

Document No.: INLATL16020425 / 20251346
 Visit No: 1
 Year: 2025
 Office: Trim

EPA Licence No.: WL109-02
 Licence Holder: Clare County Council, F1
 Facility Location: Inagh Landfill
 Rev.No: 1



Report Title	Air Emissions Compliance Monitoring Emissions
Company address	Air Scientific Ltd., 32 DeGranville Court, Dublin road, Trim, Co. Meath
Stack Emissions Testing Report Commissioned by	JRE Environmental Ltd
Facility Name	Inagh Landfill
Contact Person	Mr John Rea
EPA Licence Number	WL109-02
Licence Holder	Clare County Council, F1
Stack Reference Number	F1
Dates of the Monitoring Campaign	02/04/2025
Job Reference Number	INLATL16020425 / 20251346
Report Written By	Amanda Sheridan
Report Approved by	Dr. Brian Sheridan
Stack Testing Team	Liam Byrne
Report Date	15/05/2025
Report Type	Test Report Compliance Monitoring
Version	1
Signature of Approver	 Brian Sheridan Technical Manager



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1. Executive Summary

1. Monitoring Objectives

Overall Aim of the monitoring Campaign

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values as specified in the site licence.

Special Requirements

There were no special requirements.

Target Parameters

Carbon Monoxide (CO)
Oxides of Nitrogen (NOx) as NO ₂
Sulphur Dioxide (SO ₂)
Stack Gas Temperature
Volume (m ³ .h ⁻¹)
Oxygen (O ₂)
Carbon Dioxide (CO ₂)

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Emission Limit Values

Emission Limit Values / Mass Emissions Limit Values	mg.m ⁻³	kg.h ⁻¹
CO	50	-
NOx as NO ₂	150	-
SO ₂	-	-
Stack Gas Temperature	-	-
Volume (m ³ .h ⁻¹)	-	-

Reference Conditions

Reference Condition	Value
Oxygen Reference %	3
Temperature K	273.15
Total Pressure kPa	101.3
Moisture Correction	Yes

Executive Summary

Overall Results

Parameter	Concentration	Result	MU +/-	Blanks	Limit	Compliant	Mass Emission	Result	Run 1	Dates	Time on	Time off	O2 Ref. (%)	Accreditation	LOD
	Units						Units		Limit						
CO EN15058:2017	mg.m ⁻³	9.61	4.14	-	50	N/A	kg.h ⁻¹	-	-	02/04/2025	14:21:00	14:52:00	3	Yes	<1.7
NOx EN14792:2017	mg.m ⁻³	118.85	12.04	-	150	N/A	kg.h ⁻¹	-	-	02/04/2025	14:21:00	14:52:00	3	Yes	<1.8
SO ₂ CEN/TS 17021:2017	mg.m ⁻³	<6.1	4.61	-	-	N/A	kg.h ⁻¹	-	-	02/04/2025	14:21:00	14:52:00	3	Yes	<6.1
Oxygen (%) EN14789:2017	% v/v	12.52	0.19	-	-	N/A	-	-	-	02/04/2025	14:21:00	14:52:00	3	Yes	-
CO ₂ ISO12039:2001	% v/v	6.68	0.28	-	-	N/A	-	-	-	02/04/2025	14:21:00	14:52:00	3	Yes	-
H ₂ O EN14790:2017	% v/v	10.2	0.46	-	-	N/A	-	-	-	02/04/2025	13:40:00	14:10:00	3	Yes	-
Stack Gas Temperature	K	1272.15	-	-	-	N/A	-	-	-	02/04/2025	13:05:00	13:10:00	3	Yes	-
Stack Gas Velocity EN16911:2013	m.s ⁻¹	-	-	-	-	N/A	-	-	-	02/04/2025	13:05:00	13:10:00	3	No	-
Volumetric Flow Rate	m ³ .h ⁻¹	-	-	-	-	N/A	-	-	-	-	-	-	3	No	-
Volumetric Flow Rate (Ref)	m ³ .h ⁻¹	-	-	-	-	N/A	-	-	-	-	-	-	3	N/A	-

Accreditation details

Air Scientific Limited	INAB319T
External Analytical Laboratory	-
Other	-



Executive Summary

Monitoring Dates & Times

Parameter	Run	Location ID	Sampling Dates	Sampling Time On	Sampling Time Off	Duration (mins.)
Carbon Monoxide (CO)	Run 1	F1	02/04/2025	14:21:00	14:52:00	00:31:00
	Run 2	-	-	-	-	-
	Run 3	-	-	-	-	-
Oxides of Nitrogen (NOx) as NO ₂	Run 1	F1	02/04/2025	14:21:00	14:52:00	00:31:00
	Run 2	-	-	-	-	-
	Run 3	-	-	-	-	-
Sulphur Dioxide (SO ₂)	Run 1	F1	02/04/2025	14:21:00	14:52:00	00:31:00
	Run 2	-	-	-	-	-
	Run 3	-	-	-	-	-
Oxygen (%)	Run 1	F1	02/04/2025	14:21:00	14:52:00	00:31:00
	Run 2	-	-	-	-	-
	Run 3	-	-	-	-	-
Water Vapour (%)		F1	02/04/2025	13:40:00	14:10:00	00:30:00
Stack Gas Temperature		F1	02/04/2025	13:05:00	13:10:00	00:05:00
Stack Gas Velocity		F1	02/04/2025	13:05:00	13:10:00	00:05:00
Carbon Dioxide (%)	Run 1	F1	02/04/2025	14:21:00	14:52:00	00:31:00
	Run 2	-	-	-	-	-
	Run 3	-	-	-	-	-

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Monitoring, Equipment & Analytical Methods

Parameter	Monitoring				Analysis	
	Standard	Technical Procedure	Accredited Testing	Testing Lab	Analytical Technique	INAB Analysis
Carbon Monoxide (CO)	EN15058:2017	SOP 2004	Yes	AirSci	NCIR By Horiba PG-250	-
Oxides of Nitrogen (NOx)	EN14792:2017	SOP 2002	Yes	AirSci	Chemiluminescence	-
Sulphur Dioxide (SO ₂)	CEN/TS 17021:2017	SOP 2046	Yes	AirSci	NDIR Absorption	-
Oxygen (%)	EN14789:2017	SOP 2008	Yes	AirSci	Paramagnetic	-
Carbon Dioxide	ISO12039:2001	SOP 2045	Yes	AirSci	NDIR	-
Water Vapour (%)	EN14790:2017	SOP 2007	Yes	AirSci	Gravimetric	-
Stack Gas Temperature	EN16911:2013	SOP 2005	Yes	AirSci	Thermocouple	-
Stack Gas Velocity	EN16911:2013	SOP 2005	No	AirSci	Pitot tubes	-

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List of Equipment

ID	Item of Equipment	Manufacturer	Serial No.
ASLTM21EQ509	10 metre heated line	Buhler Technologies	N/A
ASLTM22EQ506	Mass flow meter	Siargo	N/A
ASLTM24EQ502	Buhler Sample Gas Cooler	Buhler Technologies	N/A
ASLTM20EQ507	Horiba PG350	Horiba	N/A
ASLTM22EQ504	Knob weights	KERN & Sohn GmbH	N/A
ASLTM22EQ505	Scales	Jadever	N/A
ASLTM22EQ517	K type thermocouple	TC Direct	N/A

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Sampling Deviations

Parameter	Deviation
Standard ID	-

Reference Documents

Risk Assessment (RA)	SOP1011
Site Review (SR)	SOP1015
Site Specific Protocol (SSP)	SOP1015

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Suitability of sampling location

General Information	Value
Permanent/Temporary	Permanent
Inside/ Outside	Outside

Platform Details		
Irish EPA Technical Guidance Note AG1 / BS EN 15259 Platform Requirements	Value	Comment
Sufficient Working area to manipulate probe and measuring instruments	Yes	-
Platform has 2 handrails (approx. 0.5m & 1.0 m high)	Yes	-
Platform has vertical base boards (approx. 0.25 m high)	Yes	-
Platform has chains / self closing gates at top of ladders	Yes	-
There are no obstructions present which hamper insertion of sampling equipment	No	-
Safe Access Available	Yes	-
Easy Access Available	Yes	-

Sampling Location / Platform Improvement Recommendations
None

BSEN 15259 Homogeneity Test Requirements
1: There is no requirement to perform a BSEN15259 Homogeneity Test on this stack

Process details

Parameter	
Process status	Normal
Capacity (per/hour) (if applicable)	As per normal
Continuous or Batch Process	Continuous
Feedstock	LFG
Abatement System	No
Abatement Systems Running Status	N/A
Fuel	N/A
Plume Appearance	No
Other information	None

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The process information below has been supplied by the client and as such ASL assume no responsibility or liability for any errors or omissions in the content of this Process Detail Form. The information provided in this form is provided on an 'as is' basis with no guarantees of completeness, accuracy or reliability.

