EASTMOUNT ENVIRONMENTAL SERVICES
Air Quality Specialists

FINAL REPORT

VOC and VOC HAP Emissions Testing from Residual Oil Tank No. 3 Tank Headspace and Loading Operations at Global's South Portland, Maine Terminal

Test Dates: April 11-26, 2013 and July 2, 2013

Prepared for . . .

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Final Report Date: August 9, 2013

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1.0 INTRODUCTION

1.1 General

Eastmount Environmental Services, LLC of Newburyport, MA was retained by Global Companies LLC of Waltham, MA to conduct emissions testing at their South Portland, Maine terminal. Testing was conducted to establish the emission rate of volatile organic compounds (VOC) and VOC hazardous air pollutants (VOC HAP) from the headspace emissions of Residual Oil Storage Tank No. 3, as well as emissions from storage tank and tanker truck loading operations

Testing was conducted in response to an EPA testing order for information under Section 114 of the Clean Air Act which was received by Global Companies LLC on November 2, 2011 and in accordance with testing approaches subsequently prescribed by USEPA Region I staff.

Testing on the Residual Oil Storage Tank No. 3 commenced on April 11, 2013, and was concluded on August 26, 2013. Headspace VOC emissions were measured continuously throughout this period. The Vessel Transfer Test occurred on April 16, 2013. The Loading Rack Test, during which eight tanker truckers were loaded with residual oil, occurred on July 2, 2013.

Please note that, for the purposes of this program, volatile organic compounds (VOC) are also referred as non-methane hydrocarbons (NMHC). NMHC are determined by measuring total hydrocarbons (in terms of propane) using EPA Method 25A, and methane using EPA Method 18 concurrently. Methane lb/hr emissions are subtracted from the total hydrocarbon lb/hr emissions to obtain NMHC lb/hr emissions. This is not to be confused with VOC HAP which are individual (rather than total) volatile organic compounds that are considered to be hazardous air pollutants (HAP) by the USEPA. VOC HAP are measured by EPA Method TO-15.

A summary of the primary parties involved in this test initiative is presented in Table 1-1. A summary of test parameters and methods applicable to this program can be found in Table 1-2.

1.2 Program Overview

The objective of the emission test program was to gather VOC and HAP emissions information from a residual oil storage tank and associated tanker trucks under a variety of test scenarios as prescribed by EPA Region I staff. The following summarizes the program objectives:

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1) Storage Tank 15-Day VOC Sampling – The VOC concentration and emission rate of Storage Tank No. 3 was continuously monitored and logged over a 15-day period at the outlet of the TTE exhaust system that was fitted over the two exhaust vents on the storage tank roof. VOC measurements commenced five days prior to the beginning of the transfer of residual oil from the vessel "Columbia" to the storage tank, and then continued during and after the tank filling process to collect a total of 15 days of continuous emissions data. EPA Methods 18 (methane) and 25A (total hydrocarbons) were utilized for VOC sampling. Final results were reported in terms of non-methane hydrocarbons (NMHC) in which methane is subtracted from total hydrocarbons on a lb/hr basis. Concurrent with VOC sampling, volumetric flow rate was measured continuously using a pitot tube/pressure transducer/thermocouple system. The data was logged continuously on a computer. Flow data was used to calculate VOC and HAP mass emissions.

2) Storage Tank VOC Sampling During Vessel Transfer –.VOC concentration and emission rate from the storage tank were quantified as a vessel offloaded approximately 27,387 barrels of residual oil into the tank over a 10.5 hour period. The VOC concentration was measured in accordance with EPA Methods 18 and 25A at the outlet of the TTE exhaust system. Volumetric flow data was obtained by calculating the cubic feet per hour of air displaced from the tank vent, based on the hourly residual oil transfer rate from the vessel into the storage tank. Volumetric flow data was used to calculate the hourly VOC mass emission rate from the storage tank vent during this process.

3) Tanker Truck VOC Sampling – The VOC concentration and emission rate from truck loading operations were quantified during eight filling cycles. The headspace VOC concentration of the tanker was measured in accordance with EPA Methods 18 and 25A while the tanker was being filled with residual oil. Sampling occurred just inside the tank fill hatch using a stainless steel probe equipped with a fuel filter wrapped with fiberglass cloth, a coalescing filter to remove oil mist, a heated glass fiber filter, and heated sample line that delivered the sample to the analyzer. Tank exhaust volumetric flow rate was calculated based on the fill rate of the truck in gallons per hour, and the resultant displacement of air in cubic feet per hour. This data was used to calculate VOC mass emissions from truck loading operations.

4) VOC HAPS Sampling – Over the 15-day test period, three Summa samples were collected from the storage tank TTE exhaust system in a prepared Summa canister, and were analyzed for VOC Hazardous Air Pollutants (HAP) in accordance with EPA Method TO-15. Two VOC HAP summa samples were collected during Storage Tank static breathing. Additionally, a single Summa sample was collected from the TTE exhaust system during Storage Tank loading from a vessel. Finally, a single Summa was collected during one of the eight tanker truck loading tests, Each Summa sample was analyzed for the VOC HAP compounds identified in EPA Method TO-15. Additionally, the largest 20 tentatively identified compounds (TIC) were quantified. Results are reported in units of concentration (ug/M^3) and mass emission rate (lb/hr).

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1.3 Technical Approach to Sampling

1.3.1 Storage Tank Sampling – Static Breathing

One of the unique challenges of this program was to quantify representative VOC mass emissions from the Storage Tank vent as they naturally vent or out-gas. Whereas measuring VOC concentration in the exhaust vents was fairly straightforward, measuring exhaust volumetric flow rate from the tank vents during idle periods was difficult since the flow rate of each tank vent was extremely low and likely to be undetectable using conventional EPA Method 2 procedures.

The objective was to capture the vapors that naturally out-gas from the Storage Tank vents, while also achieving a measurable flow rate, but without inducing excessive draft across the vent openings. EPA has not promulgated an applicable test method for this measurement. Per EPA Region I staff direction, a Temporary Total Enclosure (TTE) Exhaust System was constructed around the two tank exhaust vents. The exhaust of each TTE was directed into a common exhaust duct. Each TTE was large enough to encapsulate the entire vent. Each TTE was fitted with one natural draft opening (NDO) that had an adjustable damper to vary its size. The TTE common exhaust duct was fitted with an exhaust fan. The purpose of the fan was: 1) to draw tank VOC emissions from the TTE into a common exhaust duct where emissions were measured; 2) to achieve a measurable flow rate in the exhaust duct; and 3) to balance the static pressure in the TTE to approximately negative 0.01 inches water column (but never below negative 0.007 inches water column), thus achieving 100% capture of tank gases while minimizing the negative pressure of the TTE. The exhaust fan speed, the exhaust fan adjustable waste gate, and the NDO adjustable gate were varied to achieve this optimal set point during natural out-gassing.

