

Section 114 Information Collection Request Emissions Test Report

Holcim (US) Inc.
Alpena Cement Plant
EPA Registry ID: 110015742605
1435 Ford Avenue
Alpena, MI 49707
Report No. M235005A





**Section 114 Information Collection Request
Emissions Test Report**

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**Report Submittal Date:
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1.0 INTRODUCTION

Mostardi Platt conducted an air emissions test program for Holcim (US) Inc. at the Alpena Cement Plant located in Alpena, Michigan. All testing was performed as described in the *Code of Federal Regulations*, Title 40, Part 60, Appendix A (40CFR60), Methods 1, 2, 3A, 4, 26A, and 40CFR63, Appendix A, (40CFR63) Method 320.

This test program was completed to satisfy the requirements of the United States Environmental Protection Agency (USEPA) Section 114 Information Collection Request for Portland Cement Manufacturing facilities.

The identification of individuals associated with the test program is summarized below:

Location	Address	Contact
Facility Representative	Holcim (US) Inc. Alpena Plant 1435 Ford Avenue Alpena, Michigan 49707	Mallory Miller Area Environmental Engineer (224) 517-6896 Mallory.miller@holcim.com
Testing Company Representative	Mostardi Platt 888 Industrial Drive Elmhurst, IL 60126	Eric Ehlers VP, Field Operations (630) 993-2100 (phone) eehlers@mp-mail.com

2.0 TEST REQUIREMENTS

Testing was performed at the kiln stack. The following table presents a list of the parameters tested, the applicable methodologies utilized, and average test results:

Source	Parameter Tested	Test Results	Method/Regulation Citation
Kiln 20 Stack	Hydrogen Fluoride (HF)	≤ 0.10 ppmvw	USEPA Method 320, 40CFR63, Appendix A
		≤ 0.13 ppmvd @7% O ₂	
		≤ 0.03 lb/hr	
		≤ 0.0006 lb/ton clinker	
	HF ¹	≤ 0.16 ppmvd	Method 26A, 40CFR60, Appendix A
		≤ 0.20 ppmvd @7% O ₂	
		≤ 0.04 lb/hr	
		≤ 0.0007 lb/ton clinker	
	Chlorine (Cl ₂) ¹	≤ 0.04 ppmvd	USEPA Method 26A, 40CFR60, Appendix A
		≤ 0.05 ppmvd @7% O ₂	
		≤ 0.04 lb/hr	
		≤ 0.0007 lb/ton clinker	
	Hydrogen Cyanide (HCN)	1.48 ppmvw	USEPA Method 320, 40CFR63, Appendix A
		1.90 ppmvd @7% O ₂	
		0.52 lb/hr	
		0.0094 lb/ton clinker	
	Oxygen (O ₂)	9.5 % (dry)	USEPA Method 3A, 40CFR60, Appendix A
	Carbon Dioxide (CO ₂)	16.4 % (dry)	USEPA Method 320, 40CFR63, Appendix A
	Moisture (H ₂ O)	4.9 %	USEPA Method 320, 40CFR63, Appendix A
	Cyclonic Flow Determination	PASS	USEPA Method 1, 40CFR60, Appendix A, Section 11.4
	Three-point O ₂ Stratification Determination	< 5 %	USEPA Method 3A, 40CFR60, Appendix A and Method 7E, Section 8.1.2

¹ HF and Cl₂ Method 26A results are reported as the average from Train A and Train B.

Source	Parameter Tested	Test Results	Method/Regulation Citation
Kiln 21 Stack	Hydrogen Fluoride (HF)	≤ 0.10 ppmvw	USEPA Method 320, 40CFR63, Appendix A
		≤ 0.14 ppmvd @7% O ₂	
		≤ 0.02 lb/hr	
		≤ 0.0005 lb/ton clinker	
	HF ²	≤ 0.18 ppmvd	Method 26A, 40CFR60, Appendix A
		≤ 0.24 ppmvd @7% O ₂	
		≤ 0.04 lb/hr	
		≤ 0.0009 lb/ton clinker	
	Chlorine (Cl ₂) ²	≤ 0.05 ppmvd	USEPA Method 26A, 40CFR60, Appendix A
		≤ 0.06 ppmvd @7% O ₂	
		≤ 0.04 lb/hr	
		≤ 0.0009 lb/ton clinker	
	Hydrogen Cyanide (HCN)	0.64 ppmvw	USEPA Method 320, 40CFR63, Appendix A
		0.90 ppmvd @7% O ₂	
		0.21 lb/hr	
		0.0047 lb/ton clinker	
	Oxygen (O ₂)	10.6 % (dry)	USEPA Method 3A, 40CFR60, Appendix A
	Carbon Dioxide (CO ₂)	14.5 % (dry)	USEPA Method 320, 40CFR63, Appendix A
	Moisture (H ₂ O)	3.9 %	USEPA Method 320, 40CFR63, Appendix A
	Cyclonic Flow Determination	PASS	USEPA Method 1, 40CFR60, Appendix A, Section 11.4
	Three-point O ₂ Stratification Determination	< 5 %	USEPA Method 3A, 40CFR60, Appendix A and Method 7E, Section 8.1.2

² HF and Cl₂ Method 26A results are reported as the average from Train A and Train B.

3.0 QA SPECIFICATIONS AND PROCESS DIAGRAM

Table 3-1 QA/QC Specifications

Parameter	Method	QA/QC Specification	Acceptance Criteria	Actual Result
HCN	320	Method Detection Limit	0.5 ppm	0.2 ppmvw
		SNR	>2500 at 64 scans	2521 (Run 1 Average)
		S Beam	>0.9	1.334 (Run 1 Average)
		Direct HCN Analysis	±5% of tag value	-0.8%
		Dynamic Spike Analysis	≤10% of total sample volume	8.4%
			Spike gas ~twice native concentration or 3-4 ppm addition to native concentration	+4.0
			≤±20% of expected value or ≤±0.5 ppm, whichever is less restrictive	≤±20% of expected value
Cl ₂	26A	Residuals	≤±0.3 ppm, or ≤±5% of measured value, whichever is less restrictive	≤±0.3 ppm
		Detection Limit	300 µg	150 µg
		Paired Train Agreement	≤10% Relative Deviation or ≤0.2 ppm, whichever is less restrictive.	≤10% Relative Deviation

4.0 TEST PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program were performed as described in the Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40CFR60), Methods 1, 2, 3A, 4, 26A, and 40CFR63, Appendix A, Method 320; and the latest revisions thereof. Where applicable, the *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume III, Stationary Source Specific Methods, United States Environmental Protection Agency (USEPA) 600/R-94/038c, September 1994 was used to supplement procedures in addition to the appended "Draft General Test Plan".

4.1 Method 1 Sample and Velocity Traverse Determination

Sample points for testing are determined using USEPA Test Method 1, 40CFR60, Appendix A. The characteristics of the measurement location is summarized below.

Sample Point Selection

Test Location	Stack Dimensions	Upstream Diameters	Downstream Diameters	Test Parameter	Number of Sampling Points
Kiln 20	8.0 x 8.75 Feet	~1.0	~8.5	HF/Cl ₂ (26A)	42
				O ₂ (3A)	3 (stratification)
				HCN/HF/CO ₂ (320/3A)	1
Kiln 21	8.0 x 8.67	~1.0	~8.5	HF/Cl ₂ (26A)	42
				O ₂ (3A)	3 (stratification)
				HCN/HF/CO ₂ (320/3A)	1

A cyclonic flow check was performed in accordance with Section 11.4, which demonstrated it meets the criteria of an average value of less than 20° and therefore is considered to be a suitable testing location for flow rate measurements.

4.2 Method 2 Volumetric Flow Rate Determination

The gas velocity and volumetric flowrate were determined using Method 2, 40CFR60, Appendix A, as an integrated part of the HF/Cl₂ sampling system.

Velocity pressures were determined by traversing the duct with wind tunnel calibrated S-type pitot tube. Temperatures were measured using K-type thermocouples with calibrated digital temperature indicators. The molecular weight and moisture content of the gases were also determined to permit the calculation of the volumetric flowrate.

4.3 Method 3A Oxygen (O₂) and Carbon Dioxide (CO₂) Determination

O₂ and CO₂ concentrations were determined in accordance with Method 3A, 40CFR60, Appendix A and Method 320, 40CRR63, Appendix A, respectively. A Servomex analyzer was used to determine O₂ concentrations while the MKS 2030 analyzer was used to determine CO₂ concentrations. The O₂ instrument has a paramagnetic detector and operates in a nominal range of 0-25%.

A list of calibration gases used and the results of all calibration and other required quality assurance checks are found in the appendix of this report. Copies of calibration gas certifications are also appended.

4.4 Method 26A Hydrogen Fluoride (HF) and Chlorine (Cl₂) Determination

HF and Cl₂ concentrations and emission rates were determined in accordance with Method 26A, 40CFR60, Appendix A. Paired sampling trains were used to collect the samples. A total of forty-two (42) test points were sampled per run on at both the Kiln 20 and Kiln 21 stack locations. The sample was extracted isokinetically from the gas stream and passed through dilute sulfuric acid (0.1N H₂SO₄). HF was collected in the dilute acid. Cl₂ was collected in the dilute sodium hydroxide (0.1N NaOH) solution. The sample train consisted of a Teflon coated nozzle, a heated borosilicate glass probe liner, a Teflon® filter placed on the outlet of the glass probe liner, and six impingers. The first two impingers contained the 0.1N H₂SO₄, the third remained empty (and was recovered with the first two impingers), the fourth and fifth impingers contained the 0.1N NaOH, while the sixth impinger contained silica gel to absorb any remaining moisture. A de-ionized water rinse was performed on each set of impingers, and samples were stored in Nalgene sample containers for transport. The 0.1N H₂SO₄ impinger catch samples were analyzed for HF while the 0.1N NaOH impinger catch samples were analyzed for Cl₂. A method detection limit (MDL) of 150 µg was determined for both HF and Cl₂ using the "Definition and Procedure for the Determination of the Method Detection Limit, Revision 2". All equipment used was calibrated in accordance with the specifications of the method. Calibration data is appended.

Hand recorded field data sheets were reviewed and scans are retained on the Mostardi Platt network. Copies of this data is available upon request.

4.5 Method 320 Speciated Flue Gas Concentration Determinations

The sampling procedures for HCN and HF were performed in accordance with USEPA Method 320, 40CFR63, Appendix A. Data was continuously recorded with a data logging system throughout sampling, with brief interruption to properly label reference spectra.

The average gas effluent concentrations were determined from the average gas concentration displayed by the MKS 2030 analyzer.

All sampling system components were heated to 375°F +/- 25°F, including: stainless steel sample probe, stainless steel calibration tee, in line glass fiber particulate filter, Teflon® sample line, heated head sample pump, and FTIR detector cell. The sample pump distributes the gas sample to the instrument at a steady sample flow rate (+/- 10%). All components of the sampling system are constructed of stainless steel, glass, or Teflon®.

FTIR technology works on the principle that most gases absorb infrared light. This is true for all compounds except for homonuclear diatomic molecules and noble gases such as: N₂, O₂, H₂, He, Ne, and Ar. Vibrations, stretches, bends, and rotations within the bonds of a molecule determine the infrared absorption distinctiveness. The absorption creates a "fingerprint" which is unique for each given compound. The quantity of infrared light absorbed is proportional to the gas concentration. Most compounds have absorbencies at different infrared frequencies, thus allowing the simultaneous analysis of multiple compounds at one time. The FTIR software compares each sample spectrum to a user-selected list of calibration references and concentration data is generated.

FTIR data was collected using an MKS MultiGas 2030 FTIR spectrometer. Data was generated at 0.5 cm⁻¹. Each Spectra was derived from the coaddition of 62-64 scans with a new data point generated approximately every minute. HCN analyte spiking assured the ability of the FTIR to quantify HCN in the presence of effluent gas. All analyte spikes were introduced using an instrument grade stainless steel rotameter. All QA/QC procedures were within the acceptance criteria allowance of the applicable methodology and the "General Test Plan."

5.0 TEST RESULTS SUMMARIES

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 20 Breaching Duct
 Test Method: 26A - A Train

	Source Condition	Normal	Normal	Normal	
	Date	12/13/23	12/13/23	12/13/23	
	Start Time	11:30	13:15	15:00	
	End Time	13:00	14:45	16:30	
	Run 1A	Run 2A	Run 3A	Average	
Stack Conditions					
Average Gas Temperature, °F	391.7	391.7	392.1	391.8	
Flue Gas Moisture, percent by volume	4.8%	7.3%	7.5%	6.5%	
Average Flue Pressure, in. Hg	29.32	29.32	29.31	29.32	
Gas Sample Volume, dscf	36.047	36.450	36.379	36.292	
Average Gas Velocity, ft/sec	30.570	31.057	31.298	30.975	
Gas Volumetric Flow Rate, acfm	128,394	130,440	131,454	130,096	
Gas Volumetric Flow Rate, dscfm	74,239	73,495	73,767	73,834	
Gas Volumetric Flow Rate, scfm	78,002	79,250	79,784	79,012	
Average %CO ₂ by volume, dry basis	16.3	16.4	16.4	16.4	
Average %O ₂ by volume, dry basis	9.5	9.5	9.6	9.5	
Isokinetic Variance	98.2	100.3	99.7	99.4	
Hydrogen Fluoride (HF) Emissions					
ug of sample collected	≤ 150.00	≤ 150.00	≤ 150.00	≤ 150.00	
ppm	≤ 0.18	≤ 0.18	≤ 0.18	≤ 0.18	
Chlorine (Cl₂) Emissions					
ug of sample collected	≤ 150.00	≤ 150.00	≤ 150.00	≤ 150.00	
ppm	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 20 Breaching Duct
 Test Method: 26A - B Train

Source Condition	Normal	Normal	Normal	
Date	12/13/23	12/13/23	12/13/23	
Start Time	11:30	13:15	15:00	
End Time	13:00	14:45	16:30	
	Run 1B	Run 2B	Run 3B	Average
Stack Conditions				
Average Gas Temperature, °F	398.1	399.1	401.1	399.4
Flue Gas Moisture, percent by volume	3.3%	5.2%	5.3%	4.6%
Average Flue Pressure, in. Hg	29.31	29.31	29.31	29.31
Gas Sample Volume, dscf	56.684	56.906	56.524	56.705
Average Gas Velocity, ft/sec	35.577	34.720	35.736	35.344
Gas Volumetric Flow Rate, acfm	149,424	145,822	150,091	148,446
Gas Volumetric Flow Rate, dscfm	87,120	83,209	85,391	85,240
Gas Volumetric Flow Rate, scfm	90,059	87,782	90,144	89,328
Average %CO ₂ by volume, dry basis	16.3	16.4	16.4	16.4
Average %O ₂ by volume, dry basis	9.5	9.5	9.6	9.5
Isokinetic Variance	102.8	108.1	104.6	105.2
Hydrogen Fluoride (HF) Emissions				
ug of sample collected	≤ 150.00	≤ 150.00	≤ 301.00	≤ 200.33
ppm	≤ 0.11	≤ 0.11	≤ 0.23	≤ 0.15
Chlorine (Cl₂) Emissions				
ug of sample collected	≤ 150.00	≤ 150.00	≤ 150.00	≤ 150.00
ppm	≤ 0.03	≤ 0.03	≤ 0.03	≤ 0.03

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Test Location: Kiln 20 Breaching Duct
Test Method: 26A - Combined Results

Source Condition	Normal	Normal	Normal	
Date	12/13/23	12/13/23	12/13/23	
Start Time	11:30	13:15	15:00	
End Time	13:00	14:45	16:30	
	Run 1	Run 2	Run 3	Average
Stack Conditions				
Average Gas Velocity, ft/sec	33.074	32.889	33.517	33.160
Gas Volumetric Flow Rate, acfm	138,909	138,131	140,773	139,271
Gas Volumetric Flow Rate, dscfm	80,680	78,352	79,579	79,537
Gas Volumetric Flow Rate, scfm	84,031	83,516	84,964	84,170
Average %CO ₂ by volume, dry basis	16.3	16.4	16.4	16.4
Average %O ₂ by volume, dry basis	9.5	9.5	9.6	9.5
Clinker production, ton/hr	54.5	54.7	56.2	55.1
Hydrogen Fluoride (HF) Emissions				
ppm ≤	0.15	≤ 0.14	≤ 0.20	≤ 0.16
ppm@7%O ₂ ≤	0.18	≤ 0.18	≤ 0.25	≤ 0.20
lb/hr ≤	0.04	≤ 0.04	≤ 0.05	≤ 0.04
lb/ton of clinker ≤	0.0007	≤ 0.0006	≤ 0.0009	≤ 0.0007
Chlorine (Cl₂) Emissions				
ppm ≤	0.04	≤ 0.04	≤ 0.04	≤ 0.04
ppm@7%O ₂ ≤	0.05	≤ 0.05	≤ 0.05	≤ 0.05
lb/hr ≤	0.04	≤ 0.04	≤ 0.04	≤ 0.04
lb/ton of clinker ≤	0.0007	≤ 0.0006	≤ 0.0006	≤ 0.0007

Holcim (US) Inc. Alpena Cement Plant Kiln 20 Exhaust >90% Production Reference Method Test Data									
Test No.	Date	Start Time	End Time	O ₂ % (dry)	Moisture %	HCN ppmvw	HCN ppmvd @ 7% O ₂	HF ppmvw	HF ppmvd @ 7% O ₂
1	12/13/2023	11:30	12:28	9.5	5.0%	1.40	1.80	≤ 0.10	≤ 0.13
2	12/13/2023	13:15	14:14	9.5	4.8%	1.47	1.89	≤ 0.10	≤ 0.13
3	12/13/2023	15:00	15:59	9.6	4.9%	1.56	2.01	≤ 0.10	≤ 0.13
Average				9.5	4.9%	1.48	1.90	≤ 0.10	≤ 0.13

Test No.	Date	Start Time	End Time	Volumetric Flow, DSCFM	Clinker Production, ton/hr	HCN lb/hr	HCN lb/ton	HF lb/hr	HF lb/ton
1	12/13/2023	11:30	12:28	80,680	54.5	0.50	0.0092	≤ 0.03	≤ 0.0005
2	12/13/2023	13:15	14:14	78,352	54.7	0.51	0.0093	≤ 0.03	≤ 0.0005
3	12/13/2023	15:00	15:59	79,579	56.2	0.55	0.0098	≤ 0.03	≤ 0.0005
Average				79,537	55.1	0.52	0.0094	≤ 0.03	≤ 0.0005

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Test Location: Kiln 21 Breaching Duct
Test Method: 26A - A Train

Source Condition	Normal	Normal	Normal	
Date	12/12/23	12/12/23	12/12/23	
Start Time	10:20	12:30	14:15	
End Time	11:51	14:00	15:45	
	Run 1A	Run 2A	Run 3A	Average
Stack Conditions				
Average Gas Temperature, °F	384.6	388.5	390.7	387.9
Flue Gas Moisture, percent by volume	10.0%	6.7%	7.1%	7.9%
Average Flue Pressure, in. Hg	29.32	29.32	29.32	29.32
Gas Sample Volume, dscf	42.311	42.350	42.379	42.347
Average Gas Velocity, ft/sec	35.858	35.817	35.929	35.868
Gas Volumetric Flow Rate, acfm	149,229	149,058	149,521	149,269
Gas Volumetric Flow Rate, dscfm	82,291	84,778	84,460	83,843
Gas Volumetric Flow Rate, scfm	91,424	90,897	90,946	91,089
Average %CO ₂ by volume, dry basis	14.1	14.3	15.1	14.5
Average %O ₂ by volume, dry basis	11.0	10.2	10.2	10.5
Isokinetic Variance	103.0	100.1	100.5	101.2
Hydrogen Fluoride (HF) Emissions				
ug of sample collected ≤	230.00	≤ 150.00	≤ 150.00	≤ 176.67
ppm ≤	0.23	≤ 0.15	≤ 0.15	≤ 0.18
Chlorine (Cl₂) Emissions				
ug of sample collected ≤	150.00	≤ 150.00	≤ 150.00	≤ 150.00
ppm ≤	0.04	≤ 0.04	≤ 0.04	≤ 0.04

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Test Location: Kiln 21 Breaching Duct
Test Method: 26A - B Train

Source Condition	Normal	Normal	Normal	
Date	12/12/23	12/12/23	12/12/23	
Start Time	10:20	12:30	14:15	
End Time	12:57	14:00	15:45	
	Run 1B	Run 2B	Run 3B	Average
Stack Conditions				
Average Gas Temperature, °F	394.6	396.1	396.8	395.8
Flue Gas Moisture, percent by volume	11.7%	7.1%	6.9%	8.6%
Average Flue Pressure, in. Hg	28.79	29.32	29.32	29.14
Gas Sample Volume, dscf	35.124	35.853	36.982	35.986
Average Gas Velocity, ft/sec	29.874	29.521	29.358	29.584
Gas Volumetric Flow Rate, acfm	124,324	122,854	122,175	123,118
Gas Volumetric Flow Rate, dscfm	65,257	68,984	68,709	67,650
Gas Volumetric Flow Rate, scfm	73,912	74,249	73,785	73,982
Average %CO ₂ by volume, dry basis	14.1	14.3	15.1	14.5
Average %O ₂ by volume, dry basis	11.0	10.2	10.2	10.5
Isokinetic Variance	107.8	104.1	107.8	106.6
Hydrogen Fluoride (HF) Emissions				
ug of sample collected	≤ 150.00	≤ 150.00	≤ 150.00	≤ 150.00
ppm	≤ 0.18	≤ 0.18	≤ 0.17	≤ 0.18
Chlorine (Cl₂) Emissions				
ug of sample collected	≤ 150.00	≤ 150.00	≤ 150.00	≤ 150.00
ppm	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 21 Breaching Duct
 Test Method: 26A - Combined Trains

Source Condition	Normal	Normal	Normal	
Date	12/12/23	12/12/23	12/12/23	
Start Time	10:20	12:30	14:15	
End Time	11:51	14:00	15:45	
	Run 1	Run 2	Run 3	Average
Stack Conditions				
Average Gas Velocity, ft/sec	32.866	32.669	32.644	32.726
Gas Volumetric Flow Rate, acfm	136,777	135,956	135,848	136,194
Gas Volumetric Flow Rate, dscfm	73,774	76,881	76,585	75,747
Gas Volumetric Flow Rate, scfm	82,668	82,573	82,366	82,536
Average %CO ₂ by volume, dry basis	14.1	14.3	15.1	14.5
Average %O ₂ by volume, dry basis	11.0	10.2	10.2	10.5
Clinker production, ton/hr	46.2	45.0	44.8	45.3
Hydrogen Fluoride (HF) Emissions				
ppm ≤	0.21	≤ 0.16	≤ 0.16	≤ 0.18
ppm@7%O ₂ ≤	0.29	≤ 0.21	≤ 0.21	≤ 0.24
lb/hr ≤	0.05	≤ 0.04	≤ 0.04	≤ 0.04
lb/ton of clinker ≤	0.0010	0.0009	0.0009	≤ 0.0009
Chlorine (Cl₂) Emissions				
ppm ≤	0.05	≤ 0.05	≤ 0.05	≤ 0.05
ppm@7%O ₂ ≤	0.07	≤ 0.06	≤ 0.06	≤ 0.06
lb/hr ≤	0.04	≤ 0.04	≤ 0.04	≤ 0.04
lb/ton of clinker ≤	0.0008	0.0009	0.0009	≤ 0.0009

Holcim (US) Inc. Alpena Cement Plant Kiln 21 Exhaust >90% Production Reference Method Test Data									
Test No.	Date	Start Time	End Time	O ₂ % (dry)	Moisture %	HCN ppmvw	HCN ppmvd @ 7% O ₂	HF ppmvw	HF ppmvd @ 7% O ₂
1	12/12/2023	10:20	11:18	11.1	3.8%	0.62	0.91	≤ 0.10	≤ 0.15
2	12/12/2023	12:30	13:29	10.3	4.0%	0.69	0.95	≤ 0.10	≤ 0.14
3	12/12/2023	15:15	16:14	10.3	3.9%	0.62	0.85	≤ 0.10	≤ 0.14
Average				10.6	3.9%	0.64	0.90	≤ 0.10	≤ 0.14

Test No.	Date	Start Time	End Time	Volumetric Flow, DSCFM	Clinker Production, ton/hr	HCN lb/hr	HCN lb/ton	HF lb/hr	HF lb/ton
1	12/12/2023	10:20	11:18	73,774	46.2	0.20	0.0043	≤ 0.02	≤ 0.0005
2	12/12/2023	12:30	13:29	76,881	45.0	0.23	0.0052	≤ 0.02	≤ 0.0006
3	12/12/2023	15:15	16:14	76,585	44.8	0.21	0.0047	≤ 0.02	≤ 0.0006
Average				75,747	45.3	0.21	0.0047	≤ 0.02	≤ 0.0005

6.0 CERTIFICATION

Mostardi Platt is pleased to have been of service to Holcim (US) Inc. If you have any questions regarding this test report, please do not hesitate to contact us at 630-993-2100.

As project 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


Eric L. Ehlers

Project Manager


Chet A. Gutwein

Quality Assurance

APPENDICES

Appendix A – Plant Operating Data

Kiln 20 RTR - Run 1

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
Average	54.5	93.6
12/13/2023 11:30	54.7	92.3
12/13/2023 11:31	54.1	91.9
12/13/2023 11:32	54.5	93.3
12/13/2023 11:33	54.3	93.8
12/13/2023 11:34	54.5	94.2
12/13/2023 11:35	54.1	92.8
12/13/2023 11:36	54.6	92.7
12/13/2023 11:37	54.2	93.3
12/13/2023 11:38	54.0	92.6
12/13/2023 11:39	53.9	92.0
12/13/2023 11:40	53.7	92.5
12/13/2023 11:41	54.0	92.5
12/13/2023 11:42	54.5	92.3
12/13/2023 11:43	54.2	94.6
12/13/2023 11:44	53.6	91.4
12/13/2023 11:45	54.0	93.4
12/13/2023 11:46	54.6	94.8
12/13/2023 11:47	54.3	92.2
12/13/2023 11:48	54.1	93.4
12/13/2023 11:49	53.7	92.1
12/13/2023 11:50	53.7	92.5
12/13/2023 11:51	53.9	92.3
12/13/2023 11:52	53.6	92.5
12/13/2023 11:53	53.9	90.3
12/13/2023 11:54	53.7	93.0
12/13/2023 11:55	54.1	93.5
12/13/2023 11:56	53.9	90.5
12/13/2023 11:57	54.0	93.4
12/13/2023 11:58	54.2	92.5
12/13/2023 11:59	53.9	92.8
12/13/2023 12:00	53.9	92.4
12/13/2023 12:01	53.8	93.4
12/13/2023 12:02	53.9	92.5
12/13/2023 12:03	54.2	93.2
12/13/2023 12:04	53.6	92.8
12/13/2023 12:05	54.2	92.2
12/13/2023 12:06	54.1	93.4
12/13/2023 12:07	54.6	93.9
12/13/2023 12:08	54.3	93.4
12/13/2023 12:09	53.9	92.1
12/13/2023 12:10	54.3	93.2

Kiln 20 RTR - Run 1

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
12/13/2023 12:11	54.5	93.5
12/13/2023 12:12	54.7	94.9
12/13/2023 12:13	54.5	92.5
12/13/2023 12:14	54.8	93.7
12/13/2023 12:15	55.2	94.9
12/13/2023 12:16	54.7	93.4
12/13/2023 12:17	54.9	93.8
12/13/2023 12:18	54.7	93.5
12/13/2023 12:19	54.5	92.7
12/13/2023 12:20	53.9	90.7
12/13/2023 12:21	54.5	93.6
12/13/2023 12:22	54.5	92.8
12/13/2023 12:23	54.5	93.9
12/13/2023 12:24	55.2	95.0
12/13/2023 12:25	56.0	97.3
12/13/2023 12:26	56.4	97.1
12/13/2023 12:27	55.8	95.9
12/13/2023 12:28	56.0	96.2
12/13/2023 12:29	55.9	93.7
12/13/2023 12:30	55.7	95.0
12/13/2023 12:31	55.0	93.8
12/13/2023 12:32	54.3	91.9
12/13/2023 12:33	54.5	92.9
12/13/2023 12:34	55.1	97.2
12/13/2023 12:35	55.8	97.7
12/13/2023 12:36	56.5	95.9
12/13/2023 12:37	56.4	98.5
12/13/2023 12:38	56.5	94.8
12/13/2023 12:39	56.2	97.9
12/13/2023 12:40	57.1	98.0
12/13/2023 12:41	55.2	95.8
12/13/2023 12:42	59.5	103.3
12/13/2023 12:43	53.0	83.4
12/13/2023 12:44	50.4	88.0
12/13/2023 12:45	51.7	89.8
12/13/2023 12:46	52.6	90.2
12/13/2023 12:47	52.9	92.0
12/13/2023 12:48	53.7	92.2
12/13/2023 12:49	53.8	94.0
12/13/2023 12:50	54.2	93.9
12/13/2023 12:51	54.3	94.4
12/13/2023 12:52	54.3	93.5

Kiln 20 RTR - Run 1

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
12/13/2023 12:53	55.2	94.1
12/13/2023 12:54	55.2	96.0
12/13/2023 12:55	55.1	95.8
12/13/2023 12:56	55.2	96.2
12/13/2023 12:57	55.4	95.0
12/13/2023 12:58	54.7	93.2
12/13/2023 12:59	55.4	96.0
12/13/2023 13:00	55.4	95.8

Kiln 20 RTR - Run 2

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
Average	54.7	94.1
12/13/2023 13:15	55.3	95.0
12/13/2023 13:16	55.7	96.4
12/13/2023 13:17	55.8	97.8
12/13/2023 13:18	55.6	96.3
12/13/2023 13:19	55.6	95.4
12/13/2023 13:20	54.9	93.7
12/13/2023 13:21	54.9	95.3
12/13/2023 13:22	55.7	96.5
12/13/2023 13:23	56.4	96.5
12/13/2023 13:24	56.0	95.9
12/13/2023 13:25	55.8	94.8
12/13/2023 13:26	55.4	95.4
12/13/2023 13:27	56.0	96.6
12/13/2023 13:28	56.0	96.0
12/13/2023 13:29	55.7	94.4
12/13/2023 13:30	54.9	94.8
12/13/2023 13:31	54.7	94.3
12/13/2023 13:32	54.5	92.9
12/13/2023 13:33	55.1	93.5
12/13/2023 13:34	54.9	94.7
12/13/2023 13:35	55.1	95.8
12/13/2023 13:36	55.7	96.3
12/13/2023 13:37	55.9	97.0
12/13/2023 13:38	55.6	96.1
12/13/2023 13:39	55.9	97.5
12/13/2023 13:40	54.9	93.2
12/13/2023 13:41	54.2	92.5
12/13/2023 13:42	54.8	93.8
12/13/2023 13:43	55.1	95.5
12/13/2023 13:44	55.0	93.7
12/13/2023 13:45	54.0	91.5
12/13/2023 13:46	53.6	91.1
12/13/2023 13:47	53.6	91.6
12/13/2023 13:48	53.2	91.8
12/13/2023 13:49	53.5	92.5
12/13/2023 13:50	53.8	92.0
12/13/2023 13:51	54.1	93.4
12/13/2023 13:52	54.1	92.7
12/13/2023 13:53	53.9	93.6
12/13/2023 13:54	54.3	93.5
12/13/2023 13:55	53.7	93.1

Kiln 20 RTR - Run 2

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
12/13/2023 13:56	53.6	91.6
12/13/2023 13:57	54.0	91.8
12/13/2023 13:58	53.9	91.6
12/13/2023 13:59	54.0	92.6
12/13/2023 14:00	54.2	92.7
12/13/2023 14:01	54.0	93.0
12/13/2023 14:02	54.5	93.0
12/13/2023 14:03	54.5	93.2
12/13/2023 14:04	54.5	94.2
12/13/2023 14:05	54.9	94.5
12/13/2023 14:06	54.5	93.9
12/13/2023 14:07	54.9	94.2
12/13/2023 14:08	54.8	93.5
12/13/2023 14:09	54.6	93.5
12/13/2023 14:10	54.2	92.8
12/13/2023 14:11	53.8	93.2
12/13/2023 14:12	54.5	94.5
12/13/2023 14:13	54.7	92.9
12/13/2023 14:14	54.1	93.6
12/13/2023 14:15	54.7	95.2
12/13/2023 14:16	54.9	92.8
12/13/2023 14:17	54.5	93.8
12/13/2023 14:18	54.3	93.6
12/13/2023 14:19	54.7	93.9
12/13/2023 14:20	54.8	94.0
12/13/2023 14:21	54.6	94.3
12/13/2023 14:22	55.1	95.4
12/13/2023 14:23	55.2	96.5
12/13/2023 14:24	55.0	94.1
12/13/2023 14:25	55.1	93.5
12/13/2023 14:26	54.8	95.4
12/13/2023 14:27	55.3	95.7
12/13/2023 14:28	54.6	93.4
12/13/2023 14:29	54.7	94.2
12/13/2023 14:30	54.1	93.0
12/13/2023 14:31	54.1	94.0
12/13/2023 14:32	55.0	96.2
12/13/2023 14:33	54.9	94.9
12/13/2023 14:34	54.5	93.9
12/13/2023 14:35	55.0	96.2
12/13/2023 14:36	55.3	93.9
12/13/2023 14:37	54.2	94.0

Kiln 20 RTR - Run 2

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
12/13/2023 14:38	54.6	94.7
12/13/2023 14:39	54.1	93.1
12/13/2023 14:40	53.8	93.4
12/13/2023 14:41	54.1	92.5
12/13/2023 14:42	54.6	93.9
12/13/2023 14:43	54.0	92.7
12/13/2023 14:44	54.2	94.1
12/13/2023 14:45	54.7	93.8

Kiln 20 RTR - Run 3

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
Average	56.2	96.6
12/13/2023 15:00	56.2	96.5
12/13/2023 15:01	56.3	96.5
12/13/2023 15:02	56.9	98.1
12/13/2023 15:03	56.2	94.2
12/13/2023 15:04	56.1	96.6
12/13/2023 15:05	56.3	97.1
12/13/2023 15:06	55.9	95.5
12/13/2023 15:07	56.2	97.8
12/13/2023 15:08	56.3	97.0
12/13/2023 15:09	56.5	97.5
12/13/2023 15:10	56.4	97.6
12/13/2023 15:11	56.3	96.7
12/13/2023 15:12	55.9	96.0
12/13/2023 15:13	56.2	96.5
12/13/2023 15:14	57.5	97.6
12/13/2023 15:15	57.5	97.6
12/13/2023 15:16	57.8	98.3
12/13/2023 15:17	56.8	96.9
12/13/2023 15:18	56.0	96.4
12/13/2023 15:19	56.4	96.2
12/13/2023 15:20	56.0	97.1
12/13/2023 15:21	56.3	96.4
12/13/2023 15:22	56.7	98.6
12/13/2023 15:23	56.0	97.2
12/13/2023 15:24	56.0	96.0
12/13/2023 15:25	56.2	95.8
12/13/2023 15:26	55.4	95.0
12/13/2023 15:27	55.3	96.1
12/13/2023 15:28	55.4	94.5
12/13/2023 15:29	55.3	95.6
12/13/2023 15:30	55.6	94.2
12/13/2023 15:31	55.7	95.1
12/13/2023 15:32	55.8	94.6
12/13/2023 15:33	55.6	94.1
12/13/2023 15:34	55.2	95.7
12/13/2023 15:35	55.6	96.5
12/13/2023 15:36	55.6	97.1
12/13/2023 15:37	55.8	95.5
12/13/2023 15:38	55.7	94.2
12/13/2023 15:39	56.3	97.4
12/13/2023 15:40	56.1	95.5

Kiln 20 RTR - Run 3

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
12/13/2023 15:41	56.1	98.0
12/13/2023 15:42	56.4	95.9
12/13/2023 15:43	55.8	95.5
12/13/2023 15:44	56.2	96.6
12/13/2023 15:45	55.7	95.2
12/13/2023 15:46	56.4	98.5
12/13/2023 15:47	56.1	98.8
12/13/2023 15:48	58.6	103.0
12/13/2023 15:49	57.8	98.0
12/13/2023 15:50	57.3	100.7
12/13/2023 15:51	58.2	108.2
12/13/2023 15:52	58.5	91.7
12/13/2023 15:53	53.2	90.5
12/13/2023 15:54	52.8	89.9
12/13/2023 15:55	53.2	92.7
12/13/2023 15:56	53.7	94.5
12/13/2023 15:57	55.3	95.8
12/13/2023 15:58	55.7	94.1
12/13/2023 15:59	55.8	95.5
12/13/2023 16:00	55.7	94.7
12/13/2023 16:01	56.0	96.1
12/13/2023 16:02	57.1	98.4
12/13/2023 16:03	57.0	96.6
12/13/2023 16:04	56.2	96.8
12/13/2023 16:05	57.1	100.1
12/13/2023 16:06	57.3	97.5
12/13/2023 16:07	57.2	100.8
12/13/2023 16:08	61.7	116.6
12/13/2023 16:09	59.6	91.4
12/13/2023 16:10	53.4	93.1
12/13/2023 16:11	54.2	94.5
12/13/2023 16:12	53.9	93.2
12/13/2023 16:13	54.1	93.2
12/13/2023 16:14	54.8	95.4
12/13/2023 16:15	55.1	95.5
12/13/2023 16:16	55.9	97.8
12/13/2023 16:17	56.3	96.8
12/13/2023 16:18	56.1	97.0
12/13/2023 16:19	56.8	97.8
12/13/2023 16:20	59.1	104.0
12/13/2023 16:21	60.0	104.6
12/13/2023 16:22	61.9	110.9

Kiln 20 RTR - Run 3

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
12/13/2023 16:23	60.4	93.8
12/13/2023 16:24	52.7	88.4
12/13/2023 16:25	52.8	90.8
12/13/2023 16:26	54.0	93.5
12/13/2023 16:27	54.2	92.2
12/13/2023 16:28	54.8	96.4
12/13/2023 16:29	55.8	96.4
12/13/2023 16:30	55.8	95.5

Run 1

Kiln 21

EPA RTR Part 114 Information Request

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
Average	46.2	91.7
12/12/2023 10:20	46.7	88.2
12/12/2023 10:21	44.9	93.9
12/12/2023 10:22	47.2	93.2
12/12/2023 10:23	46.2	89.8
12/12/2023 10:24	45.6	90.9
12/12/2023 10:25	46.4	89.2
12/12/2023 10:26	45.3	93.2
12/12/2023 10:27	46.2	90.2
12/12/2023 10:28	46.6	92.7
12/12/2023 10:29	46.1	94.0
12/12/2023 10:30	46.3	90.2
12/12/2023 10:31	47.2	92.8
12/12/2023 10:32	45.0	86.9
12/12/2023 10:33	45.6	91.9
12/12/2023 10:34	46.1	92.0
12/12/2023 10:35	45.2	89.1
12/12/2023 10:36	46.0	91.0
12/12/2023 10:37	45.9	93.0
12/12/2023 10:38	48.1	98.5
12/12/2023 10:39	47.2	93.6
12/12/2023 10:40	46.8	92.2
12/12/2023 10:41	46.2	91.3
12/12/2023 10:42	45.4	89.1
12/12/2023 10:43	45.4	91.0
12/12/2023 10:44	47.1	95.5
12/12/2023 10:45	48.2	94.8
12/12/2023 10:46	45.9	89.8
12/12/2023 10:47	45.2	89.9
12/12/2023 10:48	45.0	89.4
12/12/2023 10:49	46.5	91.6
12/12/2023 10:50	48.0	94.1
12/12/2023 10:51	47.2	93.0
12/12/2023 10:52	46.4	90.8
12/12/2023 10:53	47.3	94.9
12/12/2023 10:54	47.6	97.2
12/12/2023 10:55	46.1	88.5
12/12/2023 10:56	44.0	85.2
12/12/2023 10:57	45.7	92.6

Run 1

Kiln 21

EPA RTR Part 114 Information Request

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
12/12/2023 10:58	47.8	96.4
12/12/2023 10:59	45.4	82.4
12/12/2023 11:00	40.9	80.2
12/12/2023 11:01	43.4	91.1
12/12/2023 11:02	52.0	107.0
12/12/2023 11:03	49.3	92.5
12/12/2023 11:04	46.7	92.6
12/12/2023 11:05	45.4	90.0
12/12/2023 11:06	47.0	97.0
12/12/2023 11:07	46.7	90.2
12/12/2023 11:08	46.1	92.3
12/12/2023 11:09	47.1	96.3
12/12/2023 11:10	46.2	85.0
12/12/2023 11:11	44.0	88.9
12/12/2023 11:12	46.1	93.7
12/12/2023 11:13	46.5	94.0
12/12/2023 11:14	48.0	96.5
12/12/2023 11:15	47.1	90.3
12/12/2023 11:16	44.9	87.9
12/12/2023 11:17	45.6	91.2
12/12/2023 11:18	46.3	92.1
12/12/2023 11:19	46.0	93.8
12/12/2023 11:20	46.5	90.8
12/12/2023 11:21	46.0	89.0
12/12/2023 11:22	45.2	89.7
12/12/2023 11:23	45.6	95.4
12/12/2023 11:24	47.0	90.6
12/12/2023 11:25	46.5	93.6
12/12/2023 11:26	46.6	90.8
12/12/2023 11:27	45.1	88.6
12/12/2023 11:28	46.7	94.7
12/12/2023 11:29	46.6	94.5
12/12/2023 11:30	46.3	90.7
12/12/2023 11:31	45.7	89.0
12/12/2023 11:32	44.6	89.2
12/12/2023 11:33	45.7	93.7
12/12/2023 11:34	46.7	91.7
12/12/2023 11:35	46.3	91.7
12/12/2023 11:36	46.1	93.1

Run 1

Kiln 21

EPA RTR Part 114 Information Request

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
12/12/2023 11:37	47.5	93.3
12/12/2023 11:38	46.5	91.0
12/12/2023 11:39	44.8	89.2
12/12/2023 11:40	45.0	90.4
12/12/2023 11:41	46.6	93.0
12/12/2023 11:42	45.7	90.8
12/12/2023 11:43	46.1	90.2
12/12/2023 11:44	46.7	91.5
12/12/2023 11:45	46.0	88.7
12/12/2023 11:46	44.0	88.5
12/12/2023 11:47	46.8	94.7
12/12/2023 11:48	48.2	91.4
12/12/2023 11:49	44.9	91.0
12/12/2023 11:50	46.6	90.9
12/12/2023 11:51	46.6	94.2

Run 2

Kiln 21

EPA RTR Part 114 Information Request

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
Average	45.0	89.5
12/12/2023 12:30	43.9	88.8
12/12/2023 12:31	45.2	90.2
12/12/2023 12:32	45.1	89.7
12/12/2023 12:33	45.1	89.4
12/12/2023 12:34	44.9	86.4
12/12/2023 12:35	44.1	88.8
12/12/2023 12:36	45.1	89.2
12/12/2023 12:37	44.8	90.4
12/12/2023 12:38	45.0	89.0
12/12/2023 12:39	45.0	89.3
12/12/2023 12:40	44.6	87.1
12/12/2023 12:41	44.3	86.9
12/12/2023 12:42	44.4	88.0
12/12/2023 12:43	45.0	92.0
12/12/2023 12:44	45.4	88.9
12/12/2023 12:45	43.9	84.3
12/12/2023 12:46	42.5	87.8
12/12/2023 12:47	44.4	90.0
12/12/2023 12:48	45.3	88.3
12/12/2023 12:49	44.2	86.0
12/12/2023 12:50	44.1	87.1
12/12/2023 12:51	44.6	90.2
12/12/2023 12:52	45.5	88.2
12/12/2023 12:53	45.3	91.8
12/12/2023 12:54	44.8	91.4
12/12/2023 12:55	45.2	90.8
12/12/2023 12:56	45.3	91.1
12/12/2023 12:57	44.9	88.7
12/12/2023 12:58	44.3	86.5
12/12/2023 12:59	43.1	85.8
12/12/2023 13:00	44.2	88.2
12/12/2023 13:01	45.1	90.9
12/12/2023 13:02	45.7	91.0
12/12/2023 13:03	45.1	88.4
12/12/2023 13:04	45.5	89.5
12/12/2023 13:05	43.9	87.0
12/12/2023 13:06	42.5	86.1
12/12/2023 13:07	44.8	88.8

Run 2

Kiln 21

EPA RTR Part 114 Information Request

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
12/12/2023 13:08	45.9	88.0
12/12/2023 13:09	44.1	88.6
12/12/2023 13:10	45.4	91.0
12/12/2023 13:11	44.4	87.1
12/12/2023 13:12	45.1	88.8
12/12/2023 13:13	45.3	88.8
12/12/2023 13:14	43.8	89.0
12/12/2023 13:15	45.7	88.5
12/12/2023 13:16	44.2	87.6
12/12/2023 13:17	45.2	92.1
12/12/2023 13:18	46.6	91.4
12/12/2023 13:19	44.3	86.0
12/12/2023 13:20	44.6	90.3
12/12/2023 13:21	45.0	89.7
12/12/2023 13:22	45.1	90.9
12/12/2023 13:23	45.1	90.4
12/12/2023 13:24	46.2	93.0
12/12/2023 13:25	47.0	90.1
12/12/2023 13:26	44.2	89.2
12/12/2023 13:27	45.1	89.9
12/12/2023 13:28	45.3	87.7
12/12/2023 13:29	45.0	88.8
12/12/2023 13:30	44.1	88.0
12/12/2023 13:31	45.4	93.9
12/12/2023 13:32	47.2	92.8
12/12/2023 13:33	46.1	89.3
12/12/2023 13:34	45.9	91.2
12/12/2023 13:35	45.0	89.9
12/12/2023 13:36	44.5	87.1
12/12/2023 13:37	45.9	89.5
12/12/2023 13:38	45.1	89.2
12/12/2023 13:39	44.8	89.8
12/12/2023 13:40	44.9	88.6
12/12/2023 13:41	45.4	93.0
12/12/2023 13:42	47.1	91.9
12/12/2023 13:43	45.9	94.8
12/12/2023 13:44	45.4	88.1
12/12/2023 13:45	44.8	90.8
12/12/2023 13:46	44.8	87.1

