

Fly Ash Management Plan

December, 2017



Fly Ash Management Plan – August 14, 2017

The Fly Ash Management Plan (FAMP) presented herein provides a comprehensive set of procedures for sampling, data analysis, and evaluation of fly ash generated at the Metro Vancouver Waste-to-Energy Facility (WTEF). The FAMP provides a detailed methodology to undertake the following steps:

1. Fly ash treatment
2. Fly ash sample collection at the WTEF
3. Fly ash TCLP analysis
4. Fly ash management QA/QC

1.0 Fly Ash Treatment

1.1 Theory Behind Wes-PHix Process

Metro Vancouver's Waste-to-Energy Facility utilizes the Wes-PHix fly ash stabilization process designed and marketed by Wheelabrator Environmental Services Inc. The process is designed to reduce the leachability of certain trace heavy metals through the addition of soluble phosphate, lime and water to form geochemically stable metal phosphate compounds that are resistant to leaching.

1.2 Underlying Chemistry

The underlying chemistry of the WES-PHix process is to maintain the alkalinity of the fly ash in a certain range to avoid having soluble lead or cadmium. The process converts soluble lead to insoluble lead phosphate compounds chloropyromorphite and hydroxypyromorphite and cadmium to cadmium carbonate and or cadmium hydroxypyromorphite, both compounds are insoluble at pH above approximately 8.0.

1.3 Plant Phosphoric Acid / Lime Dosing

Raw fly ash is fed from the WTEF's storage silo at a controlled rate to the fly ash mixer. A solution of phosphoric acid and water is sprayed on the fly ash at a predetermined rate as the material is processed through the mixer. The mixer (or pug mill) consists of two counter rotating screws that ensure the ash is well mixed with the phosphoric acid solution. This is a batch process, treated fly ash is not stored; rather it is loaded directly into a trailer located beneath the pug mill outlet drop chute. This trailer remains at the WTEF until laboratory test results clear it for transport to the landfill.

The WTEF manages fly ash alkalinity through the addition of hydrated lime into the facilities' air pollution control system. Post treatment alkalinity is managed by adjusting the phosphoric acid feed rate to the pug mill. The feed rate calculation is based on both the previous trailer load's SWEP Surrogate test final pH and laboratory Toxicity Characteristic Leaching Procedure Method 1311 final pH. The WTEF Operator targets a final lab TCLP pH range of 9.5 to 11.5 (corresponding to a treated fly ash alkalinity range of 2.75 to 3.25 meg/g).

2.0 Fly Ash Sample Collection at the WTEF

Fly ash generated at the WTEF is stored in the fly ash silo prior to off-site disposal. Fly ash is transported off-site on a regular basis to an approved landfill (i.e., typically 9 to 10 loads per week), where it is offloaded in an approved disposal area.

Prior to transport, composite samples are collected by WTEF staff from loaded fly ash trailers. Loaded fly ash trailers remain on-site at the WTEF until the analysis described in Section 3.0 below confirms that the fly ash meets all regulatory requirements and is suitable for off-site transport and disposal. The methodology for sample collection and handling at the WTEF is described in Covanta's EMS Operational Procedure No. FA2 (see Attachment).

3.0 Fly Ash TCLP Analysis

Composite samples collected from loaded fly ash trailers are sent to ALS Environmental (ALS) or an equivalent approved analytical laboratory for the following chemical analysis:

- Leachate analysis by Toxicity Characteristic Leaching Procedure (TCLP) Method 1311;
- pH analysis in accordance with "pH, Electrometric, Soil and Sediment – Prescriptive", as prescribed in the British Columbia Ministry of Environment (BC MoE) 2009 British Columbia Environmental Laboratory Manual.

Fly ash loads which meet the Leachate Quality Standards (LQS) and pH requirements of the Hazardous Waste Regulation will be released for transport and landfill disposal. The WTEF will hold all composite fly ash sample material for a minimum of four (4) weeks after the loads have been released for disposal.

