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Stack Emissions Testing Report

Total Particulate Matter
Hydrogen Chloride
Organic Compounds
Carbon Monoxide

Coventry City Council

Canley Crematorium

Cremator No. 1

Sampling Date(s) **17th April 2002**

Report by Mark Woodruff

Job Number LAB 3561

Contents

Introduction

Coventry City Council operate a Crematoria at Canley Crematorium which is subject to Local Air Pollution Control by Coventry County Council under the Environmental Protection Act 1990, Part 1.

Scientifics Limited were commissioned by Coventry City Council to carry out stack emissions testing to determine the releases of prescribed pollutants from the following Cremator under normal operating conditions.

Company	Coventry City Council	
Site	Canley Crematorium	
Stack	Cremator No. 1	
Sampling Date(s)	17th April 2002	
Cremator Manufacturer	Furance Construction Ltd	
Cremator Model	Newton	
Cremator Serial Number	CF522	
Operating Conditions	Test 1	Test 2
Coffin Construction	Standard	Standard
Mass of Deceased	Average	Average
Cremation Number	140263	140265
Process	'Crematoria'	
Guidance Note	PG5/2(95)	

Any deviations from the respective test methods are noted in the conclusion.

Written Summary

Total Particulate Matter **Passed**

Two particulate tests were performed, each lasting a complete cremation. The mean sampling time was 98 minutes. The mean particulate concentration was 0.6 mg/m^3 at reference conditions. This value is below the emission concentration limit of 80 mg/m^3 specified in PG5/2(95).

The sampling was performed in accordance with the main procedural requirements of US EPA Method 5 using a Air Testing & Support Manual Sampling Train.

Hydrogen Chloride **Passed**

Two hydrogen chloride tests were performed, each lasting a complete cremation. The mean sampling time was 98 minutes. The mean hydrogen chloride concentration was 0.61 mg/m^3 at reference conditions. This value is below the emission concentration limit of 200 mg/m^3 specified in PG5/2(95).

The sampling was performed in accordance with the main procedural requirements of US EPA Method 26A using a Air Testing & Support Manual Sampling Train.

Organic Compounds **Passed**

Two organic compounds tests were performed, each lasting a complete cremation. The mean sampling time was 98 minutes. The mean organic compounds concentration was 4.1 mg/m^3 at reference conditions. This value is below the emission concentration limit of 20 mg/m^3 specified in PG5/2(95).

The sampling was performed in accordance with the main procedural requirements of US EPA Method 25A using a heated sampling line and a Signal 3010 MINIFID portable VOC analyser with detection by FID calibrated against 11 ppm propane span gas.

Carbon Monoxide **Passed**

Two carbon monoxide tests were performed, each lasting a complete cremation. The mean sampling time was 98 minutes. The mean carbon monoxide concentration was 12 mg/m^3 at reference conditions. This value is below the emission concentration limit of 100 mg/m^3 specified in PG5/2(95).

The sampling was performed using a heated sampling line with a Testo 339 gas conditioning unit and a Testo 350 flue gas analyser with detection by electrochemical cells calibrated against 99 ppm carbon monoxide span gas.

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Emissions Summary

Company	Coventry City Council
Site	Canley Crematorium
Stack	Cremator No. 1
Sampling Date(s)	17th April 2002

Parameter	Units	Result	Limit	Outcome
Total Particulate Matter	mg/m^3	0.6	80	Passed
Total Particulate Matter Emission Rate	g/hr	0.47	-	-
Isokinetic Variation	%	-3.7	-	-
Hydrogen Chloride	mg/m^3	0.61	200	Passed
Hydrogen Chloride Emission Rate	g/hr	0.48	-	-
Organic Compounds	mg/m^3	4.1	20	Passed
Organic Compounds Emission Rate	g/hr	3.6	-	-
Carbon Monoxide	mg/m^3	12	100	Passed
Carbon Monoxide Emission Rate	g/hr	9.4	-	-
Oxygen	% v/v	11.2	-	-
Temperature	^oC	819	-	-
Moisture	% v/v	3.9	-	-
Gas Velocity	m/s	8.5	-	-
Gas Volumetric Flow Rate (Actual)	m^3/hr	3456	-	-
Gas Volumetric Flow Rate (STP)	m^3/hr	830	-	-

All results are mean values, with pollutant concentrations expressed at reference conditions. Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Preliminary Velocity and Temperature Profile

	Line A			Line B		
Traverse Point	Dynamic Pressure Pa	Temp °C	Velocity m/s	Dynamic Pressure Pa	Temp °C	Velocity m/s
1	17	805	7.98	21	808	8.88
2	18	806	8.22	20	807	8.67
3	15	804	7.49	18	809	8.23
4	17	808	7.99	19	806	8.44
5	16	807	7.75	20	808	8.67
6	19	807	8.45	17	809	8.00
7	18	806	8.22	18	809	8.23
8	17	806	7.99	19	810	8.46
9	18	808	8.22	18	811	8.24
10	19	808	8.45	18	810	8.23
Mean	17	807	8.08	18	809	8.40

Total Particulate Matter Summary

Particulate	Sampling Times	Concentration mg/m^3	Emission Rate g/hr
Test 1	12:14 - 13:51	0.41	0.37
Test 2	14:10 - 15:49	0.79	0.57
Mean Particulate Concentration		0.60	0.47

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Hydrogen Chloride Summary

HCl	Lab Result mg	Volume Sampled m^3	Concentration mg/m^3	Emission Rate g/hr
Test 1	0.74	1.7140	0.43	0.39
Test 2	1.2	1.5123	0.79	0.57
Mean HCl Concentration			0.61	0.48

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Organic Compounds Summary

Organic Compounds	Sampling Times	Concentration mg/m^3	Emission Rate g/hr
Test 1	12:14 - 13:51	7.0	6.4
Test 2	14:10 - 15:49	1.1	0.79
Mean Organic Compounds Concentration		4.1	3.6

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Carbon Monoxide Summary

Carbon Monoxide	Sampling Times	Concentration mg/m^3	Emission Rate g/hr
Test 1	12:14 - 13:51	6.3	5.8
Test 2	14:10 - 15:49	18	13
Mean Carbon Monoxide Concentration		12	9.4

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Equations 1

Test	1	2	Units
Date	17.04.02	17.04.02	-
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	759.0	758.3	mm Hg
Stack static pressure, P_{static}	5.10	5.10	mm H_2O
$P_s = P_b + \frac{(P_{static})}{13.6}$	759.4	758.6	mm Hg
Volume of water vapour collected, V_{wstd}			
Impinger volume collected	41	30	ml
Silica gel weight increase	14	22	g
Total volume of liquid collected, V_{lc}	55	52	ml
$V_{wstd} = (0.001246)(V_{lc})$	0.0682	0.0648	m^3
Volume of gas metered, V_{mstd}			
Volume of gas sample through gas meter, V_m	1.8815	1.7776	m^3
Gas meter correction factor, Y_d	0.9787	0.9787	-
Average dry gas meter temperature, T_m	25.5	26.0	°C
Average pressure drop across orifice, ΔH	51.85	37.59	mm H_2O
$V_{mstd} = \frac{(0.3592)(V_m)(P_b+(\Delta H/13.6))(Y_d)}{T_m + 273}$	1.6903	1.5905	m^3
Volume of gas at X% oxygen, $V_{mstd@X\%\ oxygen}$			
% oxygen measured in gas stream, act%O_2	10.9	11.5	%
% oxygen at which results required X%	11.0	11.0	%
% oxygen in ambient air by volume	20.9	20.9	%
$O_{xygen@11\%} = \frac{20.9 - act\%O_2}{20.9 - X\%}$	1.01	0.95	-
$V_{mstd@X\%oxygen} = (V_{mstd})(O_{xygen@11\%})$	1.7140	1.5123	m^3
Moisture content, B_{wo}			
$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$	0.039	0.039	m^3
	3.88	3.91	%
Wet volume of gas metered, V_{mstw}			
$V_{mstw} = V_{mstd@X\%oxygen} + V_{wstd}$	1.7822	1.5771	m^3

Equations 2

Test	1	2	Units
Date	17.04.02	17.04.02	-
Molecular weight of dry gas stream, M_d			
CO_2	5.7	5.4	%
O_2	10.9	11.5	%
CO	0.0006	0.0015	%
Total	16.58	16.85	%
N_2 (100 -Total)	83.42	83.15	%
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%CO+\%N_2)$	29.35	29.32	g/gmol
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - B_{wo}) + 18(B_{wo})$	28.91	28.87	g/gmol
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	34.97	34.97	-
Velocity pressure coefficient, C_p	0.79	0.79	-
Average of velocity heads, ΔP_{avg}	2.19	1.61	mm H_2O
Average square root of velocity heads, $\sqrt{\Delta P}$	1.48	1.27	$\sqrt{\text{mm } H_2O}$
Average stack gas temperature, T_s	800	839	°C
$V_s = \dfrac{(K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})}{\sqrt{(Ms)(Ps)}}$	9.03	7.90	m/s
Actual flow of stack gas, Q_a			
Area of stack, A_s	0.11	0.11	m^2
$Q_a = (60)(A_s)(V_s)$	61.4	53.7	m^3/min
Dry total flow of stack gas, Q_{std}			
Conversion factor (K/mm.Hg)	0.3592	0.3592	-
$Q_{std} = \dfrac{(Q_a)P_s(0.3592)(1-B_{wo})}{(T_s)+273}$	15.0	12.7	m^3/min
Wet total flow of stack gas, Q_{stw}			
Conversion factor (K/mm.Hg)	0.3592	0.3592	-
$Q_{std} = \dfrac{(Q_a)P_s(0.3592)}{(T_s)+273}$	15.6	13.2	m^3/min

Equations 3

Test	1	2	Units
Date	17.04.02	17.04.02	-
Percent isokinetic, %I			
Nozzle area, A_n	143.16	143.16	mm^2
Total sampling time, θ	97	99	min
$\%I = \frac{(4.6398E6)(T_s+273)(V_{mstd})}{(P_s)(V_s)(A_n)(\theta)(1-B_{wo})}$	92.0	100.6	%
Percentage isokinetic acceptable $\pm$ 10%	Yes	Yes	-
Particulate Concentration, C			
Mass of particulate collected on filter, M_f	0.0006	0.0011	g
Mass of particulate collected in probe, M_p	0.0001	0.0001	g
Mass of total particulate collected, M_n	0.0007	0.0012	g
$C_{dry} = \frac{M_n}{V_{mstd}}$	0.4	0.8	mg/m^3
$C_{wet} = \frac{M_n}{V_{mstw}}$	0.4	0.8	mg/m^3
$C_{@11\%oxygen} = \frac{M_n}{V_{mstd@11\%oxygen}}$	0.4	0.8	mg/m^3
Particulate emission rate, $E_{g/hr}$			
$E_{g/hr} = \frac{(C_{dry})(Q_{std})(60)}{1000}$	0.4	0.6	g/hr
Cremation Details			
Cremation Date	17.04.02	17.04.02	-
Cremation Number	140263	140265	-
Mass of Deceased	Average	Average	-
Gender of Deceased	Female	Male	-
Coffin Features	Standard	Standard	-

Organic Compounds & Carbon Monoxide Emissions Data

Time	OC mg/m³	O_2 % v/v	CO mg/m³	Time	OC mg/m³	O_2 % v/v	CO mg/m³
Test 1 - 17.04.02				Test 1 - 17.04.02			
12:14	46	6.2	26	12:59	1.3	11.0	10.0
12:15	52	6.8	28	13:00	1.0	10.5	9.5
12:16	44	8.3	22	13:01	1.4	10.2	10.4
12:17	54	12	15	13:02	1.3	10.4	8.3
12:18	45	12	23	13:03	1.8	10.6	7.2
12:19	46	12	14	13:04	1.7	10.3	8.2
12:20	33	9.8	8.9	13:05	1.8	10.0	9.1
12:21	31	8.5	6.0	13:06	1.8	9.9	9.0
12:22	20	8.7	7.1	13:07	1.9	9.7	9.9
12:23	21	9.5	8.7	13:08	1.9	9.5	7.6
12:24	15	9.9	9.0	13:09	1.9	9.4	6.5
12:25	18	10.3	9.4	13:10	1.5	8.8	9.2
12:26	16	9.6	7.7	13:11	2.5	8.3	13
12:27	14	8.9	7.2	13:12	2.0	8.5	12
12:28	13	8.5	7.0	13:13	2.4	8.7	16
12:29	14	8.3	5.9	13:14	3.0	8.9	17
12:30	10	8.6	5.0	13:15	2.8	9.2	16
12:31	11	8.9	5.1	13:16	2.3	9.3	15
12:32	7.3	9.1	5.2	13:17	2.3	9.4	14
12:33	4.7	9.0	6.3	13:18	1.7	9.5	13
12:34	1.8	9.2	3.2	13:19	1.8	10.1	16
12:35	5.0	8.4	0.0	13:20	2.0	10.4	8.3
12:36	3.2	9.6	2.2	13:21	2.2	10.9	7.5
12:37	6.9	11.6	8.0	13:22	2.1	11.3	5.2
12:38	7.4	10.8	1.2	13:23	2.2	12.8	0.0
12:39	6.6	10.3	0.0	13:24	1.5	8.6	9.1
12:40	3.4	10.3	0.0	13:25	1.1	6.7	12
12:41	1.6	10.8	0.0	13:26	1.7	7.1	7.2
12:42	2.3	9.9	0.0	13:27	1.4	7.0	7.1
12:43	1.3	9.7	0.0	13:28	1.0	7.2	6.3
12:44	0.6	9.9	0.0	13:29	1.3	7.3	5.5
12:45	0.5	10.2	0.0	13:30	2.1	12.1	5.6
12:46	1.2	10.3	0.0	13:31	3.9	15.9	0.0
12:47	1.2	10.9	0.0	13:32	3.9	15.4	0.0
12:48	2.1	10.5	0.0	13:33	2.7	14.2	0.0
12:49	1.8	10.0	0.0	13:34	3.1	14.5	0.0
12:50	1.8	10.7	2.4	13:35	3.8	14.7	0.0
12:51	0.2	10.9	6.2	13:36	2.9	15.1	0.0
12:52	1.6	10.5	3.6	13:37	3.8	15.7	0.0
12:53	2.2	10.4	8.3	13:38	3.6	15.9	0.0
12:54	2.0	10.9	9.9	13:39	3.7	16.4	0.0
12:55	1.5	11.0	8.8	13:40	1.0	12.4	0.0
12:56	2.0	11.1	7.6	13:41	1.0	9.2	0.0
12:57	2.5	10.4	9.4	13:42	1.7	15.0	0.0
12:58	1.4	10.6	6.0	13:43	4.3	17.5	0.0

Where - is indicated in table: Cremation over, i.e no more data collected.

Organic Compounds & Carbon Monoxide Emissions Data

Time	OC mg/m³	O_2 % v/v	CO mg/m³	Time	OC mg/m³	O_2 % v/v	CO mg/m³
Test 1 - 17.04.02				Test 2 - 17.04.02			
13:44	0.9	15	0.0	14:10	0.5	9.9	65
13:45	0.5	14	0.0	14:11	0.4	9.5	58
13:46	0.6	16	0.0	14:12	0.3	10.5	37
13:47	1.2	17	0.0	14:13	0.4	11.9	36
13:48	0.3	16	0.0	14:14	0.3	10.9	25
13:49	0.6	16	0.0	14:15	0.3	10.0	22
13:50	1.2	16	0.0	14:16	0.4	9.7	17
13:51	0.6	16	0.0	14:17	0.4	7.7	10
-	-	-	-	14:18	0.3	8.8	12
-	-	-	-	14:19	0.3	10.9	12
-	-	-	-	14:20	0.5	8.4	7.9
-	-	-	-	14:21	0.2	5.8	4.9
-	-	-	-	14:22	0.2	7.4	8.3
-	-	-	-	14:23	0.4	9.4	7.5
-	-	-	-	14:24	0.4	9.5	8.7
-	-	-	-	14:25	0.3	9.7	6.6
-	-	-	-	14:26	0.4	9.1	7.3
-	-	-	-	14:27	0.4	8.9	6.2
-	-	-	-	14:28	0.6	9.6	8.8
-	-	-	-	14:29	0.6	10.1	6.9
-	-	-	-	14:30	0.5	10.7	4.9
-	-	-	-	14:31	0.3	11.2	0.0
-	-	-	-	14:32	0.3	11.3	3.9
-	-	-	-	14:33	0.2	11.4	10.4
-	-	-	-	14:34	0.3	10.1	10.3
-	-	-	-	14:35	0.3	9.5	9.8
-	-	-	-	14:36	0.2	10.3	9.3
-	-	-	-	14:37	0.2	10.7	8.5
-	-	-	-	14:38	0.3	10.5	10.7
-	-	-	-	14:39	0.3	10.3	7.0
-	-	-	-	14:40	0.2	10.9	8.7
-	-	-	-	14:41	0.5	11	10
-	-	-	-	14:42	0.6	12	12
-	-	-	-	14:43	0.9	14	15
-	-	-	-	14:44	0.8	13	12
-	-	-	-	14:45	0.5	10.5	7.2
-	-	-	-	14:46	0.7	11.1	10
-	-	-	-	14:47	0.3	10.8	11
-	-	-	-	14:48	0.4	11.8	10
-	-	-	-	14:49	0.5	11.6	11
-	-	-	-	14:50	0.7	11.4	12
-	-	-	-	14:51	0.5	10.8	12
-	-	-	-	14:52	0.3	10.6	14
-	-	-	-	14:53	0.2	10.5	15
Mean	**7.0**	**10.9**	**6.3**	14:54	0.2	10.4	14

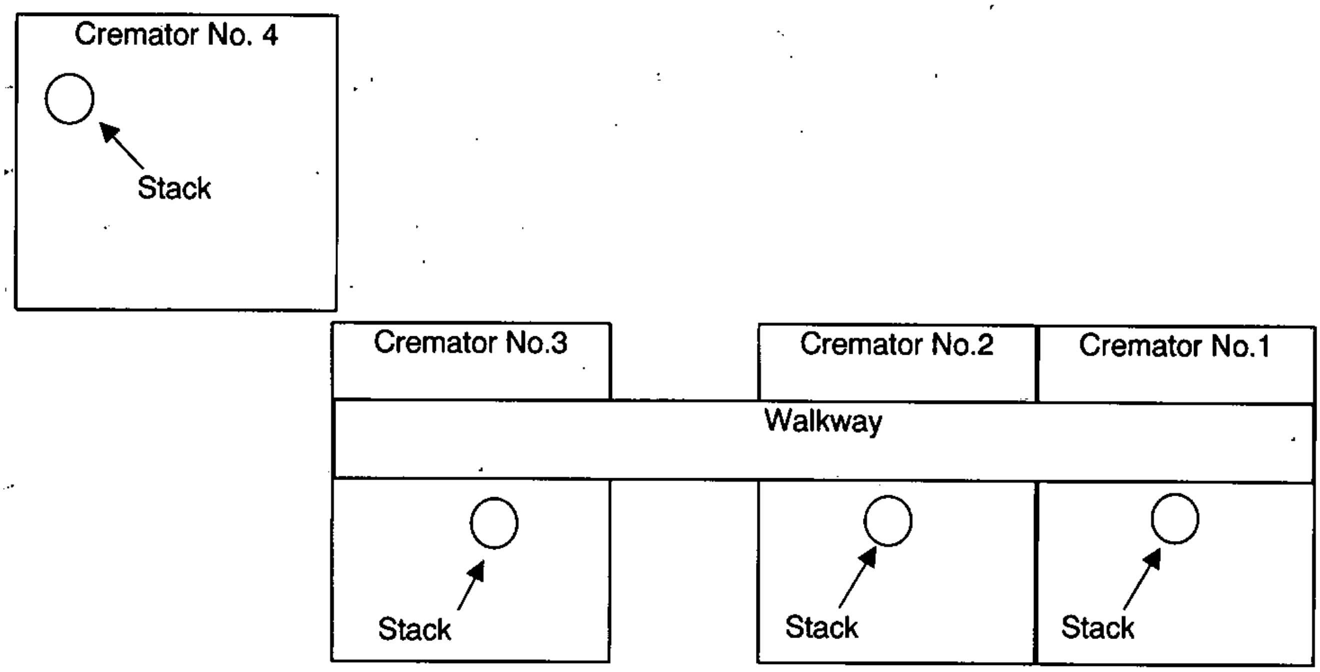
Where - is indicated in table: Cremation over, i.e no more data collected.

