Bilaga B3

Utsläpp från kremeringsugnar

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ISO 9001 REGISTERED FIRM
Certificate No.GB2000936

INTERNATIONAL ACCREDITATION BOARD
Registration No. 0044/1

addfield
Incinerate • Cremate

MANUFACTURERS DECLARATION REGARDING THE COMPLIANCE OF AN INCINERATOR WITH ANNEX III OF THE ANIMAL BY-PRODUCTS REGULATIONS (EU) NO. 142/2011

We Addfield Environmental Systems Ltd HEREBY CERTIFY that Addfield A50IC(2) meets the operating requirements set out in Annex III Section 2 of Regulation EU 142/2011 implementing Regulation EC 1069/2009 and the provisions of The Animal By-Products (Enforcement (England/Wales/Scotland)) Regulations 2011, as (Low Capacity or High Capacity) Incinerator compliant with the requirement to raise the temperature of the resultant gas to either 850°C for 2 seconds or 1100°C for 0.2 seconds

PROVIDED THAT:

1. The Incinerator is operated only with the burners specified below and set at the ratings and/or fuel flow and air settings specified and/or set by the manufacturers.
2. No alternation is made to the Incinerator flows and inputs.
3. The incinerator is operated at all times in accordance with the Manufacturer's Operating Instructions.
4. The Incinerator undergoes such annual servicing as specified in the Manufacturer's Operating instructions. Servicing is to be carried out by the Manufacturer or a suitably qualified and certified Engineer.
5. The temperature measuring equipment and any temperature recording equipment fitted to the Incinerator shall be maintained in proper working order and shall be re-calibrated by the manufacturer. Re-calibration shall be carried our in accordance with the instructions contained in the Operating Instructions and to a recognised standard (e.g. UKAS).
6. In the event of damage to or malfunction of any part of the equipment including one or more burners or any part of the temperature monitoring equipment, the Operator shall immediately report this to the Manufacturer and follow the instructions of the Manufacturer to rectify the matter to ensure that the Incinerator operates in accordance with its design specification.

Below are the expected emissions from the Addfield A50IC(2) machines. Stack emission are resulting from pet cremation - domestic cats and dogs. Operating at a nominal throughput of <50kg/hr, with a secondary after chamber in place with a minimum temperature of 850 deg.C

Parameter (EN)	**Addfield**
Particulate Matter	30 mg/Nm3
NOx	180/Nm3
SOx	62mg/Nm3
CO	42mg/Nm3
Total VOC (As carbon)	0.6mg/Nm3
Heavy Metals	0.05mg/Nm3
HCI	1.04mg/Nm3
HF	0.07mg/Nm3

Company Name: **Addfield Environmental Systems Ltd**
Make and model of incinerator: **Addfield A50IC(2)**
Make and model of burner: (4) **Ecoflam Max 120TC / (**1) **Ecoflam Max 250TC**

Fuel and air settings of burner (Powered burners only):
a) Main Burner: **Air 4-8 / Fuel 10 – 16 bar**
b) Afterburner: **Air 4-8 / Fuel 10 – 16 ba**

Signed
Print Name James Grant
Position Business Development Director
Date 04/01/2024

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

Flaura Pets

Incinerator Emissions Report

(PAEL: WCCT150)

Calculations by: Maitaishe Svotwa, Adv Dip (Chem Eng)

Written by: Matt Findlay, BEng (Chem Eng)

Reviewed by: Sherri Mason, BSc (Mech Eng)

yellowtree
WHERE INTEGRITY & SCIENCE MEET

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

Table of Contents

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

1. Declaration of Normal Operating Conditions

I, _____, hereby declare that the incinerator at Flaura Pets was operating at normal conditions when Yellow Tree conducted emissions sampling on the 24th of October 2023.

Signature: _____

Date: _____

Place: _____

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

2. Executive Summary

On the 24th of October 2023, Yellow Tree conducted emissions sampling on the veterinary waste incinerator at Flaura Pets in Somerset West.

The incinerator at Flaura Pets is classified as a Listed Activity under Subcategory 8.2 (*Crematoria and Veterinary Waste Incineration*) of the Listed Activities legislation (G.N. 893 of 2013). As a result, the incinerator is required to comply with emissions limits for particulate matter (PM), carbon monoxide (CO) and the oxides of nitrogen (NO_X).

