91.20	87.30	87.30	87.30	87.30

NOTE: Concentrations obtained using -

Test of Residuals

Linearity Point	Average x_c	d_c	% $d_{c,rel}$	ABS % $d_{c,rel}$	MAX ABS % $d_{c,rel}$	Limit	Outcome
1	0.00	1.00	0.53	0.53	1.20	5	Pass
2	120.30	0.52	0.27	0.27			
3	57.40	-1.99	-1.05	1.05			
4	151.72	1.75	0.92	0.92			
5	0.00	1.00	0.53	0.53			
6	87.30	-2.28	-1.20	1.20			

Graphical Representation of Linearity Data



Section 5 - Results of the Functional Tests

HYDROGEN CHLORIDE: LINEARITY CHECK CALCULATIONS

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)
17/10/2018

Linearity Tests performed by	-
100% value taken for Linearity Tests	100

Linearity Readings on CEM

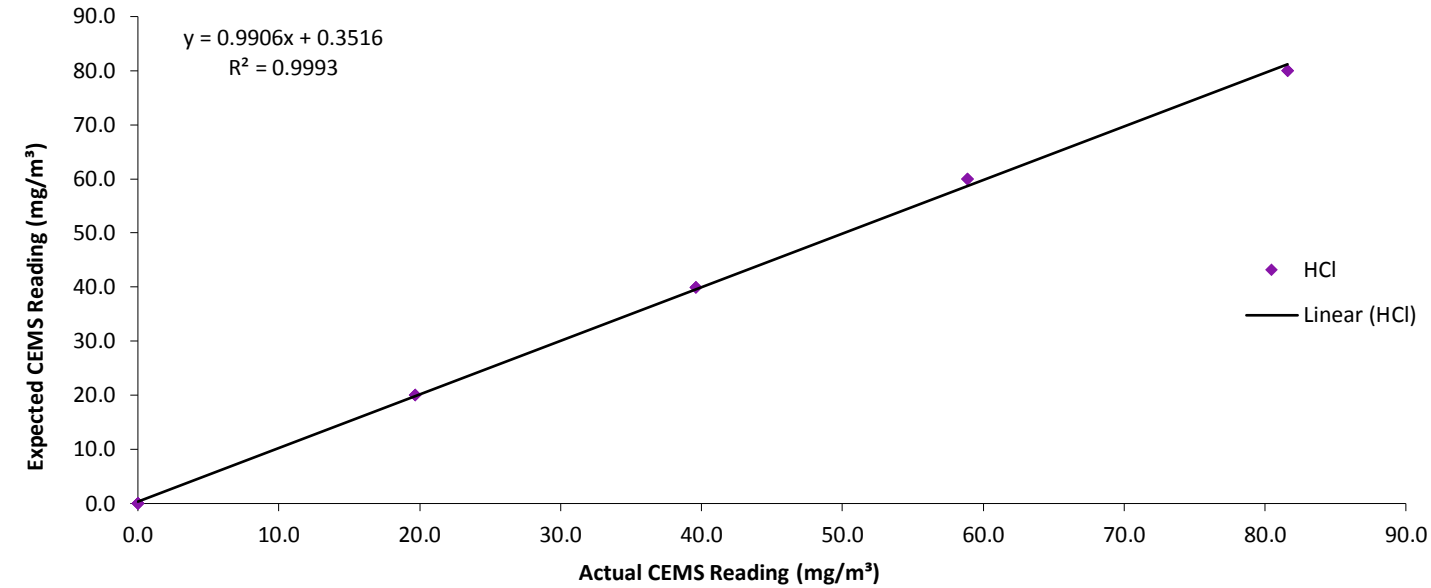
Linearity Point	Time of Readings	Linearity % Point	Expected Reading (mg/m³)	Reading 1 4 x Response (mg/m³)	Reading 2 1 x Response (mg/m³)	Reading 3 1 x Response (mg/m³)	Average CEM Reading (mg/m³)
1	-	0.00	0.00	0.00	0.00	0.00	0.00
2	-	60.00	60.00	58.90	58.90	58.90	58.90
3	-	20.00	20.00	19.67	19.67	19.67	19.67
4	-	80.00	80.00	81.60	81.60	81.60	81.60
5	-	0.00	0.00	0.00	0.00	0.00	0.00
6	-	40.00	40.00	39.60	39.60	39.60	39.60

NOTE: Concentrations obtained using -

Test of Residuals

Linearity Point	Average x_c	d_c	% $d_{c,rel}$	ABS % $d_{c,rel}$	MAX ABS % $d_{c,rel}$	Limit	Outcome
1	0.00	0.33	0.33	0.33	1.30	5	Pass
2	58.90	-1.30	-1.30	1.30			
3	19.67	-0.17	-0.17	0.17			
4	81.60	1.23	1.23	1.23			
5	0.00	0.33	0.33	0.33			
6	39.60	-0.42	-0.42	0.42			

Graphical Representation of Linearity Data



Section 5 - Results of the Functional Tests

HYDROGEN FLUORIDE: LINEARITY CHECK CALCULATIONS

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

17/10/2018

Linearity Tests performed by	-
100% value taken for Linearity Tests	10

Linearity Readings on CEM

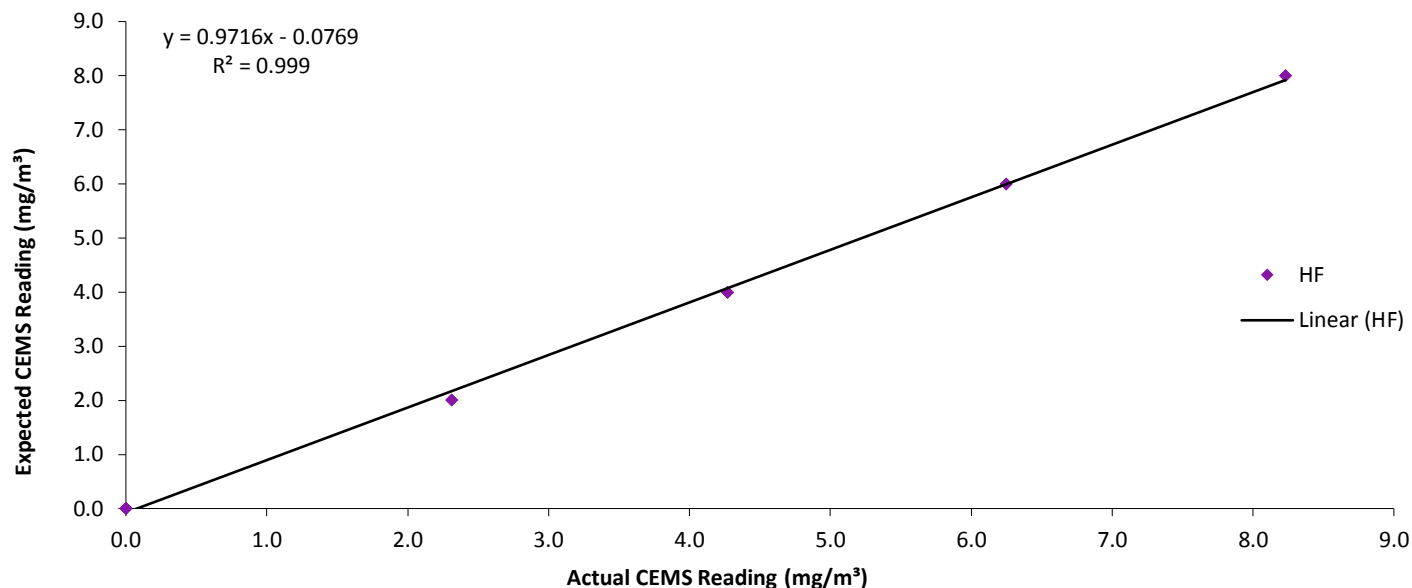
Linearity Point	Time of Readings	Linearity % Point	Expected Reading (mg/m ³)	Reading 1 4 x Response (mg/m ³)	Reading 2 1 x Response (mg/m ³)	Reading 3 1 x Response (mg/m ³)	Average CEM Reading (mg/m ³)
1	-	0.00	0.00	0.00	0.00	0.00	0.00
2	-	60.00	6.00	6.25	6.25	6.25	6.25
3	-	20.00	2.00	2.31	2.31	2.31	2.31
4	-	80.00	8.00	8.23	8.23	8.23	8.23
5	-	0.00	0.00	0.00	0.00	0.00	0.00
6	-	40.00	4.00	4.27	4.27	4.27	4.27

NOTE: Concentrations obtained using -

Test of Residuals

Linearity Point	Average x_c	d_c	% $d_{c,rel}$	ABS % $d_{c,rel}$	MAX ABS % $d_{c,rel}$	Limit	Outcome
1	0.00	-0.08	-0.83	0.83	1.71	5	Pass
2	6.25	0.00	-0.02	0.02			
3	2.31	0.17	1.71	1.71			
4	8.23	-0.08	-0.78	0.78			
5	0.00	-0.08	-0.83	0.83			
6	4.27	0.07	0.75	0.75			

