Industrial Compliance Solutions

ICS Ltd
AIR & EMISSIONS TESTING

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Project / Client Details

Rainbow Mountain Renewable Energy Limited

Site Address

Rainbow Mountain Renewable Energy Limited
216 State Highway 38
Waimangu
New Zealand

Stack Emissions Testing Report

Wet Electrostatic Precipitator (WESP)

Total Suspended Particulate
HCL
HF
SO2
NOx
CO
O2

Job Number

100747

Sampling Date/s

12th June 2024

Report Date / Version:	13/06/24 v1.0
Report By:	Toby Campbell
Business Title	Principal Environmental Consultant
CASANZ Level	Certificate Air Quality Professional (CAQP)
Professional Qualification 1	BSc Environmental Management
Professional Qualification 2	MSc Air Pollution Management and Control
Report Approved By:	Brent Kennedy
Business Title	Principal Scientist
CASANZ Level	Certificate Air Quality Professional (CAQP)
Professional Qualification 1	BSc Chemistry
Professional Qualification 2	MSc Materials and Processing Engineering

Industrial Compliance Solutions

CONTENTS

Industrial Compliance Solutions

EXECUTIVE SUMMARY (Page 1 of 9)

Stack Emissions Monitoring Objectives

Rainbow Mountain Renewable Energy Limited operates a Anaerobic-Thermal-Reduction (ATR) Pyrolysis at Rainbow Mountain, 216 State Highway 38, Waimangu which is subject to a Resource Consent, under the Resource Management Act 1991 .

Industrial Compliance Solutions were commissioned by Rainbow Mountain Renewable Energy Limited to carry out stack emissions monitoring to determine the release of total particulate matter from the following Plant under Normal operating conditions.

The results of this test shall be used to demonstrate compliance with emission limit values for a variety of parameters as specified in the Plant's Resource Consent, RM22-0076-AP.

Plant

Wet Electrostatic Precipitator (WESP)

Operator

Resource Consent: RM22-0076-AP
Rainbow Mountain Renewable Energy Limited
216 State Highway 38
Waimangu
New Zealand

Stack Emissions Monitoring Company

Industrial Compliance Solutions Ltd
Suite 4
21 Railside Place Dinsdale
Hamilton

EXECUTIVE SUMMARY (Page 2 of 9)

Emissions Summary

Rainbow Mountain Renewable Energy Limited, Rainbow Mountain, 216 State Highway 38, Waimangu
Wet Electrostatic Precipitator (WESP)
12th June 2024

Parameter	Units	Result	Emission Rate	Limit	Outcome
Total Particulate Matter	mg/m³	13.6		50	Passed
	g/hr		95.3	-	-
Hydrogen Chloride	mg/m³	0.35		10	Passed
	g/hr		2.4	-	-
Hydrogen Fluoride	mg/m³	0.03		4	Passed
	g/hr		0.24	-	-
Sulphur Dioxide	mg/m³	0.17		50	Passed
	g/hr		1.2	-	-
Oxides of Nitrogen	mg/m³	106		200	Passed
	g/hr		742	-	-
Carbon Monoxide	mg/m³	150		50	Failed
	g/hr		1050	-	-
Oxygen	% v/v	17.5	-	-	-
Carbon Monoxide	% v/v	2.8	-	-	-
Moisture	%	3.4	-	-	-
Stack Gas Temperature	°C	26.1	-	-	-
Stack Gas Velocity	m/s	3.9	-	-	-
Gas Volumetric Flow Rate (Actual)	m³/hr	8006	-	-	-
Gas Volumetric Flow Rate (STP, Wet)	m³/hr	7272	-	-	-
Gas Volumetric Flow Rate (STP, Dry)	m³/hr	7006	-	-	-

All results are mean values, with pollutant concentrations expressed at reference conditions.

Reference conditions are 273K, 101.3kPa, dry gas.

EXECUTIVE SUMMARY (Page 3 of 9)

Monitoring Times

Parameter	Run	Sampling Date	Sampling Times	Result mg/m^3	Uncertainty +/- mg/m^3
Total Particulate Matter	R1	12-Jun-24	09:29 - 10:29	17.1	2.69
Total Particulate Matter	R2	12-Jun-24	11:56 - 12:56	14.2	2.21
Total Particulate Matter	R3	12-Jun-24	14:06 - 15:06	9.43	0.92
Hydrogen Chloride	R1	12-Jun-24	09:29 - 10:29	0.45	0.04
Hydrogen Chloride	R2	12-Jun-24	11:56 - 12:56	0.30	0.03
Hydrogen Chloride	R3	12-Jun-24	14:06 - 15:06	0.29	0.02
Hydrogen Fluoride	R1	12-Jun-24	09:29 - 10:29	0.05	0.004
Hydrogen Fluoride	R2	12-Jun-24	11:56 - 12:56	0.03	0.003
Hydrogen Fluoride	R3	12-Jun-24	14:06 - 15:06	0.03	0.002
Sulphur Dioxide*	R1	12-Jun-24	09:28 - 10:28	0.16	0.02
Sulphur Dioxide*	R2	12-Jun-24	11:56 - 12:56	0.17	0.03
Sulphur Dioxide*	R3	12-Jun-24	14:06 - 15:06	0.18	0.03
Oxides of Nitrogen*	R1	12-Jun-24	09:29 - 10:29	97.5	14.6
Oxides of Nitrogen*	R2	12-Jun-24	11:56 - 12:56	119	17.8
Oxides of Nitrogen*	R3	12-Jun-24	14:06 - 15:06	102	15.3
Carbon Monoxide*	R1	12-Jun-24	09:29 - 10:29	52.6	7.9
Carbon Monoxide*	R2	12-Jun-24	11:56 - 12:56	142	21.3
Carbon Monoxide*	R3	12-Jun-24	14:06 - 15:06	255	38.2

*Estimated Uncertainty of 15%

Process Details

Parameter	Process Details
Process Status	Normal
Capacity and / or Production Rate	10 Tonnes per 16 hour cycle
Continuous or Batch Process	Batch
Feedstock (if applicable)	Flock
Abatement System	WESP
Abatement System Running Status	Operational
Fuel (if applicable)	Fuel Oil / Syngas
Plume Appearance	Visible Plume

EXECUTIVE SUMMARY (Page 4 of 9)

Monitoring Methods

Industrial Compliance Solutions Ltd employ USEPA methodologies for stack emissions testing. This section details all of the methods used on site during this monitoring campaign.

The table below summarises the monitoring methods, techniques and technical procedures employed, and details any deviations from the aforementioned hierarchy:

Sampling Methods with Subsequent Analysis

Species	Standard Method	ICS Technical Procedure	IANZ Lab Number	IANZ Accredited Method	Limit of Detection (LOD)	MU of Method (E) +/- %	MU +/- %
TPM	US EPA M5	ICS 01	N/A	N/A	~ 0.1 mg/m³	20%	15% (E)
H_2O	US EPA M4	ICS 02	N/A	N/A	0.1%	20%	-
HCL	US EPA M26A	ICS 03	365	N/A	0.5 mg/l	20%	
HF	US EPA M26A	ICS 03	365	N/A	0.05 mg/l	20%	
SO_2	US EPA M6	ICS 04	365	N/A	0.5 mg/l	20%	

where C = Calculated Measurement Uncertainty, E = Estimated Measurement Uncertainty

On-Site Testing and Analysis

The table below summarises the monitoring methods, techniques and technical procedures employed:

Species	Standard Method	ICS Technical Procedure	IANZ Lab Number	IANZ Accredited Method	Limit of Detection (LOD)	MU of Method (E) +/- %	MU +/- %
O_2 [1]	N/A	N/A	N/A	N/A	0.01%	15%	15%
NOx	N/A	N/A	N/A	N/A	1 ppm	15%	15%
CO	N/A	N/A	N/A	N/A	1 ppm	15%	15%
CO_2	N/A	N/A	N/A	N/A	0.01%	15%	15%

where C = Calculated Measurement Uncertainty, E = Estimated Measurement Uncertainty

1 - Oxygen was measured using a Testo 350 Portable Gas Analyser.

EXECUTIVE SUMMARY (Page 5 of 9)

Analytical Methods

The following tables list the analytical methods employed together with the custody and archiving details:

Sampling Methods with Subsequent Analysis

Species	Analytical Technique	Analytical Procedure	IANZ Lab Number	IANZ Accredited Analysis	Laboratory	Sample Archive Location	Archive Period
TPM	Gravimetric	ICS 01	N/A	N/A	ICS	Hamilton	3 months
H2O	Gravimetric	ICS 02	N/A	N/A	ICS	Hamilton	3 months
HCL	Ion Chromatography	M26A	365	N/A	Hill Labs	Hamilton	3 months
HF	Ion Chromatography	M26A	365	N/A	Hill Labs	Hamilton	3 months
SO2	Ion Chromatography	M6	365	N/A	Hill Labs	Hamilton	3 months

On-Site Testing and Analysis

Species	Analytical Technique	Analytical Procedure	IANZ Lab Number	IANZ Accredited Analysis	Laboratory	Sample Archive Location	Archive Period
O_2	Electrochemical	N/A	N/A	N/A	ICS	Hamilton	3 months
NOx	Electrochemical	N/A	N/A	N/A	ICS	Hamilton	3 months
CO	Electrochemical	N/A	N/A	N/A	ICS	Hamilton	3 months
CO_2	Infrared	N/A	N/A	N/A	ICS	Hamilton	3 months

EXECUTIVE SUMMARY (Page 6 of 9)

Measurement Uncertainty (MU)

Manual Extractive Testing

There are 4 ways in which to report measurement uncertainty for total particulate matter. These are listed in the hierarchical table below. The table also indicates which method has been used to calculate the MU for the parameters listed in this report.

