

Stack Emissions Monitoring Report

commissioned by Finning (UK) Ltd

Operator Name

Virtus Holdco Ltd | LON14 Data Centre

Operator Address

DC6 Prologis Park
West Drayton
UB7 9FN

Release Point

2-S - CAT 3516 standby power unit

Monitoring Organisation Name & Address

Atesta Ltd
Unit 2, Asher Court, Lyncastle Way
Appleton, Warrington
WA4 4ST

Monitoring Report Written By

Andrew Shipley | Senior Team Leader
MCERTS Level 2 | MM 13 1243 | TE1 TE2 TE3 TE4 | expires on 31/07/2025

Monitoring Report Approved By

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MCERTS Level 2 | MM 04 535 | TE1 TE2 TE3 TE4 | expires on 31/03/2026



Job Reference: JOB-1422

Report Date | Version Number

13/02/2025 | Version 1

Dates of the Monitoring Campaign

10/02/2025

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Report Contents and Monitoring Objectives

Report Contents

TITLE PAGE

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Monitoring Objective

The monitoring objective was to conduct stack emissions monitoring, as requested by the customer, for a number of prescribed pollutants.

Special Requirements

There were no special requirements for this monitoring campaign.

Opinions and Interpretations

Any opinions or interpretations contained within this test report are outside the scope of Atesta's MCERTS / ISO 17025 accreditation.

Part 1: Executive Summary - Monitoring Results Summary

Monitoring Results - Summary

test parameter	EXPRESSED AS A CONCENTRATION				EXPRESSED AS A MASS EMISSION				reference conditions	accreditation status
	result	uncertainty in result +/-	limit (ELV)	units	result	uncertainty in result +/-	limit (ELV)	units		
Total Particulate Matter	8.3	0.52		mg/m³	170	10.2		g/hr	STP, dry, 15% O ₂	MCERTS
PM ₁₀	5.8	0.82		mg/m³	121	16.7		g/hr	STP, dry, 15% O ₂	MCERTS
PM _{2.5}	5.7	0.81		mg/m³	118	16.6		g/hr	STP, dry, 15% O ₂	MCERTS
Total VOCs (as Carbon)	0.071	0.0059		mg/m³	1.5	0.12		g/hr	STP, dry, 15% O ₂	MCERTS
Oxides of Nitrogen (as NO ₂)	11.7	0.66		mg/m³	239	12.8		g/hr	STP, dry, 15% O ₂	MCERTS
Carbon Monoxide	74.0	4.3		mg/m³	1518	83.4		g/hr	STP, dry, 15% O ₂	MCERTS
Carbon Dioxide	7.8	0.28		% v/v	1851	108		kg/hr	dry	MCERTS
Oxygen	10.9	0.36		% v/v					dry	MCERTS
Stack Gas Water Vapour	5.7	0.18		% v/v					actual	MCERTS
Stack Gas Temperature	411			°C					actual	MCERTS
Stack Gas Velocity	31.8	0.29		m/s					actual	MCERTS
Stack Gas Flow Rate (ACTUAL)	32350	1493		m³/hr					actual	MCERTS
Stack Gas Flow Rate (REF)	20492	946		m³/hr					STP, dry, 15% O ₂	MCERTS

The stack gas water vapour, temperature, velocity and flow rates in the above table are calculated as an average of all of the results recorded during this monitoring campaign

The uncertainty in the result is reported at a 95% Confidence Interval in the same units as the monitoring result. In practice, this means that 95 times out of 100, the true result will lie within the stated range.

Part 1: Executive Summary - Monitoring Results Further Details

Monitoring Results - Further Details

		EXPRESSED AS A CONCENTRATION				EXPRESSED AS A MASS EMISSION				sampling date times	run time (mins)	H ₂ O (% v/v)	reference conditions
test parameter	run	result	uncertainty in result +/-	limit (ELV)	units	result	uncertainty in result +/-	limit (ELV)	units				
Total Particulate Matter	R1	8.3	0.52		mg/m ³	170	10.2		g/hr	10/02/2025 13:23 - 14:24	60	5.1	STP, dry, 15% O ₂
PM ₁₀	R1	5.9	0.81		mg/m ³	125	16.8		g/hr	10/02/2025 12:45 - 13:15	30	6.0	STP, dry, 15% O ₂
PM ₁₀	R2	5.7	0.83		mg/m ³	116	16.6		g/hr	10/02/2025 14:31 - 15:01	30	6.2	STP, dry, 15% O ₂
PM _{2.5}	R1	5.8	0.80		mg/m ³	122	16.7		g/hr	10/02/2025 12:45 - 13:15	30	6.0	STP, dry, 15% O ₂
PM _{2.5}	R2	5.6	0.82		mg/m ³	113	16.5		g/hr	10/02/2025 14:31 - 15:01	30	6.2	STP, dry, 15% O ₂
Total VOCs (as Carbon)	R1	0.071	0.0059		mg/m ³	1.5	0.12		g/hr	10/02/2025 13:10 - 14:10	60		STP, dry, 15% O ₂
Oxides of Nitrogen (as NO ₂)	R1	11.7	0.66		mg/m ³	239	12.8		g/hr	10/02/2025 13:10 - 14:10	60		STP, dry, 15% O ₂
Carbon Monoxide	R1	74.0	4.3		mg/m ³	1518	83.4		g/hr	10/02/2025 13:10 - 14:10	60		STP, dry, 15% O ₂
Carbon Dioxide	R1	7.8	0.28		% v/v	1851	108		kg/hr	10/02/2025 13:10 - 14:10	60		dry
Oxygen	R1	10.9	0.36		% v/v					10/02/2025 13:10 - 14:10	60		dry
Velocity & Flow Rate Traverse	R1	32.3	0.29		m/s	32847	1516		m ³ /hr	10/02/2025 12:25 - 12:31			actual
Stack Gas Water Vapour		5.7	0.18		% v/v								actual
Stack Gas Temperature		411			°C								actual
Stack Gas Velocity		31.8	0.29		m/s								actual
Stack Gas Flow Rate (ACTUAL)		32350	1493		m ³ /hr								actual
Stack Gas Flow Rate (REF)		20492	946		m ³ /hr								STP, dry, 15% O ₂

The stack gas water vapour, temperature, velocity and flow rates in the above table are calculated as an average of all of the results recorded during this monitoring campaign

The uncertainty in the result is reported at a 95% Confidence Interval in the same units as the monitoring result. In practice, this means that 95 times out of 100, the true result will lie within the stated range.

Part 1: Executive Summary - Monitoring and Analytical Methods

Monitoring and Analytical Methods

where analysis required	MONITORING					ANALYSIS					
test parameter	laboratory	accreditation number	technical procedure	reference method	monitoring status	laboratory	accreditation number	analytical procedure	analytical technique	analysis status	accreditation status
Total Particulate Matter	ATA	10706	TP-01	EN 13284-1	MCERTS	ATA	10706	AP-01	Gravimetric	MCERTS ^{Dev}	MCERTS
PM ₁₀	ATA	10706	TP-02	EN ISO 23210	MCERTS	ATA	10706	AP-02	Gravimetric	MCERTS	MCERTS
PM _{2.5}	ATA	10706	TP-02	EN ISO 23210	MCERTS	ATA	10706	AP-02	Gravimetric	MCERTS	MCERTS
Water Vapour	ATA	10706	TP-03	EN 14790	MCERTS	ATA	10706	TP-03	Gravimetric	MCERTS	MCERTS

where analysis not required	MONITORING						
test parameter	laboratory	accreditation number	technical procedure	reference method	monitoring status	measurement technique & equipment	accreditation status
Total VOCs (as Carbon)	ATA	10706	TP-21b	EN 12619	MCERTS	FID using iFID Mobile	MCERTS
Oxides of Nitrogen (as NO ₂)	ATA	10706	TP-22a	EN 14792	MCERTS	Chemiluminescence using Horiba PG-350E	MCERTS
Carbon Monoxide	ATA	10706	TP-22b	EN 15058	MCERTS	NDIR using Horiba PG-350E	MCERTS
Carbon Dioxide	ATA	10706	TP-22e	PD CEN TS 17405	MCERTS	NDIR using Horiba PG-350E	MCERTS
Oxygen	ATA	10706	TP-22d	EN 14789	MCERTS	Paramagnetism using Horiba PG-350E	MCERTS
Velocity & Flow Rate Traverse	ATA	10706	TP-04a	EN 16911-1 TR 17078	MCERTS	Pitot Tube, Thermocouple & Thermomanometer	MCERTS

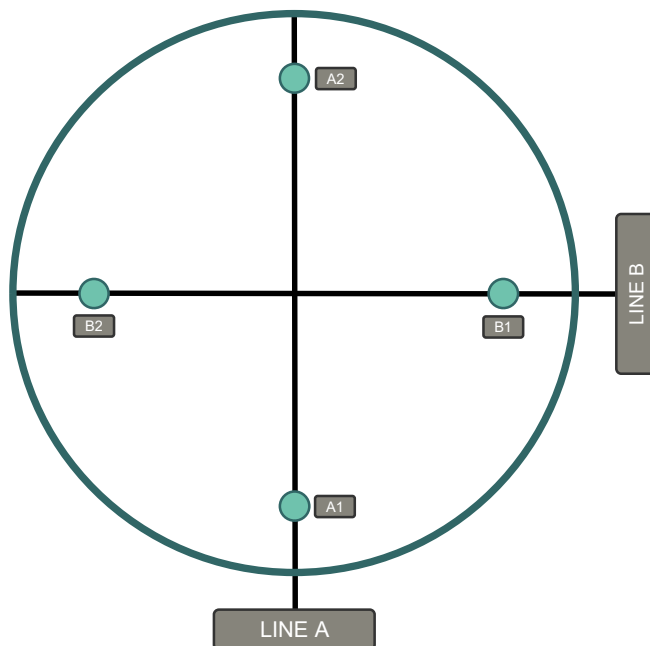
Summary of Monitoring Deviations (from Appendix 2)

test parameter	run	details of monitoring deviation
All	1	There were no deviations associated with the monitoring employed.