Table 1 contains the emissions that were measured, as well as the legislated emissions limits.

Table 1: Emissions from the Incinerator at Flaura Pets.

Pollutant	Concentration mg/Nm³, 11 % O_2	Limit
Particulate Matter (PM)	8	40
Carbon Monoxide (CO)	11	75
Oxides of Nitrogen (NO_X)	150	500
Sulphur Dioxide (SO_2)	7	-

Average PM emissions from the incinerator were below the emissions limit of 40 mg/Nm³. Average CO emissions were below the emissions limit of 75 mg/Nm³.

PM and CO are both formed when incomplete combustion of the organic material occurs in an incinerator. Flaura Pets, in conjunction with burner specialists Technoburn, and Addfield (the OEM of the cremator), made several adjustments to the cremator operation following the emissions sampling results in April of 2023. The adjustments resulted in near-optimal combustion conditions, with a secondary chamber temperature of 924 ˚C and a flue gas oxygen content of 8 – 12 %, which is reasonable for cremators.

The optimisations have resulted in PM and CO emissions that are below the limit, and Flaura Pets should be commended for taking steps to reduce emissions to well below the legislated limits.

Average NO_X emissions were below the emissions limit of 500 mg/Nm³. NO_X emissions depend on the design of the combustion installation and the material that is burned.

No SO_2 emissions were measured from the incinerator. SO_2 is generated from the sulphur in the animal carcasses and in the diesel fuel that is used to fire the incinerator, both of which are low in sulphur. Thus negligible SO_2 emissions are expected. There is no emissions limit for SO_2.

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

3. Sampling Method

3.1. Procedures

The stack was sampled according to the US EPA methods listed in Table 2.

Table 2: US EPA Methods

US EPA Method	Purpose
1	Traverse Points for Measurement in a Stack
2	Measuring Velocity with an S-type Pitot Tube
3	Determination of Molecular Weight
4	Determination of Moisture Content
5	Determination of Particulate Matter
6c	Determination of SO_2 emissions
7e	Determination of NO_x emissions
10	Determination of CO emissions

Three sampling runs, each of one-hour duration, were conducted on the incinerator in accordance with G.N. 893 of 2013.

3.2. Equipment

The measurement of PM was performed using the Tecora Isostack isokinetic sampler. It is completely automatic and digital. The elimination of manual calculations and manual adjustments to the sampling flowrate makes this instrument highly accurate.

The measurement of oxygen (O_2), carbon monoxide (CO), sulphur dioxide (SO_2), and nitric oxide (NO) and nitrogen dioxide (NO_2), which are together known as the oxides of nitrogen (NO_X), was performed using the Testo 350 gas analyser, which is fit for compliance measurement. NO and NO_2 were measured separately and summed to obtain the NO_X concentration. This is more accurate than only measuring the NO concentration and then adding 5% to compensate for the NO_2, which is a technique used by lower cost analysers. All gas was dried using a Peltier cooler, as is legally required, so that the gases are measured on a dry basis.

Links to the calibration certificates of the equipment mentioned above can be found in Appendix C: Calibration Certificates. The following images were taken during the emissions sampling of the incinerator at Flaura Pets.

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

Figure 1: Yellow Tree's Emissions Sampling Equipment at Flaura Pets

Figure 2: The Stack at Flaura Pets

3.3. Method Deviations

1. During the last 30 minutes of Run 3, the high temperatures in the stack (924 ˚C) caused the sampling nozzle to detach and fall into the stack. This may affect the isokinetic deviance within the last 30 minutes of sampling. However, the impact of this deviation was assessed by comparing the results of Run 3 with the PM results of Runs 1 and 2. PM emissions from each sampling run were within 3 mg/Nm^3 of one another. Thus, the deviation is not expected to have affected the compliance status of Flaura Pets.

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

4. Compliance

4.1. Legislation

Flaura Pets is classified as a Listed Activity under Subcategory 8.2 *(Crematoria and Veterinary Waste Incinerators)* of the Listed Activities legislation. As a result, the facility is required to comply with the emissions limits that are shown in Table 3. As specified in the table, veterinary waste incinerators do not have to sample for, or comply with, limits for mercury because this is applicable only to human crematoria.

