ISO/IEC 17025 Accredited Legal Entity, UKAS Accredited Testing Laboratory No. 4279
Exova (UK) Ltd trading as Exova Catalyst & Exova Catalyst Ireland
Unit C5, Emery Court, The Embankment Business Park, Stockport, SK4 3GL

Exova Catalyst Ireland, Unit D8 North City Business Park, North Road, Finglas, Dublin 11
Your Exova Catalyst Contact: Patrick O'Brien (+353 86 416 1434)
E: patrick.obrien@exova.com

EN 14181 AST Report Commissioned by
Covanta

Installation Name & Address
Covanta
Shellybanks Road
Off Pigeon House Road
Dublin 4

Primary Site Contact: Mark Heffernan

Industrial Emissions Licence: W0232-01

Stack Reference
A2-2 Line 2 Redundant

Dates of the Monitoring Campaign
1st - 4th May 2018

Job Reference Number
CDU-1013

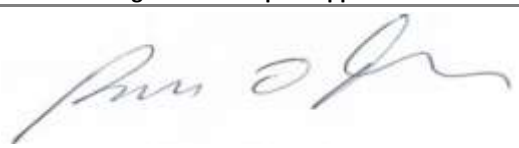
For inspection purposes only.
Consent of copyright owner required for any other use.

Report Written by
Patrick O'Brien Regional Manager MCERTS Level 2 MM 08 922 TE1 TE2 TE3 TE4

Report Approved by
Patrick O'Brien Regional Manager MCERTS Level 2 MM 08 922 TE1 TE2 TE3 TE4

Report Date
11th June 2018

Report Version
Version 1

Signature of Report Approver


EPA Export 21-08-2018:03:54:56

CONTENTS

SECTION 1A: TITLE PAGE

CONTENTS 2

SECTIONS 1B & 1C: EXECUTIVE SUMMARY

- Overall Aim of the Monitoring Campaign & Special Requirements 3
- AST Calibration Check & Linearity Summaries 3
- Summary of Standard Reference Method & EN 14181 Deviations 4
- Conclusions, Discussions and Actions arising from the Sampling 5

SECTION 2: INFORMATION ABOUT THE REGULATED INSTALLATION

- Regulatory Information 5
- Operational Information and Site Monitoring Provisions 6
- Monitoring Provisions at the Installation - Periodic Monitoring 7
- Continuous Emissions Monitors (CEM) at the Installation 9

SECTION 3: INFORMATION ABOUT THE MONITORING CAMPAIGN

- Test Laboratory Staff 10
- Standard Reference Methods (SRMs) 10

SECTION 4B: Data and Calculations - AST

SECTION 5: Results of the Functional Tests

For inspection purposes only.
Consent of copyright owner required for any other use.

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.

EPA Export 21-08-2018:03:54:56

Executive Summary (Page 1 of 2)

Covanta, Dublin 4
A2-2 Line 2 Redundant
1st - 4th May 2018

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Covanta to carry out stack emissions testing on the A2-2 Line 2 Redundant Stack at Dublin 4.

The aim of the monitoring campaign was to perform an AST Calibration Check 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.

AST CALIBRATION CHECK SUMMARY

Parameter	Calibration Function derived from QAL2?	Calibration Function as Derived from the Previous QAL2	Calibration Range from Previous QAL2 @ REF Conditions	Calibration Function that the AST was performed against (See Conclusion)	Result of Variability Test	Result of Calibration Test	Range after AST Extension @ REF Conditions
Total Particulate Matter	Yes	y = x	0 to 10	N/A	N/A	N/A	N/A
Total VOCs	Yes	y = 0.9901x + 0.8672	0 to 16.6	y = 0.9901x + 0.8672	Pass	Pass	Existing Range Still Valid
Oxides of Nitrogen (as NO_2)	Yes	y = 0.8865x + 4.6239	0 to 200	y = 0.8865x + 4.6239	Pass	Pass	Existing Range Still Valid
Sulphur Dioxide	Yes	y = 1.0381x -7.4	0 to 27	y = 1.0381x -7.4	Pass	Pass	Existing Range Still Valid
Carbon Monoxide	Yes	y = 1.1858x -1.4385	0 to 34.5	y = 1.1858x -1.4385	Pass	Pass	Existing Range Still Valid
Hydrogen Chloride	Yes	y = 0.9866x + 0.2518	0 to 2	y = 0.9866x + 0.2518	Pass	Pass	Existing Range Still Valid
Water Vapour (% v/v)	Yes	y = 1.018x + 0	0 to 29.6	y = 1.018x + 0	Pass	Pass	Existing Range Still Valid
Oxygen (% v/v)	Yes	y = 0.8282x -0.1094	0 to 13.2	y = 0.8282x -0.1094	Pass	Pass	Existing Range Still Valid

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 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 VOCs	Yes	y = 0.9354x + 1.7556	0.9998	0.63	5	Pass	0 to 15 mg/m³
Nitrogen Monoxide (as NO_2)	Yes	y = 1.0278x -13.8661	0.9990	2.23	5	Pass	0 to 499 mg/m³
Nitrogen Dioxide	Yes	y = 1.0085x + 0.2788	0.9980	2.58	5	Pass	0 to 32 mg/m³
Sulphur Dioxide	Yes	y = 1.0514x -5.5637	0.9988	1.78	5	Pass	0 to 159 mg/m³
Carbon Monoxide	Yes	y = 1.0839x -0.0575	0.9978	2.55	5	Pass	0 to 75 mg/m³
Hydrogen Chloride	Yes	y = 1.1042x -0.1203	0.9961	2.38	5	Pass	0 to 7 mg/m³
Oxygen (% v/v)	Yes	y = 0.9801x + 0.0256	0.9999	0.46	5	Pass	0 to 22 % v/v

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

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:56

Executive Summary (Page 2 of 2)

Covanta, Dublin 4
A2-2 Line 2 Redundant
1st - 4th May 2018

CONCLUSIONS, DISCUSSIONS & ACTIONS FROM THE SAMPLING EXERCISE

Oxides of Nitrogen (as NO_2), Carbon Monoxide, Hydrogen Chloride, Water Vapour & Oxygen

The CEM data was corrected using the calibration function derived during the most recent QAL2 campaign. The corrected values passed both the variability and calibration tests as required by EN 14181 and therefore the calibration function is deemed to be valid within the given tolerances. The calibration range derived in the previous QAL2 is still valid.

Total Particulate Matter

As the Total Particulate Matter emissions continue to be of a low order (less than the 95% Confidence Interval [CI] of the Daily ELV, which is 30%) and a valid calibration function was not derived during the previous QAL2. TGN M20 suggests that a minimum of 3 x 90 minute Total Particulate Matter samples runs be performed over a minimum of 1 day, and where emissions continue to be less than the 95% Confidence Interval [CI] of the Daily ELV), it is acceptable to leave the calibration function in the Data Acquisition Handling Software (DAHS) as 1.0000 (i.e. y = x), and continue to use the CEM as a qualitative indicator of rising emissions rather than a quantitative monitor. The Environment Agency should be informed if this approach has been taken.

For inspection purposes only.
Consent of copyright owner required for any other use.

Total VOCs, Nitrogen Monoxide, Nitrogen Dioxide, Sulphur Dioxide, Carbon Monoxide, Hydrogen Chloride & Oxygen

The CEM was found to give a linear response to the test gases supplied to the analyser, passing the EN 14181 test of residuals requirement.

SUMMARY OF STANDARD REFERENCE METHOD & EN 14181 DEVIATIONS

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

EPA Export 21-08-2018:03:54:56

REGULATORY INFORMATION

Covanta, Dublin 4
A2-2 Line 2 Redundant
1st - 4th May 2018

Parameter	Value
Name of the Installation	Dublin 4
Address of the Installation	See Title Page
Sector of the Installation	Incineration
Permit Number	W0232-01
Date of the Last QAL2 / AST Campaign	4th - 9th April 2018
Date CEMs Data Obtained by Exova Catalyst	14th May 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	30	10	30
Total VOCs	20	10	30
Oxides of Nitrogen (as NO_2)	400	200	20
Sulphur Dioxide	200	50	20
Carbon Monoxide	100	50	20 [1]
Hydrogen Chloride	60	10	40

[1] TGN M20, Version 3

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:56

OPERATIONAL INFORMATION AND SITE MONITORING PROVISIONS

Covanta, Dublin 4
A2-2 Line 2 Redundant
1st - 4th May 2018

Process Type and Variations in Emissions

Parameter	Value
Continuous or batch process	Continuous - 32 tonnes / hour per line
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?	N/A
Are there any factors that may affect the collected data (e.g. auto-calibrations, plant start up and shut down)	No
Reviewing historical Plant data, were low emissions expected for any determinands?	N/A
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?	Incineration of Municiple Waste

Type of Fuel

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

Abatement

Parameter	Value
Type of Abatement System	Selective non-catalytic reduction/semi-dry scrubber/bag filter/wet scrubber
Running Status	On

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:56

MONITORING PROVISIONS AT THE INSTALLATION - PERIODIC MONITORING

Covanta, Dublin 4
A2-2 Line 2 Redundant
1st - 4th May 2018

Duct Characteristics

Parameter	Units	Value
Type	-	Square
Depth	m	2.00
Width	m	2.00
Area	m^2	4.00
Port Depth	cm	20
Orientation of Duct	-	Horizontal
Number of Ports	-	4
Sample Port Size	-	5" Flange

Location of Sampling Platform

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

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	N/A
Access to sample ports unhindered by obstructions	Yes
Safe access available	Yes
Easy access available	Yes

For inspection purposes only.
Consent of copyright owner required for any other use.

Sampling Location / Platform Improvement Recommendations

The sampling location meets all the requirements specified in EPA Guidance Note AG1 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 28th August 2017, Report ID: CDU-0886, 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	133.0		> 5 Pa	Yes
Mean Velocity	m/s	17.94		-	-
Lowest Gas Velocity	m/s	13.86		-	-
Highest Gas Velocity	m/s	21.20		-	-
Ratio of Above	: 1	1.53		< 3 : 1	Yes
Maximum Angle of Swirl	°	12		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

EPA Export 21-08-2018:03:54:56

MONITORING PROVISIONS AT THE INSTALLATION - PERIODIC MONITORING

Covanta, Dublin 4
A2-2 Line 2 Redundant
1st - 4th May 2018

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.

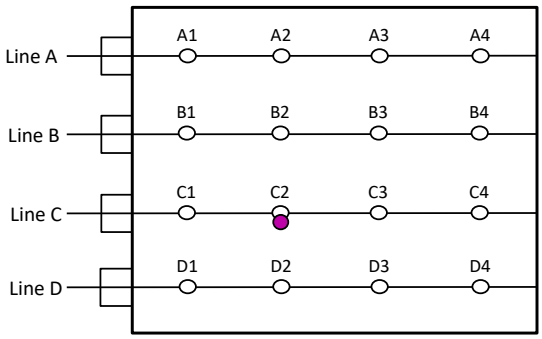
Plant Photos

Photo 1

Photo 2

For inspection purposes only.
Consent of copyright owner required for any other use.

Sample Points



where ○ = isokinetic point sampled at
● = non isokinetic/combustion gases

EPA Export 21-08-2018:03:54:56

CONTINUOUS EMISSION MONITORs (CEMs) AT THE INSTALLATION

Covanta, Dublin 4
A2-2 Line 2 Redundant
1st - 4th May 2018

Main Determinand	Type	Instrument Name	Instrument Serial Number	Measurement Principle	Certified Range (mg/m^3)	QAL1 Compliant	MCERTS Number
Total Particulate Matter	Extractive	FWE200DH	1605 8493	Light Scatter	0 - 200	Yes	MC 140249/01
Total VOCs	Extractive	FID100FT	151111252	FID	0 - 15	Yes	MC 100184/05
Oxides of Nitrogen (as NO_2)	Extractive	MCSFT	1548 0461	FTIR	0 - 400	Yes	MC 100184/05
Sulphur Dioxide	Extractive	MCSFT	1548 0461	FTIR	0 - 75	Yes	MC 100184/05
Carbon Monoxide	Extractive	MCSFT	1548 0461	FTIR	0 - 75	Yes	MC 100184/05
Hydrogen Chloride	Extractive	MCSFT	1548 0461	FTIR	120	Yes	MC 100184/05
Water Vapour	Extractive	MCSFT	1548 0461	FTIR	0 - 40	Yes	MC 100184/05
Oxygen (Dry)	Extractive	MCSFT	1548 0461	FTIR	0 - 22	Yes	MC 100184/05
Volume Flow Rate	In-Situ	Endress & Hauser	KC07F40109D	Differential Pressure	0 - 30 m/s	Yes	N/A

Peripheral Determinand	Recorded	Instrument Name
Temperature	Yes	MCSFT
Pressure	Yes	MCSFT

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:56

TEST LABORATORY STAFF

Position	Name	MCERTS Accreditation	MCERTS Number & Expiry Date	Technical Endorsements
Team Leader	Donal O Faogain	MCERTS Level 2	MM13 1259 & Feb 2020	TE1 TE2 TE3 TE4
Technician	James Magann	MCERTS Level 2	MM15 1330 & May 2021	TE1 TE2 TE3 TE4
Team Leader	Brian Walsh	MCERTS Level 1	MM17 1414	TE1
Technician	Mateusz Terlecki	MCERTS Level 1	MM17 1448	None

STANDARD REFERENCE METHODS (SRMs)

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

			Instrumental Ranges				
Determinand	**Instrument Name**	**Measurement Principle**	**Certified (mg/m³)**	**Operational (mg/m³)**	**MCERTS Number**	**Reference Method**	**MU [2] (%)**
Total Particulate Matter	MST	Gravimetric	N/A - SRM	N/A - SRM	N/A	EN 13284-1	50.0
Total VOCs	Sick Maihak 3006	FID	0 - 15	0 - 161	MC 040036	EN 12619	4.8
Oxides of Nitrogen (as NO_2)	Horiba PG-350E	Chemiluminescence	0 - 205	0 - 500	MC 130223	EN 14792	3.1
Sulphur Dioxide	MST	Ion Chromatography	N/A - SRM	N/A - SRM	N/A	EN 14791	8.0
Carbon Monoxide	Gasmet DX4000	FTIR	0 - 75	0 - 48	MC 030014	TGN M22	8.2
Hydrogen Chloride	MST	Ion Chromatography	N/A - SRM	N/A - SRM	N/A	EN 1911	8.2
Water Vapour	Gasmet DX4000	FTIR	0 -30%	0 - 40%	MC 030014	TGN M22	4.9
Oxygen (Dry)	Horiba PG-350E	Paramagnetic Cell	0 - 25%	0 - 25%	MC 130223	EN 14789	4.7
Volume Flow Rate	S-Pitot & MST	Pressure & Temperature	N/A - SRM	N/A - SRM	N/A - SRM	EN 16911-1	4.6

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

For inspection purposes only.
Consent of copyright owner required for any other use.

