Arthian

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Memorandum Report

05/11/2025

TO: **Duynie Ingredients Ltd**

FM: **Scott Durning (Arthian)**

CC: **Kate Brady (Arthian)**

RE: **Updated Air Emissions Inventory**

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1. Introduction

1.1 Background

Duynie Ingredients Ltd (Duynie) operates a modified starch manufacturing facility at its premises on Coed Aben Road, Wrexham Industrial Estate, Clwyd, LL13 9UH (the Site). Natural Resources Wales (NRW) considers that this activity should be regulated as chemicals manufacturing process under the Environmental Permitting Regulations (EPR) and so Duynie has submitted an application for an Environmental Permit for the Site.

A site visit to Duynie was undertaken by Arthian to assist with a response to a previous Request for Information (Schedule 5 Notice) issued by NRW relating to the permit application. During this site visit, it was identified that not all of the emission points at the Site have been accurately declared and presented within the Environmental Permit application.

Emission points from the following plant are expected to be in place and not included as part of the Environmental Permit application:

- 5x refined starch drying units;
- 3x horizontal reactor vessels;
- 2x dust extraction systems; and

Additionally, the following emission points were included in the Environmental Permit application:

- 1x heat exchanger/ flash dryer (now associated with a flash dryer only);
- 2x boilers;
- 1x CHP unit; and
- 1x scrubber unit

The purpose of this air emissions inventory is to describe the nature, quantities and sources of emissions to air from all emission points at the Duynie site by: addressing the issues set out in any relevant technical guidance; justifying proposals against benchmark emission levels contained in guidance; and, by providing other operational information that may be relevant.

1.2 Scope

Representative air emissions monitoring has been undertaken at the Duynie site by a competent specialist during a period where the site was operating normally. All emission points were monitored using an appropriate technique with both the monitoring and analysis of emissions from these points meeting MCERTS standards. Due to similarity between processing operations in some site units, air emissions monitoring was not undertaken for all emission points as it can be assumed that emissions from these units will be similar. It has been detailed in Section 2 where this is the case.

Additionally, air emissions monitoring was not undertaken for emissions from the CHP and flash dryer units as data is already available from the original Environmental Permit application.

Full details of monitoring standards used are available in the Air Emission Monitoring Reports attached as Appendix A.

1.3 Definitions

Term	Definition
Significant emission	Any emission that is likely to have a significant environmental impact.
De minimis emission	Any emissions that is minimal / non-detectable with no anticipated impact on the facility, surrounding community or the environment.

2. Emissions Inventory

The following emissions inventory describes the nature, quantities and sources of emissions from all air emission points at the Duynie site. Emissions have been assessed against benchmark emission levels contained in the most relevant technical guidance.

It has been determined that the site should be classed as an Organic Chemicals manufacturing installation and should be permitted in accordance with Part A(1), Section 4.1(a)(ii) of Schedule1 to The Environmental Permitting (England and Wales) Regulations 2016 (EPR):

> *"Producing organic chemicals such as organic compounds containing oxygen."*

Given this classification of the Duynie site, the most applicable BAT guidance for the Duynie site is the "Production of Large Volume Organic Chemicals" (LVOC) BAT Conclusions (BATc).

Additionally, a formal draft of the "BAT Conclusions for Common Waste Gas Management and Treatment Systems in the Chemical Sector" (WGC) has been developed by the UK BAT WGC Technical Working Group for use in the UK, based on the outputs from the EU BREF process. This BATc document is applicable to the Duynie site due to the undertaking of a chemical sector activity, listed in Schedule 1, Part 2, Chapter 4 of EPR. Although this document is currently in draft form, it has been deemed appropriate for use in the development of an emissions inventory for the Duynie site as no relevant BAT Associated Emission Levels (BAT-AELs) are provided in the LVOC BATc document and it is expected that Duynie will be required to comply with WGC BAT once it is formalised.

Schedule 25A to the Environmental Permitting Regulations (England and Wales) 2016 (EPR) provides information relating to the Medium Combustion Plant Directive (MCPD). The MCPD is applicable to all combustion plant with a rated thermal input >1MW but <50MW provided that it does not fall under any exemptions. The MCPD sets Emission Limit Values (ELVs) for all applicable combustion plant with which compliance is mandatory. As the boilers currently in place at the site and proposed CHP unit will have thermal rated inputs >1MW but <50 MW, they will fall under the MCPD and have been assessed against the benchmark emission levels contained within this.

Air emissions monitoring was undertaken for any substances which may potentially be emitted from the Duynie site's air emission points, in line with the above technical guidance.

Emission Point	Process Detail	Potentially Relevant Parameters	Mass Flow Rate (g/h)	Emission Concentration (mg/m^3)	Emission Limit Value (mg/m^3)	Relevant Technical Guidance	Significant Emission?	Method of Determination
A1 in original Environmental Permit application	Associated with a flash dryer unit which utilises steam from site boilers to dry starch. Should not be classed as a process furnace/heater as no combustion takes place within this unit. This is in line with LVOC BAT.	Total Particulate Matter	39.96	2.1	None	LVOC BAT	No	Direct monitoring
					5	UK WGC BAT [DRAFT]		
		SO_2	28.08	1.5	None	LVOC BAT	No	Direct monitoring
					150	UK WGC BAT [DRAFT]		
		TVOC	57.96	3.2	None	LVOC BAT	No	Direct monitoring
					20	UK WGC BAT [DRAFT]		
A2 in original Environmental Permit application	Combined emission point for 2, other than engines and gas turbines MCPs of the following rated thermal inputs: ▪ 1x 1.6MW Byworth Yorkshireman boiler; and ▪ 1x 1.1MW Cochran Ruston Thermax boiler. Both boilers utilise natural gas fuel and	NO_x	245.9	75.2	250	MCPD	Yes	Direct Monitoring

Updated Air Emissions Inventory

Emission Point	Process Detail	Potentially Relevant Parameters	Mass Flow Rate (g/h)	Emission Concentration (mg/m^3)	Emission Limit Value (mg/m^3)	Relevant Technical Guidance	Significant Emission?	Method of Determination
	were installed prior to 2018 so are classed as existing MCPs.							
A3 in original Environmental Permit application	Associated with a 1.4MW Jenbacher J312GS Combined Heat and Power unit which will utilise a gas engine. Has not yet been installed so will be classed as a new MCP. Will utilise natural gas fuel.	NO_x	584.3	189	95	MCPD	Yes	Calculated as not yet installed
A4 in original Environmental Permit application	Associated with a scrubber unit which is used to abate emissions from a monochloroacetic acid storage tank.	HCl	<0.004	<0.11 (Limit of Detection)	None	LVOC BAT	No	Direct monitoring
					10	UK WGC BAT [DRAFT]		
		TVOC	0.061	1.9	None	LVOC BAT	No	Direct monitoring
					150	UK WGC BAT [DRAFT]		
Refined starch drying unit 1*	Starch from the horizontal reactor vessels is sent to a drying unit in gel form. Starch is rolled while being steam-treated within these units. Emissions from these units may contain	Total Particulate Matter	230.0	14.5	None	LVOC BAT	Yes	Direct monitoring
					5	UK WGC BAT [DRAFT]		
		HCl	0.720	0.04	None	LVOC BAT	No	Direct monitoring
					10	UK WGC BAT [DRAFT]		
Refined starch drying unit 2*		Total Particulate Matter	230.0	14.5	None	LVOC BAT	Yes	Direct monitoring
					5	UK WGC BAT [DRAFT]		
		HCl	0.720	0.04	None	LVOC BAT	No	Direct monitoring

Updated Air Emissions Inventory

Emission Point	Process Detail	Potentially Relevant Parameters	Mass Flow Rate (g/h)	Emission Concentration (mg/m³)	Emission Limit Value (mg/m³)	Relevant Technical Guidance	Significant Emission?	Method of Determination
	hydrochloric acid due to the starch being mixed with sodium monochloroacetic acid within the horizontal reactor vessels.				10	UK WGC BAT [DRAFT]		
Refined starch drying unit 3*		Total Particulate Matter	230.0	14.5	None	LVOC BAT	Yes	Direct monitoring
					5	UK WGC BAT [DRAFT]		
		HCl	0.720	0.04	None	LVOC BAT	No	Direct monitoring
					10	UK WGC BAT [DRAFT]		
Refined starch drying unit 4*		Total Particulate Matter	230.0	14.5	None	LVOC BAT	Yes	Direct monitoring
					5	UK WGC BAT [DRAFT]		
		HCl	0.720	0.04	None	LVOC BAT	No	Direct monitoring
					10	UK WGC BAT [DRAFT]		
Refined starch drying unit 5*		Total Particulate Matter	230.0	14.5	None	LVOC BAT	Yes	Direct monitoring
					5	UK WGC BAT [DRAFT]		
		HCl	0.720	0.04	None	LVOC BAT	No	Direct monitoring
					10	UK WGC BAT [DRAFT]		
Horizontal reactor vessel 1**	Refined starch is mixed with sodium monochloroacetic acid and caustic within these units. Steam is injected into the reactors to provide a heat source.	Total Particulate Matter	0.151	0.67	None	LVOC BAT	No	Direct monitoring
					5	UK WGC BAT [DRAFT]		
		HCl	0.004	0.02	None	LVOC BAT	No	Direct monitoring
					10	UK WGC BAT [DRAFT]		
		TVOC	1.08	4.7	None	LVOC BAT	No	Direct monitoring
					150	UK WGC BAT [DRAFT]		
			0.151	0.67	None	LVOC BAT	No	Direct monitoring

Updated Air Emissions Inventory

Emission Point	Process Detail	Potentially Relevant Parameters	Mass Flow Rate (g/h)	Emission Concentration (mg/m^3)	Emission Limit Value (mg/m^3)	Relevant Technical Guidance	Significant Emission?	Method of Determination
Horizontal reactor vessel 2**		Total Particulate Matter			5	UK WGC BAT [DRAFT]		
		HCl	0.004	0.02	None	LVOC BAT	No	Direct monitoring
					10	UK WGC BAT [DRAFT]		
		TVOC	1.08	4.7	None	LVOC BAT	No	Direct monitoring
					150	UK WGC BAT [DRAFT]		
Horizontal reactor vessel 3**		Total Particulate Matter	0.151	0.67	None	LVOC BAT	No	Direct monitoring
					5	UK WGC BAT [DRAFT]		
		HCl	0.004	0.02	None	LVOC BAT	No	Direct monitoring
					10	UK WGC BAT [DRAFT]		
		TVOC	1.08	4.7	None	LVOC BAT	No	Direct monitoring
					150	UK WGC BAT [DRAFT]		
Dust extraction system 1	Used to remove dust during product packaging.	Total Particulate Matter	8.28	1.5	None	LVOC BAT	No	Direct monitoring
					5	UK WGC BAT [DRAFT]		
Dust extraction system 2		Total Particulate Matter	1.44	0.69	None	LVOC BAT	No	Direct monitoring
					5	UK WGC BAT [DRAFT]		

*Air emissions monitoring was carried out on 1 x refined starch drying unit due to physical access constraints. Processing operations through each unit are the same and emissions are assumed to be similar.

**Air emissions monitoring was carried out on 1 x horizontal reactor vessel. Processing operations through each unit are the same and emissions are assumed to be similar.

2.1 Emissions Inventory Discussion

The BAT-AELs for channelled emissions to air other than from process furnaces/heaters contained within the LVOC BATc document are specific to individual processes, none of which are undertaken by the Duynie site. As such, there are no BAT-AELs contained within the LVOC BATc document which are applicable to the site.

BAT-AELs which are applicable to the Duynie site are available in the formal draft of the UK WGC BATc document which was expected to be finalised and published in late 2025. At time of writing, the UK WGC BATc is not yet finalised. As no applicable BAT-AELs from the LVOC BATc document are applicable to the Duynie site, it has been deemed appropriate to compare BAT-AELs for this draft guidance against measured emissions from the site to provide indicative ELVs for the site's emission points to air.

The applicability of the BAT-AELs contained within the UK WGC BATc document is dependent on the mass flow rate of the substance/parameter from the emission point. The following table details the mass flow rate thresholds seen in the UK WGC BATc document for the substances and processes relevant to Duynie.

Substance/Parameter	Specific Process	BAT-AEL Applicable
Total Particulate Matter	All processes/sources	When mass flow rate of substance is ≥50 g/h if no carcinogenic, mutagenic or reprotoxic (CMR) substances are identified as relevant in the dust.
SO_2	All other processes/sources	When mass flow rate of substance is ≥500 g/h.
TVOC	All other processes/sources	When mass flow rate of substance is ≥100 gC/h if no CMR substances are identified as relevant in the waste gas stream.
HCl	All processes/sources	When mass flow rate of substance is ≥30 g/h

There should be no CMR substances contained within any of Duynie's emissions to air as no substances with the following hazard statements are utilised on Site:

- H350;
- H351;
- H340;
- H341;
- H360;
- H361; and
- H362.

The mass flow rate of each relevant substance emitted through the air emission points at the Duynie can be calculated through review of the recent air emissions monitoring results (Appendix A). Where the mass flow rate of a substance is lower than the threshold for which the associated BAT-AEL is applicable, the emissions have of the substance has been deemed to be "de minimis", meaning that the emissions are not anticipated to impact on the facility, surrounding community or the environment. Therefore, no monitoring conditions for these substances should be set within the Duynie site's Environmental Permit.

This assessment of emissions significance is supported by the findings of an Air Quality Assessment which has been carried out for the Duynie site (*318659 Coed Aben Road, Wrexham - Air Quality Assessment (1.0, Nov 2025*) which found that the overall impacts of air quality emissions from the site on existing sensitive human and ecological receptors is predicted to be insignificant.

Where the mass flow rate of a substance is greater than the threshold for which the associated BAT-AEL is applicable, it has been determined that emissions of this substance may be significant and monitoring conditions should be set within the Duynie site's Environmental Permit. It has been determined that

emissions of total particulate matter from the dust extraction systems are not significant as the mass flow rate is significantly lower than the BAT-AEL threshold.

The emissions inventory concludes that monitoring may be appropriate for the driers on site. The same physical access restrictions apply at the Site. It is proposed that any ongoing monitoring requirements will apply to x 1 drier on the provision that all are operated in the same way and maintained and serviced on the same schedule.

Quality Assurance

Issue Record

Revision	Description	Date	Author	Reviewer	Approver
1.0	Final Issue	05/11/2025	SD	KB	KB

Appendix A – Air Emission Monitoring Reports

Element, Unit C6, Emery Court, The Embankment Business Park, Heaton Mersey, Stockport, SK4 3GL
Your Element Contact: Richard Carter (+44(0)7585 894 426)
E: richard.carter@element.com

Stack Emissions Testing Report Commissioned by
Duynie Ingredients

Installation Name & Address
Duynie Ingredients
Coed Abden Road
Wrexham Industrial Estate
Wrexham
LL13 9UH

Stack Reference
Boiler 1

Dates of the Monitoring Campaign
25th - 26th September 2025

Job Reference Number
EMT14377

Report Written by
Stephen Taylor Team Leader MCERTS Level 2 MM 23 1803 TE1 TE3 & TE4

Report Approved by
Donal O Faogain Technical Report Writer MCERTS Level 2 MM13 1259 TE1 TE2 TE3 TE4

Report Date
8th October 2025

Version
Version 1

Signature of Report Approver


CONTENTS

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

MONITORING OBJECTIVES

Duynie Ingredients , Wrexham
Boiler 1
25th - 26th September 2025

Overall Aim of the Monitoring Campaign

Element were commissioned by Duynie Ingredients to carry out stack emissions testing on the Boiler 1 at Wrexham.

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

Oxides of Nitrogen (as NO_2), Carbon Monoxide

Executive Summary

MONITORING RESULTS

Duynie Ingredients , Wrexham
Boiler 1
25th - 26th September 2025

where MU = Measurement Uncertainty associated with the Result

				Concentration				Mass Emission			
Parameter				**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Oxides of Nitrogen (as NO_2) [1]				mg/m³	75.2	4.8	-	g/hr	246	24.1	-
Carbon Monoxide [1]				mg/m³	1.9	1.4	-	g/hr	6.1	4.5	-
Oxygen	% v/v	**Wet**	4.80	% v/v	**Dry** 5.6	0.30					
Water Vapour				% v/v	13.8	0.59					
Stack Gas Temperature				°C	123						
Stack Gas Velocity				m/s	3.8	0.22					
Volumetric Flow Rate (ACTUAL)				m³/hr	5224	391					
Volumetric Flow Rate (REF) [1]				m³/hr	3270	245					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM THE PRELIMINARY VELOCITY TRAVERSE.

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content, 3% oxygen.

MONITORING DATE(S) & TIMES

Duynie Ingredients , Wrexham
Boiler 1
25th - 26th September 2025

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Oxides of Nitrogen (as NO_2)	R1	mg/m^3	75.2	g/hr	246	26/09/2025	12:12 - 13:12	60
Carbon Monoxide	R1	mg/m^3	1.9	g/hr	6.1	26/09/2025	12:12 - 13:12	60
Oxygen	R1	% v/v	4.8			26/09/2025	12:12 - 13:12	60
Water Vapour	R1	% v/v	13.8			26/09/2025	12:12 - 13:12	60
Velocity Traverse	R1					26/09/2025	11:58 - 12:08	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Duynie Ingredients , Wrexham
Boiler 1
25th - 26th September 2025

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operating Capacity
Capacity (of 100%) and Tonnes / Hour	Variable On Demand
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Natural Gas
Abatement System	N/A
Abatement System Running Status	N/A
Fuel	Natural Gas
Plume Appearance	None Visable

MONITORING & ANALYTICAL METHODS

Duynie Ingredients , Wrexham
Boiler 1
25th - 26th September 2025

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**Sampling Status**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**Analysis Status**	**Analysis Lab**	**Overall Status**	**LOD (Average)**
Water Vapour	EN 14790	MD 005	MCERTS	EET	MD 005	Gravimetric	MCERTS	EET	MCERTS	0.10 % v/v
Oxides of Nitrogen (as NO_2)	EN 14792	MD 021	MCERTS	EET	Chemiluminescence by Horiba PG-250				MCERTS	0.41 mg/m³
Carbon Monoxide	EN 15058	MD 021	MCERTS	EET	NDIR by Horiba PG-250				MCERTS	1.96 mg/m³
Oxygen	EN 14789	MD 021	MCERTS	EET	Dry Zirconia Cell by Horiba PG-250				MCERTS	0.1 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041	MCERTS	EET	Pitot Tube and Thermocouple				MCERTS	1.2 m/s

ANALYSIS LABORATORIES

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

Element (Stockport Lab - EET)	ISO 17025 Accreditation Number: UKAS 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Velocity & Vol. Flow Rate	All	Only one out of two required sampling lines was available, 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	0.70
Width	m	-
Area	m²	0.38
Port Depth	cm	8
Orientation of Duct	-	Vertical
Number of Ports	-	1
Sample Port Size	-	5" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	MEWP
Inside / Outside	Outside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	N/A
Platform has vertical base boards (approx. 0.25m high)	N/A
Platform has chains / self closing gates at top of ladders	N/A
There are no obstructions present which hamper insertion of sampling equipment	Yes
Safe Access Available	Yes
Easy Access Available	No

Sampling Location / Platform Improvement Recommendations

The sampling location meets all the requirements specified in EA Guidance Note M1 and EN 15259, and therefore there are no improvement recommendations.

