From: Darren Hughes
To: Bass, Dave (Env. Health)
Subject: FW: PCME Calibration Visit
Date: 19 December 2013 11:07:09

Morning Dave, please find below email from PCME as requested.

Following our discussion, the first 2 test runs were carried out without the water to the abatement equipment being turned on, this gave an abnormally high readings for test 1 & 2.

The water had been turned off for routine maintenance to the filters the day before. Unfortunately it was our new maintenance man who forgot to turn the water back on.

I have spoken to our maintenance manager who will ensure all maintenance staff are fully briefed, & check to ensure the water is always turned back on after any routine maintenance. This will be a simple check of the particulate reading on the abatement control panel which would show a high particulate reading if the water is not on.

Darren..

Darren,

Apologies for the lateness of this email, the sampling results that we had from Catalyst have caused much discussion about how to calibrate your instrument this year since the results for the first 2 runs are not representative of the kind of results we normally expect from your process. Linked to this Catalyst expressed concerns that they didn't think your filter was operating correctly for the first 2 runs, and I believe they raised this concern while on site. I have attached the report for you to review and for your records.

I am advising that the calibration factor is modified this year based on the third run only means a change: -

- From 9.98
- To **7.656**

Obviously Carl is in on Monday to make the change, but if you have any concerns I can discuss these with you.

If you have any questions please do not hesitate to contact me.

Kind Regards,

James Hooley
Technical Support & Calibration Supervisor
PCME – Particulate & Emission Monitoring Systems

Unit 11, Aspen Close, Swindon, SN2 8AJ
T: 0800 328 1821
E: stuart.davidson@cat-env.com
Your Catalyst Contact: Stuart Davidson (07957 554 956)

Stack Emissions Testing Report Commissioned by
PCME Ltd

Installation Name & Address
Clark-Drain Ltd
Station Road
Yaxley
Peterborough
Cambridgeshire
PE7 3EG

EPR Permit: A12/92; Variation: PPC 20/09

Stack Reference
Galvanising Plant

Dates of the Monitoring Campaign
31st October 2013

Job Reference Number
CSW-1273

Report Written by
Wayne Rossouw Technician MCERTS Level 1 MM 10 1083 TE1 & TE4

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

Report Date
18th November 2013

Version
Version 1

Signature of Report Approver


CONTENTS

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

MONITORING OBJECTIVES

Clark-Drain Ltd, Yaxley
Galvanising Plant
31st October 2013

Overall Aim of the Monitoring Campaign

Catalyst Environmental Ltd, in partnership with PCME Ltd, were commissioned to carry out stack emissions testing on the Galvanising Plant by Clark-Drain Ltd at Yaxley.

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values (ELVs) as specified in the Site's Permit.

Special Requirements

Record the PCME Meter readings. These can be found on the back page of this Report.

Target Parameters

Total Particulate Matter, Hydrogen Chloride, Lead

Executive Summary

MONITORING RESULTS

Clark-Drain Ltd, Yaxley
Galvanising Plant
31st October 2013

where MU = Measurement Uncertainty associated with the Result

	Concentration				Mass Emission			
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Total Particulate Matter [1]	mg/m³	99.2	5.0	15	g/hr	1578	79.4	-
Hydrogen Chloride [1]	mg/m³	< 0.025	0.004	-	g/hr	< 0.40	0.06	-
Lead [1]	mg/m³	0.006	0.001	-	g/hr	0.09	0.01	-
Water Vapour	% v/v	1.9	0.09					
Stack Gas Temperature	°C	28.0						
Stack Gas Velocity	m/s	12.0						
Volumetric Flow Rate (ACTUAL)	m³/hr	17561						
Volumetric Flow Rate (REF) [1]	m³/hr	15911						

NOTE: VOLUMETRIC FLOW RATE DATA TAKEN FROM THE PRELIMINARY VELOCITY TRAVERSE.

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

MONITORING DATE(S) & TIMES

Clark-Drain Ltd, Yaxley
Galvanising Plant
31st October 2013

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	267	g/hr	4250	31/10/2013	10:49 - 11:49	60
Total Particulate Matter	R2	mg/m³	23.4	g/hr	372	31/10/2013	12:11 - 13:11	60
Total Particulate Matter	R3	mg/m³	7.0	g/hr	111	31/10/2013	13:34 - 14:34	60
Hydrogen Chloride	R1	mg/m³	< 0.03	g/hr	< 0.40	31/10/2013	10:49 - 11:49	60
Lead	R1	mg/m³	0.006	g/hr	0.090	31/10/2013	15:29 - 16:29	60
Velocity & Volumetric Flow Rate	R1					31/10/2013	10:15 - 10:25	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Clark-Drain Ltd, Yaxley
Galvanising Plant
31st October 2013

