Source Test Report

Neenah Paper - Munising
501 E. Munising Avenue
Munising, MI 49862

Source Tested: Boiler #1 (EU05)
Test Dates: March 5-6, 2024

Project No. AST-2024-0044

Prepared By
Alliance Technical Group, LLC
4500 Ball Road NE
Circle Pines, MN 55014

Regulatory Information

Permit No.	Michigan Department of Environment, Great Lakes, and Energy Air Quality Division Permit No. MI-ROP-B1470-2019a
Regulatory Citation	40 CFR 63, Subpart JJJJJJ

Source Information

Source Name	*Source ID*	*Target Parameters*
Boiler #1	EU05	PM, NOx, CO, Hg, Metals, HCl, SO$_2$

Contact Information

Test Location
Neenah Paper - Munising
501 E. Munising Avenue
Munising, MI 49862

Facility Contact
Brian Ciupak
brian.ciupak@neenah.com
(906) 387-7561

Test Company
Alliance Technical Group, LLC
4500 Ball Road NE
Circle Pines, MN 55014

Project Manager
Edward "EJ" Juers
edward.juers@alliancetg.com
(651) 247-7873

Field Team Leader
Ryan Lenski
ryan.lenski@alliancetg.com
(218) 220-8590

QA/QC Manager
Kathleen Shonk
katie.shonk@alliancetg.com
(812) 452-4785

Report Coordinator
Emily Diaz
emily.king@alliancetg.com
(812) 452-4785

Report Reviewer
Tyler Winslow
tyler.winslow@alliancetg.com
(812) 549-8434

Analytical Laboratory
Interpoll Laboratories Inc. now Alliance
Technical Group, LLC
4500 Ball Rd. NE
Circle Pines, MN 55014
Greg Holman
(763) 786-6020

Alliance Technical Group, LLC (Alliance) has completed the source testing as described in this report. Results apply only to the source(s) tested and operating condition(s) for the specific test date(s) and time(s) identified within this report. All results are intended to be considered in their entirety, and Alliance is not responsible for use of less than the complete test report without written consent. This report shall not be reproduced in full or in part without written approval from the customer.

To the best of my knowledge and abilities, all information, facts and test data are correct. Data presented in this report has been checked for completeness and is accurate, error-free and legible. Onsite testing was conducted in accordance with approved internal Standard Operating Procedures. Any deviations or problems are detailed in the relevant sections in the test report.

This report is only considered valid once an authorized representative of Alliance has signed in the space provided below; any other version is considered draft. This document was prepared in portable document format (.pdf) and contains pages as identified in the bottom footer of this document.

	April 5, 2023
Edward "EJ" Juers	Date
Alliance Technical Group, LLC	

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Introduction

1.0   Introduction

Alliance Technical Group, LLC (Alliance) was retained by Neenah Paper to conduct compliance testing at the Munising, MI facility. Portions of the facility are subject to 40 CFR 63, Subpart JJJJJJ. The facility operates under the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality Division Permit No. MI-ROP-B1470-2019a. Testing was conducted to determine the emission rates of particulate matter (PM), nitrogen oxides (NOx), carbon monoxide (CO), mercury (Hg), select metals (Arsenic, Barium, Chromium, Lead, Manganese, and Phosphorus), hydrogen chloride (HCl) and sulfur dioxide (SO_2) from the exhaust of Boiler #1 (EU05).

1.1   Facility Description

The Neenah Paper facility owns and operates Boiler #1. EU05 is capable of burning coal and natural gas. The boiler capacity is 202 MMBTU/Hr heat input. The baghouse is utilized to reduce emissions of particulate.

1.2   Project Team

Personnel involved in this project are identified in the following table.

Table 1-1: Project Team

Facility Personnel	Brian Ciupak
Regulatory Personnel	Jeremy Howe
Alliance Personnel	Ryan Lenski
	Carl Bender
	Leo Peters

1.3   Site Specific Test Plan & Notification

Testing was conducted in accordance with the Site-Specific Test Plan (SSTP) submitted to the EGLE, AQD on December 20, 2023.

Summary of Results

2.0   Summary of Results

Alliance conducted compliance testing at the Neenah Paper facility in Munising, MI on March 5-6, 2024. Testing consisted of determining the emission rates of PM, NOx, CO, Hg, Metals, HCl and SO_2 from the exhaust of Boiler #1 (EU05).

Tables 2-1 and 2-2 provide a summary of the emission testing results with comparisons to the applicable NESHAP and Michigan EGLE permit limits. This table also provides a summary of the process operating and control system data collected during testing. Any difference between the summary results listed in the following tables and the detailed results contained in appendices is due to rounding for presentation.

Table 2-1: Summary of Results – PM, HCl, CO, NOx & SO₂ Data

Emissions Data				
Run Number	**Run 1**	**Run 2**	**Run 3**	**Average**
Date	**3/5/24**	**3/5/24**	**3/5/24**	--
Filterable Particulate Matter Data				
Concentration, grain/dscf	0.0014	0.0020	8.2E-04	0.0014
Emission Rate, lb/hr	0.56	0.85	0.34	0.58
Emission Rate, lb/1000 lbs	0.0023	0.0036	0.0014	0.0025
Emission Rate, lb/1000lbs @ 50% Excess Air	0.0026	0.0042	0.0017	0.0028
Permit Limit, lb/1000lbs @ 50% Excess Air	--	--	--	0.30
Percent of Limit, %	--	--	--	1
Emission Factor, lb/MMBtu (HI)	0.0036	0.0058	0.0023	0.0039
Hydrogen Chloride Data				
Concentration, mg/dscm	18.3	25.0	23.3	22.2
Concentration, ppmvd	12.1	16.5	15.4	14.6
Emission Rate, lb/hr	3.3	4.5	4.2	4.0
Emission Factor, lb/MMBtu (HI)	0.021	0.031	0.029	0.027
Carbon Monoxide Data				
Concentration, ppmvd	17.8	18.1	22.0	19.3
Concentration, ppmvd @ 3 % O_2	26.6	27.6	33.9	29.3
NESHAP Limit, ppmvd @ 3 % O_2	--	--	--	420
Percent of Limit, %	--	--	--	7
Emission Rate, lb/hr	3.7	3.8	4.6	4.1
Nitrogen Oxide Data				
Concentration, ppmvd	267.7	265.4	258.3	263.8
Concentration, ppmvd @ 3 % O_2	398.8	405.3	397.1	400.4
Emission Rate, lb/hr	91.6	92.2	89.2	91.0
Sulfur Dioxide Data				
Concentration, ppmvd	277.0	273.5	269.7	273.4
Concentration, ppmvd @ 3 % O_2	412.6	417.7	414.7	415.0
Emission Rate, lb/hr	131.9	132.3	129.7	131.3
Process Operating / Control System Data				
Coal Feed rate, lb/hr	10,533	10,160	10,080	10,258
Heat Input, MMBtu/hr	153.06	147.63	146.47	149