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)

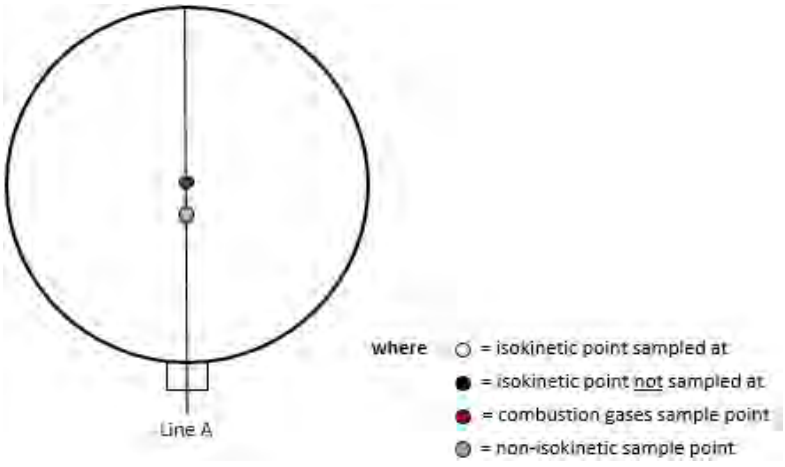
Criteria in EN 15259	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	8.6	> 5 Pa	Yes
Mean Velocity	m/s	3.77	-	-
Lowest Gas Velocity	m/s	3.70	-	-
Highest Gas Velocity	m/s	3.93	-	-
Ratio of Above	: 1	1.06	< 3 : 1	Yes
Maximum Angle of Swirl	°	7.00	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

PLANT PHOTOS

Photo 1

Photo 2

SAMPLE POINTS



APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Stephen Taylor	MCERTS Level 2	MM 23 1803	TE1 TE3 & TE4
Technician	Tom Dixon	MCERTS Level 1	MM 23 1802	TE1

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	-
Control Box DGM (2)	-
Box Thermocouples (1)	-
Box Thermocouples (2)	-
Umbilical (1)	-
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	-
Heated Probe (2)	-
Heated Probe (3)	-
S-Pitot (1)	CAT 21S.71
S-Pitot (2)	-
L-Pitot	-
Site Balance	CAT 17.108
500g / 1Kg Check Weights	CAT 17.108
Last Impinger Arm	-
Callipers	-
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	CAT 9.29
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	CAT 4.0030
Gasmet DX4000	-
Gasmet Sampling System	-
Sick 3006	-
M&C PSS	CAT 12.174
Mass Flow Controller (1)	CAT 6.23
Mass Flow Controller (2)	CAT 6.24
Mass View (1)	CAT 25.94
Mass View (2)	CAT 25.121
Hioki 5043 (V)	-
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer 500	CAT 3.265
Digital Manometer 10000	-
Digital Temperature Meter	-
Stopwatch	CAT 14.98
Barometer	CAT 13.62
Stack Thermocouple 0.5m	-
Stack Thermocouple 1.0m	-
Stack Thermocouple 1.5m	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	CAT 20.277
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	
Tape Measure	CAT 16.58

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Water Vapour	EN 14790	MD 005
Oxides of Nitrogen (as NO_2)	EN 14792	MD 021
Carbon Monoxide	EN 15058	MD 021
Oxygen	EN 14789	MD 021
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.70
Stack Width, W	m	-
Stack Area, A	m^2	0.38
Average Stack Gas Temperature, T_a	°C	123.2
Average Stack Gas Pressure	Pa	8.9
Average Stack Static Pressure, P_{static}	kPa	-0.033
Average Barometric Pressure, P_b	kPa	102.3
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m^3 p	Conc kg/m^3 p_i
CO_2 (Estimated)	-	10.00	8.62	0.1000	44.01	1.9635	0.19635
O_2	-	5.57	4.80	0.0557	32.00	1.4277	0.07955
N_2	-	84.43	72.79	0.8443	28.01	1.2498	1.05522
Moisture (H_2O)	-	-	13.79	0.1379	18.02	0.8037	0.11082

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m^3	1.331
Wet Density (STP), P_{STW}	kg/m^3	1.258
Dry Density (Actual), P_{Actual}	kg/m^3	0.926
Average Wet Density (Actual), $P_{ActualW}$	kg/m^3	0.875

Where: P_{STD} = sum of component concentrations, kg/m^3 (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m^3 (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) $= P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	123.2	0.0
Total Pressure	kPa	102.3	101.3
Moisture	%	13.79	13.79
Oxygen (Dry)	%	5.6	N/A
Oxygen (Wet)	%	4.8	3.0

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m^3/hr	5224
Gas Volumetric Flowrate (STP, Wet)	m^3/hr	3634
Gas Volumetric Flowrate (STP, Dry)	m^3/hr	3133
Gas Volumetric Flowrate REF [1]	m^3/hr	3270

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	26/09/2025
Time of Survey	-	11:58 - 12:08
Atmospheric Pressure	kPa	102.3
Average Stack Static Pressure	Pa	-33
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 210 (500Pa)	

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

Sampling Line A

Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m³	Velocity m/s	Swirl °
STATIC (Units: Pa)		*-32.7*				
Mean		**8.9**	**123.2**	**0.875**	**3.77**	
1	0.05	8.8	123.2	0.875	3.75	6.0
2	0.18	8.6	123.2	0.875	3.70	7.0
3	0.53	8.6	123.3	0.875	3.70	7.0
4	0.65	9.7	123.2	0.875	3.93	6.0

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

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	1.046	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.008	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	0.002	
- Overall corrections to dynamic measurements	u(Cf)	0.094	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00008	-
- $\varphi O_2,w$	-	4.804	
- $\varphi CO_2,w$	-	8.621	
- Oxygen, dry	u(ϕO_2,d)	0.171	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.306	
- Water Vapour	u(ϕH_2O)	0.703	
- Oxygen, wet	u(ϕO_2,w)	0.152	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.273	
Standard uncertainty associated with the stack temperature	u(Tc)	2.022	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.695	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	1.046	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00537	-
Standard uncertainty associated with the local velocities	u(vi)	0.223	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.115	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.225	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	5.96	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	390.9	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00146	
- $u^2(qV,w)$	-	39774	
- $u(qV,w)$	-	199.4	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	7.48	%

WATER VAPOUR: RESULTS SUMMARY

Duynie Ingredients , Wrexham

Boiler 1

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	% v/v	13.8		13.8
Uncertainty	±% v/v	0.59		0.59

General Sampling Information

Parameter	Value
Standard	EN 14790
Technical Procedure	MD 005

WATER VAPOUR: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	12:12 - 13:12
Sampling Dates	-	26/09/2025
Sampling Device	-	MFC / MV
Duration	mins	60
Volume Sampled (STP, Dry)	m^3	0.1846
Volume Sampled (STP, Wet)	m^3	0.2142
Sample Flow Rate	l/min	2.98
Liquid Trap Start Mass	g	4042.5
Liquid Trap End Mass	g	4063.1
Silica Trap Start Mass	g	1451.4
Silica Trap End Mass	g	1454.5
Total Mass Of Water Vapour	g	23.7
Calculated Water Vapour	% v/v	13.79

Where: MFC stands for Mass Flow Controller, MV stands for Mass View Flowmeter

WATER VAPOUR: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	3.0
Pre-Sampling Leak Rate	l/min	0.02
Post-Sampling Leak Rate	l/min	0.02
Allowable Leak Rate	l/min	0.06
Leak Test Acceptable	-	Yes

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

Measurement Uncertainty	Units	Run 1
Measurement Uncertainty (MU)	%	4.3
Allowable MU	%	20.0
MU Acceptable	%	Yes

Silica Gel	Units	Run 1
Less than 50% Faded	%	Yes

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

Method Deviations

Nature of Deviation	Run Number
(x = deviation applies to the associated run)	1
There are no deviations associated with the sampling employed.	x

WATER VAPOUR: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**	
Sampled Volume (STP)	V_m	0.1846		uV_m	m^3	0.0037	
Repeatability of Weighing	R_w	23.70		uR_w	g	0.15	
Reading of Balance	R_b	23.70		uR_b	g	0.12	
Leak	L	0.67			%	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (STP)	%	2.00		≤2%
Repeatability of Weighing	%	0.63		No Requirement
Reading of Balance	%	0.50		No Requirement
Leak	%	0.67		≤2%

	Uncertainty in Measurement Units				Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**		**Run 1**	
Sampled Volume (STP)	V_m	m^3	0.1846		74.67	
Repeatability of Weighing	R_w	g	23.70		0.58	
Reading of Balance	R_b	g	23.70		0.58	
Leak	L	% v/v	0.05		1.00	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	% v/v	0.276	
Repeatability of Weighing	% v/v	0.087	
Reading of Balance	% v/v	0.069	
Leak	% v/v	0.053	

Parameter	**Units**	**Run 1**
Combined uncertainty	% v/v	0.30
Expanded uncertainty (95% confidence)	% v/v	0.59
Expanded uncertainty (95% confidence), estimated with Method Deviations	% v/v	0.59
Uncertainty if Water Droplets are present	% v/v	N/A
Reported Uncertainty	% v/v	0.59
Expanded uncertainty (95% confidence)	%	4.3
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	4.3
Uncertainty if Water Droplets are present	%	N/A
Reported Uncertainty	%	4.3

OXIDES OF NITROGEN (as NO_2): RESULTS SUMMARY

Duynie Ingredients , Wrexham
Boiler 1

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	75.2		75.2
Uncertainty	±mg/m³	4.8		4.8
Mass Emission	g/hr	246		246
Uncertainty	±g/hr	24.1		24.1

General Sampling Information

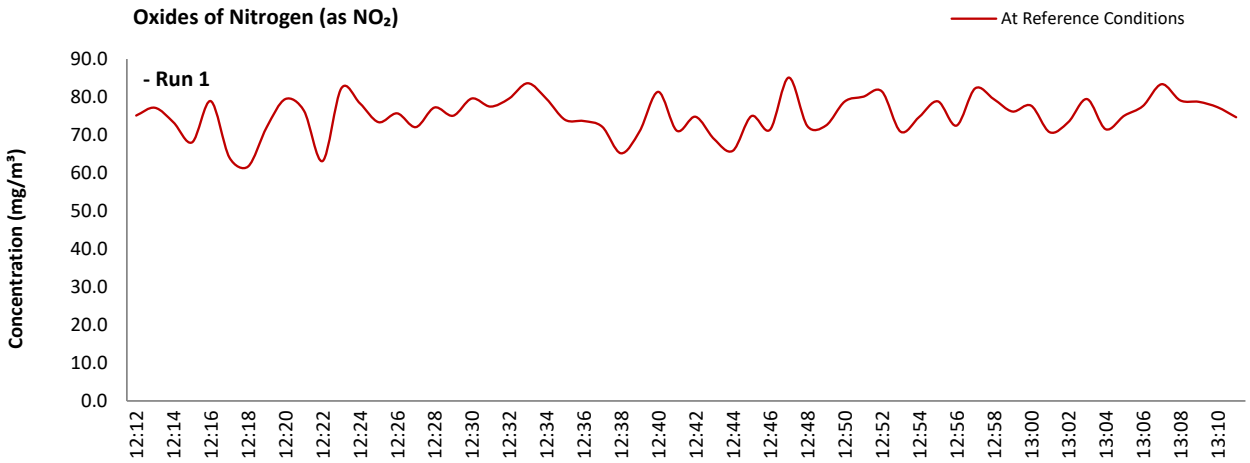
Parameter	Value	
Standard	EN 14792	
Technical Procedure	MD 021	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Date & Result of Last Converter Check	10/03/2025 - 95.8%	
Span Gas Type	Nitrogen Monoxide	
Span Gas Reference Number	12.0734	
Span Gas Expiry Date	07/04/2027	
Span Gas Start Pressure (bar)	150	
Gas Cylinder Concentration (ppm)	401	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content, 3% oxygen.

OXIDES OF NITROGEN (as NO_2): DATA TREND

Graphical Trend of Data



OXIDES OF NITROGEN (as NO_2): SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	12:12 - 13:12
Sampling Dates	-	26/09/2025
Instrument Range	ppm	500
Span Gas Value	ppm	401.0

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.8
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

	Zero Drift	Units	Run 1
CAL 1	Zero at Analyser (Pre)	ppm	0.00
CAL 1	Zero at Analyser (Post)	ppm	-0.40
CAL 1	Zero Drift	ppm	-0.40
CAL 1	Zero Drift	%	0.10
CAL 1	Drift Correction Applied	2-5%	No
	Allowable Zero Drift	± %	5.00
	Zero Drift Acceptable	-	Yes

	Span Drift	Units	Run 1
CAL 1	Span at Analyser (Pre)	ppm	401.00
CAL 1	Span at Analyser (Post)	ppm	401.40
CAL 1	Span Drift	ppm	0.40
CAL 1	Zero Adj. Span Drift	%	0.20
CAL 1	Drift Correction Applied	2-5%	No
	Allowable Span Drift	± %	5.00
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	18 - 20

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1
There are no deviations associated with the sampling employed.	

OXIDES OF NITROGEN (as NO_2): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	-		mg/m³ (REF)
Allowable MU	10.0		%
Measured concentration	78.49		mg/m³ (STP, dry)
Ratio NO / NO_2	5		%
Range Used	500.0		ppm
Range Used [A]	1026.1		mg/m³
Cal gas conc.	401.0		ppm
Conversion	2.05		ppm to mg/m³
MCERTS Range [B]	125.0		mg/m³
Lower of [A] or [B]	125.0		mg/m³
Cal gas conc.	823.0		mg/m³

Performance characteristics	RUN 1		Units
Response time	60		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.40		% full scale
Repeatability at span level	0.40		% full scale
Deviation from linearity	0.56		% of value
Zero drift	-0.10		% full scale
Span drift	0.20		% full scale
Volume or pressure flow dependence	0.40		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	0.18		% full scale/10K
Combined interference	0.60		% range
Dependence on voltage	0.40		% full scale/10V
Converter efficiency	95.8		%
Losses in the line (leak)	1.00		% of value
Uncertainty of calibration gas blending	1.40		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		mg/m³
Standard deviation of repeatability at span level	0.05		mg/m³
Lack of fit	0.40		mg/m³
Drift	-0.38		mg/m³
Volume or pressure flow dependence	0.00		mg/m³
Atmospheric pressure dependence	0.11		mg/m³
Ambient temperature dependence	0.03		mg/m³
Combined interference (from MCERTS Certificate)	0.43		mg/m³
Dependence on voltage	0.05		mg/m³
Converter efficiency	0.10		mg/m³
Losses in the line (leak)	0.45		mg/m³
Uncertainty of calibration gas blending	0.63		mg/m³
Uncertainty of calibration gas	0.91		mg/m³

			RUN 1		Units
Measurement uncertainty		**Result**	78.49		mg/m³
Combined uncertainty			1.40		mg/m³
Expanded uncertainty	k =	1.96	2.74		mg/m³
Uncertainty corrected to std conds. (O_2)			3.20		mg/m³ (REF)

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	3.49		% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement	**N/A**		-

	RUN 1		Units
Expanded uncertainty (with O_2) - at 95% Confidence	6.36		% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement	**N/A**		-

Requirement for SRM is that Uncertainty should be <10% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 10% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components).

CARBON MONOXIDE: RESULTS SUMMARY

Duynie Ingredients , Wrexham
Boiler 1

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	1.9		1.9
Uncertainty	±mg/m³	1.4		1.4
Mass Emission	g/hr	6.1		6.1
Uncertainty	±g/hr	4.5		4.5

General Sampling Information

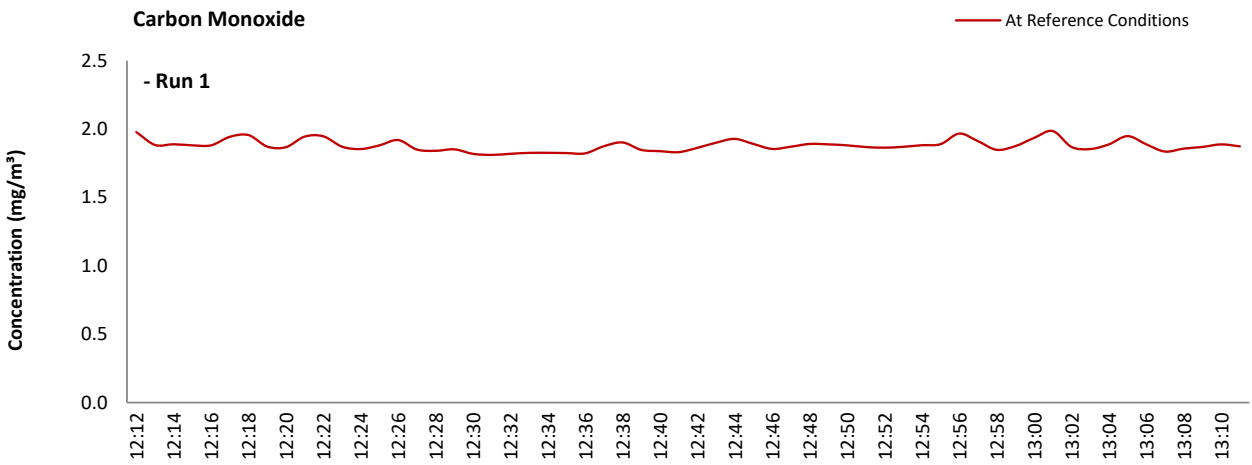
Parameter	Value	
Standard	EN 15058	
Technical Procedure	MD 021	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Carbon Monoxide	
Span Gas Reference Number	12.0734	
Span Gas Expiry Date	07/04/2027	
Span Gas Start Pressure (bar)	150	
Gas Cylinder Concentration (ppm)	395.1	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content, 3% oxygen.

CARBON MONOXIDE: DATA TREND

Graphical Trend of Data



CARBON MONOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	12:12 - 13:12
Sampling Dates	-	26/09/2025
Instrument Range	ppm	500
Span Gas Value	ppm	395.1

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.8
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

	Zero Drift	Units	Run 1
CAL 1	Zero at Analyser (Pre)	ppm	0.00
CAL 1	Zero at Analyser (Post)	ppm	0.70
CAL 1	Zero Drift	ppm	0.70
CAL 1	Zero Drift	%	0.18
CAL 1	Drift Correction Applied	2-5%	No
	Allowable Zero Drift	± %	5.00
	Zero Drift Acceptable	-	Yes

	Span Drift	Units	Run 1
CAL 1	Span at Analyser (Pre)	ppm	395.10
CAL 1	Span at Analyser (Post)	ppm	394.00
CAL 1	Span Drift	ppm	-1.10
CAL 1	Zero Adj. Span Drift	%	0.46
CAL 1	Drift Correction Applied	2-5%	No
	Allowable Span Drift	± %	5.00
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	18 - 20

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1
There are no deviations associated with the sampling employed.	

CARBON MONOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	-		mg/m³ (REF)
Allowable MU	6.0		%
Measured concentration	1.96		mg/m³ (STP, dry)
Range Used	500.0		ppm
Range Used [A]	624.6		mg/m³
Cal gas conc.	395.1		ppm
Conversion	1.25		ppm to mg/m³
MCERTS Range [B]	95.0		mg/m³
Lower of [A] or [B]	95.0		mg/m³
Cal gas conc.	493.6		mg/m³

Performance characteristics	RUN 1		Units
Response time	60		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.40		% full scale
Repeatability at span level	0.40		% full scale
Deviation from linearity	0.63		% of value
Zero drift	0.18		% full scale
Span drift	-0.46		% full scale
Volume or pressure flow dependence	0.40		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	0.05		% full scale/10K
Combined interference	0.73		% range
Dependence on voltage	0.40		% full scale/10V
Losses in the line (leak)	1.49		% of value
Uncertainty of calibration gas blending	1.40		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		mg/m³
Standard deviation of repeatability at span level	0.05		mg/m³
Lack of fit	0.35		mg/m³
Drift	0.50		mg/m³
Volume or pressure flow dependence	0.00		mg/m³
Atmospheric pressure dependence	0.08		mg/m³
Ambient temperature dependence	0.01		mg/m³
Combined interference (from MCERTS Certificate)	0.40		mg/m³
Dependence on voltage	0.05		mg/m³
Losses in the line (leak)	0.02		mg/m³
Uncertainty of calibration gas blending	0.02		mg/m³
Uncertainty of calibration gas	0.02		mg/m³

			RUN 1		Units
Measurement uncertainty		**Result**	1.96		mg/m³
Combined uncertainty			0.73		mg/m³
Expanded uncertainty	k =	1.96	1.44		mg/m³
Uncertainty corrected to std conds. (O_2)			1.68		mg/m³ (REF)

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	73.40		% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement	**N/A**		-

	RUN 1		Units
Expanded uncertainty (with O_2) - at 95% Confidence	73.59		% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement	**N/A**		-

Requirement for SRM is that Uncertainty should be <6% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 6% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components).

OXYGEN: RESULTS SUMMARY

Duynie Ingredients , Wrexham
Boiler 1

Sample Runs

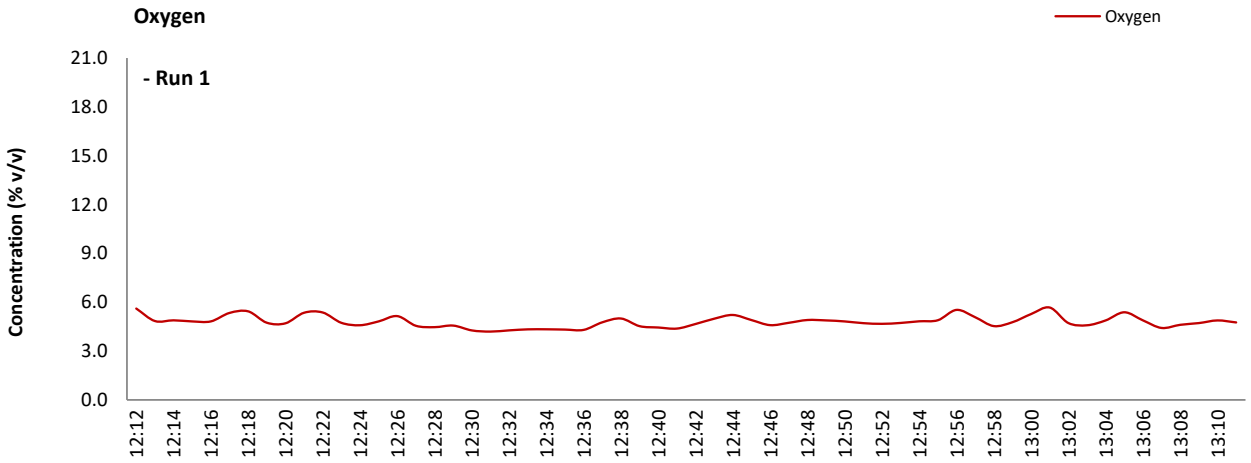
Parameter	Units	Run 1		Mean
Concentration	% v/v	4.8		4.8
Uncertainty	±% v/v	0.26		0.26

General Sampling Information

Parameter	Value	
Standard	EN 14789	
Technical Procedure	MD 021	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Synthetic Air (5 Grade)	
Span Gas Reference Number	11.0688	
Span Gas Expiry Date	31/01/2030	
Span Gas Start Pressure (bar)	180	
Gas Cylinder Concentration (% v/v)	21.53	NOTE: Dilution performed to achieve correct span value
Span Gas Uncertainty (%)	2	
Zero Gas Type	Nitrogen (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

OXYGEN: DATA TREND

Graphical Trend of Data



OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	12:12 - 13:12
Sampling Dates	-	26/09/2025
Instrument Range	% v/v	25.0
Span Gas Value	% v/v	5.0

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.8
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

	Zero Drift	Units	Run 1
CAL 1	Zero at Analyser (Pre)	% v/v	0.00
	Zero at Analyser (Post)	% v/v	0.03
	Zero Drift	% v/v	0.03
	Zero Drift	%	0.55
	Drift Correction Applied	2-5%	No
	Allowable Zero Drift	± %	5.00
	Zero Drift Acceptable	-	Yes

	Span Drift	Units	Run 1
CAL 1	Span at Analyser (Pre)	% v/v	5.42
	Span at Analyser (Post)	% v/v	5.27
	Span Drift	% v/v	-0.15
	Zero Adj. Span Drift	%	3.60
	Drift Correction Applied	2-5%	Yes
	Allowable Span Drift	± %	5.00
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	18 - 20

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1
There are no deviations associated with the sampling employed.	

