Passionate about Particulate

PCME

21 November 2011

Darren Hughes
Clark-Drain Ltd
Station Rd
Yaxley
Peterborough, PE7 3EQ

Dear Mr Hughes

Please find enclosed a copy of the report for the Isokinetic testing recently carried out at your site.

If you have any queries regarding the calibration of your PCME equipment or any other questions please do not hesitate to contact me.

Yours sincerely

Carl Marsh
Service Manager

Enc

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60 Edison Road
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Passionate about Particulate

PCME

CALIBRATION CERTIFICATE

Site: **Clark-Drain Ltd**

Calibration Date:	18th October 2011	**PCME Job No:**	J31A11946
Location:	Yaxley	**Testing House Job No:**	CAT-0847
Instrument:	DT373	**Channel Number:**	1
Channel ID:	Galvanising Plant		

All measurements at actual stack conditions

Stack Conditions	Value	Units		Value	Units
Stack Temperature	31.9	°c	Stack Oxygen Content	N/A	%
Stack Humidity	5.3	%	Stack Pressure	100.5	kPa

Calculations		
	Instrument Average (mg/m^3)	Iso Sampling Average (mg/m^3)
Run 1	9.30	7.74
Run 2	9.45*	2.86*
Run 3	9.24	12.83
Averages	9.27	10.29

* This was identified as an outlier and ignored for calibration purposes.

Existing Cal Factor	4.29

New Cal Factor	**4.76**

New cal factor has been calculated using information obtained from isokinetic sample to BS EN13284-1 and corresponding instrument averages obtained via inbuilt stored data.

Recommended Recalibration Due	**18th October 2012**

Signed:.....
Carl Marsh, Service Manager

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T: 0800 328 1821
E: toby.campbell@cat-env.com
Your Catalyst Contact: Toby Campbell (07825 130 074)

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
Galvansing Plant

Dates of the Monitoring Campaign
18th October 2011

Job Reference Number
CAT-0847

Report Written by
Scott Pilkington Team Leader MCERTS Level 2 MM 04 501 TE1 TE2 TE3 TE4

Report Approved by
James Eldridge Team Leader MCERTS Level 2 MM 05 641 TE1 TE2 TE3 TE4

Report Date
4th November 2011

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
Galvansing Plant
18th October 2011

Overall Aim of the Monitoring Campaign

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

The aim of the monitoring campaign was to conduct stack emissions testing as part of PCME's calibration service in support of the PCME particulate monitor installed at the emissions point and 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
Galvansing Plant
18th October 2011

	Concentration				Mass Emission			
Parameter	Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Total Particulate Matter [1]	mg/m³	8.8	1.0	15	g/hr	74.4	8.4	-
Hydrogen Chloride [1]	mg/m³	0.39	0.06	-	g/hr	3.3	0.47	-
Lead [1]	mg/m³	0.004	0.001	-	g/hr	0.03	0.01	-
Water Vapour	% v/v	5.3	0.26					
Stack Gas Temperature	°C	34.5						
Stack Gas Velocity	m/s	6.6						
Volumetric Flow Rate (ACTUAL)	m³/hr	9611						
Volumetric Flow Rate (REF) [1]	m³/hr	8467						

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.

Executive Summary

MONITORING DATE(S) & TIMES

Clark-Drain Ltd, Yaxley
Galvansing Plant
18th October 2011

Parameter		Units	Concentration	Sampling Date(s)	Sampling Times	Duration (mins)
Total Particulate Matter	Run 1	mg/m^3	8.7	18/10/2011	10:25 - 10:57	32
Total Particulate Matter	Run 2	mg/m^3	3.2	18/10/2011	11:21 - 11:53	32
Total Particulate Matter	Run 3	mg/m^3	14.4	18/10/2011	12:10 - 12:42	32
Hydrogen Chloride	Run 1	mg/m^3	0.39	18/10/2011	10:25 - 10:57	32
Lead	Run 1	mg/m^3	0.004	18/10/2011	10:25 - 10:57	32
Lead	Run 2	mg/m^3	0.004	18/10/2011	11:21 - 11:53	32
Lead	Run 3	mg/m^3	0.004	18/10/2011	12:10 - 12:42	32
Velocity & Volumetric Flow Rate	Run 1			18/10/2011	09:50 - 10:00	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Clark-Drain Ltd, Yaxley
Galvansing Plant
18th October 2011