Organic Compounds & Carbon Monoxide Emissions Data

Time	OC mg/m^3	O_2 % v/v	CO mg/m^3	Time	OC mg/m^3	O_2 % v/v	CO mg/m^3
Test 2 - 17.04.02				Test 2 - 17.04.02			
14:55	0.5	10.3	15	15:40	1.3	17	0.0
14:56	0.3	10.8	17	15:41	1.7	16	0.0
14:57	0.3	11.3	17	15:42	3.0	17	0.0
14:58	0.2	11.2	20	15:43	2.8	17	0.0
14:59	0.3	10.9	21	15:44	2.6	15	0.0
15:00	0.3	10.4	22	15:45	2.5	14	0.0
15:01	0.3	10.4	21	15:46	3.4	14	0.0
15:02	0.6	10.3	22	15:47	3.3	15	0.0
15:03	0.3	10.3	19	15:48	5.3	16	0.0
15:04	0.4	9.5	24	15:49	4.5	16	0.0
15:05	0.3	8.7	27	-	-	-	-
15:06	0.1	9.2	31	-	-	-	-
15:07	0.6	10.7	37	-	-	-	-
15:08	1.2	9.8	27	-	-	-	-
15:09	1.6	9.5	27	-	-	-	-
15:10	1.8	9.6	28	-	-	-	-
15:11	1.8	9.9	37	-	-	-	-
15:12	2.0	10.2	43	-	-	-	-
15:13	2.1	11.4	47	-	-	-	-
15:14	1.7	10.3	28	-	-	-	-
15:15	1.8	9.9	30	-	-	-	-
15:16	1.5	10.0	33	-	-	-	-
15:17	1.7	10.1	30	-	-	-	-
15:18	1.2	10.0	35	-	-	-	-
15:19	1.3	9.8	52	-	-	-	-
15:20	2.0	12	54	-	-	-	-
15:21	1.3	13	66	-	-	-	-
15:22	0.2	12	48	-	-	-	-
15:23	0.7	11	34	-	-	-	-
15:24	0.6	12	40	-	-	-	-
15:25	14.0	14	38	-	-	-	-
15:26	1.0	12	32	-	-	-	-
15:27	0.7	12	30	-	-	-	-
15:28	1.2	13	27	-	-	-	-
15:29	0.6	13	30	-	-	-	-
15:30	1.1	14	26	-	-	-	-
15:31	0.5	14	20	-	-	-	-
15:32	0.7	14	7.0	-	-	-	-
15:33	0.9	13	9.8	-	-	-	-
15:34	0.2	14	14	-	-	-	-
15:35	0.5	14	9.7	-	-	-	-
15:36	0.9	15	4.3	-	-	-	-
15:37	2.2	17	0.0	-	-	-	-
15:38	2.8	17	0.0	-	-	-	-
15:39	1.9	17	0.0	**Mean**	**1.1**	**11.5**	**18.2**

Where - is indicated in table: Cremation over, i.e no more data collected.

Plant Layout

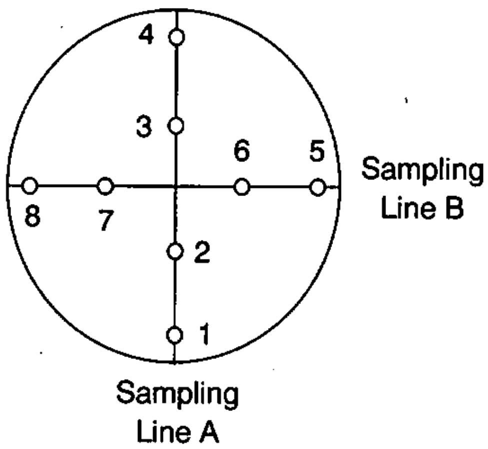


Stack Diagram

Sampling Point	Distance as a % of D	Distance into Stack (m)
1, 5	6.5	0.02
2, 6	25	0.10
3, 7	75	0.29
4, 8	93.5	0.36

Stack Diameter (D) = 0.38 m

Stack Area (A) = 0.11 m^2



Total Particulate Matter Sampling Methodology

US EPA Method 5 requires the extraction of a particulate laden sample from the stack or duct, followed by the subsequent removal of the particulate matter by a filter medium. Concurrently, a measurement of the volume of the withdrawn sample gas is required to determine the particulate concentration. The sample is extracted by using a traversing procedure that approximately integrates the sample volume and collected particulate mass over the entire cross section of the stack or duct. During the sample traverse, the velocity distribution is also determined. This data provides the stack gas flow rate which is used with the particulate concentration to calculate the mass emission rate. Throughout the sampling period, therefore, the sample gas velocity in the probe nozzle is adjusted or re-adjusted to equal the stack gas velocity at each and every traverse point.

Laboratory Preparation

All glassware and metal components are cleaned in accordance with the clean up procedures as described later.
The required number of filter papers are heated in an oven at 105°C for a period of 2 hours and then placed in a desiccator until they can be weighed to a stable weight to within ± 0.1 mg. The whole sampling train is assembled in a clean environment and the following checks carried out.

1. No obvious damage such as cracked glass, split wiring, cross threads etc.
2. With the impingers filled with the necessary amounts of distilled water/silica gel, a system leak check is performed.
3. Fluid reservoir levels for both liquid manometers are topped up to the required
4. All heated components and thermocouples are checked.
5. The umbilical cord is inspected for leaks and the wiring checked for flaws.
6. All the nozzle inlet diameters are measured and any distortions recorded.
7. Finally, the sampling train is dismantled and made ready for transport to site.

Sampling

The sampling train is unpacked and assembled as shown below. The following is then carried out.

1. A quick check to confirm all heated components are working correctly.
2. Measurement of the stack diameter and calculation of the appropriate sampling points.
3. At each of the sampling points, the pitot tube pressure drop and gas temperature are recorded.

Total Particulate Matter Sampling Methodology

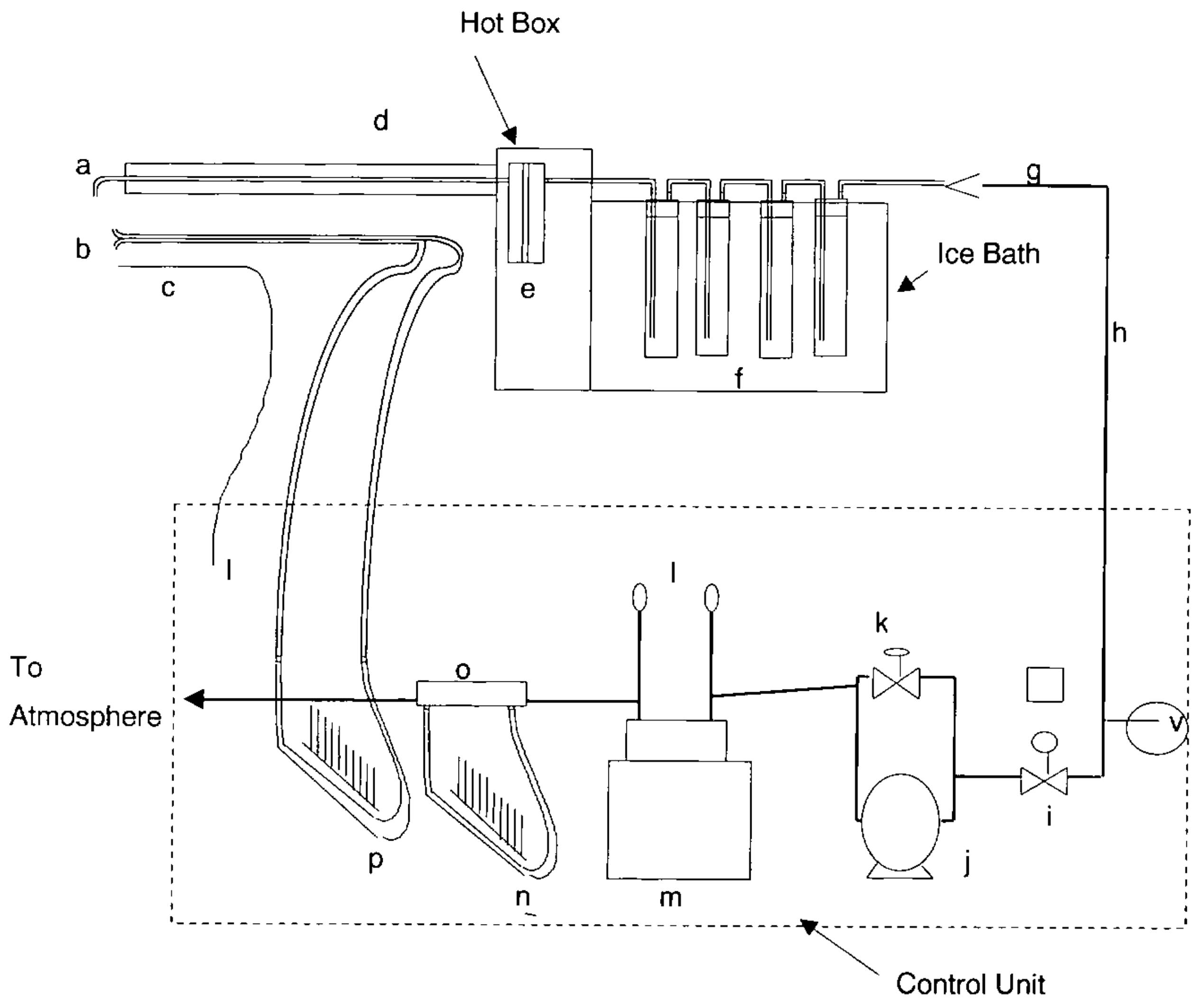
4. Measurements of the stack pressure, gas composition and moisture content are noted and the nozzle diameter determined.
5. A filter of known weight is placed in it's housing unit and inserted into the heater box.
6. The heated probe and heater box are switched on and set to the required temperatures.
7. A sampling train leak check is performed.
8. The probe is positioned at the first sampling point.
9. The initial gas meter volume is recorded.
10. Sampling is then performed for an equal time period at each of the sampling points with all necessary data recorded throughout the test.
11. When sampling is complete, the final gas meter volume is recorded and a sampling train leak check is performed.
12. The sampling train is prepared to carry out a second test as outlined in the clean up procedure.

Clean Up Procedure

1. The filter is removed and returned it to it's labelled petri dish. Any particulate matter deposited on the filter housing, probe lining and nozzle are collected and placed in the same petri dish. The filter housing, probe lining and nozzle are then rinsed with acetone, with the washings collected in a labelled container.
2. The impinger solution from the first two impingers is poured into one labelled container. Any condensate collected in the third impinger is then added to this container
3. The silica gel from the fourth impinger is emptied into a labelled container.
4. The impingers are then washed with distilled water and the washings poured into a labelled container.

Sampling Equipment

Sampling Train Used: Air Testing & Support Manual Sampling Train



Key

a	Quartz Nozzle	i	Coarse Control Valve
b	S-Type Pitot Tube	j	Vacuum Pump
c	Thermocouple	k	Fine Control Valve
d	Quartz Lined Heated Probe	l	Thermocouples
e	Filter Holder	m	Dry Gas Meter
f	Impingers	n	Orifice Manometer
g	Check Valve	o	Orifice Plate
h	Umbilical Cord	p	Pitot Manometer

Organic Compounds Sampling Methodology

The Signal 3010 MINIFID Portable Heated Total Hydrocarbon Analyser uses Flame Ionisation to detect total organic carbon in a gas stream.

Checks Carried Out before Arrival On Site

The FID analyser is set up and is tested. The following are checked; the furnace and sample line temperatures, the zero and span gas calibration and the operation of the data logger.

On Site Sampling Procedure

The FID and sample line are switched on and allowed to reach operational temperature. The analyser will take 20 minutes to reach its operational temperature of 180°C. The sample line is heated to approximately 180°C to avoid VOCs condensing in the line. When the components have reached the correct operating temperature the fuel and span gas valves are opened and the FID is ignited.

The FID will take about 20 minutes before it stabilises and gives a zero ppm reading. The zero gas is fed into the FID and the zero set. The span gas is fed into the FID and the instrument adjusted to read the certified span gas value. The zero gas is fed into the FID once more to check that the reading returns to zero, if it does not, then these steps are repeated.

The probe, with a particulate filter, is then inserted into the stack, and the data logger activated.

The data logger can be programmed to log results over a 1, 5, 10 etc minute period. The results displayed and logged are the volume concentration of propane in ppm, which are converted to mg/m³ by the following calculations:

$$C_m = C_v \frac{36}{22.4}$$

where C_m is the TOC concentration in mg/m³ (273 K; 101300 Pa)
C_v is the volume concentration of propane in ppm (by volume)

$$C_n = C_i \times \left[\frac{100}{100 - \%H_2O_m}\right] \times \left[\frac{21 - \%\,O_{ref}}{21 - \%\,O_m}\right]$$

where C_n is the TOC concentration in mg/m³ stated at reference conditions of humidity and oxygen
C_i is the TOC concentration in mg/m³ (273 K; 101 300 Pa) at flue gas conditions of humidity and oxygen
$\%\,H_2O_m$ is the measured percentage by volume of water in the flue gas
$\%\,O_m$ is the measured percentage by volume of oxygen in the flue gas
$\%\,O_{ref}$ is the percentage by volume of oxygen at the reference conditions

Carbon Monoxide Sampling Methodology

The Testo 350 flue gas analyser is a portable instrument capable of measuring oxygen, carbon dioxide, carbon monoxide, stack temperature, date and time of test. The Testo 350 has a large measuring range for process control in industrial furnaces and a high accuracy level, even in the lower measuring ranges, for limit value control. Up to 500 measurements can be stored directly on location, with online data transmission to a PC possible for long-term measurements. The mobile gas preparation unit Testo 339, which dries the sample gas, can be connected as an option for long-term measurements.

Checks Carried Out Before Arrival On Site

Condensate traps are emptied and particulate filters replaced if necessary. The analyser when switched on, carries out a self-test (approximately 60 seconds) and rinses the measuring cells with fresh air. The analyser is tested with certified bottled calibration gas. If any cells require replacing, or adjustments are required to bring the analyser within calibration, these are made and a certificate of calibration produced. The handset is cleared of data and the analyser batteries fully charged.

On-Site Sampling Procedure

The flue gas probe is connected and the analyser switched on. The analyser is allowed to perform its self-test in fresh air. The appropriate fuel type is selected. The instrument status data (instrument temperature, battery voltage and pump capacity), required for smooth operation are checked. The complete measuring system (probe, condensate trap, tubes and connections) are leak tested. The measuring variables are set and a file created to which measurements are stored. The probe is positioned into the centre of the stack and the access hole plugged. The pump is started and measurements made. During long-term measurements the electronic measuring cells need fresh air phases to regenerate. The number and duration of the required fresh air times depends on the gas concentration and sample duration.

Post-Site Procedure

The handset memory is downloaded to PC and the analyser retested with calibration gas.

Operational Range

The O_2 sensor is a self powered, diffusion limited, metal air battery fuel cell. It has a resolution of 0.1% with an accuracy of 0.1%.

The CO cell has a resolution of 1 ppm with an accuracy of +/- 20 ppm at concentrations less than 400 ppm, +/- 5% at concentrations less than 2000 ppm and +/- 10% at concentrations greater than 2000 ppm.

All sensors and electrochemical cells have filters and cross sensitivity compensation data for more accurate measurements.

Quality Assurance Checklist

Preparation:

All glassware cleaned according to the appropriate test method.	Yes
Filters are dried, desiccated and weighed to achieve stable weights.	Yes
Equipment checked for faults and calibrated if necessary.	Yes

Sampling:

Sampling train assembled and leak check performed in accordance with the appropriate test method.	Yes
Critical temperatures (hot box, probe, condenser and gas sample) maintained according to the appropriate test method.	Yes
Isokinetic variation within method requirement of ± 10%.	Yes
Sample recovery according to the appropriate test method.	Yes

Sample Analysis:

Samples sent to our accredited laboratory and analysis performed according to the appropriate analytical method.	Yes

QA Procedures:

Equipment underwent a calibration check where necessary.	Yes
Recorded information downloaded and printouts made.	Yes
Report saved electronically onto Scientifics server.	Yes
On site data sheet completed and signed off by Team Leader.	Yes
Raw data and hard copy of report filed together.	Yes

Stack Emissions Testing Team

Environmental Team Leader	Jez Anderson BSc (Hons) Physics
Environmental Technician(s)	Mark Woodruff BSc (Hons) Environmental Studies
Report by	Mark Woodruff Environmental Technican
Checked and Authorised By	[redacted] Signed
	JEZ ANDERSON Print Name
	13/5/02 Dated
	~~Business Manager~~ / Team Leader Business Title (Delete as appropriate)

Deviations from Test Methods

In this instance, testing was fully in accordance with the respective test methods.

Conclusion

The results of this monitoring exercise demonstrate that under normal operating conditions, this Plant is being operated in full compliance with all the emission concentration limits specified in PG5/2(95).

Good housekeeping and maintenance of the ducting and associated plant should be continued in order to maintain this level of Plant performance.

A regular programme of stack emissions testing in accordance with the Plant's LAPC Authorisation will be required to demonstrate continued compliance.

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Stack Emissions Testing Report

Total Particulate Matter
Hydrogen Chloride
Organic Compounds
Carbon Monoxide

Coventry City Council

Canley Crematorium

Cremator No. 2

Sampling Date(s) **16th April 2002**

Report by Mark Woodruff

Job Number LAB 3561

Contents

Introduction

Coventry City Council operate a Crematoria at Canley Crematorium which is subject to Local Air Pollution Control by Coventry County Council under the Environmental Protection Act 1990, Part 1.

Scientifics Limited were commissioned by Coventry City Council to carry out stack emissions testing to determine the releases of prescribed pollutants from the following Cremator under normal operating conditions.

Company	Coventry City Council	
Site	Canley Crematorium	
Stack	Cremator No. 2	
Sampling Date(s)	16th April 2002	
Cremator Manufacturer	Furance Construction Ltd	
Cremator Model	Newton	
Cremator Serial Number	CF409	
Operating Conditions	Test 1	Test 2
Coffin Construction	Standard	Standard
Mass of Deceased	Average	Average
Cremation Number	140256	140260
Process	'Crematoria'	
Guidance Note	PG5/2(95)	

Any deviations from the respective test methods are noted in the conclusion.

Written Summary

Total Particulate Matter **Passed**

Two particulate tests were performed, each lasting a complete cremation. The mean sampling time was 87 minutes. The mean particulate concentration was 1.2 mg/m³ at reference conditions. This value is below the emission concentration limit of 80 mg/m³ specified in PG5/2(95). max 1.2 ✓

The sampling was performed in accordance with the main procedural requirements of US EPA Method 5 using a Air Testing & Support Manual Sampling Train.

Hydrogen Chloride **Passed**

Two hydrogen chloride tests were performed, each lasting a complete cremation. The mean sampling time was 87 minutes. The mean hydrogen chloride concentration was 0.69 mg/m³ at reference conditions. This value is below the emission concentration limit of 200 mg/m³ specified in PG5/2(95). 0.88 ✓

The sampling was performed in accordance with the main procedural requirements of US EPA Method 26A using a Air Testing & Support Manual Sampling Train.

Organic Compounds **Passed**

Two organic compounds tests were performed, each lasting a complete cremation. The mean sampling time was 87 minutes. The mean organic compounds concentration was 2.9 mg/m³ at reference conditions. This value is below the emission concentration limit of 20 mg/m³ specified in PG5/2(95). max 5.2 ✓

The sampling was performed in accordance with the main procedural requirements of US EPA Method 25A using a heated sampling line and a Signal 3010 MINIFID portable VOC analyser with detection by FID calibrated against 11 ppm propane span gas.

Carbon Monoxide **Passed**

Two carbon monoxide tests were performed, each lasting a complete cremation. The mean sampling time was 87 minutes. The mean carbon monoxide concentration was 8.9 mg/m³ at reference conditions. This value is below the emission concentration limit of 100 mg/m³ specified in PG5/2(95). max 16 ✓

The sampling was performed using a heated sampling line with a Testo 339 gas conditioning unit and a Testo 350 flue gas analyser with detection by electrochemical cells calibrated against 99 ppm carbon monoxide span gas.

