A.Lanfranco & Associates Inc.
Environmental Consultants

Prepared for

METRO VANCOUVER

Metrotower III
4515 Central Boulevard
Burnaby, BC V5H 0C6

Waste-to-Energy Facility

Emissions Test Report
Fourth Quarter 2022 Survey
Operational Certificate 107051
Prepared by Louis Agassiz
Issued: December 22, 2022

CERTIFICATION

The field monitoring for this survey was conducted by certified stack test technicians as required by the British Columbia Ministry of Environment (BC MOE) Field Sampling Manual.

The field crew consisted of:

Mr. S. Harrington (certified), Mr. C. Lanfranco (certified), Mr. J. Gibbs (certified), Mr. D. Sampson (certified), Mr. C. De La O, and Mr B. Lester.

The report was prepared by Mr. L. Agassiz using reporting principles and guidelines generally acceptable to Metro Vancouver (MV).

The field crew and A. Lanfranco and Associates Inc. certify that the test methods used were BC MOE/MV approved reference methods for the parameters investigated.

Report reviewed by:

Mark Lanfranco, CST
President | Owner

TEST PROGRAM ORGANIZATION

Primary Stakeholders:	Mr. Brent Kirkpatrick Metro Vancouver Lead Senior Engineer Email: brent.kirkpatrick@metrovancouver.org Tel: (604) 451-6623 Ms. Nicole Victor Covanta Burnaby Renewable Energy Facility Manager Email: nvictor@covanta.com Tel: (604) 521-1025 ext.211
Project Manager:	Mr. Mark Lanfranco President | Owner A. Lanfranco and Associates Inc. 101 – 9488 189 St Surrey, BC Canada V4N 4W7 Tel: (604) 881-2582 Email: mark.lanfranco@alanfranco.com
Sampling Crew:	Mr. S. Harrington - A. Lanfranco and Associates Inc. Mr. C. Lanfranco - A. Lanfranco and Associates Inc. Mr. D. Sampson - A. Lanfranco and Associates Inc. Mr. J. Gibbs - A. Lanfranco and Associates Inc. Mr. C. De La O – A. Lanfranco and Associates Inc. Mr. B. Lester – A. Lanfranco and Associates Inc.

Table of Contents

List of Tables

List of Figures

SUMMARY

The following table displays the emission results from the three units located at Metro Vancouver's Waste-To-Energy Facility (WTEF) as well as the current emission limits as defined by the Operational Certificate (OC) issued by BC Ministry of Environment & Climate Change Strategy. This compliance survey represents the fourth quarter of 2022.

Table 1: Summary Comparison of Emissions Test Results with Limits

Parameter	Limit	Unit 1	Unit 2	Unit 3	Facility Average
Test Date		14-15 Nov 2022	18 Nov 2022	15-16 Nov 2022	
Particulate (mg/m^3 @ 11% O_2)	**9.0**	0.08	0.03	2.42	**0.84**
Hydrogen Fluoride (mg/m^3 @ 11% O_2)	**1.0**	0.012	0.006	0.008	**0.009**
Trace Metals - OC Class (mg/m^3 @ 11% O_2)					
Lead (Pb)	**-**	0.0036	0.0009	0.0057	**0.0034**
Arsenic (As)	**-**	0.0009	0.0004	0.0009	**0.0007**
Chromium (Cr)	**-**	0.0012	0.0005	0.0012	**0.0010**
OC Class Sum (Pb, As and Cr)	**0.064**	0.0057	0.0018	0.0078	**0.0051**
Mercury (mg/m^3 @ 11% O_2)	**0.02**	0.00004	0.00004	0.00005	**0.00004**
Cadmium (mg/m^3 @ 11% O_2)	**0.007**	0.00007	0.00007	0.00062	**0.00026**

All data is corrected to standard conditions (S) of 20 °C, 101.325 kPa (dry) unless otherwise noted.

Compared to previous testing in 2022, results were similar. Once again there was variability found for Unit 3. Most notably, particulate matter and trace metals were elevated. Despite said variability, the results are within the expected range based on normal operations and are not considered significant.

Hexavalent Chromium was measured on Unit 1 this survey and reported in Table 3. These results are similar-to historical data and at the analytical reporting detection limit.

1 INTRODUCTION

Metro Vancouver (MV) commissioned an emission survey at the Waste-To-Energy Facility (WTEF) in Burnaby BC, as required by the provincially approved Operational Certificate (OC). This report documents the results of a survey on Units 1, 2 and 3 for the fourth survey of four for the year 2022. This survey includes filterable particulate matter, trace metals, mercury (Hg), hydrogen fluoride (HF), hexavalent chromium (Cr^{6+}) and nitrous oxide (N_2O). A. Lanfranco and Associates Inc. (ALAA), of Surrey, B.C., conducted the sampling program on behalf of MV. The sampling program consisted of, but was not limited to, the planning, execution, analysis, and reporting of three emission sources located at the WTEF.

This report includes a comparison of emission results to limits established in the OC, detailed emission results, a brief outline of methods employed, equipment used, and a discussion of the survey. All supporting data and appendices are presented under separate cover.

The individual sources that were monitored for compliance are identified as Unit 1, Unit 2 and Unit 3 which represent the three distinct processing lines at the WTEF. The three boilers are identified as discharge E300670 in the operational certificate.

Sampling was conducted on November 14-16, and 18, 2022. The testing spanned several days due to process curtailments associated with air pollution control (APC) equipment maintenance on Unit 2. None of the replicates per unit took place more than one days apart however.

2 METHODOLOGY

All services provided by A. Lanfranco and Associates Inc. were conducted in accordance with approved reference methods as issued by:

- Metro Vancouver (MV)
- BC Ministry of Environment & Climate Change Strategy (BC MOE)
- Environment Canada (EC)
- US Environmental Protection Agency (EPA)

2.1 Sampling and Analytical Methods

The following table lists the test methods used for the different parameters measured. The subsequent paragraphs briefly describe each method.

