

# Report for the Periodic Monitoring of Emissions to Atmosphere

## Sheffield Teaching Hospitals Foundation NHS Trust

### Boiler 3 - Ideal

Permit No: N/A  
Installation: Royal Hallamshire  
Monitoring Dates: 31st January 2024 & 1st August 2024  
Site Address: Royal Hallamshire Boiler House, C Road, Sheffield, S10 2RX

Report Number: ES-1602/1864      Version: 1      Visit: 2 in 2024  
Date of Report: 30th August 2024  
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Signed:



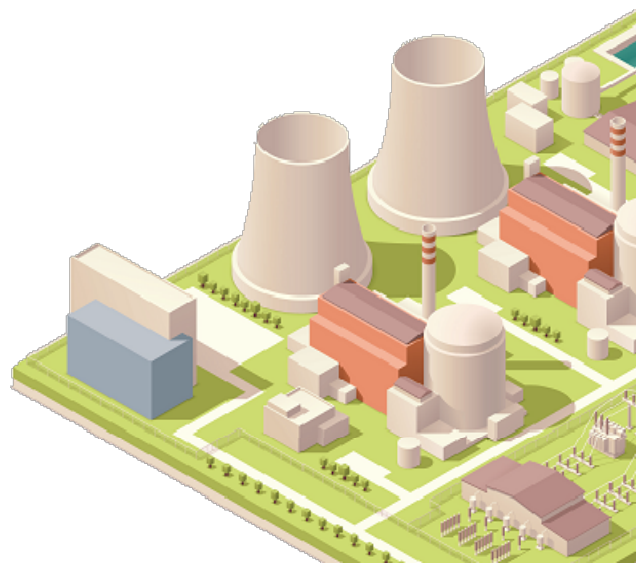
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# Contents

## Executive Summary

Monitoring Objectives	3
Monitoring Results	4
Operating Information	5
Monitoring Deviations	5

## Supporting Information

Appendix 1: General Information	6 - 7
Appendix 2: Results and Calculations	8 - 10

# Executive Summary

## Monitoring Objectives

Envirocare Technical Consultancy were contracted by Sheffield Teaching Hospitals Foundation NHS Trust to carry out emissions monitoring, to determine the release of prescribed pollutants at Boiler 3 - Ideal. There are no emission limits set for any of the pollutants at this time. The methodologies utilised and the results obtained form the basis of this report.

The substances requested for monitoring are listed below.

## Emission Point Identification

Substances to be Monitored	Boiler 3 - Ideal
Carbon Monoxide	✓
Oxides of Nitrogen (as NO <sub>2</sub> )	✓
Oxygen	✓
Volumetric Flow	✓

Special requirements: none

Opinions and interpretations expressed within this report are outside the scope of Envirocare Technical Consultancy's MCERTS and UKAS accreditation. Envirocare accepts no responsibility for information in this report that was provided by the client, the client's representative or employees of the client. Where such information has been provided by external sources this is identified in footnotes of the respective tables.

# Executive Summary

## Monitoring Results

where MU = Measurement Uncertainty associated with the result (95% Confidence)

		Concentration				Mass Emission				
Substance		Limit (mg/m³)	Result (mg/m³)	Measurement Uncertainty (MU) +/-	Reference Conditions	Limit (g/hr)	Result (g/hr)	Measurement Uncertainty (MU) +/-	Sampling Date	Sampling Times
Carbon Monoxide	R1	-	1.4	6.5	273k, 101.3kPa, Dry Gas, 3% O <sub>2</sub>	-	-	-	31/01/2024	12:02-13:02
Oxides of Nitrogen (as NO <sub>2</sub> )	R1	-	81.0	3.6		-	-	-	31/01/2024	12:02-13:02
Oxygen	R1	-	4.9%	0.27	As Measured, Dry Gas	-	-	-	31/01/2024	12:02-13:02
Volumetric Flow (Actual)	R1	-	2,798 m³/h	127	As Measured	-	-	-	01/08/2024	15:25 - 15:30
Volumetric Flow (REF)	R1	-	1,805 m³/h	82	273k, 101.3kPa, Dry Gas, 3% O <sub>2</sub> .	-	-	-	01/08/2024	15:25 - 15:30

Reference conditions (REF) are: 273k, 101.3kPa, Dry Gas, 3% O<sub>2</sub>.

