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**EN 14181 QAL2 Report Commissioned by**  
a1-cbiss Ltd

**Installation Name & Address**  
Viridor Waste Management Ltd  
Trident Park  
Ocean Way  
Cardiff  
CF24 5EN

EPR Permit: EPR/LP3030XA

**Stack Reference**  
Stream 2 - Duty Analyser

**Dates of the Monitoring Campaign**  
28/11 - 01/12/14


**Job Reference Number**  
CSW-14181-1529

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

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*This test report has been written to fully comply with the requirements in the Environment Agency's Method Implementation Document (MID) Version 3 which was published in April 2014.*

## Executive Summary (Page 1 of 2)

Viridor Waste Management Ltd, Cardiff Energy Recovery Facility  
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### Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by a1-cbiss Ltd to carry out stack emissions testing for Viridor Waste Management Ltd on the Stream 2 - Duty Analyser Stack at Cardiff Energy Recovery Facility.

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

### Special Requirements

There were no special requirements.

### QAL2 CALIBRATION SUMMARY

(D) = Duty CEMs, (S) = Standby CEMs where applicable

Parameter	Calibration Function derived from QAL2?	Source of the Calibration Function Derived	Calibration Function Derived	Result of Variability Test	Valid Calibration Range @ REF Conditions	Range after Surrogate Extension @ REF Conditions	Recommended Calibration Function to Apply to the Data Collection Software (see Conclusion)
Total Particulate Matter (D)	No	Not Derived	N/A	N/A	N/A	N/A	$y = x$
Total Particulate Matter (S)	No	Not Derived	N/A	N/A	N/A	N/A	$y = x$
Total VOCs	No	Not Derived	N/A	N/A	N/A	N/A	$y = x$
Oxides of Nitrogen (as NO <sub>2</sub> )	Yes	Parallel Test	$y = 1.0406x - 2.977$	Pass	0 to 394.9 mg/m <sup>3</sup>	N/A	$y = x$
Sulphur Dioxide	Yes	Parallel Test	$y = 0.5721x - 1.5558$	Pass	0 to 14.3 mg/m <sup>3</sup>	N/A	$y = 0.5721x - 1.5558$
Carbon Monoxide	No	Not Derived	N/A	N/A	N/A	N/A	$y = x$
Hydrogen Chloride	Yes	Parallel Test	$y = 0.9591x - 1.3691$	Pass	0 to 9.6 mg/m <sup>3</sup>	0 to 10 mg/m <sup>3</sup>	$y = x$
Hydrogen Fluoride	No	Not Derived	N/A	N/A	N/A	N/A	$y = x$
Ammonia	Yes	Parallel Test	$y = 1.1676x - 0.7516$	Pass	0 to 7.5 mg/m <sup>3</sup>	0 to 10 mg/m <sup>3</sup>	$y = x$
Water Vapour (% v/v)	Yes	Parallel Test	$y = 0.9157x - 0.0204$	Pass	0 to 18.5 % v/v	N/A	$y = x$
Oxygen (% v/v)	Yes	Parallel Test	$y = 1.0525x - 0.0037$	Pass	0 to 9.1 % v/v	N/A	$y = x$
Oxygen (% v/v)	Yes	Parallel Test	$y = 1.0574x - 0.0086$	Pass	0 to 8.7 % v/v	N/A	$y = x$
Volume Flow Rate (m <sup>3</sup> /s)	Yes	Parallel Test	$y = 1.0936x$	Pass	0 to 64.3 m <sup>3</sup> /s	N/A	$y = 1.0936x$

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/m<sup>3</sup>, unless otherwise stated.

### LINEARITY SUMMARY

Parameter	Linearity Performed?	Linearity Calibration Function	R <sup>2</sup> Value	Maximum ABS %, d <sub>c,rel</sub>	Allowable ABS %, d <sub>c,rel</sub>	Result of Residuals Test	Range Linearity Performed Over
Total Particulate Matter	No (See Conclusion)						
Total VOCs	No (See Conclusion)						
Nitrogen Monoxide (as NO <sub>2</sub> )	No (See Conclusion)						
Nitrogen Dioxide	No (See Conclusion)						
Sulphur Dioxide	No (See Conclusion)						
Carbon Monoxide	No (See Conclusion)						
Hydrogen Chloride	No (See Conclusion)						
Hydrogen Fluoride	No (See Conclusion)						
Ammonia	No (See Conclusion)						
Oxygen (% v/v)	No (See Conclusion)						

All calibration functions relate to mg/m<sup>3</sup>, unless otherwise stated.

