



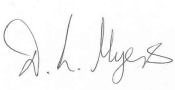
Client Staffordshire Crystal Ltd.
 Unit 14 Pedmore Road Ind. Estate
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Part 1: Executive Summary

Report for the Periodic Monitoring of Emissions to Air.

Site	Brierley Hill
Plant	Acid Fume Scrubber
Sampling Date	28th January 2016
Report Date	25th February 2016
Job Number	71962p1r0
Permit Number	PB/98 Variation 200839393

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	MCERTS No.	MM05 659 Level 2 TE: 1,2,3,4

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Monitoring Objectives

The monitoring was undertaken to check compliance with authorised emission limits.

All monitoring procedures were carried out to the MCERTS requirements under the Exova (UK) Ltd quality system to ISO 17025: 2005.

Monitoring was undertaken for the listed emissions from the following sampling positions:

Sampling Location	Emission
Acid Fume Scrubber	Hydrogen fluoride

Special Monitoring Requirements

There were no special requirements for this monitoring campaign.

Summary Of Methods

Emission	Method number	Method standard
Gas velocity and volume flow	TPM/01A	BS EN ISO 16911-1:2013
Water vapour	MM0010	BS EN 14790 : 2005
Hydrogen fluoride	MM0013	BS ISO 15713 : 2006

Summary Of Results

The table presents the atmospheric emissions from the tests undertaken on behalf of **Staffordshire Crystal Ltd.**
The results were measured from the sample positions downstream of the arrestment plant.

Emission at Brierley Hill Acid Fume Scrubber	Sampling Time			Emission Result mg/m ³ *	Authorised Limit mg/m ³ *	Uncertainty +/- mg/m ³ *	Detection Limit mg/m ³ *	Mass Emission g/h
	Date	Start	End					
s Hydrogen fluoride	28/01/16	09:57	10:37	11.4	5	1.7	0.10	51.79

* at reference conditions	Stack Gas Weight 29.00 Kg/kmol	0 °C 101.3 kPa	Without correction for moisture Oxygen No Correction %
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Where applicable

Oxides of nitrogen results are expressed as nitrogen dioxide
TOC results are expressed as total carbon

Throughout Report:

* Reference conditions (see above)
** Analysis not required
ND Non detectable
s - Subcontracted laboratory analysis

Nm³ 273 K, 101.3 kPa
- UKAS accredited only
- Not Accredited
N/A Not applicable

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a 95% confidence level. The uncertainty evaluation has been carried out in accordance with UKAS requirements.



All tests included in this report are accredited under UKAS and MCERTS accreditation schemes unless otherwise stated.
Opinions and interpretations expressed herein are outside the scope of MCERTS and UKAS accreditation.



Operating Information

The table below shows details of the operating information on each sampling date for: **Acid Fume Scrubber**

Date	Process type	Process duration	Fuel	Feedstock	Abatement	Load
28/01/2016	Acid Fume Scrubber	Continuous	-	Glass	Wet Scrubber	Normal Operation

No CEMs installed on the emission point.

Comments & Monitoring Deviations

A waste gas homogeneity test to BS EN 15259:2007 (MID) is not required:-
The homogeneity test is not applicable to non-combustion processes.
The homogeneity test is not applicable to duct areas less than 1m².

All monitoring was performed in accordance with the relevant procedures.

The sampling location is a vertical duct.

The velocity and temperature profile at the sampling location met the requirements of BS EN 13284-1: 2002.

The impinger efficiency check for hydrogen fluoride was performed and meet the required of >95%.

When the results are expressed as non-detected the mass emissions are calculated from the detection limit and therefore they are worst case results.




Part 2: Supporting Information

Report for the Periodic Monitoring of Emissions to Air.

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Site	Brierley Hill
Plant	Acid Fume Scrubber
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APPENDIX 1

Emission Monitoring Procedures And Instrumentation

Gas velocity and temperature

Documented in-house procedure TPM01/A to the main procedural requirements of BS EN ISO 16911-1:2013. Velocity and temperature measurements are performed using a calibrated Pitot tube, a calibrated pressure differential reading device and a calibrated thermocouple. Velocity and possible flow deviation measurements are carried out at selected, representative points in the gas stream.