All Storage Tank sampling took place in the common exhaust duct prior to the ID fan. A small S-type pitot tube was securely mounted in the exhaust duct at a traverse point of average velocity, and the VOC sampling probe was securely mounted in the duct center and approximately two duct diameters downstream of the pitot tube. An S-type pitot was selected over a standard pitot to avoid clogging of the pitot openings. However, the pitot tip was fabricated with 3/16" stainless steel to minimize the size of the pitot.

The Method 25A/18 VOC/methane sample was collected from the TTE exhaust duct upstream from the exhaust fan. The sampling probe was swage-locked directly onto the sampling port to ensure a leak-free fitting. A single coalescing filter was installed at the base of the probe to remove any oil mists. A quartz fiber filter, heated to 275°F, was placed in-line between the probe and sample line. The sample was transported to the VOC analyzer via approximately 200 feet of heated Teflon sample line (set at 275°F). The pitot and thermocouple were connected to a 250-foot flow line that was in turn connected to a pressure transducer/digital temperature readout. The signals from the VOC and methane analyzers and the pressure transducer/temperature readout were recorded on a data acquisition system (DAS) consisting of a data logging device and a computer. The DAS was

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programmed to collect data every 2 seconds, and record the data once every minute as an average of the thirty 2-second data points.

It should be noted that the addition of the coalescing filter just after the probe was needed to prevent oil mist from contaminating the sampling system and ruining the analyzer. During previous sampling on an asphalt storage tank, condensed oil was observed to be seeping out of the VOC analyzer bypass, which resulted in the complete rebuilding of the analyzer. Eastmount installed the coalescing filter, and demonstrated that it had negligible bias on the sample data by first sampling with the coalescing filter installed for a 24-hour period, and then removing the filter and allowing the system to sample for approximately 5 minutes. No changed was observed in the concentration. EPA Region 1 personnel reviewed this process change and approved the use of the filters.

Throughout the testing period, any anomalies in the testing or process operations were immediately reported to the Eastmount Project Director, who then contacted the EPA.

Testing was conducted in strict accordance with the approved Pretest Protocol, the EPA Quality Assurance Handbook for Air Pollutant Measurement Systems – Vol. III, and the applicable EPA Methods as found in 40 CFR 60, Appendix A, as amended.

1.3.2 Storage Tank Sampling – Vessel Transfer

During storage tank loading from the vessel, the flow and pressure dynamics of the TTE Exhaust System changed because air was displaced from the tank as it filled with oil. The TTE exhaust system flow rate was increased to a maximum setting to capture all displaced tank gas. The TTE NDOs were also completely shut to capture displaced gas from the tank, and direct the gas to the common exhaust duct. The calculated exhaust flow rate of tank air displaced by the transfer of fuel from the vessel into the tank was used in the calculation of actual VOC emissions from the storage tank during the 12-hour vessel transfer period. The TTE exhaust system sampling location was still used to measure the VOC concentration.

1.3.3 Tanker Truck Sampling

VOC concentration was measured directly from the tanker truck filling hatch on the top of the tanker. A fuel filter, wrapped with fiberglass cloth, was securely attached to the end of an unheated length of 3/8" stainless steel to be used as a probe. A single coalescing filter was attached to the base of the probe to remove oil mist. A heated filter was placed in-line between the coalescing filter and the heated Teflon sample line, which then delivered the gas sample to the VOC analyzer. Care was taken to ensure that the probe tip did not come in contact with the oil in the tank. The fiberglass cloth was periodically replaced on the probe tip filter as it became coated with oil. The volumetric flow rate of air being displaced by the oil entering the tank was calculated based on the fill rate of each truck. This data was used to calculate the mass emissions of VOC.

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1.4 Report Organization

The remainder of this Final Report is divided into four additional sections. The Summary of Results for the entire program in presented in Section 2. A description of the facility and sampling locations is presented in Section 3. Emissions monitoring equipment and procedures are described in Section 4. Section 5 addresses the quality assurance/quality control aspects of the program. All supporting field data, calculations, calibrations, test logs, and process data are appended to the Final Report.

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Table 1-1 Test Program Informational Summary

Facility Corporate Information	
Corporate Organization:	Global Companies LLC
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Table 1-2 Summary of Parameters and Test Methods

Test Location	Parameter	Test Method	Number of Runs
Storage Tank Exhaust Vent	Total VOC (as propane)	EPA 25A	Continuous sampling over 15 days
	Methane	EPA 18	
	Volumetric Flow [1]	EPA 2C	Continuous sampling over 15 days
	VOC HAPS (TO-15 list plus the first 20 TICs [2])	EPA TO-15	1 Summa canister/week plus one Summa during vessel transfer (3 samples total)
	Capture (static pressure of TTE)	EPA Method 204	Verified daily
Tanker Truck Fill Hatch	Total VOC (as propane)	EPA 25A	Continuous sampling of 8 tanker truck filling cycles
	Methane	EPA 18	
	VOC HAPS (TO-15 list plus the first 20 TICs [1])	EPA TO-15	1 Summa canister during tanker truck filling
	Volumetric Flow	Calculated based on tank volume displacement	8 filling cycles

[1] Volumetric flow rate during Vessel Transfer was calculated based on tank volume displacement.

[2] Tentatively identified compounds

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2.0 SUMMARY OF RESULTS

2.1 Overview

The following presents the results for VOC and HAP Residual Oil Storage Tank Test Program, and also a discussion of observations made during the test procedures. Tables 2-1 through 2-6 summarize the overall VOC and VOC HAP emissions data collected over the entire program.

2.2 Discussion of Program Observations

This project was completed in accordance with the program objectives and the approved Test Protocol. In general, Eastmount was able to adhere to EPA reference methodology throughout the program with regard to volumetric flow measurement, VOC sample acquisition, and capture of VOC emissions. There was no evidence of velocity pressure transducer zero drift, and the pitot tubes never became heavily coated or clogged with oil mist. The static pressure of the single TTE was maintained below -0.007 inches water column throughout the 15-day period. Daily post-test calibrations conducted on the total hydrocarbon and methane analyzers were able to meet the required post-calibration criteria.

2.2.1 Effect of Oil Mist on the Sampling System

As evidenced previous sampling programs on both asphalt and residual oil storage tanks, the sampling system has a tendency to become coated with condensed oil mist. This created problems during calibrations as exhibited by excessive time needed to reach acceptable zero and span gas readings. Furthermore, a VOC analyzer became heavily contaminated on a previous asphalt program. Therefore Eastmount was granted conditional approval to install an oil mist-removing coalescing filter immediately after the sampling probe. The result of this sample train modification was significant reduction in the amount of time needed to achieve zero and span system response to calibration gas. Furthermore, Eastmount compared the instrument VOC response to tank exhaust gas with and without the coalescing filters inline over a brief period of time (5 minutes), and saw no discernible difference between the two configurations, confirming that the filter did not interfere with sampling output.

