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Compliance Sampling Report

**Silicone Facility THROX
FGTHROX
Permit # 91-07E**

**THE DOW CORNING CORPORATION
Midland, Michigan**

Sampling Dates: November 16, 2016

** 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.*

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. An annual compliance test measuring emissions of PM₁₀ and CO is required

The internal stack testing team performed compliance testing on Nov 16th, 2016.

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

Responsible Groups	<ul style="list-style-type: none"> The Dow Corning Corporation, a subsidiary of the Dow Chemical Company Michigan Department of Environmental Quality (MDEQ) Environmental Protection Agency (EPA)
Applicable Regulations	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Silicon Manufacturing 2514 THROX unit
Plant Location	<ul style="list-style-type: none"> The Dow Corning Company, a subsidiary of the Dow Chemical Company Midland, Michigan 48667
Unit Initial Start-up	<ul style="list-style-type: none"> May 2008
Air Pollution Control Equipment	<ul style="list-style-type: none"> Quench tower HCl scrubber Two Ionizing wet scrubbers (IWS)
Emission Points	<ul style="list-style-type: none"> SV2514-006
Pollutants/Diluent Measured	<p><u>Compliance Test</u></p> <ul style="list-style-type: none"> PM₁₀ 3.5 lb/hr and 13.4 tons/yr CO 90 tons/yr VOC 6.6 lb/hr
Test Date	<ul style="list-style-type: none"> November 16, 2016

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1.2 Key Personnel

The key personnel who coordinated the test program are:

- Lindsay White provided support as the Process Focal Point. The Process Focal Point is responsible for coordinating the plant operation during the test, ensuring the unit was operating at the agreed upon conditions in the test plan, serving as the key contact for collecting any process data required and providing all technical support related to process operation.
- Michael Gruber provided support as the Environmental Focal Point. The Environmental Focal Point is responsible for ensuring that all regulatory requirements and citations are reviewed and considered for the testing.
- Chuck Glenn served as the Test Plan Coordinator. The Test Plan Coordinator is responsible for the overall leadership of the sampling program, developing the overall testing plan and determining the correct sample methods.
- Spencer Hurley is the back-up for the Test Plan Coordinator and serves in a technical review role of the test data.
- Michael Abel provided support as a technical review of the test data.
- Dan Bennett served as the Sample Team Leader. The Sample Team Leader is responsible for ensuring the data generated meets the quality assurance objectives of the plan. Jim Edmister and Kyle Kennedy assisted as a sampling technician for this testing.

2.0 PLANT AND SAMPLING LOCATION DESCRIPTION

2.1 Facility Description

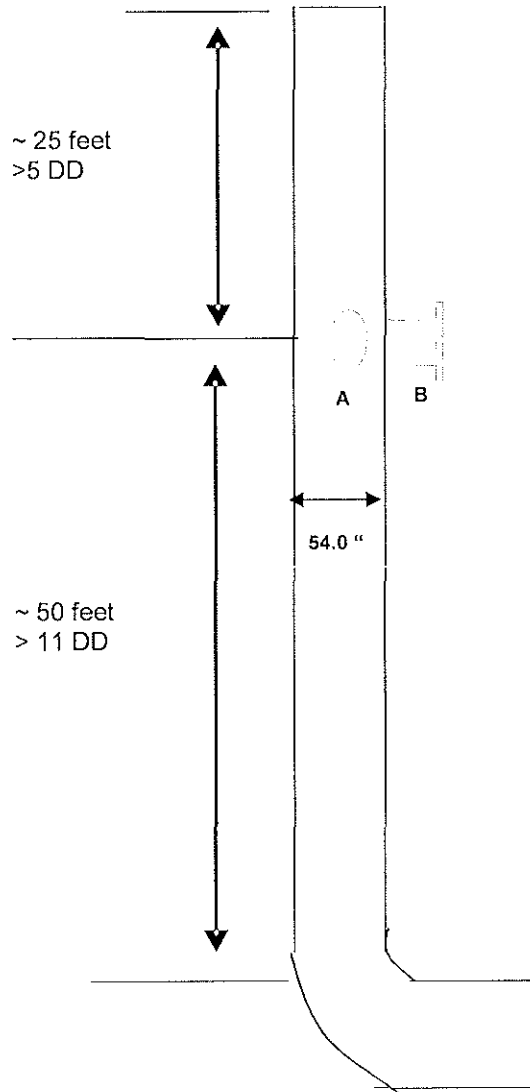
The THROX and IWS are utilized to treat emissions from various processes at the chemical facility. The typical feed rate to the THROX is approximately 28 MMBtu/hr. The permitted maximum operating rate for the THROX is 95 MMBTU/hr. The proposed production operating rate for this test is >30 MMBTU/hr.

