Source Emissions Testing – Summer Round 2015

Prepared for:
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File: 121413456
October 16, 2015

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EXECUTIVE SUMMARY

Northern Pulp Nova Scotia Corporation, referred to herein as Northern Pulp, retained Stantec Consulting Ltd. to conduct source emissions testing at the Kraft pulp mill in New Glasgow, Nova Scotia. Source emissions testing were conducted on the Recovery Boiler and the Power Boiler to fulfill the conditions specified in the current Certificate of Approval to Operate (CoA) 2011-076657-R03. The source emissions testing campaign was performed according to the pre-test plan submitted to the Nova Scotia Department of Environment. The testing was conducted on September 15-18, 2015.

In this report, source emissions testing data are presented for measurements which include concentrations and emission rates of combustion gases and total particulate matter (PM) as well as exhaust gas temperature, moisture content, velocity, and volumetric flow rate on the Recovery and Power Boilers.

The measured concentration of PM from the Recovery Boiler was below the stack limit of 77 mg/Rm^3 (corrected to 11% oxygen).

The measured concentration of PM from the Power Boiler was above the stack limit of 150 mg/Rm^3 (corrected to 11% oxygen).

A summary of the results of the source emissions testing is provided in Table E.1.

Table E.1 Source Emissions Testing Results

Exhaust Gas Parameters	Recovery Boiler	Power Boiler
Total Particulate Matter – TPM (mg/Rm^3 at 11% O_2)	3.9	190
Sulphur Dioxide – SO_2 (mg/Rm^3)	87.2	ND
Nitrogen Oxides – NO_x (mg/Rm^3)	-	103
Carbon Monoxide – CO (mg/Rm^3)	1,132	126
Volumetric Flow Rate (Rm^3/s)	72.0	33.2
Velocity (m/s)	12.3	16.8
Temperature (°C)	68.1	55.4
Moisture Content (%)	30.6	17.5
Oxygen - O_2 (%)	5.3	12.2
Carbon Dioxide - CO_2 (%)	10.4	6.4

Production for September 15, 16, 17 and 18 was 742, 833, 884 and 899 air dry metric tonnes of pulp (admt) respectively.

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1.0 INTRODUCTION

Northern Pulp Nova Scotia Corporation, referred to herein as Northern Pulp, retained Stantec Consulting Ltd. (Stantec) to conduct source emissions testing at the Kraft pulp mill in New Glasgow, Nova Scotia. Source emissions testing were conducted on the Recovery Boiler and the Power Boiler to fulfill the conditions specified in the current Certificate of Approval to Operate (CoA) 2011-076657-R03. The source emissions testing campaign was performed according the pre-test plan submitted to the Nova Scotia Department of Environment.

In this report, source emissions testing data are presented for combustion gases, total particulate matter (PM), exhaust gas temperature, exhaust flow rate, moisture content, velocity, and volumetric flow rate.

This report is in five chapters. Chapter 1 contains the introduction and the scope of work for the project. The study approach and a brief description of the various parts of the project are in Chapter 2. Chapter 3 contains a brief description of the testing methodologies, equipment, and calibration techniques used during the source emissions testing program. In Chapter 4, the results of the source emissions testing are presented and discussed, and concluding remarks are presented in Chapter 5. Appendices A through D contain supporting information for the report.

2.0 OVERALL APPROACH

The project consisted of five parts:

1. submission of the pre-test plan
2. site preparation and preliminary survey
3. on-site source emissions testing
4. laboratory analysis
5. information review and reporting

Each of these parts is described below.

2.1 SUBMISSION OF PRE-TEST PLAN

The on-site testing was conducted in accordance with the Pre-Test Plan (Appendix A) submitted on February 20, 2015 to Nova Scotia Environment (NSE). The Pre-Test Plan outlined the rationale for the selection of the associated contaminants to be tested, as well as the methodologies proposed for conducting the source testing on the exhaust stacks.

2.2 ON-SITE SOURCE EMISSIONS TESTING

Stantec set up the source emissions testing equipment and conducted a preliminary survey to measure the exhaust gas temperature, velocity, and flue gas composition in each of the boiler stacks. The data from this survey was used to determine the appropriate nozzle size to conduct isokinetic sampling (where the velocity of the gas entering the nozzle is equal to the gas velocity in the stack) for particulate matter during the source emissions testing part of the work.

Three (3) tests for total particulate matter and combustion gases were conducted at defined sampling locations on the exhaust stacks of the Recovery Boiler and the Power Boiler. The testing was completed in compliance with the sampling methods presented in Table 2.1, in accordance with the *Air Quality Regulation*, under the *Environment Act*, Section 112 issued by Nova Scotia Environment (NSE) and the requirements of the facility's approval (2011-076657-R03) issued by the NSE.

The methodologies used for testing the emissions from each exhaust stack are summarized in Table 2.1.

Table 2.1 Source Emissions Testing Matrix

Source	Number of Samples per Source	Approval Condition	Parameter	Sampling Method
Recovery Boiler	3	6. a)	Total Particulate Matter (PM)	EPS 1/RM/8
	3	-	Combustion Gases	EPS 1/RM/15
Power Boiler	3	6. a)	Total Particulate Matter (PM)	EPS 1/RM/8
	3	-	Combustion Gases	EPS 1/RM/15

2.3 LABORATORY ANALYSIS

Prior to the particulate matter testing, several filters were conditioned and pre-weighed. Following the testing, particulate matter was recovered from the nozzle, the sampling probe and the in-line filter. Following testing the filter, containing the particulate sample, was conditioned and weighed, and the net weight of the collected particulate matter was determined. After each test, the probe and nozzle were rinsed with acetone and this acetone was collected, placed into a pre-weighed container and evaporated until dry. The amount of particulate for each part of the sample was determined gravimetrically, and the mass of particulate matter collected for each test was calculated as the sum of the particulate matter collected in the filter, probe, and nozzle rinse. The contents of the impingers were recovered gravimetrically for particulate matter and reported separately. These recoveries were performed at Stantec's laboratory in Fredericton, New Brunswick.

2.4 INFORMATION REVIEW AND REPORTING

The data collected in the field, along with data from the laboratory analyses, were entered into the Stantec's source emissions testing spreadsheets for analysis. Emissions calculations were then performed to produce the detailed source emissions testing information. Spreadsheet calculations were verified by hand, and numerous spot checks of spreadsheet formulas were conducted to confirm the accuracy of data. Summary tables were prepared and incorporated into this report for submission to Northern Pulp.

3.0 TEST METHODS, EQUIPMENT, AND CALIBRATIONS

This section contains a description of the methods and equipment used to conduct the source emissions testing campaign. The calibration procedures used to ensure the quality of the source emissions testing data are also summarized in this section.

3.1 SAMPLING PROCEDURES AND EQUIPMENT

The following sub-sections contain brief descriptions of the sampling equipment and methodologies used during the source emissions testing campaign.

3.1.1 Total Particulate Matter

Particulate matter emissions from the Recovery Boiler and Power Boiler exhaust stacks were measured in accordance with the Environment Canada Reference Method EPS 1/RM/8, entitled *Reference Methods for Source Testing: Measurement of Releases of Particulate from Stationary Sources*.

The sampling train, used specifically for isokinetic sampling of particulate matter, is described in detail in EPS 1/RM/8, and is generally referred to as the 'Method 5' sampling train for particulate matter, named after the United States Environmental Protection Agency (US EPA) protocol. The sampling train consists of several different components which include: a heated sampling probe (a nozzle, stainless steel liner, thermocouple, and pitot tube assembly), a heated sample case containing a filter, an ice box containing impinger glassware, and an umbilical cord leading to the pump and control console. A schematic of the sampling system is shown in Figure 3.1. The operation of the Method 5 sampling train can be generally described as follows.

Exhaust gases are drawn through the probe nozzle at or near isokinetic conditions (*i.e.*, where the gas velocity in the nozzle is at the same velocity as the gas in the stack). The gases are then drawn through the inner stainless steel liner of the electrically heated sampling probe to the other components of the sampling train.

A pitot tube assembly is attached to the probe next to the nozzle to measure the exhaust gas velocity in the area of the probe nozzle. Using the differential pressure reading on the control console, the desired nozzle flow rate is determined from the differential pressure across a calibrated orifice.

The exhaust gases are drawn from the probe liner through a pre-weighed glass fiber filter, in the hot side of the sampling unit, and then through pre-weighed impingers in an ice bath to cool the gases and condense the moisture in the gas, before the gas enters the umbilical cord.

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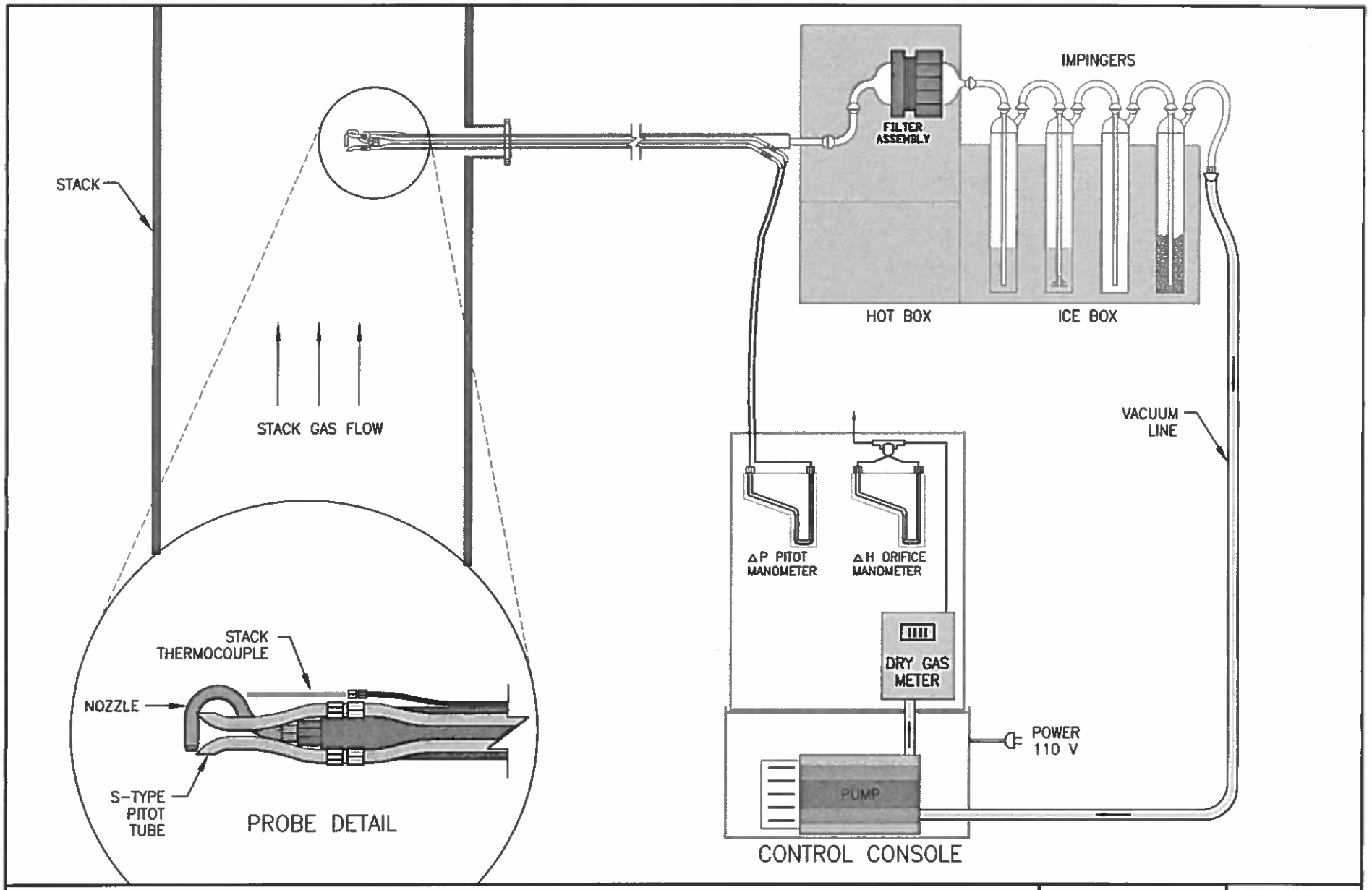

Stantec

SOURCE EMISSIONS TESTING
METHOD 5 SAMPLING TRAIN

Scale:	N.T.S.
Fig. No.:	3.1

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The umbilical cord carries the filtered, cooled exhaust gases from the sampling site to the control console. The control console contains a fiber vane vacuum pump, which is used to draw the exhaust gases through the sampling train. A calibrated dry gas meter records the volume of gas sampled.

After completion of testing, the impingers are re-weighed, with the difference in mass corresponding to the mass of water collected. This measurement is used to calculate the moisture content of the exhaust gas.

Total particulate matter is determined gravimetrically at Stantec's laboratory in Fredericton, New Brunswick.

Appendix B contains the calibration data.

3.1.2 Combustion Gases

The combustion gases (O_2, CO_2, CO, NO_x, and SO_2) were sampled according to the Environment Canada reference method EPS 1/RM/15, entitled *Reference Method for the Monitoring of Gaseous Emissions from Fossil Fuel-fired Burners*. In this method, samples of flue gas are drawn through a probe, non-isokinetically, from a single point near the centre of the stack. The combustion gases were analyzed using a Testo 350 XL Flue Gas Analyzer manufactured by Testo GmbH and Co. This unit is equipped with electrochemical cells that are used to measure the concentrations of oxygen, carbon dioxide, sulphur dioxide, nitrogen oxides, carbon monoxide, and total hydrocarbons, in accordance with EPS 1/RM/15. The system is equipped with a flue gas probe that has an integrated filter trap and condensate trap and a housing unit that contains the pump and the electrochemical cells. The equipment is manufactured and calibrated to provide an accuracy of +/- 4% for carbon monoxide, nitrogen oxides, and sulphur dioxide, +/- 0.2% for oxygen, and +/- 5% for carbon dioxide.

3.2 QUALITY ASSURANCE AND QUALITY CONTROL

Throughout the source emissions testing program, quality assurance and quality control procedures were applied to confirm the accuracy of the accurate emissions data. These checks were performed by test personnel throughout the program under the guidance of the source testing crew chief in the field and the project manager during post testing review.

The quality control (QC) checks included the following:

- use of standardized checklists and field notebooks to ensure completeness, traceability, and comparability of the process information and samples collected
- field checking of standardized forms by a second person to confirm completeness
- testing for cyclonic or reverse flow, as well as stratified flow conditions
- leak checks of sampling trains

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Equipment was calibrated according to the protocols and schedule as prescribed by Environment Canada. These calibrations include the following:

Pitots: Calibrated in a wind tunnel with probe and nozzles attached.

Gas meters: Calibrated using a critical orifice calibration set.

Nozzle: Four diameter measurements made using a micrometer across the sharpened edges.

Thermocouples: Calibrated using a potentiometric technique.

Gas Analyzer: Calibrated against reference gases using standard calibration gases within the expected range of concentrations from the source.

Calibration data are in Appendix B of this report.

4.0 RESULTS AND DISCUSSION

The results of the source emissions testing campaigns are provided and discussed in this section.

Appendices B through D contain supporting information including calibration information, field data sheets, and calculations.

4.1 EXHAUST STACK SAMPLE LOCATION DETAILS

Table 4.1 provides a summary of the sample location details for each exhaust stack sampled.

Table 4.1 Sample Location Details

Parameter	Recovery Boiler	Power Boiler
Stack Height – Above Grade (m)	69	51
Diameter / Equivalent Diameter (m)	3.51	1.93
Stack/Duct Description	Circular	Circular
Stack Orientation	Vertical	Vertical
Number of Sample Ports	4	2
Sample Port Diameter (m)	0.1	0.1
Location Upstream from any Disturbance,	>2	>2
Location Downstream from any Disturbance,	1.45	>4
Ideal or Non Ideal Flow Characteristics at The Sample Location[1]	Not Ideal	Not Ideal
Total Number of Sample Points	24	24
Number of Sample Points per Traverse	12	12
Sample Time per Point (min)	5	5
Sample time per Test for PM (min)	120	120
Sample time per test for combustion gases (min)	30	30

Notes:

[1] The exhaust gas flow characteristics at the sampling location are referred to as being "Ideal" if the sample ports are located in a straight section of stack at least eight stack diameters downstream and two stack diameters upstream of any flow disturbance.

4.2 RECOVERY BOILER

The results of the source emissions testing for total particulate matter and combustion gases from the Recovery Boiler exhaust stack are in Tables 4.2 and 4.3, respectively.

Table 4.2 Source Testing Results - Recovery Boiler - Particulate Matter

Parameter	Test #1	Test #2	Test #3	Average	Stack Emission Limit
Test Date	Sept 15, 2015	Sept 16, 2015	Sept 16, 2015	-	-
% of Normal Maximum Operating Rate[1]	97.1	97.3	97.5	97.3	
Test Start	11:15	8:40	12:30	-	-
Test Duration (min)	120	120	120	120	-
Volume of Gas Sampled (Rm^3)	2.49	2.49	2.52	2.50	-
Average Isokineticity (%)	98	98	99	99	-
Total Volume of Moisture Collected in Impingers (mL)	802.9	827.6	805.6	812.0	-
Particulate Matter From Filter and Probe Wash (mg)	19.8	13.5	13.0	15.4	-
Particulate Matter From Impingers (mg)	8.0	8.1	72.9	29.7	-
Exhaust Gas Parameters					
Exhaust Gas Temperature (°C)	68.2	68.1	68.0	68.1	-
Exhaust Gas Moisture Content (%)	30.4	31.2	30.3	30.6	-
Exhaust Gas Velocity (m/s)	12.3	12.3	12.2	12.3	-
Exhaust Gas Volumetric Flow Rate (Rm^3/s)	72.2	71.8	72.0	72.0	-
Oxygen - O_2 (%)	5.3	5.5	5.2	5.3	-
Carbon Dioxide - CO_2 (%)	10.4	10.4	10.5	10.4	-
Total Particulate Matter - PM					
Concentration at 11% O_2 (mg/Rm^3)	5.04	3.49	3.26	3.93	77
Emission Rate (kg/hr)	2.07	1.41	1.34	1.60	-

Legend:

°C Degrees Celsius.

m/s Metres per second.

Rm^3/s Dry cubic metres per second at reference conditions (25°C and 101.3 kPa).

mg/Rm^3 Milligrams per dry cubic metre at reference conditions (25°C and 101.3 kPa).

kg/hr Kilograms per hour.

[1]Normal maximum operating rate is 154,000 lb/hour black liquor as fired.

The average measured concentration of particulate matter was 3.93 mg/Rm^3 (corrected to 11% O_2), which is below the current stack emission limit of 77 mg/Rm^3 presented in Table 5 of the facility's Approval (No. 2011-076657-A03).

Table 4.3 Source Testing Results - Recovery Boiler - Combustion Gases

Parameter	Test #1	Test #2	Test #3	Average
Test Date	Sept 15, 2015	Sept 16, 2015	Sept 16, 2015	-
Test Duration (min)	30	30	30	30
Exhaust Gas Volumetric Flow Rate (Rm^3/s)	72.2	71.8	72.0	72.0
Sulphur Dioxide - SO_2				
Concentration (ppm)	43.7	59.1	54.1	52.3
Concentration (mg/Rm^3)	72.6	99.3	89.6	87.2
Emissions Rate (kg/hr)	29.8	40.1	36.8	35.5
Nitrogen Oxides - NO_x				
Concentration (ppm)				-
Concentration (mg/Rm^3)				-
Emissions Rate (kg/hr)	Not available	Not available	Not available	-
Carbon Monoxide - CO				
Concentration (ppm)	2,033	305	627	988
Concentration (mg/Rm^3)	2,328	349	718	1,132
Emissions Rate (kg/hr)	606	90.1	186	294

Legend:

Rm^3/s Dry cubic metres per second at reference conditions (25°C and 101.3 kPa).

mg/Rm^3 Milligrams per dry cubic metre at reference conditions (25°C and 101.3 kPa).

kg/hr Kilograms per hour.

Not available- an error in the electrochemical cell for NOX occurred during Recovery Boiler testing, therefore data are not available

4.3 POWER BOILER

The results of the source emissions testing for total particulate matter and combustion gases from the Power Boiler exhaust stack are in Tables 4.4 and 4.5, respectively.

Table 4.4 Source Testing Results - Power Boiler - Particulate Matter

Parameter	Test #1	Test #2	Test #3	Average	Stack Emission Limit
Test Date	Sept 17, 2015	Sept 17, 2015	Sept 18, 2015	-	-
Steam Load (klb/hr)	123.0	126.3	122.2	123.8	
Test Start	9:10	13:40	8:00	-	-
Test Duration (min)	120	120	120	120	-
Volume of Gas Sampled (Rm^3)	1.37	1.45	1.50	1.44	-
Average Isokineticity (%)	104	100	103	102	-

Table 4.4 Source Testing Results - Power Boiler - Particulate Matter

Parameter	Test #1	Test #2	Test #3	Average	Stack Emission Limit
Total Volume of Moisture Collected in Impingers (mL)	222.3	223.5	225.8	223.9	-
Particulate Matter From Filter and Probe Wash (mg)	251.8	258.7	205.1	238.5	-
Particulate Matter From Impingers (mg)	15.8	5.9	39.2	20.3	-
Exhaust Gas Parameters					
Exhaust Gas Temperature (°C)	56.1	55.1	55.2	55.4	-
Exhaust Gas Moisture Content (%)	18.1	17.3	16.9	17.5	-
Exhaust Gas Velocity (m/s)	15.9	17.2	17.3	16.8	-
Exhaust Gas Volumetric Flow Rate (Rm^3/s)	31.2	34.1	34.4	33.2	-
Oxygen - O_2 (%)	12.8	11.9	11.8	12.2	-
Carbon Dioxide - CO_2 (%)	5.8	6.6	6.7	6.4	-
Total Particulate Matter - PM					
Concentration at 11% O_2 (mg/Rm^3)	226	196	149	190	150
Emission Rate (kg/hr)	20.6	21.9	16.9	19.8	-

Legend:

°C	Degrees Celsius.
m/s	Metres per second.
Rm^3/s	Dry cubic metres per second at reference conditions (25°C and 101.3 kPa).
mg/Rm^3	Milligrams per dry cubic metre at reference conditions (25°C and 101.3 kPa).
kg/hr	Kilograms per hour.
Klb/hr	Thousand pounds per hour

The average measured concentration of particulate matter (corrected to 11% O_2) was 190 mg/Rm^3, which is above the stack emission limit of 150 mg/Rm^3 presented in Table 5 of the facility's Approval (No. 2011-076657-A03).

Table 4.5 Source Testing Results - Power Boiler - Combustion Gases

Parameter	Test #1	Test #2	Test #3	Average
Test Date	Sept 17, 2015	Sept 17, 2015	Sept 18, 2015	-
Test Duration (min)	30	30	30	30
Exhaust Gas Volumetric Flow Rate (Rm^3/s)	31.2	34.1	34.4	
Sulphur Dioxide - SO_2				
Concentration (ppm)	ND	ND	ND	-
Concentration (mg/Rm^3)	ND	ND	ND	-
Emissions Rate (kg/hr)	ND	ND	ND	-
Nitrogen Oxides - NO_x				
Concentration (ppm)	48.4	62.3	53.7	54.8
Concentration (mg/Rm^3)	91.1	117	101	103
Emissions Rate (kg/hr)	10.2	14.4	12.5	12.4
Carbon Monoxide - CO				
Concentration (ppm)	71.9	190	67.1	110
Concentration (mg/Rm^3)	82.3	218	76.9	126
Emissions Rate (kg/hr)	9.24	26.8	9.52	15.2

Legend:

Rm^3/s	Dry cubic metres per second at reference conditions (25°C and 101.3 kPa).
mg/Rm^3	Milligrams per dry cubic metre at reference conditions (25°C and 101.3 kPa).
kg/hr	Kilograms per hour.
ND	not detected in sample

5.0 CLOSURE

This report has been prepared for the sole benefit of Northern Pulp Nova Scotia Corporation. This report may not be relied upon by any other person or entity without the express written consent of Stantec and Northern Pulp Nova Scotia Corporation. Any use of this report by a third party, or any reliance on decisions made based upon this report, are the responsibility of the third party. Stantec accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Stantec makes no representation or warranty with respect to this report, other than the work was undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. Any information or facts provided by others and referred to or utilized in the preparation of this report was assumed by Stantec to be accurate.

This study was undertaken exclusively for the purpose outlined herein and was limited to those contaminants and sources specifically referenced in this report. It should be noted that the measurements were taken over a relatively short time period on-site, and the emissions results may be considered representative only for the conditions present at the time of testing. This report cannot be used or applied under any circumstances to another location or situation or for any other purpose without further evaluation of the data and related limitations.

This report was prepared by Chris Lyons, P.Eng and reviewed by Vicki Corning, P.Eng. If you have any questions regarding the contents of this report, or require any additional information, please do not hesitate to contact the undersigned.

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SOURCE EMISSIONS TESTING –
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Appendix A

Pre-test plan

SOURCE EMISSIONS TESTING – SUMMER ROUND 2015

October 16, 2015

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Fax: (902) 468-9009

February 20, 2015
File: 121413456

Attention: Mr. Marc Theriault
Nova Scotia Environment
20 Pumphouse Road
Pictou, NS B2H 5C6

Dear Mr. Theriault,

Reference: Pre-Test Plan for Source Emissions Testing Northern Pulp, Pictou Mill – 2015 Calendar Year

Please accept this Pre-test Plan for the completion of source emissions required at the Pictou Mill in New Glasgow, Nova Scotia for the 2015 calendar year.

Introduction

Northern Pulp is required to perform source emissions testing on the Recovery Boiler, Lime Kiln, Smelt Dissolving Tank, Power Boiler and the High Level Roof Vent to fulfil the conditions specified in the current Certificate of Approval (CoA) to Operate 2011-076657-R03. The required annual testing for 2015 consists of:

- Recovery Boiler and Power Boiler particulate matter testing 4 times per year;
- Lime Kiln and Smelt Dissolving Tank particulate matter testing 2 times per year;
- Lime Kiln, High Level Roof Vent and Smelt Dissolving Tank total reduced sulphur (TRS) testing 2 times per year;
- One $PM_{2.5}$ testing event per year on the four stacks noted above for particulate matter; and
- One Chlorine (Cl) and Chlorine Dioxide (ClO_2) event per year on the bleach plant exhaust (High Level Roof Vent being the source of these emissions).

Test Program Organization

The source emissions testing will be performed for:

Company Name:	Northern Pulp
Company Address:	P.O. Box 549, Station Main, New Glasgow, NS, B2H 5E8
Contact Name:	
Position:	Environmental/Technical Leader
Telephone Number:	(902) 752-8461
Email:	northernpulp.com

Reference: Pre-Test Plan for Source Emissions Testing Northern Pulp, Pictou Mill – 2015 Calendar Year

Sampling Company: Stantec Consulting Ltd.
Project Manager: Gillian Hatcher
Telephone Number: (902) 468-7777
Fax Number: (902) 468-9009
Email: @Stantec.com
Key Sampling Team: ,with support from other staff as needed)

Source Emissions Testing Program

The proposed source emissions testing methodology and proposed sampling timeframes are presented in Table 1.

Table 1 Source Emissions Testing Matrix

Source	Number of Visits	Number of Tests per Visit	Parameter	Sampling Method	Proposed Timeframe
Recovery Boiler	4	3	Total Particulate Matter (PM)	EPS 1/RM/8	Winter, Spring, Summer, Fall
	4	3	Combustion Gases	EPS 1/RM/15	Winter, Spring, Summer, Fall
	1	3	Particle Size Analysis	Microscopic technique	Fall
Power Boiler	4	3	Total Particulate Matter (PM)	EPS 1/RM/8	Winter, Spring, Summer, Fall
	4	3	Combustion Gases	EPS 1/RM/15	Winter, Spring, Summer, Fall
	1	3	Particle Size Analysis	Microscopic technique	Fall
Lime Kiln	2	3	Total Particulate Matter (PM)	EPS 1/RM/8	Spring, Fall
	2	3	Combustion Gases	EPS 1/RM/15	Spring, Fall
	1	3	Particle Size Analysis	Microscopic technique	Fall
	2	3	Total Reduced Sulphur (TRS)	US EPA Method 16B/C	Spring, Fall
Smelt Dissolving Tank	2	3	Total Particulate Matter (PM)	EPS 1/RM/8	Spring, Fall
	2	3	Combustion Gases	EPS 1/RM/15	Spring, Fall
	1	3	Particle Size Analysis	Microscopic technique	Fall
	2	3	Total Reduced Sulphur (TRS)	US EPA Method 16B/C	Winter, Summer
High Level Roof Vent	2	3	Total Reduced Sulphur (TRS)	US EPA Method 16B/C	Spring, Fall
	2	3	Combustion Gases	EPS 1/RM/15	Spring, Fall

Reference: Pre-Test Plan for Source Emissions Testing Northern Pulp, Pictou Mill – 2015 Calendar Year

Table 1 Source Emissions Testing Matrix

Source	Number of Visits	Number of Tests per Visit	Parameter	Sampling Method	Proposed Timeframe
	1	3	Chlorine and chlorine dioxide	NCASI Special Report 91-07	Spring

Note:
Timeframes are as follows based on the approval deadlines-Winter: January-March 31, 2015, Spring: April – June 30, 2015, Summer: July-September 30, 2015, Fall: October-December 31, 2015

Details of each of the methods identified in Table 1, in addition to the preliminary testing methodology, are provided in the sections that follow.

