

STACK EMISSIONS MONITORING REPORT



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Operator & Address:
<p>Celtic Recycling 29-31 Clearwater Road Queensway Meadows Newport NP19 4ST</p>

Permit Reference:
EPR Permit: EPR/YP3135TE

Release Point:
A1 Shredder

Sampling Date(s):
27th November 2025

SOCOTEC Job Number:	LSW 251121
Report Date:	17th December 2025
Version:	1
Report By:	[REDACTED]
MCERTS Number:	[REDACTED]
MCERTS Level:	MCERTS Level 2 - Business Manager
Technical Endorsements:	1, 2, 3 & 4
Report Approved By:	[REDACTED]
MCERTS Number:	[REDACTED]
Business Title:	MCERTS Level 2 - Project Manager
Technical Endorsements:	1, 2, 3 & 4
Signature:	[REDACTED]



1015

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EXECUTIVE SUMMARY

MONITORING OBJECTIVES

Celtic Recycling operates a shredding paper covered copper process at Newport which is subject to EPR Permit EPR/YP3135TE, under the Environmental Permitting Regulations 2016.

SOCOTEC UK LTD were commissioned by Celtic Recycling to carry out stack emissions monitoring to determine the release of prescribed pollutants from the following Plant under normal operating conditions.

The results of these tests shall be used to demonstrate compliance with a set of emission limit values for prescribed pollutants as specified in the Plant's EPR Permit, EPR/YP3135TE.

Plant

A1 Shredder

Operator

Celtic Recycling
29-31 Clearwater Road
Queensway Meadows
Newport
NP19 4ST

EPR Permit: EPR/YP3135TE

Stack Emissions Monitoring Test House

SOCOTEC UK LTD - Cirencester Laboratory
Units C & D
Bankside Trade Park
Cirencester
GL7 1YT
UKAS and MCERTS Accreditation Number: 1015

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.
The results of this testing relate only to the emission release point(s) listed in the report.
MCERTS accredited results will only be claimed where both the sampling and analytical stages are MCERTS accredited.
This test report shall not be reproduced, except in full, without written approval of SOCOTEC UK LTD.

EXECUTIVE SUMMARY

EMISSIONS SUMMARY					
Parameter	Units	Result	Calculated Uncertainty +/-	Emission Limit Value (ELV)	Accreditation
Total Particulate Matter	mg/m ³	0.85	0.81	10	MCERTS
Particulate Emission Rate	g/hr	2.26	2.17	-	
Oil Mist	mg/m ³	0.02	0.03	-	None
Oil Mist Emission Rate	g/hr	0.05	0.11	-	
Stack Gas Temperature	°C	15	-	-	MCERTS
Stack Gas Velocity	m/s	13.2	0.33	-	
Gas Volumetric Flow Rate (Actual)	m ³ /hr	7569	390	-	
Gas Volumetric Flow Rate (STP, Wet)	m ³ /hr	7147	368	-	
Gas Volumetric Flow Rate (STP, Dry)	m ³ /hr	7061	364	-	
Gas Volumetric Flow Rate at Reference Conditions	m ³ /hr	7147	368	-	

ND = None Detected,

Results at or below the limit of detection are highlighted by bold italic text.

The above volumetric flow rate is calculated using data from the preliminary survey. Mass emissions for non isokinetic tests are calculated using these values. For all isokinetic testing the mass emission is calculated using test specific flow data and not the above values.

Reference conditions are 273K, 101.3kPa without correction for water vapour

EXECUTIVE SUMMARY

MONITORING TIMES			
Parameter	Sampling Date(s)	Sampling Times	Sampling Duration
Total Particulate Matter Run 1	27 November 2025	09:49 - 10:49	60 minutes
Oil Mist Run 1	27 November 2025	11:00 - 12:00	60 minutes
Preliminary Stack Traverse	27 November 2025	09:35	-

EXECUTIVE SUMMARY

PROCESS DETAILS

Parameter	Process Details
Description of process	Shredding paper covered copper
Continuous or batch	Batch
Product Details	Shredded Copper
Part of batch to be monitored (if applicable)	60 Minute period
Normal load, throughput or continuous rating	Normal
Fuel used during monitoring	None
Abatement	Bag Filter
Plume Appearance	None Visible

EXECUTIVE SUMMARY

Monitoring Methods

The selection of standard reference / alternative methods employed by SOCOTEC is determined, wherever possible by the hierarchy of method selection outlined in Environment Agency technical Guidance 'Monitoring stack emissions: techniques and standards for periodic monitoring'.

