SOURCE TEST REPORT
CITIES SERVICE OIL AND GAS CO.
LISBON UNITIZATION PROJECT
CLAIBORNE PARISH, LA
WAUKESHA INTERNAL COMBUSTION ENGINE

Prepared for:

CITIES SERVICE OIL AND GAS COMPANY
620 North Street
Jackson, Mississippi 39211

Prepared by:

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87629-0100-1430

July 1987

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REPORT CERTIFICATION

The sampling and analyses performed for this report were carried out under my direction and supervision in accordance with the prescribed test methods. I have reviewed all test data and results in this report and hereby certify that they are authentic and accurate.

Vernon McKnight

Vernon McKnight, Project Manager

4/24/87

Date

1.0 INTRODUCTION

Environmental Science and Engineering, Inc. (ESE) was contracted by Cities Service Oil and Gas Company to conduct emission testing on a Waukesha 1500 HP internal combustion engine at Lisbon, Claiborne Parish, Louisiana. ESE performed nitrogen oxides (NOx) and carbon monoxide (CO) emission tests downstream of the engine's exhaust system. This report presents the results of the tests.

Nitrogen oxides and CO emission tests were conducted as outlined in EPA Methods 20 and 10, respectively. The emission test procedures are detailed in the Code of Federal Regulation, Title 40, Part 60 as well as proposed Subpart FF--Standards of Performance for Stationary Internal Combustion Engines.

Mr. Milton May coordinated the test activities for Cities Service, and Mr. Richard Bromley represented the Louisiana Department of Environmental Quality. A complete list of all project participants is presented in Appendix D.

2.0 SUMMARY AND DISCUSSION OF RESULTS

Emission test results are summarized in Table 2-1. Complete emission data are in Appendix A and calibration data are presented in Appendix B.

Three, one-hour runs were monitored for CO and NOx in the exhaust gases. Run 1 (Table 2-2) was conducted at "normal" conditions at a speed of 863 rpm and approximately 1230 h.p. Run 2 was conducted at 850 rpm and approximately 1250 h.p., and run 3 at 857 rpm and approximately 1120 h.p. The engine timing was set at 24 degrees before top dead center and was never adjusted.

Manifold pressure, on each side, as well as engine speed were used to change operating conditions of the compressor unit. Attempts to "pinch" or throttle compressor intake gas pressure were made on run 3, but yielded poor, unstable operating conditions for the engine.

Table 2-1. Emission Summary: Cities Service Oil and Gas Company Waukesha 1500 HP I.C. Engine, Lisbon, Claiborne Parish, LA, April 24, 1987. *

Run No.	Time	Sample Temperature at Analyzer (Degrees Fahr.)	k	NOx Emissions				CO Emissions			
				ppm obs.	ppm corr.	# hr.	TPY	ppm obs.	ppm corr.	# hr.	TPY
1	1305-1410	60	1.1534	4550	5143	57.8	222.4	220	216	1.5	5.67
2	1600-1700	65	1.3697	1200	1610	17.8	68.3	380	372	2.5	9.6
3	1747-1847	63	1.2162	420	500	5.3	20.5	330	323	2.1	8.1

* Source: ESE 1987

Table 2-2. Operating Conditions: Cities Service Oil and Gas Company Waukesha 1500 HP I.C. Engine, Lisbon, Claiborne Parish, LA, April 24, 1987. *

Run No.	Engine Speed (rpm)	Intake Manifold Pressure (inches of Hg)	Engine Timing (Deg. BTDC)	Exhaust Temperature (Deg. Fahr.)	Horsepower	Fuel (SCF/hr.)
1	863	+ 2.5	24	952	1230	9,791
2	850	+ 9.0	24	910	1250	9,583
3	857	+ 8.6	24	859	1112	9,250

* Source: Production Operators, Inc. 1987

3.0 SAMPLING POINTS LOCATION

The exhaust stack of the Waukesha engine was circular and 13.25 inches i.d. Two sample ports (2 inch diameter) were installed at 90 degrees apart on the circumference of the stack (Figure 3-1). Sample points were at 16.7%, 50.7%, and 83.3% of the inside stack diameter which corresponded to 2.21", 6.62", and 11.04", respectively.

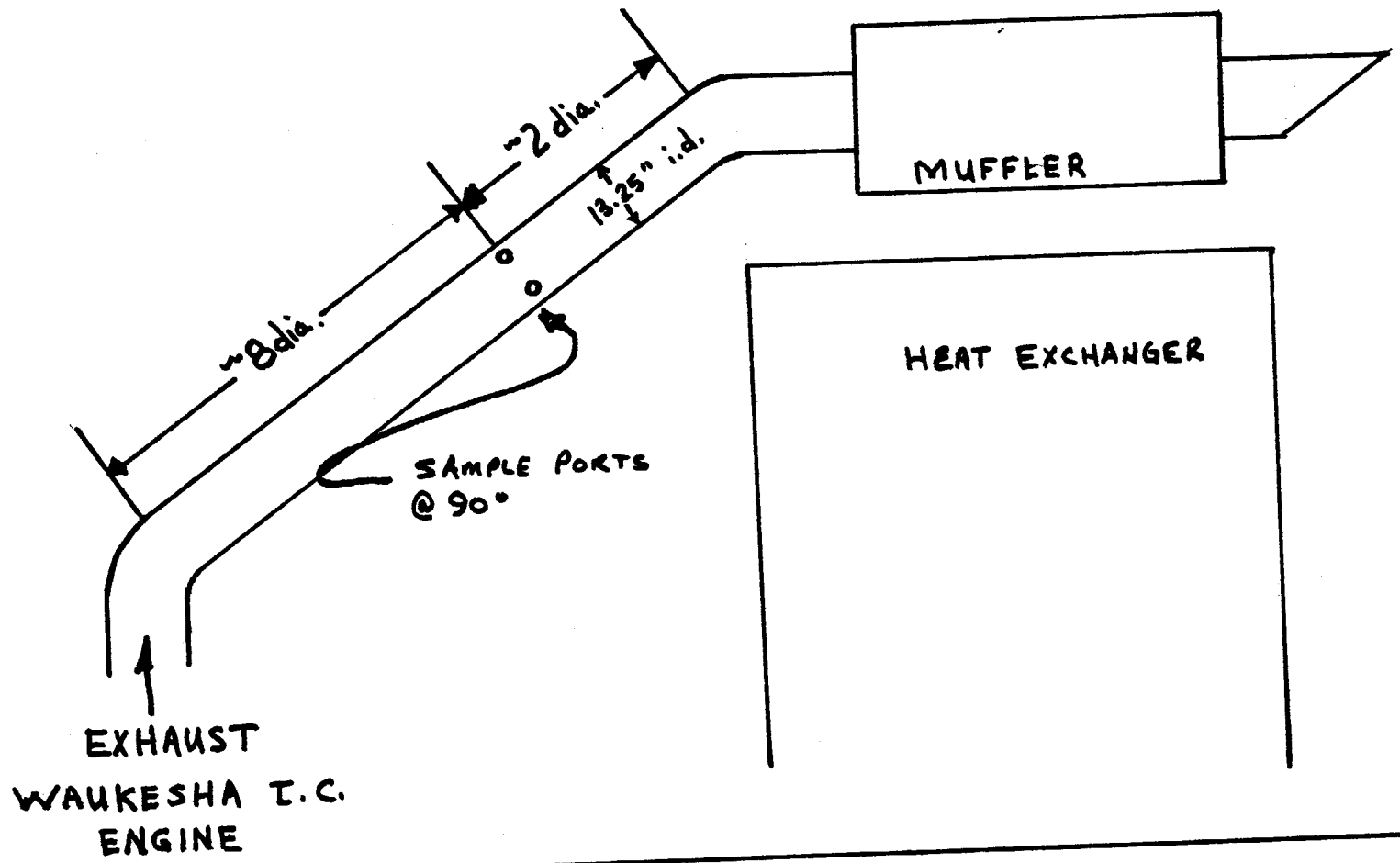


Figure 3-1. Sampling Points Location:
Cities Service Oil & Gas Co.
Lisbon, Claiborne Parish, LA

