



Element Materials Technology, Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL  
Your Element Contact: Scott Pilkington (07825 991 537)  
E: scott.pilkington@element.com

**Stack Emissions Testing Report Commissioned by**  
Blazers Fuel

**Installation Name & Address**

North West Biomass  
North West Biomass Ltd  
Kinmel Bay  
Tir Liwyd Industrial Estate  
Rhyl  
North Wales  
LL18 5JA

**Stack Reference**

Stela Drying Stack 1

**Dates of the Monitoring Campaign**

23rd April 2021

**Job Reference Number**

EMT00712

**Report Written by**

Michael biagioni  
Team Leader  
MCERTS Level 2  
MM 17 1444  
TE1 TE3 TE4

**Report Approved by**

Tom Buller  
Team Leader  
MCERTS Level 2  
MM17 1415  
TE1 TE2 TE3 TE4

**Report Date**

7th May 2021

**Version**

Version 1

**Signature of Report Approver**



## CONTENTS

TITLE PAGE

CONTENTS

EXECUTIVE SUMMARY

Monitoring Objectives	3
Monitoring Results	4
Monitoring Dates & Times	5
Process Details	6
Monitoring & Analytical Methods	7
Summary of Sampling Deviations	7
Sampling Location	8
Plant Photos / Sample Points	9

APPENDIX 1 - Monitoring Personnel & List of Equipment

APPENDIX 2 - Raw Data, Sampling Equations & Charts

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

*This test report shall not be reproduced, except in full, without the written approval of Element.*

## Executive Summary

(Page 1 of 7)

### MONITORING OBJECTIVES

North West Biomass, Kinmel Bay

Stela Drying Stack 1

23rd April 2021

#### Overall Aim of the Monitoring Campaign

Element were commissioned by Blazers Fuel to carry out stack emissions testing for North West Biomass on the Stela Drying Stack 1 at Kinmel Bay.

The aim of the monitoring campaign was to perform testing, as requested by the customer, for a number of prescribed pollutants. There are no emission limits set for any of the pollutants at this time.

#### Special Requirements

There were no special requirements.

#### Target Parameters

Total Particulate Matter

## Executive Summary

(Page 2 of 7)

### MONITORING RESULTS

North West Biomass, Kinmel Bay

Stela Drying Stack 1

23rd April 2021

where MU = Measurement Uncertainty associated with the Result

Parameter	Concentration				Mass Emission			
	Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Total Particulate Matter <sup>1</sup>	mg/m <sup>3</sup>	0.91	0.44	-	g/hr	96.0	47.5	-
Water Vapour	% v/v	1.4	0.087					
Stack Gas Temperature	°C	43.6						
Stack Gas Velocity	m/s	10.7	0.67					
Volumetric Flow Rate (ACTUAL)	m <sup>3</sup> /hr	121042	9329					
Volumetric Flow Rate (REF)	m <sup>3</sup> /hr	105825	8156					

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

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

**MONITORING DATE(S) & TIMES**

North West Biomass, Kinmel Bay  
Stela Drying Stack 1  
23rd April 2021

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m <sup>3</sup>	0.91	g/hr	96.0	23/04/2021	11:45 - 12:45	60
Velocity Traverse	R1					23/04/2021	11:35 -11:45	

All results are expressed at the respective reference conditions.

## Executive Summary

(Page 4 of 7)

### PROCESS DETAILS

North West Biomass, Kinmel Bay

Stela Drying Stack 1

23rd April 2021

#### Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	Standard Operating Capacity
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Wood Chip
Abatement System	Bag Filter and Cyclone
Abatement System Running Status	On
Fuel	N/A
Plume Appearance	None Visible

## Executive Summary

(Page 5 of 7)

### MONITORING & ANALYTICAL METHODS

North West Biomass, Kinmel Bay

Stela Drying Stack 1

23rd April 2021

Parameter	Monitoring				Analysis				Overall Status	LOD (Average)
	Standard	Technical Procedure	Sampling Status	Testing Lab	Analytical Procedure	Analytical Technique	Analysis Status	Analysis Lab		
Total Particulate Matter	EN 13284-1	CAT-TP-01	MCERTS	EET	CAT-TP-03	Gravimetric	MCERTS	EET	MCERTS	0.13 mg/m <sup>3</sup>
Water Vapour	EN 14790	CAT-TP-05	MCERTS	EET	CAT-TP-05	Gravimetric	MCERTS	EET	MCERTS	0.10 % v/v
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	MCERTS	EET	Pitot Tube and Thermocouple				MCERTS	1.8 m/s

