2019 COMPLIANCE SOURCE TESTING

Pyrox Industries Inc. - Bayview Cemetery & Crematory
Burlington, ON
Project # TC190703

Prepared for:

Pyrox Industries Inc.
7575 Thimens Blvd., Montreal, QC H4S 2A2

16-Oct-19

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Prepared for:
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16-Oct-19

Executive summary

Wood Environment and Infrastructure Solutions (Wood) was retained by Pyrox Industries Inc. (the CLIENT) to conduct compliance source testing on their cremation unit (1 of 3 identical Pyrox X-3000s) to meet the requirements of the Environmental Compliance Approval #7695-ANYP5E, dated July 13, 2017.

The facility maintains and operates three (1 installed and 2 future) natural gas fired human remains cremation units in Burlington, Ontario. The units each have a primary burner rated at 1,055,000 kilojoules per hour and a secondary burner rated at 2,110,000 kilojoules per hour. Per the ECA:

- the secondary chamber is operated with a minimum residence time of one second at a temperature of at least 1,000 degree Celsius;
- the secondary chamber is operated at a minimum combustion temperature of 1,000 degrees Celsius before the primary chamber is loaded and thereafter throughout each cremation; and
- the unit is operated such that the temperature at the outlet of the primary combustion chamber is at least 800 degrees Celsius for at least 30 minutes during the last part of each cremation.

Testing results and POI concentrations based upon the tested source emissions are summarized in the following tables. Included in Table ES.4 are the Ministry of the Environment, Conservation and Parks (MECP) POI criteria where applicable.

Measurements were carried out from July 16-18, 2019. Sampling, analysis and reporting was performed as per the MECP issued Ontario Source Testing Code (OSTC).

This report and all its results is subject to the appended Statement of Limitations.

Table ES.1: Average Stack Gas Characteristics*

Source	Flow (DRm^3/s)**	Oxygen (% dry)	Carbon Dioxide (% dry)	Moisture (%)	Stack Temp. (°C)
Cremator	0.706	14.74%	4.35%	8.96%	580

*Based on the average of the metals and semi-volatile isokinetic tests
**DRm^3 = Dry reference cubic metres (25°C, 101.3 kPa)

Table ES.2: Summary of Undiluted In-Stack Criteria

Contaminant	Units	In-Stack Concentration	Permit Criteria	% Of Criteria
O_2 10-min. average (Minimum of three tests)	% dry	7.18	Target >6%	--
CO 30-min. average (Maximum of three tests)	ppm dry @11 % O_2	6.76	Target <100 ppm	6.76%
THC 10-min. rolling average (Maximum of three tests)	ppm wet	2.42	Target <100 ppm	2.42%

Table ES.3: CEMS Relative Accuracy Test Summary

Source	Test	O_2 Criteria	O_2 Results	CO Criteria	CO Results
Cremator	BIAS	<4% of RM Mean Value	No Bias	4% of Full Scale	1.42%
	RA	<10% of RM Mean Value	2.71%	< 5ppm Abs. Difference	4.77 Abs. Difference

Table ES.4: MECP Point-Of-Impingement (POI) Concentrations, 24-Hour Averages

Parameter	CAS No.	POI Conc. ($\mu g/m^3$)	POI Criteria* ($\mu g/m^3$)	% Of Criteria
TSP	--	11.5	120	9.57%
HCl	7647-01-0	15.8	20	79.0%
Vinyl Chloride	75-01-4	2.92E-04	1	0.03%
Mercury	7439-97-6	2.51E-02	2	1.26%
Antimony	7440-36-0	2.91E-03	25	0.01%
Arsenic	7440-38-2	2.72E-04	0.3	0.09%
Barium	7440-39-3	4.51E-03	10	0.05%
Beryllium	7440-41-7	2.79E-05	0.01	0.28%
Cadmium	7440-43-9	6.24E-04	0.025	2.49%
Chromium	7440-47-3	2.78E-03	0.5	0.56%
Cobalt	7440-48-4	7.01E-05	0.1	0.07%
Copper	7440-50-8	1.04E-02	50	0.02%
Lead	7439-92-1	4.38E-03	0.5 (24-hr)	0.88%
		1.69E-03	0.2 (30-day)	0.84%
Molybdenum	7439-98-7	1.99E-03	120	0.00%
Nickel	7440-02-0	2.11E-03	0.04 (Annual)	0.53%
Selenium	7782-49-2	2.19E-03	10	0.02%
Silver	7440-22-4	3.21E-03	1	0.32%
Thallium	7440-28-0	7.29E-05	0.5	0.01%
Vanadium	7440-62-2	1.09E-04	2	0.01%
Zinc	7440-66-6	1.85E-01	120	0.15%
Benzo(a)pyrene	50-32-8	1.37E-07	0.00001 (Annual)	1.37%
Naphthalene	91-20-3	1.97E-04	22.5	0.00%
		6.24E-04	50 (10min)	0.00%
1-Methylnaphthalene	90-12-0	1.52E-05	35.5	0.00%
Tetralin	119-64-2	8.29E-05	151.5	0.00%
2-Chloronaphthalene	90-13-1	5.75E-07	1	0.00%
		(pg/m^3)	**($pgTEQ/m^3$)**	**%**
Dioxins/Furans/ Dioxin-like PCBs (TEQ)	-	9.40E-02	0.1	94.0%
		(OU/m^3)	**(OU/m^3)**	**%**
Odour	-	0.323	1 (10min)	32.3%

*24-hour average unless otherwise noted.

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1.0 INTRODUCTION

Wood Environment and Infrastructure Solutions (Wood) was retained by Pyrox Industries Inc. (the CLIENT) to conduct compliance source testing on their cremation unit (1 of 3 identical Pyrox X-3000s) to meet the requirements of the Environmental Compliance Approval #7695-ANYP5E, dated July 13, 2017.