Standard Operating Conditions

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

MONITORING & ANALYTICAL METHODS

Clark-Drain Ltd, Yaxley
Galvansing Plant
18th October 2011

	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-01	Gravimetric	Yes	CAT	Yes	0.22 mg/m³
Hydrogen Chloride	BS EN 1911	CAT-TP-11	Yes	CAT	AP01	IC	Yes	CAT	Yes	0.04 mg/m³
Lead	-	-	-	-	M30	ICP-OES	Yes	RPS	No	0.004 mg/m³
Water Vapour	BS EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.10 % 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	m^2	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	Yes
There are no obstructions present which hamper insertion of sampling equipment	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 BS EN 15259, and therefore there are no improvement recommendations.

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	11.0		> 5 Pa	Yes
Mean Velocity	m/s	6.56		-	-
Lowest Gas Velocity	m/s	3.68		-	-
Highest Gas Velocity	m/s	9.75		-	-
Ratio of Above	:1	2.65		< 3 : 1	Yes
Maximum Angle of Swirl	°	11		< 15°	Yes
No Local Negative Flow	-	Yes		-	Yes

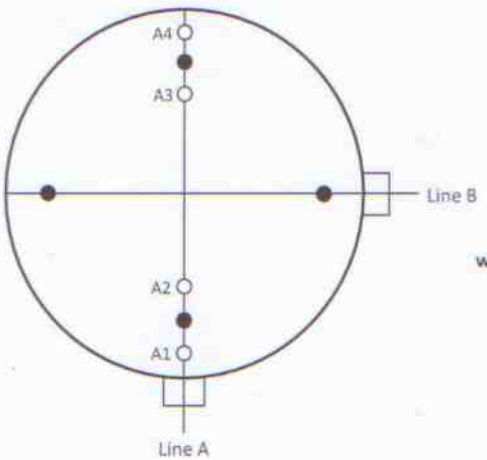
PLANT PHOTOS

Photo 1

Photo 2

Photo 3

SAMPLE POINTS



where ○ = isokinetic point sampled at
● = isokinetic point not sampled at
● = combustion gases sample point
◎ = non-isokinetic sample point

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Scott Pilkington	MCERTS Level 2	MM 04 501	TE1 TE2 TE3 TE4
Trainee	David Beynon	MCERTS Trainee	MM 11 1136	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM	CAT 7.20
Box Thermocouples	CAT 3.28
Umbilical	CAT 7.13
Oven Box	CAT 12.34
Probe	CAT 5.38
S-Pitot (1)	CAT 21P.28
S-Pitot (2)	-
L-Pitot	-
500g Check Weight	CAT 17.12
1Kg Check Weight	CAT 17.12
Last Impinger Arm	CAT 4.180
Callipers	CAT 23.12
Small DGM	-
Laboratory Balance	CAT 1.18
Tape Measure	CAT 16.16

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
Testo 350 XL	-
JCT JCC P-1 Cooler	-
5m FT-IR	-
5m 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	-
Dual Channel Heater Controller	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.32
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.32
Stopwatch	-
Barometer	CAT 13.12
Stack Thermocouple (1)	CAT 4.151
Stack Thermocouple (2)	-
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)	-

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
Heavy Metals	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	34.5
Average Stack Gas Pressure	Pa	37.5
Average Stack Static Pressure, P_{static}	kPa	0.018
Average Barometric Pressure, P_b	kPa	100.5
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/m^3 p	Conc kg/m^3 p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2 (Estimated)	-	20.80	19.70	0.2080	32.00	1.4277	0.29696
N_2	-	79.14	74.96	0.7914	28.01	1.2498	0.98913
Moisture (H_2O)	-	-	5.28	0.0528	18.02	0.8037	0.04246

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m^3	1.287
Wet Density (STP), P_{STW}	kg/m^3	1.262
Dry Density (Actual), P_{Actual}	kg/m^3	1.134
Average Wet Density (Actual), $P_{ActualW}$	kg/m^3	1.112

Where: P_{STD} = sum of component concentrations, kg/m^3 (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m^3 (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	34.5	0.0
Total Pressure	kPa	100.5	101.3
Moisture	%	5.28	5.28

