APEX COMPANIES, LLC

Air Emissions Test Report
Boiler No. 11 Relative Accuracy Test Audit
at
Billerud Escanaba, LLC
Escanaba, Michigan

Prepared for:
Billerud Escanaba, LLC
7100 County Road 426
Escanaba, Michigan 49829

State Registration No. A0884

Apex Project No. 23008999
November 9, 2023

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APEX

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Executive Summary

Billerud Escanaba, LLC retained Apex Companies, LLC to perform a Relative Accuracy Test Audit (RATA) of two analyzers that service Boiler No. 11 at the Billerud facility in Escanaba, Michigan.

The purpose of the testing was to conduct a RATA on the oxygen (O_2) and nitrogen oxides (NO_X) analyzers that service Boiler No. 11. The source is regulated by Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) No. MI-ROP-A0884-2021b, effective September 22, 2021.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 3A, 7E, 19, 205, and Performance Specifications PS-2 and PS-3.

Detailed results are presented in Tables 1 and 2 after the Tables Tab of this report. The following tables summarize the results of the testing conducted on September 21, 2023.

Boiler No. 11 Relative Accuracy Test Audit Results

Parameter	Average RM Result	Average CEMS Result	Average Difference between CEMS and RM	Relative Accuracy	Performance Specification
Oxygen (O_2), %	4.59	4.34	0.25	0.25%	≤1.0% RM
Nitrogen oxides (NO_X), lb/MMBtu	0.150	0.158	-0.0073	5.7%	≤20% RM

CEMS: continuous emission monitoring system
RM: Reference Method

1.0 Introduction

1.1 Summary of Test Program

Billerud Escanaba, LLC retained Apex Companies, LLC to perform a Relative Accuracy Test Audit (RATA) of two analyzers that service Boiler No. 11 at the Billerud facility in Escanaba, Michigan.

The purpose of the testing was to conduct a RATA on the oxygen (O_2) and nitrogen oxides (NO_X) analyzers that service Boiler No. 11. The source is regulated by Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) No. MI-ROP-A0884-2021b, effective September 22, 2021.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 3A, 7E, 19, 205, and Performance Specifications PS-2 and PS-3.

Table 1-1 lists the emission source tested, parameters, and test date.

Table 1-1
Source Tested, Parameters, and Test Date

Source	Test Parameter	Test Date
Boiler No. 11	Oxygen (O_2) Nitrogen oxides (NO_X)	September 21, 2023

1.2 Key Personnel

The key personnel involved in this test program are listed in Table 1-2. Mr. Matthew D'Anna, Scientist with Apex, led the emission testing program. Ms. Amanda Freele, Environmental Manager with Billerud Escanaba, LLC, provided process coordination and recorded operating parameters.

Table 1-2
Key Contact Information

Billerud Escanaba, LLC	Apex
Amanda Freele Environmental Engineer **Billerud Escanaba, LLC** 7100 County Road 426 Escanaba, Michigan 49829 Phone: 906.233.2603 amanda.freele@billerud.com	Dr. Derek R. Wong, Ph.D., P.E. National Account Manager Phone: 248.875.7581 derek.wong@apexcos.com Matthew D'Anna Scientist 1 **Apex Companies, LLC** 46555 Humboldt Drive, Suite 103 Novi, Michigan 48377 Phone: 810.316.0155 mattthew.danna@apexcos.com
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2.0 Source and Sampling Locations

2.1 Process Description

Billerud Escanaba, LLC operates an ABB Combustion Engineering combination fuel boiler (Boiler No. 11) rated for 750,000 pounds of steam per hour (approximately 1040 million BTU per hour heat input) that provides steam for mill processes and steam turbine-generators for producing electricity. Boiler No. 11 burns natural gas and solid fuels, which include pulverized coal, wood residue, wastewater treatment plant residuals, tire-derived fuel, and NHSM pellets.

2.2 Control Equipment Description

Emissions from Boiler No. 11 are controlled by an oven-fired air system, multi-clone dust collector, and electrostatic precipitator.

The oxygen (O_2) and nitrogen oxides (NO_x) continuous emission monitoring system (CEMS) associated with Boiler No. 11 is used to evaluate continuous compliance with permit limits.

Operating parameters were measured and recorded by Billerud Escanaba, LLC personnel during testing. Table 2-1 summarizes the operating conditions during testing of Boiler No. 11. Additional operating parameter data are included in Appendix D.

