

STACK EMISSIONS MONITORING REPORT



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Operator & Address:

Medite Europe Limited
Redmonstown,
Clonmel,
Co. Tipperary,
Ireland

Permit Reference:

IE Licence: P0027-04

Release Point:

A2-6

Sampling Date(s):

25-27th August 2025

SOCOTEC Job Number:	LIR 1288 / Q3
Report Date:	02/109/205
Version:	1
Report By:	Aidan Whitney
MCERTS Number:	MM 20 1603
MCERTS Level:	MCERTS Level 2 - Team Leader
Technical Endorsements:	1, 2, 3 & 4
Report Approved By:	Enda Flood
MCERTS Number:	MM 12 1170
Business Title:	MCERTS Level 2 - Team Leader
Technical Endorsements:	1, 2, 3 & 4
Signature:	



1015



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EXECUTIVE SUMMARY

MONITORING OBJECTIVES

Medite Europe Limited operates a wood production/wood drier process at Clonmel which is subject to IE Licence P0027-04, under the EPA Act 1992.

SOCOTEC UK LTD were commissioned by Medite Europe Limited 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 IE Licence, P0027-04.

Plant

A2-6

Operator

Medite Europe Limited
Redmonstown,
Clonmel,
Co. Tipperary,
Ireland

IE Licence: P0027-04

Stack Emissions Monitoring Test House

SOCOTEC UK LTD - East Kilbride Laboratory
2-4 Langlands Place
Kelvin South Business Park
East Kilbride
G75 0YF
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					
A2-6					
Parameter	Units	Result	Calculated Uncertainty +/-	Emission Limit Value (ELV)	Accreditation
Total Particulate Matter	mg/m ³	11.6	0.36	20	MCERTS
Particulate Emission Rate	g/hr	2104	65	-	
PM ₁₀	mg/m ³	4.97	0.16	5	MCERTS
PM ₁₀ Emission Rate	g/hr	776.1	26	-	
PM _{2.5}	mg/m ³	4.93	0.16	-	MCERTS
PM _{2.5} Emission Rate	g/hr	771.10	24.68	-	
Dioxins & Furans - UPPER Limits					
Dioxins & Furans (NATO I-TEQ)	ng/m ³	0.0048	0.0009	-	MCERTS
Dioxins & Furans (NATO I-TEQ) Emission Rate	µg/hr	0.9059	0.1649	-	
Dioxins & Furans (WHO TEQ Humans / Mammals)	ng/m ³	0.0052	0.0009	-	MCERTS
Dioxins & Furans (WHO TEQ H / M) Emission Rate	µg/hr	0.9757	0.1776	-	
Dioxins & Furans (WHO TEQ Fish)	ng/m ³	0.0056	0.0010	-	MCERTS
Dioxins & Furans (WHO TEQ Fish) Emission Rate	µg/hr	1.0423	0.1897	-	
Dioxins & Furans (WHO TEQ Birds)	ng/m ³	0.0101	0.0018	-	MCERTS
Dioxins & Furans (WHO TEQ Birds) Emission Rate	µg/hr	1.9001	0.3458	-	
Dioxins & Furans - LOWER Limits					
Dioxins & Furans (NATO I-TEQ)	ng/m ³	0.0048	0.0009	-	MCERTS
Dioxins & Furans (NATO I-TEQ) Emission Rate	µg/hr	0.9059	0.1649	-	
Dioxins & Furans (WHO TEQ Humans / Mammals)	ng/m ³	0.0052	0.0009	-	MCERTS
Dioxins & Furans (WHO TEQ H / M) Emission Rate	µg/hr	0.9757	0.1776	-	
Dioxins & Furans (WHO TEQ Fish)	ng/m ³	0.0056	0.0010	-	MCERTS
Dioxins & Furans (WHO TEQ Fish) Emission Rate	µg/hr	1.0423	0.1897	-	
Dioxins & Furans (WHO TEQ Birds)	ng/m ³	0.0101	0.0018	-	MCERTS
Dioxins & Furans (WHO TEQ Birds) Emission Rate	µg/hr	1.9001	0.3458	-	
Total Volatile Organic Compounds	mg/m ³	31.06	1.7	120	MCERTS
Total Volatile Organic Compounds Emission Rate	g/hr	5573.51	306.54	-	
Oxides of Nitrogen (as NO ₂)	mg/m ³	24	5.9	110	MCERTS
Oxides of Nitrogen (as NO ₂) Emission Rate	g/hr	4370	1058	-	
Carbon Monoxide	mg/m ³	2.36	1.98	600	MCERTS
Carbon Monoxide Emission Rate	g/hr	423.59	355.37	-	
Oxygen	% v/v	19.8	0.273	-	MCERTS
Moisture	%	9.99	0.30	-	MCERTS
Stack Gas Temperature	°C	55	-	-	MCERTS
Stack Gas Velocity	m/s	16.1	0.39	-	

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, dry gas .

EXECUTIVE SUMMARY

MONITORING TIMES			
Parameter	Sampling Date(s)	Sampling Times	Sampling Duration
Total Particulate Matter Run 1	25 August 2025	12:40 - 13:40	60 minutes
PM ₁₀ Run 1	25 August 2025	14:48 - 15:48	60 minutes
PM _{2.5} Run 1	25 August 2025	14:48 - 15:48	60 minutes
Dioxins & Furans Run 1	27 August 2025	09:11 - 16:50	360 minutes
Total Volatile Organic Compounds Run 1	26 August 2025	13:35 - 14:35	60 minutes
Combustion Gases	26 August 2025	08:56 - 09:56	60 minutes
Preliminary Stack Traverse	25 August 2025	11:22	-

EXECUTIVE SUMMARY

PROCESS DETAILS

Parameter	Process Details
Description of process	Wood Production/Wood Drier
Continuous or batch	Continuous
Product Details	Wood Drier
Part of batch to be monitored (if applicable)	N/A
Normal load, throughput or continuous rating	Normal Production
Fuel used during monitoring	N/A
Abatement	Cyclone
Plume Appearance	Heavy Plume Visible

EXECUTIVE SUMMARY

Monitoring Methods

Declaration: Unless otherwise stated as a deviation, work has been completed to conform to the specific requirements of the Irish EPA's monitoring guidance notes; AG1, AG2, and the index of preferred methods.

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 - EN 13284-1	AE 104	1015	MCERTS	0.05 mg/m ³	3.1%	1.79%
PM ₁₀	SRM - EN 23210	AE 136	1015	MCERTS	0.02 mg/m ³	3.3%	3.3%
PM _{2.5}	SRM - EN 23210	AE 136	1015	MCERTS	0.01 mg/m ³	3.2%	N/A - No ELV
Dioxins & Furans	SRM - EN 1948 - Part 1	AE 109	1015	MCERTS	0.0005 ng/m ³	18.2%	N/A - No ELV
Total Volatile Organic Compounds	SRM - EN 12619:2013	AE 102	1015	MCERTS	0.3 mg/m ³	5.5%	1.4%
Oxides of Nitrogen	SRM - EN 14792:2017	AE 102	1015	MCERTS	0.51 mg/m ³	24.2%	5.36%
Carbon Monoxide	SRM - EN 15058:2017	AE 102	1015	MCERTS	0.28 mg/m ³	83.9%	0.3%
Oxygen	SRM - EN 14789:2017	AE 102	1015	MCERTS	0.01%	1.4%	N/A - No ELV
Moisture	EN 14790	AE 105	1015	MCERTS	0.01%	3.0%	N/A - No ELV
Velocity	SRM - EN ISO 16911-1	AE 154	1015	MCERTS	5 Pa	2.4%	N/A - No ELV
Volumetric Flow Rate	SRM - EN ISO 16911-1	AE 154	1015	MCERTS	-	5.1%	5.29%
-	-	-	-	-	-	-	-

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 (East Kilbride)	N/A	8 Weeks
PM ₁₀	Gravimetric	AE 106	1015	MCERTS	SOCOTEC (East Kilbride)	N/A	8 Weeks
PM _{2.5}	Gravimetric	AE 106	1015	MCERTS	SOCOTEC (East Kilbride)	N/A	8 Weeks
Dioxins and Furans	Gas Chromatography - High Resolution Mass Spectrometry	2002a	1668	MCERTS	Marchwood	25-93193 INPUT	8 Weeks
-	-	-	-	-	-	-	-

ON-SITE TESTING							
Species	Analytical Technique	Analytical Procedure	UKAS Lab Number	Accreditation	Laboratory	Data Archive Location	Archive Period
Total Volatile Organic Compounds	Flame Ionisation Detection	AE 102	1015	MCERTS	SOCOTEC (East Kilbride)	SOCOTEC (East Kilbride)	5 years
Oxides of Nitrogen	Chemiluminescence	AE 102	1015	MCERTS	SOCOTEC (East Kilbride)	SOCOTEC (East Kilbride)	5 years
Carbon Monoxide	Non Dispersive Infra Red	AE 102	1015	MCERTS	SOCOTEC (East Kilbride)	SOCOTEC (East Kilbride)	5 years
Oxygen	Paramagnetism	AE 102	1015	MCERTS	SOCOTEC (East Kilbride)	SOCOTEC (East Kilbride)	5 years
Moisture	Gravimetric	AE 105	1015	MCERTS	SOCOTEC (East Kilbride)	-	-