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	N/A		%vol
Allowable MU	6.0		%
Measured concentration	4.80		%vol
Range Used	25.0		%vol
Cal gas conc.	21.5		%vol

Performance characteristics	RUN 1		Units
Response time	60		seconds
Number of readings in measurement	60		-
Repeatability at zero	0.04		% full scale
Repeatability at span level	0.04		% full scale
Deviation from linearity	0.05		% of value
Zero drift	0.55		% full scale
Span drift	0.00		% full scale
Volume or pressure flow dependence	0.20		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	-0.07		% full scale/10K
Combined interference	0.56		% range
Dependence on voltage	0.02		% full scale/10V
Losses in the line (leak)	1.60		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		%vol
Standard deviation of repeatability at span level	0.01		%vol
Lack of fit	0.01		%vol
Drift	0.07		%vol
Volume or pressure flow dependence	0.00		%vol
Atmospheric pressure dependence	0.02		%vol
Ambient temperature dependence	-0.01		%vol
Combined interference (from MCERTS Certificate)	0.08		%vol
Dependence on voltage	0.00		%vol
Losses in the line (leak)	0.04		%vol
Uncertainty of calibration gas	0.06		%vol

			RUN 1		Units
Measurement uncertainty		**Result**	4.80		%vol
Combined uncertainty			0.13		%vol
Expanded uncertainty	k =	1.96	0.26		%vol

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	5.31		% of Value
Result of Compliance with Uncertainty Requirement	**COMPLIANT**		-

Requirement for SRM is that Uncertainty should be 0.3% vol absolute or 6% relative whichever is the lower, on a dry gas basis. Source, EN 14789.

VERSION HISTORY

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

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Stack Emissions Testing Report Commissioned by
Duynie Ingredients

Installation Name & Address
Duynie Ingredients
Coed Abden Road
Wrexham Industrial Estate
Wrexham
LL13 9UH

Stack Reference
Dryer Stack

Dates of the Monitoring Campaign
25th - 26th September 2025

Job Reference Number
EMT14377

Report Written by
Stephen Taylor Team Leader MCERTS Level 2 MM 23 1803 TE1 TE3 & TE4

Report Approved by
Donal O Faogain Technical Report Writer MCERTS Level 2 MM13 1259 TE1 TE2 TE3 TE4

Report Date
8th October 2025

Version
Version 1

Signature of Report Approver


CONTENTS

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

MONITORING OBJECTIVES

Duynie Ingredients , Wrexham
Dryer Stack
25th - 26th September 2025

Overall Aim of the Monitoring Campaign

Element were commissioned by Duynie Ingredients to carry out stack emissions testing on the Dryer Stack at Wrexham.

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, Hydrogen Chloride

MONITORING RESULTS

Duynie Ingredients , Wrexham
Dryer Stack
25th - 26th September 2025

where MU = Measurement Uncertainty associated with the Result

		Concentration				Mass Emission			
Parameter		**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Total Particulate Matter	[1]	mg/m³	14.5	0.85	-	g/hr	230	17.6	-
Hydrogen Chloride	[1]	mg/m³	0.04	0.0019	-	g/hr	0.57	0.04	-
Water Vapour		% v/v	4.6	0.24					
Stack Gas Temperature		°C	33.3						
Stack Gas Velocity		m/s	11.4	0.22					
Volumetric Flow Rate (ACTUAL)		m³/hr	17601	865					
Volumetric Flow Rate (REF)	[1]	m³/hr	15924	782					

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

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

MONITORING DATE(S) & TIMES

Duynie Ingredients , Wrexham
Dryer Stack
25th - 26th September 2025

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	14.5	g/hr	230	25/09/2025	12:59 - 13:29, 13:31 - 14:01	60
Hydrogen Chloride	R1	mg/m³	0.04	g/hr	0.57	25/09/2025	12:59 - 13:29, 13:31 - 14:01	60
Velocity Traverse	R1					25/09/2025	12:15 - 12:25	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Duynie Ingredients , Wrexham
Dryer Stack
25th - 26th September 2025

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operating Conditions
Capacity (of 100%) and Tonnes / Hour	Normal Operation
Continuous or Batch Process	Conitnuous
Feedstock (if applicable)	N/A
Abatement System	N/A
Abatement System Running Status	N/A
Fuel	Steam
Plume Appearance	Steam Plume off process visable

MONITORING & ANALYTICAL METHODS

Duynie Ingredients , Wrexham
Dryer Stack
25th - 26th September 2025

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**Sampling Status**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**Analysis Status**	**Analysis Lab**	**Overall Status**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	MD 001	MCERTS	EET	MD 103	Gravimetric	MCERTS	EET	MCERTS	0.22 mg/m³
Hydrogen Chloride	EN 1911	MD 011	MCERTS	EET	MD 101	IC	MCERTS	EET	MCERTS	0.023 mg/m³
Water Vapour	EN 14790	MD 005	MCERTS	EET	MD 005	Gravimetric	MCERTS	EET	MCERTS	0.10 % v/v
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041	MCERTS	EET	Pitot Tube and Thermocouple				MCERTS	1.2 m/s

ANALYSIS LABORATORIES

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

Element (Stockport Lab - EET)	ISO 17025 Accreditation Number: UKAS 4279

SUMMARY OF SAMPLING DEVIATIONS

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

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.74
Width	m	-
Area	m²	0.43
Port Depth	cm	9
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	MEWP
Inside / Outside	Inside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	N/A
Platform has vertical base boards (approx. 0.25m high)	N/A
Platform has chains / self closing gates at top of ladders	N/A
There are no obstructions present which hamper insertion of sampling equipment	No
Safe Access Available	Yes
Easy Access Available	No

Sampling Location / Platform Improvement Recommendations

The sampling location meets all the requirements specified in EA Guidance Note M1 and EN 15259, and therefore there are no improvement recommendations.

EN 15259 Homogeneity Test Requirements

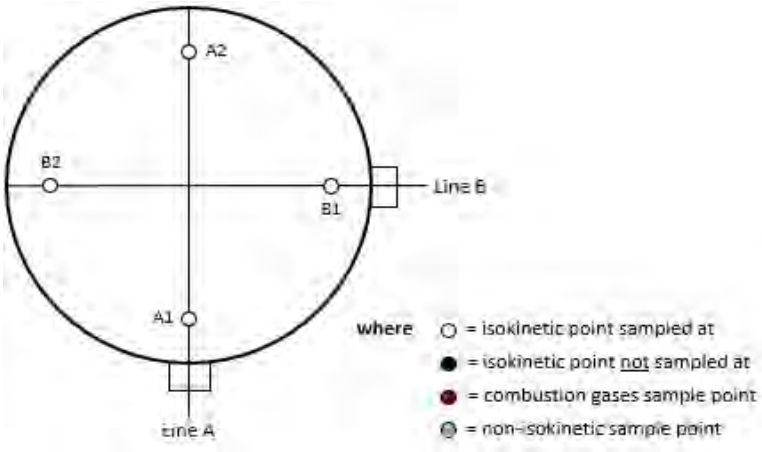
There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	26.0	> 5 Pa	Yes
Mean Velocity	m/s	10.38	-	-
Lowest Gas Velocity	m/s	5.61	-	-
Highest Gas Velocity	m/s	12.25	-	-
Ratio of Above	: 1	2.18	< 3 : 1	Yes
Maximum Angle of Swirl	°	7.00	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

PLANT PHOTOS

SAMPLE POINTS



APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Stephen Taylor	MCERTS Level 2	MM 23 1803	TE1 TE3 & TE4
Technician	Tom Dixon	MCERTS Level 1	MM 23 1802	TE1

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.95
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.31
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.31
Umbilical (2)	-
Oven Box (1)	CAT 12.36
Oven Box (2)	-
Heated Probe 0.5m	-
Heated Probe 1.0m	CAT 5.64
Heated Probe 1.5m	-
S-Pitot (1) -	CAT 21P.134
S-Pitot (2) -	CAT 21S.71
L-Pitot - Coef .993 (4.1931)	-
Site Balance	CAT 17.108
500g / 1Kg Check Weights	CAT 17.108
Last Impinger Arm	-
Callipers	CAT 23.53
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	-
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	-
Gasmet DX4000	-
Gasmet Sampling System	-
Sick 3006	-
M&C PSS	-
Mass Flow Controller (1)	-
Mass Flow Controller (2)	-
Mass View (1)	-
Mass View (2)	-
Hioki 5043 (V)	-
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer 500	CAT 3.265
Digital Manometer 10000	-
Digital Temperature Meter	-
Stopwatch	CAT 14.98
Barometer	CAT 13.62
Stack Thermocouple 0.5m	-
Stack Thermocouple 1.0m	CAT A009182
Stack Thermocouple 1.5m	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	-
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18, 1.18a, 1.18b
Tape Measure	CAT 16.58

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	MD 001
Hydrogen Chloride	EN 1911	MD 011
Water Vapour	EN 14790	MD 005
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.74
Stack Width, W	m	-
Stack Area, A	m^2	0.43
Average Stack Gas Temperature, T_a	°C	31.0
Average Stack Gas Pressure	Pa	95.3
Average Stack Static Pressure, P_{static}	kPa	-0.064
Average Barometric Pressure, P_b	kPa	102.9
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m^3 p	Conc kg/m^3 p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2 (Estimated)	-	20.80	19.84	0.2080	32.00	1.4277	0.29696
N_2	-	79.14	75.48	0.7914	28.01	1.2498	0.98913
Moisture (H_2O)	-	-	4.62	0.0462	18.02	0.8037	0.03713

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m^3	1.287
Wet Density (STP), P_{STW}	kg/m^3	1.265
Dry Density (Actual), P_{Actual}	kg/m^3	1.174
Average Wet Density (Actual), $P_{ActualW}$	kg/m^3	1.153

Where: P_{STD} = sum of component concentrations, kg/m^3 (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m^3 (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) $= P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	31.0	0.0
Total Pressure	kPa	102.8	101.3
Moisture	%	4.62	4.62

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m^3/hr	16065
Gas Volumetric Flowrate (STP, Wet)	m^3/hr	14646
Gas Volumetric Flowrate (STP, Dry)	m^3/hr	13969
Gas Volumetric Flowrate REF [1]	m^3/hr	14646

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	25/09/2025
Time of Survey	-	12:15 - 12:25
Atmospheric Pressure	kPa	102.9
Average Stack Static Pressure	Pa	-64
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 210 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	2

		Sampling Line A					Sampling Line B				
Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m³	Velocity m/s	Swirl °	ΔP Pa	Temp °C	Wet Density kg/m³	Velocity m/s	Swirl °
STATIC (Units: Pa)		*-63.0*					*-65.0*				
Mean		**115.5**	**31.0**	**1.153**	**11.82**		**75.0**	**31.0**	**1.153**	**8.93**	
1	0.11	117.0	31.0	1.153	11.90	6.0	124.0	31.0	1.153	12.25	6.0
2	0.63	114.0	31.0	1.153	11.75	7.0	26.0	31.0	1.153	5.61	7.0

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

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	1.891	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.945	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	1.547	
- Overall corrections to dynamic measurements	u(Cf)	2.576	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- $\varphi O_2,w$	-	19.839	
- $\varphi CO_2,w$	-	0.057	
- Oxygen, dry	u(ϕO_2,d)	0.637	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.236	
- Oxygen, wet	u(ϕO_2,w)	0.609	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.551	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.697	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	1.337	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00636	-
Standard uncertainty associated with the local velocities	u(vi)	0.150	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.101	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.198	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	1.91	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	789.4	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00063	
- $u^2(qV,w)$	-	162229	
- $u(qV,w)$	-	402.8	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	4.91	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Duynie Ingredients , Wrexham
Dryer Stack

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	14.5		14.5
Uncertainty	±mg/m³	0.85		0.85
Mass Emission	g/hr	230		230
Uncertainty	±g/hr	17.6		17.6

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	4.6		4.6
Uncertainty	±% v/v	0.24		0.24

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.22		0.22

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	MD 001	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	Out Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	2 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1, A2, B1, B2	

Reference Conditions

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

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1
Absolute pressure of stack gas, P_s		
Barometric pressure, P_b	mmHg	771.8
Stack static pressure, P_{static}	mmH_2O	-6.4
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	771.3
Volume of water vapour collected, V_{wstd}		
Total mass collected in impingers (liquid trap)	g	29.6
Total mass collected in impingers (silica trap)	g	9.2
Total mass of liquid collected, V_{lc}	g	38.8
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0483
Volume of gas metered dry, V_{mstd}		
Volume of gas sample through gas meter, V_m	m^3	1.0171
Gas meter correction factor, Y_d	-	1.0500
Average dry gas meter temperature, T_m	°C	24.6
Average pressure drop across orifice, ΔH	mmH_2O	32.9
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.9981
Moisture content, B_{wo} & R_{wv}		
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0462
B_{wo} as a percentage	% v/v	4.62
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	4.62
Volume of gas metered wet, V_{mstw}		
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.0464
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$		
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A
% oxygen reference condition, $REF\%O_2$	% v/v	N/A
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A
Molecular weight of dry gas stream, M_d		
CO_2 (Estimated)	% v/v	0.06
O_2 (Estimated)	% v/v	20.80
Total	% v/v	20.86
N_2	% v/v	79.14
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84
Molecular weight of stack gas (wet), M_s		
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.34
Velocity of stack gas, V_s		
Pitot tube velocity constant, K_p	-	34.97
Velocity pressure coefficient, C_p	-	0.85
Average of velocity heads, ΔP_{avg}	mmH_2O	10.39
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	3.22
Average stack gas temperature, T_s	°C	33.3
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	11.37
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})		
Area of stack, A_s	m^2	0.43
$Q_a = (60)(A_s)(V_s)$	m^3/min	293.4
Conversion factor (K/mm.Hg), C_f	-	0.3592
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	265.4
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	253.1
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A
Percent isokinetic, %I		
Nozzle diameter, D_n	mm	6.01
Nozzle area, A_n	mm^2	28.40
Total sampling time, q	min	60
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	99.5

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	12:59 - 13:29, 13:31 - 14:01
Sampling Dates	-	25/09/2025
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	1.0464
Filter I.D. Number	-	47-109437
Start Filter Mass	g	0.14738
End Filter Mass	g	0.14715
Total Mass on Filter	g	-0.00023
Probe Rinse I.D. Number	-	PR-47-109437
Start Probe Rinse Mass	g	2.88008
End Probe Rinse Mass	g	2.89544
Total Mass in Probe Rinse	g	0.01536
Total Mass Collected	mg	15.12
Calculated Concentration	mg/m^3	14.45
Balance Uncertainty / LOD	mg/m^3	0.22

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	25/09/2025
Average Volume Sampled (REF)	m^3	1.0464
Filter I.D. Number	-	47-109685
Start Filter Mass	g	0.14663
End Filter Mass	g	0.14655
Total Mass on Filter	g	-0.00008
Probe Rinse I.D. Number	-	PR-47-109685
Start Probe Rinse Mass	g	2.91771
End Probe Rinse Mass	g	2.91768
Total Mass in Probe Rinse	g	-0.00003
Total Mass Collected	mg	-0.11
Calculated Concentration	mg/m^3	-0.11
Balance Uncertainty / LOD	mg/m^3	0.22

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	17.8
Pre-Sampling Leak Rate	l/min	0.25
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)	%	5.1
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	%	99.5
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Weighing Uncertainty Criteria	Units	Run 1
Overall Weighing Uncertainty	± mg	0.33
Overall Weighing Uncertainty	± mg/m³	0.31
ELV [Daily ELV for IED]	mg/m³	N/A
Allowable Weighing Uncertainty	mg/m³	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	120

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	0.24
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/m³	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 (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
There are no deviations associated with the sampling employed.	wx	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

		Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**
Sampled Volume (Actual)	V_m	1.0171		uV_m	m^3	0.0203
Sampled Gas Temperature	T_m	297.6		uT_m	K	2.00
Sampled Gas Pressure	ρ_m	102.8		$u\rho_m$	kPa	0.50
Sampled Gas Humidity	H_m	0.00		uH_m	% v/v	1.00
Leak	L	1.40		uL	%	-
Mass of Particulate	m	15.12		um	mg	0.23
Uncollected Mass	UCM	-0.11		uUCM	mg	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.67	≤1%
Sampled Gas Pressure	%	0.49	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	1.40	≤2%
Mass of Particulate	%	-	-
Uncollected Mass	%	-	-

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m^3	0.9981	14.48
Leak	L	mg/m^3	0.117	1.00
Mass of Particulate	L_r	mg	15.123	0.96
Uncollected Mass	UCM	mg	-0.06	0.96

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m^3	0.349
Leak	mg/m^3	0.1172
Mass of Particulate	mg/m^3	0.2198
Uncollected Mass	mg/m^3	-0.0607

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

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	0.43
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.85
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.85
Reported Uncertainty	mg/m^3	0.85
Expanded uncertainty (95% confidence), without Oxygen Correction	%	5.9
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	5.9
Reported Uncertainty	%	5.9
Reported Uncertainty as % of ELV	%	N/A

HYDROGEN CHLORIDE: RESULTS SUMMARY

Duynie Ingredients , Wrexham
Dryer Stack

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.04		0.04
Uncertainty	±mg/m³	0.0019		0.0019
Mass Emission	g/hr	0.57		0.57
Uncertainty	±g/hr	0.04		0.04

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	4.6		4.6
Uncertainty	±% v/v	0.24		0.24

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	< 0.01		< 0.01

General Sampling Information

Parameter	Value	
Standard	EN 1911	
Technical Procedure	MD 011	
Name of Analytical Laboratory	EET	
Analytical Laboratory's Procedure	MD 101	
ISO 17025 Accredited Analysis?	MCERTS	
Date of Sample Analysis	01/10/2025	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Impinger Material	Polyethylene	
Absorption Solution	HPLC Grade Water	
Positioning of Filter	Out Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	2 / 2	FORMAT: Number Used / Number Required
Number of Sampling Points Used	4 / 4	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1, A2, B1, B2	

Reference Conditions

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

HYDROGEN CHLORIDE: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1
Absolute pressure of stack gas, P_s		
Barometric pressure, P_b	mmHg	771.8
Stack static pressure, P_{static}	mmH_2O	-6.4
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	771.3
Volume of water vapour collected, V_{wstd}		
Total mass collected in impingers (liquid trap)	g	29.6
Total mass collected in impingers (silica trap)	g	9.2
Total mass of liquid collected, V_{lc}	g	38.8
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0483
Volume of gas metered dry, V_{mstd}		
Volume of gas sample through gas meter, V_m	m^3	1.0171
Gas meter correction factor, Y_d	-	1.0500
Average dry gas meter temperature, T_m	°C	24.6
Average pressure drop across orifice, ΔH	mmH_2O	32.9
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	0.9981
Moisture content, B_{wo} & R_{wv}		
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0462
B_{wo} as a percentage	% v/v	4.62
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	4.62
Volume of gas metered wet, V_{mstw}		
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.0464
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$		
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A
% oxygen reference condition, $REF\%O_2$	% v/v	N/A
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A
Molecular weight of dry gas stream, M_d		
CO_2 (Estimated)	% v/v	0.06
O_2 (Estimated)	% v/v	20.80
Total	% v/v	20.86
N_2	% v/v	79.14
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84
Molecular weight of stack gas (wet), M_s		
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.34
Velocity of stack gas, V_s		
Pitot tube velocity constant, K_p	-	34.97
Velocity pressure coefficient, C_p	-	0.85
Average of velocity heads, ΔP_{avg}	mmH_2O	10.39
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	3.22
Average stack gas temperature, T_s	°C	33.3
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	11.37
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})		
Area of stack, A_s	m^2	0.43
$Q_a = (60)(A_s)(V_s)$	m^3/min	293.4
Conversion factor (K/mm.Hg), C_f	-	0.3592
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	265.4
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	253.1
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A
Percent isokinetic, %I		
Nozzle diameter, D_n	mm	6.01
Nozzle area, A_n	mm^2	28.40
Total sampling time, q	min	60
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	99.5

HYDROGEN CHLORIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	12:59 - 13:29, 13:31 - 14:01
Sampling Dates	-	25/09/2025
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	1.0464
Laboratory Result for Front Impingers	µg/ml	0.09
Laboratory Result for Back Impinger	µg/ml	< 0.05
Volume in Front Impingers	ml	338.4
Volume in Back Impinger	ml	143.3
Mass in Front Impingers	µg	30.5
Mass in Back Impinger	µg	< 7.2
Total Mass Collected	µg	37.6
Calculated Concentration	mg/m^3	0.04

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	25/09/2025
Average Volume Sampled (REF)	m^3	1.0464
Laboratory Result for Impingers	µg/ml	< 0.05
Volume in Impingers	ml	306.0
Total Mass Collected	µg	< 15.3
Calculated Concentration	mg/m^3	< 0.01

HYDROGEN CHLORIDE: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	17.8
Pre-Sampling Leak Rate	l/min	0.25
Post-Sampling Leak Rate	l/min	N/A
Allowable Leak Rate	l/min	0.40
Leak Test Acceptable	-	Yes

Absorption Efficiency	Units	Run 1
Absorption Efficiency	%	100.0
Allowable Absorption Efficiency	%	N/A [1]
Absorption Efficiency Acceptable	-	Yes [1]

[1] The concentration in the last absorber was less than 5 times the analytical detection limit.

