

October 12, 2017



BHP Billiton Petroleum
1500 Post Oak Blvd.
Houston, Texas 77056
bhpbilliton.com

Mr. Kelly Ruble
Air Section Manager, Region 14
Texas Commission on Environmental Quality
NRC Bldg, Ste 1200
6300 Ocean Dr, Unit 5839
Corpus Christi, Texas 78412-5839

Re: 40 CFR 60 Subpart JJJJ - Notification of Compliance Status
BHP Billiton Petroleum (Eagle Ford Gathering) LLC, 1500 Post Oak Blvd,
Houston, TX 77056
Black Hawk Central Gas Treating Facility
Standard Permit Registration Number: 99822
Regulated Entity Number: RN106001126
Customer Reference Number: CN603964339

Dear Mr. Ruble:

As required by 40 CFR 60.4243(b)(2)(ii), BHP Billiton Petroleum (Eagle Ford Gathering) LLC, conducted performance testing on the below Black Hawk Central Gas Treating Facility engine on Tuesday, August 22, 2017 in DeWitt County.

EPN	Internal Identifier	Make and Model	Type	Serial Number	HP Rating	Fuel	Control
C2	K-201	Waukesha L-7044 GSI ESM	4SRB	5283700882	1680	Field Gas	AFRC and Catalyst

Performance test results are provided as Attachment A to this cover letter as required by 40 CFR 60.4245(d) within the 60-day submittal time requirement. Should you have any questions, please contact me directly by phone at (361) 274-3145 or by email at [REDACTED]

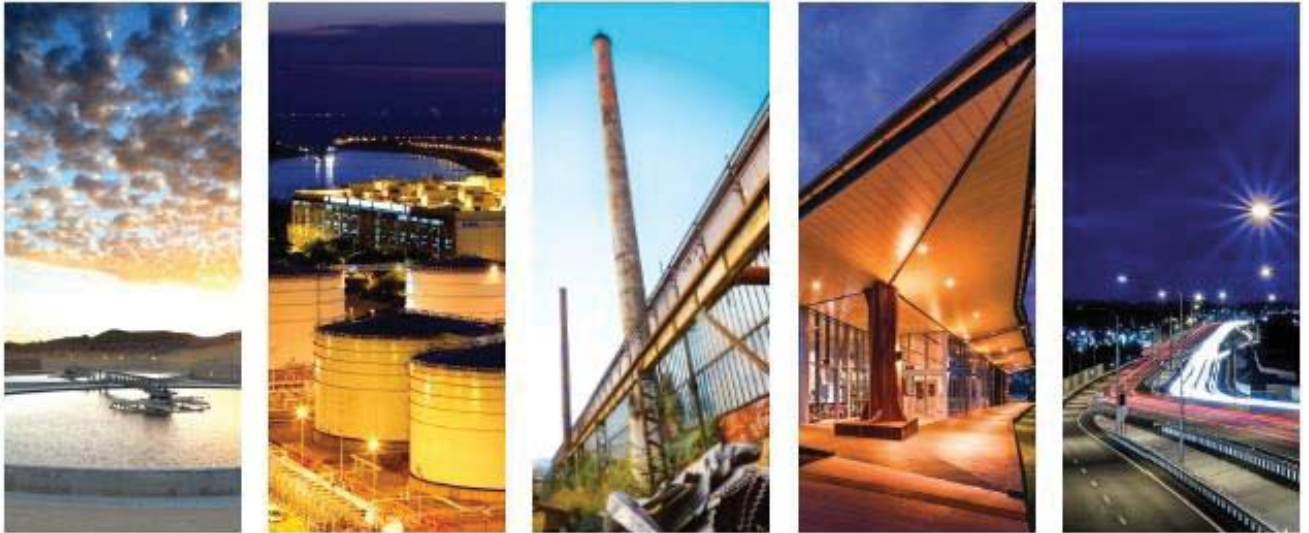
Sincerely,

A handwritten signature in black ink that reads "Leigh Barr".

Leigh Barr
Principal Environmental Specialist
BHP Billiton Petroleum

Attachment A

Emission Test Report



Emission Test Report Compressor Engine Testing

40 CFR Part 60 Subpart JJJJ
30 TAC §106.512
Waukesha K-201 L-7044 GSI ESM,
SN: 5283700882
EPN: C2
Black Hawk Central Gas Treating Facility
DeWitt County, Texas
Test Date: 8/22/2017

BHP Billiton
Houston, TX 77056

GHD
1755 Wittington Place, Suite 500
Dallas, Texas 75234

October 2017 • 11114838 • Report No. 43

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Section 1.0 Test Results Summary

BHP Billiton (BHP) contracted GHD Services, Inc. (GHD), to conduct compliance emission testing on a compressor engine at the Black Hawk Central Gas Treating Facility, DeWitt County, Texas. The purpose of this test program was to demonstrate compliance with emission limits contained in the United States Code of Federal Regulations, Title 40, Part 60, Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines and Texas Administrative Code, Title 30, Part 1, Chapter 106, Subchapter W, Rule §106.512. Three 60-minute test runs were performed at the highest achievable load conditions. The testing was completed on Tuesday, August 22, 2017. There were no issues or problems encountered during the testing. The results are summarized and compared to the regulation limits in Table 1.1 and in the following table. Engine parameters are summarized in Table 1.2.

Test Information:

Test Location: Black Hawk Central Gas Treating Facility

Source: Gas Compressor Engine

Unit: K-201

Serial Number: 5283700882

Rated Horsepower: 1680

Engine Controls: AFRC and Catalyst

Test Date: Tuesday, August 22, 2017

Test Results:

<i>Parameter</i>	<i>Average Result (g/hp-hr)</i>	<i>Permit Limit (g/hp-hr)</i>	<i>Average Result (ppmvd @ 15%O₂)</i>	<i>Regulation Limit (ppmvd @ 15%O₂)</i>
NO _x	0.009	0.274	0.539	82.00
CO	0.022	0.254	2.089	270.00
VOC	0.021	0.128	1.285	60.00

1.1 Certification

We certify that to the best of our knowledge that the source test report has been checked for completeness, and that the results presented are accurate, error-free, and representative of the actual emissions measured during testing.

Signed for:



Michael J. Tahirak
GHD Services, Inc.

1.2 Test Program Personnel

The GHD Project Manager is:

Michael J. Tahirak
GHD Services, Inc.
1755 Wittington Place, Suite 500,
Dallas, Texas 75234
972-331-8500

The GHD Site Supervisor is:

Michael Tahirak
GHD Services, Inc.
1755 Wittington Place, Suite 500,
Dallas, Texas 75234
972-331-8500

Michael Tahirak's CV is included in Appendix C.

The BHP Billiton contact is:

Leigh Barr
BHP Billiton
1714 West Schmidt Drive
Pecos, TX 79772
361-274-3145

Section 2.0 Sampling Procedures and Equipment

A continuous sample was extracted from the source and analyzed for oxides of nitrogen (NO_x), carbon monoxide (CO), volatile organic compounds (VOC), moisture, and oxygen (O₂). This test program was conducted in accordance with the reference methods (RMs) described in the United States Code of Federal Regulations, Title 40 Part 60 (40 CFR 60) Appendix A and the American Society for Testing and Materials (ASTM) Method D6348-12. The most current revisions of the reference methods were obtained from the United States Environmental Protection Agency (USEPA) Emission Measurement Center (EMC) website (www.epa.gov/ttn/emc) and the testing methods were obtained from the American Society for Testing and Materials (ASTM). A table of equipment and calibration gases used can be found in Table 2.1. The TCEQ Central Office has

provided a confirmation correspondence approving the use of the ASTM Method D6348-12 as a valid methodology for testing NO_x and CO for engines permitted under 30 TAC §106.512.

A GHD climate controlled, mobile sampling truck was brought onsite for the testing. A continuous sample of the effluent exhaust was extracted from the source via a stainless steel probe equipped with an in-stack sintered filter. The gas sample was transported via heated Teflon™ line to the MKS Multigas 2030 Fourier Transformation Infrared (FTIR) analyzer to determine the concentrations of CO, NO_x, moisture and VOC. A schematic of the FTIR sampling system used during the test is presented in Figure 1.1.

2.1 Oxygen Measurement

A slip stream of the exhaust gas was directed into the BrandGaus wet oxygen analyzer and the concentration was determined instrumentally by EPA Reference Method (RM) 3A. Data was recorded on a data acquisition system (DAS) at 1 minute intervals. O₂ concentration data was used to correct CO, NO_x and non-methane VOC concentrations to 15 percent O₂. Field data sheets can be found in Appendix A.

2.2 Exhaust Flow Rate Measurement

Exhaust volumetric flow rate was determined for the test runs on a dry basis by using RM 2, in accordance with 40 CFR Part 60 Subpart JJJJ.

For RM 2, the gas velocity was determined from the average velocity head with a type-S pitot tube, gas density, stack temperature, and stack pressure. The average velocity head was determined using an inclined manometer and a type-S pitot tube with a known coefficient of 0.84, or a standard pitot tube with a known coefficient of 0.99 that is determined geometrically by standards set forth in RM 2. Stack temperature was taken at each traverse point using a type-K thermocouple. Static pressure was determined using a straight tap and an inclined manometer.

Fuel usage of the engine tested is determined through the use of engine manufacturer specifications.

Section 3.0 Quality Assurance and Quality Control (QA/QC)

Calibration of GHD's emissions monitoring system was performed in accordance with RM 3A, and ASTM D6348-12. All calibrations were within specified limits. Calibration results are included in Table 3.1 and Table 3.2. Field data sheets used for calibration are included in Appendix A. Calibration Gas Certification sheets for all gases used are included in Appendix B.

For RM 3A, linearity and calibration error (CE) determinations were performed prior to each engine test. The purpose of this procedure was to establish an initial calibration curve and to assure that each calibration point was accurate to within 2 percent of the analyzer span value. This was accomplished by first introducing the zero calibration gas and adjusting the instrument to read zero. Next, the span gas was introduced and the analyzer's response was adjusted to match this calibration gas certified concentration. Following the zero and span adjustment, the low, mid and high-level calibration gases were injected, and the responses were recorded to verify instrument linearity.

A system bias check was performed after the linearity and CE determinations. For the system bias check, the calibration gases were introduced to the sample probe prior to the filter. The gases were transported to the analyzers in the same manner as the source sample gas. The system responses were recorded and compared to the CE values. In the event that the two measurements differ by 5 percent or more, the sources of bias are identified and eliminated before repeating the bias check. The system bias check data are presented with the field calculations in Appendix A.