Preliminary Testing: Upon arrival at each sampling location, Stantec will set up the source emissions testing equipment and conduct a preliminary survey to measure the average velocity, flue gas composition, and moisture content in the stack gases using EPS 1/RM/8 Methods B, C, and D, respectively. The data from this survey will be used to determine the appropriate nozzle size to conduct isokinetic sampling (where the velocity of the gas entering the nozzle is equal to the gas velocity in the stack) for particulate matter during the official testing part of the work. Verification for cyclonic or reverse flow will also be conducted during the preliminary survey, according to procedures outlined in the Environment Canada reference method EPS 1/RM/8.

Should fluctuations in the velocity pressure at a selected traverse point exceed 20% of the average pressure for that point; the diameter of the testing cross section will be reduced to include only those areas along the traverse which meet this requirement (less than 20% of the average). Although the diameter may be reduced, the number of sampling points along each traverse will remain the same as determined from EPS 1/RM/8, Method A, using the equivalent diameter.

Volumetric flow and exhaust gas emissions will be calculated using the full cross sectional area.

Particulate Matter: The source emissions testing of the Recovery Boiler, Lime Kiln, Smelt Dissolving Tank, and the Power Boiler for total particulate matter will be conducted in accordance with the Environment Canada reference method EPS 1/RM/8, entitled "Measurement of Releases of Particulate from Stationary Sources". In addition the alignment approach, as specified in the US EPA Guidance Document – GD-008, will be applied when source testing the Lime Kiln due to the cyclonic flow this source exhibits.

The particulate sampling train, used specifically for isokinetic sampling, is described in detail in EPS 1/RM/8, and is generally referred to as the "Method 5" sampling train for particulate matter (after the US EPA protocol). The sampling train has several different components which include: a heated sampling probe (a nozzle, stainless steel liner, thermocouple, and pitot tube assembly), a heated sample case containing a filter, an ice box containing impinger glassware, and an

umbilical cord leading to the pump, and control console. A schematic of the sampling system is shown in Figure 1.

For all source tests, leak checks of the sampling train will be performed as per accepted US EPA and Environment Canada methods. For each official test, two (2) traverses with up to twelve (12) sampling points per traverse will be used. Sampling will be conducted for five (5) minutes per sampling point, up to a maximum sampling time of 120 minutes per test.

The amount of material caught in the impingers will be determined gravimetrically and reported separately from the calculated total particulate matter emissions. All particulate matter samples will be recovered and analyzed at the Stantec laboratory in Fredericton, NB.

Microscopic Analysis (Fine Particulate, $PM_{2.5}$): As per the facility's Industrial Approval to Operate, the Environment Canada EPS 1/RM/55 or an alternative method acceptable to the Department is required for $PM_{2.5}$ testing. As the method quoted in the approval is not valid for stacks with potential for entrained water droplets in the exhaust (which applies to boilers and dissolving tank at Northern) or cyclonic flow (which applies to the Lime Kiln), we propose microscopic analysis of filters as the viable option. This method involves analysis of total particulate matter filters (collected as described above) for fine particulate percentage.

The particle size analyses will be performed by MVA Scientific Consultants, based in Duluth, GA, using a JEOL JSM-6500F field emission scanning electron microscope operating in automated mode under the control of a Thermo Scientific Noran System SIX x-ray analysis system, using their automated particle size analysis method.

Total Reduced Sulphur: The source emissions testing of the Lime Kiln, the Smelt Dissolving Tank and the High Level Roof Vent for total reduced sulphur will be conducted in accordance with US EPA Method 16B. In this method, the sample is extracted from the exhaust gas of the stack through a heated Teflon line. The sample is chilled and then passes through an SO_2 analyzer to measure SO_2 from the source. The sample exits the analyzer and is then passed through a furnace where all sulphur compounds in the gas stream are thermally oxidized to SO_2, this SO_2 is measured in a second inline analyzer. The difference in the initial SO_2 and the final SO_2 measurement is the total reduced sulphur concentration (reported as H_2S). The analyzers are both Western Research SO_2 non-dispersive ultra-violet (NDUV) continuous analyzer. Monitoring will be conducted continuously over a 24 hour period as required by the approval condition.

Chlorine, Chlorine Dioxide (Cl_2, ClO_2): Sampling will be conducted in accordance with NCASI's sampling method which consists of the extraction of a sample bubbling through midget impingers and subsequent analysis by titration. The sampling train for the Cl_2 and ClO_2 consists of series of three mini impingers, connected by Teflon tubing. The first two impingers each contain 20 ml of potassium iodide (KI) solution buffered with potassium di-hydrogen phosphate (KH_2PO_4). The third impinger contains silica gel to remove any remaining moisture from the gas stream. The impingers are cooled by an ice bath, and the dried gas is then drawn through the sampling train with a calibrated pump. Total sampling time for each test is sixty (60) minutes.

Reference: Pre-Test Plan for Source Emissions Testing Northern Pulp, Pictou Mill – 2015 Calendar Year

Following completion of each test for Cl_2 and ClO_2, the contents of the first two impingers are combined in a pre-cleaned beaker. Subsequent analysis via titration will be performed onsite by Stantec. The combined impinger solutions and de-ionized water rinse of the sample line and empty impingers would be titrated with sodium thiosulphate solution (0.010 N). The volume of titrant required to reach the first colorless endpoint would be recorded on a recovery data form. Five (5) ml of 10% sulphuric acid would be added to the sample and the titration continued. The volume of titrant required to reach the second colorless endpoint would be recorded on a recovery data form. These titrations would be conducted on site shortly following sampling by one of the field staff during the testing due to the instability of the samples, which begin to degrade after 24 hours.

Combustion Gases:

The combustion gases (O_2, CO_2, CO, NO_X, and SO_2) will be sampled according to the Environment Canada reference method EPS 1/RM/15, entitled *Reference Method for the Monitoring of Gaseous Emissions from Fossil Fuel-fired Burners*. In this method, samples of flue gas are drawn through a probe, non-isokinetically, from a single point near the centre of the stack. An ENERAC Model 500 Micro-Emission Analyzer, manufactured by ENERAC Inc., will be used to conduct the sampling. The Model 500 is equipped with a flue gas probe that has an integrated filter trap and condensate trap, and a housing unit that contains the pump and the electrochemical cells which are used to measure concentrations of sulphur dioxide, nitrogen oxides, carbon monoxide, carbon dioxide, and oxygen.

In accordance with the regulatory requirements for compliance testing, three replicate tests for each contaminant will be conducted on each stack.

Reporting

As per Approval No. 2011-076657-R03, actual particulate matter emission rates will be reported in units of g/s. The concentration released to the atmosphere will be reported in units of mg/m^3 at reference conditions of 25 °C and 101.3 kPa corrected for 11 % oxygen for the Recovery Boiler and Power Boiler and in units of kg/adubmt for the Lime Kiln and the Dissolving Tank. Fine particulate matter concentrations for the Lime Kiln, Dissolving Tank, Power Boiler and Recovery Boiler will be reported in units of mg/m^3 at reference conditions of 25 °C and 101.3 kPa corrected for 11 % oxygen. Total reduced sulphur will be reported in units of parts per million by dry volume (ppmdv). Emission rates of chlorine and chlorine dioxide from the High Level Roof Vent will be reported in units of g/s and the concentrations released to the atmospheric will be reported in units of mg/m^3.

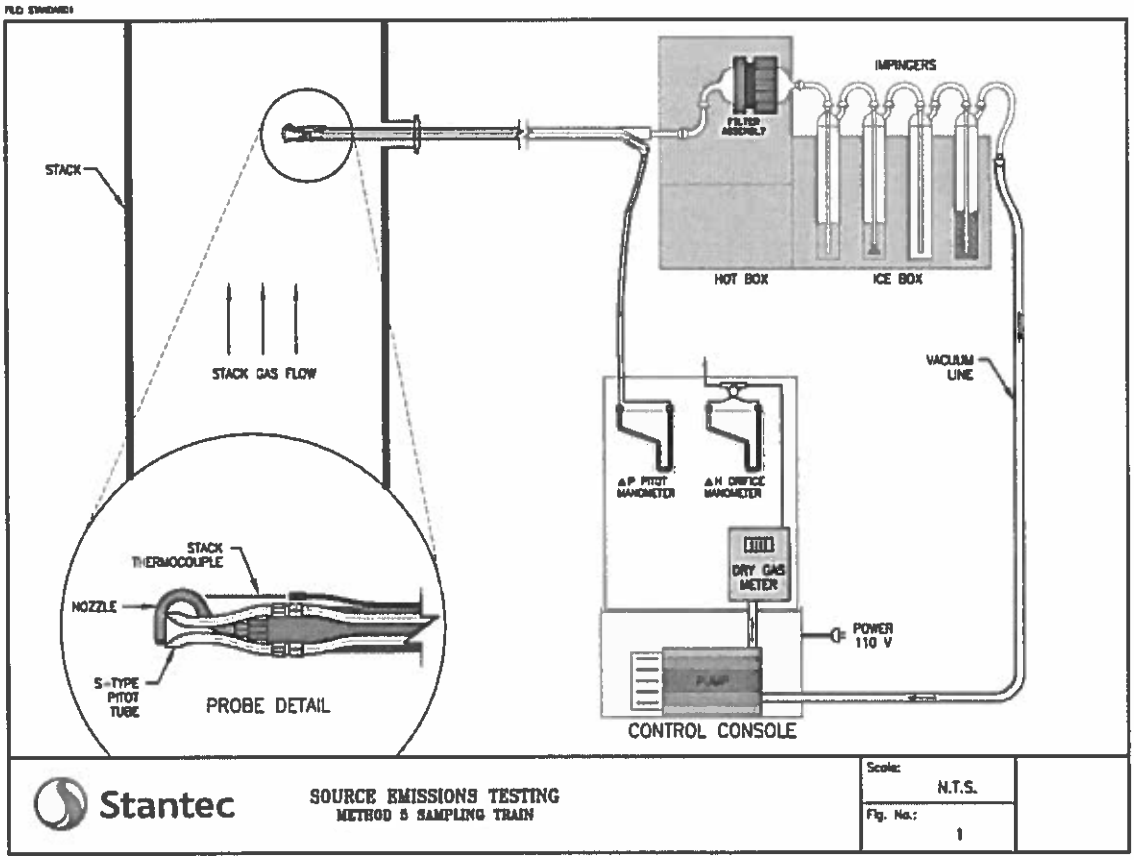
Results of each source emissions testing event will be documented in a final report for submission to Nova Scotia Environment (NSE) for review and approval within 60 days of completing the testing.

Reference: Pre-Test Plan for Source Emissions Testing Northern Pulp, Pictou Mill – 2015 Calendar Year

Sampling Locations

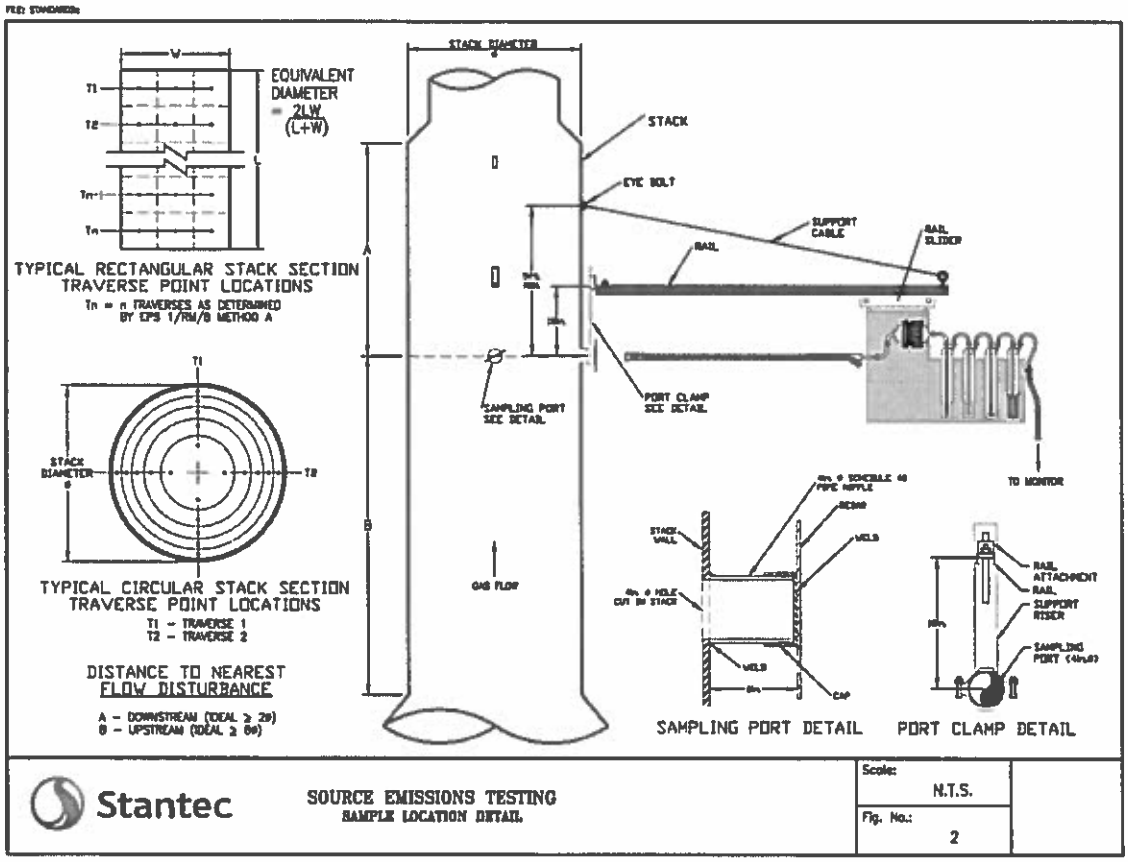
The number and location of sample points along each traverse were previously determined according to EPS 1/RM/8, Method A, using the exhaust stack diameter. A diagram of a typical sample location is provided in Figure 2.

Figure 1 Source Emission Testing, Method 5 Sampling Train



Reference: Pre-Test Plan for Source Emissions Testing Northern Pulp, Pictou Mill – 2015 Calendar Year

Figure 2 Source Emissions Testing, Sample Location Details



Reference: Pre-Test Plan for Source Emissions Testing Northern Pulp, Pictou Mill – 2015 Calendar Year

A summary of the sample location details is provided in Table 2.

Table 2 Sample Location Details

Parameter	Recovery Boiler	Lime Kiln	Smelt Dissolving Tank	Power Boiler Scrubber Stack	High Level Roof Vent
Stack Height – Above Grade (m)	69	37	51	51	65
Diameter / Equivalent Diameter (m)	3.51	1.22[3]	1.22	1.93	1.83
Stack/Duct Description	Circular	Circular	Circular	Circular	Circular
Stack Orientation	Vertical	Vertical	Vertical	Vertical	Vertical
Location of Source Testing	In Stack	In Stack	In Stack	In Stack	In Stack
Number of Sample Ports	4	2	2	2	1
Sample Port Diameter (m)	0.1	0.15	0.1	0.1	0.1
Location Upstream from any Disturbance,	>2	2	>2	>2	-
Location Downstream from any Disturbance,	1.45	8	6	> 4	-
Ideal or Non Ideal Flow Characteristics at The Sample Location[1]	Not Ideal	Not Ideal[2]	Not Ideal	Not Ideal	-
Total Number of Sample Points	24 (for PM)	24 (for PM) 1 (for TRS)	20 (for PM) 1 (for TRS)	24 (for PM)	1 (for TRS and Cl, ClO_2)
Number of Sample Points per Traverse (PM sampling)	12	12	10	12	NA
Sample Time per Point for PM samples (min)	5	5	5	5	NA
Sample time per Test for PM (min)	120	120	100	120	NA
Sample time per Test for combustion gas (min)	30	30	30	30	30 (for TRS) 60 (for Cl, ClO_2)
Sample time per Test for TRS (min)	NA	1,440	1,440	NA	1,440

[1] The exhaust gas flow characteristics at the sampling location are referred to as being "Ideal" if the sample ports are located in a straight section of stack at least eight stack diameters downstream and two stack diameters upstream of any flow disturbance.
[2] The lime kiln sampling location has been changed from ideal to not ideal due to the cyclonic flow.
[3] Field measurement – to be confirmed during the Winter/Spring Event

Quality Assurance / Quality Control

Throughout the stack testing program, rigorous quality assurance and quality control procedures will be applied to ensure the collection of reliable, representative, and reproducible emissions data. All equipment will be calibrated according to the protocols as prescribed by Environment Canada, and the US EPA. These calibrations include the following:

Reference: Pre-Test Plan for Source Emissions Testing Northern Pulp, Pictou Mill – 2015 Calendar Year

Pitots:	calibrated in a wind tunnel with probe and nozzles attached;
Gas meters:	calibrated against a critical orifice set;
Thermocouples:	calibrated using a potentiometric technique;
Nozzle:	four diameter measurements made using a micrometer across the sharpened edges; and
Combustion Gas Analyser:	2 point calibrations using span gases of known concentrations.

Calibration data will be provided in the final report.

Quality control checks will be performed at several stages during the testing program to ensure the collection of representative samples and the generation of valid results. These checks are performed by test personnel throughout the program under the guidance of the source testing crew chief. The Quality Control (QC) checks include the following:

- Use of standardized checklists and field notebooks to ensure completeness, traceability, and comparability of the process information and samples collected;
- Field checking of standardized forms by a second person to ensure accuracy and completeness;
- Strict adherence to sample chain-of-custody procedures;
- Use of appropriate field blanks (e.g., filter and solution samples); and
- Leak checks of sample trains.

All internal quality assurance and quality control procedures will be strictly adhered to during all test programs to ensure the production of useful and high quality data throughout the course of the program.

Qualifications of Source Testing Team

The successful completion of this project requires the skills of competent and experienced professionals who have a strong commitment to complete the project quickly and efficiently and to produce high quality results. The source testing team we have assembled to meet the challenges of this assignment consists of highly trained professionals who bring a broad range of expertise and experience to the project. The following paragraphs provide brief descriptions of the qualifications of the source emissions testing team:

Senior Reviewer:

Reference: Pre-Test Plan for Source Emissions Testing Northern Pulp, Pictou Mill – 2015 Calendar Year

Project Manager and Report Writer:

Reference: Pre-Test Plan for Source Emissions Testing Northern Pulp, Pictou Mill – 2015 Calendar Year

Source Testing Team:

Schedule

Table 3 provides an overview of the proposed schedule to complete the testing, as described in the above sections, for the 2015 calendar year. Stantec will confirm actual test dates, in writing, with NSE within thirty days prior to the testing commencing.

Currently we are proposing to conduct the winter testing event within the week of March 9th.

Reference: Pre-Test Plan for Source Emissions Testing Northern Pulp, Pictou Mill – 2015 Calendar Year

Table 3 Proposed Schedule

Event	Proposed Date	Scope
Winter	February-March 31 (March 9th week)	Recovery and Power Boiler PM, gases, dissolving tank TRS
Spring	April-June 30	Recovery, Power Boiler, kiln, dissolving tank PM, gases, kiln, HLRV TRS, HLRV chlorine
Summer	July-Sept. 30	Recovery and Power Boiler PM, gases, dissolving tank TRS
Fall	October-Dec. 31	Recovery, Power Boiler, kiln, dissolving tank PM, $PM_{2.5}$, gases, kiln, HLRV TRS

Closing

Your timely written approval of this pre-test plan is greatly appreciated. If you have any questions, please do not hesitate to contact me directly at (902) 468-7777.

Regards,

STANTEC CONSULTING LTD.

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Project Manager – Environmental Services
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SOURCE EMISSIONS TESTING –
SUMMER ROUND 2015

October 16, 2015

Appendix B

Calibration Data

SOURCE EMISSIONS TESTING – SUMMER ROUND 2015

October 16, 2015

VALLEY ENVIRONMENTAL CALIBRATION SERVICES

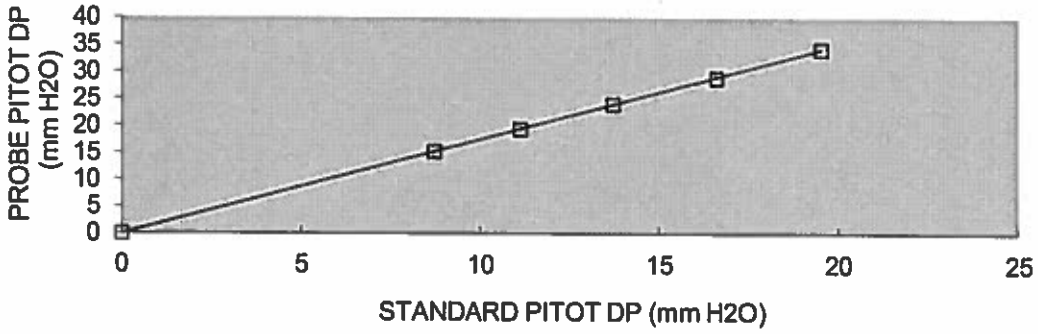
PITOT TUBE CALIBRATION REPORT

CLIENT - Stantec
PROBE ID - 4FT M5
NOZZLE - #10- 0.3125"
DATE - February 23, 2015

FAN SPEED m/s	STANDARD PITOT (mm H2O)	PROBE PITOT (mm H2O)
0.00	0.00	0.00
12.1	8.70	15.30
13.6	11.10	19.40
15.1	13.70	24.00
16.6	16.60	28.90
18.0	19.50	34.30

PITOT FACTOR Cp = **0.756**

PITOT - **4FT M5** **NOZZLE - #10- 0.3125"**
February 23, 2015



Technician: T. Ryan

Signature

VALLEY ENVIRONMENTAL SERVICES
160 Pony Drive #1
Newmarket, Ontario L3Y 7B6
PH: (905) 830 0136
FAX: (905) 830 0137

Tunnel	VES
Std. Pitot Cp	0.999
Static	-0.25
Barometric	29.15
Temperature	65
Abs Static	29.13

VALLEY ENVIRONMENTAL CALIBRATION SERVICES

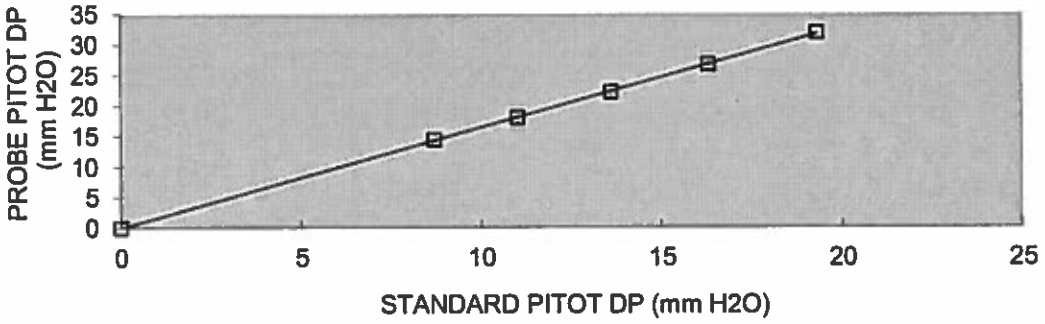
PITOT TUBE CALIBRATION REPORT

CLIENT - **Stantec**
PROBE ID - **8-2 FT M5**
NOZZLE - **#6- 0.1875"**
DATE - **March 3, 2015**

FAN SPEED m/s	STANDARD PITOT (mm H2O)	PROBE PITOT (mm H2O)
0.00	0.00	0.00
12.1	8.70	14.40
13.6	11.00	18.00
15.1	13.60	22.20
16.5	16.30	26.70
18.0	19.30	31.90

PITOT FACTOR Cp = **0.780**

PITOT - 8-2 FT M5 NOZZLE - #6- 0.1875"
March 3, 2015



Technician: T. Ryan

Signature

VALLEY ENVIRONMENTAL SERVICES
160 Pony Drive #1
Newmarket, Ontario L3Y 7B6
PH: (905) 830 0136
FAX: (905) 830 0137

Tunnel	VES
Std. Pitot Cp	0.999
Static	-0.25
Barometric	29.1
Temperature	65
Abs Static	29.08

CAL-CHEK CANADA

250 GOVERNOR'S ROAD - DUNDAS, ONTARIO L9H 3K3
TELEPHONE: (905) 628-4636 FAX: (905) 627-5903
email calchek@cogeco.ca

Scale / Balance Certification

Date: February 9, 2015

Certificate Number: S150165

Customer: Stantec Consulting Ltd.
845 Prospect Street
Fredericton, New Brunswick E3B 2T7

Room Temperature: 20.1°C

Calibration Location: 10 Timothy Road North Kingsclear Lab

Scale / Balance Manufacturer: Radwag

Resolution: 0.0001g

Model Number: XA220-2X

Serial Number: 336271

Capacity: 220 g

Capacity Calibrated To: 220 g

ACTUAL WEIGHT APPLIED GRAMS	SCALE READINGS AS FOUND	ERROR AS FOUND	ACTUAL WEIGHT APPLIED GRAMS	SCALE READINGS AS LEFT	ERROR AS LEFT
0.0020	0.0020	0.0000	0.0020	0.0020	0.0000
0.0050	0.0050	0.0000	0.0050	0.0050	0.0000
0.0100	0.0100	0.0000	0.0100	0.0100	0.0000
0.0500	0.0500	0.0000	0.0500	0.0500	0.0000
0.1000	0.1000	0.0000	0.1000	0.1000	0.0000
0.5000	0.5001	-0.0001	0.5000	0.5000	0.0000
1.0000	0.9998	0.0002	1.0000	0.9999	0.0001
5.0000	4.9999	0.0001	5.0000	4.9990	0.0010
10.0000	10.0001	-0.0001	10.0000	10.0000	0.0000
20.0000	20.0016	-0.0016	20.0000	20.0009	-0.0009
50.0000	50.0030	-0.0030	50.0000	50.0020	-0.0020
100.0000	99.9982	0.0018	100.0000	99.9992	0.0008
200.0000	200.0134	-0.0134	200.0000	200.0027	-0.0027
220.0000	220.0170	-0.0170	220.0000	220.0110	-0.0110

The above mentioned Scale / Balance has been checked for accuracy using the following N.I.S.T. calibrated dead weights as per the CSA method.

STANDARD	CAL DATE	NIST LAB #
22XE	03/10/13	681/280058-10

Obtained results are within the manufacturer's stated accuracy and/or are within +/-0.01% or 1 division whichever is greater at any point of the calibrated range.

Pass/Fail statements are based on data from measurements made, procedures utilized, professional experience and the uncertainty associated with this calibration. It is the responsibility of the user of this equipment to determine if the results identified meet specific requirements for its intended application.

Calibration Technician: Dave Newitt

Authorized Signatory: Roni Newitt

Suggested Calibration Due Date: February 2016

Due dates appearing on the certificate of calibration and label are determined by client for administrative purposes and do not imply continued conformance to specifications.

All calibrations performed at customer location unless otherwise noted.