MONITORING METHODS							
Species	Method Standard Reference Method / Alternative Method	SOCOTEC Technical Procedure	UKAS Lab Number	Method Accreditation	Limit of Detection (LOD)	Calculated MU +/- % Result	Calculated MU +/- % ELV
Total Particulate Matter	SRM - BS EN 13284-1 & MID	AE 104	1015	MCERTS	0.41 mg/m ³	96.2%	8.14%
Velocity	SRM - BS EN ISO 16911-1 & MID	AE 154	1015	MCERTS	5 Pa	2.5%	N/A - No ELV
Volumetric Flow Rate	SRM - BS EN ISO 16911-1 & MID	AE 154	1015	MCERTS	-	5.2%	N/A - No ELV

EXECUTIVE SUMMARY

Analytical Methods

The following tables list the analytical methods employed together with the custody details. Unless otherwise stated the samples are archived at the analysis lab location.

SAMPLING METHODS WITH SUBSEQUENT ANALYSIS							
Species	Analytical Technique	Analytical Procedure	UKAS Lab Number	Analysis Accreditation	Analysis Lab	Analysis Report No. Date of Analysis	Archive Period
Total Particulate Matter	Gravimetric	AE 106	1015	MCERTS	SOCOTEC (Cirencester)	N/A	8 Weeks
Oil Mist	Gravimetric	AE 106	1015	None	SOCOTEC (Bretby)	ASC/69741	8 Weeks

EXECUTIVE SUMMARY

SAMPLING LOCATION

DUCT CHARACTERISTICS		
	Value	Units
Shape	Circular	-
Depth	0.45	m
Width		m
Area	0.16	m ²
Port Depth	90	mm

SAMPLING LINES & POINTS		
	Isokinetic	Non-Iso & Gases
Sample port size	3" Flange	
Number of lines used	1	
Number of points / line	4	
Duct orientation	Vertical	
Filtration	In Stack	
Filtration for TPM	In Stack	

SAMPLING PLATFORM

General Platform Information	
Permanent / Temporary Platform / Ground level / Floor Level / Roof	Permanent
Inside / Outside	Outside
EA Guidance, Monitoring stack emissions: measurement locations.	
Is there a sufficient working area so work can be performed in a compliant manner	Yes
Platform has 2 levels of handrails (approximately 0.5 m & 1.0 m high)	Yes
Platform has vertical base boards (approximately 0.25 m high)	Yes
Platform has removable chains / self closing gates at the top of ladders	Yes
Handrail / obstructions do not hamper insertion of sampling equipment	Yes
Depth of Platform = >Stack depth / diameter + wall and port thickness + 1.5m	Yes

Sampling Platform Improvement Recommendations (if applicable)

The sampling location meets all the requirements specified in EA Guidance, Monitoring stack emissions: measurement locations.

EXECUTIVE SUMMARY

Sampling & Analytical Method Deviations

Sampling Line

There is only one available sampling port, therefore sampling was only conducted along the one sampling line. The number of sampling points along the one available line were doubled.

APPENDICES

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APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

APPENDIX 3 - Measurement Uncertainty Budget Calculations

APPENDIX 1 - Monitoring Schedule, Calibration Checklist & Monitoring Team

MONITORING SCHEDULE					
Species	Method Standard Reference Method / Alternative Method	SOCOTEC Technical Procedure	UKAS Lab Number	MCERTS Accredited Method	Number of Samples
Total Particulate Matter	SRM - BS EN 13284-1 & MID	AE 104	1015	MCERTS	1
Oil Mist	SRM - BS EN 23210	AE 136	1015	None	1
Velocity	SRM - BS EN ISO 16911-1 & MID	AE 154	1015	MCERTS	1