2.2.2 TTE Sampling System

The representativeness of the 24-hour VOC emissions data collected from the storage tank over the 15-day period largely depends on the flow dynamics that were occurring inside the EPA Method 204 TTE Exhaust System that was temporarily erected around the tank's exhaust vent. The Protocol for sampling with this particular configuration was untested and unprecedented in this application. Whereas EPA Method 204 is well suited to capturing gases and fumes from indoor VOC coating applications, using this system to capture fumes from a passive ventilation source in an outdoor setting

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with typically windy conditions posed many challenges. In this case, the goal was to demonstrate 100% capture of tank off-gas without oversampling the passive ventilation system and thus creating additional emissions. In order to demonstrate 100% capture by maintaining the TTE at negative 0.007 inches water column (or more negative), and to insure that both TTEs remained consistently negative over a variety of wind conditions, the static pressure the two TTE exhaust system had to be set fairly high.

2.3 Summary of Results - VOC/HAP Residual Oil Storage Tank Test Program

This section contains summary tables of VOC data collected over the 15-day period.

Table 2-1 summarizes the daily non-methane hydrocarbon (NMHC) emissions results from Tank No. 3 over a 15-day period (4/11/13 through 4/26/13) during normal tank breathing. All supporting data and calculations are contained in Appendix A. The ton/year annual projection in this table is based on 8760 hours per year under the assumption that the measured emission rate is representative of year-round emissions.

Table 2-2 summarizes NMHC emissions measured during a transfer of approximately 27,387 barrels of residual oil from the vessel "Columbia" into Tank No. 3 over a 10.5-hour period on 4/16/13. All supporting data and calculations are contained in Appendix B.

Table 2-3 summarizes the NMHC emissions measured at the truck loading rack on 7/2/13 during eight filling cycles. All supporting data and calculations are contained in Appendix C.

Table 2-4 summarizes the VOC HAP emissions results (Summa sampling) during normal tank breathing. All supporting data and calculations are contained in Appendix D. The ton/year annual projection in this table is based on 8760 hours per year under the assumption that the measured emission rate is representative of year-round emissions.

Table 2-5 summarizes the VOC HAP emissions results during vessel transfer operations. All supporting data and calculations are contained in Appendix D.

Table 2-6 summarizes the VOC HAP emissions results during tanker truck loading operations. All supporting data and calculations are contained in Appendix D.

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Table 2-1 No. 6 Oil Non-Methane Hydrocarbon Emissions Summary – Static Tank Breathing

Date	TTE #1 Pressure (In. w.c.)	TTE #1 Pressure (In. w.c.)	Daily Cal Status	Tank Temp (°F)	Tank Capacity (%)	Volumetric Flow Rate (scfm)	Non-Methane Hydrocarbons (Lb/hr)	Non-Methane Hydrocarbons (Tons/year)
04/11/13	-0.038	-0.029	Good	120	21.6	230	1.01	4.44
04/12/13	-0.048	-0.045	Good	126	21.1	221	1.16	5.06
04/13/13	-0.010	-0.023	Good	128	20.7	245	1.80	7.89
04/14/13	-0.020	-0.009	Good	128	6.6	248	1.19	5.21
04/15/13	-0.015	-0.010	Good	121	6.4	255	2.06	9.04
Vessel Transfer April 16 at 00:10 through 10:40 - See Table 2-2								
04/16/13	-0.060	-0.035	Good	105	60.7	241	1.71	7.47
04/17/13	-0.060	-0.028	Good	115	61.0	244	1.55	6.77
04/18/13	-0.009	-0.050	Good	122	60.6	256	1.44	6.32
04/19/13	-0.033	-0.035	Good	126	60.6	264	2.25	9.85
04/20/13	-0.019	-0.043	Good	125	60.4	270	1.92	8.39
04/21/13	readings not taken			124	60.2	276	1.84	8.06
04/22/13	-0.048	-0.032	Good	123	59.4	268	1.72	7.51
04/23/13	-0.045	-0.065	Good	121	59.0	272	2.04	8.93
04/24/13	-0.090	-0.060	Good	120	58.8	271	2.22	9.72
04/25/13	-0.060	-0.035	Good	119	58.4	272	1.71	7.47
04/26/13	-0.024	-0.018	Good	120	58.2	273	1.54	6.73
AVERAGE:						**257**	**1.70**	**7.43**

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Table 2-2 No. 6 Oil Non-Methane Hydrocarbon Emissions Summary – Vessel Transfer

April 16, 2013

Hour No.	Start Time	End Time	Transfer Rate (barrels/hr)	Displ. Flow Rate (scfm)	Measured Flow Rate (scfm)	THC as C3H8 (lb/hr)	CH4 (lb/hr)	NMHC (lb/hr)	NMHC (tons/hr)
1	0:10	1:10	3213	298	500	4.54	0.12	4.42	2.21E-03
2	1:10	2:10	2754	255	501	4.11	0.11	4.00	2.00E-03
3	2:10	3:10	2907	269	502	4.48	0.13	4.36	2.18E-03
4-5.5 (2.33 hrs)	3:10	5:30	6426	255	503	4.14	0.13	4.01	2.01E-03
6.5	5:30	6:30	2754	255	504	4.05	0.14	3.91	1.96E-03
7.5	6:30	7:30	2601	241	502	4.05	0.14	3.91	1.96E-03
8.5	7:30	8:30	2754	255	499	4.71	0.16	4.56	2.28E-03
9.5	8:30	9:30	2448	227	498	4.14	0.13	4.01	2.01E-03
10.5	9:30	10:30	1530	142	491	1.74	0.06	1.68	8.40E-04
Average:			**3043**	**244**	**500**	**4.00**	**0.12**	**3.87**	**1.94E-03**
Total Tons NMHC Per Vessel Transfer = 2.01E-02									

Note 1: One barrel = 5.56 cubic feet
Note 2: NHMC emisisons calculating using measured volumetric flow rate.
Note 3: One transfer takes approximately 10.5 hours.

