Resene Paints Limited, Upper Hutt

AIR DISCHARGE MONITORING OF THE FACTORY EXTRACTION SYSTEM, JANUARY 2019

Issue

March 2019

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Draft	5 March 2019	M. Newby	N Bailey	6 March 2019	Minor amendments
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Approved by

Name	Title	Signature
Matthew Newby, CAQP	Senior Air Quality Scientist	

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IANZ ACCREDITED LABORATORY

Tests indicated as not accredited are outside the scope of the laboratory's accreditation

Contents

Executive Summary

Source Testing New Zealand Limited (STNZ) was commissioned by Resene Paints Limited (Resene) to undertake air discharge monitoring of their Upper Hutt factory extraction manufacturing facility. The objective of the monitoring is to confirm compliance with the Company's Resource Consent (WGN160337[34175]).

The particulate discharge concentrations from the Resene Upper Hutt factory extraction system measured on 31 January 2019 was less than the method detection limit of 0.1 mg/m^3 adjusted to 0 ^{o}C, one atmosphere pressure and dry gas basis (mg/Sm^3), which equates to a mass emission rate of <0.001 kg/hr.

All three test results were below the particulate discharge limit of 10 mg/Sm^3 as stipulated in Condition 8 of the Company's Air Discharge Permit.

The Total VOCs (expressed as Toluene) discharge concentrations from the Resene Upper Hutt factory extraction system measured on 31 January 2019 ranged from 249 to 924 mg/Sm^3 with an average of 486 mg/Sm^3. The Total VOCs (expressed as Toluene) mass emission ranged from 3.27 to 10.5 kg/hr with an average of 5.74 kg/hr.

The average Total VOCs (expressed as toluene) concentration measured at the Resene Upper Hutt factory extraction system on 31 January 2019 was 486 mg/Sm^3, which exceeds the discharge limit of 150 mg/Sm^3 stipulated in Condition 8 of the Company's Air Discharge Permit.

1. Introduction

Source Testing New Zealand Limited (STNZ) was commissioned by Resene Paints Limited (Resene) to undertake air discharge monitoring of their Upper Hutt factory extraction manufacturing facility. The objective of the monitoring is to confirm compliance with the Company's Resource Consent (WGN160337[34175]). The following conditions of the consent relate to the air discharge monitoring:

Discharge Limits

8. Notwithstanding conditions 1 and 3, discharges to air relating to the exercise of this consent shall not exceed the following concentrations from the paint production plant extraction system as measured at the monitoring position on the stack:

- *Total particulate: 10 mg/m^3 (at STP, dry gas basis)*
- *Total VOCs (expressed as Toluene): 150 mg/m^3 (at STP, dry gas basis)*

Th concentration shall be determined according to the requirements defined in Condition 9 of this consent.

Air emission testing

9. The consent holder shall conduct an emission testing programme annually for the first 5 (five) years of this consent within one month of the anniversary of the granting of the consent, and thereafter at intervals to be determined by consultation with, and to the satisfaction of, the Manager, Environmental Regulation, Wellington Regional Council; following the assessment of the year 5 (2021) Air Emission Testing Report detailed in condition 11.

The emission testing programme shall be to the satisfaction of, the Manager, Environmental Regulation, Wellington Regional Council; and shall quantify the discharges of particulates and VOCs from the plant. The consent holder shall ensure that the following contaminants will be sampled in the stack for:

- *Total particulate and VOC concentrations from the stack (to be reported as mg/m3 for each sample and as a mean of all samples for each stack)*
- *Stack gas volumetric flow rate from each stack (to be reported at actual and standard condition for each sample and as a mean of all samples for each stack)*
- *Stack gas velocity from each stack (to be reported at actual condition for each sample and as a mean of all samples for each stack)*
- *The mass emission rate shall be determined as the mean of a minimum of three samples, each collected as per United States Environmental Protection Agency (USEPA) Test Methods 5 and 18.*

10. All sampling techniques employed in respect of the conditions of this consent shall be to the satisfaction of, the Manager, Environmental Regulation, Wellington Regional Council. All analysis shall be performed by an International Accreditation New Zealand (IANZ) registered laboratory or otherwise specifically approved by the Manager, Environmental Regulation, Wellington Regional Council.

Matthew Newby, Senior Air Quality Scientist with STNZ performed the testing on 31 January 2019. Matthew has 25 year's air quality monitoring and consulting experience and is designated as a Key Technical Person under STNZ's IANZ accreditation. Matthew is also a Certified Air Quality Professional (CAQP) under the Clean Air Society of Australia and New Zealand (CASANZ) certification process. This report presents the air discharge monitoring results and compares them to the Company's Air Discharge Permit.

2. Sampling Methodologies

Table 1 summarises the testing methodologies used by STNZ for VOC discharge monitoring. Three separate samples were collected in accordance with USEPA protocols.

The air discharge monitoring was performed in accordance with the USEPA Methods set out in Table 1. Three separate samples were collected in accordance with USEPA protocols. Particulate matter analysis was conducted by STNZ staff in Wellington in accordance with the below methods while the VOC analysis was conducted by R J Hill Laboratories, Hamilton.

- **Table 1: Sampling Methods**

Contaminant	STNZ Standard Test Methods	IANZ Accredited
Sampling Points	Method 1 "Sample and Velocity Traverse for Stationary Sources"	Yes
Velocity & Volumetric Flow Rate	Method 2 "Determination of Stack Gas Velocity and Volumetric Flow rate (Type "S" Pitot Tube)"	Yes
Dry Molecular Weight Determination	Method 3 "Gas Analysis For The Determination Of Dry Molecular Weight	Yes
Moisture Content Determination	Method 4 "Determination of Moisture Content in Stack Gases"	Yes
Total Particulate Matter Determination	Method 5 "Determination of Particulate Emissions From Stationary Sources"	Yes
Determination of Volatile Organic Compounds	Method 18 'Measurement of Gaseous Organic Compound Emissions by Gas Chromatography"	Yes

2.1.1 Stack Sampling Locations

Table 2 describes the sampling point characteristics of the Upper Hutt Factory extraction system outlet. The sampling port was located approximately 3 m downstream from a silencer and approximately 2 m upstream of the outlet of the stack. The sampling location met the requirements of USEPA Method 1 provided a total of 12 points were sampled. The observed flow distribution was even, allowing for the collection of representative samples.