Table 2-1
Summary of Boiler No. 11 Steam Flow

Test Run	Steam Flow (klb/hr)
1	467.9
2	475.4
3	452.0
4	428.0
5	434.1
6	440.8
7	485.8
8	496.6
9	513.0
10	542.4
Average	**473.6**

klb/hr: thousand pound per hour

2.3 Boiler No. 11 Flue Gas Sampling Location

The RATA testing for Boiler No. 11 was conducted in the CEMS room next to the exhaust stack. The sampling location is rectangular in cross section and has one sampling port. The sampling location does not meet USEPA Method 1 requirements; however, the absence of stratification at this sample location has been indicated based on previous testing and certification of the facility's CEMS. The sampling port is accessible in the CEMS room.

2.4 Process Sampling Locations

Process sampling was not required during this test program. A process sample is a sample that is analyzed for operational parameters, such as calorific value of a fuel (e.g., natural gas, coal), organic compound content (e.g., paint coatings), or composition (e.g., polymers).

3.0 Summary and Discussion of Results

3.1 Objectives and Test Matrix

The purpose of the testing was to conduct a RATA on the oxygen (O_2) and nitrogen oxides (NO_X) analyzers that service Boiler No. 11. The source is regulated by EGLE ROP No. MI-ROP-A0884-2021b, effective September 22, 2021.

Table 3-1 summarizes the sampling and analytical matrix.

Table 3-1
Sampling and Analytical Matrix

Sampling Location	Sample/Type of Pollutant	Sample Method	Date (2023)	Run	Start Time	End Time	Analytical Laboratory
Boiler No. 11	Oxygen (O_2) Nitrogen oxides (NO_X)	USEPA 3A, 7E, 19, 205	Sept. 21	1	0750	0820	Not applicable
				2	0832	0902	
				3	0913	0943	
				4	0953	1023	
				5	1034	1104	
				6	1114	1144	
				7	1155	1225	
				8	1237	1307	
				9	1318	1348	
				10	1400	1430	

3.2 Field Test Changes and Issues

Communication between Billerud Escanaba, LLC, Apex, and EGLE allowed the testing to be completed as proposed in the August 1, 2023, Intent-to-Test Plan, with the following exception:

- USEPA Method 1 was in the original Test Plan submitted to EGLE, but because the annual RATA sampling location does not meet Method 1 requirements, it was not conducted. See Section 2.3 for more information on the sampling location.
- USEPA Methods 2 and 4 were in the original Test Plan submitted to EGLE, but because these methods are not necessary to perform the RATA, Apex notified EGLE that USEPA Methods 2 and 4 would be removed from the testing program via Apex's August 25, 2023, email to EGLE.

3.3 Summary of Results

The results of the testing are presented in Table 3-2. Detailed results are presented in Appendix Tables 1 and 2 after the Tables Tab of this report. Graphs are presented after the Graphs Tab of this report. Sample calculations are presented in Appendix B.

Table 3-2
Boiler No. 11 Relative Accuracy Test Audit Results

Parameter	Average RM Result	Average CEMS Result	Average Difference between CEMS and RM	Relative Accuracy	Performance Specification
Oxygen (O_2), %	4.59	4.34	0.25	0.25%	≤1.0% RM
Nitrogen oxides (NO_X), lb/MMBtu	0.150	0.158	-0.0073	5.7%	≤20% RM

CEMS: continuous emission monitoring system
RM: Reference Method

4.0 Sampling and Analytical Procedures

Apex measured emissions in accordance with USEPA sampling methods. Table 4-1 presents the emissions test parameters and sampling methods.

Table 4-1
Emission Testing Methods

Parameter	Boiler No. 11	USEPA Reference	
		Method	Title
Oxygen (O_2) and carbon dioxide (CO_2)	•	3A	Determination of Oxygen and Carbon Dioxide Emissions from Stationary Sources (Instrument Analyzer Procedure)
Nitrogen oxides (NO_x)	•	7E	Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrument Analyzer Procedure)
Fuel factor	•	19	Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates
Gas Dilution	•	205	Verification of Gas Dilution Systems for Field Instrument Calibrations
NO_x RATA	•	PS-2	Specifications and Test Procedures for SO_2 and NO_x Continuous Emission Monitoring Systems in Stationary Sources
O_2 RATA	•	PS-3	Specifications and Test Procedures for O_2 and CO_2 Continuous Emission Monitoring Systems in Stationary Sources

4.1 Emission Test Methods

4.1.1 Oxygen, Carbon Dioxide, and Nitrogen Oxides (USEPA Methods 3A and 7E)

USEPA Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations from Stationary Sources (Instrumental Analyzer Procedure)," was used to measure oxygen (O_2) and carbon dioxide (CO_2) concentrations in the flue gas. USEPA Method 7E, "Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure)," was used to measure nitrogen oxides (NO_x) concentrations in the flue gas. Flue gas was continuously sampled in the stack and conveyed to an analyzer for concentration measurements.

