

Stack Emissions Monitoring Report

Job Reference: JOB-1989

Commissioned by Maesydd Biogas Ltd

Operator Name

Maesydd Biogas Ltd | The Maesydd

Operator Address

Pool Quay
Welshpool, Powys
SY21 9LA
EPR Permit EPR/AB3791FG

Release Point

AD Plant Engine Exhaust

Dates of the Monitoring Campaign

05/09/2025

Report Date | Version Number

25/09/2025 | Version 1

Cura Terra Primary Contact

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Monitoring organisation name & address	Report written by	Report approved by	Report approved by signature
Cura Terra OH and Emissions Testing Limited North West Office Unit 2, Asher Court, Lyncastle Way Appleton, Warrington, Cheshire, WA4 4ST	Zack Harrison Team Leader MCERTS Level 2 Endorsements: TE1 TE2 TE4 MM 21 1627 expires on 26/04/2026	Matt Pendlebury Technical Support Manager MCERTS Level 2 Endorsements: TE1 TE2 TE3 TE4 MM 04 535 expires on 31/03/2026	

Report Contents and Monitoring Objectives

Report Contents

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Monitoring Objective

The monitoring objective was to conduct stack emissions monitoring to demonstrate compliance against a set of emission limit values (ELVs) as specified in the Site's Environmental Permit.

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 Cura Terra'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		
Sulphur Dioxide	41.3	3.5	350	mg/m ³	42.5	3.8		g/hr	STP, dry, 5% O ₂	MCERTS
Total VOCs (as Carbon) †	1117	447	1000	mg/m ³	1130	452		g/hr	STP, dry, 5% O ₂	MCERTS
Oxides of Nitrogen (as NO ₂)	496	24.9	500	mg/m ³	500	29.6		g/hr	STP, dry, 5% O ₂	MCERTS
Carbon Monoxide	781	38.6	1400	mg/m ³	788	46.3		g/hr	STP, dry, 5% O ₂	MCERTS
Oxygen	7.2	0.21		% v/v					dry	MCERTS
Stack Gas Water Vapour	11.5	0.17		% v/v					actual	MCERTS
Stack Gas Temperature	364			°C					actual	MCERTS
Stack Gas Velocity	43.2	0.71		m/s					actual	MCERTS
Stack Gas Flow Rate (ACTUAL)	3127	151		m ³ /hr					actual	MCERTS
Stack Gas Flow Rate (REF)	1010	48.6		m ³ /hr					STP, dry, 5% 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.

† The uncertainties stated above are those specified in Table 4.7 (in Section 4.6.1) of EA LFTGN08 v2 2010, and are the “Assumed maximum values for total uncertainty to be applied when assessing compliance of emissions from [landfill gas] engines”. See Appendix 2 of this report for more information.

Part 1: Executive Summary - Monitoring Results Further Details

Monitoring Results - Further Details

test parameter	run	EXPRESSED AS A CONCENTRATION				EXPRESSED AS A MASS EMISSION				sampling date times	run time (mins)	H ₂ O (% v/v)	reference conditions
		result	uncertainty in result +/-	limit (ELV)	units	result	uncertainty in result +/-	limit (ELV)	units				
Sulphur Dioxide	R1	41.3	3.5	350	mg/m ³	42.5	3.8		g/hr	05/09/2025 11:58 - 12:58	60	11.5	STP, dry, 5% O ₂
Total VOCs (as Carbon) †	R1	1117	447	1000	mg/m ³	1130	452		g/hr	05/09/2025 11:55 - 12:55	60		STP, dry, 5% O ₂
Oxides of Nitrogen (as NO ₂)	R1	496	24.9	500	mg/m ³	500	29.6		g/hr	05/09/2025 11:55 - 12:55	60		STP, dry, 5% O ₂
Carbon Monoxide	R1	781	38.6	1400	mg/m ³	788	46.3		g/hr	05/09/2025 11:55 - 12:55	60		STP, dry, 5% O ₂
Oxygen		7.2	0.21		% v/v					N/A - Concurrent Testing			dry
Velocity & Flow Rate Traverse	R1	43.2	0.71		m/s	3127	151		m ³ /hr	05/09/2025 11:30 - 11:32			actual
Stack Gas Water Vapour		11.5	0.17		% v/v								actual
Stack Gas Temperature		364			°C								actual
Stack Gas Velocity		43.2	0.71		m/s								actual
Stack Gas Flow Rate (ACTUAL)		3127	151		m ³ /hr								actual
Stack Gas Flow Rate (REF)		1010	48.6		m ³ /hr								STP, dry, 5% 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.