Monitoring Location Photos



refer to Appendix 2 - Raw Data to see how the points on this diagram relate to the points used for each test



Part 1: Executive Summary - Duct and Sampling Platform Information

Duct Characteristics | Sampling Ports

parameter	units	value	parameter	value	summary of all sample ports available
shape	-	Circular	primary sample port size	5" Flange	5" Flange
dimensions	-	Diameter = 0.60 m	primary sample port depth cm	45	
area	m²	0.28	primary sample ports number of sampling lines available	2	
orientation	-	Vertical			

Sampling Location General Information

general information	details
type location access	Permanent Outside with shelter available in nearby building Stairs

CEMS | Abatement Systems

parameter	details
abatement system/s	SCR
CEMS installed on the stack	N/A

Sampling Plane Validation Criteria Summary (EN 15259) from Stack Traverse/s

criteria in EN 15259	units	value	allowed	compliant
lowest differential pressure	Pa	267.0	> 5 Pa	Yes
lowest traverse velocity	m/s	31.4	-	-
highest traverse velocity	m/s	33.0	-	-
mean traverse velocity	m/s	32.3	-	-
ratio traverse velocities	: 1	1.05	< 3 : 1	Yes
angle of swirl compliance	°	< 15	< 15°	Yes
no local negative flow	-	Yes	-	Yes

Part 1: Executive Summary - Sampling Location and Operating Information

Process Details

process detail	details
plume appearance on day of monitoring	Not visible from the sampling location
type of process	Combustion
batch or continuous process	On Demand
fuel type	Diesel
feedstock	N/A
typical load / throughput of plant	6.9 MWth
details of any unusual process occurrences	None

Part 2: Supporting Information - Appendix 1: Monitoring Personnel, Analysis Laboratories and Test Equipment Used

Monitoring Personnel

name	position	MCERTS level number expiry	MCERTS technical endorsements
Andrew Shipley	Senior Team Leader	MCERTS Level 2 MM 13 1243 31/07/2025	TE1 TE2 TE3 TE4
James Miles	Technician	MCERTS Level 1 MM 23 1793 31/07/2028	-

Analysis Laboratories

laboratory	ISO 17025 accreditation number	laboratory short name	laboratory phone number
Atesta North West	10706	ATA	0800 970 8945

Test Equipment Used

equipment type	A-EQ ID
Source sampling console	405
Low flow sampling MFCs	
ThermoFID / iFID mobile	5
Horiba PG-350E multigas analyser	69
Gasmet DX4000 FTIR	
Gasmet PSS	
Protea AtmosFIR	
Protea PIB Pump	
Gasmet syringe calibrator	
M&C PSS5-C conditioning unit	61
Digital thermomanometer	116
Top pan balance kit	465

equipment type	A-EQ ID
Pitot	98 174
Calipers	44
Barometer	21
Timer	399
Tape measure	405
Heated head filter	63
Heated tee	
10m heated line	30
1.5m heated line	
Odour barrel	
Vacuum chamber	
Dilution probe	

equipment type	A-EQ ID
10m umbilical	89
30m umbilical	
Heated probe	288 76
Filter oven	284
Ambient thermocouple	
Stack thermocouple	342 255
Exit thermocouple	165
Condenser thermocouple	
Tubes kit thermocouple	
2-way heater controller	
Air sampling pump	
5-figure analytical balance	1

Part 2: Supporting Information - Appendix 2: Total Particulate Matter | Run 1

Results

reference conditions are: STP, dry, 15% O₂

parameter	units	result $\pm$ MU (95% CI)	units	result $\pm$ MU (95% CI)
Total Particulate Matter	mg/m ³	8.3 $\pm$ 0.52	g/hr	170 $\pm$ 10.2

Analytical Laboratory Information

parameter	details
name of analytical lab	ATA
lab analytical procedure	AP-01
lab analytical technique	Gravimetric Analysis Accreditation: MCERTS
date analysis completed	12/02/2025

General Information

parameter	details
sampling date	10/02/2025
sampling times	13:23 - 13:53 13:54 - 14:24
sampling duration testing team	60 minutes tested by: AS JM
standard technical procedure	EN 13284-1 TP-01
nozzle / probe filter housing material	Titanium Borosilicate Glass
filter IDs	Sample: F-6493 Blank: F-5899

Quality Assurance

QA parameter		sample run			blank (taken on 10/02/2025)		
QA parameter	units	value	allowable	result	value	allowable	result
maximum allowable blank	mg/m³	-	-	-	0.29	N/A	N/A
leak test	%	0.95	2.00	Pass	0.85	2.00	Pass
filter intact	-	Yes	-	Pass	-	-	-
filter no signs of water marks	-	Yes	-	Pass	-	-	-
maximum run filter temperature	°C	120	< 230	Pass	-	-	-
silica trap <50% faded	-	Yes	-	Pass	-	-	-
are water droplets present	-	No	-	-	-	-	-
water vapour MU	-	3.0	20.0	Pass	-	-	-
isokinetic variation	%	96.3	95 - 115	Pass	-	-	-

Breakdown of Results

reference conditions are: STP, dry, 15% O₂

parameter	sample volume [m³]	LOD [mg]	mass on filter [mg]	mass in rinse [mg]	mass total [mg]	LOD result [mg/m³]	result [mg/m³]	result reported [mg/m³]	mass emission [g/hr]
sample run <i>F-6493</i>	2.0303	0.10	11.86	5.02	16.88	0.049	8.3	8.3	170
blank <i>F-5899</i>	2.0303	0.10	0.10	0.48	0.58	0.049	0.29	0.29	

Part 2: Supporting Information - Appendix 2: Total Particulate Matter | Run 1

Raw Data | Calculations

data	units	value
P _{bar}	mmHg	756.8
P _g	Pa	387.0
ΔH _@	mmH ₂ O	47.8
P _m	mmHg	760.3
P _s	mmHg	759.7
V _m (DGM)	m ³	1.2245
Y _d	-	1.0076
C _{stp}	-	0.3592

data	units	value
T _m	°C	7.0
ΔH _{av}	Pa	516.6
ΔP _{av}	Pa	393.7
m _{wts}	g	52.1
M _w	g/mol	18.0
V _{mol}	m ³ /mol	0.0222
T _s	°C	416.6
R _{wv} (H ₂ O)	% v/v	5.1

data	units	value
%CO _{2d}	% v/v (est)	8.00
%O _{2d}	% v/v	10.88
%O _{2w}	% v/v	10.33
%N _{2d}	% v/v	81.12
%O _{2ref}	% v/v	15.0
O _{2facd}	-	0.59
O _{2facw}	-	0.56
C _p (pitot)	-	0.84

data	units	value
M _d	g/mol	29.72
M _s	g/mol	29.12
R	J/mol	8.314
K ₄	-	4.64E+06
A _s	m ²	0.28
D _n	mm	6.02
A _n	mm ²	28.43
θ (sample time)	mins	60

where (est) refers to an estimated value

data	value
f _{WA}	0.995

metered volume calculations	units	value
allow favourable O ₂ correction	-	Yes
vol actual stack conditions, V _{mTa} = (V _{mTstw})(T _s + 273) / (P _s) / (C _{stp})	m ³	3.2047
vol dry, V _{mstd} = (V _m)(Y _d)(C _{stp}) / ((P _{bar} + (ΔH _{av} / 9.80665 / 13.6)) / (T _m + 273))	m ³	1.2040
vol dry, V _{mSSstd} [from side stream sampling (if applicable)]	m ³	N/A
vol dry, V _{mTstd} [total volume metered]	m ³	1.2040
vol wet, V _{mTstw} = (V _{mTstd})(100 / (100 - R _{wv}))	m ³	1.2682
vol dry O ₂ , V _{mTstdO₂} = (V _{mTstd}) / (O _{2facd})	m ³	2.0303
vol wet O ₂ , V _{mTstwO₂} = (V _{mTstw}) / (O _{2facw})	m ³	2.2549

isokinetic calculations	units	value
isokinetic rate, %I _r = ((K ₄)(T _s)(V _{mTstd})) / ((P _s)(v _s)(A _n)(θ)(1 - (R _{wv} / 100)))	%	96.3

stack gas density velocity volume flow rate calculations	units	value
density of stack gas, ρ = ((Ms / 1000)(Ps)(0.133322)(1000)) / ((R)(Ts + 273))	kg/m ³	0.514
velocity of stack gas, v _s = (f _{WA})(C _p) / ((2(ΔP _{av}) / (ρ)))	m/s	32.5
stack gas flow actual stack conditions, Q _a = (60)(60)(A _s)(v _s)	m ³ /hr	33083.0
stack gas flow dry, Q _{std} = (Q _a)(P _s)(C _{stp}) / (1 - (R _{wv} / 100)) / (T _s + 273)	m ³ /hr	12429.0
stack gas flow wet, Q _{stw} = (Q _a)(P _s)(C _{stp}) / (T _s + 273)	m ³ /hr	13091.6
stack gas flow dry O ₂ , Q _{stdO₂} = (Q _a)(P _s)(C _{stp}) / (1 - (R _{wv} / 100)) / ((T _s + 273)(O _{2facd}))	m ³ /hr	20958.9
stack gas flow wet O ₂ , Q _{stwO₂} = (Q _a)(P _s)(C _{stp}) / (T _s + 273)(O _{2facw})	m ³ /hr	23278.0

Part 2: Supporting Information - Appendix 2: Total Particulate Matter | Run 1

Measurement Uncertainty (MU) Calculations

parameter	units	value	standard MU	MU as %age	required standard	value	sens coeff.	MU mg/m³
DGM meter volume, V _m	m³	1.2245	0.0061	0.50	≤5%	-	-	-
DGM temperature, T _m	K	280.0	2.0	0.71	≤2%	-	-	-
DGM pressure, P _m	kPa	101.4	0.50	0.49	≤2%	-	-	-
DGM humidity, H _m	% v/v	0	1.0	1.00	≤2%	-	-	-
DGM volume STP, V _{mstd}	m³	-	-	-	-	1.2040	6.91	0.12
leak, L	% ¹ mg/m³ ²	0.92 ¹	-	0.92	≤2%	0.044 ²	1.00	0.044
mass of particulate, m	mg	16.88	0.20	-	-	16.88	0.49	0.099
uncollected mass, m _{uc}	mg	0	-	0	≤10% total mass	0	1.00	0
combined MU with O ₂ correction								0.26
expanded MU 95% CI with O ₂ correction (k = 1.96) including method deviations								0.52
expanded MU 95% CI with O ₂ correction (k = 1.96) as percentage of measured value								6.2%
expanded MU 95% CI (k = 1.96) as percentage of measured value for mass emission								6%

MU factor O ₂ correction
0.03
overall MU for O ₂ correction
4.9%
method deviation factor
1.00

method and sampling deviations
Sampling was performed in full compliance with the Standard, technical procedure and regulatory requirements.