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Table 2-3 No. 6 Oil Non-Methane Hydrocarbon Emissions Summary – Truck Loading

July 2, 2013

Truck No.	Start Time	End Time	Load Time (minutes)	Load (gallons)	Fill Rate (gal/hr)	Displacement (scfm)	NMHC (lb/hr)	NMHC (lb/load)	NMHC (Ton/load)
1	8:08	8:25	13	7000	32308	72.0	1.93	0.417	2.09E-04
2	9:09	9:20	11	7507	40947	91.2	2.89	0.529	2.65E-04
3	10:13	10:24	11	7502	40920	91.2	2.67	0.490	2.45E-04
4	11:50	12:02	11.5	7507	39167	87.3	2.40	0.459	2.30E-04
5	12:50	13:01	11.5	7502	39141	87.2	2.74	0.525	2.62E-04
6	13:53	14:05	11.5	7502	39141	87.2	2.65	0.508	2.54E-04
7	14:51	15:02	11.5	7507	39167	87.3	2.50	0.480	2.40E-04
8	15:50	16:01	11	7507	40947	91.2	2.89	0.529	2.65E-04
Average:			**12**	**7442**	**38967**	**86.8**	**2.58**	**0.492**	**2.46E-04**

Note: One Gallon = 0.13368 cubic feet

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Table 2-4 No. 6 Oil VOC HAP Emissions – Tank Breathing

Summa No.	Activity	Date	Time	Max HAP Compound	Max HAP (Tons/year)	Sum of HAP (Tons/year)	Sum of TICs (Tons/year)
1	Breathing	4/15/13	2100-2230	Xylene	1.50E-01	9.50E-01	1.12E+00
3	Breathing	4/23/13	1605-1635	Propene	2.77E-01	1.29E+00	1.98E+00

Note: The ton/year annual projection in this table is based on 8760 hours per year under the assumption that the measured emission rate is representative of year-round emissions.

Table 2-5 No. 6 Oil VOC HAP Emissions – Vessel Transfer

Summa No.	Activity	Date	Time	Max HAP Compound	Max HAP (lb/hr)	Sum of HAP (lb/hr)	Sum of TICs (lb/hr)
2	Vessel Transfer	4/16/13	0922-0942	Hexane	6.57E-02	5.17E-04	5.89E-01

Table 2-6 No. 6 Oil VOC HAP Emissions – Truck Transfer

Summa No.	Activity	Date	Time	Max HAP Compound	Max HAP (lb/transfer)	Sum of HAP (lb/transfer)	Sum of TICs (lb/transfer)
4	Truck Loading	7/2/13	1555-1556	Hexane	9.72E-02	3.54E-05	1.88E-01

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3.0 PROCESS DESCRIPTION AND SAMPLING POINT CONFIGURATION

3.1 Facility Description

The Global South Portland petroleum terminal handles distillate and residual oil products, and asphalt. The terminal operates under the Standard Industrial Classification Code (SIC) 5171, Petroleum Bulk Stations and Terminals. The facility receives products by ship, barge and/or truck, and stores the products in twelve (12) heated and non-heated petroleum storage tanks. Products are then loaded into over-the-road tank trucks through a truck loading rack or into barges for marine transport.

3.2 Sampling Location Description

3.2.1 Residual Oil Storage Tank No. 3

Emissions from Residual Oil Storage Tank No. 3 were quantified from the two exhaust vents on the tank roof. A Temporary Total Enclosure (TTE) was constructed around each vent such that the TTEs completely encapsulated the vents. Each TTE was equipped with a single natural draft opening (NDO) with a variable damper, and an exhaust duct of 7 inches inside diameter. The exhaust duct had a straight length of approximately 38 duct diameters before connecting to an induced draft fan with and operating range of approximately 350 to 800 acfm. A waste gate was located just prior to the ID fan and two duct diameters downstream from the sampling ports. The duct flow rate was primarily controlled by adjusting the waste gate opening. The fan speed could further be adjusted by changing the diameter of the belt pulleys. Each TTE was equipped with a static pressure measuring device that was used to verify the TTE static pressure on a daily basis.

All emissions measurements were made in the common exhaust duct prior to the ID fan. The duct was equipped with two national pipe thread (NPT) sampling ports located 90° apart for volumetric flow measurements, and two additional NPT ports located 90° apart for collecting VOC samples.

Figure 2-1 on the following page presents an image of TTE exhaust system tank (only one of two TTEs visible). Figure 2-2 presents a general diagram of the Tank vent and the TTE Exhaust System. Table 2-1 lists the exhaust duct dimensions and corresponding flow traverse points.

3.2.2 Tanker Truck Exhaust Vent

During tanker truck filling at the loading rack, VOC emissions were measured at the tanker truck fill hatch. A continuous gas sample was collected just inside the fill hatch during filling operations. Flow rate was not directly measured, rather it was calculated based on the fill rate of the tank and the resultant displacement of air.

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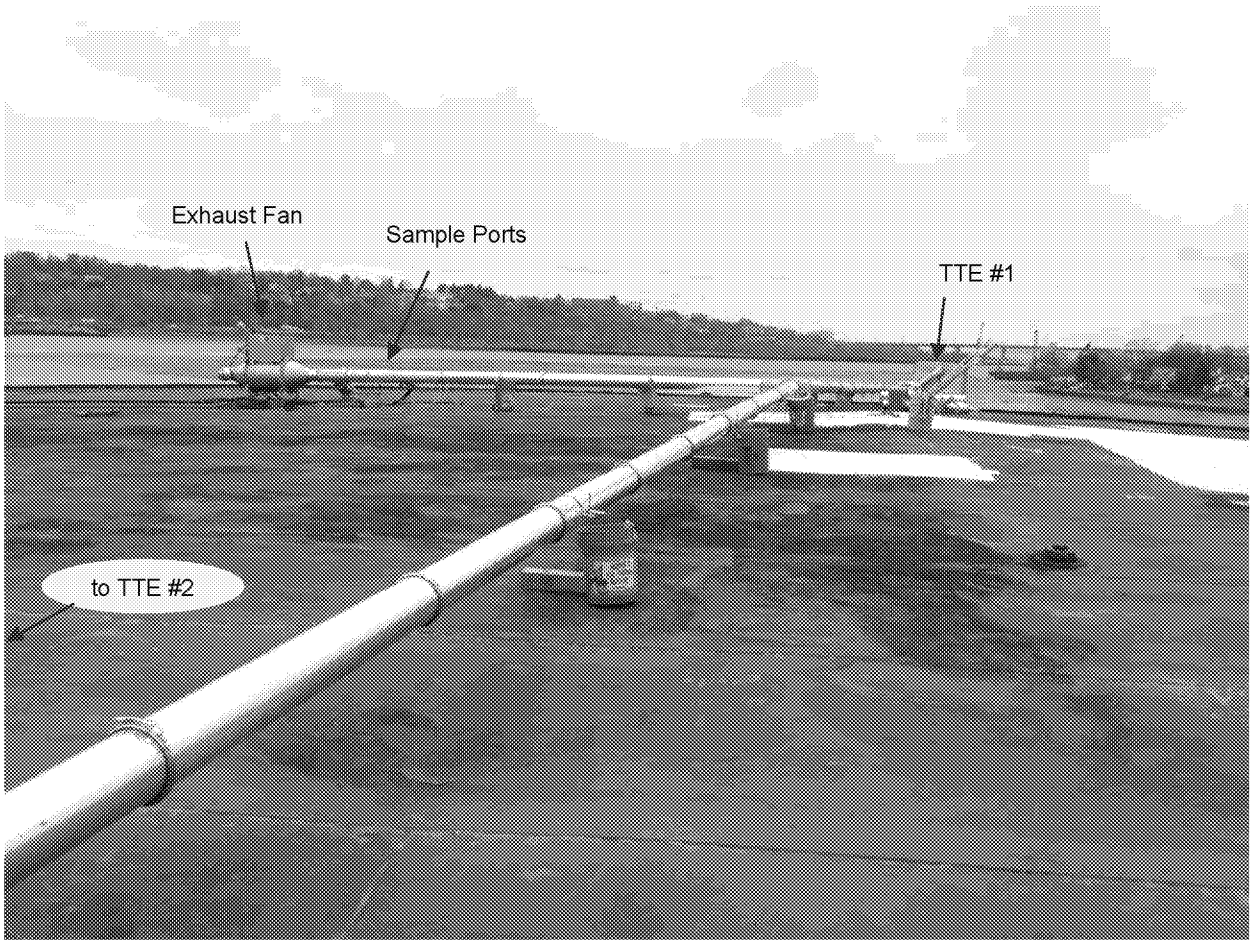

