



**Davies & Co. (Environmental) Ltd**  
*Emissions Monitoring Specialists*

## EMISSIONS MONITORING TEST REPORT

**GUILFORD CREMATORIUM**  
**New Pond Rd**  
**Godalming**  
**Surrey**  
**GU7 3DB**

**19<sup>th</sup> December 2018**

Report Authorised by



Date 29<sup>th</sup> January 2018

Emissions Monitoring Team Leader  
MCertS level 2 + TE1,2,3,4  
MM 06 707

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## 1. INTRODUCTION

The cremator at Guildford Crematorium New Pond Rd. Godalming, Surrey, GU7 3DB was monitored on the 19<sup>th</sup> December 2018 to the requirements given in Process Guidance Note PG5/2 (2012) for emission releases to atmosphere.

The work was carried out on site by the following staff of Davies & Co (Engineering) Limited:

Mr J L Boyce  
EA MCertS Level 2 + TE1,2,3,4  
MM 06 707

Davies & Co does not hold company UKAS / MCertS accreditation at this time, as the company specialises in cremator and incinerator testing that are Part B processes. Air Quality Guidance Note AQ12 (04) states that UKAS / MCertS accreditation is not a mandatory requirement for the testing of Part B processes. Davies & Co are members of the Source Testing Association, and have extensive knowledge of crematoria testing. All analysis was conducted using UKAS approved laboratories, methods and calibrated equipment.

The work on site involved monitoring a range of flue gas components in the exhaust gas ducts throughout three cremations for each cremator.

The cremator was manufactured Facultative Technologies Limited to meet the requirements of the Environmental Permitting Regulations 2016 (EPR 2016) as relevant to cremators summarised in Process Guidance Note PG5/2 (2012).

The Cremator is of FTIII model design fitted with two nozzle mix burners utilizing natural gas as support fuel

The flue ducting and test points were in accordance with the requirements of EA TGN M1.

Measurements were undertaken to enable comparisons to be made of the operation of the cremator with the requirements of the Guidance Note in terms of emission releases to air.

This report details the monitoring procedures used and the results obtained from this test work along with comparisons with the requirements and comments where appropriate.

Relevant procedures were followed to enable quality control to be maintained throughout the test preparation, site test work, laboratory analysis, calculations and reporting

## 2. PROCEDURES

### 2.1 Total Particulate Matter

A flue gas sample was extracted and filtered to collect total particulate matter. A Whatman QM-A filter paper was used with a particle retention of not less than 99.5% at a particle size of 0.3 micron. The flue gas extraction employed techniques given in BS EN 13284 Part 1.

The method employed was BS EN 13284 Part 1.

The requirement from PG 5/2 (2012) is to test for total particulate matter for a duration of one hour. As such each test is taken from 2 minutes to 62 minutes of cremation, the test starting 2 minutes into cremation to avoid the initial 'flash off' from the charging of the coffin.

The sampling was conducted using apparatus in accordance with the requirements of BS EN 13284 Part 1.

This consisted of a heated known dimension Pyrex glass nozzle, heated Pyrex glass probe liner, heated Pyrex glass filter housing with Titanium frit containing quartz microfibre filter (all heaters set to 160°C), PTFE sample line, dreschel absorption bottles, gas dryer (silica gel), sample line to pump, pump, gas meter, rotameter, pitot and impulse lines, electronic manometer, type K thermocouple, balance (for gravimetric moisture) and datalogger. Settings tables were pre-prepared to enable isokinetic flow to be maintained (based on online measurements of flue gas velocity and temperature to set nozzle flow / pump rate (l/min)).

Particulate matter analysis was carried out by weighing the filter and probe rinse collection on a calibrated balance, with the media being dried and weighed prior to and following the test.

Standard BS EN 13284 Part 1 was deviated from only in so far as a consequence of conducting tests in accordance with the requirements of PG5/2(12) that states that when the emissions are regulated as mass releases the testing should be conducted for 60 minutes continuously from 2 minutes to 62 minutes of cremation. This therefore implies that only one sampling line can be used for each test run as sampling on 2 lines would require a stop half way through the test to move the probe out of one port and into another thus losing a period within the allotted required 60 minutes. This is contrary to BS EN 13284 Part 1 that requires 2 sample lines to be used during an isokinetic test i.e. four point sampling (2 points x 2 lines) for ducts of these dimensions (450mm diameter circular stack).

The effect on uncertainty of using only one sample line is not considered to be significant and assumed to be within the calculated uncertainties stated in this report. These assumptions are on the basis that the preliminary pitot traverses confirmed the gas velocity profiles are well within required limits, and the duct diameter was relatively small considering the scope of BS EN 13284 Part 1. There is no reason to suspect that the gas sampled from only one sampling plane is not representative of the duct as a whole.

This recommended deviation is a reflection that cremation is a batch process, and that changing sampling ports part-way through a cremation could introduce more errors due to fact that a period of each cremation would not be sampled during the changeover process.





The tests reported herein were conducted to prove the performance of the cremators relative to PG5/2(12).