Table 2-2: Summary of Results – Metals & Mercury Data

Run Number	Run 1	Run 2	Run 3	Average
Date	3/6/24	3/6/24	3/6/24	--
Arsenic Data				
Concentration, ug/dscm	5.6	5.6	5.5	5.6
Concentration, mg/dscm	0.0056	0.0056	0.0055	0.0056
Emission Rate, lb/hr	0.0010	0.0010	0.0010	0.0010
Emission Factor, lb/MMBtu (HI)	6.6E-06	6.8E-06	6.8E-06	6.7E-06
Barium Data				
Concentration, ug/dscm	0.71	0.19	0.18	0.36
Concentration, mg/dscm	1.3E-04	3.4E-05	3.3E-05	6.5E-05
Emission Rate, lb/hr	5.6E-04	1.5E-04	1.5E-04	2.8E-04
Emission Factor, lb/MMBtu (HI)	8.3E-07	2.3E-07	2.3E-07	4.3E-07
Chromium Data				
Concentration, ug/dscm	4.3	1.2	1.1	2.2
Concentration, mg/dscm	0.0043	0.0012	0.0011	0.0022
Emission Rate, lb/hr	7.7E-04	2.2E-04	1.9E-04	3.9E-04
Emission Factor, lb/MMBtu (HI)	5.0E-06	1.5E-06	1.3E-06	2.6E-06
Lead Data				
Concentration, ug/dscm	6.1	3.7	3.7	4.5
Concentration, mg/dscm	0.0061	0.0037	0.0037	0.0045
Emission Rate, lb/hr	1.1E-03	6.7E-04	6.7E-04	8.1E-04
Emission Factor, lb/MMBtu (HI)	7.2E-06	4.5E-06	4.5E-06	5.4E-06
Manganese Data				
Concentration, ug/dscm	3.2	1.9	1.9	2.3
Concentration, mg/dscm	0.0032	0.0019	0.0019	0.0023
Emission Rate, lb/hr	5.8E-04	3.4E-04	3.4E-04	4.2E-04
Emission Factor, lb/MMBtu (HI)	3.8E-06	2.3E-06	2.3E-06	2.8E-06
Phosphorus Data				
Concentration, ug/dscm	62.6	52.3	53.2	56.0
Concentration, mg/dscm	0.063	0.052	0.053	0.056
Emission Rate, lb/hr	0.011	0.009	0.010	0.010
Emission Factor, lb/MMBtu (HI)	7.3E-05	6.4E-05	6.6E-05	6.8E-05
Mercury Data				
Concentration, ppb	0.037	0.036	0.041	0.038
Concentration, ug/dscm	0.31	0.30	0.34	0.32
Concentration, mg/dscm	3.1E-04	3.0E-04	3.4E-04	3.2E-04
Emission Rate, lb/hr	5.5E-05	5.4E-05	6.1E-05	5.7E-05
Emission Factor, lb/MMBtu (HI)	3.6E-07	3.7E-07	4.2E-07	3.8E-07
NESHAP Limit, lb/MMBtu (HI)	--	--	--	2.5E-05
Percent of Limit, %	--	--	--	2
Process Operating / Control System Data				
Coal Feed rate, lb/hr	10,533	10,160	10,080	10,258
Heat Input, MMBtu/hr	153.06	147.63	146.47	149.05

Testing Methodology

3.0 Testing Methodology

The emission testing program was conducted in accordance with the test methods listed in Table 3-1. Method descriptions are provided below while quality assurance/quality control data is provided in Appendix D.

Table 3-1: Source Testing Methodology

Parameter	U.S. EPA Reference Test Methods	Notes/Remarks
Volumetric Flow Rate	1 & 2	Full Velocity Traverses
Oxygen/Carbon Dioxide	3A	Instrumental Analysis
Oxygen/Carbon Dioxide	3/3A	Integrated Bag / Instrumental Analysis
Moisture Content	4	Gravimetric Analysis
Particulate Matter/Hydrogen Chloride	5/26A	Isokinetic Sampling
Sulfur Dioxide	6C	Instrumental Analysis
Nitrogen Oxides	7E	Instrumental Analysis
Carbon Monoxide	10	Instrumental Analysis
Mass Emission Factors	19	Fuel Factors/Heat Inputs
Select Metals & Mercury	29	Isokinetic Testing

3.1 U.S. EPA Reference Test Methods 1 and 2 – Sampling/Traverse Points and Volumetric Flow Rate

The sampling location and number of traverse (sampling) points were selected in accordance with U.S. EPA Reference Test Method 1. To determine the minimum number of traverse points, the upstream and downstream distances were equated into equivalent diameters and compared to Figure 1-1 in U.S. EPA Reference Test Method 1.

Full velocity traverses were conducted in accordance with U.S. EPA Reference Test Method 2 to determine the average stack gas velocity pressure, static pressure and temperature. The velocity and static pressure measurement system consisted of a pitot tube and inclined manometer. The stack gas temperature was measured with a K-type thermocouple and pyrometer.

Stack gas velocity pressure and temperature readings were recorded during each test run. The data collected was utilized to calculate the volumetric flow rate in accordance with U.S. EPA Reference Test Method 2.

3.2 U.S. EPA Reference Test Method 3A – Oxygen/Carbon Dioxide

The oxygen (O_2) and carbon dioxide (CO_2) testing was conducted in accordance with U.S. EPA Reference Test Method 3A. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless-steel probe, Teflon sample line(s), gas conditioning system and the identified gas analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the stack gas. If an unheated Teflon sample line was used, then a portable non-contact condenser was placed in the system directly after the probe. Otherwise, a heated Teflon sample line was used. The quality control measures are described in Section 3.11.

3.3 U.S. EPA Reference Test Method 3/3A – Oxygen/Carbon Dioxide

The oxygen (O_2) and carbon dioxide (CO_2) testing was conducted in accordance with U.S. EPA Reference Test Method 3/3A. One (1) integrated Tedlar bag sample was collected during each test run. The bag samples were analyzed on site with a gas analyzer. The remaining stack gas constituent was assumed to be nitrogen for the stack gas molecular weight determination. The quality control measures are described in Section 3.12.

3.4 U.S. EPA Reference Test Method 4 – Moisture Content

The stack gas moisture content (BWS) was determined in accordance with U.S. EPA Reference Test Method 4. The gas conditioning train consisted of a series of chilled impingers. Prior to testing, each impinger was filled with a known quantity of water or silica gel. Each impinger was analyzed gravimetrically before and after each test run on the same balance to determine the amount of moisture condensed.

3.5 U.S. EPA Reference Test Methods 5 and 26A – Particulate Matter/ Hydrogen Chloride

The filterable particulate matter, and hydrogen chloride testing was conducted in accordance with U.S. EPA Reference Test Methods 5 and 26A. The complete sampling system consisted of a stainless-steel nozzle, heated glass-lined probe, pre-weighed heated Teflon filter, gas conditioning train, pump and calibrated dry gas meter. The gas conditioning train consisted of four (4) chilled impingers. The first and second impingers contained 100 mL of 0.1 N H_2SO_4, the third was initially empty and the fourth contained 200-300 grams of silica gel. The probe liner and filter heating systems were maintained at 248-273°F, and the impinger temperature was maintained at 20°C (68°F) or less throughout the testing.

Following the completion of each test run, the sampling train was leak checked at vacuum pressure greater than or equal to the highest vacuum pressure observed during the run and the contents of the impingers were measured for moisture gain. The pre-weighed Teflon filter was carefully removed and placed in container 1. The probe and nozzle were rinsed and brushed three (3) times with acetone to remove any adhering particulate matter and these rinses placed in container 2. The front half of the filter holder was rinsed three (3) times with acetone and this rinse was added to container 2. The absorbing solution (0.1 N H_2SO_4) from the first and second impingers was placed into sample container 3. The back-half of the filter holder, first, second and third impingers and all glassware leading to the outlet of the third impinger were rinsed with de-ionized (DI) water. These rinses were also placed in container 3. Containers 1-2 were sealed, labeled and liquid levels marked for transport to the identified laboratory for particulate analysis. Container 3 was sealed, labeled and liquid levels marked for transport to the identified laboratory for halide analysis.

3.6 U.S. EPA Reference Test Method 6C – Sulfur Dioxide

The sulfur dioxide (SO_2) testing was conducted in accordance with U.S. EPA Reference Test Method 6C. Data was collected online and reported in one-minute averages. The sampling system consisted of a heated stainless-steel probe, Teflon sample line(s), gas conditioning system and the identified analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the source gas. If an unheated Teflon sample line was used, then a portable non-contact condenser was placed in the system directly after the probe. Otherwise, a heated Teflon sample line was used. The quality control measures are described in Section 3.11.

3.7 U.S. EPA Reference Test Method 7E – Nitrogen Oxides

The nitrogen oxides (NOx) testing was conducted in accordance with U.S. EPA Reference Test Method 7E. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless-steel probe, Teflon sample line(s), gas conditioning system and the identified gas analyzer. The gas conditioning system was a

non-contact condenser used to remove moisture from the stack gas. If an unheated Teflon sample line was used, then a portable non-contact condenser was placed in the system directly after the probe. Otherwise, a heated Teflon sample line was used. The quality control measures are described in Section 3.11.

