APPENDIX VII

UNIVERSITY OF KAMLOOPS STUDY

EMISSION SURVEY

MONITORING REPORT

(August 2005 Survey)

Prepared for

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APPENDICES

1.0 INTRODUCTION

Thompson Rivers University of Kamloops, B.C. retained A. Lanfranco and Associates Inc. of Langley, B.C., to conduct an emission survey on the exhaust of an animal waste combustor unit located at the Beaver Manufacturing site near Kamloops, B.C.

The purpose of the survey was to measure and report emission parameters from the stack associated with the wood pellet/animal waste fired boiler. The testing was conducted to provide emission information in support or in anticipation of a MWLAP emission permit application. The data was also gathered to compare to the combustor manufacturer's performance specifications guarantee.

This report documents the methods used and results found for duplicate/triplicate emission tests conducted on the combustor on August 18, 2005.

1.0 INTRODUCTION

Thompson River University of Kamloops, B.C. retained A. Lanfranco and Associates Inc. of Langley, B.C., to conduct an emission survey on the exhaust of an animal waste combustor unit located at the Beaver Manufacturing site near Kamloops, B.C.

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2.0 PROCESS DESCRIPTION

The combustor unit monitored in this survey utilized wood pellets as the primary combustion fuel. The combustor off gases were passed through a heat recovery unit prior to exhaust to the atmosphere via a 12 by 12 inch smokestack.

3.0 METHODOLOGY

The sampling and analytical methods used throughout this survey conform to the procedures outlined in the B.C. "Source Testing Code for the Measurement of Emissions of Particulates from Stationery Sources" 1982 Edition, and the B.C. air analytical manual, or EPA Reference Methods (RM). One modification to the test procedures was to measure HCl from the 3% hydrogen peroxide solution used for SOx analysis.

3.1 Sampling Techniques

The combustor stack test ports were about 6 diameters downstream and greater than 2 diameters upstream of the nearest disturbances. A total of 4 points on one traverse were selected and sampled for 15.0 minutes each, resulting in final sample volumes of about 1.0 dscm.

The contaminants investigated during this survey were collected with three independent sampling trains as follows:

Train 1 – Particulate/SOx/HCl

The Particulate train was a traditional Method 5 configuration (Fig. 1), with back-half impinger condensate collected for acid gas analysis. Hydrogen peroxide was used in the impinger section to collect SOx and HCl from this train.

The train utilized a three foot glass lined probe (heated) and nozzle.

Train 2 – $PM_{10}/PM_{2.5}$

$PM_{10}/PM_{2.5}$ was monitored using an Anderson Mark III cascade impactor which separates particle sizes by weight into eight size categories. The Mark III was used in conjunction with an EPA Method 5 train for isokinetic sampling.

Train 3 - CEM System for NO_x, THC, CO, CO_2 and O_2

Continuous emission monitoring (CEM) was conducted for NO_x/THC/O_2/CO using A. Lanfranco and Associates Inc CEM monitoring mobile laboratory. This unit is a one ton cube van outfitted with the following instrumentation:

