Wairoa Timber Processors Limited
Wairoa

AIR DISCHARGE MONITORING OF THE THERMAL ENERGY PLANT, JANUARY 2012

Issue

February 2012

new zealand accredited laboratory

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Name	Title	Signature
Matthew Newby	Key Technical Person	

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Contents

Executive Summary

Source Testing New Zealand Limited (STNZ) was commissioned by Wairoa Timber Processors Ltd to undertake air discharge monitoring of the Thermal Energy Plant located at their Wairoa processing facility.

The TPM discharge concentrations from the Wairoa Timber Processors Thermal Energy Plant on 20 January 2012 ranged from 128 to 135 mg/m^3 adjusted to 0 °C, one atmosphere pressure, 8.5 % O_2 by volume and dry gas basis (mg/Sm^3), with an average of 130 mg/Sm^3. The TPM mass emission ranged from 0.638 to 0.686 kg/hr with an average of 0.664 kg/hr.

The PM_{10} discharge concentrations from the Wairoa Timber Processors Thermal Energy Plant on 20 January 2012 ranged from 108 to 116 mg/Sm^3, with an average of 111 mg/Sm^3. The PM_{10} mass emission ranged from 0.541 to 0.582 kg/hr with an average of 0.566 kg/hr. The ratio of PM_{10} to TPM was approximately 0.85

The PM_{10} discharge concentrations for all three sampling runs were below the 150mg/Sm^3 limit stipulated by Condition 11 of the company's Discharge Permit. The mass emission rate was also below the limit specified in Condition 12 of 1 kg/hr.

On 20 January 2012, the NO_2 concentration ranged from <0.1 to 1.2 ppmv with an average of 0.3 ppmv. The NO + NO_2 (NO_x) concentration ranged from 33 to 51 ppmv with an average of 47 ppmv. The CO concentration ranged from 605 to 1,573 ppmv with an average of 1,110 ppmv. There was no SO_2 detected over the monitoring period. This was to be expected given the low sulphur content of the saw dust fuel.

All results are similar to those observed in November 2010.

1. Introduction

Source Testing New Zealand Limited (STNZ) was commissioned by Wairoa Timber Processors Ltd to undertake air discharge monitoring of the Thermal Energy Plant located at their Wairoa processing facility.

The objective of the monitoring was to assess compliance with the company's Discharge Permit (DP100552A). The following consent conditions relate to the air discharge monitoring:

11. The concentration of particulate matter less than 10 microns (PM10) in combustion gases discharged from the boiler stack, measure in accordance with Condition 13, and averaged over each emission test, shall not exceed 150 milligrams per cubic meter adjusted to 0 degrees Celsius, 101.3 kilopascals, and 8.5 % oxygen on a dry gas basis.

12. The combined mass emission rate of PM10 from all boilers, measured in accordance with Condition 13, shall not exceed 1 kilogram per hour.

13.

a) The concentration of PM10 in combustion gas discharged from both boiler emission stacks shall be measured at least once every 12 months;
b) Each test sampling shall occur when the contributing boiler is operating at greater than 75 percent of maximum output. The method of sampling and analysis for PM10 shall be USEPA Method 201A or an equivalent method as agreed in writing by the consent holder and the Consent Authority (Manager Compliance);
c) Sampling results shall be adjusted to 0 degrees Celsius, dry gas basis, 101.3 kilopascals, and 8.5 % oxygen, and as a mass emission expressed as kilograms per hour;
d) The results shall include a description of the method used, the approximate rate of fuel consumption during testing and any assumptions made;
e) The organisation performing the testing shall be currently accredited under ISO 17025 to undertake the method used to perform the testing;
f) A copy of the test results shall be provided to the Consent Authority (Manager Compliance) within 10 working days of receipt by the consent holder.

Matthew Newby, Air Quality Scientist with STNZ performed the testing on 20 January 2012. Matthew has over 15 year's air quality monitoring experience and is designated as a Key Technical Person under STNZ's IANZ accreditation. This report presents the results of the air discharge monitoring.

2. Sampling Methodologies

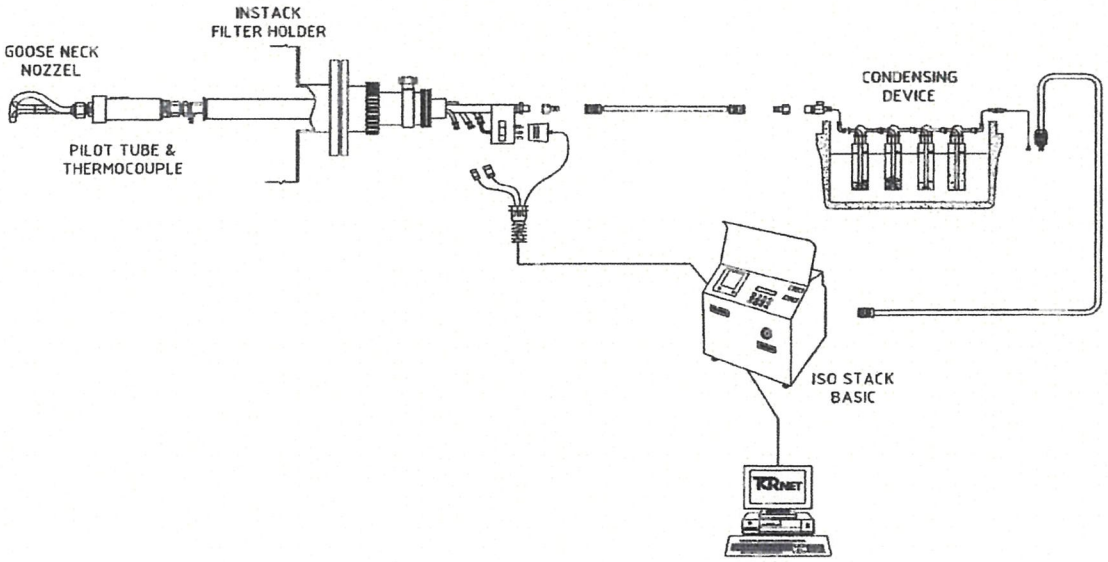
2.1 Isokinetic Stack Sampling Train

STNZ uses a Tecora IsoStack Basic Stack Sampling Train for isokinetic source sampling as depicted in Figures 1 and 2. The IsoStack Basic consol incorporates the following components:

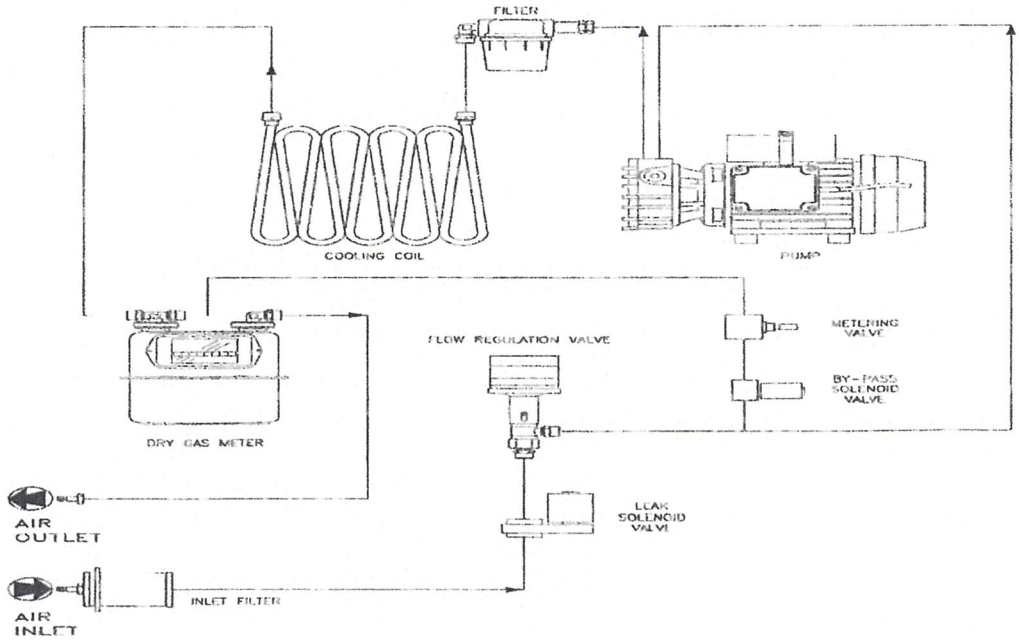
- Leak free rotary sampling pump;
- Electronic mass flow monitor and controller;
- Dry gas meter;
- Stack and dry gas meter temperature indicators;
- Differential and ambient pressure transducers; and
- Electronic data logger and printer.

These components allow for the following parameters to be constantly monitored with automatic adjustment of the sampling rate to isokinetic conditions.

- Stack temperature;
- Pitot differential pressure;
- Stack absolute and ambient pressure;
- Sampling flow rate at standard conditions;
- Sample volume at actual and standard conditions;
- Gas meter temperature;
- Elapsed sampling time; and
- Permanent real time clock and calendar.



- **Figure 1: Isostack Basic In-Stack Filter Sampling Train**



- **Figure 2: Isostack Basic Internal Flow Schematic**

2.2 Testo 350XL Portable Combustion Analyser

Gaseous products of combustion were measured using a Testo 350 XL combustion gas analyser. The Testo 350 XL utilises electrochemical cells to monitor oxygen (O_2 %), carbon monoxide (CO ppmv), nitrogen oxide (NO ppmv), nitrogen dioxide (NO_2 ppmv) and sulphur dioxide (SO_2 ppmv). The concentration of carbon dioxide (CO_2 %) is measured using an Infra Red (IR) cell.

The Testo 350XL is a self-contained emission analyser system capable of measuring O_2, CO, CO_2, NO, NO_2 and SO_2 in combustion sources, while capturing data on pressure, temperature, and flow. The unit employs temperature-controlled electrochemical sensors which operate over an ambient temperature range of 0 °C to 60 °C and can be calibrated, exchanged, and upgraded in the field without hand tools (see Figure 3). The Model 350XL has an automatic sample conditioning system that includes a Peltier cooler, moisture removal pump, and a patented non-heated sample line to provide representative samples from engines, turbines, boilers, burners, and other combustion sources. Table 1 presents the measurement specifications for the Testo 350XL combustion gas analyser.

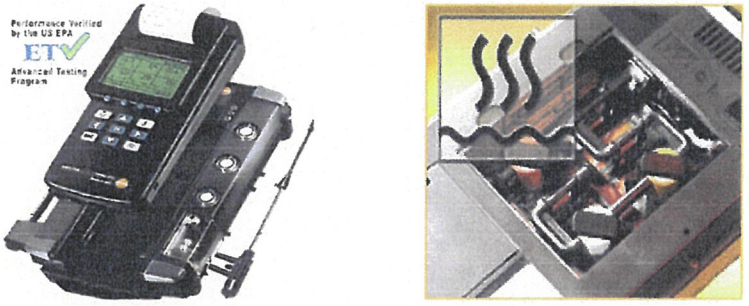


Figure 3 Testo 350XL Analyser Unit and Heated Cells

- **Table 1 Testo 350XL Cell Specifications**

Cell	Range	Accuracy	Resolution	Response Time
O_2	0 to 25% vol.	< 0.2% of m.v.	0.1 vol. %	20 s (t95)
CO_2i	0 to 50% vol.	± 0.3% vol. +1% of m.v. (0 to 25% vol.) ± 0.5% vol. +1.5% of m.v (> 25 to 50% vol.)	0.01% vol. (0 to 25% vol.) 0.01% vol. (> 25% vol.)	10 s (t90)
CO	0 to 10,000 ppm H2 comp.	< 5 ppm (0 to 99 ppm) < 5% of m.v. (100 to 2,000 ppm) < 10% of m.v. (2,001 to 10,000 ppm)	1 ppm	40 s (t90)
NO	0 to 3,000 ppm	< 5 ppm (0 to 99 ppm) < 5% of m.v. (100 to 2,000 ppm) < 10% of m.v. (2,001 to 3,000 ppm)	1 ppm	30 s (t90)
NO_2	0 to 500 ppm	< 5 ppm (0 to 99 ppm) < 5% of m.v. (500 ppm)	0.1 ppm	40 s (t90)
SO_2	0 to 5,000 ppm	< 5 ppm (0 to 99 ppm) < 5% of m.v. (100 to 2,000 ppm) < 10% of m.v. (2,001 to 5,000 ppm)	1 ppm	30 s (t90)

2.3 Sampling Methods

Table 2 summarises the testing methodologies used by STNZ for particulate discharge monitoring. Three separate samples were collected in accordance with USEPA protocols.

STNZ commenced operation in August 2008 and was formed out of an organisation that no longer performs air quality monitoring. In late October 2009 the STNZ laboratory was formally assessed by International Accreditation New Zealand (IANZ) to determine compliance with the requirements of NZS ISOIEC 17025:2005 "General requirements for the competence of testing and calibration laboratories", the laboratory's quality management system and the conditions of accreditation. The STNZ laboratory was formally accredited by International Accreditation New Zealand on 22 June 2010.