The facility maintains and operates a natural gas fired human remains cremation unit in Burlington, Ontario. The unit has a primary burner rated at 1,055,000 kilojoules per hour and a secondary burner rated at 2,110,000 kilojoules per hour.

1.1 Summary of Test Program

The program was conducted on a single exhaust stack and measured the emissions of:

- Total suspended particulate matter (TSP);
- Metals;
- Dioxin/furans, dioxin-like PCBs and polycyclic organic matter (SVOCs);
- Halogenated and aromatic volatile organic compounds and vinyl chloride (VOCs);
- Hydrogen chloride (HCl);
- Total hydrocarbons (THC)*;
- Carbon monoxide (CO);
- Oxygen/Carbon Dioxide (O_2/CO_2);
- Odour; and
- Residence Time.

* Note: Total Hydrocarbons was substituted as a conservative measure of Total Gaseous Non-Methane Hydrocarbons.

The test contaminants and the corresponding testing protocols are listed in Table 1.

Table 1: Test Contaminants

Test Contaminant	Sampling Method	Analytical Method
Flow Rate	OSTC Methods 1 – 4	N/A
Total Suspended Particulate (TSP)	OSTC Method 5	Gravimetric
Metals	U.S. EPA Method 29	ICAP, CVAAS
Dioxins / Furans / Dioxin-like PCBs / PAHs (SVOCs)	Env. Canada EPS 1/RM/2	EPS 1/RM/3 HRMS
Volatile Organic Compounds (VOCs)	EPA SW-846 Method 0030 SLO VOST	EPA 5041A/8260C GC/MS
Hydrogen Chloride (HCl)	U.S. EPA Method 26	Ion Chromatography
Oxygen/Carbon Dioxide (O_2/CO_2)	U.S. EPA Method 3A	Electrochemical / Non-dispersive Infrared
Carbon Monoxide (CO)	U.S. EPA Method 10	NDIR
Total Hydrocarbons (THC)	EPA Method 25A	Flame Ionization Detector
Odour	OSTC Method 6	Odour Panel

Note: EPA 40CFR60 – United States Environmental Protection Agency
EPS – Environment Canada's Environmental Protection Series
OSTC – Ontario Source Testing Code

1.2 Test Program Organization

1) Company Name: Pyrox Industries Inc.
Plant Location: 7575 Thimens Blvd.
Montréal, QC H4S 2A2
Contact Name: Sébastien Litalien
Telephone No.: 514-886-5195
Email: litalien.s@pyrox-industries.com

2) Company Name: Bayview Cemetery & Crematory Inc.
Plant Location: 740 Spring Gardens Road
Burlington, ON L7T 1J3
Contact Name: Gary Francis
Telephone No.: 905-522-5466
Email: gfrancis@bayviewcemetery.ca

3) Ministry of Environment, Conservation and Parks Halton-Peel District Office
District Office: Suite 300, 4145 North Service Road
Burlington ON L7L 6A3
Manger: Nick Fowler
Telephone No.: 905-319-2139
Email: nick.fowler@ontario.ca

4) Sampling Company: Wood Environment & Infrastructure Solutions
Project Coordinator: Steve McClure
Telephone Number: 905-568-2929
Email: steve.mcclure@woodplc.com
Sampling Team: Ryan Fletcher, Ozgun Kizilkaya, David Zeldin

5) Analytical Laboratory: ALS Global
Sample Coordinator: Claire Kocharakkal
Telephone Number: 905-331-3111
Email: claire.kocharakkal@ALSGlobal.com

Odour Laboratory: Environmental Odour Consulting
Sample Coordinator: Anna Bokowa
Telephone Number: 647-988-5814
Email: bokowa.anna@environmentalodourconsulting.com

2.0 SOURCE DESCRIPTION

Pyrox Industries Inc. (the CLIENT) maintains and operates three (3) natural gas fired human remains cremation units (one Pyrox X-3000 installed and two planned) at their facility in Burlington, Ontario. The unit has a primary burner rated at 1,055,000 kilojoules per hour and a secondary burner rated at 2,110,000 kilojoules per hour.

The unit exhausts into the atmosphere through a stack having an exit diameter of 0.56 metres, extending 10.0 metres above the roof and 14.6 metres above grade.

3.0 TEST PROGRAM

3.1 Objectives

The testing program consisted of the determination/collection of the following information:

- Determination of the exhaust concentrations of the test contaminants;
- Determination of the volumetric flow rate of the emission gases and the corresponding emission rates of the test contaminants;
- Determination of the Relative Accuracy and System Bias of the facility CEMS;
- Determination of the residence time in the secondary chamber;
- Collection of process data; and
- Determination of the concentration of the test contaminants at the point of impingement (POI).

3.2 Test Matrix

The test matrix for this program is provided below in Table 2.

Table 2: Test Matrix

No. of Runs	Sample/ Pollutant	Method Number	Sample Run (min)	Analytical Method	Analytical Laboratory
3	Particulate Matter / Metals	OSTC 5 EPA M29	180	Gravimetric ICP, CVAAS	ALS Global
3	SVOCs	EPS 1/RM/2	180	GC/HRMS GC/MS	ALS Global
3	VOCs*	EPA SW-846 Method 0030 SLO VOST	40	GCMS	ALS Global
3	HCl*	EPA Method 26	60	IC	ALS Global
3	O_2 and CO_2	EPA Method 3A	180	Electrochemical	Wood Analyzer
3	Odour*	OSTC Method 6	~ 10 per bag	Dynamic Olfactometry	EOC
3	Carbon Monoxide	EPA Method 10	180	NDIR	Wood Analyzer
3	Total Hydrocarbons	EPA Method 25A	180	Flame Ionization Detector	Wood Analyzer

*VOCs, HCl and Odour samples were all collected during the first 60 minutes of a cremation. Isokinetic tests were conducted over the course of two burns, one for each traverse.

