

Report for the Periodic Monitoring of Emissions to Atmosphere

Sheffield Teaching Hospitals Foundation NHS Trust

Boiler 8 - (Ideal)

| | | | |
|-------------------|------------------------------------------------------------|---------------|------------------------|
| Permit No: | N/A | | |
| Installation: | Royal Hallamshire | | |
| Monitoring Dates: | 30th January 2024 & 31st July 2024 | | |
| Site Address: | Royal Hallamshire Boiler House, C Road, Sheffield, S10 2RX | | |
| Report Number: | ES-1602/1864 | Version: | 1 |
| Date of Report: | 30th August 2024 | Visit: | 2 in 2024 |
| Report Author: | Istvan Biczky | | |
| MCERTS No: | MM 05 638 | MCERTS Level: | 2 (TE1, TE2, TE3, TE4) |
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| MCERTS No: | MM 05 653 | MCERTS Level: | 2 (TE1, TE2, TE3, TE4) |

Signed:



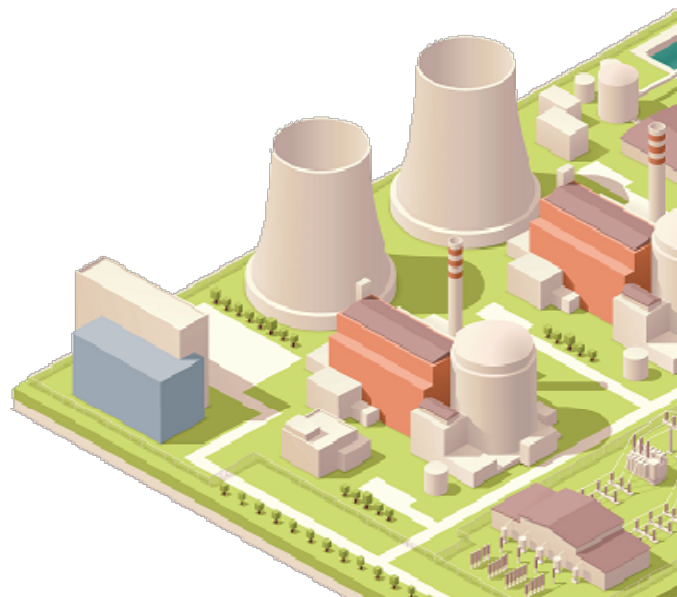
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Executive Summary

Monitoring Objectives

Envirocare Technical Consultancy were contracted by Sheffield Teaching Hospitals Foundation NHS Trust to carry out emissions monitoring, to determine the compliance of Boiler 8 - (Ideal) with the conditions specified in the operators permit (N/A) for emissions to atmosphere. 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 8 - (Ideal) |
|------------------------------------------|--------------------|
| Carbon Monoxide | ✓ |
| Oxides of Nitrogen (as NO ₂) | ✓ |
| 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 | | | Sampling Date | Sampling Times |
|------------------------------------------|---------------|----------------|----------------------------------|--------------------------------------------|---------------|---------------|----------------------------------|---------------|----------------|
| Substance | Limit (mg/m³) | Result (mg/m³) | Measurement Uncertainty (MU) +/- | Reference Conditions | Limit (g/hr) | Result (g/hr) | Measurement Uncertainty (MU) +/- | | |
| Carbon Monoxide | R1 | - | 0.27 | 273k, 101.3kPa, Dry Gas, 3% O ₂ | - | - | - | 30/01/2024 | 12:09-13:09 |
| Oxides of Nitrogen (as NO ₂) | R1 | - | 65.0 | | - | - | - | 30/01/2024 | 12:09-13:09 |
| Oxygen | R1 | - | 4.5% | As Measured, Dry Gas | - | - | - | 30/01/2024 | 12:09-13:09 |
| Volumetric Flow (Actual) | R1 | - | 2,957 m³/h | As Measured | - | - | - | 31/07/2024 | 15:15-15:20 |
| Volumetric Flow (REF) | R1 | - | 1,978 m³/h | 273k, 101.3kPa, Dry Gas, 3% O ₂ | - | - | - | 31/07/2024 | 15:15-15:20 |

Reference conditions (REF) are: 273k, 101.3kPa, Dry Gas, 3% O₂.

