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Stack Emissions Testing Report Commissioned by
SEPA

Installation Name & Address

ExxonMobil Chemical Ltd
Beverkae House
Mossmorran
Cowdenbeath
KY4 8EP

PPC Permit: PPC/A/1013495

Stack Reference

A05 - Furnace 5

Dates of the Monitoring Campaign

28th - 30th March 2022

Job Reference Number

EMT02875

Report Written by
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Report Approved by
[REDACTED] [REDACTED] MCERTS Level 2 [REDACTED] TE1 TE2 TE3 TE4

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4th May 2022

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Signature of Report Approver
[REDACTED]

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Executive Summary

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MONITORING OBJECTIVES

ExxonMobil Chemical Ltd, Mossmorran

A05 - Furncace 5

28th - 30th March 2022

Overall Aim of the Monitoring Campaign

Element were commissioned by SEPA to carry out stack emissions testing for ExxonMobil Chemical Ltd on the A05 - Furncace 5 at Mossmorran.

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values (ELVs) as specified in the Site's Permit.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter, Sulphur Dioxide, Oxides of Nitrogen (as NO₂), Carbon Monoxide

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MONITORING RESULTS

ExxonMobil Chemical Ltd, Mossmorran
A05 - Furnace 5
28th - 30th March 2022

where MU = Measurement Uncertainty associated with the Result

Parameter	Concentration				Mass Emission			
	Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Total Particulate Matter	¹ mg/m ³	0.22	0.44	-	g/hr	15.8	32.5	-
Sulphur Dioxide	¹ mg/m ³	0.79	0.06	-	g/hr	57.8	6.3	-
Oxides of Nitrogen (as NO ₂)	¹ mg/m ³	195	8.1	350	g/hr	14319	1195	-
Carbon Monoxide	¹ mg/m ³	1.1	0.75	-	g/hr	82.6	55.1	-
Oxygen	% v/v	Dry 4.2	0.12					
Water Vapour	% v/v	16.0	0.82					
Stack Gas Temperature	°C	144						
Stack Gas Velocity	m/s	12.7	0.71					
Volumetric Flow Rate (ACTUAL)	m ³ /hr	143543	10374					
Volumetric Flow Rate (REF)	¹ m ³ /hr	73290	5297					

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

¹ Reference Conditions (REF) are: 273K, 101.3kPa, dry gas, 3% oxygen.

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MONITORING DATE(S) & TIMES

ExxonMobil Chemical Ltd, Mossmorran
A05 - Furnace 5
28th - 30th March 2022

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m ³	0.22	g/hr	16.4	29/03/2022	11:15 - 12:15	60
Total Particulate Matter	R2	mg/m ³	0.21	g/hr	15.2	29/03/2022	12:26 - 13:26	60
Sulphur Dioxide	R1	mg/m ³	0.91	g/hr	66.5	29/03/2022	11:15 - 12:15	60
Sulphur Dioxide	R2	mg/m ³	0.67	g/hr	49.1	29/03/2022	12:26 - 13:26	60
Oxides of Nitrogen (as NO ₂)	R1	mg/m ³	195	g/hr	14319	29/03/2022	11:15 - 13:15	120
Carbon Monoxide	R1	mg/m ³	1.1	g/hr	82.6	29/03/2022	11:15 - 13:15	120
Oxygen	R1	% v/v	4.2			29/03/2022	11:15 - 13:15	120
Velocity Traverse	R1					29/03/2022	12:02 - 12:15	

All results are expressed at the respective reference conditions.

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PROCESS DETAILS

ExxonMobil Chemical Ltd, Mossmorran
A05 - Furncace 5
28th - 30th March 2022

Standard Operating Conditions

Parameter	Value
Process Status	Operational
Continuous or Batch Process	Continuous
Feedstock (if applicable)	N/A
Abatement System	None
Abatement System Running Status	N/A
Fuel	Internal site fuel gas
Plume Appearance	No plume visible

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MONITORING & ANALYTICAL METHODS

ExxonMobil Chemical Ltd, Mossmorran

A05 - Furnace 5

28th - 30th March 2022

Parameter	Monitoring				Analysis				Overall Status	LOD (Average)
	Standard	Technical Procedure	Sampling Status	Testing Lab	Analytical Procedure	Analytical Technique	Analysis Status	Analysis Lab		
Total Particulate Matter	EN 13284-1	CAT-TP-01	MCERTS	EET	CAT-TP-03	Gravimetric	MCERTS	EET	MCERTS	0.21 mg/m ³
Sulphur Dioxide	EN 14791	CAT-TP-09	MCERTS	EET	CAT-AP-01	IC	MCERTS	EET	MCERTS	0.02 mg/m ³
Water Vapour	EN 14790	CAT-TP-05	MCERTS	EET	CAT-TP-05	Gravimetric	MCERTS	EET	MCERTS	0.10 % v/v
Oxides of Nitrogen (as NO ₂)	EN 14792	CAT-TP-39	MCERTS	EET	Chemiluminescence by Horiba PG-350E				MCERTS	0.41 mg/m ³
Carbon Monoxide	EN 15058	CAT-TP-39	MCERTS	EET	NDIR by Horiba PG-350E				MCERTS	0.3 mg/m ³
Oxygen	EN 14789	CAT-TP-39	MCERTS	EET	Dry Paramagnetic Cell by Horiba PG-350E				MCERTS	0.1 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	MCERTS	EET	Pitot Tube and Thermocouple				MCERTS	1.2 m/s

ANALYSIS LABORATORIES

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

Element (Stockport Lab - EET)	ISO 17025 Accreditation Number: 4279
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SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Total Particulate Matter.	All runs.	Only one out of two required sampling lines was available, however the number of sample points used on the available line were increased to the minimum required by the Standard.

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SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	2.00
Width	m	-
Area	m ²	3.14
Port Depth	cm	10
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	6" Flange

Location of Sampling Platform

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

Platform Details

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

Sampling Location / Platform Improvement Recommendations

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

EN 15259 Homogeneity Test Requirements

According to EN 15259, a Homogeneity Test is required on this stack, however, as far as we are aware, it has not yet been undertaken. Unless agreed otherwise with the respective regulator, we would recommend that the Homogeneity Test be undertaken prior to the next set of emissions testing on this stack, and would be happy to carry out the work. Please contact Element for further details.