Run 2

Kiln 21

EPA RTR Part 114 Information Request

Date/Time	PRODUCTION_ CD (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
12/12/2023 13:47	44.8	90.6
12/12/2023 13:48	45.6	91.8
12/12/2023 13:49	46.3	93.1
12/12/2023 13:50	46.1	90.6
12/12/2023 13:51	46.2	90.2
12/12/2023 13:52	44.9	87.9
12/12/2023 13:53	44.6	88.9
12/12/2023 13:54	45.1	87.7
12/12/2023 13:55	46.2	90.5
12/12/2023 13:56	45.1	87.9
12/12/2023 13:57	44.8	90.4
12/12/2023 13:58	45.7	88.9
12/12/2023 13:59	45.3	92.8
12/12/2023 14:00	46.4	94.8

Run 3

Kiln 21

EPA RTR Part 114 Information Request

Date/Time	PRODUCTION_C D (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
Average	44.8	89.1
12/12/2023 14:15	43.8	89.5
12/12/2023 14:16	45.5	88.2
12/12/2023 14:17	44.2	88.8
12/12/2023 14:18	45.4	92.5
12/12/2023 14:19	45.7	89.2
12/12/2023 14:20	44.4	87.5
12/12/2023 14:21	44.9	91.0
12/12/2023 14:22	46.0	90.9
12/12/2023 14:23	46.0	91.4
12/12/2023 14:24	46.4	91.2
12/12/2023 14:25	43.9	85.4
12/12/2023 14:26	44.2	91.8
12/12/2023 14:27	47.3	92.5
12/12/2023 14:28	46.6	90.1
12/12/2023 14:29	44.3	82.0
12/12/2023 14:30	43.2	87.5
12/12/2023 14:31	46.5	95.5
12/12/2023 14:32	46.4	88.8
12/12/2023 14:33	45.4	87.1
12/12/2023 14:34	45.4	88.2
12/12/2023 14:35	43.8	88.4
12/12/2023 14:36	45.1	87.6
12/12/2023 14:37	43.9	87.5
12/12/2023 14:38	44.8	92.2
12/12/2023 14:39	45.9	89.1
12/12/2023 14:40	46.1	90.8
12/12/2023 14:41	44.3	89.1
12/12/2023 14:42	45.1	89.1
12/12/2023 14:43	45.4	90.9
12/12/2023 14:44	45.4	89.9
12/12/2023 14:45	44.1	88.7
12/12/2023 14:46	45.1	90.5
12/12/2023 14:47	44.4	90.6
12/12/2023 14:48	44.8	89.4
12/12/2023 14:49	45.3	88.6
12/12/2023 14:50	46.0	89.6
12/12/2023 14:51	45.4	91.9
12/12/2023 14:52	44.6	86.9

Run 3

Kiln 21

EPA RTR Part 114 Information Request

Date/Time	PRODUCTION_C D (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
12/12/2023 14:53	44.8	87.7
12/12/2023 14:54	45.2	90.5
12/12/2023 14:55	44.5	88.1
12/12/2023 14:56	45.3	90.5
12/12/2023 14:57	45.9	91.0
12/12/2023 14:58	45.0	86.9
12/12/2023 14:59	43.3	89.0
12/12/2023 15:00	44.5	88.6
12/12/2023 15:01	45.4	91.2
12/12/2023 15:02	46.0	92.3
12/12/2023 15:03	44.8	89.3
12/12/2023 15:04	44.6	89.1
12/12/2023 15:05	45.9	87.4
12/12/2023 15:06	44.5	89.8
12/12/2023 15:07	45.1	86.5
12/12/2023 15:08	43.5	87.4
12/12/2023 15:09	44.5	89.9
12/12/2023 15:10	44.5	88.5
12/12/2023 15:11	44.5	89.7
12/12/2023 15:12	45.6	90.6
12/12/2023 15:13	44.4	88.8
12/12/2023 15:14	45.0	88.5
12/12/2023 15:15	44.2	89.3
12/12/2023 15:16	45.2	89.9
12/12/2023 15:17	45.6	89.0
12/12/2023 15:18	44.0	87.6
12/12/2023 15:19	45.2	89.5
12/12/2023 15:20	45.1	86.5
12/12/2023 15:21	44.8	87.9
12/12/2023 15:22	43.8	89.1
12/12/2023 15:23	45.2	91.7
12/12/2023 15:24	45.5	87.9
12/12/2023 15:25	45.2	90.4
12/12/2023 15:26	44.0	84.9
12/12/2023 15:27	42.8	88.0
12/12/2023 15:28	44.1	89.1
12/12/2023 15:29	44.2	90.5
12/12/2023 15:30	44.5	87.2
12/12/2023 15:31	45.2	90.7

Run 3

Kiln 21

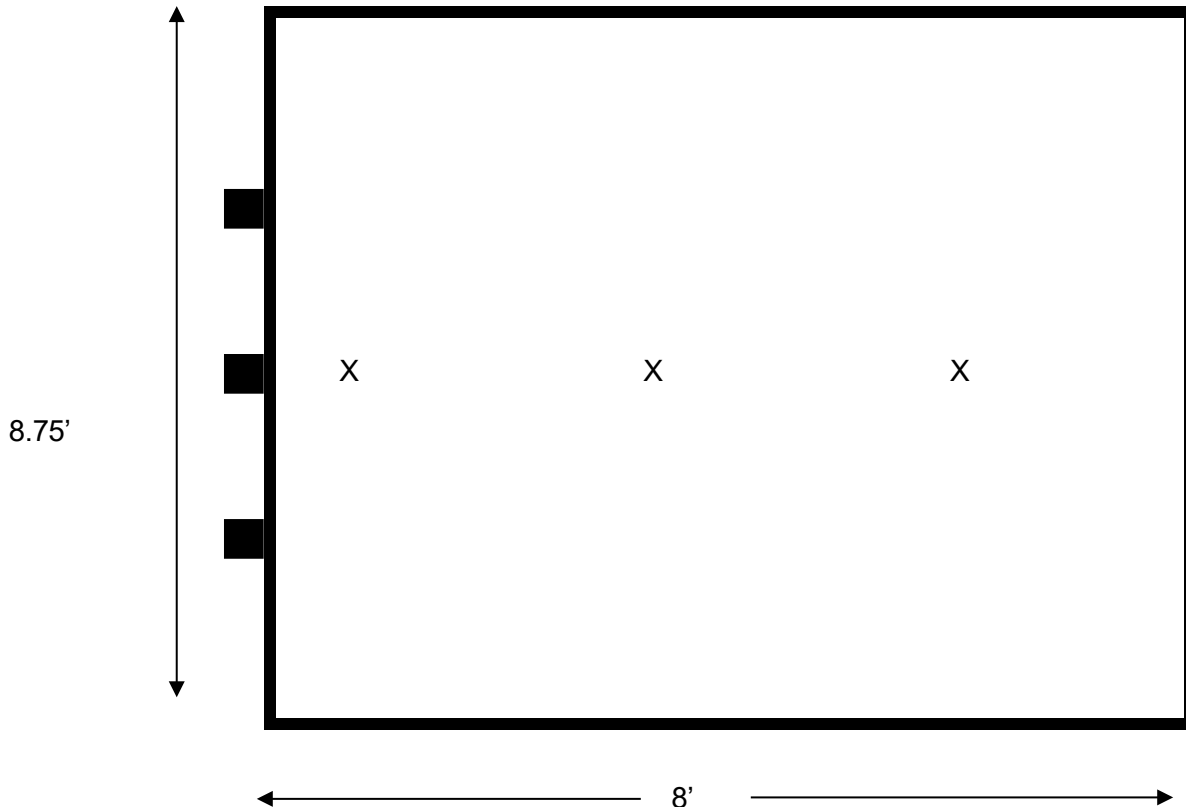
EPA RTR Part 114 Information Request

Date/Time	PRODUCTION_C D (TNHR) Expression Value	KILN_FEED_ RATE (TNHR) Raw Value
12/12/2023 15:32	44.5	87.3
12/12/2023 15:33	44.3	93.0
12/12/2023 15:34	44.8	86.1
12/12/2023 15:35	44.5	91.2
12/12/2023 15:36	45.3	89.2
12/12/2023 15:37	45.1	91.0
12/12/2023 15:38	43.9	86.0
12/12/2023 15:39	44.0	85.4
12/12/2023 15:40	43.2	87.5
12/12/2023 15:41	43.9	87.3
12/12/2023 15:42	44.9	90.3
12/12/2023 15:43	44.0	86.9
12/12/2023 15:44	43.7	86.8
12/12/2023 15:45	43.2	86.6

Appendix B – Test Section Diagrams

EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS

(Gaseous)



Job: Holcim (US) Inc.
Alpena Plant
Alpena, Michigan

Area: 70.0 square feet

Test Location: Kiln 20 Breaching Duct

No. Test Ports: 1

Length: 8.0 Feet

Tests Points per Port: 3

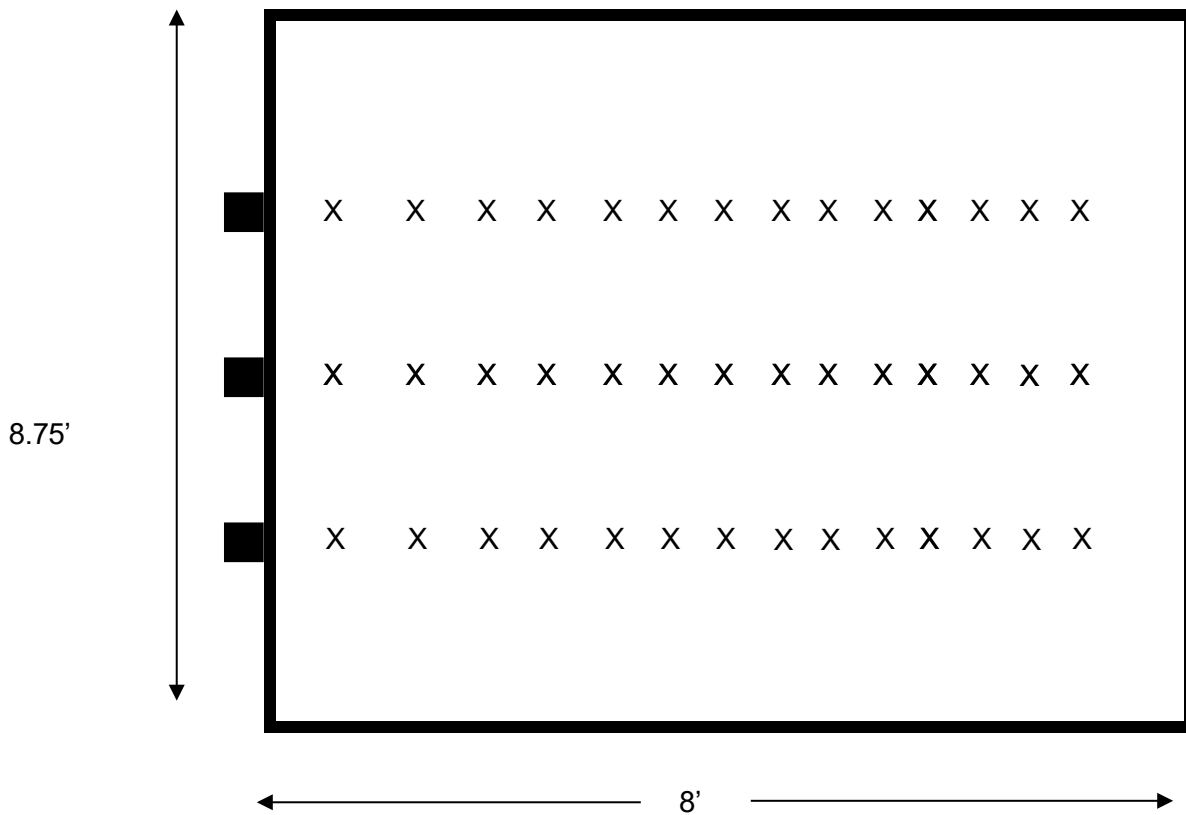
Width: 8.75 Inch

Upstream: ~1.0 diameters

Downstream: ~8.5 diameters

Port Length 3.25 Inches

EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS



Job: Holcim (US) Inc.
Alpena Plant
Alpena, Michigan

Area: 70.00 square feet

Test Location: Kiln 20 Breaching Duct

No. Test Ports: 3

Length: 8.0 Feet

Tests Points per Port: 14

Width: 8.75 Feet

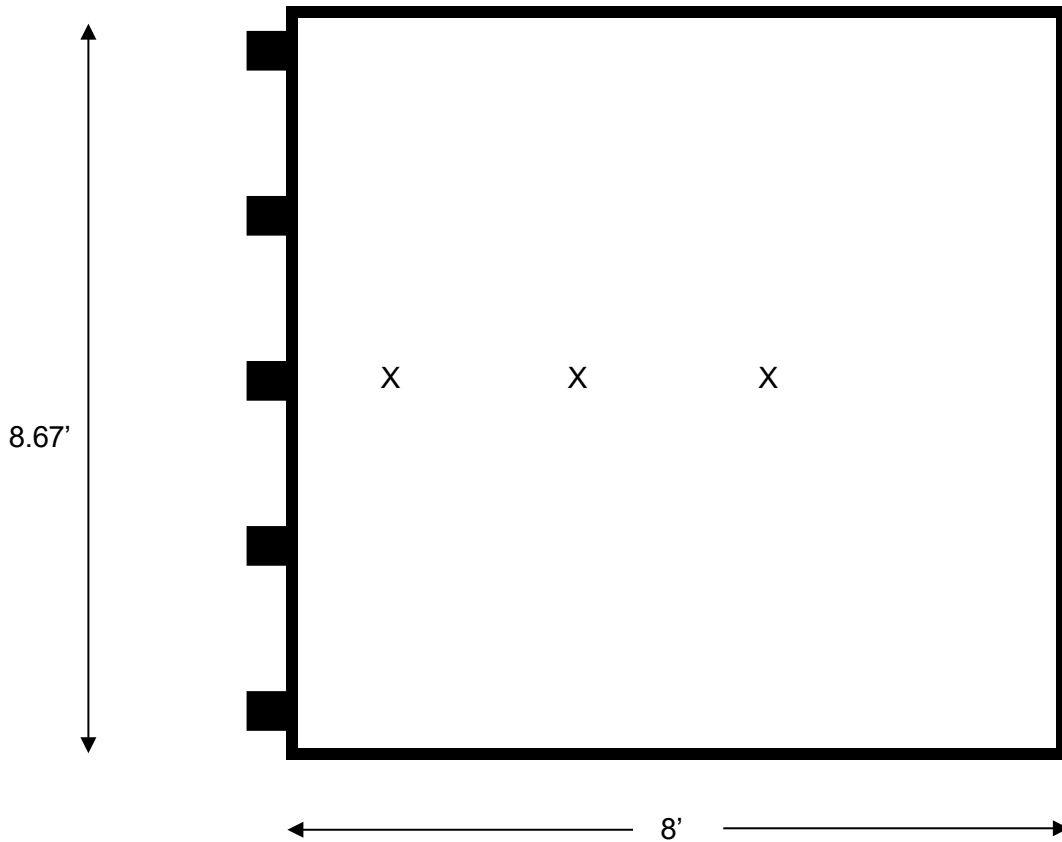
Upstream: ~1.0 diameters

Downstream: ~8.5 diameters

Port Length: 3.25 Inches

EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS

(Gaseous)



Job: Holcim (US) Inc.
Alpena Plant
Alpena, Michigan

Area: 69.36 square feet

Test Location: Kiln 21 Breaching Duct

No. Test Ports: 1

Length: 8.0 Feet

Tests Points per Port: 3

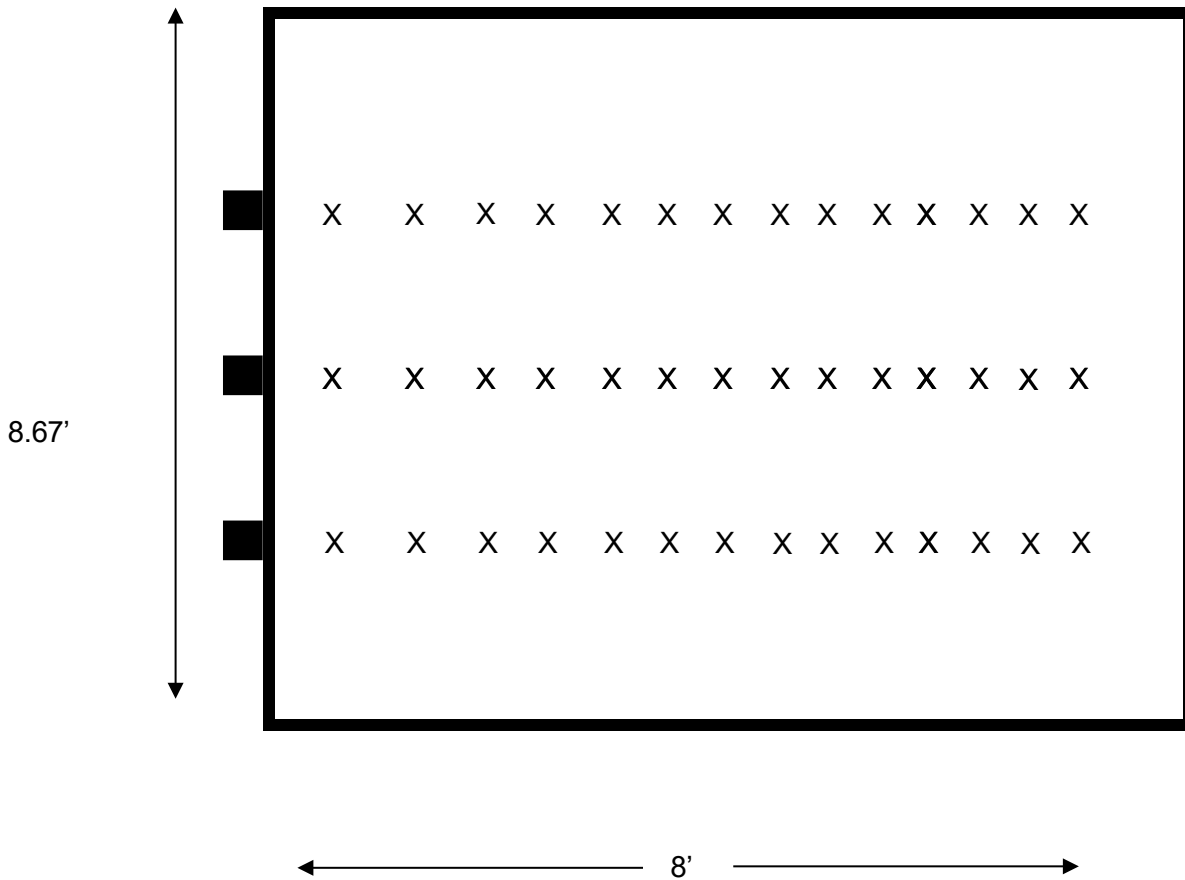
Width: 8.67 Feet

Upstream: ~1.0 diameters

Downstream: ~8.5 diameters

Port Length: 3.25 Inches

EQUAL AREA TRAVERSE FOR RECTANGULAR DUCTS



Job: Holcim (US) Inc.
Alpena Plant
Alpena, Michigan

Area: 69.36 square feet

Test Location: Kiln 21 Breaching Duct

No. Test Ports: 3

Length: 8.0 Feet

Tests Points per Port: 14

Width: 8.67 Feet

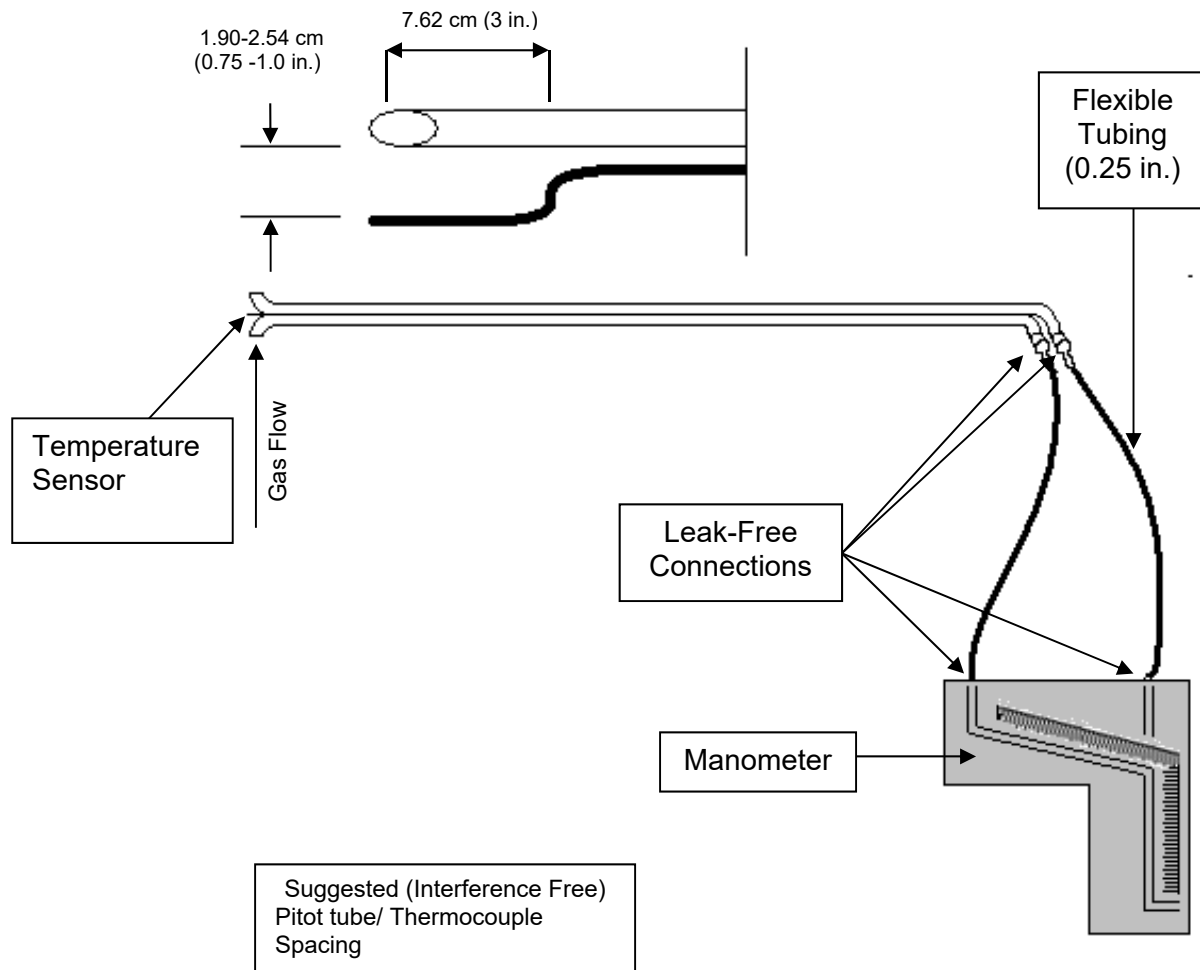
Upstream: ~1.0 diameters

Downstream: ~8.5 diameters

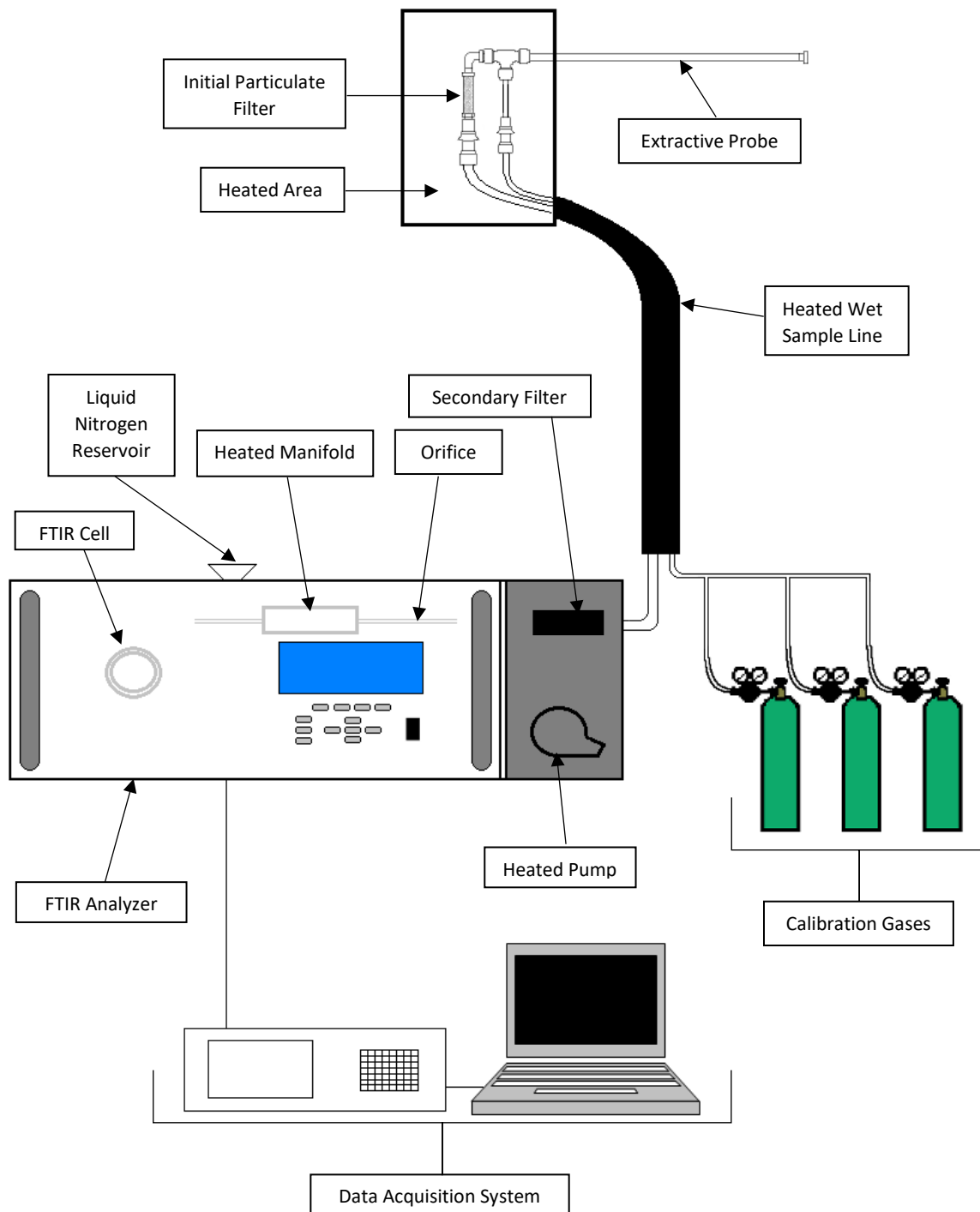
Port Length: 3.25 Inches

Appendix C – Sample Train Diagrams

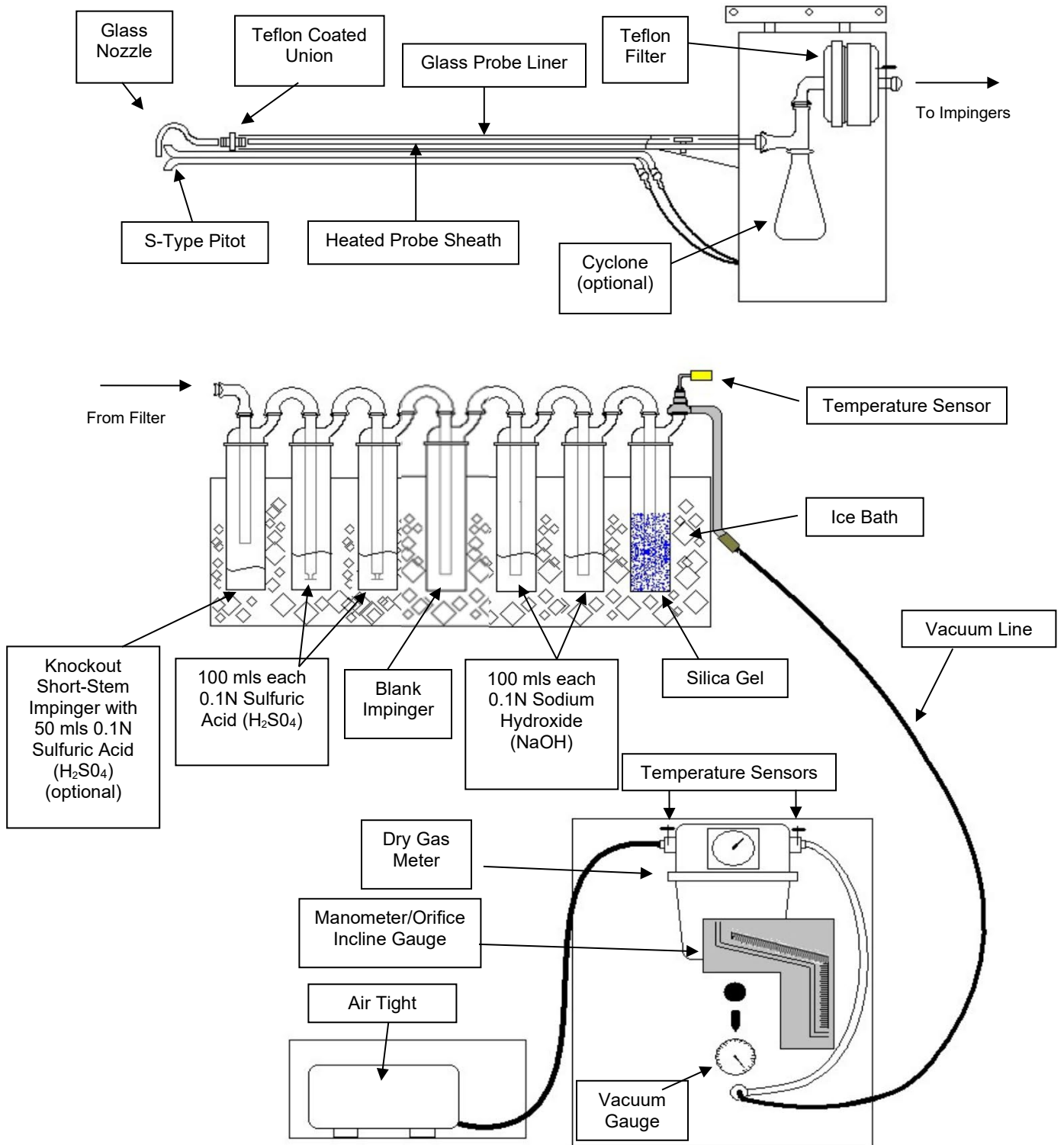
USEPA Method 2 – Type S Pitot Tube Manometer Assembly



USEPA Method 320 – Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy Sample Train Diagram



USEPA Method 26A – HF and Cl₂ Sample Train Diagram



Appendix D – Calculation Nomenclature and Formulas

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 20 Breaching Duct
 Run: 1A
 Date: 12/13/2023
 Method: 26A
 Source Condition: Normal

Dry Molecular Weight

$$Md = 0.44 \times (\%CO_2) + 0.32 \times (\%O_2) + 0.28 \times \%N_2$$

$$\%CO_2 = \underline{16.3} \qquad \%O_2 = \underline{9.5} \qquad \%N_2 = \underline{74.3}$$

$$Md = \underline{30.982}$$

Wet Molecular Weight

$$Ms = Md \times (1 - Bws) + (18.0 \times Bws)$$

$$Md = \underline{30.982} \qquad Bws = \underline{0.048}$$

$$Ms = \underline{30.355}$$

Meter Volume at Standard Conditions

$$Vm(std) = 17.647 \times Y \times Vm \times \frac{(Pbar + DH/13.6)}{Tm}$$

$$Y = \underline{0.995} \qquad Vm = \underline{34.632} \qquad Pbar = \underline{29.4}$$

$$DH = \underline{0.6} \qquad Tm = \underline{36.3}$$

$$Vm(std) = \underline{36.047}$$

Volume of Water Vapor Condensed

$$Vw(std) = 0.0471 \times (\text{net } H_2O \text{ gain})$$

$$\text{Net } H_2O = \underline{38.8}$$

$$Vw(std) = \underline{1.827}$$

Moisture Content

$$Bws = \frac{Vw(std)}{Vw(std) + Vm(std)}$$

$$Vw(std) = \underline{1.827} \qquad Vm(std) = \underline{36.047}$$

$$Bws = \underline{0.048}$$

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 20 Breaching Duct
 Run: 1A
 Date: 12/13/2023
 Method: 26A
 Source Condition: Normal

Average Duct Velocity

$$V_s = 85.49 \times C_p \times \sqrt{DP \text{ (avg)}} \times (T_s \text{ (avg)} + 460 / (P_s \times M_s))^{1/2}$$

$C_p = \frac{0.834}{29.32}$	$T_s \text{ (avg)} = \frac{391.7}{30.355}$	$\sqrt{DP \text{ (avg)}} = \frac{0.438}{}$
$P_s = \frac{29.32}{}$	$M_s = \frac{30.355}{}$	
$V_s = \frac{30.570}{}$		

Volumetric Flow Rate (Actual Basis)

$$Q = V_s \times A \times 60$$

$V_s = \frac{30.570}{}$	$A = \frac{70.000}{}$
$Q = \frac{128,394}{}$	

Volumetric Flow Rate (Standard Basis)

$$Q_{std} = 17.647 \times Q \times \frac{P_s}{T_s \text{ (avg)} + 460}$$

$Q = \frac{128,394}{}$	$P_s = \frac{29.32}{}$	$T_s \text{ (avg)} = \frac{391.7}{}$
$Q_{std} = \frac{78,002}{}$		

Volumetric Flow Rate (Standard Dry Basis)

$$Q_{std(dry)} = Q_{std} \times (1 - Bws)$$

$Q_{std} = \frac{78,002}{}$	$Bws = \frac{0.048}{}$
$Q_{std(dry)} = \frac{74,239}{}$	

Isokinetic Variation:

$$\%ISO = \frac{0.0945 \times (T_s + 460) \times V_m(std)}{V_s \times \theta \times A_n \times P_s \times (1 - Bws)}$$

$T_s = \frac{391.7}{}$	$V_m(std) = \frac{36.047}{}$	$V_s = \frac{30.570}{}$
$A_n = \frac{0.0004125}{}$	$\theta = \frac{84}{}$	$P_s = \frac{29.32}{}$
$Bws = \frac{0.048}{}$		
$\%ISO = \frac{98.2}{}$		

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 20 Breaching Duct
 Run: 1A
 Date: 12/13/2023
 Method: 26A
 Source Condition: Normal

Hydrogen Fluoride (HF) Concentration:

$$\begin{aligned}
 \text{mg/m}^3 &= \frac{\text{mg of Hydrogen Fluoride (HF)}}{\text{Vm(std)} \times 0.02832 \text{ m}^3/\text{ft}^3} \\
 \text{mg} &= \underline{0.15} \quad \text{Vm(std)} = \underline{36.047} \\
 \text{mg/m}^3 &= \underline{0.15}
 \end{aligned}$$

Hydrogen Fluoride (HF) Emission Rate:

$$\begin{aligned}
 \text{lb of Hydrogen Fluoride (HF)} &= \frac{\mu\text{g of sample} \times 10^6 \text{ grams}/\mu\text{g}}{453.6 \text{ grams/lb}} \\
 \text{Emission Rate lb/hr} &= \frac{\text{lb of Hydrogen Fluoride (HF)}}{\text{Vm(std)}} \times \text{dscfm} \times 60 \text{ min/hr} \\
 \text{lb of Hydrogen Fluoride (HF)} &= \underline{3.31\text{E-}10} \quad \text{dscfm} = \underline{74,239} \\
 \text{Emission Rate lb/hr} &= \underline{0.0409}
 \end{aligned}$$

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Test Location: Kiln 20 Exhaust
Date: 12/13/23

Sample Calculations

$$(9.46 \% - 0.16 \%) \times \frac{\text{O2 \% (dry)} \quad 10.10 \%}{10.09 \% - 0.16 \%} = 9.46 \%$$

$$C_{\text{gas}} = (C - C_o) \times \frac{C_{\text{ma}}}{C_m - C_o}$$

where:

C_{gas} = Effluent gas concentration, dry basis, ppm or %

C = Average gas concentration indicated by gas analyzer, dry basis, ppm or %

C_o = Average of initial and final system calibration bias check responses for the zero gas, ppm or %

C_m = Average of initial and final system calibration bias check responses for the upscale calibration gas, ppm or %

C_{ma} = Actual concentration of the upscale calibration gas, ppm or %

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Project #: M235005
 Test Location: Kiln 20 Exhaust
 Date: 12/13/23

FTIR Sample Calculations

Direct Recovery % of Calibration Transfer Standard

$$DR_{cts} = \frac{D_{cts}}{Cma} \times 100$$

$$Cma = \underline{100.1}$$

$$D_{cts} = \underline{100.6}$$

$$DR_{cts} = \underline{100.5\%}$$

Recovery % with Calibration Transfer Standard System Purge

$$R_{cts} = \frac{Sys_{cts}}{D_{cts}} \times 100$$

$$Sys_{cts} = \underline{98.3}$$

$$D_{cts} = \underline{100.6}$$

$$R_{cts} = \underline{98\%}$$

Direct Recovery % of Analyte Spike Gas

SF6

$$DR_{sf6} = \frac{D_{sf6}}{Cma} \times 100$$

$$Cma = \underline{5.0}$$

$$D_{sf6} = \underline{5.0}$$

$$DR_{sf6} = \underline{100\%}$$

HCN

$$DR_{asg} = \frac{D_{asg}}{Cma} \times 100$$

$$Cma = \underline{49.7}$$

$$D_{asg} = \underline{49.4}$$

$$DR_{asg} = \underline{99.3\%}$$

Dilution Factor for Analyte Spiking

$$DF = \frac{Spk_{sf6}}{D_{sf6}}$$

$$Spk_{sf6} = \underline{0.450}$$

$$D_{sf6} = \underline{5.024}$$

$$DF = \underline{0.090}$$

Recovery % for Analyte Spike With HCN

$$R_x = \frac{Spk_x}{(N_x \times (1-DF) + D_{asg} \times DF)}$$

$$Spk_x = \underline{5.7}$$

$$N_x = \underline{1.6}$$

$$DF = \underline{0.090}$$

$$D_{asg} = \underline{49.4}$$

$$R_x = \underline{97.9} \quad \%$$

where:

DR_{cts} = Recovery % of the calibration transfer standard directly to the analyzer

Cma = certified concentration of calibration gas, ppm

D_{cts} = Concentration of the calibration transfer standard gas directly to the analyzer, ppm

R_{cts} = Recovery % of the calibration transfer standard through the sampling system

Sys_{cts} = Concentration of the calibration transfer standard gas through the system, ppm

DF = Dilution Factor of analyte spike gas

Spk_{sf6} = SF6 concentration in effluent during spiking

Spk_x = Analyte concentration in effluent during spiking

D_{asg} = Concentration of the analyte spike gas directly to the analyzer, ppm

D_{sf6} = Concentration of the SF6 directly to the analyzer, ppm

R_x = Recovery % of the analyte spike gas

N_x = Native effluent (HCN) concentration prior to analyte spike

MOSTARDI PLATT

Moisture Calculations

$$V_{wc(std)} = \frac{(V_f - V_i)\rho_w RT_{std}}{P_{std}M_w} = 0.04707(V_f - V_i)$$

$$V_{wsg(std)} = \frac{(W_f - W_i)\rho_w RT_{std}}{P_{std}M_w} = 0.04715(W_f - W_i)$$

$$V_{m(std)} = 17.64 V_m Y \frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}$$

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(std)}}{V_{wc(std)} + V_{wsg(std)} + V_{m(std)}}$$

Where:

B_{ws} = Water vapor in gas stream, proportion by volume

M_w = Molecular weight of water, 18.015 lb/lb-mole

P_{bar} = Barometric pressure at the testing site, in. Hg

P_{std} = Standard absolute pressure, 29.92 in. Hg

R = Ideal gas constant, $0.048137 \text{ (in. Hg)(ft}^3\text{)/(g-mole)(}^\circ\text{R)} =$
 $[21.8348 \text{ (in. Hg)(ft}^3\text{)/(lb-mole)(}^\circ\text{R)}]/453.592 \text{ g-mole/lb-mole}$

T_m = Absolute average dry gas meter temperature, $^\circ\text{R}$

T_{std} = Standard absolute temperature, 528 $^\circ\text{R}$

V_f = Final volume of condenser water, ml

V_i = Initial volume of condenser water, ml

V_m = Dry gas volume measured by dry gas meter, dcf

$V_{m(std)}$ = Dry gas volume measured by dry gas meter, corrected to standard conditions, scf

$V_{wc(std)}$ = Volume of condensed water vapor, corrected to standard conditions, scf

$V_{wsg(std)}$ = Volume of water vapor collected in silica gel, corrected to standard conditions, scf

W_f = Final weight of silica gel, g

W_i = Initial weight of silica gel, g

Y = Dry gas meter calibration factor

ΔH = Average pressure exerted on dry gas meter outlet by gas sample bag, in. H_2O

ρ_w = Density of water, 0.9982 g/ml

13.6 = Specific gravity of mercury (Hg)

17.64 = T_{std}/P_{std}

0.04707 = ft^3/ml 0.04715 = ft^3/g

MOSTARDI PLATT

Volumetric Flow Nomenclature

- A = Cross-sectional area of stack or duct, ft²
- Bws = Water vapor in gas stream, proportion by volume
- Cp = Pitot tube coefficient, dimensionless
- Md = Dry molecular weight of gas, lb/lb-mole
- Ms = Molecular weight of gas, wet basis, lb/lb-mole
- Mw = Molecular weight of water, 18.0 lb/lb-mole
- Pbar = Barometric pressure at testing site, in. Hg
- Pg = Static pressure of gas, in. Hg (in. H₂O/13.6)
- DH= Static pressure of gas, in.H₂O
- Ps = Absolute pressure of gas, in. Hg = Pbar + Pg
- Pstd = Standard absolute pressure, 29.92 in. Hg
- Acfm = Actual volumetric gas flow rate
- Scfm= Volumetric gas flow rate, corrected to standard conditions
- Dscfm = Standard volumetric flow rate, corrected to dry conditions
- R = Ideal gas constant, 21.85 in. Hg-ft³/°R-lb-mole
- Ts = Average stack gas temperature, °F
- Tm = Average dry gas meter temperature, °F
- Tstd = Standard absolute temperature, 528°R
- vs = Gas velocity, ft/sec
- Vm(std)= Volume of gas sampled, corrected to standard conditions, scf
- Vw(std) = Volume of water vapor in gas sample, corrected to standard conditions, scf
- Vlc= Volume of liquid collected
- Y = Dry gas meter calibration factor
- Δp = Velocity head of gas, in. H₂O
- K1 = 17.647 °R/in. Hg
- %EA = Percent excess air
- %CO₂ = Percent carbon dioxide by volume, dry basis
- %O₂ = Percent oxygen by volume, dry basis
- %N₂ = Percent nitrogen by volume, dry basis
- 0.264 = Ratio of O₂ to N₂ in air, v/v
- 0.28 = Molecular weight of N₂ or CO, divided by 100
- 0.32 = Molecular weight of O₂ divided by 100
- 0.44 = Molecular weight of CO₂ divided by 100
- 13.6 = Specific gravity of mercury (Hg)

MOSTARDI PLATT

Volumetric Air Flow Calculations

$$Vm (std) = 17.647 \times Vm \times \left[\frac{\left(P_{bar} + \left[\frac{DH}{13.6} \right] \right)}{(460 + Tm)} \right] \times Y$$

$$Vw (std) = 0.0471 \times Vlc$$

$$Bws = \left[\frac{Vw (std)}{Vw (std) + Vm (std)} \right]$$

$$Md = (0.44 \times \%CO_2) + (0.32 \times \%O_2) + [0.28 \times (100 - \%CO_2 - \%O_2)]$$

$$Ms = Md \times (1 - Bws) + (18 \times Bws)$$

$$Vs = \sqrt{\frac{(Ts + 460)}{Ms \times Ps}} \times \sqrt{DP} \times Cp \times 85.49$$

$$Acfm = Vs \times Area \text{ (of stack or duct)} \times 60$$

$$Scfm = Acfm \times 17.647 \times \left[\frac{Ps}{(460 + Ts)} \right]$$

$$Scfh = Scfm \times 60 \frac{min}{hr}$$

$$Dscfm = Scfm \times (1 - Bws)$$

MOSTARDI PLATT

Isokinetic Calculation Formulas

$$1. V_{w(std)} = V_{lc} \left(\frac{\rho_w}{M_w} \right) \left(\frac{RT_{std}}{P_{std}} \right) = K_2 V_{lc}$$

$$2. V_{m(std)} = V_m Y \left(\frac{T_{std}}{T_m} \right) \left(\frac{(P_{bar} + (\frac{\Delta H}{13.6}))}{P_{std}} \right) = K_1 V_m Y \frac{(P_{bar} + (\frac{\Delta H}{13.6}))}{T_m}$$

$$3. B_{ws} = \frac{V_{w(std)}}{(V_{m(std)} + V_{w(std)})}$$

$$4. M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2)$$

$$5. M_s = M_d(1 - B_{ws}) + 18.0(B_{ws})$$

$$6. C_a = \frac{m_a}{V_a \rho_a}$$

$$7. W_a = C_a V_{aw} \rho_a$$

$$8. C_{acf} = 15.43 K_i \left(\frac{m_n P_s}{V_{w(std)} + V_{m(std)} T_s} \right)$$

$$9. C_s = (15.43 \text{ grains/gram}) (m_n / V_{m(std)})$$

$$10. v_s = K_p C_p \sqrt{\frac{\Delta P T_s}{P_s M_s}}$$

$$11. Q_{acfm} = v_s A (60_{\text{sec/min}})$$

$$12. Q_{sd} = (3600_{\text{sec/hr}})(1 - B_{ws}) v_s \left(\frac{T_{std} P_s}{T_s P_{std}} \right) A$$

$$13. E (\text{emission rate, lbs/hr}) = Q_{std} (C_s / 7000 \text{ grains/lb})$$

$$14. IKV = \frac{T_s V_{m(std)} P_{std}}{T_{std} v_s \theta A_n P_s 60(1 - B_{ws})} = K_4 \frac{T_s V_{m(std)}}{P_s v_s A_n \theta (1 - B_{ws})}$$

$$15. \%EA = \left(\frac{\%O_2 - (0.5 \%CO)}{0.264 \%N_2 - (\%O_2 - 0.5 \%CO)} \right) \times 100$$

MOSTARDI PLATT

Isokinetic Nomenclature

- A = Cross-sectional area of stack or duct, square feet
A_n = Cross-sectional area of nozzle, square feet
B_{ws} = Water vapor in gas stream, by volume
C_a = Acetone blank residue concentration, g/g
C_{act} = Concentration of particulate matter in gas stream at actual conditions, gr/acf
C_p = Pitot tube coefficient
C_s = Concentration of particulate matter in gas stream, dry basis, corrected to standard conditions, gr/dscf
IKV = Isokinetic sampling variance, must be 90.0 % ≤ IKV ≤ 110.0%
M_d = Dry molecular weight of gas, lb/lb-mole
M_s = Molecular weight of gas, wet basis, lb/lb-mole
M_w = Molecular weight of water, 18.0 lb/lb-mole
m_a = Mass of residue of acetone after evaporation, grams
P_{bar} = Barometric pressure at testing site, inches mercury
P_g = Static pressure of gas, inches mercury (inches water/13.6)
P_s = Absolute pressure of gas, inches mercury = P_{bar} + P_g
P_{std} = Standard absolute pressure, 29.92 inches mercury
Q_{acfm} = Actual volumetric gas flow rate, acfm
Q_{sd} = Dry volumetric gas flow rate corrected to standard conditions, dscfh
R = Ideal gas constant, 21.85 inches mercury cubic foot/°R-lb-mole
T_m = Dry gas meter temperature, °R
T_s = Gas temperature, °R
T_{std} = Absolute temperature, 528°R
V_a = Volume of acetone blank, ml
V_{aw} = Volume of acetone used in wash, ml
W_a = Weight of residue in acetone wash, grams
m_n = Total amount of particulate matter collected, grams
V_{1c} = Total volume of liquid collected in impingers and silica gel, ml
V_m = Volume of gas sample as measured by dry gas meter, dcf
V_{m(std)} = Volume of gas sample measured by dry gas meter, corrected to standard conditions, dscf
V_s = Gas velocity, ft/sec
V_{w(std)} = Volume of water vapor in gas sample, corrected to standard conditions, scf
Y = Dry gas meter calibration factor
ΔH = Average pressure differential across the orifice meter, inches water
Δp = Velocity head of gas, inches water
ρ_a = Density of acetone, 0.7855 g/ml (average)
ρ_w = Density of water, 0.002201 lb/ml
θ = Total sampling time, minutes
K₁ = 17.647 °R/in. Hg
K₂ = 0.04707 ft³/ml
K₄ = 0.09450/100 = 0.000945
K_p = Pitot tube constant, $85.49 \frac{ft}{sec} \left[\frac{(lb/lb-mole)(in. Hg)}{(°R)(in. H_2O)} \right]^{1/2}$
%EA = Percent excess air
%CO₂ = Percent carbon dioxide by volume, dry basis
%O₂ = Percent oxygen by volume, dry basis
%CO = Percent carbon monoxide by volume, dry basis
%N₂ = Percent nitrogen by volume, dry basis
0.264 = Ratio of O₂ to N₂ in air, v/v
28 = Molecular weight of N₂ or CO
32 = Molecular weight of O₂
44 = Molecular weight of CO₂
13.6 = Specific gravity of mercury (Hg)

MOSTARDI PLATT

Calculations for Hydrogen Fluoride By Method 26 or 26A

Concentration

$$\frac{\text{lbs HF}}{\text{dscf}} = \frac{\mu\text{g HF in sample}}{4.536 \times 10^8 \times \text{dscf}}$$

where:

$$4.536 \times 10^8 = \mu\text{g/lb}$$

dscf = Volume of gas sampled

$$\mu\text{g/lb HF} = \mu\text{g F} \times \frac{20.008}{19.000}$$

Parts Per Million

$$\text{ppm HF} = \frac{\text{lbs HF}}{\text{dscf}} \div \frac{20.008}{385 \times 10^6}$$

where:

385 = Volume of 1 lb mole of gas at 68°F and 29.92 in. Hg

106 = Conversion of ppm v/v

Emission Rate

$$\text{lbs HF /dscf} \times \text{dscfm} \times 60 \text{ min/hr} = \text{lbs/hr HF}$$

MOSTARDI PLATT

Pollutant Concentration Correction 7% for Percent Oxygen

$$C_{adj} = C_d \frac{20.9 - 7\%}{20.9 - \%O_2}$$

where:

C_{adj} = Pollutant concentration corrected to percent O_2

$20.9 - 7\%$ = Percent O_2 , the defined O_2 correction value, percent

20.9 = Percent O_2 in air

$\%O_2$ = Measured O_2 concentration dry basis, percent

C_d = Pollutant concentration measured, dry basis, ppm.