Standard Operating Conditions

Parameter	Value
Process Status	Normal
Capacity (of 100%) and Tonnes / Hour	Various
Continuous or Batch Process	Batch
Feedstock (if applicable)	Steel Components
Abatement System	Wet Scrubber
Abatement System Running Status	On
Fuel	N/A
Plume Appearance	None Visible

MONITORING & ANALYTICAL METHODS

Clark-Drain Ltd, Yaxley
Galvanising Plant
31st October 2013

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**UKAS Testing**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**UKAS Analysis**	**Analysis Lab**	**MCERTS Testing**	**LOD (Average)**
Total Particulate Matter	BS EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.1 mg/m³
Hydrogen Chloride	BS EN 1911	CAT-TP-11	Yes	CAT	CAT-AP-01	IC	Yes	CAT	Yes	0.025 mg/m³
Lead	BS EN 14385	CAT-TP-06	Yes	CAT	M31	ICP-MS	Yes	RPS	Yes	0.001 mg/m³
Water Vapour	BS EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.1 % v/v
Velocity & Vol. Flow Rate	BS EN 13284-1	CAT-TP-04	Yes	CAT	Pitot Tube and Thermocouple				Yes	N/A

ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Catalyst Environmental Ltd (CAT)	UKAS Accreditation Number: 4279
RPS Laboratories Ltd (RPS)	UKAS Accreditation Number: 0605

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Total Particulate Matter & Lead	All	One out of two sampling lines was used due to sampling location restrictions, however the number of sample points used on the available line were increased to meet the requirements of the Standard.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.72
Width	m	-
Area	m²	0.41
Port Depth	cm	9
Orientation of Duct	-	Vertical
Sample Port Size	-	4" BSP

Location of Sampling Platform

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

Platform Details

EA Technical Guidance Note M1 / BS 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	No
There are no obstructions present which hamper insertion of sampling equipment	No
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

All platforms should be designed in accordance with the requirements in the Environment Agency's Technical Guidance Note M1 and BS EN 15259.

BS EN 15259 Homogeneity Test Requirements

There is no requirement to perform a BS EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EA Technical Guidance Document (Monitoring) M1)

Criteria in M1	Units	Traverse 1		Required	Compliant
Lowest Differential Pressure	Pa	101.0		> 5 Pa	Yes
Mean Velocity	m/s	11.98		-	-
Lowest Gas Velocity	m/s	10.94		-	-
Highest Gas Velocity	m/s	12.74		-	-
Ratio of Above	: 1	1.16		< 3 : 1	Yes
Maximum Angle of Swirl	°	5		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

PLANT PHOTOS

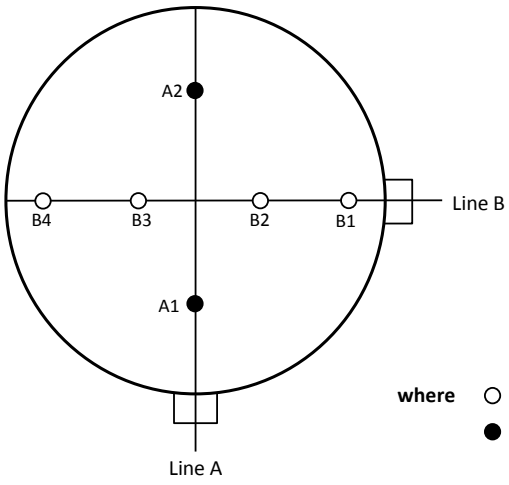
Photo 1

Photo 2

Photo 3

Photo 4

SAMPLE POINTS



where ○ = isokinetic point sampled at
● = isokinetic point not sampled at

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Matthew Hopes	MCERTS Level 2	MM 06 688	TE1 TE2 TE3 TE4
Technician	Wayne Rossouw	MCERTS Level 1	MM 10 1083	TE1 & TE4

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM	CAT 7.9
Box Thermocouples	CAT 3.22
Umbilical	CAT 3.22
Oven Box	CAT 12.24
Probe	CAT 5.102
S-Pitot (1)	CAT 21P.20
S-Pitot (2)	CAT 21S.17
L-Pitot	-
500g Check Weight	CAT 17.8
1Kg Check Weight	CAT 17.8
Last Impinger Arm	CAT 4.83 / 4.84
Callipers	CAT 23.9
Tubes Kit Thermocouple	-
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 19.8

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
Testo 350 XL	-
Servomex 5200MP	-
JCT JCC P1 Cooler	-
FT-IR	-
FT-IR Sampling System	-
Bernath 3006 FID	-
Heated Head Filter	-
Mass Flow Controller (1)	-
Mass Flow Controller (2)	-
Mass View (1)	-
Mass View (2)	-
Easylogger EN-EL-12 Bit	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.23
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.23
Stopwatch	CAT 14.54
Barometer	CAT 13.8
Stack Thermocouple (1)	CAT 4.423
Stack Thermocouple (2)	CAT 4.14
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
15m Heated Line (2)	-
20m Heated Line (1)	-
Dual Channel Heater Controller	-

