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VALERO REFINING COMPANY
PAULSBORO, NJ

TAIL GAS UNITS 80 AND 81
SOURCE EMISSIONS COMPLIANCE
TEST REPORT
TEST DATES: 8-9 FEBRUARY 2011

APC PLANT ID NUMBER: 55829
BOP NUMBER 080004

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VALERO REFINING COMPANY
PAULSBORO, NEW JERSEY

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STATEMENT OF CERTIFICATION:

"I certify under penalty of law that the information provided in this document is true, accurate and complete. I am aware that there are significant civil and criminal penalties, including fines, or imprisonment or both, for knowingly submitting false, inaccurate, or incomplete information."

Stephen Brady, Client Service Manager
Weston Solutions, Inc.

"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attached documents and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant civil and criminal penalties, including the possibility of fine or imprisonment or both, for knowingly submitting false, inaccurate or incomplete information. "

Richard Roat, Senior Environmental Engineer
Valero Refining Company

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1. INTRODUCTION

Valero Refining Company (VALERO) retained Weston Solutions, Inc. (WESTON®) to perform the source compliance testing and analysis program on the Tail Gas Units 80 and 81 at the Paulsboro, New Jersey facility.

The program was performed in order to determine the emissions compliance status of the exhaust stacks with respect to the New Jersey Department of Environmental Protection (NJDEP) Title V permit (BOP 080004) emission limits.

Methods and procedures specified by the U.S. Environmental Protection Agency (EPA) and NJDEP as approved by the NJDEP, were used throughout the compliance test program.

The compliance test program was performed on 8-9 February 2011. All tests were performed by WESTON Integrated Air Services personnel.

Parameters evaluated during the compliance test program included:

- Total Reduced Sulfur Compound (TRS; H_2S, CS_2, COS)
- Carbon Monoxide (CO)
- Total Volatile Organic Compounds (VOC)
- Carbon Dioxide (CO_2)
- Oxygen (O_2)
- Sulfur Dioxide (SO_2)

This report presents the testing and analytical data/results and associated discussion relevant to the above listed parameters.

Following this introduction is a summary of the test results presented in Section 2. The process and sampling location descriptions are provided in Section 3. Sampling and analytical procedures and equipment are described in Section 4. The process operating data including the NJDEP Emission Test Production Report Form, raw test data, example calculations, equipment calibration records and a list of WESTON project participants are provided in appendices A through E.

2. SUMMARY

During this test program the concentrations and mass rates of CO, SO_2, VOC, and TRS were determined on the exhaust stacks of Tail Gas Units 80 and 81. Three tests were performed on each unit to determine their compliance status with respect to the applicable emission limits.

A summary of the measured concentrations and mass rates compared to the NJDEP permit limits are provided in Tables 2-1 through 2-4.

Test methods specified by NJDEP were used throughout the compliance test program. A representative of the NJDEP was present during the test program to observe and approve the compliance testing and process operations.

No process, sampling, or analytical problems were encountered during the test periods and all measured concentrations and mass rates are believed to be representative of the Tail Gas Units 80 and 81 emissions encountered during the test program.

During the compliance test program, representatives of VALERO monitored and collected the applicable process data (see Appendix A).

TABLE 2-1
VALERO
PAULSBORO, NJ
TAIL GAS UNIT 80 STACK
SUMMARY OF CONTINUOUS EMISSION MONITORING TEST RESULTS

Run No.	Date	Time	Volumetric Flow	Stack Moisture	CONCENTRATIONS AND EMISSION RATES											
					O_2	CO_2	VOC						CO		SO2	
			(dscf/m)	(%)	(%)	(%)	VOC as propane (ppmvw)	VOC as propane (ppmvd)	VOC as methane (ppmvd)	methane content (ppmvd)	TNMVOC (ppmvd)[1]	TNMVOC (lb/hr)[1]	(ppmvd)	(lb/hr)	(ppmvd)	(lb/hr)
1	9-Feb-11	1408-1521	4569	3.0	0.1	5.9	58.7	60.5	181.5	109.1	72.4	0.83	81	1.6	0.1	0.005
2	9-Feb-11	1540-1834	4518	4.0	0.0	5.7	52.6	54.8	164.4	106.8	57.6	0.65	80	1.6	0.1	0.005
3	9-Feb-11	1847-2121	4561	3.5	0.0	5.6	48.6	50.4	151.2	81.0	70.2	0.80	79	1.6	0.4	0.018
Average			**4550**	**3.5**	**0.0**	**5.7**	**53.3**	**55.2**	**165.7**	**99.0**	**66.7**	**0.76**	**80**	**1.6**	**0.2**	**0.009**
											ALLOWABLE	1.0	---	5.0	---	5.0

[1] TNMVOC = Total Non-Methane Volatile Organic Carbon

TABLE 2-2
VALERO
PAULSBORO, NJ
TAIL GAS UNIT 80 STACK
SUMMARY OF TRS EMISSION MONITORING TEST RESULTS

Run No.	Date	Time	Volumetric Flow	CONCENTRATIONS AND EMISSION RATES			
				H_2S		TRS	
			(dscf/m)	(ppmvd)	lb/hr)	(ppmvd)	(lb/hr)[1]
1	9-Feb-11	1144-1515	4569	0.91	0.02	5.86	0.27
2	9-Feb-11	1533-1837	4518	0.98	0.02	6.20	0.28
3	9-Feb-11	1857-2157	4561	0.92	0.02	6.02	0.27
Average			**4550**	**0.94**	**0.02**	**6.03**	**0.27**
				Allowable	0.4	---	8.0

[1] TRS emission rate (lb/hr) measured as SO_2

TABLE 2-3
VALERO
PAULSBORO, NJ
TAIL GAS UNIT 81 STACK
SUMMARY OF CONTINUOUS EMISSION MONITORING TEST RESULTS

Run No.	Date	Time	Volumetric Flow	Stack Moisture	CONCENTRATIONS AND EMISSION RATES										
					O_2	CO_2	VOC					CO		SO2	
			(dscf/m)	(%)	(%)	(%)	VOC	VOC as methane (ppmvd)	methane content (ppmvd)	TNMVOC (ppmvd)[1]	TNMVOC (lb/hr)[1]	(ppmvd)	(lb/hr)	(ppmvd)	(lb/hr)
1	8-Feb-11	1147-1449	5408	3.2	0.0	6.4	62.7	64.7	68.5	< 1.0	< 0.01	128	3.0	2.8	0.15
2	8-Feb-11	1525-1816	5463	3.2	0.0	6.2	65.0	67.2	72.5	< 1.0	< 0.01	126	3.0	< 0.1	< 0.01
3	8-Feb-11	1836-2122	5476	3.2	0.0	6.4	65.3	67.4	69.8	< 1.0	< 0.01	124	3.0	0.1	0.01
Average			**5449**	**3.2**	**0.0**	**6.3**	**64.3**	**66.5**	**70.3**	**< 1.0**	**< 0.01**	**126**	**3.0**	**≤ 1.0**	**≤ 0.1**
										ALLOWABLE	1.0	---	5.0	---	5.0

[1] TNMVOC = Total Non-Methane Volatile Organic Carbon

TABLE 2-4
VALERO
PAULSBORO, NJ
TAIL GAS UNIT 81 STACK
SUMMARY OF TRS EMISSION MONITORING TEST RESULTS

Run No.	Date	Time	Volumetric Flow	CONCENTRATIONS AND EMISSION RATES			
				H_2S		TRS	
			(dscf/m)	(ppmvd)	(lb/hr)	(ppmvd)	(lb/hr)[1]
1	8-Feb-11	1130-1430	5408	1.65	0.05	5.98	0.32
2	8-Feb-11	1514-1814	5463	1.82	0.05	6.34	0.35
3	8-Feb-11	1826-2126	5476	1.61	0.05	6.22	0.34
Average			**5449**	**1.69**	**0.05**	**6.18**	**0.34**
				Allowable	0.4	---	8.0

[1] TRS emission rate (lb/hr) measured as SO_2

3. PROCESS AND TEST LOCATION DESCRIPTION

3.1 PROCESS DESCRIPTION

Tail Gas Units 80 and 81 are identical in size and configuration. Each unit is designed to convert sulfur from the Sulfur Recovery Units (SRUs) and Tail Gas to H_2S, H_2, H_2O, and CO_2 for subsequent recovery using the amino-based solvent TG-10. After the H_2S and CO_2 are absorbed by the solvent, they are heated and released in the Solvent Regenerator and then recycled to the SRUs. Gases containing less than 10 ppm H_2S are vented to the atmosphere from the absorber.

3.2 TEST LOCATION DESCRIPTION

Two 4-inch ID test ports (A and B), are installed 90° apart, on a straight section of the 14" ID stack at a site approximately 30 feet (25.7 duct diameters) downstream from the nearest flow disturbance, and 5.75 feet (4.9 duct diameters) upstream from the nearest flow disturbance (stack exit). Traverse point selection criteria dictated by EPA Reference Method 1 required a minimum of 8 points, 4 per axis, for the measurement of velocity. Figure 3-1 illustrates the test port and traverse point locations.

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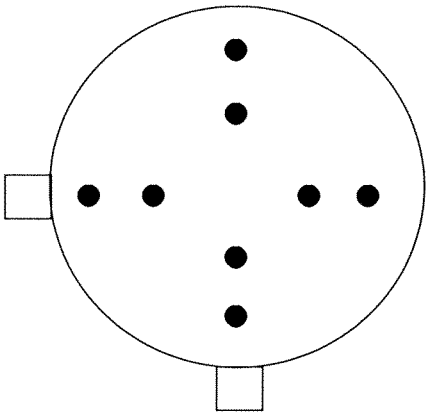
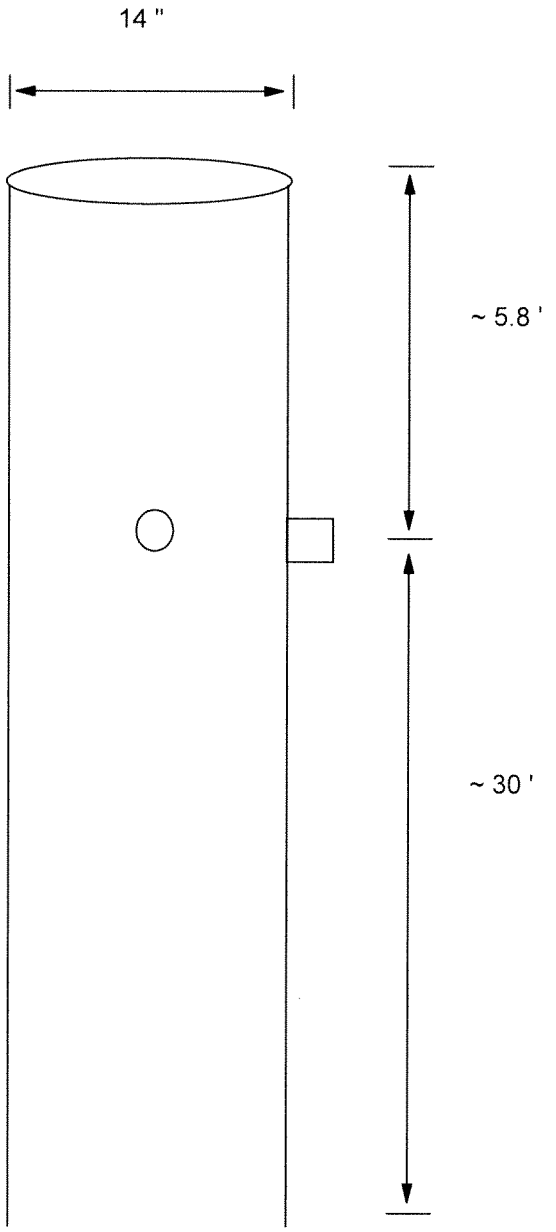
PAULSBORO, NEW JERSEY





VELOCITY TRAVERSE POINT NUMBER	DISTANCE FROM INSIDE WALL, INCHES
1	1
2	3.5
3	10.5
4	13

DRAWING NOT TO SCALE

FIGURE 3-1
TAIL GAS UNITS 80 AND 81
SAMPLE PORTS AND TRAVERSE POINT LOCATIONS

4. SAMPLING AND ANALYTICAL PROCEDURES

4.1 STACK GAS SAMPLING PROCEDURES

This section details the sampling and analytical procedures used during the performance of the test program. The test program was conducted in accordance with the U.S. EPA Reference Methods summarized in Table 4-1.

Table 4-1
Source Testing Methodology

Parameter	Method Number	Quality Control Data	Comments
Volumetric Flow Rate	1,2	Appendix D	
Moisture	4	Appendix D	
Oxygen	3A	Appendix D	Instrumental Method
Carbon Dioxide	3A	Appendix D	Instrumental Method
Carbon Monoxide	10	Appendix D	Instrumental Method
Sulfur Dioxide	6C	Appendix D	Instrumental Method
Total Non-Methane VOCs	25A and 18	Appendix D	Instrumental Method
Total Reduced Sulfur	15	Appendix D	Instrumental Method

4.2 PRE-TEST DETERMINATIONS

Preliminary test data was obtained at the stack sampling locations. Stack geometry measurements were measured and recorded, and traverse point distances verified.

A cyclonic flow check was performed prior to the initial velocity traverse. The cyclonic flow checks were negative thus verifying the suitability of the sites for obtaining representative measurements.

4.3 VOLUMETRIC FLOW RATE

Mass emission rates are calculated by multiplying measured target analyte concentrations by calculated volumetric flow rates. Volumetric flow rates are calculated using measurement data obtained by EPA Reference Methods 1-4.

