1. Introduction

1.1 Background

Dow retained AECOM to conduct Relative Accuracy Test Audit (RATA) on the Dual Nitrogen Oxides (NO_x), Sulfur Dioxide (SO_2), Carbon Monoxide (CO) and Oxygen (O_2) continuous emissions monitoring systems (CEMS) and the continuous emission rate monitoring system (CERMS) serving the 32 Rotary Kiln Incinerator (EU-32Incinerator-S1) located in the Michigan Operations Incineration Complex at the Dow Chemical Company (Dow) facility in Midland, MI (Permit: MI-ROP-A4033-2017b; SRN: A4033). The RATA was conducted on August 17, 2022.

Dow operates a hazardous waste incineration complex at its Midland, Michigan chemical manufacturing facility. This unit is equipped with dual redundant NO_x, SO_2, CO, and O_2, CEMS, called CEM1 and CEM2, and an exhaust gas volumetric flow rate CERMS serving the 32 Incinerator exhaust stack (Stack SK-3300). The initial performance specification test was performed for the CEMS and CERMS on August 23-24, 2003.

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 an exhaust gas volumetric flow rate monitor 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. Analyzers (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 NO_x, SO_2, O_2, CO, and Flow Rate.

This document presents the results of the 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 summarizes the pertinent data for this performance test:

Responsible Groups	• The Dow Chemical Company • Michigan Department of Environmental Quality (MDEQ) • United States Environmental Protection Agency (US EPA)
Applicable Regulations	• Permit: MI-ROP-A4033-2017b; 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 Relative Accuracy Test Audit (RATA)	• October 12,2021
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	• NO_x • SO_2 • O_2 • CO • Flow Rate
Test Date	• August 17, 2022

1.3 Key Personnel

The contact for the source and test report is:

Rebekah Meyerholt
Environmental Focal Point
M: (989)325-6820(cell)
E: RMeyerholt@dow.com

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

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	Dan Bruck	Dow
Environmental Focal Point	• Ensure all regulatory requirements and citations are reviewed and considered for the testing	Becky Meyerholt	Dow
Air SME	• Leadership of the sampling program • Develop the overall testing plan • Determine the correct sample methods • Completes technical review of test data	Chuck Glenn	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	Rob Sava	AECOM
Field Team Leader	• Ensures field sampling meets quality assurance objectives of plan	Randy Reinke	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 MACT CO/O_2 CEMS and CERMS were operating within the required accuracy criteria. Relative accuracy results were calculated for each CEMS/CERMS for the following:

- NO_x Mass Emission Rate (lb/hr)
- SO_2 Mass Emission Rate (lb/hr)
- O_2 Concentration (%vd)
- CO Concentration (ppmvd)
- CO Concentration (ppmvd @ 7% O_2)
- Exhaust Gas Volumetric Flow Rate (scfm)
- Exhaust Gas Volumetric Flow Rate (dscfm)

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

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.

Test program participants included: Randy Reinke, James Edmister and Quincy Crawford from AECOM.

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.

On August 16, 2022, a 9-run RATA was competed. This RATA test was invalid due to facility operating parameters not meeting the requirements of "greater than 50% of normal operating rates in accordance with Part 60 guidelines". The valid RATA testing was completed on August 17, 2022. **Appendix E** contains the final results of the attempted, invalid RATA on August 16, 2022.