## 2.2 Hydrogen Chloride

A flue gas sample was extracted and filtered. A Whatman QM-A filter paper was used with a particle retention of not less than 99.5% at a particle size of 0.3 micron. The flue gas extraction employed techniques given in BS EN 13284 Part 1.

The sampling was conducted using apparatus in accordance with the requirements of BS EN 13284 Part 1.

The method employed was BS EN 1911 Parts 1-3.

The requirement from PG 5/2 (2012) is to test for hydrogen chloride for a duration of one hour. As such each test is taken from 2 minutes to 62 minutes of cremation, the test starting 2 minutes into cremation to avoid the initial 'flash off' from the charging of the coffin.

Laboratory analysis for hydrogen chloride was carried out on the absorption medium using Ion Chromatography (IC).

## 2.3 Carbon Monoxide

A flue gas sample was continuously extracted, filtered and dried before being passed through a pre-calibrated Siemens Ultramat 23 infrared analyser for the on-line measurement of carbon monoxide.

The method employed was BS EN 15058.

The requirement from PG 5/2 (2012) is to test for carbon monoxide for a duration of one hour. As such each test is taken from 2 minutes to 62 minutes of cremation, the test starting 2 minutes into cremation to avoid the initial 'flash off' from the charging of the coffin.

The analyser has a fixed range of 0-625 mg/Nm<sup>3</sup> and was zeroed with air and calibrated with a nominal 400 ppmv carbon monoxide in balance nitrogen gas.

The analyser output was continuously recorded using a Grant 'Squirrel' data logger.

For these tests a relatively high range analyser was used due to the typical pattern of carbon monoxide concentration emissions from cremators being very low (often indicated as zero) for most of the cycle, but with occasional, high, short duration spikes of CO being emitted. The convention since non-continuous emissions monitoring became a mandatory requirement for cremators during 1990, has been to attempt to monitor the magnitude of spikes, as these are often the main contributor to total CO emissions. If, for example, a mean one minute emission of CO was say 100 mg/Nm<sup>3</sup>, it would be expected that the peak concentration during that one minute averaging period would be considerably



higher than this. It follows that utilising a lower range analyser would frequently understate CO emissions, despite increasing sensitivity at low CO concentrations.

#### 2.4 Total Organic Compounds

A flue gas sample was continuously extracted and filtered before being passed via a heated line through a pre-calibrated Signal 3030PM Flame Ionisation Detection (FID) analyser for the on-line measurement of volatile organic compounds. The analyser was ranged 0-100 ppmv total hydrocarbons and was zeroed

with air passed through a catalytic converter and calibrated with a nominal 50 ppmv propane in balance air gas.

The method employed was BS EN 12619.

The analyser output was continuously recorded using a Grant 'Squirrel' data logger.

Similar comments apply to TOC's as CO, in that the analyser scaling is set to quantify the peaks that are the nature of the emission.

#### 2.5 Oxygen

A flue gas sample was continuously extracted from the same position in the flue as the hydrogen chloride extraction, filtered and dried before being passed through a pre-calibrated Siemens Ultramat 23 electrochemical cell analyser for the on-line measurement of flue oxygen.

The method employed was BS EN 14789.

The analyser was calibrated using a standard reference gas in the laboratory before and after the site visit, and with nitrogen "zero" gas and air at the start and end of each day's testing on site. It was assumed that calibration linearity was maintained during sampling, and the post checks indicated that this was the case.

The output of the analyser was continuously recorded using a Grant 'Squirrel' data logger.

#### 2.6 Moisture

A flue gas sample was extracted and filtered. The gas sample was then passed through an absorption medium to collect any water vapour.

The method employed was BS EN 14790.

Flue gas moisture was determined gravimetrically by weighing the absorption medium and final gas drier prior to and following the test.



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This was carried out alongside testing for hydrogen chloride.

## 2.7 Temperature

Flue gas temperature was measured by the use of a calibrated Type K thermocouple.

The method employed was BS EN 13284 Part 1.

The flue gas temperature was continuously recorded using a Grant 'Squirrel' data logger.

## 2.8 Velocity and Volumetric Flow

Flue gas velocity was found from inserting a calibrated s-type pitot tube into the flue. The pitot head pressure was then measured using a calibrated electronic manometer.

The method employed was BS EN 13284 Part 1.

The electronic manometer output was continuously recorded using a Grant 'Squirrel' data logger.

Flue gas velocity was then calculated from Bernoulli's equation as the density of the flue gas was known (from measurements of flue gas moisture and temperature).

Flue gas volumetric flow rate was found from the measurement of the flue duct size and hence its area and corrected to normalised conditions (again from measurements of flue gas moisture and temperature).



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### **3. RESULTS**

The results are summarised in tables 1 and 2.

Total Particulate Matter and Hydrogen Chloride determinations are given in table 1.

A comparison of test results with site instrumentation for total particulate matter and carbon monoxide monitoring is given in table 2.

Carbon Monoxide, Total Organic Compounds, Oxygen, Temperature and Velocity and Volumetric Flow were continuously monitored.