A drift check was performed immediately after each test run following procedures outlined in RM 7E. Zero gas was introduced into the system and the monitor's response recorded. This procedure was repeated for the upscale calibration gas. The system bias was determined and may not drift from the previous run system bias by more than 3 percent.

The RM 3A QA/QC data is included in Table 3.1.

The FTIR QA/QC procedure consists of daily checks of the instrument half height peak widths, laser frequency and instrument monitor.

For ASTM D6348-12, a calibration transfer standard (CTS), 100 ppm ethylene standard, was analyzed daily before and after testing. The concentrations determined for all CTS were within plus/minus 5 percent of the certified value of the standard. The ethylene was passed through the entire system (system purge) to verify the sampling system response and to ensure the sampling system was leak-free from the sampling location to the FTIR. Nitrogen was also purged through the sampling system to confirm the system was free of contaminants.

Analyte dynamic spiking was performed before each test series to verify the ability of the sampling system to quantitatively deliver a sample from the base of the probe to the FTIR, and to confirm the ability of the FTIR to quantify each spike in the presence of effluent gas. Analyte spiking consisted of CO, NO, and propane (surrogate for VOC). The spiking gases contained a low concentration of sulfur hexafluoride (SF₆). The determined SF₆ concentration in the spiked sample was used to calculate the dilution factor of the spike and thus used to calculate the

concentration of the spiked gases. The dilution factor for all analyte spikes was less than 1:10. All spike recoveries were within the ASTM D6348-12 allowance of plus/minus 30 percent.

The QA/QC data for ASTM D6348-12 is included in Table 3.2.

The QA/QC procedure for data reduction includes using computer spreadsheet programs to generate tables of results. Data input files and equations are double-checked by a second person and tables are checked for transposition errors with spot calculations being performed by hand.

Tables

Table 1.1

Engine Results
BHP Billiton Company
Black Hawk Central Gas Treating Facility
Engine ID 5283700882
August 22, 2017

Results

Run Number	NOx		CO		VOC	
	Engine (ppmvd@15% O2)	Limit	Engine (ppmvd@15% O2)	Limit	Engine (ppmvd@15% O2)	Limit
1	0.633		4.853		1.461	
2	0.214		0.849		1.185	
3	0.771		0.565		1.208	
Average	0.539	82.00	2.089	270.00	1.285	60.00

Run Number	NOx		CO		VOC	
	Engine (g/hp-hr)	Limit	Engine (g/hp-hr)	Limit	Engine (g/hp-hr)	Limit
1	0.011		0.051		0.024	
2	0.004		0.009		0.019	
3	0.013		0.006		0.020	
Average	0.009	0.274	0.022	0.254	0.021	0.128

NOTE: Limits in ppmvd @15% O2 shown above are representative of the applicable 40 CFR Part 60 Subpart JJJJ limits. Limits in g/hp-hr shown above are representative of the engine's permitted limits under its Permit to Operate.

Table 1.2

Engine Parameters During Testing
BHP Billiton Company
Black Hawk Central Gas Treating Facility
Engine ID 5283700882
August 22, 2017

<i>Engine Parameters</i>						
<i>Run Number</i>	<i>Suction Pressure (psi)</i>	<i>Discharge Pressure (psi)</i>	<i>Engine Speed (RPM)</i>	<i>Engine Load (%)</i>	<i>Engine Run Time Hours (hrs)</i>	<i>Engine Horsepower (hp)</i>
1	576	1075	1160	92%	46742	1545
2	580	1075	1168	93%	46743	1562
3	581	1070	1163	92%	46744	1545
Average	579	1073	1164	92%		1551

<i>Run Number</i>	<i>Manifold Pressure (psi)</i>	<i>Manifold Temperature (deg F)</i>	<i>Ambient Temperature (deg F)</i>	<i>Barometric Pressure (in. Hg)</i>
1	38.0	123	85	30.05
2	38.0	124	91	30.06
3	38.0	129	93	30.06
Average	38.0	125	90	30.06

The engine load was determined by the following formula: $((\text{current HP}) / (\text{rated HP}) \times 100)$.

Table 2.1

**Equipment Data
BHP Billiton Company
Black Hawk Central Gas Treating Facility
Engine ID 5283700882
August 22, 2017**

<i>Parameter</i>	<i>Instrument ID</i>	<i>Calibration Gas Used</i>
O ₂	Brand Gaus Wet O2 Analyzer	19.96% and 11.9 % O2
NOx	MKS Multigas 2030	3000 ppm NO
CO	MKS Multigas 2030	3000 ppm CO
Ethylene	MKS Multigas 2030	100 ppm Ethylene
Total VOC	MKS Multigas 2030	1000 ppm Propane

Table 3.1

**Instrument Calibration
BHP Billiton Company
Black Hawk Central Gas Treating Facility
Engine ID 5283700882
August 22, 2017**

ACE Limit	< 2% Span
System Bias Limit	< 5% Span
Drift Limit	< 3% Span

Analyzer Calibration

3A/O2

Analyzer Calibration Error Zero	0.20%
Analyzer Calibration Error Mid	1.60%
Analyzer Calibration Error High	1.85%
System Bias Zero	0.05%
System Bias Mid	0.05%
System Bias High	0.75%

Calibration Drift/BiasCheck

Run 1

Zero Drift	-0.05%
Zero Bias	0.00%
Span Drift	0.95%
Span Bias	1.00%

Run 2

Zero Drift	0.00%
Zero Bias	0.00%
Span Drift	-0.10%
Span Bias	0.90%

Run 3

Zero Drift	0.00%
Zero Bias	0.00%
Span Drift	-0.05%
Span Bias	0.85%

Table 3.2

FTIR Calibrations
BHP Billiton Company
Black Hawk Central Gas Treating Facility
Engine ID 5283700882
August 22, 2017

Pre-Test FTIR Calibration - Direct			
	Cylinder Value (ppm)	FTIR Response (ppm)	Difference (%)
Ethylene Zero	0.00	0.10	n/a
NO Zero	0.00	-0.10	n/a
CO Zero	0.00	-0.20	n/a
Propane Zero	0.00	0.23	n/a
Ethylene High	100.00	99.04	0.96%
NO High	3000.00	2962.00	1.27%
CO High	3000.00	2938.00	2.07%
Propane High	1000.00	990.00	1.00%

Pre-Test FTIR Calibration - System			
	Direct FTIR Response	System FTIR Response	Difference (%)
Ethylene Zero	0.10	-0.20	n/a
NO Zero	-0.10	1.00	n/a
CO Zero	-0.20	1.30	n/a
Propane Zero	0.23	-0.60	n/a
Ethylene High	99.04	98.63	0.41%
NO High	2962.00	2905.00	1.92%
CO High	2938.00	2895.00	1.46%
Propane High	990.00	1023.00	3.33%

FTIR Response Time	
Response Time (seconds)	
High Ethylene	30
Zero Ethylene	30

Table 3.2

**FTIR Calibrations
BHP Billiton Company
Black Hawk Central Gas Treating Facility
Engine ID 5283700882
August 22, 2017**

FTIR Pre-Test Analyte Dynamic Spiking	
Pre Test Spike	
Concentration of CO Cylinder	3000.00
Concentration of NO Cylinder	3000.00
Concentration of Propane Cylinder	1000.00
Concentration of SF ₆ Cylinder	10.20
Stack CO Concentration	224.00
Stack NO Concentration	5.30
Stack Propane Concentration	1.70
Stack SF ₆ Concentration	0.00
Stack + Spike CO Concentration	651.00
Stack + NO Concentration	429.00
Stack + Propane Concentration	225.00
Stack + SF ₆ Concentration	1.80
Spike Dilution from SF ₆	0.176
Percent Recovery CO	88.12%
Percent Recovery NO	80.21%
Percent Recovery Propane	126.71%

Post-Test FTIR Calibration - Direct			
	Cylinder Value (ppm)	FTIR Response	Difference (%)
Ethylene Zero	0	0.17	n/a
NO Zero	0	-1.00	n/a
CO Zero	0	1.70	n/a
Ethylene High	100	99.16	0.84%
NO High	3000	2930.00	2.33%
CO High	3000	2899.00	3.37%
Propane High	1000	1003.00	0.30%

