AECOM

Permit: MI-ROP-A4033-2024
HWC MACT Subpart EEE
Michigan Operations Incineration Complex

NO_x/SO_2/CO/O_2/Flow
(CEM1 and CEM2)
Annual RATA Testing
Midland Rotary Kiln Incinerator
SVEG32INCIN01 (Stack SK-3300)

Project number: 60730322

September 6, 2024

The Dow Chemical Company
Midland, Michigan

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Quality information

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1. Introduction

1.1 Background

Dow retained AECOM to conduct a Relative Accuracy Test Audit (RATA) on the dual nitrogen oxides (NOx), sulfur dioxide (SO_2), carbon monoxide (CO) and oxygen (O_2) continuous emissions monitoring systems (CEMS) and the dual continuous emission rate monitoring systems (CERMS) serving the 32 Rotary Kiln Incinerator (EU-32Incinerator-S1) located within the Michigan Operations Incineration Complex at the Dow Chemical Company (Dow) facility in Midland, MI (Permit: MI-ROP-A4033-2024; SRN: A4033). This subsequent annual RATA was conducted on August 8, 2024.

Dow operates a hazardous waste incineration complex at its Midland, Michigan chemical manufacturing facility. This unit is equipped with dual redundant NOx, SO_2, CO, and O_2, CEMS, called CEM1 and CEM2, as well as dual redundant exhaust gas volumetric flow rate CERMS (Units A and B) serving the 32 Incinerator exhaust stack (Stack SK-3300). The initial performance specification test was performed for the CO and O_2 CEMS and CERMS on August 23-24, 2003. Monitors for NOx and SO_2 were added and an initial performance specification test was performed for these monitors with the annual RATA on August 28,2023.

Pursuant to 40CFR63.12U9(a) of the HWC MACT, Dow uses CEMS and CERMS to demonstrate compliance with the CO standard. The MACT CEMS each include a CO analyzer and an O_2 analyzer to allow the stack gas measured CO concentrations to be continuously corrected to seven (7) percent O_2. Each CEMS also includes monitors for measuring non-MACT parameters of NOx and SO_2. The stack employs exhaust gas volumetric flow rate monitors as part of CERMS that allow the measured concentrations of each CEMS to be equated to mass emission rates expressed in units of pounds per hour (lb/hr) and tons per year (ton/yr).

Dow has redundant CEMS/CERMS; each redundant system works independent of the other. The CEMS are extractive systems that each consist of three subsystems:

1. An extractive sample acquisition/conditioning system
2. Dual analyzers for each parameter (CO, O_2, NOx, and SO_2)
3. Programmable logic controller (PLC). All RATAs were performed according to the procedures detailed in 40 CFR Part 60, Appendix B, Performance Specifications (PS) 2, 3, 4B, and 6 for NOx/SO_2, O_2, CO, and Flow Rate, respectively.

This document presents the results of the subsequent annual RATA.

1.2 Overview of the Test Program

This report contains the results of the Performance Specification RATA performed for the 32 Incinerator MACT CEMS and CERMS, which serve the Midland Kiln (SVEG32INCIN01) outlet stack (Stack SK-3300) located in the Michigan Operations Incineration Complex owned and operated by Dow.

The following table (**Table 1-1**) summarizes the pertinent data for this performance test:

Table 1-1. Responsible Groups

Responsible Groups	• The Dow Chemical Company • Michigan Department of Environment, Great Lakes, and Energy (EGLE) • United States Environmental Protection Agency (US EPA)
Applicable Regulations	• Permit: MI-ROP-A4033-2024; SRN: A4033 • Hazardous Waste MACT (40 CFR 63, Subpart EEE) • 40 CFR 60, Appendix B, Performance Specifications (PS) 2/3/4B/6.
Industry / Plant	• Environmental Operations (Incineration)
Plant Location	• The Dow Chemical Company Midland, Michigan 48667
Unit Initial Start-up	• 2003
Date of Last Performance Specification Test (PST)	• August 28, 2023
Air Pollution Control Equipment	• NOx Abatement Control • Quench Tower • Condenser • Venturi Scrubber • Cl_2 Scrubber • Nine Ionizing Wet Scrubbers (IWS)
Emission Points	• SVEG32INCIN01 (Stack SK-3300)
Pollutants/Diluents Monitored	• NOx • SO_2 • O_2 • CO • Flow Rate
Test Date	• August 8, 2024

1.3 Key Personnel

The contact for the source and test report is:

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Names and affiliations of personnel, including their roles in the test program, are summarized in the following table.

Table 1-2. Key Personnel

Role	Role Description	Name	Affiliation
Process Focal Point	• Coordinate plant operation during test • Ensure the unit is operating at the agreed upon conditions in the test plan • Collect any process data and provide all technical support related to process operation	Mallory Bunker	Dow
Environmental Focal Point	• Ensure all regulatory requirements and citations are reviewed and considered for the testing	Sarah Maki	Dow
Process Analyzer	• Conducts all other QA testing and provides records for 7-day drift tests, response time tests, CGAs, etc.	Stephanie Moreno	Dow
Technical Reviewer	• Completes technical review of test data	Wayne Washburn	AECOM
Field Team Leader	• Ensures field sampling meets quality assurance objectives of plan	Pete Becker	AECOM
Sample Project Leader	• Ensures data generated meets the quality assurance objectives of the plan	James Edmister	AECOM

1.4 Executive Summary

A results summary for the RATA is presented in **Table 1-1**. The accuracy results indicate that the dual redundant CO/O_2/NOx/SO_2 CEMS and CERMS were operating within the required accuracy criteria. Relative accuracy results were calculated for each CEMS/CERMS for the following:

- NOx Concentration (ppmvd)
- SO_2 Concentration (ppmvd)
- O_2 Concentration (%vd)
- CO Concentration (ppmvd)
- Exhaust Gas Volumetric Flow Rate (scfm)

The results of the RATA indicate that each of the redundant 32-Incinerator CEMS/CERMS have passed under the requirements for annual RATA Testing.

Test program participants included Pete Becker and Quincy Crawford from AECOM and Sarah Maki from The Dow Chemical Company.