All values in the tables are corrected to the reference conditions of 273K, 101.3kPa, 11%v/v oxygen and dry gas as given in PG5/2(12) where required.

All data logs and calculations can be seen in Appendix 1.

All analysis reports can be seen in Appendix 2.





**TABLE 1**  
**Guildford Cremator**  
**Emissions Monitoring 19th December 2018**  
**Total Particulate Matter & Hydrogen Chloride Sampling**

	Test 1 19 December 2018 10:32-11:32	Test 2 19 December 2018 12:29-13:29	Test 3 19 December 2018 13:50-14:50	Average	Requirement to PG5/2 (2012)
Total Particulate Matter - g/h	90.39 ± 5.20	107.41 ± 6.00	104.77 ± 6.20	<b>100.86</b>	<120
Hydrogen Chloride - g/h	31.74 ± 1.75	38.20 ± 203.34	34.17 ± 1.93	<b>34.71</b>	<300
Carbon Monoxide - g/h	0.19 ± 0.01	0.95 ± 0.05	0.15 ± 0.01	<b>0.43</b>	<150
Organic Compounds - g/h	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	<b>0.00</b>	<20

  

Flue Oxygen - %v/v dry	15.73 ± 0.10	15.34 ± 0.10	16.08 ± 0.10	<b>15.72</b>
Flue Moisture - %v/v	6.5 ± 0.6	4.8 ± 0.5	5.6 ± 0.6	<b>5.6</b>
- %w/w	4.1 ± 0.4	3.0 ± 0.3	3.6 ± 0.4	<b>3.6</b>
Flue Temperature - Deg C	465 ± 2	497 ± 2	490 ± 2	<b>484</b>
Volumetric Flow - Nm <sup>3</sup> /h dry	1639 ± 33	1547 ± 31	1399 ± 28	<b>1528</b>

Note 1: All uncertainties (±) are calculated to a 95% confidence interval  
Uncertainties estimated using the procedure suggested in the STA Quality Guidance Note QGN001-01



#### 4. COMMENTS

The results obtained from these tests show that the cremator is compliant with the PG5/2 (2012) requirements for the mass release of pollutants to atmosphere that is understood to be the basis of the permit issued by the regulator.

No unusual charges were cremated during these tests. They were all of standard materials.

Emissions of carbon monoxide and VOC's were low indicating good mixing and combustion within the secondary combustion chamber.

No visible chimney emissions were observed throughout the test work.

PG5/2 (2012) states that the continuous emission monitors (CEMs) should be periodically checked (calibrated) to ensure that the readings being reported are correct. The summary results are given below:-

**TABLE 2**  
**Cremator Outlet**  
**Emissions Monitoring December 2018**  
**Comparison of Test Results with Site Instrumentation**

Date	Test (Cremation Number)	Particulate mg/Nm <sup>3</sup>		Carbon Monoxide mg/Nm <sup>3</sup>	
		Davies & Co	Site	Davies & Co	Site
December 19, 2018	Test 1 (80528)	105	1	0	0
December 19, 2018	Test 2 (80530)	123	1	1	0
December 19, 2018	Test 3 (80531)	153	1	0	0

Note 1: All emission concentration levels are given as mg/Nm<sup>3</sup> corrected to 11% oxygen, 273K & dry gas

Note 2: The results are a 60 minute averages, commencing 2 minutes after coffin loading.

Comments on the comparison of the results shown above are :-

#### Carbon Monoxide

Emission of carbon monoxide was negligible as recorded by both sets of instrumentation.



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### Total Particulate Matter

Analysis of the data obtained from these tests, and the recorded cycle averages from the plants own datalogging and recording package was carried out in order to determine a suitable level of PCME scaling factor adjustment necessary to improve accuracy.

The method used in accordance with PCMEs recommendations for the type of data spread supplied in this case is to compare the ratio of *Extractive test result/ PCME reading*, for each test and take an average of these ratios.

The scaling factor value at the time these tests were performed was too low, and understates particulate emissions.

It is recommended the PCME Scaling Factor is increased to a value of 127 to improve accuracy.

## **5. QUALITY CONTROL**

All the tests performed were carried out to the methods given in the appropriate listed Standards using calibrated equipment. The gas analyser was calibrated prior to use using suitable calibration gases.

Analysis of the absorber solutions was carried out at an external UKAS laboratory following UKAS approved analysis methods.

For this test work the following external laboratory was used for the given determination:

Concept Life Sciences (CLS)    }    Hydrogen Chloride



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## **APPENDIX 1**

### **Data Logs and Calculations**





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### **Explanation of Data Logs**

Data is taken from a Grant Squirrel data logger.

Time is from logger clock.

Flue Gas Temp is direct from test flue thermocouple.

Meter Temp is direct from gas meter.

(The stated meter temperature is that of the sampled gas at the meter, and is not the room ambient temperature. The temperature always increases during a test due to the heat gain from the sample pump that is contained in an enclosed box along with the gas meter, and this is quite normal).

Flue O<sub>2</sub> is from the Siemens Ultramat 23 analyser.

CO is from the Siemens Ultramat 23 analyser.

