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Stack Emissions Testing Report Commissioned by
Dunlop Oil & Marine Ltd

Installation Name & Address
Dunlop Oil & Marine Ltd
Moody Lane
Pyewipe
Grimsby
DN31 2SY

PPC Permit: EP/200200004/V1

Stack Reference
Donaldson Extract Unit

Dates of the Monitoring Campaign
9th October 2019

Job Reference Number
ERO-2406

Report Written by
Gary Thackray Technical Manager MCERTS Level 2 MM 02 078 TE1 TE2 TE3 TE4

Report Approved by
Scott Pilkington Deputy Regional Manager MCERTS Level 2 MM 04 501 TE1 TE2 TE3 TE4

Report Date
30th October 2019

Version
Version 1

Signature of Report Approver


CONTENTS

Opinions and interpretations expressed herein are outside the scope of Element's ISO 17025 accreditation.

MONITORING OBJECTIVES

Dunlop Oil & Marine Ltd, Grimsby
Donaldson Extract Unit
9th October 2019

Overall Aim of the Monitoring Campaign

Element were commissioned by Dunlop Oil & Marine Ltd to carry out stack emissions testing on the Donaldson Extract Unit at Grimsby.

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

There were no special requirements.

Target Parameters

Total Particulate Matter

Executive Summary

MONITORING RESULTS

Dunlop Oil & Marine Ltd, Grimsby
Donaldson Extract Unit
9th October 2019

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	0.80	0.79	50	g/hr	13.7	13.9	-
Water Vapour	% v/v	0.91	0.05					
Stack Gas Temperature	°C	23.2						
Stack Gas Velocity	m/s	10.9	2.3					
Volumetric Flow Rate (ACTUAL)	m³/hr	18855	4136					
Volumetric Flow Rate (REF) [1]	m³/hr	17182	3769					

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.

MONITORING DATE(S) & TIMES

Dunlop Oil & Marine Ltd, Grimsby
Donaldson Extract Unit
9th October 2019

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	0.80	g/hr	13.7	09/10/2019	13:40 - 14:40	60
Velocity Traverse	R1					09/10/2019	13:40 - 13:45	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Dunlop Oil & Marine Ltd, Grimsby
Donaldson Extract Unit
9th October 2019

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	100 % Capacity
Continuous or Batch Process	Continuous
Feedstock (if applicable)	N/A
Abatement System	Bag Filter
Abatement System Running Status	On
Fuel	N/A
Plume Appearance	No Plume Visible

MONITORING & ANALYTICAL METHODS

Dunlop Oil & Marine Ltd, Grimsby
Donaldson Extract Unit
9th October 2019

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**ISO 17025 Testing**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**ISO 17025 Analysis**	**Analysis Lab**	**MCERTS Testing**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	CAT-TP-01	Yes	EET	CAT-TP-03	Gravimetric	Yes	EET	Yes	0.18 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	EET	CAT-TP-05	Gravimetric	Yes	EET	Yes	0.1 % v/v
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	EET	Pitot Tube and Thermocouple				Yes	1.8 m/s

ANALYSIS LABORATORIES

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

Element Stockport (EET)	ISO 17025 Accreditation Number: 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Total Particulate Matter	All Runs	End of pipe sampling was necessary as there were no sampling ports installed on the stack.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Rectangular
Depth	m	0.80
Width	m	0.60
Area	m^2	0.48
Port Depth	cm	0
Orientation of Duct	-	Vertical
Number of Ports	-	Grid
Sample Port Size	-	Hole

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	MEWP
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)	N/A
Platform has vertical base boards (approx. 0.25m high)	N/A
Platform has chains / self closing gates at top of ladders	N/A
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	98.1	> 5 Pa	Yes
Mean Velocity	m/s	10.8	-	-
Lowest Gas Velocity	m/s	10.8	-	-
Highest Gas Velocity	m/s	10.8	-	-
Ratio of Above	: 1	1.0	< 3 : 1	Yes
Maximum Angle of Swirl	°	5.0	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