EXECUTIVE SUMMARY

SAMPLING LOCATION					
Sampling Plane Validation Criteria	Value	Units	Requirement	Compliant	Method
Lowest Differential Pressure	157	Pa	≥ 5 Pa	Yes	EN 15259
Lowest Gas Velocity	14.7	m/s	-	-	-
Highest Gas Velocity	17.3	m/s	-	-	-
Ratio of Gas Velocities	1.2	: 1	$< 3 : 1$	Yes	EN 15259
Mean Velocity	16.1	m/s	-	-	-
Maximum angle of flow with regard to duct axis	< 15	$^{\circ}$	$< 15^{\circ}$	Yes	EN 15259
No local negative flow	Yes	-	-	Yes	EN 15259

DUCT CHARACTERISTICS		
	Value	Units
Shape	Circular	-
Depth	2.30	m
Width	-	m
Area	4.16	m ²
Port Depth	90	mm

SAMPLING LINES & POINTS		
	Isokinetic	Non-Iso & Gases
Sample port size	4" bsp	4" bsp
Number of lines used	2	1
Number of points / line	1	1
Duct orientation	Vertical	1
Filtration	Out Stack	Out Stack
Filtration for TPM	Out Stack	-

SAMPLING PLATFORM	
General Platform Information	
Permanent / Temporary Platform / Ground level / Floor Level / Roof	Permanent
Inside / Outside	Outside

AG1 Platform requirements	
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	N/A
Depth of Platform = \geq Stack depth / diameter + wall and port thickness + 1.5m	No

Sampling Platform Improvement Recommendations (if applicable)

Although the sampling platform does not meet the requirements of AG1, in its current state it is acceptable due to use of deviations form SRM's

EXECUTIVE SUMMARY

Sampling & Analytical Method Deviations

Velocity Profile

As this sampling location shows high levels of turbulence throughout the results from the standard flow traverse are indicative. In the past, reports detailing the volumetric flow rate according to fan rating have been used to calculate mass emission rates for this stack.

Sample Line & Sample point

Only one sampling line will be accessed safely, therefore the other sampling line will not be accessed due to excessive probe overhang. It is only possible to sample from one representative sampling point for all isokinetic monitoring due to a number of factors, including excessively high flows close to the stack edge, swirl being greater than 15° & negative flow.]

Sampling Nozzle

Due to high flows in the stack, a nozzle smaller than the recommended minimum of 6mm was used to ensure isokinetic sampling rate could be met

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 - EN 13284-1	AE 104	1015	MCERTS	1
PM10	SRM - EN 23210	AE 136	1015	MCERTS	1
PM2.5	SRM - EN 23210	AE 136	1015	MCERTS	1
Dioxins & Furans	SRM - EN 1948 - Part 1	AE 109	1015	MCERTS	1
Total Volatile Organic Compounds	SRM - EN 12619:2013	AE 102	1015	MCERTS	1
Oxides of Nitrogen	SRM - EN 14792:2017	AE 102	1015	MCERTS	1
Carbon Monoxide	SRM - EN 15058:2017	AE 102	1015	MCERTS	1
Oxygen	SRM - EN 14789:2017	AE 102	1015	MCERTS	1
Moisture	EN 14790	AE 105	1015	MCERTS	1
Velocity	SRM - EN ISO 16911-1	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	LIR 9.47 / 9.44	Horiba PG-250 Analyser	LIR 12.15	Laboratory Balance	LIR 15.21
Box Thermocouples	LIR 9.48 / 9.46	FT-IR	-	Tape Measure	LIR 20.19
Meter In Thermocouple	LIR 9.48 / 9.46	FT-IR Oven Box	-	Stopwatch	-
Meter Out Thermocouple	LIR 9.48 / 9.46	Bernath 3006 FID	-	Protractor	-
Control Box Timer	LIR 17.26 / 27.25	Signal 3030 FID	-	Barometer	LIR 16.8
Oven Box	-	Servomex	-	Digital Micromanometer	LIR 1.20
Probe	LIR 6.11 / 6.7	JCT Heated Head Filter	-	Digital Temperature Meter	LIR 2.20
Probe Thermocouple	-	Thermo FID	LIR 8.44	Stack Thermocouple	-
Probe	-	Stackmaster	-	Mass Flow Controller	-
Probe Thermocouple	-	FTIR Heater Box for Heated Line	-	MFC Display module	-
S-Pitot	LIR 6.11/ 6.7	Anemometer	-	1m Heated Line (1)	-
L-Pitot	-	Ecophysics NOx Analyser	-	1m Heated Line (2)	-
Site Balance	LIR 23.12	Chiller (JCT/MAK 10)	LIR 12.19	1m Heated Line (3)	-
Last Impinger Arm	-	Heated Line Controller (1)	LIR 8.56	5m Heated Line (1)	-
Dioxins Cond. Thermocouple	-	Heated Line Controller (2)	LIR 8.77	10m Heated Line (1)	-
Callipers	LIR 15.1F	Site temperature Logger	-	10m Heated Line (2)	-
Small DGM	-		-	15m Heated Line (1)	-
Heater Controller	-		-	20m Heated Line (1)	LIR 8.77
Inclinometer (Swirl Device)	LIR 24.10		-	20m Heated Line (2)	LIR 24.10

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

CALIBRATION GASES					
Gas (traceable to ISO 17025)	Cylinder I.D Number	Supplier	ppm	%	Analytical Tolerance +/- %
Propane	LEK 391	BOC	82.8	-	2.0

Note: Span gases may be diluted to an appropriate range with a gas divider.

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
Enda Flood	MM 12 1170	MCERTS Level 2	Mar-28	Mar-29	Mar-29	Jun-28	Nov-28	Mar-28
Aidan Whitney	MM 20 1603	MCERTS Level 2	Nov-26	Nov-26	Apr-29	Mar-28	Apr-27	Sep-30
Aisling Brophy	MM 25 1882	MCERTS Trainee	Apr-30	-	-	-	-	Apr-30

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	12:40 - 13:40 25 August 2025	11.63	0.36	20	2104
Blank	-	0.05	-	-	-

Reference conditions are 273K, 101.3kPa, dry gas .

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	IAC339	0.09946	0.10667	0.00721	54.30425	54.31028	0.00603	0.01324

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	IAC 327	0.10060	0.10061	0.00001	56.66639	56.66640	0.00001	0.00006

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	101.1	CO ₂	%	0.21
Stack static pressure, P _{static}	pa	-260.0	O ₂	%	19.76
P _s = P _b + P _{static}	Kpa	100.8	Total	%	19.97
			N ₂ (100 - Total)	%	80.03
			M _d = 0.44(%CO ₂) + 0.32(%O ₂) + 0.28(%N ₂)		28.82
Vol. of water vapour collected, V_{wstd}			Molecular weight of wet gas, M_s		
Moisture trap weight increase, V _{lc}	g	101.4	M _s = M _d (1 - B _{w0}) + 18(B _{w0})	g/gmol	27.74
V _{wstd} = (0.001246)(V _{lc})	m ³	0.1263444			
Volume of gas metered dry, V_{mstd}			Actual flow of stack gas, Q_a		
Volume of gas sample through gas meter, V _m		1.262	Area of stack, A _s	m ²	4.16
Gas meter correction factor, Y _d		0.975	Q _a = (60)(A _s)(V _s)	m ³ /min	4042.6
Mean dry gas meter temperature, T _m		296	Total flow of stack gas, Q		
Mean pressure drop across orifice, DH	mmH ₂ O	41.425	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	1.138	Q _{std} = $\frac{(Q_a)P_s(0.3592)(1-B_{w0})}{(T_s)}$	Dry	3013.8
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	1.2646	Q _{stw} = $\frac{(Q_a)P_s(0.3592)}{(T_s)}$	Wet	3348.31
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	5.89
% oxygen measured in gas stream, act%O ₂		19.8	Nozzle area, A _n	mm ²	27.28
% 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 = $\frac{(4.6398E6)(T_s)(V_{mstd})}{(P_s)(V_s)(A_n)(q)(1-B_{w0})}$	%	95.9
Factor = $\frac{21.0 - \text{ref}\%O_2}{21.0 - \text{act}\%O_2}$		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_{w0}			Mass collected on filter, M _f	g	0.00721
B _{w0} = $\frac{V_{wstd}}{V_{mstd} + V_{wstd}}$	%	0.0999	Mass collected in probe, M _p	g	0.00603
		9.99	Total mass collected, M _n	g	0.01324
Moisture by FTIR			C _{wet} = $\frac{M_n}{V_{mstw}}$	mg/m ³	10.473
Velocity of stack gas, V_s			C _{dry} = $\frac{M_n}{V_{mstd}}$	mg/m ³	11.635
Velocity pressure coefficient, C _p		0.85	C _{dry@X%O2} = $\frac{M_n}{V_{mstd@X\%oxygen}}$	mg/m ³	No O2 Ref
Mean of velocity heads, DP _{avg}	Pa	185.38	Particulate Emission Rates, E		
Mean stack gas temperature, T _s	K	328	E = [(C _{wet})(Q _{stw})(60)] / 1000		2103.91
Gas density (wet, ambient), ρ	kg/m ³	1.026			
ρ = (M _s *P _s)/(8.314*T _s)					
Stack Velocity, V _s	$V_s = \frac{\sum_{i=1}^n V_i}{n}$	m/s			
		16.21			