Water vapour

Documented in-house procedure MM0010 to the main procedural requirements of BS EN 14790:2005. A measured volume of gas is extracted from the gas stream through a moisture trapping unit. The mass gain of moisture trapped is divided by the volume of gas sampled to determine the mass concentration of water vapour. For water saturated stacks the temperature of the gas stream is measured and the water vapour concentration is determined using liquid-gas equilibrium tables. Sampling points are selected in accordance with the findings of any BS EN 15259 assessment.

Hydrogen fluoride

Documented in-house procedure MM0013 to the main procedural requirements of BS ISO 15713:2006. A substantial metered volume of gas is extracted through a dedicated heated probe, filter, sample line and chilled multi-impinger train containing sodium hydroxide solution, and subsequent Ion Chromatography analysis. Sampling points are selected in accordance with the findings of any BS EN 15259 assessment.

Sampling Project Personnel Competency And Expiry Dates

		MCERTS No	Level 1	Level 2	TE1	TE2	TE3	TE4
Report prepared by:	Michelle Edwards	MM05 659	-	30/06/2017	31/12/2017	31/12/2019	30/06/2018	29/02/2020
Report authorised by:	Derek Myers	MM02 115	-	30/09/2017	31/05/2018	30/11/2018	30/11/2018	30/11/2018
Team leader:	Michelle Edwards	MM05 659	-	30/06/2017	31/12/2017	31/12/2019	30/06/2018	29/02/2020
Team leader:	Aidan Wryne	MM08 921	-	31/05/2017	31/05/2017	31/11/2018	30/11/2017	30/06/2018

Equipment References

Equipment	Reference Number
Probe	10
Stack Thermocouple	AQ184
Timer / Stopwatch	AQ308
Barometer	AQ343
Pitot	AQ296
Callipers	CV24
Tape Measure	AQ278
Impinger Thermocouple	TV34
Sample Rate Calculation Equipment	Laptop
Thermometer	AQ126
Manometer	AQ126
Balance	AQ090
Weights	AQ090a & AQ090b

Subcontracted Analysis

Exova (UK) Ltd has, with your approval, used the following sub-contracted laboratories for the laboratory analyses referenced below:

Laboratory:	Exova (UK) Ltd
Parameters:	Acid Gases - Internal method, IC
Accreditation:	UKAS Accredited testing laboratory number 4279

APPENDIX 2

Date	28/01/2016
Time	09:00
Pitot Cp	0.84

Barometric pressure	100.5	kPa
Duct static pressure	0.01	kPa
Stack Area	0.181	m ²

Stack Diameter (circular)	0.48	m
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Traverse Point	Traverse Line	Depth cm	ΔP mmH ₂ O	T °C	Angle °	velocity m/s	Traverse Line	Depth cm	ΔP mmH ₂ O	T °C	Angle °	velocity m/s
1	A						B					
2	A	5.0	7.4	12	<15	9.1	B					
3	A	5.7	7.0	12	<15	8.9	B					
4	A	8.5	5.4	12	<15	7.8	B					
5	A	12.0	5.2	12	<15	7.7	B					
6	A	17.1	4.8	12	<15	7.4	B					
7	A	30.9	4.6	12	<15	7.2	B					
8	A	36.0	4.4	12	<15	7.0	B					
9	A	39.5	4.2	12	<15	6.9	B					
10	A	42.3	4.0	12	<15	6.7	B					
11	A	43.0	3.8	12	<15	6.5	B					
12	A						B					

Average Pitot DP	5.02	mmH ₂ O
Average Temperature	285.2	K
Average Velocity	7.5	m/s
Average volumetric flow rate	1.36	m ³ /s at stack conditions
Average volumetric flow rate	1.29	m ³ /s (wet STP)
Average volumetric flow rate	1.25	m ³ /s (dry STP)
Average volumetric flow rate	N/A	m ³ /s (dry, STP, reference oxygen concentration)

