Atmospheric Emissions Survey Report

Anglo American Platinum (Pty) Ltd
Rustenburg Processing Operations: Rustenburg Base Metals Refiners
Rustenburg, North West

Final Report No. 71/19

18 October 2019

BY

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EXECUTIVE SUMMARY

C&M Consulting Engineers were appointed by Rustenburg Base Metals Refiners to conduct annual emissions survey on various stacks (point sources) on the 23rd, 24th,25th, 26th, 29th and 30th July 2019. This is as required by the Atmospheric Emissions License BPDM/BMR/AEL1.1/MARCH2016 issued by the Bojanala Platinum District Municipality on 01 February 2016 in Rustenburg, North West.

These stacks (point sources) are at the boilers, Cu and Ni tank houses. Although the Cu and Ni tank houses are not listed activities, annual once-off measurements must be submitted to the authorities as prescribed by section 5.4.2 of Atmospheric Emissions License BPDM/BMR/AEL1.1/MARCH2016.

The objective of the measurement program was to quantify the following parameters and emissions from the point sources:

SAMPLING POINT ID	PARTICULATE MATTER (PM)	SULFUR DIOXIDE (SO_2)	NITROGEN OXIDES (NO_X as NO_2)
Boiler Stack	X	X	X
Cu Tank House Stack	X	X	X
Ni Tank House Stack	X	X	X

In addition to the emission measurements mentioned above, the following parameters were measured as part of isokinetic measurements, where applicable:

- Gas velocity
- Gas volumetric flow rate
- Gas temperature as well as absolute and static pressure
- Water vapour content of the stack gas

All the point sources serving Rustenburg Base Metals Refiners, herein referred to as RBMR in Rustenburg, North West, complied with the emission standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004

(Act No. 39 of 2004) as gazetted on 22 November 2013 in Government Notice Number 37054 (Listed Activities):

This is notwithstanding whether the two boilers are exempted from the emission standards as a small boiler is defined by Government Notice Number 36973 as: “any small boiler with a design capacity equal to 10 MW but less than 50 MW net heat input per unit, based on the lower calorific value used.”

The average results obtained are shown in the following table.

Table A: Isokinetic and An-isokinetic Sampling; Average Stack Parameters, Particulate and Gas Concentrations

Stack Parameters	Unit	AEL Limits	Boiler Stack	Cu Tank House Stack	Ni Tank House Stack
Date		-	23&24/07/2019	25&26/07/2019	29&30/07/2019
Barometric Pressure	kPa	N/A	88.60	89.70	89.30
Duct Static Pressure (Gauge)	kPag		0.0785	-0.03923	-0.03955
Gas Temperature (Average)	°C		41	28	32.1
Gas Velocity	$m.s^{-1}$		7.6	6.4	11.8
Volumetric Flow Rate (Actual)	$m^3.h^{-1}$		109 000	32 800	45 600
Volumetric Flow Rate (NTP, wet)	$Nm^3.h^{-1}$		82 800	26 300	35 900
Volumetric Flow Rate (NTP, dry)	$Nm^3.h^{-1}$		78 200	25 900	34 600
Particulate Concentration (Actual)	$mg.m^{-3}$		18.1	BDL	10.6
Particulate Concentration (NTP, wet)	$mg.Nm^{-3}$		23.7	BDL	13.4
Particulate Concentration (NTP, dry)	$mg.Nm^{-3}$		25.0	BDL	13.8
Particulate Concentration (NTP, dry, 10% O_2 corrected)	$mg.Nm^{-3}$	100	47.7	N/A	N/A
Water Concentration	% (V/V)	N/A	5.6	1.4	3.9
Oxygen	%		15	20.9	21
Sulphur Dioxide (NTP, dry)	$mg.Nm^{-3}$	3 500	2.2	5.5	0.76
Oxides of Nitrogen (NTP, dry)	$mg.Nm^{-3}$	1 100	145	5.5	9.3

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ABBREVIATIONS

AEL	Atmospheric Emissions License
BDL	Below Detection Limit
°C	Degree Celsius
CO	Carbon Monoxide
Cu	Copper
KPa	Kilopascal
$m.s^{-1}$	Meter per second
$m^3.h^{-1}$	Cubic meters per hour
$mg.m^{-3}$	milligram per cubic meter
N/A	Not Applicable
Nm^3	Normal cubic meter
Ni	Nickel
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NTP	Normal Temperature and Pressure
O_2	Oxygen
PM	Particulate Matter
RBMR	Rustenburg Base Metals Refiners
SO_2	Sulfur Dioxide
SO_3	Sulfur Trioxide
V/V	Volume per volume
US EPA	United States Environmental Protection Agency

1 INTRODUCTION

C&M Consulting Engineers were appointed by Rustenburg Base Metals Refiners to conduct annual emissions survey on various stacks (point sources) on the 23rd, 24th,25th, 26th, 29th and 30th July 2019. This is as required by the Atmospheric Emissions License BPDM/BMR/AEL1.1/MARCH2016 issued by the Bojanala Platinum District Municipality on 01 February 2016 in Rustenburg, North West.

These stacks (point sources) are at the boilers, Cu and Ni tank houses. Although the Cu and Ni tank houses are not listed activities, annual once-off measurements must be submitted to the authorities as prescribed by section 5.4.2 of Atmospheric Emissions License BPDM/BMR/AEL1.1/MARCH2016.

The following section will explain in detail the applied methods of measurements.

2 Methodology

All isokinetic and anisokinetic sampling were carried out according to internationally accepted reference methods, which comply with the National Environmental Management: Air Quality Act of 2004 (Act 39 of 2004) as scheduled in the Minimum Emissions Listed Activities as prescribed in Government Notice 37054; gazetted on 22 November 2013.

A minimum of three (3) tests were conducted with a minimum duration of sixty (60) minutes each, per component measured, per point source as is prescribed in Government Notice 37054.

2.1 Isokinetic Sampling

Isokinetic sampling techniques were applied to measure the concentration of:

- Particulate Matter (PM)

The sampling methods for the abovementioned components comply with the specifications of the following internationally accepted methods:

USEPA Method 17: "Determination of Particulate Matter Emissions from Stationary Sources".

These reference methods entail in-stack filtration, with the filter at stack temperature. High-purity glass microfiber thimbles (filters) manufactured from 100% pure borosilicate glass were utilised by C&M for all isokinetic sampling applications. The thimbles are completely free of binders or additives and can be used at temperatures up to 500°C or when using solvents incompatible with cellulose thimbles. These thimbles have a 0.3 µm nominal particle retention capability.

2.2 Stack Gas Velocity

The locations of the traverse points are determined by assuming that the velocity profile adjacent to the duct/stack adjacent to the wall approximates a $^{1}/_{7}^{th}$ power law curve. This complies with the specifications of the following internationally accepted method:

USEPA Method 1: "Sample and Velocity Traverses for Stationary Sources".

Velocity pressure measurements are taken by means of an S-type pitot tube and digital manometer. Volumetric flow rates were calculated from the individual point velocities and internal dimensions of the stack. This complies with the specifications of the following internationally accepted method:

USEPA Method 2: "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)".