Figures

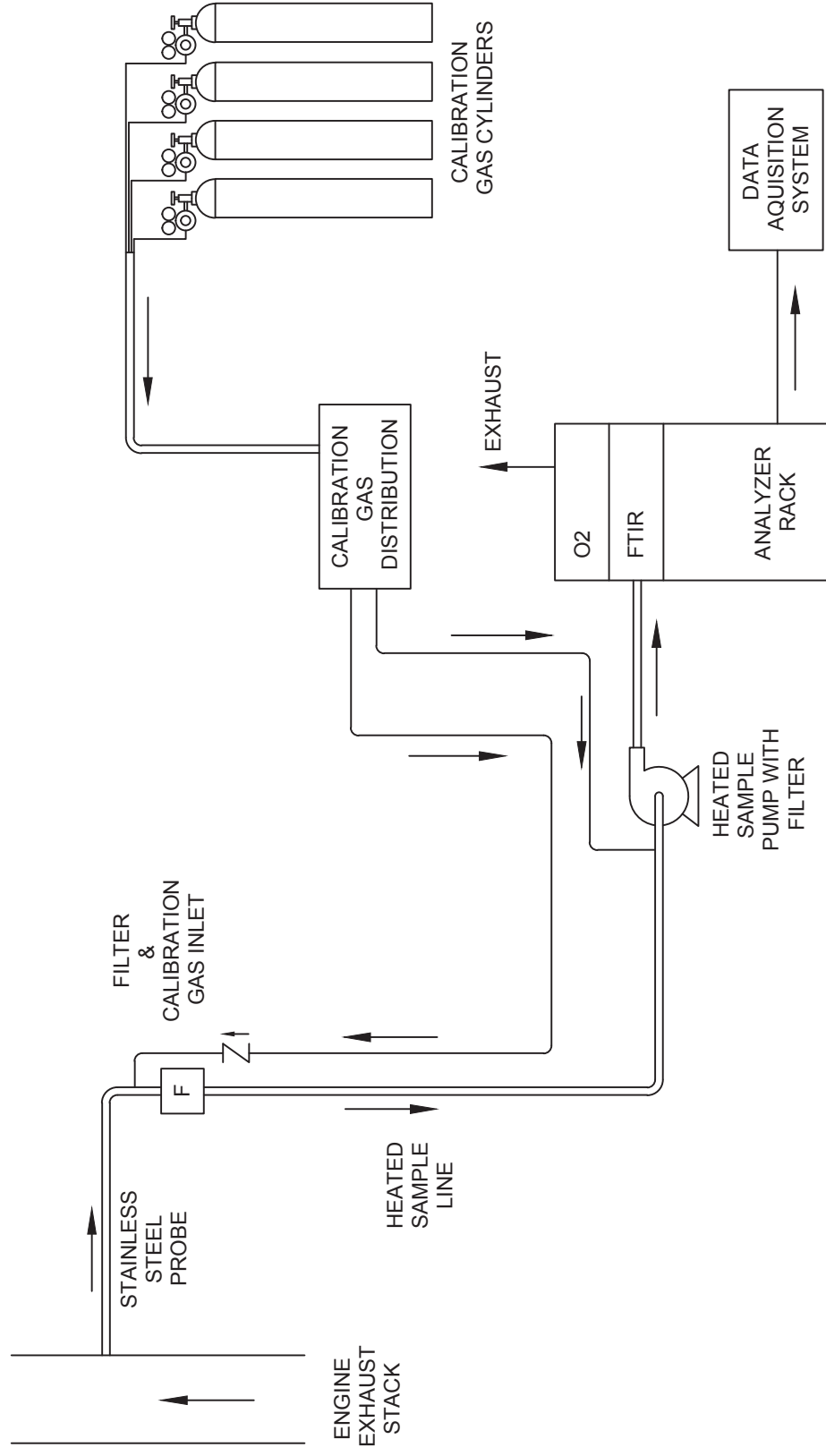


figure 1.1

GHD FTIR SAMPLING SYSTEM DIAGRAM VOC, O₂, NO_x, CO INSTRUMENT ANALYZER SAMPLING TRAIN

Appendix A

Field Data and Calculations Sheets

Client: BHP Billiton

Project #: 11114838

County: DeWitt County

Operator: Michael Tahirak

Site: Black Hawk Central Gas Treating Facility

Source: Waukesha L-7044 GSI ESM

Date: 8/22/2017

Time: 9:20 AM

Method / Gas		3A / O2	3A / O2
Analyzer Info			
Make	Wet O2	Wet O2	Wet O2
ID	EB0078973.20160314	EB0041551.20151012	
Span ¹	19.96	19.96	
Source	Waukesha L-7044 GSI ESM	Waukesha L-7044 GSI ESM	
¹ Highest Calibration Gas Used			
Calibration Gas Info			
Composition	O2/CO2 High	O2/CO2 Mid	
Concentration	19.96	11.9	
Bottle ID	EB0078973.20160314	EB0041551.20151012	
	% Span	% Span	
Zero	0.0%		
Mid	59.6%		
High	100.0%		
Analyzer Calibration			
Zero	Response 0.04	Target 0	Response
Mid	Response 12.22	Target 11.9	
High	Response 19.59	Target 19.96	
Probe Calibration			
Zero	Response 0.03	Target 0.04	Response
Mid	Response 12.23	Target 12.22	
High	Response 19.44	Target 19.59	
Results			
	Cal. Error	Sys. Bias	Cal. Error
Zero	0.2%	0.1%	
Mid	1.6%	0.1%	
High	1.9%	0.8%	
Acceptance			
Zero	Pass	Pass	
Mid	Pass	Pass	
High	Pass	Pass	
CAL ERROR MUST BE LESS THAN 2.0% SYSTEM BIAS MUST BE LESS THAN 5%			
Additional Gases Used	Composition		Bottle ID
		Concentration	



RESPONSE TIME

Client: BHP Billiton Site: Hawk Central Gas Treating Facility County: DeWitt County
Project #: 11114838 Source: Waukesha L-7044 GSI ESM Date: 8/22/2017
Operator: Michael Tahirak Method/Gas: System Time: 9:20 AM

Analyzer (ID)	Upscale Response (sec.)				Downscale Response (sec.)				Response
	1	2	3	Average	1	2	3	Average	Time ¹
FTIR/O2	75	75	75	75.00	75	75	75	75.00	75.00
System Response Time ² :									75.00

Notes:

- 1 Greater value of average upscale response and average downscale response.
- 2 Maximum value of all analyzer response times.



SUMMARY DATA SHEET

Client: BHP Billiton
Project #: 11114838

Site: k Hawk Central Gas Treating Fac
Source: Waukesha L-7044 GSI ESM
Temperature_{STD}: 68

County: DeWitt County
Date: 8/22/2017
Molar Volume: 24.055

Run Information

	1	2	3	
--	---	---	---	--

Stack Parameter

Horsepower, hp	1545	1562	1545	
mmBtu of Fuel (Fd)	--	--	--	
Moisture %	19.2	19.2	18.9	

Dry Std. Flow Rate

				Avg.
DSCFM	2309	2311	2305	2308.6

O2 (dry, drift corrected)

%	0.04%	0.05%	0.07%	0.05%
---	-------	-------	-------	-------

CO

ppmvd	17	3	2	7
ppmvd @ 15%O2	4.853	0.849	0.565	2.089
lb/hr	0.17	0.03	0.02	0.07
g/hp-hr	0.051	0.009	0.006	0.022

NOx

ppmvd	2	1	3	2
ppmvd @ 15%O2	0.633	0.214	0.771	0.539
lb/hr	0.04	0.01	0.04	0.03
g/hp-hr	0.011	0.004	0.013	0.009

VOC

ppmvd	5.2	4	4	5
ppmvd @ 15%O2	1.461	1.185	1.208	1.285
lb/hr	0.08	0.07	0.07	0.07
g/hp-hr	0.024	0.019	0.020	0.021

Client:	BHP Billiton	Site: ack Hawk Central Gas Treating Facili	County:	DeWitt County
Project #:	11114838	Source: Waukesha L-7044 GSI ESM	Date:	8/22/2017

	Gas	O2	VOC	CO	NOx	Moisture
Calibration Drift Check						
Zero	Time	10:13				
	Span	19.96				
	Drift limit	< 3.0%				
Upscale (Cma)	Initial	0.03				
	Final	0.04				
	Average (C _o)	0.035				
	Certified Value	0				
	% Drift	-0.1%				
	% Sys. Bias	0.0%				
Upscale (Cma)	Upscale Gas:	Mid				
	Initial	12.23				
	Final	12.02				
	Average (C _m)	12.125				
	Certified Value	11.9				
	% Drift	1.0%				
	% Sys. Bias	1.0%				
Run Data Calculations						
Number of Sample Points:		60	60	60	60	60
Average Concentration (C):		0.07	5.17	17.15	2.24	19.24
Drift Corrected Average (C _{gas})		0.04				
Maximum Concentration:		0.09				
Minumum Concentration:		0.07				

DATE	TIME	O2 % (wet)	VOC ppmvd	CO ppmvd	NOx ppmvd	Moisture %
8/22/2017	10:13:59	0.08	5.85	1.64	16.24	18.64
8/22/2017	10:14:59	0.09	5.19	1.47	25.29	18.73
8/22/2017	10:15:59	0.09	4.20	1.09	28.07	18.77
8/22/2017	10:16:59	0.07	4.56	3.63	1.22	19.60
8/22/2017	10:17:59	0.07	4.09	18.76	1.13	19.56
8/22/2017	10:18:59	0.07	6.62	37.19	1.78	19.78
8/22/2017	10:19:59	0.07	5.58	41.54	1.61	19.81
8/22/2017	10:20:59	0.07	5.73	65.30	1.99	19.72
8/22/2017	10:21:59	0.07	5.96	62.30	2.09	19.64
8/22/2017	10:22:59	0.07	6.55	65.69	2.10	19.58
8/22/2017	10:23:59	0.07	4.41	85.99	2.20	19.51
8/22/2017	10:24:59	0.07	5.29	81.14	2.14	19.40
8/22/2017	10:25:59	0.07	6.24	76.95	2.11	19.10
8/22/2017	10:26:59	0.07	4.95	32.55	1.48	18.94
8/22/2017	10:27:59	0.07	6.22	26.32	1.35	18.97
8/22/2017	10:28:59	0.07	6.06	20.15	1.70	18.91
8/22/2017	10:29:59	0.07	4.51	12.68	1.36	18.98
8/22/2017	10:30:59	0.07	6.88	12.83	1.65	18.91
8/22/2017	10:31:59	0.07	4.02	12.91	0.86	19.12
8/22/2017	10:32:59	0.07	5.39	12.65	1.10	19.41
8/22/2017	10:33:59	0.07	4.42	10.75	1.30	18.82
8/22/2017	10:34:59	0.07	3.73	11.15	1.11	18.71
8/22/2017	10:35:59	0.07	4.41	10.02	1.15	18.85
8/22/2017	10:36:59	0.07	5.43	11.33	1.06	18.68
8/22/2017	10:37:59	0.07	6.00	10.57	1.11	19.07
8/22/2017	10:38:59	0.07	6.37	10.43	0.94	21.20
8/22/2017	10:39:59	0.07	6.32	12.08	0.99	19.97
8/22/2017	10:40:59	0.07	5.83	11.42	1.07	19.39
8/22/2017	10:41:59	0.07	5.91	8.79	0.91	19.50
8/22/2017	10:42:59	0.07	6.38	8.07	0.80	19.47
8/22/2017	10:43:59	0.07	4.52	8.70	1.11	19.20
8/22/2017	10:44:59	0.07	5.55	9.70	0.66	19.04
8/22/2017	10:45:59	0.07	3.35	12.36	0.91	19.13
8/22/2017	10:46:59	0.07	3.54	12.23	1.26	19.24
8/22/2017	10:47:59	0.07	4.60	9.36	1.17	19.05
8/22/2017	10:48:59	0.07	3.95	7.27	1.21	19.04
8/22/2017	10:49:59	0.07	4.40	7.74	1.13	18.58
8/22/2017	10:50:59	0.07	4.25	8.18	0.80	19.05
8/22/2017	10:51:59	0.07	4.76	9.87	1.16	19.41
8/22/2017	10:52:59	0.07	6.08	10.87	1.00	20.01
8/22/2017	10:53:59	0.07	5.56	12.25	0.99	19.22
8/22/2017	10:54:59	0.07	4.77	13.76	1.29	18.99
8/22/2017	10:55:59	0.07	4.27	11.73	0.82	18.97
8/22/2017	10:56:59	0.07	5.46	9.31	0.64	18.81
8/22/2017	10:57:59	0.07	5.09	10.65	1.05	18.68
8/22/2017	10:58:59	0.07	6.95	10.40	1.02	18.71
8/22/2017	10:59:59	0.07	4.91	8.09	0.44	18.66
8/22/2017	11:00:59	0.07	6.85	6.95	0.64	19.35
8/22/2017	11:01:59	0.07	3.63	8.30	0.60	19.56
8/22/2017	11:02:59	0.07	4.45	8.69	0.53	19.20
8/22/2017	11:03:59	0.07	3.50	6.90	0.89	18.90
8/22/2017	11:04:59	0.07	6.34	5.01	1.20	19.13
8/22/2017	11:05:59	0.07	3.61	5.64	0.39	18.91
8/22/2017	11:06:59	0.07	6.41	6.10	0.59	19.14
8/22/2017	11:07:59	0.07	5.17	7.33	0.89	19.28
8/22/2017	11:08:59	0.07	5.09	5.86	0.92	19.42
8/22/2017	11:09:59	0.07	6.50	6.09	0.68	19.35
8/22/2017	11:10:59	0.07	3.81	4.47	0.80	21.11
8/22/2017	11:11:59	0.07	4.79	3.83	0.62	19.55
8/22/2017	11:12:59	0.07	4.68	4.20	0.89	19.01

