ARCO OIL and GAS COMPANY
SOUTHEASTERN DISTRICT

P.O. BOX 51408

LAFAYETTE, LOUISIANA 70505

OXIDES OF NITROGEN and CARBON MONOXIDE EMISSION TESTING on ENGINE #3 AND #16 at JEANERETTE FIELD

JULY 29-30, 1991

Submitted By :

EMISSION TESTING SERVICES, INC.

POST OFFICE BOX 15075

BATON ROUGE, LOUISIANA 70895

91098

EMISSION TESTING SERVICES, INC.

POST OFFICE BOX 15075

BATON ROUGE, LOUISIANA 70895

CONFIRMATION OF INFORMATION

EMISSION TEST REPORT

FOR

ARCO OIL and GAS COMPANY
SOUTHEASTERN DISTRICT

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JULY 29-30, 1991

JULY 23, 1991

I certify that I have personally examined and am familiar with the information submitted herein, and based on my inquiries of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate, and complete.

Mario Ramon
ARCO Oil and Gas Company
Company Representative

Brad Latham
Brad Latham
Emission Testing Services
Project Leader

Barry Gipson
Barry Gipson
Emission Testing Services
Manager

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I. INTRODUCTION

Emission Testing Services, Inc. was contracted by ARCO Oil and Gas Company to conduct emission testing on two internal combustion engines. Engine, source ID 3, is located at the Graben No. 1 facility and Engine, source ID 16, is located at the North Central Battery, Gas Production Facility. Both facilities are located at the Jeanerette Field near Jeanerette, Louisiana. Oxides of nitrogen and carbon monoxide emissions were determined in order to demonstrate compliance within permit limits. Emissions at Graben No. 1 are limited under permit number 2660-00090-00 and emissions at the North Central Battery are limited under permit number 2660-00091-01.

Testing was conducted following EPA Methods 7E and 10 for the determination of oxides of nitrogen and carbon monoxide respectively. EPA Methods 1-4 were used to determine the number and location of sample traverse points and the stack gas velocity, molecular weight, moisture, and volumetric flow rate.

The testing team consisted of Brad Latham, Scott Lesley, and Kevin Thibodeaux. Mario Ramon represented ARCO and coordinated testing with facility operations. The Louisiana Department of Environmental Quality was not represented during the testing.

Emissions from Engine #3 were determined during three test runs conducted on July 30, 1991 . During these tests, the engine was operating at a load rate of 94%.

Emissions from Engine #16 were determined during three test runs conducted on July 29, 1991 . During these tests, the engine was operating at a load rate of 94%.

II. SUMMARY

Results of emission testing conducted on Engine #3 are presented in Table I. A summary of Engine #16 test results are presented in Table II.

TABLE I
EMISSION TESTING RESULTS SUMMARY

ARCO OIL and GAS COMPANY
JEANERETTE FIELD
ENGINE #3

PARAMETER	PERMIT LIMIT	RUN 1	RUN 2	RUN 3	AVG.
DATE		7-30-91	7-30-91	7-30-91	
TIME		1034-1133	1224-1323	1358-1457	
OXIDES OF NITROGEN					
(PPM)		1610.0	1640.0	1628.4	1626.1
(lb/hr)	19.4	7.635	7.858	7.600	7.698
CARBON MONOXIDE					
(PPM)		539.2	468.9	466.8	491.6
(lb/hr)	2.48	1.556	1.368	1.326	1.417
OXYGEN, test analyzer,%		3.61	3.62	3.66	3.63
ENGINE OPERATING DATA					
Fuel rate, ft3/hr		3000	3000	3000	3000
Engine speed, rpm		613	612	612	612
Horse power,		750	750	750	750
GAS PROCESSING RATE, MM scf/day					2.5
STACK GAS DATA					
Temp., deg F		542	544	547	544
Moisture, %		17.23	16.95	17.29	17.16
Velocity, ft/sec		45.93	46.52	45.57	46.01
Flow rate, ACFM		1503.1	1522.4	1491.4	1505.6
, DSCFM		661.5	668.3	651.0	660.3

TABLE II
EMISSION TESTING RESULTS SUMMARY

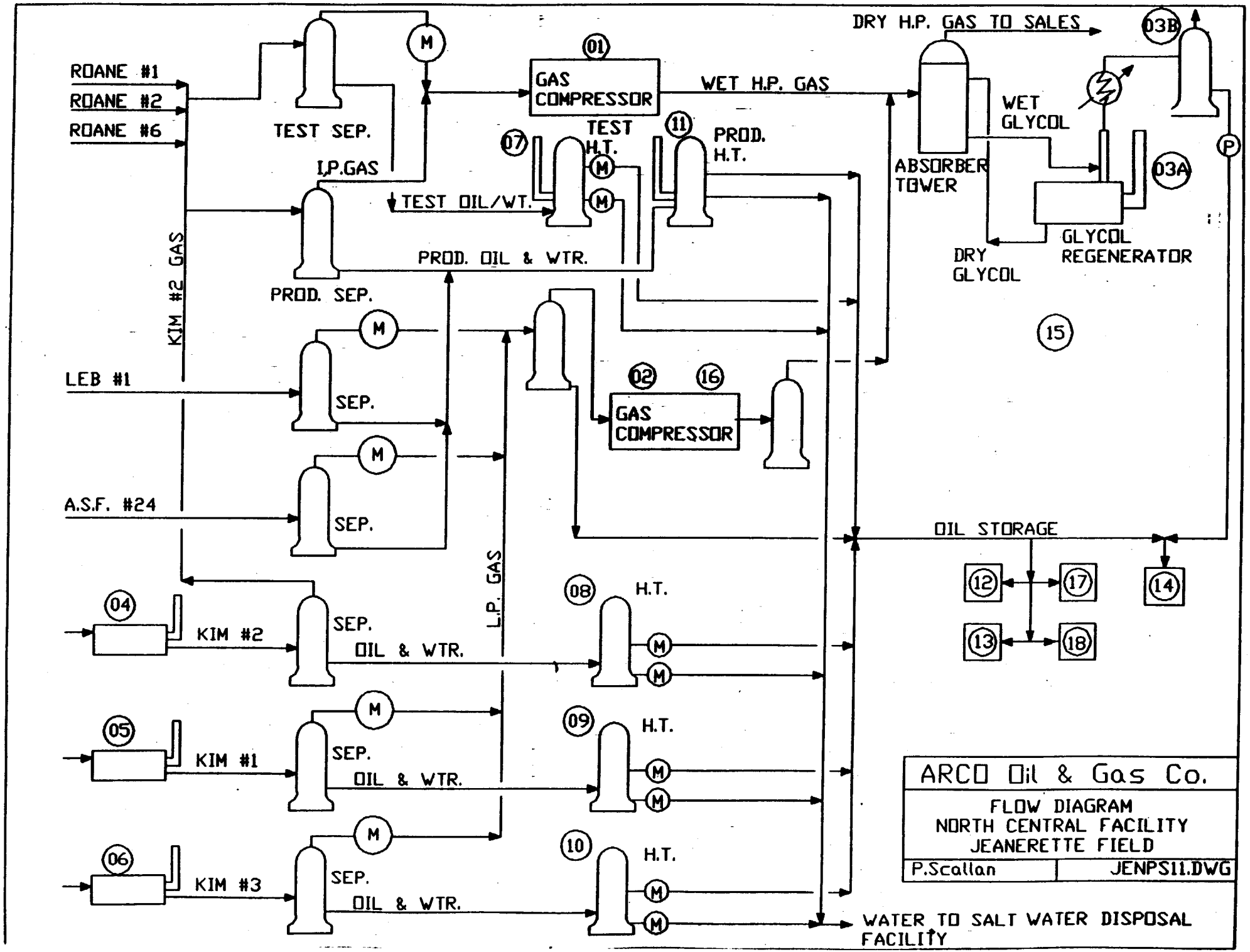
ARCO OIL and GAS COMPANY
JEANERETTE FIELD
ENGINE #16

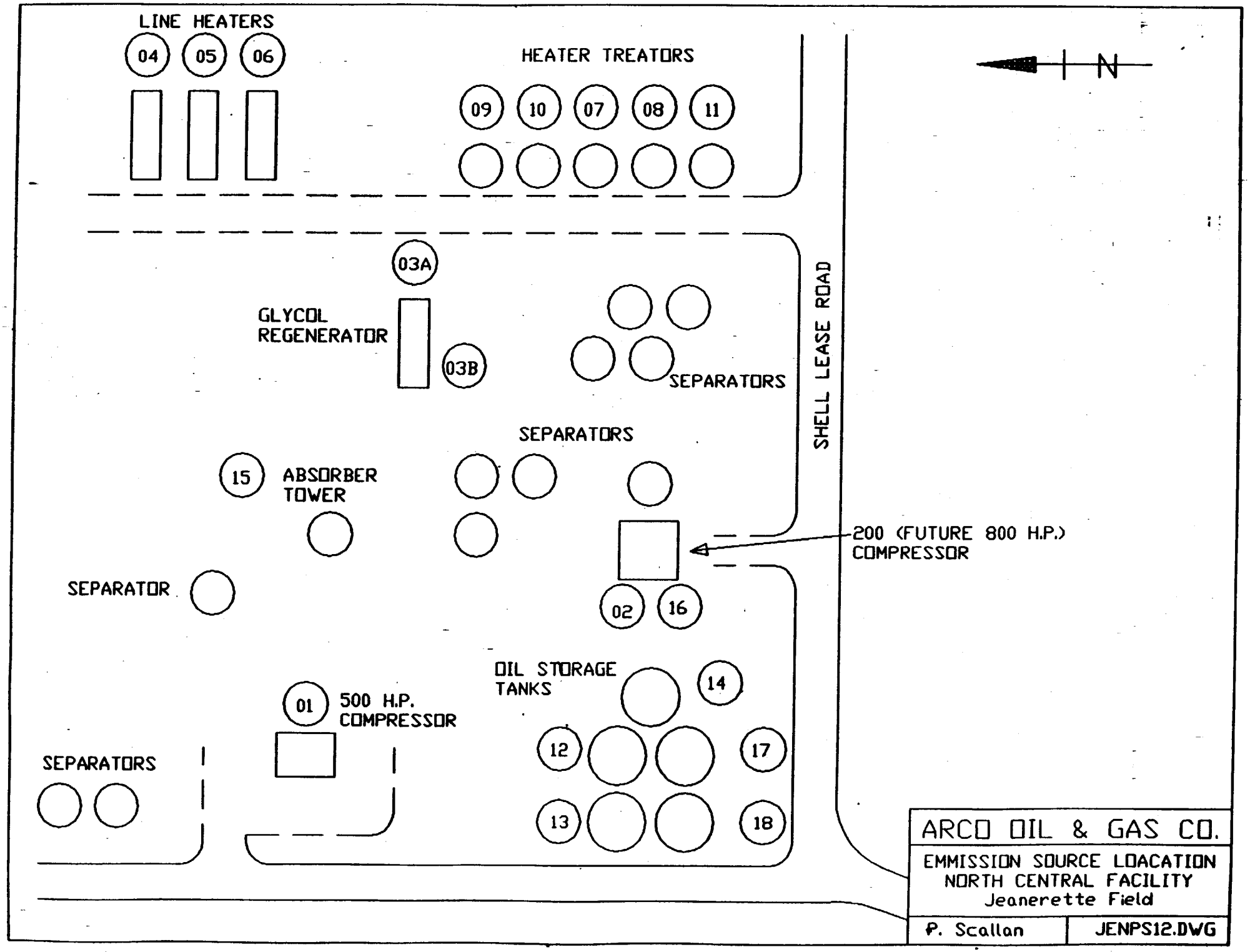
PARAMETER	PERMIT LIMIT	RUN 1	RUN 2	RUN 3	AVG.
DATE		7-29-91	7-29-91	7-29-91	
TIME		1419-1518	1538-1636	1654-1753	
OXIDES OF NITROGEN					
(PPM)		3213.5	3203.7	3171.4	3196.2
(lb/hr)	19.2	16.716	16.729	16.420	16.622
CARBON MONOXIDE					
(PPM)		324.7	319.4	321.9	322.0
(lb/hr)	2.48	1.028	1.015	1.014	1.019
OXYGEN, test analyzer,%		2.10	2.09	2.18	2.12
ENGINE OPERATING DATA					
Fuel rate, ft3/hr		2165	2165	2165	2165
Engine speed, rpm		666	657	656	660
Horse power,		750	750	750	750
GAS PROCESSING RATE, MM scf/day					2.0
STACK GAS DATA					
Temp., deg F		570	572	568	570
Moisture, %		18.51	17.90	18.14	18.18
Velocity, ft/sec		52.77	52.77	52.18	52.57
Flow rate, ACFM		1727.0	1726.7	1707.6	1720.4
, DSCFM		725.7	728.4	722.2	725.4

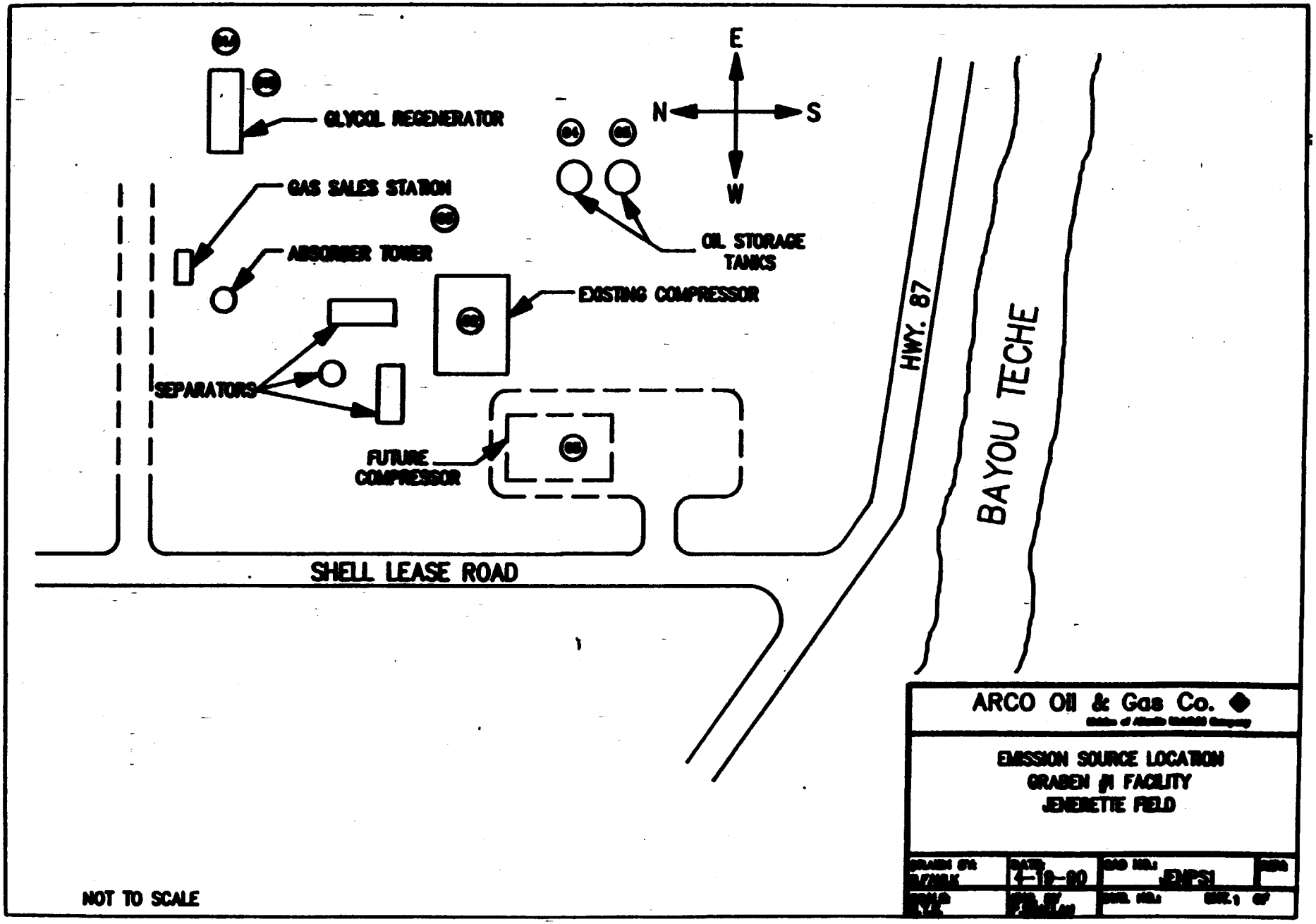
PROCESS DESCRIPTION

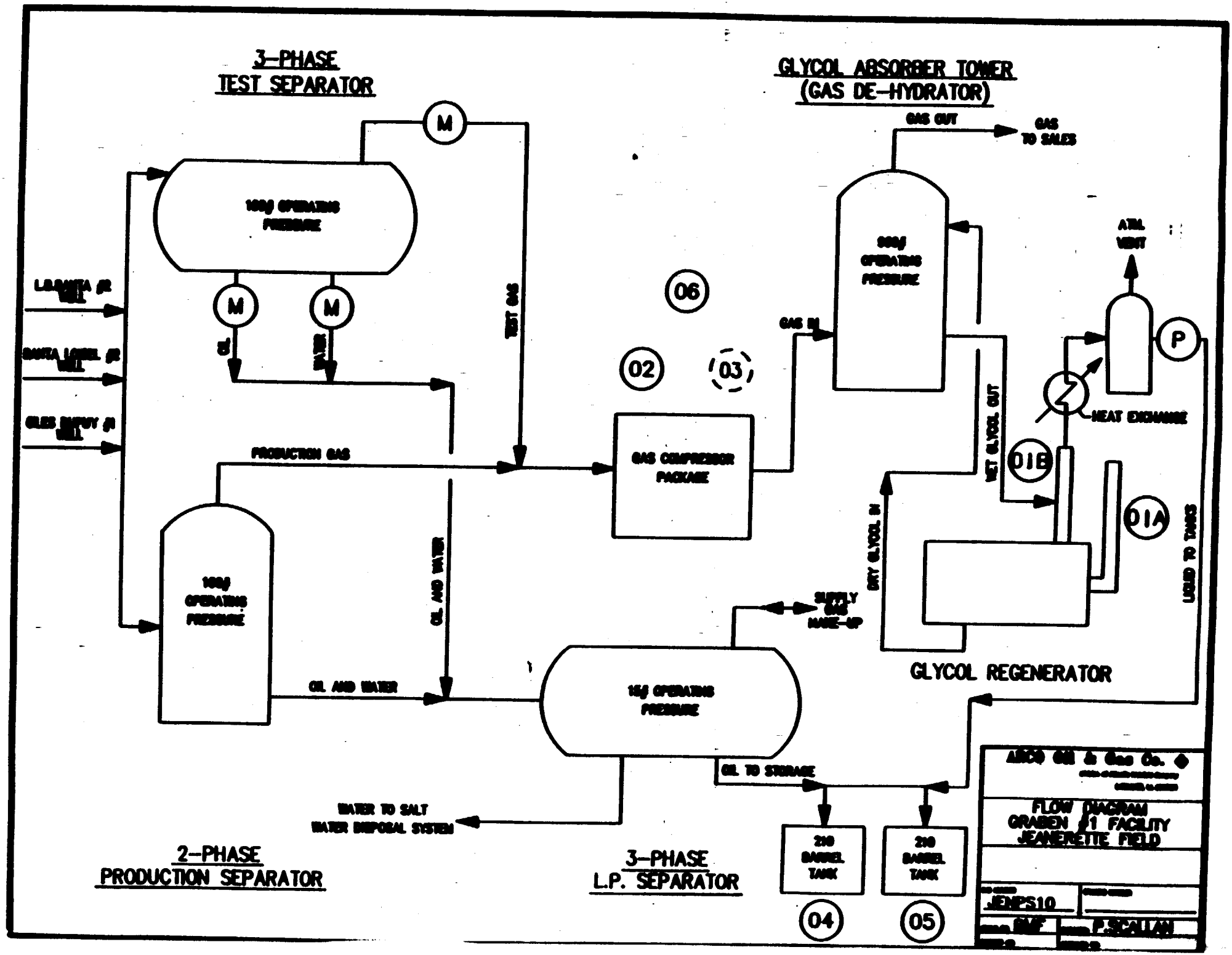
Engine, source ID 3, is located at the Graben No. 1 natural gas processing facility. Engine, source ID 16, is located at the North Central Battery. Both facilities consist of equipment which separates crude oil and salt water from natural gas. Crude oil is separated from produced saltwater and a fired reboiler is used to breakup oil and water emulsions. A glycol unit removes moisture from the natural gas which is compressed and sold.

