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Stack Emissions Testing Report Commissioned by
Fujifilm Diosynth Biotechnologies UK Ltd

Installation Name & Address
Fujifilm Diosynth Biotechnologies UK Ltd
Chilton site
PO Box 2
Belasis Avenue
Billingham
Stockton on Tees
TS23 1YN

EPR Permit: BJ89871Q

Stack Reference
Babcock boiler

Dates of the Monitoring Campaign
22nd January 2024

Job Reference Number
EMT08336

Report Written by
Kelvin Moore Team Leader MCERTS Level 2 MM 02 057 TE1 TE2 TE3 TE4

Report Approved by
John McBride Site Manager MCERTS Level 2 MM 04 515 TE1 TE2 TE3 TE4

Report Date
31st January 2024

Version
Version 1

Signature of Report Approver

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Executive Summary

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MONITORING OBJECTIVES

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham

Babcock boiler

22nd January 2024

Overall Aim of the Monitoring Campaign

Element were commissioned by Fujifilm Diosynth Biotechnologies UK Ltd to carry out stack emissions testing on the Babcock boiler at Billingham.

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

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

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MONITORING RESULTS

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham
Babcock boiler
22nd January 2024

where MU = Measurement Uncertainty associated with the Result

Parameter	Concentration				Mass Emission			
	Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Sulphur Dioxide	¹ mg/m ³	1.2	0.059	-	g/hr	4.1	0.3	-
Oxides of Nitrogen (as NO ₂)	¹ mg/m ³	167	7.6	200	g/hr	589	41.1	-
Carbon Monoxide	¹ mg/m ³	58.7	2.7	-	g/hr	207	14.5	-
Oxygen	% v/v	Dry 2.6	0.090					
Water Vapour	% v/v	3.7	0.88					
Stack Gas Temperature	°C	209						
Stack Gas Velocity	m/s	7.3	0.20					
Volumetric Flow Rate (ACTUAL)	m ³ /hr	6430	339					
Volumetric Flow Rate (REF)	¹ m ³ /hr	3525	186					

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

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

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MONITORING DATE(S) & TIMES

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham
 Babcock boiler
 22nd January 2024

Parameter	Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Sulphur Dioxide	R1 mg/m ³	1.2	g/hr	4.1	22/1/24	12:15 - 12:45	30
Oxides of Nitrogen (as NO ₂)	R1 mg/m ³	167	g/hr	589	22/01/2024	12:15 - 12:45	30
Carbon Monoxide	R1 mg/m ³	58.7	g/hr	207	22/01/2024	12:15 - 12:45	30
Oxygen	R1 % v/v	2.6			22/01/2024	12:15 - 12:45	30
Velocity Traverse	R1				22/1/245	13:25 - 13:35	

All results are expressed at the respective reference conditions.

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PROCESS DETAILS

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham
Babcock boiler
22nd January 2024

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operating Conditions
Capacity (of 100%) and Tonnes / Hour	Normal Operating Conditions
Continuous or Batch Process	Continuous
Feedstock (if applicable)	N/A
Abatement System	N/A
Abatement System Running Status	N/A
Fuel	Natuaral Gas
Plume Appearance	Not Visible

Executive Summary

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MONITORING & ANALYTICAL METHODS

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham
 Babcock boiler
 22nd January 2024

Parameter	Monitoring				Analysis				Overall Status	LOD (Average)
	Standard	Technical Procedure	Sampling Status	Testing Lab	Analytical Procedure	Analytical Technique	Analysis Status	Analysis Lab		
Sulphur Dioxide	EN 14791	MD 009	MCERTS	EET	EET-AP-01	IC	MCERTS	EET	MCERTS	0.216 mg/m ³
Water Vapour	EN 14790	MD 005	MCERTS	EET	MD 105	Gravimetric	MCERTS	EET	MCERTS	0.10 % v/v
Oxides of Nitrogen (as NO ₂)	EN 14792	MD 039	MCERTS	EET	Chemiluminescence by Horiba PG-350E			MCERTS	MCERTS	0.41 mg/m ³
Carbon Monoxide	EN 15058	MD 039	MCERTS	EET	NDIR by Horiba PG-350E			MCERTS	MCERTS	0.25 mg/m ³
Oxygen	EN 14789	MD 039	MCERTS	EET	Dry Paramagnetic Cell by Horiba PG-350E			MCERTS	MCERTS	0.1 %
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041	MCERTS	EET	Pitot Tube and Thermocouple			MCERTS	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
All	All	There are no deviations associated with the sampling employed.