The stack is measured at the sample location to the nearest 0.25 inch using a steel tape measure. Traverse points are selected in accordance with EPA Reference Method 1 on the basis of ductwork dimensions, geometry, and upstream and downstream disturbances. When a sample location does not meet EPA Reference Method 1 criteria, the maximum recommended number of traverse points are used.

Two velocity measurements were conducted in conjunction with each test run.

Gas Velocity

The velocity of the gas stream is measured in accordance with EPA Reference Method 2 by reading the instantaneous velocity pressure with an inclined manometer at each traverse point using an "S" type pitot tube. The stack pressure is calculated from the measured static pressure of the stack and the ambient barometric pressure. The static pressure is measured by using the static side of the pitot tube, and the barometric pressure is measured using a calibrated aneroid barometer. Magnahelic® gauges with scales of 0 to 5 and 0 to 25 inches of water or an inclined manometer with a scale of 0 to 10 inches of water are used for velocity pressure measurements. Manometer selection is determined by the velocity pressure of the gas stream. A manometer with a 0 to 0.25 inch scale may be used when the velocity pressure of the gas stream is less than 0.20 inches of water. By convention, any measured velocity pressures of less than 0.005 inches of water are recorded and reported as less than 0.005 inches of water. The stack temperature is measured with a calibrated thermocouple and pyrometer.

Data Acquisition and Reporting

Data are recorded at the time of collection on preprinted data sheets. Calculations are performed (where possible) with preprogrammed calculators or spreadsheet software.

Quality Control

Quality control procedures for volumetric flow measurements involve leak checks of pitot tubes, pitot tube lines and manometers.

Data transfers are minimized. Data sheets are checked for completeness and accuracy. Calculations are verified by a second person.

4.4 MOISTURE

EPA Reference Method 4 is used to measure moisture content of the stack gas. One moisture determination was performed in conjunction with each test run. Figure 4-1 presents a diagram of the EPA Reference Method 4 test train.

The EPA Reference Method 4 sampling train consists of an unheated stainless steel probe connected to a series of four (4) impingers using a flexible hose. The first and second impingers each contain 100 ml of distilled water, the third impinger is dry, and the fourth impinger contains 300 grams of dry, preweighed silica gel. The second impinger is a standard Greenburg-Smith type, the first, third, and fourth are of a modified design. All impingers are maintained in a crushed ice bath. A control console consisting of a leakless vacuum pump, a calibrated dry gas meter, a calibrated orifice, and two inclined manometers are connected to the final impinger via an umbilical cord to complete the train.

Sample Analysis

The moisture content of the stack gas is determined by measuring the difference of the final and initial volumes of liquid and silica gel weights compared to the gas sample volume.

Data Acquisition and Reduction

Data are recorded at the time of collection on preprinted data sheets. Calculations are performed with preprogrammed calculators or spreadsheet software.

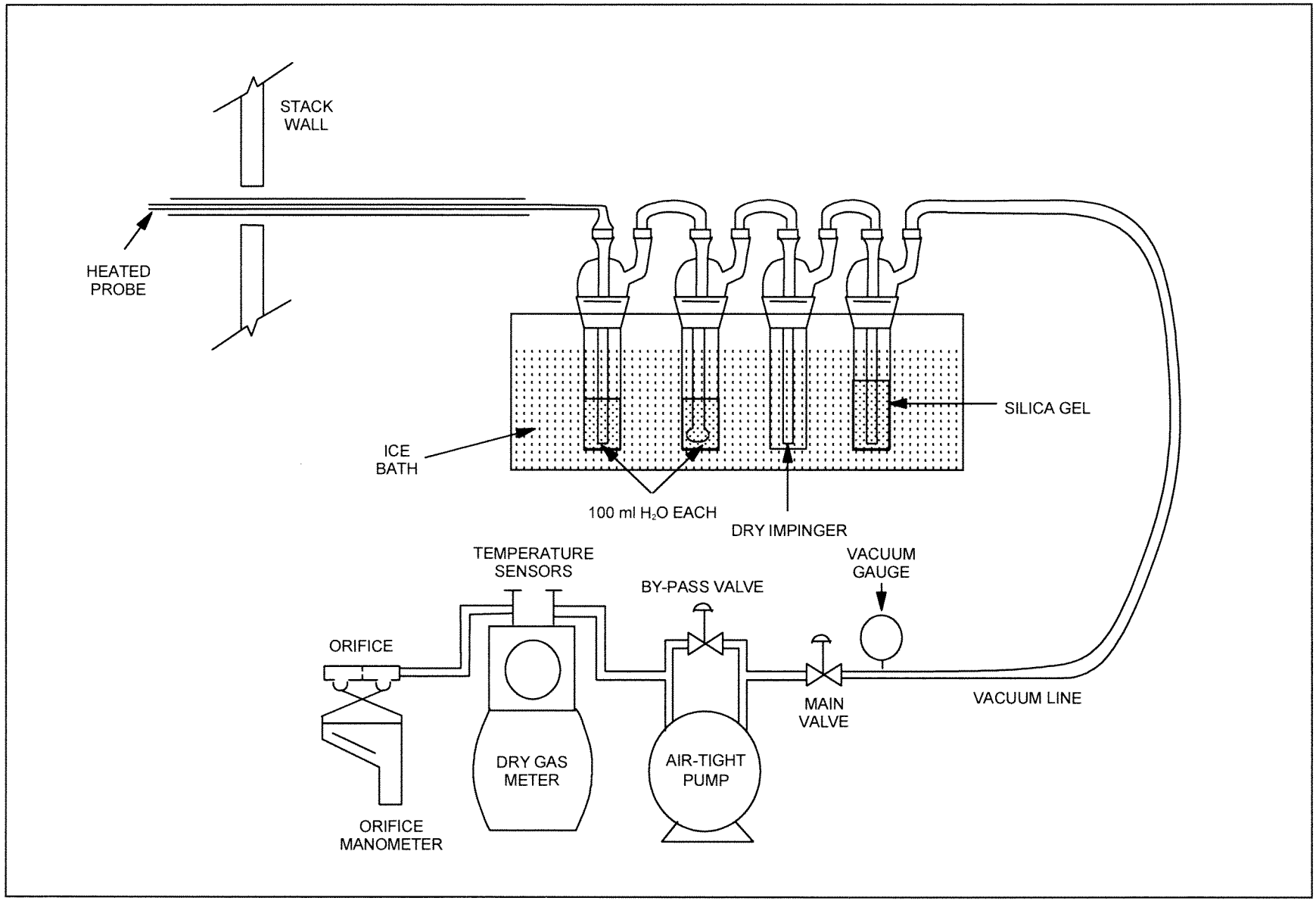


FIGURE 4-1
EPA METHOD 4 MOISTURE SAMPLING TRAIN

IASDATA\VALERO\05614.015\FIGURE 4-1 EPA 4

Quality Control

Quality control procedures for moisture measurements involve pre and post test leak checks of the sample train and maintaining silica gel exit temperature below 68°F.

Data transfers are minimized. Data sheets are checked for completeness and accuracy. Calculations are verified by a second person.

4.5 OXYGEN (INSTRUMENTAL)

Oxygen (O_2) testing is conducted in accordance with EPA Reference Method 3A.

Sampling Equipment and Procedures

Figure 4-2 illustrates the sampling system. The sample is withdrawn continuously from the source through a heated probe, filter, and sample line to a sample conditioner that removes moisture from the gas stream. The sample is then transported to a Servomex Model 4900 paramagnetic O_2 analyzer.

Sample Analysis

The O_2 analyzer uses a paramagnetic detector to produce an electrical signal which is linearly proportional to the O_2 concentration.

Data Acquisition and Reduction

Data is acquired electronically using computer software designed by WESTON for EPA Reference Method 3A analysis. This system converts electronic signals into concentrations, and provides one-minute averages during the sample run and an average concentration over the duration of the sample run.

Quality Control

At the time of analysis, O_2 in nitrogen calibration gases (certified according to EPA Protocol) are used to calibrate the analyzer and to determine a bias correction factor for the entire system bias in accordance with EPA Reference Method 7E.

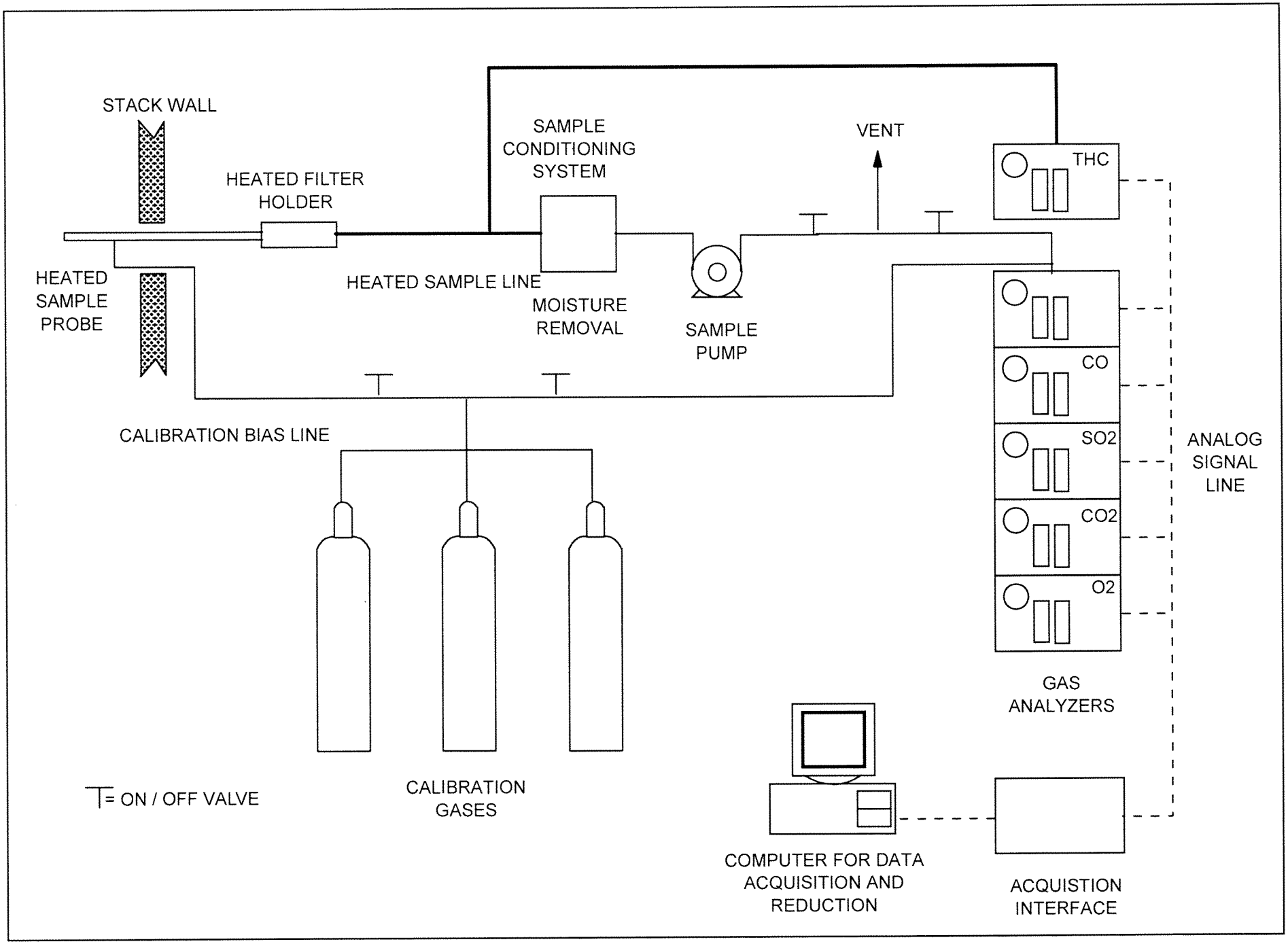


FIGURE 4-2
WESTON SAMPLING SYSTEM

IASDATA\VALERO\05614.015\FIGURE 4-2 WESTON SAMPLING SYSTEM

The calibration gases are introduced directly to the analyzer to generate a calibration curve. A zero gas and an upscale calibration gas is introduced at the probe and recovered through the sampling and analytical system. A bias correction factor is calculated using the ratio of the measured concentration of the bias gas and concentration certified by the vendor. Sample run averages are corrected for system bias results.

Per U.S. EPA Emission Measurement Center guidelines, WESTON's O_2 analyzers are grandfathered from the interference check requirements of EPA Reference Method 7E since the initial interference checks on these analyzers were performed prior to the revision date for the instrumental methods (14 August 2006).

4.6 CARBON DIOXIDE (INSTRUMENTAL)

Carbon dioxide (CO_2) testing is conducted in accordance with EPA Reference Method 3A.

Sampling Equipment and Procedures

Figure 4-2 illustrates the sampling system. The sample is withdrawn continuously from the source through a heated probe, filter, and sample line to a sample conditioner which removes moisture from the gas stream. The sample is then transported to a Servomex Model 4900 CO_2 analyzer.

Sample Analysis

The CO_2 analyzer uses a non-dispersive infrared (NDIR) detector to produce an electrical signal which is linearly proportional to CO_2 concentration.

Data Acquisition and Reduction

Data is acquired electronically using computer software designed by WESTON for EPA Reference Method 3A analysis. This system generates a calibration curve, converts electronic signals into concentrations, and provides one-minute averages during the sample run and an average concentration over the duration of the sample run.

