Derenzo and Associates, Inc.
Environmental Consultants

RECEIVED
JUL 10 2014
AIR QUALITY DIV.

EMISSIONS TEST REPORT

Title	Compliance Emissions Testing Report for the Natural Gas-Fueled Internal Combustion Engines Operated at the Breitburn Operating LP, Elmer Fudd East Central Production Facility
Report Date	July 8, 2014
Test Date(s)	June 10-11, 2014

Facility Information	
Name:	Breitburn Operating LP
Street Address:	Boiling Springs Road
City, County:	Comins, Oscoda (NE/4 SE/4 Section 7, T28N, R3E)
Phone:	(989) 731-9369

Facility Permit Information			
State Registration No.:	N7463	ROP No.:	MI-ROP-N7463-2014

Testing Contractor	
Company	Derenzo and Associates, Inc.
Mailing Address	39395 Schoolcraft Road Livonia, MI 48150
Phone	(734) 464-3880
Project No.	1404005

COMPLIANCE EMISSIONS TESTING REPORT
FOR
NATURAL GAS-FUELED
INTERNAL COMBUSTION ENGINES

BREITBURN OPERATING LP,
ELMER FUDD EAST CENTRAL PRODUCTION FACILITY

1.0 INTRODUCTION

Breitburn Operating LP (Breitburn), State Registration No. N7463 operates three (3) Caterpillar (CAT®) Model No. 3516 turbo aspirated low emission (TALE) natural gas fueled reciprocating internal combustion engines (RICE) designated as emission units EUENGINE1, EUENGINE2 and EUENGINE3 (collectively referred to flexible group FGENGINES) at the Elmer Fudd East Central Production Facility located in Comins, Oscoda County, Michigan.

Flexible Group FGENGINES Condition V.1 of the Renewable Operating Permit (ROP) issued to Breitburn (MI-ROP-N7463-2014) specifies that:

At least once each 5 years, the permitee shall verify NOx and CO emission rates from each engine in FGENGINES, by testing at owners expense, in accordance with Department requirements. The testing shall be used to develop an emission factor for NOx and CO that will be applied to the monthly fuel use to determine compliance with the 12-month rolling average emission limits specified in this permit.

The FGENGINES performance testing consisted of triplicate, one-hour test runs for the determination of nitrogen oxides (NOx) and carbon monoxide (CO) emission rates from the three (3) engines identified in the ROP. Exhaust gas velocity, moisture, oxygen (O_2) content, and carbon dioxide (CO_2) content was determined for each test period to calculate volumetric exhaust gas flowrate and pollutant mass emission rates. Instrument analyzers were used for real time analysis of NOx and CO concentrations.

The compliance testing for FGENGINES was performed on June 10 and 11, 2014, by Derenzo and Associates, Inc., an environmental consulting and testing company based in Livonia, Michigan. Daniel Wilson and Jason Logan of Derenzo and Associates performed the testing. Process operations were coordinated by Ms. Carolann Knapp of Breitburn. Mr. Jeremy Howe of the Michigan Department of Environmental Quality (MDEQ) observed the testing.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Protocol dated April 24, 2014 and approved by the MDEQ.

Questions regarding this emission test report should be directed to:

Mr. Daniel Wilson
Environmental Consultant
Derenzo and Associates, Inc.
39395 Schoolcraft
Livonia, MI 48150
(734) 464-3880

Carolann Knapp
EH&S Regional Rep
Breitburn Management
1165 Elkview Drive
P.O. Box 1256
Gaylord, MI 49734
(989) 731-9369

Report Certification

This test report was prepared by Derenzo, Associates, Inc. based on field sampling data collected by Derenzo and Associates, Inc. Facility process data were collected and provided by Breitburn Operating LP employees or representatives.

I certify that the testing was conducted in accordance with the approved test plan unless otherwise specified in this report. I believe the information provided in this report and its attachments are true, accurate, and complete.

Report Prepared By:

Daniel Wilson
Environmental Consultant
Derenzo and Associates, Inc.

Reviewed By:

Robert L. Harvey, P.E.
General Manager
Derenzo and Associates, Inc.

This test report has been reviewed by Breitburn representatives and approved for submittal to the Michigan Department of Environmental Quality. I certify that the facility operating conditions were in compliance with permit requirements and were at the maximum routine operating conditions for the facility. Based on information and belief formed after reasonable inquiry, the statements and information in this report are true, accurate and complete.

Carolann Knapp
EH&S Regional Rep
Breitburn Management

2.0 SUMMARY OF RESULTS

The exhaust gas from each natural gas-fueled RICE was monitored for three (3) one-hour test periods during which the NOx, CO, O_2, and CO_2 concentrations were measured using instrumental analyzers. Exhaust gas flowrate measurements were conducted prior to and following each one-hour test period to calculate average exhaust flowrates for each engine, and ultimately pollutant mass emission rates.