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	20.50	0.25	-	-812.8	0.41	Yes

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

ISOKINETICITY		
Run	Isokinetic Variation %	Acceptable Isokineticity
Run 1	95.87	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	0.05	1.0	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	0.05	20	2.0	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	55	180	160

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

PM ₁₀ SUMMARY					
Test	Sampling Times	Concentration mg/m ³	LOD mg/m ³	ELV mg/m ³	Emission Rate g/hr
Run 1	14:48 - 15:48 25 August 2025	5.0	0.02	5	776

Reference conditions are 273K, 101.3kPa, dry gas .

PM _{2.5} SUMMARY					
Test	Sampling Times	Concentration mg/m ³	LOD mg/m ³	ELV mg/m ³	Emission Rate g/hr
Run 1	14:48 - 15:48 25 August 2025	4.9	0.01	-	771

Reference conditions are 273K, 101.3kPa, dry gas .

FILTER INFORMATION

Sample Run	PM ₁₀ SAMPLES WEIGHTS				PM _{2.5} SAMPLES WEIGHTS			
	PM ₁₀ Filter Number	Filter Start Weight g	Filter End Weight g	PM ₁₀ Mass Gained on Filter g	PM _{2.5} Filter Number	Filter Start Weight g	Filter End Weight g	PM _{2.5} Mass Gained on Filter g
Run 1	IAC 366	0.10	0.10	0.00005	IAC 305	0.10	0.11	0.00769
Run 2	-	-	-	-	-	-	-	-
Run 3	-	-	-	-	-	-	-	-

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

ISOKINETIC SAMPLING EQUATIONS RUN 1			PM ₁₀ & PM _{2.5}	
Absolute pressure of stack gas, P_s			Molecular weight of dry gas, M_d	
Barometric pressure, P _b	kPa	101.1	CO ₂	0.21
Stack static pressure, P _{static}	Pa	-260.0	O ₂	19.76
P _s = P _b + (P _{static})	kPa	100.8	Total	19.97
			N ₂ (100 -Total)	80.03
			M _d = 0.44(%CO ₂)+0.32(%O ₂)+0.28(%N ₂)	28.82
Vol. of water vapour collected, V_{wstd}			Molecular weight of wet gas, M_s	
Moisture trap weight increase, V _{lc}	g	344.4	M _s = M _d (1 - B _{w0}) + 18(B _{w0})	26.49
V _{wstd} = (0.001246)(V _{lc})	m ³	0.4291224		
Volume of gas metered dry, V_{mstd}			Actual flow of stack gas, Q_a	
Volume of gas sample through gas meter, V _m	m	1.72	Area of stack, A _s	m ² 4.16
Gas meter correction factor, Y _d		0.97	Q _a = (60)(A _s)(V _s)	m ³ /min 4011.3
Mean dry gas meter temperature, T _m		295.00	Q _{stw} = $\frac{(Q_a)P_s(0.3592)}{(T_s)+273}$	Wet 3322.40
Mean pressure drop across orifice, DH	mmH ₂ O	103.23		
V _{mstd} = $\frac{(0.3592)(V_m)(P_b+(DH/13.6))(Y_d)}{T_m+273}$	m ³	1.559	Percent isokinetic, %I	
			Required Flow Rate @ DGM	l/min 34.00
			Actual Flow Rate @ DGM	l/min 30.9
			Isokinetic Rate	90.85
			Acceptable 90% - 130%	Yes
Volume of gas metered wet, V_{mstw}			Particulate Concentration, C_{PM10}	
V _{mstw} = V _{mstd} + V _{wstd}	m ³	1.988	Mass of particulate collected on PM ₁₀ filter, M _f	5E-05
			Mass of particulate collected on PM _{2.5} filter, M _f	0.00769
			C _{wet} = $\frac{M_n}{V_{mstw}}$	mg/m ³ 3.89
			C _{dry} = $\frac{M_n}{V_{mstd}}$	mg/m ³ 4.97
			C _{dry@X%O2} = $\frac{M_n}{V_{mstd@X\%oxygen}}$	No O2 Ref
Vol. of gas metered at O₂ Ref. Cond., V_{mstd@X%O2}			Particulate Emission Rates, E	
Is the process burning hazardous waste? (If yes, no favourable oxygen correction)	No		E = [(C _{wet})(Q _{stw})(60)] / 1000	776.11
% oxygen measured in gas stream, act%O ₂	19.76		Particulate Concentration, C_{PM2.5}	
% oxygen reference condition	21		Mass of particulate collected on filter, M _f	0.00769
O ₂ Reference O ₂ Ref = 21.0 - act%O ₂	No O2 Ref		C _{wet} = $\frac{M_n}{V_{mstw}}$	mg/m ³ 3.8682
Factor 21.0 - ref%O ₂	No O2 Ref		C _{dry} = $\frac{M_n}{V_{mstd}}$	mg/m ³ 4.9330
V _{mstd@X%oxygen} = (V _{mstd}) (O ₂ Ref)	No O2 Ref		C _{dry@X%O2} = $\frac{M_n}{V_{mstd@X\%oxygen}}$	No O2 Ref
Moisture content, B_{w0}				
B _{w0} = $\frac{V_{wstd}}{V_{mstd} + V_{wstd}}$	%	9.99	E = [(C _{wet})(Q _{stw})(60)] / 1000	
Moisture by FTIR				
			771.10	
Velocity of stack gas, V_s				
Velocity pressure coefficient, C _p		0.85		
Mean of velocity heads, DP _{avg}	Pa	187.29		
Mean stack gas temperature, T _s	K	328		
Gas density (wet, ambient), ρ	kg/m ³	0.979		
ρ = (M _s *P _s)/(8.314*T _s)				
Stack Velocity, V _s	$V_s = C_p \sqrt{\frac{\Delta DP_{avg}}{\rho}}$	m/s 16.09		
*Velocity taken from preliminary survey				

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

PM₁₀ & PM_{2.5} 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	30.89	0.50	0.50	-812.8	0.62	Yes

FLOW CRITERIA					
Run	Isokinetic Variation %	Acceptable Isokineticity (90% - 130%)	Nominal Flow Rate l/min	Maximum Flow Variation %	Acceptable Deviation from the Nominal Flow Rate (+/-5%)
Run 1	90.85	Yes	34	-49.72	No

Acceptable Isokinetic rate 90 -130%

FILTERS					
Run	Filter Material	Filter Size mm	Max Filtration Temperature °C	Pre-conditioning Filter Temperature °C	Post conditioning Filtration Temperature °C
Run 1	Glass Fibre	47	55	180	160

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

DIOXINS & FURANS SUMMARY - UPPER LIMIT

NATO I-TEQ					
Test	Sampling Times	Concentration ng/m ³	LOD ng/m ³	ELV ng/m ³	Emission Rate µg/hr
Run 1	09:11 - 16:50 27 August 2025	0.0048	0.0005	-	0.91
Field Blanks Run 1	-	0.000389	0.00031	-	-

WHO TEQ (Humans / Mammals)					
Test	Sampling Times	Concentration ng/m ³	LOD ng/m ³	ELV ng/m ³	Emission Rate µg/hr
Run 1	09:11 - 16:50 27 August 2025	0.0052	0.0005	-	0.98

WHO TEQ (Fish)					
Test	Sampling Times	Concentration ng/m ³	LOD ng/m ³	ELV ng/m ³	Emission Rate µg/hr
Run 1	09:11 - 16:50 27 August 2025	0.0056	0.0006	-	1.04

WHO TEQ (Birds)					
Test	Sampling Times	Concentration ng/m ³	LOD ng/m ³	ELV ng/m ³	Emission Rate µg/hr
Run 1	09:11 - 16:50 27 August 2025	0.0101	0.0011	-	1.90

Reference conditions are 273K, 101.3kPa, dry gas .