ESE July 1987

4.0 SAMPLING PROCEDURES

EPA METHODS 10 AND 20--CARBON MONOXIDE AND NITROGEN OXIDE SAMPLING AND ANALYSIS

A gas sample was drawn from the stack via stainless steel sample probe, a short section of unheated 1/4-inch O.D. Teflon® tubing, and a glass condenser system. The condenser system, a set of large impingers with short stems, was used to remove moisture from the sample. The condenser was kept in ice water baths for the duration of the test. A glass wool plug was placed in the first impinger exhaust arm to trap particulate matter and prevent the sample line from plugging. From the condensers, the sample traveled through an unheated 1/4-inch O.D. Teflon® line to a Teflon®-lined sample pump manufactured by Thomas Industries. Valves were installed on the pump to control the flow rate. The pump provided the samples at positive pressure to the Thermo Electron Model 10 and the Teledyne 990 analyzers. All sample wetted surfaces were stainless steel, Teflon®, or glass.

A three-way valve was installed prior to the primary condenser to allow calibration gases to be introduced to the sample analyzers.

The data from the continuous analyzers was recorded continuously on strip chart recorders. A dual-pen recorder was used to record the NO_x and CO concentrations. Oxygen concentrations were recorded manually. A schematic of the sampling system is shown in Figure 4-1.

Nitrogen Oxide Monitoring

EPA Method 20, as described in 40CFR60, Appendix A was followed to measure the actual concentration of NO_x in the stack gas. A Thermo Electron Model 10 NO/NO_x Analyzer was used to determine the NO_x concentration. Stack gas samples were analyzed continuously with this instrument for the duration of the sample run. Technical specifications for the analyzer are presented in Table 4-1.

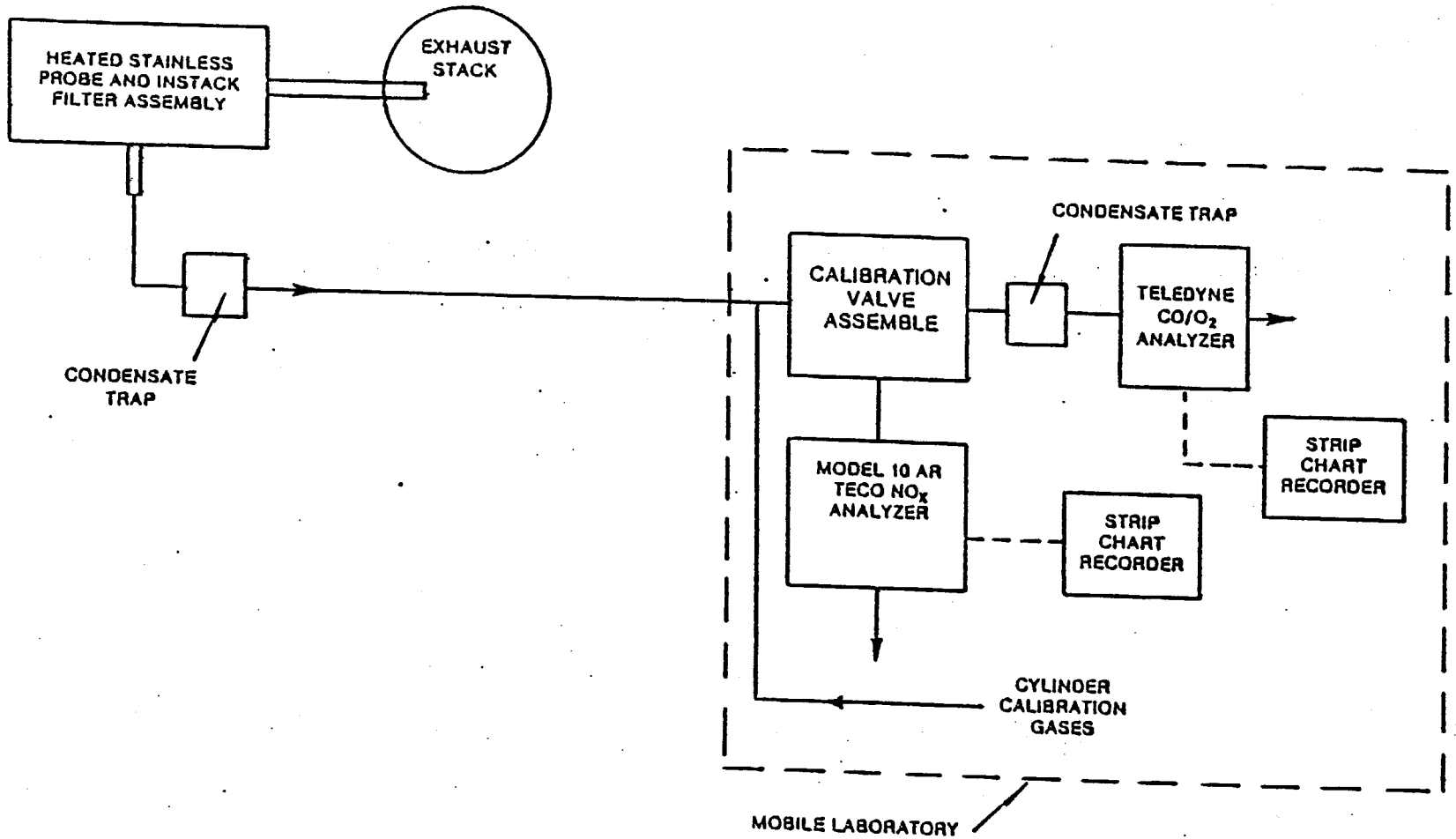


Figure 4-1
NITROGEN OXIDES AND CARBON MONOXIDE EMISSION SAMPLING SYSTEM

SOURCE: ESE, 1986.

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

GA-PAC 11/86B

Table 4-1. Technical Specifications of the Thermo Electron Model 10 NO/NO_x Analyzer

Sensitivity	Each instrument is equipped with the following ranges: 0 - 2.5 ppm 0 - 10 ppm 0 - 25 ppm 0 - 100 ppm 0 - 250 ppm 0 - 1,000 ppm 0 - 2,500 ppm 0 - 10,000 ppm
Accuracy	Derived from the NO or NO_2 calibration gas, ±1% of full scale.
Response Time (0-90%) Typical	1.5 seconds - NO mode 1.7 seconds - NO_x mode
Output	0 - 10mV and 0 - 10V
Zero Drift	Negligible after 1/2-hour warm-up.
Linearity	±1% of full scale to 2,500 ppm with air as O_2 supply ±1% of full scale to 10,000 ppm with compressed O_2
Input Power Requirements	115 VAC/60 Hz

Source: Thermo Electron, 1985.