Pre-Test Dry Gas Meter - Control Unit Calibration

Date : 11/7/2015
Barometric Pressure, Pb : 30.03
Model Number : 1848
Calibrated By : NGM
Job #:

Orifice Manometer Setting, deltaH (In. H2O)				Dry Gas Meter Volume, Vm (cu.ft)			Temperatures (F)				Time, theta (min)
								Dry Gas Meter			
						Total			Outlet, to	Average, tm	
0.8						6.593			71	71	10
1.2						6.427			72	73	8
1.8						6.853			73	74	7

Calculations

Orifice Manometer Setting, deltaH (In. H2O)	Dry Gas Correction Factor, gamma (Tolerance = 0.95 - 1.05, +/-1.5% of avg)	Orifice Pressure Differential (delta H@) yielding 0.75 cfm of air at 68F and 29.92 In.Hg as In. H2O (Tolerance = +/- 0.15 in.)	Orifice Coefficient Ko
0.8	0.821	1.478	0.797
1.2	0.825	1.541	0.777
1.8	0.840	1.503	0.772
Average	0.829	1.507	0.782

METHOD 5 DRY GAS METER CALIBRATION USING CRITICAL ORIFICES

1) Select three critical orifices to calibrate the dry gas meter which bracket the expected operating range.
2) Record barometric pressure before and after calibration procedure.
3) Run at tested vacuum (from Orifice Calibration Report), for a period of time necessary to achieve a minimum total volume of 5 cubic feet.
4) Record data and information in the GREEN cells, YELLOW cells are calculated.

DATE: 11/7/2015 | METER SERIAL #: 14676982 | BAROMETRIC PRESSURE (in Hg): INITIAL 30.03, FINAL 30.03, AVG (P_{bar}) 30.03

METER PART #: 1848 | CRITICAL ORIFICE SET SERIAL #: 1463a

IF Y VARIATION EXCEEDS 2.00%, ORIFICE SHOULD BE RECALIBRATED

ORIFICE #	RUN #	K' FACTOR (AVG)	TESTED VACUUM (in Hg)	DGM READINGS (FT^3) INITIAL	DGM READINGS (FT^3) FINAL	DGM READINGS (FT^3) NET (V_m)	TEMPERATURES °F AMBIENT	DGM INLET INITIAL	DGM INLET FINAL	DGM OUTLET INITIAL	DGM OUTLET FINAL	DGM AVG	ELAPSED TIME (MIN) θ	DGM ΔH ($in H_2O$)	(1) V_m (STD)	(2) V_{cr} (STD)	(3) Y	Y VARIATION (%)	$\Delta H_@$
15	1	0.4164	18	306.93	312.57	6.640	74	71	71	71	71	71	10.00	0.77	6.6405	5.4128	0.815		1.48
	2	0.4164	18	312.57	319.14	6.570	74	71	72	71	71	71.25	10.00	0.77	6.5674	5.4128	0.824		1.48
	3	0.4164	18	319.14	325.71	6.570	74	72	73	71	71	71.75	10.00	0.77	6.5612	5.4128	0.825		1.48
																AVG =	0.821	-0.89	
18	1	0.5085	18	325.71	332.12	6.410	74	73	74	71	71	72.25	8.00	1.20	6.4021	5.2880	0.826		1.54
	2	0.5085	18	332.12	338.52	6.40	74	74	75	71	72	73	8.00	1.20	6.3831	5.2880	0.828		1.54
	3	0.5085	18	338.52	344.99	6.470	74	75	75	72	73	73.75	8.00	1.20	6.4439	5.2880	0.821		1.54
																AVG =	0.825	-0.45	
23	1	0.6307	18	344.99	351.76	6.770	75	75	76	73	73	74.25	7.00	1.80	6.7462	5.7336	0.850		1.50
	2	0.6307	18	351.76	358.65	6.890	75	76	76	73	73	74.5	7.00	1.80	6.8626	5.7336	0.835		1.50
	3	0.6307	18	358.65	365.55	6.90	75	76	76	73	73	74.5	7.00	1.80	6.8725	5.7336	0.834		1.50
																AVG =	0.840	1.34	

USING THE CRITICAL ORIFICES AS CALIBRATION STANDARDS:

The following equations are used to calculate the standard volumes of air passed through the DGM, V_m (std), and the critical orifice, V_{cr} (std), and the DGM calibration factor, Y. These equations are automatically calculated in the spreadsheet above.

AVERAGE DRY GAS METER CALIBRATION FACTOR, Y = 0.829

AVERAGE $\Delta H_@$ = 1.51

(1) $$Vm_{(std)} = K_1 * Vm * \frac{Pbar + (\Delta H / 13.6)}{Tm}$$

= Net volume of gas sample passed through DGM, corrected to standard conditions

K_1 = 17.64 °R/in. Hg (English), 0.3858 °K/mm Hg (Metric)

T_m = Absolute DGM avg. temperature (°R - English, °K - Metric)

(2) $$Vcr_{(std)} = K' * \frac{Pbar * \Theta}{\sqrt{Tamb}}$$

= Volume of gas sample passed through the critical orifice, corrected to standard conditions

T_{amb} = Absolute ambient temperature (°R - English, °K - Metric)

K' = Average K' factor from Critical Orifice Calibration

(3) $$Y = \frac{Vcr_{(std)}}{Vm_{(std)}}$$

= DGM calibration factor

$$\Delta H_@ = \left(\frac{0.75\,\theta}{V_{cr(std)}}\right)^2 \Delta H \left(\frac{V_{m(std)}}{V_m}\right)$$

Calibration Data
Enerac 500 Combustion Analyzer

Stantec Consulting Ltd.
Location: Fredericton, NB
Date: March 11, 2015

Parameter	Unit	Span Gas Concentration	Pre-Test Calibration		Post Test Check	
			Date	11-Mar-15	Date	11-Mar-15
			Personnel	NGM	Personnel	NGM
			Ambient Air Reading	Span Gas Reading	Ambient Air Reading	Span Gas Reading
CO	ppm	200 1000	0	193 1012	0	200 1001
SO_2	ppm	200	0	178	0	200
NOX	ppm	200	0	198	0	200

Stantec Consulting Ltd.

Steel Nozzle Calibration Data Sheet

NozzleID	Nozzle Diameter (inches)					
Set - 2	<1>	<2>	<3>	<4>	Hi-Lo	Avg.
2-4	0.124	0.126	0.125	0.127		**0.126**
2-6	0.177	0.174	0.176	0.173		**0.175**
2-8	0.245	0.249	0.231	0.244		**0.242**
2-10	0.306	0.306	0.304	0.302		**0.305**
2-12	0.359	0.363	0.365	0.361		**0.362**
2-14	0.432	0.430	0.432	0.433		**0.432**
2-16	0.493	0.500	0.497	0.492		**0.496**

QA/QC Check

Each Diameter Measured To Within = 0.001 Inches

High - Low </= 0.004

Prepared By: JB

Date: Feb 05, 2015

Appendix C

Field data sheets

SOURCE EMISSIONS TESTING – SUMMER ROUND 2015

October 16, 2015

MOISTURE FIELD DATA SHEET

Project No.: ~~1251~~ 1214,3456
Client: Northern Pulp
Plant: Power Boiler Outlet
Location: ~~#~~ Pictou NS
Test: PM-1
Date: Sept 17, 2015
Analyst: JWB/JWC

Moisture Data

See other sheet

Impinger No.	Impinger Contents	Final Weight (g)	Tare Weight (g)	Weight of Moisture (g)
1	100 mL H2O	896.7	705.9	190.8
2	100 mL H2O	751.2	727.8	23.4
3	Blank	629.6	627.4	2.2
4	200g Silica Gel	911.2	905.3	5.9
		Total Weight Gain (g)		222.3
		Moisture Volume (mL)		

Volume H_2O Collected: 222.3 ml
X 0.048 = _____ ft^3 H_2O (Vwc)

DGM Final _____ ft^3
DGM Initial _____ ft^3
Final - Initial = _____ ft^3 (Vmc)

$$\text{Moisture} = \frac{\text{Vwc}}{(\text{Vwc} + \text{Vmc})}$$

Moisture = _____

Moisture = _____

17% Moisture

1/2

SOURCE TESTING FIELD DATA SHEET

Job No.: 121413456
Client: Northern Pulp
Plant: Power Boiler Outlet
Location: Pictou, NS
Test: PM-1
Date: Sept. 17, 2015
Operators: JSB/JC
Gamma: 0.829
Delta H@: 1.507
Pitot Coeff.: 0.780
Start: 9:10
Finish: 11:10

Static Pressure (in.H2O): 0.18
Port Length (in): 4
Stack Dia. (in.): 72
Probe Length (ft): 8 (8-2)
Nozzle ID (in.): 2-6 (0.175)
Console S/N: 1848

Pre-Test Leak Check:
Vacuum Pressure:
Post-Test Leak Check:
Vacuum Pressure:

K': 0.54

Traverse Point	Time (min)	Stack Gas Temp., Ts (F)	Velocity Head, dP (in.H2O)	Orifice dH (in.H2O)	Gas Meter Volume (cu.ft)	Probe Temp. (F)	Oven Temp. (F)	Impinger Outlet Temp. (F)	Gas Meter Temp. (F)		Pump Vacuum (in.Hg)
									In	Out	
	0				809.37						
1-1	2.5	133	0.55	0.26	810.33	265	260	61	61	60	-1
	5	133	0.55	0.26	811.28	266	261	61	61	60	-1
2	7.5	133	0.60	0.28	812.24	265	260	61	63	61	-1
	10	134	0.62	0.29	813.21	266	255	60	63	61	-1
3	12.5	132	0.62	0.29	814.20	267	255	60	63	61	-1
	15	132	0.64	0.30	815.19	260	253	60	63	61	-1
4	17.5	133	0.57	0.27	816.17	260	260	60	64	62	-1
	20	133	0.57	0.27	817.13	260	260	60	64	62	-1
5	22.5	131	0.57	0.27	818.10	259	266	59	64	62	-1
	25	133	0.57	0.27	819.06	260	267	59	64	62	-1
6	27.5	133	0.57	0.27	820.05	261	257	58	65	63	-1
	30	133	0.55	0.26	821.04	260	255	57	65	63	-1
7	32.5	132	0.60	0.28	822.03	265	250	57	66	64	-1
	35	133	0.61	0.29	823.06	265	248	57	66	64	-1
8	37.5	133	0.73	0.35	824.17	266	250	57	66	64	-1
	40	134	0.76	0.36	825.29	267	250	57	66	64	-1
9	42.5	135	0.91	0.44	826.53	266	285	58	67	65	-1
	45	132	0.95	0.45	827.79	260	225	59	67	65	-1
10	47.5	135	1.10	0.53	829.09	265	232	59	67	65	-2
	50	134	1.10	0.52	830.44	266	232	59	67	65	-2
11	52.5	133	1.20	0.57	831.86 *	265	225	59	67	65	-2
	55	133	1.20	0.57	833.33	266	224	59	67	65	-2
12	57.5	131	1.30	0.62	834.67	265	225	59	67	65	-2
	60	132	1.30	0.62	836.11	265	226	59	67	65	-2

SOURCE TESTING FIELD DATA SHEET

Job No.: 121413456
Client: Northern Pulp
Plant: Power Boiler Outlet
Location: Pictou, NS
Test: PM-1
Date: Sept 17, 2015
Operators: JJB / JC
Gamma: 0.529
Delta H@: 1.507
Pitot Coeff.: 0.780
Start: 9:10
Finish: 11:10

Static Pressure (in.H2O): 0.55
Port Length (in): 4
Stack Dia. (in.): 72
Probe Length (ft): 8
Nozzle ID (in.): 2-6
Console S/N: 18418

Pre-Test Leak Check:
Vacuum Pressure:
Post-Test Leak Check:
Vacuum Pressure:

K': 0.54

Traverse Point	Time (min)	Stack Gas Temp., Ts (F)	Velocity Head, dP (in.H2O)	Orifice dH (in.H2O)	Gas Meter Volume (cu.ft)	Probe Temp. (F)	Oven Temp. (F)	Impinger Outlet Temp. (F)	Gas Meter Temp. (F)		Pump Vacuum (in.Hg)
									In	Out	
	0				836.11						
2-1	2.5	131	0.95	0.45	837.37	264	244	62	68	66	-1
	5	130	0.95	0.46	839.60	265	245	61	68	66	-1
2	7.5	130	0.90	0.43	839.82	266	251	60	68	66	-1
	10	131	0.90	0.43	*	266	255	60	68	66	-1
3	12.5	132	0.80	0.38	842.21	267	257	58	69	67	-1
	15	137	0.80	0.38	843.33	265	255	59	69	67	-1
4	17.5	133	0.75	0.36	844.45	265	248	59	69	67	-2
	20	133	0.75	0.36	845.59	265	247	59	69	67	-2
5	22.5	134	0.68	0.33	846.68	266	250	60	69	68	-2
	25	134	0.67	0.32	847.75	265	249	60	70	68	-2
6	27.5	134	0.72	0.35	848.84	266	270	60	70	68	-2
	30	134	0.71	0.34	849.94	267	265	59	70	68	-2
7	32.5	134	0.40	0.39	851.10	269	257	60	71	68	-2
	35	135	0.82	0.40	852.30	270	258	61	71	69	-2
8	37.5	135	0.92	0.44	853.54	265	225	60	71	68	-2
	38/40	135	0.93	0.45	854.79	265	228	60	71	69	-2
9	42.5	133	1.05	0.51	856.10	260	230	59	72	69	-3
	45	134	1.10	0.53	857.46	260	232	59	72	69	-3
10	47.5	134	1.10	0.55	858.84	261	225	55	72	70	-3
	50	133	1.10	0.53	860.20	262	227	57	72	70	-3
11	52.5	132	1.50	0.73	861.73	251	248	56	72	70	-4
	55	132	1.45	0.70	863.32	255	250	56	72	70	-4
12	57.5	133	1.45	0.70	864.86	262	238	56	72	70	-4
	60	131	1.50	0.73	866.42	263	246	56	72	70	-4

MOISTURE FIELD DATA SHEET

Filter
0812-35

Project No.: 121413456
Client: Norther Pulp
Plant: Powr Boiler Outlet
Location: Pictou NB
Test: RM-2
Date: Sept 17, 2015
Analyst: JB/JWC

Moisture Data

Impinger No.	Impinger Contents	Final Weight (g)	Tare Weight (g)	Weight of Moisture (g)
1	100 mL H2O	911.9	726.7	185.2
2	100 mL H2O	754.0	732.5	21.5
3	Blank	628.1	625.6	2.5
4	200g Silica Gel	926.4	912.1	14.3
		Total Weight Gain (g)		223.5
		Moisture Volume (mL)		223.5

Volume H_2O Collected: 223.5 ml
X 0.048 = 10.728 ft^3 H_2O (Vwc)

DGM Final 928.99 ft^3
DGM Initial 867.02 ft^3
Final - Initial = 61.97 ft^3 (Vmc)

$$\text{Moisture} = \frac{\text{Vwc}}{(\text{Vwc} + \text{Vmc})}$$

$$\text{Moisture} = \frac{10.728}{(10.728 + 61.97)}$$

$$\text{Moisture} = \frac{0.1475693}{= 14.96\ \%}$$

SOURCE TESTING FIELD DATA SHEET

Job No.: 121413456
Client: Northern Pulp
Plant: Power Boiler Outlet
Location: Pictou, NS
Test: PM-2
Date: Sept. 17 2015
Operators: JJB/JC
Gamma: 0.629
Delta H@: 1.507
Pitot Coeff.: 0.780
Start: 1:40
Finish: 3:40

Static Pressure (in.H2O): 0.18
Port Length (in): 4
Stack Dia. (in.): 72
Probe Length (ft): 8
Nozzle ID (in.): 2-6
Console S/N: 1848

Pre-Test Leak Check: -18
Vacuum Pressure: -18
Post-Test Leak Check:
Vacuum Pressure:

K': 0.54

Traverse Point	Time (min)	Stack Gas Temp., Ts (F)	Velocity Head, dP (In.H2O)	Orifice dH (in.H2O)	Gas Meter Volume (cu.ft)	Probe Temp. (F)	Oven Temp. (F)	Impinger Outlet Temp. (F)	Gas Meter Temp. (F)		Pump Vacuum (in.Hg)
									In	Out	
	0				867.02						
1-1	2.5	130	1.20	0.54	868.38	253	245	68	78	78	-1
	5	131	1.10	0.54	869.71	255	250	64	80	78	-1
2	7.5	131	1.10	0.54	871.05	265	256	63	80	79	-1
	10	131	1.00	0.49	872.35	266	250	62	80	79	-1
3	12.5	133	0.92	0.45	873.60	264	262	59	81	79	-1
	15	131	0.90	0.44	874.84	264	258	59	82	79	-1
4	17.5	131	0.80	0.39	876.02	264	253	55	82	79	-1
	20	131	0.80	0.39	877.16	265	251	53	82	79	-1
5	22.5	130	0.80	0.39	878.28	265	251	54	83	80	-1
	25	130	0.75	0.37	879.39	266	250	53	83	80	-1
6	27.5	132	0.80	0.40	880.54	265	260	53	83	80	-1
	30	132	0.80	0.40	881.72	266	258	53	83	80	-1
7	32.5	130	0.85	0.42	882.92	266	252	54	84	80	-2
	35	130	0.85	0.42	884.10	266	252	54	84	80	-2
8	37.5	131	0.92	0.45	885.30	266	230	57	84	81	-2
	40	130	0.91	0.45	886.55	265	240	58	84	81	-2
9	42.5	130	1.10	0.54	887.87	265	260	59	84	81	-2
	45	130	1.10	0.54	889.22	265	261	60	84	81	-2
10	47.5	130	1.50	0.74	890.75	265	230	53	84	81	-3
	50	130	1.50	0.74	892.31	261	226	52	84	81	-3
11	52.5	130	1.10	0.54	893.72	260	255	51	84	81	-3
	55	131	1.50	0.74	895.26	260	247	51	84	81	-3
12	57.5	131	1.30	0.64	896.75	264	241	52	84	81	-3
	60	130	1.50	0.74	898.29	265	238	52	84	81	-3

2/2

SOURCE TESTING FIELD DATA SHEET

Job No.: 121413456
Client: Northern Pulp
Plant: Power Boiler Outlet
Location: Pictou, NS
Test: PM-2
Date: Sept. 17, 2015
Operators: JJB/JC
Gamma: 0.829
Delta H@: 1.509
Pitot Coeff.: 0.790
Start: 1:40
Finish: 3:40

Static Pressure (in.H2O): 0.18
Port Length (in): 4
Stack Dia. (in.): 72
Probe Length (ft): 8
Nozzle ID (in.): 2-6
Console S/N: 1648

Pre-Test Leak Check:
Vacuum Pressure:
Post-Test Leak Check:
Vacuum Pressure:

K': 0.54

Traverse Point	Time (min)	Stack Gas Temp., Ts (F)	Velocity Head, dP (in.H2O)	Orifice dH (in.H2O)	Gas Meter Volume (cu.ft)	Probe Temp. (F)	Oven Temp. (F)	Impinger Outlet Temp. (F)	Gas Meter Temp. (F)		Pump Vacuum (in.Hg)
									In	Out	
	0				898.29						
2-1	2.5	129	1.10	0.54	899.72	265	248	54	84	81	-4
	5	129	1.10	0.54	901.05	261	262	54	84	81	-4
2	7.5	131	1.05	0.52	*	264	252	54	84	81	-4
	10	131	1.15	0.57	903.74	263	251	54	84	81	-4
3	12.5	132	1.10	0.54	905.12	266	264	55	84	81	-4
	15	132	1.10	0.54	906.46	264	264	55	84	81	-4
4	17.5	132	0.95	0.47	907.76	266	264	56	84	81	-4
	20	132	0.95	0.47	909.02	266	264	56	84	81	-4
5	22.5	131	0.86	0.42	910.24	260	260	57	84	81	-4
	25	133	0.82	0.41	911.44	262	260	58	84	81	-4
6	27.5	133	0.81	0.40	912.66	265	258	55	84	81	-4
	30	133	0.81	0.40	913.82	265	259	54	84	81	-4
7	32.5	133	0.84	0.42	915.03	266	257	55	84	81	-4
	35	133	0.84	0.42	916.22	264	256	55	84	81	-4
8	37.5	133	0.85	0.42	917.43	266	261	56	83	80	-4
	40	133	0.77	0.38	918.57	264	254	56	83	80	-4
9	42.5	132	0.90	0.44	919.79	264	245	57	83	80	-5
	45	132	0.92	0.45	921.02	264	246	57	83	80	-5
10	47.5	132	0.95	0.47	922.28	264	250	60	83	80	-5
	50	132	0.92	0.46	923.54	265	249	61	83	80	-5
11	52.5	131	1.00	0.49	#	266	250	62	84	81	-5
	55	131	1.05	0.52	926.12	265	251	62	84	81	-5
12	57.5	130	1.20	0.59	927.51	265	252	63	84	81	-6
	60	130	1.30	0.64	928.99	264	253	64	84	81	-7

MOISTURE FIELD DATA SHEET

Project No.: 1214 13456
Client: Northern Pulp
Plant: Power Boiler Outlet
Location: Pictou NS
Test: PM-3
Date: Sept 18, 2015
Analyst: JJB / JWC

FILTER
0812-40

Moisture Data

Impinger No.	Impinger Contents	Final Weight (g)	Tare Weight (g)	Weight of Moisture (g)
1	100 mL H2O	904.0	717.2	186.8
2	100 mL H2O	744.9	723.6	21.3
3	Blank	628.7	626.1	2.6
4	200g Silica Gel	922.8	907.7	15.1
		Total Weight Gain (g)		225.8
		Moisture Volume (mL)		225.8

Volume H_2O Collected: 225.8 ml
X 0.048 = 10.8384 ft^3 H_2O (Vwc)

DGM Final 992.79 ft^3
DGM Initial 898.29 ft^3
Final - Initial = 94.5 ft^3 (Vmc)

$$\text{Moisture} = \frac{\text{Vwc}}{(\text{Vwc} + \text{Vmc})}$$

$$\text{Moisture} = \frac{10.8384}{(10.8384 + 94.5)}$$

$$\text{Moisture} = \frac{0.102891253}{10.29\ \%}$$

1/2

SOURCE TESTING FIELD DATA SHEET

Job No.: 121413456
Client: Northern P.L.P.
Plant: Power Boiler Outlet
Location: Pictou, NS
Test: PM-3
Date: Sept. 18 2015
Operators: SSB/JC
Gamma: 0.929
Delta H@: 1.507
Pitot Coeff.: 0.740
Start: 9:00
Finish:

Static Pressure (in.H2O): 0.52
Port Length (in): 4
Stack Dia. (in.): 72
Probe Length (ft): 8
Nozzle ID (in.): 2-6
Console S/N: 1848

Pre-Test Leak Check: ✓
Vacuum Pressure: -18
Post-Test Leak Check:
Vacuum Pressure:

K': 0.54

Traverse Point	Time (min)	Stack Gas Temp., Ts (F)	Velocity Head, dP (in.H2O)	Orifice dH (in.H2O)	Gas Meter Volume (cu.ft)	Probe Temp. (F)	Oven Temp. (F)	Impinger Outlet Temp. (F)	Gas Meter Temp. (F)		Pump Vacuum (in.Hg)
									In	Out	
	0				929.34						
1-1	2.5	130	1.10	0.53	930.70	232	225	61	66	67	-1
	5	130	1.10	0.53	932.05	242	230	60	67	67	-1
2	7.5	130	1.10	0.53	933.38	263	232	57	67	67	-1
	10	130	1.10	0.53	934.70	264	236	55	67	67	-1
3	12.5	131	1.05	0.51	936.01	265	243	51	68	67	-1
	15	131	1.05	0.51	937.29	266	243	50	68	67	-1
4	17.5	130	0.87	0.42	938.51	265	250	50	69	67	-1
	20	130	0.87	0.42	*	266	255	50	70	67	-1
5	22.5	131	0.90	0.43	940.89	261	257	50	71	68	-1
	25	131	0.87	0.42	942.08	260	260	50	71	68	-1
6	27.5	130	0.80	0.39	943.24	266	259	51	72	69	-1
	30	130	0.80	0.39	944.38	260	260	52	72	69	-1
7	32.5	132	0.85	0.41	945.54	261	260	54	73	69	-1
	35	133	0.80	0.39	946.69	261	258	55	73	69	-1
8	37.5	131	0.85	0.41	947.86	266	260	55	73	70	-2
	40	131	0.85	0.41	949.05	266	261	56	77	70	-2
9	42.5	130	0.90	0.44	950.27	265	255	56	74	70	-2
	45	130	0.90	0.44	951.50	266	255	56	74	70	-2
10	47.5	132	1.10	0.53	952.70	262	247	57	74	71	-2
	50	132	1.10	0.53	953.92	263	245	57	74	72	-2
11	52.5	130	1.20	0.58	955.33	263	247	57	74	72	-2
	55	130	1.30	0.63	956.80	263	249	57	75	72	-2
12	57.5	131	1.50	0.73	958.36	265	251	57	75	72	-3
	60	130	1.50	0.73	959.95	267	250	57	75	72	-3

2/2

SOURCE TESTING FIELD DATA SHEET

Job No.: 121413456
Client: Northern Pulp
Plant: Power Boiler Outlet
Location: Pictou, NS
Test: PM-3
Date: Sept. 18, 2018
Operators: JSB/JC
Gamma: 0.829
Delta H@: 1.507
Pitot Coeff.: 0.840
Start :
Finish :

Static Pressure (in.H2O): 0.52
Port Length (in): 4
Stack Dia. (in.): 72
Probe Length (ft): 8
Nozzle ID (in.): 2-6
Console S/N: 1548

Pre-Test Leak Check:
Vacuum Pressure:
Post-Test Leak Check:
Vacuum Pressure:

K': 0.54

Traverse Point	Time (min)	Stack Gas Temp., Ts (F)	Velocity Head, dP (in.H2O)	Orifice dH (in.H2O)	Gas Meter Volume (cu.ft)	Probe Temp. (F)	Oven Temp. (F)	Impinger Outlet Temp. (F)	Gas Meter Temp. (F)		Pump Vacuum (in.Hg)
									In	Out	
	0				959.95						
2-1	2.5	130	1.05	0.51	961.51	264	262	59	77	74	-4
	5	130	1.05	0.51	962.86	264	264	58	77	74	-4
2	7.5	131	1.05	0.51	964.21	266	263	58	77	74	-4
	10	132	1.10	0.54	965.60	266	265	56	77	74	-3
3	12.5	132	1.10	0.54	966.99	265	259	51	78	75	-3
	15	132	1.10	0.54	968.39	266	260	50	78	75	-3
4	17.5	132	0.97	0.47	969.72	261	263	47	78	75	-3
	20	132	1.00	0.49	971.04	261	264	47	78	75	-3
5	22.5	131	0.90	0.44	972.32	262	262	46	78	76	-3
	25	131	0.90	0.44	973.58	261	262	45	78	76	-3
6	27.5	132	0.85	0.42	974.83	260	261	44	78	76	-3
	30	133	0.85	0.42	976.08	260	259	44	78	76	-3
7	32.5	135	0.90	0.44	977.36	261	261	45	78	76	-4
	35	135	0.90	0.44	978.62	261	261	45	78	76	-4
8	37.5	133	0.90	0.44	979.88	243	253	45	78	77	-4
	40	133	0.90	0.44	981.14	244	255	45	78	77	-4
9	42.5	131	1.05	0.51	982.47	264	250	47	79	77	-4
	45	131	1.00	0.49	983.81	264	251	48	79	77	-4
10	47.6	134	1.10	0.54	985.20	265	256	48	79	77	-5
	50	134	1.10	0.54	986.57	265	258	49	79	77	-5
12	52.5	131	1.10	0.54	987.96	266	260	49	79	77	-5
	55	131	1.15	0.56	989.34	261	260	49	79	77	-5
12	57.5	131	1.40	0.69	990.85	265	252	50	79	77	-6
	60	131	1.40	0.69	992.79	266	251	50	79	77	-6

MOISTURE FIELD DATA SHEET

0812-16

Project No.: 121413456
Client: Northern Pulp
Plant: Recovery Outlet
Location: Pictou, NS
Test: PM-1
Date: Sept. 15, 2015
Analyst: JJB

Moisture Data

Impinger No.	Impinger Contents	Final Weight (g)	Tare Weight (g)	Weight of Moisture (g)
1	100 mL H2O	973.7	722.8	250.9
2	100 mL H2O	1005.8	734.8	271.0
3	Blank	454.1	625.4	228.7
4	200g Silica Gel	906.4	854.1	52.3
		Total Weight Gain (g)		802.9
		Moisture Volume (mL)		802.9

Volume H_2O Collected: 802.9 ml
X 0.048 = 38.54 $ft^3 H_2O$ (Vwc)