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.1
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	%	99.5
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Maximum Filter Temperature	°C	120

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

HYDROGEN CHLORIDE: 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	0.24
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/m³	N/A
Blank Acceptable	-	N/A

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
There are no deviations associated with the sampling employed.	wx	

HYDROGEN CHLORIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

		Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**
Sampled Volume (Actual)	V_m	1.0171		uV_m	m^3	0.0203
Sampled Gas Temperature	T_m	297.6		uT_m	K	2.00
Sampled Gas Pressure	ρ_m	102.8		$u\rho_m$	kPa	0.50
Sampled Gas Humidity	H_m	0.00		uH_m	% v/v	1.00
Leak	L	1.40		uL	%	-
Laboratory Result	L_r	1.05		uL_r	%	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.67	≤1%
Sampled Gas Pressure	%	0.49	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	1.40	≤2%
Laboratory Result	%	1.05	No Requirement

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m^3	0.9981	0.04
Leak	L	mg/m^3	0.0003	1.00
Laboratory Result	L_r	mg/m^3	0.0004	1.00

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m^3	0.001
Leak	mg/m^3	0.0003
Laboratory Result	mg/m^3	0.0004

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

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	0.001
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.002
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.002
Reported Uncertainty	mg/m^3	0.002
Expanded uncertainty (95% confidence), without Oxygen Correction	%	5.4
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	5.4
Reported Uncertainty	%	5.4
Reported Uncertainty as % of ELV	%	N/A

VERSION HISTORY

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

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Stack Emissions Testing Report Commissioned by
Duynie Ingredients

Installation Name & Address
Duynie Ingredients
Coed Abden Road
Wrexham Industrial Estate
Wrexham
LL13 9UH

Stack Reference
Dust Extractor 1

Dates of the Monitoring Campaign
25th - 26th September 2025

Job Reference Number
EMT14377

Report Written by
Stephen Taylor Team Leader MCERTS Level 2 MM 23 1803 TE1 TE3 & TE4

Report Approved by
Donal O Faogain Technical Report Writer MCERTS Level 2 MM13 1259 TE1 TE2 TE3 TE4

Report Date
8th October 2025

Version
Version 1

Signature of Report Approver


CONTENTS

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

MONITORING OBJECTIVES

Duynie Ingredients , Wrexham
Dust Extractor 1
25th - 26th September 2025

Overall Aim of the Monitoring Campaign

Element were commissioned by Duynie Ingredients to carry out stack emissions testing on the Dust Extractor 1 at Wrexham.

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

MONITORING RESULTS

Duynie Ingredients , Wrexham
Dust Extractor 1
25th - 26th September 2025

where MU = Measurement Uncertainty associated with the Result

	Concentration				Mass Emission			
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Total Particulate Matter [1]	mg/m³	1.5	0.31	-	g/hr	8.1	1.8	-
Water Vapour	% v/v	0.81	0.05					
Stack Gas Temperature	°C	33.0						
Stack Gas Velocity	m/s	23.6	1.0					
Volumetric Flow Rate (ACTUAL)	m³/hr	6004	376					
Volumetric Flow Rate (REF) [1]	m³/hr	5462	342					

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

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

MONITORING DATE(S) & TIMES

Duynie Ingredients , Wrexham
Dust Extractor 1
25th - 26th September 2025

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	1.5	g/hr	8.1	25/09/2025	14:25 - 15:25	60
Velocity Traverse	R1					25/09/2025	13:20 - 13:25	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Duynie Ingredients , Wrexham
Dust Extractor 1
25th - 26th September 2025

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operating Conditions
Capacity (of 100%) and Tonnes / Hour	Normal Operation
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Extraction
Abatement System	N/A
Abatement System Running Status	N/A
Fuel	N/A
Plume Appearance	None Visable

MONITORING & ANALYTICAL METHODS

Duynie Ingredients , Wrexham
Dust Extractor 1
25th - 26th September 2025

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**Sampling Status**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**Analysis Status**	**Analysis Lab**	**Overall Status**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	MD 001	MCERTS	EET	MD 103	Gravimetric	MCERTS	EET	MCERTS	0.15 mg/m³
Water Vapour	EN 14790	MD 005	MCERTS	EET	MD 005	Gravimetric	MCERTS	EET	MCERTS	0.10 % v/v
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041	MCERTS	EET	Pitot Tube and Thermocouple				MCERTS	3.3 m/s

ANALYSIS LABORATORIES

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

Element (Stockport Lab - EET)	ISO 17025 Accreditation Number: UKAS 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Total Particulate Matter	1	Only one out of two required sampling lines was available.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.30
Width	m	-
Area	m²	0.07
Port Depth	cm	8
Orientation of Duct	-	Vertical
Number of Ports	-	1
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	On Ground
Inside / Outside	Inside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	N/A
Platform has vertical base boards (approx. 0.25m high)	N/A
Platform has chains / self closing gates at top of ladders	N/A
There are no obstructions present which hamper insertion of sampling equipment	No
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

The sampling location meets all the requirements specified in EA Guidance Note M1 and EN 15259, and therefore there are no improvement recommendations.

EN 15259 Homogeneity Test Requirements

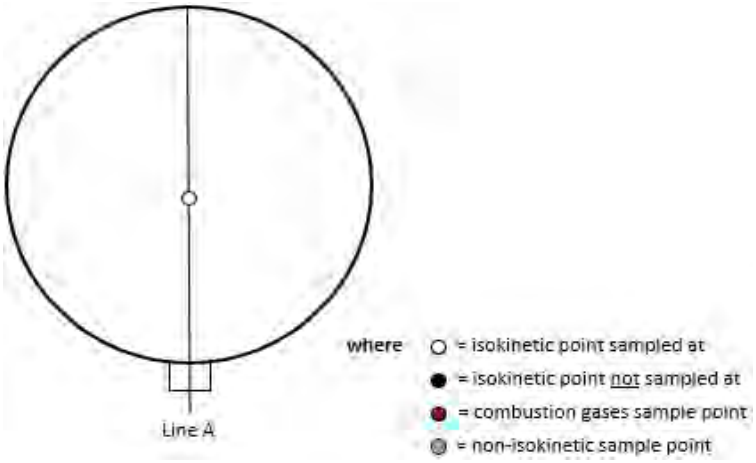
There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	359.0	> 5 Pa	Yes
Mean Velocity	m/s	20.73	-	-
Lowest Gas Velocity	m/s	20.73	-	-
Highest Gas Velocity	m/s	20.73	-	-
Ratio of Above	: 1	1.00	< 3 : 1	Yes
Maximum Angle of Swirl	°	9.00	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

PLANT PHOTOS

SAMPLE POINTS



APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Stephen Taylor	MCERTS Level 2	MM 23 1803	TE1 TE3 & TE4
Technician	Tom Dixon	MCERTS Level 1	MM 23 1802	TE1

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.95
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.31
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.31
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe 0.5m	CAT 5.18
Heated Probe 1.0m	-
Heated Probe 1.5m	-
S-Pitot (1)	CAT 21P.134
S-Pitot (2)	CAT 21S.71
L-Pitot - Coef .993 (4.1931)	-
Site Balance	CAT 17.108
500g / 1Kg Check Weights	CAT 17.108
Last Impinger Arm	-
Callipers	CAT 23.53
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	-
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	-
Gasmet DX4000	-
Gasmet Sampling System	-
Sick 3006	-
M&C PSS	-
Mass Flow Controller (1)	-
Mass Flow Controller (2)	-
Mass View (1)	-
Mass View (2)	-
Hioki 5043 (V)	-
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer 500	CAT 3.224
Digital Manometer 10000	-
Digital Temperature Meter	-
Stopwatch	CAT 14.98
Barometer	CAT 13.62
Stack Thermocouple 0.5m	CAT 4.1901
Stack Thermocouple 1.0m	-
Stack Thermocouple 1.5m	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	-
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18, 1.18a, 1.18b
Tape Measure	CAT 16.58

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	MD 001
Water Vapour	EN 14790	MD 005
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.30
Stack Width, W	m	-
Stack Area, A	m^2	0.07
Average Stack Gas Temperature, T_a	°C	33.1
Average Stack Gas Pressure	Pa	359.0
Average Stack Static Pressure, P_{static}	kPa	0.412
Average Barometric Pressure, P_b	kPa	102.8
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m^3 p	Conc kg/m^3 p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2 (Estimated)	-	20.80	20.63	0.2080	32.00	1.4277	0.29696
N_2	-	79.14	78.50	0.7914	28.01	1.2498	0.98913
Moisture (H_2O)	-	-	0.81	0.0081	18.02	0.8037	0.00654

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m^3	1.287
Wet Density (STP), P_{STW}	kg/m^3	1.283
Dry Density (Actual), P_{Actual}	kg/m^3	1.170
Average Wet Density (Actual), $P_{ActualW}$	kg/m^3	1.166

Where: P_{STD} = sum of component concentrations, kg/m^3 (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m^3 (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) $= P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	33.1	0.0
Total Pressure	kPa	103.2	101.3
Moisture	%	0.81	0.81

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m^3/hr	5274
Gas Volumetric Flowrate (STP, Wet)	m^3/hr	4793
Gas Volumetric Flowrate (STP, Dry)	m^3/hr	4754
Gas Volumetric Flowrate REF [1]	m^3/hr	4793

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	25/09/2025
Time of Survey	-	13:20 - 13:25
Atmospheric Pressure	kPa	102.8
Average Stack Static Pressure	Pa	412
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 210 (10000Pa)	

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

Sampling Line A

Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m³	Velocity m/s	Swirl °
STATIC (Units: Pa)		*412.0*				
Mean		**359.0**	**33.1**	**1.166**	**20.73**	
1	0.15	359.0	33.1	1.166	20.73	9.0

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

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	9.877	Pa
- Resolution	u(res)	0.08677	
- Calibration	u(cal)	13.420	
- Drift	u(drift)	33.333	
- Lack of Fit	u(fit)	49.714	
- Overall corrections to dynamic measurements	u(Cf)	96.554	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- $\varphi O_2,w$	-	20.631	
- $\varphi CO_2,w$	-	0.060	
- Oxygen, dry	u(ϕO_2,d)	0.637	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.042	
- Oxygen, wet	u(ϕO_2,w)	0.632	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.562	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.969	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	9.877	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00636	-
Standard uncertainty associated with the local velocities	u(vi)	0.457	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.457	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.896	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	4.32	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	330.0	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00102	
- $u^2(qV,w)$	-	28354	
- $u(qV,w)$	-	168.4	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	6.26	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Duynie Ingredients , Wrexham
Dust Extractor 1

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	1.5		1.5
Uncertainty	±mg/m³	0.31		0.31
Mass Emission	g/hr	8.1		8.1
Uncertainty	±g/hr	1.8		1.8

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	0.81		0.81
Uncertainty	±% v/v	0.05		0.05

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.15		0.15

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	MD 001	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	Out Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

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

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1
Absolute pressure of stack gas, P_s		
Barometric pressure, P_b	mmHg	771.8
Stack static pressure, P_{static}	mmH_2O	42.0
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	774.9
Volume of water vapour collected, V_{wstd}		
Total mass collected in impingers (liquid trap)	g	5.5
Total mass collected in impingers (silica trap)	g	4.5
Total mass of liquid collected, V_{lc}	g	10.0
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0125
Volume of gas metered dry, V_{mstd}		
Volume of gas sample through gas meter, V_m	m^3	1.5527
Gas meter correction factor, Y_d	-	1.0500
Average dry gas meter temperature, T_m	°C	26.9
Average pressure drop across orifice, ΔH	mmH_2O	73.9
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.5177
Moisture content, B_{wo} & R_{wv}		
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0081
B_{wo} as a percentage	% v/v	0.81
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	0.81
Volume of gas metered wet, V_{mstw}		
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.5301
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$		
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A
% oxygen reference condition, $REF\%O_2$	% v/v	N/A
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A
Molecular weight of dry gas stream, M_d		
CO_2 (Estimated)	% v/v	0.06
O_2 (Estimated)	% v/v	20.80
Total	% v/v	20.86
N_2	% v/v	79.14
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84
Molecular weight of stack gas (wet), M_s		
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.75
Velocity of stack gas, V_s		
Pitot tube velocity constant, K_p	-	34.97
Velocity pressure coefficient, C_p	-	0.85
Average of velocity heads, ΔP_{avg}	mmH_2O	45.67
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	6.76
Average stack gas temperature, T_s	°C	33.0
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	23.60
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})		
Area of stack, A_s	m^2	0.07
$Q_a = (60)(A_s)(V_s)$	m^3/min	100.1
Conversion factor (K/mm.Hg), C_f	-	0.3592
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	91.0
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	90.3
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A
Percent isokinetic, %I		
Nozzle diameter, D_n	mm	5.00
Nozzle area, A_n	mm^2	19.66
Total sampling time, q	min	60
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	100.7

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	14:25 - 15:25
Sampling Dates	-	25/09/2025
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	1.5301
Filter I.D. Number	-	47-123091
Start Filter Mass	g	0.15048
End Filter Mass	g	0.15066
Total Mass on Filter	g	0.00018
Probe Rinse I.D. Number	-	PR-47-123091
Start Probe Rinse Mass	g	2.85381
End Probe Rinse Mass	g	2.85589
Total Mass in Probe Rinse	g	0.00208
Total Mass Collected	mg	2.26
Calculated Concentration	mg/m^3	1.48
Balance Uncertainty / LOD	mg/m^3	0.15

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	25/09/2025
Average Volume Sampled (REF)	m^3	1.5301
Filter I.D. Number	-	47-123101
Start Filter Mass	g	0.15125
End Filter Mass	g	0.15125
Total Mass on Filter	g	0.00000
Probe Rinse I.D. Number	-	PR-47-123101
Start Probe Rinse Mass	g	2.79560
End Probe Rinse Mass	g	2.79571
Total Mass in Probe Rinse	g	0.00011
Total Mass Collected	mg	0.11
Calculated Concentration	mg/m^3	0.07
Balance Uncertainty / LOD	mg/m^3	0.15

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	27.2
Pre-Sampling Leak Rate	l/min	0.30
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)	%	5.8
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	%	100.7
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Weighing Uncertainty Criteria	Units	Run 1
Overall Weighing Uncertainty	± mg	0.33
Overall Weighing Uncertainty	± mg/m³	0.21
ELV [Daily ELV for IED]	mg/m³	N/A
Allowable Weighing Uncertainty	mg/m³	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	120

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	0.22
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/m³	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 (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
Only one out of two required sampling lines was available, however the number of sample points used on the available line were increased to the minimum required by the Standard	wx	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**	**Symbol**	**Units**	**Run 1**
Sampled Volume (Actual)	V_m	1.5527	uV_m	m^3	0.0311
Sampled Gas Temperature	T_m	299.9	uT_m	K	2.00
Sampled Gas Pressure	ρ_m	103.3	$u\rho_m$	kPa	0.50
Sampled Gas Humidity	H_m	0.00	uH_m	% v/v	1.00
Leak	L	1.10	uL	%	-
Mass of Particulate	m	2.26	um	mg	0.23
Uncollected Mass	UCM	0.11	uUCM	mg	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.67	≤1%
Sampled Gas Pressure	%	0.48	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	1.10	≤2%
Mass of Particulate	%	-	-
Uncollected Mass	%	-	-

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m^3	1.5177	0.97
Leak	L	mg/m^3	0.009	1.00
Mass of Particulate	L_r	mg	2.263	0.65
Uncollected Mass	UCM	mg	0.06	0.65

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m^3	0.036
Leak	mg/m^3	0.0094
Mass of Particulate	mg/m^3	0.1503
Uncollected Mass	mg/m^3	0.0402

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

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	0.16
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.31
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.31
Reported Uncertainty	mg/m^3	0.31
Expanded uncertainty (95% confidence), without Oxygen Correction	%	21.2
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	21.2
Reported Uncertainty	%	21.2
Reported Uncertainty as % of ELV	%	N/A

VERSION HISTORY

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

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Stack Emissions Testing Report Commissioned by
Duynie Ingredients

Installation Name & Address
Duynie Ingredients
Coed Abden Road
Wrexham Industrial Estate
Wrexham
LL13 9UH

Stack Reference
Dust Extractor 2

Dates of the Monitoring Campaign
25th - 26th September 2025

Job Reference Number
EMT14377

Report Written by
Stephen Taylor Team Leader MCERTS Level 2 MM 23 1803 TE1 TE3 & TE4

Report Approved by
Donal O Faogain Technical Report Writer MCERTS Level 2 MM13 1259 TE1 TE2 TE3 TE4

Report Date
8th October 2025

Version
Version 1

Signature of Report Approver


CONTENTS

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

MONITORING OBJECTIVES

Duynie Ingredients , Wrexham
Dust Extractor 2
25th - 26th September 2025

Overall Aim of the Monitoring Campaign

Element were commissioned by Duynie Ingredients to carry out stack emissions testing on the Dust Extractor 2 at Wrexham.

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

MONITORING RESULTS

Duynie Ingredients , Wrexham
Dust Extractor 2
25th - 26th September 2025

where MU = Measurement Uncertainty associated with the Result

	Concentration				Mass Emission			
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Total Particulate Matter [1]	mg/m³	0.69	0.29	-	g/hr	1.4	0.61	-
Water Vapour	% v/v	0.82	0.05					
Stack Gas Temperature	°C	41.0						
Stack Gas Velocity	m/s	9.7	0.65					
Volumetric Flow Rate (ACTUAL)	m³/hr	2303	186					
Volumetric Flow Rate (REF) [1]	m³/hr	2030	164					

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

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

MONITORING DATE(S) & TIMES

Duynie Ingredients , Wrexham
Dust Extractor 2
25th - 26th September 2025

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	0.69	g/hr	1.4	25/09/2025	15:50 - 16:50	60
Velocity Traverse	R1					25/09/2025	15:32 - 15:39	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Duynie Ingredients , Wrexham
Dust Extractor 2
25th - 26th September 2025

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operating Conditions
Capacity (of 100%) and Tonnes / Hour	Normal Operation
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Extraction
Abatement System	N/A
Abatement System Running Status	N/A
Fuel	N/A
Plume Appearance	None Visable

MONITORING & ANALYTICAL METHODS

Duynie Ingredients , Wrexham
Dust Extractor 2
25th - 26th September 2025

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**Sampling Status**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**Analysis Status**	**Analysis Lab**	**Overall Status**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	MD 001	MCERTS	EET	MD 103	Gravimetric	MCERTS	EET	MCERTS	0.15 mg/m³
Water Vapour	EN 14790	MD 005	MCERTS	EET	MD 005	Gravimetric	MCERTS	EET	MCERTS	0.10 % v/v
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041	MCERTS	EET	Pitot Tube and Thermocouple				MCERTS	3.3 m/s

ANALYSIS LABORATORIES

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

Element (Stockport Lab - EET)	ISO 17025 Accreditation Number: UKAS 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
All	1	There are no deviations associated with the sampling employed.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.29
Width	m	-
Area	m²	0.07
Port Depth	cm	7
Orientation of Duct	-	Vertical
Number of Ports	-	1
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	Scissor Lift
Inside / Outside	Inside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	N/A
Platform has vertical base boards (approx. 0.25m high)	N/A
Platform has chains / self closing gates at top of ladders	N/A
There are no obstructions present which hamper insertion of sampling equipment	No
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

The sampling location meets all the requirements specified in EA Guidance Note M1 and EN 15259, and therefore there are no improvement recommendations.

