TEXACO PIPELINE, INC.
P.O. BOX 42130
HOUSTON, TEXAS 77242-2130

EMISSION TESTING
on TPLI UNIT #2
at the LAKE BARRE BOOSTER STATION
MARCH 19, 1992

Testing conducted by :

E T S

EMISSION TESTING SERVICES, INC.

P.O. BOX 15075

BATON ROUGE, LOUISIANA 70895

(504) 925-8405

File : 92024

EMISSION TEST REPORT CERTIFICATION

for

TEXACO PIPELINE, INC.

EMISSION TESTING

on TPLI UNIT #2

at the LAKE BARRE BOOSTER STATION

MARCH 19, 1992

Testing conducted by :

EMISSION TESTING SERVICES, INC.

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.

Keith Champagne
TPLI - Proj. Engineer

Willard Lapeyrouse
Texaco Pipeline
Facility Representative

Robert Reeves
Emission Testing Services
Project Leader

Barry Gipson
Emission Testing Services
Manager

TEXACO PIPELINE, INC.

EMISSION TESTING

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MARCH 19, 1992

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I. INTRODUCTION

Emission Testing Services, Inc. was contracted by Texaco Pipeline, Inc. to conduct emission testing on the TPLI Unit #2 located at Texaco's Lake Barre Crude Oil Pressure Boosting Station near Cocodrie, Louisiana. Emissions of oxides of nitrogen and carbon monoxide were determined in order to demonstrate compliance with the facility's air emissions permit. TPLI Unit #2, source ID 2-91, emissions are permitted under Louisiana Department of Environmental Quality permit number 2880-00042-01.

EPA Methods 7E and 10 were used to determine emissions of oxides of nitrogen and carbon monoxide respectively. EPA Methods 1-4 were used to determine the number and location of sample points, and the velocity, molecular weight, and volumetric flow rate of the stack gas.

The test team consisted of Robert Reeves, Scott Lesley, and Damon Wood. Willard Lapeyrouse represented Texaco Pipeline and coordinated testing with facility operations. The Louisiana Department of Environmental Quality was not represented during the test.

On March 19, 1992, three test runs were conducted with the TPLI Unit #2 operating at 90% of rated horsepower.

II. SUMMARY

Results of emission testing on TPLI Unit #2 are presented in Table I. Oxides of nitrogen and carbon monoxide emissions were within permit limits during all three test runs. Average oxides of nitrogen emissions were 7.846 lb/hr with a permit limit of 9.70 lb/hr. Carbon monoxide emissions averaged 9.517 lb/hr which was less than the 19.4 lb/hr permit limit. Emissions versus permit limits have been graphically presented in Figure I.

EPA methods were used to determine stack gas parameters and pollutant emission rates. All testing was conducted without deviation from these methods and no unusual conditions were noted during the test.

FIGURE I
EMISSIONS vs PERMIT LIMITS

TPLI Unit #2 - Source ID 2-91

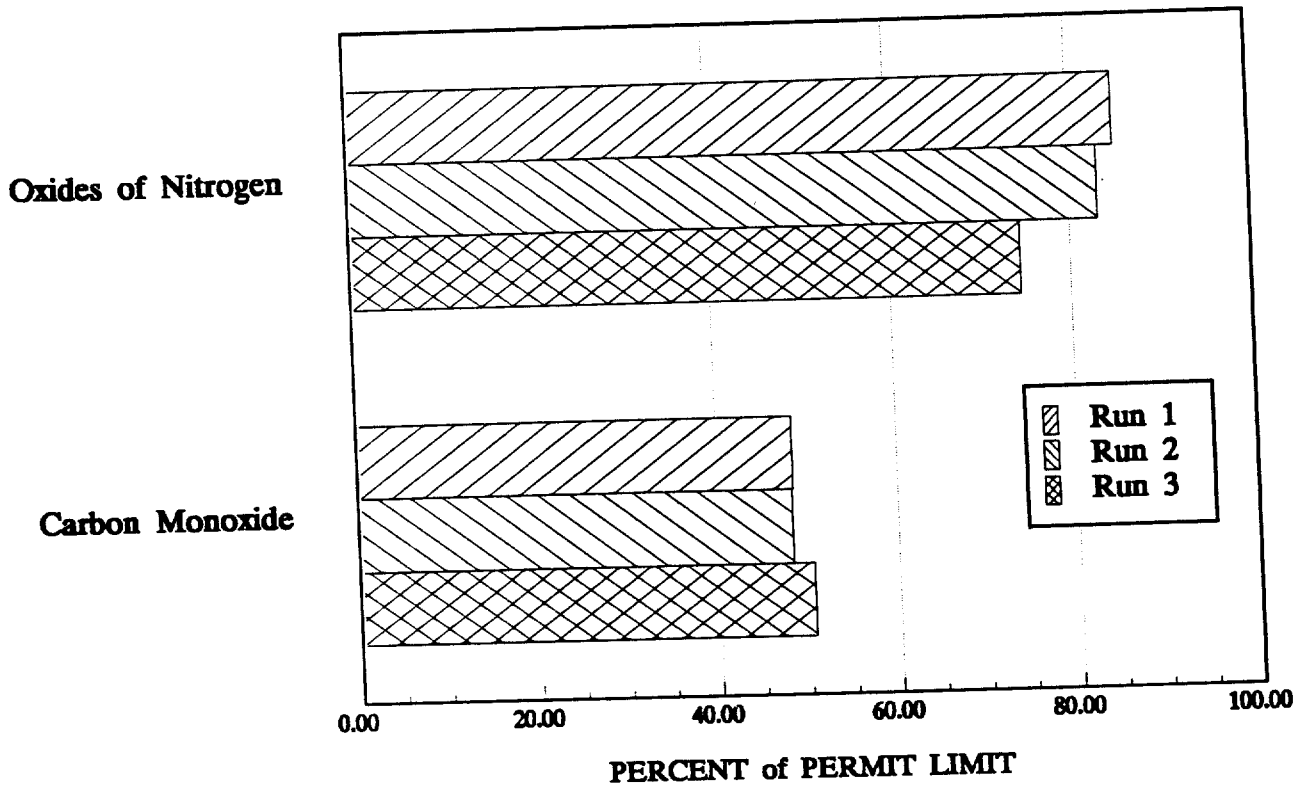


TABLE I
EMISSION TEST RESULTS SUMMARY

TEXACO PIPELINE, INC.
TPLI UNIT #2 - SOURCE ID 2-91

PARAMETER	PERMIT LIMIT	RUN 1	RUN 2	RUN 3	AVG.
DATE		3-19-92	3-19-92	3-19-92	
TIME		1329-1428	1454-1553	1615-1714	
OXIDES of NITROGEN					
PPMv		180.87	181.66	157.64	173.39
lb/hr	9.70	8.249	8.066	7.223	7.846
CARBON MONOXIDE					
PPMv		338.40	346.14	351.50	345.35
lb/hr		9.394	9.355	9.803	9.517
OXYGEN, test analyzer, %		12.06	12.18	12.22	12.15
OPERATING DATA					
Fuel Rate, M ft3/hr		13.5	13.5	13.5	13.5
Engine Speed, rpm		857	858	854	856
Engine Timing, deg		3	3	3	3
STACK GAS					
Temperature, F		669	667	664	667
Moisture, %		8.06	11.19	8.93	9.39
Velocity, ft/sec		119.56	120.35	120.99	120.30
Flow rate, acfm		15077.0	15176.2	15257.0	15170.1
dscfm		6362.0	6193.7	6391.4	6315.7

PROCESS DESCRIPTION

TPLI Unit #2 is used to boost pipeline pressure and transfer crude oil from offshore facilities. The transfer pump is driven by a 2200 hp, 8 cylinder, two cycle, pure turbocharged engine with opposed pistons for double quick expansion, dual pre-combustion cells for igniting the low fuel-to-air ratio mixture, dual electronic spark cell fuel gas regulators, and electronic fuel air ratio controls.