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	BS EN 13284-1	CAT-TP-01
Hydrogen Chloride	BS EN 1911	CAT-TP-11
Lead	BS EN 14385	CAT-TP-06
Water Vapour	BS EN 14790	CAT-TP-05
Velocity & Vol. Flow Rate	BS EN 13284-1	CAT-TP-04

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.72
Stack Width, W	m	-
Stack Area, A	m^2	0.41
Average Stack Gas Temperature, T_a	°C	28.0
Average Stack Gas Pressure	Pa	121.4
Average Stack Static Pressure, P_{static}	kPa	0.092
Average Barometric Pressure, P_b	kPa	101.1
Average Pitot Tube Calibration Coefficient, C_p	-	0.83

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2 (Estimated)	-	20.80	20.41	0.2080	32.00	1.4277	0.29696
N_2	-	79.14	77.67	0.7914	28.01	1.2498	0.98913
Moisture (H_2O)	-	-	1.86	0.0186	18.02	0.8037	0.01496

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.287
Wet Density (STP), P_{STW}	kg/m³	1.278
Dry Density (Actual), P_{Actual}	kg/m³	1.166
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	1.158

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) $= P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	28.0	0.0
Total Pressure	kPa	101.2	101.3
Moisture	%	1.86	1.86

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	17561
Gas Volumetric Flowrate (STP, Wet)	m³/hr	15911
Gas Volumetric Flowrate (STP, Dry)	m³/hr	15614
Gas Volumetric Flowrate REF [1]	m³/hr	15911

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE

(1 of 1)

Parameter	Units	Value
Date of Survey	-	31/10/2013
Time of Survey	-	10:15 - 10:25
Atmospheric Pressure	kPa	101.1
Stack Static Pressure	Pa	92
Type of Pitot Used	-	S-Type Pitot
Are Water Droplets Present?	-	No

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.83
Number of Lines Available	-	2
Number of Lines Used	-	1

	Swirl Point (taken at the sampling points used during testing)																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Angle of Swirl (°)	3	5	2	3																

			Sampling Line A - Cap Stuck			Sampling Line B			
Traverse Point	Depth m	ΔP	Temp °C	Wet Density kg/m³	Velocity m/s	ΔP Pa	Temp °C	Wet Density kg/m³	Velocity m/s
1	0.04					101.0	28.0	1.158	10.94
2	0.11					125.0	28.0	1.158	12.17
3	0.18					127.0	28.0	1.158	12.27
4	0.25					103.0	28.0	1.158	11.05
5	0.32					121.0	28.0	1.158	11.97
6	0.40					135.0	28.0	1.158	12.65
7	0.47					114.0	28.0	1.158	11.62
8	0.54					121.0	28.0	1.158	11.97
9	0.61					130.0	28.0	1.158	12.41
10	0.68					137.0	28.0	1.158	12.74
Mean						**121.4**	**28.0**	**1.158**	**11.98**

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Clark-Drain Ltd, Yaxley
Galvanising Plant

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3		Mean
Concentration	mg/m³	267.1	23.4	7.0		99.2
Uncertainty	±mg/m³	12.9	1.3	0.76		5.0
Mass Emission	g/hr	4250	372	111		1578
Uncertainty	±g/hr	205	21.2	12.0		79.4

Parameter	Units	Run 1	Run 2	Run 3		Mean
Water Vapour	% v/v	1.8	1.8	1.9		1.8
Uncertainty	±% v/v	0.089	0.091	0.096		0.092