Graphical Representation of Linearity Data



WATER VAPOUR: LINEARITY CHECK CALCULATIONS

B&W Volund, Margam Green Energy Plant
A1 - Main Stack (H001)
17/10/2018

Linearity Tests performed by	-
100% value taken for Linearity Tests	30

Linearity Readings on CEM

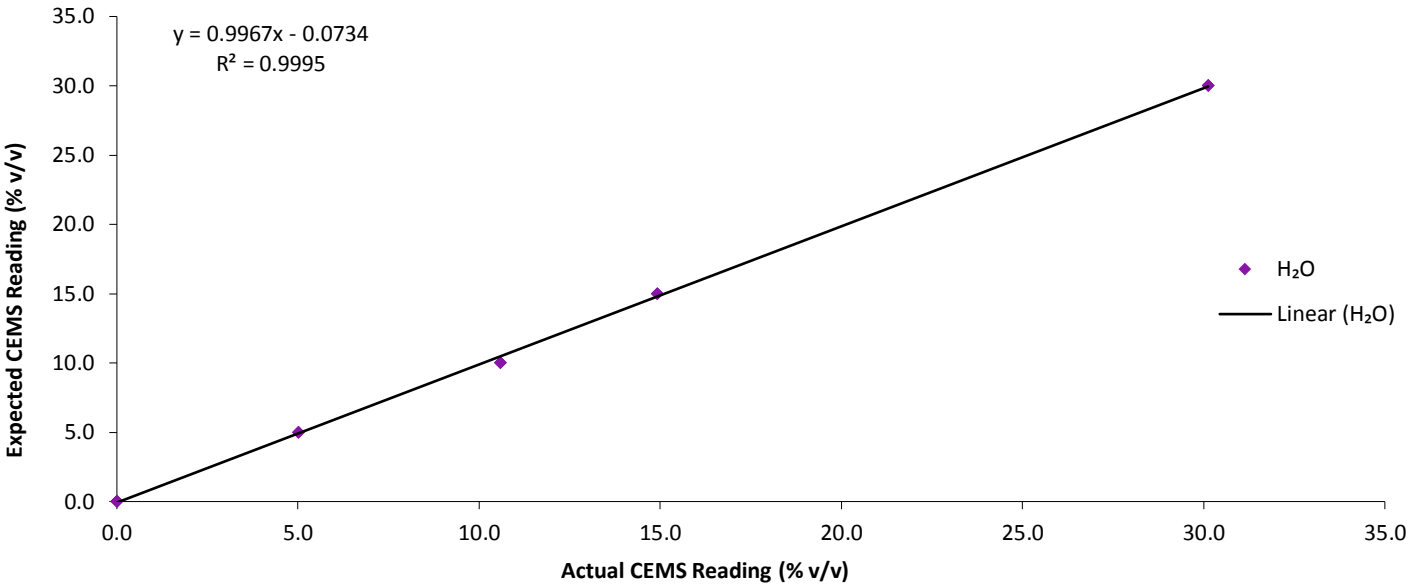
Linearity Point	Time of Readings	Linearity % Point	Expected Reading (% v/v)	Reading 1 4 x Response (% v/v)	Reading 2 1 x Response (% v/v)	Reading 3 1 x Response (% v/v)	Average CEM Reading (% v/v)
1	-	0.00	0.00	0.00	0.00	0.00	0.00
2	-	60.00	15.00	14.91	14.91	14.91	14.91
3	-	20.00	5.00	5.02	5.02	5.02	5.02
4	-	80.00	30.00	30.12	30.12	30.12	30.12
5	-	0.00	0.00	0.00	0.00	0.00	0.00
6	-	40.00	10.00	10.59	10.59	10.59	10.59

NOTE: Concentrations obtained using -

Test of Residuals

Linearity Point	Average x_c	d_c	%, $d_{c,rel}$	ABS %, $d_{c,rel}$	MAX ABS %, $d_{c,rel}$	Limit	Outcome
1	0.00	-0.08	-0.26	0.26	1.61	5	Pass
2	14.91	-0.21	-0.70	0.70			
3	5.02	-0.07	-0.24	0.24			
4	30.12	-0.04	-0.15	0.15			
5	0.00	-0.08	-0.26	0.26			
6	10.59	0.48	1.61	1.61			

Graphical Representation of Linearity Data



Section 5 - Results of the Functional Tests

OXYGEN: LINEARITY CHECK CALCULATIONS (HNA03GH001)

B&W Volund, Margam Green Energy Plant

A1 - Main Stack (H001)

17/10/2018

Linearity Tests performed by	-
100% value taken for Linearity Tests	26.2

Linearity Readings on CEM

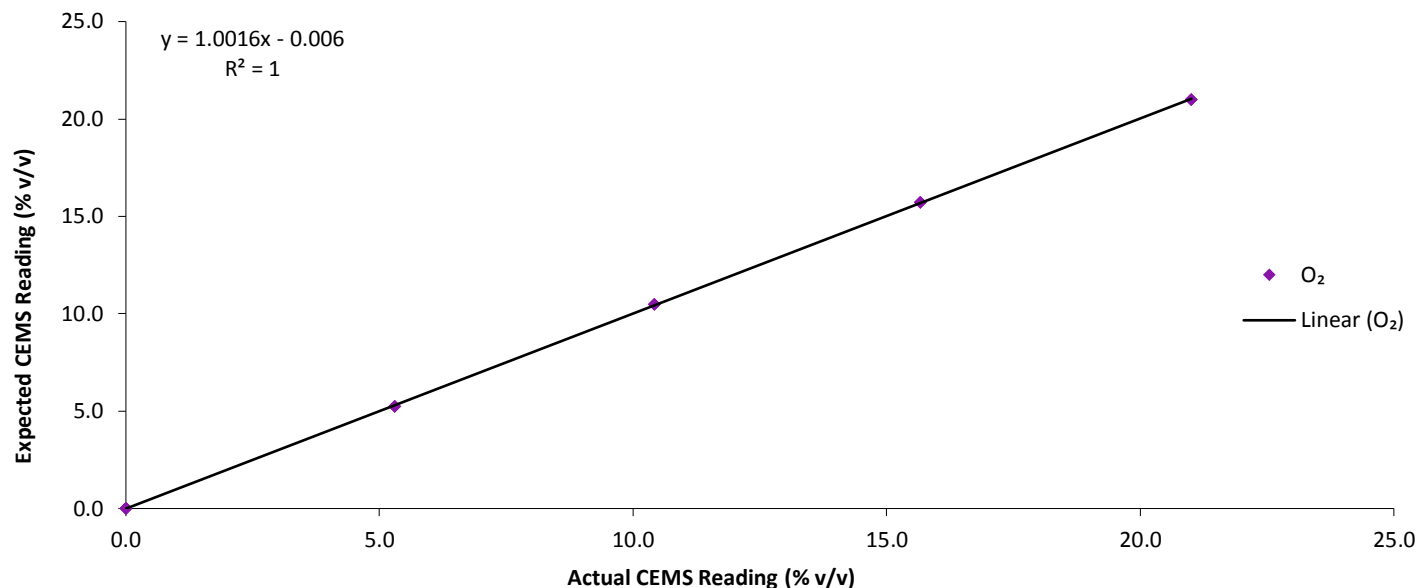
Linearity Point	Time of Readings	Linearity % Point	Expected Reading (% v/v)	Reading 1 4 x Response (% v/v)	Reading 2 1 x Response (% v/v)	Reading 3 1 x Response (% v/v)	Average CEM Reading (% v/v)
1	-	0.00	0.00	0.00	0.00	0.00	0.00
2	-	60.00	15.72	15.66	15.66	15.66	15.66
3	-	20.00	5.24	5.30	5.30	5.30	5.30
4	-	80.00	21.00	21.01	21.01	21.01	21.01
5	-	0.00	0.00	0.00	0.00	0.00	0.00
6	-	40.00	10.48	10.42	10.42	10.42	10.42

NOTE: Concentrations obtained using -

Test of Residuals

Linearity Point	Average x_c	d_c	%, $d_{c,rel}$	ABS %, $d_{c,rel}$	MAX ABS %, $d_{c,rel}$	Limit	Outcome
1	0.00	-0.01	-0.02	0.02	0.24	5	Pass
2	15.66	-0.04	-0.15	0.15			
3	5.30	0.06	0.24	0.24			
4	21.01	0.04	0.15	0.15			
5	0.00	-0.01	-0.02	0.02			
6	10.42	-0.05	-0.19	0.19			

Graphical Representation of Linearity Data



Functional test QAL2

Tested CEM measurements: Dust

Test date. 16-10-2018

Babcock & Wilcox Vølund AB

Margam Green Energy Plant

SA13 NR Port Talbot

SICK DH SB100 SN: 16278692

In-situ AMS



DGtek A/S

Dansk Gasanalyse Teknik

www.dgtek.dk

DGtek- Snaremosvej 21E - DK-7000 Fredericia

Tlf. +45 75 94 07 77 - Fax. +45 75 94 22 66

mail@dgtek.dk

Customer: Babcock & Wilcox Vølund AB - Margam		Certificate nr.: 201810116-2-dust-ssk	
Contact person:	Henrik Setterstig	Date:	16-10-2018

Analyzer type:	DH SB100	Serial nr.	1627 8692	In-situ <input checked="" type="checkbox"/>	Extractiv <input type="checkbox"/>
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Measuring range/setup					
Gastype	dust				
Unit	mg/m ³				
Range 1	100				
Range 2	-				
Zero point	0				
mA-zero point	4				
Span point	100				
mA-span point	20				

A.2 Setup

A visual inspection with reference to the AMS manual, is performed as relevant.

SICK Dusthunter DH SB100	Comments:
Internal verification (A visual control of the inside of AMS)	Ok
Dust on lenses	Ok, cleaned
Air system for keeping the lenses clean	New all looks fine
Path for the laser	Ok - free of any visible faults
After disassembled	OK, check cycle performed
Adjustment of light path	OK, Not required
Test of contamination	OK
Air system	OK

A.4 Documentation and records

The operator is required to either have, or have access to, the documentation specified in Annex A, section A.4 of EN14.181

	Comments:
A plan of the AMS	No information available at the time of the functional test
User and maintenance manuals	No information available at the time of the functional test
Logbook to document possible malfunctions and actions taken	No information available at the time of the functional test
Management systems, procedures for maintenance, calibration and training	No information available at the time of the functional test
Service reports	No information available at the time of the functional test
QAL3 documentation including actions taken as a result of out of control situations	No information available at the time of the functional test
Auditing plans and records	No information available at the time of the functional test
Maintenance schedules	No information available at the time of the functional test
Training records	No information available at the time of the functional test

A.5 Serviceability

There shall be provisions for the effective management and maintenance of the AMS, in order to ensure the maintenance of the quality of data. Such provisions include at least the following:

	Comments:
Safe and clean working environment with sufficient space and weather protections	Ok
Easy and safe acces to the AMS	Ok
Adequate supplies of reference materials, tools and spare parts	No information available at the time of the functional test
Service and support agreement	No information available at the time of the functional test

A.7 Zeropoint- and Span check

Reference zero and span materials according to the CEMS manuals, has been used to verify the corresponding readings of the AMS.

Analysator: SICK DH SP100					
Check-skeme for Dust					
Gastype	Dust				
Unit	mg/m ³				
Range during test	100				
Zero gas value	0				
AMS reading	0				
Set point on mA-output, zero	4				
mA-output, measured	4				
Spangas value (ca. 70-100% of the range)	79,2				
AMS reading	80,9				
Set point on mA-output, span	16,94				
mA-output, measured	16,59				
Max. mA-deviation in concentration	2,32				

A.8 Linearity

A test on linearity is performed, using points that will approximately be 20%, 40%, 60% og 80% of the range of the analyzer.