Licensee			
Reg. number	WL109-02	Contractor	Air Scientific Ltd.
Site Contact	Mr John Rea	Contractor's contact	Amanda Sheridan
Role		Role	-
Signature		Signature	-

Emissions point		-				
Type of process		Load of process	Abatement system		List of Solvents used per process	
Rotogravure Printing	-	As normal	Bag filter	-	-	-
Cement Plant	-		Electrostatic precipitator	-	-	-
Electrical generation	-		Cyclone	-	-	-
Steam boiler	-		Thermal oxidiser	-	-	-
Other	Yes		Active carbon bed	-	-	-
			NSCR	-	-	-
			SCR	-	-	-
			Dry scrubber	-	-	-
			Wet scrubber	-	-	-
			Lime injection	-	-	-
			Biofilter	-	-	-
			None	Yes	-	-
			Other:	-	-	-

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Stack diagram



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2. APPENDICES

II. Appendix I - Monitoring Personnel & Equipment

Stack Emissions Monitoring Personnel

Team Leader	Name	Liam Byrne
	Qualifications	B. Sci.
	System approval	Air Scientific Limited Approved
		-
Team Leader	Name	-
	Qualifications	-
	System approval	-
		-

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III. Appendix II - Stack Details & flow characteristics

Preliminary stack survey calculations

General Stack Details		
Stack details	Units	Value
Date of survey		02/04/2025
Time of survey		13:05
Type		Circular
Stack Diameter / Depth, D	m	-
Stack Width, W	m	-
Average Stack Gas Temp., Ta	C	999
Average Static Pressure, P static	kPa	0.1
Average Barometric Pressure, Pb	kPa	101.3
Type of Pitot		-
Are Water Droplets Present?		-
Average Pitot Tube Calibration Coeff, Cp		-
Negative flow		-
Highly homogeneous flow stream/gas velocity		Yes

Sample Port Size	mm	25
Initial Pitot Leak Check	Pa	-
Final Pitot Leak Check	Pa	-
Orientation of Duct		Vertical
Pitot Tube Cp		0.998
Number of Lines Available		1
Number of Lines Used		1

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Sampling Line A						
Point	Distance to duct (m)	Pa	Temp °C	Velocity (m/s)	Oxygen (%)	Angle of Swirl
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Average	-	-	-	-	-	-
Min	-	-	-	-	-	-
Max	-	-	-	-	-	-

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Sampling Line B						
Point	Distance to duct (m)	Pa	Temp °C	Velocity (m/s)	Oxygen (%)	Angle of Swirl
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Average	-	-	-	-	-	-
Min	-	-	-	-	-	-
Max	-	-	-	-	-	-

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Component	Conc. ppm	Conc. Dry % v/v	Conc. Wet % v/v	Molar Mass
Carbon Dioxide CO ₂	-	6.62	-	44.01
Oxygen O ₂	-	12.72	-	32
Nitrogen N ₂	-	80.66	-	28.1
Moisture (H ₂ O)	-	-	10.2	18.02
Reference Conditions				
Reference Conditions	Units	Numbers		
Temperature	°C	273.15		
Total Pressure	kPa	101.3		
Moisture	%	-		
Oxygen (Dry)	%	3		

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Stack Gas Composition & Molecular Weights								
Component	Molar Mass M	Density Kg/m ³ p	Conc. Dry % v/v	Dry Volume Fraction r	Dry Conc. kg/m ³ pi	Conc. wet % v/v	Wet Volume Fraction r	Wet Conc. kg/m ³ pi
Carbon Dioxide CO ₂	44.01	1.96	6.62	0.0662	0.13	5.94	0.06	0.12
Oxygen O ₂	32	1.43	12.72	0.1272	0.18	11.42	0.11	0.16
Nitrogen N ₂	28.1	1.25	80.66	0.8066	1.01	72.43	0.72	0.91
Moisture (H ₂ O)	18.02	0.8	-	-	-	10.2	0.1	0.08
where $p=M/22.41$								
$\pi = r \times p$								

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Calculation of Stack Gas Densities		
Determinant	Units	Result
Dry Density (STP), P STD	kg.m ⁻³	1.323
Wet Density (STP), P STW	kg.m ⁻³	1.275
Dry Density (Actual), P Actual	kg.m ⁻³	0.284
Average wet Density (Actual), P Actual W	kg.m ⁻³	0.274
Where		
P STD = sum of component concentrations, kg/m ³ (excluding water vapour)		
$P_{STW} = (P_{STD} + p_{H_2O}) / (1 + (p_{H_2O} / 0.8036))$		
$P_{actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times (P_a / T_a)$		
$P_{actual\ W} \text{ (at each sampling point)} = P_{STW} \times (T_s / P_s) \times (P_a / T_a)$		

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Sampling Plane Validation Criteria	Value	Units	Requirement	Compliance	Method
Lowest Differential Pressure	-	Pa	>5 Pa	N/A	EN16911:2013
Lowest Gas Velocity	-	m/s	-	N/A	-
Highest Gas Velocity	-	m/s	-	N/A	-
Ratio of Above	-	:1	<3:1	N/A	EN16911:2013
Mean Velocity	-	m/s	-	N/A	-
Angle of flow with regard to duct axis	-	degrees	< 15	N/A	EN16911:2013
No local negative flow	-	-	-	N/A	-
Homogeneous flow stream/gas velocity	-	-	-	N/A	-

Calculation of stack Gas Velocity, V	
Velocity at Traverse Point, $V = K_{cp} * \text{Sqrt}((2 * DP) / \text{Density})$	-
Where	
K _{pt} = Pitot tube calibration coefficient	-
Compressibility correction factor, assumed at a constant 0.998	0.998

Gas Volumetric Flowrate	Units	Result
Gas Volumetric Flow Rate (Actual)	m ³ .h ⁻¹	-
Gas Volumetric Flow Rate (STP, Wet)	m ³ .h ⁻¹	-
Gas Volumetric Flowrate (STP, Dry)	m ³ .h ⁻¹	-
Gas Volumetric Flowrate REF to Oxygen	m ³ .h ⁻¹	-

Standard uncertainty of velocity (m/s)	-	Expanded uncertainty of velocity (m/s)	-	Volume flow rate expanded uncertainty (m ³ /hr)	-
----------------------------------------	---	----------------------------------------	---	------------------------------------------------------------	---

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IV. Appendix 3 - Individual parameter sampling details and results

Carbon Monoxide Quality Assurance

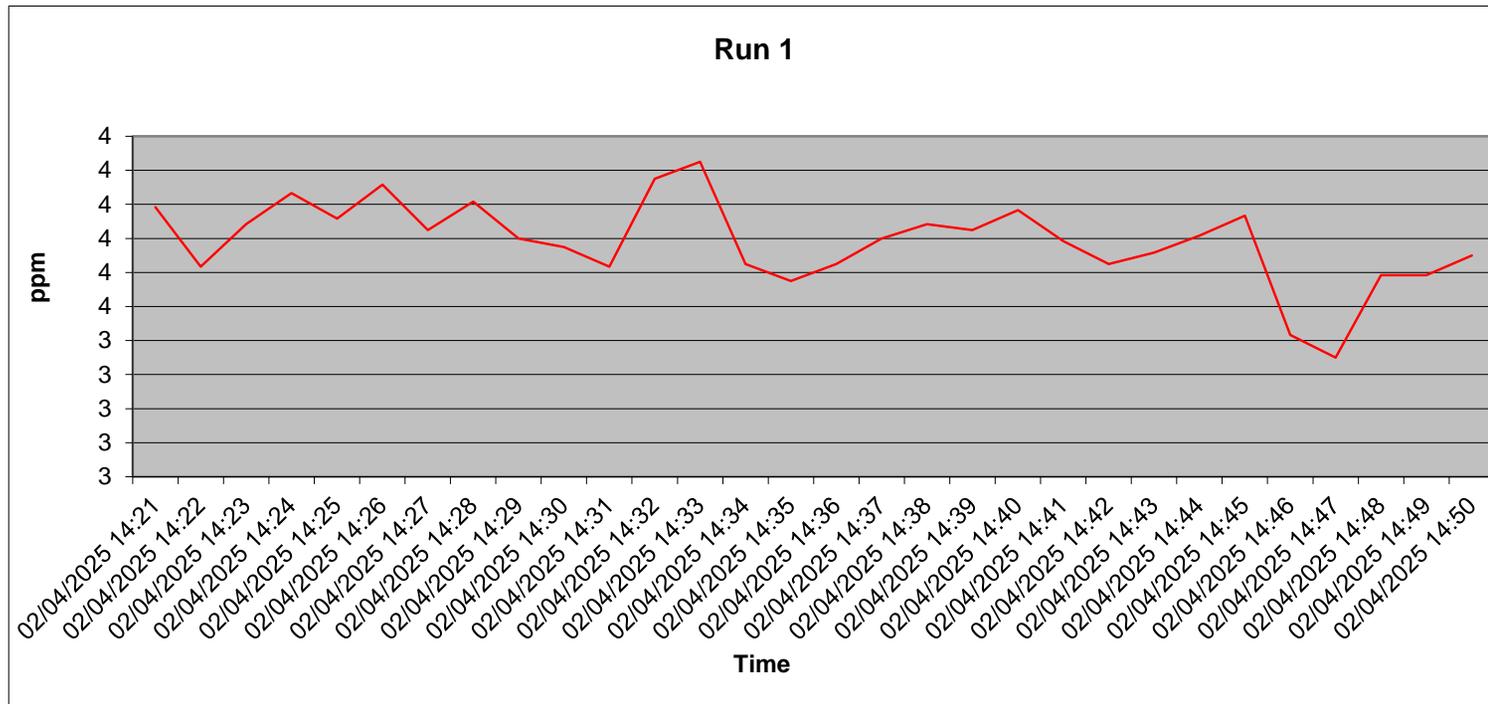
Sampling Details				
Stack ID	F1			
Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	14:21	-	-
Sampling Dates	-	02/04/2025	-	-
Instrument Range	ppm	200	-	-
Span Gas Value	ppm	148.6	-	-
Acceptable Gas Range	-	Y	-	-
Quality Assurance	Units	Run 1	Run 2	Run 3
Conditioning Unit Temperature	°C	2	-	-
Average Temperature	< °C	2	-	-
Allowable Temperature	-	4	-	-
Temperature Acceptable	-	Y	-	-
Pump flow rate	l/min	0.5	-	-
Zero Drift	Units	Run 1	Run 2	Run 3
Zero Down Sampling Line (Pre)	ppm	0	-	-
Zero Down Sampling Line (Post)	ppm	0.1	-	-
Zero Drift	ppm	-0.1	-	-
Allowable Zero Drift (5%)	ppm	7.43	-	-
Zero Drift Acceptable	Y <2%/Y 2-5%/N>5%	Y <2%	-	-
Zero Drift	%	-0.07	-	-
Span Drift	Units	Run 1	Run 2	Run 3
Span Down Sampling Line (Pre)	ppm	148.6	-	-
Span Down Sampling Line (Post)	ppm	148.9	-	-
Span Drift	ppm	-0.3	-	-
Allowable Span Drift (5%)	ppm	7.43	-	-
Span Drift Acceptable (Y/N)	Y <2%/Y 2-5%/N>5%	Y <2%	-	-
Span Drift	%	-0.2	-	-
Leak Check	Units	Run 1	Run 2	Run 3
Span Gas Conc.	ppm	148.6	-	-
Recorded Conc. down Line	ppm	148.9	-	-
Leak check acceptable (< 2%)	(Y/N)	Y <2%	-	-
Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	17	-	-