- **Table 2: 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
Gas Molecular Mass Determination (Products of Combustion)	Method 3 "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air and Dry Molecular Weight"	Yes
Moisture Content Determination	Method 4 "Determination of Moisture Content in Stack Gases"	Yes
PM_{10} Determination	Method 201A "Determination of PM_{10} Emissions (Constant Flow Rate Method)"	Yes
O_2, CO_2, CO, SO_2, NO, NO_2, & NOx Determination	Testo 350XL Combustion Gas Analyser	NA

2.3.1 Stack Sampling Locations

Table 3 describes the sampling point characteristics of the Wairoa Timber Processors Ltd, Thermal Energy Plant stack. The sampling plane was located approximately 8 m above the ID fan and approximately 8 m below the outlet of the stack. Two sampling ports were available for testing. The sampling plane exhibited uniform flow conditions enabling representative samples to be collected.

- **Table 3: 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	
Thermal Energy Plant	4" BSP	Circular 0.645 m	12.4	*>0*	12.4	*>8*	2	12	*12*

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

2.3.2 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 continuously during each of the monitoring periods. The gas velocities were used to determine volumetric flow rates and mass discharge rates for each sample.

2.3.3 Gaseous Products of Combustion

Gaseous products of combustion were monitored using a Testo 350 XL combustion gas analyser. The Testo 350 XL utilises electrochemical cells to monitor oxygen (O_2 %), carbon monoxide (CO ppmv), sulphur dioxide (SO_2 ppmv), nitrogen oxide (NO ppmv), and nitrogen dioxide (NO_2 ppmv). The concentration of carbon dioxide (CO_2 %) is monitored using an Infra Red (IR) cell. USEPA Method 3 was subsequently used to determine the molecular weight of the stack gas.

2.3.4 Particulate Matter

A gas sample was extracted at a constant flow rate through an in-stack sizing device, which separates total particulate matter and PM_{10}. Variations from isokinetic sampling conditions are maintained within well-defined limits. PM_{10} matter is collected on an in-stack filter. The particulate mass is determined gravimetrically after removal of uncombined water. This approach conforms with USEPA Method 201a Determination of PM_{10} Emissions (Constant Flow Rate Method).

3. Plant Operating Conditions

3.1 Plant Operating Conditions

On 20 January 2012 the thermal energy plant was operating at approximately 95 % of maximum normal operating conditions with a back end temperature of approximately 1,000 °C. The plant was firing on green saw dust providing steam to two kilns. During the monitoring there were no visible emissions from the stack against a clear sky.

4. Air Discharge Monitoring Results

4.1 Particulate Monitoring Results

Presented below are the results of the particulate and gaseous products of combustion monitoring performed on the thermal energy plant on 20 January 2012. Table 4 presents the results of the particulate emission testing, with Table 5 outlining a summary of the relevant stack data. Appendix A presents the moisture content and mass determination calculations. Appendix B contains the raw sampling data.

- **Table 4: Particulate Discharge Results, 20 January 2012**

Sampling Run	Sampling Period	Volume Sampled (m^3)[1]	Stack Flow Rate (m^3/h)[1]	Mass (mg)	Conc. (mg/m^3)[1]	Ave O_2 (%)[2]	Conc. @ 8.5 % O_2 (mg/m^3)[1]	Emission Rate (kg/hr)
Run 1 TPM	11:35 - 12:40	0.630	7,158	58.7	93.2	12.3	135	0.667
Run 1 PM_{10}				50.7	80.5		116	0.576
Run 2 TPM	12:58 - 14:03	0.630	7,186	60.1	95.5	11.7	128	0.686
Run 2 PM_{10}				51.0	81.0		108	0.582
Run 3 TPM	14:16 - 15:22	0.631	6,874	58.6	92.8	11.9	128	0.638
Run 3 PM_{10}				49.7	78.7		108	0.541

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

- **Table 5: Summary of Stack Conditions, 20 January 2012**

Source	Average Stack Temp. (°C)	Average Moisture Content (% v/v)	Average Velocity (m/s)	Average Volumetric Flow Rate (m^3/hr)
Thermal Energy Plant	205.1	12.4	12.1	14,194

1. Actual Conditions

The TPM discharge concentrations from the Wairoa Timber Processors Thermal Energy Plant on 20 January 2012 ranged from 128 to 135 mg/m^3 adjusted to 0 °C, one atmosphere pressure, 8.5 % O_2 by volume and dry gas basis (mg/Sm^3), with an average of 130 mg/Sm^3. The TPM mass emission ranged from 0.638 to 0.686 kg/hr with an average of 0.664 kg/hr.

The PM_{10} discharge concentrations from the Wairoa Timber Processors Thermal Energy Plant on 20 January 2012 ranged from 108 to 116 mg/Sm^3, with an average of 111 mg/Sm^3. The PM_{10} mass emission ranged from 0.541 to 0.582 kg/hr with an average of 0.566 kg/hr. The ratio of PM_{10} to TPM was approximately 0.85

The PM_{10} discharge concentrations for all three sampling runs were below the 150mg/Sm^3 limit stipulated by Condition 11 of the company's Discharge Permit. The mass emission rate was also below the limit specified in Condition 12 of 1 kg/hr.

4.1.1 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	Leak Check Vacuum (bar)	Leak Rate (cc/min)	Leak Check Vacuum (bar)	Leak Rate (cc/min)	Isokinetic Deviation (%)
Method Specs	*> -0.5*	*<570*	*> -0.5*	*<570*	*+/-50*
PM_{10} Run 1	-0.70	100	-0.70	50	2.42
PM_{10} Run 2	-0.70	300	-0.70	50	1.10
PM_{10} Run 3	-0.70	150	-0.70	50	7.74

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

	Filter Blank Mass (g)	Acetone Blank (g)
Pre	3.0299	109.2923
Post	3.0290	109.2916
Diff	-0.0009	-0.0007

The filter blanks and acetone rinse blanks are both slightly above the acceptable limit (±0.0005 g). However, given the magnitude of the samples filter mass gains, the elevated filter blank masses are not considered significant. Otherwise all quality control parameters were within the methods specification.

4.1.2 PM_{10} Quality Control

In order for the results to be accepted the D_{50} must be within 10 % of the nominated cut size where D_{50} is the diameter of particles having a 50 % probability of penetrating the cyclone. For PM_{10} monitoring the following condition must be met:

$$9.0\ \mu m \leq D_{50} \leq 11.0\ \mu m.$$

The D_{50} is primarily affected by variations in the stack temperature. The TCR IsoStack Basic automatically adjusts the flow for temperature variations reducing the error in the D_{50} calculation to less than ± 2%.

4.2 Gaseous Products of Combustion Monitoring Results

Table 8 presents the results of the Testo 350XL combustion gas analyser collected on 20 January 2012. Appendix C presents the raw Testo 350 XL data in a graphical format.