In Table 3,"existing" plant refers to a plant that was operational before April 2010, and "new" plant refers to a plant that came into operation after April 2010. "Existing" plants have been required to comply with the stricter "new" emissions limits since the 01st of April 2020. The incinerator at Flaura Pets is a new installation, thus it is required to comply with the stricter limits of a "new" activity.

Table 3: Limits Applicable to Crematoria and Veterinary Waste Incinerators

Subcategory 8.2: Crematoria and Veterinary Waste Incineration

Description:	Cremation of human remains, companion animals (pets) and the incineration of veterinary waste		
Application:	All installations		
Substance or mixture of substances		**Plant status**	**mg/Nm³ under normal conditions of 11% O_2, 273 Kelvin and 101.3 kPa.**
Common name	**Chemical symbol**		
Particulate matter	N/A	New	40
		Existing	250
Carbon monoxide	CO	New	75
		Existing	150
Oxides of nitrogen	NO_X expressed as NO_2	New	500
		Existing	1000
Mercury (Applicable to human cremation only)	Hg	New	0.05
		Existing	0.05

The emissions limits for PM, CO, and NO_X that are contained in the Provisional Atmospheric Emissions License (PAEL) issued to Flaura Pets do not deviate from those in the legislation. Mercury monitoring is not required because no human cremation takes place at the site.

Table 4: Air Emissions Limits Contained in Flaura Pet's PAEL.

7.2. Reporting Group / Emission Unit – maximum emission rates (under normal working conditions)

RG/EU Code	Activity	Pollutant Name	Maximum Release Rate (mg/Nm³)	Date to be Achieved By	Average Period (Drop-down: Instantaneous, Hourly, Daily, Monthly, Annually)	Permitted Duration of Emissions
EU002	SA0802	Particulate Matter (PM)	40	Immediate	Hourly	Continuous
	SA0802	Carbon Monoxide (CO)	75	Immediate	Hourly	Continuous
	SA0802	Oxides of Nitrogen (NOx expressed as NO_2)	500	Immediate	Hourly	Continuous

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

5. Emissions Sampling Results

Table 5 contains the emissions results from the incinerator at Flaura Pets.

Table 5: Emissions from the Incinerator at Flaura Pets

Pollutant	Concentration mg/Nm³, 11 % O_2	Limit
Particulate Matter (PM)	8	40
Carbon Monoxide (CO)	11	75
Oxides of Nitrogen (NO_X)	150	500
Sulphur Dioxide (SO_2)	7	-

5.1. Particulate Matter (PM)

PM refers to the soot, fly ash, or small solid particles that are entrained in the flue gas that exits the chimney stack. These particles typically manifest as smoke. The smoke is dense if the concentration of the particles is high. PM can be described based on three characteristics: colour, size distribution, and concentration in the flue gas stream.

The size distribution of the PM is important as smaller particles are more detrimental to human health and the environment. In some situations, it is useful to quantify the percentage of the sample that consists of small particles below 10 µm in size, and very small particles beneath 2.5 µm in size. In South Africa, the legislation does not make a distinction based on size, and so PM is quantified as a total concentration irrespective of size.

PM becomes lodged in the lungs and impairs respiration. Particles smaller than 10 µm, and especially those smaller than 2.5 µm in size (called PM_{10} and $PM_{2.5}$, respectively), are the most harmful to human health. PM_{10} is sufficiently small to become embedded deep in the respiratory system, and $PM_{2.5}$ can enter directly into the blood stream by passing through the respiratory system. According to the Global Burden of Disease Study reported in 2020, particulate matter caused 6.45 million deaths in 2019[1]. Ambient air pollution, of which fine PM has the greatest effect, is attributed to cause about 50 % of deaths from cardiovascular diseases, including ischaemic heart disease and stroke, about 20 % from chronic respiratory disease, including chronic obstructive pulmonary disease (COPD), about 12 % from respiratory infections and tuberculosis, about 7 % from maternal and neonatal disorder, and about 6 % from neoplastic disease, including lung cancer[2].

Average PM emissions from the incinerator were below the emissions limit of 40 mg/Nm³.

5.2. Carbon Monoxide (CO)

Carbon monoxide is most commonly a product of incomplete combustion and is a colourless, odourless and tasteless gas. Carbon monoxide is poisonous to human health as it binds to the

[1] https://www.thelancet.com/pb-assets/Lancet/gbd/summaries/risks/particulate-matter-pollution.pdf
[2] https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(20)30752-2.pdf

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

haemoglobin in the blood stream preventing oxygen from binding with the haemoglobin. However, in the atmosphere, CO oxidises to carbon dioxide (CO_2), which has no direct impact on human health but is associated with global warming.