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.52		0.52

General Sampling Information

Parameter	Value	
Standard	BS EN 13284-1	
Technical Procedure	CAT-TP-01	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	B1, B2, B3 & B4	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	Run 2	Run 3	
Absolute pressure of stack gas, P_s					
Barometric pressure, P_b	mmHg	758.3	758.3	758.3	
Stack static pressure, P_{static}	mmH_2O	9.4	9.4	9.4	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	758.9	758.9	758.9	
Volume of water vapour collected, V_{wstd}					
Total mass collected in impingers (liquid trap)	g	10.1	9.2	8.6	
Total mass collected in impingers (silica trap)	g	10.2	5.8	7.8	
Total mass of liquid collected, V_{lc}	g	20.3	15.0	16.4	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0253	0.0187	0.0204	
Volume of gas metered dry, V_{mstd}					
Volume of gas sample through gas meter, V_m	m^3	1.4540	1.1010	1.1370	
Gas meter correction factor, Y_d	-	1.0270	1.0270	1.0270	
Average dry gas meter temperature, T_m	°C	19.6	22.9	23.3	
Average pressure drop across orifice, ΔH	mmH_2O	58.1	35.4	33.0	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.3979	1.0443	1.0767	
Moisture content, B_{wo} & R_{wv}					
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0178	0.0176	0.0186	
B_{wo} as a percentage	% v/v	1.78	1.76	1.86	
Reported Water Vapour, checked with Tables in BS EN 14790, R_{wv}	% v/v	1.78	1.76	1.86	
Volume of gas metered wet, V_{mstw}					
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.4232	1.0630	1.0971	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$					
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	No	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	N/A	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	N/A	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	N/A	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	N/A	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	N/A	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	N/A	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	N/A	N/A	
Molecular weight of dry gas stream, M_d					
CO_2 (Estimated)	% v/v	0.06	0.06	0.06	
O_2 (Estimated)	% v/v	20.80	20.80	20.80	
Total	% v/v	20.86	20.86	20.86	
N_2	% v/v	79.14	79.14	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	28.84	28.84	
Molecular weight of stack gas (wet), M_s					
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.65	28.65	28.64	
Velocity of stack gas, V_s					
Pitot tube velocity constant, K_p	-	34.97	34.97	34.97	
Velocity pressure coefficient, C_p	-	0.83	0.83	0.83	
Average of velocity heads, ΔP_{avg}	mmH_2O	11.39	6.88	2.23	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	3.38	2.62	1.49	
Average stack gas temperature, T_s	°C	28.7	30.1	31.8	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	11.54	8.99	5.13	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})					
Area of stack, A_s	m^2	0.41	0.41	0.41	
$Q_a = (60)(A_s)(V_s)$	m^3/min	281.9	219.6	125.4	
Conversion factor (K/mm.Hg), C_f	-	0.3592	0.3592	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	254.8	197.5	112.1	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	250.2	194.0	110.1	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)(O_{2REFw})$	m^3/min	N/A	N/A	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)(O_{2REFd})$	m^3/min	N/A	N/A	N/A	
Percent isokinetic, %I					
Nozzle diameter, D_n	mm	6.78	6.78	8.85	
Nozzle area, A_n	mm^2	36.14	36.14	61.52	
Total sampling time, q	min	60	60	60	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	104.9	101.1	107.9	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3	
Sampling Times	-	10:49 - 11:49	12:11 - 13:11	13:34 - 14:34	
Sampling Dates	-	31/10/2013	31/10/2013	31/10/2013	
Sampling Device	-	ISO	ISO	ISO	
Volume Sampled (REF)	m^3	1.4232	1.0630	1.0971	
Filter I.D. Number	-	47-14482	47-16250	47-16252	
Start Filter Mass	g	0.14261	0.14432	0.14183	
End Filter Mass	g	0.51428	0.16824	0.14928	
Total Mass on Filter	g	0.37167	0.02392	0.00745	
Probe Rinse I.D. Number	-	PR-47-14482	PR-47-16250	PR-47-16252	
Start Probe Rinse Mass	g	6.93504	7.03747	6.95205	
End Probe Rinse Mass	g	6.94349	7.03842	6.95227	
Total Mass in Probe Rinse	g	0.00845	0.00095	0.00022	
Total Mass Collected	mg	380.12	24.87	7.67	
Calculated Concentration	mg/m^3	267.09	23.39	6.99	
Balance Uncertainty / LOD	mg/m^3	0.08	0.11	0.11	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	31/10/2013	
Average Volume Sampled (REF)	m^3	1.1944	
Filter I.D. Number	-	47-14481	
Start Filter Mass	g	0.14310	
End Filter Mass	g	0.14348	
Total Mass on Filter	g	0.00038	
Probe Rinse I.D. Number	-	PR-47-14481	
Start Probe Rinse Mass	g	7.00529	
End Probe Rinse Mass	g	7.00553	
Total Mass in Probe Rinse	g	0.00024	
Total Mass Collected	mg	0.62	
Calculated Concentration	mg/m^3	0.52	
Balance Uncertainty / LOD	mg/m^3	0.10	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1	Run 2	Run 3	
Mean Sampling Rate	l/min	24.89	18.85	19.46	
Pre-Sampling Leak Rate	l/min	0.04	0.03	0.05	
Post-Sampling Leak Rate	l/min	0.03	0.03	0.04	
Allowable Leak Rate	l/min	0.50	0.38	0.39	
Leak Test Acceptable	-	Yes	Yes	Yes	

Water Droplets	Units	Run 1	Run 2	Run 3	
Are Water Droplets Present	-	No	No	No	

MU (Concurrent Water Vapour)	Units	Run 1	Run 2	Run 3	
Measurement Uncertainty (MU)	%	5.0	5.2	5.1	
Allowable MU	%	20	20	20	
MU Acceptable	%	Yes	Yes	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	Run 2	Run 3	
Less than 50% Faded	%	Yes	Yes	Yes	