The testing was performed while the natural gas-fueled IC engines were operated at the maximum conditions (maximum fuel use and horsepower output) allowed by the process, which is dependent on facility and gas well conditions. Fuel use data were recorded by facility operators to calculate CO and NOx emission factors per amount of fuel used (pounds per million cubic feet of natural gas fuel, lb/MMcf).

The following table presents a summary of the average measured CO and NOx emission rates for each engine and a comparison of the results to the permitted pollutant emission rates. Tables 1, 2, and 3 at the end of this report present measured exhaust gas pollutant concentrations and mass emission rates for each one-hour test period.

	NOx Emission Rates			CO Emission Rates		
Emission Unit ID	(lb/hr)	(lb/MMscf)	(TpY)[1]	(lb/hr)	(lb/MMscf)	(TpY)[1]
EUENGINE1 (1185)	2.56	398.81	11.21	2.66	414.05	11.64
EUENGINE2 (1106)	4.63	687.11	20.26	3.38	501.98	14.80
EUENGINE3 (1107)	4.17	694.28	18.28	3.86	641.49	16.90
Permit Limit (per engine)	--	--	45.30	--	--	32.80

1. Calculated ton per year (TpY) emission rate based on continuous operation at the measured emission rate.

3.0 SOURCE AND SAMPLING LOCATION DESCRIPTION

3.1 General Process Description

The Elmer Fudd East Production Facility processes natural gas by removing moisture and compressing the processed gas into a sales pipeline.

The facility operates three (3) natural gas fueled CAT® Model No. 3516 IC engines identified as EUENGINE1 – EUENGINE1 (FGENGINES) that are connected to individual gas compressors. Facility operators refer to the engines Nos. 1185, 1106 and 1107. Therefore, both identifications are used throughout this report.

3.2 Rated Capacities, Type and Quantity of Raw Materials Used

The IC engines have a design power rating of 1,340 horsepower (hp). Fuel (natural gas) consumption and combustion air flowrate is regulated by the engine to maintain the required heat input rate and horsepower to drive the associated gas compressor. Facility operators recorded the engine speed (RPM) and the fuel use rate (thousand standard cubic feet per day, Mscf/day) throughout each one-hour test period.

Appendix A provides engine process data collected during the compliance test.

3.3 Emission Control System Description

The CAT® 3516 IC engines do not use add-on emission control equipment. The engines employ lean-burn technology (turbo-aspirated low emission design) for efficient fuel combustion and to minimize emissions. The air-to-fuel ratio is set based on the gas quality (heat content) of the fuel for the most efficient combustion. Exhaust gas is released directly to atmosphere through a noise muffler and vertical exhaust stack.

3.4 Sampling Locations (USEPA Method 1)

The exhaust stack sampling ports for the Model 3516 IC engines satisfied the USEPA Method 1 criteria for a representative sample location. The inner diameter of the engine exhaust stack is 12.5 inches. Each stack is equipped with two (2) sample ports, opposed 90°, that provide a sampling location at least 30 inches (2.4 duct diameters) downstream and 30 inches (2.4 duct diameters) upstream from any flow disturbance.

Velocity pressure traverse locations for the sampling points were determined in accordance with USEPA Method 1.

Figures 1 and 2 present the performance test sampling and measurement locations.

4.0 TEST RESULTS AND DISCUSSION

4.1 Purpose and Objectives of the Tests

Compliance testing for the three (3) CAT 3516 IC engines is required by MI-ROP-N7463-2014. The permit specifies that at least once every five (5) years NOx and CO emissions shall be measured to develop an emission factor to be used in calculating 12-month rolling total emission rates based on fuel use.

The exhaust from each natural gas-fueled IC engine was monitored for three (3) one-hour test periods during which the NOx, CO, O_2, and CO_2 concentrations were measured using instrumental analyzers. Exhaust gas moisture content was determined by gravimetric analysis of the weight gain in chilled impingers in accordance with USEPA Method 4. Velocity and volumetric flow rates were measured near the beginning and ending of each one-hour sampling period.

4.2 Variations from Normal Sampling Procedures or Operating Conditions

The compliance tests for all pollutants were performed in accordance with the Test Protocol dated April 24, 2014; and the specified USEPA test methods.

Instrument calibrations and sampling period results satisfied the quality assurance verifications required by USEPA Methods 3A, 7E, and 10. No variations from the normal operating conditions of the IC engines occurred during the testing program.

4.3 Operating Conditions during Compliance Tests

During the emission testing, the natural gas-fueled IC engines were operated at the maximum conditions (maximum fuel use and horsepower output) allowed by the process, which is dependent on facility and gas well conditions. Facility operators recorded the engine speed (RPM) and the fuel use rate (Mscf/day) throughout each one-hour test period.

Based on data provided by the facility operators, Engine #1 operated at an average engine speed of 1,153 rpm's during the test periods and consumed an average of 154.1 Mscf/d of treated gas. Engine #2 operated at an average engine speed of 1,186 rpm's during the test periods and consumed an average of 161.6 Mscf/d of treated gas. Engine #3 operated at an average engine speed of 1,162 rpm's during the test periods and consumed an average of 144.4 Mscf/d of treated gas.

