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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
3rd April 2024

Job Reference Number
EMT09126

Report Written by
Jai Graham Team Leader MCERTS Level 2 MM 19 1552 TE1 TE2 TE3 TE4

Report Approved by
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Report Date
15th April 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
3rd April 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

Executive Summary

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MONITORING RESULTS

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham

Babcock Boiler

3rd April 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	0.10	0.0062	-	g/hr	0.17	0.019	-
Oxides of Nitrogen (as NO ₂)	¹ mg/m ³	145	6.6	200	g/hr	248	25.1	-
Carbon Monoxide	¹ mg/m ³	75.9	3.3	-	g/hr	129	13.0	-
Oxygen	% v/v Dry	3.1	0.10					
Water Vapour	% v/v	8.0	0.42					
Stack Gas Temperature	°C	215						
Stack Gas Velocity	m/s	3.8	0.30					
Volumetric Flow Rate (ACTUAL)	m ³ /hr	3367	304					
Volumetric Flow Rate (REF)	¹ m ³ /hr	1706	154					

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

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

Executive Summary

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MONITORING DATE(S) & TIMES

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham

Babcock Boiler

3rd April 2024

Parameter	Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Sulphur Dioxide	R1 mg/m ³	0.10	g/hr	0.17	03/04/2024	11:46 - 12:16	30
Oxides of Nitrogen (as NO ₂)	R1 mg/m ³	145	g/hr	248	03/04/2024	11:46 - 12:16	30
Carbon Monoxide	R1 mg/m ³	75.9	g/hr	129	03/04/2024	11:46 - 12:16	30
Oxygen	R1 % v/v	3.1			03/04/2024	11:46 - 12:16	30
Velocity Traverse	R1				12 03 2024	11:24 - 11:25	

All results are expressed at the respective reference conditions.

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PROCESS DETAILS

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham
Babcock Boiler
3rd April 2024

Standard Operating Conditions

Parameter	Value
Process Status	Boiler
Capacity (of 100%) and Tonnes / Hour	High Fire
Continuous or Batch Process	Continuous
Feedstock (if applicable)	N/A
Abatement System	None
Abatement System Running Status	N/A
Fuel	Natural Gas
Plume Appearance	None

Executive Summary

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MONITORING & ANALYTICAL METHODS

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham
 Babcock Boiler
 3rd April 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	CAT-AP-01	IC	MCERTS	EET	MCERTS	0.058 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	0.41 mg/m ³	
Carbon Monoxide	EN 15058	MD 039	MCERTS	EET	NDIR by Horiba PG-350E			MCERTS	0.25 mg/m ³	
Oxygen	EN 14789	MD 039	MCERTS	EET	Dry Paramagnetic Cell by Horiba PG-350E			MCERTS	0.1 %	
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	MD 041	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
Velocity & Vol. Flow Rate, Sulphur Dioxide	All Runs	Lowest differential pressure < 5 Pa.

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	-	Horizontal
Number of Ports	-	1
Sample Port Size	-	1" BSP

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

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	3.0	> 5 Pa	No
Mean Velocity	m/s	3.80	-	-
Lowest Gas Velocity	m/s	2.39	-	-
Highest Gas Velocity	m/s	4.77	-	-
Ratio of Above	: 1	2.00	< 3 : 1	Yes
Maximum Angle of Swirl	°	7.00	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

Executive Summary

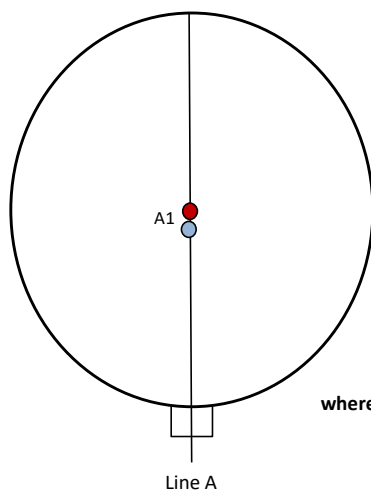
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PLANT PHOTOS

Photo 1



SAMPLE POINTS



- where
- = isokinetic point sampled at
 - = isokinetic point not sampled at
 - = combustion gases sample point
 - = non-isokinetic 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

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Jai Graham	MCERTS Level 2	MM19 1552	TE1 TE2 TE3 TE4
Technician	Joseph Robins	MCERTS Trainee	MM23 1797	None