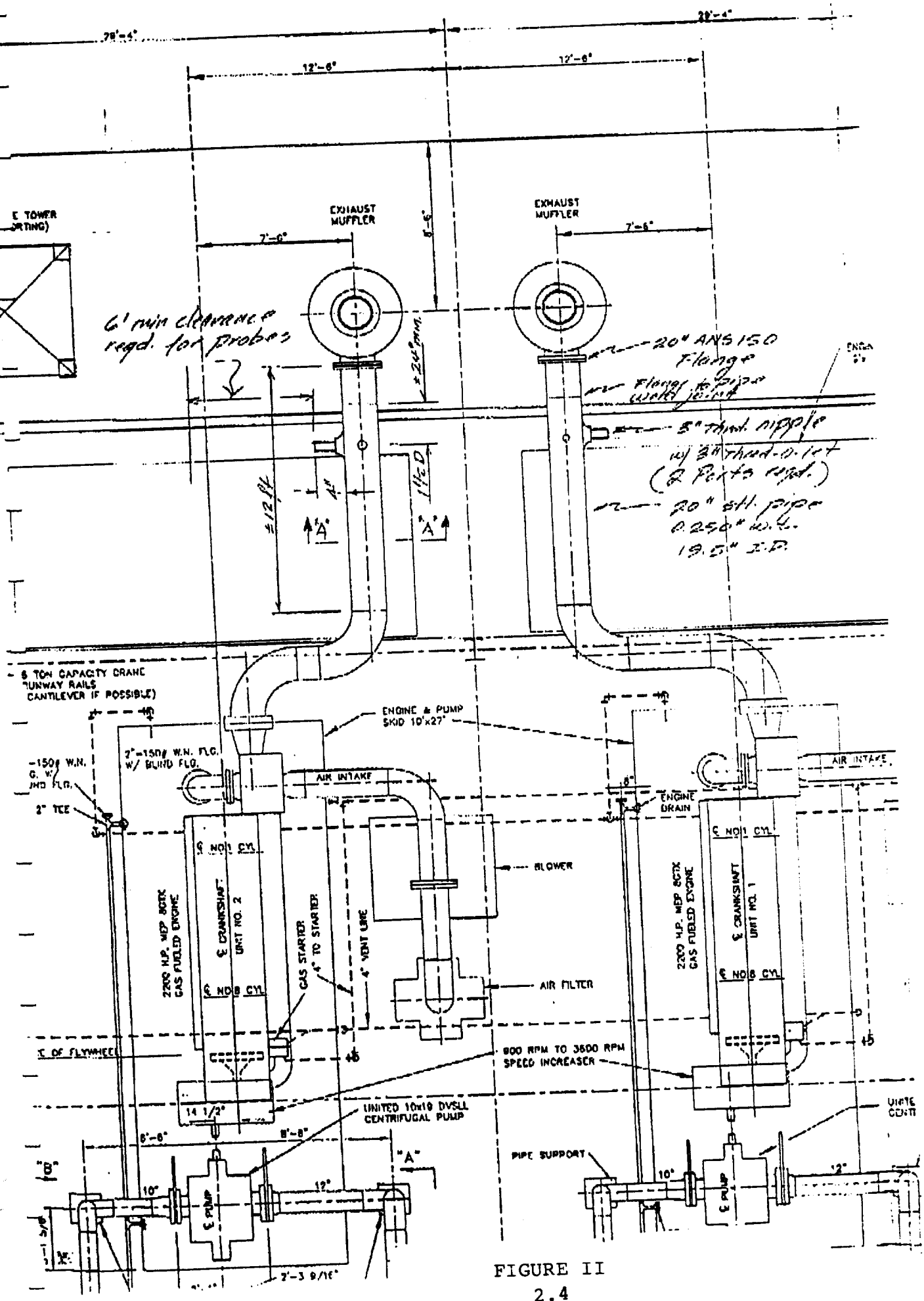
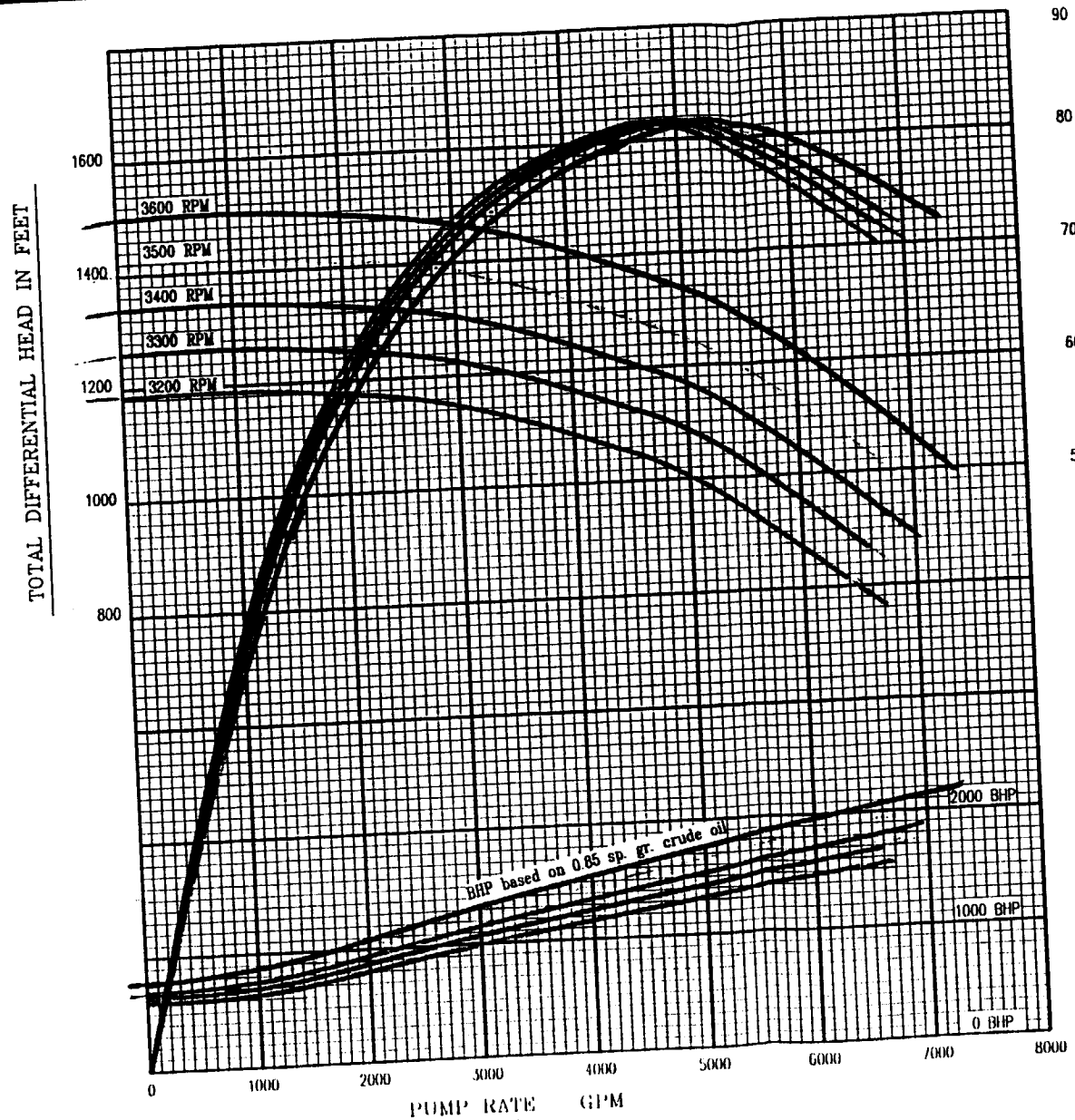

EXHAUST MUFFLER
EXHAUST MUFFLER
6' min clearance reqd. for probes
20" ANSI 150 Flange
5" thrd. nipple w/ 3" thrd-o-let (2 Perts reqd.)
20" std. pipe 0.250" w.t. 19.5" I.D.
5 TON CAPACITY CRANE RUNWAY RAILS CANTILEVER IF POSSIBLE)
ENGINE & PUMP SKID 10'x27'
AIR INTAKE
ENGINE DRAIN
BLOWER
AIR FILTER
2200 H.P. WEP 8GTK GAS FUELED ENGINE
℄ CRANKSHAFT UNIT NO. 2
℄ CRANKSHAFT UNIT NO. 1
GAS STARTER
4" TO STARTER
4" VENT LINE
900 RPM TO 3600 RPM SPEED INCREASER
UNITED 10x10 DVSLL CENTRIFUGAL PUMP
PIPE SUPPORT
℄ PUMP
2" TEE

FIGURE II



LAKE BARRE PUMP UNIT INFORMATION

PUMP SIZE, TYPE & CURVE NO.
United D – 10 x 19 DVSLL – 655

IMPELLER PATTERN
2506–H

VOLUTE PATTERN
2532–A

CASE PATTERN
2529–A
2529–A1

PUMP S/N
42267–2/ P–6235A Note: Pump was fitted with bronze impeller supplied by Power Machinery Inc
42267–4/ P–6235B Note: Pump was fitted with carbon steel impeller that was trimmed by Power Machinery Inc

GENERAL PUMP HISTORY INFORMATION
Pumps were surplus from Texaco Eastern Products Pipeline System – Delaware City, Delaware.

ACTUAL INSTALLED IMPELLER DIAMETERS
17.75 inches by Power Machinery Inc. on ±June 1991

GENERAL PUMP DRIVE AND ENGINE INFORMATION
Speed Increaser gear ratio 4.242 to 1.00
Type – Westech remanufactered Terry "U" Gear Box – Remanufactured ±April 1991

SPEED INCREASER S/N
TERRY/WESTECH 38374–1/ P–6235
TERRY/WESTECH 38374–2/ P–6235

ENGINE – M.E.P. (Fairbanks & Morse)
Model 8GTX two cycle, natural gas fueled, spark ignition engine in a blowerless turbocharged configuration – ±2000 BHP at 900 RPM.
S/Nos. 91420 & 91422

UNITS INSTALLED UNDER AFE 84188 3/91 TO 11/91

Pump RPM	Engine RPM
3600	944
3500	925
3400	900
3300	878
3200	854

TEXACO PIPELINE INC.
ENGINEERING HOUSTON, TEXAS

LAKE BARRE BOOSTER STATION
CHARACTERISTIC PUMP CURVE

		DATE	DRAWING NO.
CALC.	KRC		
DR.	KRC	10-16-91	B-721-PC
CHK.			
REV.			

FIGURE III
2.5

III. PROCEDURE

Emissions were determined using EPA methods found in Appendix A, Part 60, Title 40 of the Code of Federal Regulations. A brief description of each method used follows.

METHOD 1: SAMPLE and VELOCITY TRAVERSES for STATIONARY SOURCES

The TPLI Unit #2 has a stack diameter of 19.625 in. The sampling point was located 1.22 stack diameters upstream and 6.11 stack diameters downstream from the nearest flow disturbances. These distances do not meet the methods eight- and two-diameter requirements of the method; however, the method does provide methods of locating sampling points under these conditions. During sampling, the stack cross-section at the sampling point was divided into 16 equal areas with 8 traverse points located across 2 diameters of the stack.

METHOD 2: DETERMINATION of STACK GAS VELOCITY and VOLUMETRIC FLOW RATE (Type S pitot tube)

The average gas velocity in the stack was determined from the gas molecular weight, moisture content, and the average velocity head measured using a type S pitot tube. Volumetric flow rate was determined from the velocity and stack cross-sectional area.

METHOD 3: GAS ANALYSIS FOR CARBON DIOXIDE, OXYGEN, EXCESS AIR, and DRY MOLECULAR WEIGHT

The dry molecular weight of the stack gas was determined using an Orsat analyzer which measured the concentration of oxygen, carbon monoxide, and carbon dioxide. The remaining gas components were assumed to be nitrogen. A gas sample was removed from the centroid of the stack using a stainless steel probe fitted with a particulate filter. The probe, sample lines, and Orsat were purged sufficiently to obtain a representative grab sample for analysis.

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 a oxygen analyzer for analysis of oxygen concentration. Analyzer output was continuously recorded by a computer data acquisition system. Results from the oxygen monitor were used for reference purposes and when required, for oxygen concentration corrections for all other parameters determined from the continuous gas sample stream. Oxygen data obtained from this method 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. Sample gas passed from the probe, through a series of four impingers immersed in an ice bath. The first two impingers contained known weights 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.

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 a continuous chemiluminescence analyzer.

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.

IV. ANALYTICAL TECHNIQUE

All sample analyses were conducted following EPA methodology. Presented below are brief descriptions of each method used.

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 analyses, 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 was required.

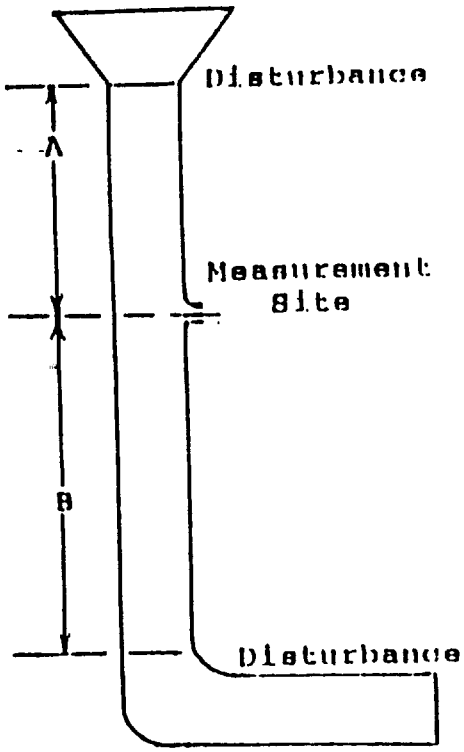
VI. TEST DATA and CALCULATIONS

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

Data from the field data forms 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.