CO emissions are highly dependent on the incinerator's design and operation. Combustion is defined as the process whereby a substance is combined with oxygen to produce an oxidised product and heat. Organic material comprised mostly of carbon. Carbon reacts with oxygen in the combustion process to produce carbon dioxide (CO_2) according to the chemical equation below. Carbon dioxide is a gas.

$$C_{(s)} + O_{2\,(g)} \rightarrow CO_{2\,(g)}$$

Carbon that does not undergo combustion will be emitted from the incinerator as PM. In order to ensure the complete combustion of carbon, it is important to make sure that sufficient oxygen (in the form of air) is available for combustion to take place. However, it is also important to avoid passing too much air through the incinerator, as this may cause additional PM formation due to the reduction of residence time and the lowering of the flame temperature in the incinerator. Carbon that undergoes partial combustion will form the gas CO, instead of CO_2, as shown beneath:

$$2C_{(s)} + O_{2\,(g)} \rightarrow 2CO_{\,(g)}$$

Average CO emissions from the incinerator were below the emissions limit of 75 mg/Nm^3.

5.3. Nitrogen Oxides (NO, NO_2)

NO_X is comprised of nitric oxide (NO), which is a clear gas, and of nitrogen dioxide (NO_2), which is a red/brown gas. NO_X reacts with volatile organic compounds (VOCs) in the presence of sunlight, creating the brown smog that is characteristic of many cities.

NO_X formation is increased at high temperatures and in situations when nitrogen and oxygen are in abundance.

Average NO_X emissions from the incinerator were below the emissions limit.

5.4. Sulphur Dioxide (SO_2)

Sulphur dioxide is a gas that is formed when the sulphur present in the fuel is burnt in the presence of oxygen ($S + O_2 \rightarrow SO_2$). SO_2 may undergo a variety of reactions in the atmosphere to form SO_3, which then combines with water in the atmosphere to form sulphuric acid (H_2SO_4). This is known as "acid rain." SO_2 also aggravates asthma.

No SO_2 emissions were detected from the incinerator. There is no emissions limit for SO_2 from Subcategory 8.2 Listed Activities.

SO_2 emissions are entirely dependent on the amount of sulphur present in the fuel and in the animal carcasses. Diesel and animal carcasses both have relatively low sulphur content and thus negligible SO_2 emissions are expected from veterinary waste incinerators. By comparison, coal combustion results in SO_2 emissions of ≈ 600 – 1 200 mg/Nm^3, while HFO combustion results in SO_2 emissions of ≈ 5 000 mg/Nm^3.

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

6. Incinerator Operation

Both CO and PM are products of incomplete combustion, and therefore it is crucial that the incinerator is operated to achieve optimal combustion. Figure 3 below shows how minimal CO emissions can be achieved by passing the optimum amount of excess air through the incinerator (indicated by the oxygen content in the flue gas). If too little excess air is passed through the incinerator, there is not enough oxygen to form CO_2, and CO becomes the dominant combustion product (along with PM). If too much excess air is passed through the incinerator, the residence time of the flue gas is reduced and the flame temperature may also be lowered, which leads to incomplete combustion of the carbon.

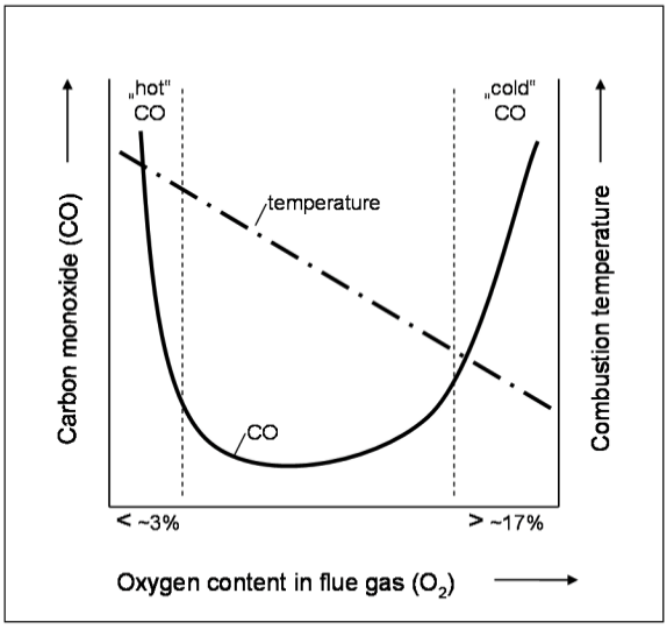

Figure 3: CO Emissions and Incinerator Temperature vs. Oxygen Content (Schetter, 2011)