Fly ash loads which do not meet the LQS or pH requirements of the Hazardous Waste Regulation will be reprocessed at the plant or further tested using the following procedures:

For leachable metals:

- A minimum of eight (8) replicates must be submitted for analysis for any results that exceed the LQS. The average of the original results and replicates are included in the calculation of 90th percentile and 95% upper confidence limit (UCL) of the mean.
- If the 90th percentile and the 95% UCL for the composite sample are less than the standard, no further action will be taken, and the fly ash trailer will be classified as

non-hazardous (subject to confirmation of non-hazardous pH, as required) and released for disposal.

- If the 90th percentile or the 95% UCL for the composite sample is greater than the standard then the load is either:
 - reprocessed at the plant; or,
 - released for disposal at an appropriate approved facility.

For pH:

- A minimum of eight replicates must be submitted for analysis when the 2:1 pH result is greater than 12.5. The 95% UCL and the 90th percentile of the distribution pH (original results and replicates) will be calculated using a log transform of the data, as pH is a logarithmic scale.
- If the 90th percentile and the 95% UCL for the composite sample are less than the standard, no further action will be taken, and the fly ash trailer will be classified as non-hazardous (subject to confirmation of non-hazardous leachable metals, as required) and released for disposal.
- If the 90th percentile or the 95th UCL for the composite sample is greater than the standard then the load is either:
 - reprocessed at the plant; or,
 - released for disposal at an appropriate approved facility.

4.0 Fly Ash Management QA/QC

4.1 Untreated Fly Ash Alkalinity

As the untreated fly ash alkalinity assumption impacts the phosphoric acid addition rate, a monthly untreated fly ash alkalinity test will be completed in triplicate. The measured alkalinity will be used to adjust the phosphoric acid addition rate.

4.2 Inter Laboratory Duplicate Analysis

Once a year, a composite sample from a trailer will be submitted to two laboratories to provide inter-laboratory duplicate analysis by TCLP Method 1311 and pH analysis. This trailer will be held on-site until both sets of sample results have been received, confirming that the fly ash meets all regulatory requirements.

Attachment – EMS Operational Procedure No. FA2, Covanta

Fly Ash Sampling

I. PURPOSE

The purpose of this procedure is to:

1. Define the steps to be taken so that a composite sample of treated fly ash can be retained for a surrogate fly ash test.
2. Minimize employee exposure to the fly during sampling.
3. Properly prepare a monthly composite sample of fly ash for lab testing. Note on-site pH testing for confirmation will also be done.

II. REFERENCES

1. Directive D0002,
2. Directive D0005,
3. EMS Book 2 - Training Module #5 - Sewer & Storm Water Discharges.
4. US EPA Method TCLP 1311
5. All related JSA's

III. GENERAL & DEFINITIONS

Per the BC Hazardous Waste Regulation, to determine the toxicity characteristic leachability of fly ash it must be subject to an extraction procedure as described in US EPA Method 1311. If this test produces an extract with a contaminant concentration greater than those prescribed in Table 1 of Schedule 4 of the Regulations, the waste is considered to be hazardous. Test 1311 is commonly called the Toxicity Characteristic Leaching Procedure (TCLP).

There are 92 potential contaminants listed in Table 1 of Schedule 4. However, contaminants that are not present in the waste, or are present in such low concentrations that the regulatory limits could not be exceeded, need not to be tested for in the TCLP. An example of this is volatile organics; these are not expected to be found in the fly ash as the combustion process operates at temperatures higher than the boiling points of the compounds. With fly ash, up to 35 metals are typically tested. Of these 35 metals, 12 are regulated by Schedule 4. Historically the contaminants of most concern in the fly ash are lead (Pb) and cadmium (Cd).

As the TCLP test itself only uses 100 grams of sample, the sampling plan is a critical component in determining the toxicity characteristic leachability of the fly ash. The objective of the sampling plan is to obtain a representative sample of the ash which exhibits the average properties of the ash as a whole. Although there are many different types of sampling methods, representative composite sampling is normally used for fly ash.

Composite sampling is when a number of random samples are collected and then combined into a single sample. This single sample is then analyzed using the TCLP. Sampling procedures are used to describe the specific details of the different types of composite samples that may be collected. In all cases, the objective is to ensure enough samples are collected over a suitable period of time to represent the variability in the fly ash. A suitable sampling plan will allow measurements that are both accurate and precise (repeatable).