- **Table 2 Sampling Locations**

Source	Port	Dimensions	Up Stream from Disturbances (Equ Stack Dia)		Down Stream from Disturbances (Equ Stack Dia)		No. of Sampling Lines	No. of Sampling Points	
Extraction system outlet	2 x 100 mm BSP	Circular 0.45 m	4.4	*2.0*	7.8	*8*	2	6	*12*

Note: Values highlighted in grey represent the method ideal requirement.

2.1.2 Stack Gas Velocity

Stack temperatures were measured using a K Type thermocouple connected to a digital thermometer. Stack gas velocities were measured at specific points across the duct using an S Type Pitot tube connected to a digital manometer in accordance with USEPA Methods 1 & 2. These measurements were conducted prior to the collection of each of the three samples. The gas velocities were used to determine volumetric flow rates and mass discharge rates for each sample.

2.1.3 Gaseous Products of Combustion

As the stack gas was primarily ambient air, USEPA Method 3 was used to determine the molecular weight based on an oxygen and carbon dioxide concentration of 20.8 % and 0.0 % respectively.

2.1.4 Particulate Matter

Particulate matter was withdrawn isokinetically from the source and collected on a glass fibre filter maintained at a temperature of 120 °C ± 14 °C. The particulate mass was determined gravimetrically, after the removal of un-combined water. This approach conforms to USEPA Method 5 "Determination of Particulate Matter from Stationary Sources". Particulate analysis was performed by STNZ staff in Wellington.

2.1.5 Volatile Organic Compounds

Air discharge monitoring for Total VOCs (expressed as Toluene) was conducted in accordance with Method 18 – "Measurement of Gaseous Organic Compounds Emissions by Gas Chromatography" with analysis performed in accordance with NIOSH Method 1500 "Hydrocarbons".

Stack gases were withdrawn from the source using a stainless-steel sampling manifold. The sample stream was passed through dual charcoal sorbent tubes in parallel at a rate of approximately 1.5 L/min. As per the method requirements, one of the tubes had been spiked with 3,500 µg to help identify any matrix interferences. The samples were then forwarded to R. J. Hill Laboratories, Hamilton where carbon disulphide was used to desorb VOC. The extract was subsequently analysed by Gas Chromatography – Flame Ionisation Detector/ Flame Ionisation Detector (GC-FID/FID).

While STNZ are IANZ accredited for the collection of samples using Method 18, RJ Hill Laboratories, Hamilton are not IANZ accredited for this specific test. However, RJ Hill Laboratories, Hamilton are a well-respected IANZ accredited laboratory and are included in STNZ's approved supplier system.

3. Plant Operating Conditions

On 31 January 2019, the plant was operating normally producing a range of solvent born paints and coatings. Table 3 presents the products manufactured and caned during the sampling.

- **Table 3: Production Data, 31 January 2019**

Products Manufactured	Products Canned
S/Gloss White	Auckland Drum Tractor B
A/Cote 210 Grey	Woodsman Wood Oil Stain
U/Cryl 403 UDB	Pal SJ Enamel Gloss Red
Woodsman Wood Oil Stain	Multi Grad GP 48 Black
IR132 BK2620 30 % Sol	True Prime P/B
W/Primer Aluminium	Super Gloss Deep
Rali Reduced Str Tint Base	U/Cryl 400 Hardener
U/Cryl 400 Hardener	
IR26	

4. Air Discharge Monitoring Results

4.1 Particulate Air Discharge Monitoring Results

Presented below are the results of the particulate air discharge monitoring of the Resene Upper Hutt factory extraction system conducted on 31 January 2019. Table 5 presents the results of the particulate emission testing with Table 6 outlining a summary of the relevant stack data. Appendix A presents the raw sampling data. Appendix B contains the moisture content and mass determination calculations.

- **Table 4: Particulate Matter Discharge Results, January 2019**

Sampling Run	Sampling Date	Sampling Period	Volume Sampled (m^3)	Stack Flow Rate (m^3/h)[1]	Mass (mg)	Conc, (mg/m^3)[1]	Emission Rate (kg/h)
PM Run 1	31/01/2019	8:50 - 9:59	1.136	12,612	<0.1	<0.1	<0.001
PM Run 2	31/01/2019	10:37 - 11:44	1.048	12,311	<0.1	<0.1	<0.001
PM Run 3	31/01/2019	12:31 - 13:36	1.090	12,770	<0.1	<0.1	<0.001

1. Corrected to 0 °C, 101.3 kPa, dry gas basis.

- **Table 5: Summary of Stack Conditions, January 2019**

Source	Average Temp. (°C)	Average Moisture Content (% v/v)	Average Velocity (m/s)	Average Volumetric Flow Rate (m^3/hr)
Factory Extraction System	33.3	1.8	27.5	14,374

1. Actual conditions

The particulate discharge concentrations from the Resene Upper Hutt factory extraction system measured on 31 January 2019 was less than the method detection limit of 0.1 mg/m^3 adjusted to 0 °C, one atmosphere pressure and dry gas basis (mg/Sm^3), which equates to a mass emission rate of <0.001 kg/hr.

All three test results were below the particulate discharge limit of 10 mg/Sm^3 as stipulated in Condition 8 of the Company's Air Discharge Permit.