TOC is from the Signal 3030PM FID analyser expressed as carbon equivalent.

Sample Point Pa is from the pitot tube to a Furness Controls FCO12 electronic manometer.

The room temperature was typically 20°C, and there were no issues with the analysers overheating. Functional and calibration checks at the start and end of each test confirmed correct operation of the analysers.

All values in the tables are corrected to the reference conditions of 273K, 101.3kPa, 11%v/v oxygen and dry gas as given in PG5/2(12) where required.



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**Guildford Cremator**

**Data Log 19 December 2018**

Test 1 Charge 2 Male, 80, Med Chipboard coffin, 80528 Charged: 10:30

Time	Flue Gas °C	Meter °C	Flue O <sub>2</sub> %v/v dry	CO mg/Nm <sup>3</sup> c.	TOC mg/Nm <sup>3</sup> c.	Sample Point Pa
10:32	402	11.0	18.16	2.85	0.00	23.3
10:33	406	11.0	15.05	1.28	0.00	17.1
10:34	405	11.1	14.58	0.48	0.00	16.9
10:35	412	11.3	14.80	0.50	0.00	16.7
10:36	409	11.5	14.85	0.51	0.00	19.3
10:37	412	11.7	14.46	1.32	0.00	23.0
10:38	412	11.9	14.54	0.67	0.00	30.1
10:39	435	12.2	14.48	2.98	0.00	32.7
10:40	428	12.5	15.87	1.27	0.00	19.7
10:41	429	12.8	15.87	0.00	0.00	17.3
10:42	430	13.1	16.06	0.00	0.00	17.4
10:43	405	13.5	16.22	0.00	0.00	15.3
10:44	406	13.8	16.50	0.00	0.00	15.4
10:45	412	14.2	16.77	0.00	0.00	12.9
10:46	408	14.5	16.51	0.00	0.00	8.4
10:47	410	14.8	15.45	0.00	0.00	6.7
10:48	412	15.2	14.88	0.00	0.00	5.5
10:49	420	15.6	14.38	0.00	0.00	4.9
10:50	421	15.9	14.14	0.00	0.00	5.1
10:51	422	16.2	14.27	0.00	0.00	5.4
10:52	412	16.6	14.32	0.00	0.00	4.8
10:53	401	17.0	14.24	0.00	0.00	5.4
10:54	527	17.3	14.58	0.00	0.00	8.5
10:55	514	17.6	14.72	0.00	0.00	11.3
10:56	510	18.0	14.85	0.00	0.00	10.2
10:57	512	18.3	14.88	0.00	0.00	10.3
10:58	511	18.7	14.95	0.00	0.00	12.1
10:59	508	19.0	15.12	0.00	0.00	12.3
11:00	509	19.3	15.21	0.00	0.00	12.4
11:01	506	19.4	15.14	0.00	0.00	12.5
11:02	505	19.8	15.19	0.00	0.00	12.2
11:03	502	20.3	15.43	0.00	0.00	12.5
11:04	502	20.6	15.60	0.00	0.00	10.6
11:05	500	21.0	15.45	0.00	0.00	11.0
11:06	497	21.3	15.66	0.00	0.00	13.5
11:07	410	21.6	15.10	0.00	0.00	15.5
11:08	499	21.9	15.48	0.00	0.00	11.0
11:09	500	22.2	15.80	0.00	0.00	10.2
11:10	501	22.5	15.93	0.00	0.00	10.2
11:11	490	22.8	16.16	0.00	0.00	15.6
11:12	494	23.1	15.20	0.00	0.00	18.8
11:13	502	23.3	15.06	0.00	0.00	10.1
11:14	506	23.6	16.19	0.00	0.00	9.6
11:15	503	23.9	16.37	0.00	0.00	10.5
11:16	490	24.1	16.74	0.00	0.00	19.2
11:17	489	24.4	15.32	0.00	0.00	22.5
11:18	492	24.6	16.17	0.00	0.00	14.7
11:19	494	24.9	17.13	0.00	0.00	14.2
11:20	483	25.1	17.39	0.00	0.00	23.3
11:21	482	25.4	16.10	0.00	0.00	30.9
11:22	483	25.6	16.35	0.00	0.00	23.5
11:23	481	25.8	16.64	0.00	0.00	31.1
11:24	479	26.0	16.54	0.00	0.00	30.8
11:25	479	26.3	16.55	0.00	0.00	30.1
11:26	481	26.5	16.72	0.00	0.00	29.9
11:27	480	26.7	16.80	0.00	0.00	28.4
11:28	485	26.9	17.52	0.00	0.00	12.8
11:29	485	27.1	18.00	0.00	0.00	12.4
11:30	482	27.3	17.68	0.00	0.00	24.4
11:31	486	27.5	16.63	0.00	0.00	22.6
11:32	485	27.7	16.64	0.00	0.00	28.5
Average	465	19.6	15.73	0.19	0.00	16.1