Table 1-1 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)	0.6% of RM 0.00% O_2	≤20.0% of RM (PS 3) [1] ≤1.0% O_2 (PS 3) [1]	Pass
	CO ppmv, dry (CEM1CO)	0.5% of ES 0.53 ppm CO	≤5% of ES (PS 4B) [2,3] ≤5 ppm CO (including CC, PS 4B) [2]	Pass
	CO ppmvd @ 7% O_2 (CEM1COCr)	0.9% of ES 0.93 ppm CO	≤5% of ES (PS 4B) [2,3] ≤5 ppm CO (including CC, PS 4B) [2]	Pass
CEMS – CEM2	O_2 percent, dry (AT33112)	0.7% of RM 0.01% O_2	≤20.0% of RM (PS 3) [1] ≤1.0% O_2 (PS 3) [1]	Pass
	CO ppmv, dry (CEM2CO)	0.5% of ES 0.53 ppm CO	≤5% of ES (PS 4B) [2,3] ≤5 ppm CO (including CC, PS 4B) [2]	Pass
	CO ppmvd @ 7% O_2 (CEM2COCr)	0.9% of ES 0.92 ppm CO	≤5% of ES (PS 4B) [2,3] ≤5 ppm CO (including CC, PS 4B) [2]	Pass
CEMS – CEM1/2	NOx, lb/hr	7.7% of RM 1.4% of ES	≤20.0% of RM (PS 2) [5] or ≤10% of ES (PS 2) [5]	Pass
	SO2 lb/hr	0.0% of ES	≤20.0% of RM (PS 2) [5] or ≤10% of ES (PS 2) [5]	Pass
CERMS (Stack SK-3300)	Gas Flow Rate, wet (scfm, SFIT3300)	3.4% of RM	≤20% of RM (PS 6) [4]	Pass
	Gas Flow Rate, dry (dscfm, FIT33009)	2.4% 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 SO2 must be either no greater than 20.0% of RM or 10% of ES.

2. Summary and Discussion of Results

The purpose of this Test Event was to demonstrate compliance with Annual RATA Requirements for the 32 Incinerator CEMS (CEM1 and CEM2) NO_x, SO_2, CO, and O_2 monitors and CERMS exhaust gas volumetric flow rate monitor at the Michigan Operations Incineration Complex in Midland, Michigan. The specific objectives were:

- Determine the relative accuracy of the 32 Incinerator MACT $NO_x/SO_2CO/O_2$ CEMS/CERMS on the Kiln SK-3300 stack.

During the RATA Testing, the process was operated at greater than 50% of normal operating rates in accordance with Part 60 guidelines. Summaries of the results for the Performance Specification Test of the 32 Incinerator CEMS (CEM1 and CEM2) NO_x, SO_2, CO and O_2 monitors and CERMS exhaust gas volumetric flow rate monitor 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 CEMS 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 NO_x, 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 MACT CEMS CEM1 and CEMS CEM 2 NO_x, SO_2, CO and O_2 monitors are presented in **Tables 2-1 through 2-4** for NO_x as lb/hr, SO_2 as lb/hr, O_2 as percent by volume on a dry basis (%vd), CO measured as parts per million by volume on a dry basis (ppmvd), CO measured as ppmvd corrected to seven (7) percent exhaust gas oxygen (ppmvd @ 7% O_2). 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 MACT CEMS CEM1 NOx, SO2, O_2 and CO monitors passed the RA criteria in PS 2, PS 3 and PS 4B.

2.2 Relative Accuracy Test Results – Stack SK-3300 CERMS

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 results are referred to as the Reference Method Results, which were measured both on a wet and dry basis. The results of the RATA program for the facility Stack SK-3300 CERMS exhaust gas flow rate monitors are presented in **Table 2-5** for flow rate measured as standard cubic feet per minute on a wet basis (scfm), and for flow rate measured as standard cubic feet per minute on a dry basis (dscfm). 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 monitor passed the RA criteria in PS 6.

