Durham/York Energy from Waste Project

Acceptance Test Procedures

for

Reliability

Throughput Capacity

Energy Recovery

Residue Quality & Quantity

Metals Recovery

COVANTA ENERGY

June, 2014

Durham/York Energy from Waste Project

Acceptance Test Procedures

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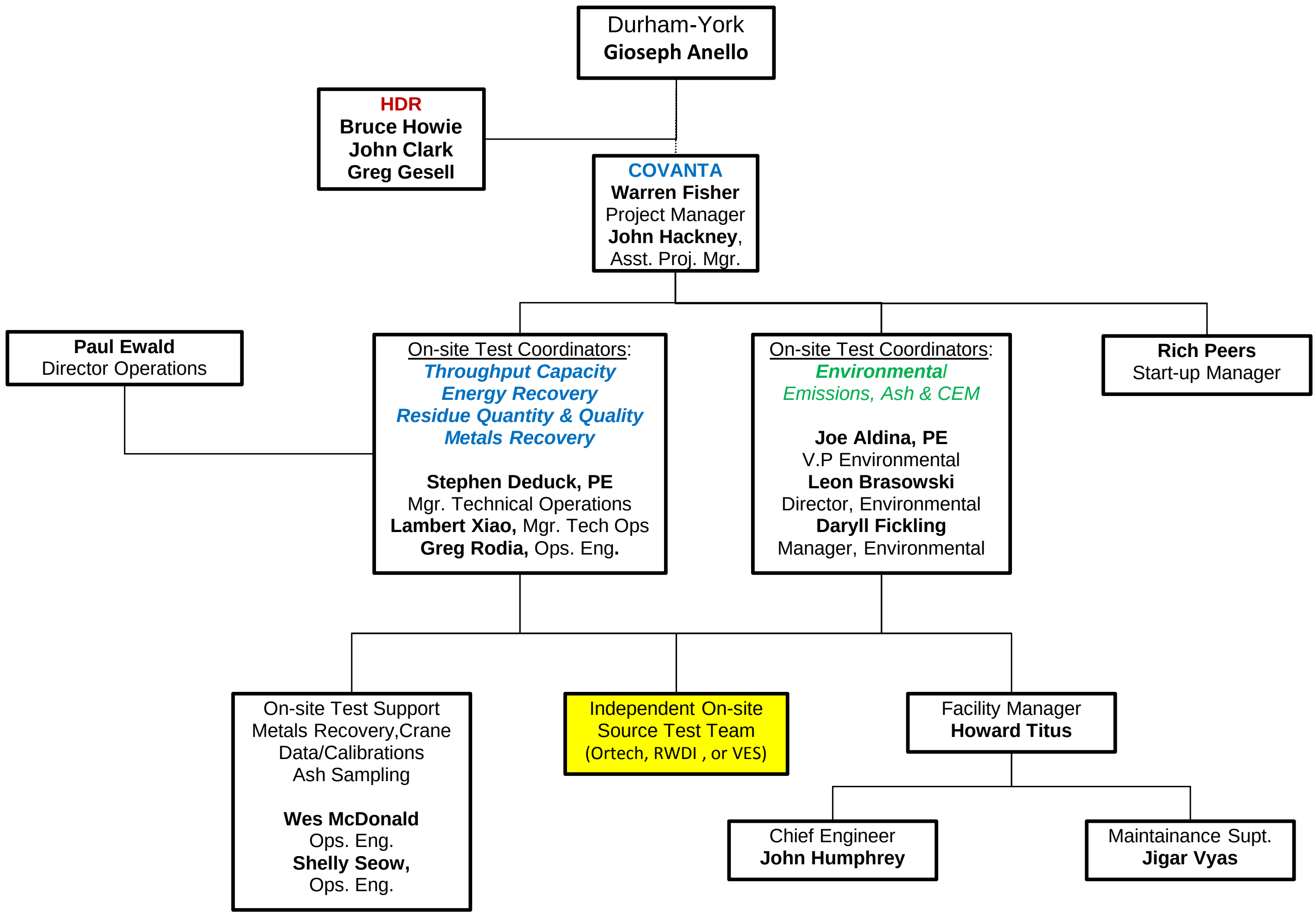
Acceptance Test Organization



28-Day Seasoning Period	30-Day Acceptance Test Period						Duration
Start-up Operations & Shakedown	Reliability Test						30 Days
	Residue Quantity Test						30 Days
CEMS RATA	Air Emissions Testing						See the Environmental Test Plan for details.
	Acoustic Auditing (if required)						To Be Determined
	5-Day Test Period sometime during the 30-day test period.						
Day of Week	Mon	Tues	Wed	Thur	Fri		
Day	1	2	3	4	5		
	Throughput Capacity Test						120 hours
	Residue Quantity & Quality Tests						120 hours
	ER1	ER2	ER3	ER4?	ER5?	<----- Energy Recovery Tests	minimum 3 x 8 hrs
	HHV1	HHV2	HHV3	HHV4?	HHV5?	<----- Boiler Calorimetry for Waste HHV	minimum 3 x 8 hrs
Residence Time & Temperature						Possible Re-test	minimum 3 x 1 hr @ 100% & 80% load each
						Fe/NFe1 / Fe/NFe2 / Fe/NFe3 <----- Metals Recovery	minimum 3 x 8 hrs
	RQ1	RQ2	RQ3	RQ4?	RQ5?	<----- Residue Quality Tests	minimum 3 x 8 hrs

Notes:

- The CEMS will be certified during Start-up Operations & Shakedown, prior to the 30-day Test Period.
- The Environmental Compliance Test for Air Emissions, Metals Recovery Tests and any required acoustic audit measurements can be performed any time during the 30-Day Reliability Test.
- Residence Time & Temperature testing may be performed again during 30-Day period for more accurate results.
- Ferrous & Non-Ferrous Metals Recovery testing is expected to be performed prior to and/or after the 5-day Test Period, but must be during the the 30-Day Test Period.

APPENDIX 10
PRE-ACCEPTANCE TESTING REQUIREMENTS AND ACCEPTANCE TEST PROCEDURES

1.1 GENERAL

The intent of the Acceptance Test is to demonstrate that the performance of the entire Facility can meet the Performance Guarantees in **Article 17 and Appendix 19** and to verify individual combustion train performance. The Owner's goal is to have achievement of the Performance Guarantees clearly and unquestionably demonstrated during the Acceptance Test, to the maximum extent possible. To the extent this cannot be accomplished due to insufficient waste quantities the DBO Contractor may identify modeling or other mechanisms to provide this additional demonstration.

Table A10-3 at the end of this appendix provides a preliminary schedule for the major milestones associated with the Acceptance Test. A revised schedule will be submitted by the DBO Contractor with the submission of the Draft Acceptance Test Plan.

It is not expected for this Appendix to cover every nuance of testing but to describe the requirements and timetable for Test Plan development and Test Performance.

1.2 MINIMUM TESTING REQUIREMENTS

All testing shall be performed simultaneously, to the extent practicable, in accordance with all applicable laws, regulations, codes and standards, the Certificate of Approval (CofA), Authorizations and Environmental Laws and Regulations. The Guiding Principles set forth in American Society of Mechanical Engineers (ASME) Performance Test Codes (PTC) 4 and 34-2007 will generally apply. Actual test measurements without consideration of uncertainty will be used for determination of test results.

Prior to Start-up and Testing, the DBO Contractor shall provide protocols, schedules and notifications to the Owner as set out in Table A10-3 at the end of this Appendix. The Acceptance Test Plan will contain the DBO Contractor's best estimate of the amount of waste required for testing on a daily basis, and the schedule and procedures of the Acceptance Tests. Processible Waste quantities needed for preliminary runs will also be specified as closely as possible. The Owner shall deliver, or cause to be delivered, such amounts of Processible Waste during the testing period

It is the objective of these tests to determine whether the Facility meets the Performance Guarantees, Technical Requirements, and operates at its design capacity.

During the Acceptance Test period, all equipment will operate at its design mode and capacity, and the operating personnel and supplies shall be those proposed to be available during normal operation of the Facility – all to demonstrate the capability of the Facility under normal operating conditions. Supplemental personnel will only be permitted where required for test purposes. During the Acceptance Tests, the DBO Contractor shall operate the Facility in conformance with all Applicable Law, regulations, codes and standards, the CofA, Authorizations and Environmental Laws Regulations. Prior to Acceptance Testing, the Facility must have completed start-up as defined in the Contract Documents and each unit will have been operated for a minimum of four (4) weeks of cumulative operation at or above 75 percent capacity to attempt to bring the heat transfer surfaces to a normal operating condition. If cleaning of the heat transfer surfaces with the exception of normal rapping, soot blowing and/or shower cleaning is performed after the four (4) week start-up period has been established, an additional three (3) weeks of operation at or above 75 percent capacity will be undertaken by the DBO Contractor.

Following the start-up and phasing-in of all process operating equipment of the Facility (Start-up Operations and Shakedown) and before conducting Acceptance Testing, all key process and temporary instrumentation and controls required for testing and documentation will be calibrated by technicians provided by the DBO Contractor, its subcontractors, or suppliers. The DBO Contractor shall make available at the Facility all satisfactory start-up or commissioning reports from vendors of all equipment to the Owner or Owner's Engineer.

Crane scales shall be used to determine all waste charged to each unit. Scales shall be capable of automatically weighing each charge, at a minimum recording the time, date, weight charged, and unit. Scale systems shall be capable of automatically printing hourly and daily totals by unit. Records shall be obtained in hard copy, as well as electronic format if possible. Crane scales shall be checked for linearity prior to the start of the test period and at the conclusion of the test period by use of a test weight near the maximum anticipated charge weight. Each crane shall be calibrated even if it is anticipated only one of the cranes will be used for charging units. Twice daily during all testing, each crane shall be checked for span by hoisting the test weight and also verifying the zero reading. Additional crane calibration testing shall also be required before and after each Energy Recovery Test. Test procedures shall address measures to be taken for addressing spillage and avoiding unrecorded data.

During the testing period, all data required to demonstrate performance shall be made available to the Owner and the Owner's Engineer(s) within 24 hours of collection. To the extent practical, all data should be collected electronically at intervals of no more than 1 minute and assembled into data summaries and forwarded to the Owner's Engineer in Excel or other acceptable format. Manually recorded test data and records and electronic data from the previous day shall be available by noon the following day. Access to DCS trends available on an operator console will be provided to the extent it does not impact the operator's ability to operate the facility.

1.3 ADJUSTMENTS PERTAINING TO THROUGHPUT CAPACITY AND ELECTRICITY PRODUCTION RATES

Steam production and electric generation are dependent upon the waste throughput rate, the waste composition, and the higher heating value ("HHV"). For Acceptance Testing purposes, it is recognized that the waste HHV delivered to the Facility may not be representative of the Reference Waste HHV, and the net electric generation must, therefore, be corrected to that obtainable with the Reference Waste HHV. For the purposes of determining the Energy Recovery, the electrical generation will be adjusted to annual average conditions. It is further recognized that, by using the combustion system as a calorimeter, the higher heating value of the waste combusted may be determined while the steam production and electric generation are measured, and the results can then be corrected for HHV to the specified conditions as described hereinafter.

The Throughput Capacity will be adjusted for waste HHV in accordance with the table of Throughput Capacity Guarantees provided in Exhibit 2 to Appendix 19 Performance Guarantees.It is further recognized that it is difficult to obtain an accurate measurement of the heating value of the waste through sampling of the waste being processed during the Acceptance Test. It is, therefore, proposed that the combustion system be used as a calorimeter, following, in general, the principles described in the ASME Power Test Code ("PTC") 4 for Stationary Steam Generating Units and 34-2007 for Waste Combustors with Energy Recovery (the "Energy Recovery Tests"). The heating value of the waste used during the Energy Recovery Tests shall be used in conjunction with Electricity Production Guarantees provided in Exhibit 2 to Appendix 19 to demonstrate compliance.

One purpose of the Energy Recovery tests is to determine the HHV of the waste processed during the test and determine the boiler steaming rate, net electrical production, and associated efficiency. The results of the Energy Recovery tests shall be adjusted for the waste HHV in accordance with the table of Electricity Production Guarantees provided in Exhibit 2 to Appendix 19.

Additional Boiler Calorimetry Tests shall be performed to determine the HHV of the waste. The results of these tests and the Energy Recovery Tests shall be used to develop (a correlation to calculate the HHV of the fuel during subsequent test periods.

1.4 PRE-ACCEPTANCE TEST CONFERENCE

There shall be a pre-Acceptance Test conference to provide a forum for all individuals associated with approval of testing of the Facility so that the DBO Contractor can clearly discuss responsibilities of the participants during the Acceptance Test. The conference shall be held at the Facility within 120 days, but no later than 90 days prior to the start of the Acceptance Test. The DBO Contractor shall notify the Owner of the date of the pre-Acceptance Test conference in writing at least fourteen (14) days in advance of such date.

At the pre-Acceptance Test conference, the Acceptance Test Plan shall be reviewed, and any changes relating to the Acceptance Test Plan shall be discussed and, if agreed upon, incorporated into the Final Acceptance Test Plan.

1.5 START-UP OPERATIONS AND SHAKEDOWN

During this phase of construction, the DBO Contractor shall gradually start-up and phase-in all process operating equipment. The DBO Contractor shall:

(a) At least 90 days prior to commencement of Start-up Operations activities, submit a procedure and schedule for Start-up Operations and Shakedown of the Facility (Start-up Operations and Shakedown Protocol) to the Owner. The schedule should outline major equipment initial operation dates, as well as the DBO Contractor's best estimate of the amount of waste, on a daily basis, required to support Start-up Operations activities.

(b) Notify the Owner ten (10) days prior to Start-up Operations. Such notification shall serve as confirmation of the DBO Contractor's intentions to initiate Start-up Operations activities and notify the Owner of any changes in the schedule and/or waste delivery schedule referred to in Part (a) above.

(c) Have designed, constructed, and equipped the Facility in accordance with the Contract Documents and be able to demonstrate that the Facility's systems and operating equipment have satisfied all hydrostatic, pneumatic, electrical, and other tests required to demonstrate mechanical operation, all prior to commencing Start-up Operations activities.

(d) Be responsible for all costs of repairs, modifications, testing, and operation and maintenance of the Facility during Start-up Operations including costs for reagents supply and residues removal/disposal.

(e) Substantially complete the training of all designated staff of the Owner and contractor personnel required for commercial operation of the Facility.

The Start-up Operations and Shakedown Protocol shall comprise, as a minimum, the following provisions:

(i) *During the Start-up Operations and Shakedown period, the Facility shall be operated for a minimum of four (4) weeks of cumulative operation at or above 75 percent of rated capacity. The DBO Contractor shall provide copies of records, logs, and data that are necessary to substantiate compliance with this requirement.*

(ii) *During Start-up Operations and Shakedown, the DBO Contractor shall operate the Facility in accordance with good power plant operating practice.*

(iii) *All instrumentation and controls shall be calibrated by technicians provided by the DBO Contractor, its subcontractors, or suppliers. The DBO Contractor shall notify the Owner of the date and time specific calibration evolutions are to occur. The Owner reserves the right and option to monitor the calibration of any instrument and/or control equipment. The DBO Contractor shall maintain an instrument/controls calibration log for each instrument and control loop that is calibrated. The DBO Contractor shall provide the Owner a copy of the calibration log prior to commencing Acceptance Tests.*

1.6 TEST PLAN STRUCTURE

The Acceptance Tests will be composed of the tests outlined in Table A10-1 and described below.

Table A10-1: Required Acceptance Tests

Test	Acceptance Test Requirements and Description:	FREQUENCY/ DURATION
30-Day Reliability Test	Facility-wide operation at a minimum of 95% of the Demonstrated Design Steam Flow. During the 30-Day Reliability Test, the 4-hour block average steam flow will not exceed 110% of the highest 4-hour block average steam flow measured during any of the three 8 hour Energy Recovery Tests.	One 30 day duration test
Throughput Capacity Test	Operation of the Facility at full load for five (5) consecutive days to demonstrate compliance with the Throughput Guarantees in Exhibit 2 to Appendix 19	One 5-day duration test
Energy Recovery Test	Demonstrate compliance with the Electricity Production Guarantees in Exhibit 2 to Appendix 19.	Minimum of –Three (3)- tests. Each test shall be a minimum of 8-hour duration tests (performed during the Throughput Capacity Test)
Residue Quality Test	Residue Quality (bottom ash only) meeting Performance Guarantees for moisture content of less than or equal to 25%, unburned carbon of less than or equal to 3% during the Energy Recovery Tests and Throughput Capacity Tests.	Simultaneous with 5 day Throughput Capacity Test
Residue Quantity Test	Residue Quantity meeting Performance Guarantee for the total Residue (including bottom ash and fly ash) weighing not more than 30% of the Tonnage combusted to produce such Residue during the 30-day Reliability Test, adjusted for the waste HHV in accordance with Table A10-2.	Measured during the 30-Day Reliability Test and the 5-Day Throughput Capacity Test.
Metals Recovery Test	The ferrous and non-ferrous recovery systems to be tested to demonstrate the Metals and Other Metals Recovery Guarantees specified in Exhibit 2 to Appendix 19.	Minimum of Three (3) 8-hour tests on each system
Environmental Compliance Test	The testing of all emission and operating parameters in accordance with requirements established by the CofA and the MOE anytime	

	during the 30-day Reliability Test. The CEMS shall be certified and used to demonstrate continuous compliance during the Test Period with all CEMS emission parameters.	

1.7 30-DAY RELIABILITY TEST

The objective of this test is to demonstrate the capability of the entire facility to process waste, and produce steam and electricity during a 30-day period.

During this test the Facility will be operated at a minimum of 95% of Demonstrated Design Steam Flow. The Demonstrated Design Steam Flow shall be established during the Energy Recovery Tests and will be the average steam flow when burning 436 tons per day of MSW with an HHV of 13 MJ/kg. During the 30-day test period, the 4-hour steam flow averages used to demonstrate compliance will be limited to the lesser of i) the actual 4-hour steam flow averages or ii) 110% of the highest 4-hour average steam flow measured during the Energy Recovery Tests.

In addition, the availability during the 30-day Reliability Test, defined as the ratio of the number of boiler-hours the processing lines are on-line to process waste versus the number of hours during the period (e.g. 30 days x 24 hours/day x 2 processing lines), shall not be below an availability of 95%.

During the 30-Day Reliability Test period, routine measurement of normal operational parameters shall be collected and reported to illustrate normal operation during the test period. This will include waste throughput, appropriate temperature, and pressures, electrical generation, etc.

1.8 THE FACILITY WILL HAVE PASSED THE 30-DAY RELIABILITY TEST CONTINGENT UPON THE SUCCESSFUL PASSAGE OF THE TESTS DESCRIBED IN SECTIONS 1.8 THRU 1.11. THROUGHPUT CAPACITY TEST

1.8 THROUGHPUT CAPACITY TEST

The objective of this test is to demonstrate compliance of the facility with the Throughput Guarantees in Exhibit 2 to Appendix 19 during a five (5) day (120-hour) test period. The Facility will be tested for one consecutive 120-hour period, during which the Facility will process at least ~~2,130~~ **tonnes (and no less than 1,000 tonnes per unit)** of Reference Waste.

2,180

The amount of waste processed during the Throughput Capacity Test shall be adjusted for the measured waste HHV in accordance with the table provided in Exhibit 2 to Appendix 19. The waste HHV shall be determined during the Energy Recovery Tests using a correlation developed from boiler calorimetry tests taken at the Facility. In the event the measured waste

HHV lies between two data points in the table in Exhibit 2 to Appendix 19, a linear interpolation will be performed to determine the waste throughput.

If the heating value of the waste burned is determined to have an HHV below 11,000 kJ/kg, the waste supplied shall be considered outside of the facility acceptable range and the test will then be repeated at the Owner's expense.

The Facility shall not have passed the Throughput Capacity Test, even though the tonnage processed meets the capacity requirements stated above, if the facility fails the Residue Quality Test.

1.9 ENERGY RECOVERY TEST

The objective of the Energy Recovery Test is to demonstrate the ability of the Facility to generate electricity at a specified throughput of waste (at a Reference Waste HHV) for the purpose of meeting the Electrical Generation Guarantee. Energy Recovery Tests shall consist of a minimum of three (3) minimum 8-hour electric generation tests performed during the 5-day Throughput Capacity Test period. During the test all Facility electrical power requirements shall be supplied by the Facility generator. The tests should include using boiler as a calorimeter (BAC) tests to determine the actual HHV of the waste to correct the kwh/tonne of reference fuel combusted. The basic formulas shall include:

1) $$\text{Fuel Heat Input} = \text{Heat Output (Steam)} + \text{Losses} - \text{Heat Credits}$$

2) $$\text{HHV of Burned Waste} = \frac{\text{Fuel Heat Input}}{\text{kgs of Burned Waste}}$$

3) $$\text{Boiler Efficiency} = \frac{\text{Heat Output(Steam)}}{\text{Heat Input}}$$

4) $$\text{Steaming Rate} = \frac{\text{kgs of Steam}}{\text{kgs of Burned Waste}}$$

5) $$\text{Electric Generation Rate} = \frac{\text{Net kWh}}{\text{kgs of Burned Waste}}$$

The determination of Heat Input will require the steam and feedwater pressure, temperature, and flow measurements. From these, the enthalpy rise from feedwater to outlet steam will be determined.

Heat losses and credits will be determined in accordance with the procedures outlined in ASME PTC 4 and 34 and require primarily a certified stack gas monitoring system to determine excess air; a traversing of the flue duct to determine gas flow rates and temperatures; determination of moisture content in the flue gas; assumption of radiation losses from PTC 4.1, Figure 8 - American Boiler Manufacturers Association (ABMA) Standard Radiation Loss Chart or as estimated from procedures in PTC 4; temperature of residue ash and fly ash; temperatures and quantities of quench water; flow, pressure, temperature, and humidity of combustion air, blowdown flow, and other measurements or determinations of minor losses. The development of the detailed Test Protocol will consider and address minor allowances for factors that may be isolated during testing as a means of simplifying the test and improving test accuracy. These minor allowances may include but will not necessarily be limited to the following: sootblowing; rapping, boiler blowdown; baghouse cleaning; and other normal operating practices required for long-term operation of the Facility. Except for equipment required specifically for testing, no temporary or portable equipment, such as air compressors, will be allowed to be used during the Energy Recovery testing period. All other equipment that contributes to parasitic load will be in a normal or "on" mode.

Each Energy Recovery Test shall be a consecutive 8-hour period (minimum) for each unit. Pertinent test data shall be recorded at appropriate intervals in accordance with the test code. More specifically, the readings taken and recorded during the test will include, but will not necessarily be limited to, the following:

- Waste feed rate;
- Boiler outlet steam – flow rates, temperatures, and pressures;
- Feedwater – flow rates, temperatures, and pressures;
- Attemperator – water flow rates, temperatures and pressures;
- Boiler drum pressures;
- Flue gas – flow rates and temperatures at the economizer outlet;
- Carbon dioxide, oxygen, carbon monoxide, and moisture in the flue gas at the outlet of the economizer;
- Residues and fly ash quantities and unburned carbon content;
- Ambient wet/dry bulb temperatures, barometric pressures;
- Residue quench water quantities (if applicable);

- Moisture in Residue;
- Boiler blowdown rate and temperature;
- Turbine generator output;
- In-house power consumption;
- Actual Net Electrical Output to the utility grid;
- Steam delivered to the Customers (if applicable)
  - In normal operating or waste based operating mode
  - In standby mode; and
- Steam measured at inlet of the turbine (waste based operations only).

Test measurements will be taken from installed plant instruments which will have been previously calibrated during the start-up period described in the Agreement prior to the test and agreed accurate by the Owner's Engineer. Special portable instrumentation may also be used where required and agreed upon.

Where appropriate, all data and measurements for the test will be read and recorded separately for each combustion unit.

1.10 1.9 RESIDUE TESTS

1.10.1 1.9.1 Residue Quality Test

The Residue (e.g. bottom ash and grate siftings only) moisture content and percent combustible matter shall be determined during the Residue Quality Test. The Residue Quality Test will be performed during the five (5) day Throughput Capacity Test and on more frequent intervals during the Energy Recovery Tests. The purpose of this test is to ensure the quality of the bottom ash from the combustion units meet the Performance Guarantees for moisture content of less than or equal to 25%, and unburned carbon of less than or equal to 3%. The Residue samples shall be collected from the combined bottom ash and siftings generated by each combustion train in accordance with ASME PTC 34, the CofA, and MOE requirements. The sampling and testing procedures for the Residue Quality Test shall be included in the Final Acceptance Test Plan, which shall be submitted to the Owner and MOE at least sixty (60) days prior to the start of the Acceptance Test for approval.

Testing of the fly and bottom ash will be performed to demonstrate compliance with appropriate regulatory requirements applicable given the intended disposition of the material.

1.10.2 1.9.2 Residue Quantity Test

The purpose of the Residue Quantity Test is to ensure the Facility meets the Exhibit 2 to Appendix 19 Performance Guarantee for the total Residue (including bottom ash, grate siftings, boiler and air pollution control fly ash) weighing not more than 30% of the Tonnage combusted to produce such Residue, adjusted for the measured waste HHV in accordance with Table A10-2. The Residue Quantity Test shall be performed during the 30-day Reliability Test and the 5-day Throughput Capacity Test. The main weigh scale and other weighting devices shall be used to determine quantity of residues generated

Table A10-2: Residue Guarantee Adjustment

Waste HHV	Ash Quantity
11.0 MJ/kg	33.5%
12.0 MJ/kg	31.7%
13.0 MJ/kg	30.0%
14.0 MJ/kg	28.2%
15.0 MJ/kg	26.5%

1.11 METALS RECOVERY TESTS

The objective of the Metals Recovery Tests are to demonstrate the capability of the Facility to meet the recovery efficiency guarantees for ferrous and non-ferrous recovery from the Residue exiting the boiler after combustion. The test plan shall include adequate sampling provisions for determining that the Facility's ferrous and non-ferrous recovery systems are in compliance with the Metals Recovery Guarantees in Exhibit 2 to Appendix 19.

1.11.1 Ferrous Recovery Test

The Ferrous Recovery Test shall be conducted on three (3) separate days during the 30 day Reliability Test. Each test shall be a minimum of 8 hours in duration. Residue Samples shall be collected at one-half (1/2) hour intervals. The unrecovered ferrous ratio shall be sampled downstream of the magnetic ferrous separator. The oversize (or grizzly scalper) ferrous shall also be collected, weighed and added to the process ferrous extracted from the magnetic separator. The total Residue weight collected during the test shall also be obtained during the test period. Compliance will be determined by comparing the average of the three (3) tests to the Metals Recovery Guarantee for ferrous metals in Exhibit 2 to Appendix 19.

1.11.2 Non-Ferrous Recovery Test

The Non-Ferrous Recovery Test shall be conducted on three (3) separate days during the 30 day Reliability Test. Each test day shall be a minimum of 8-hours in duration. Residue samples shall be collected at one-half (1/2) hour intervals. The unrecovered non-ferrous ratio shall be sampled downstream of the eddy current or non-ferrous metal separator. The oversize (or grizzly scalper) non-ferrous metals shall also be collected, weighed and added to the process non-ferrous extracted from the eddy current separator. The total Residue weight collected during the test shall also be obtained during the test period. Compliance will be determined by comparing the average of the three (3) tests to the Metals Recovery Guarantee for non-ferrous metals in Exhibit 2 to Appendix 19.

1.12 ENVIRONMENTAL COMPLIANCE TEST

1.12.1 Air Emissions

1.12.2 During the 30-Day Reliability Test, each combustion unit shall be stack-tested. The testing shall be consistent with standard practice of conducting three runs for each parameter with the average of all valid runs being used to demonstrate compliance with the requirements of the CofA and MOE requirements, Noise

If directed by the conditions of the CofA, the DBO Contractor shall carry out acoustic audit measurements on the actual noise emissions due to the operation of the entire Facility at the design rating. The noise measurements shall be performed by an Independent Acoustic Consultant in accordance with the MOE requirements. Independent Acoustic Consultant shall prepare an acoustic audit report which will be included in the Emission Test Report.

1.12.3 General

Testing shall be performed as directed by the conditions of the CofA and MOE. An Emission Test Report shall be prepared in accordance with the MOE requirements and included as part of the Acceptance Test Report described in Section 1.13. The provisions of Article 15 of this Agreement shall apply to the Testing to the extent any of the conditions of the CofA or MOE differ from the conditions as at April 22, 2009.

1.13 ACCEPTANCE TEST REPORT

After completion of the Acceptance Test, a report containing the information related to the Acceptance Test (the "Acceptance Test Report") shall be prepared by the DBO Contractor and, within 60 calendar days, 10 copies shall be submitted to the Owner. The Acceptance Test Report shall contain, but not be limited to, the following information and certifications:

- Copies of all data and log sheets.
- Copies of all laboratory analyses.
- A listing of all federal, state, county, and other regulatory agency requirements and the respective test results indicating conformance and compliance or lack of conformance/compliance with these requirements.
- All necessary certificates relating to calibrations, testing, evaluation, analyses, and performance required pursuant to the Acceptance Test Plan.

- A summary of test results supported by calculations demonstrating the ability to meet the requirements relating to the Throughput Performance Capacity and Energy Recovery Tests.

- A stand alone Emission Test Report prepared in accordance with the Certificate of Approval and MOE requirements.

- A stand alone Residue Test Report prepared in accordance with the Certificate of Approval and MOE requirements.

- A certification signed by an officer of the DBO Contractor stating that the Acceptance Tests were conducted in accordance with the Acceptance Test Plan; the requirements of the Acceptance Test were satisfied or the extent to which they were not satisfied; and the Acceptance Test demonstrated that the Facility met each of the Performance Guarantees specified in the Contract Documents.

1.14 FACILITY ACCEPTANCE TEST CRITERIA

The Facility shall be deemed to have passed the Acceptance Test Criteria if the Acceptance Test demonstrates that, each of the following criteria has been met or exceeded:

- The 30-day Reliability Test has demonstrated during the test period that the Facility has operated at a minimum of 95% of the Demonstrated Design Steam Flow with a Facility availability greater than 95%.

- The Throughput Capacity Guarantee Test has demonstrated the ability of the Facility to process waste in accordance with the Throughput Capacity Guarantee in Exhibit 2 to Appendix 19 during a consecutive five (5)-day test period , and that the amount of Reference waste (in tonnes) processed during the testing period is ~~2,130~~ 2,180 tonnes (and no less than 1,000 tonnes per unit).

- The Energy Recovery Test has demonstrated that the average net electrical production rate (in kWh/tonne) is not less than the Electrical Production Guarantee identified in Exhibit 2 to Appendix 19.

- The Residue Quality Guarantee has demonstrated that the unburned carbon content is less than 3%, and moisture content is less than 25%.

- The Residue Quantity Guarantee is demonstrated if the quantity of Residue generated (in tonnes) is less than or equal to 30% of Waste processed(in tonnes), adjusted for the measured waste HHV in accordance with Table A10-2. Residue to be Residue from the Facility, excluding ferrous and non-ferrous materials recovered, but including any returned or disposed ash resulting from the ferrous and non ferrous cleanup-The Metals Recovery Guarantee is demonstrated if the measured recovery efficiency percentages for ferrous metals and for non-ferrous metals comply with those identified by the DBO Contractor in Exhibit 2 to Appendix 19.

- The Environmental Compliance Guarantee is demonstrated if the results of the air emissions, noise, and general test requirements are in compliance with the CofA.

1.15 MINIMUM ACCEPTANCE CRITERIA

The Facility shall be deemed to have satisfied the Minimum Acceptance Criteria if the minimum criteria for throughput capacity (90% compliance with Throughput Capacity Guarantee), for energy (95% compliance with the Electrical Generation Rate Guarantee), for metals recovery (90% compliance with the Metals Recovery Guarantee, and for environmental compliance (100% compliance with the Environmental Compliance Guarantees) have been demonstrated.

