Background Report Reference

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Title: Urea Permit Compliance Testing at El Segundo Generating Stating Unit 4

Carnot

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Section 1.4
(BID Ch. 2)

UREA PERMIT COMPLIANCE TESTING AT EL SEGUNDO GENERATING STATION UNIT 4

Prepared For:

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For Submittal To:

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
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CARNOT
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SEPTEMBER 1993

REVIEW AND CERTIFICATION

All work, calculations, and other activities and tasks performed and documented in this report were carried out under my direction and supervision.

Hung M. Ha

Date 9/20/93

FOR Edward J. Filadelfia
Senior Engineer

I have reviewed, technically and editorially, details, calculations, results, conclusions and other appropriate written material contained herein, and hereby certify that the presented material is authentic and accurate.

Hung M. Ha

Date 9/20/93

FOR Edward J. Filadelfia
Senior Engineer

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SECTION 1.0

INTRODUCTION

Carnot was contracted to conduct a series of emissions tests on Unit 4 at the El Segundo Generating Station for Southern California Edison (SCE). Carnot conducted testing to comply with South Coast Air Quality Management District (SCAQMD) Permit To Construct for the urea injection system.

A test program was conducted to quantify the effect of urea injection on various stack emissions as stated in Conditions 11-B and 11-C(b) of the Permit to Construct. Emissions tests were performed on El Segundo Unit 4 for the following:

- NO_x, CO and O_2
- ROG as non-methane Hydrocarbons
- NH_3 (urea on only)
- Moisture

Table 1-1 summarizes the emissions test results.

Per verbal discussion with Mr. Darren Stroud of the SCAQMD, it was agreed that particulate emissions would be measured on one unit of each unit class because of the low potential for urea having an impact on particulate emissions. Therefore, particulates were not measured on this unit. The unit that was tested as representative of the 320/335 MW class of units was Alamitos No. 4. The results are contained in Carnot Report No. SCE1A-10840/R106B956.T and titled **Urea Permit Compliance Testing at Alamitos Generating Station Unit 4.**

The 256 MW and 150 MW load emissions testing was conducted by Matt McCune, Wayne Madden and Marc Rodabaugh of Carnot on May 24-25, 1993. Mike Escarcega of SCE coordinated the testing. Full load emission testing was conducted by Edward J. Filadelfia, Jim Mulligan and Marc Rodabaugh of Carnot on August 12, 1993. Larry Milleson of SCE coordinated the testing.

TABLE 1-1
EMISSIONS TEST RESULTS SUMMARY
EL SEGUNDO UNIT 4
MAY 1993

	Net Load 331 MW		Net Load 256 MW		Net Load 150 MW	
	Urea Off	Urea On	Urea Off	Urea On	Urea Off	Urea On
NO_x, ppm	73.5	65.8	67.0	55.3	43.9	39.3
NO_x, ppm @ 3% O_2	83.5	75.0	74.4	61.8	53.0	47.3
CO, ppm	6.5	4.7	23.4	18.5	0.0	0.0
CO, ppm @ 3% O_2	7.4	5.3	26.0	20.7	0.0	0.0
Methane, ppm	ND < 1.0	ND < 1.0	ND < 1.0	ND < 1.0	ND < 1.0	ND < 1.0
TNMHC as CH_4, ppm	8.6	8.6	20.8	21.4	17.4	17.6
Urea flow, gpm	0.0	2.2	0.0	1.3	0.0	0.7
NH_3 slip, ppm	--	6.2	--	10.6	--	4.0
ppm @ 3% O_2	--	7.1	--	11.9	--	4.8

Note: ND indicates that this species was not detected.

SECTION 2.0

UNIT DESCRIPTION

El Segundo Generating Station Unit 4 is one of six similar Combustion Engineering inverted tangentially-fired boilers in the SCE system with a rated load of 335 net MW. The boiler is fired from the top and consists of three tiers of burners with eight burners in each tier. Each burner contains one oil gun and two gas injectors. The unit is divided into two furnaces by a division wall, with burners in each of the four corners to provide the "tangential" firing.

The boiler is equipped with burner tilts, which can be varied from the horizontal to 10 degrees up and 30 degrees down. All three burners in a furnace corner are controlled by one mechanism, with all the burners in a furnace set at the same position. Combustion air is supplied by two forced draft fans through primary and secondary air ducts. The primary air ducts supply air only to the immediate vicinity of the burners. The secondary air is introduced above and below each burner. Air flow to individual burners is controlled by dampers. Existing controls regulate the position of all the primary and secondary dampers separately. The unit has two flue gas recirculation (FGR) fans that mix flue gas with the secondary air supply. The furnace is operated under positive pressure.

SECTION 3.0

TEST DESCRIPTION

3.1 TEST CONDITIONS

The testing was conducted at two conditions and at three loads. Condition 1 was with urea off and Condition 2 was with optimum urea injection. Duplicate tests were performed at the approximate net loads: 256 and 150 MW. Loads below 150 MW were not tested as urea is first used at 150 MW. Due to a load limit (on the unit) imposed by operations, tests at full load were not performed until August 12, 1993. All testing was performed with the boiler fired on natural gas fuel. The test matrix and unit operating data are outlined in Tables 3-1 and 3-2. Unit operation was established by SCE operators, and unit data were collected by SCE personnel.

3.2 SAMPLE LOCATIONS

Measurements were made using two of four sample ports accessible from the newly constructed stack sampling platform. A stack configuration drawing is presented in Figure 3-1. The stack diameter at the cross-sectional plane of the sample ports is 21 feet, 1 inch. This sample location is 62 feet, 2 inches (2.9 diameters) from the nearest upstream flow disturbance and 117 feet, 10 inches (5.6 diameters) from the stack exit.

3.3 TEST PROCEDURES

The test procedures used for the program are presented in Table 3-3. Descriptions of standard procedures are included in Appendix A. Additional information and modifications to standard procedures are presented in the following section.

3.3.1 Gaseous Emissions

Gaseous species (NO_x, CO and O_2) were measured using Carnot's Continuous Emissions Monitor (CEM) described in Appendix A. This system meets SCAQMD, CARB and EPA requirements for gaseous species. Two 30-minute gaseous emission test runs were performed for each test condition and load.

TABLE 3-1
TEST MATRIX
SCE EL SEGUNDO UNIT 4
MAY AND AUGUST 1993

Test #	Date	Time	Type of Test	Net Load MW
4-1-CEM	5/24/93	1000/1045	NO_x, CO & O_2	150
4-1-NH_3	5/24/93	1000/1030	Ammonia	150
4-2-CEM	5/24/93	1115/1145	NO_x, CO, & O_2	150
4-2-HC	5/24/93	1115/1145	Hydrocarbon	150
4-3-CEM	5/24/93	1200/1230	NO_x, CO, & O_2	150
4-3-HC	5/24/93	1200/1230	Hydrocarbon	150
4-4-CEM	5/24/93	1345/1415	NO_x, CO & O_2	150
4-4-HC	5/24/93	1345/1415	Hydrocarbon	150
4-4-NH_3	5/24/93	1345/1415	Ammonia	150
4-5-CEM	5/24/93	1435/1505	NO_x, CO & O_2	150
4-5-HC	5/24/93	1435/1505	Hydrocarbon	150
4-5-NH_3	5/24/93	1435/1505	Ammonia	150
4-6-CEM	5/25/93	1015/1053	NO_x, CO & O_2	256
4-6-HC	5/25/93	1015/1105	Hydrocarbon	256
4-6-NH_3	5/25/93	1015/1045	Ammonia	256
4-7-CEM	5/25/93	1115/1145	NO_x, CO & O_2	256
4-7-HC	5/25/93	1115/1145	Hydrocarbon	256
4-7-NH_3	5/25/93	1115/1145	Ammonia	256
4-8-CEM	5/25/93	1210/1240	NO_x, CO & O_2	256
4-8-HC	5/25/93	1210/1230	Hydrocarbon	256
4-9-CEM	5/25/93	1250/1320	NO_x, CO & O_2	256
4-9-HC	5/25/93	1250/1310	Hydrocarbon	256
4-10-CEM	8/12/93	1045/1125	NO_x, CO, O_2	331
4-10-HC	8/12/93	1050/1110	Hydrocarbon	331
4-10-NH_3	8/12/93	1045/1125	Ammonia	331
4-11-CEM	8/12/93	1130/1200	NO_x, CO, O_2	330
4-11-HC	8/12/93	1135/1155	Hydrocarbon	330
4-11-NH_3	8/12/93	1130/1200	Ammonia	330
4-12-CEM	8/12/93	1220/1250	NO_x, CO, O_2	330
4-12-HC	8/12/93	1230/1250	Hydrocarbon	330
4-13-CEM	8/12/93	1300/1330	NO_x, CO, O_2	332
4-13-NHC	8/12/93	1300/1320	Hydrocarbon	332

TABLE 3-2
UNIT OPERATING CONDITIONS
EL SEGUNDO UNIT 4
MAY AND AUGUST 1993

Test No.	Date	Net Load, MW	Urea Status	Total Urea Flow gpm
4-2	5/24/93	150	off	0.0
4-3	5/24/93	150	off	0.0
4-4	5/24/93	150	on	0.7
4-5	5/24/93	150	on	0.7
4-6	5/24/93	245	on	1.34
4-7	5/24/93	246	on	1.34
4-8	5/24/93	246	off	0.0
4-9	5/24/93	246	off	0.0
4-10	8/12/93	331	on	2.24
4-11	8/12/93	330	on	2.24
4-12	8/12/93	330	off	0.0
4-13	8/12/93	332	off	0.0

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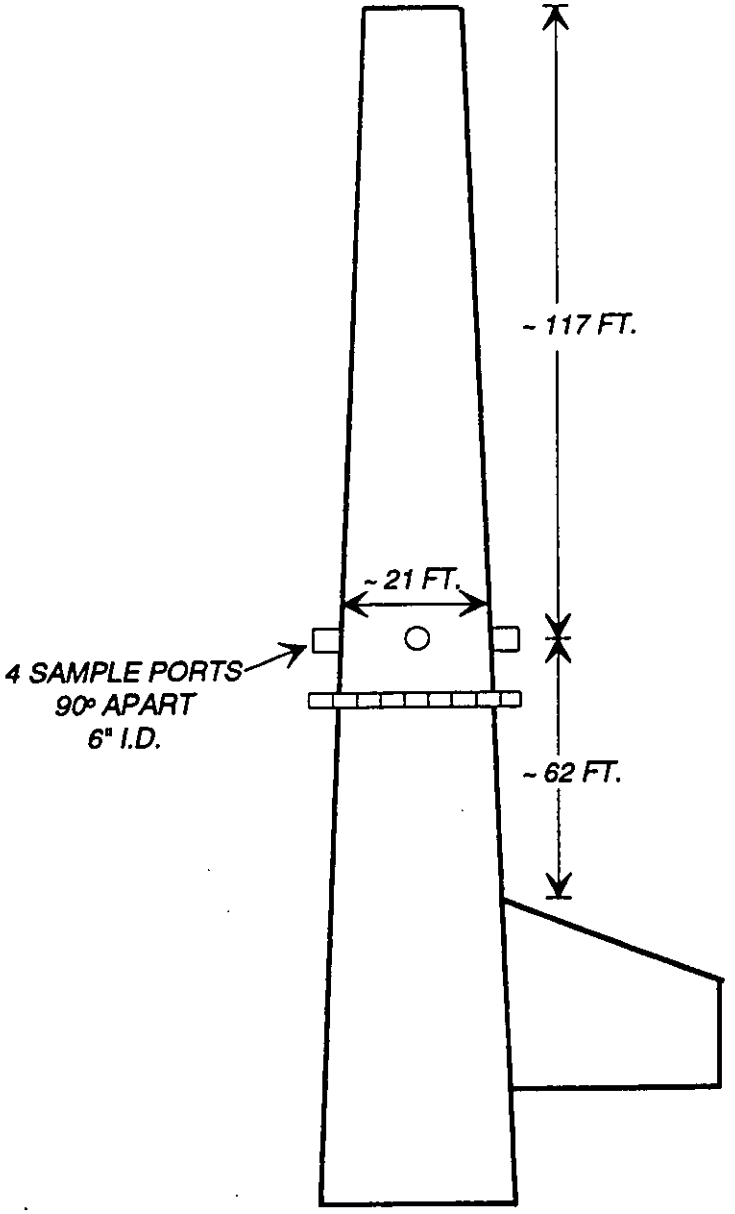


Figure 3-1. El Segundo Unit 4 Sample Location

TABLE 3-3
EMISSIONS TEST PROCEDURES - SCE/EL SEGUNDO UNIT 4
MAY 1993

Parameter	Number of Replicates	Duration of Test (Minutes)	Measurement Principle	Reference Method	Method Detection Limit
NO_x	2	30	Chemiluminescent	SCAQMD 100.1	Below 2% of instrument full scale
CO	2	30	NDIR/Gas filter correlation	SCAQMD 100.1	Below 2% of instrument full scale
O_2	2	30	Electrochemical cell	SCAQMD 100.1 EPA 3E	Below 2% of instrument full scale
ROG as Hydrocarbons	2	20	Gas chromatography/FID	SCAQMD 25.2	0.1 ppm
Ammonia	2	30	Colorimetry spectrophotometry	SCAQMD Draft 207.1	0.1 ppm

3.3.2 Reactive Organic Gases (ROG) as Hydrocarbons

Hydrocarbon samples were collected in new tedlar bags and analyzed according to SCAQMD Method 25.2. The samples were analyzed within 72 hours of collection by Atmosphere Assessments in Chatsworth, California.

3.3.3 Ammonia

Ammonia samples were collected non-isokinetically, with NH_3 being absorbed in two impingers containing 0.1 N H_2SO_4. The ammonia samples were analyzed on-site by SCAQMD NH_3 Draft Method.

3.3.4 Moisture

Moisture was determined by SCAQMD Method 4 and in conjunction with NH_3 sampling.

SECTION 4.0

RESULTS

Emissions test results are presented in Tables 4-1 through 4-6. Measurement procedures are detailed in Appendix A. Quality assurance and equipment calibrations are in Appendix B. All raw data sheets from Carnot's testing and from unit operation are included in Appendix C. Appendix D contains general and specific emissions calculations. Appendix E contains laboratory reports. Carnot's instrument strip charts are in Appendix F. Chain of Custody information is included in Appendix G.

TABLE 4-1
EMISSIONS TEST RESULTS AT 331 MW
UREA ON
EL SEGUNDO UNIT 4
AUGUST 12, 1993

Parameter	Test No. 4-10	Test No. 4-11	Test Average
Time	1045/1115	1130/1200	
NO_x, ppm	64.8	66.7	65.8
ppm @ 3% O_2	73.9	76.0	75.0
CO, ppm	4.8	4.5	4.7
ppm @ 3% O_2	5.5	5.1	5.3
O_2%	5.2	5.2	5.2
H_2O %	18.2	18.0	18.1
Methane, ppm	ND < 1.0	ND < 1.0	ND < 1.0
Total Non-Methane Hydrocarbons as methane, ppm	10.3	7.7	8.6
NH_3, ppm	5.5	6.9	6.2
NH_3 @ 3% O_2[(2)]	6.3	7.9	7.1

Note: ND indicates that this species was not detected.

TABLE 4-2
EMISSIONS TEST RESULTS AT 331 MW
UREA OFF
EL SEGUNDO UNIT 4
AUGUST 12, 1993

Parameter	Test No. 4-12	Test No. 4-13	Test Average
Time	1220/1250	1300/1330	
NO_x, ppm	73.1	73.8	73.5
ppm @ 3% O_2	83.9	83.1	83.5
CO, ppm	5.9	7.1	6.5
ppm @ 3% O_2	6.8	8.0	7.4
O_2%	5.3	5.0	5.2
Methane, ppm	ND < 1.0	ND < 1.0	ND < 1.0
Total Non-Methane Hydrocarbons as methane, ppm	10.0	7.2	8.6

Note: ND indicates that this species was not detected.

TABLE 4-3
EMISSIONS TEST RESULTS AT 256 MW
UREA ON
EL SEGUNDO UNIT 4
MAY 25, 1993

Parameter	Test No. 4-6	Test No. 4-7	Test Average
Time	1015/1045	1115/1145	
NO_x, ppm	55.4	55.1	55.3
ppm @ 3% O_2	62.0	61.6	61.8
CO, ppm	17.5	19.5	18.5
ppm @ 3% O_2	19.6	21.8	20.7
O_2 %	4.9	4.9	4.9
H_2O %	18.3	17.9	18.1
Methane, ppm	ND < 1.0	ND < 1.0	ND < 1.0
Total Non-Methane Hydrocarbons as methane, ppm	19.6	23.1	21.4
NH_3, ppm	9.7	11.5	10.6
NH_3 @ 3% O_2	10.8	12.9	11.9

Note: ND indicates that this species was not detected.

TABLE 4-4
EMISSIONS TEST RESULTS AT 256 MW
UREA OFF
EL SEGUNDO UNIT 4
MAY 25, 1993

Parameter	Test No. 4-8	Test No. 4-9	Test Average
Time	1115/1145	1210/1240	
NO_x, ppm	66.6	67.3	67.0
ppm @ 3% O_2	74.0	74.8	74.4
CO, ppm	21.1	25.6	23.4
ppm @ 3% O_2	23.5	28.5	26.0
O_2 %	4.8	4.8	4.8
Methane, ppm	ND < 1.0	ND < 1.0	ND < 1.0
Total Non-Methane Hydrocarbons as methane, ppm	21.2	20.4	20.8

Note: ND indicates that this species was not detected.

TABLE 4-5
EMISSIONS TEST RESULTS AT 150 MW
UREA ON
EL SEGUNDO UNIT 4
MAY 24, 1993

Parameter	Test No. 4-4	Test No. 4-5	Test Average
Time	1345/1415	1435/1505	
NO_x, ppm	38.6	40.0	39.3
ppm @ 3% O_2	46.4	48.1	47.3
CO, ppm	0.0	0.0	0.0
ppm @ 3% O_2	0.0	0.0	0.0
O_2%	6.0	6.0	6.0
H_2O%	18.1	16.1	17.1
Methane, ppm	ND < 1.0	ND < 1.0	ND < 1.0
Total Non-Methane Hydrocarbons as methane, ppm	17.1	18.0	17.6
NH_3, ppm	2.8	5.2	4.0
NH_3, @ 3% O_2	3.4	6.2	4.8

Note: ND indicates that this species was not detected.

TABLE 4-6
EMISSIONS TEST RESULTS AT 150 MW
UREA OFF
EL SEGUNDO UNIT 4
MAY 24, 1993

Parameter	Test No. 4-2	Test No. 4-3	Test Average
Time	1115/1145	1200/1230	
NO_x, ppm	44.1	43.7	43.9
ppm @ 3% O_2	53.0	52.6	53.0
CO, ppm	0.0	0.0	0.0
ppm @ 3% O_2	0.0	0.0	0.0
O_2 %	6.0	6.0	6.1
Methane, ppm	ND < 1.0	ND < 1.0	ND < 1.0
Total Non-Methane Hydrocarbons as methane, ppm	15.8	19.0	17.4

Note: ND indicates that this species was not detected.