4.1.1 Particulate Quality Control Data

Tables 6 and 7 present the relevant quality control parameters for the particulate emission testing. In addition, all equipment was calibrated and maintained as per the STNZ Air Quality Equipment Manual (available on request).

- **Table 6: Sampling Quality Control Data**

Sampling Run	Pre-Test Leak Check Vacuum (kPa)	Pre-Test Leak Rate (cc/min)	Post-Test Leak Check Vacuum (kPa)	Post-Test Leak Rate (cc/min)	Isokinetic Deviation (%)
Method Specs	> -70	< 570	> -70	< 570	± 10
PM Run 1	69	280	69	290	5.8
PM Run 2	69	280	69	100	0.37
PM Run 3	69	270	69	200	0.57

- **Table 7: Mass Determination Quality Control Data**

	Field Blank Mass (g)	Acetone Blank (g)
Pre	0.0582	103.8769
Post	0.0583	103.8772
Diff	0.0001	0.0003

All quality control parameters were within the methods specification.

4.2 VOC Air Discharge Monitoring Results

Presented below are the results of the Total VOCs (expressed as Toluene) air discharge monitoring of the Resene Paints Ltd, Upper Hutt factory extraction system measured on 31 January 2019. Table 8 presents the VOC (expressed as Toluene) air discharge monitoring results with the raw sampling data presented in Appendix C, with Appendix D containing the raw analytical report.

- **Table 8: Total VOCs (expressed as Toluene) Discharge Results, January 2019**

Sampling Run	Sampling Date	Sampling Period	Stack Flow Rate (m^3/h)[1]	Conc (ppmv)	Conc, (mg/m^3)[1]	Emission Rate (kg/h)
VOC Run 1	31/01/2019	8:48 - 9:55	13,124	60.7	249	3.27
VOC Run 2	31/01/2019	10:37 - 11:40	12,091	69.4	285	3.45
VOC Run 3	31/01/2019	12:31 - 13:32	11,358	225	924	10.5

1. Corrected to 0 ^oC, 101.3 kPa, dry gas basis.

The Total VOCs (expressed as Toluene) discharge concentrations from the Resene Upper Hutt factory extraction system measured on 31 January 2019 ranged from 249 to 924 mg/Sm^3 with an average of 486 mg/Sm^3. The Total VOCs (expressed as Toluene) mass emission ranged from 3.27 to 10.5 kg/hr with an average of 5.74 kg/hr.

The average Total VOCs (expressed as toluene) concentration measured at the Resene Upper Hutt factory extraction system on 31 January 2019 was 486 mg/Sm^3, which exceeds the discharge limit of 150 mg/Sm^3 stipulated in Condition 8 of the Company's Air Discharge Permit.

4.2.1 Total VOCs Sampling Quality Control

To ensure the quality of the obtained test result a field blank and field spike were performed. The results of the field and laboratory blank were both below the method detection limit. The results of the field and laboratory spikes showed excellent desorption (recovery) efficiencies of 100 % and 101 % respectively. Furthermore, while VOCs were detected in the back half of the sorbent tubes for Samples Run 2 and 3, the masses were insignificant indicating no breakthrough had occurred.

USEPA Method 18 requires the recovery efficiency (R) for the spiked compounds to be within the range 0.7 to 1.3. Table 9 presents the average R value along with the concentrations corrected for recovery efficiencies.

- **Table 9: Total VOCs (expressed as Toluene) Discharge Results corrected for spike recoveries, January 2019**

VOC	Average R Value	Run 1 (ppm)	Run 2 (ppm)	Run 3 (ppm)
Toluene	0.70	60.7	69.4	225

Appendix A Raw Particulate Sampling Data

This appendix contains 5 page including cover

The data presented in the Tecora G4 data sheets are based on assumed moisture contents. The tabulated data presented is based on actual measured moisture content. As a result, the corrected volumetric flow rates may differ between the two data sheets.

Sample Description:	Run 1	Run 2	Run 3	Averages
Sampling Date:	31/01/2019	31/01/2019	31/01/2019	
Filter ID:	ST1521	ST1522	ST1523	
Sampling Period:	8:50 - 9:59	10:37 - 11:44	12:31 - 13:36	
Total Sample Time (minutes)	60	60	60	
Nozzle Diameter (mm)	3.96	3.96	3.96	
Nozzle Area (m2)	0.0000123	0.0000123	0.0000123	
DGM Calibration Factor	0.9861	0.9861	0.9861	
Intial DGM Reading	1718.9464	1720.7293	1722.1942	
Final DGM Reading	1720.7234	1722.1875	1723.7580	
DGM Sample Volume (m^3):	1.7770	1.4582	1.5638	
DGM Std. Sample Volume (m^3):	1.1357	1.0483	1.0895	
Initial Leak Test Vacuum (kPa):	69	69	69	
Initial Leak Test Flow Rate (cc/min):	280	280	270	
Final Leak Test Vacuum (kPa):	69	69	69	
Final Leak Test Flow Rate (cc/min):	290	100	200	
Moisture Collected (g):	16.1	16.6	16.3	
Moisture Content (%):	1.7	1.9	1.8	1.8
TCR DGM Sample Volume (m^3):	1.6588	1.4507	1.5546	
Sampling Plane Mean Velocity (m/s):	28.2	26.9	27.4	27.5
TCR Isokinetic Deviation (%):	-1.4	0.0	-0.5	
Actual Isokinetic Deviation (%):	5.8	0.4	0.6	
Duct Volumetric Flow Rates				
Moist (m^3/h):	14,720	14,078	14,325	14,374
Moist Standards (m^3/h):	12,834	12,554	13,008	
Dry Standard (m^3/h):	12,612	12,311	12,770	
Mean Temperatures				
At Sampling Plane (^oC):	39.7	32.9	27.2	33.3
At DGM (^oC):	25.7	33.0	33.8	
Ambient Pressure (kPa):	101.180	101.246	101.178	
Stack Absolute Pressure (kPa)	101.219	101.210	101.114	
Dry Gas Meter Pressure (kPa)	71.854	82.780	80.459	