# Supporting Information

## Appendix 1: General Information

### Operating Information

Parameter	Process Details
Process Type	Boiler
Continuous or Batch Process	Continuous, but intermittent operation
Operating Status	Normal
Feedstock	N/A
Normal Load, Throughput or Continuous Rating	S/N - 24447331170 - 1.45 MW
Abatement System	None
Abatement System Status	N/A
Process Fuel	Natural Gas
Plume Appearance	None

### Monitoring Deviations

Parameter	Run	Deviation
All Parameters	All	There are no deviations associated with the monitoring undertaken.

### Monitoring Organisation Staff Details

Personnel	Position	MCERTS Level	MCERTS Number
Mr T Arden	Team Leader	2 (TE1, TE2, TE3, TE4)	MM 18 1478
Mr J Doyle	Technician	Trainee	MM 22 1757
Mr I Biczuk	Team Leader	2 (TE1, TE2, TE3, TE4)	MM 05 638
Mr A Pagliari	Technician	Trainee	tbc

## Monitoring Methods

Pollutant Species	Standard	Technical Procedure	Testing MCERTS	Analysis Laboratory	Analytical Procedure	Analytical Technique	Analysis MCERTS
Volumetric Flow	BS EN ISO 16911-1	ETC-SE-24a	Yes	Pitot Tube and Thermocouple			
Carbon Monoxide	BS EN 15058	ETC-SE-10 (a/b)	Yes	NDIR by Horiba PG-250 or PG350E			
Oxides of Nitrogen	BS EN 14792	ETC-SE-10 (a/b)	Yes	Chemiluminescence by Horiba PG-250 or Horiba PG-350			
Oxygen	BS EN 14789	ETC-SE-10 (a/b)	Yes	Dry Zirconia Cell by Horiba PG-250 or Dry Paramagnetic by Horiba PG-350E			

Envirocare: 2522

## Equipment Checklist

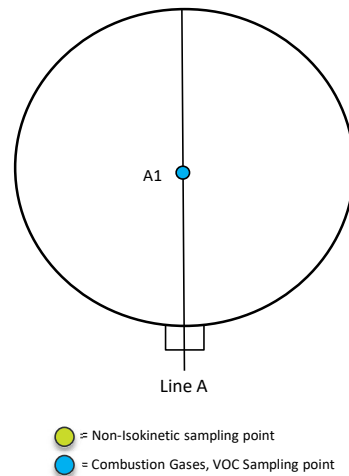
Extractive Sampling		Instrumental Analysers		Miscellaneous Items	
Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.
Control Box DGM	-	Horiba PG-250	-	Tape Measure	17.12
Box Thermocouples	-	Horiba PG-250 SRM	-	Bevel Box	-
Box Thermocouple In	-	Horiba PG-350	12.03	Stopwatch	10.01
Box Thermocouple Out	-	JCT JCC Cooler	-	Barometer	11.1
Control Box Timer	-	MAK10 Cooler	-	Digital Manometer	24.04
Umbilical	-	Horiba PS200 Cooler	-	Digital Temperature Meter	24.04
Oven Box	-	M&C PSS Gas Preparation	3.42b	Dual Channel Heat Controller	-
Heated Probe (1)	-	Gasmet DX4000 FTIR	-	1m Heated Line	-
Heated Probe (2)	-	Gasmet Sampling System	-	3m Heated Line	-
Stack Thermocouple (1)	1.07	SK-Thermo FID	-	5m Heated Line	-
Stack Thermocouple (2)	-	Bernath 3006 FID	-	10m Heated Line	-
S-Type Pitot (1)	20.27s	Testo 350XL	-	20m Heated Line	5.31
S-Type Pitot (2)	-	M&C PSP 4000	7.03	30m Heated Line	-
L-Type Pitot	20.05L	Easylogger EN-EL-12 Bit	-	Impinger Arm Thermocouple (1)	-
Site Balance	-	Hioki 5043 (V)	-	Impinger Arm Thermocouple (2)	-
500g Check Weight	-	Analyser Temperature Logger	-	Dioxins Kit Thermocouple	-
1KG Check Weight	-	-	-	Sample Temperature Logger	-
Digital Callipers	-	-	-	Laboratory Balance	-