Table 8: Products of Combustion Results, 20 January 2012

		O_2 (%)[1]	CO_2 (%)[1]	CO (ppmv)[1,2]	NO (ppmv)[1,2]	NO_2 (ppmv)[1,2]	NO_x (ppmv)[1,2,3]	SO_2 (ppmv)[1,2]
PM_{10} Run 1	Ave.	12.3	7.5	1,089	45	0.1	46	<1
	Max.	14.6	8.3	1,573	49	0.8	50	<1
	Min.	11.4	5.3	605	33	<0.1	33	<1
PM_{10} Run 2	Ave.	11.7	7.6	1,233	48	0.4	48	<1
	Max.	13.8	8.1	1,526	50	1.2	50	<1
	Min.	11.1	5.6	687	38	<0.1	38	<1
PM_{10} Run 3	Ave.	11.9	7.0	1,008	49	0.3	49	<1
	Max.	14.4	7.9	1,157	50	0.6	51	<1
	Min.	11.3	5.2	654	36	<0.1	36	<1
All Data	Ave.	12.0	7.4	1,110	47	0.3	47	<1
	Max.	14.6	8.3	1,573	50	1.2	51	<1
	Min.	11.1	5.2	605	33	<0.1	33	<1

1. Dry gas basis
2. parts per million per volume, dry gas basis
3. Columns NO, NO_2 and NOx are calculated independently of each other. Therefore the NOx data is not necessarily the sum of the maximum NO + maximum NO_2.

On 20 January 2012, the NO_2 concentration ranged from <0.1 to 1.2 ppmv with an average of 0.3 ppmv. The NO + NO_2 (NO_x) concentration ranged from 33 to 51 ppmv with an average of 47 ppmv. The CO concentration ranged from 605 to 1,573 ppmv with an average of 1,110 ppmv. There was no SO_2 detected over the monitoring period. This was to be expected given the low sulphur content of the saw dust fuel. These results are similar to those observed in November 2010.

Appendix A 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_{10} Run 1	73.4	0.630	12.7
PM_{10} Run 2	73.2	0.630	12.6
PM_{10} Run 3	68.4	0.631	11.9

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)
Run 1	ST0214/01	ST0535	3.1830	3.2333	0.0503	0.0512
TPM Rinse	ST0214/02	50	101.3008	101.3081	0.0073	0.0080
PM_{10} Rinse	ST0214/03	50	98.1748	98.1736	-0.0012	-0.0005
Run 2	ST0214/04	ST0539	3.0540	3.1040	0.0500	0.0509
TPM Rinse	ST0214/05	50	104.1491	104.1575	0.0084	0.0091
PM_{10} Rinse	ST0214/06	50	99.5851	99.5845	-0.0006	0.0001
Run 3	ST0214/07	ST0557	3.0322	3.0802	0.0480	0.0489
TPM Rinse	ST0214/08	50	104.8658	104.8740	0.0082	0.0089
PM_{10} Rinse	ST0214/09	50	105.0786	105.0787	0.0001	0.0008
Filter Blank	ST0214/10	ST0548	3.0299	3.0290	-0.0009	
Rinse Blank	ST0214/11	50	109.2923	109.2916	-0.0007	

Appendix B Raw Sampling Data

This Appendix contains 5 pages including cover.

The data presented in the IsoStack Basic 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:	PM10 Run 1	PM10 Run 2	PM10 Run 3	Averages
Sampling Date:	20/01/2012	20/01/2012	20/01/2012	
Filter ID:	ST0535	ST0539	ST0557	
Sampling Period:	11:35 - 12:40	12:58 - 14:03	14:16 - 15:22	
Total Sample Time (minutes)	60	60	60	
Nozzle Diameter (mm)	5.98	5.98	5.98	
Nozzle Area (m2)	0.0000281	0.0000281	0.0000281	
DGM Calibration Factor	1.0249	1.0249	1.0249	
Intial DGM Reading	383.6168	384.3354	385.0520	
Final DGM Reading	384.3300	385.0433	385.7650	
DGM Sample Volume (m^3):	0.7132	0.7079	0.7130	
DGM Std. Sample Volume (m^3):	0.6301	0.6296	0.6312	
Initial Leak Test Vacuum (Bar):	-0.70	-0.70	-0.70	
Initial Leak Test Flow Rate (cc/min):	100	300	150	
Final Leak Test Vacuum (Bar):	-0.70	-0.70	-0.70	
Final Leak Test Flow Rate (cc/min):	50	50	50	
Moisture Collected (g):	73.4	73.2	68.4	
Moisture Content (%):	12.7	12.6	11.9	12.4
TCR DGM Sample Volume (m^3):	0.7260	0.7211	0.7260	
Sampling Plane Mean Velocity (m/s):	12.19	12.33	11.7	12.1
TCR Isokinetic Deviation (%):	0.7	0.37	6.1	
Actual Isokinetic Deviation (%):	2.42	1.95	6.85	
Duct Volumetric Flow Rates				
Moist (m^3/h):	14,332	14,496	13,756	14,194
Moist Standards (m^3/h):	8,196	8,225	7,800	
Dry Standard (m^3/h):	7,158	7,186	6,874	
Mean Temperatures				
At Sampling Plane (°C):	202.6	206.3	206.6	205.1
At DGM (°C):	42.4	40.3	41.8	
Ambient Pressure (kPa):	100.91	100.91	100.91	
Static Pressure (Pa)	175	175	175	
Stack Absolute Pressure (kPa)	101.085	101.085	101.085	

Cyclone sampling

Wairoa PM10 Run 1

12/01/20 11:35 Fri

Port	Point	Distance (cm)	ET (hh:mm:ss)	Flow q'Va	Volume Vgn	Volume Vdn	Deviation DI	Velocity v'a	Press. diff. Pitot (Pa)	Temperature ta (°C)	Pressure Pa (kPa)
2	6	59.5	0:05:00	22.82	0.0574	0	4.6	12.98	93.771	204.9	101.113
2	5	54.5	0:05:00	20.695	0.0521	0	-5.38	12.58	84.011	203.6	101.114
2	4	45.4	0:05:00	20.775	0.0523	0	-2.42	12.66	89.192	203.76	101.118
2	3	19.1	0:05:00	20.581	0.0517	0	-3.6	12.65	89.264	203.67	101.124
2	2	9.4	0:05:00	20.389	0.0514	0	-4.88	12.72	90.415	202.7	101.107
2	1	5.4	0:05:00	20.197	0.0508	0	-4.73	12.58	88.468	202.41	101.104
1	6	59.5	0:05:00	20.367	0.0514	0	1.56	11.9	79.355	201.78	101.113
1	5	55.2	0:05:00	20.445	0.0516	0	0.43	12.02	81.658	202.16	101.122
1	4	45.4	0:05:00	20.746	0.0523	0	-0.56	12.38	85.746	202.49	101.11
1	3	19.1	0:05:00	20.354	0.0514	0	8.82	11.12	69.332	201.45	101.113
1	2	9.4	0:05:00	20.484	0.0518	0	9.41	11.11	69.32	200.76	101.108
1	1	5.4	0:05:00	20.372	0.0516	0	8.81	11.11	69.211	200.68	101.1