This Performance Specification Test for the 32-Incinerator consisted of up to 12 total valid 21-minute runs for each parameter. A maximum of three valid runs can be excluded for RATA calculations as allowed by 40 CFR Part 60, PS 2 and 3. Note that a set of three test runs for SO_2 were invalidated due to a failed post-run bias check. Therefore, an additional three runs for SO_2 were completed to replace the invalid runs. Data for invalidated test runs is included in the report appendices; however, invalid runs aren't included in the dataset of 12 valid runs and don't count toward the number of up to three valid runs excluded from relative accuracy determinations.

The remainder of this document is organized as follows. **Section 2** of this document provides a summary and discussion of results for the RATA; **Section 3** provides a description of the flue gas monitoring sample port locations and the facility CEMS system; **Section 4** describes the test procedures that were followed and a description of AECOM's portable instrumental analyzer laboratory; **Section 5** describes the Quality Assurance/Quality control measures for the test program; and **Section 6** describes how the data reduction was performed.

Additional information is contained in the Appendices as follows: **Appendix A** provides Reference Method (RM) Emissions Data from AECOM's test activities during the RATA program, **Appendix B** contains Facility Data for the RATA and initial certification QA tests and supporting documentation, **Appendix C** contains RM Quality Assurance Data, including Calibration Error Tests, System Bias and Drift Checks, System Response Times, Interference Response Tests, Gas Cylinder Certification Sheets, and QSTI Certificates, and **Appendix D** contains the Test Protocol.

Table 1-3. Relative Accuracy Test Audit Summary of Results

Monitoring System	Parameter / Analyzer	RA Result	Relative Accuracy Criteria – Part 60	Pass / Fail
CEMS – CEM1	O_2 percent, dry (AT33105)	0.8% of RM 0.01% O_2	≤20.0% of RM (PS 3) [1] ≤1.0% O_2 (PS 3) [1]	Pass
	CO ppmv, dry (AT33106 Range Calc)	0.6% of ES 0.62 ppm CO	≤5% of ES (PS 4B) [2, 3] ≤5 ppm CO (including CC, PS 4B) [2]	Pass
	NOx ppmv, dry (AT33104 Range Calc)	7.9% of RM	≤20% of RM (PS 2) [5] or ≤10% of ES (PS 2) [5]	Pass
	SO_2 ppmv, dry (AT33103)	2.1% of ES	≤20% of RM (PS 2) [5] or ≤10% of ES (PS 2) [5]	Pass
CEMS – CEM2	O_2 percent, dry (AT33112)	1.5% of RM 0.10% O_2	≤20.0% of RM (PS 3) [1] ≤1.0% O_2 (PS 3) [1]	Pass
	CO ppmv, dry (AT33113 Range Calc)	1.2% of ES 1.18 ppm CO	≤5% of ES (PS 4B) [2, 3] ≤5 ppm CO (including CC, PS 4B) [2]	Pass
	NOx ppmv, dry (AT33111 Range Calc)	9.5% of RM	≤20% of RM (PS 2) [5] or ≤10% of ES (PS 2) [5]	Pass
	SO_2 ppmv, dry (AT33110)	2.3% of ES	≤20% of RM (PS 2) [5] or ≤10% of ES (PS 2) [5]	Pass
CERMS (Stack SK-3300)	Gas Flow Rate, wet (Unit A acfm, FT33009)	2.3% of RM	≤20% of RM (PS 6) [4]	Pass
	Gas Flow Rate, wet (Unit A acfm, FT33011)	1.3% of RM	≤20% of RM (PS 6) [4]	Pass

1. Part 60 RA results for O_2 under PS 3 must be either no greater than 20.0% of RM or 1.0% O_2 by difference.
2. Part 60 RA results for CO under PS 4B must be either no greater than 10% of RM, 5% of ES, or 5 ppm CO by difference that includes the CC.
3. Part 60 RA results for CO under PS 4B expressed as a percentage of ES are based on a general emission standard of 100 ppm.
4. Part 60 RA results for CERMS under PS 6 must be no greater than 20% of RM. Exhaust gas volumetric flow rate and moisture are not required to be evaluated by US EPA but are evaluated as required by Michigan EGLE.
5. Part 60 RA results for NOx and SO_2 must be either no greater than 20% of RM or 10% of ES.

2. Summary and Discussion of Results

The purpose of this test event was to demonstrate compliance with the annual RATA requirement for the 32 Incinerator CEMS (CEM1 and CEM2) NOx, SO_2, CO, and O_2 gaseous parameter monitors and the CERMS (Units A and B) exhaust gas volumetric flow rate monitors at the Michigan Operations Incineration Complex in Midland, Michigan. The specific objectives were:

- Determine the relative accuracy of the dual redundant 32 Incinerator NOx/SO_2/CO/O_2 CEMS and Flow Rate CERMS serving the Kiln SK-3300 exhaust stack.

During the RATA, the incinerator process was operated at greater than 50% of normal operating rates in accordance with Part 60 performance specification guidelines. Summaries of the results for the Performance Specification Test of the 32 Incinerator CEMS (CEM1 and CEM2) NOx, SO_2, CO, and O_2 monitors and CERMS (Units A and B) exhaust gas volumetric flow rate monitors are presented below. This section summarizes and discusses the results of the Annual RATA Testing.

2.1 Relative Accuracy Test Results – NO_x/SO_2/CO/O_2 CEMS (CEM1 and CEM2)

Relative accuracy testing was conducted by AECOM using the instrumental analyzer procedures detailed in 40 CFR 60, Appendix A, Reference Methods (RM) 3A for O_2, 6C for SO_2, 7E for NOx, and 10 for CO. The instrumental analysis results are referred to as the Reference Method results, which were measured on a dry concentration basis. The results of the RATA program for the facility CEMS (CEM1 and CEM2) O_2, CO, NOx, and SO_2 monitors are presented in **Tables 2-1** through **2-4**, respectively. Comparisons of RM versus CEMS measurements were made for CO, NOx, and SO_2 measured concentrations expressed in units of parts per million by volume on a dry basis (ppmvd) and for O_2 concentrations expressed as percent by volume on a dry basis (%vd). AECOM field data and calculations are presented in **Appendix A**. Facility CEMS test data corresponding to the RM test run times are presented in **Appendix B**. The CEMS (CEM1 and CEM2) NOx/SO_2, O_2, and CO monitors passed the RA criteria in PS 2, PS 3, and PS 4B, respectively.