Client:	BHP Billiton	Site: Black Hawk Central Gas Treating Facility	County: DeWitt County
Project #:	11114838	Source: Waukesha L-7044 GSI ESM	Date: 8/22/2017

	Gas	O2	VOC	CO	NOx	Moisture
Calibration Drift Check						
	Time	11:26				
	Span	19.96				
	Drift limit	< 3.0%				
Zero						
	Initial	0.03				
	Final	0.04				
	Average (C ₀)	0.035				
	Certified Value	0				
	% Drift	0.0%				
	% Sys. Bias	0.0%				
Upscale (C_{ma})						
	Upscale Gas:	Mid				
	Initial	12.23				
	Final	12.04				
	Average (C _m)	12.135				
	Certified Value	11.9				
	% Drift	-0.1%				
	% Sys. Bias	0.9%				
Run Data Calculations						
Number of Sample Points:	60	60	60	60	60	
Average Concentration (C):	0.08	4.19	3.00	0.76	19.23	
Drift Corrected Average (C _{gas})	0.04					
Maximum Concentration:	0.09					
Minumum Concentration:	0.07					

DATE	TIME	O2 % (wet)	VOC ppmvd	CO ppmvd	NOx ppmvd	Moisture %
8/22/2017	11:26:59	0.07	3.55	4.08	0.53	18.07
8/22/2017	11:28:00	0.07	2.41	3.41	1.44	18.06
8/22/2017	11:28:59	0.08	4.27	2.87	2.44	18.12
8/22/2017	11:29:59	0.08	4.42	2.91	0.50	18.93
8/22/2017	11:30:59	0.08	4.32	3.74	0.37	19.47
8/22/2017	11:31:59	0.08	3.46	3.19	0.40	19.51
8/22/2017	11:32:59	0.08	1.95	3.28	0.25	19.56
8/22/2017	11:33:59	0.08	4.90	3.09	0.95	19.36
8/22/2017	11:34:59	0.08	3.80	2.89	0.79	19.77
8/22/2017	11:35:59	0.08	5.44	3.10	0.26	19.45
8/22/2017	11:36:59	0.08	4.54	3.26	0.76	19.48
8/22/2017	11:37:59	0.08	4.44	3.10	1.22	19.19
8/22/2017	11:38:59	0.08	4.59	2.94	0.39	19.15
8/22/2017	11:39:59	0.08	4.03	3.33	0.28	19.10
8/22/2017	11:40:59	0.08	4.44	3.03	0.94	19.48
8/22/2017	11:41:59	0.08	2.88	3.42	0.34	19.38
8/22/2017	11:43:00	0.08	3.26	3.51	0.36	19.33
8/22/2017	11:44:00	0.08	4.51	3.26	0.50	19.31
8/22/2017	11:44:59	0.08	3.87	3.02	0.91	19.22
8/22/2017	11:46:00	0.08	5.09	3.12	0.87	19.22
8/22/2017	11:46:59	0.08	3.44	2.86	0.68	19.07
8/22/2017	11:47:59	0.08	6.68	2.89	0.45	18.83
8/22/2017	11:48:59	0.08	4.36	3.01	0.44	18.66
8/22/2017	11:50:00	0.08	4.93	3.49	0.77	18.86
8/22/2017	11:50:59	0.08	3.80	3.09	0.52	18.69
8/22/2017	11:51:59	0.08	2.74	3.03	0.30	18.83
8/22/2017	11:52:59	0.08	2.25	3.21	0.16	18.88
8/22/2017	11:53:59	0.08	3.79	3.02	0.74	18.90
8/22/2017	11:55:00	0.08	4.19	2.58	1.45	19.15
8/22/2017	11:55:59	0.09	5.94	3.70	0.57	19.93
8/22/2017	11:56:59	0.08	4.13	3.23	-0.58	21.73
8/22/2017	11:57:59	0.08	5.57	3.17	0.23	20.25
8/22/2017	11:58:59	0.08	3.29	2.96	0.37	19.72
8/22/2017	11:59:59	0.08	3.64	3.13	0.52	19.32
8/22/2017	12:00:59	0.08	3.23	3.15	0.74	19.26
8/22/2017	12:01:59	0.08	3.75	3.97	0.52	19.30
8/22/2017	12:02:59	0.08	4.52	3.12	0.48	19.04
8/22/2017	12:03:59	0.08	2.37	3.03	0.13	19.07
8/22/2017	12:04:59	0.08	4.38	2.87	0.50	18.95
8/22/2017	12:05:59	0.08	4.80	2.50	3.09	18.91
8/22/2017	12:06:59	0.08	5.43	2.11	1.89	18.81
8/22/2017	12:08:00	0.08	5.19	2.41	1.46	19.05
8/22/2017	12:09:00	0.08	6.05	2.93	0.52	19.32
8/22/2017	12:09:59	0.08	5.23	2.57	0.95	19.46
8/22/2017	12:11:00	0.08	4.68	2.80	0.08	19.27
8/22/2017	12:11:59	0.08	2.10	2.94	0.17	18.90
8/22/2017	12:12:59	0.08	4.84	3.40	1.04	18.90
8/22/2017	12:13:59	0.08	4.98	2.65	1.27	18.81
8/22/2017	12:14:59	0.08	5.35	2.56	0.39	19.25
8/22/2017	12:16:00	0.08	5.68	3.04	0.48	19.14
8/22/2017	12:17:00	0.08	3.51	2.87	1.16	19.01
8/22/2017	12:17:59	0.08	3.45	2.51	2.23	18.91
8/22/2017	12:18:59	0.08	5.00	2.58	0.99	19.07
8/22/2017	12:20:00	0.09	4.98	3.33	0.80	19.96
8/22/2017	12:21:00	0.09	4.38	2.36	0.91	20.33
8/22/2017	12:22:00	0.09	5.10	2.68	0.95	19.78
8/22/2017	12:23:00	0.09	2.14	2.30	1.40	19.51
8/22/2017	12:23:59	0.09	2.54	2.46	1.05	19.40
8/22/2017	12:24:59	0.09	4.40	2.33	0.57	19.20
8/22/2017	12:25:59	0.09	4.17	2.56	0.53	19.21

Client:	BHP Billiton	Site: Black Hawk Central Gas Treating Facility	County: DeWitt County
Project #:	11114838	Source: Waukesha L-7044 GSI ESM	Date: 8/22/2017

	Gas	O ₂	VOC	CO	NO _x	Moisture
Calibration Drift Check						
	Time	12:39				
	Span	19.96				
	Drift limit	< 3.0%				
Zero						
	Initial	0.03				
	Final	0.04				
	Average (C _o)	0.035				
	Certified Value	0				
	% Drift	0.0%				
	% Sys. Bias	0.0%				
Upscale (C_{ma})						
	Upscale Gas:	Mid				
	Initial	12.23				
	Final	12.05				
	Average (C _m)	12.14				
	Certified Value	11.9				
	% Drift	-0.1%				
	% Sys. Bias	0.9%				
Run Data Calculations						
Number of Sample Points:	60	60	60	60	60	
Average Concentration (C):	0.09	4.27	1.99	2.72	18.86	
Drift Corrected Average (C _{gas})	0.05					
Maximum Concentration:	0.09					
Minumum Concentration:	0.08					

DATE	TIME	O2 % (wet)	VOC ppmvd	CO ppmvd	NOx ppmvd	Moisture %
8/22/2017	12:39:00	0.09	4.11	1.73	7.75	17.15
8/22/2017	12:40:00	0.09	4.55	1.59	1.47	17.86
8/22/2017	12:40:59	0.09	1.20	1.55	2.85	18.31
8/22/2017	12:41:59	0.09	3.58	1.87	1.93	18.51
8/22/2017	12:42:59	0.09	4.75	1.94	3.05	18.43
8/22/2017	12:43:59	0.09	3.43	2.10	0.64	18.27
8/22/2017	12:44:59	0.09	6.74	1.91	1.48	18.33
8/22/2017	12:46:00	0.09	3.62	2.24	1.28	18.74
8/22/2017	12:47:00	0.09	5.52	2.19	1.77	19.16
8/22/2017	12:47:59	0.09	4.08	1.65	4.18	19.00
8/22/2017	12:48:59	0.09	3.50	1.18	13.00	19.21
8/22/2017	12:49:59	0.09	3.64	1.62	2.71	19.29
8/22/2017	12:50:59	0.09	4.77	1.24	14.94	19.27
8/22/2017	12:51:59	0.09	4.58	0.75	16.37	19.21
8/22/2017	12:53:00	0.09	6.63	1.28	5.43	19.14
8/22/2017	12:54:00	0.09	4.16	1.78	1.01	18.90
8/22/2017	12:55:00	0.09	3.19	2.06	1.09	18.90
8/22/2017	12:55:59	0.09	2.19	1.90	1.54	18.88
8/22/2017	12:57:00	0.09	5.49	2.16	0.46	19.02
8/22/2017	12:58:00	0.09	4.05	2.25	0.78	19.28
8/22/2017	12:58:59	0.09	6.19	3.37	0.67	20.10
8/22/2017	12:59:59	0.09	3.73	2.59	0.84	19.95
8/22/2017	13:00:59	0.09	5.92	2.44	1.76	19.52
8/22/2017	13:01:59	0.09	3.67	2.21	1.66	19.05
8/22/2017	13:02:59	0.08	5.26	2.26	0.56	18.66
8/22/2017	13:04:00	0.09	5.62	1.99	1.78	18.83
8/22/2017	13:05:00	0.09	2.10	1.98	1.84	18.76
8/22/2017	13:06:00	0.09	4.39	1.98	1.77	18.88
8/22/2017	13:07:00	0.09	6.24	1.71	5.25	19.06
8/22/2017	13:07:59	0.09	3.50	1.41	4.35	18.75
8/22/2017	13:09:00	0.09	3.65	1.64	2.63	18.68
8/22/2017	13:10:00	0.09	4.78	1.95	1.47	18.87
8/22/2017	13:10:59	0.09	4.48	2.08	1.57	18.86
8/22/2017	13:11:59	0.09	6.31	1.88	4.50	18.85
8/22/2017	13:13:00	0.09	4.86	1.58	4.58	19.13
8/22/2017	13:14:00	0.09	2.90	2.02	0.89	18.99
8/22/2017	13:15:00	0.09	4.07	2.07	0.98	18.78
8/22/2017	13:16:00	0.09	4.32	2.22	1.18	18.82
8/22/2017	13:16:59	0.08	3.35	2.47	-0.05	18.80
8/22/2017	13:17:59	0.08	5.44	2.53	0.57	18.79
8/22/2017	13:19:00	0.08	5.02	2.60	0.73	18.88
8/22/2017	13:19:59	0.09	3.62	3.12	0.70	18.94
8/22/2017	13:21:00	0.08	6.15	2.28	0.75	18.69
8/22/2017	13:22:00	0.08	1.82	2.59	0.56	19.36
8/22/2017	13:23:00	0.09	3.60	2.13	0.88	19.00
8/22/2017	13:24:00	0.09	2.65	2.16	1.11	18.87
8/22/2017	13:25:00	0.09	2.60	2.37	0.46	18.54
8/22/2017	13:26:00	0.08	2.73	2.49	0.77	18.89
8/22/2017	13:27:00	0.09	5.55	2.35	1.97	18.70
8/22/2017	13:28:00	0.09	3.78	1.75	2.32	18.78
8/22/2017	13:29:00	0.09	5.12	1.85	1.12	18.82
8/22/2017	13:30:00	0.09	3.79	2.02	0.70	18.71
8/22/2017	13:31:00	0.09	4.81	2.16	1.00	18.82
8/22/2017	13:32:00	0.09	5.76	1.96	3.00	18.76
8/22/2017	13:33:00	0.09	3.98	2.07	1.53	18.93
8/22/2017	13:34:00	0.09	4.55	1.90	1.47	18.65
8/22/2017	13:35:00	0.09	3.34	1.55	3.97	18.84
8/22/2017	13:36:00	0.09	4.26	1.55	2.87	18.83
8/22/2017	13:37:00	0.09	4.04	1.53	1.37	18.86
8/22/2017	13:38:00	0.09	4.25	1.87	13.61	18.84