Figure 3-1 Residual Oil Storage Tank No. 3 TTE Exhaust System

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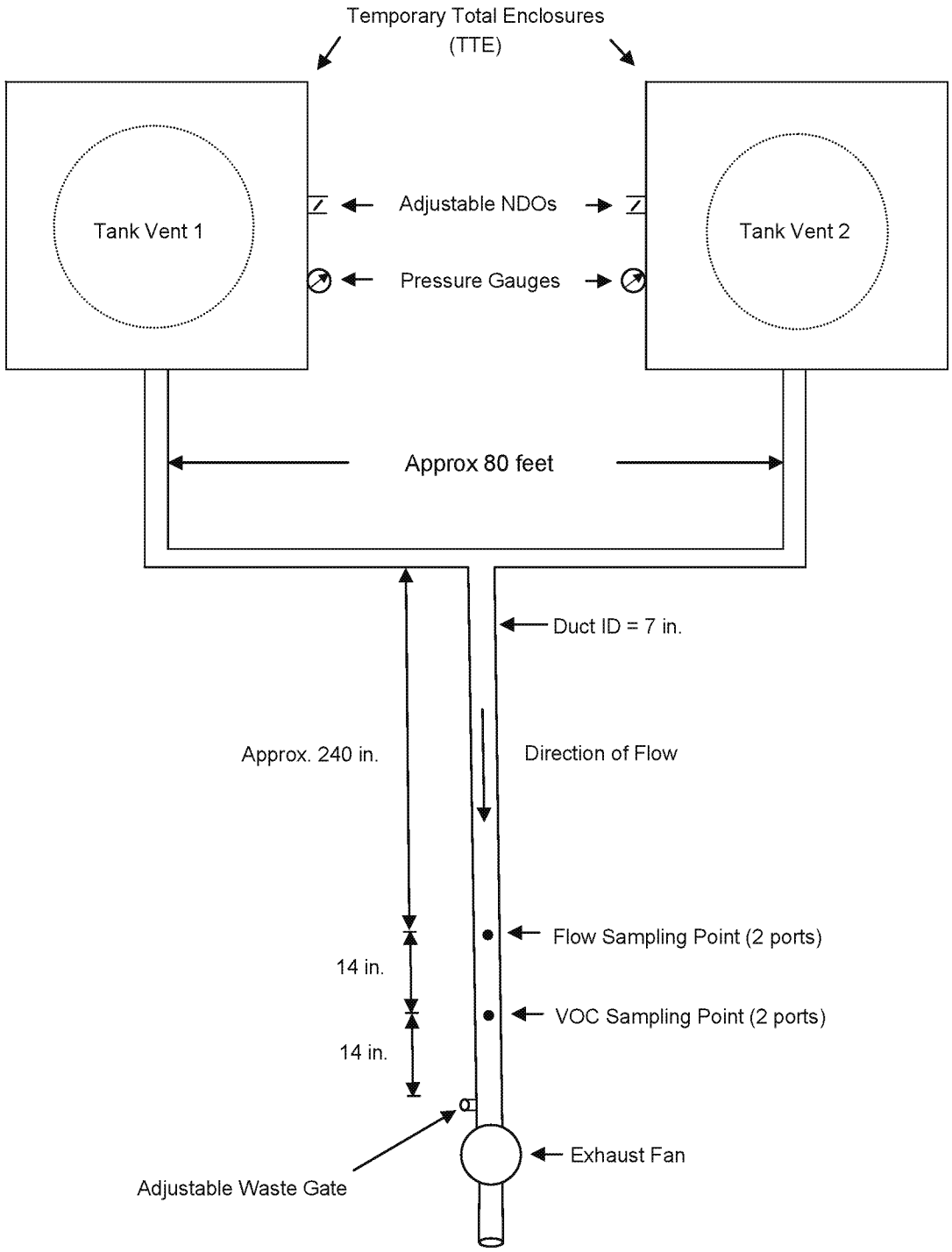

Figure 3-2 Residual Oil Storage Tank No. 3 TTE Exhaust System Diagram

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Table 3-1 Sampling Configuration – TTE Exhaust Duct

– Exhaust Duct Flow Sampling Location –		
Description	**Distance**	**Equivalent Diameters**
From nearest upstream disturbance to sampling ports	Approx. 240 inches	Approx. 34
From nearest downstream disturbance to sampling ports	14 inches	2.0
Diameter	7 inches	NA
Number of Ports	2	NA
Flow Traverse Points on a Diameter		
Traverse Point No.	**% of Diameter**	**Distance from Inside Wall**
1	6.7	0.5 inches
2	25.0	1.8 inches
3	75.0	5.3 inches
4	93.3	6.5 inches

Notes:

- **VOC and HAP were sampled at a single point in the duct center, 2 diameters downstream from the pitot tube.**
- **Velocity and temperature were measured at a single point in the duct that most closely matched the average velocity obtained during the velocity traverse.**

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4.0 TEST PROCEDURES

4.1 Overview

Emissions testing was conducted to determine the VOC and HAP concentration and mass emission rate of the subject process. Each parameter was measured in strict accordance with official EPA procedures at the sampling locations previously described. This section details the test procedures that were used during this test program.