4.4 Air Pollutant Sampling Results

The IC engine emission measurements were performed on June 10 and 11, 2014. The average measured exhaust gas volumetric flow rate for Engine No. 1 (EUENGINE1, #1185) was 1,585 dry standard cubic feet per minute (dscfm) and contained 225 parts per million by volume (ppmvd) NOx and 384 ppmvd CO. The average measured NOx and CO emission rates are equivalent to 399 pounds per million standard cubic feet (lb/MMscf) and 414 lb/MMscf, respectively.

Table 1 presents measured exhaust gas conditions and calculated air pollutant emission rates for Engine No. 1.

The average measured exhaust gas volumetric flow rate for Engine No. 2 (EUENGINE2, #1106) was 1,592 dscfm and contained 405 ppmvd NOx and 486 ppmvd CO. The average measured NOx and CO emission rates are equivalent to 687 lb/MMscf and 502 lb/MMscf, respectively.

Table 2 presents measured exhaust gas conditions and calculated air pollutant emission rates for Engine No. 2.

The average measured exhaust gas volumetric flow rate for Engine No. 3 (EUENGNE3, #1107) was 1,327 dscfm and contained 439 ppmvd NOx and 666 ppmvd CO. The average measured NOx and CO emission rates are equivalent to 694 lb/MMscf and 641 lb/MMscf, respectively.

Table 3 presents measured exhaust gas conditions and calculated air pollutant emission rates for Engine No. 3.

Appendix B provides computer calculated and field data sheets for the IC engine tests periods.

Appendix C provides raw instrumental analyzer response data for each test period.

5.0 SAMPLING AND ANALYTICAL PROCEDURES

A test protocol for the compliance testing was prepared by Derenzo and Associates and reviewed, and approved by the MDEQ. This section provides a summary of the sampling and analytical procedures that were used during the tests and presented in the test plan.

Appendix D presents sample procedures and diagrams for the USEPA sampling methods.

5.1 Exhaust Gas Velocity and Flowrate Determination (USEPA Method 2)

The IC engine exhaust stack gas velocity was determined using USEPA Method 2 prior to and following each 60-minute sampling period. An S-type Pitot tube connected to a red-oil manometer was used to determine velocity pressure. Gas temperature was measured using a K-type thermocouple mounted to the Pitot tube. The Pitot tube and connective tubing were leak-checked to verify the integrity of the measurement system.

The absence of cyclonic flow for each sampling location was verified using an S-type Pitot tube and oil manometer. The Pitot tube was positioned at all of the velocity traverse points with the planes of the face openings of the Pitot tube perpendicular to the stack cross-sectional plane. The Pitot tube was then rotated to determine the null angle (rotational angle as measured from the perpendicular, or reference, position at which the differential pressure is equal to zero).
The calculated pre-test and post-test volumetric flowrate values were averaged and used for calculating the mass emission rate for each pollutant for that test period.

5.2 Exhaust Gas Molecular Weight Determination (USEPA Method 3A)

CO_2 and O_2 content in the IC engine exhaust gas stream was measured continuously throughout each one-hour test period in accordance with USEPA Method 3A. The CO_2 content of the exhaust was monitored using a non-dispersive infrared (NDIR) gas analyzer. The O_2 content of the exhaust was monitored using a gas analyzer that utilizes a Paramagnetic sensor.

During each one-hour sampling period, a continuous sample of the IC engine exhaust gas stream was extracted from the stack using a stainless steel probe connected to a Teflon® heated sample line. The sampled gas was conditioned by removing moisture prior to being introduced to the analyzer. Therefore, measurement of O_2 and CO_2 concentrations correspond to standard dry gas conditions. The instrument was calibrated using appropriate calibration gases to determine accuracy and system bias (described in Section 6.4 of this document).

Figure 3 presents a diagram of the instrument analyzer train.

Appendix D presents detailed gas sampling procedures for the USEPA sampling trains.

5.3 Exhaust Gas Moisture Content Determinations (Method 4)

Moisture content of the IC engine exhaust gas was determined in accordance with USEPA Method 4 using a chilled impinger sampling train, which was performed concurrently with the instrumental analyzer sampling methodologies. A non-heated probe was used for the moisture determinations as the engine exhaust temperature was approximately 700°F. During each sampling period, a gas sample was extracted at a predetermined rate from the source where moisture was removed from the sampled gas stream using impingers that were submersed in an ice bath. At the conclusion of each sampling period, the moisture gain in the impingers was determined gravimetrically by weighing each impinger to determine net weight gain. Gas moisture content was calculated based on the net water gain in the impinger train and the amount of dry gas metered through the sampling train.

Figure 4 presents a diagram of the moisture sampling train.

Appendix D presents detailed gas sampling procedures for the USEPA moisture sampling train.