Part 2: Supporting Information - Appendix 2: PM₁₀ | Run 1

Results

reference conditions are: STP, dry, 15% O₂

parameter	units	result $\pm$ MU (95% CI)	units	result $\pm$ MU (95% CI)
PM ₁₀	mg/m ³	5.9 $\pm$ 0.81	g/hr	125 $\pm$ 16.8

Analytical Laboratory Information

parameter	details
name of analytical lab	ATA
lab analytical procedure	AP-02
lab analytical technique	Gravimetric Analysis Accreditation: MCERTS
date analysis completed	12/02/2025

General Information

parameter	details
sampling date	10/02/2025
sampling times	12:45 - 13:15
sampling duration testing team	30 minutes tested by: AS JM
standard technical procedure	EN ISO 23210 TP-02
sizing device material orientation	3-Stage Cascade Impactor Titanium Horizontal
filter set IDs	Sample 130 Blank 129

Quality Assurance

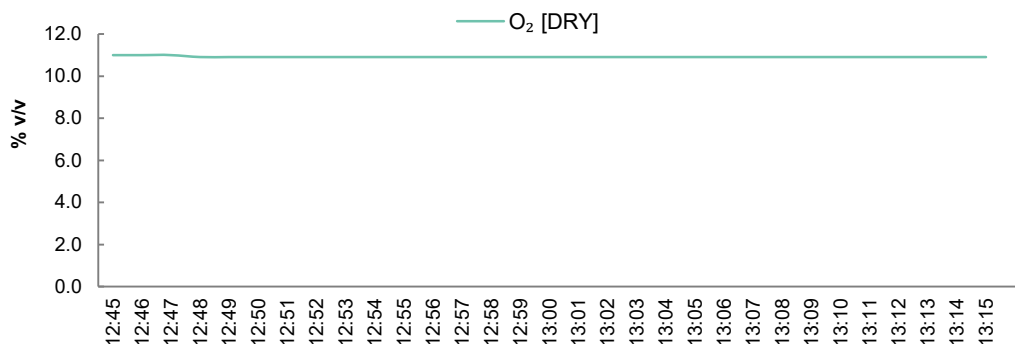
		sample run			blank (taken on 10/02/2025)		
QA parameter	units	value	allowable	result	value	allowable	result
maximum allowable blank	mg/m³	-	-	-	0.072	N/A	N/A
leak test	%	0.80	2.00	Pass	1.73	2.00	Pass
filter intact	-	Yes	-	Pass	-	-	-
filter no signs of water marks	-	Yes	-	Pass	-	-	-
silica trap <50% faded	-	Yes	-	Pass	-	-	-
are water droplets present	-	No	-	-	-	-	-
water vapour MU	%	3.1	20.0	Pass	-	-	-
isokinetic variation	%	96.3	90 - 130	Pass	-	-	-
cut off diameter	µm	10.13	9 - 11	Pass	-	-	-

Breakdown of Results

reference conditions are: STP, dry, 15% O₂

parameter	sample volume [m³]	LOD [mg]	mass collected [mg]	LOD result [mg/m³]	result [mg/m³]	result reported [mg/m³]	mass emission [g/hr]
sample run <i>PM-130-SET</i>	0.9782	0.07	5.82	0.072	5.9	5.9	125
blank <i>PM-129-SET</i>	0.9782	0.07	-0.27	0.072	-0.28	0.072	

Oxygen Data



parameter	details
filter size, material & location	47mm QF In Stack heated to 406.8°C
number sampling lines available	2
number sampling lines used	1
number sampling points ideal per line	1
number sampling points used per line	1
sampling point IDs	1
volume metering device	XC-53 Digital Source Sampling Console

Part 2: Supporting Information - Appendix 2: PM₁₀ | Run 2

Results

reference conditions are: STP, dry, 15% O₂

parameter	units	result $\pm$ MU (95% CI)	units	result $\pm$ MU (95% CI)
PM ₁₀	mg/m ³	5.7 $\pm$ 0.83	g/hr	116 $\pm$ 16.6

Analytical Laboratory Information

parameter	details
name of analytical lab	ATA
lab analytical procedure	AP-02
lab analytical technique	Gravimetric Analysis Accreditation: MCERTS
date analysis completed	12/02/2025

General Information

parameter	details
sampling date	10/02/2025
sampling times	14:31 - 15:01
sampling duration testing team	30 minutes tested by: AS JM
standard technical procedure	EN ISO 23210 TP-02
sizing device material orientation	3-Stage Cascade Impactor Titanium Horizontal
filter set IDs	Sample 131 Blank 129

Quality Assurance

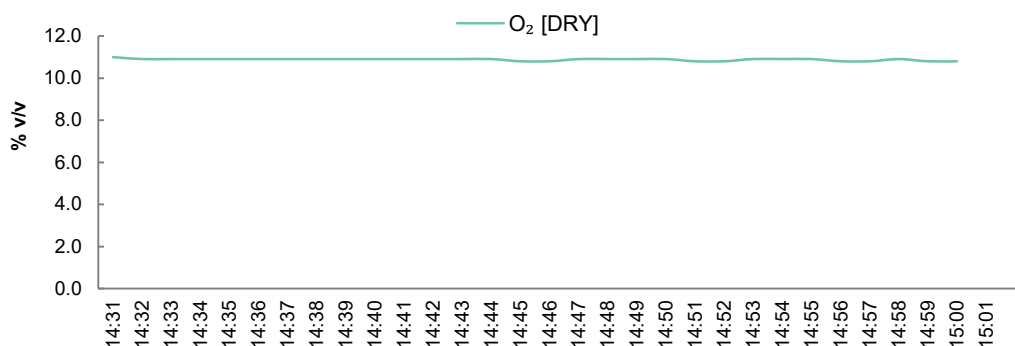
Quality Assurance		sample run			blank (taken on 10/02/2025)		
QA parameter	units	value	allowable	result	value	allowable	result
maximum allowable blank	mg/m³	-	-	-	0.099	N/A	N/A
leak test	%	0.87	2.00	Pass	1.73	2.00	Pass
filter intact	-	Yes	-	Pass	-	-	-
filter no signs of water marks	-	Yes	-	Pass	-	-	-
silica trap <50% faded	-	Yes	-	Pass	-	-	-
are water droplets present	-	No	-	-	-	-	-
water vapour MU	%	3.2	20.0	Pass	-	-	-
isokinetic variation	%	100.2	90 - 130	Pass	-	-	-
cut off diameter	µm	10.13	9 - 11	Pass	-	-	-

Breakdown of Results

reference conditions are: STP, dry, 15% O₂

parameter	sample volume [m³]	LOD [mg]	mass collected [mg]	LOD result [mg/m³]	result [mg/m³]	result reported [mg/m³]	mass emission [g/hr]
sample run <i>PM-131-SET</i>	1.0140	0.10	5.83	0.099	5.7	5.7	116
blank <i>PM-129-SET</i>	1.0140	0.10	-0.27	0.099	-0.27	0.099	

Oxygen Data



parameter	details
filter size, material & location	47mm QF In Stack heated to 420°C
number sampling lines available	2
number sampling lines used	1
number sampling points ideal per line	1
number sampling points used per line	1
sampling point IDs	1
volume metering device	XC-53 Digital Source Sampling Console

Part 2: Supporting Information - Appendix 2: PM_{2.5} | Run 1

Results reference conditions are: STP, dry, 15% O₂

parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
PM _{2.5}	mg/m ³	5.8 ± 0.8	g/hr	122 ± 16.7

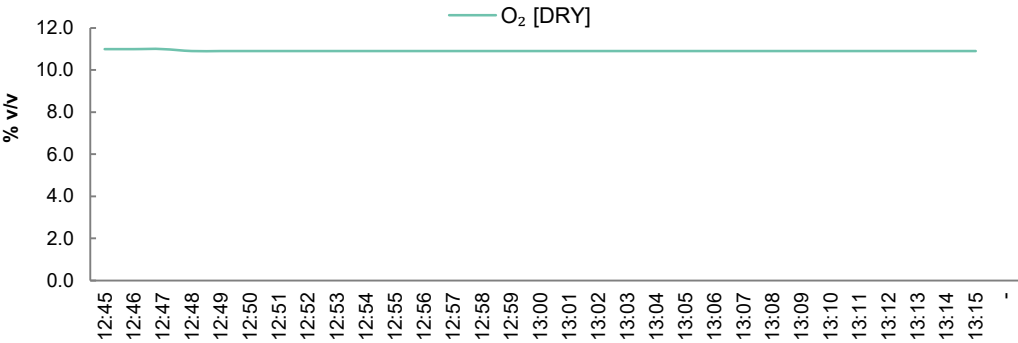
Analytical Laboratory Information

parameter	details
name of analytical lab	ATA
lab analytical procedure	AP-02
lab analytical technique	Gravimetric Analysis Accreditation: MCERTS
date analysis completed	12/02/2025

