CEMS Certification Report

Silicone Facility THROX
FGTHROX
Permit # 91-07E

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AIR QUALITY DIVISION

Dow Performance Silicones
Michigan Operations
Midland, Michigan

Sampling Dates: November 07, 2017

**** Please note the process unit is the final copy holder and owner of this document. A temporary electronic copy will be retained by internal stack testing group for a short period of time.***

Compliance Sample Report

I certify that I have personally examined and am familiar with the information submitted herein, and based on my inquiries of those individuals immediately responsible for obtaining the information; I believe the submitted information is true, accurate, and complete.

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Dow Stack Testing Team

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Dow Corning
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1.1 Summary of Test Program

Dow Corning Corporation, a subsidiary of the Dow Chemical Company, operates a chemical manufacturing facility in Midland, Michigan. The facility uses a thermal oxidizer with a caustic scrubber and two ionizing wet scrubbers to control emissions. The treatment system includes a continuous emission monitoring system (CEMS) that continuously measures stack gas concentration of nitrogen oxides (NOx), carbon dioxide (CO_2), oxygen (O_2), total hydrocarbons (THC) and air flow rate.

Each of the CEMS are required to meet the analyte specific performance specification annually.

The internal stack testing team performed the relative accuracy (RA) testing on the CEMS Nov 7th, 2017. All testing was performed according to the procedures detailed in 40 CFR Part 60, Appendix B, Performance Specifications (PS) 2, 3, 6 and 8.

The following table summarizes the pertinent data for this compliance test:

Responsible Groups	• The Dow Corning Corporation, a subsidiary of the Dow Chemical Company • Michigan Department of Environmental Quality (MDEQ) • Environmental Protection Agency (EPA)
Applicable Regulations	• Permit-91-07E • 40 CFR Part 63 Subpart FFFF • 40 CFR 50.21 PSD • 40 CFR Part 98 • 40 CFR Part 60, Appendix B, Performance Specification 2, 3 6 and 8.
Industry / Plant	• Silicone Manufacturing 2514 THROX unit
Plant Location	• The Dow Corning Company, a subsidiary of the Dow Chemical Company Midland, Michigan 48667
Unit Initial Start-up	• May 2008
Date of Last RATA	• November 15, 2016
Air Pollution Control Equipment	• Quench tower • HCl scrubber • Two ionizing wet scrubbers (IWS)
Emission Points	• SV2514-006
Pollutants/Diluent Measured	Relative Accuracy • Oxygen (O_2) RA ≤ 20% of RM or absolute difference ≤ 1.0% • Carbon Dioxide (CO_2) RA ≤ 20% of RM or absolute difference ≤ 1.0% • NOx RA ≤ 20% of RM • Total Hydrocarbon (THC) RA ≤ 20% of RM or ≤ 10% of EL (20 ppm) • Flow RA ≤ 20% of RM
Test Date	• November 07, 2017

1.2 Key Personnel

The key personnel who coordinated the test program are:

- Matthew Miner provided support as a Process Focal Point. The Process Focal Point is responsible for coordinating the plant operation during the test and ensuring the unit is operating at the agreed upon conditions in the test plan. They also serve as the key contact for collecting any process data required and providing all technical support related to process operation.

- Laura Maiers provided support as the Environmental Focal Point for this unit. The Environmental Focal Point is responsible for ensuring that all regulatory requirements and citations are reviewed and considered for the testing. All agency communication will be completed through this role. Contact information is 989-496-5327.

- Chuck Glenn served as the Test Plan Coordinator. The Test Plan Coordinator is responsible for the overall leadership of the sampling program. They also develop the overall testing plan and determine the correct sample methods.

- Spencer Hurley was the back-up for the Test Plan Coordinator. He also served as the technical review role of the test data.

- Michael Abel is a PhD chemist who serves in many roles for Environmental Analytical Chemistry (EAC). One of the roles he performs is as a technical contact for air sampling. Michael serves as a quality assurance and technical reviewer of the final test report.

- Daniel Nunez served as the Project Manager and was responsible for ensuring that the data generated meets the quality assurance objectives of the plan. Dan Bennett, Kyle Kennedy and Jim Edmister are sampling technicians that completed this testing.