Carbon Monoxide Results & Sampling Details

Parameter	Units	Run 1	Run 2	Run 3	Mean
Concentration	mg.m ⁻³	4.5	-	-	-
Uncertainty	mg.m ⁻³	4.14	-	-	-
Mass Emission	kg.h ⁻¹	-	-	-	-

General Sampling Information	
Parameter	Value
Standard	EN15058
Technical Procedure	SOP2004
Probe material	SS
Filtration Type/Size	PTFE
Heated Head Filter Used	Yes
Heated Line Temperature	180
Span Gas Reference Number	ASLTM22ING523
Span Gas Expiry Date	27-Jun
Span Gas Start Pressure (bar)	50
Gas Cylinder Concentration (ppm)	148.6
Span Gas Uncertainty (%)	<2
Zero Gas Type	N
Number of Sampling Lines Used	1
Number of Sampling Points Used	1
Sample Point I.D's	F1
Reference Conditions	
Temperature (K)	273.15
Pressure (kPa)	101.3
Gas (Wet or Dry)	Dry
Oxygen	3

Carbon Monoxide Trend



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Carbon Monoxide Measurement Uncertainty

Measured Quantities	Units	Run 1	Run 2	Run 3
Certified Range of Analyser	ppm	1.36-1000	-	-
Operational Range of Analyser	ppm	200	-	-
Measured Reading	ppm	3.6	-	-
Measured Quantities				
Measured Quantities	Units	Run 1	Run 2	Run 3
Nonlinearity	%	0.9	-	-
Temperature Dependent Zero drift	%	0.14	-	-
Temperature Dependent Span drift	%	-0.12	-	-
Cross-sensitivity	%	0.08	-	-
Leak	%	0	-	-
Calibration Gas Uncertainty	%	<2	-	-
Parameter				
Parameter	Units	Run 1	Run 2	Run 3
Combined uncertainty	mg.m ⁻³	0.95	-	-
Expanded uncertainty	mg.m ⁻³	1.9	-	-
Uncertainty corrected to std conds.	mg.m ⁻³	4.14	-	-
Expanded uncertainty expressed with a level of confidence of 95%	% of ELV	8.27	-	-
Expanded uncertainty expressed with a level of confidence of 95%	mg.m ⁻³	4.14	-	-
Expanded uncertainty expressed with a level of confidence of 95%	% of value	43.06	-	-
Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions				

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Oxides of Nitrogen Quality Assurance

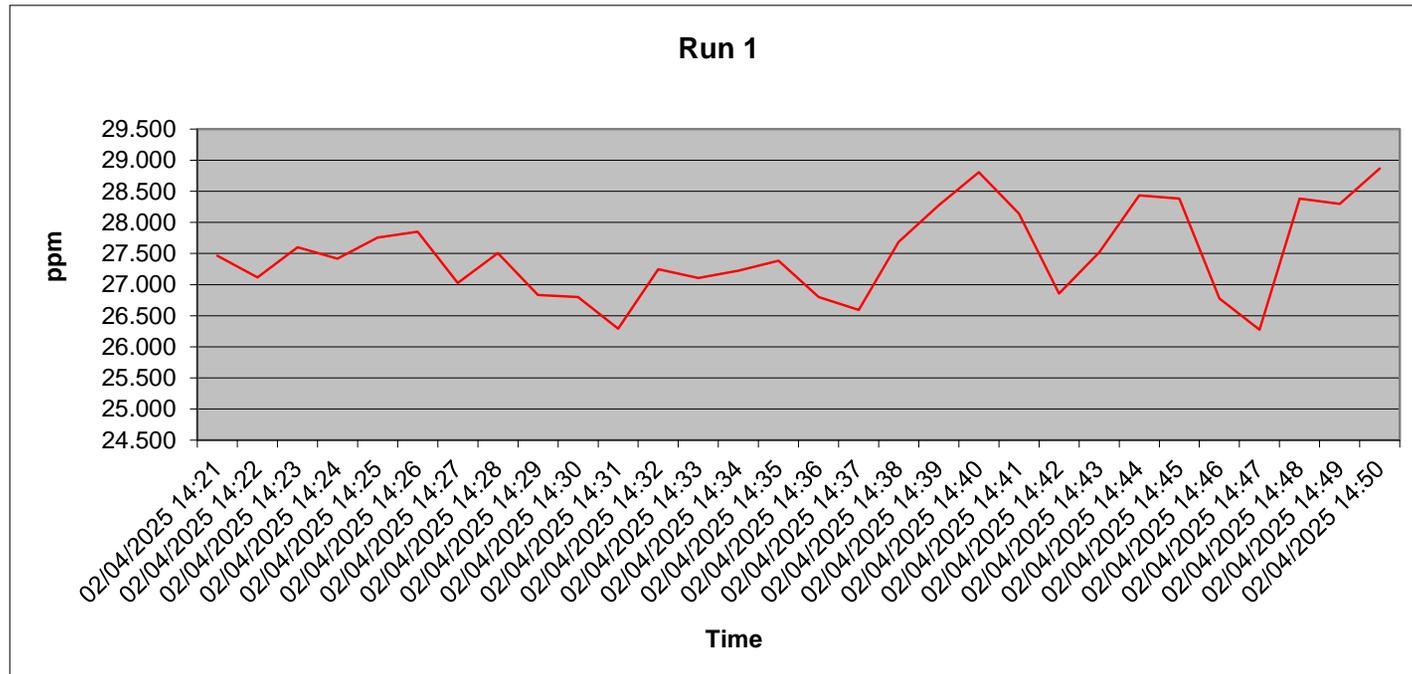
Sampling Details				
Stack ID	F1			
Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	14:21	-	-
Sampling Dates	-	02/04/2025	-	-
Instrument Range	ppm	250	-	-
Span Gas Value	ppm	165	-	-
Acceptable Gas Range	-	Yes	-	-
Quality Assurance	Units	Run 1	Run 2	Run 3
Conditioning Unit Temperature	°C	2	-	-
Average Temperature	< °C	2	-	-
Allowable Temperature	-	4	-	-
Temperature Acceptable	-	Y	-	-
Pump flow rate	l/min	0.5	-	-
Zero Drift	Units	Run 1	Run 2	Run 3
Zero Down Sampling Line (Pre)	ppm	0	-	-
Zero Down Sampling Line (Post)	ppm	0.2	-	-
Zero Drift	ppm	-0.2	-	-
Allowable Zero Drift (5%)	ppm	8.25	-	-
Zero Drift Acceptable	Y <2%/Y 2-5%/N >5%	Y <2%	-	-
Zero Drift	%	-0.12	-	-
Span Drift	Units	Run 1	Run 2	Run 3
Span Down Sampling Line (Pre)	ppm	165	-	-
Span Down Sampling Line (Post)	ppm	165.3	-	-
Span Drift	ppm	-0.3	-	-
Allowable Span Drift (5%)	ppm	8.25	-	-
Span Drift Acceptable (Y/N)	Y <2%/Y 2-5%/N >5%	Y <2%	-	-
Span Drift	%	-0.18	-	-
Leak Check	Units	Run 1	Run 2	Run 3
Span Gas Conc.	ppm	165	-	-
Recorded Conc. down Line	ppm	165.3	-	-
Leak check acceptable (< 2%)	(Y/N)	Y <2%	-	-
Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	17	-	-