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Emissions Summary

Company	Coventry City Council
Site	Canley Crematorium
Stack	Cremator No. 2
Sampling Date(s)	16th April 2002

Parameter	Units	Result	Limit	Outcome
Total Particulate Matter	mg/m^3	1.20	80	Passed
Total Particulate Matter Emission Rate	g/hr	1.3	-	-
Isokinetic Variation	%	-6.9	-	-
Hydrogen Chloride	mg/m^3	0.69	200	Passed
Hydrogen Chloride Emission Rate	g/hr	0.79	-	-
Organic Compounds	mg/m^3	2.9	20	Passed
Organic Compounds Emission Rate	g/hr	3.2	-	-
Carbon Monoxide	mg/m^3	8.9	100	Passed
Carbon Monoxide Emission Rate	g/hr	10.5	-	-
Oxygen	% v/v	11.0	-	-
Temperature	°C	793	-	-
Moisture	% v/v	4.9	-	-
Gas Velocity	m/s	11.7	-	-
Gas Volumetric Flow Rate (Actual)	m^3/hr	4761	-	-
Gas Volumetric Flow Rate (STP)	m^3/hr	1152	-	-

All results are mean values, with pollutant concentrations expressed at reference conditions. Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Preliminary Velocity and Temperature Profile

	Line A			Line B		
Traverse Point	Dynamic Pressure Pa	Temp °C	Velocity m/s	Dynamic Pressure Pa	Temp °C	Velocity m/s
1	31	795	10.95	35	799	11.64
2	34	796	11.46	34	798	11.47
3	33	795	11.29	35	798	11.63
4	35	798	11.63	36	798	11.79
5	34	797	11.46	37	797	11.94
6	33	796	11.29	35	798	11.63
7	32	796	11.12	34	799	11.47
8	31	797	10.96	34	799	11.47
9	33	798	11.30	33	799	11.31
10	34	799	11.47	34	799	11.47
Mean	33	797	11.29	35	798	11.58

Total Particulate Matter Summary

Particulate	Sampling Times	Concentration mg/m^3	Emission Rate g/hr
Test 1	15:04 - 16:27	1.20	1.3
Test 2	10:23 - 11:53	1.10	1.3
Mean Particulate Concentration		1.20	1.3

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Hydrogen Chloride Summary

HCl	Lab Result mg	Volume Sampled m^3	Concentration mg/m^3	Emission Rate g/hr
Test 1	1.2	1.3563	0.88	0.99
Test 2	0.78	1.5846	0.49	0.59
Mean HCl Concentration			0.69	0.79

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Organic Compounds Summary

Organic Compounds	Sampling Times	Concentration mg/m^3	Emission Rate g/hr
Test 1	15:04 - 16:27	5.2	5.8
Test 2	10:23 - 11:53	0.51	0.61
Mean Organic Compounds Concentration		2.9	3.2

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Carbon Monoxide Summary

Carbon Monoxide	Sampling Times	Concentration mg/m^3	Emission Rate g/hr
Test 1	15:04 - 16:27	1.7	1.9
Test 2	10:23 - 11:53	16	19
Mean Carbon Monoxide Concentration		8.9	10.5

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Equations 1

Test	1	2	Units
Date	16.04.02	17.04.02	-
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	754.5	754.5	mm Hg
Stack static pressure, P_{static}	5.10	5.10	mm H_2O
$P_s = P_b + \frac{(P_{static})}{13.6}$	754.9	754.9	mm Hg
Volume of water vapour collected, V_{wstd}			
Impinger volume collected	36	54	ml
Silica gel weight increase	17	14	g
Total volume of liquid collected, V_{lc}	53	68	ml
$V_{wstd} = (0.001246)(V_{lc})$	0.0657	0.0847	m^3
Volume of gas metered, V_{mstd}			
Volume of gas sample through gas meter, V_m	1.5340	1.7136	m^3
Gas meter correction factor, Y_d	0.9787	0.9787	-
Average dry gas meter temperature, T_m	22.5	21.5	°C
Average pressure drop across orifice, ΔH	42.80	44.84	mm H_2O
$V_{mstd} = \frac{(0.3592)(V_m)(P_b+(\Delta H/13.6))(Y_d)}{T_m + 273}$	1.3827	1.5501	m^3
Volume of gas at X% oxygen, $V_{mstd@X\%\ oxygen}$			
% oxygen measured in gas stream, act%O_2	11.2	10.8	%
% oxygen at which results required X%	11.0	11.0	%
% oxygen in ambient air by volume	20.9	20.9	%
$O_{xygen@11\%} = \frac{20.9 - act\%O_2}{20.9 - X\%}$	0.98	1.02	-
$V_{mstd@X\%oxygen} = (V_{mstd})(O_{xygen@11\%})$	1.3563	1.5846	m^3
Moisture content, B_{wo}			
$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$	0.045	0.052	m^3
	4.54	5.18	%
Wet volume of gas metered, V_{mstw}			
$V_{mstw} = V_{mstd@X\%oxygen} + V_{wstd}$	1.4220	1.6694	m^3

Equations 2

Test	1	2	Units
Date	16.04.02	17.04.02	-
Molecular weight of dry gas stream, M_d			
CO_2	5.5	5.8	%
O_2	11.2	10.8	%
CO	0.0002	0.0015	%
Total	16.72	16.54	%
N_2 (100 -Total)	83.28	83.46	%
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%CO+\%N_2)$	29.33	29.35	g/gmol
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - B_{wo}) + 18(B_{wo})$	28.82	28.76	g/gmol
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	34.97	34.97	-
Velocity pressure coefficient, C_p	0.79	0.79	-
Average of velocity heads, ΔP_{avg}	3.54	3.72	mm H_2O
Average square root of velocity heads, $\sqrt{\Delta P}$	1.88	1.93	$\sqrt{\text{mm } H_2O}$
Average stack gas temperature, T_s	800	787	°C
$V_s = \frac{(K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})}{\sqrt{(Ms)(Ps)}}$	11.55	11.78	m/s
Actual flow of stack gas, Q_a			
Area of stack, A_s	0.11	0.11	m^2
$Q_a = (60)(A_s)(V_s)$	78.6	80.1	m^3/min
Dry total flow of stack gas, Q_{std}			
Conversion factor (K/mm.Hg)	0.3592	0.3592	-
$Q_{std} = \frac{(Q_a)P_s(0.3592)(1-B_{wo})}{(T_s) + 273}$	19.0	19.4	m^3/min
Wet total flow of stack gas, Q_{stw}			
Conversion factor (K/mm.Hg)	0.3592	0.3592	-
$Q_{std} = \frac{(Q_a)P_s(0.3592)}{(T_s) + 273}$	19.9	20.5	m^3/min

Equations 3

Test	1	2	Units
Date	16.04.02	17.04.02	-
Percent isokinetic, %I			
Nozzle area, A_n	107.53	107.53	mm^2
Total sampling time, θ	83	90	min
$\%I = \frac{(4.6398E6)(T_s+273)(V_{mstd})}{(P_s)(V_s)(A_n)(\theta)(1-B_{wo})}$	92.7	93.5	%
Percentage isokinetic acceptable ± 10%	Yes	Yes	-
Particulate Concentration, C			
Mass of particulate collected on filter, M_f	0.0013	0.0014	g
Mass of particulate collected in probe, M_p	0.0003	0.0003	g
Mass of total particulate collected, M_n	0.0016	0.0017	g
$C_{dry} = \frac{M_n}{V_{mstd}}$	1.2	1.1	mg/m^3
$C_{wet} = \frac{M_n}{V_{mstw}}$	1.1	1.0	mg/m^3
$C_{@11\%oxygen} = \frac{M_n}{V_{mstd@11\%oxygen}}$	1.2	1.1	mg/m^3
Particulate emission rate, $E_{g/hr}$			
$E_{g/hr} = \frac{(C_{dry})(Q_{std})(60)}{1000}$	1.3	1.3	g/hr
Cremation Details			
Cremation Date	16.04.02	17.04.02	-
Cremation Number	140256	140260	-
Mass of Deceased	Average	Average	-
Gender of Deceased	Male	Female	-
Coffin Features	Standard	Standard	-

Organic Compounds & Carbon Monoxide Emissions Data

Time	OC mg/m³	O_2 % v/v	CO mg/m³	Time	OC mg/m³	O_2 % v/v	CO mg/m³
Test 1 - 16.04.02				Test 1 - 16.04.02			
15:04	69	8.5	25	15:49	0.4	11.7	0.0
15:05	72	8.4	29	15:50	0.2	11.9	0.0
15:06	43	8.6	14	15:51	0.2	12.0	0.0
15:07	39	8.8	16	15:52	0.4	12.0	0.0
15:08	25	8.6	12	15:53	0.6	12.1	0.0
15:09	15	8.7	8.1	15:54	0.6	12.5	0.0
15:10	15	8.8	4.1	15:55	0.6	12.6	0.0
15:11	14	9.2	6.3	15:56	0.6	12.4	0.0
15:12	9.2	9.1	3.1	15:57	0.4	12.8	0.0
15:13	4.4	8.9	2.1	15:58	0.6	12.4	0.0
15:14	1.8	9.6	1.1	15:59	0.3	8.4	0.0
15:15	2.3	9.5	1.1	16:00	0.4	9.0	0.0
15:16	2.6	9.4	5.4	16:01	0.3	10.3	0.0
15:17	3.0	9.3	2.1	16:02	0.8	12.6	0.0
15:18	6.5	9.6	1.1	16:03	1.4	12.5	1.5
15:19	7.5	9.4	0.0	16:04	1.2	12.4	0.0
15:20	6.5	9.6	0.0	16:05	1.4	12.8	0.0
15:21	6.6	9.5	0.0	16:06	1.7	12.9	0.0
15:22	4.8	9.8	0.0	16:07	1.0	12.7	0.0
15:23	1.7	9.9	0.0	16:08	0.4	12.8	0.0
15:24	0.6	9.6	0.0	16:09	0.7	11.2	0.0
15:25	1.2	9.9	1.1	16:10	0.7	9.4	0.0
15:26	0.8	10.2	0.0	16:11	0.6	12.9	0.0
15:27	2.3	10.6	0.0	16:12	1.3	13.2	0.0
15:28	3.5	10.4	0.0	16:13	0.4	13.4	0.0
15:29	3.6	10.3	0.0	16:14	0.5	13.5	0.0
15:30	3.3	9.8	0.0	16:15	0.6	13.2	1.6
15:31	3.6	10.2	0.0	16:16	0.7	13.3	0.0
15:32	3.8	10.4	0.0	16:17	0.4	13.4	0.0
15:33	3.9	10.6	0.0	16:18	0.2	13.6	0.0
15:34	3.6	10.8	0.0	16:19	0.5	13.7	0.0
15:35	4.5	12.3	0.0	16:20	0.7	13.9	0.0
15:36	3.6	10.7	0.0	16:21	0.5	13.5	0.0
15:37	2.9	8.7	0.0	16:22	0.5	13.6	0.0
15:38	3.9	11.1	0.0	16:23	0.2	13.7	1.7
15:39	3.6	11.2	0.0	16:24	0.2	13.9	0.0
15:40	3.8	11.3	0.0	16:25	0.7	13.9	0.0
15:41	3.5	10.8	0.0	16:26	0.4	12.2	0.0
15:42	2.5	10.9	0.0	16:27	0.7	14.2	0.0
15:43	1.9	11.1	0.0	-	-	-	-
15:44	2.3	11.4	0.0	-	-	-	-
15:45	2.4	11.2	0.0	-	-	-	-
15:46	1.6	11.3	0.0	-	-	-	-
15:47	0.9	11.8	1.4	-	-	-	-
15:48	0.7	11.6	1.3	-	-	-	-

Where - is indicated in table: Cremation over, i.e no more data collected.

Organic Compounds & Carbon Monoxide Emissions Data

Time	OC mg/m³	O_2 % v/v	CO mg/m³	Time	OC mg/m³	O_2 % v/v	CO mg/m³
Test 1 - 16.04.02				Test 2 - 17.04.02			
-	-	-	-	10:23	0.3	3.3	64
-	-	-	-	10:24	0.4	6.9	78
-	-	-	-	10:25	0.2	7.5	60
-	-	-	-	10:26	0.4	8.2	54
-	-	-	-	10:27	0.4	8.5	46
-	-	-	-	10:28	0.5	11.2	46
-	-	-	-	10:29	0.5	13.9	53
-	-	-	-	10:30	0.3	9.6	35
-	-	-	-	10:31	0.4	8.0	33
-	-	-	-	10:32	0.4	8.4	31
-	-	-	-	10:33	0.3	9.2	32
-	-	-	-	10:34	0.3	8.6	29
-	-	-	-	10:35	0.1	7.3	26
-	-	-	-	10:36	0.4	8.5	25
-	-	-	-	10:37	0.3	9.2	25
-	-	-	-	10:38	0.3	11.3	28
-	-	-	-	10:39	0.6	12.8	34
-	-	-	-	10:40	0.5	10.2	20
-	-	-	-	10:41	0.5	8.2	17
-	-	-	-	10:42	0.1	7.7	17
-	-	-	-	10:43	0.3	6.5	16
-	-	-	-	10:44	0.2	6.8	20
-	-	-	-	10:45	0.3	7.7	24
-	-	-	-	10:46	0.5	8.6	21
-	-	-	-	10:47	1.1	11.7	27
-	-	-	-	10:48	1.2	10.9	21
-	-	-	-	10:49	1.3	10.8	20
-	-	-	-	10:50	0.7	8.5	15
-	-	-	-	10:51	0.2	6.9	16
-	-	-	-	10:52	0.3	9.2	20
-	-	-	-	10:53	0.5	10.8	22
-	-	-	-	10:54	0.2	11.1	19
-	-	-	-	10:55	0.3	11.0	20
-	-	-	-	10:56	0.4	7.0	14
-	-	-	-	10:57	0.2	7.4	15
-	-	-	-	10:58	0.4	8.6	19
-	-	-	-	10:59	0.5	10.1	26
-	-	-	-	11:00	0.5	10.5	24
-	-	-	-	11:01	0.5	11.4	23
-	-	-	-	11:02	0.4	8.3	17
-	-	-	-	11:03	0.4	7.4	22
-	-	-	-	11:04	0.2	6.9	19
-	-	-	-	11:05	0.2	5.8	12
-	-	-	-	11:06	0.6	12.2	13
Mean	**5.2**	**11.2**	**1.7**	11:07	0.6	13.1	7.9

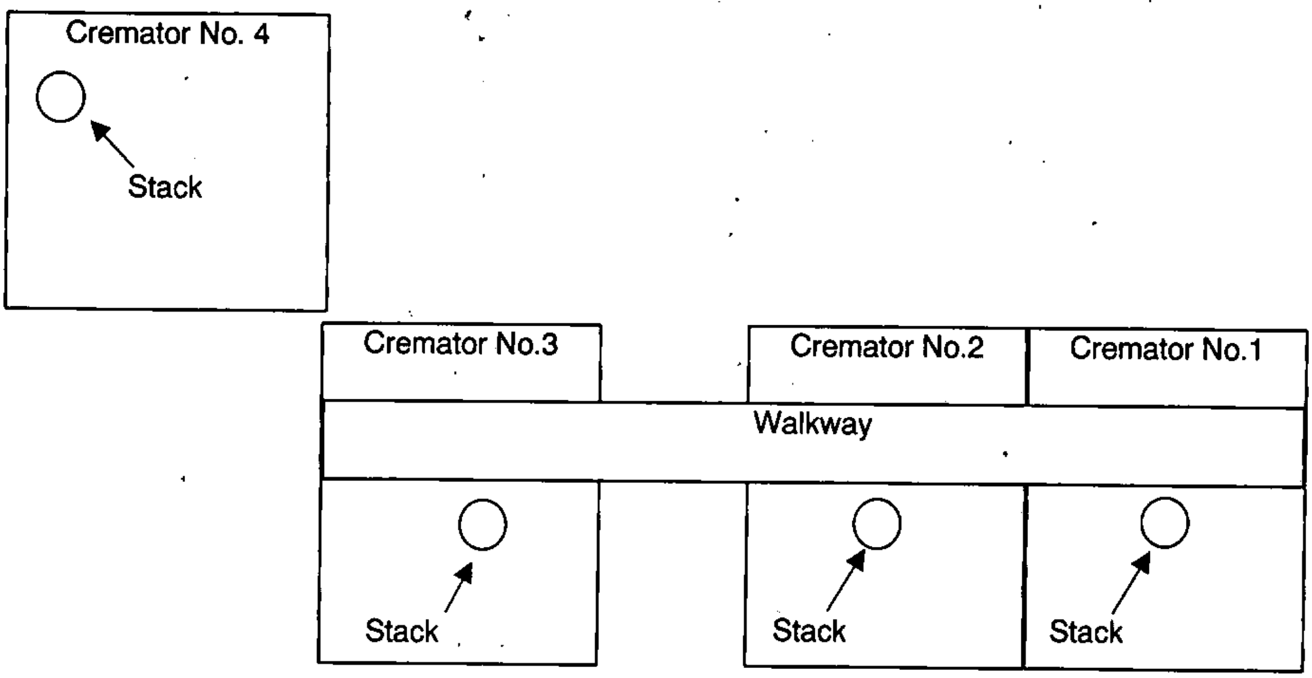
Where - is indicated in table: Cremation over, i.e no more data collected.

Organic Compounds & Carbon Monoxide Emissions Data

Time	OC mg/m³	O_2 % v/v	CO mg/m³	Time	OC mg/m³	O_2 % v/v	CO mg/m³
Test 2 - 17.04.02				Test 2 - 17.04.02			
11:08	0.7	13.5	13.4	11:53	0.6	15.5	18
11:09	0.7	13.8	8.8	-	-	-	-
11:10	0.4	12.1	8.4	-	-	-	-
11:11	0.3	7.5	5.5	-	-	-	-
11:12	0.1	8.4	7.9	-	-	-	-
11:13	0.3	9.8	7.8	-	-	-	-
11:14	0.2	10.9	7.4	-	-	-	-
11:15	0.2	13.1	0.0	-	-	-	-
11:16	0.4	12.3	2.9	-	-	-	-
11:17	0.3	10.4	0.0	-	-	-	-
11:18	0.4	12.2	0.0	-	-	-	-
11:19	0.5	14.1	0.0	-	-	-	-
11:20	0.4	12.6	0.0	-	-	-	-
11:21	0.3	11.0	0.0	-	-	-	-
11:22	0.4	12.7	0.0	-	-	-	-
11:23	0.5	14.2	0.0	-	-	-	-
11:24	0.4	8.2	0.0	-	-	-	-
11:25	0.4	6.9	0.0	-	-	-	-
11:26	0.1	9.4	0.0	-	-	-	-
11:27	7.5	12.0	0.0	-	-	-	-
11:28	0.5	10.3	0.0	-	-	-	-
11:29	0.5	8.6	0.0	-	-	-	-
11:30	0.6	9.1	0.0	-	-	-	-
11:31	0.6	15.1	0.0	-	-	-	-
11:32	0.3	14.4	0.0	-	-	-	-
11:33	0.4	13.2	0.0	-	-	-	-
11:34	0.2	13.3	0.0	-	-	-	-
11:35	0.4	13.4	0.0	-	-	-	-
11:36	0.5	13.5	0.0	-	-	-	-
11:37	0.5	13.5	0.0	-	-	-	-
11:38	0.2	13.4	0.0	-	-	-	-
11:39	0.2	13.5	0.0	-	-	-	-
11:40	0.5	14.2	0.0	-	-	-	-
11:41	1.1	16.3	0.0	-	-	-	-
11:42	0.6	15.2	0.0	-	-	-	-
11:43	0.4	11.5	0.0	-	-	-	-
11:44	0.4	13.3	0.0	-	-	-	-
11:45	0.7	14.1	0.0	-	-	-	-
11:46	0.6	12.1	0.0	-	-	-	-
11:47	0.2	11.4	22	-	-	-	-
11:48	0.4	12.2	8.5	-	-	-	-
11:49	0.5	14.7	0.0	-	-	-	-
11:50	0.6	15.5	37	-	-	-	-
11:51	0.6	15.4	72	-	-	-	-
11:52	0.6	15.2	26	**Mean**	**0.5**	**10.8**	**16.2**

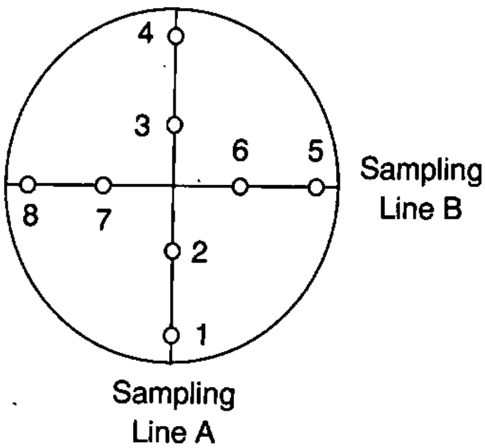
Where - is indicated in table: Cremation over, i.e no more data collected.

Plant Layout



Stack Diagram

Sampling Point	Distance as a % of D	Distance into Stack (m)
1, 5	6.5	0.02
2, 6	25	0.10
3, 7	75	0.29
4, 8	93.5	0.36



Stack Diameter (D) = 0.38 m

Stack Area (A) = 0.11 m^2

Total Particulate Matter Sampling Methodology

US EPA Method 5 requires the extraction of a particulate laden sample from the stack or duct, followed by the subsequent removal of the particulate matter by a filter medium. Concurrently, a measurement of the volume of the withdrawn sample gas is required to determine the particulate concentration. The sample is extracted by using a traversing procedure that approximately integrates the sample volume and collected particulate mass over the entire cross section of the stack or duct. During the sample traverse, the velocity distribution is also determined. This data provides the stack gas flow rate which is used with the particulate concentration to calculate the mass emission rate. Throughout the sampling period, therefore, the sample gas velocity in the probe nozzle is adjusted or re-adjusted to equal the stack gas velocity at each and every traverse point.

Laboratory Preparation

All glassware and metal components are cleaned in accordance with the clean up procedures as described later.
The required number of filter papers are heated in an oven at 105°C for a period of 2 hours and then placed in a desiccator until they can be weighed to a stable weight to within ± 0.1 mg. The whole sampling train is assembled in a clean environment and the following checks carried out.