APPENDIX A
MEASUREMENT PROCEDURES

Continuous Emissions Monitoring System

Oxygen (O_2) by Continuous Analyzer

NO/NO_x by Continuous Analyzer

Carbon Monoxide (CO) by NDIR/Gas Filter Correlation

Hydrocarbons by SCAQMD Micro TCA Method

Ammonia

Continuous Emissions Monitoring System

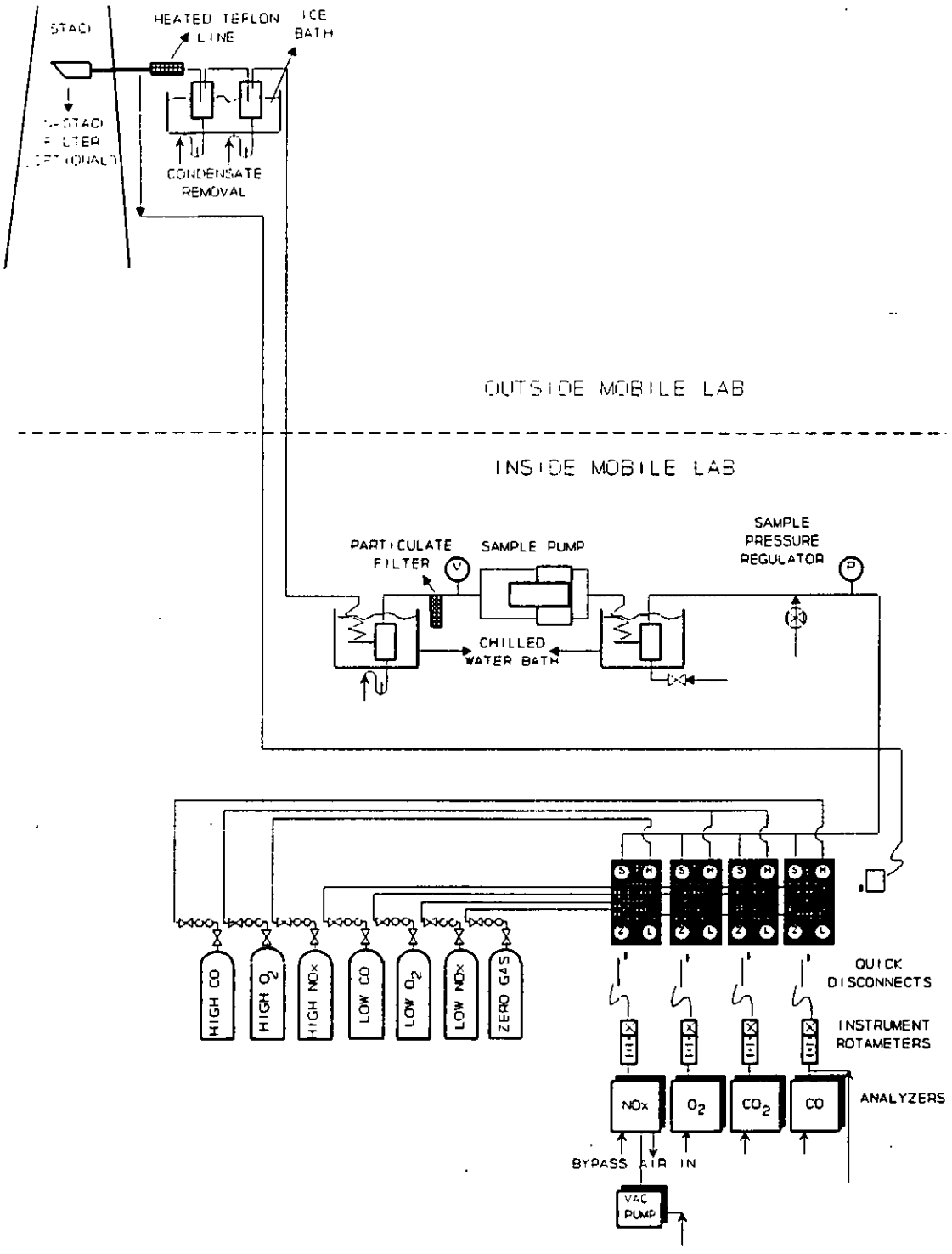
O_2, CO, and NO_x are measured using an extractive continuous emissions monitoring (CEM) package, shown in the following figure. This package is comprised of three basic subsystems. They are: (1) the sample acquisition and conditioning system, (2) the calibration gas system, and (3) the analyzers themselves. This section presents a description of the sampling and calibration systems. Descriptions of the analyzers used in this program and the corresponding reference test methods follow. Information regarding quality assurance information on the system, including calibration routines and system performance data follows.

The sample acquisition and conditioning system contains components to extract a representative sample from the stack or flue, transport the sample to the analyzers, and remove moisture and particulate material from the sample. In addition to performing the tasks above, the system must preserve the measured species and deliver the sample for analysis intact. The sample acquisition system extracts the sample through a stainless steel probe. The probe is insulated or heated as necessary to avoid condensation. If the particulate loading in the stack is high, a sintered stainless steel filter is used on the end of the probe.

Where water soluble NO_2 is to be measured, the sample is drawn from the probe through a heated teflon sample line into an on-stack cooled (approximately 35-40°F) water removal trap. The trap consists of stainless steel flasks in a bath of ice and water. This design removes the water vapor by condensation. The contact between the sample and liquid water is minimized and the soluble NO_2 is conserved. This system meets the requirements of EPA Method 20. The sample is then drawn through a teflon transport line, particulate filter, secondary water removal and into the sample pump. The pump is a dual head, diaphragm pump. All sample-wetted components of the pump are stainless steel or teflon. The pressurized sample leaving the pump flows through a third condensate trap in a refrigerated water bath ($\approx$38°F) for final moisture removal. A drain line and valve are provided to constantly expel any condensed moisture from the dryer at this point. After the dryer, the sample is directed into a distribution manifold. Excess sample is vented through a back-pressure regulator, maintaining a constant pressure of 5-6 psig to the analyzer rotameters.

The calibration system is comprised of two parts: the analyzer calibration, and the system bias check (dynamic calibration). The analyzer calibration equipment includes pressurized cylinders of certified span gas. The gases used are, as a minimum, certified to 1% by the manufacturer. Where necessary to comply with reference method requirements EPA Protocol 1 gases are used. The cylinders are equipped with pressure regulators which supply the calibration gas to the analyzers at the same pressure and flow rate as the sample. The selection of zero, span, or sample gas directed to each analyzer is accomplished by operation of the sample/calibration selector fittings.

The system bias check is accomplished by transporting the same gases used to zero and span the analyzers to the sample system as close as practical to the probe inlet. This is done either by attaching the calibration gas supply line to the probe top with flexible tubing or by actuation of a solenoid valve located at the sample conditioner inlet (probe exit). The span gas is exposed to the same elements as the sample and the system response is documented. The analyzer indications for the system calibration check must agree within 5% of the analyzer calibration. Values are adjusted and changes/repairs are made to the system to compensate for any difference in analyzer readings. Specific information on the analytical equipment and test methods used is provided in the following pages.



Schematic of CEM System

Method:	**Oxygen (O_2) by Continuous Analyzer**
Applicable Reference Methods:	EPA 3A, EPA 20, ARB 100, BA ST-14, SCAQMD 100.1
Principle:	A sample is continuously drawn from the flue gas stream, conditioned, and conveyed to the instrument for direct readout of O_2 concentration.
Analyzer:	Teledyne Model 326A
Measurement Principle:	Electrochemical cell
Ranges:	0-5, 0-10, 0-25% O_2
Accuracy:	1% of full scale
Output:	0-100 mV, linear
Interferences:	Halogens and halogenated compounds will cause a positive interference. Acid gases will consume the fuel cell and cause a slow calibration drift.
Response Time:	90% <7 seconds
Sampling Procedure:	A representative flue gas sample is collected and conditioned using the CEM system described previously. If Method 20 is used, that method's specific procedures for selecting sample points are used. Otherwise, stratification checks are performed at the start of a test program to select single or multiple-point sample locations.
Analytical Procedure:	An electrochemical cell is used to measure O_2 concentration. Oxygen in the flue gas diffuses through a Teflon membrane and is reduced on the surface of the cathode. A corresponding oxidation occurs at the anode internally, and an electric current is produced that is proportional to the concentration of oxygen. This current is measured and conditioned by the instrument's electronic circuitry to give an output in percent O_2 by volume.
Special Calibration Procedure:	The measurement cells used with the O_2 instrument have to be replaced on a regular basis. After extended use, the cell tend to produce a nonlinear response. Therefore, a three-point calibration is performed at the start of each test day to check for linearity. If the response is not linear ($\pm$ 2% of scale), the cell is replaced.

Method:	**NO/NO_x by Continuous Analyzer**
Applicable Reference Methods:	EPA 7E, EPA 20; ARB 100, BA ST-13A, SCAQMD 100.1
Principle:	A sample is continuously drawn from the flue gas stream, conditioned, and conveyed to the instrument for direct readout of NO or NO_x.
Analyzer:	Teco Model No. 10AR
Measurement Principle:	Chemiluminescence
Accuracy:	1% of full scale
Ranges:	0-2.5, 0-10, 0-25, 0-100, 0-250, 0-1000, 0-2500, 0-10,000 ppm
Output:	0-10 mV
Inferences:	Compounds containing nitrogen (other than ammonia) may cause interference.
Response Time:	90%, 1.5 seconds (NO mode) and 1.7 seconds (NO_x mode)
Sampling Procedure:	A representative flue gas sample is collected and conditioned using the CEM system described previously. If EPA Method 20 is used, that method's specific procedures for selecting sample points are used.
Analytical Procedure:	The oxides of nitrogen monitoring instrument is a chemiluminescent nitric oxide analyzer. The operational basis of the instrument is the chemiluminescent reaction of NO and ozone (O_3) to form NO_2 in an excited state. Light emission results when excited NO_2 molecules revert to their ground state. The resulting chemiluminescence is monitored through an optical filter by a high sensitivity photomultiplier tube, the output of which is electronically processed so it is linearly proportional to the NO concentration. The output of the instrument is in ppmV. When NO_2 is expected to be present in the flue gas, a supercooled water dropout flask will be placed in the sample line to avoid loss of NO_2. Since NO_2 is highly soluble in water, "freezing out" the water will allow the NO_2 to reach the analyzers for analysis. The analyzer measures NO only. In the NO_x mode, the gas is passed through a moly converter which converts NO_2 to NO and a total NO_x measurement is obtained. NO_2 is determined as the difference between NO and NO_x. Use of a moly converter instead of a stainless steel converter eliminates NH_3 interference; NH_3 is converted to NO with a stainless converter, but not with a moly converter.

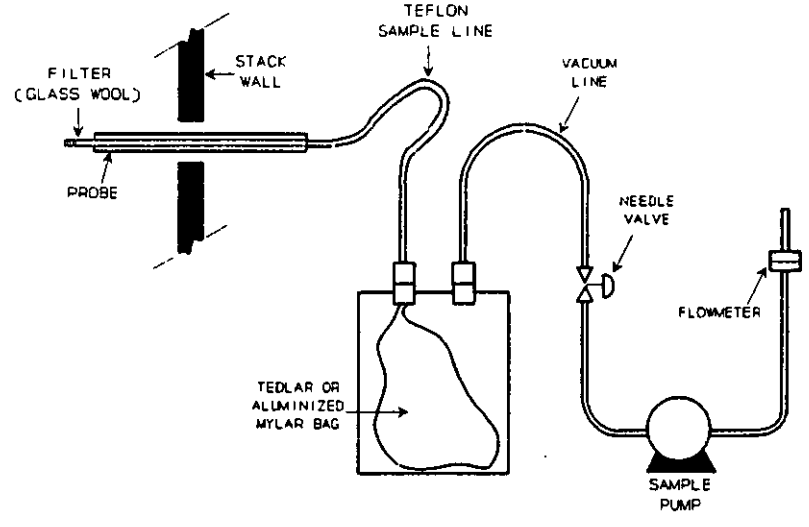
Method:	**Carbon Monoxide (CO) by NDIR/Gas Filter Correlation**
Applicable Reference Methods:	EPA 10; ARB 1-100; BA ST-6, SCAQMD 100.1
Principle:	A sample is continuously drawn from the flue gas stream, conditioned, and conveyed to the instrument for direct readout of CO concentration.
Analyzer:	TECO, Model 48
Measurement Principle:	NDIR/Gas Filter Correlation
Precision:	0.1% ppm
Ranges:	0-5, 0-10, 0-25, 0-50, 0-100, 0-250, 0-500, 0-1000, 0-5000 ppm
Output:	0-100 mV
Interferences:	Negligible interference from water and CO_2
Rise/Fall Times (0-95%)	1 minute @ 1 lpm flow, 30 second integration time
Sampling Procedure:	A representative flue gas sample is collected and conditioned using the CEM system described previously. Sample point selection has been described previously.
Analytical Procedure:	Radiation from an infrared source is chopped and then passed through a gas filter which alternates between CO and N_2 due to rotation of a filter wheel. The radiation then passes through a narrow band-pass filter and a multiple optical pass sample cell where absorption by the sample gas occurs. The IR radiation exits the sample cell and falls on a solid state IR detector.

Method: **Hydrocarbons by SCAQMD Micro Total Carbon Analysis (TCA/FID) Method**

Reference: SCAQMD Method 25.2 (draft Source Test Manual)

Principle: A Tedlar bag is filled with flue gas at a constant rate. The bag contents are analyzed by gas chromatography/flame ionization detection for CO, CO_2, methane and total gaseous non-methane hydrocarbons.

Sampling Procedure: Samples are collected using a lung-type sampling system shown in the attached figure. In this system, a bag is placed in a sealed container and the container is evacuated. Flue gas enters the bag as it expands to fill the container. Sampling rate is monitored by a rotameter on the container exhaust. This system allows sample collection without exposing the sample to pumps, flowmeters, oils, etc.



Sample Train for Determination of Hydrocarbons by SCAQMD Micro TCA Method

Analytical Procedure: In the analytical phase, gaseous carbon compounds from the tank are fractioned on a chromatographic column, eluting in the order: carbon monoxide, methane, carbon dioxide, non-methane hydrocarbons. All resulting vapors are passed through oxidizers where they are combusted to carbon dioxide, then converted to methane and measured by flame ionization detection. CO_2, CO, CH_4, and total gaseous non-methane hydrocarbons are reported separately.

This method provides lower detection limits than the standard TCA procedure, which uses GC/NDIR. Since this method does not use a steel condensate trap, it eliminates positive interferences that have been associated with carbon dioxide dissolved in water frozen in the condensate trap and released during analysis.

The TCA/FID method is appropriate for combustion sources and ambient sampling where low concentrations of hydrocarbons are expected.

Carnot subcontracts TCA analysis to qualified local laboratories experienced in the analytical procedures.

Method: Ammonia

Principle: Ammonia emissions are determined by collecting a dry, metered volume of flue gas containing ammonia vapor in dilute sulfuric acid solution. The ammonia concentration of the sample is then determined by ion selective electrode or colorimetric spectrophotometry.

Sampling Procedure: The ammonia sampling probe/train arrangement used during the test program is shown schematically in the following figure.

A sample is extracted through a glass probe fitted with a quartz wool plug or filter used to remove particulate matter. The plug is located and/or heated to avoid condensation of moisture at the plug. The sample is then passed through four impingers. The first two impingers are filled with 100 ml of 0.1 N sulfuric acid (H_2SO_4), the third is empty, and the fourth is filled with silica gel.

After each sample run, the quartz wool plug is removed and placed in a sample bottle. If a filter is used, it is generally saved but not analyzed. The impingers, glass probe, and sampling train glassware are washed with dilute H_2SO_4 into a separate sample bottle. The sample bottles containing the impinger wash solution and the quartz wool plug or filter are returned to the laboratory for analysis.

Analytical Procedure: Ammonia in source test samples is analyzed by ion selective electrode or colorimetrically. Source test samples are generally at low levels and titrations for ammonia are not applicable. The following sections discuss the two applicable analytical techniques.

Ion Selective Electrode

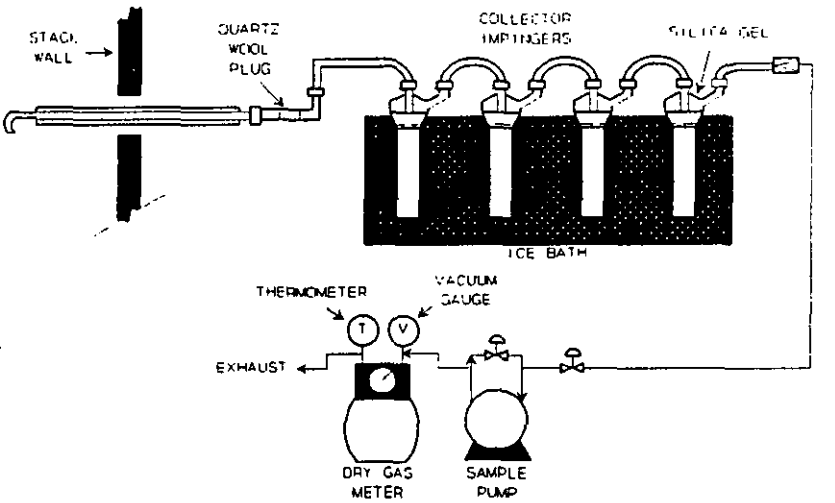
The ammonia samples are analyzed using an Orion Research Model 940 Microprocessor Ionanalyzer equipped with an ammonia ion selective electrode. The ammonia electrode is a glass electrode and reference electrode mounted behind a gas permeable membrane that separates the sample solution from the internal filling solution. After the addition of sodium hydroxide, ammonia in the sample diffuses across the electrode membrane. The measured pH change in the internal electrode solution is proportional to the concentration of ammonia in the sample solution.

The ammonia concentrations of the sample solutions are measured in units of ppm NH_3 by weight with the specific ion analyzer. By using the NH_3 concentration in ppm by weight, measuring the liquid volume of the sample solution, and obtaining the volume of the flue gas sample, the stack flue gas NH_3 concentration in ppm by volume is calculated using the equation:

$$NH_3 \text{ ppmV} = 0.049 \frac{(\text{ppm wt } NH_3 \text{ soln})(\text{liq. vol., ml})}{\text{DSCF (at } 60°F) \text{ of sampled flue gas}}$$

Colorimetric Spectrophotometry:

In the analytical phase, the resulting ammonium sulfate is mixed with Nessler reagent, forming a yellow-brown compound with a maximum absorbance in the 440 nm range. The ammonia concentration in the sample is determined colorimetrically by comparison to a standard calibration curve. Care will be taken to dilute the sample to the optimum observed range. If turbidity exists upon addition of Nessler reagent, the option of distillation or ion selective electrode will be used. Distillation will remove any aromatic and aliphatic amines along with other organic and inorganic compounds which can cause interference with the analysis.



Ammonia sampling probe/train arrangement

APPENDIX B
QUALITY ASSURANCE

Appendix B.1

Quality Assurance Program Summary

QUALITY ASSURANCE PROGRAM SUMMARY AND ARB CERTIFICATION

Carnot ensures the quality and validity of its emission measurement and reporting procedures through a rigorous quality assurance (QA) program. The program is developed and administered by an internal QA Officer and encompasses seven major areas:

1. Development and use of an internal QA manual.
2. QA reviews of reports, laboratory work, and field testing.
3. Equipment calibration and maintenance.
4. Chain of custody.
5. Training.
6. Knowledge of current test methods.
7. Agency certification.

Each of these areas is discussed individually below.

Quality Assurance Manual. Carnot has prepared a QA Manual according to EPA guidelines. The manual serves to document and formalize all of Carnot's QA efforts. The manual is constantly updated, and each member of the Source Test Division is required to read and understand its contents. The manual includes details on the other six QA areas discussed below.

QA Reviews. Carnot's review procedure includes review of each source test report by the QA Officer, and spot check reviews of laboratory and field work.

The most important review is the one that takes place before a test program begins. The QA Officer works closely with Source Test Division personnel to prepare and review test protocols. Test protocol review includes selection of appropriate test procedures, evaluation of any interferences or other restrictions that might preclude use of standard test procedures, and evaluation and/or development of alternate procedures.

Equipment Calibration and Maintenance. The equipment used to conduct the emissions measurements is maintained according to the manufacturer's instructions to ensure proper operation. In addition to the maintenance program, calibrations are carried out on each measurement device according to the schedule outlined by the California Air Resources Board (CARB). The schedule for maintenance and calibrations are given in Tables B-1 and B-2. Quality control checks are also conducted in the field for each test program. The following is a partial list of checks made as part of each CEM system test series.

- Sample acquisition and conditioning system leak check.
- 2-point analyzer calibrations (all analyzers)
- 3-point analyzer calibrations (analyzers with potential for linearity errors).
- Complete system calibration check ("dynamic calibration" through entire sample system).

- Periodic analyzer calibration checks (once per hour) are conducted at the start and end of each test run. Any change between pre- and post-test readings are recorded.

- All calibrations are conducted using gases certified by the manufacturer to be + 1% of label value (NBS traceable).

Calibration and CEM performance data are fully documented, and are included in each source test report.

Chain of Custody. Carnot maintains full chain of custody documentation on all samples and data sheets. In addition to normal documentation of changes between field sample custodians, laboratory personnel, and field test personnel, Carnot documents every individual who handles any test component in the field (e.g., probe wash, impinger loading and recovery, filter loading and recovery, etc.).

Samples are stored in a locked area to which only Source Test Division personnel have access. Neither other Carnot employees nor cleaning crews have keys to this area.

Data sheets are copied immediately upon return from the field, and this first generation copy is placed in locked storage. Any notes made on original sheets are initialed and dated.

Training. Personnel training is essential to ensure quality testing. Carnot has formal and informal training programs which include:

1. Attendance at EPA-sponsored training courses.
2. Enrollment in EPA correspondence courses.
3. A requirement for all technicians to read and understand Carnot's QA Manual.
4. In-house training and QA meetings on a regular basis.
5. Maintenance of training records.

Knowledge of Current Test Methods. With the constant updating of standard test methods and the wide variety of emerging test methods, it is essential that any qualified source tester keep abreast of new developments. Carnot subscribes to services which provide updates on EPA and CARB reference methods, and on EPA, CARB and SCAQMD rules and regulations. Additionally, source test personnel regularly attend and present papers at testing and emission-related seminars and conferences. Carnot personnel maintain membership in the Air Pollution Control Association, the Source Evaluation Society, and the ASME Environmental Control Division.

AGENCY CERTIFICATION

Carnot is certified by the CARB as an independent source test contractor for gaseous and particulate measurements. Carnot also participates in EPA QA audit programs for Methods 5, 6 and 7.