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.23
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.59
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.59
Umbilical (2)	-
Oven Box (1)	CAT 12.105
Oven Box (2)	-
Heated Probe (1)	CAT 5.13
Heated Probe (2)	CAT 5.145
Heated Probe (3)	CAT 5.52
S-Pitot (1)	CAT 21S.95
S-Pitot (2)	CAT 21P.93
L-Pitot	-
500g Check Weight	CAT 17.24
1Kg Check Weight	CAT 17.24
Last Impinger Arm	CAT 4.0002
Callipers	CAT 23.35
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	CAT 39.6
SELECT Horiba Model (2)	-
SELECT Servomex Model	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	CAT 4.112
Gasmet DX4000	CAT 19.7
Gasmet Sampling System	CAT 10.4
Bernath 3006 FID	-
Ankersmid APP100	CAT 12.84
Mass Flow Controller (1)	CAT 6.1
Mass Flow Controller (2)	CAT 6.21
Mass View (1)	CAT 25.56
Mass View (2)	-
SELECT Logger 1	-
SELECT Logger 2	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.97
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.97
Stopwatch	CAT 14.53
Barometer	CAT 13.27
Stack Thermocouple (1)	CAT 4.0017
Stack Thermocouple (2)	CAT 4.552
Stack Thermocouple (3)	-
1m Heated Line (1)	CAT 20.74
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	CAT 20.71
20m Heated Line (2)	-
Dual Channel Heater Controller	CAT 3.80
Single Channel Heater Controller	-
Laboratory Balance	CAT AUTO
Tape Measure	CAT 16.95

EPA Export 21-08-2018:03:54:56

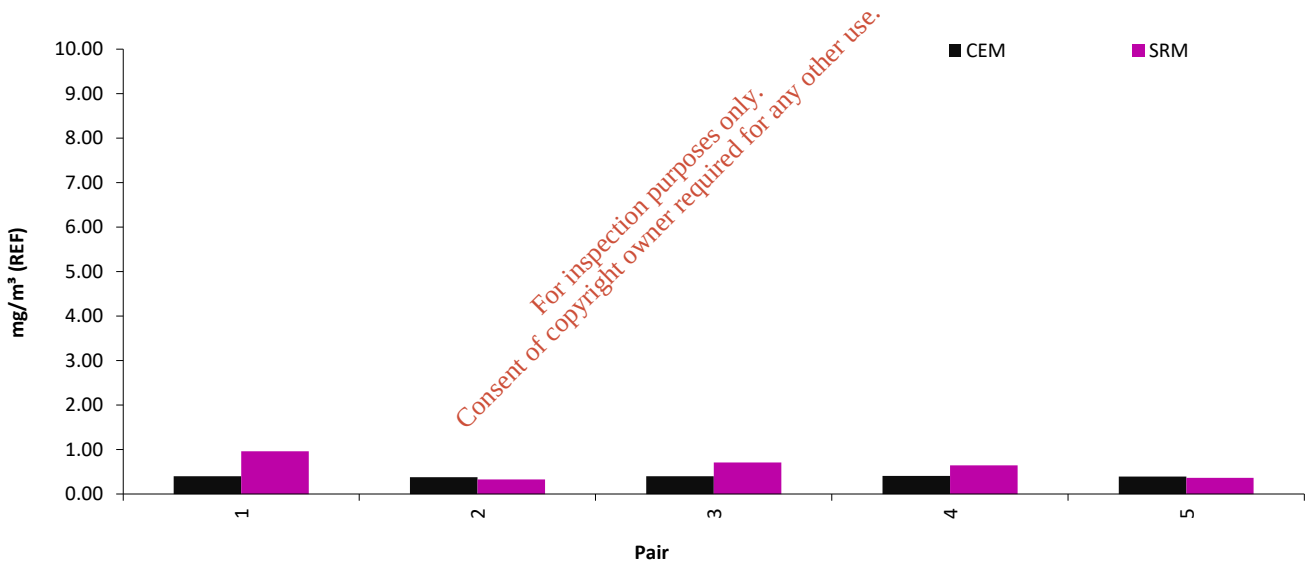
TOTAL PARTICULATE MATTER: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Pair	Date	Time	x, CEM (ACTUAL) mg/m³	y, SRM (ACTUAL) mg/m³	UNCAL CEM (STP, DRY, 11% O_2) mg/m³	SRM (STP, DRY, 11% O_2) mg/m³	Filter ID Number (47-XXXX)
1	08/05/2018	08:41 - 09:52	0.38	0.84	0.40	0.96	47-50817
2	08/05/2018	09:58 - 11:08	0.36	0.29	0.38	0.33	47-50560
3	08/05/2018	11:12 - 12:23	0.38	0.62	0.40	0.71	47-50562
4	08/05/2018	12:28 - 13:38	0.38	0.56	0.41	0.65	47-50826
5	08/05/2018	13:44 - 14:53	0.37	0.31	0.39	0.36	47-50534
DAILY ELV	-	-	-	-	-	10.00	

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



For inspection purposes only.
Consent of copyright owner required for any other use.

It can be seen from the table (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. Because of these low emissions, it had not been possible to derive a valid calibration function at the QAL2 stage. Therefore, due to a lack of a calibration function to test, it has not been possible to perform an AST. In these circumstance, EA document TGN M20, Version 3 suggests that it is allowable to report the data (as seen above) and state that as the emissions are of a low order, the Plant is operating well within its emission limits and therefore no further action is required as the CEM is effectively operating as an indicative monitor.

EPA Export 21-08-2018:03:54:56

VOLATILE ORGANIC COMPOUNDS: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, DRY) mg/m³	y, SRM (STP, DRY) mg/m³	SRM (STP, DRY, 11% O_2) mg/m³	x - x_{av} (A)	y - y_{av} (B)	(A) x (B)	$(x - x_{av})^2$	CAL CEM (STP, DRY) mg/m³
1	08/05/2018	00:32 - 01:02	-0.44	0.42	0.27	0.01	0.00	0.00	0.00	0.43
2	08/05/2018	01:32 - 02:02	-0.45	0.42	0.28	-0.01	0.00	0.00	0.00	0.42
3	08/05/2018	02:32 - 03:02	-0.45	0.42	0.28	-0.01	0.00	0.00	0.00	0.42
4	08/05/2018	03:32 - 04:02	-0.45	0.42	0.27	0.00	0.00	0.00	0.00	0.42
5	08/05/2018	05:32 - 06:02	-0.45	0.42	0.27	-0.01	0.00	0.00	0.00	0.42
6	08/05/2018	06:32 - 07:02	-0.43	0.42	0.27	0.01	0.00	0.00	0.00	0.44
7	08/05/2018	07:32 - 08:02	-0.44	0.42	0.27	0.01	0.00	0.00	0.00	0.43
				MAX SRM - MIN SRM	0.00		SUM	0.00	0.00	
				(DAILY) DELV (mg/m³)	10					
				95% CI MU (%)	30					

For inspection purposes only.
Consent of copyright owner required for any other use.

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (DRY) mg/m³	y, SRM (DRY) mg/m³	Reason for Data Pair Removal

Existing Calibration Function
y = 0.9901x + 0.8672

Source of Existing Calibration Function
QAL2

Existing Calibration Range (@ REF Conditions)
0 to 16.6 mg/m³

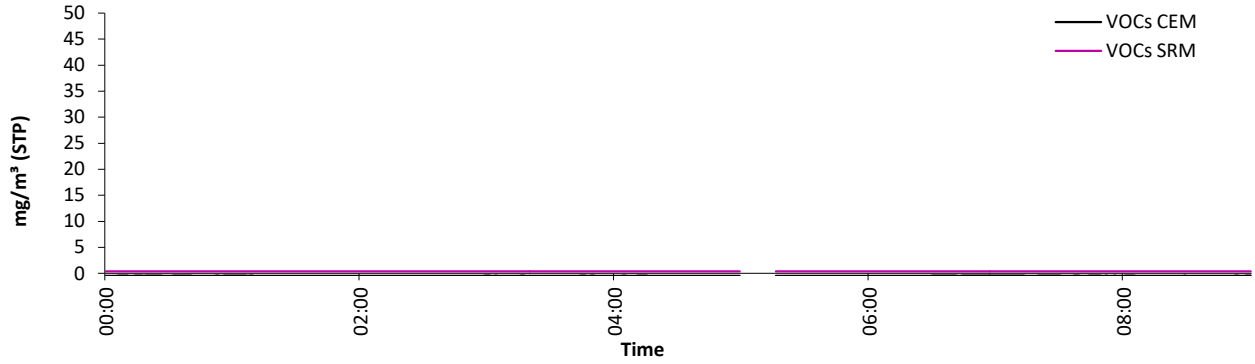
EPA Export 21-08-2018:03:54:56

VOLATILE ORGANIC COMPOUNDS: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

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



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

For inspection purposes only.
Consent of copyright owner required for any other use.

Variability Test Data

where CAL = Calibrated using AST calibration functions

Pair	Date	Time (30-minute Average)	CAL CEM (STP, DRY) mg/m³	CEM Water Vapour % v/v	CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CAL CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 11% O_2) mg/m³	SRM (STP, DRY, 11% O_2) mg/m³	ys, SRM - CAL CEM
1	08/05/2018	00:32 - 01:02	0.43	N/A	N/A	N/A	5.33	4.30	5.70	0.26	0.27	0.01
2	08/05/2018	01:32 - 02:02	0.42	N/A	N/A	N/A	5.51	4.46	5.87	0.25	0.28	0.03
3	08/05/2018	02:32 - 03:02	0.42	N/A	N/A	N/A	5.31	4.29	5.77	0.25	0.28	0.02
4	08/05/2018	03:32 - 04:02	0.42	N/A	N/A	N/A	5.31	4.29	5.72	0.25	0.27	0.02
5	08/05/2018	05:32 - 06:02	0.42	N/A	N/A	N/A	5.24	4.23	5.67	0.25	0.27	0.02
6	08/05/2018	06:32 - 07:02	0.44	N/A	N/A	N/A	5.22	4.21	5.73	0.26	0.27	0.01
7	08/05/2018	07:32 - 08:02	0.43	N/A	N/A	N/A	5.27	4.25	5.70	0.26	0.27	0.02
									MAX	0.26	**Sd**	0.01

EPA Export 21-08-2018:03:54:56

VOLATILE ORGANIC COMPOUNDS: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	1.53
Kv for 7 Pairs of Data	0.9441

The variability is accepted if Sd ≤1.5 x Q_o x Kv

Parameter	Value
Standard Deviation (Sd)	0.01
1.5 x Q_o x Kv	2.17
Outcome of Variability Test	**Pass**

Test of Calibration (Acceptance of Calibration Function)

^{t}0.95 (N-1)	1.943

where N (number of samples) = 7

The calibration is accepted if D ≤ ^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o

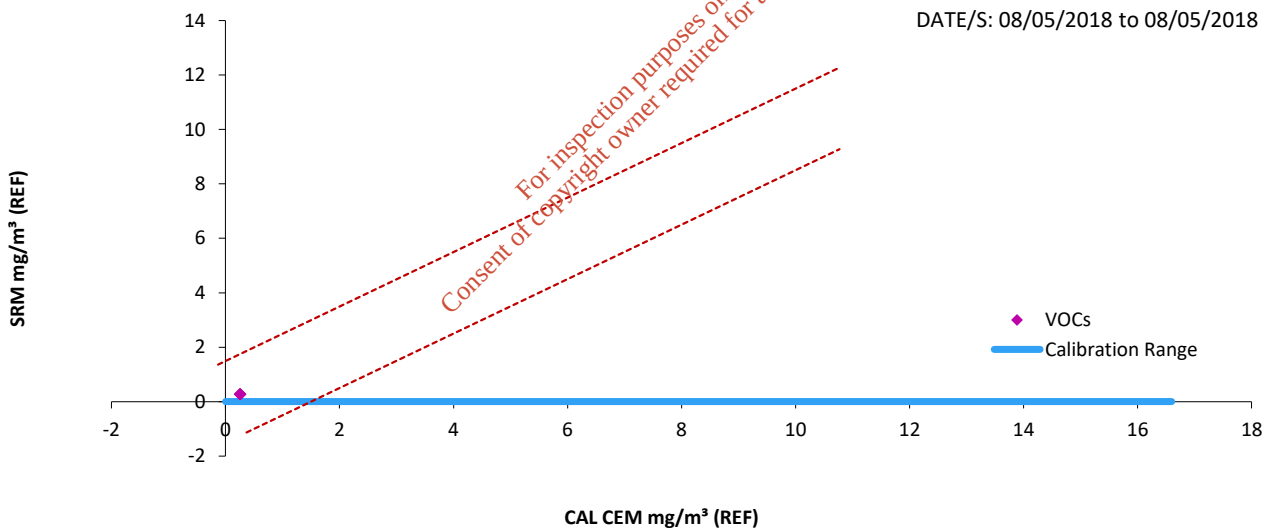
Parameter	Value
Mean Difference (D)	0.02
^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o	1.53
Outcome of Calibration Test	**Pass**

a) Calibrated Range (10% extension) (mg/m³)	0 to 0.3
b) Calibrated Range (50% of Daily ELV) (mg/m³)	0 to 5

New range up to a maximum of 50% of the Daily ELV	0 to 0.3

New Calibration Range (REF)	**Existing Range Still Valid**

PLOT 2: X-Y Plot - REF CAL CEM vs REF SRM Values



For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:56

OXIDES OF NITROGEN (as NO_2): AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, DRY) mg/m³	y, SRM (STP, DRY) mg/m³	SRM (STP, DRY, 11% O_2) mg/m³	x - x_{av} (A)	y - y_{av} (B)	(A) x (B)	(x - x_{av})²	CAL CEM (STP, DRY) mg/m³
1	08/05/2018	00:32 - 01:02	303.95	254.00	166.01	15.43	13.21	203.78	237.97	274.08
2	08/05/2018	01:32 - 02:02	259.08	217.45	143.73	-29.45	-23.34	687.33	867.13	234.30
3	08/05/2018	02:32 - 03:02	287.58	241.55	158.64	-0.95	0.77	-0.73	0.90	259.56
4	08/05/2018	03:32 - 04:02	281.75	234.68	153.57	-6.77	-6.11	41.37	45.85	254.40
5	08/05/2018	05:32 - 06:02	296.10	245.84	160.40	7.58	5.05	38.25	57.41	267.12
6	08/05/2018	06:32 - 07:02	316.14	262.69	172.03	27.61	21.90	604.82	762.39	284.88
7	08/05/2018	07:32 - 08:02	275.08	229.31	149.89	-13.45	-11.48	154.36	180.83	248.48
			MAX SRM - MIN SRM		28.30		SUM	1729.19	2152.47	
			(DAILY) DELV (mg/m³)		200					
			95% CI MU (%)		20					

For inspection purposes only.
Consent of copyright owner required for any other use.

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (DRY) mg/m³	y, SRM (DRY) mg/m³	Reason for Data Pair Removal

Existing Calibration Function
y = 0.8865x + 4.6239

Source of Existing Calibration Function
QAL2

Existing Calibration Range (@ REF Conditions)
0 to 200 mg/m³

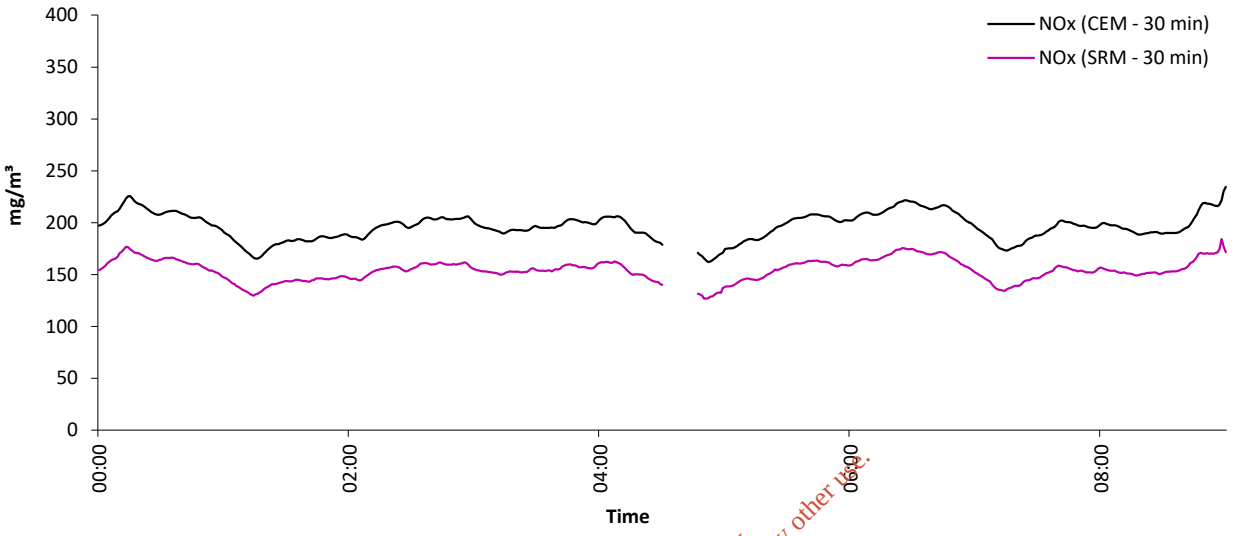
EPA Export 21-08-2018:03:54:56

OXIDES OF NITROGEN (as NO_2): AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

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



Consent of copyright owner required for any other use. For inspection purposes only.