Oxides of Nitrogen Results & Sampling Details

Parameter	Units	Run 1	Run 2	Run 3	Mean
Concentration	mg.m ⁻³	55.65	-	-	-
Uncertainty	mg.m ⁻³	12.04	-	-	-
Mass Emission	kg.h ⁻¹	-	-	-	-

General Sampling Information	
Parameter	Value
Standard	EN14792
Technical Procedure	SOP2002
Probe material	SS
Filtration Type/Size	PTFE
Heated Head Filter Used	Yes
Heated Line Temperature	180
Date & Result of last converter check	95.5 13/04/2024
Span Gas Reference Number	ASLTM23ING510
Span Gas Expiry Date	25-Jun
Span Gas Start Pressure (bar)	40
Gas Cylinder Concentration (ppm)	165
Span Gas Uncertainty (%)	<2
Zero Gas Type	N
Number of Sampling Lines Used	1
Number of Sampling Points Used	1
Sample Point I.D's	F1
Reference Conditions	
Temperature (K)	273.15
Pressure (kPa)	101.3
Gas (Wet or Dry)	Dry
Oxygen	3

Oxides of Nitrogen Trend



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Oxides of Nitrogen Measurement Uncertainty

Measured Quantities	Units	Run 1	Run 2	Run 3
Certified Range of Analyser	ppm	0.87-1000	-	-
Operational Range of Analyser	ppm	250	-	-
Measured Reading	ppm	27.11	-	-
Measured Quantities				
Measured Quantities	Units	Run 1	Run 2	Run 3
Nonlinearity	%	1.4	-	-
Temperature Dependent Zero drift	%	-0.04	-	-
Temperature Dependent Span drift	%	-0.25	-	-
Cross-sensitivity	%	0.5	-	-
Leak	%	0	-	-
Calibration Gas Uncertainty	%	<2	-	-
Mass Flow Controllers (Dilution) Uncertainty	%	<1	-	-
NOx Converter Efficiency	%	95.5	-	-
Parameter				
Parameter	Units	Run 1	Run 2	Run 3
Combined uncertainty	mg.m ⁻³	1.65	-	-
Expanded uncertainty	mg.m ⁻³	3.3	-	-
Uncertainty corrected to std conds.				
	mg.m ⁻³	12.04	-	-
Expanded uncertainty expressed with a level of confidence of 95%				
	% of ELV	8.03	-	-
Expanded uncertainty expressed with a level of confidence of 95%				
	mg.m ⁻³	12.04	-	-
Expanded uncertainty expressed with a level of confidence of 95%				
	% of value	10.13	-	-
Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions				

Sulphur Dioxide Quality Assurance

Sampling Details				
Stack ID	F1			
Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	14:21	-	-
Sampling Dates	-	02/04/2025	-	-
Instrument Range	ppm	200	-	-
Span Gas Value	ppm	151.6	-	-
Acceptable Gas Range	-	Y	-	-
Quality Assurance	Units	Run 1	Run 2	Run 3
Conditioning Unit Temperature	°C	2	-	-
Average Temperature	< °C	2	-	-
Allowable Temperature	-	4	-	-
Temperature Acceptable	-	Y	-	-
Pump flow rate	l/min	0.5	-	-
Zero Drift	Units	Run 1	Run 2	Run 3
Zero Down Sampling Line (Pre)	ppm	0.1	-	-
Zero Down Sampling Line (Post)	ppm	0.3	-	-
Zero Drift	ppm	-0.2	-	-
Allowable Zero Drift (5%)	ppm	7.58	-	-
Zero Drift Acceptable	Y <2%/Y 2-5%/N>5%	Y <2%	-	-
Zero Drift	%	-0.13	-	-
Span Drift	Units	Run 1	Run 2	Run 3
Span Down Sampling Line (Pre)	ppm	151.6	-	-
Span Down Sampling Line (Post)	ppm	151.9	-	-
Span Drift	ppm	-0.3	-	-
Allowable Span Drift (5%)	ppm	7.58	-	-
Span Drift Acceptable (Y/N)	Y <2%/Y 2-5%/N>5%	Y <2%	-	-
Span Drift	%	-0.2	-	-
Leak Check	Units	Run 1	Run 2	Run 3
Span Gas Conc.	ppm	151.6	-	-
Recorded Conc. down Line	ppm	151.9	-	-
Leak check acceptable (< 2%)	(Y/N)	Y <2%	-	-
Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	17	-	-

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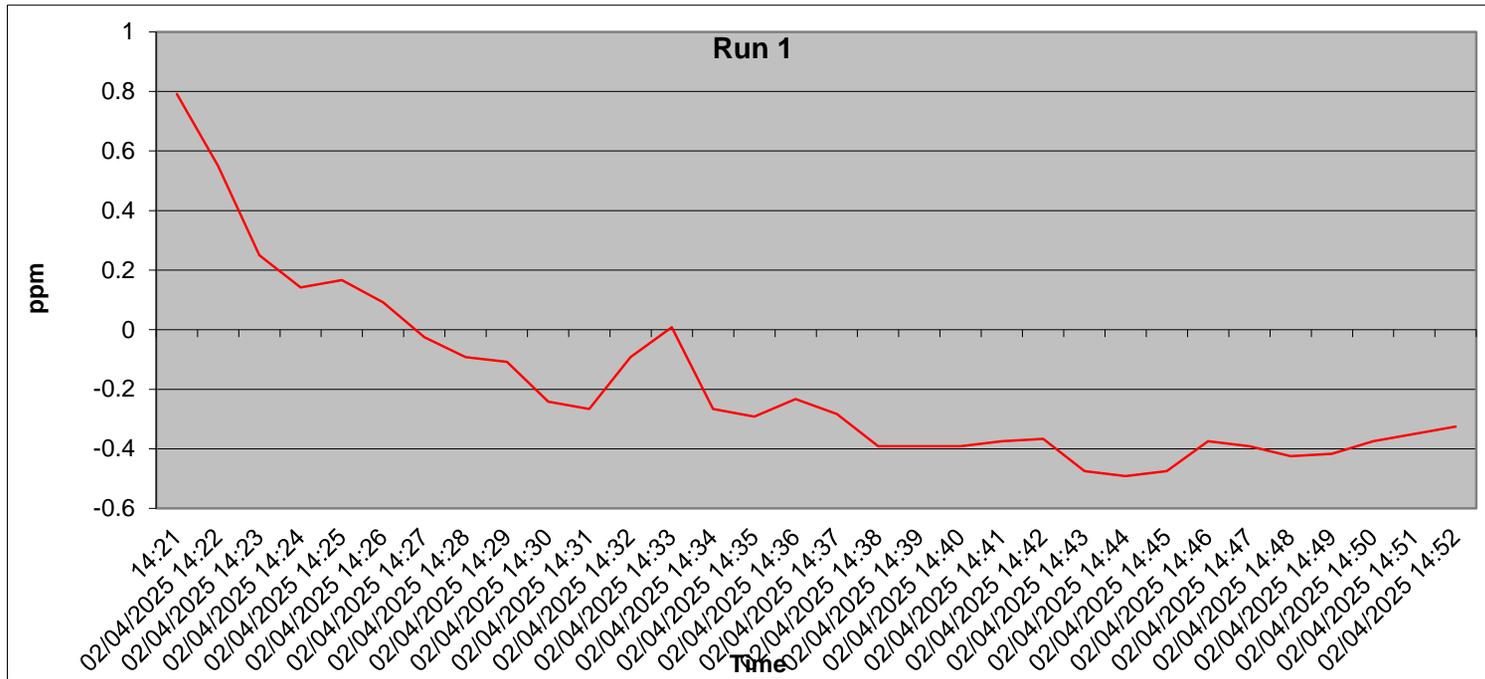
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Sulphur Dioxide Results & Sampling Details

Parameter	Units	Run 1	Run 2	Run 3	Mean
Concentration	mg.m ⁻³	-0.53	-	-	-
Uncertainty	mg.m ⁻³	4.61	-	-	-
Mass Emission	kg.h ⁻¹	-	-	-	-