4.0 SAMPLING LOCATIONS

The sampling location consists of a 0.56 metre ID exhaust. Traverse points were determined on site, with a total of 8 points (4 / traverse) for the ideal sampling location, based on the Ontario Source Testing Code.

5.0 SAMPLING AND ANALYTICAL PROCEDURES

5.1 Total Suspended Particulates and Trace Metals

Sampling for total suspended particulate matter and trace metals was conducted in a single isokinetic sampling train based on Method 5 of the Ontario Source Testing Code and EPA Method 29. A pre-tared quartz filter with low metal traces was used. The standard Method 5 train was modified to include the following impinger solutions from U.S. EPA Method 29 for metals:

- Impinger 1 100 ml of 5% HNO_3 / 10% H_2O_2 solution
- Impinger 2 100 ml of 5% HNO_3 / 10% H_2O_2 solution
- Impinger 3 Empty
- Impinger 4 100 ml of 4% $KMnO_4$ / 10% H_2SO_4
- Impinger 5 100 ml of 4% $KMnO_4$ / 10% H_2SO_4
- Impinger 6 Silica Gel

The sampling time per test, excluding port changes, leak checks or process interruptions, was 180 minutes and the sample volumes exceeded 3.0 dry reference m^3. Triplicate test runs were conducted at each source. Each traverse point was sampled for 22.5 minutes. At 4.5-minute intervals throughout each test, the following information was measured and recorded for the modified Method 5 Train:

- Sampling time
- Dry gas meter volume
- Pitot tube pressure
- Stack gas temperature
- Probe, oven and impinger temperatures
- Dry gas meter temperatures
- Control module orifice pressure
- Sampling pump vacuum pressure

The sampling equipment consisted of a Method 5 train equipped with a quartz lined probe. Velocity measurements were taken using a pre-calibrated S-type pitot assembly in conjunction with an inclined manometer. Temperature measurements were made with a K-type thermocouple in conjunction with a digital thermometer. Sample volumes were determined with calibrated positive displacement dry gas meters. Following the conclusion of each test, the probe and sampling train were disassembled and recovered at a clean location on site.

All collected samples were analyzed first gravimetrically for particulate matter as detailed in the Ontario Source Testing Code (OSTC). In accordance with OSTC Method 5, all filters were desiccated for a period of 24 hours prior to weighing and acetone from all probe rinses was evaporated to dryness and the resulting mass was combined with the filter weight gain for determining the total particulate catch.

Metals and mercury analyses on each sample were performed by the selected CALA accredited laboratory following U.S. EPA Method 29 using Inductively Coupled Argon Plasma (ICAP) analysis for metals and Cold Vapour Atomic Absorption Spectroscopy (CVAAS) analysis for mercury.

5.2 Semi-Volatile Organic Compounds

Sampling for the target semi-volatile organic compounds (dioxins/furans/dioxin-like PCBs/PAHs) was conducted using an isokinetic sampling train in accordance with the "Reference Method for Source Testing: Measurement of Releases of Selected Semi-Volatile Organic Compounds from Stationary Sources", Environment Canada Report EPS 1/RM/2. Performance of the method involved the use of an integrated sampling train consisting of a quartz filter (pre-rinsed with a Hexane/Acetone solution), condenser, polymeric resin trap (XAD-2), and impingers. The use of the condenser ensured that the sample gas passing through the XAD-2 resin trap was maintained at a temperature below 20ºC.

All glassware, filters and resin used for this program were proofed prior to the performance of the sampling program in order to ensure no background organic contamination.

The sampling time per test, excluding port changes, leak checks or process interruptions, was 180 minutes and the sample volume exceeded 3 – 4 dry reference m^3. The source gas was collected using a quartz lined probe and then passed through the filter, condenser, XAD-2 resin, and impingers in sequence.

The sampling train was recovered as per the procedures outlined in the method for subsequent analysis according to the Environment Canada Method EPS 1/RM/3.

The Toxic Equivalency (TEQ) was calculated for each Dioxin, Furan and Dioxin-like PCB isomer using the World Health Organization 2005 Toxic Equivalency Factors.

5.3 Volatile Organic Compounds

Sampling for volatile organic compounds was conducted according to U.S. EPA Method SW0030 (SLO VOST). The train consists of a stainless steel probe followed by an assembly of condensers and organic resin traps. The method utilises Tenax and Tenax/charcoal cartridges, each of which is preceded by a condensing module. The first condenser cools the gas stream and condenses the water vapour present. The flue gas and condensed moisture then pass through a cartridge containing Tenax resin (60-80 mesh). The condensate is collected in the first flask, which is continually purged by the gas stream. The second condenser and trap contain Tenax/charcoal serving as a backup for low volume breakthrough compounds. The sampling train was operated at a flow rate of 0.5 lpm for 40 minutes and the total collection during each test run (one pair of tubes) was approximately 20 dry reference litres.

Analysis of the traps was performed by ALS Global in accordance with SW-846 US EPA Method 5041A; thermal desorption purge-and-trap by gas chromatography/mass spectrometry.

5.4 Hydrogen Chloride

As the stack gas is not saturated at the sampling location, sampling for HCl was conducted using a single point sampling train, based on a modified U.S. EPA Method 26, which utilizes the following full size impinger train:

- Impinger 1 100mL 0.1N H_2SO_4
- Impinger 2 100mL 0.1N H_2SO_4
- Impinger 3 Empty
- Impinger 4 Silica Gel

Sampling was conducted at approximately 20 litres per minute for 60 minutes providing approximately 1200 litres of dry gas sample. Gas volumes were measured with a calibrated dry gas meter. A heated Teflon filter was located in an oven outside of the stack prior to the impinger train. Each test was completed during the first 60 minutes of the cremation cycle.