Carbon Monoxide/Oxygen Monitoring

The carbon monoxide concentration in the stack gas was monitored with a Teledyne 990D Carbon Monoxide/Oxygen Analyzer (Serial Number 58780). Performance test results of this analyzer as compared with EPA Method 10 specifications are presented in Table 4-2. This instrument utilizes electrochemical cells for carbon monoxide and oxygen measurement. It also incorporates a scrubber to remove acidic gases.

The gas sample for this analyzer was drawn from the stack, with a Teflon®-lined sample pump manufactured by Thomas Industries. The gas flowed from the stack through Teflon® tubing to a glass condenser where the majority of the water vapor was removed. From the condenser, the gas flow rate was reduced by a valve before entering the pump. The gas then was pumped through the analyzer at a constant rate and pressure. The internal pump in the analyzer was bypassed during monitoring, since the internal pump cannot be operated for longer than one-half hour at a time without damage to the pump.

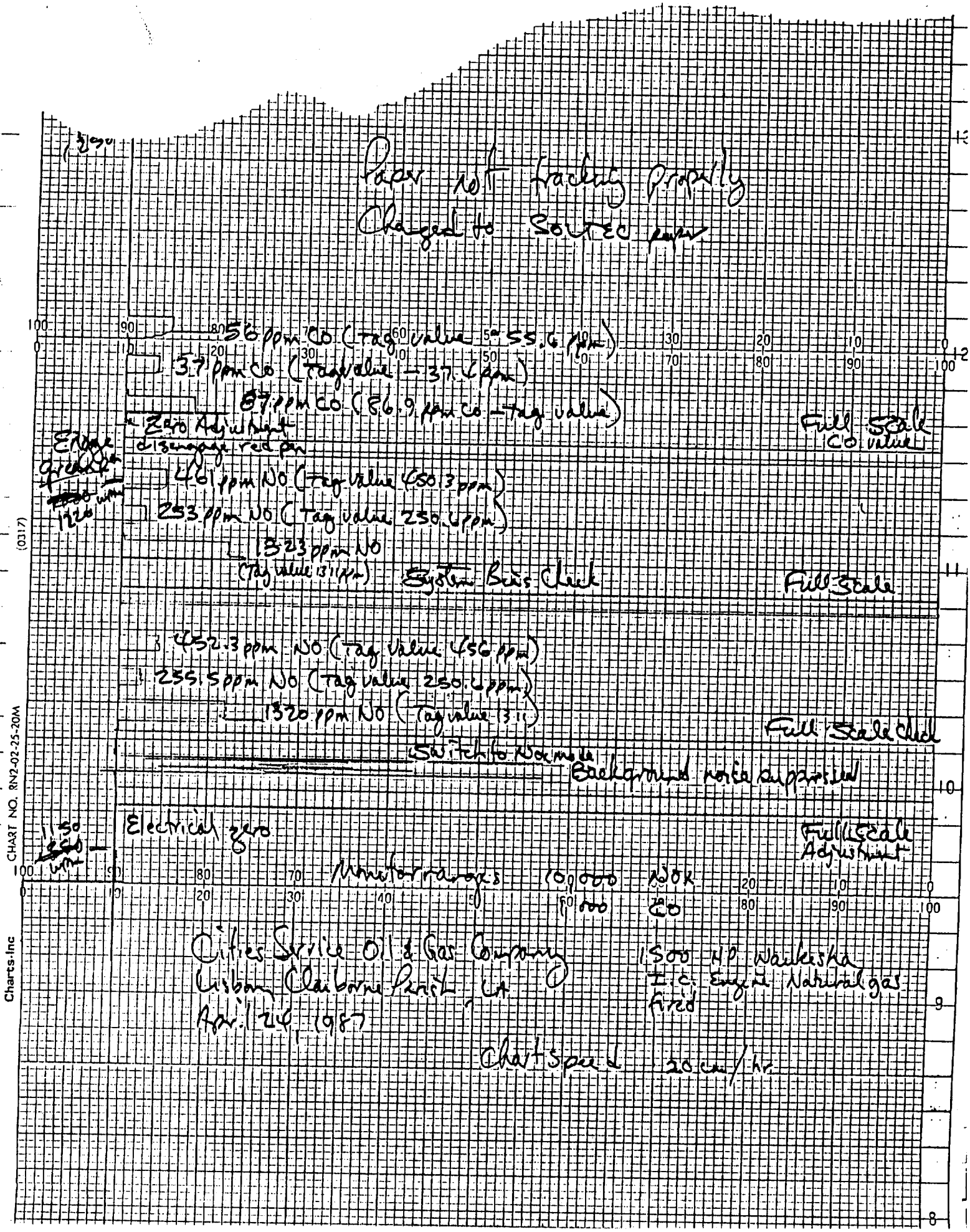
Table 4-2. Teledyne 990D CO Analyzer (Serial Number 58780) Performance Test Results Compared with Method 10 Specifications

	Method 10 Specification	Teledyne Test Results[1]
Minimum Range	0-1,000 ppm	0-1,000 ppm
Minimum Output	0-10 mV	0-1 V
Minimum Detectable Sensitivity	20 ppm	1 ppm
Maximum Rise Time, 90%	30 seconds	23 seconds
Maximum Fall Time, 90%	30 seconds	23 seconds
Maximum Zero Drift	10% in 8 hours	0% in 8 hours
Maximum Span Drift	10% in 8 hours	8% in 8 hours
Minimum Precision	±2% of full scale	0.5% of full scale
Maximum Noise	±1% of full scale	--% of full scale
Maximum Deviation from Linearity	2% of full scale	1% of full scale
Interference Rejection Ratio	CO_2--1,000 to 1 H_2O--500 to 1	*

*Electrochemical analysis is not affected by CO_2 or H_2O.
[1]In-house Test Results.

Source: ESE, 1986.

Appendix A-- Emission Data and Sample Calculations


Paper not tracking properly
Changed to SOLTEC paper
56 ppm CO (Tag value 55.6 ppm)
37 ppm CO (Tag value - 37.4 ppm)
87 ppm CO (86.9 ppm CO - Tag value)
Zero Adjustment
disengage red pen
Full Scale CO value
Engage green pen
1220 wpm
461 ppm NO (Tag value 450.3 ppm)
253 ppm NO (Tag value 250.6 ppm)
1323 ppm NO
(Tag value 1311 ppm)
System Bias Check
Full Scale
452.3 ppm NO (Tag value 456 ppm)
255.5 ppm NO (Tag value 250.6 ppm)
1320 ppm NO (Tag value 1311)
Full Scale Check
Switch to Nox mode
Background noise suppressed
Electrical zero
1150 wpm
Full Scale Adjustment
Monitor ranges 10,000 NOx
1,000 CO
Cities Service Oil & Gas Company
Lisbon, Claiborne Parish, LA
April 24, 1987
1500 HP Waukesha
I.C. Engine Natural gas
fired
Chart speed 20 cm/hr
CHART NO. RN2-02-25-20M
Charts-Inc
(0317)