For fly ash, the monthly composite is comprised of samples taken from each trailer of a "B" train after it is loaded. A total of six (6) samples from each "B" train or three (3) from each

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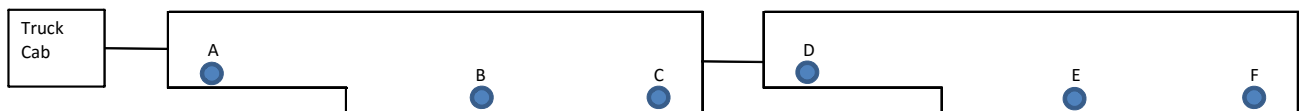
trailer in the B train. The train composites are mixed into a monthly composite at the end of each month or beginning of the following month. (Note: the monthly composite shall be prepared and sent to the lab for analysis no later than the 2nd business day of each month.)

Composite samples must be well mixed to ensure a representative sample is obtained for analysis. Sub-samples are then taken from the composite sample. Duplicates of all lab samples must be kept on site until lab test results are received. This allows retesting if required.

IV. PROCEDURES

A. Train composites

- i. Each time a "B" train is loaded for shipment a sample shall be taken out of each sampling port in each trailer. The sampling ports are labeled "A" through "F" as shown below.



- ii. Once a trailer is full open each port, one at a time, to take the sample. The sampling tool shall be inserted as far as possible. Five total scoops shall be removed from each sampling port. The 1st scoop from each port shall be discarded. The 2nd through 5th scoops from each port shall be placed in the sampling bucket/tote. (Note: this is four (4) actual sample scoops from each port.)
 - a. If only 2 of the 3 ports can be opened then a total of 7 scoops shall be taken out of each port. As before, the 1st scoop from each port shall be discarded. The 2nd through 7th scoops shall be put into the sampling container
 - b. If only 1 of the 3 ports can be opened then all 13 scoops shall be taken out of the open port. In this case a total 13 scoops shall be taken from the only open port. The 1st scoop shall be discarded. The 2nd, through 13th scoops shall be placed into the sampling container.
 - c. Should the trailers not have the sample ports on the trailers has indicated then the sample is to be from the top of the trailer above the locations where the sample ports are indicated.
- iii. Repeat this procedure on the 2nd trailer.
- iv. Log the ports that were sampled and the number of scoops from each port in each trailer.
- v. Place the FA scoops in a clean rectangular tote or on a clean piece of plastic. Mix the scoops from the "B" train thoroughly for 2-5 minutes.

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- vi. Using a garden spade, or equivalent, level the ash in the tote and divide it into 4 equal quadrants. Take 1 scoop from each quadrant and transfer to a sample bottle or a baggie (gallon-size).
- vii. The remainder of the train composite shall then be transferred to a monthly sample container and the lid placed tightly on the container.
- viii. The B-Train composite sample bottles or Bags shall be labeled using a self-adhesive label. The label shall include the sample ID number as stated below, date trailers were loaded, date and time the sample was taken, name of person taking samples.

Each B train composite bottle or Bag shall have "BURFA" to indicate that it is a fly ash sample from Burnaby. The "BT" indicates it's a B-Train sample. The "#&#" represents the trailer numbers (i.e. 13&14 for trailers 13 and 14). "Dec 21, 2012" for example is for the month, day and the year that the sample was actually taken.

BURFABT#&#/Month, Date, Year

or

BURFABT07&08/Dec 21, 2012

- ix. The B-Train sample bottles or bags shall be cleaned off and sent to the front office once complete.

B. Monthly composites

- i. The monthly composite shall be thoroughly mixed and samples taken for the lab no later than the 2nd business day of the following month.
- ii. At the end of the month of sampling, the monthly composite container should have between @ 30 500ml containers (give or take depending on how many loads were sent out for the month) of fly ash. Ensure the FA storage pile is identified with the correct dates. (Note: the amount of FA in the monthly composite will vary depending on the number of "B" trains loaded in a given month)
- iii. After the monthly FA storage pile is complete, mix the monthly sample for approximately 10 minutes. Do not discard any ash.
- iv. Place the ash in a clean container or on a piece of plastic. Level the ash and divide it into 4 equal quadrants. Take a sub-sample of the monthly FA pile by taking equal amounts of fly ash out of each quadrant. Process enough Fly ash to fill four (4) 500 mL sample bottles. One sample is for lab analysis and the other samples are duplicates. Make sure that the amount of ash taken from each quadrant is the same
- v. The monthly composite sample bottles or bags shall be labeled using a self-adhesive label. The label shall include the sample ID number as shown below, year and month the sample represents, date and time the sample was taken, name of the person taking the sample.