BHP Billiton
NOx Stratification Test Results
Black Hawk Central Gas Treating Facility
Waukesha L-7044 GSI ESM

Point 1		Point 2		Point 3	
Time	Conc. (ppmv)	Time	Conc. (ppmv)	Time	Conc. (ppmv)
10:13:59	16.24	10:33:59	1.30	10:53:59	0.99
10:14:59	25.29	10:34:59	1.11	10:54:59	1.29
10:15:59	28.07	10:35:59	1.15	10:55:59	0.82
10:16:59	1.22	10:36:59	1.06	10:56:59	0.64
10:17:59	1.13	10:37:59	1.11	10:57:59	1.05
10:18:59	1.78	10:38:59	0.94	10:58:59	1.02
10:19:59	1.61	10:39:59	0.99	10:59:59	0.44
10:20:59	1.99	10:40:59	1.07	11:00:59	0.64
10:21:59	2.09	10:41:59	0.91	11:01:59	0.60
10:22:59	2.10	10:42:59	0.80	11:02:59	0.53
10:23:59	2.20	10:43:59	1.11	11:03:59	0.89
10:24:59	2.14	10:44:59	0.66	11:04:59	1.20
10:25:59	2.11	10:45:59	0.91	11:05:59	0.39
10:26:59	1.48	10:46:59	1.26	11:06:59	0.59
10:27:59	1.35	10:47:59	1.17	11:07:59	0.89
10:28:59	1.70	10:48:59	1.21	11:08:59	0.92
10:29:59	1.36	10:49:59	1.13	11:09:59	0.68
10:30:59	1.65	10:50:59	0.80	11:10:59	0.80
10:31:59	0.86	10:51:59	1.16	11:11:59	0.62
10:32:59	1.10	10:52:59	1.00	11:12:59	0.89

Point average (ppmv) 4.9
Difference from mean (%) -117.87%
Overall average 2.236456

1.0
53.39%
64.48%

Client: BHP Billiton
 Site: ack Hawk Central Gas Treating Facility
 Project #: 11114838

Source: Waukesha L-7044 GSI ESM
 County: DeWitt County
 Operator: Michael Tahirak

Date: 8/22/2017
 Run #: 1
 Method: 2

EQUIPMENT IDS AND INFO	TEMPERATURE / PRESSURE	STACK DATA
Barometer Con. #: BE04921 T-couple Pitot Con. #: ET1 Pitot ID. # C _p 0.84 Manometer: ET-1 Meter Box:	Temperature _{STD} : 68 (°F) Temperature _{AMBIENT} : 86 (°F) Pressure _{BAROMETRIC} : 30 (in. Hg.)	Shape: Circle Area: 1.07 (ft ²) Diameter: 14.00 (in.)
	Pressure _{STATIC} : -0.58 (in. H2O.)	
	RUN VALUES	TEST INFORMATION
	Bws: 0.18 (fraction) N ₂ : 89.92 (%) CO ₂ : 10.00 (%) Md: 29.60 lb/lb-mole O ₂ : 0.08 (%) Ms: 27.51 lb/lb-mole	Number of Ports: 2 Points / Port: 8 Reads / Point: 1

Run 1 Pre		
Vs - ft/sec. 119.66		
Qa - ACFM 7675.2		
Qs - WSCFM 2813.1		
Qs - DSCFM 2306.7		

Time	Title
8:45	Run 1 Pre

Traverse Pt. No.	Distance (inches)	T _s (°F)	ΔP	SQRT(ΔP)	Null Angle
1	0.45	984	1.60	1.26	
2	1.47	985	1.60	1.26	
3	2.72	985	1.60	1.26	
4	4.52	985	1.50	1.22	
5	9.48	986	1.60	1.26	
6	11.28	986	1.60	1.26	
7	12.53	985	1.50	1.22	
8	13.55	983	1.50	1.22	
1	0.45	984	1.70	1.30	
2	1.47	986	1.70	1.30	
3	2.72	986	1.70	1.30	
4	4.52	986	1.60	1.26	
5	9.48	985	1.60	1.26	
6	11.28	985	1.60	1.26	
7	12.53	983	1.50	1.22	
8	13.55	983	1.50	1.22	
Average		985	1.59	1.26	#DIV/0!

Traverse Pt. No.	Distance (inches)	T _S (°F)	ΔP	SQRT(ΔP)	Null Angle
1	0.45	980	1.50	1.22	
2	1.47	983	1.50	1.22	
3	2.72	985	1.60	1.26	
4	4.52	985	1.50	1.22	
5	9.48	986	1.60	1.26	
6	11.28	985	1.70	1.30	
7	12.53	984	1.60	1.26	
8	13.55	984	1.50	1.22	
1	0.45	984	1.60	1.26	
2	1.47	985	1.70	1.30	
3	2.72	986	1.70	1.30	
4	4.52	985	1.70	1.30	
5	9.48	985	1.60	1.26	
6	11.28	984	1.60	1.26	
7	12.53	983	1.60	1.26	
8	13.55	983	1.50	1.22	
Average		984	1.59	1.26	#DIV/0!

Traverse Distance		T _s	ΔP	SQRT(ΔP)	Null Angle
Pt. No.	(inches)	(°F)			
1	0.45	984	1.50	1.22	
2	1.47	985	1.60	1.26	
3	2.72	987	1.60	1.26	
4	4.52	987	1.60	1.26	
5	9.48	987	1.60	1.26	
6	11.28	986	1.50	1.22	
7	12.53	986	1.50	1.22	
8	13.55	985	1.40	1.18	
1	0.45	985	1.70	1.30	
2	1.47	985	1.70	1.30	
3	2.72	986	1.70	1.30	
4	4.52	987	1.70	1.30	
5	9.48	987	1.70	1.30	
6	11.28	987	1.60	1.26	
7	12.53	987	1.60	1.26	
8	13.55	986	1.50	1.22	
Average		986	1.59	1.26	#DIV/0!

Date: 8/22/2017
Run #: Post Run 3
Method: 2

Run 3 Post		Run 3 Average Flow	
Vs - ft/sec.	120.91	Vs - ft/sec.	120.41
Qa - ACFM	7755.1	Qa - ACFM	7723.10
Qs - WSCFM	2840.0	Qs - WSCFM	2828.68
Qs - DSCFM	2300.4	Qs - DSCFM	2305.32

Time	Title
13:42	Run 3 Post

Traverse Pt. No.	Distance (inches)	T _s (°F)	ΔP	SQRT(ΔP)	Null Angle
1	0.45	985	1.60	1.26	
2	1.47	986	1.60	1.26	
3	2.72	986	1.60	1.26	
4	4.52	986	1.60	1.26	
5	9.48	987	1.60	1.26	
6	11.28	987	1.60	1.26	
7	12.53	987	1.60	1.26	
8	13.55	987	1.50	1.22	
1	0.45	986	1.70	1.30	
2	1.47	987	1.70	1.30	
3	2.72	988	1.70	1.30	
4	4.52	988	1.70	1.30	
5	9.48	987	1.70	1.30	
6	11.28	987	1.60	1.26	
7	12.53	985	1.50	1.22	
8	13.55	985	1.50	1.22	
Average		987	1.61	1.27	#DIV/0!