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m^3/hr	9611
Gas Volumetric Flowrate (STP, Wet)	m^3/hr	8467
Gas Volumetric Flowrate (STP, Dry)	m^3/hr	8020
Gas Volumetric Flowrate REF [1]	m^3/hr	8467

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE

(1 of 1)

Parameter	Units	Value
Date of Survey	-	18/10/2011
Time of Survey	-	09:50 - 10:00
Atmospheric Pressure	kPa	100.5
Stack Static Pressure	Pa	18
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 (°)	7	11	11	9																

		Sampling Line A				Sampling Line B - Cap Stuck			
Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m³	Velocity m/s	ΔP	Temp °C	Wet Density kg/m³	Velocity m/s
1	0.04	17.0	34.2	1.113	4.58				
2	0.11	11.0	34.4	1.112	3.68				
3	0.18	45.0	34.6	1.111	7.45				
4	0.25	22.0	34.6	1.111	5.21				
5	0.32	33.0	34.6	1.111	6.38				
6	0.40	39.0	34.4	1.112	6.94				
7	0.47	33.0	34.5	1.112	6.38				
8	0.54	28.0	34.5	1.112	5.88				
9	0.61	70.0	34.5	1.112	9.30				
10	0.68	77.0	34.6	1.111	9.75				
Mean		**37.5**	**34.5**	**1.112**	**6.56**				

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Clark-Drain Ltd, Yaxley
Galvansing Plant

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3		Mean
Concentration	mg/m³	8.7	3.2	14.4		8.8
Uncertainty	±mg/m³	0.94	0.91	1.1		1.0
Mass Emission	g/hr	73.8	27.3	122		74.4
Uncertainty	±g/hr	8.0	7.7	9.6		8.4

Parameter	Units	Run 1	Run 2	Run 3		Mean
Water Vapour	% v/v	5.3	5.3	5.1		5.3
Uncertainty	±% v/v	0.26	0.26	0.25		0.26

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.68		0.68

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 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	A1, A2, A3, A4	