Table 2: Reference Methods

Parameter	Reference Method
Sample and Velocity traverse points	EPS 1/RM/8 A Determination of Sampling Site and Traverse Points
Velocity and flowrate	EPS 1/RM/8 B Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
Gas molecular weight (O_2/CO_2)	EPS 1/RM/8 C Determination of Molecular Weight by Gas Analysis
Flue gas Moisture	EPS 1/RM/8 D Determination of Moisture Content
Particulate Matter	EPS 1/RM/8 E Determination of Particulate Matter Emissions from Stationary Sources
Trace Metals with Mercury	EPA Method 29 Determination of Metals Emissions from Stationary Sources
Hydrogen Fluoride (HF)	EPS1/RM/1 Reference Method for Source Testing: Measurement of Releases of Gaseous Hydrogen Chloride from Stationary Sources
Nitrous Oxide (N_2O)	N/A
Hexavalent Chromium (Cr^{6+})	EPA Method 0061

Sampling Site and Traverse Points

Primary: EPS 1/RM/8 Method A

Supporting: EPA Method 1

This method is designed to aid in the representative measurement of pollutant emissions and/or total volumetric flow rate from a stationary source. A measurement site where the effluent stream is flowing in a known direction is selected, and the cross-section of the stack is divided into a number of equal areas. Traverse points are then located within each of these equal areas.

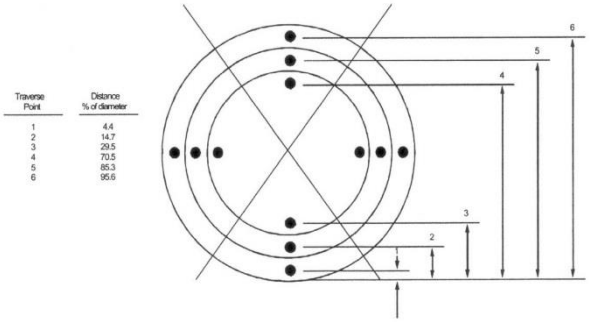

Figure 1: Example showing circular stack cross section divided

Stack Gas Velocity and Volumetric Flow Rate

Primary: EPS 1/RM/8 Method B

Supporting: EPA Method 2

The average gas velocity in a stack or duct is determined from the gas density and from the measurement of velocity pressure with an S-type pitot tube. A standard pitot tube may be used where plugging of the tube openings due to particulate matter and/or moisture is not likely to occur. Stack gas volumetric flow rate is determined from measurements of stack gas velocity, temperature, absolute pressure, dry gas composition, moisture content, and stack diameter.

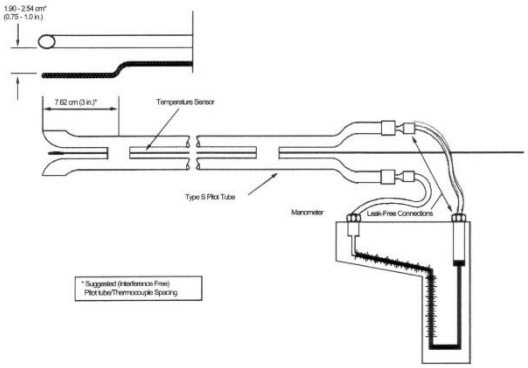

Figure 2: Type S Pitot Tube Manometer Assembly

Molecular Weight by Gas Analysis — Primary: EPS 1/RM/8 Method C; Supporting: EPA Method 3

An integrated or grab sample is extracted from a single point in the gas stream and analyzed for its components using a Fyrite analyzer, a gas chromatograph, or calibrated continuous analyzers.

Moisture Content — Primary: EPS 1/RM/8 Method D; Supporting: EPA Method 4

A gas sample is extracted from a single point in the enclosed gas stream being sampled. The moisture is condensed, and its weight measured. This weight, together with the volume of gas sampled, enables the stack gas moisture content to be calculated.

Particulate Matter — Primary: EPS 1/RM/8 Method E; Supporting: EPA Method 5

Particulate matter is withdrawn isokinetically from a number of sampling or traverse points in an enclosed gas stream. The particulate sample is collected in the nozzle, probe, and on a glass fibre filter, all maintained at a temperature of 120 ± 14°C or such other temperature as is necessary to prevent blinding of the filter from condensation. The particulate weight is determined gravimetrically after removal of uncombined water. Simultaneous determinations of the gas stream moisture content, velocity, temperature, and molecular weight allow calculations of the particulate concentration and the particulate mass emission or release rate to be made.

Trace Metal Primary: EPA Method 29 (modified)

This method is used in conjunction with the above Method 5. A stack sample is withdrawn isokinetically from the source. Particulate emissions are collected in the probe and on a heated filter, and gaseous emissions are then collected in an aqueous acidic solution of hydrogen peroxide (analyzed for all metals including Hg) and an aqueous acidic solution of potassium permanganate (analyzed only for Hg). The recovered samples are digested, and appropriate fractions are analyzed for Hg by cold vapour atomic absorption spectroscopy (CVAAS). The remaining trace metals are analyzed with inductively coupled argon plasma emission spectroscopy (ICAP), atomic absorption spectroscopy (AAS) and graphite furnace atomic absorption spectroscopy (GFAAS). Figure 3 displays the sample train and its configuration.