Quality Control

At the time of analysis, CO_2 in nitrogen calibration gases (certified according to EPA Protocol), are used to calibrate the analyzer and to determine a bias correction factor for the entire system bias in accordance with EPA Reference Method 7E.

The calibration gases are introduced directly to the analyzer to generate a calibration curve. A zero gas and an upscale calibration gas is introduced at the probe and recovered through the sampling and analytical system. A bias correction factor is calculated using the ratio of the measured concentration of the bias gas and concentration certified by the vendor. Sample run averages are corrected for system bias results.

Per U.S. EPA Emission Measurement Center guidelines, WESTON's CO_2 analyzers are grandfathered from the interference check requirements of EPA Reference Method 7E since the initial interference checks on these analyzers were performed prior to the revision date for the instrumental methods (14 August 2006).

4.7 CARBON MONOXIDE (INSTRUMENTAL)

Carbon monoxide testing is conducted in accordance with EPA Reference Method 10.

Sampling Equipment and Procedures

Figure 4-2 illustrates the sampling system. The sample is withdrawn from the source gas stream through a heated probe, filter, and sample line to a sample conditioner that removes moisture from the gas stream. The dry gas sample is then transported through sample lines to a Servomex Model 4900 infrared analyzer for continuous on-line monitoring.

Sample Analysis

The CO non-dispersive infrared (NDIR) analyzer uses gas filter correlation spectroscopy to measure the amount of CO present in the sample. Infrared radiation is chopped and passed through an alternating CO and N_2 correlation filter wheel and the sample stream. Carbon monoxide in the sample absorbs the infrared radiation, leaving the remaining radiation to be measured by a detector producing a linear output signal proportional to the CO concentration.

Data Acquisition and Reduction

Data is acquired electronically using computer software designed by WESTON for EPA Reference Method 10 analysis. The system converts electronic signals into concentrations and provides one-minute averages during the sample run and an average concentration over the duration of the sample run.

Quality Control

At the time of analysis, CO in nitrogen calibration gases (certified according to EPA Protocol) are used to calibrate the analyzer and to determine a bias correction factor for the entire system bias in accordance with EPA Reference Method 7E.

The calibration gases are introduced directly to the analyzer to generate a calibration curve. A zero gas and an upscale calibration gas is introduced at the probe and recovered through the sampling and analytical system. A bias correction factor is then calculated using the ratio of the measured concentration of the bias gas and concentration certified by the vendor. Sample run averages are corrected for system bias results.

4.8 SULFUR DIOXIDE (INSTRUMENTAL)

Sulfur dioxide (SO_2) testing is conducted in accordance with EPA Reference Method 6C.

Sampling Equipment and Procedures

Figure 4-2 illustrates the sampling system. The sample is withdrawn from the source gas stream through a heated probe, filter, and sample line to a sample conditioner which removes moisture from the gas stream. The sample is then transported to a Bovar 721-M 900 SO_2 analyzer.

Sample Analysis

The SO_2 analyzer measures, at two discrete wavelengths, the absorbtion of ultraviolet radiation by the gas sample. The concentration of the components absorbing the light are then determined from relationships developed through application of the ideal gas law in conjunction with the laws of Bouguer, Beer, and Lambet.

Data Acquisition and Reduction

Data is acquired electronically using computer software designed by WESTON for EPA Reference Method 6C analysis. This system converts electronic signals into concentrations, and provides one-minute averages during the sample run and an average concentration over the duration of the sample run.

Quality Control

At the time of analysis, SO_2 in nitrogen calibration gases (certified according to EPA Protocol) are used to calibrate the analyzer and to determine a bias correction factor for the entire system bias in accordance with EPA Reference Method 7E.

The calibration gases are introduced directly to the analyzer to generate a calibration curve. A zero gas and an upscale calibration gas is introduced at the probe and recovered through the sampling and analytical system. A bias correction factor is then calculated using the ratio of the measured concentration of the bias gas and concentration certified by the vendor. Sample run averages are corrected for system bias results.

4.9 TOTAL NON-METHANE VOC

Total non-methane volatile organic compounds (TNMVOC) concentrations are sampled using a combination of EPA Reference Methods 18 and 25A. Total VOC's are measured on site by EPA Reference Method 25A using a total hydrocarbon (THC) analyzer equipped with a flame ionization detector (FID). It should be noted that EPA Method 25A determines total organics including methane, which is not a regulated VOC. Methane concentrations are determined using a modified EPA Reference Method 18 approach with analysis performed on a gas chromatograph (GC) equipped with an FID. Dry methane concentrations are subtracted from dry total VOC concentrations resulting in TNMVOC.

Method 25A – Sampling Equipment and Procedures

Figure 4-2 shows a schematic of the WESTON sampling system. An extractive system is used at the sampling locations to obtain vent gas samples. Samples are withdrawn continuously at a single

point and transported to the FID through a heated probe, heated filter, and heated Teflon® sample line. All VOC measurements are made on a "hot, wet" basis prior to the sample conditioner.

Method 18 – Sampling Equipment and Procedures

When collecting methane sample in conjunction with the WESTON sampling system shown in Figure 4-2, a Tedlar® bag is pulled at the sample bypass vent after the sample chiller/conditioner. This dry, conditioned sample is then introduced to the analytical system. The concentration is also representative of the sample under dry conditions. In general, samples collected in Tedlar® bags should be maintained in a sun-light free, temperature controlled environment. For testing, the sample analysis should occur within 24-48 hours. For this program, the methane analysis was performed offsite within 48 hours of sample collection.

Method 25A – Sample Analysis

A continuous emission monitor is used to measure the total VOC concentration in the source gas. This analyzer utilizes a FID as described by EPA Reference Method 25A.

Prior to each test, the sampling and analytical system are calibrated using two calibration gases (zero and 80 to 90 percent of span). This step is followed by a calibration error check utilizing two additional calibration gases at approximately 30 and 50 percent of the span value. The acceptance criterion for the calibration error check is less than 5% the certified gas value.

Method 18 – Sample Analysis

The analytical system is comprised of three main components, sample introduction system, chromatograph with selected columns and detector, and the data collection system with report generator.

The sample injection system uses a heated rotary valve with Teflon® sample loop. The certified calibration gas mixtures and samples are introduced to the chromatograph using the same injector. The GC uses capillary columns, which are commercially available and chosen to resolve the target compounds within a reasonable time frame, 5 - 45 minutes.

Detection and relative intensity of calibration gas or sample gas matrices is performed by the GC detector. The GC/FID measures a change in potential across an enclosed flame. The difference in potential is directly proportional to the concentration present. Calibration curves for the target compounds are prepared at a minimum of three concentration levels, and bracket the concentration range of the samples.

The identity of target compounds is determined by comparison of the sample gas retention times compared to the retention times of calibration gas mixtures. The concentration of the target compounds is determined from comparison of the intensity of the sample peaks compared to the intensity of the calibration peaks.

Commercially available calibration gas mixtures are obtained which meet the method criteria of 1-2% accuracy.

Method 25A – Data Acquisition and Reduction

Data is acquired electronically using computer software designed by WESTON for EPA Reference Method 25A analysis.

Method 18 – Data Acquisition and Reduction

The output from the GC/FID system is collected using a commercially available data acquisition interface and software. The system generates the calibration curves and produces a report and chromatogram at the conclusion of each analysis.

Method 25A – Quality Control

The calibration and check gases are propane or methane, in either nitrogen or air, certified according to EPA Protocol. Following each sample run, the calibration drift of the system is checked by introducing the zero and one upscale gas to the system and recording the response. This difference in concentration must be within three percent of the full scale span value.

Method 18 – Quality Control

Quality controls for the integrated Tedlar® bag system include a leak check of the entire sampling system and target compound recovery checks when applicable.

4.10 DETERMINATION OF TOTAL REDUCED SULFUR EMISSIONS

Reduced sulfur testing for H_2S, COS, and CS_2 was performed using the procedures described in EPA Reference Method 15.

Sampling Equipment and Procedures

Figure 4-3 illustrates the sampling system. A Teflon®-lined, stainless steel probe of sufficient length to monitor the gas stream (without wall effects) was used to extract a gas sample from the emission source. The probe tip was directed away from stack gas flow to minimize particulate and moisture entrainment. The probe was connected directly to the recovery gas line and sample conditioning system.

The sample conditioning system consisted of a Teflon® impinger containing 1.5M citrate buffer, adjusted to a pH of 5.4 to 5.8, maintained in an ice bath. Moisture was condensed in the impingers, yielding a dry sample and thus eliminating the need for heated sample lines. Fine particulate matter was removed by a Balston® AQ Microfiber filter installed at the impinger outlet.

An unheated nylon line was connected from the filter to the sample pump inlet. Sample line length and connections were minimized to reduce surface adsorption of TRS and the possibility of leaks.

The pump outlet was connected directly to a constant pressure bottle. At this point, a major portion of the sample was vented to the atmosphere, and the remainder was used to charge the gas chromatograph (GC) sample loop.

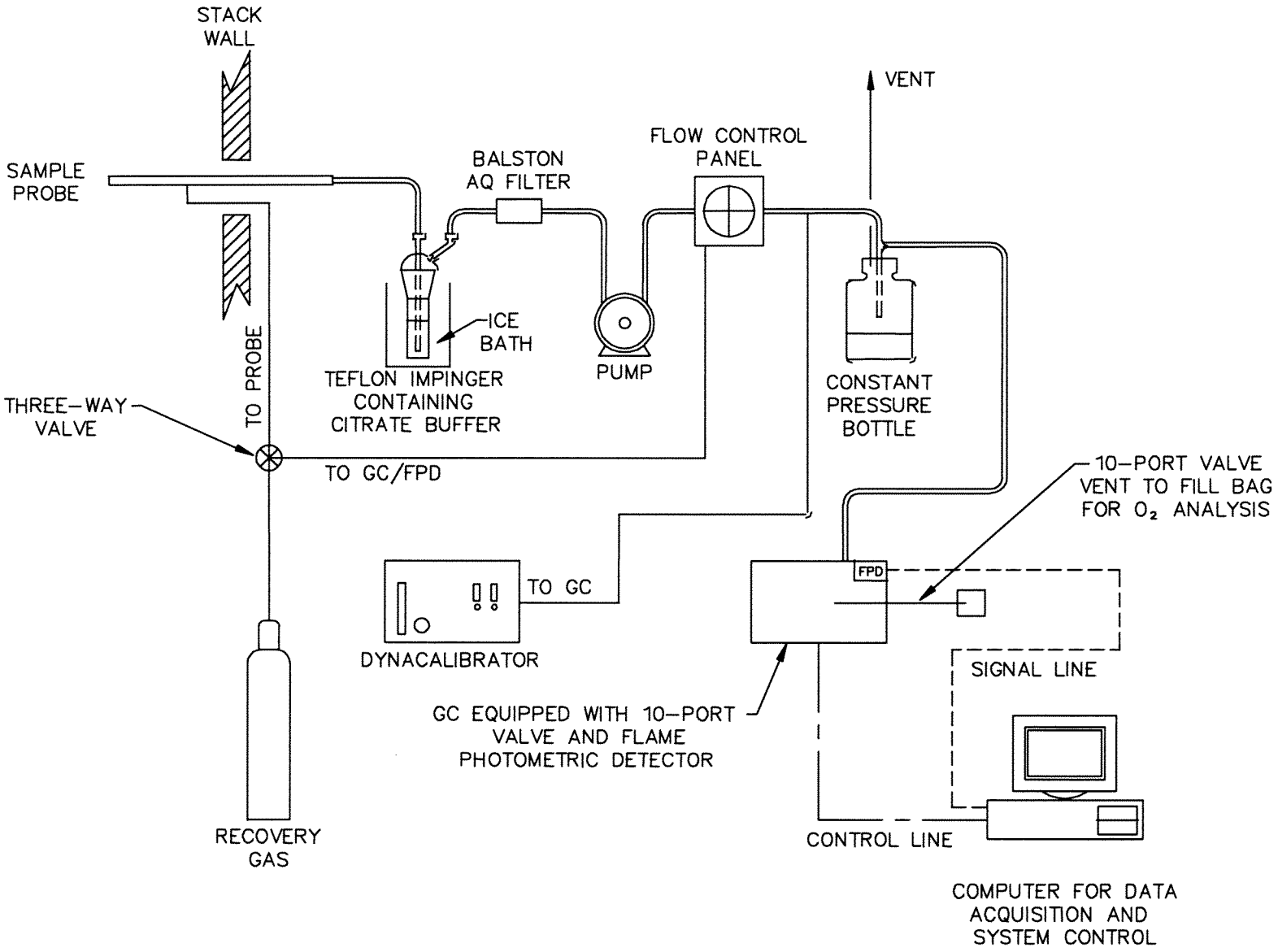


Figure 4-3 EPA Reference Method 15 Sampling and Analytical Train

Sample Analysis

Separation of hydrogen sulfide (H_2S), carbonyl sulfide (COS), and carbon disulfide (CS_2) was accomplished using gas chromatography on a XE50/H_3PO_4 column. After resolution of H_2S, and COS, the Capillary column was backflushed to achieve resolution of CS_2 within 2-3 minutes from sample injection. The gas chromatograph was operated on periodic cycle to produce a minimum of twelve injections per hour.

Detection of reduced sulfur compounds was accomplished with a flame photometric detector (FPD). The FPD response was calibrated before sampling and after each series of runs made within a 24-hour period, using gas phase standards prepared from gravimetrically certified permeation devices.