Variability Test Data

where CAL = Calibrated using AST calibration functions

Pair	Date	Time (30-minute Average)	CAL CEM (STP, DRY) mg/m³	CEM Water Vapour % v/v	CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CAL CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 11% O_2) mg/m³	SRM (STP, DRY, 11% O_2) mg/m³	ys, SRM - CAL CEM
1	08/05/2018	00:32 - 01:02	274.08	N/A	N/A	N/A	6.57	5.33	5.70	174.94	166.01	-8.93
2	08/05/2018	01:32 - 02:02	234.30	N/A	N/A	N/A	6.80	5.52	5.87	151.36	143.73	-7.64
3	08/05/2018	02:32 - 03:02	259.56	N/A	N/A	N/A	6.55	5.32	5.77	165.50	158.64	-6.87
4	08/05/2018	03:32 - 04:02	254.40	N/A	N/A	N/A	6.55	5.31	5.72	162.18	153.57	-8.62
5	08/05/2018	05:32 - 06:02	267.12	N/A	N/A	N/A	6.47	5.25	5.67	169.59	160.40	-9.19
6	08/05/2018	06:32 - 07:02	284.88	N/A	N/A	N/A	6.44	5.22	5.73	180.58	172.03	-8.55
7	08/05/2018	07:32 - 08:02	248.48	N/A	N/A	N/A	6.50	5.27	5.70	158.01	149.89	-8.12
									MAX	180.58	**Sd**	0.80

EPA Export 21-08-2018:03:54:56

OXIDES OF NITROGEN (as NO_2): AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	20.41
Kv for 7 Pairs of Data	0.9441

The variability is accepted if Sd ≤1.5 x Q_o x Kv

Parameter	Value
Standard Deviation (Sd)	0.80
1.5 x Q_o x Kv	28.90
Outcome of Variability Test	**Pass**

Test of Calibration (Acceptance of Calibration Function)

^{t}0.95 (N-1)	1.943

where N (number of samples) = 7

The calibration is accepted if D ≤ ^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o

Parameter	Value
Mean Difference (D)	8.27
^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o	21.00
Outcome of Calibration Test	**Pass**

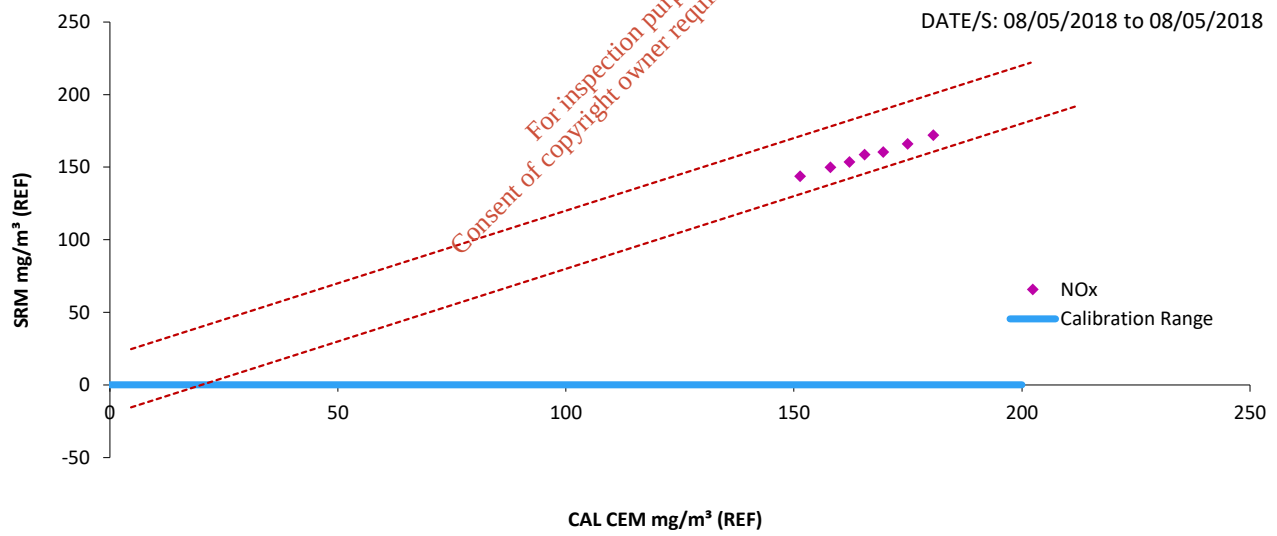
a) Calibrated Range (10% extension) (mg/m³)	0 to 198.6
b) Calibrated Range (50% of Daily ELV) (mg/m³)	0 to 100

New range up to a maximum of 50% of the Daily ELV	0 to 100

New Calibration Range (REF)	Existing Range Still Valid

For inspection purposes only.
Consent of copyright owner required for any other use.

PLOT 2: X-Y Plot - REF CAL CEM vs REF SRM Values



EPA Export 21-08-2018:03:54:56

SULPHUR DIOXIDE: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, DRY) mg/m³	y, SRM (STP, DRY) mg/m³	SRM (STP, DRY, 11% O_2) mg/m³	x - x_{av} (A)	y - y_{av} (B)	(A) x (B)	$(x - x_{av})^2$	CAL CEM (STP, DRY) mg/m³
1	08/05/2018	08:41 - 09:11	7.80	0.29	0.23	-0.32	0.16	-0.05	0.10	0.70
2	08/05/2018	09:58 - 10:28	7.72	0.08	0.05	-0.39	-0.05	0.02	0.16	0.61
3	08/05/2018	11:10 - 11:40	7.77	0.08	0.06	-0.34	-0.05	0.02	0.12	0.67
4	08/05/2018	12:25 - 12:55	8.62	0.12	0.08	0.51	-0.01	0.00	0.26	1.55
5	08/05/2018	13:39 - 14:19	8.66	0.08	0.05	0.54	-0.05	-0.03	0.29	1.59
			MAX SRM - MIN SRM		0.18		SUM	-0.05	0.93	
			(DAILY) DELV (mg/m³)		50					
			95% CI MU (%)		20					

For inspection purposes only.
Consent of copyright owner required for any other use.

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (DRY) mg/m³	y, SRM (DRY) mg/m³	Reason for Data Pair Removal

Existing Calibration Function
y = 1.0381x -7.4

Source of Existing Calibration Function
SELECT

Existing Calibration Range (@ REF Conditions)
0 to 27 mg/m³

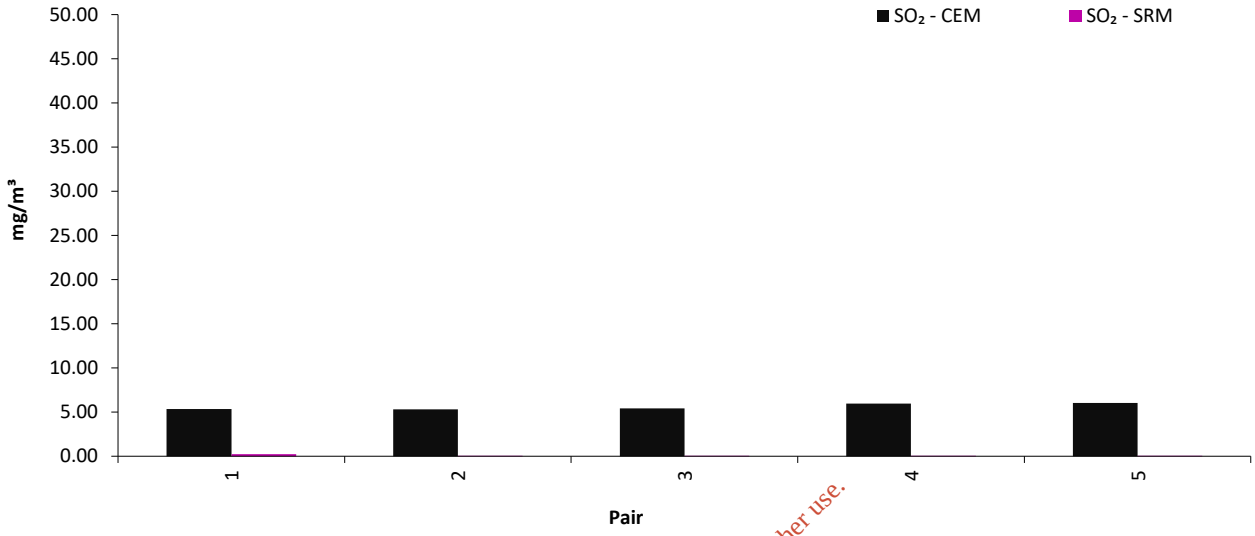
EPA Export 21-08-2018:03:54:56

SULPHUR DIOXIDE: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

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



Consent of copyright owner required for any other use.
For inspection purposes only.

Variability Test Data

where CAL = Calibrated using AST calibration functions

Pair	Date	Time (30-minute Average)	CAL CEM (STP, DRY) mg/m³	CEM Water Vapour % v/v	CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CAL CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 11% O_2) mg/m³	SRM (STP, DRY, 11% O_2) mg/m³	ys, SRM - CAL CEM
1	08/05/2018	08:41 - 09:11	0.70	N/A	N/A	N/A	6.42	5.21	8.64	0.44	0.23	-0.21
2	08/05/2018	09:58 - 10:28	0.61	N/A	N/A	N/A	6.50	5.27	6.26	0.39	0.05	-0.34
3	08/05/2018	11:10 - 11:40	0.67	N/A	N/A	N/A	6.67	5.42	6.38	0.43	0.06	-0.37
4	08/05/2018	12:25 - 12:55	1.55	N/A	N/A	N/A	6.59	5.35	6.34	0.99	0.08	-0.91
5	08/05/2018	13:39 - 14:19	1.59	N/A	N/A	N/A	6.67	5.42	6.76	1.02	0.05	-0.96
									MAX	1.02	**Sd**	0.35

EPA Export 21-08-2018:03:54:56

SULPHUR DIOXIDE: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	5.10
Kv for 5 Pairs of Data	0.9161

The variability is accepted if Sd ≤1.5 x Q_o x Kv

Parameter	Value
Standard Deviation (Sd)	0.35
1.5 x Q_o x Kv	7.01
Outcome of Variability Test	**Pass**

Test of Calibration (Acceptance of Calibration Function)

^{t}0.95 (N-1)	2.132

where N (number of samples) = 5

The calibration is accepted if D ≤ ^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o

Parameter	Value
Mean Difference (D)	0.56
^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o	5.44
Outcome of Calibration Test	**Pass**

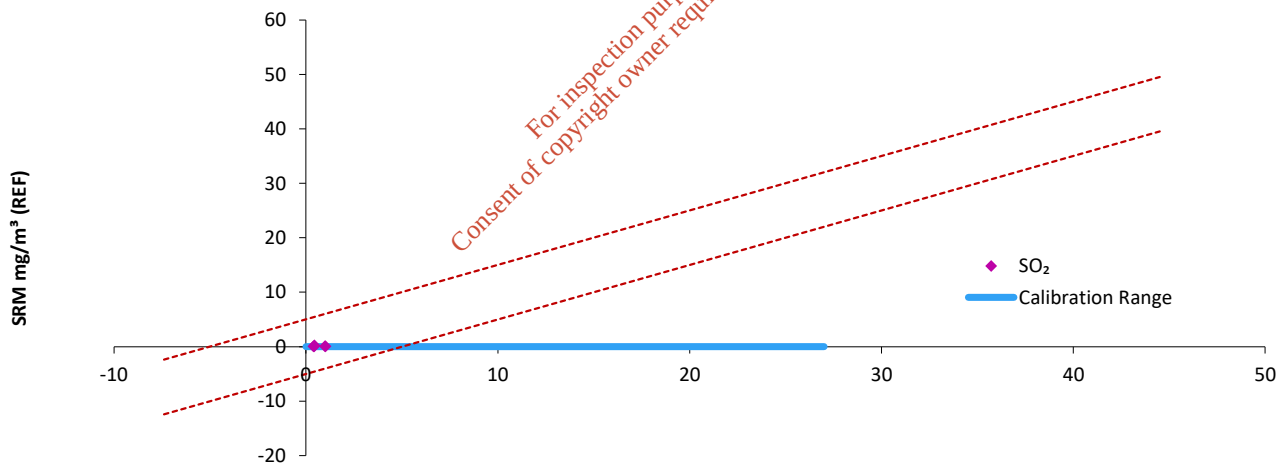
a) Calibrated Range (10% extension) (mg/m³)	0 to 1.1
b) Calibrated Range (50% of Daily ELV) (mg/m³)	0 to 25

New range up to a maximum of 50% of the Daily ELV	0 to 1.1

New Calibration Range (REF)	Existing Range Still Valid

For inspection purposes only.
Consent of copyright owner required for any other use.

PLOT 2: X-Y Plot - REF CAL CEM vs REF SRM Values



EPA Export 21-08-2018:03:54:56

CARBON MONOXIDE: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, DRY) mg/m³	y, SRM (STP, DRY) mg/m³	SRM (STP, DRY, 11% O_2) mg/m³	$x - x_{av}$ (A)	$y - y_{av}$ (B)	(A) x (B)	$(x - x_{av})^2$	CAL CEM (STP, DRY) mg/m³
1	08/05/2018	00:32 - 01:02	4.38	7.80	5.10	-0.80	-1.50	1.20	0.64	3.75
2	08/05/2018	01:32 - 02:02	4.61	7.92	5.24	-0.56	-1.38	0.78	0.32	4.03
3	08/05/2018	02:32 - 03:02	4.38	8.10	5.32	-0.79	-1.21	0.96	0.63	3.76
4	08/05/2018	03:32 - 04:02	4.79	8.83	5.78	-0.38	-0.48	0.18	0.15	4.25
5	08/05/2018	05:32 - 06:02	5.00	9.08	5.92	-0.18	-0.23	0.04	0.03	4.48
6	08/05/2018	06:32 - 07:02	5.94	10.80	7.08	0.76	1.50	1.15	0.58	5.61
7	08/05/2018	07:32 - 08:02	7.14	12.61	8.24	1.96	3.31	6.48	3.84	7.02
			MAX SRM - MIN SRM		3.14		SUM	10.79	6.20	
			(DAILY) DELV (mg/m³)		50					
			95% CI MU (%)		20					

For inspection purposes only.
Consent of copyright owner required for any other use.