Isokinetic Criterion Compliance	Units	Run 1	Run 2	Run 3	
Isokinetic Variation	%	104.9	101.1	107.9	
Allowable Isokinetic Range	%	95 - 115	95 - 115	95 - 115	
Isokineticity Acceptable	-	Yes	Yes	Yes	

Weighing Uncertainty Criteria	Units	Run 1	Run 2	Run 3	
Overall Weighing Uncertainty	± mg	0.24	0.24	0.24	
Overall Weighing Uncertainty	± mg/m³	0.17	0.23	0.22	
ELV [Daily ELV for IED]	mg/m³	15.00	15.00	15.00	
Allowable Weighing Uncertainty	mg/m³	0.75	0.75	0.75	
Weighing Uncertainty Acceptable	-	Yes	Yes	Yes	

Filter Temperatures	Units	Run 1	Run 2	Run 3	
Pre-Conditioning Temperature	°C	180	180	180	
Post-Conditioning Temperature	°C	160	160	160	
Maximum Filter Temperature	°C	29	30	32	

Test Conditions	Units	Run 1	Run 2	Run 3	
Ambient Temperature Recorded?	-	Yes	Yes	Yes	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	18.00	
Pre-Sampling Leak Rate	l/min	0.04	
Post-Sampling Leak Rate	l/min	0.04	
Allowable Leak Rate	l/min	0.36	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m³	1.5	
Blank Acceptable	-	Yes	

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	2	3	
One out of two sampling lines was used due to sampling location restrictions, however the number of sample points used on the available line were increased to meet the requirements of the Standard.	x	x	x	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value					Standard uncertainty					
Measured Quantities	**Symbol**	**Run 1**	**Run 2**	**Run 3**		**Symbol**	**Units**	**Run 1**	**Run 2**	**Run 3**	
Sampled Volume (Actual)	V_m	1.4540	1.1010	1.1370		uV_m	m^3	0.0291	0.0220	0.0227	
Sampled Gas Temperature	T_m	292.6	295.9	296.3		uT_m	K	2.0	2.0	2.0	
Sampled Gas Pressure	ρ_m	101.2	101.2	101.2		$u\rho_m$	kPa	0.5	0.5	0.5	
Sampled Gas Humidity	H_m	0.0	0.0	0.0		uH_m	% v/v	1.0	1.0	1.0	
Leak	L	0.12	0.16	0.21		uL	%	-	-	-	
Mass of Particulate	m	380.12	24.87	7.67		um	mg	0.12	0.12	0.12	
Oxygen Content	$O_{2,m}$	N/A	N/A	N/A		$uO_{2,m}$	% v/v	N/A	N/A	N/A	
Uncollected Mass	UCM	0.62	0.62	0.62		uUCM	mg	-	-	-	

	Uncertainty as a Percentage					
Measured Quantities	**Units**	**Run 1**	**Run 2**	**Run 3**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	2.00	2.00		≤2%
Sampled Gas Temperature	%	0.68	0.68	0.67		≤1%
Sampled Gas Pressure	%	0.49	0.49	0.49		≤1%
Sampled Gas Humidity	%	1.00	1.00	1.00		≤1%
Leak	%	0.12	0.16	0.21		≤2%
Mass of Particulate	%	0.56	0.75	0.73		<5% of ELV
Oxygen Content	%	N/A	N/A	N/A		≤5%
Uncollected Mass	%	-	-	-		-

	Uncertainty in Measurement Units						Sensitivity Coefficient			
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 2**	**Run 3**		**Run 1**	**Run 2**	**Run 3**	
Sampled Volume (STP)	V_m	m^3	1.3979	1.0443	1.0767		191.06	22.40	6.49	
Leak	L	mg/m^3	0.186	0.022	0.008		1.00	1.00	1.00	
Mass of Particulate	L_r	mg	380.1	24.867	7.670		0.70	0.94	0.91	
Factor for O_2 Correction	$O_{2,m}$	% v/v	N/A	N/A	N/A		N/A	N/A	N/A	
Uncollected Mass	UCM	mg	0.36	0.36	0.36		0.70	0.94	0.91	

	Uncertainty in Result				
Measured Quantities	**Units**	**Run 1**	**Run 2**	**Run 3**	
Sampled Volume (STP)	mg/m^3	6.563	0.580	0.174	
Leak	mg/m^3	0.1859	0.0215	0.0083	
Mass of Particulate	mg/m^3	0.0843	0.1129	0.1094	
Factor for O_2 Correction	mg/m^3	N/A	N/A	N/A	
Uncollected Mass	mg/m^3	0.2515	0.3367	0.3263	

Parameter	**Units**	**Run 1**	**Run 2**	**Run 3**	
Combined uncertainty	mg/m^3	6.57	0.68	0.39	
Expanded uncertainty (95% confidence)	mg/m^3	12.88	1.33	0.76	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	12.88	1.33	0.76	
Reported Uncertainty	mg/m^3	12.88	1.33	0.76	
Expanded uncertainty (95% confidence)	%	4.8	5.7	10.8	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	4.8	5.7	10.8	
Reported Uncertainty	%	4.8	5.7	10.8	