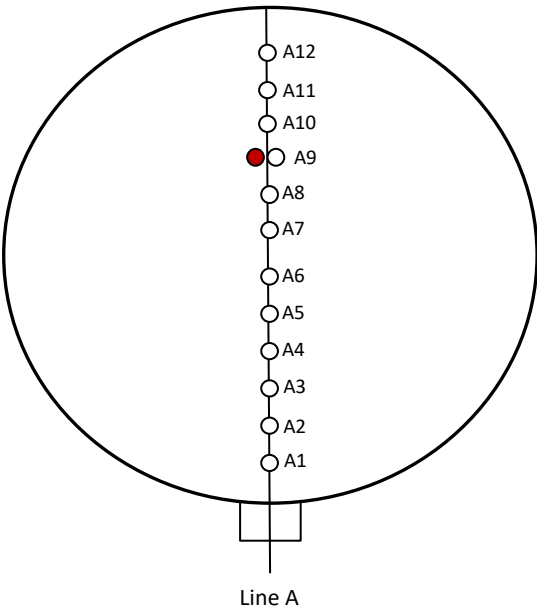
Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	86.3	> 5 Pa	Yes
Mean Velocity	m/s	12.46	-	-
Lowest Gas Velocity	m/s	12.11	-	-
Highest Gas Velocity	m/s	12.91	-	-
Ratio of Above	: 1	1.07	< 3 : 1	Yes
Maximum Angle of Swirl	°	5.00	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

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SAMPLE POINTS



where

○

= isokinetic point sampled at

●

= combustion gases sample point

APPENDICES

APPENDIX CONTENTS

APPENDIX 1 - Stack Emissions Monitoring Personnel, List of Equipment & Methods and Technical Procedures Used

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

APPENDIX 1

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
		MCERTS Level 2		TE1 TE2 TE3 TE4
		MCERTS Level 1		TE1
		MCERTS Level 1		TE1

LIST OF EQUIPMENT

Extractive Sampling		Instrumental Analysers		Miscellaneous Items	
Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.
Control Box DGM (1)	CAT 7.107	Horiba PG-250	-	Digital Manometer (1)	CAT 3.241
Control Box DGM (2)	-	Horiba PG-350E	CAT 39.28	Digital Manometer (2)	-
Box Thermocouples (1)	CAT 3.238	Servomex 4900	-	Digital Temperature Meter	-
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	CAT 14.53
Umbilical (1)	CAT 3.238	ABB AO2020-URAS26	-	Barometer	CAT 13.61
Umbilical (2)	-	Testo 350 XL	-	Stack Thermocouple (1)	CAT 4.00094
Oven Box (1)	-	JCT JCC P1 Cooler	CAT 4.0106	Stack Thermocouple (2)	CAT 4.1522
Oven Box (2)	-	Gasmet DX4000	-	Stack Thermocouple (3)	-
Heated Probe (1)	CAT 5.197	Gasmet Sampling System	-	1m Heated Line (1)	-
Heated Probe (2)	-	Sick 3006	-	1m Heated Line (2)	-
Heated Probe (3)	-	M&C PSS	CAT 12.149	1m Heated Line (3)	-
S-Pitot (1)	CAT 21S.74	Mass Flow Controller (1)	CAT 6.83	5m Heated Line (1)	-
S-Pitot (2)	CAT 21P.179	Mass Flow Controller (2)	CAT 6.84	10m Heated Line (1)	-
L-Pitot	-	Mass View (1)	-	20m Heated Line (1)	CAT 20.184
Site Balance	CAT 17.63	Mass View (2)	-	20m Heated Line (2)	-
500g / 1Kg Check Weights	CAT 17.63	Hioki 5043 (V)	-	Dual Channel Heater Controller	-
Last Impinger Arm	-	Hioki 5031 (mA)	-	Single Channel Heater Controller	-
Callipers	CAT 23.59	Bioaerosols Temperature Logger	-	Laboratory Balance	CAT 1.18, 1.18a, 1.18b
Tubes Kit Thermocouple	-	Electronic Refrigerator	-	Tape Measure	CAT 1.26

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
Sulphur Dioxide	EN 14791	CAT-TP-09
Water Vapour	EN 14790	CAT-TP-05
Oxides of Nitrogen (as NO ₂)	EN 14792	CAT-TP-39
Carbon Monoxide	EN 15058	CAT-TP-39
Oxygen	EN 14789	CAT-TP-39
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	2.00
Stack Width, W	m	-
Stack Area, A	m ²	3.14
Average Stack Gas Temperature, T _a	°C	144.0
Average Stack Gas Pressure	mmH ₂ O	9.3
Average Stack Static Pressure, P _{static}	kPa	-0.120
Average Barometric Pressure, P _b	kPa	101.0
Average Pitot Tube Calibration Coefficient, C _p	-	0.83

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m ³ p	Conc kg/m ³ p _i
CO ₂ (Estimated)	-	9.00	7.56	0.0900	44.01	1.9635	0.17672
O ₂	-	4.21	3.54	0.0421	32.00	1.4277	0.06016
N ₂	-	86.79	72.87	0.8679	28.01	1.2498	1.08469
Moisture (H ₂ O)	-	-	16.03	0.1603	18.02	0.8037	0.12885

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P _{STD}	kg/m ³	1.322
Wet Density (STP), P _{STW}	kg/m ³	1.239
Dry Density (Actual), P _{Actual}	kg/m ³	0.862
Average Wet Density (Actual), P _{ActualW}	kg/m ³	0.807

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

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

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

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF ¹
Temperature	°C	144.0	0.0
Total Pressure	kPa	100.9	101.3
Moisture	%	16.03	0.00
Oxygen (Dry)	%	4.2	3.0

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m ³ /hr	140914
Gas Volumetric Flowrate (STP, Wet)	m ³ /hr	91871
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	77143
Gas Volumetric Flowrate REF ¹	m ³ /hr	71940

APPENDIX 2

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	29/03/2022
Time of Survey	-	12:02 - 12:15
Atmospheric Pressure	kPa	101.0
Average Stack Static Pressure	Pa	-120
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 210 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.83
Number of Lines Available	-	1
Number of Lines Used	-	1

Sampling Line A						
Traverse Point	Depth m	ΔP mmH ₂ O	Temp °C	Wet Density kg/m ³	Velocity m/s	Swirl °
STATIC (Units: Pa)		-120.0				
Mean		9.3	144	0.81	12.5	
1	0.04	9.3	144	0.81	12.4	3
2	0.13	10.0	144	0.81	12.9	3
3	0.24	8.9	144	0.81	12.2	4
4	0.35	8.8	144	0.81	12.1	5
5	0.50	9.5	144	0.81	12.6	3
6	0.71	9.7	144	0.81	12.7	4
7	1.29	10.0	144	0.81	12.9	4
8	1.50	8.9	144	0.81	12.2	4
9	1.65	9.0	144	0.81	12.2	3
10	1.76	9.3	144	0.81	12.4	4
11	1.87	9.0	144	0.81	12.2	4
12	1.96	9.4	144	0.81	12.5	4

APPENDIX 2

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

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	$u(k)$	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	$u(\Delta p_i)$	1.838	Pa
- Resolution	$u(res)$	0.00087	
- Calibration	$u(cal)$	0.869	
- Drift	$u(drift)$	0.083	
- Lack of Fit	$u(fit)$	1.424	
- Overall corrections to dynamic measurements	$u(C_f)$	2.377	
Standard uncertainty associated with the molar mass of the gas	$u(M)$	0.00009	-
- $\phi O_2, w$	-	3.538	
- $\phi CO_2, w$	-	7.557	
- Oxygen, dry	$u(\phi O_2, d)$	0.129	
- Carbon Dioxide, dry	$u(\phi CO_2, d)$	0.276	
- Water Vapour	$u(\phi H_2O)$	0.818	
- Oxygen, wet	$u(\phi O_2, w)$	0.114	
- Carbon Dioxide, wet	$u(\phi CO_2, w)$	0.243	
Standard uncertainty associated with the stack temperature	$u(T_c)$	2.128	K
Standard uncertainty associated with the absolute pressure in the duct	$u(p_c)$	175.702	Pa
- Atmospheric Pressure	$u(p_{atm})$	175.692	
- Static Pressure	$u(p_{stat})$	1.838	
Standard uncertainty associated with the density in the duct	$u(\rho)$	0.00435	-
Standard uncertainty associated with the local velocities	$u(v_i)$	1.231	Pa
Standard uncertainty associated with the mean velocity	$u(\bar{v})$	0.358	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	$U_c(v)$	0.702	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	$U_{c,rel}(v)$	5.63	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	$U_c(qV, w)$	10183.6	m ³ /hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV, w)/q^2V, w$	-	0.00136	
- $u^2(qV, w)$	-	26995435	
- $u(qV, w)$	-	5195.7	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	$U_{c,rel}(qV, w)$	7.23	%

APPENDIX 2

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

ExxonMobil Chemical Ltd, Mossmorran
A05 - Furnace 5

Sample Runs

Parameter	Units	Run 1	Run 2		Mean
Concentration	mg/m ³	0.22	0.21		0.22
Uncertainty	±mg/m ³	0.45	0.44		0.44
Mass Emission	g/hr	16.4	15.2		15.8
Uncertainty	±g/hr	32.8	32.1		32.5

NOTE: Where the maximum Blank concentration is higher than the Sample concentration, the maximum Blank concentration has been reported.