† The uncertainties stated above are those specified in Table 4.7 (in Section 4.6.1) of EA LFTGN08 v2 2010, and are the “Assumed maximum values for total uncertainty to be applied when assessing compliance of emissions from [landfill gas] engines”. See Appendix 2 of this report for more information.

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
Sulphur Dioxide	CTA	2522	TP-10	EN 14791	MCERTS	RPS	0605	C27	IC	MCERTS	MCERTS
Water Vapour	CTA	2522	TP-03	EN 14790	MCERTS	CTA	2522	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)	CTA	2522	TP-21b	EN 12619	MCERTS	FID using iFID Mobile					MCERTS
Oxides of Nitrogen (as NO ₂)	CTA	2522	TP-22a	EN 14792	MCERTS	Chemiluminescence using Horiba PG-350E					MCERTS
Carbon Monoxide	CTA	2522	TP-22b	EN 15058	MCERTS	NDIR using Horiba PG-350E					MCERTS
Oxygen	CTA	2522	TP-22d	EN 14789	MCERTS	Paramagnetism using Horiba PG-350E					MCERTS
Velocity & Flow Rate Traverse	CTA	2522	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.

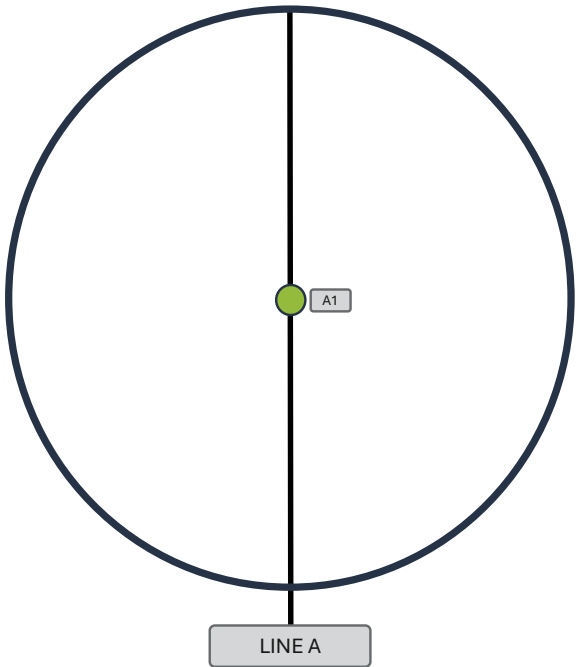
Part 1: Executive Summary - Monitoring Location

Monitoring Location Photos



Identification of Sampling Points on a Duct Diagram

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
shape	-	Circular
dimensions	-	Diameter = 0.16 m
area	m ²	0.02
orientation	-	Vertical

parameter	value
primary sample port size	1" BSP
primary sample port depth cm	10
primary sample ports number of sampling lines available	1

summary of all sample ports available
1" BSP

Sampling Location General Information

general information	details
type location access	On the Ground Inside On Ground Level

CEMS | Abatement Systems

parameter	details
abatement system/s	N/A
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	765.0	> 5 Pa	Yes
lowest traverse velocity	m/s	43.2	-	-
highest traverse velocity	m/s	43.2	-	-
mean traverse velocity	m/s	43.2	-	-
ratio traverse velocities	: 1	1.00	< 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	No visible plume
type of process	Anaerobic Digester Engine
batch or continuous process	Continuous
fuel type	Biogas
feedstock	N/A
typical load / throughput of plant	Normal operation
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
Zack Harrison	Team Leader	MCERTS Level 2 MM 21 1627 26/04/2026	TE1 TE2 TE4
Sean Egan	Team Leader	MCERTS Level 2 MM 17 1416 27/05/2027	TE1 TE2 TE3 TE4
Gian Dela Cruz	Trainee	MCERTS Trainee MM 25 1894 02/07/2030	-

Analysis Laboratories

laboratory	ISO 17025 accreditation number	laboratory short name	laboratory phone number
Cura Terra OH and Emissions Testing Limited North West	2522	CTA	0800 970 8945
RPS Laboratories Salford	0605	RPS	0161 872 2443