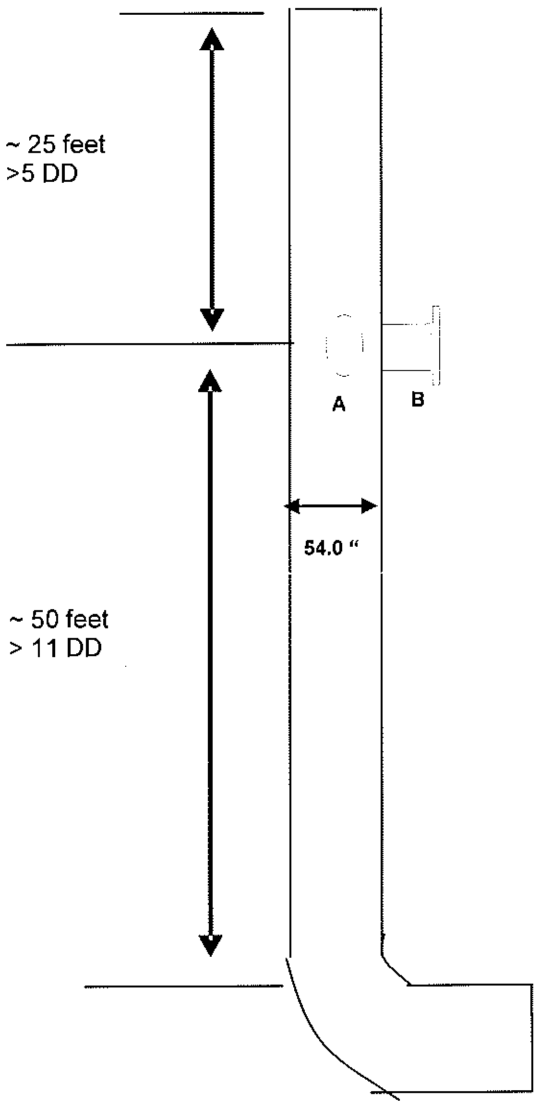
2.1 Facility Description

The THROX and IWS are utilized to treat emissions from various processes at the chemical facility. The typical feed rate to the THROX is approximately 28 MMBtu/hr. The permitted maximum operating rate for the THROX is 95 MMBTU/hr. The proposed production operating rate for this test is >30 MMBTU/hr.

2.2 Flue Gas Sampling Locations

Sampling was conducted on the THROX outlet stack. The CEMS sample points for the THROX 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 may occur, and at least one half equivalent diameters upstream from the effluent exhaust or control device. The samples were drawn from the stack for a period of 21 minutes at the three traverse points of 17, 50, and 83% of the measurement line that passes through the centroidal area of the stack or duct cross section. A calibrated multi point averaging probe was used.

Figure 2.1 Stack Description



Non-Isokinetic 16 Point Circular Traverse Layout for Outlet

Division: Dow Performance Silicones
Facility/Block: 2514 Midland THROX

Stack ID: 54 inches
Port Ext: 6 inches

Duct Downstream Length: 50 Feet
Duct Upstream Length: 25 Feet

Duct Downstream Diameters: 11 Diameters
Duct Upstream Diameters: 5.5 Diameters

Traverse Point	Stack ID	Port Ext	Traverse Pt Distance	Traverse Pt Distance	Final Probe Mark
1	54	8	2 6/16	2 6/16	8 6/16
2	54	8	7 14/16	7 14/16	13 14/16
3	54	8	16	16	22
4	54	8	38	38	44
5	54	8	46 2/16	46 2/16	52 2/16
6	54	8	51 10/16	51 10/16	57 10/16

3.1 Objectives and Test Matrix

The purpose of this test was to demonstrate compliance with the regulations for the THROX at the Dow Corning Corporation, a wholly owned subsidiary of The Dow Chemical Company in Midland, Michigan. The specific objectives were:

- Determine the relative accuracy of the continuous NOx, O_2, CO_2, THC and flow monitor systems on the THROX stack.

3.2 Facility Operations

- During the CEMS test, the plant was operated at greater than 50% of normal operating rates. The operating rate for this unit was determined based on mmBtu/Hr rate.