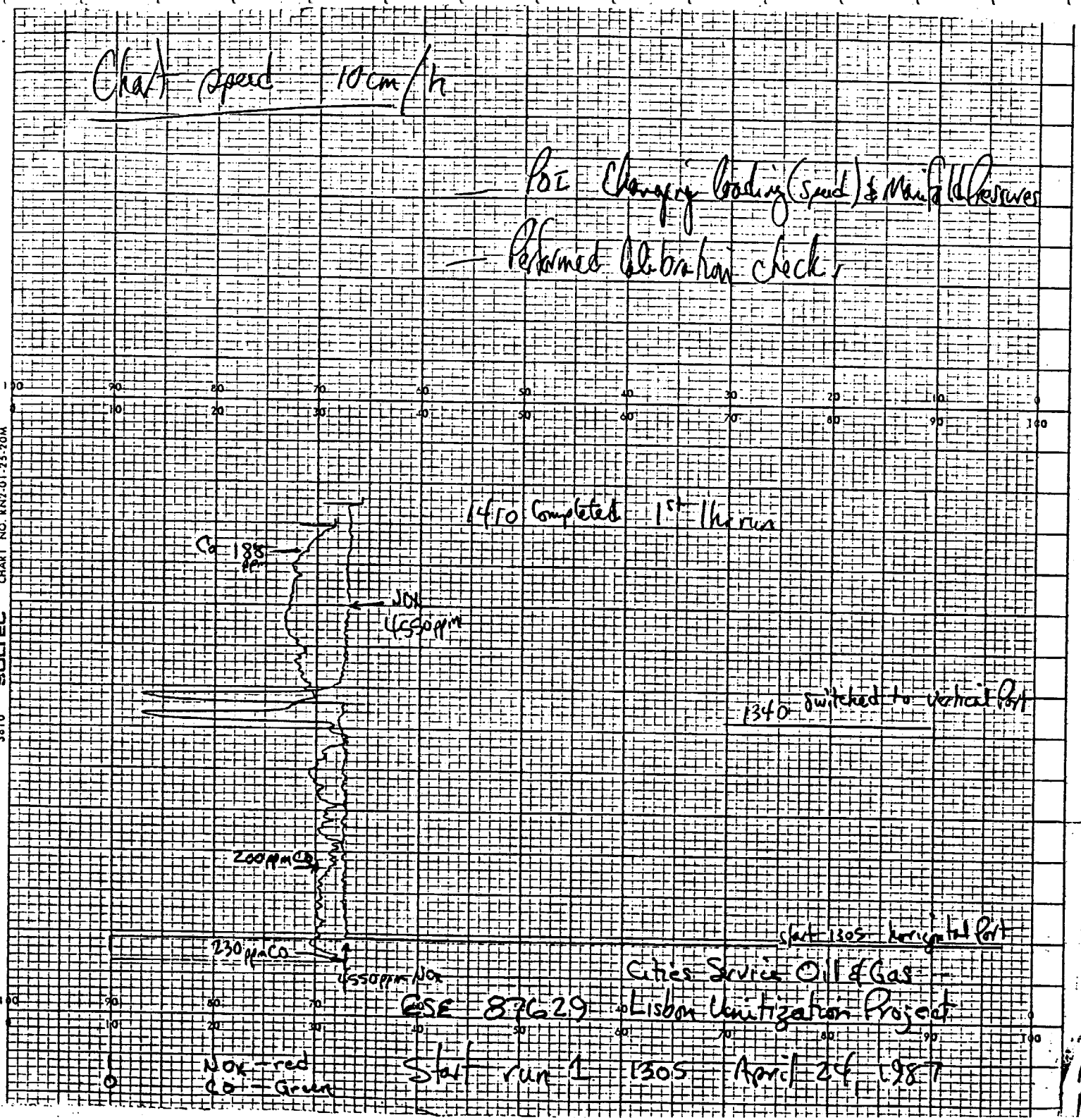
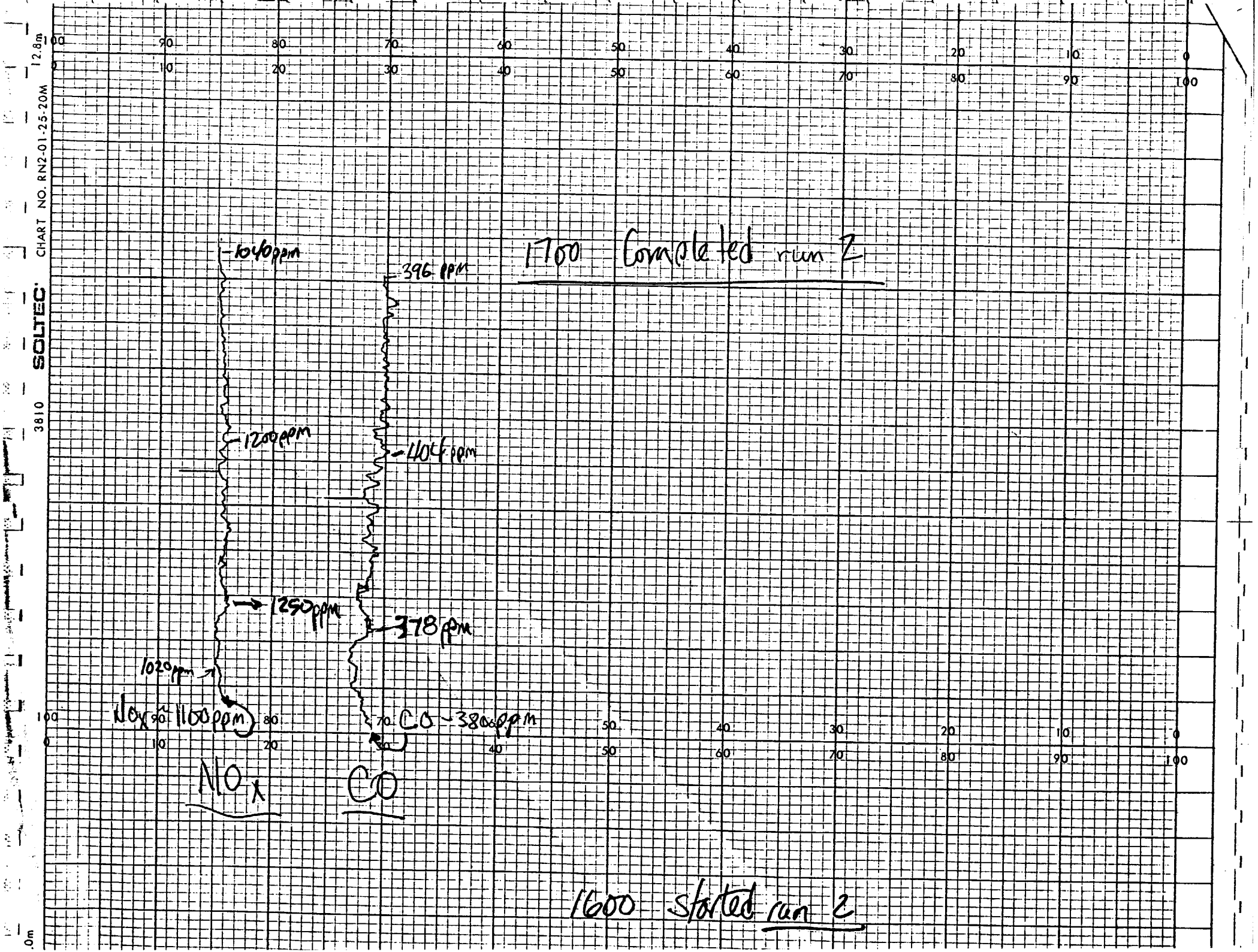
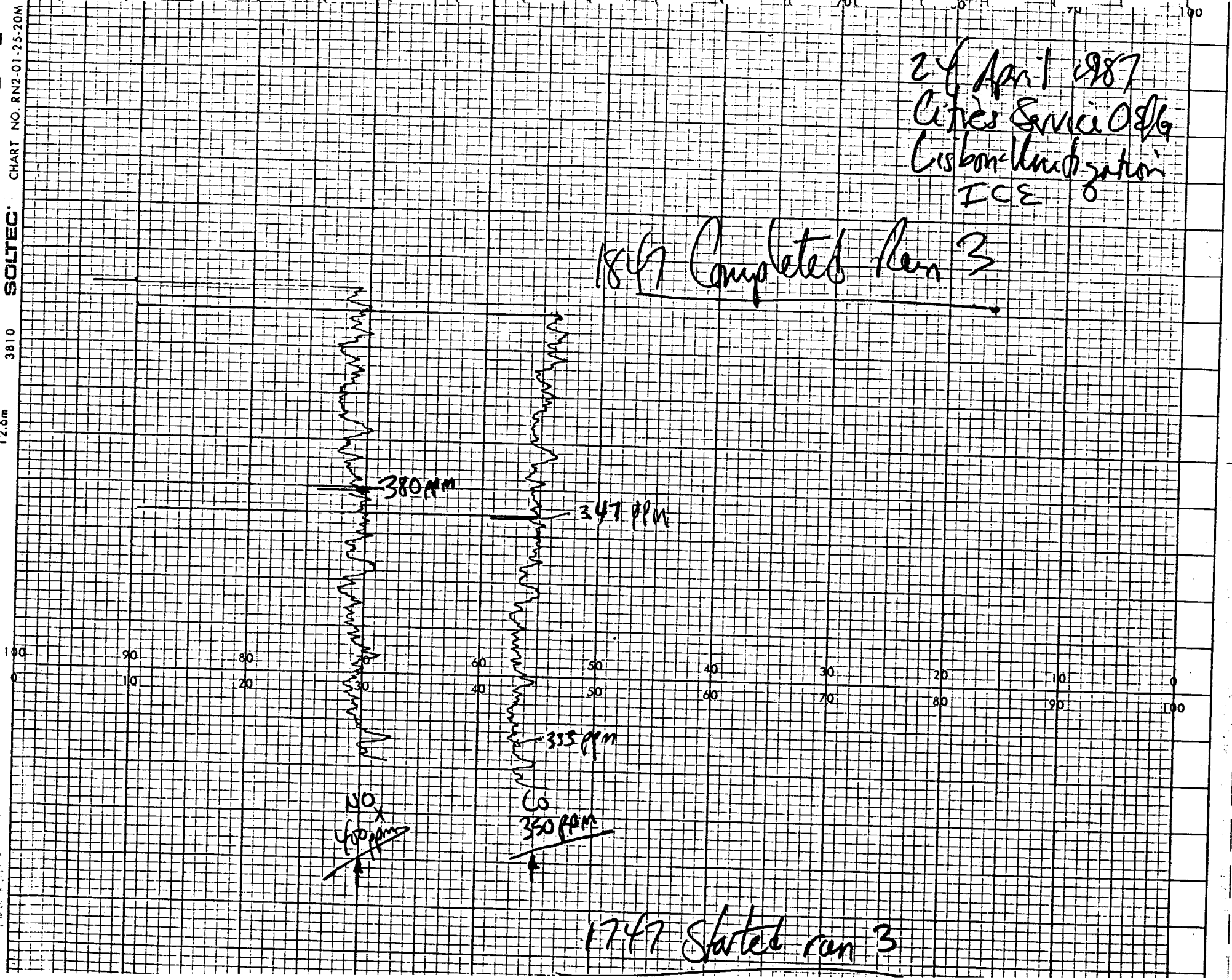