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**Guildford Cremator**

**Data Log 19 December 2018**

Test 2 Charge 3 Female, 90, Med Chipboard coffin, 80530 Charged: 12:27

Time	Flue Gas °C	Meter °C	Flue O <sub>2</sub> %v/v dry	CO mg/Nm <sup>3</sup> c.	TOC mg/Nm <sup>3</sup> c.	Sample Point Pa
12:29	511	32.3	14.17	2.36	0.00	16.9
12:30	501	32.3	14.49	1.83	0.00	11.6
12:31	496	32.3	15.28	1.84	0.00	10.8
12:32	492	32.2	15.47	2.03	0.00	14.3
12:33	496	32.2	14.94	4.21	0.00	19.0
12:34	509	32.3	13.70	4.73	0.00	22.9
12:35	510	32.3	13.59	3.72	0.00	28.0
12:36	505	32.3	14.79	3.67	0.00	25.3
12:37	508	32.3	15.13	2.70	0.00	20.0
12:38	509	32.4	14.55	1.80	0.00	18.7
12:39	510	32.3	14.53	1.58	0.00	16.8
12:40	510	32.4	15.04	1.20	0.00	15.5
12:41	512	32.5	15.25	0.75	0.00	12.2
12:42	516	32.5	14.14	1.96	0.00	12.0
12:43	516	32.6	14.01	2.81	0.00	11.7
12:44	519	32.6	14.21	1.56	0.00	12.4
12:45	517	32.6	14.06	1.42	0.00	10.0
12:46	522	32.6	13.75	1.85	0.00	9.9
12:47	523	32.7	13.83	1.97	0.00	9.4
12:48	519	32.7	13.96	1.61	0.00	7.2
12:49	521	32.7	14.99	1.25	0.00	2.9
12:50	520	32.8	13.29	1.32	0.00	4.5
12:51	503	32.9	13.78	1.04	0.00	6.1
12:52	498	33.0	14.14	0.95	0.00	6.0
12:53	498	33.0	14.21	0.65	0.00	5.8
12:54	487	33.0	14.24	0.49	0.00	12.2
12:55	498	33.1	14.74	0.46	0.00	10.9
12:56	505	33.1	13.91	0.42	0.00	10.3
12:57	504	33.1	14.22	0.43	0.00	11.0
12:58	508	33.1	14.39	0.44	0.00	9.5
12:59	510	33.1	14.41	0.46	0.00	9.8
13:00	508	33.1	14.65	0.47	0.00	9.5
13:01	498	33.0	15.43	0.52	0.00	5.6
13:02	493	33.0	16.20	0.00	0.00	5.1
13:03	491	33.2	16.39	0.00	0.00	6.2
13:04	484	33.2	16.60	0.00	0.00	6.2
13:05	489	33.2	16.78	0.00	0.00	5.8
13:06	489	33.2	16.83	0.00	0.00	5.8
13:07	486	33.3	16.93	0.00	0.00	6.7
13:08	480	33.3	17.02	0.00	0.00	11.5
13:09	492	33.4	16.81	0.00	0.00	9.5
13:10	488	33.4	15.73	0.00	0.00	14.6
13:11	492	33.3	15.70	0.00	0.00	15.6
13:12	487	33.3	15.55	0.00	0.00	19.7
13:13	488	33.4	15.90	0.00	0.00	15.0
13:14	494	33.5	16.11	0.00	0.00	15.6
13:15	488	33.5	16.31	0.00	0.00	16.4
13:16	486	33.6	16.33	0.00	0.00	31.2
13:17	477	33.7	15.36	0.00	0.00	12.3
13:18	470	33.8	17.56	0.00	0.00	10.5
13:19	461	33.7	17.96	0.00	0.00	13.0
13:20	475	33.8	17.37	0.81	0.00	31.5
13:21	475	33.8	15.60	0.00	0.00	22.6
13:22	481	33.7	16.34	0.00	0.00	21.7
13:23	480	33.8	16.75	0.00	0.00	21.3
13:24	483	33.9	16.81	0.00	0.00	20.5
13:25	485	34.0	16.82	0.00	0.00	19.0
13:26	485	34.1	16.84	0.00	0.00	25.3
13:27	481	34.1	16.28	0.00	0.00	25.8
13:28	481	34.1	15.64	0.00	0.00	34.5
13:29	477	34.2	16.04	0.00	0.00	32.6
Average	497	33.1	15.34	0.91	0.00	14.5





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Emissions Monitoring Specialists