Sampling plane requirements Re: BS EN 13284-1:2001 5.2

a	Angle of gas flow less than 15° with regard to duct axis	YES
b	No local negative flow	YES
c	Minimum pitot greater than 5Pa	YES
d	Ratio of highest to lowest local gas velocity less than 3:1	YES
	Minimum local gas velocity	6.5
	Maximum local gas velocity	9.1
	Ratio of highest to lowest local gas velocity	1.40

Moisture Determination BS EN 14790:2005

	Volume m ³	Temp °C	Pressure mbar
Meter start	2967.840	8	1005
Meter end	2967.995	8	1005
Meter Yd	0.974		
Gas volume	0.146		

Impinger	1	2	3	4
Mass start (g)	745.4	686.6	581.9	806.4
Mass End (g)	745.6	686.6	582.8	809.4
Total Mass collected (g)	4.1			
Water vapour content (% v/v)	3.4			

If water droplets are present in the gas, the water vapour content is calculated using BS EN 14790 Annex A

N/A % v/v

Preliminary Velocity Traverse & Moisture Data

Probe/Pitot ID No	10/AQ296	In-stack Filtration	Y/N	N
Pitot Calibration Factor (Cp)	0.84	Leak check OK	Y/N	Y
Gas Calibration Factor (Y)	0.974	Meter ID No		AQ126
Barometric Pressure	kPa 100.5	Initial Gas Meter Reading	m³	2967.840
Duct static Pressure	kPa 0.01	Final Gas Meter Reading	m³	2967.995
Date	28/01/2016	Sampled Vol, Dry at Meter	m³	0.155
Start Time	hh:min 09:57	Sampled Vol, Dry STP	Nm³	0.146
End Time	hh:min 10:37	Moisture content of stack gas	% v/v	3.4
Sampling Duration	hh:min 00:40			

Impinger	1	2	3	4
Initial mass (g)	745.4	686.6	581.9	806.4
Final mass (g)	745.6	686.6	582.8	809.4

Sample Point Number	Line	Sampling Time hh:min	Pitot Reading (h) mm w.g	Temperatures			Orifice Pressure (Dh) mm w.g
				Sample Gas Temperature (Ts) °C	Filter Temperature °C	Meter Temperature (Tm) °C	
Centre	Point	09:57	4.8	13	150	8	10.0
		10:02	4.8	13	150	8	10.0
		10:07	4.8	13	150	8	10.0
		10:12	4.8	13	150	8	10.0
		10:17	4.8	13	150	8	10.0
		10:22	4.8	13	150	8	10.0
		10:27	4.8	13	150	8	10.0
		10:32	4.8	13	150	8	10.0
End		10:37					
		Averages	4.8	13.0	150.0	8.0	10.0

Average velocity	7.36	m/s
Average flow rate	1.33	m³/s
Average flow rate	1.26	m³/s*

Hydrogen Fluoride - Sampling Data

Date	28/01/2016
Start time	09:57
Finish time	10:37

	UNITS	Impinger 1	Impinger 2	Impinger 3 (Drop Out)	Impinger 4 (Silica Gel)
Start mass	g	745.4	686.6	581.9	806.4
Finish mass	g	745.6	686.6	582.8	809.4
Impingers 1 & wash mass	g	165			
Impingers 2,3 & wash mass	g	127			
Field blank mass	g	216			
Sample gas volume	Nm ³	0.146			

Acid Gases	UNITS	Impinger 1 & wash conc. 71962/23	Impinger 2&3 & wash conc. 71962/24	Field Blank conc. 71962/21
Hydrogen fluoride	mg/l	10.33	0.11	0.05

		Impinger 1 Emission	Impinger 2 Emission	Detection Limit	Field Blank Emission	Total Emission	Impinger Efficiency %
Hydrogen fluoride	mg/m ³ *	11.31	0.09	0.10	0.07	11.40	99.19