ETS

EMISSION TESTING SERVICES, INC.
Traverse Point Layout



Client TEXACO PIPE LINE

Date 3-19-92

Unit Tested UNIT #2

Location LAKE BARRE

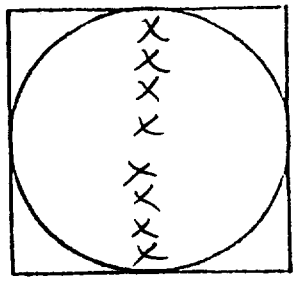
Upstream Distance (A) 2.0'

Downstream Distance (B) 10.0'

Inside Diameter 19.625

Coupling Length 4.75

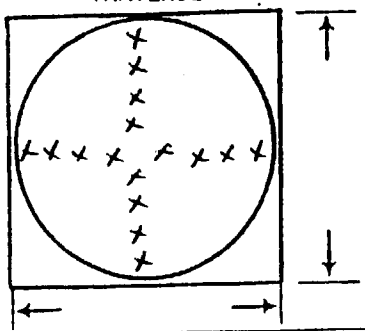
Coupling Type 3" SCREW ON



Cross Section Schematic of Stack

Traverse Point	Distance % of Diameter		Stack Diameter		Coupling Length		Traverse Points
1	.032	x	19.625	+	4.75	=	5.38
2	.105						6.81
3	.194						8.56
4	.323						11.09
5	.677						18.04
6	.806						20.57
7	.895						22.31
8	.968						23.75
9							
10							
11							
12							

CROSS SECTIONAL SCHEMATIC OF STACK TRAVERSE POINT LAYOUT



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

PLANT Texaco
DATE 19 MAR 92
LOCATION Off Shore
OPERATOR Scott L.
STACK NO. 2-91
RUN NO. 1

SAMPLE BOX NO. EE
METER BOX NO. 481
AMBIENT TEMPERATURE 75°
BAROMETRIC PRESSURE 28.98
FILTER TARE wt mg
NOZZLE DIAMETER, in. N/A

STACK DIAMETER, in. 19.63
PITOT TUBE NO. P-3-1
PITOT FACTOR 0.844
METER Δ Hₒ 1.5154
D.G.M.C. FACTOR 1.0232
K FACTOR

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	1332		678	2.0	1.414	1.5		880.000	82	77	252	65	2
2			672	2.15	1.466								
3			672	2.10	1.449				87	78	248	62	2
4			672	2.05	1.432								
5			665	2.05	1.432				94	80	256	60	2
6		+5.1	667	1.95	1.396								
7			669	1.90	1.378				97	81	250	58	2
8			659	2.05	1.432								
9	1420	OFF @	664	1.95	1.396			919.611	104	88	242	57	2
10			664	1.95	1.396								
11			663	1.95	1.396				105	89	247	60	2
12			669	1.95	1.396								
13			670	2.05	1.432				107	90	242	58	2
14			671	2.15	1.466								
15			671	2.15	1.466				106	89			
16			673	2.10	1.414								
AVERAGE	48.0	+5.1	668.688		1.423	1.5		39.611		90.875			

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS			
				10.2
FINAL	625.5	608.5	449.1	713.2
INITIAL	580.3	598.6	447.3	704.3
WEIGHT COLLECTED				

ORSAT MEASUREMENT

	CO_2	O_2	CO	N_2
1	5.8	10.7		
2				
3				

COMMENTS:

PRE-LEAK CHECK GOOD @ 0.008
POST-LEAK CHECK GOOD @ 0.001

6.1.2

E T S

Emission Testing Services, Inc.

Client : TEXACO
Source : ENGINE 2-91
Test Date : 3-19-92
Run No. : 1

DETERMINATION of STACK GAS MOISTURE, MOLECULAR WEIGHT, VELOCITY, and VOLUMETRIC FLOW RATE

A - Cross-sectional area of the stack, ft3
Acf - Stack gas flow rate, actual, acfm
Bws - Stack gas moisture fraction, %/100
Cp - Pitot tube coefficient
dH - Meter orific pressure differential, in. H2O
dP - Stack gas velocity head, in. H2O
F1 - Conversion factor, 13.6 in. H2O/ in. Hg
Kp - Pitot tube constant, 85.49
MCO2 - Molecular weight of CO2, 44.01 lb/ lb mole
Md - Stack gas molecular weight, dry lb/lb mole
MH2O - Molecular weight of water, 18.02 lb/lb mole
MN2 - Molecular weight of N2, 28.01 lb/lb mole
MO2 - Molecular weight of O2, 32.00 lb/lb mole
Ms - Stack gas molecular weight, wet lb/lb mole

Pbar - Barometric pressure, in. Hg
Pa - Stack gas static pressure, in. H2O
Ps - Stack gas absolute pressure, in. Hg
Pstd Standard absolute pressure, 29.92 in. Hg
Qsd - Stack gas volumetric flow rate, dry scfm
R - Ideal gas constant, 21.85
Tm - Meter temperature, R
Ts - Stack gas temperature, R
Tstd - Standard temperature, 528 R

Vi - Water vapor condensed, impinger 1, g
Vii - Water vapor condensed, impinger 2, g
Viii - Water vapor condensed, impinger 3, g
Viv - Water vapor condensed, impinger 4, g
Vm - Gas meter sample volume, dry ft3
Vmstd - Gas meter sample volume, dry std. ft3
Vs - Stack gas velocity, ft/sec
Vm - Total water vapor condensed, ft3
Y - Dry gas meter calibration factor
%CO2 - Stack gas CO concentration, %/100
%N2 Stack gas N2 concentration, %/100
O2 - Stack gas O2 concentration, %/100

$$Vw = \left\{ \frac{(Vi + Vii + Viii + Viv)\ R\ Tstd}{(453.6\ g/lb)\ Pstd\ MH2O} \right\} = \left\{ \frac{(49.6 + 9.9 + 1.8 + 8.9)(21.85)(528)}{(453.6)(29.92)(18.02)} \right\} = 3.31157$$

$$Vmstd = Vm\ Y \left\{ \frac{(Pb + dH/F1)\ Tstd}{Pstd\ Tm} \right\} = (39.611)(1.0232) \left\{ \frac{(28.980 + 1.5000/13.6)(528)}{(29.92)(551)} \right\} = 37.76974$$

$$Bws = \left\{ \frac{Vw}{Vw + Vmstd} \right\} = \left\{ \frac{(3.31157)}{(3.31157 + 37.76974)} \right\} = .0806$$

$$Md = (MCO2)(\%CO2) + (MO2)(\%O2) + (MN2)(\%N2)$$
$$= (44.01)(.058) + (32.00)(.102) + (28.01)(.840) = 29.345$$

$$Ms = Md\ (1 - Bws) + (MH2O\ Bws) = (29.345)(1 - .0806) + (18.02)(.0806) = 28.432$$

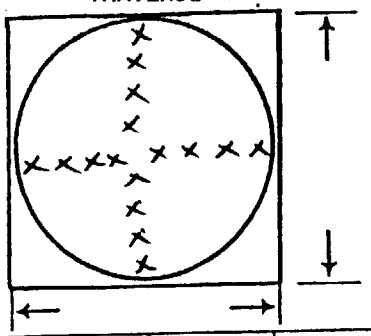
$$Vs = Kp\ Cp\ (dP)^{1/2} \left\{ \frac{Ts}{Ps\ Ms} \right\}^{1/2} = (85.49)(.8440)(1.4249) \left\{ \frac{(1129)}{(29.355)(28.432)} \right\}^{1/2} = 119.5626$$

$$Acf = (60\ sec/min)(Vs\ A) = (60)(119.5626)(2.1017) = 15077.0$$

$$Qsd = (3600\ sec/hr)(1 - Bws)(Vs\ A) \left\{ \frac{Tstd\ Ps}{Ts\ Pstd} \right\}$$

$$= (3600)(1 - .0806)(119.5626)(2.1017) \left\{ \frac{(528)(29.355)}{(1129)(29.92)} \right\} = 381720.7\ dscf/hr = 6362.0\ dscf/min$$

CROSS SECTIONAL SCHEMATIC OF STACK TRAVERSE POINT LAYOUT



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

PLANT Texaco
DATE 19 MAR 92
LOCATION OFF Shore
OPERATOR Scott L.
STACK NO. 2-51
RUN NO. 2

SAMPLE BOX NO. 22
METER BOX NO. 481
AMBIENT TEMPERATURE 73.5°
BAROMETRIC PRESSURE 28.98
FILTER TARE wt mg
NOZZLE DIAMETER, in. N/A

STACK DIAMETER, in. 19.63
PITOT TUBE NO. P-3-1
PITOT FACTOR 0.844
METER Δ He 1.9194
D.G.M.C. FACTOR 1.0232
K FACTOR

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	1456		668	2.15	1.466	1.5		920.00	90	86	247	67	2
2		+5.0	667	2.15	1.466								
3			668	2.15	1.466				96	87	256	62	2
4			668	2.10	1.449								
5			667	2.00	1.414				102	88	250	60	2
6			667	1.90	1.378								
7			667	1.95	1.396				103	87	241	61	2
8			666	1.90	1.378								
9			666	1.90	1.378				105	88	251	62	2
10			666	1.95	1.396								
11			667	1.95	1.396				106	87	246	59	2
12	1544		666	2.05	1.432			953.164					
13			666	2.05	1.432				105	87	257	59	2
14			666	2.10	1.414								
15			666	2.15	1.466				106	88	248	62	2
16			667	2.05	1.432								
AVERAGE	48.0	+5.0	666.750		1.422	1.5		33.164	94.438				

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS			
				83.9
FINAL	634.0	572.2	470.5	620.0
INITIAL	579.9	557.8	465.1	610.0
WEIGHT COLLECTED	54.1	14.4	5.4	10.

ORSAT MEASUREMENT

	CO2	O2	CO	N2
1	5.0	11.8		
2				
3				

COMMENTS:

PRE-LEAK CHECK GOOD @ 0.002
POST-LEAK CHECK GOOD @ 0.000

6.1.4

E T S

Emission Testing Services, Inc.

