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**Relative Accuracy Test Audit
Test Report**

**Billerud Escanaba, LLC
Escanaba Mill
Lime Kiln Stack
Escanaba, Michigan
July 25, 2023**

**Report Submittal Date
September 8, 2023**

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Mostardi Platt

Project No. M231813A



TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY	1
2.0 TEST METHODOLOGY	2
Method 16C Total Reduced Sulfur (TRS) as Sulfur Dioxide (SO ₂)	2
Method 3A Oxygen (O ₂) Determination	3
3.0 TEST RESULT SUMMARY	4
4.0 CERTIFICATION	6
APPENDICES	
Appendix A - Test Section Diagram	8
Appendix B - Sample Train Diagrams	10
Appendix C - Calculation Nomenclature and Formulas	13
Appendix D - Reference Method Test Data (Computerized Sheets)	17
Appendix E - Continuous Emissions Monitoring System Data and Plant Operating Data	21
Appendix F - Calibration and Response Time Data	35
Appendix G - Calibration Gas Cylinder Data	43

1.0 EXECUTIVE SUMMARY

Mostardi Platt conducted a Relative Accuracy Test Audit test program for Billerud Escanaba, LLC on the Lime Kiln at the Escanaba, Michigan facility. This report summarizes the results of the test program and test methods used.

The test location, test date, and test parameters are summarized below.

TEST INFORMATION		
Test Location	Test Date	Test Parameters
Lime Kiln	July 25, 2023	Total Reduced Sulfur (TRS) as Sulfur Dioxide (SO ₂)
		Oxygen (O ₂)

The purpose of the test program was to determine the relative accuracies of the Lime Kiln TRS and O₂ analyzer during the specified operating condition. A complete summary of test results follows the narrative portion of this report.

Parameter	Average Reference Method Data	Average CEMS Data	Relative Accuracy Acceptance Criteria	Relative Accuracy (RA)
TRS as SO ₂	5.703 ppmvd @ 10% O ₂	4.812 ppmvd @ 10% O ₂	≤ 10% of the applicable standard of 20 ppmvd @ 10% O ₂	5.81% of the APS
O ₂	4.583%	4.781%	≤ 1% mean difference	0.198% mean difference

The test results from this test program indicate that the CEM system meets the United States Environmental Protection Agency (USEPA) performance specification for relative accuracy requirements as published in 40 CFR Part 60.

The gas cylinders used to perform the RATA are summarized below.

GAS CYLINDER INFORMATION				
Parameter	Gas Vendor	Cylinder Serial Number	Cylinder Value	Expiration Date
SO ₂	Airgas	XC026184B	0.0 ppm	5/16/2031
SO ₂	Airgas	CC506130	24.72 ppm	6/17/2026
SO ₂	Airgas	CC507316	50.53 ppm	3/14/2031
O ₂	Airgas	NA	0.0 %	NA
O ₂	Airgas	XC026184B	5.012 %	9/27/2030
O ₂	Airgas	EB0046013	10.23%	5/16/2031
H ₂ S	Airgas	EB0032854	30.21 ppm	9/26/2025

The identifications of the individuals associated with the test program are summarized below.

TEST PERSONNEL INFORMATION		
Location	Address	Contact
Test Facility	Billerud Escanaba, LLC 7100 County Road 426 M.5 Rd Escanaba, MI 49829	Amanda Freele Environmental Engineer (906) 233-2603 (phone) Amanda.Freele@Billerud.com
Testing Company Personnel	Mostardi Platt 888 Industrial Drive Elmhurst, Illinois 60126	Christopher Jensen Senior Project Manager (630) 993-2100 (phone) cjensen@mp-mail.com
		Dakota Jackson Project Technician
		Jason Carsello Test Engineer

2.0 TEST METHODOLOGY

Emission testing was conducted following the USEPA methods specified in 40CFR60, Appendix A, in addition to the Mostardi Platt Quality Manual. Schematics of the test section diagram and sampling trains used are included in Appendix A and B respectively. Calculation nomenclature are included in Appendix C. Copies of analyzer print-outs for each test run are included in Appendix D. CEM data and process data as provided by Billerud Escanaba, LLC are also included in Appendix E.