## Appendix 2: Boiler 3 - Ideal Results and Calculations

Picture of the sampling location



Sampling Points Diagram



### Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.45
Width	m	-
Area	m <sup>2</sup>	0.16
Port Depth	cm	5.0
Orientation of Stack / Duct	-	Angled
Sampling Port Size	-	1" BSP
Number of Ports	-	1

Manual Sampling Points	Used / Required
Number of Sampling Lines	N / A
Number of Sampling Points	N / A
Instrumental Sampling Points	Used / Required
Number of Sampling Lines	1 / 1
Number of Sampling Points	1 / 1

Platform Type and Location	
Platform Type - Permanent / Temporary	Permanent
Location - Inside / Outside	Inside

EA Technical Guidance Note M1 Platform Requirements		
Load Baring Capacity	Load baring capacity of platform sufficient to fulfil the measurement objective	Yes
Position & Work Space	Sufficient work area to manipulate probe & operate the measurement instruments	Yes
	Depth of work area > internal diameter of stack and wall thickness plus 1.5m	Yes
	Ports on vertical ducts 1.2m to 1.5m above platform floor	Yes
	Platform has chains / self closing gates at top of ladders	Yes
Fall Prevention	Platform has adequate drainage to prevent accumulation of free-standing water	Yes
	Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
	Gaps between handrails not >0.5m	Yes
Access	Platform has vertical base boards (approx. 0.25m high)	Yes
	Access to sampling ports unhindered by obstructions	Yes
	Easy & safe access and egress available	Yes

### Sampling Location / Platform Recommendations

The Sampling location meets all the requirements specified in Environment Agency Guidance Note M1 and BS EN 15259, and no improvement actions are required.

Flow Criteria Measurements

Duct Diameter (m)	Cross Sectional Area (m²)	Barometric Pressure (mbar)	Ambient Temperature (°C)	Mean Oxygen (%)	Mean Carbon Dioxide (%)	Mean Water Vapour (%)	Stack Gas Molecular mass (g/mol)	Pitot Coefficient
0.45	0.2	1013	25.0	4.9	9.0	8.0	28.7	0.994

Sample Line	Traverse Point	Position (cm)	Differential Pressure Reading (Pa)				Stack Velocity (m/s)	Stack Temp (°C)	Angle of Swirl
			1	2	3	Average			
A	A1	3.0	13.0	13.0	13.0	13.0	5.1	75	0
	A2	11.3	11.0	11.0	11.0	11.0	4.7	76	0
	A3	33.8	16.0	16.0	16.0	16.0	5.6	77	0
	A4	42.0	9.0	9.0	9.0	9.0	4.2	76	0

Parameter	Mean Duct Velocity	Velocity Ratio (Max:Min)	Mean Stack Temperature	Mean Stack Temperature	Stack Gas Volume Flow	Stack Gas Volume Flow (STP Wet)	Stack Gas Volume Flow (REF)
Value	4.9	1.3:1	76	349	2798	2189	1805
Units	m/s	-	°C	K	m³/hr	Nm³/hr	Nm³/hr