LIST OF EQUIPMENT

Control Box DGM (1)		Horiba PG-350E		Digital Manometer (1)	
Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.
Box Thermocouples (1)	-	Servomex 5200 MP	-	Digital Temperature Meter	-
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	-
Umbilical (1)	-	ABB AO2020-URAS26	-	Barometer	CAT 13.45
Umbilical (2)	-	Testo 350 XL	-	Stack Thermocouple (1)	-
Oven Box (1)	-	JCT JCC P1 Cooler	CAT 4.491	Stack Thermocouple (2)	CAT 4.00127
Oven Box (2)	-	Gasmot DX4000	-	Stack Thermocouple (3)	-
Heated Probe (1)	-	Gasmot 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.152	Mass Flow Controller (1)	CAT 6.73	5m Heated Line (1)	-
S-Pitot (2)	-	Mass Flow Controller (2)	CAT 6.74	15m Heated Line (1)	-
L-Pitot	-	Mass View (1)	CAT 25.69	20m Heated Line (1)	-
Site Balance	CAT 17.49	Mass View (2)	CAT 25.70	20m Heated Line (2)	CAT 20.252
500g / 1Kg Check Weights	CAT 17.49	Hioki 5043 (V)	-	Dual Channel Heater Controller	-
Last Impinger Arm	CAT 4.1186	Hioki 5043 (V)	-	Single Channel Heater Controller	-
Callipers	-	Bioaerosols Temperature Logger	-	Laboratory Balance	CAT AUTO
Tubes Kit Thermocouple	-	Electronic Refrigerator	-	Tape Measure	-
Callipers	-	Bioaerosols Temperature Logger	-	Laboratory Balance	-
Tubes Kit Thermocouple	-	Electronic Refrigerator	-	Tape Measure	-

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	215.0
Average Stack Gas Pressure	Pa	8.0
Average Stack Static Pressure, P _{static}	kPa	-0.010
Average Barometric Pressure, P _b	kPa	100.1
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 p	Conc kg/m ³ p _i
CO ₂ (Estimated)	-	10.00	9.90	0.1000	44.01	1.9635	0.19635
O ₂	-	20.80	20.59	0.2080	32.00	1.4277	0.29696
N ₂	-	69.20	68.51	0.6920	28.01	1.2498	0.86489
Moisture (H ₂ O)	-	-	1.00	0.0100	18.02	0.8037	0.00804

Where: $\rho = M / 22.41$
 $p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P _{STD}	kg/m ³	1.358
Wet Density (STP), P _{STW}	kg/m ³	1.353
Dry Density (Actual), P _{Actual}	kg/m ³	0.751
Average Wet Density (Actual), P _{ActualW}	kg/m ³	0.748

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) = $P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF ¹
Temperature	°C	215.0	0.0
Total Pressure	kPa	100.1	101.3
Moisture	%	8.00	0.00
Oxygen (Dry)	%	3.1	3.0

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m ³ /hr	3367
Gas Volumetric Flowrate (STP, Wet)	m ³ /hr	1861
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	1712
Gas Volumetric Flowrate REF ¹	m ³ /hr	1706

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	12 03 2024
Time of Survey	-	11:24 - 11:25
Atmospheric Pressure	kPa	100.1
Average Stack Static Pressure	Pa	-10
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 200 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Horizontal
Pitot Tube, C _p	-	0.84
Number of Lines Available	-	1
Number of Lines Used	-	1