### ANALYSIS LABORATORIES

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

Element Materials Technology (EET)	ISO 17025 Accreditation Number: 4279
------------------------------------	--------------------------------------

### SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
TPM	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 the minimum required by the Standard

## SUITABILITY OF SAMPLING LOCATION

### Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	2.00
Width	m	-
Area	m <sup>2</sup>	3.14
Port Depth	cm	14
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	5" Flange

### Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	Temporary
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	Yes
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

Although this platform does not meet the requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259, it is adequate for the testing carried out on this stack.

### 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	86.3	> 5 Pa	Yes
Mean Velocity	m/s	11.13	-	-
Lowest Gas Velocity	m/s	10.42	-	-
Highest Gas Velocity	m/s	12.16	-	-
Ratio of Above	: 1	1.17	< 3 : 1	Yes
Maximum Angle of Swirl	°	5.00	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes



PLANT PHOTOS

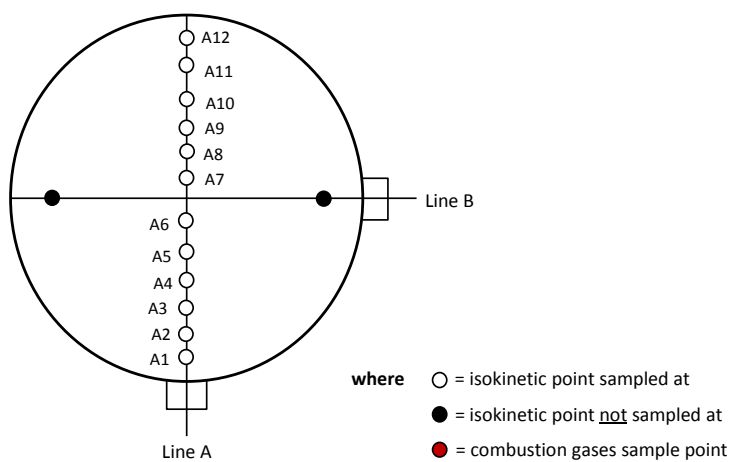
Photo 1



Photo 2



SAMPLE POINTS



## APPENDIX CONTENTS

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

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

## STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Michael Biagioni	MCERTS Level 2	MM 17 1444	TE1 TE3 TE4
Team Leader	Danny Pryke	MCERTS Level 2	MM 03 168	TE1 TE2 TE3 TE4
Technician	Danny Worthington	MCERTS Level 1	MM 19 1594	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 7.95	Horiba PG-250 SRM	-	Digital Manometer (1)	CAT 3.33
Control Box DGM (2)	-	Horiba PG-250	-	Digital Manometer (2)	CAT 3.84
Box Thermocouples (1)	CAT 3.31	Servomex 5200 MP	-	Digital Temperature Meter	CAT 3.33
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	CAT 14.53
Umbilical (1)	CAT 3.31	ABB AO2020-URAS26	-	Barometer	CAT MET
Umbilical (2)	-	Testo 350 XL	-	Stack Thermocouple (1)	CAT 4.117
Oven Box (1)	-	JCT JCC P1 Cooler	-	Stack Thermocouple (2)	CAT 4.1360
Oven Box (2)	-	ProtiR 204M	-	Stack Thermocouple (3)	-
Heated Probe (1)	CAT 5.39	Gasmet Sampling System	-	1m Heated Line (1)	-
Heated Probe (2)	CAT 5.35	Bernath 3006 FID	-	1m Heated Line (2)	-
Heated Probe (3)	-	M&C PSS	-	10m Heated Line (3)	CAT 20.109
S-Pitot (1)	CAT 215.71	Mass Flow Controller (1)	-	5m Heated Line (1)	-
S-Pitot (2)	-	Mass Flow Controller (2)	-	15m Heated Line (1)	-
L-Pitot	-	Mass View 10 l(1)	-	20m Heated Line (1)	-
Site Balance	CAT 17.46	Mass View 2l (2)	-	20m Heated Line (2)	-
500g / 1Kg Check Weights	CAT 17.46	Hioki 5043 (V)	-	Dual Channel Heater Controller	-
Last Impinger Arm	-	Hioki 5043 (V)	-	Single Channel Heater Controller	-
Callipers	CAT 23.52	Bioaerosols Temperature Logger	-	Laboratory Balance	CAT 1.18, 1.18a, 1.18b
Tubes Kit Thermocouple	-	Electronic Refrigerator	-	Tape Measure	CAT 16.96