EN 15259 Homogeneity Test Requirements

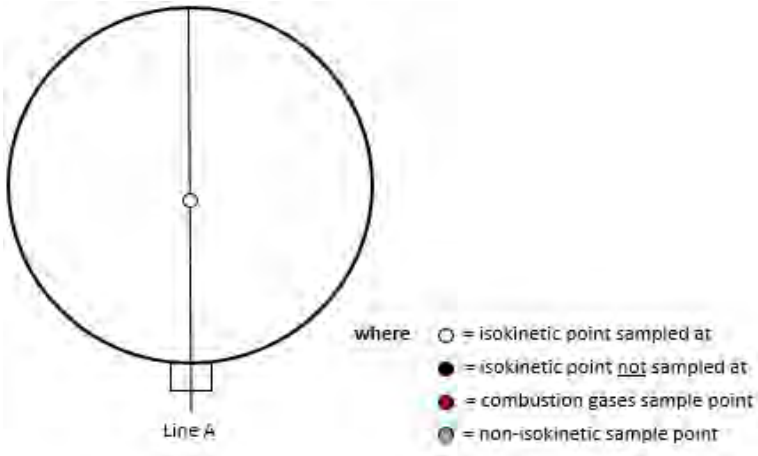
There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	104.0	> 5 Pa	Yes
Mean Velocity	m/s	11.34	-	-
Lowest Gas Velocity	m/s	11.34	-	-
Highest Gas Velocity	m/s	11.34	-	-
Ratio of Above	: 1	1.00	< 3 : 1	Yes
Maximum Angle of Swirl	°	9.00	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

PLANT PHOTOS

SAMPLE POINTS



APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Stephen Taylor	MCERTS Level 2	MM 23 1803	TE1 TE3 & TE4
Technician	Tom Dixon	MCERTS Level 1	MM 23 1802	TE1

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.95
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.31
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.31
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe 0.5m	-
Heated Probe 1.0m	CAT 5.64
Heated Probe 1.5m	-
S-Pitot (1) - Coef .838	CAT 21P.134
S-Pitot (2) - Coef .844	CAT 21S.71
L-Pitot - Coef .993 (4.1931)	-
Site Balance	CAT 17.108
500g / 1Kg Check Weights	CAT 17.108
Last Impinger Arm	-
Callipers	CAT 23.53
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	-
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	-
Gasmet DX4000	-
Gasmet Sampling System	-
Sick 3006	-
M&C PSS	-
Mass Flow Controller (1)	-
Mass Flow Controller (2)	-
Mass View (1)	-
Mass View (2)	-
Hioki 5043 (V)	-
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer 500	CAT 3.224
Digital Manometer 10000	-
Digital Temperature Meter	-
Stopwatch	CAT 14.98
Barometer	CAT 13.62
Stack Thermocouple 0.5m	CAT 4.1901
Stack Thermocouple 1.0m	-
Stack Thermocouple 1.5m	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	-
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	CAT 1.18, 1.18a, 1.18b
Tape Measure	CAT 16.58

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	MD 001
Water Vapour	EN 14790	MD 005
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.29
Stack Width, W	m	-
Stack Area, A	m^2	0.07
Average Stack Gas Temperature, T_a	°C	42.2
Average Stack Gas Pressure	Pa	104.0
Average Stack Static Pressure, P_{static}	kPa	0.027
Average Barometric Pressure, P_b	kPa	102.8
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m^3 p	Conc kg/m^3 p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2 (Estimated)	-	20.80	20.63	0.2080	32.00	1.4277	0.29696
N_2	-	79.14	78.49	0.7914	28.01	1.2498	0.98913
Moisture (H_2O)	-	-	0.82	0.0082	18.02	0.8037	0.00660

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m^3	1.287
Wet Density (STP), P_{STW}	kg/m^3	1.283
Dry Density (Actual), P_{Actual}	kg/m^3	1.132
Average Wet Density (Actual), $P_{ActualW}$	kg/m^3	1.128

Where: P_{STD} = sum of component concentrations, kg/m^3 (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m^3 (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) $= P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	42.2	0.0
Total Pressure	kPa	102.8	101.3
Moisture	%	0.82	0.82

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m^3/hr	2697
Gas Volumetric Flowrate (STP, Wet)	m^3/hr	2371
Gas Volumetric Flowrate (STP, Dry)	m^3/hr	2352
Gas Volumetric Flowrate REF [1]	m^3/hr	2371

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	25/09/2025
Time of Survey	-	15:32 - 15:39
Atmospheric Pressure	kPa	102.8
Average Stack Static Pressure	Pa	27
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 210 (10000Pa)	

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

Sampling Line A

Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m³	Velocity m/s	Swirl °
STATIC (Units: Pa)		*27.0*				
Mean		**104.0**	**42.2**	**1.128**	**11.34**	
1	0.15	104.0	42.2	1.128	11.34	9.0

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

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	6.062	Pa
- Resolution	u(res)	0.08677	
- Calibration	u(cal)	1.126	
- Drift	u(drift)	33.333	
- Lack of Fit	u(fit)	1.198	
- Overall corrections to dynamic measurements	u(Cf)	35.744	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- $\varphi O_2,w$	-	20.629	
- $\varphi CO_2,w$	-	0.060	
- Oxygen, dry	u(ϕO_2,d)	0.637	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.042	
- Oxygen, wet	u(ϕO_2,w)	0.632	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.608	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.797	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	6.062	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00615	-
Standard uncertainty associated with the local velocities	u(vi)	0.387	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.387	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.759	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	6.69	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	217.9	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00170	
- $u^2(qV,w)$	-	12362	
- $u(qV,w)$	-	111.2	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	8.08	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Duynie Ingredients , Wrexham
Dust Extractor 2

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.69		0.69
Uncertainty	±mg/m³	0.29		0.29
Mass Emission	g/hr	1.4		1.4
Uncertainty	±g/hr	0.6		0.6

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	0.82		0.82
Uncertainty	±% v/v	0.05		0.05

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.15		0.15

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	MD 001	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

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

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1
Absolute pressure of stack gas, P_s		
Barometric pressure, P_b	mmHg	770.3
Stack static pressure, P_{static}	mmH_2O	2.8
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	770.5
Volume of water vapour collected, V_{wstd}		
Total mass collected in impingers (liquid trap)	g	-2.2
Total mass collected in impingers (silica trap)	g	12.4
Total mass of liquid collected, V_{lc}	g	10.2
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0127
Volume of gas metered dry, V_{mstd}		
Volume of gas sample through gas meter, V_m	m^3	1.5753
Gas meter correction factor, Y_d	-	1.0500
Average dry gas meter temperature, T_m	°C	27.2
Average pressure drop across orifice, ΔH	mmH_2O	77.6
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	1.5358
Moisture content, B_{wo} & R_{wv}		
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0082
B_{wo} as a percentage	% v/v	0.82
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	0.82
Volume of gas metered wet, V_{mstw}		
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	1.5485
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$		
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A
% oxygen reference condition, $REF\%O_2$	% v/v	N/A
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A
Molecular weight of dry gas stream, M_d		
CO_2 (Estimated)	% v/v	0.06
O_2 (Estimated)	% v/v	20.80
Total	% v/v	20.86
N_2	% v/v	79.14
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84
Molecular weight of stack gas (wet), M_s		
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.75
Velocity of stack gas, V_s		
Pitot tube velocity constant, K_p	-	34.97
Velocity pressure coefficient, C_p	-	0.85
Average of velocity heads, ΔP_{avg}	mmH_2O	7.46
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	2.73
Average stack gas temperature, T_s	°C	41.0
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	9.69
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})		
Area of stack, A_s	m^2	0.07
$Q_a = (60)(A_s)(V_s)$	m^3/min	38.4
Conversion factor (K/mm.Hg), C_f	-	0.3592
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	33.8
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	33.6
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A
Percent isokinetic, %I		
Nozzle diameter, D_n	mm	8.02
Nozzle area, A_n	mm^2	50.56
Total sampling time, q	min	60
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	99.6

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	15:50 - 16:50
Sampling Dates	-	25/09/2025
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	1.5485
Filter I.D. Number	-	47-123098
Start Filter Mass	g	0.15180
End Filter Mass	g	0.15220
Total Mass on Filter	g	0.00040
Probe Rinse I.D. Number	-	PR-47-123098
Start Probe Rinse Mass	g	2.79989
End Probe Rinse Mass	g	2.80056
Total Mass in Probe Rinse	g	0.00067
Total Mass Collected	mg	1.07
Calculated Concentration	mg/m^3	0.69
Balance Uncertainty / LOD	mg/m^3	0.15

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	25/09/2025
Average Volume Sampled (REF)	m^3	1.5485
Filter I.D. Number	-	47-123099
Start Filter Mass	g	0.15172
End Filter Mass	g	0.15173
Total Mass on Filter	g	0.00001
Probe Rinse I.D. Number	-	PR-47-123099
Start Probe Rinse Mass	g	2.97318
End Probe Rinse Mass	g	2.97318
Total Mass in Probe Rinse	g	0.00000
Total Mass Collected	mg	0.01
Calculated Concentration	mg/m^3	0.00
Balance Uncertainty / LOD	mg/m^3	0.15

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	27.6
Pre-Sampling Leak Rate	l/min	0.20
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)	%	5.7
Allowable MU	%	20.0
MU Acceptable	%	Yes

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

Isokinetic Criterion Compliance	Units	Run 1
Isokinetic Variation	%	99.6
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Weighing Uncertainty Criteria	Units	Run 1
Overall Weighing Uncertainty	± mg	0.33
Overall Weighing Uncertainty	± mg/m³	0.21
ELV [Daily ELV for IED]	mg/m³	N/A
Allowable Weighing Uncertainty	mg/m³	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	41

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	0.18
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/m³	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 (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number	
	1	
There are no deviations associated with the sampling employed.	wx	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**	**Symbol**	**Units**	**Run 1**
Sampled Volume (Actual)	V_m	1.5753	uV_m	m^3	0.0315
Sampled Gas Temperature	T_m	300.2	uT_m	K	2.00
Sampled Gas Pressure	ρ_m	102.7	$u\rho_m$	kPa	0.50
Sampled Gas Humidity	H_m	0.00	uH_m	% v/v	1.00
Leak	L	0.73	uL	%	-
Mass of Particulate	m	1.07	um	mg	0.23
Uncollected Mass	UCM	0.01	uUCM	mg	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.67	≤1%
Sampled Gas Pressure	%	0.49	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	0.73	≤2%
Mass of Particulate	%	-	-
Uncollected Mass	%	-	-

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m^3	1.5358	0.45
Leak	L	mg/m^3	0.003	1.00
Mass of Particulate	L_r	mg	1.073	0.65
Uncollected Mass	UCM	mg	0.00	0.65

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m^3	0.017
Leak	mg/m^3	0.0029
Mass of Particulate	mg/m^3	0.1485
Uncollected Mass	mg/m^3	0.0025

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

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	0.15
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.29
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.29
Reported Uncertainty	mg/m^3	0.29
Expanded uncertainty (95% confidence), without Oxygen Correction	%	42.3
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	42.3
Reported Uncertainty	%	42.3
Reported Uncertainty as % of ELV	%	N/A

VERSION HISTORY

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

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Stack Emissions Testing Report Commissioned by
Duynie Ingredients

Installation Name & Address
Duynie Ingredients
Coed Abden Road
Wrexham Industrial Estate
Wrexham
LL13 9UH

Stack Reference
MCA Scrubber

Dates of the Monitoring Campaign
25th - 26th September 2025

Job Reference Number
EMT14377

Report Written by
Stephen Taylor Team Leader MCERTS Level 2 MM 23 1803 TE1 TE3 & TE4

Report Approved by
Donal O Faogain Technical Report Writer MCERTS Level 2 MM13 1259 TE1 TE2 TE3 TE4

Report Date
8th October 2025

Version
Version 1

Signature of Report Approver


CONTENTS

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

MONITORING OBJECTIVES

Duynie Ingredients , Wrexham
MCA Scrubber
25th - 26th September 2025

Overall Aim of the Monitoring Campaign

Element were commissioned by Duynie Ingredients to carry out stack emissions testing on the MCA Scrubber at Wrexham.

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

Hydrogen Chloride, Total VOCs (as Carbon)

MONITORING RESULTS

Duynie Ingredients , Wrexham
MCA Scrubber
25th - 26th September 2025

where MU = Measurement Uncertainty associated with the Result

	Concentration				Mass Emission			
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Hydrogen Chloride [1]	mg/m³	< 0.11	0.01	-	g/hr	< 0.003	0.02	-
Total VOCs (as Carbon) [1]	mg/m³	1.9	0.54	-	g/hr	0.06	0.29	-
Water Vapour	% v/v	1.3	0.24					
Stack Gas Temperature	°C	10.6						
Stack Gas Velocity	m/s	0.47	2.4					
Volumetric Flow Rate (ACTUAL)	m³/hr	30	153					
Volumetric Flow Rate (REF) [1]	m³/hr	29	150					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM THE PRELIMINARY VELOCITY TRAVERSE.

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

MONITORING DATE(S) & TIMES

Duynie Ingredients , Wrexham
MCA Scrubber
25th - 26th September 2025

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Hydrogen Chloride	R1	mg/m³	< 0.11	g/hr	< 0.0032	25/09/2025	10:23 - 11:23	60
Total VOCs (as Carbon)	R1	mg/m³	1.9	g/hr	0.06	25/09/2025	10:23 - 11:23	60
Velocity Traverse	R1					25/09/2025	09:55 - 10:00	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Duynie Ingredients , Wrexham
MCA Scrubber
25th - 26th September 2025

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operating Capacity
Capacity (of 100%) and Tonnes / Hour	2 Cycles Per Hour
Continuous or Batch Process	Batch
Feedstock (if applicable)	MCA & Caustic
Abatement System	Scubber
Abatement System Running Status	Scrubber Running
Fuel	N/A
Plume Appearance	None Visable

MONITORING & ANALYTICAL METHODS

Duynie Ingredients , Wrexham
MCA Scrubber
25th - 26th September 2025

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**Sampling Status**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**Analysis Status**	**Analysis Lab**	**Overall Status**	**LOD (Average)**
Hydrogen Chloride	EN 1911	MD 011	MCERTS	EET	MD 101	IC	MCERTS	EET	MCERTS	0.111 mg/m³
Total VOCs (as Carbon)	EN 12619:2013	MD 020	MCERTS	EET	Flame Ionisation Detection by Sick 3006				MCERTS	0.82 mg/m³
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041	MCERTS	EET	Pitot Tube and Thermocouple				MCERTS	1.2 m/s

ANALYSIS LABORATORIES

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

Element (Stockport Lab - EET)	ISO 17025 Accreditation Number: UKAS 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Velocity & Vol. Flow Rate	1	Lowest Differential Pressure <5Pa

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.15
Width	m	-
Area	m²	0.02
Port Depth	cm	6
Orientation of Duct	-	Vertical
Number of Ports	-	1
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	MEWP
Inside / Outside	Outside

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	N/A
Platform has vertical base boards (approx. 0.25m high)	N/A
Platform has chains / self closing gates at top of ladders	N/A
There are no obstructions present which hamper insertion of sampling equipment	No
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

The sampling location meets all the requirements specified in EA Guidance Note M1 and EN 15259, and therefore there are no improvement recommendations.

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)

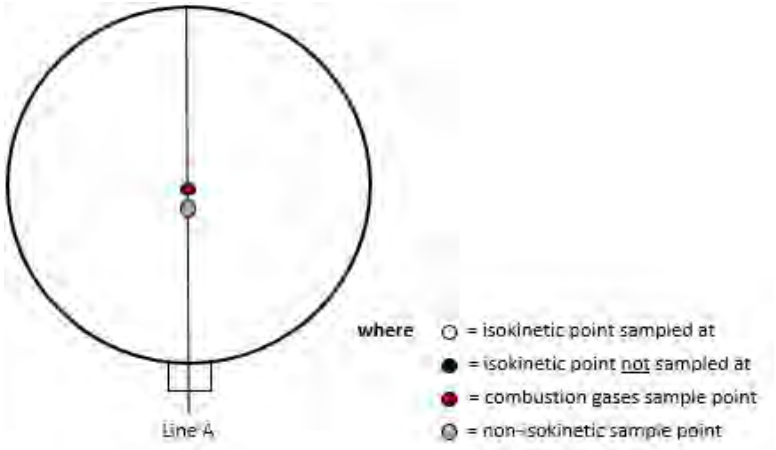
Criteria in EN 15259	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	0.2	> 5 Pa	No
Mean Velocity	m/s	0.47	-	-
Lowest Gas Velocity	m/s	0.47	-	-
Highest Gas Velocity	m/s	0.47	-	-
Ratio of Above	: 1	1.00	< 3 : 1	Yes
Maximum Angle of Swirl	°	4.00	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

PLANT PHOTOS

Photo 1

Photo 2

SAMPLE POINTS



APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Stephen Taylor	MCERTS Level 2	MM 23 1803	TE1 TE3 & TE4
Technician	Tom Dixon	MCERTS Level 1	MM 23 1802	TE1

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	-
Control Box DGM (2)	-
Box Thermocouples (1)	-
Box Thermocouples (2)	-
Umbilical (1)	-
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	-
Heated Probe (2)	-
Heated Probe (3)	-
S-Pitot (1)	CAT 21S.71
S-Pitot (2)	-
L-Pitot	-
Site Balance	CAT 17.108
500g / 1Kg Check Weights	CAT 17.108
Last Impinger Arm	-
Callipers	CAT 23.53
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-250	-
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	-
Gasmet DX4000	-
Gasmet Sampling System	-
Sick 3006	CAT 8.33
M&C PSS	CAT 12.174
Mass Flow Controller (1)	CAT 6.23
Mass Flow Controller (2)	CAT 6.24
Mass View (1)	CAT 25.94
Mass View (2)	CAT 25.121
Hioki 5043 (V)	CAT 11.103
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer 500	CAT 3.265
Digital Manometer 10000	-
Digital Temperature Meter	-
Stopwatch	CAT 14.98
Barometer	CAT 13.62
Stack Thermocouple 0.5m	-
Stack Thermocouple 1.0m	-
Stack Thermocouple 1.5m	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	CAT 20.277
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	-
Laboratory Balance	
Tape Measure	CAT 16.58

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Hydrogen Chloride	EN 1911	MD 011
Total VOCs (as Carbon)	EN 12619:2013	MD 020
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.15
Stack Width, W	m	-
Stack Area, A	m^2	0.02
Average Stack Gas Temperature, T_a	°C	10.6
Average Stack Gas Pressure	Pa	0.2
Average Stack Static Pressure, P_{static}	kPa	0.004
Average Barometric Pressure, P_b	kPa	102.8
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m^3 p	Conc kg/m^3 p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2 (Estimated)	-	20.80	20.53	0.2080	32.00	1.4277	0.29696
N_2	-	79.14	78.12	0.7914	28.01	1.2498	0.98913
Moisture (H_2O)	-	-	1.29	0.0129	18.02	0.8037	0.01038

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m^3	1.287
Wet Density (STP), P_{STW}	kg/m^3	1.281
Dry Density (Actual), P_{Actual}	kg/m^3	1.258
Average Wet Density (Actual), $P_{ActualW}$	kg/m^3	1.251

Where: P_{STD} = sum of component concentrations, kg/m^3 (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m^3 (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) $= P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	10.6	0.0
Total Pressure	kPa	102.8	101.3
Moisture	%	1.29	1.29

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m^3/hr	30
Gas Volumetric Flowrate (STP, Wet)	m^3/hr	29
Gas Volumetric Flowrate (STP, Dry)	m^3/hr	29
Gas Volumetric Flowrate REF [1]	m^3/hr	29

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	25/09/2025
Time of Survey	-	09:55 - 10:00
Atmospheric Pressure	kPa	102.8
Average Stack Static Pressure	Pa	4
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 210 (500Pa)	

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

Sampling Line A

Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m³	Velocity m/s	Swirl °
STATIC (Units: Pa)		*3.5*				
Mean		**0.2**	**10.6**	**1.251**	**0.47**	
1	0.08	0.2	10.6	1.251	0.47	4.0

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

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	1.041	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.000	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	0.000	
- Overall corrections to dynamic measurements	u(Cf)	0.084	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- $\varphi O_2,w$	-	20.531	
- $\varphi CO_2,w$	-	0.059	
- Oxygen, dry	u(ϕO_2,d)	0.637	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.066	
- Oxygen, wet	u(ϕO_2,w)	0.629	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.447	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.695	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	1.041	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00683	-
Standard uncertainty associated with the local velocities	u(vi)	1.231	Pa
Standard uncertainty associated with the mean velocity	u(v)	1.231	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	2.413	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	510.28	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	153.5	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	6.77847	
- $u^2(qV,w)$	-	6133	
- u(qV,w)	-	78.3	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	510.30	%

HYDROGEN CHLORIDE: RESULTS SUMMARY

Duynie Ingredients , Wrexham

MCA Scrubber

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	< 0.11		< 0.11
Uncertainty	±mg/m³	0.01		0.01
Mass Emission	g/hr	< 0.0032		< 0.0032
Uncertainty	±g/hr	0.0166		0.0166

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	1.3		1.3
Uncertainty	±% v/v	0.24		0.24

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	< 0.08		< 0.08

General Sampling Information

Parameter	Value	
Standard	EN 1911	
Technical Procedure	MD 011	
Name of Analytical Laboratory	EET	
Analytical Laboratory's Procedure	MD 101	
ISO 17025 Accredited Analysis?	MCERTS	
Date of Sample Analysis	01/10/2025	
Probe Material	Stainless Steel	
Filter Housing Material	Titanium	
Impinger Material	Polyethylene	
Absorption Solution	HPLC Grade Water	
Positioning of Filter	Out Stack Heated Head	
Filter Size and Material	0.1µm Glass Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

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

HYDROGEN CHLORIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	10:23 - 11:23
Sampling Dates	-	25/09/2025
Sampling Device	-	MFC / MV
Duration	mins	60
Volume Sampled (STP, Dry)	m^3	0.1904
Volume Sampled (STP, Wet)	m^3	0.1929
Volume Sampled (REF)	m^3	0.1929
Sample Flow Rate	l/min	3.17
Laboratory Result for Front Impingers	µg/ml	< 0.05
Laboratory Result for Back Impinger	µg/ml	< 0.05
Volume in Front Impingers	ml	294.4
Volume in Back Impinger	ml	132.1
Mass in Front Impingers	µg	< 14.7
Mass in Back Impinger	µg	< 6.6
Total Mass Collected	µg	< 21.3
Calculated Concentration	mg/m^3	< 0.11
Liquid Trap Start Mass	g	1271.0
Liquid Trap End Mass	g	1271.5
Silica Trap Start Mass	g	1616.0
Silica Trap End Mass	g	1617.5
Total Mass Of Water Vapour	g	2.0
Calculated Water Vapour	% v/v	1.29

Where: MFC stands for Mass Flow Controller, MV stands for Mass View Flowmeter

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	25/09/2025
Average Volume Sampled (REF)	m^3	0.1929
Laboratory Result for Impingers	µg/ml	< 0.05
Volume in Impingers	ml	310.0
Total Mass Collected	µg	< 15.5
Calculated Concentration	mg/m^3	< 0.08

HYDROGEN CHLORIDE: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	3.2
Pre-Sampling Leak Rate	l/min	0.03
Post-Sampling Leak Rate	l/min	0.03
Allowable Leak Rate	l/min	0.06
Leak Test Acceptable	-	Yes

Absorption Efficiency	Units	Run 1
Absorption Efficiency	%	100.0
Allowable Absorption Efficiency	%	N/A [1]
Absorption Efficiency Acceptable	-	Yes [1]

[1] The concentration in the last absorber was less than 5 times the analytical detection limit.