Test Equipment Used

equipment type	A-EQ ID
Source sampling console	
Low flow sampling console	
Low flow sampling MFCs	
ThermoFID / iFID mobile	287
Horiba PG-250	
Horiba PG-350E	224
Gasmet DX4000 FTIR	
Gasmet PSS	
Protea AtmosFIR	
Protea PIB 9ump	
Gasmet syringe calibrator	
M&C PSS5-C	207
Digital thermomanometer	222
Top pan balance kit	242

equipment type	A-EQ ID
S-Type pitot	
S-Type pitot tip	
Mini S-Type pitot	244
L-Type pitot	
Calipers	
Heated head filter	227
Heated tee	
1.5m heated line	296
10m heated line	292 294 555
20m heated line	
Odour barrel	
Vacuum chamber	
Dilution probe	
Tape measure	223

equipment type	A-EQ ID
Barometer	
Timer	
10m umbilical	
30m umbilical	
Heated probe	
Filter oven	
Ambient thermocouple	
Stack thermocouple	
Exit thermocouple	
Condenser thermocouple	
Tubes kit thermocouple	
2-way heater controller	
Air sampling pump	
Analytical balance	1 492

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

Results reference conditions are: STP, dry, 5% O₂

parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
Sulphur Dioxide	mg/m ³	41.3 ± 3.5	g/hr	42.5 ± 3.8

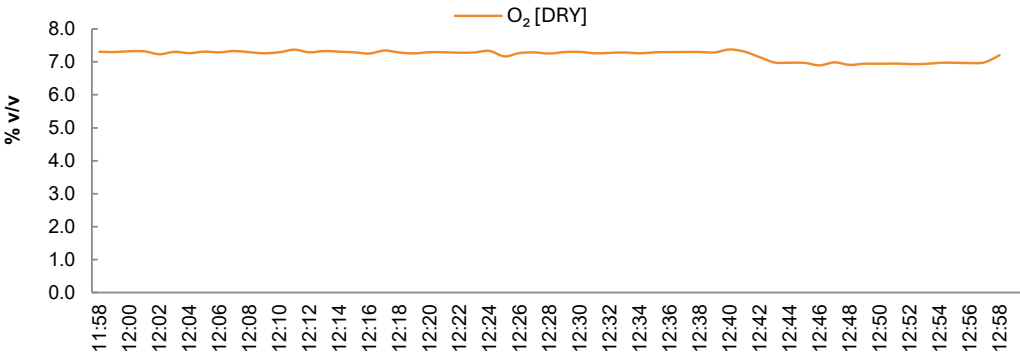
Analytical Laboratory Information

parameter	details
name of analytical lab	RPS
lab analytical procedure	C27
lab analytical technique	IC Analysis Accreditation: MCERTS
date analysis completed	12/09/2025

General Information

parameter	details
sampling date	05/09/2025
sampling times	11:58 - 12:58
sampling duration testing team	60 minutes tested by: ZH GDC SE
standard technical procedure	EN 14791 TP-10
probe filter housing material	Stainless Steel Stainless Steel Heated Head
impinger material capture media	Borosilicate Glass 0.3% H ₂ O ₂
set flow rate	5 l/min

Oxygen Data



parameter	details
filter size, material & location	Heated Head Filter Element PTFE Within Heated Head heated to 180°C
number sampling lines available	1
number sampling lines used	1
number sampling points ideal per line	1
number sampling points used per line	1
sampling point IDs	A1
volume metering device	Mass Flow Controller

Quality Assurance

QA parameter	units	sample run			blank (taken on 05/09/2025)		
		value	allowable	result	value	allowable	result
maximum allowable blank	mg/m ³	-	-	-	0.38	35	Pass
leak test	%	0.00	2.00	Pass	1.34	2.00	Pass
absorption efficiency	%	99.6	95	Pass	-	-	-
silica trap <50% faded	-	Yes	-	Pass	-	-	-
are water droplets present	-	No	-	-	-	-	-
water vapour MU	%	1.5	20.0	Pass	-	-	-

Breakdown of Results

reference conditions are: STP, dry, 5% O₂

parameter	sample volume [m ³]	LOD [mg]	impingers [front back] [mg/l]	impinger volume [front back] [ml]	mass total [mg]	LOD result [mg/m ³]	result [mg/m ³]	result reported [mg/m ³]	mass emission [g/hr]
sample run	0.1508	0.019	22.9 0.22	271 112	6.2	0.13	41.3	41.3	42.5
blank	0.1508	0.024	0.12	475	0.057	0.16	0.38	0.38	