## 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	2.00
Stack Width, W	m	-
Stack Area, A	m <sup>2</sup>	3.14
Average Stack Gas Temperature, T <sub>a</sub>	°C	44.0
Average Stack Gas Pressure	mmH <sub>2</sub> O	10.1
Average Stack Static Pressure, P <sub>static</sub>	kPa	0.012
Average Barometric Pressure, P <sub>b</sub>	kPa	102.7
Average Pitot Tube Calibration Coefficient, C <sub>p</sub>	-	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/m <sup>3</sup> p	Conc kg/m <sup>3</sup> p <sub>i</sub>
CO <sub>2</sub> (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O <sub>2</sub> (Estimated)	-	20.80	20.51	0.2080	32.00	1.4277	0.29696
N <sub>2</sub>	-	79.14	78.02	0.7914	28.01	1.2498	0.98913
Moisture (H <sub>2</sub> O)	-	-	1.42	0.0142	18.02	0.8037	0.01139

Where:  $p = M / 22.41$

$p_i = r \times p$

### Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P <sub>STD</sub>	kg/m <sup>3</sup>	1.287
Wet Density (STP), P <sub>STW</sub>	kg/m <sup>3</sup>	1.280
Dry Density (Actual), P <sub>Actual</sub>	kg/m <sup>3</sup>	1.124
Average Wet Density (Actual), P <sub>ActualW</sub>	kg/m <sup>3</sup>	1.118

Where:  $P_{STD}$  = sum of component concentrations, kg/m<sup>3</sup> (not including water vapour)  
 $P_{STW}$  = sum of all wet concentrations / 100 x density, kg/m<sup>3</sup> (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 <sup>1</sup>
Temperature	°C	44.0	0.0
Total Pressure	kPa	102.7	101.3
Moisture	%	1.42	1.42

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m <sup>3</sup> /hr	125912
Gas Volumetric Flowrate (STP, Wet)	m <sup>3</sup> /hr	109947
Gas Volumetric Flowrate (STP, Dry)	m <sup>3</sup> /hr	108388
Gas Volumetric Flowrate REF <sup>1</sup>	m <sup>3</sup> /hr	109947

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	23/04/2021
Time of Survey	-	11:35 -11:45
Atmospheric Pressure	kPa	102.7
Average Stack Static Pressure	Pa	12
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 <sub>p</sub>	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	1

Sampling Line A							Sampling Line B - Restricted Access				
Traverse Point	Depth m	ΔP mmH <sub>2</sub> O	Temp °C	Wet Density kg/m <sup>3</sup>	Velocity m/s	Swirl °	ΔP	Temp °C	Wet Density kg/m <sup>3</sup>	Velocity m/s	Swirl °
STATIC (Units: Pa)		12.0									
Mean		10.1	44.0	1.118	11.13						
1	0.04	12.0	44.0	1.118	12.16	3.0					
2	0.13	11.3	44.0	1.118	11.80	4.0					
3	0.24	11.0	44.0	1.118	11.65	3.0					
4	0.35	10.8	44.0	1.118	11.54	5.0					
5	0.50	10.0	44.0	1.118	11.10	3.0					
6	0.71	10.0	44.0	1.118	11.10	4.0					
7	1.29	10.4	44.0	1.118	11.32	3.0					
8	1.50	9.2	44.0	1.118	10.65	4.0					
9	1.65	9.2	44.0	1.118	10.65	2.0					
10	1.76	9.2	44.0	1.118	10.65	3.0					
11	1.87	9.0	44.0	1.118	10.53	4.0					
12	1.96	8.8	44.0	1.118	10.42	3.0					