MU Reported	Yes / No
a) Report a calculated MU	-
b) Report an estimated MU if there are any deviations from the sampling plane validation criteria	-
c) Report an estimated MU if there are any deviations from the specified method	Yes
d) Report the MU specified in the method	-

NOTE: The estimated uncertainty is based upon a calculated MU, coupled with the experience of the Stack Emissions Test house.

Automatic Analyser - Testo 350

MU Reported	Yes / No
a) Report a calculated MU	Yes
b) Report an estimated MU if the flow stream / gas velocity is not highly homogenous	-
c) Report an estimated MU if there are any deviations from the specified method	-
d) Report the MU specified in the method	-

NOTE: The estimated uncertainty is based upon a calculated MU, coupled with the experience of the Stack Emissions Test house.

EXECUTIVE SUMMARY (Page 7 of 9)

Sampling Location

Sampling Plane Validation Criteria (Ideal Conditions)	Value	Units	Requirement	Compliance	Method
Lowest Differential Pressure	6	Pa	> 5 Pa	Yes	In-house
Lowest Gas Velocity	2.62	m/s	-	-	-
Highest Gas Velocity	4.01	m/s	-	-	-
Ratio of Above	1.53	: 1	< 3 : 1	Yes	In-house
Mean Velocity	1.69	m/s	-	-	-
Angle of flow with regard to duct axis	0	°	< 15°	Yes	In-house
No local negative flow	-	-	-	Yes	In-house
Highly homogeneous flow stream / gas velocity	-	-	-	Yes	In-house
Sampling Plane Validation Criteria US EPA M1	**Value**	**Units**	**Requirement**	**Compliance**	**Method**
Duct diameters that measurements site is **upstream** from flow disturbance	4	Measured Diameters	> 2 Diameters	Yes	US EPA M1
Duct diameters that measurements site is **downstream** from flow disturbance	4	Measured Diameters	> 8 Diameters	No	US EPA M1

Duct Characteristics

	Value	Units
Type	Circular	-
Depth	0.86	m
Width	-	m
Area	0.57	m^2
Port Depth	483	mm

Sampling Lines & Sample Points

	TPM	Oxygen
Sample Port Size	4" Camlock	4" Camlock
Number Used	1	1
Sample Plane Orientation	Horizontal	-
Number Points / Line	12	1
In Stack / Out Stack Filtration	Out Stack	-

Sampling Platform

General Platform Information	Description
Permanent / Temporary Platform	Permanent
Inside / Outside	Outside

Ideal Platfrom Specifications	Present (Yes / No)
Minimum Platform Area 5 m2	Yes
Platform has 2 levels of handrails (approximately 0.5 m & 1.0 m high)	Yes
Platform has vertical base boards (approximately 0.25 m high)	Yes
Platform has removable chains / self closing gates at the top of ladders	N/A
Handrail / obstructions do not hamper insertion of sampling equipment	Yes
Depth of Platform = Minimum of 2m or Probe Length + 1m	Yes

Sampling Location / Platform Improvement Recommendations

Two sample lines should be installed on the stack at 45 degrees relevant to the existing port.

EXECUTIVE SUMMARY (Page 8 of 9)

Sampling & Analytical Method Deviations

One Sampling Line

Only 1 sample line was present on the stack.

EXECUTIVE SUMMARY (Page 9 of 9)

Conclusion & Discussion

The results of these tests demonstrate that under normal operating conditions, this Plant is being operated in full compliance with the emission limits specified in its Resource Consent, RM22-0076-AP.

A regular programme of stack emissions testing in accordance with the Plant's Resource Consent, RM22-0076-AP, will be required to demonstrate continued compliance.

APPENDICES

CONTENTS

APPENDIX 1 - Stack Emissions Monitoring Team

STACK EMISSIONS MONITORING TEAM

Environmental Technician 1	Toby Campbell Principal Environmental Consultant Certificate Air Quality Professional (CAQP) BSc Environmental Management MSc Air Pollution Management and Control
Environmental Technician 2	Brent Kennedy Principal Scientist Certificate Air Quality Professional (CAQP) BSc Chemistry MSc Materials and Processing Engineering

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

TOTAL SUSPENDED PARTICULATE SUMMARY

Rainbow Mountain Renewable Energy Limited, Rainbow Mountain, 216 State Highway 38, Waimangu
Wet Electrostatic Precipitator (WESP)
12th June 2024

Test	Sampling Times	Duration min	Concentration mg/m³	Emission Rate g/hr
Particulate Matter	09:29 - 10:29	60	17.1	90
Particulate Matter	11:56 - 12:56	60	14.2	118
Particulate Matter	14:06 - 15:06	60	9.4	78

Reference conditions are 273K, 101.3kPa, dry gas.

Sampling Run	Sample ID	Filter ID / Rinse ID	Volume (ml)	Initial Wt (g)	Final Wt (g)	Mass (g)	Net Mass (g)	Total Mass (g)
Run 1	0001	0001		0.36710	0.36950	0.0024	0.0020	0.0114
			40	85.67310	85.68220	0.0091	0.0094	
Run 2	0002	0002		0.36740	0.37250	0.0051	0.0047	0.0143
			40	84.66730	84.67660	0.0093	0.0096	
Run 3	0003	0003		0.36820	0.36970	0.0015	0.0011	0.0096
			40	85.0791	85.0873	0.0082	0.0085	
Filter Blank				0.3744	0.3748	0.0004		
Acetone Blank			40	84.3684	84.3681	-0.0003		

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

ISOKINETIC SAMPLING EQUATIONS 1 — Total Particulate Matter

Test	1	2	3	Units
Absolute pressure of stack gas, P_s				
Barometric pressure, P_b	757.5	757.5	757.5	mm Hg
Stack static pressure, P_{static}	0.2	0.2	0.2	mm H_2O
$P_s = P_b + \frac{(P_{static})}{13.6}$	757.5	757.5	757.5	mm Hg
Volume of water vapour collected, V_{wstd}				
Impinger volume collected	2.2	34.5	19.4	ml
Silica gel weight increase	6.4	9.0	10.8	g
Total volume of liquid collected, V_{lc}	8.6	43.5	30.2	ml
$V_{wstd} = (0.001246)(V_{lc})$	0.0107	0.0539	0.0374	m³
Volume of gas metered dry, V_{mstd}				
Volume of gas sample through gas meter, V_m	0.6874	1.0571	1.0630	m³
Gas meter correction factor, Y_d	1.015	1.015	1.015	-
Average dry gas meter temperature, T_m	12.9	18.1	16.4	°C
Average pressure drop across orifice, ΔH	13.4	30.7	30.2	mm H_2O
$V_{mstd} = \frac{(0.3592)(V_m)(P_b+(\Delta H/13.6))(Y_d)}{T_m + 273}$	0.6650	1.0060	1.0176	m³
Volume of gas metered wet, V_{mstw}				
$V_{mstw} = V_{mstd} + V_{wstd}$	0.6757	1.0600	1.0550	m³
Volume of gas metered at O_2 Ref. Cond., $V_{mstd@X\%O2}$				
% oxygen measured in gas stream, act%O_2	18.0	17.6	17.0	%
% oxygen reference condition *(21.0 denotes no O2 correction)*	21.0	21.0	21.0	%
O_2 Reference Factor O2 Ref = $\frac{21.0 - act\%O2}{21.0 - ref\%O2}$	No O2 Ref	No O2 Ref	No O2 Ref	
$V_{mstd@X\%oxygen} = (V_{mstd})\ (O_{2\ Ref})$	No O2 Ref	No O2 Ref	No O2 Ref	m³
Moisture content, B_{wo}				
$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$	0.016	0.051	0.035	m³
	1.58	5.09	3.55	%
Molecular weight of dry gas stream, M_d				
CO_2	2.3	2.9	3.1	%
O_2	18.0	17.6	17.0	%
Total	20.3	20.5	20.2	%
N_2 (100 -Total)	79.7	79.5	79.8	%
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	29.09	29.16	29.18	g/gmol
Molecular weight of stack gas (wet), M_s				
$M_s = M_d(1 - B_{wo}) + 18(B_{wo})$	28.91	28.59	28.79	g/gmol