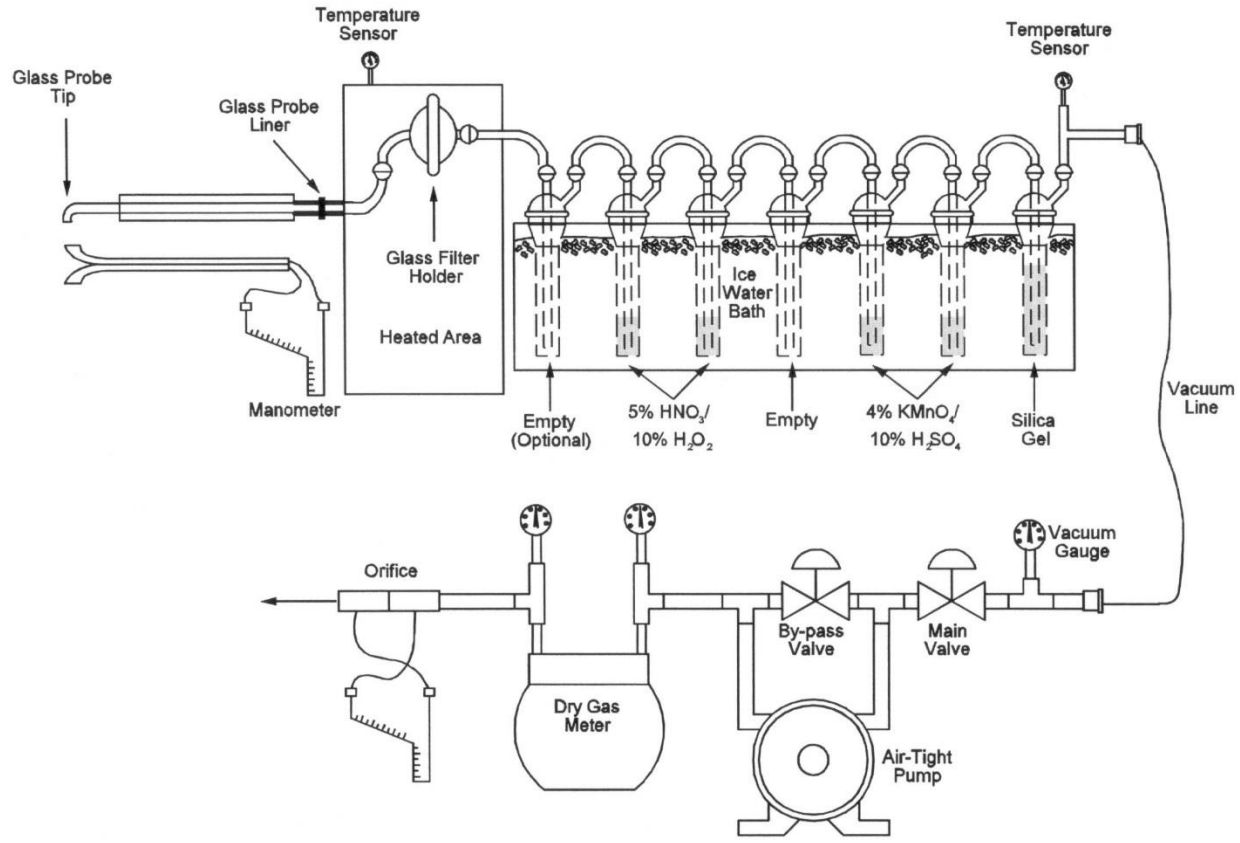

Figure 3: Particulate / Trace Metals Sampling Train

Hydrogen Fluoride — Primary: EPS 1/RM/1
Supporting: BC Method 7176106 & 7066101

HF is sampled in a four-impinger train consisting of two impingers containing distilled/deionized H_2O, one empty impinger, and a fourth containing silica gel. A sample of the stack gas is extracted from a single point near the centre of the stack over the sample duration at a constant rate. The collected samples are measured for F by ion chromatography at ALS Environmental in Burnaby, BC.

N_2O — Primary: N/A

Three N_2O samples were collected from each source using Viasensor G200 Medical Grade gas analyser, factory calibrated to Nitrous Oxide. The flue gas was introduced to the G200 after passing through a soda lime filter to remove CO_2. Multiple readings were taken over a one hour period, these readings were averaged on the analyzer and recorded on the data sheet.

Chromium $^{+6}$ Primary: EPA Method 0061

The Method 0061 sampling train (see Fig. 4) was used to collect samples, where all train components were Teflon or borosilicate glass. A small amount of 0.1 N KOH is re-circulated through the probe and first impinger via peristaltic pump. The impinger components were:

Stack Impingers
150 ml 0.1 N KOH
75 ml 0.1 N KOH
75 ml 0.1 N KOH
Empty
200 silica gel

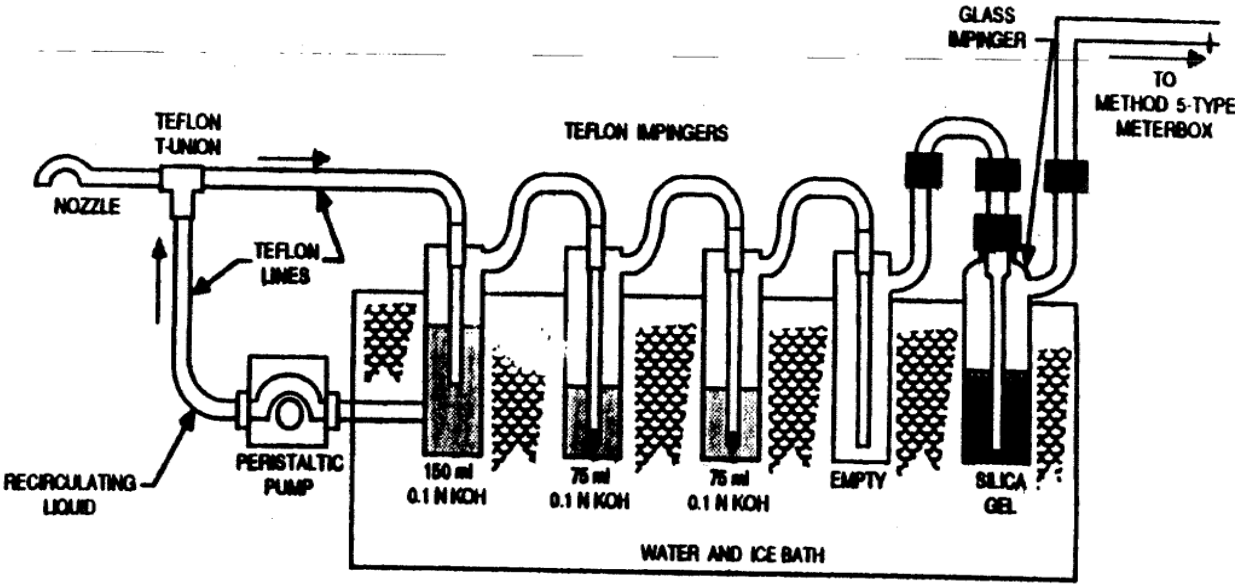

Figure 4: Hexavalent Chromium Sampling Train

Method Modifications

Three minor method modifications were instituted for this work.