# 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	$u(\Delta p_i)$	2.193	Pa
- Resolution	$u(res)$	0.52154	
- Calibration	$u(cal)$	1.016	
- Drift	$u(drift)$	1.096	
- Lack of Fit	$u(fit)$	1.177	
- Overall corrections to dynamic measurements	$u(C_f)$	3.811	
Standard uncertainty associated with the molar mass of the gas	$u(M)$	0.00003	-
- $\phi_{O_2,w}$	-	20.505	
- $\phi_{CO_2,w}$	-	0.059	
- Oxygen, dry	$u(\phi_{O_2,d})$	0.637	
- Carbon Dioxide, dry	$u(\phi_{CO_2,d})$	0.002	
- Water Vapour	$u(\phi_{H_2O})$	0.072	
- Oxygen, wet	$u(\phi_{O_2,w})$	0.628	
- Carbon Dioxide, wet	$u(\phi_{CO_2,w})$	0.002	
Standard uncertainty associated with the stack temperature	$u(T_c)$	1.617	K
Standard uncertainty associated with the absolute pressure in the duct	$u(p_c)$	175.706	Pa
- Atmospheric Pressure	$u(p_{atm})$	175.692	
- Static Pressure	$u(p_{stat})$	2.193	
Standard uncertainty associated with the density in the duct	$u(\rho)$	0.00602	-
Standard uncertainty associated with the local velocities	$u(v_i)$	1.218	Pa
Standard uncertainty associated with the mean velocity	$u(\bar{v})$	0.354	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	$U_c(v)$	0.694	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	$U_{c,rel}(v)$	6.24	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	$U_c(qV,w)$	9704.0	m <sup>3</sup> /hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00155	
- $u^2(qV,w)$	-	24512435	
- $u(qV,w)$	-	4951.0	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	$U_{c,rel}(qV,w)$	7.71	%

## TOTAL PARTICULATE MATTER: RESULTS SUMMARY

North West Biomass, Kinmel Bay  
Stela Drying Stack 1

### Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m <sup>3</sup>	0.91	0.91
Uncertainty	±mg/m <sup>3</sup>	0.44	0.44
Mass Emission	g/hr	96.0	96.0
Uncertainty	±g/hr	47.5	47.5

Parameter	Units	Run 1	Mean
Water Vapour	% v/v	1.4	1.4
Uncertainty	±% v/v	0.087	0.087

### Blank Runs

Parameter	Units	Blank 1	Maximum
Concentration	mg/m <sup>3</sup>	0.32	0.32

### 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 / 2
Number of Sampling Points Used	12 / 12
Sample Point I.D.'s	A1 - A12