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

DIOXINS & FURANS SUMMARY - LOWER LIMIT

NATO I-TEQ					
Test	Sampling Times	Concentration ng/m ³	LOD ng/m ³	ELV ng/m ³	Emission Rate µg/hr
Run 1	09:11 - 16:50 27 August 2025	0.0048	-	-	0.91

WHO TEQ (Humans / Mammals)					
Test	Sampling Times	Concentration ng/m ³	LOD ng/m ³	ELV ng/m ³	Emission Rate µg/hr
Run 1	09:11 - 16:50 27 August 2025	0.0052	-	-	0.98

WHO TEQ (Fish)					
Test	Sampling Times	Concentration ng/m ³	LOD ng/m ³	ELV ng/m ³	Emission Rate µg/hr
Run 1	09:11 - 16:50 27 August 2025	0.0056	-	-	1.04

WHO TEQ (Birds)					
Test	Sampling Times	Concentration ng/m ³	LOD ng/m ³	ELV ng/m ³	Emission Rate µg/hr
Run 1	09:11 - 16:50 27 August 2025	0.0101	-	-	1.90

Reference conditions are 273K, 101.3kPa, dry gas .

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

DIOXINS & FURANS ANALYSIS SUMMARY - RUN 1

NATO I-TEQ & WHO TEQ (Humans / Mammals)							
Congener	Result	NATO I-TEQ	WHO TEQ Humans / Mammals	Extraction Recovery		Sampling Recovery	
				Actual	Permitted	Actual	Permitted
	ng	ng	ng	%	%	%	%
Dioxins							
2,3,7,8 Tetra CDD	0.0016	0.0016	0.0016	95	50% - 130%		
1,2,3,7,8 Penta CDD	0.00999	0.0050	0.0100	77	50% - 130%		
1,2,3,4,7,8 Hexa CDD	0.00721	0.0007	0.0007	103	50% - 130%		
1,2,3,6,7,8 Hexa CDD	0.0149	0.0015	0.0015	101	50% - 130%		
1,2,3,7,8,9 Hexa CDD	0.0108	0.0011	0.0011		-		
1,2,3,4,6,7,8 Hepta CDD	0.0809	0.0008	0.0008	82	40% - 130%		
OCDD Octa CDD	0.0866	0.0001	0.00003	74	40% - 130%		
Total -Dioxins	0.212	0.0108	0.0157				
Furans							
2,3,7,8 Tetra CDF	0.0208	0.0021	0.0021	89	50% - 130%		
1,2,3,7,8 Penta CDF	0.00873	0.0004	0.0003		-	69	>=50
2,3,4,7,8 Penta CDF	0.0143	0.0072	0.0043	88	50% - 130%		
1,2,3,4,7,8 Hexa CDF	0.0123	0.0012	0.0012	92	50% - 130%		
1,2,3,6,7,8 Hexa CDF	0.0117	0.0012	0.0012	92	50% - 130%		
2,3,4,6,7,8 Hexa CDF	0.0131	0.0013	0.0013	93	50% - 130%		
1,2,3,7,8,9 Hexa CDF	0.00094	0.0001	0.0001		-	86	>=50
1,2,3,4,6,7,8 Hepta CDF	0.034	0.0003	0.0003	78	40% - 130%		
1,2,3,4,7,8,9 Hepta CDF	0.00277	0.00003	0.00003		-	89	>=50
OCDF Octa CDF	0.00563	0.00001	0.00000	70	40% - 130%		
Total -Furans	0.12427	0.0138	0.0108				
Mean Recoveries (%)				87		81	
Total Isomers	0.33627	0.0246	0.0265				
Total ITEQ (<LOD = 0)		0.0246	0.0265				

NOTE: The Total Isomers result includes all isomers below the limit of detection. This gives a "worst case" Dioxins & Furans result.

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

DIOXINS & FURANS ANALYSIS SUMMARY - RUN 1

WHO TEQ (Fish) & WHO TEQ (Birds)							
Congener	Result ng	WHO TEQ Fish ng	WHO TEQ Birds ng	Extraction Recovery		Sampling Recovery	
				Actual %	Permitted %	Actual %	Permitted %
Dioxins							
2,3,7,8 Tetra CDD	0.0016	0.0016	0.0016	95	50% - 130%		
1,2,3,7,8 Penta CDD	0.00999	0.0100	0.0100	77	50% - 130%		
1,2,3,4,7,8 Hexa CDD	0.00721	0.0036	0.0004	103	50% - 130%		
1,2,3,6,7,8 Hexa CDD	0.0149	0.0001	0.0001	101	50% - 130%		
1,2,3,7,8,9 Hexa CDD	0.0108	0.0001	0.0001		-		
1,2,3,4,6,7,8 Hepta CDD	0.0809	0.00008	0.00008	82	40% - 130%		
OCDD Octa CDD	0.0866	-	-	74	40% - 130%		
Total -Dioxins	0.212	0.0155	0.0123				
Furans							
2,3,7,8 Tetra CDF	0.0208	0.0010	0.0208	89	50% - 130%		
1,2,3,7,8 Penta CDF	0.00873	0.0004	0.0001		-	69	>=50
2,3,4,7,8 Penta CDF	0.0143	0.0072	0.0143	88	50% - 130%		
1,2,3,4,7,8 Hexa CDF	0.0123	0.0012	0.0012	92	50% - 130%		
1,2,3,6,7,8 Hexa CDF	0.0117	0.0012	0.0012	92	50% - 130%		
2,3,4,6,7,8 Hexa CDF	0.0131	0.0013	0.0013	93	50% - 130%		
1,2,3,7,8,9 Hexa CDF	0.00094	0.0001	0.0001		-	86	>=50
1,2,3,4,6,7,8 Hepta CDF	0.034	0.0003	0.0003	78	40% - 130%		
1,2,3,4,7,8,9 Hepta CDF	0.00277	0.00003	0.00003		-	89	>=50
OCDF Octa CDF	0.00563	0.00000	0.00000	70	40% - 130%		
Total -Furans	0.12427	0.0128	0.0394				
Mean Recoveries (%)				87		81	
Total Isomers	0.33627	0.0283	0.0516				
Total ITEQ (<LOD = 0)		0.0283	0.0516				

NOTE: The Total Isomers result includes all isomers below the limit of detection. This gives a "worst case" Dioxins & Furans result.

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

ISOKINETIC SAMPLING EQUATIONS - RUN 1			Dioxins & Furans	
Absolute pressure of stack gas, P_s			Molecular weight of dry gas, M_d	
Barometric pressure, P _b	kPa	101.10	CO ₂	% 0.21
Stack static pressure, P _{static}	Pa	-276.00	O ₂	% 19.76
P _s = P _b + (P _{static})	kPa	100.82	Total	% 19.97
			N ₂ (100 -Total)	% 80.03
			M _d = 0.44(%CO ₂)+0.32(%O ₂)+0.28(%N ₂)	28.82
Vol. of water vapour collected, V_{wstd}			Molecular weight of wet gas, M_s	
Moisture trap weight increase, V _{lc}	g	344.4	M _s = M _d (1 - B _{w0}) + 18(B _{w0})	g/gmol 27.98
V _{wstd} = (0.001246)(V _{lc})	m ³	0.4291	Velocity of stack gas, V_s	
Volume of gas metered dry, V_{mstd}			Velocity pressure coefficient, C _p	0.843
Volume of gas sample through gas meter, V _m	m ³	5.97	Mean of velocity heads, DP _{avq}	Pa 194.91
Gas meter correction factor, Y _d		0.93	Mean stack gas temperature, T _s	K 324.06
Mean dry gas meter temperature, T _m		296.00	Gas density (wet, ambient), ρ	
Mean pressure drop across orifice, DH	mmH ₂ O	19.96	ρ = (M _s *P _s)/(8.314*T _s)	kg/m ³ 1.047
V _{mstd} = (0.3592)(V _m)(P _b +(DH/13.6))(Y _d)	m ³	5.10	Stack Velocity, V _s	$V_s = \frac{\sum_{i=1}^n V_i}{n}$ m/s 16.23
Volume of gas metered wet, V_{mstw}			Actual flow of stack gas, Q_a	
V _{mstw} = V _{mstd} + V _{wstd}	m ³	5.5314	Area of stack, A _s	m ² 4.16
Vol. of gas metered at O₂ Ref. Cond., V_{mstd@X%O2}			Q _a = (60)(A _s)(V _s)	m ³ /min 4046.2
Is the process burning hazardous waste? (If yes, no favourable oxygen correction)	No		Total flow of stack gas, Q	
% oxygen measured in gas stream, act%O ₂	19.76		Conversion factor (K/mm.Hg)	
% oxygen reference condition	21		Q _{std} = (Q _a)P _s (0.3592)(1-B _{w0})	Dry 3128.4
O ₂ Reference O ₂ Ref = 21.0 - act%O ₂	No O ₂ Ref		(T _s)	
Factor 21.0 - ref%O ₂	No O ₂ Ref		Q _{stdO2} = (Q _a)P _s (0.3592)(1-B _{w0})(O ₂ REF)	@O2ref No O2 Ref
V _{mstd@X%oxygen} = (V _{mstd}) (O ₂ Ref)	No O ₂ Ref		(T _s)	
Moisture content, B_{w0}			Q _{stw} = (Q _a)P _s (0.3592)	Wet 3392
B _{w0} = $\frac{V_{wstd}}{V_{mstd} + V_{wstd}}$	%	0.0776	Percent isokinetic, %I	
	%	7.76	Nozzle diameter, D _n	mm 4.9
Moisture by FTIR			Nozzle area, A _n	mm ² 19.1
	%	-	Total sampling time, q	min 360.0
			%I = $\frac{(4.6398E6)(T_s)(V_{mstd})}{(P_s)(V_s)(A_n)(q)(1-B_{w0})}$	% 98.3
			Acceptable isokinetic range 95% to 115%	Yes