Parameter	Units	Run 1	Run 2		Mean
Water Vapour	% v/v	16.6	15.5		16.0
Uncertainty	±% v/v	0.84	0.79		0.82

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m ³	0.21		0.21

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

General Sampling Information

Parameter	Value
Standard	EN 13284-1
Technical Procedure	CAT-TP-01
Probe Material	Titanium
Filter Housing Material	Titanium
Positioning of Filter	In Stack
Filter Size and Material	47mm Quartz Fibre
Number of Sampling Lines Used	1 / 2
Number of Sampling Points Used	12 / 12
Sample Point I.D.'s	A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11 & A12

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 3% oxygen.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	Run 2	
Absolute pressure of stack gas, P_s				
Barometric pressure, P_b	mmHg	757.6	757.6	
Stack static pressure, P_{static}	mmH ₂ O	-12.2	-12.2	
$P_s = (P_b + (P_{static} / 13.6))$	mmHg	756.7	756.7	
Volume of water vapour collected, V_{wstd}				
Total mass collected in impingers (liquid trap)	g	157.9	155.6	
Total mass collected in impingers (silica trap)	g	43.5	38.0	
Total mass of liquid collected, V_{lc}	g	201.4	193.6	
$V_{wstd} = (0.001246)(V_{lc})$	m ³	0.2509	0.2412	
Volume of gas metered dry, V_{mstd}				
Volume of gas sample through gas meter, V_m	m ³	1.3754	1.4531	
Gas meter correction factor, Y_d	-	0.9700	0.9700	
Average dry gas meter temperature, T_m	°C	15.9	20.2	
Average pressure drop across orifice, ΔH	mmH ₂ O	54.2	62.1	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m ³	1.2635	1.3159	
Moisture content, B_{wo} & R_{wv}				
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m ³	0.1657	0.1549	
B_{wo} as a percentage	% v/v	16.57	15.49	
Reported Water Vapour, checked with Tables in EN 14790, R_{wv}	% v/v	16.57	15.49	
Volume of gas metered wet, V_{mstw}				
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m ³	1.5144	1.5571	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$				
IED & Incinerates Hazardous Material? (Yes = no positive O ₂ correction)	-	No	No	
% wet oxygen measured in gas stream, ACT%O _{2w}	% v/v	3.55	3.52	
% dry oxygen measured in gas stream, ACT%O _{2d}	% v/v	4.23	4.20	
% oxygen reference condition, REF%O ₂	% v/v	3.00	3.00	
O ₂ Reference Factor wet ($O_{2REFw} = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$)	-	1.03	1.03	
O ₂ Reference Factor dry ($O_{2REFd} = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$)	-	1.07	1.07	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m ³	1.4680	1.5118	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m ³	1.1772	1.2284	
Molecular weight of dry gas stream, M_d				
CO ₂ (Estimated)	% v/v	9.00	9.00	
O ₂	% v/v	4.23	4.20	
Total	% v/v	13.23	13.20	
N ₂	% v/v	86.77	86.80	
$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2)$	g/gmol	29.61	29.61	
Molecular weight of stack gas (wet), M_s				
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	27.69	27.81	
Velocity of stack gas, V_s				
Pitot tube velocity constant, K_p	-	34.97	34.97	
Velocity pressure coefficient, C_p	-	0.85	0.85	
Average of velocity heads, ΔP_{avg}	mmH ₂ O	8.95	9.50	
Average square root of velocity heads, $\sqrt{\Delta P}$	√mmH ₂ O	2.99	3.08	
Average stack gas temperature, T_s	°C	143.8	144.0	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})) / (V(M_s)(P_s))$	m/s	12.51	12.87	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})				
Area of stack, A_s	m ²	3.14	3.14	
$Q_a = (60)(A_s)(V_s)$	m ³ /min	2359.1	2425.7	
Conversion factor (K/mm.Hg), C_f	-	0.3592	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m ³ /min	1538.4	1581.0	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m ³ /min	1283.4	1336.1	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m ³ /min	1491.3	1534.9	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m ³ /min	1195.8	1247.2	
Percent isokinetic, %I				
Nozzle diameter, D_n	mm	8.00	8.00	
Nozzle area, A_n	mm ²	50.27	50.27	
Total sampling time, q	min	60	60	
$\%I = (4.6398E^6)(T_s + 273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	102.5	102.6	

APPENDIX 2

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2
Sampling Times	-	11:15 - 12:15	12:26 - 13:26
Sampling Dates	-	29/03/2022	29/03/2022
Sampling Device	-	ISO	ISO
Volume Sampled (REF)	m ³	1.1772	1.2284
Filter I.D. Number	-	47-87367	47-87376
Start Filter Mass	g	0.14057	0.14054
End Filter Mass	g	0.14053	0.14035
Total Mass on Filter	g	-0.00004	-0.00019
Probe Rinse I.D. Number	-	PR-47-87367	PR-47-87376
Start Probe Rinse Mass	g	2.78124	2.97760
End Probe Rinse Mass	g	2.78154	2.97801
Total Mass in Probe Rinse	g	0.00030	0.00040
Total Mass Collected	mg	0.26	0.21
Calculated Concentration	mg/m ³	0.22	0.17
Balance Uncertainty / LOD	mg/m ³	0.21	0.20

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	29/03/2022
Average Volume Sampled (REF)	m ³	1.2028
Filter I.D. Number	-	47-82491
Start Filter Mass	g	0.14636
End Filter Mass	g	0.14634
Total Mass on Filter	g	-0.00002
Probe Rinse I.D. Number	-	PR-47-82491
Start Probe Rinse Mass	g	2.92758
End Probe Rinse Mass	g	2.92777
Total Mass in Probe Rinse	g	0.00019
Total Mass Collected	mg	0.17
Calculated Concentration	mg/m ³	0.14
Balance Uncertainty / LOD	mg/m ³	0.21