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

Raw Data | Calculations

data	units	value
P _{bar}	mmHg	765.1
P _g	Pa	1.0
P _s	mmHg	765.1
V _m (metered)	m ³	0.1749
C _{stp}	-	0.3592

data	units	value
m _{wtS}	g	18.5
M _w	g/mol	18.0
V _{mol}	m ³ /mol	0.0222
T _s	°C	364.5
R _{wv} (H ₂ O)	% v/v	11.5

data	units	value
%CO _{2d}	% v/v (est)	12.75
%O _{2d}	% v/v	7.21
%O _{2w}	% v/v	6.37
%N _{2d}	% v/v	80.04
%O _{2ref}	% v/v	5.0
O _{2facd}	-	1.16
O _{2facw}	-	1.09

data	units	value
M _d	g/mol	30.33
M _s	g/mol	28.91
A _s	m ²	0.02
θ (sample time)	mins	60

where (est) refers to an estimated value

metered volume calculations	units	value
allow favourable O ₂ correction	-	Yes
vol actual stack conditions, V _{ma} = (V _{mstw})(T _s + 273) / (P _s) / (C _{stp})	m ³	0.4587
vol dry, V _{mstd} = V _m	m ³	0.1749
vol wet, V _{mstw} = (V _{mstd})(100 / (100 - R _{wv}))	m ³	0.1977
vol dry O ₂ , V _{mstdO₂} = (V _{mstd}) / (O _{2facd})	m ³	0.1508
vol wet O ₂ , V _{mstwO₂} = (V _{mstw}) / (O _{2facw})	m ³	0.1807

velocity volume flow rate calculations	units	value
velocity of stack gas, v _s = average of all velocity measurements	m/s	43.2
stack gas flow actual stack conditions, Q _a = average of all flow rate measurements	m ³ /hr	3127.4

Measurement Uncertainty (MU) Calculations

parameter	units	value	standard MU	MU as %age	required standard	value	sens coeff.	MU mg/m ³	MU factor O ₂ correction
MFC meter volume, V _m	m ³	0.1749	0.0009	0.50	≤2%	-	-	-	0.04
MFC volume STP, V _{mstd}	m ³	-	-	-	-	0.2	236	0.21	
leak, L	% ¹ mg/m ^{3.2}	0 ¹	-	0.00	≤2%	0 ²	1.00	0	overall MU for O ₂ correction
laboratory result, L _r	% ¹ mg/m ^{3.2}	3.9 ¹	-	3.9	-	1.6 ²	1.00	1.6	3.6%
combined MU with O ₂ correction									1.8
expanded MU 95% CI with O ₂ correction (k = 1.96) including method deviations									3.5
expanded MU 95% CI with O ₂ correction (k = 1.96) as percentage of measured value									8.4%
expanded MU 95% CI (k = 1.96) as percentage of measured value for mass emission									9%
expanded MU 95% CI with O ₂ correction (k = 1.96) as percentage of ELV [allowable 20.3%]									0.99%
									result
									Pass

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

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

Results reference conditions are: STP, dry, 5% O₂

parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
Total VOCs (as Carbon) †	mg/m ³	1117 ± 447	g/hr	1130 ± 452

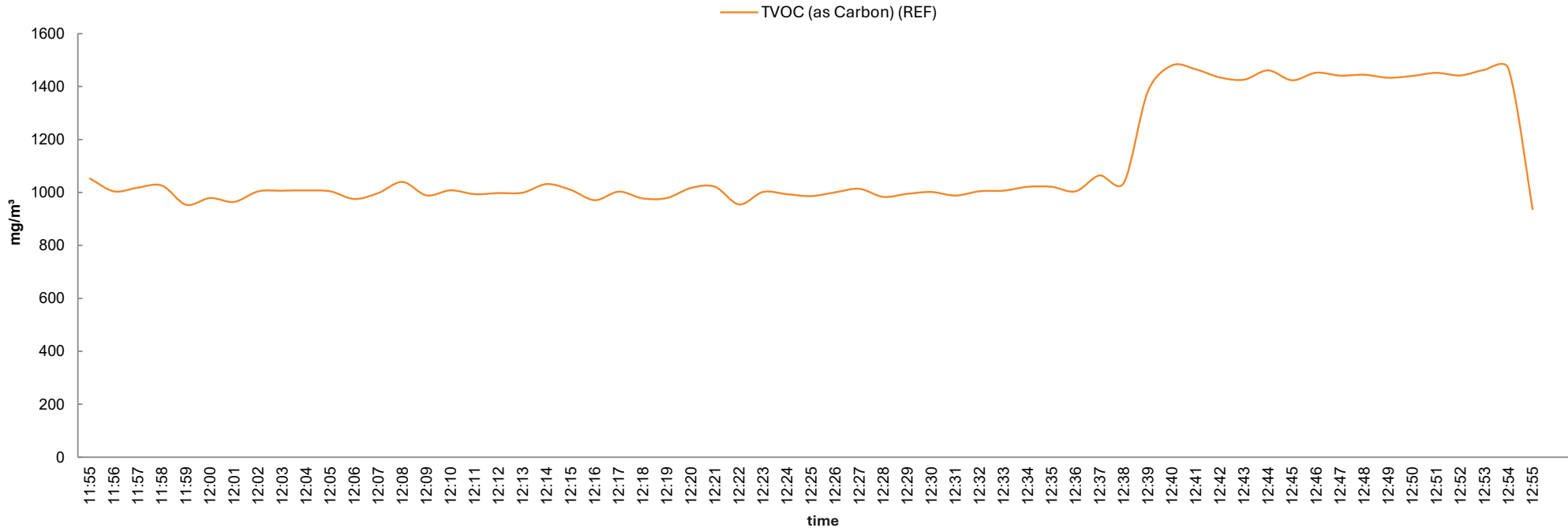
† LFTGN08 maximum value for total uncertainty (40% of measured value) applied to the results