TABLE B-1
SAMPLING INSTRUMENTS AND EQUIPMENT CALIBRATION SCHEDULE
As Specified by the CARB

Instrument Type	Frequency of Calibration	*Standard of Comparison or* Method of Calibration	Acceptance Limits
Orifice Meter (large)	12 months	Calibrated dry test meter	± 2% of volume measured
Dry Gas Meter	12 months or when repaired	Calibrated dry test meter	± 2% of volume measured
S-Type Pitot (for use with EPA-type sampling train	6 months	EPA Method 2	Cp constant (+5%) over working range; difference between average Cp for each leg must be less than 2%
Vacuum Gauges Pressure Gauges	6 months	Manometer	± 3%
Field Barometer	6 months	Mercury barometer	± 0.2" Hg
Temperature Measurement	6 months	NBS mercury thermometer or NBS calibrated platinum RTD	± 4°F for <400°F ± 1.5% for >400°F
Temperature Readout Devices	6 months	Precision potentiometer	± 2% full scale reading
Analytical Balance	12 months (check prior to each use)	Should be performed by manufacturer or qualified laboratory	± 0.3 mg of stated weight
Probe Nozzles	12 Months	Nozzle diameter check micrometer	Range < ± 0.10 mm for three measurements
Continuous Analyzers	Depends upon use, frequency and performance	As specified by manufacturers operating manuals, EPA NBS gases and/or reference methods	Satisfy all limits specified in operating specifications

TABLE B-2
EQUIPMENT MAINTENANCE SCHEDULE
Based on Manufacturer's Specifications and Carnot Experience

Equipment	Performance Requirement	Maintenance Interval	Corrective Action
Pumps	1. Absence of leaks 2. Ability to draw manufacturer required vacuum and flow	Every 500 hours of operation or 6 months, whichever is less	1. Visual inspection 2. Clean 3. Replace worn parts 4. Leak check.
Flow Measuring Device	1. Free mechanical movement 2. Absence of malfunction	Every 500 hours of operation or 6 months, whichever is less After each test, if used in H_2S sampling or other corrosive atmospheres	1. Visual inspection 2. Clean 3. Calibrate
Sampling Instruments	1. Absence of malfunction 2. Proper response to zero, span gas	As required by the manufacturer	As recommended by manufacturer
Integrated Sampling Tanks	Absence of leaks	Depends on nature of use	1. Steam clean 2. Leak check
Mobile Van Sampling Systems	Absence of leaks	Depends on nature of use	1. Change filters 2. Change gas dryer 3. Leak check 4. Check for system contamination
Sampling Lines	Sample degradation less than 2%	After each test or test series	Blow filtered air through line until dry

Appendix B.2

ARB Certification

State of California
AIR RESOURCES BOARD

Executive Order G-836

Approval to Carnot
To Conduct Testing as an Independent Contractor

WHEREAS, the Air Resources Board ("Board"), pursuant to Section 41512 of the California Health and Safety Code, has established the procedures contained in Section 91200-91220, Title 17, California Code of Regulations, to allow the use of independent testers for compliance tests required by the Board; and

WHEREAS, pursuant to Sections 91200-91220, Title 17, California Code of Regulations, the Executive Officer has determined that Carnot meets the requirements of the Board for conducting Board Test Methods 1, 2, 3, 4, 5, 6, 8, 10, and 100 (NOx, O2) when the following conditions are met:

1. Carnot conducts Board Test Method 100 for O2 using a Teledyne 326 analyzer with either a A5 or a B1 sensor, or a paramagnetic analyzer.

NOW, THEREFORE, BE IT ORDERED that Carnot is granted an approval, from the date of execution of this order, until June 30, 1994 to conduct the tests listed above, subject to compliance with Section 91200-91220, Title 17, California Code of Regulations.

BE IT FURTHER ORDERED that during the approved period the Executive Officer or his or her authorized representative may field audit one or more tests conducted pursuant to this order for each type of testing listed above.

Executed this 14th day of July 1993, at Sacramento, California.

James J. Morgester, Chief
Compliance Division

State of California

Air Resources Board

Approved Independent Contractor

Carnot

This is to certify that the company listed above has been approved by the Air Resources Board to conduct compliance testing pursuant to Section 91207, Title 17, California Code of Regulations, until June 30, 1994, for those test methods listed below:

ARB Source Test Methods:
1, 2, 3, 4, 5, 6, 8, 10, 100(NOx, O2)

James J. Morgester, Chief
Compliance Division

Laura McKinney, Manager
Investigation and Certification Section

90 56185

Appendix B.3

Equipment Calibration

CARNOT
SPAN GAS RECORD

CLIENT/LOCATION: SCE - El Segundo #4 DATE: 5-24-93

BY: McCue

GAS	SPAN CYLINDER		AUX. SPAN CYLINDER	
	CYLINDER NO.	CONCENTRATION	CYLINDER NO.	CONCENTRATION
ZERO		N_2		
NOx	ALM 7741	51.96	ALM 33901	93.49
O_2	ALM 27279	5.032	AAL 3966	8.013
CO	AAL 7957	55.07	ALM 12534	85.12
CO_2	ALM 27279	14.97	AAL 3966	22.74
SO_2				

CARNOT
INSTRUMENT LINEARITY

	ANALYZER				
	O_2	CO_2	CO	NOx	SO_2
ANALYZER RANGE	10%	25%	100 ppm	100 ppm	
SET TO HIGH STD (80-90% OF RANGE)	8.0	22.75	85.1	93.5	
ACTUAL VALUE OF LOW STD	5.032	14.97	55.07	51.96	
AS-FOUND LOW STD (50-60% OF RANGE)	5.1	15.1	53.4	50.7	
DIFFERENCE IN % OF FULL SCALE	+0.7%	+0.1%	-1.7%	-1.3%	

% ERROR CALCULATION:

$$\frac{\text{(AS FOUND - ACTUAL VALUE OF SPAN)}}{\text{RANGE}} \times 100$$

ALLOWABLE DEVIATION IS 2% OF FULL SCALE (2 SQUARES ON STRIP CHART).

CARNOT

CARNOT
SPAN GAS RECORD

CLIENT/LOCATION: SCE / El Segundo 4 DATE: 5-25-93

BY: M'Cune

GAS	SPAN CYLINDER		AUX. SPAN CYLINDER	
	CYLINDER NO.	CONCENTRATION	CYLINDER NO.	CONCENTRATION
ZERO		N_2		
NOx	ALM 7741	51.96	ALM 33901	93.49
O_2	ALM 27279	5.032	AAL 3966	8.013
CO	AAL 7957	55.07	ALM 12534	85.12
CO_2	ALM 27279	14.97	AAL 3966	22.74
SO_2				

CARNOT
INSTRUMENT LINEARITY

	ANALYZER				
	O_2	CO_2	CO	NOx	SO_2
ANALYZER RANGE	10%	25%	100 ppm	100 ppm	
SET TO HIGH STD (80-90% OF RANGE)	8.0	22.75	~~85.7~~ 85.7	93.5	
ACTUAL VALUE OF LOW STD	5.032	14.97	55.07	51.96	
AS-FOUND LOW STD (50-60% OF RANGE)	5.09	15.0	54.0	50.2	
DIFFERENCE IN % OF FULL SCALE	+0.6%	0.0%	-1.1%	-1.8%	

% ERROR CALCULATION:

$$\frac{\text{(AS FOUND - ACTUAL VALUE OF SPAN)}}{\text{RANGE}} \times 100$$

ALLOWABLE DEVIATION IS 2% OF FULL SCALE (2 SQUARES ON STRIP CHART).

CARNOT

CARNOT
CEM PERFORMANCE DATA

CLIENT/LOCATION: SCE - EL SEGUNDO UNIT 4 DATE: 5-24-93

BY: McCune

SYSTEM CONFIGURATION				
ANALYZERS IN SERVICE				
ANALYZERS:	O_2	CO_2	CO	- NOx
MODEL:	TELEDYNE	HORIBA PIR-2000	TECO 48	TECO 10AR
SERIAL NO.:	46124	912017	/	30333-237

PROBE	SAMPLE CONDITIONER
LENGTH: 10'	CONDENSER-VACUUM SIDE (CHECK FLOW): ✓
LINER MATERIAL: S.S.	CONDENSER-PRESSURE SIDE (CHECK FLOW): ✓
HEATED PROBE (Y/N): N	CONDENSER TEMPERATURE: 5°C
HEATED LINE (Y/N): Y	FILTER CONDITION (COND. OR DATE LAST CHANGED):
SAMPLE LINE	**SYSTEM LEAK CHECK**
LENGTH: 100'	PRE-TEST (cfh): 0.0 @ 24" Hg
LINER MATERIAL: TEFLON	POST-TEST (cfh): 0.0 @ 24" Hg
SYSTEM BIAS LINE: 100' / POLY FLOW	LEAK RATE (%) = POST-TEST (cfh) / SYSTEM FLOW RATE (cfm) x 60 x 100 = _____ %
ON-STACK CONDITIONER	**NOx CONVERSION EFFICIENCY**
IN SERVICE (Y/N): ✓	HIGH CAL NOx PERFORMED IN SHOP
KNOCK-OUT CONDITION (CHECK FLOW):	HIGH CAL NO (AS FOUND) /
COOLANT: ICE	LOW CAL NOx _____
	LOW CAL NO (AS FOUND) /

OPERATING CONDITIONS	
SAMPLE PRESSURE: 5 psi	SYSTEM RESPONSE TIME CHECK
SAMPLE VACUUM: 11 "Hg	UPSCALE: 45 sec.
NOx VACUUM: 29.9 "Hg	DOWNSCALE: 40 sec.

CARNOT

DEC
CA

Scott Specialty Gases, Inc.

FAX 714-887-0549
PHONE: 714-887-2571

2600 CAJON BLVD., SAN BERNARDINO, CA 92405

CARNOT
ATTN: RICK MADRIGAL
15991 RED HILL AVE
TUSTIN CA 92680

Shipped From: Scott SAN BERNARDINO, CA
Date Shipped 12/10/92
Our Project No: 22565 / 23160
Your P.O. No: 9113 ITEM # 8
Page 1 of 1
Expiration Date: 5/94

CERTIFICATE OF ANALYSIS -- EPA PROTOCOL GASES

Certified Per Traceability Protocol No. 1 Procedure No. G1 Cylinder No. ALM033901 Cylinder Pressure 2000 PSIG Certified Accuracy ±1% % NBS Traceable

COMPONENTS	CERTIFIED CONC	REFERENCE STD SRM/CRM NO.	REFERENCE STD CYL. NO.	REFERENCE STD CONC.	GAS ANALYZER MAKE/MODEL/SERIAL NO.	GAS ANALYZER LAST CAL. DATE	GAS ANALYZER ANALYTICAL PRINCIPLE
NITRIC OXIDE	91.97 PPM	GMIS TRACEABLE TO CRM1684B	ALM003667	95.60 PPM	THERMO-ELECTRON 10AR 14853-150	10/29/92	CHEMI-LUMINESCEN
NOX	93.49 PPM						

BALANCE GAS NITROGEN

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

Component NITRIC OXIDE
First Analysis Date 11/19/92 Units mv

Z 0.00	R 95.31	T 90.70
R 95.21	Z 0.00	T 90.98
Z 0.00	T 91.15	R 95.26

Mean Test Assay 92.13 PPM

Second Analysis Date 11/30/92 Units mv

Z 0.00	R 95.57	T 90.89
R 95.61	Z -0.02	T 90.95
Z 0.00	T 91.02	R 95.63

Mean Test Assay 91.81 PPM

Component _____
Date _____ Units mv

Z	R	T
R	Z	T
Z	T	R

Mean Test Assay _____

Date _____ Units mv

Z	R	T
R	Z	T
Z	T	R

Mean Test Assay _____

Component _____
Date _____ Units mv

Z	R	T
R	Z	T
Z	T	R

Mean Test Assay _____

Date _____ Units mv

Z	R	T
R	Z	T
Z	T	R

Mean Test Assay _____

Chronology: Date _____
Assay _____

Analyst G. KING

Approved By: A. Lange
A.F. LANGE, Ph.D. MANAGER, QA

Scott Specialty Gases, Inc.

2600 CAJON BOULEVARD, SAN BERNARDINO, CA 92411 (909) 887-2571 FAX: (909) 887-0549

CERTIFICATE OF ANALYSIS: EPA PROTOCOL GAS

Customer: Carnot
15991 Red Hill Ave.
Suite 110
Tustin, CA 92680-0740

Assay Laboratory
Scott Specialty Gases
2600 Cajon Boulevard
San Bernardino, CA 92411

Purchase Order 8957
Scott Project # 24740.001

ANALYTICAL INFORMATION

Certified to exceed the minimum specifications of EPA Protocol 1 Procedure #G1, Section Number 3.0.4

Cylinder Number	ALM 007741	Certification Date	03-22-93	Expiration Date	09-22-94
Cylinder Pressure	1900psig	Previous Certification Dates	NONE		

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
Nitric Oxide	50.80 ppm	± 1 % NIST Traceable
Balance Gas: Nitrogen		
NOX	51.96 ppm	

*Analytical uncertainty is inclusive of usual known error sources which at least includes reference standard error & precision of the measurement processes.

REFERENCE STANDARD

Type	Expiration Date	Cylinder Number	Concentration
CRM1683	01-94	ALM10462	47.53ppm Nitric Oxide

INSTRUMENTATION

Instrument/Model/Serial #	Last Date Calibrated	Analytical Principle
TECO / 10AR / 14853-150	01-20-93	Chemi-Luminescent

ANALYZER READINGS (Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

Components: Nitric Oxide

First Triad Analysis

Date: 3/15/93 Response Units: mv

Z1=	0.00	R1=	47.58	T1=	50.92
R2=	47.76	Z2=	0.04	T2=	50.93
Z3=	0.06	T3=	50.97	R3=	47.71

Avg. Conc. of Cust Cyl. 50.78 ppm

Date: Response Units: mv

Z1=		R1=		T1=	
R2=		Z2=		T2=	
Z3=		T3=		R3=	

Avg. Conc. of Cust Cyl.

Date: Response Units:

Z1=		R1=		T1=	
R2=		Z2=		T2=	
Z3=		T3=		R3=	

Avg. Conc. of Cust Cyl.

Second Triad Analysis

Date: 03-22-93 Response Units: mv

Z1=	0.00	R1=	47.53	T1=	50.85
R2=	47.55	Z2=	0.00	T2=	50.81
Z3=	0.00	T3=	50.83	R3=	47.53

Avg. Conc. of Cust Cyl. 50.82ppm

Date: Response Units: mv

Z1=		R1=		T1=	
R2=		Z2=		T2=	
Z3=		T3=		R3=	

Avg. Conc. of Cust Cyl.

Date: Response Units:

Z1=		R1=		T1=	
R2=		Z2=		T2=	
Z3=		T3=		R3=	

Avg. Conc. of Cust Cyl.

Calibration Curve

Concentration= Ax^2+Bx+C
A =-0.00022788
B =1.011308772
C =0.213935299

Concentration=

Concentration=

Special Notes

Analyst George King

Scott Specialty Gases, Inc.

2600 CAJON BOULEVARD, SAN BERNARDINO, CA 92411 (909) 887-2571 FAX: (909) 887-0549

CERTIFICATE OF ANALYSIS: EPA PROTOCOL GAS

Customer
CARNOT
15991 RED HILL AVE
SUITE 110
TUSTIN, CA 92680
ATTN: RICK MADRIGAL

Assay Laboratory
Scott Specialty Gases
2600 Cajon Boulevard
San Bernardino, CA 92411

Purchase Order 9764 REL#5
Project # 25145.001

ANALYTICAL INFORMATION

Certified to exceed the minimum specifications of EPA Protocol 1 Procedure #G1, Section Number 3.0.4

Cylinder Number	ALM012534	**Certification Date**	04-02-93	**Expiration Date**	* 10-02-94
Cylinder Pressure	2000 psig	**Previous Certification Dates**	NONE | ** 04-02-96 _		

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
CARBON MONOXIDE	85.12 ppm	± 1 % NIST Traceable

Balance Gas: Nitrogen

*Analytical uncertainty is inclusive of usual known error sources which at least includes reference standard error & precision of the measurement processes.

REFERENCE STANDARD

Type	Expiration Date	Cylinder Number	Concentration
CRM1679	10-94	ALM10524	96.67 ppm

INSTRUMENTATION

Instrument/Model/Serial #	Last Date Calibrated	Analytical Principle
Horiba / OPE-135D / 56565502	02-10-92	NDIR

ANALYZER READINGS (Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

Components: Carbon Monoxide

First Triad Analysis

Date: 03-26-92 Response Units: mv

Z1=	00.00	R1=	40.20	T1=	35.50
R2=	40.20	Z2=	00.01	T2=	35.50
Z3=	00.01	T3=	35.50	R3=	40.20

Avg. Conc. of Cust Cyl. 84.99 ppm

Second Triad Analysis

Date: 04-02-92 Response Units: mv

Z1=	00.00	R1=	40.20	T1=	35.60
R2=	40.20	Z2=	00.09	T2=	35.60
Z3=	00.07	T3=	35.60	R3=	40.20

Avg. Conc. of Cust Cyl. 85.24 ppm

Calibration Curve

Concentration= Ax^2+Bx+C
A =0.00005011
B =0.50595305
C =-0.0100275

Date:	Response Units: mv				
Z1=		R1=		T1=	
R2=		Z2=		T2=	
Z3=		T3=		R3=	

Avg. Conc. of Cust Cyl.

Date:	Response Units: mv				
Z1=		R1=		T1=	
R2=		Z2=		T2=	
Z3=		T3=		R3=	

Avg. Conc. of Cust Cyl.

Concentration=

Date:	Response Units:				
Z1=		R1=		T1=	
R2=		Z2=		T2=	
Z3=		T3=		R3=	

Avg. Conc. of Cust Cyl.

Date:	Response Units:				
Z1=		R1=		T1=	
R2=		Z2=		T2=	
Z3=		T3=		R3=	

Avg. Conc. of Cust Cyl.

Concentration=

Special Notes : * Acid Rain Certification Period
** Non-Acid Rain Certification Period

Analyst Maynard Johnson

Scott Specialty Gases, Inc.

2600 CAJON BLVD., SAN BERNARDINO, CA 92411
FAX [illegible]887-0549
PHONE: 714-887-2571

Shipped From: Scott SAN BERNARDINO, CA
Date Shipped 10/15/92
Our Project No: 21912
Your P.O. No: 8957
Page 1 of 1
Expiration Date: 4/94

CARNOT
ATTN: RICK MADRICAL
15991 RED HILL AVE
SUITE 110
TUSTIN CA 92680

CERTIFICATE OF ANALYSIS - EPA PROTOCOL GASES

Certified Per Traceability Protocol No. 1 Procedure No. G1 Cylinder No. AAL7957 Cylinder Pressure 1900 PSIG Certified Accuracy ±1% % NIST Traceable

COMPONENTS	CERTIFIED CONC	REFERENCE STD SRM/CRM NO.	REFERENCE STD CYL. NO.	REFERENCE STD CONC.	GAS ANALYZER MAKE/MODEL/SERIAL NO.	GAS ANALYZER LAST CAL. DATE	GAS ANALYZER ANALYTICAL PRINCIPLE
CARBON MONOXIDE	55.07 PPM	CRM1679	ALM016524	86.62 PPM	HORIBA AIA-24 4564403	6/30/92	INFRA-RED

BALANCE GAS NITROGEN

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

Component CARBON MONOXIDE
First Analysis Date 10/7/92 Units mv

Z 00.00	R 39.4	T 22.9			
R 39.4	Z 00.01	T 22.9			
Z 00.02	T 22.9	R 39.4			

Mean Test Assay 55.07 PPM

Second Analysis Date 10/14/92 Units mv

Z 00.00	R 39.4	T 22.9			
R 39.4	Z 00.01	T 22.9			
Z -00.03	T 22.9	R 39.4			

Mean Test Assay 55.07 PPM

Component _____
Date _____ Units mv

Z	R	T			
R	Z	T			
Z	T	R			

Mean Test Assay _____

Date _____ Units mv

Z	R	T			
R	Z	T			
Z	T	R			

Mean Test Assay _____

Component _____
Date _____ Units mv

Z	R	T			
R	Z	T			
Z	T	R			

Mean Test Assay _____

Date _____ Units mv

Z	R	T			
R	Z	T			
Z	T	R			

Mean Test Assay _____

Chronology: Date _____
Assay _____

Analyst M. JOHNSON

Approved By: _____
A.F. LANGE, Ph.D., MANAGER, QA

Scott Specialty Gases, Inc.

Shipped From: 2600 CAJON BLVD.
SAN BERNARDINO CA 92411
Phone: 714-887-2571 Fax: 714-887-0549

CERTIFICATE OF ANALYSIS

CARNOT
ATTN: RICK MADRIGAL
15991 RED HILL AVE
SUITE 110
TUSTIN CA 92680

PROJECT #: 02-22304
PO#: 8957
ITEM #: 0202C3013601AL
DATE:10/29/92

CYLINDER #: AAL3966
FILL PRESSURE: 1950 PSIG

ANALYTICAL ACCURACY: +/-1%

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
CARBON DIOXIDE	22.5	PCT	22.74	PCT
OXYGEN	8.	PCT	8.013	PCT
NITROGEN		BAL		BAL

CERTIFY

CARNOT 11/5 BIN#1
CERTIFIED TO HAVE BEEN BLENDED AND VERIFIED TO BE CORRECT BY ANALYSIS.