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	
8/17/2022	TIME	Oxygen (%)	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]
EU-32Incinerator Run 1	08:30-08:51	13.40	5.72	12.63	13.42		13.45		0.03		0.05	
EU-32Incinerator Run 2	08:51-09:12	13.43	5.72	12.67	13.27		13.35		-0.17		-0.08	
EU-32Incinerator Run 3	09:12-09:33	13.04	5.72	12.30	13.16		13.23		0.12		0.19	
EU-32Incinerator Run 4	10:05-10:26	12.89	5.20	12.22	12.87		12.73		-0.02		-0.16	
EU-32Incinerator Run 5	10:26-10:47	13.07	5.20	12.39	13.11		13.16		0.04		0.08	
EU-32Incinerator Run 6	10:47-11:08	12.66	5.20	12.00	12.79		12.67		0.13		0.00	
EU-32Incinerator Run 7	11:35-11:56	11.33	5.48	10.71	11.36		11.34		0.04		0.01	
EU-32Incinerator Run 8	11:56-12:17	13.18	5.48	12.46	13.09		13.11		-0.09		-0.08	
EU-32Incinerator Run 9	12:17-12:38	12.62	5.48	11.93	12.53		12.84		-0.09		0.22	
EU-32Incinerator Run 10	13:10-13:31	11.38	5.22	10.78	11.23		11.28		-0.15		-0.10	
EU-32Incinerator Run 11	13:31-13:52	11.20	5.22	10.62	11.32		11.12		0.11		-0.09	
EU-32Incinerator Run 12	13:52-14:13	12.15	5.22	11.52	12.33	X	5.92	X	0.17	X	-6.24	X

	CEM1 O2 AT33105	CEM2 O2 AT33112
Number of Runs Used in Calculation (n)	11	11
Average Difference (d_{AVG})	0.00	0.01
Standard Deviation (S_d)	0.11	0.12
t-Value ($t_{0.975}$)	2.228	2.228
Confidence Coefficient (CC)	0.072	0.082
Average of Reference Method (RM_{AVG})	12.56	12.56
Relative Accuracy (O_2) ($\lvert d_{AVG} \rvert$)	0.00	0.01
Relative Accuracy (O_2) ($\lvert d_{AVG} \rvert + \lvert CC \rvert$)	0.1	0.1
Relative Accuracy (% of Reference Method) (RA)	0.6	0.7

[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	20

Table 2-2 Relative Accuracy Results for CEM1 and CEM2 CO (ppmv and ppmvd @ 7% O2)

Carbon Monoxide Relative Accuracy Results

REFERENCE METHOD — Oxygen Conc for Correction (%): 7; Correction for Moisture

8/17/2022	TIME	Flow (dscfm)	Oxygen (%, dry)	Carbon Monoxide (ppm dry)	Carbon Monoxide (ppm, dry) (Oxygen Corrected)	Carbon Monoxide (lb/hr)	Moisture (%)	Carbon Monoxide (ppm, wet)
EU-32Incinerator Run 1	08:30-08:51	42,056	13.40	-0.2	-0.3	0.0	5.7	-0.2
EU-32Incinerator Run 2	08:51-09:12	43,232	13.43	-0.2	-0.3	0.0	5.7	-0.1
EU-32Incinerator Run 3	09:12-09:33	45,009	13.04	-0.2	-0.3	0.0	5.7	-0.2
EU-32Incinerator Run 4	10:05-10:26	47,242	12.89	-0.2	-0.3	0.0	5.2	-0.2
EU-32Incinerator Run 5	10:26-10:47	46,719	13.07	-0.2	-0.3	0.0	5.2	-0.2
EU-32Incinerator Run 6	10:47-11:08	46,118	12.66	-0.2	-0.3	0.0	5.2	-0.2
EU-32Incinerator Run 7	11:35-11:56	41,938	11.33	0.0	0.0	0.0	5.5	0.0
EU-32Incinerator Run 8	11:56-12:17	41,769	13.18	-0.2	-0.3	0.0	5.5	-0.2
EU-32Incinerator Run 9	12:17-12:38	42,836	12.62	-0.2	-0.3	0.0	5.5	-0.2
EU-32Incinerator Run 10	13:10-13:31	41,850	11.38	-0.2	-0.3	0.0	5.2	-0.2
EU-32Incinerator Run 11	13:31-13:52	41,922	11.20	-0.1	-0.2	0.0	5.2	-0.1
EU-32Incinerator Run 12	13:52-14:13	42,224	12.15	-0.2	-0.3	0.0	5.2	-0.2