Resene Upper Hutt Run 1
Isokinetic sampling 31/01/2019 08:52:52

MACHINE INFORMATION

Master Firmware	v1.9.2000
Master Serial Number	11420234P
Slave Firmware	v0.7.7000
Slave Serial Number	11420234P
Last calibration date	Refer to the STNZ Equipment Register

CV GAMMA [#] CALIBRATION

Point	Flowrate	Gamma
1	0	1

POINT LIST

start ts [timestamp]	Port [###]	Point [###]	Distance [cm]	Elapsed Time [hh:mm:ss]	rw avg [0;1]	t_{rumes} avg [°C]	t_{dgm} avg [°C]	P_{stat} avg [kPa]	P_c avg [kPa]	dP pitot avg [Pa]	P_{line} avg [kPa]	P_{amb} avg [kPa]	v'_a avg [$^m/_{sec}$]	qV_n avg [$^{lt}/_{min}$]	DI [%]	v'_N avg [$^m/_{sec}$]	Q'Va [$^{m3}/_h$]	Q'Vn [$^{m3}/_h$]	QVn [$^{m3}/_h$]	V_{gn} [lt]	V'_{ga} [lt]	V_{dgm} [lt]
31/01/2019																						
8:52:55	1	1	1.9	0:05:00	0.018	22.469	21.467	-0.005	101.175	672.739	69.669	101.18	28.396	18.741	-1.4	27.984	14845	13699	13452	93.9	103.47	147.05
31/01/2019																						
8:58:20	1	2	6.3	0:05:01	0.018	21.444	22.28	0.009	101.189	696.663	68.978	101.18	28.847	18.88	-2.6	28.09	15080	13967	13715	95.06	104.38	150.8
31/01/2019																						
9:03:27	1	3	12.8	0:05:00	0.018	22.233	23.025	0.014	101.194	724.034	67.111	101.18	29.449	19.388	-1.7	28.924	15395	14221	13965	97.66	107.5	159.6
31/01/2019																						
9:08:36	1	4	30.3	0:05:00	0.018	40.016	23.922	0.055	101.235	559.223	75.186	101.18	26.591	16.979	0.6	26.774	13901	12116	11898	85.57	99.94	125.35
31/01/2019																						
9:13:46	1	5	36.8	0:05:00	0.018	109.043	24.77	0.053	101.233	509.862	81.891	101.18	28.093	14.573	0.1	28.122	14686	10487	10299	73.68	105.06	99.4
31/01/2019																						
9:19:12	1	6	41.2	0:05:00	0.018	109.043	25.536	0.072	101.252	519.581	81.731	101.18	28.357	14.669	-0.1	28.301	14824	10588	10397	74.46	106.14	100.9
31/01/2019																						
9:27:55	2	1	1.9	0:05:00	0.018	24.122	26.419	0.037	101.217	669.26	69.887	101.18	28.4	18.634	-1.5	27.968	14847	13630	13385	93.99	104.14	149.25
31/01/2019																						
9:33:05	2	2	6.3	0:05:00	0.018	24.696	26.988	0.048	101.228	699.984	68.994	101.18	29.072	18.736	-3	28.175	15198	13927	13677	95.31	105.79	153.6
31/01/2019																						
9:38:34	2	3	12.8	0:05:00	0.018	23.881	27.685	0.041	101.221	701.18	68.24	101.18	29.062	19.013	-1.8	28.514	15193	13960	13709	96.88	107.27	158.25
31/01/2019																						
9:43:43	2	4	30.3	0:05:00	0.018	26.776	28.293	0.055	101.235	615.007	72.283	101.18	27.319	17.919	-0.6	27.131	14282	12998	12764	90.7	101.39	140.15
31/01/2019																						
9:48:55	2	5	36.8	0:05:00	0.018	26.301	28.849	0.053	101.233	612.94	73.055	101.18	27.256	17.496	-2.9	26.45	14249	12988	12754	89.56	99.97	137.2
31/01/2019																						
9:54:21	2	6	41.2	0:05:00	0.018	26.301	29.372	0.047	101.227	604.072	73.173	101.18	27.065	17.495	-2.2	26.45	14149	12896	12664	89.55	99.97	137.2

NORMALIZATION FACTOR

T_{norm}	[K]	273
P_{norm}	[kPa]	101.3

PITOT DATA SPECIFICATION

Name			828
Velocity	[$^m/_{sec}$]	2.04	0.841
Velocity	[$^m/_{sec}$]	6.96	0.848
Velocity	[$^m/_{sec}$]	8.96	0.85
Velocity	[$^m/_{sec}$]	13.99	0.847
Velocity	[$^m/_{sec}$]	16.71	0.849

DUCT AND GAS SPECIFICATION

Name			RESENE
Section			Circular
Diameter		[m]	0.43
Area		[m^2]	0.145
Port	B	[#]	2
Points	P	[#]	6
Dry gas density	ρn	[$^{Kg}/_{m^3}$]	1.286 [1.286; 1.286]
Carbon dioxide	CO_2	[%]	0 [0.000; 0.000]
Oxygen	O_2	[%]	21 [21.000; 21.000]
Water vapor ratio	rw	[0;1]	0.018 [0.018; 0.018]
Nozzle	nz	[mm]	3.96
Turbolence factor	ft	[sec]	3