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	18.3
Allowable MU	%	20.0
MU Acceptable	%	Yes

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

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	3.0
Pre-Sampling Leak Rate	l/min	0.02
Post-Sampling Leak Rate	l/min	0.03
Allowable Leak Rate	l/min	0.06
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m³	N/A
Blank Acceptable	-	N/A

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	
Lowest differential pressure < 5 Pa.	wx	

HYDROGEN CHLORIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**	**Symbol**	**Units**	**Run 1**
Sampled Volume (STP)	V_m	0.1904	uV_m	m³	0.0038
Leak	L	0.95	uL	%	-
Laboratory Result	L_r	1.05	uL_r	%	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (STP)	%	2.00	≤2%
Leak	%	0.95	≤2%
Laboratory Result	%	1.05	No Requirement

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m³	0.1904	0.58
Leak	L	mg/m³	0.001	1.00
Laboratory Result	L_r	mg/m³	0.001	1.00

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m³	0.002
Leak	mg/m³	0.0006
Laboratory Result	mg/m³	0.0012

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

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m³	0.003
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m³	0.01
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m³	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m³	0.01
Reported Uncertainty	mg/m³	0.01
Expanded uncertainty (95% confidence), without Oxygen Correction	%	4.6
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	5.5
Reported Uncertainty	%	5.5
Reported Uncertainty as % of ELV	%	N/A

TOTAL VOCs (as CARBON): RESULTS SUMMARY

Duynie Ingredients , Wrexham
MCA Scrubber

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	1.9		1.9
Uncertainty	±mg/m³	0.54		0.54
Mass Emission	g/hr	0.06		0.06
Uncertainty	±g/hr	0.29		0.29

General Sampling Information

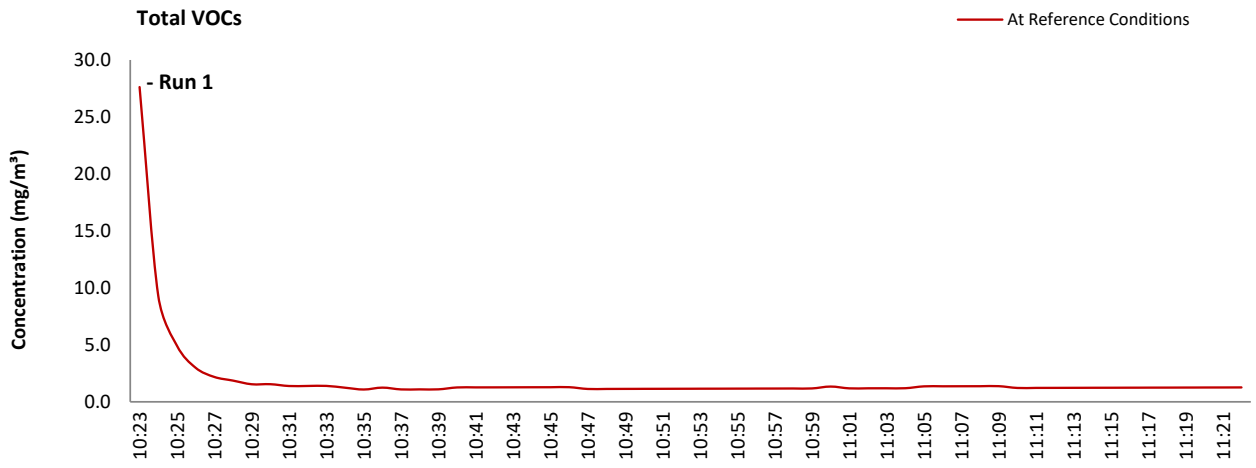
Parameter	Value	
Standard	EN 12619:2013	
Technical Procedure	MD 020	
Probe Material	Stainless Steel	
Filtration Type / Size	0.1µm Glass Fibre	
Heated Head Filter Used	Yes	
Heated Line Temperature	180°C	
Span Gas Type	Propane In Synthetic Air (5 Grade)	
Span Gas Reference Number	1.0625	
Span Gas Expiry Date	07/10/2029	
Span Gas Start Pressure (bar)	110	
Gas Cylinder Concentration (ppm)	80.4	
Span Gas Set Point (ppm)	80.40	
Span Gas Uncertainty (%)	2	
Zero Gas Type	Synthetic Air (5 Grade)	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

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

TOTAL VOCs (as CARBON): DATA TREND

Graphical Trend of Data



TOTAL VOCs (as CARBON): SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	10:23 - 11:23
Sampling Dates	-	25/09/2025
Instrument Range	ppm	100
Span Gas Value	ppm	80.4

Quality Assurance

	Zero Drift	Units	Run 1
CAL 1	Zero Down Sampling Line (Pre)	ppm	0.10
CAL 1	Zero Down Sampling Line (Post)	ppm	-0.10
CAL 1	Zero Drift	ppm	-0.20
CAL 1	Zero Drift	%	-0.25
CAL 1	Drift Correction Applied	2-5%	No
	Allowable Zero Drift	± ppm	4.02
	Zero Drift Acceptable	-	Yes

	Span Drift	Units	Run 1
CAL 1	Span Down Sampling Line (Pre)	ppm	79.60
CAL 1	Span Down Sampling Line (Post)	ppm	80.20
CAL 1	Span Drift	ppm	0.60
CAL 1	Span Drift	%	0.75
CAL 1	Drift Correction Applied	2-5%	No
	Allowable Span Drift	± ppm	4.02
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	11 - 12

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number 1	
Lowest differential pressure < 5 Pa.	x	

TOTAL VOCs (as CARBON): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1		Units
Limit value	-		mg/m³ (REF)
Allowable MU	15.0		%
Measured concentration	1.96		mg/m³ (STP, dry)
Range Used	100.0		ppm
Range Used [A]	160.6		mg/m³
Cal gas conc.	80.4		ppm
Conversion	1.61		ppm to mg/m³
MCERTS Range [B]	15.0		mg/m³
Lower of [A] or [B]	15.0		mg/m³
Cal gas conc.	129.1		mg/m³

Performance characteristics	RUN 1		Units
Response time	45		seconds
Number of readings in measurement	60		-
Repeatability at zero	2.00		% full scale
Repeatability at span level	0.00		% full scale
Deviation from linearity	0.20		% of value
Zero drift	-0.25		% full scale
Span drift	0.75		% full scale
Volume or pressure flow dependence	1.60		% of full scale
Atmospheric pressure dependence	0.30		% of value/kPa
Ambient temperature dependence	1.40		% full scale/10K
Combined interference	0.45		% range
Dependence on voltage	0.50		% full scale/10V
Losses in the line (leak)	1.00		% of value
Uncertainty of calibration gas	2.00		% of value

Performance characteristic	RUN 1		Units
Standard deviation of repeatability at zero	use rep at span		mg/m³
Standard deviation of repeatability at span level	0.00		mg/m³
Lack of fit	0.02		mg/m³
Drift	-0.18		mg/m³
Volume or pressure flow dependence	0.00		mg/m³
Atmospheric pressure dependence	0.01		mg/m³
Ambient temperature dependence	0.20		mg/m³
Combined interference (from MCERTS Certificate)	0.04		mg/m³
Dependence on voltage	0.06		mg/m³
Losses in the line (leak)	0.01		mg/m³
Uncertainty of calibration gas	0.02		mg/m³

			RUN 1		Units
Measurement uncertainty		**Result**	1.96		mg/m³
Combined uncertainty			0.28		mg/m³
Expanded uncertainty	k =	1.96	0.55		mg/m³
Uncertainty corrected to std conds. (O_2)			0.55		mg/m³ (REF)

	RUN 1		Units
Expanded uncertainty (no O_2) - at 95% Confidence	28.11		% of Value
Expanded uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (no O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement	**N/A**		-

	RUN 1		Units
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% of Value
Expanded uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Overall Allowable uncertainty (with O_2) - at 95% Confidence	N/A		% at ELV
Result of Compliance with Uncertainty Requirement	**N/A**		-

Requirement for SRM is that Uncertainty should be <15% of the value at the ELV, on a dry gas basis, or if O_2 correction is applied less than 15% + the uncertainty associated with the O_2 correction (using sqrt of sum squares to add uncertainty components).

VERSION HISTORY

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

STACK EMISSIONS MONITORING REPORT

Unit 5 Crown Industrial Estate
Kenwood Road
Stockport
SK5 6PH
Tel: 0161 443 0980

Your contact at SOCOTEC LTD
Dominic Houghton Business Manager - North Tel: 0161 443 0981 Email: dominic.houghton@socotec.com

Operator & Address:
Novidon Coed Aben Road Wrexham Ind Est Wrexham LL13 9UH

Permit Reference:
N/A - Investigative Test

Release Point:
Scrubber

Sampling Date(s):
2nd August 2023

SOCOTEC Job Number:	LNO 17896
Report Date:	8th September 2023
Version:	1
Report By: MCERTS Number: MCERTS Level: Technical Endorsements:	Mark Derbyshire MM 07 824 MCERTS Level 2 - Team Leader 1, 2, 3 & 4
Report Approved By: MCERTS Number: Business Title: Technical Endorsements: Signature:	Johnathon Orley MM 08 983 MCERTS Level 2 - Team Leader 1, 2, 3 & 4

UKAS TESTING
1015

mCERTS

CONTENTS

EXECUTIVE SUMMARY

MONITORING OBJECTIVES

Novidon operates a wet scrubber process at Wrexham

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

Plant

Scrubber

Operator

Novidon
Coed Aben Road
Wrexham Ind Est
Wrexham
LL13 9UH

Stack Emissions Monitoring Test House

SOCOTEC - Stockport Laboratory
Unit 5 Crown Industrial Estate
Kenwood Road
Stockport
SK5 6PH
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.

EXECUTIVE SUMMARY

EMISSIONS SUMMARY

Parameter	Units	Result	Calculated Uncertainty +/-	Emission Limit Value (ELV)	Accreditation
Total Particulate Matter	mg/m³	0.99	0.44	-	MCERTS
Particulate Emission Rate	g/hr	0.05	0.02	-	
Total Volatile Organic Compounds	mg/m³	0.35	1.30	-	MCERTS
Total Volatile Organic Compounds Emission Rate	g/hr	0.01	0.04	-	
Oxides of Nitrogen (as NO_2)	mg/m³	0.77	2.3	-	MCERTS
Oxides of Nitrogen (as NO_2) Emission Rate	g/hr	0.02	0.07	-	
Sulphur Dioxide	mg/m³	0.80	2.2	-	MCERTS
Sulphur Dioxide Emission Rate	g/hr	0.03	0.07	-	
Carbon Monoxide	mg/m³	1.13	1.84	-	MCERTS
Carbon Monoxide Emission Rate	g/hr	0.04	0.06	-	
Carbon Dioxide	% v/v	0.01	0.0001	-	MCERTS
Oxygen	% v/v	20.9	0.277	-	MCERTS
Moisture	%	0.14	0.03	-	MCERTS
Stack Gas Temperature	°C	24	-	-	MCERTS
Stack Gas Velocity	m/s	1.5	0.71	-	
Gas Volumetric Flow Rate (Actual)	m³/hr	35	16	-	
Gas Volumetric Flow Rate (STP, Wet)	m³/hr	32	15	-	
Gas Volumetric Flow Rate (STP, Dry)	m³/hr	32	15	-	
Gas Volumetric Flow Rate at Reference Conditions	m³/hr	32	15	-	

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	02 August 2023	11:40 - 12:40	60 minutes
Total Volatile Organic Compounds Run 1	02 August 2023	11:40 - 12:40	60 minutes
Combustion Gases	02 August 2023	11:40 - 12:40	60 minutes
Preliminary Stack Traverse	02 August 2023	11:20	-

EXECUTIVE SUMMARY

PROCESS DETAILS

Parameter	Process Details
Description of process	Wet Scrubber
Continuous or batch	Batch
Product Details	-
Part of batch to be monitored (if applicable)	Whilst operational
Normal load, throughput or continuous rating	-
Fuel used during monitoring	None
Abatement	Wet Scrubber
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	AE 104	1015	MCERTS	0.22 mg/m³	45%	N/A - No ELV
Total Volatile Organic Compounds	SRM - BS EN 12619:2013	AE 102	1015	MCERTS	0 mg/m³	372%	N/A - No ELV
Oxides of Nitrogen	SRM - BS EN 14792:2017	AE 102	1015	MCERTS	0.2 mg/m³	296%	N/A - No ELV
Sulphur Dioxide	AM - PD CEN/TS 17021:2017	AE 102	1015	MCERTS	0.8 mg/m³	269%	N/A - No ELV
Carbon Monoxide	SRM - BS EN 15058:2017	AE 102	1015	MCERTS	0.27 mg/m³	163%	N/A - No ELV
Carbon Dioxide	SRM - CEN/TS 17405	AE 102	1015	MCERTS	0.1 %	0.52%	N/A - No ELV
Oxygen	SRM - BS EN 14789:2017	AE 102	1015	MCERTS	0.01%	1.3%	N/A - No ELV
Moisture	BS EN 14790	AE 105	1015	MCERTS	0.01%	23%	N/A - No ELV
Velocity	SRM - EN ISO 16911-1	AE 154	1015	MCERTS	5 Pa	46%	N/A - No ELV
Volumetric Flow Rate	SRM - EN ISO 16911-1	AE 154	1015	MCERTS	-	46.5%	N/A - No ELV

BS EN 14790 has been validated over a range of 4 - 40%. It is however the prefered method of the Environment Agency for concentrations below 4%

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 Analyis	Archive Period
Total Particulate Matter	Gravimetric	AE 106	1015	MCERTS	SOCOTEC (Stockport)	N/A	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 (Stockport)	SOCOTEC (Stockport)	5 years
Oxides of Nitrogen	Chemiluminescence	AE 102	1015	MCERTS	SOCOTEC (Stockport)	SOCOTEC (Stockport)	5 years
Sulphur Dioxide	Non Dispersive Infra Red	AE 102	1015	MCERTS	SOCOTEC (Stockport)	SOCOTEC (Stockport)	5 years
Carbon Monoxide	Non Dispersive Infra Red	AE 102	1015	MCERTS	SOCOTEC (Stockport)	SOCOTEC (Stockport)	5 years
Carbon Dioxide	Non Dispersive Infra Red	AE 102	1015	MCERTS	SOCOTEC (Stockport)	SOCOTEC (Stockport)	5 years
Oxygen	Paramagnetic	AE 102	1015	MCERTS	SOCOTEC (Stockport)	SOCOTEC (Stockport)	5 years
Moisture	Gravimetric	AE 105	1015	MCERTS	SOCOTEC (Stockport)	-	-

EXECUTIVE SUMMARY

SAMPLING LOCATION					
Sampling Plane Validation Criteria	**Value**	**Units**	**Requirement**	**Compliant**	**Method**
Lowest Differential Pressure	2	Pa	>= 5 Pa	No	BS EN 15259
Lowest Gas Velocity	1.5	m/s	-	-	-
Highest Gas Velocity	1.5	m/s	-	-	-
Ratio of Gas Velocities	1.0	: 1	< 3 : 1	Yes	BS EN 15259
Mean Velocity	1.5	m/s	-	-	-
Maximum angle of flow with regard to duct axis	<15	°	< 15°	Yes	BS EN 15259
No local negative flow	Yes	-	-	Yes	BS EN 15259

DUCT CHARACTERISTICS		
	Value	**Units**
Shape	Circular	-
Depth	0.09	m
Width	-	m
Area	0.01	m^2
Port Depth	0	mm

SAMPLING LINES & POINTS		
	Isokinetic	**Non-Iso & Gases**
Sample port size	9cm	9cm
Number of lines used	1	1
Number of points / line	1	1
Duct orientation	Horizontal	Horizontal
Filtration	Out Stack	Out Stack
Filtration for TPM	Out Stack	-

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

M1 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	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 as specified in EA Guidance Note M1.

EXECUTIVE SUMMARY

Sampling & Analytical Method Deviations

In this instance there were no deviations from the sampling and analytical methods employed.

APPENDICES

CONTENTS

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	AE 104	1015	MCERTS	1
Total Volatile Organic Compounds	SRM - BS EN 12619:2013	AE 102	1015	MCERTS	1
Oxides of Nitrogen	SRM - BS EN 14792:2017	AE 102	1015	MCERTS	1
Sulphur Dioxide	AM - PD CEN/TS 17021:2017	AE 102	1015	MCERTS	1
Carbon Monoxide	SRM - BS EN 15058:2017	AE 102	1015	MCERTS	1
Carbon Dioxide	SRM - CEN/TS 17405	AE 102	1015	MCERTS	1
Oxygen	SRM - BS EN 14789:2017	AE 102	1015	MCERTS	1
Moisture	BS 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

CALIBRATEABLE EQUIPMENT CHECKLIST					
Extractive Sampling		Instrumental Analyser/s		Miscellaneous	
Equipment	**Equipment I.D.**	**Equipment**	**Equipment I.D.**	**Equipment**	**Equipment I.D.**
Control Box DGM	LNO 13-19	Horiba PG - 350 Analyser	LNO 21-58	Laboratory Balance	LNO 00-33/13
Box Thermocouples	LNO 03-19	FT-IR	-	Tape Measure	LNO 24-MD
Meter In Thermocouple	LNO 03-19	FT-IR Oven Box	-	Stopwatch	LNO 17-MD
Meter Out Thermocouple	LNO 03-19	Bernath 3006 FID	LNO 2107	Protractor	-
Control Box Timer	LNO 17-19	Signal 3030 FID	-	Barometer	LNO 08-MD
Oven Box	LNO 09-14	Servomex	-	Digital Micromanometer	LNO 01-MD
Probe	LNO 11-21	JCT Heated Head Filter	-	Digital Temperature Meter	LNO 03-MD
Probe Thermocouple	LNO 10-21	Thermo FID	-	Stack Thermocouple	LNO 10-MD
Probe	-	Stackmaster	-	Mass Flow Controller	-
Probe Thermocouple	-	FTIR Heater Box for Heated Line	-	MFC Display module	-
S-Pitot	LNO 06-MD	Anemometer	-	1m Heated Line (1)	-
L-Pitot	-	Ecophysics NOx Analyser	-	1m Heated Line (2)	-
Site Balance	LNO 14-MD	Chiller (JCT/MAK 10)	LNO 21-105	1m Heated Line (3)	-
Last Impinger Arm	-	Heated Line Controller (1)	LNO 03-131	5m Heated Line (1)	-
Dioxins Cond. Thermocouple	-	Heated Line Controller (2)	-	10m Heated Line (1)	-
Callipers	LNO 31-MD	Site temperature Logger	-	10m Heated Line (2)	-
Small DGM	-			15m Heated Line (1)	-
Heater Controller	-			20m Heated Line (1)	LNO 18-87
Inclinometer (Swirl Device)	LNO 25-MD			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.