Chart speed 10cm/h
— POI Changing loading (speed) & Manifold Pressures
— Performed Calibration check
1410 Completed 1st 1hr run
Co 188 ppm
NOx 4550ppm
1340 switched to vertical Port
200ppm CO
230ppm CO
4550ppm NOx
start 1305 horizontal Port
Cities Service Oil & Gas
ESE 87629 Lisbon Unitization Project
Start run 1 1305 April 24, 1987
NOx - red
CO - Green
SOLTEC
CHART NO. RN2-01-25-20M
3810
13.2m


SOLTEC
CHART NO. RN2-01-25-20M
3810
12.8m
0m
1040ppm
396 ppm
1700 Completed run 2
1200ppm
404 ppm
1250ppm
378 ppm
1020ppm
NOx ~1100ppm
CO ~380ppm
NOx
CO
1600 started run 2



24 April 1987
Cities Service O&G
Lisbon Unitization
ICE
1847 Completed Run 3
380 ppm
347 ppm
333 ppm
NOx
400 ppm
CO
350 ppm
1747 Started run 3
SOLTEC
CHART NO. RN2-01-25-20M
3810
12.6m

RESPONSE TIME DATA SHEET

PLANT: Cities Service Oil & Gas Lisbon, Claiborne Parish, LA

DATE: April 24, 1987

ANALYZER TYPE: Teledyne 990 CO/O_2

S/N: 58780

SPAN GAS CONCENTRATION: 86.9 ppm CO

ANALYZER SPAN SETTING: 1000

UPSCALE:

1. 237 SECONDS
2. 234 SECONDS
3. 239 SECONDS

AVERAGE: 237 SECONDS

DOWNSCALE:

1. 242 SECONDS
2. 242 SECONDS
3. 244 SECONDS

AVERAGE: 244 SECONDS

SYSTEM RESPONSE TIME = SLOWER AVERAGE TIME:

244 SECONDS

ANALYZED BY: [illegible]

RESPONSE TIME DATA SHEET

PLANT: Cities Service O&G Lisbon, Claiborne Parish, LA

DATE: April 24, 1987

ANALYZER TYPE: TECO model 10 NO/NOx

S/N: 10 AR 10972 121

SPAN GAS CONCENTRATION: 1311 ppm

ANALYZER SPAN SETTING: 10,000

UPSCALE:

1. 117 SECONDS
2. 112 SECONDS
3. 109 SECONDS

AVERAGE: 112 SECONDS

DOWNSCALE:

1. 122 SECONDS
2. 127 SECONDS
3. 121 SECONDS

AVERAGE: 123 SECONDS

SYSTEM RESPONSE TIME = SLOWER AVERAGE TIME:

123 SECONDS

ANALYZED BY: [illegible]

CALIBRATION DRIFT DETERMINATION

PLANT: Cities Service Oil & Gas DATE: April 24, 1987

SAMPLING LOCATION: Lisbon, Claiborne Parish, LA RUN: 1-3

ANALYZER TYPE: TECO Model 10 NO/NOx

	Day	Time	Calibration value	Monitor value	Difference	Percent of span value	
Low-level	Fri	1208	Zero Ambient Air	0.01	0.01	<.01	*
	Fri	1810	"	0.02			
High-level	Fri	1201	1311 ppm	1320 ppm	5	<0.01	*
	Fri	1815	1311 ppm	1325 ppm			

SPAN GAS CONCENTRATIONS

HIGH: _____ ppm/%

LOW: _____ ppm/%

$$* \text{Drift} = \frac{\text{Final} - \text{Initial}}{\text{Span}} \times 100$$