Facility and process diagrams are presented in Figures I-IV.


ROANE #1
ROANE #2
ROANE #6
TEST SEP.
I.P.GAS
KIM #2 GAS
PROD. SEP.
M
01
GAS COMPRESSOR
WET H.P. GAS
DRY H.P. GAS TO SALES
03B
07
TEST H.T.
11
PROD. H.T.
TEST OIL/WT.
PROD. OIL & WTR.
ABSORBER TOWER
WET GLYCOL
03A
P
DRY GLYCOL
GLYCOL REGENERATOR
15
LEB #1
SEP.
02
16
GAS COMPRESSOR
A.S.F. #24
OIL STORAGE
L.P. GAS
12
17
14
13
18
04
KIM #2
SEP.
OIL & WTR.
08
H.T.
05
KIM #1
09
06
KIM #3
10
WATER TO SALT WATER DISPOSAL FACILITY
ARCO Oil & Gas Co.
FLOW DIAGRAM
NORTH CENTRAL FACILITY
JEANERETTE FIELD
P.Scallan
JENPS11.DWG


LINE HEATERS
04
05
06
HEATER TREATORS
09
10
07
08
11
N
03A
GLYCOL
REGENERATOR
03B
SEPARATORS
SHELL LEASE ROAD
SEPARATORS
15
ABSORBER
TOWER
200 (FUTURE 800 H.P.)
COMPRESSOR
SEPARATOR
02
16
OIL STORAGE
TANKS
14
01
500 H.P.
COMPRESSOR
12
17
SEPARATORS
13
18
ARCO OIL & GAS CO.
EMMISSION SOURCE LOACATION
NORTH CENTRAL FACILITY
Jeanerette Field
P. Scallan
JENPS12.DWG


GLYCOL REGENERATOR
GAS SALES STATION
ABSORBER TOWER
SEPARATORS
FUTURE COMPRESSOR
EXISTING COMPRESSOR
OIL STORAGE TANKS
E
N
S
W
HWY. 87
BAYOU TECHE
SHELL LEASE ROAD
NOT TO SCALE
ARCO Oil & Gas Co.
EMISSION SOURCE LOCATION
GRABEN #1 FACILITY
JENERETTE FIELD


3-PHASE
TEST SEPARATOR
GLYCOL ABSORBER TOWER
(GAS DE-HYDRATOR)
GAS OUT
GAS
TO SALES
ATM.
VENT
M
M
M
OIL
WATER
TEST GAS
06
02
03
GAS IN
P
HEAT EXCHANGE
WET GLYCOL OUT
01B
01A
PRODUCTION GAS
GAS COMPRESSOR
PACKAGE
DRY GLYCOL IN
LIQUID TO TANKS
OIL AND WATER
SUPPLY
GAS
MAKE-UP
GLYCOL REGENERATOR
OIL AND WATER
OIL TO STORAGE
WATER TO SALT
WATER DISPOSAL SYSTEM
2-PHASE
PRODUCTION SEPARATOR
3-PHASE
L.P. SEPARATOR
210
BARREL
TANK
210
BARREL
TANK
04
05
ARCO Oil & Gas Co.
FLOW DIAGRAM
GRABEN #1 FACILITY
JEANERETTE FIELD
JENPS10
BMF
P.SCALLAN

METHOD 3A: DETERMINATION OF OXYGEN CONCENTRATIONS IN EMISSIONS FROM STATIONARY SOURCES. (INSTRUMENTAL ANALYZER PROCEDURE)

A gas sample was continuously extracted from the stack using a heated probe and sample line. The sample was transferred to an oxygen analyzer. Analyzer output was continuously recorded by a data acquisition system. Results from the oxygen monitor were used for reference purposes only and were not used to determine stack gas molecular weight.

METHOD 4: DETERMINATION OF MOISTURE CONTENT IN STACK GASES

A gas sample was extracted from the stack using a heated glass probe fitted with a particulate filter. The sample gas passed from the probe, through a series of four impingers immersed in an ice bath. The first two impingers contained measured volumes of water, the third was empty, and the fourth contained a known weight of silica gel. Any water vapor in the gas stream was condensed and trapped in the impingers. Moisture was determined gravimetrically.

METHOD '7E: DETERMINATION OF NITROGEN OXIDES EMISSIONS FROM STATIONARY SOURCES

A gas sample was continuously extracted from the stack at a centroidal sampling point. The sample was transferred through a heated sample line to continuous chemiluminescence analyzer for the determination of oxides of nitrogen concentration.

METHOD 10: DETERMINATION OF CARBON MONOXIDE EMISSIONS FROM STATIONARY SOURCES

A gas sample was continuously extracted from the stack at a centroidal sampling point. The sample was transferred through a heated sample line to a continuous nondispersive infrared analyzer for the determination of carbon monoxide concentration

IV. ANALYTICAL TECHNIQUE

All sample analyses were conducted following EPA methodology. A brief description follows for each method employed.

METHOD 7E: DETERMINATION OF NITROGEN OXIDES EMISSIONS FROM STATIONARY SOURCES

All samples collected were analyzed in the field using a continuous chemiluminescence analyzer. The analyzer was calibrated using gas standards prepared by EPA protocol number 1, traceable to NBS standards.

METHOD 10: DETERMINATION OF CARBON MONOXIDE EMISSIONS FROM STATIONARY SOURCES

All samples collected were analyzed in the field using a continuous nondispersive infrared analyzer. The analyzer was calibrated using gas standards prepared by EPA protocol number 1, traceable to NBS standards.

V. CHAIN of CUSTODY

For all samples transported to the laboratory for analysis, a Chain of Custody form is prepared during the sample recovery process. Since all sample analyses were conducted in the field, no chain of custody procedures were initiated.

METHOD 3A DATA SHEET

COMPANY Arco SOURCE # 3 DATE 7-3-91

PARAMETER O_2 LOAD% _____ RUN NUMBER 1

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response v	Analyzer Response %	Absolute Difference v	Absolute Difference %	% Span ±2%
Zero	0.0	0.07	0.20	0.07	0.20	0.0
Mid	1.10	0.33	0.89	0.33	0.89	0.0
High	11.70	4.40	11.71	4.35	11.58	-0.49

Calibration curve: ppm = (response v)(slope) + intercept

Slope 2.65928 Intercept 0.01182 Span Range 26.60

Analyzer Cal		Init. Analyzer Resp. v	ppm	Bias ±5	Final Analyzer Resp. v	ppm	Bias ±5	Span Drift ±3
Conc.	N_2	0.07	0.20	0.0	0.07	0.20	0.0	0.0

$$\text{Sys. Cal. Bias} = \frac{\text{Sys. cal. (ppm)} - \text{analyzer cal. (ppm)}}{\text{Span (ppm)}} \times 100$$

$$\%\text{Drift} = \frac{\text{Final sys. resp. (ppm)} - \text{Initial sys. resp. (ppm)}}{\text{span (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	v				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. v ____

Ave. conc. _____ %

COMMENTS: R: 0.99950

METHOD 7E DATA SHEET

COMPANY Arco SOURCE # 3 DATE 7-30-91

PARAMETER Nox LOAD% _____ RUN NUMBER 1

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response mv	Analyzer Response ppm	Absolute Difference mv	Absolute Difference ppm	% Drift ±2%
Zero	N_2	0.03	2.62	0.01	-7.37	-0.20
Mid	397.48	0.81	392.30	0.32	397.29	0.10
High	789.4	1.61	791.95	1.59	781.97	-0.20

Calibration curve: ppm = (response mv)(slope) + intercept

Slope 499.57872 Intercept -12.36262 Span Range 4983.42

Analyzer Cal	Init. Analyzer Resp. mv	Init. Analyzer Resp. ppm	Init. Analyzer Resp. Bias ±5	Final Analyzer Resp. mv	Final Analyzer Resp. ppm	Final Analyzer Resp. Bias ±5	Final Analyzer Resp. Drift ±3
Conc. 397.48	0.80	387.3	-0.10	0.82	397.29	0.10	0.20

Sys. Cal. Bias = $\frac{\text{Sys. cal. (ppm)} - \text{analyzer cal. (ppm)}}{\text{Span (ppm)}} \times 100$

%Drift = $\frac{\text{Final sys. resp. (ppm)} - \text{Initial sys. resp. (ppm)}}{\text{span (ppm)}} \times 100$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	mv				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. mv ____

Ave. conc. _____ ppm

COMMENTS: R. 0.99994

EMISSION TESTING SERVICES, INC.

METHOD 10 DATA SHEET

COMPANY Arco SOURCE # 3 DATE 7-30-91

PARAMETER CO LOAD% _____ RUN NUMBER 1

CALIBRATION STATISTICS

	Cylinder Value	Initial Analyzer Response mv	Initial Analyzer Response ppm	Final Analyzer Response mv	Final Analyzer Response ppm	%Drift
Zero	N_2	0.03	-1.05	0.02	-2.06	-0.10
Low	89.69	0.92	88.67	0.91	87.66	-0.10
Mid	301.4	3.06	304.39	3.03	301.96	-0.30
High	895.0	8.91	894.08	8.92	895.09	0.10

Calibration curve: ppm = (response mv)(slope) + intercept

Slope 100.80301 Intercept -4.07123 Span Range 1003.96

$$\%Drift = \frac{\text{Final response (ppm)} - \text{Initial response (ppm)}}{\text{Initial response (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	mv.				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. mv ____

Ave. conc. _____ ppm

COMMENTS: R: 0.99999

METHOD 3A DATA SHEET

COMPANY Arco SOURCE # 3 DATE 7-30-91

PARAMETER O_2 LOAD% _____ RUN NUMBER 2

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response v	Analyzer Response %	Absolute Difference v	Absolute Difference %	% Span ±2%
Zero	N_2	0.07	0.19	0.07	0.19	0.0
Mid	1.10	0.33	0.89	0.33	0.89	0.0
High	11.70	4.35	11.71	4.34	11.69	-0.07

Calibration curve: ppm = (response v)(slope) + intercept

Slope 2.69128 Intercept 0.00547 Span Range 26.92

Analyzer Cal		Init. Analyzer Resp. v	ppm	Bias ±5	Final Analyzer Resp. v	ppm	Bias ±5	Span Drift ±3
Conc.	N_2	0.07	0.19	0.0	0.07	0.19	0.0	0.0

$$\text{Sys. Cal. Bias} = \frac{\text{Sys. cal. (ppm)} - \text{analyzer cal. (ppm)}}{\text{Span (ppm)}} \times 100$$

$$\%\text{Drift} = \frac{\text{Final sys. resp. (ppm)} - \text{Initial sys. resp. (ppm)}}{\text{span (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Test Point v Sample port _____

1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. v ____

Ave. conc. _____ %

COMMENTS: R = 0.99952

METHOD 7E DATA SHEET

COMPANY Arco SOURCE # 3 DATE 7-30-91

PARAMETER NOx LOAD% _____ RUN NUMBER 2

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response mv	Analyzer Response ppm	Absolute Difference mv	Absolute Difference ppm	% Drift ±2%
Zero	N_2	0.01	-2.34	0.01	-2.34	0.0
Mid	397.48	0.82	402.29	0.81	397.29	-0.10
High	789.4	1.59	786.94	1.58	781.94	-0.10

Calibration curve: ppm = (response mv)(slope) + intercept

Slope 499.54323 Intercept -7.33820 Span Range 4988.09

Analyzer Cal	Init. Analyzer Resp. mv	ppm	Bias ±5	Final Analyzer Resp. mv	ppm	Bias ±5	Drift ±3
Conc. 397.48	0.82	402.29	0.0	0.81	~~[illegible]~~ 397.29	0.0	-0.10

Sys. Cal. Bias = $\frac{\text{Sys. cal. (ppm)} - \text{analyzer cal. (ppm)}}{\text{Span (ppm)}} \times 100$

%Drift = $\frac{\text{Final sys. resp. (ppm)} - \text{Initial sys. resp. (ppm)}}{\text{span (ppm)}} \times 100$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	mv				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. mv ____

Ave. conc. _____ ppm

COMMENTS: R = 0.99994

EMISSION TESTING SERVICES, INC.

METHOD 10 DATA SHEET

COMPANY Arco SOURCE # 3 DATE 7-30-91

PARAMETER CO LOAD% _____ RUN NUMBER 2

CALIBRATION STATISTICS

	Cylinder Value	Initial Analyzer Response mv	Initial Analyzer Response ppm	Final Analyzer Response mv	Final Analyzer Response ppm	%Drift
Zero	N_2	0.02	-0.26	0.01	-1.27	-0.10
Low	89.69	0.91	89.23	0.91	89.23	0.0
Mid	301.4	3.03	302.42	3.01	300.41	-0.20
High	895.0	8.92	894.70	8.88	890.68	-0.40

Calibration curve: ppm = (response mv)(slope) + intercept

Slope 100.55277 Intercept -2.27357 Span Range 1,003.30

$$\%Drift = \frac{\text{Final response (ppm)} - \text{Initial response (ppm)}}{\text{Initial response (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	mv.				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. mv ____

Ave. conc. _____ ppm

COMMENTS: R = 0.99999

METHOD 3A DATA SHEET

COMPANY Aeco SOURCE # 3 DATE 7-30-91

PARAMETER O_2 LOAD% _____ RUN NUMBER 3

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response v	Analyzer Response %	Absolute Difference v	Absolute Difference %	% Span ±2%
Zero	N_2	0.07	0.19	0.07	0.19	0.0
Mid	1.10	0.33	0.89	0.33	0.89	0.0
High	11.70	4.34	11.71	4.35	11.74	0.11

Calibration curve: ppm = (response v)(slope) + intercept

Slope 2.69777 Intercept 0.00419 Span Range 26.98

Analyzer Cal	Init. Analyzer Resp. v	ppm	Bias ±5	Final Analyzer Resp. v	ppm	Bias ±5	Span Drift ±3
Conc. N_2	0.07	0.19	0.0	0.07	0.19	0.0	0.0

$$\text{Sys. Cal. Bias} = \frac{\text{Sys. cal. (ppm)} - \text{analyzer cal. (ppm)}}{\text{Span (ppm)}} \times 100$$

$$\%\text{Drift} = \frac{\text{Final sys. resp. (ppm)} - \text{Initial sys. resp. (ppm)}}{\text{span (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	v				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. v ____

Ave. conc. _____ %

COMMENTS: R= 0.99952

METHOD 7E DATA SHEET

COMPANY Arco SOURCE # 3 DATE 7-30-91

PARAMETER NOx LOAD% _____ RUN NUMBER 3

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response mv	Analyzer Response ppm	Absolute Difference mv	Absolute Difference ppm	% Drift ±2%
Zero	N_2	0.01	-1.56	0.01	-1.56	0.0
Mid	397.48	0.81	400.65	0.80	395.63	-0.1
High	789.4	1.58	787.78	1.58	787.78	0.0

Calibration curve: ppm = (response mv)(slope) + intercept

Slope 502.76391 Intercept -6.58446 Span Range 5021.05

Analyzer Cal	Init. Analyzer Resp. mv	Init. Analyzer Resp. ppm	Bias ±5	Final Analyzer Resp. mv	Final Analyzer Resp. ppm	Bias ±5	Drift ±3
Conc. 397.48	0.81	400.65	0.0	0.80	395.63	0.0	-0.10

$$\text{Sys. Cal. Bias} = \frac{\text{Sys. cal. (ppm)} - \text{analyzer cal. (ppm)}}{\text{Span (ppm)}} \times 100$$

$$\%\text{Drift} = \frac{\text{Final sys. resp. (ppm)} - \text{Initial sys. resp. (ppm)}}{\text{span (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	mv				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. mv ____

Ave. conc. _____ ppm

COMMENTS: R = 0.99998

EMISSION TESTING SERVICES, INC.

METHOD 10 DATA SHEET

COMPANY Arco SOURCE # 3 DATE 7-30-91

PARAMETER CO LOAD% _____ RUN NUMBER 3

CALIBRATION STATISTICS

	Cylinder Value	Initial Analyzer Response mv	Initial Analyzer Response ppm	Final Analyzer Response mv	Final Analyzer Response ppm	%Drift
Zero	N_2	0.01	-0.80	0.02	0.21	0.10
Low	89.69	0.91	90.07	0.91	90.07	0.0
Mid	301.4	3.01	302.09	3.02	303.10	0.10
High	895.0	8.88	894.73	8.89	895.74	0.10

Calibration curve: ppm = (response mv)(slope) + intercept

Slope 100.96107 Intercept -1.80534 Span Range 1007.81

$$\%Drift = \frac{\text{Final response (ppm)} - \text{Initial response (ppm)}}{\text{Initial response (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point _____

Sample port _____

Test Point	mv				
1		11		21	
2		12		22	
3		13		23	
4		14		24	
5		15		25	
6		16		26	
7		17		27	
8		18		28	
9		19		29	
10		20		30	

Ave. mv _____

Ave. conc. _____ ppm

COMMENTS: R = 0.99999

During emission testing, ARCO personnel recorded engine operating data. These data are presented on the following pages.

EMISSION TESTING SERVICES, INC.

INTERNAL COMBUSTION ENGINE OPERATIONAL RECORD

Company Name ARCO Oil & Gas Company

Company Location Graben No. 1 Jeanerette Field

Engine Name Graben No. 1

Engine Source I. D. No. Emission Pt. No. 3

Design Specifications

Manufacturer's Name Waukesha

Model No. 704K Serial No. 335799

Parameter Specifications

A. Fuel Type Nat Gas B. Fuel Supplier ARCO Production Jeanerette Field

C. Fuel Flow Units 3M SCF/hr Meas. Method Calculated

D. Is unit equipped for waste heat recovery? NO

Describe

E. Does unit use water or steam injection? No

If so, describe measurement method (continuous flow, start-finish volumes, etc)

F. Manifold Pressure units (psia, kpa, etc.) app. -10 kpa

G. Manifold Temp.(°F, °C, etc.) None

Ultimate Fuel Analysis

C _____ S _____ H _____ Ash _____

O _____ H_2O _____ N _____

Trace Metals: Na _____ Va _____ K _____

Fuel elements added None

Fuel elements added for smoke suppression None

EMISSION TESTING SERVICES, INC.