Client : TEXACO
Source : ENGINE 2-91
Test Date : 3-19-92
Run No. : 2

DETERMINATION of STACK GAS MOISTURE, MOLECULAR WEIGHT, VELOCITY, and VOLUMETRIC FLOW RATE

A - Cross-sectional area of the stack, ft3
Acf - Stack gas flow rate, actual, acfm
Bws - Stack gas moisture fraction, %/100
Cp - Pitot tube coefficient
dH - Meter orific pressure differential, in. H2O
dP - Stack gas velocity head, in. H2O
F1 - Conversion factor, 13.6 in. H2O/ in. Hg
Kp - Pitot tube constant, 85.49
MCO2 - Molecular weight of CO2, 44.01 lb/ lb mole
Md - Stack gas molecular weight, dry lb/lb mole
MH2O - Molecular weight of water, 18.02 lb/lb mole
MN2 - Molecular weight of N2, 28.01 lb/lb mole
MO2 - Molecular weight of O2, 32.00 lb/lb mole
Ms - Stack gas molecular weight, wet lb/lb mole

Pbar - Barometric pressure, in. Hg
Ps - Stack gas static pressure, in. H2O
Pb - Stack gas absolute pressure, in. Hg
Pstd Standard absolute pressure, 29.92 in. Hg
Qsd - Stack gas volumetric flow rate, dry scfm
R - Ideal gas constant, 21.85
Tm - Meter temperature, R
Ts - Stack gas temperature, R
Tstd - Standard temperature, 528 R

Vi - Water vapor condensed, impinger 1, g
Vii - Water vapor condensed, impinger 2, g
Viii - Water vapor condensed, impinger 3, g
Viv - Water vapor condensed, impinger 4, g
Vm - Gas meter sample volume, dry ft3
Vmstd - Gas meter sample volume, dry std. ft3
Vs - Stack gas velocity, ft/sec
Vm - Total water vapor condensed, ft3
Y - Dry gas meter calibration factor
%CO2 - Stack gas CO concentration, %/100
%N2 Stack gas N2 concentration, %/100
O2 - Stack gas O2 concentration, %/100

$$Vw = \left\{ \frac{(Vi + Vii + Viii + Viv)\ R\ Tstd}{(453.6\ g/lb)\ Pstd\ MH2O} \right\} = \left\{ \frac{(54.1 + 14.4 + 5.4 + 10.0)(21.85)(528)}{(453.6)(29.92)(18.02)} \right\} = 3.95784$$

$$Vmstd = Vm\ Y \left\{ \frac{(Pb + dH/F1)\ Tstd}{Pstd\ Tm} \right\} = (33.164)(1.0232) \left\{ \frac{(28.980 + 1.5000/13.6)(528)}{(29.92)(554)} \right\} = 31.41921$$

$$Bws = \left\{ \frac{Vw}{Vw + Vmstd} \right\} = \left\{ \frac{(3.95784)}{(3.95784 + 31.41921)} \right\} = .1119$$

$$Md = (MCO2)(\%CO2) + (MO2)(\%O2) + (MN2)(\%N2)$$
$$= (44.01)(.050) + (32.00)(.118) + (28.01)(.832) = 29.281$$

$$Ms = Md\ (1 - Bws) + (MH2O\ Bws) = (29.281)(1 - .1119) + (18.02)(.1119) = 28.021$$

$$Vs = Kp\ Cp\ (dP)^{1/2} \left\{ \frac{Ts}{Ps\ Ms} \right\}^{1/2} = (85.49)(.8440)(1.4248) \left\{ \frac{(1127)}{(29.348)(28.021)} \right\}^{1/2} = 120.3490$$

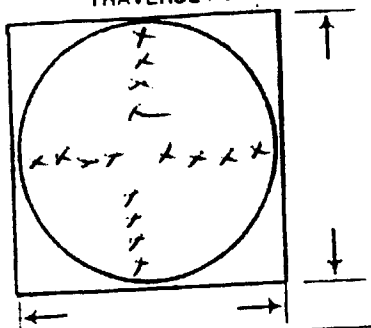
$$Acf = (60\ sec/min)(Vs\ A) = (60)(120.3490)(2.1017) = 15176.2$$

$$Qsd = (3600\ sec/hr)(1 - Bws)(Vs\ A) \left\{ \frac{Tstd\ Ps}{Ts\ Pstd} \right\}$$

$$= (3600)(1 - .1119)(120.3490)(2.1017) \left\{ \frac{(528)(29.348)}{(1127)(29.92)} \right\} = 371624.6\ dscf/hr = 6193.7\ dscf/min$$

ETS FIELD DATA, METHOD(S) 1-4

CROSS SECTIONAL SCHEMATIC OF STACK TRAVERSE POINT LAYOUT



PLANT TEXACO
DATE 19 MAR 92
LOCATION OFF SLURRY
OPERATOR SCOTT L.
STACK NO. 2-71
RUN NO. 3

SAMPLE BOX NO. EE
METER BOX NO. 481
AMBIENT TEMPERATURE 72°
BAROMETRIC PRESSURE 29.92
FILTER TARE wt mg N/A
NOZZLE DIAMETER, in. N/A

STACK DIAMETER, in. 19.63
PITOT TUBE NO. P-31
PITOT FACTOR P-3-1
METER Δ Hø 0.844 1.5194
D.G.M.C. FACTOR 1.0232
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	1618		663	2.15	1.466	1.5		953.5	81	84	245	65	2
2			664	2.15	1.466				90	84	256	60	2
3		+5.1	664	2.15	1.466								
4			664	2.15	1.466				99	84	249	58	2
5			664	2.10	1.449								
6			663	2.05	1.432				100	85	259	61	2
7			663	1.95	1.396								
8			663	1.50	1.378				102	86	248	59	2
9			663	1.55	1.396								
10			664	2.00	1.414				103	87	252	60	2
11			664	2.00	1.414			985.898					
12	1706	0=c@	664	2.05	1.432				104	88	260	64	2
13			664	2.10	1.449								
14			664	2.20	1.483				104	88	251	62	2
15			665	2.15	1.466								
16			665	2.15	1.466								
AVERAGE	48.0	+5.1	663.813		1.440	1.5		32.398		91.813			

VOLUME OF LIQUID WATER COLLECTED	IMPINGER WEIGHTS (640)			
FINAL	684.6	613.7	448.7	712.7
INITIAL	629.9	608.5	449.1	713.2
WEIGHT COLLECTED	54.7	5.2	-0.4	0.5

ORSAT MEASUREMENT

	CO2	O2	CO	N2
1	5.0	12.4	0	
2				
3				

COMMENTS:

PRE-LEAK CHECK GOOD @ 10" Hg 0.005
POST-LEAK CHECK GOOD @ 2" Hg 0.020

6.1.6

E T S

Emission Testing Services, Inc.

Client : TEXACO
Source : ENGINE 2-91
Test Date : 3-19-92
Run No. : 3

DETERMINATION of STACK GAS MOISTURE, MOLECULAR WEIGHT, VELOCITY, and VOLUMETRIC FLOW RATE

A - Cross-sectional area of the stack, ft3
Acf - Stack gas flow rate, actual, acfm
Bws - Stack gas moisture fraction, %/100
Cp - Pitot tube coefficient
dH - Meter orific pressure differential, in. H2O
dP - Stack gas velocity head, in. H2O
F1 - Conversion factor, 13.6 in. H2O/ in. Hg
Kp - Pitot tube constant, 85.49
MCO2 - Molecular weight of CO2, 44.01 lb/ lb mole
Md - Stack gas molecular weight, dry lb/lb mole
MH2O - Molecular weight of water, 18.02 lb/lb mole
MN2 - Molecular weight of N2, 28.01 lb/lb mole
MO2 - Molecular weight of O2, 32.00 lb/lb mole
Ms - Stack gas molecular weight, wet lb/lb mole
Pbar - Barometric pressure, in. Hg
Pa - Stack gas static pressure, in. H2O
Ps - Stack gas absolute pressure, in. Hg
Pstd Standard absolute pressure, 29.92 in. Hg
Qsd - Stack gas volumetric flow rate, dry scfm
R - Ideal gas constant, 21.85
Tm - Meter temperature, R
Ts - Stack gas temperature, R
Tstd - Standard temperature, 528 R
Vi - Water vapor condensed, impinger 1, g
Vii - Water vapor condensed, impinger 2, g
Viii - Water vapor condensed, impinger 3, g
Viv - Water vapor condensed, impinger 4, g
Vm - Gas meter sample volume, dry ft3
Vmstd - Gas meter sample volume, dry std. ft3
Vs - Stack gas velocity, ft/sec
Vm - Total water vapor condensed, ft3
Y - Dry gas meter calibration factor
%CO2 - Stack gas CO concentration, %/100
%N2 Stack gas N2 concentration, %/100
O2 - Stack gas O2 concentration, %/100

$$Vw = \left\{ \frac{(Vi + Vii + Viii + Viv)\ R\ Tstd}{(453.6\ g/lb)\ Pstd\ MH2O} \right\} = \left\{ \frac{(54.7 + 5.2 + -.4 + 4.5)(21.85)(528)}{(453.6)(29.92)(18.02)} \right\} = 3.01909$$

$$Vmstd = Vm\ Y \left\{ \frac{(Pb + dH/F1)\ Tstd}{Pstd\ Tm} \right\} = (32.398)(1.023) \left\{ \frac{(28.920 + 1.500/13.6)(528)}{(29.92)(552)} \right\} = 30.77593$$

$$Bws = \left\{ \frac{Vw}{Vw + Vmstd} \right\} \left\{ = \frac{(3.01909)}{(3.01909 + 30.77593)} \right\} = .0893$$

$$Md = (MCO2)(\%CO2) + (MO2)(\%O2) + (MN2)(\%N2)$$
$$= (44.01)(.050) + (32.00)(.124) + (28.01)(.826) = 29.305$$

$$Ms = Md\ (1 - Bws) + (MH2O\ Bws) = (29.305)(1 - .0893) + (18.02)(.0893) = 28.297$$

$$Vs = Kp\ Cp\ (dP)^{1/2} \left\{ \frac{Ts}{Ps\ Ms} \right\}^{1/2} = (85.49)(.844)(1.440) \left\{ \frac{(1124)}{(29.295)(28.297)} \right\}^{1/2} = 120.990$$

$$Acf = (60\ sec/min)(Vs\ A) = (60)(120.990)(2.102) = 15257.0$$

$$Qsd = (3600\ sec/hr)(1 - Bws)(Vs\ A) \left\{ \frac{Tstd\ Ps}{Ts\ Pstd} \right\}$$

$$= (3600)(1 - .0893)(120.990)(2.102) \left\{ \frac{(528)(29.295)}{(1124)(29.92)} \right\} = 383486.9\ dscf/hr = 6391.4\ dscf/min$$

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

Client : TEXACO
Source : ENGINE 2-91
Testing Date : 3-19-92
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 = (180.87)(1.1948 X 10-7)(381720.7) = 8.249

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

ENOX = (181.66)(1.1948 X 10-7)(371624.6) = 8.066

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

ENOX = (157.64)(1.1948 X 10-7)(383486.8) = 7.223

Emission Testing Services, Inc.
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Baton Rouge, LA 70895
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Client : TEXACO
Source : ENGINE 2-91
Testing Date : 3-19-92
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 = (338.40)(7.2727 X 10-8)(381720.7) = 9.394

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

ECO = (346.14)(7.2727 X 10-8)(371624.6) = 9.355

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

ECO = (351.50)(7.2727 X 10-8)(383486.8) = 9.803

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 printouts of the test data.