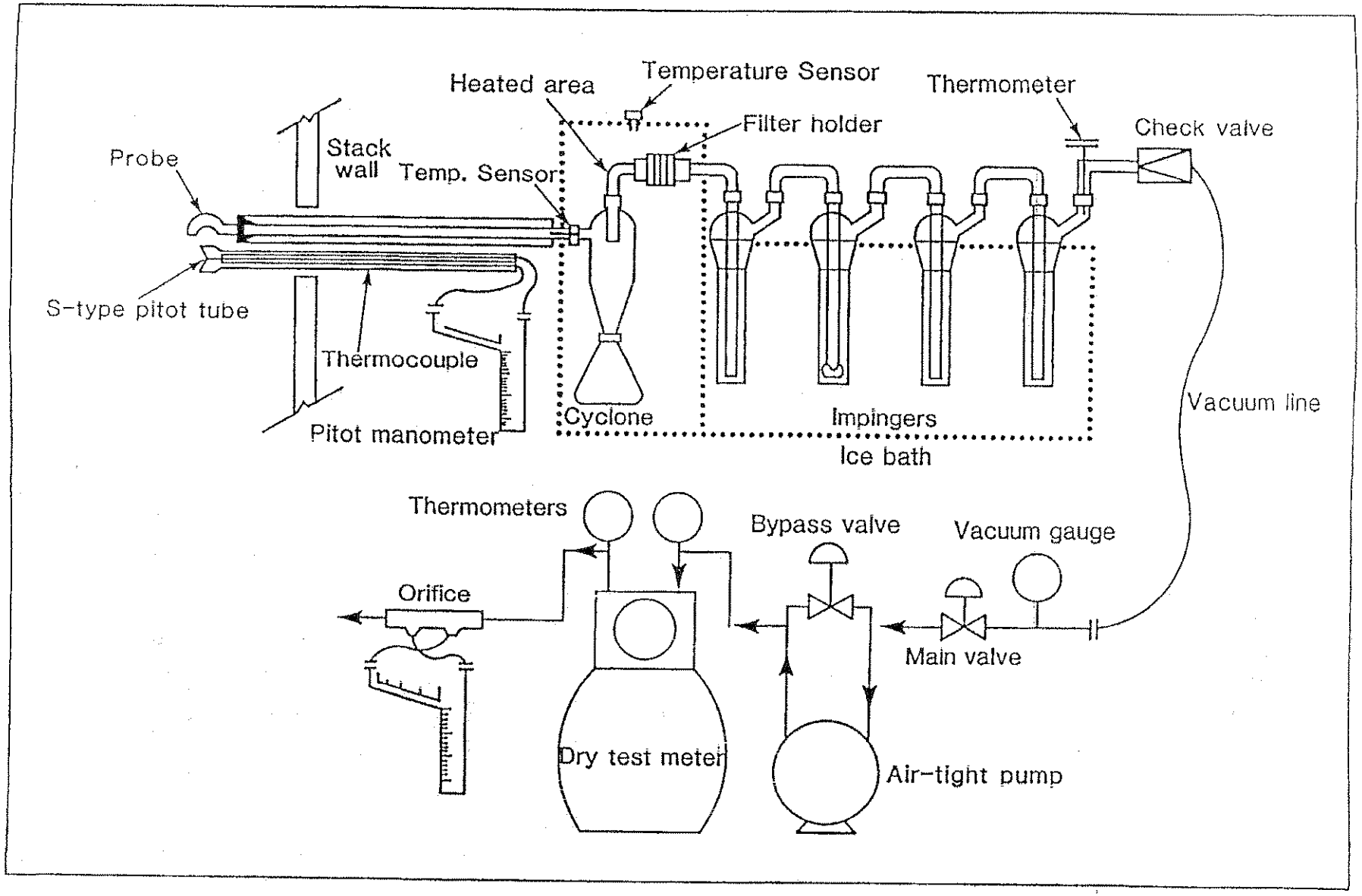

Figure 1 Particulate Sampling Train

NO_x	API Chemiluminescence Monitor, Model 252 for $NO/NO_2/NO_x$ with ranges from 0 to 2000 ppm.
SO_2/O_2	Western Research 721M Nondispersive UV Monitor, with paramagnetic O_2 sensor; range 0 - 25%. SO_2 range to 5000 ppm programmable.
CO/CO_2	California Analytical Model 200 NDIR analyzer to 1000 ppm CO/40% CO_2.
THC	JUM Model 3-300 Hot FID Analyzer with ranges from 1-100000 ppm as propane

A diagram of the sampling, conditioning and analyzer system is provided in Figure 2. With this system the stack gas sample is withdrawn from the source through a coarse filter and stainless steel probe with associated pumps, filters and water removal components.

The THC analyzer withdrew a sidestream of the filtered stack gas for hot FID analysis.