5.5 Combustion Gases

Sampling for O_2/CO_2, CO and THC was conducted as per U.S. EPA methods 3A, 10 and 25A respectively. Analyzer calibrations are conducted in accordance with EPA Methods 7E or 25A, and are calibrated to meet the criteria specified in each method prior to commencing sampling. This requires a calculation of the Analyzer Calibration Error (A three or four point analyzer calibration), the System Bias (a zero and mid/high point system calibration before and after each test) and the Bias Drift (calculation of initial and final System Biases). Data deemed valid according the criteria defined is then corrected for bias using equations found in EPA Method 7E.

A sample conditioning system was used prior to the analyzers, with the exception of the total hydrocarbons, in order to cool and dry the gases. Total hydrocarbons, carbon monoxide and oxygen were monitored in the undiluted exhaust of the unit and reported as rolling averages. A second system monitored oxygen and carbon dioxide at the isokinetic sampling location for flow and velocity calculations.

Total gaseous non-methane organics was reported using the EPA Method 25A. This is a conservative strategy as it quantifies the total hydrocarbon content as opposed to just the non-methane fraction of carbon-based organics.

Gases were sampled for the duration of each isokinetic test.

A Relative Accuracy Test Audit (RATA) for CO and O_2 was completed on the data collected from the undiluted exhaust port. A summary of the RATA test data and daily calibration drift is included in Appendix B.

5.6 Odour

5.6.1 Pre-Dilution

Pre-dilution odour sampling involves drawing a portion of the emission gases into a stream of pre-purified nitrogen from a compressed cylinder and collected in a pre-cleaned 10 L Nalophan gas sample bag. The amount of nitrogen gas mixed with the sample gas (referred to as the dilution ratio) is adjusted using a calibrated flow metering system, typically comprised of a variable pressure gauge and a capillary tube. The flow of nitrogen gas through a jet eductor creates suction through a heated probe, which draws the sample gas directly into the nitrogen stream. This system has been developed in order to minimize the loss of odorous compounds in the gas sample from condensation and adsorption onto the walls of the sample bag. Odour sampling units were cleaned and calibrated prior to mobilization.

Three samples were collected at a pre-determined "optimal" dilution. Optimal dilution was determined based on moisture content from the source and the lowest ambient temperature at which the sample gas will be exposed to during transport and/or analysis. Moisture content from the source is divided by the amount of water in air at the dew point temperature selected for the lowest sample gas temperature and the number calculated is the pre-dilution ratio.

5.6.2 Laboratory Analysis

Evaluation of the odour samples are conducted using dynamic dilution olfactometry commonly referred to as an odour panel. The odour lab follows the procedures outlined in the OSTC, Version #3, June 2010 (Part G, Method ON-6). These procedures are in accordance with ASTM Standard Practice E679-041, Determination of Odour Taste Thresholds by a Forced-Choice Ascending Concentration Series of Limits. The odour lab makes use of an AC'SCENT® Dynamic Dilution Forced-Choice Triangle Olfactometer which complies with the ASTM E679-04 standard as well as the operational requirements of British Standard, BS EN 13725:2003, "Air quality – Determination of odour concentration by dynamic olfactometry".

Each odour sample is diluted with filtered air and delivered to a panel of 8 to 9 people who have all been screened to ensure that they have normal odour sensitivity. The sample is diluted to the point where none of the panellists can detect the odour and the concentration is slowly increased until all panellists can detect the odour. The point at which statistically 50% of the panellists can just detect the odour is recorded as the odour threshold value (OTV) of the sample. The numerical value of the OTV refers to the number of times the sample must be diluted with odour free air such that statistically 50% of an average sample of the population can just detect the odour. For convenience, the OTV is commonly expressed in terms of "odour units" (ou).

5.6.3 Odour Emission Calculation

Odour emissions are calculated as the product of the analyzed concentration (ou/wet reference m^3 or simply 'ou') and the wet reference exhaust flow rate.

5.7 Residence Time

Residence time was calculated using the flow measured in the stack, the volume of the secondary chamber and oxygen & temperature measurements recorded in both the stack exhaust and the undiluted locations.

Eq. 1: Flow in Secondary Chamber

$$Q_{2nd} = \frac{Q_{stack} * T_{2nd} * (20.9\% - O_2\%_{stack})}{(T_{stack} * (20.9\% - O_2\%_{2nd})}$$

Eq. 2: Residence Time in Secondary Chamber

$$RT = \frac{Q_{2nd}}{V_{2nd}}$$

Where:

- Q_{2nd} = Flow in secondary chamber (m^3/s)
- Q_{stack} = Flow measured at isokinetic sampling location (m^3/s)
- T_{2nd} =Temperature recorded by CEMS in secondary chamber (degree Rankine)
- T_{stack} = Temperature measure at isokinetic sampling location (degree Rankine)
- $O_2\%_{2nd}$ = Oxygen measured in secondary chamber (% v/v)
- $O_2\%_{stack}$ = Oxygen measured at isokinetic sampling location (% v/v)
- RT = Residence Time (secs)
- V_{2nd} = Volume of secondary chamber (m^3)

5.8 Process Data

Crematorium personnel were responsible for the collection, compilation and reporting, of the pertinent process data during the test program. Process data supplied by CLIENT staff can be found in Appendix F.