2.2 Relative Accuracy Test Results – Stack SK-3300 CERMS (Units A and B)

Relative accuracy testing was conducted by AECOM using the source emissions testing procedures detailed in 40 CFR 60, Appendix A, Reference Methods (RM) 2, 3A, and 4 for exhaust gas velocity, O_2/CO_2, and moisture, respectively, that were used to calculate exhaust gas volumetric rate. The source emissions testing flow rate results are referred to as the Reference Method results, which were measured at actual wet conditions, expressed as actual cubic feet per minute (acfm), and then corrected to standard conditions for temperature and pressure, expressed both on a wet and dry basis as standard cubic feet per minute (scfm) and dry standard cubic feet per minute (dscfm), respectively. The results of the RATA program for the facility Stack SK-3300 CERMS exhaust gas flow rate monitors (Units A and B) are presented in **Table 2-5** for flow rate measured as actual cubic feet per minute on a wet basis (acfm). AECOM field data and calculations are presented in **Appendix A**. Facility CERMS test data corresponding to the RM test run times are presented in **Appendix B**. The Stack SK-3300 CERMS exhaust gas flow rate monitors passed the RA criteria in PS 6, as required by Michigan EGLE.

Table 2-1. Relative Accuracy Results for CEM1 and CEM 2 O_2 (percent by volume, dry)

Oxygen Relative Accuracy Results										
		REFERENCE METHOD	Correction for Moisture		STACK ANALYZERS			ARITHMETIC DIFFERENCE and RATA Calculations		
					CEM1 O2 AT33105		CEM2 O2 AT33112		CEM1 O2 AT33105	CEM2 O2 AT33112
8/8/2024	TIME	Oxygen (%, dry)	Moisture (%)	Oxygen(%, wet)	Oxygen (%, dry)	Use of Run[1]	Oxygen (%, dry)	Use of Run[1]	Oxygen (%, dry) Use of Run[1]	Oxygen (%, dry) Use of Run[1]
RATA-R1	08:40-09:01	11.27	6.40	10.55	11.14		11.15		-0.13	-0.12
RATA-R2	09:01-09:22	12.69	6.40	11.87	12.72		12.82		0.03	0.13
RATA-R3	09:22-09:43	12.95	6.40	12.12	12.97		13.02		0.02	0.07
RATA-R4	10:05-10:26	10.73	6.93	9.98	10.61		11.02		-0.12	0.29
RATA-R5	10:26-10:47	12.39	6.93	11.53	12.48		12.54		0.09	0.15
RATA-R6	10:47-11:08	13.77	6.93	12.81	13.53		13.75		-0.24	-0.02
RATA-R7	12:28-12:49	12.71	6.37	11.90	12.93		12.99		0.22	0.28
RATA-R8	12:49-13:10	13.18	6.37	12.34	13.41		13.35		0.23	0.17
RATA-R9	13:10-13:31	11.27	6.37	10.55	11.41		11.32		0.14	0.05
RATA-R10	14:25-14:46	13.38	6.15	12.55	13.39		13.50		0.01	0.12
RATA-R11	14:46-15:07	11.03	6.15	10.35	11.01		11.19		-0.02	0.16
RATA-R12	15:07-15:28	12.87	6.15	12.08	12.77		12.81		-0.10	-0.06
								Number of Runs Used in Calculation (n)	12	12
								Average Difference (d_{AVG})	0.012	0.102
								Standard Deviation (S_d)	0.143	0.126
								t-Value ($t_{0.975}$)	2.201	2.201
								Confidence Coefficient (CC)	0.091	0.080
								Average of Reference Method (RM_{AVG})	12.353	12.353
								Relative Accuracy (O_2) ($\lvert d_{AVG} \rvert$)	0.01	0.10
								Relative Accuracy (% of Reference Method) (RA)	0.8	1.5

[1] An X in this column denotes a run which is not used in calculation of relative accuracy.

	ACCEPTANCE CRITERIA	
Performance Specification 3 (and 4B)		
Absolute value of difference between mean RM and mean CEMS (% O_2)	1.0	1.0
Relative Accuracy (% of Reference Method) (RA)	20.0	20.0

Table 2-2. Relative Accuracy Results for CEM1 and CEM2 CO (ppmvd)