Prior to compliance testing and between each test all measuring instrumentation was calibrated with Protocol 1 and NIST Traceable, 1% certified calibration gas standards.

Calibration gas certificates are appended.

3.2 Analytical Techniques

Sample clean-up of the probe and front half glassware from the particulate trains was conducted with sequential rinses of deionized H_2O and acetone. Impingers 1 to 3 were measured and transferred with deionized H_2O to individual polyethylene sample containers for future analysis

The particulate sampling filter was removed from the filter holder (after cooling) with tweezers and placed in a labelled petri dish for transportation to the laboratory Any filter material adhering to the silicone gasket was removed and added to the filter.

Gravimetric analysis of the particulate samples was conducted by A. Lanfranco and Associates Inc. at their Langley laboratory. Following 105°C drying and desiccation, the filters and probe washings particulate were determined by the difference in initial and final weights, adjusted for blank values.

Sulphur oxides were determined by the barium thorin titration procedure at A. Lanfranco and Associates Langley, B.C. laboratory. Chloride analysis was conducted by ion chromatography at Norwest Laboratories in Langley, B.C.

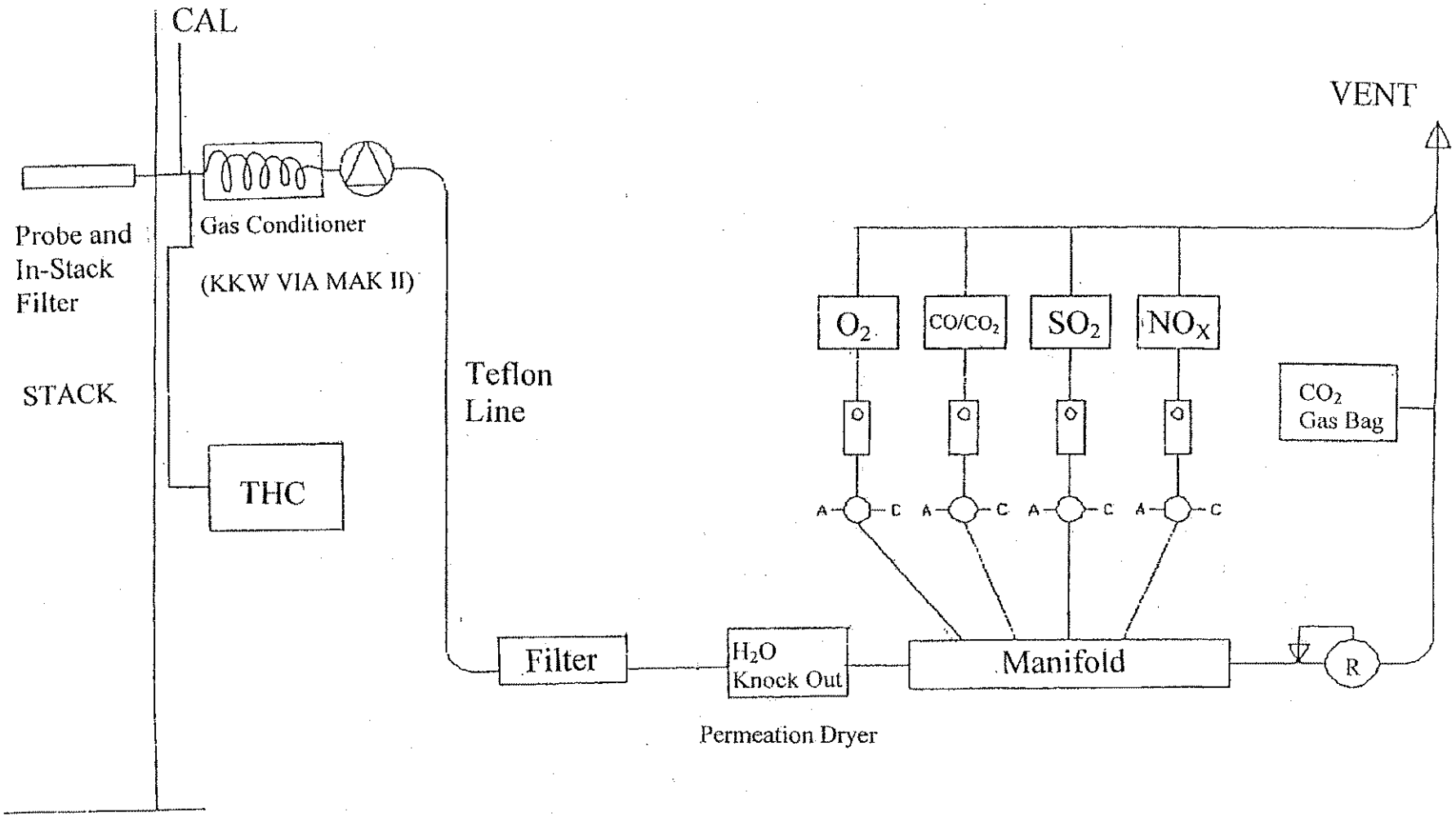

Figure 2

CONTINUOUS GAS SCHEMATIC

Analysis of gaseous components was done on-site by the continuous analyzer system. Additionally, combustion gas analysis for O_2 and CO_2 was conducted on site by grab sample Fyrite analysis.

3.3 Quality Assurance / Quality Control (QA/QC)

QA/QC of this survey was accomplished by the following mechanisms.

1. Pre and Post test leak checks.
2. Use of EPA Protocol calibration gases
3. Calibration of volume measuring and monitoring instrumentation.
4. Analysis of all blank solutions and filters
5. Calibration of CEM system to EPA/EC specifications
6. EPA audit sample analysis for SO_x

CEM Calibration Sequences