DGM Final 491.29 ft^3
DGM Initial 386.00 ft^3
Final - Initial = 105.29 ft^3 (Vmc)

$$\text{Moisture} = \frac{\text{Vwc}}{(\text{Vwc} + \text{Vmc})}$$

$$\text{Moisture} = \frac{38.54}{(38.54 + 105.29)}$$

Moisture = 0.268 = 26.8%

SOURCE TESTING FIELD DATA SHEET

Job No.: 1214113456
Client: Northern Pulp
Plant: Recovery Outlet
Location: Pictou, NS
Test: PM-1
Date: Sept. 15/2015
Operators: JSB/JC
Gamma: 10.929
Delta H@: 1.507
Pitot Coeff.: 0.756
Start: 1115
Finish:

Static Pressure (in.H2O): 1.10
Port Length (in): 4
Stack Dia. (in.): 138
Probe Length (ft): 4
Nozzle ID (in.): 2-10 (0.308)
Console S/N: 1848

Pre-Test Leak Check: 0
Vacuum Pressure: -18
Post-Test Leak Check:
Vacuum Pressure:

K: 3.69

Ts DP Dh Tm

Traverse Point	Time (min)	Stack Gas Temp., Ts (F)	Velocity Head, dP (in.H2O)	Orifice dH (in.H2O)	Gas Meter Volume (cu.ft)	Probe Temp. (F)	Oven Temp. (F)	Impinger Outlet Temp. (F)	Gas Meter Temp. (F)		Pump Vacuum (in.Hg)
									In	Out	
	0				386.00						
1	2.5	154	0.51	1.62	388.68	225	260	65	69	69	-1
	5	154	0.51	1.62	390.93	260	270	63	70	69	-2
2	7.5	154	0.51	1.62	393.15	265	250	61	69	69	-2
	10	154	0.51	1.62	395.34	266	257	60	69	69	-2
3	12.5	155	0.50	1.67	397.53	265	268	61	70	69	-2
	15	155	0.50	1.59	399.70	264	258	65	71	69	-2
4	17.5	155	0.50	1.59	401.86	265	252	69	71	69	-2
	20	155	0.50	1.59	404.00	266	251	70	71	69	-2
5	22.5	155	0.49	1.56	406.13	265	263	78	72	70	-2
	25	155	0.49	1.56	408.25	267	263	76	72	70	-2
6	27.5	155	0.50	1.59	410.39	265	261	80	73	69	-2
	30	156	0.50	1.59	412.55	266	264	80	73	70	-2
7	32.5	155	0.50	1.59	414.69	265	250	75	74	70	-2
	35	155	0.50	1.59	416.83	261	252	71	74	71	-2
8	37.5	156	0.50	1.60	419.00	265	261	70	75	70	-2
	40	156	0.50	1.60	421.17	265	262	70	75	70	-2
9	42.5	154	0.50	1.60	423.76	266	257	71	76	70	-2
	45	154	0.50	1.60	425.56	269	247	71	76	70	-2
10	47.5	154	0.50	1.60	427.77	265	264	71	76	71	-3
	50	154	0.50	1.60	429.95	267	263	72	76	71	-3
11	52.5	155	0.50	1.60	432.14	264	255	74	76	72	-3
	55	155	0.50	1.60	434.30	266	256	74	76	72	-3
12	57.5	155	0.51	1.63	436.48	266	261	74	78	72	-3
	60	155	0.51	1.63	438.67	266	262	74	79	72	-3

SOURCE TESTING FIELD DATA SHEET

Job No.: 121413456
Client: Northern Pulp
Plant: Recovery Outlet
Location: Pictou, NS
Test: PM-1
Date: Sept. 15/2015
Operators: JDB/JC
Gamma: 0.329
Delta H@: 1.507
Pitot Coeff.: 0.75
Start :
Finish : 13:30

Static Pressure (in.H2O): 1.10
Port Length (in): 4
Stack Dia. (in.): 138
Probe Length (ft): 9
Nozzle ID (in.): 2-10(a)05
Console S/N: 1848

Pre-Test Leak Check:
Vacuum Pressure:
Post-Test Leak Check: 0
Vacuum Pressure: -18

K': 3.69

Traverse Point	Time (min)	Stack Gas Temp., Ts (F)	Velocity Head, dP (in.H2O)	Orifice dH (in.H2O)	Gas Meter Volume (cu.ft)	Probe Temp. (F)	Oven Temp. (F)	Impinger Outlet Temp. (F)	Gas Meter Temp. (F)		Pump Vacuum (in.Hg)
		Ts	dP	dH			FILTER	DRYER	Tm		
									In	Out	
	0				0138.67						
1	2.5	155	0.50	1.60	440.84	266	260	74	78	72	-3
	5	153	0.50	1.60	443.04	267	261	74	78	72	-3
2	7.5	153	0.50	1.60	445.22	265	259	75	76	72	-3
	10	153	0.50	1.60	447.41	262	260	75	78	72	-3
3	12.5	155	0.50	1.60	449.60	266	263	75	78	73	-3
	15	155	0.50	1.60	451.89	264	260	75	78	73	-3
4	17.5	154	0.50	1.60	454.09	263	259	74	79	73	-3
	20	154	0.50	1.60	456.26	264	261	73	79	73	-3
5	22.5	155	0.50	1.61	458.33	263	238	73	78	73	-3
	25	154	0.50	1.61	460.58	264	242	71	78	73	-3
6	27.5	154	0.50	1.61	462.65	264	254	71	78	73	-3
	30	155	0.50	1.61	464.89	263	258	71	78	73	-3
7	32.5	155	0.50	1.61	466.88	262	265	71	78	73	-3
	35	155	0.50	1.61	469.29	263	253	72	79	73	-3
8	37.5	155	0.50	1.61	471.49	263	258	72	79	73	-3
	40	155	0.50	1.61	473.81 *	264	243	73	79	74	-4
9	42.5	156	0.50	1.61	475.89	265	250	74	80	74	-4
	45	156	0.50	1.61	477.60	265	257	74	80	74	-4
10	47.5	156	0.50	1.61	480.14	264	248	75	80	74	-4
	50	155	0.50	1.61	482.34	265	257	78	81	75	-4
11	52.5	156	0.50	1.61	484.58	264	242	80	81	75	-4
	55	155	0.50	1.61	486.89	265	262	80	81	75	-4
12	57.5	154	0.50	1.62	489.00	264	260	80	82	75	-4
	60	155	0.50	1.62	491.29	265	253	80	82	75	-4

COMBUSTION GAS ANALYSIS
CONCENTRATION FIELD SHEET

Sampling Methodology: Environment Canada EPS 1/RM/15

Stantec

Project No.: 121413456
Client: Northern Pulp
Plant: Recovery Outlet
Location: Pictou, NS

Fuel Type: Black Liquor

Time Start: 12:00
Time Finish: 12:30

Test No.: 1
Date:

Personnel: JJB

Time	Concentrations							
	O_2 (%)	CO_2 (%)	CO (ppm)	SO_2 (ppm)	NO_X (ppm)	NO_2 (ppm)	NO (ppm)	THC (PPM)
0	5.2	10.5	2401	41	0			
5	5.3	10.4	1224	38	0			
10	5.3	10.4	off scale	45	0			
15	5.3	10.4	off scale	46	0			
20	5.3	10.4	2288	48	0			
25	5.3	10.4	2314	43	0			
30	5.3	10.4	1940	45	0			

MOISTURE FIELD DATA SHEET

FILTER #
0812-11

Project No.: 121413456
Client: Northern Pulp
Plant: Recovery Outlet
Location: Pictou NS
Test: PM-3
Date: Sept. 16, 2015
Analyst: J.B

Moisture Data

Impinger No.	Impinger Contents	Final Weight (g)	Tare Weight (g)	Weight of Moisture (g)
1	100 mL H2O	487.4	723.8	263.6
2	100 mL H2O	1023.7	731.0	292.7
3	Blank	864.7	625.1	239.6
4	200g Silica Gel	923.9	892.2	31.7
		Total Weight Gain (g)		827.6
		Moisture Volume (mL)		827.6

Volume H_2O Collected: 827.6 ml
X 0.048 = 39.72 ft^3 H_2O (Vwc)

DGM Final 701.39 ft^3
DGM Initial 596.17 ft^3
Final - Initial = 105.22 ft^3 (Vmc)

$$\text{Moisture} = \frac{\text{Vwc}}{(\text{Vwc} + \text{Vmc})}$$

$$\text{Moisture} = \frac{39.72}{(105.22 + 39.72)}$$

Moisture = 0.274 = 27.4%

SOURCE TESTING FIELD DATA SHEET

Job No.: 121413456
Client: Northern Pulp
Plant: Recovery Outlet
Location: Pictou, NS
Test: PM-3
Date: Sept. 16, 2015
Operators: JJB/JC
Gamma: 0.[illegible]
Delta H@: 1.507
Pitot Coeff.: 0.796
Start: 6:40
Finish:

Static Pressure (in.H2O): 1.10
Port Length (in): 4
Stack Dia. (in.): 138"
Probe Length (ft): 4
Nozzle ID (in.): 2-10 (0.305)
Console S/N: 15448

Pre-Test Leak Check:
Vacuum Pressure:
Post-Test Leak Check:
Vacuum Pressure:

K': 3.69

Traverse Point	Time (min)	Stack Gas Temp., Ts (F)	Velocity Head, dP (in.H2O)	Orifice dH (in.H2O)	Gas Meter Volume (cu.ft)	Probe Temp. (F)	Oven Temp. (F)	Impinger Outlet Temp. (F)	Gas Meter Temp. (F)		Pump Vacuum (in.Hg)
									In	Out	
	0				596.17						
1	2.5	155	0.50	1.58	598.32	225	255	61	66	65	-3
	5	155	0.50	1.58	600.51	235	255	60	66	65	-3
2	7.5	156	0.50	1.58	602.69	265	258	48	67	66	-3
	10	156	0.50	1.58	604.86	265	260	47	67	66	-3
3	12.5	156	0.48	1.51	607.01	265	260	48	69	66	-3
	15	156	0.48	1.51	609.14	266	261	48	69	66	-3
4	17.5	156	0.48	1.51	611.26	265	258	49	70	67	-3
	20	156	0.49	1.55	613.36	265	260	49	70	67	-3
5	22.5	156	0.49	1.55	615.52	264	245	51	72	67	-3
	25	156	0.49	1.55	617.66	266	247	52	72	67	-3
6	27.5	155	0.49	1.56	619.77	265	263	51	74	68	-3
	30	155	0.50	1.59	621.97	266	262	51	74	68	-3
7	32.5	154	0.50	1.60	624.17	265	259	52	75	69	-4
	35	154	0.50	1.60	626.35	262	260	52	75	69	-3
8	37.5	153	0.50	1.60	628.55	266	263	55	77	70	-3
	40	153	0.50	1.60	630.75	266	264	55	77	71	-4
9	42.5	153	0.50	1.60	632.94	265	259	57	79	71	-4
	45	153	0.50	1.60	635.18	266	260	58	79	72	-4
10	47.5	151	0.51	1.64	637.39	265	261	60	80	72	-4
	50	151	0.51	1.64	639.60	265	262	60	80	72	-4
11	52.5	153	0.51	1.64	641.82	265	261	61	81	73	-4
	55	153	0.51	1.64	644.03	266	262	61	81	77	-4
12	57.5	153	0.51	1.64	646.23	266	260	63	81	73	-4
	60	153	0.51	1.64	648.42	265	261	64	81	74	-4

SOURCE TESTING FIELD DATA SHEET

Job No.: 121413456
Client: Northern Pulp
Plant: 121413456
Location: Pictou, NS RECOVERY OUTLET
Test: PM-3
Date: Sept. 16, 2015
Operators: JJB/JC
Gamma: 0.~~829~~
Delta H@: 1.507
Pitot Coeff.: 0.756
Start :
Finish : 10:40

Static Pressure (in.H2O): 1.10
Port Length (in): 4
Stack Dia. (in.): 138
Probe Length (ft): 4
Nozzle ID (in.): 2-10(0.305)
Console S/N: 1848

Pre-Test Leak Check:
Vacuum Pressure:
Post-Test Leak Check:
Vacuum Pressure:

K': 3.69

Traverse Point	Time (min)	Stack Gas Temp., Ts (F)	Velocity Head, dP (in.H2O)	Orifice dH (in.H2O)	Gas Meter Volume (cu.ft)	Probe Temp. (F)	Oven Temp. (F)	Impinger Outlet Temp. (F)	Gas Meter Temp. (F) Tm		Pump Vacuum (in.Hg)
									In	Out	
	0				648.42						
1	2.5	155	0.51	1.64	650.66	265	255	65	81	74	-4
	5	154	0.51	1.64	652.86	266	256	65	81	75	-4
2	7.5	156	0.51	1.64	655.07	265	249	62	81	75	-4
	10	166	0.51	1.64	657.28	266	263	58	82	75	-4
3	12.5	157	0.51	1.64	659.48	265	249	55	82	75	-4
	15	155	0.51	1.65	661.67	265	252	54	82	75	-4
4	17.5	165	0.51	1.65	663.87	265	257	53	82	76	-4
	20	155	0.51	1.65	666.25	266	265	52	82	76	-4
5	22.5	156	0.51	1.65	668.26	265	260	52	82	76	-4
	25	157	0.51	1.64	670.38	265	261	53	82	76	-4
6	27.5	156	0.51	1.65	672.55	266	258	53	82	76	-4
	30	156	0.51	1.65	~~674.27~~ 674.48	265	253	54	82	76	-4
7	32.5	157	0.51	1.64	676.88	265	261	55	82	76	-5
	35	154	0.51	1.65	679.10	265	256	56	83	76	-5
8	37.5	155	0.51	1.65	681.31	265	260	57	83	77	-5
	40	155	0.51	1.65	683.53	265	257	58	83	77	-5
9	42.5	155	0.51	1.65	685.75	265	255	59	83	77	-5
	45	154	0.51	1.65	688.01	266	261	61	84	77	-5
10	47.5	154	0.51	~~1.65~~ 1.66	690.25	264	251	61	83	77	-5
	50	154	0.51	1.65	692.49	265	257	62	84	77	-5
11	52.5	154	0.51	1.66	694.71	264	246	55	83	77	-5
	55	155	0.51	1.65	696.95	265	250	51	83	77	-5
12	57.5	154	0.51	1.66	699.30	265	247	51	83	77	-5
	60	154	0.51	1.65	701.39	265	247	51	82	77	-5

COMBUSTION GAS ANALYSIS CONCENTRATION FIELD SHEET

Sampling Methodology: Environment Canada EPS 1/RM/15

Stantec

Project No.: 121413456
Client: Northern Pulp
Plant: Recovery Outlet
Location: Pictou, NS

Fuel Type: _____

Time Start: 9:00
Time Finish: 9:30

Test No.: 3
Date: Sept. 16, 2015

Personnel: JJB

Time	Concentrations							
	O_2 (%)	CO_2 (%)	CO (ppm)	SO_2 (ppm)	NO_X (ppm)	NO_2 (ppm)	NO (ppm)	THC (PPM)
0	5.4	10.4	175	57	ϕ			
5	5.5	10.3	228	58	ϕ			
10	5.5	10.3	236	58	ϕ			
15	5.4	10.4	144	60	ϕ			
20	5.4	10.4	321	60	ϕ			
25	5.6	10.3	545	60	ϕ			
30	5.4	10.4	489	61	ϕ			

MOISTURE FIELD DATA SHEET

FILTER #:

0812 -12

Project No.: 121413456
Client: Northern Pulp
Plant: Recovery Outlet
Location: Pictou NS
Test: PM-4
Date: Sept 16, 2015
Analyst: JJB

Moisture Data

Impinger No.	Impinger Contents	Final Weight (g)	Tare Weight (g)	Weight of Moisture (g)
1	100 mL H2O	1001.2	728.5	272.7
2	100 mL H2O	1018.6	734.4	284.2
3	Blank	848.0	625.6	222.4
4	200g Silica Gel	941.7	915.4	26.3
		Total Weight Gain (g)		805.6
		Moisture Volume (mL)		805.6

Volume H_2O Collected: 805.6 ml
X 0.048 = 38.6688 ft^3 H_2O (Vwc)

DGM Final 808.97 ft^3
DGM Initial 701.95 ft^3
Final - Initial = 107.02 ft^3 (Vmc)

$$\text{Moisture} = \frac{\text{Vwc}}{\text{(Vwc + Vmc)}}$$

$$\text{Moisture} = \frac{38.6688}{(38.6688 + 107.02)} \qquad 145.6888$$

$$\text{Moisture} = \frac{0.265421}{= 26.54\ \%}$$

SOURCE TESTING FIELD DATA SHEET

Job No.: 1214 13456
Client: Northern Pulp
Plant: Recovery Outlet
Location: Pictou, NS
Test: PM-4
Date: Sept. 16, 2015
Operators: JB/JC
Gamma: 0.989
Delta H@: 1.507
Pitot Coeff.: 0.756
Start: 12:30
Finish:

Static Pressure (in.H2O): 1.10
Port Length (in): 4
Stack Dia. (in.): 138
Probe Length (ft): 4
Nozzle ID (in.): 2-10 (0.305)
Console S/N: 1848

Pre-Test Leak Check: -18
Vacuum Pressure: -19
Post-Test Leak Check:
Vacuum Pressure:

K': 3.69

Traverse Point	Time (min)	Stack Gas Temp., Ts (F)	Velocity Head, dP (in.H2O)	Orifice dH (in.H2O)	Gas Meter Volume (cu.ft)	Probe Temp. (F)	Oven Temp. (F)	Impinger Outlet Temp. (F)	Gas Meter Temp. (F)		Pump Vacuum (in.Hg)
									In	Out	
	0				701.95						
1	2.5	155	0.50	1.61	704.15	258	250	63	76	75	-4
	5	155	0.50	1.61	706.38	260	252	62	76	75	-4
2	7.5	155	0.50	1.61	708.62	263	259	51	77	74	-4
	10	155	0.51	1.64	710.85	264	260	49	77	75	-4
3	12.5	153	0.51	1.64	713.09	265	264	48	78	74	-4
	15	154	0.51	1.64	715.30	265	265	47	78	74	-4
4	17.5	152	0.51	1.64	717.53	265	258	47	77	74	-4
	20	152	0.50	1.61	719.76	266	259	47	77	74	-4
5	22.5	155	0.50	1.61	721.99	266	266	47	77	73	-4
	25	155	0.50	1.61	724.22	266	266	47	78	73	-4
6	27.5	155	0.50	1.61	726.42	265	256	49	78	73	-4
	30	155	0.50	1.61	728.63	264	256	49	78	73	-4
7	32.5	155	0.50	1.61	730.84	265	258	51	79	74	-4
	35	155	0.50	1.61	733.03	265	257	52	79	74	-4
8	37.5	155	0.50	1.61	735.21	266	257	52	80	74	-4
	40	155	0.50	1.61	737.42	266	258	52	80	74	-4
9	42.5	154	0.50	1.61	739.65	265	255	53	80	74	-4
	45	154	0.50	1.61	741.87	266	253	54	40	74	-4
10	47.5	155	0.50	1.61	744.10	261	255	53	82	75	-4
	50	155	0.50	1.61	746.33	262	257	54	82	76	-4
11	52.5	155	0.50	1.61	748.55	265	257	54	84	75	-4
	55	155	0.50	1.61	750.78	266	258	54	84	76	-4
12	57.5	155	0.50	1.61	753.02	265	258	55	84	77	-4
	60	155	0.50	1.61	755.27	265	258	56	84	77	-4

SOURCE TESTING FIELD DATA SHEET

Job No.: 1214 13456
Client: Northern Pulp
Plant: Recovery Outlet
Location: Pictou NS
Test: PM-4
Date: Sept. 16, 2015
Operators: JJB/JC
Gamma: 0.9929
Delta H@: 1.507
Pitot Coeff.: 0.756
Start: ~12:30 pm
Finish: ~2:33 pm

Static Pressure (in.H2O): 1.10
Port Length (in): 4
Stack Dia. (in.): 135
Probe Length (ft): 4
Nozzle ID (in.): 2-10 (.305)
Console S/N: 1848

Pre-Test Leak Check:
Vacuum Pressure:
Post-Test Leak Check:
Vacuum Pressure:

K': 3.69

Traverse Point	Time (min)	Stack Gas Temp., Ts (F)	Velocity Head, dP (in.H2O)	Orifice dH (in.H2O)	Gas Meter Volume (cu.ft)	Probe Temp. (F)	Oven Temp. (F)	Impinger Outlet Temp. (F)	Gas Meter Temp. (F)		Pump Vacuum (in.Hg)
									In	Out	
	0				755.27						
1	2.5	155	0.50	1.62	757.54	266	255	58	83	78	-5
	5	155	0.50	1.62	759.80	265	257	59	83	78	-5
2	7.5	165	0.49	1.59	762.05	266	261	49	82	77	-5
	10	155	0.49	1.59	764.29	266	262	49	82	77	-5
3	12.5	155	0.49	1.59	766.55	265	250	47	82	77	-5
	15	154	0.49	1.59	768.78	265	259	46	81	77	-5
4	17.5	155	0.49	1.59	771.01	265	257	46	83	77	-5
	20	154	0.49	1.59	773.25	265	257	47	83	77	-5
5	22.5	153	0.49	1.59	775.44	265	261	47	82	77	-5
	25	154	0.49	1.59	777.66	265	263	49	82	78	-5
6	27.5	154	0.49	1.59	779.91	265	259	49	83	77	-5
	30	155	0.49	1.59	MISSED *	265	260	50	83	77	-5
7	32.5	154	0.49	1.59	784.39	265	258	51	82	77	-5
	35	154	0.49	1.59	786.67	265	259	51	82	77	-5
8	37.5	154	0.49	1.59	788.88	265	262	51	82	77	-5
	40	154	0.49	1.59	791.15	265	257	52	82	77	-5
9	42.5	154	0.49	1.59	793.36	265	262	52	82	77	-5
	45	153	0.49	1.59	795.79	265	262	52	82	77	-5
10	47.5	153	0.49	1.59	797.84	265	260	53	82	77	-5
	50	153	0.49	1.59	800.06	265	258	54	82	77	-5
11	52.5	153	0.49	1.59	802.29	265	259	55	81	76	-5
	55	154	0.49	1.59	804.54	264	250	57	82	76	-6
12	57.5	154	0.49	1.59	806.73	265	261	58	82	76	-6
	60	154	0.49	1.59	808.97	265	252	60	80	76	-6

COMBUSTION GAS ANALYSIS CONCENTRATION FIELD SHEET

Sampling Methodology: Environment Canada EPS 1/RM/15

Stantec

Project No.: 121413456
Client: Northern Pulp
Plant: Recovery Outlet
Location: Pictou, NS

Fuel Type: _____

Time Start: 13:00
Time Finish: 13:30

Test No.: 9
Date: _____

Personnel: JJR

Time	Concentrations							
	O_2 (%)	CO_2 (%)	CO (ppm)	SO_2 (ppm)	NO_x (ppm)	NO_2 (ppm)	NO (ppm)	THC (PPM)
0	5.2	10.5	1591	53	0			
5	5.2	10.5	1230	52	0			
10	5.2	10.5	907	53	0			
15	5.2	10.5	201	55	0			
20	5.2	10.5	197	56	0			
25	5.3	10.4	123	55	0			
30	5.3	10.4	139	55	0			

Appendix D

Calculations

SOURCE EMISSIONS TESTING – SUMMER ROUND 2015

October 16, 2015

Source Testing Data Checklist

Project Number:
Spreadsheet Checker:
Date Checked:
Data Entered By:

Data Entry		Yes or No	Notes:
1) Are the facility and client names consistent across the trials?		y	
2) Have the stack height, stack diameter, fuel burned, and operating conditions been entered on the Data Entry tab?		y	
3) If the sheet has been modified to include more/less points or traverses have the average and summation formulas been adjusted (Calc sheets)?		na	
4) Have any changes to the testing protocol been entered in the sheet (as appropriate)?		na	
5) For clients with multiple tests (e.g. PM and Formaldehyde):		na	
	A) Are the data copied over correctly (if appropriate)?	na	
	B) Are the facility and client names consistent between all tests?	na	
	C) If appropriate, does the data calculated in each trial agree between the different tests (velocity, volume, molecular weights, etc)?	na	
Analysis			
1) Have the results been corrected to the reference conditions stated in the Pre-Test Plan/Approval to Operate?		y	
2) If applicable, are the results on the Summary sheet corrected to a particular O_2 or CO_2 concentration?		y	
3) Have the isokineticity values been scanned for low (< 90%) and high (> 120%) numbers?		y	
4) Looking at the Data Entry, Calculations, and Summary sheets, are the results consistent across all trials?		y-	
5) Has a scan of the raw data (including gas data) been performed to find any obvious typos?		y	
6) If source has been tested previously, are the results similar?		y	
7) For PM tests, are there any outliers on the Recovery sheet (in particular, the Probe Wash)?		n	
8) Have the calibration data been checked (Cp, nozzle ID, gamma)?		y	
9) If appropriate, are the SO_2 emission reasonable (based on fuel type)?		y	
10) If relevant, do the Chain of Custody forms agree with what was analyzed? Do the lab results make sense?		y	
Final Product			
1) Are the labels on the velocity charts meaningful/correct (West Traverse vs. Traverse 1)?		y	
2) Has the axis been formatted (min and max) so the data is easy to see?		y	
3) Have the calibration documents been saved?		y	
4) Have the fieldsheets been scanned and saved?		y	

Raw Data for: Northern Pulp Power Boiler PM

Test #1

Client: Northern Pulp
Job Number: 121413456

Plant: Power Boiler
Location: Pictou, NS
Test: PM-1
Date: 17-Sep-15
Personnel: JJB/JC

Test Start: 9:10 AM
Test Finish: 11:10 AM

Particulate Collected from Filter (mg):	184.8
Particulate Collected from Probe Wash (mg):	67.0
Particulate Collected from Impinger Wash (mg):	15.8
Total Particulate Collected (mg):	251.8

Impinger No.	Impinger Contents	Final Weight (g)	Tare Weight (g)	Weight of Moisture (g)
1	100 mL H2O	896.7	705.9	190.8
2	100 mL H2O	751.2	727.8	23.4
3	Blank	629.6	627.4	2.2
4	200g Silica Gel	911.2	905.3	5.9
			Total Weight Gain (g)	222.3
			Moisture Volume (mL)	222.3

Parameters

Barometric Pressure, Pbar (in. Hg)	30.00
Stack Static Pressure, Pstatic (in. H2O)	0.18
Ambient Temp, (°F)	65
H2O Volume Collected, Vw (mL)	222.3
Total # Sampling Points,	24
Sampling Time per Point, (min)	5
Readings Taken Every __ mins	2.5
Regulatory Agency	NSENV

O2, (%)	12.8
CO2, (%)	5.8
N2, (%)	81.3
CO(ppm)	71.9
NOx (ppm)	48.4
SO2 (ppm)	0.0

Stack Diameter, (in.)	72
Stack Area, (sq. ft.)	28.27
Probe Length, (ft.)	8
Nozzle Diameter, (in.)	0.175
Pitot Coefficient, (Cp)	0.780
Gamma, meter constant	0.829
Port length (in.)	4

	Traverse Point	Time (min)	Stack Gas Temp, Ts (°F)	S-type Pitot delta P (in. H2O)	Orifice delta H (in. H2O)	Gas Meter Volume (cu. ft.)	Gas Meter Temp Inlet (°F)	Gas Meter Temp Outlet (°F)
						809.370		
Traverse 1	1	2.5	133	0.55	0.26	810.330	61	60
		5	133	0.55	0.26	811.280	61	60
	2	7.5	133	0.60	0.28	812.240	63	61
		10	134	0.62	0.29	813.210	63	61
	3	12.5	132	0.62	0.29	814.200	63	61
		15	132	0.64	0.30	815.190	63	61
	4	17.5	133	0.57	0.27	816.170	64	62
		20	133	0.57	0.27	817.130	64	62
	5	22.5	131	0.57	0.27	818.100	64	62
		25	133	0.57	0.27	819.060	64	62
	6	27.5	133	0.57	0.27	820.050	65	63
		30	133	0.59	0.26	821.040	65	63
	7	32.5	132	0.60	0.28	822.030	66	64
		35	133	0.61	0.29	823.060	66	64
	8	37.5	133	0.73	0.35	824.170	66	64
		40	134	0.76	0.36	825.290	66	64
	9	42.5	135	0.91	0.44	826.530	67	65
		45	132	0.95	0.45	827.790	67	65
	10	47.5	135	1.10	0.53	829.090	67	65
		50	134	1.10	0.53	830.440	67	65
	11	52.5	133	1.20	0.57	831.860	67	65
		55	133	1.20	0.57	833.230	67	65
	12	57.5	131	1.30	0.62	834.670	67	65
		60	132	1.30	0.62	836.110	67	65
						836.110		
Traverse 2	1	62.5	131	0.95	0.45	837.370	68	66
		65	130	0.95	0.46	838.600	68	66
	2	67.5	130	0.90	0.43	839.820	68	66
		70	131	0.90	0.43	840.110	68	66
	3	72.5	132	0.80	0.38	842.210	69	67
		75	132	0.80	0.38	843.330	69	67
	4	77.5	133	0.75	0.36	844.450	69	67
		80	133	0.75	0.36	845.590	69	67
	5	82.5	134	0.68	0.33	846.680	69	68
		85	134	0.67	0.32	847.750	70	68
	6	87.5	134	0.72	0.35	848.840	70	68
		90	134	0.71	0.34	849.940	70	68
	7	92.5	134	0.80	0.39	851.100	71	68
		95	135	0.82	0.40	852.300	71	69
	8	97.5	135	0.92	0.44	853.540	71	69
		100	133	0.93	0.45	854.790	71	69
	9	102.5	133	1.05	0.51	856.100	72	69
		105	134	1.10	0.53	857.460	72	69
	10	107.5	134	1.10	0.55	858.940	72	70
		110	133	1.10	0.53	860.280	72	70
	11	112.5	132	1.50	0.73	861.730	72	70
		115	132	1.45	0.70	863.320	72	70
	12	117.5	133	1.45	0.70	864.860	72	70
		120	131	1.50	0.73	866.420	72	70