INTERNAL COMBUSTION ENGINE

TEST RUN LOG

(GAS ENGINES)

Company ARCO Oil & GAS

Engine GRABEN No. 1

Operator ETS B.L

Date: 7-30-91 Test Time: Start 10:34 End 11:34

Ambient Temperature, at time of test 92°F

Engine Load Condition %

DATA LOG TIME (15 minute intervals)	10:34	10:49	11:04	11:19
Fuel Feed (flow)	3000			
Intake Manifold Temp.	NONE			
Intake Manifold Pressure	9.0"Hg	8.5 ~~8.5~~	8.5	8.5
Fuel Header Pressure	4 oz			
Engine Speed (rpm)	613	613	612	613
Spark Ignition Timing	24°			
Horse Power	750			

Run Conditions: RUN #1

Remarks: 81°F wet 92°F Dry

EMISSION TESTING SERVICES, INC.

INTERNAL COMBUSTION ENGINE

TEST RUN LOG

(GAS ENGINES)

Company: ARCO Oil & GAS

Engine: GRABAN No. 1

Operator: ETS BL.

Date: 7-30-91 Test Time: Start 1224 End 1324

Ambient Temperature, at time of test _____

Engine Load Condition % _____

DATA LOG TIME (15 minute intervals)	1224	1239	1254	1309
Fuel Feed (flow)	3000			
Intake Manifold Temp.	None			
Intake Manifold Pressure	8.5" Hg	9.0	9.0	9.0
Fuel Header Pressure	4 oz			
Engine Speed (rpm)	612	612	612	612
Spark Ignition Timing	24°			
Horse Power	750			

Run Conditions: RUN #2

Remarks: 81°F 95°F

EMISSION TESTING SERVICES, INC.

INTERNAL COMBUSTION ENGINE

TEST RUN LOG

(GAS ENGINES)

Company: ARCO Oil & GAS

Engine: GRAMBAN No. 1

Operator: ETS B.C.

Date: 7-30-91 Test Time: Start 1358 End 1458

Ambient Temperature, at time of test

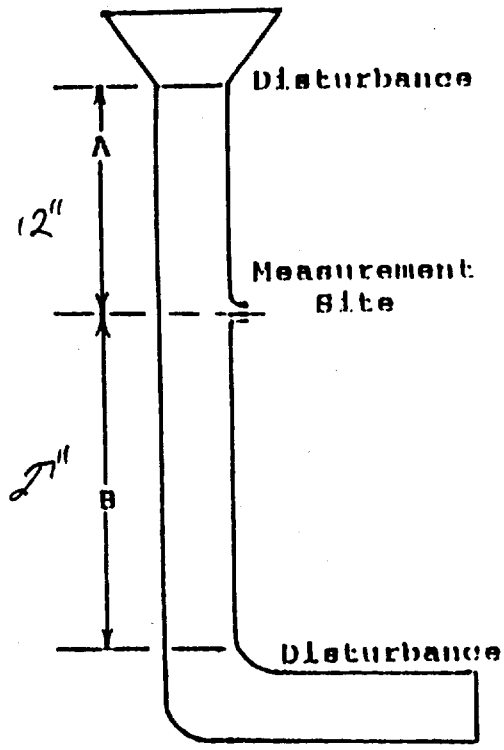
Engine Load Condition %

DATA LOG TIME (15 minute intervals)	1358	1413	14:28	14:43
Fuel Feed (flow)	3000			
Intake Manifold Temp.	NONE			
Intake Manifold Pressure	8.5"Hg	8.5"Hg	8.5"Hg	8.5"Hg
Fuel Header Pressure	4 oz			
Engine Speed (rpm)	612	612	611	611
Spark Ignition Timing	24°			
Horse Power	750			

Run Conditions: RUN # 1

Remarks: 88°F Wet 99°F Dry

Traverse Point Layout



Client: ARCO

Date: 29 July 91

Unit Tested: Eng. # 16

Location: North Central Battery

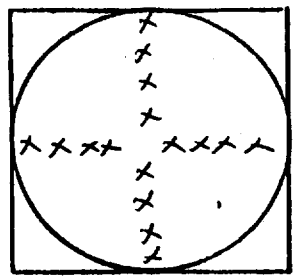
Upstream Distance (A): 12"

Downstream Distance (B): 27"

Inside Diameter: 10"

Coupling Length: 5"

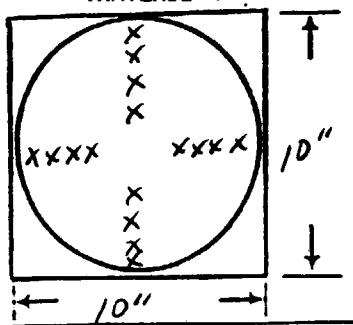
Coupling Type: 3" Female



Cross Section Schematic of Stack

Traverse Point	Distance % of Diameter		Stack Diameter		Coupling Length		Traverse Points
1	0.032	x	10"	+	5"	=	~~5.320~~ 5.5
2	0.105						6.050
3	0.194						6.940
4	0.323						8.230
5	0.677						11.770
6	0.806						13.060
7	0.895						13.950
8	0.968						~~14.680~~ 14.5
9							
10							
11							
12							

CROSS SECTIONAL SCHEMATIC OF STACK
TRAVERSE POINT LAYOUT



E T S FIELD DATA, METHOD(S) 1-4

PLANT Arco
DATE 072991
LOCATION Jeanerette, LA
OPERATOR K. Thibodeaux
STACK NO. #16 Engine
RUN NO. 1

SAMPLE BOX NO. BL
METER BOX NO. 500
AMBIENT TEMPERATURE N/A
BAROMETRIC PRESSURE 30.12
FILTER TARE wt mg N/A
NOZZLE DIAMETER, in. N/A

STACK DIAMETER, in. 10"
PITOT TUBE NO. P-3-3
PITOT FACTOR 0.837
METER Δ He 1.7259
D.G.M.C. FACTOR 0.9906
K FACTOR N/A

TRAVERSE POINT NUMBER	SAMPLING TIME (Θ), min.	STATIC PRESSURE (in.H2O)	STACK TEMP (Ts), °F	VELOCITY HEAD (ΔPs)	(√ΔPs)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft3	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tmin), °F	OUTLET (Tmout), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge
1	1418	-0.105	580	.500	.707	1.5	1.5	289.900	107	98	252	73	3.0
2	1421		580	.515	.718								
3	1424		579	.545	.738								
4	1427		577	.500	.707								
5	1430		570	.525	.724								
6	1433		574	.495	.703								
7	1436		560	.440	.663								
8	1442	off	558	.390	.624	1.5	1.5		140	117	260	70	3.0
1	1446	on	555	.680	.825	1.5	1.5		125	112	249	73	3.0
2	1449		562	.635	.797								
3	1452		570	.545	.738								
4	1455		573	.490	.700								
5	1458		573	.300	.548								
6	1501		573	.240	.490								
7	1504		572	.200	.447								
8	1510	off	571	.205	.453	1.5	1.5	320.110	145	121	271	75	3.0
AVERAGE	48 min	-0.105	570.44		0.664	1.5		30.210	120.12				

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS			
FINAL	589.4	571.1	476.0	607.4
INITIAL	495.2	545.5	472.7	594.1
WEIGHT COLLECTED	94.2	25.6	3.3	9.3

132.4

ORSAT MEASUREMENT

	CO2	O2	CO	N2
1	10.0	2.3	0.0	
2				
3				

COMMENTS:

PRE-LEAK CHECK GOOD @ 15" Hg. - .002 CFM
POST-LEAK CHECK GOOD @ 12" Hg. - .001 CFM
Wet - 78.8°F
Dry - 89.6°F

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #16
Testing Date : 7-29-91
Run : 1

DETERMINATION OF STACK GAS MOISTURE CONTENT

Bws - Moisture fraction content
dH - Pressure differential across meter orifice, in H2O
Mw - Molecular weight of water, 18.0 lb/ lb mole
Pb - Barometric pressure at meter, in-Hg
Pst - Standard absolute pressure, 29.92 in-Hg
R - Ideal gas constant, 21.85 in-Hg ft3/ lb-mole deg R
Tm - Absolute temperature at meter, deg R
Tst - Standard absolute temperature, 528 deg R
Vm - Dry gas volume measured by meter, DCF
Vmstd- Dry gas volume at standard conditions, DSCF
Vw - Volume of water vapor collected, SCF
Wwc - Weight of water vapor collected, lb
I1w, I2w, I3w, weight of water condensed by impingers, g
SGw, weight of water collected by silica gel, g
Y - Dry gas meter calibration factor

$$Wwc = (I1w + I2w + I3w + SGw) / (453.6\ g/lb)$$

$$= (94.2 + 25.6 + 3.3 + 9.3) / (453.6) = .29189$$

$$Vw = \frac{Wwc\ R\ Tst}{Pst\ Mw} = \frac{(.29189)(21.85)(528)}{(29.92)(18.0)} = 6.25268$$

$$Vmstd = Vm\ Y \frac{(Pb + dH/13.6)}{Pst} \frac{Tst}{Tm}$$

$$= (30.210)(.9906) \frac{(30.120 + 1.5000/13.6)}{(29.92)} \frac{(528)}{(580.)}$$

$$= 27.51960$$

$$Bws = \frac{Vw}{Vw + Vmstd} = \frac{(6.25268)}{(6.25268 + 27.51960)} = .1851$$

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #16
Testing Date : 7-29-91
Run : 1

DETERMINATION OF DRY MOLECULAR WEIGHT

Md - Dry molecular weight, lb/ lb-mole
%CO2 - Percent CO2 by volume (dry basis)
%O2 - Percent O2 by volume (dry basis)
%CO - Percent CO by volume (dry basis)
%N2 - Percent N2 by volume (dry basis)
0.280 - Molecular weight of N2 or CO, divided by 100
0.320 - Molecular weight of O2, divided by 100
0.440 - Molecular weight of CO2, divided by 100

$$Md = 0.440(\%CO2) + 0.320(\%O2) + 0.280(\%N2 + \%CO)$$

$$Md = 0.440(10.0) + 0.320(2.3) + 0.280(87.7 + .0)$$

$$= 29.692$$

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #16
Testing Date : 7-29-91
Run : 1

DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE

A - Cross-sectional area of stack, ft2
Bws - Moisture fraction of stack gas
Cp - Pitot tube coefficient
dP - Avg., square root of velocity head, (in-H2O)**0.5
Kp - Pitot tube constant,
ft/sec (lb in-Hg/ lb-mole deg R in H2O)**0.5
Md - Molecular weight of stack gas, dry basis, lb/ lb-mole
Ms - Molecular weight of stack gas, wet basis, lb/ lb-mole
Pbar - Barometric pressure at measurement site, in-Hg
Pg - Static pressure of the stack gas, in H2O
Ps - Absolute stack gas pressure, in-Hg
Pstd - Standard absolute pressure, 29.92 in-Hg
Acf - Actual stack gas flow rate, ACF/min
Qsd - Dry volumetric stack gas flow rate
standard conditions, DSCF/Hr
Ts - Average stack gas temperature, deg R
Tstd - Standard absolute temperature, 528 deg R
Vs - Average stack gas velocity, ft/sec
3600 - Conversion factor, sec to Hr
18.0 - Molecular weight of water, lb/lb-mole

$$Ms = Md\ (1 - Bws) + 18.0\ (Bws) =$$

$$= (29.692)(1 - .1851) + (18.0)(.1851) = 27.527$$

$$Vs = Kp\ Cp\ dP \left(\frac{Ts}{Ps\ Ms}\right)^{0.5} =$$

$$= (85.49)(.8370)(.6615)\left(\frac{1030.}{[30.112][27.527]}\right)^{0.5} = 52.7718$$

$$Acf = (60)(Vs)(A) = (60)(52.7718)(.5454) = 1727.0$$

$$Qsd = 3600\ (1 - Bws)\ Vs\ A\ \frac{Tstd}{Ts}\ \frac{Ps}{Pstd} =$$

$$Qsd = 3600(1 - .1851)(52.7718)(.5454)\frac{(528)(30.112)}{(1030.)(29.92)}$$

= 43541.9 DSCFH
= 725.7 DSCFM

Scott Specialty Gases

a division of Scott Environmental Technology, Inc.

1290 COMBERMERE STREET, TROY, MICHIGAN 48084 (313) 589-2950

Customer :
EMISSION TESTING SERVICES
10389 MAMMOTH DRIVE
BATON ROUGE LA 70895

Our Project # : 22331
Your P.O. # : 910322-FD
Expiration Date : 10-17-92
Cylinder Number : AAL-21037
Cylinder Pressure : 1900 psig

CERTIFICATE OF ANALYSIS - EPA PROTOCOL GASES

PERFORMED ACCORDING TO SECTION 3.0.4

Certified Per Traceability Protocol # 1 — Procedure # G1

File # PO 129

Certified Accuracy 1 % NBS Traceable

ANALYZED CYLINDER		REFERENCE STD			INSTRUMENTATION		
COMPONENT	CERTIFIED CONC.	SRM # (CRM #)	CYLINDER NUMBER	CONC.	INSTR/MODEL/SERIAL #	LAST CALIBRATION DATE	ANALYTICAL PRINCIPLE
NITRIC OXIDE	396.5 PPM .98 397.48	16866	CLN-340	489.00 PPM	BECKMAN 951 A	3-5-91	CHEMILUMINESCENCE
		1685	AAL-9851	236.00 PPM			

BALANCE GAS : NITROGEN

NITROGEN DIOXIDE 0.98 PPM (FROM SECOND ANALYSIS)

DRAFT PROTOCOL

FIRST ANALYSIS — DATE : 4-11-91

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	(mV)	RESULTS PPM
0.00	81.10	396.51	489.00 PPM	100.00	489.00
0.00	81.10	396.51		100.00	489.00
0.00	81.10	396.51		100.00	489.00

CALCULATED RESULTS: 396.51, 396.51, 396.51

AVERAGE : 396.51 PPM

SECOND ANALYSIS — DATE : 4-17-91

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	(mV)	RESULTS PPM
0.00	81.10	396.51	489.00 PPM	100.00	489.00
0.00	81.10	396.51		100.00	489.00
0.00	81.10	396.51		100.00	489.00
0.00	81.30 NOX	397.49			

CALCULATED RESULTS: 396.51, 396.51, 396.51 — 397.49 PPM NOX

AVERAGE : 396.51 PPM

CALIBRATION CURVE — 1 st DEGREE

SRM # (CRM #)	CONC. PPM	SPLIT PT (%)	DVM (mV)	FITTED VALUE	PERCENT ERROR
16866	489.00	100	100.00	489.00	0.00
	236.00	48	48.30	236.00	-0.00
		0		0.00	0.00
		0		0.00	0.00
		0		0.00	0.00
		0		0.0000	0.00
		0		0.00	0.00
1685	236.00	LOW	48.30	236.00	-0.00
N/A	236.00	GMIS*	0.00	-0.36	0.00

* GMIS - GAS MANUFACTURER'S INTERNAL STANDARD

Analyst : Frank P. Dora

Approved By : P. Shapiro

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the Company without [illegible]

METHOD 3A DATA SHEET

COMPANY Arco SOURCE # 3 DATE 7-3-91

PARAMETER O_2 LOAD% _____ RUN NUMBER 1

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response v	Analyzer Response %	Absolute Difference v	Absolute Difference %	% Span ±2%
Zero	0.0	0.07	0.20	0.07	0.20	0.0
Mid	1.10	0.33	0.89	0.33	0.89	0.0
High	11.70	4.40	11.71	4.35	11.58	-0.49

Calibration curve: ppm = (response v)(slope) + intercept

Slope 2.65928 Intercept 0.01182 Span Range 26.60

Analyzer Cal		Init. Analyzer Resp. v	ppm	Bias ±5	Final Analyzer Resp. v	ppm	Bias ±5	Span Drift ±3
Conc.	N_2	0.07	0.20	0.0	0.07	0.20	0.0	0.0

$$\text{Sys. Cal. Bias} = \frac{\text{Sys. cal. (ppm)} - \text{analyzer cal. (ppm)}}{\text{Span (ppm)}} \times 100$$

$$\%\text{Drift} = \frac{\text{Final sys. resp. (ppm)} - \text{Initial sys. resp. (ppm)}}{\text{span (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	v				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. v ____

Ave. conc. _____ %

COMMENTS: R: 0.99950

Scott Specialty Gases

a division of Scott Environmental Technology, Inc.

1290 COMBERMERE STREET, TROY, MICHIGAN 48084 (313) 589-2950

Our Project # : 22331

Your P.O. # : 910322-FD

Expiration Date : 10-23-92

Cylinder Number : ALM-016218

Cylinder Pressure 1900 psig

ustomer :
EMISSION TESTING SERVICE
10389 MAMMOTH DRIVE
BATON ROUGE LA 70895

* * * * CERTIFICATE OF ANALYSIS - EPA PROTOCOL GASES * * * *
PERFORMED ACCORDING TO SECTION 3.0.4

Certified Per Traceability Procedure # G1
Protocol # 1

File # PO 135

Certified Accuracy 1 % NBS Traceable

ANALYZED CYLINDER		REFERENCE STD			INSTRUMENTATION		
COMPONENT	CERTIFIED CONC.	SRM # (CRM #)	CYLINDER NUMBER	CONC.	INSTR/MODEL/SERIAL #	LAST CALIBRATION DATE	ANALYTICAL PRINCIPLE
ITRIC OXIDE	789.4 PPM	2630	FF-16158	1428.00 PPM	BECKMAN 951A	2-12-91	CHEMILUMINESCENCE
		GMIS1	AAL1111	513.00 PPM			

ALANCE GAS : NITROGEN

ITROGEN DIOXIDE 5.71 PPM (FROM SECOND ANALYSIS)

FIRST ANALYSIS DATE : 4-11-91

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	(mV)	RESULTS PPM
.00	55.30	790.32	1428.00 PPM	100.00	1428.00
.00	55.40	791.75		100.00	1428.00
.00	55.40	791.75		100.00	1428.00

CALCULATED RESULTS 790.32, 791.75, 791.75

AVERAGE : 791.27 PPM

SECOND ANALYSIS DATE : ,4-18-91

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	(mV)	RESULTS PPM
0.00	55.10	787.47	1428.00 PPM	100.00	1428.00
0.00	55.10	787.47		100.00	1428.00
0.00	55.10	787.47		100.00	1428.00
0.00	55.50 NOX	793.17			

CALCULATED RESULTS 787.47, 787.47, 787.47

793.17 PPM NOX

AVERAGE : 787.47 PPM

CALIBRATION CURVE 2 nd DEGREE

SRM # (CRM #)	CONC. PPM	SPLIT PT (%)	DVM (mV)	FITTED VALUE	PERCENT ERROR
2630	1428.00	100	100.00	1428.00	0.00
	513.00	36	35.70	510.71	-0.45
	489.00	34	34.20	489.31	0.06
	250.30	18	17.40	249.65	-0.26
	0.00	0	0.00	0.00	0.00
		0		0.0000	0.00
		0		0.00	0.00
16838	250.30	LOW	17.40	249.65	-0.26
N/A	513.00	GMIS1	35.70	510.71	-0.45

GMIS - GAS MANUFACTURER'S INTERNAL STANDARD

Analyst : Frank P. Dom

Approved By : S. Shapiro

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the Company without extra cost.