3.3 Comments / Exceptions

- As allowed by 40 CFR Part 60, PS 2, 3 and 4, this Performance Specification Test consisted of a minimum of 9 RM tests used for RA calculations. More than nine sets of RM tests may have been performed. If this option was selected, a maximum of three sets of the test results were rejected so long as the total number of test results used to determine the RA was greater than or equal to nine. All data was reported, including the rejected data.
- Tom Gasloli of the Michigan Department of Environmental Quality was present during sampling.

Summary of Results
Continuous Emission/Emission Rate Monitor Certification

Table 3.1 Performance Results for Emission Reporting Tags

Monitor	Results	Allowable	Pass/Fail Semi/Annual
NOx Mass Emissions (lb/hr)	17 %	No greater than 20% RA using RM	Pass
			Pass

Please note that the relative accuracy performance results for NOx emission reporting tag reflect the relative accuracy based on a comparison with the reference method and emission reporting tag.

Table 3.2 Performance Results for CEMS System

Monitor	Results	Allowable	Pass/Fail Semi/Annual
CO2 Conc. (%)	0.9 %	No greater than 20.0 % of mean value of RM or the absolute difference between RM and CEMS <= 1.0%	Pass
	0.0 %		Pass
			Pass
O2 Conc. (%)	0.5 %	No greater than 20.0 % of mean value of RM or the absolute difference between RM and CEMS <= 1.0%	Pass
	0.0 %		Pass
			Pass
THC Conc. (ppm)	149 %	No greater than 20.0 % RA using RM or No greater than 10 % RA using EL	Use Alternative
	1 %		Pass
			Pass
Vol Flow (scfm)	20 %	No greater than 20% RA using RM	Pass
SIC Flow (scfm)	4 %	No greater than 20% RA using RM	Pass

4.1 Test Methods

The relative accuracies of the CEMS were determined by comparison to EPA methods for measurement of each component gas. The performance specifications (PS) require the use of the following methods:

- PS 2 - Method 7E for NO_x;
- PS 3 - Method 3A for O_2;
- PS 3 - Method 3A for CO_2;
- PS 6 - Methods 1, 2, 3 and 4 for flow; and
- PS 8 - Method 25A for THC

4.2 Procedures

Relative Accuracy

The above methods were performed using mobile continuous emission monitors provided by The Dow Chemical Company internal testing team. Gas was withdrawn from the stack and transported to monitors located at ground level. A stainless-steel probe was inserted into the stack and used to collect sample gas. A Teflon sample line heated to 250°F transported sample gas from the probe to the analyzers. The analyzers were kept at a constant temperature inside the mobile laboratory.

Sample gas was collected continuously from the stack for a period of 21 minutes per run at the three traverse points of 16.7%, 50% and 83.3% of the measurement line that passes through the centroidal area of the stack or duct cross section. At the mobile laboratory, the stack gas was routed to a condenser and then transported to the analyzers for analysis.

The Relative Accuracy Tests was conducted by comparison of the CEMS response to a value measured by a Performance Test Method (PTM) which, in this case, will be Method 7E for NOx, EPA Method 25A for THC, EPA Methods 1-4 for Flowrate and 3A for O_2.

EPA Method 1 (Sample Point Determination)

The number and location of traverse points in the stack were determined according to the procedures outlined in EPA Method 1.

EPA Method 2 (Flue Gas Velocity and Volumetric Flow Rate)

The flue gas velocity and volumetric flow rate were determined according to the procedures outline in 40 CFR 60, Appendix A, EPA Method 2. Velocity measurements were made using S-type pitot tubes conforming to the geometric specifications outlined in EPA Method 2. Differential pressures were measured with fluid manometer. Flue gas temperature, velocity, and volumetric flow rate data was recorded.

EPA Method 3A (Flue Gas Composition and Molecular Weight)

EPA Method 3A (Instrumental Method) was utilized to determine the diluent during each run on the outlet.

An analyzer measured O_2 content on the basis of the strong paramagnetic properties of O_2 relative to other compounds present in combustion gases. In the presence of a magnetic field, O_2 molecules become temporary magnets. The analyzer determines the sample gas O_2 concentration by detecting the displacement torque of the sample test body in the presence of a magnetic field.