FINAL REPORT

Method : EPA

DUCT AND GAS SPECIFICATION

Circular section

Diameter	m :	0.645
Port	n° :	02
Down stream	m :	10.000
Up stream	m :	5.000
Molecular weight	kg/kmol :	30.136
Density	kg/m^3 :	1.345
CO2	% :	11.2
O2	% :	8.6
Water vapor content	kg/m^3 :	0.0965
Water vapor ratio rw	:	0.120
Ambient pressure	kPa :	100.91

PROGRAMMED VALUES

Cyclone flow rate at 108 °C q'Va l/m : 15.690

Derived flow qVdn l/m : 0.00000

MEASURE POINT

Suggested point for diameter : 02

Selected number of point : 02

SAMPLED VOLUMES

Dry at gas meter	Vg	m^3 :	0.7260
Dry derived	Vdn	m^3 :	0.0000
Dry std. condition	Vgn	m^3 :	0.6260
Wet at measure plain	V'ga	m^3 :	1.2412
Nozzle diameter		mm :	5.99
Average flow	q'Va	l/min :	20.687
Average flow	q'Vn	l/min :	10.434
Average nozzle speed	v'N	m/s :	12.29
Average duct speed	V'a	m/s :	12.19
Total derived time	ETd	hh:mm:ss :	0:00:00
Total elapsed time	ETt	hh:mm:ss :	1:00:00

ISOKINETIC CONDITION

ISO rate	v'N/v'a	:	1.01
ISO deviation	DI	% :	0.7

DUCT FLOW RATE

Moist actual	Q'Va	m^3/h :	14331.6
Moist standard	Q'Vn	m^3/h :	8214.04
Dry standard	QVn	m^3/h :	7228.35

AVERAGE VALUES

Actual temperature	ta	°C :	202.55
Gas meter temperature	tg	°C :	42.42
Aux.1 temperature		°C :	-100.00
Aux.2 temperature		°C :	-100.00
Actual pressure		kPa :	101.112
Press. diff. Pitot		Pa :	83.036

Cyclone sampling
Wairoa PM10 Run 2
12/01/20 12:59 Fri

Port	Point	Distance (cm)	ET (hh:mm:ss)	Flow q'Va	Volume Vgn	Volume Vdn	Deviation DI	Velocity v'a	Press. diff. Pitot (Pa)	Temperature ta (°C)	Pressure Pa (kPa)
1	6	59.5	0:05:00	22.511	0.0567	0	2.91	12.98	96.01	203.01	101.068
1	5	55.2	0:05:00	20.873	0.0524	0	-6.52	13.25	97.605	204.94	101.071
1	4	45.4	0:05:00	20.891	0.0523	0	-4.64	13	93.884	205.49	101.074
1	3	19.1	0:05:00	20.55	0.0516	0	6.78	11.42	72.606	204.76	101.079
1	2	9.4	0:05:00	20.391	0.0511	0	8.13	11.19	69.457	205.99	101.1
1	1	5.4	0:05:00	20.772	0.052	0	7.84	11.43	72.51	205.84	101.098
2	6	59.5	0:05:00	20.554	0.0514	0	-4.04	12.71	89.591	206.01	101.061
2	5	55.2	0:05:00	20.496	0.0512	0	-4.95	12.79	90.704	206.55	101.075
2	4	45.4	0:05:00	20.726	0.0517	0	-4.06	12.82	90.82	207.89	101.061
2	3	19.1	0:05:00	20.903	0.0521	0	3.11	12.03	79.964	208.14	101.067
2	2	9.4	0:05:00	20.832	0.0519	0	1	12.24	82.689	208.43	101.069
2	1	5	0:05:00	20.767	0.0517	0	1.43	12.15	81.035	208.27	101.072

FINAL REPORT
Method : EPA

DUCT AND GAS SPECIFICATION
Circular section

Diameter	m :	0.645
Port	n° :	02
Down stream	m :	10.000
Up stream	m :	8.000
Molecular weight	kg/kmol :	30.136
Density	kg/m^3 :	1.345
CO2	% :	11.2
O2	% :	8.6
Water vapor content	kg/m^3 :	0.0965
Water vapor ratio rw	:	0.120
Ambient pressure	kPa :	100.91

PROGRAMMED VALUES
Cyclone flow rate at 100 °C q'Va l/m : 15.690
Derived flow qVdn l/m : 0.00000

MEASURE POINT
Suggested point for diameter : 02
Selected number of point : 02

SAMPLED VOLUMES

Dry at gas meter	Vg	m^3 :	0.7211
Dry derived	Vdn	m^3 :	0.0000
Dry std. condition	Vgn	m^3 :	0.6260
Wet at measure plain	V'ga	m^3 :	1.2513
Nozzle diameter		mm :	5.98
Average flow	q'Va	l/min :	20.854
Average flow	q'Vn	l/min :	10.423
Average nozzle speed	v'N	m/s :	12.38
Average duct speed	v'a	m/s :	12.33
Total derived time ETd hh:mm:ss		:	0:00:00
Total elapsed time ETt hh:mm:ss		:	1:00:00

ISOKINETIC CONDITION

ISO rate	v'N/v'a	:	1.00
ISO deviation	DI	% :	0.37

DUCT FLOW RATE

Moist actual	Q'Va	m^3/h :	14496.2
Moist standard	Q'Vn	m^3/h :	8240.89
Dry standard	QVn	m^3/h :	7251.96

AVERAGE VALUES

Actual temperature	ta	°C :	206.27
Gas meter temperature	tg	°C :	40.52
Aux.1 temperature		°C :	-100
Aux.2 temperature		°C :	-100
Actual pressure		kPa :	101.075
Press. diff. Pitot		Pa :	84.321

Cyclone sampling
Wairoa PM10 Run 3
12/01/20 Fri

Port	Point	Distance (cm)	ET (hh:mm:ss)	Flow q'Va	Volume Vgn	Volume Vdn	Deviation DI	Velocity v'a	Press. diff. Pitot (Pa)	Temperature ta (°C)	Pressure Pa (kPa)
2	6	59.5	0:05:00	22.726	0.0568	0	15.27	11.7	75.857	206.65	101.038
2	5	55.2	0:05:00	20.684	0.0515	0	4.53	11.72	76.069	207.03	101.043
2	4	45.4	0:05:00	20.882	0.052	0	12.45	11.02	67.104	207.86	101.039
2	3	19.1	0:05:00	20.744	0.0519	0	6.58	11.55	74.018	205.84	101.047
2	2	9.4	0:05:00	20.597	0.0515	0	4.77	11.68	75.432	206.05	101.049
2	1	5.4	0:05:00	20.602	0.0515	0	5.76	11.56	74.07	205.93	101.036
1	6	59.5	0:05:00	20.692	0.0516	0	-0.9	12.39	84.914	207.58	101.033
1	5	55.2	0:05:00	20.823	0.0518	0	-0.75	12.45	85.569	208.42	101.034
1	4	45.4	0:05:00	20.826	0.052	0	-0.97	12.48	86.183	207.15	101.033
1	3	19.1	0:05:00	20.973	0.0524	0	7.85	11.54	73.941	205.23	101.047
1	2	9.4	0:05:00	20.703	0.0519	0	8.34	11.34	71.428	205.3	101.041
1	1	5.4	0:05:00	20.819	0.0521	0	13.03	10.93	66.267	205.78	101.029