STACK ANALYZERS

8/17/2022	CEM1CORangeCalc Carbon Monoxide (ppm, dry)	Use of Run[1]	CEM2CORangeCalc Carbon Monoxide (ppm, dry)	Use of Run[1]	CEM1CORangeCalc Carbon Monoxide (ppm, dry) (Oxygen Corrected)	Use of Run[1]	CEM2CORangeCalc Carbon Monoxide (ppm, dry) (Oxygen Corrected)	Use of Run[1]
EU-32Incinerator Run 1	0.36		0.36		0.66	X	0.67	X
EU-32Incinerator Run 2	0.40		0.26		0.73	X	0.47	
EU-32Incinerator Run 3	0.32		0.37		0.58		0.66	
EU-32Incinerator Run 4	0.29		0.32		0.50		0.54	
EU-32Incinerator Run 5	0.26		0.19		0.47		0.35	
EU-32Incinerator Run 6	0.36		0.39		0.61		0.65	
EU-32Incinerator Run 7	0.51		0.69	X	0.75		1.01	
EU-32Incinerator Run 8	0.34		0.29		0.60		0.52	
EU-32Incinerator Run 9	0.27		0.26		0.45		0.45	
EU-32Incinerator Run 10	0.47	X	0.30		0.68		0.44	
EU-32Incinerator Run 11	0.52	X	0.55	X	0.76		0.77	X
EU-32Incinerator Run 12	0.42	X	0.23	X	0.69	X	0.21	X

ARITHMETIC DIFFERENCE and RATA Calculations

8/17/2022	CEM1CORangeCalc Carbon Monoxide (ppm, dry)	Use of Run[1]	CEM2CORangeCalc Carbon Monoxide (ppm, dry)	Use of Run[1]	CEM1CORangeCalc Carbon Monoxide (ppm, dry) (Oxygen Corrected)	Use of Run[1]	CEM2CORangeCalc Carbon Monoxide (ppm, dry) (Oxygen Corrected)	Use of Run[1]
EU-32Incinerator Run 1	0.54		0.54		1.00	X	1.01	X
EU-32Incinerator Run 2	0.56		0.41		1.03	X	0.77	
EU-32Incinerator Run 3	0.49		0.53		0.88		0.96	
EU-32Incinerator Run 4	0.47		0.50		0.82		0.86	
EU-32Incinerator Run 5	0.44		0.37		0.78		0.66	
EU-32Incinerator Run 6	0.54		0.57		0.93		0.97	
EU-32Incinerator Run 7	0.48		0.67	X	0.71		0.97	
EU-32Incinerator Run 8	0.51		0.46		0.90		0.82	
EU-32Incinerator Run 9	0.46		0.45		0.77		0.78	
EU-32Incinerator Run 10	0.66	X	0.49		0.95		0.70	
EU-32Incinerator Run 11	0.67	X	0.69	X	0.97		0.98	X
EU-32Incinerator Run 12	0.59	X	0.39	X	0.95	X	0.47	X

	CEM1CORangeCalc	CEM2CORangeCalc	CEM1CORangeCalc (Oxygen Corrected)	CEM2CORangeCalc (Oxygen Corrected)
Number of Runs Used in Calculation (n)	9	9	9	9
Average Difference (d_{AVG})	0.50	0.48	0.86	0.83
Standard Deviation (S_d)	0.04	0.06	0.09	0.12
t-Value ($t_{0.975}$)	2.306	2.306	2.306	2.306
Confidence Coefficient (CC)	0.03	0.05	0.07	0.09
Applicable Standard (or Permit Limit)	100	100	100	100
Average of Reference Method (RM_{AVG})	-0.15	-0.18	-0.26	-0.26
Relative Accuracy (CO, NO_X, SO_2, O_2,CO_2) ($\|d_{AVG}\|+\|CC\|$)	0.53	0.53	0.93	0.92
Relative Accuracy (% of Reference Method) (RA)	-345.1	-299.3	-361.9	347.1
Relative Accuracy (% of Permit Limit) (RA)	0.5	0.5	0.9	0.9