3.8   U.S. EPA Reference Test Method 10 – Carbon Monoxide

The carbon monoxide (CO) testing was conducted in accordance with U.S. EPA Reference Test Method 10. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless-steel probe, Teflon sample line(s), gas conditioning system, and the identified gas analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the gas. If an unheated Teflon sample line was used, then a portable non-contact condenser was placed in the system directly after the probe. Otherwise, a heated Teflon sample line was used. The quality control measures are described in Section 3.11.

3.9   U.S. EPA Reference Test Method 19 – Mass Emission Factors

The pollutant concentrations were converted to mass emission factors (lb/MMBtu) using procedures outlined in U.S. EPA Reference Test Method 19.

3.10   U.S. EPA Reference Test Method 29 – Metals

The metals testing was conducted in accordance with U.S. EPA Reference Test Method 29. The complete sampling system consisted of a glass nozzle, glass-lined probe, pre-cleaned heated quartz filter, gas conditioning system, pump and calibrated dry gas meter. The gas conditioning train consisted of seven (7) chilled impingers. The first impinger was empty, the second and third contained 100 mL of HNO_3/H_2O_2, the fourth was empty, the fifth and sixth contained 100 mL of acidic $KMnO_4$, and the seventh contained 200-300 grams of silica gel. The probe liner and filter heating systems were maintained at a temperature of 120 ± 14°C (248 ±25°F), and the impinger temperature was maintained at 20°C (68°F) or less throughout testing. Prior to testing, all glassware was cleaned and sealed in a controlled environment as outlined in the test method.

Following the completion of each test run, the sample train was leak checked at a vacuum pressure equal to or greater than the highest vacuum pressure observed during the run and the contents of the impingers were measured for moisture gain. The quartz filter was carefully removed and placed into container 1. The probe and nozzle were rinsed and brushed three (3) times with 0.1 N HNO_3 using a non-metallic brush and these rinses were placed in container 2. The front half of the filter holder was rinsed three (3) times with 0.1 N HNO_3 and these rinses were added to container 3. The contents of impingers 1, 2, and 3 were placed in container 4. Impingers 1, 2, and 3 along with the filter support, back half of the filter holder and all connecting glassware were triple rinsed with 0.1 N HNO_3 and these rinses were added to container 4. The contents of impinger 4 were placed in container 5A. The impinger and connecting glassware were triple rinsed with HNO_3 and these rinses added to container 5A. The contents of impingers 5 and 6 were placed in container 5B. The impingers and all connecting glassware were triple rinsed with acidified $KMNO_4$ and then with de-ionized (DI) water and these rinses were added to container 5B. Impingers 5 and 6 were rinsed again with 25 mL of 8N HCl and this rinse was collected into container 5C, which contained 200 mL of DI water. All containers were sealed, labeled and liquid levels marked for transport to the identified laboratory for analysis.

3.11   Quality Assurance/Quality Control – U.S. EPA Reference Test Methods 3A, 6C, 7E and 10

Cylinder calibration gases used met EPA Protocol 1 (+/- 2%) standards. Copies of all calibration gas certificates can be found in the Quality Assurance/Quality Control Appendix.

Low Level gas was introduced directly to the analyzer. After adjusting the analyzer to the Low-Level gas concentration and once the analyzer reading was stable, the analyzer value was recorded. This process was repeated for the High-Level gas. For the Calibration Error Test, Low, Mid, and High-Level calibration gases were sequentially introduced directly to the analyzer. All values were within 2.0 percent of the Calibration Span or 0.5 ppmv/% absolute difference.

High or Mid-Level gas (whichever was closer to the stack gas concentration) was introduced at the probe and the time required for the analyzer reading to reach 95 percent or 0.5 ppmv/% (whichever was less restrictive) of the gas concentration was recorded. The analyzer reading was observed until it reached a stable value, and this value was recorded. Next, Low-Level gas was introduced at the probe and the time required for the analyzer reading to decrease to a value within 5.0 percent or 0.5 ppmv/% (whichever was less restrictive) was recorded. If the Low-Level gas was zero gas, the response was 0.5 ppmv/% or 5.0 percent of the upscale gas concentration (whichever was less restrictive). The analyzer reading was observed until it reached a stable value, and this value was recorded. The measurement system response time and initial system bias were determined from these data. The System Bias was within 5.0 percent of the Calibration Span or 0.5 ppmv/% absolute difference.

High or Mid-Level gas (whichever was closer to the stack gas concentration) was introduced at the probe. After the analyzer response was stable, the value was recorded. Next, Low-Level gas was introduced at the probe, and the analyzer value recorded once it reached a stable response. The System Bias was within 5.0 percent of the Calibration Span or 0.5 ppmv/% absolute difference or the data was invalidated, and the Calibration Error Test and System Bias were repeated.

Drift between pre- and post-run System Bias was within 3 percent of the Calibration Span or 0.5 ppmv/% absolute difference. If the drift exceeded 3 percent or 0.5 ppmv/%, the Calibration Error Test and System Bias were repeated.

To determine the number of sampling points, a gas stratification check was conducted prior to initiating testing. The pollutant concentrations were measured at three points (16.7, 50.0 and 83.3 percent of the measurement line). Each traverse point was sampled for a minimum of twice the system response time.

If the pollutant concentration at each traverse point did not differ more than 5 percent or 0.5 ppmv/0.3% (whichever was less restrictive) of the average pollutant concentration, then single point sampling was conducted during the test runs. If the pollutant concentration did not meet these specifications but differed less than 10 percent or 1.0 ppmv/0.5% from the average concentration, then three (3) point sampling was conducted (stacks less than 7.8 feet in diameter - 16.7, 50.0 and 83.3 percent of the measurement line; stacks greater than 7.8 feet in diameter – 0.4, 1.0, and 2.0 meters from the stack wall). If the pollutant concentration differed by more than 10 percent or 1.0 ppmv/0.5% from the average concentration, then sampling was conducted at a minimum of twelve (12) traverse points. Copies of stratification check data can be found in the Quality Assurance/Quality Control Appendix.

An $NO_2 - NO$ converter check was performed on the analyzer at the completion of testing. Mid-level nitrogen oxide protocol 1 calibration gas was mixed at a 1:1 ratio with span level protocol 1 oxygen calibration gas in a Tedlar sample bag to form NO_2 gas. The NO_2 gas was delivered to the nitrogen oxides analyzer directly from a Tedlar sample bag. The response of the analyzer was stable for the 30-minute duration of the test with the variation less than 2.0% at the end of the test from the maximum value of the test.

A Data Acquisition System with battery backup was used to record the instrument response in one (1) minute averages. The data was continuously stored as a *.CSV file in Excel format on the hard drive of a computer. At the completion of testing, the data was also saved to the Alliance server. All data was reviewed by the Field Team Leader before leaving the facility. Once arriving at Alliance's office, all written and electronic data was relinquished to the report coordinator and then a final review was performed by the Project Manager.

3.12   Quality Assurance/Quality Control – U.S. EPA Reference Test Method 3/3A

Cylinder calibration gases used met EPA Protocol 1 (+/- 2%) standards. Copies of all calibration gas certificates can be found in the Quality Assurance/Quality Control Appendix.

Low-Level gas was introduced directly to the analyzer. After adjusting the analyzer to the Low-Level gas concentration and once the analyzer reading was stable, the analyzer value was recorded. This process was repeated for the High-Level gas. For the Calibration Error Test, Low, Mid, and High-Level calibration gases were sequentially introduced directly to the analyzer. All values were within 2.0 percent of the Calibration Span or 0.5% absolute difference.

At the completion of testing, the data was also saved to the Alliance server. All data was reviewed by the Field Team Leader before leaving the facility. Once arriving at Alliance's office, all written and electronic data was relinquished to the report coordinator and then a final review was performed by the Project Manager.