CARBON MONOXIDE ANALYZER
PRINCIPLE OF OPERATION and SPECIFICATIONS

THERMO ENVIRONMENTAL INSTRUMENTS

Model Number : 48

I. PRINCIPLES of OPERATION

The model 48 CO analyzer utilizes non-dispersive infrared (NDIR) detection of CO enhanced by gas filter correlation (GFC). The analyzer consists of an optical bench, Gas filter chopper, infrared (IR) source, IR detector, and associated electronics.

Sample gas is passed through an optical White Cell in which a beam of IR radiation passes. The White Cell provides a long beam path length in a relatively small cell by utilizing optical mirrors to produce multiple passes of the IR beam through the cell. IR radiation is produced using a wire wound resistor that is heated by passing a regulated DC voltage through the resistor causing it to radiate in the IR range. The radiation is passed through a gas filter chopper and a narrow bandpass interference filter before entering the White cell. As the IR beam passes through the cell, CO molecules absorb the IR proportional to the concentration of CO in the sample. The remaining IR exits the cell and is measured by an IR detector.

Interference from gases in the sample that absorb IR at the same wavelengths as CO are eliminated using GFC. GFC utilizes a correlation wheel consisting of two optical cells, one filled with CO and the other filled with N2. The wheel, positioned in the IR beam path before it enters the White Cell, is rotated by a synchronous motor. The IR beam passes alternately through the CO and N2 cells of the wheel. The CO filter acts to produce a reference beam which can not be further absorbed by CO in the sample cell. The N2 filter is transparent to IR radiation and produces a measure beam which can be absorbed by CO in the sample cell. The chopped detector signal is modulated by the alternation between the two gas filters with an amplitude related to the concentration of CO in the sample cell. Other gases do not cause detector signal modulation since they absorb the reference and measure beams equally.

II. SPECIFICATIONS

Ranges	:	0 to 1 PPM	Detection Limit		
		0 to 2 PPM	Minimum	:	0.10 PPM
		0 to 5 PPM	Maximum	:	1000 PPM
		0 to 10 PPM			
		0 to 20 PPM	Response Time	:	1 min
		0 to 50 PPM			
		0 to 100 PPM	Linearity	:	+/- 1%
		0 to 200 PPM			
		0 to 500 PPM	Noise	:	0.05 RMS
		0 to 1000 PPM			
24 hr Zero Drift :		+/- 0.2 PPM	Precision	:	+/- 0.1 PPM
24 hr Span Drift :		+/- 1% full scale			
			Sample flow rate	:	0.5 - 2 l/min

Interferences : Negligible interference from H2O and CO2

OXYGEN ANALYZER
PRINCIPLE OF OPERATION and SPECIFICATIONS

THERMOX

Model Number : 254

I. PRINCIPLES of OPERATION

The THERMOX oxygen analyzer consists of two units, a sensor and a control-readout unit. The sensor assembly incorporates an electrochemical cell, furnace, resistance temperature detector (RTD), flow block, and associated plumbing. The control-readout unit contains the electronics necessary for control of the cell furnace temperature, detector signal conditioning, and multiple range functions.

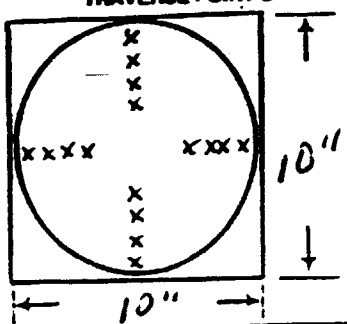
The electrochemical cell consists of a closed-end tube made of zirconium oxide (zirconia) with electrodes of porous platinum coated onto the inside and outside. When heated, the zirconia cell becomes a conductor of electricity due to the mobility of oxygen ions in its crystal structure. When the electrodes are in contact with gases of equal pressure having different oxygen concentrations, a voltage is produced that is logarithmically proportional to the ratio of the oxygen concentration on the reference side of the cell, ambient air, and the oxygen concentration on the other side of the cell, the sample gas.

Since the electrochemical cell voltage is also dependent on the cell temperature, the cell temperature is maintained at a constant level using an electrically heated furnace. Furnace temperature is sensed using a platinum RTD and controlled using a proportional temperature controller located in the control unit.

II. SPECIFICATIONS

Ranges	:	0 to 10%
	:	0 to 25%
Detection Limits		
minimum	:	0.01%
maximum	:	25%
Response Time	:	3 sec
Zero Drift, 24 hr	:	+/- 0.2%
Span Drift, 24 hr	:	+/- 0.2%
Precision	:	+/- 0.1%
Linearity	:	+/- 1%
Noise	:	0.05 RMS
Sample flow rate	:	0.5 - 2 l/min
Interferences	:	None

CROSS SECTIONAL SCHEMATIC OF STACK
TRAVERSE POINT LAYOUT



E T S FIELD DATA, METHOD(S) 1-4

PLANT Arco
DATE 073091
LOCATION Jeanerette, LA.
OPERATOR K. Thibodeaux
STACK NO. Engine #3
RUN NO. 1

SAMPLE BOX NO. BL
METER BOX NO. 500
AMBIENT TEMPERATURE N/A
BAROMETRIC PRESSURE 30.20
FILTER TARE wt mg N/A
NOZZLE DIAMETER, in. N/A

STACK DIAMETER, in. 10"
PITOT TUBE NO. P-3-3
PITOT FACTOR 0.837
METER Δ He 1.7759
D.G.M.C. FACTOR 0.9906
K FACTOR N/A

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H2O)	STACK TEMP (Ts), °F	VELOCITY HEAD (ΔPs)	(√ΔPs)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft3	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tmin), °F	OUTLET (Tmout), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge
1	1038	-0.050	550	.465	.682	1.5	1.5	390.500	97	97	242	75	10.0
2	1041		557	.410	.640								
3	1044		555	.390	.624								
4	1047		553	.350	.592								
5	1050		538	.345	.587								
6	1053		534	.315	.561								
7	1056		512	.285	.534								
8	1102	off @	501	.215	.464	1.5	1.5		117	101	263	70	7.2
1	1107	on @	510	.345	.587	1.5	1.5		110	96	252	73	7.2
2	1110		536	.365	.604								
3	1113		548	.340	.583								
4	1116		552	.300	.548								
5	1119		557	.325	.570								
6	1122		558	.335	.579								
7	1125		560	.335	.579								
8	1131	off @	558	.360	.600	1.5	1.5	420.744	125	109	271	72	7.2
AVERAGE	48 min	-0.050	542.19		.5834	1.50		30.244		106.0			

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS			
FINAL	561.3	549.3	474.0	602.2
INITIAL	465.8	529.6	472.0	592.7
WEIGHT COLLECTED	95.5	19.7	2.0	7.5

124.7

ORSAT MEASUREMENT

	CO_2	O_2	CO	N_2
1	7.4	4.8		
2				
3				

COMMENTS:

PRE-LEAK CHECK GOOD @ 15" Hg. - .002 CFM
POST-LEAK CHECK GOOD @ 15" Hg. - .001 CFM
Wet - 80.6°F
Dry - 92.3°F

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #3
Testing Date : 7-30-91
Run : 1

DETERMINATION OF DRY MOLECULAR WEIGHT

Md - Dry molecular weight, lb/ lb-mole
%CO2 - Percent CO2 by volume (dry basis)
%O2 - Percent O2 by volume (dry basis)
%CO - Percent CO by volume (dry basis)
%N2 - Percent N2 by volume (dry basis)
0.280 - Molecular weight of N2 or CO, divided by 100
0.320 - Molecular weight of O2, divided by 100
0.440 - Molecular weight of CO2, divided by 100

$$Md = 0.440(\%CO2) + 0.320(\%O2) + 0.280(\%N2 + \%CO)$$

$$Md = 0.440(7.4) + 0.320(4.8) + 0.280(87.8 + .0)$$

$$= 29.376$$

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #3
Testing Date : 7-30-91
Run : 1

DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE

A - Cross-sectional area of stack, ft2
Bws - Moisture fraction of stack gas
Cp - Pitot tube coefficient
dP - Avg., square root of velocity head, (in-H2O)**0.5
Kp - Pitot tube constant,
ft/sec (lb in-Hg/ lb-mole deg R in H2O)**0.5
Md - Molecular weight of stack gas, dry basis, lb/ lb-mole
Ms - Molecular weight of stack gas, wet basis, lb/ lb-mole
Pbar - Barometric pressure at measurement site, in-Hg
Pg - Static pressure of the stack gas, in H2O
Ps - Absolute stack gas pressure, in-Hg
Pstd - Standard absolute pressure, 29.92 in-Hg
Acf - Actual stack gas flow rate, ACF/min
Qsd - Dry volumetric stack gas flow rate
standard conditions, DSCF/Hr
Ts - Average stack gas temperature, deg R
Tstd - Standard absolute temperature, 528 deg R
Vs - Average stack gas velocity, ft/sec
3600 - Conversion factor, sec to Hr
18.0 - Molecular weight of water, lb/lb-mole

$$Ms = Md\ (1 - Bws) + 18.0\ (Bws) =$$

$$= (29.376)(1 - .1723) + (18.0)(.1723) = 27.416$$

$$Vs = Kp\ Cp\ dP \left(\frac{Ts}{Ps\ Ms}\right)^{0.5} =$$

$$= (85.49)(.8370)(.5834)\left(\frac{1002.}{[30.196][27.416]}\right)^{0.5} = 45.9313$$

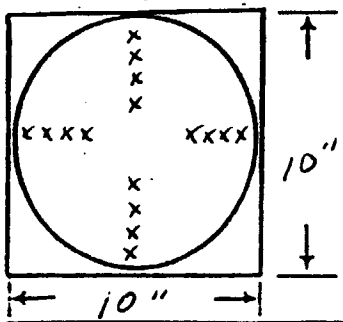
$$Acf = (60)(Vs)(A) = (60)(45.9313)(.5454) = 1503.1$$

$$Qsd = 3600\ (1 - Bws)\ Vs\ A\ \frac{Tstd}{Ts}\ \frac{Ps}{Pstd} =$$

$$Qsd = 3600(1 - .1723)(45.9313)(.5454)\frac{(528)(30.196)}{(1002.)(29.92)}$$

= 39690.1 DSCFH
= 661.5 DSCFM

CROSS SECTIONAL SCHEMATIC OF STACK TRAVERSE POINT LAYOUT



E T S FIELD DATA, METHOD(S) 1-4

PLANT Arco
DATE 07 30 91
LOCATION Jeanerette, LA.
OPERATOR K. Thibodeaux
STACK NO. Engine #3
RUN NO. 2

SAMPLE BOX NO. EE
METER BOX NO. 500
AMBIENT TEMPERATURE N/A
BAROMETRIC PRESSURE 30.09
FILTER TARE wt mg N/A
NOZZLE DIAMETER, in. N/A

STACK DIAMETER, in. 10"
PITOT TUBE NO. P-7-7
PITOT FACTOR 0.877
METER Δ He 1.7759
D.G.M.C. FACTOR 0.9906
K FACTOR N/A

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in.H2O)	STACK TEMP (Ts), °F	VELOCITY HEAD (ΔPs)	(√ΔPs)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in., H2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft3	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tmin), °F	OUTLET (Tmout), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge
1	1233	-0.05	510	.290	.538	1.5	1.5	420.900	106	103	242	76	8.0
2	1236		523	.315	.561								
3	1239		540	.325	.570								
4	1242		553	.355	.596								
5	1245		554	.375	.612								
6	1248		558	.390	.624								
7	1251		559	.410	.640								
8	1257	off	560	.425	.652	1.5	1.5		126	110	257	73	8.0
1	1302	on	503	.260	.510	1.5	1.5		120	105	265	74	8.0
2	1305		527	.350	.592								
3	1308		545	.370	.608								
4	1311		552	.355	.596								
5	1314		554	.350	.592								
6	1317		557	.345	.587								
7	1320		555	.345	.587						~~269~~	~~70~~	
8	1324	off	556	.350	.592	1.5	1.5	457.952	130	115	269	70	8.0
AVERAGE	48 min	-0.050	544.1		0.5911	1.50		37.052	114.37				

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS			
FINAL	655.4	526.2	473.7	600.3
INITIAL	533.9	510.1	472.3	592.1
WEIGHT COLLECTED	121.5	16.1	1.4	8.2
TOTAL WEIGHT				

147.2

ORSAT MEASUREMENT

	CO2	O2	CO	N2
1	8.4	5.4		
2				
3				
4				

COMMENTS:

PRE-LEAK CHECK GOOD @ 15" Hg. - .001 CFM
POST-LEAK CHECK GOOD @ 10" Hg. - .001 CFM
Wet - 80.6 °F
Dry - 95.0 °F

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #3
Testing Date : 7-30-91
Run : 2

DETERMINATION OF STACK GAS MOISTURE CONTENT

Bws - Moisture fraction content
dH - Pressure differential across meter orifice, in H2O
Mw - Molecular weight of water, 18.0 lb/ lb mole
Pb - Barometric pressure at meter, in-Hg
Pst - Standard absolute pressure, 29.92 in-Hg
R - Ideal gas constant, 21.85 in-Hg ft3/ lb-mole deg R
Tm - Absolute temperature at meter, deg R
Tst - Standard absolute temperature, 528 deg R
Vm - Dry gas volume measured by meter, DCF
Vmstd- Dry gas volume at standard conditions, DSCF
Vw - Volume of water vapor collected, SCF
Wwc - Weight of water vapor collected, lb
I1w, I2w, I3w, weight of water condensed by impingers, g
SGw, weight of water collected by silica gel, g
Y - Dry gas meter calibration factor

$$Wwc = (I1w + I2w + I3w + SGw) / (453.6\ g/lb)$$

$$= (121.5 + 16.1 + 1.4 + 8.2) / (453.6) = .32452$$

$$Vw = \frac{Wwc\ R\ Tst}{Pst\ Mw} = \frac{(.32452)(21.85)(528)}{(29.92)(18.0)} = 6.95162$$

$$Vmstd = Vm\ Y \frac{(Pb + dH/13.6)}{Pst} \frac{Tst}{Tm}$$

$$= (37.052)(.9906) \frac{(30.090 + 1.5000/13.6)}{(29.92)} \frac{(528)}{(574.)}$$

$$= 34.05634$$

$$Bws = \frac{Vw}{Vw + Vmstd} = \frac{(6.95162)}{(6.95162 + 34.05634)} = .1695$$

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #3
Testing Date : 7-30-91
Run : 2

DETERMINATION OF DRY MOLECULAR WEIGHT

Md - Dry molecular weight, lb/ lb-mole
%CO2 - Percent CO2 by volume (dry basis)
%O2 - Percent O2 by volume (dry basis)
%CO - Percent CO by volume (dry basis)
%N2 - Percent N2 by volume (dry basis)
0.280 - Molecular weight of N2 or CO, divided by 100
0.320 - Molecular weight of O2, divided by 100
0.440 - Molecular weight of CO2, divided by 100

$$Md = 0.440(\%CO2) + 0.320(\%O2) + 0.280(\%N2 + \%CO)$$

$$Md = 0.440(8.4) + 0.320(5.4) + 0.280(86.2 + .0)$$

$$= 29.560$$

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #3
Testing Date : 7-30-91
Run : 2

DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE

A - Cross-sectional area of stack, ft2
Bws - Moisture fraction of stack gas
Cp - Pitot tube coefficient
dP - Avg., square root of velocity head, (in-H2O)**0.5
Kp - Pitot tube constant,
ft/sec (lb in-Hg/ lb-mole deg R in H2O)**0.5
Md - Molecular weight of stack gas, dry basis, lb/ lb-mole
Ms - Molecular weight of stack gas, wet basis, lb/ lb-mole
Pbar - Barometric pressure at measurement site, in-Hg
Pg - Static pressure of the stack gas, in H2O
Ps - Absolute stack gas pressure, in-Hg
Pstd - Standard absolute pressure, 29.92 in-Hg
Acf - Actual stack gas flow rate, ACF/min
Qsd - Dry volumetric stack gas flow rate
standard conditions, DSCF/Hr
Ts - Average stack gas temperature, deg R
Tstd - Standard absolute temperature, 528 deg R
Vs - Average stack gas velocity, ft/sec
3600 - Conversion factor, sec to Hr
18.0 - Molecular weight of water, lb/lb-mole

$$Ms = Md\ (1 - Bws) + 18.0\ (Bws) =$$

$$= (29.560)(1 - .1695) + (18.0)(.1695) = 27.600$$

$$Vs = Kp\ Cp\ dP \left(\frac{Ts}{Ps\ Ms}\right)^{0.5} =$$

$$= (85.49)(.8370)(.5911)\left(\frac{1004.}{[30.079][27.600]}\right)^{0.5} = 46.5201$$

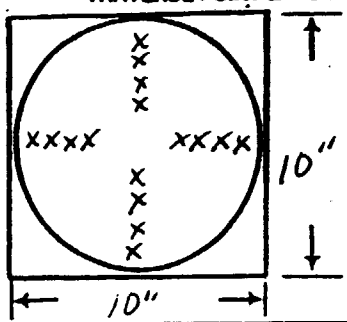
$$Acf = (60)(Vs)(A) = (60)(46.5201)(.5454) = 1522.4$$

$$Qsd = 3600\ (1 - Bws)\ Vs\ A \frac{Tstd}{Ts} \frac{Ps}{Pstd} =$$

$$Qsd = 3600(1 - .1695)(46.5201)(.5454)\frac{(528)(30.079)}{(1004.)(29.92)}$$

$$= 40100.3 \text{ DSCFH}$$
$$= 668.3 \text{ DSCFM}$$

CROSS SECTIONAL SCHEMATIC OF STACK TRAVERSE POINT LAYOUT



E T S FIELD DATA, METHOD(S) 14

PLANT Arco
DATE 07 30 91
LOCATION Jeanette Hill
OPERATOR K. Thibodeaux
STACK NO. #3 Engine
RUN NO. 3

SAMPLE BOX NO. BL
METER BOX NO. 500
AMBIENT TEMPERATURE N/A
BAROMETRIC PRESSURE 29.12
FILTER TARE wt mg N/A
NOZZLE DIAMETER, in. N/A

STACK DIAMETER, in. 10"
PITOT TUBE NO. P-3-3
PITOT FACTOR 0.837
METER Δ Hₒ 1.7759
D.G.M.C. FACTOR 0.9906
K FACTOR N/A

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in.H₂O)	STACK TEMP (Ts), °F	VELOCITY HEAD (ΔPs)	(√ΔPs)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in., H₂O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tmin), °F	OUTLET (Tmout), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge
1	1404	-0.090	557	.440	.663	1.5	1.5	458.000	112	109	240	75	3.0
2	1407		558	.430	.656								
3	1410		560	.395	.628								
4	1413		560	.385	.620								
5	1416		554	.340	.583								
6	1419		543	.305	.552								
7	1422		529	.275	.524								
8	1428		501	.175	.418	1.5	1.5		135	117	267	72	3.0
1	1433		558	.335	.579	1.5	1.5		124	115	253	74	3.0
2	1436		560	.325	.570								
3	1439		557	.335	.579								
4	1442		559	.330	.574								
5	1445		557	.325	.570								
6	1448		553	.340	.583								
7	1451		539	.345	.587								
8	1457		507	.320	.566	1.5	1.5	492.007	139	120	270	76	3.0
AVERAGE	48 min	-0.090	547.0		.5783	1.50		34.007	121.37				