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

RUN TITLE: TEXACO PIPELINE
DATE: 3/19/92
RUN: 1
SOURCE: 2-91

TIME	CO-PPM	NOX-PPM	O2%	TIME	CO-PPM	NOX-PPM	O2%
13:29:23	340.94	177.31	12.10	13:59:25	335.53	185.49	12.05
13:30:23	337.49	180.11	12.13	14:00:25	334.54	180.33	12.07
13:31:23	336.02	180.97	12.10	14:01:25	339.46	184.85	12.05
13:32:24	338.97	179.68	12.11	14:02:25	337.00	185.49	12.03
13:33:24	338.97	169.13	12.09	14:03:25	336.51	182.48	11.99
13:34:24	341.92	175.37	12.07	14:04:26	334.05	181.40	12.06
13:35:24	343.40	174.51	12.07	14:05:26	336.02	180.54	12.11
13:36:24	343.89	172.79	12.10	14:06:26	335.03	173.22	12.10
13:37:24	346.35	174.51	12.12	14:07:26	336.51	182.05	12.07
13:38:24	349.79	174.94	12.13	14:08:26	340.94	177.10	12.10
13:39:24	346.35	176.67	12.07	14:09:26	335.53	187.00	12.01
13:40:24	342.90	174.73	12.10	14:10:26	335.03	189.15	12.00
13:41:24	348.81	176.88	12.11	14:11:26	332.58	186.35	12.03
13:42:24	340.94	179.25	12.07	14:12:26	332.08	186.78	11.98
13:43:24	341.43	176.24	12.09	14:13:26	331.59	186.14	12.01
13:44:24	339.95	178.39	12.07	14:14:26	332.58	187.22	12.00
13:45:24	341.92	177.53	12.10	14:15:26	332.08	186.35	11.99
13:46:24	341.43	175.80	12.07	14:16:26	332.58	194.75	12.01
13:47:24	338.48	179.25	12.03	14:17:26	335.53	187.65	12.01
13:48:24	339.46	177.31	12.11	14:18:26	334.05	185.49	11.98
13:49:24	336.51	175.59	12.04	14:19:26	335.53	187.65	12.01
13:50:25	339.95	178.39	12.11	14:20:26	335.03	185.28	12.00
13:51:25	340.94	175.37	12.10	14:21:26	336.51	187.00	12.07
13:52:25	341.92	177.10	12.11	14:22:26	331.10	192.38	11.99
13:53:25	341.43	173.22	12.09	14:23:27	330.61	186.57	11.99
13:54:25	341.43	176.24	12.10	14:24:27	335.03	188.51	12.00
13:55:25	343.89	176.02	12.12	14:25:27	337.99	186.57	11.97
13:56:25	338.48	179.68	12.00	14:26:27	337.99	184.63	11.98
13:57:25	339.46	176.88	12.06	14:27:27	338.48	180.54	11.96
13:58:25	340.44	178.17	12.07	14:28:27	342.41	185.49	12.01

	CO-PPM	NOX-PPM	O2-%
AVG.	338.40	180.87	12.06

RUN TITLE: TEXACO PIPELINE
DATE: 3/19/92
RUN: 2
SOURCE: 2-91

TIME	CO-PPM	NOX-PPM	O2%	TIME	CO-PPM	NOX-PPM	O2%
14:54:09	347.33	184.10	12.13	15:24:12	339.46	205.29	12.12
14:55:09	356.18	186.67	12.13	15:25:12	337.00	202.94	12.11
14:56:09	356.18	185.17	12.17	15:26:12	342.41	172.75	12.23
14:57:09	356.18	180.89	12.15	15:27:12	345.85	168.69	12.18
14:58:09	360.61	182.60	12.14	15:28:12	342.90	167.19	12.17
14:59:09	362.08	177.89	12.15	15:29:12	339.46	168.04	12.21
15:00:09	364.54	179.61	12.15	15:30:12	341.92	166.97	12.20
15:01:09	358.64	178.75	12.15	15:31:12	340.94	170.40	12.18
15:02:09	358.15	184.31	12.17	15:32:12	342.41	168.69	12.20
15:03:09	354.71	186.67	12.13	15:33:12	342.41	172.97	12.20
15:04:09	355.20	189.02	12.14	15:34:13	342.41	168.90	12.20
15:05:09	352.25	193.95	12.18	15:35:13	343.40	168.26	12.21
15:06:09	349.30	194.16	12.11	15:36:13	344.38	170.61	12.18
15:07:09	349.30	197.37	12.14	15:37:13	344.38	164.62	12.20
15:08:10	346.35	198.44	12.14	15:38:13	348.31	162.69	12.24
15:09:10	342.41	196.73	12.13	15:39:13	344.87	164.83	12.24
15:10:10	343.40	202.51	12.12	15:40:13	340.44	169.76	12.21
15:11:10	341.43	202.30	12.14	15:41:13	340.44	163.55	12.25
15:12:10	341.43	200.16	12.14	15:42:14	347.33	167.40	12.25
15:13:10	340.94	200.37	12.09	15:43:14	346.84	165.48	12.27
15:14:10	339.46	200.37	12.09	15:44:14	346.35	164.41	12.30
15:15:10	339.46	196.52	12.08	15:45:14	348.81	166.33	12.33
15:16:11	337.49	199.51	12.12	15:46:14	344.87	165.69	12.32
15:17:11	343.89	201.01	12.15	15:47:14	344.87	168.26	12.31
15:18:11	340.44	199.73	12.12	15:48:14	345.85	168.26	12.32
15:19:11	339.46	197.80	12.08	15:49:14	345.36	166.76	12.27
15:20:11	344.38	200.80	12.11	15:50:14	349.30	164.19	12.30
15:21:11	340.44	200.58	12.12	15:51:15	347.33	169.12	12.31
15:22:12	340.94	203.15	12.11	15:52:15	357.17	164.41	12.31
15:23:12	337.49	204.01	12.06	15:53:15	340.94	166.97	12.31

	CO-PPM	NOX-PPM	O2%
AVG.	346.14	181.66	12.18

RUN TITLE: TEXACO PIPELINE
DATE: 3/19/92
RUN: 3
SOURCE: 2-91

TIME	CO-PPM	NOX-PPM	O2%	TIME	CO-PPM	NOX-PPM	O2%
16:15:07	361.59	155.99	12.26	16:45:13	340.94	162.84	12.20
16:16:07	359.13	157.28	12.19	16:46:13	343.40	158.35	12.23
16:17:07	359.13	158.56	12.21	16:47:13	341.92	158.35	12.25
16:18:07	359.13	158.77	12.17	16:48:13	342.90	156.42	12.27
16:19:08	358.64	156.42	12.20	16:49:13	345.36	161.56	12.27
16:20:08	356.67	155.78	12.17	16:50:13	342.90	162.41	12.25
16:21:08	355.69	153.85	12.21	16:51:13	344.87	158.56	12.24
16:22:08	365.04	150.85	12.23	16:52:14	345.36	159.63	12.23
16:23:09	363.07	153.64	12.17	16:53:14	344.87	161.98	12.20
16:24:09	360.12	149.14	12.20	16:54:14	344.38	161.56	12.27
16:25:10	361.10	153.64	12.19	16:55:14	347.82	161.13	12.20
16:26:10	358.15	150.64	12.21	16:56:14	345.85	161.98	12.18
16:27:10	358.15	156.63	12.20	16:57:14	343.40	164.12	12.15
16:28:11	359.13	153.21	12.21	16:58:14	344.38	163.48	12.18
16:29:11	356.67	151.07	12.19	16:59:14	348.81	162.63	12.15
16:30:11	355.69	152.57	12.23	17:00:15	344.87	162.41	12.18
16:31:11	353.72	157.28	12.20	17:01:15	345.85	165.62	12.18
16:32:11	350.28	158.77	12.23	17:02:15	347.82	162.41	12.23
16:33:11	351.76	156.85	12.18	17:03:15	351.26	151.28	12.25
16:34:11	353.23	152.57	12.15	17:04:15	356.18	155.78	12.31
16:35:11	357.17	156.21	12.24	17:05:15	349.30	156.42	12.27
16:36:11	355.20	150.43	12.24	17:06:15	344.87	157.49	12.25
16:37:12	351.26	159.20	12.27	17:07:16	351.26	156.42	12.25
16:38:12	348.81	161.98	12.21	17:08:16	351.26	151.92	12.24
16:39:12	346.35	160.27	12.18	17:09:16	356.18	154.49	12.29
16:40:12	346.35	158.35	12.27	17:10:16	357.66	152.99	12.23
16:41:12	342.90	162.20	12.21	17:11:16	356.18	152.99	12.20
16:42:12	345.36	166.26	12.21	17:12:16	358.15	154.06	12.23
16:43:12	340.94	163.91	12.18	17:13:16	360.12	153.42	12.23
16:44:13	340.94	164.77	12.15	17:14:17	360.61	158.35	12.21

	CO-PPM	NOX-PPM	O2%
AVG.	351.50	157.64	12.22

Run Title: TEXACO NOX CONV.
Date: 3/19/1992

Time	NOX-VTS	NOX-PPM
12:21:37	4.293	188.095
12:22:37	4.289	187.881
12:23:37	4.313	188.951
12:24:37	4.288	187.881
12:25:37	4.293	188.095
12:26:37	4.303	188.523
12:27:37	4.274	187.239
12:28:37	4.288	187.881
12:29:37	4.259	186.597
12:30:37	4.274	187.239
12:31:38	4.269	187.025
12:32:38	4.234	185.527
12:33:38	4.230	185.313
12:34:38	4.234	185.527
12:35:38	4.225	185.099
12:36:38	4.210	184.457
12:37:38	4.205	184.243
12:38:38	4.205	184.243
12:39:38	4.210	184.457
12:40:38	4.200	184.029
12:41:38	4.176	182.958
12:42:38	4.181	183.173
12:43:38	4.181	183.173
12:44:38	4.186	183.387
12:45:38	4.166	182.530
12:46:38	4.151	181.888
12:47:38	4.161	182.316
12:48:38	4.147	181.674
12:49:38	4.137	181.246
12:50:38	4.127	180.818
12:51:38	4.142	181.460

ETS
EMISSION TESTING SERVICES, INC.
P.O. BOX 15075 • BATON ROUGE, LA 70895

METHOD 3A DATA SHEET

COMPANY Texaco Pipeline SOURCE # 2-51 DATE 3-19-92

PARAMETER O_2 LOAD% _____ RUN NUMBER 1

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response v	Analyzer Response %	Absolute Difference v	Absolute Difference %	% Span ±2%
Zero	N2	0.07	-0.21	0.04	-0.29	-0.33
Mid	7.42	3.35	7.76	3.26	7.54	-0.92
High	20.9	8.70	20.77	8.60	20.53	-1.00