DUCT FLOW RATE

Dry actual	QV_a	[$^{m3}/_h$]	14455 [11725; 16451]
Moist actual	$Q'V_a$	[$^{m3}/_h$]	14720 [13901; 15395]
Moist standard [T_{norm} P_{norm}]	$Q'V_n$	[$^{m3}/_h$]	12956 [10487; 14221]
Dry standard [T_{norm} P_{norm}]	QV_n	[$^{m3}/_h$]	12723 [10299; 13965]

AVERAGE VALUES

Total Points		[#]	12
Velocity	v'_a	[$^m/_{sec}$]	28.158 [22.840; 32.047]
Stack temperature	t_{rumes}	[°C]	39.693 [18.729; 109.043]
Stack Absolute Pressure	P_c	[kPa]	101.219 [101.076; 101.370]
Stack Static Pressure	P_{stat}	[kPa]	0.039 [-0.104; 0.190]
Isokinetic Deviation	DI	[%]	-1.4
Velocity at nozzle	v'_N	[$^m/_{sec}$]	27.74 [0.000; 32.928]
Stack Differential Pitot Pressure	dP_{pitot}	[Pa]	630.025 [382.900; 858.743]
Ambient Pressure	P_{amb}	[kPa]	101.18 [101.180; 101.180]

SAMPLED VOLUMES

Elapsed time	et	[hh:mm:ss]	1:00:01
Total encoder impulses		[#]	33175
Standard Volume [T_{norm} P_{norm}]	V_{gn}	[m^3]	1.0763
Moist Volume at stack conditions	V'_{ga}	[m^3]	1.2552
Volume at dgm conditions	V_{dgm}	[m^3]	1.6588
Gas meter temperature	t_{dgm}	[°C]	25.712 [21.146; 29.589]
Gas Meter Pressure	P_{dgm}	[kPa]	71.854 [65.824; 95.615]

Resene Upper Hutt Run 2
Isokinetic sampling 31/01/2019 10:37:33

MACHINE INFORMATION

Master Firmware	v1.9.2000
Master Serial Number	11420234P
Slave Firmware	v0.7.7000
Slave Serial Number	11420234P
Last calibration date	Refer to the STNZ Equipment Register

CV GAMMA [#] CALIBRATION

Point	Flowrate	Gamma
1	0	1

POINT LIST

start ts [timestamp]	Port [###]	Point [###]	Distance [cm]	Elapsed Time [hh:mm:ss]	rw avg [0;1]	t_{rumes} avg [°C]	t_{dgm} avg [°C]	P_{stat} avg [kPa]	P_c avg [kPa]	dP pitot avg [Pa]	P_{line} avg [kPa]	P_{amb} avg [kPa]	v'_a avg [$^m/_{sec}$]	qV_n avg [$^{lt}/_{min}$]	DI [%]	v'_N avg [$^m/_{sec}$]	Q'Va [$^{m3}/_h$]	Q'Vn [$^{m3}/_h$]	QVn [$^{m3}/_h$]	V_{gn} [lt]	V'_{ga} [lt]	V_{dgm} [lt]
31/01/2019																						
10:37:49	1	1	1.9	0:05:00	0.018	37.571	30.641	-0.042	101.204	620.631	83.585	101.246	27.951	17.03	-4.3	26.742	14612	12832	12601	86.62	100.43	116.75
31/01/2019																						
10:43:01	1	2	6.3	0:05:00	0.018	66.475	30.734	-0.042	101.204	638.358	83.198	101.246	29.648	17.383	0.5	29.815	15499	12452	12228	88.03	111.53	119.2
31/01/2019																						
10:48:03	1	3	12.8	0:05:00	0.018	61.083	40.554	-0.044	101.202	646.083	82.74	101.246	29.583	17.508	0	29.565	15465	12625	12398	87.72	107.69	121.4
31/01/2019																						
10:53:08	1	4	30.3	0:05:00	0.018	25	31.522	-0.022	101.224	564.741	82.916	101.246	26.104	17.462	0.6	26.286	13646	12492	12267	87.92	97.79	119.8
31/01/2019																						
10:58:15	1	5	36.8	0:05:00	0.018	25	31.865	-0.024	101.222	565.99	83.195	101.246	26.146	17.335	-0.1	26.095	13668	12512	12287	87.49	97.32	118.95
31/01/2019																						
11:03:21	1	6	41.2	0:05:00	0.018	25	32.202	-0.031	101.215	556.659	83.193	101.246	25.921	17.248	0.1	25.967	13551	12404	12180	87.57	97.42	119.2
31/01/2019																						
11:12:39	2	1	1.9	0:05:00	0.018	25	32.688	-0.071	101.175	632.557	81.041	101.246	27.654	18.301	-0.3	27.562	14457	13228	12989	93.43	103.93	130.7
31/01/2019																						
11:18:38	2	2	6.3	0:05:00	0.018	25.973	32.836	-0.067	101.179	630.313	81.387	101.246	27.649	18.225	-0.4	27.537	14454	13183	12945	92.79	103.58	129.35
31/01/2019																						
11:23:41	2	3	12.8	0:05:00	0.018	26	32.938	-0.061	101.185	657.311	80.435	101.246	28.239	18.781	0.4	28.378	14763	13464	13221	94.66	105.66	133.55
31/01/2019																						
11:29:04	2	4	30.3	0:05:01	0.018	26	33.089	-0.007	101.239	507.026	83.81	101.246	24.785	16.724	1.8	25.255	12957	11823	11610	84.95	94.78	115.1
31/01/2019																						
11:34:08	2	5	36.8	0:05:00	0.018	26	33.135	-0.006	101.24	506.272	84.322	101.246	24.766	16.483	0.5	24.892	12947	11814	11601	84.19	93.94	113.4
31/01/2019																						
11:39:40	2	6	41.2	0:05:00	0.018	26	33.232	-0.015	101.231	503.783	84.317	101.246	24.711	16.464	0.6	24.865	12918	11787	11575	84.05	93.79	113.25