FINAL REPORT
Method : EPA

DUCT AND GAS SPECIFICATION
Circular section

Diameter	m :	0.645
Port	n° :	02
Down stream	m :	10.000
Up stream	m :	8.000
Molecular weight	kg/kmol :	30.136
Density	kg/m^3 :	1.345
CO2	% :	11.2
O2	% :	8.6
Water vapor content	kg/m^3 :	0.0965
Water vapor ratio rw	:	0.120
Ambient preasure	kPa :	100.91

PROGRAMMED VALUES
Cyclone flow rate at 100 °C q'Va l/m : 15.690
Derived flow qVdn l/m : 0.00000

MEASURE POINT
Suggested point for diameter : 02
Selected number of point : 02

SAMPLED VOLUMES

Dry at gas meter	Vg m^3 :	0.7260
Dry derived	Vdn m^3 :	0.0000
Dry std. condition	Vgn m^3 :	0.6273
Wet at measure plain	V'gs m^3 :	1.2551
Nozzle diameter	mm :	5.96
Average flow q'Va	l/min :	20.918
Average flow q'Vn	l/min :	19.451
Average nozzle speed	v'N m/s :	12.41
Average duct speed	v'a m/s :	11.7
Total derived time ETd	hh:mm:ss :	0:00:00
Total elapsed time ETt	hh:mm:ss :	1:00:00

ISOKINETIC CONDITION

ISO rate	v'N/v'a :	1.06
ISO deviation DI	% :	6.1

DUCT FLOW RATE

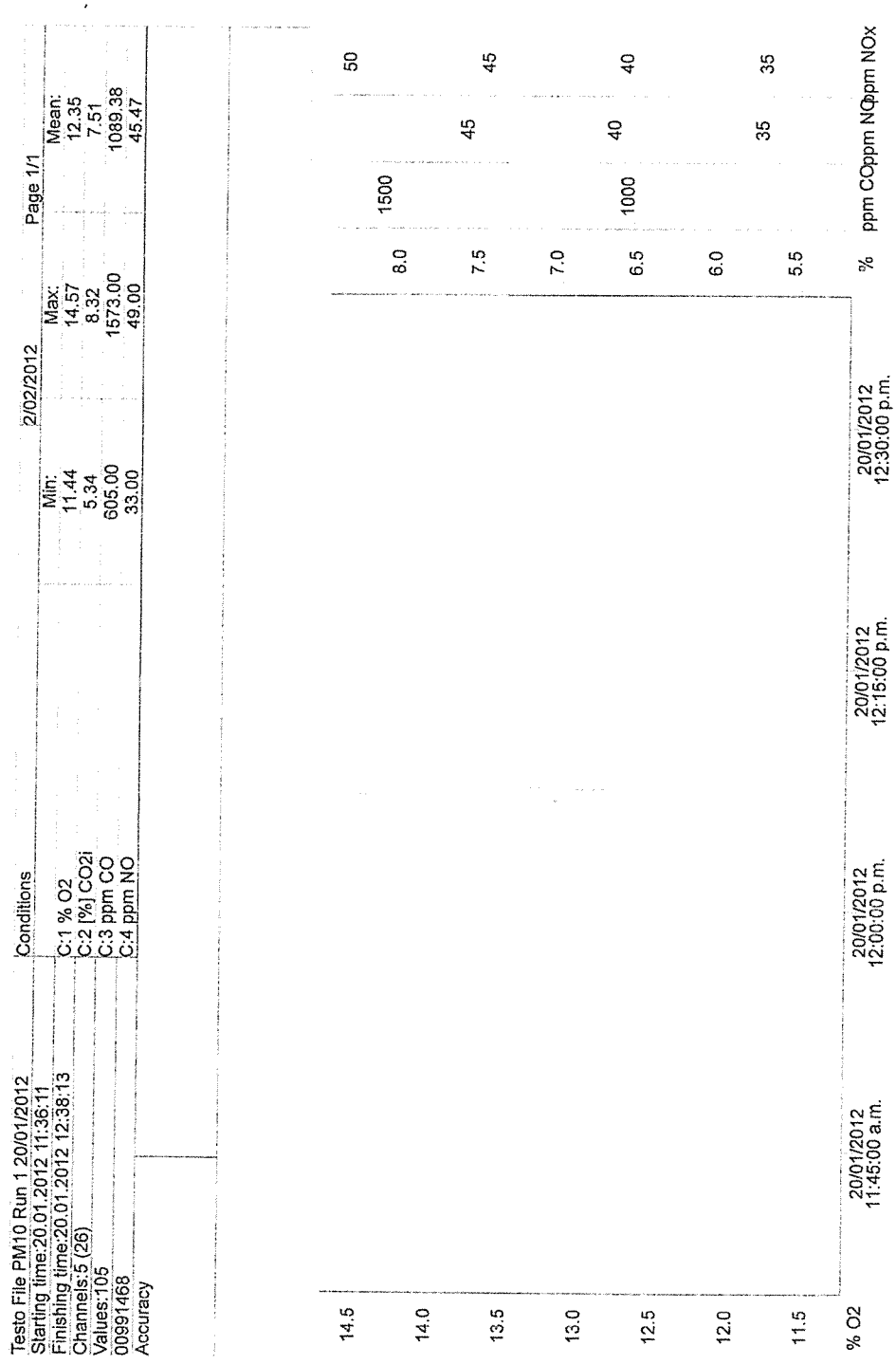
Moist actual	Q'Va m^3/h :	13755.5
Moist standard	Q'Vs m^3/h :	7812.15
Dry standard	QVn m^3/h :	6874.69

AVERAGE VALUES

Actual temperature	ta °C :	206.57
Gas meter temperature	tg °C :	41.79
Aux.1 temperature	°C :	-100.00
Aux.2 temperature	°C :	-100.00
Actual preasure	kPa :	101.030
Press. diff. Pitot	Pa :	75.773

