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Stack Emissions Testing Report Commissioned by
 Envea UK Ltd

Installation Name & Address

Clark-Drain Ltd
 Station Road
 Yaxley
 Peterborough
 Cambridgeshire
 PE7 3EQ

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

Stack Reference
 Galvanising Plant

Dates of the Monitoring Campaign
 11th March 2019

Job Reference Number
 CAT-4778

Report Written by
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Executive Summary

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MONITORING OBJECTIVES

Clark-Drain Ltd, Yaxley
Galvanising Plant
11th March 2019

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Envea UK Ltd to carry out stack emissions testing for Clark-Drain Ltd on the Galvanising Plant 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.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter

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MONITORING RESULTS

Clark-Drain Ltd, Yaxley
Galvanising Plant
11th March 2019

where MU = Measurement Uncertainty associated with the Result

Parameter	Concentration				Mass Emission			
	Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Total Particulate Matter ¹	mg/m ³	6.0	0.56	15	g/hr	79.2	8.4	-
Water Vapour	% v/v	2.5	0.13					
Stack Gas Temperature	°C	22.9						
Stack Gas Velocity	m/s	9.7	0.18					
Volumetric Flow Rate (ACTUAL)	m ³ /hr	14265	695					
Volumetric Flow Rate (REF)	m ³ /hr	13239	645					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM AN AVERAGE OF ALL OF THE ISOKINETIC RUNS.

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

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MONITORING DATE(S) & TIMES

Clark-Drain Ltd, Yaxley
Galvanising Plant
11th March 2019

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m ³	2.8	g/hr	37.5	11/03/2019	09:45 - 10:15, 10:16 - 10:46	60
Total Particulate Matter	R2	mg/m ³	8.3	g/hr	110	11/03/2019	10:50 - 11:20, 11:21 - 11:51	60
Total Particulate Matter	R3	mg/m ³	6.8	g/hr	89.7	11/03/2019	12:00 - 12:30, 12:31 - 13:01	60
Velocity Traverse	R1					11/03/2019	09:35 - 09:42	

All results are expressed at the respective reference conditions.

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PROCESS DETAILS

Clark-Drain Ltd, Yaxley
Galvanising Plant
11th March 2019

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	100% of Capacity
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

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MONITORING & ANALYTICAL METHODS

Clark-Drain Ltd, Yaxley

Galvanising Plant

11th March 2019

Parameter	Monitoring				Analysis				MCERTS Testing	LOD (Average)
	Standard	Technical Procedure	ISO 17025 Testing	Testing Lab	Analytical Procedure	Analytical Technique	ISO 17025 Analysis	Analysis Lab		
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	CAT	CAT-TP-03	Gravimetric	Yes	CAT	Yes	0.19 mg/m ³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.1 % v/v
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	CAT	Pitot Tube and Thermocouple				Yes	1.2 m/s

ANALYSIS LABORATORIES

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

Exova Catalyst (CAT)	ISO 17025 Accreditation Number: 4279
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SUMMARY OF SAMPLING DEVIATIONS

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

Executive Summary

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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
Number of Ports	-	3
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 / 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	Yes
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 EN 15259.

EN 15259 Homogeneity Test Requirements

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

Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	78.9	> 5 Pa	Yes
Mean Velocity	m/s	9.71	-	-
Lowest Gas Velocity	m/s	9.56	-	-
Highest Gas Velocity	m/s	9.83	-	-
Ratio of Above	: 1	1.03	< 3 : 1	Yes
Maximum Angle of Swirl	°	0.00	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

Executive Summary

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PLANT PHOTOS

Photo 1



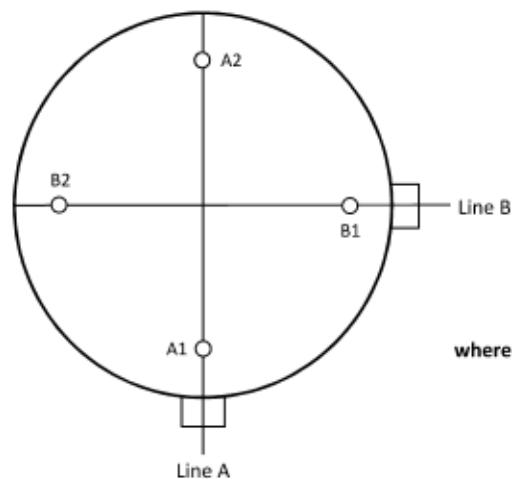
Photo 2



Photo 3



SAMPLE POINTS



where

- = isokinetic point sampled at
- = isokinetic point not sampled at
- = combustion gases sample point
- = non-isokinetic sample point