Results and comments:	See annex.
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A.10 Zeropoint and span drift

Taking the QAL3 readings in consideration, the zero and span points should be evaluated.

QAL 3 point	Comments:
Zeropoint	The analyzer has self-control for drift
Spanpoint	The analyzer has self-control for drift

A.12 I/O box for measurement company

Analog signals	Yes
Digital signals	None

Comments	
The analyzer is free of any visible faults.	
The analyzer passed the linearity test.	
Navn:	Underskrift
Stefan W.S. Krog	

Plant: GMAB
Margam

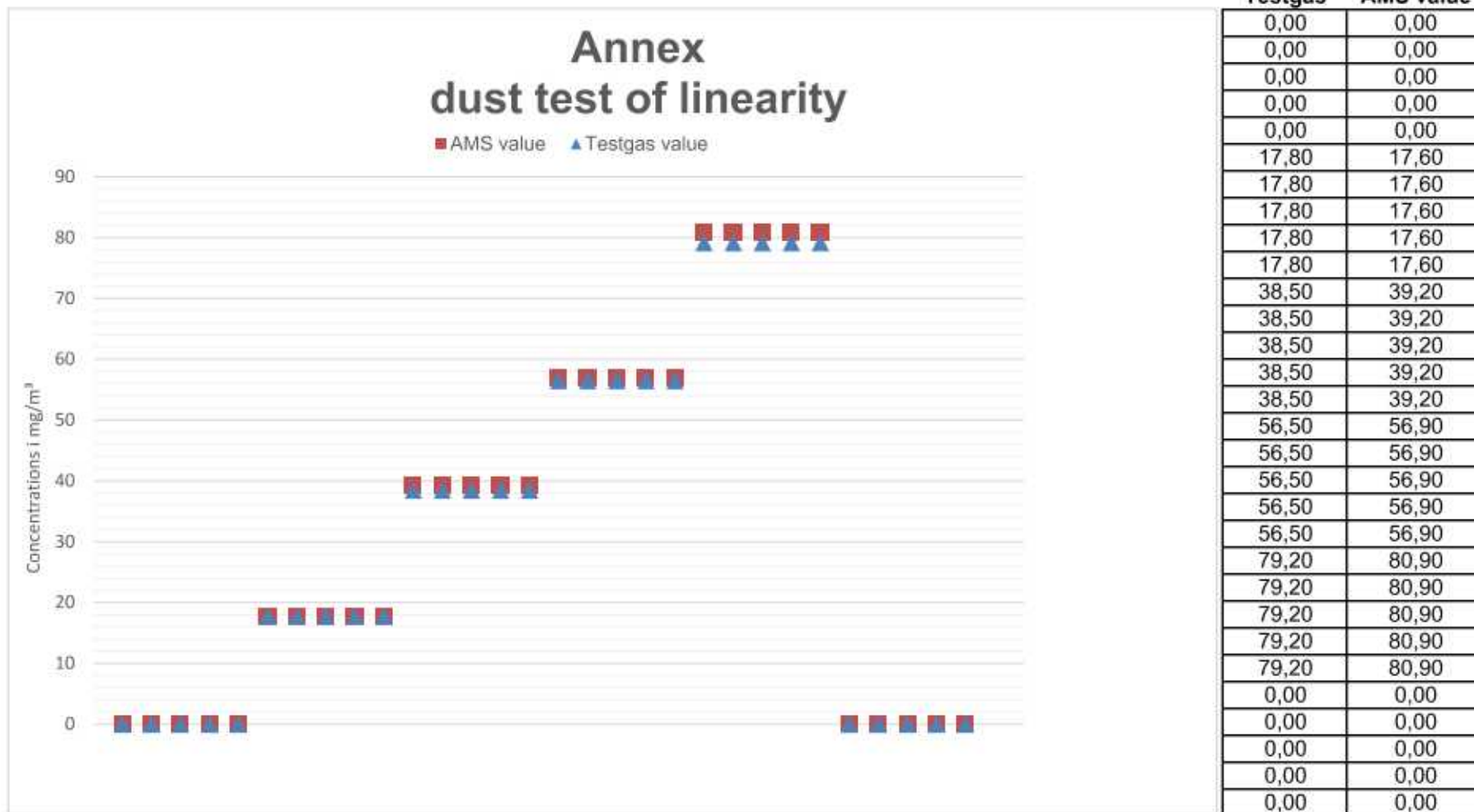
Analyzer:
Gas:
Applies limit (Cu) 1/2 hr ELV
Applied measuring range:
Max. residual:
Max. residual < 5%:

DH SB 100
DUST
45 mg/m³ (wet)
100 mg/m³ (wet)
1,11 %
APPROVED

Regression line: $Y_i = A + B X_i$

A = -0,18
B = 1,02

Testdate: 16-10-2018



Dusthunter - Parameter protocol

Type of device: DH SB100

Mounting location:

Sensor 1

Device information

Device version	Dist.flange-meas.vol.400mm
Firmware version	01.06.02
Serial number	16308341
Identity number	01525
Hardware version	1.1
Firmware bootloader	01.00.02

Installation parameter

Bus adress	1
------------	---

Calibration coefficients for calculation of concentration

cc2	0.0000
cc1	1.0000
cc0	0.0000

Device parameter

Factory settings

Correction of scattered light	on	
Depth of immersion	0.4	m
Correction factor depth of immersion	1.0	
Response time sensor	1.0	s
Response time diagnosis values	10.0	s
Reference value scattered light	2.4	V
Reference value background light	1.4	V
Fail save shutter	not installed	

Factory settings

Scattered light (SL)

cc2	0.0000
cc1	1.1481
cc0	0.0000

Background light (BL)

cc2	0.0000
cc1	1.4105
cc0	0.0000

Laser current

cc2	0.0000
cc1	30.3000
cc0	0.0000

Device temperature

cc2	0.0000
cc1	100.0000
cc0	-275.1500

Motor current

cc2	0.0000
cc1	2000.0000
cc0	0.0000

Power supply

cc2	0.0000
cc1	11.0000
cc0	0.0000

Dusthunter - Diagnosis protocol

Type of device: DH SB100

Mounting location:

Sensor 1

Device information

Device version	Dist.flange-meas.vol.400mm
Firmware version	01.06.02
Serial number	16308341
Identity number	01525
Hardware version	1.1
Firmware bootloader	01.00.02

System state

Error	inactive
Maintenance	active
Maintenance request	inactive
Function check	inactive
Operation	active

Error

EEPROM	inactive
CRC sum parameter	inactive
Version Parameter	inactive
CRC sum factory settings	inactive
Version factory settings	inactive
Contamination	inactive
Motor current	inactive
Detection of final position	inactive
Threshold value	inactive
Span test	inactive
Overflow measured value	inactive
Overflow constant light	inactive
Monitor signal	inactive
Laser current to high (>100mA)	inactive
Power supply (24V) < 18V	inactive
Power supply (24V) > 30V	inactive

Warnings

Reference value	inactive
Contamination	inactive
Default factory parameter	inactive
Test mode	inactive
Power supply (24V) < 19V	inactive
Power supply (24V) > 29V	inactive
Laser current to high (>60mA)	inactive

Measured value

Concentration	-2.3 mg/m ³
Scattered light	-0.236

Diagnosis value

Background light	1.928 V
Monitor	3.979 V
Laser current	33.3 mA
Constant light	1.5 V
Device temperature	22.0 °C
Power supply (24V)	24.0 V
Laserbyte	250
Monitor factor	1.005
Peak value device temp.	46 °C
Peak value motor current	890 mA

Check values

Contamination scattered light	5.5 %
Contamination background light	5.5 %
Contamination	5.5 %
Zero point	0.12 %
Span 70	69.42 %

Filter check

Nominal value Filter 1	0.0 %
Measured value Filter 1	0.0 %
Nominal value Filter 2	17.8 %
Measured value Filter 2	18.0 %
Nominal value Filter 3	38.5 %
Measured value Filter 3	39.2 %
Nominal value Filter 4	56.5 %
Measured value Filter 4	56.9 %
Nominal value Filter 5	79.2 %
Measured value Filter 5	80.9 %

MCU Parameter Protocol

Device Type: MCU

Mounting Location: Dust_009

Device Information

Device Type	MCU
Serial Number	16278692
Ident Number	13535
Systemtime	08 Sep 2018 13:08:29
Firmware Version	01.12.02
Hardware Version	1.8
Bootloader Version	01.00.02

Calculation Values

Sources

Temperature Source	Constant Value
Pressure Source	Constant Value
Moisture Source	Constant Value

Constants

Temperature Constant	0.00°C
Pressure Constant	1013.25mbar
Moisture Constant	0.00%

Adjustment

Function Check Output Duration	90s
Output Check Results on AO	yes

System Configuration

Number of external AO	2
Number of external AI	0
Serial Expansion Module	Ethernet

Serial Expansion Module

Type	Ethernet 10BaseT
Profibus Address	126
Modbus Address	1
IP Address	192.168.000.103
Subnet Mask	255.255.255.000
Gateway	000.000.000.000
TCP Port	2111

I/O Configuration

Analog Output General Settings

Error Current Selection	yes
Error Current Value	21 mA
Maint. Current Selection	Measured value
Maint. Current Value	0.50mA
Span Value	70%

Analog Output 1

Live Zero	4mA
Limit Low	0.00
Limit High	200.00
Calibration factor CC0	-0.8264
Calibration factor CC1	171.1909
Calibration factor CC2	-0.0003

Analog Output 2

Live Zero	4mA
Limit Low	0.00
Limit High	200.00

Analog Output 3

Live Zero	4mA
Limit Low	0.00
Limit High	500.00

Analog Output 4

Live Zero	4mA
Limit Low	0.00
Limit High	0.00

Analog Output 5

Live Zero	4mA
Limit Low	0.00
Limit High	0.00

Analog Input 1 (Temperature)

Limit Low	0.00°C
Limit High	0.00°C
Calibration factor CC0	0.0200
Calibration factor CC1	0.0222
Calibration factor CC2	0.0000

Analog Input 2 (Pressure)