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

ISOKINETIC SAMPLING EQUATIONS 2 — Total Particulate Matter

Test	1	2	3	Units
Velocity of stack gas, V_s				
Pitot tube velocity constant, K_p	34.97	34.97	34.97	-
Velocity pressure coefficient, C_p	0.84	0.84	0.84	-
Average stack gas temperature, T_s	23	27	29	°C
$V_s = \frac{(K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)}{\sqrt{(M_s)(P_s)}}$	2.76	4.40	4.45	m/s
V_s corrected for angle of swirl	2.76	4.40	4.45	m/s
Actual flow of stack gas, Q_a				
Area of stack, A_s	0.57	0.57	0.57	m²
$Q_a = (60)(A_s)(V_s)$	95.1	151.8	153.4	m³/min
	5704.8	9105.3	9206.9	m³/hr
Dry total flow of stack gas, Q_{std}				
Conversion factor (K/mm.Hg)	0.3592	0.3592	0.3592	-
$Q_{std} = \frac{(Q_a)P_s(0.3592)(1-B_{wo})}{(T_s) +273}$	86.1	130.8	133.4	m³/min
	5168	7846	8004	m³/hr
Dry total flow of stack gas, at O2 Ref. Cond., $Q_{std@X\%O2}$				
% oxygen measured in gas stream, act%O_2	18.0	17.6	17.0	%
% oxygen reference condition *(21.0 denotes no O2 correction)*	21.0	21.0	21.0	%
O_2 Reference Factor $O2\ Ref = \frac{21.0 - act\%O2}{21.0 - ref\%O2}$	No O2 Ref	No O2 Ref	No O2 Ref	
$Q_{std@X\%O2} = (Q_{std})\ (O_{2\ Ref})$	No O2 Ref	No O2 Ref	No O2 Ref	m³/min
Wet total flow of stack gas, Q_{stw}				
Conversion factor (K/mm.Hg)	0.3592	0.3592	0.3592	-
$Q_{stw} = \frac{(Q_a)P_s(0.3592)}{(T_s) +273}$	87.5	137.8	138.3	m³/min
	5251	8267	8298	m³/hr
Percent isokinetic, %I				
Nozzle diameter, D_n	9.28	9.28	9.28	mm
Nozzle area, A_n	67.64	67.65	67.65	mm²
Total sampling time, θ	60	60	60	min
$\%I = \frac{(4.6398E6)(T_s+273)(V_{mstd})}{(P_s)(V_s)(A_n)(\theta)(1-B_{wo})}$	109.2	108.8	107.9	%
Acceptable isokinetic range 90% to 110%"	Yes	Yes	Yes	-

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

ISOKINETIC SAMPLING EQUATIONS 3

Total Particulate Matter

Test	1	2	3	Units
Particulate Concentration, C				
Mass of particulate collected on filter, M_f	0.0020	0.0047	0.0011	g
Mass of particulate collected in probe, M_p	0.0094	0.0096	0.0085	g
Mass of total particulate collected, M_n	0.0114	0.0143	0.0096	g
$C_{wet} = \frac{M_n}{V_{mstw}}$	16.87	13.49	9.10	mg/m³
$C_{dry} = \frac{M_n}{V_{mstd}}$	17.14	14.21	9.43	mg/m³
$C_{dry@X\%O2} = \frac{M_n}{V_{mstd@X\%oxygen}}$	No O2 Ref	No O2 Ref	No O2 Ref	mg/m³
Particulate Emission Rates, E				
$E = [(C_{wet})(Q_{stw})(60)] / 1000$	90.0	117.5	78.3	g/hr
	0.090	0.118	0.078	kg/h
Weighing, Conditioning & Filtration Temperatures				
Pre-conditioning temperature	105	105	105	°C
Maximum filtration temperature	105	105	105	°C
Post-conditioning temperature	105	105	105	°C

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

TOTAL SUSPENDED PARTICULATE QUALITY ASSURANCE CHECKLIST

Leak Test Results	Value Run 1	Value Run 2	Value Run 3	Units
Mean Sampling Rate	11.6	17.9	18.0	litre/min
Pre-sampling Leak Rate	0.21	0.12	0.09	litre/min
Post-sampling Leak Rate	0.19	0.14	0.10	litre/min
Acceptable Leak Rate	0.23	0.36	0.36	litre/min
Leak Tests Acceptable	Yes	Yes	Yes	-

Overall Blank Value	Value Run 1	Units
Overall Blank Value	0.15	mg/m³
Daily Emission Limit Value	50	mg/m³
Acceptable Blank Value	5.0	mg/m³
Overall Blank Acceptable	Yes	-

Isokinetic Criterion Compliance	Value Run 1	Value Run 2	Value Run 3	Units
Isokinetic Variation	109.2	108.8	107.9	%
Acceptable Isokineticity	Yes	Yes	Yes	-

Acceptable isokinetic range 90% to 110%"

Total Particulate Matter Filters	Value Run 1	Value Run 2	Value Run 3	Units
Filter Material	GF	GF	GF	-
Filter Size	82	82	82	mm

GF = Glass Fibre

QF = Quartz Fibre

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

WET CHEMISTRY SUMMARY

Rainbow Mountain Renewable Energy Limited, Rainbow Mountain, 216 State Highway 38, Waimangu
Wet Electrostatic Precipitator (WESP)
12th June 2024

Concurrent Iso-Kinetic Tests	Sampling Times	Duration min	Concentration mg/m³	Emission Rate g/hr
Hydrogen Chloride R1	09:29 - 10:29	60	0.45	2.37
Hydrogen Chloride R2	11:56 - 12:56	60	0.30	2.47
Hydrogen Chloride R3	14:06 - 15:06	60	0.29	2.45
		Average	0.35	2.43

Reference conditions are 273K, 101.3kPa, dry gas.

Concurrent Iso-Kinetic Tests	Sampling Times	Duration min	Concentration mg/m³	Emission Rate g/hr
Hydrogen Fluoride R1	09:29 - 10:29	60	0.05	0.24
Hydrogen Fluoride R2	11:56 - 12:56	60	0.03	0.25
Hydrogen Fluoride R3	14:06 - 15:06	60	0.03	0.24
		Average	0.03	0.24

Reference conditions are 273K, 101.3kPa, dry gas.

Concurrent Iso-Kinetic Tests	Overall Blank Value mg/m³	Daily Emission Limit Value mg/m³	Weighing Uncertainty ± mg
Hydrogen Chloride	0.00	0	0.00
Hydrogen Fluoride	0.00	0	0.00

Non Iso-Kinetic Tests	Sampling Times	Duration min	Concentration mg/m³	Emission Rate g/hr
Sulphur Dioxide R1	09:28 - 10:28	60	0.2	0.8
Sulphur Dioxide R2	11:56 - 12:56	60	0.2	1.3
Sulphur Dioxide R3	14:06 - 15:06	60	0.2	1.5
		Average	0.2	1.2

Reference conditions are 273K, 101.3kPa, dry gas.

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

WET CHEMISTRY SAMPLING DATA AND QUALITY ASSURANCE

Rainbow Mountain Renewable Energy Limited, Rainbow Mountain, 216 State Highway 38, Waimangu
Wet Electrostatic Precipitator (WESP)
12th June 2024

Concurrent Iso-Kinetic Tests - HCL and HF

Leak Test Results	Value Run 1	Value Run 2	Value Run 3	Units
Mean Sampling Rate	11.6	17.9	18.0	litre/min
Pre-sampling Leak Rate	0.21	0.12	0.09	litre/min
Post-sampling Leak Rate	0.19	0.14	0.10	litre/min
Acceptable Leak Rate	0.23	0.36	0.36	litre/min
Leak Tests Acceptable	Yes	Yes	Yes	-

Overall Blank Value	HCL	HF	Units
Overall Blank Value	0.33	0.03	mg/m³
Daily Emission Limit Value	10	4	mg/m³
Acceptable Blank Value	1.0	0.4	mg/m³
Overall Blank Acceptable	Yes	Yes	-

Isokinetic Criterion Compliance	Value Run 1	Value Run 2	Value Run 3	Units
Isokinetic Variation	109.2	108.8	107.9	%
Acceptable Isokineticity	Yes	Yes	Yes	-

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

WET CHEMISTRY SAMPLING DATA AND QUALITY ASSURANCE

Rainbow Mountain Renewable Energy Limited, Rainbow Mountain, 216 State Highway 38, Waimangu
Wet Electrostatic Precipitator (WESP)
0-Jan-00

Non-Kinetic Tests - SO_2

Leak Test Results	Value Run 1	Value Run 2	Value Run 3	Units
Mean Sampling Rate	9.1	8.5	8.0	litre/min
Pre-sampling Leak Rate	0.01	0.01	0.01	litre/min
Post-sampling Leak Rate	0.02	0.02	0.02	litre/min
Acceptable Leak Rate	0.18	0.17	0.16	litre/min
Leak Tests Acceptable	Yes	Yes	Yes	-

Overall Blank Value	SO_2	Units
Overall Blank Value	0.13	mg/m³
Daily Emission Limit Value	50	mg/m³
Acceptable Blank Value	5.0	mg/m³
Overall Blank Acceptable	Yes	-

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

GASES SUMMARY

Rainbow Mountain Renewable Energy Limited, Rainbow Mountain, 216 State Highway 38, Waimangu
Wet Electrostatic Precipitator (WESP)
12th June 2024

Parameter	Concentration		Emission Rate	Span Gas	Range
	%	mg/m^3	g/hr	%	%
O_2	17.5	-	-	20.9	25
NOx	-	106.0	742	-	-
CO	-	149.8	1050	-	-
CO_2	2.8	-	-	-	-