GRAVIMETRIC MASTER GAS - AGAINST NIST CERTIFIED WEIGHTS INDEPENDENT LABORATORY

ANALYST: JDLT
JOSEPH DE LA TORRE

APPROVED BY: Armand Lange
DR. ARMAND LANGE, PH.D

9113

Scott Specialty Gases, Inc.

Shipped From: 2600 CAJON BLVD.
SAN BERNARDINO CA 92411
Phone: 714-887-2571 Fax: 714-887-0549

CERTIFICATE OF ANALYSIS

CARNOT
ATTN: RICK MADRIGAL
15991 RED HILL AVE
SUITE 110
TUSTIN CA 92680

PROJECT #: 02-21678
PO#: 8880 ITEM # 1
ITEM #: 020203000700AL
DATE: 9/24/92

CYLINDER #: ALM027279
FILL PRESSURE: 2000 PSIG

ANALYTICAL ACCURACY: +/-1%

COMPONENT	REQUESTED GAS CONC	MOLES	ANALYSIS (MOLES)	
CARBON DIOXIDE	15.	PCT	14.97	PCT
OXYGEN	5.	PCT	5.032	PCT
NITROGEN		BAL		BAL

CERTIFIED

CARNOT 9/28 BIN#9
CERTIFIED TO HAVE BEEN BLENDED AND VERIFIED TO BE CORRECT BY ANALYSIS.

GRAVIMETRIC MASTER GAS - AGAINST NIST CERTIFIED WEIGHTS INDEPENDENT LABORATORY

ANALYST: J. De La Torre
JOSEPH DE LA TORRE

APPROVED BY: C. Lange
DR ARMAND LANGE PH D

POST TEST DRY GAS METER CALIBRATION CHECK

CALIBRATED BY WM
DATE 5/27/93
FIELD GAS METER I.D. ES-31
INITIAL Yd 1.006
INITIAL H@ 2.110

DATA ENTRY BY WM
BAROMETRIC PRESSURE 29.897
TEST METETER ES-13
TEST METER Y (Yt) 0.9980
TEST METER LAST CAL. 4/05/93

FIELD METER				TEST METER				RESULTS	
VOLUME cu.ft.	TEMP. IN	TEMP. OUT	DELTA "H2O	TIME min.	VOLUME cu.ft.	TEMP. Avg.	DELTA "H2O	Q cfm	Y
5.185	80.0	75.0	1.00	10	5.268	73.5	1.5	0.519	1.025
5.237	82.0	75.0	1.00	10	5.268	71.5	1.5	0.524	1.020
5.257	82.0	75.0	1.00	10	5.256	71.5	1.5	0.526	1.014
						AVERAGES		0.523	1.020

PASS - INDIVIDUAL Yd VALUES ACCEPTABLE
PASS - INDIVIDUAL DELTA H@ VALUES ACCEPTABLE
PASS - POST TEST Yd WITHIN LIMITS

ES-31
YD = 1.0064
ΔH@ = 2.11
ΔH@1.00 = 0.510

POST-TEST DRY GAS METER CALIBRATION DATA

CALIBRATED BY WM
DATE 5-22-93
FIELD METER ID ES-31
BAROMETRIC PRESS 29.89

TEST METER ID ES-13
TEST METER Y (Y_i) .9980
TEST METER LAST CAL 4/5/93

TEST PROGRAM PRECEDING CALIBRATION CHECK EC SECONDARY/SCE
AVERAGE ΔH FROM TEST RUNS 2.4
MAXIMUM VACUUM FROM TEST RUNS 15"
LEAK CHECK VAC 15" INIT. WM

FIELD METER								TEST METER					
				TEMPERATURE							TEMPERATURE		
ΔH	FINAL VOLUME	INITIAL VOLUME	VOLUME (V_w)	INLET (t_i)	OUTLET (t_o)	VACUUM	TIME (θ)	FINAL VOLUME	INITIAL VOLUME	VOLUME (V_w)	INLET	OUTLET	METER PRESS.
1.0	113.253	108.068	5.185	80	75	5"	1:44 / 1:54	5.268	0000	5.268	72	75	1.50
1.0	118.490	113.253	5.237	82	75	5"	1:55:25 / 2:05:05	5.268	0000	5.268	70	73	1.50
1.0	123.747	118.490	~~5.257~~ 5.257	82	75	5"	2:06:10 / 2:16:10	5.256	0000	5.256	70	73	1.50

CARNOT

APPENDIX C
DATA SHEETS

Appendix C.1

Sample Locations

CARNOT

SAMPLING POINT LOCATION DATA - EPA METHOD 1

PLANT: SCE / El Segundo / UNIT 4 DATA BY: KE/MR

DATE: 11/20/92 - 11/22/92

TEST LOCATION: STACK

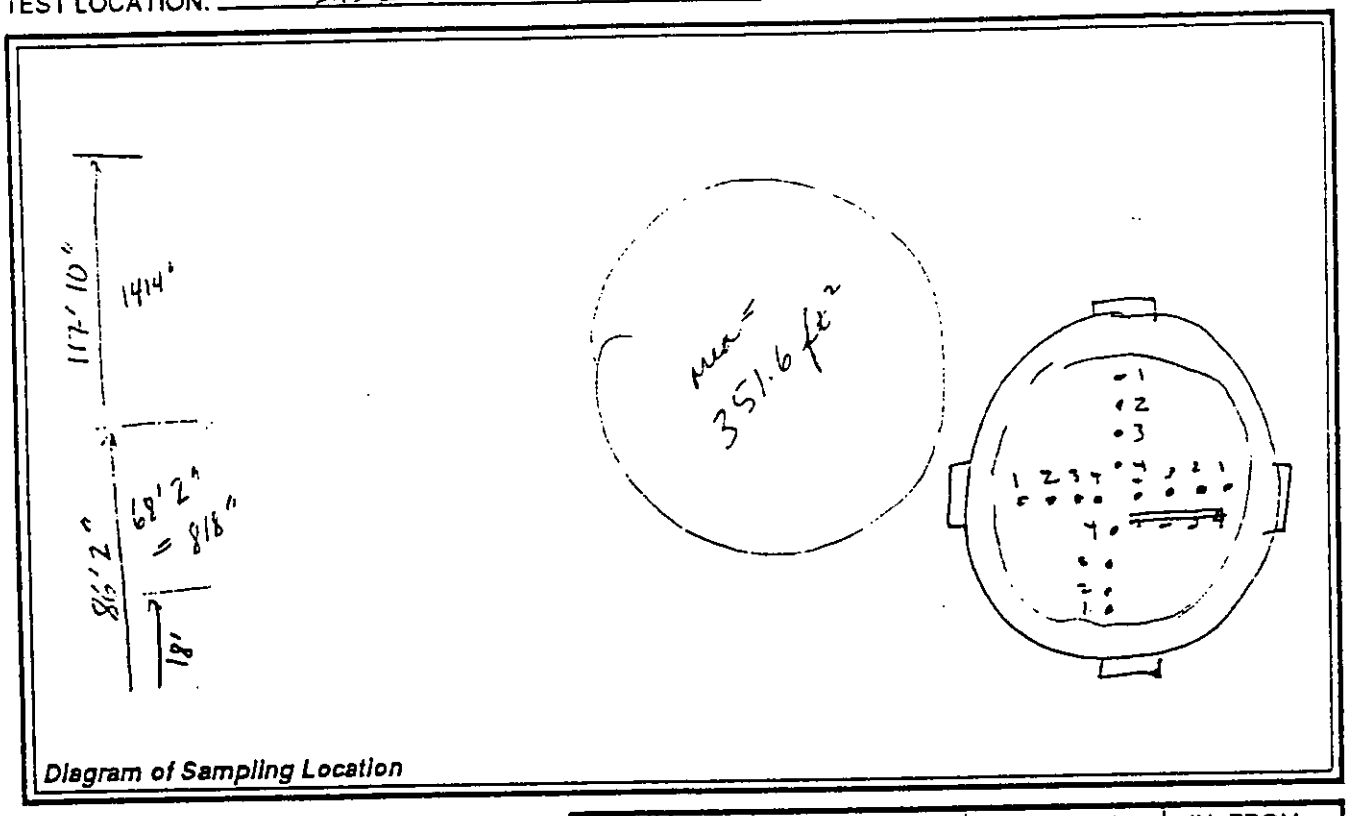


Diagram of Sampling Location

UPSTREAM DIST./DIA.: 1414 / 5.57

DOWNSTREAM DIST./DIA.: 818 / 3.22

COUPLING LENGTH: 10"

NO. OF SAMPLING PTS.: 16 (4/diameter)

STACK DIMENSION: 253.9" diameter 21' 2"

STACK AREA, FT²: ~~351.6~~ ft² 351.6 ✓

SAMPLE POINT	% OF DIAMETER	IN. FROM NEAR WALL	IN. FROM NOZZLE*
1	3.2	8.125	26.125
2	10.5	26.660	44.660
3	19.4	49.257	67.257
4	32.3	82.010	100.01

*INCHES FROM WALL PLUS COUPLING LENGTH

Appendix C.2

Unit Data

CARNOT

UNIT DATA

Client: SCE Location: EL SEGUNDO

Unit: EL SEG. #4 Data by: M. ESCARCEGA

TEST #	4-2	4-3	4-4	4-5
DATE	5/24/93	5/24/93	5/24/93	5/24/93
TIME	1115	1200	1345	1435
LOAD MW	151	150	150	150
AUX. LOAD	5.6	5.8	5.7	5.4
UREA ON/OFF	OFF	OFF	ON	ON
UREA LOOP / MODE	—	—	3/3	3/3
UREA FLOW GPM	—	—	0.70	.68
H_2O FLOW / PRESS. GPM	—	—	4.6/64.9	4.4/64.0
O_2% NORTH	2.0	2.2	2.2	2.2
O_2% SOUTH	2.2	2.2	2.3	2.3
STM. PRES PSI	2201	2200	2200	2200
STM FLOW KLB/HR	942	945	939	938
FDWTR FLOW KLB/HR	1064	1063	1050	1050
FUEL FLOW 10^6 SCF	1425	1421	1415	1432
FUEL FLOW %	40.8	41.0	40.6	40.2
AIR FLOW %	41.0	40.9	41.0	40.3
SH STM TEMP °F	1049	1050	1049	1050
RH STM TEMP °F	998	1000	998	1001
FD FAN % NORTH	—	—	—	—
FD FAN % SOUTH	—	—	—	—
FD FAN AMPS NORTH	135	134	134	137
FD FAN AMPS SOUTH	119	119	118	119

CARNOT

	4-1	4-2	4-3	
O2/CO BIAS SET POINT	0	0	0	0
BLR MASTER	42.08	41.49	41.17	41.34
FGR AMPS NORTH	55	55	55	55
FGR AMPS SOUTH	54	54	54	54
FGR OUTLET DAMPER NORTH	—	—	—	—
FGR OUTLET DAMPER SOUTH	—	—	—	—
FGR INLET DAMPER NORTH	—	—	—	—
FGR INLET DAMPER SOUTH	—	—	—	—
BNR TILTS NORTH 1-4	-19/-32/-19/-22	-19/-/-20/-22	-19/-/-20/-22	-16/-30/-17/-19°
BNR TILTS SOUTH 1-4	-24/-26/-25/-26	-25/-27/-25/-26	-23/-26/-24/-24	-18°/-19°/-18°/-18°
WP/FURN dP N/S	3.9/4.3	4.0/4.3	4.2/4.3	4.1/4.3
BOOS	NONE	NONE	NONE	NONE
APH OUT °F NORTH	216	216	218	219
APH OUT °F SOUTH	186	186	187	187

NOTES:

CARNOT

UNIT DATA

Client: SCE Location: EL SEGUNDO

Unit: EL SEG. #4 Data by: M. ESCARCEGA

TEST #	4-6	4-7	4-8	4-9
DATE	5/25/93	5/25/93	5/25/93	5/25/93
TIME	1217	1115	1210	1250
LOAD MW	245	242	246	246
AUX. LOAD	5.0	5.0	5.0	5.1
UREA ON/OFF	ON	ON	OFF	OFF
UREA LOOP / MODE	1 / 2	1 / 2	—	—
UREA FLOW GPM	1.34	1.34	0	0
H_2O FLOW / PRES. GPM / PSI	6.02 / 55.0	5.94 / 55.0	—	—
O_2 % NORTH	1.7	1.8	1.7	1.7
O_2 % SOUTH	1.6	1.6	1.6	1.6
STM. PRES PSI	2249	2350	2247	2350
STM FLOW KLB/HR	1520	1515	1527	1517
FDWTR FLOW KLB/HR	1685	1680	1690	1695
FUEL FLOW 10^6 SCF	1270	1225	1235	1215
FUEL FLOW %	63.9	63.5	64.1	64.8
AIR FLOW %	64.8	65.1	63.7	64.7
SH STM TEMP °F	1050	1049	1050	1050
RH STM TEMP °F	1000	1000	1000	999
FD FAN % NORTH	—	—	—	—
FD FAN % SOUTH	—	—	—	—
FD FAN AMPS NORTH	169	171	173	174
FD FAN AMPS SOUTH	168	167	168	169

CARNOT

	4-1	4-2	4-3	4-4
O2/CO BIAS SET POINT	0	0	0	0
BLR MASTER	65.0	63.9	64.6	64.37
FGR AMPS NORTH	52	52	52	52
FGR AMPS SOUTH	51	51	51	51
FGR OUTLET DAMPER NORTH	—	—	—	—
FGR OUTLET DAMPER SOUTH	—	—	—	—
FGR INLET DAMPER NORTH	—	—	—	—
FGR INLET DAMPER SOUTH	—	—	—	—
BNR TILTS NORTH	-6/-19/-7/-9	-6/-19/-7/-9	-5/-19/-6/-9	-6/-21/-7/-10
BNR TILTS SOUTH	-10/-11/-9/-10	-8/-9/-9/-9	-8/-10/-8/-10	-9/-10/-9/-10
WP/FURN dP N/S	5.9/5.7	5.7/5.6	5.0/5.6	5.0/5.6
BOOS	NONE	NONE	NONE	NONE
APH OUT °F NORTH	242	241	240	241
APH OUT °F SOUTH	210	210	209	209

NOTES:

CARNOT

UNIT DATA

Client: SCE Location: EL SEGUNDO

Unit: EL SEG #4 Data by: L Milleson

TEST #	4-10	4-11	4-12	4-13
DATE	8-12-93	8-12-93	8-12-93	8-12-93
TIME	10:45	11:30	12:20	13:00
LOAD MW	331	330	330	332
AUX. LOAD	8.7	8.7	8.7	8.7
UREA ON/OFF	ON	ON	OFF	OFF
UREA LOOP / Mode	1/1	1/1	—	—
UREA FLOW GPM	2.24	2.24	0	0
H_2O FLOW GPM	4.38	4.42	—	—
O_2% NORTH	1.7	1.6	1.7	1.7
O_2% SOUTH	2.1	1.9	1.9	2.0
STM. PRES PSI	2400	2398	2400	2400
STM FLOW KLB/HR	2259	2258	2258	2258
FDWTR FLOW KLB/HR	2446	2442	2436	2482
FUEL FLOW 10^6 SCF	3124	3150	3150	3152
FUEL FLOW %	87.2	87.2	87.1	88.1
AIR FLOW %	91	91	91	91
SH STM TEMP °F	1050	1050	1050	1050
RH STM TEMP °F	1002	1003	1003	1003
FD FAN % NORTH	—	—	—	—
FD FAN % SOUTH	—	—	—	—
FD FAN AMPS NORTH	271	279	264	265
FD FAN AMPS SOUTH	270	277	269	262

SCREENS B & H

CARNOT

	4-10	4-11	4-12	4-13
O2/CO BIAS SET POINT	0	0	0	0
BLR MASTER	86.25	86.98	98.23	88.66
FGR AMPS NORTH	59	58	59	61
FGR AMPS SOUTH	55	54	56	56
FGR OUTLET DAMPER NORTH	—	—	—	—
FGR OUTLET DAMPER SOUTH	—	—	—	—
FGR INLET DAMPER NORTH	—	—	—	—
FGR INLET DAMPER SOUTH	—	—	—	—
BNR TILTS NORTH	10/3/11/9	10/3/11/8	10/3/11/9	10/3/11/8
BNR TILTS SOUTH	5/6/11/4	4/11/11/9	5/6/12/5	6/8/11/6
WP/FURN dP	7.7	7.8	7.6	7.6
BOOS	2N 4S	2N 4S	2N 4S	2N 4S
APH OUT °F NORTH	270	270	268	268
APH OUT °F SOUTH	231	232	230	230

NOTES:

Appendix C.3

CEM Data

CARNOT

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: SCE / EL SEGUNDO #4 CONDITION: ~150 MW

DATE: 5-24-93 OPERATOR: McCUNE

TEST NUMBER: 4-1-CEM TEST LOCATION: STACK

TEST NO.	TIME	SAMPLE POINT/ CONDITION	DRY, UNCORRECTED							CORRECTED TO ___% ___, DRY		
			O_2	CO_2	CO	NOx	NO	NO_2	SO_2	CO	NOx	SO_2
SPAN GAS CONCENTRATION			5.07	14.97	55.07	51.96						
		AS FOUND ANAL. SPAN	5.03	15.0	55.0	52.0						
		SYSTEM ZERO	0.0	0.0	0.0	0.9						
		SYSTEM SPAN	5.08	14.91	55.0	49.8						
	BEGIN 1003 / END 1008	S-4	6.0	8.5	0	40.3						
	BEGIN 1002 / END 1004	S-3	6.0	8.5	0	40.3						
	BEGIN 1004 / END 1006	S-2	6.0	8.5	0	40.5						
	BEGIN 1006 / END 1008	S-1 *	7.2	7.9	0	38.0						
	BEGIN 1012 / END 1014	W-4	5.9	8.6	0	41.1						
	BEGIN 1014 / END 1018	W-3	6.0	8.6	0	41.0						
	BEGIN 1018 / END 1020	W-2	5.9	8.6	0	41.0						
	BEGIN 1020 / END 1022	W-1	5.9	8.6	0	41.0						
	BEGIN 1026 / ~~END~~ 1028	N-4 N-3	6.0 6.0	8.6 8.6	0 0	41.3 41.5						
	BEGIN 1030 / ~~END~~ 1032	N-2 N-1	6.0 6.0	8.6 8.6	0 0	41.5 41.5						
	BEGIN 1039 / ~~END~~ 1041	E-4 E-3	6.0 6.0	8.6 8.6	0 10	41.0 41.0						
	BEGIN 1043 / ~~END~~ 1045	E-2 E-1	6.0 6.0	8.6 8.6	0 20	41.0 41.0						
		SYSTEM ZERO	0.0	0.8	0.0	1.4						
		SYSTEM SPAN	5.08	14.8	55.0	50.0						
RAW AVERAGE			5.98	8.58	0.2	41.0						
CORRECTED AVERAGE			5.92	8.49	0.2	42.5						
COMMENTS:												

CARNOT

PMF-039

* AIR IN-LEAKAGE NEAR PORT - DIFFICULT POINT

CARNOT

PAGE 1 OF ___

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: SCE / EL SEGUNDO 4 2 CONDITION: ~150 MW

DATE: 5-24-93 OPERATOR: MCCUNE

TEST NUMBER: 4-2-CEM TEST LOCATION: STACK

TEST NO.	TIME	SAMPLE POINT/ CONDITION	DRY, UNCORRECTED							CORRECTED TO ___% ___, DRY		
			O_2	CO_2	CO	NOx	NO	NO_2	SO_2	CO	NOx	SO_2
SPAN GAS CONCENTRATION			5.032	14.97	55.07	51.90						
		AS FOUND ANAL. SPAN										
		SYSTEM ZERO	0.0	0.0	0.0	0.0						
		SYSTEM SPAN	5.03	14.8	55.0	50.0						
	BEGIN 1115 / END 1120	5-4	6.1	8.5	0	42.5						
	BEGIN 1120 / END 1125		6.1	8.5	0	42.5						
	BEGIN 1125 / END 1130		6.1	8.5	0	42.5						
	BEGIN 1130 / END 1135		6.1	8.5	0	42.5						
	BEGIN 1135 / END 1140		6.1	8.5	0	42.3						
	BEGIN 1140 / END 1145		6.1	8.5	0	42.1						
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
		SYSTEM ZERO	0.0	0.0	0.0	0.0						
		SYSTEM SPAN	5.13	14.9	54.9	50.0						
RAW AVERAGE			6.1	8.5	0	42.4						
CORRECTED AVERAGE			6.0	8.6	0	44.1						
COMMENTS:												

CARNOT

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: SCE/ EL SEGUNDO 4 & 3 CONDITION: ~150 MW

