



Exova Catalyst, Unit 11, Aspen Close, Swindon, SN2 8AJ  
T: 0800 328 1821 (or + 44 161 432 3286 from overseas)  
E: stuart.davidson@exova.com  
Your Exova Catalyst Contact: Stuart Davidson (07957 554 956)

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

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

Primary Site Contact: Leon Wolf

EPR Permit: EPR/LP3030XA

**Stack Reference**  
Stream 1 - Standby Unit

**Dates of the Monitoring Campaign**  
12-18/11/14

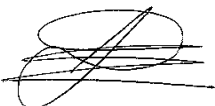
**Job Reference Number**  
CSW-14181-1633

Report Written by
Paul Martin Deputy Regional Manager MCERTS Level 2 MM 04 503 TE1 TE2 TE3 TE4

Report Approved by
James Harmer Technical Manager MCERTS Level 2 MM 03 156 TE1 TE2 TE3 TE4

Report Date
12th December 2014

Report Version
Draft V1

Signature of Report Approver


## CONTENTS

### SECTION 1A: TITLE PAGE

CONTENTS	2
----------	---

### SECTIONS 1B & 1C: EXECUTIVE SUMMARY

Overall Aim of the Monitoring Campaign & Special Requirements	3
QAL2 Calibration & 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 Monitoring Systems (CEMS) at the Installation	9

### SECTION 3: INFORMATION ABOUT THE MONITORING CAMPAIGN

Test Laboratory Staff	10
Standard Reference Methods (SRMS)	10

### SECTION 4A: Data and Calculations - QAL2

### SECTION 5: Results of the Functional Tests

*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 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  
Stream 1 - Standby Unit  
12-18/11/14

### Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by a1-cbiss to carry out stack emissions testing for Viridor Waste Management Ltd on the Stream 1 - Standby Unit 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

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 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	$y = 1.1278x - 13.8551$	Pass	0 to 390.7 mg/m <sup>3</sup>	N/A	$y = x$
Sulphur Dioxide	Yes	Parallel Test	$y = 0.9043x - 2.1376$	Pass	0 to 60.8 mg/m <sup>3</sup>	N/A	$y = 0.9043x - 2.1376$
Carbon Monoxide	No	Not Derived	N/A	N/A	N/A	N/A	$y = x$
Hydrogen Chloride	Yes	Parallel Test	$y = 0.8664x - 1.2732$	Pass	0 to 21.6 mg/m <sup>3</sup>	N/A	$y = 0.8664x - 1.2732$
Hydrogen Fluoride	No	Not Derived	N/A	N/A	N/A	N/A	$y = x$
Ammonia	Yes	Parallel Test	$y = 1.0297x - 2.3875$	Pass	0 to 29.4 mg/m <sup>3</sup>	N/A	$y = x$
Water Vapour (% v/v)	Yes	Parallel Test	$y = 0.9775x + 0.0029$	Pass	0 to 21.4 % v/v	N/A	$y = x$
Oxygen (% v/v)	Yes	Parallel Test	$y = 1.026x + 0.0088$	Pass	0 to 7.7 % v/v	N/A	$y = x$
Volume Flow Rate (m <sup>3</sup> /s)	Yes	Parallel Test	$y = 1.0727x$	Pass	0 to 63.5 m <sup>3</sup> /s	N/A	$y = 1.0727x$

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)						
Volume Flow Rate (m <sup>3</sup> /s)	No (See Conclusion)						

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

## Executive Summary (Page 2 of 2)

Viridor Waste Management Ltd, Cardiff Energy Recovery Facility  
Stream 1 - Standby Unit  
12-18/11/14

### 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, Hydrogen Chloride and Volumetric 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).

#### Oxides of Nitrogen (as NO<sub>2</sub>), 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 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, should be used and entered into the Data Collection Software (DCS). We are unable to provide a calibration function at this time and so recommend leaving as  $y = x$ .