INSTRUMENTAL SPAN & ZERO CHECKS

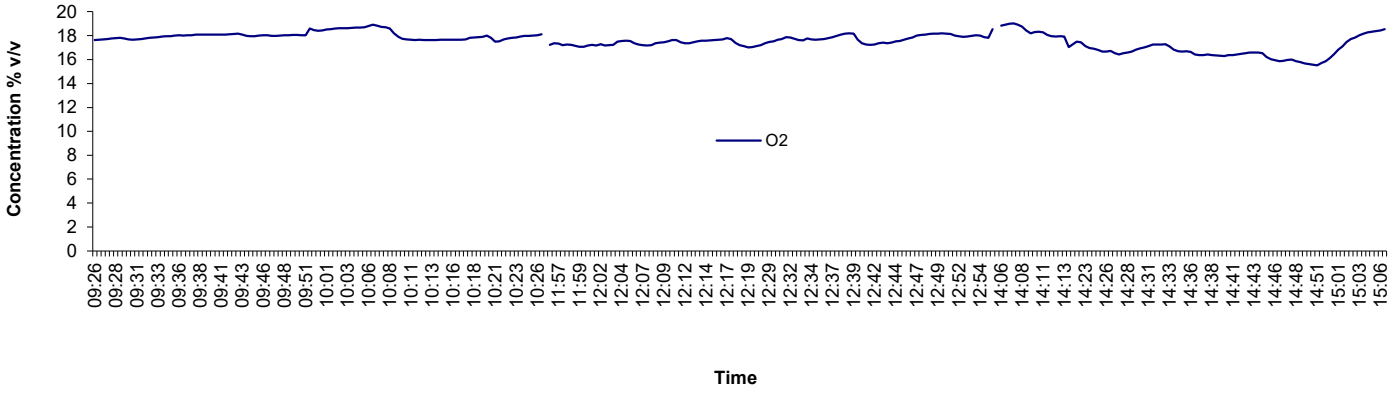
	Pre-Test		Post-Test	
Parameter	Start Time	End Time	Start Time	End Time
O_2	9:15	9:25	15:12	15:21

Parameter Drift	Analyser Range	Zero Start	Zero Finish	Zero Drift %	Span Start	Span Finish	Span Drift ppm *	Span Drift %
O_2 (% v/v)	25	0	0.00	0.00	20.90	20.90	0.00	0.00

* NOTE 1: The Span Drift value is the figure after it has been corrected for Zero Drift.

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

OXYGEN EMISSIONS CHART



OXYGEN EMISSIONS DATA

Time	O_2 % v/v		Time	O_2 % v/v		Time	O_2 % v/v	
09:26	17.6		09:36	18.0		09:47	18.0	
09:26	17.7		09:37	18.0		09:47	18.0	
09:27	17.7		09:37	18.1		09:48	18.0	
09:27	17.7		09:38	18.1		09:48	18.0	
09:28	17.8		09:38	18.1		09:49	18.0	
09:28	17.8		09:39	18.1		09:49	18.1	
09:29	17.8		09:39	18.1		09:50	18.1	
09:29	17.8		09:40	18.1		09:50	18.1	
09:30	17.7		09:40	18.1		09:51	18.0	
09:30	17.7		09:41	18.1		09:59	18.6	
09:31	17.7		09:41	18.1		09:59	18.5	
09:31	17.7		09:42	18.1		10:00	18.4	
09:32	17.8		09:42	18.1		10:00	18.4	
09:32	17.8		09:43	18.2		10:01	18.5	
09:33	17.9		09:43	18.1		10:01	18.5	
09:33	17.9		09:44	18.0		10:02	18.6	
09:34	17.9		09:44	17.9		10:02	18.6	
09:34	18.0		09:45	18.0		10:03	18.6	
09:35	18.0		09:45	18.0		10:03	18.6	
09:35	18.0		09:46	18.0		10:04	18.6	
09:36	18.0		09:46	18.0		10:04	18.7	

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

OXYGEN EMISSIONS DATA (continued)

Time	O_2 % v/v		Time	O_2 % v/v		Time	O_2 % v/v	
10:05	18.7		10:20	18.0		12:03	17.2	
10:05	18.7		10:20	17.8		12:04	17.5	
10:06	18.8		10:21	17.5		12:04	17.6	
10:06	18.9		10:21	17.5		12:05	17.6	
10:07	18.8		10:22	17.7		12:05	17.6	
10:07	18.7		10:22	17.8		12:06	17.4	
10:08	18.7		10:23	17.8		12:06	17.3	
10:08	18.6		10:23	17.9		12:07	17.2	
10:09	18.2		10:24	17.9		12:07	17.2	
10:09	17.9		10:24	18.0		12:08	17.2	
10:10	17.7		10:25	18.0		12:08	17.3	
10:10	17.7		10:25	18.0		12:09	17.4	
10:11	17.7		10:26	18.1		12:09	17.5	
10:11	17.6		10:26	18.1		12:10	17.5	
10:12	17.7					12:10	17.6	
10:12	17.6		11:56	17.2		12:11	17.6	
10:13	17.6		11:56	17.4		12:11	17.4	
10:13	17.6		11:57	17.3		12:12	17.4	
10:14	17.6		11:57	17.2		12:12	17.4	
10:14	17.6		11:58	17.3		12:13	17.5	
10:15	17.6		11:58	17.2		12:13	17.5	
10:15	17.6		11:59	17.1		12:14	17.6	
10:16	17.6		11:59	17.1		12:14	17.6	
10:16	17.6		12:00	17.1		12:15	17.6	
10:17	17.7		12:00	17.2		12:15	17.6	
10:17	17.7		12:01	17.2		12:16	17.6	
10:18	17.8		12:01	17.2		12:16	17.7	
10:18	17.9		12:02	17.3		12:17	17.8	
10:19	17.9		12:02	17.2		12:17	17.7	
10:19	17.9		12:03	17.2		12:18	17.4	

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

OXYGEN EMISSIONS DATA (continued)

Time	O_2 % v/v		Time	O_2 % v/v		Time	O_2 % v/v	
12:18	17.2		12:41	17.3		12:56	18.6	
12:19	17.1		12:41	17.2				
12:19	17.0		12:42	17.3		14:06	18.8	
12:20	17.1		12:42	17.3		14:06	18.9	
12:20	17.1		12:43	17.4		14:07	19.0	
12:21	17.2		12:43	17.4		14:07	19.0	
12:29	17.4		12:44	17.4		14:08	18.9	
12:29	17.5		12:44	17.5		14:08	18.8	
12:30	17.5		12:45	17.6		14:09	18.4	
12:30	17.7		12:45	17.6		14:09	18.2	
12:31	17.7		12:46	17.8		14:10	18.3	
12:31	17.9		12:46	17.9		14:10	18.3	
12:32	17.8		12:47	18.0		14:11	18.3	
12:32	17.7		12:47	18.1		14:11	18.1	
12:33	17.6		12:48	18.1		14:12	18.0	
12:33	17.6		12:48	18.1		14:12	17.9	
12:34	17.8		12:49	18.2		14:13	18.0	
12:34	17.7		12:49	18.2		14:13	17.9	
12:35	17.7		12:50	18.2		14:21	17.0	
12:35	17.7		12:50	18.2		14:22	17.3	
12:36	17.7		12:51	18.1		14:22	17.5	
12:36	17.8		12:51	18.0		14:23	17.4	
12:37	17.9		12:52	17.9		14:23	17.1	
12:37	18.0		12:52	17.9		14:24	17.0	
12:38	18.1		12:53	17.9		14:24	16.9	
12:38	18.2		12:53	18.0		14:25	16.8	
12:39	18.2		12:54	18.1		14:25	16.7	
12:39	18.2		12:54	18.0		14:26	16.7	
12:40	17.7		12:55	17.9		14:26	16.7	
12:40	17.4		12:55	17.8		14:27	16.5	

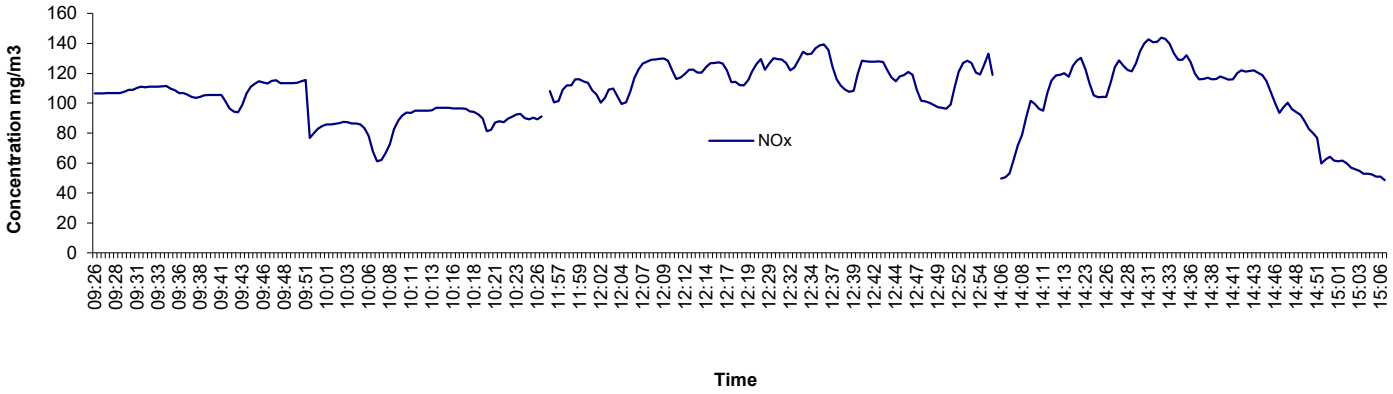
APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

OXYGEN EMISSIONS DATA (continued)