An analyzer measured CO_2 based on its absorption of infrared radiation. The infrared unit uses a single beam, single wavelength technique, with wavelength selection being achieved by a carefully specified narrow band optical filter making it highly selective for CO_2 measurement in the presence of other infrared-absorbing gases.

EPA Method 4 (Moisture)

A calibrated Method 5 console pulled stack gas samples through a Method 5 probe equipped with a glass liner to determine percent moisture of the stack gas. Stack gas was bubbled through two impingers containing water, one empty impinger, and one impinger containing silica gel. All of the impingers were weighed prior to sampling. The impinger train was kept iced in order to knock out all moisture in the stack gas. After the final leak check following each run, the exterior of the impingers were dried off and the impingers were weighed to determine percent moisture. ***Dow was allowed to complete up to 4-63 minute moisture runs. A sample was collected to coincide with each of the 1 minute runs. For each moisture sample, no more than 3-21 minute runs were represented.***

EPA Method 7E (NO_X Sampling and Analysis)

EPA Method 7E was utilized to determine nitrogen oxide concentrations during each run on the outlet.

An analyzer measured NOx using chemiluminescence technology. Ozone is combined with nitric oxide to form nitrogen dioxide in an activated state. The activated NO_2 luminesces broadband visible to infrared light as it reverts to a lower energy state. A photomultiplier and associated electronics counts the photons that are proportional to the amount of NO present. Since the stream contains both NO and NO_2, the amount of nitrogen oxide (NO_2) must first be converted to nitric oxide, NO, by passing the sample through a converter before the above ozone activation reaction is applied. The above reaction yields the amount of NO and NO_2 combined in the air sample.

EPA Method 25A (Total VOC Sampling and Analysis)

EPA Method 25A will be utilized to determine total THC as propane concentrations during each run on the outlet.

A gas sample is extracted from the source through a heated line to a flame ionization analyzer (FIA). Results will be reported as volume concentration equivalent to propane.