All calibrations for the survey were conducted by challenging the analyzers with calibration gas introduced at the probe end of the system. This provided a QA/QC check on system bias and showed the integrity of the overall sampling/conditioning system. The initial and between test calibrations consisted of a check of zero and span drift, followed by calibration with a zero gas and at least two span gases. Span gases utilized were selected as those which most closely approximated the anticipated pollutant/diluent concentrations.

Calibration gas mixtures used were:

Cylinder No.	NO_x (ppm)	CO (ppm)	SO_2 ppm	O_2 (Vol %)	THC ppm as propane
Zero Gas	0	0	0	0	0
No. 1 Gas	-	-	-	0	31.2
No. 2 Gas	81.1	160	160	0	-
No. 3 Gas	222	435	450	-	82.5
No. 4 Gas	465	906	889	-	-
Ambient Air	-	-	-	20.9	
Low O_2 Span	0	0	-	11.07	

4.0 RESULTS

The results of the particulate and stack parameters were calculated using a computer program consistent with reporting requirements of the GVRD and MWLAP. The computer outputs were checked by hand calculation. Some of the computer output results were converted by hand calculations to appropriate units for presentation in Tables1 to 3.

In the following table, particulate and flowrate are shown in actual, standard or corrected standard terms. The "std" particulate results are mg/m^3 at standard conditions of 20°C and 101.3 KPa (dry) while the "corrected" results are "std" corrected to 12% CO_2 by the formula

$$\frac{12.0}{\%\ CO_2}$$

or corrected to 8 % O_2

$$\frac{12.9}{20.9 - \%\ O_2}$$

The "actual" flowrate results are volumetric flowrate at stack conditions while the standard flowrates are flowrates corrected to 20°C and 101.3 KPa (dry).

Point by point isokinetic rates are presented in Appendix 1.

Detailed test results are presented in Tables 1 and 2 Supporting data is presented in Tables 3 and the Appendices.

Cyclonic flow was checked for and was not present in the stack and all points were sampled isokinetically (100+/- 10%).