Sampling Line A						
Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m ³	Velocity m/s	Swirl °
<i>STATIC (Units: Pa)</i>		-10.0				
Mean		8.0	215.0	0.748	3.80	
1	0.04	8.0	215.0	0.748	3.90	7.0
2	0.14	12.0	215.0	0.748	4.77	7.0
3	0.42	3.0	215.0	0.748	2.39	7.0
4	0.52	9.0	215.0	0.748	4.13	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	$u(\Delta p_i)$	1.057	Pa
- Resolution	$u(res)$	0.00087	
- Calibration	$u(cal)$	0.007	
- Drift	$u(drift)$	0.083	
- Lack of Fit	$u(fit)$	0.026	
- Overall corrections to dynamic measurements	$u(C_f)$	0.117	
Standard uncertainty associated with the molar mass of the gas	$u(M)$	0.00005	-
- $\varphi_{O_2,w}$	-	20.592	
- $\varphi_{CO_2,w}$	-	9.900	
- Oxygen, dry	$u(\phi_{O_2,d})$	0.637	
- Carbon Dioxide, dry	$u(\phi_{CO_2,d})$	0.306	
- Water Vapour	$u(\phi_{H_2O})$	0.051	
- Oxygen, wet	$u(\phi_{O_2,w})$	0.630	
- Carbon Dioxide, wet	$u(\phi_{CO_2,w})$	0.303	
Standard uncertainty associated with the stack temperature	$u(T_c)$	2.490	K
Standard uncertainty associated with the absolute pressure in the duct	$u(p_c)$	175.695	Pa
- Atmospheric Pressure	$u(p_{atm})$	175.692	
- Static Pressure	$u(p_{stat})$	1.057	
Standard uncertainty associated with the density in the duct	$u(\rho)$	0.00403	-
Standard uncertainty associated with the local velocities	$u(v_i)$	0.285	Pa
Standard uncertainty associated with the mean velocity	$u(\bar{v})$	0.151	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	$U_c(v)$	0.297	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	$U_{c,rel}(v)$	7.82	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	$U_c(qV,w)$	304.1	m ³ /hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00212	
- $u^2(qV,w)$	-	24066	
- $u(qV,w)$	-	155.1	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	$U_{c,rel}(qV,w)$	9.03	%

SULPHUR DIOXIDE: RESULTS SUMMARY

Fujifilm Diosynth Biotechnologies UK Ltd, Billingham
Babcock Boiler

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	0.10	0.10
Uncertainty	±mg/m ³	0.01	0.01
Mass Emission	g/hr	0.2	0.2
Uncertainty	±g/hr	0.02	0.02

Parameter	Units	Run 1	Mean
Water Vapour	% v/v	8.00	8.00
Uncertainty	±% v/v	0.42	0.42

Blank Runs

Parameter	Units	Blank 1	Maximum
Concentration	mg/m ³	< 0.06	< 0.06

General Sampling Information

Parameter	Value
Standard	EN 14791
Technical Procedure	MD 009
Name of Analytical Laboratory	EET
Analytical Laboratory's Procedure	CAT-AP-01
ISO 17025 Accredited Analysis?	MCERTS
Date of Sample Analysis	12/04/2024
Probe Material	Stainless Steel
Filter Housing Material	Titanium
Impinger Material	Polyethylene
Absorption Solution	0.3% Hydrogen Peroxide
Positioning of Filter	In Stack
Filter Size and Material	47mm Quartz 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

Reference Conditions

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

SULPHUR DIOXIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	11:46 - 12:16
Sampling Dates	-	03/04/2024
Sampling Device	-	MFC / MV
Duration	mins	30
Volume Sampled (STP, Dry)	m ³	0.2780
Volume Sampled (STP, Wet)	m ³	0.3021
Volume Sampled (REF)	m ³	0.2770
Sample Flow Rate	l/min	8.96
Laboratory Result for Front Impingers	µg/ml	0.10
Laboratory Result for Back Impinger	µg/ml	< 0.05
Volume in Front Impingers	ml	221.5
Volume in Back Impinger	ml	102.4
Mass in Front Impingers	µg	22.2
Mass in Back Impinger	µg	< 5.1
Total Mass Collected	µg	27.3
Calculated Concentration	mg/m ³	0.10
Liquid Trap Start Mass	g	1747.1
Liquid Trap End Mass	g	1763.1
Silica Trap Start Mass	g	1573.5
Silica Trap End Mass	g	1576.9
Total Mass Of Water Vapour	g	19.4
Calculated Water Vapour	% v/v	8.00

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

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	03/04/2024
Average Volume Sampled (REF)	m ³	0.2770
Laboratory Result for Impingers	µg/ml	< 0.05
Volume in Impingers	ml	306.4
Total Mass Collected	µg	< 15.3
Calculated Concentration	mg/m ³	< 0.06

SULPHUR DIOXIDE: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	9.0
Pre-Sampling Leak Rate	l/min	0.10
Post-Sampling Leak Rate	l/min	0.10
Allowable Leak Rate	l/min	0.18
Leak Test Acceptable	-	Yes

Absorption Efficiency	Units	Run 1
Absorption Efficiency	%	100.0
Allowable Absorption Efficiency	%	95
Absorption Efficiency Acceptable	-	Yes