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

DIOXINS & FURANS QUALITY ASSURANCE CHECKLIST

Leak Test Results	Mean Sampling Rate litre/min	Pre-sampling Leak Rate litre/min	Post-sampling Leak Rate litre/min	Maximum Vacuum mm Hg	Leak Tests Acceptable litre/min	Acceptable Leak Rate litre/min	Leak Tests Acceptable litre/min
Run 1	15.37	0.20	0.25	-609.6	Yes	0.77	Yes

Isokinetic Criterion Compliance	Isokinetic Variation %	Acceptable Isokineticity %
Run 1	98.3	Yes

Acceptable isokinetic range 95% to 115%

Filtration	Filter Material	Filter Size mm	Maximum Filtration Temperature °C
Run 1	Glass Fibre	47	120

Critical Sampling Requirement	Maximum Temperature at Condenser / Adsorber °C	Acceptable Temperature?	Temperature during storage / transit <25°C
Run 1	0	Yes	Yes
Acceptance Criteria	< 20°C	-	< 25°C

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

TOTAL VOLATILE ORGANIC COMPOUNDS SUMMARY

Test	Sampling Times	Concentration mg/m ³	LOD mg/m ³	ELV mg/m ³	Emission Rate g/hr
Run 1	13:35 - 14:35 26 August 2025	31.1	0.30	120	5573.51

Reference conditions are 273K, 101.3kPa, dry gas .

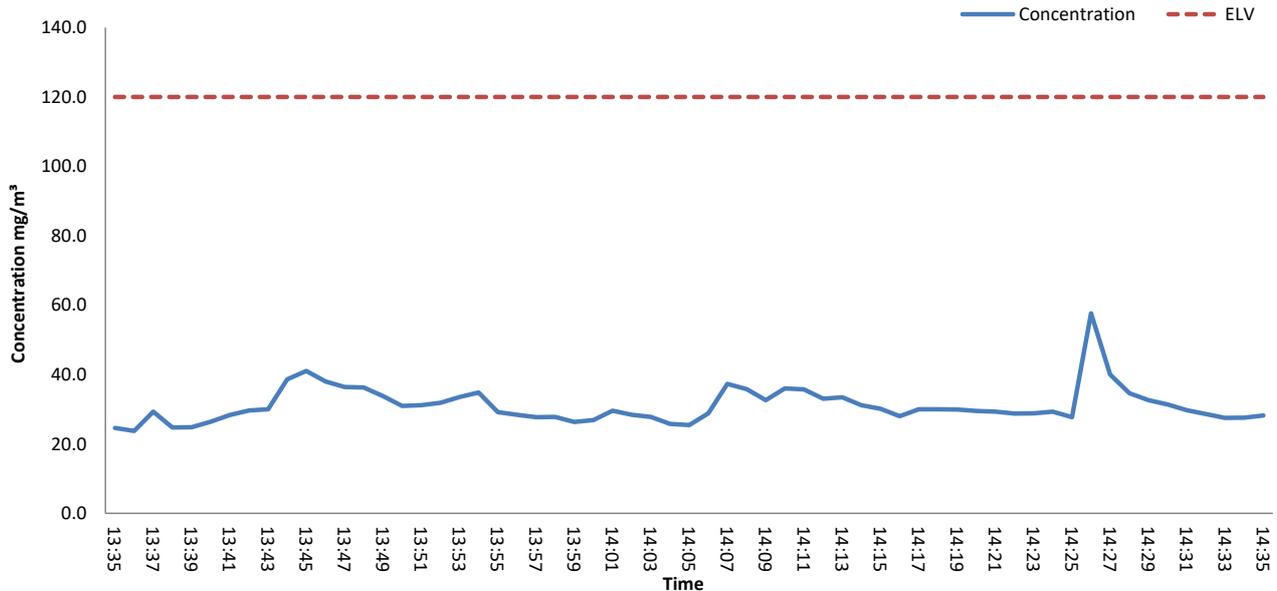
INSTRUMENTAL SPAN & ZERO CHECKS

PRE-SAMPLING CALIBRATION CHECKS								
Date	26 August 2025							
Start Time	11:53							
End Time	12:04							
Gas	Span Conc (ppm)	Analyser Range	Instrument Zero Reading	Instrument Span Reading	Instrument Zero Reading	Zero Down line reading	Span down line reading	Leak Rate (%)
Propane	82.8	100	-0.12	82.7	-0.80	0.40	81.9	0.98

Zero and Span gas contained 20% Oxygen

2								
Date	26 August 2025							
Start Time	17:20							
End Time	17:30							
Gas	Mean Raw Value ppm	Zero down line reading	Span down line reading	Zero Drift (%)	Span Drift (%)	Corrected for Zero Drift	Corrected for Span Drift	Corrected Values ppm / %
Propane	17.39	1.02	81.1	0.75	-1.67	x	x	N/A - not corrected

TOTAL VOLATILE ORGANIC COMPOUNDS EMISSIONS CHART



Reference conditions are 273K, 101.3kPa, dry gas .

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

COMBUSTION GASES SUMMARY

Test	Sampling Time and Date	Concentration mg/m ³	LOD mg/m ³	ELV mg/m ³	Emission Rate g/hr
Oxides of Nitrogen	08:56 - 09:56 26 August 2025	24.4	0.51	110	4370
Carbon Monoxide	08:56 - 09:56 26 August 2025	2.4	0.28	600	423.59

Test	Sampling Time and Date	Concentration %	LOD %
Oxygen	08:56 - 09:56 26 August 2025	19.76	0.01

Reference conditions are 273K, 101.3kPa, dry gas .

PRE-SAMPLING CALIBRATION DATA

Date	26 August 2025
Start Time	08:35
End Time	08:50

Chiller Temperature (°C)	2.9
Requirement	< 4°C
Compliant	Yes

Gas	Analyser Range (ppm / %)	Zero Reading at analyser	Span Reading at analyser	Zero Check at analyser	Zero Check down line	Span Check down line	Response Time (Secs)	Leak Rate %
Nitric Oxide	250	0.00	209.9	0.10	0.00	208.1	30	0.87
Carbon Monoxide	200	0.00	169.6	0.47	0.60	168.6	30	0.59
Oxygen	25	0.00	20.97	0.11	0.03	20.97	30	0.00