Table A10-3: Tentative Acceptance Test Schedule

No.	Milestone Description	No. of Days Before Start of Acceptance Test
1	DBO Contractor issues Draft Acceptance Test Protocol and Preliminary Test Schedule.	180
2	Owner and Owner's Engineer provides comments on Draft Test Protocol to DBO Contractor.	120
3	Pre-Acceptance Conference with DBO Contractor, all subcontractors, Owner and Owner's Engineer.	120-90
4	DBO Contractor submits Final Acceptance Test Protocol and Final Test Schedule to Owner and MOE.	90-60
5	DBO Contractor notifies Owner of their intent to start-up the Facility.	Minimum 40
6	DBO Contractor begins the start-up/shakedown period of Facility.	Minimum 30
7	Start of Acceptance Test and 30-Day Reliability Test.	0
8	Completion of Acceptance Test and 30-Day Reliability Test.	-30
9	DBO Contractor submits Acceptance Test Report to Owner and Owner's Engineer.	-90
10	Owner and Owner's Engineer's issues or approvals of Acceptance Test Report.	-120

Exhibit 2 to Appendix 19

The performance guarantees:

1.	**Construction Period Guarantee**		
	Length of time from Notice to Proceed to Schedule Acceptance Date (days)	1,217 days	
2.	**Throughput Capacity Guarantee (140,000 tonnes per year)**		
	HHV	Tonnes per day	
	11.0 MJ/kg	515	
	12.0 MJ/kg	472	
	13.0 MJ/kg *	436	
	14.0 MJ/kg	405	
	15.0 MJ/kg	378	
	* = Design waste HHV		
3.	**Electricity Production Guarantee* (Annual Average)** ***Not including the Future District Energy System component** **(See Part 9 to this form, below)**		
	Throttle Conditions Proposed (Bar)		Approx. 90 — 1305 psi
	Throttle Conditions Proposed (^{o}C)		Approx. 496 — 924.8 F
	Maximum Steam load (kg/hr)		Approx. 72,000 @ VWO
	Electricity Production Guarantee at or above 100% of the Guaranteed Annual Throughput [See Note 1]		
	HHV	Gross Electrical Output (kWh/tonne)	Net Electrical Output (kWh/tonne
	11.0 MJ/kg	712	627
	12.0 MJ/kg	793	700
	13.0 MJ/kg	868	767
	14.0 MJ/kg	949	840
	15.0 MJ/kg	1030	913

Note 1. The Guaranteed Annual Throughput is calculated by multiplying the "Tonnes per Day" in the table in item 2 above by the number of days in the year by 0.88. The Electrical Production Guarantee (Annual Average) shall be determined using the equations set forth in Exhibit 1 to Appendix 19. Maximum Continuous Rating or "MCR" for each boiler is the Guaranteed Annual Throughput calculated at 13 MJ/kg divided by two (2).

	Electricity Production Guarantee at 90% of Guaranteed Annual Throughput [See Note 1]		
	HHV	Gross Electrical Output (kWh/tonne)	Net Electrical Output (kWh/tonne)
	11.0 MJ/kg	701	606
	12.0 MJ/kg	781	677
	13.0 MJ/kg	854	742
	14.0 MJ/kg	934	813
	15.0 MJ/kg	1014	884

4.	**Residue Quality and Quantity Guarantee:** The Average monthly quality and quantity of Residue (to include bottom ash, fly ash, siftings, scrubber residue and all other process residue) from combustion of processible waste:		
	Unburned Combustible Matter (% dry weight – not exceed 3.0%)	3%	
	Total Residue (bottom and fly ash) excluding ferrous and other materials (tonne of residue/tonne of processible waste – not to exceed 30%@ 13.0 MJ/kg)	**Waste HHV**	**Ash Quantity**
		11.0 MJ/kg	33.5%
		12.0 MJ/kg	31.7%
		13.0 MJ/kg	30.0%
		14.0 MJ/kg	28.2%
		15.0 MJ/kg	26.5%
	Percent Moisture in Bottom Ash Residue (tonne of residue/tonne of processible waste – not to exceed 25%)	25%	

5.	**Metals Recovery Guarantee (recovery efficiency test)**	
	Measured as tonnes ferrous recovered/tonnes ferrous in residue pre-processing – expressed as a percentage	80% Ferrous & 60% Non-Ferrous

6.	**Other Material Recovery** (Specify material; tonne of material recovered/tonne of material recoverable – expressed as %)	
	Material 1: Non-Ferrous	**n/a**
	Material 2:	**n/a**
	Material 3:	**n/a**

7.	**Guaranteed Facility Availability**	
	the proportion of time the Incinerator Unit is available to process the Regions' waste within a calendar year time period, expressed as a percentage (minimum requirement is 90% availability or 7,884 hours available in a year)	**90%**

8.	**Guaranteed Maximum Emission Limits**

Acceptable manufacturers of flyash handling systems are Materials Handling Equipment Co., Wolf Materials Handling Systems, S. Huot, EDC, CDM Systems, Allen Sherman Hoff, CP Manufacturing Co., Jervis B. Webb, Martin Sprocket & Gear, Nordstrong Equipment Ltd, Screw Conveyor Corp. or equal.

Acceptable manufacturers of bottom ash handling systems are Vulcan, Jervis B. Webb, S. Huot, Wolf Material Handling Systems, CP Manufacturing Co., EDC, Allen Sherman Hoff, Nordstrong Equipment Ltd, Process Barron or equal.

Note: Vibrating conveyors will be supplied by General Kinematics, Triple S. Dynamics, or equal.

8.14 Ferrous and Non Ferrous Recovery System

A ferrous recovery system and non ferrous recovery system must be provided for the Facility which must meet or exceed the requirements for ferrous and non-ferrous recovery included in the Project Agreement. This system may consist of conveyors, magnets, eddy current separators, screens and other equipment required for a complete, operational system. Ample space and access should be provided for maintenance of all system components.

Bottom ash should have oversized bulky materials removed prior to recovery of smaller ferrous materials. Use of drum magnets is preferred over belt magnets for ferrous recovery. System should be designed with product cleanliness in mind to minimize residual ash being carried with the recovered metal. Ferrous recovery will be at least 80 percent of all material greater than 2.5 cm and less than 15 cm.

Non-ferrous metal should be recovered after all ferrous metal has been removed from the residue. Eddy current separators should be arranged to minimize possible damage from tramp ferrous metal. Non-ferrous recovery will be greater than 60 percent of all non-ferrous greater than 1 cm and less than 5 cm.

Highlights added ex post facto!

Durham/York Energy from Waste Project

Acceptance Test Procedures

30-Day

Reliability Test

&

Residue Quantity Test

COVANTA ENERGY

June, 2014

Table of Contents

1 OBJECTIVE

1.1 30-Day Reliability Test

The objective of the 30-Day Reliability Test is to demonstrate the capability of the ***Facility*** to process waste and produce steam and electricity over an extended time period. The total combined steam flow from both boilers must average ***95% of Demonstrated Design Steam Flow*** over the 30 days while achieving an ***availability of 95%.*** Comparison to DDSF will be based on 4-hour block averages. Demonstrated Design Steam Flow is established during the 8-hour Energy Recovery Tests and is defined as the average steam flow when burning 436 tonnes per day (TePD) of MSW (480 tons/day-TPD) that has an HHV of 13 MJ/kg (5,589 BTU/lb). Any ***4-hour average steam flows, from either boiler, above 110%*** of the highest 4-hour average measured during the Energy Recovery Tests will ***be recorded as the 110% value*** *per Agreement requirements*.

1.2 30-Day Residue Quantity Test

The objective of the Residue Quantity Test is to ensure the Facility meets the Exhibit 2 to Appendix 19 Guarantee for the total Residue generated over a 30 day period. The Residue Quantity guarantee, stated as a percentage of the Tonnage processed, varies with Waste HHV as shown in Table A10-2 below and in item 4 of Exhibit 2 to Appendix 19 of the Project Agreement.

Table A10-2: Residue Guarantee Adjustment

Waste HHV	Ash Quantity
11.0 MJ/kg	33.5%
12.0 MJ/kg	31.7%
13.0 MJ/kg	30.0%
14.0 MJ/kg	28.2%
15.0 MJ/kg	26.5%

From Appendix 10 of the Project Agreement

Residue is defined as all materials remaining after the processing of waste and after metals recovery, i.e. bottom ash, grate siftings, boiler and APC flyash, including added reagents, i.e. pozzolans, cement, hydrated lime and activated carbon and water. Recovered ferrous and non-ferrous metals, including recovered, over-sized, grizzly metals are not considered as part of Residue for the Residue Quantity Guarantee.

"Residue" means Bottom Ash, Fly Ash, grate siftings, APC Plant waste and other material that remains after combustion of waste and recovery of metals in the Facility.

Definition of Residue from Project Agreement

2 CONCURRENT TESTS

Tests will be performed to generate a correlation to determine the higher heating value (HHV) of the Acceptable Waste Processed during the 30-Day Reliability Test. A minimum of three (3) 8-hour refuse HHV tests using the boiler as a calorimeter will be performed during the 5-Day Throughput Capacity Test, although it is expected that five (5) can be achieved. The HHV tests will be performed as part of the Energy Recovery Tests. As shown in the test schedule and listed below, all other Acceptance Tests are scheduled to be performed concurrently during the 30-Day Reliability Test and the 30-Day Residue Quantity Test period.

- A 5-Day Throughput Capacity Test
- A 5-day Residue Quantity Test
- A 5-Day Residue Quality Test
- 3-5, 8-hour Energy Recovery and Residue Quality Tests
- Environmental Air Emissions Tests
    - including all Ministry of the Environment, (MOE), Environmental Compliance Approval (ECA) testing requirements
- Metals Recovery Tests
- Residence Time and Temperature Tests
- Noise Measurements

3 TEST PREREQUISITES

Prior to the commencement of the 30-Day Reliability Test, Covanta Durham-York Inc., (Covanta) will have:

- Had the Pre-Acceptance Test Conference *(completed 4/24/14)*
- Provided the Owner with a best estimate of refuse tonnage requirements necessary for the testing, factoring in preliminary indications of refuse HHV and pit level
- Performed and submitted documentation for the required instrument calibrations
- Completed the 28 day seasoning period.

Refer to the Energy Recovery Test Procedures for more details of test prerequisites.

4 TEST INSTRUMENTATION & DATA

During the Reliability Test period, process data points will be measured by the permanent plant Distributed Control System (DCS). The data will be used to document normal operating conditions throughout the thirty (30) day test period. During boiler calorimetry tests, process data will also be obtained by the DCS in conjunction with the manual data collection necessary for HHV calculation purposes as outlined in the Energy Recovery test procedures. The list of data points that will be logged for the Reliability Test at 1 minute intervals is included in the Energy Recovery test procedures. Averages, maximums and minimums and graphs of key parameters will be made available along with the data files on electronic media. The data files will be in Excel format. Data from the previous day will be forwarded to the Owner's Engineer by noon of the following day. Prior notice will be given to the Owner's Engineer via email or text for events such as crane span checks and ash weighing. If the OE cannot be found or is not available, photographs will be used to document these events.

The certified main truck weigh scales will be used with a combination of trucks, containers and loader buckets to determine the net quantities of residue generated and also be used with a pit volume determination for calculation of refuse processed over the 30 days as a back-up to the crane scales.

5 TEST PROCEDURES

5.1 General

5.1.1 Normal Operation

The Project will be operated in a manner consistent with expected day-to-day long-term operation, with all equipment and accessories performing in their expected day-to-day long-term mode. Facility staffing shall be at normal levels with no additional operations and maintenance staff with the exception of staff dedicated to performing tests or collecting data.

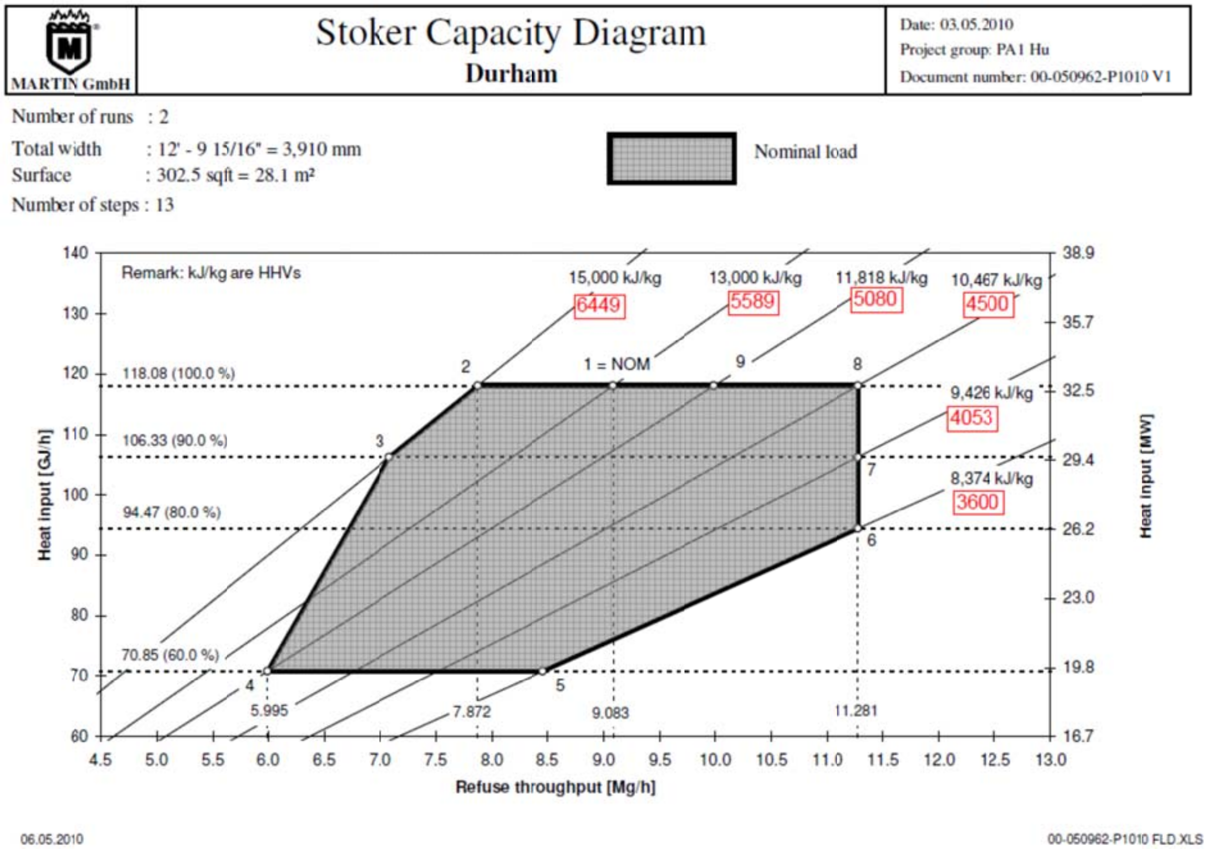
5.1.2 Low HHV of Waste

If waste HHV drops below the Project Agreement design basis of 11,000 kJ/kg (4,729 BTU/lb) where 100% design heat input cannot be maintained, then the boilers cannot be expected to maintain 100% design steam flow and Table A10-2 may not be valid for % Ash Quantity. In this case, if the steam flow cannot be maintained above 95% of DDSF, then any day where HHV has been determined to have dropped below 11,000 kJ/kg, will be eliminated from the testing, but only if Covanta can demonstrate to the Owner's Engineer that reasonable steps were taken to mix the waste in the pit and that other negative effects of low HHV on operation are occurring. However, if the 95% DDSF minimum limit and the % Ash Quantity maximum limit can be achieved/maintained, then the test days can remain.

A Day is defined as 24 hours as referenced to the actual start time of the test, for example, 12:01 AM to 12:00AM.

Refuse HHV will be determined using a specific steam ratio correlation, including corrections for:

1. Ambient air temperature
2. Amount of heat input from steam coil air heaters
3. Economizer exit gas temperature
4. Economizer exit O_2 concentration, i.e. excess air.
5. Main steam and feedwater temperatures and pressures.



5.1.3 Downtime

Per the Agreement, shutdown time of up to 5% (72 boiler-hours or 36 Facility-hours) may be excluded from the 30-day test period. For example, one boiler could be down for 72 hours or both boilers for 36 hours or any combination totaling 72. Shutdown start/end times for either combustion/steam generation unit are defined as the boiler being online/offline which will be taken as when the refuse feed-chute damper is open/closed.

The Owner's Engineer will consider retroactive declarations of downtime when the feed-chute damper is not shut if the total downtime remains less than the 72-hour limit.

Additionally, it is proposed that shutdown time, which Covanta can demonstrate to the reasonable satisfaction of the Owner, to be solely caused by the uncontrollable processing of Unacceptable Waste, shall be added to the maximum shutdown allowance, provided that any hours spent performing non-routine maintenance work performed during such shutdown time shall be charged against the above shutdown time. The amount of such time shall be at the Owner's reasonable discretion.

5.1.4 Auxiliary Fuel

Although not contemplated, low HHV MSW or a partial pluggage of fuel feed, may require the use of auxiliary fuel to maintain minimum furnace temperature as required by environmental permit conditions. If auxiliary fuel is utilized during the testing, any effect on steam production will be accounted for. If significant quantities of auxiliary fuel are used, then the aux fuel ***HHV*** will be obtained from utility documentation. The use of auxiliary fuel during a boiler calorimetry test will cause that test to be invalidated unless such usage occurs in the last hour of the test. If so, and operation has been steady, both parties may agree to use the data for a 7-hour period.

5.1.5 Insufficient Waste Deliveries

If waste flow during the 30-Day test period is not sufficient to keep both units operating at 100% design heat input, then one unit may be shut down to keep the test on the other unit proceeding. If the time period of low waste is more than several days, then the units can be alternated to demonstrate the reliability of each. The test would not be extended past the original 30 day period without consideration of schedule relief. The Residue Quantity Test should be able to proceed with one unit operating without alteration.

5.1.6 Data Transmittal

Copies of all data sheets recorded by Covanta during the test will be made available for review by the County and it's consultant within 12 hours of the end of each 24 hour period. A password -protected “Cloud” data storage and access area may be utilized. Covanta will make efforts to submit/post data earlier during days when either Energy or Metals Recovery Tests are not being performed.

5.2 30-Day Reliability Test

5.2.1 Demonstrated Design Steam Flow

Since the 30-Day Reliability Test will begin prior to the Energy Recovery Tests and Demonstrated Design Steam Flow (DDSF) is to be established during the Energy Recovery Tests, DDSF would not be available for use during the initial days of the Reliability Test. For the time period prior to establishing DDSF, the total boiler design steam flow of 67,300 kg/hr (148 klb/hr) will be used as DDSF until the Energy Recovery Tests are performed and DDSF is confirmed. Therefore, the 95% limit becomes 63,935 kg/hr (141 klb/hr) for the time period up to when the Energy Recovery Tests are completed.

It Covanta’s intent to keep both boilers at the same steam flow for this testing, but it should be recognized that DDSF is the combined steam flow from both boilers, so one boiler could theoretically operate at 80% of design MCR and the other at 110%, as long as the average/total steam flow averages 95% or above DDSF for the 30 days. It should be noted that steam flow for either boiler over 110% of the ***highest 4-hour block logged during any Energy Recovery Test*** is only counted as 110% per the Agreement.

5.3 30-Day Residue Quantity Test

5.3.1 Residue Quantity

For comparison to the Residue Quantity guarantee, the following materials must be collected and weighed on the Facility truck scales during the 30-day test period:

- ***Combined bottom ash*** – collected in Residue building bottom ash bays 2 and 3 consisting of bottom ash and grate siftings and added moisture along with undersized and unrecovered metals.
- ***Total APC & boiler flyash*** – collected in any of the flyash bays in the Residue building and includes all added reagents, i.e. carbon, lime, pozzolans and cement and added moisture.

The recovered grizzly and ferrous and non-ferrous metals are not included in the residue weights for comparison to the guarantees.

The bays used for collecting and storing test residue will be scraped clean with the front-end loader prior to storing test residue and will be scraped clean again at the end of the test.

5.3.2 Daily Determination of Residue Quantities

If practical, Residue quantities will be determined daily throughout the 30-Day test period. Possible means are by either segregating the residue streams in the ash bays, in containers or by weighing the material on the Facility truck scales and returning to the bays if it is unavoidable that the ash must be mixed back in with next day's ash. If daily is not practical, the least practical time period will be done.

5.4 Refuse Cranes

The weighing system of the refuse cranes will be used to provide Project throughput data for the 30 day period. The crane load cell system's accuracy and reliability will be demonstrated to the Owner prior to the start of testing. The crane weight cell measurements will be recorded automatically for each crane. The crane scale recording will include the date, time, refuse weight and the unit number into which the refuse was fed.

Crane weight cell calibration and throughput data adjustment will be performed as follows:

Frequency. Calibration (Span) checks will be performed immediately prior to the start of the test and recalibrated once each shift of the 30-Day Residue Quantity Test. A span check will be required even if a crane has not been used during an entire shift, i.e. the checks will be performed on both cranes whether they are being used to feed the hoppers or not.

Span. A reference calibration block or blocks weighed on the Owner's truck scales prior to the testing and witnessed by the Owner will be connected to the grapple. The reference weight(s) will be lifted three successive times and their readings noted on a data sheet.

Calibration. During the 30-Day Residue Quantity Test, recalibrations will be performed at any time the scale weight system exhibits outputs which deviates from the "true" calibration reference weight by 150 lbs. in two (2) consecutive daily checks (consisting of 3 lifts per check). This recalibration will be performed only if a re-tare does not eliminate the deviation between the system output and the true weight. Scale calibration procedures are included at the end of these procedures. The OE will be notified when a calibration is to be performed. The Owner's Engineer will be notified via email or text message prior to a re-calibration.

Data Calibration Correction. Throughput data for any twelve hour interval will be adjusted for crane calibration drift if the average of the span checks differs from previous span checks by more than 100 pounds between the indicated weights and reference weights. This average difference will be applied (added or subtracted) to all grapple lifts in this time period.

The above calibration procedure may be refined or altered based on manufacturers crane weight cell system configuration, recommendations and results of the calibrations performed during the commissioning of the system.

6 DATA ANALYSIS AND CALCULATIONS

6.1 30-Day Reliability Test

6.1.1 Demonstrated Design Steam Flow (DDSF)

Per the Project Agreement, the Facility must average at or above 95% of Demonstrated Design Steam Flow for the 30-Day test period. Demonstrated Design Steam Flow is defined in the Agreement as the steam flow achieved when burning the reference amount of 436 TePD (480 TPD) of MSW having a Reference Waste HHV of 13.0 MJ/kg (5,589 BTU/lb). DDSF has been agreed to be taken as the Martin guaranteed steam flow of 33,640 kg/hr per boiler or 67,280 kg/hr relating to 436 TePd (18,166 kg/hr or 9,083 kg/hr-boiler) and a 13,000 kJ/kg HHV.

MARTIN GmbH für Umwelt- und Energietechnik	Date : 12-21-2010	Name : Nachreiner	Sheet : No. : 1	Doc. - No. : 00-050962-Q1100 V3
Project : Durham Our No. : 050 962	(refractory in 1-st pass) 100 % heat input, load point LP1=NOM Very low NOx design, medium fouled boiler condition			
BOILER DESIGN DATA	Units of measurement			
	US- units	Metric- units	US- units	Metric- units
Refuse throughput per unit	%	%	100,00	100,00
Refuse quantity per unit	lb/h	kg/h	20.025	9.083
Lower calorific value of refuse (LHV)	BTU/lb	kJ/kg	5.000	11.630
Higher calorific value of refuse (HHV)	BTU/lb	kJ/kg	5.589	13.000
Design pressure (approx.)	psig	atü	1.529	107,5
Drum pressure (approx.)	psig	atü	1.380	97,0
Live steam pressure (approx.)	psig	atü	1.300	91,4
Live steam temperature	°F	°C	930	499
Saturated steam temperature	°F	°C	585	307
Feedwater temperature	°F	°C	275	135
Steam output, calcul.	lb/h	kg/h	75.618	34.300
, guarant.	lb/h	kg/h	74.163	33.640
Considered blow down	%	%	2,0	2,0
Gross heat release LHV	MBTU/hr	GJ/h	100,09	105,60
Gross heat release HHV	MBTU/hr	GJ/h	111,92	118,08
Heat input from preheated air	MBTU/hr	GJ/h	3,01	3,18
Total heat input LHV	MBTU/hr	GJ/h	103,10	108,78
Total heat input HHV	MBTU/hr	GJ/h	114,93	121,26

6.1.2 Actual Gross and Reference Steam Flow[SGD3]s – 4-Hour Blocks

During the 30-Day Reliability Test, actual steam flow for each 4-hour block will be calculated as totals of 4, 1-hour averages. The 1-hour averages will be based on 60, 1-minute data samples logged by the plant DCS for each of the boiler steam flows 1-FIR-5250 and 2-FIR-5250.

As shown above, it is recognized that the DDSF or Martin guaranteed steam flow relates to design conditions of main steam temperature and gauge pressure of 499°C and 91.4 atü (kg/cm^2), respectively, which equate to a main steam enthalpy of 3,384 kJ/kg, a feedwater temperature of 135°C which equates to an enthalpy of 574 kJ/kg and a preheated air heat credit of 3.18 GJ/hr. It has been further agreed that no corrections for heat credit will be made to the 4-hour steam flow blocks, but normalization to design steam enthalpy will be included and will be performed as follows:

$$W_{DDSF\ 4hr} = W_{Act\ 4hr} \times \frac{\Delta H_{4hr}}{2,810}$$

<u>_where_</u>: **_<u>All for individual boilers</u>_**

$W_{DDSF\ 4hr}$	=	Demonstrated Design Steam Flow 4-hour block (kg/hr)
$W_{Act\ 4hr}$	=	Average steam flow during 4-hr block (kg/hr)
_2,810_	=	Design main steam to feedwater enthalpy difference (kJ/kg)
	=	(3,384 – 574)
ΔH_{4hr}	=	Average enthalpy difference of main steam & feedwater, 4-hr block (kJ/kg)

The individual boiler steam flows will be used for comparison to the 110% per boiler limit, but will be added together for use in comparison to the 95% guarantee

A sample DDSF spreadsheet is included at the end of these procedures. The DDSF 4-hour block data will be entered into the Reliability Test tracking spreadsheet, a sample of which is also included at the end of these procedures.

6.1.3 Steam Flow from Auxiliary Fuel

Steam generated by auxiliary fuel at any time shall be excluded from steam production when calculating refuse HHV and 4-hour block averages.

The heat input from any auxiliary fuel firing for each occurrence will be established by multiplying the measured auxiliary fuel consumption by its estimated higher heating value. The boiler efficiency when firing auxiliary fuel will be assumed to be 85%. The heat inputs from auxiliary fuel firing for each respective occurrence multiplied by the boiler efficiency will yield the steam side heat gain in GJ (MMBtu). The steam side heat gain for each respective occurrence divided by the differential enthalpy demonstrated during the test will yield the steam quantities attributed to auxiliary fuel firing.

Each boiler has flow meters on the natural gas burners that will be calibrated prior to testing and are logged in the plant DCS, 1-FE-3601 & 2-FE-3601..

6.1.4 Steam Flow from Refuse

Steam generated from refuse in any 4-hour period will be determined by subtracting the klbs of steam generated from aux fuel from the gross steam logged by the DCS. The total steam flow from refuse for each 4-hour block is the sum of boilers 1 and 2.

6.1.5 4-Hour Maximum Limit of Refuse Steam Flow

Per the agreement, the 4-hour block of steam flow from refuse cannot count as greater than 110% of the highest 4-hour block measured during any of the 8-hour Energy Recovery Tests. If a 4-hour block of refuse steam flow for either boiler during the Reliability Test is greater than 110% of the highest 4-hour block from any of the Energy Recovery Tests, then 110% of the highest value from the Energy Recovery test will be substituted and used in the calculation of the 30-Day average.

In essence, use of the 4-hour blocks prevents intentional excessive over-firing, while still allowing brief unintentional spikes above 110%, as long as any excursion does not result in a 4-hour block above the excursion limit which could be inferred as intentional and excessive.

6.1.6 Steam Flow Adjusted for Downtime

Steam generated from refuse in any 4-hour period will be determined by excluding shutdown time. For example if 1 hour of shut-down time for one unit is declared in a four-hour block, the steam generated in the other 3 hours for that unit will be added to the steam generated in 4 hours for the other unit and the operating hours for that 4-hour block is reduced to 3.5. Since there are 720 hours in 30 days and any downtime in excess of 72 hours is not allowable, the 30-day denominator cannot be less than 684, i.e. (720+720-72)/2.

6.1.7 Comparison to 95% Minimum Required DDSF

The 4-hour block totals of steam generated from refuse would then all be summed to obtain the 30-Day net steam total. This 30-Day total would then be divided by the total number of Facility operating hours which accounts for downtime. Note that Facility operating hours are the sum of the two unit's operating hours divided by 2. This average steam rate in klbs per hour when divided by the Demonstrated Design Steam flow must be above the required minimum of 95%.

The Facility will have passed the 30-Day Reliability Test contingent upon the successful passage of the Throughput Capacity, Energy Recovery, Residue Tests (Quality and Quantity) and Metals Recovery.

6.2 Residue Quantity

6.2.1 8-Hour HHV Calculations and 30-Day Refuse HHV

Boiler calorimetry test sample calculations are shown in the energy test calculations (sub-pages 1-10). The calculations illustrate the procedure that will be employed in determining the refuse higher heating value during the 3-5, 8-hour periods of the 5-Day Throughput Capacity Test. These 3-5, 8-hour HHV's will be used to validate a correlation between fuel heating value and specific steam production. The method and calculations for determining the daily and 30-day HHV is the same as the 5-Day Throughput Capacity Test shown in those test procedures. The specific steam output ratio will be based on boiler feedwater flows using boiler steam flows to estimate boiler blowdown. Alternatively, blowdown valve turns could be used. Permanent plant instrumentation will be utilized to measure the feedwater and steam flows.

Auxiliary Fuel and Downtime Adjustments

No adjustments are required to be made to residue quantity for aux fuel use or downtime, since no Residue would be generated from aux fuel and no Residue would be generated during downtime. Steam flow from refuse, which accounts for aux fuel use, is used when comparing to the 95% of Demonstrated Design Steam Flow minimum limit.

6.2.2 Residue Percentage and Guarantee vs HHV

The amount of Residue generated will vary with the amount of ash in the MSW, so the Residue Quantity Guarantee must take into account the HHV of the MSW. Table A10-2 achieves this correction by showing the Guaranteed % Ash Quantity as a function of Waste HHV.

The above bottom ash and flyash streams will be summed over the 30–day period and that total will be divided by the total tonnes of Waste processed during the same 30 days to determine the percentage of Residue generated-to-Waste processed. The average HHV as determined for the 30 days using the HHV correlation will be used to select the appropriate guarantee from the Agreement Table A10-2 according to the below linear regression equation of Table A10-2:

$$Guaranteed\ Ash\ Quantity(\%) = -1.75 \times \frac{HHV(MJ/kg)}{1000} + 52.73$$

If the calculated percentage of Residue to the as-fired waste during the test is less than or equal to the guarantee value, then the Facility will have passed the 30-Day portion of the Residue Quantity Test.

Table A10-2: Residue Guarantee Adjustment

Waste HHV	Ash Quantity
11.0 MJ/kg	33.5%
12.0 MJ/kg	31.7%
13.0 MJ/kg	30.0%
14.0 MJ/kg	28.2%
15.0 MJ/kg	26.5%

From Appendix 10 of the Project Agreement

7 MANPOWER

7.1 Staffing

The 30-Day Reliability Test and Residue Quantity Test will be conducted by Covanta Durham-York, Inc. with the Owner and the Owner's Engineer witnessing the testing.

7.2 General

Facility personnel will be utilized to staff and perform the various test duties during the test period. Test data sheets will be made available for review by the Owner and Owner's Engineer during and after the test. Temporary labor will be obtained to supplement the plant staff for data collection and processing.

8 REFERENCES

The Acceptance Test Procedures and Sample Calculations are based on the following:

8.1.1 Project Agreement

Project Agreement between, "The Regional Municipality of Durham" and "The Regional Municipality of York" as "Owner" and "Covanta Durham York Renewable Energy Ltd." as "DBO Contractor".

8.1.2 ASME PTC 34 2007 "Waste Combustors with Energy Recovery"

8.1.3 ASME PTC 4-1998 "Fired Steam Generators"

SAMPLE CALC

	Actual Steam Flow		Steam temp		Steam Press		Steam Enthalpy		FW temp		FW Press		FW Enthalpy		MS-FW Enthalpy		Steam Output		Ref Steam Flow	
Reference Values					91.4 atü or kg/cm^2						97.6 atü or kg/cm^2									
			499.0		89.6 bar-g		3384.0		135.0		95.7		574.0		2810.0				133.84	
4-hr block	U1	U2	U1	U2	U1	U2	U1	U2	U1	U2	U1	U2	U1	U2	U1	U2	U1	U2	U1	U2
	Mg	Mg	°C	°C	bar-g	bar-g	kJ/kg	kJ/kg	°C	°C	bar-g	bar-g	kJ/kg	kJ/kg	kJ/kg	kJ/kg	GJ	GJ	Mg	Mg
1	133.24	131.90	490.0	502.0	89.7	90.0	3361.1	3391.1	135.0	134.0	100.0	101.0	574.3	570.1	2786.8	2821.0	371.31	372.09	132.14	132.42
2	150.95	131.96	490.0	502.0	89.7	91.0	3361.1	3389.9	135.0	134.0	100.0	101.0	574.3	570.1	2786.8	2819.8	420.67	372.10	149.70	132.42

132.54 Mg, ER highest 4-hour block
145.80 Mg, 110% of highest 4-hr block

As-tested result ---> 96.5% **30-Day Capacity** 64.96

67.280 <--- Mg/h DDSF
63.916 95.0% <--- Minimum limit

SAMPLE CALC

* - max is 110% of highest ER 4-hr block.