5.4 NOx and CO Concentration Measurements (USEPA Methods 7E and 10)

NOx and CO pollutant concentrations in the exhaust of the IC engine were determined using a chemiluminescence NOx analyzer and non-dispersive infrared (NDIR) CO analyzer. Three (3) one-hour sampling periods were performed for the IC engine exhaust testing. Throughout each one-hour test period, a continuous sample of the engine exhaust gas was extracted from the stack using the Teflon® heated sample line and gas conditioning system described in Section 5.2 of this document, and delivered to the instrumental analyzers. Instrument response for each analyzer was recorded on a data logging system that monitored the analog output of the instrumental analyzers continuously and logged data as one-minute averages. Prior to, and at the conclusion of each test, the instruments were calibrated using appropriate upscale calibration and zero gas to determine analyzer calibration error and system bias. Sampling times were recorded on field data sheets.

Appendix B presents the computer calculated and field data sheets from the testing program.

6.0 <u>INTERNAL QA/QC ACTIVITIES</u>

6.1 NOx Converter Efficiency Test

The NO_2 – NO conversion efficiency of the TEI Model 42C instrumental analyzer was verified prior to the commencement of the performance tests. The instrument analyzer NO_2 – NO converter uses a catalyst at high temperatures to convert the NO_2 to NO for measurement. A USEPA Protocol 1 certified NO_2 calibration gas was used to verify the efficiency of the NO_2 – NO converter.

The NO_2 – NO conversion efficiency test satisfied the USEPA Method 7E criteria (the calculated NO_2 – NO conversion efficiency is greater than or equal to 90%).

6.2 Sampling System Response Time Determination

The response time of the sampling system was determined prior to the compliance test program by introducing upscale gas and zero gas, in series, into the sampling system using a tee connection at the base of the sample probe. The elapsed time for the analyzer to display a reading of 95% of the expected concentration was determined using a stopwatch.

Sampling periods did not commence until the sampling probe had been in place for at least twice the system response time.

6.3 Instrumental Analyzer Interference Check

The instrumental analyzers used to measure NOx, CO, O_2, and CO_2 have had an interference response test performed prior to their use in the field, pursuant to the interference response test procedures specified in USEPA Method 7E. The appropriate interference test gases (i.e. gases that would be encountered in the exhaust gas stream) were introduced into each analyzer, separately and as a mixture with the analyte that each analyzer is designed to measure. All of analyzers exhibited a composite deviation of less than 3.0% of the span for all measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

6.4 Instrument Calibration and System Bias Checks

At the beginning of the test day, initial three-point instrument calibrations were performed by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were preformed prior to and at the conclusion of each sampling period by introducing the appropriate upscale calibration gas and zero gas into the sampling system (at the base of the stainless steel sampling probe prior to the particulate filter and Teflon® heated sample line) and verifying the instrument response against the initial instrument calibration readings. If the drift error is within 3% of the span over the period of the test run, the test run is considered acceptable.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO_2, O_2, NOx, CO, and zeroed using pure nitrogen or hydrocarbon free air.

A ten-step gas dilution module (STEC Model SGD-710C) was used to provide intermediate calibration gas concentrations as needed. The ten-step gas divider was NIST certified within the previous year with a primary flow standard in accordance with Method 205. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of gas divider. The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

6.5 Meter Box Calibrations

The dry gas meter sampling console used for moisture testing was calibrated prior to and after the testing program. This calibration uses the critical orifice calibration technique presented in USEPA Method 5. The metering consol calibration exhibited no data outside the acceptable ranges presented in USEPA Method 5.

Appendix E presents test equipment quality assurance data (NO_2 – NO conversion efficiency test data, instrument calibration and system bias check records, calibration gas certifications, interference test results, meter box calibration records, and pitot tube calibration records).

Table 1. Summary of Engine No. 1 (1185) Test Results (CAT G3516 LE)
Breitburn - Elmer Fudd

Test No.	1	2	3	
Test date	06/11/14	06/11/14	06/11/14	Test
Test period (24-hr clock)	14:33-15:33	16:06-17:06	17:35-18:35	Avg.
Exhaust gas composition				
CO_2 content (% vol)	9.00	9.10	9.06	9.05
O_2 content (% vol)	7.67	7.66	7.68	7.67
Moisture (% vol)	12.9	13.2	13.3	13.1
Exhaust gas flowrate				
Standard conditions (scfm)	1,822	1,852	1,801	1,825
Dry basis (dscfm)	1,587	1,607	1,561	1,585
Nitrogen oxides emission rates				
NO_X conc. (ppmvd)*	222.15	229.63	223.87	225.22
NO_X emissions (lb/hr)	2.53	2.65	2.51	2.56
NO_X emissions (ton/yr)	11.07	11.59	10.97	11.21
NO_X permit limit (ton/yr)				*45.30*
NO_X emissions (lb/MMscf)	392.95	400.93	402.54	398.81
Carbon monoxide emission rates				
CO conc. (ppmvd)*	383.60	385.64	382.81	384.01
CO emissions (lb/hr)	2.66	2.70	2.61	2.66
CO emissions (ton/yr)	11.64	11.85	11.42	11.64
CO permit limit (ton/yr)				*32.80*
CO emissions (lb/MMscf)	413.13	409.95	419.07	414.05

* Corrected for calibration bias.