Numbers in bold indicate detection limits

Laboratory	Exova Catalyst UK	
Method N ^o & Accreditation Status	IC (Acetate Separation)	UKAS
Date of analysis	03/02/2016	

Hydrogen Fluoride - Emission Results

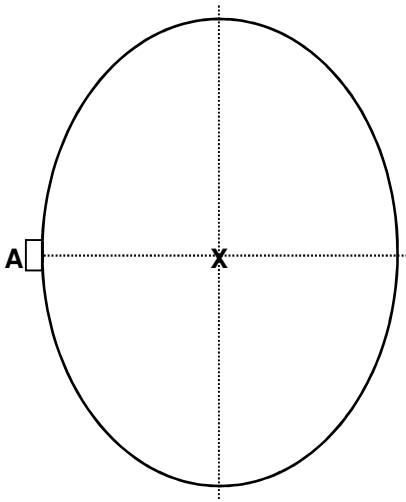
APPENDIX 3

Diagram Of The Sampling Location

Diagram of sampling points across the cross section of the duct (not to scale).

Traverse length = 0.48 m

Point	% of D	Location cm
1	50.0	24.0



General Calculations

Stack area:

$$\text{Area of a circle} = \frac{\pi \cdot D^2}{4}$$

D = Diameter (m)
 $\pi = 3.142$

Pressure conversion:

1mmH₂O = 0.00980665 kPa
 1mmH₂O = 9.80665 Pa
 1 mar = 0.1 kPa

Water vapour concentration:

From reference calculations (taken from BS EN 14790):

$$V_{WC(\%)} = \frac{\frac{m_{WC} \cdot V_{mol(std)}}{M_w}}{\frac{m_{WC} \cdot V_{mol(std)}}{M_w} + V_{m(std)}} \times 100$$

VWC (%) = Water vapour content on wet basis, in volume % (m³ of water vapour in m³ of wet gas)
 Vm(std) = Dry gas volume measured, corrected to standard conditions (m³)
 mWC = Mass of water collected in the impingers (g)
 Mw = Molecular weight of water, 18.01534 rounded to 18 (g/mol)
 Vmol(std) = Molar volume of water at standard conditions = 0.0224 (m³/mol)

Gas meter volume at standard conditions (STP)

From reference calculations (taken from BS EN 14790):

$$V_{m(std)} = y_d \times (V_2 - V_1) \times \frac{T_{std}}{T_m} \times \frac{P_m}{P_{std}}$$

Vm(std) = Dry gas meter volume at standard conditions (m³)
 y_d = Gas meter calibration coefficient
 (V₂-V₁) = Dry gas meter volume at actual conditions (m³)
 T_m = Actual Temperature (K)
 T_{std} = Standard temperature (273 K)
 p_m = Absolute pressure at the gas meter (kPa)
 p_{std} = Standard gas pressure (101.3 kPa)

Isokenetic Ratio (%):

From reference calculations (taken from EA TGN M2):

$$\text{IsokeneticRatio}(\%) = \frac{\text{Velocity at the sampling nozzle}}{\text{Velocity of the stack gas}} \times 100$$

Estimating Measurement Uncertainty

Uncertainty estimates are calculated using the general rule of uncertainty propagation. Guidance is taken from publications including UKAS document M3003 and ISO 20988:2007.

Flow Calculations

Velocity:

From reference calculations (taken from ISO 10780):

$$\bar{v} = KC \sqrt{\frac{T_s \Delta p}{P_e M_s}}$$

\bar{v} = Average velocity (m/s)

C = velocity calculation constant = 129

T_s = Average stack temperature (K)

M_s = Molar mass of gas; assume 29 kg/kmol unless the molar mass is < 27 kg/kmol or > 31 g/kmol

K = Pitot calibration coefficient

P_e = Absolute gas pressure (kPa)

Δp = Average pitot tube pressure differential (kPa)

Volume flow rate

From reference calculations (taken from ISO 10780):

$$q_{va} = \bar{v}A$$

q_{va} = Average flow rate (m³/s)