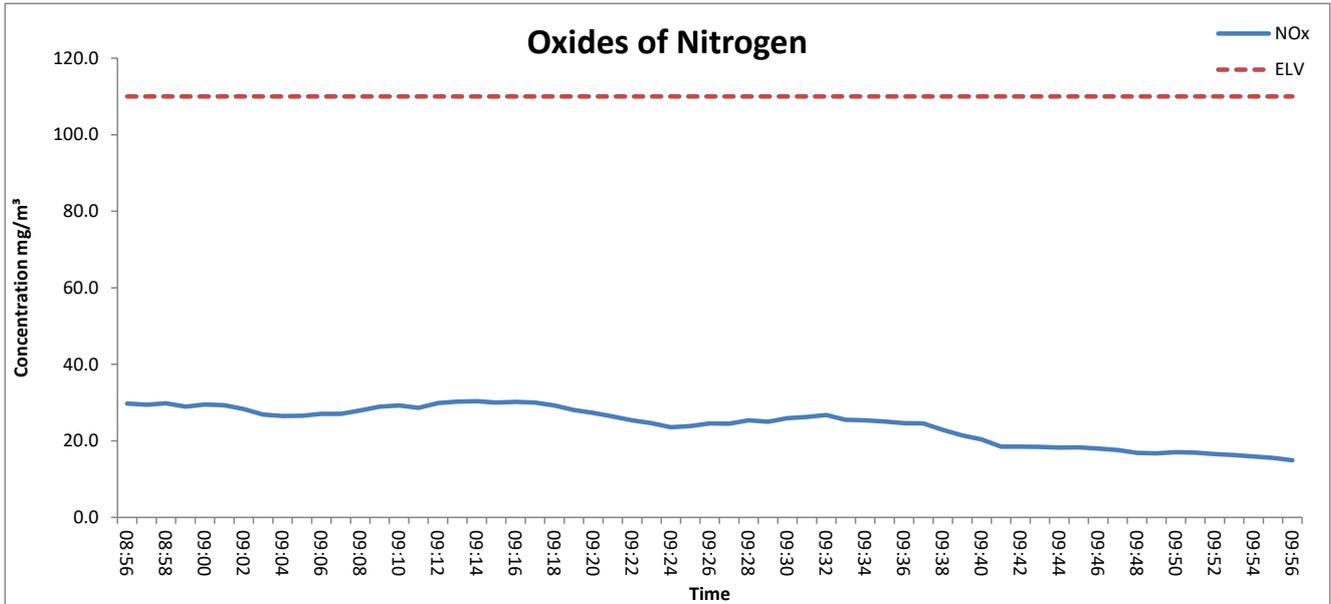
POST-SAMPLING CALIBRATION DATA

Date	26 August 2025
Start Time	11:11
End Time	11:18

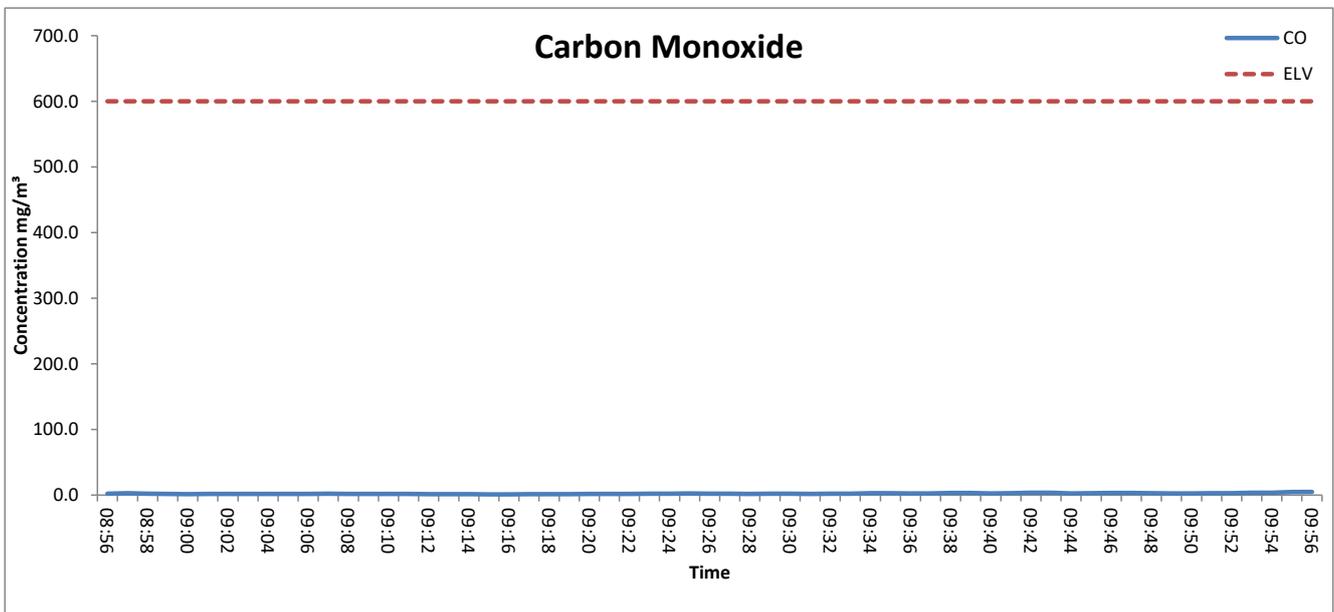
Chiller Temperature (°C)	2.9
Requirement	< 4°C
Compliant	Yes

Gas	Zero Check at Analyser	Span Check at Analyser	Zero Drift (% of Span Gas)	Span Drift (% of Span Gas)	Corrected for Zero Drift	Corrected for Span Drift	Corrected Values ppm / %
Nitric Oxide	0.00	212.3	-0.05	1.18	x	x	N/A - not corrected
Carbon Monoxide	0.40	169.4	-0.04	-0.03	x	x	N/A - not corrected
Oxygen	0.04	20.87	-0.32	-0.13	x	x	N/A - not corrected

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts
OXIDES OF NITROGEN (as NO₂) EMISSIONS CHART

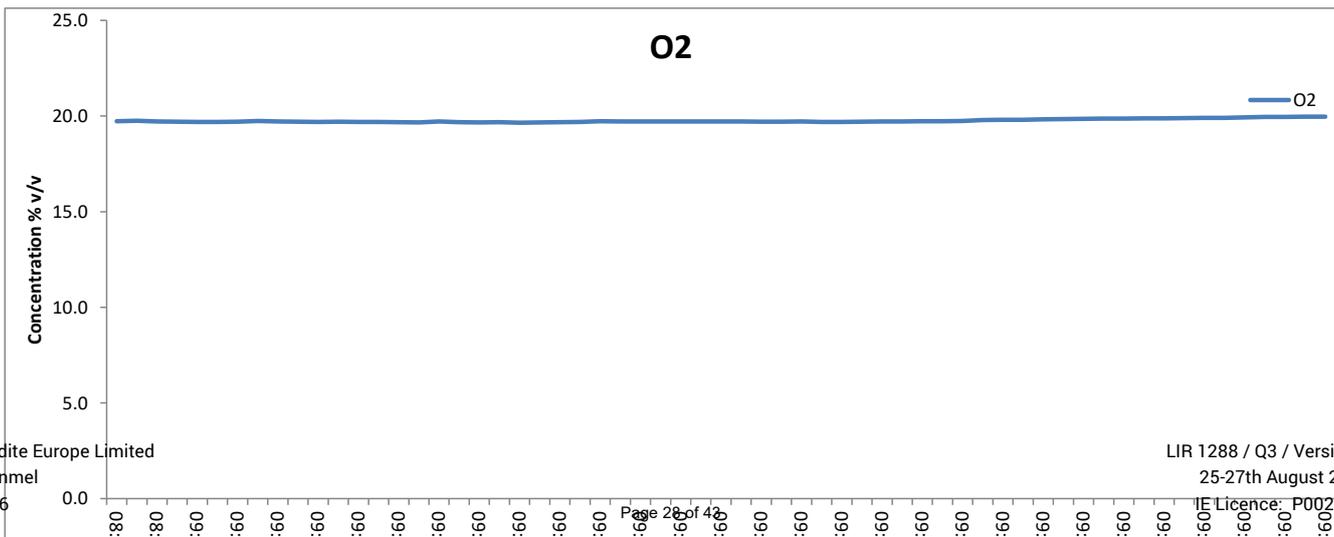


CARBON MONOXIDE EMISSIONS CHART



APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

OXYGEN EMISSIONS CHART



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Time

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

MOISTURE CALCULATIONS

Moisture Determination - Isokinetic							
Test Number	Sampling Time and Date	Start Weight	End Weight	Total gain	Concentration	LOD	Uncertainty
		kg	kg	kg	%	%	%
Run 1	12:40 - 13:40 25 August 2025	2.4252	2.5266	0.1014	10.0	0.01	3.0

Moisture Quality Assurance							
Test Number	Sampling Duration	Total Volume Sampled	Sampling Rate	Start Leak Rate	End Leak Rate	Acceptable Leak Rate	Leak Tests Acceptable?
	mins	l	l/min	l/min	l/min	l/min	
Run 1	60	1265	20.5	0.25	-	0.41	Yes

PRELIMINARY STACK SURVEY

Stack Characteristics		
Stack Diameter / Depth, D	2.30	m
Stack Width, W	-	m
Stack Area, A	4.16	m ²
Average stack gas temperature	55	°C
Stack static pressure	-0.276	kPa
Barometric Pressure	101.1	kPa

Stack Gas Composition & Molecular Weights								
Component	Molar Mass	Density	Conc Dry	Dry Volume Fraction	Dry Conc	Conc Wet	Wet Volume Fraction	Wet Conc
	M	kg/m ³ ρ	% Vol	r	kg/m ³ pi	% Vol	r	kg/m ³ pi
CO ₂	44	1.963059	0.210476	0.002105	0.004132	0.189447	0.001894	0.003719
O ₂	32	1.427679	19.756393	0.197564	0.282058	17.782531	0.177825	0.253877
N ₂	28	1.249219	80.033130	0.800331	0.999789	72.037014	0.720370	0.899900
H ₂ O	18	0.803070	-	-	-	9.991008	0.099910	0.080235