Table 2. Summary of Engine No. 2 (1106) Test Results (CAT G3516 LE)
Breitburn - Elmer Fudd

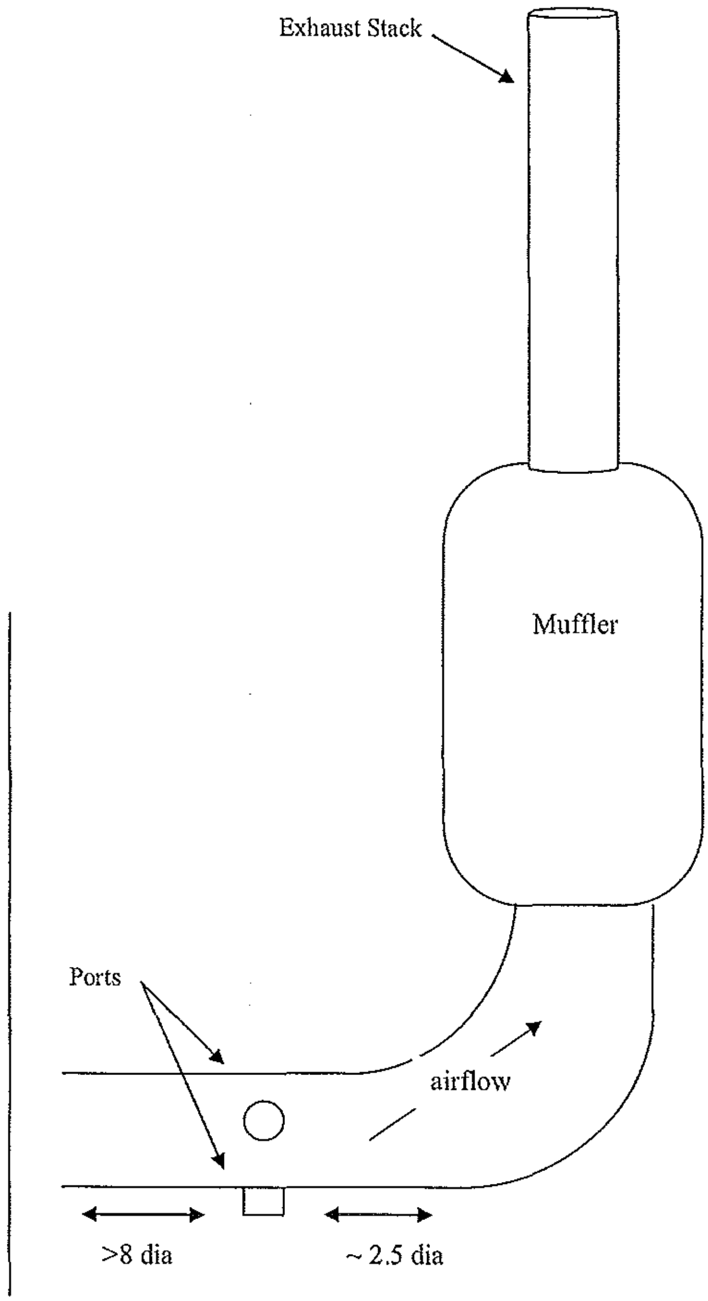
Test No.	1	2	3	
Test date	06/11/14	06/11/14	06/11/14	Test
Test period (24-hr clock)	9:28-10:28	10:58-11:58	12:24-13:24	Avg.
Exhaust gas composition				
CO_2 content (% vol)	8.51	8.45	8.48	8.48
O_2 content (% vol)	8.50	8.58	8.60	8.56
Moisture (% vol)	12.4	13.5	15.2	13.7
Exhaust gas flowrate				
Standard conditions (scfm)	1,802	1,831	1,895	1,843
Dry basis (dscfm)	1,588	1,582	1,607	1,592
Nitrogen oxides emission rates				
NO_X conc. (ppmvd)*	419.00	400.53	396.20	405.25
NO_X emissions (lb/hr)	4.77	4.54	4.56	4.63
NO_X emissions (ton/yr)	20.89	19.90	19.99	20.26
NO_X permit limit (ton/yr)				*45.30*
NO_X emissions (lb/MMscf)	709.43	673.12	678.77	687.11
Carbon monoxide emission rates				
CO conc. (ppmvd)*	493.78	481.39	483.52	486.23
CO emissions (lb/hr)	3.42	3.32	3.39	3.38
CO emissions (ton/yr)	14.99	14.56	14.85	14.80
CO permit limit (ton/yr)				*32.80*
CO emissions (lb/MMscf)	509.02	492.56	504.34	501.98

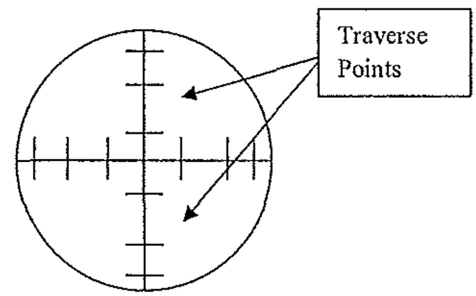
* Corrected for calibration bias.