TABLE 1 COMBUSTOR EMISSION RESULTS

Parameter	Test 1	Test 2	Average
Test Date	Aug. 18/05	Aug. 18/05	
Test Time	13:35 - 14:35*	16:56 - 17:56*	
Duration (minutes)	60	60	60
Particulate (mg/Sm^3)	38.0	41.6	39.8
Particulate (mg/Sm^3) @ 11% O_2	38.0	48.4	43.2
Particulate (Kg/hr)	0.05	0.05	0.05
HCl (mg/Sm3) @ 11% O_2	4	16 and 22	14
NOx (mg/Sm^3) as NO_2@ 11% O_2	155	288 and 354	234 with prelim
SOx (mg/Sm^3) @ 11% O_2	54	118 and 72	81
CO (mg/Sm^3) @ 11% O_2	< 1	1 and 1	3 with prelim
THC (mg/Sm^3) @ 11% O_2	1	< 1 and < 1	< 1
PM_{10} (% of particulate)	96		
$PM_{2.5}$ (% of particulate)	85		
Flowrate (mg/Sm^3)	22.8	21.8	22.3
Temperature (oC)	162	210	186
O_2 (vol % dry)	11.0	11.1 and 12.4	11.7 with prelim
CO_2 (vol % dry)	9.1	8.7 and 7.5	8.3 with prelim
H_2O (vol %)	13.0	12.3	12.7
Isokinetic Variation (%)	103	103	103

* particulate test times, see CEM data for gaseous test time data

A preliminary gaseous test from 1005 to 1104 gave 9 CO, 1 THC, and 140 mg/Sm^3 @11% O_2

TABLE 2 COMBUSTOR PARTICLE SIZING RESULTS

Parameter	Test 1
Test Date	Aug.18/05
Test Time	15:18-16:43
Test Duration (minutes)	85
PM_{10} (% of partic. <10 micron)	96
$PM_{2.5}$ (% of partic.<2.5 micron)	85

TABLE 2a Combustor Stack $PM_{10}/PM_{2.5}$ Particle Size Data

PARTICLE SIZE DISTRIBUTION (Aug. 18/05)

Stage	mg	Wt. % in Size Range Than Size Range	Cum. % Less (microns)	Size Range (microns)	ECD*
0	0.7	2.7	97.2	>14.2	14.2
1	0.3	1.2	96.0	9.0 – 14.2	9.0
2	0.5	1.9	94.1	6.3 – 9.0	6.3
3	0.8	3.1	91.0	4.3 – 6.3	4.3
4	1.2	4.6	86.4	2.7 - 4.3	2.7
5	0.6	2.3	84.1	1.3 - 2.7	1.3
6	0.4	1.5	82.6	0.84 – 1.3	0.84
7	2.0	7.7	74.9	0.57 - 0.84	0.57
Fltr	19.5	74.9	0	0 - 0.57	<0.57