4.2 Methodology

4.2.1 Non-Methane Hydrocarbons (NMHC) – EPA Methods 25A and 18

Non-methane hydrocarbons (NMHC) were measured at the storage tank exhaust vent and the tanker truck open hatch. NMHC consists of measurements of total hydrocarbons (THC) determined in accordance with EPA Method 25A, and methane (CH_4) determined in accordance with EPA Method 18. Eastmount met the requirements of Methods 25A and 18 by utilizing one VIG Model 200 total hydrocarbon/methane analyzer equipped with a flame ionization detector (FID) for total hydrocarbons, and a methane-specific gas chromatograph (GC) also utilizing an FID.

The THC portion of the analyzer was initially calibrated with zero air and three certified standards of propane-in-balance-air at the beginning of the sampling program, and re-calibrated as necessary throughout the 15-day program. On a daily basis, zero air and an upscale propane standard were introduced to the analyzer through the entire system to determine system drift and accordingly, the validity of the data collected following the previous daily calibration check. All calibrations were performed in accordance with Method 25A and met or exceeded Method 25A accuracy criteria. All data was logged on a computer.

The methane gas chromatograph portion of the analyzer was calibrated in accordance with EPA reference Method 18. Eastmount utilized an internal gas chromatograph (GC) column in the VIG Model 200 to determine methane concentrations. The system was initially calibrated using zero air and three certified standards of methane-in-balance-air introduced to the GC. The GC was fully calibrated at the beginning of the sampling program, thereafter as required. On a daily basis, zero air and an upscale methane standard were introduced to the analyzer through the entire system to demonstrate system drift and to validate sample integrity. Please note that although methane sampling is considered to be continuous, a methane sample injection occurs on a three-minute cycle.

All data was logged on a data acquisition system (DAS) consisting of an Iotech DAQ 56 data logger and a computer. Concentration data was recorded by the DAS in two-second intervals, and reported in one-minute averages.

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4.2.2 Volumetric Flow Rate (EPA Methods 1-4)

Volumetric flow rate was measured from the storage tank TTE exhaust system in accordance with EPA Method 2C. Eastmount used an S-type pitot tube manufactured by Apex Instruments. It was constructed of 3/16" tubing to minimize its size within the duct. A K-type thermocouple was incorporated into the pitot assembly which was encased in a ½" stainless steel sheath. This sheath was necessary to allow permanent installation of the pitot tube at the point of average velocity without allowing ambient air from entering the exhaust duct. The pitot tube was connected to a calibrated Dwyer (or equivalent) pressure transducer with a range of 0 to 5 inches sensitivity via 250 feet of tubing to measure the exhaust duct flow rate during both idle periods (no fuel being transferred), and also during fuel transfer periods. Additionally, flow rate was calculated during tank filling using the theoretical amount of air being displaced during fuel transfer into the tank.

Eastmount conducted an initial flow traverse at all traverse points. The pitot tube/thermocouple was then fixed in position at a traverse point that most closely matched the average duct velocity. The pitot tube was periodically removed to be inspected, cleaned if necessary, leak checked, and re-positioned in the duct. At no time during this program did the pitot system develop a leak, become clogged, or become dislodged from its intended position in the duct.

The molecular weight and moisture of the gas in the exhaust duct was assumed to be ambient during normal storage tank off-gassing since the majority of the gas entering and leaving the TTE was ambient air. During vessel transfer operations, Eastmount determined (utilizing a Tedlar bag and calibrated oxygen analyzed), that the oxygen concentration level in the storage tank was essentially ambient, and therefore the molecular weight on ambient air was used in all flow rate calculations.

Volumetric flow rate data was logged on a data acquisition system (DAS) consisting of an Iotech DAQ 56 data logger and a computer. Flow data consisting of velocity pressure and temperature were recorded by the DAS in two-second intervals, and reported in one-minute averages.

4.2.3 VOC HAPS - EPA TO-15

VOC Hazardous air pollutants (HAPS) were determined by collecting a sample in a prepared, pre-evacuated Summa canister with a calibrated flow orifice meter to allow canister filling for approximately 30 minutes. The sample was delivered to the canister via a short length of ¼" OD Teflon tubing and a short ¼" stainless steel probe which was positioned in the duct center using a leak-free Swagelok fitting. A total of four Summa samples were collected during this program – two during normal tank breathing, one during vessel transfer, and one during truck loading.

Maxxam Analytics of Burlington, Ontario conducted the final analysis of the Summa canisters in strict accordance with EPA Method TO-15. Analysis of VOC HAPs were determined by Gas Chromatography/Mass Spectrometry (GC/MS). The analytes consisted of the standard TO-15 list of

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VOC HAPs plus the first 20 tentatively identified compounds (TICs). Results were reported in ug/M^3 and lb/hr for each compound.

4.2.4 Temporary Total Enclosure (TTE) System – EPA Method 204

A temporary total enclosure (TTE) was constructed around the two exhaust vents on Storage Tank No. 3. The purpose of this approach was to capture vapors breathing from the tank vent, and deliver them to a common sampling location at a velocity that was measurable using EPA Method 2C equipment. Each TTE fully encapsulated each exhaust vent. Each TTE was equipped with a single adjustable natural draft opening (NDO) and an exhaust duct. The exhaust of each TTE was connected to a common exhaust duct equipped with sampling ports, an adjustable waste gate, and an exhaust fan.

The static pressure of each TTE was measured using a Dwyer Model DM-1123 digital low pressure gauge with a range of -0.5 to 0.5 inches w.c., and a resolution of 0.001 inches. The gauge was located on the side of each TTE. The positive pressure tap was fitted with a flexible Tygon tube that was positioned inside the TTE. The negative pressure tap was left opened to atmosphere, but was protected from the wind using a shield. The static pressure of each TTE was maintained at negative 0.007 inches water column (w.c.) or more negative in order to achieve 100% capture. The static pressure was measured daily, and recorded on the daily check list.

4.2.5 Test Log / Daily Activities

Eastmount maintained a test log consisting of daily equipment checks and calibrations throughout the 15-day test program. The log served to document all testing, calibration and QA/QC activities. As this program occurred over an extended period of time, it was essential to conduct calibrations and other equipment inspections on a daily basis. Daily calibrations and equipment checks were recorded on field data sheets which can be found in Appendices A3 and A4. Please refer to Section 5.2 of this report for a complete summary of daily onsite QA/QC activities.

4.3 Description of VOC and Methane Sampling

4.3.1 VOC and Methane Sampling System

What follows is a description of the transportable continuous emissions monitor system used to quantify VOC and methane emissions. The system meets all the specifications of Reference Method 18 and 25A:

- **Probe** - A short length of stainless steel probe was used at the sampling location. The probe was of sufficient length (4 inches) to reach the centroidal area of duct.