95.0% **30-Day Availability**

	DDSF Steam		Aux Burner Steam		Refuse Steam		Ltd. Refuse Stm. *		Tot Mg Ref Stm	Downtime		Operating		Total Net Op Hours
Totals			597.32	34.02					**44431.51**	24.0	48.0	696	672	**684.0**
									Total	Downtime		Operating		Net Op
4-hr block	U1	U2	U1	U2	U1	U2	U1	U2	Facility	U1	U2	U1	U2	Facility
	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg	unit-hours		unit-hours		Fac-hours
1	132.14	132.42	0	0	132.14	132.42	132.14	132.42	264.56	0	0	4	4	4
2	149.70	132.42	0	0	149.70	132.42	**145.80**	132.42	278.22	0	0	4	4	4
3	158.76	132.54	0	0	158.76	132.54	**145.80**	132.54	278.34	0	0	4	4	4
4	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
5	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
6	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
7	**145.00**	0	0	0	**145.00**	0.00	**145.00**	0.00	145.00	0	4	4	0	2
8	132.54	0	0	0	132.54	0.00	132.54	0.00	132.54	0	4	4	0	2
9	132.54	0	0	0	132.54	0.00	132.54	0.00	132.54	0	4	4	0	2
10	132.54	0	0	0	132.54	0.00	132.54	0.00	132.54	0	4	4	0	2
11	132.54	0	0	0	132.54	0.00	132.54	0.00	132.54	0	4	4	0	2
12	132.54	0	0	0	132.54	0.00	132.54	0.00	132.54	0	4	4	0	2
13	132.54	0	0	0	132.54	0.00	132.54	0.00	132.54	0	4	4	0	2
14	132.54	0	0	0	132.54	0.00	132.54	0.00	132.54	0	4	4	0	2
15	132.54	0	0	0	132.54	0.00	132.54	0.00	132.54	0	4	4	0	2
16	132.54	0	0	0	132.54	0.00	132.54	0.00	132.54	0	4	4	0	2
17	132.54	0	0	0	132.54	0.00	132.54	0.00	132.54	0	4	4	0	2
18	132.54	0	0	0	132.54	0.00	132.54	0.00	132.54	0	4	4	0	2
19	154.22	158.76	0	0	154.22	158.76	**145.80**	**145.80**	291.59	0	0	4	4	4
20	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
21	132.54	132.54	34.02	34.02	98.52	98.52	98.52	98.52	197.04	0	0	4	4	4
22	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
23	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
24	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
25	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
26	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
27	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
28	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
29	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
30	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
31	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
32	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
33	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
34	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
35	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
36	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
37	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
38	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
39	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
40	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
41	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
42	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
43	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
44	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
45	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
46	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
47	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
48	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
49	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
50	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
51	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
52	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
53	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
54	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
55	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
56	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
57	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
58	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
59	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4

60	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
61	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
62	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
63	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
64	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
65	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
66	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
67	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
68	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
69	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
70	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
71	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
72	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
73	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
74	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
75	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
76	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
77	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
78	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
79	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
80	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
81	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
82	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
83	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
84	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
85	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
86	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
87	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
88	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
89	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
90	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
91	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
92	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
93	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
94	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
95	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
96	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
97	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
98	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
99	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
100	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
101	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
102	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
103	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
104	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
105	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
106	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
107	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
108	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
109	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
110	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
111	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
112	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
113	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
114	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
115	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
116	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
117	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
118	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
119	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
120	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
121	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
122	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
123	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
124	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
125	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
126	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
127	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
128	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4

129	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
130	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
131	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
132	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
133	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
134	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
135	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
136	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
137	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
138	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
139	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
140	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
141	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
142	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
143	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
144	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
145	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
146	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
147	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
148	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
149	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
150	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
151	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
152	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
153	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
154	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
155	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
156	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
157	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
158	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
159	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
160	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
161	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
162	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
163	132.54	132.54	0	0	132.54	132.54	132.54	132.54	265.08	0	0	4	4	4
164	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	0	0	4	4	4
165	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	0	0	4	4	4
166	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	0	0	4	4	4
167	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	0	0	4	4	4
168	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	0	0	4	4	4
169	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	0	0	4	4	4
170	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	0	0	4	4	4
171	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	0	0	4	4	4
172	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	0	0	4	4	4
173	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	0	0	4	4	4
174	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	0	0	4	4	4
175	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	4	0	0	4	2
176	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	4	0	0	4	2
177	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	4	0	0	4	2
178	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	4	0	0	4	2
179	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	4	0	0	4	2
180	66.27	132.54	33.14	0	33.14	132.54	33.14	132.54	165.68	4	0	0	4	2

Durham/York Energy from Waste Project

Acceptance Test Procedures

5-Day

Throughput Capacity Test

Residue Quality Test

Residue QuantityTest

COVANTA ENERGY

June, 2014

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1 OBJECTIVE

1.1 Throughput Capacity Test

The objective of the Throughput Capacity Test is to demonstrate that the Facility can meet the Throughput Capacity Guarantee during a consecutive, five (5) day, (120-hour) test period. The Facility must process 2,180 tonnes of Acceptable Waste at the Reference Waste HHV of 13 MJ/kg (5,589 BTU/lb) HHV or an equivalent, as shown in item 2 of Exhibit 2 to Appendix 19 of the Agreement and below, in tonnes per day versus HHV. Over the course of the five (5) day test, each unit must itself process at least 1,000 tonnes of Reference Waste or an equivalent. The Facility will not have passed the Throughput Capacity Test even if the required tonnes of Waste are processed if the Residue Quality Test is not passed. If the waste HHV is below 11 MJ/kg, it is considered out of the facility acceptable range and the test will then be repeated at the Owner's expense.

2.	**Throughput Capacity Guarantee (140,000 tonnes per year)**	
	HHV	Tonnes per day
	11.0 MJ/kg	**515**
	12.0 MJ/kg	**472**
	13.0 MJ/kg *	**436**
	14.0 MJ/kg	**405**
	15.0 MJ/kg	**378**
	* = Design waste HHV	

Item 2 of Exhibit 2, Appendix 19 of the Project Agreement

1.2 Residue Quality Test

The objective of the Residue Quality Test is to demonstrate that the Facility shall produce Residue (consisting of bottom ash and grate siftings only) containing not more than three percent (3%) unburned carbon by dry weight and twenty-five (25) percent moisture by weight after the combustion of Acceptable Waste. The average results during the five (5) day Throughput Capacity Test will be compared to the guarantee. Additionally, Residue Quality will also be sampled more frequently during the 8-hour Energy Recovery tests and those average results will also be compared to the guarantees.

1.10.1 1.9.1 Residue Quality Test

The Residue (e.g. bottom ash and grate siftings only) moisture content and percent combustible matter shall be determined during the Residue Quality Test. The Residue Quality Test will be performed during the five (5) day Throughput Capacity Test and on more frequent intervals during the Energy Recovery Tests. The purpose of this test is to ensure the quality of

Excerpt from page 9 of Appendix 10 of the Project Agreement

1.3 Residue Quantity Test

The objective of the Residue Quantity Test is to demonstrate that the Facility meets the Performance Guarantee for the generation of total Residue (including bottom ash, grate siftings, boiler and air pollution control flyash) as a percentage of waste combusted.

Bottom Ash" means the solid residue left after the incineration burning process, except Fly Ash, grate siftings, and APC Plant waste.

"Residue" means Bottom Ash, Fly Ash, grate siftings, APC Plant waste and other material that remains after combustion of waste and recovery of metals in the Facility.

Definitions of Bottom Ash & Residue from Project Agreement

Residue will be weighed with truck scales over the 30-Day Reliability Test and 5-Day Throughput Capacity Test for comparison to the guarantees. The percent guarantees vary with Waste HHV per item 4, Exhibit 2, Appendix 19 of the Agreement shown below and exclude recovered ferrous and non-ferrous metals as shown in the above definition of Residue.

4.	**Residue Quality and Quantity Guarantee:** The Average monthly quality and quantity of Residue (to include bottom ash, fly ash, siftings, scrubber residue and all other process residue) from combustion of processible waste:		
	Unburned Combustible Matter (% dry weight – not exceed 3.0%)	3%	
	Total Residue (bottom and fly ash) excluding ferrous and other materials (tonne of residue/tonne of processible waste – not to exceed 30%@ 13.0 MJ/kg)	**Waste HHV**	**Ash Quantity**
		11.0 MJ/kg	33.5%
		12.0 MJ/kg	31.7%
		13.0 MJ/kg	30.0%
		14.0 MJ/kg	28.2%
		15.0 MJ/kg	26.5%
	Percent Moisture in Bottom Ash Residue (tonne of residue/tonne of processible waste – not to exceed 25%)	25%	

Residue Quantity Guarantee vs Waste HHV from Project Agreement

2 CONCURRENT TESTS

Tests will be performed to determine the higher heating value (HHV) of the Waste during the five-day Throughput Capacity Test. A minimum of three, 8-hour refuse HHV tests using the boiler as a calorimeter will be performed but it is anticipated that 5, 8-hour tests can be completed. Each of the 8-hour HHV tests will be performed as part of the Energy Recovery Tests. As shown in the test schedule and listed below, the five day Throughput Capacity Test will be performed during the 30-Day Reliability and Residue Quantity Test Period with the following tests performed concurrently during the 5-Day period..

- A 5-day Residue Quality Test
- A 5-day Residue Quantity Test

- 3-5, 8-hour Energy Recovery & Residue Quality Tests
- Environmental Air Emissions Tests (can be performed anytime during the 30 days)

Three, 8-hour Metals Recovery Tests may or may not be performed during the 5-Day period, but must be performed during the 30-day period.

3 TEST PREREQUISITES

Prior to the commencement of testing, Covanta Durham-York, (Covanta) will provide the Owner with the refuse tonnage requirements necessary for the Throughput Capacity Test, factoring in preliminary indications of refuse HHV and pit level.

Refer to the Energy Recovery Test Procedures for other general test prerequisites.

4 TEST INSTRUMENTATION & DATA

During the capacity test period, process data points will be measured by the permanent plant Distributed Control System (DCS). The data will be used to document normal operating conditions throughout the five (5) day test period. During the concurrent boiler calorimetry tests, process data will also be obtained by the DCS in conjunction with the manual data collection necessary for HHV calculation purposes. In general, the boiler calorimetry test data will be obtained as outlined for an Energy Recovery Test procedures. The list of data points that will be logged for the Throughput Capacity Test at 1 minute intervals is included in Table 1A of the Energy Recovery Test Procedures. Averages, maximums and minimums and graphs of key parameters will be made available along with the data files on electronic media. The data files will be in Excel format. Data from the previous day will be forwarded to the Owner's Engineer by noon of the following day.

5 TEST PROCEDURES

5.1 General

The Project will be operated in a manner consistent with expected day-to-day long-term operation, with all equipment and accessories performing in their expected day-to-day long-term mode.

5.1.1 Refuse Cranes

The weighing system of the refuse cranes will be used to provide Project throughput data for the five day period. The crane load cell system's accuracy and reliability will be demonstrated to the Owner prior to the start of testing. The crane weight cell measurements will be recorded automatically for each crane in the crane pulpits. The crane scale recording will include the date, time, feed weight and the unit number into which the refuse was fed.

Crane weight cell calibration and throughput data adjustment will be performed as follows. Refer to detailed procedure listing at the end of these procedures.

> Frequency. Calibration (Span) checks will be performed immediately prior to the start of the test and recalibrated once each 12- hour shift of the Throughput Capacity Test. A span check will be required even if a crane has not been used during an entire shift. The checks will be performed on both cranes even if the crane is not being used to feed the hoppers.
>
> Span. A Reference calibration block or blocks weighed on the Owner's truck scales prior to the

testing and witnessed by the Owner will be connected to the grapple. The reference weight(s) will be lifted three successive times and their readings noted on a data sheet, (sample included at end of these procedures).

Calibration. During the Capacity Test, recalibrations will be performed at any time the scale weight system exhibits two consecutive outputs where both deviate from the "true" calibration reference weight by 68 kg (150 lb). This recalibration will be performed only if a re-zero does not eliminate the deviation between the system output and the true weight. Scale calibration procedures are included at the end of these procedures. Tare checks will be performed as required during the test period.

Data Calibration Correction. Throughput data for any twelve hour interval will be adjusted for crane calibration drift if the average of the span checks differs from previous span checks by more than 45.4 kg (100) pounds between the indicated weights and reference weights. This average difference will be applied (added or subtracted) to all grapple lifts in this time period. See sample calculation spreadsheet at the end of these procedures.

The above calibration procedure may be refined or altered based on manufacturers crane weight cell system configuration, recommendations and results of the calibrations performed during the commissioning of the system.

5.1.2 Downtime

Covanta proposes that shutdown time which can be demonstrated by Covanta, to the reasonable satisfaction of the Owner, to be solely caused by the uncontrollable processing of Unacceptable Waste shall be added to the end of the test, thereby extending the test. The amount of such time shall be limited to 5% (6 hours) at the Owner's reasonable discretion.

The Owner or their representative will be notified prior to making a request to declare downtime.

5.1.3 Auxiliary Fuel

Although not contemplated, auxiliary fuel may have to be utilized to maintain environmental permit conditions, due to low HHV fuel or a partial pluggage of fuel feed, for example. If auxiliary fuel is utilized during the testing, any effect on steam production will be accounted for. Steam generated by auxiliary fuel during downtime shall be excluded from daily steam production totals when calculating refuse HHV. If significant quantities of auxiliary fuel are used, then the aux fuel HHV will be obtained from shipment tickets or utility records. The use of auxiliary fuel during a boiler calorimetry test will cause that test to be invalidated unless such usage occurs in the last hour of the test. If so, and operation has been steady, both parties may agree to use the data for a 7-hour period.

5.1.4 Data Transmittal

Copies of all data sheets recorded by Covanta during the test will be made available for review by the Owner and the Owner's Engineer within 12 hours of the end of each 24 hour period. A password - protected "Cloud" data storage and access area may be utilized. Covanta will make efforts to submit/post data earlier during days when either Energy or Metals Recovery Tests are not being performed.

5.2 Throughput Capacity Test

5.2.1 Test Period/Guarantee

The Throughput Capacity Test will be conducted over a 5-Day -- 120 consecutive hour -- test period during the 30-Day Reliability test period, where the Facility must process 2,180 tonnes of Reference Waste or the equivalent, with each unit processing no less than 1,000 tonnes of Reference Waste.

5.2.2 Adjustment for HHV

For the Throughput Capacity Test period, the higher heating value (HHV) of the Waste processed is expected to be different than the Reference value of 13,000 kJ/kg (5,589 BTU/lb). An adjustment to throughput for waste HHV is taken care of by the following table of HHV versus guaranteed throughput from the Agreement;

2.	**Throughput Capacity Guarantee (140,000 tonnes per year)**	
	HHV	Tonnes per day
	11.0 MJ/kg	515
	12.0 MJ/kg	472
	13.0 MJ/kg *	436
	14.0 MJ/kg	405
	15.0 MJ/kg	378
	* = Design waste HHV	

Guarantee Throughput Capacity from Exhibit 2 to Appendix 19

Therefore, the actual throughput for the five days is compared to the table value at the average actual HHV for the 5 days.

5.2.3 Low Waste HHV

Per the Agreement, if waste HHV drops below 11,000 kJ/kg (4,729 BTU/lb), it is considered out of the facility acceptable range and the test will be repeated at the Owner's expense. Covanta proposes that if the Throughput Capacity and Residue Quality & Quantities Guarantees can still be met, that the test continue and include any days where the HHV drops below 11,000 kJ/kg. The limit could be applied to time periods as short as 8 hours as long as Covanta can demonstrate that reasonable steps were taken to mix the waste in the pit prior to feeding and that the low HHV waste is causing negative operation impacts, e.g. low steam flow, long feeder stroke lengths, long run times, maximum air pre-heating.

5.2.4 Residue Quality

The Facility will not be deemed to pass the Throughput Capacity Test if it fails the Residue Quality Test even if it has processed more than the required 2,180 tonnes of Reference Waste.

5.3 Residue Quality Test

5.3.1 General

The Residue Quality Test will be conducted over the 5-day Throughput Capacity Test. The sampling location and general sampling procedure will be identical to the procedures mutually agreed upon for the Energy Recovery Test with the exception that 45.4 kg (100 lb) samples will be obtained at 2-hour intervals (refer to the sample data sheet at the end of these procedures and also Energy Test Section 5.9). The samples collected throughout each 24 hour period shall be thoroughly mixed and randomly reduced into daily samples using the 5-Day general sampling procedure depicted at the end of this test plan.

5.3.2 Sampling Location

The samples for the Residue Quality Tests will be obtained as the material falls off of vibrating conveyor AH-CV-011 and onto the Eddy Current Separator (ECS) screen. Since this location is downstream of grizzly and ferrous recovery, corrections must be made for the removal of those materials.

5.3.3 Exclusion of Bulky Non-Combustibles

With mutual agreement of Owner's Engineer and Covanta, it shall be permissible to exclude from the representative sample of Residue those items which because of their substantial bulk or general nature can be considered relatively noncombustible, such as waste bundled by metal or otherwise noncombustible straps or ties (for example, baled newspapers), canned goods in unopened noncombustible containers whose contents have not been exposed to the flame and the like. Any materials excluded from the Residue Quality Test will still be counted in the Residue Quantity Test.

5.3.4 Sample Processing

Each sample will be screened to determine the percentage of plus 50 mm (2 inch) material and minus 50 mm (2 inch) material. The plus 50 mm (2 inch) material will be hand sifted and sorted to extract material that consists of unburned combustible material. The unburned combustible material (if any) will be included with the minus 50 mm (2 inch) material. A portable scale will be utilized for weighing. The minus 50 mm sample shall be deposited in a leak tight container to eliminate any potential moisture loss.

5.3.5 Duplicate Samples

One duplicate sample shall be held by Covanta D-Y, one retained by the Owner, and one test sample forwarded to the independent laboratory. The Owner's Engineer will be notified when sample compositing is done in order to have the opportunity to witness the procedure. Preliminary results are expected to be obtained 3 to 5 days after the sample is received by the lab.

5.3.6 Lab Analysis Methods

The determination of residue total moisture will be conducted in accordance with ASTM D-3302. It is felt that a more representative and accurate moisture determination can be made using ASTM Method D-3302. The moisture determination in accordance with ASTM Method D-3302 is based on air drying the entire sample (approximately 4,000 - 5,000 g) and therefore is considered as the more appropriate method The Residue unburned combustible determination will be performed in accordance with ASTM D 5468 – 02 (Reapproved 2007) "Standard Test Method for Gross Calorific and Ash Value of Waste Materials", utilizing the adiabatic bomb calorimeter and assuming a HHV of 27.91 MJ/kg (12,000 Btu/lb) to convert to a percentage basis as recommended in PTC 34..

5.4 Residue Quantity Test

For comparison to the Residue Quantity guarantee, the following materials must be collected and weighed during the 5-day test period:

- ***Combined bottom ash*** – collected in Residue building bottom ash bays 2 and 3 consisting of bottom ash and grate siftings and added moisture along with undersized and unrecovered metals.
- ***Total APC & boiler flyash*** – collected in any of the flyash bays in the Residue building and includes all added reagents, i.e. carbon, lime, pozzolans and cement and added moisture.

The recovered grizzly and ferrous and non-ferrous metals are not included in the residue weights for comparison to the guarantees. The bays used for collecting and storing test residue will be scraped clean with the front-end loader prior to storing test residue and will be scraped clean again at the end of the test.

6 DATA ANALYSIS AND CALCULATIONS

6.1 Throughput Performance Test

6.1.1 Throughput Guarantees Adjusted for HHV

The guarantee table from Exhibit 2 to Appendix 19 of the Agreement accounts for the HHV variation by listing the guaranteed throughput versus the corresponding Waste HHV. Therefore, actual throughput is compared to the guaranteed value corresponding to the average HHV of waste measured over the 5 days. If the HHV lies between two points of the table, a linear interpolation will be performed to determine the waste throughput.

6.1.2 Refuse Higher Heating Value (HHV-BTU/lb)

Refuse higher heating value (MJ/kg) will be determined during each of the 8-hour Energy Recovery Tests from boiler calorimetry tests performed in accordance with ASME PTC-34. These HHV results will be used to validate a correlation between refuse higher heating value (MJ/kg-fuel) and specific steam production (also in MJ/kg-fuel). The specific steam production correlation can then be used to determine the average refuse HHV of that processed throughout the overall five (5) day, 120 hour period.

6.1.3 Number of HHV Tests

A minimum of three (3) refuse HHV determinations will be made. Each boiler calorimetry test will be a minimum of eight hour duration. Each boiler will be tested individually as much as practical in order to develop 6 data points to be used in the specific steam ratio correlation.

6.1.4 PTC 34 HHV Boiler Calorimetry Calculations

Boiler calorimetry test calculations will be identical to the HHV determination portion of the energy test calculations (sub-pages 1-11). The calculations are in accordance with ASME PTC 34 and illustrate the procedure that will be employed in determining the refuse higher heating value over the 8-hour periods. Refer to the Energy Recovery test procedures for further explanation. The method and calculations for determining the 5-day average HHV by using the specific steam output correlation concept are shown after those procedures and described as follows.

6.1.5 Development of Site-specific Steam Correlation

A theoretical correlation between HHV or fuel heat input and steam output, both on a MJ/kg-fuel basis, can be developed using design boiler operating parameters, a combination of design and typical waste ultimate analyses and classical, ASME PTC 4 boiler efficiency calculations.

6.1.5.1 Waste Ultimate Analyses

The waste ultimate analyses are taken from the Durham – York Martin stoker data load points 1, 2/3, 7, 8 & 9 with HHV's of 5589, 6449, 4052, 4500 & 5089, respectively. These HHV's are supplemented by typical ultimate analyses for 4000, 4500, 5000, 5500, 6000 & 6500 BTU/lb. Refer to ***Table A*** & the below excerpt from Table A.

Ultimate Analysis % BY WGT	Heat of		7		8		9		D-Y		2	
HHV (BTU/lb-fuel)	Combustion	4000	4051.65	4500	4500.06	5000	5080.89	5500	5589	6000	6448.92	6500
Carbon	14976	22.92	22.927	25.74	25.505	28.51	28.774	31.130	31.729	33.770	36.508	36.25
Hydrogen	49527	3.24	3.295	3.64	3.665	4.04	4.135	4.430	4.560	4.810	5.246	5.18
Nitrogen	2700	0.48	0.628	0.58	0.699	0.67	0.789	0.870	0.870	1.060	1.001	1.25
Oxygen	-4644	23.70	22.653	26.43	25.200	28.99	28.430	30.960	31.350	32.780	36.072	34.05
Sulfur	4500	0.02	0.029	0.02	0.032	0.03	0.036	0.040	0.040	0.050	0.046	0.06
Total Inert	0	22.44	23.700	21.19	21.400	20.26	18.500	16.570	15.920	14.530	11.700	12.21
Moisture	0	27.20	26.500	22.40	23.200	17.50	19.000	16.000	15.160	13.000	9.000	11.00

Table A Excerpt

6.1.5.2 Combustion Calculations

Classic combustion calculations are used to calculate excess air and air & gas weights using Durham-York design data for O_2 along with an assumed 1% unburned carbon in the ash. See ***Table A*** & the below excerpt from Table A.

Dry O2 (%)		7.448	7.448	7.448	7.448	7.448	7.448	7.448	7.448	7.448	7.448	7.448
Excess Air		55.1	54.8	55.0	54.8	55.0	54.8	54.9	54.8	54.8	54.8	54.7
		lb/100 lb-fuel										
Dry Air Req'd = (0% Xs) x 28.967 x 4.77 x Mols O2 from Air		269.89	276.27	304.40	307.89	339.07	348.01	374.54	384.28	410.35	442.89	446.39
Dry Air Req'd = (1 + Xs) x 28.967 x 4.77 x Mols O2 from Air		418.53	427.78	471.97	476.75	525.57	538.87	580.23	595.03	635.37	685.80	690.63
Moist from Air = Line 55 x Specific Humidity	*0.0131*	5.48	5.60	6.18	6.25	6.89	7.06	7.60	7.79	8.32	8.98	9.05
Wet Gas Weight = Line 55 + Line 56 + (100-Ash)		501.35	509.45	556.75	561.38	612.00	627.25	671.09	686.75	729.02	782.96	787.35
Dry Gas Weight = Line 57 - Line 56 - 18 x (mols H2O)		439.76	447.95	495.69	499.23	551.56	564.29	607.95	623.09	664.76	718.15	721.06

Table A Excerpt

6.1.5.3 Boiler Heat Losses, Credits, Efficiency & Output

Using the air & gas weights along with design values of operating parameters for flue gas and air shown in ***Table B*** and a summary of Table B below,

D-Y Base Conditions:

Steam Produced - pph	75,618
Waste Combusted - TPD	240.3
Waste Combusted - lb/hr	20,025
Final Steam Temp - °F	930.0
Final Steam Press - psia	1314.7
Boiler FW Temp - °F	275.0
Boiler FW Press - psia	1464.7
EEGT (F)	330.0
Ambient Air Temp - °F	80.0
Preheated Air Temp - °F	200.0
Excess Air - %	54.8
% Heated Air	87.2%
Wgt Inlet air Temp F	184.6
Blowdown - pph	1,543
Drum Press - psia	1394.7
FW Flow - pph	77,161

Boiler heat losses, credits, output and efficiency are calculated in accordance with ASME PTC 4. Refer to ***Table A*** & the below excerpt from Table A.

Losses (BTU/lb)		1,009.2	1,013.1	1,040.1	1,054.3	1,069.8	1,106.8	1,138.3	1,153.4	1,188.7	1,229.9	1,249.3
Dry Gas		266.52	271.59	300.43	302.68	334.31	342.12	368.56	377.78	403.06	435.41	437.29
Moisture from H2O/H2 in Fuel		653.26	650.84	639.01	650.91	623.59	650.92	646.68	650.43	651.29	650.08	666.49
Moisture from Air		6.27	6.41	7.07	7.14	7.87	8.07	8.69	8.91	9.51	10.27	10.34
Fixed losses	2.08%	*83.2*	*84.3*	*93.6*	*93.6*	*104.0*	*105.7*	*114.4*	*116.3*	*124.8*	*134.1*	*135.2*
Unb Comb	2.08	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Radiation												
Unaccounted												
Misc-ash quench vapor												
SNCR water												
Credits (BTU/lb) Ref. 77°F		110.95	113.41	125.12	126.39	139.33	142.86	153.82	157.75	168.44	181.81	183.09
Dry comb air sens heat		108.32	110.71	122.15	123.38	136.02	139.46	150.16	153.99	164.43	177.48	178.74
Moist in comb air		2.64	2.70	2.98	3.01	3.31	3.40	3.66	3.75	4.01	4.32	4.36
Gross Efficiency (%)		*75.45%*	*75.68%*	*77.51%*	*77.21%*	*79.18%*	*78.81%*	*79.87%*	*79.93%*	*80.73%*	*81.45%*	*81.31%*
Output (BTU/lb-fuel)		*3,101.7*	*3,151.9*	*3,585.0*	*3,572.1*	*4,069.6*	*4,117.0*	*4,515.5*	*4,593.4*	*4,979.8*	*5,400.8*	*5,433.8*

Table A Excerpt

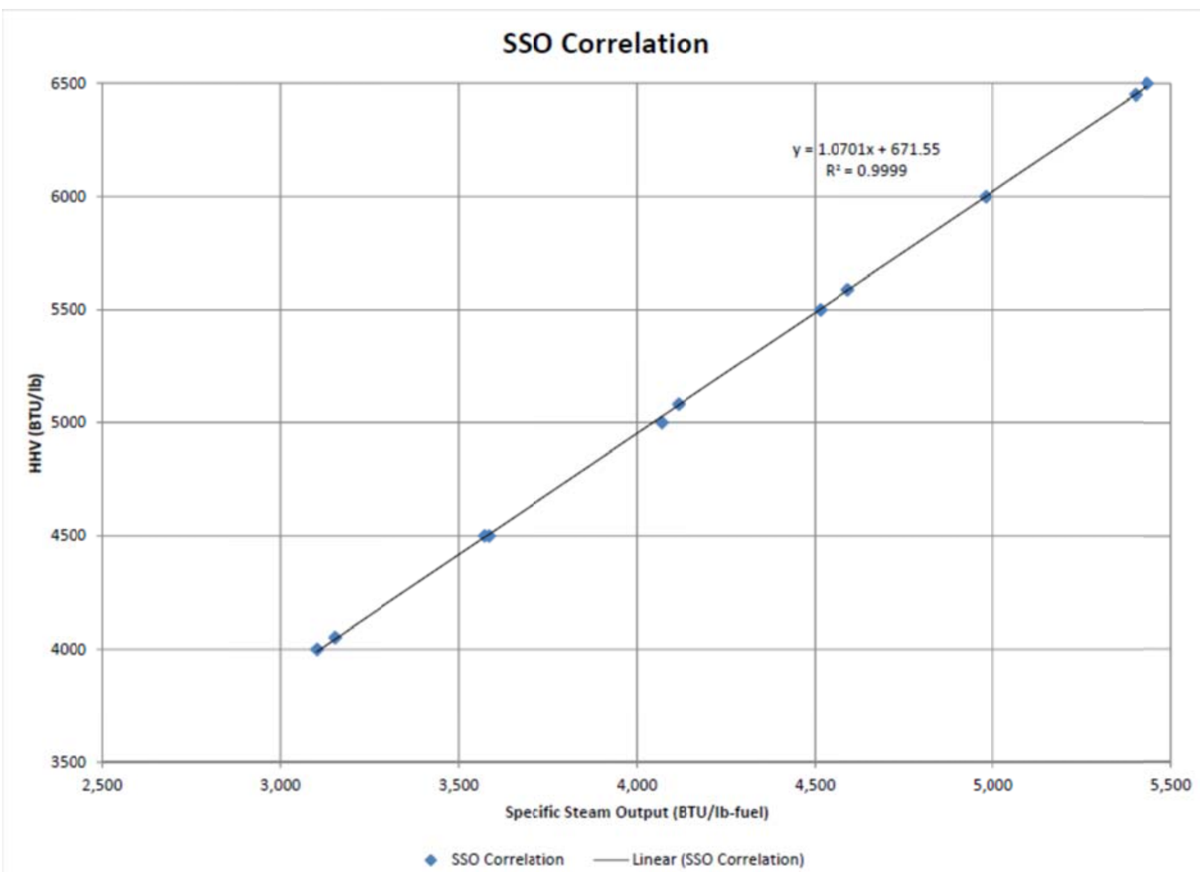
$$Output + Losses = HHV + Credits \rightarrow Output = HHV + Credits - Losses$$

$$Boiler\ Efficiency\ (\%) = \frac{Output}{(HHV + Credits)}$$

Note that a value for fixed losses of ~2% is assumed which reconciles the efficiency calculations with design results. This value may be adjusted based on actual test results. The fixed losses include unburned carbon, radiation, miscellaneous, unaccounted and SNCR water while the adjustment would also account for varying ratios of moisture and inerts in the waste which would not affect HHV.

6.1.5.4 Specific Steam Output Correlation

A correlation is then developed from fuel heat input (HHV – in MJ/kg-fuel) versus specific steam output (SSO - also in MJ/kg-fuel). This linear correlation is shown as Figure A having an equation 1.07 x SSO + 672, and an r^2 correlation coefficient of an almost perfect 0.9999.



6.1.5.5 Development of Adjustment Factors

This correlation is referenced to the site-specific design operating parameters of economizer exit gas temperature, (EEGT) ambient air temperature, heated or underfire air (UFA) temperature and excess air, which will differ in actual operation. Therefore, the actual calculated specific steam output must be adjusted to these design parameters before using the correlation. The adjustment factors are calculated by varying the parameter by 10° (or 10% in the case of excess air), performing similar PTC 4 efficiency calculations again and developing the percent change in SSO per change in parameter. See ***Table C*** for the calculations of the following summarized adjustment factors:

Parameter	Adjustment	Basis
EEGT	+0.40	% SSO/10 deg F
Ambient Air Temperature	-0.28	% SSO/10 deg F
Heated/UFA air temperature	-0.32	% SSO/10 deg F
Excess Air	+0.52	% SSO/10% excess air

.

6.1.5.6 Measured Specific Steam Output Ratio

The specific steam output ratio as defined as the heat in the steam (MJ) divided by the kg of fuel will be based on boiler feedwater flow minus boiler blowdown flow. Blowdown flows will be isolated during the 8-hour tests. When blowdown is opened during the remainder of the 5-day period, since it is very small, (≤0.5% of boiler heat output), its amount will be estimated and added into the specific steam heat output. Steam flow indications and/or blowdown valve turns may be used in the estimate of blowdown.

6.1.5.7 Calculating HHV using the Correlation

As shown in ***Table D***, the data for an operating time period is used to calculate the raw SSO and the adjustment factors which allow a calculation of adjusted SSO. This adjusted SSO is referenced to the design values of the parameters and can be used with the correlation equation to obtain the estimated refuse HHV. In these calculations, excess air is determined from dry %O2 using an empirical equation and any heat input from auxiliary fuel (natural gas) is accounted for. The full heat input from the natural gas is used with an assumed boiler efficiency of 85%.