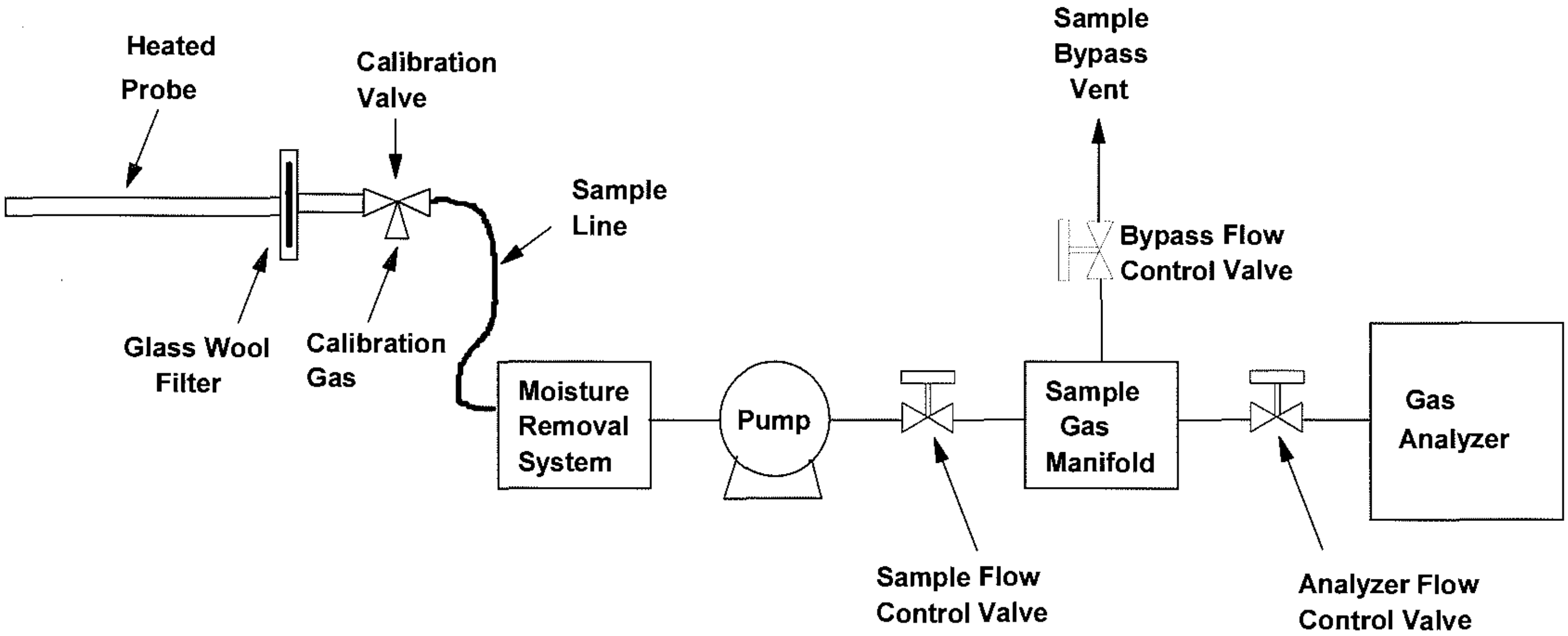
4.3 List of Sampling Equipment

REFERENCE METHOD	EQUIPMENT	ID #	RANGE	SPAN
Method 3A (O_2)	Teledyne Paramagnetic Analyzer	(S/N:376)	0-25 %	21.9 %
Method 3A (CO_2)	Teledyne Infrared Analyzer	(S/N: 344)	0-25 %	20.4 %
Method 7E (NO_x)	CAA Chemiluminescent Analyzer	(S/N: 6L09006)	0-3000 ppmv	277.3 ppmv
Method 25A (THC)	CAA FID Analyzer	(S/N: CO1021)	0-20000 ppmv	30.3 ppmv

4.4 List of CEMS Equipment

Monitor System	EQUIPMENT	ID #
Oxygen FGTHROX	Braud Gaus Model 4705	S/N: 10687
Carbon Dioxide FGTHROX	California Analytical Instruments Model ZRE	S/N: A9E4415
Total Hydrocarbon FGTHROX	California Analytical Instruments Model 600 HFID	S/N: A09023
Nitrogen Oxides FGTRHOX	Thermo Scientific Model 42I	S/N: 0733125534
Air Flow FGTHROX	Monitoring Solutions Model CEM Flow	S/N: 012808-000-1017
Air Flow FGTHROX	SIC Model FLSE100-PK17835HSHS	S/N: 13488341

FIGURE 4.1: SAMPLING TRAIN USED FOR NOx, CO_2 & O_2 (M7E & M3A)



Stack Gas Velocity & Volumetric Rates (EPA M2)

The velocity and volumetric flow rate of the stack gas are calculated using the following equations:

$$V_S = K_P C_P \left(\sqrt{\Delta p}\right)_{AVG} \sqrt{\frac{T_{S(AVG)}}{P_S M_S}}$$

$$Q_W = V_S A_S (60\ sec/min)$$

$$Q_{SW} = Q_W \left(\frac{528\ ^\circ R}{T_S}\right)\left(\frac{P_S}{29.92''\ Hg}\right)$$

$$Q_{SD} = Q_{SW}(DGF)$$

Where: V_S = Stack gas velocity (ft/sec)

K_P = Pitot Tube Constant, 85.49 $\frac{ft}{sec}\sqrt{\frac{(lb/lb\ mol)(''\ Hg)}{(^\circ R)(''H_2O)}}$

C_P = Pitot Tube Coefficient, 0.84 (dimensionless)

Δp = Velocity Head of Stack Gas, ("H_2O)

T_S = Stack Temperature (°R)

P_S = Absolute Stack Pressure ("Hg)

M_S = Molecular weight of stack gas, wet basis (lb/lb-mole)

Q_W = Stack Gas Wet Volumetric Flow at Stack Conditions (ft^3/min)

Q_{SW} = Stack Gas Wet Volumetric Flow at Standard Conditions (ft^3/min)

A_S = Stack Area (ft^2)

Q_{SD} = Stack Gas Flow @ Std. Conditions, dry basis (dscf/min)