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	753.8	753.8	753.8	
Stack static pressure, P_{static}	mmH_2O	1.8	1.8	1.8	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	753.9	753.9	753.9	
Volume of water vapour collected, V_{wstd}					
Total mass collected in impingers (liquid trap)	g	16.4	18.0	19.7	
Total mass collected in impingers (silica trap)	g	8.3	5.4	2.5	
Total mass of liquid collected, V_{lc}	g	24.7	23.4	22.2	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0308	0.0292	0.0277	
Volume of gas metered dry, V_{mstd}					
Volume of gas sample through gas meter, V_m	m^3	0.5427	0.5158	0.5137	
Gas meter correction factor, Y_d	-	1.0590	1.0590	1.0590	
Average dry gas meter temperature, T_m	°C	12.6	14.1	14.5	
Average pressure drop across orifice, ΔH	mmH_2O	31.4	31.6	30.7	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.5466	0.5168	0.5138	
Moisture content, B_{wo} & R_{wv}					
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0533	0.0534	0.0511	
B_{wo} as a percentage	% v/v	5.33	5.34	5.11	
Reported Water Vapour, checked with Tables in BS EN 14790, R_{wv}	% v/v	5.33	5.34	5.11	
Volume of gas metered wet, V_{mstw}					
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.5774	0.5459	0.5415	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$					
WID & 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	20.90	20.90	20.90	
Total	% v/v	20.96	20.96	20.96	
N_2	% v/v	79.04	79.04	79.04	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.85	28.85	28.85	
Molecular weight of stack gas (wet), M_s					
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.27	28.27	28.29	
Velocity of stack gas, V_s					
Pitot tube velocity constant, K_p	-	34.97	34.97	34.97	
Velocity pressure coefficient, C_p	-	0.84	0.84	0.84	
Average of velocity heads, ΔP_{avg}	mmH_2O	3.15	3.25	3.15	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	1.77	1.80	1.77	
Average stack gas temperature, T_s	°C	32.9	31.4	31.3	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	6.25	6.33	6.23	
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	152.6	154.6	152.1	
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	135.1	137.6	135.4	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	127.9	130.2	128.5	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)(O_{2REFw})$	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	7.84	7.84	7.84	
Nozzle area, A_n	mm^2	48.28	48.28	48.28	
Total sampling time, q	min	32	32	32	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	112.6	104.6	105.4	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3	
Sampling Times	-	10:25 - 10:57	11:21 - 11:53	12:10 - 12:42	
Sampling Dates	-	18/10/2011	18/10/2011	18/10/2011	
Sampling Device	-	ISO	ISO	ISO	
Volume Sampled (REF)	m^3	0.5774	0.5459	0.5415	
Filter I.D. Number	-	47-6905	47-6906	47-6907	
Start Filter Mass	g	0.14155	0.14166	0.14200	
End Filter Mass	g	0.14614	0.14299	0.14896	
Total Mass on Filter	g	0.00459	0.00133	0.00696	
Probe Rinse I.D. Number	-	PR-47-6905	PR-47-6906	PR-47-6907	
Start Probe Rinse Mass	g	2.91415	3.08863	3.10650	
End Probe Rinse Mass	g	2.91459	3.08906	3.10736	
Total Mass in Probe Rinse	g	0.00044	0.00043	0.00086	
Total Mass Collected	mg	5.03	1.76	7.82	
Calculated Concentration	mg/m^3	8.71	3.22	14.44	
Balance Uncertainty / LOD	mg/m^3	0.21	0.22	0.22	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	18/10/2011	
Average Volume Sampled (REF)	m^3	0.5549	
Filter I.D. Number	-	47-6904	
Start Filter Mass	g	0.14259	
End Filter Mass	g	0.14285	
Total Mass on Filter	g	0.00026	
Probe Rinse I.D. Number	-	PR-47-6904	
Start Probe Rinse Mass	g	3.14864	
End Probe Rinse Mass	g	3.14876	
Total Mass in Probe Rinse	g	0.00012	
Total Mass Collected	mg	0.38	
Calculated Concentration	mg/m^3	0.68	
Balance Uncertainty / LOD	mg/m^3	0.22	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1	Run 2	Run 3	
Mean Sampling Rate	l/min	17.96	17.07	17.00	
Pre-Sampling Leak Rate	l/min	0.08	0.09	0.12	
Post-Sampling Leak Rate	l/min	0.06	0.10	0.12	
Allowable Leak Rate	l/min	0.36	0.34	0.34	
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)	%	4.9	4.9	4.9	
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	%	112.6	104.6	105.4	
Allowable Isokinetic Range	%	95 - 115	95 - 115	95 - 115	
Isokineticity Acceptable	-	Yes	Yes	Yes	

Balance Uncertainty Criteria (1)	Units	Run 1	Run 2	Run 3	
Balance Uncertainty	± mg	0.12	0.12	0.12	
Balance Uncertainty	± mg/m³	0.21	0.22	0.22	
Daily ELV	mg/m³	15.00	15.00	15.00	
Allowable Balance Uncertainty	± mg/m³	0.75	0.75	0.75	
Balance Uncertainty Acceptable	-	Yes	Yes	Yes	

Balance Uncertainty Criteria (2)	Units	Run 1	Run 2	Run 3	
Balance Uncertainty	± mg	0.12	0.12	0.12	
20 x Balance Uncertainty	mg	2.40	2.40	2.40	
Mass Collected	mg	5.03	1.76	7.82	
Sample Time	mins	32	32	32	
Balance Uncertainty Acceptable	-	N/A	N/A	N/A	

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	33	31	31	

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	15.00	
Pre-Sampling Leak Rate	l/min	0.04	
Post-Sampling Leak Rate	l/min	0.04	
Allowable Leak Rate	l/min	0.30	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	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

Measured Quantities	Value Symbol	Run 1	Run 2	Run 3
Sampled Volume (Actual)	V_m	0.5427	0.5158	0.5137
Sampled Gas Temperature	T_m	285.6	287.1	287.5
Sampled Gas Pressure	p_m	100.5	100.5	100.5
Sampled Gas Humidity	H_m	0.0	0.0	0.0
Leak	L	0.33	0.59	0.71
Mass of Particulate	m	5.03	1.76	7.82
Oxygen Content	$O_{2,m}$	N/A	N/A	N/A
Uncollected Mass	UCM	0.38	0.38	0.38