PLANT PHOTOS

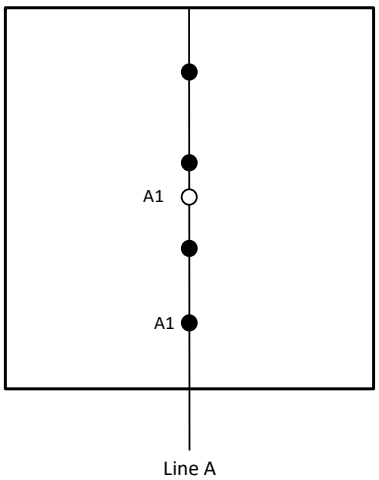
Photo 1

Photo 2

Photo 3

Photo 4

SAMPLE POINTS



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

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Gary Thackray	MCERTS Level 2	MM 02 078	TE1 TE2 TE3 TE4
Technician	Greg Clough	MCERTS Level 1	MM 18 1505	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.59
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.157
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.157
Umbilical (2)	-
Oven Box (1)	CAT 12.56
Oven Box (2)	-
Heated Probe (1)	CAT 5.132
Heated Probe (2)	-
Heated Probe (3)	-
S-Pitot (1)	CAT 21p.159
S-Pitot (2)	CAT 21s.58
L-Pitot	-
Site Balance	CAT 17.35
500g / 1Kg Check Weights	CAT 17.35
Last Impinger Arm	CAT 4.888
Callipers	CAT 23.34
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	-
Horiba PG-250 SRM	-
Servomex 5200 MP	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	-
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	-
M&C PSS	-
Mass Flow Controller (1)	-
Mass Flow Controller (2)	-
Mass View (1)	-
Mass View (2)	-
Hioki 5031 (mA)	-
Hioki 5043 (V)	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.154
Digital Manometer (2)	CAT 3.156
Digital Temperature Meter	CAT 3.154
Stopwatch	CAT 14.53
Barometer	CAT 13.42
Stack Thermocouple (1)	-
Stack Thermocouple (2)	-
Stack Thermocouple (3)	CAT 4.875
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	-
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18, 1.18a, 1.18b
Tape Measure	CAT 16.01

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	0.80
Stack Width, W	m	0.60
Stack Area, A	m^2	0.48
Average Stack Gas Temperature, T_a	°C	23.0
Average Stack Gas Pressure	mmH_2O	10.0
Average Stack Static Pressure, P_{static}	kPa	0.080
Average Barometric Pressure, P_b	kPa	100.1
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

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	20.61	0.2080	32.00	1.4277	0.29696
N_2	-	79.14	78.42	0.7914	28.01	1.2498	0.98913
Moisture (H_2O)	-	-	0.91	0.0091	18.02	0.8037	0.00735

Where: p = M / 22.41

p_i = r x 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	1.283
Dry Density (Actual), P_{Actual}	kg/m³	1.174
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	1.170

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	23.0	0.0
Total Pressure	kPa	100.2	101.3
Moisture	%	0.91	0.91

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	18688
Gas Volumetric Flowrate (STP, Wet)	m³/hr	17046
Gas Volumetric Flowrate (STP, Dry)	m³/hr	16890
Gas Volumetric Flowrate REF [1]	m³/hr	17046

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	09/10/2019
Time of Survey	-	13:40 - 13:45
Atmospheric Pressure	kPa	100.1
Average Stack Static Pressure	Pa	80
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with Liquid Incline Manometer	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	1
Number of Lines Used	-	1

Sampling Line A

Traverse Point	Depth m	ΔP mmH_2O	Temp °C	Wet Density kg/m^3	Velocity m/s	Swirl °
STATIC (Units: Pa)		*80.0*				
Mean		**10.0**	**23.0**	**1.170**	**10.81**	
1	0.40	10.0	23.0	1.170	10.81	5.0

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(Δpi)	2.186	Pa
- Resolution	u(res)	0.52154	
- Calibration	u(cal)	1.001	
- Drift	u(drift)	1.096	
- Lack of Fit	u(fit)	1.159	
- Overall corrections to dynamic measurements	u(Cf)	3.778	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- $\varphi O_2,w$	-	20.610	
- $\varphi CO_2,w$	-	0.059	
- Oxygen, dry	u(ϕO_2,d)	0.637	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.047	
- Oxygen, wet	u(ϕO_2,w)	0.631	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.510	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.706	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	2.186	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00631	-
Standard uncertainty associated with the local velocities	u(vi)	1.184	Pa
Standard uncertainty associated with the mean velocity	u(v)	1.184	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	2.321	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	21.46	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	4099.6	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.01253	
- $u^2(qV,w)$	-	4374965	
- $u(qV,w)$	-	2091.6	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	21.94	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Dunlop Oil & Marine Ltd, Grimsby
Donaldson Extract Unit

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.80		0.80
Uncertainty	±mg/m³	0.79		0.79
Mass Emission	g/hr	13.7		13.7
Uncertainty	±g/hr	13.9		13.9

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	0.91		0.91
Uncertainty	±% v/v	0.05		0.05

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.35		0.35

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	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