Appendix E- Laboratory Sample Analysis

Chain-of-Custody Form						
Project Number: M235005				Date Results Required:		
Client: Holcim - Alpena				TAT Required:		
Plant/Test Location: K20 and K21				Project Supervisor: ELE		
Sample Number	Sample Date	Sample Point Identification	# of Conts	Sub Lab	Analysis Required	Volume, mls
001	12/12/23	#1A 26A K21 0.1N H2SO4	1		M26A (HF)	
002	12/12/23	#1A 26A K21 0.1N NaOH	1		M26A (Cl ₂)	
003	12/12/23	#2A 26A K21 0.1N H2SO4	1		M26A (HF)	
004	12/12/23	#2A 26A K21 0.1N NaOH	1		M26A (Cl ₂)	
005	12/12/23	#3A 26A K21 0.1N H2SO4	1		M26A (HF)	
006	12/12/23	#3A 26A K21 0.1N NaOH	1		M26A (Cl ₂)	
007	12/12/23	#1B 26A K21 0.1N H2SO4	1		M26A (HF)	
008	12/12/23	#1B 26A K21 0.1N NaOH	1		M26A (Cl ₂)	
009	12/12/23	#2B 26A K21 0.1N H2SO4	1		M26A (HF)	
010	12/12/23	#2B 26A K21 0.1N NaOH	1		M26A (Cl ₂)	
011	12/12/23	#3B 26A K21 0.1N H2SO4	1		M26A (HF)	
012	12/12/23	#3B 26A K21 0.1N NaOH	1		M26A (Cl ₂)	
013	12/13/23	#1A 26A K20 0.1N H2SO4	1		M26A (HF)	
014	12/13/23	#1A 26A K20 0.1N NaOH	1		M26A (Cl ₂)	
015	12/13/23	#2A 26A K20 0.1N H2SO4	1		M26A (HF)	
016	12/13/23	#2A 26A K20 0.1N NaOH	1		M26A (Cl ₂)	
017	12/13/23	#3A 26A K20 0.1N H2SO4	1		M26A (HF)	
018	12/13/23	#3A 26A K20 0.1N NaOH	1		M26A (Cl ₂)	
019	12/13/23	#1B 26A K20 0.1N H2SO4	1		M26A (HF)	
020	12/13/23	#1B 26A K20 0.1N NaOH	1		M26A (Cl ₂)	
021	12/13/23	#2B 26A K20 0.1N H2SO4	1		M26A (HF)	
022	12/13/23	#2B 26A K20 0.1N NaOH	1		M26A (Cl ₂)	
023	12/13/23	#3B 26A K20 0.1N H2SO4	1		M26A (HF)	
024	12/13/23	#3B 26A K20 0.1N NaOH	1		M26A (Cl ₂)	

025	12/12/23	A Train Field Blank 0.1N H ₂ SO ₄	1		M26A (HF)	
026	12/12/23	A Train Field Blank 0.1N NaOH	1		M26A (Cl ₂)	
027	12/13/23	B Train Field Blank 0.1N H ₂ SO ₄	1		M26A (HF)	
028	12/13/23	B Train Field Blank 0.1N NaOH	1		M26A (Cl ₂)	
029	12/13/23	0.1N H ₂ SO ₄ Reagent Blank	1		M26A (HF)	
030	12/13/23	0.1N NaOH Reagent Blank	1		M26A (Cl ₂)	
031	12/13/23	DI Water Reagent Blank	1		M26A (HF and Cl ₂)	
Delivered to Lab by: Date/Time:			Received by: Date/Time:		Processed by: Date/Time:	

Laboratory Notes:

K20

Client: Holcim	Analysis Date: 12/27/2023
Facility: Alpena	Analysis Location: Elmhurst
Test Location: K20	Analyst: JMG
Project Number: M233810	
Method: 26A	
Date Samples Received: 12/15/2023	

Train A

Sampling Date		12/13/2023	12/13/2023	12/13/2023	12/13/2023		
	UNITS	M26A DI Blank	M26A H2SO4 Blank	M26A H2SO4-R1	M26A H2SO4-R1 Dup	RDL	MDL
Sulfuric Acid Volume	ml	200	200	371	371		
Hydrofluoric Acid	ug	<150	<150	<150	<150	150	15

Sampling Date		12/13/2023	12/13/2023	12/12/2023			
	UNITS	M26A- H2SO4 R2	M26A- H2SO4 R3	Train Blank A		RDL	MDL
Sulfuric Acid Volume	ml	271	298	250			
Hydrofluoric Acid	ug	<150	<150	<150		150	15

Train B

Sampling Date		12/13/2023	12/13/2023	12/13/2023	12/13/2023		
	UNITS	M26A DI Blank	M26A H2SO4 Blank	M26A H2SO4-R1	M26A H2SO4-R1 Dup	RDL	MDL
Sulfuric Acid Volume	ml	200	200	349	349		
Hydrofluoric Acid	ug	<150	<150	<150	<150	150	15

Sampling Date		12/13/2023	12/13/2023	12/13/2023			
	UNITS	M26A- H2SO4 R2	M26A- H2SO4 R3	M26A- H2SO4 R4		RDL	MDL
Sulfuric Acid Volume	ml	372	357	250			
Hydrofluoric Acid	ug	<150	301	<150		150	15

Client: Holcim		Analysis Date: 12/27/2023									
Facility: Alpena		Analysis Location: Elmhurst									
Test Location: K20		Analyst: JMG									
Project Number: M233810											
Method: 26A											
Date Samples Received: 12/15/2023											
Standard ppm HF	Area	Response Factor	Calculated Value	Slope of Regression Curve							
1	0.1913	0.1913	0.96	0.2000							
2	0.3898	0.1949	1.95								
5	0.9837	0.1967	4.92	Response Factor Ave							
8	1.6527	0.2066	8.26	0.1999							
10	2.0977	0.2098	10.49								
Lot Number	Ricca 8209004										
	R ²	0.9992									
Sample Number	Sample Date	Sample ID	Sample Area	PPM F	PPM X Dilution Factor	Dilution Factor	Total ml	mg F in soln	mg HF in soln	mg HF in soln avg	ug HF in soln
031	12/13/2023	DI Reagent Blank	0.0044	0.0220	0.0220	1	200	0.0044	0.0046		
031	12/13/2023	DI Reagent Blank	0.0024	0.0120	0.0120	1	200	0.0024	0.0025	0.0036	3.580858027
029	12/13/2023	H2SO4 Reagent Blank	0.0019	0.0095	0.0095	1	200	0.0019	0.0020		
029	12/13/2023	H2SO4 Reagent Blank	0.0014	0.0070	0.0070	1	200	0.0014	0.0015	0.0017	1.737769337
013	12/13/2023	Test 1A H2SO4 Imp	0.0541	0.2705	0.2705	1	371	0.1003	0.1057		
013	12/13/2023	Test 1A H2SO4 Imp	0.0552	0.2760	0.2760	1	371	0.1024	0.1078	0.1068	106.7682847
013	12/13/2023	Test 1A H2SO4 Imp	0.0573	0.2865	0.2865	1	371	0.1063	0.1119		
013	12/13/2023	Test 1A H2SO4 Imp	0.0589	0.2945	0.2945	1	371	0.1093	0.1151	0.1135	113.5084601
015	12/13/2023	Test 2A H2SO4 Imp	0.0759	0.3795	0.3795	1	271	0.1028	0.1083		
015	12/13/2023	Test 2A H2SO4 Imp	0.0680	0.3400	0.3400	1	271	0.0921	0.0970	0.1027	102.6782076
017	12/13/2023	Test 3A H2SO4 Imp	0.0229	0.1145	0.1145	1	298	0.0341	0.0359		
017	12/13/2023	Test 3A H2SO4 Imp	0.0239	0.1195	0.1195	1	298	0.0356	0.0375	0.0367	36.72064587
025	12/12/2023	Train Blank A	0.0008	0.0040	0.0040	1	250	0.0010	0.0010		
025	12/12/2023	Train Blank A	0.0022	0.0110	0.0110	1	250	0.0027	0.0028	0.0019	1.9277537
			Expected Value		% Difference						
Lot Number: Thermo 21-191JKS			Run 1 H2SO4 Spike W/ 2ppm		1.1110						
			Run 1 H2SO4 Spike W/ 2ppm		1.1110		0.21%				
CCV ppm F	Area	PPM F									
1 ppm ICV	0.2169	1.0844									
5 ppm CCV	1.0029	5.0141									
5 ppm CCV	0.991	4.9546									
5 ppm CCV	0.9834	4.9166									
5 ppm CCV	0.9873	4.9361									
Standard ppm F	Area	Difference									
1	0.1884	0.77%									
2	0.3926	0.36%									
5	0.9943	0.53%									
8	1.6780	0.75%									
10	2.1312	0.79%									

Client:	Holcim	Analysis Date:	12/27/2023									
Facility:	Alpena	Analysis Location:	Elmhurst									
Test Location:	K20	Analyst:	JMG									
Project Number:	M233810											
Method:	26A											
Date Samples Received:	12/15/2023											
Standard ppm HF	Area	Response Factor	Calculated Value	Slope of Regression Curve								
1	0.1913	0.1913	0.96	0.2000								
2	0.3898	0.1949	1.95									
5	0.9837	0.1967	4.92	Response Factor Ave								
8	1.6527	0.2066	8.26	0.1999								
10	2.0977	0.2098	10.49									
Lot Number	Ricca 8209004											
	R ²	0.9992										
Sample Number	Sample Date	Sample ID	Sample Area	PPM F	PPM X Dilution Factor	Dilution Factor	Total ml	mg F in soln	mg HF in soln	mg HF in soln avg	ug HF in soln	
031	12/13/2023	DI Reagent Blank	0.0044	0.0220	0.0220	1	200	0.0044	0.0046			
031	12/13/2023	DI Reagent Blank	0.0024	0.0120	0.0120	1	200	0.0024	0.0025	0.0036	3.580858027	
029	12/13/2023	H2SO4 Reagent Blank	0.0019	0.0095	0.0095	1	200	0.0019	0.0020			
029	12/13/2023	H2SO4 Reagent Blank	0.0014	0.0070	0.0070	1	200	0.0014	0.0015	0.0017	1.737769337	
019	12/13/2023	Test 1B H2SO4 Imp	0.0446	0.2230	0.2230	1	349	0.0778	0.0820			
019	12/13/2023	Test 1B H2SO4 Imp	0.0470	0.2350	0.2350	1	349	0.0820	0.0864	0.0842	84.1722807	
019	12/13/2023	Test 1B H2SO4 Imp	0.0490	0.2450	0.2450	1	349	0.0855	0.0901			
019	12/13/2023	Test 1B H2SO4 Imp	0.0483	0.2415	0.2415	1	349	0.0843	0.0888	0.0894	89.41007546	
021	12/13/2023	Test 2B H2SO4 Imp	0.0263	0.1315	0.1315	1	372	0.0489	0.0515			
021	12/13/2023	Test 2B H2SO4 Imp	0.0302	0.1510	0.1510	1	372	0.0562	0.0592	0.0553	55.34005442	
023	12/13/2023	Test 3B H2SO4 Imp	0.1624	0.8119	0.8119	1	357	0.2899	0.3053			
023	12/13/2023	Test 3B H2SO4 Imp	0.1583	0.7914	0.7914	1	357	0.2825	0.2976	0.3015	301.4500569	
027	12/13/2023	Train Blank B	0.0101	0.0505	0.0505	1	250	0.0126	0.0133			
027	12/13/2023	Train Blank B	0.0108	0.0540	0.0540	1	250	0.0135	0.0142	0.0138	13.75734058	
CCV ppm F	Area	PPM F										
1 ppm ICV	0.2169	1.0844										
5 ppm CCV	1.0029	5.0141										
5 ppm CCV	0.991	4.9546										
5 ppm CCV	0.9834	4.9166										
5 ppm CCV	0.9873	4.9361										
Standard ppm F	Area	Difference										
1	0.1884	0.77%										
2	0.3926	0.36%										
5	0.9943	0.53%										
8	1.6780	0.75%										
10	2.1312	0.79%										

K20

Client: Holcim	Analysis Date: 12/27/2023
Facility: Alpena	Analysis Location: Elmhurst
Test Location: K20	Analyst: JMG
Project Number: M233810	
Method: 26A	
Date Samples Received: 12/15/2023	

Train A

Sampling Date		12/13/2023	12/13/2023	12/13/2023	12/13/2023		
	UNITS	M26A DI Blank	M26A NaOH Blank	M26A NaOH-R1	M26A NaOH-R1 Dup	RDL	MDL
Sodium Hydroxide Volume	ml	200	200	215	215		
Chlorine	ug	<150	<150	<150	<150	150	15

Sampling Date		12/13/2023	12/13/2023	12/12/2023			
	UNITS	M26A- NaOH R2	M26A- NaOH R3	Train A Blank		RDL	MDL
Sodium Hydroxide Volume	ml	214	228	250			
Chlorine	ug	<150	<150	<150		150	15

Train B

Sampling Date		12/13/2023	12/13/2023	12/13/2023	12/13/2023		
	UNITS	M26A DI Blank	M26A NaOH Blank	M26A NaOH-R1	M26A NaOH-R1 Dup	RDL	MDL
Sodium Hydroxide Volume	ml	200	200	225	225		
Chlorine	ug	<150	<150	<150	<150	150	15

Sampling Date		12/13/2023	12/13/2023	12/13/2023			
	UNITS	M26A- NaOH R2	M26A- NaOH R3	Train B Blank		RDL	MDL
Sodium Hydroxide Volume	ml	219	240	250			
Chlorine	ug	<150	<150	<150		150	15

Client: Holcim		Analysis Date: 12/27/2023								
Facility: Alpena		Analysis Location: Elmhurst Lab								
Test Location: K20		Analyst: JMG								
Project Number: M233810										
Method: 26A										
Date Samples Received: 12/15/2023										
Standard ppm Cl	Area	Response Factor	Calculated Value	Slope of Regression Curve						
1	0.1287	0.1287	0.96	0.1343						
2	0.2659	0.1330	1.98							
5	0.6594	0.1319	4.91	Response Factor Ave						
8	1.1042	0.1380	8.22	0.1343						
10	1.3971	0.1397	10.40							
Lot Number	Ricca 8209004									
	R ²	0.9993								
Sample Number	Sample Date	Sample ID	Sample Area	PPM Cl	PPM X Dilution Factor	Dilution Factor	Total ml	mg Cl in soln	ug Cl2 in soln	ug Cl2 in soln
031	12/13/2023	DI Reagent Blank	0.0041	0.0305	0.0305	1	200	0.0061		
031	12/13/2023	DI Reagent Blank	0.0001	0.0007	0.0007	1	200	0.0001	0.0031	3.126361542
030	12/13/2023	NaOH Reagent Blank	0.0055	0.0409	0.0409	1	200	0.0082		
030	12/13/2023	NaOH Reagent Blank	0.0051	0.0380	0.0380	1	200	0.0076	0.0079	7.890341035
014	12/13/2023	Test 1A NaOH Imp	0.0132	0.0983	0.0983	1	215	0.0211		
014	12/13/2023	Test 1A NaOH Imp	0.0136	0.1012	0.1012	1	215	0.0218	0.0214	21.44535144
014	12/13/2023	Test 1A NaOH Imp	0.0084	0.0625	0.0625	1	215	0.0134		
014	12/13/2023	Test 1A NaOH Imp	0.0106	0.0789	0.0789	1	215	0.0170	0.0152	15.20379393
016	12/13/2023	Test 2A NaOH Imp	0.0203	0.1511	0.1511	1	214	0.0323		
016	12/13/2023	Test 2A NaOH Imp	0.0195	0.1452	0.1452	1	214	0.0311	0.0317	31.6998173
018	12/13/2023	Test 3A NaOH Imp	0.0427	0.3178	0.3178	1	228	0.0725		
018	12/13/2023	Test 3A NaOH Imp	0.0452	0.3365	0.3365	1	228	0.0767	0.0746	74.59052017
026	12/12/2023	Train Blank	0.0041	0.0305	0.0305	1	250	0.0076		
026	12/12/2023	Train Blank	0.0053	0.0395	0.0395	1	250	0.0099	0.0087	8.7463686
				Expected Value	% Difference					
		Run 1 H2SO4 Spike W/ 2ppm	0.1479	1.1009	1.0395					
		Run 1 H2SO4 Spike W/ 2ppm	0.1418	1.0555	1.0395	3.72%				
CCV ppm Cl	Area	PPM Cl								
5 ppm ICV	0.6538	4.8667								
5 ppm CCV	0.6864	5.1094								
5 ppm CCV	0.6895	5.1324								
Standard ppm Cl	Area	Difference								
1	0.1291	0.15%								
2	0.2779	2.16%								
5	0.6632	0.29%								
8	1.1314	1.20%								
10	1.4305	1.17%								

Client: Holcim		Analysis Date: 12/27/2023									
Facility: Alpena		Analysis Location: Elmhurst Lab									
Test Location: K20		Analyst: JMG									
Project Number: M233810											
Method: 26A											
Date Samples Received: 12/15/2023											
Standard ppm Cl	Area	Response Factor	Calculated Value	Slope of Regression Curve							
1	0.1287	0.1287	0.96	0.1343							
2	0.2659	0.1330	1.98								
5	0.6594	0.1319	4.91	Response Factor Ave							
8	1.1042	0.1380	8.22	0.1343							
10	1.3971	0.1397	10.40								
Lot Number	Ricca 8209004										
	R ²	0.9993									
Sample Number	Sample Date	Sample ID	Sample Area	PPM Cl	PPM X Dilution Factor	Dilution Factor	Total ml	mg Cl in soln	mg Cl2 in soln avg	ug Cl2 in soln	
031	12/13/2023	DI Reagent Blank	0.0041	0.0305	0.0305	1	200	0.0061			
031	12/13/2023	DI Reagent Blank	0.0001	0.0007	0.0007	1	200	0.0001	0.0031	3.126361542	
029	12/13/2023	NaOH Reagent Blank	0.0055	0.0409	0.0409	1	200	0.0082			
029	12/13/2023	NaOH Reagent Blank	0.0051	0.0380	0.0380	1	200	0.0076	0.0079	7.890341035	
020	12/13/2023	Test 1B NaOH Imp	0.0291	0.2166	0.2166	1	225	0.0487			
020	12/13/2023	Test 1B NaOH Imp	0.0245	0.1824	0.1824	1	225	0.0410	0.0449	44.88561929	
020	12/13/2023	Test 1B NaOH Imp	0.0235	0.1749	0.1749	1	225	0.0394			
020	12/13/2023	Test 1B NaOH Imp	0.0262	0.1950	0.1950	1	225	0.0439	0.0416	41.61968803	
022	12/13/2023	Test 2B NaOH Imp	0.0457	0.3402	0.3402	1	219	0.0745			
022	12/13/2023	Test 2B NaOH Imp	0.0515	0.3834	0.3834	1	219	0.0840	0.0792	79.22646771	
024	12/13/2023	Test 3B NaOH Imp	0.0636	0.4734	0.4734	1	240	0.1136			
024	12/13/2023	Test 3B NaOH Imp	0.0774	0.5761	0.5761	1	240	0.1383	0.1259	125.9477078	
028	12/13/2023	Train B Train Blank	0.0107	0.0796	0.0796	1	250	0.0199			
028	12/13/2023	Train B Train Blank	0.0092	0.0685	0.0685	1	250	0.0171	0.0185	18.51624842	
CCV ppm Cl	Area	PPM Cl									
5 ppm ICV	0.6538	4.8667									
5 ppm CCV	0.6864	5.1094									
5 ppm CCV	0.6895	5.1324									
Standard ppm Cl	Area	Difference									
1	0.1291	0.15%									
2	0.2779	2.16%									
5	0.6632	0.29%									
8	1.1314	1.20%									
10	1.4305	1.17%									

K21

Client: Holcim	Analysis Date: 12/27/2023
Facility: Alpena	Analysis Location: Elmhurst
Test Location: K21	Analyst: JMG
Project Number: M233810	
Method: 26A	
Date Samples Received: 12/15/2023	

Train A

Sampling Date		12/12/2023	12/12/2023	12/12/2023	12/12/2023		
	UNITS	M26A DI Blank	M26A H2SO4 Blank	M26A H2SO4-R1	M26A H2SO4-R1 Dup	RDL	MDL
Sulfuric Acid Volume	ml	200	200	380	380		
Hydrofluoric Acid	ug	<150	<150	226	234	150	15

Sampling Date		12/12/2023	12/12/2023	12/12/2023			
	UNITS	M26A- H2SO4 R2	M26A- H2SO4 R3	Train A Field Blank		RDL	MDL
Sulfuric Acid Volume	ml	407	409	250			
Hydrofluoric Acid	ug	<150	<150	<150		150	15

Train B

Sampling Date		12/12/2023	12/12/2023	12/12/2023	12/12/2023		
	UNITS	M26A DI Blank	M26A H2SO4 Blank	M26A H2SO4-R1	M26A H2SO4-R1 Dup	RDL	MDL
Sulfuric Acid Volume	ml	200	200	334	334		
Hydrofluoric Acid	ug	<150	<150	<150	<150	150	15

Sampling Date		12/12/2023	12/12/2023	12/13/2023			
	UNITS	M26A- H2SO4 R2	M26A- H2SO4 R3	M26A- H2SO4 R4		RDL	MDL
Sulfuric Acid Volume	ml	347	368	250			
Hydrofluoric Acid	ug	<150	<150	<150		150	15

Client: Holcim		Analysis Date: 12/27/2023									
Facility: Alpena		Analysis Location: Elmhurst									
Test Location: K21		Analyst: JMG									
Project Number: M233810											
Method: 26A											
Date Samples Received: 12/15/2023											
Standard ppm HF	Area	Response Factor	Calculated Value	Slope of Regression Curve							
1	0.1913	0.1913	0.96	0.2000							
2	0.3898	0.1949	1.95								
5	0.9837	0.1967	4.92	Response Factor Ave							
8	1.6527	0.2066	8.26	0.1999							
10	2.0977	0.2098	10.49								
Lot Number	Ricca 8209004										
	R ²	0.9992									
Sample Number	Sample Date	Sample ID	Sample Area	PPM F	PPM X Dilution Factor	Dilution Factor	Total ml	mg F in soln	mg HF in soln	mg HF in soln avg	ug HF in soln
031	12/12/2023	DI Reagent Blank	0.0044	0.0220	0.0220	1	200	0.0044	0.0046		
031	12/12/2023	DI Reagent Blank	0.0024	0.0120	0.0120	1	200	0.0024	0.0025	0.0036	3.580858027
029	12/12/2023	H2SO4 Reagent Blank	0.0019	0.0095	0.0095	1	200	0.0019	0.0020		
029	12/12/2023	H2SO4 Reagent Blank	0.0014	0.0070	0.0070	1	200	0.0014	0.0015	0.0017	1.737769337
001	12/12/2023	Test 1A H2SO4 Imp	0.1102	0.5510	0.5510	1	380	0.2094	0.2205		
001	12/12/2023	Test 1A H2SO4 Imp	0.1152	0.5760	0.5760	1	380	0.2189	0.2305	0.2255	225.5203322
001	12/12/2023	Test 1A H2SO4 Imp	0.1161	0.5805	0.5805	1	380	0.2206	0.2323		
001	12/12/2023	Test 1A H2SO4 Imp	0.1174	0.5870	0.5870	1	380	0.2230	0.2349	0.2336	233.6246564
003	12/12/2023	Test 2A H2SO4 Imp	0.0237	0.1185	0.1185	1	407	0.0482	0.0508		
003	12/12/2023	Test 2A H2SO4 Imp	0.0265	0.1325	0.1325	1	407	0.0539	0.0568	0.0538	53.7955461
005	12/12/2023	Test 3A H2SO4 Imp	0.0309	0.1545	0.1545	1	409	0.0632	0.0666		
005	12/12/2023	Test 3A H2SO4 Imp	0.0343	0.1715	0.1715	1	409	0.0701	0.0739	0.0702	70.21325356
025	12/12/2023	Train Blank A	0.0008	0.0040	0.0040	1	250	0.0010	0.0010		
025	12/12/2023	Train Blank A	0.0022	0.0110	0.0110	1	250	0.0027	0.0028	0.0019	1.9277537
					Expected Value	% Difference					
Lot Number: Thermo 21-191JKS			Run 1 H2SO4 Spike W/ 2ppm	0.2537	1.2562						
			Run 1 H2SO4 Spike W/ 2ppm	0.2640	1.3199	1.2562	3.02%				
CCV ppm F	Area	PPM F									
1 ppm ICV	0.2169	1.0844									
5 ppm CCV	1.0029	5.0141									
5 ppm CCV	0.991	4.9546									
5 ppm CCV	0.9834	4.9166									
5 ppm CCV	0.9873	4.9361									
Standard ppm F	Area	Difference									
1	0.1884	0.77%									
2	0.3926	0.36%									
5	0.9943	0.53%									
8	1.6780	0.75%									
10	2.1312	0.79%									

Client:	Holcim	Analysis Date:	12/27/2023									
Facility:	Alpena	Analysis Location:	Elmhurst									
Test Location:	K21	Analyst:	JMG									
Project Number:	M233810											
Method:	26A											
Date Samples Received:	12/15/2023											
Standard ppm HF	Area	Response Factor	Calculated Value	Slope of Regression Curve								
1	0.1913	0.1913	0.96	0.2000								
2	0.3898	0.1949	1.95									
5	0.9837	0.1967	4.92	Response Factor Ave								
8	1.6527	0.2066	8.26	0.1999								
10	2.0977	0.2098	10.49									
Lot Number	Ricca 8209004											
	R ²	0.9992										
Sample Number	Sample Date	Sample ID	Sample Area	PPM F	PPM X Dilution Factor	Dilution Factor	Total ml	mg F in soln	mg HF in soln	mg HF in soln avg	ug HF in soln	
031	12/12/2023	DI Reagent Blank	0.0044	0.0220	0.0220	1	200	0.0044	0.0046			
031	12/12/2023	DI Reagent Blank	0.0024	0.0120	0.0120	1	200	0.0024	0.0025	0.0036	3.580858027	
029	12/12/2023	H2SO4 Reagent Blank	0.0019	0.0095	0.0095	1	200	0.0019	0.0020			
029	12/12/2023	H2SO4 Reagent Blank	0.0014	0.0070	0.0070	1	200	0.0014	0.0015	0.0017	1.737769337	
007	12/12/2023	Test 1B H2SO4 Imp	0.0469	0.2345	0.2345	1	334	0.0783	0.0825			
007	12/12/2023	Test 1B H2SO4 Imp	0.0480	0.2400	0.2400	1	334	0.0802	0.0844	0.0835	83.45663569	
007	12/12/2023	Test 1B H2SO4 Imp	0.0473	0.2365	0.2365	1	334	0.0790	0.0832			
007	12/12/2023	Test 1B H2SO4 Imp	0.0466	0.2330	0.2330	1	334	0.0778	0.0820	0.0826	82.57721909	
009	12/12/2023	Test 2B H2SO4 Imp	0.0538	0.2690	0.2690	1	347	0.0933	0.0983			
009	12/12/2023	Test 2B H2SO4 Imp	0.0493	0.2465	0.2465	1	347	0.0855	0.0901	0.0942	94.19684009	
011	12/12/2023	Test 3B H2SO4 Imp	0.0377	0.1885	0.1885	1	368	0.0694	0.0731			
011	12/12/2023	Test 3B H2SO4 Imp	0.0396	0.1980	0.1980	1	368	0.0729	0.0767	0.0749	74.8989116	
027	12/13/2023	Train Blank B	0.0101	0.0505	0.0505	1	250	0.0126	0.0133			
027	12/13/2023	Train Blank B	0.0108	0.0540	0.0540	1	250	0.0135	0.0142	0.0138	13.75734058	
CCV ppm F	Area	PPM F										
1 ppm ICV	0.2169	1.0844										
5 ppm CCV	1.0029	5.0141										
5 ppm CCV	0.991	4.9546										
5 ppm CCV	0.9834	4.9166										
5 ppm CCV	0.9873	4.9361										
Standard ppm F	Area	Difference										
1	0.1884	0.77%										
2	0.3926	0.36%										
5	0.9943	0.53%										
8	1.6780	0.75%										
10	2.1312	0.79%										

K21

Client: Holcim	Analysis Date: 12/27/2023
Facility: Alpena	Analysis Location: Elmhurst
Test Location: K21	Analyst: JMG
Project Number: M233810	
Method: 26A	
Date Samples Received: 12/15/2023	

Train A

Sampling Date		12/12/2023	12/12/2023	12/12/2023	12/12/2023		
	UNITS	M26A DI Blank	M26A NaOH Blank	M26A NaOH-R1	M26A NaOH-R1 Dup	RDL	MDL
Sodium Hydroxide Volume	ml	200	200	222	222		
Chlorine	ug	<150	<150	<150	<150	150	15

Sampling Date		12/12/2023	12/12/2023	12/12/2023			
	UNITS	M26A- NaOH R2	M26A- NaOH R3	Train A Blank		RDL	MDL
Sodium Hydroxide Volume	ml	235	214	250			
Chlorine	ug	<150	<150	<150		150	15

Train B

Sampling Date		12/12/2023	12/12/2023	12/12/2023	12/12/2023		
	UNITS	M26A DI Blank	M26A NaOH Blank	M26A NaOH-R1	M26A NaOH-R1 Dup	RDL	MDL
Sodium Hydroxide Volume	ml	200	200	238	238		
Chlorine	ug	<150	<150	<150	<150	150	15

Sampling Date		12/12/2023	12/12/2023	12/13/2023			
	UNITS	M26A- NaOH R2	M26A- NaOH R3	Train B Blank		RDL	MDL
Sodium Hydroxide Volume	ml	204	226	250			
Chlorine	ug	<150	<150	<150		150	15

Client: Holcim		Analysis Date: 12/27/2023								
Facility: Alpena		Analysis Location: Elmhurst Lab								
Test Location: K21		Analyst: JMG								
Project Number: M233810										
Method: 26A										
Date Samples Received: 12/15/2023										
Standard ppm Cl	Area	Response Factor	Calculated Value	Slope of Regression Curve						
1	0.1231	0.1231	0.97	0.1272						
2	0.2527	0.1264	1.99							
5	0.6209	0.1242	4.88	Response Factor Ave						
8	1.0373	0.1297	8.16	0.1271						
10	1.3207	0.1321	10.38							
Lot Number	Ricca 8209004									
	R ²		0.9992							
Sample Number	Sample Date	Sample ID	Sample Area	PPM Cl	PPM X Dilution Factor	Dilution Factor	Total ml	mg Cl in soln	ug Cl2 in soln	ug Cl2 in soln
031	12/12/2023	DI Reagent Blank	0.0041	0.0322	0.0322	1	200	0.0064		
031	12/12/2023	DI Reagent Blank	0.0001	0.0008	0.0008	1	200	0.0002	0.0033	3.302409059
030	12/12/2023	NaOH Reagent Blank	0.0055	0.0432	0.0432	1	200	0.0086		
030	12/12/2023	NaOH Reagent Blank	0.0051	0.0401	0.0401	1	200	0.0080	0.0083	8.334651436
002	12/12/2023	Test 1A NaOH Imp	0.0173	0.1360	0.1360	1	222	0.0302		
002	12/12/2023	Test 1A NaOH Imp	0.0175	0.1376	0.1376	1	222	0.0305	0.0304	30.37272789
002	12/12/2023	Test 1A NaOH Imp	0.0192	0.1510	0.1510	1	222	0.0335		
002	12/12/2023	Test 1A NaOH Imp	0.0147	0.1156	0.1156	1	222	0.0257	0.0296	29.58722631
004	12/12/2023	Test 2A NaOH Imp	0.0008	0.0063	0.0063	1	235	0.0015		
004	12/12/2023	Test 2A NaOH Imp	0.0046	0.0362	0.0362	1	235	0.0085	0.0050	4.988996543
006	12/12/2023	Test 3A NaOH Imp	0.0215	0.1691	0.1691	1	214	0.0362		
006	12/12/2023	Test 3A NaOH Imp	0.0203	0.1596	0.1596	1	214	0.0342	0.0352	35.16751133
026	12/12/2023	Train Blank	0.0041	0.0322	0.0322	1	250	0.0081		
026	12/12/2023	Train Blank	0.0053	0.0417	0.0417	1	250	0.0104	0.0092	9.238882488
				Expected Value	% Difference					
		Run 1 H2SO4 Spike W/ 2ppm		0.1274	1.0619					
		Run 1 H2SO4 Spike W/ 2ppm		0.1303	1.0245	4.59%				
CCV ppm Cl	Area	PPM Cl								
5 ppm ICV	0.6515	5.1227								
5 ppm CCV	0.6478	5.0936								
5 ppm CCV	0.6482	5.0967								
5 ppm CCV	0.6425	5.0519								
Standard ppm Cl	Area	Difference								
1	0.1242	0.44%								
2	0.2549	0.43%								
5	0.6688	3.58%								
8	1.0675	1.41%								
10	1.3792	2.12%								

Client:	Holcim	Analysis Date:	12/27/2023								
Facility:	Alpena	Analysis Location:	Elmhurst Lab								
Test Location:	K21	Analyst:	JMG								
Project Number:	M233810										
Method:	26A										
Date Samples Received:	12/15/2023										
Standard ppm Cl	Area	Response Factor	Calculated Value	Slope of Regression Curve							
1	0.1231	0.1231	0.97	0.1272							
2	0.2527	0.1264	1.99								
5	0.6209	0.1242	4.88	Response Factor Ave							
8	1.0373	0.1297	8.16	0.1271							
10	1.3207	0.1321	10.38								
Lot Number	Ricca 8209004										
	R²	0.9992									
Sample Number	Sample Date	Sample ID	Sample Area	PPM Cl	PPM X Dilution Factor	Dilution Factor	Total ml	mg Cl in soln	mg Cl2 in soln avg	ug Cl2 in soln	
031	12/12/2023	DI Reagent Blank	0.0041	0.0322	0.0322	1	200	0.0064			
031	12/12/2023	DI Reagent Blank	0.0001	0.0008	0.0008	1	200	0.0002	0.0033	3.302409059	
030	12/12/2023	NaOH Reagent Blank	0.0055	0.0432	0.0432	1	200	0.0086			
030	12/12/2023	NaOH Reagent Blank	0.0051	0.0401	0.0401	1	200	0.0080	0.0083	8.334651436	
008	12/12/2023	Test 1B NaOH Imp	0.0488	0.3837	0.3837	1	238	0.0913			
008	12/12/2023	Test 1B NaOH Imp	0.0492	0.3869	0.3869	1	238	0.0921	0.0917	91.69689155	
008	12/12/2023	Test 1B NaOH Imp	0.0486	0.3821	0.3821	1	238	0.0909			
008	12/12/2023	Test 1B NaOH Imp	0.0508	0.3994	0.3994	1	238	0.0951	0.0930	93.00684714	
010	12/12/2023	Test 2B NaOH Imp	0.0210	0.1651	0.1651	1	204	0.0337			
010	12/12/2023	Test 2B NaOH Imp	0.0216	0.1698	0.1698	1	204	0.0346	0.0342	34.16578058	
012	12/12/2023	Test 3B NaOH Imp	0.0388	0.3051	0.3051	1	226	0.0689			
012	12/12/2023	Test 3B NaOH Imp	0.0379	0.2980	0.2980	1	226	0.0673	0.0681	68.14835609	
028	12/13/2023	Train B Train Blank	0.0107	0.0841	0.0841	1	250	0.0210			
028	12/13/2023	Train B Train Blank	0.0092	0.0723	0.0723	1	250	0.0181	0.0196	19.5589108	
CCV ppm Cl	Area	PPM Cl									
5 ppm ICV	0.6515	5.1227									
5 ppm CCV	0.6478	5.0936									
5 ppm CCV	0.6482	5.0967									
5 ppm CCV	0.6425	5.0519									
Standard ppm Cl	Area	Difference									
1	0.1242	0.44%									
2	0.2549	0.43%									
5	0.6688	3.58%									
8	1.0675	1.41%									
10	1.3792	2.12%									

Appendix F - Reference Method Test Data

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Test Location: Kiln 20 Breaching Duct
Project #: M235005
Test Method: 26A
Test Engineer: PPP
Test Technician: CLM

	<u>Run 1A</u>	<u>Run 2A</u>	<u>Run 3A</u>
Meter ID:	CM43	CM43	CM43
Pitot ID:	S8-058	S8-058	S8-058
Filter ID:	Teflon	Teflon	Teflon
Nozzle Diameter (Inches):	0.275	0.275	0.275
Meter Calibration Date:	12/7/2023	12/7/2023	12/7/2023
Meter Calibration Factor (Y):	0.995	0.995	0.995
Meter Orifice Setting (Delta H):	1.823	1.823	1.823
Nozzle Kit ID Number and Material:	8 GLASS	8 GLASS	8 GLASS

Leak Checks

Pre Pitot Leak Check	0.0	@	3.5	"H ₂ O	0.0	@	3.8	"H ₂ O	0.0	@	4.2	"H ₂ O
Post Pitot Leak Check	0.0	@	4.0	"H ₂ O	0.0	@	4.0	"H ₂ O	0.0	@	4.0	"H ₂ O
Pre Nozzle Leak Check	0.0100	@	13	"Hg	0.0000	@	12	"Hg	0.0100	@	14	"Hg
Post Nozzle Leak Check	0.0000	@	10	"Hg	0.0000	@	10	"Hg	0.0000	@	10	"Hg
Pitot Tube Coefficient:	0.834											
Probe Length (Feet):	8.0											
Probe Liner Material:	Glass											
Sample Plane:	Horizontal											
Port Length (Inches):	3.25											
Port Size (Diameter, Inches):	6.00											
Port Type:	Nipple											
Duct Shape:	Rectangular											
Length (Feet):	8											
Width (Feet):	8.75											
Duct Area (Square Feet):	70.000											
Upstream Diameters:	~1.0											
Downstream Diameters:	~8.5											
Number of Ports Sampled:	3											
Number of Points per Port:	14											
Minutes per Point:	2.0											
Minutes per Reading:	2.0											
Total Number of Traverse Points:	42											
Test Length (Minutes):	84											
Train Type:	Hot Box											
Source Condition:	Normal											
Diluent Model/Serial Number:	1440D1/4662											
Moisture Balance ID:	S10-25											
# of Runs	3											

Run 1A - Method 26A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 20 Breaching Duct
 Source Condition: Normal

Date: 12/13/23
 Start Time: 11:30
 End Time: 13:00

DRY GAS METER CONDITIONS				STACK CONDITIONS			
	ΔH :	0.58	in. H ₂ O	Static Pressure	-0.80	in. H ₂ O	
Meter Temperature, T _m :	36.3	°F		Flue Pressure (Ps):	29.32	in. Hg. abs.	
Sqrt ΔP :	0.438	in. H ₂ O		Carbon Dioxide:	16.27	%	
Stack Temperature, T _s :	391.7	°F		Oxygen:	9.46	%	
Meter Volume, V _m :	34.632	ft ³		Nitrogen:	74.27	%	
Meter Volume, V _{mstd} :	36.047	dscf		Gas Weight dry, M _d :	30.982	lb/lb mole	
Meter Volume, V _{wstd} :	1.827	wscf		Gas Weight wet, M _s :	30.355	lb/lb mole	
Isokinetic Variance:	98.2	%I		Excess Air:	93.227	%	
Test Length:	84.00	in. mins.		Gas Velocity, V _s :	30.570	fps	
Nozzle Diameter:	0.275	in. inches		Volumetric Flow:	128,394	acfm	
Barometric Pressure:	29.38	in. Hg		Volumetric Flow:	74,239	dscfm	
				Volumetric Flow:	78,002	scfm	

MOISTURE DETERMINATION

Initial Impinger Content:	3495.4	ml	Silica Initial Wt.	864.0	grams
Final Impinger Content:	3520.6	ml	Silica Final Wt.	877.6	grams
Impinger Difference:	25.2	ml	Silica Difference:	13.6	grams
Total Water Gain:	38.8		Moisture, Bws:	0.048	