Calculations for: Northern Pulp Power Boiler PM
Test #1

Client: Northern Pulp
Job Number: 121413456

Plant: Power Boiler
Location: Pictou, NS
Test: PM-1
Date: 17-Sep-15
Personnel: JJB/JC

Calculated Parameters

Stack Gas Pressure, Ps (in.Hg)	30.01
Stack Gas Molecular Weight, Dry Basis, Md (lb/lb-mole)	29.44
Volume of Water Vapour Collected, Vwc (cu.ft)	10.670
Stack Gas Moisture Content (% as decimal)	0.181
Stack Gas Molecular Weight, Wet Basis, Ms (lb/lb-mole)	27.38

Isokineticity Checks

Check range	Within Criteria
Check average	Within Criteria

	Traverse Point	Time (min)	Stack Gas Temp, Ts (R)	S-type Pitot, delta P (in. H2O)	Orifice delta H (in. H2O)	Stack Gas Velocity, Us (ft/s)	Meter Press., Pm (in. Hg)	Gas Meter Avg. Temp, Tm (R)	Gas Meter Volume, Vm (cu. ft.)	Vol. @ Ref., Vmc (cu. ft.)	Isokinetics I (%)
Traverse 1	1	2.5	593	0.55	0.28	41.93	30.02	521	0.960	0.824	105.37
		5	593	0.55	0.28	41.93	30.02	521	0.950	0.815	104.27
	2	7.5	593	0.60	0.28	43.80	30.02	522	0.960	0.821	100.60
		10	594	0.62	0.29	44.56	30.02	522	0.970	0.830	100.08
	3	12.5	592	0.62	0.29	44.48	30.02	522	0.990	0.847	101.97
		15	592	0.64	0.30	45.20	30.02	522	0.990	0.847	100.37
	4	17.5	593	0.57	0.27	42.69	30.02	523	0.980	0.837	105.16
		20	593	0.57	0.27	42.69	30.02	523	0.960	0.820	103.01
	5	22.5	591	0.57	0.27	42.62	30.02	523	0.970	0.828	103.91
		25	593	0.57	0.27	42.69	30.02	523	0.960	0.820	103.01
	6	27.5	593	0.57	0.27	42.69	30.02	524	0.990	0.844	106.03
		30	593	0.59	0.28	43.43	30.02	524	0.990	0.844	104.21
	7	32.5	592	0.60	0.28	43.78	30.02	525	0.990	0.842	103.06
		35	593	0.61	0.29	44.16	30.02	525	1.030	0.878	106.44
	8	37.5	593	0.73	0.35	48.31	30.03	525	1.110	0.945	104.87
		40	594	0.76	0.36	49.34	30.03	525	1.120	0.953	103.79
	9	42.5	595	0.91	0.44	54.03	30.03	526	1.240	1.053	104.93
		45	592	0.95	0.45	55.07	30.03	526	1.260	1.070	104.09
	10	47.5	595	1.10	0.53	59.40	30.04	526	1.300	1.105	100.08
		50	594	1.10	0.53	59.35	30.04	526	1.350	1.147	103.84
	11	52.5	593	1.20	0.57	61.94	30.04	526	1.420	1.207	104.49
		55	593	1.20	0.57	61.94	30.04	526	1.370	1.164	100.81
	12	57.5	591	1.30	0.62	64.36	30.05	526	1.440	1.224	101.65
		60	592	1.30	0.62	64.42	30.05	526	1.440	1.224	101.73
Traverse 2	1	62.5	591	0.95	0.45	55.02	30.03	527	1.260	1.068	103.80
		65	590	0.95	0.46	54.97	30.03	527	1.230	1.043	101.25
	2	67.5	590	0.90	0.43	53.51	30.03	527	0.220	0.187	18.60
		70	591	0.90	0.43	53.55	30.03	527	1.290	1.094	109.18
	3	72.5	592	0.80	0.38	50.53	30.03	528	2.100	1.777	188.30
		75	592	0.80	0.38	50.53	30.03	528	1.120	0.948	100.43
	4	77.5	593	0.75	0.36	48.97	30.03	528	1.120	0.948	103.80
		80	593	0.75	0.36	48.97	30.03	528	1.140	0.965	105.66
	5	82.5	594	0.68	0.33	46.67	30.02	529	1.090	0.921	106.08
		85	594	0.67	0.32	46.32	30.02	529	1.070	0.904	104.60
	6	87.5	594	0.72	0.35	48.02	30.03	529	1.090	0.921	102.99
		90	594	0.71	0.34	47.68	30.03	529	1.100	0.929	104.67
	7	92.5	594	0.80	0.38	50.62	30.03	530	1.160	0.979	103.90
		95	595	0.82	0.40	51.29	30.03	530	1.200	1.012	106.15
	8	97.5	595	0.92	0.44	54.33	30.03	530	1.240	1.045	103.57
		100	595	0.93	0.45	54.62	30.03	530	1.250	1.054	103.84
	9	102.5	593	1.05	0.51	57.94	30.04	531	1.310	1.104	102.17
		105	594	1.10	0.53	59.35	30.04	531	1.360	1.146	103.72
	10	107.5	594	1.10	0.55	59.35	30.04	531	1.480	1.248	112.77
		110	593	1.10	0.53	59.30	30.04	531	1.260	1.061	95.92
	11	112.5	592	1.50	0.73	69.19	30.05	531	1.530	1.288	99.71
		115	592	1.45	0.70	68.03	30.05	531	1.590	1.339	105.38
	12	117.5	593	1.45	0.70	68.09	30.05	531	1.540	1.297	102.15
		120	591	1.50	0.73	69.13	30.05	531	1.560	1.314	101.58
		Total	Average	Average	Average	Average	Average	Average	Total	Total	Average
		120	593	0.88	0.42	52.31	30.03	527	57.050	48.374	103.50

Combustion Gas Data for: Northern Pulp

Client: Northern Pulp
Job Number: 121413456

Plant: Power Boiler
Location: Pictou, NS
Test: PM-1
Date: 17-Sep-15
Personnel: JJB/JC

Test Start: 9:30 AM
Test Finish: 10:00 AM

Time (min)	O2 (%)	CO2 (%)	CO (ppm)	SO2 (ppm)	NOx (ppm)
0	12.2	5.5	75	0	48
5	13.1	5.6	83	0	48
10	13.2	5.7	68	0	49
15	13.0	5.8	64	0	44
20	12.9	6.1	68	0	47
25	12.7	6.0	73	0	51
30	12.8	6.0	72	0	52
Average:	**12.8**	**5.8**	**72**	**0**	**48**

Raw Data for: Northern Pulp Power Boiler PM

Test #2

Client: Northern Pulp
Job Number: 121413456

Plant: Power Boiler
Location: Pictou, NS
Test: PM-2
Date: 17-Sep-15
Personnel: JJB/JWC

Test Start: 1:40 PM
Test Finish: 3:40 PM

Particulate Collected from Filter (mg):	198.8
Particulate Collected from Probe Wash (mg):	60.0
Particulate Collected from Impinger Wash (mg):	5.9
Total Particulate Collected (mg):	258.7

Impinger No.	Impinger Contents	Final Weight (g)	Tare Weight (g)	Weight of Moisture (g)
1	100 mL H2O	911.9	726.7	185.2
2	100 mL H2O	754.0	732.5	21.5
3	Blank	828.1	825.6	2.5
4	200g Silica Gel	926.4	912.1	14.3
			Total Weight Gain (g)	223.5
			Moisture Volume (mL)	223.5

Parameters

Barometric Pressure, Pbar (in. Hg)	30.00	O2, (%)	11.9	Stack Diameter, (in.)	72
Stack Static Pressure, Pstatic (in. H2O)	0.18	CO2, (%)	6.6	Stack Area, (sq. ft.)	28.27
Ambient Temp, (°F)	65	N2, (%)	81.5	Probe Length, (ft.)	8
H2O Volume Collected, Vw (mL)	223.5	CO(ppm)	190.4	Nozzle Diameter, (in.)	0.175
Total # Sampling Points,	24	NOx (ppm)	62.3	Pitot Coefficient, (Cp)	0.78
Sampling Time per Point, (min)	5	SO2 (ppm)	0.0	Gamma, meter constant	0.829
Readings Taken Every __ mins	2.5			Port length (in.)	4
Regulatory Agency	NSENV				

	Traverse Point	Time (min)	Stack Gas Temp, Ts (°F)	S-type Pitot delta P (in. H2O)	Orifice delta H (in. H2O)	Gas Meter Volume (cu. ft.)	Gas Meter Temp Inlet (°F)	Gas Meter Temp Outlet (°F)
						867.020		
Traverse 1	1	2.5	130	1.20	0.54	868.380	78	78
		5	131	1.10	0.54	869.710	80	78
	2	7.5	131	1.10	0.54	871.050	80	79
		10	131	1.00	0.49	872.350	80	79
	3	12.5	133	0.92	0.45	873.600	81	79
		15	131	0.90	0.44	874.840	82	79
	4	17.5	131	0.80	0.39	876.020	82	79
		20	131	0.80	0.39	877.160	82	79
	5	22.5	130	0.80	0.39	878.280	83	80
		25	130	0.75	0.37	879.390	83	80
	6	27.5	132	0.80	0.40	880.540	83	80
		30	132	0.80	0.40	881.720	83	80
	7	32.5	130	0.85	0.42	882.920	84	80
		35	130	0.85	0.42	884.100	84	80
	8	37.5	131	0.92	0.45	885.300	84	81
		40	130	0.91	0.45	886.550	84	81
	9	42.5	130	1.10	0.54	887.870	84	81
		45	130	1.10	0.54	889.220	84	81
	10	47.5	130	1.50	0.74	890.750	84	81
		50	130	1.50	0.74	892.310	84	81
	11	52.5	130	1.10	0.54	893.720	84	81
		55	131	1.50	0.74	895.260	84	81
	12	57.5	131	1.30	0.64	896.750	84	81
		60	130	1.50	0.74	898.290	84	81
						898.290		
Traverse 2	1	62.5	129	1.10	0.54	899.720	84	81
		65	129	1.10	0.54	901.050	84	81
	2	67.5	131	1.50	0.63	902.200	84	81
		70	131	1.15	0.57	903.740	84	81
	3	72.5	132	1.10	0.54	905.120	84	81
		75	132	1.10	0.54	906.460	84	81
	4	77.5	132	0.95	0.47	907.760	84	81
		80	132	0.95	0.47	909.020	84	81
	5	82.5	131	0.85	0.42	910.240	84	81
		85	133	0.82	0.41	911.440	84	81
	6	87.5	133	0.81	0.40	912.660	84	81
		90	133	0.81	0.40	913.820	84	81
	7	92.5	133	0.84	0.42	915.030	84	81
		95	133	0.84	0.42	916.220	84	81
	8	97.5	133	0.85	0.42	917.430	83	80
		100	133	0.77	0.38	918.570	83	80
	9	102.5	132	0.90	0.44	919.790	83	80
		105	132	0.92	0.45	921.020	83	80
	10	107.5	132	0.95	0.47	922.280	83	80
		110	132	0.92	0.45	923.540	83	80
	11	112.5	131	1.00	0.49	925.000	84	81
		115	131	1.05	0.52	926.120	84	81
	12	117.5	130	1.20	0.59	927.510	84	81
		120	130	1.30	0.64	928.990	84	81

Calculations for: Northern Pulp Power Boiler PM
Test #2

Client: Northern Pulp
Job Number: 121413456

Plant: Power Boiler
Location: Pictou, NS
Test: PM-2
Date: 17-Sep-15
Personnel: JJS/JWC

Calculated Parameters

Stack Gas Pressure, Ps (in.Hg)	30.01
Stack Gas Molecular Weight, Dry Basis, Md (lb/lb-mole)	29.53
Volume of Water Vapour Collected, Vwc (cu.ft)	10.728
Stack Gas Moisture Content (% as decimal)	0.173
Stack Gas Molecular Weight, Wet Basis, Ms (lb/lb-mole)	27.53

Isokineticity Checks

Check range	Within Criteria
Check average	Within Criteria

	Traverse Point	Time (min)	Stack Gas Temp, Ts (R)	S-type Pitot, delta P (in. H2O)	Orifice delta H (in. H2O)	Stack Gas Velocity, Us (ft/s)	Meter Press., Pm (in. Hg)	Gas Meter Avg. Temp, Tm (R)	Gas Meter Volume, Vm (cu. ft.)	Vol. @ Ref., Vmc (cu. ft.)	Isokinetics I (%)
Traverse 1	1	2.5	590	1.20	0.54	61.81	30.04	538	1.360	1.130	97.01
		5	591	1.10	0.54	59.04	30.04	539	1.330	1.103	98.99
	2	7.5	591	1.10	0.54	59.04	30.04	540	1.340	1.110	99.84
		10	591	1.00	0.49	56.29	30.04	540	1.300	1.077	101.37
	3	12.5	593	0.92	0.45	54.08	30.03	540	1.250	1.034	101.69
		15	591	0.90	0.44	53.40	30.03	541	1.240	1.025	101.72
	4	17.5	591	0.80	0.39	50.35	30.03	541	1.180	0.975	102.66
		20	591	0.80	0.39	50.35	30.03	541	1.140	0.942	99.18
	5	22.5	590	0.80	0.39	50.30	30.03	542	1.120	0.924	97.18
		25	590	0.75	0.37	48.71	30.03	542	1.110	0.916	99.46
	6	27.5	592	0.80	0.40	50.39	30.03	542	1.150	0.949	99.95
		30	592	0.80	0.40	50.39	30.03	542	1.180	0.974	102.56
	7	32.5	590	0.85	0.42	51.85	30.03	542	1.200	0.989	100.92
		35	590	0.85	0.42	51.85	30.03	542	1.180	0.973	99.24
	8	37.5	591	0.92	0.45	53.99	30.03	543	1.200	0.988	97.01
		40	590	0.91	0.45	53.85	30.03	543	1.250	1.030	101.52
	9	42.5	590	1.10	0.54	58.99	30.04	543	1.320	1.088	97.53
		45	590	1.10	0.54	58.99	30.04	543	1.350	1.112	99.74
	10	47.5	590	1.50	0.74	68.88	30.05	543	1.530	1.261	98.85
		50	590	1.50	0.74	68.88	30.05	543	1.560	1.286	98.75
	11	52.5	590	1.10	0.54	58.99	30.04	543	1.410	1.162	104.18
		55	591	1.50	0.74	68.94	30.05	543	1.540	1.269	97.57
	12	57.5	591	1.30	0.64	64.18	30.05	543	1.490	1.228	101.38
		60	590	1.50	0.74	68.88	30.05	543	1.540	1.269	97.49
Traverse 2	1	62.5	589	1.10	0.54	58.94	30.04	543	1.430	1.178	105.57
		65	589	1.10	0.54	58.94	30.04	543	1.330	1.096	98.18
	2	67.5	591	1.50	0.65	68.94	30.05	543	1.150	0.948	72.84
		70	591	1.15	0.57	60.36	30.04	543	1.540	1.269	111.38
	3	72.5	592	1.10	0.54	59.09	30.04	543	1.380	1.137	102.13
		75	592	1.10	0.54	59.09	30.04	543	1.340	1.104	99.17
	4	77.5	592	0.95	0.47	54.91	30.03	543	1.300	1.071	103.51
		80	592	0.95	0.47	54.91	30.03	543	1.260	1.038	100.33
	5	82.5	591	0.85	0.42	51.90	30.03	543	1.220	1.005	102.60
		85	593	0.82	0.41	51.06	30.03	543	1.200	0.988	102.92
	6	87.5	593	0.81	0.40	50.75	30.03	543	1.220	1.005	105.27
		90	593	0.81	0.40	50.75	30.03	543	1.160	0.955	100.10
	7	92.5	593	0.84	0.42	51.88	30.03	543	1.210	0.997	102.53
		95	593	0.84	0.42	51.88	30.03	543	1.190	0.980	100.84
	8	97.5	593	0.85	0.42	51.98	30.03	542	1.210	0.998	102.12
		100	593	0.77	0.38	49.48	30.03	542	1.140	0.941	101.08
	9	102.5	592	0.90	0.44	53.44	30.03	542	1.220	1.007	99.98
		105	592	0.92	0.45	54.04	30.03	542	1.230	1.015	99.70
	10	107.5	592	0.95	0.47	54.91	30.03	542	1.260	1.040	100.51
		110	592	0.92	0.45	54.04	30.03	542	1.260	1.040	102.13
	11	112.5	591	1.00	0.49	56.29	30.04	543	1.460	1.203	113.22
		115	591	1.05	0.52	57.68	30.04	543	1.120	0.923	84.77
	12	117.5	590	1.20	0.59	61.81	30.04	543	1.390	1.145	98.34
		120	590	1.30	0.64	64.12	30.05	543	1.480	1.220	100.81
		Total 120	Average 591	Average 1.02	Average 0.50	Average 56.51	Average 30.04	Average 542	Total 61.970	Total 51.116	Average 100.07

Combustion Gas Data for: Northern Pulp

Client: Northern Pulp
Job Number: 121413456

Plant: Power Boiler
Location: Pictou, NS
Test: PM-2
Date: 17-Sep-15
Personnel: JJB/JWC

Test Start: 2:00 PM
Test Finish: 2:30 PM

Time (min)	O2 (%)	CO2 (%)	CO (ppm)	SO2 (ppm)	NOx (ppm)
0	12.6	6.2	180	0	53
5	12.5	6.3	160	0	58
10	12.1	6.5	165	0	66
15	11.9	6.6	252	0	62
20	10.9	6.8	238	0	67
25	11.0	7.0	200	0	65
30	12.0	6.9	138	0	65
Average:	**11.9**	**6.6**	**190**	**0**	**62**

Raw Data for: Northern Pulp Power Boiler PM
Test #3

Client: Northern Pulp
Job Number: 121413456

Plant: Power Boiler
Location: Pictou, NS
Test: PM-3
Date: 17-Sep-15
Personnel: JJB/JC

Test Start: 8:00 AM
Test Finish: 10:00 AM

Particulate Collected from Filter (mg):	166.1
Particulate Collected from Probe Wash (mg):	39.0
Particulate Collected from Impinger Wash (mg):	39.2
Total Particulate Collected (mg):	205.1

Impinger No.	Impinger Contents	Final Weight (g)	Tare Weight (g)	Weight of Moisture (g)
1	100 mL H2O	904.0	717.2	186.8
2	100 mL H2O	744.9	723.6	21.3
3	Blank	628.7	626.1	2.6
4	200g Silica Gel	922.8	907.7	15.1
			Total Weight Gain (g)	225.8
			Moisture Volume (mL)	225.8

Parameters

Barometric Pressure, Pbar (in. Hg)	30.00
Stack Static Pressure, Pstatic (in. H2O)	0.52
Ambient Temp, (°F)	65
H2O Volume Collected, Vw (mL)	225.80
Total # Sampling Points,	24
Sampling Time per Point, (min)	5
Readings Taken Every __ mins	2.5
Regulatory Agency	NSENV

O2, (%)	11.84
CO2, (%)	6.66
N2, (%)	81.50
CO(ppm)	67.1
NOx (ppm)	53.7
SO2 (ppm)	0.0

Stack Diameter, (in.)	72
Stack Area, (sq. ft.)	28.27
Probe Length, (ft.)	8
Nozzle Diameter, (in.)	0.175
Pitot Coefficient, (Cp)	0.78
Gamma, meter constant	0.829
Port length (in.)	4

	Traverse Point	Time (min)	Stack Gas Temp, Ts (°F)	S-type Pitot delta P (in. H2O)	Orifice delta H (in. H2O)	Gas Meter Volume (cu. ft.)	Gas Meter Temp Inlet (°F)	Gas Meter Temp Outlet (°F)
						929.340		
Traverse 1	1	2.5	130	1.10	0.53	930.700	66	67
		5	130	1.10	0.53	932.050	67	67
	2	7.5	130	1.10	0.53	933.380	67	67
		10	130	1.10	0.53	934.700	67	67
	3	12.5	131	1.05	0.51	936.010	68	67
		15	131	1.05	0.51	937.290	68	67
	4	17.5	130	0.87	0.42	938.510	69	67
		20	130	0.87	0.42	939.000	70	67
	5	22.5	131	0.90	0.43	940.890	71	68
		25	131	0.79	0.42	942.080	71	68
	6	27.5	130	0.80	0.39	943.240	72	69
		30	130	0.80	0.64	944.380	72	69
	7	32.5	132	0.85	0.44	945.540	73	69
		35	133	0.80	0.39	946.680	73	69
	8	37.5	131	0.85	0.41	947.860	73	70
		40	131	0.85	0.41	949.050	73	70
	9	42.5	130	0.90	0.44	950.270	74	70
		45	130	0.90	0.44	951.500	74	70
	10	47.5	132	1.10	0.53	952.700	74	71
		50	132	1.10	0.53	953.920	74	72
	11	52.5	130	1.20	0.58	955.330	74	72
		55	130	1.30	0.63	956.800	75	72
	12	57.5	131	1.50	0.73	958.360	75	72
		60	130	1.50	0.73	959.96	75	72
						959.950		
Traverse 2	1	62.5	130	1.05	0.51	961.510	77	74
		65	130	1.05	0.51	962.860	77	74
	2	67.5	131	1.05	0.51	964.210	77	74
		70	132	1.10	0.54	965.600	77	74
	3	72.5	132	1.10	0.54	966.990	78	75
		75	132	1.10	0.54	968.390	78	75
	4	77.5	132	0.97	0.47	969.720	78	75
		80	132	1.00	0.49	971.040	78	75
	5	82.5	131	0.90	0.44	972.320	78	76
		85	131	0.90	0.44	973.580	78	76
	6	87.5	132	0.85	0.42	974.830	78	76
		90	133	0.85	0.42	976.080	78	76
	7	92.5	135	0.90	0.44	977.360	78	76
		95	135	0.90	0.44	978.620	78	76
	8	97.5	133	0.90	0.44	979.880	78	77
		100	133	0.90	0.44	981.140	78	77
	9	102.5	131	1.05	0.51	982.470	79	77
		105	131	1.00	0.49	983.810	79	77
	10	107.5	134	1.10	0.54	985.200	79	77
		110	134	1.10	0.54	986.570	79	77
	11	112.5	131	1.10	0.54	987.960	79	77
		115	131	1.15	0.56	989.340	79	77
	12	117.5	131	1.40	0.69	990.850	79	77
		120	131	1.40	0.69	992.790	79	77

Calculations for: Northern Pulp Power Boiler PM
Test #3

Client: Northern Pulp
Job Number: 121413456

Plant: Power Boiler
Location: Pictou, NS
Test: PM-3
Date: 17-Sep-15
Personnel: JJB/JC

Calculated Parameters

Stack Gas Pressure, Ps (in.Hg)	30.04
Stack Gas Molecular Weight, Dry Basis, Md (lb/lb-mole)	29.54
Volume of Water Vapour Collected, Vwc (cu.ft)	10.838
Stack Gas Moisture Content (% as decimal)	0.169
Stack Gas Molecular Weight, Wet Basis, Ms (lb/lb-mole)	27.58

Isokineticity Checks

Check range	Within Criteria
Check average	Within Criteria

	Traverse Point	Time (min)	Stack Gas Temp, Ts (R)	S-type Pitot, delta P (in. H2O)	Orifice delta H (in. H2O)	Stack Gas Velocity, Us (ft/s)	Gas Meter: Meter Press., Pm (in. Hg)	Gas Meter: Avg. Temp, Tm (R)	Gas Meter: Volume, Vm (cu. ft.)	Vol. @ Ref., Vmc (cu. ft.)	Isokinetics I (%)
Traverse 1	1	2.5	590	1.10	0.53	58.90	30.04	527	1.360	1.154	103.09
		5	590	1.10	0.53	58.90	30.04	527	1.350	1.145	102.23
	2	7.5	590	1.10	0.53	58.90	30.04	527	1.330	1.128	100.72
		10	590	1.10	0.53	58.90	30.04	527	1.320	1.119	99.96
	3	12.5	591	1.05	0.51	57.60	30.04	528	1.310	1.110	101.52
		15	591	1.05	0.51	57.60	30.04	528	1.280	1.084	99.20
	4	17.5	590	0.87	0.42	52.39	30.03	528	1.220	1.032	103.66
		20	590	0.87	0.42	52.39	30.03	529	0.490	0.414	41.60
	5	22.5	591	0.90	0.43	53.33	30.03	530	1.890	1.595	157.58
		25	591	0.79	0.42	49.87	30.03	530	1.190	1.004	106.10
	6	27.5	590	0.80	0.39	50.23	30.03	531	1.160	0.977	102.29
		30	590	0.80	0.64	50.23	30.05	531	1.140	0.961	100.59
	7	32.5	592	0.85	0.44	51.87	30.03	531	1.160	0.976	99.33
		35	593	0.80	0.39	50.36	30.03	531	1.140	0.959	100.69
	8	37.5	591	0.85	0.41	51.82	30.03	532	1.180	0.992	100.85
		40	591	0.85	0.41	51.82	30.03	532	1.190	1.000	101.71
	9	42.5	590	0.90	0.44	53.28	30.03	532	1.220	1.025	101.16
		45	590	0.90	0.44	53.28	30.03	532	1.230	1.033	101.99
	10	47.5	592	1.10	0.53	59.00	30.04	533	1.200	1.007	90.09
		50	592	1.10	0.53	59.00	30.04	533	1.220	1.023	91.50
	11	52.5	590	1.20	0.56	61.52	30.04	533	1.410	1.182	101.09
		55	590	1.30	0.63	64.04	30.05	534	1.470	1.232	101.18
	12	57.5	591	1.50	0.73	68.84	30.05	534	1.560	1.308	100.07
		60	590	1.50	0.73	68.79	30.05	534	1.590	1.333	101.91
Traverse 2	1	62.5	590	1.05	0.51	57.55	30.00	536	1.560	1.300	118.84
		65	590	1.05	0.51	57.55	30.04	536	1.350	1.127	102.97
	2	67.5	591	1.05	0.51	57.60	30.04	536	1.350	1.127	103.06
		70	592	1.10	0.54	59.00	30.04	536	1.390	1.160	103.76
	3	72.5	592	1.10	0.54	59.00	30.04	537	1.390	1.158	103.58
		75	592	1.10	0.54	59.00	30.04	537	1.400	1.166	104.32
	4	77.5	592	0.97	0.47	55.41	30.04	537	1.330	1.108	105.54
		80	592	1.00	0.49	56.26	30.03	537	1.320	1.099	103.14
	5	82.5	591	0.90	0.44	53.33	30.04	537	1.280	1.065	105.25
		85	591	0.90	0.44	53.33	30.03	537	1.260	1.048	103.59
	6	87.5	592	0.85	0.42	51.87	30.03	537	1.250	1.040	105.84
		90	593	0.85	0.42	51.91	30.03	537	1.250	1.040	105.92
	7	92.5	595	0.90	0.44	53.51	30.03	537	1.280	1.065	105.58
		95	595	0.90	0.44	53.51	30.03	537	1.260	1.048	103.94
	8	97.5	593	0.90	0.44	53.42	30.03	536	1.260	1.047	103.67
		100	593	0.90	0.44	53.42	30.03	536	1.260	1.047	103.67
	9	102.5	591	1.05	0.51	57.60	30.03	536	1.330	1.105	101.05
		105	591	1.00	0.49	56.21	30.04	536	1.340	1.113	104.34
	10	107.5	594	1.10	0.54	59.10	30.04	536	1.390	1.155	103.45
		110	594	1.10	0.54	59.10	30.04	536	1.370	1.138	101.97
	11	112.5	591	1.10	0.54	58.95	30.04	536	1.390	1.155	103.20
		115	591	1.15	0.56	60.28	30.04	536	1.380	1.146	100.21
	12	117.5	591	1.40	0.69	66.51	30.04	536	1.510	1.255	99.38
		120	591	1.40	0.69	66.51	30.05	536	1.940	1.612	127.72
		Total	Average	Average	Average	Average	Average	Average	Total	Total	Average
		120	591	1.02	0.51	56.73	30.04	534	63.450	53.122	102.79