DGF = Dry Gas Fraction

VOLUMETRIC FLOW RUN 1 EXAMPLE

$$V_S = \left(85.49\ \frac{ft}{sec}\sqrt{\frac{(lb/lb\ mol)(''\ Hg)}{(^\circ R)(''H_2O)}}\right)(0.84)(0.22\ ''\ H_2O)\sqrt{\frac{583\ ^\circ R}{(29.82\ ''\ Hg)(27.6\ lb/lb\ mol)}} = \underline{13.34\ \ ft/sec}$$

$$Q_W = \left(\frac{13.34\ ft}{sec}\right)\left(\frac{15.90 ft^2}{1}\right)\left(\frac{60\ sec}{min}\right) = \underline{12733\ acfm}$$

$$Q_{WS} = \left(\frac{12733\ cf}{min}\right)\left(\frac{528\ ^\circ R}{583\ ^\circ R}\right)\left(\frac{29.82\ ''\ Hg}{29.92''\ Hg}\right) = \underline{11488\ scfm}$$

$$Q_{SD} = (11488\ scfm)(0.874) = \underline{10046\ dscfm}$$

REFERENCE METHOD CALIBRATION EXAMPLES

Analyzer Calibration Error Calculations

The calibration error test consisted of challenging each reference monitor at three measurement points against known calibration gas values. Calibration error for the reference is calculated using the following equation:

$$CE_{RM} = \frac{|Analyzer\ Response - Calibration\ Gas\ Value|}{Span\ of\ Analzyer} \times 100$$

<u>Reference NOx Calibration Error Example Run #1</u>

$$CE_{RM} = \frac{|(0.0\ ppmv)\ - (0.0\ ppmv)|}{(277.3\ ppmv)} \times 100 = \underline{0.0\ \%}$$

$$CE_{RM} = \frac{|(151.8\ ppmv)\ - (151.8\ ppmv)|}{(277.3\ ppmv)} \times 100 = \underline{0.0\ \%}$$

$$CE_{RM} = \frac{|(276.0\ ppmv)\ - (277.3\ ppmv)|}{(277.3\ ppmv)} \times 100 = \underline{0.5\ \%}$$

System Calibration Bias Calculations

The system bias calibration test consisted of challenging the reference sample system at two measurement points against the local calibration values. Calibration bias calculations for the reference sample system are calculated using the following equation:

$$CB_{RM} = \frac{|System\ Calibration\ Response - Analzyer\ Calibration\ Response|}{Span\ of\ Analzyer} \times 100$$

<u>Reference NOx Initial System Bias Run #1 Example</u>

$$CB_{RM} = \frac{|(0.0\ ppmv) - (0.0\ ppmv)|}{(277.3\ ppmv)} \times 100 = \underline{0.0\ \%}$$

$$CB_{RM} = \frac{|(151.8\ ppmv) - (151.8\ ppmv)|}{(277.3\ ppmv)} \times 100 = \underline{0.0\ \%}$$

Calibration Drift Calculations

The calibration drift tests were conducted at the beginning and end of each run. Analyzer maintenance, repair or adjustment could not be completed until the system calibration response was recorded. Calibration drift for the reference is calculated using the following equation:

$$CD_{RM} = \frac{|Final\ System\ Cal\ Response - Initial\ System\ Cal\ Response|}{Span\ of\ Analzyer} \times 100$$

Reference NOx Calibration Drift Run #1 Example

$$CD_{RM} = \frac{|(0.0\ ppmv) - (0.0\ ppmv)|}{(277.3\ ppmv)} \times 100 = \underline{0.0\ \%}$$

$$CD_{RM} = \frac{|(149.9\ ppmv) - (151.8\ ppmv)|}{(277.3\ ppmv)} \times 100 = \underline{0.7\ \%}$$

EMISSION RATE EXAMPLES

System Calibration Drift Correction

The gas concentrations are corrected for the system calibration bias. The concentrations are calculated using the following equations:

$$C_{Gas} = \left(\overline{C} - C_O\right)\left(\frac{C_{MA}}{C_M - C_O}\right)$$

where: C_{Gas} = Effluent Concentration, dry ppm or %
$\overline{C}$ = Average Analyzer Concentration, ppm or %
C_O = Average Initial and Final System Calibration Responses for Zero Gas, ppm or %
C_M = Average Initial and Final System Calibration Responses for Upscale Calibration Gas, ppm or %
C_{MA} = Actual Concentration of Upscale Calibration Gas, ppm or %