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

Calculation of Stack Gas Densities		
Determinand	Result	Units
Dry Density (STP), P_{STD}	1.2860	kg/m ³
Wet Density (STP), P_{STW}	1.2377	kg/m ³
Dry Density (Actual), P_{Actual}	1.0653	kg/m ³
Average Wet Density (Actual), $P_{ActualW}$	1.025	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	25 August 2025
Time of Survey	11:22
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	0.07	166.6	17.0	55	15.2	63.1	-	<15
2	0.21	156.8	16.0	55	14.7	61.2	-	<15
3	0.38	205.8	21.0	55	16.9	70.2	-	<15
4	0.61	176.4	18.0	55	15.6	65.0	-	<15
5	1.15	196.0	20.0	55	16.5	68.5	-	<15
6	1.69	186.2	19.0	55	16.1	66.7	-	<15
7	1.92	176.4	18.0	55	15.6	65.0	-	<15
8	2.09	205.8	21.0	55	16.9	70.2	-	<15
9	2.23	215.6	22.0	55	17.3	71.8	-	<15
-	-	-	-	-	-	-	-	-
Mean	-	187.3	19.1	55	16.1	66.9	-	-

Sampling Line B								
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 °
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
Mean	-	-	-	-	-	-	-	-

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	103	104	-1.0	Pass	105	106	-1.0	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	-276	-280	4.0	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	157	Pa	>= 5 Pa	Yes
Lowest Gas Velocity	14.7	m/s	-	-
Highest Gas Velocity	17.3	m/s	-	-
Ratio of Gas Velocities	1.2	-	< 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	16.1	m/s

Calculation of Stack Gas Volumetric Flowrate, Q			
Duct gas flow conditions	Actual	Reference	Units
Temperature	55	0	°C
Total Pressure	100.824	101.3	kPa
Oxygen	19.8	21	%
Moisture	9.99	0.00	%
Pitot tube calibration coefficient, K_{pt}	0.84		

Gas Volumetric Flowrate	Result	Units
Average Stack Gas Velocity (V_a)	16.09	m/s
Stack Area (A)	4.16	m ²
Gas Volumetric Flowrate (Actual), Q_{Actual}	240680.95	m ³ /hr
Gas Volumetric Flowrate (STP, Wet), Q_{STP}	199381.56	m ³ /hr
Gas Volumetric Flowrate (STP, Dry), $Q_{STP,Dry}$	179461.34	m ³ /hr
Gas Volumetric Flowrate (REF), Q_{Ref}	179461.34	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

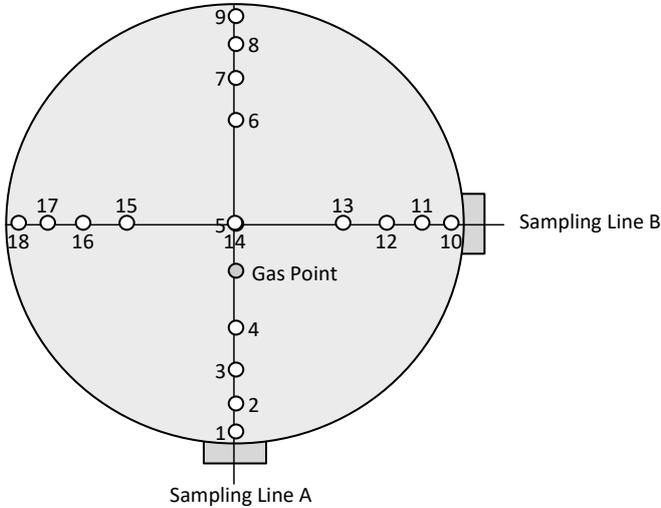
APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

STACK DIAGRAM

	Value	Units
Stack Depth	2.30	m
Stack Width	-	m
Area	4.16	m ²

Non-Isokinetic/Gases Sampling			
Sampling Point	Distance (% of Depth)	Distance into Stack	Units
A	30	0.69	m

Isokinetic Sampling			
Sampling Point	Distance (% of Depth)	Distance into Stack (m)	Swirl °
1	5.6	0.13	< 15
2	16.7	0.38	< 15
3	27.8	0.64	< 15
4	38.9	0.89	< 15
5	50.0	1.15	< 15
6	61.1	1.41	< 15
7	72.2	1.66	< 15
8	83.3	1.92	< 15
9	94.4	2.17	< 15
10	5.6	0.13	< 15
11	16.7	0.38	< 15
12	27.8	0.64	< 15
13	38.9	0.89	< 15
14	50.0	1.15	< 15
15	61.1	1.41	< 15
16	72.2	1.66	< 15
17	83.3	1.92	< 15
18	94.4	2.17	< 15
-	-	-	-
-	-	-	-



SAMPLING LOCATION

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	0.06	-	-
as a %	0.20	0.61	0.49	1.0	N/A	0.26	1.22	0.000
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	0.95	13.2433	1.0	0.0819	0.0000	-
MU as mg/m ³	0.1506	0.0527	-	0.0819	0.0000	0.18
MU as %	1.29	0.4531	-	0.704	0.0003	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	0.36	mg/m³	3.08	% Result	1.79	% 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 - PM 10

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 %
MU required	≤ 2%	≤ 2%	≤ 1%	≤ 1%	≤ 10%	≤ 5% of ELV	≤ 2%
Run 1	0.003	2.0	0.50	1.0	N/A	0.03	-
as a %	0.20	0.6	0.49	1.0	N/A	0.36288	1.62
compliant?	Yes	Yes	Yes	Yes	N/A	Yes	Yes

Run	Volume (STP) m ³	Mass of particulate mg	O2 Correction -	Leak mg/m ³	Combined uncertainty
Run 1	3.83	0.6415	4.97	1.000	-
MU as mg/m ³	0.06	0.0181	-	0.046	-
MU as %	1.29	64.1479	-	0.935	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	0.16	mg/m³	3.27	% Result	3.25	% 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 - PM 2.5

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 %
MU required	≤ 2%	≤ 2%	≤ 1%	≤ 1%	≤ 10%	≤ 5% of ELV	≤ 2%
Run 1	0.003	2.0	0.50	1.0	N/A	0.02	-
as a %	0.20	0.6	0.49	1.0	N/A	-	1.62
compliant?	Yes	Yes	Yes	Yes	N/A	N/A	Yes

Run	Volume (STP) m ³	Mass of particulate mg	O2 Correction -	Leak mg/m ³	Combined uncertainty
Run 1	3.81	0.6415	4.93	1.000	-
MU as mg/m ³	0.06	0.0128	-	0.046	64.17
MU as %	1.29	64.1479	-	0.935	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	0.16	mg/m³	3.23	% Result	N/A	% 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 - DIOXINS & FURANS

Run	Sampled Volume m ³	Sampled Gas Temp K	Sampled Gas Pressure kPa	Sampled Gas Humidity % by volume	Oxygen Content % by volume	Leak %	Uncollected Mass ng/m ³
MU required	≤ 2%	≤ 2%	≤ 1%	≤ 1%	≤ 10%	≤ 5%	≤ 10% ELV
Run 1	0.010	2.0	0.50	1.0	N/A	-	0.00039
as a %	0.20	0.7	0.49	1.0	N/A	1.63	N/A
compliant?	Yes	Yes	Yes	Yes	N/A	Yes	N/A

Run	Volume (STP) m ³	O2 Correction -	Mass of Dioxin & Furan ng	Leak ng/m ³	Uncollected Mass ng/m ³	Laboratory analysis -	Combined uncertainty
Run 1	4.6965	1.0	0.3363	0.00005	0.00022	-	-
MU as ng/m ³	0.0001	-	0.0001	0.00005	0.0000104	0.0004	0.0004
MU as %	1.3222	-	2.4460	0.9389	0.2164	8.60	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	0.0009	ng/m³	18.2	% Result	N/A	% 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 - MOISTURE

Run	Sampled Volume m ³	Sampled Gas Temp K	Sampled Gas Pressure kPa	Sampled Gas Humidity % by volume	Oxygen Content % by volume	Leak %
MU required	≤ 2%	≤ 2%	≤ 1%	≤ 1%	≤ 10%	≤ 2%
Run 1	0.0023	2.0	0.50	1.0	N/A	-
as a %	0.20	0.61	0.49	1.0	N/A	1.22
compliant?	Yes	Yes	Yes	Yes	N/A	Yes

Run	Volume (STP) m ³	Mass Gained mg	O ₂ Correction -	Leak mg/m ³	Uncollected Mass mg	Combined uncertainty
Run 1	0.95	101400	1.0	627.25	58	-
MU as % v/v	0.145	0.011	-	0.079	0.006	0.166
MU as %	1.29	0.10	-	0.70	0.06	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	0.33	% v/v	2.96	%
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APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - VOLATILE ORGANIC COMPOUNDS RUN 1

Measured Concentration	31.1	mg/m ³
Limit	120	mg/m ³
Calibration Gas Concentration	132.48	mg/m ³
Range	160	mg/m ³