\bar{v} = Average velocity (m/s)

A = Stack cross-sectional area (m²)

Volume flow rate corrected for moisture

From reference calculations (taken from BS ISO 9096):

$$q_m = q_{va} \frac{(100 - H_a)}{(100 - H_m)}$$

q_m = Corrected volume flowrate (m³/s)

q_{va} = Volume flow rate at actual conditions (m³/s)

H_a = Moisture at actual conditions (%volume)

H_m = Reference moisture (%volume)

Volume flow rate corrected for temperature and pressure

From reference calculations (taken from BS ISO 9096):

$$q_m = q_{va} \frac{(T_m P_a)}{(T_a P_m)}$$

q_m = Corrected volume flowrate (m³/s)

q_{va} = Volume flow rate at actual conditions (m³/s)

T_a = Temperature at actual conditions (K)

T_m = Reference Temperature (K)

p_a = Absolute gas pressure at actual conditions (kPa)

p_m = Reference pressure (kPa)

Volume flow rate corrected for oxygen

From reference calculations (taken from BS ISO 9096):

$$q_m = q_{va} \frac{(20.9 - O_{2,ref})}{(20.9 - O_{2,m})}$$

q_m = Corrected volume flowrate (m³/s)

q_{va} = Volume flow rate at actual conditions (m³/s)

$O_{2,m}$ = Actual oxygen concentration (%)

$O_{2,ref}$ = Reference oxygen concentration (%)

Concentration Calculations

Concentration:

From reference calculations (taken from BS EN 13284-1):

$$c = \frac{m}{V}$$

c = Concentration
 m = Mass of substance
 V = Volume sampled

Mass Emission

$$\text{Mass emission} = c \times q_m$$

c = Concentration
 q = Volume flow rate

Concentration corrected for oxygen:

From reference calculations (taken from BS ISO 9096):

$$c_m = c_a \times \frac{20.9 - O_{2,ref}}{20.9 - O_{2,a}}$$

c_m = Concentration at reference conditions
 c_a = Actual concentration
 $O_{2, ref}$ = Reference oxygen (%)
 $O_{2, a}$ = Actual Oxygen (%)

Concentration corrected for moisture:

From reference calculations (taken from BS ISO 9096):

Convert wet gas to dry gas

$$c_{dry} = c_{wet} \times \frac{100}{100 - H_a}$$

Convert dry gas to wet gas

$$c_{wet} = c_{dry} \times \frac{100 - H_a}{100}$$

c_{wet} = Concentration wet gas
 c_{dry} = Concentration dry gas
 H_a = Water vapour content (%vol)

Conversion of parts per million (ppm) to mg/m³

From reference calculations (taken from EA TGN M2):

$$\text{Concentration}(mg / m^3) = \frac{\text{Concentration}(ppm) \times \text{molecular weight}(g)}{\text{molar volume}(l) \text{ at a given temperature}}$$

molar volume at 273K = 22.4 litres

When Converting TOC

$$\text{Concentration}(mg / m^3) = \frac{\text{Concentration}(ppm) \times \text{molecular weight of carbon in span gas}(g)}{\text{molar volume}(l) \text{ at a given temperature}}$$

molar volume at 273K = 22.4 litres

Calculation of Uncertainty Estimates - Manual Monitoring Techniques

$$C_m = \frac{Q_m}{V_{std}}$$

$$V_{std} = V_{T.p} \times \frac{T_{std}}{T} \times \frac{P}{P_{std}}$$

Where:

C_m	=	the measured concentration	in	mg/m ³
Q_m	=	mass concentration collected in absorber solution and filter	in	mg
v_s	=	the volume of the sample solution	in	l
V_{std}	=	volume sampled at standard conditions	in	m ³
T_m	=	mean temperature of gas meter	in	K
T_{std}	=	standard temperature	=	273K
$p=p_{rel}+P_{atm}$	=	absolute pressure = gas meter pressure + atmospheric pressure	in	kPa
P_{std}	=	standard pressure	=	101.325 kPa
$V_{T.p}$	=	volume sampled as indicated by the gas meter	in	m ³