Standard uncertainty Symbol	Units	Run 1	Run 2	Run 3
uV_m	m^3	0.0109	0.0103	0.0103
uT_m	K	2.0	2.0	2.0
up_m	kPa	0.5	0.5	0.5
uH_m	% v/v	1.0	1.0	1.0
uL	%	-	-	-
um	mg	0.12	0.12	0.12
$uO_{2,m}$	% v/v	N/A	N/A	N/A
uUCM	mg	-	-	-

Measured Quantities	Uncertainty as a Percentage Units	Run 1	Run 2	Run 3	Requirement of Standard
Sampled Volume (Actual)	%	2.00	2.00	2.00	≤2%
Sampled Gas Temperature	%	0.70	0.70	0.70	≤1%
Sampled Gas Pressure	%	0.50	0.50	0.50	≤1%
Sampled Gas Humidity	%	1.00	1.00	1.00	≤1%
Leak	%	0.33	0.59	0.71	≤2%
Mass of Particulate	%	1.39	1.47	1.48	<5% of ELV
Oxygen Content	%	N/A	N/A	N/A	≤5%
Uncollected Mass	%	-	-	-	-

Measured Quantities	Uncertainty in Measurement Units Symbol	Units	Run 1	Run 2	Run 3	Sensitivity Coefficient Run 1	Run 2	Run 3
Sampled Volume (STP)	V_m	m^3	0.5466	0.5168	0.5138	15.94	6.24	28.10
Leak	L	mg/m^3	0.017	0.011	0.059	1.00	1.00	1.00
Mass of Particulate	L_r	mg	5.030	1.760	7.820	1.73	1.83	1.85
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	0.22	0.22	0.22	1.73	1.83	1.85

Measured Quantities	Uncertainty in Result Units	Run 1	Run 2	Run 3
Sampled Volume (STP)	mg/m^3	0.208	0.077	0.346
Leak	mg/m^3	0.0168	0.0109	0.0589
Mass of Particulate	mg/m^3	0.2078	0.2198	0.2216
Factor for O_2 Correction	mg/m^3	N/A	N/A	N/A
Uncollected Mass	mg/m^3	0.3800	0.4019	0.4052

Parameter	Units	Run 1	Run 2	Run 3
Combined uncertainty	mg/m^3	0.48	0.46	0.58
Expanded uncertainty (95% confidence)	mg/m^3	0.94	0.91	1.14
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.94	0.91	1.14
Reported Uncertainty	mg/m^3	0.94	0.91	1.14
Expanded uncertainty (95% confidence)	%	10.8	28.2	7.9
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	10.8	28.2	7.9
Reported Uncertainty	%	10.8	28.2	7.9

HYDROGEN CHLORIDE: RESULTS SUMMARY

Clark-Drain Ltd, Yaxley
Galvansing Plant

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.39		0.39
Uncertainty	±mg/m³	0.06		0.06
Mass Emission	g/hr	3.3		3.3
Uncertainty	±g/hr	0.47		0.47

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	5.33		5.33
Uncertainty	±% v/v	0.26		0.26

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	< 0.03		< 0.03

General Sampling Information

Parameter	Value	
Standard	BS EN 1911	
Technical Procedure	CAT-TP-11	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Impinger Material	Borosilicate Glass	
Absorption Solution	HPLC Grade Water	
Positioning of Filter	In 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	A1, A2, A3, A4	

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	753.8	
Stack static pressure, P_{static}	mmH_2O	1.8	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	753.9	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	16.4	
Total mass collected in impingers (silica trap)	g	8.3	
Total mass of liquid collected, V_{lc}	g	24.7	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0308	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	0.5427	
Gas meter correction factor, Y_d	-	1.0590	
Average dry gas meter temperature, T_m	°C	12.6	
Average pressure drop across orifice, ΔH	mmH_2O	31.4	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.5466	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0533	
B_{wo} as a percentage	% v/v	5.33	
Reported Water Vapour, checked with Tables in BS EN 14790, R_{wv}	% v/v	5.33	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.5774	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
WID & 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	20.90	
Total	% v/v	20.96	
N_2	% v/v	79.04	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.85	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.27	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.84	
Average of velocity heads, ΔP_{avg}	mmH_2O	3.15	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	1.77	
Average stack gas temperature, T_s	°C	32.9	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	6.25	
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	152.6	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	135.1	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	127.9	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)(O_{2REFw})$	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	7.84	
Nozzle area, A_n	mm^2	48.28	
Total sampling time, q	min	32	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	112.6	