APPENDICES

APPENDIX CONTENTS

APPENDIX 1 - Stack Emissions Monitoring Personnel, List of Equipment & Methods and Technical Procedures Used

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

APPENDIX 3 - PCME Meter

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	David Burns	MCERTS Level 2	MM 05 579	TE1 TE2 TE3 TE4
Technician	Lee Heaton	MCERTS Level 1	MM 18 1433	None

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 7.58	Horiba PG-350E	-	Digital Manometer (1)	CAT 3.143
Control Box DGM (2)	-	Horiba PG-250	-	Digital Manometer (2)	CAT 3.145
Box Thermocouples (1)	CAT 3.148	Servomex 4900	-	Digital Temperature Meter	-
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	CAT 14.86
Umbilical (1)	CAT 3.148	ABB AO2020-URAS26	-	Barometer	CAT 13.41
Umbilical (2)	-	Servomex 5200MP	-	Stack Thermocouple (1)	-
Oven Box (1)	CAT 12.201	Ankersmid APS 313	-	Stack Thermocouple (2)	CAT 4.1041
Oven Box (2)	-	Gasmeter DX4000	-	Stack Thermocouple (3)	-
Heated Probe (1)	-	Gasmeter Sampling System	-	1m Heated Line (1)	-
Heated Probe (2)	CAT 5.130	Bernath 3006 FID	-	1m Heated Line (2)	-
Heated Probe (3)	-	M&C PSS	-	1m Heated Line (3)	-
S-Pitot (1)	CAT 21P.97	Mass Flow Controller (1)	-	5m Heated Line (1)	-
S-Pitot (2)	CAT 21S.56	Mass Flow Controller (2)	-	15m Heated Line (1)	-
L-Pitot	-	Mass View (1)	-	20m Heated Line (1)	-
Site Balance	CAT 17.38	Mass View (2)	-	20m Heated Line (2)	-
500g / 1Kg Check Weights	CAT 17.38	Hioki 5043 (V)	-	Dual Channel Heater Controller	-
Last Impinger Arm	CAT 4.902/4.903	Easylogger EN-EL-12 Bit	-	Single Channel Heater Controller	-
Callipers	CAT 23.41	Bioaerosols Temperature Logger	-	Laboratory Balance	CAT 1.18 / 1.18a
Tubes Kit Thermocouple	-	Electronic Refrigerator	-	Tape Measure	CAT 16.49

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
Water Vapour	EN 14790	CAT-TP-05
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

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	22.0
Average Stack Gas Pressure	Pa	81.4
Average Stack Static Pressure, P _{static}	kPa	0.253
Average Barometric Pressure, P _b	kPa	101.7
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	20.29	0.2080	32.00	1.4277	0.29696
N ₂	-	79.14	77.19	0.7914	28.01	1.2498	0.98913
Moisture (H ₂ O)	-	-	2.46	0.0246	18.02	0.8037	0.01976

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	1.275
Dry Density (Actual), P _{Actual}	kg/m ³	1.199
Average Wet Density (Actual), P _{ActualW}	kg/m ³	1.188

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	22.0	0.0
Total Pressure	kPa	102.0	101.3
Moisture	%	2.46	2.46

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m ³ /hr	14232
Gas Volumetric Flowrate (STP, Wet)	m ³ /hr	13255
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	12929
Gas Volumetric Flowrate REF ¹	m ³ /hr	13255

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID)

(1 of 1)

Parameter	Units	Value
Date of Survey	-	11/03/2019
Time of Survey	-	09:35 - 09:42
Atmospheric Pressure	kPa	101.7
Average Stack Static Pressure	Pa	253
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 210 (500Pa)	

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	-	2

Sampling Line A							Sampling Line B				
Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m ³	Velocity m/s	Swirl °	ΔP Pa	Temp °C	Wet Density kg/m ³	Velocity m/s	Swirl °
STATIC (Units: Pa)		252.0					254.0				
Mean		81.8	22.0	1.188	9.73		81.0	22.0	1.188	9.68	
1	0.11	83.5	22.0	1.188	9.83	0.0	78.9	22.0	1.188	9.56	0.0
2	0.61	80.1	22.0	1.188	9.63	0.0	83.1	22.0	1.188	9.81	0.0