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

Slope 24313 Intercept -0.3825 Span Range 23.93

Analyzer Cal		Init. Analyzer Resp. v	ppm	Bias ±5	Final Analyzer Resp. v	ppm	Bias ±5	Span Drift ±3
Conc.	N2	0.14	-0.04	0.71	0.16	0.01	1.25	2.26

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

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

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 = 0.999

ETS
EMISSION TESTING SERVICES, INC.
P.O. BOX 15075 • BATON ROUGE, LA 70895

METHOD 7E DATA SHEET

COMPANY Texaco Pipeline SOURCE # 2-51 DATE 3-15-92

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	0.00	0.34	0.00	0.34	0.0
Mid	231.7	5.23	230.89	5.22	232.65	0.40
High	397.48	9.02	397.95	9.02	400.16	0.50

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

Slope ~~[illegible]~~ 44.0809 Intercept 0.3422 Span Range 441.15

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. 231.7	5.12	226.04	-1.10	5.12	226.04	-1.50	-0.09

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:

$R = 0.99999$

ETS
EMISSION TESTING SERVICES, INC.
P.O. BOX 15075 • BATON ROUGE, LA 70895

METHOD 10 DATA SHEET

COMPANY Texaco Pipeline SOURCE # 2-51 DATE 3-19-92

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	N2	0.00		0.00		0.0
Low	89.65	0.84		0.84		0.0
Mid	455.6	4.79		4.79		0.0
High	895.0	8.85		8.85		0.0

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

Slope 100.6992 Intercept 4.5345 Span Range 1010.53

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

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 = 0.9999

ETS
EMISSION TESTING SERVICES, INC.
P.O. BOX 15075 • BATON ROUGE, LA 70895

METHOD 3A DATA SHEET

COMPANY Texaco Pipeline SOURCE # 2-91 DATE 3-19-92

PARAMETER O2 LOADS _____ RUN NUMBER 3

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response v	Analyzer Response %	Absolute Difference v	Absolute Difference %	% Span ±2%
Zero	N2	0.04	-0.18	0.04	-0.18	0.0
Mid	7.42	3.26		3.26		0.0
High	20.9	8.60		8.60		0.0

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

Slope 2.4455 Intercept -0.2781 Span Range 24.22

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.	N2	0.16	0.11	1.20	0.16	0.11	1.20	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 = 0.999

ETS
EMISSION TESTING SERVICES, INC.
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METHOD 7E DATA SHEET

COMPANY Texaco Pipeline SOURCE # 2-51 DATE 3-19-92

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	N2	0.00	0.21	0.00	0.21	0.0
Mid	231.7	5.27	231.20	5.29	232.08	0.20
High	392.48	9.07	392.77	9.07	392.77	0.0

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

Slope 43.8325 Intercept 0.2076 Span Range 438.53

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. 231.7	5.12	224.63	-1.50	5.12	224.63	-1.70	-0.05

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 _____

Test Point mv 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. mv _____

Ave. conc. _____ ppm

COMMENTS: R = 0.99999

ETS
EMISSION TESTING SERVICES, INC.
P.O. BOX 15075 • BATON ROUGE, LA 70895

METHOD 10 DATA SHEET

COMPANY Texaco Pipeline SOURCE # 2-91 DATE 3-19-92

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	0.00		0.00		0.0
Low	8.65	0.84		0.84		0.0
Mid	495.6	4.79		4.79		0.0
High	895.0	8.89		8.89		0.0

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

Slope 100.6992 Intercept 0.5345 Span Range 1011.53

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

TEST DATA

Start time _____ Finish time _____ Minutes per point ____

Test Point mv 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. mv _____

Ave. conc. _____ ppm

COMMENTS:

ETS
EMISSION TESTING SERVICES, INC.
P.O. BOX 15075 • BATON ROUGE, LA 70895

METHOD 3A DATA SHEET

COMPANY Texaco Pipeline SOURCE # 2-91 DATE 3-19-92

PARAMETER O2 LOAD% _____ RUN NUMBER 3

CALIBRATION STATISTICS

Cylinder Value		Analyzer Response v	Analyzer Response %	Absolute Difference v	Absolute Difference %	% Span ±2%
Zero	N2	0.04	-0.18	0.04	-0.18	0.0
Mid	7.42	3.26	7.71	3.26	7.71	0.0
High	20.9	8.60	20.79	8.60	20.79	0.0

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

Slope 2.4499 Intercept -0.2781 Span Range 24.22

Analyzer Cal		Init. Analyzer Resp. v	ppm	Bias ±5	Final Analyzer Resp. v	ppm	Bias ±5	Span Drift ±3
Conc.	N2	0.16	0.11	-0.07	0.16	0.11	-0.07	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:

ETS
EMISSION TESTING SERVICES, INC.
P.O. BOX 15075 • BATON ROUGE, LA 70895

METHOD 7E DATA SHEET

COMPANY Texaco Pipeline SOURCE # 2-91 DATE 3-19-92

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	N2	0.00	-0.03	0.00	-0.03	0.0
Mid	231.7	5.29	231.78	5.29	231.78	0.0
High	397.48	5.07	397.43	5.07	397.43	0.0

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

Slope 43.8221 Intercept -0.0349 Span Range 438.19

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. 231.7	5.12	224.33	-1.70	5.12	224.33	-1.70	0.0

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 _____

Test Point mv 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. mv _____

Ave. conc. _____ ppm

COMMENTS:

r = 0.99999

ETS
EMISSION TESTING SERVICES, INC.
P.O. BOX 15075 • BATON ROUGE, LA 70895

METHOD 10 DATA SHEET

COMPANY Texaco Pipeline SOURCE # 2-91 DATE 3-15-92

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	0.00		0.00		0.0
Low	89.69	0.84		0.84		0.0
Mid	495.6	4.79		4.79		0.0
High	895.0	8.89		8.89		0.0

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

Slope 100.6992 Intercept 45345 Span Range 1011.53,

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

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:

Presented on the following pages are TPLI Unit #2 operating data collected during the emissions test. A fuel gas analysis follows the operating data.

EMISSION TESTING SERVICES, INC.

INTERNAL COMBUSTION ENGINE
OPERATIONAL RECORD

Company Name Texaco Pipeline Inc

Company Location Lake Barre Booster Station

Engine Name M.E.P. - Fairbanks - Morse

Engine Source I. D. No. 2-91 (TPLI Unit #2)

Design Specifications

Manufacturer's Name MEP - Fairbanks Morse

Model No. 8GTK Serial No. 91420.

Parameter Specifications

A. Fuel Type Nat. Gas B. Fuel Supplier Texaco

C. Fuel Flow Units _____ Meas. Method Orifice Flow Meter

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.) psig for both

G. Manifold Temp.(^{o}F, ^{o}C, etc.) °F

Ultimate Fuel Analysis

C _____ S _____ H _____ Ash _____

O _____ H_2O _____ N _____

Trace Metals: Na _____ Va _____ K _____

Fuel elements added _____

Fuel elements added for smoke suppression _____

#1

EMISSION TESTING SERVICES, INC.

INTERNAL COMBUSTION ENGINE

TEST RUN LOG

(GAS ENGINES)

Company Texaco Pipeline INC

Engine Fairbanks Morse 38D8 1/8 CIX

Operator Texaco Pipeline Jon Yaeche (Fairbanks Morse Ser Rep)

Date: 3/19/92 Test Time: Start _____ End _____

Ambient Temperature, at time of test 75°F Dry 69°F wet

Engine Load Condition % 90% 90% 90% 90%

DATA LOG TIME (15 minute intervals)	13:38	13:53	14:08	14:23
Fuel Feed (flow)	135 MCF	135 MCF	135 MCF	135 MCF
Intake Manifold Temp.	130°F	130°F	130°F	130°F
Intake Manifold Pressure	11.6 PSI	11.6 PSI	11.6 PSI	11.6 PSI
Fuel Header Pressure	35.5	35.5	35.5	35.5
Engine Speed (rpm)	851	851	851	851
Spark Ignition Timing	30 ATDC	30 ATDC	30 ATDC	30 ATDC
Horse Power	1480	1480	1480	1480

Run Conditions: _____

Remarks: _____

#2

EMISSION TESTING SERVICES, INC.

INTERNAL COMBUSTION ENGINE

TEST RUN LOG

(GAS ENGINES)

Company Texaco Pipeline INC

Engine Fairbanks Morse 38D8 1/8 GTX

Operator Texaco Pipeline Readings by Jon Yancke (Fairbanks Morse Ser. Rep)

Date: 3/4/92 Test Time: Start _____ End _____

Ambient Temperature, at time of test 65°Cool 73°F Dry

Engine Load Condition % 90% 90% 90% 90%

DATA LOG TIME (15 minute intervals)	1503	1518	1533	1548
Fuel Feed (flow)	13.5 MFC	13.5 MFC	13.5 MFC	13.5 MFC
Intake Manifold Temp.	131°F	131°F	131°F	131°F
Intake Manifold Pressure	11.5 PSI	11.5 PSI	11.5 PSI	11.7
Fuel Header Pressure	35.5 PSI	35.5 PSI	35.5 PSI	35.5 PSI
Engine Speed (rpm)	900	900	900	852
Spark Ignition Timing	3° ATDC	3° ATDC	3° ATDC	3° ATDC
Horse Power	1980	1980	1980	1980

Run Conditions: _____

Remarks: _____

#3

EMISSION TESTING SERVICES, INC.

INTERNAL COMBUSTION ENGINE

TEST RUN LOG

(GAS ENGINES)

Company Texaco Pipeline Inc

Engine Fairbanks Morse 38D8⅛ GTX

Operator Texaco Pipeline, Readings by: Jon Vaughn (Fairbanks Morse Sec. Rep.)