2.3 Stack Gas Temperature

The gas temperatures are measured by means of a Type-K thermocouple connected to a digital thermometer.

2.4 Moisture Content

The Moisture content of the gas stream was calculated from the temperature of the gas leaving the condenser unit and the mass of liquid condensed during each test. This complies with the specifications of the following internationally accepted method: **USEPA Method 4:** "Determination of Moisture Content in Stack Gases".

2.5 Anisokinetic Sampling

2.5.1 Combustion Gas Components (O_2, NO, NO_2, NOx, CO, SO_2)

An ECOM J2KN Pro portable emissions' analyser was used to measure the concentrations of O_2, NO, NO_2, NOx, CO and SO_2 present in the stack gas streams on a volume/volume basis. The analyser complies with EN 50379-2:2004: Specification for portable electrical apparatus designed to measure combustion gas parameters of heating appliances. This is only applicable to O_2 and CO.

The analyser utilises calibrated electro-chemical sensors and an Infrared Bench (NDIR) to detect and quantify the concentrations of the various gases. These sensors are calibrated against calibration standard NMISA gases.

2.5.2 Oxides of Sulphur (SO_2 & SO_3)

Sampling of SO_2 and SO_3 compounds present in the duct/stack gas were conducted by withdrawing duct/stack gas which were bubbled through an isopropanol solution for the collection of SO_3 and a peroxide solution for the collection of SO_2. The SO_2/SO_3 samples represent an approximate average concentration of 60 (sixty) minutes per sample taken.

The samples were analysed for the sulphite and sulphate ions. The SO_2 measurement complies with the specifications of the following internationally accepted method:

USEPA Method 6: "Determination of Sulfur Dioxide Emissions from Stationary Sources".

Although SO_3 is not specified as an analyte in USEPA Method 6, it is separated and therefore the concentration of SO_3 is also quantified.

2.5.3 Oxides of Nitrogen (NOx as NO_2)

Sampling of NO and NO_2 compounds present in the duct/stack gas were conducted by withdrawing duct/stack gas which were bubbled through a solution containing sodium hydroxide and potassium permanganate for the collection of NOx compounds. The NO_X samples represent an approximate average concentration of 60 (sixty) minutes per sample taken.

The samples were analysed for the nitrate ions but no speciation of NO and NO_2 is possible using this method and the results are expressed as: NOx as NO_2. This procedure complies with the specifications of the following internationally accepted method:

USEPA Method 7D: "Determination of Nitrogen Oxide (NO_X) Emissions from Stationary Sources".

3 RESULTS

USEPA Method 17 indicates that isokinetic results will be acceptable if the isokinetic sampling efficiency is found to be: **90% ≤ Sampling Efficiency ≤ 110%**

Where concentrations are reported at NTP or mg. Nm^{-3} it refers to the conversion of concentrations to normalised conditions of 0 ºC (273 K) and 101.325 kPa.

Normalised temperature and pressure: This condition is also referred to as NTP and imply concentrations recalculated from actual conditions to gas volumes at 0ºC (273.15K) and 101.325 kPa. As these conditions imply a reduction in the sampled gas volume due to the effect of reduced temperature and increased pressure, the resulting calculated concentration is higher than at actual stack gas conditions.

NTP, dry: Current emission limits imposed by the Department of Environmental Affairs require results to be reported at NTP on a dry basis, i.e. based on the gas volume with water vapour removed. The removal of the water vapour content from the stack gas implies a further reduction in gas volume, resulting in even higher calculated concentrations.

NTP, dry, corrected to 10% O_2: This reporting condition was introduced to ensure that everybody report results at the same conditions. If the measured concentration of O_2 is higher than the reference level of 10% the resulting calculated concentration will be higher. If the measured concentration of O_2 is less than 10% the calculated concentration will be less. Therefore, there is no benefit in diluting a stack gas stream with ambient air to yield a lower concentration at the conditions above, as it will result in a high O_2 concentration and an equally higher concentration when corrected to 10% O_2.

The average test results obtained are shown in the following tables:

Table 3.1: Boiler Stack; Stack Conditions and Isokinetic Particulate Emissions

Description	Unit	Test 1	Test 2	Test 3	Average
Date	-	23/07/2019		24/07/2019	-
Test Start Time	-	10h17	13h57	10h19	-
Test Duration	min	60	60	60	60
Barometric Pressure	kPa	88.90	88.50	88.40	88.60
Duct Static Pressure (Gauge)	kPag	0.0785	0.0785	0.0785	0.0785
Gas Temperature (Average)	°C	41	42	42	41
Gas Velocity	$m.s^{-1}$	7.8	7.7	7.4	7.6
Stack Diameter	m	2.25			
Volumetric Flow Rate (Actual)	$m^3.h^{-1}$	111 000	110 000	106 000	109 000
Volumetric Flow Rate (NTP, wet)	$Nm^3.h^{-1}$	84 800	83 500	80 100	82 800
Volumetric Flow Rate (NTP, dry)	$Nm^3.h^{-1}$	80 200	79 700	74 600	78 200
Particulate Concentration (Actual)	$mg.m^{-3}$	45.1	9.1	BDL	18.1
Particulate Concentration (NTP, wet)	$mg.Nm^{-3}$	59.0	12.0	BDL	23.7
Particulate Concentration (NTP, dry)	$mg.Nm^{-3}$	62.3	12.6	BDL	25.0
Particulate Concentration (NTP, dry, 10% O_2 corrected)	$mg.Nm^{-3}$	120	22.8	BDL	47.7
Particulate Emission Rate	$kg.h^{-1}$	5.0	1.0	BDL	2.0
Water Concentration	% (V/V)	5.4	4.5	6.82	5.57
Total Isokinetic Volume Sampled (NTP, wet)	Nm^3	0.92	0.79	0.81	0.84
Total Isokinetic Volume Sampled (NTP, dry)	Nm^3	0.87	0.75	0.76	0.79
Isokinetic Efficiency	%	110	97.7	104	104

Table 3.2: Boiler Stack; Summary of Combustion Gas Analyser Components per Test

Component	O_2	CO	NO	NO_2	NOx	SO_2
Unit	**%**	**mg.Nm^{-3} (NTP, dry, 10% O_2 corrected)**				
Test 1 on 23/07/2019						
Average	15.3	463	400	18.6	632	4.3
Minimum	14.7	BDL	227	BDL	349	BDL
Maximum	19.5	1020	470	27.7	749	66.1
Median	15.0	480	408	19.8	646	BDL
Test 2 on 23/07/2019						
Average	14.9	407	409	32.4	660	BDL
Minimum	13.2	159	255	18.6	410	BDL
Maximum	17.5	904	524	41.0	845	BDL
Median	14.9	379	401	33.5	648	BDL
Test 3 on 24/07/2019						
Average	14.8	214	366	39.2	601	BDL
Minimum	14.2	144	328	36.5	540	BDL
Maximum	15.9	286	390	43.8	642	BDL
Median	14.6	220	366	40.1	602	BDL

Table 3.3: Cu Tank House Stack; Stack Conditions and Isokinetic Particulate Emissions