Span = 10,000

CALIBRATION DRIFT DETERMINATION

PLANT: Cities Service Oil & Gas DATE: April 24, 1987

SAMPLING LOCATION: Lisbon, Claiborne Parish, LA RUN: 1-3

ANALYZER TYPE: Teledyne 990 CO / O_2

CO only

	Day	Time	Calibration value	Monitor value	Difference	Percent of span value	
CO Low-level	Fri.	1232	37.4 ppm	37.0	1.0	0.1	*
	Fri	1855	"	38.0			
High-level	Fri.	1239	86.9 ppm	87.0 ppm	0	0	*
	Fri.	1900	"	87.0 ppm			

SPAN GAS CONCENTRATIONS

HIGH: _____ ppm/%

LOW: _____ ppm/%

$$* \text{Drift} = \frac{\text{Final Response} - \text{Initial Response}}{\text{Span}} \times 100$$

Span = 1000

NO_2 TO NO CONVERSION EFFICIENCY

Procedure: A mid-level NO in N2 calibration gas is added to a leak-tight Tedlar bag. A mixture of purified air at 20.9 percent 02 was added to achieve a gas mixture with an approximate 1:1 dilution. The bag was immediately attached to the calibration valve assembly and the sampling system was operated for 30 minutes. Stable repsonse was generated at the highest peak value observed.

Specification: 30-minute response decrease of $\leq$2 percent of peak value.

Conversion Test Result by ESE on November 24, 1986: No appreciable downward drift from peak response for 35 minutes.

INTERFERENCE RESPONSE

Procedure: Introduce the gaseous components into the measurement system. Record the interference response.

Specification: Interference ≤ 2 percent of span.

Interference Test Result for TECO Model 10 Analyzer

Gas Type	Gas Concentration	Analyzer Response	Percent of Span
CO	500 ppm	<0.1	<0.1
SO_2	201 ppm	<0.1	<0.1
CO_2	10 percent	<0.1	<0.1
O_2	20.9 percent	<0.1	<0.1

The only interference possible for the Teledyne 990 is from oxides of nitrogen, oxides of sulfur, hydrogen, and hydrogen sulfide. These are all removed in a scrubber system furnished by Teledyne.

Source: ESE, 1986.

D-AR87.1/ICE.1
03/18/87

SAMPLE CALCULATIONS
FOR EMISSIONS FROM
INTERNAL COMBUSTION ENGINES

Client Cities Service Oil & Gas
Plant Lisbon Unitization Project 1500 h.p. Waukesha
Location Claiborne Parish, LA
Date of Test April 24, 1987
Calculated By Mark M. Kimball Date 4 Aug 1987
Checked By W. Pike Moore, III Date 4 Aug 1987

FROM RUN NO. 1 (FOR NO_x EMISSIONS):

1. Determine corrected NO_x emissions, in ppm, by the equation:

NO_x corr = NO_x obs (FDA) (K)

Where:

NO_x corr = NO_x emissions corrected to reference ambient conditions,

NO_x obs = Observed NO_x emissions,

FDA = Fraction of dry air in gas stream, and

K = Correction Factor,

Defined as

$K = (K_H)(K_T)$

Where:

$K_H = 0.844 + 0.151\ (H/100) + 0.075\ (H/100)^2$

$K_T = 1 - (T-85)\ (0.0135)$

and

H = Observed humidity, grains of H_2O/lb of dry air,

T = Inlet of air temperature, °F.

Example:

NO_x obs = 4550 ppm
Inlet Temperature = 78 °F, dry
= 65 °F, wet
Humidity = 31
FDA = 0.98
K = 1.1534

Therefore,

NO_x corr = NO_x obs (FDA) (K)
= (4550) (0.98) (1.1534)
= 5143

2. Determine NO_x emissions, in TPY, by:

NO_x TPY = NO_x corr x C x f-factor x 20.9/(20.9 - $\%O_2$) x GCV x Q x Time x Ton/2,200 lb

Where:

C = Conversion factor, 1.194E-7 lb/scf/ppm,
f-factor = Oxygen based f-factor, scf/MMBTU,
GCV = Gross caloric value of fuel, MMBTU/scf,
Q = Fuel flow rate, scf/hr, and
Time = Operating time for engine, as specified.

Example:

NO_x corr = 5143 ppm
C = 1.194E-7 lb/scf/ppm
f-factor = 8710 scf/MMBTU
O_2 = 1.056 %
GCV = 0.00105 MMBTU/scf
Q = 9791 scf/hr
Time = — (as specified)

NO_x TPY = 5143 ppm x 1.194E-7 lb/scf/ppm x 8710 scf/MMBTU x (20.9/20.9-1.056) x 0.00105 MMBTU/scf x 9791 scf/hr x 24 hr/day x 6.77 days/week x 52 weeks/year x ton/2,200 lb = 222.4 tpy

FROM RUN NO. 1 (FOR CO EMISSIONS):

1. Determine corrected CO emissions, in ppm, by the equation =

$CO_{corr} = CO_{obs}$ (FDA)

Where:

CO_{corr} = CO emission corrected for moisture,
CO_{obs} = observed co emissions, and
FDA = fraction of dry air in gas stream.

Example:

CO_{obs} = 220 ppm
FDA = 0.98

Therefore,

$CO_{corr} = CO_{obs}$ (FDA)
= (220) (0.98)
= 216

2. Determine CO emissions, in TPY, by:

$CO_{TYP} = CO_{corr}$ x C x f-factor x (20.9 /(20.9 - $\%O_2$)
x GCV x Q x time x ton/2,200 lb

Note: variables defined above.

Example:

CO_{corr} = 216 ppm

C = 7.268E-8 lb/scf/ppm

f-factor = 8,710 scf/MMBTU

O_2 = 1.056 %

GCV = 0.00105 MMBTU/scf

Q = 9791 scf/hr

Time = — (as specified)

CO_{TPY} = 216 ppm x 7.268E-8 lb/scf/ppm x 8,710 scf/MMBTU x (20.9/20.9-1.056)(0.00105 MMBTU/scf) x 9791 scf/hr x 24 hr/day x 6.77 days/week x 52 weeks/year x ton/2,200 lb = 5.67 tpy

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

NITROGEN OXIDE AND CARBON MONOXIDE
EMISSION DATA

PLANT Cities Service Oil and Gas Lisbon, LA DATE April 24, 1987

SOURCE Waukesha 1500HP IC Engine RUN NO. 1

TIME	NO_x (ppm, dry)	CO (ppm, dry)	OXYGEN (%, dry)	COMMENTS
1305	4500	230		
1310	4550	200		
1315	4450	205		
1320	4450	230		
1325	4450	200		
1330	4500	210		
1335	4500	230		
1340	4450	200		
1345	4550	185		
1350	4550	180		
1355	4550	170		
1400	4625	188		
1410	4550	216		

ANALYZED BY [illegible]

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

NITROGEN OXIDE AND CARBON MONOXIDE
EMISSION DATA

PLANT Cities Service Oil and Gas Lisbon, LA DATE April 24, 1987

SOURCE Waukesha 1500 HP IC Engine RUN NO. 2

TIME	NO_x (ppm, dry)	CO (ppm, dry)	OXYGEN (%, dry)	COMMENTS
1600	1100	380		
1605	1040	360		
1610	1040	340		
1615	1100	378		
1620	1080	370		
1625	1060	385		
1630	1060	370		
1635	1100	384		
1640	1050	404		
1645	1060	390		
1650	1060	400		
1655	1060	396		
1700	1040	408		