## Instrumental Gas Analyser Calibrations

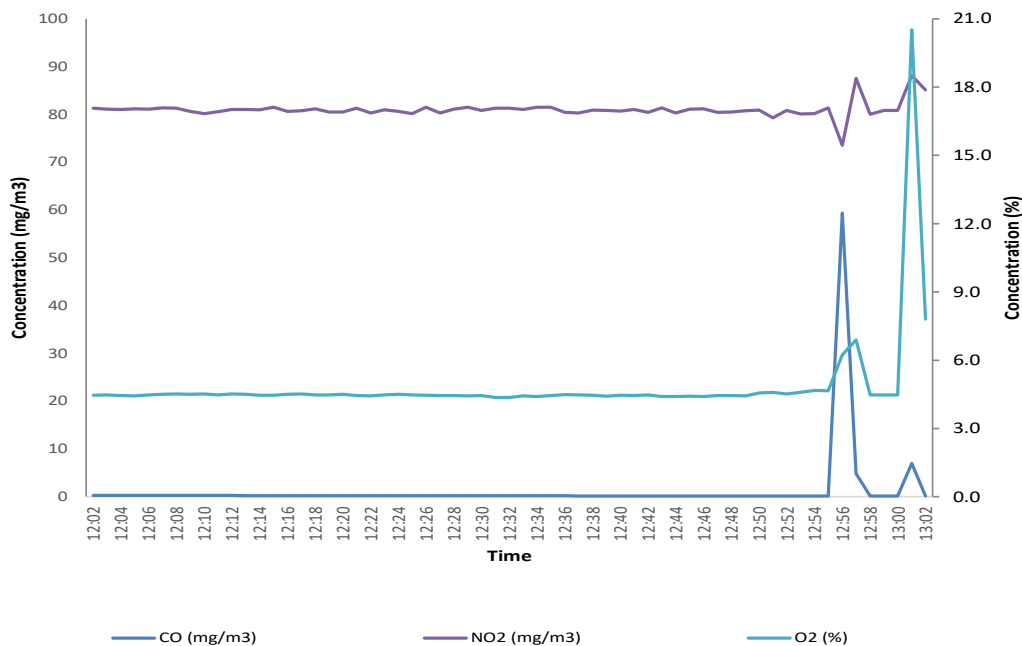
Date	Operators	Combustion Gas Analyser	Flame Ionisation Detector
31/01/2024	RB / JD / TA	12.03	-

Calibration Gas	Certified Concentration	Analyser Range	T90 Time	Analyser Span	Pre-sample Cal		Post-sample Cal		Zero Drift (%)	Span Drift (%)	Drift Acceptable
					Zero	Span	Zero	Span			
Carbon Monoxide	165.3ppm	250ppm	55	165	0.20	165	0.20	170	0.12	2.60	Yes
Nitrogen Monoxide	206ppm	500ppm	55	207	0.10	207	-0.10	208	-0.05	0.63	Yes
Oxygen	21.07%	25%	65	21.1	-0.05	21.1	0.00	20.9	0.00	-0.81	Yes

## Instrumental Gas Analyser Results

Substance	Run	Corrected Concentration			Units	Basis	O <sub>2</sub> Correction
		Average	Max	Min			
Carbon Monoxide	1	1.38	59.3	0.17	mg/m <sup>3</sup>	-	3%
Oxides of Nitrogen (as NO <sub>2</sub> )	1	81	88	73.5	mg/m <sup>3</sup>	NO <sub>x</sub> as NO <sub>2</sub>	3%
Oxygen	1	4.9	20.5	4.4	%	-	-

## Instrumental Gas Analyser Chart - Run 1



## Uncertainty

### Uncertainty of Carbon Monoxide by Horiba Gas Analyser - Run 1

Parameter	Value	Unit	Cal Gas
Emission Limit Value (ELV)	-	mg/m <sup>3</sup>	CO
Reading	1.1	ppm	
Span Gas Certified Value	165	ppm	
Range	250	ppm	

Source of Uncertainty	Uncertainty Criteria	Probability Distribution	Divisor	Source Uncertainty u	Combined Uncertainty u <sup>2</sup>
Zero Drift/Lower limit of detection (ppm)	-0.30	Rectangular	1.73	-0.17	0.03
Span Drift (ppm)	-4.5	Rectangular	1.73	-2.6	6.8
Linearity (% of value)	0.50	Rectangular	1.73	0.003	0.00001
Setting Gas Divider (% of value)	0.35	Normal	1.00	0.004	0.00001
Interference (% of value)	-0.48	Rectangular	1.73	-0.003	0.000009
Standard deviation of repeatability at zero point (% of range)	0.10	Rectangular	-	0.25	0.06
Standard deviation of repeatability at span point (% of range)	0.20	Rectangular	-	0.50	0.25
<b>Total</b>					7.1
<b>Combined Standard Uncertainty <math>[(\sum u^2)^{0.5}]</math></b>					2.7
<b>Expanded Total Uncertainty (ppm) (95% confidence)</b>					5.2
<b>Expanded Total Uncertainty as a % of emission conc. (95% confidence)</b>					473
<b>Expanded Total Uncertainty (mg/m<sup>3</sup>) (95% confidence)</b>					6.5
<b>Expanded Total Uncertainty as a % of emission limit value (95% confidence)</b>					-