Description	Unit	Test 1	Test 2	Test 3	Average
Date	-	25/07/2019			
Test Start Time	-	10h02	11h27	12h41	-
Test Duration	min	60	60	60	60
Barometric Pressure	kPa	89.70	89.70	89.70	89.70
Duct Static Pressure (Gauge)	kPag	-0.04511	-0.04119	-0.03138	-0.03923
Gas Temperature (Average)	°C	25	29	31	28
Gas Velocity	$m.s^{-1}$	6.4	6.3	6.4	6.4
Stack Diameter	m	1.35			
Volumetric Flow Rate (Actual)	$m^3.h^{-1}$	32 900	32 700	32 700	32 800
Volumetric Flow Rate (NTP, wet)	$Nm^3.h^{-1}$	26 700	26 100	26 000	26 300
Volumetric Flow Rate (NTP, dry)	$Nm^3.h^{-1}$	26 300	25 700	25 600	25 900
Particulate Concentration (Actual)	$mg.m^{-3}$	BDL	BDL	BDL	BDL
Particulate Concentration (NTP, wet)	$mg.Nm^{-3}$	BDL	BDL	BDL	BDL
Particulate Concentration (NTP, dry)	$mg.Nm^{-3}$	BDL	BDL	BDL	BDL
Particulate Emission Rate	$kg.h^{-1}$	BDL	BDL	BDL	BDL
Water Concentration	% (V/V)	1.4	1.4	1.5	1.4
Total Isokinetic Volume Sampled (NTP, wet)	Nm^3	0.76	0.76	0.71	0.74
Total Isokinetic Volume Sampled (NTP, dry)	Nm^3	0.75	0.75	0.70	0.73
Isokinetic Efficiency	%	91.3	99.8	93.1	94.7

Table 3.4: Cu Tank House Stack; Summary of Combustion Gas Analyser Components per Test

Component	O_2	CO	NO	NO_2	NOx	SO_2
Unit	**%**	**mg.Nm^{-3} (NTP, dry)**				
Test 1 on 25/07/2019						
Average	21	BDL	0.20	0.063	0.38	BDL
Minimum	20.8	BDL	BDL	BDL	BDL	BDL
Maximum	21	BDL	1.3	2.1	4.1	BDL
Median	21	BDL	BDL	BDL	BDL	BDL
Test 2 on 25/07/2019						
Average	21	BDL	0.055	0.070	0.16	BDL
Minimum	20.6	BDL	BDL	BDL	BDL	BDL
Maximum	21	BDL	6.7	2.1	12.3	BDL
Median	21	BDL	BDL	BDL	BDL	BDL
Test 3 on 25/07/2019						
Average	20.9	BDL	0.12	BDL	0.18	BDL
Minimum	20.7	BDL	BDL	BDL	BDL	BDL
Maximum	21	BDL	1.3	BDL	2.1	BDL
Median	20.9	BDL	BDL	BDL	BDL	BDL

Table 3.5: NI Tank House Stack; Stack Conditions and Isokinetic Particulate Emissions

Description	Unit	Test 1	Test 2	Test 3	Average
Date	-	29/07/2019			
Test Start Time	-	09h50	11h05	12h17	-
Test Duration	min	60	60	60	60
Barometric Pressure	kPa	89.40	89.30	89.20	89.30
Duct Static Pressure (Gauge)	kPag	-0.05295	-0.03432	-0.03138	-0.03955
Gas Temperature (Average)	°C	30	32	35	32
Gas Velocity	$m.s^{-1}$	12.3	11.8	11.2	11.8
Stack Diameter	m	1.17			
Volumetric Flow Rate (Actual)	$m^3.h^{-1}$	47 700	45 700	43 400	45 600
Volumetric Flow Rate (NTP, wet)	$Nm^3.h^{-1}$	37 900	36 100	33 800	35 900
Volumetric Flow Rate (NTP, dry)	$Nm^3.h^{-1}$	36 800	34 500	32 300	34 600
Particulate Concentration (Actual)	$mg.m^{-3}$	24.3	10.8	BDL	10.6
Particulate Concentration (NTP, wet)	$mg.Nm^{-3}$	30.6	13.6	BDL	13.4
Particulate Concentration (NTP, dry)	$mg.Nm^{-3}$	31.5	14.3	BDL	13.8
Particulate Emission Rate	$kg.h^{-1}$	1.2	0.49	BDL	0.51
Water Concentration	% (V/V)	2.9	4.4	4.5	3.9
Total Isokinetic Volume Sampled (NTP, wet)	Nm^3	1.0	0.99	0.93	0.97
Total Isokinetic Volume Sampled (NTP, dry)	Nm^3	0.97	0.94	0.89	0.94
Isokinetic Efficiency	%	101	104	104	103

Table 3.6: Ni Tank House Stack; Summary of Combustion Gas Analyser Components per Test

Component	O_2	CO	NO	NO_2	NOx	SO_2
Unit	**%**	**mg.Nm^{-3} (NTP, dry)**				
Test 1 on 29/07/2019						
Average	21	0.86	2.3	BDL	3.5	BDL
Minimum	20.1	BDL	1.3	BDL	2.1	BDL
Maximum	21	1.3	2.7	BDL	4.1	BDL
Median	21	1.3	2.7	BDL	4.1	BDL
Test 2 on 29/07/2019						
Average	21	0.64	6.7	BDL	10.2	BDL
Minimum	21	BDL	2.7	BDL	4.1	BDL
Maximum	21	1.3	9.4	BDL	14.4	BDL
Median	21	1.3	9.4	BDL	14.4	BDL
Test 3 on 29/07/2019						
Average	21	1.1	11.9	BDL	18.2	BDL
Minimum	21	BDL	9.4	BDL	14.4	BDL
Maximum	21	1.3	13.4	BDL	20.5	BDL
Median	21	1.3	12.1	BDL	18.5	BDL

Table 3.7: Wet Chemical Method; Oxides of Nitrogen Components per Test

ID	Test Number	Test Start Time	Test Duration (min)	NOx as NO_2
				$mg.Nm^{-3}$ (NTP, dry)
Boiler Stack (23&24/07/2019)	1	10h16	60	160
	2	13h52	60	182
	3	15h17	60	93.3
	Average Concentration			**145**
	Average Emission Rate ($kg.hr^{-1}$)			**11.3**
Cu Tank House Stack (26/07/2019	1	08h45	60	2.1
	2	09h53	60	4.6
	3	11h00	60	9.8
	Average Concentration			**5.5**
	Average Emission Rate ($kg.hr^{-1}$)			**0.14**
Ni Tank House Stack (30/07/2019)	1	08h50	60	8.7
	2	10h02	60	6.3
	3	11h12	60	12.8
	Average Concentration			**9.3**
	Average Emission Rate ($kg.hr^{-1}$)			**0.32**

