San Marcos 10/93
LFG EFD

SAN MARCOS LANDFILL
TURBINE
70535)

*see attachment for data on
Plant eff.

– CORRECTED REPORT.

SOURCE TEST RESULTS FOR EMISSION TESTING OF LANDFILL ENERGY PARTNERS ENGINE NO. 1 AT SAN MARCOS LANDFILL

Prepared For:

LANDFILL ENERGY PARTNERS I
Newark, California

For Submittal To:

COUNTY OF SAN DIEGO AIR POLLUTION CONTROL DISTRICT
San Diego, California

Prepared By:

Craig H. Fry

CARNOT
Tustin, California

OCTOBER 1993

CARNOT

October 14, 1993
LAI1B-10338
R023C828.TL

Ms. Janet E. Cawyer
County of San Diego Air Pollution Control District
9150 Chesapeake Drive
San Diego, CA 92123-1096

Dear Ms. Cawyer:

Enclosed you will find two (2) copies of Carnot's revised report titled "**Source Test Results for Emission Testing of Landfill Energy Partners Engine No. 1 at San Marcos Landfill.**"

I have incorporated the changes for ppm @ 3% O_2 correction and a three point O_2 linearity.

If you have any questions, please give me a call at (714) 259-9520. Thank you for your help.

Sincerely,

CARNOT

Craig H. Fry
Field Measurement Specialist

CHF/wp

Enclosure

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

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.

Date 8/23/93

Craig H. Fry
Field Measurement Specialist

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.

Date 8-23-93

Eric A. Mazzi
Senior Engineer

TABLE OF CONTENTS

SECTION PAGE

1.0 INTRODUCTION 1

2.0 UNIT DESCRIPTION 3

3.0 TEST DESCRIPTION 4
- 3.1 TEST CONDITIONS 4
- 3.2 SAMPLE LOCATION 4
- 3.3 TEST PROCEDURES 4
  - 3.3.1 Oxygen, Carbon Dioxide, Carbon Monoxide and Nitrogen Oxides 4

4.0 RESULTS 8

A MEASUREMENT PROCEDURES A-1

B QUALITY ASSURANCE B-1
- B.1 Quality Assurance Program Summary B-2
- B.2 ARB Certification B-7
- B.3 Calibration Data B-8

C FIELD DATA AND SOURCE TEST CALCULATIONS C-1
- C.1 Sample Locations C-2
- C.2 CEM Correction Spreadsheets C-3
- C.3 CEM Raw Data C-4
- C.4 CEM Strip Charts C-5
- C.5 CEM O_2 Linearity C-6

D CALCULATIONS D-1
- D.1 General Emissions Calculations D-2

SECTION 1.0

INTRODUCTION

Carnot has been contracted by Landfill Energy Partners I to perform source testing on the landfill gas fired turbine No. 1 located at San Marcos Landfill in San Marcos, California. The source testing is required to show compliance with the County of San Diego Air Pollution Control District (SDAPCD), Permit to Operate No. 870535.

On March 30 1993, the SDAPCD conducted source testing on Engine No. 1 and found the NO_x @ 3% O_2 emission to be in exceedance of the permit limit. Carnot repeated the NO_x testing at the same operating condition, but with only one turbine operating at the time of sampling as specified in the SDAPCD Permit to Operate test conditions. In addition, measurements of exhaust CO, O_2, and CO_2 were conducted on the turbine. A description of test methods and procedures is described in detail in Section 3.0

The source testing was conducted on August 9, 1993. The measurements were performed by Craig Fry and Robert Conklin of Carnot. Bruno Lukosz of Landfill Energy Partners was on site during testing to operate the turbines. Janet Cawyer of the SDAPCD was on site during all testing for observation.

A summary of the results is presented in Table 1-1. The results of testing found the turbine NO_x emissions to be in exceedance of the SDAPCD permit conditions of 263 ppm @ 3% O_2. Table 4-1 presents detailed results of the testing conducted on the turbine. All field raw data is included in the appendices.

TABLE 1-1
SUMMARY OF TEST RESULTS
SAN MARCOS LANDFILL TURBINE NO. 1
STACK EXHAUST
AUGUST 9, 1993

Parameter	Exhaust	Permit Limit	Applicable SCAQMD Rule
O_2, % dry	17.5		
CO_2, % dry	3.0		
CO, ppm	6.2 ✓		
CO, ppm @ 3% O_2	32.3 ✓	325	P/C
NO_x, ppm	57.1 ✓		
NO_x, ppm @ 3% O_2	297 ✓	263	P/C

NOTE: The results in this table are the averages of triplicate measurements. See Section 4.0 for complete emission test results. The NO_x concentration has been adjusted for NO_2 recovery.

P/C - SDAPCD Permit Operating Condition Application No. 870535

SECTION 2.0

UNIT DESCRIPTION

The Landfill Energy Partner Engine #1 is a Solar Saturn recuperated gas turbine Model GSC 1200 R. The turbine is a component of San Marcos Landfill Gas Recovery System which extracts the landfill gas and uses the turbine to incinerate the extracted vapor. The turbine burns 304 scfm of landfill gas and generates 710 KW of electrical power. The turbine uses only combustion optimization for emission control.

SECTION 3.0

TEST DESCRIPTION

3.1 TEST CONDITIONS

The turbine was operated at normal load during testing. Turbine No. 2 was shut off during testing as specified in the SDAPCD Permit to Operate. The turbine was burning approximately 304 scfm of landfill gas and produced 711 KW of electrical power during testing conditions.

3.2 SAMPLE LOCATION

Exhaust measurements were conducted at the stack sample location. Two ½ inch ports at 90° from each other are located 66 inches above the silencer and 78 inches below the stack exit. The stack diameter is 32 inches, which gives 2.1 duct diameters downstream and 2.4 duct diameters upstream from all flow disturbances. Figure 3-1 is a diagram of the stack sampling location.

3.3 TEST PROCEDURES

The test procedures used for the turbine testing are summarized in Table 3-1. The procedures selected are consistent with SDAPCD source test methods. Brief discussions of each procedure are given below in Section 3.3.1.

3.3.1 Oxygen, Carbon Dioxide, Carbon Monoxide and Nitrogen Oxides

Measurements of O_2, CO_2, CO, and NO_x at the exhaust were conducted following SDAPCD Methods 3A and 20 sampling techniques using continuous emission monitoring system (CEMS).