Stack Flow Example Calculations

Run 1

Gas Velocity	119.66	Average stack temperature, °R	1446
Barometric pressure	30.05	Absolute stack pressure, in. Hg	30.02
Static pressure (in. H ₂ O)	-0.58	Stack gas molecular weight, wet	27.51
Stack moisture, B _{WS} , %	18.00%		
Stack flow, Q, dscfm	2312		
Pitot tube correction factor	0.84		

1. Absolute stack pressure, in. Hg

Applicable? **Yes**

$$P_s = P_{\text{bar}} + (P_g * \frac{1}{13.6}) = 30.01 \text{ (in. Hg)}$$

Where:

P_{bar} = barometric pressure, inches Hg

P_g = gas static pressure, inches H₂O

$\frac{1}{13.6}$ = conversion, inches H₂O to inches Hg

2. Square root of DP_{avg}

Applicable? **Yes**

$$\sqrt{\Delta P_{\text{avg}}} = \frac{\sum_{i=1}^n \Delta p_i}{n} = 1.26 \text{ (in. H}_2\text{O)}$$

Where:

ΔP = individual velocity pressure reading, inches H₂O

n = number of individual traverse points

3. Average stack temperature, °R

Applicable? **Yes**

$$= t_s + 460 = 1444.8125 \text{ (deg. R)}$$

Where:

t_s = Average stack temperature, °F

460 = Conversion, °F to °R

4. Stack gas velocity, ft/sec

Applicable? **Yes**

$$= 85.49 * C_p * \sqrt{\Delta P_{avg}} * \sqrt{\frac{T_s}{P_s * M_s}} = 119.69 \text{ ft/sec}$$

Where: $\frac{\text{ft}}{\text{sec}} \sqrt{\frac{(\text{lb} / \text{lb-mole})(\text{inches Hg})}{(^{\circ}\text{R})(\text{inches H}_2\text{O})}}$
85.49 = Pitot tube constant,

C_p = Pitot tube correction factor, dimensionless

$\sqrt{\Delta P_{avg}}$ = average square root of velocity pressure, inches H₂O

T_s = stack temperature, degrees R

P_s = stack pressure, inches Hg

M_s = stack gas molecular weight, wet, pounds per pound-mole

5. Stack gas volumetric flow rate, dscfh

Applicable? **Yes**

$$= 3600 * (1 - B_{ws}) * V_s * A_s * \frac{T_{std}}{T_s} * \frac{P_s}{P_{std}} = 138486.0 \text{ dscf/hr}$$

Where:

3600 = seconds per minute

$1 - B_{ws}$ = Dry fraction of stack gas

V_s = stack gas velocity, ft/sec

A_s = stack area, ft²

T_{std} = standard temperature, 528 °R

T_s = average stack temperature, °R

P_s = Absolute stack pressure, inches Hg

P_{std} = standard pressure, 29.92 inches Hg

GHD Reciprocating Engine Data Collection Sheet

Client: BHP Billiton
 Site: Black Hawk Central Gas Treating Facility
 County, State: DeWitt County, TX
 Job Number: 11114838
 GPS LAT: 29.118692
 GPS LONG: -97.401375

Test Reg/Permit:
 Unit Make: Waukesha
 Unit Model: L-7044 GSI ESM
 Unit Number: K-201
 Unit S/N: 5283700882
 Rated hp: 1680
 Rated Speed:

Test Run Number	1	2	3
Date	8/22/2017	8/22/2017	8/22/2017
Start Time	10:13	11:26	12:39
Stop Time	11:12	12:25	13:38
Engine Data			
Fuel Pressure (psia)	--	--	--
Fuel Temp. (°F)	--	--	--
Fuel Flow (scf/hr)	--	--	--
Load % ((current HP / rated HP) x 100)	92%	93%	92%
Engine Speed (rpm)	1160	1168	1163
Ignition Timing (°BTDC)	12	12	12
Intake Manifold Press. (psi)	38	38	38
Intake Manifold Temp (°F)	123	124	129
Air to Fuel Ratio	--	--	--
Engine Oil Pressure (psi)	59	59	58
Engine Oil Temp. (°F)	186	185	188
Exhaust Temp. (°F)	--	--	--
Test Run Time (hrs)	1	1	1
Engine Run Time (hrs)	46742	46743	46744
Engine Controls	AFRC and Catalyst	AFRC and Catalyst	AFRC and Catalyst
Compressor Data			
Gas Production (MMscfd)	--	--	--
Suction Pressure (psig)	576	580	581
1 st Stage Discharge Pressure (psig)	1050	1050	1050
2 nd Stage Discharge Pressure (psig)	1050	1050	1050
3 rd Stage Discharge Pressure (psig)	1075	1075	1070
Compressor Oil Pressure (psi)	60	60	58
Compressor Oil Temp. (°F)	--	--	--
Ambient Conditions			
Altitude (ft)	--	--	--
Temperature (°F)	85	91	93
Barometric Pressure (inches)	30.05	30.06	30.06

NO_x Emissions Example Calculations

Run 1

Run average NO _x concentration, ppmv	2.24
Run average O ₂ concentration, %	0.04%
Horsepower, hp	1545
NO _x Molecular weight, lb/lb-mole	46.01
Stack flow, Q, dscfm	2309

1. Concentration corrected to 15% Oxygen, dry basis

Applicable? **Yes**

$$C_c = C_d * \frac{20.9\% - 15\%}{20.9\% - \%O_2} = 0.63 \text{ (ppmv)}$$

Where:

C_c = Oxygen corrected run average pollutant concentration, ppmv, dry basis

C_d = Run average pollutant concentration, ppmv, dry basis

20.9 = Theoretical ambient oxygen concentration, percent

15 = Oxygen correction, percent

%O₂ = Run average oxygen concentration, dry basis, percent

2. NO_x Emission rate (g/hp-hr)

Applicable? **Yes**

$$E = \frac{C_c * 1.194 * 10^{-7} * Q * 60 * 453592}{hp} = 0.01 \text{ g/hp-hr}$$

Where:

E = pollutant emission rate, g/ hp-hr

C_c = Oxygen corrected run average pollutant concentration, ppmv, dry basis

1.194 X 10⁻⁷ = conversion, ppm NO_x to lb/scf

Q = Stack flowrate, dscfm

453.592 = conversion, g to lb

hp = Horsepower

CO Emissions Example Calculations

Run 1

Run average CO concentration, ppmv	17.15
Run average O2 concentration, %	0.04%
Horsepower, hp	1545
CO Molecular weight, lb/lb-mole	28
Stack flow, Q, dscfm	2309

1. Concentration corrected to 15% Oxygen, dry basis

Applicable? **Yes**

$$C_c = C_d * \frac{20.9\% - 15\%}{20.9\% - \%O_2} = 4.85 \text{ (ppmv)}$$

Where:

C_c = Oxygen corrected run average pollutant concentration, ppmv, dry basis

C_d = Run average pollutant concentration, ppmv, dry basis

20.9 % = Theoretical ambient oxygen concentration, percent

15% = Oxygen correction, percent

$\%O_2$ = Run average oxygen concentration, dry basis, percent

2. CO Emission rate (g/hp-hr)

Applicable? **Yes**

$$E = \frac{C_c * 0.726 * 10^{-7} * Q * 60 * 453592}{hp} = 0.05 \text{ g/hp-hr}$$

Where:

E = pollutant emission rate, g/ hp-hr

C_c = Oxygen corrected run average pollutant concentration, ppmv, dry basis

0.726×10^{-7} = conversion, ppm CO to lb/scf

Q = Stack flowrate, dscfm

453.592 = conversion, g to lb

hp = Horsepower

VOC Emissions Example Calculations

Run 1

Run average VOC concentration, ppmv	5.17
Run average O2 concentration, %	0.04%
Horsepower, hp	1545
Propane Molecular weight, lb/lb-mole	44.1
Stack flow, Q, dscfm	2309

Note: VOCs quantified and expressed as C₃H₈

1. Concentration corrected to 15% Oxygen, dry basis

Applicable? **Yes**

$$C_c = C_d * \frac{20.9\% - 15\%}{20.9\% - \%O_2} = 1.46 \text{ (ppmv)}$$

Where:

C_c = Oxygen corrected run average pollutant concentration, ppmv, dry basis

C_d = Run average pollutant concentration, ppmv, dry basis

20.9 % = Theoretical ambient oxygen concentration, percent

15% = Oxygen correction, percent

%O₂ = Run average oxygen concentration, dry basis, percent

2. VOC Emission rate (g/hp-hr)

Applicable? **Yes**

$$E = \frac{C_c * 1.142 * 10^{-7} * Q * 60 * 453592}{hp} = 0.02 \text{ g/hp-hr}$$

Where:

E = pollutant emission rate, g/ hp-hr

C_c = Oxygen corrected run average pollutant concentration, ppmv, dry basis

1.142 X 10⁻⁷ = conversion, ppm VOC to lb/scf

Q = Stack flowrate, dscfm

453.592 = conversion, g to lb

hp = Horsepower

New Reference <F1>

Config FT-IR <F2>

Pause Scan <F3>

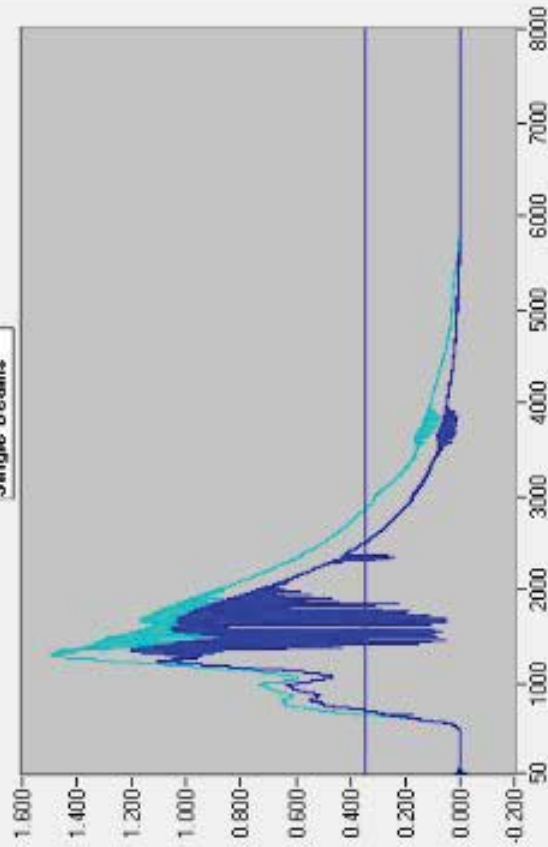
Clear Charts <F4>

Print Panel <F6>

Save Spectrum <F7>

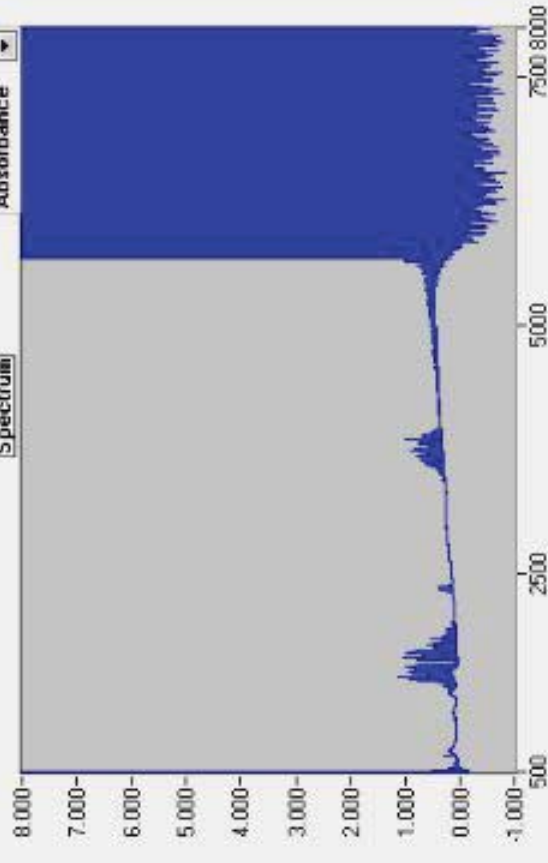
Return <F8>

Single Beams



Spectrum

Absorbance



Zoom In
Zoom Out
Reset

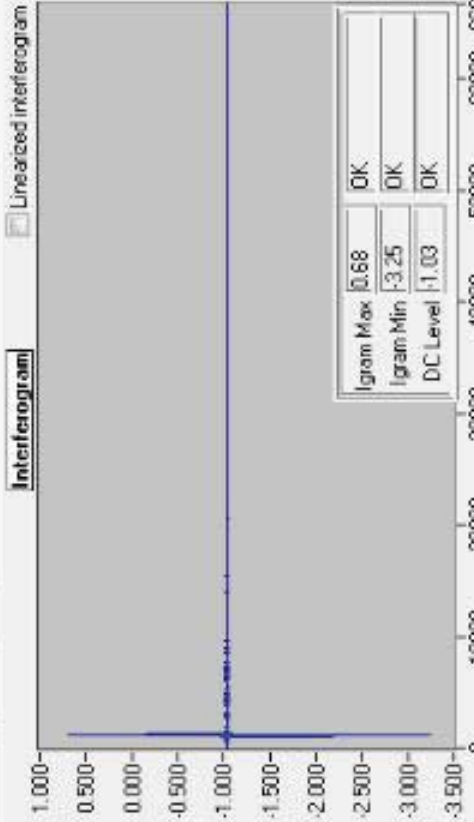


Cursor 0

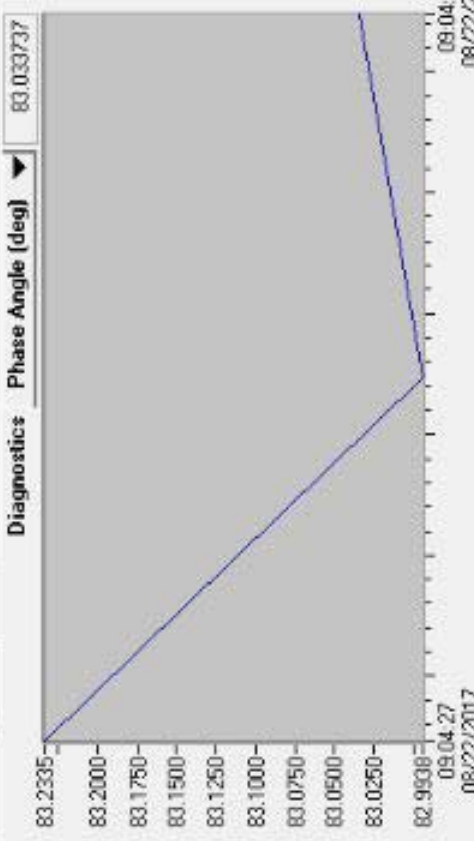
0.345



Interferogram



Linearized interferogram



Diagnostics Phase Angle (deg)

83.033737

Zoom In
Zoom Out
Reset



Cursor 0

0.345



83.033737

Interferogram Max 0.68 OK

Interferogram Min -3.25 OK

DC Level 1.03 OK

Current Date/Time 08/22/2017, 09:05:00

Ref Date/Time 04/12/2017, 13:47:28

time since ref 3163.1732

Bad Scan Counter 0

08/22/2017 09:04:57

Measure

Show Ref

Default Ref

Load Ref

Config FT-IR <F2>

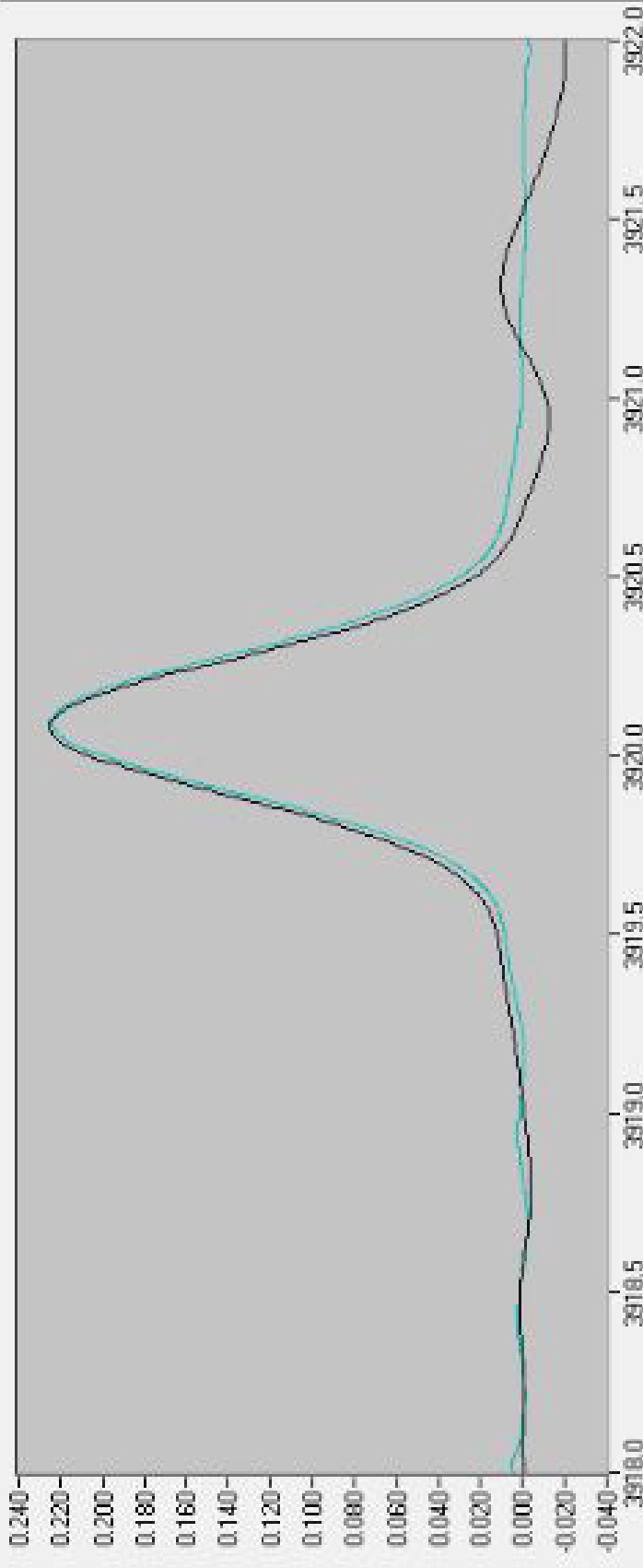
Print Panel <F6>

Return <F8>

IGRAM P/P ENERGY

0.000

0.465



LASER FREQ RESULTS

Original Laser Freq	15798.2881
Auto Correct Water Line	3920.0946
Auto Corrected Laser Freq	15798.2466
Calculated Laser Freq	15798.2771

Set Laser Freq to Calculated

SAMPLE PEAK RESULTS

FwHH (cm-1)	0.4623
Freq (cm-1)	3920.0876
peak (AU)	0.2541
baseline (AU)	0.0287
amplitude (AU)	0.2253

REFERENCE PEAK RESULTS

FwHH (cm-1)	0.4647
Freq (cm-1)	3920.0952
peak (AU)	0.2004
baseline (AU)	0.0024
amplitude (AU)	0.1980

Appendix B

Calibration Gas Certification Sheets



Assay Laboratory: Red Ball TGS
555 Craig Kennedy Way
Shreveport, LA 71107
800-551-8150

EPA PROTOCOL GAS CERTIFICATE OF ANALYSIS

Cylinder Number:	EB0078973	Certification Date:	03/24/2016
Product ID Number:	122020	Expiration Date:	03/22/2024
Cylinder Pressure:	1900 PSIG	MFG Facility:	RBTGS-Shreveport-LA
COA #	EB0078973.20160314-0	Lot Number:	EB0078973.20160314
Customer PO. NO.:		Tracking Number:	084269959
Customer:		Previous Certification Dates:	

This calibration standard has been certified per the May 2012 EPA Traceability Protocol, Document EPA-600/R-12/531, using procedure G1.

Do Not Use This Cylinder Below 100 psig (0.7 Megapascal).

Certified Concentration(s)

Component	Concentration	Uncertainty	Analytical Principle	Assayed On
Oxygen	19.96 %	±0.08 %	MPA	03/24/2016
Nitrogen	Balance			

Analytical Measurement Data Available Online.

Reference Standard(s)

Serial Number	Lot	Expiration	Type	Balance	Component	Concentration	Uncertainty(%)	NIST Reference
EB0055387	EB0055387.20140228G	10/07/2022	GMIS	N2	O2	23.79 %	0.505	071001
EB0055407	EB0055407.20140228Ga	10/07/2022	GMIS	N2	O2	19.92 %	0.508	071001

Analytical Instrumentation

Component	Analytical Principle	Make	Model	Serial	MPC Date
O2	MPA	Horiba	VA-3013	H0000P11	03/01/2016

Red Ball Technical Gas Service
PGVP Vendor ID # G12016
Information and Ordering
800-551-8150
Fax (318-425-6309)



Fred Holt

Fred Holt
Analyst



Assay Laboratory: Red Ball TGS
555 Craig Kennedy Way
Shreveport, LA 71107
800-551-8150

EPA PROTOCOL GAS CERTIFICATE OF ANALYSIS

Cylinder Number:	EB0041551	Certification Date:	10/20/2016
Product ID Number:	125338	Expiration Date:	10/18/2024
Cylinder Pressure:	1900 PSIG	MFG Facility:	RBTGS-Shreveport-LA
COA #	EB0041551.20161012-0	Lot Number:	EB0041551.20161012
Customer PO. NO.:		Tracking Number:	065124248
Customer:		Previous Certification Dates:	

This calibration standard has been certified per the May 2012 EPA Traceability Protocol, Document EPA-600/R-12/531, using procedure G1.

Do Not Use This Cylinder Below 100 psig (0.7 Megapascal).