General Sampling Information	
Parameter	Value
Standard	CEN/TS 17021
Technical Procedure	SOP 2046
Probe material	SS
Filtration Type/Size	PTFE
Heated Head Filter Used	Yes
Heated Line Temperature	180
Date & Result of last converter check	-
Span Gas Reference Number	ASLTM22ING524
Span Gas Expiry Date	Jun-25
Span Gas Start Pressure (bar)	55
Gas Cylinder Concentration (ppm)	151.6
Span Gas Uncertainty (%)	<2
Zero Gas Type	N
Number of Sampling Lines Used	1
Number of Sampling Points Used	1
Sample Point I.D's	F1
Reference Conditions	
Temperature (K)	273.15
Pressure (kPa)	101.3
Gas (Wet or Dry)	Dry
Oxygen	3

Sulphur Dioxide Trend



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Sulphur Dioxide Measurement Uncertainty

Measured Quantities	Units	Run 1	Run 2	Run 3
Certified Range of Analyser	ppm	2.14 to 1000	-	-
Operational Range of Analyser	ppm	200	-	-
Measured Reading	ppm	-0.18	-	-
Measured Quantities				
Measured Quantities	Units	Run 1	Run 2	Run 3
Nonlinearity	%	0.8	-	-
Temperature Dependent Zero drift	%	0.8	-	-
Temperature Dependent Span drift	%	2	-	-
Cross-sensitivity	%	1.5	-	-
Leak	%	0	-	-
Calibration Gas Uncertainty	%	<2 %	-	-
Parameter				
Parameter	Units	Run 1	Run 2	Run 3
Combined uncertainty	mg.m ⁻³	1.08	-	-
Expanded uncertainty	mg.m ⁻³	2.15	-	-
Uncertainty corrected to std conds.	mg.m ⁻³	4.61	-	-
Expanded uncertainty expressed with a level of confidence of 95%				
Expanded uncertainty expressed with a level of confidence of 95%	% of ELV	-	-	-
Expanded uncertainty expressed with a level of confidence of 95%	mg.m ⁻³	4.61	-	-
Expanded uncertainty expressed with a level of confidence of 95%				
Expanded uncertainty expressed with a level of confidence of 95%	% of value	-407.94	-	-
Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions				

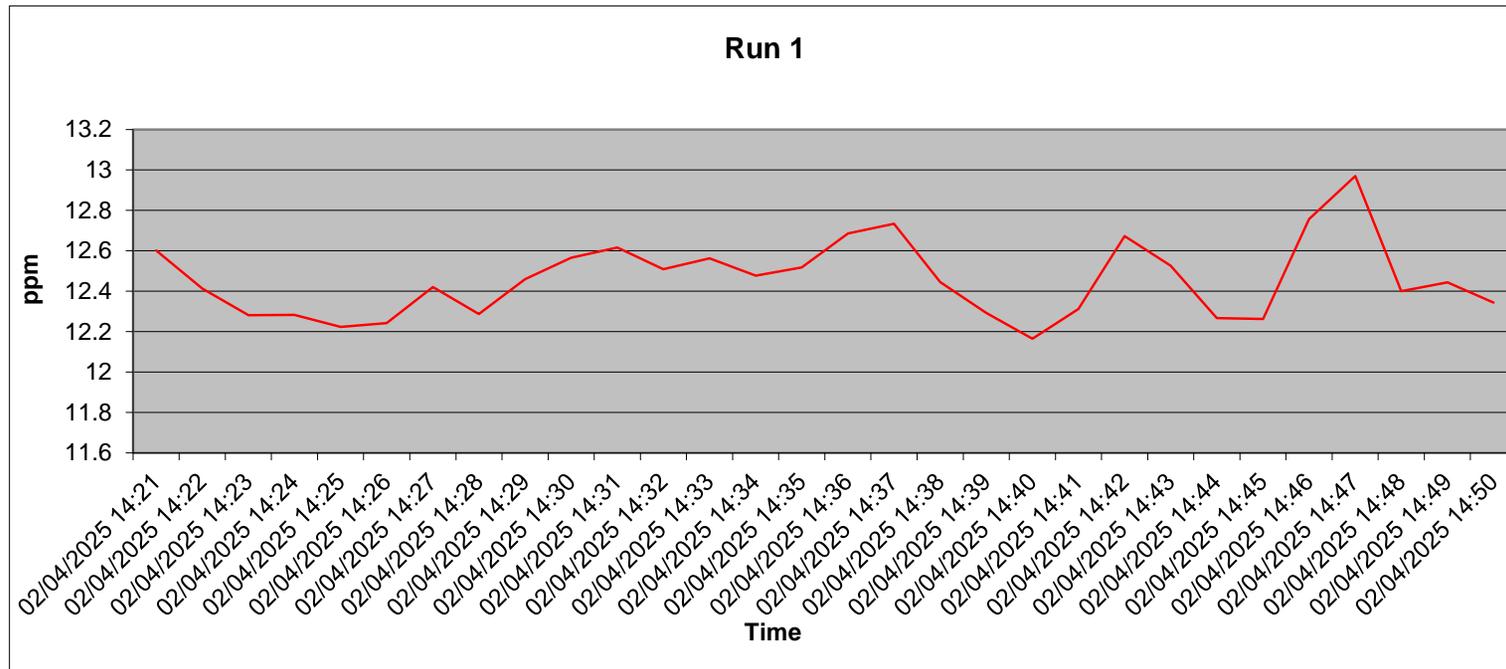
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Oxygen Quality Assurance

Sampling Details				
Stack ID	F1			
Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	14:21	-	-
Sampling Dates	-	02/04/2025	-	-
Instrument Range	ppm	25	-	-
Span Gas Value	ppm	20.9	-	-
Acceptable Gas Range	-	Y	-	-
Quality Assurance	Units	Run 1	Run 2	Run 3
Conditioning Unit Temperature	°C	2	-	-
Average Temperature	< °C	2	-	-
Allowable Temperature	-	4	-	-
Temperature Acceptable	-	Y	-	-
Pump flow rate	l/min	0.5	-	-
Zero Drift	Units	Run 1	Run 2	Run 3
Zero Down Sampling Line (Pre)	%	0	-	-
Zero Down Sampling Line (Post)	%	0.01	-	-
Zero Drift	%	-0.01	-	-
Allowable Zero Drift (5%)	%	1.05	-	-
Zero Drift Acceptable (Y/N)	Y <2%/Y 2-5%/N>5%	Y <2%	-	-
Span Drift	Units	Run 1	Run 2	Run 3
Span Down Sampling Line (Pre)	%	20.9	-	-
Span Down Sampling Line (Post)	%	20.9	-	-
Span Drift	%	0	-	-
Allowable Span Drift (5%)	%	1.05	-	-
Span Drift Acceptable (Y/N)	Y <2%/Y 2-5%/N>5%	Y <2%	-	-
Leak Check	Units	Run 1	Run 2	Run 3
Span Gas Conc.	%	20.9	-	-
Recorded Conc. down Line	%	20.9	-	-
Leak check acceptable (< 2%)	(Y/N)	Y <2%	-	-
Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	17	-	-
Combined uncertainty	% vol	0.19	-	-
% of value	%	1.49	-	-
Expanded uncertainty	% of value	2.99	-	-
Expanded uncertainty	% vol	0.37	-	-

Oxygen trend



Carbon Dioxide Quality Assurance

Sampling Details				
Stack ID	F1			
Parameter	Units	Run 1	Run 2	Run 3
Sampling Times	-	14:21	-	-
Sampling Dates	-	02/04/2025	-	-
Instrument Range	ppm	20	-	-
Span Gas Value	ppm	15.01	-	-
Acceptable Gas Range	-	Y	-	-
Quality Assurance	Units	Run 1	Run 2	Run 3
Conditioning Unit Temperature	°C	2	-	-
Average Temperature	< °C	2	-	-
Allowable Temperature	-	4	-	-
Temperature Acceptable	-	Y	-	-
Pump flow rate	l/min	0.5	-	-
Zero Drift	Units	Run 1	Run 2	Run 3
Zero Down Sampling Line (Pre)	%	0	-	-
Zero Down Sampling Line (Post)	%	0.01	-	-
Zero Drift	%	-0.01	-	-
Allowable Zero Drift (4%)	%	0.6	-	-
Zero Drift Acceptable	Y <2%/Y 2-4% /N>4%	Y <2%	-	-
Span Drift	Units	Run 1	Run 2	Run 3
Span Down Sampling Line (Pre)	%	15.01	-	-
Span Down Sampling Line (Post)	%	15.02	-	-
Span Drift	%	-0.01	-	-
Allowable Span Drift (4%)	%	0.6	-	-
Span Drift Acceptable	Y <2%/Y 2-4% /N>4%	Y <2%	-	-
Leak Check	Units	Run 1	Run 2	Run 3
Span Gas Conc.	ppm	15.01	-	-
Recorded Conc. down Line	ppm	15.02	-	-
Leak check acceptable (< 2%)	(Y/N)	Y <2%	-	-
Test Conditions	Units	Run 1	Run 2	Run 3
Run Ambient Temperature Range	°C	17	-	-
Combined uncertainty	% vol	0.14	-	-
% of value	%	2.07	-	-
Expanded uncertainty	% of value	4.13	-	-
Expanded uncertainty	% vol	0.28	-	-