ANALYZED BY [illegible]

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

NITROGEN OXIDE AND CARBON MONOXIDE
EMISSION DATA

PLANT Cities Service Oil & Gas Lisbon, LA DATE April 24, 1987

SOURCE Waukesha 1500 HP IC Engine RUN NO. 3

TIME	NO_x (ppm, dry)	CO (ppm, dry)	OXYGEN (%, dry)	COMMENTS
1747	400	350		
1752	400	333		
1757	370	330		
1802	400	335		
1807	380	333		
1812	400	350		
1817	390	345		
1822	380	347		
1827	350	350		
1832	350	340		
1837	360	360		
1842	390	360		
1847	380	360		

ANALYZED BY [illegible]

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

87629

NITROGEN OXIDE AND CARBON MONOXIDE
EMISSION DATA

PLANT Cities Service DATE April 1987

SOURCE Lisbon Unitization RUN NO. 1-3

WET BULB DRY BULB

TIME	NO_x (ppm, dry)	CO (ppm, dry)	OXYGEN (%, dry)	COMMENTS
13:30	64	78		
13:45	64	76		
14:00	64	76		
14:15	62	75		
14:30	64	76		
14:45	65	77		
15:00	65	78		
15:15	65	78		
15:30	65	78		
15:45	65	78		
16:00	65	78		
16:15	65	79		
16:30	65	79		
16:45	66	80		
17:00	66	79		
17:15	66	79		

ANALYZED BY MMK

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.

NITROGEN OXIDE AND CARBON MONOXIDE EMISSION DATA

87629

PLANT Cities Service DATE April 1987

SOURCE Lisbon Unitization RUN NO.

TIME	NO_x (ppm, dry)	CO (ppm, dry)	OXYGEN (%, dry)	COMMENTS
1730	65	78		
1745	66	78		
1800	66	77		
1815	65	77		
1830	65	77		
1845	64	77		

ANALYZED BY

Appendix B-- Calibration Data

Scott Specialty Gases a division of Scott Environmental Technology, Inc.
PLUMSTEADVILLE, PA. 18949 PHONE: 215-766-8861 TWX: 510-665-9344

Environmental Sciences & Engineering
ATTN: Charles Reshard
5 miles west of I-75
on State Rd. 26
Gainesville, FL 32602

Date Shipped 7-3-86
Our Project No: 334148
Your P.O. No: 14738
Page 1 of 4

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES*

(Concentrations are in mole % or ppm)

Cylinder Number AAL 17251 Certified Accuracy ± 1 % NBS Traceable Analysis Dates: First 6-26-86 Last 7-2-86

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
NO	1311 ppm.	1-2-87	Chemiluminescent	2631/2630	1311 ppm	1310 ppm
					1311 ppm	1310 ppm
					1312 ppm	1311 ppm
N_2	Bal.					

Cylinder Number AAL 17242 Certified Accuracy ± 1 % NBS Traceable Analysis Dates: First 6-25-86 Last 7-2-86

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
NO	813.5 ppm	1-2-87	Chemiluminescent	1687/1686	817.8 ppm	813.8 ppm
					818.1 ppm	812.7 ppm
					817.2 ppm	814.1 ppm
N_2	Bal.					

*We hereby certify the cylinder gas has been analyzed according to EPA Protocol No:

Analyst Christian Sautter
Christian Sautter

Approved By
Francis E. Nevill

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.

NBS/SRM MATERIALS ■ EPA PROTOCOL GASES ■ ACUBLEND ■ CALIBRATION & SPECIALTY GAS MIXTURES
PURE GASES ■ ACCESSORY PRODUCTS ■ CUSTOM ANALYTICAL SERVICES
TROY, MICHIGAN / SAN BERNARDINO, CALIFORNIA / HOUSTON, TEXAS

Scott Specialty Gases a division of Scott Environmental Technology, Inc.

PLUMSTEADVILLE, PA. 18949 PHONE: 215-766-8861 TWX: 510-665-9344

Date Shipped 7-3-86

Our Project No: 334148

Your P.O. No: 14738

Page 2 of 4

Environmental Sciences & Engineering
ATTN: Charles Reshard

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES*

(Concentrations are in mole % or ppm)

Cylinder Number AAL 17250 Certified Accuracy ± 1 % NBS Traceable Analysis Dates: First 6-18-86 Last 6-25-86

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
NO	452.3 ppm	12-25-86	Chemiluminescent	1687/1686	449.0 ppm	452.9 ppm
					448.9 ppm	452.3 ppm
					449.4 ppm	451.8 ppm
N_2	Bal.					

Cylinder Number AAL 17243 Certified Accuracy ± 1 % NBS Traceable Analysis Dates: First 6-18-86 Last 6-25-86

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
NO	250.6 ppm	12-25-86	Chemiluminescent	1687/1686	252.3 ppm	250.6 ppm
					252.3 ppm	250.5 ppm
					252.4 ppm	250.8 ppm
N_2	Bal.					

*We hereby certify the cylinder gas has been analyzed according to EPA Protocol No:

Analyst Christian Sautter Approved By Francis E. Nevill

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 visid
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Page 3 of 4

Environmental Sciences & Engineering
ATTN: Charles Reshard

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES*

(Concentrations are in mole % or ppm)

Cylinder Number A AL-10956 Certified Accuracy ±1 % NBS Traceable Analysis Dates: First 6-25-86 Last 7-2-86

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
O_2	5.350%	7-2-87	Thermal Conductivity	2652/2657	5.379%	5.340%
					5.352%	5.347%
					5.341%	5.363%
N_2	Bal.					

Cylinder Number A AL-10244 Certified Accuracy ±1 % NBS Traceable Analysis Dates: First 6-25-86 Last 7-2-86

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
O_2	10.13%	7-2-87	Thermal Conductivity	2652/2657	10.13%	10.10%
					10.14%	10.14%
					10.15%	10.15%
N_2	Bal.					

*We hereby certify the cylinder gas has been analyzed according to EPA Protocol No:

Analyst George E. Dicker Approved By Francis E. Nevill

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.

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Date Shipped 7-3-86
Our Project No: 334148
Your P.O. No: 14738
Page 4 of 4

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES*
(Concentrations are in mole % or ppm)

Cylinder Number AAL-232 Certified Accuracy ±1 % NBS Traceable Analysis Dates: First 6-25-86 Last 7-2-86

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
O_2	17.41%	7-2-87	Thermal Conductivity	2652/2657	17.40%	17.46%
					17.41%	17.39%
					17.42%	17.39%
N_2	Bal.					

Cylinder Number _____ Certified Accuracy _____ % NBS Traceable Analysis Dates: First _____ Last _____

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND

*We hereby certify the cylinder gas has been analyzed according to EPA Protocol No:

Analyst George E. Dicker Approved By Francis E. Nevill

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.