Port- Point No.	Clock Time	Velocity Head Δp in. H ₂ O	Orifice ΔH in. H ₂ O	Actual Meter Vol. ft ³	Stack Temp °F	Meter Temp Inlet °F	Outlet °F	Pump Vacuum °Hg	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	11:30:00	0.18	0.60	172.617	390	35	35	6	261	260	56
1-2	11:32:00	0.18	0.60	173.450	390	35	35	6	260	260	56
1-3	11:34:00	0.20	0.60	174.260	394	35	35	6	261	261	56
1-4	11:36:00	0.20	0.60	175.130	392	35	35	6	261	260	57
1-5	11:38:00	0.21	0.60	175.980	393	35	35	6	260	260	57
1-6	11:40:00	0.22	0.70	176.860	395	35	35	6	260	261	57
1-7	11:42:00	0.20	0.70	177.750	394	36	36	6	261	261	57
1-8	11:44:00	0.19	0.70	178.620	392	36	36	6	260	260	57
1-9	11:46:00	0.19	0.70	179.460	391	36	36	6	261	260	58
1-10	11:48:00	0.18	0.60	180.300	392	36	36	6	262	261	58
1-12	11:50:00	0.18	0.60	181.110	390	36	36	6	260	260	58
1-13	11:52:00	0.17	0.60	181.930	389	36	36	6	261	261	58
1-14	11:54:00	0.16	0.60	182.730	390	36	36	6	260	260	58
	11:56:00			183.492							
2-1	12:00:00	0.18	0.50	183.492	390	36	36	6	260	260	58
2-2	12:02:00	0.18	0.50	184.310	392	36	36	5	260	260	58
2-3	12:04:00	0.19	0.50	185.200	393	36	36	5	261	261	58
2-4	12:06:00	0.20	0.50	185.970	392	36	36	5	262	260	59
2-5	12:08:00	0.20	0.60	186.840	394	36	36	5	261	260	59
2-6	12:10:00	0.21	0.60	187.690	393	36	36	5	262	261	59
2-7	12:12:00	0.22	0.60	188.620	392	36	36	5	260	260	59
2-8	12:14:00	0.22	0.60	189.480	390	36	36	5	261	261	59
2-9	12:16:00	0.20	0.60	190.400	391	36	36	5	260	260	59
2-10	12:18:00	0.20	0.60	191.250	390	36	36	5	261	261	59
2-11	12:20:00	0.19	0.60	192.110	392	37	37	5	262	260	59
2-12	12:22:00	0.18	0.60	192.970	390	37	37	5	260	260	59
2-13	12:24:00	0.17	0.50	193.770	392	37	37	5	261	260	59
2-14	12:26:00	0.17	0.50	194.580	391	37	37	5	260	260	59
	12:28:00			195.349							
3-1	12:32:00	0.17	0.50	195.349	390	37	37	5	260	260	58
3-2	12:34:00	0.18	0.50	196.155	391	37	37	5	261	261	58
3-3	12:36:00	0.19	0.50	196.980	390	37	37	5	260	260	59
3-4	12:38:00	0.19	0.50	197.850	392	37	37	5	261	261	59
3-5	12:40:00	0.20	0.60	198.750	393	37	37	5	262	260	59
3-6	12:42:00	0.21	0.60	199.580	394	37	37	5	260	260	59
3-7	12:44:00	0.22	0.60	200.420	392	37	37	5	261	261	59
3-8	12:46:00	0.22	0.60	201.310	390	37	37	5	262	260	59
3-9	12:48:00	0.21	0.60	202.280	393	37	37	5	261	260	59
3-10	12:50:00	0.20	0.60	203.140	392	37	37	5	262	261	59
3-11	12:52:00	0.19	0.60	203.980	394	37	37	5	260	260	59
3-12	12:54:00	0.18	0.60	204.810	393	37	37	5	261	261	59
3-13	12:56:00	0.18	0.50	205.670	392	38	38	5	260	260	59
3-14	12:58:00	0.18	0.50	206.480	390	38	38	5	261	261	59
	13:00:00			207.249							

Total	1:22:00			34.632		36.3	36.3				
Average			0.58		391.7	36.3		5			
Min			0.50		389.0	35.0		5			
Max			0.70		395.0	38.0		6			

Impinger Weight Sheet - Run 1A

Client: Holcim (US) Inc. Facility: Alpena Cement Plant Test Location: Kiln 20 Breaching Duct Project #: M235005 Date: 12/13/2023 Test Method: 26A Weighed/Measured By: EE Balance ID: S10-25	Scale Calibration Check Date: <u>12/13/2023</u> Scale Calibration Check (see QS-6.05C for procedure) must be within $\pm 0.5g$ of certified mass <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Certified Weight, grams</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Result, grams</u></th> </tr> <tr> <td style="text-align: center;">200</td> <td style="text-align: center; border-bottom: 1px solid black;">200.0</td> </tr> <tr> <td style="text-align: center;">500</td> <td style="text-align: center; border-bottom: 1px solid black;">500.0</td> </tr> <tr> <td style="text-align: center;">700</td> <td style="text-align: center; border-bottom: 1px solid black;">700.0</td> </tr> </table>	<u>Certified Weight, grams</u>	<u>Result, grams</u>	200	200.0	500	500.0	700	700.0
<u>Certified Weight, grams</u>	<u>Result, grams</u>								
200	200.0								
500	500.0								
700	700.0								

IMPINGER	FINAL	INITIAL	GAIN
CONTENTS	MLS / GRAMS	MLS / GRAMS	MLS / GRAMS
0.1N H2SO4	755.8	736.4	19.4
0.1N H2SO4	698.8	695.6	3.2
Empty	590.4	589.1	1.3
0.1N NaOH	752.8	751.7	1.1
0.1N NaOH	722.8	722.6	0.2
Silica Gel	877.6	864.0	13.6

<u>3,520.6</u> Liquid Final	<u>3,495.4</u> Liquid Initial	<u>25.2</u> Liquid Gain
<u>877.6</u> Silica Final	<u>864.0</u> Silica Initial	<u>13.6</u> Silica Gain

Run 2A - Method 26A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 20 Breaching Duct
 Source Condition: Normal

Date: 12/13/23
 Start Time: 13:15
 End Time: 14:45

DRY GAS METER CONDITIONS				STACK CONDITIONS			
	ΔH :	0.62	in. H ₂ O	Static Pressure	-0.80	in. H ₂ O	
Meter Temperature, T _m :	35.7	°F		Flue Pressure (Ps):	29.32	in. Hg. abs.	
Sqrt ΔP :	0.443	in. H ₂ O		Carbon Dioxide:	16.38	%	
Stack Temperature, T _s :	391.7	°F		Oxygen:	9.54	%	
Meter Volume, V _m :	34.971	ft ³		Nitrogen:	74.1	%	
Meter Volume, V _{mstd} :	36.450	dscf		Gas Weight dry, M _d :	31.002	lb/lb mole	
Meter Volume, V _{wstd} :	2.854	wscf		Gas Weight wet, M _s :	30.058	lb/lb mole	
Isokinetic Variance:	100.3	%I		Excess Air:	95.237	%	
Test Length:	84.00	in. mins.		Gas Velocity, V _s :	31.057	fps	
Nozzle Diameter:	0.275	in. inches		Volumetric Flow:	130,440	acfm	
Barometric Pressure:	29.38	in Hg		Volumetric Flow:	73,495	dscfm	
				Volumetric Flow:	79,250	scfm	

MOISTURE DETERMINATION

Initial Impinger Content:	3583.0	ml	Silica Initial Wt.	769.2	grams
Final Impinger Content:	3625.7	ml	Silica Final Wt.	787.1	grams
Impinger Difference:	42.7	ml	Silica Difference:	17.9	grams
Total Water Gain:	60.6		Moisture, Bws:	0.073	

Port- Point No.	Clock Time	Velocity Head Δp in. H ₂ O	Orifice ΔH in. H ₂ O	Actual Meter Vol. ft ³	Stack Temp °F	Meter Temp Inlet °F	Outlet °F	Pump Vacuum °Hg	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	13:15:00	0.19	0.60	207.428	390	35	35	5	260	260	48
1-2	13:17:00	0.19	0.60	208.280	390	35	35	5	261	261	48
1-3	13:19:00	0.19	0.60	209.150	391	35	35	5	260	260	48
1-4	13:21:00	0.20	0.60	209.980	390	35	35	5	261	261	48
1-5	13:23:00	0.20	0.60	210.820	392	35	35	5	262	260	48
1-6	13:25:00	0.22	0.60	211.680	393	35	35	5	261	261	48
1-7	13:27:00	0.21	0.60	212.590	394	35	35	5	262	260	48
1-8	13:29:00	0.22	0.70	213.470	392	35	35	5	260	260	48
1-9	13:31:00	0.20	0.70	214.360	390	35	35	5	261	261	48
1-10	13:33:00	0.19	0.60	215.290	391	35	35	5	262	260	48
1-12	13:35:00	0.19	0.60	216.120	390	35	35	5	261	260	48
1-13	13:37:00	0.18	0.60	216.920	392	35	35	5	260	260	49
1-14	13:39:00	0.18	0.60	217.740	390	35	35	5	261	260	49
	13:41:00			218.511							
2-1	13:45:00	0.18	0.60	218.110	391	35	35	5	260	260	48
2-2	13:47:00	0.18	0.60	218.925	390	35	35	5	261	261	48
2-3	13:49:00	0.19	0.60	219.760	392	35	35	5	262	260	49
2-4	13:51:00	0.20	0.60	220.610	393	35	35	5	261	261	49
2-5	13:53:00	0.20	0.60	221.470	392	35	35	5	262	260	49
2-6	13:55:00	0.21	0.60	222.320	391	36	36	5	260	260	49
2-7	13:57:00	0.22	0.70	223.190	390	36	36	5	262	260	49
2-8	13:59:00	0.22	0.70	224.150	392	36	36	5	260	260	49
2-9	14:01:00	0.21	0.70	225.000	390	36	36	5	261	261	49
2-10	14:03:00	0.20	0.60	225.890	391	36	36	5	262	260	49
2-11	14:05:00	0.19	0.60	226.750	390	36	36	5	261	260	49
2-12	14:07:00	0.19	0.60	227.580	392	36	36	5	260	260	49
2-13	14:09:00	0.18	0.60	228.420	390	36	36	5	262	260	49
2-14	14:11:00	0.18	0.60	229.250	391	36	36	5	261	259	49
	14:13:00			230.055							
3-1	14:17:00	0.18	0.60	230.055	391	36	36	5	260	260	
3-2	14:19:00	0.18	0.60	230.880	390	36	36	5	261	261	
3-3	14:21:00	0.19	0.60	231.710	392	36	36	5	260	260	
3-4	14:23:00	0.20	0.60	232.540	393	36	36	5	261	261	
3-5	14:25:00	0.20	0.60	233.410	394	36	36	5	262	260	
3-6	14:27:00	0.21	0.60	234.290	392	36	36	5	260	260	
3-7	14:29:00	0.22	0.70	235.230	392	36	36	5	261	261	
3-8	14:31:00	0.22	0.70	236.080	394	36	36	5	261	260	
3-9	14:33:00	0.21	0.70	236.970	395	37	37	5	261	261	
3-10	14:35:00	0.20	0.60	237.850	394	37	37	5	260	261	
3-11	14:37:00	0.19	0.60	238.690	392	37	37	5	261	260	
3-12	14:39:00	0.19	0.60	239.540	393	37	37	5	260	260	
3-13	14:41:00	0.18	0.60	240.380	394	37	37	5	260	260	
3-14	14:43:00	0.18	0.60	241.210	392	37	37	5	261	260	
	14:45:00			241.998							

Total	1:22:00			34.971		35.7	35.7				
Average			0.62		391.7	35.7		5			
Min			0.60		390.0	35.0		5			
Max			0.70		395.0	37.0		5			

Impinger Weight Sheet - Run 2A

Client: Holcim (US) Inc. Facility: Alpena Cement Plant Test Location: Kiln 20 Breaching Duct Project #: M235005 Date: 12/13/2023 Test Method: 26A Weighed/Measured By: EE Balance ID: S10-25	Scale Calibration Check Date: <u>12/13/2023</u> Scale Calibration Check (see QS-6.05C for procedure) must be within $\pm 0.5g$ of certified mass <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Certified Weight, grams</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Result, grams</u></th> </tr> <tr> <td style="text-align: center;">200</td> <td style="text-align: center; border-bottom: 1px solid black;">200.0</td> </tr> <tr> <td style="text-align: center;">500</td> <td style="text-align: center; border-bottom: 1px solid black;">500.0</td> </tr> <tr> <td style="text-align: center;">700</td> <td style="text-align: center; border-bottom: 1px solid black;">700.0</td> </tr> </table>	<u>Certified Weight, grams</u>	<u>Result, grams</u>	200	200.0	500	500.0	700	700.0
<u>Certified Weight, grams</u>	<u>Result, grams</u>								
200	200.0								
500	500.0								
700	700.0								

IMPINGER	FINAL	INITIAL	GAIN
CONTENTS	MLS / GRAMS	MLS / GRAMS	MLS / GRAMS
0.1N H2SO4	775.4	737.3	38.1
0.1N H2SO4	724.7	722.2	2.5
Empty	660.1	658.6	1.5
0.1N NaOH	735.7	734.4	1.3
0.1N NaOH	729.8	730.5	-0.7
Silica Gel	787.1	769.2	17.9

<u>3,625.7</u> Liquid Final	<u>3,583.0</u> Liquid Initial	<u>42.7</u> Liquid Gain
<u>787.1</u> Silica Final	<u>769.2</u> Silica Initial	<u>17.9</u> Silica Gain

Run 3A - Method 26A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 20 Breaching Duct
 Source Condition: Normal

Date: 12/13/23
 Start Time: 15:00
 End Time: 16:30

DRY GAS METER CONDITIONS				STACK CONDITIONS			
	ΔH :	0.61	In. H ₂ O	Static Pressure	-1.00	in. H ₂ O	
Meter Temperature, T _m :	42.9	°F		Flue Pressure (Ps):	29.31	in. Hg. abs.	
Sqrt ΔP :	0.446	In. H ₂ O		Carbon Dioxide:	16.36	%	
Stack Temperature, T _s :	392.1	°F		Oxygen:	9.56	%	
Meter Volume, V _m :	35.407	ft ³		Nitrogen:	74.08	%	
Meter Volume, V _{mstd} :	36.379	dscf		Gas Weight dry, M _d :	31.000	lb/lb mole	
Meter Volume, V _{wstd} :	2.967	wscf		Gas Weight wet, M _s :	30.020	lb/lb mole	
Isokinetic Variance:	99.7	%I		Excess Air:	95.628	%	
Test Length:	84.00	in. mins.		Gas Velocity, V _s :	31.298	fps	
Nozzle Diameter:	0.275	in. inches		Volumetric Flow:	131,454	acfm	
Barometric Pressure:	29.38	in. Hg		Volumetric Flow:	73,767	dscfm	
				Volumetric Flow:	79,784	scfm	

MOISTURE DETERMINATION

Initial Impinger Content:	3497.9	ml	Silica Initial Wt.	877.6	grams
Final Impinger Content:	3551.7	ml	Silica Final Wt.	886.8	grams
Impinger Difference:	53.8	ml	Silica Difference:	9.2	grams
Total Water Gain:	63.0		Moisture, Bws:	0.075	

Port- Point No.	Clock Time	Velocity Head Δp in. H ₂ O	Orifice ΔH in. H ₂ O	Actual Meter Vol. ft ³	Stack Temp °F	Meter Temp Inlet °F	Outlet °F	Pump Vacuum °Hg	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	15:00:00	0.18	0.60	242.642	391	42	42	5	260	261	55
1-2	15:02:00	0.18	0.60	243.480	390	42	42	5	260	260	55
1-3	15:04:00	0.19	0.60	244.310	392	42	42	5	261	261	55
1-4	15:06:00	0.20	0.60	245.220	393	42	42	5	261	260	55
1-5	15:08:00	0.20	0.60	246.150	395	42	42	5	260	260	55
1-6	15:10:00	0.22	0.60	246.920	393	42	42	5	260	260	55
1-7	15:12:00	0.23	0.70	247.860	392	42	42	5	261	261	55
1-8	15:14:00	0.23	0.70	248.820	394	42	42	5	261	260	56
1-9	15:16:00	0.22	0.60	249.710	395	42	42	5	260	260	56
1-10	15:18:00	0.20	0.60	250.620	394	42	42	5	260	260	56
1-12	15:20:00	0.19	0.60	251.510	393	42	42	5	261	260	56
1-13	15:22:00	0.19	0.60	252.330	393	42	42	5	260	261	56
1-14	15:24:00	0.18	0.60	253.190	394	42	42	5	260	260	56
	15:26:00			253.700							
2-1	15:30:00	0.18	0.60	253.700	392	42	42	5	261	260	55
2-2	15:32:00	0.18	0.60	254.530	390	42	42	5	260	260	55
2-3	15:34:00	0.19	0.60	255.410	392	42	42	5	260	260	55
2-4	15:36:00	0.20	0.60	256.290	390	42	42	5	261	260	56
2-5	15:38:00	0.20	0.60	257.090	391	42	42	5	260	261	56
2-6	15:40:00	0.22	0.60	257.980	390	42	42	5	260	260	56
2-7	15:42:00	0.22	0.60	258.880	390	42	42	5	260	260	56
2-8	15:44:00	0.22	0.60	259.810	392	43	43	5	261	260	56
2-9	15:46:00	0.21	0.60	260.720	393	43	43	5	261	260	56
2-10	15:48:00	0.20	0.60	261.610	391	43	43	5	261	261	56
2-11	15:50:00	0.19	0.60	262.490	390	43	43	5	260	261	56
2-12	15:52:00	0.19	0.60	263.350	392	43	43	5	261	260	56
2-13	15:54:00	0.18	0.60	264.180	393	43	43	5	260	260	56
2-14	15:56:00	0.18	0.60	264.991	392	43	43	5	261	260	56
	15:58:00			265.815							
3-1	16:02:00	0.19	0.60	265.815	390	44	44	5	261	260	
3-2	16:04:00	0.19	0.60	266.680	392	44	44	5	260	260	
3-3	16:06:00	0.19	0.60	267.550	394	44	44	5	260	260	
3-4	16:08:00	0.20	0.60	268.390	393	44	44	5	261	260	
3-5	16:10:00	0.20	0.60	269.280	392	44	44	5	260	261	
3-6	16:12:00	0.22	0.60	270.180	393	44	44	5	260	260	
3-7	16:14:00	0.23	0.70	271.090	394	44	44	5	260	260	
3-8	16:16:00	0.22	0.60	271.990	394	44	44	5	261	260	
3-9	16:18:00	0.21	0.60	272.970	392	44	44	5	260	260	
3-10	16:20:00	0.20	0.60	273.850	390	44	44	5	261	260	
3-11	16:22:00	0.20	0.60	274.780	392	44	44	5	261	261	
3-12	16:24:00	0.19	0.60	275.580	390	44	44	5	260	260	
3-13	16:26:00	0.18	0.60	276.390	391	44	44	5	260	260	
3-14	16:28:00	0.18	0.60	277.280	392	44	44	5	261	260	
	16:30:00			278.049							

Total	1:22:00			35.407		42.9	42.9				
Average			0.61		392.1		42.9		5		
Min			0.60		390.0		42.0		5		
Max			0.70		395.0		44.0		5		

Impinger Weight Sheet - Run 3A

Client: Holcim (US) Inc. Facility: Alpena Cement Plant Test Location: Kiln 20 Breaching Duct Project #: M235005 Date: 12/13/2023 Test Method: 26A Weighed/Measured By: EE Balance ID: S10-25	Scale Calibration Check Date: <u>12/13/2023</u> Scale Calibration Check (see QS-6.05C for procedure) must be within $\pm 0.5g$ of certified mass <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Certified Weight, grams</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Result, grams</u></th> </tr> <tr> <td style="text-align: center;">200</td> <td style="text-align: center; border-bottom: 1px solid black;">200.0</td> </tr> <tr> <td style="text-align: center;">500</td> <td style="text-align: center; border-bottom: 1px solid black;">500.0</td> </tr> <tr> <td style="text-align: center;">700</td> <td style="text-align: center; border-bottom: 1px solid black;">700.0</td> </tr> </table>	<u>Certified Weight, grams</u>	<u>Result, grams</u>	200	200.0	500	500.0	700	700.0
<u>Certified Weight, grams</u>	<u>Result, grams</u>								
200	200.0								
500	500.0								
700	700.0								

IMPINGER	FINAL	INITIAL	GAIN
CONTENTS	MLS / GRAMS	MLS / GRAMS	MLS / GRAMS
0.1N H2SO4	767.0	723.3	43.7
0.1N H2SO4	695.3	690.8	4.5
Empty	592.8	590.5	2.3
0.1N NaOH	758.8	756.8	2.0
0.1N NaOH	737.8	736.5	1.3
Silica Gel	886.8	877.6	9.2

<u>3,551.7</u> Liquid Final	<u>3,497.9</u> Liquid Initial	<u>53.8</u> Liquid Gain
<u>886.8</u> Silica Final	<u>877.6</u> Silica Initial	<u>9.2</u> Silica Gain

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Test Location: Kiln 20 Breaching Duct
Project #: M235005
Test Method: 26A
Test Engineer: CLC
Test Technician: CLM

	<u>Run 1B</u>	<u>Run 2B</u>	<u>Run 3B</u>
Temp ID:	CM49	CM49	CM49
Meter ID:	CM49	CM49	CM49
Pitot ID:	S8-059	S8-059	S8-059
Filter ID:	Teflon	Teflon	Teflon
Nozzle Diameter (Inches):	0.311	0.311	0.311
Meter Calibration Date:	10/24/2023	10/24/2023	10/24/2023
Meter Calibration Factor (Y):	1.007	1.007	1.007
Meter Orifice Setting (Delta H):	1.732	1.732	1.732
Nozzle Kit ID Number and Material:	#18/ 662	#18/ 662	#18/ 662

Leak Checks

Pre Pitot Leak Check	0.0	@	3.2	"H ₂ O	0.0	@	3.2	"H ₂ O	0.0	@	3.4	"H ₂ O
Post Pitot Leak Check	0.0	@	3.4	"H ₂ O	0.0	@	3.3	"H ₂ O	0.0	@	3.3	"H ₂ O
Pre Nozzle Leak Check	0.0012	@	13	"Hg	0.0013	@	14	"Hg	0.0013	@	13	"Hg
Post Nozzle Leak Check	0.0000	@	11	"Hg	0.0010	@	11	"Hg	0.0011	@	11	"Hg
Pitot Tube Coefficient:	0.839											
Probe Length (Feet):	8.0											
Probe Liner Material:	Glass											
Sample Plane:	Horizontal											
Port Length (Inches):	3.25											
Port Size (Diameter, Inches):	6.00											
Port Type:	Nipple											
Duct Shape:	Rectangular											
Length (Feet):	8											
Width (Feet):	8.75											
Duct Area (Square Feet):	70.000											
Upstream Diameters:	~1.0											
Downstream Diameters:	~8.5											
Number of Ports Sampled:	3											
Number of Points per Port:	14											
Minutes per Point:	2.0											
Minutes per Reading:	2.0											
Total Number of Traverse Points:	42											
Test Length (Minutes):	84											
Train Type:	Hot Box											
Source Condition:	Normal											
Diluent Model/Serial Number:	1440D1/4662											
Moisture Balance ID:	S10-25											
# of Runs	3											

Run 1B - Method 26A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 20 Breaching Duct
 Source Condition: Normal

Date: 12/13/23
 Start Time: 11:30
 End Time: 13:00

DRY GAS METER CONDITIONS				STACK CONDITIONS			
ΔH:	1.39	in. H ₂ O		Static Pressure	-1.00	in. H ₂ O	
Meter Temperature, T _m :	42.3	°F		Flue Pressure (Ps):	29.31	in. Hg. abs.	
Sqrt ΔP:	0.507	in. H ₂ O		Carbon Dioxide:	16.27	%	
Stack Temperature, T _s :	398.1	°F		Oxygen:	9.46	%	
Meter Volume, V _m :	54.348	ft ³		Nitrogen:	74.27	%	
Meter Volume, V _{mstd} :	56.684	dscf		Gas Weight dry, M _d :	30.982	lb/lb mole	
Meter Volume, V _{wstd} :	1.912	wscf		Gas Weight wet, M _s :	30.558	lb/lb mole	
Isokinetic Variance:	102.8	%I		Excess Air:	93.227	%	
Test Length:	84.00	in. mins.		Gas Velocity, V _s :	35.577	fps	
Nozzle Diameter:	0.311	in. inches		Volumetric Flow:	149,424	acfm	
Barometric Pressure:	29.38	in. Hg		Volumetric Flow:	87,120	dscfm	
				Volumetric Flow:	90,059	scfm	

MOISTURE DETERMINATION

Initial Impinger Content:	3523.0	ml	Silica Initial Wt.	886.7	grams
Final Impinger Content:	3563.6	ml	Silica Final Wt.	886.7	grams
Impinger Difference:	40.6	ml	Silica Difference:	0.0	grams
Total Water Gain:	40.6		Moisture, Bws:	0.033	

Port- Point No.	Clock Time	Velocity Head Δp in. H ₂ O	Orifice ΔH in. H ₂ O	Actual Meter Vol. ft ³	Stack Temp °F	Meter Temp Inlet °F	Outlet °F	Pump Vacuum °Hg	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	11:30:00	0.22	1.30	172.864	404	39	39	8	262	260	46
1-2	11:32:00	0.23	1.28	174.240	404	39	39	8	262	260	47
1-3	11:34:00	0.25	1.34	175.450	403	39	39	8	263	260	47
1-4	11:36:00	0.27	1.40	176.720	404	39	39	8	263	261	47
1-5	11:38:00	0.31	1.52	178.150	403	39	39	9	262	260	46
1-6	11:40:00	0.32	1.55	179.660	404	40	40	9	262	260	46
1-7	11:42:00	0.30	1.49	180.910	404	40	40	8	261	259	47
1-8	11:44:00	0.28	1.44	182.440	402	40	40	8	261	259	48
1-9	11:46:00	0.25	1.35	183.730	400	40	40	8	260	259	49
1-10	11:48:00	0.23	1.29	184.990	399	40	40	8	259	259	49
1-12	11:50:00	0.23	1.29	186.290	400	40	40	8	258	259	50
1-13	11:52:00	0.21	1.23	187.480	400	40	40	8	258	260	50
1-14	11:54:00	0.20	1.20	188.710	400	40	40	8	258	260	50
	11:56:00			189.876							
2-1	12:00:00	0.20	1.20	189.876	403	41	41	8	260	260	51
2-2	12:02:00	0.23	1.31	191.230	400	43	43	8	261	260	51
2-3	12:04:00	0.26	1.40	192.510	400	43	43	8	261	261	50
2-4	12:06:00	0.29	1.49	193.840	400	43	43	9	263	262	52
2-5	12:08:00	0.21	1.55	195.340	399	43	43	9	263	261	52
2-6	12:10:00	0.21	1.55	196.610	398	44	44	9	262	261	52
2-7	12:12:00	0.20	1.52	197.990	398	44	44	8	262	261	53
2-8	12:14:00	0.28	1.46	199.420	396	44	44	8	263	261	52
2-9	12:16:00	0.28	1.46	200.730	396	45	45	8	263	261	52
2-10	12:18:00	0.26	1.40	202.140	395	45	45	8	263	260	53
2-11	12:20:00	0.25	1.37	203.440	395	45	45	8	262	259	53
2-12	12:22:00	0.24	1.34	204.820	395	45	45	8	260	258	53
2-13	12:24:00	0.22	1.28	206.130	395	45	45	8	260	259	53
2-14	12:26:00	0.21	1.25	207.340	395	45	45	8	262	260	53
	12:28:00			208.555							
3-1	12:32:00	0.21	1.24	208.555	396	45	45	8	261	261	53
3-2	12:34:00	0.22	1.27	209.910	396	44	44	8	263	262	53
3-3	12:36:00	0.25	1.36	211.160	395	44	44	8	263	261	54
3-4	12:38:00	0.20	1.52	212.460	394	43	43	9	262	261	54
3-5	12:40:00	0.22	1.58	213.890	395	43	43	9	262	260	54
3-6	12:42:00	0.21	1.54	215.260	396	43	43	9	262	260	54
3-7	12:44:00	0.29	1.48	216.620	395	42	42	8	263	260	54
3-8	12:46:00	0.18	1.46	218.140	394	43	43	8	263	261	53
3-9	12:48:00	1.70	1.43	219.430	394	43	43	8	262	260	53
3-10	12:50:00	0.17	1.43	220.740	395	43	43	8	261	260	52
3-11	12:52:00	0.25	1.37	222.150	394	43	43	8	261	261	52
3-12	12:54:00	0.24	1.34	223.470	395	43	43	8	263	262	52
3-13	12:56:00	0.23	1.31	224.780	395	43	43	8	263	261	52
3-14	12:58:00	0.22	1.27	225.990	395	43	43	8	262	261	53
	13:00:00			227.212							

Total	1:22:00			54.348		42.3	42.3				
Average			1.39		398.1				8		
Min			1.20		394.0		39.0		8		
Max			1.58		404.0		45.0		9		

Impinger Weight Sheet - Run 1B

Client: Holcim (US) Inc. Facility: Alpena Cement Plant Test Location: Kiln 20 Breaching Duct Project #: M235005 Date: 12/13/2023 Test Method: 26A Weighed/Measured By: EE Balance ID: S10-25	Scale Calibration Check Date: <u>12/13/2023</u> Scale Calibration Check (see QS-6.05C for procedure) must be within $\pm 0.5g$ of certified mass <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Certified Weight, grams</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Result, grams</u></th> </tr> <tr> <td style="text-align: center;">200</td> <td style="text-align: center; border-bottom: 1px solid black;">200.0</td> </tr> <tr> <td style="text-align: center;">500</td> <td style="text-align: center; border-bottom: 1px solid black;">500.0</td> </tr> <tr> <td style="text-align: center;">700</td> <td style="text-align: center; border-bottom: 1px solid black;">700.0</td> </tr> </table>	<u>Certified Weight, grams</u>	<u>Result, grams</u>	200	200.0	500	500.0	700	700.0
<u>Certified Weight, grams</u>	<u>Result, grams</u>								
200	200.0								
500	500.0								
700	700.0								

IMPINGER	FINAL	INITIAL	GAIN
CONTENTS	MLS / GRAMS	MLS / GRAMS	MLS / GRAMS
0.1N H2SO4	725.4	693.6	31.8
0.1N H2SO4	738.8	730.0	8.8
Empty	656.4	656.4	0.0
0.1N NaOH	709.4	709.4	0.0
0.1N NaOH	733.6	733.6	0.0
Silica Gel	886.7	886.7	0.0

<u>3,563.6</u> Liquid Final	<u>3,523.0</u> Liquid Initial	<u>40.6</u> Liquid Gain
<u>886.7</u> Silica Final	<u>886.7</u> Silica Initial	<u>0.0</u> Silica Gain

Run 2B - Method 26A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 20 Breaching Duct
 Source Condition: Normal

Date: 12/13/23
 Start Time: 13:15
 End Time: 14:45

DRY GAS METER CONDITIONS				STACK CONDITIONS			
	ΔH :	1.40	In. H ₂ O	Static Pressure	-1.00	in. H ₂ O	
Meter Temperature, T _m :	43.1	°F		Flue Pressure (Ps):	29.31	in. Hg. abs.	
Sqrt ΔP :	0.492	In. H ₂ O		Carbon Dioxide:	16.38	%	
Stack Temperature, T _s :	399.1	°F		Oxygen:	9.54	%	
Meter Volume, V _m :	54.644	ft ³		Nitrogen:	74.1	%	
Meter Volume, V _{mstd} :	56.906	dscf		Gas Weight dry, M _d :	31.002	lb/lb mole	
Meter Volume, V _{wstd} :	3.127	wscf		Gas Weight wet, M _s :	30.325	lb/lb mole	
Isokinetic Variance:	108.1	%I		Excess Air:	95.237	%	
Test Length:	84.00	in. mins.		Gas Velocity, V _s :	34.720	fps	
Nozzle Diameter:	0.311	in. inches		Volumetric Flow:	145,822	acfm	
Barometric Pressure:	29.38	in Hg		Volumetric Flow:	83,209	dscfm	
				Volumetric Flow:	87,782	scfm	

MOISTURE DETERMINATION

Initial Impinger Content:	3554.6	ml	Silica Initial Wt.	885.0	grams
Final Impinger Content:	3608.9	ml	Silica Final Wt.	897.1	grams
Impinger Difference:	54.3	ml	Silica Difference:	12.1	grams
Total Water Gain:	66.4		Moisture, Bws:	0.052	

Port- Point No.	Clock Time	Velocity Head Δp in. H ₂ O	Orifice ΔH in. H ₂ O	Actual Meter Vol. ft ³	Stack Temp °F	Meter Temp Inlet °F	Outlet °F	Pump Vacuum °Hg	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	13:15:00	0.21	1.23	228.696	403	41	41	5	261	260	52
1-2	13:17:00	0.23	1.29	230.100	404	41	41	5	261	261	52
1-3	13:19:00	0.26	1.38	231.340	403	41	41	5	263	262	52
1-4	13:21:00	0.27	1.41	232.670	404	41	41	5	263	261	52
1-5	13:23:00	0.20	1.50	233.940	403	41	41	6	262	261	53
1-6	13:25:00	0.22	1.56	235.340	404	41	41	6	262	260	53
1-7	13:27:00	0.21	1.53	236.740	404	42	42	6	262	260	53
1-8	13:29:00	0.20	1.51	238.130	402	42	42	6	262	260	53
1-9	13:31:00	0.29	1.48	239.520	400	42	42	5	263	260	54
1-10	13:33:00	0.27	1.42	240.920	399	42	42	5	263	261	53
1-12	13:35:00	0.25	1.36	242.240	400	42	42	5	262	260	53
1-13	13:37:00	0.23	1.30	243.570	400	42	42	5	260	260	53
1-14	13:39:00	0.21	1.24	244.860	400	42	42	5	259	260	53
	13:41:00			246.014							
2-1	13:45:00	0.21	1.24	246.014	401	42	42	5	261	261	52
2-2	13:47:00	0.23	1.30	247.320	402	43	43	5	260	260	52
2-3	13:49:00	0.25	1.36	248.640	401	43	43	5	260	262	51
2-4	13:51:00	0.27	1.42	249.990	400	43	43	5	261	260	52
2-5	13:53:00	0.29	1.48	251.340	399	43	43	5	261	261	52
2-6	13:55:00	0.30	1.52	252.670	398	43	43	6	263	262	52
2-7	13:57:00	0.30	1.52	254.010	397	43	43	6	263	261	53
2-8	13:59:00	0.20	1.52	255.450	396	43	43	6	262	261	53
2-9	14:01:00	0.29	1.49	256.880	396	43	43	5	262	260	54
2-10	14:03:00	0.28	1.46	258.240	395	43	43	5	263	260	54
2-11	14:05:00	0.24	1.34	259.560	394	43	43	5	263	261	54
2-12	14:07:00	0.24	1.34	260.910	394	43	43	5	262	260	54
2-13	14:09:00	0.23	1.31	262.340	394	44	44	5	261	259	54
2-14	14:11:00	0.21	1.25	263.520	395	44	44	5	262	260	54
	14:13:00			264.674							
3-1	14:17:00	0.20	1.22	264.674	396	44	44	5	261	261	54
3-2	14:19:00	0.22	1.28	265.920	396	44	44	5	263	262	54
3-3	14:21:00	0.24	1.34	267.240	397	44	44	5	263	261	54
3-4	14:23:00	0.27	1.43	268.630	397	44	44	5	262	261	55
3-5	14:25:00	0.30	1.52	269.920	397	44	44	6	262	260	55
3-6	14:27:00	0.21	1.55	271.330	398	44	44	6	262	260	55
3-7	14:29:00	0.21	1.55	272.740	398	45	45	6	263	260	54
3-8	14:31:00	0.29	1.49	274.120	398	45	45	5	261	261	55
3-9	14:33:00	0.27	1.43	275.550	399	45	45	5	260	260	55
3-10	14:35:00	0.23	1.40	276.920	399	45	45	5	260	261	55
3-11	14:37:00	0.25	1.37	278.240	399	45	45	5	261	260	56
3-12	14:39:00	0.25	1.37	279.560	400	45	45	5	262	261	56
3-13	14:41:00	0.23	1.30	280.880	401	45	45	5	263	262	56
3-14	14:43:00	0.22	1.27	282.110	401	45	45	5	263	261	56
	14:45:00			283.340							

Total	1:22:00			54.644		43.1	43.1				
Average			1.40		399.1		43.1		5		
Min			1.22		394.0		41.0		5		
Max			1.56		404.0		45.0		6		

Impinger Weight Sheet - Run 2B

Client: Holcim (US) Inc. Facility: Alpena Cement Plant Test Location: Kiln 20 Breaching Duct Project #: M235005 Date: 12/13/2023 Test Method: 26A Weighed/Measured By: EE Balance ID: S10-25	Scale Calibration Check Date: <u>12/13/2023</u> <u>Scale Calibration Check (see QS-6.05C for procedure)</u> must be within $\pm 0.5g$ of certified mass <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Certified Weight, grams</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Result, grams</u></th> </tr> <tr> <td style="text-align: center;">200</td> <td style="text-align: center; border-bottom: 1px solid black;">200.0</td> </tr> <tr> <td style="text-align: center;">500</td> <td style="text-align: center; border-bottom: 1px solid black;">500.0</td> </tr> <tr> <td style="text-align: center;">700</td> <td style="text-align: center; border-bottom: 1px solid black;">700.0</td> </tr> </table>	<u>Certified Weight, grams</u>	<u>Result, grams</u>	200	200.0	500	500.0	700	700.0
<u>Certified Weight, grams</u>	<u>Result, grams</u>								
200	200.0								
500	500.0								
700	700.0								

IMPINGER	FINAL	INITIAL	GAIN
CONTENTS	MLS / GRAMS	MLS / GRAMS	MLS / GRAMS
0.1N H2SO4	785.7	738.4	47.3
0.1N H2SO4	747.5	743.7	3.8
Empty	616.8	615.3	1.5
0.1N NaOH	697.5	696.2	1.3
0.1N NaOH	761.4	761.0	0.4
Silica Gel	897.1	885.0	12.1

<u>3,608.9</u> Liquid Final	<u>3,554.6</u> Liquid Initial	<u>54.3</u> Liquid Gain
<u>897.1</u> Silica Final	<u>885.0</u> Silica Initial	<u>12.1</u> Silica Gain

Run 3B - Method 26A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 20 Breaching Duct
 Source Condition: Normal

Date: 12/13/23
 Start Time: 15:00
 End Time: 16:30

DRY GAS METER CONDITIONS				STACK CONDITIONS			
	ΔH :	1.39	in. H ₂ O	Static Pressure	-1.00	in. H ₂ O	
Meter Temperature, T _m :	47.2	°F		Flue Pressure (Ps):	29.31	in. Hg. abs.	
Sqrt ΔP :	0.506	in. H ₂ O		Carbon Dioxide:	16.36	%	
Stack Temperature, T _s :	401.1	°F		Oxygen:	9.56	%	
Meter Volume, V _m :	54.723	ft ³		Nitrogen:	74.08	%	
Meter Volume, V _{mstd} :	56.524	dscf		Gas Weight dry, M _d :	31.000	lb/lb mole	
Meter Volume, V _{wstd} :	3.146	wscf		Gas Weight wet, M _s :	30.315	lb/lb mole	
Isokinetic Variance:	104.6	%I		Excess Air:	95.628	%	
Test Length:	84.00	in. mins.		Gas Velocity, V _s :	35.736	fps	
Nozzle Diameter:	0.311	in. inches		Volumetric Flow:	150,091	acfm	
Barometric Pressure:	29.38	in. Hg		Volumetric Flow:	85,391	dscfm	
				Volumetric Flow:	90,144	scfm	

MOISTURE DETERMINATION

Initial Impinger Content:	3550.1	ml	Silica Initial Wt.	886.7	grams
Final Impinger Content:	3603.6	ml	Silica Final Wt.	900.0	grams
Impinger Difference:	53.5	ml	Silica Difference:	13.3	grams
Total Water Gain:	66.8		Moisture, Bws:	0.053	

Port- Point No.	Clock Time	Velocity Head Δp in. H ₂ O	Orifice ΔH in. H ₂ O	Actual Meter Vol. ft ³	Stack Temp °F	Meter Temp Inlet °F	Outlet °F	Pump Vacuum °Hg	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	15:00:00	0.21	1.24	284.853	400	45	45	8	263	262	49
1-2	15:02:00	0.23	1.30	286.230	400	45	45	8	263	261	49
1-3	15:04:00	0.24	1.33	287.560	401	45	45	8	262	261	48
1-4	15:06:00	0.26	1.39	288.810	401	45	45	8	262	260	49
1-5	15:08:00	0.29	1.48	290.130	402	46	46	8	262	260	50
1-6	15:10:00	0.31	1.54	291.520	402	46	46	9	262	260	51
1-7	15:12:00	0.30	1.51	292.910	402	46	46	9	261	259	51
1-8	15:14:00	0.30	1.51	294.350	402	46	46	9	261	259	51
1-9	15:16:00	0.27	1.43	295.770	401	46	46	8	260	259	52
1-10	15:18:00	0.26	1.40	297.060	399	46	46	8	259	259	53
1-12	15:20:00	0.24	1.34	298.360	400	46	46	8	258	259	53
1-13	15:22:00	0.23	1.31	299.750	400	46	46	8	258	260	53
1-14	15:24:00	0.20	1.21	300.940	400	46	46	8	258	260	53
	15:26:00			302.154							
2-1	15:30:00	0.21	1.24	302.154	402	46	46	8	263	261	52
2-2	15:32:00	0.22	1.27	303.560	401	46	46	8	262	261	52
2-3	15:34:00	0.24	1.34	304.720	400	46	46	8	262	261	51
2-4	15:36:00	0.27	1.43	306.090	400	46	46	8	263	261	52
2-5	15:38:00	0.29	1.49	307.450	399	47	47	8	263	261	53
2-6	15:40:00	0.30	1.52	308.840	398	47	47	9	263	260	53
2-7	15:42:00	0.30	1.52	310.240	399	47	47	9	262	261	54
2-8	15:44:00	0.31	1.55	311.640	399	47	47	9	263	261	54
2-9	15:46:00	0.29	1.50	313.120	399	48	48	8	263	261	54
2-10	15:48:00	0.27	1.43	314.450	400	48	48	8	263	260	53
2-11	15:50:00	0.25	1.37	315.760	400	48	48	8	262	259	53
2-12	15:52:00	0.23	1.31	317.140	401	48	48	8	260	258	53
2-13	15:54:00	0.22	1.28	318.480	402	48	48	8	260	259	53
2-14	15:56:00	0.20	1.22	319.620	402	48	48	8	262	260	53
	15:58:00			320.842							
3-1	16:02:00	0.20	1.22	320.842	402	48	48	8	262	260	53
3-2	16:04:00	0.22	1.28	322.130	402	48	48	8	263	260	53
3-3	16:06:00	0.24	1.34	323.450	401	48	48	8	263	261	54
3-4	16:08:00	0.29	1.49	324.770	402	48	48	8	262	260	55
3-5	16:10:00	0.30	1.52	326.180	402	49	49	9	261	260	56
3-6	16:12:00	0.31	1.55	327.510	403	49	49	9	261	261	56
3-7	16:14:00	0.30	1.52	328.930	403	49	49	9	262	260	56
3-8	16:16:00	0.29	1.49	330.350	403	49	49	8	263	260	56
3-9	16:18:00	0.27	1.43	331.790	403	49	49	8	262	260	57
3-10	16:20:00	0.26	1.40	333.140	403	49	49	8	260	261	57
3-11	16:22:00	0.25	1.37	334.460	403	49	49	8	260	261	57
3-12	16:24:00	0.24	1.34	335.780	402	49	49	8	260	262	56
3-13	16:26:00	0.23	1.31	337.140	402	49	49	8	260	261	56
3-14	16:28:00	0.21	1.25	338.480	402	49	49	8	260	261	55
	16:30:00			339.576							

Total	1:22:00			54.723		47.2	47.2				
Average			1.39		401.1	47.2		8			
Min			1.21		398.0	45.0		8			
Max			1.55		403.0	49.0		9			

Impinger Weight Sheet - Run 3B

Client: Holcim (US) Inc. Facility: Alpena Cement Plant Test Location: Kiln 20 Breaching Duct Project #: M235005 Date: 12/13/2023 Test Method: 26A Weighed/Measured By: EE Balance ID: S10-25	Scale Calibration Check Date: <u>12/13/2023</u> Scale Calibration Check (see QS-6.05C for procedure) must be within $\pm 0.5g$ of certified mass <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Certified Weight, grams</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Result, grams</u></th> </tr> <tr> <td style="text-align: center;">200</td> <td style="text-align: center; border-bottom: 1px solid black;">200.0</td> </tr> <tr> <td style="text-align: center;">500</td> <td style="text-align: center; border-bottom: 1px solid black;">500.0</td> </tr> <tr> <td style="text-align: center;">700</td> <td style="text-align: center; border-bottom: 1px solid black;">700.0</td> </tr> </table>	<u>Certified Weight, grams</u>	<u>Result, grams</u>	200	200.0	500	500.0	700	700.0
<u>Certified Weight, grams</u>	<u>Result, grams</u>								
200	200.0								
500	500.0								
700	700.0								

IMPINGER	FINAL	INITIAL	GAIN
CONTENTS	MLS / GRAMS	MLS / GRAMS	MLS / GRAMS
0.1N H2SO4	738.8	696.5	42.3
0.1N H2SO4	754.8	748.9	5.9
Empty	653.9	651.2	2.7
0.1N NaOH	709.2	707.2	2.0
0.1N NaOH	746.9	746.3	0.6
Silica Gel	900.0	886.7	13.3

<u>3,603.6</u> Liquid Final	<u>3,550.1</u> Liquid Initial	<u>53.5</u> Liquid Gain
<u>900.0</u> Silica Final	<u>886.7</u> Silica Initial	<u>13.3</u> Silica Gain

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Test Location: Kiln 20 Exhaust
Date: 12/13/23