Executive Summary

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SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.56
Width	m	-
Area	m ²	0.25
Port Depth	cm	6
Orientation of Duct	-	Angled
Number of Ports	-	2
Sample Port Size	-	1" BSP

Location of Sampling Platform

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

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	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

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

Sampling Plane Validation Criteria (from EN 15259)

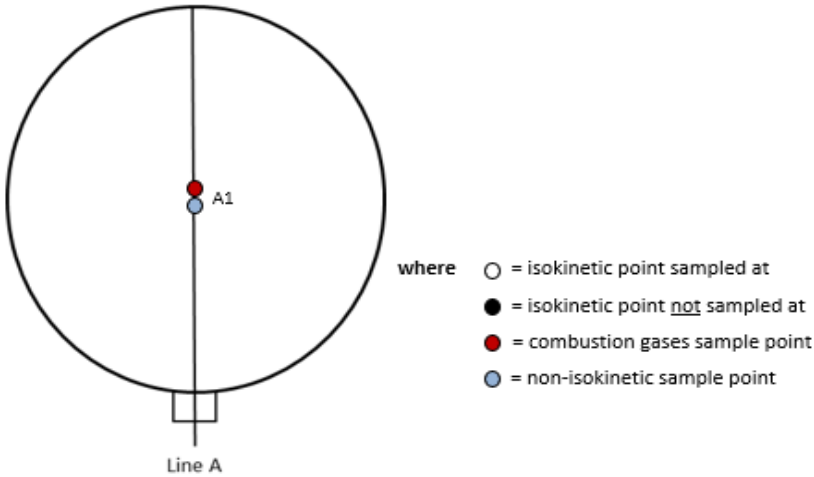
Criteria in EN 15259	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	25.0	> 5 Pa	Yes
Mean Velocity	m/s	7.3	-	-
Lowest Gas Velocity	m/s	6.9	-	-
Highest Gas Velocity	m/s	7.5	-	-
Ratio of Above	: 1	1.1	< 3 : 1	Yes
Maximum Angle of Swirl	°	8.0	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

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PLANT PHOTOS



SAMPLE POINTS



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

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Kelvin Moore	MCERTS Level 2	MM 02 057	TE1 TE2 TE3 TE4
Trainee	Joe Robins	MCERTS Trainee	MM 23 1797	None

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)	-	Horiba PG-350E	CAT 39.19	Digital Manometer (1)	CAT 3.176
Control Box DGM (2)	-	Horiba PG-250 SRM	-	Digital Manometer (2)	CAT 3.181
Box Thermocouples (1)	-	Servomex 4900	-	Digital Temperature Meter	CAT 3.176
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	CAT 14.104
Umbilical (1)	-	ABB AO2020-URAS26	-	Barometer	CAT 13.48
Umbilical (2)	-	Testo 350 XL	-	Stack Thermocouple (1)	CAT 4.1664
Oven Box (1)	-	JCT JCC P1 Cooler	CAT 4.0104	Stack Thermocouple (2)	-
Oven Box (2)	-	Gasmeter DX4000	-	Stack Thermocouple (3)	-
Heated Probe (1)	-	Gasmeter Sampling System	-	1m Heated Line (1)	-
Heated Probe (2)	-	Sick 3006	-	1m Heated Line (2)	-
Heated Probe (3)	-	M&C PSS	-	1m Heated Line (3)	-
S-Pitot (1)	CAT 21P.154	Mass Flow Controller (1)	CAT 6.75	5m Heated Line (1)	-
S-Pitot (2)	-	Mass Flow Controller (2)	CAT 6.76	15m Heated Line (1)	-
L-Pitot	-	Mass View (1)	CAT 25.75	20m Heated Line (1)	CAT 20.138
Site Balance	CAT 17.5	Mass View (2)	CAT 25.76	20m Heated Line (2)	-
500g / 1Kg Check Weights	CAT 17.5	Easylogger EN-EL-12 Bit	-	Dual Channel Heater Controller	-
Last Impinger Arm	CAT 4.1188	Easylogger EN-EL-12 Bit	CAT 11.102	Single Channel Heater Controller	-
Callipers	-	Bioaerosols Temperature Logger	-	Laboratory Balance	-
Tubes Kit Thermocouple	-	Electronic Refrigerator	-	Tape Measure	CAT 16.100