General Information

parameter	details
sampling date	10/02/2025
sampling times	12:45 - 13:15
sampling duration testing team	30 minutes tested by: AS JM
standard technical procedure	EN ISO 23210 TP-02
sizing device material orientation	3-Stage Cascade Impactor Titanium Horizontal
filter set IDs	Sample 130 Blank 129

Oxygen Data



parameter	details
filter size, material & location	47mm QF In Stack heated to 406.8°C
number sampling lines available	2
number sampling lines used	1
number sampling points ideal per line	1
number sampling points used per line	1
sampling point IDs	1
volume metering device	XC-53 Digital Source Sampling Console

Quality Assurance

QA parameter	units	sample run			blank (taken on 10/02/2025)		
		value	allowable	result	value	allowable	result
maximum allowable blank	mg/m ³	-	-	-	0.072	N/A	N/A
leak test	%	0.80	2.00	Pass	1.73	2.00	Pass
silica trap <50% faded	-	Yes	-	Pass	-	-	-
are water droplets present	-	No	-	-	-	-	-
water vapour MU	%	3.1	20.0	Pass	-	-	-
isokinetic variation	%	96.3	90 - 130	Pass	-	-	-
cut off diameter	µm	2.47	2.25 - 2.75	Pass	-	-	-

Breakdown of Results reference conditions are: STP, dry, 15% O₂

parameter	sample volume [m ³]	LOD [mg]	mass collected [mg]	LOD result [mg/m ³]	result [mg/m ³]	result reported [mg/m ³]	mass emission [g/hr]
sample run <i>PM-130-SET</i>	0.9782	0.07	5.68	0.072	5.8	5.8	122
blank <i>PM-129-SET</i>	0.9782	0.07	-0.41	0.072	-0.42	0.072	

Part 2: Supporting Information - Appendix 2: PM_{2.5} | Run 1

Raw Data | Calculations

data	units	value
P_{bar}	mmHg	756.8
P_{g}	Pa	387.0
$\Delta H_{\text{@}}$	mmH ₂ O	47.8
P_{m}	mmHg	760.3
P_{s}	mmHg	759.7
V_{m} (metered)	m ³	0.5895
Y_{d}	-	1.0076
C_{stp}	-	0.3592

data	units	value
T_m	$^{\circ}\text{C}$	6.0
ΔH_{av}	Pa	517.1
ΔP_{av}	Pa	361.3
m_{wts}	g	30.0
M_w	g/mol	18.0
V_{mol}	m^3/mol	0.0222
T_s	$^{\circ}\text{C}$	393.3
$R_{wv}(\text{H}_2\text{O})$	% v/v	6.0

data	units	value
%CO _{2d}	% v/v (est)	8.00
%O _{2d}	% v/v	10.91
%O _{2w}	% v/v	10.26
%N _{2d}	% v/v	81.09
%O _{2ref}	% v/v	15.0
O _{2facd}	-	0.59
O _{2facw}	-	0.56
C _p (pitot)	-	0.84

data	units	value
FR _{ma}	m ³ /hr	3.0208
M _d	g/mol	29.72
M _s	g/mol	29.02
R	J/mol	8.314
A _s	m ²	0.28
D _n	mm	6.02
A _n	mm ²	28.43
θ (sample time)	mins	30

where (est) refers to an estimated value

data	value
f_{WA}	0.995

isokinetic metered volume calculations	units	value
isokinetic rate, %I _r = ((V _n) / (V _s))(100)	%	96.3
allow favourable O ₂ correction	-	Yes
vol actual stack conditions, V _{ma} = (V _{mstw})(T _s + 273) / (P _s) / (C _{slp})	m ³	1.5104
vol dry, V _{mstd} = (V _m)(Y _d)(C _{slp})((P _{bar} + (ΔH _{av} / 9.80665 / 13.6)) / (T _m + 273))	m ³	0.5817
vol wet, V _{mstw} = (V _{mstd})(100 / (100 - R _{wv}))	m ³	0.6186
vol dry O ₂ , V _{mstdO₂} = (V _{mstd}) / (O _{2facd})	m ³	0.9782
vol wet O ₂ , V _{mstwO₂} = (V _{mstw}) / (O _{2facw})	m ³	1.1076

stack gas density velocity volume flow rate calculations	units	value
density of stack gas, $\rho = ((M_s / 1000)(P_s)(0.133322)(1000)) / ((R)(T_s + 273))$	kg/m ³	0.531
velocity of stack gas, $v_s = (f_{WA})(C_p)\sqrt{((2(\Delta P_{av}) / (\rho)))}$	m/s	30.7
velocity through nozzle, $v_n = ((R_{ma}) / (3600)) / ((A_n) / 1000000)$	m/s	29.5
stack gas flow actual stack conditions, $Q_a = (60)(60)(A_s)(v_s)$	m ³ /hr	31210.7
stack gas flow dry, $Q_{std} = (Q_a)(P_s)(C_{stp})(1 - (R_{wv} / 100)) / (T_s + 273)$	m ³ /hr	12020.0
stack gas flow wet, $Q_{stw} = (Q_a)(P_s)(C_{stp}) / (T_s + 273)$	m ³ /hr	12783.7
stack gas flow dry O_2 , $Q_{stdO_2} = (Q_a)(P_s)(C_{stp})(1 - (R_{wv} / 100)) / ((T_s + 273)(O_{2facd}))$	m ³ /hr	20214.2
stack gas flow wet O_2 , $Q_{stwO_2} = (Q_a)(P_s)(C_{stp}) / ((T_s + 273)(O_{2facw}))$	m ³ /hr	22887.3

Measurement Uncertainty (MU) Calculations

parameter	units	value	standard MU	MU as %age	required standard	value	sens coeff.	MU mg/m³
DGM meter volume, V _m	m³	0.5895	0.0029	0.50	≤2%	-	-	-
DGM temperature, T _m	K	279.0	2.0	0.72	≤1%	-	-	-
DGM pressure, P _m	kPa	101.4	0.50	0.49	≤1%	-	-	-
DGM humidity, H _m	% v/v	0	1.0	1.00	≤1%	-	-	-
DGM volume STP, V _{mstd}	m³	-	-	-	-	0.5817	9.98	0.082
leak, L	% ¹ mg/m³ ²	1.21 ¹	-	1.21	≤2%	0.041 ²	1.00	0.041
mass of particulate, m	mg	5.82	0.14	-	-	5.82	1.02	0.14
uncollected mass, m _{uc}	mg	0	-	0	≤10% total mass	0	1.00	0
particle sizing, ps	% ¹ mg/m³ ²	10 ¹	-	10	0	0.34 ²	1.00	0.34
			combined MU with O ₂ correction					0.41
			expanded MU 95% CI with O ₂ correction (k = 1.96) including method deviations					0.8
			expanded MU 95% CI with O ₂ correction (k = 1.96) as percentage of measured value					13.9%
			expanded MU 95% CI (k = 1.96) as percentage of measured value for mass emission					13.7%

MU factor O₂ correction
0.03

overall MU for O ₂ correction
5%

method deviation factor
1.00

method and sampling deviations
Sampling was performed in full compliance with the Standard, technical procedure and regulatory requirements.

Part 2: Supporting Information - Appendix 2: PM_{2.5} | Run 2

Results reference conditions are: STP, dry, 15% O₂

parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
PM _{2.5}	mg/m³	5.6 ± 0.82	g/hr	113 ± 16.5

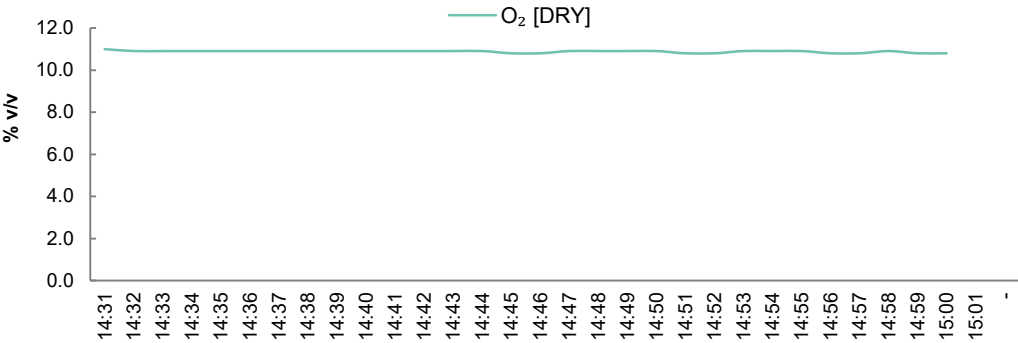
Analytical Laboratory Information

parameter	details
name of analytical lab	ATA
lab analytical procedure	AP-02
lab analytical technique	Gravimetric Analysis Accreditation: MCERTS
date analysis completed	12/02/2025

General Information

parameter	details
sampling date	10/02/2025
sampling times	14:31 - 15:01
sampling duration testing team	30 minutes tested by: AS JM
standard technical procedure	EN ISO 23210 TP-02
sizing device material orientation	3-Stage Cascade Impactor Titanium Horizontal
filter set IDs	Sample 131 Blank 129

Oxygen Data



parameter	details
filter size, material & location	47mm QF In Stack heated to 420°C
number sampling lines available	2
number sampling lines used	1
number sampling points ideal per line	1
number sampling points used per line	1
sampling point IDs	1
volume metering device	XC-53 Digital Source Sampling Console