Time	O_2 % v/v		Time	O_2 % v/v		Time	O_2 % v/v	
14:27	16.4		14:42	16.6		15:05	18.3	
14:28	16.6		14:43	16.6		15:05	18.4	
14:28	16.6		14:43	16.6		15:06	18.4	
14:29	16.7		14:44	16.6		15:06	18.5	
14:29	16.8		14:44	16.6				
14:30	16.9		14:45	16.2				
14:30	17.0		14:45	16.0				
14:31	17.1		14:46	15.9				
14:31	17.3		14:46	15.9				
14:32	17.3		14:47	15.9				
14:32	17.3		14:47	16.0				
14:33	17.3		14:48	16.0				
14:33	17.1		14:48	15.9				
14:34	16.8		14:49	15.8				
14:34	16.7		14:49	15.7				
14:35	16.7		14:50	15.6				
14:35	16.7		14:50	15.6				
14:36	16.6		14:51	15.5				
14:36	16.4		14:59	15.7				
14:37	16.4		14:59	15.9				
14:37	16.4		15:00	16.1				
14:38	16.4		15:00	16.5				
14:38	16.4		15:01	16.8				
14:39	16.3		15:01	17.1				
14:39	16.3		15:02	17.5				
14:40	16.3		15:02	17.7				
14:40	16.4		15:03	17.9				
14:41	16.4		15:03	18.0				
14:41	16.4		15:04	18.2				
14:42	16.5		15:04	18.3				

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

NOx EMISSIONS CHART



NOx EMISSIONS DATA

Time	NOx mg/m^3		Time	NOx mg/m^3		Time	NOx mg/m^3	
09:26	106.5		09:36	106.7		09:47	114.9	
09:26	106.5		09:37	105.7		09:47	115.3	
09:27	106.5		09:37	104.3		09:48	113.5	
09:27	106.7		09:38	103.6		09:48	113.5	
09:28	106.7		09:38	104.3		09:49	113.5	
09:28	106.7		09:39	105.3		09:49	113.5	
09:29	106.9		09:39	105.5		09:50	113.7	
09:29	107.5		09:40	105.5		09:50	114.7	
09:30	109.0		09:40	105.5		09:51	115.5	
09:30	109.0		09:41	105.5		09:59	77.0	
09:31	110.2		09:41	101.6		09:59	80.0	
09:31	111.0		09:42	96.7		10:00	83.1	
09:32	110.8		09:42	94.4		10:00	84.8	
09:32	111.0		09:43	94.0		10:01	86.0	
09:33	111.0		09:43	98.9		10:01	86.0	
09:33	111.0		09:44	106.7		10:02	86.2	
09:34	111.2		09:44	111.0		10:02	86.6	
09:34	111.4		09:45	112.9		10:03	87.6	
09:35	109.8		09:45	114.7		10:03	87.4	
09:35	108.8		09:46	113.9		10:04	86.4	
09:36	106.7		09:46	113.1		10:04	86.4	

NOx EMISSIONS DATA (continued)

Time	NOx mg/m^3		Time	NOx mg/m^3		Time	NOx mg/m^3	
10:05	86.0		10:24	93.0		12:11	117.4	
10:05	83.3		10:24	90.1		12:12	119.6	
10:06	78.2		10:25	89.3		12:12	122.5	
10:06	67.9		10:25	90.3		12:13	122.3	
10:07	61.2		10:26	89.3		12:13	120.5	
10:07	62.2		10:26	91.3		12:14	120.5	
10:08	66.7					12:14	124.2	
10:08	72.4		11:56	108.0		12:15	126.8	
10:09	82.5		11:56	100.6		12:15	127.0	
10:09	88.7		11:57	101.4		12:16	127.2	
10:10	91.7		11:57	109.0		12:16	126.6	
10:10	93.8		11:58	112.1		12:17	121.9	
10:11	93.6		11:58	111.8		12:17	114.1	
10:11	95.0		11:59	116.0		12:18	114.3	
10:12	95.0		11:59	116.2		12:18	112.3	
10:12	95.0		12:00	114.5		12:19	112.1	
10:13	95.0		12:00	113.7		12:19	115.5	
10:13	95.2		12:01	108.8		12:20	121.5	
10:14	96.9		12:01	105.7		12:20	126.0	
10:14	96.9		12:02	100.4		12:21	129.5	
10:15	96.9		12:02	103.6		12:29	122.5	
10:15	96.9		12:03	109.2		12:29	126.6	
10:16	96.7		12:03	109.8		12:30	130.1	
10:16	96.7		12:04	104.7		12:30	129.5	
10:17	96.7		12:04	99.5		12:31	129.3	
10:17	96.5		12:05	100.6		12:31	127.0	
10:18	94.6		12:05	107.5		12:32	121.9	
10:18	94.2		12:06	116.8		12:32	124.0	
10:19	92.6		12:06	122.7		12:33	129.3	
10:19	89.9		12:07	126.4		12:33	134.4	
10:20	81.3		12:07	127.9		12:34	132.6	
10:20	82.3		12:08	128.9		12:34	133.2	
10:21	87.2		12:08	129.3		12:35	136.7	
10:21	87.8		12:09	129.7		12:35	138.7	
10:22	87.4		12:09	129.9		12:36	139.4	
10:22	89.7		12:10	128.5		12:36	135.9	
10:23	91.1		12:10	121.9		12:37	124.4	
10:23	92.6		12:11	116.4		12:37	116.2	

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

NOx EMISSIONS DATA (continued)

Time	NOx mg/m^3		Time	NOx mg/m^3		Time	NOx mg/m^3	
12:38	111.6		14:06	49.7		14:32	141.2	
12:38	109.2		14:06	50.5		14:32	143.9	
12:39	107.5		14:07	53.2		14:33	143.0	
12:39	108.4		14:07	62.4		14:33	139.8	
12:40	119.9		14:08	71.8		14:34	133.6	
12:40	128.5		14:08	78.8		14:34	128.9	
12:41	128.1		14:09	90.5		14:35	128.9	
12:41	127.9		14:09	101.8		14:35	132.2	
12:42	127.9		14:10	99.5		14:36	127.2	
12:42	128.1		14:10	96.3		14:36	119.9	
12:43	127.4		14:11	95.0		14:37	116.2	
12:43	122.1		14:11	106.7		14:37	116.4	
12:44	117.2		14:12	115.1		14:38	117.0	
12:44	114.7		14:12	118.6		14:38	116.2	
12:45	118.0		14:13	119.0		14:39	116.4	
12:45	118.8		14:13	120.1		14:39	118.0	
12:46	120.9		14:21	117.8		14:40	116.8	
12:46	119.0		14:22	125.0		14:40	115.7	
12:47	109.2		14:22	128.5		14:41	116.2	
12:47	101.8		14:23	130.3		14:41	120.1	
12:48	101.2		14:23	122.9		14:42	121.9	
12:48	100.4		14:24	113.3		14:42	121.1	
12:49	98.7		14:24	105.3		14:43	121.7	
12:49	97.3		14:25	104.1		14:43	121.9	
12:50	96.9		14:25	104.3		14:44	120.3	
12:50	96.3		14:26	104.3		14:44	118.8	
12:51	99.1		14:26	113.9		14:45	114.7	
12:51	111.0		14:27	124.2		14:45	107.1	
12:52	120.9		14:27	128.7		14:46	99.9	
12:52	127.0		14:28	125.0		14:46	93.4	
12:53	128.5		14:28	122.1		14:47	97.3	
12:53	127.0		14:29	121.5		14:47	100.4	
12:54	120.5		14:29	126.8		14:48	96.0	
12:54	119.2		14:30	134.8		14:48	94.2	
12:55	125.8		14:30	140.0		14:49	92.1	
12:55	133.0		14:31	142.8		14:49	87.8	
12:56	119.0		14:31	141.0		14:50	82.7	

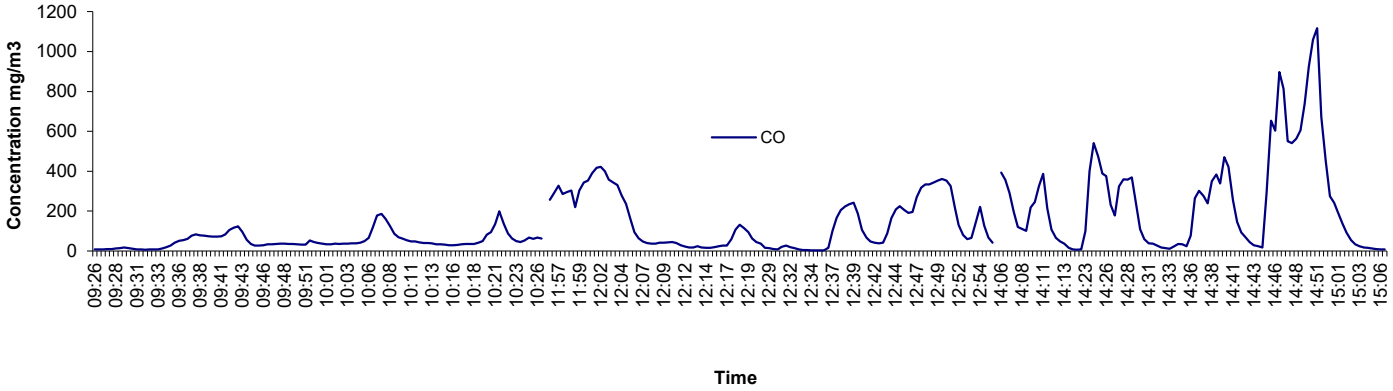
APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

NOxEMISSIONS DATA (continued)

Time	NOx mg/m^3		Time	NOx mg/m^3		Time	NOx mg/m^3	
14:50	80.0							
14:51	77.0							
14:59	59.7							
14:59	62.6							
15:00	64.2							
15:00	61.6							
15:01	61.2							
15:01	61.6							
15:02	59.9							
15:02	57.1							
15:03	55.8							
15:03	54.8							
15:04	52.9							
15:04	52.9							
15:05	52.3							
15:05	50.9							
15:06	50.9							
15:06	48.6							