Table 3.8: Wet Chemical Method; Oxides of Sulphur Gas Components per Test

ID	Test Number	Test Start Time	Test Duration (min)	SO_2	SO_3
				M6	
	mg.Nm^{-3} (NTP, dry)				
Boiler Stack (23&24/07/2019)	1	10h16	60	3.3	10.2
	2	13h52	60	1.4	79.2
	3	15h17	60	1.8	9.0
	Average Concentration			**2.2**	**32.8**
	Average Emission Rate (kg.hr^{-1})			**0.17**	**2.6**
Cu Tank House (25/07/2019)	1	10h23	60	1.2	0.55
	2	11h31	60	8.9	0.52
	3	12h40	60	6.3	0.086
	Average Concentration			**5.5**	**0.39**
	Average Emission Rate (kg.hr^{-1})			**0.14**	**0.01**
Ni Tank House (29/07/2019)	1	09h35	60	0.86	1.5
	2	10h44	60	0.94	424
	3	11h55	60	0.48	188
	Average Concentration			**0.76**	**205**
	Average Emission Rate (kg.hr^{-1})			**0.026**	**7.1**

4 DISCUSSION

4.1 Associated Emissions Standards and Compliance

The associated minimum emission standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) as gazetted on 22 November 2013 in Government Notice Number 37054:

Category 1: Combustion Installations

(1) *Subcategory 1.1: Solid Fuel Combustion Installations*

Description:	Solid fuels combustion installations used primarily for steam raising or electricity generation.		
Application:	All installations with design capacity equal to or greater than 50 MW heat input per unit, based on the lower calorific value of the fuel used.		
Substance or mixture of substances		**Plant status**	**mg/Nm³ under normal conditions of 10% O_2, 273 Kelvin and 101.3 kPa.**
Common name	**Chemical symbol**		
Particulate matter	N/A	New	50
		Existing	100
Sulphur dioxide	SO_2	New	500
		Existing	3500
Oxides of nitrogen	NO_X expressed as NO_2	New	750
		Existing	1100

(a) The following special arrangement shall apply –

(i) Continuous emission monitoring of PM, SO_2 and NO_X is required, however, installations less than 100 MW heat input per unit must adhere to periodic emission monitoring as stipulated in Part 2 of this Notice.

(ii) Where co-feeding with waste materials with calorific value allowed in terms of the Waste Disposal Standards published in terms of the Waste Act, 2008 (Act No.59 of 2008) occurs, additional requirements under subcategory 1.6 shall apply.

All the point sources serving Rustenburg Base Metals Refiners, herein referred to as RBMR in Rustenburg, North West, complied with the emission standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) as gazetted on 22 November 2013 in Government Notice Number 37054 (Listed Activities):

This is notwithstanding whether the two boilers are exempted from the emission standards as a small boiler is defined by Government Notice Number 36973 as: “any

small boiler with a design capacity equal to 10 MW but less than 50 MW net heat input per unit, based on the lower calorific value used."

The average results obtained are shown in the following tables

4.2 Sample Port Location

Only the Boiler conformed to the sample port location specification.

Cu Tank House stack

Only one sample port was available for isokinetic measurements. It is advised that two sample ports be installed which are situated at a right angle to each other on the same cross-sectional area of the stack. This location should be preferably more than six pipe diameters downstream and more than two pipe diameters upstream of any disturbance to the volumetric flow inside the duct.

Ni Tank House stack

Only one sample port was available for isokinetic measurements. It is advised that two sample ports be installed which are situated at a right angle to each other on the same cross-sectional area of the stack. This location should be preferably more than six pipe diameters downstream and more than two pipe diameters upstream of any disturbance to the volumetric flow inside the duct.

4.3 Isokinetic Sampling Efficiency

The parameter which must be controlled to establish isokinetic sampling is the gas velocity as it enters the nozzle of the sample probe, which must be equal to the actual gas velocity at the specific sample point in the duct/stack.

A sampling efficiency outside the prescribed specification can lead to either over or under sampling of particles of a certain size.

The isokinetic sampling efficiencies were calculated from the applicable measurements and found to be within the specified limit of the prescribed method for all isokinetic measurements conducted on the 23rd, 24th,25th and 29th July 2019

4.4 Additional Notes

Terminology

"existing plant" unless where specified, shall mean any plant that was legally authorized to operate before 01 April 2010 or any plant where application for authorisation in terms of the National Environmental Act, 1998 (Act No. 107 of 1998), was made before 01 April 2010.

"new plant" unless where specified, shall mean a plant or process where the application for authorisation in terms of the National Environmental Management Act 1998, (Act No. 107 of 1998), was made on or after 01 April 2010.

5 QUALITY CONTROL

All in-house calibration certificates are displayed on C&M equipment. Calibration procedures with copies of the calibration certificates are available on request.

5.1 SANAS Accredited Analytical Laboratories

As prescribed by the National Environmental Management: Air Quality Act of 2004 (Act 39 of 2004) as scheduled in the Minimum Emissions Listed Activities as prescribed in Government Notice 37054; gazetted on 22 November 2013, C&M only makes use of analytical laboratories which is SANAS accredited for the specific analysis required.

5.2 Calibration and Design of S-Type Pitot Tubes

The S-Type Pitot Tubes utilised by C&M sampling technicians to take pressure-velocity measurements, conforms to the specific design specifications and are routinely calibrated (quarterly, unless damaged) using a wind tunnel at C&M's office. This procedure complies with the specifications of the following internationally accepted method:

USEPA Method 2: "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)".

5.3 Calibration of Portable Gas Analysers Using Electro-Chemical Sensors

The analysers utilising electro-chemical sensors to detect and quantify the concentrations of the various gases are calibrated bi-monthly. The calibration is done with SANAS certified laboratory test gas with known concentration.

The test gas is connected to the analyser and the electro-chemical sensors values are recorded, the sensors are then forced to the concentration of the test gas value, the test gas is removed to see if the detected concentration drops back to zero and the test gas is connected again to verify that the sensors are calibrated.

6 CONCLUSIONS

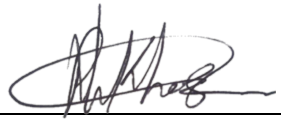
It is C&M's opinion that the component emissions reported are representative of the true emissions from the various point sources, at the time the samples were taken.

The results may become non-representative of the true emissions from the various point sources if deviations from process operating conditions, raw material feed rate and/or composition changes as well as upset conditions occur other than what was present at the time of taking the various samples.

7 QUALITY ASSURANCE

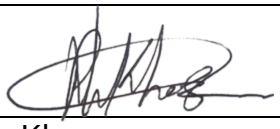
On-site team leader

I, Leslie Khosa, hereby confirm that all sampling was conducted according to the prescribed procedures and that all deviations from these procedures has been noted and communicated to the person responsible for analysing and reporting the data.

	Signed on
Leslie Khosa Project Manager	18/10/2019

Data analysis and reporting

I, Leslie Khosa, hereby confirm that all data have been checked for irregularities and that all deviations from the referenced procedures and methods have been included in the report.