2.2 Flue Gas Sampling Locations

Sampling was conducted on the THROX outlet stack. The analyzer 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 60 minutes at the three traverse points of the measurement line that passes through the centroidal area of the stack or duct cross section 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.

EPA M17/M202 sampling was collected using isokinetic methodology across the stack at sample points as required by EPA M1.

Figure 2.1 Stack Description



Isokinetic 12 Point Circular Traverse Layout for Outlet

Division: Dow Performance

Facility/Block: Silicones

Stack ID: 54 inches

Port Ext: 8 inches

Duct Downstream Length: 32 Feet

Duct Downstream Diameters: 7 Diameters

Duct Upstream Length: 3 Feet

Duct Upstream Diameters: 0.5 Diameters

Traverse Point	Stack ID	Port Ext	Traverse Pt Distance	Traverse Pt Distance ϕ	Final Probe Mark
1	54	8	2 6/16	2 6/16	10 6/16
2	54	8	7 14/16	7 14/16	15 14/16
3	54	8	16	16	24
4	54	8	38	38	46
5	54	8	46 2/16	46 2/16	54 2/16
6	54	8	51 10/16	51 10/16	59 10/16

3.0 SUMMARY AND DISCUSSION OF TEST RESULTS

3.1 Objectives and Test Matrix

The purpose of this test report is to demonstrate compliance with the regulations for the THROX at the Silicon facility in Midland, Michigan. The specific objectives are:

- Determine the emissions of PM₁₀, CO and VOC.

3.2 Comments / Exceptions

- Kathy Brewer of the Michigan Department of Environmental Quality was present during sampling

Emission Results

Sample Type	Test Method	Sampling Time (Min/Run)	Allowable Emission Rate	Actual Emission Rate*
PM ₁₀ as Total Particulate Matter	EPA Method 17/202	60	3.5 lb/hr 13.4 ton/yr	1.0 lb/hr 4.5 ton/yr
Carbon Monoxide	EPA Method 10	60	90 ton/yr	< 1 ton/yr
VOC	EPA Method 25A	60	6.6 lb/hr	< 0.1 lb/hr

* Emissions based on average of three one-hour runs.

Testing Run Data

PARAMETER	RUN 1	RUN 2	RUN 3	AVERAGE
Run Date	11/16/2016	11/16/2016	11/16/2016	N/A
Run Times	1423/1453 1458/1528	1623/1653 1700/1730	1758/1828 1836/1906	N/A
Stack Gas Wet Flow (cf/hr)	7.17E+05	6.90E+05	7.22E+05	7.10E+05
Stack Gas Wet Flow Std Cond (scf/hr)	6.44E+05	6.23E+05	6.52E+05	6.40E+05
Stack Gas Dry Flow (dscf/hr)	5.54E+05	5.41E+05	5.68E+05	5.54E+05
Volume gas collected (dscf/hr)	33.672	33.696	34.636	34.00
Nozzle Volume @ Stack Cond (cf/hr)	44.756	44.203	45.232	44.73
Total Particulate Weight M17 (g)	0.0103	0.0087	0.0044	0.0078
Total Particulate Weight M202 (g)	0.0275	0.0187	0.0161	0.0208
Total Weight (g)	0.0378	0.0274	0.0205	0.0286
Emissions Total PM (lb/hr)	1.4	1.0	0.7	1.0
Emissions Total PM (ton/yr)	6.0	4.2	3.2	4.5
Conc. THC as Propane (ppmv)	0.4	0.3	0.3	0.3
THC as Propane Emissions (Lb/Hr)	< 0.1	< 0.1	< 0.1	< 0.1
Conc. CO in Outlet (ppmv)	0.6	0.6	0.6	0.6
Reported CO Emissions (ton/yr)	< 1	< 1	< 1	< 1