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

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1
Absolute pressure of stack gas, P_s		
Barometric pressure, P_b	mmHg	750.8
Stack static pressure, P_{static}	mmH_2O	8.2
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	751.4
Volume of water vapour collected, V_{wstd}		
Total mass collected in impingers (liquid trap)	g	3.0
Total mass collected in impingers (silica trap)	g	4.1
Total mass of liquid collected, V_{lc}	g	7.1
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0088
Volume of gas metered dry, V_{mstd}		
Volume of gas sample through gas meter, V_m	m^3	1.0650
Gas meter correction factor, Y_d	-	0.9640
Average dry gas meter temperature, T_m	°C	16.9
Average pressure drop across orifice, ΔH	mmH_2O	32.7
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.9580
Moisture content, B_{wo} & R_{wv}		
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0091
B_{wo} as a percentage	% v/v	0.91
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	0.91
Volume of gas metered wet, V_{mstw}		
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	0.9669
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	28.74
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	10.13
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	3.18
Average stack gas temperature, T_s	°C	23.2
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	10.91
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	0.48
$Q_a = (60)(A_s)(V_s)$	m^3/min	314.2
Conversion factor (K/mm.Hg), C_f	-	0.3592
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	286.4
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	283.7
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	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	5.89
Nozzle area, A_n	mm^2	27.25
Total sampling time, q	min	60
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	99.1

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	13:40 - 14:40
Sampling Dates	-	09/10/2019
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	0.9669
Filter I.D. Number	-	47-64962
Start Filter Mass	g	0.14604
End Filter Mass	g	0.14620
Total Mass on Filter	g	0.00016
Probe Rinse I.D. Number	-	PR-47-64962
Start Probe Rinse Mass	g	2.58539
End Probe Rinse Mass	g	2.58600
Total Mass in Probe Rinse	g	0.00061
Total Mass Collected	mg	0.77
Calculated Concentration	mg/m^3	0.80
Balance Uncertainty / LOD	mg/m^3	0.18

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	09/10/2019
Average Volume Sampled (REF)	m^3	0.9669
Filter I.D. Number	-	47-64961
Start Filter Mass	g	0.14511
End Filter Mass	g	0.14523
Total Mass on Filter	g	0.00012
Probe Rinse I.D. Number	-	PR-47-64961
Start Probe Rinse Mass	g	2.64575
End Probe Rinse Mass	g	2.64597
Total Mass in Probe Rinse	g	0.00022
Total Mass Collected	mg	0.34
Calculated Concentration	mg/m^3	0.35
Balance Uncertainty / LOD	mg/m^3	0.18

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	17.1
Pre-Sampling Leak Rate	l/min	0.20
Post-Sampling Leak Rate	l/min	0.20
Allowable Leak Rate	l/min	0.40
Leak Test Acceptable	-	Yes

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.6
Allowable MU	%	20.0
MU Acceptable	%	Yes

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

Isokinetic Criterion Compliance	Units	Run 1
Isokinetic Variation	%	99.1
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Weighing Uncertainty Criteria	Units	Run 1
Overall Weighing Uncertainty	± mg	0.32
Overall Weighing Uncertainty	± mg/m³	0.33
ELV [Daily ELV for IED]	mg/m³	50.00
Allowable Weighing Uncertainty	mg/m³	2.50
Weighing Uncertainty Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Pre-Conditioning Temperature	°C	180
Post-Conditioning Temperature	°C	160
Maximum Filter Temperature	°C	24

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	20.0
Pre-Sampling Leak Rate	l/min	0.20
Allowable Leak Rate	l/min	0.40
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m^3	5.0
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	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1	
End of pipe sampling was necessary as there were no sampling ports installed on the stack.	x	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**	**Symbol**	**Units**	**Run 1**
Sampled Volume (Actual)	V_m	1.0650	uV_m	m^3	0.0213
Sampled Gas Temperature	T_m	289.9	uT_m	K	2.0
Sampled Gas Pressure	ρ_m	100.2	$u\rho_m$	kPa	0.5
Sampled Gas Humidity	H_m	0.0	uH_m	% v/v	1.0
Leak	L	1.17	uL	%	-
Mass of Particulate	m	0.77	um	mg	0.17
Uncollected Mass	UCM	0.34	uUCM	mg	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.69	≤1%
Sampled Gas Pressure	%	0.50	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	1.17	≤2%
Mass of Particulate	%	0.35	<5% of ELV
Uncollected Mass	%	-	-

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m^3	0.9580	0.83
Leak	L	mg/m^3	0.005	1.00
Mass of Particulate	L_r	mg	0.770	1.03
Uncollected Mass	UCM	mg	0.20	1.03

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m^3	0.021
Leak	mg/m^3	0.0054
Mass of Particulate	mg/m^3	0.1758
Uncollected Mass	mg/m^3	0.2030

	Oxygen Correction Part of MU Budget	
Measured Quantities	**Units**	**Run 1**
O_2 Correction Factor	-	N/A
Stack Gas O_2 Content	% v/v	N/A
MU for O_2 Correction	-	N/A
Overall MU For O_2 Measurement	%	N/A

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	0.27
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.53
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.79
Reported Uncertainty	mg/m^3	0.79
Expanded uncertainty (95% confidence), without Oxygen Correction	%	66.3
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	99.5
Reported Uncertainty	%	99.5