6.1.5.8 Correlation Validation

The correlation is validated by comparing its resultant HHV to an HHV determined by ASME PTC 34, 8-hour, boiler-as-a-calorimeter (B-A-C) test for the same time period. If the correlation HHV is within 2% of the B-A-C HHV, then the correlation can be considered valid and can be used for any time period. If the difference is greater than 2%, then the correlation equation can be adjusted to minimize the differences from all B-A-C tests so that the average difference falls within an acceptable range. The “calibration” adjustment is accomplished by adjusting the value of the fixed losses used in the calculation of the correlation coefficients to match actual operation and can also be performed if the average difference is less than 2% to make the correlation more accurate.

6.1.6 Residue Sampling & Unburned Combustible Requirement

Residue samples of 45.4 kg (100 lbs) will be taken every two hours of the 5-day capacity test. Daily composite samples will be made and sent to the lab for analysis. If the 5-day mathematical average unburned combustible content after adjustment for materials removed prior to sampling is greater than the Residue Quality Guarantee of 3% by dry weight then the Throughput Capacity test is failed even if the Facility processes more than the required tonnage.

6.2 Residue Quality

6.2.1 Adjustment for Materials Removed

The laboratory determination of the unburned carbon and moisture shall adjusted for weights of non-combustibles previously removed (i.e. ferrous, grizzly and +50 mm (+2 inch) stream) in the calculation for determining compliance with the guarantee values. The adjustment for weights of noncombustible, non-absorbing materials (+50 mm, grizzly & ferrous) previously removed will be performed as follows:

Unburned Carbon

$$Cunb1(\%) = \frac{Cunb(MJ/kg)}{27.91\ Mj/kg} \times \frac{-50mm}{Total\ sample} \times \frac{Total\ Bottom\ Ash + Non - Ferrous}{Grizzly + Ferrous + Total\ Bottom\ Ash + Non - Ferrous}$$

Where:

Cunb1 = Residue unburned carbon (% dry basis) adjusted for weights of non-combustibles previously removed.

Cunb = Residue unburned combustible HHV (dry basis) as determined by laboratory analysis.

27.91 = MJ/kg HHV of combustibles per ASME PTC 34, Section 4-7.5.3 (12,000 BTU/lb)

\- 50 mm = The total weight of minus 50 mm, residue sample, material (dry basis) screened for the 5-Day or 8-hr period.

Total Sample = The total dry weight of residue sample, inert material for the 5-Day or 8- hr period .

Total Bottom Ash = bottom ash, grate siftings and moisture

Non-Ferrous = Non-ferrous material removed by ECS

Grizzly = oversized material removed by grizzly scalper

Ferrous = Ferrous material removed by magnet

Oversized “Grizzly”, bottom ash, ferrous and non-ferrous material will be collected on floor and weighed on truck scales using front-end loader or container. This grizzly material may be dumped into the ferrous bay after weighing. The floors under the grizzly scalper and in all relevant bays of the residue building will be scraped clean with the front-end loader prior to storing test residue and will be scraped clean again at the end of the test.

The moisture laboratory results will be adjusted using the test ratios established to account for the quantities of grizzly, ferrous and plus 50 mm material removed during the 5-day and 8-hour periods. These ratios will be identical to the ratios used for the unburned carbon adjustment.

6.3 Residue Quantity

The above bottom ash and flyash streams will be summed over the 5–day period and that total will be divided by the total tonnes of Waste processed during the same 5 days to determine the percentage of Residue generated to Waste processed. The same average HHV as determined for the Throughput Capacity Test using the correlation will be used to select the appropriate guarantee from the Agreement table of Exhibit 2 to Appendix 19. If the calculated percentage of Residue to the as-fired waste during the test is less than or equal to the guarantee value, then the Facility will have passed the Residue Quantity Test.

7 MANPOWER

7.1 Staffing

The Throughput capacity, Residue Quality and residue Quantity Tests will be conducted by Covanta Durham-York, Inc. with the Owner and the Owner's Engineer witnessing the testing.

7.2 General

Facility personnel will be utilized to staff and perform the various test duties during the test period. Test data sheets will be made available for review by the Owner and Owner's Engineer during and after the test. Temporary labor will be obtained to supplement the plant staff for Residue sampling and data collection and processing.

7.3 Flue Gas Testing

The on-site flue gas testing required for boiler calorimetry tests will be performed by an independent flue gas testing company.

7.4 Laboratory

The Residue analysis will be performed by a mutually agreeable certified laboratory experienced in ash testing.

8 REFERENCES

8.1 Test Plan & Sample Calculations

The Acceptance Test procedures and sample calculations are based on the following:

8.1.1 Project Agreement

Project Agreement between, "The Regional Municipality of Durham" and "The Regional Municipality of York" as "Owner" and "Covanta Durham York Renewable Energy Ltd." as "DBO Contractor".

8.1.2 ASME PTC 34 2007 "Waste Combustors with Energy Recovery"

8.1.3 ASME PTC 4-1998 "Fired Steam Generators"

8.1.4 ASTM D 3302 – 07 "Standard Test Method for Total Moisture in Coal"

8.1.5 ASTM D 5468 – 02 (Reapproved 2007) "Standard Test Method for Gross Calorific and Ash Value of Waste Materials"

1 Set System to Bypass

Set the weight system to bypass printing and recording the zero or span check values. During this procedure, weights should only be displayed, not recorded.

2 Zero Check

Lower an empty grapple at least halfway into the pit (to simulate normal crane operation), raise it in automatic above a hopper and wait for a stable reading.

Record the Zero reading.

3 Connect Test Weight

Connect the test weight.

4 Lift Test Weight

Lift & lower the test weight halfway into the pit, raise it in automatic over the hopper and wait for a stable reading. Record the Lift 1 reading.

5 Repeat Test Weight Lift Twice

Repeat step 4 twice. Record the Lift 2 and Lift 3 readings.

6 **Calculate Average Weight of Three Lifts**

Calculate the average of Lifts 1, 2, & 3. Record the average lift,

7 Calculate Deviation

Calculate the difference between the average lift and the test weight. Record the deviation.

8 Is Deviation Greater Than 68 kg (150 lbs) ?

8.1 NO - Crane Can Return to Service

If the deviation is less than + or – 68 kg (150 lbs), the crane can be returned to service.

8.2 YES - Perform Tare with Empty Grapple

If the deviation is greater than + of – 68 kg (150 lbs), disconnect the weight, put the grapple over the hopper in automatic and re-tare the system.

8.2.1 Repeat Steps 3 through 7

8.2.2 Is Deviation Greater Than 68 kg (150 lbs)?

8.2.2.1 NO - Crane Can Return to Service

8.2.2.2 YES – Is the deviation greater than 136 kg (300 lbs.)

8.2.2.2.1 Yes – Perform Complete Recalibration

If the deviation is greater than 136 kg (300 lbs), a complete recalibration must be performed and the deviation must be shown to be less than 68 kg (150 lbs) Inform shift supervisor.

8.2.2.2.2 No - Is this the 2nd consecutive deviation greater than 68 kg (150 lbs.)?

8.2.2.2.2.1 Yes - Perform Complete Recalibration

If the deviation is still greater than 68 kg (150 lbs), for the 2nd consecutive time, i.e. before/after a shift, a complete recalibration must be performed and the deviation must be shown to be less than 68 kg (150 lbs) Inform shift supervisor.

Repeat Steps 3 through 7

8.2.2.2.2.2 No – Crane can return to service.

Covanta Durham-York Crane Scale Span Check Record Sheet

Date/Time	***Crane***	***Test Weight***	***Zero***	***Lift***			***Average***	***Deviation***	***Remarks / Initial***
				1	***2***	***3***			

Crane Calibration Drift Adjustment Calculation

Reference Weight (Reference Block Weight)	**3,629**	kg			
Initial Span Check Reading	3,696.8	@	6:00		
Final Span Check Reading	3,719.5	@	18:00		
Average of the Initial and Final Span Checks	**3,708**	kg			
Difference between Average and Reference Weight	**79**	kg	>	45.4	kg

Adjustment to each grapple feed is warranted.

Linear Drift Equation: Reference Weight Reading = 1.89 * (Feed Time - 0600) + 3,697

Feed at	Feed Weight Reading (kg)	Ref. Weight (Drifted, by Equation)	Difference (Drift)	% Difference (% Drift)		Feed Weight % of Ref. Drifted Weight	Proportioned Drift (%)	Feed Weight Drifted	Adjusted Feed Weight (kg)
8:00	**3,402**	3,700.6	71.8	1.98%		91.93%	1.82%	61.90	**3,340.08**
9:00	**3,493**	3,702.5	73.7	2.03%		94.33%	1.92%	66.93	**3,425.77**
11:30	**3,175**	3,707.2	78.4	2.16%		85.65%	1.85%	58.78	**3,116.40**
12:45	**3,402**	3,709.6	80.8	2.23%		91.71%	2.04%	69.47	**3,332.51**
14:25	**3,810**	3,712.7	83.9	2.31%		102.63%	2.37%	90.46	**3,719.76**
16:15	**3,266**	3,716.2	87.4	2.41%		87.88%	2.12%	69.14	**3,196.76**
Total	**20,548**								**20,131.28**

Residue Sampling Procedures
5-Day Residue Quality Test
Bottom Ash Only

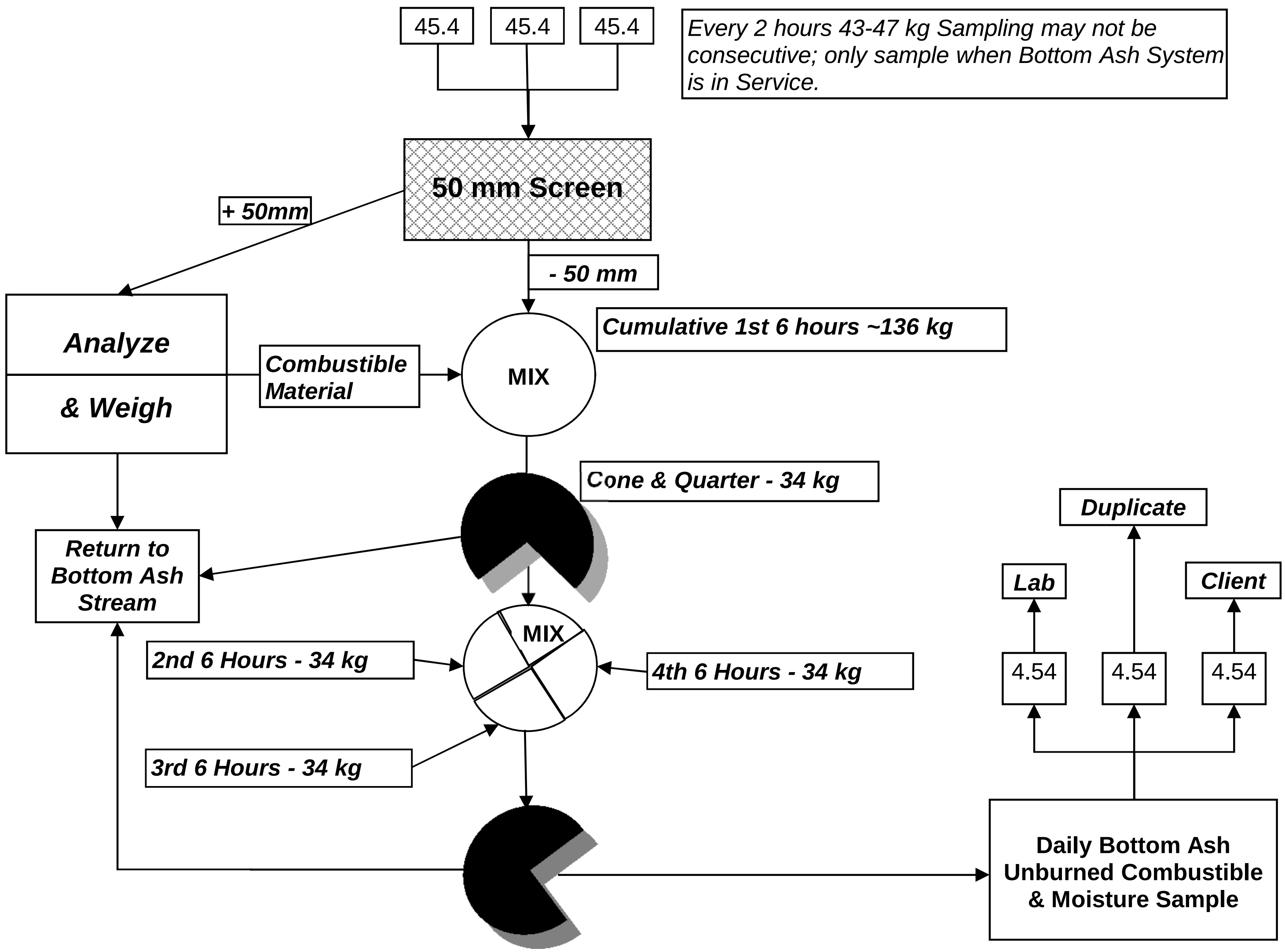


Figure 3

Covanta Durham-York
5-Day Bottom Ash Quality Sampling

Date	Time (2 hr. intervals)	Sample Number	Sample Weight (45.4 kg)		Screened Weight +50 mm	Screened Weight - 50 mm
		1				
		2				
		3				
		4				
		5				
		6				
		7				
		8				
		9				
		10				
		11				
		12				
				Sub-totals		
		1				
		2				
		3				
		4				
		5				
		6				
		7				
		8				
		9				
		10				
		11				
		12				
				Sub-totals		

Table 4C

Ultimate Analysis % BY WGT	Heat of		7		8		9		1/D-Y		2/3	
HHV (BTU/lb-fuel)	Combustion	**4000**	**4051.65**	**4500**	**4500.06**	**5000**	**5080.89**	**5500**	**5589**	**6000**	**6448.92**	**6500**
Carbon	14976	**22.92**	**22.927**	**25.74**	**25.505**	**28.51**	**28.774**	**31.130**	**31.729**	**33.770**	**36.508**	**36.25**
Hydrogen	49527	**3.24**	**3.295**	**3.64**	**3.665**	**4.04**	**4.135**	**4.430**	**4.560**	**4.810**	**5.246**	**5.18**
Nitrogen	2700	**0.48**	**0.628**	**0.58**	**0.699**	**0.67**	**0.789**	**0.870**	**0.870**	**1.060**	**1.001**	**1.25**
Oxygen	-4644	23.70	22.653	26.43	25.200	28.99	28.430	30.960	31.350	32.780	36.072	34.05
Sulfur	4500	0.02	0.029	0.02	0.032	0.03	0.036	0.040	0.040	0.050	0.046	0.06
Total Inert	0	22.44	23.700	21.19	21.400	20.26	18.500	16.570	15.920	14.530	11.700	12.21
Moisture	0	**27.20**	**26.500**	**22.40**	**23.200**	**17.50**	**19.000**	**16.000**	**15.160**	**13.000**	**9.000**	**11.00**
Dry O2 (%)		**7.448**	**7.448**	**7.448**	**7.448**	**7.448**	**7.448**	**7.448**	**7.448**	**7.448**	**7.448**	**7.448**
Excess Air		**55.1**	**54.8**	**55.0**	**54.8**	**55.0**	**54.8**	**54.9**	**54.8**	**54.8**	**54.8**	**54.7**
		Air & Gas Weights - lb/100 lb-fuel										
Dry Air Req'd = (0% Xs) x 28.967 x 4.77 x Mols O2 from Air		269.89	276.27	304.40	307.89	339.07	348.01	374.54	384.28	410.35	442.89	446.39
Dry Air Req'd = (1 + Xs) x 28.967 x 4.77 x Mols O2 from Air	***Spec. Hum.***	418.53	427.78	471.97	476.75	525.57	538.87	580.23	595.03	635.37	685.80	690.63
Moist from Air = Line 55 x Specific Humidity	***0.0131***	5.48	5.60	6.18	6.25	6.89	7.06	7.60	7.79	8.32	8.98	9.05
Wet Gas Weight = Line 55 + Line 56 + (100-Ash)	*lb H_2O/ lb*	501.35	509.45	556.75	561.38	612.00	627.25	671.09	686.75	729.02	782.96	787.35
Dry Gas Weight = Line 57 - Line 56 - 18 x (mols H2O)	*dry air*	439.76	447.95	495.69	499.23	551.56	564.29	607.95	623.09	664.76	718.15	721.06
Losses (BTU/lb)		**1,069.6**	**1,074.3**	**1,108.1**	**1,122.3**	**1,145.3**	**1,183.5**	**1,221.4**	**1,237.8**	**1,279.3**	**1,327.3**	**1,347.5**
Dry Gas		266.52	271.59	300.43	302.68	334.31	342.12	368.56	377.78	403.06	435.41	437.29
Moisture from H2O/H2 in Fuel		653.26	650.84	639.01	650.91	623.59	650.92	646.68	650.43	651.29	650.08	666.49
Moisture from Air		6.27	6.41	7.07	7.14	7.87	8.07	8.69	8.91	9.51	10.27	10.34
Fixed losses	3.59%	***143.6***	***145.5***	***161.6***	***161.6***	***179.5***	***182.4***	***197.5***	***200.6***	***215.4***	***231.5***	***233.4***
Unb Comb	2.05											
Radiation												
Unaccounted												
Misc-ash quench vapor												
SNCR water												
Credits (BTU/lb) Ref. 77°F		**110.95**	**113.41**	**125.12**	**126.39**	**139.33**	**142.86**	**153.82**	**157.75**	**168.44**	**181.81**	**183.09**
Dry comb air sens heat		108.32	110.71	122.15	123.38	136.02	139.46	150.16	153.99	164.43	177.48	178.74
Moist in comb air		2.64	2.70	2.98	3.01	3.31	3.40	3.66	3.75	4.01	4.32	4.36
Gross Efficiency (%)		***73.98%***	***74.21%***	***76.04%***	***75.74%***	***77.72%***	***77.34%***	***78.40%***	***78.46%***	***79.26%***	***79.98%***	***79.84%***
Output (BTU/lb-fuel)		***3,041.3***	***3,090.8***	***3,517.1***	***3,504.2***	***3,994.1***	***4,040.2***	***4,432.4***	***4,509.0***	***4,889.2***	***5,303.5***	***5,335.6***

$$Output + Losses = HHV + Credits \rightarrow Output = HHV + Credits - Losses$$

$$Boiler\ Efficiency\ (\%) = \frac{Output}{(HHV + Credits)}$$

MARTIN GmbH für Umwelt- und Energietechnik (seit 1925)	Date : 12-21-2010	Name : Nachreiner	Sheet : No. : 1	Doc. - No. : 00-050962-Q1100 V3

Project : **Durham** (refractory in 1-st pass)

Our No. : 050 962 100 % heat input, load point LP1=NOM

Very low NOx design, medium fouled boiler condition

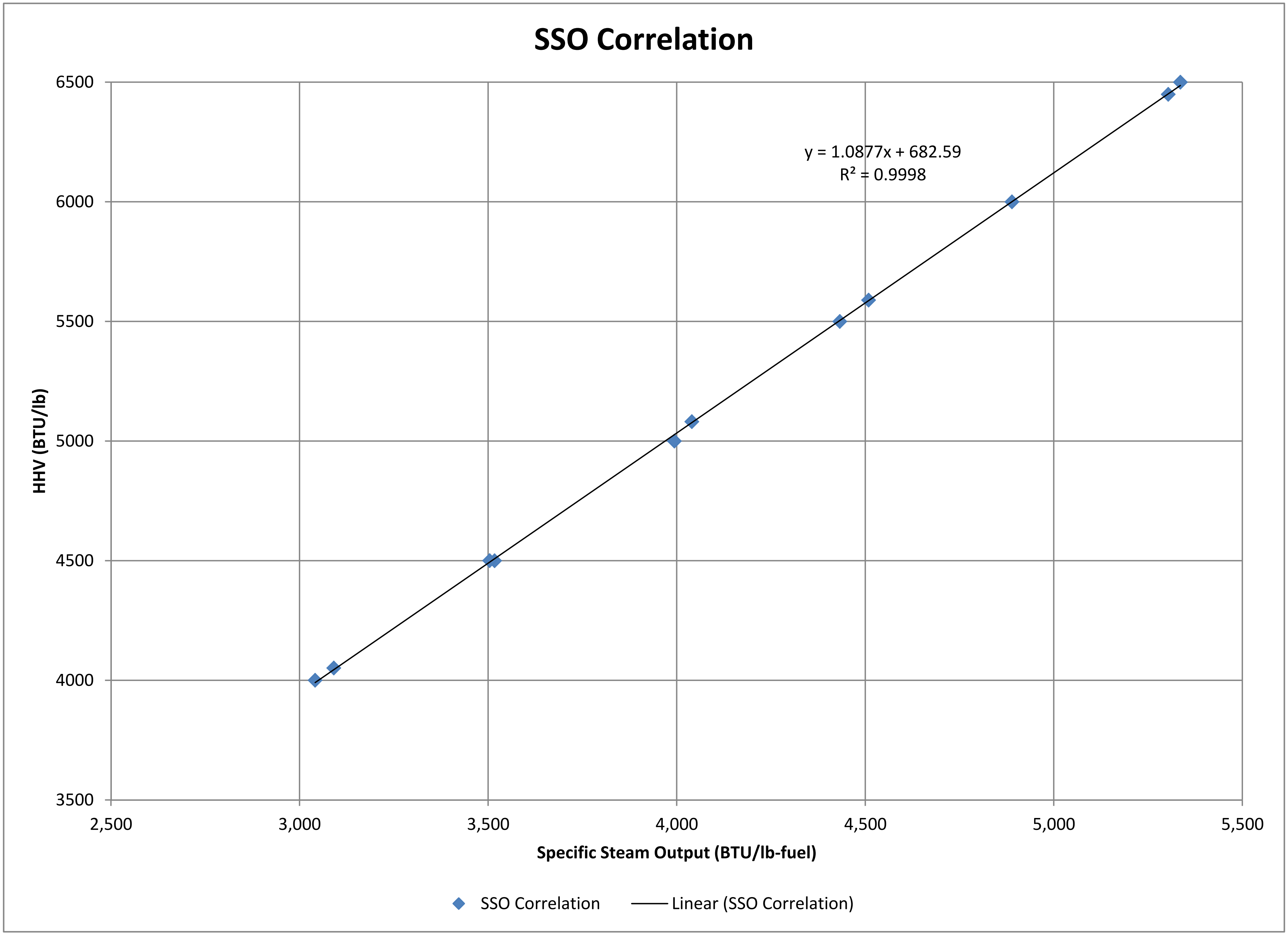
BOILER DESIGN DATA	Units of measurement			
	US- units	Metric- units	US- units	Metric- units
Refuse throughput per unit	%	%	100,00	100,00
Refuse quantity per unit	lb/h	kg/h	20.025	9.083
Lower calorific value of refuse (LHV)	BTU/lb	kJ/kg	5.000	11.630
Higher calorific value of refuse (HHV)	BTU/lb	kJ/kg	5.589	13.000
Ash	%	%	15,92	15,92
Moisture	%	%	15,16	15,16
Combustible matter	%	%	68,92	68,92
Design pressure (approx.)	psig	atü	1.529	107,5
Drum pressure (approx.)	psig	atü	1.380	97,0
Live steam pressure (approx.)	psig	atü	1.300	91,4
Live steam temperature	°F	°C	930	499
Saturated steam temperature	°F	°C	585	307
Feedwater temperature	°F	°C	275	135
Flue gas temperature at boiler outlet	°F	°C	330	166
Preheated air temperature	°F	°C	200	93
Ambient temperature	°F	°C	80	27
Boiler efficiency, calcul.	%	%	79,96 (HHV)	89,11 (LHV)
, guarant.	%	%	78,46 (HHV)	87,39 (LHV)
Steam output, calcul.	lb/h	kg/h	75.618	34.300
, guarant.	lb/h	kg/h	74.163	33.640
Considered blow down	%	%	2,0	2,0
Quantity of injected water (calcul.) :				
First stage : SH2 - SH3	lb/h	kg/h	2.315	1.050
Second stage : SH3 - SH4	lb/h	kg/h	1.411	640
Total (steam temp. control)	lb/h	kg/h	3.726	1.690
Part load	%	%	80	80
Gross heat release LHV	MBTU/hr	GJ/h	100,09	105,60
Gross heat release HHV	MBTU/hr	GJ/h	111,92	118,08
Heat input from preheated air	MBTU/hr	GJ/h	3,01	3,18
Total heat input LHV	MBTU/hr	GJ/h	103,10	108,78
Total heat input HHV	MBTU/hr	GJ/h	114,93	121,26
Combustion air quantity	SCFM	Nm³/h	26.540	42.010
Flue gas quantity, furnace	SCFM	Nm³/h	30.560	48.380
Flue gas quantity, system exit	SCFM	Nm³/h	33.470	52.980

% BY WGT	Heat of	HHV (BTU/lb-fuel)		EEGT		Ambient Air T		UFA Temp		Excess Air %	
HHV	**Combustion**		5589	5589	5589	5589	5589	5589	5589	5589	5589
Carbon	14976		31.73	31.73	31.73	31.73	31.73	31.73	31.73	31.73	31.73
Hydrogen	49527		4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56
Nitrogen	2700		0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Oxygen	-4644		31.35	31.35	31.35	31.35	31.35	31.35	31.35	31.35	31.35
Sulfur	4500		0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Total Inert	0		15.92	15.92	15.92	15.92	15.92	15.92	15.92	15.92	15.92
Moisture	0		15.16	15.16	15.16	15.16	15.16	15.16	15.16	15.16	15.16

Dry O2 (%)			-	**7.448**	**7.448**	**7.448**	**7.448**	**7.448**	**7.448**	**7.448**	**8.265**
Excess Air			**0.0**	**54.8**	**54.8**	**54.8**	**54.8**	**54.8**	**54.8**	**54.8**	**64.8**
Dry Air Req'd = (0% Xs) x 28.967 x 4.77 x Mols O2 from Air			386.11	386.11	386.11	386.11	386.11	386.11	386.11	386.11	386.11
Dry Air Req'd = (1 + Xs) x 28.967 x 4.77 x Mols O2 from Air			386.11	597.88	597.88	597.88	597.88	597.88	597.88	597.88	636.31
Moist from Air = Line 19 x Specific H		0.0131	5.06	7.83	7.83	7.83	7.83	7.83	7.83	7.83	8.34
Wet Gas Weight = Line 19 + Line 20 + (100-Ash)			475.25	689.79	689.79	689.79	689.79	689.79	689.79	689.79	728.73
Dry Gas Weight = Line 21 - Line 20 - 18 x (mols H2O)			414.33	626.10	626.10	626.10	626.10	626.10	626.10	626.10	664.53

EEGT (F)		**330.0**		**330.0**	**340.0**	**330.0**	**330.0**	**330.0**	**330.0**	**330.0**	**330.0**
Ambient Air Temp - °F		**80.0**		80	80	80	70	80	80	80	80
Preheated Air Temp - °F		**200.0**		200	200	200	190	200	190	200	192.6
Excess Air - %		**54.8**									
% Heated Air		**87.2%**		**87.2%**	**87.2%**	**87.2%**	**87.2%**	**87.2%**	**87.2%**	**87.2%**	**87.2%**
Wgt Inlet air Temp F		**184.6**		**184.6**	**184.6**	**184.6**	**174.6**	**184.6**	**175.9**	**184.6**	**178.1**

Losses (BTU/lb)				**1,155.2**	**1,173.4**	**1,155.2**	**1,155.2**	**1,155.2**	**1,155.2**	**1,155.2**	**1,179.3**
Dry Gas				379.60	394.86	379.60	379.60	379.60	379.60	379.60	403.08
Moisture from H2O/H2 in Fuel				650.43	652.99	650.43	650.43	650.43	650.43	650.43	650.43
Moisture from Air				8.95	9.31	8.95	8.95	8.95	8.95	8.95	9.53
Fixed losses	2.08%			***116.3***	***116.3***	***116.3***	***116.3***	***116.3***	***116.3***	***116.3***	***116.3***
Unb Comb	2.08%										
Radiation											
Unaccounted											
Misc											
SNCR water											
Delta Losses (BTU/lb)					**18.19**						**24.06**
Credits (BTU/lb)				**158.50**	**158.50**	**158.50**	**143.74**	**158.50**	**145.64**	**158.50**	**158.59**
Dry comb air sens heat				154.73	154.73	154.73	140.32	154.73	142.18	154.73	154.82
Moist in comb air				3.77	3.77	3.77	3.42	3.77	3.46	3.77	3.77
Delta Credits (BTU/lb)							**(14.76)**		**(12.86)**		**0.08**
Gross Efficiency (%)				79.90%	79.58%	79.90%	79.85%	79.90%	79.86%	79.90%	79.48%
Delta Efficiency (%)				0.00%	-0.40%	0.00%	-0.06%	0.00%	-0.06%	0.00%	-0.52%
Output (BTU/lb-fuel)				4,592.3	4,574.1	4,592.3	4,577.5	4,592.3	4,579.4	4,592.3	4,568.3
Delta Output (%)					**-0.40%**		**-0.32%**		**-0.28%**		**-0.52%**


SSO Correlation
6500
6000
5500
5000
4500
4000
3500
HHV (BTU/lb)
2,500
3,000
3,500
4,000
4,500
5,000
5,500
Specific Steam Output (BTU/lb-fuel)
y = 1.0877x + 682.59
R² = 0.9998
SSO Correlation
Linear (SSO Correlation)

COVANTA DURHAM / YORK

HHV Calculation Sheet

From:	10/1/13
	0:00:00
To:	10/2/13
	0:00:00
From:	10/1/13
	0:00:00
To:	10/2/13
	0:00:00

REFERENCE VALUES	DATA INPUTS	UNITS	VALUE
	Refuse Processed Boiler 1	Tons	**240.3**
	Refuse Processed Boiler 2	Tons	**240.3**
	Total Operating Time - Unit 1	Hours	**24.0**
	Total Operating Time - Unit 2	Hours	**24.0**
	Boiler 1 Steam Production	klbs	**1,779.9**
	Boiler 2 Steam Production	klbs	**1,779.9**
	Boiler 1 Blowdown Flow	klbs	**37.0**
	Boiler 2 Blowdown Flow	klbs	**37.0**
930 deg F	Boiler 1 Stm Temp	deg F	**930.0**
	Boiler 2 Stm Temp	deg F	**930.0**
1300 psig	Boiler 1 Stm Press	psig	**1,300.0**
	Boiler 2 Stm Press	psig	**1,300.0**
275 deg F	Boiler 1 Feedwater Temperature	deg F	**275.0**
	Boiler 2 Feedwater Temperature	deg F	**275.0**
	Boiler 1 Feedwater Pressure	deg F	**1,450.0**
	Boiler 2 Feedwater Pressure	deg F	**1,450.0**
	Boiler 1 Drum Pressure	psig	**1,380.0**
	Boiler 2 Drum Pressure	psig	**1,380.0**
330 deg F	Blr 1 Econ Exit Gas Temp	deg F	**330.0**
	Blr 2 Econ Exit Gas Temp	deg F	**330.0**
200 deg F	Blr 1 Heated Comb Air Temp	deg F	**200.0**
	Blr 2 Heated Comb Air Temp	deg F	**200.0**
80 deg F	Boiler 1 Ambient Air Temp	deg F	**80.0**
	Boiler 2 Ambient Air Temp	deg F	**80.0**
	Blr 1 Econ Exit Dry O2	%	**7.45**
	Blr 2 Econ Exit Dry O2	%	**7.45**
1,000 Btu/cuft	Aux Fuel Usage - Boiler 1 Natural Gas	kcuft	
1,000 Btu/cuft	Aux Fuel Usage - Boiler 2 Natural Gas	kcuft	
	ENTHALPIES		
1,455.71 Btu/lb	Main Steam	Btu/lb	1,455.71
			1,455.71
247.14 Btu/lb	Feedwater	Btu/lb	247.07
			247.07
	Blowdown	Btu/lb	598.48
			598.48
	CALCULATIONS		
54.83 %	% Excess Air from %O2	%	54.83
	% Excess Air from %O2	%	54.83
	Blr 1 Steam Ht Output	MBTUH	90.18
85% Eff. on Aux Fuel	Blr 2 Steam Ht Output	MBTUH	90.18
	Ht Output due to Aux Fuel	BTUH	
	Ht Output due to Aux Fuel	BTUH	
	Blr 1Ht Output from Refuse	MBTUH	90.18
	Blr 2Ht Output from Refuse	MBTUH	90.18
	Blr 1 Spec Stm Output (BTU/lb ref fired)		4,503.31
	Blr 2 Spec Stm Output (BTU/lb ref fired)		4,503.31
	ADJUSTMENTS		
Factors	***BOILER 1***		
0.40 % output/10 deg F	Econ Gas Temp	BTU/lb	0.0
-0.28 % output/10 deg F	Heated Combustion Air Temp	BTU/lb	0.0
-0.32 % output/10 deg F	Ambient Air Temp	BTU/lb	0.0
0.52 % output/10%	Excess Air	BTU/lb	(0.0)
1.0877 682.59	Adjusted SSO (BTU/lb ref fired)	Btu/lb	4,503.3
5589 0.15%	**HHV from Correlation (Btu/lb)**		**5,581**
	BOILER 2		
0.40 % output/10 deg F	Econ Gas Temp	BTU/lb	0.0
-0.28 % output/10 deg F	Heated Combustion Air Temp	BTU/lb	0.0
-0.32 % output/10 deg F	Ambient Air Temp	BTU/lb	0.0
0.52 % output/10%	Excess Air	BTU/lb	(0.0)
	Adjusted SSO (BTU/lb ref fired)	Btu/lb	4,503.3
5589 0.15%	**HHV from Correlation (Btu/lb)**		**5,581**

Durham/York Energy from Waste Project

Acceptance Test Procedures

Energy Recovery Tests

&

Residue Quality Test
(8-hour Portion)

COVANTA
ENERGY

June, 2014

Table of Contents

1 OBJECTIVE

1.1 Energy Recovery Test

The objective of the Energy Recovery Test is to demonstrate compliance with the Electricity Production Guarantees in Exhibit 2 to Appendix 19 of the Project Agreement, ("Agreement"). The Energy Recovery Test will determine the Project gross and net electrical outputs per tonne of Reference Waste, (kWh/tonne) for comparison to values shown in item 3 of the table on page 6 of Exhibit 2 to Appendix 19. The table shows the guarantees varying with Waste HHV, so the test objective will be to measure the actual kWh/tonne values and compare the average as-tested Energy Recovery in kWh/tonne to the table guarantee value at same as-tested average HHV. The only correction the Agreement allows to the as-tested kWh/tonne values is the adjustment of the power outputs to annual average ambient conditions.