Carbon Monoxide Relative Accuracy Results													
		REFERENCE METHOD							STACK ANALYZERS		ARITHMETIC DIFFERENCE		
			Oxygen Conc for Correction (%)		7		Correction for Moisture		CEM1CORangeCalc	CEM2CORangeCalc	CEM1CORangeCalc		CEM2CORangeCalc
8/8/2024	TIME	Flow (dscfm)	Oxygen (%, dry)	Carbon Monoxide (ppm dry)	Carbon Monoxide (ppm, dry) (Oxygen Corrected)	Carbon Monoxide (lb/hr)	Moisture (%)	Carbon Monoxide (ppm, wet)	Carbon Monoxide (ppm, dry)	Use of Run [1]	Carbon Monoxide (ppm, dry)	Use of Run [1]	Carbon Monoxide (ppm, dry)	Use of Run [1]	Carbon Monoxide (ppm, dry)	Use of Run [1]
RATA-R1	08:40-09:01	42,677	11.27	0.09	0.13	0.02	6.40	0.08	0.72		1.36		0.63		1.27	
RATA-R2	09:01-09:22	40,089	12.69	0.02	0.03	0.00	6.40	0.02	0.54		0.77		0.52		0.75	
RATA-R3	09:22-09:43	40,431	12.95	0.05	0.08	0.01	6.40	0.04	0.62		1.06		0.57		1.01	
RATA-R4	10:05-10:26	43,366	10.73	0.07	0.10	0.01	6.93	0.07	0.67		1.43		0.60		1.36	
RATA-R5	10:26-10:47	43,681	12.39	0.03	0.06	0.01	6.93	0.03	0.42		1.03		0.39		1.00	
RATA-R6	10:47-11:08	40,800	13.77	-0.01	-0.02	0.00	6.93	-0.01	0.64		1.02		0.65		1.03	
RATA-R7	12:28-12:49	39,808	12.71	0.07	0.11	0.01	6.37	0.06	0.78		1.10		0.71		1.03	
RATA-R8	12:49-13:10	39,766	13.18	-0.08	-0.15	-0.01	6.37	-0.08	0.39		1.02		0.47		1.10	
RATA-R9	13:10-13:31	39,879	11.27	-0.05	-0.07	-0.01	6.37	-0.04	0.54		1.16		0.59		1.21	
RATA-R10	14:25-14:46	40,565	13.38	-0.11	-0.21	-0.02	6.15	-0.10	0.52		1.03		0.63		1.14	
RATA-R11	14:46-15:07	39,679	11.03	-0.05	-0.08	-0.01	6.15	-0.05	0.39		0.84		0.44		0.89	
RATA-R12	15:07-15:28	40,115	12.87	-0.09	-0.15	-0.02	6.15	-0.08	0.48		1.05		0.57		1.14	
													Number of Runs Used in Calculation (n)		12	
													Average Difference (d_{AVG})		0.565	
													Standard Deviation (S_d)		0.094	
													t-Value ($t_{0.975}$)		2.201	
													Confidence Coefficient (CC)		0.060	
													Applicable Standard (or Permit Limit)		100	
													Average of Reference Method (RM_{AVG})		-0.005	
													Relative Accuracy (CO, NO_X, SO_2, O_2,CO_2) ($|d_{AVG}|+|CC|$)		0.62	
													Relative Accuracy (% of Permit Limit) (RA)		0.6	
[1] An X in this column denotes a run which is not used in calculation of relative accuracy.																
													Performance Specification 4B			
													Relative Accuracy (CO) ($|d_{AVG}|+|CC|$)(RA as ppmv)		5	5
													Relative Accuracy (% of Reference Method) (RA)		10	10
													Relative Accuracy (% of Permit Limit) (RA)		5	5

Table 2-3. Relative Accuracy Results for CEM1 and CEM2 NOx (ppmvd)

Nitrogen Oxides Relative Accuracy Results											
		REFERENCE METHOD					STACK ANALYZERS		ARITHMETIC DIFFERENCE		
			Oxygen Conc for Correction (%)		7		CEM1NOxRange Calc	CEM2NOxRange Calc	CEM1NOxRange Calc		CEM2NOxRange Calc	
8/8/2024	TIME	Flow (dscfm)	Oxygen (%, dry)	Nitrogen Oxides (ppm dry)	Nitrogen Oxides (ppm, dry) (Oxygen Corrected)	Nitrogen Oxides (lb/hr)	Nitrogen Oxides (ppm, dry)	Nitrogen Oxides (ppm, dry)	Nitrogen Oxides (ppm, dry)	Use of Run [1]	Nitrogen Oxides (ppm, dry)	Use of Run [1]
RATA-R1	08:40-09:01	42,677	11.27	116.35	167.98	35.57	122.62	124.78	6.27		8.43	
RATA-R2	09:01-09:22	40,089	12.69	113.68	192.38	32.65	121.40	123.36	7.72		9.68	
RATA-R3	09:22-09:43	40,431	12.95	101.31	177.16	29.35	108.12	110.56	6.81		9.25	
RATA-R4	10:05-10:26	43,366	10.73	93.18	127.30	28.95	99.61	102.19	6.43		9.01	
RATA-R5	10:26-10:47	43,681	12.39	99.29	162.13	31.07	105.84	108.01	6.55		8.72	
RATA-R6	10:47-11:08	40,800	13.77	103.18	201.05	30.16	110.43	112.63	7.25		9.45	
RATA-R7	12:28-12:49	39,808	12.71	126.03	213.84	35.94	134.95	137.14	8.92		11.11	
RATA-R8	12:49-13:10	39,766	13.18	153.28	276.13	43.67	163.53	166.10	10.25		12.82	
RATA-R9	13:10-13:31	39,879	11.27	140.22	202.44	40.06	150.11	152.06	9.89		11.84	
RATA-R10	14:25-14:46	40,565	13.38	154.63	285.68	44.94	166.28	168.30	11.65		13.67	
RATA-R11	14:46-15:07	39,679	11.03	134.30	189.17	38.18	145.09	146.48	10.79		12.18	
RATA-R12	15:07-15:28	40,115	12.87	153.39	265.51	44.08	163.72	165.62	10.33		12.23	
							Number of Runs Used in Calculation (n)		12		12	
							Average Difference (d_{AVG})		8.571		10.699	
							Standard Deviation (S_d)		1.946		1.807	
							t-Value ($t_{0.975}$)		2.201		2.201	
							Confidence Coefficient (CC)		1.237		1.148	
							Applicable Standard (or Permit Limit)					
							Average of Reference Method (RM_{AVG})		124.070		124.070	
							Relative Accuracy (% of Reference Method) (RA)		7.9		9.5	
							Relative Accuracy (% of Permit Limit) (RA)		--		--	
[1] An X in this column denotes a run which is not used in calculation of relative accuracy.												
							Performance Specification 2					
							Relative Accuracy (% of Reference Method) (RA)		20		20	
							Relative Accuracy (% of Permit Limit) (RA)		10		10	

Table 2-4. Relative Accuracy Results for CEM1 and CEM2 SO_2 (ppmvd)