- ECD = Effective Cut Diameter

FIGURE 3 COMBUSTOR PARTICLE SIZE DATA – August 18, 2005

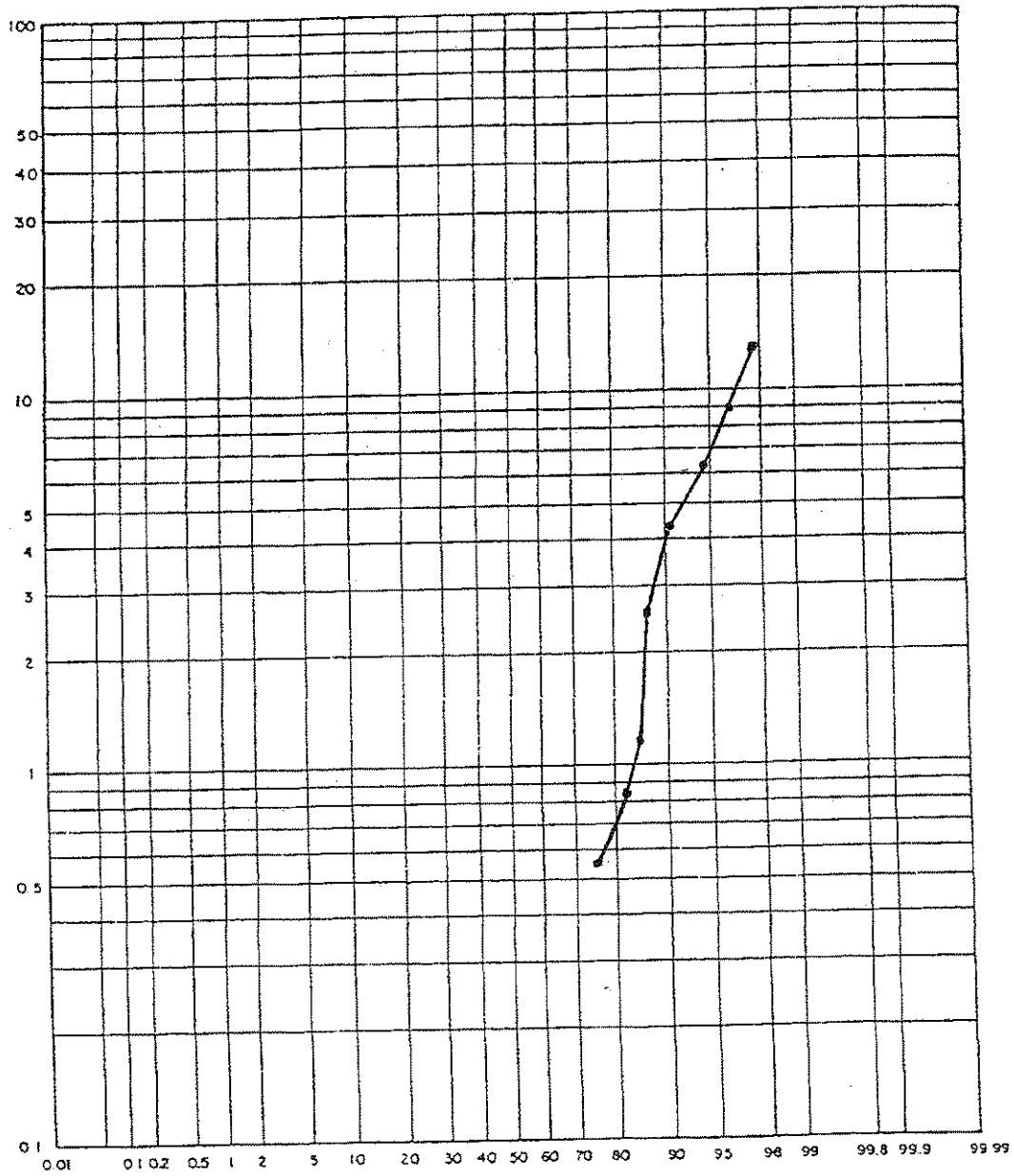

TABLE 3 GRAVIMETRIC RESULTS (Combustor)

	Filter Particulate (mg)	Probe and Washings Particulate (mg)	Total Particulate (mg)
1	24 6	14 2	38.8
2	37.4	8.6	46.0

5.0 DISCUSSION

The emissions of most pollutants were very low, except for NO_x and perhaps SO_x. The magnitude of all emissions was in the anticipated ranges and no significantly unusual results were found.

The PM_{10} and $PM_{2.5}$ data shows that the material emitted is extremely fine with 85% of the material less than 2.5 microns.

Much of the THC and CO was below detection limits, suggesting very good combustion occurred during testing.

Normal variation between test results was found, particularly in view of the fact that the stack temperatures continued to rise throughout the test period, suggesting the system was still stabilizing while tests commenced.

All instrumentation was operated within the calibrated ranges, and all tests were conducted by certified emission testing technicians.

There were no problems encountered in sample collection or analysis. Samples were collected isokinetically at all points (where required) and the processes operated in a normal manner during testing. The test results, therefore, are considered to be an accurate representation of emission characteristics for the process conditions maintained on the test dates.