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Sulphur Dioxide	EN 14791	MD 009
Water Vapour	EN 14790	MD 005
Oxides of Nitrogen (as NO ₂)	EN 14792	MD 039
Carbon Monoxide	EN 15058	MD 039
Oxygen	EN 14789	MD 039
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.56
Stack Width, W	m	-
Stack Area, A	m ²	0.25
Average Stack Gas Temperature, T _a	°C	209.0
Average Stack Gas Pressure	Pa	27.3
Average Stack Static Pressure, P _{static}	kPa	0.060
Average Barometric Pressure, P _b	kPa	99.4
Average Pitot Tube Calibration Coefficient, C _p	-	0.84

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m ³ ρ	Conc kg/m ³ ρ _i
CO ₂ (Estimated)	-	10.25	9.87	0.1025	44.01	1.9635	0.20126
O ₂	-	2.57	2.48	0.0257	32.00	1.4277	0.03674
N ₂	-	87.18	83.95	0.8718	28.01	1.2498	1.08957
Moisture (H ₂ O)	-	-	3.70	0.0370	18.02	0.8037	0.02970

Where: $\rho = M / 22.41$
 $\rho_i = r \times \rho$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P _{STD}	kg/m ³	1.328
Wet Density (STP), P _{STW}	kg/m ³	1.308
Dry Density (Actual), P _{Actual}	kg/m ³	0.738
Average Wet Density (Actual), P _{ActualW}	kg/m ³	0.728

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)
 $P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$
 $P_{ActualW}$ (at each sampling point) = P_{STW} x (T_s / P_s) x (P_a / T_a)

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF ¹
Temperature	°C	209.0	0.0
Total Pressure	kPa	99.5	101.3
Moisture	%	3.70	0.00
Oxygen (Dry)	%	2.6	3.0

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m ³ /hr	6430
Gas Volumetric Flowrate (STP, Wet)	m ³ /hr	3576
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	3444
Gas Volumetric Flowrate REF ¹	m ³ /hr	3525

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	22/1/245
Time of Survey	-	13:25 - 13:35
Atmospheric Pressure	kPa	99.4
Average Stack Static Pressure	Pa	60
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	-	Angled
Pitot Tube, C _p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	2

Traverse Point	Depth m	ΔP Pa	Sampling Line A				Swirl °	ΔP Pa	Sampling Line B			
			Temp °C	Wet Density kg/m ³	Velocity m/s	Swirl °			Temp °C	Wet Density kg/m ³	Velocity m/s	Swirl °
<i>STATIC (Units: Pa)</i>		60.0					60.0					
Mean		27.0	209	0.73	7.2		27.5	209	0.73	7.3		
1	0.08	25.0	209	0.73	6.9	8.0	29.0	209	0.73	7.5	7.0	
2	0.48	29.0	209	0.73	7.5	7.0	26.0	209	0.73	7.1	7.0	