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

CO EMISSIONS CHART



CO EMISSIONS DATA

Time	CO mg/m^3		Time	CO mg/m^3		Time	CO mg/m^3	
09:26	7.5		09:36	53.7		09:47	33.7	
09:26	7.5		09:37	61.2		09:47	35.0	
09:27	8.7		09:37	76.2		09:48	36.2	
09:27	10.0		09:38	83.7		09:48	36.2	
09:28	10.0		09:38	78.7		09:49	35.0	
09:28	12.5		09:39	77.5		09:49	35.0	
09:29	13.7		09:39	73.7		09:50	33.7	
09:29	18.7		09:40	72.5		09:50	32.5	
09:30	13.7		09:40	72.5		09:51	32.5	
09:30	11.2		09:41	73.7		09:59	52.5	
09:31	8.7		09:41	83.7		09:59	45.0	
09:31	7.5		09:42	104.9		10:00	40.0	
09:32	6.2		09:42	117.4		10:00	36.2	
09:32	7.5		09:43	123.7		10:01	33.7	
09:33	7.5		09:43	97.4		10:01	33.7	
09:33	8.7		09:44	56.2		10:02	36.2	
09:34	12.5		09:44	35.0		10:02	35.0	
09:34	20.0		09:45	27.5		10:03	36.2	
09:35	27.5		09:45	27.5		10:03	36.2	
09:35	41.2		09:46	30.0		10:04	37.5	
09:36	51.2		09:46	33.7		10:04	38.7	

CO EMISSIONS DATA (continued)

Time	CO mg/m^3		Time	CO mg/m^3		Time	CO mg/m^3	
10:05	42.5		10:24	45.0		12:11	28.7	
10:05	50.0		10:24	52.5		12:12	22.5	
10:06	65.0		10:25	67.5		12:12	17.5	
10:06	118.7		10:25	61.2		12:13	18.7	
10:07	178.6		10:26	66.2		12:13	23.7	
10:07	186.1		10:26	62.5		12:14	18.7	
10:08	159.9					12:14	16.2	
10:08	127.4		11:56	257.3		12:15	16.2	
10:09	87.4		11:56	289.8		12:15	20.0	
10:09	70.0		11:57	327.3		12:16	23.7	
10:10	62.5		11:57	286.1		12:16	27.5	
10:10	53.7		11:58	296.1		12:17	27.5	
10:11	48.7		11:58	302.3		12:17	60.0	
10:11	47.5		11:59	219.9		12:18	108.7	
10:12	43.7		11:59	302.3		12:18	131.2	
10:12	40.0		12:00	344.8		12:19	114.9	
10:13	40.0		12:00	353.5		12:19	93.7	
10:13	37.5		12:01	389.8		12:20	62.5	
10:14	33.7		12:01	417.2		12:20	45.0	
10:14	33.7		12:02	422.2		12:21	36.2	
10:15	32.5		12:02	399.8		12:29	16.2	
10:15	30.0		12:03	358.5		12:29	13.7	
10:16	30.0		12:03	342.3		12:30	10.0	
10:16	31.2		12:04	331.0		12:30	7.5	
10:17	33.7		12:04	279.8		12:31	21.2	
10:17	35.0		12:05	236.1		12:31	27.5	
10:18	35.0		12:05	163.6		12:32	20.0	
10:18	35.0		12:06	93.7		12:32	13.7	
10:19	41.2		12:06	63.7		12:33	8.7	
10:19	50.0		12:07	48.7		12:33	5.0	
10:20	82.4		12:07	40.0		12:34	5.0	
10:20	93.7		12:08	36.2		12:34	3.7	
10:21	133.7		12:08	36.2		12:35	3.7	
10:21	198.6		12:09	41.2		12:35	3.7	
10:22	136.2		12:09	42.5		12:36	3.7	
10:22	88.7		12:10	43.7		12:36	16.2	
10:23	62.5		12:10	45.0		12:37	101.2	
10:23	50.0		12:11	40.0		12:37	167.4	

CO EMISSIONS DATA (continued)

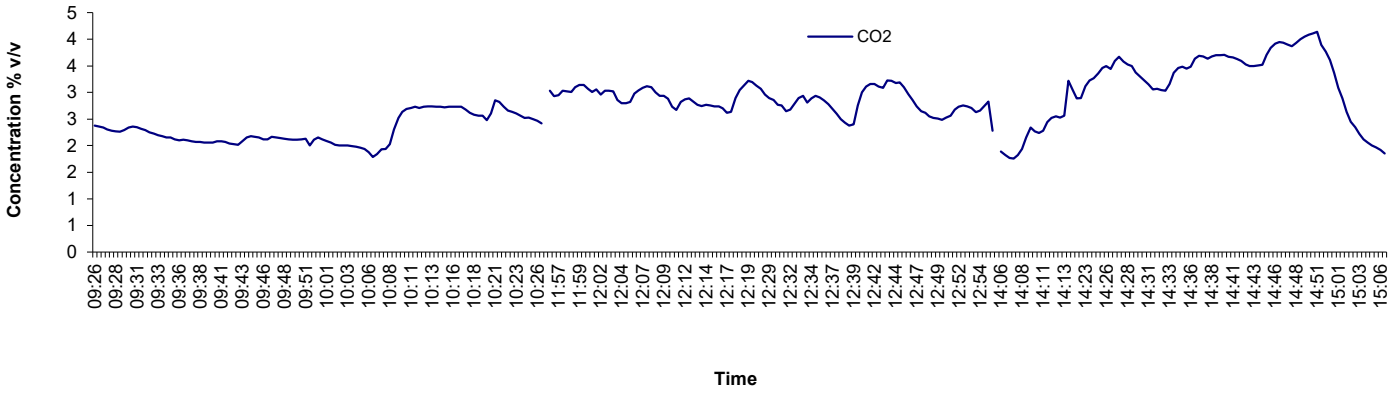
Time	CO mg/m^3		Time	CO mg/m^3		Time	CO mg/m^3	
12:38	204.9		14:06	393.5		14:32	26.2	
12:38	222.4		14:06	357.3		14:32	18.7	
12:39	234.9		14:07	289.8		14:33	13.7	
12:39	242.3		14:07	197.4		14:33	11.2	
12:40	188.6		14:08	121.2		14:34	22.5	
12:40	104.9		14:08	111.2		14:34	35.0	
12:41	67.5		14:09	101.2		14:35	33.7	
12:41	47.5		14:09	218.6		14:35	23.7	
12:42	41.2		14:10	246.1		14:36	76.2	
12:42	38.7		14:10	326.0		14:36	266.1	
12:43	41.2		14:11	387.3		14:37	301.1	
12:43	88.7		14:11	212.4		14:37	276.1	
12:44	166.1		14:12	106.2		14:38	238.6	
12:44	208.6		14:12	65.0		14:38	349.8	
12:45	226.1		14:13	47.5		14:39	382.3	
12:45	207.4		14:13	36.2		14:39	338.5	
12:46	191.1		14:21	16.2		14:40	469.7	
12:46	196.1		14:22	8.7		14:40	422.2	
12:47	269.8		14:22	6.2		14:41	254.8	
12:47	317.3		14:23	7.5		14:41	147.4	
12:48	334.8		14:23	99.9		14:42	92.4	
12:48	334.8		14:24	401.0		14:42	68.7	
12:49	343.5		14:24	542.2		14:43	45.0	
12:49	352.3		14:25	473.5		14:43	30.0	
12:50	361.0		14:25	388.5		14:44	23.7	
12:50	353.5		14:26	376.0		14:44	17.5	
12:51	326.0		14:26	231.1		14:45	289.8	
12:51	219.9		14:27	178.6		14:45	653.3	
12:52	129.9		14:27	323.5		14:46	603.4	
12:52	80.0		14:28	359.8		14:46	898.2	
12:53	60.0		14:28	358.5		14:47	813.2	
12:53	65.0		14:29	368.5		14:47	550.9	
12:54	147.4		14:29	238.6		14:48	540.9	
12:54	221.1		14:30	109.9		14:48	563.4	
12:55	126.2		14:30	60.0		14:49	604.6	
12:55	67.5		14:31	38.7		14:49	738.3	
12:56	41.2		14:31	36.2		14:50	924.4	

CO EMISSIONS DATA (continued)

Time	CO mg/m^3		Time	CO mg/m^3		Time	CO mg/m^3	
14:50	1059.3							
14:51	1118.1							
14:59	672.1							
14:59	448.5							
15:00	273.6							
15:00	242.3							
15:01	189.9							
15:01	138.7							
15:02	91.2							
15:02	53.7							
15:03	33.7							
15:03	23.7							
15:04	17.5							
15:04	15.0							
15:05	12.5							
15:05	10.0							
15:06	8.7							
15:06	8.7							

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

CO_2 EMISSIONS CHART



CO_2 EMISSIONS DATA

Time	CO_2 %		Time	CO_2 %		Time	CO_2 %	
09:26	2.4		09:36	2.1		09:47	2.2	
09:26	2.4		09:37	2.1		09:47	2.2	
09:27	2.3		09:37	2.1		09:48	2.1	
09:27	2.3		09:38	2.1		09:48	2.1	
09:28	2.3		09:38	2.1		09:49	2.1	
09:28	2.3		09:39	2.1		09:49	2.1	
09:29	2.3		09:39	2.1		09:50	2.1	
09:29	2.3		09:40	2.1		09:50	2.1	
09:30	2.3		09:40	2.1		09:51	2.1	
09:30	2.4		09:41	2.1		09:59	2.0	
09:31	2.4		09:41	2.1		09:59	2.1	
09:31	2.3		09:42	2.0		10:00	2.2	
09:32	2.3		09:42	2.0		10:00	2.1	
09:32	2.3		09:43	2.0		10:01	2.1	
09:33	2.2		09:43	2.1		10:01	2.1	
09:33	2.2		09:44	2.2		10:02	2.0	
09:34	2.2		09:44	2.2		10:02	2.0	
09:34	2.2		09:45	2.2		10:03	2.0	
09:35	2.2		09:45	2.2		10:03	2.0	
09:35	2.1		09:46	2.1		10:04	2.0	
09:36	2.1		09:46	2.1		10:04	2.0	