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS			
FINAL	675.1	562.4	475.8	604.4
INITIAL	561.3	549.3	474.0	596.3
WEIGHT COLLECTED	113.8	13.1	1.8	8.1
TOTAL WEIGHT				

136.8

ORSAT MEASUREMENT

	CO_2	O_2	CO	N_2
1	9.0	3.5		
2				
3				
4				

COMMENTS:

PRE-LEAK CHECK GOOD @ 15" Hg. - .002 CFM
POST-LEAK CHECK GOOD @ 10" Hg. - .001 CFM
Wet - 79.7°F
Dry - 98.6

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #3
Testing Date : 7-30-91
Run : 3

DETERMINATION OF STACK GAS MOISTURE CONTENT

Bws - Moisture fraction content
dH - Pressure differential across meter orifice, in H2O
Mw - Molecular weight of water, 18.0 lb/ lb mole
Pb - Barometric pressure at meter, in-Hg
Pst - Standard absolute pressure, 29.92 in-Hg
R - Ideal gas constant, 21.85 in-Hg ft3/ lb-mole deg R
Tm - Absolute temperature at meter, deg R
Tst - Standard absolute temperature, 528 deg R
Vm - Dry gas volume measured by meter, DCF
Vmstd- Dry gas volume at standard conditions, DSCF
Vw - Volume of water vapor collected, SCF
Wwc - Weight of water vapor collected, lb
I1w, I2w, I3w, weight of water condensed by impingers, g
SGw, weight of water collected by silica gel, g
Y - Dry gas meter calibration factor

$$Wwc = (I1w + I2w + I3w + SGw) / (453.6\ g/lb)$$

$$= (113.8 + 13.1 + 1.8 + 8.1) / (453.6) = .30159$$

$$Vw = \frac{Wwc\ R\ Tst}{Pst\ Mw} = \frac{(.30159)(21.85)(528)}{(29.92)(18.0)} = 6.46048$$

$$Vmstd = Vm\ Y \frac{(Pb + dH/13.6)}{Pst} \frac{Tst}{Tm}$$

$$= (34.007)(.9906) \frac{(30.120 + 1.5000/13.6)}{(29.92)} \frac{(528)}{(581.)}$$

$$= 30.91184$$

$$Bws = \frac{Vw}{Vw + Vmstd} = \frac{(6.46048)}{(6.46048 + 30.91184)} = .1729$$

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #3
Testing Date : 7-30-91
Run : 3

DETERMINATION OF DRY MOLECULAR WEIGHT

Md - Dry molecular weight, lb/ lb-mole
%CO2 - Percent CO2 by volume (dry basis)
%O2 - Percent O2 by volume (dry basis)
%CO - Percent CO by volume (dry basis)
%N2 - Percent N2 by volume (dry basis)
0.280 - Molecular weight of N2 or CO, divided by 100
0.320 - Molecular weight of O2, divided by 100
0.440 - Molecular weight of CO2, divided by 100

$$Md = 0.440(\%CO2) + 0.320(\%O2) + 0.280(\%N2 + \%CO)$$

$$Md = 0.440(9.0) + 0.320(3.5) + 0.280(87.5 + .0)$$

$$= 29.580$$

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #3
Testing Date : 7-30-91
Run : 3

DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE

A - Cross-sectional area of stack, ft2
Bws - Moisture fraction of stack gas
Cp - Pitot tube coefficient
dP - Avg., square root of velocity head, (in-H2O)**0.5
Kp - Pitot tube constant,
ft/sec (lb in-Hg/ lb-mole deg R in H2O)**0.5
Md - Molecular weight of stack gas, dry basis, lb/ lb-mole
Ms - Molecular weight of stack gas, wet basis, lb/ lb-mole
Pbar - Barometric pressure at measurement site, in-Hg
Pg - Static pressure of the stack gas, in H2O
Ps - Absolute stack gas pressure, in-Hg
Pstd - Standard absolute pressure, 29.92 in-Hg
Acf - Actual stack gas flow rate, ACF/min
Qsd - Dry volumetric stack gas flow rate
standard conditions, DSCF/Hr
Ts - Average stack gas temperature, deg R
Tstd - Standard absolute temperature, 528 deg R
Vs - Average stack gas velocity, ft/sec
3600 - Conversion factor, sec to Hr
18.0 - Molecular weight of water, lb/lb-mole

$$Ms = Md\ (1 - Bws) + 18.0\ (Bws) =$$

$$= (29.580)(1 - .1729) + (18.0)(.1729) = 27.578$$

$$Vs = Kp\ Cp\ dP \left(\frac{Ts}{Ps\ Ms}\right)^{0.5} =$$

$$= (85.49)(.8370)(.5784)\left(\frac{1007.}{[30.113][27.578]}\right)^{0.5} = 45.5749$$

$$Acf = (60)(Vs)(A) = (60)(45.5749)(.5454) = 1491.4$$

$$Qsd = 3600\ (1 - Bws)\ Vs\ A\ \frac{Tstd}{Ts}\ \frac{Ps}{Pstd} =$$

$$Qsd = 3600(1 - .1729)(45.5749)(.5454)\frac{(528)(30.113)}{(1007.)(29.92)}$$

$$= 39060.0 \text{ DSCFH}$$
$$= 651.0 \text{ DSCFM}$$

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #3
Testing Date : 7-30-91
Run : 1 - 3

OXIDES OF NITROGEN EMISSION RATE

ENOX - NOX emission rate as NO2, lb/hr
F - NO2 factor, 1.1948 X 10-7 (lb/ft3)/ PPM
NOXmsc - NOX concentration as measured, PPM
Qsd - Dry volumetric stack gas flow rate, DSCF/hr

ENOX = (NOXmsc)(F)(Qsd)

-------- RUN 1 --------

ENOX = (1610.00)(1.1948 X 10-7)(39690.1) = 7.635

-------- RUN 2 --------

ENOX = (1640.00)(1.1948 X 10-7)(40100.3) = 7.858

-------- RUN 3 --------

ENOX = (1628.41)(1.1948 X 10-7)(39060.0) = 7.600

Emission Testing Services, Inc.
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Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #3
Testing Date : 7-30-91
Run : 1 - 3

CARBON MONOXIDE EMISSION RATE

ECO - Carbon Monoxide Emission Rate - Lb/Hr
F - CO conv. factor, 7.2727 X 10-8 (lb/ft3)/(PPM)
COms - Concentration of carbon monoxide - PPM
Qsd - Dry volumetric stack gas flow rate, DSCF/Hr

ECO = (COms)(F)(Qsd)

-------- RUN 1 --------

ECO = (539.17)(7.2727 X 10-8)(39690.1) = 1.556

-------- RUN 2 --------

ECO = (468.94)(7.2727 X 10-8)(40100.3) = 1.368

-------- RUN 3 --------

ECO = (466.77)(7.2727 X 10-8)(39060.0) = 1.326

Test analyzer response, Method 3A, 7E, and 10, was recorded by a computer data acquisition system. One minute average data were printed as recorded and served as a hardcopy record of the test data. Presented on the following pages are the computer print outs of the test data.

Each test analyzer is calibrated before and after each test run by challenging the analyzer with a set of certified calibration gases. Analyzer response is recorded by a computer data acquisition system. Calibration data sheets are manually completed as the calibrations are performed serving as hardcopy records of the calibration. Calibration results are taken from the computer system to avoid any data acquisition bias. Analyzer calibration data sheets are presented following the test data.

Run Title: ENGINE # 3 RUN 1
Date: 07/30/91

Time	CO-PPM	NOX-PPM	O2 %
10:34:09	502.55	1617.52	3.66
10:35:09	493.67	1619.96	3.73
10:36:09	530.10	1624.84	3.74
10:37:09	508.93	1615.08	3.69
10:38:09	573.42	1556.52	3.71
10:39:09	514.84	1617.52	3.62
10:40:09	517.79	1568.72	3.67
10:41:09	568.01	1576.04	3.69
10:42:09	572.44	1554.08	3.61
10:43:10	578.35	1590.68	3.69
10:44:10	550.28	1607.76	3.64
10:45:10	577.36	1544.32	3.57
10:46:10	594.59	1610.20	3.61
10:47:11	558.65	1607.76	3.56
10:48:11	554.71	1632.16	3.43
10:49:11	910.66	1527.24	3.51
10:50:11	599.02	1573.60	3.51
10:51:11	562.10	1634.60	3.58
10:52:11	500.56	1646.80	3.64
10:53:11	761.98	1534.56	3.53
10:54:11	772.81	1524.80	3.53
10:55:11	543.88	1615.08	3.58
10:56:11	652.19	1561.40	3.62
10:57:11	724.07	1566.28	3.53
10:58:11	708.32	1517.48	3.62
10:59:11	672.87	1558.96	3.58
11:00:11	561.11	1580.92	3.60
11:01:12	551.27	1619.96	3.64
11:02:12	513.85	1619.96	3.66
11:03:12	482.34	1680.96	3.58
11:04:12	474.47	1668.76	3.58

Run Title: ENGINE # 3 RUN 1
Date: 07/30/91

Time	CO-PPM	NOX-PPM	O2 %
11:05:12	596.56	1522.36	3.57
11:06:12	598.53	1573.60	3.60
11:07:12	559.15	1568.72	3.57
11:08:12	559.15	1558.96	3.53
11:09:12	488.25	1617.52	3.64
11:10:12	477.42	1622.40	3.61
11:11:12	459.70	1693.16	3.57
11:12:12	459.20	1639.48	3.65
11:13:12	445.91	1666.32	3.69
11:14:12	434.10	1666.32	3.64
11:15:12	424.74	1746.84	3.54
11:16:12	428.68	1717.56	3.64
11:17:12	423.76	1693.16	3.62
11:18:12	435.08	1680.96	3.67
11:19:13	429.66	1690.72	3.65
11:20:13	432.13	1659.00	3.61
11:21:13	484.31	1593.12	3.64
11:22:13	523.70	1600.44	3.65
11:23:13	501.54	1627.28	3.64
11:24:13	475.94	1607.76	3.64
11:25:13	535.51	1590.68	3.60
11:26:13	479.88	1641.92	3.69
11:27:13	479.39	1637.04	3.64
11:28:13	428.68	1637.04	3.62
11:29:13	482.34	1622.40	3.69
11:30:13	473.97	1610.20	3.65
11:31:13	507.94	1544.32	3.56
11:32:13	635.95	1583.36	3.60
11:33:13	501.54	1612.64	3.57
AVG CONC	539.17	1610.00	3.61

Run Title: ENGINE # 3 RUN 2
Date: 07/30/90

Time	CO-PPM	NOX-PPM	O2 %
12:24:28	461.84	1678.54	3.53
12:25:28	527.65	1602.91	3.58
12:26:28	481.98	1654.15	3.67
12:27:29	431.39	1646.83	3.66
12:28:29	442.69	1646.83	3.66
12:29:29	527.65	1695.62	3.67
12:30:29	494.25	1617.55	3.67
12:31:29	680.88	1622.43	3.67
12:32:29	527.16	1663.91	3.66
12:33:29	394.56	1705.38	3.66
12:34:30	402.41	1671.22	3.66
12:35:30	398.48	1683.42	3.67
12:36:31	404.38	1698.06	3.58
12:37:31	406.34	1673.66	3.65
12:38:31	396.52	1690.74	3.69
12:39:31	410.76	1695.62	3.66
12:40:31	395.54	1705.38	3.62
12:41:31	399.47	1693.18	3.63
12:42:31	422.55	1724.90	3.48
12:43:31	436.79	1654.15	3.63
12:44:31	478.05	1590.71	3.59
12:45:31	514.39	1519.96	3.59
12:46:31	575.78	1593.15	3.59
12:47:32	514.39	1651.71	3.70
12:48:32	421.57	1649.27	3.65
12:49:33	472.64	1639.51	3.65
12:50:33	402.90	1654.15	3.66
12:51:33	444.65	1590.71	3.66
12:52:33	504.08	1559.00	3.57
12:53:34	420.58	1727.34	3.51
12:54:34	476.08	1612.67	3.66

Run Title: ENGINE # 3 RUN 2
Date: 07/30/90

Time	CO-PPM	NOX-PPM	O2 %
12:55:34	412.73	1690.74	3.71
12:56:34	528.14	1615.11	3.69
12:57:34	434.83	1619.99	3.67
12:58:34	460.86	1546.80	3.62
12:59:34	437.77	1683.42	3.62
13:00:34	407.32	1751.74	3.51
13:01:34	430.90	1688.30	3.61
13:02:35	408.80	1683.42	3.69
13:03:35	395.54	1678.54	3.66
13:04:35	407.32	1649.27	3.70
13:05:35	415.67	1641.95	3.54
13:06:35	553.19	1461.40	3.54
13:07:35	767.81	1607.79	3.40
13:08:35	580.69	1607.79	3.61
13:09:35	447.60	1632.19	3.66
13:10:35	417.64	1634.63	3.71
13:11:35	456.44	1512.64	3.57
13:12:35	484.92	1615.11	3.65
13:13:36	643.56	1515.08	3.58
13:14:36	663.20	1505.32	3.57
13:15:36	538.95	1583.39	3.59
13:16:36	530.60	1573.63	3.63
13:17:36	543.86	1646.83	3.69
13:18:36	407.82	1663.91	3.63
13:19:36	408.80	1656.59	3.62
13:20:36	445.14	1668.78	3.54
13:21:36	415.67	1676.10	3.62
13:22:36	404.87	1688.30	3.62
13:23:36	417.64	1688.30	3.59
AVG CONC	468.94	1640.00	3.62

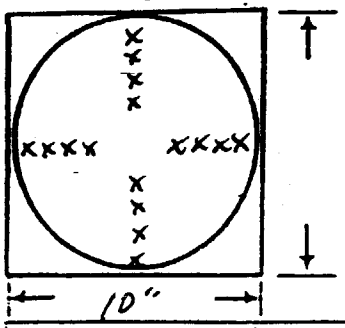
Run Title: ENGINE # 3 RUN 3
Date: 07/30/91

Time	CO-PPM	NOX-PPM	O2 %
13:58:21	389.71	1665.61	3.65
13:59:21	441.49	1707.36	3.68
14:00:21	537.64	1560.03	3.48
14:01:21	440.99	1663.16	3.67
14:02:21	543.06	1587.04	3.60
14:03:21	501.64	1645.97	3.67
14:04:21	480.44	1658.25	3.72
14:05:21	405.98	1641.06	3.68
14:06:21	545.04	1631.23	3.65
14:07:21	438.53	1645.97	3.71
14:08:21	417.82	1645.97	3.76
14:09:21	407.96	1658.25	3.73
14:10:21	415.85	1682.80	3.71
14:11:22	417.32	1695.08	3.73
14:12:22	401.55	1690.17	3.71
14:13:22	446.91	1616.50	3.61
14:14:22	481.92	1552.66	3.65
14:15:22	499.67	1643.51	3.60
14:16:23	407.96	1697.53	3.69
14:17:23	403.52	1702.44	3.68
14:18:23	420.78	1734.37	3.61
14:19:23	440.01	1648.42	3.63
14:20:24	436.06	1631.23	3.73
14:21:24	433.10	1606.68	3.65
14:22:24	411.90	1655.79	3.77
14:23:24	430.15	1655.79	3.72
14:24:24	432.61	1557.57	3.60
14:25:24	550.95	1709.81	3.48
14:26:24	474.03	1631.23	3.68
14:27:24	620.48	1611.59	3.55
14:28:24	422.75	1638.60	3.67

Run Title: ENGINE # 3 RUN 3
Date: 07/30/91

Time	CO-PPM	NOX-PPM	O2 %
14:29:24	441.98	1685.26	3.60
14:30:24	573.14	1528.10	3.61
14:31:24	447.90	1623.87	3.68
14:32:24	840.89	1584.58	3.63
14:33:24	597.30	1587.04	3.65
14:34:24	473.04	1557.57	3.63
14:35:24	583.50	1493.73	3.65
14:36:24	600.26	1557.57	3.61
14:37:24	470.09	1611.59	3.71
14:38:24	415.85	1601.77	3.69
14:39:25	469.10	1572.30	3.60
14:40:25	470.09	1623.87	3.68
14:41:25	414.86	1584.58	3.72
14:42:25	454.31	1631.23	3.67
14:43:25	402.53	1660.70	3.73
14:44:25	414.86	1636.15	3.69
14:45:25	412.89	1645.97	3.64
14:46:25	437.05	1680.35	3.64
14:47:25	393.66	1658.25	3.64
14:48:25	651.54	1601.77	3.65
14:49:25	437.05	1621.41	3.67
14:50:25	397.60	1670.52	3.71
14:51:26	414.86	1616.50	3.65
14:52:26	479.45	1594.40	3.61
14:53:26	462.20	1614.05	3.73
14:54:26	408.94	1599.31	3.68
14:55:26	402.53	1560.03	3.52
14:56:26	479.45	1648.42	3.72
14:57:26	461.21	1582.12	3.65
AVG CONC	466.77	1628.41	3.66

CROSS SECTIONAL SCHEMATIC OF STACK TRAVERSE POINT LAYOUT



E T S FIELD DATA, METHOD(S) 1-4

PLANT Arco
DATE 072991
LOCATION Torrance Ca, CA.
OPERATOR K. Thibodeaux
STACK NO. #16 Engine
RUN NO. 2

SAMPLE BOX NO. EE
METER BOX NO. 500
AMBIENT TEMPERATURE n/a
BAROMETRIC PRESSURE 30.06
FILTER TARE wt mg n/a
NOZZLE DIAMETER, in. n/a

STACK DIAMETER, in. 10"
PITOT TUBE NO. P-3-3
PITOT FACTOR 0.837
METER Δ Hₒ 1.7759
D.G.M.C. FACTOR 0.9906
K FACTOR n/a

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in.H₂O)	STACK TEMP (Ts), °F	VELOCITY HEAD (ΔPs)	VELOCITY HEAD (√ΔPs)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in.. H₂O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tmin), °F	OUTLET (Tmout), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge
1	1540	-0.140	569	.610	.781	1.5	1.5	321.700	115	114	262	74	5.0
2	1543		572	.520	.721								
3	1546		574	.460	.678								
4	1549		574	.470	.685								
5	1552		575	.285	.534								
6	1555		573	.225	.474								
7	1553		575	.240	.490								
8	1604	off ⊘	574	.205	.453	1.5	1.5		127	113	272	73	5.0
1	1608	on ⊘	558	.455	.674	1.5	1.5		118	111	249	71	5.0
2	1611		562	.475	.689								
3	1614		565	.515	.718								
4	1617		571	.555	.745								
5	1620		574	.560	.748								
6	1623		577	.565	.752								
7	1626		580	.560	.748								
8	1632	off ⊘	580	.470	.685	1.5	1.5	356.201	123	109	252	75	5.0
AVERAGE	48 min	-0.140	572.06		0.6609	1.5		34.501	116.25				