1. Reagent blanks for metals trains were made to the same volumes as all samples. In other words, exactly 100 ml of the various reagents used to recover samples was NOT done, as some sample components (probe washing for example) required more than 100 ml to adequately clean and rinse the probe. Instead, sample recovery was conducted with however much rinsing was deemed adequate. In the laboratory, the blanks and samples were made up with the appropriate reagent so that all samples and blanks were the same volume.

2. Filter and residue weighing were not conducted with the six-hour interval technique. Instead, the sample filters and beakers were conditioned with cooling and desiccation and then weighed on two separate laboratory scales after 24 hours. Duplicate or triplicate Blank samples were carried through the gravimetric analysis, and the sample results were adjusted with the Blank data to determine the net filter and probe wash residue weight gain. This is the Environment Canada approved modified approach for weighing probe wash residue.

3. For the purposes of calculating a result, all parameters were given the value of ½ the detection limit when the analysis yielded 'non-detect' results.

All results are expressed using the metric system and corrected to standard conditions of 20 °C and 101.325 kPa, dry gas (unless otherwise noted).

2.2 Calculations

The following sections show the equations and define the variables that were used for this survey. The equations are organized in three sections. Equations 1-11 were used to calculate parameter concentration at standard conditions on a dry basis. Equations 12-26 were used to sample within the 100 ± 10% isokinetic variation and to confirm that sampling meets this isokinetic variation threshold. Equations 27-29 were used to calculate the volumetric flowrate of the stack flue gas.

2.2.1 Parameter Concentration Calculations

$$c = \frac{m}{V_{std}} \quad \textbf{Equation 1}$$

$$m_{part} = m_{filter} + m_{pw} \quad \textbf{Equation 2}$$

$$m_i = m_{ana,i} - m_{blank} \quad \textbf{Equation 3}$$

$$m_{HF} = \frac{20.006}{18.998}(m_F - m_{blank})/1000 \quad \textbf{Equation 4}$$

$$V_{std} = \frac{V_{std(imp)}}{35.315} \quad \textbf{Equation 5}$$

$$V_{std(imp)} = \frac{V_{samp} \times y \times P_m \times (T_{std} + 459.67)}{P_{std} \times (T_{m(ave)} + 459.67)} \quad \textbf{Equation 6}$$

$$V_{samp} = V_{final} - V_{init} \quad \textbf{Equation 7}$$

$$P_m = P_B + \frac{\Delta H_{ave}}{13.6} \quad \textbf{Equation 8}$$

$$\Delta H_{ave} = \frac{1}{n}\sum_{i=1}^{n} \Delta H_{i(act)}, where\ n = the\ number\ of\ points \quad \textbf{Equation 9}$$

$$OC = \frac{20.9 - \%O_{2c}}{20.9 - \%O_{2m}} \quad \textbf{Equation 10}$$

$$\%O_{2m} = \frac{1}{n}\sum_{i=1}^{n} \%O_{2i}, where\ n = the\ number\ of\ O_2\ measurements \quad \textbf{Equation 11}$$

Where,

c	= *Parameter concentration*
m	= *Parameter mass*
m_i	= *Net analytical mass (mg, ng, or µg)*
$m_{ana,i}$	= *Analytical mass (mg, ng, or µg)*
m_{blank}	= *Blank analytical mass (mg, ng, or µg)*
m_{part}	= *Total particulate mass (mg)*
m_{filter}	= *Net particulate gain from filter (mg)*
m_{pw}	= *Net particulate gain from probe wash (mg)*
m_{HF}	= *Net mass of HF(mg)*
m_F	= *Net mass of F (µg)*
$V_{std(imp)}$	= *Sample volume at standard conditions (ft^3)*
V_{std}	= *Sample volume at standard conditions (m^3)*
V_{samp}	= *Sample volume at actual conditions (ft^3)*
V_{final}	= *Final gas meter reading (ft^3)*
V_{init}	= *Initial gas meter reading (ft^3)*
T_{std}	= *Standard temperature (68 °F)*
T_m	= *Gas meter temperature (°F)*
$T_{m(ave)}$	= *Average gas meter temperature (°F)*
P_m	= *Absolute meter pressure (inches of Hg)*
P_B	= *Barometric pressure (inches of Hg)*
P_{std}	= *Standard barometric pressure (29.92 inches of Hg)*
ΔH_{ave}	= *Average of individual point orifice pressures (inches of H_2O)*
$\Delta H_{i(act)}$	= *Individual recorded point orifice pressures (inches of H_2O)*
OC	= *Oxygen correction factor (dimensionless)*
$\%O_{2c}$	= *Oxygen concentration to correct to (% dry basis)*
$\%O_{2i}$	= *Individual oxygen measurements (% dry basis)*
$\%O_{2m}$	= *Average measured stack gas oxygen concentration (% dry basis)*

Equation 1 is the general concentration calculation used for all parameters. The mass, *m*, is the net analytic mass for the given parameter. For particulate, *m* is the sum of the mass contributed from probe washing and filter particulate.

For trace metals and Hg, *m* is the blank corrected (Equation 3) analytical result (Appendix 1) for each metals species and run. If the analytical result was below the detection limit, half of the detection limit (DL) was used for *m* in Equation 1.

The HF concentration was calculated from analytic results. Equation 4 was used to convert the F mass to HF, and this result was used as *m* in equation 1. As with the trace metals, half the detection limit was substituted for results that were non-detectable.