#### 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  
Stream 1 - Standby Unit  
12-18/11/14

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	18th November 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 VOCs	20	10	30
Oxides of Nitrogen (as NO <sub>2</sub> )	400	200	20
Nitrogen Monoxide	-	-	20
Nitrogen Dioxide	-	-	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

Viridor Waste Management Ltd, Cardiff Energy Recovery Facility  
Stream 1 - Standby Unit  
12-18/11/14

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

(Page 1 of 2)

Viridor Waste Management Ltd, Cardiff Energy Recovery Facility  
Stream 1 - Standby Unit  
12-18/11/14

### Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	1.89
Width	m	-
Area	m <sup>2</sup>	2.81
Port Depth	cm	16
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 1-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	123.3		> 5 Pa	Yes
Mean Velocity	m/s	18.10		-	-
Lowest Gas Velocity	m/s	15.14		-	-
Highest Gas Velocity	m/s	19.86		-	-
Ratio of Above	: 1	1.31		< 3 : 1	Yes
Maximum Angle of Swirl	°	4		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

MONITORING PROVISIONS AT THE INSTALLATION - PERIODIC MONITORING

(Page 2 of 2)

Viridor Waste Management Ltd, Cardiff Energy Recovery Facility

Stream 1 - Standby Unit

12-18/11/14

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

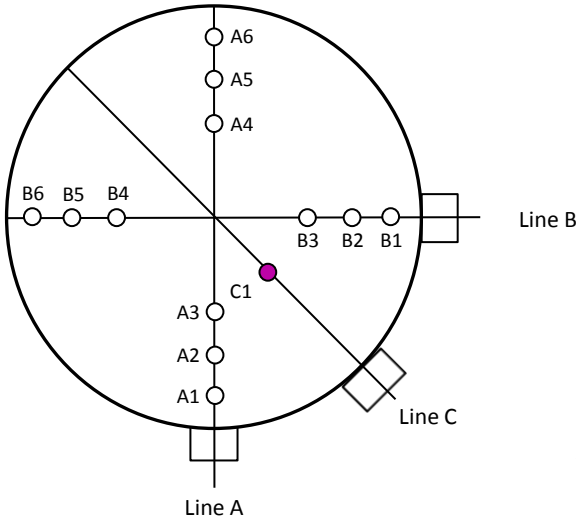
Photo 1



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

Viridor Waste Management Ltd, Cardiff Energy Recovery Facility  
Stream 1 - Standby Unit  
12-18/11/14

Main Determinand	Type	Instrument Name	Instrument Serial Number	Measurement Principle	Certified Range (mg/m³)	QAL1 Compliant	MCERTS Number
Total VOCs	Extractive	Graphite 52M	784	FID	0 - 15	Yes	MC 060082/08
Oxides of Nitrogen (as NO <sub>2</sub> )	Extractive	MIR FT	2568	FTIR	0 - 200	Yes	MC 040031/07
Sulphur Dioxide	Extractive	MIR FT	2568	FTIR	0 - 75	Yes	MC 040031/07
Carbon Monoxide	Extractive	MIR FT	2568	FTIR	0- 75	Yes	MC 040031/07
Hydrogen Chloride	Extractive	MIR FT	2568	FTIR	0 - 15	Yes	MC 040031/07
Hydrogen Fluoride	Extractive	MIR FT	2568	FTIR	N/A	No	N/A
Ammonia	Extractive	MIR FT	2568	FTIR	0 - 15	Yes	MC 040031/07
Water Vapour	Extractive	MIR FT	2568	FTIR	0 - 30%	Yes	MC 040031/07
Oxygen (Wet)	In-Situ	Oxymitter 4000	M-1304088	Zirconia Cell	0 - 25%	Yes	MC 070087/03
Volume Flow Rate	In-Situ	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

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	22/11/2013	95.9	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
NONE				
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 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 SRM	Chemiluminescence	0 - 200	0 - 400	MC 110186	EN 14792	7
Sulphur Dioxide	MST	Ion Chromatography	N/A - SRM	N/A - SRM	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	CAT 9.14	Digital Manometer (1)	CAT 3.89/3.56
Control Box DGM (2)	-	Horiba PG-250 SRM	-	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	Hioki 5043 (V)	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