Appendix A

Location: Neenah Paper - Munising, MI

Source: Boiler #1

Project No.: AST-2024-0044

Run No.: 1

Parameter: HCL/PM

Meter Pressure (Pm), in. Hg

$$Pm = Pb + \frac{\Delta H}{13.6}$$

where,

Pb	29.53	= barometric pressure, in. Hg
ΔH	1.377	= pressure differential of orifice, in H_2O
Pm	29.63	= in. Hg

Absolute Stack Gas Pressure (Ps), in. Hg

$$Ps = Pb + \frac{Pg}{13.6}$$

where,

Pb	29.53	= barometric pressure, in. Hg
Pg	-0.20	= static pressure, in. H_2O
Ps	29.52	= in. Hg

Standard Meter Volume (Vmstd), dscf

$$Vmstd = \frac{17.636 \times Y \times Vm \times Pm}{Tm}$$

where,

Y	1.011	= meter correction factor
Vm	39.780	= meter volume, cf
Pm	29.63	= absolute meter pressure, in. Hg
Tm	530.8	= absolute meter temperature, °R
Vmstd	39.593	= dscf

Standard Wet Volume (Vwstd), scf

$$Vwstd = 0.04716 \times Vlc$$

where,

Vlc	101	= weight of H_2O collected, g
Vwstd	4.763	= scf

Moisture Fraction (BWSsat), dimensionless (theoretical at saturated conditions)

$$BWSsat = \frac{10^{6.37-\left(\frac{2,827}{Ts+365}\right)}}{Ps}$$

where,

Ts	283.4	= stack temperature, °F
Ps	29.52	= absolute stack gas pressure, in. Hg
BWSsat	3.436	= dimensionless

Moisture Fraction (BWS), dimensionless (measured)

$$BWS = \frac{Vwstd}{(Vwstd + Vmstd)}$$

where,

Vwstd	4.763	= standard wet volume, scf
Vmstd	39.593	= standard meter volume, dscf
BWS	0.107	= dimensionless

Location: Neenah Paper - Munising, MI
Source: Boiler #1
Project No.: AST-2024-0044
Run No.: 1
Parameter: HCL/PM

Moisture Fraction (BWS), dimensionless

$$BWS = BWSmsd \text{ unless } BWSsat < BWSmsd$$

where,

BWSsat	3.436	= moisture fraction (theoretical at saturated conditions)
BWSmsd	0.107	= moisture fraction (measured)
BWS	0.107	

Molecular Weight (DRY) (Md), lb/lb-mole

$$Md = (0.44 \times \% CO_2) + (0.32 \times \% O2) + (0.28 (100 - \% CO_2 - \% O2))$$

where,

CO_2	9.6	= carbon dioxide concentration, %
O_2	8.9	= oxygen concentration, %
Md	29.89	= lb/lb mol

Molecular Weight (WET) (Ms), lb/lb-mole

$$Ms = Md (1 - BWS) + 18.015 (BWS)$$

where,

Md	29.89	= molecular weight (DRY), lb/lb mol
BWS	0.107	= moisture fraction, dimensionless
Ms	28.62	= lb/lb mol

Average Velocity (Vs), ft/sec

$$Vs = 85.49 \times Cp \times (\Delta P^{1/2}) avg \times \sqrt{\frac{Ts}{Ps \times Ms}}$$

where,

Cp	0.840	= pitot tube coefficient
$\Delta P^{1/2}$	0.473	= velocity head of stack gas, (in. $H_2O)^{1/2}$
Ts	743.0	= absolute stack temperature, °R
Ps	29.52	= absolute stack gas pressure, in. Hg
Ms	28.62	= molecular weight of stack gas, lb/lb mol
Vs	31.9	= ft/sec

Average Stack Gas Flow at Stack Conditions (Qa), acfm

$$Qa = 60 \times Vs \times As$$

where,

Vs	31.9	= stack gas velocity, ft/sec
As	39.87	= cross-sectional area of stack, ft^2
Qa	76,281	= acfm

Average Stack Gas Flow at Standard Conditions (Qs), dscfm

$$Qs = 17.636 \times Qa \times (1 - BWS) \times \frac{Ps}{Ts}$$

where,

Qa	76,281	= average stack gas flow at stack conditions, acfm
BWS	0.107	= moisture fraction, dimensionless
Ps	29.52	= absolute stack gas pressure, in. Hg
Ts	743.0	= absolute stack temperature, °R
Qs	47,701	= dscfm

Location: **Neenah Paper - Munising, MI**
Source: **Boiler #1**
Project No.: **AST-2024-0044**
Run No.: **1**
Parameter: **HCL/PM**

Dry Gas Meter Calibration Check (Yqa), dimensionless

$$Yqa = \frac{Y - \left(\frac{\Theta}{Vm} \sqrt{\frac{0.0319 \times Tm \times 29}{\Delta H@ \times \left(Pb + \frac{\Delta\,Havg.}{13.6} \right) \times Md}} \sqrt{\Delta H}\ avg. \right)}{Y} \times 100$$

where,

Y	1.011	= meter correction factor, dimensionless
Θ	60	= run time, min.
Vm	39.78	= total meter volume, dcf
Tm	530.8	= absolute meter temperature, °R
ΔH@	1.705	= orifice meter calibration coefficient, in. H_2O
Pb	29.53	= barometric pressure, in. Hg
ΔH avg	1.377	= average pressure differential of orifice, in H_2O
Md	29.89	= molecular weight (DRY), lb/lb mol
$(\Delta H)^{1/2}$	1.170	= average squareroot pressure differential of orifice, (in. H2O)$^{1/2}$
Yqa	0.5	= percent

Volume of Nozzle (Vn), ft³

$$Vn = \frac{Ts}{Ps} \left(0.002669 \times Vlc + \frac{Vm \times Pm \times Y}{Tm} \right)$$

where,

Ts	743.0	= absolute stack temperature, °R
Ps	29.52	= absolute stack gas pressure, in. Hg
Vlc	101.0	= volume of H_2O collected, ml
Vm	39.780	= meter volume, cf
Pm	29.63	= absolute meter pressure, in. Hg
Y	1.011	= meter correction factor, unitless
Tm	530.8	= absolute meter temperature, °R
Vn	63.302	= volume of nozzle, ft³

Isokinetic Sampling Rate (I), %

$$I = \left(\frac{Vn}{\theta \times 60 \times An \times Vs} \right) \times 100$$

where,

Vn	63.302	= nozzle volume, ft3
θ	60.0	= run time, minutes
An	0.00053	= area of nozzle, ft²
Vs	31.9	= average velocity, ft/sec
I	103.9	= %

Filterable PM Concentration (C_s), grain/dscf

$$C_s = \frac{M_n \times 0.0154}{Vmstd}$$

where,

Mn	3.5	= filterable PM mass, mg
Vmstd	39.593	= standard meter volume, dscf
C_s	0.0014	= grain/dscf

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Location: **Neenah Paper - Munising, MI**
Source: **Boiler #1**
Project No.: **AST-2024-0044**
Run No.: **1**
Parameter: **HCL/PM**

Filterable PM Emission Rate (PMR), lb/hr

$$PMR = \frac{C_s \times Qs \times 60}{7.0E + 03}$$

where,

C_s	0.0014	= filterable PM concentration, grain/dscf
Qs	47,701	= average stack gas flow at standard conditions, dscfm
PMR	0.56	= lb/hr

Filterable PM Emission Factor (EF$_{PM}$), lb/MMBtu

$$EF_{PM} = \frac{PMR}{HI}$$

where,

PMR	0.56	= filterable PM emission rate, lb/hr
HI	153	= heat input, MMBtu/hr
EF$_{PM}$	0.0036	= lb/MMBtu

Filterable PM Emission Factor (EF$_{PM}$), lb/1000 lbs

$$EF_{PM} = \frac{PMR}{FR}$$

where,

PMR	0.56	= filterable PM emission rate, lb/hr
FR	240	= exhaust rate, 1000 lb/hr
EF$_{PM}$	0.0023	= lb/1000 lbs

Filterable PM Emission Rate, lb/1000lbs @ 50% Excess Air)

$$CA_{aEA} = \frac{PMR \times (100 \times EA_\%)}{150.00}$$

PMR	2.3E-03	= lb/1000 lbs
EA	70.2754	= Percent Excess air
CA$_{aEA}$	0.0026	= corrected, lb/1000lbs @ 50% Excess Air