General Information

parameter	details
sampling start date & time	05/09/2025 11:55
sampling end date & time	05/09/2025 12:55
test time mins	60
testing team	ZH GDC SE
standard technical procedure	EN 12619 TP-21b
analyser type	iFID Mobile
heated head & line temperature	180°C

parameter	details
probe material	Stainless Steel
filter size, material & location	Filter Element PTFE Within Heated Head
number sampling lines available	1
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	05/09/25 10:53	0.00	791.01	-0.50	790.00	33	0.1	P	05/09/25 13:29	6.70	790.00	0.9	P	-0.9	P	±5	22.0

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	ZH	No	60	A-CYL-32	791.01	11/10/2025	0.9	Synthetic Air	10l 800ppm Propane in Air	791.01	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/m ³	1000
measured concentration (REF)	mg/m ³	1117

MU budget			
parameter	units	min	max
ambient temp	°C	22.0	22.0
voltage	V	90.0	130.0

overall MU for O ₂ correction
3.6%
MU factor O ₂ correction
0.04

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/m ³	0.56
repeatability at span	rs	% of value	0.08	MCERTS certificate MC050062	U _{rs}	mg/m ³	0.89
lack of fit	lof	% of value	2	maximum allowable	U _{lof}	mg/m ³	12.9
maximum short term zero drift (ABS) [after drift correction]	dz	% of value	0.92	day of testing	U _{dz}	mg/m ³	5.9
maximum short term span drift (ABS) [after drift correction]	ds	% of value	0.91	day of testing	U _{ds}	mg/m ³	5.9
influence of sample gas flow	f	% of value	-0.42	MCERTS certificate MC050062	U _f	mg/m ³	-2.7
influence of sample gas pressure	p	% of value	0	MCERTS certificate MC050062	U _p	mg/m ³	0
influence of ambient temperature zero point (/ 35k)	tz	% of value	-2.4	MCERTS certificate MC050062	U _{tz}	mg/m ³	0
influence of ambient temperature span point (/ 35k)	ts	% of value	-2.7	MCERTS certificate MC050062	U _{ts}	mg/m ³	0
influence of supply voltage (/ 60V)	v	% of value	-0.46	MCERTS certificate MC050062	U _v	mg/m ³	-2
cross sensitivity at zero	iz	% of value	3.8	MCERTS certificate MC050062	U _{iz}	mg/m ³	24.5
cross sensitivity at span	is	% of value	3.9	MCERTS certificate MC050062	U _{is}	mg/m ³	25.2
maximum leak	L	% of value	0.13	day of testing	U _L	mg/m ³	0.82
uncertainty associated with calibration gas	adj	% of value	0.9	span gas calibration certificate	U _{adj}	mg/m ³	5
combined MU with O ₂ correction						mg/m ³	44
expanded MU with O ₂ correction (k = 1.96)						mg/m ³	86.2
expanded MU 95% CI with O ₂ correction (k = 1.96) as percentage of measured value						%	7.7
expanded MU 95% CI (k = 1.96) as percentage of measured value for mass emission						%	8.3
expanded MU with O ₂ correction (k = 1.96) as percentage of ELV [allowable 15.4%]						%	8.6
							result
							N/A [>ELV]

† This MU budget calculates the measurement uncertainty (MU) based upon the equipment used and the Standard followed. The reported MU is that specified in Table 4.7 (in Section 4.6.1) of EA LFTGN08 v2 2010, and is the “Assumed maximum value for total uncertainty to be applied when assessing compliance of emissions from [landfill gas] engines” which is 40% for Total VOCs.