Limit Low	0.00mbar
Limit High	0.00mbar
Calibration factor CC0	0.0300
Calibration factor CC1	0.0222
Calibration factor CC2	0.0000

Analog Input 3 (Moisture)

Limit Low	0.00%
Limit High	0.00%

Limit Switch

Limiting Value	50.00
----------------	-------

T90 Time

T90 Time DH	60.0s
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MCU Diagnosis Protocol

Device Type: MCU

Mounting Location: Dust_009

Device Information

Device Type	MCU
Serial Number	16278692
Ident Number	13535
Systemtime	08 Sep 2018 13:08:29
Firmware Version	01.12.02
Hardware Version	1.8
Bootloader Version	01.00.02

MCU System Status

Failure	inactive
Maintenance	inactive
Maintenance Request	inactive
Function Check	inactive
Limit	inactive
Operation	active

Errors

I2C Module	inactive
Application selection	inactive
I/O Range Error	inactive
AI NAMUR	inactive
Internal Error	inactive
Power supply 5V	inactive
Power supply 12V	inactive
Power supply(24V) <21V	inactive
Power supply(24V) >30V	inactive

Warnings

I2C Modul	inactive
Factory defaults	inactive
No Sensor found	inactive
RTC	inactive
Power supply(24V) <22V	inactive
Power supply(24V) >29V	inactive

aktuelle Messwerte

Conc. a.c. (SL)	0.09mg/m ³
Conc. a.c. (Ext)	0.00mg/m ³
Conc. s.c. (SL)	0.09mg/m ³
Conc. s.c. (Ext)	0.00mg/m ³
Opacity	0.00%
rel. Opacity	0.00%
Extinction	0.00
Transmission	0.00%
Scattered Light	0.22
Temperature	0.00°C
Pressure	1013.25mbar
rel. Moisture	0.00%
O2 Concentration	6.00%

Analog Outputs

Current A0 1	3.82mA
Current A0 2	16.42mA
Current A0 3	8.97mA
Current A0 4	0.00mA
Current A0 5	0.00mA

Analog Inputs

Current AI 1	0.02mA
Current AI 2	0.03mA
Current AI 3	0.00mA
Current AI 4	0.00mA

Digital Outputs

act. Status DO 1 (Failure)	inactive
act. Status DO 2 (Maintenance)	active
act. Status DO 3 (Function Check)	inactive
act. Status DO 4 (Maintenance Req.)	inactive
act. Status DO 5 (Limit)	inactive

Functional test QAL2

Tested CEMS: TOC, HCl, CO, SO₂, HF, NO_x

Tested peripheral CEMS: O₂, H₂O

Test date. 17-10-2018

Babcock & Wilcox Vølund AB

Margam Green Energy Plant

SA13 NR Port Talbot

SICK MCS100FT SN: 16280511

Extractive AMS



DGtek A/S

Dansk Gasanalyse Teknik

www.dgtek.dk

DGtek- Snaremosvej 21E - DK-7000 Fredericia

Tlf. +45 75 94 07 77 - Fax. +45 75 94 22 66

mail@dgtek.dk

Customer: Babcock & Wilcox Vølund AB - Margam		Certificate no.: 20181017_ssk	
Contact person:	Henrik Setterstig	Date:	17-10-2018

Analyzer type:	MCS100FT	Serial no.	16280511	In-situ <input type="checkbox"/>	Extractiv <input checked="" type="checkbox"/>
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Measuring range:					
Parameter	CO	SO ₂	NO	NO ₂	NO _x
Unit	mg/Nm ³ (dry)	mg/Nm ³ (dry)	mg/Nm ³ (dry)	mg/Nm ³ (dry)	mg/Nm ³ (dry)
Range 1	1000	400	650	100	1000
Range 2	-	-	-	-	-
Zero	0	0	0	0	0
mA Zero	4	4	4	4	4
Span	1000	400	650	100	1000
mA Span	20	20	20	20	20

Measuring range:					
Parameter	O ₂	CO ₂	H ₂ O	HCl	TOC
Unit	vol% (dry)	vol% (dry)	vol%	mg/Nm ³ (dry)	mgC/Nm ³ (wet)
Range 1	25	25	40	100	100
Range 2	-	-	-	-	-
Zero	0	0	0	0	0
mA Zero	4	4	4	4	4
Span	25	25	40	100	100
mA Span	20	20	20	20	20

QAL2 Functional test

Measuring range:					
Parameter	NH ₃	HF			
Unit	mg/Nm ³ (dry)	mg/Nm ³ (dry)			
Range 1	60	10			
Range 2	-	-			
Zero	0	0			
mA Zero	4	4			
Span	60	10			
mA Span	20	20			

QAL2 Functional test

Used test gas:					
Gas	N ₂	SO ₂	NO	NO ₂	HCl
Unit	Vol%	mg/Nm ³	mg/Nm ³	mg/Nm ³	mol
Concentration	100	142	401,8	77,9	0,01
Max deviation %		2	2	2	2
Certificate	-	9471146001	9471146001	9471150001	test-liqued
Supplier	BOC	Air Liquide	Air Liquide	Air Liquide	Analytech

Used test gas:					
Gas	O ₂	CO ₂	CO	C ₃ H ₈	HF
Unit	Vol%	Vol%	mg/Nm ³	mgC/Nm ³	mol
Concentration	2,008	20,09	152	30,07	0,0005
Max deviation %	2	2	2	2	2
Certificate	9471150001	9471150001	9471146001	2692320	test-liquid
Supplier	Air Liquide	Air Liquide	Air Liquide	BOC	Analytech

Used test gas:					
Gas	NH ₃				
Unit	mg/Nm ³				
Concentration	19,15				
Max deviation %	3				
Certificate	9471052001				
Supplier	Air Liquide				

Gas mixing system			
Type:	HovaCAL 312-MF	Serial no.	3071601
Certificate	1604324		

A.3 Sampling system

A visual inspection with reference to CEMS manuals, has been carried out on the following when applicable:

MCS100FT	Comments:
Sampling probe and filters	Ok - free of any visible faults
Gas conditioning system	AMS is hot/wet so no gas conditioning
Pumps	Ok - free of any visible faults
All connections	Ok - free of any visible faults
Sample lines	Ok - free of any visible faults
Power supplies	Ok - free of any visible faults

The sampling system is free of any visible faults.

A.4 Documentation and records

The operator is required to either have, or have access to, the documentation specified in Annex A, section A.4 of EN14.181

	Comments:
A plan of the AMS	No information available at the time of the functional test
User and maintenance manuals	No information available at the time of the functional test
Logbook to document possible malfunctions and actions taken	No information available at the time of the functional test
Management systems, procedures for maintenance, calibration and training	No information available at the time of the functional test
Service reports	No information available at the time of the functional test
QAL3 documentation including actions taken as a result of out of control situations	No information available at the time of the functional test
Auditing plans and records	No information available at the time of the functional test
Maintenance schedules	No information available at the time of the functional test
Training records	No information available at the time of the functional test

A.5 Serviceability

There shall be provisions for the effective management and maintenance of the AMS, in order to ensure the maintenance of the quality of data. Such provisions include at least the following:

	Comments:
Safe and clean working environment with sufficient space and weather protections	Ok
Easy and safe access to the AMS	Ok
Adequate supplies of reference materials, tools and spare parts	No information available at the time of the functional test
Service and support agreement	No information available at the time of the functional test

A.6 Leak test

Leak test has been performed according to the AMS manuals. The test has covered the entire sampling system.

	Bemærkninger:
Leak test	Ok - no leakage found

A.7 Zeropoint- and Span check

Reference zero and span materials according to the CEMS manuals, has been used to verify the corresponding readings of the AMS.

Analyzer: MCS100FT					
Check-schem for CO, SO₂, NO, NO₂, og NO_x.					
Parameter	CO	SO₂	NO	NO₂	NO_x
Unit	mg/Nm ³ (dry)	mg/Nm ³ (dry)	mg/Nm ³ (dry)	mg/Nm ³ (dry)	mg/Nm ³ (dry)
Measuring range during test	1000	400	650	100	1000
Zero gas value (N₂-gas is 0,0)	0,00	0,00	0,00	0,00	0,00
AMS measured value	0,00	0,50	0,00	0,00	0,20
Expected value from mA output	4,00	4,02	4,00	4,00	4,00
Measured value mA from AMS	3,99	4,01	N.A	N.A	4,00
Spangas value	152,00	142,00	401,80	77,90	614,75
AMS measured value	151,72	139,60	399,75	70,40	611,62
Expected value from mA output	6,43	9,58	13,84	15,26	13,79
Measured value mA from AMS	6,39	9,57	N.A	N.A	13,82
Deviation mA output (measuring Unit)	2,34	0,35	N.A	N.A	-2,13

Analyzer: MCS100FT					
Check-schem for O₂, CO₂, H₂O, HCl og TOC					
Parameter	O ₂	CO ₂	H ₂ O	HCl	TOC
Unit	vol% (dry)	vol% (dry)	vol%	mg/Nm ³ (dry)	mgC/Nm ³ (dry)
Measuring range during test	25	25	40	100	100
Zero gas value (N₂-gas er 0,0)	0,00	0,00	0,00	0,00	0,00
AMS measured value	0,04	-0,01	0,00	0,07	-0,01
Expected value from mA output	4,03	3,99	4,00	4,01	4,00
Measured value mA from AMS	4,02	3,98	4,00	4,01	3,99
Spangas value	2,01	20,09	40,00	80,00	30,07
AMS measured value	2,24	20,07	40,20	81,60	29,95
Expected value from mA output	5,43	16,84	20,08	17,06	8,79
Measured value mA from AMS	5,43	16,83	20,05	17,04	8,78
Deviation mA output (measuring Unit)	0,01	N.A	0,08	0,10	0,08

Analysator: MCS100FT					
Check-schem for NH₃ og HF					
Parameter	NH₃	HF			
Unit	mg/Nm ³ (dry)	mg/Nm ³ (dry)			
Measuring range during test	60	10			
Zero gas value (N₂-gas er 0,0)	0,00	0,00			
AMS measured value	0,03	0,00			
Expected value from mA output	4,01	4,00			
Measured value mA from AMS	4,00	4,00			
Spangas value	19,15	8,00			
AMS measured value	18,93	8,17			
Expected value from mA output	9,05	17,07			
Measured value mA from AMS	9,03	17,10			
Deviation mA output (measuring Unit)	0,01	0,27			

A.8 Linearity

The linearity of the analyser's response has been checked using five different materials, including a zero concentration.