2.2.2 Isokinetic Variation Calculations

$$\Delta H_i = \frac{2.62 \times 10^7 \times c_p \times A_n \times (1 - B_{wo}) \times M_D \times (T_m + 459.67) \times \Delta p_i}{k_o \times M_w \times (T_{Stk} + 459.67)}$$ **Equation 12**

$$R_m = 85.49 \times c_p \times \sqrt{\Delta p_i} \times \sqrt{\frac{(T_{stk_i} + 459.67)}{M_w \times P_B}} \times 60 \times A_n \times \frac{(T_{m_i} + 459.67) \times (1 - B_{wo})}{(T_{stk_i} + 459.67) \times y}$$ **Equation 13**

$$A_n = \pi \left(\frac{d_n}{24}\right)^2$$ **Equation 14**

$$M_w = M_D \times (1 - B_{wo}) + 18 \times B_{wo}$$ **Equation 15**

$$M_D = 0.44 \times \%CO_2 + 0.32 \times \%O_2 + 0.28 \times (100 - \%CO_2 - \%O_2)$$ **Equation 16**

$$T_{Stk} = \frac{1}{n}\sum_{i=1}^{n} T_{Stk_i}, where\ n = the\ number\ of\ points$$ **Equation 17**

$$B_{wo} = \frac{V_{cond}}{V_{cond} + V_{std(imp)}}$$ **Equation 18**

$$V_{cond} = 0.04707 \times V_{gain}$$ **Equation 19**

$$Iso = \frac{1}{n}\sum_{i=1}^{n} Iso_i, where\ n = the\ number\ of\ points$$ **Equation 20**

$$Iso_i = \frac{v_{nzi}}{v_i}$$ **Equation 21**

$$v_i = 85.49 \times c_p \times \sqrt{\Delta p_i} \times \sqrt{\frac{(T_{Stk_i} + 459.67)}{(P_{Stk} \times M_W)}}$$ **Equation 22**

$$v_{nzi} = \frac{(V_i - V_{i-1}) \times y \times (T_{Stk_i} + 459.67) \times (P_B + \frac{\Delta H_{i(act)}}{13.6})}{A_n \times t_i \times 60 \times (T_{m(i)} + 459.67) \times P_{stk} \times (1 - B_{wo})}$$ **Equation 23**

$$P_{stk} = P_B + \frac{P_g}{13.6}$$ **Equation 24**

$$v_{stk} = \frac{1}{n}\sum_{i=1}^{n} v_i \, , where\ n = the\ number\ of\ points$$ **Equation 25**

$$v_{nz} = \frac{1}{n}\sum_{i=1}^{n} v_{nzi} \, , where\ n = the\ number\ of\ points$$ **Equation 26**

Where,

A_n = *Nozzle area (ft^2)*
d_n = *Diameter of nozzle (inches)*
c_p = *Pitot coefficient (dimensionless)*
Δp_i = *Individual point differential pressures (inches of H_2O)*
T_{Stk} = *Average flue gas temperature (°F), second subscript i, indicates individual point measurements*
T_m = *Average gas meter temperature (°F), second subscript i, indicates individual point measurements*
k_o = *Gas meter calibration constant (dimensionless)*
y = *Gas meter calibration factor (dimensionless)*
$\Delta H_{i(act)}$ = *Calculated individual point orifice pressures (inches of H_2O)*
P_g = *Stack Static pressure (inches of H_2O)*
P_{stk} = *Absolute stack pressure (inches of Hg)*
M_w = *Wet gas molecular weight (g/gmol)*
M_D = *Dry gas molecular weight (g/gmol)*
$\%CO_2$ = *Stack gas carbon dioxide concentration (% dry basis)*
$\%O_2$ = *Stack gas oxygen concentration (% dry basis)*
B_{wo} = *Stack gas water vapour, proportion by volume*
V_i = *Gas meter reading at individual point(ft^3)*
t_i = *Sample time at each point (minutes)*
V_{cond} = *Total volume of water vapor collected, corrected to standard conditions (ft^3)*
V_{gain} = *Condensate gain of impinger contents (mL)*
P_{std} = *Standard pressure (29.92 inches of Hg)*
v_{stk} = *Average flue gas velocity (ft/sec)*
v_i = *Individual point flue gas velocity (ft/sec)*
v_{nz} = *Average velocity at nozzle(ft/sec)*
v_{nzi} = *Individual point velocity at nozzle(ft/sec)*
Iso_i = *Individual point isokinetic variation (%)*
Iso = *Average isokinetic variation (%)*
R_m = *Isokinetic sampling rate (ft^3/min)*

2.2.3 Volumetric Flowrate Calculations

$$Q_S = Q_A \times \frac{(T_{Std} + 459.67)}{(T_{Stk} + 459.67)} \times \frac{P_{Stk}}{P_{Std}}$$ **Equation 27**

$$Q_A = \frac{v_{stk} \times 60 \times A_{stk}}{35.315}$$ **Equation 28**

$$A_{stk} = \pi \left(\frac{d}{24}\right)^2$$ **Equation 29**

Where,

Q_A = *Actual flowrate (Am^3/min)*
Q_S = *Flowrate (m^3/min) at standard conditions on a dry basis*
A_{stk} = *Area of stack (ft^2)*
d = *Diameter of stack (inches)*

3 DETAILED TEST RESULTS

The results of stack emissions were calculated using a "STACK" computer program developed by A. Lanfranco and Associates for BC MOE requirements.

Tables 3-15 present the detailed results of all emissions parameters tested and operational conditions for each of the units. Additional data and the computer outputs can be found in the accompanying Appendices.