	Signed on
Leslie Khosa Project Manager	18/10/2019

Overall approval

I, Kgomotso Malefo, hereby approve this report on behalf of C&M Consulting Engineers Directorate

	Signed on
Kgomotso Malefo Sampling Director	18/10/2019

APPENDIX

Analytical Laboratory SANAS Certificate (Chemtech)

sanas
South African National Accreditation System

CERTIFICATE OF ACCREDITATION

In terms of section 22(2) (b) of the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, 2006 (Act 19 of 2006), read with sections 23(1), (2) and (3) of the said Act, I hereby certify that:-

CHEMTECH LABORATORY SERVICES CC

Co. Reg. No.: 1998/037710/23

Facility Accreditation Number: **T0361**

is a South African National Accreditation System accredited facility provided that all conditions and requirements are complied with

This certificate is valid as per the scope as stated in the accompanying schedule of accreditation, Annexure "A", bearing the above accreditation number for

CHEMICAL ANALYSIS .

The facility is accredited in accordance with the recognised International Standard

ISO/IEC 17025:2005

The accreditation demonstrates technical competency for a defined scope and the operation of a quality management system

While this certificate remains valid, the Accredited Facility named above is authorised to use the relevant accreditation symbol to issue facility reports and/or certificates

Ms B Radebe
Acting Chief Executive Officer

Effective Date: 27 November 2017
Certificate Expires: 01 November 2022

Gas Analyser Calibration Gas Certificate Carbon Monoxide (CO) [Page 1 of 2]

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Certificate of Analysis

Name and Customer Address: C & M Consulting Engineers
170 Watermeyer Street
Pretoria
0184

Description: Primary Reference Gas Mixture (PRGM), cylinder number MS1 8088 containing a mixture of carbon monoxide (CO) in nitrogen (N_2) prepared on 02 March 2018.

Method of Preparation: Gravimetric preparation in accordance with the International Organization for Standardization, ISO 6142 (Gas Analysis – Preparation of calibration gas mixtures – Gravimetric Method). After preparation, the composition was verified using Non-Dispersive Infrared (NDIR) spectroscopy.

Intended use: The material can be used to validate and/or calibrate analytical methods or the calibration of measurement systems used to determine the mole fraction of CO in nitrogen.

Result: Mole fraction of carbon monoxide (CO): $(149{,}96 \pm 0{,}75) \times 10^{-6}$ mol.mol^{-1}

Uncertainty: The reported expanded uncertainty of measurements is stated as the standard uncertainty of measurement multiplied by a coverage factor, $k = 2$, which for a normal distribution approximates a level of confidence of 95,45 %.

Traceability: The mole fraction is traceable to the national standard of mass and, by comparison, to NMISA primary standard gas mixtures (PSGMs).

Homogeneity: The homogeneity of the mixture has been assured by rolling the cylinder on a roller bench for a minimum of 2 hours after preparation.

Stability: The certificate is valid until 02 March 2020, provided that the cylinder pressure does not drop below 500 kPa.

Storage: Store away from direct heat between temperatures of 10 to 40 °C in a well-ventilated area. More guidance on the use of calibration gas mixtures can be found in ISO 16664 (Gas Analysis – Handling of calibration gases and gas mixtures – Guidelines).

Analysed by	Checked by	For Chief Executive Officer
David Mogale Metrologist	James Tshilonga Metrologist (Technical Signatory)	
Date of issue 19 March 2018	Page 1 of 2	Certificate number PRGM2080519088

TQM-5096-1

Your measure of excellence

Gas Analyser Calibration Gas Certificate Carbon Monoxide (CO) [Page 2 of 2]

ANALYSIS OF CO-in-NITROGEN
(Cylinder number: M51 8068)

Safety: The cylinder should be handled with care and by experienced personnel in a laboratory environment suitably equipped for the safe handling of gases materials.

Cylinder: The PRGM is contained in a passivated aluminium cylinder. The cylinder has a water capacity volume of 5 ℓ and is pressurised to 11,2 MPa. The outlet connection of the cylinder valve conforms to BS 341 nr. 4 specifications.

Remarks: The reported uncertainties of measurements were calculated in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "Guidance to the Expression of Uncertainty in Measurement" (International Organization for Standardization, Geneva, Switzerland, 1993);

The national measurement standards are monitored for stability at intervals of 3 months, 6 months, 9 months and then annually after preparation. Customers will be notified of any stability problems and mixtures will be recertified free of charge if such problems are encountered.

Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

---end of certificate---

Analysed by	Checked by	For Chief Executive Officer
David Mogale Metrologist	James Tshilongo Metrologist (Technical Signatory)	
Date of issue 15 March 2018	Page 2 of 2	Certificate number PRGM20000518068

Gas Analyser Calibration Gas Certificate Nitrogen Dioxide (NO2) [Page 1 of 2]

nmisa
National Metrology Institute of South Africa

Certificate of Analysis

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Analysis of:	Certified NO_2 in nitrogen reference material
Description of sample:	Cylinder manufactured by NMISA
Identification of sample:	Cylinder number: M39 5395
Analysed for:	C & M Consulting Engineers 170 Watermeyer Street Meyerspark Pretoria 0184
Analysis procedure:	CHEM/APG-0006
Location of analysis:	CSIR Campus, Building 4W, Room W10
Date samples received:	29 March 2019
Date/s samples analysed:	17 April 2019

1 PROCEDURE

1.1 Method

The nitrogen dioxide (NO_2) was certified using a non-dispersive ultraviolet (NDUV) spectroscopy analyser calibrated with primary standard gas mixtures of NO_2-in-nitrogen over the mole fraction range of 10 to 100 µmol.mol^{-1}.

1.2 Standards used

1.2.1 Primary standard gas mixtures of NO_2 in nitrogen prepared by the NMISA.

1.2.2 The primary standard gas mixtures were prepared according to International Organization for Standardization, ISO 6142 (Gas Analysis – Preparation of calibration gas mixtures – Gravimetric Method). The mole fraction is traceable to the national measurement standard for mass and mole.

Analysed by Tshepiso Mphaka Metrologist (Technical Signatory)	Checked by Gumani Mphaphuli Metrologist	For Chief Executive Officer
Date of Issue 23 April 2019	Page 1 of 2	Certificate number CHEM/APG-0393

Your measure of excellence

ANALYSIS OF NO_2-in-nitrogen
(Cylinder number: M39 5395)

2 RESULTS

The mole fraction of NO_2 in the gas cylinder is certified as (100,07 ± 3,0) x µmol.mol^{-1}

3 EXPIRY DATE

The mixture was prepared on 26 February 2018 and it will expire on 26 August 2019.

4 REMARKS

4.1 The reported uncertainties of measurement were calculated and expressed in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "A Guide to the Expression of Uncertainty in Measurement" (International Organisation for Standardisation, Geneva, Switzerland, 1993).

4.2 The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by a coverage factor of k=2, which approximates a level of confidence of 95,45%.

4.3 Certain of the NMISA certificates are consistent with the NMISA capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details, see http://www.bipm.org.