Run 1								Analyzer Data O2 % (dry)
Spectrum	Time	H2O %	CO2 % (wet)	FTIR Data HCN ppmvw	HF ppmvw	Cell Temp	Pressure	
RUN 1_020967.LAB	11:30	3.59	16.33	1.54	≤ 0.10	191.04	0.98	9.32
RUN 1_020968.LAB	11:31	3.67	16.29	1.63	≤ 0.10	190.97	0.98	9.39
RUN 1_020969.LAB	11:32	3.71	16.07	1.52	≤ 0.10	191.05	0.98	9.42
RUN 1_020970.LAB	11:33	3.88	15.94	1.57	≤ 0.10	191.05	0.98	9.35
RUN 1_020971.LAB	11:34	3.88	16.21	1.57	≤ 0.10	191.13	0.98	9.48
RUN 1_020972.LAB	11:35	3.90	16.13	1.45	≤ 0.10	191.12	0.98	9.37
RUN 1_020973.LAB	11:36	4.56	15.78	1.50	≤ 0.10	191.01	0.98	9.28
RUN 1_020974.LAB	11:37	4.52	15.64	1.37	≤ 0.10	190.94	0.98	9.37
RUN 1_020975.LAB	11:38	4.41	15.87	1.44	≤ 0.10	190.99	0.98	9.55
RUN 1_020976.LAB	11:39	4.36	16.19	1.35	≤ 0.10	191.00	0.98	9.36
RUN 1_020977.LAB	11:40	4.35	16.14	1.58	≤ 0.10	191.05	0.98	9.30
RUN 1_020978.LAB	11:41	4.33	15.90	1.50	≤ 0.10	190.96	0.98	9.31
RUN 1_020979.LAB	11:42	4.33	15.93	1.52	≤ 0.10	190.94	0.98	9.39
RUN 1_020980.LAB	11:43	4.31	15.78	1.43	≤ 0.10	190.87	0.98	9.23
RUN 1_020981.LAB	11:44	4.31	15.66	1.53	≤ 0.10	190.97	0.98	9.38
RUN 1_020982.LAB	11:45	4.33	15.63	1.52	≤ 0.10	191.07	0.98	9.59
RUN 1_020983.LAB	11:46	4.35	15.46	1.43	≤ 0.10	191.04	0.98	9.35
RUN 1_020984.LAB	11:47	4.36	15.55	1.45	≤ 0.10	191.05	0.98	9.35
RUN 1_020985.LAB	11:48	5.16	15.12	1.33	≤ 0.10	191.04	0.98	9.59
RUN 1_020986.LAB	11:49	5.26	15.21	1.36	≤ 0.10	191.01	0.98	9.59
RUN 1_020987.LAB	11:50	4.75	15.35	1.39	≤ 0.10	191.01	0.98	9.52
RUN 1_020988.LAB	11:51	5.07	15.64	1.50	≤ 0.10	190.97	0.98	9.54
RUN 1_020989.LAB	11:52	4.85	15.71	1.42	≤ 0.10	190.96	0.98	9.52
RUN 1_020990.LAB	11:53	4.55	15.49	1.30	≤ 0.10	190.97	0.98	9.35
RUN 1_020991.LAB	11:54	4.62	15.54	1.27	≤ 0.10	190.97	0.98	9.35
RUN 1_020992.LAB	11:55	4.77	15.56	1.41	≤ 0.10	190.99	0.98	9.49
RUN 1_020993.LAB	11:56	5.07	15.47	1.46	≤ 0.10	190.97	0.98	9.37
RUN 1_020994.LAB	11:57	5.36	15.24	1.44	≤ 0.10	190.97	0.98	9.30
RUN 1_020995.LAB	11:58	5.61	15.19	1.55	≤ 0.10	191.02	0.98	9.45
RUN 1_020996.LAB	11:59	5.95	15.28	1.42	≤ 0.10	191.05	0.98	9.46
RUN 1_020997.LAB	12:00	5.58	15.23	1.42	≤ 0.10	191.00	0.98	9.41
RUN 1_020998.LAB	12:01	5.46	15.08	1.39	≤ 0.10	191.00	0.98	9.49
RUN 1_020999.LAB	12:02	6.14	15.09	1.56	≤ 0.10	191.01	0.98	9.48
RUN 1_021000.LAB	12:03	6.67	15.19	1.39	≤ 0.10	190.97	0.98	9.55
RUN 1_021001.LAB	12:04	5.99	15.28	1.31	≤ 0.10	190.94	0.98	9.47
RUN 1_021002.LAB	12:05	5.78	15.11	1.26	≤ 0.10	191.04	0.98	9.60
RUN 1_021003.LAB	12:06	6.17	15.03	1.37	≤ 0.10	191.05	0.98	9.55
RUN 1_021004.LAB	12:07	5.67	15.31	1.42	≤ 0.10	191.05	0.98	9.39
RUN 1_021005.LAB	12:08	5.55	15.17	1.34	≤ 0.10	191.00	0.98	9.53
RUN 1_021006.LAB	12:09	5.45	15.10	1.27	≤ 0.10	191.03	0.98	9.55
RUN 1_021007.LAB	12:10	5.28	15.00	1.27	≤ 0.10	190.98	0.98	9.44
RUN 1_021008.LAB	12:11	5.29	15.25	1.37	≤ 0.10	191.00	0.98	9.53
RUN 1_021009.LAB	12:12	5.57	15.14	1.34	≤ 0.10	190.99	0.98	9.56
RUN 1_021010.LAB	12:13	5.40	15.08	1.28	≤ 0.10	191.05	0.98	9.55
RUN 1_021011.LAB	12:14	5.37	15.17	1.30	≤ 0.10	191.05	0.98	9.42
RUN 1_021012.LAB	12:15	5.44	15.12	1.26	≤ 0.10	190.99	0.98	9.59
RUN 1_021013.LAB	12:16	5.40	15.02	1.21	≤ 0.10	191.04	0.98	9.62
RUN 1_021014.LAB	12:17	5.39	14.70	1.21	≤ 0.10	190.94	0.98	9.42
RUN 1_021015.LAB	12:18	5.23	15.01	1.26	≤ 0.10	191.13	0.98	9.54
RUN 1_021016.LAB	12:19	5.28	15.34	1.31	≤ 0.10	191.15	0.98	9.75
RUN 1_021017.LAB	12:20	5.18	15.59	1.32	≤ 0.10	191.05	0.98	9.71
RUN 1_021018.LAB	12:21	5.12	15.45	1.39	≤ 0.10	190.94	0.98	9.59
RUN 1_021019.LAB	12:22	5.13	15.43	1.44	≤ 0.10	190.94	0.98	9.67
RUN 1_021020.LAB	12:23	5.11	15.41	1.32	≤ 0.10	190.94	0.98	9.52
RUN 1_021021.LAB	12:24	5.10	15.38	1.33	≤ 0.10	190.94	0.98	9.35
RUN 1_021022.LAB	12:25	5.07	15.28	1.37	≤ 0.10	190.94	0.98	9.45
RUN 1_021023.LAB	12:26	5.06	15.37	1.46	≤ 0.10	190.94	0.98	9.46
RUN 1_021024.LAB	12:27	5.04	15.29	1.42	≤ 0.10	191.04	0.98	9.35
RUN 1_021025.LAB	12:28	5.15	15.36	1.41	≤ 0.10	191.09	0.98	9.41
RUN 1_021026.LAB	12:29	5.30	15.33	1.44	≤ 0.10	191.14	0.98	9.54
Average		4.99	15.46	1.40	≤ 0.10	191.01	0.98	9.46

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Test Location: Kiln 20 Exhaust
Date: 12/13/23

Run 2

Spectrum	Time	FTIR Data				Cell Temp	Pressure	Analyzer Data O2 % (dry)
		H2O %	CO2 % (wet)	HCN ppmvw	HF ppmvw			
RUN 2_021117.LAB	13:15	3.41	16.5	1.71	≤ 0.10	190.8	0.98	9.24
RUN 2_021118.LAB	13:16	3.48	16.3	1.63	≤ 0.10	190.8	0.98	9.22
RUN 2_021119.LAB	13:17	3.53	16.1	1.73	≤ 0.10	190.9	0.98	9.40
RUN 2_021120.LAB	13:18	3.55	16.3	1.66	≤ 0.10	191.0	0.98	9.36
RUN 2_021121.LAB	13:19	3.57	16.1	1.74	≤ 0.10	191.1	0.98	9.31
RUN 2_021122.LAB	13:20	3.59	16.0	1.58	≤ 0.10	191.1	0.98	9.34
RUN 2_021123.LAB	13:21	4.65	16.0	1.57	≤ 0.10	191.0	0.98	9.38
RUN 2_021124.LAB	13:22	4.37	16.0	1.52	≤ 0.10	191.0	0.98	9.43
RUN 2_021125.LAB	13:23	4.84	15.7	1.49	≤ 0.10	191.0	0.98	9.33
RUN 2_021126.LAB	13:24	4.78	15.8	1.45	≤ 0.10	191.0	0.98	9.54
RUN 2_021127.LAB	13:25	4.80	16.0	1.68	≤ 0.10	191.0	0.99	9.46
RUN 2_021128.LAB	13:26	4.87	15.7	1.57	≤ 0.10	191.0	0.99	9.33
RUN 2_021129.LAB	13:27	4.92	15.8	1.59	≤ 0.10	191.0	0.98	9.43
RUN 2_021130.LAB	13:28	4.91	15.8	1.61	≤ 0.10	191.0	0.99	9.42
RUN 2_021131.LAB	13:29	4.96	16.0	1.61	≤ 0.10	191.0	0.99	9.34
RUN 2_021132.LAB	13:30	4.93	15.7	1.62	≤ 0.10	191.0	0.99	9.41
RUN 2_021133.LAB	13:31	4.91	15.6	1.66	≤ 0.10	190.9	0.99	9.43
RUN 2_021134.LAB	13:32	4.92	15.8	1.55	≤ 0.10	191.0	0.99	9.39
RUN 2_021135.LAB	13:33	4.99	15.8	1.59	≤ 0.10	190.9	0.99	9.29
RUN 2_021136.LAB	13:34	5.03	15.5	1.42	≤ 0.10	191.0	0.99	9.48
RUN 2_021137.LAB	13:35	5.08	15.5	1.60	≤ 0.10	190.9	0.99	9.53
RUN 2_021138.LAB	13:36	5.05	15.5	1.44	≤ 0.10	190.9	0.99	9.33
RUN 2_021139.LAB	13:37	5.06	15.6	1.33	≤ 0.10	191.0	0.99	9.39
RUN 2_021140.LAB	13:38	5.02	15.4	1.35	≤ 0.10	191.0	0.99	9.61
RUN 2_021141.LAB	13:39	4.97	15.3	1.40	≤ 0.10	190.9	0.99	9.48
RUN 2_021142.LAB	13:40	4.94	15.4	1.42	≤ 0.10	191.0	0.99	9.46
RUN 2_021143.LAB	13:41	4.93	15.6	1.38	≤ 0.10	191.0	0.99	9.63
RUN 2_021144.LAB	13:42	4.99	15.5	1.49	≤ 0.10	191.0	0.99	9.53
RUN 2_021145.LAB	13:43	4.95	15.4	1.36	≤ 0.10	191.1	0.99	9.48
RUN 2_021146.LAB	13:44	4.92	15.5	1.46	≤ 0.10	191.0	0.99	9.57
RUN 2_021147.LAB	13:45	4.91	15.4	1.35	≤ 0.10	190.9	0.99	9.61
RUN 2_021148.LAB	13:46	5.00	15.3	1.50	≤ 0.10	191.0	0.99	9.42
RUN 2_021149.LAB	13:47	4.94	15.4	1.38	≤ 0.10	191.0	0.99	9.46
RUN 2_021150.LAB	13:48	4.92	15.4	1.41	≤ 0.10	191.0	0.99	9.62
RUN 2_021151.LAB	13:49	4.92	15.5	1.36	≤ 0.10	191.0	0.99	9.46
RUN 2_021152.LAB	13:50	4.96	15.5	1.45	≤ 0.10	190.9	0.99	9.54
RUN 2_021153.LAB	13:51	4.99	15.5	1.41	≤ 0.10	191.0	0.99	9.66
RUN 2_021154.LAB	13:52	4.99	15.4	1.34	≤ 0.10	190.9	0.99	9.56
RUN 2_021155.LAB	13:53	5.01	15.6	1.31	≤ 0.10	190.9	0.99	9.48
RUN 2_021156.LAB	13:54	4.97	15.3	1.28	≤ 0.10	191.0	0.99	9.61
RUN 2_021157.LAB	13:55	5.05	15.3	1.31	≤ 0.10	191.0	0.99	9.70
RUN 2_021158.LAB	13:56	5.05	15.4	1.32	≤ 0.10	191.0	0.99	9.49
RUN 2_021159.LAB	13:57	5.01	15.6	1.38	≤ 0.10	191.0	0.99	9.45
RUN 2_021160.LAB	13:58	4.94	15.5	1.33	≤ 0.10	191.1	0.99	9.61
RUN 2_021161.LAB	13:59	4.92	15.5	1.42	≤ 0.10	191.0	0.99	9.59
RUN 2_021162.LAB	14:00	4.90	15.4	1.48	≤ 0.10	190.9	0.99	9.46
RUN 2_021163.LAB	14:01	4.93	15.6	1.47	≤ 0.10	190.9	0.99	9.56
RUN 2_021164.LAB	14:02	4.95	15.6	1.50	≤ 0.10	191.0	0.99	9.56
RUN 2_021165.LAB	14:03	5.04	15.3	1.42	≤ 0.10	191.2	0.99	9.39
RUN 2_021166.LAB	14:04	5.10	15.2	1.40	≤ 0.10	191.1	0.99	9.47
RUN 2_021167.LAB	14:05	5.09	15.2	1.32	≤ 0.10	190.9	0.99	9.49
RUN 2_021168.LAB	14:06	5.16	15.3	1.48	≤ 0.10	190.9	0.99	9.51
RUN 2_021169.LAB	14:07	5.12	15.2	1.38	≤ 0.10	190.9	0.99	9.43
RUN 2_021170.LAB	14:08	5.11	15.2	1.47	≤ 0.10	190.9	0.99	9.43
RUN 2_021171.LAB	14:09	5.15	15.4	1.41	≤ 0.10	190.9	0.99	9.61
RUN 2_021172.LAB	14:10	5.19	15.1	1.38	≤ 0.10	190.9	0.99	9.48
RUN 2_021173.LAB	14:11	5.21	15.2	1.31	≤ 0.10	190.9	0.99	9.70
RUN 2_021174.LAB	14:12	5.24	15.3	1.45	≤ 0.10	191.0	0.99	9.61
RUN 2_021175.LAB	14:13	5.24	15.6	1.47	≤ 0.10	191.0	0.99	9.43
RUN 2_021176.LAB	14:14	5.22	15.5	1.49	≤ 0.10	191.0	0.99	9.48
Average		4.83	15.59	1.47	≤ 0.10	191.00	0.99	9.47

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Project #: M235005
 Test Location: Kiln 20 Exhaust
 Date: 12/13/23

Run 3

Spectrum	Time	H2O %	FTIR Data		HF ppmvw	Cell Temp	Pressure	Analyzer Data O2 % (dry)
			CO2 % (wet)	HCN ppmvw				
RUN 3_021271.LAB	15:00	3.68	15.8	1.59	≤ 0.10	191.0	0.99	9.46
RUN 3_021272.LAB	15:01	3.78	15.7	1.54	≤ 0.10	190.9	0.99	9.33
RUN 3_021273.LAB	15:02	3.83	15.6	1.45	≤ 0.10	191.0	0.99	9.50
RUN 3_021274.LAB	15:03	3.82	15.6	1.43	≤ 0.10	190.9	0.99	9.56
RUN 3_021275.LAB	15:04	3.84	15.7	1.61	≤ 0.10	191.0	0.99	9.32
RUN 3_021276.LAB	15:05	3.92	15.5	1.66	≤ 0.10	191.1	0.99	9.46
RUN 3_021277.LAB	15:06	5.26	15.1	1.52	≤ 0.10	191.1	0.99	9.60
RUN 3_021278.LAB	15:07	4.86	15.5	1.64	≤ 0.10	190.9	0.99	9.41
RUN 3_021279.LAB	15:08	5.41	15.5	1.69	≤ 0.10	190.9	0.99	9.44
RUN 3_021280.LAB	15:09	5.29	15.4	1.73	≤ 0.10	190.9	0.99	9.54
RUN 3_021281.LAB	15:10	5.16	15.7	1.70	≤ 0.10	190.9	0.99	9.41
RUN 3_021282.LAB	15:11	5.17	15.8	1.86	≤ 0.10	190.9	0.99	9.33
RUN 3_021283.LAB	15:12	5.07	15.4	1.61	≤ 0.10	190.9	0.99	9.45
RUN 3_021284.LAB	15:13	5.09	15.6	1.61	≤ 0.10	190.9	0.99	9.63
RUN 3_021285.LAB	15:14	5.14	15.3	1.59	≤ 0.10	191.0	0.99	9.42
RUN 3_021286.LAB	15:15	5.25	15.3	1.68	≤ 0.10	191.0	0.99	9.32
RUN 3_021287.LAB	15:16	5.23	15.4	1.61	≤ 0.10	191.1	0.99	9.45
RUN 3_021288.LAB	15:17	5.19	15.6	1.61	≤ 0.10	191.1	0.99	9.41
RUN 3_021289.LAB	15:18	5.13	15.6	1.54	≤ 0.10	190.9	0.99	9.25
RUN 3_021290.LAB	15:19	5.17	15.4	1.67	≤ 0.10	191.0	0.99	9.52
RUN 3_021291.LAB	15:20	5.16	15.3	1.52	≤ 0.10	190.9	0.99	9.46
RUN 3_021292.LAB	15:21	5.11	15.3	1.47	≤ 0.10	190.9	0.99	9.35
RUN 3_021293.LAB	15:22	5.09	15.3	1.43	≤ 0.10	191.0	0.99	9.51
RUN 3_021294.LAB	15:23	5.16	15.1	1.48	≤ 0.10	191.0	0.99	9.51
RUN 3_021295.LAB	15:24	5.20	15.2	1.56	≤ 0.10	191.0	0.99	9.51
RUN 3_021296.LAB	15:25	5.19	15.3	1.55	≤ 0.10	191.1	0.99	9.40
RUN 3_021297.LAB	15:26	5.20	15.2	1.47	≤ 0.10	191.1	0.99	9.48
RUN 3_021298.LAB	15:27	5.12	15.4	1.41	≤ 0.10	191.1	0.99	9.59
RUN 3_021299.LAB	15:28	5.08	15.5	1.54	≤ 0.10	191.0	0.99	9.37
RUN 3_021300.LAB	15:29	5.01	16.0	1.58	≤ 0.10	191.0	0.99	9.68
RUN 3_021301.LAB	15:30	5.09	15.9	1.67	≤ 0.10	191.0	0.99	9.57
RUN 3_021302.LAB	15:31	5.08	15.6	1.60	≤ 0.10	190.9	0.99	9.49
RUN 3_021303.LAB	15:32	5.11	15.7	1.57	≤ 0.10	190.9	0.99	9.50
RUN 3_021304.LAB	15:33	5.02	15.5	1.46	≤ 0.10	191.0	0.99	9.64
RUN 3_021305.LAB	15:34	4.98	15.4	1.52	≤ 0.10	191.0	0.99	9.59
RUN 3_021306.LAB	15:35	4.98	15.2	1.52	≤ 0.10	190.9	0.99	9.45
RUN 3_021307.LAB	15:36	4.92	15.3	1.48	≤ 0.10	191.0	0.99	9.55
RUN 3_021308.LAB	15:37	4.92	15.8	1.49	≤ 0.10	191.0	0.99	9.53
RUN 3_021309.LAB	15:38	4.91	15.9	1.61	≤ 0.10	190.9	0.99	9.31
RUN 3_021310.LAB	15:39	4.97	15.7	1.64	≤ 0.10	190.9	0.99	9.41
RUN 3_021311.LAB	15:40	5.00	15.7	1.54	≤ 0.10	190.9	0.99	9.59
RUN 3_021312.LAB	15:41	5.08	15.9	1.60	≤ 0.10	191.0	0.99	9.38
RUN 3_021313.LAB	15:42	5.00	15.9	1.60	≤ 0.10	191.0	0.99	9.43
RUN 3_021314.LAB	15:43	4.95	15.7	1.59	≤ 0.10	191.0	0.99	9.66
RUN 3_021315.LAB	15:44	4.89	15.8	1.54	≤ 0.10	191.0	0.99	9.61
RUN 3_021316.LAB	15:45	4.93	15.8	1.62	≤ 0.10	191.0	0.99	9.48
RUN 3_021317.LAB	15:46	4.91	15.8	1.54	≤ 0.10	191.0	0.99	9.50
RUN 3_021318.LAB	15:47	4.92	15.7	1.48	≤ 0.10	191.0	0.99	9.50
RUN 3_021319.LAB	15:48	4.92	15.6	1.44	≤ 0.10	190.9	0.99	9.31
RUN 3_021320.LAB	15:49	4.91	15.6	1.46	≤ 0.10	190.9	0.99	9.34
RUN 3_021321.LAB	15:50	4.88	15.5	1.62	≤ 0.10	191.0	0.99	9.54
RUN 3_021322.LAB	15:51	4.94	15.4	1.54	≤ 0.10	191.1	0.99	9.34
RUN 3_021323.LAB	15:52	5.02	15.5	1.53	≤ 0.10	191.1	0.99	9.27
RUN 3_021324.LAB	15:53	4.93	15.7	1.47	≤ 0.10	191.1	0.99	9.45
RUN 3_021325.LAB	15:54	4.92	15.7	1.50	≤ 0.10	190.9	0.99	9.43
RUN 3_021326.LAB	15:55	4.93	15.5	1.54	≤ 0.10	190.9	0.99	9.38
RUN 3_021327.LAB	15:56	4.95	15.8	1.57	≤ 0.10	190.8	0.99	9.41
RUN 3_021328.LAB	15:57	5.02	15.9	1.62	≤ 0.10	190.9	0.99	9.45
RUN 3_021329.LAB	15:58	5.02	15.6	1.47	≤ 0.10	191.0	0.99	9.45
RUN 3_021330.LAB	15:59	5.05	15.7	1.55	≤ 0.10	191.0	0.99	9.46
Average		4.93	15.56	1.56	≤ 0.10	191.00	0.99	9.46

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Test Location: Kiln 21 Breaching Duct
Project #: M235005
Test Method: 26A
Test Engineer: CLC
Test Technician: CLM

	<u>Run 1A</u>	<u>Run 2A</u>	<u>Run 3A</u>
Meter ID:	CM43	CM43	CM43
Pitot ID:	S8-058	S8-058	S8-058
Filter ID:	Teflon	Teflon	Teflon
Nozzle Diameter (Inches):	0.275	0.275	0.275
Meter Calibration Date:	12/7/2023	12/7/2023	12/7/2023
Meter Calibration Factor (Y):	0.995	0.995	0.995
Meter Orifice Setting (Delta H):	1.823	1.823	1.823
Nozzle Kit ID Number and Material:	8 glass	8 glass	8 glass

Leak Checks

Pre Pitot Leak Check	0.0	@	3.5	"H ₂ O	0.0	@	3.8	"H ₂ O	0.0	0	4.0	"H ₂ O
Post Pitot Leak Check	0.0	@	4.0	"H ₂ O	0.0	@	3.8	"H ₂ O	0.0	@	3.8	"H ₂ O
Pre Nozzle Leak Check	0.0100	@	13	"Hg	0.0100	@	13	"Hg	0.0000	@	12	"Hg
Post Nozzle Leak Check	0.0000	@	10	"Hg	0.0000	@	10	"Hg	0.0000	@	10	"Hg
Pitot Tube Coefficient:	0.834											
Probe Length (Feet):	8.0											
Probe Liner Material:	Glass											
Sample Plane:	Horizontal											
Port Length (Inches):	3.25											
Port Size (Diameter, Inches):	6.00											
Port Type:	Nipple											
Duct Shape:	Rectangular											
Length (Feet):	8											
Width (Feet):	8.67											
Duct Area (Square Feet):	69.360											
Upstream Diameters:	~1.0											
Downstream Diameters:	~8.5											
Number of Ports Sampled:	3											
Number of Points per Port:	14											
Minutes per Point:	2.0											
Minutes per Reading:	2.0											
Total Number of Traverse Points:	42											
Test Length (Minutes):	84											
Train Type:	Anderson Box											
Source Condition:	Normal											
Diluent Model/Serial Number:	1440D1/4662											
Moisture Balance ID:	S10-25											
# of Runs	3											

Run 1A - Method 26A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 21 Breaching Duct
 Source Condition: Normal

Date: 12/12/23
 Start Time: 10:20
 End Time: 11:51

DRY GAS METER CONDITIONS				STACK CONDITIONS			
ΔH:	0.83	in. H ₂ O		Static Pressure	-0.80	in. H ₂ O	
Meter Temperature, T _m :	39.4	°F		Flue Pressure (Ps):	29.32	in. Hg. abs.	
Sqrt ΔP:	0.508	in. H ₂ O		Carbon Dioxide:	14.05	%	
Stack Temperature, T _s :	384.6	°F		Oxygen:	10.99	%	
Meter Volume, V _m :	40.874	ft ³		Nitrogen:	74.96	%	
Meter Volume, V _{mstd} :	42.311	dscf		Gas Weight dry, M _d :	30.688	lb/lb mole	
Meter Volume, V _{wstd} :	4.696	wscf		Gas Weight wet, M _s :	29.420	lb/lb mole	
Isokinetic Variance:	103.0	%l		Excess Air:	---	%	
Test Length:	84.00	in. min.		Gas Velocity, V _s :	35.858	fps	
Nozzle Diameter:	0.275	in. inches		Volumetric Flow:	149,229	acfm	
Barometric Pressure:	29.38	in Hg		Volumetric Flow:	82,291	dscfm	
				Volumetric Flow:	91,424	scfm	

MOISTURE DETERMINATION

Initial Impinger Content:	3623.5	ml	Silica Initial Wt.	746.0	grams
Final Impinger Content:	3711.2	ml	Silica Final Wt.	758.0	grams
Impinger Difference:	87.7	ml	Silica Difference:	12.0	grams
Total Water Gain:	99.7		Moisture, Bws:	0.100	

Port- Point No.	Clock Time	Velocity Head Δp in. H ₂ O	Orifice ΔH in. H ₂ O	Actual Meter Vol. ft ³	Stack Temp °F	Meter Temp Inlet °F	Outlet °F	Pump Vacuum °Hg	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	10:20:00	0.25	0.80	26.225	394	37	37	6	261	260	55
1-2	10:22:00	0.25	0.80	27.160	388	38	38	6	260	260	55
1-3	10:24:00	0.26	1.00	28.120	290	38	38	6	260	260	55
1-4	10:26:00	0.26	1.00	29.250	385	38	38	6	260	259	56
1-5	10:28:00	0.28	0.90	30.300	388	38	38	5	260	260	56
1-6	10:30:00	0.28	0.90	31.280	390	38	38	5	261	260	56
1-7	10:32:00	0.28	0.90	32.250	389	38	38	5	260	260	56
1-8	10:34:00	0.26	0.90	33.300	390	38	38	5	260	260	56
1-9	10:36:00	0.25	0.90	34.300	392	38	38	5	261	260	56
1-10	10:38:00	0.25	0.80	35.280	390	39	39	5	260	260	56
1-12	10:40:00	0.25	0.80	36.250	390	39	39	5	260	260	56
1-13	10:42:00	0.24	0.80	37.240	392	39	39	5	261	260	56
1-14	10:44:00	0.24	0.80	38.150	390	39	39	5	260	260	57
	10:46:00			39.151							
2-1	10:51:00	0.24	0.80	39.151	390	38	38	5	260	260	56
2-2	10:53:00	0.24	0.80	40.150	388	38	38	5	260	259	56
2-3	10:55:00	0.25	0.80	41.080	385	39	39	5	261	260	56
2-4	10:57:00	0.26	0.80	42.050	386	39	39	5	260	260	57
2-5	10:59:00	0.28	0.80	43.450	390	39	39	5	260	260	57
2-6	11:01:00	0.28	0.80	44.880	391	39	39	5	261	260	57
2-7	11:03:00	0.27	0.80	45.190	392	39	39	5	262	261	57
2-8	11:05:00	0.27	0.80	46.210	390	39	39	5	260	260	57
2-9	11:07:00	0.26	0.80	47.140	388	39	39	5	260	260	57
2-10	11:09:00	0.26	0.80	48.160	390	39	39	5	260	261	57
2-11	11:11:00	0.25	0.80	49.150	390	40	40	5	262	260	57
2-12	11:13:00	0.24	0.80	50.110	389	40	40	5	261	260	57
2-13	11:15:00	0.24	0.80	51.890	385	40	40	5	260	260	57
2-14	11:17:00	0.24	0.80	52.040	389	40	40	5	260	259	57
	11:19:00			52.998							
3-1	11:23:00	0.24	0.70	52.998	390	40	40	5	260	260	57
3-2	11:25:00	0.25	0.80	53.980	389	40	40	5	260	260	57
3-3	11:27:00	0.25	0.80	54.950	291	40	40	5	260	260	57
3-4	11:29:00	0.26	0.80	55.980	392	40	40	5	260	259	57
3-5	11:31:00	0.28	0.80	56.980	390	41	41	5	261	260	57
3-6	11:33:00	0.28	0.90	58.020	390	41	41	5	260	259	57
3-7	11:35:00	0.28	0.90	59.060	392	41	41	5	260	260	57
3-8	11:37:00	0.28	0.90	60.090	390	41	41	5	261	260	57
3-9	11:39:00	0.27	0.80	61.130	391	41	41	5	260	260	57
3-10	11:41:00	0.26	0.80	62.150	390	41	41	5	260	259	57
3-11	11:43:00	0.26	0.80	63.140	388	41	41	5	261	260	58
3-12	11:45:00	0.26	0.80	64.150	390	41	41	5	260	260	58
3-13	11:47:00	0.25	0.80	65.150	389	41	41	5	260	260	58
3-14	11:49:00	0.25	0.80	66.170	385	41	41	5	261	260	58
	11:51:00			67.099							
Total	1:22:00			40.874		39.4	39.4				
Average			0.83		384.6			5			
Min			0.70		290.0		37.0	5			
Max			1.00		394.0		41.0	6			

Impinger Weight Sheet - Run 1A

Client: Holcim (US) Inc. Facility: Alpena Cement Plant Test Location: Kiln 21 Breaching Duct Project #: M235005 Date: 12/12/2023 Test Method: 26A Weighed/Measured By: EE Balance ID: S10-25	Scale Calibration Check Date: <u>12/12/2023</u> <u>Scale Calibration Check (see QS-6.05C for procedure)</u> must be within $\pm 0.5g$ of certified mass <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Certified Weight, grams</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Result, grams</u></th> </tr> <tr> <td style="text-align: center;">200</td> <td style="text-align: center; border-bottom: 1px solid black;">200.0</td> </tr> <tr> <td style="text-align: center;">500</td> <td style="text-align: center; border-bottom: 1px solid black;">500.0</td> </tr> <tr> <td style="text-align: center;">700</td> <td style="text-align: center; border-bottom: 1px solid black;">700.0</td> </tr> </table>	<u>Certified Weight, grams</u>	<u>Result, grams</u>	200	200.0	500	500.0	700	700.0
<u>Certified Weight, grams</u>	<u>Result, grams</u>								
200	200.0								
500	500.0								
700	700.0								

IMPINGER	FINAL	INITIAL	GAIN
CONTENTS	MLS / GRAMS	MLS / GRAMS	MLS / GRAMS
0.1N H2SO4	829.3	738.9	90.4
0.1N H2SO4	745.5	749.9	-4.4
Empty	666.6	652.8	13.8
0.1N NaOH	731.0	744.1	-13.1
0.1N NaOH	738.8	737.8	1.0
Silica Gel	758.0	746.0	12.0

<u>3,711.2</u> Liquid Final	<u>3,623.5</u> Liquid Initial	<u>87.7</u> Liquid Gain
<u>758.0</u> Silica Final	<u>746.0</u> Silica Initial	<u>12.0</u> Silica Gain

Run 2A - Method 26A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 21 Breaching Duct
 Source Condition: Normal

Date: 12/12/23
 Start Time: 12:30
 End Time: 14:00

DRY GAS METER CONDITIONS				STACK CONDITIONS			
ΔH:	0.83	In. H ₂ O		Static Pressure	-0.80	in. H ₂ O	
Meter Temperature, T _m :	45.3	°F		Flue Pressure (Ps):	29.32	in. Hg. abs.	
Sqrt ΔP:	0.510	In. H ₂ O		Carbon Dioxide:	14.33	%	
Stack Temperature, T _s :	388.5	°F		Oxygen:	10.24	%	
Meter Volume, V _m :	41.397	ft ³		Nitrogen:	75.4	%	
Meter Volume, V _{mstd} :	42.350	dscf		Gas Weight dry, M _d :	30.702	lb/lb mole	
Meter Volume, V _{wstd} :	3.057	wscf		Gas Weight wet, M _s :	29.847	lb/lb mole	
Isokinetic Variance:	100.1	%I		Excess Air:	---	%	
Test Length:	84.00	in mins.		Gas Velocity, V _s :	35.817	fps	
Nozzle Diameter:	0.275	in inches		Volumetric Flow:	149,058	acfm	
Barometric Pressure:	29.38	in Hg		Volumetric Flow:	84,778	dscfm	
				Volumetric Flow:	90,897	scfm	

MOISTURE DETERMINATION

Initial Impinger Content:	3501.5	ml	Silica Initial Wt.	850.8	grams
Final Impinger Content:	3553.2	ml	Silica Final Wt.	864.0	grams
Impinger Difference:	51.7	ml	Silica Difference:	13.2	grams
Total Water Gain:	64.9		Moisture, Bws:	0.067	

Port- Point No.	Clock Time	Velocity Head Δp in. H ₂ O	Orifice ΔH in. H ₂ O	Actual Meter Vol. ft ³	Stack Temp °F	Meter Temp Inlet °F	Outlet °F	Pump Vacuum °Hg	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	12:30:00	0.25	0.80	72.218	393	44	44	4	260	261	53
1-2	12:32:00	0.25	0.80	73.220	394	44	44	4	261	260	53
1-3	12:34:00	0.26	0.80	74.960	390	44	44	4	260	260	53
1-4	12:36:00	0.26	0.80	75.210	392	44	44	4	261	261	53
1-5	12:38:00	0.27	0.80	76.220	390	44	44	4	262	260	53
1-6	12:40:00	0.28	0.90	77.250	389	44	44	4	260	260	53
1-7	12:42:00	0.28	0.90	78.270	390	44	44	4	261	260	54
1-8	12:44:00	0.28	0.90	79.320	392	44	44	4	260	260	54
1-9	12:46:00	0.28	0.80	80.350	394	45	45	4	260	259	54
1-10	12:48:00	0.26	0.80	81.410	391	45	45	4	261	260	54
1-12	12:50:00	0.26	0.80	82.400	390	45	45	4	260	260	54
1-13	12:52:00	0.25	0.80	83.420	392	45	45	4	260	260	54
1-14	12:54:00	0.24	0.80	84.400	390	45	45	4	260	260	54
	12:56:00			85.363							
2-1	13:00:00	0.24	0.80	85.363	289	45	45	4	261	260	54
2-2	13:02:00	0.25	0.80	86.400	391	45	45	4	260	260	54
2-3	13:04:00	0.25	0.80	87.390	390	45	45	4	261	261	55
2-4	13:06:00	0.26	0.80	88.380	392	45	45	4	262	260	55
2-5	13:08:00	0.28	0.80	89.390	391	45	45	4	260	259	55
2-6	13:10:00	0.28	0.90	90.430	390	45	45	4	261	260	55
2-7	13:12:00	0.28	0.90	91.490	392	45	45	4	260	260	55
2-8	13:14:00	0.27	0.90	92.530	390	45	45	4	261	260	55
2-9	13:16:00	0.26	0.90	93.550	391	45	45	4	260	260	56
2-10	13:18:00	0.25	0.80	94.560	389	45	45	4	260	260	56
2-11	13:20:00	0.25	0.80	95.550	390	46	46	4	260	260	56
2-12	13:22:00	0.25	0.80	96.530	390	46	46	4	261	261	56
2-13	13:24:00	0.24	0.80	97.510	391	46	46	4	262	260	56
2-14	13:26:00	0.24	0.80	98.490	390	46	46	4	260	260	56
	13:28:00			99.452							
3-1	13:32:00	0.24	0.80	99.452	390	46	46	4	260	260	56
3-2	13:34:00	0.24	0.80	100.420	391	46	46	4	260	260	56
3-3	13:36:00	0.25	0.80	101.400	390	46	46	4	261	261	56
3-4	13:38:00	0.26	0.80	102.410	392	46	46	4	262	260	57
3-5	13:40:00	0.28	0.90	103.410	390	46	46	4	260	260	57
3-6	13:42:00	0.28	0.90	104.450	389	46	46	4	260	259	57
3-7	13:44:00	0.28	0.90	105.510	392	46	46	4	261	260	57
3-8	13:46:00	0.28	0.90	106.550	390	46	46	4	260	260	58
3-9	13:48:00	0.28	0.90	107.590	392	46	46	4	261	260	58
3-10	13:50:00	0.26	0.80	108.640	394	46	46	4	260	260	58
3-11	13:52:00	0.26	0.80	109.650	393	46	46	4	260	260	58
3-12	13:54:00	0.25	0.80	110.650	392	47	47	4	260	260	58
3-13	13:56:00	0.25	0.80	111.630	390	47	47	4	261	261	58
3-14	13:58:00	0.25	0.80	112.620	391	47	47	4	260	269	58
	14:00:00			113.615							

Total	1:22:00			41.397		45.3	45.3				
Average			0.83		388.5		45.3		4		
Min			0.80		289.0		44.0		4		
Max			0.90		394.0		47.0		4		

Impinger Weight Sheet - Run 2A

Client: Holcim (US) Inc. Facility: Alpena Cement Plant Test Location: Kiln 21 Breaching Duct Project #: M235005 Date: 12/12/2023 Test Method: 26A Weighed/Measured By: EE Balance ID: S10-25	Scale Calibration Check Date: <u>12/12/2023</u> Scale Calibration Check (see QS-6.05C for procedure) must be within $\pm 0.5g$ of certified mass <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Certified Weight, grams</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Result, grams</u></th> </tr> <tr> <td style="text-align: center;">200</td> <td style="text-align: center; border-bottom: 1px solid black;">200.0</td> </tr> <tr> <td style="text-align: center;">500</td> <td style="text-align: center; border-bottom: 1px solid black;">500.0</td> </tr> <tr> <td style="text-align: center;">700</td> <td style="text-align: center; border-bottom: 1px solid black;">700.0</td> </tr> </table>	<u>Certified Weight, grams</u>	<u>Result, grams</u>	200	200.0	500	500.0	700	700.0
<u>Certified Weight, grams</u>	<u>Result, grams</u>								
200	200.0								
500	500.0								
700	700.0								

IMPINGER	FINAL	INITIAL	GAIN
CONTENTS	MLS / GRAMS	MLS / GRAMS	MLS / GRAMS
0.1N H2SO4	755.7	717.8	37.9
0.1N H2SO4	710.0	699.2	10.8
Empty	586.8	585.6	1.2
0.1N NaOH	753.0	752.5	0.5
0.1N NaOH	747.7	746.4	1.3
Silica Gel	864.0	850.8	13.2

<u>3,553.2</u> Liquid Final	<u>3,501.5</u> Liquid Initial	<u>51.7</u> Liquid Gain
<u>864.0</u> Silica Final	<u>850.8</u> Silica Initial	<u>13.2</u> Silica Gain

Run 3A - Method 26A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 21 Breaching Duct
 Source Condition: Normal

Date: 12/12/23
 Start Time: 14:15
 End Time: 15:45

DRY GAS METER CONDITIONS				STACK CONDITIONS			
	ΔH :	0.82	In. H ₂ O	Static Pressure	-0.80	in. H ₂ O	
Meter Temperature, T _m :	46.3	°F		Flue Pressure (Ps):	29.32	in. Hg. abs.	
Sqrt ΔP :	0.512	In. H ₂ O		Carbon Dioxide:	15.09	%	
Stack Temperature, T _s :	390.7	°F		Oxygen:	10.24	%	
Meter Volume, V _m :	41.508	ft ³		Nitrogen:	74.67	%	
Meter Volume, V _{mstd} :	42.379	dscf		Gas Weight dry, M _d :	30.824	lb/lb mole	
Meter Volume, V _{wstd} :	3.255	wscf		Gas Weight wet, M _s :	29.909	lb/lb mole	
Isokinetic Variance:	100.5	%I		Excess Air:	---	%	
Test Length:	84.00	in. mins.		Gas Velocity, V _s :	35.929	fps	
Nozzle Diameter:	0.275	in. inches		Volumetric Flow:	149,521	acfm	
Barometric Pressure:	29.38	in. Hg		Volumetric Flow:	84,460	dscfm	
				Volumetric Flow:	90,946	scfm	

MOISTURE DETERMINATION

Initial Impinger Content:	3632.6	ml	Silica Initial Wt.	758.0	grams
Final Impinger Content:	3690.5	ml	Silica Final Wt.	769.2	grams
Impinger Difference:	57.9	ml	Silica Difference:	11.2	grams
Total Water Gain:	69.1		Moisture, Bws:	0.071	

Port- Point No.	Clock Time	Velocity Head Δp in. H ₂ O	Orifice ΔH in. H ₂ O	Actual Meter Vol. ft ³	Stack Temp °F	Meter Temp Inlet °F	Outlet °F	Pump Vacuum °Hg	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	14:15:00	0.24	0.70	14.790	390	45	45	5	260	263	49
1-2	14:17:00	0.24	0.70	15.760	392	45	45	5	261	262	49
1-3	14:19:00	0.25	0.80	16.780	391	45	45	5	262	260	49
1-4	14:21:00	0.26	0.80	17.750	390	45	45	5	260	261	49
1-5	14:23:00	0.26	0.80	18.770	389	45	45	5	261	260	49
1-6	14:25:00	0.28	0.90	19.760	388	45	45	5	260	260	50
1-7	14:27:00	0.28	0.90	20.800	390	45	45	5	260	259	50
1-8	14:29:00	0.28	0.90	21.820	391	45	45	5	261	260	50
1-9	14:31:00	0.28	0.90	22.870	393	45	45	5	260	260	50
1-10	14:33:00	0.27	0.80	23.920	391	45	45	5	260	260	50
1-12	14:35:00	0.26	0.80	24.940	390	46	46	5	261	260	51
1-13	14:37:00	0.25	0.80	25.960	389	46	46	5	262	261	51
1-14	14:39:00	0.25	0.80	26.950	390	46	46	5	260	260	51
	14:41:00			27.911							
2-1	14:45:00	0.25	0.80	27.911	389	46	46	5	260	260	51
2-2	14:47:00	0.25	0.80	28.920	391	46	46	5	260	259	51
2-3	14:49:00	0.26	0.80	29.910	390	46	46	5	261	260	51
2-4	14:51:00	0.26	0.80	30.910	391	46	46	5	260	260	51
2-5	14:53:00	0.27	0.90	31.920	393	46	46	5	260	260	51
2-6	14:55:00	0.28	0.90	32.950	394	46	46	5	261	261	51
2-7	14:57:00	0.28	0.90	33.990	392	46	46	5	261	260	51
2-8	14:59:00	0.28	0.90	35.030	390	46	46	5	260	261	52
2-9	15:01:00	0.27	0.80	36.090	391	46	46	5	261	260	52
2-10	15:03:00	0.27	0.80	37.110	390	47	47	5	260	261	52
2-11	15:05:00	0.26	0.80	38.200	391	47	47	5	260	260	52
2-12	15:07:00	0.25	0.80	39.250	390	47	47	5	261	261	52
2-13	15:09:00	0.25	0.80	40.240	389	47	47	5	261	260	52
2-14	15:11:00	0.24	0.80	41.180	390	47	47	5	260	260	52
	15:13:00			42.098							
3-1	15:17:00	0.25	0.80	42.098	390	47	47	5	261	260	52
3-2	15:19:00	0.25	0.80	43.089	391	47	47	5	260	261	52
3-3	15:21:00	0.26	0.80	44.090	390	47	47	5	260	260	52
3-4	15:23:00	0.26	0.80	45.100	391	47	47	5	261	261	52
3-5	15:25:00	0.27	0.80	46.120	393	47	47	5	261	260	52
3-6	15:27:00	0.28	0.90	47.180	393	47	47	5	260	260	52
3-7	15:29:00	0.28	0.90	48.200	392	47	47	5	260	260	52
3-8	15:31:00	0.28	0.90	49.250	390	47	47	5	261	261	52
3-9	15:33:00	0.27	0.90	50.290	391	47	47	5	261	260	53
3-10	15:35:00	0.27	0.80	51.310	390	47	47	5	260	260	53
3-11	15:37:00	0.26	0.80	52.360	391	48	48	5	261	261	53
3-12	15:39:00	0.25	0.80	53.410	390	48	48	5	262	260	53
3-13	15:41:00	0.25	0.80	54.360	390	48	48	5	260	260	53
3-14	15:43:00	0.24	0.80	55.340	391	48	48	5	261	261	53
	15:45:00			56.298							

Total	1:22:00			41.508		46.3	46.3				
Average			0.82		390.7	46.3		5			
Min			0.70		388.0	45.0		5			
Max			0.90		394.0	48.0		5			

Impinger Weight Sheet - Run 3A

Client: Holcim (US) Inc. Facility: Alpena Cement Plant Test Location: Kiln 21 Breaching Duct Project #: M235005 Date: 12/12/2023 Test Method: 26A Weighed/Measured By: EE Balance ID: S10-25	Scale Calibration Check Date: <u>12/12/2023</u> Scale Calibration Check (see QS-6.05C for procedure) must be within $\pm 0.5g$ of certified mass <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Certified Weight, grams</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Result, grams</u></th> </tr> <tr> <td style="text-align: center;">200</td> <td style="text-align: center; border-bottom: 1px solid black;">200.0</td> </tr> <tr> <td style="text-align: center;">500</td> <td style="text-align: center; border-bottom: 1px solid black;">500.0</td> </tr> <tr> <td style="text-align: center;">700</td> <td style="text-align: center; border-bottom: 1px solid black;">700.0</td> </tr> </table>	<u>Certified Weight, grams</u>	<u>Result, grams</u>	200	200.0	500	500.0	700	700.0
<u>Certified Weight, grams</u>	<u>Result, grams</u>								
200	200.0								
500	500.0								
700	700.0								

IMPINGER	FINAL	INITIAL	GAIN
CONTENTS	MLS / GRAMS	MLS / GRAMS	MLS / GRAMS
0.1N H2SO4	814.0	758.4	55.6
0.1N H2SO4	746.3	745.6	0.7
Empty	659.1	658.4	0.7
0.1N NaOH	738.4	738.3	0.1
0.1N NaOH	732.7	731.9	0.8
Silica Gel	769.2	758.0	11.2

<u>3,690.5</u> Liquid Final	<u>3,632.6</u> Liquid Initial	<u>57.9</u> Liquid Gain
<u>769.2</u> Silica Final	<u>758.0</u> Silica Initial	<u>11.2</u> Silica Gain

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Test Location: Kiln 21 Breaching Duct
Project #: M235005
Test Method: 26A
Test Engineer: CLC
Test Technician: CLM

	<u>Run 1B</u>	<u>Run 2B</u>	<u>Run 3B</u>
Temp ID:	CM49	CM49	CM49
Meter ID:	CM49	CM49	CM49
Pitot ID:	S8-059	S8-059	S8-059
Filter ID:	Teflon	Teflon	Teflon
Nozzle Diameter (Inches):	0.275	0.275	0.275
Meter Calibration Date:	10/24/2023	10/24/2023	10/24/2023
Meter Calibration Factor (Y):	1.007	1.007	1.007
Meter Orifice Setting (Delta H):	1.732	1.732	1.732
Nozzle Kit ID Number and Material:	#18/ 662	#18/ 662	#18/ 662