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (DRY) mg/m³	y, SRM (DRY) mg/m³	Reason for Data Pair Removal

Existing Calibration Function
y = 1.1858x -1.4385

Source of Existing Calibration Function
QAL2

Existing Calibration Range (@ REF Conditions)
0 to 34.5 mg/m³

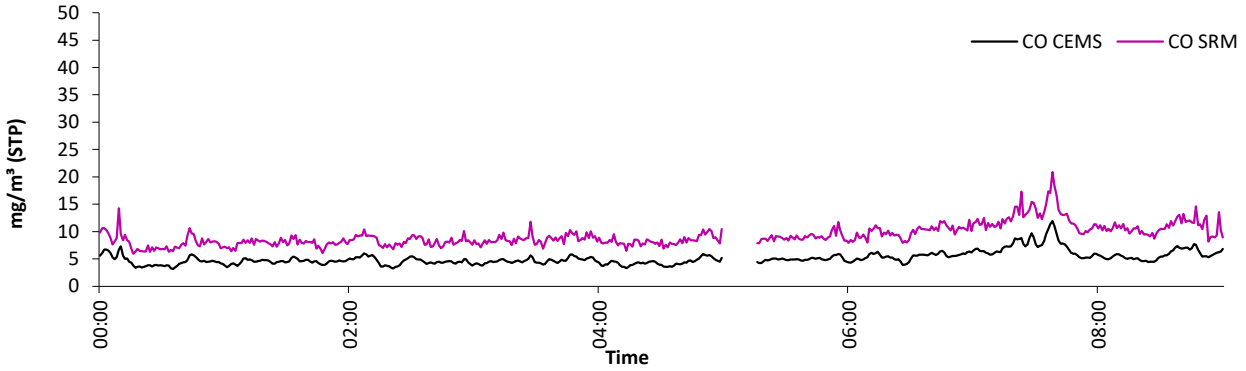
EPA Export 21-08-2018:03:54:56

CARBON MONOXIDE: AST CALCULATIONS

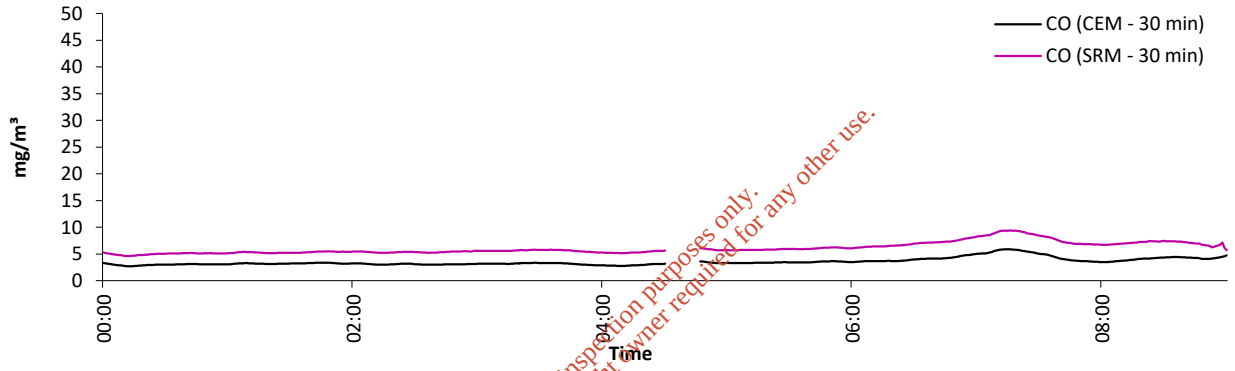
Covanta, Dublin 4

A2-2 Line 2 Redundant

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



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



For inspection purposes only.
Consent of copyright owner required for any other use.

Variability Test Data

where CAL = Calibrated using AST calibration functions

Pair	Date	Time (30-minute Average)	CAL CEM (STP, DRY) mg/m³	CEM Water Vapour % v/v	CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CAL CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 11% O_2) mg/m³	SRM (STP, DRY, 11% O_2) mg/m³	ys, SRM - CAL CEM
1	08/05/2018	00:32 - 01:02	3.75	N/A	N/A	N/A	6.57	5.33	5.70	2.39	5.10	2.71
2	08/05/2018	01:32 - 02:02	4.03	N/A	N/A	N/A	6.80	5.52	5.87	2.61	5.24	2.63
3	08/05/2018	02:32 - 03:02	3.76	N/A	N/A	N/A	6.55	5.32	5.77	2.40	5.32	2.92
4	08/05/2018	03:32 - 04:02	4.25	N/A	N/A	N/A	6.55	5.31	5.72	2.71	5.78	3.07
5	08/05/2018	05:32 - 06:02	4.48	N/A	N/A	N/A	6.47	5.25	5.67	2.85	5.92	3.08
6	08/05/2018	06:32 - 07:02	5.61	N/A	N/A	N/A	6.44	5.22	5.73	3.55	7.08	3.52
7	08/05/2018	07:32 - 08:02	7.02	N/A	N/A	N/A	6.50	5.27	5.70	4.47	8.24	3.78
									MAX	4.47	**Sd**	0.42

EPA Export 21-08-2018:03:54:56

CARBON MONOXIDE: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	5.10
Kv for 7 Pairs of Data	0.9441

The variability is accepted if Sd ≤1.5 x Q_o x Kv

Parameter	Value
Standard Deviation (Sd)	0.42
1.5 x Q_o x Kv	7.23
Outcome of Variability Test	**Pass**

Test of Calibration (Acceptance of Calibration Function)

^{t}0.95 (N-1)	1.943

where N (number of samples) = 7

The calibration is accepted if D ≤ ^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o

Parameter	Value
Mean Difference (D)	3.10
^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o	5.41
Outcome of Calibration Test	**Pass**

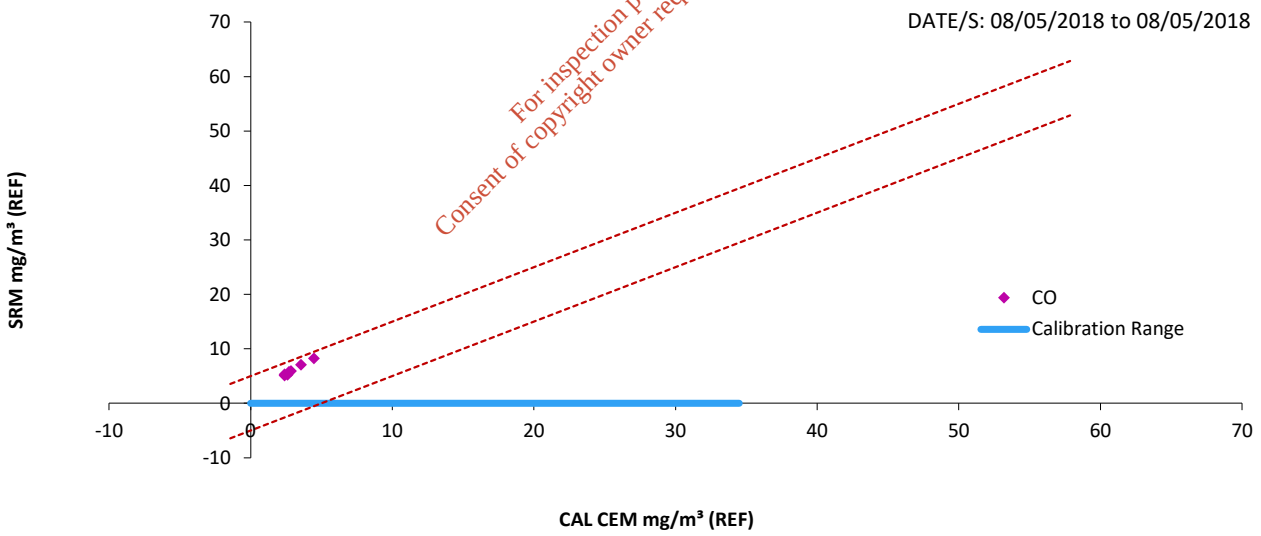
a) Calibrated Range (10% extension) (mg/m³)	0 to 4.9
b) Calibrated Range (50% of Daily ELV) (mg/m³)	0 to 25

New range up to a maximum of 50% of the Daily ELV	0 to 4.9

New Calibration Range (REF)	**Existing Range Still Valid**

For inspection purposes only.
Consent of copyright owner required for any other use.

PLOT 2: X-Y Plot - REF CAL CEM vs REF SRM Values



EPA Export 21-08-2018:03:54:56

HYDROGEN CHLORIDE: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Calibration Data

Pair	Date	Time (60-minute Average)	x, CEM (STP, DRY) mg/m³	y, SRM (STP, DRY) mg/m³	SRM (STP, DRY, 11% O_2) mg/m³	x - x_{av} (A)	y - y_{av} (B)	(A) x (B)	$(x - x_{av})^2$	CAL CEM (STP, DRY) mg/m³
1	08/05/2018	08:41 - 09:52	-0.26	0.02	0.01	0.01	0.00	0.00	0.00	-0.01
2	08/05/2018	09:58 - 11:08	-0.25	0.02	0.02	0.02	0.00	0.00	0.00	0.01
3	08/05/2018	11:12 - 12:23	-0.26	0.03	0.02	0.01	0.00	0.00	0.00	-0.01
4	08/05/2018	12:28 - 13:38	-0.29	0.02	0.02	-0.02	0.00	0.00	0.00	-0.04
5	08/05/2018	13:44 - 14:53	-0.30	0.02	0.02	-0.03	0.00	0.00	0.00	-0.05

			MAX SRM - MIN SRM	0.00		SUM	0.00	0.00		
			(DAILY) DELV (mg/m³)	10						
			95% CI MU (%)	40						

For inspection purposes only.
Consent of copyright owner required for any other use.

Outliers Data

Pair	Date	Time (60-minute Average)	x, CEM (DRY) mg/m³	y, SRM (DRY) mg/m³	Reason for Data Pair Removal

Existing Calibration Function
y = 0.9866x + 0.2518

Source of Existing Calibration Function
QAL2

Existing Calibration Range (@ REF Conditions)
0 to 2 mg/m³

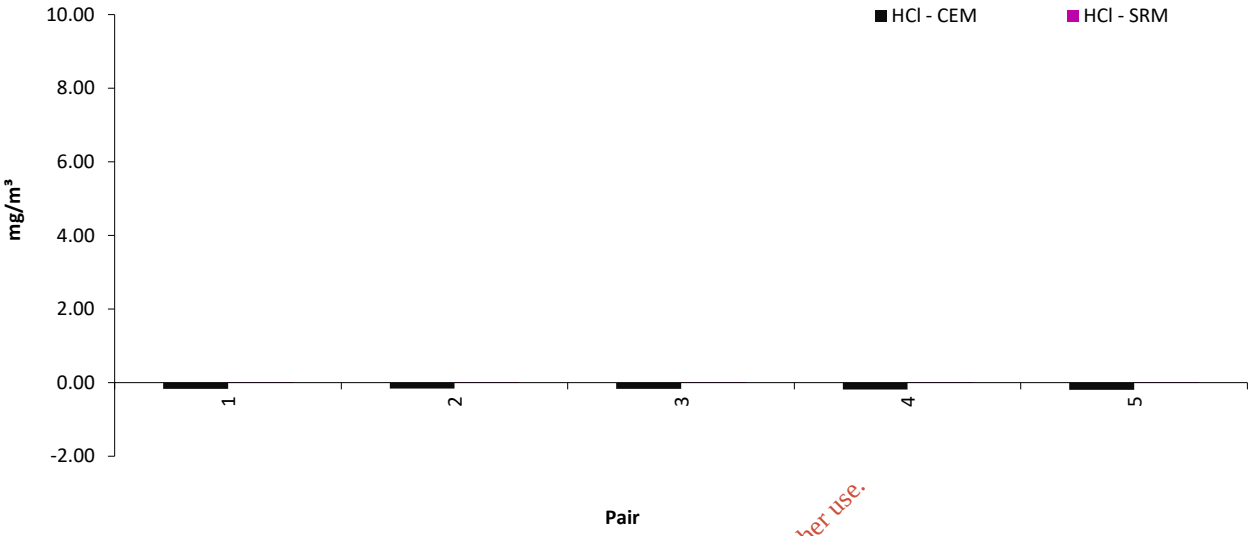
EPA Export 21-08-2018:03:54:56

HYDROGEN CHLORIDE: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

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



Consent of copyright owner required for any other use. For inspection purposes only.

Variability Test Data

where CAL = Calibrated using AST calibration functions

Pair	Date	Time (60-minute Average)	CAL CEM (STP, DRY) mg/m³	CEM Water Vapour % v/v	CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CAL CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 11% O_2) mg/m³	SRM (STP, DRY, 11% O_2) mg/m³	ys, SRM - CAL CEM
1	08/05/2018	08:41 - 09:52	-0.01	N/A	N/A	N/A	5.32	4.29	7.30	0.00	0.01	0.02
2	08/05/2018	09:58 - 11:08	0.01	N/A	N/A	N/A	5.30	4.28	6.13	0.00	0.02	0.01
3	08/05/2018	11:12 - 12:23	-0.01	N/A	N/A	N/A	5.24	4.23	6.41	0.00	0.02	0.02
4	08/05/2018	12:28 - 13:38	-0.04	N/A	N/A	N/A	5.33	4.31	6.77	-0.02	0.02	0.04
5	08/05/2018	13:44 - 14:53	-0.05	N/A	N/A	N/A	5.35	4.32	6.68	-0.03	0.02	0.05
									MAX	0.00	**Sd**	0.01

EPA Export 21-08-2018:03:54:56

HYDROGEN CHLORIDE: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	2.04
Kv for 5 Pairs of Data	0.9161

The variability is accepted if Sd ≤1.5 x Q_o x Kv

Parameter	Value
Standard Deviation (Sd)	0.01
1.5 x Q_o x Kv	2.80
Outcome of Variability Test	**Pass**

Test of Calibration (Acceptance of Calibration Function)

^{t}0.95 (N-1)	2.132

where N (number of samples) = 5

The calibration is accepted if D ≤ ^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o

Parameter	Value
Mean Difference (D)	0.03
^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o	2.05
Outcome of Calibration Test	**Pass**

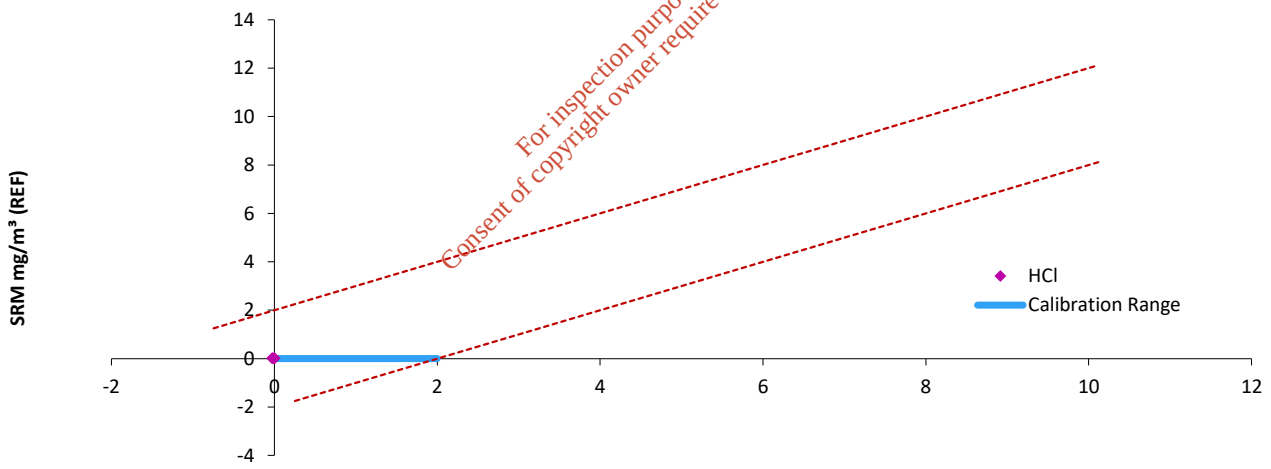
a) Calibrated Range (10% extension) (mg/m³)	0 to 0
b) Calibrated Range (50% of Daily ELV) (mg/m³)	0 to 5

New range up to a maximum of 50% of the Daily ELV	0 to 0

New Calibration Range (REF)	**Existing Range Still Valid**

For inspection purposes only.
Consent of copyright owner required for any other use.