Operational Rates

PARAMETER	RUN 1	RUN 2	RUN 3	AVERAGE
Run Date	11/16/2016	11/16/2016	11/16/2016	N/A
Run Times	1423/1453 1458/1528	1623/1653 1700/1730	1758/1828 1836/1906	N/A
Gas Flow Dry Vent (lb/hr)	1330.7	1344.4	1358.8	1344.6
Gas Flow Wet Vent (lb/hr)	475.7	499.2	416.2	463.7
Gas Flow MeCl (lb/hr)	138.7	133.2	122.3	131.4
Gas Flow THROX Out Stack (scfm)	11784.7	13976.0	14114.4	13291.7
Silicon Loading (lb/hr)	18.2	19.9	19.9	19.3
Heat Input (mmBtu/hr)	30.2	30.2	33.2	31.2

4.0 SAMPLING AND ANALYTICAL PROCEDURES

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4.1 Test Methods

The PM₁₀ and CO emissions were determined using the following methods:

- Methods 1-4 for volumetric flow rate;
- Methods 17 and 202 for PM₁₀;
- Method 10 for CO; and
- Method 25A for THC as Propane

4.2 Procedures

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 60 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.

Isokinetic samples were collected for particulate matter sampling as described in the methods below.

EPA Method 1 (Sample Point Determination)

The number and location of traverse points in the stack was 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 was 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 were recorded.

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

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

An analyzer measured O₂ content on the basis of the strong paramagnetic properties of O₂ relative to other compounds present in combustion gases. In the presence of a magnetic field, O₂ molecules become temporary magnets. The analyzer determines the sample gas O₂ concentration by detecting the displacement torque of the sample test body in the presence of a magnetic field.

An analyzer measured CO₂ 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 CO₂ measurement in the presence of other infrared-absorbing gases.

EPA Method 4 (Moisture)

A calibrated Method 5 console will pull stack gas samples through a Method 5 probe equipped with a glass liner to determine percent moisture of the stack gas. Stack gas will be bubbled through two impingers containing water, one empty impinger, and one impinger containing silica gel. All of the impingers will be weighed prior to sampling. The impinger train will be 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 will be dried off and the impingers were weighed to determine percent moisture.

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.

EPA Method 10 (CO Sampling and Analysis)

EPA Method 10 will be utilized to determine carbon monoxide concentrations during each run on the outlet.

An analyzer measured CO 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 measurement in the presence of other infrared-absorbing gases.

EPA M202 in Conjunction with EPA M17 (Filterable and Condensable Particulate Matter Sampling and Analysis)

EPA Method 202 will be utilized in conjunction with EPA Method 17 to determine both filterable (FPM) and condensable particulate matter (CPM) concentrations during each run on the outlet.

Using EPA Method 17 methodology, filterable particulate matter (FPM) is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at stack temperature. The FPM mass is determined gravimetrically after the removal of uncombined water.

EPA Method 202 methodology is used to collect condensable particulate matter (CPM) in dry impingers after filterable PM has been collected on a filter maintained as specified in Method 17 of appendix A-6 to part 60. The organic and aqueous fractions of the impingers and an out-of-stack CPM filter are then taken to dryness and weighed. The total of the impinger fractions and the CPM filter represents the CPM. Analysis for FPM and CPM will be completed by Enthalpy Analytical

FIGURE 4.1: SAMPLING TRAIN USED FOR CO, CO₂ & O₂ (M10 & M3A)