Hydrogen Chloride Concentration (C$_{HCl}$), mg/dscm

$$C_{HCl} = \frac{M_{HCl} \times 35.313}{Vmstd \times 1.0E + 03}$$

where,

M$_{HCl}$	20,500	= hydrogen chloride mass, ug
Vmstd	39.593	= standard meter volume, dscf
C$_{HCl}$	18.3	= mg/dscm

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Location: **Neenah Paper - Munising, MI**
Source: **Boiler #1**
Project No.: **AST-2024-0044**
Run No.: **1**
Parameter: **HCL/PM**

Hydrogen Chloride Concentration (C_{HClp}), ppmvd

$$C_{HClp} = \frac{M_{HCl} \times 24.04 \frac{L}{mol}}{MW \times Vmstd \times 28.32}$$

where,

M_{HCl}	20,500	= hydrogen chloride mass, ug
MW	36.5	= molecular weight, g/g mol
Vmstd	39.593	= standard meter volume, dscf
C_{HClp}	12.1	= ppmvd

Hydrogen Chloride Emission Rate (ER_{HCl}), lb/hr

$$ER_{HCl} = \frac{M_{HCl} \times Qs \times 60 \frac{min}{hr}}{Vmstd \times 4.54\,E+08}$$

where,

M_{HCl}	20,500	= hydrogen chloride mass, ug
Qs	47,701	= average stack gas flow at standard conditions, dscfm
Vmstd	39.593	= standard meter volume, dscf
ER_{HCl}	3.3	= lb/hr

Hydrogen Chloride Emission Factor (EF_{HCl}), lb/MMBtu

$$EF_{HCl} = \frac{ER_{HCl}}{HI}$$

where,

ER_{HCl}	3.27	= hydrogen chloride emission rate, lb/hr
HI	153	= heat input, MMBtu/hr
EF_{HCl}	0.021	= lb/MMBtu

Location: Neenah Paper - Munising, MI
Source: Boiler #1
Project No.: AST-2024-0044
Run No. /Method Run 1 / Method 3A

O_2 - Outlet Concentration (C_{O_2}), % dry

$$C_{O_2} = (C_{obs} - C_0) \times \left(\frac{C_{MA}}{(C_M - C_0)} \right)$$

where,

C_{obs}	8.9	= average analyzer value during test, % dry
C_0	0.2	= average of pretest & posttest zero responses, % dry
C_{MA}	10.6	= actual concentration of calibration gas, % dry
C_M	10.6	= average of pretest & posttest calibration responses, % dry
C_{O_2}	8.9	= O_2 Concentration, % dry

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Location:	Neenah Paper - Munising, MI
Source:	Boiler #1
Project No.:	AST-2024-0044
Run No. /Method	Run 1 / Method 3A

CO_2 - Outlet Concentration (C_{CO_2}), % dry

$$C_{CO_2} = (C_{obs} - C_0) \times \left(\frac{C_{MA}}{(C_M - C_0)} \right)$$

where,

C_{obs}	10.1	= average analyzer value during test, % dry
C_o	0.1	= average of pretest & posttest zero responses, % dry
C_{MA}	8.2	= actual concentration of calibration gas, % dry
C_M	8.6	= average of pretest & posttest calibration responses, % dry
C_{CO_2}	9.6	= CO_2 Concentration, % dry

Location: Neenah Paper - Munising, MI
Source: Boiler #1
Project No.: AST-2024-0044
Run No. /Method Run 1 / Method 6C

SO₂ - Outlet Concentration (C_{SO_2}), ppmvd

$$C_{SO_2} = \frac{C_{SO_2w}}{1 - BWS}$$

where,

C_{SO_2w}	247.4	= SO₂ - Outlet Concentration, ppmvw
BWS	0.107	= moisture fraction, unitless
C_{SO_2}	277.0	= ppmvd

SO₂ - Outlet Concentration (C_{SO_2w}), ppmvw

$$C_{SO_2w} = C_{SO_2} \times (1 - BWS)$$

where,

C_{SO_2}	277.0	= SO₂ - Outlet Concentration, ppmvd
BWS	0.107	= moisture fraction, unitless
C_{SO_2w}	247.4	= ppmvw

SO₂ - Outlet Concentration (C_{SO_2c3}), ppmvd @ 3% O₂

$$C_{SO_2c3} = C_{SO_2} \times \left(\frac{20.9 - 3}{20.9 - O_2} \right)$$

where,

C_{SO_2}	277.0	= SO₂ - Outlet Concentration, ppmvd
C_{O_2}	8.9	= oxygen concentration, %
C_{SO_2c3}	412.6	= ppmvd @3% O₂

SO₂ - Outlet Emission Rate (ER_{SO_2}), lb/hr

$$ER_{SO_2} = \frac{C_{SO_2} \times MW \times Qs \times 60\frac{min}{hr} \times 28.32\frac{L}{ft^3}}{24.04\frac{L}{g-mole} \times 1.0E06 \times 453.59\frac{g}{lb}}$$

where,

C_{SO_2}	277.0	= SO₂ - Outlet Concentration, ppmvd
MW	64.066	= SO₂ molecular weight, g/g-mole
Qs	47,701	= stack gas volumetric flow rate at standard conditions, dscfm
ER_{SO_2}	131.9	= lb/hr

Location: Neenah Paper - Munising, MI
Source: Boiler #1
Project No.: AST-2024-0044
Run No. /Method Run 1 / Method 7E

NOx - Outlet Concentration (C_{NOx}), ppmvd

$$C_{NOx} = \frac{C_{NOxw}}{1 - BWS}$$

where,

C_{NOxw}	239.1	= NOx - Outlet Concentration, ppmvw
BWS	0.107	= moisture fraction, unitless
C_{NOx}	267.7	= ppmvd

NOx - Outlet Concentration (C_{NOxw}), ppmvw

$$C_{NOxw} = C_{NOx} \times (1 - BWS)$$

where,

C_{NOx}	267.7	= NOx - Outlet Concentration, ppmvd
BWS	0.107	= moisture fraction, unitless
C_{NOxw}	239.1	= ppmvw

NOx - Outlet Concentration (C_{NOxc3}), ppmvd @ 3% O_2

$$C_{NOxc3} = C_{NOx} \times \left(\frac{20.9 - 3}{20.9 - O_2} \right)$$

where,

C_{NOx}	267.7	= NOx - Outlet Concentration, ppmvd
C_{O_2}	8.9	= oxygen concentration, %
C_{NOxc3}	398.8	= ppmvd @3% O_2

NOx - Outlet Emission Rate (ER_{NOx}), lb/hr

$$ER_{NOx} = \frac{C_{NOx} \times MW \times Qs \times 60 \frac{min}{hr} \times 28.32 \frac{L}{ft^3}}{24.04 \frac{L}{g-mole} \times 1.0E06 \times 453.592 \frac{g}{lb}}$$

where,

C_{NOx}	267.7	= NOx - Outlet Concentration, ppmvd
MW	46.0055	= NOx molecular weight, g/g-mole
Qs	47,701	= stack gas volumetric flow rate at standard conditions, dscfm
ER_{NOx}	91.6	= lb/hr

Location: Neenah Paper - Munising, MI

Source: Boiler #1

Project No.: AST-2024-0044

Run No. /Method Run 1 / Method 10

CO - Outlet Concentration (C_{CO}), ppmvd

$$C_{CO} = \frac{C_{COw}}{1 - BWS}$$

where,

C_{COw}	15.9	= CO - Outlet Concentration, ppmvw
BWS	0.107	= moisture fraction, unitless
C_{CO}	17.8	= ppmvd

CO - Outlet Concentration (C_{COw}), ppmvw

$$C_{COw} = C_{CO} \times (1 - BWS)$$

where,

C_{CO}	17.8	= CO - Outlet Concentration, ppmvd
BWS	0.107	= moisture fraction, unitless
C_{COw}	15.9	= ppmvw

CO - Outlet Concentration (C_{COc3}), ppmvd @ 3% O_2

$$C_{COc3} = C_{CO} \times \left(\frac{20.9 - 3}{20.9 - O_2} \right)$$

where,

C_{CO}	17.8	= CO - Outlet Concentration, ppmvd
C_{O_2}	8.9	= oxygen concentration, %
C_{COc3}	26.6	= ppmvd @3% O_2