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID) - MEASUREMENT UNCERTAINTY

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	$u(k)$	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	$u(\Delta p_i)$	1.704	Pa
- Resolution	$u(res)$	0.00087	
- Calibration	$u(cal)$	0.690	
- Drift	$u(drift)$	0.083	
- Lack of Fit	$u(fit)$	1.130	
- Overall corrections to dynamic measurements	$u(C_f)$	1.904	
Standard uncertainty associated with the molar mass of the gas	$u(M)$	0.00003	-
- $\phi_{O_2,w}$	-	20.289	
- $\phi_{CO_2,w}$	-	0.059	
- Oxygen, dry	$u(\phi_{O_2,d})$	0.637	
- Carbon Dioxide, dry	$u(\phi_{CO_2,d})$	0.002	
- Water Vapour	$u(\phi_{H_2O})$	0.125	
- Oxygen, wet	$u(\phi_{O_2,w})$	0.622	
- Carbon Dioxide, wet	$u(\phi_{CO_2,w})$	0.002	
Standard uncertainty associated with the stack temperature	$u(T_c)$	1.505	K
Standard uncertainty associated with the absolute pressure in the duct	$u(p_c)$	175.696	Pa
- Atmospheric Pressure	$u(p_{atm})$	175.692	
- Static Pressure	$u(p_{stat})$	1.205	
Standard uncertainty associated with the density in the duct	$u(\rho)$	0.00640	-
Standard uncertainty associated with the local velocities	$u(v_i)$	0.126	Pa
Standard uncertainty associated with the mean velocity	$u(v)$	0.089	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	$U_c(v)$	0.175	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	$U_{c,rel}(v)$	1.81	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	$U_c(qV,w)$	693.6	m ³ /hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00062	
- $u^2(qV,w)$	-	125213	
- $u(qV,w)$	-	353.9	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	$U_{c,rel}(qV,w)$	4.87	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Clark-Drain Ltd, Yaxley
Galvanising Plant

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3		Mean
Concentration	mg/m ³	2.8	8.3	6.8		6.0
Uncertainty	±mg/m ³	0.49	0.61	0.58		0.56
Mass Emission	g/hr	37.5	110	89.7		79.2
Uncertainty	±g/hr	6.7	9.7	8.8		8.4

Parameter	Units	Run 1	Run 2	Run 3		Mean
Water Vapour	% v/v	2.3	3.0	2.1		2.5
Uncertainty	±% v/v	0.12	0.15	0.11		0.13

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m ³	0.26		0.26

General Sampling Information

Parameter	Value	
Standard	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	2 / 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, B1 & B2	