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	Run 2	
Mean Sampling Rate	l/min	22.2	23.5	
Pre-Sampling Leak Rate	l/min	0.07	0.03	
Post-Sampling Leak Rate	l/min			
Allowable Leak Rate	l/min	N/A	N/A	
Leak Test Acceptable	-	Yes	Yes	
Water Droplets	Units	Run 1	Run 2	
Are Water Droplets Present	-	No	No	
MU (Concurrent Water Vapour)	Units	Run 1	Run 2	
Measurement Uncertainty (MU)	%	5.1	5.1	
Allowable MU	%	20.0	20.0	
MU Acceptable	%	Yes	Yes	
Silica Gel (Concurrent Water Vapour)	Units	Run 1	Run 2	
Less than 50% Faded	%	Yes	Yes	
Isokinetic Criterion Compliance	Units	Run 1	Run 2	
Isokinetic Variation	%	102.5	102.6	
Allowable Isokinetic Range	%	95 - 115	95 - 115	
Isokineticity Acceptable	-	Yes	Yes	
Weighing Uncertainty Criteria	Units	Run 1	Run 2	
Overall Weighing Uncertainty	± mg	0.35	0.35	
Overall Weighing Uncertainty	± mg/m ³	0.30	0.29	
ELV [Daily ELV for IED]	mg/m ³	N/A	N/A	
Allowable Weighing Uncertainty	mg/m ³	N/A	N/A	
Weighing Uncertainty Acceptable	-	N/A	N/A	
Filter Temperatures	Units	Run 1	Run 2	
Pre-Conditioning Temperature	°C	180	180	
Post-Conditioning Temperature	°C	160	160	
Maximum Filter Temperature	°C	144	144	
Test Conditions	Units	Run 1	Run 2	
Ambient Temperature Recorded?	-	Yes	Yes	

APPENDIX 2

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	20.0	
Pre-Sampling Leak Rate	l/min	0.07	
Post-Sampling Leak Rate	l/min		
Allowable Leak Rate	l/min	N/A	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m ³	N/A	
Blank Acceptable	-	N/A	

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

Method Deviations

Nature of Deviation	Run Number		
	1	2	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)			
Only one out of two required sampling lines was available, however the number of sample points used on the available line were increased to the minimum required by the Standard	x	x	

APPENDIX 2

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty				
Measured Quantities	Symbol	Run 1	Run 2	Symbol	Units	Run 1	Run 2	
Sampled Volume (Actual)	V _m	1.3754	1.4531	uV _m	m ³	0.0275	0.0291	
Sampled Gas Temperature	T _m	288.9	293.2	uT _m	K	2.00	2.00	
Sampled Gas Pressure	p _m	100.9	100.9	up _m	kPa	0.50	0.50	
Sampled Gas Humidity	H _m	0.00	0.00	uH _m	% v/v	1.00	1.00	
Leak	L	0.31	0.13	uL	%	-	-	
Mass of Particulate	m	0.26	0.25	um	mg	0.25	0.25	
Uncollected Mass	UCM	0.17	0.17	uUCM	mg	-	-	

Measured Quantities	Uncertainty as a Percentage			Requirement of Standard
	Units	Run 1	Run 2	
Sampled Volume (Actual)	%	2.00	2.00	≤2%
Sampled Gas Temperature	%	0.69	0.68	≤1%
Sampled Gas Pressure	%	0.50	0.50	≤1%
Sampled Gas Humidity	%	1.00	1.00	≤1%
Leak	%	0.31	0.13	≤2%
Mass of Particulate	%	-	-	<5% of ELV
Uncollected Mass	%	-	-	-

Measured Quantities	Uncertainty in Measurement Units				Sensitivity Coefficient	
	Symbol	Units	Run 1	Run 2	Run 1	Run 2
Sampled Volume (STP)	V _m	m ³	1.2635	1.3159	0.18	0.16
Leak	L	mg/m ³	0.000	0.000	1.00	1.00
Mass of Particulate	L _r	mg	0.263	0.250	0.85	0.83
Uncollected Mass	UCM	mg	0.10	0.10	0.85	0.83

Measured Quantities	Uncertainty in Result		
	Units	Run 1	Run 2
Sampled Volume (STP)	mg/m ³	0.006	0.005
Leak	mg/m ³	0.0004	0.0002
Mass of Particulate	mg/m ³	0.2124	0.2079
Uncollected Mass	mg/m ³	0.0834	0.0816

Measured Quantities	Oxygen Correction Part of MU Budget		
	Units	Run 1	Run 2
O ₂ Correction Factor	-	1.07	1.07
Stack Gas O ₂ Content	% v/v	4.23	4.20
MU for O ₂ Correction	-	0.03	0.03
Overall MU For O ₂ Measurement	%	2.98	2.98

Parameter	Units	Run 1	Run 2
Combined uncertainty	mg/m ³	0.23	0.22
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m ³	0.45	0.44
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m ³	0.45	0.44
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	0.45	0.44
Reported Uncertainty	mg/m ³	0.45	0.44
Expanded uncertainty (95% confidence), without Oxygen Correction	%	200.0	210.6
Expanded uncertainty (95% confidence), with Oxygen Correction	%	200.0	210.6
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	200.0	210.6
Reported Uncertainty	%	200.0	210.6

APPENDIX 2

SULPHUR DIOXIDE: RESULTS SUMMARY

ExxonMobil Chemical Ltd, Mossmorran
A05 - Furncace 5

Sample Runs

Parameter	Units	Run 1	Run 2	Mean
Concentration	mg/m ³	0.91	0.67	0.79
Uncertainty	±mg/m ³	0.07	0.05	0.06
Mass Emission	g/hr	66.5	49.1	57.8
Uncertainty	±g/hr	7.2	5.3	6.3

Parameter	Units	Run 1	Run 2	Mean
Water Vapour	% v/v	16.6	15.5	16.0
Uncertainty	±% v/v	0.84	0.79	0.82

Blank Runs

Parameter	Units	Blank 1	Maximum
Concentration	mg/m ³	< 0.01	< 0.01

General Sampling Information

Parameter	Value
Standard	EN 14791
Technical Procedure	CAT-TP-09
Name of Analytical Laboratory	EET
Analytical Laboratory's Procedure	CAT-AP-01
ISO 17025 Accredited Analysis?	MCERTS
Date of Sample Analysis	07/04/2022
Probe Material	Titanium
Filter Housing Material	Titanium
Impinger Material	Polyethylene
Absorption Solution	3% Hydrogen Peroxide
Positioning of Filter	In Stack
Filter Size and Material	47mm Quartz Fibre
Number of Sampling Lines Used	1 / 2
Number of Sampling Points Used	12 / 12
Sample Point I.D.'s	A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11 & A12

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 3% oxygen.