PLOT 2: X-Y Plot - REF CAL CEM vs REF SRM Values



EPA Export 21-08-2018:03:54:56

WATER VAPOUR: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

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
1	08/05/2018	00:32 - 01:02	23.48	25.34	0.12	0.22	0.03	0.01	23.90
2	08/05/2018	01:32 - 02:02	23.06	24.81	-0.31	-0.31	0.09	0.09	23.47
3	08/05/2018	02:32 - 03:02	23.33	25.12	-0.04	0.00	0.00	0.00	23.75
4	08/05/2018	03:32 - 04:02	23.53	25.34	0.17	0.22	0.04	0.03	23.95
5	08/05/2018	05:32 - 06:02	23.05	24.68	-0.31	-0.44	0.14	0.10	23.47
6	08/05/2018	06:32 - 07:02	23.49	25.25	0.13	0.13	0.02	0.02	23.91
7	08/05/2018	07:32 - 08:02	23.60	25.30	0.24	0.18	0.04	0.06	24.03
						SUM	0.35	0.31	

MAX SRM - MIN SRM	0.66
(DAILY) DELV (% v/v)	30
95% CI MU (%)	30

For inspection purposes only.
Consent of copyright owner required for any other use.

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (ACTUAL) % v/v	y, SRM (ACTUAL) % v/v	Reason for Data Pair Removal

Existing Calibration Function
y = 1.018x + 0

Source of Existing Calibration Function
QAL2

Existing Calibration Range
0 to 29.6 % v/v

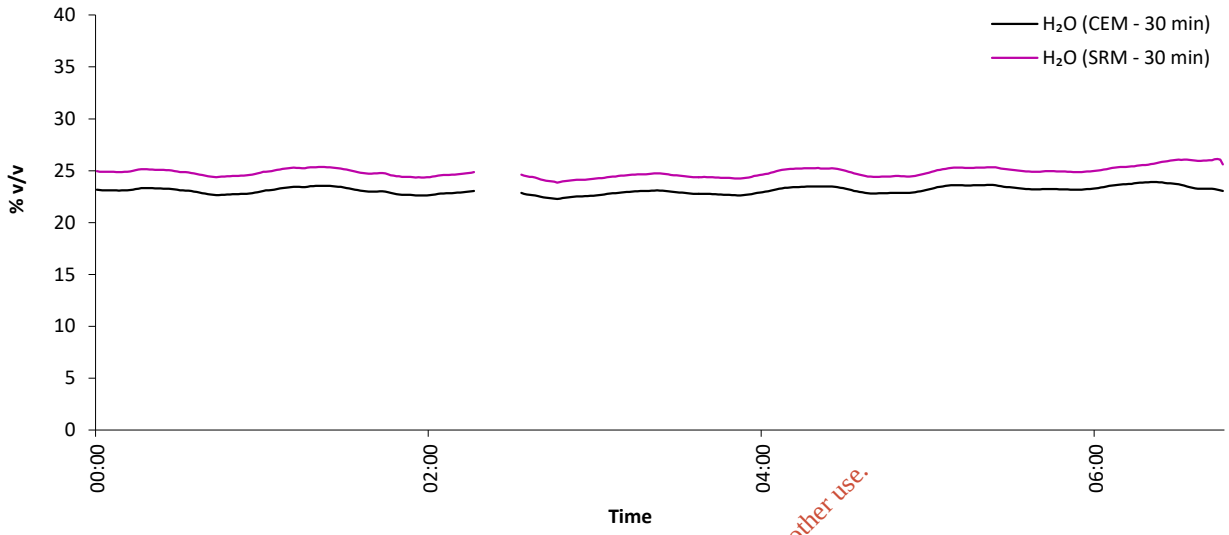
EPA Export 21-08-2018:03:54:56

WATER VAPOUR: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

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



For inspection purposes only.
Consent of copyright owner required for any other use.

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (ACTUAL) % v/v	ys, SRM (ACTUAL) % v/v	ys, SRM - CAL CEM
1	08/05/2018	00:32 - 01:02	23.90	25.34	1.44
2	08/05/2018	01:32 - 02:02	23.47	24.81	1.34
3	08/05/2018	02:32 - 03:02	23.75	25.12	1.38
4	08/05/2018	03:32 - 04:02	23.95	25.34	1.39
5	08/05/2018	05:32 - 06:02	23.47	24.68	1.21
6	08/05/2018	06:32 - 07:02	23.91	25.25	1.34
7	08/05/2018	07:32 - 08:02	24.03	25.30	1.27
		MAX	24.03	**Sd**	0.07

EPA Export 21-08-2018:03:54:56

WATER VAPOUR: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	4.59
Kv for 7 Pairs of Data	0.9441

The variability is accepted if Sd ≤1.5 x Q_o x Kv

Parameter	Value
Standard Deviation (Sd)	0.07
1.5 x Q_o x Kv	6.50
Outcome of Variability Test	**Pass**

Test of Calibration (Acceptance of Calibration Function)

^{t}0.95 (N-1)	1.943

where N (number of samples) = 7

The calibration is accepted if D ≤ ^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o

Parameter	Value
Mean Difference (D)	1.34
^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o	4.65
Outcome of Calibration Test	**Pass**

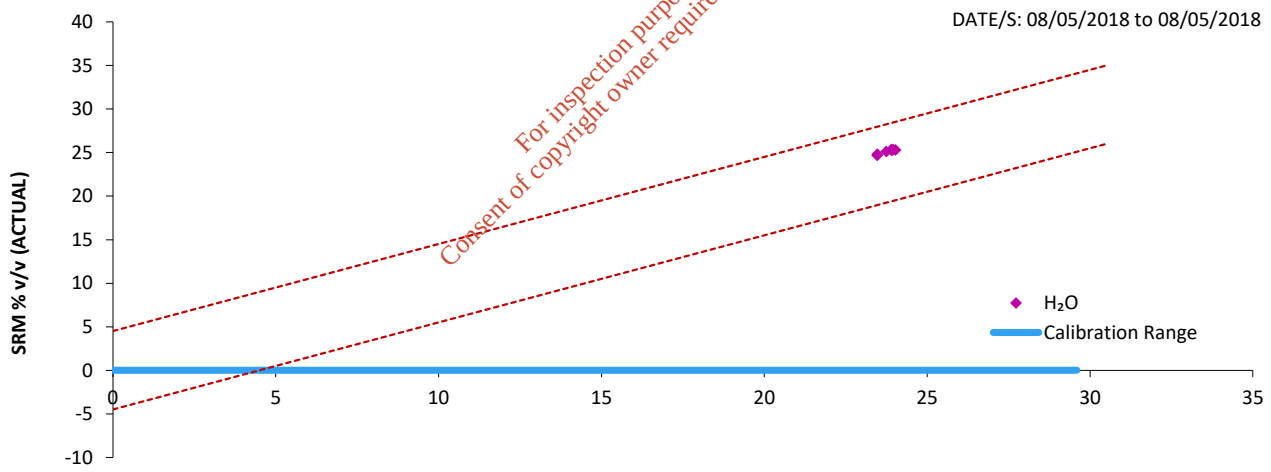
a) Calibrated Range (10% extension) (% v/v)	0 to 26.4
b) Calibrated Range (50% of Daily ELV) (% v/v)	0 to 15

New range up to a maximum of 50% of the Daily ELV	0 to 15

New Calibration Range	Existing Range Still Valid

For inspection purposes only.
Consent of copyright owner required for any other use.

PLOT 2: X-Y Plot - REF CAL CEM vs REF SRM Values



EPA Export 21-08-2018:03:54:56

OXYGEN: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

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
1	08/05/2018	00:32 - 01:02	6.57	5.70	0.02	-0.04	0.00	0.00	5.33
2	08/05/2018	01:32 - 02:02	6.80	5.87	0.24	0.13	0.03	0.06	5.52
3	08/05/2018	02:32 - 03:02	6.55	5.77	0.00	0.03	0.00	0.00	5.32
4	08/05/2018	03:32 - 04:02	6.55	5.72	-0.01	-0.02	0.00	0.00	5.31
5	08/05/2018	05:32 - 06:02	6.47	5.67	-0.08	-0.06	0.01	0.01	5.25
6	08/05/2018	06:32 - 07:02	6.44	5.73	-0.11	-0.01	0.00	0.01	5.22
7	08/05/2018	07:32 - 08:02	6.50	5.70	-0.05	-0.04	0.00	0.00	5.27

MAX SRM - MIN SRM	0.20	SUM	0.04	0.08
(DAILY) DELV (% v/v)	21			
95% CI MU (%)	10			

For inspection purposes only.
Consent of copyright owner required for any other use.

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (DRY) % v/v	y, SRM (DRY) % v/v	Reason for Data Pair Removal

Existing Calibration Function
y = 0.8282x -0.1094

Source of Existing Calibration Function
QAL2

Existing Calibration Range
0 to 13.2 % v/v

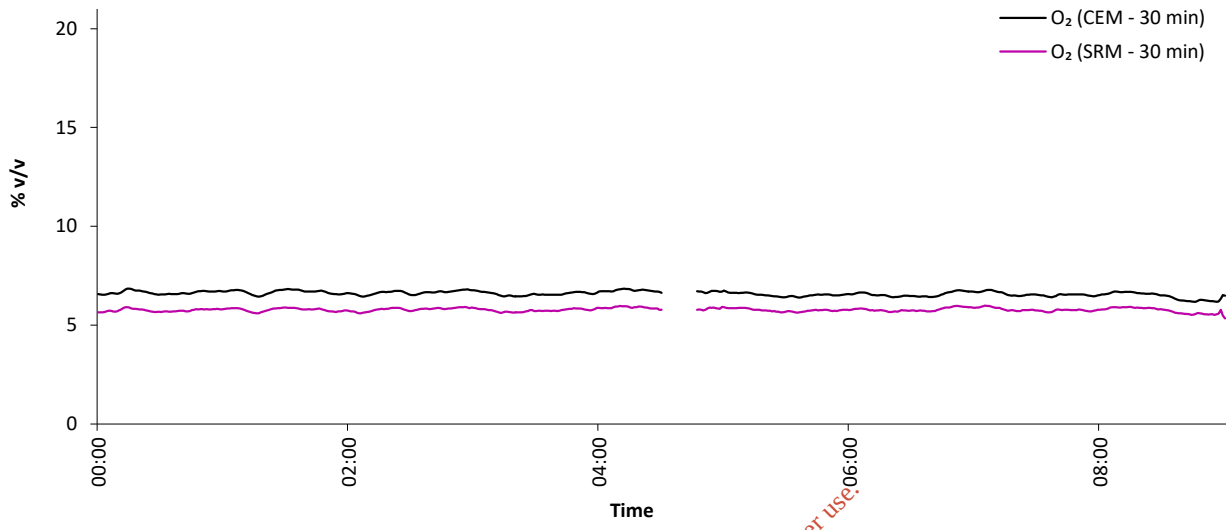
EPA Export 21-08-2018:03:54:56

OXYGEN: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

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



For inspection purposes only.
Consent of copyright owner required for any other use.

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (DRY) % v/v	ys, SRM (DRY) % v/v	ys, SRM - CAL CEM
1	08/05/2018	00:32 - 01:02	5.33	5.70	0.37
2	08/05/2018	01:32 - 02:02	5.52	5.87	0.35
3	08/05/2018	02:32 - 03:02	5.32	5.77	0.46
4	08/05/2018	03:32 - 04:02	5.31	5.72	0.40
5	08/05/2018	05:32 - 06:02	5.25	5.67	0.42
6	08/05/2018	06:32 - 07:02	5.22	5.73	0.51
7	08/05/2018	07:32 - 08:02	5.27	5.70	0.43
		MAX	5.52	**Sd**	0.05

EPA Export 21-08-2018:03:54:56

OXYGEN: AST CALCULATIONS

Covanta, Dublin 4

A2-2 Line 2 Redundant

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	1.07
Kv for 7 Pairs of Data	0.9441

The variability is accepted if Sd ≤1.5 x Q_o x Kv

Parameter	Value
Standard Deviation (Sd)	0.05
1.5 x Q_o x Kv	1.52
Outcome of Variability Test	**Pass**

Test of Calibration (Acceptance of Calibration Function)

^{t}0.95 (N-1)	1.943

where N (number of samples) = 7

The calibration is accepted if D ≤ ^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o

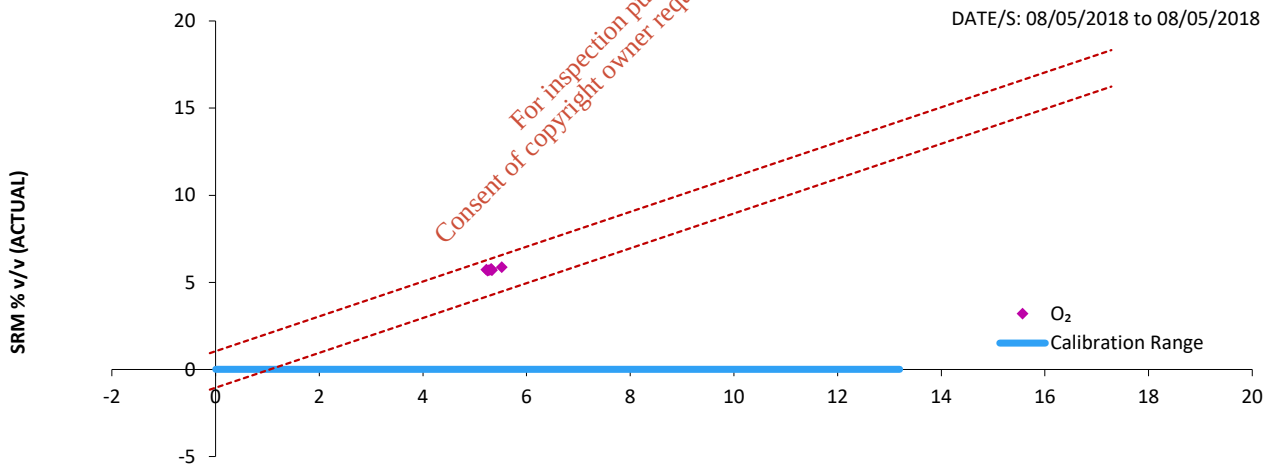
Parameter	Value
Mean Difference (D)	0.42
^{t}0.95 (N-1) x Sd / SQRT (N) + Q_o	1.11
Outcome of Calibration Test	**Pass**

a) Calibrated Range (10% extension) (% v/v)	0 to 6.1
b) Calibrated Range (50% of Daily ELV) (% v/v)	0 to 10.5

New range up to a maximum of 50% of the Daily ELV	0 to 6.1

New Calibration Range	Existing Range Still Valid

PLOT 2: X-Y Plot - REF CAL CEM vs REF SRM Values



For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:56

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:56

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:56

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:56

FUNCTIONAL CHECKS OF CEM

Covanta, Dublin 4
A2-2 Line 2 Redundant

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/m³ / %)	QAL3 Check Gas Supplier	Cylinder Number	Cylinder Expiry Date	Certified Accuracy
Total VOCs	C_3H_8	8.0	BOC	232710	18/06/2021	2.7
Nitrogen Monoxide	NO	128.7	BOC	189547	15/06.2019	2
Nitrogen Dioxide	NO_2	135.9	BOC	189507	14/06/2019	5
Sulphur Dioxide	SO_2	31.7	BOC	189547	15/06.2019	2
Carbon Monoxide	CO	34.6	BOC	189547	15/06.2019	2
Hydrogen Chloride	HCl	8.8	BOC	179279	12/01/2018	2
Oxygen	O_2	1.92	BOC	189507	14/06/2019	5
Zero Gas	AIR	N/A	BOC	N/A	N/A	N/A

For inspection purposes only.
Consent of copyright owner required for any other use.