Supporting Information

Appendix 1: General Information

Operating Information

| Parameter | Process Details |
|----------------------------------------------|----------------------------|
| Process Type | Boiler |
| Continuous or Batch Process | Continuous when in demand |
| Operating Status | Normal |
| Feedstock | N/A |
| Normal Load, Throughput or Continuous Rating | S/N - 0315R002329 - 1.5 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

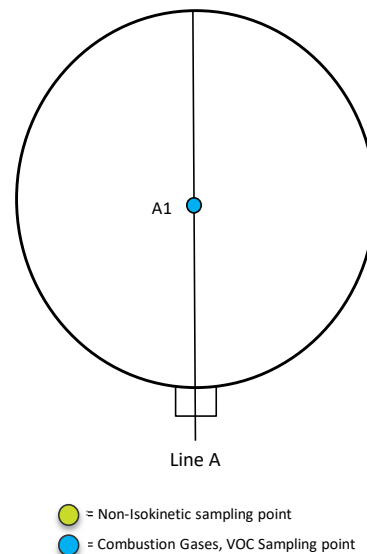
| Extractive Sampling | | Instrumental Analysers | | Miscellaneous Items | |
|------------------------|----------------|-----------------------------|----------------|-------------------------------|----------------|
| Equipment Type | Equipment I.D. | Equipment Type | Equipment I.D. | Equipment Type | 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 8 - (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 ² | 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 | 4.5 | 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 | 12.0 | 12.0 | 12.0 | 12.0 | 4.8 | 71 | 0 |
| | A2 | 11.3 | 15.0 | 15.0 | 15.0 | 15.0 | 5.4 | 71 | 0 |
| | A3 | 33.8 | 14.0 | 14.0 | 14.0 | 14.0 | 5.2 | 71 | 0 |
| | A4 | 42.0 | 14.0 | 14.0 | 14.0 | 14.0 | 5.2 | 71 | 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 | 5.2 | 1.1:1 | 71 | 344 | 2957 | 2347 | 1978 |
| Units | m/s | - | °C | K | m³/hr | Nm³/hr | Nm³/hr |

Instrumental Gas Analyser Calibrations

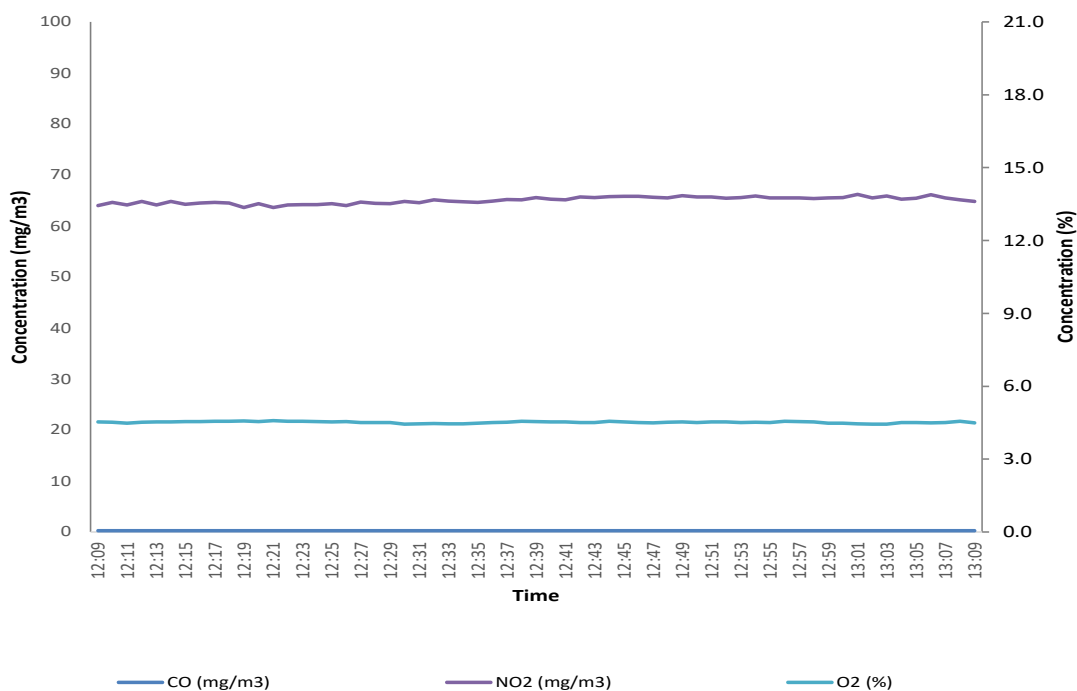
| Date | Operators | Combustion Gas Analyser | Flame Ionisation Detector |
|------------|-----------|-------------------------|---------------------------|
| 30/01/2024 | RB / JD | 12.03 | - |