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.3
Allowable MU	%	20.0
MU Acceptable	%	Yes

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	9.0
Pre-Sampling Leak Rate	l/min	0.10
Post-Sampling Leak Rate	l/min	0.10
Allowable Leak Rate	l/min	0.18
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
Lowest differential pressure < 5 Pa.	wx

SULPHUR DIOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value		Standard uncertainty		
	Symbol	Run 1	Symbol	Units	Run 1
Sampled Volume (STP)	V _m	0.2780	uV _m	m ³	0.0056
Leak	L	1.12	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	%	1.12	≤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	0.2780	0.35
Leak	L	mg/m ³	0.001	1.00
Laboratory Result	L _r	mg/m ³	0.001	1.00

Measured Quantities	Uncertainty in Result	
	Units	Run 1
Sampled Volume (STP)	mg/m ³	0.002
Leak	mg/m ³	0.0006
Laboratory Result	mg/m ³	0.0009

Measured Quantities	Oxygen Correction Part of MU Budget	
	Units	Run 1
O ₂ Correction Factor	-	1.00
Stack Gas O ₂ Content	% v/v	3.06
MU for O ₂ Correction	-	0.03
Overall MU For O ₂ Measurement	%	2.79

Parameter	Units	Run 1
Combined uncertainty	mg/m ³	0.002
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m ³	0.004
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m ³	0.01
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	0.01
Reported Uncertainty	mg/m ³	0.01
Expanded uncertainty (95% confidence), without Oxygen Correction	%	4.5
Expanded uncertainty (95% confidence), with Oxygen Correction	%	5.3
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	6.3
Reported Uncertainty	%	6.3

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	145.36	145.36
Uncertainty	±mg/m ³	6.61	6.61
Mass Emission	g/hr	248.0	248.0
Uncertainty	±g/hr	25.1	25.1

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	08/03/2024 - 95.8%
Span Gas Type	Nitrogen Monoxide
Span Gas Reference Number	CYL 12.0515
Span Gas Expiry Date	31/01/2025
Span Gas Start Pressure (bar)	120
Gas Cylinder Concentration (ppm)	410.1
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

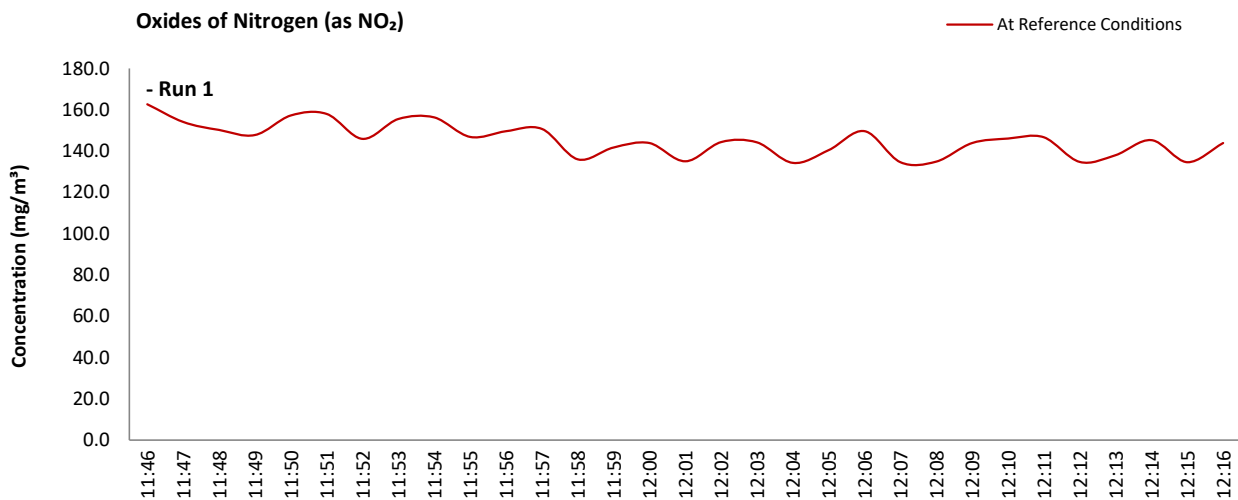
FORMAT: Number Used / Number Required

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	-	11:46 - 12:16
Sampling Dates	-	03/04/2024
Instrument Range	ppm	250
Span Gas Value	ppm	97.5