DATE: 5-24-93 OPERATOR: McCUNE

TEST NUMBER: 4-3-CEM TEST LOCATION: STACK

TEST NO.	TIME	SAMPLE POINT/ CONDITION	DRY, UNCORRECTED							CORRECTED TO ___% ___, DRY		
			O_2	CO_2	CO	NOx	NO	NO_2	SO_2	CO	NOx	SO_2
SPAN GAS CONCENTRATION			5.032	14.97	55.07	51.96						
		AS FOUND ANAL. SPAN										
		SYSTEM ZERO	0.0	0.0	0.0	0.0						
		SYSTEM SPAN	5.03	14.8	55.0	50.0						
	BEGIN 1200 / END 1205	S-4	6.1	8.5	0	42.2						
	BEGIN 1205 / END 1210		6.1	8.5	0	42.2						
	BEGIN 1210 / END 1215		6.1	8.5	0	42.0						
	BEGIN 1215 / END 1220		6.1	8.5	0	41.7						
	BEGIN 1220 / END 1225		6.1	8.5	0	41.9						
	BEGIN 1225 / END 1230		6.1	8.5	0	42.1						
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
		SYSTEM ZERO	0.0	0.0	0.0	-0.1						
		SYSTEM SPAN	5.18	14.8	54.5	50.0						
RAW AVERAGE			6.1	8.5	0.0	42.0						
CORRECTED AVERAGE			6.0	8.6	0.0	43.7						
COMMENTS:												

CARNOT

PAGE 1 OF ___

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: SCE / EL SEGUNDO 4 CONDITION: ~150 MW w/ UREA

DATE: 5-24-93 OPERATOR: McCune

TEST NUMBER: 4-4 - CEM TEST LOCATION: STACK

TEST NO.	TIME	SAMPLE POINT/ CONDITION	DRY, UNCORRECTED							CORRECTED TO ___% ___, DRY		
			O_2	CO_2	CO	NOx	NO	NO_2	SO_2	CO	NOx	SO_2
SPAN GAS CONCENTRATION			5.027	14.97	55.07	51.96						
		AS FOUND ANAL. SPAN										
		SYSTEM ZERO	0.0	0.0	0.0	-0.1						
		SYSTEM SPAN	5.18	14.8	54.5	50.0						
	BEGIN 1345	5-4	6.2	8.5	0	36.8						
	END 1350											
	BEGIN 1350		6.2	8.5	0	37.1						
	END 1355											
	BEGIN 1355		6.2	8.5	0	37.1						
	END 1400											
	BEGIN 1400		6.1	8.5	0	37.0						
	END 1405											
	BEGIN 1405		6.1	8.5	0	37.0						
	END 1410											
	BEGIN 1410	▽	6.1	8.5	0	37.0						
	END 1415											
	BEGIN ___											
	END ___											
	BEGIN ___											
	END ___											
	BEGIN ___											
	END ___											
	BEGIN ___											
	END ___											
	BEGIN ___											
	END ___											
	BEGIN ___											
	END ___											
		SYSTEM ZERO	0.0	0.0	0.0	-0.5						
		SYSTEM SPAN	5.12	14.8	55.0	49.8						
RAW AVERAGE			6.15	8.5	0	37.0						
CORRECTED AVERAGE			6.0	8.6	0	38.6						
COMMENTS:												

CARNOT

PAGE ___ OF ___

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: SCE / EL SEGUNDO 4 CONDITION: ~150 MW

DATE: 5-24-93 OPERATOR: _____

TEST NUMBER: 4-5-CEM TEST LOCATION: _____

TEST NO.	TIME	SAMPLE POINT/ CONDITION	DRY, UNCORRECTED							CORRECTED TO ___% ___, DRY		
			O_2	CO_2	CO	NOx	NO	NO_2	SO_2	CO	NOx	SO_2
SPAN GAS CONCENTRATION			5.032	14.97	55.07	51.96						
		AS FOUND ANAL. SPAN										
		SYSTEM ZERO	0.0	0.0	0.0	-0.5						
		SYSTEM SPAN	5.12	14.8	55.0	49.8						
	BEGIN 1435 / END 1440	5-4	6.15	8.5	0	37.9						
	BEGIN 1440 / END 1445		6.15	8.5	0	38.0						
	BEGIN 1445 / END 1450		6.15	8.5	0	38.5						
	BEGIN 1450 / END 1455		6.15	8.5	0	38.5						
	BEGIN 1455 / END 1500		6.15	8.5	0	38.2						
	BEGIN 1500 / END 1505	↓	6.15	8.5	0	38.2						
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
		SYSTEM ZERO	0.0	0.0	0.0	-0.5						
		SYSTEM SPAN	5.12	14.8	55.0	49.8						
RAW AVERAGE			6.15	8.5	0	38.2						
CORRECTED AVERAGE			6.0	8.6	0	40.0						
COMMENTS:												

CARNOT

PMF-039

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: SCE / EL SEGUNDO 4 CONDITION: ~240 MW w/ UREA

DATE: 5-25-93 OPERATOR: McCune

TEST NUMBER: 4-6-CEM TEST LOCATION: STACK

TEST NO.	TIME	SAMPLE POINT/ CONDITION	DRY, UNCORRECTED							CORRECTED TO ___% ___, DRY		
			O_2	CO_2	CO	NOx	NO	NO_2	SO_2	CO	NOx	SO_2
SPAN GAS CONCENTRATION			5.032	14.97	55.07	51.96						
		AS FOUND ANAL. SPAN	5.03	15.0	55.0	52.0						
		SYSTEM ZERO	0.0	0.0	0.2	0.2						
		SYSTEM SPAN	5.12	14.9	55.1	50.4				-		
	BEGIN 10:15 END 10:17	S-4	5.0	9.1	14	53.5						
	BEGIN 10:17 END 10:19	S-3	5.0	9.1	14	53.5						
	BEGIN 10:19 END 10:21	S-2	5.0	9.1	19	53.0						
	BEGIN 10:21 END 10:23	S-1	5.0	9.1	17	52.5						
	BEGIN 1025 END 1027	E-4	5.05	9.1	17	53.8						
	BEGIN 1027 END 1029	E-3	5.0	9.1	18	53.8						
	BEGIN 1029 END 1031	E-2	5.0	9.1	17	52.8						
	BEGIN 1031 END 1033	E-1	5.05	9.1	14	53.3						
	BEGIN 1035 END 1037	N-4 N-3	4.95 5.0	9.1 9.1	18 20	53.1 53.2						
	BEGIN 1039 END 1041	N-2 N-1	5.0 5.0	9.1 9.1	22 18	53.0 54.0						
	BEGIN 1045 END 1047	W-4 W-3	4.95 5.0	9.1 9.1	18 17	53.0 53.9						
	BEGIN 1049 END 1051	W-2 W-1	4.95 4.95	9.1 9.1	18 22	54.5 #28						
		SYSTEM ZERO	0.0	0.0	0.2	0.0						
		SYSTEM SPAN	5.1	14.8	55.2	49.5						
RAW AVERAGE			5.0	9.1	17.7	53.4						
CORRECTED AVERAGE			4.9	9.2	17.5	55.4						
COMMENTS:												

CARNOT

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: SCE/ EL SEGUNDO 4 CONDITION: 240 MW W/ OFA

DATE: 5-25-93 OPERATOR: MCCUNE

TEST NUMBER: 4-7-EEM TEST LOCATION: STACK

TEST NO.	TIME	SAMPLE POINT/ CONDITION	DRY, UNCORRECTED							CORRECTED TO ___% ___, DRY		
			O_2	CO_2	CO	NOx	NO	NO_2	SO_2	CO	NOx	SO_2
SPAN GAS CONCENTRATION			5.032	14.97	55.07	51.96						
		AS FOUND ANAL. SPAN										
		SYSTEM ZERO	0.0	0.0	0.2	0.0						
		SYSTEM SPAN	5.1	14.8	55.2	49.5						
	BEGIN 1115 / END 1120	W-4	4.95	9.1	24	52.5						
	BEGIN 1120 / END 1125		4.95	9.1	23	52.0						
	BEGIN 1125 / END 1130		4.95	9.1	19	52.5						
	BEGIN 1130 / END 1135		5.0	9.1	17	52.2						
	BEGIN 1135 / END 1140		5.0	9.1	17	52.5						
	BEGIN 1140 / END 1145	↓	4.95	9.1	18	53.0						
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
		SYSTEM ZERO	0.0	0.0	0.2	0.0						
		SYSTEM SPAN	5.1	14.8	55.0	49.4						
RAW AVERAGE			4.97	9.1	19.7	52.5						
CORRECTED AVERAGE			4.98	9.2	19.5	55.1						
COMMENTS:												

CARNOT

PMF-C39

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: SCE/ EL SEGUNDO CONDITION: 240 MW

DATE: 5-25-93 OPERATOR: McCune

TEST NUMBER: 4-B-CEM TEST LOCATION: STACK

TEST NO.	TIME	SAMPLE POINT/ CONDITION	DRY, UNCORRECTED							CORRECTED TO ___% ___, DRY		
			O_2	CO_2	CO	NOx	NO	NO_2	SO_2	CO	NOx	SO_2
SPAN GAS CONCENTRATION			5.032	14.97	55.07	519½						
		AS FOUND ANAL. SPAN										
		SYSTEM ZERO	0.0	0.0	0.2	0.0						
		SYSTEM SPAN	5.1	14.9	55.0	49.4						
	BEGIN 1210 END 1215	W-4	4.9	9.1	22	63.5						
	BEGIN 1215 END 1220		4.9	9.1	21	63.5						
	BEGIN 1220 END 1225		4.95	9.1	19	63.8						
	BEGIN 1225 END 1230		4.9	9.1	22	63.5						
	BEGIN 1230 END 1235		4.9	9.1	22	64.0						
	BEGIN 1235 END 1240		4.9	9.1	22	63.7						
	BEGIN ___ END											
	BEGIN ___ END											
	BEGIN ___ END											
	BEGIN ___ END											
	BEGIN ___ END											
	BEGIN ___ END											
		SYSTEM ZERO	0.0	0.0	0.2	0.0						
		SYSTEM SPAN	5.1	14.8	55.3	49.8						
RAW AVERAGE			4.9	9.1	21.3	63.6						
CORRECTED AVERAGE			4.8	9.2	21.1	66.6						
COMMENTS:												

CARNOT

PMF-039

CARNOT

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: SCE / EL SEGUNDO 4 CONDITION: 250 MW

DATE: 5-25-93 OPERATOR: McCune

TEST NUMBER: 4-9-CEM TEST LOCATION: STACK

TEST NO.	TIME	SAMPLE POINT/ CONDITION	DRY, UNCORRECTED							CORRECTED TO ___% ___. DRY		
			O_2	CO_2	CO	NOx	NO	NO_2	SO_2	CO	NOx	SO_2
SPAN GAS CONCENTRATION			5.032	14.97	5507	51.96						
		AS FOUND ANAL. SPAN										
		SYSTEM ZERO	0.0	0.0	0.2	0.0						
		SYSTEM SPAN	5.1	14.8	55.3	49.8						
	BEGIN 1250 / END 1255	W-4	4.9	9.2	23	64.2						
	BEGIN 1255 / END 1300		4.9	9.2	26	64.0						
	BEGIN 1300 / END 1305		4.9	9.2	26	64.5						
	BEGIN 1305 / END 1310		4.9	9.2	25	64.0						
	BEGIN 1310 / END 1315		4.9	9.2	23	65.0						
	BEGIN 1315 / END 1320		4.9	9.2	32	65.0						
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
	BEGIN ___ / END ___											
		SYSTEM ZERO	0.0	0.0	0.2	0.0						
		SYSTEM SPAN	5.1	14.8	55.1	49.8						
RAW AVERAGE			4.9	9.2	25.3	64.5						
CORRECTED AVERAGE			4.9	9.3	25.6	67.3						
COMMENTS:												

8/13/93

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Reference Method Gaseous Measurements

Client:	SCE EL SEGUNDO			Condition:	Urea On	
Unit:	#4			Load:	320 MW	
Location:	STACK					
		O2%	CO2%	CO ppm	NOx ppm	
Analyzer Range:		10.00		100.0	100.0	
Span Value:		4.97		55.6	50.0	
Test #:	4-10-CEM		Time:	1045/1115		Date: 8/10/93
		O2%	CO2%	CO ppm	NOx ppm	
System Zero		0.10		0.0	-0.2	
System Span		5.20		55.0	48.5	
Start	Stop					
1045	1050	5.45		4.5	63.0	
1050	1055	5.35		5.0	64.2	
1055	1100	5.35		5.0	64.5	
1100	1105	5.40		4.0	62.5	
1105	1110	5.40		5.0	62.0	
1110	1115	5.40		5.2	64.0	
Raw Average		5.39		4.7	63.2	
As founds		4.92		55.0	51.0	
System Zero		0.08		0.0	-0.1	
System Span		5.10		54.9	49.0	
Corrected Average		**5.21**		**4.8**	**64.8**	
System Bias Check						
Zero Pre-test		0.01		0.0	0.0	< 5% **Pass**
Zero Post-test		0.01		0.0	0.0	< 5% **Pass**
Span Pre-test		0.02		0.0	0.0	< 5% **Pass**
Span Post-test		0.01		0.0	0.0	<5% **Pass**

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8/13/93

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Reference Method Gaseous Measurements

Client:	SCE EL SEGUNDO		Condition:	Urea On	
Unit:	#4		Load:	320 MW	
Location:	STACK				
	O2%	CO2%	CO ppm	NOx ppm	
Analyzer Range:	10.00		100.0	100.0	
Span Value:	4.97		55.6	50.0	
Test #:	4-11-CEM	Time:		Date:	8/10/93
	O2%	CO2%	CO ppm	NOx ppm	
System Zero	0.08		0.00	-0.10	
System Span	5.10		54.90	49.00	
Start / Stop					
1130 / 1135	5.35		5.0	62.0	
1135 / 1140	5.40		4.9	64.2	
1140 / 1145	5.40		5.0	65.0	
1145 / 1150	5.42		3.5	68.2	
1150 / 1155	5.40		3.8	67.4	
1155 / 1200	5.38		7.1	61.1	
Raw Average	5.39		4.4	65.4	
As founds	4.95		55.0	51.0	
System Zero	0.10		0.0	0.0	
System Span	5.15		55.0	49.0	
Corrected Average	5.24		4.5	66.7	
System Bias Check					
Zero Pre-test	0.01		0.0	0.0	< 5% Pass
Zero Post-test	0.01		0.0	0.0	< 5% Pass
Span Pre-test	0.01		0.0	0.0	< 5% Pass
Span Post-test	0.02		0.0	0.0	<5% Pass

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Reference Method Gaseous Measurements

Client: SCE EL SEGUNDO
Unit: #4
Location: STACK

Condition: Urea Off
Load: 320 MW

		O2%	CO2%	CO ppm	NOx ppm		
Analyzer Range:		10.00		100.0	100.0		
Span Value:		4.97		55.6	50.0		
Test #:	4-13-CEM		Time:	1300/1330		Date:	8/10/93
		O2%	CO2%	CO ppm	NOx ppm		
System Zero		0.10		0.0	0.1		
System Span		5.10		55.0	50.0		
Start	Stop						
1300	1305	5.10		7.5	73.5		
1305	1310	5.10		6.0	74.3		
1310	1315	5.10		7.4	74.0		
1315	1320	5.10		7.5	73.5		
1320	1325	5.10		6.6	73.6		
1325	1330	5.12		7.5	74.0		
Raw Average		5.10		7.0	73.8		
As founds		4.95		55.0	51.2		
System Zero		0.10		0.0	0.0		
System Span		5.10		55.0	50.0		
Corrected Average		**4.97**		**7.1**	**73.8**		
System Bias Check							
Zero Pre-test		0.01		0.0	0.0	< 5%	Pass
Zero Post-test		0.01		0.0	0.0	< 5%	Pass
Span Pre-test		0.01		0.0	0.0	< 5%	Pass
Span Post-test		0.01		0.0	0.0	<5%	Pass

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Reference Method Gaseous Measurements

Client: SCE EL SEGUNDO
Unit: #4
Location: STACK

Condition: Urea Off
Load: 320 MW

	O2%	CO2%	CO ppm	NOx ppm		
Analyzer Range:	10.00		100.0	100.0		
Span Value:	4.97		55.6	50.0		
Test #: 4-12-CEM		Time:	1220/1250		Date:	8/10/93
	O2%	CO2%	CO ppm	NOx ppm		
System Zero	0.10		0.0	0.0		
System Span	5.15		55.0	49.0		
Start / Stop						
1220 / 1225	5.40		5.0	72.0		
1225 / 1230	5.45		5.8	73.5		
1230 / 1235	5.45		6.0	72.2		
1235 / 1240	5.42		6.1	72.1		
1240 / 1245	5.40		6.5	72.0		
1245 / 1250	5.32		6.0	73.5		
Raw Average	5.42		5.9	72.4		
As founds	4.92		55.0	51.2		
System Zero	0.10		0.0	0.1		
System Span	5.10		55.0	50.0		
Corrected Average	**5.27**		**5.9**	**73.1**		
System Bias Check						
Zero Pre-test	0.01		0.0	0.0	< 5%	Pass
Zero Post-test	0.01		0.0	0.0	< 5%	Pass
Span Pre-test	0.02		0.0	0.0	< 5%	Pass
Span Post-test	0.01		0.0	0.0	<5%	Pass

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Appendix C.4

Ammonia

CARNOT

SAMPLE TRAIN TEST DATA

CLIENT: SCE/El Segundo
SAMPLE LOCATION: Stack
OPERATOR/ASSISTANT: EP

UNIT: 4
TEST NO.: 4-1-NH_3
METHOD: SCAQMD 207 (?)
TEST CONDITION:
AMB. TEMP., °F:
METER VOL. (START/END):

PAGE 1 OF 1
PROJECT # 10-852
DATE 5/24/93

PRE-TEST DATA:

Barometric Press., in. Hg.	29.94
Assumed Stack Press.	
Assumed Moisture	
Assumed Molecular Wt.	
Assumed ΔP	
Assumed ΔH	
Stack Diameter, in.	
Sample Time: Total	30
per point	10
Total of Traverse Points	Single

ΔH = ________ x ΔP

EQUIPMENT INFO:

Meter No.	ES-32
Meter, Yd.	
CFM @ ΔH = 1.0	
Pitot ID, Cp	
O_2/CO_2 Method	
Teflon Connecting Line (Y/N)	
Probe: Mat'l	
Probe: Length	
Nozzle: Mat'l	
Nozzle: Diam.	
Filter: No.	
Filter: Mat'l	

Imp.	Mat'l	Wt.(End)	Wt.(Start)	Wt.(g)
#1	0.1N H_2SO_4	603.4	582.0	
#2	"	598.7	597.3	
#3	—	546.1	545.6	
#4	SG	686.4	682.4	
#5				
Total				

POST TEST INFO:
Filter Appearance
Impinger Appearance
Silica Gel Spent (Y/N)

SAMPLE TRAIN LEAK CHECK:

	CFM	Vac.	Pitot	Init.
Pre-Test	.006	15"	—	WM
Post-Test				

PRE-TEST CALIBRATION CHECK:

	Time	ΔH	Meter Reading	Meter Temp. In	Meter Temp. Out
Init.					
Final					

SAMPLE POINT	TIME	METER CONDITIONS ΔP	ΔH	METER READING	TEMPERATURES, °F STACK	PROBE	METER IN	METER OUT	OVEN	IMP. OUT	O_2	VAC.	STATIC PRESS. iwg
	10:00		2.4	653.581	200	251	71	66	—	ICED	—	12.5	—
	10:10				199	265			—	↓	—		—
	10:20								—		—		—
	10:30			660.965					—		—		—
									—		—		—
									—				—

CHAIN OF CUSTODY INFORMATION

Impingers Loaded	EP
Impingers Recovered	MR
Filter Loaded	
Filter Recovered	
Probe Wash	

TEST SUMMARY

Calculated by:	
Checked by:	
Sample Vol., c.f.	6.494
Stack Press., iwg	
ΔH, iwg	2.4
ΔP, iwg	
Meter Temp., °F	68.5
Stack Temp., °F	
Water Collected, g	
O_2/CO_2	
Comments:	

Appendix C.5

Non-Methane Hydrocarbon

CARNOT
TEDLAR BAG SAMPLE DATA

CLIENT/PROJECT: SCE / EI Segundo

DATE: 8/12/93 UNIT: 4/ BY: S. Mullings

	BAG ID 4-10-THC	BAG ID 4-11-THC	BAG ID
TEST NO.	4-10-THC	4-11-THC	
SAMPLE RATE	.5 L/m	.5 L/m	
START TIME	1050	1135	
STOP TIME	1110	1155	
SAMPLE LOCATION	STACK	STACK	

DATE: 8/12/93 UNIT: 4/ BY: S Mullings

	BAG ID	BAG ID	BAG ID
TEST NO.	4-12-THC	4-13-THC	
SAMPLE RATE	.5 L/m	.5 L/m	
START TIME	1230	1300	
STOP TIME	1250	1320	
SAMPLE LOCATION	STACK	STACK	