Table 3: Process Data Summary

Cremation Date	Weight (kg)	Casket Type	Start Time	Finish Time	Gas Meter (ccf)	Gas Meter (ccf)
					Start	End
16-Jul-19	88	Cardboard	9:15	10:45	591753	--
16-Jul-19	68	Cardboard	11:36	13:09	--	591795
17-Jul-19	95	Cardboard	8:35	10:05	591844	--
17-Jul-19	95	Cardboard	11:26	12:56	--	591874
18-Jul-19	64	Cardboard	8:20	9:50	591918	--
18-Jul-19	46	Cardboard	10:25	11:55	--	591940

6.0 RESULTS AND DISCUSSION

6.1 Schedule of the Test Program

The sampling program was conducted per the following schedules.

Table 4: Test Schedule

Test ID	Date	1st Traverse		2nd Traverse	
		Start	Finish	Start	Finish
ORG/MET-1	16-Jul-19	9:22	10:52	11:39	13:09
ORG/MET-2	17-Jul-19	8:35	10:05	11:26	12:56
ORG/MET-3	18-Jul-19	8:20	9:50	10:25	11:55
CEM-1	16-Jul-19	9:22	10:52	11:39	13:09
CEM-2	17-Jul-19	8:36	10:07	11:27	12:57
CEM-3	18-Jul-19	8:20	9:51	10:26	11:56
		Start Time		**Finish Time**	
VOST-1	16-Jul-19	11:39		12:19	
VOST-2	17-Jul-19	8:36		9:16	
VOST-3	18-Jul-19	8:20		9:00	
HCl	17-Jul-19	8:35		9:35	
HCl	17-Jul-19	11:26		12:26	
HCl	18-Jul-19	8:20		9:20	
Odour	17-Jul-19	11:27		11:57	

6.2 Test Results

Results of the sampling program can be found within the following tables. Calculations are shown in Appendix B.

Table 5: Summary of Stack Gas Characteristics

Test ID	Flow (DRm^3/s)*	Oxygen (% dry)	Carbon Dioxide (% dry)	Moisture (%)	Stack Temp. (°C)
TSP / Metals – 1	0.787	14.69%	3.90%	10.1%	576
TSP / Metals – 2	0.678	14.44%	5.19%	9.46%	605
TSP / Metals – 3	0.670	15.09%	3.97%	8.90%	558
Average	**0.711**	**14.74%**	**4.35%**	**9.49%**	**580**
ORG – 1	0.784	14.69%	3.90%	7.78%	582
ORG – 2	0.679	14.44%	5.19%	9.04%	596
ORG – 3	0.636	15.09%	3.97%	8.50%	565
Average	**0.700**	**14.74%**	**4.35%**	**8.44%**	**581**
Total Average	**0.706**	**14.74%**	**4.35%**	**8.96%**	**580**

*DRm^3 = Dry reference cubic metres (25°C, 101.3 kPa)

Table 6: Summary of In-Stack Concentrations

Contaminant	Units	Value	Permit Criteria	% Of Criteria
O_2 10-min. average (Minimum of three tests)	% dry	7.18	Target >6%	--
CO 30-min. average (Maximum of three tests)	ppm dry @11 % O_2	6.76	Target <100 ppm	6.76%
THC 10-min. rolling average (Maximum of three tests)	ppm wet	2.42	Target <100 ppm	2.42%

Table 7: Testing Results: TSP / HCl / Trace Metals

Compound	CAS	Test 1 (g/s)	Test 2 (g/s)	Test 3 (g/s)	Average (g/s)
TSP	N/A	3.08E-02	2.93E-02	2.61E-02	2.88E-02
HCl	7647-01-0	3.07E-02	8.16E-02	6.41E-03	3.96E-02
Mercury	7439-97-6	4.06E-07	6.72E-05	1.21E-04	6.29E-05
Antimony	7440-36-0	5.99E-06	9.90E-06	5.96E-06	7.28E-06
Arsenic	7440-38-2	7.16E-07	6.60E-07	6.69E-07	6.82E-07
Barium	7440-39-3	6.12E-06	1.60E-05	1.17E-05	1.13E-05
Beryllium	7440-41-7	7.02E-08	7.25E-08	6.67E-08	6.98E-08
Cadmium	7440-43-9	1.34E-06	1.61E-06	1.74E-06	1.56E-06
Chromium	7440-47-3	5.42E-06	8.69E-06	6.78E-06	6.96E-06
Cobalt	7440-48-4	1.53E-07	2.14E-07	1.60E-07	1.75E-07
Copper	7440-50-8	2.61E-05	2.85E-05	2.32E-05	2.59E-05
Lead	7439-92-1	9.52E-06	1.36E-05	9.79E-06	1.10E-05
Molybdenum	7439-98-7	4.83E-06	5.61E-06	4.54E-06	4.99E-06
Nickel	7440-02-0	4.82E-06	7.07E-06	3.99E-06	5.29E-06
Selenium	7782-49-2	1.21E-05	2.59E-06	1.72E-06	5.48E-06
Silver	7440-22-4	1.07E-05	8.53E-06	4.91E-06	8.03E-06
Thallium	7440-28-0	1.46E-07	2.29E-07	1.73E-07	1.83E-07
Vanadium	7440-62-2	2.58E-07	3.14E-07	2.45E-07	2.72E-07
Zinc	7440-66-6	1.76E-04	6.30E-04	5.88E-04	4.65E-04