Certified Concentration(s)

Component	Concentration	Uncertainty	Analytical Principle	Assayed On
Oxygen	11.90 %	±0.09 %	MPA	10/20/2016
Nitrogen	Balance			

Analytical Measurement Data Available Online.

Reference Standard(s)

Serial Number	Lot	Expiration	Type	Balance	Component	Concentration	Uncertainty(%)	NIST Reference
EB0055387	EB0055387.20140228G	10/07/2022	GMIS	N2	O2	23.79 %	0.505	071001
EB0032246	LD131022.115903.1G	10/07/2022	GMIS	N2	O2	11.97 %	0.527	071001

Analytical Instrumentation

Component	Analytical Principle	Make	Model	Serial	MPC Date
O2	MPA	Horiba	VA-3013	H0000P11	09/26/2016

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PJLA
Calibration and Testing
Accreditation #62754

B. Theus

Brandon Theus
Analytical Chemist

This is to certify the gases referenced have been calibrated/tested, and verified to meet the defined specifications. This calibration/test was performed using Gases or Scales that are traceable through National Institute of Standards and Technology (NIST) to the International System of Units (SI). The basis of compliance stated is a comparison of the measurement parameters to the specified or required calibration/testing process. The expanded uncertainties use a coverage factor of k=2 to approximate the 95% confidence level of the measurement, unless otherwise noted. This calibration certificate applies only to the item described and shall not be reproduced other than in full, without written approval from Red Ball Technical Gas Services. If not included, the uncertainty of calibrations are available upon request and were taken into account when determining pass or fail.

Version 02-E, Revised on 2016-04-27



Assay Laboratory: Red Ball TGS
555 Craig Kennedy Way
Shreveport, LA 71107
800-551-8150

CERTIFICATE OF ANALYSIS (Zero Ambient Nitrogen)

Cylinder Number: EB0081125
Product ID Number: 121026
Cylinder Pressure: 1900 PSIG
COA #: EB0081125.20170818-0
Customer PO. NO.:
Customer:

Certification Date:
Expiration Date:
MFG Facility:
Lot Number:
Tracking Number:
Previous Certification Dates:

08/18/2017
08/16/2025
RBTGS-Shreveport-LA
EB0081125.20170818
083079775

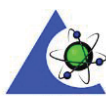
This mixture is for laboratory use only, not for drug, household or other use.
This mixture is certified in Mole % to be within $\pm 2\%$ of the actual number reported with a confidence of 95%.
This mixture was manufactured by scale; weights traceable to N.I.S.T. Certificate #822/266926-02.
Do Not Use This Cylinder Below 100 psig (0.7 Megapascal).

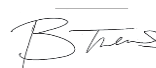
Composing Material: Zero Ambient Nitrogen, Cert., Sz152

Component	Specification	Concentration
Nitrogen	Balance	Balance
Oxygen as Impurity	<1.0 PPM	<1.0 PPM
Carbon Dioxide as Impurity	<0.5 PPM	<0.5 PPM
Carbon Monoxide as Impurity	<0.5 PPM	<0.5 PPM
Total Oxides of Nitrogen as Impurity	<0.1 PPM	<0.1 PPM
Sulfur Dioxide as Impurity	<0.1 PPM	<0.1 PPM
Total Hydrocarbons as Impurity	<0.1 PPM	<0.1 PPM

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Accreditation #62754



Brandon Theus
Analytical Chemist

Version 02-B, Revised on 2015-05-27



Assay Laboratory: Red Ball TGS
555 Craig Kennedy Way
Shreveport, LA 71107
800-551-8150

CERTIFIED GAS CERTIFICATE OF ANALYSIS

Cylinder Number:	EB0073342	Certification Date:	02/22/2016
Product ID Number:	124838	Expiration Date:	02/21/2018
Cylinder Pressure:	1900 PSIG	MFG Facility:	RBTGS-Shreveport-LA
COA #	EB0073342.20160222-0	Lot Number:	EB0073342.20160222
Customer PO. NO.:		Tracking Number:	084249308
Customer:		Previous Certification Dates:	

This mixture is for laboratory use only, not for drug, household or other use.

This mixture is certified in Mole % to be within $\pm 2\%$ of the actual number reported with a confidence of 95%.

This mixture was manufactured by scale; weights traceable to N.I.S.T. Certificate #822/266926-02.

Do Not Use This Cylinder Below 100 psig (0.7 Megapascal).

Certified Concentration(s)

Component	Concentration	Uncertainty	Analytical Principle
Ethylene	99.0 PPM	$\pm 2\%$ NIST	FTIR
Nitrogen	Balance		

Analytical Measurement Data Available Online.

Reference Standard(s)

Lot	Expiration	Type	Balance	Component	Concentration	Uncertainty(%)	NIST Reference
EB0055702.BL1509079	09/14/2016	PS	N2	C2H4	100.6 PPM	2	BL1509079

Analytical Instrumentation

Component	Analytical Principle	Make	Model	Serial
C2H4	FTIR	MKS	MKS 2031DJG2EKVS13T	017146467

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Accreditation #62754

Fred Holt

Fred Holt
Analyst

Version 02-B, Revised on 2015-05-27



Assay Laboratory: Red Ball TGS
555 Craig Kennedy Way
Shreveport, LA 71107
800-551-8150

CERTIFIED GAS CERTIFICATE OF ANALYSIS

Cylinder Number:	EB0046571	Certification Date:	05/11/2017
Product ID Number:	125571	Expiration Date:	05/11/2019
Cylinder Pressure:	1900 PSIG	MFG Facility:	RBTGS-Shreveport-LA
COA #	EB0046571.20170503-0	Lot Number:	EB0046571.20170503
Customer PO. NO.:		Tracking Number:	065272484
Customer:		Previous Certification Dates:	

This mixture is for laboratory use only, not for drug, household or other use.

This mixture is certified in Mole % to be within $\pm 2\%$ of the actual number reported with a confidence of 95%.

This mixture was manufactured by scale; weights traceable to N.I.S.T. Certificate #822/266926-02.

Do Not Use This Cylinder Below 100 psig (0.7 Megapascal).

Certified Concentration(s)

Component	Concentration	Uncertainty	Analytical Principle
Propane	1000 PPM	$\pm 2\%$ NIST	FTIR
Carbon Monoxide	3000 PPM	$\pm 2\%$ NIST	GCF
Nitric Oxide	3000 PPM	$\pm 2\%$ NIST	Chemiluminescence
Sulfur Hexafluoride	10.2 PPM	$\pm 2\%$ NIST	FTIR
Total Oxides of Nitrogen	3020 PPM		
Nitrogen	Balance		

Analytical Measurement Data Available Online.

Reference Standard(s)

Lot	Expiration	Type	Balance	Component	Concentration	Uncertainty(%)	NIST Reference
47-G-29	02/20/2022	SRM	N2	NO	2989 PPM	0.217	2631a
EB0003465.20160718	03/21/2025	GMIS	N2	NO	2860 PPM	0.181	2631A
EB0013721	05/05/2025	GMIS	N2	CO	2333 PPM	0.347	2639a
EB0031829.20160114g	05/17/2024	GMIS	N2	C3H8	2461 PPM	0.57	2647a
EB0043392.20160721	07/21/2017	PS	N2	SF6	10.1 PPM	5	BL1108098
EB0063630.20161027	03/07/2024	GMIS	N2	CO	4930 PPM	0.388	2639A
GC1302210752	06/14/2021	GMIS	N2	C3H8	1003 PPM	0.549	2647a

Analytical Instrumentation

Component	Analytical Principle	Make	Model	Serial
NO	Chemiluminescence	Thermo	42i-HL	1162380008
C3H8	FTIR	MKS	MKS 2031DJG2EKVS13T	017146467
SF6	FTIR	MKS	MKS 2031DJG2EKVS13T	017146467
CO	GCF	Thermo	T48C	0414606441

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Accreditation #62754



Nate Fielder
Analyst

Version 02-B, Revised on 2015-05-27

Appendix C

Tester CV



Michael Tahirak

Project Manager

Qualified (Education): Attended State University of New York at Buffalo, Physical Geography and Cartography.

Connected (professional affiliations):

QSTI (Qualified Source Testing Individual) I: Manual Gas Volume Measurements & Isokinetic PM Sampling Methods

QSTI II: Hazardous Metals Measurement Sampling Methods

QSTI III: Manual Gaseous Pollutants Source Sampling Methods

QSTI IV: Gaseous Pollutants Instrumental Sampling Methods

Professional Summary: Michael has nearly 25 years of source testing experience at all levels of the work, from Field Technician to Project Manager on hundreds of source tests, including international testing.

Project Manager

Tynes Bay Municipal Waste Incinerator |
Ministry of Works and Environment | Bermuda

Michael has managed this annual contract for regulatory compliance stack testing. It includes multiple parameters and air toxics along with the challenges of international travel and shipments of equipment and hazardous goods. An annual project performed for 16 years.

Project Manager

Owens Corning | Owens Corning
Environmental Management Office |
Granville, Ohio

- Michael has managed many stack testing projects at multiple facilities for this major manufacturing firm. Programs have included regulatory compliance issues and in-house studies for research and development, and optimization cost-effectiveness studies. Testing performed at both fiberglass production and asphalt/roofing products facilities. Work has included facilities in Newark, Columbus, and Mt. Vernon, Ohio; Albany, NY; Atlanta, GA; Baltimore, MD; Kansas City, MO; and others.

Project Manager

Eastman Kodak Company | Rochester, New York

- Project Manager for this major firm on many high profile projects. The projects for this firm have been wide-ranging and performed at multiple

locations at three of their major facilities. Has been project manager of all HSE work performed by 4 former Kodak employees at the Kodak Park, Rochester location since it was outsourced 12 years ago. Works in close conjunction with Kodak HSE manager to ensure all required and requested projects are completed properly and within budget.

Project Manager

Sabin Metals | Sabin Metal Corporation |
Rochester, New York

- Managed multiple and repeat projects for this specialty metals client. Projects including compliance testing, pilot model testing, and optimization testing. Facilities include Scottsville, NY, a pilot kiln in Wisconsin, and Williston, ND. A repeat client for over 5 years.

Project Manager

Engine Testing | Various Clients | Throughout Texas

Manages and performs 40 CFR Part 60 Subpart JJJJ; 30 TAC 106.512; 40 CFR Part 63, Subpart ZZZZ and other engine testing, utilizing FTIR throughout Texas, including dozens of tests in the Permian and Eagle Ford Basins.

Work history

2002 – present	GHD (formerly Conestoga-Rovers & Associates), Niagara Falls, NY
1992 - 2002	E3 Killam, Buffalo, NY

www.ghd.com