APPENDIX 1 - Monitoring Schedule, Calibration Checklist & Monitoring Team

CALIBRATABLE EQUIPMENT CHECKLIST					
Extractive Sampling		Instrumental Analyser/s		Miscellaneous	
Equipment	Equipment I.D.	Equipment	Equipment I.D.	Equipment	Equipment I.D.
Control Box DGM	P2556	Horiba PG - 250 Analyser	-	Laboratory Balance	P3225
Box Thermocouples	P2556	FT-IR	-	Tape Measure	P581
Meter In Thermocouple	P2556	FT-IR Oven Box	-	Stopwatch	-
Meter Out Thermocouple	P2556	Bernath 3006 FID	-	Protractor	-
Control Box Timer	P2556	Signal 3030 FID	-	Barometer	P341
Oven Box	-	Servomex	-	Digital Micromanometer	P1940
Probe	-	JCT Heated Head Filter	-	Digital Temperature Meter	P824
Probe Thermocouple	P2157	Thermo FID	-	Stack Thermocouple	P2156
Probe	-	Stackmaster	-	Mass Flow Controller	-
Probe Thermocouple	-	FTIR Heater Box for Heated Line	-	MFC Display module	-
S-Pitot	P2155 (0.83)	Anemometer	-	1m Heated Line (1)	-
L-Pitot	-	Ecophysics NOx Analyser	-	1m Heated Line (2)	-
Site Balance	P3336	Chiller (JCT/MAK 10)	-	1m Heated Line (3)	-
Last Impinger Arm	-	Heated Line Controller (1)	-	5m Heated Line (1)	-
Dioxins Cond. Thermocouple	-	Heated Line Controller (2)	-	10m Heated Line (1)	-
Callipers	-	Site temperature Logger	-	10m Heated Line (2)	-
Small DGM	-		-	15m Heated Line (1)	-
Heater Controller	-		-	20m Heated Line (1)	-
Inclinometer (Swirl Device)	P2372		-	20m Heated Line (2)	-

NOTE: If the equipment I.D is represented by a dash (-), then this piece of equipment has not been used for this test.

STACK EMISSIONS MONITORING TEAM

MONITORING TEAM								
Personnel	MCERTS Number	MCERTS		TE / H&S Qualifications and Expiry Date				
		Level	Expiry	TE1	TE2	TE3	TE4	H&S
██████████	██████████	MCERTS Level 2	Sep-27	Mar-28	Jun-28	Jun-28	Aug-28	Sep-27
██████████	██████████	MCERTS Level 1	Sep-27	-	-	-	-	Sep-27

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

TOTAL PARTICULATE MATTER SUMMARY					
Parameter	Sampling Times	Concentration mg/m ³	Uncertainty mg/m ³	ELV mg/m ³	Emission Rate g/hr
Run 1	09:49 - 10:49 27 November 2025	0.85	0.81	10	2.3
Blank	-	0.41	-	-	-

Reference conditions are 273K, 101.3kPa without correction for water vapour

Acetone Blank Value mg/l	Acceptable Value mg/l
0.3	1.0

FILTER INFORMATION

SAMPLES								
Test	Filter & Probe Rinse Number	Filter Start Weight g	Filter End Weight g	Mass Gained on Filter g	Probe Rinse Start Weight g	Probe Rinse End Weight g	Mass Gained on Probe g	Combined Total Mass Gained g
Run 1	321599	0.10655	0.10749	0.00094	97.84977	97.84987	0.00010	0.00104

If total mass gained is less than the LOD then the LOD is reported

BLANKS								
Test	Filter & Probe Number	Filter Start Weight g	Filter End Weight g	Mass Gained Filter g	Probe Start Weight g	Probe End Weight g	Mass Gained Probe g	Combined Total Mass Gained g
Run 1	321600	0.10620	0.10644	0.00024	86.55427	86.55453	0.00026	0.00050