In addition to, the following three principles are necessary to achieve effective combustion in incinerators and cremators.[3]

- The temperature at the entry and exit of the secondary chamber should be maintained at a minimum temperature of 850 °C.
- The combustion gases should be held in the secondary chamber for at least two seconds.
- The oxygen concentration within the secondary chamber should be maintained at greater than 6 % oxygen but should theoretically remain close to 6 %. In practice, the optimal oxygen concentration tends to be near 10 % to 12 % due to unideal mixing in the cremator and air ingress before the measurement point, which can inflate the oxygen measurement.

[3] United Nations Environment Programme, 2008. *Guidelines on Best Available Techniques and Provisional Guidance on Best Environmental Practices.* Section VI.G. Part III Source category (g):
Available at: http://chm.pops.int/Portals/0/Repository/batbep_guideline08/UNEP-POPS-BATBEP-GUIDE-08-12.English.PDF

In April of 2023, Yellow Tree measured PM emissions of 1 935 mg/Nm^3 and CO emissions of 133 mg/Nm^3 (Report No. YTS421FP).

At certain periods during sampling in April, the oxygen concentration in the flue gas increased to nearly 19 %, which is much higher than the recommended 10 % that applies to incinerators and cremators. During these periods, CO emissions increased to a level above the limit. It was recommended that the incinerator operation be adjusted to maintain optimal oxygen levels near 10 %, and to avoid a constant switching "on and off" of the burners, which may have exacerbated PM emissions by causing smoldering of the organic matter.

Following the emissions results from April 2023, Flaura Pets, in conjunction with burner specialists Technoburn, and Addfield (the OEM of the cremator), made several adjustments to the cremator operation, including:

- Reducing the amount of organic matter in the cremator to cremate no more than two animals at a time;
- Adjusting the burner nozzle size and flue gas pressure settings to avoid overheating of the primary and secondary chambers, which could cause the burners to switch off and on continuously;
- Raising the incinerator floor in the primary chamber to get direct contact of the burner flames with the animal carcasses;
- Other changes not specified here.

After the operation was optimised, during sampling in October of 2024, the oxygen content in the flue gas was within a reasonable range, at between 8 – 12 % oxygen. The secondary chamber was held at 924 ˚C, in accordance with the best available techniques recommended by the United Nations. A screenshot of the cremator setting during sampling are shown in Figure 4.

The optimisations have resulted in PM and CO emissions that are below the limit, and Flaura Pets should be commended for taking steps to reduce emissions to well below the legislated limits.