Performance characteristics	Value	Units	specification	MU Met?
Response time	40	seconds	<180	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.25	% full scale	<1 % range	Yes
Repeatability at span level	0.15	% full scale	<2 % range	Yes
Deviation from linearity	0.70	% of value	<2 % range	Yes
Zero drift	0.75	% full scale	<5% range / 24hr	Yes
Span drift	-1.67	% full scale	<5% range / 24hr	Yes
volume or pressure flow dependence	0.02	% of full scale/3 kPa	<2 % / 3 kPa	Yes
atmospheric pressure dependence	0.80	% of full scale/2 kPa	<3% / 2 kPa	Yes
ambient temperature dependence	0.01	% full scale/10K	<3% range / 10 K	Yes
dependence on voltage	0.10	% full scale/10V	< 0.1%vol /10 volt	Yes
losses in the line (leak)	0.98	% of value	< 2% of span gas value	Yes
Uncertainty of calibration gas	1.0	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	ur0	0.02
Standard deviation of repeatability at span level	urs	0.02
Lack of fit	ufit	0.65
Drift	u0dr	0.21
volume or pressure flow dependence	uspres	0.00
atmospheric pressure dependence	uapres	0.04
ambient temperature dependence	utemp	0.00
Dependence on voltage	uvolt	0.14
losses in the line (leak)	uleak	0.18
Uncertainty of calibration gas	ucalib	0.18
Uncertainty in factor	uf	0.46

Measurement uncertainty Measured Concentration	31.06	mg/m ³
Combined uncertainty	0.87	mg/m ³
Expanded uncertainty	1.70	mg/m ³

Expanded uncertainty expressed with a level of confidence of 95%	1.42	% ELV
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Expanded uncertainty expressed with a level of confidence of 95%	1.70	mg/m³
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Expanded uncertainty expressed with a level of confidence of 95%	5.49	% value
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Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - OXIDES OF NITROGEN

Limit value	110	mg/m ³
Concentration @ Ref conditions	24.4	mg/m ³
Cal gas conc	430	mg/m ³
Analyser Full Scale	513	mg/m ³

	Value	Units	specification	MU Met?
Response time	30	seconds	180	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.11	% full scale	<1 % range	Yes
Repeatability at span level	0.1	% full scale	<2 % range	Yes
Deviation from linearity	-0.40	% of value	<2 % range	Yes
Zero drift	-0.05	% full scale	<5% range / 24hr	Yes
Span drift	1.18	% full scale	<5% range / 24hr	Yes
volume or pressure flow dependence	0.25	% of full scale/3 kPa	<2 % / 3 kPa	Yes
atmospheric pressure dependence	0.25	% of full scale/2 kPa	<3% / 2 kPa	Yes
ambient temperature dependence zero / span	0.00	% full scale/10K	<3% range / 10 K	Yes
Combined interference	-0.01	% range	<4% of Range	Yes
dependence on voltage	0.01	% full scale/10V	< 0.1%vol /10 volt	Yes
Influence of Vibration	N/A	% of upper limit of Cal range	<2%	-
losses in the line (leak)	0.01	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
repeatability	$U_r = S_r$	0.0037
lack of fit	U_{lof}	-0.2309
short term zero drift	$U_{d,z}$	-0.0275
short term span drift	$U_{d,s}$	0.6789
influence of Ambient Temp at Zero	$U_{t,z}$	0.0000
influence of Ambient Temp at Span	$U_{t,s}$	2.0250
influence of sample gas pressure	U_p	0.0000
influence of sample gas flow	U_{fit}	0.1732
influence of supply voltage	U_v	0.0262
Combined Interference	U_i	-0.0018
Uncertainty of Cal gas	U_{adj}	2.0980

Measurement uncertainty (Concentration Measured)	24.35	mg/m ³
Combined uncertainty	3.01	mg/m ³
Expanded at a 95% confidence interval	5.90	mg/m ³

Expanded uncertainty expressed with a level of confidence of 95%	5.36	% ELV
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Expanded uncertainty expressed with a level of confidence of 95%	5.9	mg/m³
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Expanded uncertainty expressed with a level of confidence of 95%	24.2	% value
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Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - CARBON MONOXIDE

Limit value	600	mg/m ³
Concentration @ Ref conditions	2.4	mg/m ³
Cal gas conc	211.8	mg/m ³
Analyser Full Scale	250	mg/m ³

Performance characteristics	Value	Units	specification	MU Met?
Response time	30	seconds	180	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.1	% full scale	<1 % range	Yes
Repeatability at span level	0.2	% full scale	<2 % range	Yes
Deviation from linearity	0.61	% of value	<2 % range	Yes
Zero drift	-0.04	% full scale	<5% range / 24hr	Yes
Span drift	-0.03	% full scale	<5% range / 24hr	Yes
volume or pressure flow dependence	0.2	% of full scale/3 kPa	<2 % / 3 kPa	Yes
atmospheric pressure dependence	0.44	% of full scale/2 kPa	<3% / 2 kPa	Yes
ambient temperature dependence zero / span	-0.8	% full scale/10K	<3% range / 10 K	Yes
Combined interference	-0.01	% of Range	<4% of Range	Yes
dependence on voltage	-0.06	% full scale/10V	< 0.1%vol / 10 volt	Yes
Influence of Vibration	N/A	% of upper limit of Cal range	<2%	N/A
losses in the line (leak)	0.01	% of value	< 2% of value	Yes
Uncertainty of calibration gas	1.00	% of value	< 2% of value	Yes

N/A - Horiba's are not effected by Vibration

Performance characteristic	Uncertainty	Value of uncertainty quantity
repeatability	$U_r = S_r$	0.003
lack of fit	U_{lof}	0.12
short term zero drift	$U_{d,z}$	0.35
short term span drift	$U_{d,s}$	-0.02
influence of Ambient Temp zero	$U_{t,z}$	-0.14
influence of Ambient Temp span	$U_{t,s}$	0.16
influence of sample gas pressure	U_p	0.00
influence of sample gas flow	U_{fit}	0.14
influence of supply voltage	U_v	-0.09
Combined Interference	U_i	-0.30
Uncertainty of Cal gas	U_{adj}	0.85

Measurement uncertainty (Concentration Measured)	2.4	mg/m ³
Combined uncertainty	1.0	mg/m ³
Expanded uncertainty	2.0	mg/m ³

Expanded uncertainty expressed with a level of confidence of 95%	0.3	% ELV
Expanded uncertainty expressed with a level of confidence of 95%	2.0	mg/m ³
Expanded uncertainty expressed with a level of confidence of 95%	83.9	% value

Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - OXYGEN

Reference	N/A	%vol
Reported Concentration	19.76	%vol
Calibration gas	20.95	%vol
Analyser Full Scale	25	%vol

	Value	Units	specification	MU Met?
Response time	30	seconds	200	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.02	% Vol	≤0.2% Vol	Yes
Repeatability at span level	0.02	% Vol	≤0.2% Vol	Yes
Deviation from linearity	-0.10	% Vol	≤0.3% Vol	Yes
Zero drift	0.04	% Vol	≤0.2% Vol	Yes
Span drift	-0.13	% Vol	≤0.2% Vol	Yes
volume or pressure flow dependence	-0.01	% Vol for flow range	≤0.2% Vol	Yes
atmospheric pressure dependence	0.19	% Vol for 3kPa	≤0.2% Vol	Yes
ambient temperature dependence	-0.40	% Vol/20K	≤0.5% Vol	Yes
Combined interference	0.00	% Vol	≤0.4% Vol	Yes
dependence on voltage	0.02	% Vol	≤0.2% Vol	Yes
losses in the line (leak)	0.00	% of value	< 2% of value	Yes
Uncertainty of calibration gas	0.5	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
repeatability	$U_r = S_r$	0.0042
lack of fit	U_{lof}	-0.0577
short term zero drift	U_{dz}	0.0214
short term span drift	U_{ds}	-0.0756
influence of Ambient Temp at Zero	U_{tz}	-0.0030
influence of Ambient Temp at Span	U_{ts}	-0.0011
influence of sample gas pressure	U_p	0.0000
influence of sample gas flow	U_{fit}	-0.0029
influence of supply voltage	U_v	0.0115
Combined Interference	U_i	0.0000
Uncertainty of Cal gas	U_{adj}	0.0988

Measurement uncertainty (Concentration Measured)	19.76	% vol
Combined uncertainty	0.14	% vol
Expanded uncertainty	0.27	% vol

Expanded uncertainty expressed with a level of confidence of 95%	0.27	% vol
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Expanded uncertainty expressed with a level of confidence of 95%	1.38	%
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Maximum permissible uncertainty is 6% of value or 0.3% by volume.

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	16.1	m/s
Measured Volumetric Flow rate at Actual Conditions	240681	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	-	1.51		
Uncertainty of mean local dynamic pressures	-	1.51		
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	28.94	<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	1.67	<1% of value	Yes
Uncertainty of absolute pressure in the duct	pa	514		
Uncertainty associated with the calculation of density	kg/m ³	0.008		
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	0.20
Expanded uncertainty at a 95% Confidence Interval	0.39

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	1.2
Expanded uncertainty at a 95% Confidence Interval	2.4

Measurement Uncertainty Volumetric Flow Rate	m ³ /hr
Combined uncertainty	6309
Expanded uncertainty at a 95% Confidence Interval	12365

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	5.1

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