Flue gas was extracted from the stack through:

- A stainless-steel probe.
- Heated Teflon sample line to prevent condensation.
- A chilled Teflon impinger train (equipped with a peristaltic pump) to remove moisture from the sampled gas stream before entering the analyzer.
- O_2, CO_2, and NO_x analyzers.

Figure 4-1 depicts the USEPA Methods 3A and 7E sampling train. Data were recorded at 1-second intervals on a computer equipped with data acquisition software. Recorded concentrations were averaged over the duration of each test run. Computer-generated field data sheets are included in Appendix C.

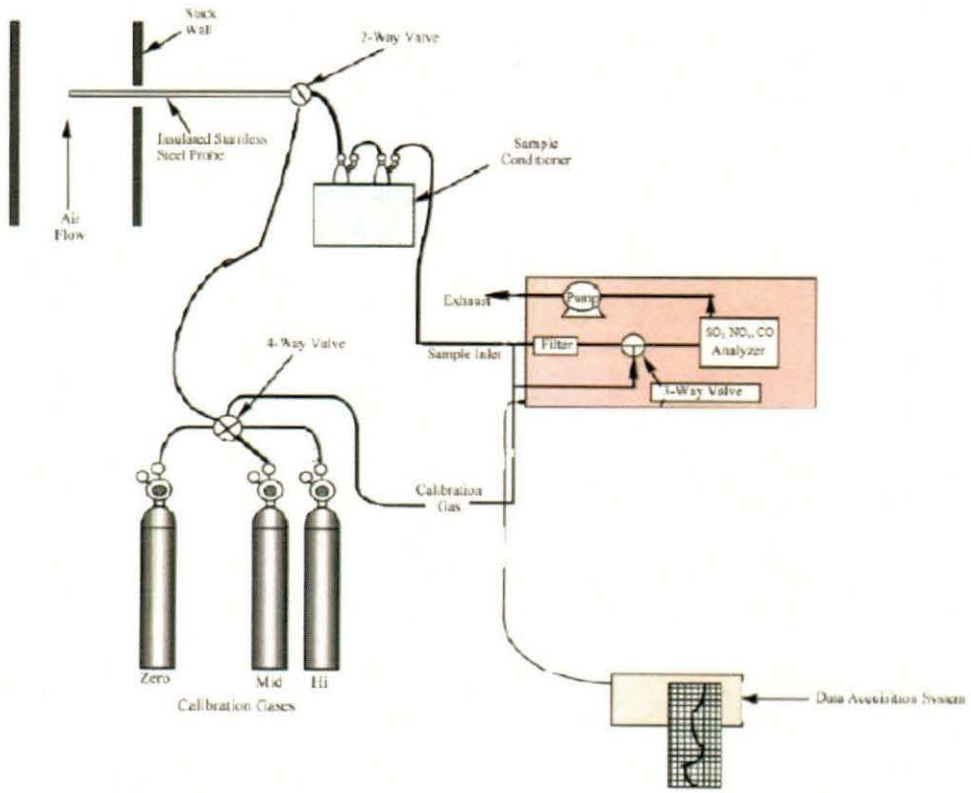


Figure 4-1. USEPA Methods 3A and 7E Sampling Train

The pollutant concentrations were measured using an analyzer calibrated with zero-, mid-, and high-USEPA-Traceability-Protocol-certified calibration gases. The mid-level gas was 40 to 60% of the high-level (also referred to as span) gas.

Calibration Error Check. A calibration error check was performed by introducing zero-, mid-, and high-level calibration gases directly into the analyzer. The calibration error check was performed to verify the analyzer response was within ±2% of the certified calibration gas introduced.

System Bias Test. Before each test run, a system bias test was performed where known concentrations of calibration gases were introduced at the probe tip to measure if an analyzer's response was within ±5% of the introduced calibration gas concentrations. At the conclusion of each test run, an additional system-bias check was performed to evaluate the analyzer drift from pre- and post-test system-bias checks. The system-bias check evaluates the analyzer drift against the ±3% quality assurance/quality control (QA/QC) requirement.

The analyzer drift data was used to correct the measured flue gas concentrations. Recorded concentrations were averaged over the duration of each test run.

NO/NO_2 Conversion Check. An NO/NO_2 conversion check was performed before testing by introducing an NO_2 calibration gas into the NO_X analyzer. The analyzer's NO_X concentration response was greater than 90% of the introduced NO_2 calibration gas concentration and met the converter efficiency requirement of Section 13.5 of USEPA Method 7E.