NORMALIZATION FACTOR

T_{norm}	[K]	273
P_{norm}	[kPa]	101.3

PITOT DATA SPECIFICATION

Name			828
Velocity	[$^m/_{sec}$]	2.04	0.841
Velocity	[$^m/_{sec}$]	6.96	0.848
Velocity	[$^m/_{sec}$]	8.96	0.85
Velocity	[$^m/_{sec}$]	13.99	0.847
Velocity	[$^m/_{sec}$]	16.71	0.849

DUCT AND GAS SPECIFICATION

Name			RESENE
Section			Circular
Diameter		[m]	0.43
Area		[m^2]	0.145
Port	B	[#]	2
Points	P	[#]	6
Dry gas density	ρn	[$^{Kg}/_{m^3}$]	1.286 [1.286; 1.286]
Carbon dioxide	CO_2	[%]	0 [0.000; 0.000]
Oxygen	O_2	[%]	21 [21.000; 21.000]
Water vapor ratio	rw	[0;1]	0.018 [0.018; 0.018]
Nozzle	nz	[mm]	3.96
Turbolence factor	ft	[sec]	3

DUCT FLOW RATE

Dry actual	QV_a	[$^{m3}/_h$]	13824 [11210; 16562]
Moist actual	$Q'V_a$	[$^{m3}/_h$]	14078 [12918; 15499]
Moist standard [T_{norm} P_{norm}]	$Q'V_n$	[$^{m3}/_h$]	12551 [11787; 13464]
Dry standard [T_{norm} P_{norm}]	QV_n	[$^{m3}/_h$]	12325 [11575; 13221]

AVERAGE VALUES

Total Points		[#]	12
Velocity	v'_a	[$^m/_{sec}$]	26.929 [21.837; 32.263]
Stack temperature	t_{rumes}	[°C]	32.925 [7.031; 66.475]
Stack Absolute Pressure	P_c	[kPa]	101.21 [101.083; 101.325]
Stack Static Pressure	P_{stat}	[kPa]	-0.036 [-0.163; 0.079]
Isokinetic Deviation	DI	[%]	0
Velocity at nozzle	v'_N	[$^m/_{sec}$]	26.913 [0.000; 34.264]
Stack Differential Pitot Pressure	dP_{pitot}	[Pa]	584.44 [392.881; 763.100]
Ambient Pressure	P_{amb}	[kPa]	101.246 [101.246; 101.246]

SAMPLED VOLUMES

Elapsed time	et	[hh:mm:ss]	1:00:01
Total encoder impulses		[#]	29013
Standard Volume [T_{norm} P_{norm}]	V_{gn}	[m^3]	1.0594
Moist Volume at stack conditions	V'_{ga}	[m^3]	1.2081
Volume at dgm conditions	V_{dgm}	[m^3]	1.4507
Gas meter temperature	t_{dgm}	[°C]	32.962 [30.496; 417.942]
Gas Meter Pressure	P_{dgm}	[kPa]	82.78 [77.864; 99.380]

Resene Upper Hutt Run 3
Isokinetic sampling 31/01/2019 12:31:18

MACHINE INFORMATION

Master Firmware	v1.9.2000
Master Serial Number	11420234P
Slave Firmware	v0.7.7000
Slave Serial Number	11420234P
Last calibration date	Refer to the STNZ Equipment Register

CV GAMMA [#] CALIBRATION

Point	Flowrate	Gamma
1	0	1

POINT LIST

start ts [timestamp]	Port [###]	Point [###]	Distance [cm]	Elapsed Time [hh:mm:ss]	rw avg [0;1]	t_{rumes} avg [°C]	t_{dgm} avg [°C]	P_{stat} avg [kPa]	P_c avg [kPa]	dP pitot avg [Pa]	P_{line} avg [kPa]	P_{amb} avg [kPa]	v'_a avg [$^m/_{sec}$]	qV_n avg [$^{lt}/_{min}$]	DI [%]	v'_N avg [$^m/_{sec}$]	Q'Va [$^{m3}/_h$]	Q'Vn [$^{m3}/_h$]	QVn [$^{m3}/_h$]	V_{gn} [lt]	V'_{ga} [lt]	V_{dgm} [lt]
31/01/2019																						
12:31:33	1	1	1.9	0:05:00	0.018	26.499	35.55	-0.049	101.129	616.129	80.292	101.178	27.366	18.053	0	27.345	14306	13018	12784	91.69	102.57	130.7
31/01/2019																						
12:36:39	1	2	6.3	0:05:00	0.018	26.237	34.996	-0.052	101.126	623.987	80.387	101.178	27.532	17.972	-1.2	27.192	14393	13108	12872	92.01	102.83	130.75
31/01/2019																						
12:41:48	1	3	12.8	0:05:00	0.018	27.4	34.555	-0.063	101.115	626.968	80.284	101.178	27.649	18.063	-0.7	27.439	14454	13112	12876	92.04	103.3	130.8
31/01/2019																						
12:47:00	1	4	30.3	0:05:00	0.018	27.4	34.122	-0.061	101.117	597.516	81.041	101.178	26.985	17.594	-0.9	26.727	14107	12797	12567	89.86	100.82	126.3
31/01/2019																						
12:53:00	1	5	36.8	0:05:00	0.018	27.4	33.787	-0.061	101.117	595.625	81.171	101.178	26.948	17.614	-0.7	26.757	14088	12780	12550	90.03	101.02	126.2
31/01/2019																						
12:58:20	1	6	41.2	0:05:00	0.018	27.4	33.563	-0.062	101.116	597.685	81.318	101.178	26.994	17.533	-1.3	26.633	14112	12801	12571	89.79	100.75	125.55
31/01/2019																						
13:03:22	2	1	1.9	0:05:00	0.018	27.4	33.363	-0.061	101.117	590.795	81.169	101.178	26.833	17.769	0.5	26.993	14028	12725	12496	89.75	100.71	125.65
31/01/2019																						
13:08:29	2	2	6.3	0:05:00	0.018	27.4	33.191	-0.082	101.096	675.351	79.097	101.178	28.705	18.653	-1.2	28.341	15006	13610	13365	95.6	107.28	137.25
31/01/2019																						
13:13:34	2	3	12.8	0:05:00	0.018	27.4	33.161	-0.07	101.108	683.258	78.614	101.178	28.868	18.842	-0.8	28.624	15091	13689	13443	96.38	108.14	139.2
31/01/2019																						
13:18:37	2	4	30.3	0:05:00	0.018	27.4	33.258	-0.063	101.115	595.186	80.994	101.178	26.931	17.65	-0.4	26.812	14079	12771	12541	89.95	100.93	126.15
31/01/2019																						
13:24:11	2	5	36.8	0:05:00	0.018	27.4	33.27	-0.065	101.113	599.631	80.626	101.178	27.036	17.833	0.2	27.091	14134	12821	12590	91.2	102.34	128.5
31/01/2019																						
13:29:18	2	6	41.2	0:05:00	0.018	27.4	33.215	-0.076	101.102	596.937	80.843	101.178	26.975	17.764	0	26.989	14102	12790	12560	90.74	101.85	127.5