If total mass gained is less than the LOD then the LOD is reported

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

ISOKINETIC SAMPLING EQUATIONS - RUN 1				TPM	
Absolute pressure of stack gas, P_s			Molecular weight of dry gas, M_d		
Barometric pressure, P _b	Kpa	100.9	CO ₂	%	0.04
Stack static pressure, P _{static}	pa	10.0	O ₂	%	20.80
P _s = P _b + P _{static}	Kpa	100.9	Total	%	20.84
			N ₂ (100 - Total)	%	79.16
Vol. of water vapour collected, V_{wstd}			M _d = 0.44(%CO ₂)+0.32(%O ₂)+0.28(%N ₂)		
Moisture trap weight increase, V _{lc}	g	-	Molecular weight of wet gas, M_s		
V _{wstd} = (0.001246)(V _{lc})	m ³	-	M _s = M _d (1 - B _{w0}) + 18(B _{w0})	g/gmol	28.71
Volume of gas metered dry, V_{mstd}			Actual flow of stack gas, Q_a		
Volume of gas sample through gas meter, V _m		1.256	Area of stack, A _s	m ²	0.16
Gas meter correction factor, Y _d		1.022	Q _a = (60)(A _s)(V _s)	m ³ /min	47.4
Mean dry gas meter temperature, T _m		289	Total flow of stack gas, Q		
Mean pressure drop across orifice, DH	mmH ₂ O	48.180	Conversion factor (K/mm.Hg)		0.3592
V _{mstd} = $\frac{(0.3592)(V_m)(P_b + (DH/13.6))(Y_d)}{T_m}$	m ³	1.214	Q _{std} = $\frac{(Q_a)P_s(0.3592)(1-B_{w0})}{(T_s)}$	Dry	44.0
Volume of gas metered wet, V_{mstw}			Q _{stdO₂} = $\frac{(Q_a)P_s(0.3592)(1-B_{w0})(O_2\text{REF})}{(T_s)}$	@O ₂ ref	No O2 Ref
V _{mstw} = V _{mstd} + V _{wstd}	m ³	1.2289	Q _{stw} = $\frac{(Q_a)P_s(0.3592)}{(T_s)}$	Wet	44.51
Vol. of gas metered at O₂ Ref. Cond., V_{mstd@X%O₂}			Percent isokinetic, %I		
Is the process burning hazardous waste? (if yes, no favourable oxygen correction)		No	Nozzle diameter, D _n	mm	9.79
% oxygen measured in gas stream, act%O ₂		20.8	Nozzle area, A _n	mm ²	75.34
% oxygen reference condition		21	Total sampling time, q	min	60
O ₂ Reference O ₂ Ref = 21.0 - act%O ₂		No O2 Ref	%I = $\frac{(4.6398E6)(T_s)(V_{mstd})}{(P_s)(V_s)(A_n)(q)(1-B_{w0})}$	%	97.1
Factor = $\frac{21.0 - \text{ref}\%O_2}{21.0 - \text{act}\%O_2}$		No O2 Ref	Acceptable isokinetic range 95% to 115%		
V _{mstd@X%oxygen} = (V _{mstd})(O ₂ Ref)	m ³	No O2 Ref	Particulate Concentration, C		
Moisture content, B_{w0}			Mass collected on filter, M _f		
B _{w0} = $\frac{V_{wstd}}{V_{mstd} + V_{wstd}}$	%	0.0120	Mass collected in probe, M _p	g	0.00010
		1.20	Total mass collected, M _n	g	0.00104
Moisture by FTIR			C _{wet} = $\frac{M_n}{V_{mstw}}$		
	%	-		mg/m ³	0.846
Velocity of stack gas, V_s			C _{dry} = $\frac{M_n}{V_{mstd}}$		
Velocity pressure coefficient, C _p		0.83		mg/m ³	0.857
Mean of velocity heads, DP _{avg}	Pa	21.56	C _{dry@X%O₂} = $\frac{M_n}{V_{mstd@X\%oxygen}}$		
Mean stack gas temperature, T _s	K	290		mg/m ³	No O2 Ref
Gas density (wet, ambient), ρ			Particulate Emission Rates, E		
ρ = (M _s *P _s)/(8.314*T _s)	kg/m ³	1.204	E = [(C _{wet})(Q _{stw})(60)] / 1000		
Stack Velocity, V _s = $\frac{\sum_{i=1}^n V_i}{n}$	m/s	4.97			