1. No obvious damage such as cracked glass, split wiring, cross threads etc.
2. With the impingers filled with the necessary amounts of distilled water/silica gel, a system leak check is performed.
3. Fluid reservoir levels for both liquid manometers are topped up to the required
4. All heated components and thermocouples are checked.
5. The umbilical cord is inspected for leaks and the wiring checked for flaws.
6. All the nozzle inlet diameters are measured and any distortions recorded.
7. Finally, the sampling train is dismantled and made ready for transport to site.

Sampling

The sampling train is unpacked and assembled as shown below. The following is then carried out.

1. A quick check to confirm all heated components are working correctly.
2. Measurement of the stack diameter and calculation of the appropriate sampling points.
3. At each of the sampling points, the pitot tube pressure drop and gas temperature are recorded.

Total Particulate Matter Sampling Methodology

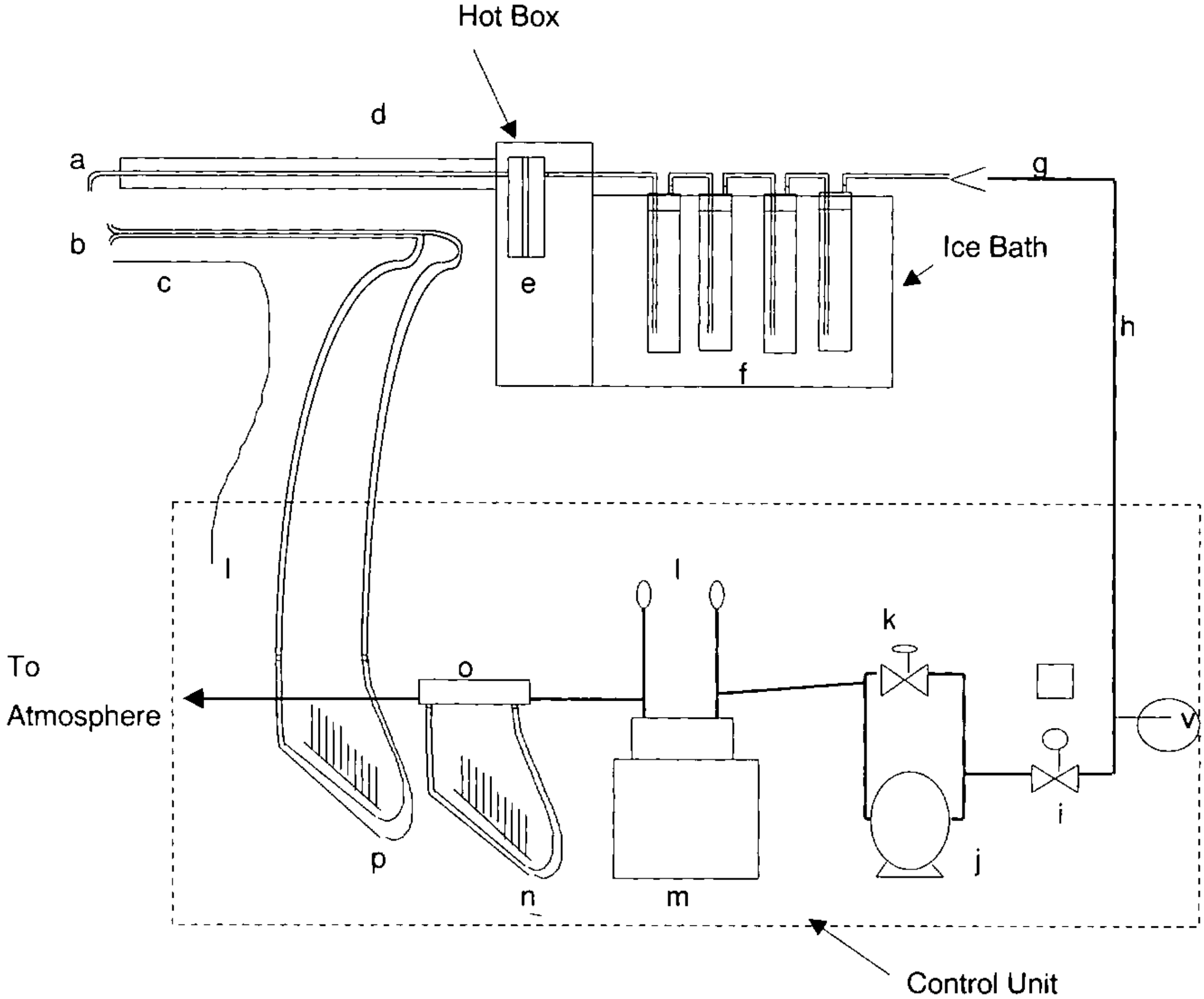
4. Measurements of the stack pressure, gas composition and moisture content are noted and the nozzle diameter determined.
5. A filter of known weight is placed in it's housing unit and inserted into the heater box.
6. The heated probe and heater box are switched on and set to the required temperatures.
7. A sampling train leak check is performed.
8. The probe is positioned at the first sampling point.
9. The initial gas meter volume is recorded.
10. Sampling is then performed for an equal time period at each of the sampling points with all necessary data recorded throughout the test.
11. When sampling is complete, the final gas meter volume is recorded and a sampling train leak check is performed.
12. The sampling train is prepared to carry out a second test as outlined in the clean up procedure.

Clean Up Procedure

1. The filter is removed and returned it to it's labelled petri dish. Any particulate matter deposited on the filter housing, probe lining and nozzle are collected and placed in the same petri dish. The filter housing, probe lining and nozzle are then rinsed with acetone, with the washings collected in a labelled container.
2. The impinger solution from the first two impingers is poured into one labelled container. Any condensate collected in the third impinger is then added to this container
3. The silica gel from the fourth impinger is emptied into a labelled container.
4. The impingers are then washed with distilled water and the washings poured into a labelled container.

Sampling Equipment

Sampling Train Used: Air Testing & Support Manual Sampling Train



Key

a	Quartz Nozzle	i	Coarse Control Valve
b	S-Type Pitot Tube	j	Vacuum Pump
c	Thermocouple	k	Fine Control Valve
d	Quartz Lined Heated Probe	l	Thermocouples
e	Filter Holder	m	Dry Gas Meter
f	Impingers	n	Orifice Manometer
g	Check Valve	o	Orifice Plate
h	Umbilical Cord	p	Pitot Manometer

Organic Compounds Sampling Methodology

The Signal 3010 MINIFID Portable Heated Total Hydrocarbon Analyser uses Flame Ionisation to detect total organic carbon in a gas stream.

Checks Carried Out before Arrival On Site

The FID analyser is set up and is tested. The following are checked; the furnace and sample line temperatures, the zero and span gas calibration and the operation of the data logger.

On Site Sampling Procedure

The FID and sample line are switched on and allowed to reach operational temperature. The analyser will take 20 minutes to reach its operational temperature of 180°C. The sample line is heated to approximately 180°C to avoid VOCs condensing in the line. When the components have reached the correct operating temperature the fuel and span gas valves are opened and the FID is ignited.

The FID will take about 20 minutes before it stabilises and gives a zero ppm reading. The zero gas is fed into the FID and the zero set. The span gas is fed into the FID and the instrument adjusted to read the certified span gas value. The zero gas is fed into the FID once more to check that the reading returns to zero, if it does not, then these steps are repeated.

The probe, with a particulate filter, is then inserted into the stack, and the data logger activated.

The data logger can be programmed to log results over a 1, 5, 10 etc minute period. The results displayed and logged are the volume concentration of propane in ppm, which are converted to mg/m³ by the following calculations:

$$C_m = C_v \frac{36}{22.4}$$

where C_m is the TOC concentration in mg/m³ (273 K; 101300 Pa)
C_v is the volume concentration of propane in ppm (by volume)

$$C_n = C_i \times \left[\frac{100}{100 - \%H_2O_m} \right] \times \left[\frac{21 - \%O_{ref}}{21 - \%O_m} \right]$$

where

C_n	is the TOC concentration in mg/m³ stated at reference conditions of humidity and oxygen
C_i	is the TOC concentration in mg/m³ (273 K; 101 300 Pa) at flue gas conditions of humidity and oxygen
$\% H_2O_m$	is the measured percentage by volume of water in the flue gas
$\% O_m$	is the measured percentage by volume of oxygen in the flue gas
$\% O_{ref}$	is the percentage by volume of oxygen at the reference conditions

Carbon Monoxide Sampling Methodology

The Testo 350 flue gas analyser is a portable instrument capable of measuring oxygen, carbon dioxide, carbon monoxide, stack temperature, date and time of test. The Testo 350 has a large measuring range for process control in industrial furnaces and a high accuracy level, even in the lower measuring ranges, for limit value control. Up to 500 measurements can be stored directly on location, with online data transmission to a PC possible for long-term measurements. The mobile gas preparation unit Testo 339, which dries the sample gas, can be connected as an option for long-term measurements.

Checks Carried Out Before Arrival On Site

Condensate traps are emptied and particulate filters replaced if necessary. The analyser when switched on, carries out a self-test (approximately 60 seconds) and rinses the measuring cells with fresh air. The analyser is tested with certified bottled calibration gas. If any cells require replacing, or adjustments are required to bring the analyser within calibration, these are made and a certificate of calibration produced. The handset is cleared of data and the analyser batteries fully charged.

On-Site Sampling Procedure

The flue gas probe is connected and the analyser switched on. The analyser is allowed to perform its self-test in fresh air. The appropriate fuel type is selected. The instrument status data (instrument temperature, battery voltage and pump capacity), required for smooth operation are checked. The complete measuring system (probe, condensate trap, tubes and connections) are leak tested. The measuring variables are set and a file created to which measurements are stored. The probe is positioned into the centre of the stack and the access hole plugged. The pump is started and measurements made. During long-term measurements the electronic measuring cells need fresh air phases to regenerate. The number and duration of the required fresh air times depends on the gas concentration and sample duration.

Post-Site Procedure

The handset memory is downloaded to PC and the analyser retested with calibration gas.

Operational Range

The O_2 sensor is a self powered, diffusion limited, metal air battery fuel cell. It has a resolution of 0.1% with an accuracy of 0.1%.

The CO cell has a resolution of 1 ppm with an accuracy of +/- 20 ppm at concentrations less than 400 ppm, +/- 5% at concentrations less than 2000 ppm and +/- 10% at concentrations greater than 2000 ppm.

All sensors and electrochemical cells have filters and cross sensitivity compensation data for more accurate measurements.

Quality Assurance Checklist

Preparation:

All glassware cleaned according to the appropriate test method.	Yes
Filters are dried, desiccated and weighed to achieve stable weights.	Yes
Equipment checked for faults and calibrated if necessary.	Yes

Sampling:

Sampling train assembled and leak check performed in accordance with the appropriate test method.	Yes
Critical temperatures (hot box, probe, condenser and gas sample) maintained according to the appropriate test method.	Yes
Isokinetic variation within method requirement of ± 10%.	Yes
Sample recovery according to the appropriate test method.	Yes

Sample Analysis:

Samples sent to our accredited laboratory and analysis performed according to the appropriate analytical method.	Yes

QA Procedures:

Equipment underwent a calibration check where necessary.	Yes
Recorded information downloaded and printouts made.	Yes
Report saved electronically onto Scientifics server.	Yes
On site data sheet completed and signed off by Team Leader.	Yes
Raw data and hard copy of report filed together.	Yes

Stack Emissions Testing Team

Environmental Team Leader	Jez Anderson BSc (Hons) Physics
Environmental Technician(s)	Mark Woodruff BSc (Hons) Environmental Studies

Report by	Mark Woodruff Environmental Technican

Checked and Authorised By	[redacted]	Signed
	JEZ ANDERSON	Print Name
	13/5/02.	Dated
	~~Business Manager~~ / Team Leader (Delete as appropriate)	Business Title

Deviations from Test Methods

In this instance, testing was fully in accordance with the respective test methods.

Conclusion

The results of this monitoring exercise demonstrate that under normal operating conditions, this Plant is being operated in full compliance with all the emission concentration limits specified in PG5/2(95).

Good housekeeping and maintenance of the ducting and associated plant should be continued in order to maintain this level of Plant performance.

A regular programme of stack emissions testing in accordance with the Plant's LAPC Authorisation will be required to demonstrate continued compliance.

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AIR & EMISSIONS TESTING GROUP

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Stack Emissions Testing Report

Total Particulate Matter
Hydrogen Chloride
Organic Compounds
Carbon Monoxide

Coventry City Council

Canley Crematorium

Cremator No. 3

Sampling Date(s) **16th April 2002**

Report by Jez Anderson

Job Number LAB 3561

Contents

Introduction

Coventry City Council operate a Crematoria at Canley Crematorium which is subject to Local Air Pollution Control by Coventry County Council under the Environmental Protection Act 1990, Part 1.

Scientifics Limited were commissioned by Coventry City Council to carry out stack emissions testing to determine the releases of prescribed pollutants from the following Cremator under normal operating conditions.

Company	Coventry City Council	
Site	Canley Crematorium	
Stack	Cremator No. 3	
Sampling Date(s)	16th April 2002	
Cremator Manufacturer	Furance Construction Ltd	
Cremator Model	Newton	
Cremator Serial Number	CF 408	
Operating Conditions	<u>Test 1</u>	<u>Test 2</u>
Coffin Construction	Standard	Standard
Mass of Deceased	Average	Average
Cremation Number	140249	140253
Process	'Crematoria'	
Guidance Note	PG5/2(95)	

Any deviations from the respective test methods are noted in the conclusion.

Written Summary

Total Particulate Matter **Passed**

Two particulate tests were performed, each lasting a complete cremation. The mean sampling time was 93 minutes. The mean particulate concentration was 52 mg/m³ at reference conditions. This value is below the emission concentration limit of 80 mg/m³ specified in PG5/2(95). max 54 ✓

The sampling was performed in accordance with the main procedural requirements of US EPA Method 5 using a Air Testing & Support Manual Sampling Train.

Hydrogen Chloride **Passed**

Two hydrogen chloride tests were performed, each lasting a complete cremation. The mean sampling time was 93 minutes. The mean hydrogen chloride concentration was 32 mg/m³ at reference conditions. This value is below the emission concentration limit of 200 mg/m³ specified in PG5/2(95). max 37 ✓

The sampling was performed in accordance with the main procedural requirements of US EPA Method 26A using a Air Testing & Support Manual Sampling Train.

Organic Compounds **Passed**

Two organic compounds tests were performed, each lasting a complete cremation. The mean sampling time was 93 minutes. The mean organic compounds concentration was 0.79 mg/m³ at reference conditions. This value is below the emission concentration limit of 20 mg/m³ specified in PG5/2(95). max 0.82 ✓

The sampling was performed in accordance with the main procedural requirements of US EPA Method 25A using a heated sampling line and a Signal 3010 MINIFID portable VOC analyser with detection by FID calibrated against 11 ppm propane span gas.

Carbon Monoxide **Passed**

Two carbon monoxide tests were performed, each lasting a complete cremation. The mean sampling time was 93 minutes. The mean carbon monoxide concentration was 3.2 mg/m³ at reference conditions. This value is below the emission concentration limit of 100 mg/m³ specified in PG5/2(95). max 3.8 ✓

The sampling was performed using a heated sampling line with a Testo 339 gas conditioning unit and a Testo 350 flue gas analyser with detection by electrochemical cells calibrated against 99 ppm carbon monoxide span gas.

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Emissions Summary

Company	Coventry City Council
Site	Canley Crematorium
Stack	Cremator No. 3
Sampling Date(s)	16th April 2002

Parameter	Units	Result	Limit	Outcome
Total Particulate Matter	mg/m^3	52	80	Passed
Total Particulate Matter Emission Rate	g/hr	25	-	-
Isokinetic Variation	%	-7.4	-	-
Hydrogen Chloride	mg/m^3	32	200	Passed
Hydrogen Chloride Emission Rate	g/hr	15	-	-
Organic Compounds	mg/m^3	0.79	20	Passed
Organic Compounds Emission Rate	g/hr	0.38	-	-
Carbon Monoxide	mg/m^3	3.2	100	Passed
Carbon Monoxide Emission Rate	g/hr	1.6	-	-
Oxygen	% v/v	13.9	-	-
Temperature	°C	842	-	-
Moisture	% v/v	9.3	-	-
Gas Velocity	m/s	7.7	-	-
Gas Volumetric Flow Rate (Actual)	m^3/hr	3155	-	-
Gas Volumetric Flow Rate (STP)	m^3/hr	689	-	-

All results are mean values, with pollutant concentrations expressed at reference conditions. Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Preliminary Velocity and Temperature Profile

	Line A			Line B		
Traverse Point	Dynamic Pressure Pa	Temp °C	Velocity m/s	Dynamic Pressure Pa	Temp °C	Velocity m/s
1	12	776	6.73	15	779	7.54
2	14	776	7.27	16	780	7.79
3	13	778	7.02	14	781	7.29
4	15	777	7.53	13	781	7.03
5	12	779	6.74	15	780	7.54
6	16	778	7.78	12	782	6.75
7	13	779	7.02	15	782	7.55
8	14	780	7.29	16	782	7.80
9	15	780	7.54	14	781	7.29
10	16	780	7.79	15	783	7.55
Mean	14	778	7.27	14	781	7.41

Total Particulate Matter Summary

Particulate	Sampling Times	Concentration mg/m^3	Emission Rate g/hr
Test 1	11:06 - 12:46	45	26
Test 2	13:08 - 14:33	59	24
Mean Particulate Concentration		52	25

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Hydrogen Chloride Summary

HCl	Lab Result mg	Volume Sampled m^3	Concentration mg/m^3	Emission Rate g/hr
Test 1	31	1.2081	26	15
Test 2	26	0.7049	37	15
Mean HCl Concentration			32	15

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Organic Compounds Summary

Organic Compounds	Sampling Times	Concentration mg/m^3	Emission Rate g/hr
Test 1	11:06 - 12:46	0.75	0.43
Test 2	13:08 - 14:33	0.82	0.33
Mean Organic Compounds Concentration		0.79	0.38

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Carbon Monoxide Summary

Carbon Monoxide	Sampling Times	Concentration mg/m^3	Emission Rate g/hr
Test 1	11:06 - 12:46	3.8	2.2
Test 2	13:08 - 14:33	2.5	0.99
Mean Carbon Monoxide Concentration		3.2	1.6

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Equations 1

Test	1	2	Units
Date	16.04.02	16.04.02	-
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	754.5	754.5	mm Hg
Stack static pressure, P_{static}	5.10	5.10	mm H_2O
$P_s = P_b + \frac{(P_{static})}{13.6}$	754.9	754.9	mm Hg
Volume of water vapour collected, V_{wstd}			
Impinger volume collected	117	70	ml
Silica gel weight increase	35	6	g
Total volume of liquid collected, V_{lc}	152	76	ml
$V_{wstd} = (0.001246)(V_{lc})$	0.1885	0.0947	m^3
Volume of gas metered, V_{mstd}			
Volume of gas sample through gas meter, V_m	1.8292	1.1500	m^3
Gas meter correction factor, Y_d	0.9787	0.9787	-
Average dry gas meter temperature, T_m	19.5	21.5	°C
Average pressure drop across orifice, ΔH	46.67	21.96	mm H_2O
$V_{mstd} = \frac{(0.3592)(V_m)(P_b+(\Delta H/13.6))(Y_d)}{T_m + 273}$	1.6663	1.0380	m^3
Volume of gas at X% oxygen, $V_{mstd@X\%\ oxygen}$			
% oxygen measured in gas stream, act%O_2	13.7	14.2	%
% oxygen at which results required X%	11.0	11.0	%
% oxygen in ambient air by volume	20.9	20.9	%
$O_{xygen@11\%} = \frac{20.9 - act\%O_2}{20.9 - X\%}$	0.73	0.68	-
$V_{mstd@X\%oxygen} = (V_{mstd})(O_{xygen@11\%})$	1.2081	0.7049	m^3
Moisture content, B_{wo}			
$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$	0.102	0.084	m^3
	10.16	8.36	%
Wet volume of gas metered, V_{mstw}			
$V_{mstw} = V_{mstd@X\%oxygen} + V_{wstd}$	1.3966	0.7996	m^3

Equations 2

Test	1	2	Units
Date	16.04.02	16.04.02	-
Molecular weight of dry gas stream, M_d			
CO_2	4.1	3.8	%
O_2	13.7	14.2	%
CO	0.0003	0.0002	%
Total	17.81	18.01	%
N_2 (100 -Total)	82.19	81.99	%
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%CO+\%N_2)$	29.20	29.18	g/gmol
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - B_{wo}) + 18(B_{wo})$	28.06	28.24	g/gmol
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	34.97	34.97	-
Velocity pressure coefficient, C_p	0.79	0.79	-
Average of velocity heads, ΔP_{avg}	2.08	0.98	mm H_2O
Average square root of velocity heads, $\sqrt{\Delta P}$	1.44	0.99	$\sqrt{\text{mm } H_2O}$
Average stack gas temperature, T_s	900	783	°C
$V_s = \dfrac{(K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})}{\sqrt{(Ms)(Ps)}}$	9.38	6.08	m/s
Actual flow of stack gas, Q_a			
Area of stack, A_s	0.11	0.11	m^2
$Q_a = (60)(A_s)(V_s)$	63.8	41.4	m^3/min
Dry total flow of stack gas, Q_{std}			
Conversion factor (K/mm.Hg)	0.3592	0.3592	-
$Q_{std} = \dfrac{(Q_a)P_s(0.3592)(1-B_{wo})}{(T_s)+273}$	13.3	9.7	m^3/min
Wet total flow of stack gas, Q_{stw}			
Conversion factor (K/mm.Hg)	0.3592	0.3592	-
$Q_{std} = \dfrac{(Q_a)P_s(0.3592)}{(T_s)+273}$	14.7	10.6	m^3/min