CEM Checks

Parameter	Analyser System Check				Sampling Line System Check			
	Gas Conc. (mg/m³ / %)	Zero (mg/m³ / %)	Span (mg/m³ / %)	Response (T_{90} - secs)	Gas Conc. (mg/m³ / %)	Zero (mg/m³ / %)	Span (mg/m³ / %)	Response (T_{90} - secs)
Total VOCs	8.0	0.2	8.3	36	8.0	0.0	8.1	62
Nitrogen Monoxide	128.7	0.1	137.8	59	128.7	-1.2	131.3	54
Nitrogen Dioxide	135.9	0.1	136.6	55	135.9	-0.2	134.8	53
Sulphur Dioxide	31.7	-0.4	35.1	55	31.7	-0.1	36.2	67
Carbon Monoxide	34.6	0.3	34.0	59	34.6	0.0	33.3	60
Hydrogen Chloride	8.8	0.0	7.6	210	8.8	0.1	8.1	100
Oxygen	1.92	20.5	1.9	55	1.92	20.6	2.0	53

Reference Materials Used for CEM Linearity Checks

Parameter	Linearity Check Gas	Concentration (mg/m³ / %)	Linearity Check Gas Supplier	Cylinder Number	Cylinder Expiry Date	Certified Accuracy
Total VOCs	C_3H_8	130.4	BOC	1.0310a	24/11/2022	2
Nitrogen Monoxide	NO	568.8	BOC	12.0145	22/03/2020	2
Nitrogen Dioxide	NO_2	85.6	BOC	139408	29/08/2019	2
Sulphur Dioxide	SO_2	288.1	BOC	12.0145	22/03/2020	2
Carbon Monoxide	CO	124.7	BOC	12.0145	22/03/2020	2
Hydrogen Chloride	HCl	25.4	BOC	8.0458	21/02/2019	2
Oxygen	O_2	21.2	BOC	11.0344	14/04/2023	2
Zero Gas	N_2 / Inst. Air (FID)	N/A	BOC	N/A	N/A	N/A

Interferences Taken at the Same Time as the CEM Checks

Where Performed	Sampling Line

Parameter	Interference Value (mg/m³ or % for O_2 & CO_2)											
	C_3H_8			SO_2	CO	HCl			H_2O	O_2	NO	NO2
Total VOCs (C_3H_8)				0.4	0.4	0.3			0.0	0.6	0.4	0.6

EPA Export 21-08-2018:03:54:56

Nitrogen Monoxide (NO)	-0.2					2.5			0.0	-0.6		-0.6
Nitrogen Dioxide (NO_2)	0.0			0.0	0.0	0.2			0.0		0.0	
Sulphur Dioxide (SO_2)	-0.3					-0.5			0.0	7.0		7.0
Carbon Monoxide (CO)	0.2					0.1			0.0	0.5		0.5
Hydrogen Chloride (HCl)	-0.1			0.0	0.0				0.0	2.0	0.0	2.0
Oxygen (O_2)	20.6			0.1	0.1	0.0			0.0		0.1	

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:56

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

Functional Checks Performed By	SICK (Reports appended)
Date/s Functional Checks Performed	19th - 21st February 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.	Yes	
Cleanliness of the optical components.	Yes	
Flushing air supply.	Yes	
Optical path free from obstructions.	Yes	
After re-assembly at the measurement location, at least the following shall be checked:		
Alignment of the measuring system.	Yes	
Contamination control (internal check of optical surfaces).	Yes	

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.	Yes	
Gas conditioning systems.	Yes	
Pumps.	Yes	
All connections.	Yes	
Sample lines.	Yes	
Power supplies.	Yes	
Filters.	Yes	
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	Not installed
The sampling system shall be in good condition and free of any visible faults, which may decrease the quality of the data.	Yes	

For inspection purposes only.
Consent of copyright owner required for any other use.

3. Leak testing

Requirement	Performed	Notes
Leak Testing shall be performed according to the CEMs manuals. The test shall cover the entire sampling system.	Yes	See Section 5 of the Test Report - "CEMs Checks" for the results of the leak check.

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.	Yes	See Section 5 of the Test Report - "CEMs Checks" for the results of the zero and span checks. The reading on the DAHS was cross-referenced with the CEMs screen to ensure the logged reading was correct.

EPA Export 21-08-2018:03:54:56

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

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.	Yes	See Section 5 of the Test Report - "CEMs Checks" for the results of the zero and span checks. The reading on the DAHS was cross-referenced with the CEMs screen to ensure the logged reading was correct.

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.	Yes	Performed by Exova Catalyst
The linearity of the CEM response shall be checked using five different reference materials, including a zero concentration.	Yes	
The reference material with zero concentration, as well as the reference materials with four different concentrations, shall have a verifiable quantity and quality.	Yes	See Section 5 of the Test Report - "Reference Materials Used for CEMs Linearity Checks".
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 ≤2% and where they are	Yes	
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)	Yes	
The individual CEMs are tested using the following concentrations applied in a randomised sequence:		
Reference material with zero concentration	Yes	
Reference material concentration approximately 20% of the range (i.e. the short-term ELV)	Yes	
Reference material concentration approximately 40% of the range (i.e. the short-term ELV)	Yes	
Reference material concentration approximately 60% of the range (i.e. the short-term ELV)	Yes	
Reference material concentration approximately 80% of the range (i.e. the short-term ELV)	Yes	
Reference material with zero concentration	Yes	

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.	Yes	

Consent of copyright owner required for any other use. For inspection purposes only.

EPA Export 21-08-2018:03:54:56

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

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.	Yes	

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)	Yes	Parameter specific response times can be found in the Zero and Span Gas Functional Test Table (above).

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.	Yes	
Instrument manufacturer.	Yes	
Instrument type.	Yes	
Instrument model.	Yes	
Instrument serial no.	Yes	
Operating principle.	Yes	
Operating range.	Yes	
Certification details.	Yes	
Compliance with MCERTS. (including certificate no.)	Yes	
Location.	Yes	
Date and time work was undertaken.	Yes	
Equipment used - type, serial no's, calibration dates.	Yes	
Gases used - certificate no's, expiry dates, binary or mixture.	Yes	
Calibration and linearity data as required by EN14181.	Yes	
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.	Yes	
Name and signature of the service engineer present on the service report?	Yes	

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:56

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

10. Documentation and Records		
Requirement	**Available**	**Notes**
A plan of the CEM.	Yes	
All manuals (maintenance, users, etc).	Yes	
Log books to document possible malfunctions and action taken.	Yes	
Service reports.	Yes	
QAL3 documentation including actions taken as a result of out of control situations.	Yes	
Management system procedures for maintenance, calibration and training.	Yes	
Training records.	Yes	
Maintenance schedules.	Yes	
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.	Yes	
Existing instrument calibration functions / gain factors.	Yes	
Documentation and records audit completed and validated prior to commencing SRM testing.	Yes	

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:56

TOTAL VOCs: LINEARITY CHECK CALCULATIONS

Covanta, Dublin 4
A2-2 Line 2 Redundant
03/05/2018

Linearity Tests performed by	Donal O Faogain
100% value taken for Linearity Tests	20

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	16:34	0.00	0.00	-2.00	-2.00	-2.00	-2.00
2	14:46	60.00	12.00	11.00	11.00	11.00	11.00
3	14:58	20.00	4.00	2.50	2.50	2.50	2.50
4	16:41	80.00	16.00	15.10	15.10	15.10	15.10
5	17:05	0.00	0.00	-1.90	-1.90	-1.90	-1.90
6	14:52	40.00	8.00	6.80	6.80	6.80	6.80

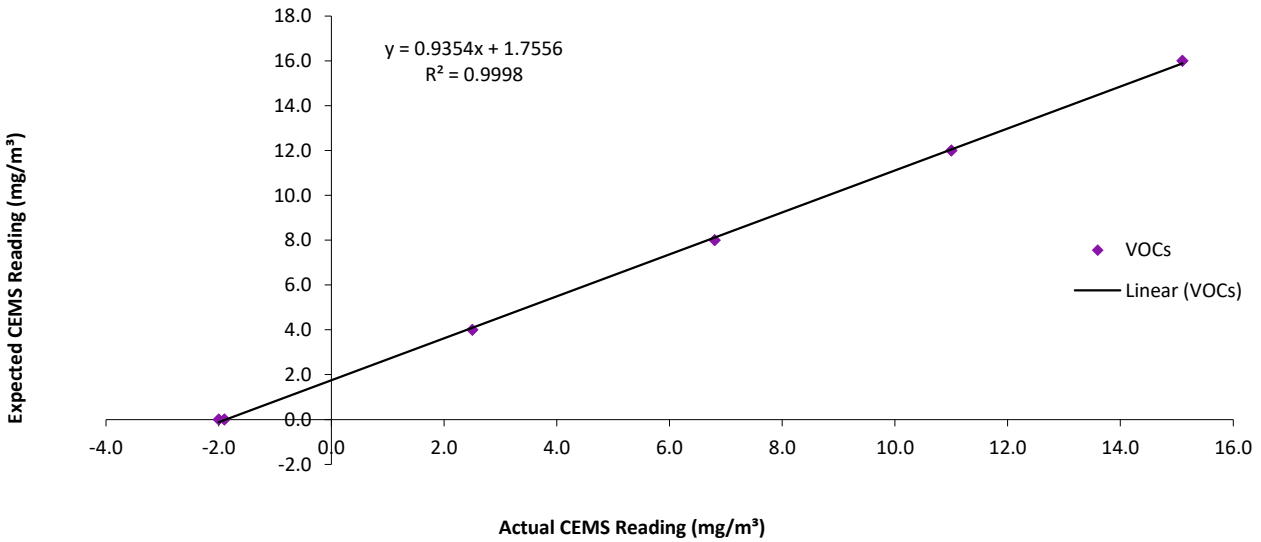
NOTE: Concentrations obtained using Calibrated Mass Flow Controllers

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	-2.00	-0.13	-0.63	0.63	0.63	5	Pass
2	11.00	0.05	0.25	0.25			
3	2.50	0.10	0.50	0.50			
4	15.10	-0.12	-0.62	0.62			
5	-1.90	-0.02	-0.12	0.12			
6	6.80	0.13	0.63	0.63			

For inspection purposes only.
Consent of copyright owner required for any other use.

Graphical Representation of Linearity Data



EPA Export 21-08-2018:03:54:56

NITROGEN MONOXIDE: LINEARITY CHECK CALCULATIONS

Covanta, Dublin 4
A2-2 Line 2 Redundant
04/05/2018

Linearity Tests performed by	Donal O Faogain
100% value taken for Linearity Tests	400

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

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	08:00	0.00	0.00	9.60	9.70	9.60	9.63
2	08:07	60.00	240.00	234.90	235.00	235.60	235.17
3	08:14	20.00	80.00	87.80	87.80	87.90	87.83
4	08:31	80.00	320.00	325.50	325.50	325.50	325.50
5	08:37	0.00	0.00	9.70	9.70	9.70	9.70
6	08:22	40.00	160.00	163.30	163.30	163.30	163.30

NOTE: Concentrations obtained using Calibrated Mass Flow Controllers

Linearity Readings on CEM (as NO_2)

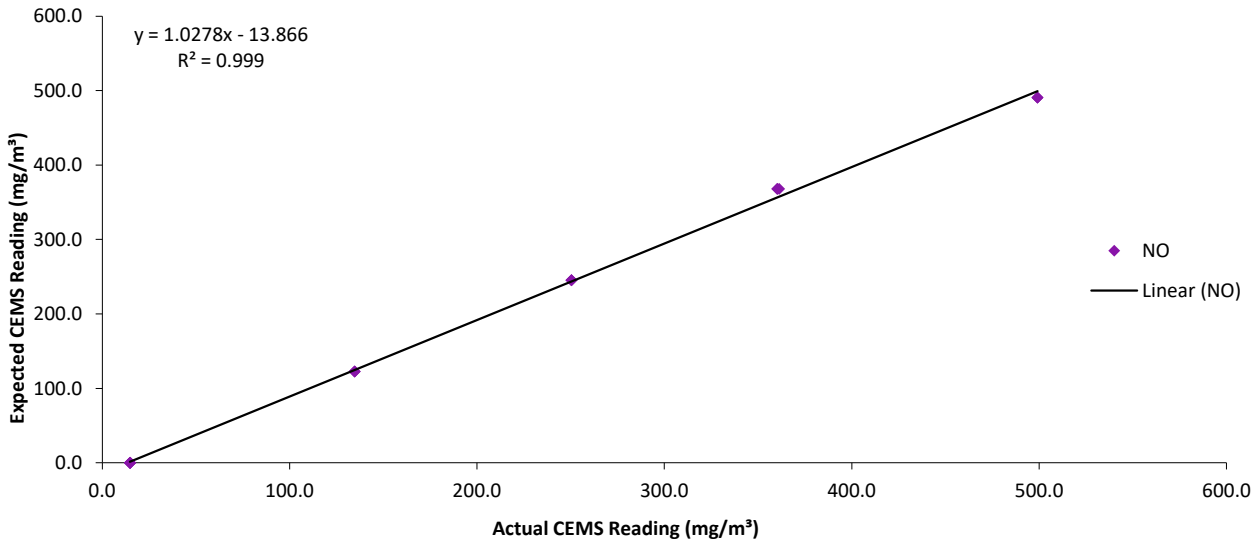
Linearity Point	Time of Readings	Linearity % Point	Expected Reading (mg/m³)	Reading 1 4 x Response (mg/m³)	Reading 2 1 x Response (mg/m³)	Reading 3 1 x Response (mg/m³)	Average CEM Reading (mg/m³)
1	08:00	0.00	0.00	14.72	14.87	14.72	14.77
2	08:07	60.00	368.00	360.18	360.33	361.25	360.59
3	08:14	20.00	122.67	134.63	134.63	134.78	134.68
4	08:31	80.00	490.67	499.10	499.10	499.10	499.10
5	08:37	0.00	0.00	14.87	14.87	14.87	14.87
6	08:22	40.00	245.33	250.39	250.39	250.39	250.39

Test of Residuals (as NO_2)

Linearity Point	Average x_c	d_c	$\%, d_{c,rel}$	ABS %, $d_{c,rel}$	MAX ABS %, $d_{c,rel}$	Limit	Outcome
1	14.77	1.07	0.18	0.18	2.23	5	Pass
2	360.59	-10.77	-1.76	1.76			
3	134.68	1.76	0.29	0.29			
4	499.10	8.52	1.39	1.39			
5	14.87	-13.70	-2.23	2.23			
6	250.39	-1.75	-0.28	0.28			

For inspection purposes only.
Consent of copyright owner required for any other use.