Table 8: Testing Results: SVOC's

Compound	CAS	Test 1 (g/s)	Test 2 (g/s)	Test 3 (g/s)	Average (g/s)
Poly-Aromatic Hydrocarbons					
1-Methylnaphthalene	90-12-0	8.43E-08	1.76E-08	1.20E-08	3.80E-08
1-Methylphenanthrene	832-69-9	2.31E-09	1.70E-09	1.79E-09	1.93E-09
2-Chloronaphthalene	90-13-1	1.48E-09	1.41E-09	1.43E-09	1.44E-09
2-methylanthracene	613-12-7	2.10E-08	7.82E-09	7.41E-09	1.21E-08
2-Methylnaphthalene	91-57-6	1.21E-07	3.35E-08	2.32E-08	5.91E-08
3-Methylcholanthrene	56-49-5	7.38E-09	7.07E-09	7.14E-09	7.20E-09
7,12-Dimethylbenzo(a)anthracene	57-97-6	1.48E-09	1.41E-09	1.43E-09	1.44E-09
9,10-dimethylanthracene	781-43-1	1.48E-09	1.41E-09	1.43E-09	1.44E-09
9-Methylphenanthrene	883-20-5	1.20E-08	3.61E-09	3.02E-09	6.23E-09
Acenaphthene	83-32-9	4.52E-08	1.62E-08	1.03E-08	2.39E-08
Acenaphthylene	208-96-8	2.90E-08	4.17E-08	4.93E-08	4.00E-08
Anthracene	120-12-7	1.48E-08	1.67E-08	1.08E-08	1.41E-08
Benzo(a)Anthracene	56-55-3	1.48E-09	6.86E-09	1.79E-09	3.38E-09
Benzo(a)fluorene	238-84-6	1.48E-09	2.10E-09	1.43E-09	1.67E-09
Benzo(a)Pyrene	50-32-8	2.41E-09	3.44E-09	3.14E-09	3.00E-09
Benzo(b)Fluoranthene	205-99-2	1.48E-09	6.50E-09	5.74E-09	4.57E-09
Benzo(b)fluorene	243-17-14	1.48E-09	3.13E-09	2.25E-09	2.29E-09
Benzo(e)Pyrene	192-97-2	1.90E-09	4.31E-09	4.07E-09	3.43E-09
Benzo(g,h,i)Perylene	191-24-2	4.97E-09	1.41E-09	2.83E-09	3.07E-09
Benzo(k)Fluoranthene	207-08-9	1.48E-09	6.88E-09	4.48E-09	4.28E-09
Chrysene	218-01-9	5.31E-09	1.51E-08	1.17E-08	1.07E-08
Coronene	191-07-1	1.01E-08	7.07E-09	7.14E-09	8.11E-09
Dibenzo(a,h)Anthracene	53-70-3	1.48E-09	1.41E-09	1.43E-09	1.44E-09
Fluoranthene	206-44-0	5.46E-08	5.84E-08	4.50E-08	5.27E-08
Fluorene	86-73-7	1.94E-07	1.38E-07	1.04E-07	1.45E-07
Indeno(1,2,3-cd)Pyrene	193-39-5	1.48E-09	1.52E-09	1.43E-09	1.47E-09
Naphthalene	91-20-3	3.57E-07	6.50E-07	4.74E-07	4.94E-07
Perylene	198-55-0	1.48E-09	1.41E-09	1.43E-09	1.44E-09
Phenanthrene	85-01-8	3.12E-07	1.79E-07	1.35E-07	2.09E-07
Picene	213-46-7	7.38E-09	7.07E-09	7.14E-09	7.20E-09
Pyrene	129-00-0	4.20E-08	4.97E-08	3.71E-08	4.30E-08
Tetralin	119-64-2	1.81E-07	2.01E-07	2.41E-07	2.08E-07
Dioxins/Furans/Dioxin-like PCBs (TEQ)	See Appendix B	4.10E-10	2.52E-10	4.39E-11	2.35E-11

Table 9: Testing Results: VOC's

Compound	CAS	Test 1 (g/s)	Test 2 (g/s)	Test 3 (g/s)	Average (g/s)
1,1,1,2-Tetrachloroethane	630-20-6	8.68E-07	6.62E-07	6.67E-07	7.32E-07
1,1,1-Trichloroethane	71-55-6	4.34E-07	3.31E-07	3.33E-07	3.66E-07
1,1,2,2-Tetrachloroethane	79-34-5	8.68E-07	6.62E-07	6.67E-07	7.32E-07
1,1,2-Trichloroethane	79-00-5	8.68E-07	6.62E-07	6.67E-07	7.32E-07
1,1-Dichloroethane	75-34-3	4.34E-07	3.31E-07	3.33E-07	3.66E-07
1,1-Dichloroethene	75-35-4	4.34E-07	3.31E-07	3.33E-07	3.66E-07
1,2,3-Trichloropropane	96-18-4	8.68E-07	6.62E-07	6.67E-07	7.32E-07
1,2-Dichloroethane	107-06-2	4.34E-07	3.31E-07	3.33E-07	3.66E-07
1,2-Dichloropropane	78-87-5	4.34E-07	3.31E-07	3.33E-07	3.66E-07
Benzene	71-43-2	2.17E-06	6.79E-06	2.67E-06	3.87E-06
Bromobenzene	108-86-1	8.68E-07	6.62E-07	6.67E-07	7.32E-07
Bromodichloromethane	75-27-4	4.34E-07	3.31E-07	3.33E-07	3.66E-07
Bromoform	75-25-2	4.34E-07	3.31E-07	3.33E-07	3.66E-07
Bromomethane	74-83-9	3.90E-06	2.98E-06	3.00E-06	3.29E-06
Carbon Tetrachloride	56-23-5	4.34E-07	3.31E-07	3.33E-07	3.66E-07
Chlorodibromomethane	124-48-1	4.34E-07	3.31E-07	3.33E-07	3.66E-07
Chloroethane	75-00-3	8.68E-07	6.62E-07	6.67E-07	7.32E-07
Chloroform	67-66-3	4.34E-07	3.31E-07	3.33E-07	3.66E-07
Chloromethane	74-87-3	2.60E-06	1.99E-06	2.00E-06	2.20E-06
Dibromomethane	74-95-3	4.34E-07	3.31E-07	3.33E-07	3.66E-07
Dichlorodifluoromethane	75-71-8	8.68E-07	6.62E-07	6.67E-07	7.32E-07
Dichlorofluoromethane	75-43-4	8.68E-07	6.62E-07	6.67E-07	7.32E-07
Ethylbenzene	100-41-4	5.21E-07	4.30E-07	3.33E-07	4.28E-07
Methylene Chloride	75-09-2	9.85E-05	2.40E-05	5.67E-06	4.27E-05
Tetrachloroethene	127-18-4	4.34E-07	3.31E-07	3.33E-07	3.66E-07
Toluene	108-88-3	5.29E-06	1.79E-06	1.67E-06	2.92E-06
trans,1,2-Dichloroethene	156-60-5	4.34E-07	3.31E-07	3.33E-07	3.66E-07
Trichloroethene	79-01-6	4.34E-07	3.31E-07	3.33E-07	3.66E-07
Trichlorofluoromethane	75-69-4	8.68E-07	6.62E-07	6.67E-07	7.32E-07
Vinyl Chloride	75-01-4	8.68E-07	6.62E-07	6.67E-07	7.32E-07
Xylenes	1330-20-7	1.78E-06	3.28E-06	1.57E-06	2.21E-06