4.4 The analysis was carried out at an ambient temperature of 22 °C ± 2 °C and a relative humidity of 40 %RH ± 10 %RH.

end of certificate

Approved by: Tshepiso Mphaho, Metrologist (Technical Signatory)	Checked by: Oumani Mphaphuli, Metrologist	For Chief Executive Officer
Date of issue: 23 April 2019	Page 2 of 2	Certificate number: CHEMAPG-6388

TQM-5006-1

Gas Analyser Calibration Gas Certificate Nitrogen Oxide (NO) [Page 1 of 2]

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4823
Reception: +27 12 841 4152
Fax: +27 12 841 4456
E-mail enquiries: info@nmisa.org

Certificate of Analysis

Name and Customer Address: C & M Consulting Engineers
170 Watermeyer Street
Meyerspark
Pretoria
0184

Description: Primary Reference Gas Mixture (PRGM), cylinder number M55 5681 containing a mixture of nitric oxide (NO) in nitrogen (N_2) prepared on 13 March 2018.

Method of Preparation: Gravimetric preparation in accordance with the International Organization for Standardization, ISO 6142 (Gas Analysis – Preparation of calibration gas mixtures – Gravimetric Method). After preparation, the composition was verified using non-dispersive ultraviolet spectroscopy.

Intended use: The material can be used to validate and/or calibrate analytical methods or the calibration of measurement systems used to determine the mole fraction of NO in N_2.

Result: Mole fraction of NO: (348,5 ± 2,8) μmol.mol^{-1}

Uncertainty: The reported expended uncertainty of measurements is stated as the standard uncertainty of measurement multiplied by a coverage factor, $k = 2$, which for a normal distribution approximates a level of confidence of 95,45 %.

Traceability: The mole fraction is traceable to the national standard of mass and, by comparison, to NMISA primary standard gas mixtures (PSGMs).

Homogeneity: The homogeneity of the mixture has been assured by rolling the cylinder on a roller bench for a minimum of 2 hours after preparation.

Stability: The certificate is valid until 13 March 2020, provided that the cylinder pressure does not drop below 500 kPa.

Storage: Store away from direct heat between temperatures of 10 to 40 °C in a well-ventilated area. More guidance on the use of calibration gas mixtures can be found in ISO 16664 (Gas Analysis – Handling of calibration gases and gas mixtures – Guidelines).

Analysed by	Checked by	For Chief Executive Officer
Mudalo Joesla Metrologist	James Tshilongo Metrologist (Technical Signatory)	
Date of issue 19 March 2018	Page 1 of 2	Certificate number PRGM10035681

TQM-5099-1

Your measure of excellence

Gas Analyser Calibration Gas Certificate Nitrogen Oxide (NO) [Page 2 of 2]

ANALYSIS OF NO-in-N_2
(Cylinder number: M65 5681)

Safety: The cylinder should be handled with care and by experienced personnel in a laboratory environment suitably equipped for the safe handling of gases materials.

Cylinder: The PRGM is contained in a passivated aluminium cylinder. The cylinder has a water capacity volume of 5 ℓ and is pressurised to 13,6 MPa. The outlet connection of the cylinder valve conforms to CGA 330 specifications.

Remarks: The reported uncertainties of measurements were calculated in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "Guidance to the Expression of Uncertainty in Measurement" (International Organization for Standardization, Geneva, Switzerland, 1993);

The national measurement standards are monitored for stability at intervals of 3 months, 6 months, 9 months and then annually after preparation. Customers will be notified of any stability problems and mixtures will be recertified free of charge if such problems are encountered.

Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

----------*end of certificate*----------

Analysed by	Checked by	For Chief Executive Officer
Mudalo Jeasia Metrologist	James Tshilongo Meteologist (Technical Signatory)	
Date of Issue 19 March 2018	Page 2 of 2	Certificate number PRGM10005681

Gas Analyser Calibration Gas Certificate Sulphur Dioxide (SO_2) [Page 1 of 2]

Private Bag X34, Lynnwood Ridge, Pretoria, 0040
CSIR Campus, Meiring Naude Road, Brummeria, 0184
Calibration office: +27 12 841 4623
Reception: +27 12 841 4152
Fax: +27 12 841 4458
E-mail enquiries: info@nmisa.org

Certificate of Analysis

Name and Customer Address: C & M Consulting Engineers
170 Watermeyer Street
Pretoria
0184

Description: Primary Reference Gas Mixture (PRGM), cylinder number D19 4939 containing a mixture of sulphur dioxide (SO_2) in nitrogen (N_2) prepared on 01 March 2018.

Method of Preparation: Gravimetric preparation in accordance with the International Organization for Standardization, ISO 6142 (Gas Analysis – Preparation of calibration gas mixtures – Gravimetric Method). After preparation, the composition was verified using non-dispersive ultraviolet spectroscopy (UV).

Intended use: The material can be used to validate and/or calibrate analytical methods or the calibration of measurement systems used to determine the mole fraction of SO_2 in N_2.

Result: Mole fraction of sulphur dioxide (SO_2): $(399,9 \pm 2,0) \times 10^{-6}$ mol/mol

Uncertainty: The reported expanded uncertainty of measurements is stated as the standard uncertainty of measurement multiplied by a coverage factor, $k = 2$, which for a normal distribution approximates a level of confidence of 95,45 %.

Traceability: The mole fraction is traceable to the national standard of mass and, by comparison, to NMISA primary standard gas mixtures (PSGMs).

Homogeneity: The homogeneity of the mixture has been assured by rolling the cylinder on a roller bench for a minimum of 2 hours after preparation.

Stability: The certificate is valid until 01 March 2020, provided that the cylinder pressure does not drop below 500 kPa.

Storage: Store away from direct heat between temperatures of 10 to 40 °C in a well-ventilated area. More guidance on the use of calibration gas mixtures can be found in ISO 16664 (Gas Analysis – Handling of calibration gases and gas mixtures – Guidelines).

Analysed by	Checked by	For Chief Executive Officer
David Mogale Metrologist	James Tshilenge Metrologist (Technical Signatory)	
Date of issue 19 March 2018	Page 1 of 2	Certificate number PRGM1804939

TQM-5096-1

Your measure of excellence

Gas Analyser Calibration Gas Certificate Sulphur Dioxide (SO_2) [Page 2 of 2]

ANALYSIS OF SO_2-in-N_2
(Cylinder number: 019 4935)

Safety: The cylinder should be handled with care and by experienced personnel in a laboratory environment suitably equipped for the safe handling of gases materials.

Cylinder: The PRGM is contained in a passivated aluminium cylinder. The cylinder has a water capacity volume of 5 ℓ and is pressurised to 11,6 MPa. The outlet connection of the cylinder valve conforms to CGA 330 specifications.

Remarks: The reported uncertainties of measurements were calculated in accordance with the BIPM, IEC, ISO, IUPAP, OIML document entitled "Guidance to the Expression of Uncertainty in Measurement" (International Organization for Standardization, Geneva, Switzerland, 1993);

The national measurement standards are monitored for stability at intervals of 3 months, 6 months, 9 months and then annually after preparation. Customers will be notified of any stability problems and mixtures will be recertified free of charge if such problems are encountered.

Certain of the NMISA certificates are consistent with the capabilities that are included in appendix C of the MRA (Mutual Recognition Arrangement) drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities and ranges and measurement uncertainties specified in Appendix C. For details see http://www.bipm.org.