Leak Checks

Pre Pitot Leak Check	0.0	@	3.4	"H ₂ O	0.0	@	3.5	"H ₂ O	0.0	@	3.2	"H ₂ O
Post Pitot Leak Check	0.0	@	3.2	"H ₂ O	0.0	@	3.2	"H ₂ O	0.0	@	3.3	"H ₂ O
Pre Nozzle Leak Check	0.0010	@	13	"Hg	0.0012	@	14	"Hg	0.0012	@	14	"Hg
Post Nozzle Leak Check	0.0000	@	10	"Hg	0.0000	@	10	"Hg	0.0000	@	10	"Hg
Pitot Tube Coefficient:	0.839											
Probe Length (Feet):	8.0											
Probe Liner Material:	Glass											
Sample Plane:	Horizontal											
Port Length (Inches):	3.25											
Port Size (Diameter, Inches):	6.00											
Port Type:	Nipple											
Duct Shape:	Rectangular											
Length (Feet):	8											
Width (Feet):	8.67											
Duct Area (Square Feet):	69.360											
Upstream Diameters:	~1.0											
Downstream Diameters:	~8.5											
Number of Ports Sampled:	3											
Number of Points per Port:	14											
Minutes per Point:	2.0											
Minutes per Reading:	2.0											
Total Number of Traverse Points:	42											
Test Length (Minutes):	84											
Train Type:	Anderson Box											
Source Condition:	Normal											
Diluent Model/Serial Number:	1440D1/4662											
Moisture Balance ID:	S10-25											
# of Runs	3											

Run 1B - Method 26A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 21 Breaching Duct
 Source Condition: Normal

Date: 12/12/23
 Start Time: 10:20
 End Time: 12:57

DRY GAS METER CONDITIONS				STACK CONDITIONS			
ΔH:	0.50	in. H ₂ O		Static Pressure	-8.00	in. H ₂ O	
Meter Temperature, T _m :	40.6	°F		Flue Pressure (Ps):	28.79	in. Hg. abs.	
Sqrt ΔP:	0.413	in. H ₂ O		Carbon Dioxide:	14.05	%	
Stack Temperature, T _s :	394.6	°F		Oxygen:	10.99	%	
Meter Volume, V _m :	33.636	ft ³		Nitrogen:	74.96	%	
Meter Volume, V _{mstd} :	35.124	dscf		Gas Weight dry, M _d :	30.688	lb/lb mole	
Meter Volume, V _{wstd} :	4.658	wscf		Gas Weight wet, M _s :	29.202	lb/lb mole	
Isokinetic Variance:	107.8	%		Excess Air:	---	%	
Test Length:	84.00	in. mins.		Gas Velocity, V _s :	29.874	fps	
Nozzle Diameter:	0.275	in. inches		Volumetric Flow:	124,324	acfm	
Barometric Pressure:	29.38	in. Hg		Volumetric Flow:	65,257	dscfm	
				Volumetric Flow:	73,912	scfm	

MOISTURE DETERMINATION

Initial Impinger Content:	3588.9	ml	Silica Initial Wt.	868.1	grams
Final Impinger Content:	3679.5	ml	Silica Final Wt.	876.4	grams
Impinger Difference:	90.6	ml	Silica Difference:	8.3	grams
Total Water Gain:	98.9		Moisture, Bws:	0.117	

Port- Point No.	Clock Time	Velocity Head Δp in. H ₂ O	Orifice ΔH in. H ₂ O	Actual Meter Vol. ft ³	Stack Temp °F	Meter Temp Inlet °F	Outlet °F	Pump Vacuum °Hg	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	10:20:00	0.16	0.47	57.694	392	39	39	3	260	260	43
1-2	10:22:00	0.17	0.50	59.470	395	39	39	3	261	260	43
1-3	10:24:00	0.18	0.50	60.240	395	39	39	3	262	260	43
1-4	10:26:00	0.18	0.50	61.160	395	39	39	3	261	261	45
1-5	10:28:00	0.19	0.56	61.940	395	39	39	3	261	261	45
1-6	10:30:00	0.20	0.59	62.840	394	39	39	4	262	260	45
1-7	10:32:00	0.20	0.59	63.710	394	39	39	4	262	260	45
1-8	10:34:00	0.19	0.56	64.650	394	39	39	3	263	260	45
1-9	10:36:00	0.17	0.50	65.350	395	39	39	3	263	261	44
1-10	10:38:00	0.16	0.50	66.110	395	39	39	3	263	260	43
1-12	10:40:00	0.16	0.50	66.990	394	39	39	3	262	259	44
1-13	10:42:00	0.15	0.44	67.650	395	39	39	3	260	258	45
1-14	10:44:00	0.14	0.41	68.210	395	39	39	3	260	259	45
	10:46:00			69.050							
2-1	10:51:00	0.15	0.44	69.050	394	39	39	3	261	260	45
2-2	10:53:00	0.15	0.44	69.820	395	39	39	3	261	261	45
2-3	10:55:00	0.17	0.50	70.620	395	40	40	3	263	262	45
2-4	10:57:00	0.18	0.53	71.420	395	40	40	3	263	261	46
2-5	10:59:00	0.19	0.56	72.320	395	40	40	3	262	261	46
2-6	11:01:00	0.20	0.59	72.990	395	40	40	4	262	260	46
2-7	11:03:00	0.20	0.59	73.910	395	40	40	4	261	261	47
2-8	11:05:00	0.20	0.59	74.720	395	41	41	4	261	260	47
2-9	11:07:00	0.18	0.53	75.640	395	41	41	3	260	262	46
2-10	11:09:00	0.17	0.50	76.520	395	41	41	3	260	261	46
2-11	11:11:00	0.15	0.44	77.310	395	41	41	3	260	260	46
2-12	11:13:00	0.15	0.44	77.980	395	41	41	3	260	260	46
2-13	11:15:00	0.15	0.44	78.720	395	41	41	3	261	260	46
2-14	11:17:00	0.14	0.41	79.425	394	41	41	3	262	260	46
	11:19:00			80.154							
3-1	11:23:00	0.15	0.44	80.154	394	41	41	3	261	261	46
3-2	11:25:00	0.15	0.44	80.920	394	41	41	3	261	261	46
3-3	11:27:00	0.15	0.44	81.720	394	42	42	3	262	260	46
3-4	11:29:00	0.14	0.41	82.430	394	42	42	3	262	260	47
3-5	11:31:00	0.16	0.47	83.310	395	42	42	3	263	260	47
3-6	11:33:00	0.17	0.50	83.910	396	42	42	3	263	261	48
3-7	11:35:00	0.19	0.56	84.740	395	42	42	3	261	261	48
3-8	11:37:00	0.20	0.59	85.630	395	43	43	4	261	260	47
3-9	11:39:00	0.20	0.56	86.440	394	43	43	4	260	262	46
3-10	11:41:00	0.19	0.53	87.330	394	43	43	3	261	260	46
3-11	11:43:00	0.18	0.53	88.240	394	43	43	3	261	261	47
3-12	11:45:00	0.18	0.53	88.750	395	43	43	3	263	262	47
3-13	11:47:00	0.17	0.50	89.740	395	43	43	3	263	261	47
3-14	11:49:00	0.16	0.48	90.530	395	43	43	3	262	261	48
	11:51:00			91.330							

Total	1:22:00			33.636		40.6	40.6				
Average			0.50		394.6	40.6		3			
Min			0.41		392.0	39.0		3			
Max			0.59		396.0	43.0		4			

Impinger Weight Sheet - Run 1B

Client: Holcim (US) Inc. Facility: Alpena Cement Plant Test Location: Kiln 21 Breaching Duct Project #: M235005 Date: 12/12/2023 Test Method: 26A Weighed/Measured By: EE Balance ID: S10-25	Scale Calibration Check Date: <u>12/12/2023</u> Scale Calibration Check (see QS-6.05C for procedure) must be within $\pm 0.5g$ of certified mass <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Certified Weight, grams</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Result, grams</u></th> </tr> <tr> <td style="text-align: center;">200</td> <td style="text-align: center; border-bottom: 1px solid black;">200.0</td> </tr> <tr> <td style="text-align: center;">500</td> <td style="text-align: center; border-bottom: 1px solid black;">500.0</td> </tr> <tr> <td style="text-align: center;">700</td> <td style="text-align: center; border-bottom: 1px solid black;">700.0</td> </tr> </table>	<u>Certified Weight, grams</u>	<u>Result, grams</u>	200	200.0	500	500.0	700	700.0
<u>Certified Weight, grams</u>	<u>Result, grams</u>								
200	200.0								
500	500.0								
700	700.0								

IMPINGER	FINAL	INITIAL	GAIN
CONTENTS	MLS / GRAMS	MLS / GRAMS	MLS / GRAMS
0.1N H2SO4	836.5	748.6	87.9
0.1N H2SO4	758.8	758.3	0.5
Empty	610.0	608.7	1.3
0.1N NaOH	711.5	711.8	-0.3
0.1N NaOH	762.7	761.5	1.2
Silica Gel	876.4	868.1	8.3

<u>3,679.5</u> Liquid Final	<u>3,588.9</u> Liquid Initial	<u>90.6</u> Liquid Gain
<u>876.4</u> Silica Final	<u>868.1</u> Silica Initial	<u>8.3</u> Silica Gain

Run 2B - Method 26A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 21 Breaching Duct
 Source Condition: Normal

Date: 12/12/23
 Start Time: 12:30
 End Time: 14:00

DRY GAS METER CONDITIONS				STACK CONDITIONS			
ΔH:	0.52	In. H ₂ O		Static Pressure	-0.80	in. H ₂ O	
Meter Temperature, T _m :	44.5	°F		Flue Pressure (Ps):	29.32	in. Hg. abs.	
Sqrt ΔP:	0.416	In. H ₂ O		Carbon Dioxide:	14.33	%	
Stack Temperature, T _s :	396.1	°F		Oxygen:	10.24	%	
Meter Volume, V _m :	34.600	ft ³		Nitrogen:	75.4	%	
Meter Volume, V _{mstd} :	35.853	dscf		Gas Weight dry, M _d :	30.702	lb/lb mole	
Meter Volume, V _{wstd} :	2.737	wscf		Gas Weight wet, M _s :	29.802	lb/lb mole	
Isokinetic Variance:	104.1	%I		Excess Air:	---	%	
Test Length:	84.00	in. mins.		Gas Velocity, V _s :	29.521	fps	
Nozzle Diameter:	0.275	in. inches		Volumetric Flow:	122,854	acfm	
Barometric Pressure:	29.38	in. Hg		Volumetric Flow:	68,984	dscfm	
				Volumetric Flow:	74,249	scfm	

MOISTURE DETERMINATION

Initial Impinger Content:	3517.0	ml	Silica Initial Wt.	858.8	grams
Final Impinger Content:	3564.1	ml	Silica Final Wt.	869.8	grams
Impinger Difference:	47.1	ml	Silica Difference:	11.0	grams
Total Water Gain:	58.1		Moisture, Bws:	0.071	

Port- Point No.	Clock Time	Velocity Head Δp in. H ₂ O	Orifice ΔH in. H ₂ O	Actual Meter Vol. ft ³	Stack Temp °F	Meter Temp Inlet °F	Outlet °F	Pump Vacuum °Hg	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	12:30:00	0.14	0.42	91.770	398	43	43	3	261	261	46
1-2	12:32:00	0.15	0.45	92.770	399	43	43	3	261	261	47
1-3	12:34:00	0.15	0.45	93.340	397	43	43	3	262	260	47
1-4	12:36:00	0.16	0.48	94.230	398	43	43	3	262	260	46
1-5	12:38:00	0.17	0.51	94.810	399	43	43	3	263	260	46
1-6	12:40:00	0.18	0.55	95.620	400	43	43	3	263	261	47
1-7	12:42:00	0.19	0.57	96.530	401	43	43	3	261	261	47
1-8	12:44:00	0.20	0.60	97.340	401	43	43	4	261	260	47
1-9	12:46:00	0.20	0.60	98.230	400	43	43	4	261	261	46
1-10	12:48:00	0.20	0.60	99.150	399	43	43	4	263	262	46
1-12	12:50:00	0.19	0.60	99.940	398	43	43	3	263	261	47
1-13	12:52:00	0.18	0.54	100.820	398	43	43	3	262	261	48
1-14	12:54:00	0.16	0.48	101.640	398	43	43	3	262	260	49
	12:56:00	0.15	0.45	102.540	398	43	43	3	262	261	49
2-1	13:00:00			103.110							
2-2	13:02:00	0.14	0.42	103.110	394	43	43	3	261	261	48
2-3	13:04:00	0.15	0.45	103.920	394	43	43	3	261	260	48
2-4	13:06:00	0.15	0.45	104.780	394	43	43	3	260	262	47
2-5	13:08:00	0.17	0.51	105.420	395	43	43	3	261	260	46
2-6	13:10:00	0.18	0.54	106.340	395	44	44	3	261	261	46
2-7	13:12:00	0.20	0.60	106.990	395	44	44	4	263	262	47
2-8	13:14:00	0.20	0.60	107.730	396	44	44	4	263	261	47
2-9	13:16:00	0.19	0.56	108.830	396	45	45	3	262	261	47
2-10	13:18:00	0.18	0.54	109.610	395	45	45	3	262	260	48
2-11	13:20:00	0.17	0.51	110.540	395	45	45	3	262	260	49
2-12	13:22:00	0.16	0.48	111.490	395	45	45	3	263	260	49
2-13	13:24:00	0.15	0.45	112.340	395	45	45	3	263	261	49
2-14	13:26:00	0.15	0.45	112.950	395	45	45	3	262	260	49
	13:28:00			113.740							
3-1	13:32:00	0.15	0.45	113.740	394	45	45	3	261	261	49
3-2	13:34:00	0.16	0.48	114.500	394	45	45	3	261	261	49
3-3	13:36:00	0.17	0.51	115.285	394	46	46	3	262	260	50
3-4	13:38:00	0.18	0.54	116.096	394	46	46	3	262	260	49
3-5	13:40:00	0.18	0.54	116.931	395	46	46	3	263	260	49
3-6	13:42:00	0.18	0.54	117.765	396	46	46	3	263	261	50
3-7	13:44:00	0.19	0.57	118.598	395	46	46	3	261	261	50
3-8	13:46:00	0.20	0.61	119.455	395	47	47	4	261	260	50
3-9	13:48:00	0.20	0.61	120.336	394	47	47	4	260	262	50
3-10	13:50:00	0.20	0.61	121.217	394	47	47	4	261	260	50
3-11	13:52:00	0.18	0.54	122.098	394	47	47	3	261	261	50
3-12	13:54:00	0.18	0.54	122.934	395	47	47	3	263	262	50
3-13	13:56:00	0.17	0.51	123.770	395	47	47	3	263	261	50
3-14	13:58:00	0.16	0.48	124.582	395	47	47	3	262	261	50
	14:00:00			126.370							

Total	1:22:00			34.600		44.5	44.5				
Average			0.52		396.1				3		
Min			0.42		394.0				3		
Max			0.61		401.0				4		

Impinger Weight Sheet - Run 2B

Client: Holcim (US) Inc. Facility: Alpena Cement Plant Test Location: Kiln 21 Breaching Duct Project #: M235005 Date: 12/12/2023 Test Method: 26A Weighed/Measured By: EE Balance ID: S10-25	Scale Calibration Check Date: <u>12/12/2023</u> <u>Scale Calibration Check (see QS-6.05C for procedure)</u> must be within $\pm 0.5g$ of certified mass <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Certified Weight, grams</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Result, grams</u></th> </tr> <tr> <td style="text-align: center;">200</td> <td style="text-align: center; border-bottom: 1px solid black;">200.0</td> </tr> <tr> <td style="text-align: center;">500</td> <td style="text-align: center; border-bottom: 1px solid black;">500.0</td> </tr> <tr> <td style="text-align: center;">700</td> <td style="text-align: center; border-bottom: 1px solid black;">700.0</td> </tr> </table>	<u>Certified Weight, grams</u>	<u>Result, grams</u>	200	200.0	500	500.0	700	700.0
<u>Certified Weight, grams</u>	<u>Result, grams</u>								
200	200.0								
500	500.0								
700	700.0								

IMPINGER	FINAL	INITIAL	GAIN
CONTENTS	MLS / GRAMS	MLS / GRAMS	MLS / GRAMS
0.1N H2SO4	727.4	690.2	37.2
0.1N H2SO4	747.6	743.4	4.2
Empty	648.7	645.7	3.0
0.1N NaOH	701.2	698.9	2.3
0.1N NaOH	739.2	738.8	0.4
Silica Gel	869.8	858.8	11.0

<u>3,564.1</u> Liquid Final	<u>3,517.0</u> Liquid Initial	<u>47.1</u> Liquid Gain
<u>869.8</u> Silica Final	<u>858.8</u> Silica Initial	<u>11.0</u> Silica Gain

Run 3B - Method 26A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Test Location: Kiln 21 Breaching Duct
 Source Condition: Normal

Date: 12/12/23
 Start Time: 14:15
 End Time: 15:45

DRY GAS METER CONDITIONS				STACK CONDITIONS			
ΔH:	0.52	In. H ₂ O		Static Pressure	-0.80	in. H ₂ O	
Meter Temperature, T _m :	48.2	°F		Flue Pressure (Ps):	29.32	in. Hg. abs.	
Sqrt ΔP:	0.414	In. H ₂ O		Carbon Dioxide:	15.09	%	
Stack Temperature, T _s :	396.8	°F		Oxygen:	10.24	%	
Meter Volume, V _m :	35.954	ft ³		Nitrogen:	74.67	%	
Meter Volume, V _{mstd} :	36.982	dscf		Gas Weight dry, M _d :	30.824	lb/lb mole	
Meter Volume, V _{wstd} :	2.732	wscf		Gas Weight wet, M _s :	29.942	lb/lb mole	
Isokinetic Variance:	107.8	%I		Excess Air:	---	%	
Test Length:	84.00	in. mins.		Gas Velocity, V _s :	29.358	fps	
Nozzle Diameter:	0.275	in. inches		Volumetric Flow:	122,175	acfm	
Barometric Pressure:	29.38	in. Hg		Volumetric Flow:	68,709	dscfm	
				Volumetric Flow:	73,785	scfm	

MOISTURE DETERMINATION

Initial Impinger Content:	3536.7	ml	Silica Initial Wt.	876.4	grams
Final Impinger Content:	3586.1	ml	Silica Final Wt.	885.0	grams
Impinger Difference:	49.4	ml	Silica Difference:	8.6	grams
Total Water Gain:	58.0		Moisture, Bws:	0.069	

Port- Point No.	Clock Time	Velocity Head Δp in. H ₂ O	Orifice ΔH in. H ₂ O	Actual Meter Vol. ft ³	Stack Temp °F	Meter Temp Inlet °F	Outlet °F	Pump Vacuum °Hg	Probe Temp °F	Filter Exit Temp °F	Impinger Exit Temp °F
1-1	14:15:00	0.15	0.45	128.398	401	45	45	3	263	260	46
1-2	14:17:00	0.16	0.48	129.340	400	45	45	3	263	261	47
1-3	14:19:00	0.16	0.48	130.010	400	45	45	3	263	260	47
1-4	14:21:00	0.16	0.48	130.820	400	45	45	3	262	259	48
1-5	14:23:00	0.17	0.51	131.650	399	45	45	3	260	258	48
1-6	14:25:00	0.17	0.51	132.510	400	46	46	3	260	259	47
1-7	14:27:00	0.19	0.57	133.340	401	46	46	3	261	261	46
1-8	14:29:00	0.20	0.60	133.980	400	46	46	4	261	260	46
1-9	14:31:00	0.20	0.60	134.920	399	46	46	4	260	262	46
1-10	14:33:00	0.19	0.57	135.830	399	46	46	3	261	260	46
1-12	14:35:00	0.19	0.57	136.660	398	47	47	3	261	261	47
1-13	14:37:00	0.17	0.51	137.730	398	47	47	3	263	262	48
1-14	14:39:00	0.16	0.48	138.420	398	47	47	3	262	260	49
	14:41:00			139.250							
2-1	14:45:00	0.14	0.42	139.250	398	48	48	3	261	260	49
2-2	14:47:00	0.15	0.45	139.990	398	48	48	3	261	261	49
2-3	14:49:00	0.16	0.48	140.810	397	48	48	3	263	262	50
2-4	14:51:00	0.17	0.51	141.730	397	48	48	3	263	261	50
2-5	14:53:00	0.18	0.54	142.550	397	48	48	3	262	261	50
2-6	14:55:00	0.20	0.61	143.340	397	49	49	4	262	260	50
2-7	14:57:00	0.20	0.61	144.250	397	49	49	4	263	261	50
2-8	14:59:00	0.20	0.61	145.030	396	49	49	4	262	261	50
2-9	15:01:00	0.19	0.58	145.910	396	49	49	3	262	260	50
2-10	15:03:00	0.18	0.55	146.820	395	49	49	3	262	260	49
2-11	15:05:00	0.16	0.49	147.730	395	49	49	3	263	260	49
2-12	15:07:00	0.15	0.46	148.550	395	49	49	3	263	261	49
2-13	15:09:00	0.15	0.46	149.140	395	49	49	3	262	260	49
2-14	15:11:00	0.14	0.43	149.930	395	49	49	3	262	260	49
	15:13:00			150.830							
3-1	15:17:00	0.15	0.46	150.830	395	49	49	3	261	260	50
3-2	15:19:00	0.15	0.46	151.620	395	49	49	3	260	262	50
3-3	15:21:00	0.16	0.49	152.450	395	49	49	3	261	260	51
3-4	15:23:00	0.17	0.52	153.320	395	49	49	3	261	261	51
3-5	15:25:00	0.18	0.55	153.990	395	50	50	3	263	262	51
3-6	15:27:00	0.18	0.55	154.920	395	50	50	3	263	261	51
3-7	15:29:00	0.19	0.58	155.650	395	50	50	3	262	261	51
3-8	15:31:00	0.20	0.61	156.720	395	50	50	4	260	262	50
3-9	15:33:00	0.20	0.61	157.410	394	50	50	4	261	260	50
3-10	15:35:00	0.19	0.58	158.570	394	51	51	4	261	261	50
3-11	15:37:00	0.18	0.55	159.370	394	51	51	3	263	262	50
3-12	15:39:00	0.17	0.52	159.990	395	51	51	3	263	261	50
3-13	15:41:00	0.16	0.49	160.990	395	51	51	3	262	261	50
3-14	15:43:00	0.14	0.43	161.720	395	51	51	3	262	261	50
	15:45:00			164.352							

Total	1:22:00			35.954		48.2	48.2				
Average			0.52		396.8				3		
Min			0.42		394.0		45.0		3		
Max			0.61		401.0		51.0		4		

Impinger Weight Sheet - Run 3B

Client: Holcim (US) Inc. Facility: Alpena Cement Plant Test Location: Kiln 21 Breaching Duct Project #: M235005 Date: 12/12/2023 Test Method: 26A Weighed/Measured By: EE Balance ID: S10-25	Scale Calibration Check Date: <u>12/12/2023</u> Scale Calibration Check (see QS-6.05C for procedure) must be within $\pm 0.5g$ of certified mass <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Certified Weight, grams</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Result, grams</u></th> </tr> <tr> <td style="text-align: center;">200</td> <td style="text-align: center; border-bottom: 1px solid black;">200.0</td> </tr> <tr> <td style="text-align: center;">500</td> <td style="text-align: center; border-bottom: 1px solid black;">500.0</td> </tr> <tr> <td style="text-align: center;">700</td> <td style="text-align: center; border-bottom: 1px solid black;">700.0</td> </tr> </table>	<u>Certified Weight, grams</u>	<u>Result, grams</u>	200	200.0	500	500.0	700	700.0
<u>Certified Weight, grams</u>	<u>Result, grams</u>								
200	200.0								
500	500.0								
700	700.0								

IMPINGER	FINAL	INITIAL	GAIN
CONTENTS	MLS / GRAMS	MLS / GRAMS	MLS / GRAMS
0.1N H2SO4	753.8	713.6	40.2
0.1N H2SO4	748.4	744.1	4.3
Empty	614.7	612.7	2.0
0.1N NaOH	692.0	690.8	1.2
0.1N NaOH	777.2	775.5	1.7
Silica Gel	885.0	876.4	8.6

<u>3,586.1</u> Liquid Final	<u>3,536.7</u> Liquid Initial	<u>49.4</u> Liquid Gain
<u>885.0</u> Silica Final	<u>876.4</u> Silica Initial	<u>8.6</u> Silica Gain

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Project #: M235005
 Test Location: Kiln 21 Exhaust
 Date: 12/12/23

Run 1

Spectrum	Time	H2O %	FTIR Data		HF ppmvw	Cell Temp	Pressure	Analyzer Data O2 % (dry)
			CO2 % (wet)	HCN ppmvw				
RUN 1_020050.LAB	10:20	3.74	14.17	0.69	≤ 0.10	190.94	0.99	10.41
RUN 1_020051.LAB	10:21	3.85	14.37	0.71	≤ 0.10	191.03	0.99	10.23
RUN 1_020052.LAB	10:22	3.94	13.90	0.72	≤ 0.10	191.01	0.99	10.32
RUN 1_020053.LAB	10:23	3.86	14.02	0.67	≤ 0.10	191.03	0.99	10.55
RUN 1_020054.LAB	10:24	3.75	13.94	0.57	≤ 0.10	190.95	0.99	10.55
RUN 1_020055.LAB	10:25	3.64	13.74	0.53	≤ 0.10	191.05	0.99	10.62
RUN 1_020056.LAB	10:26	3.42	13.00	0.55	≤ 0.10	191.05	0.99	11.23
RUN 1_020057.LAB	10:27	3.33	13.12	0.64	≤ 0.10	191.05	0.99	11.27
RUN 1_020058.LAB	10:28	3.19	13.27	0.55	≤ 0.10	191.00	0.99	11.14
RUN 1_020059.LAB	10:29	2.93	12.19	0.61	≤ 0.10	190.94	0.99	12.05
RUN 1_020060.LAB	10:30	2.80	12.01	0.57	≤ 0.10	191.05	0.99	12.16
RUN 1_020061.LAB	10:31	2.80	12.46	0.61	≤ 0.10	190.99	0.99	11.89
RUN 1_020062.LAB	10:32	2.96	13.74	0.59	≤ 0.10	190.96	0.99	11.18
RUN 1_020063.LAB	10:33	2.94	13.70	0.56	≤ 0.10	191.02	0.99	10.82
RUN 1_020064.LAB	10:34	2.94	13.47	0.60	≤ 0.10	190.94	0.99	11.22
RUN 1_020065.LAB	10:35	3.39	13.03	0.65	≤ 0.10	191.00	0.99	11.18
RUN 1_020066.LAB	10:36	3.37	13.57	0.74	≤ 0.10	190.96	0.99	11.22
RUN 1_020067.LAB	10:37	3.42	13.55	0.63	≤ 0.10	190.94	0.99	11.02
RUN 1_020068.LAB	10:38	3.51	13.36	0.63	≤ 0.10	191.03	0.99	11.08
RUN 1_020069.LAB	10:39	3.67	13.02	0.66	≤ 0.10	191.05	0.99	11.16
RUN 1_020070.LAB	10:40	3.85	13.07	0.53	≤ 0.10	190.96	0.99	11.39
RUN 1_020071.LAB	10:41	3.77	13.54	0.66	≤ 0.10	191.05	0.99	11.29
RUN 1_020072.LAB	10:42	3.73	12.91	0.59	≤ 0.10	191.05	0.99	11.00
RUN 1_020073.LAB	10:43	3.70	13.01	0.60	≤ 0.10	191.04	0.99	11.45
RUN 1_020074.LAB	10:44	3.66	13.45	0.60	≤ 0.10	191.02	0.99	11.37
RUN 1_020075.LAB	10:45	3.62	13.48	0.61	≤ 0.10	191.03	0.99	11.01
RUN 1_020076.LAB	10:46	3.61	13.32	0.57	≤ 0.10	190.94	0.99	11.21
RUN 1_020077.LAB	10:47	3.59	13.38	0.57	≤ 0.10	190.94	0.99	11.17
RUN 1_020078.LAB	10:48	3.54	13.95	0.53	≤ 0.10	190.94	0.99	10.95
RUN 1_020079.LAB	10:49	3.51	13.72	0.58	≤ 0.10	191.02	0.99	11.03
RUN 1_020080.LAB	10:50	3.51	13.80	0.64	≤ 0.10	191.05	0.99	10.68
RUN 1_020081.LAB	10:51	4.19	13.36	0.73	≤ 0.10	191.05	0.99	11.09
RUN 1_020082.LAB	10:52	5.31	13.35	0.74	≤ 0.10	190.99	0.99	10.88
RUN 1_020083.LAB	10:53	4.15	13.55	0.60	≤ 0.10	191.02	0.99	11.11
RUN 1_020084.LAB	10:54	3.97	13.60	0.57	≤ 0.10	190.94	0.99	11.07
RUN 1_020085.LAB	10:55	4.02	13.38	0.54	≤ 0.10	191.02	0.99	11.05
RUN 1_020086.LAB	10:56	4.01	13.56	0.66	≤ 0.10	191.05	0.99	10.99
RUN 1_020087.LAB	10:57	4.02	13.77	0.62	≤ 0.10	191.00	0.99	11.17
RUN 1_020088.LAB	10:58	3.90	13.30	0.59	≤ 0.10	191.05	0.99	11.01
RUN 1_020089.LAB	10:59	4.04	13.32	0.56	≤ 0.10	190.96	0.99	10.84
RUN 1_020090.LAB	11:00	4.16	13.50	0.62	≤ 0.10	191.05	0.99	11.30
RUN 1_020091.LAB	11:01	4.03	13.70	0.61	≤ 0.10	190.96	0.99	11.21
RUN 1_020092.LAB	11:02	3.90	13.60	0.64	≤ 0.10	190.94	0.99	10.86
RUN 1_020093.LAB	11:03	3.85	13.75	0.56	≤ 0.10	191.03	0.99	11.15
RUN 1_020094.LAB	11:04	3.84	14.28	0.66	≤ 0.10	190.99	0.99	11.06
RUN 1_020095.LAB	11:05	3.83	14.13	0.76	≤ 0.10	190.94	0.99	10.83
RUN 1_020096.LAB	11:06	3.83	13.79	0.65	≤ 0.10	191.01	0.99	10.86
RUN 1_020097.LAB	11:07	4.37	13.34	0.62	≤ 0.10	191.03	0.99	10.38
RUN 1_020098.LAB	11:08	4.73	13.44	0.60	≤ 0.10	190.94	0.99	10.92
RUN 1_020099.LAB	11:09	4.46	13.63	0.59	≤ 0.10	190.99	0.99	10.98
RUN 1_020100.LAB	11:10	4.34	13.82	0.59	≤ 0.10	191.05	0.99	11.27
RUN 1_020101.LAB	11:11	4.28	13.52	0.61	≤ 0.10	191.05	0.99	11.17
RUN 1_020102.LAB	11:12	4.15	13.58	0.64	≤ 0.10	191.05	0.99	11.08
RUN 1_020103.LAB	11:13	3.93	13.88	0.65	≤ 0.10	191.04	0.99	11.03
RUN 1_020104.LAB	11:14	3.95	13.68	0.63	≤ 0.10	190.94	0.99	11.26
RUN 1_020105.LAB	11:15	3.84	13.69	0.52	≤ 0.10	191.00	0.99	11.15
RUN 1_020106.LAB	11:16	3.91	13.88	0.59	≤ 0.10	191.05	0.99	11.00
RUN 1_020107.LAB	11:17	3.90	13.88	0.63	≤ 0.10	191.08	0.99	11.37
RUN 1_020108.LAB	11:18	3.76	13.80	0.50	≤ 0.10	191.10	0.99	11.20
RUN 1_020109.LAB	11:19	3.75	14.07	0.71	≤ 0.10	190.96	0.99	10.87
Average		3.77	13.52	0.62	≤ 0.10	191.00	0.99	11.07

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Project #: M235005
 Test Location: Kiln 21 Exhaust
 Date: 12/12/23

Run 2

Spectrum	Time	H2O %	FTIR Data		HF ppmvw	Cell Temp	Pressure	Analyzer Data O2 % (dry)
			CO2 % (wet)	HCN ppmvw				
RUN 2_020256.LAB	12:30	3.77	13.2	0.63	≤ 0.10	191.0	0.99	10.46
RUN 2_020257.LAB	12:31	3.74	13.2	0.60	≤ 0.10	191.1	0.99	10.56
RUN 2_020258.LAB	12:32	3.85	13.6	0.67	≤ 0.10	191.0	0.99	10.23
RUN 2_020259.LAB	12:33	3.69	12.9	0.56	≤ 0.10	191.0	0.99	10.63
RUN 2_020260.LAB	12:34	3.71	12.9	0.55	≤ 0.10	191.0	0.99	10.69
RUN 2_020261.LAB	12:35	3.71	12.9	0.53	≤ 0.10	190.9	0.99	10.83
RUN 2_020262.LAB	12:36	3.76	13.2	0.56	≤ 0.10	190.9	0.99	10.68
RUN 2_020263.LAB	12:37	3.72	12.8	0.60	≤ 0.10	190.9	0.99	10.60
RUN 2_020264.LAB	12:38	4.23	13.0	0.69	≤ 0.10	190.9	0.99	10.63
RUN 2_020265.LAB	12:39	5.04	12.8	0.71	≤ 0.10	190.9	0.99	10.69
RUN 2_020266.LAB	12:40	4.57	12.8	0.67	≤ 0.10	190.9	0.99	10.52
RUN 2_020267.LAB	12:41	3.98	12.7	0.67	≤ 0.10	191.0	0.99	10.57
RUN 2_020268.LAB	12:42	3.80	12.9	0.63	≤ 0.10	191.1	0.99	11.00
RUN 2_020269.LAB	12:43	3.79	13.0	0.62	≤ 0.10	191.1	0.99	10.83
RUN 2_020270.LAB	12:44	3.76	12.8	0.58	≤ 0.10	191.0	0.99	10.57
RUN 2_020271.LAB	12:45	3.79	12.9	0.66	≤ 0.10	191.0	0.99	10.79
RUN 2_020272.LAB	12:46	3.86	13.3	0.66	≤ 0.10	191.0	0.99	10.64
RUN 2_020273.LAB	12:47	3.86	13.3	0.66	≤ 0.10	191.0	0.99	10.37
RUN 2_020274.LAB	12:48	3.97	14.0	0.62	≤ 0.10	191.0	0.99	10.57
RUN 2_020275.LAB	12:49	3.83	13.4	0.62	≤ 0.10	191.0	0.99	10.06
RUN 2_020276.LAB	12:50	3.85	13.9	0.68	≤ 0.10	191.1	0.99	10.39
RUN 2_020277.LAB	12:51	3.83	14.0	0.71	≤ 0.10	191.0	0.99	10.28
RUN 2_020278.LAB	12:52	3.95	14.1	0.66	≤ 0.10	190.9	0.99	10.49
RUN 2_020279.LAB	12:53	4.93	13.6	0.73	≤ 0.10	191.0	0.99	10.26
RUN 2_020280.LAB	12:54	5.13	13.7	0.70	≤ 0.10	191.0	0.99	10.24
RUN 2_020281.LAB	12:55	4.16	13.8	0.72	≤ 0.10	190.9	0.99	10.36
RUN 2_020282.LAB	12:56	3.96	13.9	0.67	≤ 0.10	191.0	0.99	10.56
RUN 2_020283.LAB	12:57	3.91	14.0	0.74	≤ 0.10	190.9	0.99	10.40
RUN 2_020284.LAB	12:58	3.90	14.1	0.67	≤ 0.10	190.9	0.99	10.28
RUN 2_020285.LAB	12:59	3.87	14.1	0.69	≤ 0.10	191.0	0.99	10.29
RUN 2_020286.LAB	13:00	3.83	13.8	0.58	≤ 0.10	191.0	0.99	10.20
RUN 2_020287.LAB	13:01	3.83	14.0	0.72	≤ 0.10	191.0	0.99	10.25
RUN 2_020288.LAB	13:02	3.92	14.5	0.76	≤ 0.10	191.1	0.99	10.56
RUN 2_020289.LAB	13:03	3.92	14.5	0.70	≤ 0.10	191.1	0.99	10.38
RUN 2_020290.LAB	13:04	3.98	14.7	0.73	≤ 0.10	191.0	0.99	10.10
RUN 2_020291.LAB	13:05	3.83	13.9	0.61	≤ 0.10	190.9	0.99	10.32
RUN 2_020292.LAB	13:06	3.84	13.9	0.65	≤ 0.10	191.0	0.99	9.91
RUN 2_020293.LAB	13:07	4.59	14.0	0.77	≤ 0.10	191.0	0.99	10.29
RUN 2_020294.LAB	13:08	5.24	13.9	0.78	≤ 0.10	191.0	0.99	10.41
RUN 2_020295.LAB	13:09	4.39	13.7	0.82	≤ 0.10	191.1	0.99	10.63
RUN 2_020296.LAB	13:10	4.02	14.0	0.71	≤ 0.10	191.0	0.99	10.37
RUN 2_020297.LAB	13:11	3.89	14.1	0.64	≤ 0.10	190.9	0.99	10.36
RUN 2_020298.LAB	13:12	3.90	14.4	0.70	≤ 0.10	191.0	0.99	10.57
RUN 2_020299.LAB	13:13	3.89	14.5	0.69	≤ 0.10	190.9	0.99	10.58
RUN 2_020300.LAB	13:14	3.93	14.6	0.73	≤ 0.10	191.0	0.99	10.52
RUN 2_020301.LAB	13:15	3.97	14.7	0.84	≤ 0.10	191.0	0.99	10.42
RUN 2_020302.LAB	13:16	3.88	14.3	0.75	≤ 0.10	191.0	0.99	10.41
RUN 2_020303.LAB	13:17	3.88	14.3	0.79	≤ 0.10	191.0	0.99	10.22
RUN 2_020304.LAB	13:18	3.95	14.6	0.79	≤ 0.10	191.0	0.99	10.16
RUN 2_020305.LAB	13:19	3.98	14.7	0.77	≤ 0.10	191.0	0.99	10.41
RUN 2_020306.LAB	13:20	3.99	14.6	0.80	≤ 0.10	191.0	0.99	10.34
RUN 2_020307.LAB	13:21	4.17	14.0	0.77	≤ 0.10	191.1	0.99	10.11
RUN 2_020308.LAB	13:22	5.10	13.5	0.85	≤ 0.10	191.0	0.99	10.36
RUN 2_020309.LAB	13:23	5.02	13.8	0.84	≤ 0.10	190.9	0.99	10.02
RUN 2_020310.LAB	13:24	4.17	13.9	0.70	≤ 0.10	191.0	0.99	10.31
RUN 2_020311.LAB	13:25	3.93	13.8	0.69	≤ 0.10	191.0	0.99	10.46
RUN 2_020312.LAB	13:26	3.85	13.7	0.74	≤ 0.10	191.0	0.99	10.75
RUN 2_020313.LAB	13:27	3.89	13.9	0.67	≤ 0.10	190.9	0.99	10.47
RUN 2_020314.LAB	13:28	3.91	14.1	0.64	≤ 0.10	191.0	0.99	10.55
RUN 2_020315.LAB	13:29	3.76	13.5	0.63	≤ 0.10	191.0	0.99	10.68
Average		4.04	13.75	0.69	≤ 0.10	191.0	0.99	10.44

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Project #: M235005
 Test Location: Kiln 21 Exhaust
 Date: 12/12/23

Run 3

Spectrum	Time	H2O %	FTIR Data		HF ppmvw	Cell Temp	Pressure	Analyzer Data O2 % (dry)
			CO2 % (wet)	HCN ppmvw				
RUN 3_020404.LAB	15:15	3.83	14.5	0.71	≤ 0.10	191.0	0.99	10.38
RUN 3_020405.LAB	15:16	3.81	14.4	0.68	≤ 0.10	191.1	0.99	10.52
RUN 3_020406.LAB	15:17	3.78	14.3	0.59	≤ 0.10	191.0	0.99	10.83
RUN 3_020407.LAB	15:18	3.81	14.3	0.64	≤ 0.10	190.9	0.99	10.60
RUN 3_020408.LAB	15:19	3.73	14.1	0.65	≤ 0.10	191.0	0.99	10.59
RUN 3_020409.LAB	15:20	3.78	14.3	0.53	≤ 0.10	191.1	0.99	10.79
RUN 3_020410.LAB	15:21	3.70	14.0	0.55	≤ 0.10	191.0	0.99	10.75
RUN 3_020411.LAB	15:22	3.68	14.0	0.57	≤ 0.10	190.9	0.99	10.81
RUN 3_020412.LAB	15:23	3.67	13.9	0.56	≤ 0.10	190.9	0.99	10.92
RUN 3_020413.LAB	15:24	3.71	14.0	0.61	≤ 0.10	190.9	0.99	10.99
RUN 3_020414.LAB	15:25	3.94	14.0	0.66	≤ 0.10	190.9	0.99	10.83
RUN 3_020415.LAB	15:26	4.84	13.9	0.71	≤ 0.10	190.9	0.99	10.95
RUN 3_020416.LAB	15:27	4.73	14.2	0.67	≤ 0.10	190.9	0.99	10.87
RUN 3_020417.LAB	15:28	4.08	14.6	0.70	≤ 0.10	191.0	0.99	10.63
RUN 3_020418.LAB	15:29	3.85	14.6	0.64	≤ 0.10	191.0	0.99	10.53
RUN 3_020419.LAB	15:30	3.88	15.1	0.62	≤ 0.10	191.0	0.99	10.68
RUN 3_020420.LAB	15:31	3.76	14.5	0.58	≤ 0.10	191.0	0.99	10.29
RUN 3_020421.LAB	15:32	3.73	14.5	0.66	≤ 0.10	191.0	0.99	10.42
RUN 3_020422.LAB	15:33	3.71	14.5	0.62	≤ 0.10	191.0	0.99	10.58
RUN 3_020423.LAB	15:34	3.73	14.5	0.62	≤ 0.10	191.0	0.99	10.91
RUN 3_020424.LAB	15:35	3.66	14.3	0.56	≤ 0.10	191.0	0.99	10.70
RUN 3_020425.LAB	15:36	3.70	14.7	0.54	≤ 0.10	191.0	0.99	10.68
RUN 3_020426.LAB	15:37	3.71	14.7	0.56	≤ 0.10	191.0	0.99	10.86
RUN 3_020427.LAB	15:38	3.73	14.7	0.64	≤ 0.10	190.9	0.99	10.72
RUN 3_020428.LAB	15:39	3.71	14.4	0.61	≤ 0.10	191.0	0.99	10.71
RUN 3_020429.LAB	15:40	4.59	14.4	0.68	≤ 0.10	191.0	0.99	10.77
RUN 3_020430.LAB	15:41	5.23	14.7	0.72	≤ 0.10	191.0	0.99	10.80
RUN 3_020431.LAB	15:42	4.21	14.6	0.70	≤ 0.10	191.0	0.99	10.72
RUN 3_020432.LAB	15:43	3.88	14.6	0.64	≤ 0.10	191.1	0.99	10.70
RUN 3_020433.LAB	15:44	3.83	15.0	0.63	≤ 0.10	191.1	0.99	10.69
RUN 3_020434.LAB	15:45	3.82	15.2	0.56	≤ 0.10	191.0	0.99	10.56
RUN 3_020435.LAB	15:46	3.80	15.2	0.66	≤ 0.10	190.9	0.99	10.51
RUN 3_020436.LAB	15:47	3.70	14.7	0.61	≤ 0.10	191.0	0.99	10.54
RUN 3_020437.LAB	15:48	3.65	14.4	0.55	≤ 0.10	191.0	0.99	10.23
RUN 3_020438.LAB	15:49	3.74	14.8	0.57	≤ 0.10	190.9	0.99	10.47
RUN 3_020439.LAB	15:50	3.75	14.7	0.55	≤ 0.10	190.9	0.99	10.71
RUN 3_020440.LAB	15:51	3.69	14.6	0.62	≤ 0.10	190.9	0.99	11.01
RUN 3_020441.LAB	15:52	3.67	14.5	0.58	≤ 0.10	191.0	0.99	10.67
RUN 3_020442.LAB	15:53	3.71	14.9	0.64	≤ 0.10	191.0	0.99	10.67
RUN 3_020443.LAB	15:54	4.20	14.8	0.65	≤ 0.10	191.0	0.99	10.91
RUN 3_020444.LAB	15:55	4.77	14.1	0.76	≤ 0.10	191.0	0.99	10.81
RUN 3_020445.LAB	15:56	4.39	14.3	0.77	≤ 0.10	191.0	0.99	10.78
RUN 3_020446.LAB	15:57	3.89	14.8	0.65	≤ 0.10	190.9	0.99	10.69
RUN 3_020447.LAB	15:58	3.74	14.5	0.61	≤ 0.10	191.0	0.99	10.68
RUN 3_020448.LAB	15:59	3.66	14.3	0.54	≤ 0.10	191.0	0.99	10.69
RUN 3_020449.LAB	16:00	3.70	14.3	0.58	≤ 0.10	191.0	0.99	10.75
RUN 3_020450.LAB	16:01	3.79	14.7	0.65	≤ 0.10	191.0	0.99	10.74
RUN 3_020451.LAB	16:02	3.75	14.5	0.58	≤ 0.10	190.9	0.99	10.68
RUN 3_020452.LAB	16:03	3.66	14.2	0.58	≤ 0.10	190.9	0.99	10.83
RUN 3_020453.LAB	16:04	3.59	14.0	0.59	≤ 0.10	190.9	0.99	10.87
RUN 3_020454.LAB	16:05	3.67	14.4	0.60	≤ 0.10	191.0	0.99	10.54
RUN 3_020455.LAB	16:06	3.70	14.7	0.61	≤ 0.10	191.0	0.99	10.75
RUN 3_020456.LAB	16:07	3.67	14.6	0.62	≤ 0.10	191.0	0.99	10.93
RUN 3_020457.LAB	16:08	3.79	14.5	0.59	≤ 0.10	191.0	0.99	11.14
RUN 3_020458.LAB	16:09	4.79	14.5	0.66	≤ 0.10	191.0	0.99	10.82
RUN 3_020459.LAB	16:10	5.01	14.9	0.79	≤ 0.10	190.9	0.99	10.71
RUN 3_020460.LAB	16:11	3.95	14.3	0.66	≤ 0.10	190.9	0.99	10.94
RUN 3_020461.LAB	16:12	3.75	14.4	0.57	≤ 0.10	190.9	0.99	10.75
RUN 3_020462.LAB	16:13	3.73	14.8	0.55	≤ 0.10	191.0	0.99	10.78
RUN 3_020463.LAB	16:14	3.70	14.9	0.62	≤ 0.10	191.0	0.99	10.65
Average		3.91	14.50	0.62	≤ 0.10	191.00	0.99	10.72