Table 3: Unit 1 Summary of Emission Test Results

Parameter	Run 1	Run 2	Run 3	Average
Test Date - Particulate/Metals	14-Nov-22	15-Nov-22	15-Nov-22	
Test Time - Particulate/Metals	12:07 - 14:11	10:02 - 12:06	12:47 - 14:52	
Duration - Minutes	120	120	120	
Test Date - Acid Gases	15-Nov-22	15-Nov-22	15-Nov-22	
Test Time - Acid Gases	10:35 - 11:35	12:00 - 13:00	13:18 - 14:18	
Duration - Minutes	60	60	60	
Stack Temperature (°C)	143	147	143	144
Average Gas Velocity (m/s)	14.8	13.3	13.0	13.7
Dry Flow Rate (m^3/min)	1321	1188	1159	1223
Moisture (Vol. %)	14.1	13.8	15.2	14.3
Oxygen (Vol. %)(dry basis)	10.5	10.6	9.9	10.3
Carbon Dioxide (Vol. %)(dry basis)	9.4	9.2	9.0	9.2
Particulate (mg/m^3 @ 11% O_2)	0.08	0.03	0.11	**0.08**
Hydrogen Fluoride (mg/m^3 @ 11% O_2)	0.012	0.020	0.005	**0.012**
Ammonia (mg/m^3 @ 11% O_2)	2.21	2.42	1.07	**1.90**
Nitrous Oxide (mg/m^3 @ 11% O_2)*	2.59	0.17	0.18	**0.98**
Trace Metals - Operational Certificate List (mg/m^3 @ 11% O_2)				
OC Class (Pb, As and Cr)	0.00214	0.01222	0.00267	**0.00568**
Aluminum (mg/m^3 @ 11% O_2)	0.01307	0.03584	0.02970	0.02620
Cadmium (mg/m^3 @ 11% O_2)	0.00007	0.00011	0.00004	0.00007
Lead (mg/m^3 @ 11% O_2)	0.00086	0.00896	0.00090	0.00357
Mercury (mg/m^3 @ 11% O_2)	0.00004	0.00004	0.00004	0.00004
Phosphorus (mg/m^3 @ 11% O_2)	0.00078	0.00276	0.00082	0.00145
Hexavalent Chromium (mg/Sm^3 @ 11% O_2)*	0.00014	0.00014	0.00014	0.00014
Isokinetic Variation (%)	104	103	105	104

*N_2O was sampled on 16 Nov 2022

All data is corrected to standard conditions (S) of 20 ˚C, 101.325 kPa (dry) unless otherwise noted.

Table 4: Unit 1 Trace Metals Emissions (OC Class)

Metal	Test 1 (mg/m^3 @ 11% O_2)	Test 2 (mg/m^3 @ 11% O_2)	Test 3 (mg/m^3 @ 11% O_2)	Average (mg/m^3 @ 11% O_2)
OC Class				
Pb	0.00086	0.00896	0.00090	0.00357
As	0.00031	0.00207	0.00033	0.00090
Cr	0.00098	0.00119	0.00145	0.00120
Sum of OC Class	0.00214	0.01222	0.00267	0.00568
Other				
Al	0.01307	0.03584	0.02970	0.02620
Cd	0.00007	0.00011	0.00004	0.00007
P	0.00078	0.00276	0.00082	0.00145
Hg	0.00004	0.00004	0.00004	0.00004

All data is corrected to standard conditions (S) of 20˚C, 101.325 kPa (dry) unless otherwise noted.

Table 5: Unit 1 Detailed Trace Metals Emissions

Metal	Test 1 (mg/m^3 @ 11% O_2)	Test 2 (mg/m^3 @ 11% O_2)	Test 3 (mg/m^3 @ 11% O_2)	Average (mg/m^3 @ 11% O_2)
Pb	0.00086	0.00896	0.00090	0.00357
Sb	0.00132	0.00086	0.00082	0.00100
Cu	0.00124	0.00358	0.00111	0.00198
Mn	0.00093	0.00183	0.00091	0.00122
V	0.00031	0.00034	0.00033	0.00033
Zn	0.00408	0.01354	0.00290	0.00684
As	0.00031	0.00207	0.00033	0.00090
Cr	0.00098	0.00119	0.00145	0.00120
Co	0.00008	0.00039	0.00008	0.00018
Ni	0.00140	0.00114	0.00114	0.00123
Se	0.00179	0.00052	0.00049	0.00093
Te	0.00237	0.00069	0.00065	0.00124
Tl	0.00086	0.00171	0.00049	0.00102
Cd	0.00007	0.00011	0.00004	0.00007
Hg	0.00004	0.00004	0.00004	0.00004

All data is corrected to standard conditions (S) of 20˚C, 101.325 kPa (dry) unless otherwise noted.

Table 6: Unit 1 - Summary of Operating Data

Parameter		Run 1	Run 2	Run 3	Normal
Test Date - Particulate/Metals		14-Nov-22	15-Nov-22	15-Nov-22	
Test Time - Particulate/Metals		12:07 - 14:11	10:02 - 12:06	12:47 - 14:52	
Boiler Steam Production	**(kg/hr)**	37737	35941	36551	37350
Percentage of normal	**(%)**	101%	96%	98%	
Boiler Secondary Combustion Zone Temp	**(°C)**	913	917	928	960
Percentage of normal	**(%)**	95%	96%	97%	
Rate of refuse fired	**(kg/hr)**	10483	9984	10153	10375
Percentage of normal	**(%)**	101%	96%	98%	
Rate of aux. fuel fired (Natural Gas)	**(m^3/hr)**	0	0	0	273
Percentage of normal (%)	**(%)**	0%	0%	0%	

*Normal refers to the average operating rate from the previous 30 days

Table 7: Unit 1 - Summary of Cr^{6+} Operating Data

Parameter		Run 1	Run 2	Run 3	Normal
Test Date - Cr6		17-Nov-22	18-Nov-22	18-Nov-22	
Test Time - Cr6		11:40 - 15:10	08:40 - 10:50	11:32 - 13:40	
Boiler Steam Production	**(kg/hr)**	38109	36002	37370	37350
Percentage of normal	**(%)**	102%	96%	100%	
Boiler Secondary Combustion Zone Temp	**(°C)**	959	914	942	960
Percentage of normal	**(%)**	100%	95%	98%	
Rate of refuse fired	**(kg/hr)**	10586	10001	10381	10375
Percentage of normal	**(%)**	102%	96%	100%	
Rate of aux. fuel fired (Natural Gas)	**(m^3/hr)**	0	252	252	273
Percentage of normal (%)	**(%)**	0%	92%	92%	