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	
CAL 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	
CAL 1	Span at Analyser (Pre)	ppm	97.50
	Span at Analyser (Post)	ppm	97.00
	Span Drift	ppm	-0.50
	Zero Adj. Span Drift	%	0.51
	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	8 - 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	200.0	mg/m ³ (REF)
Allowable MU	10.0	%
Measured concentration	144.86	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	0.15	% of value
Zero drift	0.00	% full scale
Span drift	-0.51	% 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	95.8	%
Losses in the line (leak)	1.03	% 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	0.18	mg/m ³
Drift	-0.43	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	0.18	mg/m ³
Losses in the line (leak)	0.86	mg/m ³
Uncertainty of calibration gas blending	1.17	mg/m ³
Uncertainty of calibration gas	1.67	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		144.86	mg/m ³
Expanded uncertainty	k =	2.39	mg/m ³
Expanded uncertainty	1.96	4.68	mg/m ³
Uncertainty corrected to std conds. (O ₂)		4.70	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	3.23	% of Value
Expanded uncertainty (no O ₂) - at 95% Confidence	2.34	% 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	4.55	% of Value
Expanded uncertainty (with O ₂) - at 95% Confidence	3.97	% at ELV
Overall Allowable uncertainty (with O ₂) - at 95% Confidence	10.5	% 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	75.88	75.88
Uncertainty	±mg/m ³	3.29	3.29
Mass Emission	g/hr	129.5	129.5
Uncertainty	±g/hr	13.0	13.0

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	CYL 12.0515
Span Gas Expiry Date	31/01/2025
Span Gas Start Pressure (bar)	120
Gas Cylinder Concentration (ppm)	406.8
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

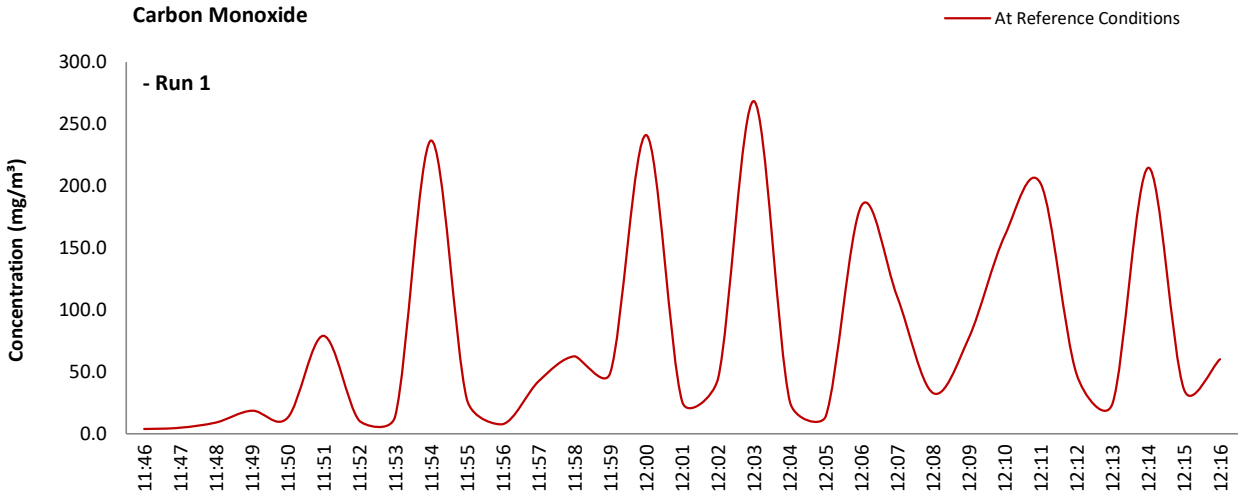
FORMAT: Number Used / Number Required

Reference Conditions

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

CARBON MONOXIDE: DATA TREND

Graphical Trend of Data



CARBON MONOXIDE: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	11:46 - 12:16
Sampling Dates	-	03/04/2024
Instrument Range	ppm	200
Span Gas Value	ppm	160.0