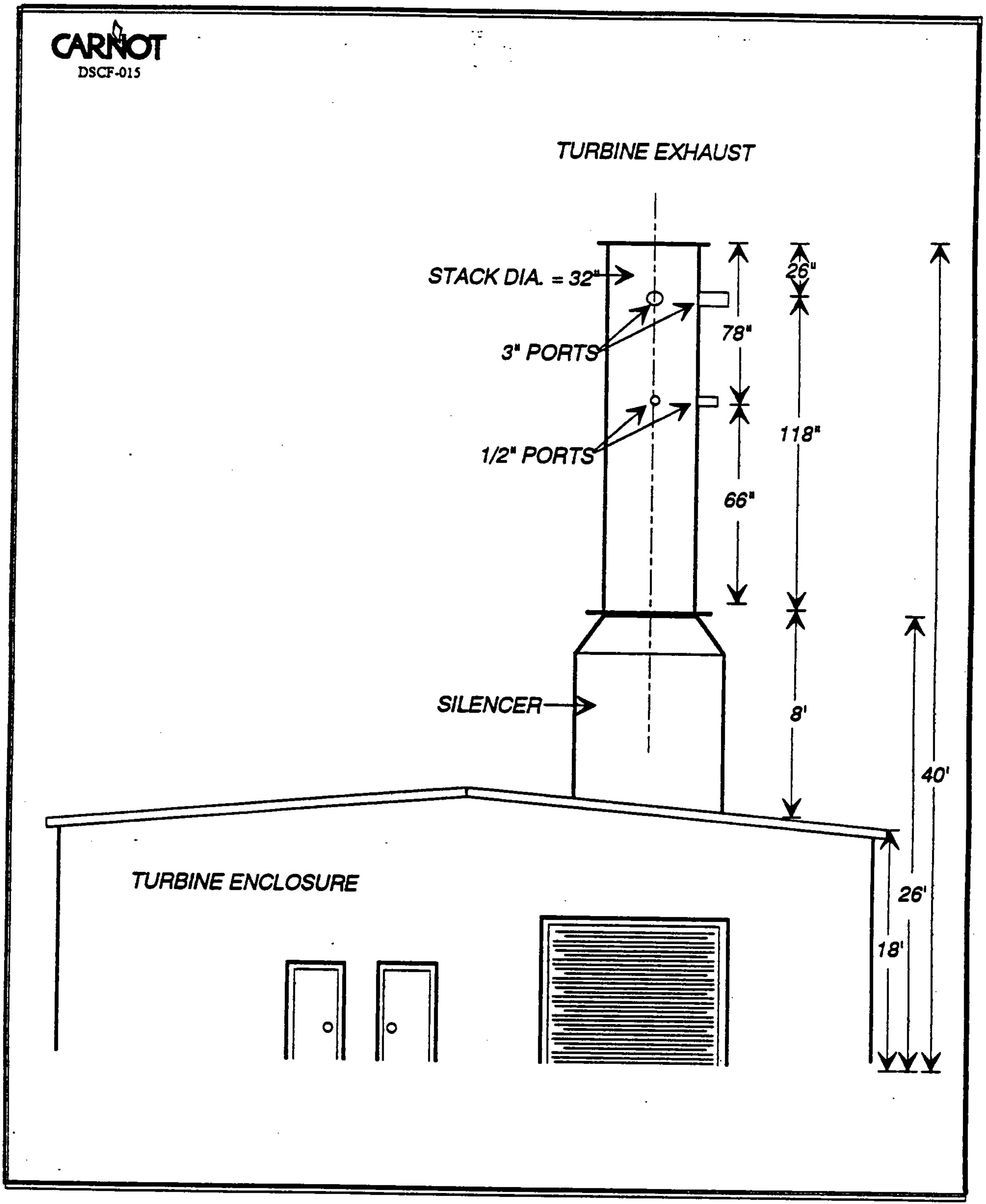


Figure 3-1. Diagram of Turbine No. 1 Exhaust Sampling Location

TABLE 3-1
TURBINE SOURCE TEST PROCEDURES

Parameter	Sampling Method	Analytical Technique	Reference Method
NO_x, NO, NO_2	CEMS	Chemiluminescent	SDAPCD 20
O_2	CEMS	Micro Fuel Call	SDAPCD 3A & 20
CO_2	CEMS	NDIR	SDAPCD 3A
CO	CEMS	NDIR/GFC	SDAPCD 20

These CEMS measurements were made using Carnot's continuous emissions monitoring system described in Appendix A. The sampling system uses a stainless steel probe connected to a 25' heated teflon line. The sample then travels through a moisture knockout cooled with dry ice. A peristaltic pump continuously drains the moisture knockout when not frozen. The sample is then transported to the mobile CEMS via teflon tubing to an additional conditioning and filtering system. Leak checks were conducted prior to and at the completion of the test project. The leak checks were conducted by operating the sample pump, plugging the probe inlet and all pressure side system exits except for one analyzer rotameter, then measuring the leakage rate on the rotameter.

For this testing project, the SDAPCD Method 20 for high NO_2 sampling procedures were used since it has been demonstrated that more than 5% of the NO_x emissions is NO_2. The testing procedure using this method is described below.

A pretest CEMS calibration series was conducted on site. A three point calibration was performed first using high, mid and zero span gas. Instrument linearity response of ±2% of span value is acceptable. A NO_x conversion efficiency test was performed by introducing NO_2 gas at a known concentration and recording the conversion to NO through the NO_x converter. The analyzer was switched from NO_x to NO mode of operation and the NO_2 concentration response is recorded. An efficiency of 90% conversion is acceptable. The NO_2 gas was then directed to the probe tip for an NO_2 system recovery test. An 85% recovery of NO_2 is required for acceptability.

Triplicate 40 minute tests were conducted. Each test was conducted for 30 minutes in NO_x operational mode and 10 minutes in the NO operational mode. NO_2 concentration was determined by difference.

EPA Protocol 1 Calibration Gas was used for CO and NO_x analyzer calibration. All other gases were manufacturer certified to be ±1% and traceable to NIST. A pre- and post-test system recovery check was conducted for each test run. The system recovery check was conducted by delivering zero and span gas to the CEMS probe tip and recording the as-found species concentration. No analyzer adjustments were made between these pre- and post-system recovery checks. Calculations for the correction of measured system recovery and instrument drift were applied to each test run. The allowable limit of system recovery deviation is 5% of instrument range.

A post test NO_2 recovery test was conducted similar to the NO_2 recovery pre-test. The NO_x concentrations are adjusted for NO_2 loss by applying the average NO_2 recovery results to the NO_2 concentration and adding them back to the NO_x concentration. O_2, CO_2 and CO concentrations were averaged for the 40-minute test duration and the NO_x concentration was averaged for the 30-minute period in the NO_x mode. The correction for NO_x and CO ppm @ 3% O_2 uses 20.95% O_2.

SECTION 4.0

RESULTS

The results of the source test on the San Marcos Landfill Turbine No. 1 are presented in Table 4-1. The results indicate that the turbine is operating in exceedance of the SDAPCD Permit to Operate No. 870535 NO_x limit of 263 ppm @ 3% O_2. The average NO_x ppm @ 3% O_2 is 297. Carbon monoxide is 32.3 ppm @ 3% O_2, which is below the permit limit of 325.

TABLE 4-1
GENERAL RESULTS
SAN MARCOS LANDFILL TURBINE NO. 1
STACK EXHAUST
AUGUST 9, 1993

Parameter	First Run	Second Run	Third Run	Average
O_2, % dry	17.4 ✓	17.5 ✓	17.6 ✓	17.5 ✓
CO_2, % dry	3.0	3.0	3.0	3.0 ✓
CO, ppm	5.6 ✓	6.3 ✓	6.6 ✓	6.2 ✓
CO, ppm @ 3% O_2	28.3 ✓	32.8 ✓	35.4 ✓	32.3 ✓
NO_x, ppm	55.5 ✓	58.3 ✓	57.5 ✓	57.1 ✓
NO_2 ppm	5.4 ✓	6.5 ✓	5.1 ✓	5.7 ✓
NO_x, ppm @ 3% O_2	281 ✓	303 ✓	308 ✓	297 ✓

NOTE: The NO_x and NO_2 concentration has been adjusted for NO_2 recovery.

APPENDIX A
MEASUREMENT PROCEDURES

Continuous Emissions Monitoring System
Oxygen (O_2) by Continuous Analyzer
Carbon Dioxide (CO_2) by Continuous Analyzer
NO/NO_x by Continuous Analyzer
Carbon Monoxide (CO) by NDIR/Gas Filter Correlation