2722.83

Combustion Gas Data for: Northern Pulp

Client: Northern Pulp
Job Number: 121413456

Plant: Power Boiler
Location: Pictou, NS
Test: PM-3
Date: 17-Sep-15
Personnel: JJB/JC

Test Start: 8:30 AM
Test Finish: 9:00 AM

Time (min)	O2 (%)	CO2 (%)	CO (ppm)	SO2 (ppm)	NOx (ppm)
0	11.5	6.9	83	0	52
5	11.9	6.6	55	0	52
10	11.9	6.7	62	0	55
15	12.0	6.6	57	0	52
20	11.5	6.9	71	0	55
25	12.1	6.5	82	0	54
30	12.0	6.5	60	0	56
Average:	11.8	6.7	67	0	54

DATA ENTRY

Northern Pulp
Pictou, NS
Fuel: Natural Gas
Operating Conditions: normal
Emission Control Equipment: scrubber
Stack Height from Grade: 51 m
Stack Diameter: 1.93 m

Reference Temperature, Tref (F):	77
(K):	298
Reference Pressure, Pref (in.Hg):	29.92
(Bar):	1.0

Parameter	Symbol	Units	Test 1	Test 2	Test 3	Average
Test ID	-	-	PM-1	PM-2	PM-3	-
Date	-	-	17-Sep-15	17-Sep-15	17-Sep-15	n/a
Start Time	-	-	9:10 AM	1:40 PM	8:00 AM	n/a
End Time	-	-	11:10 AM	3:40 PM	10:00 AM	n/a
Total Sampling Time	-	min	120	120	120	120
Stack Diameter	D	in.	72	72	72	72
Average Stack Gas Temperature	Ts	F	133	131	131	132
Average Dry Gas Meter Temperature	Tm	F	67	82	74	74
Barometric Pressure	Pbar	in.Hg	30.00	30.00	30.00	30.00
Stack Static Pressure	Pstatic	in.H2O	0.18	0.18	0.52	0.29
Average Pressure Drop (Head)	dP	in.H2O	0.88	1.02	1.02	0.97
Average deltaH Orifice	dH	in.H2O	0.42	0.50	0.51	0.47
Average Meter Temperature	Tm	F	67	82	74	74
Gas Sample Volume	Vm	cu.ft	57.05	61.97	63.45	60.82
Average Isokinetics	I	%	104	100	103	102
Nozzle Diameter	Dn	in.	0.175	0.175	0.175	0.175
Pitot Coefficient	Cp	-	0.780	0.780	0.780	0.780
Gamma, meter constant	y	-	0.829	0.829	0.829	0.829
Reference Temperature	Tref	R	537	537	537	537
Reference Pressure	Pref	in.Hg	29.92	29.92	29.92	29.92
Stack Gas Oxygen Content	Co2	%	12.8	11.9	11.8	12.2
Stack Gas Carbon Dioxide Content	Cco2	%	5.8	6.6	6.7	6.4
Stack Gas Nitrogen Content	Cn2	%	81.3	81.5	81.5	81.5
Stack Gas Sulphur Dioxide Content	Cso2	ppm	0.0	0.0	0.0	0.0
Stack Gas Nitrogen Oxides Content	Cnox	ppm	48.4	62.3	53.7	54.8
Stack Gas Carbon Monoxide Content	Cco	ppm	71.9	190.4	67.1	109.8
Volume of Water Collected	Vw	mL	222.3	223.5	225.8	223.9
Particulate Collected from Filter	-	mg	184.8	198.8	166.1	183.2
Particulate Collected from Probe Wash	-	mg	67.0	60.0	39.0	55.3
Particulate Collected from Impinger Wash	-	mg	15.8	5.9	39.2	20.3
Total Particulate Collected (excluding impingers)	Mp	mg	251.8	258.7	205.1	238.5

Legend:
F - degrees Fahrenheit
K - degrees Kelvin
Bar - bars
in.Hg - inches of mercury
in. - inches
in.H2O - inches of water
cu.ft - cubic feet
R - degrees Rankin
NOx - as NO2

CALCULATIONS

Northern Pulp
Pictou, NS
Fuel: Natural Gas
Operating Conditions: normal
Emission Control Equipment: scrubber
Stack Height from Grade: 51 m
Stack Diameter: 1.93 m

Variable	Symbol	Units	Calculation	Test 1	Test 2	Test 3	Average
Stack Area	As	sq.ft	As = Pi x ((D/12)^2) y 4	28.27	28.27	28.27	28.27
		sq.m	As (sq.m) = As (sq.ft) x 0.0929	2.63	2.63	2.63	2.63
Barometric Pressure	Pbar	kPa	Pbar (kPa) = Pbar (in.Hg) x 3.386	101.6	101.6	101.6	101.6
Stack Static Pressure	Pstatic	kPa	Pstatic (kPa) = Pstatic (in.H2O) x 0.249	0.04	0.04	0.13	0.07
Avg. Stack Temperature	Ts	R	Ts (R) = Ts (F) + 460	593	591	591	592
Avg. Meter Temperature	Tm	R	Tm (R) = Tm (F) + 460	527	542	534	534.0
Nozzle Diameter	Dn	mm	Dn (mm) = Dn (in.) x 25.4	4	4	4	4.4
Gas Meter Pressure	Pm	in.Hg	Pm = Pbar + (dH / 13.6)	30.03	30.04	30.04	30.03
Sample Volume at Ref Cond	Vmc	cu.ft	Vmc = Tref/Pref x (Vm x Pm x y) / Tm	48.40	51.12	53.14	50.9
		cu.m	Vmc (cu.m) = 0.02832 x Vmc (cu.ft)	1.37	1.45	1.50	1.44
Volume of Water Vapour	Vwc	cu.ft	Vwc = 0.0480 x Vw	10.67	10.73	10.84	10.75
Water Fraction	Bwo	-	Bwo = Vwc / (Vwc + Vmc)	0.181	0.173	0.169	0.2
Molecular Weight, Dry	Md	lb/lb-mol	Md = 0.44 (Co2) + 0.32 (O2) + 0.28 (N2)	29.44	29.53	29.54	29.5
Molecular Weight, Wet	Ms	lb/lb-mol	Ms = Md (1 - Bwo) + (18 x Bwo)	27.38	27.53	27.58	27.5
Stack Pressure	Ps	in.Hg	Ps = Pbar + (Pstatic / 13.6)	30.01	30.01	30.04	30.02
Stack Gas Velocity	Us	ft/s	Us = 85.33 x Cp x ((dP x Ts)/(Ps x Ms))^0.5	52.31	56.51	56.73	55.2
		m/s	Us (m/s) = 0.3048 x Us (ft/s)	15.94	17.22	17.29	16.8
Actual Stack Gas Flow Rate	Q	acfm	Q = 60 x Us x As	88,738	95,868	96,233	93,613
Dry Stack Gas Flow Rate	Qs	Rcfm	Qs = Q x (1-Bwo) x (Tref/Ts) x (Ps/Pref)	66,060	72,202	72,872	70,378
		Rcms	Qs (Rcms) = 0.000472 x Qs (Rcfm)	31.18	34.08	34.40	33.2
Sulphur Dioxide - SO2							
SO2 Measured Concentration	Cso2	ppm	Measurement from Flue Gas Analyzer	0.00	0.00	0.00	0.00
Uncorrected @ Ref Cond	Cso2	mg/Rcm	Cso2 (mg/Rcm) = Cso2 (ppm) x 2.62	0.00	0.00	0.00	0.00
SO2 Emission Rate	ERso2	g/s	ERso2 = Cso2/1000 x Qs	0.00	0.00	0.00	0.00
		kg/hr	ERso2 (kg/hr) = 3.6 x ERso2 (g/s)	0.00	0.00	0.00	0.00
SO2 Concentration							
Corrected to 11% O2	Cso2	mg/Rcm	Cso2 (11% O2) = Cso2 (mg/Rcm) x (20.9-11) / (20.9-Co2)	0.00	0.00	0.00	0.00
Corrected to 3% O2	Cso2	mg/Rcm	Cso2 (3% O2) = Cso2 (mg/Rcm) x (20.9-3) / (20.9-Co2)	0.00	0.00	0.00	0.00
Corrected to 12% CO2	Cso2	mg/Rcm	Cso2 (12% CO2) = Cso2 (mg/Rcm) x (12/Co2)	0.00	0.00	0.00	0.00
Nitrogen Oxides - NOx							
NOx Measured Concentration	Cnox	ppm	Measurement from Flue Gas Analyzer	48.43	62.29	53.71	54.81
Uncorrected @ Ref Cond	Cnox	mg/Rcm	Cnox (mg/Rcm) = Cnox (ppm) x 1.882	91.14	117.22	101.09	103.15
NOx Emission Rate	ERnox	g/s	ERnox = Cnox/1000 x Qs	2.84	3.99	3.48	3.44
		kg/hr	ERnox (kg/hr) = 3.6 x ERnox (g/s)	10.23	14.38	12.52	12.38
NOx Concentration							
Corrected to 11% O2	Cnox	mg/Rcm	Cnox (11% O2) = Cnox (mg/Rcm) x (20.9-11) / (20.9-Co2)	111.99	128.35	110.46	116.93
Corrected to 3% O2	Cnox	mg/Rcm	Cnox (3% O2) = Cnox (mg/Rcm) x (20.9-3) / (20.9-Co2)	202.49	232.07	199.73	211.43
Corrected to 12% CO2	Cnox	mg/Rcm	Cnox (12% CO2) = Cnox (mg/Rcm) x (12/Co2)	188.11	212.76	182.07	194.31
Carbon Monoxide - CO							
CO Measured Concentration	Cco	ppm	Measurement from Flue Gas Analyzer	71.86	190.43	67.14	109.81
Uncorrected @ Ref Cond	Cco	mg/Rcm	Cco (mg/Rcm) = Cco (ppm) x 1.149	82.28	218.04	76.88	125.73
CO Emission Rate	ERco	g/s	ERco = Cco/1000 x Qs	2.57	7.43	2.64	4.21
		kg/hr	ERco (kg/hr) = 3.6 x ERco (g/s)	9.24	26.75	9.52	15.17
CO Concentration							
Corrected to 11% O2	Cco	mg/Rcm	Cco (11% O2) = Cco (mg/Rcm) x (20.9-11) / (20.9-Co2)	101.09	238.75	84.01	141.28
Corrected to 3% O2	Cco	mg/Rcm	Cco (3% O2) = Cco (mg/Rcm) x (20.9-3) / (20.9-Co2)	182.79	431.67	151.89	255.45
Corrected to 12% CO2	Cco	mg/Rcm	Cco (12% CO2) = Cco (mg/Rcm) x (12/Co2)	169.81	395.75	138.46	234.67
Particulate Concentration	Cs	mg/Rcm	Cs = Mp / Vmc	183.66	178.74	136.28	166.22
Particulate Emission Rate	ERp	g/s	ERp = Cs/1000 x Qs	5.73	6.09	4.69	5.50
		kg/hr	ERp (kg/hr) = 3.6 x ERp (g/s)	20.62	21.93	16.87	19.81
Particulate Concentration							
Corrected to 11% O2	Cs	mg/Rcm	Cs (11% O2) = Cs x (20.9-11) / (20.9-Co2)	225.67	195.71	148.91	190.10
Corrected to 3% O2	Cs	mg/Rcm	Cs (3% O2) = Cs x (20.9-3) / (20.9-Co2)	408.02	353.86	269.25	343.71
Corrected to 12% CO2	Cs	mg/Rcm	Cs (12% CO2) = Cs x (12/Co2)	379.05	324.41	245.44	316.30

Legend: sq.ft - square feet
sq.m - square metres
Pi = 3.142
R = degrees Rankin
ppm - parts per million
in.Hg - inches of mercury
cu.ft - cubic feet
cu.m - cubic metres
Ref Cond - reference temperature and pressure (25 C and 101.3 kPa)
Rcms - dry reference cubic metres per second
Rcfm - dry reference cubic feet per minute
mg/Rcm - miligrams per dry reference cubic metre
g/s - grams per second
NOx - as NO2
acfm - actual cubic feet per minute

OFFICIAL STACK TESTING RESULTS
Northern Pulp
Pictou, NS

Fuel: Natural Gas
Operating Conditions: normal
Emission Control Equipment: scrubber
Stack Height from Grade: 51 m
Stack Diameter: 1.93 m

Parameter	Test 1	Test 2	Test 3	Average	NSENV Limits
Test ID	PM-1	PM-2	PM-3	-	-
Test Date	17-Sep-15	17-Sep-15	17-Sep-15	-	-
Stack Gas Temperature (C)	56.1	55.1	55.2	55.4	-
Moisture Content (%)	18.1	17.3	16.9	17.5	-
Velocity (m/s)	15.9	17.2	17.3	16.8	-
Volumetric Flow (Rcms)	31.2	34.1	34.4	33.2	-
Oxygen - O2 (%)	12.8	11.9	11.8	12.2	-
Carbon Dioxide - CO2 (%)	5.81	6.61	6.66	6.36	-
Sulphur Dioxide - SO2					
SO2 Measured Concentration (ppm)	0.0	0.0	0.0	0.0	-
Uncorrected at Ref Cond (mg/Rcm)	0.0	0.0	0.0	0.0	-
Emission Rate (kg/hr)	0.00	0.00	0.00	0.00	-
Nitrogen Oxides - NOx					
NOx Measured Concentration (ppm)	48.4	62.3	53.7	54.8	-
Uncorrected at Ref Cond (mg/Rcm)	91.1	117.2	101.1	103.2	-
Emission Rate (kg/hr)	10.23	14.38	12.52	12.38	-
Carbon Monoxide - CO					
CO Measured Concentration (ppm)	71.9	190.4	67.1	109.8	-
Uncorrected at Ref Cond (mg/Rcm)	82.3	218.0	76.9	125.7	-
Emission Rate (kg/hr)	9.24	26.75	9.52	15.17	-
Particulate Matter - PM					
Particulate Concentration (mg/Rcm)	183.7	178.7	136.3	166.2	-
Concentration, corrected to 11% O2 (mg/Rcm)	225.7	195.7	148.9	190.1	150
Particulate Emission Rate (kg/hr)	20.62	21.93	16.87	19.81	-

Legend:
C - degrees Celsius
m/s - metres per second
Rcms - dry reference cubic metres per second
ppm - parts per million
Ref Cond - reference temperature and pressure (25 C and 101.3 kPa)
mg/Rcm - milligrams per dry reference cubic metre
NOx - as NO2
ND - non-detectable

Particulate Recoveries: Impinger Catch, Probe Wash, Filter Catch

Client: Northern Pulp
Facility: Power Boiler
Location: Pictou, NS
Job Number: 121413456

IMPINGER CATCH

Container ID	Beaker Pre Weights (g)				Sample ID	Recoveries					Beaker Post Weights (g)				Uncorrected Particulate Weight (g)	Corrected Particulate Weight (g)
	Date Analysed by					Jar + Sample + Rinse (g)	Jar Tare (g)	Sample Collected (g)	Rinse Water (g)	Total Rinse Water (g)	Date Analysed by					
	Trial 1	Trial 2	Trial 3	Average							Trial 1	Trial 2	Trial 3	Average		
N1	112.6340	112.6344		112.6342	PM-1	684.8	372.6	222.3	40.6	130.7	112.6512	112.6507		112.6510	0.0168	0.0158
W1	117.9277	117.9275		117.9276	PM-2	699.2	373.0	223.5	24.9	127.6	117.9347	117.9342		117.9345	0.0069	0.0059
B5	110.3820	110.3821		110.3821	PM-3	1175.0	375.9	225.8	36.7	610.0	110.4259	110.4259		110.4259	0.0439	0.0392
																Conc. (g/mL)
U3	111.1023	111.1020		111.1022	WB	660.0	371.8	288.2		288.2	111.1041	111.1046		111.1044	0.0022	0.000008

PROBE WASH

Container ID	Beaker Pre Weights (g)				Sample ID	Recoveries					Beaker Post Weights (g)				Uncorrected Particulate Weight (g)	Corrected Particulate Weight (g)
	Date Analysed by					Jar + Acetone (g)	Jar Tare (g)	Recovered Acetone (g)	Rinse Acetone	Total Acetone (g)	Date Analysed by					
	Trial 1	Trial 2	Trial 3	Average							Trial 1	Trial 2	Trial 3	Average		
K3	110.8456	110.8451		110.8454	PM-1	395.1	286.7	108.4	24.9	133.3	110.9188	110.9188		110.9188	0.0735	0.0570
O2	111.6365	111.6361		111.6363	PM-2	398.8	310.2	88.6	18.1	106.7	111.7017	111.7012		111.7015	0.0651	0.0500
Y4	110.5959	110.5954		110.5957	PM-3	381.5	285.5	96.0	17.3	113.3	110.6404	110.6399		110.6402	0.0445	0.0390
																Conc. (g/mL)
B1	111.6523	111.6520		111.6522	AB	340.9	286.1	54.8		54.8	111.6547	111.6549		111.6548	0.0026	0.000038

Density of Acetone 0.7850 g/ml

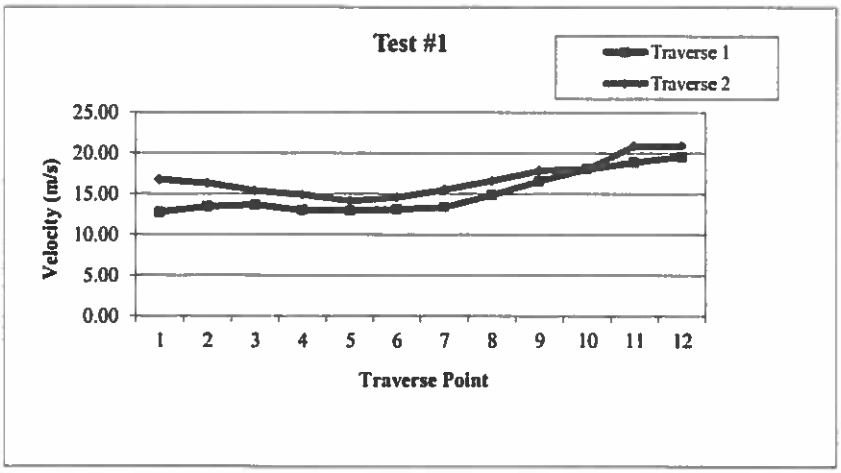
FILTER CATCH

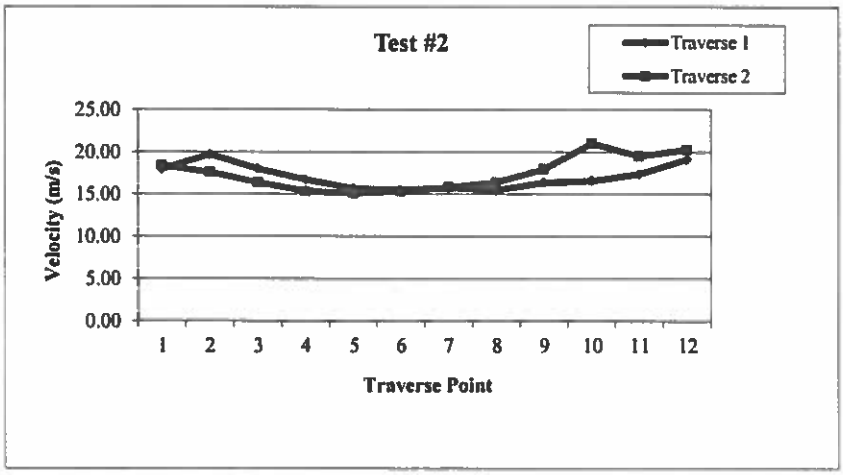
Filter ID	Pre Weights (g)				Sample ID	Post Weights (g)				Particulate Weight from Filter (g)
	Analysed by					Date: Analysed by				
	Trial 1	Trial 2	Trial 3	Average		Trial 1	Trial 2	Trial 3	Average	
0716-05	0.3316	0.3316		0.3316	PM-1	0.5216	0.5111		0.5164	0.1848
0612-35	0.3709	0.3705		0.3707	PM-2	0.5697	0.5692		0.5695	0.1988
0612-40	0.3724	0.3720		0.3722	PM-3	0.5385	0.5380		0.5383	0.1661

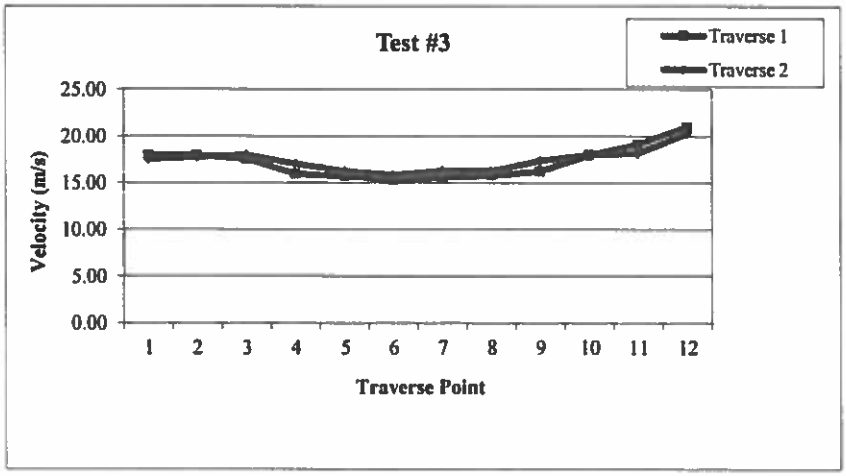
Northern Pulp
Power Boiler

121413456

Stack Gas Velocity Profiles
Pictou, NS







Source Testing Data Checklist

Project Number:	121413456
Spreadsheet Checker:	CAL
Date Checked:	10/14/2015
Data Entered By:	

Data Entry		Yes or No	Notes:
1) Are the facility and client names consistent across the trials?			
2) Have the stack height, stack diameter, fuel burned, and operating conditions been entered on the Data Entry tab?			
3) If the sheet has been modified to include more/less points or traverses have the average and summation formulas been adjusted (Calc sheets)?			
4) Have any changes to the testing protocol been entered in the sheet (as appropriate)?			
5) For clients with multiple tests (e.g. PM and Formaldehyde):			
	A) Are the data copied over correctly (if appropriate)?		
	B) Are the facility and client names consistent between all tests?		
	C) If appropriate, does the data calculated in each trial agree between the different tests (velocity, volume, molecular weights, etc)?		
Analysis			
1) Have the results been corrected to the reference conditions stated in the Pre-Test Plan/Approval to Operate?			
2) If applicable, are the results on the Summary sheet corrected to a particular O_2 or CO_2 concentration?			
3) Have the isokineticity values been scanned for low (< 90%) and high (> 120%) numbers?			
4) Looking at the Data Entry, Calculations, and Summary sheets, are the results consistent across all trials?			
5) Has a scan of the raw data (including gas data) been performed to find any obvious typos?			
6) If source has been tested previously, are the results similar?			
7) For PM tests, are there any outliers on the Recovery sheet (in particular, the Probe Wash)?			
8) Have the calibration data been checked (Cp, nozzle ID, gamma)?			
9) If appropriate, are the SO_2 emission reasonable (based on fuel type)?			
10) If relevant, do the Chain of Custody forms agree with what was analyzed? Do the lab results make sense?			
Final Product			
1) Are the labels on the velocity charts meaningful/correct (West Traverse vs. Traverse 1)?			
2) Has the axis been formatted (min and max) so the data is easy to see?			
3) Have the calibration documents been saved?			
4) Have the fieldsheets been scanned and saved?			