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

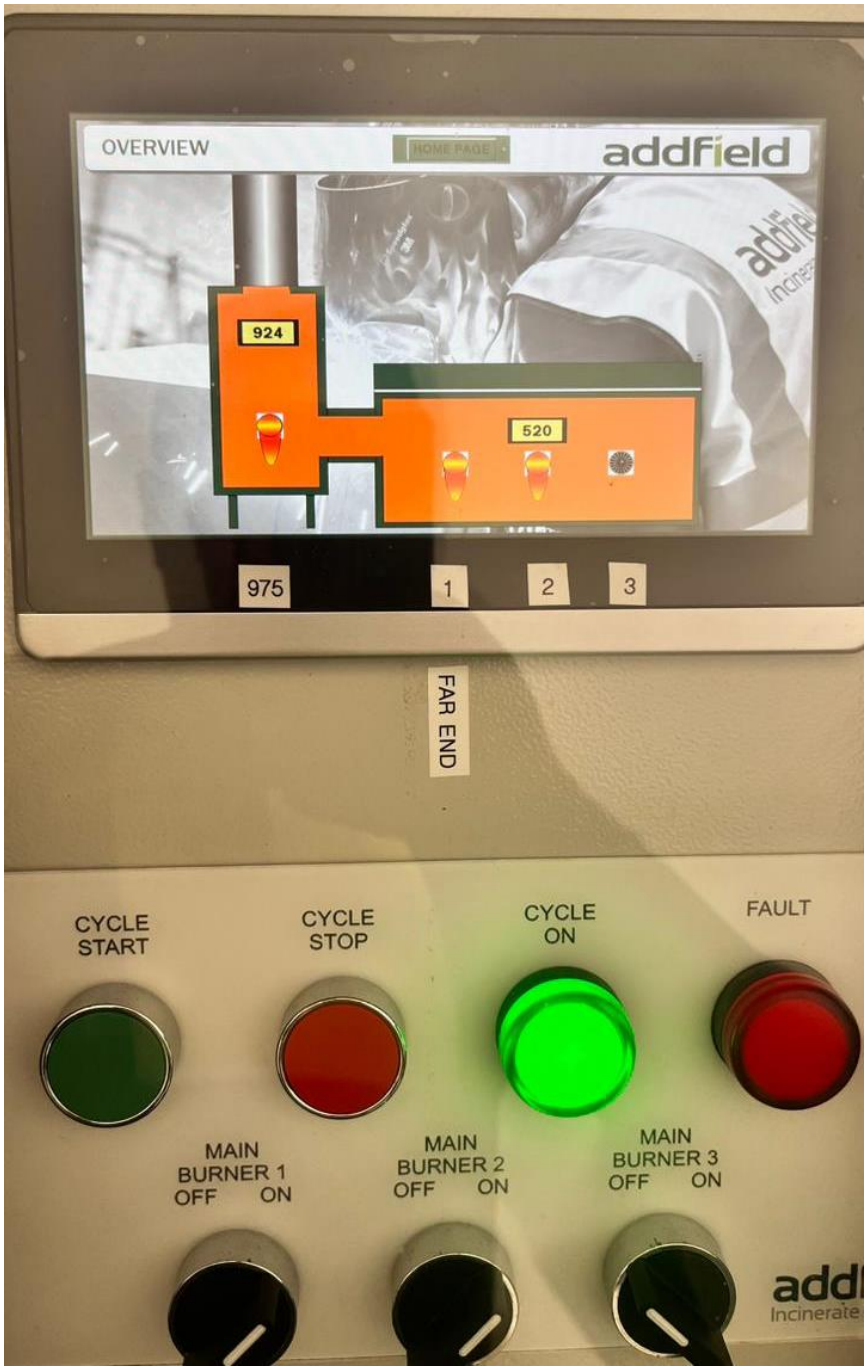

Figure 4: Incinerator Settings at the Time of Sampling

7. Conclusions

The veterinary waste incinerator at Flaura Pets is classified as a Listed Activity under Subcategory 8.2 *(Crematoria and Veterinary Waste Incinerators)* of the Listed Activities legislation. The incinerator is required to comply with emissions limits of 40 mg/Nm^3 for PM, 75 mg/Nm^3 for CO and 500 mg/Nm^3 for NO_X.

Flaura Pets, in conjunction with Technoburn and Addfield, made several adjustments to the cremator operation following the emissions sampling results in April of 2023. The adjustments resulted in near-optimal combustion conditions, with a secondary chamber temperature of 924 ˚C and a flue gas oxygen content of 8 – 12 %, which is reasonable for cremators.

Average PM emissions were below the emissions limit of 40 mg/Nm^3, and average CO emissions were below the emissions limit of 75 mg/Nm^3.

Average NO_X emissions were below the emissions limit of 500 mg/Nm^3.

Flaura Pets should be commended for making the adjustments necessary to attain low PM and CO emissions from the incinerator.

Yellow Tree would like to thank Flaura Pets for the opportunity to be of service. Yellow Tree's passion is to assist clients in quantifying their emissions accurately, to advise clients about engineering solutions to air emissions problems, and to help clients in making improvements in keeping with their environmental policies while constraining the costs of such solutions.