CALIBRATION GASES					
Gas (traceable to ISO 17025)	**Cylinder I.D Number**	**Supplier**	**ppm**	**%**	**Analytical Tolerance +/- %**
Oxygen	HPC 2307	BOC	-	9.88	2.0
Propane	HPC 2178	BOC	80.7	-	2.0
Nitric Oxide	HPC 2253	BOC	40.1	-	2.0
Sulphur Dioxide	HPC 2153	BOC	34.2	-	2.0
Carbon Monoxide	HPC 2153	BOC	80.3	-	2.0
Carbon Dioxide	HPC 2243	BOC	-	8.01	2.0

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**
Mark Derbyshire	MM 07 824	MCERTS Level 2	May-26	Nov-26	Apr-27	May-28	Jul-27	Feb-27
Oliver Denty	MM22 1747	MCERTS Trainee	Sep-27	-	-	-	-	Sep-27

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

TOTAL PARTICULATE MATTER SUMMARY					
Parameter	Sampling Times	Concentration mg/m³	Uncertainty mg/m³	ELV mg/m³	Emission Rate g/hr
Run 1	11:40 - 12:40 02 August 2023	0.99	0.44	-	0.05
Blank	-	1.4	-	-	-

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

Acetone Blank Value mg/l	Acceptable Value mg/l
0.33	10

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	G4983	0.10426	0.10435	0.00009	61.35040	61.35120	0.00080	0.00089

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	G4956	0.10962	0.10966	0.00004	72.56380	72.56500	0.00120	0.00124

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		
Barometric pressure, P_b	Kpa	101.9
Stack static pressure, P_{static}	pa	5.0
$P_s = P_b + P_{static}$	Kpa	101.9
Vol. of water vapour collected, V_{wstd}		
Moisture trap weight increase,Vlc	g	1.0
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.001246
Volume of gas metered dry, V_{mstd}		
Volume of gas sample through gas meter, V_m		1.002
Gas meter correction factor, Y_d		0.964
Mean dry gas meter temperature, T_m		295
Mean pressure drop across orifice, DH	mmH_2O	23.205
$V_{mstd} = \frac{(0.3592)(V_m)(P_b+(DH/13.6))(Y_d)}{T_m}$	m^3	0.901
Volume of gas metered wet, V_{mstw}		
$V_{mstw} = V_{mstd} + V_{wstd}$	m^3	0.9022
Vol. of gas metered at O_2 Ref. Cond., $V_{mstd@X\%O2}$		
Is the process burning hazardous waste? *(If yes, no favourable oxygen correction)*		No
% oxygen measured in gas stream, act%O_2		20.9
% oxygen reference condition		21
O_2 Reference Factor O_2 Ref = $\frac{21.0 - act\%O_2}{21.0 - ref\%O_2}$		No O2 Ref
$V_{mstd@X\%oxygen} = (V_{mstd})(O_{2\ Ref})$	m^3	No O2 Ref
Moisture content, B_{wo}		
$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$		0.0014
	%	0.14
Moisture by FTIR	%	-
Velocity of stack gas, V_s		
Velocity pressure coefficient, C_p		0.84
Mean of velocity heads, DP_{avg}	Pa	3.92
Mean stack gas temperature, T_s	K	297
Gas density $_{(wet,\ ambient)}$, p		
p=(Ms*Ps)/(8.314*Ts)	kg/m^3	1.190
Stack Velocity, Vs $V_s = \frac{\sum_{i=1}^{n} V_i}{n}$	m/s	2.16

Molecular weight of dry gas, M_d		
CO_2	%	0.01
O_2	%	20.90
Total	%	20.91
N_2 (100 -Total)	%	79.09
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$		28.84
Molecular weight of wet gas, M_s		
$M_s = M_d(1 - B_{wo}) + 18(B_{wo})$	g/gmol	28.82
Actual flow of stack gas, Q_a		
Area of stack, A_s	m^2	0.01
$Q_a = (60)(A_s)(V_s)$	m^3/min	0.8
Total flow of stack gas, Q		
Conversion factor (K/mm.Hg)		0.3592
$Q_{std} = \frac{(Q_a)P_s(0.3592)(1-B_{wo})}{(T_s)}$	Dry	0.8
$Q_{stdO2} = \frac{(Q_a)P_s(0.3592)(1-B_{wo})(O_2REF)}{(T_s)}$	@O_2ref	No O2 Ref
$Q_{stw} = \frac{(Q_a)P_s(0.3592)}{(T_s)}$	Wet	0.76
Percent isokinetic, %I		
Nozzle diameter, D_n	mm	11.82
Nozzle area, A_n	mm^2	109.74
Total sampling time, q	min	60
$\%I = \frac{(4.6398E6)(T_s)(V_{mstd})}{(P_s)(V_s)(A_n)(q)(1-B_{wo})}$	%	114.3
Acceptable isokinetic range 95% to 115%		Yes
Particulate Concentration, C		
Mass collected on filter, M_f	g	0.00009
Mass collected in probe, M_p	g	0.00080
Total mass collected, M_n	g	0.00089
$C_{wet} = \frac{M_n}{V_{mstw}}$	mg/m^3	0.986
$C_{dry} = \frac{M_n}{V_{mstd}}$	mg/m^3	0.988
$C_{dry@X\%O2} = \frac{M_n}{V_{mstd@X\%oxygen}}$	mg/m^3	No O2 Ref
Particulate Emission Rates, E		
$E = [(C_{wet})(Q_{stw})(60)] / 1000$		0.05

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	16.10	0.11	-	9753.6	0.32	Yes

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

ISOKINETICITY		
Run	Isokinetic Variation %	Acceptable Isokineticity
Run 1	114.29	Yes

Acceptable isokinetic range 95% to 115%

WEIGHING BALANCE UNCERTAINTY			
Run	Result mg/m³	5% ELV mg/m³	LOD < 5% ELV
Run 1	0.22	No ELV	N/A - No ELV

The above is based on both the Filter and rinse uncertainty

BLANK VALUE				
Run	Overall Blank Value mg/m^3	Daily Emission mg/m^3	Acceptable Blank Value mg/m^3	Overall Blank Acceptable mg/m^3
Blank 1	1.37	-	-	-

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	0	180	160

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

TOTAL VOLATILE ORGANIC COMPOUNDS SUMMARY

Test	Sampling Times	Concentration mg/m³	LOD mg/m³	ELV mg/m³	Emission Rate g/hr
Run 1	11:40 - 12:40 02 August 2023	0.35	0.40	-	0.01

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

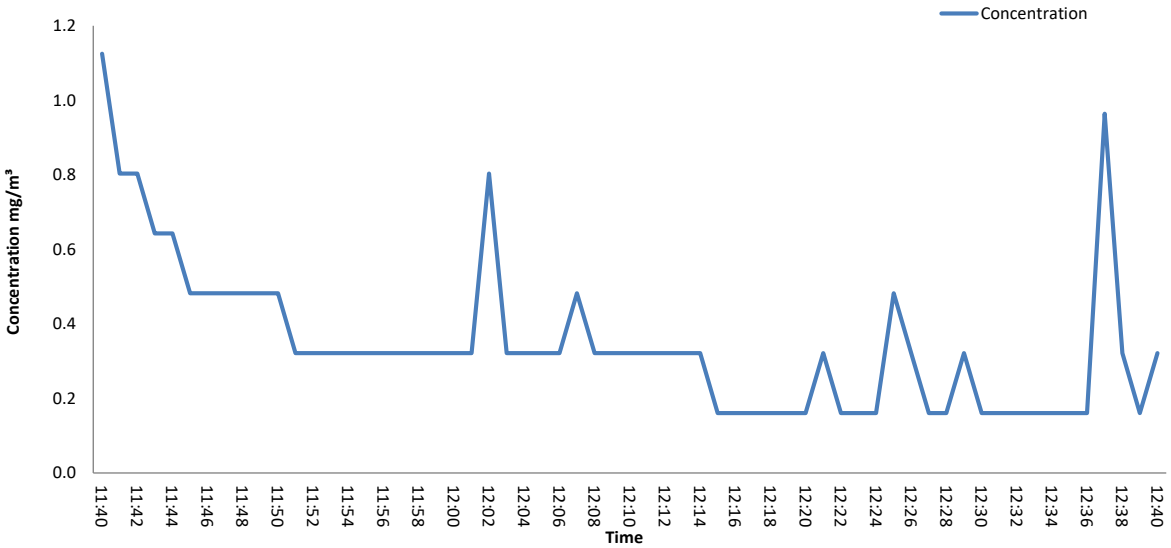
INSTRUMENTAL SPAN & ZERO CHECKS

PRE-SAMPLING CALIBRATION CHECKS								
Date	02 August 2023							
Start Time	11:15							
End Time	11:25							
Gas	Gas Conc (ppm)	Range	Instrument Zero Reading	Instrument Span Reading	Instrument Zero Reading	Zero Down line reading	Span down line reading	Leak Rate (%)
Propane	80.7	100	0.00	80.7	0.01	0.03	80.6	0.12

Zero and Span gas contained 20% Oxygen

POST-SAMPLING CALIBRATION CHECKS								
Date	02 August 2023							
Start Time	15:50							
End Time	16:01							
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	0.41	0.11	79.9	0.10	-0.97	×	×	N/A - not corrected

TOTAL VOLATILE ORGANIC COMPOUNDS EMISSIONS CHART



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

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

COMBUSTION GASES SUMMARY

Test	Sampling Time and Date	Concentration mg/m³	LOD mg/m³	ELV mg/m³	Emission Rate g/hr
Oxides of Nitrogen	11:40 - 12:40 02 August 2023	0.77	0.20	-	0.02
Sulphur Dioxide	11:40 - 12:40 02 August 2023	0.80	0.80	-	0.03
Carbon Monoxide	11:40 - 12:40 02 August 2023	1.1	0.27	-	0.04

Test	Sampling Time and Date	Concentration %	LOD %
Carbon Dioxide	11:40 - 12:40 02 August 2023	0.10	0.100
Oxygen	11:40 - 12:40 02 August 2023	21.0	0.01

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

PRE-SAMPLING CALIBRATION DATA

Date	02 August 2023
Start Time	11:10
End Time	11:24

Chiller Temperature (°C)	2.8
Requirement	< 4°C
Compliant	Yes

Gas	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	100	0.00	40.1	0.02	0.03	40.1	15	-0.02
Sulphur Dioxide	200	0.00	34.2	0.03	0.05	34.1	15	0.29
Carbon Monoxide	200	0.00	80.3	0.06	0.07	80.1	15	0.25
Carbon Dioxide	10	0.00	8.01	0.02	0.05	8.00	15	0.12
Oxygen	25	0.00	9.88	0.01	0.03	9.87	15	0.10

POST-SAMPLING CALIBRATION DATA

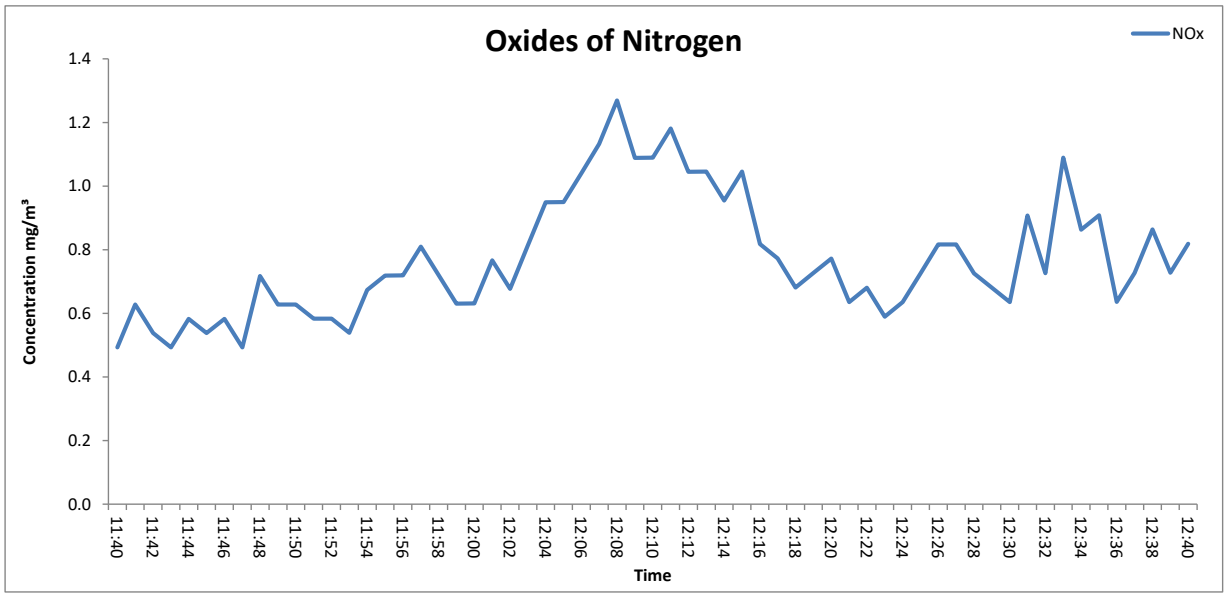
Date	02 August 2023
Start Time	15:50
End Time	16:08

Chiller Temperature (°C)	2.4
Requirement	< 4°C
Compliant	Yes

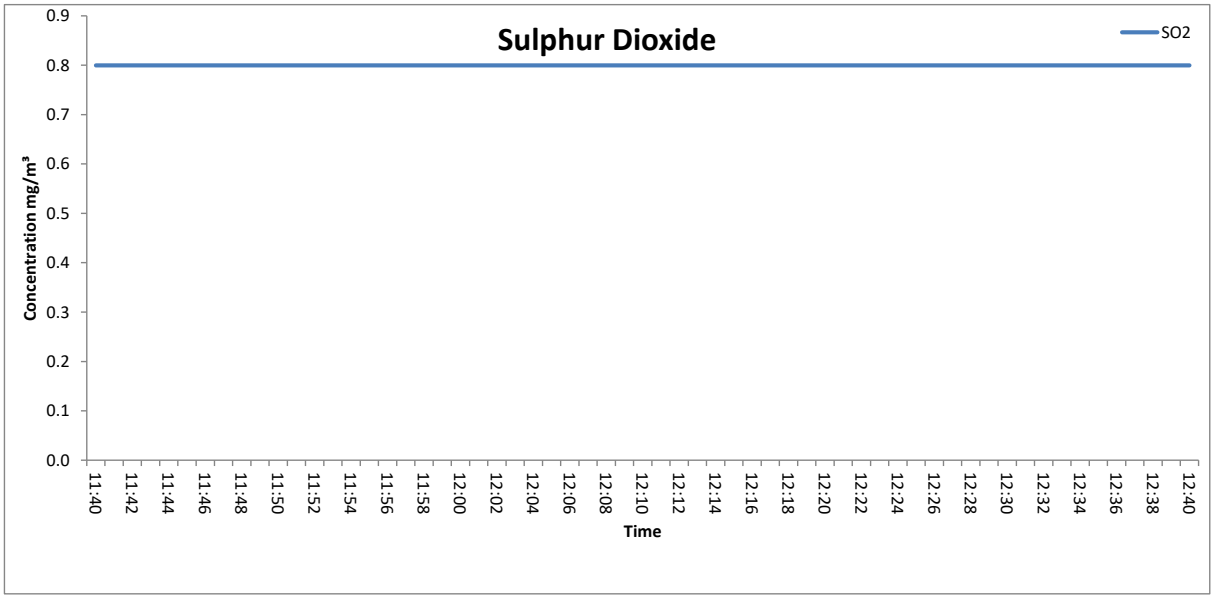
Gas	Zero Check at Analyser	Span Check at Analyser	Zero Drift (%)	Span Drift (%)	Corrected for Zero Drift	Corrected for Span Drift	Corrected Values ppm / %
Nitric Oxide	0.18	39.9	0.40	-0.90	×	×	N/A - not corrected
Sulphur Dioxide	0.14	34.0	0.33	-0.91	×	×	N/A - not corrected
Carbon Monoxide	0.90	80.1	1.06	-1.30	×	×	N/A - not corrected
Carbon Dioxide	0.10	8.00	1.02	-1.12	×	×	N/A - not corrected
Oxygen	0.08	9.86	0.72	-0.91	×	×	N/A - not corrected

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

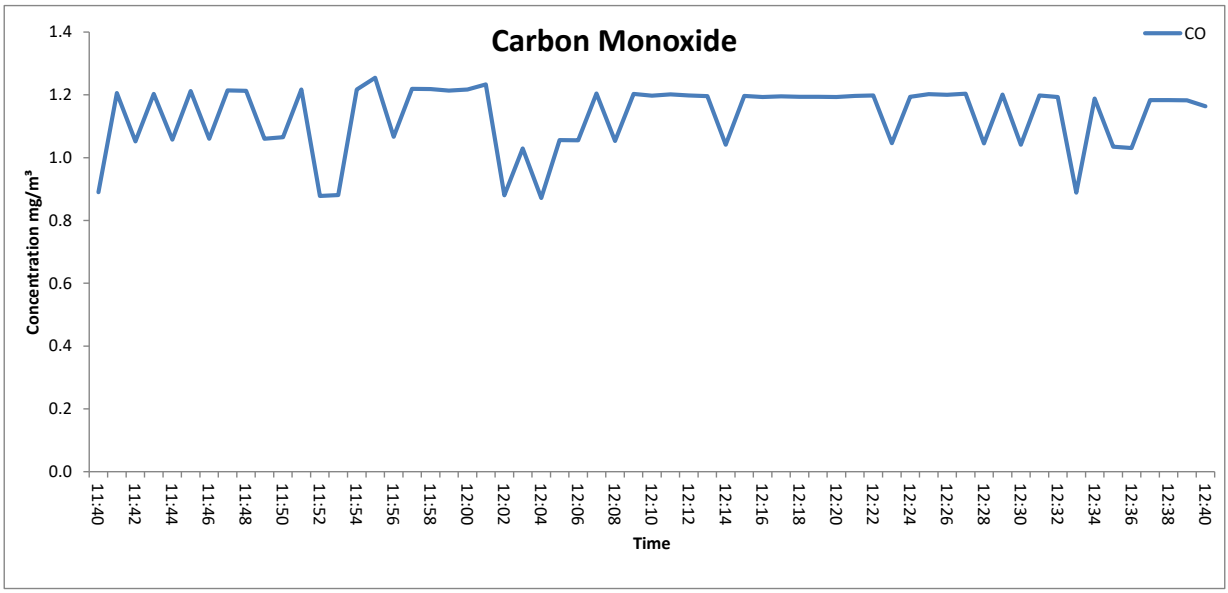
OXIDES OF NITROGEN (as NO_2) EMISSIONS CHART