CO_2 EMISSIONS DATA (continued)

Time	CO_2 %		Time	CO_2 %		Time	CO_2 %	
10:05	2.0		10:24	2.6		12:11	2.8	
10:05	1.9		10:24	2.5		12:12	2.9	
10:06	1.9		10:25	2.5		12:12	2.9	
10:06	1.8		10:25	2.5		12:13	2.8	
10:07	1.8		10:26	2.5		12:13	2.8	
10:07	1.9		10:26	2.4		12:14	2.8	
10:08	1.9					12:14	2.8	
10:08	2.0		11:56	3.0		12:15	2.8	
10:09	2.3		11:56	2.9		12:15	2.7	
10:09	2.5		11:57	3.0		12:16	2.7	
10:10	2.6		11:57	3.0		12:16	2.7	
10:10	2.7		11:58	3.0		12:17	2.6	
10:11	2.7		11:58	3.0		12:17	2.6	
10:11	2.7		11:59	3.1		12:18	2.9	
10:12	2.7		11:59	3.1		12:18	3.1	
10:12	2.7		12:00	3.1		12:19	3.1	
10:13	2.7		12:00	3.1		12:19	3.2	
10:13	2.7		12:01	3.0		12:20	3.2	
10:14	2.7		12:01	3.1		12:20	3.1	
10:14	2.7		12:02	3.0		12:21	3.1	
10:15	2.7		12:02	3.0		12:29	3.0	
10:15	2.7		12:03	3.0		12:29	2.9	
10:16	2.7		12:03	3.0		12:30	2.9	
10:16	2.7		12:04	2.9		12:30	2.8	
10:17	2.7		12:04	2.8		12:31	2.8	
10:17	2.7		12:05	2.8		12:31	2.7	
10:18	2.6		12:05	2.8		12:32	2.7	
10:18	2.6		12:06	3.0		12:32	2.8	
10:19	2.6		12:06	3.0		12:33	2.9	
10:19	2.6		12:07	3.1		12:33	2.9	
10:20	2.5		12:07	3.1		12:34	2.8	
10:20	2.6		12:08	3.1		12:34	2.9	
10:21	2.9		12:08	3.0		12:35	2.9	
10:21	2.8		12:09	2.9		12:35	2.9	
10:22	2.7		12:09	2.9		12:36	2.9	
10:22	2.7		12:10	2.9		12:36	2.8	
10:23	2.6		12:10	2.7		12:37	2.7	
10:23	2.6		12:11	2.7		12:37	2.6	

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

CO_2 EMISSIONS DATA (continued)

Time	CO_2 %		Time	CO_2 %		Time	CO_2 %	
12:38	2.5		14:06	1.9		14:32	3.1	
12:38	2.4		14:06	1.8		14:32	3.1	
12:39	2.4		14:07	1.8		14:33	3.0	
12:39	2.4		14:07	1.8		14:33	3.2	
12:40	2.8		14:08	1.8		14:34	3.4	
12:40	3.0		14:08	1.9		14:34	3.5	
12:41	3.1		14:09	2.2		14:35	3.5	
12:41	3.2		14:09	2.3		14:35	3.5	
12:42	3.2		14:10	2.3		14:36	3.5	
12:42	3.1		14:10	2.2		14:36	3.6	
12:43	3.1		14:11	2.3		14:37	3.7	
12:43	3.2		14:11	2.4		14:37	3.7	
12:44	3.2		14:12	2.5		14:38	3.6	
12:44	3.2		14:12	2.6		14:38	3.7	
12:45	3.2		14:13	2.5		14:39	3.7	
12:45	3.1		14:13	2.6		14:39	3.7	
12:46	3.0		14:21	3.2		14:40	3.7	
12:46	2.9		14:22	3.0		14:40	3.7	
12:47	2.7		14:22	2.9		14:41	3.7	
12:47	2.7		14:23	2.9		14:41	3.6	
12:48	2.6		14:23	3.1		14:42	3.6	
12:48	2.6		14:24	3.2		14:42	3.5	
12:49	2.5		14:24	3.3		14:43	3.5	
12:49	2.5		14:25	3.4		14:43	3.5	
12:50	2.5		14:25	3.5		14:44	3.5	
12:50	2.5		14:26	3.5		14:44	3.5	
12:51	2.6		14:26	3.4		14:45	3.7	
12:51	2.7		14:27	3.6		14:45	3.8	
12:52	2.7		14:27	3.7		14:46	3.9	
12:52	2.8		14:28	3.6		14:46	4.0	
12:53	2.7		14:28	3.5		14:47	3.9	
12:53	2.7		14:29	3.5		14:47	3.9	
12:54	2.6		14:29	3.4		14:48	3.9	
12:54	2.7		14:30	3.3		14:48	3.9	
12:55	2.8		14:30	3.2		14:49	4.0	
12:55	2.8		14:31	3.2		14:49	4.1	
12:56	2.3		14:31	3.1		14:50	4.1	

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

CO_2 EMISSIONS DATA (continued)

Time	CO_2 %		Time	CO_2 %		Time	CO_2 %	
14:50	4.1							
14:51	4.1							
14:59	3.9							
14:59	3.8							
15:00	3.6							
15:00	3.4							
15:01	3.1							
15:01	2.9							
15:02	2.6							
15:02	2.5							
15:03	2.4							
15:03	2.2							
15:04	2.1							
15:04	2.1							
15:05	2.0							
15:05	2.0							
15:06	1.9							
15:06	1.9							

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

PRELIMINARY STACK SURVEY

Rainbow Mountain Renewable Energy Limited, Rainbow Mountain, 216 State Highway 38, Waimangu
Wet Electrostatic Precipitator (WESP)
12th June 2024

Time of Survey	09:00 - 09:15
Velocity Measurement Device:	S-Type Pitot

Sampling Line A							
Traverse Point	Distance into duct (m)	ΔP pt mmH_2O	ΔP pt Pa	Temp °C	Velocity m/s	O_2 % Vol	Angle of Swirl °
1	0.02	0.6	6	17	2.62	17.5	0
2	0.06	0.6	6	18	2.62	17.5	
3	0.10	1.0	10	18	3.39	17.5	
4	0.15	1.0	10	18	3.39	17.5	
5	0.21	1.0	10	18	3.39	17.5	
6	0.30	1.2	12	18	3.71	17.5	
7	0.55	1.4	14	18	4.01	17.5	
8	0.64	1.2	12	18	3.71	17.5	
9	0.70	1.0	10	18	3.39	17.5	
10	0.75	1.1	11	18	3.55	17.5	0
Mean	-	1.0	10	17.9	3.38	-	

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

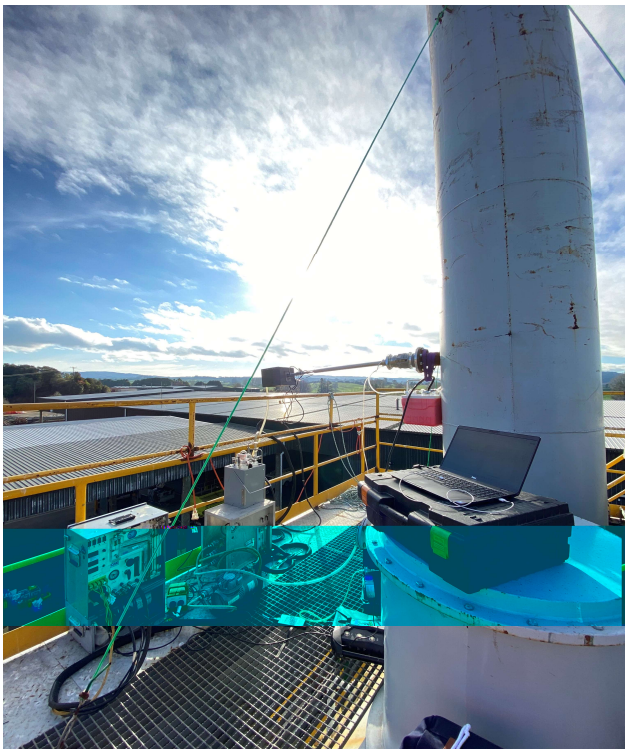
STACK PARAMETERS / SAMPLE LOCATION

	Value	Units
Stack Shape	Circular	-
Stack Depth	0.86	m
Stack Width	-	m
Area	0.57	m^2
Port Depth (including clamp)	483	mm

Gases and Non-Isokinetic Testing

Sampling Point	Distance (% of Depth)	Distance into Stack	Units
1	30	0.26	m

Sampling Location



Isokinetic Testing

Sampling Point	Distance into Stack	Probe Marking	Units
1	0.02	0.50	m
2	0.06	0.54	m
3	0.10	0.58	m
4	0.15	0.63	m
5	0.21	0.70	m
6	0.30	0.79	m
7	0.55	1.03	m
8	0.64	1.12	m
9	0.70	1.19	m
10	0.75	1.24	m
11	0.80	1.28	m
12	0.84	1.32	m

APPENDIX 4 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - TOTAL PARTICULATE MATTER

(R1 CALCULATIONS SHOWN)

	Value	Units
Limit value	50	mg/m³
Measured concentration	17.1	mg/m³
Reference oxygen	N/A	% by volume

Measured Quantities	Symbol	Value	Units
Sampled Volume	V_m	0.6650	m³
Sampled Gas Temperature	T_m	286	K
Sampled Gas Pressure	ρ_m	101	KPa
Sampled Gas Humidity	H_m	0.0	% by volume
Oxygen Content	$O_{2,m}$	N/A	% by volume
Mass of Particulate	m	11.4	mg
Leak	L	1.63	%
Uncollected Mass	UCM	0.19	mg

NOTE: Sampled Gas Temperature, Pressure and Humidity are at the Dry Gas Meter.