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

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	$u(k)$	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	$u(\Delta p_i)$	1.086	Pa
- Resolution	$u(res)$	0.00087	
- Calibration	$u(cal)$	0.077	
- Drift	$u(drift)$	0.083	
- Lack of Fit	$u(fit)$	0.018	
- Overall corrections to dynamic measurements	$u(C_f)$	0.179	
Standard uncertainty associated with the molar mass of the gas	$u(M)$	0.00005	-
- $\phi_{O_2,w}$	-	2.479	
- $\phi_{CO_2,w}$	-	9.871	
- Oxygen, dry	$u(\phi_{O_2,d})$	0.079	
- Carbon Dioxide, dry	$u(\phi_{CO_2,d})$	0.314	
- Water Vapour	$u(\phi_{H_2O})$	0.189	
- Oxygen, wet	$u(\phi_{O_2,w})$	0.076	
- Carbon Dioxide, wet	$u(\phi_{CO_2,w})$	0.303	
Standard uncertainty associated with the stack temperature	$u(T_c)$	2.459	K
Standard uncertainty associated with the absolute pressure in the duct	$u(p_c)$	175.694	Pa
- Atmospheric Pressure	$u(p_{atm})$	175.692	
- Static Pressure	$u(p_{stat})$	0.768	
Standard uncertainty associated with the density in the duct	$u(\rho)$	0.00393	-
Standard uncertainty associated with the local velocities	$u(v_i)$	0.160	Pa
Standard uncertainty associated with the mean velocity	$u(\bar{v})$	0.100	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	$U_c(v)$	0.196	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	$U_{c,rel}(v)$	2.70	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	$U_c(qV,w)$	339.0	m ³ /hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00072	
- $u^2(qV,w)$	-	29911	
- $u(qV,w)$	-	172.9	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	$U_{c,rel}(qV,w)$	5.27	%

SULPHUR DIOXIDE: RESULTS SUMMARY

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham
Babcock boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	1.2	1.2
Uncertainty	±mg/m ³	0.059	0.059
Mass Emission	g/hr	4.1	4.1
Uncertainty	±g/hr	0.30	0.30

Parameter	Units	Run 1	Mean
Water Vapour	% v/v	3.7	3.7
Uncertainty	±% v/v	0.88	0.88

Blank Runs

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

General Sampling Information

Parameter	Value
Standard	EN 14791
Technical Procedure	MD 009
Name of Analytical Laboratory	EET
Analytical Laboratory's Procedure	EET-AP-01
ISO 17025 Accredited Analysis?	MCERTS
Date of Sample Analysis	31/01/2024
Probe Material	Stainless Steel
Filter Housing Material	N/A
Impinger Material	Polyethylene
Absorption Solution	0.3% Hydrogen Peroxide
Positioning of Filter	Out Stack Heated Head
Filter Size and Material	0.1µm Glass Fibre
Number of Sampling Lines Used	1/1
Number of Sampling Points Used	1/1
Sample Point I.D.'s	A1

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

Reference Conditions

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

SULPHUR DIOXIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	12:15 - 12:45
Sampling Dates	-	22/1/24
Sampling Device	-	MFC / MV
Duration	mins	30
Volume Sampled (STP, Dry)	m ³	0.0682
Volume Sampled (STP, Wet)	m ³	0.0708
Volume Sampled (REF)	m ³	0.0701
Sample Flow Rate	l/min	2.20
Laboratory Result for Front Impingers	µg/ml	0.25
Laboratory Result for Back Impinger	µg/ml	0.31
Volume in Front Impingers	ml	200.1
Volume in Back Impinger	ml	101.9
Mass in Front Impingers	µg	50.0
Mass in Back Impinger	µg	31.6
Total Mass Collected	µg	81.6
Calculated Concentration	mg/m ³	1.17
Liquid Trap Start Mass	g	1607.0
Liquid Trap End Mass	g	1609.5
Silica Trap Start Mass	g	1508.8
Silica Trap End Mass	g	1508.4
Total Mass Of Water Vapour	g	2.1
Calculated Water Vapour	% v/v	3.70

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

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	22/1/24
Average Volume Sampled (REF)	m ³	0.0701
Laboratory Result for Impingers	µg/ml	< 0.05
Volume in Impingers	ml	291.4
Total Mass Collected	µg	< 14.6
Calculated Concentration	mg/m ³	< 0.21

SULPHUR DIOXIDE: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	2.2
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	0.00
Allowable Leak Rate	l/min	0.04
Leak Test Acceptable	-	Yes

Absorption Efficiency	Units	Run 1
Absorption Efficiency	%	61.3
Allowable Absorption Efficiency	%	95
Absorption Efficiency Acceptable	-	No

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	23.7
Allowable MU	%	20.0
MU Acceptable	%	No

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

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	2.0
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	0.00
Allowable Leak Rate	l/min	0.04
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	
	(x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	1
There are no deviations associated with the sampling employed.	wx	