CARNOT
TEDLAR BAG SAMPLE DATA

CLIENT/PROJECT: _____

DATE: 5-24-93 UNIT: 4 BY: WM

	BAG ID 1	BAG ID 2	BAG ID 3

CARNOT
TEDLAR BAG SAMPLE DATA

CLIENT/PROJECT: _____

DATE: 5-24-93 UNIT: 4 BY: WH

	BAG ID 1	BAG ID 2	BAG ID 3

APPENDIX D
CALCULATIONS

Appendix D.1

General Emissions Calculations

EMISSION CALCULATIONS

1. Sample Volume and Isokinetics

a. Sample gas volume, dscf

$$V_{m\ std} = 0.03342\ V_m \left(P_{bar} + \frac{H}{13.6}\right)\left(\frac{T_{ref}}{T_m}\right)(Y)$$

b. Water vapor volume, scf

$$V_{w\ std} = 0.0472\ V_{lc}\left(\frac{T_{ref}}{528\ ^\circ R}\right)$$

c. Moisture content, nondimensional

$$B_{wo} = \frac{V_{w\ std}}{V_{m\ std} + V_{w\ std}}$$

d. Stack gas molecular weight, lb/lb mole

$$MW_{dry} = 0.44\ (\%CO_2) + 0.32\ (\%O_2) + 0.28\ (\%N_2)$$

$$MW_{wet} = MW_{dry}\ (1 - B_{wo}) + 18\ (B_{wo})$$

e. Absolute stack pressure, iwg

$$P_s = P_{bar} + \frac{P_{sg}}{13.6}$$

f. Stack velocity, ft/sec

$$V_s = 2.90\ C_p \sqrt{\Delta P T_s}\ \sqrt{\left(\frac{29.92}{p_s}\right)\left(\frac{28.95}{MW_{wet}}\right)}$$

g. Actual stack flow rate, wacfm

$$Q = (V_s)(A_s)(60)$$

h. Standard stack gas flow rate, dscfm

$$Q_{sd} = Q\ (1 - B_{wo})\left(\frac{T_{ref}}{T_s}\right)\left(\frac{P_s}{29.92}\right)$$

i. Percent isokinetic

$$I = \left(\frac{17.32(T_s)(V_{m\ std})}{(1 - B_{wo})(\Theta)(V_s)(P_s)(D_n^2)}\right)\left(\frac{528\ ^\circ R}{T_{ref}}\right)$$

2. Particulate Emissions

a. Grain loading, gr/dscf

$$C = 0.01543 \left(\frac{M_n}{V_{m\ std}} \right)$$

b. Grain loading at 12% CO_2, gr/dscf

$$C_{12\%\,CO_2} = C \left(\frac{12}{\%\,CO_2} \right)$$

c. Mass emissions, lb/hr

$$M = C(Q_{std}) \frac{(60\ \text{min/hr})}{(7000\ gr/lb)}$$

3. Gaseous Emissions, lb/hr

$$M = (ppm)(10^{-6}) \left(\frac{MW_i\ lb/lb\ mole}{SV} \right) (Q_{std})(60\ \text{min/hr})$$

where,

SV = *specific molar volume of an ideal gas*:

$SV = 385.3\ ft^3/lb\ mole \quad for\ T_{ref} = 528\ °R$

$SV = 379.5\ ft^3/lb\ mole \quad for\ T_{ref} = 520\ °R$

4. Emissions Rates, lb/10^6 Btu

a. Fuel factor at 68 °F, dscf/10^6 Btu at 0% O_2

$$F_{68} = \frac{10^6 [3.64(\%H) + 1.53(\%C) + 0.14\ (\%N) + 0.57(\%S) - 0.46(\%O_2 fuel)]}{HHV,\ Btu/lb}$$

b. Fuel factor at 60 °F

$$F_{60} = F_{68} \left(\frac{520\ °R}{528\ °R} \right)$$

c. Gaseous Emissions factor

$$\left(\frac{lb}{10^6\ Btu} \right)_i = (ppm)_i\ (10^{-6}) \left(\frac{MW_i\ lb}{lb\ mole} \right) \left(\frac{1}{SV} \right) (F) \left(\frac{20.9}{20.9 - \%O_2} \right)$$

d. Paticulate emission factor

$$\left(\frac{lb}{10^6\ Btu} \right) = C \left(\frac{1\ lb}{7000\ gr} \right) (F) \left(\frac{20.9}{20.9 - \%O_2} \right)$$

Nomenclature:

A_s = stack area, ft^2

B_{ws} = flue gas moisture content

$C_{12\% CO_2}$ = particulate grain loading, gr/dscf corrected to 12% CO_2

C = particulate grain loading, gr/dscf

C_p = pitot calibration factor, dimensionless

Dn = nozzle diameter, in.

F = fuel F factor, dscf/10^6 Btu at 0% O_2

H = orifice pressure differential, iwg

I = % isokinetics

M_n = mass of collected particulate, mg

M_i = mass emissions of species i, lb/hr

MW = molecular weight of flue gas

MW_i = molecular weight of species i:

NO_x	:	46
CO	:	28
SO_x	:	64
HC	:	16

θ = sample time, min.

ΔP = average velocity head, iwg = $\left(\overline{\sqrt{\Delta P}}\right)^2$

P_{bar} = barometric pressure, in.Hg

P_s = stack absolute pressure, in.Hg

P_{sg} = stack static pressure, iwg

Nomenclature (Continued):

Q	=	wet stack gas flow rate at actual conditions, wacfm
Qsd	=	dry stack gas flow rate at standard conditions, dscfm
SV	=	specific molar volume of an ideal gas at standard conditions, ft^3/lb mole
Tm	=	meter temperature, °R
T_{ref}	=	reference temperature, °R
Ts	=	stack temperature, °R
V_s	=	stack velocity, ft/sec
V_{lc}	=	volume of liquid collected in impingers, ml
Vm	=	dry meter volume uncorrected, dcf
$V_{m\ std}$	=	dry meter volume at standard conditions, dscf
$V_{w\ std}$	=	volume of water vapor at standard conditions, scf
Y	=	meter calibration coefficient

Appendix D.2

Specific Emissions Calculations

CARNOT SOURCE TEST DATA SUMMARY

AMMONIA

Client/Location	SCE/EL SEG 4	**Reference Temp (F)**	60
Unit	4	**Fuel**	NAT GAS
Sample Location	STACK	**Data By**	MAR
		Date of Data Entry	24-May-93

Test No	**4-4-NH3**	**4-5-NH3**	**4-6-NH3**	**4-7-NH3**	
Date	24-May-93	24-May-93	25-May-93	25-May-93	
Test Method	SCAQMD	SCAQMD	SCAQMD	SCAQMD	
Sample Train	ES-31	ES-31	ES-31	ES-31	
Pitot Factor	0.841	0.841	0.841	0.841	
Meter Cal Factor	1.02	1.02	1.02	1.02	
Sample Time (Min)	30	30	30	30	
Bar Press (in Hg)	29.95	29.95	29.86	29.86	
Start/Stop Time	1345/1415	1453/1505	1015/1045	1115/1145	
Stack Press (iwg)	0.02	0.02	0.02	0.02	
Stack Temp (F)	203.3	204.7	221.7	223.7	
Stack O2 (%)	6.00	6.00	4.90	4.90	
Stack CO2 (%)	8.60	8.60	9.10	9.10	
Meter Vol (acf)	23.074	23.204	23.270	21.905	
Meter Temp (F)	70.7	70.0	71.3	70.2	
Meter Press (iwg)	2.40	2.40	2.33	2.13	
Liquid Vol (ml)	110.3	96.8	112.0	103.0	
Std Sample Vol (SCF)	23.218	23.380	23.314	21.983	
Std Sample Vol (Nm^3)	0.613	0.617	0.615	0.580	
Moisture Fraction	0.181	0.161	0.183	0.179	
Ammonia Conc (ug/ml)	3.14	5.62	11.90	9.97	
Sample Vol (ml)	414	432	379	509	
Ammonia Conc (ppmv)	2.80	5.19	9.66	11.54	
Ammonia Conc @ 3% O2	3.36	6.24	10.81	12.91	

CARNOT

Client:	SCE	**BP in Hg:**	29.81
Date:	8/12/93	**Tref R:**	520
Location:	Elsegudo 4	**Meter No**	ES-47
Unit:	Natural Gas	**Yd:**	1.004

Blank: 0.00

Test #	Vm (adcf)	Tm (F)	Hm (in. H20)	Tot Vol (ml)	Solution NH3 (ppm)	Vmstd (SCF)	O2 (%)	NH3 (ppm)	NH3 @ 3% O2
4-10-NH3	23.660	65.9	2.50	525	5.05	23.549	5.21	5.5	6.3
4-11-NH3	23.690	69.3	2.50	460	7.20	23.427	5.24	6.9	7.9

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FAX (714) 259-0372

APPENDIX E
LABORATORY REPORTS

AMMONIA DETERMINATION USING NESSLER'S REAGENT

CLIENT:	SCE/EL SEG	ANALYST:	MAR
LOCATION:	UNIT 4	CALIBRATION DATE:	5/24/93
PROJECT:	10 852	ANALYSIS DATE:	5/24/93
		CONC. OF STD. (ug/ml)=	10.031

CALIBRATION:

Vol. std added (ml)	Expected conc.(ug/ml)	Absorb. (OD)	ABS-BLK	Measured conc. (ug/ml)	%diff	R.F. (mg/OD)
0	0.00	0.300	0.000	---	---	
4	0.80	0.348	0.048	0.75	-6.15%	0.836
6	1.20	0.397	0.097	1.22	1.74%	0.620
10	2.01	0.482	0.182	2.04	1.81%	0.551
12	2.41	0.523	0.223	2.44	1.23%	0.540
14	2.81	0.564	0.264	2.83	0.82%	0.532
16	3.21	0.597	0.297	3.15	-1.89%	0.540
20	4.01	0.670	0.370	3.85	-4.00%	0.542
slope=	0.1039				Avg R.F.=	0.603
y-intercept=	-0.0303					
r2=	0.9979					
					% of std	
RICCA STD	2.42		0.233	2.53	104.68%	

ANALYSIS:

Test no.	Absorbance	Dil factor	Conc (ug/ml)	TV
4-1-NH3 (ABORT)	0.017	1.1	0.51	366
4-4-NH3 DUP	0.126	2.0	3.01	414
4-4-NH3	0.263	1.1	3.14	414
4-5-NH3	0.262	2.0	5.62	432
4-6-NH3	0.217	5.0	11.90	379
4-7-NH3	0.177	5.0	9.97	509
				% diff
Ricca Std Dup	0.244	1.0	2.64	4.18%
Ricca Std Dup	0.249	1.0	2.69	6.08%

SCE El Segundo	8/12/93	std=	9.485		
ml added	conc.	abs	abs-blk	conc fnd	% diff
0	0.00	0.041	0.000		
6	1.14	0.119	0.078	1.10	-3.10%
8	1.52	0.171	0.130	1.55	2.31%
10	1.90	0.211	0.170	1.90	0.08%
12	2.28	0.258	0.217	2.30	1.26%
14	2.66	0.299	0.258	2.66	0.14%
16	3.04	0.339	0.298	3.01	-0.98%
18	3.41	0.382	0.341	3.38	-1.09%
20	3.79	0.434	0.393	3.83	0.87%
slope=	0.116				
y-int=	-0.050				
r2=	0.999				
RICCA STD	2.44	0.288	0.247	2.56	5.10%
sample #	abs	dil ftr	conc	TV	ug/mL
4-A-NH3	0.095	2.50	3.12	513	0.006091
4-A-NH3	0.238	1.25	3.11	513	0.006059
4-10-NH3	0.248	2.00	5.15	525	0.009802
4-10-NH3	0.411	1.25	4.98	525	0.009482
4-11-NH3	0.369	2.00	7.24	460	0.015737
4-11-NH3	0.447	1.67	7.16	460	0.015558

AtmAA Inc.
21354 Nordhoff St., Suite 113, Chatsworth, CA 91311 (818) 718-6070 • FAX (818) 718-9779
environmental consultants
laboratory services

June 2, 1993

LTR/201/93

RECEIVED
JUN 03 1993
CARNOT

Jody Hone
CARNOT
15991 Red Hill Ave. Suite 110
Tustin, CA 92680

re: 10852

Dear Jody:

Please find enclosed the laboratory analysis report, quality assurance summary, and the original chain of custody form for four Tedlar bag samples received on May 25, 1993.

The samples were analyzed for methane and total gaseous non-methane organics.

Sincerely,

AtmAA, Inc.

Michael L. Porter
Laboratory Director

Encl.
MLP/krp

AtmAA Inc.
21354 Nordhoff St., Suite 113, Chatsworth, CA 91311 (818) 718-6070 • FAX (818) 718-9779
environmental consultants
laboratory services

LABORATORY ANALYSIS REPORT

Methane & Total Gaseous Non-Methane Organics
Analysis in Tedlar Bag Samples

Report Date:	June 2, 1993
Client:	CARNOT
P.O. No.:	9912
Project No.:	10852
Date Received:	May 25, 1993
Date Analyzed:	May 26, 1993

ANALYSIS DESCRIPTION

Methane and total gaseous non-methane organics were measured by flame ionization detection/total combustion analysis portion (FID/TCA).

AtmAA Lab No.:	91453-38	91453-39	91453-40	91453-41
Sample I.D.:	4-2-HC	4-3-HC	4-4-HC	4-5-HC
Components	(Concentration in ppmv)			
Methane	< 1	< 1	< 1	< 1
TGNMO	15.8	19.0	17.1	18.0

TGNMO is total gaseous non-methane organics measured and reported as ppm methane.

Michael L. Porter
Laboratory Director

QUALITY ASSURANCE SUMMARY

(Repeat Analysis)

Project No.: 10852
Date Received: May 25, 1993
Date Analyzed: May 26, 1993

Components	Sample ID	Repeat Analysis Run #1	Repeat Analysis Run #2	Mean Conc.	% Diff. From Mean
		(Concentration in ppmv)			
Methane	4-3-HC	< 1	< 1	---	---
TGNMO	4-3-HC	19.2	18.8	19.0	1.0

A set of 4 Tedlar bag samples laboratory numbers, 91453-(38-41) was analyzed for methane and TGNMO. Agreement between repeat analyses is a measure of precision and is shown above in the column "% Difference from Mean." Repeat analyses are an important part of AtmAA's quality assurance program. The average % Difference from Mean for 1 repeat measurement from the sample set of 4 Tedlar bag samples is 1.0%.

AtmAA Inc.
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environmental consultants
laboratory services

LABORATORY ANALYSIS REPORT

Methane & Total Gaseous Non-Methane Organics
Analysis in Tedlar Bag Samples

Report Date:	June 2, 1993
Client:	CARNOT
P.O. No.:	9916
Project No.:	10852
Date Received:	May 26, 1993
Date Analyzed:	May 26, 1993

ANALYSIS DESCRIPTION

Methane and total gaseous non-methane organics were measured by flame ionization detection/total combustion analysis portion (FID/TCA).

AtmAA Lab No.:	91463-1	91463-2	91463-3	91463-4
Sample I.D.:	4-6-NH3	4-7-NH3	4-8-HC	4-9-HC
Components	(Concentration in ppmv)			
Methane	< 1	< 1	< 1	< 1
TGNMO	19.6	23.1	21.2	20.4

TGNMO is total gaseous non-methane organics measured and reported as ppm methane.

Michael L. Porter
Laboratory Director

QUALITY ASSURANCE SUMMARY
(Repeat Analysis)

Project No.: 10852
Date Received: May 26, 1993
Date Analyzed: May 26, 1993

Components	Sample ID	Repeat Analysis Run #1	Repeat Analysis Run #2	Mean Conc.	% Diff. From Mean
		(Concentration in ppmv)			
Methane	4-6-HH3	< 1	< 1	---	---
	4-9-HC	< 1	< 1	---	---
TGNMO	4-6-HH3	19.1	20.1	19.6	2.6
	4-9-HC	21.7	19.2	20.4	6.1

A set of 4 Tedlar bag samples laboratory numbers, 91463-(1-4) was analyzed for methane and TGNMO. Agreement between repeat analyses is a measure of precision and is shown above in the column "% Difference from Mean." Repeat analyses are an important part of AtmAA's quality assurance program. The average % Difference from Mean for 2 repeat measurements from the sample set of 4 Tedlar bag samples is 4.3%.

AtmAA Inc.
21354 Nordhoff St., Suite 113, Chatsworth, CA 91311 (818) 718-6070 • FAX (818) 718-9779
environmental consultants
laboratory services

August 16, 1993 LTR/305/93

Ed Filadelfia
CARNOT
15991 Red Hill Ave. Suite 110
Tustin, CA 92680

re: 10-852

Dear Ed:

Please find enclosed the laboratory analysis report, quality assurance summary, and the original chain of custody form for four Tedlar bag samples received on August 13, 1993.

The samples were analyzed for methane and total gaseous non-methane organics.

Sincerely,

AtmAA, Inc.

Michael L. Porter
Laboratory Director

Encl.
MLP/krp

AtmAA Inc.
21354 Nordhoff St., Suite 113, Chatsworth, CA 91311 (818) 718-6070 • FAX (818) 718-9779
environmental consultants
laboratory services

LABORATORY ANALYSIS REPORT

Methane & Total Gaseous Non-Methane Organics
Analysis in Tedlar Bag Samples

Report Date:	August 16, 1993
Client:	CARNOT
P.O. No.:	1175
Project No.:	10-852
Date Received:	August 13, 1993
Date Analyzed:	August 13, 1993

ANALYSIS DESCRIPTION

Methane and total gaseous non-methane organics were measured by flame ionization detection/total combustion analysis portion (FID/TCA).

AtmAA Lab No.:	92253-11	92253-12	92253-13	92253-14
Sample I.D.:	4-10-HC	4-11-HC	4-12-HC	4-13-HC
Components	(Concentration in ppmv)			
Methane	< 1	< 1	< 1	< 1
TGNMO	10.3	7.73	10.0	7.15

TGNMO is total gaseous non-methane organics measured and reported as ppm methane.