Quality Assurance

QA parameter	units	sample run			blank (taken on 10/02/2025)		
		value	allowable	result	value	allowable	result
maximum allowable blank	mg/m³	-	-	-	0.069	N/A	N/A
leak test	%	0.87	2.00	Pass	1.73	2.00	Pass
silica trap <50% faded	-	Yes	-	Pass	-	-	-
are water droplets present	-	No	-	-	-	-	-
water vapour MU	%	3.2	20.0	Pass	-	-	-
isokinetic variation	%	100.2	90 - 130	Pass	-	-	-
cut off diameter	µm	2.47	2.25 - 2.75	Pass	-	-	-

Breakdown of Results reference conditions are: STP, dry, 15% O₂

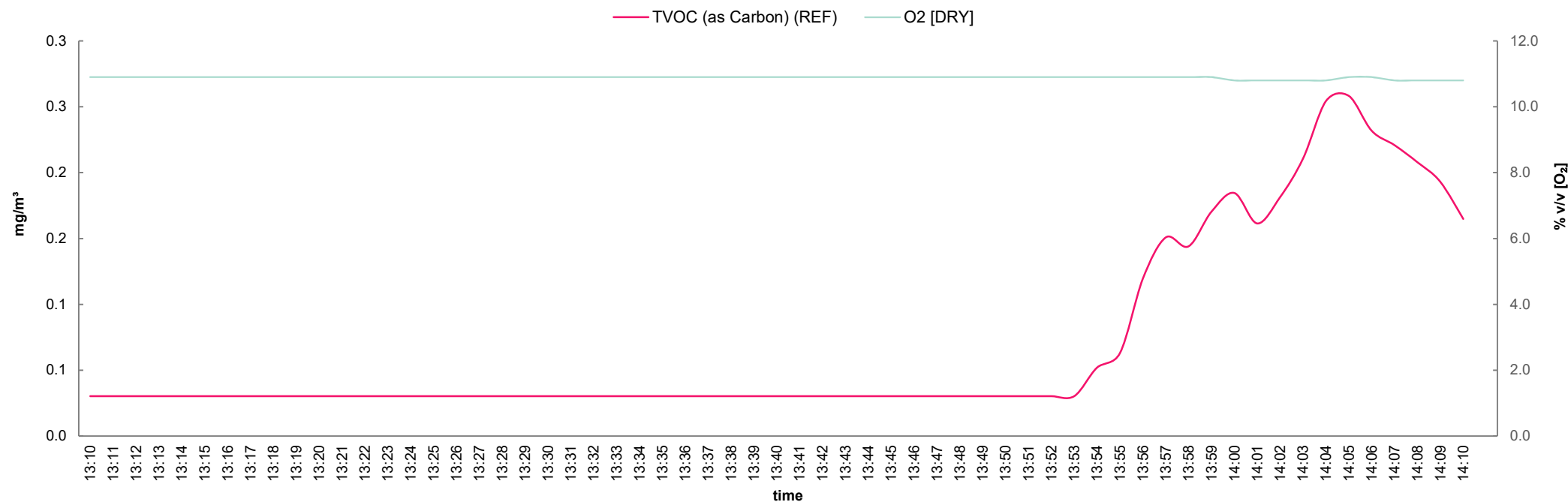
parameter	sample volume [m³]	LOD [mg]	mass collected [mg]	LOD result [mg/m³]	result [mg/m³]	result reported [mg/m³]	mass emission [g/hr]
sample run <i>PM-131-SET</i>	1.0140	0.07	5.69	0.069	5.6	5.6	113
blank <i>PM-129-SET</i>	1.0140	0.07	-0.27	0.069	-0.27	0.069	

reference conditions are: STP, dry, 15% O₂

General Information

parameter	details
probe material	Stainless Steel
filter size, material & location	Filter Element GF Within Heated Head
number sampling lines available	2
number sampling lines used	1
number sampling points ideal per line	1
number sampling points used per line	1
sampling point IDs	A1

Plot of Emissions Over Time



Part 2: Supporting Information - Appendix 2: Total VOCs (as Carbon) | Run 1

Analyser Calibration Information with QA checks

where [A] = at analyser, [L] = down sampling line

	pre-test calibration events								post-test calibration events			quality assurance					
CAL ID	date & time	zero [A] [ppm]	span [A] [ppm]	zero [L] [ppm]	span [L] [ppm]	T ₉₀ [s]	leak [%]		date & time	zero [L] [ppm]	span [L] [ppm]	zero drift [%]		span drift [%]		allowable [%]	temp [°C]
1	10/02/25 11:37	0.00	80.12	1.60	80.65	31	0.0	P	10/02/25 14:00	0.02	78.05	-2.0	P	-1.3	P	±5	5.0

Analyser Calibration Extended Information

CAL ID	performed by	drift corr. applied	log period [s]	CYL ID	CYL conc. [ppm]	CYL expiry	CYL MU [%]	zero gas type	span [CYL] gas type	span target [ppm]	range [ppm]	LOD [ppm]
1	AS	Yes	60	A-CYL-153	80.12	30/10/2029	1.1	Synthetic Air	5l 80ppm Propane in Air	80.12	AUTO	0.03

Part 2: Supporting Information - Appendix 2: Total VOCs (as Carbon) | Run 1

Measurement Uncertainty (MU) Calculations

general information	units	value
emission limit value (ELV) (REF)	mg/m³	N/A
measured concentration (REF)	mg/m³	0.071

MU budget			
parameter	units	min	max
ambient temp	°C	4.0	6.0
voltage	V	90.0	130.0

overall MU for O ₂ correction
4.9%
MU factor O ₂ correction
0.03

performance characteristics	MU budget input parameters				MU budget		
	symbol	units	value	source	symbol	units	value
repeatability at zero	rz	% of value	0.05	MCERTS certificate MC050062	U _{rz}	mg/m³	0.000035
repeatability at span	rs	% of value	0.08	MCERTS certificate MC050062	U _{rs}	mg/m³	0.000056
lack of fit	lof	% of value	2	maximum allowable	U _{lof}	mg/m³	0.00081
maximum short term zero drift (ABS) [after drift correction]	dz	% of value	0	day of testing	U _{dz}	mg/m³	0
maximum short term span drift (ABS) [after drift correction]	ds	% of value	0	day of testing	U _{ds}	mg/m³	0
influence of sample gas flow	f	% of value	-0.42	MCERTS certificate MC050062	U _f	mg/m³	-0.00017
influence of sample gas pressure	p	% of value	0	MCERTS certificate MC050062	U _p	mg/m³	0
influence of ambient temperature zero point (/ 35k)	tz	% of value	-2.4	MCERTS certificate MC050062	U _{tz}	mg/m³	-0.000032
influence of ambient temperature span point (/ 35k)	ts	% of value	-2.7	MCERTS certificate MC050062	U _{ts}	mg/m³	-0.000036
influence of supply voltage (/ 60V)	v	% of value	-0.46	MCERTS certificate MC050062	U _v	mg/m³	-0.00012
cross sensitivity at zero	iz	% of value	3.8	MCERTS certificate MC050062	U _{iz}	mg/m³	0.0015
cross sensitivity at span	is	% of value	3.9	MCERTS certificate MC050062	U _{is}	mg/m³	0.0016
maximum leak	L	% of value	0	day of testing	U _L	mg/m³	0
uncertainty associated with calibration gas	adj	% of value	1.1	span gas calibration certificate	U _{adj}	mg/m³	0.00039
combined MU with O ₂ correction						mg/m³	0.003
expanded MU with O ₂ correction (k = 1.96)						mg/m³	0.0059
expanded MU 95% CI with O ₂ correction (k = 1.96) as percentage of measured value						%	8.3
expanded MU 95% CI (k = 1.96) as percentage of measured value for mass emission						%	8.1

method and sampling deviations
Sampling was performed in full compliance with the Standard, technical procedure and regulatory requirements.

Part 2: Supporting Information - Appendix 2: Oxides of Nitrogen (as NO₂) | Run 1

Results reference conditions are: STP, dry, 15% O₂

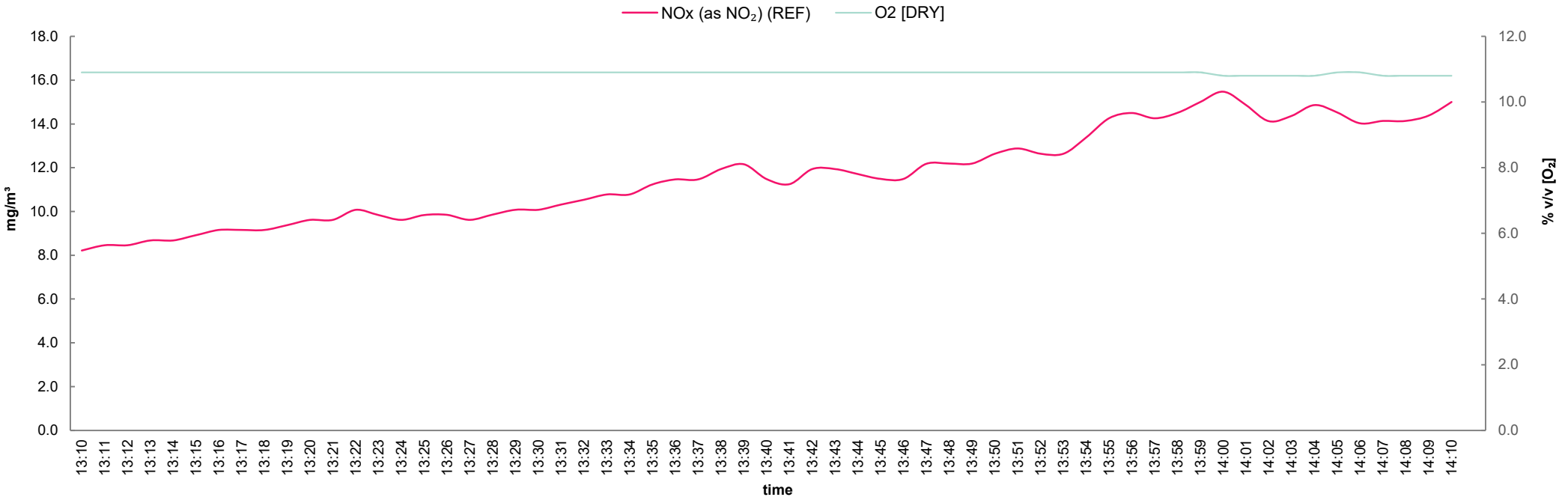
parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
Oxides of Nitrogen (as NO ₂)	mg/m ³	11.7 ± 0.66	g/hr	239 ± 12.8