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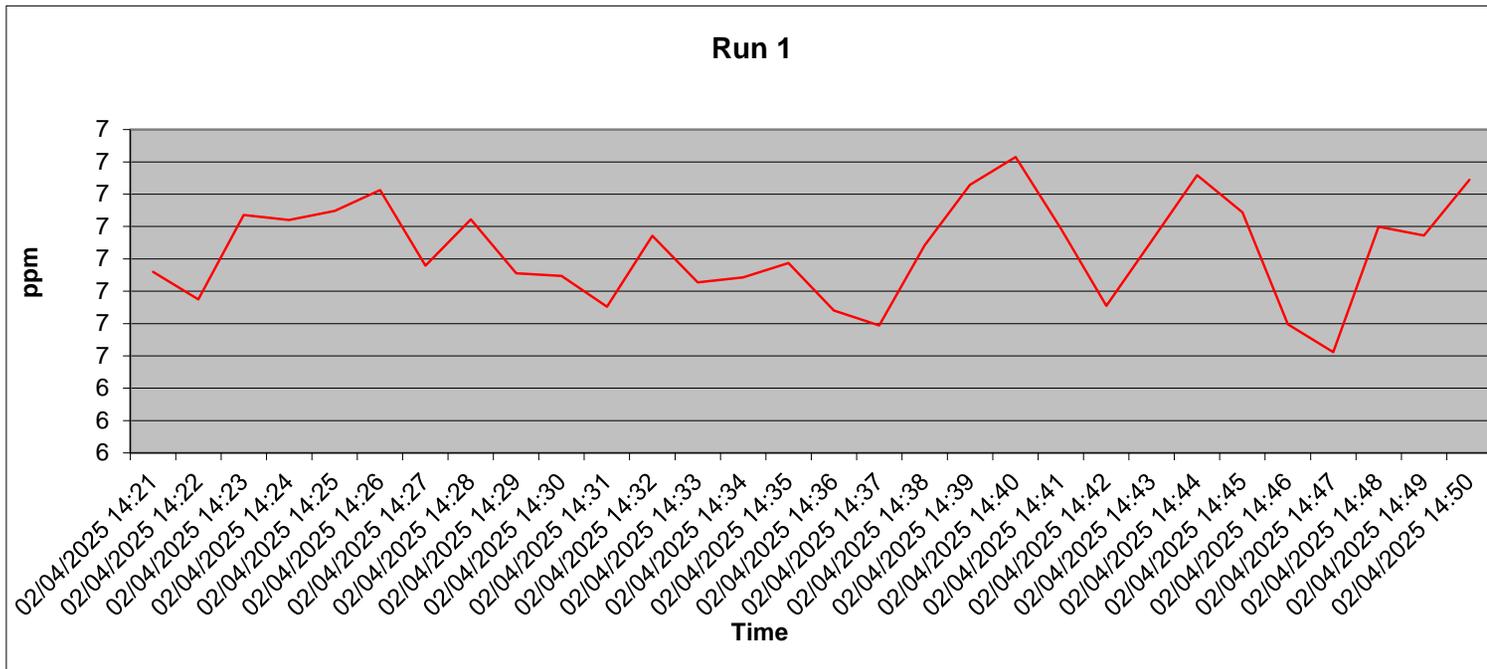
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Carbon Dioxide Results & Sampling Details

Parameter	Units	Run 1	Run 2	Run 3	Mean
Concentration	%	6.68	-	-	-
Uncertainty	%	0.28	-	-	-

General Sampling Information	
Parameter	Value
Standard	ISO 12039
Technical Procedure	SOP 2045
Probe material	SS
Filtration Type/Size	Ceramic
Heated Head Filter Used	Yes
Heated Line Temperature	180
Span Gas Reference Number	ASLTM23ING504
Span Gas Expiry Date	28-Jun
Span Gas Start Pressure (bar)	30
Gas Cylinder Concentration (ppm)	15.01
Span Gas Uncertainty (%)	<2
Zero Gas Type	N
Number of Sampling Lines Used	1
Number of Sampling Points Used	1
Sample Point I.D's	F1
Reference Conditions	
Temperature (K)	273.15
Pressure (kPa)	101.3
Gas (Wet or Dry)	Dry
Oxygen	3

Carbon Dioxide Trend



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Moisture Results & Sampling Details

Title:	Determination of Moisture				
Method:	EN 14790				
Stack Name	F1	Time off	Temperature at Pump	0	Deg C
Test Time	13:40	14:10	Pressure at Pump	101.3	kPa
Dry Gas Meter Reading Before	-	m ³	Humidity at Pumps	0.1	%
Dry Gas Meter Reading After	-	m ³			
Volume of Air Sampled	-	m ³			
Normalised Air Volume Sampled	0.09	Nm ³			
Leak Rate	0.001				
Balance Calibration					
	Weight				
500.0	500	g			
1000.0	1000	g			
Inpinger Weights					
	Initial	Final	Difference		
1	491	494.8	3.8		
2	440.1	443.2	3.1		
3	455.8	456.9	1.1		
4	645	645.2	0.2		
Volume of Air Sampled	0.09	Nm ³	8.2		
Moisture Content (EN 14790)	10.2	%			
Combined uncertainty					
		0.23	%		
Expanded uncertainty as percentage of measured value					
		4.56	% measured value		
Expanded uncertainty in units of measurement					
		0.46	%		
Expanded uncertainty as percentage of limit value					
		-	% ELV		

Uncert Sheets

CO Uncert

Uncertainty calculation for Gaseous Measurement CO

Limit value	50 mg/m3 (corre Cal gas conc	185.75 mg.m-3
Measured concentration	4.50 mg/m3 Full Scale	200 mg/m3
Measured concentration	9.61 mg/m3 (Corrected)	

Correction for reference conditions					
		O2, %	Moisture,	Pressure, KPa	Temperature, K
	ref	3.00	0.00	101.30	273.00
	measured	12.52	0.00	101.30	275.15
	Uncert	0.35	1.00	0.00	1.00
Factors		2.12	1.00	1.00	1.01
Uncertainty in factor		0.09	0.01	0.00	0.00
Correction Factor		2.14	uf	0.09	

Performance characteristics	Value		specification
Response time	180	seconds	180.000
Logger sampling interval	60	seconds	
Measurement period	32	minutes	
Number of readings in measurement	32		
Repeatability at zero	0.25	% full scale	<1 % range
Repeatability at span level	0.15	% full scale	<2 % range
Deviation from linearity(lack of fit)	0.7	% of value	<2 % range
Zero drift	-0.125	mg/m3	<2% range / 24hr
Span drift	-0.375	mg/m3	<2% range/24hr
volume or pressure flow dependence	0.02	% of full scale/3 kPa	<2 % / 3 kPa
atmospheric pressure dependence	0.8	% of full scale/2 kPa	<3% / 2 kPa
ambient temperature dependence	0.01	% full scale/10K	<3% range / 10 K
N2O (mg/m3)	20	0.2 mg/m3	
CO2 (% vol)	15	0.2 mg/m3	
CH4 (mg/m3)	40	0.7 mg/m3	
H2O (% vol)	20	0.2 mg/m3	
dependence on voltage	0.1	% full scale/10V	<2% range
losses in the line (leak)	0.00	% of value	< 0.1%vol /10 volt
Uncertainty of calibration gas	2	% of value	< 2% of value

Effect of drift
0.00 mg/m3
0.00 % full scale

	min	max	value at calib
flow	95.00	105	100 kPa
pressure	100.76	100.92	100.88 kPa
temp	287	288.5	287.5 K
N2O range	0	40	0 mg/m3
CO2 range	0	15	0 %vol
CH4 range	0	57	0 mg/m3
H2O range	0	1	0 %vol
Voltage	93	121	110 V

Performance characteristic	Uncertainty	Value of uncertainty quantity	mg/m3
Standard deviation of repeatability at zero	ur0	for mean	use rep at span
Standard deviation of repeatability at span level	urs	for mean	0.05
Lack of fit	ufit		0.02
Drift	u0dr		0.00

Uncert Sheets

volume or pressure flow dependence		uspres			0.04		
atmospheric pressure dependence		uapres			0.05		
ambient temperature dependence		utemp			0.00		
N2O (mg/m3)		uinterf			0.23	Use largest of sum of all positive or all negative influences	
CO2 (% vol)		uinterf			0.12		0.93 all +ves
CH4 (mg/m3)		uinterf			0.58		0 all -ves
H2O (% vol)		uinterf			0.01	0.93 largest	Criteria sum <4% range 0.089980469
Dependence on voltage		uvolt			0.17	Value to use for intereference uncertainty	
losses in the line (leak)		uleak			0.00	uint	0.93
Uncertainty of calibration gas		ucalib			0.05		
Uncertainty in factor		uf			0.40		