Standard Uncertainty	Symbol	Value	Units	Uncertainty as a %	Uncertainty Required	Uncertainty Met?
Sampled Volume	uV_m	0.0133	m³	2.0	≤ 2%	Yes
Sampled Gas Temperature	uT_m	2.9	K	1.0	≤ 1%	Yes
Sampled Gas Pressure	$u\rho_m$	1.01	KPa	1.0	≤ 1%	Yes
Sampled Gas Humidity	uH_m	0.0	% by volume	0.0	≤ 1%	Yes
Oxygen Content	$uO_{2,m}$	N/A	% by volume	N/A	≤ 10%	N/A
Mass of Particulate	um	0.05	mg	0.2	≤ 5% of ELV	Yes
Leak	-	-	-	1.6	≤ 2%	Yes
Uncollected Mass	-	-	-	0.1	≤ 10% of ELV	Yes

Parameter	Symbol	Value	Units	Uncertainty in Result	Units	Uncertainty as a %	Units
Volume (STP)	V	0.6332	m³	0.43	mg/m³	2.53	%
Mass of Particulate	m	11.4	mg	0.08	mg/m³	0.44	%
Factor for O2 Correction	fc	N/A	-	1.25	mg/m³	7.31	%
Leak	L	0.16	mg/m³	0.16	mg/m³	0.94	%
Uncollected mass	UCM	0.11	mg	0.16	mg/m³	0.94	%
Combined uncertainty				1.35	mg/m³	7.86	%

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	**2.69**	**mg/m³**	**15.72**	**%**
R2 - Uncertainty expressed at a 95% confidence level (where k = 2)	**2.21**	**mg/m³**	**15.54**	**%**
R3 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.92**	**mg/m³**	**9.79**	**%**

(k is a coverage factor which gives a 95% confidence in the quoted figures)

NOTE: Because there are one or more method deviations from US EPA M5, a calculated MU can not be quoted for the concentration or mass emission of total particulate matter. Instead, this figure may be used to make a best estimate of what the MU might be.

APPENDIX 4 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - CONCURRENT ISO-KINETIC HCL

(R1 CALCULATIONS SHOWN)

	Value	Units
Limit value	10	mg/m³
Measured concentration	0.5	mg/m³
Reference oxygen	N/A	% by volume

Measured Quantities	Symbol	Value	Units
Sampled Volume	V_m	0.66	m³
Sampled Gas Temperature	T_m	286	K
Sampled Gas Pressure	ρ_m	101	KPa
Sampled Gas Humidity	H_m	0.00	% by volume
Oxygen Content	$O_{2,m}$	N/A	% by volume
Mass of HCL	m	0.3	mg
Leak	L	1.63	%
Uncollected Mass	UCM	0.005	mg

NOTE: Sampled Gas Temperature, Pressure and Humidity are at the Dry Gas Meter.

Standard Uncertainty	Symbol	Value	Units	Uncertainty as a %	Uncertainty Required	Uncertainty Met?
Sampled Volume	uV_m	0.013	m³	2.0	≤ 2%	Yes
Sampled Gas Temperature	uT_m	2.86	K	1.0	≤ 1%	Yes
Sampled Gas Pressure	$u\rho_m$	1.01	KPa	1.0	≤ 1%	Yes
Sampled Gas Humidity	uH_m	0.0	% by volume	0.0	≤ 1%	Yes
Oxygen Content	$uO_{2,m}$	N/A	% by volume	N/A	≤ 10%	N/A
Mass of HCL	um	0.01	mg	0.2	≤ 5% of ELV	Yes
Leak	-	-	-	1.6	≤ 2%	Yes
Uncollected Mass	-	-	-	0.1	≤ 10% of ELV	Yes

Parameter	Symbol	Value	Units	Uncertainty in Result	Units	Uncertainty as a %	Units
Volume (STP)	V	0.63	m³	0.01	mg/m³	2.53	%
Mass of HCL	m	0.3	mg	0.02	mg/m³	3.33	%
Factor for O2 Correction	fc	N/A	-	0.0	mg/m³	0.0	%
Leak	L	0.16	mg/m³	0.004	mg/m³	0.94	%
Uncollected mass	UCM	0.11	mg	0.004	mg/m³	0.94	%
Combined uncertainty				Units	mg/m³	4.39	%

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.04**	**mg/m³**	**8.79**	**%**
R2 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.03**	**mg/m³**	**8.51**	**%**
R3 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.02**	**mg/m³**	**8.42**	**%**

(k is a coverage factor which gives a 95% confidence in the quoted figures)

NOTE: Because there are one or more method deviations from , a calculated MU can not be quoted for the concentration or mass emission of total particulate matter. Instead, this figure may be used to make a best estimate of what the MU might be.

APPENDIX 4 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - CONCURRENT ISO-KINETIC HF

(R1 CALCULATIONS SHOWN)

	Value	Units
Limit value	4	mg/m³
Measured concentration	0.05	mg/m³
Reference oxygen	N/A	% by volume

Measured Quantities	Symbol	Value	Units
Sampled Volume	V_m	0.66	m³
Sampled Gas Temperature	T_m	286	K
Sampled Gas Pressure	ρ_m	101	KPa
Sampled Gas Humidity	H_m	0.00	% by volume
Oxygen Content	$O_{2,m}$	N/A	% by volume
Mass of HF	m	0	mg
Leak	L	1.63	%
Uncollected Mass	UCM	0.000	mg

NOTE: Sampled Gas Temperature, Pressure and Humidity are at the Dry Gas Meter.

Standard Uncertainty	Symbol	Value	Units	Uncertainty as a %	Uncertainty Required	Uncertainty Met?
Sampled Volume	uV_m	0.013	m³	2.0	≤ 2%	Yes
Sampled Gas Temperature	uT_m	2.86	K	1.0	≤ 1%	Yes
Sampled Gas Pressure	$u\rho_m$	1.01	KPa	1.0	≤ 1%	Yes
Sampled Gas Humidity	uH_m	0.0	% by volume	0.0	≤ 1%	Yes
Oxygen Content	$uO_{2,m}$	N/A	% by volume	N/A	≤ 10%	No
Mass of HF	um	0	mg	0.0	≤ 5% of ELV	Yes
Leak	-	-	-	1.6	≤ 2%	Yes
Uncollected Mass	-	-	-	0.1	≤ 10% of ELV	Yes

Parameter	Symbol	Value	Units	Uncertainty in Result	Units	Uncertainty as a %	Units
Volume (STP)	V	0.63	m³	0.00	mg/m³	0.00	%
Mass of HF	m	0.0	mg	0.00	mg/m³	asurement Equa	%
Factor for O2 Correction	fc	N/A	-	% by volume	mg/m³	0.0	%
Leak	L	0.16	mg/m³	0.000	mg/m³	0.00	%
Uncollected mass	UCM	0.11	mg	0.000	mg/m³	0.00	%
Combined uncertainty				0.00	mg/m³	ertainty as percer	%

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.004**	**mg/m³**	**8.79**	**%**
R2 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.003**	**mg/m³**	**8.51**	**%**
R3 - Uncertainty expressed at a 95% confidence level (where k = 2)	**0.002**	**mg/m³**	**8.42**	**%**

(k is a coverage factor which gives a 95% confidence in the quoted figures)

NOTE: Because there are one or more method deviations from , a calculated MU can not be quoted for the concentration or mass emission of total particulate matter. Instead, this figure may be used to make a best estimate of what the MU might be.

APPENDIX 4 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - TESTO 350

General Information

Parameter	Value	UNITS
Technique	Electrochemical	-
Gas	Oxygen	-
Range	25	%
Measured reading	17.57	%

Operational conditions

Parameter	Value	UNITS
Zero and Span interval	1	hrs

Individual errors as standard uncertainties *u* (i)

Parameter	Value	UNITS
Nonlinearity *u* (lin)	0.406	%
Repeatability *u* (r)	0.203	%
Zero drift *u* (d)	0.015	%
Span drift *u* (s)	0.015	%
Cross-sensitivity *u* (cs)	0.406	%
Calibration gas uncertainty *u* (cal)	0.203	%

NOTE: Drift has already been corrected for, in the concentrations reported in this test report, using a linear correction equation. Drift has been quoted in this table to enable calculation of a 'worst case' measurement uncertainty.

Combined uncertainty of measurement *u* (c)

Parameter	Value	UNITS
RMS sum, *u* (c)	0.642	%
Extended uncertainty, *U* (c)	1.284	%
Proportional ext. uncertainty	**7.3%**	**of reading**