Parameter	USEPA Reference Method	Notes/Remarks
O ₂ %	USEPA Method 3A, 40CFR60, Appendix A	Instrument Analysis of O ₂ % on a dry basis
TRS as SO ₂	USEPA Method 16C, 40CFR60, Appendix A	Instrument Analysis of TRS as SO ₂ ppmvd to calculate TRS as SO ₂ at 10 % O ₂

The following test methodologies were used:

Method 16C Total Reduced Sulfur (TRS) as Sulfur Dioxide (SO₂)

Integrated gas samples were extracted from the gas stream in accordance with Method 16C (analyzer technique), 40CFR60, for the determination of total reduced sulfur (TRS) emissions from stationary sources. This method selectively removed sulfur dioxide (SO₂) by bubbling the gas sample through a citrate buffer solution, then thermally oxidizing TRS compounds present to SO₂ via furnace tube that was set at 1100 degrees Celsius +/- 50 degrees Celsius. The gas was then sent to the THERMO Model 43i SO₂ analyzer. The instrument operated in the nominal range of 0 ppm to 100 ppm with the specific range determined by the high-level span calibration gas.

In addition to a zero-air calibration gas, two calibration gases were used to perform the calibration error prior to the start of the sample runs. After each run, a drift check was performed with a zero gas and the mid-level SO₂ calibration gas.

In accordance with Method 16C, a performance check of the system was conducted prior to the start of the sample runs using a separate H₂S gas. System performance checks were performed after every third test run and used to correct the TRS data.

The Model 43i operates on the principle that SO₂ molecules absorb ultraviolet (UV) light and become excited at one wavelength, then decay to a lower energy state emitting UV light at a different wavelength. Specifically,



The sample is drawn into the Model 43i through the sample bulkhead. The sample flows through a hydrocarbon "kicker", which removes hydrocarbons from the sample by forcing the hydrocarbon molecules to permeate through the tube wall. The SO₂ molecules pass through the hydrocarbon "kicker" unaffected.

The sample flows into the fluorescence chamber, where pulsating UV light excites the SO₂ molecules. The condensing lens focuses the pulsating UV light into the mirror assembly. The mirror assembly contains four selective mirrors that reflect only the wavelengths which excite SO₂ molecules.

As the excited SO₂ molecules decay to lower energy states, they emit UV light that is proportional to the SO₂ concentration. The bandpass filter allows only the wavelengths emitted by the excited SO₂ molecules to reach the photomultiplier tube (PMT). The PMT detects the UV light emission from the decaying SO₂ molecules. The photodetector, located at the back of the fluorescence chamber, continuously monitors the pulsating UV light source and is connected to a circuit that compensates for fluctuations in the lamp intensity.

As the sample leaves the optical chamber, it passes through a flow sensor, a capillary, and the "shell" side of the hydrocarbon kicker. The Model 43i outputs the SO₂ concentration to the front panel display, the analog outputs, and also makes the data available over the serial or Ethernet connection.

Stack gas was delivered to the analyzer through a heated extractive gas sampling system. The glass probe and Teflon filter area were heated to a minimum of 250 degrees Fahrenheit. The entire system was calibrated in accordance with the Method.

Method 3A Oxygen (O₂) Determination

Stack gas O₂ concentrations were determined in accordance with USEPA Method 3A. A Servomex analyzer was used to determine the O₂ concentrations in the manner specified in the Method. The instrument has a paramagnetic detector and the O₂ operates in the nominal range of 0% to 25% with the specific range determined by the high-level calibration gas. High-range calibrations were performed using USEPA Protocol gas. Zero nitrogen (a low ppm pollutant in balance nitrogen calibration gases) was introduced during other instrument calibrations to check instrument zero. High- and a mid-range % O₂ levels in balance nitrogen were also introduced. Zero and mid-range calibrations were performed using USEPA Protocol gas after each test run. Copies of the gas cylinder certifications are found in Appendix G. This testing met the performance specifications as outlined in the Method.