Sulfur Dioxide Relative Accuracy Results

		REFERENCE METHOD							STACK ANALYZERS			ARITHMETIC DIFFERENCE		
			Oxygen Conc for Correction (%)		7		Correction for Moisture		CEMS CEM1 SO2 AT33103		CEMS CEM1 SO2 AT33110	CEMS CEM1 SO2 AT33103		CEMS CEM1 SO2 AT33110
8/8/2024	TIME	Flow (dscfm)	Oxygen (%, dry)	Sulfur Dioxide (ppm dry)	Sulfur Dioxide (ppm, dry) (Oxygen Corrected)	Sulfur Dioxide (lb/hr)	Moisture (%)	Sulfur Dioxide (ppm, wet)	Sulfur Dioxide (ppm, dry)	Use of Run [1]	Sulfur Dioxide (ppm, dry)	Sulfur Dioxide (ppm, dry)	Use of Run [1]	Sulfur Dioxide (ppm, dry)
SO2 RA-1	08:40-09:01	42,677	11.27	0.11	0.16	0.05	6.40	0.10	0.06		0.02	-0.05		-0.09
SO2 RA-2	09:01-09:22	40,089	12.69	-0.88	-1.50	-0.35	6.40	-0.83	0.06		0.02	0.94		0.90
SO2 RA-3	09:22-09:43	40,431	12.95	-0.39	-0.68	-0.16	6.40	-0.36	0.06		0.02	0.45		0.41
SO2 RA-4	12:28-12:49	39,808	12.71	1.22	2.06	0.48	6.37	1.14	0.06		0.02	-1.16		-1.20
SO2 RA-5	12:49-13:10	39,766	13.18	0.32	0.57	0.13	6.37	0.30	0.06		0.02	-0.26		-0.30
SO2 RA-6	13:10-13:31	39,879	11.27	0.49	0.70	0.19	6.37	0.46	0.06		0.02	-0.43		-0.47
SO2 RA-7	14:25-14:46	40,565	13.38	0.14	0.26	0.06	6.15	0.13	0.06		0.02	-0.08		-0.12
SO2 RA-8	14:46-15:07	39,679	11.03	0.34	0.48	0.14	6.15	0.32	0.06		0.02	-0.28		-0.32
SO2 RA-9	15:07-15:28	40,115	12.87	0.79	1.37	0.32	6.15	0.74	0.06		0.02	-0.73		-0.77
SO2 RA-10	15:52-16:13	40,345	13.03	0.70	1.23	0.28	6.42	0.65	0.06		0.02	-0.64		-0.68
SO2 RA-11	16:13-16:34	39,828	12.41	-0.89	-1.45	-0.35	6.42	-0.83	0.06		0.02	0.95		0.91
SO2 RA-12	16:34-16:55	40,495	12.46	0.71	1.17	0.29	6.42	0.66	0.06		0.01	-0.65		-0.70
								Number of Runs Used in Calculation (n)				12		12
								Average Difference (d_{AVG})				-0.161		-0.202
								Standard Deviation (S_d)				0.655		0.655
								t-Value ($t_{0.975}$)				2.201		2.201
								Confidence Coefficient (CC)				0.416		0.416
								Applicable Standard (or Permit Limit)				27		27
								Average of Reference Method (RM_{AVG})				0.221		0.221
								Relative Accuracy (CO, NO_X, SO_2, O_2,CO_2) ($\lvert d_{AVG}\rvert+\lvert CC\rvert$)				0.58		0.62
								Relative Accuracy (% of Reference Method) (RA)				261.2		279.8
								Relative Accuracy (% of Permit Limit) (RA)				2.1		2.3
[1] An X in this column denotes a run which is not used in calculation of relative accuracy.														
								Performance Specification 2						
								Relative Accuracy (% of Reference Method) (RA)				20		20
								Relative Accuracy (% of Permit Limit) (RA)				10		10

Table 2-5. Relative Accuracy Results for CERMS Flow Rate, Units A and B (acfm)

		REFERENCE METHOD		STACK ANALYZERS				ARITHMETIC DIFFERENCE			
				SK3300 Actual Flow FT33009		SK3300 Actual Flow FT33011		SK3300 Actual Flow FT33009		SK3300 Actual Flow FT33011	
Run Number	TIME	Flow (dscfm)	Flow (acfm)	Flow Rate (acfm)	Use of Run [1]	Flow Rate (acfm)	Use of Run [1]	Flow Rate (acfm)	Use of Run [1]	Flow Rate (acfm)	Use of Run [1]
Flow Run 1	08:40-09:01	42,677	50,007	49,839		49,305		-168		-702	
Flow Run 2	09:01-09:22	40,089	47,502	48,782		48,164		1,280		662	
Flow Run 3	09:22-09:43	40,431	47,956	49,108		48,546		1,152		590	
Flow Run 4	10:05-10:26	43,366	51,761	52,136		51,799		375		38	
Flow Run 5	10:26-10:47	43,681	52,259	53,477		53,006		1,218		747	
Flow Run 6	10:47-11:08	40,800	48,947	50,227		49,882		1,280		935	
Flow Run 7	12:28-12:49	39,808	47,509	48,647		48,023		1,138		514	
Flow Run 8	12:49-13:10	39,766	47,432	48,307		48,005		875		573	
Flow Run 9	13:10-13:31	39,879	47,449	48,137		47,544		688		95	
Flow Run 10	14:25-14:46	40,565	48,140	48,507		48,071		367		-69	
Flow Run 11	14:46-15:07	39,679	47,005	48,065		47,444		1,060		439	
Flow Run 12	15:07-15:28	40,115	47,564	48,208		48,071		644		507	
						Number of Runs Used in Calculation (n)		12		12	
						Average Difference (d_{AVG})		825.7		360.7	
						Standard Deviation (S_d)		455.4		448.0	
						t-Value ($t_{0.975}$)		2.201		2.201	
						Confidence Coefficient (CC)		289.3		284.6	
						Permit Limit					
						Average of Reference Method (RM_{AVG})		48,627.6		48,627.6	
						Relative Accuracy (% of Reference Method) (RA)		2.3		1.3	

[1] An X in this column denotes a run which is not used in calculation of relative accuracy.

Performance Specification

Relative Accuracy (% of Reference Method) (RA)
Note: There is no specification for Relative Accuracy of a Flow Monitor by itself within the EPA Performance Specifications. PS6 speaks of CERMS, and provides specifications for emission rate monitors. Flow rate is a component, and the individual value is not addressed.