**Guildford Cremator**

**Data Log 19 December 2018**

Test 3 Charge 4 Male, 87, Med Chipboard coffin, 80531 Charged: 13:48

Time	Flue Gas °C	Meter °C	Flue O <sub>2</sub> %v/v dry	CO mg/Nm <sup>3</sup> c.	TOC mg/Nm <sup>3</sup> c.	Sample Point Pa
13:50	509	33.0	15.42	1.21	0.00	11.9
13:51	510	33.1	15.27	0.51	0.00	12.5
13:52	505	33.1	15.76	0.58	0.00	12.1
13:53	504	33.1	16.21	0.61	0.00	11.5
13:54	499	33.1	16.41	0.64	0.00	13.1
13:55	499	33.2	16.30	0.60	0.00	12.4
13:56	496	33.2	15.98	0.58	0.00	14.1
13:57	495	33.3	15.38	0.89	0.00	22.1
13:58	496	33.4	14.49	1.89	0.00	20.3
13:59	490	33.4	16.13	0.60	0.00	13.8
14:00	496	33.5	16.11	0.00	0.00	10.9
14:01	497	33.5	16.26	0.00	0.00	10.8
14:02	491	33.5	16.26	0.00	0.00	18.3
14:03	506	33.5	15.69	0.00	0.00	18.4
14:04	511	33.7	14.88	0.00	0.00	17.0
14:05	511	33.7	14.91	0.00	0.00	16.6
14:06	513	33.7	15.08	0.00	0.00	13.9
14:07	506	33.8	15.11	0.00	0.00	6.2
14:08	508	33.8	14.68	0.00	0.00	7.9
14:09	507	33.9	14.98	0.00	0.00	5.7
14:10	509	34.0	14.55	0.45	0.00	5.8
14:11	508	34.0	14.60	0.45	0.00	8.2
14:12	495	34.0	14.84	0.00	0.00	13.0
14:13	491	34.0	14.93	0.00	0.00	12.6
14:14	488	34.0	15.01	0.00	0.00	11.1
14:15	489	34.1	15.06	0.00	0.00	14.2
14:16	484	34.1	15.31	0.00	0.00	14.3
14:17	487	34.1	15.36	0.00	0.00	11.2
14:18	483	34.1	15.18	0.00	0.00	11.6
14:19	485	34.1	15.41	0.00	0.00	10.1
14:20	482	34.2	15.11	0.00	0.00	10.4
14:21	482	34.2	15.06	0.00	0.00	9.8
14:22	483	34.2	15.22	0.00	0.00	9.7
14:23	482	34.2	15.41	0.00	0.00	8.7
14:24	480	34.3	15.40	0.00	0.00	8.5
14:25	482	34.4	15.46	0.00	0.00	7.6
14:26	481	34.4	15.53	0.00	0.00	7.0
14:27	482	34.5	15.50	0.00	0.00	6.9
14:28	480	34.5	15.65	0.00	0.00	7.9
14:29	482	34.6	16.05	0.00	0.00	5.9
14:30	484	34.6	16.25	0.00	0.00	5.9
14:31	482	34.7	16.58	0.00	0.00	5.5
14:32	480	34.7	16.73	0.00	0.00	6.4
14:33	478	34.8	16.92	0.00	0.00	8.5
14:34	476	34.9	17.18	0.00	0.00	7.9
14:35	474	34.8	17.42	0.00	0.00	8.8
14:36	469	34.9	17.64	0.00	0.00	10.8
14:37	467	34.9	17.79	0.00	0.00	9.8
14:38	468	34.9	17.97	0.00	0.00	9.9
14:39	462	34.9	18.18	0.00	0.00	15.3
14:40	480	34.9	17.80	0.00	0.00	15.2
14:41	484	35.0	17.39	0.00	0.00	14.1
14:42	488	35.0	17.48	0.00	0.00	14.0
14:43	492	35.0	17.48	0.00	0.00	13.3
14:44	492	35.0	17.55	0.00	0.00	13.3
14:45	494	35.1	17.59	0.00	0.00	12.3
14:46	494	35.1	17.62	0.00	0.00	12.5
14:47	497	35.1	17.65	0.00	0.00	12.9
14:48	488	35.1	17.74	0.00	0.00	19.5
14:49	477	35.1	17.04	0.00	0.00	20.6
14:50	460	35.1	17.19	0.00	0.00	27.3
Average	490	34.2	16.08	0.15	0.00	11.9





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*Emissions Monitoring Specialists*

## Guildford Cremator

### Total Particulate Matter and Hydrogen Chloride

Contract Guildford Crematorium DEM1207  
Date 19th December 2018  
Location Cremator Stack  
Engineer(s) JB  
Absorbent H<sub>2</sub>O

Test Log	Test 1		Test 2		Test 3	
Barometric Pressure(kPa)	101.0		101.0		101.0	
Gas Meter Temperature(Deg C)	19.6		33.1		34.2	
Oxygen Concentration(%v/v dry)	15.73		15.34		16.08	
Flue Gas Volumetric Flow(Nm <sup>3</sup> /h dry)	1639		1547		1399	
Time	Start	End	Start	End	Start	End
Gas Meter Reading(Am <sup>3</sup> dry)	10:32	11:32	12:29	13:29	13:50	14:50
Gas Meter Reading(Am <sup>3</sup> dry)	109.599	110.316	111.106	111.694	111.861	112.427
Absorber Weight(g)	3589.2	3626.4	3468.0	3489.1	3574.1	3598.1
Filter Reference	GU191218F1		GU191218F2		GU191218F3	
Filter Weight(g)	0.54810	0.57622	0.54785	0.57561	0.55443	0.58315
Probe Rinse Reference	GU191218R		GU191218R		GU191218R	
Probe Rinse Weight(g)	76.49874	76.50740	76.50740	76.51595	76.51595	76.52480
Sample Reference HCl	GU181218 H1		GU181218 H2		GU181218 H3A+B	
Absorbent Volume(ml)	500		500		250	250
Absorbent(mg/l as HCl)	26		26		49	0.18
Blank(mg/l as HCl)	0.17		0.17		0.17	0.17