Equations 3

Test	1	2	Units
Date	16.04.02	16.04.02	-
Percent isokinetic, %I			
Nozzle area, A_n	153.96	153.96	mm^2
Total sampling time, θ	100	85	min
$\%I = \dfrac{(4.6398E6)(T_s+273)(V_{mstd})}{(P_s)(V_s)(A_n)(\theta)(1-B_{wo})}$	92.6	92.5	%
Percentage isokinetic acceptable $\pm$ 10%	Yes	Yes	-
Particulate Concentration, C			
Mass of particulate collected on filter, M_f	0.0542	0.0417	g
Mass of particulate collected in probe, M_p	0.0003	0.0002	g
Mass of total particulate collected, M_n	0.0545	0.0419	g
$C_{dry} = \dfrac{M_n}{V_{mstd}}$	32.7	40.4	mg/m^3
$C_{wet} = \dfrac{M_n}{V_{mstw}}$	39.0	52.4	mg/m^3
$C_{@11\%oxygen} = \dfrac{M_n}{V_{mstd@11\%oxygen}}$	45.1	59.4	mg/m^3
Particulate emission rate, $E_{g/hr}$			
$E_{g/hr} = \dfrac{(C_{dry})(Q_{std})(60)}{1000}$	26.0	23.6	g/hr
Cremation Details			
Cremation Date	16.04.02	16.04.02	-
Cremation Number	140249	140253	-
Mass of Deceased	Average	Average	-
Gender of Deceased	Female	Female	-
Coffin Features	Standard	Standard	-

Organic Compounds & Carbon Monoxide Emissions Data

Time	OC mg/m³	O_2 % v/v	CO mg/m³	Time	OC mg/m³	O_2 % v/v	CO mg/m³
Test 1 - 16.04.02				Test 1 - 16.04.02			
11:06	2.0	10.3	17.5	11:51	0.3	15.2	0.0
11:07	1.5	10.5	15.5	11:52	1.0	15.3	0.0
11:08	1.1	10.8	17.1	11:53	0.6	15.3	0.0
11:09	0.9	11.2	16.6	11:54	1.0	15.5	0.0
11:10	1.3	11.3	15.4	11:55	0.6	12.6	0.0
11:11	0.5	11.2	14.0	11:56	0.2	11.1	0.0
11:12	0.5	11.1	15.2	11:57	0.5	13.4	0.0
11:13	0.4	11.3	15.5	11:58	0.4	16.2	0.0
11:14	0.2	11.4	13.1	11:59	0.3	15.0	0.0
11:15	0.7	11.3	11.6	12:00	0.2	13.6	0.0
11:16	0.4	11.3	11.6	12:01	0.6	15.2	0.0
11:17	0.7	10.5	9.5	12:02	1.2	16.6	0.0
11:18	1.3	10.1	12.6	12:03	0.9	15.3	0.0
11:19	1.5	10.4	11.8	12:04	0.5	13.9	0.0
11:20	2.2	10.6	9.6	12:05	0.5	14.2	0.0
11:21	1.9	10.8	8.6	12:06	0.6	14.7	0.0
11:22	2.1	10.9	13.6	12:07	0.9	15.3	0.0
11:23	1.9	10.6	14.4	12:08	1.8	18.0	0.0
11:24	1.0	10.3	21.0	12:09	0.8	16.6	0.0
11:25	0.9	10.5	17.8	12:10	0.4	11.6	0.0
11:26	0.5	10.8	17.2	12:11	0.6	12.4	0.0
11:27	0.4	10.9	16.1	12:12	0.8	14.4	0.0
11:28	0.5	11.2	20.4	12:13	0.3	14.5	0.0
11:29	0.4	11.1	17.7	12:14	0.3	14.6	0.0
11:30	0.4	11.0	15.0	12:15	0.6	14.9	0.0
11:31	0.4	11.2	7.7	12:16	0.9	15.2	0.0
11:32	0.2	11.3	6.5	12:17	0.9	15.3	0.0
11:33	0.2	11.8	0.0	12:18	1.0	15.4	0.0
11:34	0.4	12.4	0.0	12:19	0.6	15.2	0.0
11:35	0.7	12.8	0.0	12:20	0.7	15.5	0.0
11:36	0.7	13.0	0.0	12:21	0.6	15.2	0.0
11:37	0.7	13.2	0.0	12:22	0.3	15.3	0.0
11:38	0.7	13.4	0.0	12:23	0.3	15.4	0.0
11:39	0.5	13.8	0.0	12:24	0.7	15.5	0.0
11:40	1.0	14.1	0.0	12:25	0.6	15.2	0.0
11:41	0.8	14.5	0.0	12:26	0.3	15.3	0.0
11:42	1.1	14.6	0.0	12:27	0.3	15.4	0.0
11:43	1.2	14.9	0.0	12:28	0.6	15.2	0.0
11:44	0.3	15.1	0.0	12:29	0.6	15.2	0.0
11:45	0.5	14.0	0.0	12:30	0.3	15.2	0.0
11:46	0.5	13.5	0.0	12:31	0.3	15.1	0.0
11:47	0.5	14.0	0.0	12:32	0.9	15.3	0.0
11:48	0.6	14.9	0.0	12:33	0.9	15.2	0.0
11:49	0.3	15.0	0.0	12:34	0.6	15.3	0.0
11:50	0.3	15.0	0.0	12:35	0.3	15.4	0.0

Where - is indicated in table: Cremation over, i.e no more data collected.

Organic Compounds & Carbon Monoxide Emissions Data

Time	OC mg/m³	O_2 % v/v	CO mg/m³	Time	OC mg/m³	O_2 % v/v	CO mg/m³
Test 1 - 16.04.02				Test 2 - 16.04.02			
12:36	0.7	15.5	0.0	13:08	0.3	10.5	27.4
12:37	0.7	15.5	0.0	13:09	0.5	10.6	19.2
12:38	1.0	15.5	0.0	13:10	0.5	10.4	24.8
12:39	1.0	15.5	0.0	13:11	0.3	10.8	22.1
12:40	1.3	15.6	0.0	13:12	0.3	10.7	23.1
12:41	0.7	15.5	0.0	13:13	0.3	10.6	18.0
12:42	0.7	15.5	0.0	13:14	0.2	10.9	14.9
12:43	1.3	15.5	0.0	13:15	0.2	11.2	16.6
12:44	1.3	15.6	0.0	13:16	0.2	11.1	8.8
12:45	0.7	15.6	0.0	13:17	0.5	11.2	6.4
12:46	1.3	15.5	0.0	13:18	0.5	11.1	5.1
-	-	-	-	13:19	0.7	11.3	10.3
-	-	-	-	13:20	0.7	11.4	7.8
-	-	-	-	13:21	0.4	11.2	5.1
-	-	-	-	13:22	0.4	11.5	2.6
-	-	-	-	13:23	0.5	11.3	1.3
-	-	-	-	13:24	0.2	11.2	1.3
-	-	-	-	13:25	0.2	12.4	0.0
-	-	-	-	13:26	0.4	12.3	0.0
-	-	-	-	13:27	0.8	11.7	0.0
-	-	-	-	13:28	0.6	11.8	0.0
-	-	-	-	13:29	0.4	12.1	0.0
-	-	-	-	13:30	0.5	13.4	0.0
-	-	-	-	13:31	0.7	13.5	0.0
-	-	-	-	13:32	0.6	12.7	0.0
-	-	-	-	13:33	0.7	13.6	0.0
-	-	-	-	13:34	0.7	13.4	0.0
-	-	-	-	13:35	0.5	13.8	0.0
-	-	-	-	13:36	1.1	14.6	0.0
-	-	-	-	13:37	0.3	14.7	0.0
-	-	-	-	13:38	0.8	14.5	0.0
-	-	-	-	13:39	0.6	14.8	0.0
-	-	-	-	13:40	0.6	14.9	0.0
-	-	-	-	13:41	0.6	15.2	0.0
-	-	-	-	13:42	0.9	15.2	0.0
-	-	-	-	13:43	1.2	15.1	0.0
-	-	-	-	13:44	1.6	15.6	0.0
-	-	-	-	13:45	1.3	15.4	0.0
-	-	-	-	13:46	0.6	15.2	0.0
-	-	-	-	13:47	0.3	15.1	0.0
-	-	-	-	13:48	0.9	15.3	0.0
-	-	-	-	13:49	0.6	15.2	0.0
-	-	-	-	13:50	0.3	15.4	0.0
-	-	-	-	13:51	0.3	15.2	0.0
Mean	**0.7**	**13.7**	**3.8**	13:52	0.3	15.2	0.0

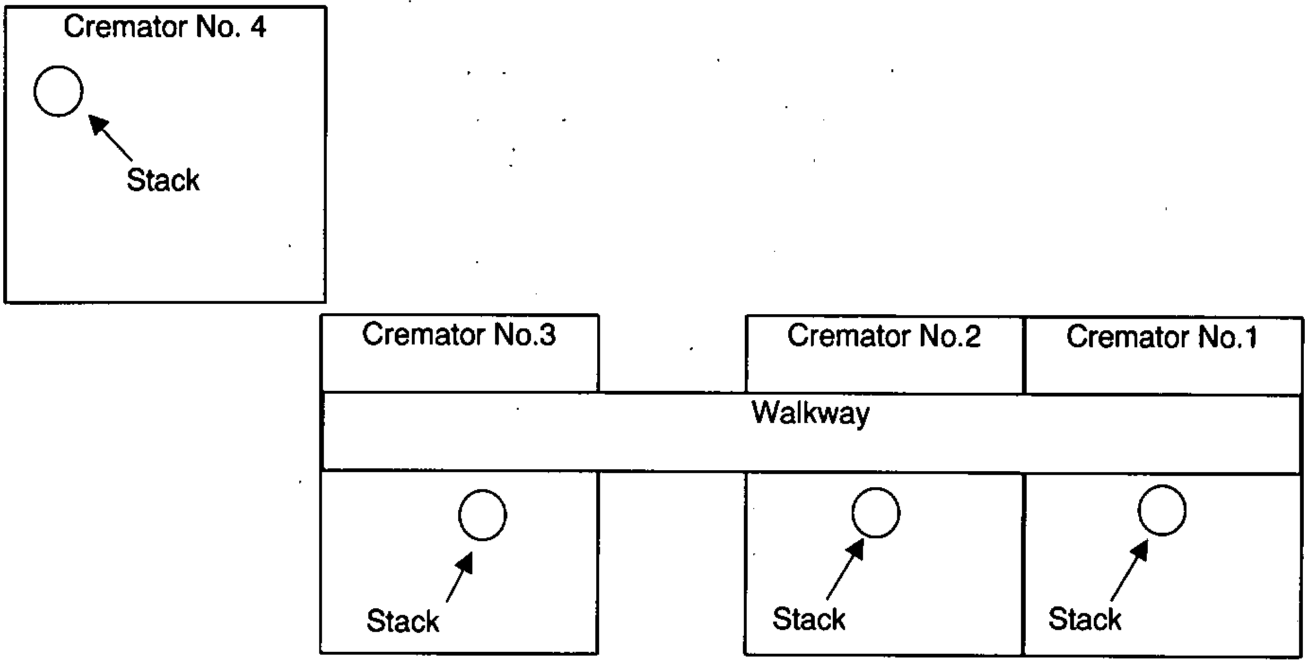
Where - is indicated in table: Cremation over, i.e no more data collected.

Organic Compounds & Carbon Monoxide Emissions Data

Time	OC mg/m^3	O_2 % v/v	CO mg/m^3	Time	OC mg/m^3	O_2 % v/v	CO mg/m^3
Test 2 - 16.04.02				Test 2 - 16.04.02			
13:53	0.7	15.7	0.0	-	-	-	-
13:54	0.6	15.2	0.0	-	-	-	-
13:55	0.9	15.3	0.0	-	-	-	-
13:56	0.3	15.2	0.0	-	-	-	-
13:57	0.9	15.1	0.0	-	-	-	-
13:58	0.6	15.2	0.0	-	-	-	-
13:59	0.6	15.3	0.0	-	-	-	-
14:00	0.6	15.4	0.0	-	-	-	-
14:01	0.6	15.5	0.0	-	-	-	-
14:02	1.2	15.2	0.0	-	-	-	-
14:03	0.6	15.3	0.0	-	-	-	-
14:04	0.9	15.4	0.0	-	-	-	-
14:05	1.0	15.5	0.0	-	-	-	-
14:06	0.6	15.4	0.0	-	-	-	-
14:07	0.3	15.3	0.0	-	-	-	-
14:08	0.9	15.4	0.0	-	-	-	-
14:09	1.3	15.5	0.0	-	-	-	-
14:10	1.3	15.5	0.0	-	-	-	-
14:11	0.7	15.6	0.0	-	-	-	-
14:12	0.3	15.6	0.0	-	-	-	-
14:13	0.6	15.5	0.0	-	-	-	-
14:14	0.3	15.6	0.0	-	-	-	-
14:15	1.6	15.6	0.0	-	-	-	-
14:16	0.7	15.7	0.0	-	-	-	-
14:17	1.0	15.6	0.0	-	-	-	-
14:18	0.6	15.4	0.0	-	-	-	-
14:19	2.0	15.8	0.0	-	-	-	-
14:20	2.0	15.7	0.0	-	-	-	-
14:21	1.4	15.8	0.0	-	-	-	-
14:22	2.3	15.6	0.0	-	-	-	-
14:23	2.2	15.5	0.0	-	-	-	-
14:24	1.3	15.6	0.0	-	-	-	-
14:25	0.7	15.6	0.0	-	-	-	-
14:26	1.6	15.6	0.0	-	-	-	-
14:27	0.6	15.5	0.0	-	-	-	-
14:28	0.6	15.4	0.0	-	-	-	-
14:29	1.0	15.5	0.0	-	-	-	-
14:30	1.9	15.5	0.0	-	-	-	-
14:31	2.3	15.6	0.0	-	-	-	-
14:32	2.6	15.6	0.0	-	-	-	-
14:33	2.3	15.6	0.0	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	**Mean**	**0.8**	**14.2**	**2.5**

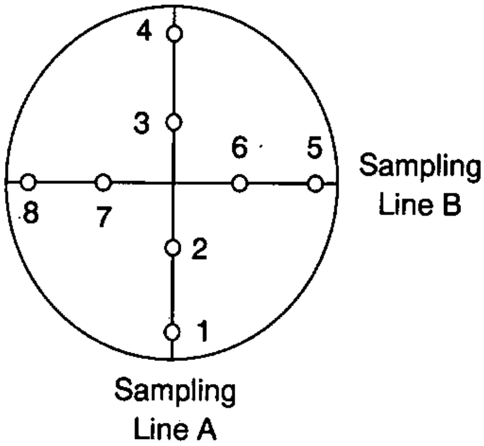
Where - is indicated in table: Cremation over, i.e no more data collected.

Plant Layout



Stack Diagram

Sampling Point	Distance as a % of D	Distance into Stack (m)
1, 5	6.5	0.02
2, 6	25	0.10
3, 7	75	0.29
4, 8	93.5	0.36



Stack Diameter (D) = 0.38 m

Stack Area (A) = 0.11 m^2

Total Particulate Matter Sampling Methodology

US EPA Method 5 requires the extraction of a particulate laden sample from the stack or duct, followed by the subsequent removal of the particulate matter by a filter medium. Concurrently, a measurement of the volume of the withdrawn sample gas is required to determine the particulate concentration. The sample is extracted by using a traversing procedure that approximately integrates the sample volume and collected particulate mass over the entire cross section of the stack or duct. During the sample traverse, the velocity distribution is also determined. This data provides the stack gas flow rate which is used with the particulate concentration to calculate the mass emission rate. Throughout the sampling period, therefore, the sample gas velocity in the probe nozzle is adjusted or re-adjusted to equal the stack gas velocity at each and every traverse point.

Laboratory Preparation

All glassware and metal components are cleaned in accordance with the clean up procedures as described later.
The required number of filter papers are heated in an oven at 105°C for a period of 2 hours and then placed in a desiccator until they can be weighed to a stable weight to within ± 0.1 mg. The whole sampling train is assembled in a clean environment and the following checks carried out.

1. No obvious damage such as cracked glass, split wiring, cross threads etc.
2. With the impingers filled with the necessary amounts of distilled water/silica gel, a system leak check is performed.
3. Fluid reservoir levels for both liquid manometers are topped up to the required
4. All heated components and thermocouples are checked.
5. The umbilical cord is inspected for leaks and the wiring checked for flaws.
6. All the nozzle inlet diameters are measured and any distortions recorded.
7. Finally, the sampling train is dismantled and made ready for transport to site.

Sampling

The sampling train is unpacked and assembled as shown below. The following is then carried out.

1. A quick check to confirm all heated components are working correctly.
2. Measurement of the stack diameter and calculation of the appropriate sampling points.
3. At each of the sampling points, the pitot tube pressure drop and gas temperature are recorded.

Total Particulate Matter Sampling Methodology

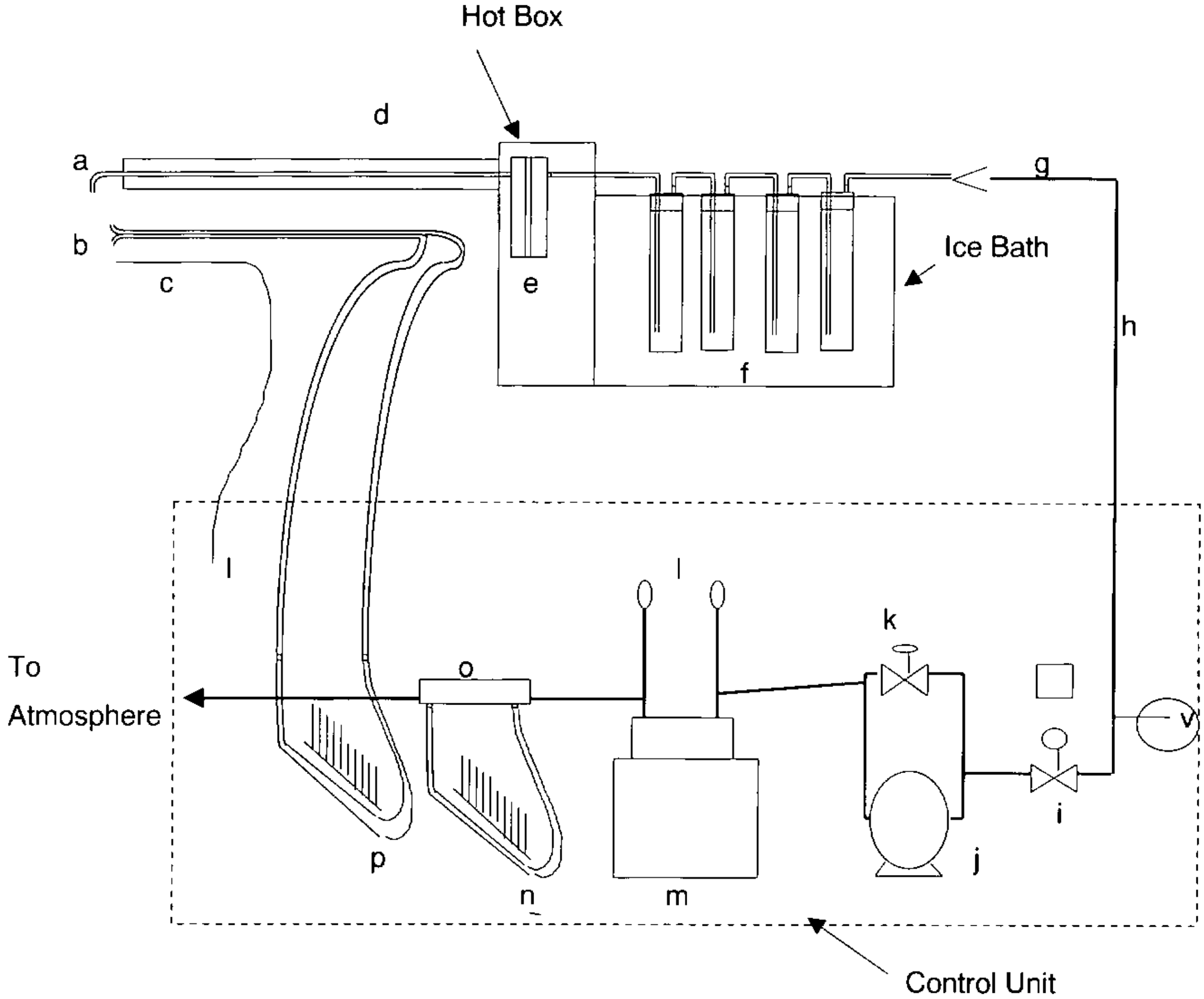
4. Measurements of the stack pressure, gas composition and moisture content are noted and the nozzle diameter determined.
5. A filter of known weight is placed in it's housing unit and inserted into the heater box.
6. The heated probe and heater box are switched on and set to the required temperatures.
7. A sampling train leak check is performed.
8. The probe is positioned at the first sampling point.
9. The initial gas meter volume is recorded.
10. Sampling is then performed for an equal time period at each of the sampling points with all necessary data recorded throughout the test.
11. When sampling is complete, the final gas meter volume is recorded and a sampling train leak check is performed.
12. The sampling train is prepared to carry out a second test as outlined in the clean up procedure.