Table 3. Summary of Engine No. 3 (1107) Test Results (CAT G3516 LE)
Breitburn - Elmer Fudd

Test No.	1	2	3	
Test date	06/10/14	06/10/14	06/10/14	Test
Test period (24-hr clock)	9:45-10:45	19:17-20:16	20:48-21:48	Avg.
Exhaust gas composition				
CO_2 content (% vol)	7.59	8.90	8.89	8.46
O_2 content (% vol)	8.80	7.95	7.92	8.22
Moisture (% vol)	12.4	12.4	12.5	12.4
Exhaust gas flowrate				
Standard conditions (scfm)	1,503	1,517	1,525	1,515
Dry basis (dscfm)	1,317	1,329	1,335	1,327
Nitrogen oxides emission rates				
NO_X conc. (ppmvd)*	435.35	478.47	402.44	438.75
NO_X emissions (lb/hr)	4.11	4.56	3.85	4.17
NO_X emissions (ton/yr)	18.00	19.97	16.87	18.28
NO_X permit limit (ton/yr)				*45.30*
NO_X emissions (lb/MMscf)	684.88	767.28	630.67	694.28
Carbon monoxide emission rates				
CO conc. (ppmvd)*	675.08	670.23	653.45	666.25
CO emissions (lb/hr)	3.88	3.89	3.81	3.86
CO emissions (ton/yr)	16.99	17.02	16.67	16.90
CO permit limit (ton/yr)				*32.80*
CO emissions (lb/MMscf)	646.61	654.38	623.48	641.49

* Corrected for calibration bias.





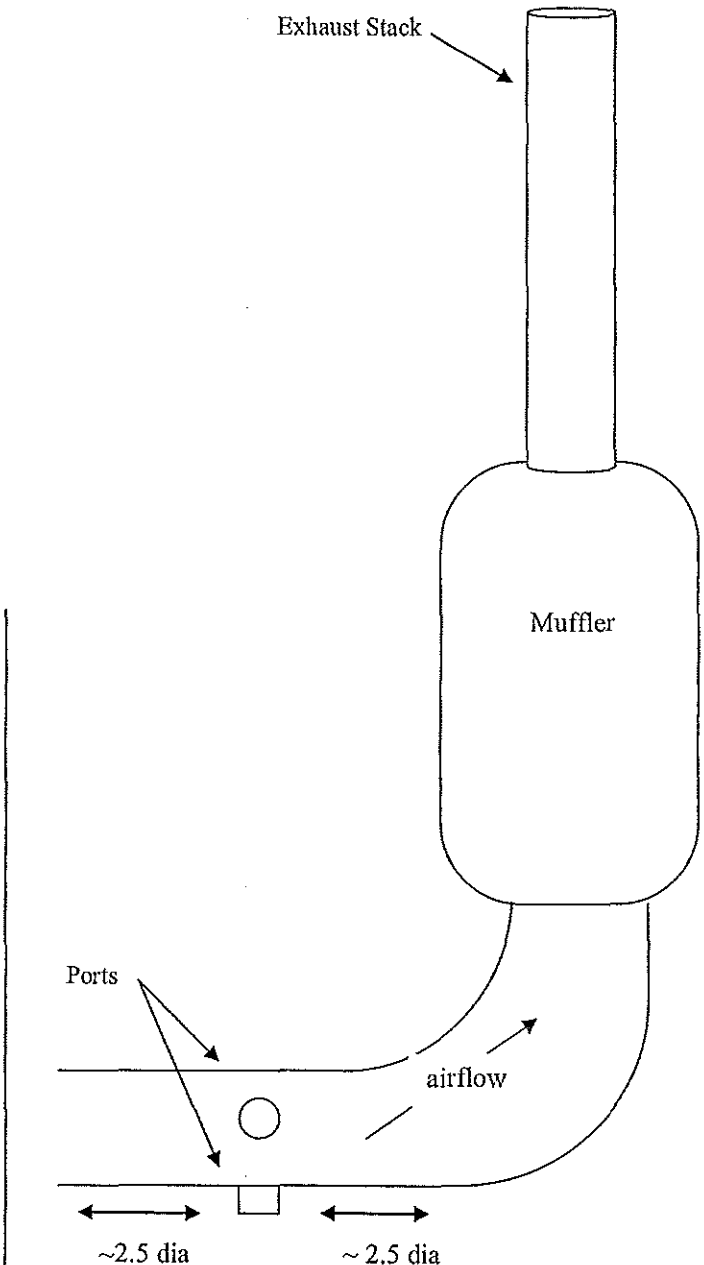
Diameter = 12.5"