Appendix C Testo 350XL Combustion Gas Data

This Appendix contains 4 pages including cover.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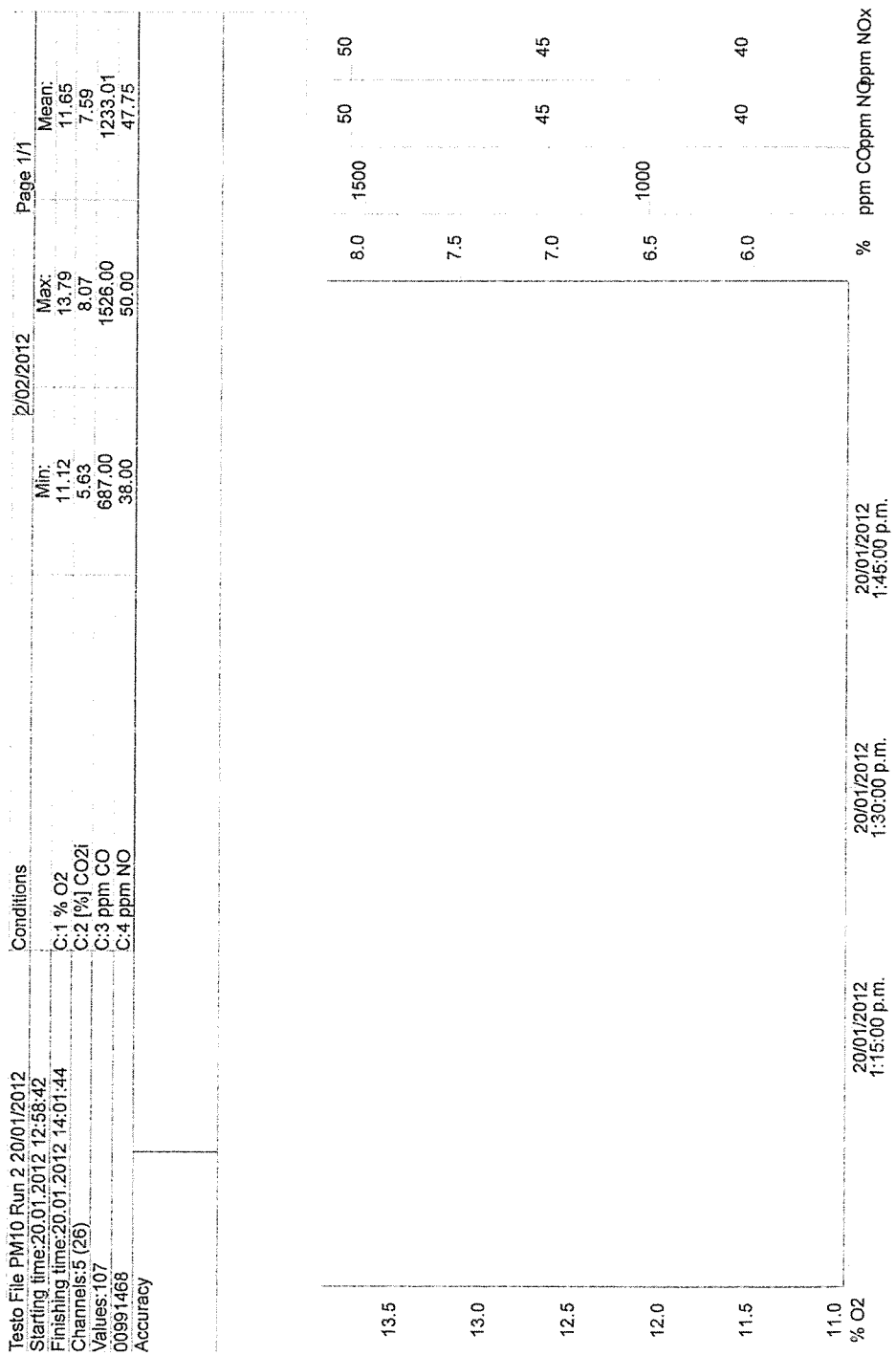
Starting time:20.01.2012 11:36:11
Finishing time:20.01.2012 12:38:13
Channels:5 (26)
Values:105
00991468
Accuracy
Conditions
2/02/2012
Page 1/1
Min:
Max:
Mean:
C:1 % O2
11.44
14.57
12.35
C:2 [%] CO2i
5.34
8.32
7.51
C:3 ppm CO
605.00
1573.00
1089.38
C:4 ppm NO
33.00
49.00
45.47
% O2
ppm CO
ppm NO
ppm NOx
20/01/2012 11:45:00 a.m.
20/01/2012 12:00:00 p.m.
20/01/2012 12:15:00 p.m.
20/01/2012 12:30:00 p.m.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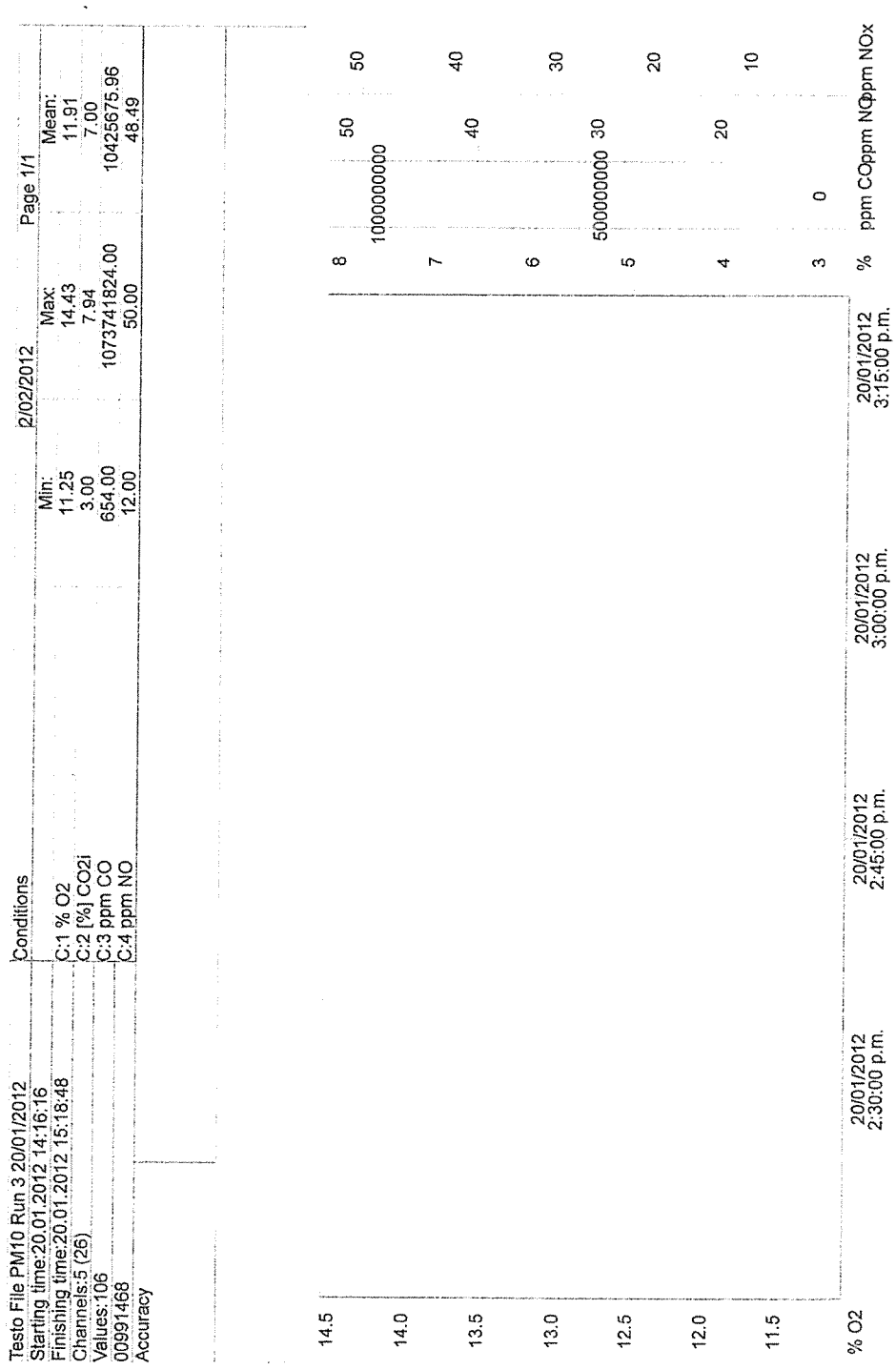
Starting time:20.01.2012 12:58:42
Finishing time:20.01.2012 14:01:44
Channels:5 (26)
Values:107
00991468
Accuracy
Conditions
C:1 % O2
C:2 [%] CO2i
C:3 ppm CO