Date: 3/19/92 Test Time: Start _____ End _____

Ambient Temperature, at time of test 72° DRY 64° WET

Engine Load Condition % 90% 90% 90% 90%

DATA LOG TIME (15 minute intervals)	1625	1640	1655	17:10
Fuel Feed (flow)	13.5 MCF	13.5 MCF	13.5 MCF	13.5 MCF
Intake Manifold Temp.	132°	132°	132°	132°
Intake Manifold Pressure	11.7	11.7	11.7	11.7
Fuel Header Pressure	3.55	3.55	3.55	3.55
Engine Speed (rpm)	851	850	850	851
Spark Ignition Timing	3° ATDC	3° ATDC	3° ATDC	3° ATDC
Horse Power	1480	1480	1480	1480

Run Conditions: _____

Remarks: _____

8

CHROMATOGRAPHIC COMPOSITION ANALYSIS REPORT

PLANT:	TEXACO	LAB:	PARADIS GAS PROCESSING PLANT
SOURCE:	LAKE BARRE	ANALYSIS NUMBER:	130201
METER#:	408-486	ANALYZED BY:	AMK
SAMPLE DATE:	2-11-92	DATE OF ANALYSIS:	2-14-92
SAMPLE TEMP:	78	SAMPLED BY:	GF
SAMPLE PRESS:	830	SAMPLE OF:	GAS

COMPONENT	LIQUID PERCENT	MOL PCT	WEIGHT PCT	GPM @ 15.025
HYDROGEN		0.00		
NITROGEN		0.35		
CARBON DIOXIDE		1.35		0.23
METHANE		89.80		15.53
ETHANE		4.43		1.21
PROPANE		2.01		0.57
ISO-BUTANE		0.52		0.17
N-BUTANE		0.67		0.22
ISO-PENTANE		0.27		0.10
N-PENTANE		0.24		0.09
HEXANES		0.20		0.09
HEPTANES+		0.16		0.08
TOTALS		100.00	TOTAL	18.28
			C2+	2.52

3.00 # DEW POINT

CALCULATED REAL SPECIFIC GRAVITY @ 60F (AIR 1) 0.648

CALCULATED REAL GAS HEATING VALUE @ 15.025 PSIA AND 60 F

DRY BASIS 1142

WET BASIS 1122

SOUTHERN FLOW COMPANIES

CUST 8880-10 FOR: TEXACO USA 738573013
FLD 1271 ATTN JOHNNY KIVES RM #133
STA 426 P O BOX 7
DATE 05/01/91
GC # 001 HARVEY LA 70059

SAMPLE IDENT: TEXACO E & P INC 738573013
LAKE BARRE 34 LEASE
34 LEASE FUEL 408-426 NO: 910501-093250

TYPE GAS GPA

SAMPLE: DATE 04/20/91 CYL NO 0-4 PSIG 58 GRAV NA DIFF/IN H2O NA WATER LBS/MMCF NA
DATA: TIME NA FLOW MMCF NA TEMP 75 F SAMPLED BY - D.J. FORET
MEMO: .

COMPONENT	ANALYSIS	MOL PERCENT	GPM PSIA 15.025
CO2	CARBON DIOXIDE	1.86	.323
N2	NITROGEN	.24	.027
C1	METHANE	88.06	15.225
C2	ETHANE	4.86	1.326
C3	PROPANE	2.27	.638
IC4	ISO-BUTANE	.60	.200
NC4	N-BUTANE	.82	.264
IC5	ISO-PENTANE	.32	.119
NC5	N-PENTANE	.26	.096
C6+	HEXANES PLUS	.71	.316
	TOTAL	100.00	

TOTAL ETHANE + GPM 2.959
TOTAL ISO-PENTANE + GPM 0.531

COMPRESSIBILITY FACTOR @ 15.025 PSIA			0.9971
SPECIFIC GRAVITY - 60 DEG F (AIR = 1)			0.671
C6+ MOLECULAR WEIGHT			93.288
THE FOLLOWING VALUES BASED ON BTU (PSIA, 60 DEG F) PB		15.025	14.730
BTU / CU FT (FPV)	DRY	1167.4	1144.4
	WET	1147.4	1124.4

VI. APPENDIX

The following appendices are presented as supporting documentation to the emission test report.

7.1.1 Texaco Pipeline correspondance to LA DEQ

7.2.1 Resumes of Test Personnel

7.3.1 Equipment Calibrations

7.4.1 Gas Standard Certifications

7.5.1 Continuous Analyzer descriptions and specifications

TEXACO PIPELINE INC

January 29, 1992

Louisiana Department of Environmental Quality
Office of Air Quality
P.O. Box 82135 phone:(504) 765-0741 or 765-0219
Baton Rouge, Louisiana 70884-2135

Attention: Mr. Gus Vonbodugen

RE: Permit NO. 2880-00042-01 dated Aug. 5, 1991: Emission Stack test for either point source 1-91 or 2-91 at Texaco Pipeline Inc's Lake Barre Crude Oil Pressure Boosting Station located near Cocodrie, Louisiana in Terrebonne Parish - AFE 84188

Per telephone conversation with your Staff Engineer Mr. James McGee and our Project Engineer Mr. Keith Champagne on January 28, 1992; we wish to advise that our plan to perform required emission stack tests on or about February 10, 1992 as stated in our previous letter dated January 6th, has been rescheduled. As discussed with Mr. Barry Gipson with Emission Testing Service of Baton Rouge, we have set a tentative test date for Thursday, March 19, 1992.

The change in the test schedule was brought about by the following items:

1. Our subcontractor that will erect the booster station pump shelter plans to move on location on February 10th and we are hesitant to conduct the stack test at the same time.

2. We are continuing to experience problems with the two 2200 horsepower Fairbanks and Morse natural gas engines, related to cold starts and engine idling problems. Some of the engine problems are caused by weather, ie. rain and condensation shorting out the ignition system and also causing cylinder misfiring. Once the pump shelter has been installed these types of problems should be reduced or eliminated.

3. The cold start and rough idling problems are also affected by an electronic device that controls the air fuel mixture under starting and low load conditions. The engine Vendor is currently working to reprogram the IC chips that control the air fuel mixtures; we expect the new chips to be installed during the week of February 3rd.

If additional information is required, please contact me at phone no. 713-953-4302 or Mr. Keith Champagne at phone 713-953-4319.

Very truly yours,

Signed: C. W. HARSHBARGER

C.W. Harshbarger

KRC

cc: EDL, Emission Testing Service File: E:\KRC\KRC08-92.LEG

TEXACO PIPELINE INC

January 6, 1992

Louisiana Department of Environmental Quality
Office of Air Quality
P.O. Box 82135
Baton Rouge, Louisiana 70884-2135 phone: 504-765-0741

Attention: Dr. Michael McDaniel

RE: Permit NO. 2880-00042-01 dated Aug. 5, 1991: Texaco Pipeline Inc's Lake Barre Crude Oil Pressure Boosting Station, Cocodrie, Terrebonne Parish, Louisiana AFE 84188

In accordance with the terms and conditions mentioned in our air quality permit for the above noted facility, we wish to advise that construction of the facility is approximately 95% complete. For the most part installation of the pumps, piping and engines are complete except for additional testing and adjustments that are being performed on the main pump unit engines (Emission Source Points 1-91 and 2-91).

Additional work to be done at this site involves the installation of a metal pump shelter; that will serve to protect the pumps, engines and control equipment from the elements. We expect to complete the pump shelter in late January or early February 1992.

On December 9, 1991 the pump unit engines; points 1-91 and 2-91, were officially deemed as complete and operation of the station was transferred from construction to operations personnel. Anticipated throughput for this station has not reached the rate of 171,500 BPD (62.6 MMBBLS/YR.) as stated in our permit application, and as a result we are currently running one unit at approximately 75% of rated load.

Since we do not anticipate a significant increase in throughput at this facility in the year 1992, we plan to perform the required emissions testing at the current load. And, if throughput should increase beyond the current forecast rate for 1992; we can arrange to retest the emission source at the higher load, if required.

We plan to perform the emission testing on or about February 10, 1992 and by copy of this letter we are providing the requested 30 day notice prior to testing one of the engines. For the purpose of obtaining the required emission source data we have contracted Emission Testing Service of Baton Rouge, to provide this service. We understand that Emission Testing Service has provided this service for a number of other companies for source locations in Louisiana.

If additional information concerning this permit is required, please contact Mr. Keith Champagne at phone 713-953-4319.

Very truly yours,

Signed: C. W. HARSHBARGER

C.W. Harshbarger

KRC
cc: EDL, Emission Testing Service File: E:\KRC\KRC03-92.LEG

Robert E. Reeves
Sampling Specialist
Emission Testing Services, Incorporated
Baton Rouge, Louisiana

EDUCATION

High School Graduate

SLU - Business

WKG-TV Video College - Basic Electricity, Electronics

EPA certified opacity reader (Method 9)

EXPERIENCE

1989 to Present - Emission testing specialist for ETS. Performs EPA Reference methods for compliance testing as well as other non-routine source evaluations. Responsibilities also include equipment calibrations and maintenance of analytical instruments.

1988 to 1989 - Air condition maintenance and installation for refrigeration corporation. Experience with water cooled units as well as small residential units.

1986 to 1988 - Legal courier for law firm. Performed various types of legal leg-work. Experience includes: filing various legal documents in all levels of the judicial system, pulling records, legal research & case preparation.

Brian Scott Lesley
Sampling Specialist
Emission Testing Services, Inc.
Baton Rouge, Louisiana

EDUCATION

High School Graduate

USAF Security Specialist Technical School - Certified
San Antonio, Texas

USAF Telecommunication System Control Specialist Technical School - Certified - Biloxi, Mississippi

Louisiana State University

Florida Junior College

EXPERIENCE

1990 to Present - Emission testing specialist for ETS. Performs EPA Reference methods for compliance testing as well as other non-routine source evaluations. Responsibilities also include equipment calibrations and maintenance of analytical instruments.

1989 to 1990 - Worked as helper for National Maintenance Corporation. Responsibilities included assisting millwrights, pipefitters, boilermakers and welders.

1982 to 1988 - USAF - Air National Guard

Damon Wood
Sampling Trainee
Emission Testing Services, Incorporated
Baton Rouge, Louisiana

EDUCATION

High School Graduate

LSU - One year

University of Southwestern Louisiana - one year

EXPERIENCE

Present - Emission Testing Sampling Trainee for ETS. Performs EPA Reference methods for compliance testing as well as other non-routine source evaluations. Responsibilities also include equipment calibrations and maintenance of analytical instruments.

1990 (May to August) - West Paine Laboratories, Inc. located in Baton Rouge - Lab Technician

1987 to 1990 - Animal Health Clinic - Veterinary Assistant.

ETS
EMISSION TESTING SERVICES, INC.

METER BOX CALIBRATION DATA AND CALCULATION FORM

(English Units)

Leak Check Good @ 0.0012

I.D.G.M.R. 843.75

Date 11 MAR 92

Meter box number 481

Barometric pressure, P_b 30.29 in. Hg

Calibrated by SCOTT L.