1.2 8-Hour Residue Quality Test

The objective of the 8-hour portion of the Residue Quality Test is to demonstrate compliance with the Residue Quality Guarantee of 25% by weight moisture and 3% by dry weight unburned carbon in the residue as noted in Appendix 10 of the Agreement. These 8-hour test runs have more frequent sampling than during the 5-Day Residue Quality Test. For purposes of the Residue Quality Test, the Agreement defines residue as bottom ash and grate siftings, but not including any flyash, added reagents or recovered metals.

2 CONCURRENT TESTS

As stated in the Agreement, the Energy Recovery Test must consist of a minimum of three (3) separate eight (8)-hour analysis periods performed during the 5-day Throughput Capacity Test. It is anticipated that five (5) test runs will be performed. As shown in the test schedule, the 8-hour runs will be performed during the 5-Day Residue Quality & Quantity Test which is during the 30-Day Reliability and Residue Quantity Tests. Boiler-as-a-calorimeter tests to determine Waste higher heating value (HHV) will be performed concurrently with the Energy Recovery runs along with the 8-hour portion of the Residue Quality Test.

3 TEST PREREQUISITES

3.1 Pre-test Meeting

Covanta Durham York, Renewable Energy Ltd. (Covanta) must meet with the Owner and the Owner's Engineer at the plant 90 days prior to discuss and review the procedures for conducting the Acceptance Testing. This meeting took place on April 24, 2014 at the Regions' office.

3.2 Instrument Calibrations

Prior to the commencement of testing, Covanta will confirm the calibrations of the instruments used for obtaining data required for calculation purposes. These data points are noted on Tables 1A and 1B. Documentation of these calibrations or calibration checks will be furnished to the Owner's Engineer prior to the start of testing. The calibrations/checks will be performed by qualified personnel employed by Covanta or by an independent contractor.

3.3 Furnace "Seasoning"

The testing will commence after a furnace "seasoning" period of 28 cumulative days, where the boilers will operate at or above 75% of capacity using design MCR steam flow as the criteria. The 28 days do not have to be consecutive. Off line cleaning of any heat transfer surfaces, other than normal online soot-blowing, after the 4 week period, will require an additional three (3) weeks of operation at or above 75%

capacity.

3.4 Stabile Operation

Prior to the first 8-hour Energy Recovery and boiler calorimetry tests, the steam generators will be reasonably stabilized at nominal full load output for 24 hours with all Project normal auxiliary functions and power generation equipment operating as intended. Major Project control systems will be in automatic mode.

Stabile operation is required for the start and end of all test runs and HHV determinations. If the boiler is not in stable condition at the end of a test run, the boiler should be returned to a stable condition prior to ending the run. If the instability can be anticipated prior to the end of the test run (for example, a large non-combustible object is observed passing through the furnace), the test run may be terminated for less than the expected test duration if mutually agreed upon with the Owner's Engineer.

3.5 Sootblowing

Soot-blowing will be completed sufficiently prior to commencement of a test (~two hours), if required, to allow the boiler to stabilize to steady state conditions. Furthermore, soot-blowing will not be performed during the eight-hour test periods.

4 TEST INSTRUMENTATION

4.1 Permanent Plant Data

Most of the data points required for the Energy Recovery Test will be obtained utilizing the existing primary measurement elements which monitor process temperatures, pressures, flows, levels and electrical parameters. The outputs from these primary measurement elements are recorded and processed by the permanent plant Distributed Control System (DCS). The data points will be recorded at 1-minute intervals and are listed at the end of these procedures. Special acceptance test data reports will be assembled to provide a concise tabulation of all test measurements.

4.2 Special Test Equipment

Some required data points are not available from permanent plant instrumentation, so special test equipment is required for manual or automatic input data. The special test equipment consists of electronic humidity data-loggers, digital potentiometer/datalogger, Type "K" thermocouple wire and barometer. Relative humidity and dry bulb temperatures will be obtained on the charging floor for determination of test specific humidity and outdoors for cooling tower performance adjustments. A test thermocouple/digital potentiometer combination will be used to measure the quench bath water temperature at the ash dischargers and possibly to supplement the station indication of heated air temperature. The data points are listed at the end of these procedures. Those collected manually will be obtained at a minimum of 60 minute intervals.

4.3 Flue Gas Measurement

Flue gas constituents consisting of volumetric measurements of O2 (%), CO2(%), H2O% and flue gas flows will be determined at the economizer outlet. The volumetric flow rates will be determined in accordance with EPA Method 2 using a calibrated S-type pitot tube. Flue gas carbon dioxide, oxygen, excess air and molecular weight will be determined in accordance with EPA Method 3. Dry, volumetric determinations of CO2 and O2 will be from a continuous flue gas sample collected and run to test electronic analyzers. Data from electronic analyzers would be logged once per minute. Flue gas moisture will be determined in accordance with EPA Method 4 and will be analyzed every two hours. Flow traverses will be performed every half hour. The results obtained from the test analyzers shall take precedence over any redundant CEM results.

4.4 Instrument Lists

The preliminary instrumentation list compiled for the Test period is included in Tables 1A and 1B. The tabulation contains the process parameter monitored, the recording frequency and the measurement method of each respective data point.

4.5 Instrument Calibration

Instrument calibrations, which will be performed and documented by the general contractor and their subcontractors, will be provided for all instruments used to measure test data. These instrument calibrations will be performed as part of the start-up and commissioning of the Facility. Prior to the scheduled commencement date of the performance tests, ***the data points used for calculation purposes*** will be rechecked by qualified personnel (either plant I&C technicians or an independent contractor) to verify the accuracy and validity of the previously performed calibrations. These checks include the plant total, OFA, seal air and IGR flow elements using pitot tube traverses. Documentation of the verifications will be provided to the Owner’s Engineer prior to the start of the testing. If plant I&C technicians are used, the Owner’s Engineer will be informed of the schedule in order to be able to witness the calibration checks. The points used in the calculations are identified in the tables at the end of these procedures.

4.6 Typical Data Package

The 1-minute data will be obtained from the DCS in Excel spreadsheet format and electronically forwarded to the Consulting Engineer. Test average sheets and charts of key operating parameters will be included in the electronic files. Data from the previous day will be forwarded to the Consulting Engineer by noon of the following day. A password -protected “Cloud” data storage and access area may be utilized. Covanta will make efforts to submit/post data earlier during days when either Energy or Metals Recovery Tests are not being performed.

5 <u>TEST PROCEDURES</u>

5.1 General

The Energy Recovery Tests and 8-hour Residue Quality Tests shall consist of at least three (3) 8-hour analyses. It is anticipated that 2 additional 8-hour test runs for a total of 5 will be performed. The Facility shall be operated at or near the design capacity refuse throughput rate of 436 TePD. During the Energy Recovery Test all Facility electrical power requirements will be supplied by the Project generator.

5.2 Air Pre-heaters/Auxiliary Fuel/Interruptions

The Project will be operated in a manner consistent with normal daily operating procedures. The operating requirements of the air pre-heaters (out-of-service/in service/number of in-service coils) will be determined prior to each eight-hour test period. Air pre-heater use is typically required when waste is wet or of poor quality as determined by the plant operations staff. Once a test starts, changes to the air pre-heaters will be kept at a minimum to maintain consistent operating parameters. No auxiliary fuel will be used during the tests. Furthermore, if a significant processing interruption occurs during the eight-hour test period, except during the last hour of the test, the test will be repeated. If an interruption occurs during the last hour of the test, the test may still be deemed valid if both Covanta and the Owner's Engineer agree.

5.3 Crane Weigh Cell - Initial Calibration

The Project throughput will be established using the crane weigh cells. An initial calibration of the crane weight cell system will be performed by the Covanta personnel, including lifting a full span test weight. The County and Owner's Engineer will be given the opportunity to witness the calibration if they so desire.

5.4 Crane Weigh Cell Calibration Procedure

Crane weigh cell calibration checks will be performed before and after each 8-hour test period as part of the twice daily calibration check requirement in the Agreement. The checks will be performed on both cranes even if only one is being used for loading the hoppers. Each calibration check will consist of lifting the reference calibration weight and recording the reading on a data sheet. If the difference between the span check reading and reference weight exceeds 68 kg (150 lbs), a "re-zero" of the system will be performed. If a "re-zero" of the system does not eliminate the difference, a complete recalibration of the system will be performed when a second consecutive excess deviation occurs.

5.5 Throughput Data Adjusted for Drift

Throughput data will be mathematically adjusted for crane calibration drift if the average difference between the span check indicated weight and the previous span check differs by more than 45.4 kg (100 pounds). Adjustments will be applied (added or subtracted) to all grapple lifts in the respective time period between span checks. See the sample calculation in the Throughput Capacity Test procedures.

5.6 Initial/Final Charging Hopper Levels/Spillage

The load of refuse in the feed hopper shall be visually estimated at the beginning of each energy test. The waste in the feed hopper shall be brought to the same approximate level at the conclusion of each energy test. Digital photos of the hopper levels will be taken for documentation.

Crane operators will also be given direction and training to not allow any refuse to spill back over the edge of the feed hopper and into the pit after the grapple load weight has been recorded.

5.7 Residue Sampling Times

Process Residue sampling procedures will be instituted 60 minutes after the tests begin. The 60 minute lag time is allotted for the test Refuse to "travel" from the charging hoppers to the ash discharger. The Residue will be sampled for each test for 8 hours.

5.8 Residue Collection

For the determination of heat losses, the materials making up the total residue stream exiting the combustion system and APC plant will be weighed or assumed, including recovered metals, as described below. Flyash from the boiler and APC plant is collected separately, kept separate and leaves the Facility separately from bottom ash and grate siftings. The streams will be collected in bays of the residue building and weighed separately in containers or trucks on the Facility truck scales.

The bays will be scraped clean by the front end loader prior to the start of the 8-hour test and at the end of the test.

5.8.1 Mixed Bottom Ash

The mixed bottom ash consisting predominantly of bottom ash and grate siftings will be collected in Bays 2 and 3 of the Residue building. This material also includes screened -25 mm (-1") ferrous and -10 mm (-3/8") non-ferrous metal.

5.8.2 Recovered Ferrous

The recovered +1" ferrous material will be collected in Bay 1.

5.8.3 Recovered Non-Ferrous

The recovered non-ferrous metal will be collected in Bay 4.

5.8.4 Fly Ash

Due to the addition of reagents into the flyash making the calculation of heat loss difficult and the small value of the sensible heat loss due to fly ash, (<0.05%), the amount of flyash in the flue gas leaving the boiler boundary at the economizer exit will be assumed to be 10% of the total wet ash and not weighed. After the 30 Day test is complete, the assumed percentage can be refined based on the long term measured quantities of Residue, metals, flyash and reagents.

5.9 Residue Sampling Procedure

Residue sampling will be performed during the Energy Recovery Test to determine the unburned carbon and moisture in the residue required for heat loss calculation purposes. The sampling procedure shown in Figure 1 is as follows:

5.9.1 Combustibles and Moisture Sampling

The sampling procedure shall be performed to collect an eight (8) hour gross sample. A sample will be collected every 10 minutes weighing approximately 22.7 kg (50 pounds). The sample collection point shall be from conveyor AH-CV-011, as it falls onto the ECS screen. A "belt-swipe" across the conveyor with a shovel or hoe will be used to collect a representative cross-section of the material on the conveyor. Each sample will be screened to determine the percentage of plus 50 mm (2 inch) material and minus 50 mm (2 inch) material. The plus 50 mm (2 inch) material will be hand sifted and sorted to extract material that consists of unburned combustible material. The unburned combustible material (if any) will be included with the minus 50 mm (2 inch) material. A portable scale will be utilized for weighing. The minus 50 mm sample shall be deposited in a leak tight container to eliminate any potential moisture loss.

The first four hourly samples will be separately mixed and then quartered and combined into a four (4) hour sample. This sample will be mixed and quartered and then combined with the last four hour prepared sample. From the combined sample, three (3) separate five kilogram, (5 kg), (10 lb) samples, one for lab processing, one for the client and one to serve as back-up sample will be placed in air tight containers. All unused sample material will be returned to the Residue stream. A schematic representation of the 8-hour sampling procedure along with a sample data sheet are included at the end of these procedures.

5.9.2 Ash Analysis

Moisture - Total residue moisture analysis will be conducted in accordance with ASTM D 3302 – 07, "Standard Test Method for Total Moisture in Coal". The moisture determination in accordance with ASTM Method D 3302 is based on air drying the entire residue sample (approximately 4,000 - 5,000 g) and therefore is considered an appropriate method.

Unburned Combustible - The Residue unburned combustible determination will be performed in accordance with ASTM D 5468 – 02 (Reapproved 2007) “Standard Test Method for Gross Calorific and Ash Value of Waste Materials”, utilizing the adiabatic bomb calorimeter and assuming a HHV of 27,913 kJ/kg (12,000 Btu/lb) to convert to a percentage basis.

The laboratory determined unburned carbon does not have to be adjusted for carbon injected as mercury control reagent because the flyash is kept separate from the bottom ash. Please refer to the 5-Day Residue Quality Test Procedure for details on calculations for comparison to the Residue Quality Guarantee.

Flyash will not be sampled and will be assumed to contain zero moisture and the same unburned combustible as the bottom ash when calculating boiler heat losses.

5.9.3 Lab Reports

The laboratory Residue analysis and report will be included as part of the Test report submitted by Covanta to the Region for review to show amounts of any materials removed by lab prior to analysis. Laboratory raw data sheets will be provided for both the moisture and unburned combustible analysis. The laboratory determined calorific value of unburned combustibles in kJ/kg will be converted to a dry percentage basis by dividing the calorific value of combustible, i.e., 27,913 kJ/kg (12,000 Btu/lb). Covanta will expedite sample analysis if schedule requires.

5.10 Data Transmittal

All data recorded by Covanta during the Energy Recovery Tests will be furnished to the County within 24 hours of the conclusion of each test.

6 DATA ANALYSIS AND CALCULATIONS

6.1 Correction for As-Tested Waste HHV

For the Energy Recovery Test the Waste delivered to the Facility may not be representative of the composition of Reference Waste. As the gross and net electrical energy production rates per tonne of Waste will vary with the HHV of that Waste, the as-tested energy production rates must be compared to guarantees that vary with the HHV of the Waste. These guaranteed electric generation rates in kWh/tonne of as-tested Waste versus HHV are shown in the table in item 3 of Exhibit 2 to Appendix 19 of the Agreement as follows:

3.	**Electricity Production Guarantee* (Annual Average)** ***Not including the Future District Energy System component** **(See Part 9 to this form, below)**			
	Throttle Conditions Proposed (Bar)		**Approx. 90**	1305 psi
	Throttle Conditions Proposed (°C)		**Approx. 496**	924.8 F
	Maximum Steam load (kg/hr)		**Approx. 72,000 @ VWO**	
	Electricity Production Guarantee at or above 100% of the Guaranteed Annual Throughput [See Note 1]			
	<u>HHV</u>	Gross Electrical Output (kWh/tonne)	Net Electrical Output (kWh/tonne	
	11.0 MJ/kg	**712**	**627**	
	12.0 MJ/kg	**793**	**700**	
	13.0 MJ/kg	**868**	**767**	
	14.0 MJ/kg	**949**	**840**	
	15.0 MJ/kg	**1030**	**913**	

Item 3 of Exhibit 2, Appendix 19 of the Project Agreement

By using the combustion system as a calorimeter for determining the higher heating value of the as-tested Waste, the as-tested energy recovery rates can be compared to the guaranteed rates.

6.2 Calculations

The sample calculations, process diagram and assumptions are presented at the end of these procedures. The calculations are based on ASME PTC 34, "Waste Combustors with Energy Recovery" – 2007 which uses the boiler-as-a-calorimeter test method to determine boiler efficiency and fuel/refuse higher heating value when the fuel cannot be representatively sampled and when a fuel/refuse ultimate analysis cannot be feasibly obtained. The calculations are also based on ASME PTC 4, "Fired Steam Generators" – 1998. These calculation procedures are used to determine the as-tested waste HHV fired during 8-hour test period along with the as-tested energy recovery rates.

A pre-test uncertainty analysis is provided in the "Calculation" section of this test plan so that the accuracy of the test can be quantified. The uncertainty value will not be applied to any test results for comparison to guarantees. The post-test uncertainty analysis will be performed for only one 8-hour test.

The calculation procedures contain the following. Page numbers refer to sub-pages of calculations.

6.2.1 <u>Page 1 - Pertinent Test Data</u>

This table contains the average test parameters measured during each eight hour test period. The measurement source for each process point is indicated as well as schematically depicted on the simplified process flow diagram included. For the two units, some data is totaled and some are calculated as weighted averages based on steam flow, air flow or flue gas flow as appropriate.

6.2.2 <u>Page 2 - Residue Analysis</u>

The Residue analysis total weights are determined per the general method outlined in Section 5.9. The sample weights and percentages of plus 50 mm and minus 50 mm (plus 2 inch and minus 2 inch) material will be obtained following procedures in Section 5.8. A moisture content for the plus 50 mm (2 inch) to minus 200 mm (8 inch) Residue material is not reported since it is assumed that the moisture content present in the plus 50 mm (2 inch) material is negligible. The plus 50 mm (2 inch) Residue stream is determined by manually screening the Residue samples through a nominal 50 mm (2 inch) screen. The material that is separated through this screen is generally "non-absorbing" material such as metal cans, straps, bulky waste, etc.

The unburned carbon associated with the plus 50 mm (2 inch), and oversized grizzly material is assumed to be zero since it primarily consists of inert material. This assumption is considered reasonable since any combustible material that might be present in the plus 50 mm (2 inch) stream will be removed and included in the minus 50 mm (2 inch) stream.

Flyash quantity is assumed at 10% of total wet ash and assumed to contain no moisture as it leaves the boiler boundary and the same unburned combustible as the bottom ash.

6.2.3 Page 3 - Flue Gas Flows and Enthalpies

Flue flows and enthalpies on dry, wet & mass bases are first calculated.

6.2.4 Page 4 - Measured Combustion Air Analysis

Measured air flows are corrected for actual air temperatures and humidity.

6.2.5 Page 5 - Total Air Analysis

The total air flow for each respective unit which includes the two un-heated and un-measured streams of air infiltration and VLN cooling air (if needed) in addition to the venturi-measured total air stream is determined by performing a nitrogen balance based on the flue gas constituents and flue gas flow measured at the economizer outlet. The nitrogen balance also requires a minor technical adjustment for the nitrogen content of the refuse. Reference waste composition nitrogen content 0.87% will be assumed for this purpose.

6.2.6 Page 6 - Ashpit Quench Bath

A water mass balance is performed around the boilers to establish the combined a) vapor from H2O in the fuel, b) vapor from the combustion of H2 in the fuel, c) quench water evaporation from the ash discharger and d) moisture from SNCR carrier water. The ash discharger make-up water temperature, the fuel temperature and the SNCR water temperature are all assumed to be the same, so measurement of the make-up water flow and SNCR water flow are unnecessary. The calculated combined moisture is equal to the difference of the measured total moisture in the flue gas minus the moisture in air. The mass balance is as follows:

$$\begin{aligned}&total\ vapor\ in\ flue\ gas - moisture\ in\ air\\&\qquad = H2O\ in\ fuel + H2O\ from\ combustion\ of\ H2 + quench\ vapor + SNCR\ carrier\ water\end{aligned}$$

The total water weight leaving the ash dischargers is calculated by multiplying the overall test bottom ash quantity by the test residue moisture content.

6.2.7 Page 7 - Reference Data

Enthalpies of the various parameters used in the calculations are summarized on page 7.

6.2.8 Page 8 – Heat Output & Losses

The boiler-as-a-calorimeter method is being used to obtain the boiler efficiency and MSW HHV. PTC 34 is the applicable Code since it deals with fuels that can't be sampled and ultimate analyses determined.

6.2.8.1 Heat Output

The heat output is based on the heat in the primary steam exiting the superheater outlet and the heat in the boiler blowdown exiting the drum. The heat output in primary steam will be based on the feedwater flow measurement less blowdown (if blowdown will be required for steam purity considerations) in conjunction with the boiler feedwater inlet and steam outlet conditions (temperature and pressure).

6.2.8.2 Heat Losses

Heat losses are determined in general accordance with ASME PTC 34. PTC 34 specifies either BTUH or % of heat input losses, while these calculations divide the MJ/h (BTUH) losses by the fuel rate in kg/hr (lb/hr) to obtain a MJ/kg (BTU/lb) fuel loss and subsequently the percent losses. The following losses are measured or estimated:

QrLDFg	Dry Gas
QrLWF, QrLApEv, QrLWAd	Combined moisture in the fuel, combustion of H2 in the fuel, ash discharger quench vapor, SNCR carrier water
QrLRsApW	Ash discharger quench water
QrLWDA	Moisture in combustion air
QrLUbC	Unburned combustible
QrLRs	Sensible heat in residue
QrLSrc	Radiation/convection (estimated from PTC 34 diagram)

For the heat loss due to sensible heat in the dry flyash, the quantity of flyash is assumed to be 10% of the total wet ash and the temperature is assumed to be the economizer exit gas temperature. The assumed 10% may be refined by mutual agreement of Covanta and the Region's Engineer based on quantities of flyash and bottom ash measured over the 30-Day Residue Quantity Test. For the unburned combustible loss, the flyash is assumed to have the same unburned combustible as the bottom ash.

An unaccounted loss QpLunac of 0.5% of heat input is applied to account for miscellaneous minor heat losses. Heat loss due to carbon monoxide will not be included as a separate heat loss calculation since it is a very minor heat loss and is included in the unaccounted loss.

6.2.9 Page 9 - Heat Credits, HHV & As-Tested Boiler Efficiency

The boiler efficiency calculations include the following heat credits. Heated underfire air and unheated air are considered separately. Unheated air consists of overfire air, seal air, air infiltration and VLN cooling air, (if needed). Air infiltration temperature is assumed to be the same as the measured overfire and seal air temperature.

QrBDA	Sensible heat in dry combustion air
QrBWA	Moisture in incoming air.
QrBF	Sensible Heat in fuel

The energy added by the VLN fan power is not included in the heat credit category in the waste HHV calculation. This assumption is considered reasonable since the heat credit due to VLN fan power represents a negligible amount of heat added to the controlled boundary and is considered to be offset by the additional radiation loss from the VLN duct. Eliminating this heat credit also simplifies the HHV test.

6.2.10 Page 10 - Annual Average Dry Bulb Correction

The air-cooled condenser and turbine exhaust performance curves necessary to perform the required adjustments to annual average ambient air temperature are included below. The average annual ambient temperature used is 8°C as shown in the weather data tables below for Toronto (Pearson Airport) and Oshawa. This adjustment for average air temperature is made independently of refuse HHV.

6.2.11 Page 11 – Adjusted Power Outputs Per Ton & Design Demonstrated Steam Flow

The gross and net electrical outputs in kWh are calculated per actual tonne of waste processed. These values averaged for all energy recovery tests are then compared to those in the guarantee table 3. of Exhibit 2 to Appendix 19 of the Project Agreement.

STATION_NAME	PROVINCE	_DECIMAL	E_DECIMA	ELEVATION	ORMAL_I	L_ELEMENT	MONTH	VALUE	LY_NORMA	L_NORMAN	N_NORMA	CCURRENC	IRST_YEAR	AST_YEAR
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	1	-5.49	A		A		1981	2010
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	2	-4.54	A		A		1981	2010
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	3	0.06	A		A		1981	2010
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	4	7.06	A		A		1981	2010
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	5	13.12	A		A		1981	2010
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	6	18.6	A		A		1981	2010
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	7	21.45	A		A		1981	2010
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	8	20.55	A		A		1981	2010
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	9	16.2	A		A		1981	2010
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	10	9.5	A		A		1981	2010
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	11	3.72	A		A		1981	2010
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	12	-2.18	A		A		1981	2010
TORONTO LESTER B. PEARSON INT'L A	ONT	43.67722	-79.6306	173400	1	Mean	13	8.17		A	A		1981	2010

OSHAWA, ONTARIO

Home > North America > Canada > Ontario

Elevation: 139 meters Latitude: 43 55N Longitude: 078 54W

WEATHER

- Monthly - Summary
  - Nearby
  - Forecast
- Monthly - All Data
- Climate Summary
- Daily Averages
- Hourly Data

CURRENT CONDITIONS

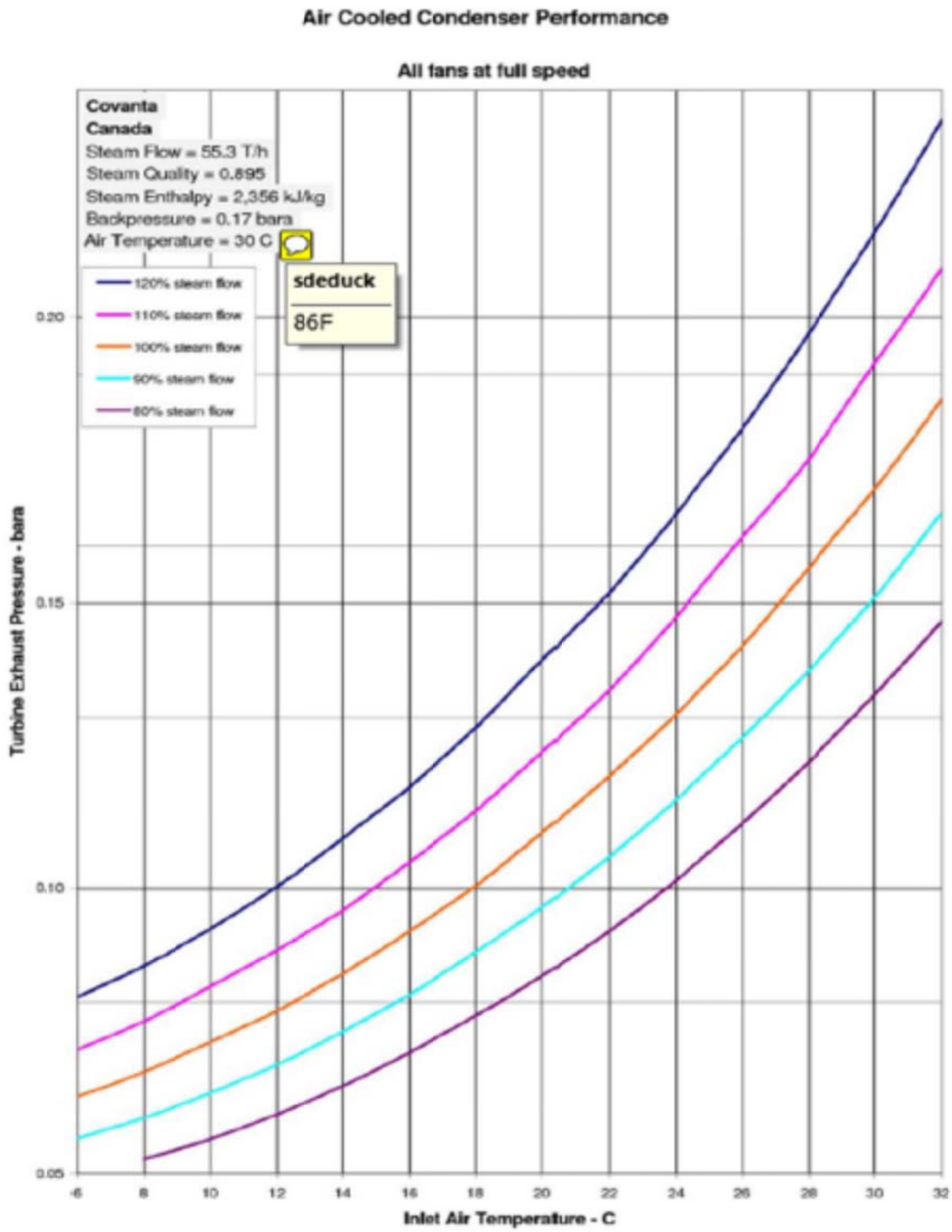
SHARE

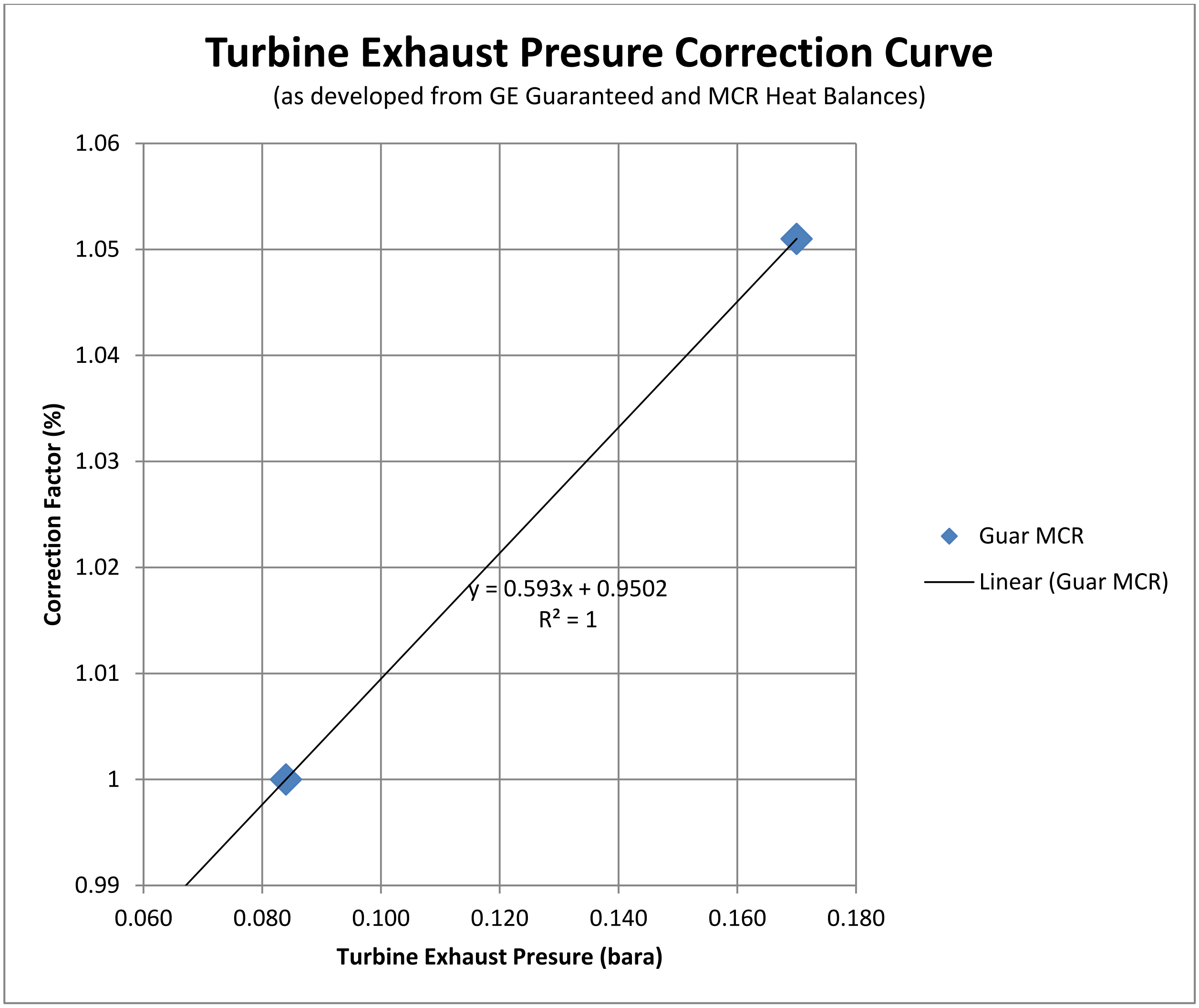
PRINT THIS DATA

MONTHLY - WEATHER AVERAGES SUMMARY [Show All Data] [°F] °C

Average Temperature Years on Record: 26

	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
C	8.1	-4.8	-3.6	0.4	6.6	12.3	17.6	20.6	20	15.9	9.5	4.2	-1.2


Air Cooled Condenser Performance
All fans at full speed
Covanta
Canada
Steam Flow = 55.3 T/h
Steam Quality = 0.895
Steam Enthalpy = 2,356 kJ/kg
Backpressure = 0.17 bara
Air Temperature = 30 C
sdeduck
86F
120% steam flow
110% steam flow
100% steam flow
90% steam flow
80% steam flow
Turbine Exhaust Pressure - bara
0.20
0.15
0.10
0.05
6
8
10
12
14
16
18
20
22
24
26
28
30
32
Inlet Air Temperature - C



6.2.11.1 Turbine Steam Rate Correction

If the refuse HHV is below the firing diagram limit of 10,467 kJ/kg (4500 BTU/lb), as shown in the Stoker Capacity Diagram, and the turbine throttle steam flow is less than the MCR amount of 67,300 kg/hr (148,330 lb/hr), then the turbine performance curve included below, will be used to determine a corrected turbine generator gross electrical output. This correction is only applied if the refuse HHV is less than 10,467 kJ/kg (4500 BTU/lb) and the turbine throttle flow is less than 67,300 kg/hr (148,330 lb/hr).