C:4 ppm NO
2/02/2012
Page 1/1
Min:
11.12
5.63
687.00
38.00
Max:
13.79
8.07
1526.00
50.00
Mean:
11.65
7.59
1233.01
47.75
13.5
13.0
12.5
12.0
11.5
11.0
% O2
8.0
7.5
7.0
6.5
6.0
%
1500
1000
ppm CO
50
45
40
ppm NO
ppm NOx
20/01/2012
1:15:00 p.m.
20/01/2012
1:30:00 p.m.
20/01/2012
1:45:00 p.m.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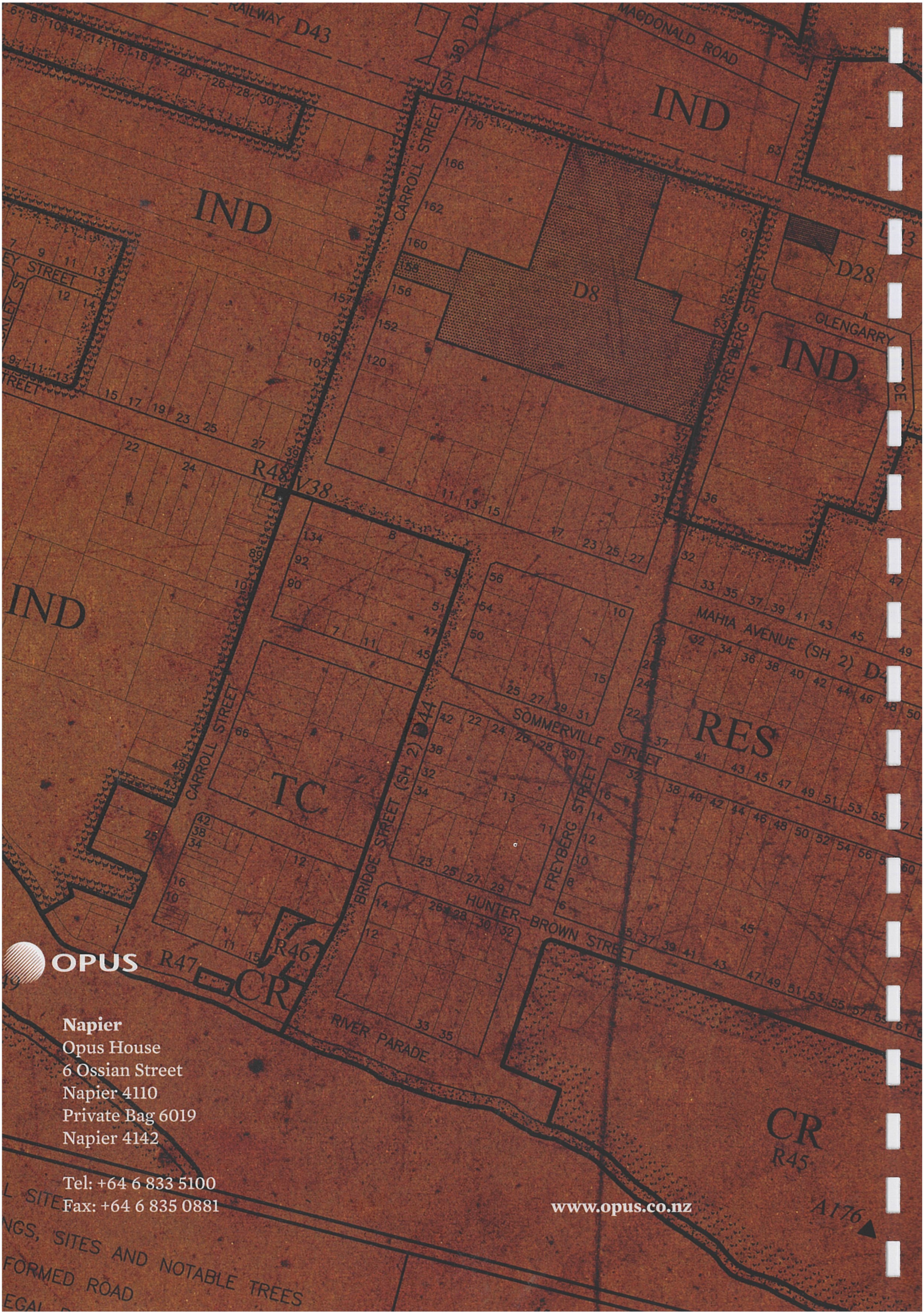
Starting time:20.01.2012 14:16:16
Finishing time:20.01.2012 15:18:48
Channels:5 (26)
Values:106
00991468
Accuracy
Conditions
C:1 % O2
C:2 [%] CO2i
C:3 ppm CO
C:4 ppm NO
2/02/2012
Min:
11.25
3.00
654.00
12.00
Max:
14.43
7.94
1073741824.00
50.00
Page 1/1
Mean:
11.91
7.00
10425675.96
48.49
% O2
ppm CO
ppm NO
ppm NOx
20/01/2012 2:30:00 p.m.
20/01/2012 2:45:00 p.m.
20/01/2012 3:00:00 p.m.
20/01/2012 3:15:00 p.m.



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