#### Calculation: General

Barometric Pressure(kPa)	101.0	101.0	101.0
Gas Meter temperature(Deg C)	19.6	33.1	34.2
Gas Volume Sampled(Am <sup>3</sup> dry)	0.717	0.588	0.566
Gas Volume Sampled(Nm <sup>3</sup> dry)	0.6670	0.5229	0.5015
Mass of Dry Gas(g @ 1292.8 g/Nm <sup>3</sup> )	862.32	676.00	648.34
Change in Absorber Weight(g)	37.2	21.1	24.0
Water Vapour Volume(Nm <sup>3</sup> @ 803.9 g/Nm <sup>3</sup> )	0.0463	0.0262	0.0299
Gas Volume(Nm <sup>3</sup> wet)	0.7133	0.5491	0.5314
Mass of Wet Gas(g)	899.52	697.10	672.34
Moisture Concentration(%v/v)	6.5	4.8	5.6
Moisture Concentration(%w/w)	4.1	3.0	3.6

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**Calculation: Particulate**

Increase In Filter Weights(g)	0.03678	0.03631	0.03757
Particulate Emission(mg/Nm <sup>3</sup> dry)	55.14	69.44	74.91
Oxygen Concentration(%v/v dry)	15.73	15.34	16.08
<b>Particulate Emission</b>	<b>105.06</b>	<b>123.20</b>	<b>153.18</b>
<b>(mg/Nm<sup>3</sup> @ 11 %v/v Oxygen dry)</b>			
Flue Gas Volumetric Flow(Nm <sup>3</sup> /h dry)	1639	1547	1399
<b>Particulate Emission(g/h)</b>	<b>90.39</b>	<b>107.41</b>	<b>104.77</b>
Required Sample Velocity(Nm/s)	2.86	2.70	2.44
Nozzle Used(mm)	8.5	8.5	8.5
Area of Nozzle(m <sup>2</sup> )	0.00005675	0.00005675	0.00005675
Test Duration(mins)	60	60	60
Actual Sample Velocity(Nm/s)	3.27	2.56	2.45
Isokinetic Closure(%)	114	95	101
		103	
Start Leak Check(%)	1.2	1.2	1.2
	@10 l/min	@10 l/min	@10 l/min
End Leak Check(%)	1.2	1.2	1.2
	@10 l/min	@10 l/min	@10 l/min

**Calculation: HCl**

Absorbent(mg/l as HCl)	26	26	49.18
Blank(mg/l as HCl)	0.17	0.17	0.17
Chloride Absorbed(mg/l as HCl)	25.83	25.83	49.01
Chloride Absorbed(mg as HCl)	12.92	12.92	12.25
HCl(mg)	12.92	12.92	12.25
HCl Emission(mg/Nm <sup>3</sup> dry)	19.36	24.70	24.43
Oxygen Concentration(%v/v dry)	15.73	15.34	16.08
<b>HCl Emission</b>	<b>36.89</b>	<b>43.82</b>	<b>49.96</b>
<b>(mg/Nm<sup>3</sup> @ 11 %v/v Oxygen dry)</b>			
Flue Gas Volumetric Flow(Nm <sup>3</sup> /h dry)	1639	1547	1399
<b>HCl Emission(g/h)</b>	<b>31.74</b>	<b>38.20</b>	<b>34.17</b>



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## **Guildford Cremator**

### **Flue Gas Volumetric Flow**

Contract Guildford Crematorium DEM1207  
Date 19th December 2018  
Location Cremator Stack  
Engineer(s) JB

Test Log	Test 1	Test 2	Test 3
Flue Gas Temperature(Deg C)	465	497	490
Flue Gas Pitot Head Sample Points(Pa)	16.1	14.5	11.9
Flue Gas Moisture(%v/v)	6.5	4.8	5.6
Flue Gas Moisture(%w/w)	4.1	3.0	3.6
Flue Gas Duct Dimensions(mm)	450mm Diameter Circular duct		
Flue Gas Duct Area(m <sup>2</sup> )	0.1591		

### **Calculation**

Flue Gas Density(kg/m <sup>3</sup> )	0.4709	0.4533	0.4565
Flue Gas Velocity(Am/s)	8.27	8.00	7.23
Flue Gas Volumetric Flowrate(Am <sup>3</sup> /h)	4737	4580	4140
Flue Gas Volumetric Flowrate(Am <sup>3</sup> /h dry)	4430	4361	3908
<b>Flue Gas Volumetric Flowrate(Nm<sup>3</sup>/h dry)</b>	<b>1639</b>	<b>1547</b>	<b>1399</b>