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### SUMMARY OF STANDARD REFERENCE METHOD & EN 14181 DEVIATIONS

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

### CONCLUSIONS, DISCUSSIONS & ACTIONS FROM THE SAMPLING EXERCISE

#### Sulphur Dioxide and Volume Flow Rate

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 Collection Software (DCS). It should be noted that the CEMS Volume Flow Rate originally read 5 x too high. This was due to a rogue factor in the internal calculations. It should be confirmed that this rogue factor has been removed.

#### Oxides of Nitrogen (as NO<sub>2</sub>), Hydrogen Chloride, Ammonia, Water Vapour and Oxygen

A valid calibration function has been derived from the parallel tests which passes the variability test. The average difference between the standardised CEMS and standardised SRM is less than half of the 95% Confidence Interval [CI] of the Daily ELV, and therefore the SRM and CEMS are deemed to be extremely close in agreement with one another. In these situations, Environment Agency Guidance via MID 14181 suggests that it may not be necessary to apply the new calibration function and the calibration function in the Data Collection Software (DCS) could be left at 1.0000 (i.e.  $y = x$ ). Agreement from the Environment Agency must be sought before applying this guidance.

#### 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%) and the spread of data is poor, a valid calibration function has not been derived from the parallel tests. In these circumstances, TGN M20 does not require a calibration function to be derived. Instead it requires a minimum of 5 Total Particulate Matter sample runs to be performed to prove that the emissions are of a low order. These results can be seen in Section 4A of this test report. The CEMS is effectively being used as a qualitative indicator of rising emissions rather than a quantitative monitor. The Environment Agency should be informed of this situation.

#### Total VOCs and Carbon Monoxide

As the emissions are of a low order (less than the 95% Confidence Interval of the Daily ELV) and the spread of data is poor, a valid calibration function has not been derived from the parallel tests. The graphical representation of the data can be seen in Section 4A at the back of this test report. Environment Agency guidance suggests that the CEMS should be calibrated with surrogates, and therefore, the calibration function derived from the linearity test, when carried out at a future date, should be used and entered into the Data Collection Software (DCS). As an interim measure, and until the linearity exercise is completed, it is recommended that a function of  $y = x$  is used.

#### Hydrogen Fluoride

The plot for Hydrogen Fluoride can be seen in Appendix 2. The Permit does not list a Daily ELV requirement for Hydrogen Fluoride.

#### Linearities

The linearity testing is still to be performed.

### REGULATORY INFORMATION

Viridor Waste Management Ltd, Cardiff Energy Recovery Facility  
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Parameter	Value
Name of the Installation	Cardiff Energy Recovery Facility
Address of the Installation	See Title Page
Sector of the Installation	Incineration
Permit Number	EPR/LP3030XA
Date of the Last QAL2 / AST Campaign	N/A - First QAL2
Date CEMS Data Obtained by Exova Catalyst	2nd December 2014

### Regulated Determinands and Emission Limit Values (ELVs)

Determinand	Short-Term ELV (mg/m <sup>3</sup> )	Daily or 48hr Average ELV (mg/m <sup>3</sup> )	Uncertainty Requirement (%)
Total Particulate Matter	30	10	30
Total VOCs	20	10	30
Oxides of Nitrogen (as NO <sub>2</sub> )	400	200	20
Sulphur Dioxide	200	50	20
Carbon Monoxide	100	50	20 <sup>1</sup>
Hydrogen Chloride	60	10	40
Hydrogen Fluoride	2*	-	40
Ammonia	-	ERF of 10 mg/m <sup>3</sup>	40

where ERF = Emissions Range Factor (this is not an ELV) taken from guidance, EN 14181 EA Communication 1, Nov 2011.

<sup>1</sup> Taken from MID 14181 v3

\* Periodic Limit - No Continuous Limit set

## OPERATIONAL INFORMATION AND SITE MONITORING PROVISIONS

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### 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)	Commissioning
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)	No
Reviewing historical Plant data, were low emissions expected for any determinands?	Commissioning - Historical data not available
Was the CEMS reading zero for any determinands, if so, was this investigated to ensure it was working?	Full Service carried out by CBISS
What product was being processed during the tests?	Municipal Waste

### Type of Fuel

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

### Abatement

Parameter	Value
Type of Abatement System	Bag Filters & Carbon/Lime Injection
Running Status	On

## MONITORING PROVISIONS AT THE INSTALLATION - PERIODIC MONITORING

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### Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	1.89
Width	m	-
Area	m <sup>2</sup>	2.81
Port Depth	cm	20
Orientation of Duct	-	Vertical
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

### 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 12th November 2014, Report ID: CSW-15259-1633-Viridor-Cardiff EfW-A1-Stream 2-Report, and the stack gas profile was found to be homogenous.