Continuous Emissions Monitoring System

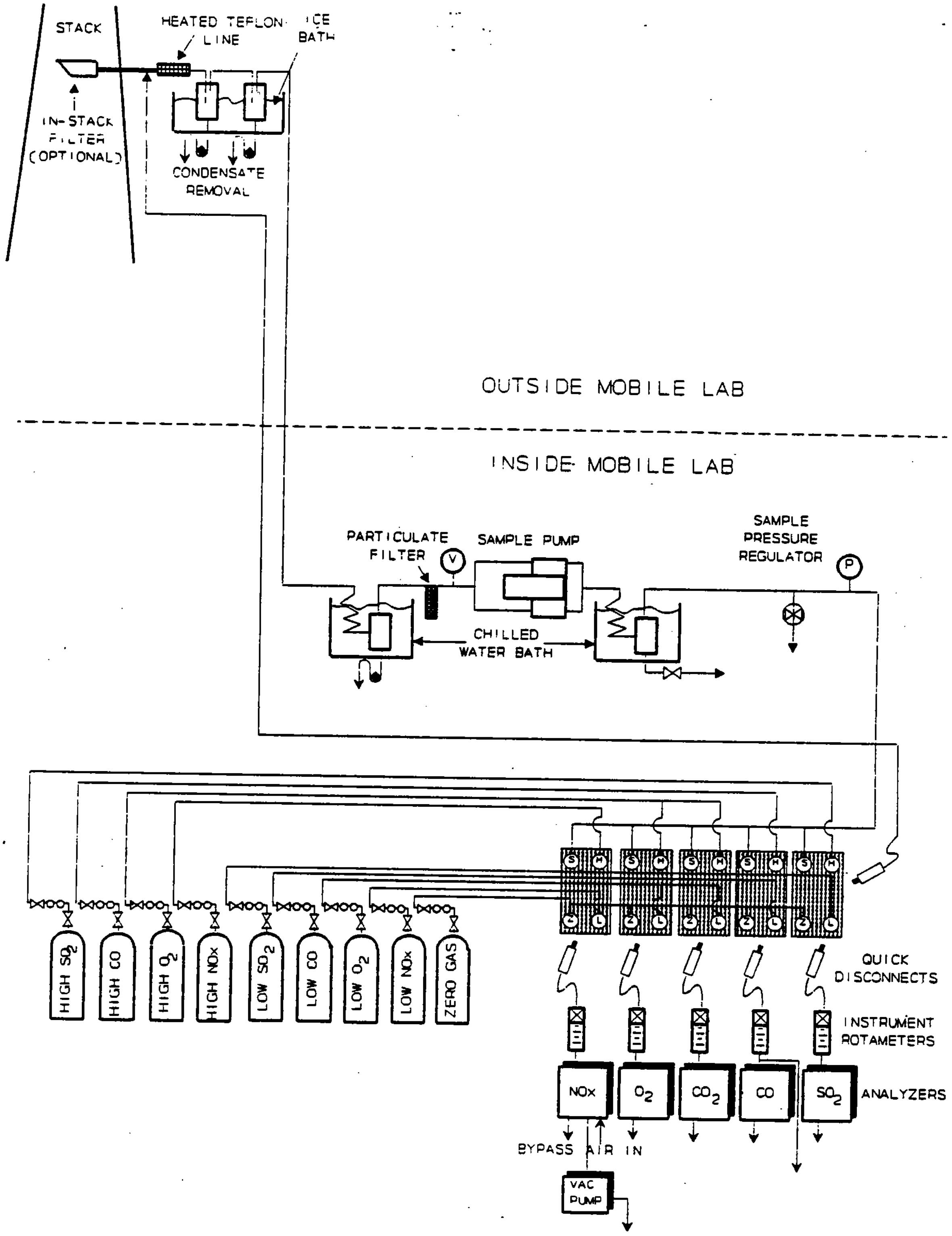
O_2, CO, CO_2, NO, NO_x and SO_2 are measured using an extractive continuous emissions monitoring (CEM) package, shown in the following figure. This package is comprised of three basic subsystems. They are: (1) the sample acquisition and conditioning system, (2) the calibration gas system, and (3) the 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 and/or SO_2 are 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 and SO_2 are 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 (≈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 (± 2% of scale), the cell is replaced.

Method:	**Carbon Dioxide (CO_2) by Continuous Analyzer**
Applicable Reference Methods:	EPA 3A, ARB 100, BA ST-5, 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_2 concentration.
Analyzer:	Horiba PIR 2000
Measurement Principle:	Non-dispersive infrared (NDIR)
Accuracy:	1% of full scale
Ranges:	0-5, 0-10, 0-25%
Output:	0-10 mV
Interferences:	A possible interference includes water. Since the instrument receives dried sample gas, this interference is not significant.
Response Time:	1.2 seconds
Sampling Procedure:	A representative flue gas sample is collected and conditioned using the CEM system described previously.
Analytical Procedure:	Carbon dioxide concentrations are measured by short path length non-dispersive infrared analyzers. These instruments measure the differential in infrared energy absorbed from energy beams passed through a reference cell (containing a gas selected to have minimal absorption of infrared energy in the wavelength absorbed by the gas component of interest) and a sample cell through which the sample gas flows continuously. The differential absorption appears as a reading on a scale of 0 to 100%.

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.

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

L McKinney
Laura McKinney, Manager
Investigation and Certification Section

Appendix B.3
Calibration Data

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

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

Purchase Order 9895
Project # 25797.006

ANALYTICAL INFORMATION

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

Cylinder Number ALM 035858
Cylinder Pressure 1950 psig
Certification Date 05-26-93
Previous Certification Dates NONE
Acid Rain Exp 11-26-94
General Exp 05-26-95

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
NITRIC OXIDE	89.26PPM	± 1 % NIST Traceable

Balance Gas: Nitrogen

NOX	90.11 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
CRM 1684B	09-94	ALM24490	95.30PPM NITRIC OXIDE

INSTRUMENTATION

Instrument/Model/Serial #	Last Date Calibrated	Analytical Principle
TECO / 10AR / 14853-150	04-30-93	Chemi-Luminescent

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

Components
NITRIC OXIDE

First Triad Analysis

Date: 04-12-93	Response Units: mv	
Z1= 0.00	R1= 95.20	T1= 89.40
R2= 94.89	Z2= 0.00	T2= 89.51
Z3= 0.00	T3= 89.52	R3= 95.12
Avg. Conc. of Cust Cyl.	89.69PPM	

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: 05-26-93	Response Units: mv	
Z1= 0.00	R1= 95.30	T1= 88.78
R2= 95.24	Z2= 0.00	T2= 88.80
Z3= 0.00	T3= 85.85	R3= 95.30
Avg. Conc. of Cust Cyl.	88.83 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.		

Calibration Curve

Concentration= Ax + B
A =1.003248165
B =0.65344292

Concentration=

Concentration=

Special Notes : If this product is used for Aicd Rain Rule Compliance, the Acid Rain Expiration Date noted above applies per 40 CFR Part 75, Appendix H. Otherwise the General Expiration Date applies

George King
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

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

Purchase Order 9895
Project # 25796.004

ANALYTICAL INFORMATION

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

Cylinder Number AAL261
Cylinder Pressure 2000 psig
Certification Date 06-08-93
Previous Certification Dates NONE
Acid Rain Exp 12-08-94
General Exp 06-08-95

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
NITRIC OXIDE	49.20 PPM	± 1 % NIST Traceable
Balance Gas: Nitrogen		
NOX	49.87 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
GMIS	05-11-93	AAL14822	89.20 ppm

INSTRUMENTATION

Instrument/Model/Serial #	Last Date Calibrated	Analytical Principle
TECO / 10AR / 38644-258	05-11-93	Chemi-Luminescent

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

Components
Nitric Oxide

First Triad Analysis

Date: 06-01-93		Response Units: mv	
Z1= 0.00	R1= 88.64	T1= 48.82	
R2= 88.71	Z2= 0.00	T2= 48.76	
Z3= 0.00	T3= 48.80	R3= 88.65	
Avg. Conc. of Cust Cyl.		49.09 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: 06-08-93		Response Units: mv
Z1= 0.00	R1= 89.23	T1= 49.35
R2= 89.22	Z2= 0.00	T2= 49.30
Z3= 0.00	T3= 49.29	R3= 89.20
Avg. Conc. of Cust Cyl.		49.30 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.		

Calibration Curve

Concentration= Ax^2+Bx+C
A =-0.0005080
B =1.054
C =-0.1090

Concentration=

Concentration=

Special Notes: If this product is used for Acid Rain Rule Compliance, the Acid Rain Expiration Date noted above applies per 40 CFR Part 75, Appendix H. Otherwise the General Expiration Date applies

Analyst Joseph De La Torre

CARNOT
SPAN GAS RECORD

CLIENT/LOCATION: Landfill Energy

DATE: 8-9-93

BY: CHF

GAS	SPAN CYLINDER		AUX. SPAN CYLINDER	
	CYLINDER NO.	CONCENTRATION	CYLINDER NO.	CONCENTRATION
ZERO				
NOx	AAL261	49,87	ALM035858	90.11
O_2	AAL6069	8.015	ALM5618	12.48
CO	AAL21065	11,12	AAL7964	16,17
CO_2	AAL6089	22.41	ALM5618	14,98
~~SO_2~~ NO_2	BL4168	79,3		22.4

CARNOT
INSTRUMENT LINEARITY

	ANALYZER				
	O_2	CO_2	CO	NOx	SO_2
ANALYZER RANGE	0-25	0-25	0-20	0-100	
SET TO HIGH STD (80-90% OF RANGE)	12.48	22.41	16.17	90.11	
ACTUAL VALUE OF LOW STD	8.015	14.98	11,12	49,87	
AS-FOUND LOW STD (50-60% OF RANGE)	8,075	14,95	11,5	49,7	
DIFFERENCE IN % OF FULL SCALE					

% 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).