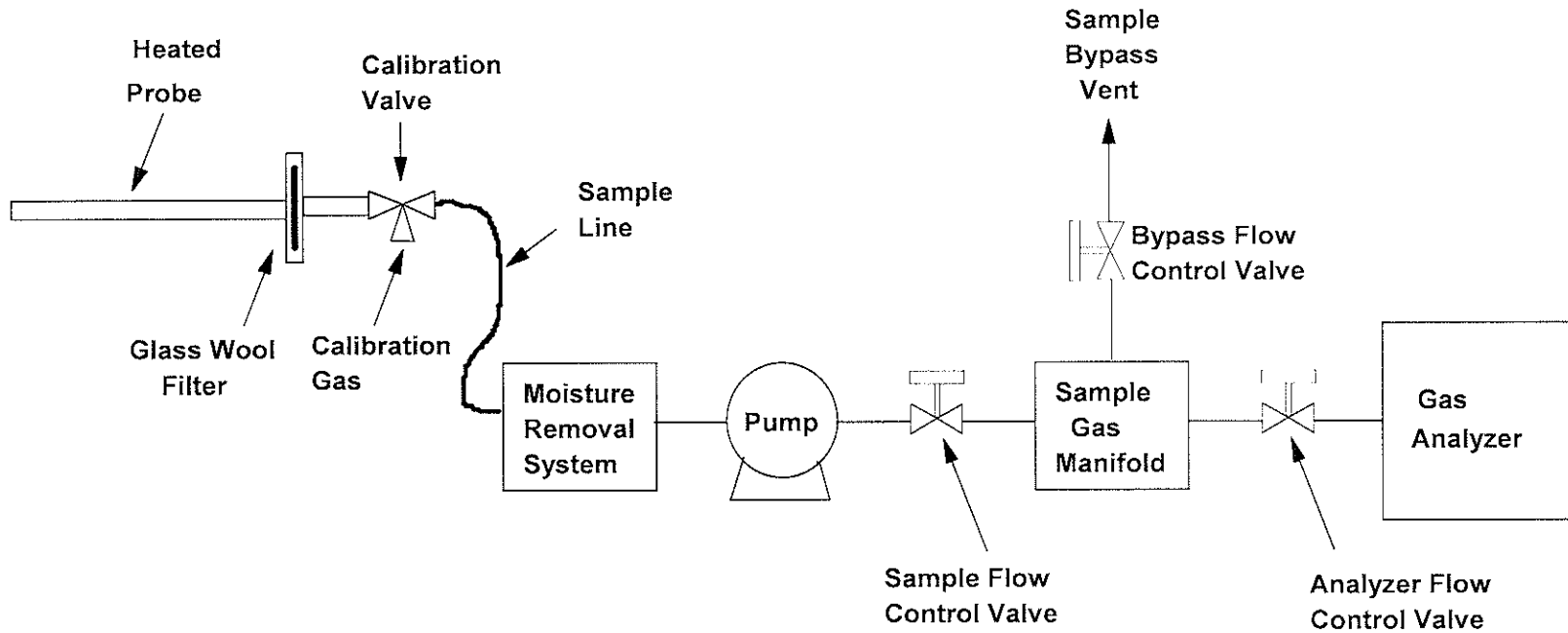


FIGURE 4.2: SAMPLING TRAIN FOR VOC (M25A) - Glass Wool