Data Acquisition and Reduction

The FPD responses were recorded by a windows-based computer equipped with software designed by WESTON for reduced sulfur compound analysis. The software controls the timing of the gas-chromatography cycle, integrates and records peaks, performs calculations, and prints the results. Calibration curves were generated by the software using log-log linear least squares best fit of the data.

Quality Control

Permeation devices certified by the vendor were used to calibrate the FPD response. The temperature of the devices was maintained at a constant value (as certified by vendor) to ensure a constant, accurate permeation rate. The temperature of the permeation chamber was verified at the time of sampling with a National Institute of Standards and Technology (NIST) traceable mercury-in-glass thermometer. The temperature of the permeation chamber was maintained at 50.0 ± 0.1 °C.

VICI-Metronics supplied the permeation devices for the testing. The devices were gravimetrically analyzed to measure the permeation rate before shipment.

Various concentrations of the permeants are generated by varying the flow of the diluent gas stream over the devices. A calibration curve was constructed of at least three concentrations of each

permeant; three successive injections at each concentration yield peak areas that differ from the mean peak area value by less than 5%.

Sampling system integrity was evaluated after every sampling run by introducing compressed gas containing H_2S in nitrogen at the probe tip and measuring the concentration of the gas after it had passed through the sample conditioning and transport systems. The same gas was then introduced directly to the constant-pressure bottle for direct introduction to the GC sample loop and analysis. The ratio of the concentrations is the system recovery and was used to correct the measured reduced sulfur compound concentrations.

The concentration of the H_2S recovery gas was certified by the manufacturer. This gas served also as an audit gas to evaluate the analytical system integrity and the calibration accuracy. The results of the gas analysis when introduced directly to the GC were compared to the certified concentration. The two values agreed to within ± 10%.

APPENDIX A
PROCESS DATA AND NJDEP EMISSION TEST PRODUCTION REPORT FORM

MultiMonitor 1.3 Hourly Average (PBRFRaw)

Tag ID / Calculation:	73f301b1.pv Total TGU Gas Curr							
Description:	Hr Avg							
Engineering Unit:	MLB/H							
Lab Sample Time:								
Lab Days (UMTWHFS):								
DateTime	Value_001	Value_002	Value_003	Value_004	Value_005	Value_006	Value_007	Value_008
Tue, 08 Feb 11, 12:00:00 AM	19.22							
Tue, 08 Feb 11, 01:00:00 AM	19.27							
Tue, 08 Feb 11, 02:00:00 AM	19.48							
Tue, 08 Feb 11, 03:00:00 AM	19.90							
Tue, 08 Feb 11, 04:00:00 AM	20.00							
Tue, 08 Feb 11, 05:00:00 AM	19.94							
Tue, 08 Feb 11, 06:00:00 AM	20.48							
Tue, 08 Feb 11, 07:00:00 AM	23.12							
Tue, 08 Feb 11, 08:00:00 AM	24.33							
Tue, 08 Feb 11, 09:00:00 AM	25.04							
Tue, 08 Feb 11, 10:00:00 AM	25.32							
Tue, 08 Feb 11, 11:00:00 AM	25.21							
Tue, 08 Feb 11, 12:00:00 PM	25.04							
Tue, 08 Feb 11, 01:00:00 PM	25.13							
Tue, 08 Feb 11, 02:00:00 PM	25.14							
Tue, 08 Feb 11, 03:00:00 PM	25.09							
Tue, 08 Feb 11, 04:00:00 PM	25.12							
Tue, 08 Feb 11, 05:00:00 PM	25.16							
Tue, 08 Feb 11, 06:00:00 PM	25.12							
Tue, 08 Feb 11, 07:00:00 PM	25.11							
Tue, 08 Feb 11, 08:00:00 PM	25.13							
Tue, 08 Feb 11, 09:00:00 PM	25.21							
Tue, 08 Feb 11, 10:00:00 PM	23.70							
Tue, 08 Feb 11, 11:00:00 PM	20.72							
Wed, 09 Feb 11, 12:00:00 AM	19.69							

	72F301Q.PV CORRECTED TAIL GAS FLOW MLB/H
	Value_012
Wed, 09 Feb 11, 12:00:00 AM	15.15
Wed, 09 Feb 11, 12:01:00 AM	14.81
Wed, 09 Feb 11, 12:02:00 AM	14.91
Wed, 09 Feb 11, 12:03:00 AM	14.75
Wed, 09 Feb 11, 12:04:00 AM	14.97
Wed, 09 Feb 11, 12:05:00 AM	14.83
Wed, 09 Feb 11, 12:06:00 AM	14.70
Wed, 09 Feb 11, 12:07:00 AM	14.75
Wed, 09 Feb 11, 12:08:00 AM	14.48
Wed, 09 Feb 11, 12:09:00 AM	14.80
Wed, 09 Feb 11, 12:10:00 AM	14.75
Wed, 09 Feb 11, 12:11:00 AM	14.55
Wed, 09 Feb 11, 12:12:00 AM	14.35
Wed, 09 Feb 11, 12:13:00 AM	14.58
Wed, 09 Feb 11, 12:14:00 AM	14.71
Wed, 09 Feb 11, 12:15:00 AM	14.69
Wed, 09 Feb 11, 12:16:00 AM	14.32
Wed, 09 Feb 11, 12:17:00 AM	15.32
Wed, 09 Feb 11, 12:18:00 AM	15.18
Wed, 09 Feb 11, 12:19:00 AM	15.12
Wed, 09 Feb 11, 12:20:00 AM	15.36
Wed, 09 Feb 11, 12:21:00 AM	15.18
Wed, 09 Feb 11, 12:22:00 AM	15.10
Wed, 09 Feb 11, 12:23:00 AM	15.15
Wed, 09 Feb 11, 12:24:00 AM	14.89
Wed, 09 Feb 11, 12:25:00 AM	14.80
Wed, 09 Feb 11, 12:26:00 AM	15.04
Wed, 09 Feb 11, 12:27:00 AM	14.78
Wed, 09 Feb 11, 12:28:00 AM	14.64
Wed, 09 Feb 11, 12:29:00 AM	14.79
Wed, 09 Feb 11, 12:30:00 AM	14.38
Wed, 09 Feb 11, 12:31:00 AM	14.51
Wed, 09 Feb 11, 12:32:00 AM	14.55
Wed, 09 Feb 11, 12:33:00 AM	14.35
Wed, 09 Feb 11, 12:34:00 AM	14.59
Wed, 09 Feb 11, 12:35:00 AM	14.55
Wed, 09 Feb 11, 12:36:00 AM	14.25
Wed, 09 Feb 11, 12:37:00 AM	14.44

Wed, 09 Feb 11, 12:38:00 AM	14.26
Wed, 09 Feb 11, 12:39:00 AM	14.50
Wed, 09 Feb 11, 12:40:00 AM	14.61
Wed, 09 Feb 11, 12:41:00 AM	14.76
Wed, 09 Feb 11, 12:42:00 AM	15.57
Wed, 09 Feb 11, 12:43:00 AM	15.38
Wed, 09 Feb 11, 12:44:00 AM	15.41
Wed, 09 Feb 11, 12:45:00 AM	15.48
Wed, 09 Feb 11, 12:46:00 AM	15.08
Wed, 09 Feb 11, 12:47:00 AM	15.15
Wed, 09 Feb 11, 12:48:00 AM	15.14
Wed, 09 Feb 11, 12:49:00 AM	15.12
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Wed, 09 Feb 11, 12:51:00 AM	15.06
Wed, 09 Feb 11, 12:52:00 AM	15.28
Wed, 09 Feb 11, 12:53:00 AM	15.56
Wed, 09 Feb 11, 12:54:00 AM	15.83
Wed, 09 Feb 11, 12:55:00 AM	15.93
Wed, 09 Feb 11, 12:56:00 AM	15.62
Wed, 09 Feb 11, 12:57:00 AM	15.98
Wed, 09 Feb 11, 12:58:00 AM	16.01
Wed, 09 Feb 11, 12:59:00 AM	15.83
Wed, 09 Feb 11, 01:00:00 AM	15.89
Wed, 09 Feb 11, 01:01:00 AM	16.17
Wed, 09 Feb 11, 01:02:00 AM	16.07
Wed, 09 Feb 11, 01:03:00 AM	16.38
Wed, 09 Feb 11, 01:04:00 AM	16.00
Wed, 09 Feb 11, 01:05:00 AM	16.15
Wed, 09 Feb 11, 01:06:00 AM	16.24
Wed, 09 Feb 11, 01:07:00 AM	15.89
Wed, 09 Feb 11, 01:08:00 AM	16.47
Wed, 09 Feb 11, 01:09:00 AM	15.96
Wed, 09 Feb 11, 01:10:00 AM	16.06
Wed, 09 Feb 11, 01:11:00 AM	16.24
Wed, 09 Feb 11, 01:12:00 AM	15.92
Wed, 09 Feb 11, 01:13:00 AM	16.05
Wed, 09 Feb 11, 01:14:00 AM	15.86
Wed, 09 Feb 11, 01:15:00 AM	15.99
Wed, 09 Feb 11, 01:16:00 AM	15.96
Wed, 09 Feb 11, 01:17:00 AM	15.64
Wed, 09 Feb 11, 01:18:00 AM	15.73
Wed, 09 Feb 11, 01:19:00 AM	15.86
Wed, 09 Feb 11, 01:20:00 AM	15.72
Wed, 09 Feb 11, 01:21:00 AM	15.78
Wed, 09 Feb 11, 01:22:00 AM	15.55
Wed, 09 Feb 11, 01:23:00 AM	15.85
Wed, 09 Feb 11, 01:24:00 AM	15.82

Wed, 09 Feb 11, 01:25:00 AM	15.36
Wed, 09 Feb 11, 01:26:00 AM	15.71
Wed, 09 Feb 11, 01:27:00 AM	15.28
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Wed, 09 Feb 11, 01:34:00 AM	14.95
Wed, 09 Feb 11, 01:35:00 AM	14.98
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Wed, 09 Feb 11, 01:47:00 AM	14.88
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Wed, 09 Feb 11, 02:01:00 AM	15.49
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Wed, 09 Feb 11, 09:44:00 PM	19.97
Wed, 09 Feb 11, 09:45:00 PM	20.30
Wed, 09 Feb 11, 09:46:00 PM	20.31

Wed, 09 Feb 11, 09:47:00 PM	20.39
Wed, 09 Feb 11, 09:48:00 PM	20.23
Wed, 09 Feb 11, 09:49:00 PM	20.38
Wed, 09 Feb 11, 09:50:00 PM	20.11
Wed, 09 Feb 11, 09:51:00 PM	20.37
Wed, 09 Feb 11, 09:52:00 PM	19.94
Wed, 09 Feb 11, 09:53:00 PM	20.07
Wed, 09 Feb 11, 09:54:00 PM	20.04
Wed, 09 Feb 11, 09:55:00 PM	20.00
Wed, 09 Feb 11, 09:56:00 PM	20.13
Wed, 09 Feb 11, 09:57:00 PM	19.95
Wed, 09 Feb 11, 09:58:00 PM	20.12
Wed, 09 Feb 11, 09:59:00 PM	19.93
Wed, 09 Feb 11, 10:00:00 PM	20.04
Wed, 09 Feb 11, 10:01:00 PM	20.05
Wed, 09 Feb 11, 10:02:00 PM	20.02
Wed, 09 Feb 11, 10:03:00 PM	20.01
Wed, 09 Feb 11, 10:04:00 PM	19.57
Wed, 09 Feb 11, 10:05:00 PM	19.60
Wed, 09 Feb 11, 10:06:00 PM	19.60
Wed, 09 Feb 11, 10:07:00 PM	19.59
Wed, 09 Feb 11, 10:08:00 PM	19.53
Wed, 09 Feb 11, 10:09:00 PM	19.63
Wed, 09 Feb 11, 10:10:00 PM	19.45
Wed, 09 Feb 11, 10:11:00 PM	19.58
Wed, 09 Feb 11, 10:12:00 PM	19.86
Wed, 09 Feb 11, 10:13:00 PM	19.76
Wed, 09 Feb 11, 10:14:00 PM	19.86
Wed, 09 Feb 11, 10:15:00 PM	19.26
Wed, 09 Feb 11, 10:16:00 PM	19.38
Wed, 09 Feb 11, 10:17:00 PM	19.62
Wed, 09 Feb 11, 10:18:00 PM	19.68
Wed, 09 Feb 11, 10:19:00 PM	19.68
Wed, 09 Feb 11, 10:20:00 PM	19.65
Wed, 09 Feb 11, 10:21:00 PM	19.94
Wed, 09 Feb 11, 10:22:00 PM	19.88
Wed, 09 Feb 11, 10:23:00 PM	19.92
Wed, 09 Feb 11, 10:24:00 PM	19.85
Wed, 09 Feb 11, 10:25:00 PM	20.16
Wed, 09 Feb 11, 10:26:00 PM	20.01
Wed, 09 Feb 11, 10:27:00 PM	20.29
Wed, 09 Feb 11, 10:28:00 PM	20.15
Wed, 09 Feb 11, 10:29:00 PM	20.00
Wed, 09 Feb 11, 10:30:00 PM	19.95
Wed, 09 Feb 11, 10:31:00 PM	19.82
Wed, 09 Feb 11, 10:32:00 PM	19.94
Wed, 09 Feb 11, 10:33:00 PM	19.93