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Each monthly composite subsample bottle or bag shall have "BURFA" to indicate that it is a fly ash sample from Burnaby. The "Month" shall be the month the sample represents (i.e. 01 for January, 10 for September, etc...) / "Dec 21, 2012" is for the month, day and year that the sample was actually taken.

BURFAMonth/Month Day Year

Or

BURFA11/Dec 21, 2012

- C. Chain-of-custody forms (COCs): COCs documenting the samples and each analysis to be performed will be submitted to and completed by the laboratory performing the analyses. No sample preservation other than temperature control, if appropriate, will be used on any of the residue samples either in the field or in the lab.

V. Surrogate TCLP Procedure

D. How to make TCLP Fluid No. 2

- a. Take a clean 2-L volumetric flask and measure 11.4 mls of glacial acetic acid into the flask. Measurement of the glacial acetic acid will be done with a clean pipette with 0.1 ml markings on it.
- b. Using a graduated cylinder or other container fill the 2-L volumetric flask to the line on the neck with ASTM Type II water. (Note1 Type 1 or store bought de-ionized water can be used if there is no other choice. Note2: be very careful when filling to the line. Once the level rises into the neck it is very easy to over shoot the mark.)
- c. Place the fluid from the volumetric flask into one of the 2-L tumbling jars. Tumble the fluid for 5-10 minutes. (Note there must be at least 2 jars on there with approximately the same volume of liquid at the same time.)
- d. While the fluid is tumbling calibrate the pH meter with pH buffer solution 7, 4 and 2, in that order.
- e. After the Type 2 fluid has tumbled for 5-10 minutes measure the pH of the fluid in each bottle. The pH must be between 2.83 and 2.93. If it is not, discard the fluid and try again. It doesn't take a large error to get you outside the specified range.
- f. Clean all glassware and tools with soap and water. Drain dry.

i. To determine the final pH of the ash

- a. Measure out 50 grams of ash processed.
- b. Place ash in the 2-L plastic container with 1 liter of TCLP fluid No.2.
- c. Using the attached log sheet, note the container number, the pH of the fluid without any ash, and the date and time that the sample starts. In the comment

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section note any pertinent information about the sample such as time frame the ash represents (i.e. Trailers 13 and 14 treated FA, untreated FA at ??? lime feedrate, etc.)

- d. Let the ash and fluid tumble for at least 4 hours.
- e. Before removing the ash and fluid from the tumbler recalibrate the pH probe with pH buffer solution 4, 7, and 10 in that order.
- f. Remove the bottle(s) from the tumbler. Remove the lid and take the final pH of the sample. The pH should be between 8.5 and 11.5. Note the date and time that the sample was removed from the tumbler as well as the final pH.
- g. Give sample log to EHS to enter data into the database.
- h. Empty 2-L container into the internally reused wastewater system. Wash and dry the containers in preparation for the next use.

(Note: all equipment used for ash sampling shall be cleaned between each use. This includes glassware, plastic bottles, cement mixers, wheelbarrows, etc.)

EMS OPERATIONAL PROCEDURE No. FA2

Approved _____

Fly Ash Sampling

Revisions page:

December 21, 2012

This document was basically rewritten to reflect all the changes in the Management and sampling of Flyash including the steps necessary for the Surrogate TCLP Procedure.

Jan 28, 2014

- 1) Reviewed with no changes

Dec 23, 2016

- 1) Added Should the trailers not have the sample ports on the trailers has indicated then the sample is to be from the top of the trailer above the locations where the sample ports are indicated.
- 2) In section VIII and IX added or bags.
- 3) In section B monthly composite V. added or bags