| 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 | -0.10 | 165 | -0.06 | 0.06 | Yes |
| Nitrogen Monoxide | 206ppm | 500ppm | 55 | 207 | 0.10 | 207 | 0.10 | 206 | 0.05 | -0.29 | Yes |
| Oxygen | 21.07% | 25% | 65 | 21.1 | -0.05 | 21.1 | -0.16 | 20.8 | -0.76 | -0.52 | Yes |

Instrumental Gas Analyser Results

| Substance | Run | Corrected Concentration | | | Units | Basis | O ₂ Correction |
|------------------------------------------|-----|-------------------------|-----|------|-------------------|------------------------------------|---------------------------|
| | | Average | Max | Min | | | |
| Carbon Monoxide | 1 | 0.27 | 0.3 | 0.27 | mg/m ³ | - | 3% |
| Oxides of Nitrogen (as NO ₂) | 1 | 65 | 66 | 63.6 | mg/m ³ | NO _x as NO ₂ | 3% |
| Oxygen | 1 | 4.5 | 4.6 | 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 ³ | CO |
| Reading | 0.2 | ppm | |
| Span Gas Certified Value | 165 | ppm | |
| Range | 250 | ppm | |

| Source of Uncertainty | Uncertainty Criteria | Probability Distribution | Divisor | Source Uncertainty u | Combined Uncertainty u ² |
|----------------------------------------------------------------------------|----------------------|--------------------------|---------|----------------------|-------------------------------------|
| Zero Drift/Lower limit of detection (ppm) | 0.10 | Rectangular | 1.73 | 0.06 | 0.003 |
| Span Drift (ppm) | 0.0 | Rectangular | 1.73 | 0.00 | 0.00 |
| Linearity (% of value) | 0.50 | Rectangular | 1.73 | 0.001 | 0.000 |
| Setting Gas Divider (% of value) | 0.35 | Normal | 1.00 | 0.001 | 0.000 |
| Interference (% of value) | -0.48 | Rectangular | 1.73 | -0.001 | 0.000 |
| 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 |
| Total | | | | | 0.32 |
| Combined Standard Uncertainty [(sum u ²) ^{0.5}] | | | | | 0.56 |
| Expanded Total Uncertainty (ppm) (95% confidence) | | | | | 1.1 |
| Expanded Total Uncertainty as a % of emission conc. (95% confidence) | | | | | - |
| Expanded Total Uncertainty (mg/m ³) (95% confidence) | | | | | 1.4 |
| Expanded Total Uncertainty as a % of emission limit value (95% confidence) | | | | | - |