Wed, 09 Feb 11, 10:34:00 PM	20.08
Wed, 09 Feb 11, 10:35:00 PM	19.97
Wed, 09 Feb 11, 10:36:00 PM	20.01
Wed, 09 Feb 11, 10:37:00 PM	20.15
Wed, 09 Feb 11, 10:38:00 PM	20.27
Wed, 09 Feb 11, 10:39:00 PM	20.59
Wed, 09 Feb 11, 10:40:00 PM	20.22
Wed, 09 Feb 11, 10:41:00 PM	20.63
Wed, 09 Feb 11, 10:42:00 PM	20.72
Wed, 09 Feb 11, 10:43:00 PM	20.80
Wed, 09 Feb 11, 10:44:00 PM	20.64
Wed, 09 Feb 11, 10:45:00 PM	20.44
Wed, 09 Feb 11, 10:46:00 PM	20.06
Wed, 09 Feb 11, 10:47:00 PM	18.87
Wed, 09 Feb 11, 10:48:00 PM	19.33
Wed, 09 Feb 11, 10:49:00 PM	19.79
Wed, 09 Feb 11, 10:50:00 PM	19.90
Wed, 09 Feb 11, 10:51:00 PM	19.59
Wed, 09 Feb 11, 10:52:00 PM	19.66
Wed, 09 Feb 11, 10:53:00 PM	19.52
Wed, 09 Feb 11, 10:54:00 PM	19.23
Wed, 09 Feb 11, 10:55:00 PM	18.99
Wed, 09 Feb 11, 10:56:00 PM	19.10
Wed, 09 Feb 11, 10:57:00 PM	19.25
Wed, 09 Feb 11, 10:58:00 PM	19.31
Wed, 09 Feb 11, 10:59:00 PM	19.20
Wed, 09 Feb 11, 11:00:00 PM	18.74
Wed, 09 Feb 11, 11:01:00 PM	19.32
Wed, 09 Feb 11, 11:02:00 PM	19.62
Wed, 09 Feb 11, 11:03:00 PM	19.47
Wed, 09 Feb 11, 11:04:00 PM	19.07
Wed, 09 Feb 11, 11:05:00 PM	18.63
Wed, 09 Feb 11, 11:06:00 PM	18.56
Wed, 09 Feb 11, 11:07:00 PM	18.01
Wed, 09 Feb 11, 11:08:00 PM	18.01
Wed, 09 Feb 11, 11:09:00 PM	18.24
Wed, 09 Feb 11, 11:10:00 PM	17.63
Wed, 09 Feb 11, 11:11:00 PM	17.45
Wed, 09 Feb 11, 11:12:00 PM	17.79
Wed, 09 Feb 11, 11:13:00 PM	17.20
Wed, 09 Feb 11, 11:14:00 PM	17.13
Wed, 09 Feb 11, 11:15:00 PM	17.22
Wed, 09 Feb 11, 11:16:00 PM	17.18
Wed, 09 Feb 11, 11:17:00 PM	16.92
Wed, 09 Feb 11, 11:18:00 PM	16.18
Wed, 09 Feb 11, 11:19:00 PM	16.88
Wed, 09 Feb 11, 11:20:00 PM	16.72

Wed, 09 Feb 11, 11:21:00 PM	16.82
Wed, 09 Feb 11, 11:22:00 PM	16.75
Wed, 09 Feb 11, 11:23:00 PM	16.39
Wed, 09 Feb 11, 11:24:00 PM	16.39
Wed, 09 Feb 11, 11:25:00 PM	16.11
Wed, 09 Feb 11, 11:26:00 PM	16.04
Wed, 09 Feb 11, 11:27:00 PM	15.88
Wed, 09 Feb 11, 11:28:00 PM	15.21
Wed, 09 Feb 11, 11:29:00 PM	15.46
Wed, 09 Feb 11, 11:30:00 PM	14.58
Wed, 09 Feb 11, 11:31:00 PM	14.87
Wed, 09 Feb 11, 11:32:00 PM	15.25
Wed, 09 Feb 11, 11:33:00 PM	14.84
Wed, 09 Feb 11, 11:34:00 PM	14.78
Wed, 09 Feb 11, 11:35:00 PM	14.92
Wed, 09 Feb 11, 11:36:00 PM	15.13
Wed, 09 Feb 11, 11:37:00 PM	15.03
Wed, 09 Feb 11, 11:38:00 PM	14.98
Wed, 09 Feb 11, 11:39:00 PM	15.17
Wed, 09 Feb 11, 11:40:00 PM	15.24
Wed, 09 Feb 11, 11:41:00 PM	15.16
Wed, 09 Feb 11, 11:42:00 PM	15.21
Wed, 09 Feb 11, 11:43:00 PM	15.14
Wed, 09 Feb 11, 11:44:00 PM	15.35
Wed, 09 Feb 11, 11:45:00 PM	15.19
Wed, 09 Feb 11, 11:46:00 PM	15.21
Wed, 09 Feb 11, 11:47:00 PM	15.03
Wed, 09 Feb 11, 11:48:00 PM	15.01
Wed, 09 Feb 11, 11:49:00 PM	15.10
Wed, 09 Feb 11, 11:50:00 PM	15.28
Wed, 09 Feb 11, 11:51:00 PM	15.24
Wed, 09 Feb 11, 11:52:00 PM	15.17
Wed, 09 Feb 11, 11:53:00 PM	15.41
Wed, 09 Feb 11, 11:54:00 PM	15.37
Wed, 09 Feb 11, 11:55:00 PM	15.23
Wed, 09 Feb 11, 11:56:00 PM	15.19
Wed, 09 Feb 11, 11:57:00 PM	15.06
Wed, 09 Feb 11, 11:58:00 PM	15.22
Wed, 09 Feb 11, 11:59:00 PM	15.23

APPENDIX B
RAW TEST DATA

Sample and Velocity Traverse Point Data Sheet - Method 1

Client Yates
Loaction/Plant Paulsboro NJ
Source Tail Gas 80

Operator DV
Date 2/9/11
W.O. Number

Duct Type	☒ Circular	☐ Rectangular Duct	Indicate appropriate type
Traverse Type	☐ Particulate Traverse	☒ Velocity Traverse	

Distance from far wall to outside of port (in.) = C	30
Port Depth (in.) = D	16
Depth of Duct, diameter (in.) = C-D	14
Area of Duct (ft^2)	1.069
Total Traverse Points	8
Total Traverse Points per Port	4

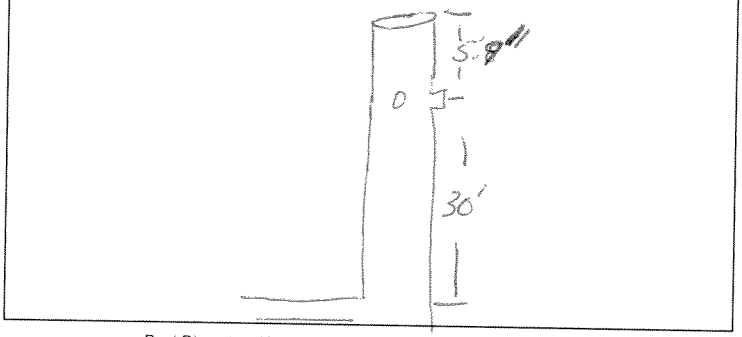
Rectangular Ducts Only	
Width of Duct, rectangular duct only (in.)	
Total Ports (rectangular duct only)	

Flow Disturbances	
Upstream - A (ft)	~~5.8'~~ 5.75'
Downstream - B (ft)	~~25.7~~ 30'
Upstream - A (duct diameters)	4.9
Downstream - B (duct diameters)	~~25.7~~

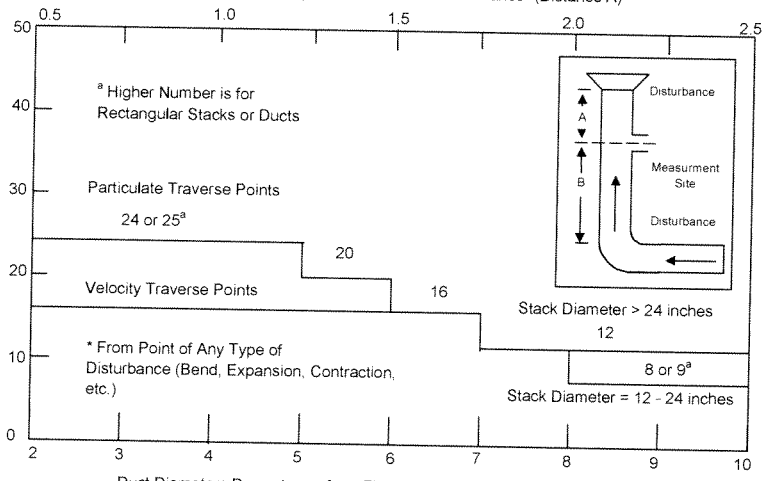
Traverse Point Locations

Traverse Point	% of Duct	Distance from Inside Duct Wall (in)	Distance from Outside of Port (in)	
1	6.7	0.938	16.938	17"
2	25	3.5	19.5	19½"
3	75	10.5	26.5	26½"
4	93.3	13.062	29.062	29"
5				
6				
7				
8				
9				
10				
11				
12				

Diagram of Stack



Duct Diameters Upstream from Flow Disturbance* (Distance A)



Duct Diameters Downstream from Flow Disturbance* (Distance B)

Equivalent Diameter = (2*L*W)/(L+W)

Traverse Point Location Percent of Stack -Circular

Traverse Point Location	Number of Traverse Points												
		1	2	3	4	5	6	7	8	9	10	11	12
	1		14.6		6.7		4.4		3.2		2.6		2.1
	2		85.4		25		14.6		10.5		8.2		6.7
	3				75		29.6		19.4		14.6		11.8
	4				93.3		70.4		32.3		22.6		17.7
	5						85.4		67.7		34.2		25
	6						95.6		80.6		65.8		35.6
	7								89.5		77.4		64.4
	8								96.8		85.4		75
	9										91.8		82.3
	10										97.4		88.2
	11												93.3
	12												97.9

Traverse Point Location Percent of Stack -Rectangular

Traverse Point Location	Number of Traverse Points											
	1	2	3	4	5	6	7	8	9	10	11	12
1		25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2		75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3			83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4				87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5					90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6						91.7	78.6	68.8	61.1	55.0	50.0	45.8
7							92.9	81.3	72.2	65.0	59.1	54.2
8								93.8	83.3	75.0	68.2	62.5
9									94.4	85.0	77.3	70.8
10										95.0	86.4	79.2
11											95.5	87.5
12												95.8

Rectangular Stack Points & Matrix
9 - 3 x 3
12 - 4 x 3
16 - 4 x 4
20 - 5 x 4
25 - 5 x 5
30 - 6 x 5
36 - 6 x 6
42 - 7 x 6
49 - 7 x 7

WESTON MANAGERS DESIGNERS/CONSULTANTS

Sample and Velocity Traverse Point Data Sheet - Method 1

Client: Valero
Loaction/Plant: Tail Gas 80" Paulsboro NJ
Source: Tail Gas 81
Operator: DV
Date: 2/9/11
W.O. Number:

Duct Type	☒ Circular	☐ Rectangular Duct	Indicate appropriate type
Traverse Type	☐ Particulate Traverse	☒ Velocity Traverse	

Distance from far wall to outside of port (in.) = C	30
Port Depth (in.) = D	16
Depth of Duct, diameter (in.) = C-D	14
Area of Duct (ft^2)	1.069
Total Traverse Points	8
Total Traverse Points per Port	4

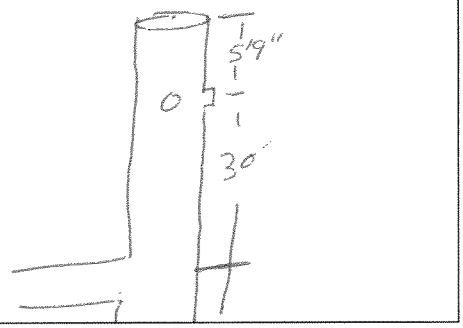
Rectangular Ducts Only	
Width of Duct, rectangular duct only (in.)	
Total Ports (rectangular duct only)	

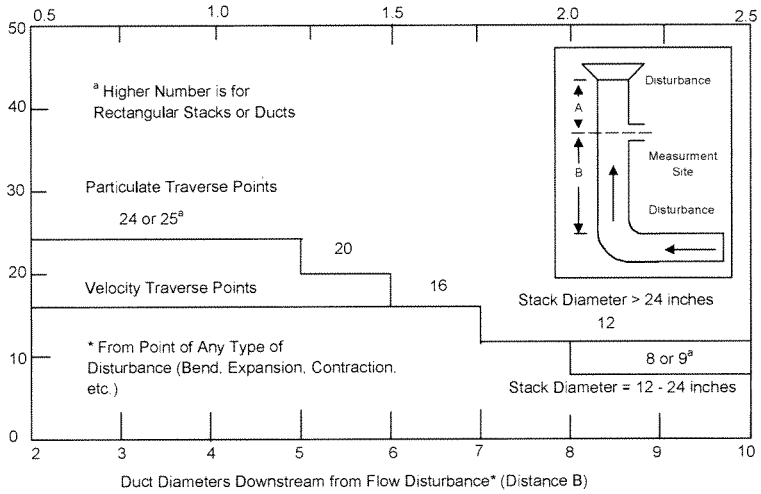
Flow Disturbances	
Upstream - A (ft)	5.75'
Downstream - B (ft)	30'
Upstream - A (duct diameters)	4.9
Downstream - B (duct diameters)	25.7