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

15991 RED HILL AVE
SUITE 110
TUSTIN CA 92680

PROJECT #: 02-26734-001
PO#: 1101
ITEM #: 02023124 1BL
DATE: 8/04/93

CYLINDER #: BAL4168
ANALYTICAL ACCURACY: +/-1%
FILL PRESSURE: 2000 PSIG
BLEND TYPE : GRAVIMETRIC MASTER GAS

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
NITROGEN DIOXIDE	80.	PPM	79.30	PPM
NITROGEN		BAL		BAL

8/5 BIN#10 2000 PSIG
CERTIFIED TO HAVE BEEN BLENDED AND VERIFIED TO BE CORRECT BY ANALYSIS.

GRAVIMETRIC MASTER GAS - AGAINST NIST CERTIFIED WEIGHTS INDEPENDENT LABORATORY

ANALYST: GEORGE KING

APPROVED BY: Robert Shealy
ROBERT SHEALY

PLUMSTEADVILLE, PENNSYLVANIA / TROY, MICHIGAN / HOUSTON, TEXAS / DURHAM, NORTH CAROLINA
SOUTH PLAINFIELD, NEW JERSEY / FREMONT, CALIFORNIA / WAKEFIELD, MASSACHUSETTS / LONGMONT, COLORADO

Scott Specialty Gases, Inc.

2600 CAJON BOULEVARD, SAN BERNARDINO, CA 92411 (909) 887-2571 FAX: (909) 8

CERTIFICATE OF ANALYSIS: EPA PROTOCOL GAS

Customer	**Assay Laboratory**	
CARNOT	Scott Specialty Gases	Pur
ATTN: RICK MADRIGAL	2600 Cajon Boulevard	Proj
15991 RED HILL AVE	San Bernardino, CA 92411	
SUITE 110		
TUSTIN, CA 92680		

ANALYTICAL INFORMATION

Certified to exceed the minimum specifications of EPA Protocol 1 Procedure #G1, Section Number 3.

Cylinder Number	ALM 035858	**Certification Date**	05-26-93	Acid
Cylinder Pressure	1950 psig	**Previous Certification Dates**	NONE	Gener

ANALYZED CYLINDER

Components	**Certified Concentration**	**Anal**
NITRIC OXIDE	89.26PPM	±1

Balance Gas: Nitrogen

NOX	98.11 ppm

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

REFERENCE STANDARD

Type	**Expiration Date**	**Cylinder Number**	**Con**
CRM 1684B	09-94	ALM24490	95.3

INSTRUMENTATION

Instrument/Model/Serial #	**Last Date Calibrated**	**Anal**
TECO / 10AR / 14853-150	04-30-93	Chem

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

Components: NITRIC OXIDE

First Triad Analysis

Date: 04-12-93	Response Units: mv	
Z1= 0.00	R1= 95.20	T1= 89.40
R2= 94.89	Z2= 0.00	T2= 89.51
Z3= 0.00	T3= 89.52	R3= 95.12
Avg. Conc. of Cust Cyl.	89.69PPM	

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: 05-26-93	Response Units: mv	
Z1= 0.00	R1= 95.30	T1= 88.78
R2= 95.24	Z2= 0.00	T2= 88.80
Z3= 0.00	T3= 85.85	R3= 95.30
Avg. Conc. of Cust Cyl.	88.83 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.		

Special Notes : If this product is used for Aicd Rain Rule Compliance, the Acid Rain Expiration per 40 CFR Part 75, Appendix H. Otherwise the General Expiration Date applies

Analy

Assay ____________

Analyst ____ M. JOHNSON ____

Approved By: ____________
A.F. LANCE, Ph.D., MANAGER, QA

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To Rick Madrigal	From Nancy Wallace
Co. Carnot	Co. SSG
Dept.	Phone #
Fax # 714-259-0372	Fax #

Scott Specialty
2600 CAJON BLVD., SAN BERNARDIN

CARNOT
JIM MULLIGAN
15991 RED HILL AVE
SUITE 110
TUSTIN CA 92680

Shipped From: Scott SAN BERNARDINO, CA
Date Shipped 06/11/92
Our Project No: 19562
Your P.O. No: 8346
Page 1 of 1
Expiration Date: 12/93

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES

Certified Per Traceability Protocol No. 1 Procedure No. G1 Cylinder No. AAL21065 Cylinder Pressure 2000 PSIG Certified Accuracy ±1% % NIST Traceable

		REFERENCE STD			GAS ANALYZER		
COMPONENTS	CERTIFIED CONC	SRM/CRM NO.	CYL. NO.	CONC.	MAKE/MODEL/SERIAL NO.	LAST CAL. DATE	ANALYTICAL PRINCIPLE
CARBON MONOXIDE	11.12 PPM	SRM1677	CAL5078	9.900 PPM	HORIBA AIA-24 4564403	06/03/92	

BALANCE GAS NITROGEN

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

Component CARBON MONOXIDE
First Analysis Date 06/09/92 Units mv
Z 00.00 R 19.5 T 22.0
R 19.5 Z 00.01 T 22.0
Z 00.07 T 22.0 R 19.5
Mean Test Assay 11.15 PPM
Second Analysis Date 06/16/92 Units mv
Z 00.0 R 19.5 T 21.9
R 19.5 Z 00.0 T 21.9
Z 00.0 T 21.9 R 19.5
Mean Test Assay 11.09 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: RICH MADRIGAL
15991 RED HILL AVE
SUITE 110
TUSTIN CA 92680

PROJECT #: 02-20636
PO#: 8641
ITEM #: 0202C3013601AL
DATE: 7/15/92

CYLINDER #: AAL6069
FILL PRESSURE: 1950 PSIG

ANALYTICAL ACCURACY: +/-1%

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
CARBON DIOXIDE	22.5	PCT	22.41	PCT
OXYGEN	8.	PCT	8.015	PCT
NITROGEN		BAL		BAL

ARNOT 7/16 BIN 1
ERTIFIED TO HAVE BEEN BLENDED
ND VERIFIED TO BE CORRECT BY
NALYSIS.

GRAVIMETRIC MASTER GAS -
AGAINST NIST CERTIFIED WEIGHTS
INDEPENDENT LABORATORY

NALYST: M.J.
MAYNARD JOHNSON

APPROVED BY:
DR ARMAND LANGE PHD

Scott Specialty Gases, Inc.

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

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CARNO

CERTIFICATE OF ANALYSIS

CARNOT
RICK MADRIGAL
15991 RED HILL AVE
TUSTIN CA 92680

PROJECT #: 02-22392
PO#: 9059
ITEM #: 0202C3000701AL
DATE: 10/30/92

CYLINDER #: ALM005618
FILL PRESSURE: 2000 PSIG

ANALYTICAL ACCURACY: +/-1%

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
CARBON DIOXIDE	15.	PCT	14.98	PCT
OXYGEN	12.5	PCT	12.48	PCT
NITROGEN		BAL		BAL

CERTIFI

ARNOT 11/5 BIN#10
ERTIFIED TO HAVE BEEN BLENDED
ND VERIFIED TO BE CORRECT BY
NALYSIS.

GRAVIMETRIC MASTER GAS -
AGAINST NIST CERTIFIED WEIGHTS
INDEPENDENT LABORATORY

NALYST: ______________
JOSEPH DE LA TORRE

APPROVED BY: ______________
DR.ARMAND LANGE,PH.D

APPENDIX C

FIELD DATA AND SOURCE TEST CALCULATIONS

Appendix C.1

Sample Locations

CARNOT
SAMPLING POINT LOCATION DATA - EPA METHOD 1

PLANT: SAN MARCOS LANDFILL DATA BY: BC

DATE: 8/9/93

TEST LOCATION: STACK

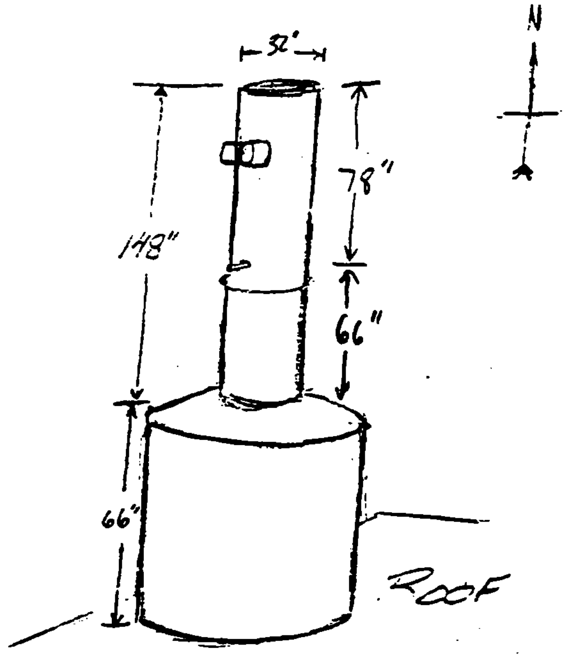


Diagram of Sampling Location

UPSTREAM DIST./DIA.: 2.44

DOWNSTREAM DIST./DIA.: 2.06

COUPLING LENGTH: 6"