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

ISOKINETIC SAMPLING EQUATIONS - RUN 2			OIL MIST	
Absolute pressure of stack gas, P_s			Molecular weight of dry gas, M_d	
Barometric pressure, P _b	Kpa	100.9	CO ₂	% 0.04
Stack static pressure, P _{static}	pa	10.0	O ₂	% 20.80
P _s = P _b + P _{static}	Kpa	100.9	Total	% 20.84
			N ₂ (100 -Total)	% 79.16
Vol. of water vapour collected, V_{wstd}			M _d = 0.44(%CO ₂)+0.32(%O ₂)+0.28(%N ₂)	
Moisture trap weight increase, V _{lc}	g	-	Molecular weight of wet gas, M_s	
V _{wstd} = (0.001246)(V _{lc})	m ³	-	M _s = M _d (1 - B _{wo}) + 18(B _{wo})	g/gmol 28.71
Volume of gas metered dry, V_{mstd}			Actual flow of stack gas, Q_a	
Volume of gas sample through gas meter, V _m		1.289	Area of stack, A _s	m ² 0.16
Gas meter correction factor, Y _d		1.022	Q _a = (60)(A _s)(V _s)	m ³ /min 47.3
Mean dry gas meter temperature, T _m		293	Total flow of stack gas, Q	
Mean pressure drop across orifice, DH	mmH ₂ O	48.313	Conversion factor (K/mm.Hg)	0.3592
V _{mstd} = $\frac{(0.3592)(V_m)(P_b + (DH/13.6))(Y_d)}{T_m}$	m ³	1.230	Q _{std} = $\frac{(Q_a)P_s(0.3592)(1-B_{wo})}{(T_s)}$	Dry 43.8
Volume of gas metered wet, V_{mstw}			Q _{stdO2} = $\frac{(Q_a)P_s(0.3592)(1-B_{wo})(O_2REF)}{(T_s)}$	@O ₂ ref No O2 Ref
V _{mstw} = V _{mstd} + V _{wstd}	m ³	1.2447	Q _{stw} = $\frac{(Q_a)P_s(0.3592)}{(T_s)}$	Wet 44.28
Vol. of gas metered at O₂ Ref. Cond., V_{mstd@X%O2}			Percent isokinetic, %I	
Is the process burning hazardous waste? (If yes, no favourable oxygen correction)		No	Nozzle diameter, D _n	mm 9.79
% oxygen measured in gas stream, act%O ₂		20.8	Nozzle area, A _n	mm ² 75.34
% oxygen reference condition		21	Total sampling time, q	min 60
O ₂ Reference O ₂ Ref = 21.0 - act%O ₂		No O2 Ref	%I = $\frac{(4.6398E6)(T_s)(V_{mstd})}{(P_s)(V_s)(A_n)(q)(1-B_{wo})}$	% 98.9
Factor $\frac{21.0 - ref\%O_2}{21.0 - act\%O_2}$		No O2 Ref	Acceptable isokinetic range 95% to 115%	Yes
V _{mstd@X%oxygen} = (V _{mstd}) (O ₂ Ref)	m ³	No O2 Ref	Particulate Concentration, C	
Moisture content, B_{wo}			Mass collected on filter, M _f	g N/A
B _{wo} = $\frac{V_{wstd}}{V_{mstd} + V_{wstd}}$	%	0.0120	Mass collected in probe, M _p	g N/A
		1.20	Total mass collected, M _n	g N/A
Moisture by FTIR			C _{wet} = $\frac{M_n}{V_{mstw}}$	mg/m ³ N/A
Velocity of stack gas, V_s			C _{dry} = $\frac{M_n}{V_{mstd}}$	mg/m ³ N/A
Velocity pressure coefficient, C _p		0.83	C _{dry@X%O2} = $\frac{M_n}{V_{mstd@X\%oxygen}}$	mg/m ³ No O2 Ref
Mean of velocity heads, DP _{avg}	Pa	21.40	Particulate Emission Rates, E	
Mean stack gas temperature, T _s	K	290	E = [(C _{wet})(Q _{stw})(60)] / 1000	
Gas density (wet, ambient), p				
p=(M _s *P _s)/(8.314*T _s)	kg/m ³	1.201		
Stack Velocity, V _s $V_s = \frac{\sum_{i=1}^n V_i}{n}$	m/s	4.95		