Raw Data for: Northern Pulp Recovery Boiler PM

Test #1

Client: Northern Pulp
Job Number: 121413456

Plant: Recovery Boiler
Location: Pictou, NS
Test: PM-1
Date: 15-Sep-15
Personnel: JIB

Test Start: 11:15 AM
Test Finish: 1:30 PM

Particulate Collected from Filter (mg):	13.7
Particulate Collected from Probe Wash (mg):	6.1
Particulate Collected from Impinger Wash (mg):	8.0
Total Particulate Collected (mg):	19.8

Impinger No.	Impinger Contents	Final Weight (g)	Tare Weight (g)	Weight of Moisture (g)
1	100 mL H2O	973.7	722.8	250.9
2	100 mL H2O	1005.8	734.8	271.0
3	Blank	854.1	625.4	228.7
4	200g Silica Gel	906.4	854.1	52.3
			Total Weight Gain (g)	802.9
			Moisture Volume (mL)	802.9

Parameters

Barometric Pressure, Pbar (in. Hg)	29.90	O2, (%)	5.3	Stack Diameter, (in.)	138
Stack Static Pressure, Pstatic (in. H2O)	1.10	CO2, (%)	10.4	Stack Area, (sq. ft.)	103.87
Ambient Temp, (°F)	64	N2, (%)	84.3	Probe Length, (ft.)	4
H2O Volume Collected, Vw (mL)	802.9	CO(ppm)	2033.4	Nozzle Diameter, (in.)	0.305
Total # Sampling Points,	24	NOx (ppm)	0.0	Pitot Coefficient, (Cp)	0.756
Sampling Time per Point, (min)	5	SO2 (ppm)	43.7	Gamma, meter constant	0.829
Readings Taken Every __ mins	2.5			Port length (in.)	4
Regulatory Agency	NSENV				

	Traverse Point	Time (min)	Stack Gas Temp, Ts (°F)	S-type Pitot delta P (in. H2O)	Orifice delta H (in. H2O)	Gas Meter Volume (cu. ft.)	Gas Meter Temp Inlet (°F)	Gas Meter Temp Outlet (°F)
						386.000		
Traverse 1	1	2.5	154	0.51	1.62	388.580	69	69
		5	154	0.51	1.62	390.930	70	69
	2	7.5	154	0.51	1.62	393.150	69	69
		10	154	0.51	1.62	395.340	69	69
	3	12.5	155	0.50	1.62	397.530	70	69
		15	155	0.50	1.59	399.700	71	69
	4	17.5	155	0.50	1.59	401.860	71	69
		20	155	0.50	1.59	404.000	71	69
	5	22.5	155	0.49	1.56	406.130	72	70
		25	155	0.49	1.56	408.250	72	70
	6	27.5	155	0.50	1.59	410.390	73	69
		30	156	0.50	1.59	412.550	73	70
	7	32.5	155	0.50	1.59	414.690	74	70
		35	155	0.50	1.59	416.830	74	71
	8	37.5	156	0.50	1.60	419.000	75	70
		40	156	0.50	1.60	421.170	75	70
	9	42.5	154	0.50	1.60	423.460	76	70
		45	154	0.50	1.60	425.560	76	70
	10	47.5	154	0.50	1.60	427.770	76	71
		50	154	0.50	1.60	429.950	76	71
	11	52.5	155	0.50	1.60	432.140	76	72
		55	155	0.50	1.60	434.300	76	72
	12	57.5	155	0.51	1.63	436.480	78	72
		60	155	0.51	1.63	438.670	78	72
						438.670		
Traverse 2	1	62.5	155	0.50	1.60	440.840	78	72
		65	155	0.50	1.60	443.040	78	72
	2	67.5	153	0.50	1.60	445.220	78	72
		70	153	0.50	1.60	447.410	78	72
	3	72.5	155	0.50	1.60	449.600	78	73
		75	155	0.50	1.61	451.890	78	73
	4	77.5	154	0.50	1.60	454.090	79	73
		80	154	0.50	1.61	456.260	79	73
	5	82.5	155	0.50	1.61	458.330	78	73
		85	154	0.50	1.61	460.580	78	73
	6	87.5	154	0.50	1.61	462.650	78	73
		90	155	0.50	1.61	464.890	78	73
	7	92.5	155	0.50	1.61	466.880	78	73
		95	155	0.50	1.61	469.290	79	73
	8	97.5	155	0.50	1.61	471.490	79	73
		100	155	0.50	1.61	473.810	79	74
	9	102.5	156	0.50	1.61	475.890	80	74
		105	156	0.50	1.61	477.950	80	74
	10	107.5	156	0.50	1.61	480.140	80	74
		110	155	0.50	1.61	482.340	81	75
	11	112.5	155	0.50	1.61	484.580	81	75
		115	155	0.50	1.61	486.890	81	75
	12	117.5	154	0.50	1.62	489.000	82	75
		120	155	0.50	1.62	491.290	82	75

Calculations for: Northern Pulp Recovery Boiler PM
Test #1

Client: Northern Pulp
Job Number: 121413458

Plant: Recovery Boiler
Location: Pictou, NS
Test: PM-1
Date: 15-Sep-15
Personnel: JJB

Calculated Parameters

Stack Gas Pressure, Ps (in.Hg)	29.98
Stack Gas Molecular Weight, Dry Basis, Md (lb/lb-mole)	29.88
Volume of Water Vapour Collected, Vwc (cu.ft)	38.539
Stack Gas Moisture Content (% as decimal)	0.304
Stack Gas Molecular Weight, Wet Basis, Ms (lb/lb-mole)	26.26

Isokineticity Checks

Check range	Within Criteria
Check average	Within Criteria

	Traverse Point	Time (min)	Stack Gas Temp, Ts (R)	S-type Pitot, delta P (in. H2O)	Orifice delta H (in. H2O)	Stack Gas Velocity, Us (ft/s)	Meter Press., Pm (in. Hg)	Gas Meter Avg. Temp, Tm (R)	Gas Meter Volume, Vm (cu. ft.)	Vol. @ Ref., Vmc (cu. ft.)	Isokinetics I (%)
Traverse 1	1	2.5	614	0.51	1.62	40.68	30.02	529	2.580	2.178	115.43
		5	614	0.51	1.62	40.68	30.02	530	2.350	1.982	105.04
	2	7.5	614	0.51	1.62	40.68	30.02	529	2.220	1.874	99.32
		10	614	0.51	1.62	40.68	30.02	529	2.190	1.849	97.98
	3	12.5	615	0.50	1.62	40.31	30.02	530	2.190	1.847	98.94
		15	615	0.50	1.59	40.31	30.02	530	2.170	1.829	97.94
	4	17.5	615	0.50	1.59	40.31	30.02	530	2.160	1.820	97.49
		20	615	0.50	1.59	40.31	30.02	530	2.140	1.803	96.59
	5	22.5	615	0.49	1.58	39.91	30.01	531	2.130	1.791	96.92
		25	615	0.49	1.58	39.91	30.01	531	2.120	1.783	96.47
	6	27.5	615	0.50	1.59	40.31	30.02	531	2.140	1.800	96.41
		30	616	0.50	1.59	40.35	30.02	532	2.160	1.815	97.29
	7	32.5	615	0.50	1.59	40.31	30.02	532	2.140	1.797	96.22
		35	615	0.50	1.59	40.31	30.02	533	2.140	1.795	96.13
	8	37.5	616	0.50	1.60	40.35	30.02	533	2.170	1.820	97.58
		40	616	0.50	1.60	40.35	30.02	533	2.170	1.820	97.58
	9	42.5	614	0.50	1.60	40.28	30.02	533	2.290	1.919	102.69
		45	614	0.50	1.60	40.28	30.02	533	2.100	1.760	94.17
	10	47.5	614	0.50	1.60	40.28	30.02	534	2.210	1.850	99.01
		50	614	0.50	1.60	40.28	30.02	534	2.180	1.825	97.67
	11	52.5	615	0.50	1.60	40.31	30.02	534	2.190	1.832	98.11
		55	615	0.50	1.60	40.31	30.02	534	2.160	1.807	96.76
	12	57.5	615	0.51	1.63	40.72	30.02	535	2.180	1.820	96.52
		60	615	0.51	1.63	40.72	30.02	535	2.190	1.828	96.96
Traverse 2	1	62.5	615	0.50	1.60	40.31	30.02	535	2.170	1.812	97.03
		65	615	0.50	1.60	40.31	30.02	535	2.200	1.837	98.37
	2	67.5	613	0.50	1.60	40.25	30.02	535	2.180	1.820	97.32
		70	613	0.50	1.60	40.25	30.02	535	2.190	1.828	97.76
	3	72.5	615	0.50	1.60	40.31	30.02	536	2.190	1.827	97.83
		75	615	0.50	1.61	40.31	30.02	536	2.290	1.910	102.30
	4	77.5	614	0.50	1.60	40.28	30.02	536	2.200	1.833	98.11
		80	614	0.50	1.61	40.28	30.02	536	2.170	1.808	96.77
	5	82.5	615	0.50	1.61	40.31	30.02	536	2.070	1.726	92.47
		85	614	0.50	1.61	40.28	30.02	536	2.250	1.877	100.43
	6	87.5	614	0.50	1.61	40.28	30.02	536	2.070	1.726	92.40
		90	615	0.50	1.61	40.31	30.02	536	2.240	1.868	100.07
	7	92.5	615	0.50	1.61	40.31	30.02	536	1.990	1.660	88.90
		95	615	0.50	1.61	40.31	30.02	536	2.410	2.008	107.56
	8	97.5	615	0.50	1.61	40.31	30.02	536	2.200	1.833	98.19
		100	615	0.50	1.61	40.31	30.02	537	2.320	1.931	103.45
	9	102.5	616	0.50	1.61	40.35	30.02	537	2.080	1.730	92.73
		105	616	0.50	1.61	40.35	30.02	537	2.060	1.713	91.84
	10	107.5	616	0.50	1.61	40.35	30.02	537	2.190	1.821	97.64
		110	615	0.50	1.61	40.31	30.02	538	2.200	1.828	97.82
	11	112.5	615	0.50	1.61	40.31	30.02	538	2.240	1.860	99.60
		115	615	0.50	1.61	40.31	30.02	538	2.310	1.918	102.71
	12	117.5	614	0.50	1.62	40.28	30.02	539	2.110	1.750	93.66
		120	615	0.50	1.62	40.31	30.02	539	2.290	1.899	101.73
		Total 120	Average 615	Average 0.50	Average 1.60	Average 40.34	Average 30.02	Average 534	Total 105.290	Total 88.067	Average 98.16

Combustion Gas Data for: Northern Pulp

Client: Northern Pulp
Job Number: 121413456

Plant: Recovery Boiler
Location: Pictou, NS
Test: PM-1
Date: 15-Sep-15
Personnel: JJB

Test Start: 12:00 PM
Test Finish: 12:30 PM

Time (min)	O2 (%)	CO2 (%)	CO (ppm)	SO2 (ppm)	NOx (ppm)
0	5.2	10.5	2401	41	
5	5.3	10.4	1224	38	
10	5.3	10.4		45	
15	5.3	10.4		46	
20	5.3	10.4	2288	48	
25	5.3	10.4	2314	43	
30	5.3	10.4	1940	45	
Average:	5.3	10.4	2033	44	

Raw Data for: Northern Pulp Recovery Boiler PM

Test #2

Client: Northern Pulp
Job Number: 121413456

Plant: Recovery Boiler
Location: Pictou, NS
Test: PM-3
Date: 16-Sep-15
Personnel: JIB

Test Start: 8:40 AM
Test Finish: 10:40 AM

Particulate Collected from Filter (mg):	12.1
Particulate Collected from Probe Wash (mg):	1.5
Particulate Collected from Impinger Wash (mg):	8.1
Total Particulate Collected (mg):	13.5

Impinger No.	Impinger Contents	Final Weight (g)	Tare Weight (g)	Weight of Moisture (g)
1	100 mL H2O	987.4	723.8	263.6
2	100 mL H2O	1023.7	731.0	292.7
3	Blank	864.7	625.1	239.6
4	200g Silica Gel	923.9	892.2	31.7
			Total Weight Gain (g)	827.6
			Moisture Volume (mL)	827.6

Parameters

Barometric Pressure, Pbar (in. Hg)	29.90	O2, (%)	5.5	Stack Diameter, (in.)	138
Stack Static Pressure, Pstatic (in. H2O)	1.10	CO2, (%)	10.4	Stack Area, (sq. ft.)	103.87
Ambient Temp, (°F)	64	N2, (%)	84.2	Probe Length, (ft.)	4
H2O Volume Collected, Vw (mL)	827.6	CO(ppm)	304.6	Nozzle Diameter, (in.)	0.305
Total # Sampling Points,	24	NOx (ppm)	0.0	Pitot Coefficient, (Cp)	0.756
Sampling Time per Point, (min)	5	SO2 (ppm)	59.1	Gamma, meter constant	0.829
Readings Taken Every __ mins	2.5			Port length (in.)	4
Regulatory Agency	NSENV				

	Traverse Point	Time (min)	Stack Gas Temp, Ts (°F)	S-type Pitot delta P (in. H2O)	Orifice delta H (in. H2O)	Gas Meter Volume (cu. ft.)	Gas Meter Temp Inlet (°F)	Gas Meter Temp Outlet (°F)
						596.170		
Traverse 1	1	2.5	155	0.50	1.58	598.320	66	65
		5	155	0.50	1.58	600.510	66	65
	2	7.5	156	0.50	1.58	602.690	67	66
		10	156	0.50	1.58	604.860	67	66
	3	12.5	156	0.48	1.51	607.010	69	66
		15	156	0.48	1.51	609.140	69	66
	4	17.5	156	0.48	1.51	611.260	70	67
		20	156	0.48	1.55	613.360	70	67
	5	22.5	156	0.48	1.55	615.520	72	67
		25	155	0.48	1.55	617.600	72	67
	6	27.5	155	0.48	1.56	619.770	74	68
		30	154	0.50	1.59	621.970	74	68
	7	32.5	154	0.50	1.60	624.170	75	68
		35	153	0.50	1.60	626.350	75	69
	8	37.5	153	0.50	1.60	628.550	77	70
		40	153	0.50	1.60	630.750	77	71
	9	42.5	153	0.50	1.60	632.940	79	71
		45	153	0.50	1.60	635.180	79	72
	10	47.5	151	0.51	1.64	637.390	80	72
		50	151	0.51	1.64	639.600	80	72
	11	52.5	153	0.51	1.64	641.820	81	73
		55	153	0.51	1.64	644.030	81	73
	12	57.5	153	0.51	1.64	646.230	81	73
		60	153	0.51	1.64	648.420	81	74
						648.420		
Traverse 2	1	62.5	155	0.51	1.64	650.660	81	74
		65	154	0.51	0.64	652.860	81	75
	2	67.5	156	0.51	1.64	655.070	81	75
		70	156	0.51	1.64	657.280	82	75
	3	72.5	157	0.51	1.64	659.480	82	75
		75	155	0.51	1.65	661.670	82	75
	4	77.5	155	0.51	1.65	663.870	82	76
		80	155	0.51	1.65	666.250	82	76
	6	82.5	156	0.51	1.65	668.260	82	76
		85	157	0.51	1.64	670.380	82	76
	6	87.5	156	0.51	1.65	672.550	82	76
		90	156	0.51	1.65	674.680	82	76
	7	92.5	157	0.51	1.64	676.880	82	76
		95	154	0.51	1.65	679.100	83	76
	8	97.5	155	0.51	1.65	681.310	83	77
		100	155	0.51	1.65	683.530	83	77
	9	102.5	155	0.51	1.65	685.750	83	77
		105	154	0.51	1.65	688.010	84	77
	10	107.5	154	0.51	1.66	690.250	83	77
		110	154	0.51	1.65	692.490	84	77
	11	112.5	154	0.51	1.66	694.710	83	77
		115	155	0.51	1.65	696.950	83	77
	12	117.5	154	0.51	1.66	699.300	83	77
		120	154	0.51	1.65	701.390	82	77

Calculations for: Northern Pulp Recovery Boiler PM
Test #2

Client: Northern Pulp
Job Number: 121413456

Plant: Recovery Boiler
Location: Pictou, NS
Test: PM-3
Date: 15-Sep-15
Personnel: JJB

Calculated Parameters

Stack Gas Pressure, Ps (in.Hg)	29.98
Stack Gas Molecular Weight, Dry Basis, Md (lb/lb-mole)	29.88
Volume of Water Vapour Collected, Vwc (cu.ft)	38.725
Stack Gas Moisture Content (% as decimal)	0.312
Stack Gas Molecular Weight, Wet Basis, Ms (lb/lb-mole)	28.18

Isokineticity Checks

Check range	Within Criteria
Check average	Within Criteria

	Traverse Point	Time (min)	Stack Gas Temp, Ts (R)	S-type Pitot, delta P (in. H2O)	Orifice delta H (in. H2O)	Stack Gas Velocity, Us (ft/s)	Gas Meter: Meter Press., Pm (in. Hg)	Gas Meter: Avg. Temp, Tm (R)	Gas Meter: Volume, Vm (cu. ft.)	Vol. @ Ref., Vmc (cu. ft.)	Isokinetics I (%)
Traverse 1	1	2.5	615	0.50	1.58	40.38	30.02	526	2.150	1.827	98.73
		5	615	0.50	1.58	40.38	30.02	526	2.190	1.861	100.56
	2	7.5	616	0.50	1.58	40.41	30.02	527	2.180	1.849	99.99
		10	616	0.50	1.58	40.41	30.02	527	2.170	1.841	99.54
	3	12.5	616	0.48	1.51	39.60	30.01	528	2.150	1.820	100.44
		15	618	0.48	1.51	39.60	30.01	528	2.130	1.803	99.51
	4	17.5	618	0.48	1.51	39.60	30.01	529	2.120	1.791	98.85
		20	618	0.48	1.55	39.60	30.01	529	2.100	1.774	97.93
	5	22.5	618	0.48	1.55	39.60	30.01	530	2.160	1.822	100.54
		25	615	0.48	1.55	39.57	30.01	530	2.080	1.754	96.74
	6	27.5	615	0.48	1.56	39.57	30.01	531	2.170	1.825	100.64
		30	614	0.50	1.59	40.35	30.02	531	2.200	1.850	99.90
	7	32.5	614	0.50	1.60	40.35	30.02	532	2.200	1.849	99.60
		35	613	0.50	1.60	40.32	30.02	532	2.180	1.830	98.72
	8	37.5	613	0.50	1.60	40.32	30.02	534	2.200	1.842	99.35
		40	613	0.50	1.60	40.32	30.02	534	2.200	1.840	99.26
	9	42.5	613	0.50	1.60	40.32	30.02	535	2.190	1.826	98.62
		45	613	0.50	1.60	40.32	30.02	536	2.240	1.868	100.78
	10	47.5	611	0.51	1.64	40.65	30.02	536	2.210	1.842	98.21
		50	611	0.51	1.64	40.65	30.02	536	2.210	1.842	98.21
	11	52.5	613	0.51	1.64	40.72	30.02	537	2.220	1.847	98.83
		55	613	0.51	1.64	40.72	30.02	537	2.210	1.838	98.18
	12	57.5	613	0.51	1.64	40.72	30.02	537	2.200	1.830	97.74
		60	613	0.51	1.64	40.72	30.02	538	2.190	1.820	97.20
Traverse 2	1	62.5	615	0.51	1.64	40.78	30.02	538	2.240	1.861	99.59
		65	614	0.51	0.64	40.75	29.95	538	2.200	1.822	97.40
	2	67.5	616	0.51	1.64	40.82	30.02	538	2.210	1.835	98.24
		70	616	0.51	1.64	40.82	30.02	539	2.210	1.833	98.15
	3	72.5	617	0.51	1.64	40.85	30.02	539	2.200	1.825	97.78
		75	615	0.51	1.65	40.78	30.02	539	2.190	1.817	97.18
	4	77.5	615	0.51	1.65	40.78	30.02	539	2.200	1.823	97.54
		80	615	0.51	1.65	40.78	30.02	539	2.380	1.972	105.52
	5	82.5	616	0.51	1.65	40.82	30.02	539	2.010	1.666	89.19
		85	617	0.51	1.64	40.85	30.02	539	2.120	1.757	94.14
	6	87.5	616	0.51	1.65	40.82	30.02	539	2.170	1.798	96.29
		90	616	0.51	1.65	40.82	30.02	539	2.130	1.765	94.51
	7	92.5	617	0.51	1.64	40.85	30.02	539	2.200	1.823	97.69
		95	614	0.51	1.65	40.75	30.02	540	2.220	1.838	98.25
	8	97.5	615	0.51	1.65	40.78	30.02	540	2.210	1.828	97.80
		100	615	0.51	1.65	40.78	30.02	540	2.220	1.836	98.24
	9	102.5	615	0.51	1.65	40.78	30.02	540	2.220	1.836	98.24
		105	614	0.51	1.65	40.75	30.02	541	2.260	1.868	99.84
	10	107.5	614	0.51	1.66	40.75	30.02	540	2.240	1.853	99.05
		110	614	0.51	1.65	40.75	30.02	541	2.240	1.851	98.95
	11	112.5	614	0.51	1.66	40.75	30.02	540	2.220	1.836	98.16
		115	615	0.51	1.65	40.78	30.02	540	2.240	1.853	99.13
	12	117.5	614	0.51	1.66	40.75	30.02	540	2.350	1.944	103.91
		120	614	0.51	1.65	40.75	30.02	540	2.090	1.730	92.50
		Total	Average	Average	Average	Average	Average	Average	Total	Total	Average
		120	615	0.50	1.60	40.50	30.02	535	105.220	87.765	98.44

Combustion Gas Data for: Northern Pulp

Client: Northern Pulp
Job Number: 121413456

Plant: Recovery Boiler
Location: Pictou, NS
Test: PM-3
Date: 16-Sep-15
Personnel: JJB

Test Start: 9:00 AM
Test Finish: 9:30 AM

Time (min)	O2 (%)	CO2 (%)	CO (ppm)	SO2 (ppm)	NOx (ppm)
0	5.4	10.4	175	57	
5	5.5	10.3	222	58	
10	5.5	10.3	236	58	
15	5.4	10.4	144	60	
20	5.4	10.4	321	60	
25	5.6	10.3	545	60	
30	5.4	10.4	489	61	
Average:	5.5	10.4	305	59	

Raw Data for: Northern Pulp Recovery Boiler PM

Test #3

Client: Northern Pulp
Job Number: 121413456

Plant: Recovery Boiler
Location: Pictou, NS
Test: PM-4
Date: 16-Sep-15
Personnel: JJB/JC

Test Start: 12:30 PM
Test Finish: 2:30 PM

Particulate Collected from Filter (mg):	12.9
Particulate Collected from Probe Wash (mg):	0.1
Particulate Collected from Impinger Wash (mg):	72.9
Total Particulate Collected (mg):	13.0

Impinger No.	Impinger Contents	Final Weight (g)	Tare Weight (g)	Weight of Moisture (g)
1	100 mL H2O	1001.2	728.5	272.7
2	100 mL H2O	1018.6	734.4	284.2
3	Blank	848.0	625.6	222.4
4	200g Silica Gel	941.7	915.4	26.3
			Total Weight Gain (g)	805.6
			Moisture Volume (mL)	805.6

Parameters

Barometric Pressure, Pbar (in. Hg)	29.90	O2, (%)	5.2	Stack Diameter, (in.)	138
Stack Static Pressure, Pstatic (in. H2O)	1.10	CO2, (%)	10.5	Stack Area, (sq. ft.)	103.87
Ambient Temp, (°F)	64	N2, (%)	84.3	Probe Length, (ft.)	4
H2O Volume Collected, Vw (mL)	805.60	CO(ppm)	626.9	Nozzle Diameter, (in.)	0.305
Total # Sampling Points,	24	NOx (ppm)	0.0	Pitot Coefficient, (Cp)	0.756
Sampling Time per Point, (min)	5	SO2 (ppm)	54.1	Gamma, meter constant	0.829
Readings Taken Every ___ mins	2.5			Port length (in.)	4
Regulatory Agency	NSENV				

	Traverse Point	Time (min)	Stack Gas Temp, Ts (°F)	S-type Pitot delta P (in. H2O)	Orifice delta H (in. H2O)	Gas Meter Volume (cu. ft.)	Gas Meter Temp Inlet (°F)	Gas Meter Temp Outlet (°F)
						701.950		
Traverse 1	1	2.5	155	0.50	1.61	704.150	76	75
		5	155	0.50	1.61	706.380	76	75
	2	7.5	155	0.50	1.61	708.620	77	74
		10	155	0.51	1.64	710.850	77	75
	3	12.5	153	0.51	1.64	713.080	78	74
		15	154	0.51	1.64	715.300	78	74
	4	17.5	152	0.51	1.64	717.530	77	74
		20	152	0.50	1.61	719.760	77	74
	5	22.5	155	0.50	1.61	721.990	77	73
		25	155	0.50	1.61	724.220	78	73
	6	27.5	155	0.50	1.61	726.420	78	73
		30	155	0.50	1.61	728.630	78	73
	7	32.5	155	0.50	1.64	730.840	78	74
		35	155	0.50	1.61	733.030	79	74
	8	37.5	155	0.50	1.61	735.210	80	74
		40	155	0.50	1.61	737.420	80	74
	9	42.5	154	0.50	1.61	739.650	80	74
		45	154	0.50	1.61	741.870	80	74
	10	47.5	155	0.50	1.61	744.100	82	75
		50	155	0.50	1.61	746.330	82	76
	11	52.5	155	0.50	1.61	748.550	84	75
		55	155	0.50	1.61	750.780	84	76
	12	57.5	155	0.50	1.61	753.020	84	77
		60	155	0.50	1.61	755.27	84	77
						755.270		
Traverse 2	1	62.5	155	0.50	1.62	757.540	83	78
		65	155	0.50	1.62	759.800	83	78
	2	67.5	155	0.49	1.59	762.050	82	77
		70	155	0.49	1.59	764.290	82	77
	3	72.5	155	0.49	1.59	766.530	82	77
		75	154	0.49	1.59	768.780	81	77
	4	77.5	155	0.49	1.59	771.010	83	77
		80	154	0.49	1.59	773.250	83	77
	5	82.5	153	0.49	1.59	775.440	82	77
		85	154	0.49	1.59	777.660	82	78
	6	87.5	154	0.49	1.59	779.910	83	77
		90	155	0.49	1.59	782.100	83	77
	7	92.5	154	0.49	1.59	784.390	82	77
		95	154	0.49	1.59	786.670	82	77
	8	97.5	154	0.49	1.59	788.880	82	77
		100	154	0.49	1.59	791.150	82	77
	9	102.5	154	0.49	1.59	793.360	82	77
		105	153	0.49	1.59	795.690	82	77
	10	107.5	153	0.49	1.59	797.840	82	77
		110	153	0.49	1.59	800.060	82	77
	11	112.5	153	0.49	1.59	802.290	81	76
		115	154	0.49	1.59	804.540	82	76
	12	117.5	154	0.49	1.59	806.730	82	76
		120	154	0.49	1.59	808.970	80	76

Calculations for: Northern Pulp Recovery Boiler PM
Test #3

Client: Northern Pulp
Job Number: 121413456

Plant: Recovery Boiler
Location: Pictou, NS
Test: PM-4
Date: 16-Sep-15
Personnel: JJB/JC

Calculated Parameters

Stack Gas Pressure, Ps (in.Hg)	29.98
Stack Gas Molecular Weight, Dry Basis, Md (lb/lb-mole)	29.88
Volume of Water Vapour Collected, Vwc (cu.ft)	38.869
Stack Gas Moisture Content (% as decimal)	0.303
Stack Gas Molecular Weight, Wet Basis, Ms (lb/lb-mole)	26.28

Isokineticity Checks

Check range	Within Criteria
Check average	Within Criteria

	Traverse Point	Time (min)	Stack Gas Temp, Ts (R)	S-type Pitot, delta P (in. H2O)	Orifice delta H (in. H2O)	Stack Gas Velocity, Us (ft/s)	Meter Press., Pm (in. Hg)	Gas Meter Avg. Temp, Tm (R)	Gas Meter Volume, Vm (cu. ft.)	Vol. @ Ref., Vmc (cu. ft.)	Isokinetics I (%)
Traverse 1	1	2.5	615	0.50	1.61	40.30	30.02	536	2.200	1.835	98.18
		5	615	0.50	1.61	40.30	30.02	536	2.230	1.860	99.50
	2	7.5	615	0.50	1.61	40.30	30.02	536	2.240	1.868	99.95
		10	615	0.51	1.64	40.70	30.02	536	2.230	1.858	98.44
	3	12.5	613	0.51	1.64	40.64	30.02	536	2.230	1.858	98.28
		15	614	0.51	1.64	40.67	30.02	536	2.220	1.850	97.92
	4	17.5	612	0.51	1.64	40.60	30.02	536	2.230	1.860	98.29
		20	612	0.50	1.61	40.20	30.02	536	2.230	1.860	99.26
	5	22.5	615	0.50	1.61	40.30	30.02	535	2.230	1.862	99.60
		25	615	0.50	1.61	40.30	30.02	536	2.230	1.860	99.50
	6	27.5	615	0.50	1.61	40.30	30.02	536	2.200	1.835	98.16
		30	615	0.50	1.61	40.30	30.02	536	2.210	1.843	98.61
	7	32.5	615	0.50	1.64	40.30	30.02	536	2.210	1.842	98.53
		35	615	0.50	1.61	40.30	30.02	537	2.190	1.823	97.54
	8	37.5	615	0.50	1.61	40.30	30.02	537	2.180	1.813	97.00
		40	615	0.50	1.61	40.30	30.02	537	2.210	1.838	98.33
	9	42.5	614	0.50	1.61	40.27	30.02	537	2.230	1.855	99.14
		45	614	0.50	1.61	40.27	30.02	537	2.220	1.846	98.70
	10	47.5	615	0.50	1.61	40.30	30.02	538	2.230	1.850	98.95
		50	615	0.50	1.61	40.30	30.02	539	2.230	1.848	98.86
	11	52.5	615	0.50	1.61	40.30	30.02	540	2.220	1.838	98.32
		55	615	0.50	1.61	40.30	30.02	540	2.230	1.844	98.67
	12	57.5	615	0.50	1.61	40.30	30.02	541	2.240	1.851	99.02
		60	615	0.50	1.61	40.30	30.02	541	2.250	1.859	99.47
Traverse 2	1	62.5	615	0.50	1.62	40.30	29.90	541	2.270	1.868	99.95
		65	615	0.50	1.62	40.30	30.02	541	2.260	1.868	99.91
	2	67.5	615	0.49	1.59	39.90	30.02	540	2.250	1.863	100.66
		70	615	0.49	1.59	39.90	30.02	540	2.240	1.854	100.21
	3	72.5	615	0.49	1.59	39.90	30.02	540	2.260	1.871	101.10
		75	614	0.49	1.59	39.86	30.02	539	2.230	1.848	99.77
	4	77.5	615	0.49	1.59	39.90	30.02	540	2.230	1.844	99.57
		80	614	0.49	1.59	39.86	30.02	540	2.240	1.853	100.04
	5	82.5	613	0.49	1.59	39.83	30.02	540	2.190	1.813	97.81
		85	614	0.49	1.59	39.86	30.02	540	2.220	1.838	99.14
	6	87.5	614	0.49	1.59	39.86	30.02	540	2.250	1.861	100.48
		90	615	0.49	1.59	39.90	30.02	540	2.190	1.811	97.86
	7	92.5	614	0.49	1.59	39.86	30.02	540	2.290	1.896	102.36
		95	614	0.49	1.59	39.86	30.02	540	2.280	1.887	101.92
	8	97.5	614	0.49	1.59	39.86	30.02	540	2.210	1.830	98.79
		100	614	0.49	1.59	39.86	30.02	540	2.270	1.879	101.47
	9	102.5	614	0.49	1.59	39.86	30.02	540	2.210	1.830	98.79
		105	613	0.49	1.59	39.83	30.02	540	2.330	1.929	104.07
	10	107.5	613	0.49	1.59	39.83	30.02	540	2.150	1.780	96.03
		110	613	0.49	1.59	39.83	30.02	540	2.220	1.838	99.15
	11	112.5	613	0.49	1.59	39.83	30.02	539	2.230	1.849	99.79
		115	614	0.49	1.59	39.86	30.02	539	2.250	1.864	100.67
	12	117.5	614	0.49	1.59	39.86	30.02	539	2.190	1.815	97.98
		120	614	0.49	1.59	39.86	30.02	538	2.240	1.860	100.41
		Total 120	Average 614	Average 0.50	Average 1.60	Average 40.13	Average 30.02	Average 538	Total 107.020	Total 88.603	Average 99.30