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	762.8	762.8	762.8	
Stack static pressure, P_{static}	mmH ₂ O	23.9	23.9	23.9	
$P_s = (P_b + (P_{static} / 13.6))$	mmHg	764.5	764.5	764.5	
Volume of water vapour collected, V_{wstd}					
Total mass collected in impingers (liquid trap)	g	6.2	11.1	9.2	
Total mass collected in impingers (silica trap)	g	10.3	11.2	6.3	
Total mass of liquid collected, V_{lc}	g	16.5	22.3	15.5	
$V_{wstd} = (0.001246)(V_{lc})$	m ³	0.0206	0.0278	0.0193	
Volume of gas metered dry, V_{mstd}					
Volume of gas sample through gas meter, V_m	m ³	0.9120	0.9310	0.9120	
Gas meter correction factor, Y_d	-	1.0110	1.0110	1.0110	
Average dry gas meter temperature, T_m	°C	11.4	13.2	12.9	
Average pressure drop across orifice, ΔH	mmH ₂ O	25.1	24.6	24.6	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m ³	0.8904	0.9033	0.8856	
Moisture content, B_{wo} & R_{wv}					
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m ³	0.0226	0.0298	0.0213	
B_{wo} as a percentage	% v/v	2.26	2.98	2.13	
Reported Water Vapour, checked with Tables in EN 14790, R_{wv}	% v/v	2.26	2.98	2.13	
Volume of gas metered wet, V_{mstw}					
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m ³	0.9109	0.9311	0.9050	
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	28.60	28.52	28.61	
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 ₂ O	8.20	8.02	8.03	
Average square root of velocity heads, $\sqrt{\Delta P}$	√mmH ₂ O	2.86	2.83	2.83	
Average stack gas temperature, T_s	°C	22.0	22.7	24.0	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(V_{Ts} + 273)) / (V(M_s)(P_s))$	m/s	9.78	9.70	9.71	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} ($Q_{stw@O_2}$), Dry@O_{2REF} ($Q_{std@O_2}$)					
Area of stack, A_s	m ²	0.41	0.41	0.41	
$Q_a = (60)(A_s)(V_s)$	m ³ /min	239.0	236.9	237.3	
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	222.5	220.0	219.4	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m ³ /min	217.5	213.5	214.7	
$Q_{stw@O_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m ³ /min	N/A	N/A	N/A	
$Q_{std@O_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m ³ /min	N/A	N/A	N/A	
Percent isokinetic, %I					
Nozzle diameter, D_n	mm	5.96	5.96	5.96	
Nozzle area, A_n	mm ²	27.93	27.93	27.93	
Total sampling time, q	min	60	60	60	
$\%I = (4.6398E^6)(T_s + 273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	99.5	102.8	100.2	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	09:45 - 10:15, 10:16 - 10:46	10:50 - 11:20, 11:21 - 11:51	12:00 - 12:30, 12:31 - 13:01
Sampling Dates	-	11/03/2019	11/03/2019	11/03/2019
Sampling Device	-	ISO	ISO	ISO
Volume Sampled (REF)	m ³	0.9109	0.9311	0.9050
Filter I.D. Number	-	47-59539	47-59540	47-59541
Start Filter Mass	g	0.14663	0.14699	0.14676
End Filter Mass	g	0.14896	0.15466	0.15141
Total Mass on Filter	g	0.00233	0.00767	0.00465
Probe Rinse I.D. Number	-	PR-47-59539	PR-47-59540	PR-47-59541
Start Probe Rinse Mass	g	3.02283	3.33493	3.15336
End Probe Rinse Mass	g	3.02309	3.33502	3.15484
Total Mass in Probe Rinse	g	0.00025	0.00009	0.00148
Total Mass Collected	mg	2.58	7.76	6.13
Calculated Concentration	mg/m ³	2.83	8.33	6.77
Balance Uncertainty / LOD	mg/m ³	0.19	0.18	0.19

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	11/03/2019
Average Volume Sampled (REF)	m ³	0.9157
Filter I.D. Number	-	47-59556
Start Filter Mass	g	0.14806
End Filter Mass	g	0.14818
Total Mass on Filter	g	0.00012
Probe Rinse I.D. Number	-	PR-47-59556
Start Probe Rinse Mass	g	2.98296
End Probe Rinse Mass	g	2.98308
Total Mass in Probe Rinse	g	0.00012
Total Mass Collected	mg	0.24
Calculated Concentration	mg/m ³	0.26
Balance Uncertainty / LOD	mg/m ³	0.19

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	Run 2	Run 3	
Mean Sampling Rate	l/min	15.4	15.7	15.4	
Pre-Sampling Leak Rate	l/min	0.10	0.10	0.10	
Post-Sampling Leak Rate	l/min	0.10	0.10	0.10	
Allowable Leak Rate	l/min	0.31	0.31	0.31	
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)	%	5.1	5.1	5.2	
Allowable MU	%	20.0	20.0	20.0	
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	%	99.5	102.8	100.2	
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	0.32	0.32	0.32	
Overall Weighing Uncertainty	± mg/m ³	0.35	0.34	0.35	
ELV [Daily ELV for IED]	mg/m ³	15.00	15.00	15.00	
Allowable Weighing Uncertainty	mg/m ³	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	22	24	24	
Test Conditions	Units	Run 1	Run 2	Run 3	
Ambient Temperature Recorded?	-	Yes	Yes	Yes	