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

	CEM1CORangeCalc	CEM2CORangeCalc	CEM1CORangeCalc (Oxygen Corrected)	CEM2CORangeCalc (Oxygen Corrected)
Performance Specification 4				
Relative Accuracy (% of Reference Method) (RA)	10	10	10	10
Relative Accuracy (% of Permit Limit) (RA)	5	5	5	5
Performance Specification 4A				
Relative Accuracy (CO) ($\|d_{AVG}\|+\|CC\|$)(RA as ppmv)	5	5	5	5
Relative Accuracy (% of Reference Method) (RA)	10	10	10	10
Relative Accuracy (% of Permit Limit) (RA)	5	5	5	5
Performance Specification 4B				
Relative Accuracy (CO) ($\|d_{AVG}\|+\|CC\|$)(RA as ppmv)	5	5	5	5
Relative Accuracy (% of Reference Method) (RA)	10	10	10	10
Relative Accuracy (% of Permit Limit) (RA)	5	5	5	5

Table 2-3 Relative Accuracy Results for CEM1 and CEM2 NO_x (lb/hr)

Nitrogen Oxides Relative Accuracy Results

8/17/2022	TIME	REFERENCE METHOD: Flow (dscfm)	Oxygen (%, dry)	Nitrogen Oxides (ppm dry)	Nitrogen Oxides (ppm, dry) (Oxygen Corrected) — Oxygen Conc for Correction (%): 7	Nitrogen Oxides (lb/hr)	STACK ANALYZERS: CEM1NOxRangeCalc Nitrogen Oxides (ppm, dry)	Use of Run[1]	CEM2NOxRangeCalc Nitrogen Oxides (ppm, dry)	Use of Run[1]	AIR1_NOX_FLW_OMA Nitrogen Oxides (lb/hr)	Use of Run[1]	ARITHMETIC DIFFERENCE and RATA: CEM1NOxRangeCalc Nitrogen Oxides (ppm, dry)	Use of Run[1]	CEM2NOxRangeCalc Nitrogen Oxides (ppm, dry)	Use of Run[1]	AIR1_NOX_FLW_OMA Nitrogen Oxides (lb/hr)	Use of Run[1]
EU-32Incinerator Run 1	08:30-08:51	42,056	13.40	90.4	167.5	27.2	94.90		94.96		31.97	X	4.50		4.56		4.73	X
EU-32Incinerator Run 2	08:51-09:12	43,232	13.43	67.0	124.7	20.7	70.79		70.86		21.50		3.81		3.88		0.75	
EU-32Incinerator Run 3	09:12-09:33	45,009	13.04	83.2	147.3	26.8	87.68		87.93		27.93		4.44		4.69		1.09	
EU-32Incinerator Run 4	10:05-10:26	47,242	12.89	75.6	131.2	25.6	79.87		80.48	X	25.96		4.32		4.93	X	0.39	
EU-32Incinerator Run 5	10:26-10:47	46,719	13.07	61.2	108.6	20.5	64.52		64.96		21.24		3.36		3.80		0.77	
EU-32Incinerator Run 6	10:47-11:08	46,118	12.66	85.4	144.1	28.2	89.08		89.45		29.66		3.65		4.03		1.43	
EU-32Incinerator Run 7	11:35-11:56	41,938	11.33	59.0	85.6	17.7	61.74		62.39		20.62		2.77		3.42		2.90	
EU-32Incinerator Run 8	11:56-12:17	41,769	13.18	123.8	223.0	37.0	129.81	X	130.17	X	38.40		6.00	X	6.37	X	1.35	
EU-32Incinerator Run 9	12:17-12:38	42,836	12.62	137.5	230.8	42.2	143.14	X	142.06		44.78		5.69	X	4.61		2.60	
EU-32Incinerator Run 10	13:10-13:31	41,850	11.38	110.6	161.5	33.2	116.03		115.49		36.75	X	5.41		4.87		3.58	X
EU-32Incinerator Run 11	13:31-13:52	41,922	11.20	70.4	100.9	21.1	74.59		74.80		22.56		4.21		4.42		1.42	
EU-32Incinerator Run 12	13:52-14:13	42,224	12.15	58.8	93.4	17.8	62.06	X	31.29	X	18.56	X	3.29	X	-27.49	X	0.78	X