3.0 TEST RESULT SUMMARY

Client: Billerud Escanaba, LLC				Location: Lime Kiln				
Facility: Escanaba Mill				Date: 7/25/23				
Project #: M231813				Test Method: 16C, 3A				
Applicable Standard: 20								
TRS as SO2 RATA								
Primary CEM Monitor Information								
SO ₂ Monitor/Model:		TECO 43iQ-CAN		SO ₂ Serial # :		12218618488		
O ₂ Monitor/Model:		TECO Citicel		O ₂ Serial # :		CC031506-3		
1=accept 0=reject	Test Run	Test Date	Start Time	End Time	RM SO2 ppmvd @ 10 % O2	CEM SO2 ppmvd @ 10 % O2	(RM-CEM) Difference (di)	(RM-CEM) Difference ² (di ²)
1	1	07/25/23	08:00	08:29	6.60	5.88	0.72	0.518
1	2	07/25/23	08:45	09:14	7.08	6.93	0.15	0.023
1	3	07/25/23	09:30	09:59	5.80	4.90	0.90	0.810
1	4	07/25/23	10:39	11:08	7.15	6.21	0.94	0.884
1	5	07/25/23	11:27	11:56	5.76	4.80	0.96	0.922
0	6	07/25/23	12:11	12:40	4.45	3.66	0.79	0.624
1	7	07/25/23	15:28	15:57	5.75	4.57	1.18	1.392
1	8	07/25/23	16:11	16:40	4.66	3.57	1.09	1.188
1	9	07/25/23	16:55	17:24	3.58	2.89	0.69	0.476
1	10	07/25/23	17:59	18:28	4.95	3.56	1.39	1.932
n					9			
t(0.975)					2.306			
Mean Reference Method Value					5.703		RM avg	
Mean CEM Value					4.812		CEM avg	
Sum of Differences					8.020		di	
Mean Difference					0.891		d	
Sum of Differences Squared					8.145		di ²	
Standard Deviation					0.353		sd	
Confidence Coefficient 2.5% Error (1-tail)					0.272		cc	
Relative Accuracy - APS					5.81		RA	

^A Relative accuracy based upon +/- 10% of applicable standard

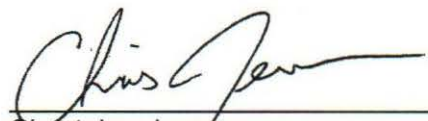
Client: Billerud Escanaba, LLC				Location: Lime Kiln				
Facility: Escanaba Mill				Date: 7/25/23				
Project #: M231813				Test Method: 3A				
O₂ % (dry) RATA								
Primary CEM Monitor Information								
O ₂ Monitor/Model:			TECO Citicel		O ₂ Serial # :		CC031506-3	
1=accept 0=reject	Test Run	Test Date	Start Time	End Time	RM O ₂ % (dry)	CEM O ₂ % (dry)	(RM-CEM) Difference (di)	(RM-CEM) Difference ² (di ²)
1	1	07/25/23	08:00	08:29	4.25	4.06	0.19	0.04
1	2	07/25/23	08:45	09:14	5.50	5.00	0.50	0.25
1	3	07/25/23	09:30	09:59	4.47	4.30	0.17	0.03
1	4	07/25/23	10:39	11:08	4.61	5.42	-0.81	0.66
1	5	07/25/23	11:27	11:56	4.44	5.52	-1.08	1.17
0	6	07/25/23	12:11	12:40	6.92	4.48	2.44	5.95
1	7	07/25/23	15:28	15:57	4.31	4.10	0.21	0.04
1	8	07/25/23	16:11	16:40	4.49	4.88	-0.39	0.15
1	9	07/25/23	16:55	17:24	4.65	4.42	0.23	0.05
1	10	07/25/23	17:59	18:28	4.53	5.33	-0.80	0.64
n					9			
t(0.975)					2.306			
Mean Reference Method Value					4.583		RM avg	
Mean CEM Value					4.781		CEM avg	
Sum of Differences					-1.780		di	
Mean Difference					-0.198		d	
Sum of Differences Squared					3.027		di ²	
Standard Deviation					0.578		sd	
Confidence Coefficient 2.5% Error (1-tail)					0.444		cc	
Relative Accuracy					0.198		RA	

4.0 CERTIFICATION

Mostardi Platt is pleased to have been of service to Billerud Escanaba, LLC. If you have any questions regarding this test report, please do not hesitate to contact us at 630-993-2100.


As program manager, I hereby certify that this test report represents a true and accurate summary of emissions test results and the methodologies employed to obtain those results, and the test program was performed in accordance with the methods specified in this test report.

MOSTARDI PLATT



Christopher Jensen

Program Manager



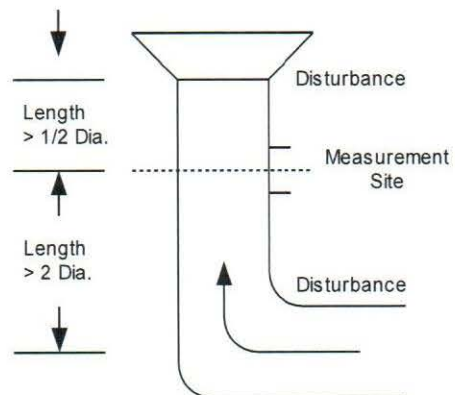
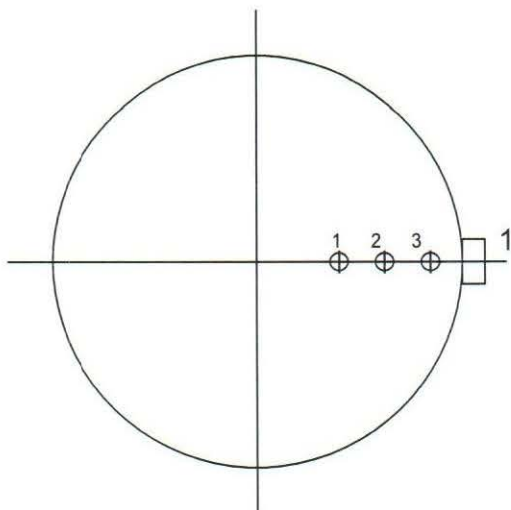
Scott W. Banach