- **Coalescing Filter** - A coalescing filter was installed in-line between the probe and heated

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filter/calibration Tee. The purpose of the coalescing filter was to remove oil mist from the gas stream to protect the sample line surface and the VOC analyzer from oil coating.

- **Calibration Tee** - Stainless steel tee (3/8") located between the probe and the sample line allowed the operator to inject calibration gas through the entire sampling system. Excess calibration gas exits the probe, eliminating any potential over pressurization.

- **Heated Filter** - A heated, spun-glass fiber filter contained in a heated sheath was used to remove particulate from the gas stream. The filter was located between the sample probe and sample line. It is designed to remove particulate from the gas stream. The filter was heated to 275°F.

- **Sample Line** - A heated 3/8" OD Teflon sample line was used to transport the sample stream from the test locations to the analyzer. The line was heated to 275°F to minimize condensation of hydrocarbons before reaching the analyzer.

- **System Calibration Line** - A ¼" OD Teflon tube was used to transfer calibration gas from the cylinder to the calibration tee between the probe and filter.

- **Sample Pump** - A leak-free pump (integrated into the VIG analyzer) was used to pull the sample gas through the system at a flow rate sufficient to minimize the response time of the measurement system. The components of the pump that contact the gas stream are constructed of stainless steel or Teflon. The sample pump was heated to 275°F to prevent condensation.

- **THC Analyzer –** One VIG Model 200 flame ionization analyzer (FIA) was used.

- **Data Acquisition System (DAS) –** The VOC analyzer's response was recorded on a Dell Inspiron 1710 computer working in unison with an Iotech Data Acquisition System. This system was programmed to collect a data point every 2 seconds, and report/save the data in one-minute averages to the Iotech software. This software operates in a Windows environment.

4.3.2 VOC and Methane Sampling Procedures

Both the THC FID and the methane GC were initially calibrated using zero air and low, mid and high propane-in-air calibration gases, certified in accordance with EPA Protocol procedures. The internal GC in the VIG that measured methane was calibrated using zero air and zero, low, mid and high methane-in-air calibration gases certified in accordance with EPA Protocol procedures. Calibrations were conducted through the entire sample system. A description of the specific procedures is provided below:

- **Zero:** The zero point of the analyzer was determined using a pre-purified cylinder of

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air. The zero point was analyzed for a minimum of five minutes to monitor drift before sampling commences.

- **High:** The high calibration gas was 80-90% of span. It was introduced to the sample system and the response of the analyzer was adjusted accordingly.
- **Low:** The low calibration gas was 25-35% of span. It was introduced to the sample system and the response of the analyzer was recorded.
- **Mid:** The mid calibration gas was 45-55% of span. It was introduced to the sample system and the response of the analyzer was recorded.

Once the analyzer was calibrated, the system was switched to sample mode and sampling commenced. The response time of the system was determined from the time the gas valve was shut off to the time the response of the FIA is 95% of the steady state sample value. The DAS then recorded the analyzer response throughout the test run. On a daily basis, the sampling system was post-calibrated. The post calibration consisted of delivering zero and a representative upscale calibration point through the entire sampling system and recording the system response. This response was used in conjunction with the initial system calibration in order to determine calibration drift over the test run period. If the analyzer drift was within the 3% of the measurement range, then the data collected between the previous and current calibrations was considered valid. If the analyzer drift was outside 3% of the measurement range, then the data would have been voided, and an entire system recalibration (zero and three upscale points) would have occurred.

4.4 Reference Method Volumetric Flow Determination

In conjunction with VOC monitoring, Eastmount continuously measured volumetric flow in accordance with EPA Methods 1-2C, 40 CFR 60, Appendix A. The following is a description of the individual components that comprised the sampling train.

4.4.1 Volumetric Flow Rate Equipment

Eastmount conduct volumetric flow rate determinations during this test program in accordance with procedures delineated in EPA Methods 1 and 2C, 40 CFR 60, Appendix A. The system components necessary to conduct this testing are detailed below:

- **Pitot Tube -** A small S-type pitot tube (constructed of 3/16" tubing) was used to measure gas velocities. A pitot coefficient of 0.84 was used.
- **Pitot Lines -** The pitot tube was connected to a pressure transducer via a 250-foot, leak-free flow line also equipped with thermocouple wire.
- **Pressure Transducer -** A pressure transducer, manufactured by Apex Instruments, with a range of 0-5" w.c. and a 0.01" w.c. sensitivity, was used to measure the velocity pressure drop.

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- **Thermocouple** - A "K" type thermocouple was used to monitor the gas temperature.
- **Static Pressure** - Duct static pressure was measured by rotating the pitot tubes perpendicular to the direction of flow, disconnecting the negative pitot (if positive) and recording the deflection of the manometer.

4.4.2 Volumetric Flow Rate Sampling Procedure

The following describes the procedure used to measure flow rate from the storage tank exhaust duct:

1. Assemble pitot tube, flow line, and pressure transducer. Mark the pitot tube with the appropriate traverse points.
2. Conduct a leak check on the system as follows: (a) blow through the pitot impact opening until at least 7.6 cm (3.0 in.) H_20 velocity head registers on the pressure transducer display, and close off the impact opening. The pressure shall remain stable for at least 15 seconds; (2) do the same for the static pressure side, except using suction to obtain the minimum of 7.6 cm (3.0 in.) H_20.
3. Conduct a preliminary traverse of the exhaust duct with the TTE/ID fan system operating normally. Record the velocity pressure and temperature at each location
4. Position the pitot tube/thermocouple at the traverse point that most closely matches the average velocity pressure, and lock it into position.
5. Commence recording flow and temperature data.
6. Inspect, leak check and re-zero the system as required. This procedure was carried out weekly by Eastmount onsite personnel.

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5.0 QUALITY ASSURANCE/QUALITY CONTROL

5.1 Overview

Sampling was conducted by trained personnel with extensive experience in Reference Method sampling. All sampling and analysis was conducted in strict accordance with EPA test procedures. The quality control procedures found in the EPA Quality Assurance Handbook for Air Pollution Measurement Systems were adhered to as well.

Eastmount Environmental Services, LLC has established and implements a Quality Management System that conforms to all of the requirements of the ASTM 7036 D - 04 quality standard entitled "Standard Practice for Competence of Air Emission Testing Bodies (AETB)". A copy of the company's AETB Certification Statement is available on request. The company has also developed a Quality Policy Statement confirming management's commitment to undertake its scope of services in full conformance with all aspects of its Quality Management System and the ASTM D7036-04 practice standard. Further, the company has defined a set of Quality Objectives as part of its Quality Policy Statement that serve as the basis for maintaining the highest level of quality in its day-to-day testing and calibration initiatives. This program was carried out in full accordance with the company's Quality Management System.