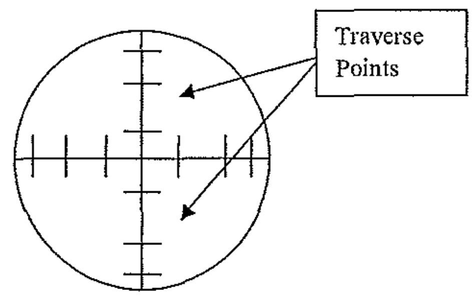
Sampling Point	Distance from stack wall
1	0.55
2	1.83
3	3.70
4	8.80
5	10.68
6	11.95

Diagram not to scale

All measurements were verified prior to testing

Sampling and measurement locations for the internal combustion engines (#1 & #2) emissions testing program at the BreitBurn Elmer Fudd East Central facility in Oscoda County, Michigan.	Scheduled Sampling Date(s): June 10 - 11, 2014
	Derenzo and Associates, Inc.





Diameter = 12.5"

Sampling Point	Distance from stack wall
1	0.50
2	1.31
3	2.43
4	4.04
5	8.46
6	10.08
7	11.19
8	12.00

Diagram not to scale

All measurements were verified prior to testing

Sampling and measurement locations for the internal combustion engines (#3) emissions testing program at the BreitBurn Elmer Fudd East Central facility in Oscoda County, Michigan.	Scheduled Sampling Date(s): June 10 - 11, 2014
	Derenzo and Associates, Inc.