Table 10: Testing Results: Odour

Bag ID	Odour Strength (ou.)	Flow (WRm^3/s)	Odour Emission (ou/s)
Bag 1	332	0.748	248
Bag 2	202		151
Bag 3	247		185
Geometric Mean	**255**		**191**

Table 11: Residence Time

Parameters	Units	Results*
Volume of Secondary Chamber	m^3	2.95
Flow measured in Stack	am^3/s	2.25
Temperature measured in Stack	'C	580
Oxygen measured in Stack	% v/v	14.7%
Oxygen measured in Secondary Chamber	% v/v	10.9%
Temperature recorded in Secondary Chamber	'C	1016
Flow Calculated in Secondary Chamber	am^3/s	2.09
Residence Time Calculated in Secondary Chamber	**Seconds**	**1.41**

*Average of values recorded during isokinetic sampling

6.3 CEMS RATA Testing

Relative accuracy (RA) testing was performed on the CEM system on July 17th and 18th, 2019. The relative accuracy of the CEMS measured O_2 and CO values for the units are summarized in Table 12.

Table 12: CEMS Relative Accuracy Test Summary

Cremator	Test	O_2 Criteria	O_2 Results	CO Criteria	CO Results
Cremator	BIAS	<4% of RM Mean Value	No Bias	4% of Full Scale	1.42%
	RA	<10% of RM Mean Value	2.71%	< 5ppm Abs. Difference	4.77 Abs. Difference

RM = Reference Method Test Data

These results are based on the data presented in the following tables.

Table 13: CEMS Relative Accuracy Test Data

Test Run No.	Date (dd-mm-yr)	Start Time (Dur 30min)	CO (ppmd)	O_2 (% dry)
Reference Method				
1	17-Jul-19	11:27	4.33	9.41
2	17-Jul-19	11:57	4.31	9.79
3	17-Jul-19	12:27	4.97	11.58
4	18-Jul-19	8:20	4.41	9.94
5	18-Jul-19	8:50	4.71	9.90
6	18-Jul-19	9:20	5.42	11.76
7	18-Jul-19	10:26	5.31	10.81
8	18-Jul-19	10:56	4.82	10.90
9	18-Jul-19	11:26	5.08	11.50
		AVERAGE	**4.82**	**10.62**
CEMS System				
1	17-Jul-19	11:27	12.68	8.87
2	17-Jul-19	11:57	12.54	9.40
3	17-Jul-19	12:27	12.39	11.29
4	18-Jul-19	8:20	8.47	9.97
5	18-Jul-19	8:50	8.84	10.00
6	18-Jul-19	9:20	8.59	11.83
7	18-Jul-19	10:26	8.22	10.80
8	18-Jul-19	10:56	7.39	10.93
9	18-Jul-19	11:26	7.15	11.59
		AVERAGE	**9.56**	**10.52**

7.0 DISPERSION MODELLING

7.1 Model Inputs

Cremator exhausts (STCK1, STCK2, and STCK3) were modelled for the CLIENT's facility using the US EPA AERMOD dispersion modelling program (AERMOD version 16216r, and AERMET version 16216), according to Section 6(1), O.Reg. 419/05.

All contaminants emitted from the cremator stack were modelled based on a nominal emission rate (1 g/s) approach and prorated.

The source parameters modelled are provided in Table 14.

Table 14: Source Parameters

Source ID	Source Type	X Coordinate	Y Coordinate	Base Elevation	Release Height	Temp	Exit Velocity	Stack Diameter
		(m)	(m)	(m)	(m)	(K)	(m/s)	(m)
STCK1	Point	591207.00	4793371.34	106.14	14.6	853	9.131	0.56
STCK2	Point	591208.71	4793373.12	106.14	14.6	853	9.131	0.56
STCK3	Point	591210.63	4793374.96	106.14	14.6	853	9.131	0.56

Note: Odour modelling used the param

1,874 discrete Cartesian receptors were modelled around the facility. The coordinates defining the property line are provided in the following table.