Measurement uncertainty			
Combined uncertainty		0.95	mg/m3
Expanded uncertainty	k = 2	1.90	mg/m3
Uncertainty corrected to std conds			
		4.14	mg/m3
Expanded uncertainty	expressed with a level of	8.27 % ELV	
Expanded uncertainty	expressed with a level of	4.14 mg.m-3	
Expanded uncertainty	expressed with a level of	43.06 % value	

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

NOx Uncert

Uncertainty calculation for Gaseous Measurement NOx EN14792

RUN 1			
Limit value	150 mg/m3 (corre Cal gas conc	338.745 mg.m-3 (NO2)	
Measured concentration	27 ppm		
Measured concentration	55.65 mg/m3 (101.3 Full Scale	513.25 mg/m3 (NO2)	
Measured concentration	118.85 mg/m3 (Corrected)		
NO/NO2 ratio	100.00		
Gas	NO		
Full Scale	250 ppm		
Cal gas conc	165 ppm		

Correction for reference conditions					
		O2, %	Moisture,	Pressure, KPa	Temperature, K
	ref	3.00	0.00	101.30	273.00
	measured	12.52	0.00	101.30	275.15
	Uncert	0.35	0.00	0.00	1.00
Factors		2.12	1.00	1.00	1.01
Uncertainty in factor		0.09	0.00	0.00	0.00

Uncert Sheets

Conversion	2.053
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Correction Factor	2.14	uf	0.09
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Performance characteristics	Value		specification
Response time	180	seconds	180.000
Logger sampling interval	60	seconds	
Measurement period	32	minutes	
Number of readings in measurement	32		
Repeatability at zero	0.03	% full scale	<1 % range
Repeatability at span level	0.06	% full scale	<2 % range
Deviation from linearity(lack of fit)	0.2	% of value	<2 % range
Zero drift	0.8	mg/m3	<2% range / 24hr
Span drift	1.48	mg/m3	<2% range/24hr
volume or pressure flow dependence	0	%of full scale/kPa	<2 % / kPa
atmospheric pressure dependence	0	%of value /kPa	<3% / kPa
ambient temperature dependence	0.3	% full scale/10K	<3% range / 10 K
NH3 (mg/m3)	20	0.0	mg/m3
CO2 (% vol)	15	0.2	mg/m3
H2O (% vol)	30	0.0	mg/m3
dependence on voltage	0.1	% full scale/10V	<2% range
losses in the line (leak)	0	% of value	< 0.1%vol /10 volt
Converter efficiency	95.5	%	>95%
Uncertainty of calibration gas	2	% of value	< 2% of value

Effect of drift
0.00 mg/m3
0.00 % full scale

	min	max	value at calib	
flow	95.00	105	100	kPa
pressure	101.30	101.3	101.3	kPa
temp	289	289	289	K
NH3 range	0	0	0	mg/m3
CO2 range	0	15	0	%vol
H2O range	0	0	0	%vol
Voltage	93	121	110	V

Performance characteristic	Uncertainty	Value of uncertainty quantity	mg/m3
Standard deviation of repeatability at zero	ur0	for mean	use rep at span
Standard deviation of repeatability at span level	urs	for mean	0.05
Lack of fit	ufit		0.06
Drift	u0dr		0.00
volume or pressure flow dependence	uspres		0.00
atmospheric pressure dependence	uapres		0.00
ambient temperature dependence	utemp		0.00
NH3	uintenf		0.00
CO2 (% vol)	uintenf		0.12
H2O (% vol)	uintenf		0.00
Dependence on voltage	uvolt		0.44
losses in the line (leak)	uleak		0.00
Uncertainty of calibration gas	ucalib		0.64
converter efficiency	uceff		1.45
Uncertainty in factor	uf		4.88

Use largest of sum of all positive or all negative influences		
0.12 all +ves	Criteria sum <4% range 1.11296124	
0 all -ves		
0.12 largest		
Value to use for intereference uncertainty		uint 0.12

Measurement uncertainty			
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Uncert Sheets

Combined uncertainty			1.65	mg/m3
Expanded uncertainty	k =	2	3.30	mg/m3
Uncertainty corrected to std conds				
			12.04	mg/m3
Expanded uncertainty	expressed with a level of		8.03 % ELV	
Expanded uncertainty	expressed with a level of		12.04 mg.m-3	
Expanded uncertainty	expressed with a level of		10.13 % value	

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Note: Enter values into green boxes
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

corrected drift to be based on mg/m3 reading and the correction alert to be based on % full scale

SO₂ Uncert

Run 1

Uncertainty calculation for Gaseous Measurement SO2 EA M21

Limit value	-	mg/m3 (corre Cal gas conc	433.576	mg.m-3
Measured concentration	-0.53	mg/m3	Full Scale	572
Measured concentration	-1.13	mg/m3 (Corrected)		

Correction for reference conditions					
		O2, %	Moisture,	Pressure, KPa	Temperature, K
	ref	3.00	0.00	101.30	273.00
	measured	12.52	0.00	101.30	275.15
	Uncert	0.35	1.00	0.00	1.00
Factors		2.12	1.00	1.00	1.01
Uncertainty in factor		0.09	0.01	0.00	0.00
Correction Factor		2.14	uf	0.09	

Performance characteristics	Value	specification
Response time	180 seconds	180.000
Logger sampling interval	60 seconds	
Measurement period	32 minutes	
Number of readings in measurement	32	
Repeatability at zero	0.25 % full scale	<1 % range

Effect of drift
0.00 mg/m3
0.00 % full scale

Uncert Sheets

Repeatability at span level	0.15	% full scale		<2 % range					
Deviation from linearity(lack of fit)	0.7	% of value		<2 % range					
Zero drift	0	mg/m3		<2% range / 24hr					
Span drift	0.5	mg/m3		<2% range/24hr					
volume or pressure flow dependence	0.02	% of full scale/3 kPa		<2 % / 3 kPa	flow	95.00	105	100	kPa
atmospheric pressure dependence	0.8	% of full scale/2 kPa		<3% / 2 kPa	pressure	100.76	100.92	100.88	kPa
ambient temperature dependence	0.01	% full scale/10K		<3% range / 10 K	temp	287	288.5	287.5	K
N2O (mg/m3)	20	0.2	mg/m3		N2O range	0	40	0	mg/m3
CO2 (% vol)	15	0.2	mg/m3		CO2 range	0	15	0	%vol
CH4 (mg/m3)	40	0.7	mg/m3		CH4 range	0	57	0	mg/m3
H2O (% vol)	20	0.2	mg/m3		H2O range	0	1	0	%vol
dependence on voltage	0.1	% full scale/10V		<2% range	Voltage	93	121	110	V
losses in the line (leak)	2	% of value		< 0.1%vol /10 volt					
Uncertainty of calibration gas	2	% of value		< 2% of value					

Performance characteristic	Uncertainty	Value of uncertainty quantity	mg/m3
Standard deviation of repeatability at zero	ur0	for mean	use rep at span
Standard deviation of repeatability at span level	urs	for mean	0.15
Lack of fit	ufit		0.00
Drift	u0dr		0.00
volume or pressure flow dependence	uspres		0.11
atmospheric pressure dependence	uapres		0.14
ambient temperature dependence	utemp		0.00
N2O (mg/m3)	uintenf		0.23
CO2 (% vol)	uintenf		0.12
CH4 (mg/m3)	uintenf		0.58
H2O (% vol)	uintenf		0.01
Dependence on voltage	uvolt		0.49
losses in the line (leak)	uleak		-0.01
Uncertainty of calibration gas	ucalib		-0.01
Uncertainty in factor	uf		-0.05

Use largest of sum of all positive or all negative influences	
0.93 all +ves	Criteria sum <4% range -0.010576042
0 all -ves	
0.93 largest	
Value to use for intereference uncertainty	
uint	0.93

Measurement uncertainty			
Combined uncertainty		1.08	mg/m3
Expanded uncertainty	k = 2	2.15	mg/m3
Uncertainty corrected to std conds			
		4.61	mg/m3
Expanded uncertainty	expressed with a level of	0.00	% ELV
Expanded uncertainty	expressed with a level of	4.61	mg.m-3
Expanded uncertainty	expressed with a level of	-407.94	% value

Requirement in standard is for uncertainty to be < 10% at ELV at standard conditions

Uncert Sheets

Note: Enter values into green boxes
 Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed for the STA by R Robinson, NPL

O₂ Uncert

Run 1

Uncertainty calculation for Gaseous Measurement Oxygen EN14789

Limit value	n/a	%vol	Calibration gas	20.9	%vol
Measured concentration	12.52	%vol	Full Scale	25	%vol