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	25.0	
Pre-Sampling Leak Rate	l/min	0.10	
Post-Sampling Leak Rate	l/min	0.10	
Allowable Leak Rate	l/min	0.50	
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	Run Number			
	1	2	3	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)				
There are no deviations associated with the sampling employed.	wx	wx	wx	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value				Standard uncertainty				
	Symbol	Run 1	Run 2	Run 3	Symbol	Units	Run 1	Run 2	Run 3
Sampled Volume (Actual)	V _m	0.9120	0.9310	0.9120	uV _m	m ³	0.0182	0.0186	0.0182
Sampled Gas Temperature	T _m	284.4	286.2	285.9	uT _m	K	2.0	2.0	2.0
Sampled Gas Pressure	p _m	101.9	101.9	101.9	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	0.65	0.64	0.65	uL	%	-	-	-
Mass of Particulate	m	2.58	7.76	6.13	um	mg	0.17	0.17	0.17
Uncollected Mass	UCM	0.24	0.24	0.24	uUCM	mg	-	-	-

Measured Quantities	Uncertainty as a Percentage				Requirement of Standard
	Units	Run 1	Run 2	Run 3	
Sampled Volume (Actual)	%	2.00	2.00	2.00	≤2%
Sampled Gas Temperature	%	0.70	0.70	0.70	≤1%
Sampled Gas Pressure	%	0.49	0.49	0.49	≤1%
Sampled Gas Humidity	%	1.00	1.00	1.00	≤1%
Leak	%	0.65	0.64	0.65	≤2%
Mass of Particulate	%	1.24	1.22	1.25	<5% of ELV
Uncollected Mass	%	-	-	-	-

Measured Quantities	Uncertainty in Measurement Units					Sensitivity Coefficient		
	Symbol	Units	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Sampled Volume (STP)	V _m	m ³	0.8904	0.9033	0.8856	3.18	9.22	7.65
Leak	L	mg/m ³	0.011	0.031	0.025	1.00	1.00	1.00
Mass of Particulate	L _r	mg	2.580	7.757	6.130	1.10	1.07	1.11
Uncollected Mass	UCM	mg	0.14	0.14	0.14	1.10	1.07	1.11

Measured Quantities	Uncertainty in Result			
	Units	Run 1	Run 2	Run 3
Sampled Volume (STP)	mg/m ³	0.069	0.204	0.166
Leak	mg/m ³	0.0106	0.0307	0.0254
Mass of Particulate	mg/m ³	0.1866	0.1826	0.1879
Uncollected Mass	mg/m ³	0.1500	0.1468	0.1510

Measured Quantities	Oxygen Correction Part of MU Budget			
	Units	Run 1	Run 2	Run 3
O ₂ Correction Factor	-	N/A	N/A	N/A
Stack Gas O ₂ Content	% v/v	N/A	N/A	N/A
MU for O ₂ Correction	-	N/A	N/A	N/A
Overall MU For O ₂ Measurement	%	N/A	N/A	N/A

Parameter	Units	Run 1	Run 2	Run 3
Combined uncertainty	mg/m ³	0.25	0.31	0.29
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m ³	0.49	0.61	0.58
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m ³	N/A	N/A	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	0.49	0.61	0.58
Reported Uncertainty	mg/m ³	0.49	0.61	0.58
Expanded uncertainty (95% confidence), without Oxygen Correction	%	17.3	7.3	8.5
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	N/A	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	17.3	7.3	8.5
Reported Uncertainty	%	17.3	7.3	8.5

PCME METER

Contract Details	
Test House Job Number	CAT-4778
Company	Clark-Drain Ltd
Site	Yaxley
Stack	Galvanising Plant
Sampling Date	11/03/2019
PCME Job Number	20023916

Stack Conditions	Value	Units
Stack Temperature	22.9	°C
Stack Humidity	2.5	% v/v
Stack Oxygen Content	N/A	% v/v
Stack Pressure	102	kPa

Current Instrument Settings	Type	Serial Number
Controller Type	IM	34304
Channel Type	DT373	34803
Channel Number	Stack 1	
Instrument Checks	Pass	
Current Calibration Factor	9.132	
Time on Display	10:12	
Time Difference - Meter v Actual	00:00	
GMT / BST?	GMT	
Was Time Changed?	No	

Hardware Status	
Zero	8
Span	10065
S/C	10068
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	09:45	10:46	2.61	10.62	2.83	2.90	N/A	N/A	2.63
2	10:50	11:51	8.95	192.10	8.33	8.59	N/A	N/A	7.73
3	12:00	13:01	4.55	38.37	6.77	6.92	N/A	N/A	6.29
Mean			5.37		5.98	6.14	N/A	N/A	5.55

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.