SULPHUR DIOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value		Standard uncertainty		
	Symbol	Run 1	Symbol	Units	Run 1
Sampled Volume (STP)	V _m	0.0682	uV _m	m ³	0.0014
Leak	L	0.00	uL	%	-
Laboratory Result	L _r	0.90	uL _r	%	-

Measured Quantities	Uncertainty as a Percentage		Requirement of Standard
	Units	Run 1	
Sampled Volume (STP)	%	2.00	≤2%
Leak	%	0.00	≤2%
Laboratory Result	%	0.90	No Requirement

Measured Quantities	Uncertainty in Measurement Units			Sensitivity Coefficient
	Symbol	Units	Run 1	
Sampled Volume (STP)	V _m	m ³	0.0682	17.08
Leak	L	mg/m ³	0.000	1.00
Laboratory Result	L _r	mg/m ³	0.010	1.00

Measured Quantities	Uncertainty in Result	
	Units	Run 1
Sampled Volume (STP)	mg/m ³	0.023
Leak	mg/m ³	0.0000
Laboratory Result	mg/m ³	0.0105

Measured Quantities	Oxygen Correction Part of MU Budget	
	Units	Run 1
O ₂ Correction Factor	-	0.97
Stack Gas O ₂ Content	% v/v	2.51
MU for O ₂ Correction	-	0.03
Overall MU For O ₂ Measurement	%	2.70

Parameter	Units	Run 1
Combined uncertainty	mg/m ³	0.03
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m ³	0.05
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m ³	0.06
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	0.06
Reported Uncertainty	mg/m ³	0.06
Expanded uncertainty (95% confidence), without Oxygen Correction	%	4.3
Expanded uncertainty (95% confidence), with Oxygen Correction	%	5.1
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	5.1
Reported Uncertainty	%	5.1

OXIDES OF NITROGEN (as NO₂): RESULTS SUMMARY

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham
Babcock boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	167	167
Uncertainty	±mg/m ³	7.6	7.6
Mass Emission	g/hr	589	589
Uncertainty	±g/hr	41.1	41.1

General Sampling Information

Parameter	Value
Standard	EN 14792
Technical Procedure	MD 039
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	3/11/23 - 102.5%
Span Gas Type	Nitrogen Monoxide
Span Gas Reference Number	12.0557
Span Gas Expiry Date	19/9/25
Span Gas Start Pressure (bar)	100
Gas Cylinder Concentration (ppm)	401.5
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	A1