Traverse Point Locations

Traverse Point	% of Duct	Distance from Inside Duct Wall (in)	Distance from Outside of Port (in)	
1	6.7	0.938	16.938	17"
2	25	3.5	19.5	19½"
3	75	10.5	26.5	26½"
4	93.3	13.062	29.062	29"
5				
6				
7				
8				
9				
10				
11				
12				

Diagram of Stack





Equivalent Diameter = (2*L*W)/(L+W)

Traverse Point Location Percent of Stack -Circular

Traverse Point	Number of Traverse Points												
	1	2	3	4	5	6	7	8	9	10	11	12
1		14.6		6.7		4.4		3.2		2.6		2.1
2		85.4		25		14.6		10.5		8.2		6.7
3				75		29.6		19.4		14.6		11.8
4				93.3		70.4		32.3		22.6		17.7
5						85.4		67.7		34.2		25
6						95.6		80.6		65.8		35.6
7								89.5		77.4		64.4
8								96.8		85.4		75
9										91.8		82.3
10										97.4		88.2
11												93.3
12												97.9

Traverse Point Location Percent of Stack -Rectangular

Traverse Point	Number of Traverse Points											
	1	2	3	4	5	6	7	8	9	10	11	12
1		25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2		75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3			83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4				87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5					90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6						91.7	78.6	68.8	61.1	55.0	50.0	45.8
7							92.9	81.3	72.2	65.0	59.1	54.2
8								93.8	83.3	75.0	68.2	62.5
9									94.4	85.0	77.3	70.8
10										95.0	86.4	79.2
11											95.5	87.5
12												95.8

Rectangular Stack Points & Matrix
9 - 3 x 3
12 - 4 x 3
16 - 4 x 4
20 - 5 x 4
25 - 5 x 5
30 - 6 x 5
36 - 6 x 6
42 - 7 x 6
49 - 7 x 7

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Determination of Stack Gas Velocity - Method 2

Client	Valero	**Operator**	MS/DV	**Pitot Coeff (Cp)**	0.84
Location/Plant	Paulsboro, NJ	**Date**	9-Feb-11	**Stack Area, ft^2 (As)**	1.069
Source	Unit 80	**W.O. Number**	05614.015.001.0001	**Pitot Tube/Thermo ID**	INC 1

	Run Number	Time	Barometric Press, in Hg (Pb)	Static Press, in H_20 (Pstatic)	Source Moisture, % (BWS)	O_2, %	CO_2, %
	1 Pre	1156-1208	30.45	-0.69	2.96	0.1	5.9
	1 Post	1530-1536	30.45	-0.67	2.96	0.1	5.9

Cyclonic Flow Determination		Traverse Location		Leak Check good ? Y / N		Leak Check good ? Y / N			
Delta P at O°	Angle yeilding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)		
		A	1	1.90	83	1.70	85		
			2	2.00	83	1.90	86		
			3	1.80	83	1.70	86		
			4	1.50	83	1.60	85		
		B	1	1.70	85	1.60	86		
			2	1.90	84	1.70	86		
			3	1.80	84	1.70	86		
			4	1.50	83	1.60	85		
Avg Angle		Avg Delta P & Temp		1.76250	83.5	1.68750	85.6		
		avg $\sqrt{DeltaP}$		1.32595		1.29856			
		Average gas stream velocity, ft/sec.		75.25		73.84			
		Vol. flow rate @ actual conditions, wacf/min		4827		4736			
		Vol. flow rate at standard conditions, dscf/min		4622		4517			

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$$

$$Tsa = Ts + 460$$

$$Ps = Pb + (Pstatic/13.6)$$

$$Vs = 85.49 * Cp * avg\sqrt{DeltaP} * \sqrt{Tsa/(Ps * MWs)}$$

$$Qs(act) = 60 * Vs * As$$

$$Qs(std) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(act)$$

where:
MWd = Dry molecular weight source gas, lb/lb-mole.
MWs = Wet molecular weight source gas, lb/lb-mole.
Tsa = Source Temperature, absolute(oR)
Ps = Absolute stack static pressure, inches Hg.
Vs = Average gas stream velocity, ft/sec.
Qs(act) = Volumetric flow rate of wet stack gas at actual, wacf/min
Qs(std) = Volumetric flow rate of dry stack gas at standard conditions, dscf/min

Comments _____

Determination of Stack Gas Velocity - Method 2

Client	Valero	**Operator**	MS/DV	**Pitot Coeff (Cp)**	0.84
Location/Plant	Paulsboro, NJ	**Date**	9-Feb-11	**Stack Area, ft^2 (As)**	1.069
Source	Unit 80	**W.O. Number**	05614.015.001.0001	**Pitot Tube/Thermo ID**	INC 1

Run Number	**2 Pre**	**2 Post**
Time	**1530-1536**	**1836-1841**
Barometric Press, in Hg (Pb)	**30.45**	**30.45**
Static Press, in H_20 (Pstatic)	**-0.67**	**-0.68**
Source Moisture, % (BWS)	**4.01**	**4.01**
O_2, %	**0.0**	**0.0**
CO_2, %	**5.7**	**5.7**

Cyclonic Flow Determination		**Traverse Location**		Leak Check good ? Y / N		Leak Check good ? Y / N			
Delta P at O°	Angle yeilding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)		
		A	**1**	**1.70**	**85**	**1.80**	**87**		
			2	**1.90**	**86**	**2.00**	**87**		
			3	**1.70**	**86**	**1.80**	**87**		
			4	**1.60**	**85**	**1.60**	**86**		
		B	**1**	**1.60**	**86**	**1.70**	**86**		
			2	**1.70**	**86**	**1.70**	**87**		
			3	**1.70**	**86**	**1.80**	**87**		
			4	**1.60**	**85**	**1.60**	**86**		
Avg Angle		**Avg Delta P & Temp**		**1.68750**	**85.6**	**1.75000**	**86.6**		
		avg $\sqrt{DeltaP}$		**1.29856**		**1.32208**			
		Average gas stream velocity, ft/sec.		**74.03**		**75.45**			
		Vol. flow rate @ actual conditions, wacf/min		**4749**		**4839**			
		Vol. flow rate at standard conditions, dscf/min		**4480**		**4557**			

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$$

$$Tsa = Ts + 460$$

$$Ps = Pb + (Pstatic/13.6)$$

$$Vs = 85.49 * Cp * avg\sqrt{DeltaP} * \sqrt{Tsa/(Ps * MWs)}$$

$$Qs(act) = 60 * Vs * As$$

$$Qs(std) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(act)$$

where:
MWd = Dry molecular weight source gas, lb/lb-mole.
MWs = Wet molecular weight source gas, lb/lb-mole.
Tsa = Source Temperature, absolute(oR)
Ps = Absolute stack static pressure, inches Hg.
Vs = Average gas stream velocity, ft/sec.
Qs(act) = Volumetric flow rate of wet stack gas at actual, wacf/min
Qs(std) = Volumetric flow rate of dry stack gas at standard conditions, dscf/min

Comments _____

Determination of Stack Gas Velocity - Method 2

Client	Valero	**Operator**	MS/DV	**Pitot Coeff (Cp)**	0.84
Location/Plant	Paulsboro, NJ	**Date**	9-Feb-11	**Stack Area, ft^2 (As)**	1.069
Source	Unit 80	**W.O. Number**	05614.015.001.0001	**Pitot Tube/Thermo ID**	INC 1

Run Number	**3 Pre**	**3 Post**
Time	**1836-1841**	**2049-2058**
Barometric Press, in Hg (Pb)	**30.45**	**30.45**
Static Press, in H_20 (Pstatic)	**-0.68**	**-0.69**
Source Moisture, % (BWS)	**3.55**	**3.55**
O_2, %	**0.0**	**0.0**
CO_2, %	**5.6**	**5.6**

Cyclonic Flow Determination		Traverse Location		Leak Check good ? Y / N		Leak Check good ? Y / N			
Delta P at O°	Angle yeilding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)		
		A	1	1.80	87	1.60	86		
			2	2.00	87	1.80	87		
			3	1.80	87	1.80	87		
			4	1.60	86	1.70	86		
		B	1	1.70	86	1.70	86		
			2	1.70	87	1.80	86		
			3	1.80	87	1.80	86		
			4	1.60	86	1.60	86		
Avg Angle		**Avg Delta P & Temp**		**1.75000**	**86.6**	**1.72500**	**86.3**		
		avg $\sqrt{DeltaP}$		**1.32208**		**1.31301**			
		Average gas stream velocity, ft/sec.		**75.40**		**74.86**			
		Vol. flow rate @ actual conditions, wacf/min		**4836**		**4801**			
		Vol. flow rate at standard conditions, dscf/min		**4576**		**4546**			

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$$

$$Tsa = Ts + 460$$

$$Ps = Pb + (Pstatic/13.6)$$

$$Vs = 85.49 * Cp * avg\sqrt{DeltaP} * \sqrt{Tsa/(Ps * MWs)}$$

$$Qs(act) = 60 * Vs * As$$

$$Qs(std) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(act)$$

where:
MWd = Dry molecular weight source gas, lb/lb-mole.
MWs = Wet molecular weight source gas, lb/lb-mole.
Tsa = Source Temperature, absolute(oR)
Ps = Absolute stack static pressure, inches Hg.
Vs = Average gas stream velocity, ft/sec.
Qs(act) = Volumetric flow rate of wet stack gas at actual, wacf/min
Qs(std) = Volumetric flow rate of dry stack gas at standard conditions, dscf/min

Comments _____

Determination of Moisture Content in Stack Gases - Method 4

Client	Valero				
Location/Plant	Paulsboro, NJ	**Operator**	MS/DV	**Date**	9-Feb-11
Source	Unit 80	**Meter Box ID**	21	**Meter Box Y**	0.9849
W.O. Number	05614.015.001.0001	**Temperature °C or °F**	F	**Sample Volume, ft³ or L**	ft

Run Number		Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer)		Meter Press, Delta H (in H_2O)	Impinger Volume, ml	Silica Gel Weight , g	Corrected Volume, Vm(std)	Leak Rate Check
1				Inlet	Outlet				74.994	Initial _____
	End Test	1508	447.532		37	0.5	240	308.5		Final _____
Baro Press., Pb (in Hg)	Start Test	1153	377.305		35	0.5	200	300	Moisture Volume, Vw(std)	Percent Moisture (%), BWS
30.45	Avg. or Total	195	70.227	36.0		0.5	40.0	8.5	2.28	2.96

Run Number		Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer)		Meter Press, Delta H (in H_2O)	Impinger Volume, ml	Silica Gel Weight , g	Corrected Volume, Vm(std)	Leak Rate Check
2				Inlet	Outlet				60.418	Initial _____
	End Test	1831	504.392		38	0.5	246	307.6		Final _____
Baro Press., Pb (in Hg)	Start Test	1535	447.700		36	0.5	200	300	Moisture Volume, Vw(std)	Percent Moisture (%), BWS
30.45	Avg. or Total	168	56.692	37.0		0.5	46.0	7.6	2.52	4.01

Run Number		Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer)		Meter Press, Delta H (in H_2O)	Impinger Volume, ml	Silica Gel Weight , g	Corrected Volume, Vm(std)	Leak Rate Check
3				Inlet	Outlet				72.168	Initial _____
	End Test	2101	571.669		37	0.5	248	308.4		Final _____
Baro Press., Pb (in Hg)	Start Test	1858	504.429		30	0.5	200	300	Moisture Volume, Vw(std)	Percent Moisture, %
30.45	Avg. or Total	173	67.240	33.5		0.5	48.0	8.4	2.66	3.55

$$BWS = \left(\frac{Vw(std)}{Vw(std) + Vm(std)}\right) * 100$$

$$Vw(std) = (0.04707 * Vwc) + (0.04715 * Wwsg)$$

if Vm is liters than $Vm = Vml * 28.32$

if Tm is C°than $Tm = (Tmc * 1.8) + 32$

$$Vm(std) = \frac{17.64 * Y * Vm * (Pb + (deltaH/13.6))}{(Tm + 460)}$$

WHERE:

Vm(std)= Sample volume corrected to standard temp and pressure, scf or L
Vm= Actual sample volume, calculated, scf
Vml= Actual sample volume, calculated, Liters
Y= Dry gas meter calibration factor.
Pb= Barometric pressure, in. Hg
delta H= Meter pressure, in H2O
Tm= Average temperature of meter (DGM is used) or rotomter, degrees °F
Tmc= Average temperature of meter (DGM is used) or rotomter, degrees °C
Vw(std)= Volume of water vapor at standard conditions, scf or L
Vwc= Volume of water condensed, mL
Wwsg= Weight of Silica Gel, g
Bws= Water vapor in gas stream, percent

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Use either ft³ or liters in calculations. DO NOT MIX CUBIC FEET AND LITERS IN ANY CALCULATION.