NORMALIZATION FACTOR

T_{norm}	[K]	273
P_{norm}	[kPa]	101.3

PITOT DATA SPECIFICATION

Name			828
Velocity	[$^m/_{sec}$]	2.04	0.841
Velocity	[$^m/_{sec}$]	6.96	0.848
Velocity	[$^m/_{sec}$]	8.96	0.85
Velocity	[$^m/_{sec}$]	13.99	0.847
Velocity	[$^m/_{sec}$]	16.71	0.849

DUCT AND GAS SPECIFICATION

Name			RESENE
Section			Circular
Diameter		[m]	0.43
Area		[m^2]	0.145
Port	B	[#]	2
Points	P	[#]	6
Dry gas density	ρn	[$^{Kg}/_{m^3}$]	1.286 [1.286; 1.286]
Carbon dioxide	CO_2	[%]	0 [0.000; 0.000]
Oxygen	O_2	[%]	21 [21.000; 21.000]
Water vapor ratio	rw	[0;1]	0.018 [0.018; 0.018]
Nozzle	nz	[mm]	3.96
Turbolence factor	ft	[sec]	3

DUCT FLOW RATE

Dry actual	QV_a	[$^{m3}/_h$]	14066 [11793; 15922]
Moist actual	$Q'V_a$	[$^{m3}/_h$]	14325 [14028; 15091]
Moist standard [T_{norm} P_{norm}]	$Q'V_n$	[$^{m3}/_h$]	13001 [12725; 13689]
Dry standard [T_{norm} P_{norm}]	QV_n	[$^{m3}/_h$]	12767 [12496; 13443]

AVERAGE VALUES

Total Points		[#]	12
Velocity	v'_a	[$^m/_{sec}$]	27.401 [22.972; 31.016]
Stack temperature	t_{rumes}	[°C]	27.228 [7.300; 27.400]
Stack Absolute Pressure	P_c	[kPa]	101.114 [100.980; 101.208]
Stack Static Pressure	P_{stat}	[kPa]	-0.064 [-0.198; 0.030]
Isokinetic Deviation	DI	[%]	-0.5
Velocity at nozzle	v'_N	[$^m/_{sec}$]	27.245 [0.000; 30.340]
Stack Differential Pitot Pressure	dP_{pitot}	[Pa]	616.227 [432.374; 787.716]
Ambient Pressure	P_{amb}	[kPa]	101.178 [101.178; 101.178]

SAMPLED VOLUMES

Elapsed time	et	[hh:mm:ss]	1:00:00
Total encoder impulses		[#]	31091
Standard Volume [T_{norm} P_{norm}]	V_{gn}	[m^3]	1.099
Moist Volume at stack conditions	V'_{ga}	[m^3]	1.2325
Volume at dgm conditions	V_{dgm}	[m^3]	1.5546
Gas meter temperature	t_{dgm}	[°C]	33.835 [32.954; 37.983]
Gas Meter Pressure	P_{dgm}	[kPa]	80.459 [77.235; 95.110]

Appendix B Moisture Content and Particulate Mass Determinations

This Appendix contains 2 pages including cover

Moisture Content Determinations

Sampling Run	Moisture Mass Collected (g)	Gas Volume Sampled (m^3)[1]	Stack Moisture Content (%)
PM Run 1	16.1	1.136	1.7
PM Run 2	16.6	1.048	1.9
PM_1Run 3	16.3	1.090	1.8

1. Corrected to 0 °C, one atmosphere pressure, dry gas basis

Particulate Mass Determinations

Sampling Run	Sample ID	Filter ID/ Rinse Vol (ml)	Initial Weight (g)	Final Weight (g)	Mass (g)	Net Mass (g)	Total Mass (g)
PM Run 1	ST0799/01	ST1521	0.0580		-0.0580	-0.0581	0.0000
	ST0799/02	50	82.4043	82.4626	0.0583	0.0581	
PM Run 2	ST0799/03	ST1522	0.0556		-0.0556	-0.0557	-0.0005
	ST0799/04	50	102.2903	102.3457	0.0554	0.0552	
PM Run 3	ST0799/05	ST1523	0.0578		-0.0578	-0.0579	-0.0005
	ST0799/06	50	96.9722	97.0298	0.0576	0.0574	
Filter Blank	ST0799/07	ST1524	0.0582	0.0583	0.0001		
Rinse Blank	ST0799/08	100	103.8769	103.8772	0.0003		

Note:
Due to the small size of the filters used (37 mm), the filters are easily damaged and so were added to the acetone rinse to prevent sample loss.