Michael L. Porter
Laboratory Director

QUALITY ASSURANCE SUMMARY

(Repeat Analysis)

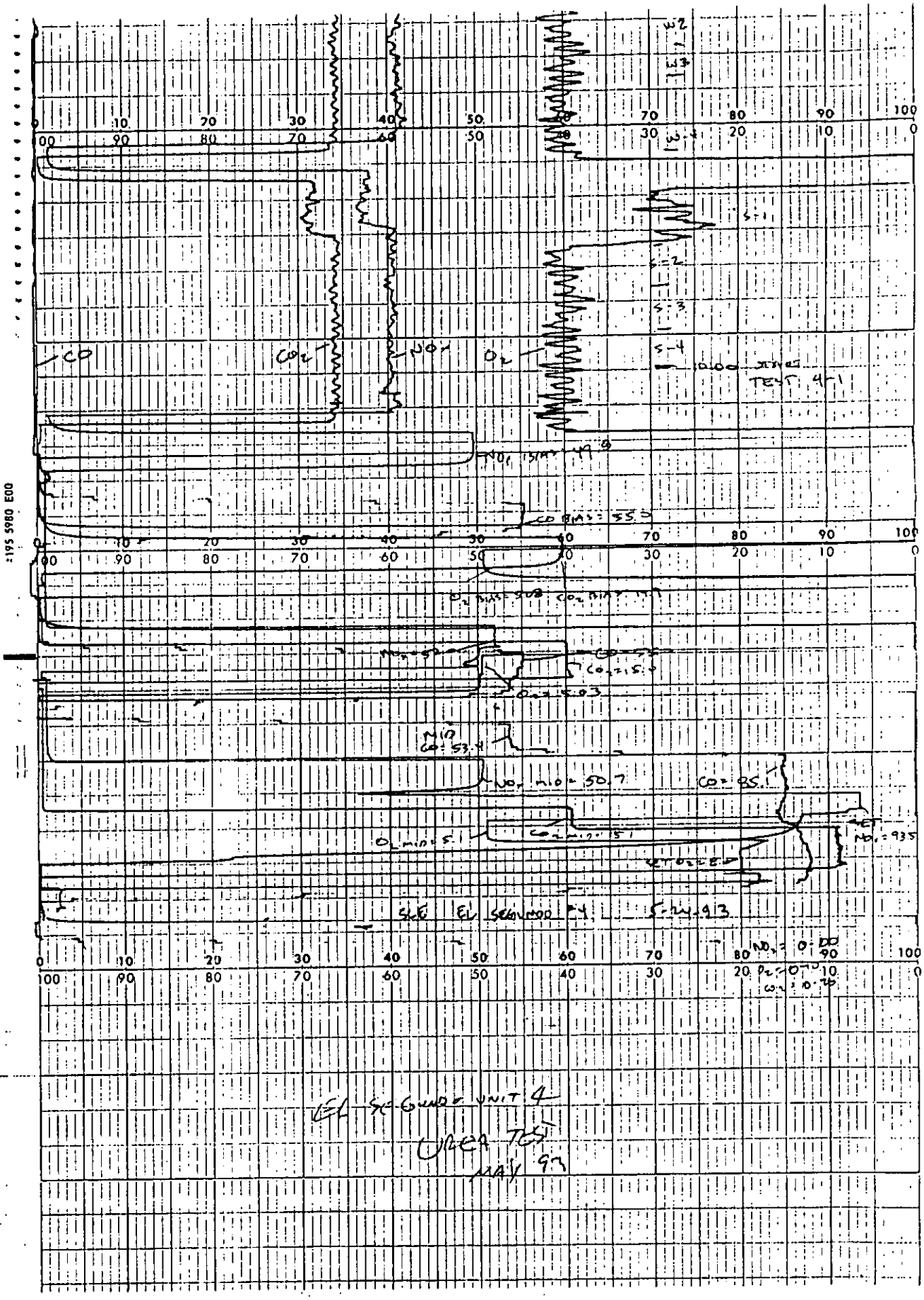
Project No.: 10-852
Date Received: August 13, 1993
Date Analyzed: August 13, 1993

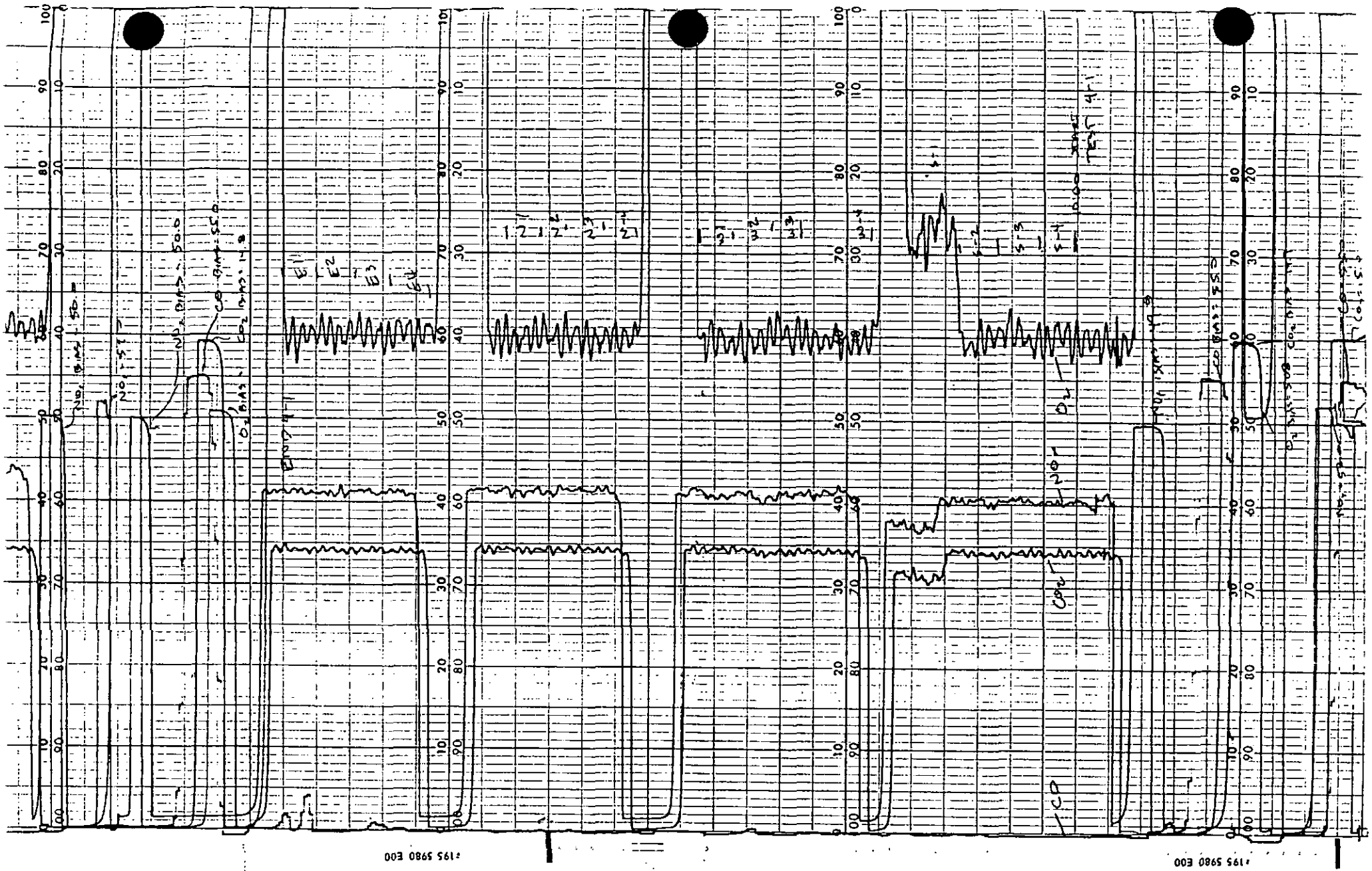
Components	Sample ID	Repeat Analysis Run #1 (Concentration in ppmv)	Repeat Analysis Run #2 (Concentration in ppmv)	Mean Conc. (Concentration in ppmv)	% Diff. From Mean (Concentration in ppmv)
Methane	4-11-HC	< 1	< 1	---	---
TGNMO	4-11-HC	7.36	8.10	7.73	4.8

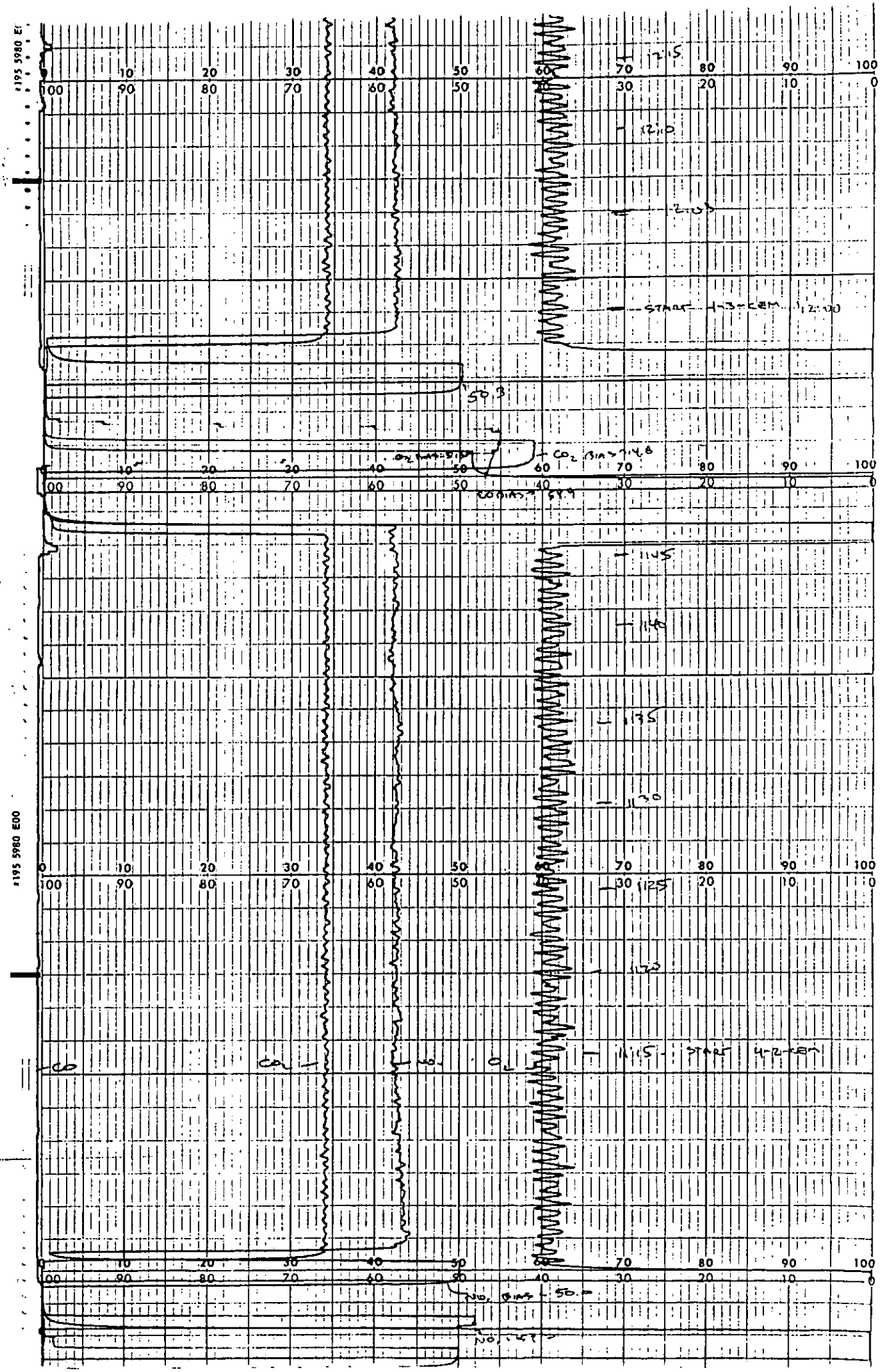
A set of 4 Tedlar bag samples laboratory numbers, 92253-(11-14) was analyzed for methane and TGNMO. Agreement between repeat analyses is a measure of precision and is shown above in the column "% Difference from Mean." Repeat analyses are an important part of AtmAA's quality assurance program. The average % Difference from Mean for 1 repeat measurement from the sample set of 4 Tedlar bag samples is 4.8%.

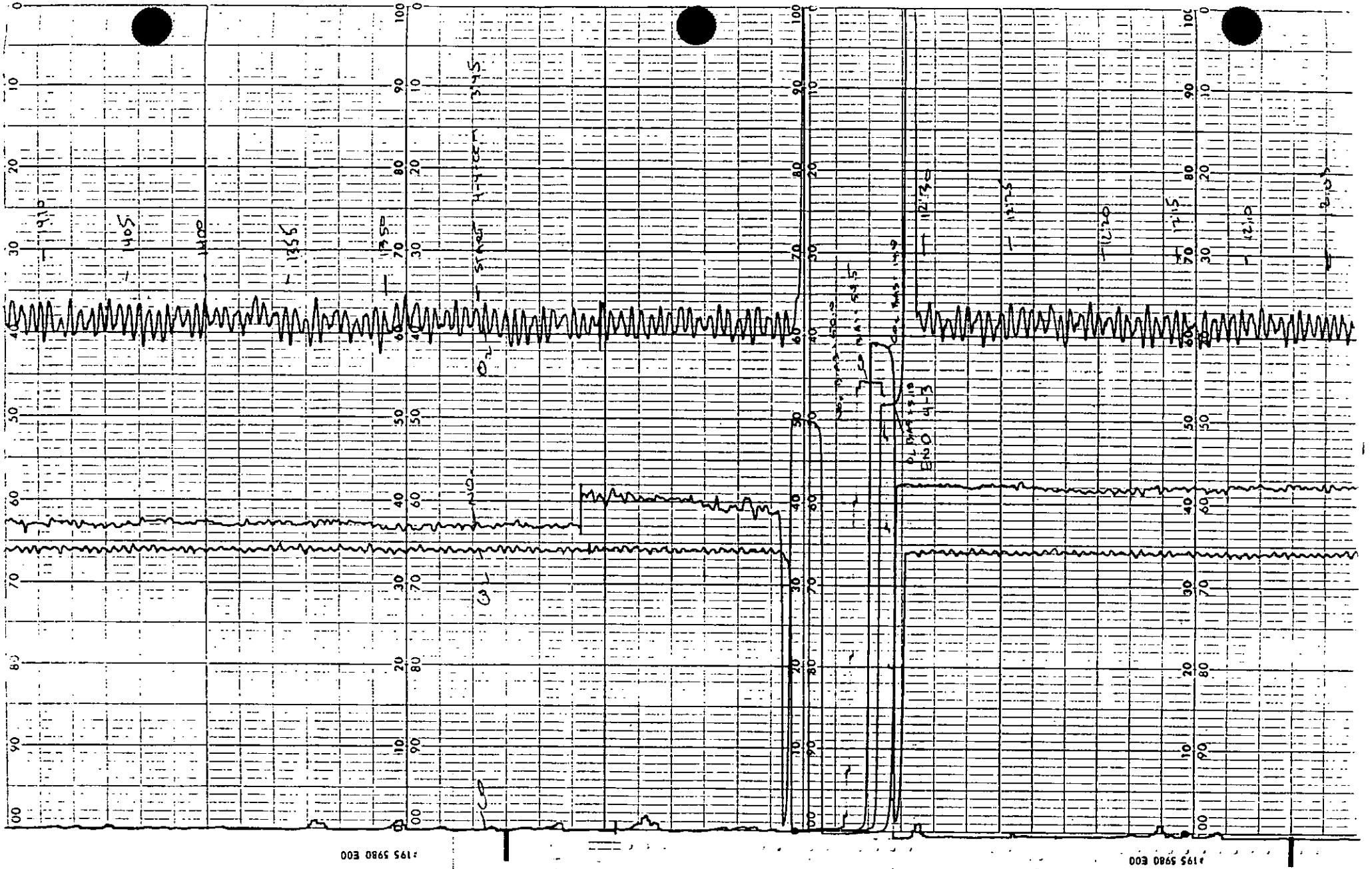
APPENDIX F

INSTRUMENT STRIP CHARTS


CO
O2
20% O2
1000 MWe
TEST 4-1
NOx, ppm = 49.9
CO ppm = 55.5
O2 bias sub CO2 ppm =
CO2 = 5.0
O2 = 5.03
NOx, ppm = 50.7
CO = 85.1
O2 = 5.1
CO2 = 5.1
ET NOx = 93.5
5-24-93
20% O2 = 0.00
CO2 = 0.00
EL SEGUNDO UNIT 4
UREA TEST
MAY 93




#195 5980 EE
#195 5980 EOO
12:15
12:10
12:05
START 4-3-CEM 12:00
59.3
CO2 BIAS 7.48
CO BIAS 59.9
11:45
11:40
11:35
11:30
11:25
11:20
11:15 START 4-2-CEM
CO
CO2
O2
NO. BIAS 50.0
NO. 49.9