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

8. Appendix A: Report Details

Sampling and Reporting Conducted by:	Yellow Tree Unit D14 Prime Park Mocke Road Diep River
Calculations by:	Maitaishe Svotwa 
Report Written by:	Matt Findlay 
Report Reviewed by:	Sherri Mason 
Sampling Conducted by:	Sakhumzi Baliso, NDip (Analytical Chem) Sibusiso Dlamini: NDip (Chem Eng)
Sample Analysis Conducted by:	PM: Yellow Tree, Aphiwe Gugushe, (MSc, Chemistry), analysed on the 26th of October 2023.
Emissions Sampling Conducted at:	Flaura Pets 21 Tradelink Park Fabriek Street Strand
Report Compiled for:	Flaura Pets 21 Tradelink Park Fabriek Street Strand

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

9. Appendix B: Emissions Sampling Data

Test Number	1	2	3	Average
Date	24-Oct-23	24-Oct-23	24-Oct-23	
Start Time	10:19	11:27	12:50	
End Time	11:19	12:27	14:42	
Test Duration	01:00	01:00	01:00	
Sampled Vol - Wet Actual Conditions (m^3)	2.6304	2.4106	2.0437	
Sampled Vol - Dry, STP (Nm^3)	0.6262	0.7660	0.4675	
Gas Flow Rate - Wet Actual Conditions (m^3/h)	5419	4781	5535	5245
Gas Flow Rate - Dry, STP (Nm^3/h)	1290	1519	1266	1359
Isokinetic Deviance (%)	-6.9	-5.0	-7.1	
Stack Diameter (m)	0.35	0.35	0.35	
Nozzle Size (mm)	8	8	7	
Port No.	1&2	1&2	1&2	
Filter No.	C6392	C6393	C6394	
Average Velocity (m/s)	15.56	13.73	15.89	15.06
Average Stack Temp (°C)	808.34	536.95	851.64	732.31
Average Stack Pressure (kPa)	99.30	99.27	99.23	99.27
Moisture (% v/v)				3.80
Cake Mass (g)	0.0072	0.0078	0.0025	
Particulate Matter (mg/m^3) - Actual Conditions	3	3	1	2
Particulate Matter (mg/Nm^3) - STP	11	10	5	9
Particulate Matter (mg/Nm^3) - STP, 11% O_2	**9**	**9**	**6**	**8**
O_2 Average	8.5%	9.3%	11.5%	9.8%
CO Average (11% O_2) mg/Nm^3	13	12	8	11
SO_2 Average (11% O_2) mg/Nm^3	22	0	0	7
NO Average (11% O_2) mg/Nm^3	101	118	74	98
NO_2 Average (11% O_2) mg/Nm^3	0	0	0	0
NO_x Average (11% O_2) mg/Nm^3	155	181	113	150
Estimated Expanded Measurement Uncertainty k=2 (±)				
Particulate Matter (mg/Nm^3) - STP, 11% O_2	1	1	2	1
CO (11% O_2) mg/Nm^3	8	9	11	9
SO_2 (11% O_2) mg/Nm^3	10	6	6	7
NO (11% O_2) mg/Nm^3	7	8	7	7
NO_2 (11% O_2) mg/Nm^3	4	4	4	4
NO_x (11% O_2) mg/Nm^3	12	13	12	12
Absolute Pollutant Emissions				
PM Emission Rate (g/h)	14.8	15.5	6.8	12.4
CO Emission Rate (g/h)	20.5	21.9	9.0	17.1
SO_2 Emission Rate (g/h)	36.1	0.0	0.0	12.0
NO_x Emission Rate (g/h)	248.3	323.3	136.8	236.1

Client	Report	Version	Report No.	Date
Flaura Pets	Air Emissions	01	YTS2798FP	2023-11-01

10. Appendix C: Calibration Certificates

Tecora Isostack Isokinetic Sampler

https://yellowtree1.sharepoint.com/:b:/s/YellowTreeCalibrationCertificates/ER3_vdOp0uBEm6nrUbiYQXcB-KLYhes_Qpcon-VLNQJ6Fw?e=9tgO3o

Testo 350 Gas Analyser

https://yellowtree1.sharepoint.com/:b:/s/YellowTreeCalibrationCertificates/EcaK2pCz7u5Ip9cqr6RwRUMBRxbDO60LyeZFNIjC8d0Nog?e=zbsBpA

Richter Scale

https://yellowtree1.sharepoint.com/:b:/s/YellowTreeCalibrationCertificates/EYAPYfP0eYtEpw9XryjvGOsBaQ4rP5v3k2tAbltBR7boqA?e=nA45aZ