Combustion Gas Data for: Northern Pulp

Client: Northern Pulp
Job Number: 121413456

Plant: Recovery Boiler
Location: Pictou, NS
Test: PM-4
Date: 16-Sep-15
Personnel: JJB/JC

Test Start:
Test Finish:

Time (min)	O2 (%)	CO2 (%)	CO (ppm)	SO2 (ppm)	NOx (ppm)
0	5.2	10.5	1591	53	
5	5.2	10.5	1230	52	
10	5.2	10.5	907	53	
15	5.2	10.5	201	55	
20	5.2	10.5	197	56	
25	5.3	10.4	123	55	
30	5.3	10.4	139	55	
Average:	5.2	10.5	627	54	

DATA ENTRY

Northern Pulp
Pictou, NS
Fuel: Fuel oil
Operating Conditions: normal
Emission Control Equipment: precipitator
Stack Height from Grade: 69 m
Stack Diameter: 3.51 m

Reference Temperature, Tref (F):	77	
(K):	298	
Reference Pressure, Pref (In.Hg):	29.92	
(Bar):	1.0	

Parameter	Symbol	Units	Test 1	Test 2	Test 3	Average
Test ID	-	-	PM-1	PM-3	PM-4	-
Date	-	-	15-Sep-15	16-Sep-15	16-Sep-15	n/a
Start Time	-	-	11:15 AM	8:40 AM	12:30 PM	n/a
End Time	-	-	1:30 PM	10:40 AM	2:30 PM	n/a
Total Sampling Time	-	min	120	120	120	120
Stack Diameter	D	in.	138	138	138	138
Average Stack Gas Temperature	Ts	F	155	155	154	155
Average Dry Gas Meter Temperature	Tm	F	74	75	78	76
Barometric Pressure	Pbar	in.Hg	29.90	29.90	29.90	29.90
Stack Static Pressure	Pstatic	in.H2O	1.10	1.10	1.10	1.10
Average Pressure Drop (Head)	dP	in.H2O	0.50	0.50	0.50	0.50
Average deltaH Orifice	dH	in.H2O	1.60	1.60	1.60	1.60
Average Meter Temperature	Tm	F	74	75	78	76
Gas Sample Volume	Vm	cu.ft	105.29	105.22	107.02	105.84
Average Isokinetics	I	%	98	98	99	99
Nozzle Diameter	Dn	in.	0.305	0.305	0.305	0.305
Pitot Coefficient	Cp	-	0.756	0.756	0.756	0.756
Gamma, meter constant	y	-	0.829	0.829	0.829	0.829
Reference Temperature	Tref	R	537	537	537	537
Reference Pressure	Pref	in.Hg	29.92	29.92	29.92	29.92
Stack Gas Oxygen Content	Co2	%	5.3	5.5	5.2	5.3
Stack Gas Carbon Dioxide Content	Cco2	%	10.4	10.4	10.5	10.4
Stack Gas Nitrogen Content	Cn2	%	84.3	84.2	84.3	84.3
Stack Gas Sulphur Dioxide Content	Cso2	ppm	43.7	59.1	54.1	52.3
Stack Gas Nitrogen Oxides Content	Cnox	ppm	0.0	0.0	0.0	0.0
Stack Gas Carbon Monoxide Content	Cco	ppm	2033.4	304.6	626.9	988.3
Volume of Water Collected	Vw	mL	802.9	827.6	805.6	812.0
Particulate Collected from Filter	-	mg	13.7	12.1	12.9	12.9
Particulate Collected from Probe Wash	-	mg	6.1	1.5	0.1	2.6
Particulate Collected from Impinger Wash	-	mg	8.04	8.05	72.92	29.67
Total Particulate Collected (excluding impingers)	Mp	mg	19.8	13.51	12.97	15.43

Legend:
F - degrees Fahrenheit
K - degrees Kelvin
Bar - bars
in.Hg - inches of mercury
in. - inches
in.H2O - inches of water
cu.ft - cubic feet
R - degrees Rankin
NOx - as NO2

CALCULATIONS

Northern Pulp
Pictou, NS
Fuel: Fuel oil
Operating Conditions: normal
Emission Control Equipment: precipitator
Stack Height from Grade: 69 m
Stack Diameter: 3.51 m

Variable	Symbol	Units	Calculation	Test 1	Test 2	Test 3	Average
Stack Area	As	sq.ft	As = Pi x ((D/12)^2) / 4	103.87	103.87	103.87	103.87
		sq.m	As (sq.m) = As (sq.ft) x 0.0929	9.65	9.65	9.65	9.65
Barometric Pressure	Pbar	kPa	Pbar (kPa) = Pbar (in.Hg) x 3.386	101.2	101.2	101.2	101.2
Stack Static Pressure	Pstatic	kPa	Pstatic (kPa) = Pstatic (in.H2O) x 0.249	0.27	0.27	0.27	0.27
Avg. Stack Temperature	Ts	R	Ts (R) = Ts (F) + 460	615	615	614	615
Avg. Meter Temperature	Tm	R	Tm (R) = Tm (F) + 460	534	535	538	535.9
Nozzle Diameter	Dn	mm	Dn (mm) = Dn (in.) x 25.4	8	8	8	7.7
Gas Meter Pressure	Pm	in.Hg	Pm = Pbar + (dH / 13.6)	30.02	30.02	30.02	30.02
Sample Volume at Ref Cond	Vmc	cu.ft	Vmc = Tref/Pref x (Vm x Pm x y) / Tm	88.06	87.77	88.81	88.2
		cu.m	Vmc (cu.m) = 0.02832 x Vmc (cu.ft)	2.49	2.49	2.52	2.50
Volume of Water Vapour	Vwc	cu.ft	Vwc = 0.0480 x Vw	38.54	39.72	38.67	38.98
Water Fraction	Bwo	-	Bwo = Vwc / (Vwc + Vmc)	0.304	0.312	0.303	0.3
Molecular Weight, Dry	Md	lb/lb-mol	Md = 0.44 (Co2) + 0.32 (Co2) + 0.28 (Co)	29.88	29.88	29.88	29.9
Molecular Weight, Wet	Ms	lb/lb-mol	Ms = Md (1 - Bwo) + (18 x Bwo)	26.26	26.18	26.28	26.2
Stack Pressure	Ps	in.Hg	Ps = Pbar + (Pstatic / 13.6)	29.98	29.98	29.98	29.98
Stack Gas Velocity	Us	ft/s	Us = 85.33 x Cp x ((dP x Ts)/(Ps x Ms))^0.5	40.34	40.50	40.13	40.3
		m/s	Us (m/s) = 0.3048 x Us (ft/s)	12.30	12.34	12.23	12.3
Actual Stack Gas Flow Rate	Q	acfm	Q = 60 x Us x As	251,404	252,407	250,073	251,295
Dry Stack Gas Flow Rate	Qs	Rcfm	Qs = Q x (1-Bwo) x (Tref/Ts) x (Ps/Pref)	153,063	152,124	152,602	152,596
		Rcms	Qs (Rcms) = 0.000472 x Qs (Rcfm)	72.25	71.80	72.03	72.0
Sulphur Dioxide - SO2							
SO2 Measured Concentration	Cso2	ppm	Measurement from Flue Gas Analyzer	43.71	59.14	54.14	52.33
Uncorrected @ Ref Cond	Cso2	mg/Rcm	Cso2 (mg/Rcm) = Cso2 (ppm) x 2.62	114.53	154.95	141.85	137.11
SO2 Emission Rate	ERso2	g/s	ERso2 = Cso2/1000 x Qs	8.27	11.13	10.22	9.87
		kg/hr	ERso2 (kg/hr) = 3.6 x ERso2 (g/s)	29.79	40.05	36.78	35.54
SO2 Concentration							
Corrected to 11% O2	Cso2	mg/Rcm	Cso2 (11% O2) = Cso2 (mg/Rcm) x (20.9-11) / (20.9-Co2)	72.62	99.34	89.61	87.19
Corrected to 3% O2	Cso2	mg/Rcm	Cso2 (3% O2) = Cso2 (mg/Rcm) x (20.9-3) / (20.9-Co2)	131.30	179.61	162.03	157.64
Corrected to 12% CO2	Cso2	mg/Rcm	Cso2 (12% CO2) = Cso2 (mg/Rcm) x (12/Cco2)	131.97	179.53	162.56	158.02
Nitrogen Oxides - NOx							
NOx Measured Concentration	Cnox	ppm	Measurement from Flue Gas Analyzer				
Uncorrected @ Ref Cond	Cnox	mg/Rcm	Cnox (mg/Rcm) = Cnox (ppm) x 1.882				
NOx Emission Rate	ERnox	g/s	ERnox = Cnox/1000 x Qs				
		kg/hr	ERnox (kg/hr) = 3.6 x ERnox (g/s)				
NOx Concentration							
Corrected to 11% O2	Cnox	mg/Rcm	Cnox (11% O2) = Cnox (mg/Rcm) x (20.9-11) / (20.9-Co2)				
Corrected to 3% O2	Cnox	mg/Rcm	Cnox (3% O2) = Cnox (mg/Rcm) x (20.9-3) / (20.9-Co2)				
Corrected to 12% CO2	Cnox	mg/Rcm	Cnox (12% CO2) = Cnox (mg/Rcm) x (12/Cco2)				
Carbon Monoxide - CO							
CO Measured Concentration	Cco	ppm	Measurement from Flue Gas Analyzer	2033.40	304.57	626.86	988.28
Uncorrected @ Ref Cond	Cco	mg/Rcm	Cco (mg/Rcm) = Cco (ppm) x 1.145	2328.24	348.73	717.75	1131.58
CO Emission Rate	ERco	g/s	ERco = Cco/1000 x Qs	168.21	25.04	51.70	81.65
		kg/hr	ERco (kg/hr) = 3.6 x ERco (g/s)	605.54	90.14	186.11	293.93
CO Concentration							
Corrected to 11% O2	Cco	mg/Rcm	Cco (11% O2) = Cco (mg/Rcm) x (20.9-11) / (20.9-Co2)	1476.19	223.56	453.42	717.72
Corrected to 3% O2	Cco	mg/Rcm	Cco (3% O2) = Cco (mg/Rcm) x (20.9-3) / (20.9-Co2)	2669.07	404.22	819.82	1297.70
Corrected to 12% CO2	Cco	mg/Rcm	Cco (12% CO2) = Cco (mg/Rcm) x (12/Cco2)	2682.75	404.05	822.53	1303.11
Particulate Concentration	Cs	mg/Rcm	Cs = Mp / Vmc	7.94	5.44	5.16	6.18
Particulate Emission Rate	ERp	g/s	ERp = Cs/1000 x Qs	0.57	0.39	0.37	0.45
		kg/hr	ERp (kg/hr) = 3.6 x ERp (g/s)	2.07	1.41	1.34	1.60
Particulate Concentration							
Corrected to 11% O2	Cs	mg/Rcm	Cs (11% O2) = Cs x (20.9-11) / (20.9-Co2)	5.04	3.49	3.26	3.93
Corrected to 8% O2	Cs	mg/Rcm	Cs (8% O2) = Cs x (20.9-8) / (20.9-Co2)	6.56	4.54	4.25	5.12
Corrected to 12% CO2	Cs	mg/Rcm	Cs (12% CO2) = Cs x (12/Cco2)	9.15	6.30	5.91	7.12

Legend:
sq.ft - square feet
sq.m - square metres
Pi - 3.142
R - degrees Rankin
ppm - parts per million
in.Hg - inches of mercury
cu.ft - cubic feet
cu.m - cubic metres
Ref Cond - reference temperature and pressure (25 C and 101.3 kPa)
Rcms - dry reference cubic metres per second
Rcfm - dry reference cubic feet per minute
mg/Rcm - milligrams per dry reference cubic metre
g/s - grams per second
NOx - as NO2
acfm - actual cubic feet per minute

OFFICIAL STACK TESTING RESULTS
Northern Pulp
Pictou, NS

Fuel: Fuel oil
Operating Conditions: normal
Emission Control Equipment: precipitator
Stack Height from Grade: 69 m
Stack Diameter: 3.51 m

Parameter	Test 1	Test 2	Test 3	Average	NSENV Limits
Test ID	PM-1	PM-3	PM-4	-	-
Test Date	15-Sep-15	16-Sep-15	16-Sep-15	-	-
Stack Gas Temperature (C)	68.2	68.1	68.0	68.1	-
Moisture Content (%)	30.4	31.2	30.3	30.6	-
Velocity (m/s)	12.3	12.3	12.2	12.3	-
Volumetric Flow (Rcms)	72.2	71.8	72.0	72.0	-
Oxygen - O2 (%)	5.29	5.46	5.23	5.32	-
Carbon Dioxide - CO2 (%)	10.41	10.36	10.47	10.41	-
Sulphur Dioxide - SO2					
SO2 Measured Concentration (ppm)	43.71	59.14	54.14	52.33	-
Uncorrected at Ref Cond (mg/Rcm)	72.62	99.34	89.61	87.19	-
Emission Rate (kg/hr)	29.79	40.05	36.78	35.54	-
Nitrogen Oxides - NOx					
NOx Measured Concentration (ppm)					-
Uncorrected at Ref Cond (mg/Rcm)					-
Emission Rate (kg/hr)					-
Carbon Monoxide - CO					
CO Measured Concentration (ppm)	2033.4	304.6	626.9	988.3	-
Uncorrected at Ref Cond (mg/Rcm)	2328.2	348.7	717.8	1131.6	-
Emission Rate (kg/hr)	605.54	90.14	186.11	293.93	-
Particulate Matter - PM					
Particulate Concentration (mg/Rcm)	7.9	5.44	5.16	6.18	-
Concentration, Corrected to 11% O_2(mg/Rcm)	5.04	3.49	3.26	3.93	77
Particulate Emission Rate (kg/hr)	2.07	1.41	1.34	1.60	-

Legend:
C - degrees Celsius
m/s - metres per second
Rcms - dry reference cubic metres per second
ppm - parts per million
Ref Cond - reference temperature and pressure (25 C and 101.3 kPa)
mg/Rcm - miligrams per dry reference cubic metre
NOx - as NO2
ND - non-detectable

Particulate Recoveries: Impinger Catch, Probe Wash, Filter Catch

Client: Northern Pulp
Facility: Recovery Boiler
Location: Pictou, NS
Job Number: 121413456

IMPINGER CATCH

Container ID	Beaker Pre Weights (g) Date Analysed by Trial 1	Trial 2	Trial 3	Average	Sample ID	Recoveries Jar + Sample + Rinse (g)	Jar Tare (g)	Sample Collected (g)	Rinse Water (g)	Total Rinse Water (g)	Beaker Post Weights (g) Date Analysed by Trial 1	Trial 2	Trial 3	Average	Uncorrected Particulate Weight (g)	Corrected Particulate Weight (g)
X2	105.9279	105.9280		105.9280	PM-1	1245.5	381.1	862.9	31.2	92.7	105.9365	105.9369		105.9367	0.0088	0.0080
M3	111.9272	111.9270		111.9271	PM-3	1284.7	376.9	827.6	30.6	110.6	111.9360	111.9360		111.9360	0.0089	0.0081
V1	112.8044	112.8044		112.8044	PM-4	1352.4	378.3	805.6	45.0	213.5	112.8792	112.8787		112.8790	0.0746	0.0729
																Conc. (g/mL)
U3	111.1023	111.1020		111.1022	WB	660.0	371.6	288.2		288.2	111.1041	111.1046		111.1044	0.0022	0.000008

PROBE WASH

Container ID	Beaker Pre Weights (g) Date Analysed by Trial 1	Trial 2	Trial 3	Average	Sample ID	Recoveries Jar + Acetone (g)	Jar Tare (g)	Recovered Acetone (g)	Rinse Acetone	Total Acetone (g)	Beaker Post Weights (g) Date Analysed by Trial 1	Trial 2	Trial 3	Average	Uncorrected Particulate Weight (g)	Corrected Particulate Weight (g)
I4	117.1338	117.1340		117.1339	PM-1	379.0	308.5	70.5	6.8	77.3	117.1436	117.1439		117.1438	0.0099	0.0081
X3	109.8548	109.8548		109.8548	PM-3	354.2	309.9	44.3	4.0	48.3	109.8584	109.8588		109.8586	0.0038	0.0015
D4	109.8760	109.8757		109.8759	PM-4	374.4	308.8	65.6	8.4	74.0	109.8793	109.8798		109.8796	0.0037	0.0001
																Conc. (g/mL)
B1	111.6523	111.6520		111.6522	AB	340.9	286.1	54.8		54.8	111.6547	111.6549		111.6548	0.0026	0.000038

Density of Acetone 0.7850 g/ml

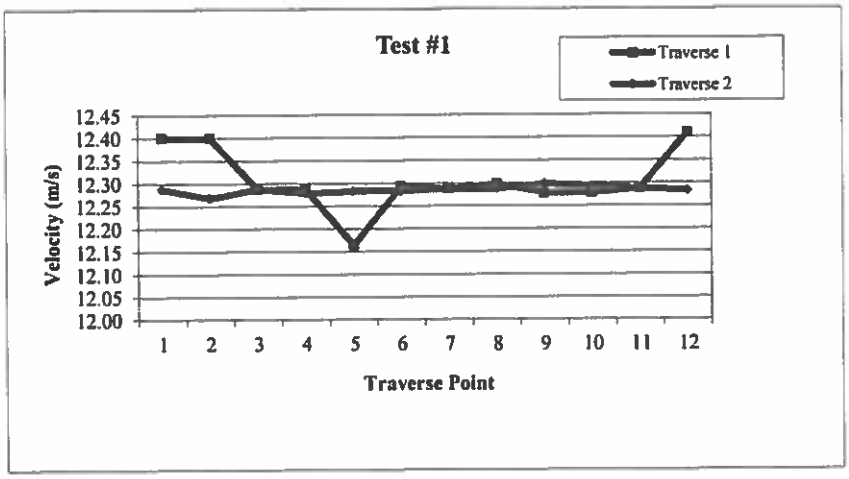
FILTER CATCH

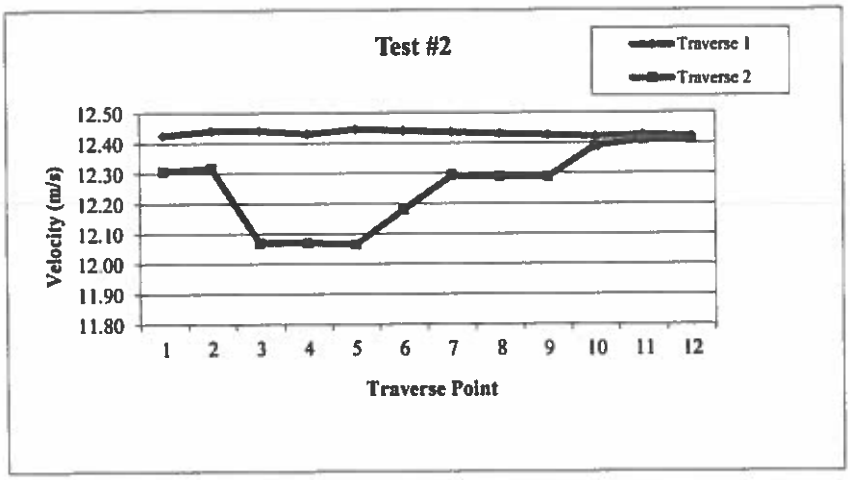
Filter ID	Pre Weights (g) Analysed by Trial 1	Trial 2	Trial 3	Average	Sample ID	Post Weights (g) Date: Analysed by Trial 1	Trial 2	Trial 3	Average	Particulate Weight from Filter (g)
0812-10	0.3702	0.3705		0.3704	PM-1	0.3840	0.3841		0.3841	0.0137
0812-11	0.3703	0.3701		0.3702	PM-3	0.3823	0.3822		0.3823	0.0121
0812-12	0.3693	0.3690		0.3692	PM-4	0.3818	0.3822		0.3820	0.0129
				#DIV/0!						

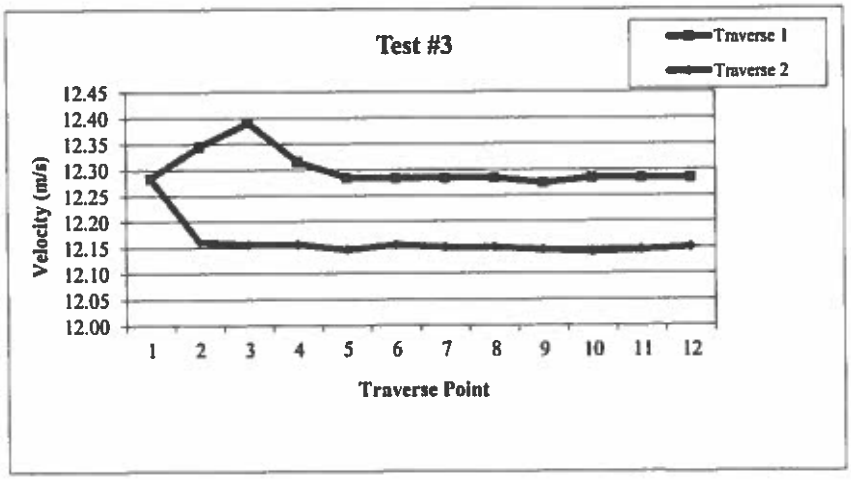
Northern Pulp
Recovery Boiler

121413456

Stack Gas Velocity Profiles
Pictou, NS







Project: 121413456
Test: PM1 (Power Boiler)
Date: Oct 14/15
Analyst: CAL

Absolute stack gas pressure (Ps) in in.Hg is:

$$Ps = P_{bar} + \frac{P_{static}\ in.H_2O}{13.6\ in.H_2O/in.Hg}$$

$$Ps = \frac{30.00}{} + \frac{0.18}{13.6}$$

$$Ps = 30.01\ in.Hg$$

The molecular weight of the stack gas on a dry basis (Md) in lb/lb-mole is:

$$Md = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28[(\%N_2) + (\%CO)] + 0.40\%Ar$$

$$Md = 0.44 \times \frac{5.8}{} + 0.32 \times \frac{12.8}{} + 0.28\left(\frac{81.3}{} + \frac{/}{}\right) + 0.40\left(\frac{/}{} + \frac{/}{}\right)$$

$$Md = \frac{2.55}{} + \frac{4.16}{} + \frac{22.76}{} + \frac{/}{}$$

$$Md = 29.41\ lb/lb\text{-mole}$$

The volume of water vapour collected at reference conditions (Vwc) in ft^3 is:

$$Vwc = 0.0480\ ft^3/mL \times \text{volume of moisture collected mL.}$$

$$Vwc = 0.0480 \times \frac{222.3}{}$$

$$Vwc = \frac{10.67}{}\ ft^3$$

The average _H orifice in in.H_2O is:

$$\text{\_H orifice}_{avg.} = \frac{\Sigma \text{ H orifice}}{\text{\# points}}$$

$$\text{\_H orifice}_{avg.} = \frac{20.15}{48}$$

$$\text{\_H orifice}_{avg.} = 0.42 \text{ in.}H_2O$$

The pressure at the gas meter (Pm) in in.Hg is:

$$Pm = P_{bar} + \frac{\text{\_H orifice}_{avg.} \text{ in.}H_2O}{13.6 \text{ in.}H_2O/\text{in.Hg}}$$

$$Pm = 30.00 + \frac{0.42}{13.6}$$

$$Pm = 30.00 + 0.031$$

$$Pm = 30.03 \text{ in.Hg}$$

The temperature of the gas meter (Tm) in °R is:

$$Tm = \frac{\Sigma \text{ meter temp. °F}}{\text{\# points}} + 460$$

$$Tm = \frac{6398}{72} + 460$$

$$Tm = 66.64 + 460$$

$$Tm = 526.64 \text{ °R}$$

The total volume of gas metered (Vm) in ft^3 is:

$Vm = Vf\ ft^3 - Vi\ ft^3$

$Vm = 866.42 - 809.37$

$Vm = 57.05\ ft^3$

The dry gas volume at reference conditions (Vmc) in ft^3 is:

$$Vmc = \frac{T_{ref}\ °R}{P_{ref}\ in.Hg} \times \frac{Pm\ in.Hg \times Vm\ ft^3 \times ?}{Tm\ °R}$$

$$Vmc = \frac{537}{29.92} \times \frac{30.03 \times 57.65 \times 0.829}{526.64}$$

$Vmc = 48.40\ ft^3 \times 1\ m^3 / 35.31\ ft^3 = 137\ m^3$

The stack gas moisture content, i.e. the proportion by volume of water vapour in the gas stream (Bwo) is:

$$Bwo = \frac{Vwc\ ft^3}{Vwc\ ft^3 + Vmc\ ft^3}$$

$$Bwo = \frac{10.67}{10.67 + 48.4}$$

$$Bwo = \frac{10.67}{59.07}$$

$Bwo = 0.181$

The Molecular weight of the stack gas on a wet basis (Ms) in lb/lb-mole is:

Ms = Md lb/lb-mole (1-Bwo) + 18 lb/lb-mole x Bwo

Ms = 29.41 x (1 - 0.181) + 18 x 0.191

Ms = 29.41 x 0.819 + ~~18.191~~ 3.25

Ms = ~~24.10~~ 27.34 lb/lb-mole

The average temperature of the stack ($Ts_{avg.}$) in °R is:

$Ts_{avg.} = \frac{\Sigma Ts\ °F}{\#\ points} + 460$

$Ts_{avg.} = \frac{6379}{48} + 460$

$Ts_{avg.} = 132.9 + 460$

$Ts_{avg.} = 592.9$ °R

The average velocity ($Us_{avg.}$) of the stack in ft/s is:

$Us_{avg.} = \frac{\Sigma V}{\#\ points}$

$Us_{avg.} = \frac{2510.8}{48}$

$Us_{avg.} = 52.30$ ft/s x 1 m / 3.281 ft = 15.94 m/s

$U_{S1} = 85.33 C_P \sqrt{\frac{\Delta P_1 \cdot T_{S1}}{P_S \cdot M_S}} = 85.33(0.78)\sqrt{\frac{0.85(59}{30.01(2}}$

$U_{S1} = 41.96$ ft/s

The cross-sectional area of the stack (As) in ft^2 is:

$$As = \frac{\Pi (D\ ft)^2}{4}$$

$$As = \frac{\Pi}{4} \times \left(\frac{72/12}{}\right)^2$$

$$As = 0.7854 \times 36$$

$$As = 28.27\ ft^2$$

The volumetric stack gas flowrate on a dry basis at reference conditions (Qs) in ft^3/hr is:

$$Qs = 3600\ s/hr \times Us\ ft/s \times As\ ft^2 \times (1\text{-}Bwo) \times \frac{T_{ref}\ °R}{Ts_{avg.}\ °R} \times \frac{Ps\ in.Hg}{P_{ref}\ in.Hg}$$

$$Qs = 3600 \times 52.3 \times 28.27 \times (1 - 0.181) \times \frac{537}{592.9} \times \frac{30.01}{29.92}$$

$$Qs = 3600 \times 52.3 \times 28.27 \times 0.819 \times 0.906 \times 1.003$$

$$Qs = 3960113.8\ ft^3/hr \times 1\ hr / 60\ min = 66001.9\ ft^3/min$$

$$Qs = 66002\ ft^3/min \times 1\ m^3 / 35.31\ ft^3 \times 1\ min / 60\ s = 31.2\ m^3/s$$

The total amount of particulate matter collected (Mp) in mg is:

Mp = 251.8 mg

The concentration of the particulate matter in the stack gas on a dry basis at reference conditions (Cp) in lb/ft^3 is:

$$Cp = 2.205 \times 10^{-6} \text{ lb/mg} \times \frac{Mp \text{ mg}}{Vmc \text{ ft}^3}$$

$$Cp = 2.205 \times 10^{-6} \text{ lb/mg} \times \frac{251.8}{48.4}$$

Cp = 1.15×10^{-5} lb/ft^3 x 453,590 mg / lb x 35.31 ft^3 / m^3 = 183.7 mg/m^3

The emission rate of the particulate matter from the stack on a dry basis at reference conditions (ERp) in lb/hr is:

Erp = Cp lb/ft^3 x Qs ft^3/hr

ERp = 1.15×10^{-5} x 3 960 114

ERp = 45.54 lb/hr x 1 kg / 2.20 lb = 20.7 kg/hr