NOx System Calibration Drift Correction for Run #1 Example

$$C_{Gas} = (48.2\,ppmv - 0.0\,ppmv)\left(\frac{151.8\,ppmv}{150.9\,ppmv - 0.0\,ppmv}\right) = \underline{48.5\,ppmv}$$

NOx Outlet Emission Rate

$$E_{Gas} = \frac{(C_{Gas})(Q_{SD})(Gas_{MW})(28.32\ L/ft^3)}{(10^6\,ppmv)(24.056\ L/mol)(453.6\ g/lb)}$$

where: E_{Gas} = Emission of Gas, (lb/hr)
C_{Gas} = Concentration of Gas, $(dry\,ppmv)$
Q_{SD} = Stack Gas Flow @ Std. Conditions, dry basis $(dscf/hr)$
Gas_{MW}= Molecular Weight of Gas $(g/g\ mol)$ Where:
NOx_{MW} = Molecular Weight of NOx $(46.01\ g/g\ mol)$

NOx Emissions for Run #1

$$E_{Gas} = \frac{(48.5\,ppmv)(6.03x10^5\ dscfh)(46.01\ g/gmol)(28.32\ L/ft^3)}{(10^6\,ppmv)(24.056\ L/mol)(453.6\ g/lb)} = \underline{3.5\ lb/hr}$$

CEMS CERTIFICATION RATA CALCULATION EXAMPLES

The average twenty-one minute Flow, NO_x, THC, CO_2 and O_2 value for each reference run was corrected for sample system bias. The best nine runs were chosen from the twelve runs allowed and used to establish the RATA certification for the CEMS.

Standard Deviation

The standard deviation between the nine runs chosen should 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 nine selected runs

d = Arithmetic difference between corrected Reference Method NOx values and CEMS NOx values

n = Number of sample runs used for standard deviation calculation

<u>Emission Rate NOx Standard Deviation Example</u>

$$S_D = \sqrt{\left[\frac{(1.63\ lb/hr) - \frac{(3.75\ lb/hr)^2}{9}}{8}\right]} = \underline{0.09\ lb/hr}$$

<u>Concentration CO2 Standard Deviation Example</u>

$$S_D = \sqrt{\left[\frac{(0.005\ \%) - \frac{(0.18\ \%)^2}{9}}{8}\right]} = \underline{0.01\ \%}$$

<u>Concentration O2 Standard Deviation Example</u>

$$S_D = \sqrt{\left[\frac{(0.044\ \%) - \frac{(0.53\ \%)^2}{9}}{8}\right]} = \underline{0.04\ \%}$$

<u>Concentration THC Standard Deviation Example</u>

$$S_D = \sqrt{\left[\frac{(0.18\ ppmv) - \frac{(1.09\ ppmv)^2}{9}}{8}\right]} = \underline{0.08\ ppmv}$$

<u>VOL Flow Standard Deviation Example</u>

$$S_D = \sqrt{\left[\frac{(43159383\ acfm) - \frac{(19664\ acfm)^2}{9}}{8}\right]} = \underline{156.2\ scfm}$$

<u>SIC Flow Standard Deviation Example</u>

$$S_D = \sqrt{\left[\frac{(1055255\ acfm) - \frac{(2470\ acfm)^2}{9}}{8}\right]} = \underline{217.3\ scfm}$$

Confidence Coefficient

The 95% confidence coefficient of the nine runs chosen should be calculated. The factor of 2.306 comes from Table 2.1 (t-value table) of the 40 CFR Part 266, Appendix IX. 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 nine selected runs
n = Number of sample runs used for standard deviation calculation

<u>Emission Rate NOx Confidence Coefficient Example</u>

$$CC = 2.306 \times \left(\frac{0.09\ lb/hr}{\sqrt{9}}\right) = \underline{0.07\ lb/hr}$$

<u>Concentration CO2 Confidence Coefficient Example</u>

$$CC = 2.306 \times \left(\frac{0.01\ \%}{\sqrt{9}}\right) = \underline{0.01\ \%}$$