Quality Assurance

APPENDICES

Appendix A – Test Section Diagram

GASEOUS TRAVERSE FOR ROUND DUCTS



Job: Billerud Escanaba, LLC
Escanaba Mill
Escanaba, Michigan

Date: July 25, 2023

Test Location: Lime Kiln

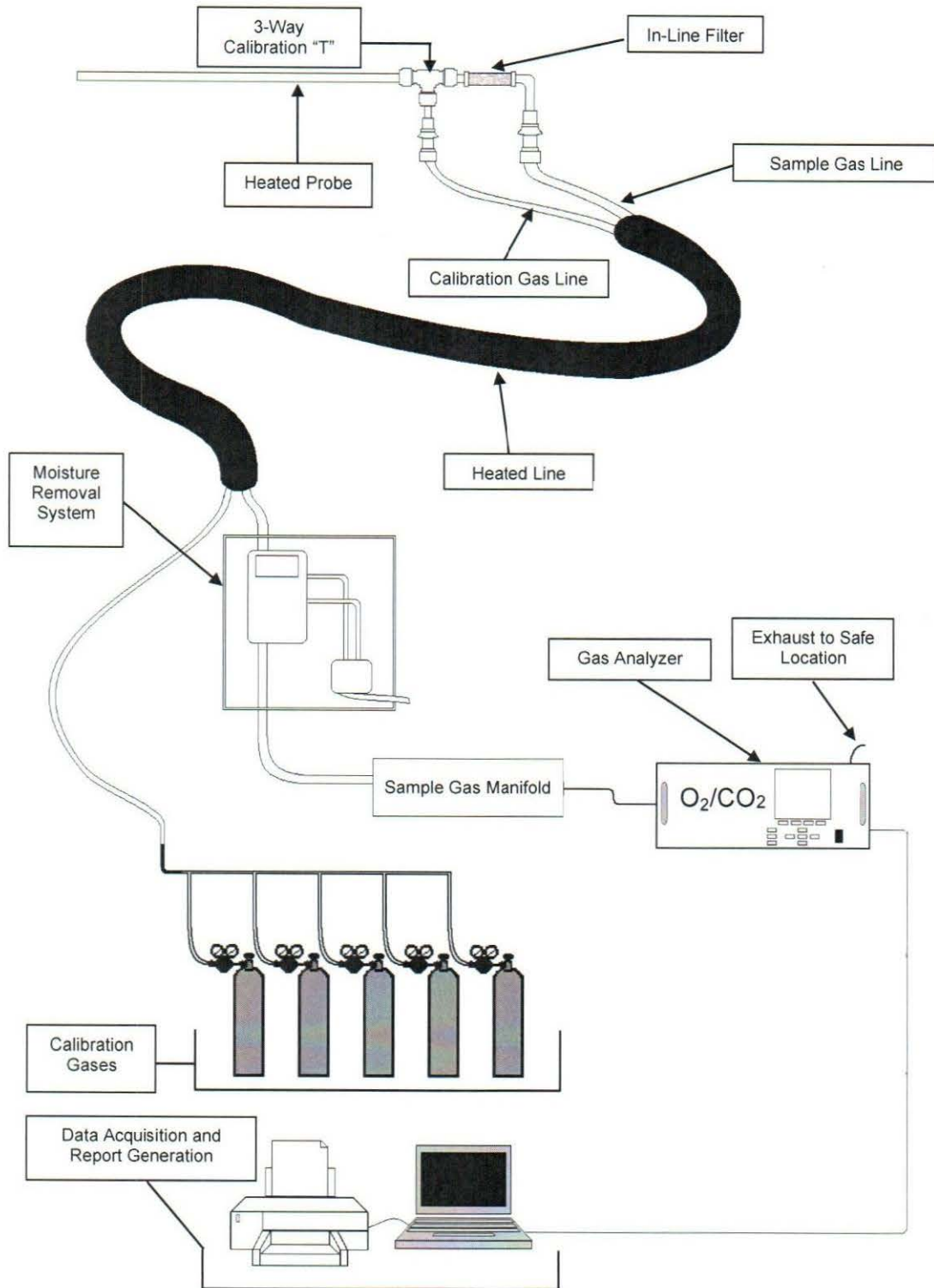
Duct Diameter: 4.667 feet