	CEM1NOxRangeCalc	CEM2NOxRangeCalc	AIR1_NOX_FLW_OMA
Number of Runs Used in Calculation (n)	9	9	9
Average Difference (d_{AVG})	4.05	4.25	1.41
Standard Deviation (S_d)	0.76	0.49	0.84
t-Value ($t_{0.975}$)	2.306	2.306	2.306
Confidence Coefficient (CC)	0.58	0.38	0.64
Applicable Standard (or Permit Limit)	151	151	151
Average of Reference Method (RM_{AVG})	78.08	84.96	26.66
Relative Accuracy (CO, NO_x, SO_2, O_2,CO_2) ($\|d_{AVG}\|+\|CC\|$)	4.6	4.6	2.1
Relative Accuracy (% of Reference Method) (RA)	5.9	5.4	7.7
Relative Accuracy (% of Permit Limit) (RA)	3.1	3.1	1.4
Performance Specification 2			
Relative Accuracy (% of Reference Method) (RA)	20	20	20
Relative Accuracy (% of Permit Limit) (RA)	10	10	10

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

Table 2-4 Relative Accuracy Results for CEM1 and CEM2 SO_2 (lb/hr)

Sulfur Dioxide Relative Accuracy Results

		REFERENCE METHOD							STACK ANALYZERS						ARITHMETIC DIFFERENCE and RATA					
			Oxygen Conc for Correction (%)		7		Correction for Moisture		CEMS CEM1 SO2 AT33103		CEMS CEM1 SO2 AT33110		AIR1_SO2_FLW_ OMA		CEMS CEM1 SO2 AT33103		CEMS CEM1 SO2 AT33110		AIR1_SO2_FLW_ OMA	
8/17/2022	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)	Use of Run[1]	Sulfur Dioxide (lb/hr)	Use of Run[1]	Sulfur Dioxide (ppm, dry)	Use of Run[1]	Sulfur Dioxide (ppm, dry)	Use of Run[1]	Sulfur Dioxide (lb/hr)	Use of Run[1]
32Incinerator Ru	08:30-08:51	42,056	13.40	0.1	0.2	0.0	5.7	0.1	0.06		0.02		0.03		-0.04		-0.08		-0.01	
32Incinerator Ru	08:51-09:12	43,232	13.43	0.0	0.0	0.0	5.7	0.0	0.06		0.02		0.03		0.04		0.00		0.02	
32Incinerator Ru	09:12-09:33	45,009	13.04	0.0	0.0	0.0	5.7	0.0	0.06		0.02		0.03		0.06		0.02		0.03	
32Incinerator Ru	10:05-10:26	47,242	12.89	0.1	0.2	0.0	5.2	0.1	0.06		0.02		0.03		-0.05		-0.09		-0.02	
32Incinerator Ru	10:26-10:47	46,719	13.07	0.0	0.1	0.0	5.2	0.0	0.06		0.02		0.03		0.01		-0.03		0.00	
32Incinerator Ru	10:47-11:08	46,118	12.66	0.0	0.1	0.0	5.2	0.0	0.06		0.02		0.03		0.02		-0.03		0.01	
32Incinerator Ru	11:35-11:56	41,938	11.33	0.1	0.2	0.0	5.5	0.1	0.06		0.02		0.03		-0.06		-0.10		-0.02	
32Incinerator Ru	11:56-12:17	41,769	13.18	0.1	0.2	0.0	5.5	0.1	0.06		0.02		0.02		-0.02		-0.07		-0.01	
32Incinerator Ru	12:17-12:38	42,836	12.62	0.0	0.1	0.0	5.5	0.0	0.06		0.02		0.03		0.02		-0.03		0.01	
32Incinerator Ru	13:10-13:31	41,850	11.38	0.2	0.3	0.1	5.2	0.2	0.06	X	0.02	X	0.03	X	-0.17	X	-0.21	X	-0.07	X
32Incinerator Ru	13:31-13:52	41,922	11.20	0.1	0.2	0.1	5.2	0.1	0.06	X	0.02	X	0.02	X	-0.06	X	-0.10	X	-0.03	X
32Incinerator Ru	13:52-14:13	42,224	12.15	0.1	0.1	0.0	5.2	0.1	0.06	X	40.90	X	0.02	X	0.00	X	40.84	X	0.00	X