HYDROGEN CHLORIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	10:25 - 10:57	
Sampling Dates	-	18/10/2011	
Sampling Device	-	ISO	
Volume Sampled (REF)	m^3	0.5774	
Laboratory Result for Front Impingers	µg/ml	0.73	
Laboratory Result for Back Impinger	µg/ml	0.05	
Volume in Front Impingers	ml	303.1	
Volume in Back Impinger	ml	102.7	
Mass in Front Impingers	µg	221.3	
Mass in Back Impinger	µg	< 5.1	
Total Mass Collected	µg	226.4	
Calculated Concentration	mg/m^3	0.39	

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	18/10/2011	
Average Volume Sampled (REF)	m^3	0.5774	
Laboratory Result for Impingers	µg/ml	< 0.05	
Volume in Impingers	ml	303.7	
Total Mass Collected	µg	< 15.2	
Calculated Concentration	mg/m^3	< 0.03	

HYDROGEN CHLORIDE: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	17.96
Pre-Sampling Leak Rate	l/min	0.08
Post-Sampling Leak Rate	l/min	0.06
Allowable Leak Rate	l/min	0.36
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)	%	4.9
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	%	112.6
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Maximum Filter Temperature	°C	33

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

HYDROGEN CHLORIDE: QUALITY ASSURANCE

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	15.00	
Pre-Sampling Leak Rate	l/min	0.04	
Post-Sampling Leak Rate	l/min	0.04	
Allowable Leak Rate	l/min	0.30	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	N/A	
Blank Acceptable	-	N/A	

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	
There are no deviations associated with the sampling employed.	x			

HYDROGEN CHLORIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	0.5427		uV_m	m^3	0.0109	
Sampled Gas Temperature	T_m	285.6		uT_m	K	2.0	
Sampled Gas Pressure	p_m	100.5		up_m	kPa	0.5	
Sampled Gas Humidity	H_m	0.0		uH_m	% v/v	1.0	
Leak	L	0.33		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	%	0.70		≤1%
Sampled Gas Pressure	%	0.50		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.33		≤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	0.5466		0.72	
Leak	L	mg/m^3	0.0008		1.00	
Laboratory Result	L_r	mg/m^3	0.027		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	0.0093	
Leak	mg/m^3	0.001	
Laboratory Result	mg/m^3	0.027	
Factor for O_2 Correction	mg/m^3	N/A	

Parameter	**Units**	**Run 1**	
Combined uncertainty	mg/m^3	0.03	
Expanded uncertainty (95% confidence)	mg/m^3	0.06	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.06	
Reported Uncertainty	mg/m^3	0.06	
Expanded uncertainty (95% confidence)	%	14.1	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	14.1	
Reported Uncertainty	%	14.1	

LEAD: RESULTS SUMMARY

Clark-Drain Ltd, Yaxley
Galvansing Plant

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3		Mean
Concentration	mg/m³	0.004	0.004	0.004		0.004
Uncertainty	±mg/m³	0.0006	0.0006	0.0006		0.0006
Mass Emission	g/hr	0.03	0.03	0.03		0.03
Uncertainty	±g/hr	0.005	0.005	0.005		0.005

NOTE: Where the maximum Blank concentration is higher than the Sample concentration, the Blank concentration has been reported.

Parameter	Units	Run 1	Run 2	Run 3		Mean
Water Vapour	% v/v	5.33	5.34	5.11		5.26
Uncertainty	±% v/v	0.26	0.26	0.25		0.26

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.004		0.004

General Sampling Information

Parameter	Value	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In 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	A1, A2, A3, A4	