Determination of Stack Gas Velocity - Method 2

Client: Valero | Operator: MG/MD | Pitot Coeff (Cp): 0.84
Location/Plant: Benicia, CA | Date: 12-7-11 | Stack Area, ft² (As): 1.069
Source: Turbine Unit 80 | W.O. Number: 03014.015.001 | Pitot Tube/Thermo ID: Inc #1

	Run Number	Time	Barometric Press, in Hg (Pb)	Static Press, in H_2O (Pstatic)	Source Moisture, % (BWS)	O_2, %	CO_2, %
	1	1156 - 1208	30.15	-0.69			
	2	1530 - 1536	30.45	-0.67			
	3	1836 - 1841	30.45	-0.68			

Cyclonic Flow Determination		Traverse Location		Leak Check good ? (Y) / N		Leak Check good ? (Y) / N		Leak Check good ? (Y) / N	
Delta P at O°	Angle yeilding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)
0.13	∞	A	1	1.9	83	1.7	85	1.8	87
0.09	3		2	2.0	83	1.9	86	2.0	87
0.10	∞		3	1.8	83	1.7	86	1.8	87
0.12	∞		4	1.5	83	1.6	85	1.6	86
0.14	3	B	1	1.7	85	1.6	86	1.7	86
0.12	∞		2	1.7	84	1.7	86	1.7	87
0.12	∞		3	1.6	84	1.7	86	1.8	87
0.12	∞		4	1.5	83	1.6	85	1.6	86
Avg Angle		Avg Delta P & Temp		1.76250	83.5	1.6875	85.6	1.75000	86.6
		$\sqrt{\text{Delta P}}$ avg		1.32595		1.29852		1.32208	
		Average gas stream velocity, ft/sec.							
		Vol. flow rate @ actual conditions, wacf/min							
		Vol. flow rate at standard conditions, dscf/min							

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$$

$$Tsa = Ts + 460$$

$$Ps = Pb + (Pstatic/13.6)$$

$$Vs = 85.49 * Cp * avg\sqrt{DeltaP} * \sqrt{Tsa/(Ps * MWs)}$$

$$Qs(act) = 60 * Vs * As$$

$$Qs(std) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(act)$$

where:
MWd = Dry molecular weight source gas, lb/lb-mole.
MWs = Wet molecular weight source gas, lb/lb-mole.
Tsa = Source Temperature, absolute(oR)
Ps = Absolute stack static pressure, inches Hg.
Vs = Average gas stream velocity, ft/sec.
Qs(act) = Volumetric flow rate of wet stack gas at actual, wacf/min
Qs(std) = Volumetric flow rate of dry stack gas at standard conditions, dscf/min

Comments: _____
method2.xls

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Determination of Stack Gas Velocity - Method 2

Client: Valero | Operator: MS/DV | Pitot Coeff (Cp): 0.84
Location/Plant: Paulsboro NJ | Date: 2-9-11 | Stack Area, ft² (As): 1.069
Source: Un. 1 80 | W.O. Number: 0564.015.001 | Pitot Tube/Thermo ID: Inc #1

Run Number	4		
Time	2049 - 2058		
Barometric Press, in Hg (Pb)	30.45		
Static Press, in H_20 (Pstatic)	-.69		
Source Moisture, % (BWS)	3.55		
O_2, %	0.0		
CO_2, %	5.6		

Cyclonic Flow Determination		Traverse Location		Leak Check good ? Y / N		Leak Check good ? Y / N		Leak Check good ? Y / N	
Delta P at O°	Angle yeilding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)
		A	1	1.6	86				
			2	1.8	87				
			3	1.8	87				
			4	1.7	86				
		B	1	1.7	86				
			2	1.8	4C				
			3	1.4	86				
			4	1.6	86				
Avg Angle		Avg Delta P & Temp		1.72500	86.3				
		Avg $\sqrt{\text{Delta P}}$		1.31301					
Average gas stream velocity, ft/sec.									
Vol. flow rate @ actual conditions, wacf/min									
Vol. flow rate at standard conditions, dscf/min									

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$$

$$Tsa = Ts + 460$$

$$Ps = Pb + (Pstatic/13.6)$$

$$Vs = 85.49 * Cp * avg\sqrt{DeltaP} * \sqrt{Tsa/(Ps * MWs)}$$

$$Qs(act) = 60 * Vs * As$$

$$Qs(std) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(act)$$

where:
MWd = Dry molecular weight source gas, lb/lb-mole.
MWs = Wet molecular weight source gas, lb/lb-mole.
Tsa = Source Temperature, absolute(oR)
Ps = Absolute stack static pressure, inches Hg.
Vs = Average gas stream velocity, ft/sec.
Qs(act) = Volumetric flow rate of wet stack gas at actual, wacf/min
Qs(std) = Volumetric flow rate of dry stack gas at standard conditions, dscf/min

Comments _____

method2.xls

Determination of Moisture Content in Stack Gases - Method 4

Client: Valero
Location/Plant: Paulsboro, NJ
Source: #4 Tail Gas Unit 80
W.O. Number: 05614.045.001
Operator: MS
Meter Box ID: 21
Temperature °C or °F: °F
Date: 2-9-11
Meter Box Y: 0.9849
Sample Volume, ft³ or L: ft³

Run Number		Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer) Inlet	Outlet	Meter Press, Delta H (in H_2O)	Impinger Volume, ml	Silica Gel Weight, g	Corrected Volume, Vm(std)	Leak Rate Check
1				~~Inlet~~ Ave					74.994	Initial DS
	End Test	1408	447.532	37		0.5	240	308.5		Final 0.00 @ 6 in
Baro Press., Pb (in Hg)	Start Test	1153	377.365	35		0.5	200	300	Moisture Volume, Vw(std)	Percent Moisture (%), BWS
30.45	Avg. or Total	195	70.227	36		0.5	40	8.5	2.284	2.96

Run Number		Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer) Inlet	Outlet	Meter Press, Delta H (in H_2O)	Impinger Volume, ml	Silica Gel Weight, g	Corrected Volume, Vm(std)	Leak Rate Check
2									60.418	Initial 0.00 @ 5 in
	End Test	1831	504.392	38		0.5	246	307.6		Final 0.000 @ 5"
Baro Press., Pb (in Hg)	Start Test	1535	447.700	36		0.5	200	300	Moisture Volume, Vw(std)	Percent Moisture (%), BWS
30.45	Avg. or Total	168	56.692	37		0.5	46	7.6	2.524	4.01

Freeze Up

Run Number		Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer) Inlet	Outlet	Meter Press, Delta H (in H_2O)	Impinger Volume, ml	Silica Gel Weight, g	Corrected Volume, Vm(std)	Leak Rate Check
3									72.168	Initial 0.001 @ 7"
	End Test	2101	571.669	37		0.5	248	308.4		Final 0.00 @ 9"
Baro Press., Pb (in Hg)	Start Test	1858 06	504.429	30		0.5	200	300	Moisture Volume, Vw(std)	Percent Moisture (%), BWS
30.45	Avg. or Total	173	67.24	33.5		0.5	48	8.4	2.655	3.55

$$Vm(std) = \frac{17.64 * Y * Vm * (Pb + (deltaH / 13.6))}{(Tm + 460)}$$

if Tm is C° than $Tm = (Tmc * 1.8) + 32$

if Vm is liters than $Vm = Vml * 28.32$

$$Vw(std) = (0.04707 * Vwc) + (0.04715 * Wwsg)$$

$$BWS = \left(\frac{Vw(std)}{Vw(std) + Vm(std)} \right) * 100$$

WHERE:
Vm(std)= Sample volume corrected to standard temp and pressure, scf or L
Vm= Actual sample volume, calculated, scf
Vml= Actual sample volume, calculated, Liters
Y= Dry gas meter calibration factor.
Pb= Barometric pressure, in. Hg
delta H= Meter pressure, in H2O
Tm= Average temperature of meter (DGM is used) or rotomter, degrees °
Tmc= Average temperature of meter (DGM is used) or rotomter, degrees °
Vw(std)= Volume of water vapor at standard conditions, scf or L
Vwc= Volume of water condensed, mL
Wwsg= Weight of Silica Gel, g
Bws= Water vapor in gas stream, percer

Use either ft³ or liters in calculations. DO NOT MIX CUBIC FEET AND LITERS IN ANY CALCULATION.

* at stack platform

DS = Dead Stop

Method4

Determination of Stack Gas Velocity - Method 2

Client: Valero
Location/Plant: Paulsboro, NJ
Source: Unit 81
Operator: MS/DV
Date: 8-Feb-11
W.O. Number: 05614.015.001.0001
Pitot Coeff (Cp): 0.84
Stack Area, ft² (As): 1.069
Pitot Tube/Thermo ID: INC 1

Run Number	1 Pre	1 Post	
Time	1135-1142	1515-1522	
Barometric Press, in Hg (Pb)	30.00	30.00	
Static Press, in H_20 (Pstatic)	-2.00	-1.80	
Source Moisture, % (BWS)	3.16	3.16	
O_2, %	0.0	0.0	
CO_2, %	6.4	6.4	

Cyclonic Flow Determination		Traverse Location		Leak Check good ? Y / N		Leak Check good ? Y / N			
Delta P at O°	Angle yeilding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)		
		A	1	2.90	82	3.00	83		
			2	2.90	83	3.00	83		
			3	2.40	83	2.50	83		
			4	2.00	82	2.00	82		
		B	1	2.40	82	2.50	84		
			2	2.70	82	2.80	84		
			3	2.40	82	2.20	84		
			4	1.90	81	2.00	82		
Avg Angle		Avg Delta P & Temp		2.45000	82.1	2.50000	83.1		
		avg $\sqrt{DeltaP}$		1.56116		1.57642			
		Average gas stream velocity, ft/sec.		89.21		90.15			
		Vol. flow rate @ actual conditions, wacf/min		5722		5782			
		Vol. flow rate at standard conditions, dscf/min		5383		5432			

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$$

$$Tsa = Ts + 460$$

$$Ps = Pb + (Pstatic/13.6)$$

$$Vs = 85.49 * Cp * avg\sqrt{DeltaP} * \sqrt{Tsa/(Ps * MWs)}$$

$$Qs(act) = 60 * Vs * As$$

$$Qs(std) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(act)$$

where:
MWd = Dry molecular weight source gas, lb/lb-mole.
MWs = Wet molecular weight source gas, lb/lb-mole.
Tsa = Source Temperature, absolute(oR)
Ps = Absolute stack static pressure, inches Hg.
Vs = Average gas stream velocity, ft/sec.
Qs(act) = Volumetric flow rate of wet stack gas at actual, wacf/min
Qs(std) = Volumetric flow rate of dry stack gas at standard conditions dscf/min

Comments _____

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Determination of Stack Gas Velocity - Method 2

Client: Valero
Location/Plant: Paulsboro, NJ
Source: Unit 81
Operator: MS/DV
Date: 8-Feb-11
W.O. Number: 05614.015.001.0001
Pitot Coeff (Cp): 0.84
Stack Area, ft^2 (As): 1.069
Pitot Tube/Thermo ID: INC 1

Run Number	2 Pre	2 Post	
Time	1515-1522	1828-1835	
Barometric Press, in Hg (Pb)	30.00	30.00	
Static Press, in H_20 (Pstatic)	-1.80	-1.80	
Source Moisture, % (BWS)	3.22	3.22	
O_2, %	0.0	0.0	
CO_2, %	6.2	6.2	

Cyclonic Flow Determination		Traverse Location		Leak Check good ? Y / N		Leak Check good ? Y / N			
Delta P at O°	Angle yeilding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)		
		A	1	3.00	83	3.10	82		
			2	3.00	83	3.10	82		
			3	2.50	83	2.60	82		
			4	2.00	82	2.10	81		
		B	1	2.50	84	2.50	82		
			2	2.80	84	2.70	82		
			3	2.20	84	2.20	82		
			4	2.00	82	2.10	81		
Avg Angle		Avg Delta P & Temp		2.50000	83.1	2.55000	81.8		
		avg $\sqrt{DeltaP}$		1.57642		1.59245			
		Average gas stream velocity, ft/sec.		90.21		91.01			
		Vol. flow rate @ actual conditions, wacf/min		5786		5837			
		Vol. flow rate at standard conditions, dscf/min		5432		5494			

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$$

$$Tsa = Ts + 460$$

$$Ps = Pb + (Pstatic/13.6)$$

$$Vs = 85.49 * Cp * avg\sqrt{DeltaP} * \sqrt{Tsa/(Ps * MWs)}$$

$$Qs(act) = 60 * Vs * As$$

$$Qs(std) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(act)$$

where:
MWd = Dry molecular weight source gas, lb/lb-mole.
MWs = Wet molecular weight source gas, lb/lb-mole.
Tsa = Source Temperature, absolute(oR)
Ps = Absolute stack static pressure, inches Hg.
Vs = Average gas stream velocity, ft/sec.
Qs(act) = Volumetric flow rate of wet stack gas at actual, wacf/min
Qs(std) = Volumetric flow rate of dry stack gas at standard conditions dscf/min

Comments _____

Determination of Stack Gas Velocity - Method 2

Client	Valero	Operator	MS/DV	Pitot Coeff (Cp)	0.84
Location/Plant	Paulsboro, NJ	Date	8-Feb-11	Stack Area, ft^2 (As)	1.069
Source	Unit 81	W.O. Number	05614.015.001.0001	Pitot Tube/Thermo ID	INC 1

Run Number	3 Pre	3 Post	
Time	1828-1835	2146-2153	
Barometric Press, in Hg (Pb)	30.00	30.00	
Static Press, in H_20 (Pstatic)	-1.80	-1.90	
Source Moisture, % (BWS)	3.19	3.19	
O_2, %	0.0	0.0	
CO_2, %	6.4	6.4	