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 (θ), min.
0.5	5.5	5.4210 844.3	56°	59 71	60 61	62.75	14.7162
1.0	5	4.932 849.721	58°	62 68	61 64	63.75	9.5830
1.5	10	9.939 854.653	58°	66 80	62 66	68.5	15.4635
2.0	10	9.930 864.592	58.5°	67 75	67 70	69.75	13.4143
3.0	10	9.986 874.522	58.5°	64 83	67 70	72.25	10.9528
4.0	10	884.508	[illegible]				

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H@_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\,\theta}{V_w}\right]^2$
0.5	0.0368	1.0265	1.9081
1.0	0.0737	1.0225	1.9695
1.5	0.110	1.0228	1.9058
2.0	0.147	1.0239	1.9114
3.0	0.221	1.0205	1.9024
4.0	0.294	N/A	N/A
Average		1.0232	1.9194

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 [signature]

PITOT TUBE CALIBRATION

Pitot Tube Number P-3-1 Cp (std) 0.99

Calibrated By ROB JONES Date 12-10-90

	Point Number	Standard Pitot Δ p (in. H_2O)	"S" Type Pitot Δ p (in. H_2O) "A" Side	"B" Side
H	1	1.55	2.15	2.15
M	2	0.630	0.870	0.870
L	3	0.055	0.075	0.075

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

"A" Side $Cp_{(s)}$	"A" Side Deviation	"B" Side $Cp_{(s)}$	"B" Side Deviation
0.841	0.003	0.841	0.003
0.842	0.002	0.842	0.002
0.848	0.004	0.848	0.004

$\overline{Cp}$ = 0.844 = 0.844

$\left| \overline{Cp}\ (\text{Side A}) - \overline{Cp}\ (\text{Side B}) \right|$ = 0.00 (must be $\leq$ 0.01)

Avg. Dev. (Side A) = 0.003 (must be $\leq$ 0.01)

(Side B) = 0.003 (must be $\leq$ 0.01)

$Cp = \dfrac{\overline{Cp}\ (\text{Side A}) + \overline{Cp}\ (\text{Side B})}{2}$ (should be $0.80 \leq Cp \leq 0.85$) = 0.844

ETS
EMISSION TESTING SERVICES, INC.
P.O. BOX 15075 • BATON ROUGE, LA 70895

OXYGEN CYLINDER CERTIFICATION

Company: Scott Specialty

Cylinder: ALM 003373

Instrument: Orsat Analysis

Analyst: Brad Latham

Date: March 13, 1991

Expiration: March 13, 1992

Trial	O_2	CO_2
1	7.5	0.00
2	7.4	0.00
3	7.5	0.00
4	7.5	0.00
5	7.3	0.00
6	7.4	0.00
7	7.3	0.00
8	7.5	0.00
9	7.4	0.00

O_2 % avg.= 7.42

ETS
EMISSION TESTING SERVICES, INC.
P.O. BOX 15075 • BATON ROUGE, LA 70895

Company: Scott Specialty Gases

Analyst: Brad Latham

Cylinder # AAL-18808

Date: 5/26/89

Instrument: Orsat Analysis

Trial	O_2	CO_2
1	20.9	0.0
2	20.9	0.0
3	20.9	0.0
4	20.9	0.0
5	20.9	0.0
6	20.9	0.0
7	20.9	0.0
8	20.9	0.0
9	20.9	0.0

Mean O_2 = 20.9%

TELEX: 510-100-8831 (ScotGas)
FAX: 714-887-0549
PHONE: 714-887-2571

Scott Specialty Gases a division of

Scott Environmental Technology Inc. 2600 CAJON BLVD., SAN BERNARDINO, CA 92405

Shipped From: Scott SAN BERNARDINO, CA
Date Shipped 9/26/90
Our Project No: -9145
Your P.O. No: FD082790
Page 1 of 1
Expiration Date: 3/92

EMISSION TESTING SERVICES
P.O. BOX 15075
BATON ROUGE, LA 70895
FRED DOUGLASPO# FD082790

CERTIFICATE OF ANALYSIS—EPA PROTOCOL GASES*

Certified Per Traceability Protocol No. 1 Procedure No. G1 Cylinder No. 1L-1733 Cylinder Pressure 1900 psig < Certified Accuracy ±1% % NBS Traceable

REFERENCE STD

COMPONENTS	CERTIFIED CONC	SRM/CRM NO.	CYL. NO.	CONC.
NITRIC OXIDE	230.9 ppm	CRM1685B	CAL-5827	236 ppm
NOX	231.7 ppm			

GAS ANALYZER

MAKE/MODEL/SERIAL NO.	LAST CAL. DATE	ANALYTICAL PRINCIPLE
THERMO-ELECTRON 10 AR 14853-150	9/3/90	CHEMI-LUMINENSCENT

7.4.3

ALANCE GAS NITROGEN

NALYZER READINGS: Z = Zero Gas T = Test Gas R = Reference Gas

mponent NITRIC OXIDE
..st Analysis Date 9/14/90 Units mv

Z	0.00	R	94.40	T	92.82
R	94.69	Z	0.06	T	92.69
Z	0.04	T	92.68	R	94.55

Mean Test Assay 231.5 ppm

Second Analysis Date 9/21/90 Units mv

Z	0.00	R	94.40	T	92.18
R	94.25	Z	0.01	T	92.35
Z	0.02	T	92.05	R	94.05

Mean Test Assay 230.9 ppm

Component ____ Date ____ Units ____

Z		R		T	
R		Z		T	
Z		T		R	

Mean Test Assay ____

Date ____ Units ____

Z		R		T	
R		Z		T	
Z		T		R	

Mean Test Assay ____

Component ____ Date ____ Units ____

Z		R		T	
R		Z		T	
Z		T		R	

Mean Test Assay ____

Date ____ Units ____

Z		R		T	
R		Z		T	
Z		T		R	

Mean Test Assay ____

Chronology: Date ____
Assay ____

Analyst L. OLDHAM

Approved By: [signature]

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 : 10-17-92

Cylinder Number : AAL-21037

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 # PO 129

Certified Accuracy 1 % NBS Traceable

ANALYZED CYLINDER

COMPONENT	CERTIFIED CONC.
NITRIC OXIDE	396.5 PPM

BALANCE GAS : NITROGEN

REFERENCE STD

SRM # (CRM #)	CYLINDER NUMBER	CONC.
16866	CLM-840	489.00 PPM
1685	AAL-9851	236.00 PPM

INSTRUMENTATION

INSTR/MODEL/SERIAL #	LAST CALIBRATION DATE	ANALYTICAL PRINCIPLE
BECKMAN 951 A	3-5-91	CHEMILUMINESCENCE

NITROGEN DIOXIDE . 0.98 PPM (FROM SECOND ANALYSIS)

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 R. Dora

Approved By : J. 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.

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 # P07000

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 DEGRE

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

Analyst : Don Eichler Jr.

Approved By : [signature]

* GMIS - GAS MANUFACTURER'S INTERNAL STANDARD

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.

7.4.5

Scott Specialty Gases

Scott Environmental Technology, Inc.

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

Shipped From : Scott Troy

Our Project # : 519603

Your P.O. # : FD111490 REPLACE

Expiration Date : 8-6-92

Cylinder Number ALM-010244

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 # 81

File # P08200

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	495.6 PPM	1681	CAL-7913	970.0 PPM	HORIBA/OPE-144E/560172153	11-25-[illegible]	NON-DISPERSIVE INFRARED
		GMIS#	XA-9163	1001 PPM			

GAS : NITROGEN

CERTIFIED EPA PROTOCOL

7.4.6

IRST ANALYSIS DATE : 1-30-91

GAS (mV)	TEST GAS (mV)	RESULTS PPM	REFERENCE GAS CONC.	REFERENCE GAS (mV)	RESULTS PPM	ZERO GAS (mV)
).04	50.92	493.1	970.0 PPM	96.55	963.9	0.11
).11	50.93	492.5		96.67	964.4	0.22
).13	50.94	492.4		96.53	962.7	0.19
CALCULATED RESULTS		496.3				
		495.4				
		496.1				
AVERAGE :		495.9 PPM				

SECOND ANALYSIS DATE : 2-6-91

TEST GAS (mV)	RESULTS PPM	REFERENCE STANDARD CONC.	REFERENCE GAS (mV)	RESULTS PPM
50.84	491.6	970.0 PPM	96.77	965.5
50.96	491.7		96.44	960.8
50.89	491.3		96.50	961.8
CALCULATED RESULTS	493.9			
	496.4			
	495.5			
AVERAGE :	495.3 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 : Frank P. Dora

Approved By : C. 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.

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 #)	CYLINDER NUMBER	CONC.	GAS ANALYZER: MAKE/MODEL/SERIAL #	LAST CALIBRATION DATE	ANALYTICAL PRINCIPLE
CARBON MONOXIDE	895.0 PPM	1681	CAL-7913	970.0 PPM	HORIBA/OPE-144E/560172153	11-2-90	NON-DISPERSIVE INFRARED
		GMIS*	XA-9163	1001 PPM			

BALANCE GAS : NITROGEN

7.4.7

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 interest.

* GMIS - GAS MANUFACTURER'S INTERNAL STANDARD

Analyst : [signature] Approved By : [signature]

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

OXIDES OF NITROGEN ANALYZER
PRINCIPLE OF OPERATION and SPECIFICATIONS

THERMO ENVIRONMENTAL INSTRUMENTS

Model Number : 14A

I. PRINCIPLES of OPERATION

The model 14A NO-NO2-NOX analyzer utilizes the principle of chemiluminescence for the detection of nitrogen oxides. The analyzer consists of a photomultiplier, ozone generator, reaction chamber, NO2 to NO converter, and associated plumbing and electronics.

Sample gas is blended with O3 in a reaction chamber. The gas-phase reaction of NO and O3 produce a characteristic luminescence with an intensity linearly proportional to the concentration of NO. Chemiluminescence from the reaction is monitored through an optical filter using a highly sensitive photomutiplier. The filter photomultiplier combination responds to light in a narrow wavelength band unique to the NO and O3 reaction. In order to measure NOX, NO plus NO2, the sample gas is diverted through a NO2 to NO converter before entering the reaction chamber. The resulting chemiluminescent response is linearly proportional to the NOX concentration of the sample gas.

Ozone for the reaction is produced using an ozone generator. The generator uses a high energy electric arc discharge and dry ambient air to produce ozone.

II. SPECIFICATIONS

Ranges	:	0 to 0.01 PPM 0 to 0.025 PPM 0 to 0.1 PPM 0 to 0.25 PPM 0 to 1.0 PPM 0 to 10 PPM 0 to 100 PPM 0 to 1000 PPM 0 to 2500 PPM	Detection Limit Minimum Maximum	: : :	 0.001 PPM 2500 PPM
			Response Time	:	1 sec
			Linearity	:	+/- 1%
			Noise	:	0.05 RMS
12 hr Zero Drift 12 hr Span Drift	: :	< 12% < 12%	Precision	:	+/- 1.0 PPM
			Sample flow rate	:	0.5 - 2 l/min

Interferences : Negligible interference from H2O, carbon and sulfur compounds

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 0 to 2 PPM 0 to 5 PPM 0 to 10 PPM 0 to 20 PPM 0 to 50 PPM 0 to 100 PPM 0 to 200 PPM 0 to 500 PPM 0 to 1000 PPM	Detection Limit Minimum Maximum	: :	 0.10 PPM 1000 PPM
			Response Time	:	1 min
			Linearity	:	+/- 1%
			Noise	:	0.05 RMS
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			