Filter not used

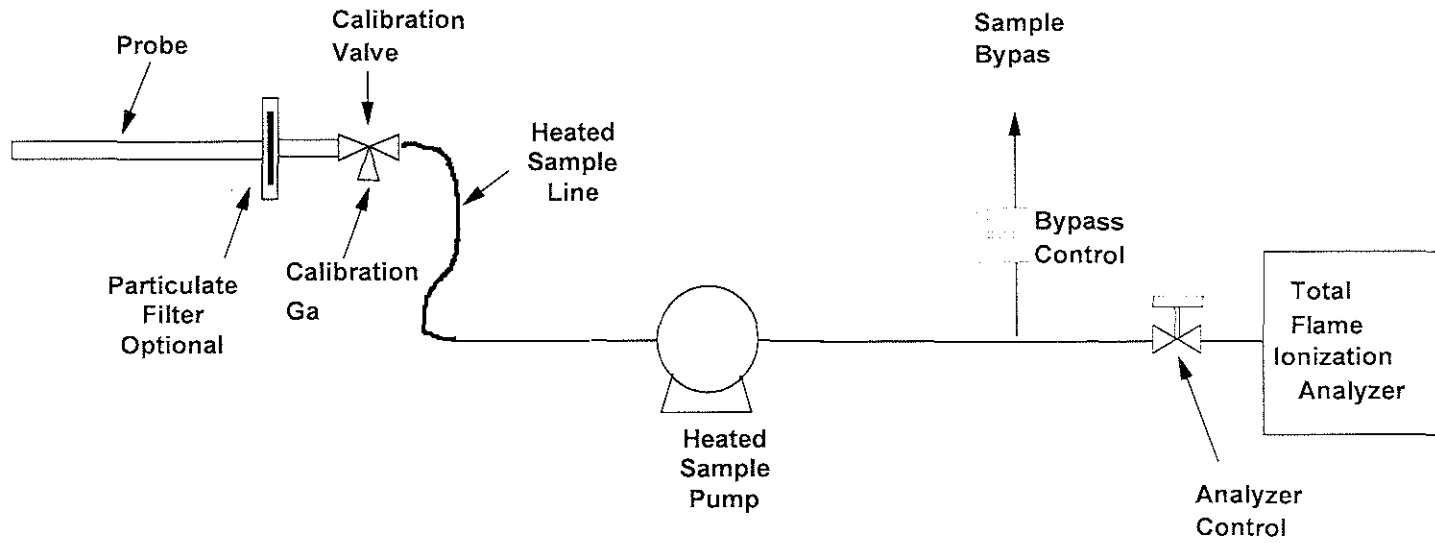
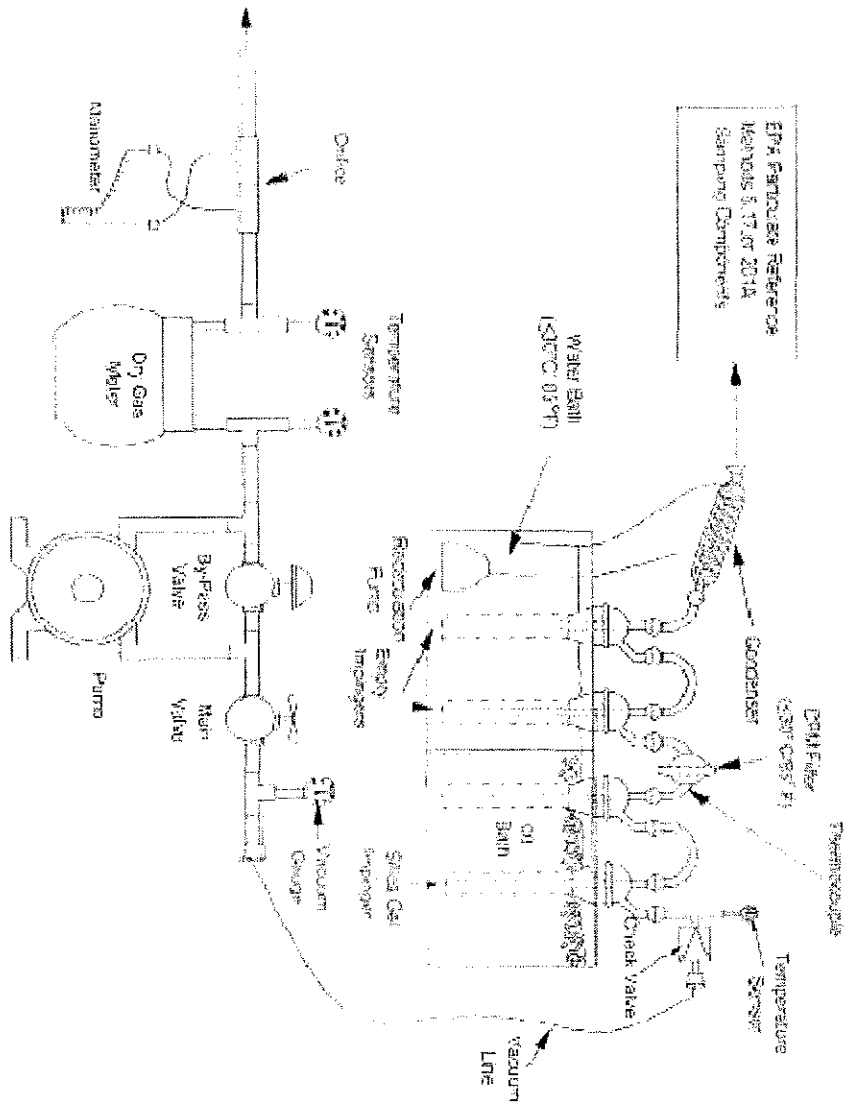