3. Facility and CEMS Description

3.1 Process Description

This section briefly describes the 32 Incinerator. The unit is designed to thermally treat liquid and solid wastes. As necessary, fuel gas is used as a supplemental fuel. The 32 Incinerator is a hazardous waste incinerator with a rotary kiln and secondary combustion chamber (SCC). Destruction of organic compounds takes place in the combustion chambers. The rotary kiln typically operates above 800°C and the SCC typically operates above 980°C. The permitted nominal thermal output capacity of this unit is 130 million British thermal units per hour (MMBtu/hr). The waste supplies most of the heat. Natural gas is used to maintain the temperature when the Btu content of the waste is limited and to maintain the flame during startups and shutdowns. After the combustion gases exit the SCC, they enter the NOx reactor. A urea solution is air atomized into this chamber to control NOx generation as required. Next, the combustion gases enter the quench section. In the quench section, the process vapors are contacted with water that is injected into the quench to cool the gases.

3.2 Process Emissions Control Description

The air pollution control system consists of a packed tower condenser, venturi scrubber, chlorine scrubber, and ionizing wet scrubbers.

The packed tower condenser is a counter current vessel, where gas is contacted with recycled water over a packed bed. The tower serves to scrub gases and further lower the temperature of the combustion gas. The high-energy venturi scrubber removes the major portion of the very fine particulate material from the gas stream. The pH of the venturi scrubber recycle water is controlled by the addition of caustic to the chlorine scrubber, which is the source of water for the venturi scrubber.

The chlorine scrubber removes the remainder of the hydrogen chloride and chlorine from the gas stream by contact with pH-controlled scrubber liquor across a packed bed, and it serves to remove entrained water droplets from the gas stream. The ionizing wet scrubbers remove the low levels of fine particulate matter from the gas stream. The gas passes through charged fields. Under these conditions, the charged sub-micron particles are attracted to the charged plates and rods and are then removed by a continuous flow of water through the beds.

The emission test point for this test was the Rotary Kiln Incinerator Stack identified as SVEG32INCIN01 (Stack SK-3300).

3.3 Flue Gas Sampling Locations

Sampling was conducted on the Kiln outlet stack (Stack SK-3300). The CEMS sample points for the Kiln stack are at least two equivalent diameters downstream from the nearest control device, the point of pollutant generation, or other point at which a change in the pollutant concentration occurs, and at least one-half equivalent diameters upstream from the effluent exhaust or control device. The stack has sampling ports installed as shown in **Figure 3.1**. The samples were drawn from the stack for a period of 21 minutes continuously following a stratification test conducted at the three traverse points of 16.7, 50.0, and 83.3 percent of the measurement line that passes through the centroidal area of the stack cross section.

3.4 Facility CEMS Description

The facility employs dual redundant MACT CO/O_2 CEMS (CEM1 and CEM2) along with flow rate CERMS (Units A and B) in order to comply with the HWC MACT monitoring requirements of and to demonstrate continuous compliance with the CO emission limits specified in their air permit (Michigan EGLE Permit MI-ROP-A4033-2024). In addition, the CEMS include NOx and SO_2 monitors in accordance with Michigan EGLE requirements.

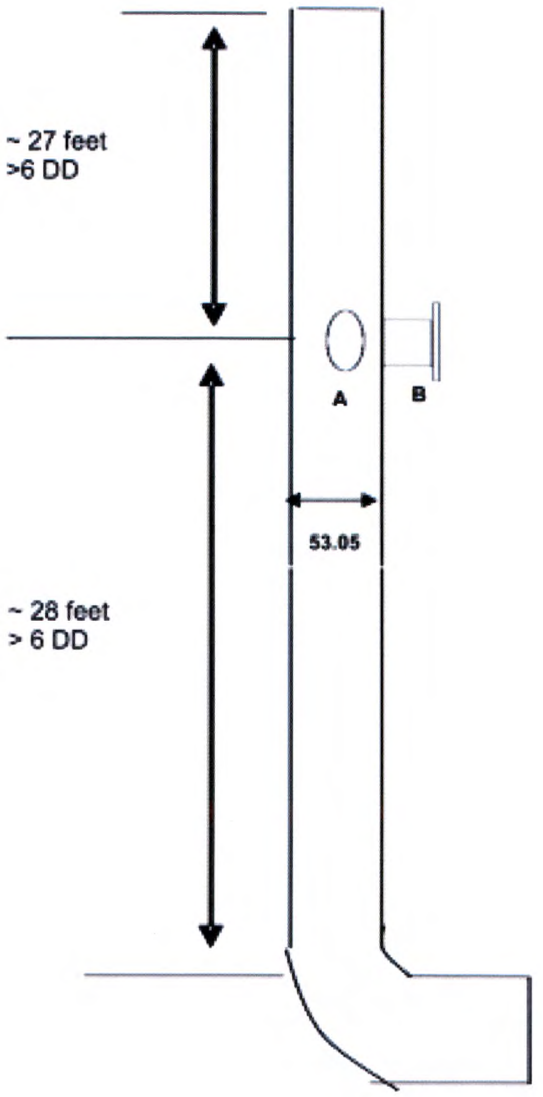
Each CEMS is a dry-extractive non-dilution type that was designed and installed to meet emissions monitoring requirements outlined in 40 CFR Part 60, Appendix B, Performance Specifications (PS) 2, 3, 4B for NOx/SO_2, O_2, and CO, respectively.

Each CEMS consists of an extractive sample probe, with a sintered metal element filter at the probe inlet tip. A heated sample line runs between the probe and CEMS cabinet to a sample conditioning system. The CEMS analyzers are housed in a climate-controlled shelter, which is located at the base of the stack. The CEMS analyzers are wired into the DAHS, which in turn calculates emissions from analyzer outputs and provides the required regulatory reports. Specifications for each CEMS/CERMS monitor are presented in **Table 3-1**. A schematic of the facility emissions stack layout showing the sample test port locations is provided in **Figure 3-1**.