<u>Concentration O2 Confidence Coefficient Example</u>

$$CC = 2.306 \times \left(\frac{0.04\ \%}{\sqrt{9}}\right) = \underline{0.03\ \%}$$

<u>Concentration THC Confidence Coefficient Example</u>

$$CC = 2.306 \times \left(\frac{0.08\ ppmv}{\sqrt{9}}\right) = \underline{0.06\ ppmv}$$

<u>VOL Flow Confidence Coefficient Example</u>

$$CC = 2.306 \times \left(\frac{156.2\ acfm}{\sqrt{9}}\right) = \underline{120.1\ scfm}$$

<u>SIC Flow Confidence Coefficient Example</u>

$$CC = 2.306 \times \left(\frac{217.3\ acfm}{\sqrt{9}}\right) = \underline{167\ scfm}$$

Relative Accuracy

The relative accuracy of the CEMS were calculated to prove:

- NOx emissions (lb/hr) are within 20% RA using the reference method value as per 40 CFR 60 PS 2
- CO2 and O2 concentrations (%) are within 20% RA using the reference method value as per 40 CFR 60 PS 3
- THC concentration (ppmv) is within 20% RA using the reference method value as per 40 CFR PS 8
- VOL and SIC flow rates (acfm) are within 20% RA using the reference method value as per 40 CFR 60 PS 6

Relative Accuracy

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

Where: *RA* = Relative Accuracy
CC = Confidence coefficient
d = Arithmetic diff between Reference Method and CEMS values
RM = Reference Method Value

Emission Rate NOx Relative Accuracy Example

$$RA = \left[\frac{(|0.42\ lb/hr| + |0.07\ lb/hr|)}{(2.94\ lb/hr)}\right] x\ 100\% = \underline{17\ \%}$$

Concentration CO2 Relative Accuracy Example

$$RA = \left[\frac{(|0.02\ \%| + |0.03\ \%|)}{(3.1\ \%)}\right] x\ 100\% = \underline{0.9\ \%}$$

Concentration O2 Relative Accuracy Example

$$RA = \left[\frac{(|0.03\ \%| + |0.03\ \%|)}{(12.3\ \%)}\right] x\ 100\% = \underline{0.5\ \%}$$

Concentration THC Relative Accuracy Example

$$RA = \left[\frac{(|0.12\ ppmv| + |0.06\ ppmv|)}{(0.12\ ppmv)}\right] x\ 100\% = \underline{149\ \%}$$

VOL Flow Relative Accuracy Example

$$RA = \left[\frac{(|2185\ scfm| + |120.1\ scfm|)}{(11515\ scfm)}\right] x\ 100\% = \underline{20\ \%}$$

SIC Flow Relative Accuracy Example

$$RA = \left[\frac{(|274\ scfm| + |167\ scfm|)}{(11515\ acfm)}\right] x\ 100\% = \underline{4\ \%}$$

Alternative Relative Accuracy

As found in 40 CFR 60 Appendix B performance specifications 3 and 8, alternative relative accuracy limits can be used to demonstrate the CEMS meets certification requirements. The following values will be used was calculated to prove:

- CO2 and O2 concentrations (%) are within 1% absolute difference of the reference method value as per 40 CFR 60 PS 3
- THC concentration (ppmv) is within 10% ARA using the emission limit value as per 40 CFR PS 8

THC Relative Accuracy

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

Where: *RA* = Relative Accuracy
CC = Confidence coefficient
d = Arithmetic difference between Reference Method and CEMS values
EL = Emission Limit Value (20 ppmv)

CO2 and O2 Relative Accuracy

$$ARA = |Ref\ Method| - |CEMS|$$

Concentration CO2 Relative Accuracy Example

$$RA = [3.09\ \%] - [3.10\ \%] = \underline{0.0\ \%}$$

Concentration O2 Relative Accuracy Example

$$RA = [12.34\ \%] - [12.38\ \%] = \underline{0.0\ \%}$$

Concentration THC Relative Accuracy Example

$$RA = \left[\frac{(|0.12\ ppmv| + |0.06\ ppmv|)}{(20\ ppmv)}\right] x\ 100\% = \underline{1\ \%}$$