### Sampling Plane Validation Criteria (from EA Technical Guidance Document (Monitoring) TGN M1 / EN 15259)

Criteria in M1	Units	Traverse 1		Required	Compliant
Lowest Differential Pressure	Pa	151.5		> 5 Pa	Yes
Mean Velocity	m/s	19.40		-	-
Lowest Gas Velocity	m/s	16.15		-	-
Highest Gas Velocity	m/s	21.87		-	-
Ratio of Above	: 1	1.35		< 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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Pro-forma for Site Provisions for Monitoring

Requirement	Compliant	Notes
A safe and clean working environment with sufficient space and weather protection.	No	Construction activities all around site and in CEMS room, contractors in and out of CEMS room
Easy and safe access to the CEMS.	Yes	Access to CEMS on ground floor
Adequate supplies of reference materials, tools and spare parts.	Yes	Gas bottles located outside, all full bottles
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 CEMS.	No	Currently contractors have cut through gas lines, being repaired
Compliance with MID 15259	Yes	See the Sampling Plane Validation Criteria table on the previous page.

Plant Photos

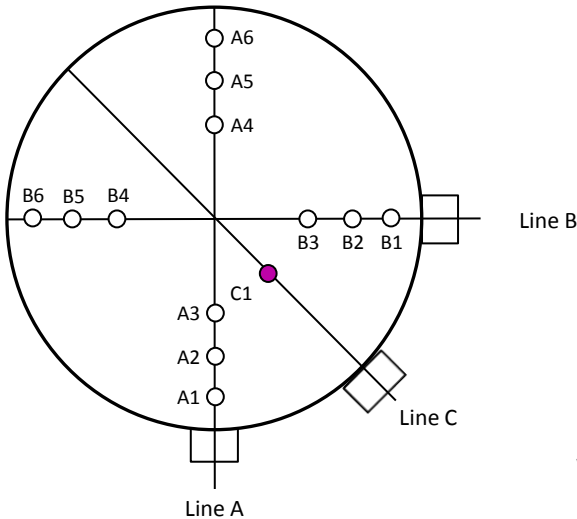
Photo 1



Photo 2



Sample Points



where

○ = isokinetic point sampled at

● = isokinetic point not sampled at

● = non-isokinetic / combustion gases sample point



### CONTINUOUS EMISSION MONITORING SYSTEMS (CEMS) AT THE INSTALLATION

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Main Determinand	Type	Instrument Name	Instrument Serial Number	Measurement Principle	Certified Range (mg/m³)	QAL1 Compliant	MCERTS Number
Total Particulate Matter (D)	In-Situ	PCME LMS181	45844	Light Scatter	0 - 15	Yes	MC090152/01
Total Particulate Matter (S)	In-Situ	PCME LMS181	45234	Light Scatter	0 - 15	Yes	MC090152/01
Total VOCs	Extractive	Graphite 52M	797	FID	0 - 15	Yes	MC 060082/08
Oxides of Nitrogen (as NO <sub>2</sub> )	Extractive	MIR FT	2566	FTIR	0 - 200	Yes	MC 040031/07
Sulphur Dioxide	Extractive	MIR FT	2566	FTIR	0 - 75	Yes	MC 040031/07
Carbon Monoxide	Extractive	MIR FT	2566	FTIR	0 - 75	Yes	MC 040031/07
Hydrogen Chloride	Extractive	MIR FT	2566	FTIR	0 - 15	Yes	MC 040031/07
Hydrogen Fluoride	Extractive	MIR FT	2566	FTIR	N/A	No	N/A
Ammonia	Extractive	MIR FT	2566	FTIR	0 - 15	Yes	MC 040031/07
Water Vapour	Extractive	MIR FT	2566	FTIR	0 - 30%	Yes	MC 040031/07
Oxygen (Wet) (D)	Extractive	Oxymitter 4000	M-1304090	Zirconia Cell	0 - 25%	Yes	MC 070087/03
Oxygen (Wet) (S)	Extractive	Oxymitter 4000	M-1304089	Zirconia Cell	0 - 25%	Yes	MC 070087/03
Volume Flow Rate	In-Situ	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

Where (D) = Duty CEMS, (S) = Standby CEMS

Peripheral Determinand	Recorded	Instrument Name
Temperature	Yes	MIR FT
Pressure	Yes	MIR FT

Record of NO <sub>x</sub> Converter Check	Date of Last Check	Result of Check (Allowable is ≥ 95%)	
CEMS	N/A	N/A	Pass
SRM	N/A	N/A	Pass