Stratification Test Results Summary

Holcim (US) Inc.
Alpena Cement Plant
Kiln 20 Exhaust
December 13, 2023

Number of Ports Sampled: 1
Number of Points per Port: 3
Total Number of Traverse Points: 3

Port No.	Point No.	Time	O ₂ %	Actual % Difference O ₂ %	Mean Difference O ₂ %
1	1	11:35	9.48	0.82	0.08
	2	11:45	9.38	0.25	0.02
	3	11:55	9.35	0.57	0.05
Average			9.40		

One point traverse (<5% difference) 
Three point traverse (0.4, 1.2, and 2.0 meters), <10% difference 
Twelve point traverse (Method 1 points) >10% difference 

One point traverse (<0.3% mean difference) 
Three point traverse (0.4, 1.2, and 2.0 meters), < 0.5% mean difference for O₂ 
Twelve point traverse (Method 1 points) >0.5% mean difference for O₂ 

Stratification Test Results Summary

Holcim (US) Inc.
Alpena Cement Plant
Kiln 21 Exhaust
December 12, 2023

Number of Ports Sampled: 1
Number of Points per Port: 3
Total Number of Traverse Points: 3

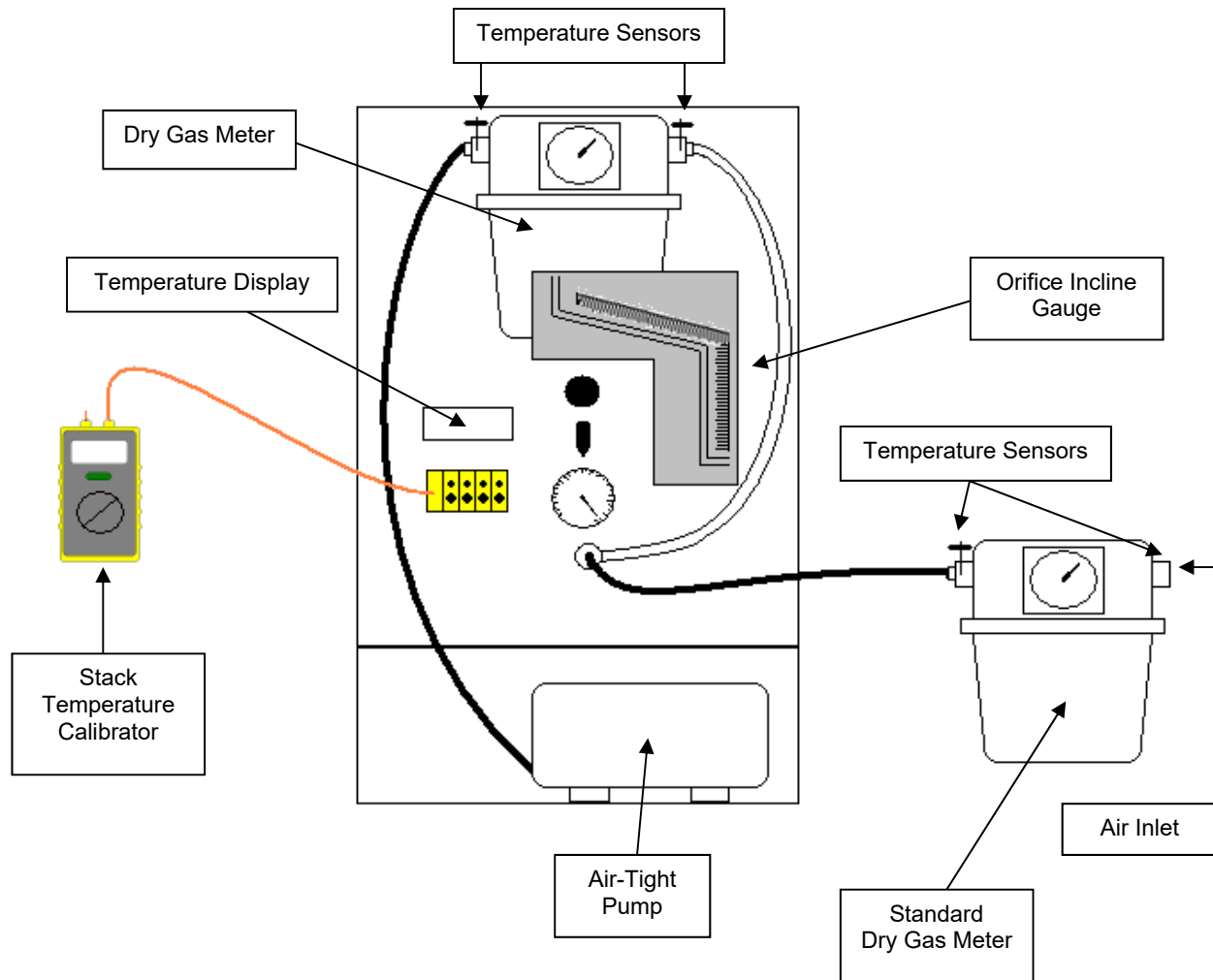
Port No.	Point No.	Time	O ₂ %	Actual % Difference O ₂ %	Mean Difference O ₂ %
1	1	10:00	10.77	1.25	0.13
	2	10:10	10.73	0.88	0.09
	3	10:20	10.41	2.13	0.23
Average			10.64		

One point traverse (<5% difference) 
Three point traverse (0.4, 1.2, and 2.0 meters), <10% difference 
Twelve point traverse (Method 1 points) >10% difference 

One point traverse (<0.3% mean difference) 
Three point traverse (0.4, 1.2, and 2.0 meters), < 0.5% mean difference for O₂ 
Twelve point traverse (Method 1 points) >0.5% mean difference for O₂ 

Appendix G - Calibration Data

Dry Gas Meter/Control Module Calibration Diagram



Meter Box Calibration

Dry Gas Meter Calibration Data

Dry Gas Meter No. CM43
Standard Meter No. 366118
Standard Meter (Y) 0.99950

Date: December 7, 2023
Calibrated By: LPH
Barometric Pressure: 29.16

Run Number	Orifice Setting in H ₂ O Chg (H)	Standard Meter Gas Volume vr	Dry Gas Meter Gas Volume vd	Standard Meter Temp. F° tr	Dry Gas Meter Inlet Temp. F° tdi	Dry Gas Meter Outlet Temp. F° tdo	Dry Gas Meter Avg. Temp. F° td	Time Min	Time Sec	Y	Chg (H)
Final		48.756	92.379	64	65	65					
Initial		43.751	87.279	63	63	63					
Difference	1 0.20	5.005	5.100	64	64	64	64	20	32	0.981	1.925
Final		55.005	98.672	64	66	66					
Initial		48.979	92.610	64	65	65					
Difference	2 0.50	6.026	6.062	64	66	66	66	15	4	0.995	1.786
Final		60.315	104.001	64	67	67					
Initial		55.159	98.835	64	67	67					
Difference	3 0.70	5.156	5.166	64	67	67	67	10	53	1.002	1.777
Final		65.800	9.525	65	68	68					
Initial		60.476	4.176	64	68	68					
Difference	4 0.90	5.324	5.349	65	68	68	68	9	50	0.999	1.749
Final		71.655	15.402	64	68	68					
Initial		65.924	9.647	64	68	68					
Difference	5 1.20	5.731	5.755	64	68	68	68	9	24	1.000	1.836
Final		43.652	87.193	63	63	63					
Initial		38.574	82.101	63	63	63					
Difference	6 2.00	5.078	5.092	63	63	63	63	6	29	0.992	1.865

Average **0.995** **1.823**

Stack Temperature Sensor Calibration			
Temperature ID :	100769	Name :	LPH
Ambient Temperature, °F :	55.5	Date :	12/7/2023

Temperature Calibrator			
Model # :	CL23A	Certification Date:	May 1, 2023
Serial # :	T-285668	Expiration Date:	May 2, 2024

Primary Standards Directly Traceable National Institute of Standards and Technology (NIST)

Reference Source Temperature (°F)	Test Thermometer Temperature (°F)	Temperature Difference %
0	0	0.0
250	249	0.1
600	599	0.1
1200	1201	0.1

$$\frac{(\text{Ref. Temp., } ^\circ\text{F} + 460) - (\text{Test Therm. Temp., } ^\circ\text{F} + 460)}{\text{Ref. Temp., } ^\circ\text{F} + 460} * 100 \leq 1.5 \%$$

Meter Box Calibration

Dry Gas Meter Calibration Data

Dry Gas Meter No. CM43
Standard Meter No. 366118
Standard Meter (Y) 0.99950

Date: January 4, 2024
Calibrated By: HH
Barometric Pressure: 29.60

Run Number	Orifice Setting in H ₂ O Chg (H)	Standard Meter Gas Volume vr	Dry Gas Meter Gas Volume vd	Standard Meter Temp. F° tr	Dry Gas Meter Inlet Temp. F° tdi	Dry Gas Meter Outlet Temp. F° tdo	Dry Gas Meter Avg. Temp. F° td	Time Min	Time Sec	Y	Chg (H)
Final		89.760	49.442	62	62	62					
Initial		84.730	44.418	62	61	61					
Difference	1 0.20	5.030	5.024	62	62	62	62	19	14	0.999	1.646
Final		94.766	54.464	63	63	63					
Initial		89.760	49.442	62	62	62					
Difference	2 0.50	5.006	5.022	63	63	63	63	12	30	0.995	1.755
Final		99.827	59.525	63	65	65					
Initial		94.766	54.464	63	63	63					
Difference	3 0.70	5.061	5.061	63	64	64	64	10	47	1.000	1.787
Final		106.075	65.791	63	66	66					
Initial		99.827	59.525	63	65	65					
Difference	4 0.90	6.248	6.266	63	66	66	66	11	41	0.999	1.765
Final		111.146	70.870	63	67	67					
Initial		106.075	65.791	63	66	66					
Difference	5 1.20	5.071	5.079	63	67	67	67	7	58	1.002	1.658
Final		84.730	44.418	62	61	61					
Initial		79.622	39.357	62	61	61					
Difference	6 2.00	5.108	5.061	62	61	61	61	6	33	1.002	1.853

Average **0.999** **1.744**

Stack Temperature Sensor Calibration			
Temperature ID :	285668	Name :	HH
Ambient Temperature, °F :	61.6	Date :	January 4, 2024

Temperature Calibrator			
Model # :	CL23A	Certification Date:	May 2, 2023
Serial # :	285668	Expiration Date:	May 2, 2024

Primary Standards Directly Traceable National Institute of Standards and Technology (NIST)

Reference Source Temperature (°F)	Test Thermometer Temperature (°F)	Temperature Difference %
0	1	0.2
250	252	0.3
600	601	0.1
1200	1205	0.3

$$\frac{(\text{Ref. Temp., } ^\circ\text{F} + 460) - (\text{Test Therm. Temp., } ^\circ\text{F} + 460)}{\text{Ref. Temp., } ^\circ\text{F} + 460} * 100 \leq 1.5 \%$$

Meter Box Calibration

Dry Gas Meter Calibration Data

Dry Gas Meter No. CM49
 Standard Meter No. 16541852
 Standard Meter (Y) 1.00440

Date: October 24, 2023
 Calibrated By: try
 Barometric Pressure: 29.28

Run Number	Orifice Setting in H ₂ O Chg (H)	Standard Meter Gas Volume vr	Dry Gas Meter Gas Volume vd	Standard Meter Temp. F° tr	Dry Gas Meter Inlet Temp. F° tdi	Dry Gas Meter Outlet Temp. F° tdo	Dry Gas Meter Avg. Temp. F° td	Time Min	Time Sec	Y	Chg (H)
Final		99.317	104.541	66	70	70					
Initial		93.389	98.578	65	69	69					
Difference 1	0.20	5.928	5.963	66	70	70	70	22	37	1.006	1.637
Final		105.237	110.485	66	70	70					
Initial		99.424	104.644	66	70	70					
Difference 2	0.50	5.813	5.841	66	70	70	70	14	43	1.006	1.804
Final		112.223	117.514	66	69	69					
Initial		105.383	110.635	66	70	70					
Difference 3	0.70	6.840	6.879	66	70	70	70	14	8	1.004	1.684
Final		121.290	126.598	66	70	70					
Initial		112.363	117.645	66	68	69					
Difference 4	0.90	8.927	8.953	66	69	70	69	16	13	1.005	1.674
Final		126.421	131.731	66	70	70					
Initial		121.363	126.672	66	70	70					
Difference 5	1.20	5.058	5.059	66	70	70	70	8	4	1.009	1.718
Final		93.292	98.475	65	68	68					
Initial		85.768	91.004	65	67	67					
Difference 6	2.00	7.524	7.471	65	68	68	68	9	42	1.011	1.873

Average **1.007** **1.732**

Stack Temperature Sensor Calibration			
Temperature ID :	100769	Name :	try
Ambient Temperature, °F :	65.9	Date :	October 24, 2023

Temperature Calibrator			
Model # :	CL23A	Certification Date:	May 2, 2023
Serial # :	T-285688	Expiration Date:	May 1, 2024

Primary Standards Directly Traceable National Institute of Standards and Technology (NIST)

Reference Source Temperature (°F)	Test Thermometer Temperature (°F)	Temperature Difference %
0	2	0.4
250	252	0.3
600	602	0.2
1200	1206	0.4

$$\frac{(\text{Ref. Temp., } ^\circ\text{F} + 460) - (\text{Test Therm. Temp., } ^\circ\text{F} + 460)}{\text{Ref. Temp., } ^\circ\text{F} + 460} * 100 \leq 1.5 \%$$

Meter Box Calibration

Dry Gas Meter Calibration Data

Dry Gas Meter No. CM49
Standard Meter No. 366118
Standard Meter (Y) 0.99950

Date: January 17, 2024
Calibrated By: HGS1
Barometric Pressure: 29.19

Run Number	Orifice Setting in H ₂ O Chg (H)	Standard Meter Gas Volume vr	Dry Gas Meter Gas Volume vd	Standard Meter Temp. F° tr	Dry Gas Meter Inlet Temp. F° tdi	Dry Gas Meter Outlet Temp. F° tdo	Dry Gas Meter Avg. Temp. F° td	Time Min	Time Sec	Y	Chg (H)
Final		85.320	105.308	60	67	67					
Initial		80.088	100.004	60	69	69					
Difference	1 0.20	5.232	5.304	60	68	68	68	20	55	1.001	1.788
Final		90.564	110.596	59	67	67					
Initial		85.320	105.308	59	68	68					
Difference	2 0.50	5.244	5.288	59	68	68	68	13	6	1.006	1.740
Final		101.426	121.456	59	61	61					
Initial		96.321	116.346	59	60	60					
Difference	3 0.70	5.105	5.110	59	61	61	61	10	56	1.000	1.815
Final		106.525	126.561	59	62	62					
Initial		101.426	121.456	59	61	61					
Difference	4 0.90	5.099	5.105	59	62	62	62	9	41	1.001	1.831
Final		111.631	131.653	59	63	63					
Initial		106.525	126.561	59	62	62					
Difference	5 1.20	5.106	5.092	59	63	63	63	8	21	1.006	1.807
Final		80.088	100.004	60	69	69					
Initial		74.665	94.535	61	69	69					
Difference	6 2.00	5.423	5.469	61	69	69	69	7	5	1.002	1.909

Average **1.003** **1.815**

Stack Temperature Sensor Calibration			
Temperature ID :	100769	Name :	HH
Ambient Temperature, °F :	57.2	Date :	January 18, 2024

Temperature Calibrator			
Model # :	CL23A	Certification Date:	May 2, 2023
Serial # :	T-285668	Expiration Date:	May 2, 2024

Primary Standards Directly Traceable National Institute of Standards and Technology (NIST)

Reference Source Temperature (°F)	Test Thermometer Temperature (°F)	Temperature Difference %
0	2	0.4
250	252	0.3
600	602	0.2
1200	1206	0.4

$$\frac{(\text{Ref. Temp., } ^\circ\text{F} + 460) - (\text{Test Therm. Temp., } ^\circ\text{F} + 460)}{\text{Ref. Temp., } ^\circ\text{F} + 460} * 100 \leq 1.5 \%$$

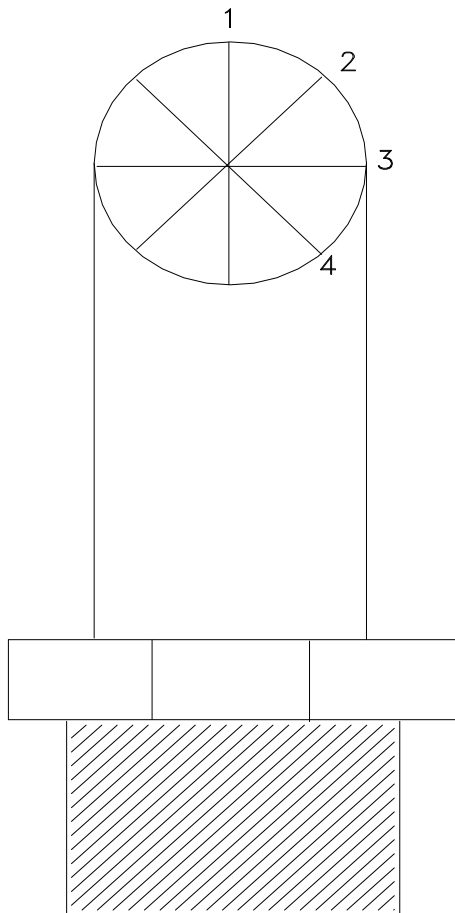
Nozzle Calibration

Date: 11/6/2019

Nozzle ID No.: 662

Analyst: CRR

Material/Type: Glass



<u>0.273</u>	1
<u>0.275</u>	2
<u>0.276</u>	3
<u>0.275</u>	4

Valid Data

Average
<u>0.275</u>

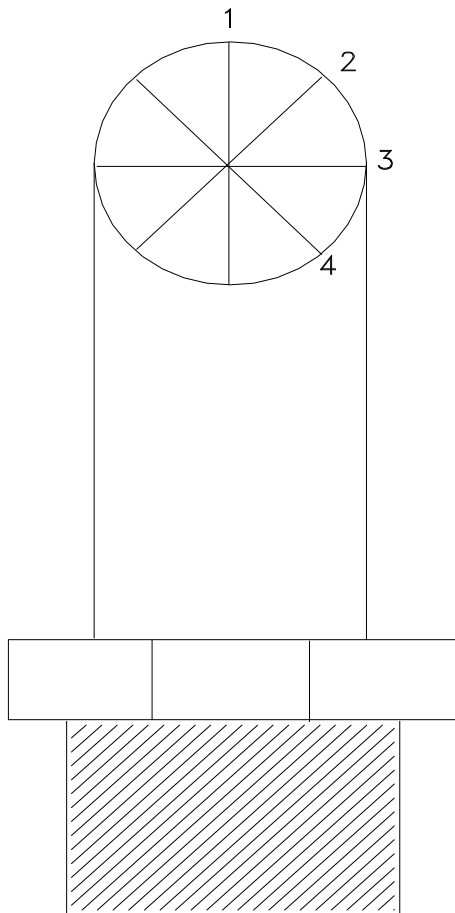
Nozzle Calibration

Date: 4/24/2023

Nozzle ID No.: 9T-C

Analyst: RMF

Material/Type: Teflon



0.275 1

0.275 2

0.275 3

0.274 4

Valid Data

Average

0.275

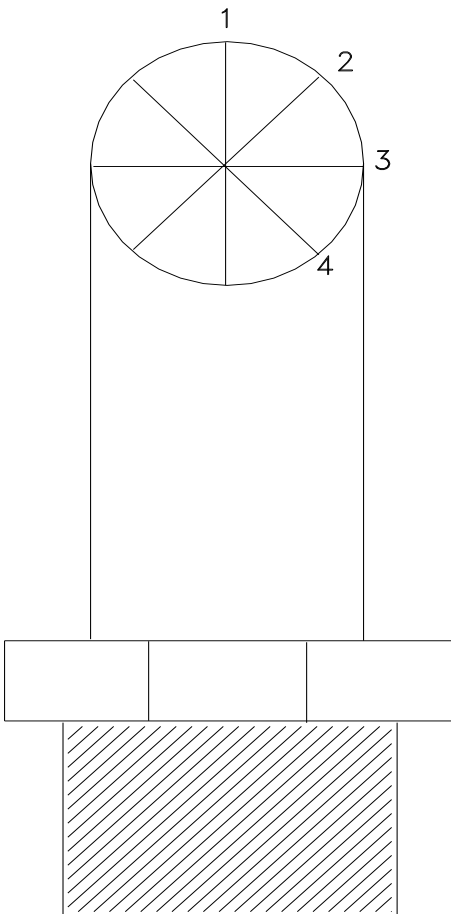
Nozzle Calibration

Date: 10/10/2023

Nozzle ID No.: 9-10

Analyst: SWK

Material/Type: SS



0.309 1

0.309 2

0.312 3

0.312 4

Valid Data

Average

0.311



Airflow Sciences Corporation

Probe Calibration for Method 2

Data Collection and Analysis

Date: 9/21/2023
Temperature (°F): 72.6
Pressure ("Hg): 29.48
Personnel: wgj
Probe: S8-058-A

Wind Tunnel Target DP [I.W.C]	Wind Tunnel Actual DP [I.W.C]	S-Probe DP [I.W.C.]	C _p	C _{p(avg)}	C _p -C _{p(avg)}	σ _{max}	
0.81	0.81	1.15	0.831	0.832	0.000	0.000	Pass
0.81	0.81	1.15	0.832		0.000		
0.81	0.81	1.15	0.832		0.000		
1.81	1.82	2.55	0.837	0.837	0.000	0.001	Pass
1.81	1.82	2.55	0.837		0.000		
1.81	1.82	2.55	0.838		0.001		



Airflow Sciences Corporation

Probe Calibration for Method 2

Data Collection and Analysis

Date: 9/21/2023
Temperature (°F): 72.6
Pressure ("Hg): 29.48
Personnel: wgj
Probe: S8-058-B

Wind Tunnel Target DP [I.W.C]	Wind Tunnel Actual DP [I.W.C]	S-Probe DP [I.W.C.]	C _p	C _{p(avg)}	C _p -C _{p(avg)}	σ _{max}	
0.81	0.81	1.15	0.833	0.833	0.000	0.000	Pass
0.81	0.81	1.15	0.832		0.000		
0.81	0.81	1.15	0.833		0.000		
1.81	1.82	2.56	0.835	0.836	0.000	0.000	Pass
1.81	1.83	2.56	0.836		0.000		
1.81	1.83	2.56	0.836		0.000		



Airflow Sciences Corporation

Probe Calibration for Method 2

Wind Tunnel Facility: Airflow Sciences Corporation
 Wind Tunnel Location: Livonia, MI
 Probe Type: S-Type Pitot
 Probe ID: S8-058-A
 Probe Calibration Date: 09/21/23
 Test Point Location: center
 Ambient Temperature (°F): 72.6
 Barometric Pressure ("Hg): 29.48

Repetition	Nominal Low Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C_p
		DP _{std} ("H ₂ O)	Temperature (°F)	DP ("H ₂ O)	Yaw Angle (°)	
1	60	0.81	72.6	1.15	0	0.83
2	60	0.81	72.6	1.15	0	0.83
3	60	0.81	72.6	1.15	0	0.83
Average ($C_{p(avg-low)}$)						0.83

Repetition	Nominal High Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C_p
		DP _{std} ("H ₂ O)	Temperature (°F)	DP ("H ₂ O)	Yaw Angle (deg)	
1	90	1.82	72.6	2.55	0	0.84
2	90	1.82	72.6	2.55	0	0.84
3	90	1.82	72.6	2.55	0	0.84
Average ($C_{p(avg-high)}$)						0.84

$$\% \text{ Difference} = \frac{C_{p(avg-low)} - C_{p(avg-high)}}{C_{p(avg-low)}} \times 100\% = \underline{-0.67\%} \quad \text{Pass}$$

Note: (1) The percent difference between the low and high velocity setting C_p values shall be within +/- 3 %.
 (2) If calibrating a 3-D probe for this method, the pitch angle setting must be 0°.

$$C_p = \underline{0.834}$$



Airflow Sciences Corporation

Probe Calibration for Method 2

Wind Tunnel Facility: Airflow Sciences Corporation
 Wind Tunnel Location: Livonia, MI
 Probe Type: S-Type Pitot
 Probe ID: S8-058-B
 Probe Calibration Date: 09/21/23
 Test Point Location: center
 Ambient Temperature (°F): 72.6
 Barometric Pressure ("Hg): 29.48

Repetition	Nominal Low Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C _p
		DP _{std} ("H ₂ O)	Temperature (°F)	DP ("H ₂ O)	Yaw Angle (°)	
1	60	0.81	72.6	1.15	0	0.83
2	60	0.81	72.6	1.15	0	0.83
3	60	0.81	72.6	1.15	0	0.83
Average (C _{p(avg-low)})						0.83

Repetition	Nominal High Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C _p
		DP _{std} ("H ₂ O)	Temperature (°F)	DP ("H ₂ O)	Yaw Angle (deg)	
1	90	1.82	72.6	2.56	0	0.84
2	90	1.83	72.6	2.56	0	0.84
3	90	1.83	72.6	2.56	0	0.84
Average (C _{p(avg-high)})						0.84

$$\% \text{ Difference} = \frac{C_{p(\text{avg-low})} - C_{p(\text{avg-high})}}{C_{p(\text{avg-low})}} \times 100\% = \underline{-0.37\%} \quad \text{Pass}$$

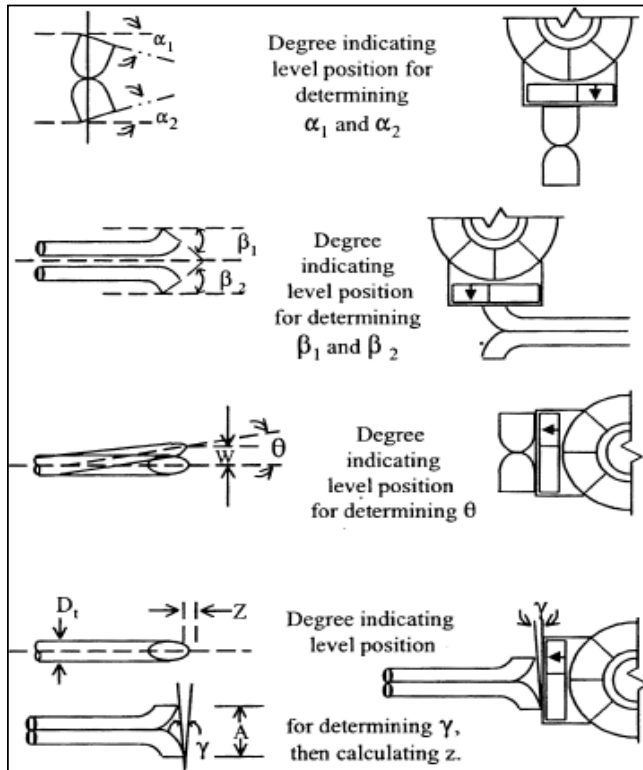
Note: (1) The percent difference between the low and high velocity setting C_p values shall be within +/- 3 %.
 (2) If calibrating a 3-D probe for this method, the pitch angle setting must be 0°.

$$C_p = \underline{0.834}$$

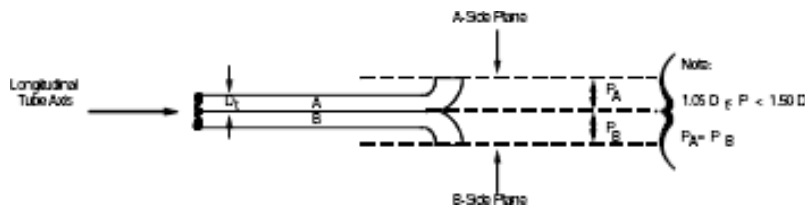


Airflow Sciences Corporation

Probe Inspection for Method 2G



α_1	0.4 (°)	Pass
α_2	0.5 (°)	Pass
β_1	0.3 (°)	Pass
β_2	0.3 (°)	Pass
D_t	0.375 (")	Pass
P_a	0.474 (")	Pass
P_b	0.474 (")	Pass
z	<0.02 (")	Pass
w	0.007 (")	Pass



Certification

I certify that Type S probe ID **S8-058** meets or exceeds all specifications, criteria, and applicable design features.

Certified by: W Jambeck

Date: 9/21/2023



Airflow Sciences Corporation

Probe Calibration for Method 2

Data Collection and Analysis

Date: 9/21/2023
Temperature (°F): 72.8
Pressure ("Hg): 29.48
Personnel: wgj
Probe: S8-059-A

Wind Tunnel Target DP [I.W.C]	Wind Tunnel Actual DP [I.W.C]	S-Probe DP [I.W.C.]	C _p	C _{p(avg)}	C _p -C _{p(avg)}	σ _{max}	
0.81	0.81	1.13	0.838	0.838	0.000	0.000	Pass
0.81	0.81	1.14	0.837		0.000		
0.81	0.81	1.14	0.838		0.000		
1.81	1.81	2.51	0.840	0.840	0.000	0.000	Pass
1.81	1.81	2.51	0.840		0.000		
1.81	1.81	2.51	0.840		0.000		



Airflow Sciences Corporation

Probe Calibration for Method 2

Data Collection and Analysis

Date: 9/21/2023
Temperature (°F): 73.1
Pressure ("Hg): 29.47
Personnel: wgj
Probe: S8-059-B

Wind Tunnel Target DP [I.W.C]	Wind Tunnel Actual DP [I.W.C]	S-Probe DP [I.W.C.]	C _p	C _{p(avg)}	C _p -C _{p(avg)}	σ _{max}	
0.81	0.81	1.16	0.828	0.828	0.000	0.000	Pass
0.81	0.81	1.16	0.828		0.000		
0.81	0.81	1.16	0.828		0.000		
1.81	1.81	2.58	0.829	0.829	0.000	0.000	Pass
1.81	1.81	2.58	0.829		0.000		
1.81	1.81	2.58	0.829		0.000		



Airflow Sciences Corporation

Probe Calibration for Method 2

Wind Tunnel Facility: Airflow Sciences Corporation
 Wind Tunnel Location: Livonia, MI
 Probe Type: S-Type Pitot
 Probe ID: S8-059-A
 Probe Calibration Date: 09/21/23
 Test Point Location: center
 Ambient Temperature (°F): 72.8
 Barometric Pressure ("Hg): 29.48

Repetition	Nominal Low Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C _p
		DP _{std} ("H ₂ O)	Temperature (°F)	DP ("H ₂ O)	Yaw Angle (°)	
1	60	0.81	72.8	1.13	0	0.84
2	60	0.81	72.8	1.14	0	0.84
3	60	0.81	72.8	1.14	0	0.84
Average (C _{p(avg-low)})						0.84

Repetition	Nominal High Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C _p
		DP _{std} ("H ₂ O)	Temperature (°F)	DP ("H ₂ O)	Yaw Angle (deg)	
1	90	1.81	72.8	2.51	0	0.84
2	90	1.81	72.8	2.51	0	0.84
3	90	1.81	72.8	2.51	0	0.84
Average (C _{p(avg-high)})						0.84

$$\% \text{ Difference} = \frac{C_{p(\text{avg-low})} - C_{p(\text{avg-high})}}{C_{p(\text{avg-low})}} \times 100\% = \underline{-0.30\%} \quad \text{Pass}$$

Note: (1) The percent difference between the low and high velocity setting C_p values shall be within +/- 3 %.
 (2) If calibrating a 3-D probe for this method, the pitch angle setting must be 0°.

$$C_p = \underline{0.839}$$



Airflow Sciences Corporation

Probe Calibration for Method 2

Wind Tunnel Facility: Airflow Sciences Corporation
 Wind Tunnel Location: Livonia, MI
 Probe Type: S-Type Pitot
 Probe ID: S8-059-B
 Probe Calibration Date: 09/21/23
 Test Point Location: center
 Ambient Temperature (°F): 73.1
 Barometric Pressure ("Hg): 29.47

Repetition	Nominal Low Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C_p
		DP _{std} ("H ₂ O)	Temperature (°F)	DP ("H ₂ O)	Yaw Angle (°)	
1	60	0.81	73.1	1.16	0	0.83
2	60	0.81	73.1	1.16	0	0.83
3	60	0.81	73.1	1.16	0	0.83
Average ($C_{p(avg-low)}$)						0.83

Repetition	Nominal High Velocity Setting (ft/s)	Calibration Pitot		Tested Probe		Calculated C_p
		DP _{std} ("H ₂ O)	Temperature (°F)	DP ("H ₂ O)	Yaw Angle (deg)	
1	90	1.81	73.1	2.58	0	0.83
2	90	1.81	73.1	2.58	0	0.83
3	90	1.81	73.1	2.58	0	0.83
Average ($C_{p(avg-high)}$)						0.83

$$\% \text{ Difference} = \frac{C_{p(avg-low)} - C_{p(avg-high)}}{C_{p(avg-low)}} \times 100\% = \underline{-0.17\%} \quad \text{Pass}$$

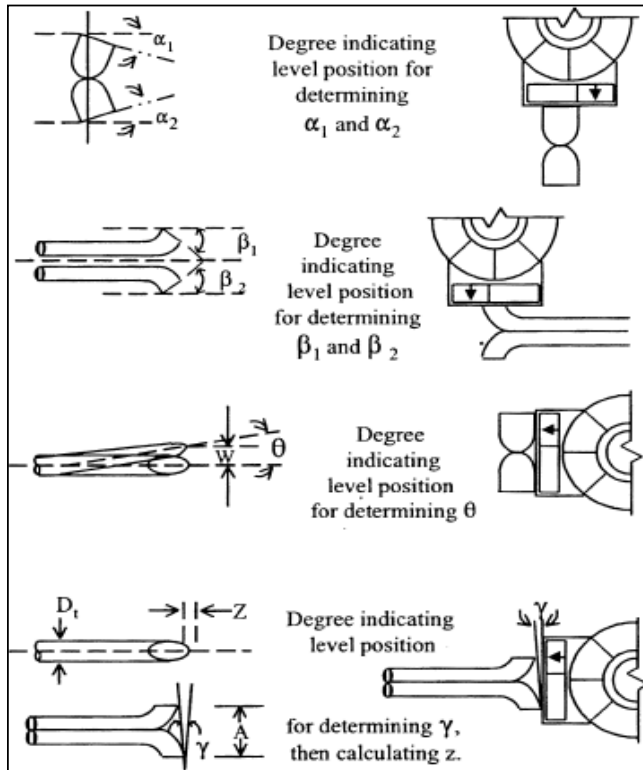
Note: (1) The percent difference between the low and high velocity setting C_p values shall be within +/- 3 %.
 (2) If calibrating a 3-D probe for this method, the pitch angle setting must be 0°.

$$C_p = \underline{0.829}$$

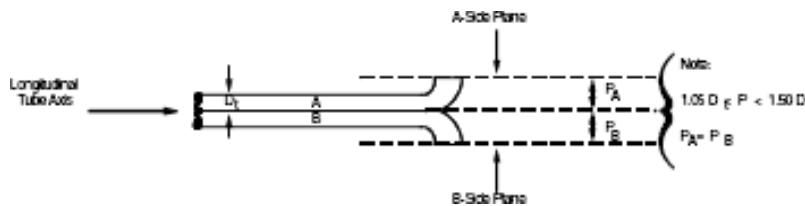


Airflow Sciences Corporation

Probe Inspection for Method 2G



α_1	0.9 ($^\circ$)	Pass
α_2	0.5 ($^\circ$)	Pass
β_1	0.7 ($^\circ$)	Pass
β_2	0.9 ($^\circ$)	Pass
D_t	0.375 (")	Pass
P_a	0.471 (")	Pass
P_b	0.471 (")	Pass
z	<0.02 (")	Pass
w	0.005 (")	Pass



Certification

I certify that Type S probe ID **S8-059** meets or exceeds all specifications, criteria, and applicable design features.

Certified by: W Jambeck

Date: 9/21/2023

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Test Location: Kiln 20 Exhaust
Date: 12/13/2023
Operator: E. Ehlers
Operating Condition Normal

Sample System:	FTIR		
Probe Length:	12.0	ft	
Probe Type:	FTIR		
Sample Plane:	Horizontal		
Port Type:	Flange		
Duct Shape:	Rectangular		
Length (traverse side of duct):	8	ft	
Width:	8.75	ft	
Location of Test Ports:	Side of duct		
Duct Area:	69.36	Sq. Ft.	
Upstream Diameters:	~1.0	Minimum Upstream Distance	4.2 Feet
Downstream Diameters:	~8.5	Minimum Downstream Distance	16.6 Feet
Number of Ports Sampled:	1	Ideal Upstream Distance	16.6 Feet
Number of Points per Port:	1	Ideal Downstream Distance	66.6 Feet
Total Number of Traverse Points:	1		

Calibration Gases

Type	Setting	Cylinder ID	Cylinder Value	Analyzer Response	Difference, % of Span	Expiration Date	Mid cylinder % of high cylinder	Final Bottle Pressure, PSI
O2 % (dry)	Zero	Zero Nitrogen	0.0	-0.06	0.31%	N/A		1700
	Mid	ALM039009	10.10	10.16	-0.31%	10/26/2031	52.20%	600
	High	CC743660	19.35	19.50	-0.78%	6/18/2029		1000

Type	Compound	Cylinder ID	Cylinder Value	Expiration Date	Final Bottle Pressure, PSI
Zero Gas	Nitrogen	Zero Nitrogen	0.0	N/A	1700
Calibration Transfer Standard	Ethylene	EB0153603	100.1	9/6/2031	1000
Analyte Spike Gas	HCN	CC768243	49.70	2/29/2024	1600
	SF6		5.000		

Response Time Data

Type	RM Analyzer Make/Model	RM Analyzer s/n	Analyzer Span	RM Gas Span
O2 % (dry)	Servomex 1440	4662	25	19.35
HF ppmvw	MKS 2030	000583	10	N/A
HCN ppmvw	MKS 2030	000583	200	N/A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Project #: M235005
 Diluent: O2 %

Test Location: Kiln 20 Exhaust
 Date: 12/13/23
 Operator: E. Ehlers
 O2 % Correction: 7

O2 % (dry) Correction Data

Run #	Cma	Precal	Postcal	Pre zero	Post zero	Co	Cm	C	Cgas	Span Bias	Span Drift	Zero Bias	Zero Drift
1	10.10	10.14	10.04	0.21	0.10	0.16	10.09	9.46	9.5	0.62	-0.52	-0.83	-0.57
2	10.1	10.04	10.00	0.10	0.07	0.09	10.02	9.47	9.5	0.83	-0.21	-0.67	-0.16
3	10.1	10.00	9.98	0.07	0.04	0.06	9.99	9.46	9.6	0.93	-0.10	-0.52	-0.16

Concentration of Cal Gas C = Average value of test Co=Average Pre and Post Zero
 erage Pre and Post Span Cgas = Corrected gas value of test

Calibration Corrected and Calculated Data

Run #	Run Date	Start Time	End Time	Moisture %	O2 % (dry)	CO2 % (wet)	CO2 % (dry)	HCN ppmvw	HCN ppmvd @ 7% O2	HF ppmvw	HF ppmvd @ 7% O2
1	12/13/23	11:30	12:28	4.99%	9.46	15.46	16.27	1.40	1.80	0.10	0.13
2	12/13/23	13:15	14:14	4.83%	9.54	15.59	16.38	1.47	1.89	0.10	0.13
3	12/13/23	15:00	15:59	4.93%	9.56	15.56	16.36	1.56	2.01	0.10	0.13

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Test Location: Kiln 20 Exhaust
Date: 12/13/23
Project #: M235005

Linearity Cal/Pre 1 Cal		
<u>Time</u>	<u>O2 % (dry)</u>	
7:44	-0.06	iz
7:45	9.44	
7:46	19.50	
7:47	19.51	ih
7:48	19.50	
7:49	12.70	
7:50	0.03	
7:51	2.32	
7:52	2.38	
7:53	-0.17	
7:54	10.68	
7:55	10.19	
7:56	10.16	im
11:04	0.19	
11:05	1.00	
11:06	0.36	
11:07	0.21	z
11:08	2.72	
11:09	10.06	
11:10	10.12	
11:11	10.13	
11:12	10.14	
11:13	10.14	m
11:14	10.14	

Client: Holcim (US) Inc.