Reference Conditions

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

LEAD: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	Run 2	Run 3	
Absolute pressure of stack gas, P_s					
Barometric pressure, P_b	mmHg	753.8	753.8	753.8	
Stack static pressure, P_{static}	mmH_2O	1.8	1.8	1.8	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	753.9	753.9	753.9	
Volume of water vapour collected, V_{wstd}					
Total mass collected in impingers (liquid trap)	g	16.4	18.0	19.7	
Total mass collected in impingers (silica trap)	g	8.3	5.4	2.5	
Total mass of liquid collected, V_{lc}	g	24.7	23.4	22.2	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0308	0.0292	0.0277	
Volume of gas metered dry, V_{mstd}					
Volume of gas sample through gas meter, V_m	m^3	0.5427	0.5158	0.5137	
Gas meter correction factor, Y_d	-	1.0590	1.0590	1.0590	
Average dry gas meter temperature, T_m	°C	12.6	14.1	14.5	
Average pressure drop across orifice, ΔH	mmH_2O	31.4	31.6	30.7	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.5466	0.5168	0.5138	
Moisture content, B_{wo} & R_{wv}					
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0533	0.0534	0.0511	
B_{wo} as a percentage	% v/v	5.33	5.34	5.11	
Reported Water Vapour, checked with Tables in BS EN 14790, R_{wv}	% v/v	5.33	5.34	5.11	
Volume of gas metered wet, V_{mstw}					
$V_{mstw} = (V_{mste})(100/(100 - R_{wv}))$	m^3	0.5774	0.5459	0.5415	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$					
WID & 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	20.90	20.90	20.80	
Total	% v/v	20.96	20.96	20.86	
N_2	% v/v	79.04	79.04	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.85	28.85	28.84	
Molecular weight of stack gas (wet), M_s					
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.27	28.27	28.29	
Velocity of stack gas, V_s					
Pitot tube velocity constant, K_p	-	34.97	34.97	34.97	
Velocity pressure coefficient, C_p	-	0.84	0.84	0.84	
Average of velocity heads, ΔP_{avg}	mmH_2O	3.15	3.25	3.15	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	1.77	1.80	1.77	
Average stack gas temperature, T_s	°C	32.9	31.4	31.3	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	6.25	6.33	6.23	
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	152.6	154.6	152.1	
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	135.1	137.6	135.4	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	127.9	130.2	128.5	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)(O_{2REFw})$	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	7.84	7.84	7.84	
Nozzle area, A_n	mm^2	48.28	48.28	48.28	
Total sampling time, q	min	32	32	32	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	112.6	104.6	105.4	

LEAD: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3	
Sampling Times	-	10:25 - 10:57	11:21 - 11:53	12:10 - 12:42	
Sampling Dates	-	18/10/2011	18/10/2011	18/10/2011	
Sampling Device	-	ISO	ISO	ISO	
Volume Sampled (REF)	m^3	0.5774	0.5459	0.5415	
Mass on Filter / in Rinse	µg	< 2.00	< 2.00	< 2.00	
Total Mass Collected	µg	< 2.00	< 2.00	< 2.00	
Calculated Concentration	mg/m^3	< 0.0035	< 0.0037	< 0.0037	
Reported Concentration [1]	mg/m^3	0.0036	0.0037	0.0037	
Mass Emission	g/hr	0.03	0.03	0.03	

Where: ISO stands for Manual Isokinetic Sampling Train

BS EN 14385 (Section 9.2.1) states 'If the sample values or blank values are smaller than the detection limit, then the value of ½ detection limit is to be taken for calculation'.

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	18/10/2011	
Average Volume Sampled (REF)	m^3	0.5549	
Lead			
Mass on Filter / in Rinse	µg	< 2.00	
Total Mass Collected	µg	2.00	
Calculated Concentration	mg/m^3	0.0036	
Reported Concentration	mg/m^3	0.0036	

LEAD: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	Run 2	Run 3	
Mean Sampling Rate	l/min	17.96	17.07	17.00	
Pre-Sampling Leak Rate	l/min	0.08	0.09	0.12	
Post-Sampling Leak Rate	l/min	0.06	0.10	0.12	
Allowable Leak Rate	l/min	0.36	0.34	0.34	
Leak Test Acceptable	-	Yes	Yes	Yes	

Detection Limit	Units	Run 1	Run 2	Run 3	
Lead	$\mu g/m^3$	3.5	3.7	3.7	
Allowable Detection Limit	$\mu g/m^3$	0.50	0.50	0.50	
Detection Limit 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)	%	4.9	4.9	4.9	
Allowable MU	%	20	20	20	
MU Acceptable	%	Yes	Yes	Yes	

LEAD: QUALITY ASSURANCE

(PAGE 2 OF 2)

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	%	112.6	104.6	105.4	
Allowable Isokinetic Range	%	95 - 115	95 - 115	95 - 115	
Isokineticity Acceptable	-	Yes	Yes	Yes	