APPENDIX 2

SULPHUR DIOXIDE: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	Run 2	
Absolute pressure of stack gas, P_s				
Barometric pressure, P_b	mmHg	757.6	757.6	
Stack static pressure, P_{static}	mmH ₂ O	-12.2	-12.2	
$P_s = (P_b + (P_{static} / 13.6))$	mmHg	756.7	756.7	
Volume of water vapour collected, V_{wstd}				
Total mass collected in impingers (liquid trap)	g	157.9	155.6	
Total mass collected in impingers (silica trap)	g	43.5	38.0	
Total mass of liquid collected, V_{lc}	g	201.4	193.6	
$V_{wstd} = (0.001246)(V_{lc})$	m ³	0.2509	0.2412	
Volume of gas metered dry, V_{mstd}				
Volume of gas sample through gas meter, V_m	m ³	1.3754	1.4531	
Gas meter correction factor, Y_d	-	0.9700	0.9700	
Average dry gas meter temperature, T_m	°C	15.9	20.2	
Average pressure drop across orifice, ΔH	mmH ₂ O	54.2	62.1	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m ³	1.2635	1.3159	
Moisture content, B_{wo} & R_{wv}				
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m ³	0.1657	0.1549	
B_{wo} as a percentage	% v/v	16.57	15.49	
Reported Water Vapour, checked with Tables in EN 14790, R_{wv}	% v/v	16.57	15.49	
Volume of gas metered wet, V_{mstw}				
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m ³	1.5144	1.5571	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$				
IED & Incinerates Hazardous Material? (Yes = no positive O ₂ correction)	-	No	No	
% wet oxygen measured in gas stream, ACT%O _{2w}	% v/v	3.55	3.52	
% dry oxygen measured in gas stream, ACT%O _{2d}	% v/v	4.23	4.20	
% oxygen reference condition, REF%O ₂	% v/v	3.00	3.00	
O ₂ Reference Factor wet ($O_{2REFw} = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$)	-	1.03	1.03	
O ₂ Reference Factor dry ($O_{2REFd} = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$)	-	1.07	1.07	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m ³	1.4680	1.5118	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m ³	1.1772	1.2284	
Molecular weight of dry gas stream, M_d				
CO ₂ (Estimated)	% v/v	9.00	9.00	
O ₂	% v/v	4.23	4.20	
Total	% v/v	13.23	13.20	
N ₂	% v/v	86.77	86.80	
$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2)$	g/gmol	29.61	29.61	
Molecular weight of stack gas (wet), M_s				
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	27.69	27.81	
Velocity of stack gas, V_s				
Pitot tube velocity constant, K_p	-	34.97	34.97	
Velocity pressure coefficient, C_p	-	0.85	0.85	
Average of velocity heads, ΔP_{avg}	mmH ₂ O	8.95	9.50	
Average square root of velocity heads, $\sqrt{\Delta P}$	√mmH ₂ O	2.99	3.08	
Average stack gas temperature, T_s	°C	143.8	144.0	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})) / (V(M_s)(P_s))$	m/s	12.51	12.87	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})				
Area of stack, A_s	m ²	3.14	3.14	
$Q_a = (60)(A_s)(V_s)$	m ³ /min	2359.1	2425.7	
Conversion factor (K/mm.Hg), C_f	-	0.3592	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m ³ /min	1538.4	1581.0	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m ³ /min	1283.4	1336.1	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m ³ /min	1491.3	1534.9	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m ³ /min	1195.8	1247.2	
Percent isokinetic, %I				
Nozzle diameter, D_n	mm	8.00	8.00	
Nozzle area, A_n	mm ²	50.27	50.27	
Total sampling time, q	min	60	60	
$\%I = (4.6398E^6)(T_s + 273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	102.5	102.6	

APPENDIX 2

SULPHUR DIOXIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	Run 2
Sampling Times	-	11:15 - 12:15	12:26 - 13:26
Sampling Dates	-	29/03/2022	29/03/2022
Sampling Device	-	ISO	ISO
Volume Sampled (REF)	m ³	1.1772	1.2284
Laboratory Result for Front Impingers	µg/ml	2.97	1.64
Laboratory Result for Back Impinger	µg/ml	0.14	
Volume in Front Impingers	ml	352.2	501.3
Volume in Back Impinger	ml	158.6	
Mass in Front Impingers	µg	1046.0	822.1
Mass in Back Impinger	µg	22.2	
Total Mass Collected	µg	1068.2	822.1
Calculated Concentration	mg/m ³	0.91	0.67

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	29/03/2022
Average Volume Sampled (REF)	m ³	1.2028
Laboratory Result for Impingers	µg/ml	< 0.05
Volume in Impingers	ml	322.6
Total Mass Collected	µg	< 16.1
Calculated Concentration	mg/m ³	< 0.01

APPENDIX 2

SULPHUR DIOXIDE: QUALITY ASSURANCE

(PAGE 1 OF 2)

Sample Runs

Leak Test Results	Units	Run 1	Run 2	
Mean Sampling Rate	l/min	22.2	23.5	
Pre-Sampling Leak Rate	l/min	0.07	0.03	
Post-Sampling Leak Rate	l/min	N/A	N/A	
Allowable Leak Rate	l/min	N/A	N/A	
Leak Test Acceptable	-	Yes	Yes	
Absorption Efficiency	Units	Run 1		
Absorption Efficiency	%	97.9		
Allowable Absorption Efficiency	%	95		
Absorption Efficiency Acceptable	-	Yes		
Water Droplets	Units	Run 1	Run 2	
Are Water Droplets Present	-	No	No	
MU (Concurrent Water Vapour)	Units	Run 1	Run 2	
Measurement Uncertainty (MU)	%	5.1	5.1	
Allowable MU	%	20.0	20.0	
MU Acceptable	%	Yes	Yes	
Silica Gel (Concurrent Water Vapour)	Units	Run 1	Run 2	
Less than 50% Faded	%	Yes	Yes	
Isokinetic Criterion Compliance	Units	Run 1	Run 2	
Isokinetic Variation	%	102.5	102.6	
Allowable Isokinetic Range	%	95 - 115	95 - 115	
Isokineticity Acceptable	-	Yes	Yes	
Filter Temperatures	Units	Run 1	Run 2	
Maximum Filter Temperature	°C	144	144	
Test Conditions	Units	Run 1	Run 2	
Ambient Temperature Recorded?	-	Yes	Yes	

SULPHUR DIOXIDE: QUALITY ASSURANCE

(PAGE 2 OF 2)

Blank Runs

Leak Test Results	Units	Blank 1	
Expected Sampling Rate	l/min	20.0	
Pre-Sampling Leak Rate	l/min	0.07	
Post-Sampling Leak Rate	l/min		
Allowable Leak Rate	l/min	N/A	
Leak Test Acceptable	-	Yes	
Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m ³	N/A	
Blank Acceptable	-	N/A	

Method Deviations

Nature of Deviation	Run Number		
	1	2	
(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)			
There are no deviations associated with the sampling employed.	wx	wx	

SULPHUR DIOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value			Symbol	Standard uncertainty			
	Symbol	Run 1	Run 2		Units	Run 1	Run 2	
Sampled Volume (Actual)	V_m	1.3754	1.4531		uV_m	m ³	0.0275	0.0291
Sampled Gas Temperature	T_m	288.9	293.2		uT_m	K	2.00	2.00
Sampled Gas Pressure	p_m	100.9	100.9		up_m	kPa	0.50	0.50
Sampled Gas Humidity	H_m	0.00	0.00		uH_m	% v/v	1.00	1.00
Leak	L	0.31	0.13		uL	%	-	-
Laboratory Result	L_r	2.90	2.90		uL_r	%	-	-

Measured Quantities	Uncertainty as a Percentage			Requirement of Standard
	Units	Run 1	Run 2	
Sampled Volume (Actual)	%	2.00	2.00	≤2%
Sampled Gas Temperature	%	0.69	0.68	≤1%
Sampled Gas Pressure	%	0.50	0.50	≤1%
Sampled Gas Humidity	%	1.00	1.00	≤1%
Leak	%	0.31	0.13	≤2%
Laboratory Result	%	2.90	2.90	No Requirement

Measured Quantities	Uncertainty in Measurement Units				Sensitivity Coefficient	
	Symbol	Units	Run 1	Run 2	Run 1	Run 2
Sampled Volume (STP)	V_m	m ³	1.2635	1.3159	0.72	0.51
Leak	L	mg/m ³	0.002	0.000	1.00	1.00
Laboratory Result	L_r	mg/m ³	0.026	0.019	1.00	1.00