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS			
FINAL	650.3	509.9	472.4	616.6
INITIAL	542.8	485.4	468.8	606.4
WEIGHT COLLECTED	107.5	24.5	3.6	10.2

45.8

ORSAT MEASUREMENT

	CO_2	O_2	CO	N_2
1	10.0	2.4		
2				
3				

COMMENTS:

PRE-LEAK CHECK GOOD @ 15" Hg. - .005 CFM
POST-LEAK CHECK GOOD @ 12" Hg. - .002 CFM
Wet - 77 °F
Dry - 88.7

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #16
Testing Date : 7-29-91
Run : 2

DETERMINATION OF STACK GAS MOISTURE CONTENT

Bws - Moisture fraction content
dH - Pressure differential across meter orifice, in H2O
Mw - Molecular weight of water, 18.0 lb/ lb mole
Pb - Barometric pressure at meter, in-Hg
Pst - Standard absolute pressure, 29.92 in-Hg
R - Ideal gas constant, 21.85 in-Hg ft3/ lb-mole deg R
Tm - Absolute temperature at meter, deg R
Tst - Standard absolute temperature, 528 deg R
Vm - Dry gas volume measured by meter, DCF
Vmstd- Dry gas volume at standard conditions, DSCF
Vw - Volume of water vapor collected, SCF
Wwc - Weight of water vapor collected, lb
I1w, I2w, I3w, weight of water condensed by impingers, g
SGw, weight of water collected by silica gel, g
Y - Dry gas meter calibration factor

$$Wwc = (I1w + I2w + I3w + SGw) / (453.6\ g/lb)$$

$$= (107.5 + 24.5 + 3.6 + 10.2) / (453.6) = .32143$$

$$Vw = \frac{Wwc\ R\ Tst}{Pst\ Mw} = \frac{(.32143)(21.85)(528)}{(29.92)(18.0)} = 6.88550$$

$$Vmstd = Vm\ Y \frac{(Pb + dH/13.6)}{Pst} \frac{Tst}{Tm}$$

$$= (34.501)(.9906) \frac{(30.060 + 1.5000/13.6)}{(29.92)} \frac{(528)}{(576.)}$$

$$= 31.57698$$

$$Bws = \frac{Vw}{Vw + Vmstd} = \frac{(6.88550)}{(6.88550 + 31.57698)} = .1790$$

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #16
Testing Date : 7-29-91
Run : 2

DETERMINATION OF DRY MOLECULAR WEIGHT

Md - Dry molecular weight, lb/ lb-mole
%CO2 - Percent CO2 by volume (dry basis)
%O2 - Percent O2 by volume (dry basis)
%CO - Percent CO by volume (dry basis)
%N2 - Percent N2 by volume (dry basis)
0.280 - Molecular weight of N2 or CO, divided by 100
0.320 - Molecular weight of O2, divided by 100
0.440 - Molecular weight of CO2, divided by 100

$$Md = 0.440(\%CO2) + 0.320(\%O2) + 0.280(\%N2 + \%CO)$$

$$Md = 0.440(10.0) + 0.320(2.4) + 0.280(87.6 + .0)$$

$$= 29.696$$

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #16
Testing Date : 7-29-91
Run : 2

DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE

A - Cross-sectional area of stack, ft2
Bws - Moisture fraction of stack gas
Cp - Pitot tube coefficient
dP - Avg., square root of velocity head, (in-H2O)**0.5
Kp - Pitot tube constant,
ft/sec (lb in-Hg/ lb-mole deg R in H2O)**0.5
Md - Molecular weight of stack gas, dry basis, lb/ lb-mole
Ms - Molecular weight of stack gas, wet basis, lb/ lb-mole
Pbar - Barometric pressure at measurement site, in-Hg
Pg - Static pressure of the stack gas, in H2O
Ps - Absolute stack gas pressure, in-Hg
Pstd - Standard absolute pressure, 29.92 in-Hg
Acf - Actual stack gas flow rate, ACF/min
Qsd - Dry volumetric stack gas flow rate
standard conditions, DSCF/Hr
Ts - Average stack gas temperature, deg R
Tstd - Standard absolute temperature, 528 deg R
Vs - Average stack gas velocity, ft/sec
3600 - Conversion factor, sec to Hr
18.0 - Molecular weight of water, lb/lb-mole

$$Ms = Md\ (1 - Bws) + 18.0\ (Bws) =$$

$$= (29.696)(1 - .1790) + (18.0)(.1790) = 27.602$$

$$Vs = Kp\ Cp\ dP \left(\frac{Ts}{Ps\ Ms}\right)^{0.5} =$$

$$= (85.49)(.8370)(.6611)\left(\frac{1032.}{[30.050][27.602]}\right)^{0.5} = 52.7650$$

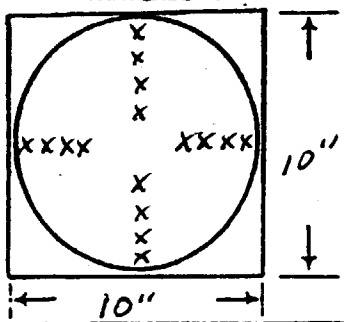
$$Acf = (60)(Vs)(A) = (60)(52.7650)(.5454) = 1726.7$$

$$Qsd = 3600\ (1 - Bws)\ Vs\ A \frac{Tstd}{Ts} \frac{Ps}{Pstd} =$$

$$Qsd = 3600(1 - .1790)(52.7650)(.5454)\frac{(528)(30.050)}{(1032.)(29.92)}$$

= 43703.4 DSCFH
= 728.4 DSCFM

CROSS SECTIONAL SCHEMATIC OF STACK
TRAVERSE POINT LAYOUT



E T S FIELD DATA, METHOD(S) 1-4

PLANT Arco
DATE 072991
LOCATION Jeanerette, LA.
OPERATOR K. Thibodeaux
STACK NO. #16 Engine
RUN NO. 3

SAMPLE BOX NO. B6
METER BOX NO. 500
AMBIENT TEMPERATURE N/A
BAROMETRIC PRESSURE 30.10
FILTER TARE wt mg N/A
NOZZLE DIAMETER, in. N/A

STACK DIAMETER, in. 10"
PITOT TUBE NO. P-3-7
PITOT FACTOR 0.837
METER Δ Hₒ 1.7759
D.G.M.C. FACTOR 0.9906
K FACTOR N/A

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in.H₂O)	STACK TEMP (Ts), °F	VELOCITY HEAD (ΔPs)	(√ΔPs)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in.. H₂O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET (Tmin), °F	OUTLET (Tmout), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge
1	1655	-0.150	552	.275	.524	1.5	1.5	356.300	110	105	260	71	6.5
2	1658		564	.410	.640								
3	1701		567	.510	.714								
4	1704		572	.510	.714								
5	1707		574	.520	.721								
6	1710		578	.565	.752								
7	1713		581	.545	.738								
8	1719	off @	582	.565	.752	1.5	1.5		119	106	271	73	7.5
1	1724	on @	538	.490	.700	1.5	1.5		115	103	253	71	7.5
2	1727		549	.635	.797								
3	1730		557	.610	.781								
4	1733		570	.500	.707								
5	1736		573	.345	.587								
6	1739		575	.235	.485								
7	1742		576	.200	.447								
8	1748	off @	575	.180	.424	1.5	1.5	390.377	117	104	241	75	7.5
AVERAGE	48 min	-0.150	567.69		0.6552	1.5		34.077	109.87				

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS			
FINAL	713.2	585.8	477.6	598.9
INITIAL	589.4	571.1	476.0	591.0
WEIGHT COLLECTED	123.8	14.7	1.6	7.9

148.0

ORSAT MEASUREMENT

	CO_2	O_2	CO	N_2
1	10.0	2.5	0.0	
2				
3				

COMMENTS:

PRE-LEAK CHECK GOOD @ 15" Hg. - .002 CFM
POST-LEAK CHECK GOOD @ 10" Hg. - .001 CFM
Wet - 77°F
Dry - 86°F

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #16
Testing Date : 7-29-91
Run : 3

DETERMINATION OF STACK GAS MOISTURE CONTENT

Bws - Moisture fraction content
dH - Pressure differential across meter orifice, in H2O
Mw - Molecular weight of water, 18.0 lb/ lb mole
Pb - Barometric pressure at meter, in-Hg
Pst - Standard absolute pressure, 29.92 in-Hg
R - Ideal gas constant, 21.85 in-Hg ft3/ lb-mole deg R
Tm - Absolute temperature at meter, deg R
Tst - Standard absolute temperature, 528 deg R
Vm - Dry gas volume measured by meter, DCF
Vmstd- Dry gas volume at standard conditions, DSCF
Vw - Volume of water vapor collected, SCF
Wwc - Weight of water vapor collected, lb
I1w, I2w, I3w, weight of water condensed by impingers, g
SGw, weight of water collected by silica gel, g
Y - Dry gas meter calibration factor

$$Wwc = (I1w + I2w + I3w + SGw) / (453.6\ g/lb)$$

$$= (123.8 + 14.7 + 1.6 + 7.9) / (453.6) = .32628$$

$$Vw = \frac{Wwc\ R\ Tst}{Pst\ Mw} = \frac{(.32628)(21.85)(528)}{(29.92)(18.0)} = 6.98940$$

$$Vmstd = Vm\ Y \frac{(Pb + dH/13.6)}{Pst} \frac{Tst}{Tm}$$

$$= (34.037)(.9906) \frac{(30.100 + 1.5000/13.6)}{(29.92)} \frac{(528)}{(570.)}$$

$$= 31.54260$$

$$Bws = \frac{Vw}{Vw + Vmstd} = \frac{(6.98940)}{(6.98940 + 31.54260)} = .1814$$

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Client : ARCO
Source : ENGINE #16
Testing Date : 7-29-91
Run : 3

DETERMINATION OF DRY MOLECULAR WEIGHT

Md - Dry molecular weight, lb/ lb-mole
%CO2 - Percent CO2 by volume (dry basis)
%O2 - Percent O2 by volume (dry basis)
%CO - Percent CO by volume (dry basis)
%N2 - Percent N2 by volume (dry basis)
0.280 - Molecular weight of N2 or CO, divided by 100
0.320 - Molecular weight of O2, divided by 100
0.440 - Molecular weight of CO2, divided by 100

$$Md = 0.440(\%CO2) + 0.320(\%O2) + 0.280(\%N2 + \%CO)$$

$$Md = 0.440(10.0) + 0.320(2.5) + 0.280(87.5 + .0)$$

$$= 29.700$$

Emission Testing Services, Inc.
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Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #16
Testing Date : 7-29-91
Run : 3

DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE

A - Cross-sectional area of stack, ft2
Bws - Moisture fraction of stack gas
Cp - Pitot tube coefficient
dP - Avg., square root of velocity head, (in-H2O)**0.5
Kp - Pitot tube constant,
ft/sec (lb in-Hg/ lb-mole deg R in H2O)**0.5
Md - Molecular weight of stack gas, dry basis, lb/ lb-mole
Ms - Molecular weight of stack gas, wet basis, lb/ lb-mole
Pbar - Barometric pressure at measurement site, in-Hg
Pg - Static pressure of the stack gas, in H2O
Ps - Absolute stack gas pressure, in-Hg
Pstd - Standard absolute pressure, 29.92 in-Hg
Acf - Actual stack gas flow rate, ACF/min
Qsd - Dry volumetric stack gas flow rate
standard conditions, DSCF/Hr
Ts - Average stack gas temperature, deg R
Tstd - Standard absolute temperature, 528 deg R
Vs - Average stack gas velocity, ft/sec
3600 - Conversion factor, sec to Hr
18.0 - Molecular weight of water, lb/lb-mole

$$Ms = Md\ (1 - Bws) + 18.0\ (Bws) =$$

$$= (29.700)(1 - .1814) + (18.0)(.1814) = 27.578$$

$$Vs = Kp\ Cp\ dP \left(\frac{Ts}{Ps\ Ms}\right)^{0.5} =$$

$$= (85.49)(.8370)(.6553)\left(\frac{1028.}{[30.089][27.578]}\right)^{0.5} = 52.1804$$

$$Acf = (60)(Vs)(A) = (60)(52.1804)(.5454) = 1707.6$$

$$Qsd = 3600\ (1 - Bws)\ Vs\ A \frac{Tstd}{Ts} \frac{Ps}{Pstd} =$$

$$Qsd = 3600(1 - .1814)(52.1804)(.5454)\frac{(528)(30.089)}{(1028.)(29.92)}$$

= 43334.3 DSCFH
= 722.2 DSCFM

Emission Testing Services, Inc.
P.O. Box 15075
Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #16
Testing Date : 7-29-91
Run : 1 - 3

OXIDES OF NITROGEN EMISSION RATE

ENOX - NOX emission rate as NO2, lb/hr
F - NO2 factor, 1.1948 X 10-7 (lb/ft3)/ PPM
NOXmsc - NOX concentration as measured, PPM
Qsd - Dry volumetric stack gas flow rate, DSCF/hr

ENOX = (NOXmsc)(F)(Qsd)

-------- RUN 1 --------

ENOX = (3213.52)(1.1948 X 10-7)(43541.9) = 16.718

-------- RUN 2 --------

ENOX = (3203.73)(1.1948 X 10-7)(43703.4) = 16.729

-------- RUN 3 --------

ENOX = (3171.35)(1.1948 X 10-7)(43334.3) = 16.420

Emission Testing Services, Inc.
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Baton Rouge, LA 70895
504-925-8405

Client : ARCO
Source : ENGINE #16
Testing Date : 7-29-91
Run : 1 - 3

CARBON MONOXIDE EMISSION RATE

ECO - Carbon Monoxide Emission Rate - Lb/Hr
F - CO conv. factor, 7.2727 X 10-8 (lb/ft3)/(PPM)
COms - Concentration of carbon monoxide - PPM
Qsd - Dry volumetric stack gas flow rate, DSCF/Hr

ECO = (COms)(F)(Qsd)

-------- RUN 1 --------

ECO = (324.67)(7.2727 X 10-8)(43541.9) = 1.028

-------- RUN 2 --------

ECO = (319.39)(7.2727 X 10-8)(43703.4) = 1.015

-------- RUN 3 --------

ECO = (321.85)(7.2727 X 10-8)(43334.3) = 1.014

Test analyzer response, Method 3A, 7E, and 10, was recorded by a computer data acquisition system. One minute average data were printed as recorded and served as a hardcopy record of the test data. Presented on the following pages are the computer print outs of the test data.

Each test analyzer is calibrated before and after each test run by challenging the analyzer with a set of certified calibration gases. Analyzer response is recorded by a computer data acquisition system. Calibration data sheets are manually completed as the calibrations are performed serving as hardcopy records of the calibration. Calibration results are taken from the computer system to avoid any data acquisition bias. Analyzer calibration data sheets are presented following the test data.

14:32:19	320.70	3208.27	2.12
14:33:19	323.74	3203.39	2.15
14:34:19	322.76	3208.27	2.11
14:35:19	324.73	3179.00	2.11
14:36:19	323.74	3186.32	2.11
14:37:19	322.76	3191.20	2.07
14:38:19	325.72	3213.15	2.16
14:39:19	324.73	3203.39	2.06
14:40:19	324.73	3196.08	2.12
14:41:19	324.73	3208.27	2.16
14:42:19	323.74	3193.64	2.12
14:43:20	321.77	3196.08	2.07
14:44:20	322.76	3198.52	2.07
14:45:20	323.74	3183.88	2.09
14:46:20	325.72	3205.83	2.03
14:47:20	328.67	3183.88	2.08
14:48:20	331.14	3179.00	2.12
14:49:20	325.72	3181.44	2.07

Run Title: ENGINE # 16 RUN 1
Date: 07/29/91

Time	CO-PPM	NOX-PPM	O2 %
14:50:20	326.70	3222.91	2.06
14:51:20	327.69	3193.64	2.04
14:52:20	329.17	3203.39	2.07
14:53:20	323.74	3213.15	2.16
14:54:20	325.72	3208.27	2.13
14:55:20	325.72	3186.32	2.09
14:56:20	323.74	3169.25	2.02
14:57:20	322.76	3193.64	2.09
14:58:20	325.72	3205.83	2.09
14:59:20	327.69	3218.03	2.12
15:00:20	325.72	3210.71	2.11
15:01:20	323.74	3186.32	2.09
15:02:20	322.76	3193.64	2.09
15:03:20	320.78	3232.66	2.15
15:04:20	323.74	3213.15	2.11
15:05:20	323.74	3198.52	2.04
15:06:20	324.73	3210.71	2.07
15:07:20	325.72	3213.15	2.04
15:08:20	327.69	3222.91	2.06
15:09:21	326.70	3235.10	2.11
15:10:21	325.72	3218.03	2.08
15:11:21	325.72	3205.83	2.09
15:12:21	325.72	3218.03	2.08
15:13:21	319.80	3239.98	2.08
15:14:21	324.73	3225.35	2.09
15:15:21	324.73	3247.30	2.15
15:16:21	326.70	3222.91	2.13
15:17:21	325.72	3218.03	2.09
15:18:21	326.21	3215.59	2.07
AVG CONC	324.67	3213.52	2.10

Run Title: ENGINE # 16 RUN 2
Date: 07/29/91

Time	CO-PPM	NOX-PPM	O2 %
15:38:04	317.71	3232.94	2.08
15:39:04	319.68	3199.00	2.04
15:40:04	321.16	3220.82	2.06
15:41:04	319.68	3203.85	2.04
15:42:04	315.73	3186.88	2.03
15:43:04	313.76	3186.88	2.06
15:44:04	316.23	3211.12	2.01
15:45:04	314.25	3206.28	2.07
15:46:04	316.72	3211.12	2.11
15:47:04	317.71	3201.43	2.09
15:48:04	317.21	3225.67	2.12
15:49:04	314.74	3215.97	2.08
15:50:05	315.73	3196.58	2.13
15:51:05	315.73	3223.25	2.09
15:52:05	318.69	3218.40	2.11
15:53:05	320.67	3220.82	2.13
15:54:05	317.71	3206.28	2.07
15:55:05	322.64	3220.82	2.08
15:56:05	323.13	3223.25	2.13
15:57:05	324.61	3201.43	2.08
15:58:05	322.15	3208.70	2.09
15:59:05	316.72	3182.03	2.04
16:00:05	318.69	3208.70	2.02
16:01:05	320.67	3189.31	2.06
16:02:05	321.65	3184.46	2.02
16:03:05	319.68	3186.88	2.09
16:04:05	321.65	3194.16	2.08
16:05:05	324.12	3174.76	2.03
16:06:05	320.67	3194.16	1.99
16:07:05	318.69	3194.16	2.07
16:08:05	314.74	3184.46	2.01