General Information

parameter	details
sampling start date & time	10/02/2025 13:10
sampling end date & time	10/02/2025 14:10
test time mins	60
testing team	AS JM
standard technical procedure	EN 14792 TP-22a
analyser type	Horiba PG-350E
heated head & line temperature	180°C

parameter	details
probe material	Stainless Steel
filter size, material & location	Filter Element GF Within Heated Head
number sampling lines available	2
number sampling lines used	1
number sampling points ideal per line	1
number sampling points used per line	1
sampling point IDs	A1

Plot of Emissions Over Time



Part 2: Supporting Information - Appendix 2: Oxides of Nitrogen (as NO₂) | Run 1

Analyser Calibration Information with QA checks

where [A] = at analyser, [L] = down sampling line

	pre-test calibration events							post-test calibration events			quality assurance						
CAL ID	date & time	zero [A] [ppm]	span [A] [ppm]	zero [L] [ppm]	span [L] [ppm]	T ₉₀ [s]	leak [%]		date & time	zero [A] [ppm]	span [A] [ppm]	zero drift [%]		span drift [%]	allowable [%]	temp [°C]	
1	10/02/25 11:17	0.00	206.27	0.70	209.60	34	0.0	P	10/02/25 15:08	0.00	201.30	0.0	P	-2.4	P	±5	4.5

Analyser Calibration Extended Information

CAL ID	performed by	drift corr. applied	log period [s]	CYL ID	CYL conc. [ppm]	CYL expiry	CYL MU [%]	zero gas type	span [CYL] gas type	span target [ppm]	range [ppm]	LOD [ppm]
1	AS	Yes	60	A-CYL-141	206.27	21/08/2027	1.2	Nitrogen 5.2	5l 200ppm NO 160ppm CO 16% CO2 in Nitrogen	206.27	250	0.09

Part 2: Supporting Information - Appendix 2: Oxides of Nitrogen (as NO₂) | Run 1

Measurement Uncertainty (MU) Calculations

general information	units	value
emission limit value (ELV) (REF)	mg/m ³	N/A
measured concentration (REF)	mg/m ³	11.7

MU budget			
parameter	units	min	max
ambient temp	°C	4.0	5.0
voltage	V	90.0	130.0

overall MU for O ₂ correction
4.9%

MU factor O ₂ correction
0.03

performance characteristics	MU budget input parameters				MU budget		
	symbol	units	value	source	symbol	units	value
repeatability at zero	rz	% of value	0	MCERTS certificate MC130223	U _{rz}	mg/m ³	0
repeatability at span	rs	% of value	0.1	MCERTS certificate MC130223	U _{rs}	mg/m ³	0.012
lack of fit	lof	% of value	2	maximum allowable	U _{lof}	mg/m ³	0.13
maximum short term zero drift (ABS) [after drift correction]	dz	% of value	0	day of testing	U _{dz}	mg/m ³	0
maximum short term span drift (ABS) [after drift correction]	ds	% of value	0	day of testing	U _{ds}	mg/m ³	0
influence of sample gas flow	f	% of value	0.1	MCERTS certificate MC130223	U _f	mg/m ³	0.0067
influence of sample gas pressure	p	% of value	0	MCERTS certificate MC130223	U _p	mg/m ³	0
influence of ambient temperature zero point (/ 35k)	tz	% of value	0	MCERTS certificate MC130223	U _{tz}	mg/m ³	0
influence of ambient temperature span point (/ 35k)	ts	% of value	1.8	MCERTS certificate MC130223	U _{ts}	mg/m ³	0.002
influence of supply voltage (/ 60V)	v	% of value	0.4	MCERTS certificate MC130223	U _v	mg/m ³	0.018
cross sensitivity at zero	iz	% of value	0.63	MCERTS certificate MC130223	U _{iz}	mg/m ³	0.042
cross sensitivity at span	is	% of value	-0.52	MCERTS certificate MC130223	U _{is}	mg/m ³	-0.035
maximum leak	L	% of value	0	day of testing	U _L	mg/m ³	0
uncertainty associated with calibration gas	adj	% of value	1.2	span gas calibration certificate	U _{adj}	mg/m ³	0.068
combined MU with O ₂ correction						mg/m ³	0.34
expanded MU with O ₂ correction (k = 1.96)						mg/m ³	0.66
expanded MU 95% CI with O ₂ correction (k = 1.96) as percentage of measured value						%	5.6
expanded MU 95% CI (k = 1.96) as percentage of measured value for mass emission						%	5.4

method and sampling deviations
Sampling was performed in full compliance with the Standard, technical procedure and regulatory requirements.

Part 2: Supporting Information - Appendix 2: Carbon Monoxide | Run 1

Results reference conditions are: STP, dry, 15% O₂

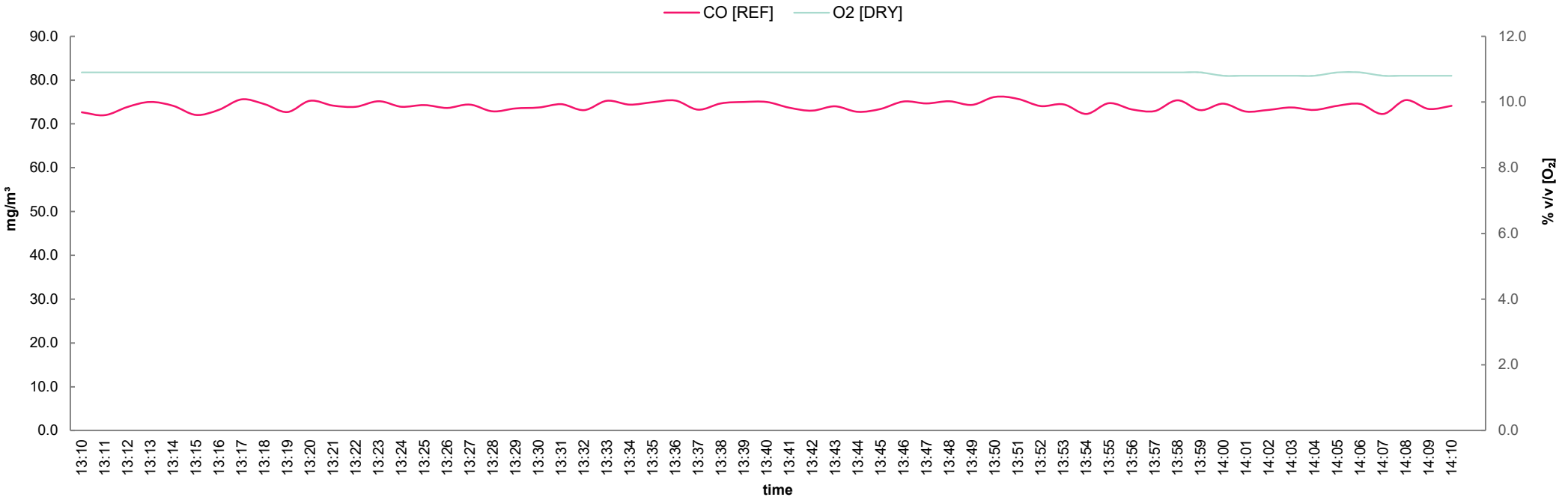
parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
Carbon Monoxide	mg/m ³	74 ± 4.3	g/hr	1518 ± 83.4

General Information

parameter	details
sampling start date & time	10/02/2025 13:10
sampling end date & time	10/02/2025 14:10
test time mins	60
testing team	AS JM
standard technical procedure	EN 15058 TP-22b
analyser type	Horiba PG-350E
heated head & line temperature	180°C

parameter	details
probe material	Stainless Steel
filter size, material & location	Filter Element GF Within Heated Head
number sampling lines available	2
number sampling lines used	1
number sampling points ideal per line	1
number sampling points used per line	1
sampling point IDs	A1

Plot of Emissions Over Time



Part 2: Supporting Information - Appendix 2: Carbon Monoxide | Run 1

Analyser Calibration Information with QA checks

where [A] = at analyser, [L] = down sampling line

	pre-test calibration events								post-test calibration events			quality assurance					
CAL ID	date & time	zero [A] [ppm]	span [A] [ppm]	zero [L] [ppm]	span [L] [ppm]	T ₉₀ [s]	leak [%]		date & time	zero [A] [ppm]	span [A] [ppm]	zero drift [%]		span drift [%]	allowable [%]	temp [°C]	
1	10/02/25 11:17	0.00	168.98	0.60	167.30	34	1.0	P	10/02/25 15:08	-1.00	161.50	-0.3	P	-4.2	P	±5	4.5

Analyser Calibration Extended Information

CAL ID	performed by	drift corr. applied	log period [s]	CYL ID	CYL conc. [ppm]	CYL expiry	CYL MU [%]	zero gas type	span [CYL] gas type	span target [ppm]	range [ppm]	LOD [ppm]
1	AS	Yes	60	A-CYL-141	168.98	21/08/2027	1.0	Nitrogen 5.2	5l 200ppm NO 160ppm CO 16% CO2 in Nitrogen	168.98	200	0.32