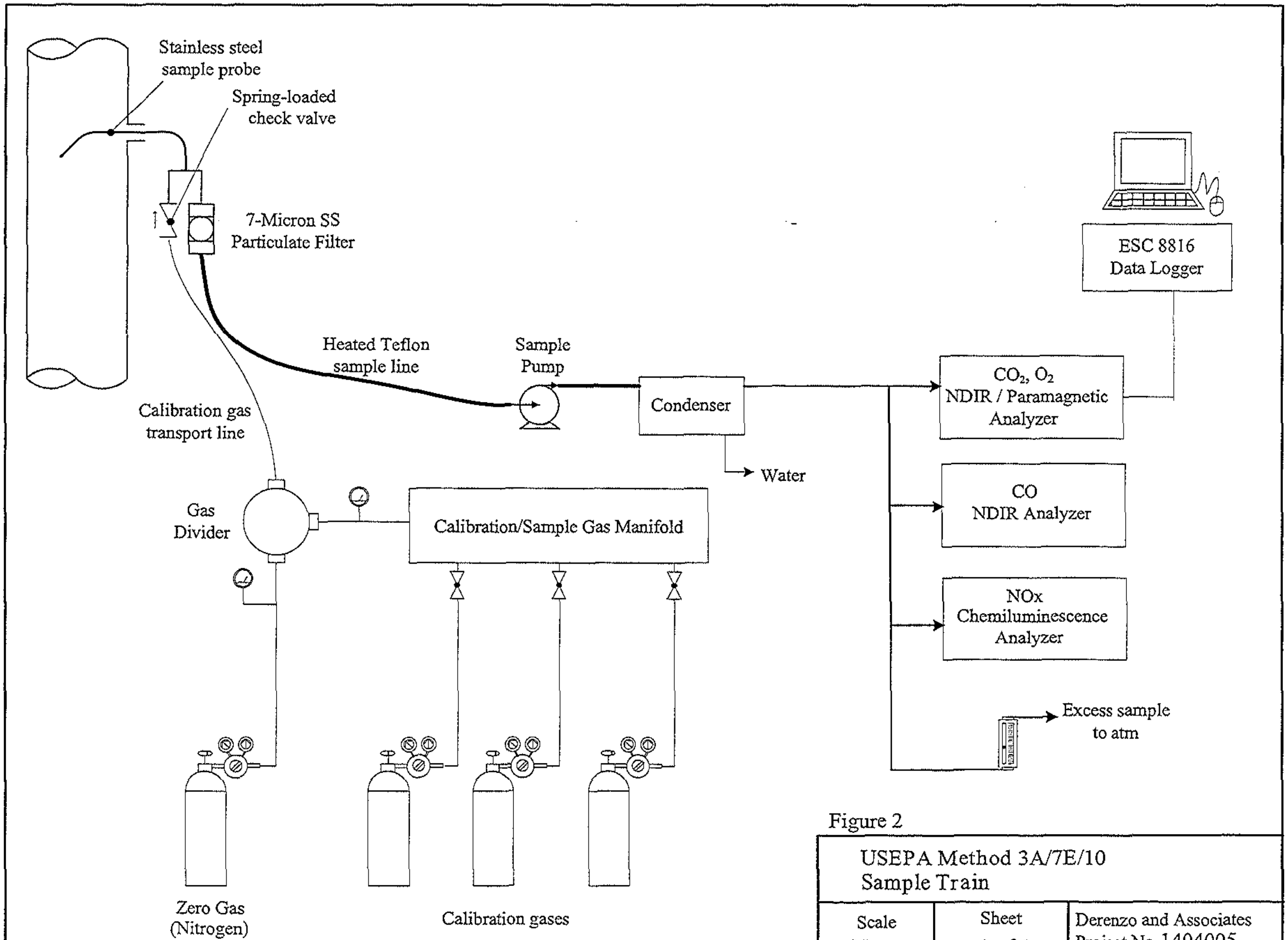


Figure 2

USEPA Method 3A/7E/10 Sample Train		
Scale None	Sheet 1 of 1	Derenzo and Associates Project No. 1404005

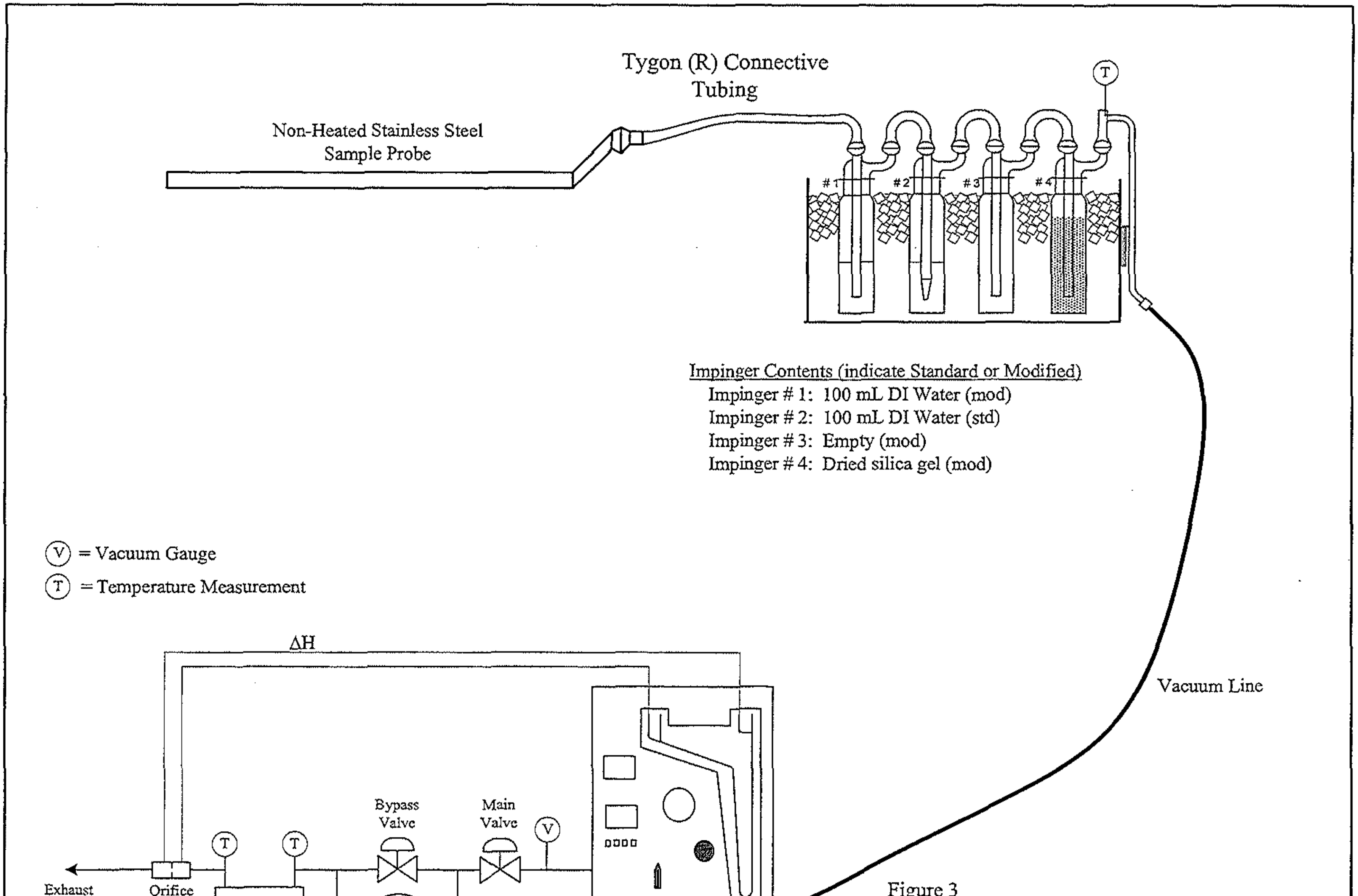


Figure 3

USEPA Method 4 Sample Train		
Scale None	Sheet 1 of 1	Derenzo and Associates Project No. 1404005