----------end of certificate----------

Analysed by	Checked by	For Chief Executive Officer
David Mogale Metrologist	James Tshilenge Metrologist (Technical Signatory)	
Date of issue 19 March 2018	Page 2 of 2	Certificate number PRGM1004939

TQM-5099-1

Mass Flowmeter Calibration Certificate

Model: 4043
Serial Number: 40431345002
Verification date: 24-Jul-2019

Rev: F

Summary Status	
☐ As-Found	☒ In Tolerance
☒ As-Left	☐ Out of Tolerance

Environmental Conditions
Pressure: 99.6 kPa
Temperature: 20.2°C

Air Flow

Tolerance: ±(1.75% of reading or 0.050 SLPM*)

Reference (SLPM)	Measured (SLPM)	Allowable Range Min	Max
0.549	0.552	0.499	0.599
1.590	1.588	1.540	1.640
3.553	3.556	3.491	3.615
7.988	7.976	7.848	8.128
15.05	15.07	14.79	15.31
24.50	24.51	24.07	24.93
41.57	41.65	40.84	42.29
71.63	71.55	70.37	72.68
110.2	110.0	108.2	112.1
147.5	147.8	145.0	150.1
181.8	182.5	178.6	185.0
PASS			

Oxygen Flow

Tolerance: ±(1.75% of reading or 0.050 SLPM*)

Reference (SLPM)	Measured (SLPM)	Allowable Range Min	Max
0.551	0.544	0.501	0.601
1.581	1.660	1.514	1.614
3.528	3.534	3.466	3.590
7.990	8.000	7.850	8.130
14.92	14.93	14.66	15.18
24.48	24.53	24.05	24.90
41.28	41.39	40.55	42.00
71.43	71.25	70.18	72.68
110.0	110.2	108.1	111.9
147.5	147.5	144.9	150.1
182.4	183.9	179.2	185.6
PASS			

Temperature

Tolerance: ±1.000 °C

Reference (°C)	Measured (°C)	Allowable Range Min	Max
20.08	20.10	19.08	21.08
PASS			

Pressure

Tolerance: ±0.110 psia

Reference (psia)	Measured (psia)	Allowable Range Min	Max
14.44	14.43	14.33	14.55
23.65	23.63	23.54	23.76
PASS			

Internal Calibration Reference(s)

Measurement Type	Reference (FC10)	Due for Calibration
Temperature	UKFC10T	23-Aug-2019
Pressure	UKFC10P	23-Aug-2019
Flow	UKFC10F	23-Aug-2019

TSI Std Conditions: 70 °F (21.11 °C) and 14.7 psia

Verified by: Tom Giura

TSI Instruments Ltd.
Stirling Road
High Wycombe, Bucks HP12 3ST UK

*Tolerance specified: whichever is greater

Printed 24-Jul-2019 04:46, Ver 3.5.4.1 Page 1 of 1

TSI does hereby certify that this flowmeter has been calibrated using TSI procedure 10000021269. The calibration of the reference standards maintain national laboratory traceability to members of the European co-operation for Accreditation (EA).

Radwag Fine Weigh Scale Calibration Certificate [Page 1 of 2]

Lasec

52 Old Mill Road, Ndabeni, 7405
Head Office: PO Box 2110, Cape Town, 8000, South Africa
+27 21 531 7504 +27 21 531 7562
www.lasec.com sales@lasec.com

Certificate of Calibration

Certificate No: 18090180

Calibrated for
C&M CONSULTING ENGINEERS
LABORATORY
170 WATERMEYER STREET (M14)
MEYERSPARK
PRETORIA
GAUTENG

Instrument details:
Manufacturer Radwag
Description AS220/C/2
Serial No. 381338/13

Calibration conducted at
C&M CONSULTING ENGINEERS
LABORATORY
170 WATERMEYER STREET (M14)
MEYERSPARK
PRETORIA
GAUTENG

Position of Balance
Going into the Laboratory straight ahead next to the left side of the window on a firm balance bench

Traceable Equipment used for Calibration

Make	*Description*	*Model*	*Serial No*	*Certificate No*	*Cal date*
Radwag	Mass set	0.001 g - 5000 g	K-461/09	M17-941	11-12 December 2017

Traceability
The results of measurements are traceable to the relevant national measurement standards.

Uncertainty of measurement
The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor (k=2), providing a confidence level of approx. 95%, the uncertainty of measurement has been estimated in accordance with the principles defined in the GUM, Guide of Uncertainty of Measurement, ISO, Geneva, 1993.

Certificate reproduction
This certificate may not be reproduced, except in full, without the written approval of the calibrating laboratory.

Calibration laboratory statement
The measurement results recorded on this certificate are for the specified instrument only and were correct at the time of calibration. The subsequent accuracy will depend on the correct care, handling and frequency of use. It is recommended that recalibration be undertaken at an interval that will ensure that the instrument remains within the desired limit.

Page 1 of 2

Radwag Fine Weigh Scale Calibration Certificate [Page 2 of 2]

Certificate of Calibration

Certificate No: 18090180

Calibration procedure:
The Balance has been calibrated by using traceable standard mass pieces in terms of Mass Procedure 2 Rev 06

Settling time

Time in seconds
4

Linearity

Applied Mass Piece	Balance As Found Before Adjustment	Deviation	Balance As Found After Adjustment	Deviation
(g)	(g)	(g)	(g)	(g)
2.2000	2.1998	0.0002	2.1999	0.0001
55.0002	55.0002	0.0000	55.0002	0.0000
110.0000	110.0000	0.0000	110.0001	-0.0001
170.0001	170.0007	-0.0006	170.0002	-0.0001
219.9999	220.0007	-0.0008	220.0008	-0.0009

Repeatability

110 (g)	
Applied Mass Piece	Standard Deviation ±
(g)	(g)
110.0000	0.00004

Off Centre Corner Load

Applied Mass Piece	
60 (g)	
Position	Display
Centre	60.0003
Top Left	59.9997
Bottom Right	60.0006
Top Right	60.0001
Bottom Left	60.0003

Measurement of Uncertainty 0 - 220 (g) 0.0006 (g)