TAR FUME DATA - RUN 1		
Parameters	Units	Results
Mass Collected	mg	0.0200
Concentration wet	mg/m ³	0.0161
Concentration Dry	mg/m ³	0.0163
Mass Emission	g/hr	0.0531

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

TOTAL PARTICULATE MATTER QUALITY ASSURANCE CHECKLIST

LEAK RATE						
Run	Mean Sampling Rate litre/min	Pre-sampling Leak Rate litre/min	Post-sampling Leak Rate litre/min	Maximum Vacuum mm Hg	Acceptable Leak Rate litre/min	Leak Tests Acceptable?
Run 1	21.39	0.17	-	-381	0.43	Yes
Run 2	21.95	0.17	-	-381	0.44	Yes

In BS EN 13284-1:2017 a post sampling leak check is not required.

ISOKINETICITY		
Run	Isokinetic Variation %	Acceptable Isokineticity
Run 1	97.15	Yes
Run 2	98.91	Yes

Acceptable isokinetic range 95% to 115%

WEIGHING BALANCE UNCERTAINTY			
Run	Result mg/m ³	5% ELV mg/m ³	LOD < 5% ELV
Run 1	0.41	0.5	Yes
Run 2	0.00	0.5	Yes

The above is based on both the Filter and rinse uncertainty

BLANK VALUE				
Run	Overall Blank Value mg/m ³	Daily Limit Value mg/m ³	Acceptable Blank Value mg/m ³	Overall Blank Acceptable
Blank 1	0.41	10	1.0	Yes

FILTERS					
Run	Filter Material	Filter Size mm	Max Filtration Temperature °C	Pre-use Filter Conditioning Temperature °C	Post-use Filter Conditioning Temperature °C
Run 1	Glass Fibre	47	17	180	160
Run 2	Glass Fibre	47	18	180	160

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

PRELIMINARY STACK SURVEY

Stack Characteristics		
Stack Diameter / Depth, D	0.45	m
Stack Width, W		m
Stack Area, A	0.16	m ²
Average stack gas temperature	15	°C
Stack static pressure	0.01	kPa
Barometric Pressure	100.9	kPa

Stack Gas Composition & Molecular Weights								
Component	Molar Mass M	Density kg/m ³ p	Conc Dry % Vol	Dry Volume Fraction r	Dry Conc kg/m ³ pi	Conc Wet % Vol	Wet Volume Fraction r	Wet Conc kg/m ³ pi
CO ₂	44	1.963059	0.042095	0.000421	0.000826	0.041590	0.000416	0.000816
O ₂	32	1.427679	20.800000	0.208000	0.296957	20.550400	0.205504	0.293394
N ₂	28	1.249219	79.157905	0.791579	0.988856	78.208010	0.782080	0.976990
H ₂ O	18	0.803070	-	-	-	1.200000	0.012000	0.009637

Where: $p = M / 22.41$ $pi = r \times p$

Calculation of Stack Gas Densities		
Determinand	Result	Units
Dry Density (STP), P_{STD}	1.2866	kg/m ³
Wet Density (STP), P_{STW}	1.2808	kg/m ³
Dry Density (Actual), P_{Actual}	1.2149	kg/m ³
Average Wet Density (Actual), $P_{ActualW}$	1.209	kg/m ³

Where:

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

$P_{Actual} = P_{STD} \times (Ts / Ps) \times (Pa / Ta)$

$P_{STW} = (P_{STD} + pi \text{ of H}_2\text{O}) / (1 + (pi \text{ of H}_2\text{O} / 0.8036))$

$P_{ActualW} = P_{STW} \times (Ts / Ps) \times (Pa / Ta)$

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

PRELIMINARY STACK SURVEY

TRAVERSE 1

Date of Survey	27 November 2025
Time of Survey	09:35
Velocity Measurement Device:	S-Type Pitot