Filter Temperatures	Units	Run 1	Run 2	Run 3	
Maximum Filter Temperature	°C	33	31	31	

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

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	15.00	
Pre-Sampling Leak Rate	l/min	0.04	
Post-Sampling Leak Rate	l/min	0.04	
Allowable Leak Rate	l/min	0.30	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m^3	N/A	
Blank Acceptable	-	N/A	

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 a port cap being stuck, however the number of sample points used on the available line were increased to meet the requirements of the Standard.	x	x	x	

LEAD: 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	0.5427	0.5158	0.5137		uV_m	m^3	0.0109	0.0103	0.0103	
Sampled Gas Temperature	T_m	285.6	287.1	287.5		uT_m	K	2.0	2.0	2.0	
Sampled Gas Pressure	p_m	100.5	100.5	100.5		up_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	0.33	0.59	0.71		uL	%	-	-	-	
Laboratory Result	L_r	8.00	8.00	8.00		uL_r	%	-	-	-	
Oxygen Content	$O_{2,m}$	N/A	N/A	N/A		$uO_{2,m}$	% v/v	N/A	N/A	N/A	

	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	%	0.70	0.70	0.70		≤1%
Sampled Gas Pressure	%	0.50	0.50	0.50		≤1%
Sampled Gas Humidity	%	1.00	1.00	1.00		≤1%
Leak	%	0.33	0.59	0.71		≤2%
Laboratory Result	%	8.00	8.00	8.00		No Requirement
Oxygen Content	%	N/A	N/A	N/A		≤5%

	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	0.5466	0.5168	0.5138		0.01	0.01	0.01	
Leak	L	mg/m^3	7.0E-06	1.2E-05	1.5E-05		1.00	1.00	1.00	
Laboratory Result	L_r	mg/m^3	0.0003	0.0003	0.0003		1.00	1.00	1.00	
Factor for O_2 Correction	$O_{2,m}$	% v/v	N/A	N/A	N/A		N/A	N/A	N/A	

	Uncertainty in Result				
Measured Quantities	Units	Run 1	Run 2	Run 3	
Sampled Volume (STP)	mg/m^3	0.0001	0.0001	0.0001	
Leak	mg/m^3	7.0E-06	1.2E-05	1.5E-05	
Laboratory Result	mg/m^3	0.0003	0.0003	0.0003	
Factor for O_2 Correction	mg/m^3	N/A	N/A	N/A	

Parameter	Units	Run 1	Run 2	Run 3	
Combined uncertainty	mg/m^3	0.0003	0.0003	0.0003	
Expanded uncertainty (95% confidence)	mg/m^3	0.0006	0.0006	0.0006	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.0006	0.0006	0.0006	
Reported Uncertainty	mg/m^3	0.0006	0.0006	0.0006	
Expanded uncertainty (95% confidence)	%	16.4	16.4	16.4	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	16.4	16.4	16.4	
Reported Uncertainty	%	16.4	16.4	16.4	

PCME METER

Contract Details	
Test House Job Number	CAT-0847
Company	**Clark-Drain Ltd**
Site	Yaxley
Stack	Galvansing Plant
Sampling Date	18/10/2011
PCME Job Number	**J31A11946**

Stack Conditions	Value	Units
Stack Temperature	31.9	°C
Stack Humidity	5.3	% v/v
Stack Oxygen Content	N/A	% v/v
Stack Pressure	100.5	kPa

Current Instrument Settings	Type	Serial Number
Controller Type	IM	34304
Channel Type	DT373	3403
Channel Number	1	
Instrument Checks	Pass	
Current Calibration Factor	4.29	
Time on Display	11:18	
Time for Report (ISO)	11:32	
GMT / BST?	BST	
Was Time Changed?	No	

Hardware Status	
Zero	2
Span	10004
S/C	10018
Contamination Ring	-
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	10:25	10:57	9.30	9.88	8.71	9.20	N/A	N/A	7.74
2	11:21	11:53	9.45	10.06	3.22	3.41	N/A	N/A	2.86
3	12:10	12:42	9.24	10.40	14.44	15.22	N/A	N/A	12.83
Mean			**9.33**		**8.79**	**9.28**	**N/A**	**N/A**	**7.81**

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