FIGURE 4.3: SAMPLING TRAIN FOR CPM (M202 with M17)



5.0 CALCULATIONS

Stack Gas Velocity & Volumetric Rates (EPA M2)

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

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

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

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

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

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

K_P = Pitot Tube Constant, $85.49 \frac{ft}{sec} \sqrt{\frac{(lb/lb \text{ mol})(\text{" Hg})}{(^\circ R)(\text{" H}_2\text{O})}}$

C_P = Pitot Tube Coefficient, 0.84 (dimensionless)

Δp = Velocity Head of Stack Gas, ("H₂O)

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 (ft³/min)

Q_{SW} = Stack Gas Wet Volumetric Flow at Standard Conditions (ft³/min)

A_S = Stack Area (ft²)

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

DGF = Dry Gas Fraction

VOLUMETRIC FLOW RUN 1 EXAMPLE

$$V_S = \left(85.49 \frac{ft}{sec} \sqrt{\frac{(lb/lb \text{ mol})(\text{" Hg})}{(^\circ R)(\text{" H}_2\text{O})}} \right) (0.84)(0.205 \text{ " H}_2\text{O}) \sqrt{\frac{532 \text{ }^\circ R}{(29.92 \text{ " Hg})(27.2 \text{ lb/lb mol})}} = \underline{12.53 \text{ ft/sec}}$$

$$Q_W = \left(\frac{12.53 \text{ ft}}{sec} \right) \left(\frac{15.90 \text{ ft}^2}{1} \right) \left(\frac{60 \text{ sec}}{min} \right) \left(\frac{60 \text{ min}}{1 \text{ hr}} \right) = \underline{7.17 \times 10^5 \text{ acfh}}$$

$$Q_{WS} = \left(\frac{7.17 \times 10^5 \text{ acf}}{hr} \right) \left(\frac{528 \text{ }^\circ R}{532 \text{ }^\circ R} \right) \left(\frac{29.92 \text{ " Hg}}{29.92 \text{ " Hg}} \right) = \underline{6.44 \times 10^5 \text{ scfh}}$$

$$Q_{SD} = (6.44 \times 10^5 \text{ scfh})(0.860) = \underline{5.54 \times 10^5 \text{ dscfh}}$$

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:

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

Reference CO Calibration Error Example

$$CE_{RM} = \frac{|(0.0 ppmv) - (0.0 ppmv)|}{(30.0 ppmv)} \times 100 = \underline{0.0 \%}$$

$$CE_{RM} = \frac{|(15.3 ppmv) - (15.1 ppmv)|}{(30.0 ppmv)} \times 100 = \underline{0.7 \%}$$

$$CE_{RM} = \frac{|(30.0 ppmv) - (30.0 ppmv)|}{(30.0 ppmv)} \times 100 = \underline{0.0 \%}$$

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:

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

Reference CO Initial System Bias Run #1 Example

$$CB_{RM} = \frac{|(0.0 ppmv) - (0.0 ppmv)|}{(30.0 ppmv)} \times 100 = \underline{0.0 \%}$$

$$CB_{RM} = \frac{|(14.8 ppmv) - (15.3 ppmv)|}{(30.0 ppmv)} \times 100 = \underline{1.7 \%}$$

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:

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

Reference CO Calibration Drift Run #1 Example

$$CD_{RM} = \frac{|(0.4\ ppmv) - (0.0\ ppmv)|}{(30.0\ ppmv)} \times 100 = \underline{1.3\ \%}$$

$$CD_{RM} = \frac{|(15.5\ ppmv) - (14.8\ ppmv)|}{(30.0\ ppmv)} \times 100 = \underline{2.3\ \%}$$

System Calibration Drift Correction

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

$$C_{Gas} = (\bar{C} - C_0) \left(\frac{C_{MA}}{C_M - C_0} \right)$$

- where:
- C_{Gas} = Effluent Concentration, dry ppm or %
 - \bar{C} = Average Analyzer Concentration, ppm or %
 - C_0 = 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 %

CO System Calibration Drift Correction for Run #1 Example

$$C_{Gas} = (0.5\ ppmv - 0.2\ ppmv) \left(\frac{15.1\ ppmv}{15.2\ ppmv - 0.2\ ppmv} \right) = \underline{0.6\ ppmv}$$

Particulate Matter Outlet Emission Rate Example Calculation

$$E_{PMT} = \frac{(E_{PMF})(Q_{SD})}{(Vmstd \text{ dscf/hr})(453.6 \text{ g/lb})}$$

where:

E_{PMF} = Total Weight Gain, (g)

E_{PMT} = Emission of Total Particulate Matter, (lb/hr)

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

Q_{SW} = Stack Gas Flow @ Std. Conditions, wet basis (scf/hr)

VM_{STD} = Volume Stack gas Collected (dscf/hr)

Particulate Matter Emissions for Run #1 Example

$$E_{PMT} = \frac{(0.0378 \text{ g})(5.54 \times 10^5 \text{ dscfh})}{(33.672 \text{ dscfh})(453.6 \text{ g/lb})} = \underline{1.4 \text{ lb/hr}}$$

$$E_{PMT} = \left(\frac{1.4 \text{ lb}}{\text{hr}}\right) \left(\frac{\text{ton}}{2000 \text{ lb}}\right) \left(\frac{24 \text{ hr}}{1 \text{ day}}\right) \left(\frac{365 \text{ day}}{\text{yr}}\right) = \underline{6.0 \text{ ton/yr}}$$

THC Outlet Emission Rate

$$E_{THC} = \frac{(THC_{Gas})(Q_{SW})(Gas_{MW})(28.32 \text{ L/ft}^3)}{(10^6 \text{ ppmv})(24.056 \text{ L/mol})(453.6 \text{ g/lb})}$$

where: E_{THC} = Emission of THC, (lb/hr)

THC_{Gas} = Concentration of THC Gas, (wet ppmv)

Q_{SW} = Stack Gas Flow @ Std. Conditions, wet basis (scf/hr)

Gas_{MW} = Molecular Weight of Gas (g/g mol) Where:

VOC_{MW} = Molecular Weight of VOC as Propane (44.1 g/g mol)

THC Emissions for Run #1 Example

$$E_{THC} = \frac{(0.4 \text{ ppmvw})(6.44 \times 10^5 \text{ scfh})(44.1 \text{ g/gmol})(28.32 \text{ L/ft}^3)}{(10^6 \text{ ppmv})(24.056 \text{ L/mol})(453.6 \text{ g/lb})} = \underline{< 0.1 \text{ lb/hr}}$$

CO Outlet Emission Rate

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

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:
 CO_{MW} = Molecular Weight of CO (28.01 g/g mol)

CO Emissions for Run #1 Example

$$E_{Gas} = \frac{(0.6 \text{ ppmvd})(5.54 \times 10^5 \text{ dscfh})(28.01 \text{ g/gmol})(28.32 \text{ L/ft}^3)}{(10^6 \text{ ppmv})(24.056 \text{ L/mol})(453.6 \text{ g/lb})} = \underline{0.02 \text{ lb hr}}$$

$$E_{TUC} = \left(\frac{0.02 \text{ lb}}{\text{hr}}\right) \left(\frac{24 \text{ hr}}{\text{day}}\right) \left(\frac{365 \text{ days}}{\text{yr}}\right) \left(\frac{\text{ton}}{2000 \text{ lb}}\right) = \underline{< 1 \text{ ton/yr}}$$