Appendix C Raw VOC Sampling Data

This appendix includes 2 pages including the cover

Sample Description	Sampling Date	Sampling Period	Sample Duration (min)	Initial Flow (mL/min)	Final Flow (mL/min)	Ave Flow (mL/min)	Sample Vol (m^3)	DGM Temp (^oC)	Ambient Press. (kPa)	Sample Vol (m^3)[1]
VOC Run 1 - Spike	31/01/2019	8:48 - 9:55	60	780.14	741.12	760.6	0.0456	25.7	101.2	0.0417
VOC Run 2 - Spike	31/01/2019	10:37 - 11:40	60	846.12	832.11	839.1	0.0503	33.0	101.2	0.0449
VOC Run 3 - Spike	31/01/2019	12:31 - 13:32	60	815.42	820.11	817.8	0.0491	33.8	101.2	0.0436
VOC Run 1 - Sample	31/01/2019	8:48 - 9:55	60	908.18	879.79	894.0	0.0536	25.7	101.2	0.0490
VOC Run 2 - Sample	31/01/2019	10:37 - 11:40	60	813.13	804.62	808.9	0.0485	33.0	101.2	0.0433
VOC Run 3 - Sample	31/01/2019	12:31 - 13:32	60	827.75	828.92	828.3	0.0497	33.8	101.2	0.0442

1. Corrected to 0 ^oC, 101.3 kPa, dry gas basis

Appendix D Raw VOC Analytical Report

This appendix includes 3 pages including the cover

Hill Laboratories
TRIED, TESTED AND TRUSTED
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Certificate of Analysis

Client:	Source Testing NZ Limited	**Lab No:**	2109784 SPv1
Contact:	Matthew Newby	**Date Received:**	17-Jan-2019
	PO Box 32017	**Date Reported:**	14-Feb-2019
	Maungaraki	**Quote No:**	88854
	Lower Hutt 5050	**Order No:**	
		Client Reference:	ST0799
		Submitted By:	Matthew Newby

Sample Type: 400/200 mg CSC tube SKC 226-09

Sample Name:	Toluene Spike 1 ST0799/02 31-Jan-2019	Toluene Spike 2 ST0799/04 31-Jan-2019	Toluene Spike 3 ST0799/06 31-Jan-2019	Travel Blank	Lab (rig) Blank
Lab Number:	2109784.1	2109784.2	2109784.3	2109784.6	2109784.8
Toluene in large charcoal tubes by GC-FID/FID					
Toluene front µg/sample	5,800	4,000	4,100	< 4	< 4
Toluene back µg/sample	< 2	< 2	< 2	< 2	< 2
Volatile organic compounds reported as toluene equivalent					
Volatile organic compounds as toluene front µg/sample	15,200	13,500	29,000	< 8	< 8
Volatile organic compounds as toluene back µg/sample	< 4	< 4	< 4	< 4	< 4

Sample Name:	Toluene Sample 1 ST0799/01 31-Jan-2019	Toluene Sample 2 ST0799/03 31-Jan-2019	Toluene Sample 3 ST0799/05 31-Jan-2019		
Lab Number:	2109784.10	2109784.11	2109784.12		
Toluene in large charcoal tubes by GC-FID/FID					
Toluene front µg/sample	2,900	680	830	-	-
Toluene back µg/sample	< 2	< 2	< 2	-	-
Volatile organic compounds reported as toluene equivalent					
Volatile organic compounds as toluene front µg/sample	12,800	10,300	27,000	-	-
Volatile organic compounds as toluene back µg/sample	< 4	6	5	-	-

Sample Type: 400/200 mg CSC SKC 226-09 Desorption Efficiency

Sample Name:	Travel Spike	Lab Spike			
Lab Number:	2109784.7	2109784.9			
Toluene in large charcoal tubes by GC-FID/FID DE					
Toluene front % recovery	100	101	-	-	-
Toluene back % recovery	< 1	< 1	-	-	-

Analyst's Comments

Spikes were prepared to contain 3,500 µg/sample toluene.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: 400/200 mg CSC tube SKC 226-09

Test	Method Description	Default Detection Limit	Sample No
Toluene in large charcoal tubes by GC-FID/FID	Break into fractions, desorption with CS2, analysis by dual column GC-FID/FID, NIOSH Method 1003 (halogenated hydrocarbons), 1300 (ketones), 1500 (hydrocarbons), 1501 (aromatic hydrocarbons), 1450 (esters)	2 - 4 µg/sample	1-3, 6, 8, 10-12
Volatile organic compounds reported as toluene equivalent	Break into fractions, desorption with CS2, analysis by dual column GC-FID/FID, NIOSH Method 1501 (aromatic hydrocarbons) Issue 3, 2003	4 - 8 µg/sample	1-3, 6, 8, 10-12

Sample Type: 400/200 mg CSC tube SKC 226-09			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
CS2 Miscellaneous Solvents in large tubes by GC-FID/FID (screen)	Break into fractions, desorption with CS2, analysis by dual column GC-FID/FID,. NIOSH Method 1003 (halogenated hydrocarbons), 1300 (ketones), 1500 (hydrocarbons), 1501 (aromatic hydrocarbons), 1450 (esters).	-	1-3, 6-12

Sample Type: 400/200 mg CSC SKC 226-09 Desorption Efficiency			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Toluene in large charcoal tubes by GC-FID/FID DE	Break into fractions, desorption with CS2, analysis by dual column GC-FID/FID, NIOSH Method 1003 (halogenated hydrocarbons), 1300 (ketones), 1500 (hydrocarbons), 1501 (aromatic hydrocarbons), 1450 (esters)	1 % recovery	7, 9

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

Ara Heron BSc (Tech)
Client Services Manager - Environmental