Duct Area: 17.11 square feet

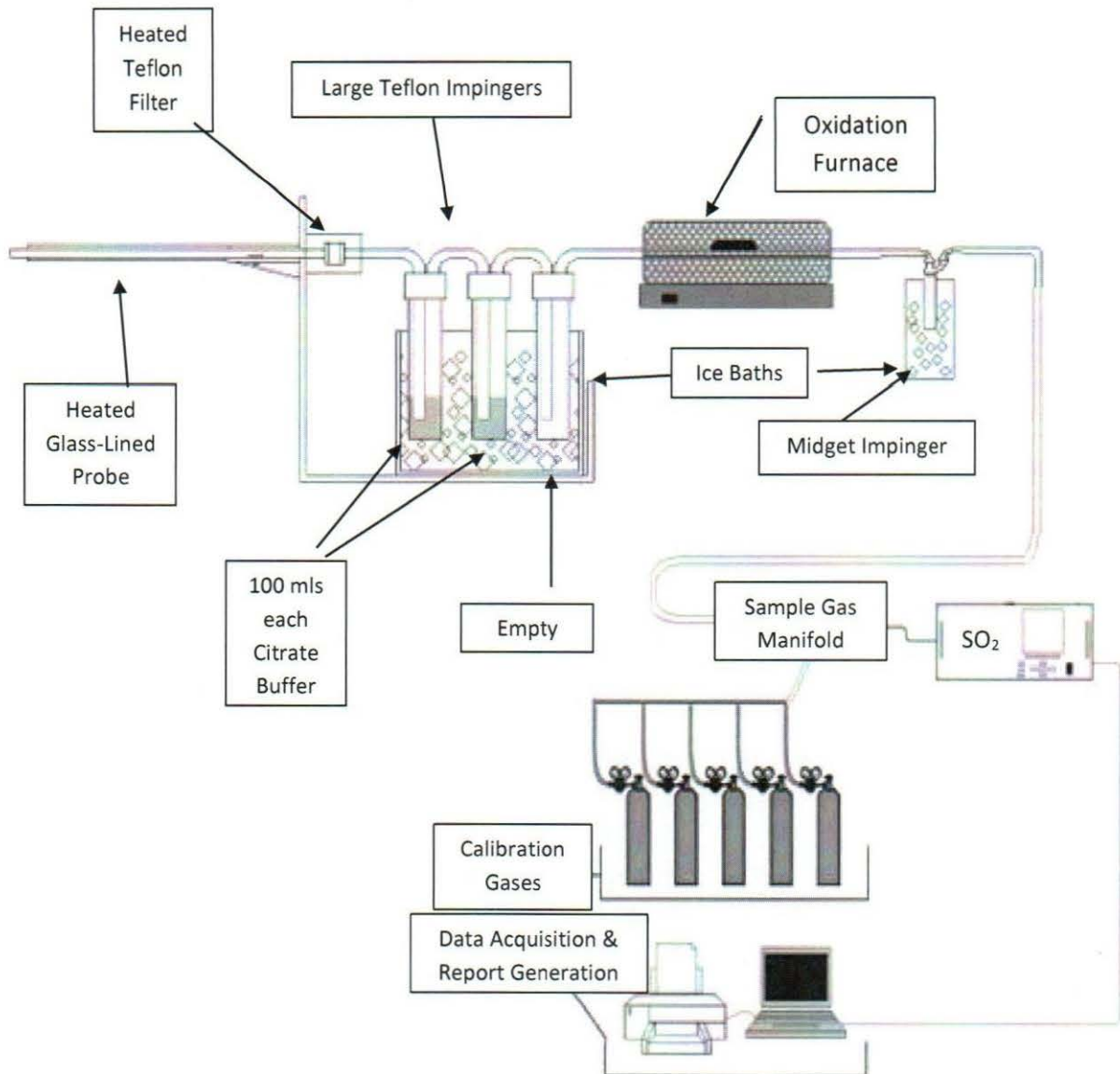
No. Sample Points: 3

Appendix B – Sample Train Diagram

USEPA Method 3A Extractive Gaseous Sampling Diagram



USEPA Method 16C – Total Reduced Sulfur Sample Train Diagram



Appendix C – Calculation Nomenclature and Formulas