All of Eastmount's field testing staff are nationally certified as Qualified Stack Testing Individuals (QSTI). Specifically, the Eastmount Project Director for this program is certified in all four groups associated with the QSTI certification program. The QSTI certification is recognized by EPA as the officially designated standard of expert air emissions testing acumen. It confirms that an individual demonstrates the knowledge and ability to carry out source testing and fundamental air quality engineering to the highest standards.

All calculations were conducted in strict accordance with the equations found in the individual Methods. Strict QA/QC protocols were followed during all phases of this project. These protocols included:

- QA objectives for measurement data;
- Data reduction;
- Internal QC;
- Calibration of equipment;
- Corrective action, if necessary; and
- Use of standardized field data sheets.

These specific procedures in addition to Eastmount's usual high standard of quality control will help validate the results obtained in this test program. As the majority of our emissions testing work is done for compliance purposes, strict QC procedures are incorporated into our everyday work performance.

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5.2 Daily Onsite QA/QC Activities

The following section describes the onsite QA/QC activities that occurred on a daily basis throughout the program. Eastmount provided training to Global personnel to specifically carry out the required daily procedures. All activities were entered onto standardized field data sheets that were used to log equipment checks and calibrations.

5.2.1 VOC Analyzer

The total hydrocarbon analyzer was initially fully calibrated using the procedures defined in Sections 4.3.2 and 5.3.4 of this report. This consisted of first zeroing the analyzer(s) through the entire system with UHP air, spanning the instrument(s) with a high calibration gas of 80-90% of instrument range, and then introducing two additional gases at 45-55% and 25-35% of analyzer range.

On each day of the 15-day sampling period, zero gas and a single upscale gas were introduced to the system to verify that the system calibration was within the tolerance of EPA Method 25A. The system was fully re-calibrated once just prior to the vessel transfer to ensure a good calibration for the single vessel transfer event. Otherwise, daily post-calibrations were conducted to demonstrate that the system response had not drifted from the initial calibration by more than 3% of the sampling range of the analyzer. A pass/fail range was calculated by Eastmount based on the most recent initial calibration results, allowing the operator to quickly determine the status of the daily calibration.

All calibration data, including the operator name, date/time, calibration gas concentrations, and calibration status (pass/fail) were documented on the daily calibration data sheets that can be found in Appendix A2. A pass/fail range was established on the data sheet to allow the operator to quickly determine the status of the calibration. Calibration data values were entered into a spreadsheet logged on data sheets. Any anomalies (analyzer drift, analyzer recalibration, malfunctions such as analyzer flame-out, etc.) were cited in the log, and were immediately reported to the EPA. At no time did the analyzers fail calibration criteria during this program.

5.2.2 Flow Monitor

The pitot tube and pressure transducer system were inspected on a weekly daily basis. The pitot tube was removed from the exhaust duct and inspected to ensure that the pitot openings were clear and free of condensed oil or other contaminants. The pitot system was leak checked by pressurizing the positive line, sealing it, and observing a steady transducer reading for 15 seconds. The negative line underwent the same leak check procedures under negative pressure. Once leak checking was completed, the pitot system was re-zeroed (if needed), and the pitot was returned to the traverse point of average velocity. Any anomalies (clogged pitot, leak in the system, etc.) were recorded on the test log, and reported to the EPA. During this program, there were no issues regarding pitot leaks, significant zero drift, clogging of the pitot openings, or significant coating of the pitot head.

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5.2.3 TTE Pressure

The static pressure of the TTE was checked and recorded in the Test Log on a daily basis. The static pressure needed to be at least negative 0.007 inches w.c.. If the static pressure of the TTE was found to be less than negative 0.007" w.c., the ID fan waste gate and/or NDO damper(s) were adjusted to achieve the required static pressure. All TTE daily static pressure reading were recorded on the daily test log forms.

5.2.4 Process Data

In addition to test parameters, the following operating parameters were recorded on a daily basis:

- Temperature of the product in the storage tank.
- Percent of capacity of storage tank (where 100% = filled to safe maximum level).

5.3 Volatile Organic Compounds

The following subsections present the Continuous Emissions Monitoring System (CEMS) criteria for VOC that were adhered to throughout the test program:

5.3.1 Leak Check

Prior to the initiation of testing, the reference method VOC system was leak checked from the end of the sampling probe by ensuring that the system vacuum reached the capacity of the sampling pump (~20"Hg) while all rotameters indicated no flow. If a leak was detected, it was traced, fixed and the leak check procedure repeated until successful.

5.3.2 System Response Time

Prior to the initiation of sampling, a reference method VOC system response time was determined. During the test program, the system was allowed to sample a minimum of 2.0 times the response time prior to the initiation of any sampling runs.

5.3.3 Calibration Gases

All calibration gases utilized were prepared according to EPA Protocol standards.

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5.3.4 Calibration Criteria

- **Calibration Error** – As an initial analyzer calibration procedure, or as necessary following a daily calibration drift check, a calibration error test was conducted for each analyzer channel for the low and mid level gases, as follows. Following instrument calibration (zero and span), the mid and low range calibration gases were injected and the instrument responses recorded. From these values calibration error was calculated for low and mid level gases in accordance with the formula presented below. The maximum allowable calibration error is 5% of the expected value for both the low and mid level gases. If this limit was not achieved, corrective action was taken and the procedure repeated until successful.

$$CalibrationError = \frac{(Concentration_{Response} - Concentration_{Predicted})}{Concentration_{Cylinder}} \times 100$$

- **Calibration Drift** – On a daily basis and following the most recent full system calibration error check, a calibration drift test was conducted using zero and a single upscale gases for each analyzer channel. The zero and upscale calibration gases were injected and the instrument responses recorded. From these values, calibration drift was calculated in accordance with the formula presented below. The maximum allowable calibration drift is 3% of instrument span. If this limit was not achieved, the data was considered invalid, corrective action was taken, and full system calibration conducted.

$$Drift = \left| (Response_{final} - Response_{initial}) / Instrument\ Span \right| \times 100$$

5.4 Volumetric Flow Equipment Calibrations

Eastmount's pitot tubes and thermocouples are maintained in accordance with specifications set forth in EPA "Quality Assurance Handbook for Air Pollution Measurement Systems - Volume III Stationary Source Specific Methods" and with manufacturer's suggested procedures. A summary is presented below:

- **Thermocouples** - All type K thermocouples are calibrated against ASTM mercury-in-glass thermometers at three points that bracket the operating temperature of the specific thermocouple. The typical calibration points are an ice bath, ambient air, boiling water, and hot oil.
- **Pitot Tubes** - All Type "S" stainless steel pitot tubes are designed to meet the dimensional criteria set forth in Method 2, therefore a coefficient of 0.84 (Type "S") is used.
- **Pressure Transducers** – All pressure transducers used in this program were calibrated against an inclined manometer at four pressure points.

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