Table 3-1. Facility CEMS/CERMS Equipment Specifications

CEMS / CERMS	Parameter	Units	Manufacturer	Model	Serial No.
CEM1	CO	ppmvd	ABB, Inc.	Uras 26	3.420486.1
	NO_x	ppmvd	ABB, Inc.	Limas 21	3.420210.1
	SO_2	ppmvd	ABB, Inc.	Limas 21	3.244191.2
	O_2	Vol%, dry	ABB, Inc.	Magnos 28	3.420977.1
CEM2	CO	ppmvd	ABB, Inc.	Uras 26	3.254586.5
	NO_x	ppmvd	ABB, Inc.	Limas 11	3.244191.2
	SO_2	ppmvd	ABB, Inc.	Limas 11	3.244191.2
	O_2	Vol%, dry	ABB, Inc.	Magnos 206	3.255856.5
CERMS (Units A and B)	Flow Rate	acfm	Panametric	GM868-1-11-10003-S	1289 & 1878

Figure 3-1. Facility Process Diagram



4. RATA Test Procedures

The following is a description of the testing that was completed on the 32 Incinerator NOx/SO_2/CO/O_2 CEMS and flow rate CERMS to fulfill the monitoring system requirements in the HWC MACT as well as the certification requirements of 40 CFR Part 60 as specified in the Michigan EGLE air permit (MI-ROP-A4033-2024).

4.1 Relative Accuracy Test Methods

AECOM followed the instrumental analyzer procedures specified in EPA Methods 3A, 6C, 7E, and 10 (40 CFR Part 60, Appendix A) for the determination of O_2/CO_2, SO_2, NOx, and CO concentrations, respectively. Exhaust gas volumetric flow rates were calculated using measurements made following the source testing procedures specified in EPA Methods 2 and 4 (40 CFR Part 60, Appendix A) for the determination of gas velocity and moisture, respectively. The following subsections describe the sample procedures in more detail.

AECOM conducted a minimum of nine valid 21-minute test periods using the AECOM transportable instrumental analyzer laboratory, which is described later in this section. Average undiluted dry concentrations by volume of O_2, SO_2, NOx, and CO were determined for each test run. During each test run, the sample probe extracted a continuous sample along a traverse line through the center of the stack cross section as is specified in Performance Specification 2 (PS 2) of 40 CFR Part 60, Appendix B. Prior to sampling, a stratification test was completed where the sample probe was traversed across the stack at three points (16.7%, 50.0%, and 83.3%) of a measurement line passing through the stack centroid. The results of the Stratification Test are presented in **Appendix A**.

Relative accuracy (RA) determinations followed calculations delineated in PS 2, PS 3, PS 4B, and PS 6 (40 CFR 60, Appendix B) for SO_2/NOx, O_2, CO, and flow rate, respectively. RA results are evaluated in accordance with the criteria specified in 40 CFR Part 60 (Appendix B, PS 2, PS 3, PS 4B, and PS 6). Each monitor of each CEMS/CERMS passes the RATA if it meets the least restrictive RA criterion in the applicable performance specification. The least restrictive Part 60 RA criterion for each O_2 analyzer is ≤20 percent of the average RM value or ≤1% absolute difference from the average reference method value. The least restrictive Part 60 RA criterion for each CO analyzer is ≤5 percent of the emission standard (100 ppm regulatory emission limit) or 5 ppm CO by difference plus the confidence coefficient (CC). The least restrictive Part 60 RA criterion for each NOx and SO_2 analyzer is ≤20 percent of the average RM value or ≤10% of the emission standard. The criterion for the flow rate analyzers is ≤20 percent of the average RM value.

The O_2/CO_2, SO_2, NOx, CO, and flow rate RM test run data and calculation results are presented in **Appendix A**.

4.2 Transportable Instrumental Analyzer Laboratory

A transportable instrumental analyzer laboratory (i.e., Mobile Lab) was used to provide an environmentally controlled shelter to house RM analyzers and the sample delivery and conditioning system to measure NOx, SO_2, CO, O_2, and CO_2 by volume on a dry basis. The AECOM RM monitoring system is contained in a temperature controlled portable shelter that was delivered to the site and set up prior to the start of the RATA program. The sample delivery and conditioning system consists of a stainless-steel sample probe, a heated particulate filter assembly, a heat-traced Teflon sample line, a refrigerated gas conditioning system (for moisture and condensable particulate removal), a sample gas manifold, and a sample pump. The clean dry sample was then delivered to the gas analyzers for the determination of undiluted NO_x, SO_2, CO, O_2, and CO_2 concentrations.

The analog output signals from each analyzer were connected to a data acquisition system (DAS) using a software package to perform the test calculations. The DAS then stored the data in engineering units and provided 1-minute and 10-second averages based upon a minimum of 60 readings per minute. The O_2 and CO_2 were measured using a Servomex 1400 or 4900 Series analyzer with paramagnetic and non-

dispersive infrared (NDIR) detectors, for O_2 and CO_2 respectively, on approximate span gas ranges of 0-25% and 0-20%. The CO was measured using a Thermo Model 48i gas filter correlation (GFC)/NDIR analyzer on an approximate span gas range of 0-30 ppm. The NOx was measured using a Thermo Model 42i chemiluminescent analyzer on an approximate span gas range of 0-300 ppm. The SO_2 was measured using an Ametek 900 or 9900 series ultraviolet analyzer on an approximate span gas range of 0-50 ppm.

4.3 RM Calibration Procedures

The initial phase of the instrumental analyzer methods (e.g., Methods 3A, 6C, 7E, and 10) requires initial measurement system performance tests to be performed, including calibration error tests, system bias checks, response-time tests, an NO_2 converter test (for NO_X analyzers), and interference checks, as applicable.

Prior to performing test runs, AECOM conducted direct instrument calibration error tests using zero and two upscale gases each for the NOx, SO_2, O_2/CO_2 and CO instruments prior to initiation of testing. Following these direct calibrations, an initial system bias check was performed by sending zero and one upscale gas, from one gas cylinder at a time, up to the sample probe and back down through the components of the sampling system. Following the initial system bias checks, response-time data was obtained for each analyzer. Subsequently, system bias and drift checks were performed both prior to and following each test run set of up to three consecutive runs using zero and one upscale calibration gas. These system checks allowed for the determination of initial and final system bias, as well as system drift for each test run set. Test run sets of three 21-minute test runs were performed during a continuous and uninterrupted period of 63 minutes followed by a system bias and drift check. The calibration gases used during this program were prepared in accordance with EPA Protocol G1 procedures as specified by the National Institute of Standards and Technology (NIST). The $NOx/SO_2/O_2/CO_2/CO$ calibration compressed gas standards were contained in individual cylinders having a purified nitrogen gas balance.