Comments: There is no emission limit applicable for O₂ and H₂O but the following virtual ELV's and uncertainty is applied: Moisture (H₂O): ELV=30 vol% - Oxygen (O₂): ELV=21 vol%

A.9 Interferences

A test has been performed, while the monitored process gasses, contain components that are known interferences, as identified during QAL 1.

Comments: The Interference test have been done using H₂O, as it is the most interfering gas.

Interfering gas:												
Vol% H ₂ O		H ₂ O	CO	SO ₂	NO	NO ₂	HF	NH ₃	HCl	O ₂	CO ₂	TOC
0	Before adj.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	After adj.											
5	Before adj.	5,02	0,03	0,39	0,42	1,48	0,26	0,07	-0,05	0,05	-0,06	0,06
	After adj.											
10	Before adj.	10,59	0,48	0,73	-0,19	1,10	0,35	0,20	-0,09	0,06	0,01	0,08
	After adj.											
15	Before adj.	14,91	0,42	0,35	-0,15	0,29	0,34	0,16	-0,09	0,07	-0,02	0,09
	After adj.											
20	Before adj.	20,28	0,25	1,32	0,16	1,41	0,37	0,73	0,03	0,07	0,02	0,09
	After adj.											
30	Before adj.	30,12	0,26	-0,26	0,024	1,03	0,45	0,4	0,11	0,09	-0,009	0,1
	After adj.											

A.10 Zero and span drift

The zero point and span drift has been obtained from and evaluated on basis of the records of QAL3.

QAL 3 point	Comments:
Zero	No information available at the time of the functional test
Span	No information available at the time of the functional test

A.11 Response time

Parameter	SO ₂				
Unit	mg/Nm ³ (dry)				
Concentration	142				
Concentration at T90	128				
Time in sec.	102				
Comments	OK				

Parallel measurements analog output 4-20 mA

Analog signals	All analog signals are verified.
Digital signals	Modbus

Conclusion:

The analyzer was span adjusted:

NO (1.0 to 1.084189) - CO (1.0 to 1.02633356) CO₂ (1.0 to 1.0100553) N₂O (1.0 to 0.9) NH₃ (1.0 to 1.06388889) HCl (1.0 to 0.8421)

NO2 was already adjustet to 1.1822755 at arrival

HF was already adjustet to 0.7518 at arrival but adjusted to 1.12502806

The results in the test is after the above adjustments

The analyzer passed the linearity test.

Name:

Signature:

Stefan W.S. Krog

Plant: Babcock & Wilcox Vølund AB - Margam

Analyzer:

MCS100FT

Gas:

CO

Applies limit (Cu) 1/2 hr ELV

150 mg/Nm³ (dry)

Applied measuring range:

1000 mg/Nm³ (dry)

Regression line: $Y_i = A + B X_i$

A = -1,00

Max. residual:

1,52 %

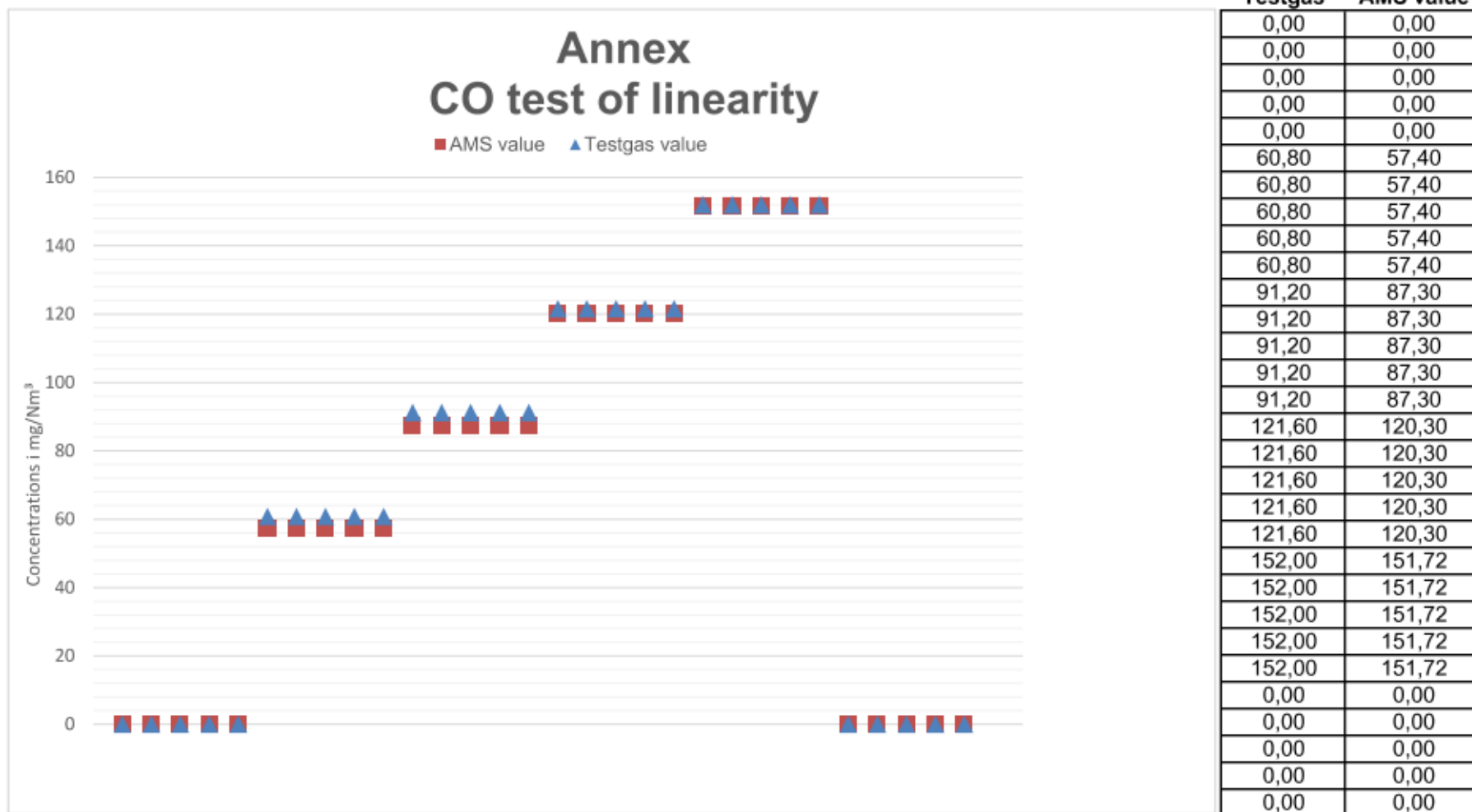
Testdato:

17-10-2018

B = 0,99

Max. residual < 5%:

APPROVED



Plant: Babcock & Wilcox Vølund AB - Margam

Analyzer:

MCS100FT

Gas:

SO₂

Applies limit (Cu) 2 x daily ELV

150 mg/Nm³ (dry)

Applied measuring range:

400 mg/Nm³ (dry)

Regression line: $Y_i = A + B X_i$

A = 0,99

B = -0,42

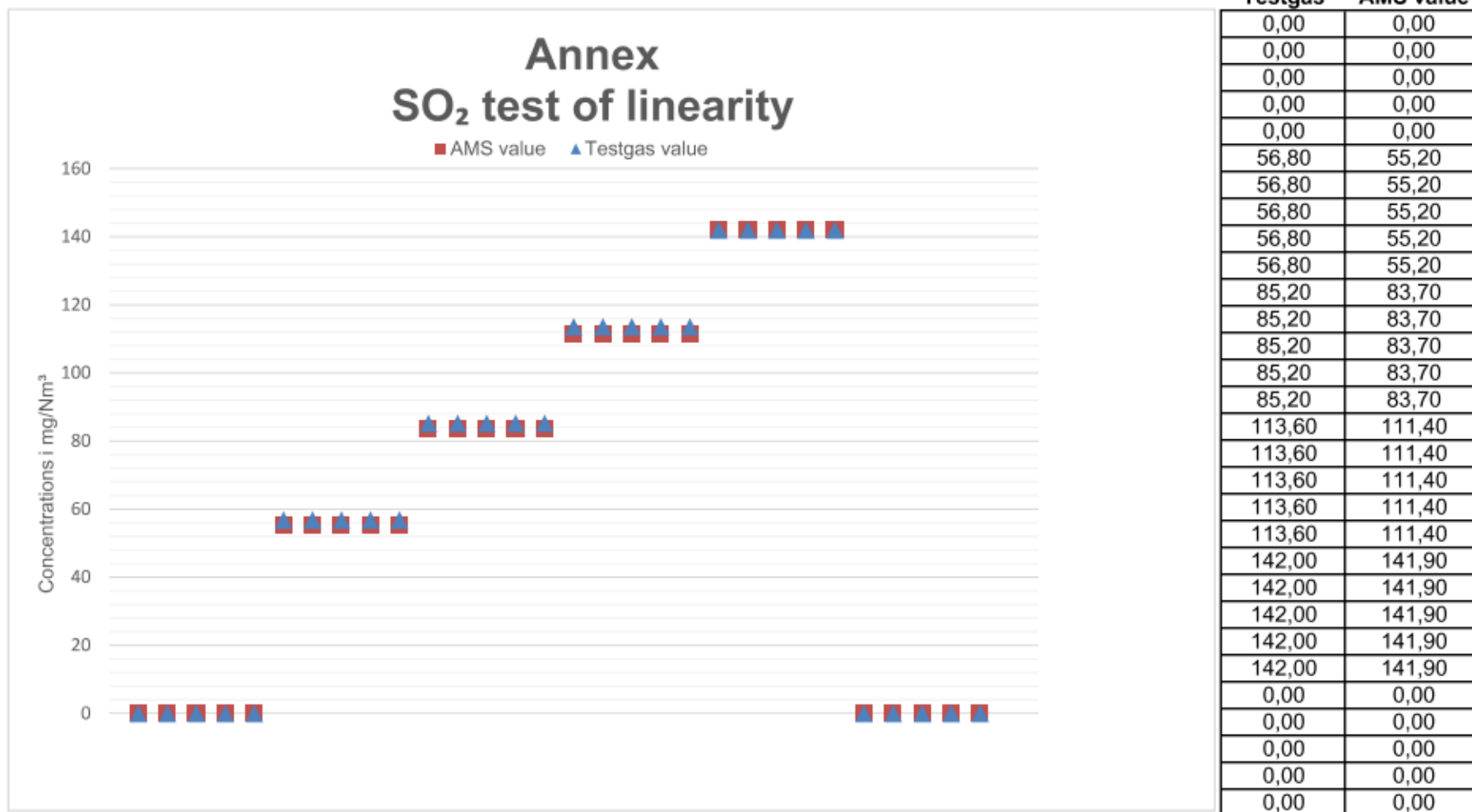
Max. residual:

0,90 %

Testdato: 17-10-2018

Max. residual < 5%:

APPROVED



Plant: Babcock & Wilcox Vølund AB - Margam

Analyzer:

MCS100FT

Gas:

NO

Applies limit (Cu) 1/2 hr ELV

392 mg/Nm³ (dry)

Applied measuring range:

650 mg/Nm³ (dry)

Regression line: $Y_i = A + B X_i$

A = 0,18

Max. residual:

0,36 %

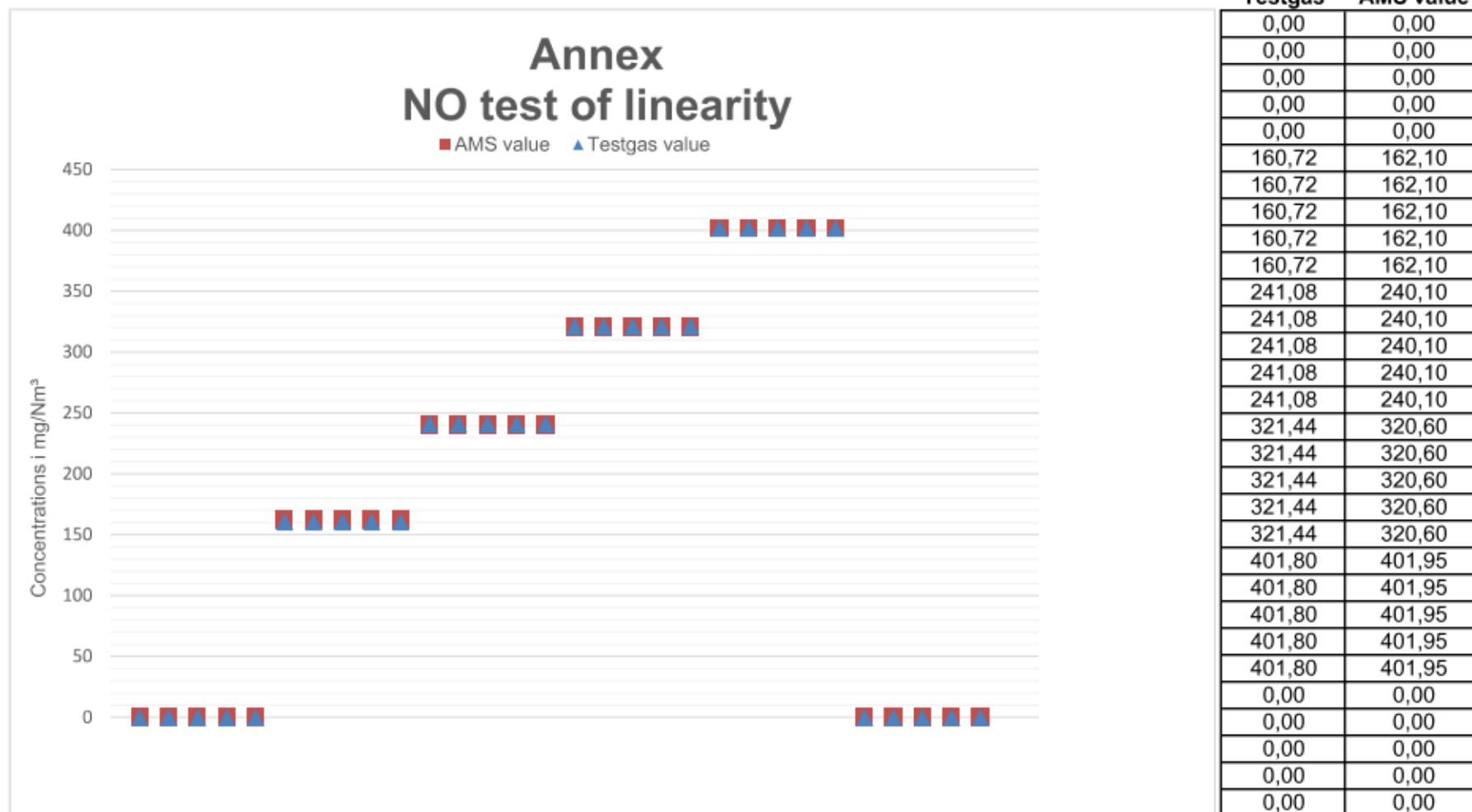
Testdato:

17-10-2018

B = 1,00

Max. residual < 5%:

APPROVED



Plant: Babcock & Wilcox Vølund AB - Margam

Analyzer:

MCS100FT

Gas:

NO₂

Applies limit (Cu) 1/2 hr ELV

600 mg/Nm³ (dry)

Applied measuring range:

100

Regression line: $Y_i = A + B X_i$

A = 0,11

Max. residual:

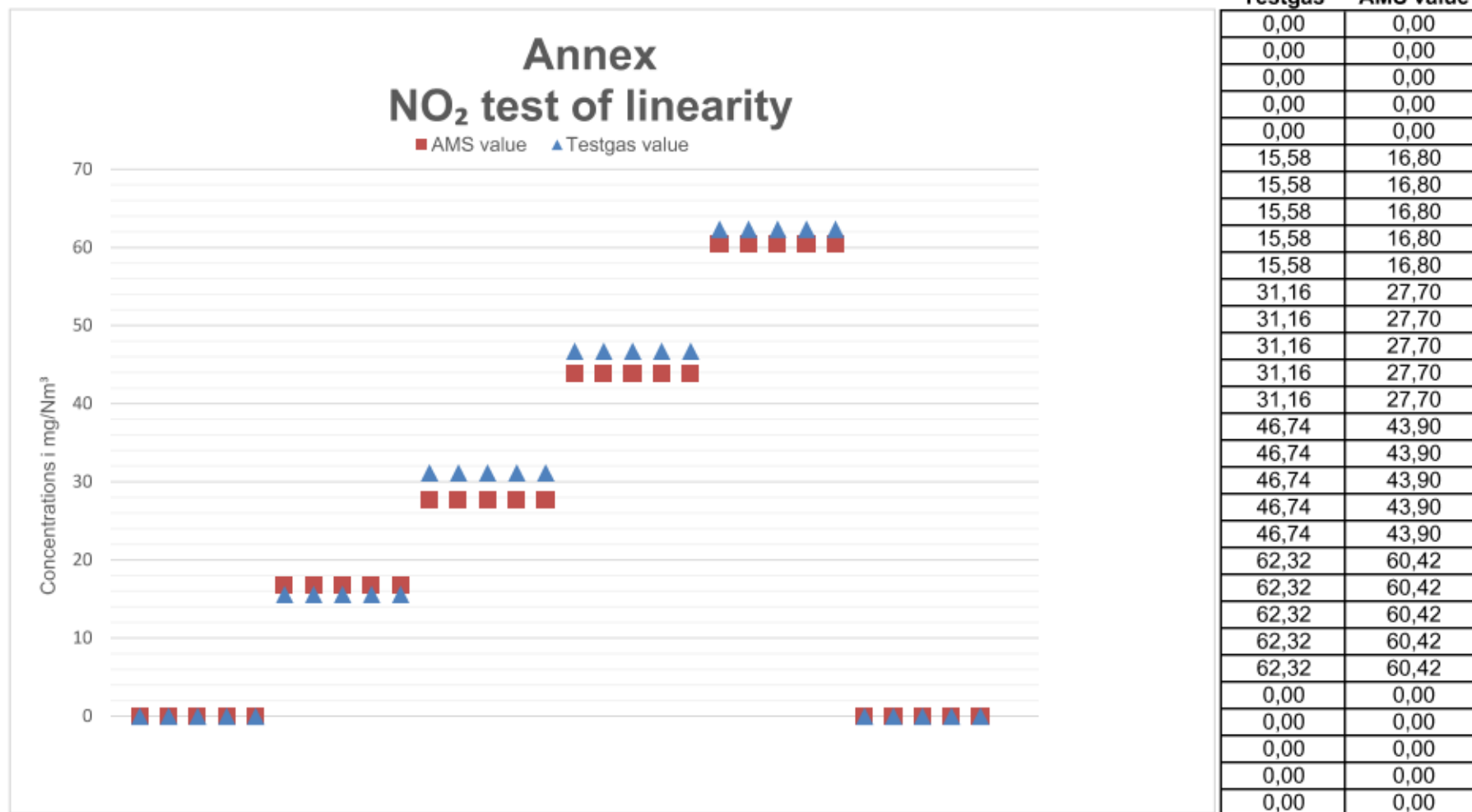
0,34 %

Testdato: 17-10-2018

B = 0,95

Max. residual < 5%:

APPROVED



Plant: Babcock & Wilcox Vølund AB - Margam

Analyzer:

MCS100FT

Gas:

NO_x

Applies limit (Cu) 1/2 hr ELV

600 mg/Nm³ (dry)

Applied measuring range:

1000 mg/Nm³ (dry)

Regression line: $Y_i = A + B X_i$

A = 0,28

Max. residual:

0,36 %

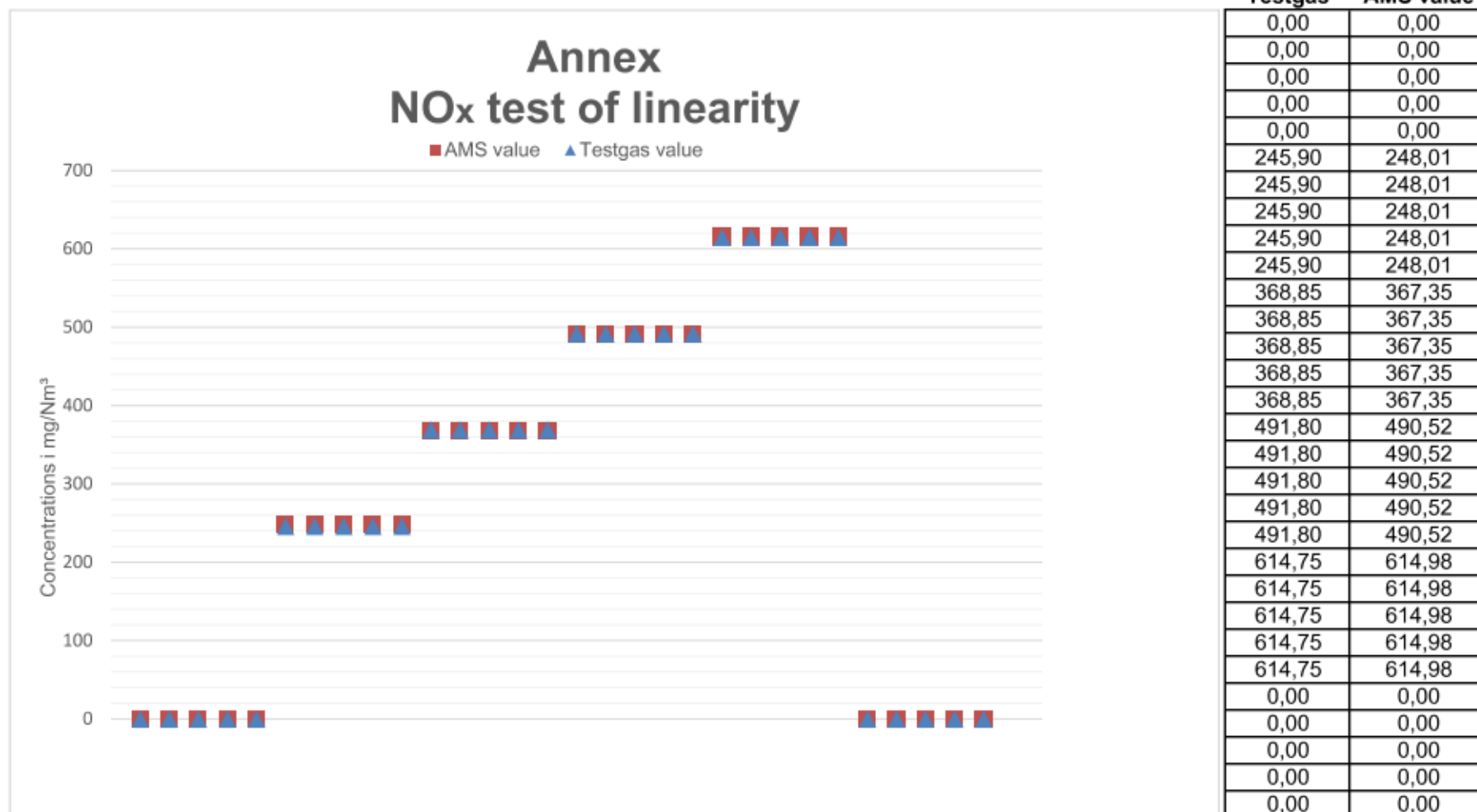
Testdato:

17-10-2018

B = 1,00

Max. residual < 5%:

APPROVED



Plant: Babcock & Wilcox Vølund AB - Margam

Analyzer:

MCS100FT

Gas:

HCl

Applies limit (Cu) 1/2 hr ELV

90 mg/Nm³ (dry)

Applied measuring range:

100 mg/Nm³ (dry)

Regression line: $Y_i = A + B X_i$

A = -0,33

Max. residual:

1,44 %

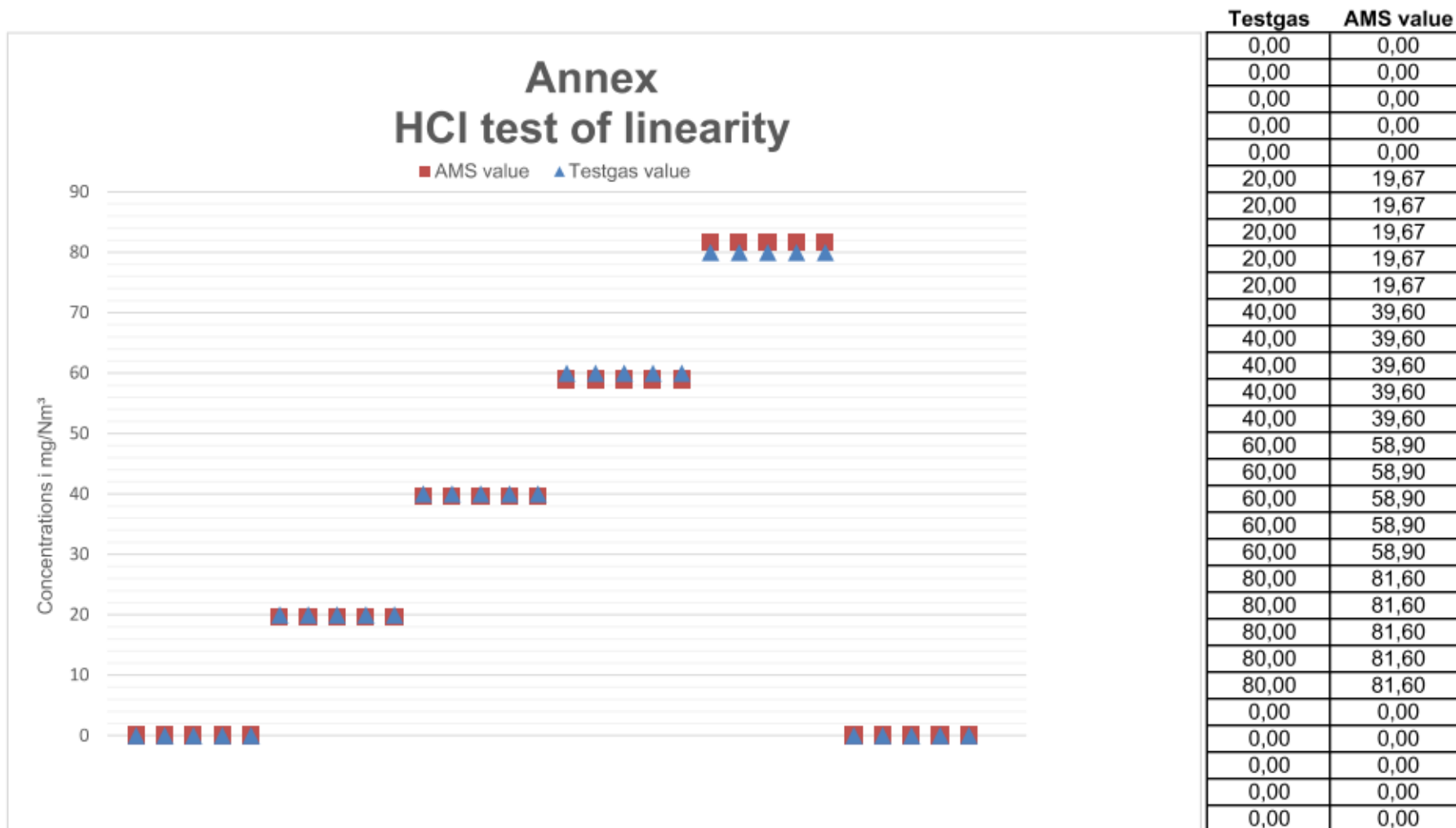
Testdato:

17-10-2018

B = 1,01

Max. residual < 5%:

APPROVED



Plant: Babcock & Wilcox Vølund AB - Margam

Analyzer:

MCS100FT

Gas:

HF

Applies limit (Cu) 1/2 hr ELV

6 mg/Nm³ (dry)

Applied measuring range:

10 mg/Nm³ (dry)

Regression line: $Y_i = A + B X_i$

A = 0,08

Max. residual:

2,85 %

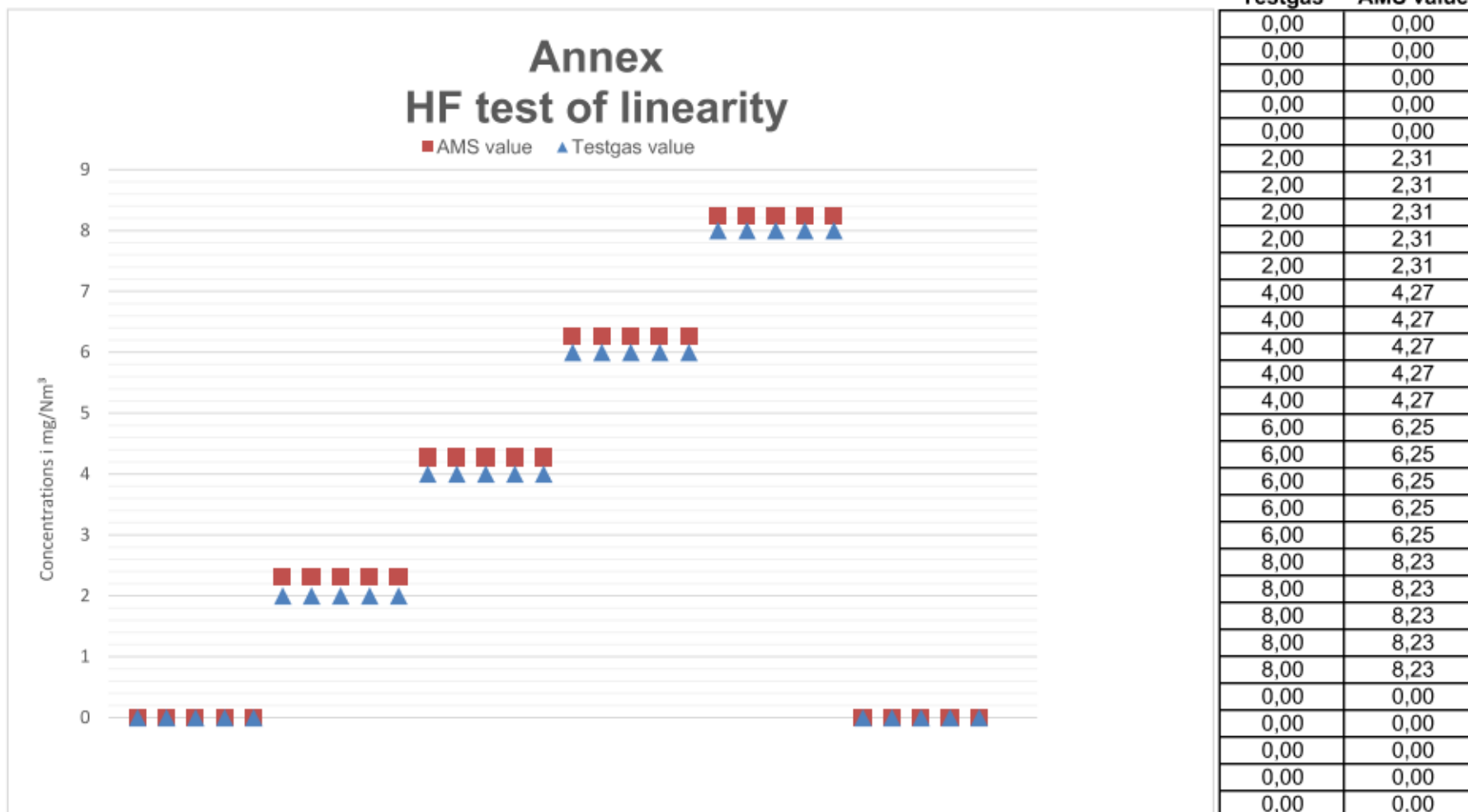
Testdato:

17-10-2018

B = 1,03

Max. residual < 5%:

APPROVED



Plant: Babcock & Wilcox Vølund AB - Margam

Analyzer:

MCS100FT

Gas:

TOC

Applies limit (Cu) 1/2 hr ELV

30 mgC/Nm³ (dry)

Applied measuring range:

100 mgC/Nm³ (dry)

Regression line: $Y_i = A + B X_i$

A = 0,06

Max. residual:

0,52 %

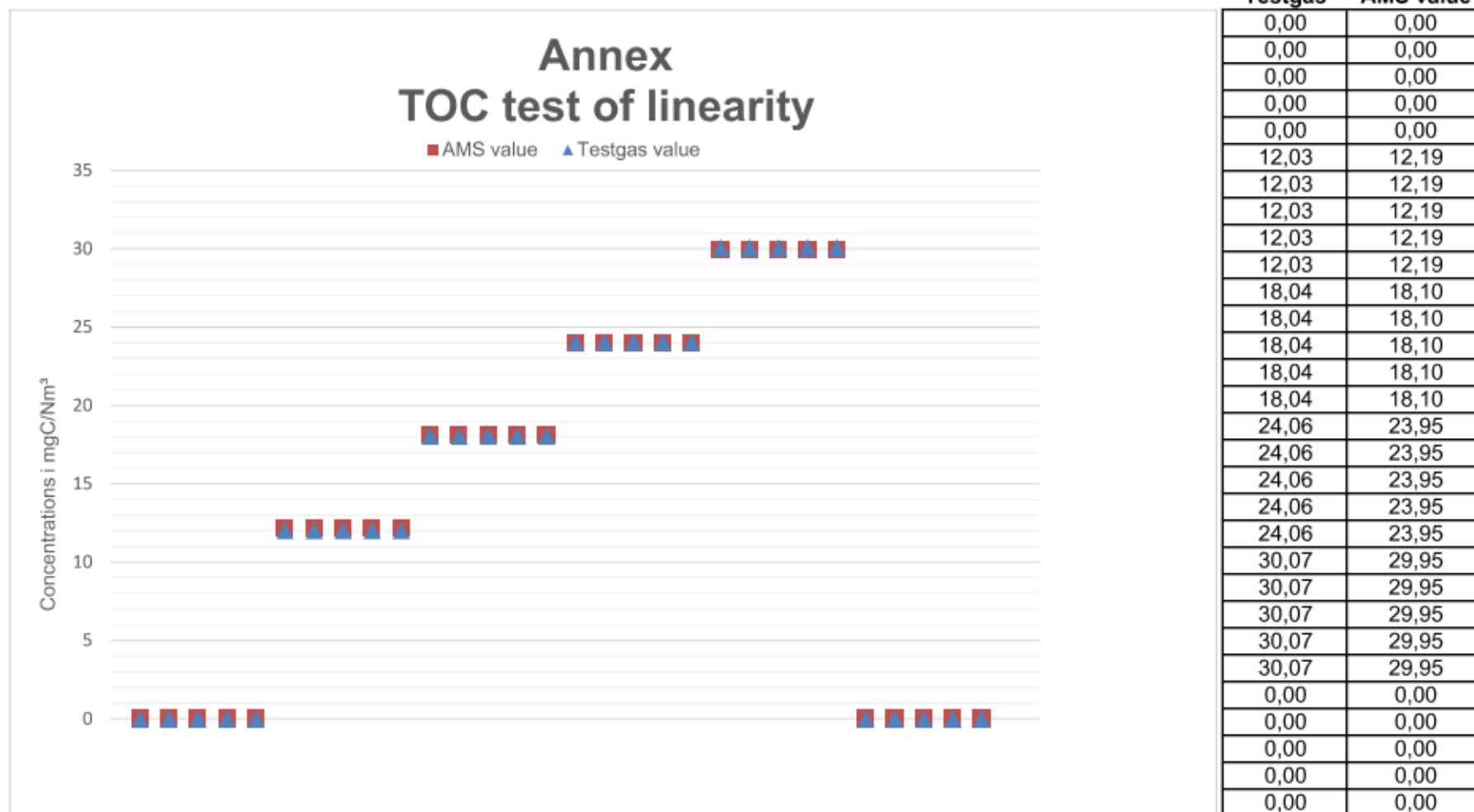
Testdato:

17-10-2018

B = 1,00

Max. residual < 5%:

APPROVED



Plant: GMAB
Margam

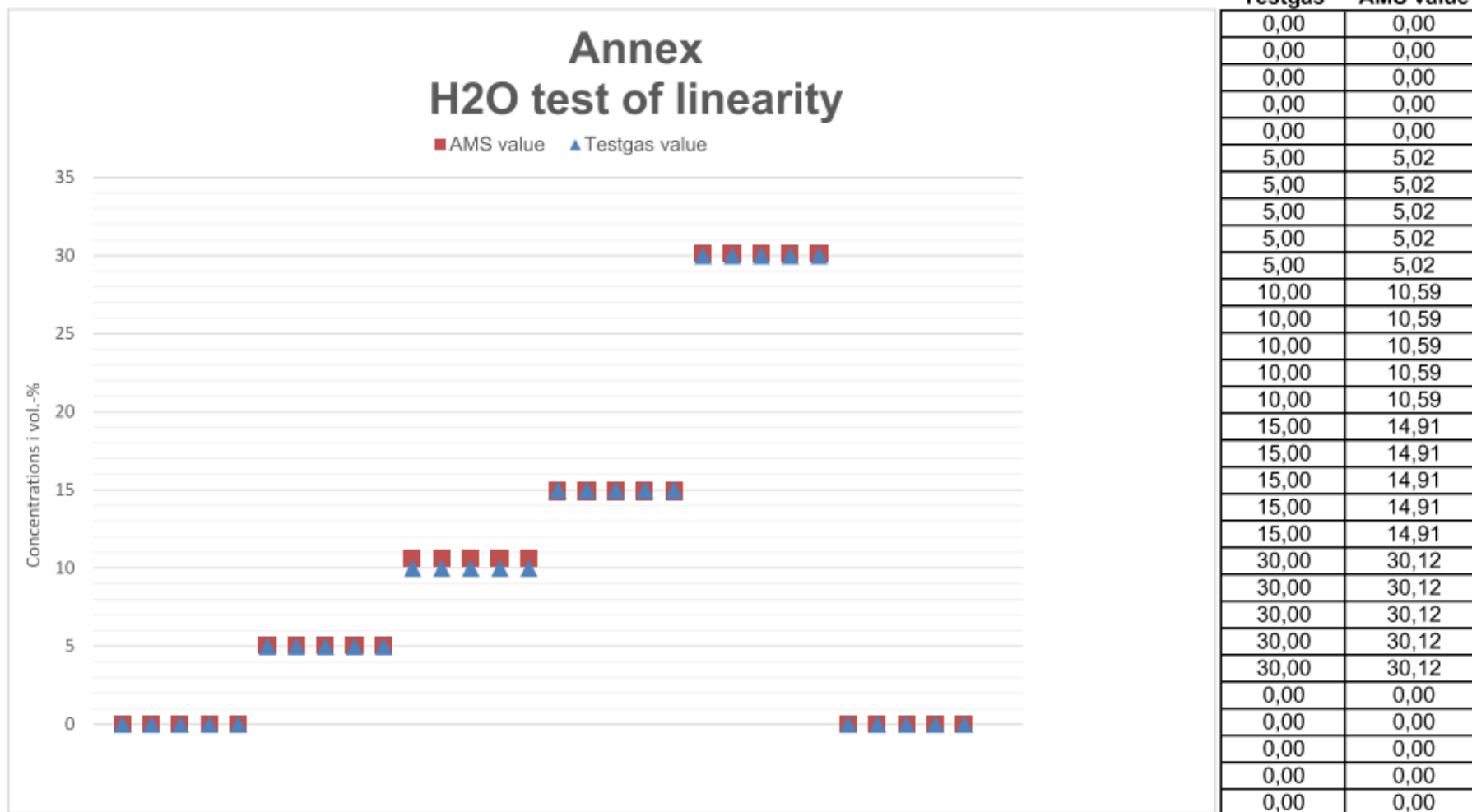
Analyzer:
Gas:
Applies limit (Cu) ELV
Applied measuring range:
Max. residual:
Max. residual < 5%:

MCS100FT
H2O
30 Vol.-%
40 Vol.-%
1,61 %
APPROVED

Regression line: $Y_i = A + B X_i$

A = 0,08
B = 1,00

Testdato: 17-10-2018



Plant: GMAB
Margam

Analyzer:
Gas:
Applies limit (Cu) ELV
Applied measuring range:
Max. residual:
Max. residual < 5%:

MCS100FT
O2
21 Vol.-%
25 Vol.-%
0,29 %
APPROVED

Regression line: $Y_i = A + B X_i$

A = 0,00
B = 1,00

Testdato: 18-10-2018