Sampling Line A								
Traverse Point	Distance into duct (m)	DP pt Pa (average of 3 readings)	DP pt mmH ₂ O (average of 3 readings)	Temp °C	Velocity m/s	Volumetric Flow Rate (actual) m ³ /s	O ₂ % Vol	Angle of Swirl °
1	0.05	140.5	14.3	15	12.6	2.0	-	<15
2	0.11	153.5	15.7	15	13.2	2.1	-	<15
3	0.34	160.1	16.3	15	13.5	2.1	-	<15
4	0.40	160.1	16.3	15	13.5	2.1	-	<15
Mean	-	153.5	15.7	15	13.2	2.1	-	-

PRELIMINARY STACK SURVEY QUALITY ASSURANCE CHECKLIST

PITOT LEAK CHECK								
Run	Pre Traverse Leak Rate				Post Traverse Leak Rate			
	Start Value mmH ₂ O	End Value mmH ₂ O	Difference %	Outcome	Start Value mmH ₂ O	End Value mmH ₂ O	Difference %	Outcome
Run 1	95	95	0.0	Pass	94	94	0.0	Pass

To complete a compliant pitot leak check a pressure of over 80 mmH₂O (or 800 Pa) is applied and the pressure drop monitored over 15 seconds. A drop of less than 5% must be observed.

S-Type Pitot Stagnation Check				
Run	Stagnation (Pa)	Reference (Pa)	Difference (Pa)	Outcome (Permitted +/- 10 Pa)
Run 1	25	25	0.0	Pass

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

PRELIMINARY STACK SURVEY (CONTINUED)

Sampling Plane Validation Criteria				
EA Technical Guidance Note (Monitoring) M1	Result	Units	Requirement	Compliant
Lowest Average Differential Pressure	140	Pa	>= 5 Pa	Yes
Lowest Gas Velocity	12.6	m/s	-	-
Highest Gas Velocity	13.5	m/s	-	-
Ratio of Gas Velocities	1.1	-	< 3 : 1	Yes
Maximum angle of flow with regard to duct axis	<15	°	< 15°	Yes
No local negative flow	Yes	-	-	Yes

Calculation of Stack Gas Velocity, V		
Velocity at Traverse Point, $V = K_{pt} \times (1-e) \times \sqrt{2 \times DP_{pt} / P_{ActualW}}$		
Where:		
K_{pt} = Pitot tube calibration coefficient		
(1-e) = Compressibility correction factor, assumed at a constant 0.998		
Average Stack Gas Velocity, V_a	13.2	m/s

Calculation of Stack Gas Volumetric Flowrate, Q			
Duct gas flow conditions	Actual	Reference	Units
Temperature	15	0	°C
Total Pressure	100.91	101.3	kPa
Oxygen	20.8	21	%
Moisture	1.20	1.20	%
Pitot tube calibration coefficient, K_{pt}	0.83		

Gas Volumetric Flowrate	Result	Units
Average Stack Gas Velocity (V_a)	13.22	m/s
Stack Area (A)	0.16	m ²
Gas Volumetric Flowrate (Actual), Q_{Actual}	7569.11	m ³ /hr
Gas Volumetric Flowrate (STP, Wet), Q_{STP}	7147.26	m ³ /hr
Gas Volumetric Flowrate (STP, Dry), $Q_{STP,Dry}$	7061.50	m ³ /hr
Gas Volumetric Flowrate (REF), Q_{Ref}	7147.26	m ³ /hr

Where:

$Q_{Actual} = V_a \times A \times 3600$
 $Q_{STP} = Q (Actual) \times (T_s / T_a) \times (P_a / P_s)$
 $Q_{STP,Dry} = Q (STP) / (100 - (100 / Ma))$
 $Q_{Ref} = Q (STP) \times ((100 - Ma) / (100 - Ms)) \times ((21 - O_{2a}) / (21 - O_{2s}))$

Nomenclature:

T_s = Absolute Temperature, Standard Conditions, 273 K
 P_s = Absolute Pressure, Standard Conditions, 101.3 kPa
 T_a = Absolute Temperature, Actual Conditions, K
 P_a = Absolute Pressure, Actual Conditions, kPa
 Ma = Water vapour, Actual Conditions, % Vol
 Ms = Water vapour, Reference Conditions, % Vol
 O_{2a} = Oxygen, Actual Conditions, % Vol
 O_{2s} = Oxygen, Reference Conditions, % Vol