Clean Up Procedure

1. The filter is removed and returned it to it's labelled petri dish. Any particulate matter deposited on the filter housing, probe lining and nozzle are collected and placed in the same petri dish. The filter housing, probe lining and nozzle are then rinsed with acetone, with the washings collected in a labelled container.
2. The impinger solution from the first two impingers is poured into one labelled container. Any condensate collected in the third impinger is then added to this container
3. The silica gel from the fourth impinger is emptied into a labelled container.
4. The impingers are then washed with distilled water and the washings poured into a labelled container.

Sampling Equipment

Sampling Train Used: Air Testing & Support Manual Sampling Train



Key

a	Quartz Nozzle	i	Coarse Control Valve
b	S-Type Pitot Tube	j	Vacuum Pump
c	Thermocouple	k	Fine Control Valve
d	Quartz Lined Heated Probe	l	Thermocouples
e	Filter Holder	m	Dry Gas Meter
f	Impingers	n	Orifice Manometer
g	Check Valve	o	Orifice Plate
h	Umbilical Cord	p	Pitot Manometer

Organic Compounds Sampling Methodology

The Signal 3010 MINIFID Portable Heated Total Hydrocarbon Analyser uses Flame Ionisation to detect total organic carbon in a gas stream.

Checks Carried Out before Arrival On Site

The FID analyser is set up and is tested. The following are checked; the furnace and sample line temperatures, the zero and span gas calibration and the operation of the data logger.

On Site Sampling Procedure

The FID and sample line are switched on and allowed to reach operational temperature. The analyser will take 20 minutes to reach its operational temperature of 180°C. The sample line is heated to approximately 180°C to avoid VOCs condensing in the line. When the components have reached the correct operating temperature the fuel and span gas valves are opened and the FID is ignited.

The FID will take about 20 minutes before it stabilises and gives a zero ppm reading. The zero gas is fed into the FID and the zero set. The span gas is fed into the FID and the instrument adjusted to read the certified span gas value. The zero gas is fed into the FID once more to check that the reading returns to zero, if it does not, then these steps are repeated.

The probe, with a particulate filter, is then inserted into the stack, and the data logger activated.

The data logger can be programmed to log results over a 1, 5, 10 etc minute period. The results displayed and logged are the volume concentration of propane in ppm, which are converted to mg/m³ by the following calculations:

$$C_m = C_v \frac{36}{22.4}$$

where C_m is the TOC concentration in mg/m³ (273 K; 101300 Pa)

C_v is the volume concentration of propane in ppm (by volume)

$$C_n = C_i \times \left[\frac{100}{100 - \%H_2O_m}\right] \times \left[\frac{21 - \%O_{ref}}{21 - \%O_m}\right]$$

where C_n is the TOC concentration in mg/m³ stated at reference conditions of humidity and oxygen

C_i is the TOC concentration in mg/m³ (273 K; 101 300 Pa) at flue gas conditions of humidity and oxygen

$\% H_2O_m$ is the measured percentage by volume of water in the flue gas

$\% O_m$ is the measured percentage by volume of oxygen in the flue gas

$\% O_{ref}$ is the percentage by volume of oxygen at the reference conditions

Carbon Monoxide Sampling Methodology

The Testo 350 flue gas analyser is a portable instrument capable of measuring oxygen, carbon dioxide, carbon monoxide, stack temperature, date and time of test. The Testo 350 has a large measuring range for process control in industrial furnaces and a high accuracy level, even in the lower measuring ranges, for limit value control. Up to 500 measurements can be stored directly on location, with online data transmission to a PC possible for long-term measurements. The mobile gas preparation unit Testo 339, which dries the sample gas, can be connected as an option for long-term measurements.

Checks Carried Out Before Arrival On Site

Condensate traps are emptied and particulate filters replaced if necessary. The analyser when switched on, carries out a self-test (approximately 60 seconds) and rinses the measuring cells with fresh air. The analyser is tested with certified bottled calibration gas. If any cells require replacing, or adjustments are required to bring the analyser within calibration, these are made and a certificate of calibration produced. The handset is cleared of data and the analyser batteries fully charged.

On-Site Sampling Procedure

The flue gas probe is connected and the analyser switched on. The analyser is allowed to perform its self-test in fresh air. The appropriate fuel type is selected. The instrument status data (instrument temperature, battery voltage and pump capacity), required for smooth operation are checked. The complete measuring system (probe, condensate trap, tubes and connections) are leak tested. The measuring variables are set and a file created to which measurements are stored. The probe is positioned into the centre of the stack and the access hole plugged. The pump is started and measurements made. During long-term measurements the electronic measuring cells need fresh air phases to regenerate. The number and duration of the required fresh air times depends on the gas concentration and sample duration.

Post-Site Procedure

The handset memory is downloaded to PC and the analyser retested with calibration gas.

Operational Range

The O_2 sensor is a self powered, diffusion limited, metal air battery fuel cell. It has a resolution of 0.1% with an accuracy of 0.1%.

The CO cell has a resolution of 1 ppm with an accuracy of +/- 20 ppm at concentrations less than 400 ppm, +/- 5% at concentrations less than 2000 ppm and +/- 10% at concentrations greater than 2000 ppm.

All sensors and electrochemical cells have filters and cross sensitivity compensation data for more accurate measurements.

Quality Assurance Checklist

Preparation:

All glassware cleaned according to the appropriate test method.	Yes
Filters are dried, desiccated and weighed to achieve stable weights.	Yes
Equipment checked for faults and calibrated if necessary.	Yes

Sampling:

Sampling train assembled and leak check performed in accordance with the appropriate test method.	Yes
Critical temperatures (hot box, probe, condenser and gas sample) maintained according to the appropriate test method.	Yes
Isokinetic variation within method requirement of ± 10%.	Yes
Sample recovery according to the appropriate test method.	Yes

Sample Analysis:

Samples sent to our accredited laboratory and analysis performed according to the appropriate analytical method.	Yes

QA Procedures:

Equipment underwent a calibration check where necessary.	Yes
Recorded information downloaded and printouts made.	Yes
Report saved electronically onto Scientifics server.	Yes
On site data sheet completed and signed off by Team Leader.	Yes
Raw data and hard copy of report filed together.	Yes

Stack Emissions Testing Team

Environmental Team Leader	Jez Anderson BSc (Hons) Physics
Environmental Technician(s)	Mark Woodruff BSc (Hons) Environmental Studies

Report by	Jez Anderson Team Leader	
Checked and Authorised By	[redacted]	Signed
	Jez Anderson	Print Name
	13/5/02	Dated
	~~Business Manager~~ / Team Leader (Delete as appropriate)	Business Title

Deviations from Test Methods

In this instance, testing was fully in accordance with the respective test methods.

Conclusion

The results of this monitoring exercise demonstrate that under normal operating conditions, this Plant is being operated in full compliance with all the emission concentration limits specified in PG5/2(95).

Good housekeeping and maintenance of the ducting and associated plant should be continued in order to maintain this level of Plant performance.

A regular programme of stack emissions testing in accordance with the Plant's LAPC Authorisation will be required to demonstrate continued compliance.

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AIR & EMISSIONS TESTING GROUP

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Stack Emissions Testing Report

Total Particulate Matter
Hydrogen Chloride
Organic Compounds
Carbon Monoxide

Coventry City Council

Canley Crematorium

Cremator No. 4

Sampling Date(s) **15th April 2002**

Report by Mark Woodruff

Job Number LAB 3561

Contents

Introduction

Coventry City Council operate a Crematoria at Canley Crematorium which is subject to Local Air Pollution Control by Coventry County Council under the Environmental Protection Act 1990, Part 1.

Scientifics Limited were commissioned by Coventry City Council to carry out stack emissions testing to determine the releases of prescribed pollutants from the following Cremator under normal operating conditions.

Company	Coventry City Council	
Site	Canley Crematorium	
Stack	Cremator No. 4	
Sampling Date(s)	15th April 2002	
Cremator Manufacturer	Furance Construction Ltd	
Cremator Model	Joule	
Cremator Serial Number	CF407	
Operating Conditions	Test 1	Test 2
Coffin Construction	Standard	Standard
Mass of Deceased	Average	Large
Cremation Number	140241	140245
Process	'Crematoria'	
Guidance Note	PG5/2(95)	

Any deviations from the respective test methods are noted in the conclusion.

Written Summary

Total Particulate Matter **Passed**

Two particulate tests were performed, each lasting a complete cremation. The mean sampling time was 117 minutes. The mean particulate concentration was 54 mg/m³ at reference conditions. This value is below the emission concentration limit of 80 mg/m³ specified in PG5/2(95).

max 75 ✓ but v close

The sampling was performed in accordance with the main procedural requirements of US EPA Method 5 using a Air Testing & Support Manual Sampling Train.

Hydrogen Chloride **Passed**

Two hydrogen chloride tests were performed, each lasting a complete cremation. The mean sampling time was 117 minutes. The mean hydrogen chloride concentration was 43 mg/m³ at reference conditions. This value is below the emission concentration limit of 200 mg/m³ specified in PG5/2(95).

max 70 ✓

The sampling was performed in accordance with the main procedural requirements of US EPA Method 26A using a Air Testing & Support Manual Sampling Train.

Organic Compounds **Failed**

max 93 ✗

Two organic compounds tests were performed, each lasting a complete cremation. The mean sampling time was 117 minutes. The mean organic compounds concentration was 78 mg/m³ at reference conditions. This value is above the emission concentration limit of 20 mg/m³ specified in PG5/2(95).

The sampling was performed in accordance with the main procedural requirements of US EPA Method 25A using a heated sampling line and a Signal 3010 MINIFID portable VOC analyser with detection by FID calibrated against 11 ppm propane span gas.

Carbon Monoxide **Passed**

CO max 82 ✓

Two carbon monoxide tests were performed, each lasting a complete cremation. The mean sampling time was 117 minutes. The mean carbon monoxide concentration was 41 mg/m³ at reference conditions. This value is below the emission concentration limit of 100 mg/m³ specified in PG5/2(95).

The sampling was performed using a heated sampling line with a Testo 339 gas conditioning unit and a Testo 350 flue gas analyser with detection by electrochemical cells calibrated against 99 ppm carbon monoxide span gas.

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Emissions Summary

Company	Coventry City Council
Site	Canley Crematorium
Stack	Cremator No. 4
Sampling Date(s)	15th April 2002

Parameter	Units	Result	Limit	Outcome
Total Particulate Matter	mg/m^3	54	80	Passed
Total Particulate Matter Emission Rate	g/hr	63	-	-
Isokinetic Variation	%	-3.2	-	-
Hydrogen Chloride	mg/m^3	43	200	Passed
Hydrogen Chloride Emission Rate	g/hr	49	-	-
Organic Compounds	mg/m^3	78	20	Failed
Organic Compounds Emission Rate	g/hr	94	-	-
Carbon Monoxide	mg/m^3	41	100	Passed
Carbon Monoxide Emission Rate	g/hr	52	-	-
Oxygen	% v/v	9.9	-	-
Temperature	°C	884	-	-
Moisture	% v/v	11.1	-	-
Gas Velocity	m/s	9.0	-	-
Gas Volumetric Flow Rate (Actual)	m^3/hr	5179	-	-
Gas Volumetric Flow Rate (STP)	m^3/hr	1077	-	-

All results are mean values, with pollutant concentrations expressed at reference conditions. Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Preliminary Velocity and Temperature Profile

	Line A			Line B		
Traverse Point	Dynamic Pressure Pa	Temp °C	Velocity m/s	Dynamic Pressure Pa	Temp °C	Velocity m/s
1	20	805	8.79	23	810	9.45
2	25	806	9.83	24	810	9.65
3	22	806	9.22	22	809	9.23
4	23	806	9.43	23	809	9.44
5	20	807	8.80	25	811	9.85
6	24	808	9.64	25	811	9.85
7	23	807	9.43	24	811	9.65
8	25	809	9.84	23	811	9.45
9	23	809	9.44	25	812	9.86
10	24	808	9.64	25	811	9.85
Mean	22	807	9.41	23	811	9.63

Total Particulate Matter Summary

Particulate	Sampling Times	Concentration mg/m³	Emission Rate g/hr
Test 1	13:05 -14:59	32	41
Test 2	15:18 - 17:18	75	85
Mean Particulate Concentration		54	63

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Hydrogen Chloride Summary

HCl	Lab Result mg	Volume Sampled m³	Concentration mg/m³	Emission Rate g/hr
Test 1	25	1.7172	15	18
Test 2	105	1.5044	70	80
Mean HCl Concentration			43	49

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Organic Compounds Summary

Organic Compounds	Sampling Times	Concentration mg/m³	Emission Rate g/hr
Test 1	13:05 -14:59	93	117
Test 2	15:18 - 17:18	62	71
Mean Organic Compounds Concentration		78	94

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Carbon Monoxide Summary

Carbon Monoxide	Sampling Times	Concentration mg/m³	Emission Rate g/hr
Test 1	13:05 -14:59	82	103
Test 2	15:18 - 17:18	0.65	0.74
Mean Carbon Monoxide Concentration		41	52

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Equations 1

Test	1	2	Units
Date	15.04.02	15.04.02	-
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	753.0	753.0	mm Hg
Stack static pressure, P_{static}	5.10	5.10	mm H_2O
$P_s = P_b + \frac{(P_{static})}{13.6}$	753.4	753.4	mm Hg
Volume of water vapour collected, V_{wstd}			
Impinger volume collected	99	119	ml
Silica gel weight increase	35	36	g
Total volume of liquid collected, V_{lc}	134	155	ml
$V_{wstd} = (0.001246)(V_{lc})$	0.1662	0.1931	m^3
Volume of gas metered, V_{mstd}			
Volume of gas sample through gas meter, V_m	1.6653	1.5110	m^3
Gas meter correction factor, Y_d	0.9787	0.9787	-
Average dry gas meter temperature, T_m	17.2	19.7	°C
Average pressure drop across orifice, ΔH	24.08	20.98	mm H_2O
$V_{mstd} = \frac{(0.3592)(V_m)(P_b+(\Delta H/13.6))(Y_d)}{T_m + 273}$	1.5226	1.3693	m^3
Volume of gas at X% oxygen, $V_{mstd@X\%\ oxygen}$			
% oxygen measured in gas stream, act%O_2	9.7	10.0	%
% oxygen at which results required X%	11.0	11.0	%
% oxygen in ambient air by volume	20.9	20.9	%
$O_{xygen@11\%} = \frac{20.9 - act\%O_2}{20.9 - X\%}$	1.13	1.10	-
$V_{mstd@X\%oxygen} = (V_{mstd})(O_{xygen@11\%})$	1.7172	1.5044	m^3
Moisture content, B_{wo}			
$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$	0.098	0.124	m^3
	9.84	12.36	%
Wet volume of gas metered, V_{mstw}			
$V_{mstw} = V_{mstd@X\%oxygen} + V_{wstd}$	1.8834	1.6975	m^3

Equations 2

Test	1	2	Units
Date	15.04.02	15.04.02	-
Molecular weight of dry gas stream, M_d			
CO_2	6.4	6.2	%
O_2	9.7	10.0	%
CO	0.0104	0.0000	%
Total	16.10	16.22	%
N_2 (100 -Total)	83.90	83.78	%
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%CO+\%N_2)$	29.41	29.39	g/gmol
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - B_{wo}) + 18(B_{wo})$	28.28	27.98	g/gmol
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	34.97	34.97	-
Velocity pressure coefficient, C_p	0.79	0.79	-
Average of velocity heads, ΔP_{avg}	2.10	1.84	mm H_2O
Average square root of velocity heads, $\sqrt{\Delta P}$	1.45	1.35	$\sqrt{\text{mm } H_2O}$
Average stack gas temperature, T_s	900	867	°C
$V_s = \frac{(K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s + 273})}{\sqrt{(Ms)(Ps)}}$	9.38	8.71	m/s
Actual flow of stack gas, Q_a			
Area of stack, A_s	0.16	0.16	m^2
$Q_a = (60)(A_s)(V_s)$	89.6	83.1	m^3/min
Dry total flow of stack gas, Q_{std}			
Conversion factor (K/mm.Hg)	0.3592	0.3592	-
$Q_{std} = \frac{(Q_a)P_s(0.3592)(1-B_{wo})}{(T_s) +273}$	18.6	17.3	m^3/min
Wet total flow of stack gas, Q_{stw}			
Conversion factor (K/mm.Hg)	0.3592	0.3592	-
$Q_{std} = \frac{(Q_a)P_s(0.3592)}{(T_s) +273}$	20.7	19.7	m^3/min

Equations 3

Test	1	2	Units
Date	15.04.02	15.04.02	-
Percent isokinetic, %I			
Nozzle area, A_n	113.11	113.11	mm^2
Total sampling time, θ	114	120	min
$\%I = \frac{(4.6398E6)(T_s+273)(V_{mstd})}{(P_s)(V_s)(A_n)(\theta)(1-B_{wo})}$	100.8	92.9	%
Percentage isokinetic acceptable ± 10%	Yes	Yes	-
Particulate Concentration, C			
Mass of particulate collected on filter, M_f	0.0558	0.1124	g
Mass of particulate collected in probe, M_p	0.0000	0.0000	g
Mass of total particulate collected, M_n	0.0558	0.1124	g
$C_{dry} = \frac{M_n}{V_{mstd}}$	36.6	82.1	mg/m^3
$C_{wet} = \frac{M_n}{V_{mstw}}$	29.6	66.2	mg/m^3
$C_{@11\%oxygen} = \frac{M_n}{V_{mstd@11\%oxygen}}$	32.5	74.7	mg/m^3
Particulate emission rate, $E_{g/hr}$			
$E_{g/hr} = \frac{(C_{dry})(Q_{std})(60)}{1000}$	41.0	85.1	g/hr
Cremation Details			
Cremation Date	15.04.02	15.04.02	-
Cremation Number	140241	140245	-
Mass of Deceased	Average	Large	-
Gender of Deceased	Male	Male	-
Coffin Features	Standard	Standard	-

Organic Compounds & Carbon Monoxide Emissions Data

Time	OC mg/m³	O_2 % v/v	CO mg/m³	Time	OC mg/m³	O_2 % v/v	CO mg/m³
Test 1 - 15.04.02				Test 1 - 15.04.02			
13:05	9.1	9.9	0.0	13:50	75	3.9	15
13:06	9.2	9.8	7.8	13:51	83	4.5	14
13:07	8.2	7.5	874	13:52	102	4.9	12
13:08	7.7	8.6	33	13:53	114	5.1	9.4
13:09	8.1	9.4	17	13:54	118	5.3	9.5
13:10	7.6	8.8	107	13:55	115	5.2	7.9
13:11	7.0	8.6	9.1	13:56	118	5.8	7.4
13:12	7.5	7.9	5.7	13:57	129	6.0	6.7
13:13	10.0	9.3	0.0	13:58	177	9.6	6.6
13:14	9.6	9.2	40	13:59	185	10.2	5.8
13:15	9.6	9.5	23	14:00	195	10.5	0.0
13:16	8.1	9.6	11	14:01	197	10.5	0.0
13:17	12	9.9	0.0	14:02	205	9.2	0.0
13:18	14	10.5	5.9	14:03	224	9.8	0.0
13:19	14	10.7	0.0	14:04	213	9.1	0.0
13:20	17	10.3	0.0	14:05	221	9.4	0.0
13:21	40	11.1	0.0	14:06	230	9.5	0.0
13:22	109	10.2	0.0	14:07	237	9.9	0.0
13:23	178	11.1	0.0	14:08	248	10.2	0.0
13:24	193	10.1	0.0	14:09	251	10.2	0.0
13:25	212	10.9	0.0	14:10	253	10.3	0.0
13:26	256	12.6	12	14:11	263	10.6	0.0
13:27	263	12.7	0.0	14:12	199	8.6	0.0
13:28	250	12.6	8.9	14:13	218	11.0	0.0
13:29	277	13.2	0.0	14:14	162	9.0	0.0
13:30	254	12.6	0.0	14:15	201	11.1	0.0
13:31	274	13.3	0.0	14:16	213	12.0	0.0
13:32	164	8.4	0.0	14:17	133	6.9	0.0
13:33	198	13.0	0.0	14:18	86	12.3	0.0
13:34	63	5.4	0.0	14:19	27	6.9	0.0
13:35	45	4.9	0.0	14:20	8.0	12.1	0.0
13:36	36	0.8	492	14:21	16	12.3	0.0
13:37	37	0.1	3080	14:22	6.5	7.4	0.0
13:38	35	0.4	1202	14:23	6.7	13.1	0.0
13:39	35	0.8	822	14:24	2.6	14.2	0.0
13:40	36	1.4	246	14:25	2.8	8.5	0.0
13:41	41	1.6	133	14:26	6.0	9.1	0.0
13:42	41	2.6	70	14:27	39	12.8	0.0
13:43	48	3.1	54	14:28	31	8.9	0.0
13:44	52	3.5	44	14:29	56	13.4	0.0
13:45	53	4.1	37	14:30	34	9.0	0.0
13:46	53	3.8	30	14:31	90	9.9	0.0
13:47	67	4.4	25	14:32	109	9.9	0.0
13:48	78	4.4	22	14:33	223	13.9	0.0
13:49	81	4.9	19	14:34	332	15.9	0.0

Where - is indicated in table: Cremation over, i.e no more data collected.