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

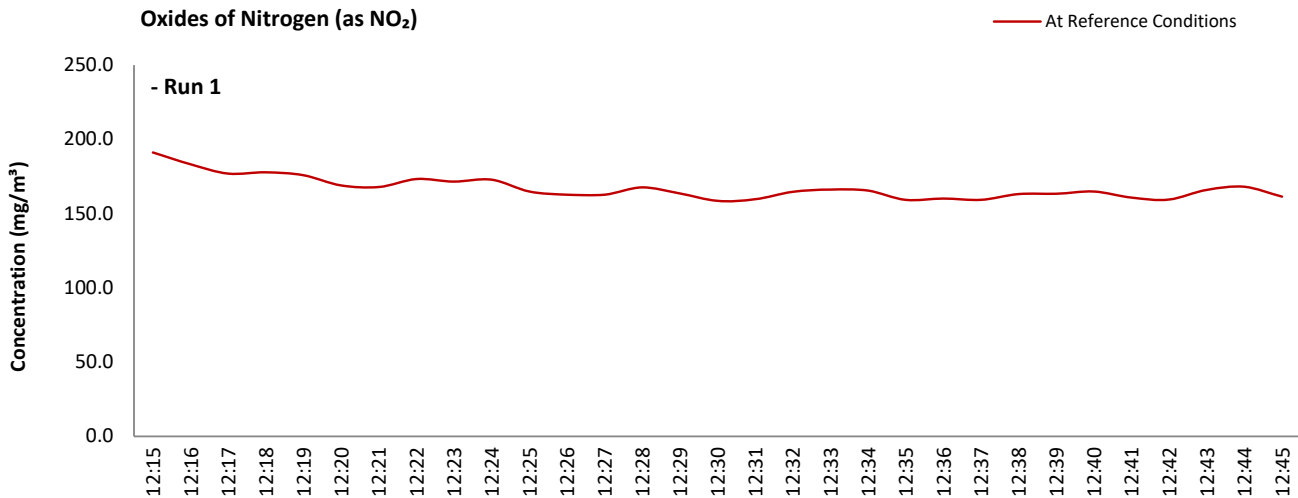
FORMAT: Number Used / Number Required

Reference Conditions

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

OXIDES OF NITROGEN (as NO₂): DATA TREND

Graphical Trend of Data



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

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	12:15 - 12:45
Sampling Dates	-	22/01/2024
Instrument Range	ppm	250
Span Gas Value	ppm	97.5

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.4
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

Zero Drift	Units	Run 1	
CAL 1	Zero at Analyser (Pre)	ppm	0.00
	Zero at Analyser (Post)	ppm	0.20
	Zero Drift	ppm	0.20
	Zero Drift	%	0.21
	Drift Correction Applied	2-5%	No
	Allowable Zero Drift	± %	5.00
	Zero Drift Acceptable	-	Yes

Span Drift	Units	Run 1	
CAL 1	Span at Analyser (Pre)	ppm	97.40
	Span at Analyser (Post)	ppm	95.60
	Span Drift	ppm	-1.80
	Zero Adj. Span Drift	%	2.05
	Drift Correction Applied	2-5%	Yes
	Allowable Span Drift	± %	5.00
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	18 - 16

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number	
		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	200.0	mg/m ³ (REF)
Allowable MU	10.0	%
Measured concentration	170.84	mg/m ³ (STP, dry)
Ratio NO / NO ₂	5	%
Range Used	250.0	ppm
Range Used [A]	513.1	mg/m ³
Cal gas conc.	97.5	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.	200.0	mg/m ³

Performance characteristics	RUN 1	Units
Response time	31	seconds
Number of readings in measurement	30	-
Repeatability at zero	0.00	% full scale
Repeatability at span level	0.10	% full scale
Deviation from linearity	0.23	% of value
Zero drift	0.21	% full scale
Span drift	0.00	% 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	102.5	%
Losses in the line (leak)	0.10	% 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	0.27	mg/m ³
Drift	0.24	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	-0.12	mg/m ³
Losses in the line (leak)	0.10	mg/m ³
Uncertainty of calibration gas blending	1.38	mg/m ³
Uncertainty of calibration gas	1.97	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		170.84	mg/m ³
Expanded uncertainty		2.55	mg/m ³
Expanded uncertainty	k = 1.96	5.00	mg/m ³
Uncertainty corrected to std conds. (O ₂)		4.90	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	2.93	% of Value
Expanded uncertainty (no O ₂) - at 95% Confidence	2.50	% 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	4.57	% of Value
Expanded uncertainty (with O ₂) - at 95% Confidence	4.27	% at ELV
Overall Allowable uncertainty (with O ₂) - at 95% Confidence	10.6	% 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).

CARBON MONOXIDE: RESULTS SUMMARY

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham
Babcock boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	58.7	58.7
Uncertainty	±mg/m ³	2.7	2.7
Mass Emission	g/hr	207	207
Uncertainty	±g/hr	14.5	14.5

General Sampling Information

Parameter	Value
Standard	EN 15058
Technical Procedure	MD 039
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Span Gas Type	Carbon Monoxide
Span Gas Reference Number	12.0557
Span Gas Expiry Date	19/9/25
Span Gas Start Pressure (bar)	100
Gas Cylinder Concentration (ppm)	402.5
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	A1

NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

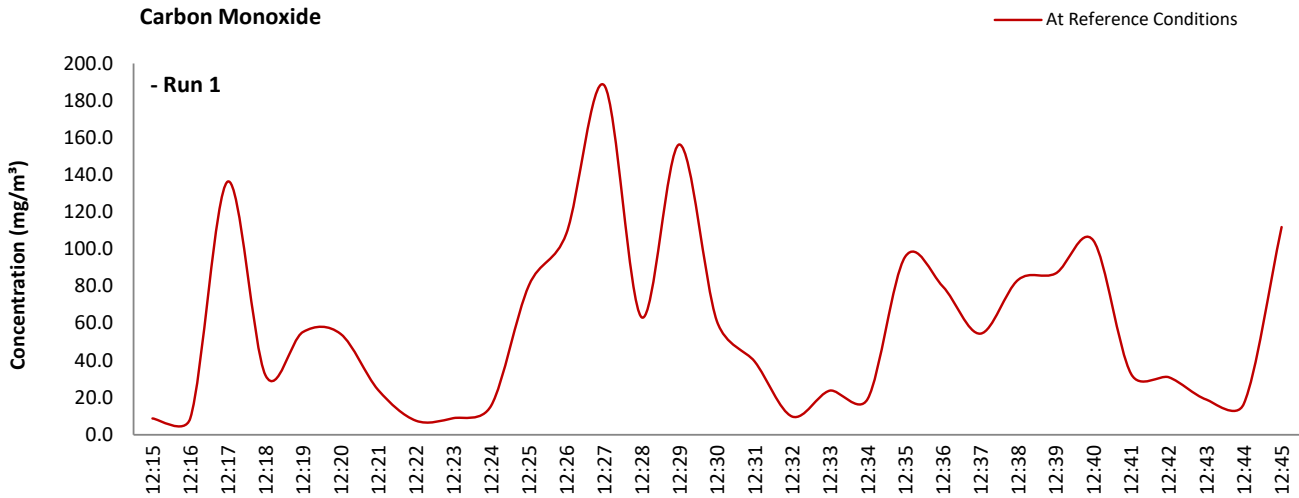
FORMAT: Number Used / Number Required

Reference Conditions

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

CARBON MONOXIDE: DATA TREND

Graphical Trend of Data



APPENDIX 2

CARBON MONOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	12:15 - 12:45
Sampling Dates	-	22/01/2024
Instrument Range	ppm	200
Span Gas Value	ppm	160.0

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.4
Allowable Temperature	< °C	4.0
Temperature Acceptable	-	Yes

Zero Drift	Units	Run 1	
CAL 1	Zero at Analyser (Pre)	ppm	0.00
	Zero at Analyser (Post)	ppm	-0.10
	Zero Drift	ppm	-0.10
	Zero Drift	%	0.06
	Drift Correction Applied	2-5%	No
	Allowable Zero Drift	± %	5.00
	Zero Drift Acceptable	-	Yes

Span Drift	Units	Run 1	
CAL 1	Span at Analyser (Pre)	ppm	160.00
	Span at Analyser (Post)	ppm	159.30
	Span Drift	ppm	-0.70
	Zero Adj. Span Drift	%	0.37
	Drift Correction Applied	2-5%	No
	Allowable Span Drift	± %	5.00
	Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	18 - 16

Method Deviations

Nature of Deviation (x = deviation applies to the associated run)	Run Number	
		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	59.96	mg/m ³ (STP, dry)
Range Used	200.0	ppm
Range Used [A]	249.8	mg/m ³
Cal gas conc.	160.0	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.	199.9	mg/m ³

Performance characteristics	RUN 1	Units
Response time	28	seconds
Number of readings in measurement	30	-
Repeatability at zero	0.10	% full scale
Repeatability at span level	0.20	% full scale
Deviation from linearity	0.54	% of value
Zero drift	-0.06	% full scale
Span drift	-0.37	% 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)	0.00	% of value
Uncertainty of calibration gas blending	1.40	% of value
Uncertainty of calibration gas	2.00	% of value

Performance characteristic	RUN 1	Units
Standard deviation of repeatability at zero	use rep at span	mg/m ³
Standard deviation of repeatability at span level	0.04	mg/m ³
Lack of fit	0.23	mg/m ³
Drift	-0.20	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)	0.00	mg/m ³
Uncertainty of calibration gas blending	0.48	mg/m ³
Uncertainty of calibration gas	0.69	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		59.96	mg/m ³
Expanded uncertainty		0.93	mg/m ³
Expanded uncertainty	k = 1.96	1.82	mg/m ³
Uncertainty corrected to std conds. (O ₂)		1.78	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	3.03	% 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	4.63	% 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).