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

### Reference Conditions

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

## TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
<b>Absolute pressure of stack gas, <math>P_s</math></b>			
Barometric pressure, $P_b$	mmHg	770.3	
Stack static pressure, $P_{static}$	mmH <sub>2</sub> O	3.3	
$P_s = (P_b + (P_{static} / 13.6))$	mmHg	770.6	
<b>Volume of water vapour collected, <math>V_{wstd}</math></b>			
Total mass collected in impingers (liquid trap)	g	10.9	
Total mass collected in impingers (silica trap)	g	5.4	
Total mass of liquid collected, $V_{lc}$	g	16.3	
$V_{wstd} = (0.001246)(V_{lc})$	m <sup>3</sup>	0.0203	
<b>Volume of gas metered dry, <math>V_{mstd}</math></b>			
Volume of gas sample through gas meter, $V_m$	m <sup>3</sup>	1.4640	
Gas meter correction factor, $Y_d$	-	1.0160	
Average dry gas meter temperature, $T_m$	°C	19.9	
Average pressure drop across orifice, $\Delta H$	mmH <sub>2</sub> O	56.7	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m <sup>3</sup>	1.4127	
<b>Moisture content, <math>B_{wo}</math> &amp; <math>R_{wv}</math></b>			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m <sup>3</sup>	0.0142	
$B_{wo}$ as a percentage	% v/v	1.42	
Reported Water Vapour, checked with Tables in EN 14790, $R_{wv}$	% v/v	1.42	
<b>Volume of gas metered wet, <math>V_{mstw}</math></b>			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m <sup>3</sup>	1.4330	
<b>Volume of gas metered at Oxygen Reference Conditions, <math>V_{mstd@X\%O_2}</math> &amp; <math>V_{mstw@X\%O_2}</math></b>			
IED & Incinerates Hazardous Material? (Yes = no positive O <sub>2</sub> correction)	-	No	
% wet oxygen measured in gas stream, ACT%O <sub>2w</sub>	% v/v	N/A	
% dry oxygen measured in gas stream, ACT%O <sub>2d</sub>	% v/v	N/A	
% oxygen reference condition, REF%O <sub>2</sub>	% v/v	N/A	
O <sub>2</sub> Reference Factor wet ( $O_{2REFw} = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$ )	-	N/A	
O <sub>2</sub> Reference Factor dry ( $O_{2REFd} = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$ )	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m <sup>3</sup>	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m <sup>3</sup>	N/A	
<b>Molecular weight of dry gas stream, <math>M_d</math></b>			
CO <sub>2</sub> (Estimated)	% v/v	0.06	
O <sub>2</sub> (Estimated)	% v/v	20.80	
Total	% v/v	20.86	
N <sub>2</sub>	% v/v	79.14	
$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2)$	g/gmol	28.84	
<b>Molecular weight of stack gas (wet), <math>M_s</math></b>			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.69	
<b>Velocity of stack gas, <math>V_s</math></b>			
Pitot tube velocity constant, $K_p$	-	34.97	
Velocity pressure coefficient, $C_p$	-	0.84	
Average of velocity heads, $\Delta P_{avg}$	mmH <sub>2</sub> O	9.27	
Average square root of velocity heads, $\sqrt{\Delta P}$	√mmH <sub>2</sub> O	3.04	
Average stack gas temperature, $T_s$	°C	43.6	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(T_s + 273)) / (V(M_s)(P_s))$	m/s	10.70	
<b>Total flow of stack gas: Actual (<math>Q_a</math>), Wet (<math>Q_{stw}</math>), Dry (<math>Q_{std}</math>), Wet@O<sub>2REF</sub> (<math>Q_{stwO_2}</math>), Dry@O<sub>2REF</sub> (<math>Q_{stdO_2}</math>)</b>			
Area of stack, $A_s$	m <sup>2</sup>	3.14	
$Q_a = (60)(A_s)(V_s)$	m <sup>3</sup> /min	2017.4	
Conversion factor (K/mm.Hg), $C_i$	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_i)) / ((T_s) + 273)$	m <sup>3</sup> /min	1763.8	
$Q_{std} = ((Q_a)(P_s)(C_i)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m <sup>3</sup> /min	1738.8	
$Q_{stwO_2} = ((Q_a)(P_s)(C_i)) / ((T_s) + 273) / (O_{2REFw})$	m <sup>3</sup> /min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_i)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m <sup>3</sup> /min	N/A	
<b>Percent isokinetic, %I</b>			
Nozzle diameter, $D_n$	mm	7.09	
Nozzle area, $A_n$	mm <sup>2</sup>	39.52	
Total sampling time, $q$	min	60	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	107.6	



## TOTAL PARTICULATE MATTER: SAMPLING DETAILS

### Sample Runs

Parameter	Units	Run 1
Sampling Times	-	11:45 - 12:45
Sampling Dates	-	23/04/2021
Sampling Device	-	ISO
Volume Sampled (REF)	m <sup>3</sup>	1.4330
Filter I.D. Number	-	47-79817
Start Filter Mass	g	0.14829
End Filter Mass	g	0.14929
Total Mass on Filter	g	0.00100
Probe Rinse I.D. Number	-	PR-47-79817
Start Probe Rinse Mass	g	2.99201
End Probe Rinse Mass	g	2.99231
Total Mass in Probe Rinse	g	0.00030
Total Mass Collected	mg	1.30
Calculated Concentration	mg/m <sup>3</sup>	0.91
Balance Uncertainty / LOD	mg/m <sup>3</sup>	0.13