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - TOTAL PARTICULATE MATTER

Run	Sampled Volume m ³	Sampled Gas Temp K	Sampled Gas Pressure kPa	Sampled Gas Humidity % by volume	Oxygen Content % by volume	Limit of Detection % by mass	Leak %	Uncollected Mass mg
MU required	≤ 2%	≤ 2%	≤ 1%	≤ 1%	≤ 10%	≤ 5% of ELV	≤ 2%	≤ 10% of ELV
Run 1	0.002	2.0	0.50	1.0	N/A	0.50	-	-
as a %	0.20	0.69	0.50	1.0	N/A	4.07	0.79	0.005
compliant?	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes
Run 2	0.002	2.0	0.50	1.0	N/A	0.000	-	-
as a %	0.20	0.68	0.50	1.0	N/A	4.07	0.77	0.005
compliant?	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Run	Volume (STP) m ³	Mass of particulate mg	O ₂ Correction -	Leak mg/m ³	Uncollected Mass mg	Combined uncertainty
Run 1	1.14	1.0400	1.0	0.0039	0.0003	-
MU as mg/m ³	0.0113	0.4069	-	0.0039	0.0002	0.41
MU as %	1.33	48.0769	-	0.459	0.0278	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	0.81	mg/m³	96.20	% Result	8.14	% ELV
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(k is a coverage factor which gives a 95% confidence in the quoted figures)

Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - VELOCITY & VOLUMETRIC FLOW RATE

Measured Velocity at Actual Conditions	13.2	m/s
Measured Volumetric Flow rate at Actual Conditions	7569	m ³ /hr

Performance Characteristics & Source of Value	Units	Values	Requirement	Compliant
Uncertainty of Local Gas Velocity Determination	-	0.010		
Uncertainty of pitot tube coefficient	-	1.27		
Uncertainty of mean local dynamic pressures	-	1.27		
Factor loading, function of the number of measurements.	3 readings	0.591	minimum 3	Yes
Range of measurement device	pa	1000		
Resolution	pa	1.00		
Calibration uncertainty	pa	24.08	<1% of Value or 20 Pa whichever is greater	Yes
Drift	% range	0.10		
Linearity	% range	0.06	<2% of value	Yes
Uncertainty of gas density determination				
Uncertainty of molar mass determination	kg/mol	0.00002		
Uncertainty of temperature measurement	K	1.47	<1% of value	Yes
Uncertainty of absolute pressure in the duct	pa	515		
Uncertainty associated with the calculation of density	kg/m ³	0.007		
Uncertainty associated with the measurement of local velocity	-	0.0001		
Uncertainty associated with the measurement of mean velocity	-	0.0002		

Measurement Uncertainty - Velocity	m/s
Combined uncertainty	0.17
Expanded uncertainty at a 95% Confidence Interval	0.33

Note - The expanded uncertainty uses a coverage factor of k = 2.

Expanded Measurement Uncertainty of Velocity at a 95% Confidence Interval	%
Expressed as a % of the Measured Velocity	1.3
Expanded uncertainty at a 95% Confidence Interval	2.5

Measurement Uncertainty Volumetric Flow Rate	m ³ /hr
Combined uncertainty	199
Expanded uncertainty at a 95% Confidence Interval	390

Note - The expanded uncertainty uses a coverage factor of k = 2.

Expanded Measurement Uncertainty of Volumetric Flow Rate at a 95% Confidence Interval	%
Expressed as a % of the Measured Volumetric Flow Rate	2.6
Expanded uncertainty at a 95% Confidence Interval	5.2

Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

END OF REPORT

Thank you for choosing SOCOTEC for your environmental monitoring needs. We hope our services have met your requirements and that you are fully satisfied with your experience of working with us, we really do value your custom and would welcome your feedback. We would appreciate it if you could take a moment to complete a short online questionnaire so that we can improve our operations and address any areas that have not met with your expectations, by clicking on the following

https://www.surveymonkey.co.uk/r/CAE_customer_feedback_weblink