Performance characteristics	Value			specification	
Response time	180	seconds		< 200 s	
Logger sampling interval	60	seconds			
Measurement period	32	minutes			
Number of readings in measurement	32	Assuming 1 minute collected over 1 hour			
Repeatability at zero	0.015	% by volume	stdev	<0.2 % range	
Repeatability at span level	0.014	% by volume	stdev	<0.4 % range	
Deviation from linearity	0.13	% vol	+/-	<0.3 % volume	
Zero drift (during measurement period)	0	% vol at zero level	+/-	<2% of volume / 24hr	range of variation from conditions at calibration
Span drift (during measurement period)	0	% vol at span level	+/-	<2% volume/24hr	
volume or pressure flow dependence	0	% of fs / 10l/h	+ - 5 l/h	<1% range	min
atmospheric pressure dependence	0.3	% of fs/kPa	+ - 2kPa	< 1.5 % range	max
ambient temperature dependence	-0.07	% by volume /10K	+ - 15K	<0.3% volume 10 K	value at calib
CO ₂ (% vol)	15	0.07	% by volume per	15	flow
NO (mg/m ³)	300	0.02	% by volume per	300	pressure
NO ₂ (mg/m ³)	30	0	% by volume per	30	temp
Combined interference	0.56	% range		<2% range	CO ₂ range
Dependence on voltage	0.1	% by volume /10V	+ - 5%	< 0.1%vol /10 volt	NO range
Losses in the line (leak)	2	% of value		< 2% of value	NO ₂ range
Uncertainty of calibration gas	0.5	% of value			Voltage
					5
					15
					10 l/h
					99.00
					101
					100 kPa
					280
					285
					285 K
					8
					15
					0 % vol
					100
					150
					0 mg/m ³
					5
					7.5
					0 mg/m ³
					105
					115
					110 V

Effect of drift
0.00 % vol
0.00 % full scale

Uncert Sheets

Standard deviation of repeatability at zero		ur0		for mean		Only use rep at span
Standard deviation of repeatability at span level		urs		for mean		0.00
Lack of fit		ufit				0.08
Drift		u0dr				0.00
volume or pressure flow dependence		uspres				0.00
atmospheric pressure dependence		uapres				0.04
ambient temperature dependence		utemp				-0.02
CO2						0.05
NO						0.01
NO2						0.00
Combined interference (from mcerts)						0.08
dependence on voltage		uvolt				0.03
losses in the line (leak)		uleak				0.14
Uncertainty of calibration gas		ucalib				0.04

Use largest of sum of all positive or all negative influences

0.06 all +ves
0 all -ves
0.06 largest

Value to use for interference uncertainty
 uint 0.06

Measurement uncertainty			12.52	%vol
Combined uncertainty			0.19	%vol
% of value			1.49	%
Coverage factor k =	2			
Expanded uncertainty	expressed with a level of confidence		2.99 % of value	
Expanded uncertainty	expressed with a level of confidence		0.37 % vol	

Requirement for SRM is that Uncertainty should be < 6% of value, on a dry gas basis

Note: Enter values into green boxes
 Dark blue boxes indicate information that can be obtained from MCERTS tests
 Purple boxes are from manufacturer specification, or CEN standard as MCERTS data not available

Developed for the STA by R Robinson, NPL

corrected drift alert to be based on % full scale

CO₂ Uncert

Run 1
Uncertainty calculation for Gaseous Measurement Carbon Dioxide

Limit value	n/a	%vol	Calibration gas	15.01	%vol
Measured concentration	6.68	%vol	Full Scale	25	%vol

Uncert Sheets

Performance characteristics	Value			specification
Response time	180	seconds		< 200 s
Logger sampling interval	60	seconds		
Measurement period	32	minutes		
Number of readings in measurement	32	Assuming 1 minute collected over 1 hour		
Repeatability at zero	0.015	% by volume	stdev	<0.2 % range
Repeatability at span level	0.014	% by volume	stdev	<0.4 % range
Deviation from linearity	0.13	% vol	+/-	<0.3 % volume
Zero drift (during measurement period)	0	% vol at zero level	+/-	<2% of volume / 24hr
Span drift (during measurement period)	0	% vol at span level	+/-	<2% volume/24hr
volume or pressure flow dependence	0	% of fs / 10l/h	+ - 5 l/h	<1% range
atmospheric pressure dependence	0.3	% of fs/kPa	+ - 2kPa	< 1.5 % range
ambient temperature dependence	-0.07	% by volume /10K	+ - 15K	<0.3% volume 10 K
CO2 (% vol)	15	0.07	% by volume per	15
NO (mg/m3)	300	0.02	% by volume per	300
NO2 (mg/m3)	30	0	% by volume per	30
Combined interference	0.56	% range		<2% range
Dependence on voltage	0.1	% by volume /10V	+ - 5%	< 0.1%vol /10 volt
Losses in the line (leak)	2	% of value		< 2% of value
Uncertainty of calibration gas	0.5	% of value		

Effect of drift
0.00 % vol
0.00 % full scale

	range of variation from conditions at calibration		
	min	max	value at calib
flow	5	15	10 l/h
pressure	99.00	101	100 kPa
temp	280	285	285 K
CO2 range	8	15	0 % vol
NO range	100	150	0 mg/m3
NO2 range	5	7.5	0 mg/m3
Voltage	105	115	110 V

Performance characteristic	Uncertainty	Value of uncertainty quantity	% vol
Standard deviation of repeatability at zero	ur0	for mean	Only use rep at span
Standard deviation of repeatability at span level	urs	for mean	0.00
Lack of fit	ufit		0.08
Drift	u0dr		0.00
volume or pressure flow dependence	uspres		0.00
atmospheric pressure dependence	uapres		0.04
ambient temperature dependence	utemp		-0.02
CO2			0.05
NO			0.01
NO2			0.00
Combined interference (from mcerts)			0.08
dependence on voltage	uvolt		0.03
losses in the line (leak)	uleak		0.08
Uncertainty of calibration gas	ucalib		0.02

Use largest of sum of all positive or all negative influences
0.06 all +ves
0 all -ves
0.06 largest
Value to use for intereference uncertainty
uint 0.06

Measurement uncertainty	6.68	%vol
Combined uncertainty	0.14	%vol
% of value	2.07	%
Coverage factor k =	2	
Expanded uncertainty	expressed with a level of	4.13 % of value

Uncert Sheets

Expanded uncertainty	expressed with a level of	0.28 % vol
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Requirement for SRM is that Uncertainty should be < 6% of value, on a dry gas basis

Note: Enter values into green boxes
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Developed for the STA by R Robinson, NPL

Moisture Uncert

Run 1						
Uncertainty calculation for Moisture						
Limit value (ELV)	0	mg.m ⁻³	Reference oxygen	3	% by volume	Measurement Equation $c = \frac{m}{V} f_c$
Measured concentration	10.18	mg.m ⁻³ (at reference conditions)				
Measured Quantities	Symbol	Value	Standard uncertainty	Units	Uncertainty as percentage	Uncertainty at lv
Sampled Volume	V _m	0.09	uV _m	0.001 m ³	1.11	
Sampled gas Temperature	T _m	273	uT _m	2 k	0.73	
Sampled gas Pressure	p _m	101.3	up _m	1 kPa	0.99	
Sampled gas Humidity	H _m	0	uH _m	1 % by volume	1.00	
Oxygen content	O _{2,m}	12.72	uO _{2,m}	0.1 % by volume	0.79	
Note - Sampled gas humidity, temperature and pressure are values at the gas meter						
Leak	L	0.001		%	0.00	
Uncollected Mass (Instack filter - no rinse)	UCM	0		mg	#REF!	
Intermediate calculations						
Factor for std conds	fs	1.00				
uncertainty components	symbol	sensitivity coeff		u (in units of fs)		
	p _m	0.010		0.010		
	H _m	0.010		0.010		
	T _m	0.004		0.007		
	ufs			0.016		1.58
Corrected volume	V	0.09	uV	0.002 m ³	$V = V_m f_s$	1.94

Uncert Sheets

Factor for O2 correction	fc	2.17			
uncertainty components	symbol	sensitivity coeff	u		
	O _{2,m}	0.26	0.026		
Factor for O2 Correction	ufc	2.17	0.026		1.21

$$f_c = \frac{21 - O_{2,ref}}{21 - O_{2,m}}$$

Parameter	Value	Units	Sensitivity c	Uncertainty contribution	Uncertainty as %
Corrected Volume (standard conditions)	V	0.09 m ³	113.15	0.20 mg.m ⁻³	1.94 %
Factor for O2 Correction	fc	2.17	4.68	0.12 mg.m ⁻³	1.21 %
Leak	L	0.00 mg.m ⁻³	1.00	0.00 mg.m ⁻³	0.00 %
Combined measurement uncertainty				0.23 mg.m⁻³	

Expanded uncertainty as percentage of measured value	4.56	% measured of value	expressed with a level of confidence of 95% (Using a coverage factor k=2)
Expanded uncertainty in units of measurement	0.465	mg.m ⁻³	
Expanded uncertainty as percentage of limit value	0.00	% ELV	