MARTIN GmbH

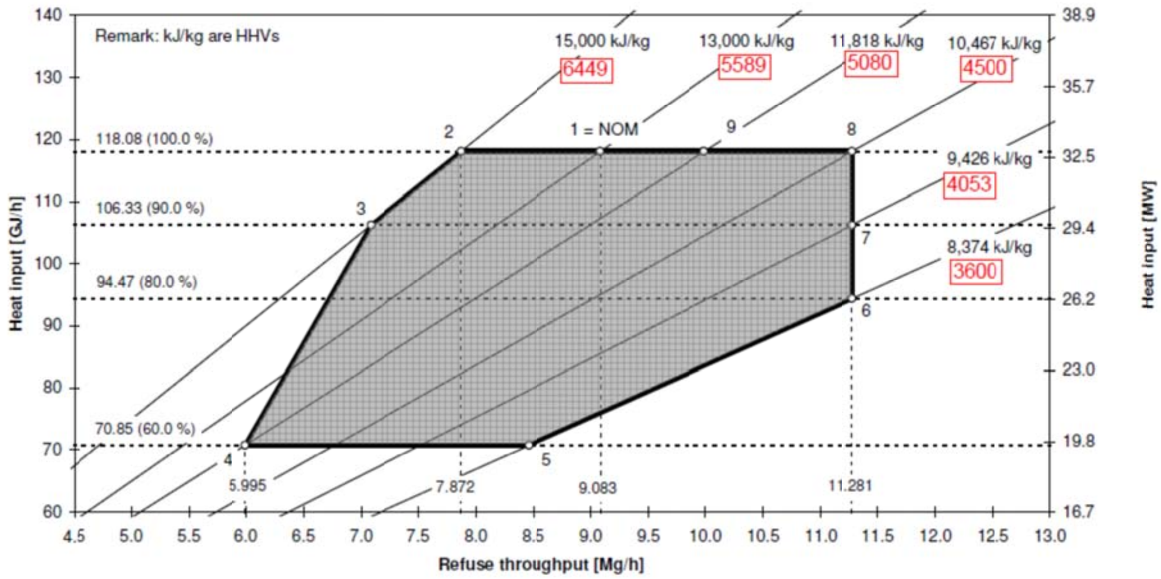
Stoker Capacity Diagram

Durham

Date: 03.05.2010
Project group: PA1 Hu
Document number: 00-050962-P1010 V1

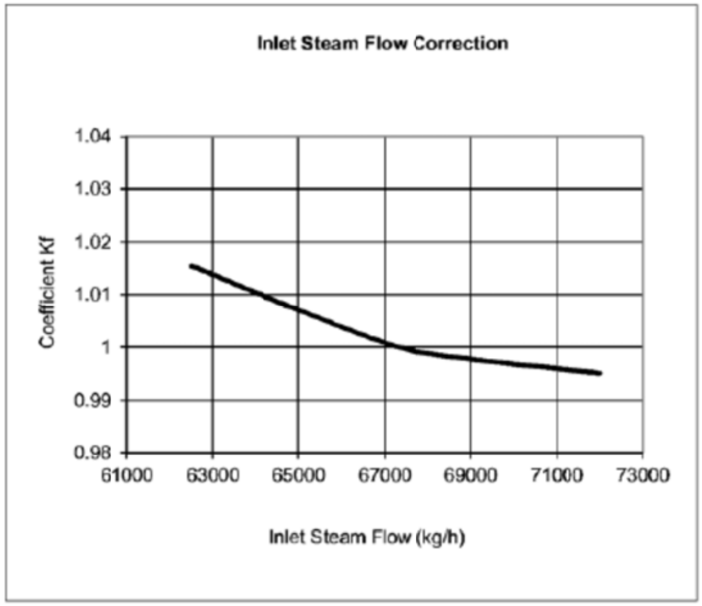
Number of runs : 2
Total width : 12' - 9 15/16" = 3,910 mm
Surface : 302.5 sqft = 28.1 m²
Number of steps : 13

Nominal load



06.05.2010 00-050962-P1010 FLD.XLS

2-8 Consumption Correction Curve versus Inlet Steam Flow



	TITLE:	DOCUMENT CODE	REVISION
GE Oil & Gas	PERFORMANCES CORRECTION CURVES	1TV0022NT2170	2
REVISION DESCRIPTION:		PAGE MARKER	SECURITY CODE

6.2.12 Page 11 - Adjusted Gross and Net Electrical Output

The adjusted gross and net electrical outputs (kw) from page 10 are divided by the actual throughput (tonne/hr) to obtain the outputs on a kwh/tonne basis. The adjusted electrical outputs on a kwh/tonne basis are then compared to the values on item 3 of Exhibit 2 Appendix 19 for demonstration of the guarantee at the appropriate waste HHV.

6.3 Averaging

The average result of the 3-5, 8-hour analyses will be used to compare the Project's as-tested Energy Recovery to that guaranteed at the appropriate waste HHV.

6.4 Uncertainty Analysis

The pre-test uncertainty analysis included at the end of these procedures, shows an uncertainty band of ± 2.3% on HHV or ~ 290 kJ/kg (125 BTU/lb).The analysis is only used for assessment of the quality of the test and not for test passage.

7 MANPOWER

7.1 Participants

The Energy Recovery Test and the 8-hour portion of the Residue Quality Test will be conducted by

Covanta, with the Owner and Owner's Engineer witnessing the testing.

7.2 Staffing Requirements

The normal Facility staff will be used to operate the Project during the testing. Additional Facility personnel will be utilized to staff and perform the various test duties during the test period. The anticipated test manpower requirements are as follows:

Control Room Data Acquisition and Test Coordination	2 persons
Balance of Plant Data Acquisition and Test Coordination	2-3 persons
Flue Gas Team	3-4 persons
Ash Sampling	3-4 persons
Ash Weighing (Total quantities)	1-2 persons
Crane Scale-Refuse Throughput-Manual Logging	1-2 persons

Test data sheets will be made available for review by the Owner's Engineer during and after the test. Temporary labor will be obtained to supplement the plant staff for residue sampling and other data collection as needed.

8 REFERENCES

8.1 Contracts & Codes

The Test procedures and sample calculations are based on the following:

8.1.1 **Agreement –** Project Agreement between, "The Regional Municipality of Durham" and "The Regional Municipality of York" as "Owner" and "Covanta Durham York Renewable Energy Ltd." as "DBO Contractor".

8.1.2 ASME PTC 34 – 2007 "Waste Combustors with Energy Recovery"

8.1.3 ASME PTC 4 – 1998 "Fired Steam Generators"

8.1.4 ASTM D 3302 – 07 "Standard Test Method for Total Moisture in Coal"

8.1.5 ASTM D 5468 – 02 (Reapproved 2007) "Standard Test Method for Gross Calorific and Ash Value of Waste Materials"

8.2 Tables & Figures

The following curves & diagrams have been obtained from the equipment manufacturers, test codes and other sources and included for use in making adjustments to reference performance parameters:

8.2.1 DCS Instrumentation List

8.2.2 Special Test Data List

8.2.3 8-hr Residue Sampling Chart

8.2.4 8-hr Residue Sampling Data Sheet

8.2.5 Process Diagram

8.2.6 Sample Energy Recovery & Boiler-as-A-Calorimeter Calculations

8.2.7 Energy Recovery & B-A-C Calculation Assumptions

8.2.8 PTC-34 Radiation Loss Diagram

8.2.9 ACC Performance Curve

8.2.10 Annual Average Weather Data for Toronto & Oshawa

8.2.11 Uncertainty Analysis

Except as noted, all data points logged once a minute by DAS.
UNITS 1 & 2 INSTRUMENT TAG NUMBERS HAVE PREFIX "1" & "2", RESPECTIVELY.

	Description	Tag No.		Remarks
	Flows (kg/hr)			
1	Feedwater	FIR-5252	**Proj. Agr.**	
2	Steam	FIR-5250	Proj. Agr.	Not used in calcs.
3	Continuous Blow Down		**Proj. Agr.**	By valve position
4	Total Air m3/h	FIR-4202	**Proj. Agr.**	
5	Secondary Air m3/h	FIR-4205	**Proj. Agr.**	PRI = TOT - SEC - SEAL
6	Seal Air m3/h	FIR-4206	**Proj. Agr.**	
7	Tertiary Air m3/h	FIR-4208	**Proj. Agr.**	
8	Hydrated Lime-Ca(OH)$_2$	WIC-4873	Info only	
9	Aqueous Ammonia l/h	FIR-3854	Info only	
10	Carbon	WIC-4882	Info only	
11	Natural Gas m3/h	FIR-3601		
	Temperatures (deg C)			
	Air & Gas			
12	Ambient Air	TIR-4218	**Proj. Agr.**	
13	Heated Air	TIR-4215	**Proj. Agr.**	Test Grid if used-takes precedence.
14	Tertiary Air	TIR-4216	Proj. Agr.	
15	Furnace Sidewall	TIR-4303	Info only	2 point average
16	Roof	TIR-4301	Info only	3 point average
17	2nd/3rd Pass	TIR-4312	Info only	
18	Evaporator Outlet	TIR-4318	Info only	
19	Superheater 2/3	TIR-4313	Info only	
20	Superheater 2/1.2	TIR-4314	Info only	
21	Superheater 1.3/1.2	TIR-4315	Info only	
22	Superheater 1.2/1.1	TIR-4316	Info only	
23	Econ. Inlet	TIR-4317	Info only	
24	Econ. Outlet/Quench Inlet	TI-4748	**Proj. Agr.**	
25	Quench Outlet	TI-4761	Info only	
26	Reactor Outlet	TI-47691/2/3	Info only	
27	Fabric Filter Outlet	TI-4846	Info only	
	Steam & Water			
28	Feedwater/Econ Inlet	TI-5211	**Proj. Agr.**	Same as SH attemp. Temp.
29	Econ Outlet	TI-5210	Info only	
30	SH 1.3 Outlet	TI-5209-1/2	Proj. Agr.	Left & Right
31	SH 4 Inlet	TI-5208-1/2	Proj. Agr.	Left & Right
32	SH 2 Outlet	TI-5207	Proj. Agr.	
33	SH 3 Inlet	TI-5206	Proj. Agr.	
34	SH3 Outlet	TIR-5223	**Proj. Agr.**	
	Pressures			
	Air & Gas mPa			
35	Primary Air	PIR-4203	Info only	
36	Secondary Air Front	PIT-4209	**Proj. Agr.**	
37	Secondary Air Rear	PIT-4210	**Proj. Agr.**	
38	Tertiary Header	PIT-4204	**Proj. Agr.**	
39	Tertiary Air Front	PIT-4211	Proj. Agr.	
40	Tertiary Air Rear	PIT-4213	Proj. Agr.	
41	Furnace Pressure	PIR-4302	Info only	
42	Evaporator Outlet	PIR-4309	Info only	
43	Horizontal SH dP	PDIR-4308	Info only	
44	Econ. Inlet	PIR-4318	Info only	
45	Econ. Outlet	PIR-4747	Info only	
46	Econ dP	PDIR-4310	Info only	
47	Quench dP	PDI-4749	Info only	
47a	Quench Outlet	PI-4764	Info only	

48	Reactor dP	PDI-4765	Info only	
48a	Reactor Outlet	PI-4770	Info only	
49	Filter dP	PDI-4790	Info only	
50	Filter Outlet	PI-4846	Info only	
	Steam & Water barg			
51	Feedwater	PIR-5242	**Proj. Agr.**	
52	Drum	PIT-5007	**Proj. Agr.**	
53	FSH Outlet	PIR-5240	**Proj. Agr.**	
	Miscellaneous			
54	ID Fan Speed	SI-4847	Info only	
55	Boiler Drum Level cm/inch	LT-5001	Info only	
	Quench Inlet/Econ Outlet	AE-4740		CEM System
56	Wet O2 (%)		Per CofA	"
57	Dry O2 (%)		**Proj. Agr.**	"
58	Dry SO2 (ppm)		Per CofA	"
59	Dry CO (ppm)		**Proj. Agr.**	"
60	Dry HCl (ppm)		Per CofA	"
61	Dry THC (ppm)		"	"
	Filter Outlet (dry vol)	AE-4712		CEM System
62	HF		Per CofA	"
63	HCl		"	"
64	NH_3		"	"
65	O_2		"	"
66	CO		"	"
67	CO_2		"	"
68	SO_2		"	"
69	NO_x		"	"
70	H_2O		"	"
71	Flow		"	"
72	Opacity		"	"
	Common			
73	Turbine Throttle Press barg	PIR-0216	Proj. Agr.	
74	Turbine Throttle Temp (°C)	TIR-0215	Proj. Agr.	
75	Turbine Throttle Flow kg/hr	FIR-0201	Proj. Agr.	
76	Turbine Exhaust Pressure bara	PIT-800	Info only	
77	Turbine Exhaust Temp (°C)	TI-0802	Info only	
78	Condensate Tank Temp (°C)	TI-0849	Info only	
78a	LP FW HTR #1 Inlet condensate (°C)	TI-0942	Info only	
79	Ambient Air Temp (°C)	TI-0803 A/B	**Proj. Agr.**	
80	DA Press barg	PIR-0406	Info only	
81	DA Storage Tank Temp (°C)	TI-0403	Info only	
82	FW Temp (°C)	TIR-0440	Info only	
83	FW Press barg	PIR-0441	Info only	
84	Turbine Gross Elec. Output (MW)	MFM-G1-SEL	**Proj. Agr.**	735 METER
85	Net Electrical Output (MW)	MFM-L1-SEL	**Proj. Agr.**	735 METER
86	In-plant Elec xfmr 101/102	DM-101/102	**Proj. Agr.**	
87	In-plant Elec xfmr 103/104	DM-103/104	**Proj. Agr.**	
88	In-plant Elec xfmr 105/106	DM-105/106	**Proj. Agr.**	

Notes:

"Proj. Agr." means required to be logged by the Project Amendment
"Proj. Agr." in bold means:
relied upon data used in calculations
must be calibrated for test
calibration check documentation provided to consultant prior to test.
Remainder of data is for informational purposes only.

TABLE 1B

Covanta Durham-York
SPECIAL TEST INSTRUMENTATION LIST

Special Test Data points collected for performance tests.
All data from these instruments are used in calculations.
Where applicable, the instruments must be calibrated prior to test.
Any calibration documentation must be provided to HDR prior to test.

	Description	Frequency	Method
1	Waste Quantity	Each grapple	Crane scales
2	Residue Quantity	8 hours	Truck Scales
3	Residue Carbon Content	10 Minutes	Lab Analysis
4	Residue Moisture Content	10 Minutes	Lab Analysis
5	Heated Combustion Air Temp	1 Minute	3 pt.local T/C grid
6	Barometric Pressure	60 Minutes	Barometer
7	Ash Discharger Quench Bath Temperature	1 Minute	Test T/C
8	Combustion air humidity	1 Minute	Test probe/datalogger
9	Secondary & seal air temperature	1 Minute	Test T/C & datalogger
10	Economizer exit flue gas flow (pitot traverses)	30 minutes	EPA Methods 1 & 2
11	Economizer exit flue gas O_2/CO_2 by electronic analyzers	1 min.	EPA Method 3
12	Economizer exit flue gas H_2O (moisture trains changed every 2 hours)	2 hours/ continuous	EPA Method 4

Residue Sampling Procedure
8-Hour Test (Bottom Ash Only)

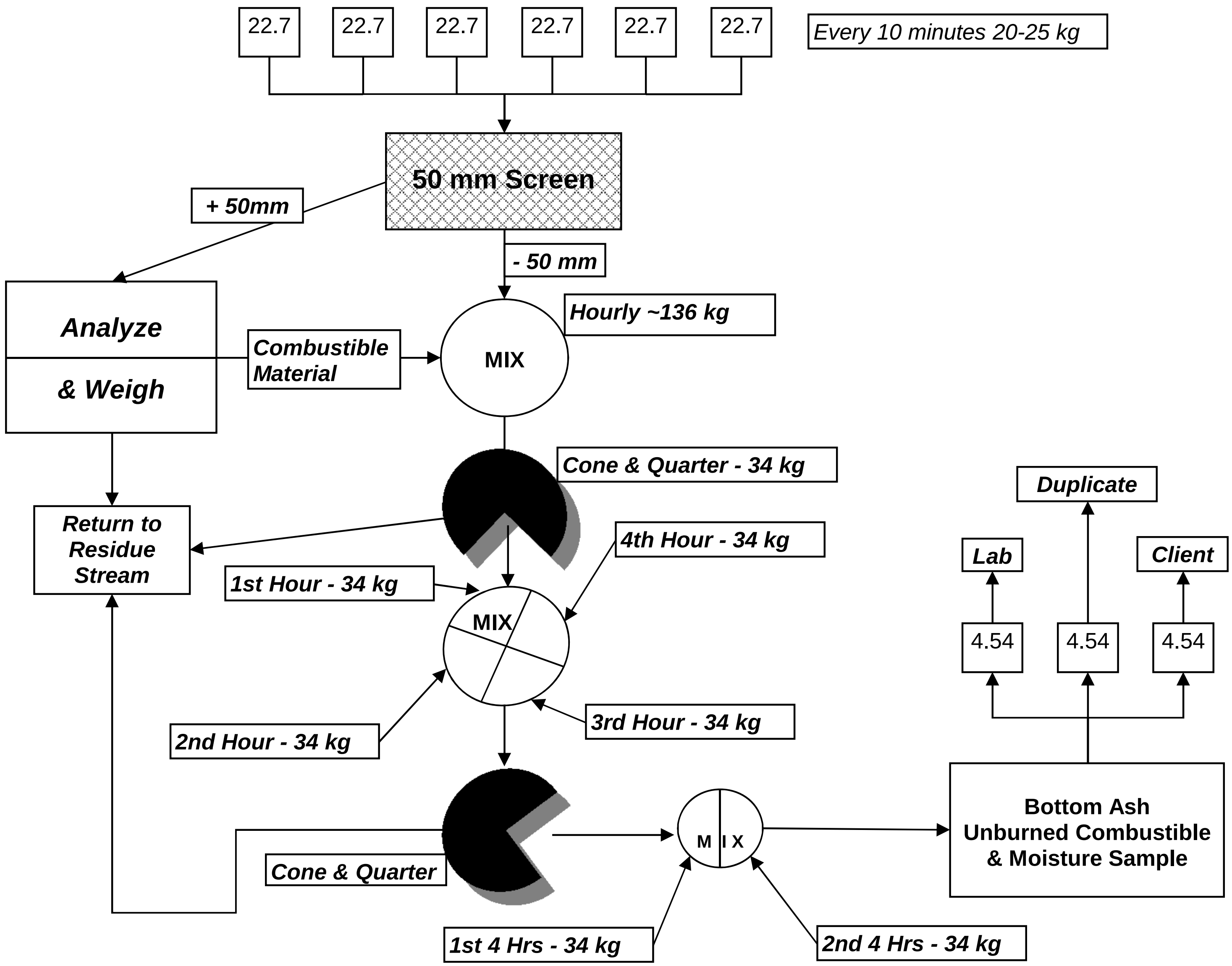
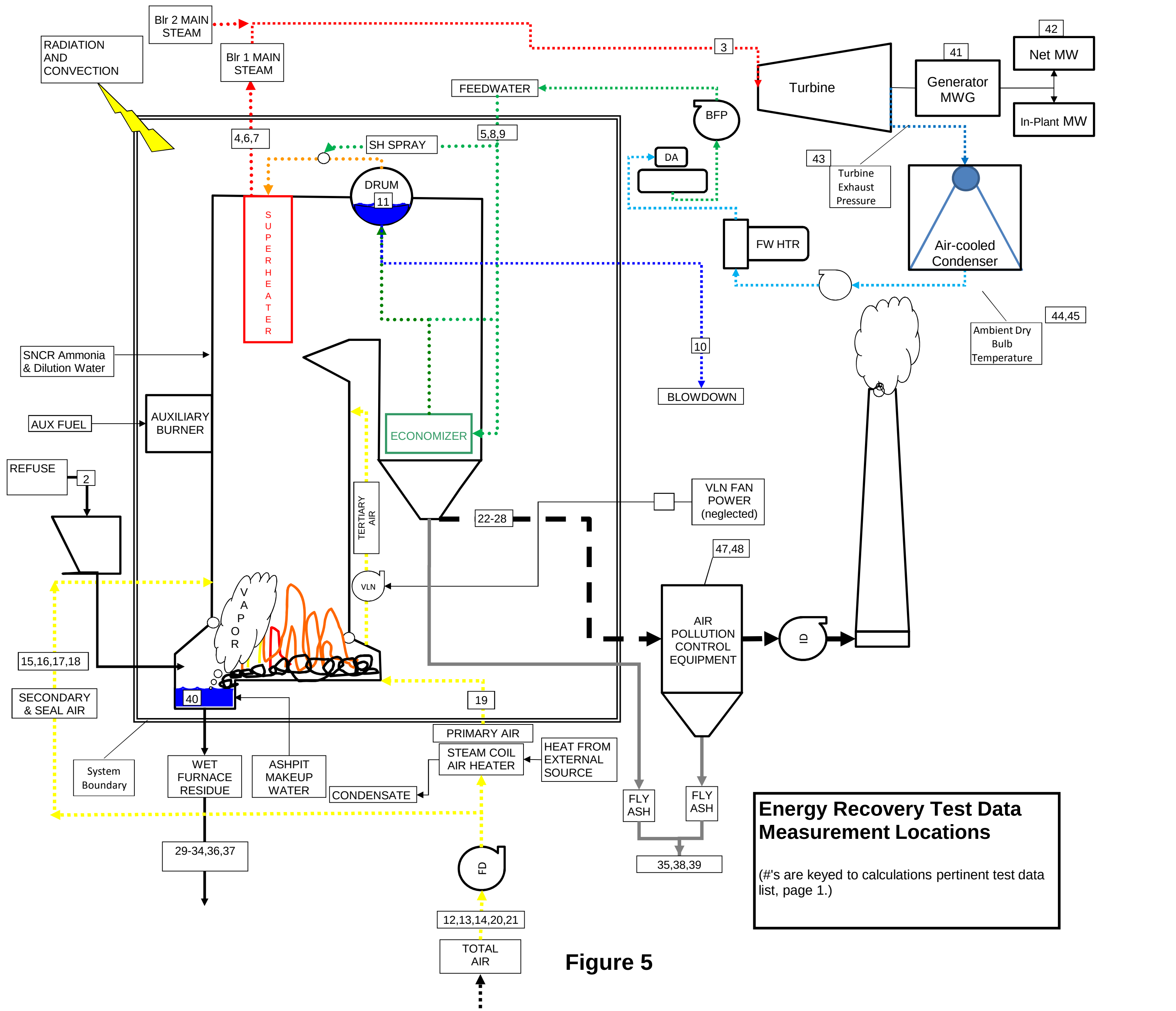


Figure 1

Covanta Durham-York
8 Hour Test Bottom Ash Sampling

Date: ________________

	Time (10 min. intervals)	Sample Number	Sample Weight (~ 22.7 kg)	Screened Weight + 50 mm	- 50 mm
Hour 1		1			
		2			
		3			
		4			
		5			
		6			
Sub-total					
Hour 2		1			
		2			
		3			
		4			
		5			
		6			
Sub-total					
Hour 3		1			
		2			
		3			
		4			
		5			
		6			
Sub-total					
Hour 4		1			
		2			
		3			
		4			
		5			
		6			
Sub-total					
4 hr totals					



Energy Recovery Test Data Measurement Locations

(#'s are keyed to calculations pertinent test data list, page 1.)

Figure 5

TABLE 1

PERTINENT TEST DATA

Test Name: Martin Data

Test Date:

Test Start: Test End:

	Item	Units	Unit 1	Unit 2	Average or Wtd. Avg. or Total	Measurement Source
1	Test duration	hours	8.0	8.0	8.00	----
2	Refuse feed rate	kg/hr	9,083	9,083	18,167	Crane Weigh Cell
3	Total FW/Steam flow	kg/hr	-		-	Station Instrument
4	Main steam flow	kg/hr	34,300	34,300	68,600	Station Instrument
5	Feedwater flow	kg/hr	35,000	35,000	70,000	Station Instrument
6	Suphtr. stm temperature	°C	499.0	499.0	499.0	Station Instrument
7	Suphtr. stm pressure	barg	89.7	89.7	89.7	Station Instrument
8	Feedwater temperature	°C	135.0	135.0	135.0	Station Instrument
9	Feedwater pressure	barg	96.6	96.6	96.6	Station Instrument
10	Continuous blowdown rate	kg/hr	700	700.0	1,400	Verify Valve Closed
11	Boiler drum pressure	barg	95.2	95.2	95.2	Station Instrument
12	Inlet air dry bulb temp.	°C	-	-	26.7	Digital Psychrometer
12A	Relative humidity %	%	-	-	15.6	Digital Psychrometer
13	Inlet air wet bulb temp.	°C	-	-	20.9	Calculated
14	Total air flow	m^3/h	42,010	42,010.0	84,020	Station Instrument
15	Overfire air flow	m^3/h	5,400	5,400.0	10,800	Station Instrument
16	Seal air flow	m^3/h	1,350	1,350.0	2,700	Station Instrument
17	Overfire air pressure	mbar	40.0	40.0	40.0	Station Instrument
18	OFA and Seal air temp after fan	°C	30.0	30.0	30.0	Test T/C, wtd. avg.
19	Heated underfire air temperature	°C	93.3	93.3	93.3	Test T/C Grid wtd avg.
20	Barometric pressure	mbara	- -		1013.1	Barometer
21	Moisture in combustion air	kg/kg dry ai			0.0131	Calculated
22	CO_2 in dry flue gas	% vol	12.835	12.835	12.84	Manually @ Econ. Outlet
23	O_2 in dry flue gas	% vol	7.448	7.448	7.45	Manually @ Econ. Outlet
24	N_2 in dry flue gas	% vol	79.72	79.717	79.72	Calculated
25	H_2O in flue gas	% vol	14.563	14.563	14.56	Manually @ Econ. Outlet
26	Flue gas flow	act m^3/h	80,201	80,201	160,403	Manually @ Econ. Outlet
27	Economizer exit gas temp.	°C	166.0	166.0	166.0	Station Instrument
28	Sampling point gas temp.	°C	166.0	166.0	166.0	Manually @ Econ. Outlet
	Residue:					
	Sample (Bottom Ash)					
29	Fines (-2")	kg			1,960	Manual Residue Sampling
30	Overs (+2")	kg			218	Manual Residue Sampling
	Total Flow					
31	Grizzly Rejects	kg			2,722	Truck Scale
32	Ferrous	kg			7,258	Truck Scale
33	Non-Ferrous	kg			726	Truck Scale
34	Bottom Ash	kg			24,957	Truck Scale
35	Fly Ash **10.00%**	kg			2,773	Calculated from assumed %
36	Moisture in -2" bottom ash bottom ash	%			20.0	Laboratory Analysis
37	Combustibles in -2" bottom ash	dry %			3.00	Laboratory Analysis
38	Moisture in flyash leaving test boundary	%			0.0	Assumed zero %
39	Combustibles in flyash	dry %			3.00	Assumed same % as BA
40	Ash discharger water bath temp	°C	54.4	54.4	54.4	Test Thermocouples
41	Turbine Gross MW	MWG			17.13	Station Instrument
42	Net MW Exported	MWN			15.07	Station Instrument
43	Turbine Exhaust Pressure	bara			0.10	Station Instrument
44	ACC Ambient Air Temperature	°C			13.3	Station Instrument
45	Annual average dry bulb temp.	°C	-		7.8	Historical weather data

AS TESTED PERFORMANCE PARAMETERS
TABLE 2
RESIDUE ANALYSIS

Sample Weights		Combined Ash kg	Combined Ash %
	+2" to -8" Material	218	10.0
	-2" Material	+ 1,960	+ 90.0
	-8" Material	2,177	100.0

Total Weights			Combined Ash (kg)	Flyash (kg)
	Bottom Ash (Excluding +8" Grizzly Material & All Metals)		24,957	2,773
-2" Ash	-2" Wet Ash @	90.0%	22,462	
-2" Ash	Moisture of wet ash	20.0%	4,493.0	
-2" Ash	Dry Aggregate (by difference)		17,969	2,773
-2" Ash	Combustibles of dry aggre	3.00%	539	83
-2" Ash	Dry Ash (by difference)		17,429	2,690
	Total +2" to (-8")	10.0%	2,496	
	+8" Grizzly Material, Ferrous & Non-Ferrous Metals (metals and inerts)		10,705	

Component Weights	Combined Ash				Fly Ash			
	kg	(1) kg/h	(2) %	(3) kg/kg fuel	kg	(1) kg/h	(2) %	(3) kg/kg fuel
Dry Ash + Inerts:								
-2" Ash	17,429	2,179			2,690	336		
+2" to (-8")	2,496	312						
+8" Grizzly, Ferrous & Non-Fe	10,705	1,338						
Subtotal	30,630	3,829	90.25	0.2108	2,690	336	7.92	0.0185
Unburned Combustible								
-2" Combustible	539	67.4			83	10.4		
+2" to (-8") Combustible	0	0			0	0		
Subtotal	539	67.4	1.59	0.0037	83	10.4	0.25	0.0006
Total Dry Residue :	**31,169**	**3,896.1**	**91.8**	**0.215**	**2,773**	**347**	**8.2**	**0.019**

Notes:
(1) Divisor is 8 hours
(2) % of Total Dry Residue (excluding Carbon Injection)
(3) Divisor is 18,167 kg/hr of refuse

TABLE 3

FLUE GAS FLOW & ANALYSIS
(Based on Average Data for Test Runs @ Econ. Exit)

	% VOL (DRY)	% VOL (WET)	M.W. kg/kg-mol	R.W. (DRY)	R.W. (WET)	% WT (DRY)	% WT (WET)	KG/HR
CO2	12.835	10.966	44.010	5.649	4.826	18.60	16.89	21,473
O2	7.448	6.363	32.000	2.383	2.036	7.85	7.13	9,059
N2	79.717	68.108	28.016	22.334	19.081	73.55	66.79	84,897
H2O		14.563	18.016	0.000	2.624	0.00	9.19	11,674
Totals	100.0	100.00		30.366	28.567	100.0	100.0	127,102

From flue gas report, average flow = 160,403 a m3/hr
Gas temperature @ sampling point = 166 °C

Specific volume = $\frac{8.314 \times (273.15 + 166\ °F)}{28.567 \times (1.013\ bara) \times (cm2/m2)}$ = 1.262 m3/kg

Wet gas mass flow = 160,403 / 1.262 = 127,102 kg/hr

Percent excess air = $\frac{(O2 - CO/2) \times 100}{0.2682 \times N2 - (O2 - CO/2)}$ = 53.46 %

(per ASME PTC 19.10 Flue and Exhaust Gas Analysis, Section 6.03.6.3.1)

		deg C	deg Kelvin	deg F
Enthalpies From PTC-4, 5.19.4 & 5.19.11	Flue Gas Temp @ econ out	166.0	439.2	330.8

	Flue Gas @ Economizer Outlet		
	Enth. (H) (kJ/kg)	R.H. (WET)	R.H. (DRY)
CO2	128.37	21.69	23.88
O2	131.72	9.39	10.34
N2	145.83	97.41	107.26
H2O	266.73	24.50	0.00
Totals		152.98	141.47

Total Measured Air Flow

Average uncorrected total wet air flow in cfm is taken from Table 1.