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	
CAL 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	
CAL 1	Span at Analyser (Pre)	ppm	160.00
	Span at Analyser (Post)	ppm	152.00
	Span Drift	ppm	-8.00
	Zero Adj. Span Drift	%	5.00
	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	8 - 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	75.62	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	0.46	% 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	0.22	% 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)	0.50	% 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	0.20	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)	0.22	mg/m ³
Uncertainty of calibration gas blending	0.61	mg/m ³
Uncertainty of calibration gas	0.87	mg/m ³

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		75.62	mg/m ³
Expanded uncertainty		1.13	mg/m ³
Expanded uncertainty	k = 1.96	2.21	mg/m ³
Uncertainty corrected to std conds. (O ₂)		2.22	mg/m ³ (REF)

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	2.92	% 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	4.33	% 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	3.06	3.06
Uncertainty	±% v/v	0.10	0.10

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	SELECT
Span Gas Expiry Date	00/01/1900
Span Gas Start Pressure (bar)	100
Gas Cylinder Concentration (% v/v)	21.12
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

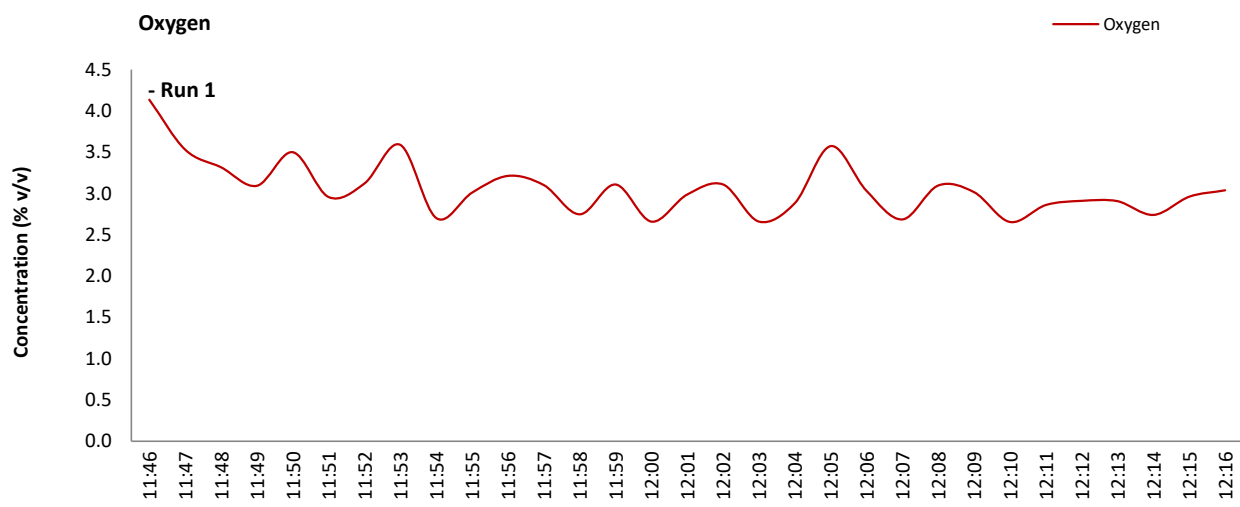
NOTE: Dilution performed to achieve correct span value

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

OXYGEN: DATA TREND

Graphical Trend of Data



OXYGEN: SAMPLING DETAILS & QUALITY ASSURANCE

Sampling Details

Parameter	Units	Run 1
Sampling Times	-	11:46 - 12:16
Sampling Dates	-	03/04/2024
Instrument Range	% v/v	25.0
Span Gas Value	% v/v	5.0

Quality Assurance

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

Zero Drift	Units	Run 1	
CAL 1	Zero at Analyser (Pre)	% v/v	0.00
	Zero at Analyser (Post)	% v/v	0.00
	Zero Drift	% v/v	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	
CAL 1	Span at Analyser (Pre)	% v/v	5.00
	Span at Analyser (Post)	% v/v	5.01
	Span Drift	% v/v	0.01
	Zero Adj. Span Drift	%	0.20
	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	8 - 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

OXYGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Performance characteristics	RUN 1	Units
Limit value	N/A	%vol
Allowable MU	6.0	%
Measured concentration	3.06	%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	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	0.20	% 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	0.04	%vol

Measurement uncertainty	Result	RUN 1	Units
Combined uncertainty		3.06	%vol
Expanded uncertainty	k = 1.96	0.10	%vol

	RUN 1	Units
Expanded uncertainty (no O ₂) - at 95% Confidence	3.19	% 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