HYDROGEN CHLORIDE: RESULTS SUMMARY

Clark-Drain Ltd, Yaxley
Galvanising Plant

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	< 0.025		< 0.025
Uncertainty	±mg/m³	0.004		0.004
Mass Emission	g/hr	< 0.40		< 0.40
Uncertainty	±g/hr	0.06		0.06

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	1.8		1.8
Uncertainty	±% v/v	0.089		0.092

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	< 0.02		< 0.02

General Sampling Information

Parameter	Value	
Standard	BS EN 1911	
Technical Procedure	CAT-TP-11	
Name of Analytical Laboratory	CAT	
Analytical Laboratory's Procedure	CAT-AP-01	
UKAS Accredited Analysis?	Yes	
Date of Sample Analysis	08/11/2013	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Impinger Material	Polypropylene	
Absorption Solution	HPLC Grade Water	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	B1, B2, B3 & B4	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

HYDROGEN CHLORIDE: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	758.3	
Stack static pressure, P_{static}	mmH_2O	9.4	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	758.9	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	8.6	
Total mass collected in impingers (silica trap)	g	7.8	
Total mass of liquid collected, V_{lc}	g	16.4	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0204	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	1.1370	
Gas meter correction factor, Y_d	-	1.0270	
Average dry gas meter temperature, T_m	°C	23.3	
Average pressure drop across orifice, ΔH	mmH_2O	33.0	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.0767	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0186	
B_{wo} as a percentage	% v/v	1.86	
Reported Water Vapour, checked with Tables in BS EN 14790, R_{wv}	% v/v	1.86	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.0971	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2 (Estimated)	% v/v	20.80	
Total	% v/v	20.86	
N_2	% v/v	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.64	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.83	
Average of velocity heads, ΔP_{avg}	mmH_2O	2.23	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	1.49	
Average stack gas temperature, T_s	°C	31.75	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	5.13	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.41	
$Q_a = (60)(A_s)(V_s)$	m^3/min	125.37	
Conversion factor (K/mm.Hg), C_f	-	0.36	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	112.15	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	110.06	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)(O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)(O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	8.85	
Nozzle area, A_n	mm^2	61.52	
Total sampling time, q	min	60.00	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	107.91	

HYDROGEN CHLORIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	10:49 - 11:49	
Sampling Dates	-	31/10/2013	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	1.0971	
Laboratory Result for Front Impingers	µg/ml	< 0.05	
Laboratory Result for Back Impinger	µg/ml	0.05	
Volume in Front Impingers	ml	365.1	
Volume in Back Impinger	ml	190.7	
Mass in Front Impingers	µg	< 18.3	
Mass in Back Impinger	µg	< 9.5	
Total Mass Collected	µg	< 27.8	
Calculated Concentration	mg/m^3	< 0.03	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	31/10/2013	
Average Volume Sampled (REF)	m^3	1.0971	
Laboratory Result for Impingers	µg/ml	< 0.05	
Volume in Impingers	ml	356.4	
Total Mass Collected	µg	< 17.8	
Calculated Concentration	mg/m^3	< 0.02	

HYDROGEN CHLORIDE: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1		
Mean Sampling Rate	l/min	19.46		
Pre-Sampling Leak Rate	l/min	0.05		
Post-Sampling Leak Rate	l/min	0.04		
Allowable Leak Rate	l/min	0.39		
Leak Test Acceptable	-	Yes		

Absorption Efficiency	Units	Run 1		
Absorption Efficiency	%	100.0		
Allowable Absorption Efficiency	%	N/A [1]		
Absorption Efficiency Acceptable	-	N/A [1]		

[1] The concentration in the last absorber was less than 5 times the analytical detection limit.

Water Droplets	Units	Run 1		
Are Water Droplets Present	-	No		

MU (Concurrent Water Vapour)	Units	Run 1		
Measurement Uncertainty (MU)	%	5.0		
Allowable MU	%	20		
MU Acceptable	%	Yes		

Silica Gel (Concurrent Water Vapour)	Units	Run 1		
Less than 50% Faded	%	Yes		

Isokinetic Criterion Compliance	Units	Run 1		
Isokinetic Variation	%	107.9		
Allowable Isokinetic Range	%	95 - 115		
Isokineticity Acceptable	-	Yes		

Filter Temperatures	Units	Run 1		
Maximum Filter Temperature	°C	29		

Test Conditions	Units	Run 1	Run 2	Run 3	
Ambient Temperature Recorded?	-	Yes			

HYDROGEN CHLORIDE: QUALITY ASSURANCE

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	18.00	
Pre-Sampling Leak Rate	l/min	0.04	
Post-Sampling Leak Rate	l/min	0.04	
Allowable Leak Rate	l/min	0.36	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m³	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
There are no deviations associated with the sampling employed.	wx	