OXYGEN: RESULTS SUMMARY

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham
Babcock boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	% v/v	2.6	2.6
Uncertainty	±% v/v	0.091	0.091

General Sampling Information

Parameter	Value
Standard	EN 14789
Technical Procedure	MD 039
Probe Material	Stainless Steel
Filtration Type / Size	0.1µm Glass Fibre
Heated Head Filter Used	Yes
Heated Line Temperature	180°C
Span Gas Type	Synthetic Air (5 Grade)
Span Gas Reference Number	11.0609
Span Gas Expiry Date	26/09/2028
Span Gas Start Pressure (bar)	100
Gas Cylinder Concentration (% v/v)	21.46
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	A1

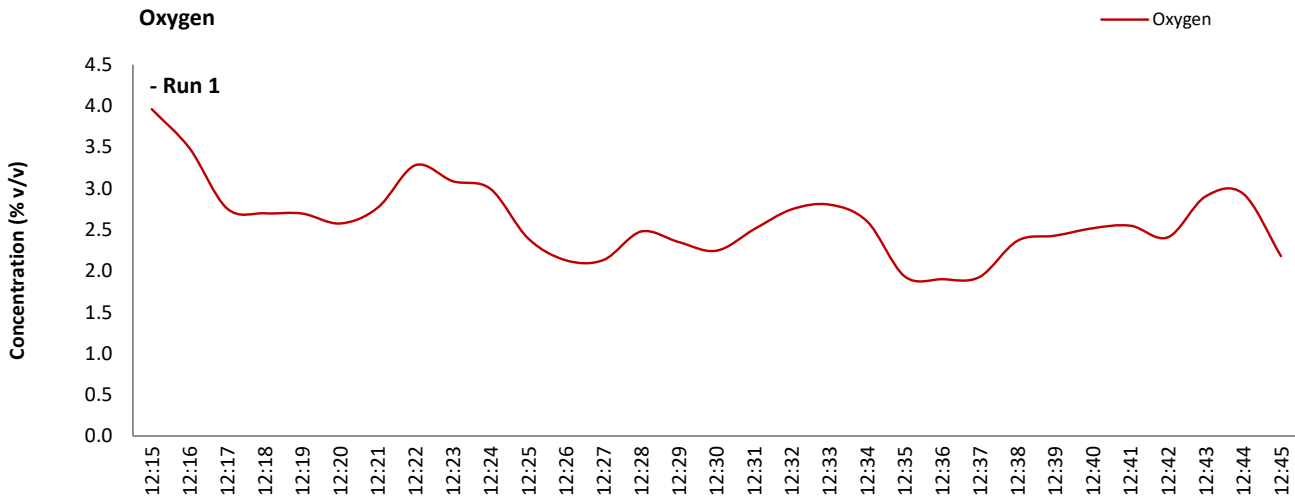
NOTE: Dilution performed to achieve correct span value

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	-	12:15 - 12:45
Sampling Dates	-	22/01/2024
Instrument Range	% v/v	25.0
Span Gas Value	% v/v	5.0

Quality Assurance

Conditioning Unit Temperature	Units	Run 1
Average Temperature	°C	2.4
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	-0.16
Zero Drift	% v/v	-0.16
Zero Drift	%	3.32
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	4.82
Span at Analyser (Post)	% v/v	4.44
Span Drift	% v/v	-0.38
Zero Adj. Span Drift	%	4.40
Drift Correction Applied	2-5%	Yes
Allowable Span Drift	± %	5.00
Span Drift Acceptable	-	Yes

Test Conditions	Units	Run 1
Run Ambient Temperature Range	°C	18 - 16

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

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	N/A	%vol
Allowable MU	6.0	%
Measured concentration	2.61	%vol
Range Used	25.0	%vol
Cal gas conc.	21.5	%vol

Performance characteristics	RUN 1	Units
Response time	41	seconds
Number of readings in measurement	30	-
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)	0.40	% 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	%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)	0.01	%vol
Uncertainty of calibration gas	0.03	%vol

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		2.61	%vol
Expanded uncertainty	k = 1.96	0.05	%vol
		0.09	%vol

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	3.50	% of Value
Result of Compliance with Uncertainty Requirement	COMPLIANT	-

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

VERSION HISTORY

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