Organic Compounds & Carbon Monoxide Emissions Data

Time	OC mg/m^3	O_2 % v/v	CO mg/m^3	Time	OC mg/m^3	O_2 % v/v	CO mg/m^3
Test 1 - 15.04.02				Test 2 - 15.04.02			
14:35	311	15.6	0.0	15:18	30	7.6	4.6
14:36	131	8.5	0.0	15:19	41	10.6	0.0
14:37	160	11.2	0.0	15:20	16	8.7	0.0
14:38	79	9.5	0.0	15:21	19	10.4	0.0
14:39	40	10.3	0.0	15:22	26	11.1	0.0
14:40	5.1	10.5	0.0	15:23	16	7.5	0.0
14:41	3.3	10.2	0.0	15:24	13	7.9	0.0
14:42	1.7	10.7	0.0	15:25	14	10.8	0.0
14:43	3.3	10.2	0.0	15:26	17	11.5	0.0
14:44	3.5	10.8	0.0	15:27	9.5	11.3	0.0
14:45	5.1	10.5	0.0	15:28	6.1	12.0	0.0
14:46	5.4	11.1	0.0	15:29	4.9	13.5	0.0
14:47	3.4	10.4	0.0	15:30	7.2	13.3	0.0
14:48	5.4	11.1	0.0	15:31	9.0	12.8	0.0
14:49	3.4	10.7	0.0	15:32	3.5	10.4	0.0
14:50	17	17.8	0.0	15:33	1.9	11.3	0.0
14:51	13	18.2	0.0	15:34	6.8	12.9	0.0
14:52	14	18.3	0.0	15:35	14	12.9	0.0
14:53	6.9	18.4	0.0	15:36	12	13.1	0.0
14:54	21	18.4	35	15:37	23	13.9	0.0
14:55	17	18.9	680	15:38	29	13.4	0.0
14:56	10	17.4	150	15:39	27	12.7	0.0
14:57	11	17.6	129	15:40	30	13.0	0.0
14:58	22	18.5	130	15:41	25	12.8	0.0
14:59	58	19.7	733	15:42	32	12.9	0.0
-	-	-	-	15:43	23	10.4	0.0
-	-	-	-	15:44	18	9.8	0.0
-	-	-	-	15:45	26	13.9	0.0
-	-	-	-	15:46	13	13.9	0.0
-	-	-	-	15:47	18	13.0	0.0
-	-	-	-	15:48	5.2	13.9	0.0
-	-	-	-	15:49	2.2	12.5	0.0
-	-	-	-	15:50	5.1	13.8	0.0
-	-	-	-	15:51	1.5	9.1	0.0
-	-	-	-	15:52	5.9	11.7	0.0
-	-	-	-	15:53	4.2	12.2	0.0
-	-	-	-	15:54	4.6	13.1	0.0
-	-	-	-	15:55	7.2	13.3	0.0
-	-	-	-	15:56	6.9	13.0	0.0
-	-	-	-	15:57	10	12.2	0.0
-	-	-	-	15:58	14	10.2	0.0
-	-	-	-	15:59	12	13.2	0.0
-	-	-	-	16:00	9.6	3.9	0.0
-	-	-	-	16:01	12	5.2	0.0
Mean	**93.3**	**9.7**	**81.6**	16:02	16	5.3	0.0

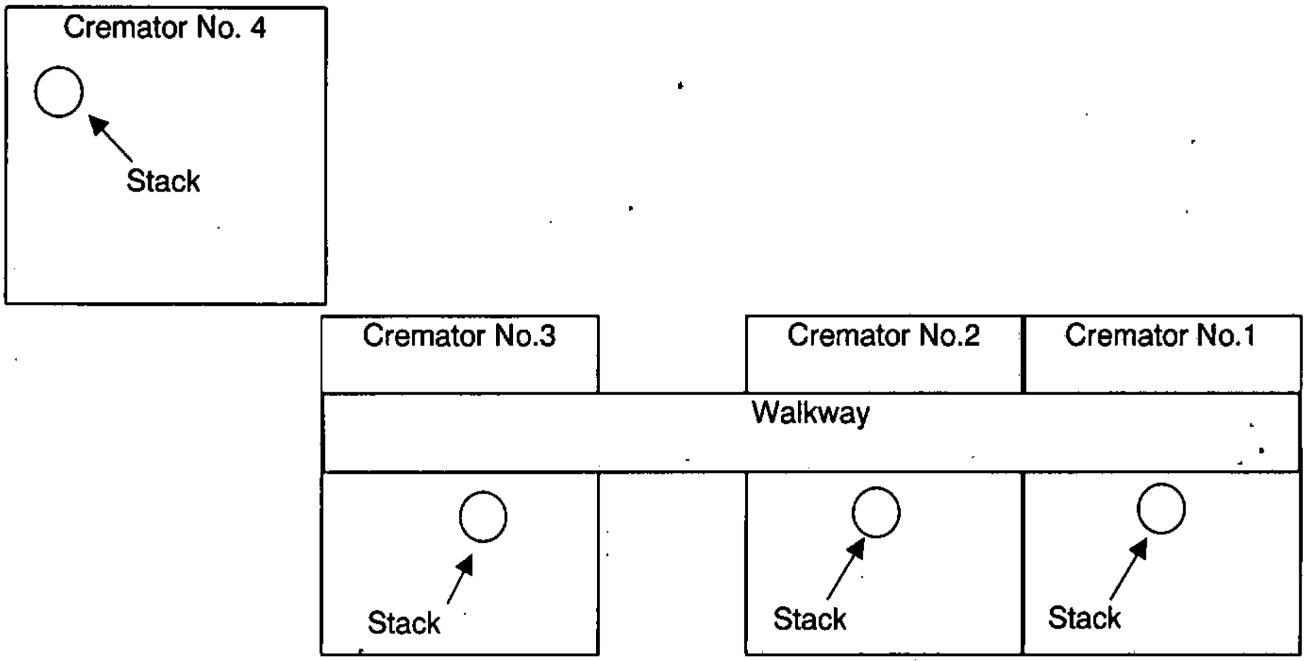
Where - is indicated in table: Cremation over, i.e no more data collected.

Organic Compounds & Carbon Monoxide Emissions Data

Time	OC mg/m³	O_2 % v/v	CO mg/m³	Time	OC mg/m³	O_2 % v/v	CO mg/m³
Test 2 - 15.04.02				Test 2 - 15.04.02			
16:03	14	5.4	0.0	16:48	135	12.2	0.0
16:04	14	6.1	0.0	16:49	100	13.3	0.0
16:05	13	6.1	0.0	16:50	102	14.0	0.0
16:06	15	6.5	0.0	16:51	64	12.2	0.0
16:07	18	6.9	0.0	16:52	45	12.1	0.0
16:08	17	6.9	0.0	16:53	43	12.4	0.0
16:09	17	7.0	0.0	16:54	37	12.1	0.0
16:10	19	7.5	0.0	16:55	45	12.4	0.0
16:11	16	7.2	0.0	16:56	33	12.5	0.0
16:12	14	7.1	0.0	16:57	34	12.4	0.0
16:13	16	7.6	0.0	16:58	25	12.8	0.0
16:14	18	7.6	0.0	16:59	50	12.8	0.0
16:15	76	7.8	0.0	17:00	66	14.6	0.0
16:16	123	7.8	0.0	17:01	88	13.1	0.0
16:17	133	7.9	0.0	17:02	198	17.0	16
16:18	124	5.9	0.0	17:03	206	17.2	30
16:19	141	6.5	0.0	17:04	184	17.4	28
16:20	167	6.5	0.0	17:05	67	13.3	0.0
16:21	176	5.6	0.0	17:06	27	6.8	0.0
16:22	164	4.8	0.0	17:07	28	10.6	0.0
16:23	162	5.0	0.0	17:08	24	11.8	0.0
16:24	174	5.9	0.0	17:09	38	14.3	0.0
16:25	152	6.3	0.0	17:10	31	11.4	0.0
16:26	147	6.4	0.0	17:11	44	10.5	0.0
16:27	114	5.7	0.0	17:12	104	13.2	0.0
16:28	125	5.8	0.0	17:13	123	13.3	0.0
16:29	131	5.9	0.0	17:14	88	9.8	0.0
16:30	144	6.4	0.0	17:15	94	13.6	0.0
16:31	148	6.5	0.0	17:16	47	9.7	0.0
16:32	138	6.6	0.0	17:17	88	13.9	0.0
16:33	140	6.4	0.0	17:18	36	9.7	0.0
16:34	137	6.3	0.0	-	-	-	-
16:35	127	6.3	0.0	-	-	-	-
16:36	135	6.9	0.0	-	-	-	-
16:37	132	6.7	0.0	-	-	-	-
16:38	136	6.7	0.0	-	-	-	-
16:39	137	6.5	0.0	-	-	-	-
16:40	115	6.8	0.0	-	-	-	-
16:41	108	7.3	0.0	-	-	-	-
16:42	100	7.2	0.0	-	-	-	-
16:43	107	7.8	0.0	-	-	-	-
16:44	103	7.9	0.0	-	-	-	-
16:45	107	8.8	0.0	-	-	-	-
16:46	115	10.5	0.0	-	-	-	-
16:47	113	11.1	0.0	**Mean**	**61.8**	**10.0**	**0.6**

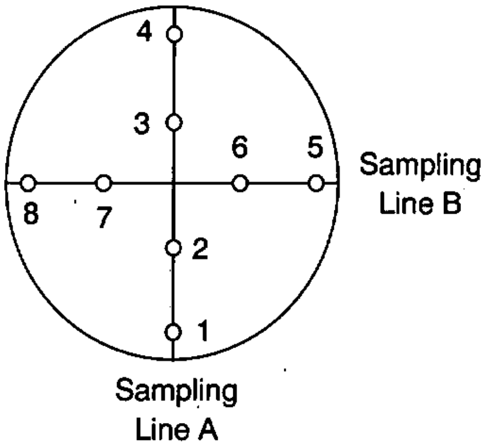
Where - is indicated in table: Cremation over, i.e no more data collected.

Plant Layout



Stack Diagram

Sampling Point	Distance as a % of D	Distance into Stack (m)
1, 5	6.5	0.03
2, 6	25	0.11
3, 7	75	0.34
4, 8	93.5	0.42



Stack Diameter (D) = 0.45 m

Stack Area (A) = 0.16 m^2

Total Particulate Matter Sampling Methodology

US EPA Method 5 requires the extraction of a particulate laden sample from the stack or duct, followed by the subsequent removal of the particulate matter by a filter medium. Concurrently, a measurement of the volume of the withdrawn sample gas is required to determine the particulate concentration. The sample is extracted by using a traversing procedure that approximately integrates the sample volume and collected particulate mass over the entire cross section of the stack or duct. During the sample traverse, the velocity distribution is also determined. This data provides the stack gas flow rate which is used with the particulate concentration to calculate the mass emission rate. Throughout the sampling period, therefore, the sample gas velocity in the probe nozzle is adjusted or re-adjusted to equal the stack gas velocity at each and every traverse point.

Laboratory Preparation

All glassware and metal components are cleaned in accordance with the clean up procedures as described later.
The required number of filter papers are heated in an oven at 105°C for a period of 2 hours and then placed in a desiccator until they can be weighed to a stable weight to within ± 0.1 mg. The whole sampling train is assembled in a clean environment and the following checks carried out.

1. No obvious damage such as cracked glass, split wiring, cross threads etc.
2. With the impingers filled with the necessary amounts of distilled water/silica gel, a system leak check is performed.
3. Fluid reservoir levels for both liquid manometers are topped up to the required
4. All heated components and thermocouples are checked.
5. The umbilical cord is inspected for leaks and the wiring checked for flaws.
6. All the nozzle inlet diameters are measured and any distortions recorded.
7. Finally, the sampling train is dismantled and made ready for transport to site.

Sampling

The sampling train is unpacked and assembled as shown below. The following is then carried out.

1. A quick check to confirm all heated components are working correctly.
2. Measurement of the stack diameter and calculation of the appropriate sampling points.
3. At each of the sampling points, the pitot tube pressure drop and gas temperature are recorded.

Total Particulate Matter Sampling Methodology

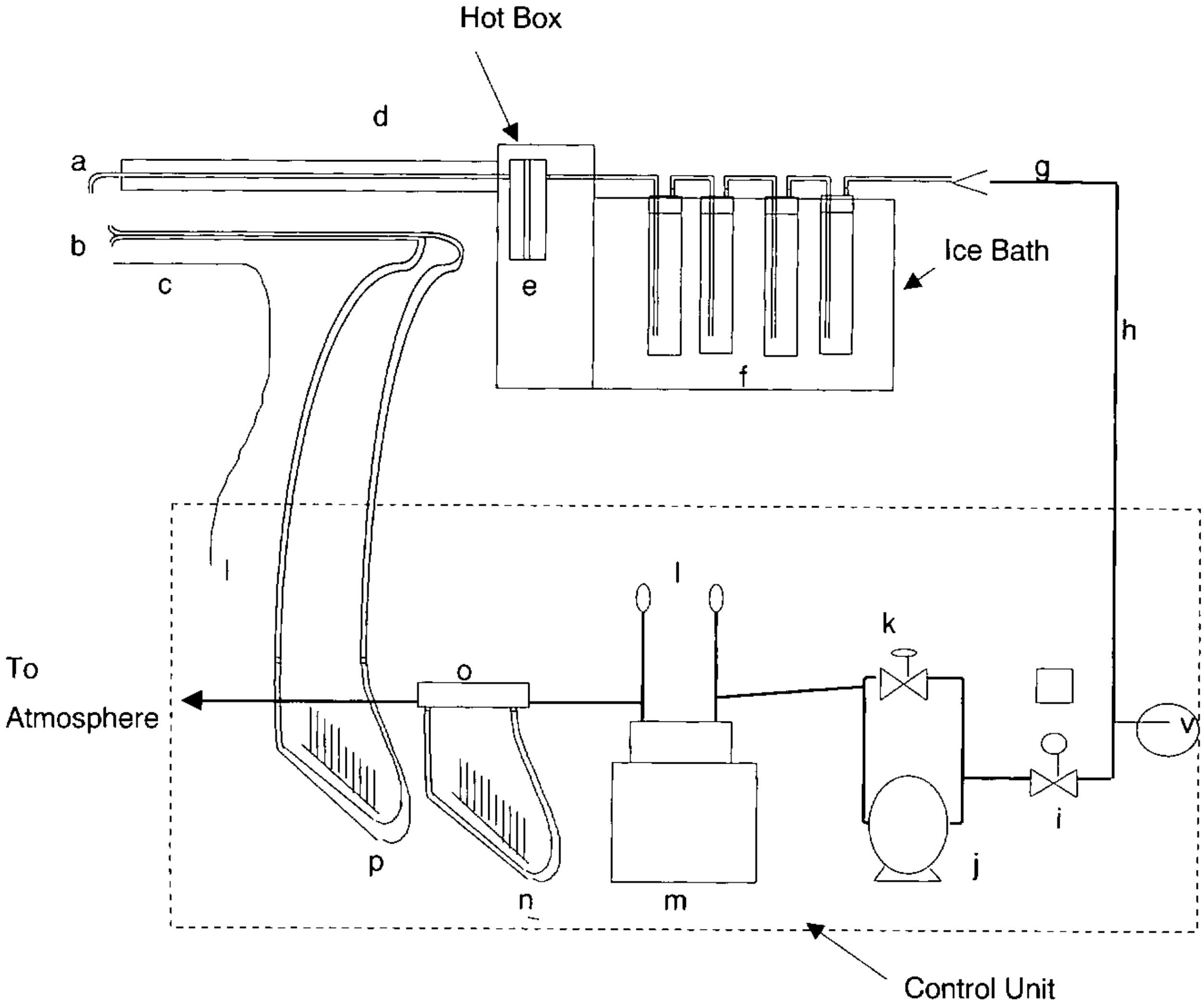
4. Measurements of the stack pressure, gas composition and moisture content are noted and the nozzle diameter determined.
5. A filter of known weight is placed in it's housing unit and inserted into the heater box.
6. The heated probe and heater box are switched on and set to the required temperatures.
7. A sampling train leak check is performed.
8. The probe is positioned at the first sampling point.
9. The initial gas meter volume is recorded.
10. Sampling is then performed for an equal time period at each of the sampling points with all necessary data recorded throughout the test.
11. When sampling is complete, the final gas meter volume is recorded and a sampling train leak check is performed.
12. The sampling train is prepared to carry out a second test as outlined in the clean up procedure.

Clean Up Procedure

1. The filter is removed and returned it to it's labelled petri dish. Any particulate matter deposited on the filter housing, probe lining and nozzle are collected and placed in the same petri dish. The filter housing, probe lining and nozzle are then rinsed with acetone, with the washings collected in a labelled container.
2. The impinger solution from the first two impingers is poured into one labelled container. Any condensate collected in the third impinger is then added to this container.
3. The silica gel from the fourth impinger is emptied into a labelled container.
4. The impingers are then washed with distilled water and the washings poured into a labelled container.

Sampling Equipment

Sampling Train Used: Air Testing & Support Manual Sampling Train



Key

a	Quartz Nozzle	i	Coarse Control Valve
b	S-Type Pitot Tube	j	Vacuum Pump
c	Thermocouple	k	Fine Control Valve
d	Quartz Lined Heated Probe	l	Thermocouples
e	Filter Holder	m	Dry Gas Meter
f	Impingers	n	Orifice Manometer
g	Check Valve	o	Orifice Plate
h	Umbilical Cord	p	Pitot Manometer

Organic Compounds Sampling Methodology

The Signal 3010 MINIFID Portable Heated Total Hydrocarbon Analyser uses Flame Ionisation to detect total organic carbon in a gas stream.

Checks Carried Out before Arrival On Site

The FID analyser is set up and is tested. The following are checked; the furnace and sample line temperatures, the zero and span gas calibration and the operation of the data logger.

On Site Sampling Procedure

The FID and sample line are switched on and allowed to reach operational temperature. The analyser will take 20 minutes to reach its operational temperature of 180°C. The sample line is heated to approximately 180°C to avoid VOCs condensing in the line. When the components have reached the correct operating temperature the fuel and span gas valves are opened and the FID is ignited.

The FID will take about 20 minutes before it stabilises and gives a zero ppm reading. The zero gas is fed into the FID and the zero set. The span gas is fed into the FID and the instrument adjusted to read the certified span gas value. The zero gas is fed into the FID once more to check that the reading returns to zero, if it does not, then these steps are repeated.

The probe, with a particulate filter, is then inserted into the stack, and the data logger activated.

The data logger can be programmed to log results over a 1, 5, 10 etc minute period. The results displayed and logged are the volume concentration of propane in ppm, which are converted to mg/m³ by the following calculations:

$$C_m = C_v \frac{36}{22.4}$$

where C_m is the TOC concentration in mg/m³ (273 K; 101300 Pa)

C_v is the volume concentration of propane in ppm (by volume)

$$C_n = C_i \times \left[\frac{100}{100 - \%H_2O_m}\right] \times \left[\frac{21 - \%O_{ref}}{21 - \%O_m}\right]$$

where C_n is the TOC concentration in mg/m³ stated at reference conditions of humidity and oxygen

C_i is the TOC concentration in mg/m³ (273 K; 101 300 Pa) at flue gas conditions of humidity and oxygen

$\% H_2O_m$ is the measured percentage by volume of water in the flue gas

$\% O_m$ is the measured percentage by volume of oxygen in the flue gas

$\% O_{ref}$ is the percentage by volume of oxygen at the reference conditions

Carbon Monoxide Sampling Methodology

The Testo 350 flue gas analyser is a portable instrument capable of measuring oxygen, carbon dioxide, carbon monoxide, stack temperature, date and time of test. The Testo 350 has a large measuring range for process control in industrial furnaces and a high accuracy level, even in the lower measuring ranges, for limit value control. Up to 500 measurements can be stored directly on location, with online data transmission to a PC possible for long-term measurements. The mobile gas preparation unit Testo 339, which dries the sample gas, can be connected as an option for long-term measurements.