CO - Outlet Emission Rate (ER_{CO}), lb/hr

$$ER_{CO} = \frac{C_{CO} \times MW \times Qs \times 60 \frac{min}{hr} \times 28.32 \frac{L}{ft^3}}{24.04 \frac{L}{g-mole} \times 1.0E06 \times 453.592 \frac{g}{lb}}$$

where,

C_{CO}	17.8	= CO - Outlet Concentration, ppmvd
MW	28.01	= CO molecular weight, g/g-mole
Qs	47,701	= stack gas volumetric flow rate at standard conditions, dscfm
ER_{CO}	3.7	= lb/hr

Location: Neenah Paper - Munising, MI

Source: Boiler #1

Project No.: AST-2024-0044

Run No.: 1

Parameter: Metals

Meter Pressure (Pm), in. Hg

$$Pm = Pb + \frac{\Delta H}{13.6}$$

where,

Pb	29.52	= barometric pressure, in. Hg
ΔH	2.227	= pressure differential of orifice, in. H_2O
Pm	29.68	= in. Hg

Absolute Stack Gas Pressure (Ps), in. Hg

$$Ps = Pb + \frac{Pg}{13.6}$$

where,

Pb	29.52	= barometric pressure, in. Hg
Pg	-0.20	= static pressure, in. H_2O
Ps	29.51	= in. Hg

Standard Meter Volume (Vmstd), dscf

$$Vmstd = \frac{17.636 \times Y \times Vm \times Pm}{Tm}$$

where,

Y	1.011	= meter correction factor
Vm	75.120	= meter volume, cf
Pm	29.68	= absolute meter pressure, in. Hg
Tm	526.4	= absolute meter temperature, °R
Vmstd	75.525	= dscf

Standard Wet Volume (Vwstd), scf

$$Vwstd = 0.04716 \times Vlc$$

where,

Vlc	116.2	= weight of H_2O collected, g
Vwstd	5.480	= scf

Moisture Fraction (BWSsat), dimensionless (theoretical at saturated conditions)

$$BWSsat = \frac{10^{6.37 - \left(\frac{2,827}{Ts+365}\right)}}{Ps}$$

where,

Ts	283.4	= stack temperature, °F
Ps	29.51	= absolute stack gas pressure, in. Hg
BWSsat	3.440	= dimensionless

Moisture Fraction (BWS), dimensionless (measured)

$$BWS = \frac{Vwstd}{(Vwstd + Vmstd)}$$

where,

Vwstd	5.480	= standard wet volume, scf
Vmstd	75.525	= standard meter volume, dscf
BWS	0.068	= dimensionless

Moisture Fraction (BWS), dimensionless

$$BWS = BWSmsd \text{ unless } BWSsat < BWSmsd$$

where,

BWSsat	3.440	= moisture fraction (theoretical at saturated conditions)
BWSmsd	0.068	= moisture fraction (measured)
BWS	0.068	

Molecular Weight (DRY) (Md), lb/lb-mole

$$Md = (0.44 \times \% CO_2) + (0.32 \times \% O2) + (0.28 (100 - \% CO_2 - \% O2))$$

where,

CO_2	9.2	= carbon dioxide concentration, %
O_2	9.1	= oxygen concentration, %
Md	29.84	= lb/lb mol

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Location: **Neenah Paper - Munising, MI**
Source: **Boiler #1**
Project No.: **AST-2024-0044**
Run No.: **1**
Parameter: **Metals**

Molecular Weight (WET) (Ms), lb/lb-mole

$$Ms = Md\,(1 - BWS) + 18.015\,(BWS)$$

where,

Md	29.84	= molecular weight (DRY), lb/lb mol
BWS	0.068	= moisture fraction, dimensionless
Ms	29.04	= lb/lb mol

Average Velocity (Vs), ft/sec

$$Vs = 85.49 \times Cp \times (\Delta P^{1/2})\,avg \times \sqrt{\frac{Ts}{Ps \times Ms}}$$

where,

Cp	0.840	= pitot tube coefficient
$\Delta P^{1/2}$	0.459	= velocity head of stack gas, (in. $H_2O)^{1/2}$
Ts	743.1	= absolute stack temperature, °R
Ps	29.51	= absolute stack gas pressure, in. Hg
Ms	29.04	= molecular weight of stack gas, lb/lb mol
Vs	30.7	= ft/sec

Average Stack Gas Flow at Stack Conditions (Qa), acfm

$$Qa = 60 \times Vs \times As$$

where,

Vs	30.7	= stack gas velocity, ft/sec
As	39.87	= cross-sectional area of stack, ft^2
Qa	73,381	= acfm

Average Stack Gas Flow at Standard Conditions (Qs), dscfm

$$Qs = 17.636 \times Qa \times (1 - BWS) \times \frac{Ps}{Ts}$$

where,

Qa	73,381	= average stack gas flow at stack conditions, acfm
BWS	0.068	= moisture fraction, dimensionless
Ps	29.51	= absolute stack gas pressure, in. Hg
Ts	743.1	= absolute stack temperature, °R
Qs	47,911	= dscfm

Dry Gas Meter Calibration Check (Yqa), dimensionless

$$Yqa = \frac{Y - \left(\dfrac{\Theta}{Vm}\sqrt{\dfrac{0.0319 \times Tm \times 29}{\Delta H@ \times \left(Pb + \dfrac{\Delta Havg.}{13.6}\right) \times Md}}\sqrt{\Delta H}\,avg.\right)}{Y} \times 100$$

where,

Y	1.011	= meter correction factor, dimensionless
Θ	90	= run time, min.
Vm	75.12	= total meter volume, dcf
Tm	526.4	= absolute meter temperature, °R
$\Delta H@$	1.705	= orifice meter calibration coefficient, in. H_2O
Pb	29.52	= barometric pressure, in. Hg
ΔH avg	2.227	= average pressure differential of orifice, in H_2O
Md	29.84	= molecular weight (DRY), lb/lb mol
$(\Delta H)^{1/2}$	1.489	= average squareroot pressure differential of orifice, (in. H2O)$^{1/2}$
Yqa	-0.2	= percent

Volume of Nozzle (Vn), ft^3

$$Vn = \frac{Ts}{Ps}\left(0.002669 \times Vlc + \frac{Vm \times Pm \times Y}{Tm}\right)$$

where,

Ts	743.1	= absolute stack temperature, °R
Ps	29.51	= absolute stack gas pressure, in. Hg
Vlc	116.2	= volume of H_2O collected, ml
Vm	75.120	= meter volume, cf
Pm	29.68	= absolute meter pressure, in. Hg
Y	1.011	= meter correction factor, unitless
Tm	526.4	= absolute meter temperature, °R
Vn	115.661	= volume of nozzle, ft^3

Location: <u>Neenah Paper - Munising, MI</u>
Source: <u>Boiler #1</u>
Project No.: <u>AST-2024-0044</u>
Run No.: <u>1</u>
Parameter: <u>Metals</u>

Isokinetic Sampling Rate (I), %

$$I = \left(\frac{Vn}{\theta \times 60 \times An \times Vs} \right) \times 100$$

where,

Vn	115.661	= nozzle volume, ft3
θ	90.0	= run time, minutes
An	0.00071	= area of nozzle, ft^2
Vs	30.7	= average velocity, ft/sec
I	98.8	= %

Arsenic Concentration (C_{As}), ug/dscm

$$C_{As} = \frac{M_{As} \times 35.313}{Vmstd}$$

where,

M_{As}	12	= arsenic mass, ug
Vmstd	75.525	= standard meter volume, dscf
C_{As}	5.6	= ug/dscm

Arsenic Concentration (C_{As}), mg/dscm

$$C_{As} = \frac{M_{As} \times 35.313}{Vmstd \times 1.0E + 03}$$

where,

M_{As}	12.0	= arsenic mass, ug
Vmstd	75.525	= standard meter volume, dscf
C_{As}	0.0056	= mg/dscm