Facility: Alpena Cement Plant

Project #: M235005

Test Location: Kiln 20 Exhaust

Date: 12/13/23

Post 1/Pre 2

<u>Time</u>	<u>O2 % (dry)</u>	
13:06	0.10	z
13:07	1.54	
13:08	9.85	
13:09	10.03	
13:10	10.04	m

Post 2/Pre 3

<u>Time</u>	<u>O2 % (dry)</u>	
14:51	0.07	z
14:52	4.37	
14:53	9.98	
14:54	10.00	m

Post 3

<u>Time</u>	<u>O2 % (dry)</u>	
16:37	0.04	z
16:38	7.22	
16:39	9.96	
16:40	9.97	
16:41	9.98	m

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Operating Condition: Normal

Test Location: Kiln 20 Exhaust
Date: 12/13/2023
Operator: E. Ehlers
FTIR s/n: 000583

System Leak Check: 0.0 mL/min

Nitrogen (Zero) Direct to FTIR

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
N2 DIR_020666.LAB	12/13/23	7:42:22	0.0	0.0	0.0	191.0	0.98	0.1	0.0	0.005
N2 DIR_020667.LAB	12/13/23	7:42:30	0.0	0.0	0.0	190.9	0.98	0.0	-0.2	0.000
N2 DIR_020668.LAB	12/13/23	7:42:38	0.0	0.0	0.0	190.9	0.98	0.2	0.0	-0.001
N2 DIR_020669.LAB	12/13/23	7:42:46	0.0	0.0	0.0	191.0	0.98	0.0	0.0	0.002
N2 DIR_020670.LAB	12/13/23	7:42:55	0.0	0.0	0.0	191.0	0.98	0.0	0.1	-0.001
N2 DIR_020671.LAB	12/13/23	7:43:03	0.0	0.0	0.0	191.0	0.98	0.0	0.0	0.002
N2 DIR_020672.LAB	12/13/23	7:43:11	0.0	0.0	0.0	191.0	0.98	0.1	0.0	-0.004
N2 DIR_020673.LAB	12/13/23	7:43:19	0.0	0.0	0.0	191.0	0.98	0.1	0.1	0.003
N2 DIR_020674.LAB	12/13/23	7:43:28	0.0	0.0	0.0	191.0	0.98	0.1	0.0	0.002

Calibration Transfer Standard (CTS), Direct to FTIR

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
CTS DIR_020705.LAB	12/13/23	7:49:32	0.0	0.0	0.0	191.1	0.98	100.7	0.1	-0.004	100.6%
CTS DIR_020706.LAB	12/13/23	7:49:40	0.0	0.0	0.0	191.0	0.98	100.5	0.0	-0.005	100.4%
CTS DIR_020707.LAB	12/13/23	7:49:48	0.0	0.0	0.0	191.0	0.98	100.2	0.0	0.004	100.1%
CTS DIR_020708.LAB	12/13/23	7:49:57	0.0	0.0	0.0	191.0	0.98	100.3	0.0	0.004	100.2%
CTS DIR_020709.LAB	12/13/23	7:50:05	0.0	0.0	0.0	191.0	0.98	101.1	0.0	0.002	101.0%
CTS DIR_020710.LAB	12/13/23	7:50:13	0.0	0.0	0.0	190.9	0.98	100.7	0.2	0.002	100.6%
CTS DIR_020711.LAB	12/13/23	7:50:22	0.0	0.0	0.0	190.9	0.98	100.8	0.0	0.003	100.7%
Average								100.6		0.003	100.5%

Analyte Spike Gas (HCN) Direct to FTIR

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % HCN
HCN DIR_020720.LAB	12/13/23	7:52:21	0.0	0.0	0.0	191.1	0.98	-0.1	49.2	5.024	99.0%
HCN DIR_020721.LAB	12/13/23	7:52:29	0.0	0.0	0.0	191.0	0.98	-0.1	49.2	5.025	99.1%
HCN DIR_020722.LAB	12/13/23	7:52:38	0.0	0.0	0.0	191.0	0.98	-0.1	49.6	5.020	99.7%
HCN DIR_020723.LAB	12/13/23	7:52:46	0.0	0.0	0.0	191.0	0.98	0.0	49.4	5.024	99.4%
HCN DIR_020724.LAB	12/13/23	7:52:54	0.0	0.0	0.0	191.1	0.98	-0.2	48.9	5.026	98.5%
HCN DIR_020725.LAB	12/13/23	7:53:03	0.0	0.0	0.0	191.1	0.98	-0.1	49.2	5.014	99.0%
HCN DIR_020726.LAB	12/13/23	7:53:11	0.0	0.0	0.0	191.1	0.98	-0.1	49.7	5.035	99.9%
HCN DIR_020727.LAB	12/13/23	7:53:19	0.0	0.0	0.0	191.1	0.98	-0.1	49.6	5.023	99.8%
Average									49.4	5.024	99.3%

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
CTS REMOTE_020808.LAB	12/13/23	11:06:17	0.0	0.0	0.0	190.9	0.98	98.2	0.3	0.000	98.1%
CTS REMOTE_020809.LAB	12/13/23	11:06:26	0.0	0.0	0.0	191.0	0.98	97.9	0.4	0.003	97.9%
CTS REMOTE_020810.LAB	12/13/23	11:06:34	0.0	0.0	0.0	191.0	0.98	98.3	0.3	0.007	97.7%
CTS REMOTE_020811.LAB	12/13/23	11:06:42	0.0	0.0	0.0	191.0	0.98	98.4	0.5	0.002	97.8%
CTS REMOTE_020812.LAB	12/13/23	11:06:50	0.0	0.0	0.0	191.0	0.98	98.2	0.4	0.004	97.6%
CTS REMOTE_020813.LAB	12/13/23	11:06:59	0.0	0.0	0.0	191.0	0.98	98.2	0.3	-0.002	97.6%
CTS REMOTE_020814.LAB	12/13/23	11:07:07	0.0	0.0	0.0	191.0	0.98	98.0	0.4	0.001	97.4%
CTS REMOTE_020815.LAB	12/13/23	11:07:15	0.0	0.0	0.0	190.9	0.98	97.9	0.5	0.002	97.3%

Response Time Test

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Response Time (sec)
CTS REMOTE_020804.LAB	12/13/23	11:05:44	0.1	0.1	0.0	191.0	0.98	95.7	0.5	0.000	-
CTS REMOTE_020805.LAB	12/13/23	11:05:53	0.1	0.1	0.0	190.9	0.98	97.6	0.3	0.002	16.272
CTS REMOTE_020806.LAB	12/13/23	11:06:01	0.1	0.0	0.0	190.9	0.98	98.1	0.5	0.000	24.272
CTS REMOTE_020807.LAB	12/13/23	11:06:09	0.1	0.0	0.0	190.9	0.98	98.2	0.4	0.001	
CTS REMOTE_020808.LAB	12/13/23	11:06:17	0.0	0.0	0.0	190.9	0.98	98.2	0.3	0.000	
CTS REMOTE_020809.LAB	12/13/23	11:06:26	0.0	0.0	0.0	191.0	0.98	97.9	0.4	0.003	
CTS REMOTE_020810.LAB	12/13/23	11:06:34	0.0	0.0	0.0	191.0	0.98	98.3	0.3	0.007	
CTS REMOTE_020811.LAB	12/13/23	11:06:42	0.0	0.0	0.0	191.0	0.98	98.4	0.5	0.002	
CTS REMOTE_020812.LAB	12/13/23	11:06:50	0.0	0.0	0.0	191.0	0.98	98.2	0.4	0.004	

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Operating Condition: Normal

Test Location: Kiln 20 Exhaust
Date: 12/13/2023
Operator: E. Ehlers
FTIR s/n: 000583

Pre 1 Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
NATIVE_020909.LAB	12/13/23	11:20:52	2.5	16.3	0.0	190.9	0.98	0.7	1.4	-0.002
NATIVE_020910.LAB	12/13/23	11:21:01	2.5	16.7	0.0	190.9	0.98	0.6	1.6	-0.006
NATIVE_020911.LAB	12/13/23	11:21:09	2.5	17.2	0.0	190.9	0.98	0.5	1.7	0.001
									1.6	-0.002

Pre 1 Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
PRE 1 SPIKE_020930.LAB	12/13/23	11:24:04	2.2	15.3	0.0	190.9	0.98	0.6	5.7	0.450	0.090	97.9%
PRE 1 SPIKE_020931.LAB	12/13/23	11:24:12	2.2	15.3	0.0	190.9	0.98	0.5	5.8	0.446	0.089	99.3%
PRE 1 SPIKE_020932.LAB	12/13/23	11:24:21	2.2	15.4	0.0	191.0	0.98	0.6	5.9	0.450	0.090	101.2%
PRE 1 SPIKE_020933.LAB	12/13/23	11:24:29	2.2	15.6	0.0	191.0	0.98	0.6	5.9	0.443	0.088	101.3%
PRE 1 SPIKE_020934.LAB	12/13/23	11:24:37	2.2	15.4	0.0	191.0	0.98	0.8	5.9	0.445	0.089	101.9%
PRE 1 SPIKE_020935.LAB	12/13/23	11:24:45	2.2	15.0	0.0	191.0	0.98	0.6	5.7	0.447	0.089	96.7%
PRE 1 SPIKE_020936.LAB	12/13/23	11:24:54	2.2	14.7	0.0	191.0	0.98	0.5	5.6	0.450	0.090	95.1%
PRE 1 SPIKE_020937.LAB	12/13/23	11:25:02	2.2	14.5	0.0	191.0	0.98	0.7	5.7	0.443	0.088	97.8%

Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 1_021048.LAB	12/13/23	12:58:25	5.2	15.1	0.0	191.0	0.98	0.5	1.4	-0.007
RUN 1_021049.LAB	12/13/23	12:59:29	5.2	15.3	0.0	191.0	0.98	0.5	1.4	-0.009
RUN 1_021050.LAB	12/13/23	13:00:32	5.2	15.3	0.0	191.0	0.98	0.5	1.5	-0.006
									1.5	-0.007

Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
RUN 1 POST SPIKE_021057.LAB	12/13/23	13:02:23	5.1	14.7	0.0	191.0	0.98	0.6	4.4	0.261	0.052	111.9%
RUN 1 POST SPIKE_021058.LAB	12/13/23	13:02:31	5.0	14.5	0.0	191.0	0.98	0.7	4.1	0.272	0.054	102.0%
RUN 1 POST SPIKE_021059.LAB	12/13/23	13:02:40	5.0	14.4	-0.1	191.0	0.98	0.2	4.1	0.278	0.055	100.6%
RUN 1 POST SPIKE_021060.LAB	12/13/23	13:02:48	5.0	14.3	0.0	191.0	0.99	0.5	4.0	0.268	0.053	100.1%
RUN 1 POST SPIKE_021061.LAB	12/13/23	13:02:56	5.0	14.5	0.0	191.0	0.99	0.4	3.9	0.272	0.054	97.5%
RUN 1 POST SPIKE_021062.LAB	12/13/23	13:03:04	5.0	14.7	0.0	190.9	0.99	0.7	4.2	0.267	0.053	104.1%
RUN 1 POST SPIKE_021063.LAB	12/13/23	13:03:13	5.0	14.8	0.0	190.9	0.98	0.3	4.0	0.269	0.054	100.0%
RUN 1 POST SPIKE_021064.LAB	12/13/23	13:03:21	5.0	14.8	0.0	190.9	0.99	0.6	4.0	0.272	0.054	99.2%

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 1 POST CTS_021079.LAB	12/13/23	13:05:41	0.9	0.1	0.0	190.9	0.98	97.3	0.6	0.007	96.7%
RUN 1 POST CTS_021080.LAB	12/13/23	13:05:49	0.9	0.1	0.0	190.9	0.98	97.4	0.6	0.001	96.8%
RUN 1 POST CTS_021081.LAB	12/13/23	13:05:58	0.8	0.1	0.0	190.9	0.98	97.2	0.4	0.006	96.6%
RUN 1 POST CTS_021082.LAB	12/13/23	13:06:06	0.8	0.1	0.0	190.9	0.98	97.2	0.5	0.003	96.6%
RUN 1 POST CTS_021083.LAB	12/13/23	13:06:14	0.7	0.1	0.0	190.9	0.98	97.1	0.4	0.006	96.6%
RUN 1 POST CTS_021084.LAB	12/13/23	13:06:22	0.7	0.1	0.0	191.0	0.98	97.2	0.3	0.002	96.6%
RUN 1 POST CTS_021085.LAB	12/13/23	13:06:31	0.7	0.0	0.0	191.1	0.98	97.2	0.4	0.000	96.6%
RUN 1 POST CTS_021086.LAB	12/13/23	13:06:39	0.7	0.0	0.0	191.1	0.98	97.4	0.5	0.003	96.8%

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Operating Condition: Normal

Test Location: Kiln 20 Exhaust
Date: 12/13/2023
Operator: E. Ehlers
FTIR s/n: 000583

Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 2_021197.LAB	12/13/23	14:43:54	5.2	12.2	0.0	190.9	0.99	0.4	0.9	-0.001
RUN 2_021198.LAB	12/13/23	14:44:58	5.1	12.7	0.0	191.0	0.99	0.5	0.9	-0.008
RUN 2_021199.LAB	12/13/23	14:46:02	5.0	14.5	0.0	191.0	0.99	0.5	1.3	-0.004
									1.0	-0.004

Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
RUN 2 POST SPIKE_021205.LAB	12/13/23	14:47:32	4.5	13.8	0.0	191.0	0.99	0.5	6.1	0.495	0.099	106.3%
RUN 2 POST SPIKE_021206.LAB	12/13/23	14:47:40	4.5	13.7	0.0	191.0	0.99	0.7	6.3	0.486	0.097	111.1%
RUN 2 POST SPIKE_021207.LAB	12/13/23	14:47:48	4.5	13.8	0.0	191.0	0.99	0.5	6.1	0.490	0.098	106.9%
RUN 2 POST SPIKE_021208.LAB	12/13/23	14:47:57	4.5	14.2	-0.1	191.0	0.99	0.6	6.2	0.490	0.098	108.7%
RUN 2 POST SPIKE_021209.LAB	12/13/23	14:48:05	4.5	14.5	-0.1	191.0	0.99	0.3	6.2	0.472	0.094	111.4%
RUN 2 POST SPIKE_021210.LAB	12/13/23	14:48:13	4.5	14.7	0.0	191.0	0.99	0.6	6.1	0.482	0.096	108.1%
RUN 2 POST SPIKE_021211.LAB	12/13/23	14:48:21	4.4	14.6	0.0	191.0	0.99	0.8	6.1	0.478	0.095	109.6%
RUN 2 POST SPIKE_021212.LAB	12/13/23	14:48:29	4.4	14.6	-0.1	191.0	0.99	0.4	6.2	0.484	0.096	109.1%

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 2 POST CTS_021221.LAB	12/13/23	14:50:04	0.5	0.1	0.0	191.0	0.99	97.4	0.2	0.001	96.8%
RUN 2 POST CTS_021222.LAB	12/13/23	14:50:12	0.5	0.1	0.0	191.0	0.99	97.8	0.3	0.003	97.2%
RUN 2 POST CTS_021223.LAB	12/13/23	14:50:20	0.4	0.1	0.0	191.0	0.99	97.8	0.3	0.005	97.2%
RUN 2 POST CTS_021224.LAB	12/13/23	14:50:28	0.4	0.1	0.0	191.0	0.99	97.7	0.3	0.001	97.2%
RUN 2 POST CTS_021225.LAB	12/13/23	14:50:37	0.4	0.1	0.0	191.0	0.99	97.7	0.5	0.009	97.1%
RUN 2 POST CTS_021226.LAB	12/13/23	14:50:45	0.4	0.1	0.0	191.0	0.99	97.6	0.4	0.004	97.0%
RUN 2 POST CTS_021227.LAB	12/13/23	14:50:53	0.4	0.1	0.0	191.0	0.99	97.7	0.3	0.005	97.1%
RUN 2 POST CTS_021228.LAB	12/13/23	14:51:01	0.3	0.1	0.0	191.0	0.99	97.7	0.3	-0.004	97.1%

Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 3_021347.LAB	12/13/23	16:29:39	4.9	15.6	0.0	191.0	0.99	0.5	1.6	-0.004
RUN 3_021348.LAB	12/13/23	16:30:43	4.9	15.6	0.0	191.2	0.99	0.4	1.4	-0.002
RUN 3_021349.LAB	12/13/23	16:31:48	4.9	15.3	0.0	191.0	0.99	0.5	1.4	-0.004
									1.5	-0.003

Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
RUN 3 POST SPIKE_021355.LAB	12/13/23	16:33:27	4.5	14.6	0.0	190.9	0.99	0.3	4.9	0.382	0.076	95.9%
RUN 3 POST SPIKE_021356.LAB	12/13/23	16:33:35	4.5	14.7	0.0	190.9	0.99	0.8	5.2	0.387	0.077	101.0%
RUN 3 POST SPIKE_021357.LAB	12/13/23	16:33:43	4.5	14.4	0.0	190.9	0.99	0.5	5.0	0.374	0.074	99.5%
RUN 3 POST SPIKE_021358.LAB	12/13/23	16:33:51	4.5	14.3	0.0	190.9	0.99	0.4	5.0	0.384	0.076	96.5%
RUN 3 POST SPIKE_021359.LAB	12/13/23	16:33:59	4.5	14.3	0.0	190.9	0.99	0.2	5.0	0.375	0.075	98.6%
RUN 3 POST SPIKE_021360.LAB	12/13/23	16:34:08	4.4	14.3	-0.1	190.9	0.99	0.2	4.9	0.390	0.078	93.9%
RUN 3 POST SPIKE_021361.LAB	12/13/23	16:34:16	4.4	14.5	0.0	190.9	0.99	0.4	5.0	0.380	0.076	97.8%
RUN 3 POST SPIKE_021362.LAB	12/13/23	16:34:24	4.4	14.7	0.0	190.9	0.99	0.5	5.1	0.385	0.077	99.0%

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 3 POST CTS_021373.LAB	12/13/23	16:36:12	0.2	0.1	0.0	190.9	0.99	97.8	0.5	0.001	97.3%
RUN 3 POST CTS_021374.LAB	12/13/23	16:36:21	0.2	0.1	0.0	190.9	0.99	98.1	0.3	-0.007	97.5%
RUN 3 POST CTS_021375.LAB	12/13/23	16:36:29	0.2	0.1	0.0	190.9	0.99	97.9	0.5	-0.002	97.3%
RUN 3 POST CTS_021376.LAB	12/13/23	16:36:37	0.2	0.1	0.0	190.9	0.99	97.8	0.3	-0.007	97.2%
RUN 3 POST CTS_021377.LAB	12/13/23	16:36:45	0.2	0.1	0.0	190.9	0.99	98.0	0.3	-0.003	97.4%
RUN 3 POST CTS_021378.LAB	12/13/23	16:36:54	0.2	0.1	0.0	190.9	0.99	97.8	0.4	-0.005	97.3%
RUN 3 POST CTS_021379.LAB	12/13/23	16:37:02	0.1	0.1	0.0	190.9	0.99	97.7	0.4	-0.009	97.1%
RUN 3 POST CTS_021380.LAB	12/13/23	16:37:10	0.1	0.0	0.0	190.9	0.99	98.0	0.4	-0.003	97.4%

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Operating Condition: Normal

Test Location: Kiln 20 Exhaust
Date: 12/13/2023
Operator: E. Ehlers
FTIR s/n: 000583

Post Test CTS, Direct Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
POST CTS DIR_021397.LAB	12/13/23	16:42:26	0.9	0.0	0.0	191.1	0.99	99.5	0.1	-0.003	98.9%
POST CTS DIR_021398.LAB	12/13/23	16:42:34	0.7	0.0	0.0	191.1	0.99	99.8	0.1	-0.004	99.2%
POST CTS DIR_021399.LAB	12/13/23	16:42:42	0.6	0.0	0.0	191.1	0.99	99.7	0.3	-0.001	99.1%
POST CTS DIR_021400.LAB	12/13/23	16:42:51	0.5	0.0	0.0	191.1	0.99	100.0	0.0	-0.006	99.3%
POST CTS DIR_021401.LAB	12/13/23	16:42:59	0.4	0.0	0.0	191.1	0.99	100.1	0.0	-0.004	99.5%
POST CTS DIR_021402.LAB	12/13/23	16:43:07	0.4	0.0	0.0	191.1	0.99	99.9	0.0	-0.002	99.3%
POST CTS DIR_021403.LAB	12/13/23	16:43:15	0.3	0.0	0.0	191.1	0.99	99.9	0.2	0.000	99.3%
POST CTS DIR_021404.LAB	12/13/23	16:43:24	0.3	0.0	0.0	191.1	0.99	100.1	0.0	-0.008	99.5%
Average								99.9			

Post Test N2, Direct Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
POST N2 DIR_021425.LAB	12/13/23	16:52:51	0.0	0.0	0.0	190.9	0.99	0.0	0.1	0.000
POST N2 DIR_021426.LAB	12/13/23	16:55:03	0.0	0.0	0.0	191.1	0.99	0.0	0.0	-0.002
POST N2 DIR_021427.LAB	12/13/23	16:57:14	0.0	0.0	0.0	191.0	0.99	0.0	0.1	-0.001

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Test Location: Kiln 21 Exhaust
Date: 12/12/2023
Operator: E. Ehlers
Operating Condition Normal

Sample System:	FTIR		
Probe Length:	12.0	ft	
Probe Type:	FTIR		
Sample Plane:	Horizontal		
Port Type:	Flange		
Duct Shape:	Rectangular		
Length (traverse side of duct):	8	ft	
Width:	8.67	ft	
Location of Test Ports:	Side of duct		
Duct Area:	69.36	Sq. Ft.	
Upstream Diameters:	~1.0	Minimum Upstream Distance	4.2 Feet
Downstream Diameters:	~8.5	Minimum Downstream Distance	16.6 Feet
Number of Ports Sampled:	1	Ideal Upstream Distance	16.6 Feet
Number of Points per Port:	1	Ideal Downstream Distance	66.6 Feet
Total Number of Traverse Points:	1		

Calibration Gases

Type	Setting	Cylinder ID	Cylinder Value	Analyzer Response	Difference, % of Span	Expiration Date	Mid cylinder % of high cylinder	Final Bottle Pressure, PSI
O2 % (dry)	Zero	Zero Nitrogen	0.0	0.00	0.00%	N/A		1700
	Mid	ALM039009	10.10	10.20	-0.52%	10/26/2031	52.20%	600
	High	CC743660	19.35	19.38	-0.16%	6/18/2029		1000

Type	Compound	Cylinder ID	Cylinder Value	Expiration Date	Final Bottle Pressure, PSI
Zero Gas	Nitrogen	Zero Nitrogen	0.0	N/A	1700
Calibration Transfer Standard	Ethylene	EB0153603	100.1	9/6/2031	1000
Analyte Spike Gas	HCN	CC768243	49.70	2/29/2024	1600
	SF6		5.000		

Response Time Data

Type	RM Analyzer Make/Model	RM Analyzer s/n	Analyzer Span	RM Gas Span
O2 % (dry)	Servomex 1440	4662	25	19.35
HF ppmvw	MKS 2030	000583	10	N/A
HCN ppmvw	MKS 2030	000583	200	N/A

Client: Holcim (US) Inc.
 Facility: Alpena Cement Plant
 Project #: M235005
 Diluent: O2 %

Test Location: Kiln 21 Exhaust
 Date: 12/12/23
 Operator: E. Ehlers
 O2 % Correction: 7

O2 % (dry) Correction Data

Run #	Cma	Precal	Postcal	Pre zero	Post zero	Co	Cm	C	Cgas	Span Bias	Span Drift	Zero Bias	Zero Drift
1	10.10	10.11	10.04	0.05	0.14	0.10	10.08	11.07	11.1	0.83	-0.36	-0.72	0.47
2	10.1	10.04	10.36	0.14	0.40	0.27	10.20	10.44	10.3	-0.83	1.65	-2.07	1.34
3	10.1	10.36	10.60	0.40	0.55	0.48	10.48	10.72	10.3	-2.07	1.24	-2.84	0.78

Concentration of Cal Gas C = Average value of test Co=Average Pre and Post Zero
 erage Pre and Post Span Cgas = Corrected gas value of test

Calibration Corrected and Calculated Data

Run #	Run Date	Start Time	End Time	Moisture %	O2 % (dry)	CO2 % (wet)	CO2 % (dry)	HCN ppmvw	HCN ppmvd @ 7% O2	HF ppmvw	HF ppmvd @ 7% O2
1	12/12/23	10:20	11:18	3.77%	11.10	13.52	14.05	0.62	0.91	0.10	0.15
2	12/12/23	12:30	13:29	4.04%	10.34	13.75	14.33	0.69	0.95	0.10	0.14
3	12/12/23	15:15	16:14	3.91%	10.34	14.50	15.09	0.62	0.85	0.10	0.14

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Test Location: Kiln 21 Exhaust
Date: 12/12/23
Project #: M235005

Linearity Cal/Pre 1 Cal		
<u>Time</u>	<u>O2 % (dry)</u>	
7:55	0.00	
7:56	0.00	iz
7:57	4.58	
7:58	18.96	
7:59	19.38	
8:00	19.38	
8:01	19.38	ih
8:02	19.46	
8:03	5.52	
8:04	0.21	
8:05	0.12	
8:06	0.13	
8:07	2.86	
8:08	3.31	
8:09	0.05	
8:10	2.73	
8:11	12.21	
8:12	10.20	
8:13	10.20	im
8:14	13.64	
8:15	19.57	
8:16	20.83	
8:17	20.77	
8:18	19.42	
8:19	4.53	
8:20	0.09	
8:21	0.06	
8:22	0.05	z
8:23	7.21	
8:24	10.11	m

Client: Holcim (US) Inc.

Facility: Alpena Cement Plant

Project #: M235005

Test Location: Kiln 21 Exhaust

Date: 12/12/23

Post 1/Pre 2

<u>Time</u>	<u>O2 % (dry)</u>	
11:52	0.14	z
11:53	3.43	
11:54	10.33	
11:55	10.36	
11:56	10.35	
11:57	10.00	
11:58	10.02	
11:59	10.04	m

Post 2/Pre 3

<u>Time</u>	<u>O2 % (dry)</u>	
14:07	0.40	z
14:08	3.91	
14:09	10.31	
14:10	10.33	
14:11	10.36	m

Post 3

<u>Time</u>	<u>O2 % (dry)</u>	
15:56	0.55	z
15:57	3.88	
15:58	10.72	
15:59	10.88	
16:00	10.49	
16:01	10.60	m

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Operating Condition: Normal

Test Location: Kiln 21 Exhaust
Date: 12/12/2023
Operator: E. Ehlers
FTIR s/n: 000583

System Leak Check: 0.0 mL/min

Nitrogen (Zero) Direct to FTIR

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
N2 DIR_019520.LAB	12/12/23	7:52:35	0.0	0.0	0.0	190.9	0.98	0.0	0.0	0.000
N2 DIR_019521.LAB	12/12/23	7:52:43	0.0	0.0	0.0	191.0	0.98	0.0	0.1	0.000
N2 DIR_019522.LAB	12/12/23	7:52:51	0.0	0.0	0.0	191.0	0.98	0.0	0.0	0.000
N2 DIR_019523.LAB	12/12/23	7:53:00	0.0	0.0	0.0	191.0	0.98	0.1	0.1	0.002
N2 DIR_019524.LAB	12/12/23	7:53:08	0.0	0.0	0.0	191.0	0.98	-0.2	0.0	0.002
N2 DIR_019525.LAB	12/12/23	7:53:16	0.0	0.0	0.0	190.9	0.98	0.0	0.1	0.000
N2 DIR_019526.LAB	12/12/23	7:53:24	0.0	0.0	0.0	191.0	0.98	0.0	0.0	0.000
N2 DIR_019527.LAB	12/12/23	7:53:33	0.0	0.0	0.0	191.0	0.98	-0.2	0.1	-0.001
N2 DIR_019528.LAB	12/12/23	7:53:41	0.0	0.0	0.0	191.0	0.98	0.0	0.0	-0.001

Calibration Transfer Standard (CTS), Direct to FTIR

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
CTS DIR_019608.LAB	12/12/23	8:05:18	0.0	0.0	0.0	191.0	0.98	98.8	0.1	0.002	98.7%
CTS DIR_019609.LAB	12/12/23	8:05:27	0.0	0.0	0.0	191.0	0.98	98.8	0.0	0.003	98.7%
CTS DIR_019610.LAB	12/12/23	8:05:35	0.0	0.0	0.0	191.0	0.98	98.8	0.1	0.001	98.7%
CTS DIR_019611.LAB	12/12/23	8:05:43	0.0	0.0	0.0	191.0	0.98	98.7	0.2	-0.004	98.6%
CTS DIR_019612.LAB	12/12/23	8:05:51	0.0	0.0	0.0	191.0	0.98	98.8	0.0	-0.008	98.7%
CTS DIR_019613.LAB	12/12/23	8:06:00	0.0	0.0	0.0	191.0	0.98	98.9	0.2	-0.004	98.8%
CTS DIR_019614.LAB	12/12/23	8:06:08	0.0	0.0	0.0	191.0	0.99	98.4	0.0	-0.004	98.3%
		Average						98.7		-0.004	98.6%

Analyte Spike Gas (HCN) Direct to FTIR

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % HCN
HCN DIR_019635.LAB	12/12/23	8:09:22	0.0	0.0	0.0	190.9	0.98	-0.1	49.3	4.986	99.2%
HCN DIR_019636.LAB	12/12/23	8:09:30	0.0	0.0	0.0	190.9	0.98	0.2	49.2	4.984	99.0%
HCN DIR_019637.LAB	12/12/23	8:09:38	0.0	0.0	0.0	190.9	0.98	0.0	49.4	4.985	99.4%
HCN DIR_019638.LAB	12/12/23	8:09:46	0.0	0.0	0.0	191.0	0.98	0.0	49.2	4.986	99.1%
HCN DIR_019639.LAB	12/12/23	8:09:55	0.0	0.0	0.0	191.0	0.98	0.0	49.4	4.980	99.4%
HCN DIR_019640.LAB	12/12/23	8:10:03	0.0	0.0	0.0	191.0	0.98	0.0	49.2	4.982	99.1%
HCN DIR_019641.LAB	12/12/23	8:10:11	0.0	0.0	0.0	191.0	0.98	0.1	49.3	4.975	99.2%
HCN DIR_019642.LAB	12/12/23	8:10:19	0.0	0.0	0.0	190.9	0.98	-0.3	49.5	4.972	99.7%
		Average							49.3	4.981	99.2%

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
CTS REMOTE_019689.LAB	12/12/23	8:21:12	0.0	0.0	0.0	190.8	0.99	99.0	0.1	-0.009	98.9%
CTS REMOTE_019690.LAB	12/12/23	8:21:20	0.0	0.0	0.0	190.8	0.98	99.0	0.2	-0.007	98.9%
CTS REMOTE_019691.LAB	12/12/23	8:21:28	0.0	0.0	0.1	190.8	0.98	98.9	0.2	-0.002	100.2%
CTS REMOTE_019692.LAB	12/12/23	8:21:37	0.0	0.0	0.0	190.9	0.99	98.9	0.1	-0.007	100.2%
CTS REMOTE_019693.LAB	12/12/23	8:21:45	0.0	0.0	0.0	190.9	0.98	99.0	0.2	-0.003	100.2%
CTS REMOTE_019694.LAB	12/12/23	8:21:53	0.0	0.0	0.0	190.9	0.99	98.7	0.2	0.001	100.0%
CTS REMOTE_019695.LAB	12/12/23	8:22:01	0.0	0.0	0.0	190.9	0.99	98.7	0.1	-0.005	100.0%
CTS REMOTE_019696.LAB	12/12/23	8:22:10	0.0	0.0	0.0	190.9	0.99	98.8	0.3	-0.003	100.0%

Response Time Test

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Response Time (sec)
CTS REMOTE_019672.LAB	12/12/23	8:18:52	0.4	0.1	0.0	191.0	0.99	31.5	1.0	-0.015	-
CTS REMOTE_019673.LAB	12/12/23	8:19:00	0.1	0.0	0.0	191.0	0.98	97.3	0.3	0.000	16.234
CTS REMOTE_019674.LAB	12/12/23	8:19:08	0.1	0.0	0.0	191.0	0.98	98.2	0.2	0.002	24.234
CTS REMOTE_019675.LAB	12/12/23	8:19:16	0.0	0.0	0.0	191.0	0.98	98.4	0.4	-0.005	
CTS REMOTE_019676.LAB	12/12/23	8:19:25	0.0	0.0	0.0	191.0	0.98	98.6	0.3	-0.001	
CTS REMOTE_019677.LAB	12/12/23	8:19:33	0.0	0.0	0.0	191.0	0.98	98.7	0.2	-0.003	
CTS REMOTE_019678.LAB	12/12/23	8:19:41	0.0	0.0	0.0	191.0	0.99	98.7	0.2	-0.005	
CTS REMOTE_019679.LAB	12/12/23	8:19:49	0.0	0.0	0.0	190.9	0.98	98.5	0.3	-0.002	
CTS REMOTE_019680.LAB	12/12/23	8:19:58	0.0	0.0	0.0	190.9	0.98	98.8	0.3	-0.005	

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Operating Condition: Normal

Test Location: Kiln 21 Exhaust
Date: 12/12/2023
Operator: E. Ehlers
FTIR s/n: 000583

Pre 1 Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
NATIVE_019972.LAB	12/12/23	9:35:17	5.0	13.0	0.0	190.9	0.99	0.3	0.5	-0.003
NATIVE_019973.LAB	12/12/23	9:35:26	5.0	13.3	0.0	190.9	0.98	0.2	0.5	0.005
NATIVE_019974.LAB	12/12/23	9:35:34	5.0	13.3	0.0	191.0	0.98	0.3	0.4	-0.003
									0.5	0.000

Pre 1 Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
PRE 1 SPIKE_020007.LAB	12/12/23	9:40:26	3.8	13.8	0.0	190.9	0.99	0.1	4.3	0.394	0.079	99.2%
PRE 1 SPIKE_020008.LAB	12/12/23	9:40:35	3.7	13.4	0.0	190.9	0.99	0.2	4.2	0.397	0.080	96.2%
PRE 1 SPIKE_020009.LAB	12/12/23	9:40:43	3.7	13.4	0.0	191.0	0.99	0.3	4.2	0.396	0.080	95.7%
PRE 1 SPIKE_020010.LAB	12/12/23	9:40:51	3.7	13.5	0.0	191.0	0.98	0.2	4.4	0.397	0.080	99.4%
PRE 1 SPIKE_020011.LAB	12/12/23	9:40:59	3.8	13.8	0.0	191.0	0.98	0.2	4.3	0.393	0.079	100.3%
PRE 1 SPIKE_020012.LAB	12/12/23	9:41:08	3.8	13.9	0.0	191.0	0.99	0.4	4.2	0.398	0.080	95.0%
PRE 1 SPIKE_020013.LAB	12/12/23	9:41:16	3.8	14.2	0.0	191.0	0.98	0.3	4.4	0.391	0.079	102.8%
PRE 1 SPIKE_020014.LAB	12/12/23	9:41:24	3.9	14.4	0.0	191.0	0.99	0.2	4.3	0.397	0.080	98.6%

Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 1_020128.LAB	12/12/23	11:43:36	3.6	14.0	0.0	190.9	0.99	0.4	0.6	-0.003
RUN 1_020129.LAB	12/12/23	11:44:40	3.5	13.9	0.0	191.0	0.99	0.4	0.6	-0.002
RUN 1_020130.LAB	12/12/23	11:45:44	3.5	13.9	0.0	191.0	0.99	0.4	0.6	-0.002
									0.6	-0.002

Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
RUN 1 POST SPIKE_020140.LAB	12/12/23	11:48:11	3.1	12.1	0.0	190.9	0.99	0.3	5.2	0.478	0.096	98.5%
RUN 1 POST SPIKE_020141.LAB	12/12/23	11:48:19	3.1	12.0	0.0	190.9	0.99	0.4	5.2	0.477	0.096	98.8%
RUN 1 POST SPIKE_020142.LAB	12/12/23	11:48:27	3.1	12.1	0.0	190.9	0.99	0.2	5.3	0.476	0.096	101.2%
RUN 1 POST SPIKE_020143.LAB	12/12/23	11:48:35	3.1	12.4	0.0	190.9	0.99	0.3	5.2	0.472	0.095	100.2%
RUN 1 POST SPIKE_020144.LAB	12/12/23	11:48:44	3.2	12.7	0.0	191.0	0.99	0.3	5.3	0.472	0.095	102.0%
RUN 1 POST SPIKE_020145.LAB	12/12/23	11:48:52	3.2	12.8	0.0	191.0	0.99	0.3	5.1	0.472	0.095	98.1%
RUN 1 POST SPIKE_020146.LAB	12/12/23	11:49:00	3.2	12.7	0.0	191.0	0.99	0.4	5.2	0.479	0.096	98.1%
RUN 1 POST SPIKE_020147.LAB	12/12/23	11:49:08	3.1	12.4	0.0	191.0	0.99	0.3	5.1	0.477	0.096	97.6%

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 1 POST CTS_020163.LAB	12/12/23	11:51:41	0.1	0.0	0.0	191.0	0.99	97.9	0.2	-0.002	99.1%
RUN 1 POST CTS_020164.LAB	12/12/23	11:51:49	0.1	0.0	0.0	191.0	0.99	97.2	0.2	-0.003	98.4%
RUN 1 POST CTS_020165.LAB	12/12/23	11:51:57	0.0	0.0	0.0	191.0	0.99	97.3	0.3	-0.008	98.5%
RUN 1 POST CTS_020166.LAB	12/12/23	11:52:06	0.0	0.0	0.0	191.0	0.99	96.5	0.3	0.002	97.8%
RUN 1 POST CTS_020167.LAB	12/12/23	11:52:14	0.0	0.0	0.0	191.0	0.99	97.3	0.3	-0.004	98.6%
RUN 1 POST CTS_020168.LAB	12/12/23	11:52:22	0.0	0.0	0.0	191.0	0.99	97.4	0.3	0.002	98.6%
RUN 1 POST CTS_020169.LAB	12/12/23	11:52:30	0.0	0.0	0.0	191.0	0.99	97.5	0.4	0.001	98.7%
RUN 1 POST CTS_020170.LAB	12/12/23	11:52:39	0.0	0.0	0.0	191.0	0.99	97.6	0.2	-0.001	98.8%

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Operating Condition: Normal

Test Location: Kiln 21 Exhaust
Date: 12/12/2023
Operator: E. Ehlers
FTIR s/n: 000583

Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 2_020338.LAB	12/12/23	13:58:33	4.5	14.7	0.0	190.9	0.99	0.4	0.8	-0.005
RUN 2_020339.LAB	12/12/23	13:59:37	4.0	14.7	0.0	191.0	0.99	0.4	0.7	-0.003
RUN 2_020340.LAB	12/12/23	14:00:41	3.9	14.4	0.0	191.0	0.99	0.4	0.6	-0.004
									0.7	-0.004

Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
RUN 2 POST SPIKE_020355.LAB	12/12/23	14:03:26	3.6	13.7	0.0	190.9	0.99	0.3	4.4	0.381	0.077	99.4%
RUN 2 POST SPIKE_020356.LAB	12/12/23	14:03:34	3.7	13.9	0.0	190.9	0.99	0.4	4.5	0.382	0.077	100.7%
RUN 2 POST SPIKE_020357.LAB	12/12/23	14:03:42	3.7	13.9	0.0	190.9	0.99	0.3	4.3	0.384	0.077	96.8%
RUN 2 POST SPIKE_020358.LAB	12/12/23	14:03:50	3.6	13.7	0.0	190.9	0.99	0.3	4.4	0.384	0.077	98.1%
RUN 2 POST SPIKE_020359.LAB	12/12/23	14:03:59	3.6	13.5	0.0	190.9	0.99	0.3	4.3	0.386	0.077	96.9%
RUN 2 POST SPIKE_020360.LAB	12/12/23	14:04:07	3.5	13.2	0.0	190.9	0.99	0.3	4.3	0.381	0.076	97.6%
RUN 2 POST SPIKE_020361.LAB	12/12/23	14:04:15	3.5	13.1	0.0	190.9	0.99	0.3	4.3	0.388	0.078	96.6%
RUN 2 POST SPIKE_020362.LAB	12/12/23	14:04:23	3.4	12.8	0.0	190.9	0.99	0.5	4.4	0.374	0.075	100.5%

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 2 POST CTS_020374.LAB	12/12/23	14:06:23	0.1	0.0	0.0	191.0	0.99	98.2	0.2	0.002	99.4%
RUN 2 POST CTS_020375.LAB	12/12/23	14:06:31	0.1	0.0	0.0	191.0	0.99	98.0	0.3	0.003	99.2%
RUN 2 POST CTS_020376.LAB	12/12/23	14:06:39	0.1	0.0	0.0	191.0	0.99	97.8	0.2	-0.010	99.0%
RUN 2 POST CTS_020377.LAB	12/12/23	14:06:48	0.0	0.0	0.0	191.0	0.99	98.2	0.3	-0.002	99.4%
RUN 2 POST CTS_020378.LAB	12/12/23	14:06:56	0.0	0.0	0.0	191.0	0.99	97.9	0.3	-0.001	99.1%
RUN 2 POST CTS_020379.LAB	12/12/23	14:07:04	0.0	0.0	0.0	191.0	0.99	98.0	0.2	-0.005	99.2%
RUN 2 POST CTS_020380.LAB	12/12/23	14:07:12	0.0	0.0	0.0	191.0	0.99	97.8	0.2	-0.003	99.1%
RUN 2 POST CTS_020381.LAB	12/12/23	14:07:21	0.0	0.0	0.0	191.0	0.99	97.7	0.3	-0.003	99.0%

Native Effluent Prior to Analyte Spike

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 3_020484.LAB	12/12/23	15:41:36	3.7	14.2	0.0	190.8	0.99	0.4	0.5	-0.004
RUN 3_020485.LAB	12/12/23	15:42:40	3.6	13.9	0.0	190.9	0.99	0.4	0.5	-0.003
RUN 3_020486.LAB	12/12/23	15:43:44	3.9	14.3	0.0	190.9	0.99	0.4	0.6	-0.006
									0.5	-0.004

Effluent Spike Using Analyte

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Dilution Factor	Recovery % HCN
RUN 3 POST SPIKE_020509.LAB	12/12/23	15:51:28	3.3	12.9	0.0	190.8	0.99	0.3	4.8	0.432	0.087	99.9%
RUN 3 POST SPIKE_020510.LAB	12/12/23	15:51:37	3.3	12.9	0.0	190.8	0.99	0.4	4.8	0.425	0.085	101.6%
RUN 3 POST SPIKE_020511.LAB	12/12/23	15:51:45	3.4	13.0	0.0	190.8	0.99	0.3	4.9	0.431	0.087	103.4%
RUN 3 POST SPIKE_020512.LAB	12/12/23	15:51:53	3.3	12.8	0.0	190.8	0.99	0.3	4.8	0.429	0.086	101.4%
RUN 3 POST SPIKE_020513.LAB	12/12/23	15:52:02	3.3	12.6	0.0	190.8	0.99	0.4	4.6	0.436	0.087	96.8%
RUN 3 POST SPIKE_020514.LAB	12/12/23	15:52:10	3.2	12.4	0.0	190.8	0.99	0.4	4.7	0.437	0.088	98.2%
RUN 3 POST SPIKE_020515.LAB	12/12/23	15:52:18	3.2	12.3	0.0	190.8	0.99	0.4	4.8	0.431	0.087	100.9%
RUN 3 POST SPIKE_020516.LAB	12/12/23	15:52:27	3.3	12.5	0.0	190.8	0.99	0.3	4.7	0.434	0.087	98.4%

CTS, System Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 3 POST CTS_020533.LAB	12/12/23	15:55:14	0.0	0.0	0.0	191.0	0.99	98.9	0.0	-0.001	100.2%
RUN 3 POST CTS_020534.LAB	12/12/23	15:55:22	0.0	0.0	0.0	191.0	0.99	98.8	0.2	-0.001	100.1%
RUN 3 POST CTS_020535.LAB	12/12/23	15:55:30	0.0	0.0	0.0	191.0	0.99	98.8	0.3	0.003	100.0%
RUN 3 POST CTS_020536.LAB	12/12/23	15:55:39	0.0	0.0	0.0	191.0	0.99	98.6	0.0	0.002	99.9%
RUN 3 POST CTS_020537.LAB	12/12/23	15:55:47	0.0	0.0	0.0	191.0	0.99	98.8	0.2	-0.001	100.0%
RUN 3 POST CTS_020538.LAB	12/12/23	15:55:55	0.0	0.0	0.0	191.0	0.99	98.7	0.2	-0.004	99.9%
RUN 3 POST CTS_020539.LAB	12/12/23	15:56:03	0.0	0.0	0.0	191.0	0.99	98.9	0.2	-0.009	100.2%
RUN 3 POST CTS_020540.LAB	12/12/23	15:56:13	0.0	0.0	0.0	191.0	0.99	99.1	0.1	-0.001	100.3%

Client: Holcim (US) Inc.
Facility: Alpena Cement Plant
Project #: M235005
Operating Condition: Normal

Test Location: Kiln 21 Exhaust
Date: 12/12/2023
Operator: E. Ehlers
FTIR s/n: 000583

Post Test CTS, Direct Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet	Recovery % Ethylene
RUN 3 POST CTS DIR_020594.LAB	12/12/23	16:07:49	0.0	0.0	0.0	191.0	0.99	98.3	-0.1	-0.006	99.6%
RUN 3 POST CTS DIR_020595.LAB	12/12/23	16:07:57	0.0	0.0	0.0	191.0	0.99	99.2	-0.1	-0.005	100.5%
RUN 3 POST CTS DIR_020596.LAB	12/12/23	16:08:05	0.0	0.0	0.0	191.0	0.99	98.6	-0.1	-0.007	99.9%
RUN 3 POST CTS DIR_020597.LAB	12/12/23	16:08:14	0.0	0.0	0.0	191.0	0.99	99.0	0.0	-0.001	100.2%
RUN 3 POST CTS DIR_020598.LAB	12/12/23	16:08:22	0.0	0.0	0.0	191.0	0.99	98.9	0.0	-0.006	100.2%
RUN 3 POST CTS DIR_020599.LAB	12/12/23	16:08:30	0.0	0.0	0.0	191.0	0.99	98.7	0.1	-0.005	99.9%
RUN 3 POST CTS DIR_020600.LAB	12/12/23	16:08:38	0.0	0.0	0.0	191.0	0.99	98.6	-0.1	-0.002	99.9%
RUN 3 POST CTS DIR_020601.LAB	12/12/23	16:08:47	0.0	0.0	0.0	190.9	0.99	99.0	0.0	0.001	100.2%
Average								98.8			

Post Test N2, Direct Purge

Spectrum	Date	Time	H2O% %v	CO2 %v wet	HF ppmv wet	FTIR Gas Cell Temperature deg C	FTIR Gas Cell Pressure atm	Ethylene ppmv wet	HCN ppmv wet	SF6 ppmv wet
RUN 3 POST N2 DIR_020611.LAB	12/12/23	16:20:51	0.0	0.0	0.0	191.0	0.99	-0.1	0.0	0.000
RUN 3 POST N2 DIR_020612.LAB	12/12/23	16:23:03	0.0	0.0	0.0	191.0	0.99	-0.1	0.0	-0.001
RUN 3 POST N2 DIR_020613.LAB	12/12/23	16:25:15	0.0	0.0	0.0	191.0	0.99	-0.1	-0.1	-0.001

Zero Gas and In-Stack Detection Limit Study
Holcim (US) Inc.
Alpena Cement Plant
Kiln 21 Exhaust
12/12/2023

Time	DL summary - zero gas		Time	DL summary - in stack	
	HF ppm (10) 191C	HCN (100) 191C		HF ppm (10) 191C	HCN (100) 191C
7:55:53 AM	0.01	-0.02	9:54:03 AM	-0.01	0.46
7:56:01 AM	0.02	-0.03	9:55:08 AM	-0.02	0.47
7:56:09 AM	0.00	0.09	9:56:14 AM	-0.01	0.52
7:56:18 AM	0.04	0.06	9:57:19 AM	0.00	0.53
7:56:26 AM	-0.03	0.17	9:58:26 AM	-0.01	0.52
7:56:34 AM	0.02	0.13	9:59:30 AM	-0.01	0.51
7:56:42 AM	0.01	0.05	10:00:34 AM	-0.02	0.55
Standard Deviation	0.02	0.07	Standard Deviation	0.01	0.03
3x = DL	0.06	0.20	3x = DL	0.02	0.09

Appendix H - Gas Cylinder Certifications

CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Part Number:	E03NI80E15A0138	Reference Number:	48-402876811-1
Cylinder Number:	ALM039009	Cylinder Volume:	141.0 CF
Laboratory:	124 - Los Angeles (SAP) - CA	Cylinder Pressure:	2015 PSIG
PGVP Number:	B32023	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Oct 26, 2023

Expiration Date: Oct 26, 2031

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted. The results relate only to the items tested. The report shall not be reproduced except in full without approval of the laboratory. Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON DIOXIDE	10.00 %	10.08 %	G1	+/- 0.6% NIST Traceable	10/26/2023
OXYGEN	10.00 %	10.10 %	G1	+/- 1.3% NIST Traceable	10/26/2023
NITROGEN	Balance				

CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	08010611	K005428	13.94 % CARBON DIOXIDE/NITROGEN	+/- 0.6%	Jan 30, 2024
NTRM	98051113	SG9163010BAL	9.507 % OXYGEN/NITROGEN	+/- 0.7%	Mar 22, 2030

ANALYTICAL EQUIPMENT		
Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
SIEMENS 6E CO2	NDIR	Oct 23, 2023
SIEMENS OXYMAT 6	PARAMAGNETIC	Oct 09, 2023

Triad Data Available Upon Request



CERTIFICATE OF ANALYSIS

Grade of Product: EPA PROTOCOL STANDARD

Part Number:	E03NI62E15A3356	Reference Number:	54-402141622-1
Cylinder Number:	CC743660	Cylinder Volume:	158.6 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12021	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Jun 18, 2021

Expiration Date: Jun 18, 2029

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted. The results relate only to the items tested. The report shall not be reproduced except in full without approval of the laboratory. Do Not Use This Cylinder below 100 psig. i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON DIOXIDE	19.00 %	18.76 %	G1	+/- 0.6% NIST Traceable	06/18/2021
OXYGEN	19.00 %	19.35 %	G1	+/- 0.7% NIST Traceable	06/18/2021
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	060118	K008299	23.04 % CARBON DIOXIDE/NITROGEN	+/- 0.5%	Jun 27, 2022

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
CO2-1 HORIBA VIA-510 V1E3H7P5	NDIR	Jun 17, 2021
O2-1 HORIBA MPA-510 3VUYL9NR	Paramagnetic	Jun 14, 2021

Triad Data Available Upon Request



Signature on file

CERTIFICATE OF ANALYSIS
Grade of Product: PRIMARY STANDARD

Part Number:	X02NI99P15AD524	Reference Number:	141-402838188-1
Cylinder Number:	EB0153603	Cylinder Volume:	140.0 CF
Laboratory:	124 - Stryker (SAP) - OH	Cylinder Pressure:	2015 PSIG
Analysis Date:	Sep 06, 2023	Valve Outlet:	350
Lot Number:	141-402838188-1		

Expiration Date: Sep 06, 2031

Primary Standard Gas Mixtures are traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
ETHYLENE	100.0 PPM	100.1 PPM	+/- 1%
NITROGEN	Balance		



CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	MOSTARDI PLATT	Reference Number:	160-402841763-1
Part Number:	X03NI99C15AC0W8	Cylinder Volume:	144.4 CF
Cylinder Number:	CC768249	Cylinder Pressure:	2015 PSIG
Laboratory:	124 - Plumsteadville - PA	Valve Outlet:	350SS
Analysis Date:	Sep 11, 2023		
Lot Number:	160-402841763-1		

Expiration Date: Mar 11, 2024

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
SULFUR HEXAFLUORIDE	5.000 PPM	5.022 PPM	+/- 5%
HYDROGEN CYANIDE	50.00 PPM	49.72 PPM	+/- 5%
NITROGEN	Balance		



Signature on file

END OF THE REPORT