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, 5% O₂

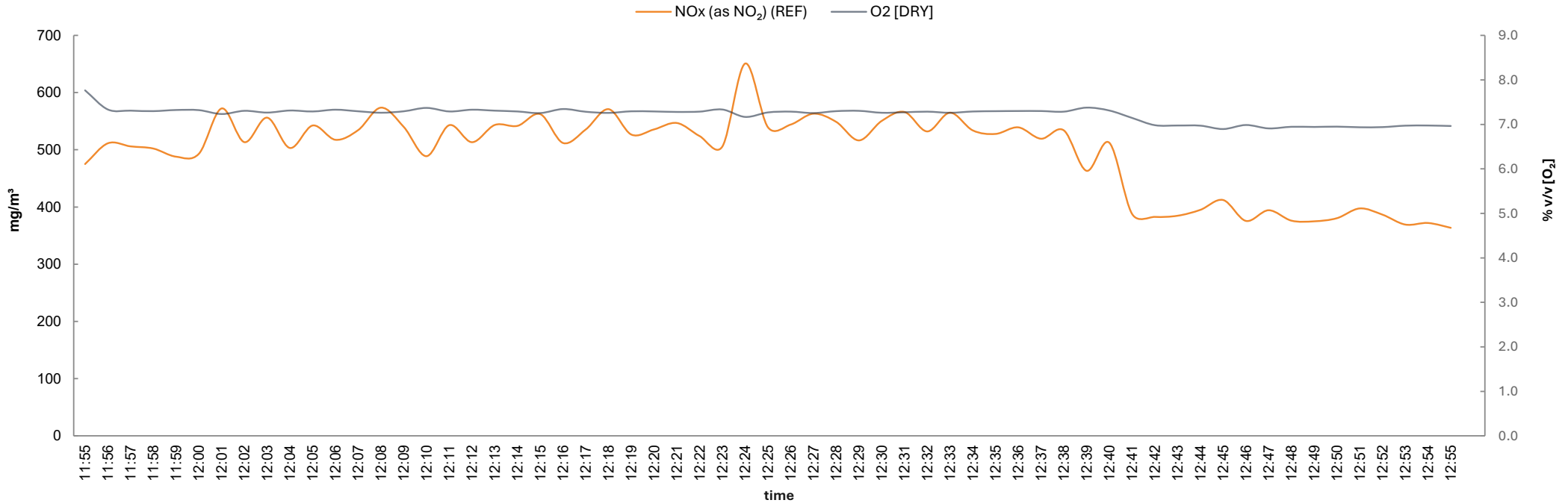
parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
Oxides of Nitrogen (as NO ₂)	mg/m ³	496 ± 24.9	g/hr	500 ± 29.6

General Information

parameter	details
sampling start date & time	05/09/2025 11:55
sampling end date & time	05/09/2025 12:55
test time mins	60
testing team	ZH GDC SE
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 PTFE Within Heated Head
number sampling lines available	1
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

CAL ID	pre-test calibration events							post-test calibration events			quality assurance						
	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	05/09/25 11:03	0.00	431.92	0.00	426.70	43	1.2	P	05/09/25 13:38	0.00	426.00	0.0	P	-1.4	P	±5	22.0

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	ZH	No	60	A-CYL-117	431.92	07/09/2026	1.3	Nitrogen 5.2	10l 400ppm NO 1600ppm CO 16% CO2 in Nitrogen	431.92	500	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	500
measured concentration (REF)	mg/m ³	496

MU budget			
parameter	units	min	max
ambient temp	°C	22.0	22.0
voltage	V	90.0	130.0

overall MU for O ₂ correction
3.6%
MU factor O ₂ correction
0.04

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	0.5
lack of fit	lof	% of value	2	maximum allowable	U _{lof}	mg/m ³	5.7
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	1.4	day of testing	U _{ds}	mg/m ³	3.9
influence of sample gas flow	f	% of value	0.1	MCERTS certificate MC130223	U _f	mg/m ³	0.29
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
influence of supply voltage (/ 60V)	v	% of value	0.4	MCERTS certificate MC130223	U _v	mg/m ³	0.76
cross sensitivity at zero	iz	% of value	0.63	MCERTS certificate MC130223	U _{iz}	mg/m ³	1.8
cross sensitivity at span	is	% of value	-0.52	MCERTS certificate MC130223	U _{is}	mg/m ³	-1.5
maximum leak	L	% of value	1.2	day of testing	U _L	mg/m ³	3.5
uncertainty associated with calibration gas	adj	% of value	1.3	span gas calibration certificate	U _{adj}	mg/m ³	3.2
combined MU with O ₂ correction						mg/m ³	12.7
expanded MU with O ₂ correction (k = 1.96)						mg/m ³	24.9
expanded MU 95% CI with O ₂ correction (k = 1.96) as percentage of measured value						%	5
expanded MU 95% CI (k = 1.96) as percentage of measured value for mass emission						%	5.9
expanded MU with O ₂ correction (k = 1.96) as percentage of ELV [allowable 10.6%]						%	5
							result
							Pass