Measured Quantities	Uncertainty in Result		
	Units	Run 1	Run 2
Sampled Volume (STP)	mg/m ³	0.023	0.017
Leak	mg/m ³	0.0016	0.0005
Laboratory Result	mg/m ³	0.0263	0.0194

Measured Quantities	Oxygen Correction Part of MU Budget		
	Units	Run 1	Run 2
O ₂ Correction Factor	-	1.07	1.07
Stack Gas O ₂ Content	% v/v	4.23	4.20
MU for O ₂ Correction	-	0.03	0.03
Overall MU For O ₂ Measurement	%	2.98	2.98

Parameter	Units	Run 1	Run 2
Combined uncertainty	mg/m ³	0.04	0.03
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m ³	0.07	0.05
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m ³	0.07	0.05
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	0.07	0.05
Reported Uncertainty	mg/m ³	0.07	0.05
Expanded uncertainty (95% confidence), without Oxygen Correction	%	7.6	7.6
Expanded uncertainty (95% confidence), with Oxygen Correction	%	8.1	8.2
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	8.1	8.2
Reported Uncertainty	%	8.1	8.2

APPENDIX 2

OXIDES OF NITROGEN (as NO₂): RESULTS SUMMARY

ExxonMobil Chemical Ltd, Mossmorran
A05 - Furncace 5

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	195	195
Uncertainty	±mg/m ³	8.1	8.1
Mass Emission	g/hr	14319	14319
Uncertainty	±g/hr	1195	1195

General Sampling Information

Parameter	Value
Standard	EN 14792
Technical Procedure	CAT-TP-39
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Date & Result of Last Converter Check	26/05/2021 - 95.3%
Span Gas Type	Nitrogen Monoxide
Span Gas Reference Number	CYL 12.0405
Span Gas Expiry Date	05/11/2023
Span Gas Start Pressure (bar)	180
Gas Cylinder Concentration (ppm)	408.5
Span Gas Uncertainty (%)	2
Zero Gas Type	Nitrogen (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	A9

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

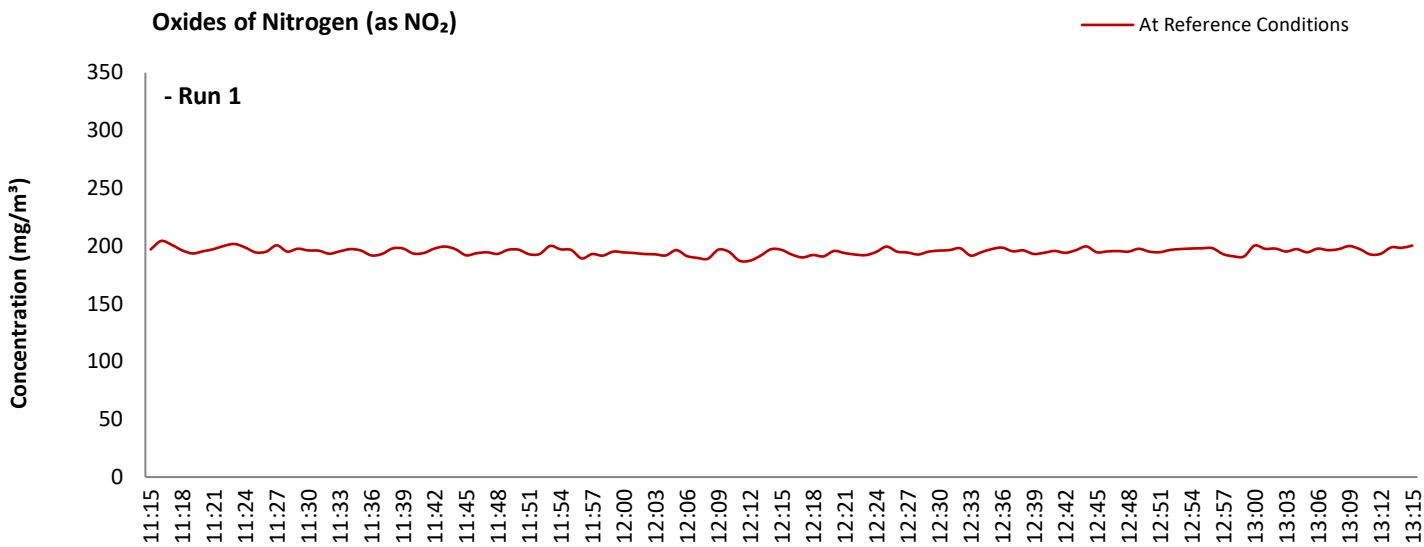
FORMAT: Number Used / Number Required

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 3% oxygen.

OXIDES OF NITROGEN (as NO₂): DATA TREND

Graphical Trend of Data



APPENDIX 2

OXIDES OF NITROGEN (as NO₂): SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	11:15 - 13:15
Sampling Dates	-	29/03/2022
Instrument Range	ppm	500
Span Gas Value	ppm	170.5

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.5
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

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

Span Drift	Units	Run 1
Span at Analyser (Pre)	ppm	170.54
Span at Analyser (Post)	ppm	170.40
Span Drift	ppm	-0.14
Zero Adj. Span Drift	%	0.08
Drift Correction Applied	2-5%	No
Allowable Span Drift	± %	5.00
Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	10

Method Deviations

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

OXIDES OF NITROGEN (as NO₂): MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	350.0	mg/m ³ (REF)
Allowable MU	10.0	%
Measured concentration	182.18	mg/m ³ (STP, dry)
Ratio NO / NO ₂	5	%
Range Used	500.0	ppm
Range Used [A]	1026.1	mg/m ³
Cal gas conc.	170.5	ppm
Conversion	2.05	ppm to mg/m ³
MCERTS Range [B]	205.0	mg/m ³
Lower of [A] or [B]	205.0	mg/m ³
Cal gas conc.	350.0	mg/m ³

Performance characteristics	RUN 1	Units
Response time	31	seconds
Number of readings in measurement	120	-
Repeatability at zero	0.00	% full scale
Repeatability at span level	0.10	% full scale
Deviation from linearity	0.31	% of value
Zero drift	0.00	% full scale
Span drift	-0.08	% full scale
Volume or pressure flow dependence	0.10	% of full scale
Atmospheric pressure dependence	0.10	% of value/kPa
Ambient temperature dependence	0.04	% full scale/10K
Combined interference	0.63	% range
Dependence on voltage	-0.23	% full scale/10V
Converter efficiency	95.3	%
Losses in the line (leak)	0.61	% of value
Uncertainty of calibration gas blending	1.40	% of value
Uncertainty of calibration gas	2.00	% of value