Cyclonic Flow Determination		Traverse Location		Leak Check good ? Y / N		Leak Check good ? Y / N			
Delta P at O°	Angle yeilding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)		
		A	1	3.10	82	3.00	81		
			2	3.10	82	3.00	81		
			3	2.60	82	2.60	81		
			4	2.10	81	2.00	79		
		B	1	2.50	82	2.40	80		
			2	2.70	82	2.70	81		
			3	2.20	82	2.30	81		
			4	2.10	81	2.10	80		
Avg Angle		Avg Delta P & Temp		2.55000	81.8	2.51250	80.5		
		avg $\sqrt{DeltaP}$		1.59245		1.58111			
		Average gas stream velocity, ft/sec.		90.95		90.21			
		Vol. flow rate @ actual conditions, wacf/min		5834		5786			
		Vol. flow rate at standard conditions, dscf/min		5493		5459			

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$$

$$Tsa = Ts + 460$$

$$Ps = Pb + (Pstatic/13.6)$$

$$Vs = 85.49 * Cp * avg\sqrt{DeltaP} * \sqrt{Tsa/(Ps * MWs)}$$

$$Qs(act) = 60 * Vs * As$$

$$Qs(std) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(act)$$

where:
MWd = Dry molecular weight source gas, lb/lb-mole.
MWs = Wet molecular weight source gas, lb/lb-mole.
Tsa = Source Temperature, absolute(oR)
Ps = Absolute stack static pressure, inches Hg.
Vs = Average gas stream velocity, ft/sec.
Qs(act) = Volumetric flow rate of wet stack gas at actual, wacf/min
Qs(std) = Volumetric flow rate of dry stack gas at standard conditions dscf/min

Comments _____

Determination of Moisture Content in Stack Gases - Method 4

Client	Valero			**Date**	8-Feb-11
Location/Plant	Paulsboro, NJ	**Operator**	MS/DV	**Meter Box Y**	0.9849
Source	Unit 81	**Meter Box ID**	21		
W.O. Number	05614.015.001.0001	**Temperature °C or °F**	F	**Sample Volume, ft³ or L**	ft

Run Number		Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer)		Meter Press, Delta H (in H_2O)	Impinger Volume, ml	Silica Gel Weight , g	Corrected Volume, Vm(std)	Leak Rate Check
1				Inlet	Outlet				66.039	Initial _____
	End Test	1432	239.853		56	0.5	236	309.7		Final _____
Baro Press., Pb (in Hg)	Start Test	1145	175.250		45	0.5	200	300	Moisture Volume, Vw(std)	Percent Moisture (%), BWS
30.00	Avg. or Total	167	64.603	50.5		0.5	36.0	9.7	2.15	3.16

Run Number		Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer)		Meter Press, Delta H (in H_2O)	Impinger Volume, ml	Silica Gel Weight , g	Corrected Volume, Vm(std)	Leak Rate Check
2				Inlet	Outlet				70.206	Initial _____
	End Test	1713	309.000		46	0.5	240	309.6		Final _____
Baro Press., Pb (in Hg)	Start Test	1513	240.590		51	0.5	200	300	Moisture Volume, Vw(std)	Percent Moisture (%), BWS
30.00	Avg. or Total	180	68.410	48.5		0.5	40.0	9.6	2.34	3.22

Run Number		Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer)		Meter Press, Delta H (in H_2O)	Impinger Volume, ml	Silica Gel Weight , g	Corrected Volume, Vm(std)	Leak Rate Check
3				Inlet	Outlet				69.970	Initial _____
	End Test	2124	376.594		42	0.5	239	309.9		Final _____
Baro Press., Pb (in Hg)	Start Test	1830	309.084		45	0.5	200	300	Moisture Volume, Vw(std)	Percent Moisture, %
30.00	Avg. or Total	174	67.510	43.5		0.5	39.0	9.9	2.30	3.19

$$BWS = \left(\frac{Vw(std)}{Vw(std) + Vm(std)}\right) * 100$$

$$Vw(std) = (0.04707 * Vwc) + (0.04715 * Wwsg)$$

if Vm is liters than $Vm = Vml * 28.32$

if Tm is C° than $Tm = (Tmc * 1.8) + 32$

$$Vm(std) = \frac{17.64 * Y * Vm * (Pb + (deltaH/13.6))}{(Tm + 460)}$$

WHERE:

Vm(std)= Sample volume corrected to standard temp and pressure, scf or L
Vm= Actual sample volume, calculated, scf
Vml= Actual sample volume, calculated, Liters
Y= Dry gas meter calibration factor.
Pb= Barometric pressure, in. Hg
delta H= Meter pressure, in H2O
Tm= Average temperature of meter (DGM is used) or rotomter, degrees °F
Tmc= Average temperature of meter (DGM is used) or rotomter, degrees °C
Vw(std)= Volume of water vapor at standard conditions, scf or L
Vwc= Volume of water condensed, mL
Wwsg= Weight of Silica Gel, g
Bws= Water vapor in gas stream, percent

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Use either ft³ or liters in calculations. DO NOT MIX CUBIC FEET AND LITERS IN ANY CALCULATION.

Determination of Stack Gas Velocity - Method 2

Client: Valero
Location/Plant: Paulsboro, NJ
Source: Tail Gas Incinerator #1

Operator: MS / DVD
Date: 2-8-11
W.O. Number: 05614.015.001

Pitot Coeff (Cp): .84
Stack Area, ft² (As): 1.069
Pitot Tube/Thermo ID: Inc #1

	Run 1	Run 2	Run 3
Time	1135	~~1335~~ MS 1515	~~1625~~ MS 1828
Barometric Press, in Hg (Pb)	30.00	30.00	30.00
Static Press, in H_2O (Pstatic)	-2.0	-1.8 ~~-2.0~~ MS	-1.8
Source Moisture, % (BWS)	3.16	3.19	3.19
O_2, %	0.0	0.0	0.0
CO_2, %	6.4	6.2	6.4

Cyclonic Flow Determination		Traverse Location		Leak Check good? (Y) / N		Leak Check good? (Y) / N		Leak Check good? (Y) / N	
Delta P at O°	Angle yeilding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)
0.17	3	A	1	~~2.9~~ MS 2.9	82	3.0	83	3.1	82
0.08	4		2	~~2.9~~ MS 2.9	83	3.0	83	3.1	82
0.00	0		3	~~2.4~~ MS 2.4	83	2.5	83	2.6	82
0.00	0		4	2.0	82	2.0	82	2.1	81
0.31	5	B	1	2.4	82	2.5	84	2.5	82
0.00	0		2	2.7	82	2.8	84	2.7	82
0.00	0		3	2.4	82	2.2	84	2.2	82
0.06	3		4	1.9	81	2.0	82	2.1	81
Avg Angle		Avg Delta P & Temp		2.45000	82.1	2.500	83.13	2.550	81.750
		avg $\sqrt{\text{DeltaP}}$		1.56116		1.5764		1.592	
		Average gas stream velocity, ft/sec.		89.214		90.207			
		Vol. flow rate @ actual conditions, wacf/min		5722.17		5785.55			
		Vol. flow rate at standard conditions, dscf/min		5382.97		5433.26			

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$$

$$Tsa = Ts + 460$$

$$Ps = Pb + (Pstatic/13.6)$$

$$Vs = 85.49 * Cp * avg\sqrt{DeltaP} * \sqrt{Tsa/(Ps * MWs)}$$

$$Qs(act) = 60 * Vs * As$$

$$Qs(std) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(act)$$

where:
MWd = Dry molecular weight source gas, lb/lb-mole.
MWs = Wet molecular weight source gas, lb/lb-mole.
Tsa = Source Temperature, absolute(oR)
Ps = Absolute stack static pressure, inches Hg.
Vs = Average gas stream velocity, ft/sec.
Qs(act) = Volumetric flow rate of wet stack gas at actual,
Qs(std) = Volumetric flow rate of dry stack gas at standard conditions, dscf/min

Comments _____

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PA

Determination of Stack Gas Velocity - Method 2

Client: Valero | Operator: MS/DVD | Pitot Coeff (Cp): 0.84
Location/Plant: Paulsboro, NJ | Date: 2-8-11 | Stack Area, ft² (As): 1.069
Source: Tail Gas Unit #81 | W.O. Number: D5614.015.001 | Pitot Tube/Thermo ID: Inc. #1

Run Number	4		
Time	2146-2153		
Barometric Press, in Hg (Pb)	30.00		
Static Press, in H_20 (Pstatic)	-1.9		
Source Moisture, % (BWS)	3.19		
O_2, %	0.8		
CO_2, %	0.4		

Cyclonic Flow Determination		Traverse Location		Leak Check good ? Y / N		Leak Check good ? Y / N		Leak Check good ? Y / N	
Delta P at O°	Angle yeilding zero Delta P	Port	Point	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)	Delta P	Source Temp, F° (Ts)
		A	1	3.0	81				
			2	3.0	81				
			3	2.6	81				
			4	2.0	79				
		B	1	2.4	80				
			2	2.7	81				
			3	2.3	81				
			4	2.1	80				
Avg Angle		Avg Delta P & Temp		2.513	80.5				
		avg √DeltaP		1.5811					
Average gas stream velocity, ft/sec.									
Vol. flow rate @ actual conditions, wacf/min									
Vol. flow rate at standard conditions, dscf/min									

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWs = (MWd * (1 - (BWS/100))) + (18 * (BWS/100))$$

$$Tsa = Ts + 460$$

$$Ps = Pb + (Pstatic/13.6)$$

$$Vs = 85.49 * Cp * avg\sqrt{DeltaP} * \sqrt{Tsa/(Ps * MWs)}$$

$$Qs(act) = 60 * Vs * As$$

$$Qs(std) = 17.64 * (1 - (BWS/100)) * (Ps/Tsa) * Qs(act)$$

where:
MWd = Dry molecular weight source gas, lb/lb-mole.
MWs = Wet molecular weight source gas, lb/lb-mole.
Tsa = Source Temperature, absolute(oR)
Ps = Absolute stack static pressure, inches Hg.
Vs = Average gas stream velocity, ft/sec.
Qs(act) = Volumetric flow rate of wet stack gas at actual,
Qs(std) = Volumetric flow rate of dry stack gas at standard conditions, dscf/min

Comments _____

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Determination of Moisture Content in Stack Gases - Method 4

Client Valero
Location/Plant Paulsboro, NJ
Source Tail Gas Unit #1
W.O. Number 056014.015.001

Operator MS/DDD
Meter Box ID 21
Temperature °C or °F °F

Date 2-8-11
Meter Box Y 0.9849
Sample Volume, ft³ or L 49

Run Number		Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer) Inlet	Outlet	Meter Press, Delta H (in H_2O)	Impinger Volume, ml	Silica Gel Weight, g	Corrected Volume, Vm(std)	Leak Rate Check
1				~~Avg Inlet~~					66.039	Initial DS
	End Test	1432	239.853	56		0.5	236	309.7		Final DS
Baro Press., Pb (in Hg)	Start Test	1145	175.250	45		~~0.5~~ LC	200	300	Moisture Volume, Vw(std)	Percent Moisture (%), BWS
30.00	Avg. or Total	167	~~27~~ 64.603	50.5		0.5	36	9.7	2.152	3.16

Run Number		Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer) Inlet	Outlet	Meter Press, Delta H (in H_2O)	Impinger Volume, ml	Silica Gel Weight, g	Corrected Volume, Vm(std)	Leak Rate Check
2									~~70.751~~	Initial DS
	End Test	1713	~~209.000~~	46		0.5	240	309.6	70.206 SG	Final DS
Baro Press., Pb (in Hg)	Start Test	1513	240.089	51		0.5	200	300	Moisture Volume, Vw(std)	Percent Moisture (%), BWS
30.00	Avg. or Total	~~17~~ 200	68.941	48.5		0.5	40	9.6	~~2.335~~ 2.339 SG	~~3.19~~ 3.22 SG

Run Number		Sample Time (min)	Meter Volume, Vm	Meter Temp (or ambient temp for rotometer) Inlet	Outlet	Meter Press, Delta H (in H_2O)	Impinger Volume, ml	Silica Gel Weight, g	Corrected Volume, Vm(std)	Leak Rate Check
3									69.97	Initial DS
	End Test	2124.53 1724	376.594	42		0.5	239	309.9		Final DS
Baro Press., Pb (in Hg)	Start Test	1830	309.084	45		0.5	200	300	Moisture Volume, Vw(std)	Percent Moisture (%), BWS
30.00	Avg. or Total	174	67.510	43.5		0.5	39	9.9	2.303	3.19

$$Vm(std) = \frac{17.64 * Y * Vm * (Pb + (deltaH / 13.6))}{(Tm + 460)}$$

if Tm is C° than $Tm = (Tmc * 1.8) + 32$

if Vm is liters than $Vm = Vml * 28.32$

$$Vw(std) = (0.04707 * Vwc) + (0.04715 * Wwsg)$$

$$BWS = \left(\frac{Vw(std)}{Vw(std) + Vm(std)} \right) * 100$$

WHERE:
Vm(std)= Sample volume corrected to standard temp and pressure, scf or L
Vm= Actual sample volume, calculated, scf
Vml= Actual sample volume, calculated, Liters
Y= Dry gas meter calibration factor.
Pb= Barometric pressure, in. Hg
delta H= Meter pressure, in H2O
Tm= Average temperature of meter (DGM is used) or rotomter, degrees °
Tmc= Average temperature of meter (DGM is used) or rotomter, degrees °
Vw(std)= Volume of water vapor at standard conditions, scf or L
Vwc= Volume of water condensed, mL
Wwsg= Weight of Silica Gel, g
Bws= Water vapor in gas stream, percer

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Use either ft³ or liters in calculations. DO NOT MIX CUBIC FEET AND LITERS IN ANY CALCULATION.

DS = Dead Stop