Part 2: Supporting Information - Appendix 2: Carbon Monoxide | Run 1

Measurement Uncertainty (MU) Calculations

general information	units	value
emission limit value (ELV) (REF)	mg/m ³	N/A
measured concentration (REF)	mg/m ³	74

MU budget			
parameter	units	min	max
ambient temp	°C	4.0	5.0
voltage	V	90.0	130.0

overall MU for O ₂ correction
4.9%

MU factor O ₂ correction
0.03

performance characteristics	MU budget input parameters				MU budget		
	symbol	units	value	source	symbol	units	value
repeatability at zero	rz	% of value	0.1	MCERTS certificate MC130223	U _{rz}	mg/m ³	0.074
repeatability at span	rs	% of value	0.2	MCERTS certificate MC130223	U _{rs}	mg/m ³	0.15
lack of fit	lof	% of value	2	maximum allowable	U _{lof}	mg/m ³	0.85
maximum short term zero drift (ABS) [after drift correction]	dz	% of value	0	day of testing	U _{dz}	mg/m ³	0
maximum short term span drift (ABS) [after drift correction]	ds	% of value	0	day of testing	U _{ds}	mg/m ³	0
influence of sample gas flow	f	% of value	0.1	MCERTS certificate MC130223	U _f	mg/m ³	0.043
influence of sample gas pressure	p	% of value	0	MCERTS certificate MC130223	U _p	mg/m ³	0
influence of ambient temperature zero point (/ 35k)	tz	% of value	-0.2	MCERTS certificate MC130223	U _{tz}	mg/m ³	-0.0014
influence of ambient temperature span point (/ 35k)	ts	% of value	2	MCERTS certificate MC130223	U _{ts}	mg/m ³	0.014
influence of supply voltage (/ 60V)	v	% of value	0.5	MCERTS certificate MC130223	U _v	mg/m ³	0.14
cross sensitivity at zero	iz	% of value	-0.48	MCERTS certificate MC130223	U _{iz}	mg/m ³	-0.21
cross sensitivity at span	is	% of value	-0.87	MCERTS certificate MC130223	U _{is}	mg/m ³	-0.37
maximum leak	L	% of value	0.99	day of testing	U _L	mg/m ³	0.42
uncertainty associated with calibration gas	adj	% of value	0.97	span gas calibration certificate	U _{adj}	mg/m ³	0.36
combined MU with O ₂ correction						mg/m ³	2.2
expanded MU with O ₂ correction (k = 1.96)						mg/m ³	4.3
expanded MU 95% CI with O ₂ correction (k = 1.96) as percentage of measured value						%	5.8
expanded MU 95% CI (k = 1.96) as percentage of measured value for mass emission						%	5.5

method and sampling deviations
Sampling was performed in full compliance with the Standard, technical procedure and regulatory requirements.

Part 2: Supporting Information - Appendix 2: Carbon Dioxide | Run 1

Results

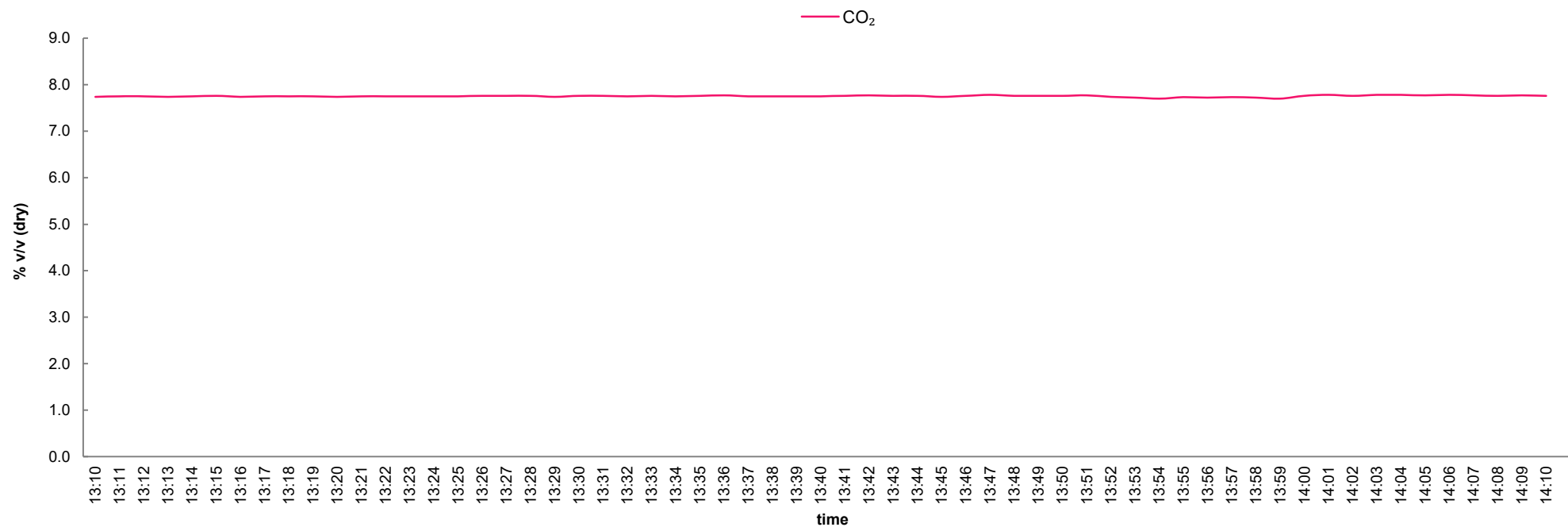
parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
Carbon Dioxide	% v/v	7.8 ± 0.28	kg/hr	1851 ± 108

General Information

parameter	details
sampling start date & time	10/02/2025 13:10
sampling end date & time	10/02/2025 14:10
test time mins	60
testing team	AS JM
standard technical procedure	PD CEN TS 17405 TP-22e
analyser type	Horiba PG-350E
heated head & line temperature	180°C

parameter	details
probe material	Stainless Steel
filter size, material & location	Filter Element GF Within Heated Head
number sampling lines available	2
number sampling lines used	1
number sampling points ideal per line	1
number sampling points used per line	1
sampling point IDs	A1

Plot of Emissions Over Time



Part 2: Supporting Information - Appendix 2: Carbon Dioxide | Run 1

Analyser Calibration Information with QA checks

where [A] = at analyser, [L] = down sampling line

CAL ID	pre-test calibration events							post-test calibration events			quality assurance						
	date & time	zero [A] [% v/v]	span [A] [% v/v]	zero [L] [% v/v]	span [L] [% v/v]	T ₉₀ [s]	leak [%]		date & time	zero [A] [% v/v]	span [A] [% v/v]	zero drift [%]		span drift [%]	allowable [%]	temp [°C]	
1	10/02/25 11:17	0.00	15.87	0.01	15.72	34	0.9	P	10/02/25 15:08	0.02	16.18	0.0	P	2.0	P	±5	4.5

Analyser Calibration Extended Information

CAL ID	performed by	drift corr. applied	log period [s]	CYL ID	CYL conc. [% v/v]	CYL expiry	CYL MU [%]	zero gas type	span [CYL] gas type	span target [% v/v]	range [% v/v]	LOD [% v/v]
1	AS	No	60	A-CYL-141	15.87	21/08/2027	1.1	Nitrogen 5.2	5l 200ppm NO 160ppm CO 16% CO2 in Nitrogen	15.87	20	0.10

Part 2: Supporting Information - Appendix 2: Carbon Dioxide | Run 1

Measurement Uncertainty (MU) Calculations

general information	units	value
measured concentration (dry)	% v/v	7.8

MU budget			
parameter	units	min	max
ambient temp	°C	4.0	5.0
voltage	V	90.0	130.0

performance characteristics	MU budget input parameters				MU budget		
	symbol	units	value	source	symbol	units	value
repeatability at zero	rz	% of value	0	MCERTS certificate MC130223	U _{rz}	% v/v	0
repeatability at span	rs	% of value	0.1	MCERTS certificate MC130223	U _{rs}	% v/v	0.0078
lack of fit	lof	% of value	2	maximum allowable	U _{lof}	% v/v	0.09
maximum short term zero drift (ABS) [after drift correction]	dz	% of value	0.0024	day of testing	U _{dz}	% v/v	0.00011
maximum short term span drift (ABS) [after drift correction]	ds	% of value	2	day of testing	U _{ds}	% v/v	0.087
influence of sample gas flow	f	% of value	0.1	MCERTS certificate MC130223	U _f	% v/v	0.0045
influence of sample gas pressure	p	% of value	0	MCERTS certificate MC130223	U _p	% v/v	0
influence of ambient temperature zero point (/ 35k)	tz	% of value	-0.2	MCERTS certificate MC130223	U _{tz}	% v/v	-0.00015
influence of ambient temperature span point (/ 35k)	ts	% of value	1	MCERTS certificate MC130223	U _{ts}	% v/v	0.00074
influence of supply voltage (/ 60V)	v	% of value	0.4	MCERTS certificate MC130223	U _v	% v/v	0.012
cross sensitivity at zero	iz	% of value	0	MCERTS certificate MC130223	U _{iz}	% v/v	0
cross sensitivity at span	is	% of value	-0.55	MCERTS certificate MC130223	U _{is}	% v/v	-0.025
maximum leak	L	% of value	0.95	day of testing	U _L	% v/v	0.042
uncertainty associated with calibration gas	adj	% of value	1.1	span gas calibration certificate	U _{adj}	% v/v	0.041
combined MU						% v/v	0.14
expanded MU 95% CI (k = 1.96)						% v/v	0.28
expanded MU 95% CI (k = 1.96) as percentage of measured value						%	3.6
expanded MU 95% CI (k = 1.96) as percentage of measured value for mass emission						%	5.8

method and sampling deviations
Sampling was performed in full compliance with the Standard, technical procedure and regulatory requirements.