Performance characteristic	RUN 1	Units
Standard deviation of repeatability at zero	use rep at span	mg/m ³
Standard deviation of repeatability at span level	0.01	mg/m ³
Lack of fit	0.37	mg/m ³
Drift	0.00	mg/m ³
Volume or pressure flow dependence	0.00	mg/m ³
Atmospheric pressure dependence	0.06	mg/m ³
Ambient temperature dependence	0.01	mg/m ³
Combined interference (from MCERTS Certificate)	0.75	mg/m ³
Dependence on voltage	-0.03	mg/m ³
Converter efficiency	0.25	mg/m ³
Losses in the line (leak)	0.64	mg/m ³
Uncertainty of calibration gas blending	1.47	mg/m ³
Uncertainty of calibration gas	2.10	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		182.18	mg/m ³
Expanded uncertainty	k =	2.88	mg/m ³
Expanded uncertainty	1.96	5.65	mg/m ³
Uncertainty corrected to std conds. (O ₂)		6.06	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	3.10	% of Value
Expanded uncertainty (no O ₂) - at 95% Confidence	1.62	% at ELV
Overall Allowable uncertainty (no O ₂) - at 95% Confidence	10.0	% at ELV
Result of Compliance with Uncertainty Requirement	N/A	-

	RUN 1	Units
Expanded uncertainty (with O ₂) - at 95% Confidence	4.17	% of Value
Expanded uncertainty (with O ₂) - at 95% Confidence	3.28	% at ELV
Overall Allowable uncertainty (with O ₂) - at 95% Confidence	10.4	% at ELV
Result of Compliance with Uncertainty Requirement	COMPLIANT	-

Requirement for SRM is that Uncertainty should be <10% of the value at the ELV, on a dry gas basis, or if O₂ correction is applied less than 10% + the uncertainty associated with the O₂ correction (using sqrt of sum squares to add uncertainty components).

APPENDIX 2

CARBON MONOXIDE: RESULTS SUMMARY

ExxonMobil Chemical Ltd, Mossmorran
A05 - Furncace 5

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	1.1	1.1
Uncertainty	±mg/m ³	0.75	0.75
Mass Emission	g/hr	82.6	82.6
Uncertainty	±g/hr	55.1	55.1

General Sampling Information

Parameter	Value
Standard	EN 15058
Technical Procedure	CAT-TP-39
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Span Gas Type	Carbon Monoxide
Span Gas Reference Number	CYL 12.0405
Span Gas Expiry Date	05/11/2023
Span Gas Start Pressure (bar)	180
Gas Cylinder Concentration (ppm)	100.3
Span Gas Uncertainty (%)	2
Zero Gas Type	Nitrogen (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	A9

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

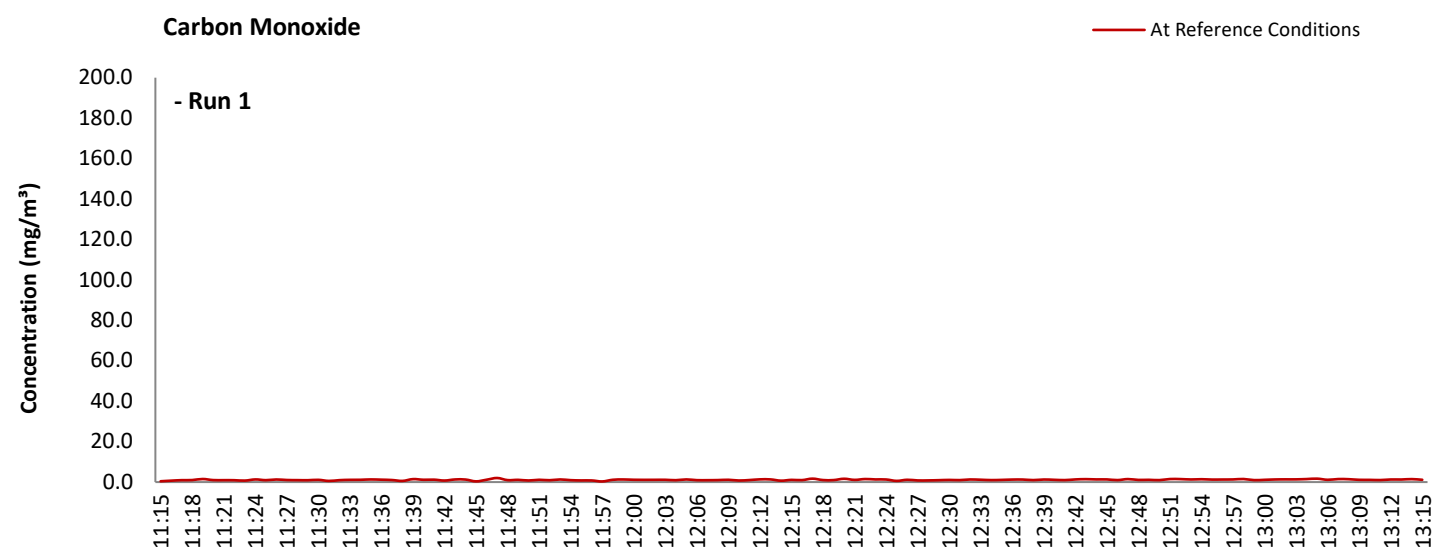
Reference Conditions

Reference Conditions are: 273K, 101.3kPa, dry gas, 3% oxygen.

APPENDIX 2

CARBON MONOXIDE: DATA TREND

Graphical Trend of Data



APPENDIX 2

CARBON MONOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	11:15 - 13:15
Sampling Dates	-	29/03/2022
Instrument Range	ppm	200
Span Gas Value	ppm	100.3

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.5
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

Zero Drift	Units	Run 1
Zero at Analyser (Pre)	ppm	0.00
Zero at Analyser (Post)	ppm	-0.30
Zero Drift	ppm	-0.30
Zero Drift	%	0.30
Drift Correction Applied	2-5%	No
Allowable Zero Drift	± %	5.00
Zero Drift Acceptable	-	Yes

Span Drift	Units	Run 1
Span at Analyser (Pre)	ppm	100.30
Span at Analyser (Post)	ppm	99.90
Span Drift	ppm	-0.40
Zero Adj. Span Drift	%	0.10
Drift Correction Applied	2-5%	No
Allowable Span Drift	± %	5.00
Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	10

Method Deviations

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

CARBON MONOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	-	mg/m ³ (REF)
Allowable MU	6.0	%
Measured concentration	1.05	mg/m ³ (STP, dry)
Range Used	200.0	ppm
Range Used [A]	249.8	mg/m ³
Cal gas conc.	100.3	ppm
Conversion	1.25	ppm to mg/m ³
MCERTS Range [B]	75.0	mg/m ³
Lower of [A] or [B]	75.0	mg/m ³
Cal gas conc.	125.3	mg/m ³

Performance characteristics	RUN 1	Units
Response time	28	seconds
Number of readings in measurement	120	-
Repeatability at zero	0.10	% full scale
Repeatability at span level	0.20	% full scale
Deviation from linearity	0.43	% of value
Zero drift	-0.30	% full scale
Span drift	-0.10	% full scale
Volume or pressure flow dependence	0.10	% of full scale
Atmospheric pressure dependence	0.22	% of value/kPa
Ambient temperature dependence	-0.20	% full scale/10K
Combined interference	-0.48	% range
Dependence on voltage	-0.35	% full scale/10V
Losses in the line (leak)	1.10	% of value
Uncertainty of calibration gas blending	1.40	% of value
Uncertainty of calibration gas	2.00	% of value