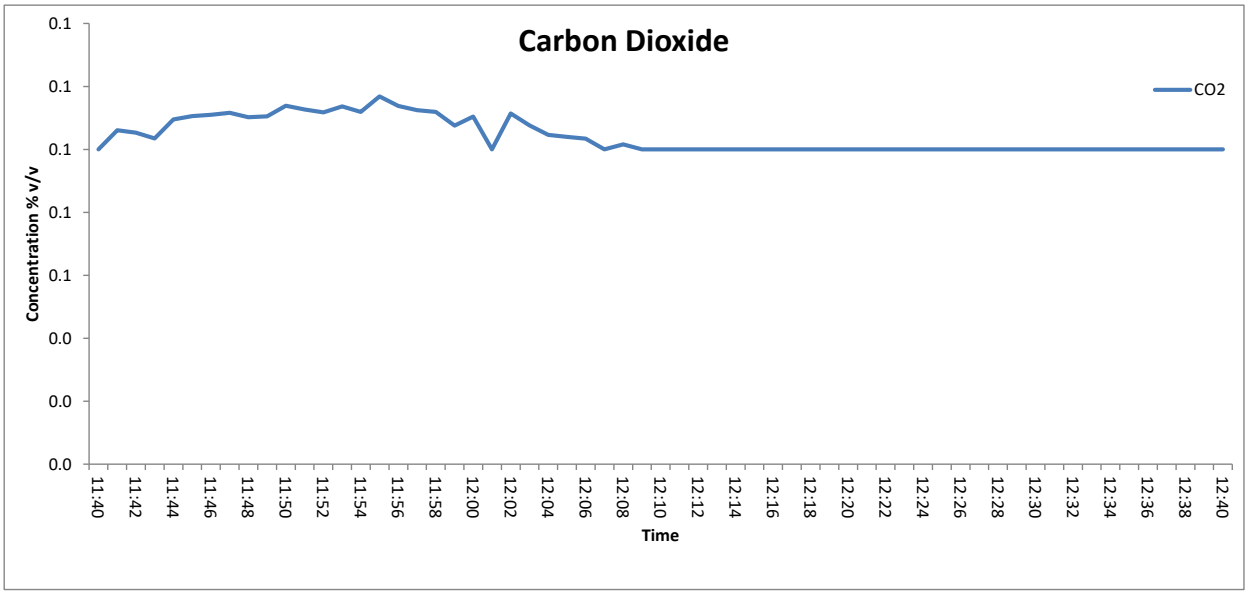
SULPHUR DIOXIDE EMISSIONS CHART



CARBON MONOXIDE EMISSIONS CHART

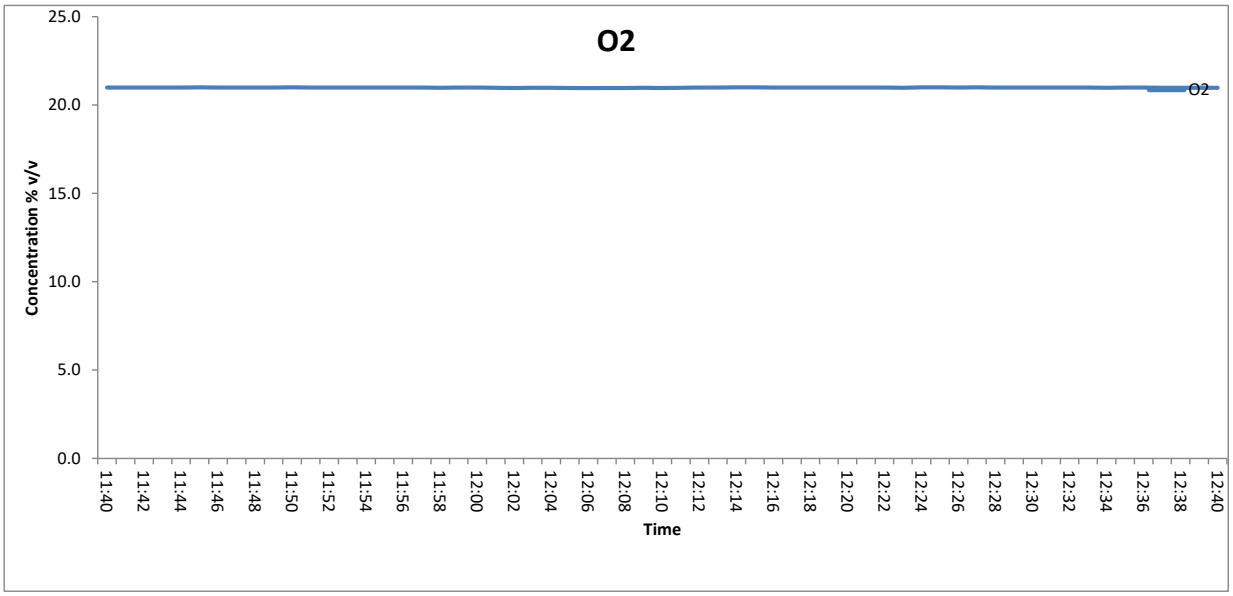


CARBON DIOXIDE EMISSIONS CHART



APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

OXYGEN EMISSIONS CHART



APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

MOISTURE CALCULATIONS

Moisture Determination - Isokinetic							
Test Number	Sampling Time and Date	Start Weight kg	End Weight kg	Total gain kg	Concentration %	LOD %	Uncertainty %
Run 1	11:40 - 12:40 02 August 2023	3.1253	3.1263	0.0010	0.1	0.01	23.3

Moisture Quality Assurance							
Test Number	Sampling Duration mins	Total Volume Sampled l	Sampling Rate l/min	Start Leak Rate l/min	End Leak Rate l/min	Acceptable Leak Rate l/min	Leak Tests Acceptable?
Run 1	60	902	16.1	0.11	-	0.32	Yes

PRELIMINARY STACK SURVEY

Stack Characteristics		
Stack Diameter / Depth, D	0.09	m
Stack Width, W	-	m
Stack Area, A	0.01	m^2
Average stack gas temperature	24	^oC
Stack static pressure	0.005	kPa
Barometric Pressure	101.9	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	0.011429	0.000114	0.000224	0.011413	0.000114	0.000224
O_2	32	1.427679	20.928582	0.209286	0.298793	20.899679	0.208997	0.298380
N_2	28	1.249219	79.059990	0.790600	0.987633	78.950807	0.789508	0.986269
H_2O	18	0.803070	-	-	-	0.138101	0.001381	0.001109

Where: p = M / 22.41 p*i* = r x p

Calculation of Stack Gas Densities		
Determinand	Result	Units
Dry Density (STP), P_{STD}	1.2866	kg/m^3
Wet Density (STP), P_{STW}	1.2860	kg/m^3
Dry Density (Actual), P_{Actual}	1.1897	kg/m^3
Average Wet Density (Actual), $P_{ActualW}$	1.189	kg/m^3

Where:

P_{STD} = sum of component concentrations, kg/m^3 (not including water vapour)

$P_{STW} = (P_{STD} + pi \text{ of } H_2O) / (1 + (pi \text{ of } H_2O / 0.8036))$

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

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

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

PRELIMINARY STACK SURVEY

TRAVERSE 1

Date of Survey	02 August 2023
Time of Survey	11:20
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_2O (average of 3 readings)	Temp °C	Velocity m/s	Volumetric Flow Rate (actual) m^3/s	O_2 % Vol	Angle of Swirl °
1	0.04	2.0	0.2	24	1.5	0.0	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
Mean	-	2.0	0.2	24	1.5	0.0	-	-

Sampling Line B								
Traverse Point	Distance into duct (m)	DP pt Pa (average of 3 readings)	DP pt mmH_2O (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 mmH2O	End Value mmH2O	Difference %	Outcome	Start Value mmH2O	End Value mmH2O	Difference %	Outcome
Run 1	137	135	1.5	Pass	149	147	1.3	Pass

To complete a compliant pitot leak check a pressure of over 80 mmH_2O (or 800 Pa) is applied and the pressure drop monitored over 5 mins. 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	5	5	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	2	Pa	>= 5 Pa	No
Lowest Gas Velocity	1.5	m/s	-	-
Highest Gas Velocity	1.5	m/s	-	-
Ratio of Gas Velocities	1.0	-	< 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} x (1-e) * Ö(2 * 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, Va	**1.5**	m/s

Calculation of Stack Gas Volumetric Flowrate, Q			
Duct gas flow conditions	Actual	Reference	Units
Temperature	24	0	°C
Total Pressure	101.905	101.3	kPa
Oxygen	20.9	21	%
Moisture	0.14	0.14	%
Pitot tube calibration coefficient, K_{pt}	0.84		

Gas Volumetric Flowrate	Result	Units
Average Stack Gas Velocity (Va)	1.53	m/s
Stack Area (A)	0.01	m^2
Gas Volumetric Flowrate (Actual), Q_{Actual}	35.01	m^3/hr
Gas Volumetric Flowrate (STP, Wet), Q_{STP}	32.37	m^3/hr
Gas Volumetric Flowrate (STP, Dry), $Q_{STP,Dry}$	32.33	m^3/hr
Gas Volumetric Flowrate (REF), Q_{Ref}	32.37	m^3/hr

Where:
Q_{Actual} = Va x A x 3600
Q_{STP} = Q (Actual) x (Ts / Ta) x (Pa / Ps) x 3600
$Q_{STP,Dry}$ = Q (STP) / (100 - (100 / Ma)) x 3600
Q_{Ref} = Q (STP) x ((100 - Ma) / (100 - Ms)) x ((21 - O_2a) / (21 - O_2s))

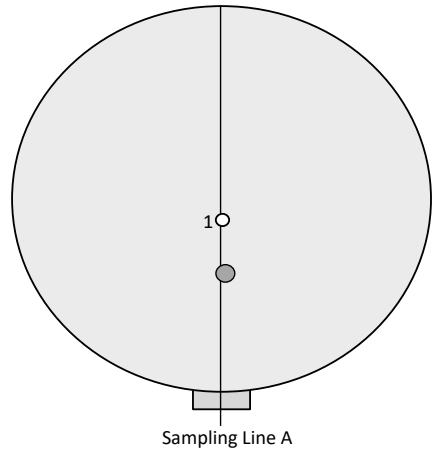
Nomenclature:
Ts = Absolute Temperature, Standard Conditions, 273 K
Ps = Absolute Pressure, Standard Conditions, 101.3 kPa
Ta = Absolute Temperature, Actual Conditions, K
Pa = Absolute Pressure, Actual Conditions, kPa
Ma = Water vapour, Actual Conditions, % Vol
Ms = Water vapour, Reference Conditions, % 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	0.09	m
Stack Width	-	m
Area	0.01	m^2

Non-Isokinetic/Gases Sampling			
Sampling Point	Distance (% of Depth)	Distance into Stack	Units
A	40	0.04	m



○ Isokinetic sampling point
● Isokinetic sampling points not used
◍ Non Isokinetic/Gases sampling point

Isokinetic Sampling			
Sampling Point	Distance (% of Depth)	Distance into Stack (m)	Swirl °
1	44.4	0.04	< 15
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
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-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

SAMPLING LOCATION

Scrubber Vent

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - TOTAL PARTICULATE MATTER

Run	Sampled Volume	Sampled Gas Temp	Sampled Gas Pressure	Sampled Gas Humidity	Oxygen Content	Limit of Detection	Leak	Uncollected Mass
	m^3	K	kPa	% by volume	% by volume	% by 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	0.2000	-	-
as a %	0.20	0.67	0.49	1.0	N/A	N/A	0.68	N/A
compliant?	**Yes**	**Yes**	**Yes**	**Yes**	**N/A**	**N/A**	**Yes**	**N/A**

Run	Volume (STP)	Mass of particulate	O_2 Correction	Leak	Uncollected Mass	Combined uncertainty
	m^3	mg	-	mg/m^3	mg	
Run 1	0.83	0.8900	1.0	0.0039	0.0007	-
MU as mg/m^3	0.01	0.2217	-	0.0039	0.0008	**0.22**
MU as %	1.32	22.4719	-	0.394	0.0804	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.44**	**mg/m^3**	**45.03**	**% Result**	**N/A**	**% ELV**

(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	0.002	2.0	0.50	1.0	N/A	-
as a %	0.20	0.67	0.49	1.0	N/A	0.68
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	0.83	1000	1.0	4.38	58	-
MU as % v/v	0.00	0.01	-	0.00	0.008	**0.02**
MU as %	1.32	10.00	-	0.39	5.77	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.03**	**% v/v**	**23**	**%**

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - VOLATILE ORGANIC COMPOUNDS RUN 1

Measured Concentration	0.4	mg/m^3
Limit	-	mg/m^3
Calibration Gas Concentration	129.12	mg/m^3
Range	160	mg/m^3

Performance characteristics	Value	Units	specification	MU Met?
Response time	10	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	0.10	% full scale	<5% range / 24hr	Yes
Span drift	-0.97	% 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)	0.12	% 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	0.06
volume or pressure flow dependence	uspres	0.00
atmopsheric pressure dependence	uapres	0.04
ambient temperature dependence	utemp	0.00
Dependence on voltage	uvolt	0.14
losses in the line (leak)	uleak	0.00
Uncertainty of calibration gas	ucalib	0.00
Uncertainty in factor	uf	0.00

Measurement uncertainty Measured Concentration	0.35	mg/m^3
Combined uncertainty	0.66	mg/m^3
Expanded uncertainty	1.30	mg/m^3

Expanded uncertainty expressed with a level of confidence of 95%	**-**	**% ELV**
Expanded uncertainty expressed with a level of confidence of 95%	**1.30**	**mg/m^3**
Expanded uncertainty expressed with a level of confidence of 95%	**372**	**% value**

Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - OXIDES OF NITROGEN

Limit value	-	mg/m^3
Concentration @ Ref conditions	0.8	mg/m^3
Cal gas conc	82	mg/m^3
Analyser Full Scale	205	mg/m^3

	Value	Units	specification	MU Met?
Response time	15	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	0.40	% full scale	<5% range / 24hr	Yes
Span drift	-0.90	% full scale	<5% range / 24hr	Yes
volume or pressure flow dependence	0.1	% of full scale/3 kPa	<2 % / 3 kPa	Yes
atmospheric pressure dependence	0.10	% 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	0.00	% 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)	0.00	% 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	$U_{d,z}$	0.2328
short term span drift	$U_{d,s}$	-0.5183
influence of Ambient Temp at Zero	$U_{t,z}$	0.0000
influence of Ambient Temp at Span	$U_{t,s}$	0.9000
influence of sample gas pressure	U_p	0.0000
influence of sample gas flow	U_{fit}	0.0693
influence of supply voltage	U_v	0.0003
Combined Interfence	U_i	-0.0018
Uncertainty of Cal gas	U_{adj}	0.4010

Measurement uncertainty (Concentration Measured)	0.77	mg/m^3
Combined uncertainty	1.16	mg/m^3
Expanded at a 95% confidence interval	2.28	mg/m^3

Expanded uncertainty expressed with a level of confidence of 95%	**-**	**% ELV**

Expanded uncertainty expressed with a level of confidence of 95%	**2.3**	**mg/m^3**

Expanded uncertainty expressed with a level of confidence of 95%	**296**	**% value**

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - SULPHUR DIOXIDE

Limit value	-	mg/m^3
Concentration @ Ref conditions	0.8	mg/m^3
Cal gas conc	97.128	mg/m^3
Analyser Full Scale	572	mg/m^3

Performance characteristics	Value	Units	specification	MU Met?
Response time	15	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	0.65	% full scale	<5% range / 24hr	Yes
Span drift	-1.81	% full scale	<5% range / 24hr	Yes
volume or pressure flow dependence	0.6	% of full scale/3 kPa	<2 % / 3 kPa	Yes
atmospheric pressure dependence	0.00	% of full scale/2 kPa	<3% / 2 kPa	Yes
ambient temperature dependence zero / span	0.0021	% full scale/10K	<3% range / 10 K	Yes
Cross-sensitivity	0.00	% range	<4% of Range	Yes
dependence on voltage	-0.05	% full scale/10V	< 0.1%vol /10 volt	Yes
Influence of vibration	N/A	% of upper limit of Cal range	<2%	-

Uncertainty of calibration gas	% of value	Value of uncertainty quantity
repeatability	$U_r = S_r$	0.008
lack of fit	U_{lof}	0.404
short term zero drift	$U_{d,z}$	0.144
short term span drift	$U_{d,s}$	0.087
influence of Ambient Temp at Zero	$U_{t,z}$	-0.906
influence of Ambient Temp at Span	$U_{t,s}$	0.001
influence of sample gas pressure	U_p	0.000
influence of sample gas flow	U_{fit}	0.416
influence of supply voltage	U_v	-0.156
Combined Interfence	U_i	0.000
Uncertainty of Cal gas	U_{adj}	0.004

Measurement uncertainty (Concentration Measured)	0.8	mg/m^3
Combined uncertainty	1.1	mg/m^3
Expanded uncertainty	2.2	mg/m^3

Expanded uncertainty expressed with a level of confidence of 95%	**-**	**% ELV**
Expanded uncertainty expressed with a level of confidence of 95%	**2.2**	**mg/m^3**
Expanded uncertainty expressed with a level of confidence of 95%	**269**	**% value**

Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - CARBON MONOXIDE

Limit value	-	mg/m^3
Concentration @ Ref conditions	1.1	mg/m^3
Cal gas conc	100.4	mg/m^3
Analyser Full Scale	250	mg/m^3

Performance characteristics	Value	Units	specification	MU Met?
Response time	15	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	1.06	% full scale	<5% range / 24hr	Yes
Span drift	-1.30	% 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)	0.00	% 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	$U_{d,s}$	0.61
influence of Ambient Temp zero	$U_{t,z}$	-0.36
influence of Ambient Temp span	$U_{t,s}$	0.18
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 Interfence	U_i	-0.15
Uncertainty of Cal gas	U_{adj}	0.40

Measurement uncertainty (Concentration Measured)	1.1	mg/m^3
Combined uncertainty	0.9	mg/m^3
Expanded uncertainty	1.8	mg/m^3

Expanded uncertainty expressed with a level of confidence of 95%	**-**	**% ELV**
Expanded uncertainty expressed with a level of confidence of 95%	**1.8**	**mg/m^3**
Expanded uncertainty expressed with a level of confidence of 95%	**163**	**% value**

Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - CARBON DIOXIDE

Limit value	-
Measured concentration	0.10
Calibration gas	8.01
Analyser Full Scale	10

Performance characteristics	Value	Units	specification	MU Met?
Response time	15	seconds	< 200 s	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60.00000001	minutes	-	-
Number of readings in measurement	60.00000001	-	-	-
Repeatability at zero	0.015	% by volume	<0.2 % range	Yes
Repeatability at span level	0.014	% by volume	<0.4 % range	Yes
Deviation from linearity	0.13	% vol	<0.3 % volume	Yes
Zero drift (during measurement period)	0.1	% vol at zero level	<5% range / 24hr	Yes
Span drift (during measurement period)	-0.11	% vol at span level	<5% range / 24hr	Yes
volume or pressure flow dependence	0.02	% of fs / 10l/h	<1% range	Yes
atmospheric pressure dependence	0.8	% of fs/kPa	< 1.5 % range	Yes
ambient temperature dependence	0.01	% by volume /10K	<0.3% volume 10 K	Yes
Combined interference	0.56	% range	<2% range	Yes
Dependence on voltage	0.1	% by volume /10V	< 0.1%vol /10 volt	Yes
Losses in the line (leak)	0.124843945	% of value	< 2% of value	Yes
Uncertainty of calibration gas	1	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	ur0	-
Standard deviation of repeatability at span level	urs	0.001807392
Lack of fit	ufit	0.0751
Drift	u0dr	0.05690997
volume or pressure flow dependence	uspres	0.0000
atmospheric pressure dependence	uapres	0.004888081
ambient temperature dependence	utemp	0.0005
Combined interference (from mcerts)	-	0.032331615
dependence on voltage	uvolt	0.086
losses in the line (leak)	uleak	7.50052E-05
Uncertainty of calibration gas	ucalib	0.000600792

Measurement uncertainty	0.10	%vol
Combined uncertainty	0.13	%vol
Expanded uncertainty	0.26	%

Expanded uncertainty expressed with a level of confidence of 95%	**0.52**	**% of value**

Expanded uncertainty expressed with a level of confidence of 95%	**497**	**% vol**

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	20.99	%vol
Calibration gas	9.88	%vol
Analyser Full Scale	25	%vol

	Value	Units	specification	MU Met?
Response time	15	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	0.13	% of value	<2 % range	Yes
Zero drift	0.72	% full scale	<5% range / 24hr	Yes
Span drift	-0.91	% full scale	<5% range / 24hr	Yes
volume or pressure flow dependence	0.03	% of full scale/3 kPa	<2 % / 3 kPa	Yes
atmospheric pressure dependence	0.05	% of full scale/2 kPa	<3% / 2 kPa	Yes
ambient temperature dependence	-0.05	% full scale/10K	<3% range / 10 K	Yes
Combined interference	0.01	% range	<4% of Range	Yes
dependence on voltage	0.00	% full scale/10V	< 0.1%vol /10 volt	Yes
losses in the line (leak)	0.01	% of value	< 2% of value	Yes
Uncertainty of calibration gas	0.0	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
repeatability	$U_r = S_r$	0.0083
lack of fit	U_{lof}	0.0751
short term zero drift	$U_{d,z}$	0.4138
short term span drift	$U_{d,s}$	-0.5259
influence of Ambient Temp at Zero	$U_{t,z}$	0.0013
influence of Ambient Temp at Span	$U_{t,s}$	0.0022
influence of sample gas pressure	U_p	0.0000
influence of sample gas flow	U_{fit}	0.0173
influence of supply voltage	U_v	0.0001
Combined Interfence	U_i	0.0017
Uncertainty of Cal gas	U_{adj}	0.0494

Measurement uncertainty (Concentration Measured)	20.99	%
Combined uncertainty	0.68	%
Expanded uncertainty	1.32	%

Expanded uncertainty expressed with a level of confidence of 95%	**1.3**	**%**
Expanded uncertainty expressed with a level of confidence of 95%	**6.3**	**% vol**

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - VELOCITY & VOLUMETRIC FLOW RATE

Measured Velocity at Actual Conditions	1.5	m/s
Measured Volumetric Flow rate at Actual Conditions	35	m³/hr

Performance Characteristics & Source of Value	Units	Values	Requirement	Compliant
Uncertainty of Local Gas Velocity Determination				
Uncertainty of pitot tube coefficient	-	0.010		
Uncertainty of mean local dynamic pressures	-	0.34		
Factor loading, function of the number of measurements.	3 readings	0.591	minimum 3	Yes
Range of measurment device	pa	1000		
Resolution	pa	1.00		
Calibration uncertainty	pa	2.24	<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	0.00003		
Uncertainty of temperature measurement	K	1.52	<1% of value	Yes
Uncertainty of absolute pressure in the duct	pa	520		
Uncertainty associated with the calculation of density	kg/m3	0.007		
Uncertainty associated with the measurement of local velocity	-	0.0001		
Uncertainty associated with the measurement of mean velocity	-	0.0558		

Measurement Uncertainty - Velocity	m/s
Combined uncertainty	0.36
Expanded uncertainty at a 95% Confidence Interval	0.71

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	23.6
Expanded uncertainty at a 95% Confidence Interval	46.3

Measurement Uncertainty Volumetric Flow Rate	m³/hr
Combined uncertainty	8
Expanded uncertainty at a 95% Confidence Interval	16

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	23.7
Expanded uncertainty at a 95% Confidence Interval	46.5

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