Run Title: ENGINE # 16 RUN 2
Date: 07/29/91

Time	CO-PPM	NOX-PPM	O2 %
16:09:05	317.71	3167.49	2.06
16:10:05	318.69	3174.76	2.13
16:11:05	318.69	3196.58	2.11
16:12:05	320.67	3184.46	2.06
16:13:05	322.15	3179.61	2.11
16:14:05	324.12	3203.85	2.12
16:15:06	327.08	3167.49	2.11
16:16:06	325.11	3184.46	2.04
16:17:06	324.61	3203.85	2.16
16:18:06	322.15	3199.00	2.12
16:19:06	318.69	3228.09	2.13
16:20:06	318.69	3184.46	2.12
16:21:06	320.67	3220.82	2.08
16:22:06	318.69	3211.12	2.15
16:23:06	317.71	3199.00	2.15
16:24:06	318.69	3203.85	2.13
16:25:06	317.71	3206.28	2.09
16:26:06	315.73	3201.43	2.11
16:27:06	314.74	3235.37	2.11
16:28:06	315.24	3199.00	2.11
16:29:06	317.71	3220.82	2.09
16:30:06	320.67	3203.85	2.09
16:31:06	321.65	3223.25	2.11
16:32:06	320.67	3228.09	2.12
16:33:06	322.64	3218.40	2.07
16:34:06	322.64	3211.12	2.13
16:35:06	318.69	3215.97	2.08
16:36:06	318.69	3232.94	2.13
AVG CONC	319.39	3203.73	2.09

Run Title: ENGINE # 16 RUN 3
Date: 07/29/91

Time	CO-PPM	NOX-PPM	O2 %
16:54:17	321.64	3224.87	2.18
16:55:17	321.64	3237.15	2.18
16:56:17	321.64	3237.15	2.19
16:57:17	325.58	3222.42	2.22
16:58:17	326.07	3219.96	2.19
16:59:17	326.56	3200.32	2.19
17:00:17	324.10	3207.69	2.27
17:01:17	322.13	3205.23	2.22
17:02:17	324.59	3183.14	2.17
17:03:17	324.59	3168.41	2.17
17:04:18	324.59	3146.31	2.18
17:05:18	323.61	3185.59	2.13
17:06:18	321.64	3168.41	2.11
17:07:18	320.16	3165.95	2.13
17:08:18	319.18	3180.68	2.14
17:09:18	319.18	3168.41	2.15
17:10:18	317.21	3200.32	2.19
17:11:18	316.23	3158.59	2.21
17:12:18	320.16	3173.32	2.18
17:13:18	321.64	3156.13	2.18
17:14:18	322.13	3173.32	2.19
17:15:18	322.63	3136.49	2.15
17:16:18	324.59	3141.40	2.15
17:17:18	323.12	3134.04	2.11
17:18:18	323.61	3163.50	2.14
17:19:18	322.63	3148.77	2.13
17:20:18	318.69	3156.13	2.19
17:21:18	320.66	3141.40	2.11
17:22:18	321.15	3170.86	2.18
17:23:18	321.64	3173.32	2.18
17:24:18	320.16	3165.95	2.15

Run Title: ENGINE # 16 RUN 3
Date: 07/29/91

Time	CO-PPM	NOX-PPM	O2 %
17:25:18	319.18	3180.68	2.18
17:26:18	319.18	3161.04	2.22
17:27:18	321.64	3148.77	2.22
17:28:19	317.21	3168.41	2.14
17:29:19	320.16	3156.13	2.17
17:30:19	319.18	3192.96	2.18
17:31:19	321.64	3200.32	2.22
17:32:19	321.64	3156.13	2.19
17:33:19	322.63	3151.22	2.18
17:34:19	323.61	3161.04	2.21
17:35:19	325.09	3173.32	2.19
17:36:19	322.63	3158.59	2.19
17:37:19	328.53	3151.22	2.23
17:38:19	325.58	3158.59	2.17
17:39:19	326.56	3165.95	2.19
17:40:19	326.56	3178.23	2.17
17:41:19	322.63	3178.23	2.13
17:42:19	320.66	3151.22	2.15
17:43:19	319.67	3163.50	2.17
17:44:19	319.67	3183.14	2.19
17:45:19	319.67	3163.50	2.17
17:46:19	319.67	3173.32	2.19
17:47:19	320.66	3151.22	2.15
17:48:19	321.64	3153.68	2.17
17:49:19	323.61	3153.68	2.22
17:50:19	321.64	3165.95	2.19
17:51:19	319.18	3146.31	2.22
17:52:19	319.67	3161.04	2.19
17:53:20	318.20	3158.59	2.23
AVG CONC	321.85	3171.35	2.18

METHOD 3A DATA SHEET

COMPANY Arco SOURCE # 16 DATE 7-29-91

PARAMETER O_2 LOAD% _____ RUN NUMBER 1

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response v	Analyzer Response %	Absolute Difference v	Absolute Difference %	% Span ±2%
Zero	0.0	0.07	0.14	0.07	0.14	0.0
Mid	1.10	0.37	0.95	0.34	0.87	-0.31
High	11.70	4.37	11.71	4.35	11.66	-0.20

Calibration curve: ppm = (response v)(slope) + intercept

Slope 2.69057 Intercept -0.04722 Span Range 26.86

Analyzer Cal		Init. Analyzer Resp. v	Init. Analyzer Resp. ppm	Init. Analyzer Resp. Bias ±5	Final Analyzer Resp. v	Final Analyzer Resp. ppm	Final Analyzer Resp. Bias ±5	Span Drift ±3
Conc.	N_2	0.07	0.14	0.0	0.07	0.14	0.0	0.0

$$\text{Sys. Cal. Bias} = \frac{\text{Sys. cal. (ppm)} - \text{analyzer cal. (ppm)}}{\text{Span (ppm)}} \times 100$$

$$\%\text{Drift} = \frac{\text{Final sys. resp. (ppm)} - \text{Initial sys. resp. (ppm)}}{\text{span (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point _____

Test Point v Sample port _____

1		11		21	
2		12		22	
3		13		23	
4		14		24	
5		15		25	
6		16		26	
7		17		27	
8		18		28	
9		19		29	
10		20		30	

Ave. v _____

Ave. conc. _____ %

COMMENTS: R = 0.99974

METHOD 7E DATA SHEET

COMPANY Arco SOURCE # 16 DATE 7-29-91

PARAMETER NOx LOAD% _____ RUN NUMBER 1

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response mv	ppm	Absolute Difference mv	ppm	% Drift ±2%
Zero	N_2	0.02	-3.91	0.02	-3.91	0.0
Mid	397.48	0.84	405.62	0.84	405.62	0.0
High	789.4	1.60	785.18	1.61	790.17	0.10

Calibration curve: ppm = (response mv)(slope) + intercept

Slope 499.42473 Intercept -13.90161 Span Range 4980.35

Analyzer Cal	Init. Analyzer Resp. mv	ppm	Bias ±5	Final Analyzer Resp. mv	ppm	Bias ±5	Drift ±3
Conc. 397.48	0.83	400.62	-0.10	0.83	400.62	-0.10	0.0

Sys. Cal. Bias = $\frac{\text{Sys. cal. (ppm) - analyzer cal. (ppm)}}{\text{Span (ppm)}}$ X 100

%Drift = $\frac{\text{Final sys. resp. (ppm) - Initial sys. resp. (ppm)}}{\text{span (ppm)}}$ X 100

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	mv				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. mv ____

Ave. conc. _____ ppm

COMMENTS: R = 0.99984

EMISSION TESTING SERVICES, INC.

METHOD 10 DATA SHEET

COMPANY Arco SOURCE # 16 DATE 7-29-91

PARAMETER CO LOAD% _____ RUN NUMBER 1

CALIBRATION STATISTICS

	Cylinder Value	Initial Analyzer Response mv	Initial Analyzer Response ppm	Final Analyzer Response mv	Final Analyzer Response ppm	%Drift
Zero	N_2	0.01	3.72	0.02	4.73	0.10
Low	89.69	0.91	94.59	0.91	94.59	0.0
Mid	301.4	2.84	289.46	3.02	307.64	1.80
High	895.0	8.87	898.31	8.88	899.32	0.10

Calibration curve: ppm = (response mv)(slope) + intercept

Slope 100.97014 Intercept 2.70930 Span Range 1,012.41

$$\%Drift = \frac{\text{Final response (ppm)} - \text{Initial response (ppm)}}{\text{Initial response (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	mv				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. mv ____

Ave. conc. _____ ppm

COMMENTS: $R = 0.99980$

METHOD 3A DATA SHEET

COMPANY Arco SOURCE # 16 DATE 7-29-91

PARAMETER O_2 LOAD% _____ RUN NUMBER 2

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response v	Analyzer Response %	Absolute Difference v	Absolute Difference %	% Span ±2%
Zero	0.0	0.07	0.18	0.07	0.18	0.0
Mid	1.10	0.34	0.91	0.34	0.91	0.0
High	11.70	4.35	11.71	4.34	11.69	-0.07

Calibration curve: ppm = (response v)(slope) + intercept

Slope 2.59433 Intercept -0.00841 Span Range 26.94

Analyzer Cal		Init. Analyzer Resp. v	Init. Analyzer Resp. ppm	Bias ±5	Final Analyzer Resp. v	Final Analyzer Resp. ppm	Bias ±5	Span Drift ±3
Conc.	N_2	0.07	0.18	0.0	0.07	0.18	0.0	0.0

$$\text{Sys. Cal. Bias} = \frac{\text{Sys. cal. (ppm)} - \text{analyzer cal. (ppm)}}{\text{Span (ppm)}} \times 100$$

$$\%\text{Drift} = \frac{\text{Final sys. resp. (ppm)} - \text{Initial sys. resp. (ppm)}}{\text{span (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Test Point v Sample port _____

1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. v ____

Ave. conc. _____ %

COMMENTS: R=0.999578

METHOD 7E DATA SHEET

COMPANY Arco SOURCE # 16 DATE 7-29-91

PARAMETER Nox LOAD% _____ RUN NUMBER 2

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response mv	ppm	Absolute Difference mv	ppm	% Drift ±2%
Zero	N2	0.02	-3.11	0.03	1.85	0.10
Mid	397.48	0.84	403.90	0.84	403.90	0.0
High	789.4	1.61	786.09	1.60	781.13	-0.10

Calibration curve: ppm = (response mv)(slope) + intercept

Slope 496.35103 Intercept -13.03568 Span Range 4950.47

Analyzer Cal	Init. Analyzer Resp. mv	ppm	Bias ±5	Final Analyzer Resp. mv	ppm	Bias ±5	Drift ±3
Conc. 397.48	0.83	398.84	-0.10	0.84	403.90	0.0	-0.10

$$\text{Sys. Cal. Bias} = \frac{\text{Sys. cal. (ppm)} - \text{analyzer cal. (ppm)}}{\text{Span (ppm)}} \times 100$$

$$\%\text{Drift} = \frac{\text{Final sys. resp. (ppm)} - \text{Initial sys. resp. (ppm)}}{\text{span (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	mv				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. mv ____

Ave. conc. _____ ppm

COMMENTS: R. 0.99990

ETS
EMISSION TESTING SERVICES, INC.

METHOD 10 DATA SHEET

COMPANY Arco SOURCE # 16 DATE 7-29-91

PARAMETER CO LOAD% _____ RUN NUMBER 2

CALIBRATION STATISTICS

	Cylinder Value	Initial Analyzer Response mv	Initial Analyzer Response ppm	Final Analyzer Response mv	Final Analyzer Response ppm	%Drift
Zero	N2	0.02	-0.52	0.02	-0.52	0.0
Low	89.69	0.91	89.4	0.91	89.4	0.0
Mid	301.4	3.02	302.58	3.02	302.58	0.0
High	895.0	8.88	894.63	8.90	896.65	0.20

Calibration curve: ppm = (response mv)(slope) + intercept

Slope 101.03260 Intercept -2.53958 Span Range 1,007.79

$$\%Drift = \frac{\text{Final response (ppm)} - \text{Initial response (ppm)}}{\text{Initial response (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point _____

Sample port _____

Test Point	mv				
1		11		21	
2		12		22	
3		13		23	
4		14		24	
5		15		25	
6		16		26	
7		17		27	
8		18		28	
9		19		29	
10		20		30	

Ave. mv _____

Ave. conc. _____ ppm

COMMENTS: r-0.99999

M E T H O D 3 A D A T A S H E E T

COMPANY Arco SOURCE # 16 DATE 7-29-91

PARAMETER O_2 LOAD% _____ RUN NUMBER 3

C A L I B R A T I O N S T A T I S T I C S

	Cylinder Value	Analyzer Response v	Analyzer Response %	Absolute Difference v	Absolute Difference %	% Span ±2%
Zero	0.0	0.07	0.18	0.07	0.18	0.0
Mid	1.10	0.34	0.91	0.34	0.91	0.0
High	11.70	4.34	11.71	4.35	11.74	0.11

Calibration curve: ppm = (response v)(slope) + intercept

Slope 2.70088 Intercept -0.00973 Span Range 26.99

Analyzer Cal	Init. Analyzer Resp. v	ppm	Bias ±5	Final Analyzer Resp. v	ppm	Bias ±5	Span Drift ±3
Conc. N_2	0.07	0.18	0.0	0.07	0.18	0.0	0.0

$$\text{Sys. Cal. Bias} = \frac{\text{Sys. cal. (ppm)} - \text{analyzer cal. (ppm)}}{\text{Span (ppm)}} \times 100$$

$$\%\text{Drift} = \frac{\text{Final sys. resp. (ppm)} - \text{Initial sys. resp. (ppm)}}{\text{span (ppm)}} \times 100$$

T E S T D A T A

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	v				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. v ____

Ave. conc. _____ %

COMMENTS: R-0.99959

METHOD 7E DATA SHEET

COMPANY Arco SOURCE # 16 DATE 7-29-91

PARAMETER NOx LOAD% _____ RUN NUMBER 3

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response mv	ppm	Absolute Difference mv	ppm	% Drift ±2%
Zero	N_2	0.03	-3.16	0.03	-3.16	0.0
Mid	397.48	0.84	404.0	0.85	409.03	0.10
High	789.4	1.60	786.03	1.61	791.06	0.10

Calibration curve: ppm = (response mv)(slope) + intercept

Slope 502.67020 Intercept -18.23846 Span Range 5,008.46

Analyzer Cal	Init. Analyzer Resp. mv	ppm	Bias ±5	Final Analyzer Resp. mv	ppm	Bias ±5	Drift ±3
Conc. 397.48	0.84	404.0	0.0	0.83	398.98	-0.20	-0.10

$$\text{Sys. Cal. Bias} = \frac{\text{Sys. cal. (ppm)} - \text{analyzer cal. (ppm)}}{\text{Span (ppm)}} \times 100$$

$$\%\text{Drift} = \frac{\text{Final sys. resp. (ppm)} - \text{Initial sys. resp. (ppm)}}{\text{span (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Sample port _____

Test Point	mv				
1	____	11	____	21	____
2	____	12	____	22	____
3	____	13	____	23	____
4	____	14	____	24	____
5	____	15	____	25	____
6	____	16	____	26	____
7	____	17	____	27	____
8	____	18	____	28	____
9	____	19	____	29	____
10	____	20	____	30	____

Ave. mv ____

Ave. conc. _____ ppm

COMMENTS: R = 0.99990

ETS
EMISSION TESTING SERVICES, INC.

METHOD 10 DATA SHEET

COMPANY Arco SOURCE # 16 DATE 7-29-91

PARAMETER CO LOAD% _____ RUN NUMBER 3

CALIBRATION STATISTICS

	Cylinder Value	Initial Analyzer Response mv	Initial Analyzer Response ppm	Final Analyzer Response mv	Final Analyzer Response ppm	%Drift
Zero	N_2	0.02	-0.26	0.03	0.75	0.10
Low	89.69	0.91	89.45	0.91	89.45	0.0
Mid	301.4	3.02	302.12	3.03	303.13	0.10
High	895.0	8.90	894.78	8.90	894.78	0.0

Calibration curve: ppm = (response mv)(slope) + intercept

Slope 100.79272 Intercept -2.27413 Span Range 1,005.65

$$\%Drift = \frac{\text{Final response (ppm)} - \text{Initial response (ppm)}}{\text{Initial response (ppm)}} \times 100$$

TEST DATA

Start time _____ Finish time _____ Minutes per point _____

Sample port _____

Test Point	mv.				
1		11		21	
2		12		22	
3		13		23	
4		14		24	
5		15		25	
6		16		26	
7		17		27	
8		18		28	
9		19		29	
10		20		30	

Ave. mv _____

Ave. conc. _____ ppm

COMMENTS: R = 0.99999

During emission testing, ARCO personnel recorded engine operating data. These data are presented on the following pages.

EMISSION TESTING SERVICES, INC.

INTERNAL COMBUSTION ENGINE OPERATIONAL RECORD

Company Name ARCO Oil & Gas Company

Company Location North Central Battery

Engine Name N.C. 800 Hp Engine

Engine Source I. D. No. Emission Pt. # 16

Design Specifications

Manufacturer's Name Waukesha

Model No. 7042 Serial No. 339537

Parameter Specifications

A. Fuel Type Nat Gas B. Fuel Supplier Jeanerette Field

C. Fuel Flow Units SCF/HR Meas. Method _____

D. Is unit equipped for waste heat recovery? No

Describe _____

E. Does unit use water or steam injection? No.

If so, describe measurement method (continuous flow, start-finish volumes, etc) _____

F. Manifold Pressure units (psia, kpa, etc.) 10" ~~Hg~~ Mw

G. Manifold Temp.(°F, °C, etc.) N/A

Ultimate Fuel Analysis

C _____ S _____ H _____ Ash _____

O _____ H_2O _____ N _____

Trace Metals: Na _____ Va _____ K _____

Fuel elements added None

Fuel elements added for smoke suppression None

EMISSION TESTING SERVICES, INC.

INTERNAL COMBUSTION ENGINE

TEST RUN LOG

(GAS ENGINES)

Company ARCO OIL & GAS

Engine NORTH CENTRAL 800 HP ENGINE

Operator ETS B.L.

Date: 7-29-91 Test Time: Start 14:20 End 15:20

Ambient Temperature, at time of test 90°F

Engine Load Condition % _____

DATA LOG TIME (15 minute intervals)	14:20	14:35	14:50	1505
Fuel Feed (flow)	2165	—	—	—
Intake Manifold Temp.	NONE	—	—	—
Intake Manifold Pressure	9.5" Hg	9.5" Hg	9.5" Hg	9.5" Hg
Fuel Header Pressure	4 oz	—	—	—
Engine Speed (rpm)	659	664	663	676
Spark Ignition Timing	24°	—	—	—
Horse Power	750	—	—	—

Run Conditions: RUN # 1

Remarks: 79°F WET, 90°F DRY

EMISSION TESTING SERVICES, INC.

INTERNAL COMBUSTION ENGINE

TEST RUN LOG

(GAS ENGINES)

Company: ARCO Oil & GAS

Engine: NORTH CENTRAL 800 HP ENGINE

Operator: ETS BL.

Date: 7-29-91 Test Time: Start 15:38 End 16:38

Ambient Temperature, at time of test _____

Engine Load Condition % _____

DATA LOG TIME (15 minute intervals)	15:38	15:53	16:08	16:23
Fuel Feed (flow)	2165			
Intake Manifold Temp.	NONE			
Intake Manifold Pressure	9.5" Hg	9.5" Hg	9.5" Hg	9.5" Hg
Fuel Header Pressure	4 oz			
Engine Speed (rpm)	657	657	657	657
Spark Ignition Timing	24°			
Horse Power	750			

Run Conditions: RUN # 2

Remarks: 77% wet 89% Dry

EMISSION TESTING SERVICES, INC.