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, 5% O₂

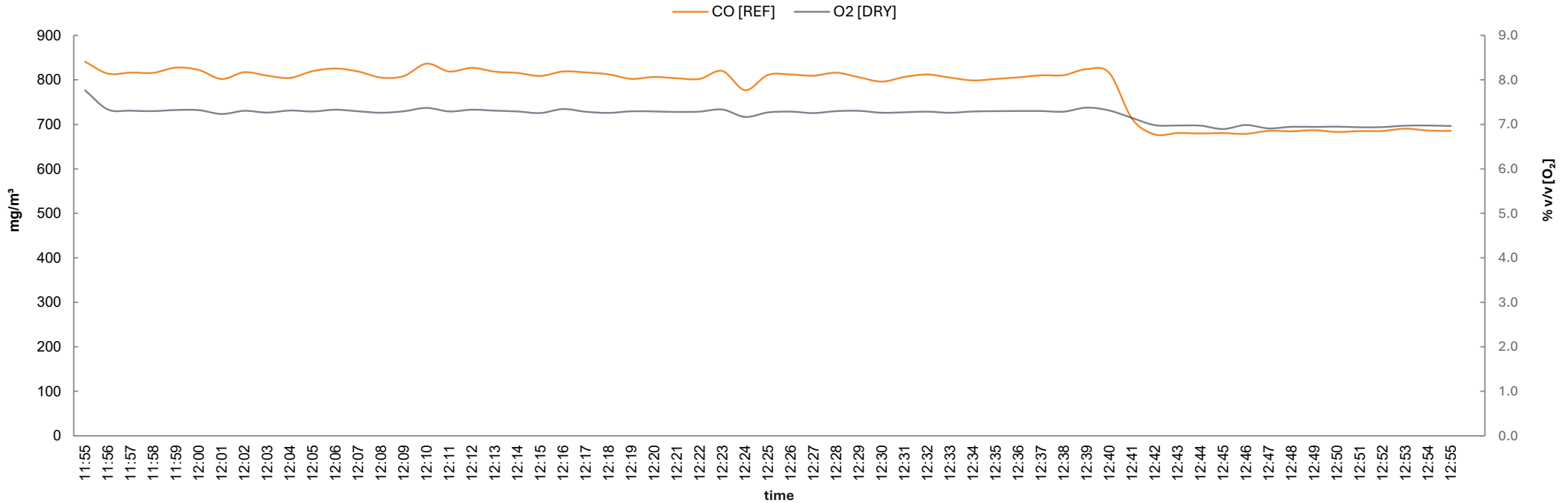
parameter	units	result ± MU (95% CI)	units	result ± MU (95% CI)
Carbon Monoxide	mg/m ³	781 ± 38.6	g/hr	788 ± 46.3

General Information

parameter	details
sampling start date & time	05/09/2025 11:55
sampling end date & time	05/09/2025 12:55
test time mins	60
testing team	ZH GDC SE
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 PTFE Within Heated Head
number sampling lines available	1
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	05/09/25 11:03	0.00	1707.83	0.00	1680.00	39	1.6	P	05/09/25 13:38	0.00	1668.00	0.0	P	-2.3	P	±5	22.0

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	ZH	Yes	60	A-CYL-117	1707.83	07/09/2026	1.1	Nitrogen 5.2	10l 400ppm NO 1600ppm CO 16% CO2 in Nitrogen	1707.83	2000	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	1400
measured concentration (REF)	mg/m ³	781

MU budget			
parameter	units	min	max
ambient temp	°C	22.0	22.0
voltage	V	90.0	130.0

overall MU for O ₂ correction
3.6%
MU factor O ₂ correction
0.04

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	0.78
repeatability at span	rs	% of value	0.2	MCERTS certificate MC130223	U _{rs}	mg/m ³	1.6
lack of fit	lof	% of value	2	maximum allowable	U _{lof}	mg/m ³	9
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	0.45
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
influence of ambient temperature span point (/ 35k)	ts	% of value	2	MCERTS certificate MC130223	U _{ts}	mg/m ³	0
influence of supply voltage (/ 60V)	v	% of value	0.5	MCERTS certificate MC130223	U _v	mg/m ³	1.5
cross sensitivity at zero	iz	% of value	-0.48	MCERTS certificate MC130223	U _{iz}	mg/m ³	-2.2
cross sensitivity at span	is	% of value	-0.87	MCERTS certificate MC130223	U _{is}	mg/m ³	-3.9
maximum leak	L	% of value	1.6	day of testing	U _L	mg/m ³	7.3
uncertainty associated with calibration gas	adj	% of value	1.1	span gas calibration certificate	U _{adj}	mg/m ³	4.3
combined MU with O ₂ correction						mg/m ³	19.7
expanded MU with O ₂ correction (k = 1.96)						mg/m ³	38.6
expanded MU 95% CI with O ₂ correction (k = 1.96) as percentage of measured value						%	4.9
expanded MU 95% CI (k = 1.96) as percentage of measured value for mass emission						%	5.9
expanded MU with O ₂ correction (k = 1.96) as percentage of ELV [allowable 7%]						%	2.8
							result
							Pass