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**Guildford Cremator**

**Emissions Monitoring 2018**

**Test Instrumentation Calibration Data**

	Siemens Ultramat 23		Signal 3030PM
	CO	O <sub>2</sub>	VOC
Date of Check	19/12/2018	19/12/2018	19/12/2018
Time of Check	09:30	09:30	09:40
Test Reference	Tests 1 - 3	Tests 1 - 3	Tests 1 - 3
Zero reading at analyser	0 mg/m <sup>3</sup>	20.95%	0.0 ppm
Span reading at analyser	498 mg/m <sup>3</sup>	0.01%	50.2 ppm
Zero check down line	0 mg/m <sup>3</sup>	20.95%	0.0 ppm
Span check down line	498 mg/m <sup>3</sup>	0.03%	50.1 ppm
Zero reading post test at analyser	0 mg/m <sup>3</sup>	20.95%	0.1 ppm
Date of Check	19/12/2018	19/12/2018	19/12/2018
Time of Check	15:10	15:10	15:20
Test Reference	Tests 1 - 3	Tests 1 - 3	Tests 1 - 3
Zero reading at analyser	0 mg/m <sup>3</sup>	21.05%	-0.1 ppm
Span reading at analyser	495 mg/m <sup>3</sup>	0.01%	50.1 ppm
Zero check down line	0 mg/m <sup>3</sup>	21.05%	-0.1 ppm
Span check down line	495 mg/m <sup>3</sup>	0.01%	50.0 ppm
Zero in air post test at analyser	0 mg/m <sup>3</sup>	21.05%	-0.1 ppm

**Calibration Gases**

Gas	Supplier	Cylinder No.	Certified Conc.	Analytical Tolerance ± %
Carbon monoxide in Nitrogen	DRM	AGG2010-1-2	397 ppm	2
Propane in synthetic air	DRM	AGG2010-2-2	496 mg/m <sup>3</sup>	2
Oxygen	-	-	50.3 ppm	-





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## APPENDIX 2

### Analysis Reports

#### Particulate Weight Determination

Reference			Clean Dry Weight g	Dirty Dry Weight g
Filters	GU191218FOB	16	0.55448	0.55449
	GU191218F1	Z7	0.5481	0.57622
	GU191218F2	Z8	0.54785	0.57561
	GU191218F3	Z9	0.55443	0.58315
Rinses	GU191218ROB		78.94125	78.94148
	GU191218R		76.49874	76.52480



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**CONCEPT LIFE SCIENCES**  
DL V.0190 SC LYCL

Concept Life Sciences is a trading name of  
Concept Life Sciences Analytical & Development  
Services Limited registered in England and  
Wales (No 2514786)

## Concept Life Sciences

### Certificate of Analysis

Hadfield House  
Hadfield Street  
Crompton  
Manchester  
M16 9FE  
Tel: 0161 874 2400  
Fax: 0161 874 2404

**Report Number:** 792565-1

**Date of Report:** 15-Jan-2019

**Customer:** Davies & Co (Environmental)  
Moor Road  
Leeds  
LS10 2DD

**Customer Contact:** . Reports

**Customer Job Reference:** DEM1207

**Customer Purchase Order:** 50001748

**Date Job Received at Concept:** 28-Dec-2018

**Date Analysis Started:** 02-Jan-2019

**Date Analysis Completed:** 15-Jan-2019

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation

This report should not be reproduced except in full without the written approval of the laboratory

Tests covered by this certificate were conducted in accordance with Concept Life Sciences SOPs

All results have been reviewed in accordance with Section 25 of the Concept Life Sciences, Analytical Services Quality Manual



Report checked  
and authorised by:  
David Plachcinski  
Customer Service Advisor

Issued by:  
David Plachcinski  
Customer Service Advisor

Validity: unknown

Digitally signed by David Plachcinski  
Date: 2019.01.15 11:02 GMT  
Reason: Issued  
Location: Concept

Page 1 of 2

792565-1



**Davies & Co. (Environmental) Ltd**  
Emissions Monitoring Specialists

Concept Reference: 792565						
Customer Reference: DEM1207						
Impinger(DI water)		Analysed as Impinger(DI water)				
Hydrogen Chloride						
Concept Reference		792565 001	792565 002	792565 003	792565 004	792565 005
Customer Sample Reference		GU181218 H1	GU181218 H2	GU181218 H3A	GU181218 H3B	GU181218 HBLANK
Test Sample		AR	AR	AR	AR	AR
Date Sampled		18-DEC-2018	18-DEC-2018	18-DEC-2018	18-DEC-2018	18-DEC-2018
Determinand	Method	LOD	Units	Symbol		
Hydrogen Chloride	IC	0.05	mg/l	U	29 <sup>th</sup>	29 <sup>th</sup>
					40 <sup>th</sup> 18 <sup>th</sup>	6.18 <sup>th</sup>
						6.17 <sup>th</sup>

**Index to symbols used in 792565-1**

Value	Description
AR	As Received
13	Results have been blank corrected
195	Due to levels found in the sample that are outside of the normal calibration range of the instrument, analysis was conducted on a diluted sample
U	Analysis is UKAS accredited