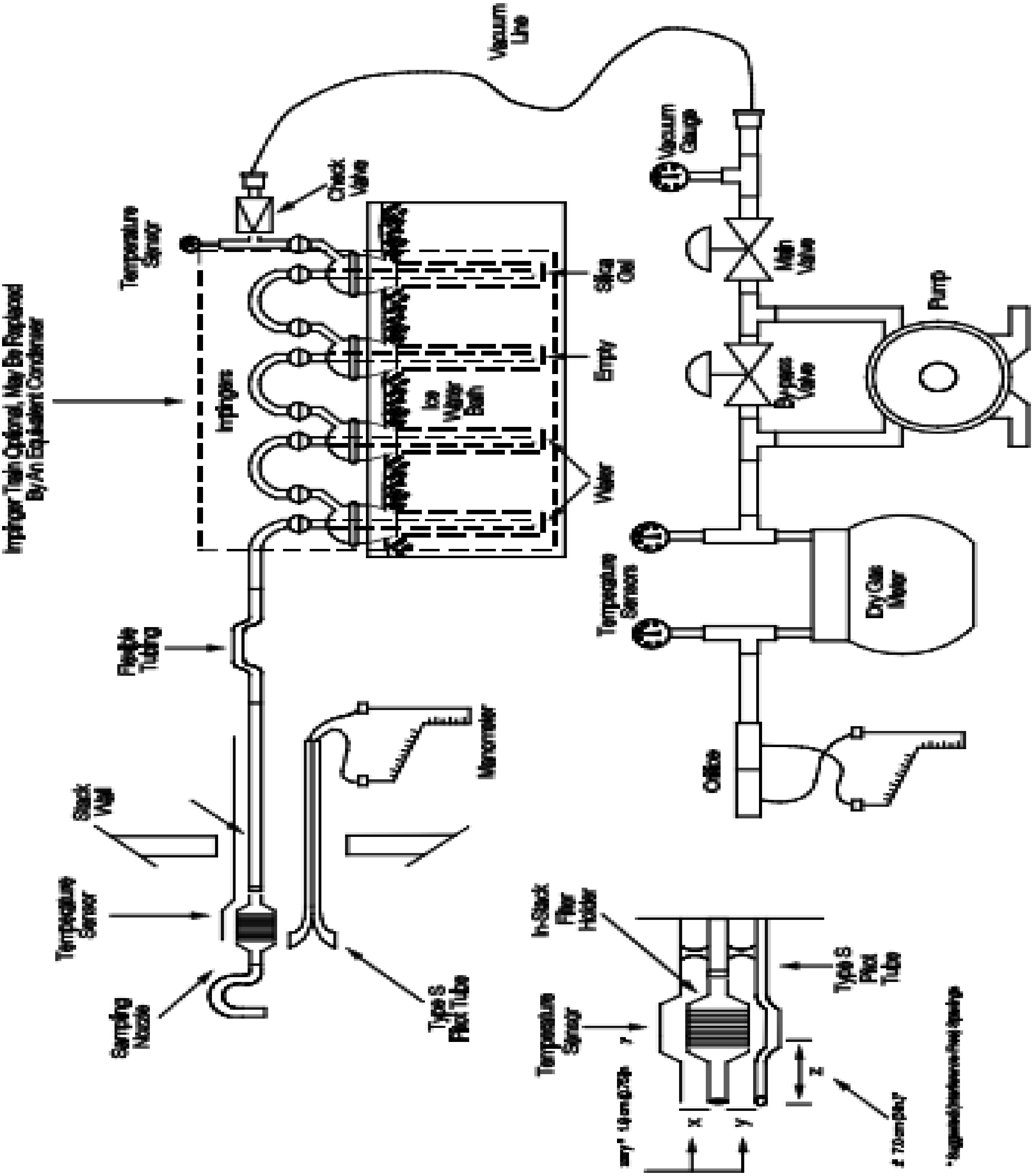
Date of Calibration 09 October 2018
Date of Issue 10 October 2018

	Name	Signature
Calibrated By:	Thokozane Malaza	
Checked By:	Lisette Nel	
Technical Signatory	Patrick Masombuka	

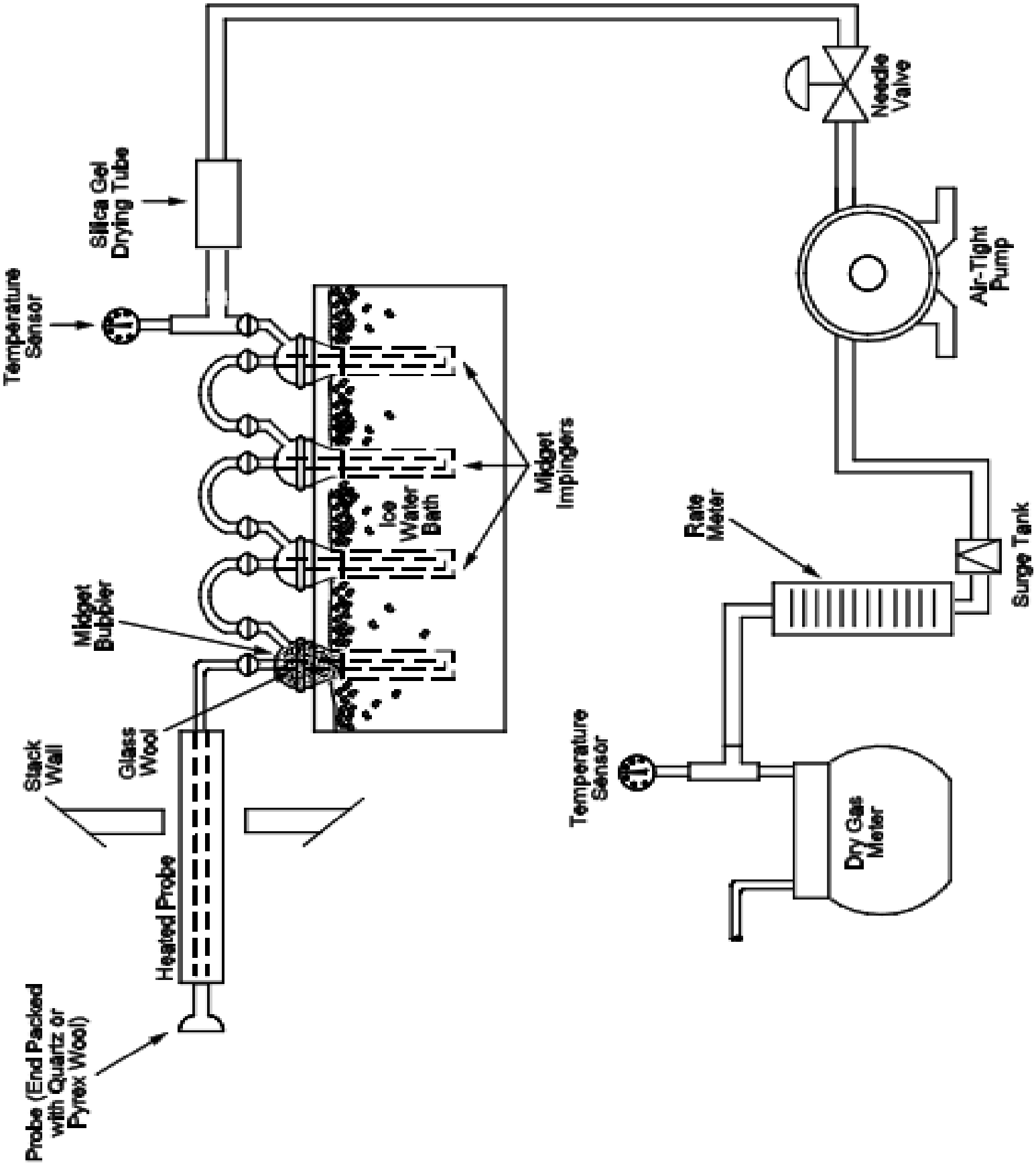
Page 2 of 2

End of Document

Isokinetic Sampling Train (USEPA Method 17: In-Stack Filtration)



Anisokinetic Sampling Train (USEPA Method 6)



Anisokinetic Sampling Train (USEPA Method 7D)