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 | QA Concurrent Testing

Results

parameter	units	result ± MU (95% CI)
Oxygen	% v/v	7.2 ± 0.21

General Information

parameter	details
sampling start date & time	N/A - Concurrent Testing
sampling end date & time	N/A - Concurrent Testing
testing team	ZH GDC SE

parameter	details
standard technical procedure	EN 14789 TP-22d
analyser type	Horiba PG-350E

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	05/09/25 11:03	0.00	21.18	0.31	20.97	22	1.0	P	05/09/25 13:38	0.00	21.07	0.0	P	-0.5	P	±5	22.0

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	ZH	No	60	A-CYL-154	21.18	09/02/2030	1.2	Nitrogen 5.2	10l Synthetic Air	21.18	25	0.03

Part 2: Supporting Information - Appendix 2: Oxygen | QA Concurrent Testing

Measurement Uncertainty (MU) Calculations

general information	units	value
measured concentration (dry)	% v/v	7.2

MU budget			
parameter	units	min	max
ambient temp	°C	22.0	22.0
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	0.0014
repeatability at span	rs	% of value	0.02	MCERTS certificate MC130223	U _{rs}	% v/v	0.0014
lack of fit	lof	% of value	2	maximum allowable	U _{lof}	% v/v	0.083
maximum short term zero drift (ABS) [after drift correction]	dz	% of value	0	day of testing	U _{dz}	% v/v	0
maximum short term span drift (ABS) [after drift correction]	ds	% of value	0.52	day of testing	U _{ds}	% v/v	0.022
influence of sample gas flow	f	% of value	-0.01	MCERTS certificate MC130223	U _f	% v/v	-0.00042
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
influence of ambient temperature span point (/ 35k)	ts	% of value	-0.15	MCERTS certificate MC130223	U _{ts}	% v/v	0
influence of supply voltage (/ 60V)	v	% of value	0.02	MCERTS certificate MC130223	U _v	% v/v	0.00056
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	0.041
uncertainty associated with calibration gas	adj	% of value	1.2	span gas calibration certificate	U _{adj}	% v/v	0.043
combined MU						% v/v	0.1
expanded MU 95% CI (k = 1.96)						% v/v	0.21
expanded MU 95% CI (k = 1.96) as percentage of measured value						%	2.8

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

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

Supporting Information

parameter	units	value
barometric pressure	kPa	100.2
average wet density	kg/m ³	0.547
average stack static pressure	Pa	1.0
pitot tube coefficient, C _p	-	0.821

ND = Not Detected

NM = Not Measured

Line A					
static pressure = 1 Pa					
Pt	Depth m	ΔP Pa	Temp °C	Vel m/s	Swirl °
1	0.08	765.0	364.0	43.2	< 15

General Information

parameter	details
traverse date	05/09/2025
traverse times performed by	11:30 - 11:32 performed by: ZH GDC SE
standard technical procedure	EN 16911-1 TR 17078 TP-04a
device used	S-type Pitot with KIMO MP 210 (2500Pa module)

Limit of Detection (LOD) is 2.5 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	11.9
standard uncertainty associated with the molar mass of the gas	-	0.000059
standard uncertainty associated with the temperature	K	3.3
standard uncertainty associated with the absolute pressure in the duct	Pa	176
standard uncertainty associated with the density of the gas effluent	kg/m ³	0.0032
standard uncertainty associated with the local velocities	m/s	0.37
standard uncertainty associated with the mean velocity	m/s	0.36

ND = Not Detected		
parameter	units	value
standard uncertainty associated with the mean velocity (95% CI)	m/s	0.71
standard uncertainty associated with the mean velocity (95% CI), relative	%	1.6
standard uncertainty associated with the volume flow rate @ actual (95% CI)	m ³ /hr	151
standard uncertainty associated with the volume flow rate @ actual (95% CI), relative	%	4.8
standard uncertainty associated with the volume flow rate @ ref 1 (95% CI)	m ³ /hr	48.6
standard uncertainty associated with the volume flow rate @ ref 1 (95% CI), relative	%	4.8

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