## TEST LABORATORY STAFF

Position	Name	MCERTS Accreditation	MCERTS Number & Expiry Date	Technical Endorsements
Team Leader	Martin Futter	MCERTS Level 2	MM 03 216, Expiry: 31/03/2015	TE1 TE2 TE3 TE4
Technician	Luke Prowse	MCERTS Level 1	MM 11 1145, Expiry: 31/12/2016	TE1 TE2 TE3 TE4
Team Leader	Matthew Hopes	MCERTS Level 2	MM 06 688, Expiry 31/07/2016	TE1 TE2 TE3 TE4
NONE				

## 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 (%)
			Certified (mg/m <sup>3</sup> )	Operational (mg/m <sup>3</sup> )			
Total Particulate Matter	MST	Gravimetric	0 - 5	0 - 50	N/A	BS EN 13284-1	181
Total VOCs	Sick Maihak 3006	FID	0 - 15	0 - 125	MC 040036	EN 12619	74
Oxides of Nitrogen (as NO <sub>2</sub> )	Horiba PG-250	Chemiluminescence	0 - 125	0 - 400	MC 050056	EN 14792	7
Sulphur Dioxide	MST	Ion Chromatography	N/A - SRM	0 - 75	N/A	EN 14791	15
Carbon Monoxide	Gasmet DX4000	FTIR	0 - 75	0 - 75	MC 030014	TGN M22	68
Hydrogen Chloride	Gasmet DX4000	FTIR	0 - 15	0 - 75	MC 030014	TGN M22	27
Hydrogen Fluoride	Gasmet DX4000	FTIR	N/A	0 - 10	MC 030014	TGN M22	52
Ammonia	Gasmet DX4000	FTIR	N/A	0 - 20	MC 030014	TGN M22	15
Water Vapour	Gasmet DX4000	FTIR	0 - 30%	0 - 30%	MC 030014	TGN M22	7
Oxygen (Dry)	Horiba PG-250 SRM	Paramagnetic Cell	0 - 25%	0 - 25%	MC 110186	EN 14789	7
Volume Flow Rate	S-Pitot & MP200	Pressure & Temperature	N/A - SRM	N/A - SRM		EN 13284-1	10

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

where: **MST stands for Manual Sampling Train**

NOTE 2: Volume Flow Rate calibration is performed following the requirements of EN ISO 16911-2, Exova Catalyst do not hold accreditation for this Method at this time.

## 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 7.18	Horiba PG-250 SRM	CAT 9.14	Digital Manometer (1)	CAT 3.89/3.56
Control Box DGM (2)	-	Horiba PG-250	-	Digital Manometer (2)	-
Box Thermocouples (1)	CAT 3.38	Servomex 4900	-	Digital Temperature Meter	CAT 3.89/3.56
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	CAT 14.62/14.39
Umbilical (1)	CAT 3.38	ABB AO2020-URAS26	-	Barometer	CAT 13.17
Umbilical (2)	-	Servomex 5200MP	CAT 24.8	Stack Thermocouple (1)	CAT 4.261
Oven Box (1)	CAT 12.41	JCT JCC P1 Cooler	CAT 4.204	Stack Thermocouple (2)	CAT 4.329
Oven Box (2)	-	Gasmet DX4000	CAT 19.4	Stack Thermocouple (3)	CAT 4.427
Heated Probe (1)	CAT 5.46	Gasmet Sampling System	CAT 10.3	1m Heated Line (1)	CAT 20.39
Heated Probe (2)	CAT 5.61	Bernath 3006 FID	CAT 8.13	1m Heated Line (2)	CAT 20.40
Heated Probe (3)	CAT 5.45	M&C PSS	CAT 12.46	1m Heated Line (3)	-
S-Pitot (1)	CAT 21P.32	Mass Flow Controller (1)	CAT 6.34	5m Heated Line (1)	-
S-Pitot (2)	CAT 21S.26	Mass Flow Controller (2)	CAT 6.35	15m Heated Line (1)	-
L-Pitot	-	Mass View (1)	CAT 25.27	20m Heated Line (1)	CAT 20.63
500g Check Weight	CAT 17.14	Mass View (2)	CAT 25.28	20m Heated Line (2)	-
1Kg Check Weight	CAT 17.14	Easylogger EN-EL-12 Bit	CAT 11.32	Dual Channel Heater Controller	CAT 3.39
Last Impinger Arm	CAT 4.210/4.211	Easylogger EN-EL-12 Bit	CAT 11.33	Single Channel Heater Controller	-
Callipers	CAT 23.18			Laboratory Balance	CAT 1.18 / 1.18a
Tubes Kit Thermocouple	-			Tape Measure	CAT 16.22