NO. OF SAMPLING PTS.: 18

STACK DIMENSION: 32"

STACK AREA, FT²: 5.59

SAMPLE POINT	% OF DIAMETER	IN. FROM NEAR WALL	IN. FROM NOZZLE*
1	3.2	1.0	6.0
2	10.5	3.4	9.4
3	19.4	6.2	15.2
4	32.3	10.3	16.3
5	67.7	21.7	27.6
6	80.6	25.8	31.8
7	89.5	28.6	34.6
8	96.8	31.0	37.0

*INCHES FROM WALL PLUS COUPLING LENGTH

Appendix C.2

CEM Correction Spreadsheets

NO2 CORRECTION CALCULATIONS

NO2 RECOVERY %

	PRE TEST	POST TEST	AVERAGE
NO2 ppm	70.5	71	
NO2 RECOVERY ppm	63.2	66.5	
% RECOVERY	89.6	93.7	91.7

NO2 CORRECTION

	First Run	Second Run	Third Run
NO2 raw ppm	5.0	6.0	4.7
NO2 corr. ppm	5.4	6.5	5.1
NOx raw ppm	55.1	57.8	57.1
NOx corr. ppm	55.5	58.3	57.5

CEM System Bias and Linearity Correction Calculations

Test No 1-CEM-1

	O2	CO2	CO	NOx	Acceptance Criteria	Ru Stat
		Linearity				
Analyzer Range	25	25	20	100		
High Cal	12.48	22.41	16.17	90.11		
Low Cal	8.015	14.98	11.12	49.87		
Analyzer Reads	8.08	14.95	11.50	49.70		
Analyzer Cal. Error,%	0.2	-0.1	1.9	-0.2	< 2%	PASS
		System Bias				
Pretest Bias						
Zero	0.08	0.00	0.70	0.30	< 5%	PASS
Span	12.50	14.75	11.16	49.10	< 5%	PASS
Posttest Bias						
Zero	0.13	0.00	0.20	0.80	< 5%	PASS
Span	12.40	14.80	11.00	50.00	< 5%	PASS
Span Value	12.48	14.98	11.16	49.87		
Zero Drift, %	0.18	0.00	-2.50	0.50	< 3%	PASS
Span Drift, %	-0.40	0.20	-0.80	0.90	< 3%	PASS
Test Ave.	17.32	2.95	5.80	54.70		
Corrected Ave.	17.40	2.99	5.62	55.11		

CEM System Bias and Linearity Correction Calculations

Test No 2-CEM-1

	O2	CO2	CO	NOx	Acceptance Criteria	Run Statu
		Linearity				
Analyzer Range	25	25	20	100		
High Cal	12.48	22.41	16.17	90.11		
Low Cal	8.015	14.98	11.12	49.87		
Analyzer Reads	8.08	14.95	11.50	49.70		
Analyzer Cal. Error,%	0.2	-0.1	1.9	-0.2	< 2%	PASS
		System Bias				
Pretest Bias						
Zero	0.13	0.00	0.10	0.60	< 5%	PASS
Span	12.42	14.90	11.16	49.20	< 5%	PASS
Posttest Bias						
Zero	0.13	0.00	0.00	1.00	< 5%	PASS
Span	12.38	14.80	11.20	48.20	< 5%	PASS
Span Value	12.48	14.98	11.16	49.87		
Zero Drift, %	0.00	0.00	-0.50	0.40	< 3%	PASS
Span Drift, %	-0.16	-0.40	0.20	-1.00	< 3%	PASS
Test Ave.	17.33	2.95	6.35	56.30		
Corrected Ave.	17.49	2.98	6.32	57.78		

CEM System Bias and Linearity Correction Calculations

Test No 3-CEM-1

	O2	CO2	CO	NOx	Acceptance Criteria	Run Statu
		Linearity				
Analyzer Range	25	25	20	100		
High Cal	12.48	22.41	16.17	90.11		
Low Cal	8.015	14.98	11.12	49.87		
Analyzer Reads	8.08	14.95	11.50	49.70		
Analyzer Cal. Error,%	0.2	-0.1	1.9	-0.2	< 2%	PASS
		System Bias				
Pretest Bias						
Zero	0.00	0.00	0.00	0.20	< 5%	PASS
Span	12.52	14.98	11.20	49.90	< 5%	PASS
Posttest Bias						
Zero	0.00	0.00	0.00	0.20	< 5%	PASS
Span	12.48	14.95	11.16	48.20	< 5%	PASS
Span Value	12.48	14.98	11.16	49.87		
Zero Drift, %	0.00	0.00	0.00	0.00	< 3%	PASS
Span Drift, %	-0.16	-0.12	-0.20	-1.70	< 3%	PASS
Test Ave.	17.60	2.95	6.60	56.10		
Corrected Ave.	17.57	2.95	6.59	57.07		

Appendix C.3

CEM Raw Data

CARNOT

PAGE ____ OF ____

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: Landfill Energy

CONDITION: ____

ATE: 8-9-93

OPERATOR: CHF

TEST NUMBER: 2-CEM-1

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												
		AS FOUND ANAL. SPAN										
		SYSTEM ZERO	.13	.00	.1	.6						
		SYSTEM SPAN	12.42	14.9	11.16	49.2						
	BEGIN 1210 END 1220	Start	17.4	2.95	6.4	55.2						
	BEGIN 20 END 30		17.3	2.95	6.4	56.8						
	BEGIN 30 END 40		17.3	2.95	6.0	56.9						
	BEGIN 40 END 1250	NO_2	17.3	2.95	6.6	56.7	50.7	6.0				
	BEGIN END											
	BEGIN END											
	BEGIN END											
	BEGIN END											
	BEGIN END											
	BEGIN END											
	BEGIN END											
	BEGIN END											
		SYSTEM ZERO	.13	.00	0.0	1.0						
		SYSTEM SPAN	12.38	14.8	11.2	48.2						
RAW AVERAGE			17.33	2.95	6.35	56.3		6.0				
CORRECTED AVERAGE												
COMMENTS:												

CARNOT

PAGE ____ OF ____

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: Land fill Energy

DATE: 8-9-93

TEST NUMBER: 1-CEM-1

CONDITION: Full Load

OPERATOR: CHF

TEST LOCATION: Turbine No. 1 Stk.

TEST NO.	TIME	SAMPLE POINT/ CONDITION	DRY, UNCORRECTED O_2	CO_2	CO	NOx	NO	NO_2	SO_2	CORRECTED TO ___% ___, DRY CO	NOx	SO_2
SPAN GAS CONCENTRATION												
		AS FOUND ANAL. SPAN										
		SYSTEM ZERO										
		SYSTEM SPAN										
	BEGIN 954 END	High	12.48	22.41	16.2	90.11						
	BEGIN --- END	Low	8.075	14.95	11.5	49.7						
	BEGIN --- END	Zero	.03	.03	.02	.1						
	BEGIN --- END	NO_2					0.0	70.5				
	BEGIN --- END	NO_2 Recovery						63.2		89.6% Recovery		
	BEGIN 1043 END	System Zero	.08	0.0	0.7	.3						
	BEGIN --- END	System Span	12.5	14.75	16.16	49.1						
	BEGIN 1100 END 1110	Start	17.33	2.95	5.0	54.3						
	BEGIN 1110 END 1120		17.33	2.95	5.2	54.9						
	BEGIN 1120 END 1130		17.3	2.95	6.4	54.8						
	BEGIN 1130 END 1140	NO_2	17.3	2.95	6.6	55.0	50.0	5.0				
	BEGIN 1140 END	End										
		SYSTEM ZERO	.125	.0	.2	.8						
		SYSTEM SPAN	12.4	14.8	11.0	50.0						
RAW AVERAGE			17.32	2.95	5.8	54.7		5.0				
CORRECTED AVERAGE												
COMMENTS:												