Graphical Representation of Linearity Data (as NO_2)



EPA Export 21-08-2018:03:54:56

NITROGEN DIOXIDE: LINEARITY CHECK CALCULATIONS

Covanta, Dublin 4
A2-2 Line 2 Redundant
04/05/2018

Linearity Tests performed by	Donal O Faogain
100% value taken for Linearity Tests	40

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	08:37	0.00	0.00	-0.20	-0.20	-0.20	-0.20
2	08:45	60.00	24.00	22.40	22.50	22.50	22.47
3	08:51	20.00	8.00	7.70	7.80	8.10	7.87
4	09:02	80.00	32.00	32.30	32.10	32.00	32.13
5	09:08	0.00	0.00	-0.20	-0.20	-0.20	-0.20
6	08:57	40.00	16.00	15.60	15.60	15.60	15.60

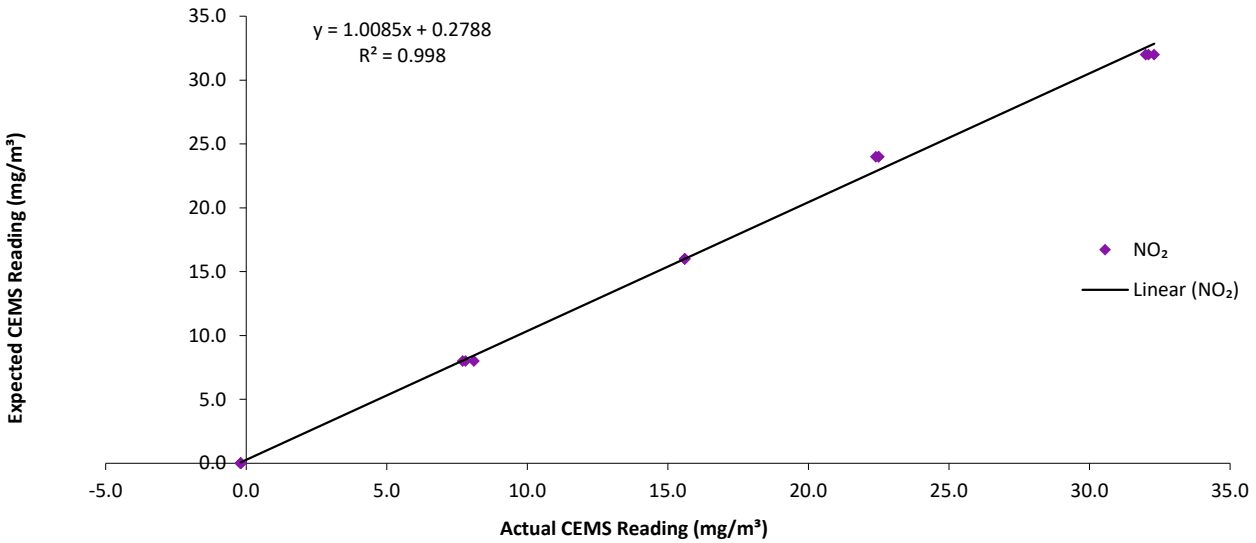
NOTE: Concentrations obtained using Calibrated Mass Flow Controllers

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	-0.20	0.05	0.12	0.12	2.58	5	Pass
2	22.47	-1.03	-2.58	2.58			
3	7.87	0.20	0.50	0.50			
4	32.13	0.72	1.79	1.79			
5	-0.20	0.05	0.12	0.12			
6	15.60	0.02	0.04	0.04			

For inspection purposes only.
Consent of copyright owner required for any other use.

Graphical Representation of Linearity Data



EPA Export 21-08-2018:03:54:56

SULPHUR DIOXIDE: LINEARITY CHECK CALCULATIONS

Covanta, Dublin 4
A2-2 Line 2 Redundant
03/05/2018

Linearity Tests performed by	Donal O Faogain
100% value taken for Linearity Tests	200

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	18:30	0.00	0.00	4.20	4.30	4.30	4.27
2	18:37	60.00	120.00	117.30	117.30	117.20	117.27
3	18:57	20.00	40.00	47.00	47.00	46.80	46.93
4	18:50	80.00	160.00	158.80	158.80	158.80	158.80
5	19:04	0.00	0.00	5.00	5.20	5.00	5.07
6	18:44	40.00	80.00	79.80	79.90	79.90	79.87

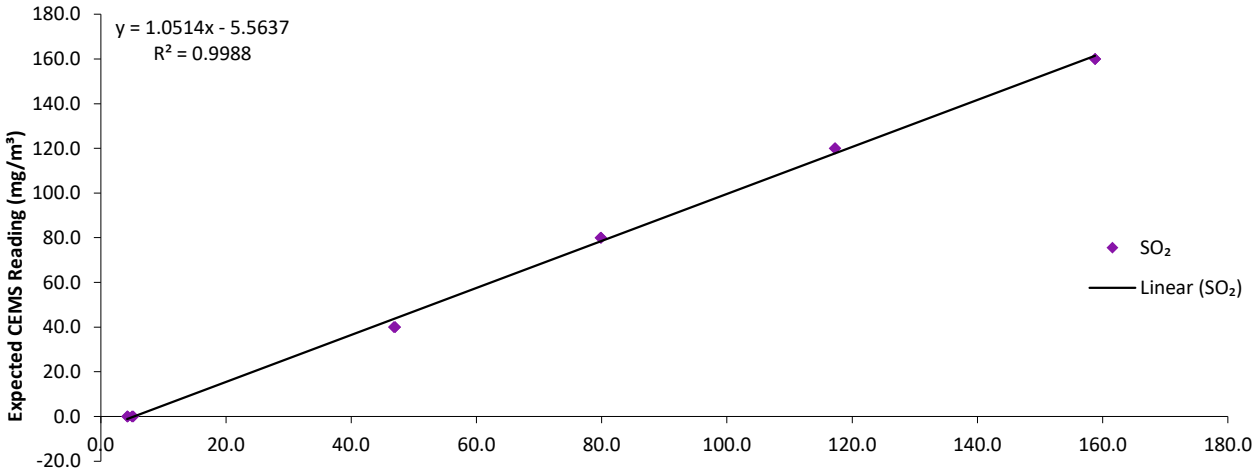
NOTE: Concentrations obtained using Calibrated Mass Flow Controllers

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	4.27	-1.10	-0.55	0.55	1.78	5	Pass
2	117.27	-2.10	-1.05	1.05			
3	46.93	3.57	1.78	1.78			
4	158.80	1.43	0.72	0.72			
5	5.07	-0.30	-0.15	0.15			
6	79.87	-1.50	-0.75	0.75			

For inspection purposes only.
Consent of copyright owner required for any other use.

Graphical Representation of Linearity Data



EPA Export 21-08-2018:03:54:56

CARBON MONOXIDE: LINEARITY CHECK CALCULATIONS

Covanta, Dublin 4
A2-2 Line 2 Redundant
03/05/2018

Linearity Tests performed by	Donal O Faogain
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	17:55	0.00	0.00	0.00	0.00	0.00	0.00
2	18:01	60.00	60.00	52.80	52.80	52.80	52.80
3	18:07	20.00	20.00	19.60	19.50	19.50	19.53
4	18:24	80.00	80.00	75.30	75.30	75.30	75.30
5	18:30	0.00	0.00	0.00	0.00	0.00	0.00
6	18:13	40.00	40.00	37.20	37.20	37.20	37.20

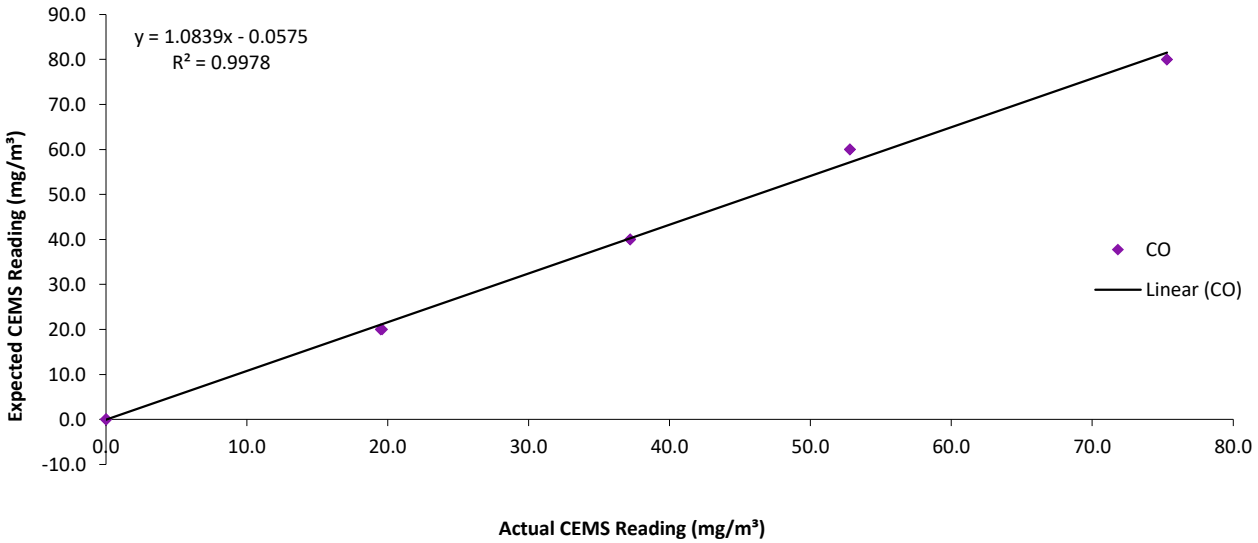
NOTE: Concentrations obtained using Calibrated Mass Flow Controllers

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	-0.12	-0.12	0.12	2.55	5	Pass
2	52.80	-2.55	-2.55	2.55			
3	19.53	1.00	1.00	1.00			
4	75.30	1.54	1.54	1.54			
5	0.00	-0.12	-0.12	0.12			
6	37.20	0.26	0.26	0.26			

For inspection purposes only.
Consent of copyright owner required for any other use.

Graphical Representation of Linearity Data



EPA Export 21-08-2018:03:54:56

HYDROGEN CHLORIDE: LINEARITY CHECK CALCULATIONS

Covanta, Dublin 4
A2-2 Line 2 Redundant
04/05/2018

Linearity Tests performed by	Donal O Faogain
100% value taken for Linearity Tests	10

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	09:08	0.00	0.00	0.00	0.00	0.00	0.00
2	09:28	60.00	6.00	5.70	5.60	5.70	5.67
3	09:49	20.00	2.00	2.00	2.00	2.00	2.00
4	09:17	80.00	8.00	7.00	7.10	7.20	7.10
5	09:59	0.00	0.00	0.10	0.00	0.00	0.03
6	09:39	40.00	4.00	3.90	4.00	4.00	3.97

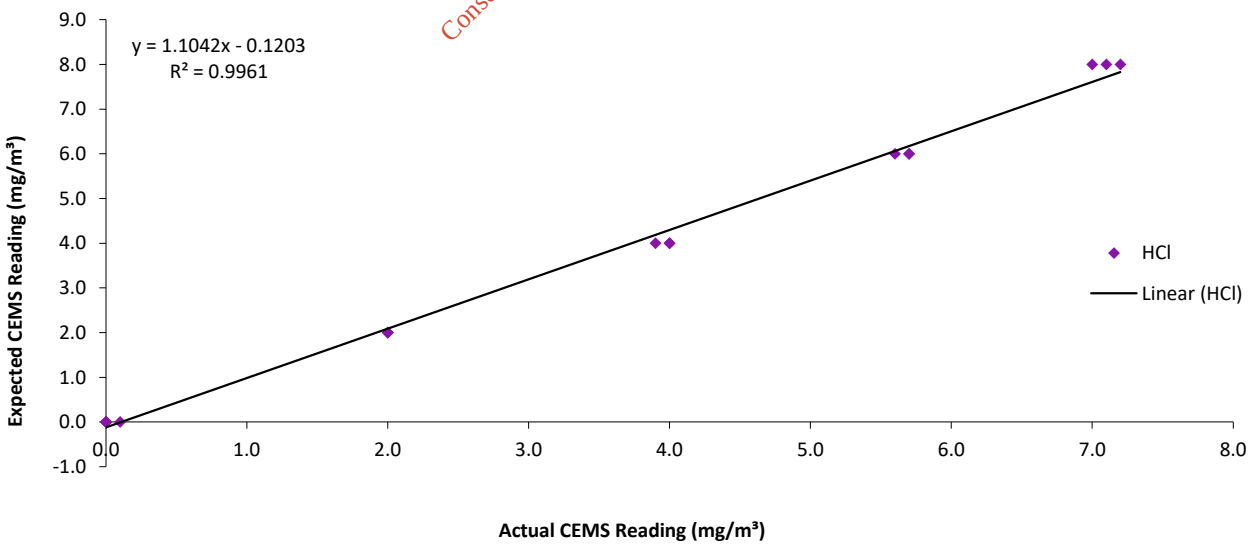
NOTE: Concentrations obtained using Calibrated Mass Flow Controllers

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	-0.12	-1.21	1.21	2.38	5	Pass
2	5.67	0.13	1.33	1.33			
3	2.00	0.07	0.75	0.75			
4	7.10	-0.24	-2.37	2.37			
5	0.03	-0.09	-0.88	0.88			
6	3.97	0.24	2.38	2.38			

For inspection purposes only.
Consent of copyright owner required for any other use.

Graphical Representation of Linearity Data



EPA Export 21-08-2018:03:54:57

OXYGEN: LINEARITY CHECK CALCULATIONS

Covanta, Dublin 4
A2-2 Line 2 Redundant
03/05/2018

Linearity Tests performed by	Donal O Faogain
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	17:15	0.00	0.00	0.00	0.00	0.00	0.00
2	17:34	60.00	15.72	16.10	16.10	16.10	16.10
3	17:22	20.00	5.24	5.20	5.20	5.20	5.20
4	17:42	80.00	21.15	21.50	21.50	21.50	21.50
5	17:54	0.00	0.00	0.00	0.00	0.00	0.00
6	17:28	40.00	10.48	10.70	10.70	10.70	10.70

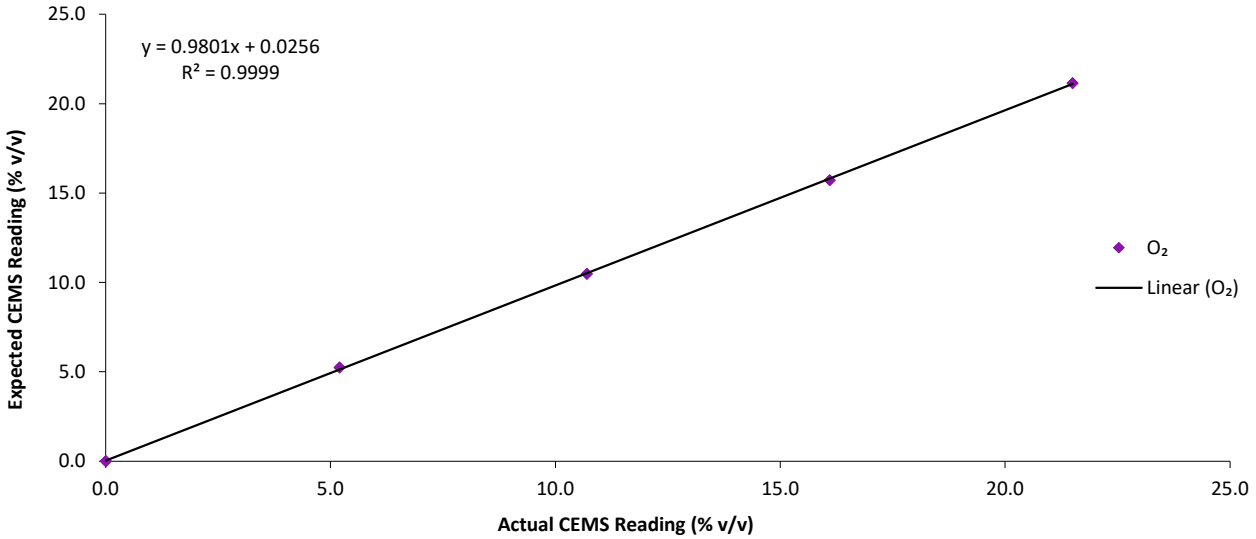
NOTE: Concentrations obtained using Calibrated Mass Flow Controllers

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	0.03	0.10	0.10	0.46	5	Pass
2	16.10	0.09	0.33	0.33			
3	5.20	-0.12	-0.46	0.46			
4	21.50	-0.05	-0.20	0.20			
5	0.00	0.03	0.10	0.10			
6	10.70	0.03	0.13	0.13			

For inspection purposes only.
Consent of copyright owner required for any other use.