Expression for calculation of the combined uncertainty of the measured concentration

$$\frac{u^2(C_m)}{(C_m)^2} = \frac{u^2(Q_m)}{(Q_m)^2} + \frac{u^2(v_s)}{(v_s)^2} + \frac{u^2(V_{std})}{(V_{std})^2}$$

Expression for calculation of the combined uncertainty of the gas volume

$$V_{std} = V_{T.p} \times \frac{T_{std}}{T_m} \times \frac{P}{P_{std}}$$

Assuming that uncertainties associated with the standard quantities T_{std} and P_{std} are negligible

Expression for calculation of the combined uncertainty of the measured concentration

$$\frac{u^2(C_m)}{(C_m)^2} = \frac{u^2(Q_m)}{(Q_m)^2} + \frac{u^2(v_s)}{(v_s)^2} + \frac{u^2(V_{T.p})}{(V_{T.p})^2} + \frac{u^2(T)}{(T)^2} + \frac{u^2(p_{rel})}{(p)^2} + \frac{u^2(p_{atm})}{(p)^2}$$

$$u(C_m) = \sqrt{\left(\frac{u^2(Q_m)}{(Q_m)^2} + \frac{u^2(v_s)}{(v_s)^2} + \frac{u^2(V_{T.p})}{(V_{T.p})^2} + \frac{u^2(T)}{(T)^2} + \frac{u^2(p_{rel})}{(p)^2} + \frac{u^2(p_{atm})}{(p)^2} \right)} \times (C_m)^2$$

Overall expanded uncertainty (k = 2)

$$U(C_m) = u(C_m) \times k$$

Uncertainty of the measured concentration at oxygen reference concentration

$$u(C_{m,O_2,ref}) = \sqrt{\left(\frac{u^2(Q_m)}{(Q_m)^2} + \frac{u^2(v_s)}{(v_s)^2} + \frac{u^2(V_{T.p})}{(V_{T.p})^2} + \frac{u^2(T)}{(T)^2} + \frac{u^2(p_{rel})}{(p)^2} + \frac{u^2(p_{atm})}{(p)^2} + \frac{u^2(O_{2,meas,dry})}{(21 - O_{2,meas,dry})^2} \right)} \times (C_{m,O_2,ref})^2$$

Where:

$u(C_{m,O_2,ref})$	=	uncertainty associated with the mass concentration at O ₂ reference concentration	in	mg/m ³
$C_{m,O_2,ref}$	=	mass concentration at O ₂ reference concentration	in	mg/m ³
$O_{2,meas}$	=	O ₂ measured concentration	in	% volume
$u((O_{2,meas})_{dry})$	=	uncertainty associated to the measured O ₂ concentration	in	% (relative to O _{2,meas})

APPENDIX 4

Uncertainty Estimate For The Measurement Of Hydrogen Fluoride

Mass Concentration Of Hydrogen Fluoride

Symbol	Mass concentration of HF	Units
C_m	11.80	mg/m ³
C_m at O ₂ ref	N/A	mg/m ³

Symbol	Daily emission limit value	Units
DELV	5.0	mg/m ³

Reference Oxygen		
O _{2,ref}	0.0	% (0 = No Correction)

Symbol	Source of Uncertainty	Value	Units	Probability Distribution	Divisor	ci	Ui
$u(Q_m)$	Analytical Uncertainty	7.0	%	Normal (k=2)	1	1	7
Q_m	Concentration in absorption solution	10.44	mg/l	Normal	-	1	0.7308
$u(Q_m)/Q_m$	Relative	-	-	Normal	-	-	0.0700
						$u(Q_m)^2/Q_m^2$	0.0049