PMF-C39

CARNOT

O_2 CO_2 CO Test averaged for 40 mins
NOx Test average for 30 mins

CARNOT

PAGE ___ OF ___

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: Landfill Energy

CONDITION:

DATE: 8-9-93

OPERATOR: CHF

TEST NUMBER: 3-CEM-1

TEST LOCATION:

TEST NO.	TIME	SAMPLE POINT/ CONDITION	DRY, UNCORRECTED O$_2$	CO$_2$	CO	NOx	NO	NO$_2$	SO$_2$	CORRECTED TO ___% ___, DRY CO	NOx	SO$_2$
SPAN GAS CONCENTRATION												
		AS FOUND ANAL SPAN										
		SYSTEM ZERO	0.0	0.0	0.0	0.2						
		SYSTEM SPAN	12.52	14.98	11.2	49.9						
	BEGIN 1315 END 1325	Stack	17.6	2.95	7.0	55.7						
	BEGIN 1325 END 1335		17.6	2.95	6.8	56						
	BEGIN 1335 END 1345		17.6	2.95	6.2	56.5						
	BEGIN 1349 END 1359	NO_2	17.6	2.95	6.4	55	50.3	4.7				
	BEGIN --- END											
	BEGIN END ---	NO_2 Direct					.2	71				
	BEGIN END ---	NO_2 Recovery Test					-	66.5		93.7	%	recov
	BEGIN --- END											
	BEGIN --- END											
	BEGIN --- END											
	BEGIN --- END											
	BEGIN --- END											
		SYSTEM ZERO	0.0	0.0	0.0	.2						
		SYSTEM SPAN	12.48	14.95	11.16	48.2						
RAW AVERAGE			17.6	2.95	6.6	56.1		4.7				
CORRECTED AVERAGE											303	
COMMENTS:												

PMF-C39

CARNOT

O_2, CO_2, CO Test averaged for 40 mins

NOx averaged for 30 min

NO_2 from 10 min test

For all

Th Test

CARNOT
CEM PERFORMANCE DATA

CLIENT/LOCATION: Land fill Energy DATE: 8-9-93

BY: CHF

SYSTEM CONFIGURATION

ANALYZERS IN SERVICE

ANALYZERS:	O_2	CO_2	CO	NOx
MODEL:	Teledyne	Horiba 2000	Thermo 48	Thermo E 'c
SERIAL NO.:	46124	912017		10AR-30333-257

PROBE

LENGTH: 3'

LINER MATERIAL: SS

HEATED PROBE (Y/N): N

HEATED LINE (Y/N): Y

SAMPLE CONDITIONER

CONDENSER-VACUUM SIDE (CHECK FLOW): ✓

CONDENSER-PRESSURE SIDE (CHECK FLOW): ✓

CONDENSER TEMPERATURE: 34

FILTER CONDITION (COND. OR DATE LAST CHANGED): Good

SAMPLE LINE

LENGTH: 100

LINER MATERIAL: Teflon

SYSTEM BIAS LINE: Poly

SYSTEM LEAK CHECK

PRE-TEST (cfh): 0.00

POST-TEST (cfh): 0.00

LEAK RATE (%) =

$$\frac{\text{POST-TEST (cfh)}}{\text{SYSTEM FLOW RATE (cfm) x 60}} \times 100 = \_\_\_\_\%$$

ON-STACK CONDITIONER

IN SERVICE (Y/N): Y

KNOCK-OUT CONDITION (CHECK FLOW): ✓

COOLANT: Dry Ice and Antifreeze

NOx CONVERSION EFFICIENCY See Data Sheet

HIGH CAL NOx ______

HIGH CAL NO (AS FOUND) /

LOW CAL NOx ______

LOW CAL NO (AS FOUND) /

OPERATING CONDITIONS

SAMPLE PRESSURE: 5

SAMPLE VACUUM: 10

NOx VACUUM: 29

SYSTEM RESPONSE TIME CHECK

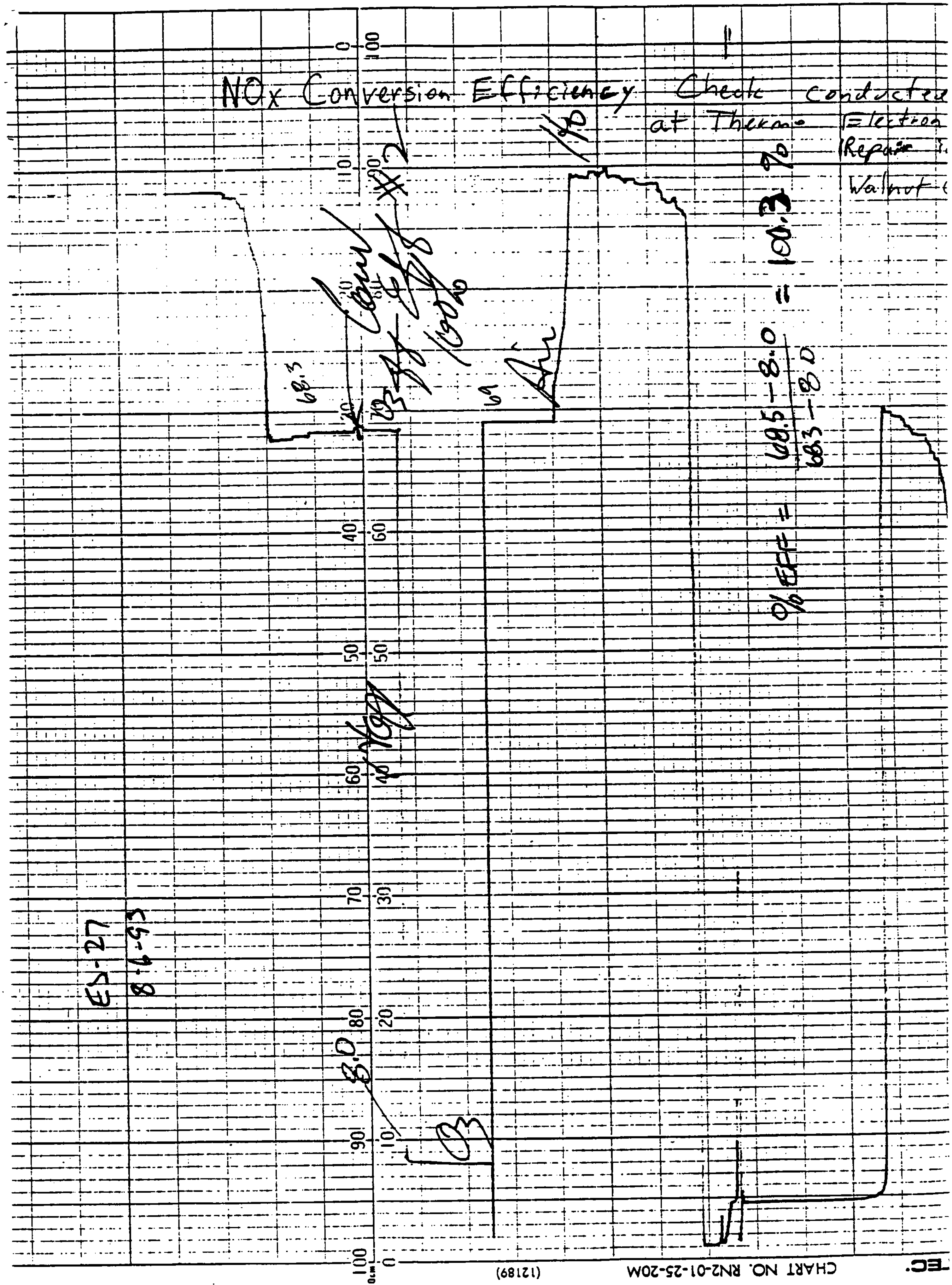
UPSCALE: 30 sec.

DOWNSCALE: ______ sec.