Part 2: Supporting Information - Appendix 2: Oxygen | Run 1

Results

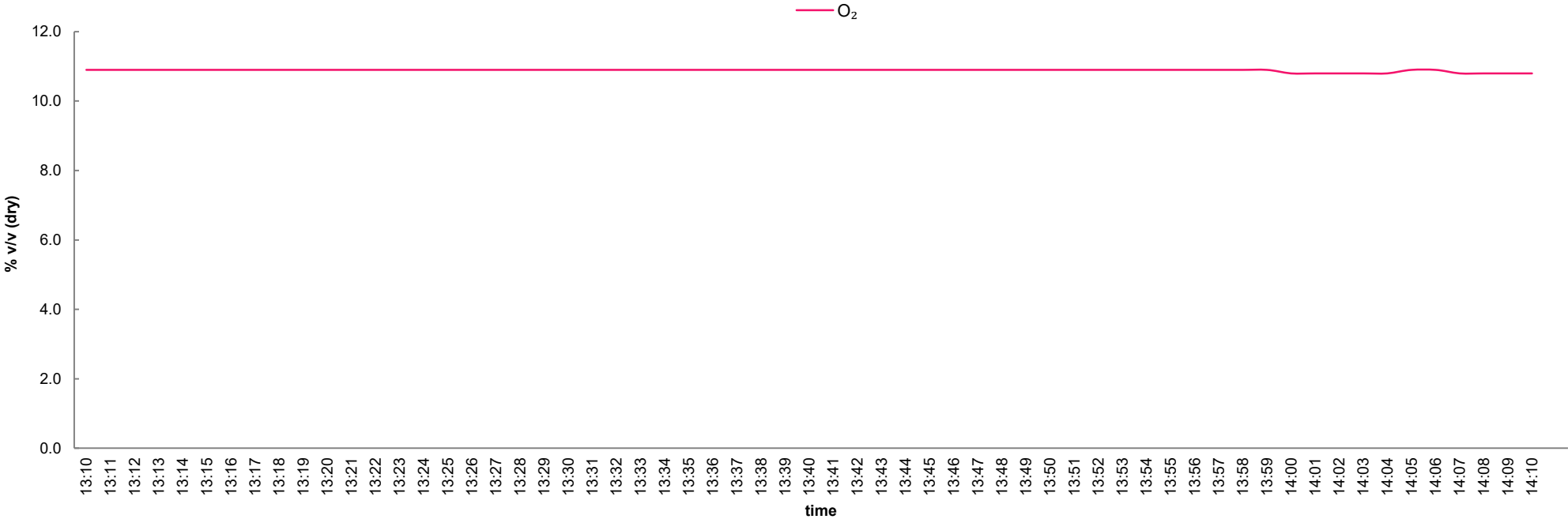
parameter	units	result ± MU (95% CI)
Oxygen	% v/v	10.9 ± 0.36

General Information

parameter	details
sampling start date & time	10/02/2025 13:10
sampling end date & time	10/02/2025 14:10
test time mins	60
testing team	AS JM
standard technical procedure	EN 14789 TP-22d
analyser type	Horiba PG-350E
heated head & line temperature	180°C

parameter	details
probe material	Stainless Steel
filter size, material & location	Filter Element GF Within Heated Head
number sampling lines available	2
number sampling lines used	1
number sampling points ideal per line	1
number sampling points used per line	1
sampling point IDs	A1

Plot of Emissions Over Time



Part 2: Supporting Information - Appendix 2: Oxygen | Run 1

Analyser Calibration Information with QA checks

where [A] = at analyser, [L] = down sampling line

	pre-test calibration events								post-test calibration events			quality assurance					
CAL ID	date & time	zero [A] [% v/v]	span [A] [% v/v]	zero [L] [% v/v]	span [L] [% v/v]	T ₉₀ [s]	leak [%]		date & time	zero [A] [% v/v]	span [A] [% v/v]	zero drift [%]		span drift [%]		allowable [%]	temp [°C]
1	10/02/25 11:17	0.00	21.14	0.19	20.93	30	1.0	P	10/02/25 15:08	0.15	20.90	0.3	P	-1.5	P	±5	4.5

Analyser Calibration Extended Information

CAL ID	performed by	drift corr. applied	log period [s]	CYL ID	CYL conc. [% v/v]	CYL expiry	CYL MU [%]	zero gas type	span [CYL] gas type	span target [% v/v]	range [% v/v]	LOD [% v/v]
1	AS	No	60	A-CYL-137	21.14	15/08/2029	1.2	Nitrogen 5.2	5l Synthetic Air	21.14	25	0.03

Part 2: Supporting Information - Appendix 2: Oxygen | Run 1

Measurement Uncertainty (MU) Calculations

general information	units	value
measured concentration (dry)	% v/v	10.9

MU budget			
parameter	units	min	max
ambient temp	°C	4.0	5.0
voltage	V	90.0	130.0

performance characteristics	MU budget input parameters				MU budget		
	symbol	units	value	source	symbol	units	value
repeatability at zero	rz	% of value	0.02	MCERTS certificate MC130223	U _{rz}	% v/v	0.0022
repeatability at span	rs	% of value	0.02	MCERTS certificate MC130223	U _{rs}	% v/v	0.0022
lack of fit	lof	% of value	2	maximum allowable	U _{lof}	% v/v	0.13
maximum short term zero drift (ABS) [after drift correction]	dz	% of value	0.34	day of testing	U _{dz}	% v/v	0.022
maximum short term span drift (ABS) [after drift correction]	ds	% of value	1.5	day of testing	U _{ds}	% v/v	0.092
influence of sample gas flow	f	% of value	-0.01	MCERTS certificate MC130223	U _f	% v/v	-0.00063
influence of sample gas pressure	p	% of value	0	MCERTS certificate MC130223	U _p	% v/v	0
influence of ambient temperature zero point (/ 35k)	tz	% of value	-0.4	MCERTS certificate MC130223	U _{tz}	% v/v	-0.00041
influence of ambient temperature span point (/ 35k)	ts	% of value	-0.15	MCERTS certificate MC130223	U _{ts}	% v/v	-0.00016
influence of supply voltage (/ 60V)	v	% of value	0.02	MCERTS certificate MC130223	U _v	% v/v	0.00084
cross sensitivity at zero	iz	% of value	0	MCERTS certificate MC130223	U _{iz}	% v/v	0
cross sensitivity at span	is	% of value	0	MCERTS certificate MC130223	U _{is}	% v/v	0
maximum leak	L	% of value	0.99	day of testing	U _L	% v/v	0.062
uncertainty associated with calibration gas	adj	% of value	1.2	span gas calibration certificate	U _{adj}	% v/v	0.065
combined MU						% v/v	0.18
expanded MU 95% CI (k = 1.96)						% v/v	0.36
expanded MU 95% CI (k = 1.96) as percentage of measured value						%	3.3

method and sampling deviations
Sampling was performed in full compliance with the Standard, technical procedure and regulatory requirements.

Part 2: Supporting Information - Appendix 2: Velocity & Flow Rate Traverse | Run 1

Supporting Information

parameter	units	value
barometric pressure	kPa	100.9
average wet density	kg/m³	0.514
average stack static pressure	Pa	327.0
pitot tube coefficient, C _p	-	0.829

ND = Not Detected

NM = Not Measured

Line A						Line B			
static pressure = 267 Pa						static pressure = 387 Pa			
Pt	Depth m	ΔP Pa	Temp °C	Vel m/s	Swirl °	ΔP Pa	Temp °C	Vel m/s	Swirl °
1	0.09	372.0	414.3	31.4	< 15	388.0	414.9	32.0	< 15
2	0.51	402.0	414.6	32.6	< 15	412.0	415.2	33.0	< 15
						267.0			

General Information

parameter	details
traverse date	10/02/2025
traverse times performed by	12:25 - 12:31 performed by: AS JM
standard technical procedure	EN 16911-1 TR 17078 TP-04a
device used	S-type Pitot with KIMO MP 210 (500Pa module)

Limit of Detection (LOD) is 1 m/s for this device combination

Quality Assurance

parameter	details
result of pitot stagnation test	Pass
result of pitot leak check (pre)	Pass
result of pitot leak check (post)	Pass
water droplets present	No

Part 2: Supporting Information - Appendix 2: Velocity & Flow Rate Traverse | Run 1

Measurement Uncertainty (MU) Calculations

ND = Not Detected		
parameter	units	value
standard uncertainty on the coefficient of the pitot tube	-	0.0015
standard uncertainty associated with the mean local dynamic pressures	Pa	5.8
standard uncertainty associated with the molar mass of the gas	-	0.000035
standard uncertainty associated with the temperature	K	3.5
standard uncertainty associated with the absolute pressure in the duct	Pa	176
standard uncertainty associated with the density of the gas effluent	kg/m³	0.0028
standard uncertainty associated with the local velocities	m/s	0.26
standard uncertainty associated with the mean velocity	m/s	0.15

ND = Not Detected		
parameter	units	value
standard uncertainty associated with the mean velocity (95% CI)	m/s	0.29
standard uncertainty associated with the mean velocity (95% CI), relative	%	0.9
standard uncertainty associated with the volume flow rate @ actual (95% CI)	m³/hr	1516
standard uncertainty associated with the volume flow rate @ actual (95% CI), relative	%	4.6
standard uncertainty associated with the volume flow rate @ ref 1 (95% CI)	m³/hr	954
standard uncertainty associated with the volume flow rate @ ref 1 (95% CI), relative	%	4.6

method and sampling deviations
Sampling was performed in full compliance with the Standard, technical procedure and regulatory requirements.