	CEMS CEM1 SO2 AT33103	CEMS CEM1 SO2 AT33110	AIR1_SO2_FLW_ OMA
Number of Runs Used in Calculation (n)	9	9	9
Average Difference (d_{AVG})	0.00	-0.04	0.00
Standard Deviation (S_d)	0.04	0.04	0.02
t-Value ($t_{0.975}$)	2.306	2.306	2.306
Confidence Coefficient (CC)	0.03	0.03	0.01
Applicable Standard (or Permit Limit)	27	27	36
Average of Reference Method (RM_{AVG})	0.06	0.06	0.03
Relative Accuracy (CO, NO_X, SO_2, O_2,CO_2) ($\lvert d_{AVG}\rvert + \lvert CC \rvert$)	0.0	0.1	0.0
Relative Accuracy (% of Reference Method) (RA)	54.6	121.4	52.0
Relative Accuracy (% of Permit Limit) (RA)	0.1	0.3	0.0
Performance Specification 2			
Relative Accuracy (% of Reference Method) (RA)	20	20	20
Relative Accuracy (% of Permit Limit) (RA)	10	10	10

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

Table 2-5 Relative Accuracy Results for CERMS Flow Rate, wet (scfm) and dry (dscfm)

		REFERENCE METHOD		STACK ANALYZERS				ARITHMETIC DIFFERENCE			
				SK3300 Dry Flow FIT33009		SK3300 Total Flow SFIT3300		SK3300 Dry Flow FIT33009		SK3300 Total Flow SFIT3300	
Run Number	TIME	Flow (dscfm)	Flow (scfm)	Flow Rate (dscfm)	Use of Run[1]	Flow Rate (scfm)	Use of Run[1]	Flow Rate (dscfm)	Use of Run[1]	Flow Rate (scfm)	Use of Run[1]
Flow Run 1	08:30-08:51	42,056	44,607	46,167	X	49,379	X	4,112	X	4,772	X
Flow Run 2	08:51-09:12	43,232	45,855	41,759		44,808		-1,474		-1,047	
Flow Run 3	09:12-09:33	45,009	47,739	44,022		46,938		-986		-802	
Flow Run 4	10:05-10:26	47,242	49,831	44,723	X	47,496		-2,518	X	-2,335	
Flow Run 5	10:26-10:47	46,719	49,280	44,925		47,749		-1,794		-1,531	
Flow Run 6	10:47-11:08	46,118	48,647	45,964		45,964		-154		-2,682	
Flow Run 7	11:35-11:56	41,938	44,372	44,230		47,716		2,292		3,344	
Flow Run 8	11:56-12:17	41,769	44,193	41,953		44,822		184		629	
Flow Run 9	12:17-12:38	42,836	45,322	43,350		46,246		514		924	
Flow Run 10	13:10-13:31	41,850	44,156	43,398		46,239		1,548		2,083	
Flow Run 11	13:31-13:52	41,922	44,232	41,848		44,600		-74		367	
Flow Run 12	13:52-14:13	42,224	44,551	41,828	X	45,196	X	-397	X	645	X
Number of Runs Used in Calculation (n)								9		10	
Average Difference (d_{AVG})								6		-105	
Standard Deviation (S_d)								1,339		1,930	
t-Value ($t_{0.975}$)								2.306		2.262	
Confidence Coefficient (CC)								1,029		1,381	
Permit Limit											
Average of Reference Method (RM_{AVG})								43,488		43,617	
Relative Accuracy (in dscfm) ($\|d_{AVG}\|+\|CC\|$)								1,035		1,486	
Relative Accuracy (% of Reference Method) (RA)								2.4		3.4	
Relative Accuracy (% of Permit Limit) (RA)								#DIV/0!		#DIV/0!	