Appendix C.4

CEM Strip Charts

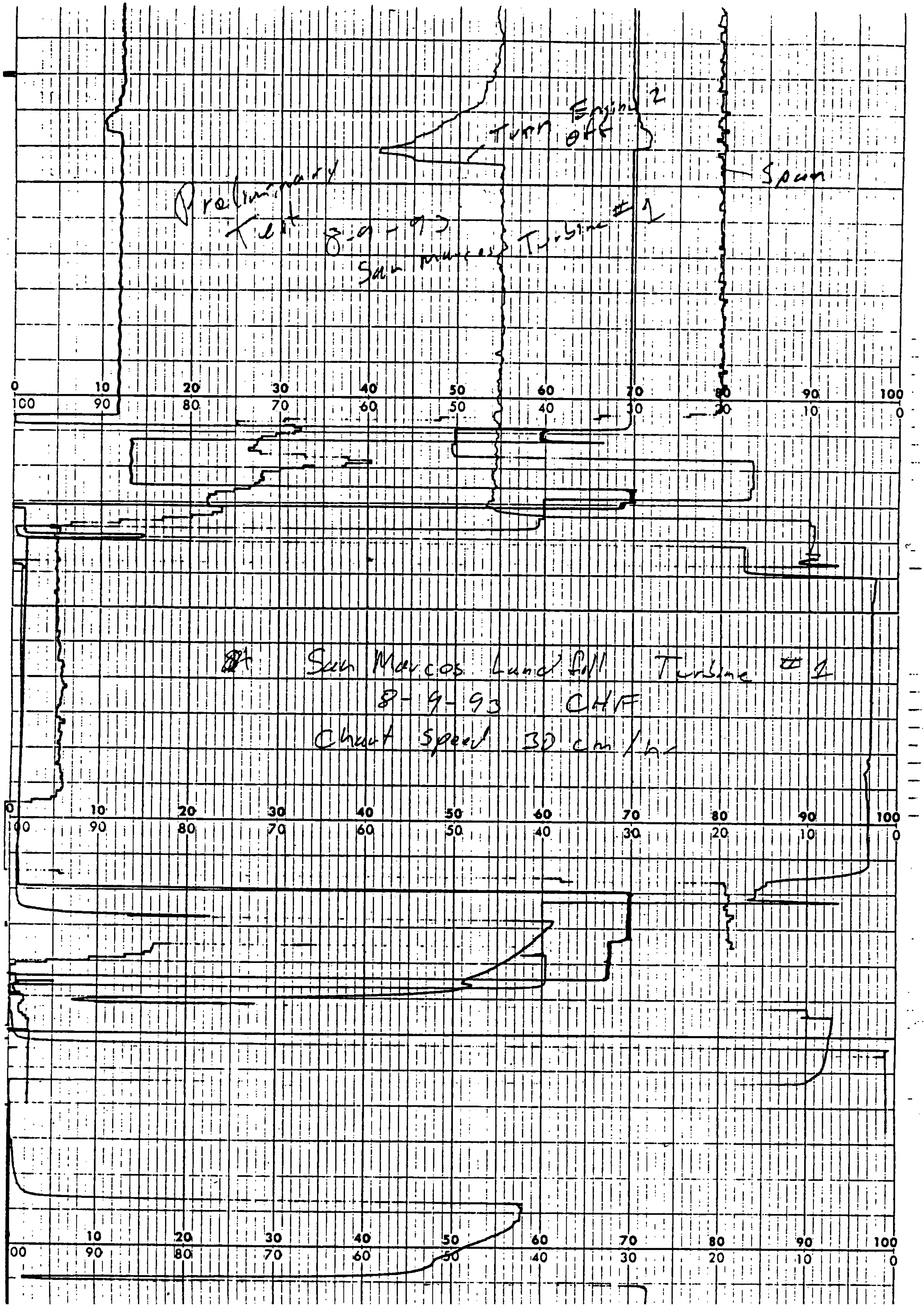
NOx Conversion Efficiency Check conducted at Thermo Electron Repair Walnut



Conv Eff #2 100%

% Eff = $\frac{68.5 - 8.0}{68.3 - 8.0}$ = 100.3 %

ES-27
8-6-93

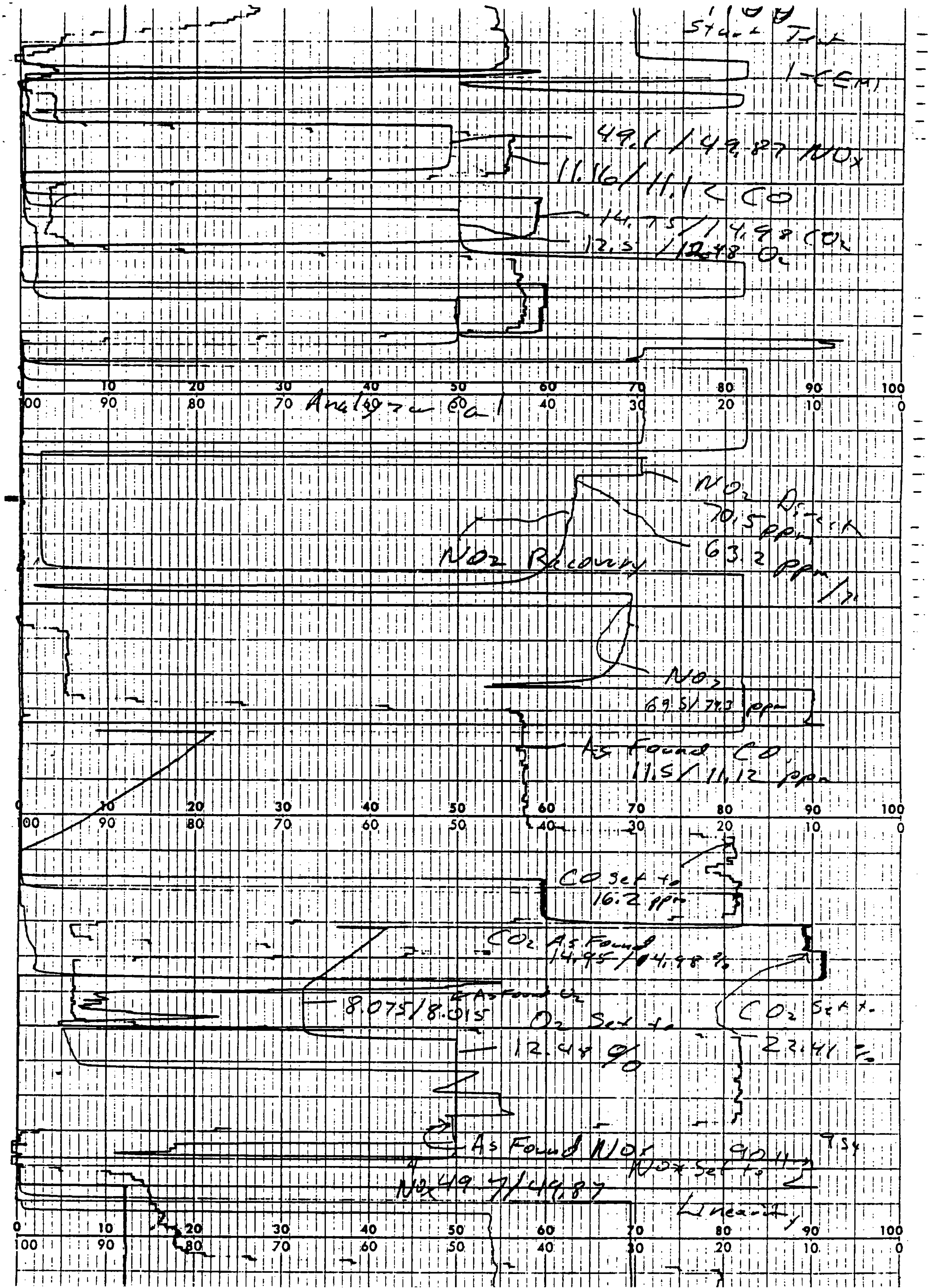


Preliminary Test 8-9-93
San Marcos Turbine #1

Turn Engine 2 off

Span

San Marcos Landfill Turbine #1
8-9-93 CHF
Chart Speed 30 cm/hr



Start Test

1-CEM

49.1 / 49.87 NOx

11.16 / 11.1 CO

14.75 / 14.98 CO2

12.5 / 12.48 O2

Analyzer Cal

NO2 Detect 70.5 ppm

63.2 ppm

/ 7.