INTERNAL COMBUSTION ENGINE

TEST RUN LOG

(GAS ENGINES)

Company ARCO OIL & GAS

Engine NORTH CENTRAL 800 HP ENGINE

Operator ETS RC

Date: 7-29-91 Test Time: Start 1651 End 1751

Ambient Temperature, at time of test

Engine Load Condition %

DATA LOG TIME (15 minute intervals)	1651	17:06	17:21	17:36
Fuel Feed (flow)	2165	2165		
Intake Manifold Temp.	NONE			
Intake Manifold Pressure	9.5"Hg	9.5"Hg	9.5"Hg	9.5"Hg
Fuel Header Pressure	40#			
Engine Speed (rpm)	655	658	657	655
Spark Ignition Timing	24°			
Horse Power	750			

Run Conditions: RUN #3

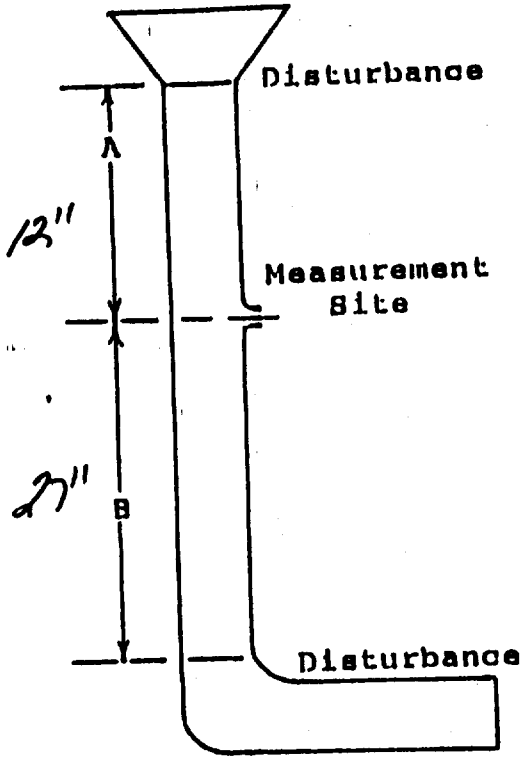
Remarks: 77°F wet, 86°F Dry

VI. TEST DATA & CALCULATIONS

All emission test field data, unit operations data, and laboratory analytical data are contained in this section along with the associated data reduction calculations.

Data from the field data sheets were manually input into a computer for data processing and calculations. Integrity of data input is maintained by using a double entry system. The computer performed all calculations and produced the calculations and results summary pages. Input data accuracy were further verified by comparison of raw field data to the computer data printed on the summary pages. Computer program integrity and calculations verification are validated by processing a known set of data. Further controls on the computer program are conducted by comparison of manual spot calculations of the raw data input to computer calculations results.

Traverse Point Layout



Client: Arco

Date: 30 July 91

Unit Tested: Eng. #3

Location: Jeanerette

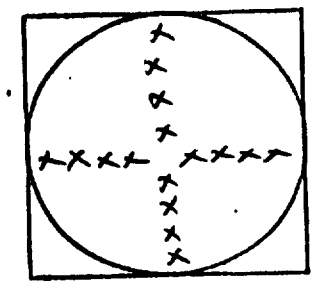
Upstream Distance (A): 12"

Downstream Distance (B): 27"

Inside Diameter: 10"

Coupling Length: 5"

Coupling Type: 3" Female



Cross Section Schematic of Stack

Traverse Point	Distance % of Diameter		Stack Diameter		Coupling Length		Traverse Points
1	0.032	x	10"	+	5"	=	~~5.320~~ 5.5
2	0.105						6.050
3	0.194						6.940
4	0.323						8.230
5	0.677						11.770
6	0.806						13.060
7	0.895						13.950
8	0.968						~~14.680~~ 14.5
9							
10							
11							
12							

VII. APPENDIX

Contained in this section is a copy of the dry gas meter calibration, pitot tube calibration, gas standard certifications and resumes of Emission Testing Services, Inc. personnel who performed the testing. Also contained at the end of this section are excerpts from the operating manuals for each of the continuous analyzers used. The excerpts describe the principle operation of the instrument, analytical technique, performance characteristics, etc.

PITOT TUBE CALIBRATION

Pitot Tube Number P-3-3

Calibrated By Raymond Jones

Cp (std) 0.99

Date 6-5-91

Point Number	Standard Pitot Δ p (in. H_2O)	"S" Type Pitot Δ p (in. H_2O) "A" Side	"B" Side
1	1.46	2.03	2.02
2	.605	.840	.841
3	.07	.10	.10

Calculations:

$$Cp_{(s)} = Cp_{(std)} \times \sqrt{\frac{\Delta p\ (std)}{\Delta p\ (s)}}$$

Deviation $= Cp_{(s)} - \overline{Cp}$ (Side A or B)

Avg. Dev. $= \dfrac{\sum_{1}^{3} \left| Cp_{(s)} - \overline{Cp} \right|}{3}$ (Side A or B)

"A" Side $Cp_{(s)}$	Deviation	"B" Side $Cp_{(s)}$	Deviation
.840	.004	.842	.005
.840	.004	.842	.003
.828	.008	.828	.009

$\overline{Cp}$ = .836 = .837

$\left| \overline{Cp}\ (\text{Side A}) - \overline{Cp}\ (\text{Side B}) \right|$ = .001 (must be $\leq$ 0.01)

Avg. Dev. (Side A) = .005 (must be $\leq$ 0.01)

(Side B) = .006 (must be $\leq$ 0.01)

$Cp = \dfrac{\overline{Cp}\ (\text{Side A}) + \overline{Cp}\ (\text{Side B})}{2}$ (should be $0.80 \leq Cp \leq 0.85$) = .837

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English Units)

Date 7-24-91

Meter box number 500

Barometric pressure, P_b 30.18 in. Hg

Calibrated by B. Magee Jr.

Orifice manometer setting (ΔH), in. H_2O	Wet test meter (V_w), ft^3	Dry gas meter (V_d), ft^3	Wet test meter (t_w), °F	Dry gas meter Inlet (t_{d_i}), °F	Dry gas meter Outlet (t_{d_o}), °F	Dry gas meter Avg[a] (t_d), °F	Time (0), min.
0.5	5	5.225 / 200.244	86°	109 / 114	99 / 103	106.75	12.78
1.0	5	5.269 / 205.513	86.5°	114 / 119	104 / 107	111.0	9.01
1.5	10	10.560 / 216.073	87°	116 / 129	107 / 111	115.75	14.55
2.0	10	10.631 / 226.704	87.5°	121 / 133	110 / 113	119.25	12.75
3.0	10	10.634 / 237.340	88°	124 / 132	112 / 114	120.50	10.48
4.0	10						

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H@_i = \frac{0.0317 \; H}{P_b (t_d + 460)} \left[\frac{(t_w + 460) \; 0}{V_w}\right]^2$
0.5	0.0368	0.9920	1.8047
1.0	0.0737	0.9890	1.7839
1.5	0.110	0.9931	1.7333
2.0	0.147	0.9903	1.7672
3.0	0.221	0.9887	1.7903
4.0	0.294		
Average		0.9906	1.7759

Y = Ratio of reading of wet test meter to dry test meter; tolerance for individual values ± 0.02 from average.

$H_@$ = Orifice pressure differential that equates to 0.75 cfm of air @ 68 F and 29.92 inches of mercury, in. H_2O; tolerance for individual values ± 0.20 from average.

Calibrated by [illegible]

Scott Specialty Gases

a division of Scott Environmental Technology, Inc.

1290 COMBERMERE STREET, TROY, MICHIGAN 48084 (313) 589-2950

Shipped from : Scott Troy

Our Project # : 518237

Your P.O. # : FD111490

Expiration Date : 6-19-92

Cylinder Number ALM-002828

Cylinder Pressure 1900 psig

Customer :
EMISSIONS TESTING SERVICES
10389 MAMMOTH DRIVE
BATON ROUGE, LA. 70895

**** CERTIFICATE OF ANALYSIS - EPA PROTOCOL GASES ****
PERFORMED ACCORDING TO SECTION 3.0.4

Certified Per Traceability Protocol # 1

Procedure # G1

File # PD7000

Certified Accuracy 1 % NBS Traceable

COMPONENT	CERTIFIED CONC.	REFERENCE STD: SRM # (CRM #)	REFERENCE STD: CYLINDER NUMBER	REFERENCE STD: CONC.	GAS ANALYZER: MAKE/MODEL/SERIAL #	GAS ANALYZER: LAST CALIBRATION DATE	ANALYTICAL PRINCIPLE
CARBON MONOXIDE	89.69 PPM	1681	CAL-7913	970.0 PPM	HORIBA/OPE-144E/56017215310	25-90	NON-DISPERSIVE INFRARED
		GMIS*	IA-9163	1001 PPM			

BALANCE GAS : NITROGEN

CERTIFIED PROTOCOL

FIRST ANALYSIS DATE : 12-11-90

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	REFERENCE GAS (mV)	RESULTS PPM
0.00	9.60	90.37	243.3 PPM	25.60	243.9
0.00	9.60	90.37		25.60	243.9
0.00	9.60	90.37		25.60	243.9

CALCULATED RESULTS 90.16, 90.16, 90.16

AVERAGE : 90.16 PPM

SECOND ANALYSIS DATE : 12-19-90

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE STANDARD CONC.	REFERENCE GAS (mV)	RESULTS PPM
0.00	9.50	89.43	243.3 PPM	25.60	243.9
0.00	9.50	89.43		25.60	243.9
0.00	9.50	89.43		25.60	243.9

CALCULATED RESULTS 89.22, 89.22, 89.22

AVERAGE : 89.22 PPM

CALIBRATION CURVE 2 nd DEGREE

SRM # (CRM #)	CONC. PPM	SPLIT PT (%)	DVM (mV)	FITTED VALUE	PERCENT ERROR
	1001	100	100.00	1001	0.00
1681	970.0	97	97.20	971.2	0.13
	243.3	24	25.60	243.9	0.24
	100.4	10	10.70	100.8	0.42
	0.0000	0	0.00	0.0000	0.00
		0		0.00	0.00
		0		0.00	0.00
GMIS	100.4	LOW	10.70	100.8	0.42
1681	970.0	HIGH	97.20	971.2	0.13

* GMIS - GAS MANUFACTURER'S INTERNAL STANDARD

Analyst : Don Eichler Jr.

Approved By : [signature]

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the Company without extra cost.

Scott Specialty Gases

a division of Scott Environmental Technology, Inc.

1290 COMBERMERE STREET, TROY, MICHIGAN 48084 (313) 589-2950

Shipping Item # [illegible]

Our Project # : 518237

Your P.O. # : FD111490

Expiration Date : 6-20-92

Cylinder Number ALM-010585

Cylinder Pressure 1900 psig

Customer :
EMISSION TESTING SERVICES
10389 MAMMOTH DRIVE
BATON ROUGE, LA. 70895

**** CERTIFICATE OF ANALYSIS - EPA PROTOCOL GASES ****
PERFORMED ACCORDING TO SECTION 3.0.4

Certified Per Traceability Protocol # 1

Procedure # G1

File # P07006

Certified Accuracy 1 % NBS Traceable

COMPONENT	CERTIFIED CONC.	REFERENCE STD: SRM # (CRM #)	REFERENCE STD: CYLINDER NUMBER	REFERENCE STD: CONC.	GAS ANALYZER: MAKE/MODEL/SERIAL #	GAS ANALYZER: LAST CALIBRATION DATE	ANALYTICAL PRINCIPLE
CARBON MONOXIDE	301.4 PPM	1681	CAL-7913	970.0 PPM	HORIBA/OPE-144E/560172153	10-25-90	NON-DISPERSIVE INFRARED
		GMIS*	IA-9163	1001 PPM			

BALANCE GAS : NITROGEN

CERTIFIED PROTOCOL

FIRST ANALYSIS — DATE : 12-11-90

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	REFERENCE GAS (mV)	RESULTS PPM
0.00	31.60	302.3	970.0 PPM	97.20	971.2
0.00	31.60	302.3		97.20	971.2
0.00	31.60	302.3		97.20	971.2

CALCULATED RESULTS: 301.9, 301.9, 301.9

AVERAGE : 301.9 PPM

SECOND ANALYSIS — DATE : 12-20-90

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE STANDARD CONC.	REFERENCE GAS (mV)	RESULTS PPM
0.00	31.50	301.3	970.0 PPM	97.20	971.2
0.00	31.50	301.3		97.20	971.2
0.00	31.50	301.3		97.20	971.2

CALCULATED RESULTS: 300.9, 300.9, 300.9

AVERAGE : 300.9 PPM

CALIBRATION CURVE — 2 nd DEGRE

SRM # (CRM #)	CONC. PPM	SPLIT PT (%)	DVM (mV)	FITTED VALUE	PERCE ERRC
	1001	100	100.00	1001	0.0
1681	970.0	97	97.20	971.2	0.1
	243.3	24	25.60	243.9	0.2
	100.4	10	10.70	100.8	0.4
	0.0000	0	0.00	0.0000	0.0
		0		0.00	0.0
		0		0.00	0.0
GMIS	100.4	LOW	10.70	100.8	0.
1681	970.0	HIGH	97.20	971.2	0.

* GMIS - GAS MANUFACTURER'S INTERNAL STANDARD

Analyst : Don Eckl Jr

Approved By : [signature]

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the Company without extra cost.

Scott Specialty Gases

a division of Scott Environmental Technology, Inc.

1290 COMBERMERE STREET, TROY, MICHIGAN 48084 (313) 589-2950

Shipped From : Scott Troy

Our Project # : 518237

Your P.O. # : FD111490

Expiration Date : 6-20-92

Cylinder Number ALM-010638

Cylinder Pressure 1900 psig

Customer :
EMISSION TESTING SERVICES
10389 MAMMOTH DRIVE
BATON ROUGE, LA. 70895

**** CERTIFICATE OF ANALYSIS - EPA PROTOCOL GASES ****
PERFORMED ACCORDING TO SECTION 3.0.4

Certified Per Traceability Protocol # 1

Procedure # G1

File # P07046

Certified Accuracy 1 % NBS Traceable

CERTIFIED PROTOCOL

COMPONENT	CERTIFIED CONC.	REFERENCE STD: SRM # (CRM #)	REFERENCE STD: CYLINDER NUMBER	REFERENCE STD: CONC.	GAS ANALYZER: MAKE/MODEL/SERIAL #	GAS ANALYZER: LAST CALIBRATION DATE	ANALYTICAL PRINCIPLE
CARBON MONOXIDE	895.0 PPM	1681	CAL-7913	970.0 PPM	HORIBA/OPE-144E/560172153	11-21-90	NON-DISPERSIVE INFRARED
		GMIS*	IA-9163	1001 PPM			

BALANCE GAS : NITROGEN

FIRST ANALYSIS DATE : 12-11-90

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	REFERENCE GAS (mV)	RESULTS PPM
0.00	90.10	896.1	970.0 PPM	97.20	971.2
0.00	90.10	896.1		97.20	971.2
0.00	90.10	896.1		97.20	971.2

CALCULATED RESULTS 895.0, 895.0, 895.0

AVERAGE : 895.0 PPM

SECOND ANALYSIS DATE : 12-20-90

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE STANDARD CONC.	REFERENCE GAS (mV)	RESULTS PPM
0.00	90.10	896.1	970.0 PPM	97.20	971.2
0.00	90.10	896.1		97.20	971.2
0.00	90.10	896.1		97.20	971.2

CALCULATED RESULTS 895.0, 895.0, 895.0

AVERAGE : 895.0 PPM

CALIBRATION CURVE 2 nd DEGREE

SRM # (CRM #)	CONC. PPM	SPLIT PT (%)	DVM (mV)	FITTED VALUE	PERCENT ERROR
	1001	100	100.00	1001	0.00
1681	970.0	97	97.20	971.2	0.13
	243.3	24	25.60	243.9	0.24
	100.4	10	10.70	100.8	0.42
	0.0000	0	0.00	0.0000	0.00
		0		0.00	0.00
		0		0.00	0.00
GMIS	100.4	LOW	10.70	100.8	0.42
1681	970.0	HIGH	97.20	971.2	0.13

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the Company without charge.

* GMIS - GAS MANUFACTURER'S INTERNAL STANDARD

Analyst : [signature]

Approved By : [signature]

Scott Specialty Gases

a division of Scott Environmental Technology, Inc.

1290 COMBERMERE STREET, TROY, MICHIGAN 48084 (313) 589-2950

Shipped From : Scott Michigan

Our Project # : 522331

Your P.O. # : 910322-FB

Expiration Date : 10-17-92

Cylinder Number : AAL12738

Cylinder Pressure : 1900 psig

stomer :
EMISSION TESTING SERVICES
10389 MAMMOTH DRIVE
BATON ROUGE LA 70895

* * * * CERTIFICATE OF ANALYSIS - EPA PROTOCOL GASES * * * *
PERFORMED ACCORDING TO SECTION 3.0.4

Certified Per Traceability Protocol # 1 — Procedure # G1

File # PO 139

Certified Accuracy 1 % NBS Traceable

ANALYZED CYLINDER		REFERENCE STD			INSTRUMENTATION		
COMPONENT	CERTIFIED CONC.	SRM # (CRM #)	CYLINDER NUMBER	CONC.	INSTR/MODEL/SERIAL #	LAST CALIBRATION DATE	ANALYTICAL PRINCIPLE
TRIC OXIDE	45.51 PPM	1684	ALM003644	97.28 PPM	HORIBA	4-24-91	CHEMILUMINESCENCE
	.20	6MIS#	AAL12853	22.60 PPM	OPE-235		
LANCE GAS : NITROGEN	45.71						

TROGEN DIOXIDE 0.20 PPM (FROM SECOND ANALYSIS)

EPA PROTOCOL

FIRST ANALYSIS — DATE : 4-8-91

ERO AS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	(mV)	RESULTS PPM
00	46.00	45.61	97.28 PPM	98.00	97.28
00	46.00	45.61		98.00	97.28
00	46.00	45.61		98.00	97.28
CALCULATED RESULTS		45.61			
		45.61			
		45.61			
AVERAGE :		45.61 PPM			

SECOND ANALYSIS — DATE : 4-17-91

ZERO GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	(mV)	RESULTS PPM
0.00	45.80	45.41	97.28 PPM	98.00	97.28
0.00	45.80	45.41		98.00	97.28
0.00	45.80	45.41		98.00	97.28
0.00	46.00 NOX	45.61			
CALCULATED RESULTS		45.41			
		45.41			
		45.41	45.61 PPM NOX		
AVERAGE :		45.41 PPM			

CALIBRATION CURVE — 1 st DEGREE

SRM # (CRM #)	CONC. PPM	SPLIT PT (%)	DVM (mV)	FITTED VALUE	PERCENT ERROR
1684	97.28	100	98.00	97.28	-0.00
	48.00	49	48.60	48.19	0.40
	22.60	23	22.90	22.65	0.24
	0.00	0	0.00	0.00	0.00
		0		0.00	0.00
		0		0.0000	0.00
		0		0.00	0.00
6MIS	22.60	LOW	22.90	22.65	0.24
1684	97.28	HIGH	98.00	97.28	-0.00

6MIS - GAS MANUFACTURER'S INTERNAL STANDARD

Analyst : Joseph Ou

Approved By : L Shapiro

The only liability of this Company for gas which fails to comply with this analysis shall be replacement thereof by the Company without charge.