Arsenic Emission Rate (ER_{As}), lb/hr

$$ER_{As} = \frac{M_{As} \times Qs \times 60}{Vmstd \times 4.54E + 08}$$

where,

M_{As}	12.0	= arsenic mass, ug
Qs	47,911	= average stack gas flow at standard conditions, dscfm
Vmstd	75.525	= standard meter volume, dscf
ER_{As}	0.0010	= lb/hr

Arsenic Emission Factor (EF_{As}), lb/MMBtu

$$EF_{As} = \frac{ER_{As}}{HI}$$

where,

ER_{As}	1.0E-03	= arsenic emission rate, lb/hr
HI	153.06	= heat input, MMBtu/hr
EF_{As}	6.6E-06	= lb/MMBtu

Heat Input, MMBtu/hr

$$HI = \frac{F_R \times F_{HV}}{1,000,000}$$

where,

F_R	10,533	= feed rate, lb/hr
F_{HV}	14,531	= fuel heating value, Btu/lb
HI	153.06	= MMBtu/hr

Appendix B

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Emission Calculations

Location **Neenah Paper - Munising, MI**
Source **Boiler #1**
Project No. **AST-2024-0044**
Parameter **HCL/PM**

Run Number		Run 1	Run 2	Run 3	Average
Date		3/5/24	3/5/24	3/5/24	--
Start Time		8:45	11:33	13:34	--
Stop Time		10:04	12:42	14:45	--
Run Time, min	(θ)	60.0	60.0	60.0	60.0
INPUT DATA					
Coal Feed rate, lb/hr	(FR)	10,533	10,160	10,080	10,258
Heat Input, MMBtu/hr	(HI)	153.06	147.63	146.47	149
Barometric Pressure, in. Hg	(Pb)	29.53	29.53	29.53	29.53
Meter Correction Factor	(Y)	1.011	1.011	1.011	1.011
Orifice Calibration Value	(ΔH @)	1.705	1.705	1.705	1.705
Meter Volume, ft^3	(Vm)	39.780	37.850	38.045	38.558
Meter Temperature, °F	(Tm)	71.2	71.4	71.5	71.3
Meter Temperature, °R	(Tm)	530.8	531.1	531.1	531.0
Meter Orifice Pressure, in. WC	(ΔH)	1.377	1.265	1.300	1.314
Volume H$_2$O Collected, mL	(Vlc)	101.0	60.3	52.8	71.4
Nozzle Diameter, in	(Dn)	0.312	0.312	0.312	0.312
Area of Nozzle, ft^2	(An)	0.0005	0.0005	0.0005	0.0005
Filterable PM Mass, mg	(Mn)	3.5	5.0	2.0	3.5
Hydrogen Chloride Mass, ug	(M$_{HCl}$)	20,500	26,700	24,970	24,057
ISOKINETIC DATA					
Standard Meter Volume, ft^3	(Vmstd)	39.593	37.644	37.837	38.358
Standard Water Volume, ft^3	(Vwstd)	4.763	2.844	2.490	3.366
Moisture Fraction Measured	(BWSmsd)	0.107	0.070	0.062	0.080
Moisture Fraction @ Saturation	(BWSsat)	3.436	3.407	3.352	3.398
Moisture Fraction	(BWS)	0.107	0.070	0.062	0.080
Meter Pressure, in Hg	(Pm)	29.63	29.62	29.63	29.63
Volume at Nozzle, ft^3	(Vn)	63.302	57.743	57.433	59.49
Isokinetic Sampling Rate, (%)	(I)	103.9	97.2	98.3	99.8
DGM Calibration Check Value, (+/- 5%)	(Y$_{qa}$)	0.5	-0.3	-1.1	-0.3
EMISSION CALCULATIONS					
Filterable PM Concentration, grain/dscf	(C$_s$)	0.0014	0.0020	8.2E-04	0.0014
Filterable PM Emission Rate, lb/hr	(PMR)	0.56	0.85	0.34	0.58
Filterable PM Emission Rate, lb/1000 lbs	(PMR)	0.0023	0.0036	0.0014	0.0025
Percent Excess Air	%EA	70.3	74.5	75.8	73.5
Filterable PM Emission Rate, lb/1000lbs @ 50% Excess Air	(C$_{sEA}$)	0.0026	0.0042	0.0017	0.0028
Filterable PM Emission Factor, lb/MMBtu (HI)	(EF$_{PM}$)	0.0036	0.0058	0.0023	0.0039
Hydrogen Chloride Concentration, mg/dscm	(C$_{HCl}$)	18.3	25.0	23.3	22.2
Hydrogen Chloride Concentration, ppmvd	(C$_{HClp}$)	12.1	16.5	15.4	14.6
Hydrogen Chloride Emission Rate, lb/hr	(ER$_{HCl}$)	3.3	4.5	4.2	4.0
Hydrogen Chloride Emission Factor, lb/MMBtu (HI)	(EF$_{HCl}$)	0.021	0.031	0.029	0.027

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Emission Calculations
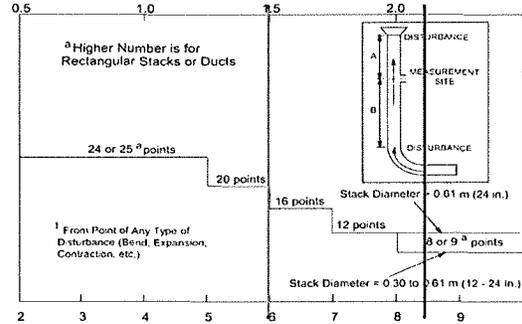
Location **Neenah Paper - Munising, MI**
Source **Boiler #1**
Project No. **AST-2024-0044**
Parameter **HCL/PM**

Run Number		Run 1	Run 2	Run 3	Average
Date		3/5/24	3/5/24	3/5/24	--
Start Time		8:45	11:33	13:34	--
Stop Time		10:04	12:42	14:45	--
Run Time, min		60.0	60.0	60.0	60.0
VELOCITY HEAD, in. WC					
Point 1		0.21	0.20	0.12	0.18
Point 2		0.21	0.23	0.20	0.21
Point 3		0.35	0.24	0.23	0.27
Point 4		0.21	0.23	0.22	0.22
Point 5		0.20	0.25	0.22	0.22
Point 6		0.26	0.24	0.23	0.24
Point 7		0.25	0.23	0.24	0.24
Point 8		0.24	0.23	0.22	0.23
Point 9		0.20	0.21	0.22	0.21
Point 10		0.20	0.18	0.11	0.16
Point 11		0.18	0.18	0.20	0.19
Point 12		0.21	0.21	0.21	0.21
Point 13		0.24	0.23	0.22	0.23
Point 14		0.24	0.23	0.22	0.23
Point 15		0.24	0.24	0.24	0.24
Point 16		0.23	0.23	0.25	0.24
Point 17		0.24	0.25	0.24	0.24
Point 18		0.20	0.21	0.22	0.21
Point 19		0.21	0.21	0.21	0.21
Point 20		0.19	0.12	0.22	0.18
CALCULATED DATA					
Square Root of ΔP, (in. WC)$^{1/2}$	(ΔP)	0.473	0.465	0.458	0.466
Pitot Tube Coefficient	(C_p)	0.840	0.840	0.840	0.840
Barometric Pressure, in. Hg	(P_b)	29.53	29.53	29.53	29.53
Static Pressure, in. WC	(P_g)	-0.20	-0.20	-0.20	-0.20
Stack Pressure, in. Hg	(P_s)	29.52	29.52	29.52	29.52
Stack Cross-sectional Area, ft^2	(A_s)	39.87	39.87	39.87	39.87
Temperature, °F	(T_s)	283.4	282.8	281.8	282.6
Temperature, °R	(T_s)	743.0	742.5	741.4	742.3
Moisture Fraction Measured	(BWSmsd)	0.107	0.070	0.062	0.080
Moisture Fraction @ Saturation	(BWSsat)	3.436	3.407	3.352	3.398
Moisture Fraction	(BWS)	0.107	0.070	0.062	0.080
O_2 Concentration, %	(O_2)	8.88	9.18	9.26	9.11
CO_2 Concentration, %	(CO_2)	9.62	9.4	9.38	9.47
Molecular Weight, lb/lb-mole (dry)	(M_d)	29.89	29.87	29.87	29.88
Molecular Weight, lb/lb-mole (wet)	(M_s)	28.62	29.04	29.14	28.93
Velocity, ft/sec	(V_s)	31.9	31.1	30.6	31.2
VOLUMETRIC FLOW RATE					
At Stack Conditions, acfm	(Q_a)	76,281	74,367	73,101	74,583
At Standard Conditions, scfm	(Q_{sw})	53,439	52,137	51,322	52,300
At Standard Conditions, dscfm	(Q_s)	47,701	48,475	48,153	48,110