### Uncertainty of Oxides of Nitrogen by Horiba Gas Analyser - Run 1

Parameter	Value	Unit	Cal Gas
Emission Limit Value (ELV)	-	mg/m <sup>3</sup>	NO
Reading	39.5	ppm	
Span Gas Certified Value	206	ppm	
Range	500	ppm	

Source of Uncertainty	Uncertainty Criteria	Probability Distribution	Divisor	Source Uncertainty u	Combined Uncertainty u <sup>2</sup>
Zero Drift/Lower limit of detection (ppm)	0.20	Rectangular	1.73	0.12	0.01
Span Drift (ppm)	-1.20	Rectangular	1.73	-0.69	0.48
Linearity (% of value)	0.54	Rectangular	1.73	0.12	0.02
Setting Gas Divider (% of value)	0.35	Normal	1.00	0.14	0.02
Interference (% of value)	0.63	Rectangular	1.73	0.14	0.02
Standard deviation of repeatability at zero point (% of range)	0.00	Rectangular	-	0.00	0.00
Standard deviation of repeatability at span point (% of range)	0.10	Rectangular	-	0.50	0.25
<b>Total</b>					0.80
<b>Combined Standard Uncertainty <math>[(\sum u^2)^{0.5}]</math></b>					0.89
<b>Expanded Total Uncertainty (ppm) (95% confidence)</b>					1.8
<b>Expanded Total Uncertainty as a % of emission conc. (95% confidence)</b>					4.4
<b>Expanded Total Uncertainty (mg/m<sup>3</sup>) (95% confidence)</b>					3.6
<b>Expanded Total Uncertainty as a % of emission limit value (95% confidence)</b>					-

Uncertainty of Oxygen by Horiba Gas Analyser - Run 1

Parameter	Value	Unit
Reading	4.9	%
Span Gas Certified Value	21.1	%
Range	25.0	%

Cal Gas
O <sub>2</sub>

Source of Uncertainty	Uncertainty Criteria	Probability Distribution	Divisor	Source Uncertainty u	Combined Uncertainty u²
Zero Drift/Lower limit of detection (%vol)	-0.16	Rectangular	1.73	-0.09	0.0085
Span Drift (%vol)	0.17	Rectangular	1.73	0.10	0.0096
Linearity (% of value)	0.41	Rectangular	1.73	0.01	0.00013
Setting Gas Divider (% of value)	0.35	Normal	1.00	0.02	0.0003
Interference (% of value)	0.00	Rectangular	1.73	0.000	0.000
Standard deviation of repeatability at zero point (% of range)	0.02	Rectangular	-	0.005	0.00003
Standard deviation of repeatability at span point (% of range)	0.02	Rectangular	-	0.005	0.00003
Total					0.019
Combined Standard Uncertainty $[(\sum u^2)^{0.5}]$					0.14
Expanded Total Uncertainty (%) (95% confidence)					0.27
Expanded Total Uncertainty as a % of emission conc. (95% confidence)					5.5

Uncertainty of Volumetric Flow - Run 1

Parameter	Value	Unit
Measured Volumetric Flow Rate Actual	2798	m³/hr

Performance Characteristics & Source Value	Value	Units
Standard Uncertainty - Pitot tube Coefficient	0.005	-
Standard Uncertainty - Mean Local Dynamic Pressure	1.1	Pa
Standard Uncertainty - Molar Mass of Stack Gas	0.0001	-
Standard Uncertainty - Stack Gas Temperature	0.50	K
Standard Uncertainty - Absolute Pressure in Duct	176	Pa
Standard Uncertainty - Density of Stack Gas	0.007	-
Standard Uncertainty - Mean Velocity	0.03	m/s
Expanded Uncertainty Mean Velocity (95% confidence)	0.06	m/s
Expanded Uncertainty Mean Velocity (95% Confidence), Relative	1.2	%
Standard Uncertainty - Volumetric Flow Rate	65	-
Standard Uncertainty - Volumetric Flow Rate (95% Confidence)	127	m³/hr
Standard Uncertainty - Volumetric Flow Rate (95% Confidence), Relative	4.5	%

95% confidence interval factor - 1.96

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