Checks Carried Out Before Arrival On Site

Condensate traps are emptied and particulate filters replaced if necessary. The analyser when switched on, carries out a self-test (approximately 60 seconds) and rinses the measuring cells with fresh air. The analyser is tested with certified bottled calibration gas. If any cells require replacing, or adjustments are required to bring the analyser within calibration, these are made and a certificate of calibration produced. The handset is cleared of data and the analyser batteries fully charged.

On-Site Sampling Procedure

The flue gas probe is connected and the analyser switched on. The analyser is allowed to perform its self-test in fresh air. The appropriate fuel type is selected. The instrument status data (instrument temperature, battery voltage and pump capacity), required for smooth operation are checked. The complete measuring system (probe, condensate trap, tubes and connections) are leak tested. The measuring variables are set and a file created to which measurements are stored. The probe is positioned into the centre of the stack and the access hole plugged. The pump is started and measurements made. During long-term measurements the electronic measuring cells need fresh air phases to regenerate. The number and duration of the required fresh air times depends on the gas concentration and sample duration.

Post-Site Procedure

The handset memory is downloaded to PC and the analyser retested with calibration gas.

Operational Range

The O_2 sensor is a self powered, diffusion limited, metal air battery fuel cell. It has a resolution of 0.1% with an accuracy of 0.1%.

The CO cell has a resolution of 1 ppm with an accuracy of +/- 20 ppm at concentrations less than 400 ppm, +/- 5% at concentrations less than 2000 ppm and +/- 10% at concentrations greater than 2000 ppm.

All sensors and electrochemical cells have filters and cross sensitivity compensation data for more accurate measurements.

Quality Assurance Checklist

Preparation:

All glassware cleaned according to the appropriate test method.	Yes
Filters are dried, desiccated and weighed to achieve stable weights.	Yes
Equipment checked for faults and calibrated if necessary.	Yes

Sampling:

Sampling train assembled and leak check performed in accordance with the appropriate test method.	Yes
Critical temperatures (hot box, probe, condenser and gas sample) maintained according to the appropriate test method.	Yes
Isokinetic variation within method requirement of ± 10%.	Yes
Sample recovery according to the appropriate test method.	Yes

Sample Analysis:

Samples sent to our accredited laboratory and analysis performed according to the appropriate analytical method.	Yes

QA Procedures:

Equipment underwent a calibration check where necessary.	Yes
Recorded information downloaded and printouts made.	Yes
Report saved electronically onto Scientifics server.	Yes
On site data sheet completed and signed off by Team Leader.	Yes
Raw data and hard copy of report filed together.	Yes

Stack Emissions Testing Team

Environmental Team Leader	Jez Anderson BSc (Hons) Physics
Environmental Technician(s)	Mark Woodruff BSc (Hons) Environmental Studies

Report by	Mark Woodruff Environmental Technican	
Checked and Authorised By	[redacted]	Signed
	JEZ ANDERSON	Print Name
	13/5/02	Dated
	~~Business Manager~~ / Team Leader (Delete as appropriate)	Business Title

Deviations from Test Methods

In this instance, testing was fully in accordance with the respective test methods.

Conclusion

The results of these tests demonstrate that under normal operating conditions, this Plant is being operated with emissions of Organic Compounds in excess of the emission concentration limits specified in PG5/2(95).

The performance of the Plant should be immediately investigated and steps taken to reduce emissions of Organic Compounds to a level below the emission concentration limits specified in PG5/2(95).

A regular programme of stack emissions testing in accordance with the Plant's LAPC Authorisation will be required to demonstrate future compliance.

scientifics®
AIR & EMISSIONS TESTING GROUP
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Tel: 0161 477 3004 Fax: 0161 480 4642
Mobile: 07973 319576 (24 Hours)
Email: james.bealing@scientifics.com

Stack Emissions Testing Report

Organic Compounds

Coventry City Council

Canley Crematorium

Cremator No. 4

Sampling Date(s) **7th August 2002**

Report by Jez Anderson

Job Number LAB 3792

Contents

Introduction

Coventry City Council operate a Crematoria at Canley Crematorium which is subject to Local Air Pollution Control by Coventry County Council under the Environmental Protection Act 1990, Part 1.

Scientifics Limited were commissioned by Coventry City Council to carry out stack emissions testing to determine the releases of prescribed pollutants from the following Cremator under normal operating conditions.

Company	Coventry City Council	
Site	Canley Crematorium	
Stack	Cremator No. 4	
Sampling Date(s)	7th August 2002	
Cremator Manufacturer	Furnance Construction Ltd	
Cremator Model	Joule	
Cremator Serial Number	CF407	
Operating Conditions	<u>Test 1</u>	<u>Test 2</u>
Coffin Construction	Standard	Standard
Mass of Deceased	Average	Small
Cremation Number	141057	141060
Process	'Crematoria'	
Guidance Note	PG5/2(95)	

Any deviations from the respective test methods are noted in the conclusion.

Coventry City Council

Rachel.

here is the report of the re testing of the Yours cremator.

I am pleased to say that it passed.

City Development Directorate
Environmental Services

Coventry Bereavement Services
The Lodge
Cannon Hill Road
Coventry
CV4 7DF

Telephone 024 7641 8055 or 7641 5886
Fax 024 7669 3863

With compliments [redacted] 15/?/02

Written Summary

Organic Compounds **Passed**

Two organic compounds tests were performed, each lasting a complete cremation. The mean sampling time was 85.5 minutes. The mean organic compounds concentration was 1.7 mg/m^3 at reference conditions. This value is below the emission concentration limit of 20 mg/m^3 specified in PG5/2(95).

The sampling was performed in accordance with the main procedural requirements of US EPA Method 25A using a heated sampling line and a Signal 3010 MINIFID portable VOC analyser with detection by FID calibrated against 11 ppm propane span gas.

Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Emissions Summary

Company	Coventry City Council
Site	Canley Crematorium
Stack	Cremator No. 4
Sampling Date(s)	7th August 2002

Parameter	Units	Result	Limit	Outcome
Organic Compounds	mg/m^3	1.7	20	Passed
Organic Compounds Emission Rate	g/hr	1.8	-	-
Oxygen	% v/v	9.8	-	-
Temperature	°C	757	-	-
Moisture	% v/v	11.1	-	-
Gas Velocity	m/s	9.0	-	-
Gas Volumetric Flow Rate (Actual)	m^3/hr	5179	-	-
Gas Volumetric Flow Rate (STP)	m^3/hr	1077	-	-

Organic Compounds Summary

Organic Compounds	Sampling Times	Concentration mg/m^3	Emission Rate g/hr
Test 1	11:07 - 12:40	2.2	2.4
Test 2	12:52 - 14:10	1.1	1.2
Mean Organic Compounds Concentration		1.7	1.8

All results are mean values, with pollutant concentrations expressed at reference conditions. Reference conditions are 273K, 101.3kPa and 11% oxygen, dry gas.

Organic Compounds Emissions Data

Time	OC mg/m³	O_2 % v/v	Time	OC mg/m³	O_2 % v/v
Test 1 - 07.08.02			Test 1 - 07.08.02		
11:07	2.8	0.0	11:52	0.6	11.9
11:08	3.5	4.2	11:53	0.1	5.9
11:09	4.1	8.1	11:54	0.4	11.0
11:10	4.1	10.6	11:55	0.0	9.2
11:11	5.3	12.7	11:56	0.1	7.0
11:12	6.3	13.1	11:57	0.3	11.8
11:13	5.6	10.6	11:58	0.0	7.1
11:14	5.0	9.3	11:59	0.3	12.4
11:15	6.4	8.9	12:00	0.1	7.0
11:16	6.9	9.5	12:01	0.3	10.0
11:17	6.4	8.5	12:02	0.1	7.6
11:18	5.9	9.6	12:03	0.2	7.4
11:19	6.2	10.4	12:04	0.2	11.4
11:20	5.8	9.4	12:05	0.1	7.7
11:21	5.1	8.2	12:06	0.2	13.0
11:22	5.9	9.9	12:07	0.1	7.5
11:23	5.5	8.4	12:08	0.2	13.0
11:24	5.4	7.8	12:09	0.3	7.4
11:25	4.8	6.3	12:10	0.2	13.3
11:26	5.5	7.6	12:11	1.3	8.3
11:27	5.4	7.2	12:12	0.5	13.7
11:28	5.0	7.0	12:13	0.2	8.3
11:29	4.9	7.1	12:14	0.2	13.4
11:30	5.0	7.6	12:15	0.1	8.7
11:31	4.6	6.7	12:16	0.0	9.7
11:32	4.6	7.2	12:17	0.2	13.6
11:33	4.7	7.5	12:18	0.1	9.2
11:34	4.4	7.4	12:19	0.2	9.7
11:35	4.2	7.1	12:20	0.2	11.1
11:36	4.2	7.8	12:21	0.0	9.7
11:37	4.0	7.5	12:22	0.1	10.1
11:38	4.1	7.9	12:23	0.1	10.2
11:39	4.5	8.5	12:24	0.0	9.8
11:40	4.3	9.3	12:25	0.2	10.1
11:41	4.3	9.6	12:26	0.0	10.7
11:42	4.9	10.7	12:27	0.6	10.3
11:43	4.5	10.2	12:28	0.6	9.9
11:44	4.8	11.0	12:29	0.5	10.4
11:45	0.5	11.0	12:30	0.4	10.0
11:46	0.5	12.8	12:31	0.4	10.8
11:47	0.1	5.5	12:32	1.0	10.6
11:48	0.0	6.4	12:33	0.6	10.4
11:49	0.2	6.2	12:34	0.3	10.1
11:50	0.4	10.7	12:35	0.3	10.7
11:51	0.1	5.6	12:36	0.5	15.1

Organic Compounds Emissions Data

Time	OC mg/m³	O_2 % v/v	Time	OC mg/m³	O_2 % v/v
Test 1 - 07.08.02			Test 2 - 07.08.02		
12:37	1.7	18.1	12:52	0.8	1.8
12:38	3.2	19.6	12:53	0.0	2.3
12:39	0.8	14.5	12:54	0.2	6.0
12:40	0.3	8.5	12:55	0.2	9.3
-	-	-	12:56	0.3	11.0
-	-	-	12:57	0.4	10.9
-	-	-	12:58	0.5	10.6
-	-	-	12:59	0.4	11.2
-	-	-	13:00	0.7	11.1
-	-	-	13:01	0.6	10.0
-	-	-	13:02	0.6	10.9
-	-	-	13:03	0.8	13.0
-	-	-	13:04	0.6	8.3
-	-	-	13:05	0.9	10.1
-	-	-	13:06	1.0	11.0
-	-	-	13:07	0.8	9.4
-	-	-	13:08	0.9	10.4
-	-	-	13:09	0.8	9.2
-	-	-	13:10	0.6	7.8
-	-	-	13:11	0.7	5.9
-	-	-	13:12	0.6	6.0
-	-	-	13:13	0.7	5.3
-	-	-	13:14	0.6	5.1
-	-	-	13:15	0.7	4.3
-	-	-	13:16	0.7	4.9
-	-	-	13:17	0.7	4.2
-	-	-	13:18	0.7	5.3
-	-	-	13:19	0.7	6.1
-	-	-	13:20	0.8	6.3
-	-	-	13:21	0.7	5.6
-	-	-	13:22	0.8	6.7
-	-	-	13:23	0.6	6.5
-	-	-	13:24	0.8	7.5
-	-	-	13:25	0.6	8.8
-	-	-	13:26	0.8	9.7
-	-	-	13:27	0.7	10.3
-	-	-	13:28	1.1	10.8
-	-	-	13:29	0.9	9.8
-	-	-	13:30	1.0	10.0
-	-	-	13:31	1.0	11.1
-	-	-	13:32	2.2	10.7
-	-	-	13:33	1.9	11.9
-	-	-	13:34	1.5	11.7
-	-	-	13:35	1.7	12.5
Mean	**2.2**	**9.5**	13:36	1.6	12.6

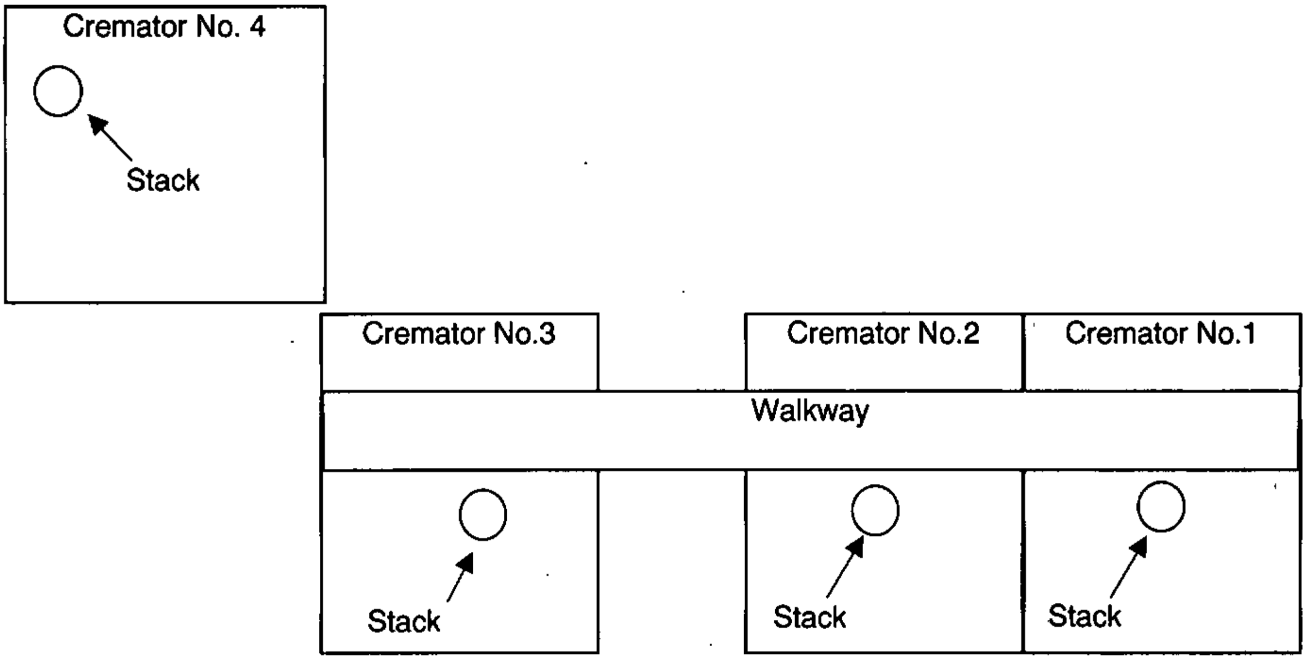
Where - is indicated in table: Cremation over, i.e no more data collected.

Organic Compounds Emissions Data

Time	OC mg/m^3	O_2 % v/v
Test 2 - 07.08.02		
13:37	1.7	13.1
13:38	1.7	13.2
13:39	1.7	13.1
13:40	1.6	13.2
13:41	2.1	14.3
13:42	0.9	6.8
13:43	1.7	12.6
13:44	0.9	7.4
13:45	1.7	12.8
13:46	1.0	8.5
13:47	1.6	12.6
13:48	1.7	13.2
13:49	1.0	9.1
13:50	1.8	13.9
13:51	1.0	9.0
13:52	1.4	12.2
13:53	1.4	12.2
13:54	1.0	9.0
13:55	1.9	14.6
13:56	1.0	8.9
13:57	1.9	14.7
13:58	1.2	9.7
13:59	2.0	14.8
14:00	1.2	10.2
14:01	2.1	15.0
14:02	1.1	9.9
14:03	2.3	15.4
14:04	1.2	10.2
14:05	2.4	15.5
14:06	1.2	10.2
14:07	2.3	15.3
14:08	1.3	10.3
14:09	2.0	15.6
14:10	1.9	15.2
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
Mean	**1.1**	**10.1**

Where - is indicated in table: Cremation over, i.e no more data collected.

Plant Layout



Oxygen Sampling Methodology

The Testo 350 flue gas analyser is a portable instrument capable of measuring oxygen, carbon dioxide, carbon monoxide, stack temperature, date and time of test. The Testo 350 has a large measuring range for process control in industrial furnaces and a high accuracy level, even in the lower measuring ranges, for limit value control. Up to 500 measurements can be stored directly on location, with online data transmission to a PC possible for long-term measurements. The mobile gas preparation unit Testo 339, which dries the sample gas, can be connected as an option for long-term measurements.

Checks Carried Out Before Arrival On Site

Condensate traps are emptied and particulate filters replaced if necessary. The analyser when switched on, carries out a self-test (approximately 60 seconds) and rinses the measuring cells with fresh air. The analyser is tested with certified bottled calibration gas. If any cells require replacing, or adjustments are required to bring the analyser within calibration, these are made and a certificate of calibration produced. The handset is cleared of data and the analyser batteries fully charged.

On-Site Sampling Procedure

The flue gas probe is connected and the analyser switched on. The analyser is allowed to perform its self-test in fresh air. The appropriate fuel type is selected. The instrument status data (instrument temperature, battery voltage and pump capacity), required for smooth operation are checked. The complete measuring system (probe, condensate trap, tubes and connections) are leak tested. The measuring variables are set and a file created to which measurements are stored. The probe is positioned into the centre of the stack and the access hole plugged. The pump is started and measurements made. During long-term measurements the electronic measuring cells need fresh air phases to regenerate. The number and duration of the required fresh air times depends on the gas concentration and sample duration.

Post-Site Procedure

The handset memory is downloaded to PC and the analyser retested with calibration gas.

Operational Range

The O_2 sensor is a self powered, diffusion limited, metal air battery fuel cell. It has a resolution of 0.1% with an accuracy of 0.1%.

The CO cell has a resolution of 1 ppm with an accuracy of +/- 20 ppm at concentrations less than 400 ppm, +/- 5% at concentrations less than 2000 ppm and +/- 10% at concentrations greater than 2000 ppm.

All sensors and electrochemical cells have filters and cross sensitivity compensation data for more accurate measurements.

Organic Compounds Sampling Methodology

The Signal 3010 MINIFID Portable Heated Total Hydrocarbon Analyser uses Flame Ionisation to detect total organic carbon in a gas stream.

Checks Carried Out before Arrival On Site

The FID analyser is set up and is tested. The following are checked; the furnace and sample line temperatures, the zero and span gas calibration and the operation of the data logger.

On Site Sampling Procedure

The FID and sample line are switched on and allowed to reach operational temperature. The analyser will take 20 minutes to reach its operational temperature of 180°C. The sample line is heated to approximately 180°C to avoid VOCs condensing in the line. When the components have reached the correct operating temperature the fuel and span gas valves are opened and the FID is ignited.

The FID will take about 20 minutes before it stabilises and gives a zero ppm reading. The zero gas is fed into the FID and the zero set. The span gas is fed into the FID and the instrument adjusted to read the certified span gas value. The zero gas is fed into the FID once more to check that the reading returns to zero, if it does not, then these steps are repeated.

The probe, with a particulate filter, is then inserted into the stack, and the data logger activated.

The data logger can be programmed to log results over a 1, 5, 10 etc minute period. The results displayed and logged are the volume concentration of propane in ppm, which are converted to mg/m³ by the following calculations:

$$C_m = C_v \frac{36}{22.4}$$

where C_m is the TOC concentration in mg/m³ (273 K; 101300 Pa)
C_v is the volume concentration of propane in ppm (by volume)

$$C_n = C_i \times \left[\frac{100}{100 - \%H_2O_m}\right] \times \left[\frac{21 - \%\,O_{ref}}{21 - \%\,O_m}\right]$$

where C_n is the TOC concentration in mg/m³ stated at reference conditions of humidity and oxygen
C_i is the TOC concentration in mg/m³ (273 K; 101 300 Pa) at flue gas conditions of humidity and oxygen
$\%\,H_2O_m$ is the measured percentage by volume of water in the flue gas
$\%\,O_m$ is the measured percentage by volume of oxygen in the flue gas
$\%\,O_{ref}$ is the percentage by volume of oxygen at the reference conditions

Quality Assurance Checklist

QA Procedures:

Equipment underwent a calibration check where necessary.	Yes
Recorded information downloaded and printouts made.	Yes
Report saved electronically onto Scientifics server.	Yes
On site data sheet completed and signed off by Team Leader.	Yes
Raw data and hard copy of report filed together.	Yes

Deviations from Test Methods

In this instance, testing was fully in accordance with the respective test methods.

Conclusion

The results of this monitoring exercise demonstrate that under normal operating conditions, this Plant is being operated in full compliance with the Organic Compounds emission concentration limit specified in PG5/2(95).

Good housekeeping and maintenance of the ducting and associated plant should be continued in order to maintain this level of Plant performance.

A regular programme of stack emissions testing in accordance with the Plant's LAPC Authorisation will be required to demonstrate continued compliance.

Test Performed and Report Written by — Jez Anderson, Team Leader

Checked and Authorised By [redacted] Signed

JEZ ANDERSON Print Name

8/8/02 Dated

~~Business Manager~~ / Team Leader Business Title

(Delete as appropriate)