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Location Neenah Paper - Munising, MI
Source Boiler #1
Project No. AST-2024-0044
Date: 03/05/24

Stack Parameters

Duct Orientation:	Vertical	
Duct Design:	Circular	
Distance from Far Wall to Outside of Port:	91.50	in
Nipple Length:	6.00	in
Depth of Duct:	85.50	in
Width of Duct:	--	in
Cross Sectional Area of Duct:	39.87	ft²
Equivalent Diameter:	--	in
No. of Test Ports:	2	
Distance A:	15.0	ft
Distance A Duct Diameters:	2.1	(must be ≥ 0.5)
Distance B:	42.4	ft
Distance B Duct Diameters:	6.0	(must be ≥ 2)
Minimum Number of Traverse Points:	20	
Actual Number of Traverse Points:	20	
Number of Readings per Point:	1	
Measurer (Initial and Date):	LHP 3/5/24	
Reviewer (Initial and Date):	RML 3/5/24	

ᵃHigher Number is for Rectangular Stacks or Ducts

24 or 25 ᵃ points
20 points
16 points
12 points
8 or 9 ᵃ points

¹ From Point of Any Type of Disturbance (Bend, Expansion, Contraction, etc.)

Stack Diameter > 0.61 m (24 in.)
Stack Diameter = 0.30 to 0.61 m (12 - 24 in.)

CIRCULAR DUCT

LOCATION OF TRAVERSE POINTS
Number of traverse points on a diameter
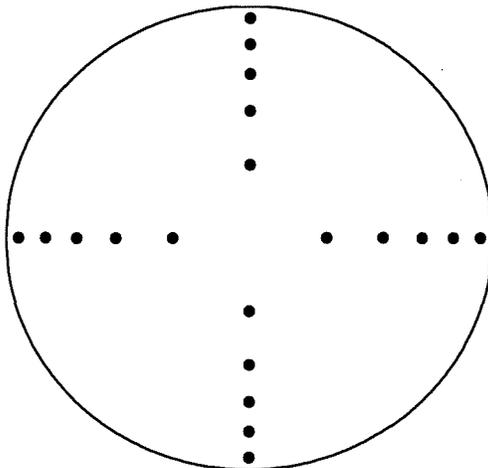
	2	3	4	5	6	7	8	9	10	11	12
1	14.6	--	6.7	--	4.4	--	3.2	--	2.6	--	2.1
2	85.4	--	25.0	--	14.6	--	10.5	--	8.2	--	6.7
3	--	--	75.0	--	29.6	--	19.4	--	14.6	--	11.8
4	--	--	93.3	--	70.4	--	32.3	--	22.6	--	17.7
5	--	--	--	--	85.4	--	67.7	--	34.2	--	25.0
6	--	--	--	--	95.6	--	80.6	--	65.8	--	35.6
7	--	--	--	--	--	--	89.5	--	77.4	--	64.4
8	--	--	--	--	--	--	96.8	--	85.4	--	75.0
9	--	--	--	--	--	--	--	--	91.8	--	82.3
10	--	--	--	--	--	--	--	--	97.4	--	88.2
11	--	--	--	--	--	--	--	--	--	--	93.3
12	--	--	--	--	--	--	--	--	--	--	97.9

*Percent of stack diameter from inside wall to traverse point.

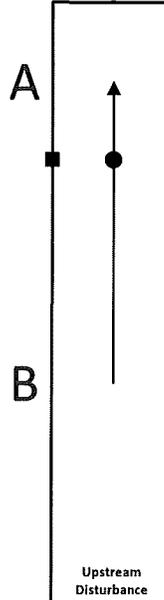| Traverse Point	% of Diameter	Distance from inside wall	Distance from outside of port
1	2.6	2.22	8 1/4
2	8.2	7.01	13
3	14.6	12.48	18 1/2
4	22.6	19.32	25 5/16
5	34.2	29.24	35 1/4
6	65.8	56.26	62 1/4
7	77.4	66.18	72 3/16
8	85.4	73.02	79
9	91.8	78.49	84 1/2
10	97.4	83.28	89 1/4
11	--	--	--
12	--	--	--

Stack Diagram
A = 15 ft.
B = 42.4 ft.
Depth of Duct = 85.5 in.

Cross Sectional Area

Downstream Disturbance

A

B

Upstream Disturbance

Method 2 Data

Location **Neenah Paper - Munising, MI**

Source **Boiler #1**

Project No. **AST-2024-0044**

Date **3/5/24**

Saturation Moisture Content Check		
Stack Temperature (Ts):	287.0	°F
Moisture Fraction @ Sat.:	3.638	

Stack Parameters		
Pitot Tube ID#:	04-08-a1	
Pitot Tube Coefficient (Cp):	0.840	
Barometric Pressure (Pb):	29.51	in. Hg
Static Pressure(Pg):	-0.20	in. WC
Stack Pressure (Ps):	29.50	in. Hg

Calculations	
Square Root of ΔP, (in. W.C.)$^{1/2}$	0.489
Average ΔP, (in. W.C.)	0.24
Average Temperature (Ts), °F	287.0
Average Temperature (Ts), °R	746.7
Moisture (BWS), % (enter as percent)	7.0
O_2 Concentration, %	9.0
CO_2 Concentration, %	9.0
Molecular Weight (Md), lb/lb-mole (dry)	29.80
Molecular Weight (Ms), lb/lb-mole (wet)	28.97
Velocity (Vs), ft/sec	32.8
VFR at stack conditions (Qa), acfm	78,536
VFR at standard conditions (Qs), dscfm	50,883

Traverse Point	ΔP (in. WC)	Ts (°F)
1	0.19	287
2	0.19	287
3	0.31	287
4	0.29	287
5	0.28	287
6	0.27	287
7	0.28	287
8	0.26	287
9	0.19	287
10	0.16	287
1	0.19	287
2	0.19	287
3	0.31	287
4	0.29	287
5	0.28	287
6	0.27	287
7	0.28	287
8	0.26	287
9	0.19	287
10	0.16	287

Cyclonic Flow Check

Location Neenah Paper - Munising, MI

Source Boiler #1

Project No. AST-2024-0044

Date 03/05/24

Sample Point	Angle ($\Delta P=0$)
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	5
11	5
12	5
13	0
14	0
15	0
16	0
17	0
18	0
19	10
20	10
Average	1

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Location   Neenah Paper - Munising, MI

Source   Boiler #1

Project No.   AST-2024-0044

Parameter   HCL/PM

Analysis   Gravimetric

Run 1	Date:	3/5/24			
Impinger No.	1	2	3	4	Total
Contents	H2SO4	H2SO4	Empty	Silica	--
Initial Mass, g	411.7	400.0	300.0	1546.3	2658.0
Final Mass, g	473.0	400.0	300.0	1586.0	2759.0
Gain	61.3	0.0	0.0	39.7	101.0
Run 2	Date:	3/5/24			
Impinger No.	1	2	3	4	Total
Contents	H2SO4	H2SO4	Empty	Silica	--
Initial Mass, g	458.6	400.0	300.0	1546.0	2704.6
Final Mass, g	509.3	400.0	300.0	1555.6	2764.9
Gain	50.7	0.0	0.0	9.6	60.3
Run 3	Date:	3/5/24			
Impinger No.	1	2	3	4	Total
Contents	H2SO4	H2SO4	Empty	Silica	--
Initial Mass, g	446.1	400.0	300.0	1529.0	2675.1
Final Mass, g	491.2	400.0	300.0	1536.7	2727.9
Gain	45.1	0.0	0.0	7.7	52.8