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Scott Specialty Gases Scott Environmental Technology, Inc.
PLUMSTEADVILLE, PA. 18949 PHONE: 215-766-8861 TWX: 510-665-9344

Date Shipped 2/26/87
Our Project No: 337843
Your P.O. No: 16992
Page 1 of 2

ENVIRONMENTAL SCIENCE & ENG.
ATTN: CHARLIE RESHAD
STATE RD
GAINSVILLE, FL 32602

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES*
(Concentrations are in mole % or ppm)

Cylinder Number CAL-10735 Certified Accuracy ±1 % NBS Traceable Analysis Dates: First 2/18/87 Last 2/25/87

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
CARBON MONOXIDE	37.44 PPM	8/25/87	NDIR	1677/1679	37.40 PPM	37.40 PPM
NITROGEN	BALANCE				37.41 PPM	37.50 PPM
					37.37 PPM	37.41 PPM

Cylinder Number CAL-9168 Certified Accuracy ±1 % NBS Traceable Analysis Dates: First 2/18/87 Last 2/25/87

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
CARBON MONOXIDE	55.61 PPM	8/25/87	NDIR	1677/1679	55.61 PPM	55.58 PPM
NITROGEN	BALANCE				55.56 PPM	55.61 PPM
					55.63 PPM	55.64 PPM

*We hereby certify the cylinder gas has been analyzed according to EPA Protocol No: 2

Analyst Rene Bedoya
RENE BEDOYA

Approved By
FRANCIS E. NEVILL

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.

CERTIFIED REFERENCE MATERIALS ■ EPA PROTOCOL GASES ■ ACUBLEND® ■ CALIBRATION & SPECIALTY GAS MIXTURES
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Date Shipped 2/26/87
Our Project No: 337843
Your P.O. No: 16992
Page 2 of 2

ENV. SCIENCE.
ATTN: CHARLIE RESHAD

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES*
(Concentrations are in mole % or ppm)

Cylinder Number CAL-5188 Certified Accuracy ±1 % NBS Traceable Analysis Dates: First 2/18/87 Last 2/25/87

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
CARBON MONOXIDE	86.94 PPM	8/25/87	NDIR	1677/1679	86.93 PPM	86.92 PPM
NITROGEN	BALANCE				86.89 PPM	86.91 PPM
					86.90 PPM	86.98 PPM

Cylinder Number _____ Certified Accuracy _____ % NBS Traceable Analysis Dates: First _____ Last _____

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND

*We hereby certify the cylinder gas has been analyzed according to EPA Protocol No: 2

Analyst Rene Bedoya
RENE BEDOYA

Approved By
FRANCIS E. NEVILL

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.

CERTIFIED REFERENCE MATERIALS ■ EPA PROTOCOL GASES ■ ACUBLEND® ■ CALIBRATION & SPECIALTY GAS MIXTURES
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Appendix C-- Engine Operating Data

87629

Testing Log

24 April 1987
Cities Service O&G
Lisbon Unitization
10 Engine
W. Parke Moore, III

Arrived on site 0745
Commenced setting up

lapse time approx. 4 hrs

Problems incurred
① Teledyne a) low flow
b) no O_2 response 00.0

remedies
- I replaced O_2 detector active element & received correct response
- To improve flow, I bypassed the O_2 sensor

② T&CO a) no reaction chamber vacuum

1155 Commenced T&CO w/u & calibration runs on both CO & NO
response times & Cal. Concentrations

NO	CO
250.6	37.44
452.3	55.61
813.5 – ran out	86.94
1311 –	

1305 Completed calibrations & Commenced testing

Cities Service Oil & gas Co.
ESE

W. Pake Moore, III
April 24, 1987

1410 - Completed the 1st one hour run

1412 - POI increasing the speed of the IC Engine to 950 rpm from

1433 - P.O.I. Still making adjustments to speed & Intake manifold pressure in order to increase loading for a safe Steady state condition

1st attempt was at 990 rpm & +4.8" Hg
then adjustments to 920 rpm & +3.5" Hg
" " " 920 rpm & +4.4" Hg
(928 ppm CO 5000 ppm NOx) est. 1310 hp
- Conducted Cals & Response times

1600 - Commenced run 2
1700 - Completed run 2
1710 - POI to conduct adjmts after cals & response times
1745 ~~1640~~ - POI makes final adjustments
1747 ~~1641~~ - Started the final run (3)

Operating Parameters

		Speed	Exhaust Temp	Intake Man. Pressure
1305	run 1	863 rpm	952°F	+2.5" Hg
	~~run 2~~	NO approx 4550		CO approx 220
		1200 – 1250 hp est.		235,000 scf/day
	run 2	950 rpm		~~+4.8~~ wm adjustment
		1330 hp		264,000 scf/day
		850 rpm	~910°F	+9" Hg
1600	run 2	NO ~1200 ppm		CO ~ 380 ppm
		1250 hp		230,000 scf/day

	Speed	Exhaust Temp	Manifold
run 3	857 rpm	859°F	+8.6" Hg

NO	CO
420 ppm	330 ppm
1120 hp	222,000

This page is to be used to record the data from one stack (or other emission point) only. as many times as there are individual emission points, and use one page for each point. Note the numbers indicate explanatory notes on pages 4 and 5.

Point source ID number[1]	Descriptive name of the equipment served by this stack	Height of stack above grade[2]	Stack diameter[3]	Stack gas exit temperature
1	Lisbon Compressor	21 ft	1.1 I.D. ft	1050 °F

Stack gas flow rate at process conditions, not at standard	Stack gas exit velocity	If this stack serves a "boiler"[4], give the type(s) of fuel used and the heat input (i.e., fuel rate x heating value)	% of annual throughput of pollutants through this emission point (totals 100%)				Normal operating time of this point		
			Dec-Feb	Mar-May	June-Aug	Sept-Nov	hrs/day	days/week	wks/yr
6400 ft^3/min	111.5 ft/sec	NONE type(s) of fuel 10^6 BTU/hr 1st fuel 10^6 BTU/hr 2nd fuel, if any	25 %	25 %	25 %	25 %	24	7	52

Name of pollutant	Pollution control equipment code[5]	Control equipment efficiency[6]	Average emission rate lbs/hr	Maximum emission rate lbs/hr	Annual emission rate tons/yr	Emission estimation method[7]	Add, change or delete code[8]	Concentration in gases exiting the stack[9]
particulate matter	000	0	0	0	0	0		NA gr/std ft^3
sulfur dioxide	000	0	0	0	0	0		NA PPM (VOL.)
nitrogen dioxide	000	0	59.64	59.64	237.6	6		
hydrocarbons	000	0	3.31	3.31	13.2	6		
carbon monoxide	000	0	3.31	3.31	13.2	6		

Fill in this column only as required by note 9.

If this stack is from equipment which burns fuel, give the % of the total fuel used by the equipment which is used, either directly or indirectly, for space heating (or cooling) at the plant. (i.e., to heat or cool the air in a room) If this stack is not from a fuel burning equipment, or if fuel is burned but none of the heat is intended to heat or cool air in a room, enter a zero below:

0 % "space heat"

Give below the fuel or process materials charging rate to the unit served by this stack.[11]

Name of fuel/ process material	Annual rate	Maximum hourly rate
Processed Natural Gas	86.5MMCF /yr	.01 MMCF /hr
	/yr	/hr
	/yr	/hr
	/yr	/hr
	/yr	/hr
	/yr	/hr

Appendix D-- Project Participants

C-BRLS.5/CS-LOR.1
07-31-87

LIST OF PARTICIPANTS

Cities Service Oil and Gas Company	
Milton May	Representative
Louisiana Department of Environmental Quality	
Richard Bromley	Inspector
Environmental Science and Engineering, Inc.	
Parke Moore	Project Director
Mark Kimball	Technician
Ray Spann	Technician