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

Performance Specification	***ACCEPTANCE CRITERIA***
Relative Accuracy (% of Reference Method) (RA)	20

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 two redundant MACT CO/O_2 CEMS, CEM1 and CEM2, along with a flow rate CERMS 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-A4033-2017b).

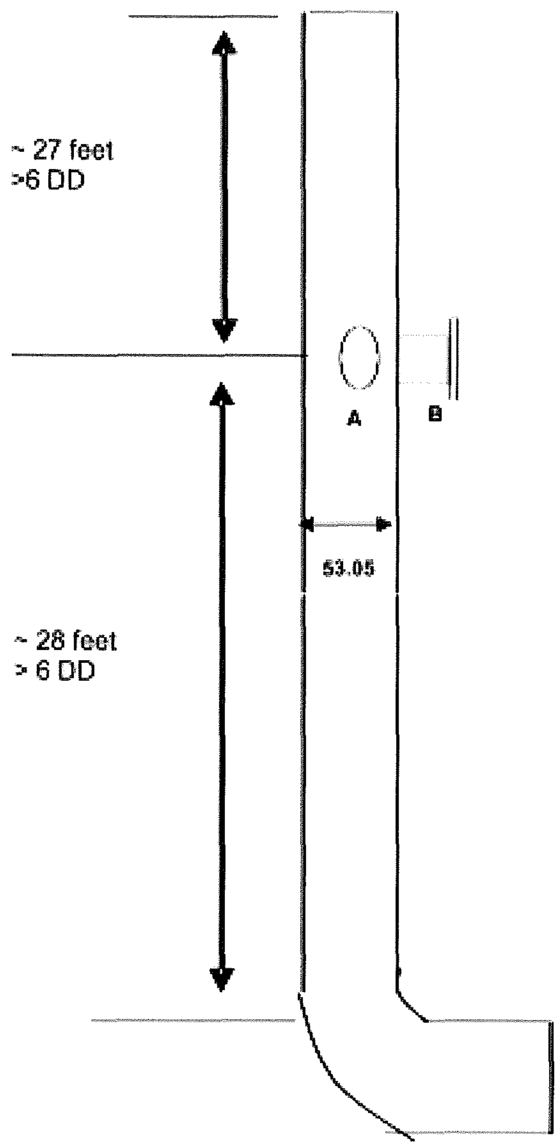
Each MACT CEMS is a dry-extractive non-dilution type that was designed and installed to meet emissions monitoring requirements outlined in 40 CFR Part 60, Appendix B, Performance Specifications (PS) 3 and 4B.

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 14	3.244193.2
	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 16	3.244195.2
CEM2	CO	ppmvd	ABB, Inc.	Uras 14	3.244192.2
	NO_x	ppmvd	ABB, Inc.	Limas 11	3.244190.2
	SO_2	ppmvd	ABB, Inc.	Limas 11	3.244190.2
	O_2	Vol%, dry	ABB, Inc.	Magnos 16	3.244194.2
CERMS	Flow Rate	scfm / dscfm	Panametric	GM868-1-11-10003-S	1289 & 1878

Figure 3-1 Schematic of Stack Sample Port Locations



4. RATA Test Procedures

The following is a description of the testing that was completed on the 32 Incinerator MACT $NO_x/SO_2/CO/O_2$ CEMS/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-A4033-2017b).

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, SO_2, NO_x, 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 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, NO_x, 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 O_2, SO_2, NO_x, and CO, and flow rate. 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 the 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 NO_x 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, SO_2, NO_x, 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 NO_x, 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 CO_2 and O_2 were measured using a Servomex 4900 Series analyzer with paramagnetic and non-dispersive infrared (NDIR) detectors on an approximate span gas ranges of 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 NO_x was measured using a Thermo iQ series 42 chemiluminescent analyzer on an approximate span gas range of 0-300 ppm. The SO_2 was measured using an Ametek 900 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 NO_x, 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 $NO_x/SO_2/O_2/CO_2/CO$ 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 included to meet the requirements of Method 7E (Subsection 8.2.7) as referenced in Methods 3A 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 NO_x, 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 NO_x, 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 $NO_x/SO_2/CO/O_2$ 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 in this section.

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