HYDROGEN CHLORIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	1.4540		uV_m	m^3	0.0291	
Sampled Gas Temperature	T_m	292.6		uT_m	K	2.0	
Sampled Gas Pressure	ρ_m	101.2		$u\rho_m$	kPa	0.5	
Sampled Gas Humidity	H_m	0.0		uH_m	% v/v	1.0	
Leak	L	0.12		uL	%	-	
Laboratory Result	L_r	6.80		uL_r	%	-	
Oxygen Content	$O_{2,m}$	N/A		$uO_{2,m}$	% v/v	N/A	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.68		≤1%
Sampled Gas Pressure	%	0.49		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.12		≤2%
Laboratory Result	%	6.80		No Requirement
Oxygen Content	%	N/A		≤5%

	Uncertainty in Measurement Units				Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**		**Run 1**	
Sampled Volume (STP)	V_m	m^3	1.3979		0.02	
Leak	L	mg/m^3	1.8E-05		1.00	
Laboratory Result	L_r	mg/m^3	0.002		1.00	
Factor for O_2 Correction	$O_{2,m}$	% v/v	N/A		N/A	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.0006	
Leak	mg/m^3	1.8E-05	
Laboratory Result	mg/m^3	0.002	
Factor for O_2 Correction	mg/m^3	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m^3	0.002	
Expanded uncertainty (95% confidence)	mg/m^3	0.004	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.004	
Reported Uncertainty	mg/m^3	0.004	
Expanded uncertainty (95% confidence)	%	14.2	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	14.2	
Reported Uncertainty	%	14.2	

LEAD: RESULTS SUMMARY

Clark-Drain Ltd, Yaxley
Galvanising Plant

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.0057		0.0057
Uncertainty	±mg/m³	0.0008		0.0008
Mass Emission	g/hr	0.090		0.090
Uncertainty	±g/hr	0.012		0.012

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	1.9		1.9
Uncertainty	±% v/v	0.099		0.099

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.0026		0.0026

General Sampling Information

Parameter	Value	
Standard	BS EN 14385	
Technical Procedure	CAT-TP-06	
Name of Analytical Laboratory	RPS	
Analytical Laboratory's Procedure	M31	
UKAS Accredited Analysis?	Yes	
Date of Sample Analysis	11/11/2013	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Impinger Material	Borosilicate Glass	
Absorption Solution	Nitric Peroxide	
Positioning of Filter	Out Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	B1, B2, B3 & B4	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

LEAD: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	758.3	
Stack static pressure, P_{static}	mmH_2O	2.7	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	758.5	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	9.8	
Total mass collected in impingers (silica trap)	g	7.3	
Total mass of liquid collected, V_{lc}	g	17.1	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0213	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	1.1369	
Gas meter correction factor, Y_d	-	1.0270	
Average dry gas meter temperature, T_m	°C	20.7	
Average pressure drop across orifice, ΔH	mmH_2O	32.6	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.0862	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0192	
B_{wo} as a percentage	% v/v	1.92	
Reported Water Vapour, checked with Tables in BS EN 14790, R_{wv}	% v/v	1.92	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.1075	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2 (Estimated)	% v/v	20.80	
Total	% v/v	20.86	
N_2	% v/v	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.63	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.83	
Average of velocity heads, ΔP_{avg}	mmH_2O	2.23	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	1.49	
Average stack gas temperature, T_s	°C	32.1	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	5.14	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.41	
$Q_a = (60)(A_s)(V_s)$	m^3/min	125.5	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	112.1	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	109.9	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)(O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)(O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	8.85	
Nozzle area, A_n	mm^2	61.52	
Total sampling time, q	min	60	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	109.0	

LEAD: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	15:29 - 16:29	
Sampling Dates	-	31/10/2013	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	1.1075	
Mass on Filter / in Rinse	µg	6.00	
Mass in Front Impingers	µg	0.20	
Mass in Back Impinger	µg	0.08	
Total Mass Collected	µg	6.27	
Calculated Concentration	mg/m^3	0.0057	
Reported Concentration	mg/m^3	0.0057	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	31/10/2013	
Average Volume Sampled (REF)	m^3	1.1075	
Mass on Filter / in Rinse	µg	0.80	
Mass in Front Impingers	µg	0.88	
Mass in Back Impinger	µg	1.16	
Total Mass Collected	µg	2.84	
Calculated Concentration	mg/m^3	0.0026	
Reported Concentration	mg/m^3	0.0026	

LEAD: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	19.46	
Pre-Sampling Leak Rate	l/min	0.10	
Post-Sampling Leak Rate	l/min	0.12	
Allowable Leak Rate	l/min	0.39	
Leak Test Acceptable	-	Yes	