Table 15: Property Boundary Co-ordinates

X (m)	Y (m)	Elevation (m)
591100.19	4793402.22	106.00
591279.73	4793224.96	83.40
591338.00	4793285.00	78.80
591217.16	4793402.10	106.80
591237.40	4793422.35	106.80
591204.68	4793456.13	106.90
591194.98	4793448.70	106.70
591180.49	4793437.65	106.80
591157.75	4793424.34	107.00
591141.18	4793417.09	106.70
591125.38	4793410.49	106.20
591113.13	4793406.61	106.00

Intermediate property line receptors were placed at 10 meters spacing around the property line. Also, a nested grid of receptors was included in the model extending 4800 meters from the property line in each direction at 20, 50, 100, 200 and 500 meters spacing in accordance with Air Dispersion Modelling Guideline in Ontario, version 3.0, February 2017.

The Dispersion Modelling Input Summary table is provided below.

Table 16: Dispersion Modelling Input Summary Table

Relevant Section of the Regulation	Section Title	Description of how the Approved Dispersion Model was Used
Section 8	Negligible Sources	Not applicable
Section 9	Same Structure Contamination	No
Section 10	Operating Conditions	Based on all sources operating simultaneously
Section 11	Source of Contaminant Emission Rates	Contaminant emissions were estimated based on compliance source testing
Section 12	Combined Effect of Assumptions for Operation Conditions and Emission Rates	Conservative
Section 13	Meteorological Conditions	Toronto, Ontario data set (1996-2000) (pre-processed crops met file recommended by the MECP)
Section 14	Area of Modelling Coverage	~ 100 km^2
Section 15	Stack Height for Certain New Sources of Contaminant	See Table 2
Section 16	Terrain Data	Yes
Section 17	Averaging Periods	1 Hour, 24 Hour, Annual

7.2 Point-of-Impingement Criteria

The MECP has at minimum 1-hr, 24-hr, or annual point-of-impingement (POI) criterion for all the emitted compounds.

The relevant criteria were obtained from the Schedule 3 Standards in the Air Contaminants Benchmarks (ACB) List, published on April 2018. The POI criterion for each compound is shown in the Emission Summary table (Table 17).

Odour

Odour modelling was performed with actual emission rates (converted to a 10-min averaging time using a factor of 1.65) and with stack parameters specific to the period during which the odour samples were taken.

7.3 Model Results

Modelling files are provided on a DVD.

Table 17: Emission Summary Table

Compound	CAS	Average Emission rate	Maximum POI Concentration	Averaging Period	MECP ACB	% of Limit
		(g/s)	(µg/m³)	(Hour)	(µg/m³)	
TSP	N/A	2.88E-02	11.5	24	120	9.57%
HCl	7647-01-0	3.96E-02	15.8	24	20	79.0%
Vinyl Chloride	75-01-4	7.32E-07	2.92E-04	24	1	0.03%
Mercury	7439-97-6	6.29E-05	2.51E-02	24	2	1.26%
Antimony	7440-36-0	7.28E-06	2.91E-03	24	25	0.01%
Arsenic	7440-38-2	6.82E-07	2.72E-04	24	0.3	0.09%
Barium	7440-39-3	1.13E-05	4.51E-03	24	10	0.05%
Beryllium	7440-41-7	6.98E-08	2.79E-05	24	0.01	0.28%
Cadmium	7440-43-9	1.56E-06	6.24E-04	24	0.025	2.49%
Chromium	7440-47-3	6.96E-06	2.78E-03	24	0.5	0.56%
Cobalt	7440-48-4	1.75E-07	7.01E-05	24	0.1	0.07%
Copper	7440-50-8	2.59E-05	1.04E-02	24	50	0.02%
Lead	7439-92-1	1.10E-05	4.38E-03	24	0.5	0.88%
			1.69E-03	30 days	0.2	0.84%
Molybdenum	7439-98-7	4.99E-06	1.99E-03	24	120	0.00%
Nickel	7440-02-0	5.29E-06	2.11E-03	Annual	0.04	0.53%
Selenium	7782-49-2	5.48E-06	2.19E-03	24	10	0.02%
Silver	7440-22-4	8.03E-06	3.21E-03	24	1	0.32%
Thallium	7440-28-0	1.83E-07	7.29E-05	24	0.5	0.01%
Vanadium	7440-62-2	2.72E-07	1.09E-04	24	2	0.01%
Zinc	7440-66-6	4.65E-04	1.85E-01	24	120	0.15%
Benzo(a)pyrene	50-32-8	3.00E-09	1.37E-07	Annual	0.00001	1.37%
Naphthalene	91-20-3	4.94E-07	1.97E-04	24	22.5	0.00%
			6.24E-04	10-min	50	0.00%
1-Methylnaphthalene	90-12-0	3.80E-08	1.52E-05	24	35.5	0.00%
Tetralin	119-64-2	2.08E-07	8.29E-05	24	151.5	0.00%
2-Chloronaphthalene	90-13-1	1.44E-09	5.75E-07	24	1	0.00%
		(pg/s)	(pg/m³)		(pgTEQ/m³)	%
Dioxins/Furans/ Dioxin-like PCBs (TEQ)	—	235	9.40E-02	24	0.10	94.0%
		(OU/s)	(OU/m³)		(OU/m³)	%
Odour	—	191	0.323	10-min	1	32.3%

8.0 CLOSURE

The Wood sampling team is grateful for the cooperation of Pyrox and Bayview during the execution of this test program. Wood looks forward to future projects together.

Yours truly,
Wood Environment & Infrastructure Solutions
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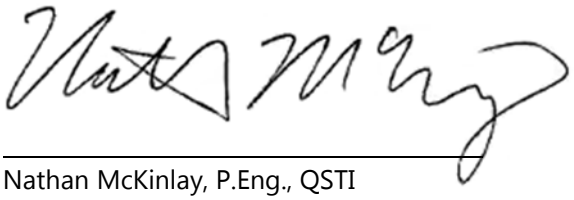

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