Total Wet Air Flow = 84,020 m3/hr Assumes 26.67 °C temperature
(Uncorrected)

Inlet Air Specific Volume at T = 26.67 °C = 299.8 °K
Corrected Total Air Flow = 84,020 m3/h = 84,020 x V 299.8 / V 299.8

Specific Volume of Dry Air = (26.67 + 273.15) x 8.314 / (1.013 x 28.97) = 0.8493 m3/kg

Dry Air Density = 1 / 0.8493 = 1.1774 kg/m3

Wet Air Density = 1.0131 kg wet air/kg dry air x 1.1774 kg dry air/m = 1.1929 kg wet air/m3

Total Measured Wet Air 84,020 acmh › 1.1929 kg wet air/m3

= **100,226** kg/hr

Moisture in Total Measure Air = (0.0131 x 100,226) / (1 + 0.0131) = **1,297.0** kg/hr

Overfire Air and Seal Air Flow

Average uncorrected wet overfire air flow & seal air flow in cfm is taken from Table 1.

Wet Overfire Air Flow = 10,800 cmh Assumes 26.67 °C temperature
Wet Seal Air Flow = 2,700 cmh Assumes 26.67 °C temperature
Combined OFA & Seal Air Flow = 10,800 + 2,700 = 13,500 cmh @ 40.0 mbar

OFA & Seal Air Specific Volume at T = 30 °C = 303.2 °K
Corrected OFA & Seal Air Flow = 13,575 acmh = 13,500 x V 303.2 / V 299.8

Specific Volume of Dry Air = (30.0 + 273.15) x 8.314 / (1.053 x 28.97) = 0.8261 m3/kg

Dry Air Density = 1 / 0.8261 = 1.2105 kg/m3

Wet Air Density = 1.0131 kg wet air/kg dry air x 1.2105 kg dry air/m = 1.2264 kg wet air/m3

OFA & Seal Air (Wet) = 13,575 acmh › 1.2264 kg wet air/m3

= **16,648** kg/hr

Moisture in OFA & Seal Air = (0.0131 x 16,648) / (1 + 0.0131) = **215.4** kg/hr

Wet Underfire Air =
Total Wet Air - Wet OFA & Seal Air = 100,226 - 16,648 = **83,578** kg/hr
Moisture in Underfire air =
Total Air H_2O - OF & Seal Air H_2O = 1,297.0 - 215.4 = **1,081.6** kg/hr

(Continued from Page 4)

Assume ref. waste N2 content of test fuel = 0.87 %
Therefore, N2 in flue gas from fuel =

18,167 kg fuel/hr x 0.0087 kg N2/kg fuel = 158 kg/hr

N2 in flue gas = 84,897 kg/hr

Total Dry comb. air supplied (Incl. Air Infiltration) = $\frac{84{,}897 - 158}{0.7685}$ = **110,265** kg/hr

Moisture in air = 0.0131 kg/kg dry air from psychrometric chart for 26.67 °C db / 20.89 °C wb, therefore

Moisture in Calculated Total Air = 0.0131 x 110,265 = **1,445.6** kg/hr

Total Calculated wet air = 110,265 + 1445.6 = **111,711** kg/hr
(Including Air Infiltration & VLN cooling air)

Total Calculated Wet Air (including air infiltration & VLN cooling air) is greater than Total Measured Wet Air
Wet Air Infiltration (incl. VLN cooling air) = Calculated Total Wet Air - Measured Total Wet Air
= 111,711 - 100,226
= 11,485 kg/hr

Wet Un-heated Air = Total Wet Air - Wet UFA
= 111,711 - 83,578
= 28,133 kg/hr

Moisture in Wet Air Infiltration (incl. VLN cooling air) = Total Air Moisture - Moisture in Measured Total Ai
= 1,445.6 - 1,297.0
= 148.6 kg/hr

Calculated moisture in Flue Gas from H_2 and H_2O in fuel and Ash Discharger Quench Water Vapor:

A water balance around the boiler gives:

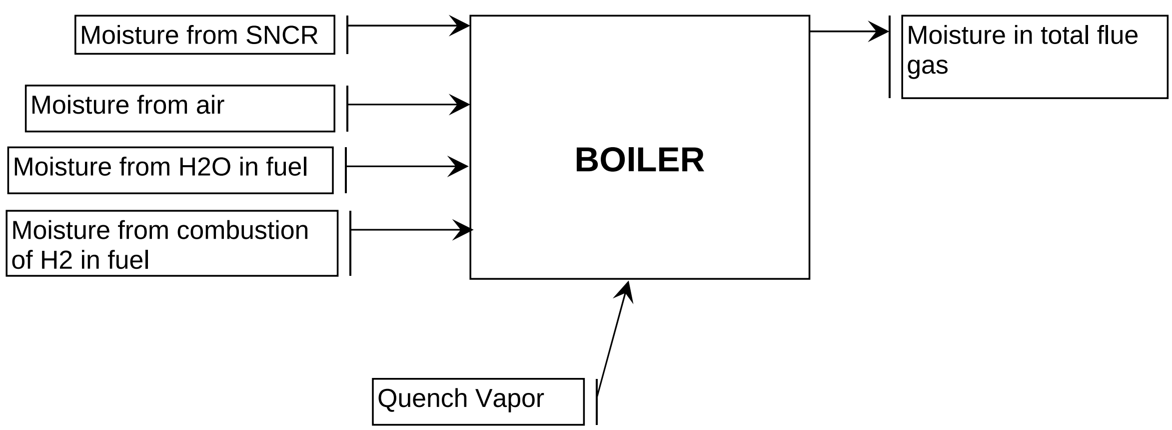
Vapor in flue gas = moisture from H2 and H20 in the fuel + moisture in air + quench vapor + SNCR & carrier water

Therefore:

Moisture from H2 and H2O in fuel + quench vapor + SNCR & carrier water = Vapor in gas - moisture in air

= 11,674 - 1,445.6

= 10,229 kg/hr = 0.563 kg/kg FUEL



DATA FOR HEAT OUTPUT AND LOSS CALCULATIONS

Enthalpy of feedwater @	135 °C,	9761.33 kPa	574.06	kJ/kg
Enthalpy of drum water @ saturated pressure		9623.33 kPa	1391.5	kJ/kg
Enthalpy of steam @	499 °C,	9071.33 kPa	3383.91	kJ/kg
Enthalpy of dry underfire air at 93.3°C comb. temp. referenced to 25°C			68.85	kJ/kg
Enthalpy of dry overfire air at 30.0°C air temp. referenced to 25°C			5.02	kJ/kg
Enthalpy of dry flue gas at 166.0°C econ exit temp. referenced to 25°C			141.47	kJ/kg
Enthalpy of liquid water @ the amb. air temperature of 26.7°C ref. 0°C			111.65	kJ/kg
Enthalpy of water vapor @ UFA temp. of 93.3°C ref. 25°C			128.14	kJ/kg
Enthalpy of water vapor @ the OFA temp. aft. fan of 30.0°C ref. 25°C			9.28	kJ/kg
Enthalpy of steam vapor @ 166.0°C and 1 psia referenced to 0°C			2813.92	kJ/kg
Enthalpy of liquid water @ reference temperature of 25°C ref. 0°C			104.67	kJ/kg
Enthalpy of water vapor @ econ exit temp. of 166.0°C referenced to 25°C			266.7	kJ/kg
Enthalpy of ash discharger water bath @ 54.4°C			228.0	kJ/kg
Enthalpy of dry residue @ air inlet temp of 26.7°C		299.8 °K	1.241	kJ/kg
Enthalpy of dry residue @ ash discharger temp of 54.4°C or		327.6 °K	22.834	kJ/kg
Enthalpy of dry fly ash @ econ. exit temp. of 166.0°C or		439.2 °K	120.174	kJ/kg
HHV of unburned combustibles			27,913	kJ/kg
Radiation & convection loss per ASME PTC 34, Fig. I-1				
with 97.0 GJ/hr actual average heat output per boiler, 2 boilers =			1.506	GJ/hr
Enthalpy of dry fuel @ ambient temp. of 26.7°C ref. 25°C			1.254	kJ/kg
Enthalpy of liquid water @ ambient temp. of 26.7°C ref. 25°C			7.0	kJ/kg

Reference documents:

ASME Performance Test Code for Fired Steam Generators, ASME PTC 4
ASME Performance Test Code for Waste Combustor with Energy Recovery, ASME PTC 34
ASME Steam Tables 1967 Edition

Table 4 - Reference Composition Acceptable Waste

Energy Content 12,995 kJ (HHV) per kilogram

REFERENCE WASTE ULTIMATE ANALYSIS

	%
Moisture	15.16
Total Inert	15.92
Carbon	31.73
Hydrogen	4.56
Oxygen	31.35
Nitrogen	0.87
Sulfur	0.04
Chlorine	0.31
Flourine	0.030
Iron, oxidizable	0.030
	100.00

BOILER EFFICIENCY CALCULATION
AS TESTED CONDITIONS
-HEAT LOSS METHOD-
(ASME PTC 34, SECTION 5.11)

kJoule per kg A.F. Fuel

HEAT OUTPUT due to-

Steam:
(kg/hr of fluid)/(kg/hr fuel) x (h out - h in, kJ/kg)
68,600 / 18,167 x (3,383.91 - 574.06) = 10,610.48

Blowdown:
(kg/hr of fluid)/(kg/hr fuel) x (h out - h in, kJ/kg)
1,400 / 18,167 x (1,391.45 - 574.06) 62.99

Total Heat Output: = 10,673.47

HEAT LOSSES due to-

Dry gas:
(kg/hr dry gas)/(kg/hr fuel) x (flue gas h @ Tgas econ exit ref. 25°C, kJ/kg)
115,428 / 18,167 x (141.47) = 898.91

Moisture from H2 and H2O in fuel, ash discharger quench water vapor and SNCR carrier water:
(kg/hr moisture)/(kg/hr fuel) x (h econ gas exit @ 1 psia - h liquid @ T = 25°C, kJ/kg)
10,229 / 18,167 x (2813.92 - 104.67) = 1525.45

Ash discharger quench water:
Liquid: (kg/hr liquid)/(kg/hr fuel) x (h water @ Tquench - h water @ Tamb air, kJ/kg)
562 / 18,167 x (227.96 - 111.65) = 3.60

Sensible heat in dry bottom residue:
(kg/hr dry residue)/(kg/hr fuel) x (h res @ Tquench - h res @Tamb air, kJ/kg)
3,896 / 18,167 x (22.834 - 1.241) = 4.63

Sensible heat in dry fly ash residue:
(kg/hr dry residue)/(kg/hr fuel) x (h res @ Tecon exit - h res @Tamb air, kJ/kg)
347 / 18,167 x (120.174 - 1.241) = 2.27

Moisture from total air:
(kg/hr air moisture)/(kg/hr fuel) x (h water vap @ Tgas econ exit ref. 25°C, kJ/kg)
1,446 / 18,167 x (266.7) = 21.23

Unburned combustibles:
(lb unburned combustibles/hr)/(kg/hr fuel) x HHV unburned
77.80 / 18,167 x 27,913 = 119.54

Radiation & Convection Loss:
Per ASME PTC 34, Fig. I-1 = 1.506 GJ/hr
1,506,091 / 18,167 = 82.90

Unaccounted for:
0.5 % of heat output and losses (heat input) = 66.99
0.005 x (10,673.5 + 2,725.5)

Total Heat Losses: = 2725.52

HEAT CREDITS due to- kJoule per kg A.F. Fuel

Dry underfire air sensible heat:
(kg/hr dry air)/(kg/hr fuel) x (h in @ 93.3°C ref. 25°C, kJ/kg)
82,496 / 18,167 x (68.85) = 312.66

Dry overfire air, seal air & air infiltration sensible heat:
(kg/hr dry air)/(kg/hr fuel) x (h in @ 30.0°C ref. 25°C, kJ/kg)
27,769 / 18,167 x (5.02) = 7.68

Moisture in incoming underfire air:
(kg/hr moisture)/(kg/hr fuel) x (h vap in @ 93.3°C ref 25°C, kJ/kg)
1,081.6 / 18,167 x (128.14) = 7.63

Moisture in incoming overfire, seal air & air infiltration:
(kg/hr moisture)/(kg/hr fuel) x (h vap in @ 30.0°C ref 25°C, kJ/kg)
364.0 / 18,167 x (9.28) = 0.19

Fuel sensible heat:
(dry fuel, lb dry fuel/lb fuel) x (h in @ ambient air temp of 26.7°C ref 25°C, kJ/kg) +
(moisture in fuel, lb H2O/lb fuel) x (h in @ ambient air temp of 26.7°C ref 25°C, kJ/kg)
0.848 x 1.254 + 0.152 x 6.98 = 2.12

Total Heat Credits: 330.28

Gross Heat Input = HHV of Fuel + Heat Credit = Heat Output + Heat Losses

or

HHV of FUEL = Heat Output + Heat Losses - Heat Credit
= 10673.47 + 2725.52 - 330.28
= **13,069** kJ/kg

EFFICIENCY= (1 - (Heat Losses/Heat Input))*100= (1 - 2725.52 / 13,399) x 100 = **79.66** %

Gross Heat Input = 13,399 kJ/kg

HEAT LOSS SUMMARY:

	%
Dry gas:	6.71
Moisture from H2 and H2O in fuel, ash discharger quench water vapor & SNCR:	11.38
Moisture from total air:	0.16
Ash discharger quench water: Liquid:	0.03
Sensible heat in dry bottom residue:	0.03
Sensible heat in dry fly ash:	0.02
Unburned combustibles:	0.89
Radiation/Correction:	0.62
Unaccounted for:	0.50
Total Heat Losses:	20.34

Adjustment For Annual Average Dry Bulb Temperature

Turbine performance is dependent upon exhaust vacuum, which is dependent upon air-cooled condenser (ACC) performance. ACC performance is dependent upon the dry bulb ambient air temperature. An adjustment is made to the as-tested ACC performance for the difference between the average annual dry bulb temperature and the as-tested dry bulb temperature. Per average local weather conditions: (see Procedures page 10)

The average annual dry bulb temperature = 8 °C

Air-Cooled Condenser Performance:

The as-tested ACC ambient dry bulb temperature was: **13.3** °C
Per the ACC performance curve, (see Figures section) the condenser vacuum corresponding to the as-tested dry bulb temperature of 13.3 °C is: 82.3 mbara
Per the ACC performance curve, the condenser vacuum corresponding to the average annual dry bulb temperature of 8 °C is: 68.0 mbara
Therefore, the correction to exhaust pressure for temperature difference is 14.3 mbar

Turbine Performance:

Per the curve defining change in exhaust pressure vs. change in turbine-generator output (see page 12 of procedures), a 14.3 mbar change in exhaust pressure at design throttle flow results in a 0.85% change in turbine heat rate. Therefore, the overall adjusted gross electrical output is :

17.13 * (1 + 0.0085) = 17.28 **MWG**

The MW correction is also added to the as-tested NET electrical exported:

15.07 + 17.28 - 17.13 = 15.22 **MWN**

See SAMPLE CALCULATION CURVES at the end of these procedures.

Adjusted Power Outputs Per Ton:

Gross Electrical Output = 17,471 kW adjusted for annual average dry bulb temperature. / 18.167 Actual TPH = 962 kWh/tonne

Compared to the guarantee of 876 kWh/tonne at the same HHV.

Surpassing the guarantee by: 86 kWh/tonne
or 9.8%

Net Electrical Export = 15,415 kW adjusted for annual average dry bulb temperature. / 18.167 Actual TPH = 849 kWh/tonne

Compared to the guarantee of 774 kWh/tonne at the same HHV.

Surpassing the guarantee by: 74 kWh/tonne
or 9.6%

Demonstrated Design Steam Flow =

Actual steam flow (kg/hr) x 13.0 MJ/kg x 436.0 Tonne/Day
/ As-tested HHV x As-tested throughput

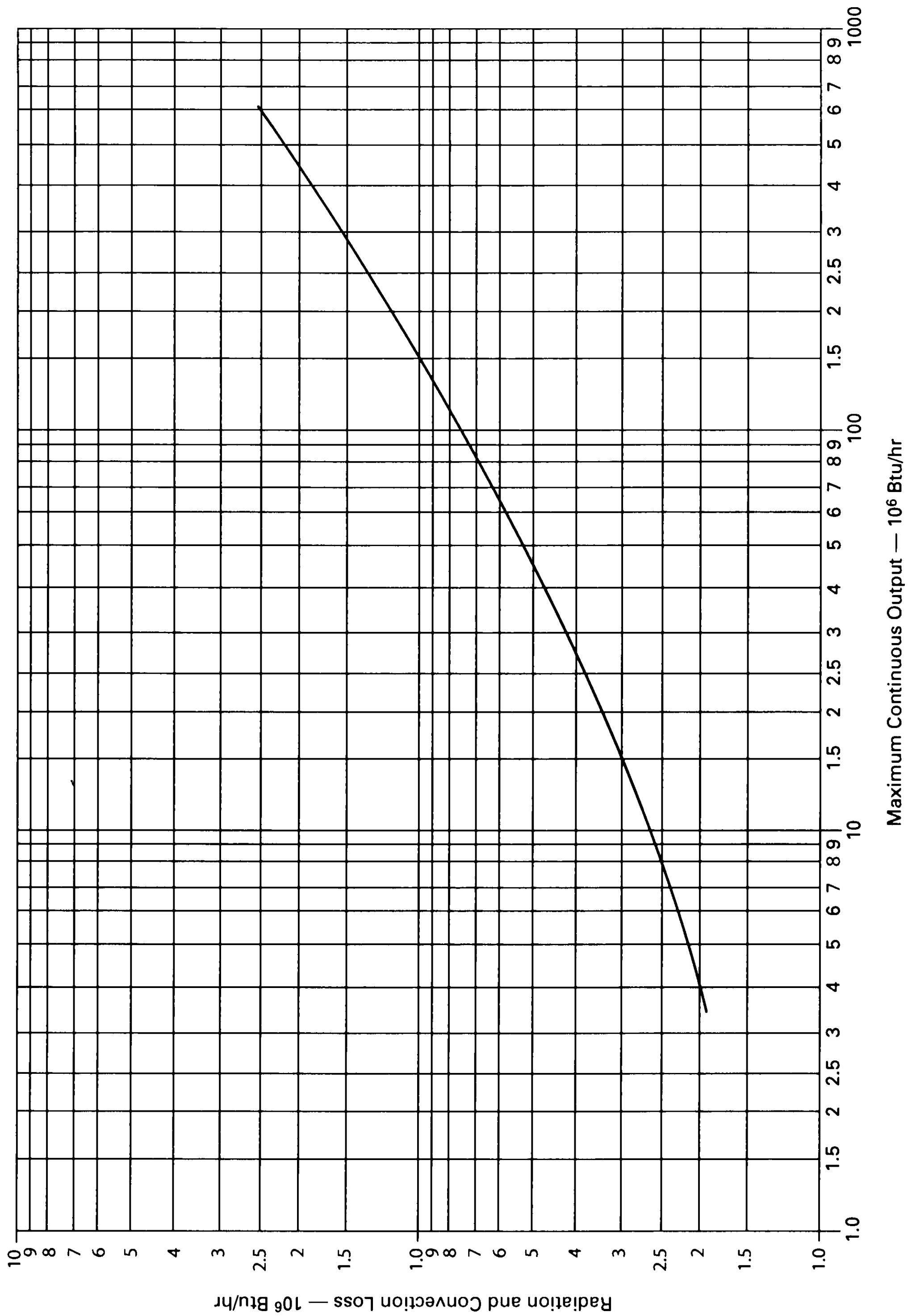
68,600 kg/hr x 13.0 MJ/kg x 436.0 Tonne/Day
/ 13.07 MJ/kg x 435.9975 Tonne/Day

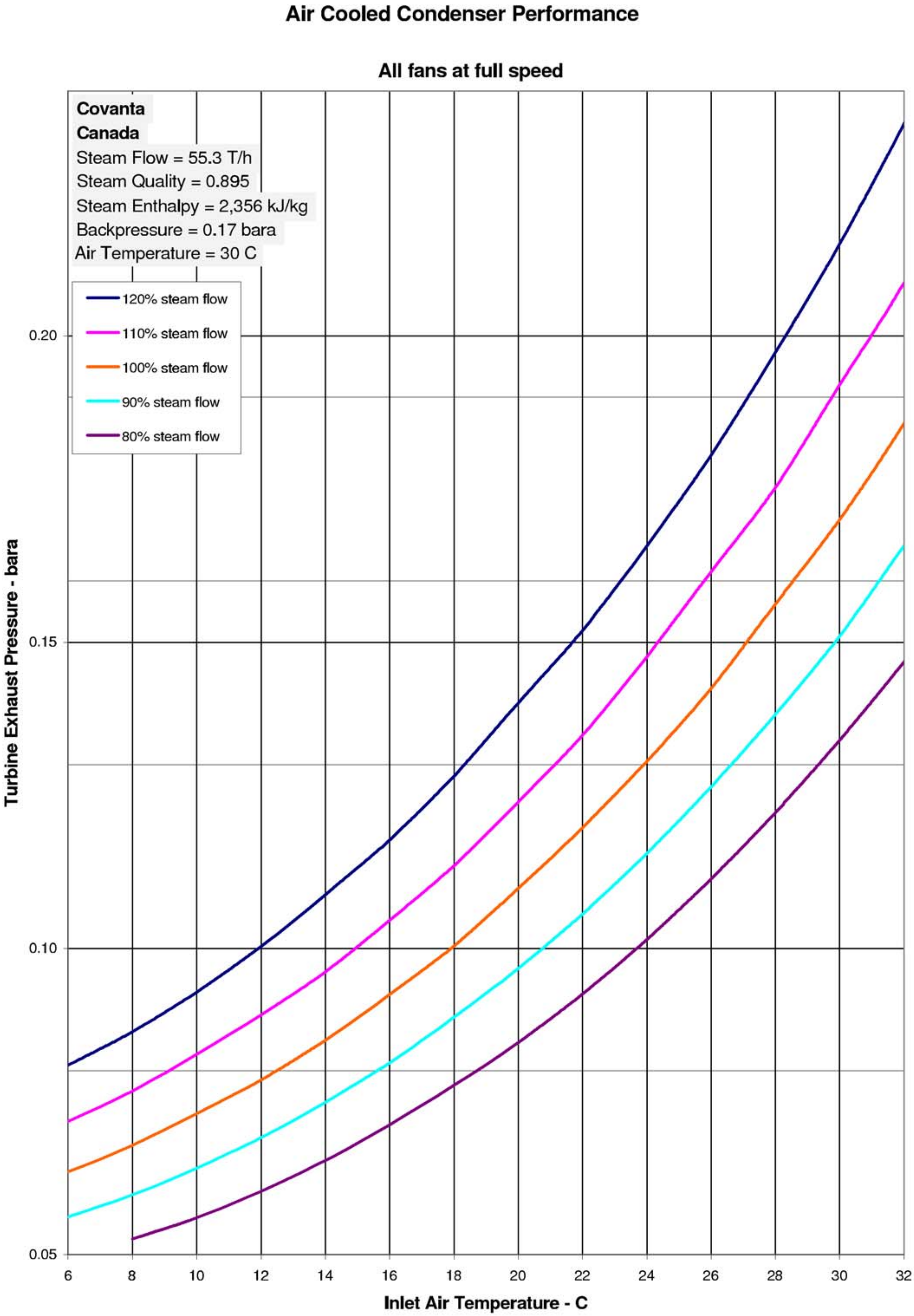
= 68,240 kg/hr

	List of Constants & Assumptions for Boiler-As-Calorimeter Calculations
1	Main steam flow used only as a check against FW flow.
2	Boiler blowdown used for example only. CBD closed for HHV test.
3	Inlet air dry & wet bulb temperatures (or relative humidity) taken on charging floor.
4	+50 mm material, grizzly, ferrous and non-ferrous assumed to have no moisture & no unburned combustible.
5	Fly ash assumed to have no moisture and same unburned combustible as bottom ash.
6	CO in flue gas is small enough to be neglected.
7	Make-up water to ash discharger & SNCR and its carrier water assumed to be same temperature as water in fuel/MSW.
8	All dry fly ash leaving boiler assumed to be at same temperature as economizer exit gas temperature.
9	HHV of unburned combustibles taken as 27.913 MJ/kg in unbC loss calculation.
10	Unburned combustible detection limit assumed if unburned combustible is not detected.
11	Unaccounted losses of 0.5% assumed.
12	Bottom ash to flyash ratio assumed as 90%. Can be refined based on 30-Day Residue quantity results.
13	Reference Waste Nitrogen content of 0.87% by weight assumed in calculation of total air by N_2 balance.

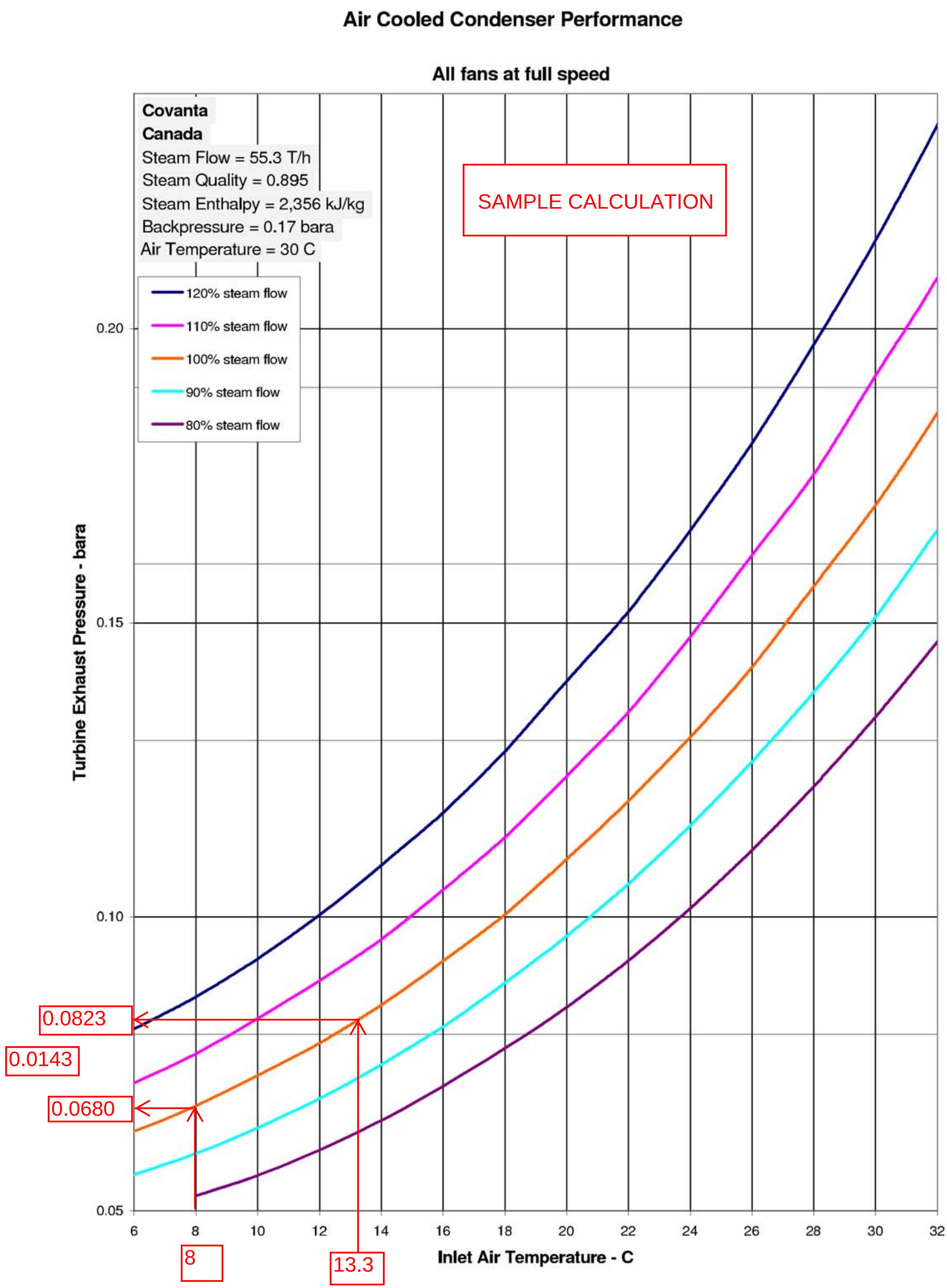
Table 6

Fig. I-1 Standard Radiation and Convection Loss Chart

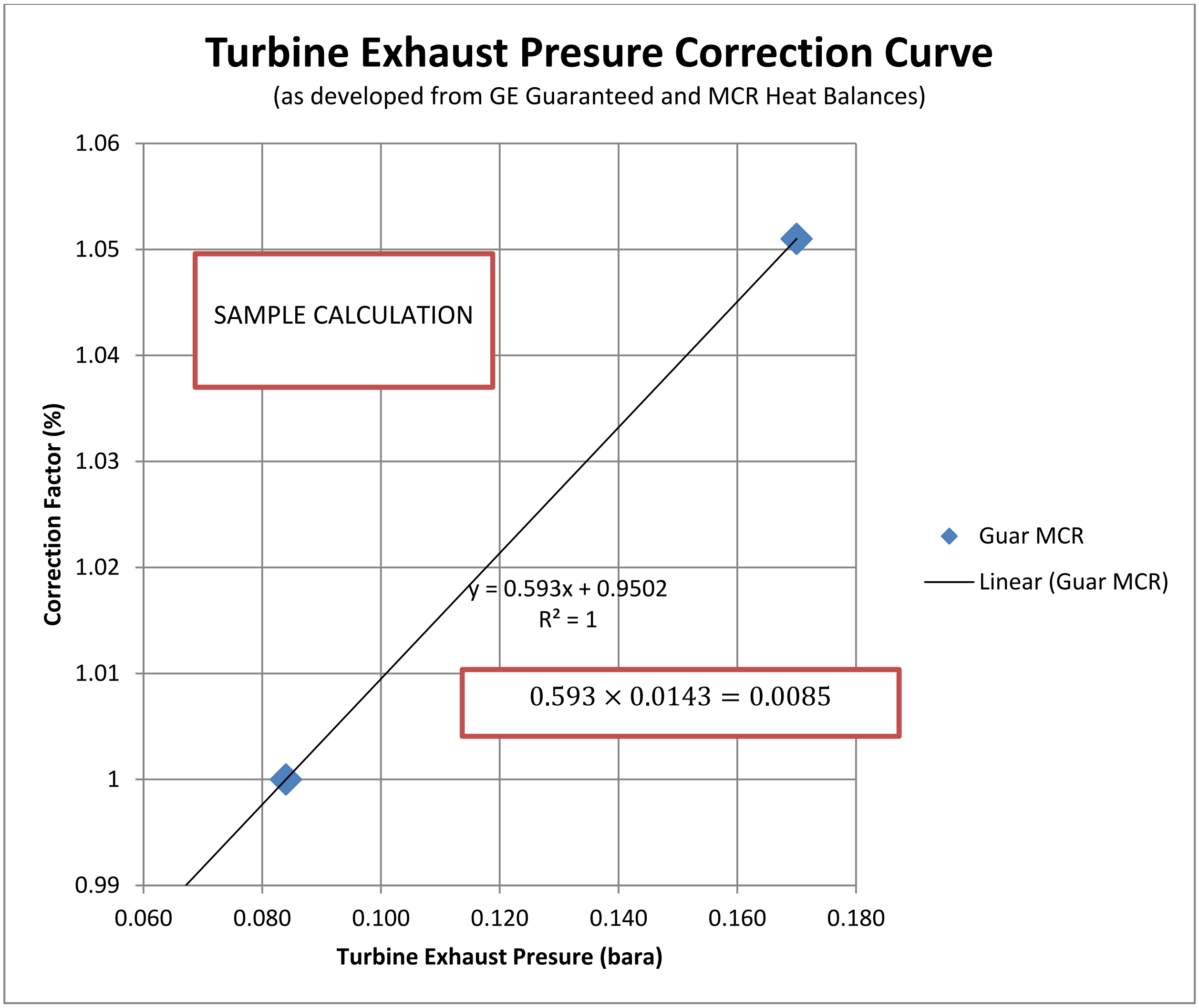




Air Cooled Condenser Performance
All fans at full speed
Covanta
Canada
Steam Flow = 55.3 T/h
Steam Quality = 0.895
Steam Enthalpy = 2,356 kJ/kg
Backpressure = 0.17 bara
Air Temperature = 30 C
120% steam flow
110% steam flow
100% steam flow
90% steam flow
80% steam flow
Turbine Exhaust Pressure - bara
0.20
0.15
0.10
0.05
6
8
10
12
14
16
18
20
22
24
26
28
30
32
Inlet Air Temperature - C