Absorption Efficiency	Units	Run 1	
Absorption Efficiency	%	98.8	
Allowable Absorption Efficiency	%	90	
Absorption Efficiency Acceptable	-	Yes	

Detection Limit	Units	Run 1	
Detection Limit	µg/m³	0.5	
Allowable Detection Limit	µg/m³	5	
Detection Limit Acceptable	-	Yes	

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	No	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.1	
Allowable MU	%	20	
MU Acceptable	%	Yes	

Silica Gel (Concurrent Water Vapour)	Units	Run 1	
Less than 50% Faded	%	Yes	

Isokinetic Criterion Compliance	Units	Run 1	
Isokinetic Variation	%	109.0	
Allowable Isokinetic Range	%	95 - 115	
Isokineticity Acceptable	-	Yes	

Filter Temperatures	Units	Run 1	
Maximum Filter Temperature	°C	181	

Impingers Exit Temperature	Units	Run 1	
Maximum Temperature Recorded	°C	12	
Maximum Allowable Temperature	°C	30	
Exit Temperature Acceptable	-	Yes	

Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

LEAD: QUALITY ASSURANCE

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Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	18.00	
Pre-Sampling Leak Rate	l/min	0.14	
Post-Sampling Leak Rate	l/min	0.11	
Allowable Leak Rate	l/min	0.36	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m³	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation	Run Number	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
One out of two sampling lines was used due to sampling location restrictions, however the number of sample points used on the available line were increased to meet the requirements of the Standard.	x	

LEAD: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	1.1369		uV_m	m³	0.0227	
Sampled Gas Temperature	T_m	293.7		uT_m	K	2.0	
Sampled Gas Pressure	ρ_m	101.1		$u\rho_m$	kPa	0.5	
Sampled Gas Humidity	H_m	0.0		uH_m	% v/v	1.0	
Leak	L	0.62		uL	%	-	
Laboratory Result	L_r	6.50		uL_r	%	-	
Oxygen Content	$O_{2,m}$	N/A		$uO_{2,m}$	% v/v	N/A	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.68		≤1%
Sampled Gas Pressure	%	0.49		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.62		≤2%
Laboratory Result	%	6.50		No Requirement
Oxygen Content	%	N/A		≤5%

	Uncertainty in Measurement Units				Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**		**Run 1**	
Sampled Volume (STP)	V_m	m³	1.0862		0.01	
Leak	L	mg/m³	2.0E-05		1.00	
Laboratory Result	L_r	mg/m³	0.0004		1.00	
Factor for O_2 Correction	$O_{2,m}$	% v/v	N/A		N/A	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m³	0.0001	
Leak	mg/m³	2.0E-05	
Laboratory Result	mg/m³	0.0004	
Factor for O_2 Correction	mg/m³	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m³	0.0004	
Expanded uncertainty (95% confidence)	mg/m³	0.0008	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m³	0.0008	
Reported Uncertainty	mg/m³	0.0008	
Expanded uncertainty (95% confidence)	%	13.6	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	13.6	
Reported Uncertainty	%	13.6	

PCME METER

Contract Details	
Test House Job Number	CSW-1273
Company	**Clark-Drain Ltd**
Site	Yaxley
Stack	Galvanising Plant
Sampling Date	31/10/2013
PCME Job Number	**J33A14790**

Stack Conditions	Value	Units
Stack Temperature	30.2	°C
Stack Humidity	1.8	% v/v
Stack Oxygen Content	N/A	% v/v
Stack Pressure	101.2	kPa

Current Instrument Settings	Type	Serial Number
Controller Type	IM	34304
Channel Type	DT 373	34803
Channel Number	Stack1	
Instrument Checks	Pass	
Current Calibration Factor	9.98	
Time on Display	14:02	
Time Difference - Meter v Actual	PCME 14:02, Catalyst 13:28	
GMT / BST?	GMT	
Was Time Changed?	No	

Hardware Status	
Zero	2
Span	10056
S/C	10032
Contamination Ring	N/A
Comms Check	Pass

Summary of Test Data - Results of SRM vs CEM

Run	Start Time	Finish Time	Instrument Average	Instrument Maximum	TPM Conc. STP WET	TPM Conc. STP DRY	TPM Conc. STP WET, % O_2	TPM Conc. STP DRY, % O_2	TPM Conc. ACTUAL
1	10:49	11:49	8.7	23.3	267.09	271.92	N/A	N/A	240.23
2	12:11	13:11	8.0	20.8	23.39	23.81	N/A	N/A	21.04
3	13:34	14:34	8.2	21.7	6.99	7.12	N/A	N/A	6.29
Mean			**8.29**		**99.16**	**100.95**	**N/A**	**N/A**	**89.19**

For all matters relating to the function, performance and calibration of the PCME Meter, please speak directly to PCME on 01480 468 200.

Times listed in the table above relate to the actual time of the tests, and not the times as read by the PCME meter.