1405
1400
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1005
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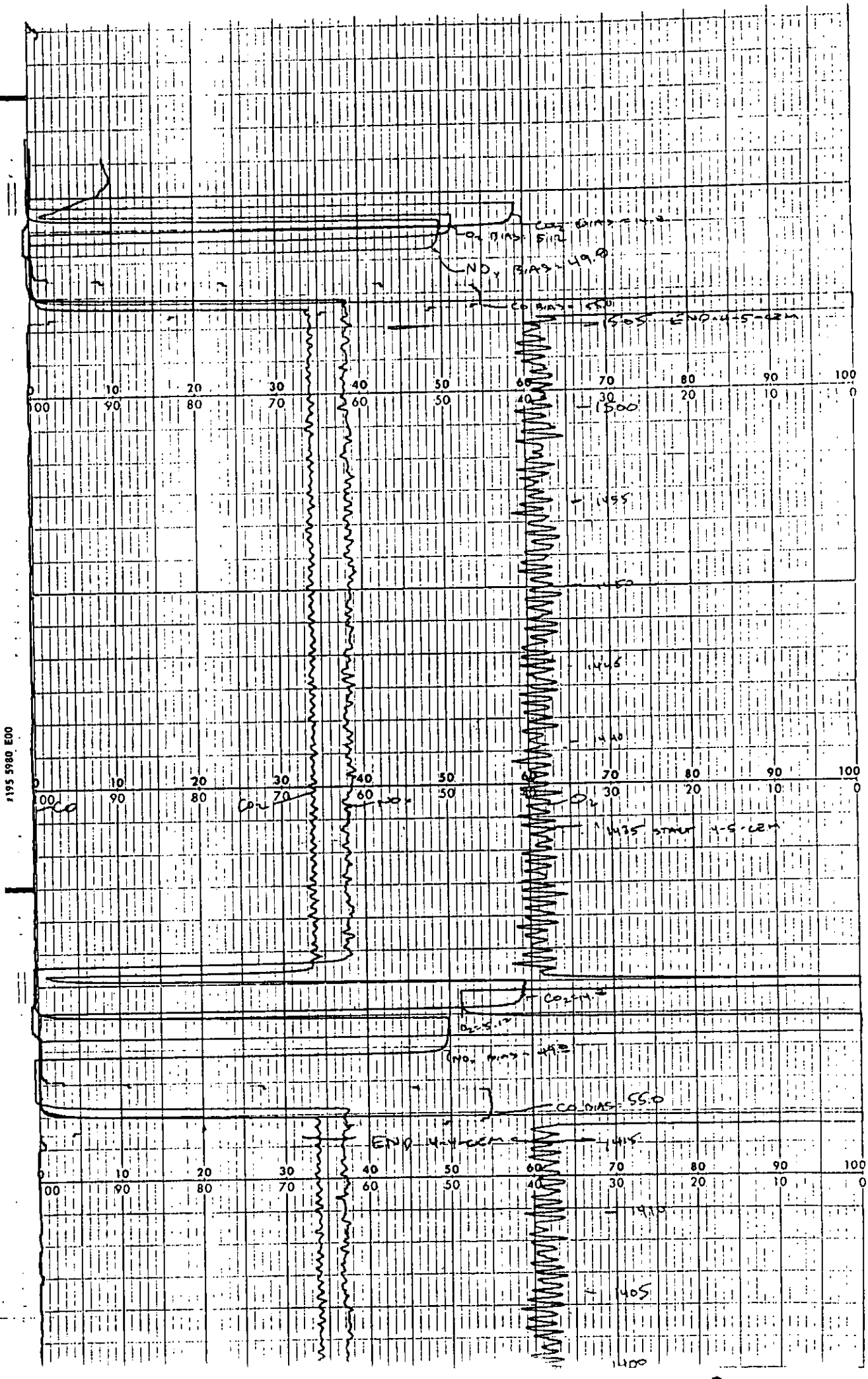
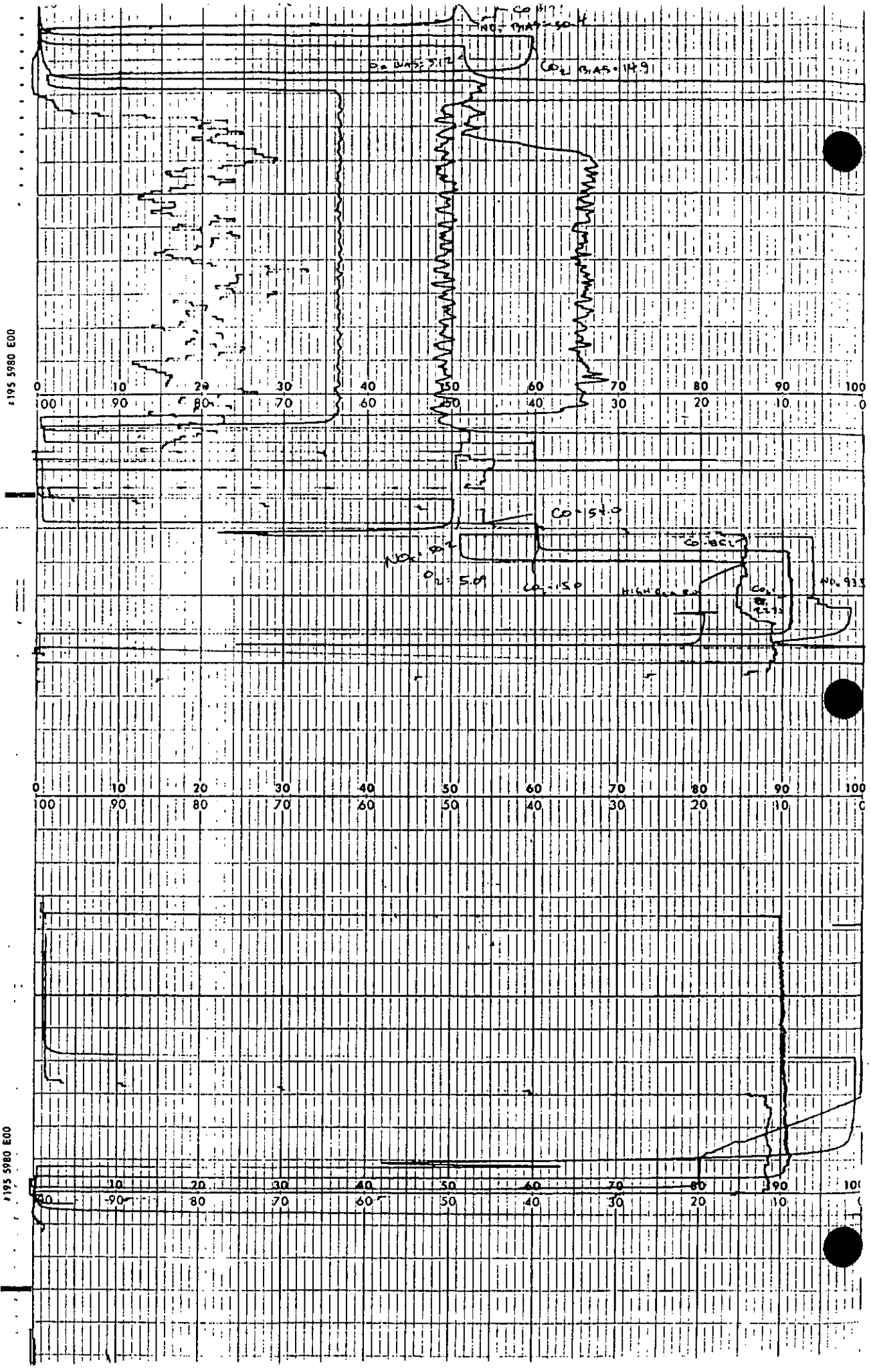
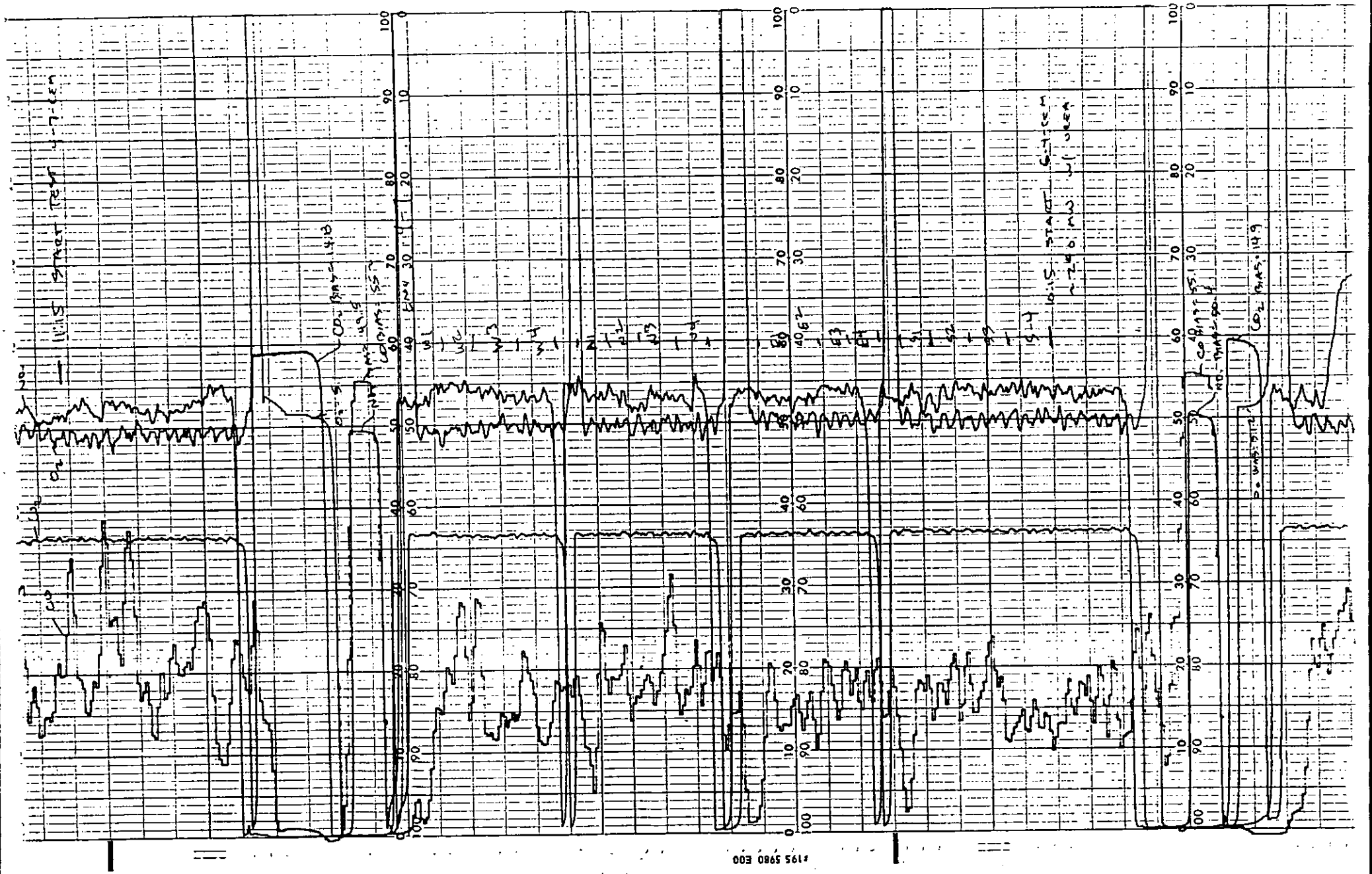
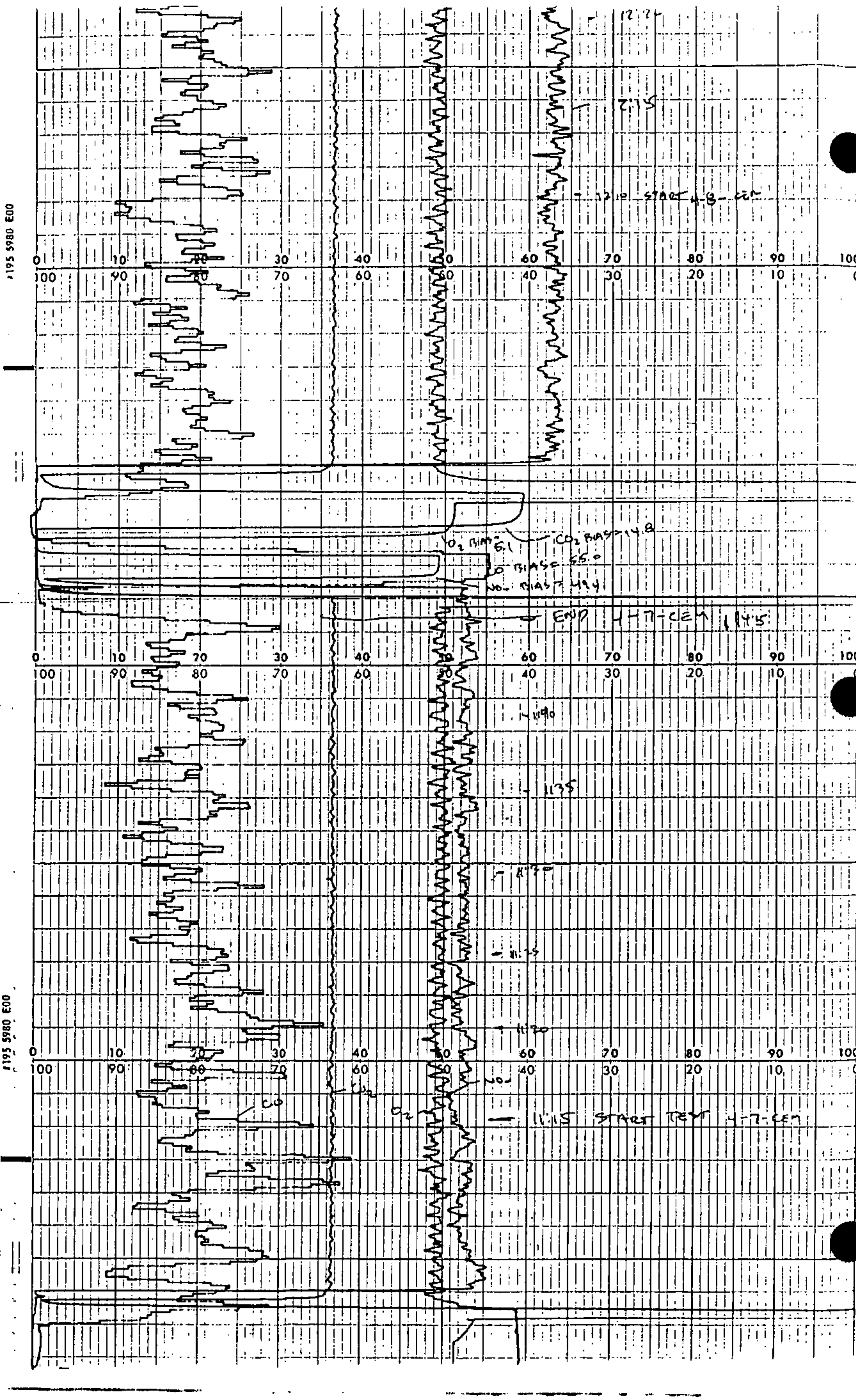
230
225
220
215
210
205
200
155
150
145
140
135
130
125
120
115
110
105
100
55
50
45
40
35
30
25
20
15
10
5
0
ICP
CVP
O2 Baseline
END 4-13
195 5980 E00
195 5980 E00

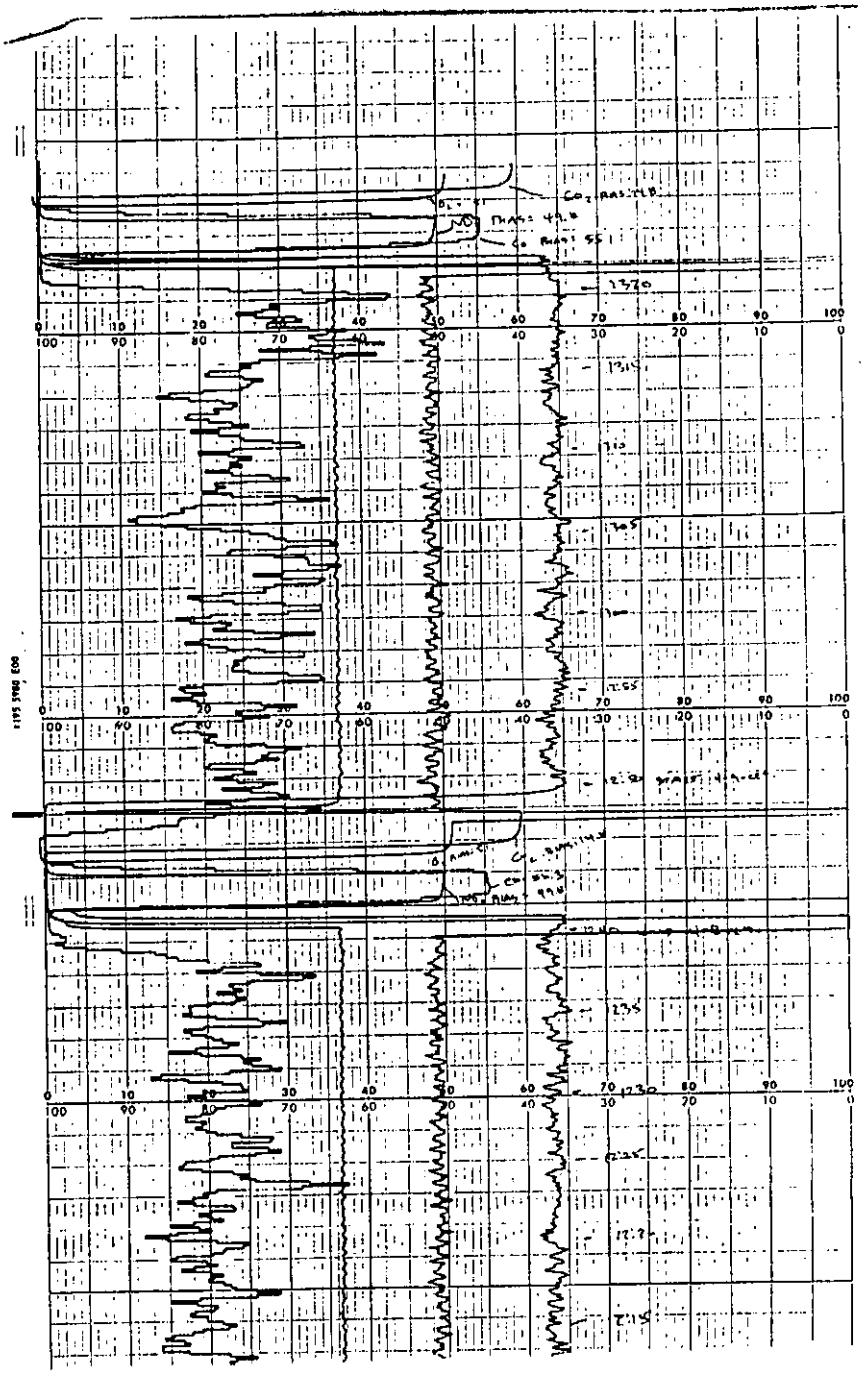

NOx BIAS = 49.0
CO BIAS = 55.0
1505
1455
1445
1435 START 4-5-02
1415
1405
1400
15.00
CO
O2
NOx
CO2


CO BIAS = 5.2
CO2 BIAS = 14.9
CO = 54.0
NO = 9
O2 = 5.0
CO = 150
CO = 8CC
HIGH
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
-90





#195 5980 E00
12:10 START 4-8-CEM
O2 BIAS = 5.1
CO2 BIAS = 14.8
CO BIAS = 55.0
NOx BIAS = 49.4
END 4-7-CEM 11:45
11:15 START TEST 4-7-CEM
CO
O2
NOx



APPENDIX G

CHAIN OF CUSTODY

CHAIN OF CUSTODY

PROJECT # 10852 OUTSIDE LAB REQUIRED (Y/N) _____ SAMPLE DATE 5/25/93

CLIENT/LOCATION El Segundo PROJECT MANAGER EE

SAMPLE LOCATION STACK METHOD(S) 252 TECHNICIAN WM

COMPLIANCE TEST (Y/N) Y DATE DUE _____

DATE	TIME	TEST #	SAMPLE DESCRIPTION	CONTAINERS	SAMPLER	COMMENTS
5/25	10:15	U-6	TEDLAR BAG		WM	
5/25	11:15	U-7	"	1	WM	
5/25	12:10	U-8	"	1	WM	
5/25	12:50	U-9	"	1	WM	
/	:					
/	:					
/	:					
/	:					
/	:					
/	:					
/	:					
/	:					
/	:					
/	:					
/	:					

TRANSFER OF SAMPLES FROM FIELD SAMPLE CUSTODIAN (FSC):

RELEASED BY (FSC)	DATE AND TIME	RECEIVED BY	DATE AND TIME
W. R. Madden	5/25/93 4:00	W. R. Madden	5/25/93 4:00
	/ / :		/ / :
	/ / :		/ / :

ANALYSIS REQUIRED: _____

15991 Red Hill Ave., Suite 110, Tustin, California 92680-7388 (714) 259-9520 - FAX (714) 259-0372

CARNOT

CERTIFICATION OF SAMPLE RECEIPT

PROJECT # 10852 OUTSIDE LAB REQUIRED (Y/N) Y SAMPLE DATE 5/24/93

CLIENT/LOCATION SCE ElSegundo 4 PROJECT MANAGER EF

SAMPLE LOCATION Stack METHOD(S) SCAQMD 25.2 TECHNICIAN WM

COMPLIANCE TEST (Y/N) Y DATE DUE 5/2

	TEST #	COMPLETE DESCRIPTION		
1453-38	4-2-HC	Tedlar bag Sample	5/24/93	1115
-39	4-3-HC	"		1200
-40	4-4-HC	"		1345
-41	4-5-HC	"		1435

CHAIN OF CUSTODY PRIOR TO SHIPMENT:

RELEASED BY	DATE	TIME	RECEIVED BY	DATE	TIME
Jody L. Hone	5/25/93	:		/ /	:
	/ /	:		/ /	:
	/ /	:		/ /	:

OUTSIDE LAB INFORMATION

SAMPLES SHIPPED TO Atmospheric Assessment Assoc
21354 Nordhoff St. Ste 13
Chatsworth, CA 91311
PHONE: 818) 718-1070

CARNOT SHIPPER Jody Hone
DATE 5/25/93
CARRIER # Rite O Way
AIR BILL #

RECIPIENT Kent Peter
COMPANY AtmAA
DATE 5/25/93

15991 Red Hill Ave., Suite 110, Tustin, California 92680-7388 (714) 259-9520 - FAX (714) 259-0372

CARNOT

CERTIFICATION OF SAMPLE RECEIPT

PROJECT # 10852 OUTSIDE LAB REQUIRED (Y/N) Y SAMPLE DATE 5/25/93

PROJECT MANAGER EF

SAMPLE LOCATION STACK METHOD(S) SCAQMD 25.2 TECHNICIAN WM (ANALYZE BY)

COMPLIANCE TEST (Y/N) Y DATE DUE 5-28-93

TEST #	COMPLETE DESCRIPTION	
4-6-NH_3	1 TEDLAR BAG	91463 - 1
4-7-NH_3	1 TEDLAR BAG	2
4-8-HC	1 TEDLAR BAG	3
4-9-HC	1 TEDLAR BAG	4

CHAIN OF CUSTODY PRIOR TO SHIPMENT:

RELEASED BY	DATE	TIME	RECEIVED BY	DATE	TIME
Wayne Madden	5/26/93	8:57		5/26/93	8:57
	/ /	:		/ /	:
	/ /	:		/ /	:

OUTSIDE LAB INFORMATION

SAMPLES SHIPPED TO MIKE PORTER
ATMAA, INC.
CHATSWORTH, CA
PHONE: (818) 718-6070

CARNOT SHIPPER Wayne Madden
DATE 5/26/93
CARRIER # Right O' Way
AIR BILL #

RECIPIENT
COMPANY AtmAA
DATE 5/26/93

15991 Red Hill Ave., Suite 110, Tustin, California 92680-7388 (714) 259-9520 - FAX (714) 259-0372

CARNOT

CERTIFICATION OF SAMPLE RECEIPT

PROJECT # 10852 OUTSIDE LAB REQUIRED (Y/N) Y SAMPLE DATE 5 12519

PROJECT MANAGER EF

SAMPLE LOCATION STACK METHOD(S) SCAQMD 25.2 TECHNICIAN WM

ANALYZE BY

COMPLIANCE TEST (Y/N) Y DATE DUE 5-28-93

TEST #	COMPLETE DESCRIPTION
4-6-NH_3	1 TEDLAR BAG
4-7-NH_3	1 TEDLAR BAG
4-8-HC	1 TEDLAR BAG
4-9-HC	1 TEDLAR BAG

CHAIN OF CUSTODY PRIOR TO SHIPMENT:

RELEASED BY	DATE	TIME	RECEIVED BY	DATE	TIME
Wg R Madd	5126193	8:57	[signature]	5126193	8:57
	/ /	:		/ /	:
	/ /	:		/ /	:

OUTSIDE LAB INFORMATION

SAMPLES SHIPPED TO MIKE PORTER
ATMAA, INC.
CHATSWORTH, CA
PHONE: (818) 718-6020

CARNOT SHIPPER Wayne Madden
DATE 5'26'93
CARRIER # Right O' Way
AIR BILL #

RECIPIENT
COMPANY
DATE / /

15991 Red Hill Ave., Suite 110, Tustin, California 92680-7388 (714) 259-9520 - FAX (714) 259-0372

CARNOT

WORK AUTHORIZATION AND ANALYSIS INSTRUCTIONS FOR CONTRACT LABORATORIES

P.O. # 1175 AMOUNT $ 340

CHAIN OF CUSTODY AND SAMPLE IDENTIFICATION ✓ ATTACHED ___ LISTED BELOW ___ TO FOLLOW

PROJECT # 10 852

TYPE OF SAMPLE TEDLAR BAGS

OF SAMPLES IN TOTAL SHIPMENT 4

ANALYSIS INSTRUCTIONS:

ANALYZE THESE FOUR TEDLAR BAGS FOR COMPLIANCE FOLLOWING SCAQMD DRAFT 25.2 FOR CH_4 + TNMHC

REFERENCE METHOD REQUIRED:

SCAQMD 25.2

COMMENTS:

DELIVER REPORT TO ED FILADELPHIA

SIGNED Wm R. Mall

15991 Red Hill Ave., Suite 110, Tustin, California 92680-7388 (714) 259-9520 - FAX (714) 259-0372

CARNOT

CHAIN OF CUSTODY

PROJECT # 10852 OUTSIDE LAB REQUIRED (Y/N) Y SAMPLE DATE 2-1-1

CLIENT/LOCATION _____ PROJECT MANAGER EF

SAMPLE LOCATION STACK METHOD(S) SCAQMD 25.2 TECHNICIAN SM / MR

COMPLIANCE TEST (Y/N) Y DATE DUE _____

DATE	TIME	TEST #	SAMPLE DESCRIPTION	CONTAINERS	SAMPLER	COMMENTS
2-1	:	1		1		
1	:			1		
1	:	4		1		
1	:			1		
1	:					
1	:					
1	:					
1	:					
1	:					
1	:					
1	:					
1	:					
1	:					
1	:					
1	:					

TRANSFER OF SAMPLES FROM FIELD SAMPLE CUSTODIAN (FSC):

RELEASED BY (FSC)	DATE AND TIME	RECEIVED BY	DATE AND TIME
	/ / :		/ / :
	/ / :		/ / :
	/ / :		/ / :

ANALYSIS REQUIRED: ANALYZE FOUR (4) TEDLAR BAGS FOR COMPLIANCE RESULTS ACCORDING TO SCAQMD 25.2 (REPORT CH_4 + TNMHC IN PPM)

15991 Red Hill Ave., Suite 110, Tustin, California 92680-7388 (714) 259-9520 - FAX (714) 259-0372

CARNOT