**Where:** ISO stands for Manual Isokinetic Sampling Train

### Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	23/04/2021
Average Volume Sampled (REF)	m <sup>3</sup>	1.4330
Filter I.D. Number	-	47-79792
Start Filter Mass	g	0.14846
End Filter Mass	g	0.14898
Total Mass on Filter	g	0.00052
Probe Rinse I.D. Number	-	PR-47-79792
Start Probe Rinse Mass	g	3.11835
End Probe Rinse Mass	g	3.11829
Total Mass in Probe Rinse	g	-0.00006
Total Mass Collected	mg	0.46
Calculated Concentration	mg/m <sup>3</sup>	0.32
Balance Uncertainty / LOD	mg/m <sup>3</sup>	0.13

# TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

## Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	24.8	
Pre-Sampling Leak Rate	l/min	0.32	
Post-Sampling Leak Rate	l/min		
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)	%	6.1	
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	%	107.6	
Allowable Isokinetic Range	%	95 - 115	
Isokineticity Acceptable	-	Yes	
Weighing Uncertainty Criteria	Units	Run 1	
Overall Weighing Uncertainty	± mg	0.36	
Overall Weighing Uncertainty	± mg/m <sup>3</sup>	0.25	
ELV [Daily ELV for IED]	mg/m <sup>3</sup>	N/A	
Allowable Weighing Uncertainty	mg/m <sup>3</sup>	N/A	
Weighing Uncertainty Acceptable	-	N/A	
Filter Temperatures	Units	Run 1	
Pre-Conditioning Temperature	°C	180	
Post-Conditioning Temperature	°C	160	
Maximum Filter Temperature	°C	46	
Test Conditions	Units	Run 1	
Ambient Temperature Recorded?	-	Yes	

## TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 2 OF 2)

### Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	20.0	
Pre-Sampling Leak Rate	l/min	0.27	
Post-Sampling Leak Rate	l/min		
Allowable Leak Rate	l/min	0.40	
Leak Test Acceptable	-	Yes	

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

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
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 the minimum required by the Standard	x

## TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value		Standard uncertainty		
	Symbol	Run 1	Symbol	Units	Run 1
Sampled Volume (Actual)	$V_m$	1.4640	$uV_m$	$m^3$	0.0293
Sampled Gas Temperature	$T_m$	292.9	$uT_m$	K	2.00
Sampled Gas Pressure	$p_m$	102.7	$up_m$	kPa	0.50
Sampled Gas Humidity	$H_m$	0.00	$uH_m$	% v/v	1.00
Leak	L	1.29	uL	%	-
Mass of Particulate	m	1.30	um	mg	0.18
Uncollected Mass	UCM	0.46	uUCM	mg	-

Measured Quantities	Uncertainty as a Percentage		Requirement of Standard
	Units	Run 1	
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	%	1.29	≤2%
Mass of Particulate	%	-	<5% of ELV
Uncollected Mass	%	-	-

Measured Quantities	Uncertainty in Measurement Units			Sensitivity Coefficient
	Symbol	Units	Run 1	
Sampled Volume (STP)	$V_m$	$m^3$	1.4127	0.64
Leak	L	mg/ $m^3$	0.007	1.00
Mass of Particulate	$L_r$	mg	1.300	0.70
Uncollected Mass	UCM	mg	0.27	0.70

Measured Quantities	Uncertainty in Result	
	Units	Run 1
Sampled Volume (STP)	mg/ $m^3$	0.022
Leak	mg/ $m^3$	0.0068
Mass of Particulate	mg/ $m^3$	0.1256
Uncollected Mass	mg/ $m^3$	0.1867

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

Parameter	Units	Run 1
Combined uncertainty	mg/ $m^3$	0.23
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/ $m^3$	0.44
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/ $m^3$	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/ $m^3$	0.44
Reported Uncertainty	mg/ $m^3$	0.44
Expanded uncertainty (95% confidence), without Oxygen Correction	%	48.9
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	48.9
Reported Uncertainty	%	48.9



Version Number	Record of changes made within this version of the document
V1	The original document issued to the client