Volume of sampled gas

Symbol	Source of Uncertainty	Value	Units	Probability Distribution	Divisor	ci	Ui
$u(calV_{T,p})$	Calibration	0.0007	m ³	Normal	2	1	0.0004
$u(repV_{T,p})$	Repeatability	0.0001	m ³	Normal	1	1	0.0001
$u(driftV_{T,p})$	Drift	0.0004	m ³	Rectangular	$\sqrt{3}$	1	0.0002
$u(resV_{T,p})$	Resolution	0.0002	m ³	Rectangular	$\sqrt{3}$	1	0.0001
$u(V_{T,p})$	Combined Uncertainty	-	-	Normal	-	-	0.0005
$u(V_{T,p})/V_{T,p}$	Relative	0.146	m ³	-	-	-	0.0032
						$u(V_m)^2/V_m^2$	0.000010

Temperature of the DGM

Symbol	Source of Uncertainty	Value	Units	Probability Distribution	Divisor	ci	Ui
$u(calT_m)$	Calibration	1.00	K	Normal	2	1	0.5000
$u(calT_c)$	Calibration	1.0	K	2.00	2	1	0.5000
$u(resT_m)$	Resolution	0.1	K	Rectangular	$\sqrt{3}$	1	0.0577
$u(driftT_m)$	Drift	1.0	K	Rectangular	$\sqrt{3}$	1	0.5774
$u(T_m)$	Combined Uncertainty	-	-	Normal	-	-	0.9147
$u(T_m)/T_m$	Relative	281.0	K	Normal	-	-	0.0033
						$u(T_m)^2/T_m^2$	0.000011

Atmospheric Pressure

Symbol	Source of Uncertainty	Value	Units	Probability Distribution	Divisor	ci	Ui
$u(P_{atm})$	Metrological Office	300	Pa	Normal	$\sqrt{3}$	1	173
$u(P_{atm})$	Combined Uncertainty	-	-	Normal	-	-	173
$u(P_{atm})/P$	Relative	100500	-	Normal	-	-	0.00
						$u(P_{atm})^2/P^2$	0.00

Relative DGM Pressure

Symbol	Source of Uncertainty	Value	Units	Probability Distribution	Divisor	ci	Ui
$u(P_{rel})$	DGM Pressure	40	Pa	Normal	1	1	40
$u(P_{rel})$	Combined Uncertainty	-	-	Normal	-	-	40
$u(P_{rel})/P$	Relative	100598	-	Normal	-	-	0.0004
						$u(P_{rel})^2/P^2$	0.0000002

Volume (mass) of Absorption Solution

Symbol	Source of Uncertainty	Value	Units	Probability Distribution	Divisor	ci	Ui
$u(repvs)$	Repeatability	0.13	g (ml)	Normal	1	1	0.13
$u(calvs)$	Calibration (Tare)	0.10	g (ml)	Rectangular	1	1	0.10
$u(drvs)$	Drift	0.10	g (ml)	Rectangular	1	1	0.10
$u(resvs)$	Resolution	0.05	g (ml)	Rectangular	$\sqrt{3}$	1	0.03
$u(vs)$	Combined Uncertainty	-	-	-	-	-	0.19
$u(vs)/vs$	Relative	165	-	Normal	-	-	0.0012
						$u(vs)^2/vs^2$	0.0000014

Oxygen reference concentration

Symbol	Source of Uncertainty	Value	Units	Probability Distribution	Divisor	ci	Ui
$u((O_2.meas)dry)rel$	Measurement of oxygen	N/A	%	Normal	1	1	N/A
	Uncertainty of oxygen correction	-	-	-	-	-	N/A
	Measured Oxygen	N/A	%	-	-	-	N/A
						$u(O_{rel})^2/O^2$	N/A

Measurement uncertainty

$u(C_m)$	Combined Standard Uncertainty				±	0.83	mg/m ³
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Expanded uncertainty expressed with a level of confidence of 95%, k=2

$U(C_m)$	Expanded Combined Uncertainty	$k = 2$			±	1.66	mg/m ³
$U(C_m,rel)$	Expanded Combined Uncertainty	$k = 2$			±	14.0	%
$U(C_m,rel,ELV)$	Expanded Combined Uncertainty	$k = 2$			±	33.1	%

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor ($k = 2$), providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.