4.1.2 Emission Rate (USEPA Method 19)

USEPA Method 19, "Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates," was used to calculate emission rates of NO_x in pounds per million British thermal units. Oxygen concentrations and an F factor from 40 CFR Appendix F to Part 75 - Conversion Procedures was used to calculate emission rates using USEPA Method 19, Equation 19-1:

$$E = C_d F_d \left(\frac{20.9}{20.9 - \%O_{2d}}\right)$$

Where:

E	=	Pollutant emission rate (lb/MMBtu)
C_d	=	Pollutant concentration, dry basis (lb/dscf)
F_d	=	F factor (dscf/MMBtu)
$\%O_{2d}$	=	Oxygen concentration, dry basis (%, dry)

4.1.3 Gas Dilution (USEPA Method 205)

USEPA Method 205, "Verification of Gas Dilution Systems for Field Instrument Calibrations," was used to introduce known values of calibration gases into the analyzers. The gas dilution system consists of calibrated orifices or mass flow controllers and dilutes a high-level calibration gas to within ±2% of predicted values. The gas divider is capable of diluting gases at set increments and will be evaluated for accuracy in the field in accordance with USEPA Method 205.

Before testing, the gas divider dilutions were measured to evaluate that they are within ±2% of predicted values. Two sets of three dilutions of the high-level calibration gas were performed. In addition, a certified mid-level calibration gas was introduced into an analyzer; this calibration gas concentration will be within ± 10% of a gas divider dilution concentration.

4.2 Process Data

Billerud Escanaba, LLC recorded process data during testing. Process data are included in Appendix D.

5.0 Quality Assurance and Quality Control

5.1 QA/QC Procedures

Equipment used in this emissions test program passed Quality Assurance (QA) and Quality Control (QC) procedures. Refer to Appendix A for equipment calibrations. Before testing, the sampling equipment was cleaned, inspected, and calibrated according to procedures outlined in the applicable USEPA sampling method and USEPA's "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III, Stationary Source-Specific Methods."

5.2 QA/QC Audits

Onsite QA/QC procedures were performed in accordance with the respective USEPA sampling methods. Equipment inspection and calibration measurements are presented in Appendix A.

5.2.1 Instrument Analyzer QA/QC

The instrument analyzer sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. The analyzers passed the applicable calibration criteria. Table 5-1 summarizes the gas cylinders used during this test program. Analyzer calibration, bias, and drift data are included in Appendix A. Gas cylinder certifications are included in Appendix A.

Table 5-1
Calibration Gas Cylinder Information

Parameter	Gas Vendor	Cylinder Serial Number	Cylinder Value	Expiration Date
Nitrogen	Airgas	CC354795	99.9995%	02/04/2029
Nitrogen	Airgas	CC407692	99.9995%	12/06/2030
Nitrogen dioxide	Airgas	CC500150	19.76 ppm	03/10/2024
Nitrogen oxides Nitric oxide	Airgas	XC034257B	94.99 ppm 94.98 ppm	10/06/2030
Nitrogen oxides Nitric oxide	Airgas	XC025037B	507.4 ppm 504.4 ppm	06/21/2031
Nitrogen oxides Nitric oxide	Airgas	AAL-5925	845.6 ppm 845.6 ppm	03/13/2025
Nitrogen oxides Nitric oxide	Airgas	XC034410B	1,008 ppm 1,008 ppm	01/03/2026
Carbon dioxide Oxygen	Airgas	SG9161438BAL	11.10% 11.04%	6/08/2024
Carbon dioxide Oxygen	Airgas	CC58208	22.27% 21.91%	6/22/2030

5.3 Data Reduction and Validation

The emissions testing Project Manager validated computer spreadsheets. The computer spreadsheets were used to ensure that field calculations were accurate. Random inspection of the field data sheets was conducted to verify data have been recorded appropriately. At the completion of a test, the raw field data were entered into computer spreadsheets to provide applicable onsite emissions calculations. The computer data were checked against the raw field sheets for accuracy during review of the report.

5.4 QA/QC Problems

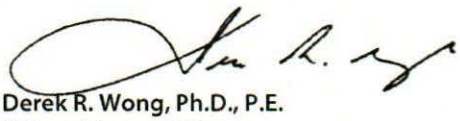
Equipment audits and QA/QC procedures demonstrate sample collection accuracy and compliance for the test runs.

6.0 Limitations

The information and opinions rendered in this report are exclusively for use by Billerud Escanaba, LLC. Apex Companies, LLC will not distribute or publish this report without the consent of Billerud Escanaba, LLC except as required by law or court order. The information and opinions are given in response to a limited assignment and should be implemented only in light of that assignment. Apex Companies, LLC accepts responsibility for the competent performance of its duties in executing the assignment and preparing reports in accordance with the normal standards of the profession, but disclaims any responsibility for consequential damages.

Submitted by:

Apex Companies, LLC



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