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

| Parameter | Value | Unit | Cal Gas |
|----------------------------|-------|-------------------|---------|
| Emission Limit Value (ELV) | - | mg/m ³ | NO |
| Reading | 31.7 | ppm | |
| Span Gas Certified Value | 206 | ppm | |
| Range | 500 | ppm | |

| Source of Uncertainty | Uncertainty Criteria | Probability Distribution | Divisor | Source Uncertainty u | Combined Uncertainty u ² |
|----------------------------------------------------------------------------|----------------------|--------------------------|---------|----------------------|-------------------------------------|
| Zero Drift/Lower limit of detection (ppm) | 0.00 | Rectangular | 1.73 | 0.00 | 0.000 |
| Span Drift (ppm) | 0.50 | Rectangular | 1.73 | 0.29 | 0.08 |
| Linearity (% of value) | 0.54 | Rectangular | 1.73 | 0.10 | 0.01 |
| Setting Gas Divider (% of value) | 0.35 | Normal | 1.00 | 0.11 | 0.01 |
| Interference (% of value) | 0.63 | Rectangular | 1.73 | 0.12 | 0.01 |
| Standard deviation of repeatability at zero point (% of range) | 0.00 | Rectangular | - | 0.000 | 0.000 |
| Standard deviation of repeatability at span point (% of range) | 0.10 | Rectangular | - | 0.50 | 0.25 |
| Total | | | | | 0.37 |
| Combined Standard Uncertainty [(sum u ²) ^{0.5}] | | | | | 0.61 |
| Expanded Total Uncertainty (ppm) (95% confidence) | | | | | 1.2 |
| Expanded Total Uncertainty as a % of emission conc. (95% confidence) | | | | | 3.8 |
| Expanded Total Uncertainty (mg/m ³) (95% confidence) | | | | | 2.4 |
| Expanded Total Uncertainty as a % of emission limit value (95% confidence) | | | | | - |

Uncertainty of Oxygen by Horiba Gas Analyser - Run 1

| Parameter | Value | Unit |
|--------------------------|-------|------|
| Reading | 4.5 | % |
| Span Gas Certified Value | 21.1 | % |
| Range | 25.0 | % |

| Cal Gas |
|----------------|
| O ₂ |

| Source of Uncertainty | Uncertainty Criteria | Probability Distribution | Divisor | Source Uncertainty u | Combined Uncertainty u ² |
|-----------------------------------------------------------------------------|----------------------|--------------------------|---------|----------------------|-------------------------------------|
| Zero Drift/Lower limit of detection (%vol) | 0.18 | Rectangular | 1.73 | 0.10 | 0.0108 |
| Span Drift (%vol) | 0.27 | Rectangular | 1.73 | 0.16 | 0.0243 |
| Linearity (% of value) | 0.41 | Rectangular | 1.73 | 0.01 | 0.00011 |
| Setting Gas Divider (% of value) | 0.35 | Normal | 1.00 | 0.02 | 0.0002 |
| 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 | | | | | 0.036 |
| Combined Standard Uncertainty [(sum u²)^{0.5}] | | | | | 0.19 |
| Expanded Total Uncertainty (%) (95% confidence) | | | | | 0.37 |
| Expanded Total Uncertainty as a % of emission conc. (95% confidence) | | | | | 8.2 |

Uncertainty of Volumetric Flow - Run 1

| Parameter | Value | Unit |
|--------------------------------------|-------|--------------------|
| Measured Volumetric Flow Rate Actual | 2957 | m ³ /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 | 0.008 | - |
| 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 | 1.3 | % |
| Standard Uncertainty - Volumetric Flow Rate | 68 | - |
| Standard Uncertainty - Volumetric Flow Rate (95% Confidence) | 134 | m ³ /hr |
| Standard Uncertainty - Volumetric Flow Rate (95% Confidence), Relative | 4.5 | % |

| |
|---------------------------------------|
| 95% confidence interval factor - 1.96 |
|---------------------------------------|

| Document Version Number | Record of change within different version numbers |
|-------------------------|--------------------------------------------------------------|
| ES-1602 | Original version of the document issued to client. |
| ES-1864 | Incorporated flows version of the document issued to client. |