*Normal refers to the average operating rate from the previous 30 days

Table 8: Unit 2 Summary of Emission Test Results

Parameter	Run 1	Run 2	Run 3	Average
Test Date - Particulate/Metals	18-Nov-22	18-Nov-22	18-Nov-22	
Test Time - Particulate/Metals	09:32 - 11:35	12:01 - 14:03	14:25 - 16:27	
Duration - Minutes	120	120	120	
Test Date - Acid Gases	18-Nov-22	18-Nov-22	18-Nov-22	
Test Time - Acid Gases	10:28 - 11:28	11:35 - 12:35	14:42 - 13:42	
Duration - Minutes	60	60	60	
Stack Temperature (°C)	145	144	146	145
Average Gas Velocity (m/s)	13.9	14.0	13.5	13.8
Dry Flow Rate (m^3/min)	1242	1264	1219	1242
Moisture (Vol. %)	14.1	13.4	13.2	13.6
Oxygen (Vol. %)(dry basis)	10.6	11.2	10.3	10.7
Carbon Dioxide (Vol. %)(dry basis)	9.3	8.8	9.6	9.3
Particulate (mg/m^3 @ 11% O_2)	0.03	0.04	0.03	**0.03**
Hydrogen Fluoride (mg/m^3 @ 11% O_2)	0.010	0.004	0.004	**0.006**
Ammonia (mg/m^3 @ 11% O_2)	0.077	0.296	0.246	**0.206**
Nitrous Oxide (mg/m^3 @ 11% O_2)*	3.42	0.16	1.76	**1.78**
Trace Metals - Operational Certificate List (mg/m^3 @ 11% O_2)				
OC Class (Pb, As and Cr)	0.00167	0.00121	0.00244	**0.00177**
Aluminum (mg/m^3 @ 11% O_2)	0.00845	0.01222	0.00775	0.00947
Cadmium (mg/m^3 @ 11% O_2)	0.00008	0.00005	0.00008	0.00007
Lead (mg/m^3 @ 11% O_2)	0.00051	0.00056	0.00167	0.00091
Mercury (mg/m^3 @ 11% O_2)	0.00004	0.00005	0.00004	0.00004
Phosphorus (mg/m^3 @ 11% O_2)	0.00084	0.00093	0.00168	0.00115
Isokinetic Variation (%)	102	101	101	102

*N_2O was sampled on 18 Nov 2022

All data is corrected to standard conditions (S) of 20˚C, 101.325 kPa (dry) unless otherwise noted.

Table 9: Unit 2 Trace Metals Emissions (OC Class)

Metal	Test 1 (mg/m^3 @ 11% O_2)	Test 2 (mg/m^3 @ 11% O_2)	Test 3 (mg/m^3 @ 11% O_2)	Average (mg/m^3 @ 11% O_2)
OC Class				
Pb	0.0005	0.0006	0.0017	0.0009
As	0.0005	0.0004	0.0003	0.0004
Cr	0.0007	0.0003	0.0004	0.0005
Sum of OC Class	0.0017	0.0012	0.0024	0.0018
Other				
Al	0.00845	0.01222	0.00775	0.0095
Cd	0.00008	0.00005	0.00008	0.0001
P	0.00084	0.00093	0.00168	0.0012
Hg	0.00004	0.00005	0.00004	0.0000

All data is corrected to standard conditions (S) of 20˚C, 101.325 kPa (dry) unless otherwise noted.

Table 10: Unit 2 Detailed Trace Metals Emissions

Metal	Test 1 (mg/m^3 @ 11% O_2)	Test 2 (mg/m^3 @ 11% O_2)	Test 3 (mg/m^3 @ 11% O_2)	Average (mg/m^3 @ 11% O_2)
Pb	0.00051	0.00056	0.00167	0.00091
Sb	0.00084	0.00093	0.00244	0.00140
Cu	0.00057	0.00056	0.00189	0.00101
Mn	0.00101	0.00056	0.00051	0.00069
V	0.00034	0.00037	0.00034	0.00035
Zn	0.00534	0.00255	0.00219	0.00336
As	0.00051	0.00037	0.00034	0.00040
Cr	0.00065	0.00029	0.00044	0.00046
Co	0.00004	0.00009	0.00008	0.00007
Ni	0.00216	0.00226	0.00121	0.00188
Se	0.00051	0.00056	0.00051	0.00052
Te	0.00068	0.00074	0.00067	0.00070
Tl	0.00069	0.00056	0.00051	0.00058
Cd	0.00008	0.00005	0.00008	0.00007
Hg	0.00004	0.00005	0.00004	0.00004

All data is corrected to standard conditions (S) of 20˚C, 101.325 kPa (dry) unless otherwise noted.

Table 11: Unit 2 - Summary of Operating Data

Parameter		Run 1	Run 2	Run 3	Normal
Test Date - Particulate/Metals		18-Nov-22	18-Nov-22	18-Nov-22	
Test Time - Particulate/Metals		09:32 - 11:35	12:01 - 14:03	14:25 - 16:27	
Boiler Steam Production	**(kg/hr)**	37031	37038	36942	34071
Percentage of normal	**(%)**	109%	109%	108%	
Boiler Secondary Combustion Zone Temp	**(°C)**	937	948	954	967
Percentage of normal	**(%)**	97%	98%	99%	
Rate of refuse fired	**(kg/hr)**	10286	10288	10262	9464
Percentage of normal	**(%)**	109%	109%	108%	
Rate of aux. fuel fired (Natural Gas)	**(m^3/hr)**	0	0	0	120
Percentage of normal (%)	**(%)**	0%	0%	0%	