Interference check data provided by each instrument's manufacturer is maintained on file to meet the requirements of Method 7E (Subsection 8.2.7) as additionally referenced in Methods 3A, 6C, and 10.

The RM calibration data, including initial calibration error tests, pre-run and post-run system bias and drift checks, system response time tests, manufacturer interference test data, and certificates of analysis for the RM test calibration gases, are provided in **Appendix A**.

5. Quality Assurance/ Quality Control Measures

5.1 Overview

During the monitoring phase of the program, a strict quality assurance/quality control (QA/QC) program was adhered to. The QA/QC aspects of the program are discussed below.

5.2 Leak Check Procedure

Prior to conducting the RATA, AECOM's Instrumental Measurement System was leak checked and verified to be leak free. Following the initial leak check, the system bias and drift criteria (as referenced in EPA Method 7E, 40 CFR Part 60, Appendix A) served as a continuous sample integrity check.

5.3 System Calibrations

During the test program, AECOM used EPA instrumental analyzer methods (i.e., 3A, 6C, 7E, and 10, in 40 CFR Part 60, Appendix A) for the measurement of NOx, SO_2, O_2/CO_2 and CO. The initial phase of instrumental analysis requires calibration of the involved monitors. Prior to performing test runs, AECOM conducted direct instrument calibration error tests using zero and two upscale gases each for the NOx, SO_2, O_2/CO_2, and CO instruments prior to initiation of testing. Following these direct calibrations, an initial system bias check was performed by sending zero and one upscale gas, from one gas cylinder at a time, up to the sample probe and back down through the relevant components of the sampling system. During the initial system bias checks, response-time data was obtained for each analyzer. Subsequently, system bias checks were performed both prior to and following each test run using zero and one upscale calibration gas. These system checks allowed for the determination of initial and final system bias, as well as system drift for each test run. The calibration gases used during this program were prepared to EPA Protocol G1/G2 standards. Certificates of analysis for the calibration gases are presented in Appendix B. The measurement system performance criteria in 40 CFR Part 60, Appendix A, Methods 3A, 6C, 7E, and 10 are listed below and were the performance criteria for the reference method instruments during this program.

Procedure	Performance Criterion
Calibration error	<±2% of the calibration span
System bias	<±5% of the calibration span
System drift	<±3% of the calibration span

The instrumental analysis methods also require correction of data for calibration drift and/or bias. The values used for the determination of relative accuracy were corrected for system drift and bias observed during each test run. System bias and drift as well as response-time data are presented in **Appendix A** of this report.

5.4 Interference Checks

Interference checks are required for each make and model of instrumental analyzer used for reference method measurements and signed documentation of the results must be included in each test report (as referenced in 40 CFR 60, Appendix A, Method 7E, Subsection 8.2.7). Copies of the instrument specific test results are presented in Appendix A of this document.

6. Data Reduction

6.1 Overview

The objective of the monitoring program was to determine the relative accuracy (RA) of the $NOx/SO_2/CO/O_2$ CEMS/CERMS. RA results have been reported on an individual analyzer basis (concentrations) and for exhaust gas volumetric flow rate. Photocopies of the raw field data sheets and data printouts are also presented in the appendices. Equations and example calculations from the data reduction process are presented in **Appendix A**. Equations for the calculation of relative accuracy (RA) are presented below in this section of the report.

6.2 Calculation of Relative Accuracy

Standard Deviation

The standard deviation (SD) between the minimum of nine test runs chosen must be calculated. The following equation was used to calculate standard deviation:

$$S_D = \sqrt{\left[\frac{(Sum\ of\ d^2) - \frac{(Sum\ of\ d)^2}{n}}{n-1}\right]}$$

Where:

SD = Standard deviation of a minimum of nine selected runs

d = Arithmetic difference between the facility CEMS and RM test run averages

n = Number of sample test runs used for standard deviation calculation

Confidence Coefficient

The 95% confidence coefficient (CC) of the minimum of nine test runs chosen must be calculated. The student T Value of 2.306 (for nine runs) in the equation comes from Table 2-1 (t-Values) of PS 2 in 40 CFR Part 60, Appendix B. The T Value needs to be adjusted for the chosen number of test runs according to Table 2-1 in PS 2. The following equation was used to calculate the confidence coefficient:

$$CC = 2.306 \times \left(\frac{S_D}{\sqrt{n}}\right)$$

Where:

CC = Confidence coefficient

Sd = Standard deviation of the minimum of nine selected test runs

n = Number of sample test runs used for standard deviation calculation

Relative Accuracy

The relative accuracy of the CEMS/CERMS were calculated as required by PS 2, PS 3, PS 4B, and PS 6 for NOx/SO_2 (ppmvd), O_2 (%vd), CO (ppmvd), and flow rate (acfm), respectively. The relative accuracies are calculated to verify:

- RAs for NOx and SO_2 are no greater than either 20% of RM or 10% of ES (applicable emission standard) as specified in PS 2 of 40CFR60, Appendix B
- RA for O_2 (%vd) is no greater than 20.0% of RM or 1.0% O_2 absolute difference (not including CC) as specified in PS 3 of 40CFR60, Appendix B
- RA for CO (ppmvd) is no greater than 10% of RM, 5% of ES (applicable emission standard), or 5 ppm CO absolute difference (plus CC) as specified in PS 4B of 40CFR60, Appendix B
- RA for flow rate (acfm) is no greater than 20% as specified in PS 6 of 40CFR60, Appendix B

Relative Accuracy (% of RM or % of ES)

$$RA = \left[\frac{(|avg\ d| + |CC|)}{avg\ RM}\right] x\ 100\%$$

Relative Accuracy (by Absolute Difference)

For Pollutant Parameters (e.g., SO_2, NOx, CO): RA = |avg d| + |CC|

For Diluent Gas Parameters (e.g., O_2 and CO_2): RA = |avg d|

Where:

RA = Relative accuracy

CC = Confidence coefficient

d = Arithmetic difference between RM and CEMS values for each test run

avg d = Average arithmetic difference between RM and CEMS values for all test runs

RM = Reference Method value

ES = Emission Standard substituted for RM