Performance characteristic	RUN 1	Units
Standard deviation of repeatability at zero	use rep at span	mg/m ³
Standard deviation of repeatability at span level	0.02	mg/m ³
Lack of fit	0.19	mg/m ³
Drift	0.00	mg/m ³
Volume or pressure flow dependence	0.00	mg/m ³
Atmospheric pressure dependence	0.05	mg/m ³
Ambient temperature dependence	-0.03	mg/m ³
Combined interference (from MCERTS Certificate)	-0.21	mg/m ³
Dependence on voltage	-0.04	mg/m ³
Losses in the line (leak)	0.01	mg/m ³
Uncertainty of calibration gas blending	0.01	mg/m ³
Uncertainty of calibration gas	0.01	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		1.05	mg/m ³
Expanded uncertainty	k = 1.96	0.36	mg/m ³
Expanded uncertainty		0.70	mg/m ³
Uncertainty corrected to std conds. (O ₂)		0.75	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	66.33	% of Value
Expanded uncertainty (no O ₂) - at 95% Confidence	N/A	% at ELV
Overall Allowable uncertainty (no O ₂) - at 95% Confidence	N/A	% at ELV
Result of Compliance with Uncertainty Requirement	N/A	-

	RUN 1	Units
Expanded uncertainty (with O ₂) - at 95% Confidence	66.39	% of Value
Expanded uncertainty (with O ₂) - at 95% Confidence	N/A	% at ELV
Overall Allowable uncertainty (with O ₂) - at 95% Confidence	N/A	% at ELV
Result of Compliance with Uncertainty Requirement	N/A	-

Requirement for SRM is that Uncertainty should be <6% of the value at the ELV, on a dry gas basis, or if O₂ correction is applied less than 6% + the uncertainty associated with the O₂ correction (using sqrt of sum squares to add uncertainty components).

APPENDIX 2

OXYGEN: RESULTS SUMMARY

ExxonMobil Chemical Ltd, Mossmorran
A05 - Furncace 5

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	% v/v	4.2		4.2
Uncertainty	±% v/v	0.12		0.12

General Sampling Information

Parameter	Value
Standard	EN 14789
Technical Procedure	CAT-TP-39
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Span Gas Type	Synthetic Air (5 Grade)
Span Gas Reference Number	CYL 11.0519
Span Gas Expiry Date	14/03/2027
Span Gas Start Pressure (bar)	170
Gas Cylinder Concentration (% v/v)	21.14
Span Gas Uncertainty (%)	2
Zero Gas Type	Nitrogen (5 Grade)
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	A9

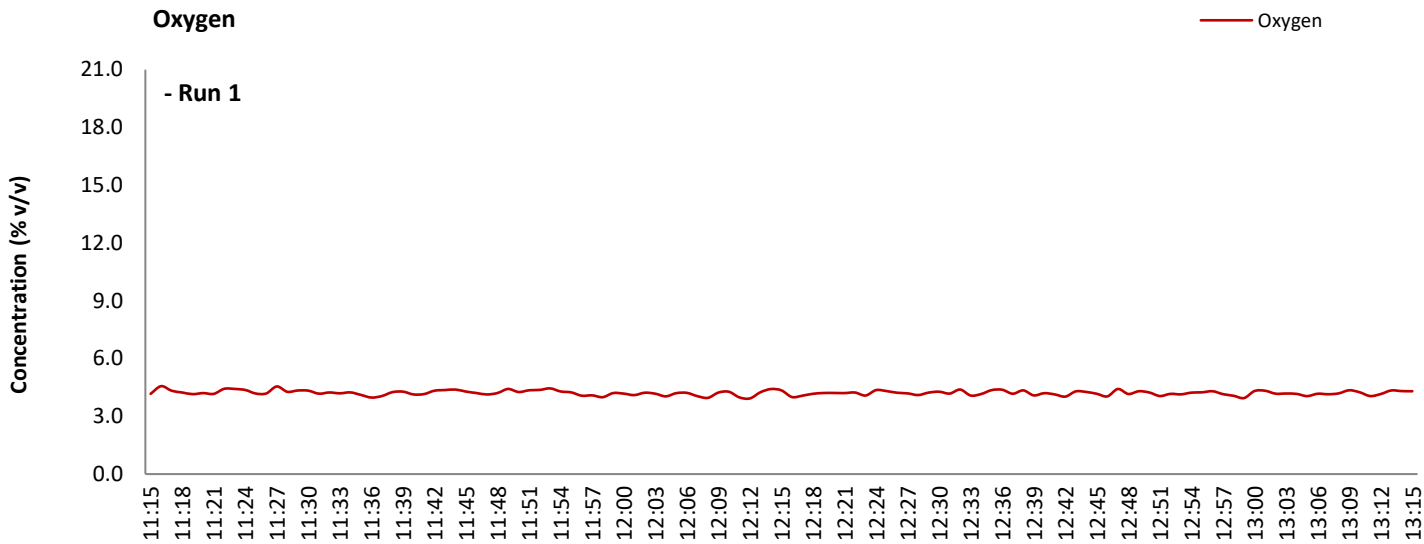
NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

OXYGEN: DATA TREND

Graphical Trend of Data



APPENDIX 2

OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	11:15 - 13:15
Sampling Dates	-	29/03/2022
Instrument Range	% v/v	25.0
Span Gas Value	% v/v	3.0

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.5
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

Zero Drift	Units	Run 1
Zero at Analyser (Pre)	% v/v	0.00
Zero at Analyser (Post)	% v/v	0.09
Zero Drift	% v/v	0.09
Zero Drift	%	2.90
Drift Correction Applied	2-5%	Yes
Allowable Zero Drift	± %	5.00
Zero Drift Acceptable	-	Yes

Span Drift	Units	Run 1
Span at Analyser (Pre)	% v/v	3.10
Span at Analyser (Post)	% v/v	3.12
Span Drift	% v/v	0.02
Zero Adj. Span Drift	%	2.33
Drift Correction Applied	2-5%	Yes
Allowable Span Drift	± %	5.00
Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	10

Method Deviations

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

APPENDIX 2

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	N/A	%vol
Allowable MU	6.0	%
Measured concentration	4.22	%vol
Range Used	25.0	%vol
Cal gas conc.	21.1	%vol

Performance characteristics	RUN 1	Units
Response time	41	seconds
Number of readings in measurement	120	-
Repeatability at zero	0.02	% full scale
Repeatability at span level	0.02	% full scale
Deviation from linearity	0.07	% of value
Zero drift	0.00	% full scale
Span drift	0.00	% full scale
Volume or pressure flow dependence	0.10	% of full scale
Atmospheric pressure dependence	0.19	% of value/kPa
Ambient temperature dependence	-0.21	% full scale/10K
Combined interference	0.00	% range
Dependence on voltage	0.02	% full scale/10V
Losses in the line (leak)	0.00	% of value
Uncertainty of calibration gas	2.00	% of value

Performance characteristic	RUN 1	Units
Standard deviation of repeatability at zero	use rep at span	%vol
Standard deviation of repeatability at span level	0.00	%vol
Lack of fit	0.01	%vol
Drift	0.00	%vol
Volume or pressure flow dependence	0.00	%vol
Atmospheric pressure dependence	0.01	%vol
Ambient temperature dependence	-0.03	%vol
Combined interference (from MCERTS Certificate)	0.00	%vol
Dependence on voltage	0.00	%vol
Losses in the line (leak)	0.00	%vol
Uncertainty of calibration gas	0.05	%vol

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		0.06	%vol
Expanded uncertainty	k = 1.96	0.12	%vol

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	2.78	% of Value
Result of Compliance with Uncertainty Requirement	COMPLIANT	-

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

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