*Normal refers to the average operating rate from the previous 30 days

Table 12: Unit 3 Summary of Emission Test Results

Parameter	Run 1	Run 2	Run 3	Average
Test Date - Particulate/Metals	15-Nov-22	16-Nov-22	16-Nov-22	
Test Time - Particulate/Metals	12:05 - 14:08	09:56 - 11:57	12:22 - 14:23	
Duration - Minutes	120	120	120	
Test Date - Acid Gases	16-Nov-22	8-Sep-22	8-Sep-22	
Test Time - Acid Gases	10:12 - 11:12	10:31-11:31	11:42-12:42	
Duration - Minutes	60	60	60	
Stack Temperature (°C)	149	152	156	152
Average Gas Velocity (m/s)	12.1	13.4	13.1	12.9
Dry Flow Rate (m^3/min)	1057	1160	1147	1121
Moisture (Vol. %)	15.2	15.4	13.8	14.8
Oxygen (Vol. %)(dry basis)	10.0	10.1	10.5	10.2
Carbon Dioxide (Vol. %)(dry basis)	10.0	9.8	9.3	9.7
Particulate (mg/m^3 @ 11% O_2)	0.75	3.11	3.39	**2.42**
Hydrogen Fluoride (mg/m^3 @ 11% O_2)	0.004	0.004	0.015	**0.008**
Ammonia (mg/m^3 @ 11% O_2)	2.70	2.67	2.26	**2.54**
Nitrous Oxide (mg/m^3 @ 11% O_2)*	1.81	1.80	0.17	**1.26**
Trace Metals - Operational Certificate List (mg/m^3 @ 11% O_2)				
OC Class (Pb, As and Cr)	0.00661	0.00948	0.00718	**0.00775**
Aluminum (mg/m^3 @ 11% O_2)	0.01616	0.02461	0.02190	0.02089
Cadmium (mg/m^3 @ 11% O_2)	0.00065	0.00059	0.00063	0.00062
Lead (mg/m^3 @ 11% O_2)	0.00504	0.00590	0.00602	0.00565
Mercury (mg/m^3 @ 11% O_2)	0.00006	0.00004	0.00005	0.00005
Phosphorus (mg/m^3 @ 11% O_2)	0.00301	0.00205	0.00475	0.00327
Isokinetic Variation (%)	103	104	102	**103**

*N_2O was sampled on 16 Nov 2022

All data is corrected to standard conditions (S) of 20˚C, 101.325 kPa (dry) unless otherwise noted.

Table 13: Unit 3 Trace Metals Emissions (OC Class)

Metal	Test 1 (mg/m^3 @ 11% O_2)	Test 2 (mg/m^3 @ 11% O_2)	Test 3 (mg/m^3 @ 11% O_2)	Average (mg/m^3 @ 11% O_2)
OC Class				
Pb	0.00504	0.00590	0.00602	0.00565
As	0.00038	0.00198	0.00037	0.00091
Cr	0.00119	0.00160	0.00079	0.00120
Sum of OC Class	0.00661	0.00948	0.00718	0.00775
Other				
Al	0.01616	0.02461	0.02190	0.0209
Cd	0.00065	0.00059	0.00063	0.0006
P	0.00301	0.00205	0.00475	0.0033
Hg	0.00006	0.00004	0.00005	0.0000

All data is corrected to standard conditions (S) of 20 ˚C, 101.325 kPa (dry) unless otherwise noted.

Table 14: Unit 3 Detailed Trace Metals Emissions

Metal	Test 1 (mg/m^3 @ 11% O_2)	Test 2 (mg/m^3 @ 11% O_2)	Test 3 (mg/m^3 @ 11% O_2)	Average (mg/m^3 @ 11% O_2)
Pb	0.00504	0.00590	0.00602	0.00565
Sb	0.00197	0.00145	0.00475	0.00272
Cu	0.00492	0.00547	0.00485	0.00508
Mn	0.00124	0.00185	0.00183	0.00164
V	0.00038	0.00034	0.00037	0.00036
Zn	0.04798	0.08437	0.05165	0.06133
As	0.00038	0.00198	0.00037	0.00091
Cr	0.00119	0.00160	0.00079	0.00120
Co	0.00012	0.00009	0.00023	0.00015
Ni	0.00105	0.00065	0.00037	0.00069
Se	0.00056	0.00051	0.00055	0.00054
Te	0.00075	0.00068	0.00073	0.00072
Tl	0.00056	0.00051	0.00104	0.00071
Cd	0.00065	0.00059	0.00063	0.00062
Hg	0.00006	0.00004	0.00005	0.00005

All data is corrected to standard conditions (S) of 20 ˚C, 101.325 kPa (dry) unless otherwise noted.

Table 15: Unit 3 - Summary of Operating Data

Parameter		Run 1	Run 2	Run 3	Normal
Test Date - Particulate/Metals		15-Nov-22	16-Nov-22	16-Nov-22	
Test Time - Particulate/Metals		12:05 - 14:08	09:56 - 11:57	12:22 - 14:23	
Boiler Steam Production	**(kg/hr)**	36029	38025	38038	37817
Percentage of normal	**(%)**	95%	101%	101%	
Boiler Secondary Combustion Zone Temp	**(°C)**	911	957	952	915
Percentage of normal	**(%)**	100%	105%	104%	
Rate of refuse fired	**(kg/hr)**	10008	10563	10566	10505
Percentage of normal	**(%)**	95%	101%	101%	
Rate of aux. fuel fired (Natural Gas)	**(m^3/hr)**	0	0	0	134
Percentage of normal (%)	**(%)**	0%	0%	0%	

*Normal refers to the average operating rate from the previous 30 days

4 DISCUSSION

All Units are in compliance with limits as set out in the OC.

This survey meets the fourth quarter requirements and includes the annual test for hexavalent chromium. This year, Unit 1 was chosen for the hexavalent chromium testing.

As stated in Section 2.1, EPA Method 5/29 was modified slightly to accommodate performance based analytical protocols utilized in B.C. for trace metals sampling and analysis. The analytical modification consists of using volumes of recovery reagents different than the method stipulates. In order to validate (ie performance-based QA) the modification, sample Blanks and all samples were made up to the same volume, so that subtraction of the Blank data, was done on equivalent sample sizes. In addition, special Hg spiking of blank filters and peroxide solutions was conducted. This spiking is referred to as a “matrix spike” and is reported in Appendix B, Quality Control for mercury, where the recovery of spiked mercury was calculated to be an acceptable 85 to 115%. It should be noted that independent front half/back half analysis of all trace metals was conducted for this survey. In addition, individual quartz filter blanks were analyzed for each unit.

Sampling was conducted in accordance with their respective reference methods (EPA 29 except as discussed) and passed all appropriate quality assurance and quality control criteria. As per a BC MOE request, operational data has been included in Tables 7, 11, and 15 of this report as of the fourth quarter 2022.

All sampling was conducted/supervised by certified emission testing personnel, using calibrated source sampling equipment and quality-controlled reagents. It is therefore stated that the survey and this report complies with the MV’s WTEF compliance testing requirements for this fourth survey in 2022.