Graphical Representation of Linearity Data



EPA Export 21-08-2018:03:54:57

SICK (UK) LTD
Waldkirch House,
39 Hedley Rd
St Albans,
Herts,
Al1 5BN

Tel : 0044 (0)1727 831121
Fax : 0044 (0)1727 855332
E – Mail : info@sick.co.uk

Standby MCS100FT

BS EN 14181 – Functional Test & Maintenance Report

For inspection purposes only.
Consent of copyright owner required for any other use.

Customer	Covanta
Site	Dublin (DWtE)
Contact	Darrah English
Device Location/Duty	CEMS Shelter
Tag or KKS No.	
Service Ref No.	SVON020645
Survey Dates	19/02/18
Device Type	MCS100FT
Serial Number	15080459
FID100FT installed (Y/N)	Y
Oxygen sensor installed (Y/N)	Y
MCERTS Cert No	MC100184/01
Certification Details	See Certificate
Measurement Principle MCS100FT	Fourier Transform Infra Red
Measurement Principle FID100FT	Flame Ionisation
Measurement Principle Oxygen	Zirconium Dioxide
SICK Engineer	Matt Curtis
Signature	

EPA Export 21-08-2018:03:54:57

Current installation data

Installation location	Outdoors ☐	Under a roof ☐	Indoors ☒		
	Cabinet ☐	Container ☐	Air-conditioned ☒		
Fitting position Sample gas sampling	Horizontal ☒	Vertical ☐	Angle 55 °		
Measuring point name (e.g.: KKS)	Main Stack		Remarks		
Supply voltage	230 V	AC ☒ DC ☐	USV ☐		
Gas warning unit	☐				
Ambient Temperature	7 °C		°F		
Medium temperature	°C		°F		
Medium pressure	1002 mbar		kPa		
Medium moisture	2.4 rel.%				
O_2 concentration of medium	21.11 Vol.%				

Plant status

In operation ☐ Not in operation ☒ Start-up operation ☐ Shutdown operation ☐

Measured values before check

Direct Calibration ☒ Calibration via probe ☐

Component	HCl	CO	NO	SO2	O2	NO2
Unit	mg/m3	mg/m3	mg/m3	mg/m3	%	mg/m3
Measuring range	0 - 150	0 - 1500	0 - 2000	0 - 1500	0 - 25	0 - 100
Curr. Measured value	0.17	0.12	3.64	4.53	21.03	4.91
Actual Zero	0.0195	0.0515	0.0023	-0.2977	20.67	0.0187
Expected Span	60.1	802.39	410.71	226.47	2.01	159.08
Measured Span	60.22	805.94	406.40	234.45	2.11	159.52

Component	CO2	VOC	H2O			
Unit	%	mg/m3	%			
Measuring range	0 - 35	0 - 30	0 - 50			
Curr. Measured value	0.03	15.38	0.73			
Actual Zero	-0.1043	-0.529	0.0732			
Expected Span	24.04	8.14	N/A			
Measured Span	23.62	8.24	N/A			

Component						
Unit						
Measuring range	-	-	-	-	-	-
Curr. Measured value						
Actual Zero						
Expected Span						
Measured Span						

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:57

1.	Alignment & Cleanliness		
1.1	Visual inspection of the analyser	☒	OK
1.2	Internal check of the analyser	☒	OK
1.3	Cleanliness of optical components	☒	OK
1.4	Flushing of air supply	☒	OK
1.5	Obstructions in the optical path	☒	None

2.	Sampling System		
2.1	System in good condition and free from faults	☒	OK
2.2	Visual Inspection of sampling probe	☒	OK
2.3	Check of the Gas Conditioning System	☒	OK
2.4	Check of the sample pump	☐	N/A Eductor
2.5	Check of all hoses, gas lines and connections	☒	OK
2.6	Check of power supplies	☒	OK
2.7	Check of all filters	☒	OK
2.8	Check of heated lines are operating correctly	☒	OK
2.9	Efficiency of NOx converter > 95% (if applicable)	☐	N/A not installed
2.10	Has the response time been checked by applying gas to probe	☐	

For inspection purposes only.
Consent of copyright owner required for any other use.

3.	Serviceability		
3.1	Safe & Clean working environment for servicing	☒	Yes
3.2	Adequate supply of reference gases	☒	Yes
3.3	Adequate supply of spare parts	☒	Yes
3.4	Ability to apply gas at probe	☒	Yes
3.5	Output signals checked	☒	Yes

4.	Zero Span & Leak Checks		
4.1	Leak check of whole system carried out	☒	Yes
4.2	Have span checks been carried out at suitable levels	☒	Yes (see calibration sheet)
4.3	Have zero checks been carried out at suitable levels	☒	Yes (see calibration sheet)

5.	Linearity		
5.1	Checks at 0, 20%, 40%, 60% & 80% of 2 x Daily ELV's	☐	N/A
5.2	Different concentrations applied in a random sequence	☐	N/A
5.3	Has the response time for each component been recorded (T90)	☐	N/A
5.4	Have the first readings been taken at 3 x T90	☐	N/A
5.5	Have three readings been taken at at least 4 x T90 apart	☐	N/A
5.6	Are the gases used traceable to ISO 17025 standards	☐	N/A

EPA Export 21-08-2018:03:54:57

6. Compressed air station	Y	N	Remarks
6.1 Instrument air meets specification?	☒	☐	OK
6.2 Without any visual damage?	☒	☐	OK
6.3 Without any visual contamination?	☒	☐	OK
6.4 Filter housing cleaned?	☐	☒	
6.5 Filter housing exchanged?	☐	☒	
6.6 System pressures OK?	☒	☐	OK

7. Device	Y	N	Remarks
7.1 Without any visual damage?	☒	☐	None visible
7.2 Gas warning unit checked visually?	☐	☒	None Fitted
7.3 Consumables exchanged in accordance with maintenance interval?	☒	☐	
7.4 Wearing parts exchanged?	☐	☒	N/A
7.5 Internal values checked?	☒	☐	All OK
7.6 OQ/PQ Test performed?	☐	☒	N/A
7.7 Recording cross-sensitivities, if required, adjustment using mobile adjustment unit checked visually?	☐	☒	except FID
7.8 Adjustment with test gases carried out?	☐	☒	No adjustments required, all QAL3 results OK
7.9 Signal outputs OK?	☒	☐	All OK
7.10 Leak tightness checked carried out?	☒	☐	All OK

For inspection purposes only.
Consent of copyright owner required for any other use.

8. Analyser cabinet	Y	N	Remarks
8.1 Without any visual damage?	☒	☐	
8.2 Cabinet fan filter pad exchanged?	☒	☐	
8.3 Pump maintenance carried out?	☐	☒	N/A eductor
8.4 Return valves (option) exchanged?	☐	☒	N/A
8.5 Visual check carried out on air-conditioner (option)	☒	☐	All OK

EPA Export 21-08-2018:03:54:57

9. Sample gas sampling	Y	N	Remarks
9.1 Without any visual damage?	☒	☐	All OK
9.2 Fine Filter exchanged?	☒	☐	
9.3 Return valve exchanged?	☒	☐	
9.4 Sampling probe disassembled and cleaned?	☐	☒	

10. Gas supply	Y	N	Remarks
10.1 Without any visual damage?	☒	☐	
10.2 Gas system leak-tightness OK?	☒	☐	
10.3 Pressures OK (primary and extraction pressure)?	☒	☐	
10.4 Gases within durability limits?	☒	☐	

Measured values after check Direct Calibration ☒ Calibration via probe ☐

Component	HCl	CO	NO	SO2	O2	NO2
Unit	mg/m3	mg/m3	mg/m3	mg/m3	%	mg/m3
Measuring range	0 - 150	0 - 1500	0 - 2000	0 - 1500	0 - 25	0 - 100
Curr. Measured value	0.23	0.17	3.75	5.36	20.94	4.90
Actual Zero	0.0239	0.0532	0.3518	-0.0123	21.07	0.6212
Expected Span	60.1	802.39	410.71	226.47	2.01	159.08
Measured Span	61.32	802.32	410.54	232.98	2.2	156.52
Component	CO2	VOC	H2O			
Unit	%	mg/m3	%			
Measuring range	0 - 35	0 - 30	0 - 50			
Curr. Measured value	0.06	15.90	0.71			
Actual Zero	0.1314	-0.433	0.0618			
Expected Span	24.04	8.14	N/A			
Measured Span	23.83	7.98	N/A			
Component						
Unit						
Measuring range	-	-	-	-	-	-
Curr. Measured value						
Actual Zero						
Expected Span						
Measured Span						

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:57

Final test	Y	N	Remarks
Device data saved?	☒	☐	
Full report of IR Cube saved?	☐	☒	
Measuring system running without problems?	☒	☐	
Customer instructed?	☒	☐	

Parts Used (if maintenance is carried out):

Description	Part No.	Quantity
MCS SFU fine filter kit	2039002	1
MCS cell inlet filter kit	2045339	1
Cabinet door filter	5309684	1
IR Cube desiccant cartridge	5320799	1
FID100FT catalyzer relay	6041449	1
Non return valve (MCS SFU)	5310158	1
Non return valve (MCS cell inlet)	4048555	1
PTFE tube 8mm	Ex stock	N/A
PTFE tube 6mm	Ex stock	N/A

Additional comments	
Quality of maintenance work by plant personnel:	Good
Cleanliness of and devices:	Good
Problems found, solution applied:	None
Recommendation for repair, changes, additional work	None
Proposal (if required) how to reach higher availability and better emission data quality	N/A
Training requirements :	Staff MCS100FT trained
Calibration gas check sheet:	Gas list up to date
Check on site log book:	OK

For inspection purposes only.
Consent of copyright owner required for any other use.

Remarks

Name
Matt Curtis

Date 19/02/18

Signature

EPA Export 21-08-2018:03:54:57

SICK (UK) LTD
Waldkirch House,
39 Hedley Rd
St Albans,
Herts,
Al1 5BN

Tel : 0044 (0)1727 831121
Fax : 0044 (0)1727 855332
E – Mail : info@sick.co.uk

FWE200 Line 2 Standby

BS EN 14181 – Functional Test & Maintenance Report

Customer	Covanta
Site	**Dublin (DwtE)**
Contact	
Service Ref No.	SVON020645
Survey Dates	21/02/18
Device Type	FWE200
Serial Number	16058492
Device Location	Line 2 Mezzanine
MCERTS Cert No	MC0039/01
Certification Details	See Certificate
Measurement Principle	Forward Scattered Light (Extractive)
SICK Engineer	Matt Curtis
Signature	

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:57

Dust reading before check

	Dust in mg / m³	mg/m³	0.7
	Contamination	%	5.198
	Control cycle, Zero point values		0.097
	Control cycle, Span value		70.08

Plant operating status:	**Offline**

1. Alignment & Cleanliness

1.1	Visual Inspection of the analyser	☒	OK
1.2	Internal check of the analyser	☒	OK
1.3	Cleanliness of optical components	☒	OK
1.4	Flushing of air supply	☒	OK
1.5	Obstructions in the optical path	☒	None

2. Sampling System

2.1	System in good condition and free from faults	☒	Yes
2.2	Visual Inspection of sampling probe	☒	OK
2.3	Check of the Gas Conditioning System	☒	OK
2.4	Check of the sample pump	☐	N/A
2.5	Check of all hoses, gas lines and connections	☒	OK
2.6	Check of power supplies	☒	OK
2.7	Check of all filters	☒	Blower filter replaced
2.8	Check of heated lines are operating correctly	☐	N/A
2.9	Efficiency of NOx converter > 95% (if applicable)	☐	N/A
2.10	Has the response time been checked by applying gas to probe	☐	N/A

For inspection purposes only.
Consent of copyright owner required for any other use.

3. Serviceability

3.1	Safe & clean working environment for servicing	☒	Dusty but OK
3.2	Adequate supply of reference gases	☐	N/A
3.3	Adequate supply of spare parts	☒	Supplied by Sick (UK) Ltd
3.4	Ability to apply gas at probe	☐	N/A
3.5	Output signals checked	☒	OK

EPA Export 21-08-2018:03:54:57

4. Zero Span & Leak Checks

4.1	Leak check of whole system carried out	☐	N/A
4.2	Have span checks been carried out at suitable levels	☒	Self check results recorded
4.3	Have zero checks been carried out at suitable levels	☒	Self check results recorded

5. Linearity

5.1	Checks at 0, 20%, 40%, 60% & 80% of 2 X Daily ELV's	☐	N/A
5.2	Different concentrations applied in a random sequence	☐	N/A
5.3	Has the response time for each component been recorded (T90)	☐	N/A
5.4	Have the first readings been taken at 3 x T90	☐	N/A
5.5	Have three readings been taken at at least 4 x T90 apart	☐	N/A
5.6	Are the gases used traceable to ISO 17025 standards	☐	N/A

6. Visual Inspection

6.1	Check if measured values are plausible in the control room	☒	OK
6.2	Check if there is any error message	☒	None
6.3	Check for mechanical damage	☒	None
6.4	Check attachments and connections	☒	OK

7. Purge Air Unit

7.1	Check the hose and hose clamps	☒	OK
7.2	Replace the filter insert and check filter housing of the purge-air supply. Part no: 7047560 or 5306091	☒	Replaced
7.3	Check function of filter	☒	OK

Consent of copyright owner required for any other use.
For inspection purposes only.

8. Probe

8.1	Clean probe	☐	Not required
8.2	Checking the probe surfaces for sign of corrosion	☐	Not required
8.3	Check and if necessary replace the sealing, latest each 12 month. Part no 7047036 or 7047937	☐	Check at annual service

EPA Export 21-08-2018:03:54:57

9. Optical unit

9.1	Clean housing	☐	Not required
9.2	Cleaning the surfaces of the optical parts and the probe. part no. 4003353	☐	Not required
9.3	Check event log	☒	OK
9.4	Check the transmitter diode	☐	Not required
9.5.	Check parameterization	☐	N/A
9.6	Check function of control cycle	☒	OK
9.7	Check function of motor drive (only FW101)	☐	N/A
9.8	Linearity check with control filter set	☐	N/A
9.9	Check if control cycle is (zero/span) valid at the analogue output within the evaluation unit	☒	OK

Linearity Measurement	**Expected Transmission**	**Actual Transmission**	**Deviation-%** Act/set value-1	< 2% OK?
Zero	N/A %	N/A %	N/A	N/A
Span (70%)	N/A %	N/A %	N/A	N/A
Filter 1 (aprox. 30%) actual:	N/A %	N/A %	N/A	N/A
Filter 2 (aprox. 50%) actual:	N/A %	N/A %	N/A	N/A
Filter 3 (aprox. 85%) actual:	N/A %	N/A %	N/A	N/A

For inspection purposes only.
Consent of copyright owner required for any other use.

10. Connection unit

	Check the analogue and digital input and output signals	☒	OK

11. Final check

11.1	Check function of complete measurement system	☒	OK
11.2	Check the availability of the system	☒	OK
11.3	Save device data	☒	Saved via SOPAS
11.4	Check weekly / quarterly log files of the user	☐	N/A
11.5	Complete Service Report and Measurement Log-file	☒	Completed

EPA Export 21-08-2018:03:54:57

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

Quality of maintenance work by plant personnel: OK
Cleanliness of measuring station and devices: Surfaces dusty from process
Maintenance work done (in addition to Annex 1):
Problems found, solution applied: None
Recommendation for repair, changes None
Proposal how to reach higher availability and better emission data quality: None
Training provided to plant personnel, proposal for settlement: Liase with customer
Other Comments:

Dust reading after check

Dust in mg / m³	mg/m³	0.6
Contamination	%	3.031
Control cycle, Zero point values		70.34
Control cycle, Span value		0.097

Remarks
Approved by customer Name: Darrah English Position:EC&I Engineer

For inspection purposes only.
Consent of copyright owner required for any other use.

EPA Export 21-08-2018:03:54:57