Air Cooled Condenser Performance
All fans at full speed
Covanta
Canada
Steam Flow = 55.3 T/h
Steam Quality = 0.895
Steam Enthalpy = 2,356 kJ/kg
Backpressure = 0.17 bara
Air Temperature = 30 C
120% steam flow
110% steam flow
100% steam flow
90% steam flow
80% steam flow
SAMPLE CALCULATION
Turbine Exhaust Pressure - bara
0.20
0.15
0.10
0.05
0.0823
0.0143
0.0680
6
8
10
12
14
16
18
20
22
24
26
28
30
32
8
13.3
Inlet Air Temperature - C


Turbine Exhaust Presure Correction Curve
(as developed from GE Guaranteed and MCR Heat Balances)
SAMPLE CALCULATION
y = 0.593x + 0.9502
R² = 1
0.593 × 0.0143 = 0.0085
Guar MCR
Linear (Guar MCR)
Correction Factor (%)
1.06
1.05
1.04
1.03
1.02
1.01
1
0.99
0.060
0.080
0.100
0.120
0.140
0.160
0.180
Turbine Exhaust Presure (bara)

1 PERFORMANCES TABLE

			I Guaranteed Performance	II Maximum Continuous Rating (MCR)	III Design VWO	IV Air Heater Design Point	V In-Plant Load	VI District Heating Mode
TURBINE INLET FLANGE	Pressure	bars a	89.7	89.7	89.7	89.7	89.7	89.7
	Temperature	°C	497	497	497	497	497	497
	Flow	kg/h	67300	67300	72000	68500	10700	64780
BLEED 1	Pressure	bars a	15.2	15.2	16.4	14.4	-	14.6
	Enthalpy	kj/kg	3040	3040	3040	3026	-	3040
	Temperature	°C	301	301	303	294	-	300
	Flow	kg/h	2710	2710	2839	6640	0	2710
BLEED 2	Pressure	bars a	4.5	4.5	4.9	4.3	-	3.4
	Enthalpy	kj/kg	2809	2809	2810	2798	-	2772
	Temperature	°C	178	178	180	172	-	157
	Flow	kg/h	1489	1489	1294	1599	0	13954
BLEED 3	Pressure	bars a	2.2	2.2	2.4	2.1	-	1.7
	Enthalpy	kj/kg	2701	2701	2702	2692	-	2672
	Temperature	°C	124	124	126	122	-	115
	Flow	kg/h	3061	2995	3386	2837	0	2229
BLEED 4	Pressure	bars a	0.9	1.0	1.0	0.9	-	0.7
	Enthalpy	kj/kg	2573	2577	2573	2568	-	2547
	Temperature	°C	97.9	98.5	99.6	97.3	-	90.3
	Flow	kg/h	5666	4334	6697	4037	0	3822
TURBINE EXHAUST FLANGE	Pressure	bars a	0.084	0.17	0.068	0.17	0.164	0.08
	Enthalpy	kj/kg	2311	2376	2296	2375	2687	2312
	Temperature	°C	42.5	56.6	38.5	56.6	100	41.5
	Flow	kg/h	54304	55702	57714	53317	10658	41994
	Moisture	%	11.2	9.6	11.5	9.7	0.0	11.0
ROTATING SPEED	Turbine	tr/min	5900	5900	5900	5900	5900	5900
Power at Generator Terminals		**KW**	**17570**	**16720**	**19080**	**16390**	**1500**	**15550**

		FUEL HHV UNCERTAINTY - BAC METHOD: MEASURED GAS WEIGHT							
		SENSITIVITY	RANDOM	SYSTEMATIC		RANDOM	SYSTEMATIC	RANDOM	SYSTEMATIC
	kJ/kg	COEFF	%	%		% HHV	% HHV	% HHV^2	% HHV^2
Base HHV	12996.9	1%							
H_2O/moisture in wet gas, %	13013.0	-16.0	0.00	10.00		0.00	-160.50	0.00	25759.95
Refuse fuel flow rate, kg/hr	12869.5	127.5	0.50	0.50		63.73	63.73	4062.08	4062.08
Vol flow rate wet gas, m3/hr	13020.7	-23.7	0.50	5.00		-11.86	-118.63	140.73	14073.02
MS Temp (°C)	13045.8	-48.8	0.50	2.00		-24.42	-97.70	596.52	9544.33
FW Flow (kgh)	13028.8	-31.9	0.50	2.00		-15.93	-63.73	253.88	4062.08
FW Temp (°C)	12971.6	25.4	0.50	2.00		12.68	50.71	160.71	2571.34
N_2,% where gas weight measured	13001.4	-4.4	1.50	10.00		-6.63	-44.20	43.95	1953.23
% C res:bottom ash	12998.1	-1.2	0.00	20.00		0.00	-23.26	0.00	541.06
Air temp lvg SCAH, °C	12991.4	5.6	0.10	4.00		0.56	22.33	0.31	498.64
Total Air Flow, m3/hr	12993.0	4.0	0.50	5.00		1.98	19.77	3.91	390.92
Wet bulb temp, °C	12988.6	8.4	0.30	2.00		2.51	16.75	6.31	280.49
MS Press (bar)	12992.7	4.2	0.50	2.00		2.09	8.37	4.38	70.12
Econ Exit Gas temp (meas), °C	13000.9	-4.0	0.25	2.00		-0.99	-7.91	0.98	62.55
MF res:bottom ash	12996.2	0.7	0.00	10.00		0.00	6.98	0.00	48.70
Dry bulb temp, °C	12999.3	-2.3	0.80	1.25		-1.86	-2.91	3.46	8.45
Air temp ent AH, °C	12996.2	0.7	0.10	4.00		0.07	2.79	0.00	7.79
Overfire Air Flow, m3/hr	12997.4	-0.5	0.50	5.00		-0.23	-2.33	0.05	5.41
CO_2,% where gas weight measured	12997.6	-0.7	1.50	1.50		-1.05	-1.05	1.10	1.10
Barometric press, mm hg	12996.0	0.9	0.01	2.00		0.01	1.86	0.00	3.46
Res temp:bottom ash	12997.2	-0.2	1.25	5.00		-0.29	-1.16	0.08	1.35
O_2,% where gas weight measured	12997.2	-0.2	1.50	3.00		-0.35	-0.70	0.12	0.49
FW Press (bar)	12996.7	0.2	0.50	2.00		0.12	0.47	0.01	0.22
% C res:fly ash	12996.9	0.0	0.00	20.00		0.00	0.00	0.00	0.00
MF res:fly ash	12996.9	0.0	0.00	10.00		0.00	0.00	0.00	0.00
Aux equip drive input, kwh	12996.9	0.0	0.20	2.00		0.00	0.00	0.00	0.00
Seal Air Flow, m3/hr	12996.9	0.0	0.50	5.00		0.00	0.00	0.00	0.00
							SUM	5,278.59	63,946.77
Base HHV, kJ/kg	12996.9								
RandomUncertainty	72.7	20278.2							
Systematic Uncertainty	252.9	63946.8							
Student's T	1.96	84225.0							
Overall Uncertainty (kJ/kg)	290	290.2							
Overall Uncertainty (%)	2.23								

Table 9

Durham/York Energy from Waste Project

Acceptance Test Procedures

Metals Recovery Tests

COVANTA ENERGY

June, 2014

1 OBJECTIVE

1.1 Ferrous Recovery Test

The objective of the Ferrous Recovery Test is to demonstrate that the Facility ferrous recovery system will recover from the Residue, 80% by weight of magnetic ferrous metal material greater than 2.5 cm (1") contained therein as stated in the Metals Recovery Guarantee in Exhibit 2 to Appendix 19 of the Project Agreement.

1.2 Non-Ferrous Recovery Test

The objective of the Non-Ferrous Recovery Test is to demonstrate that the facility non-ferrous metal recovery system, will recover from the Residue 60% by weight of non-ferrous metal material greater than 1 cm (3/8") contained therein as stated in the Metals Recovery Guarantee in Exhibit 2 to Appendix 19 of the Project Agreement.

2 PROCEDURES

2.1 Test Schedule & Concurrent Tests

The Ferrous and Non-Ferrous Recovery Tests may be performed anytime during the 30-Day Reliability Test period and not necessarily during the 5-Day Throughput Capacity Test period. Sampling for the Ferrous and Non-Ferrous Recovery Tests will be performed concurrently. Three, 8-hour Ferrous and Non-Ferrous Recovery Tests must be performed on three separate days to satisfy the Project Agreement requirements.

2.2 *Boiler Load*

Boiler steam load must average at least 95% of design MCR for each of the 3, 8-hour test runs.

2.3 *Results*

A weighted average of the results from the three test runs shall be used to determine the extent to which the Facility meets the Metals Recovery Guarantee stated in Section 1.1 and Section 1.2, respectively.

2.4 Sampling Procedure

Each of the 8-hour test runs will adhere to the following procedures. Please refer to Figure 1, the Residue Flow Diagram, for a graphical representation of the following test procedures. Individual residue stream designator in Figure 1 is keyed to the following test procedure.

2.4.1 General

Only bottom ash discharged from the boiler ash dischargers will be sampled. Fly ash does not have to be sampled or weighed. Further details of sampling location and practical sampling techniques will be confirmed when the Facility starts up. The Owner's Engineer, HDR will be consulted for agreement on these details.

2.4.2 Sampling Location and Sample Quantity

The residue stream for determination of the unrecovered ferrous ratio and unrecovered non-ferrous metal ratio will be sampled downstream of the eddy current separator of the non-ferrous metal recovery system. This stream contains both the un-recovered ferrous and un-recovered non-ferrous metals that were missed by the system. A front end loader bucket or other suitable container will be used to collect the sample in bay #3 of the residue building. Samples will be obtained by positioning the front end loader or other suitable container in this bay.

These samples will be collected at one-half (1/2) hour intervals, targeting 91 kg (200 pounds) each. Each of these samples will be partially processed for unrecovered ferrous metals every half hour and fully processed every hour. The remaining sampled material after extracting unrecovered ferrous will be combined and stored for further processing after the 8-hour sample collection period to determine the weight of unrecovered non-ferrous metal.
During each run, sample weights may vary to produce a total 8-hour sample residue weight of approximately 1,450 kg (3,200 pounds).

2.4.3 Ferrous Samples

After collecting the residue to be sampled with the front end loader or other suitable container, there are nine (9) steps to determine the weight of the plus 2.5 cm (1") unrecovered ferrous material.

2.4.3.1 Step 1 – Screen

The raw collected samples ***(S)*** will be screened through a nominal 2.5 centimeter (1") screen. Note the quantity ***(S)*** is not directly weighed, but calculated by weighing the screened components, ***X+Z & Y***.

2.4.3.2 Step 2 – Weigh

2.4.3.2.1 *Step 2a*

The plus 2.5 cm (1") fraction ***(X+Z)*** will be collected and weighed.

2.4.3.2.2 *Step 2b*

The minus 2.5 cm (1") fraction ***(Y)*** will be collected and weighed.

2.4.3.3 Step 3 – Magnet

The plus 2.5 cm (1”) material ***(X+Z)*** will be evenly spread out on the floor and then a permanent or electro magnet will be passed over the sample at a distance of approximately 2.5 cm (1”) to extract the unrecovered ferrous metal ***(X)***.

2.4.3.4 Step 4 – Weigh

The plus 2.5 cm (1”) ferrous fraction ***(X)*** is the unrecovered ferrous metal which will be collected and weighed.

2.4.3.5 Step 5 – Segregate

The plus 2.5 cm (1”) ferrous fraction ***(X)*** will be visually separated into two piles, one that is clearly and predominantly metal (X'_A) and another that is clearly small bits of metal engulfed in clinker, (X''_A).

2.4.3.6 Step 6 – Weigh

Each pile (X'_A) & (X''_A) from Step 5.

2.4.3.7 Step 7 – Crush

Remove the clinker from the small metal (X''_A) by hand-crushing with sledges & hammers.

2.4.3.8 Step 8 – Magnet

The crushed material (X''_A) will be evenly spread out on a concrete floor and then a permanent or electro magnet will be passed over the sample at a distance of approximately 2.5 cm (1”) to extract the unrecovered ferrous metal, (X'_B).

2.4.3.9 Step 9 – Weigh

The encapsulated metal extracted from the clinker, (X'_B). No ferrous is to be discarded even if it is broken up into pieces less than 2.5 cm (1”). The crushed off clinker material (X''_B) is returned to the sample pile in order to process for unrecovered non-ferrous metal.

2.4.4 Non-Ferrous Samples

Please refer to Figure 2, the Non-Ferrous Sample Processing Diagram, for a graphical representation of the following test procedures.

2.4.4.1 Recombine, Cone & Quarter Samples

After being processed for unrecovered plus 2.5 cm (1”) ferrous metals described above in Section 2.4.3, all remaining sampled residue will be re-combined ($Y + Z + X''_B$), coned and quartered and one quarter from each ½ hour stored in a 5-

gallon pail for further processing to determine the weight of unrecovered plus 1cm (3/8") non-ferrous metal material.

2.4.4.2 Sample Processing Methodology

When the 8-hour sample collection process is completed, one-quarter of the re-combined residue sample remaining after extraction of the plus 2.5 cm (1") unrecovered non-ferrous metal will be reintroduced into the existing Facility eddy current separator (ECS) to extract the unrecovered non-ferrous metal material.

2.4.4.3 Processing Preparations

- Prior to re-running the sample residue through the ECS, the ECS conveyor shall be cleared of any residue, the Residue system upstream of the ECS will be turned off to avoid mixing sample residue with fresh bottom ash and all non-ferrous metal will be cleared from the floor of bay #4.
- The ECS diverter plate will be positioned closer to the ECS to help prevent missing any non-ferrous again. The degree to which the plate will be adjusted will be agreed upon with the Owner's Engineer based on observed system operation and trials prior to the testing.
- A tarp will be draped in the exit housing of the ECS/diverter plate to catch the small amount of initially unrecovered non-ferrous metal material.

2.4.4.4 Sample Processing and Analysis

The 8-hour samples will be slowly & evenly poured onto ECS conveyor belt from the 5-gallon pails. Once the entire 8-hour combined residue samples have been processed, the unrecovered non-ferrous metals will be collected from the tarp, separated from any ash contamination using a hand-held metal detector and weighed. This weight ***(w)*** is the amount of non-ferrous metals which was missed in the first run of non-ferrous metal recovery process and consequently considered the "unrecovered" non-ferrous metals.

2.4.5 Grizzly Scalper (A)

The oversize material will be collected in the bulk material drop off area at the base of the grizzly scalper. This area will be cleared of any material prior to and at the end of each test run. The oversized material will be visually inspected on a regular basis to identify and exclude non-metallic material from the pile. The grizzly scalper ferrous extracted during the test period will be collected and then weighed on one of the Facility truck scales using either the front-end loader, a truck or a suitable container and applicable tare weights.

2.4.6 + 2.5 cm (1") Process Ferrous (B)

The process ferrous will be the metal extracted by the magnetic drum separator. This material then passes over the 2.5 cm (1") vibrating conveyor screen and continues to the process ferrous conveyor, which drops the process ferrous into bay #1 during the test period. The process ferrous will be collected and then weighed on one of the Facility truck scales. Minus 2.5 cm (1") material drops into bay #2. Bay #1 will be scraped clean both prior to and at the end of each 8-hour test run.

2.4.7 +1 cm (3/8") Non-Ferrous Metal (C)

The eddy current separator separates the ash and non-ferrous metal after passing over the 1cm (3/8") vibrating screen conveyor. The extracted non-ferrous metal is then conveyed to non-ferrous load-out bay #4. From there it will be collected and weighed on the truck scale. The minus 1cm (3/8") material drops into bay #3. Bays #3 & #4, and if possible, Bay #2 will all be scraped clean both prior to and at the end of each 8-hour test run.

2.4.8 Bottom Ash (D)

This material is the remaining ash that has been separated out with the process ferrous and the process non-ferrous metal and will collected in bay #3. This material is the residue to be sampled for unrecovered ferrous and unrecovered non-ferrous metals and to which the unrecovered ferrous and unrecovered non-ferrous ratios are applied. This stream will be segregated as much as possible from the -1 cm (3/8) material.

2.4.9 Total Bottom Ash Weight

For information only and if it does not interfere with the testing, the 8 - hour total Residue weight collected during each run will be determined by totaling the net weight of all relevant materials collected, weighed and calculated during the run. The total Residue weight is the sum of the following components (refer to Figure 1):

1. (A) Grizzly rejects
2. (B) +2.5 cm (1") recovered ferrous metals
3. (C) +1cm (3/8") recovered non-Ferrous metals
4. (D) ECS reject bottom ash (excludes -1 cm screened ash)
5. (S) Total material sampled
6. (F) -2.5 cm bottom ash from the ferrous screen
7. (N) -1 cm bottom ash from the non-ferrous screen

2.4.10 Sampled Residue

Note: If the sampled residue is not returned to Stream D before it is weighed on the truck scales, the sampled residue weight must be mathematically added to Stream D at the end of each 8-hour run.

3 CALCULATIONS AND ANALYSIS

3.1 Unrecovered Ferrous Ratio and Unrecovered Non-Ferrous Metal Ratio

The Unrecovered Ferrous Ratio and Unrecovered Non-Ferrous Metal Ratio used in determining the Ferrous Recovery Efficiency and Non-Ferrous Metal Recovery Efficiency shall be calculated as follows, respectively, using the values from each respective run:

Unrecovered Ferrous Ratio (***UnFeR)*** = $\frac{X}{S} = \frac{X}{(X+Y+Z)}$

Unrecovered Non-Ferrous Metal Ratio ***(UnNFeR)*** $\frac{W}{S} = \frac{W}{(X+Y+Z)}$

Where:

X = +2.5 cm (1") Unrecovered Ferrous (kg/lbs.)
Y = -2.5 cm Material (-2.5 cm Ash, -2.5 cm Ferrous & -2.5 cm Non-Ferrous), (kg/lbs.)
Z = +2.5cm Non-Magnetic Material (kg/lbs.)
W = +1cm (3/8") Unrecovered Non-Ferrous Metal Material (kg/lbs.)
S = Total sample weight = X+Y+Z

The total weight of ferrous metal (X) and non-ferrous metal (W) extracted from the sampled residue during each 8-hour test run is divided by the 8-hour total sampled residue weight in the above formulas, respectively. This calculation yields the fraction of unrecovered ferrous metal and unrecovered non-ferrous metal in the sampled residue stream (kg unrecovered ferrous ÷ kg sample residue and kg unrecovered non-ferrous metal/kg sample residue). These 2 ratios must be established for Stream D (refer to Figure 1).

3.2 Unrecovered Ferrous Weight (*UnFeW*) for Each Run

The total unrecovered ferrous weight for each 8-hour run is determined by multiplying the unrecovered ferrous ratio (UnFeR) by the total bottom ash (Stream D in Figure 1) weight accumulated during each run.

UnFeW = UnFeR x D

3.3 Unrecovered Non-Ferrous Metal Weight (UnNFeW) for Each Run

The total unrecovered non-ferrous metal weight for each 8-hour run is determined by multiplying the unrecovered non-ferrous metal ratio (UnNFeR) by the ECS reject ash (Stream D in Figure 1) weight accumulated during each run.

$$UnNFeW = UnNFeR \times D$$

3.4 Ferrous Removal Efficiency (FeRE)

The Ferrous Removal Efficiency is calculated by dividing the +2.5 cm (1") ferrous metal recovered during each test run (sum of grizzly scalper ferrous and process ferrous) by the total +2.5 cm (1") ferrous (sum of the grizzly scalper ferrous, process ferrous and unrecovered ferrous) in the residue stream. Sample calculations for determining the Ferrous Removal Efficiency are detailed in Section 4 of this test plan.

$$FeRE = \frac{(A + B)}{(A + B + UnFeW)}$$

3.5 Non-Ferrous Metal Removal Efficiency (NFeRE)

The Non-Ferrous Metal Removal Efficiency is calculated by dividing the +1 cm (3/8") non-ferrous metal recovered during each test run (process non-ferrous metal) by the total +1 cm (3/8") non-ferrous metal (sum of the process non-ferrous metal and unrecovered non-ferrous metal) in the residue stream. Sample calculations for determining the Non-Ferrous Metal Removal Efficiency are detailed in Section 4 of this test plan.

$$NFeRE = \frac{(C)}{(C + UnNFeW)}$$

3.6 Total Residue/Metals Percentages

For informational purposes only, the percentages of ferrous and non-ferrous in the total residue are calculated.

3.6.1 Total Residue (excluding flyash)

The total residue stream for the Metals Recovery Test is taken as all materials except flyash as listed in section 2.4.9. The streams F & N (unders screenings) may not be separately weighed and may be estimated for these tests.

3.6.2 Percentage of Ferrous in Residue

For information only, to calculate the percentage of ferrous in the total residue, take the total +2.5 cm (1") ferrous (the sum of grizzly scalper ferrous, process ferrous and unrecovered ferrous) divided by the total residue (the sum of grizzly scalper ferrous, process ferrous, process non-ferrous and bottom ash).

3.6.3 Percentage of Non-Ferrous Metal in Residue

For information only, to calculate the percentage of non-ferrous metal in the total residue, take the total +1cm (3/8") non-ferrous metal (the sum of process non-ferrous metal and unrecovered non-ferrous metal) divided by the total residue (the sum of grizzly scalper ferrous, process ferrous, process non-ferrous and bottom ash).

4 SAMPLE CALCULATIONS

(Refer to Figure 1 for individual residue stream designator)

4.1 *Process Residue Stream Samples – Day 1*

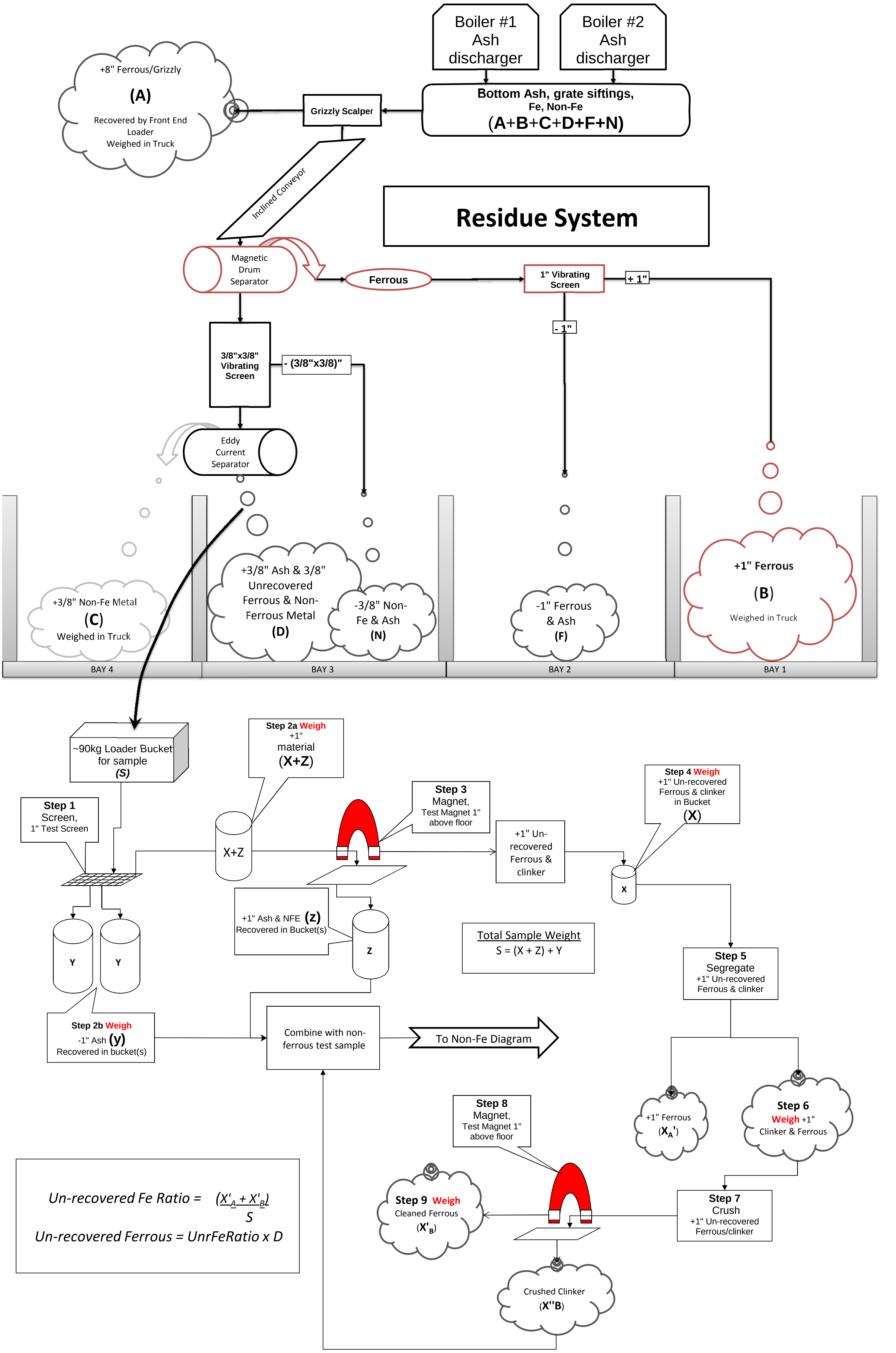
Samples are taken every half hour. Samples are processed partially on a half hour basis and completed on an hourly basis. The following intermediate summary table is presented to aid in following the calculations and does not represent a raw data sheet or a final calculation sheet.

Sample Number (one-hour total)	Sample -2.5 cm		Sample + 2.5 cm		Total Sample		Unrecovered Plus 2.5 cm (1") Ferrous		Unrecovered Plus 1cm (3/8") Non-Ferrous Metal	
	(Y)		**(X+Z)**		**(S)**		**(X)**		**(W)**	
	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
1	151.5	334.0	43.6	96.1	195.1	430	5.0	11	N/A	N/A
2	133.7	294.8	38.7	85.3	172.4	380	4.5	10	N/A	N/A
3	145.4	320.5	49.6	109.3	195.0	430	5.6	12	N/A	N/A
4	131.2	289.2	36.6	80.7	167.8	370	4.6	10	N/A	N/A
5	155.5	342.8	39.5	87.1	195.0	430	5.4	12	N/A	N/A
6	145.7	321.2	44.8	98.8	190.5	420	4.4	10	N/A	N/A
7	136.0	299.8	40.9	90.2	176.9	390	4.1	9	N/A	N/A
8	121.9	268.7	36.9	81.3	158.8	350	3.6	8	N/A	N/A
Total	1120.9	2471.1	330.6	728.8	1451.5	3200.0	37.2	82.0	5.9	13.1

4.2 Days 2 & 3 Sample Data

Typical to Day 1 residue stream samples test data listed in Section 4.1, Days 2 & 3 sample test data is summarized below along with bulk weights collected and detail calculation steps, including 3-run totals and averages.

Sample Data & Calculations	***Run 1***	***Run 2***	***Run 3***	***Total/Average***
Metals Recovery Test	***Kg***	***Kg***	***Kg***	***Kg***
Grizzly scalper Ferrous ***(A)***	3,424.70	3,279.5	3,300	10,004.2
+2.5 cm (1”) Recovered Ferrous ***(B)***	4168.6	3,878.3	3,900	11,946.9
+1 cm (3/8”) Non-Ferrous Metal ***(C)***	469.5	537.5	550	1,557.0
Bottom Ash/ECS Rejects ***(D)***	47,103.8	47,893.0	47,250	142,246.8
Sampled Residue ***(S)***	1,451.5	1,459.2	1475	4,385.7
Sampled +2.5 cm (1”) Unrecovered Ferrous ***(X)***	37.2	44.9	46.9	129.0
Sampled +1cm (3/8”) Unrecovered Non-Ferrous Metal ***(W)***	5.9	5.03	5.3	16.2
Unrecovered Ferrous Ratio ***(UnRFeR = X/S)***	2.563%	3.077%	3.180%	2.942%
Unrecovered Ferrous ***(UnRFeR x D)***	1,207.2	1,473.9	1,502.4	4,183.5
Unrecovered Non-Ferrous Metal Ratio ***(UnRNFeR = W/S)***	0.4065%	0.3450%	0.3593%	1.111%
Unrecovered Non-Ferrous Metal ***(UnRNFeR x D)***	191.5	165.3	169.8	526.5
Total Recovered Ferrous ***(A+B)***	7,593.3	7,157.8	7,200.0	21,951.1
Total Ferrous in Residue ***(A+B+UnRFe)***	8,800.5	8,631.6	8,702.4	26,134.5
Ferrous Recovery Efficiency (%)	86.3%	82.9%	82.7%	84.0%
Total Non-Ferrous in Residue ***(C+UnRNFe)***	660.97	702.76	719.78	2,083.51
Non-Ferrous Recovery Efficiency (%)	71.0%	76.5%	76.4%	74.7%
Total Residue (8-hour) Weight, for info. only.	55,166.5	55,588.3	55190.9	165,945.7
% Ferrous in Residue, for info. only.	16.0%	15.5%	15.8%	15.7%
% Non-Ferrous In Residue, for info. only.	1.20%	1.26%	1.30%	1.26%

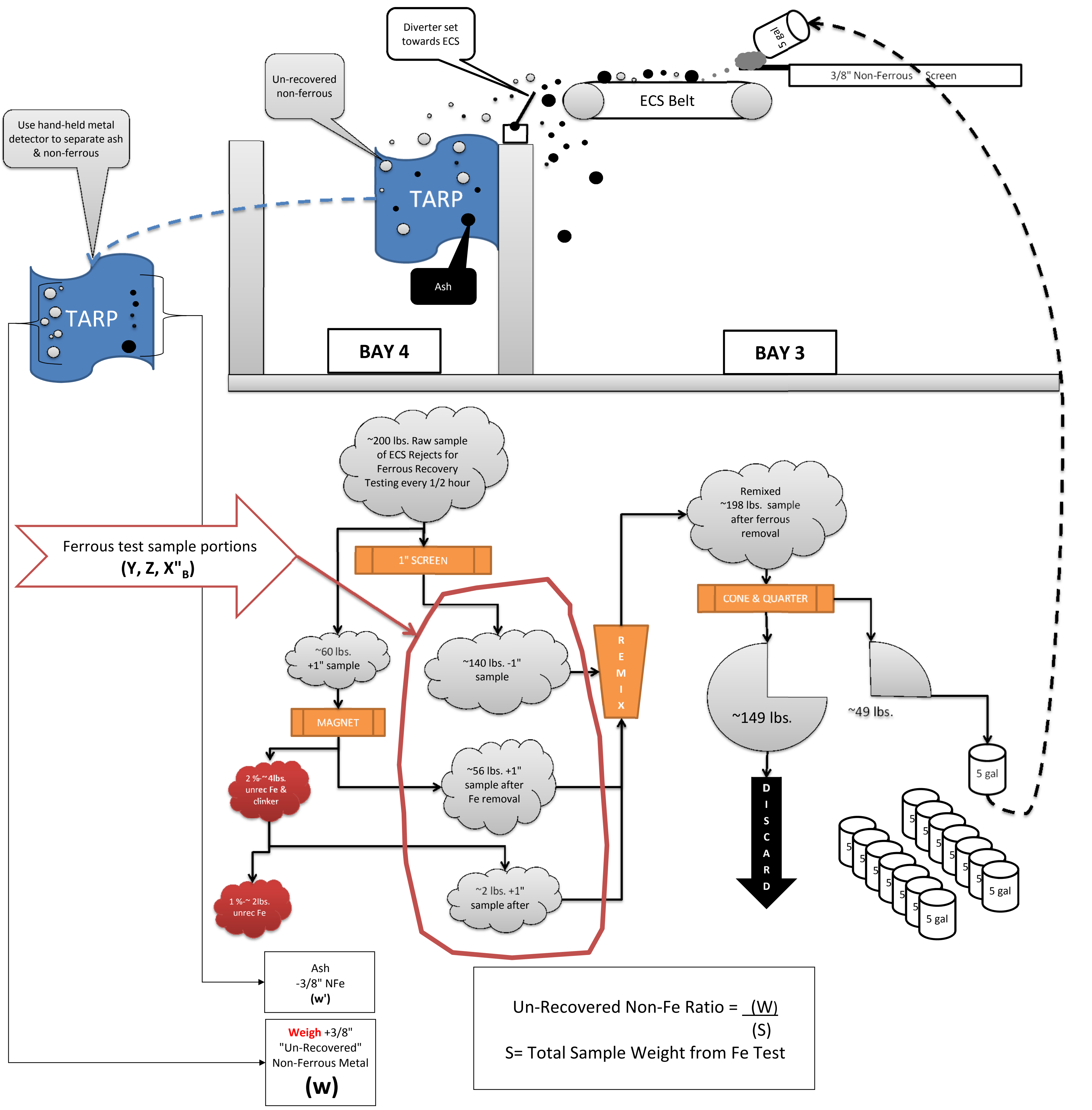


$$Un\text{-}recovered\ Fe\ Ratio = \frac{(X'_A + X'_B)}{S}$$

$$Un\text{-}recovered\ Ferrous = UnrFeRatio \times D$$

Residue Flow Diagram

Figure 1



Non-Ferrous Sample Processing Diagram
Figure 2