NO2 Recovery

NO2 69.5 / 74.3 ppm

As Found CO 11.5 / 11.12 ppm

CO Set to 16.2 ppm

CO2 As Found 14.95 / 14.98 %

As Found O2 8.075 / 8.015

O2 Set to 12.48 %

CO2 Set to 22.41 %

As Found NOx

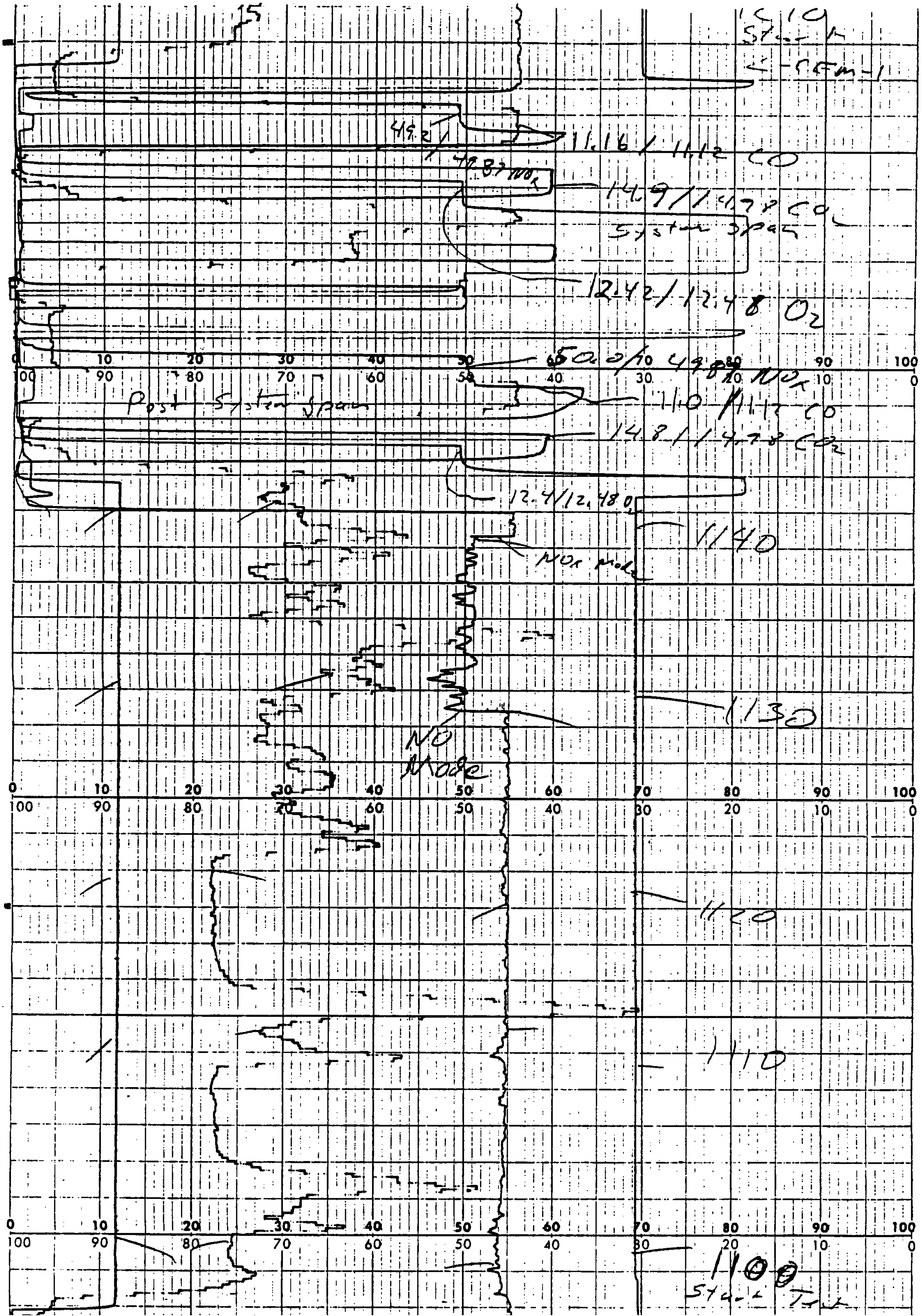
NOx 49.7 / 49.87

90.11

NOx Set to

95

Linearity



15

1510
Start
R-CEM-1

49.2/49.8 NOx

11.16/11.12 CO

14.9/14.78 CO2

System Span

12.42/12.48 O2

50.0/49.8 NOx

Post System Span

11.0/11.12 CO

14.8/14.78 CO2

12.4/12.48 O2

1140

NOx mode

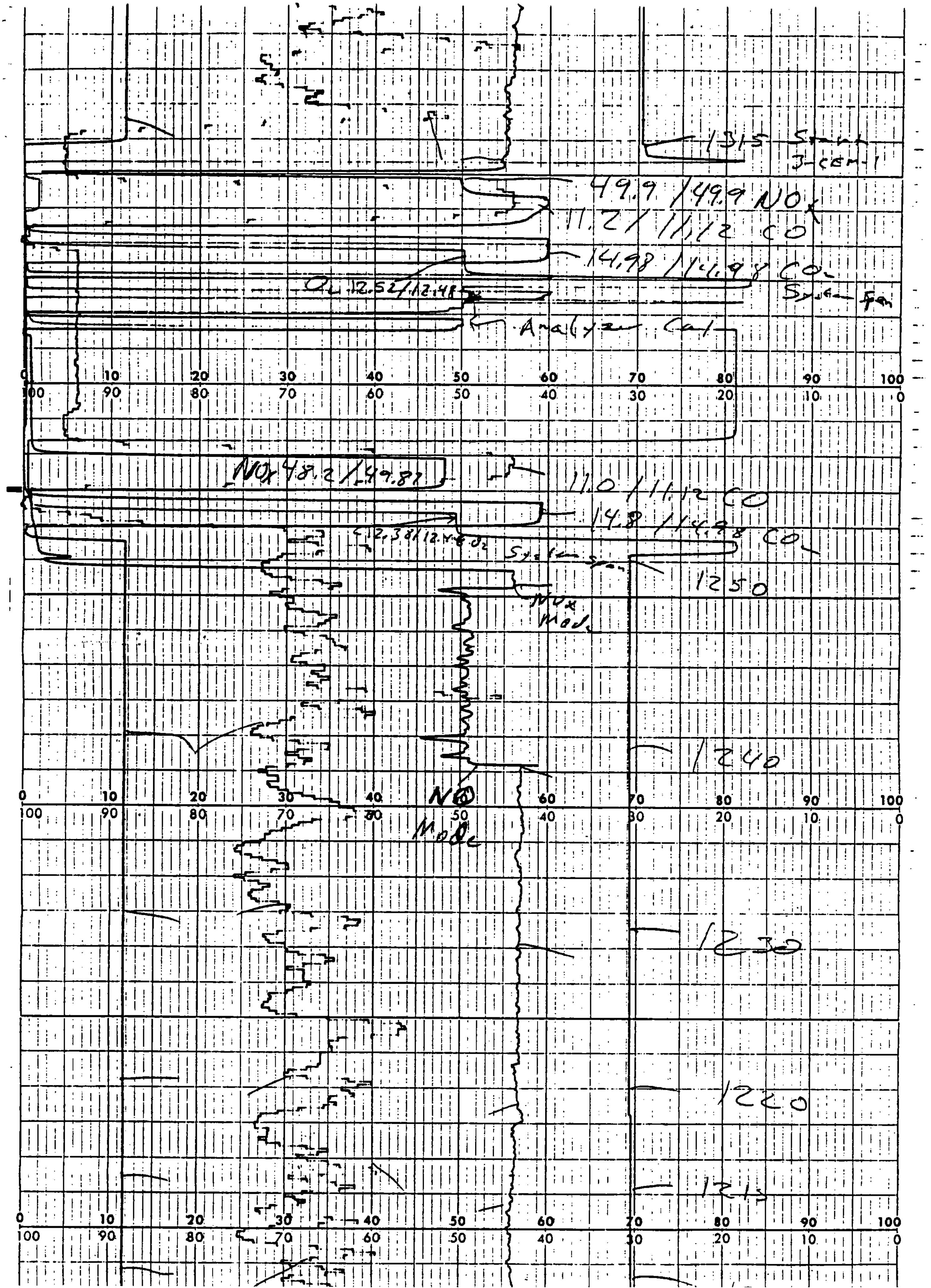
1130

NO Mode

1120

1110

1100
Start Test



1315 Stand
J-CEM-1

49.9 / 49.9 NOx

11.2 / 11.12 CO

14.98 / 14.98 CO2

O2 12.52 / 12.48

System Span

Analyzer Cal

NOx 48.2 / 49.87

11.0 / 11.12 CO

14.8 / 14.98 CO2

12.38 / 12.48 O2

System Span

1250

NOx Mode

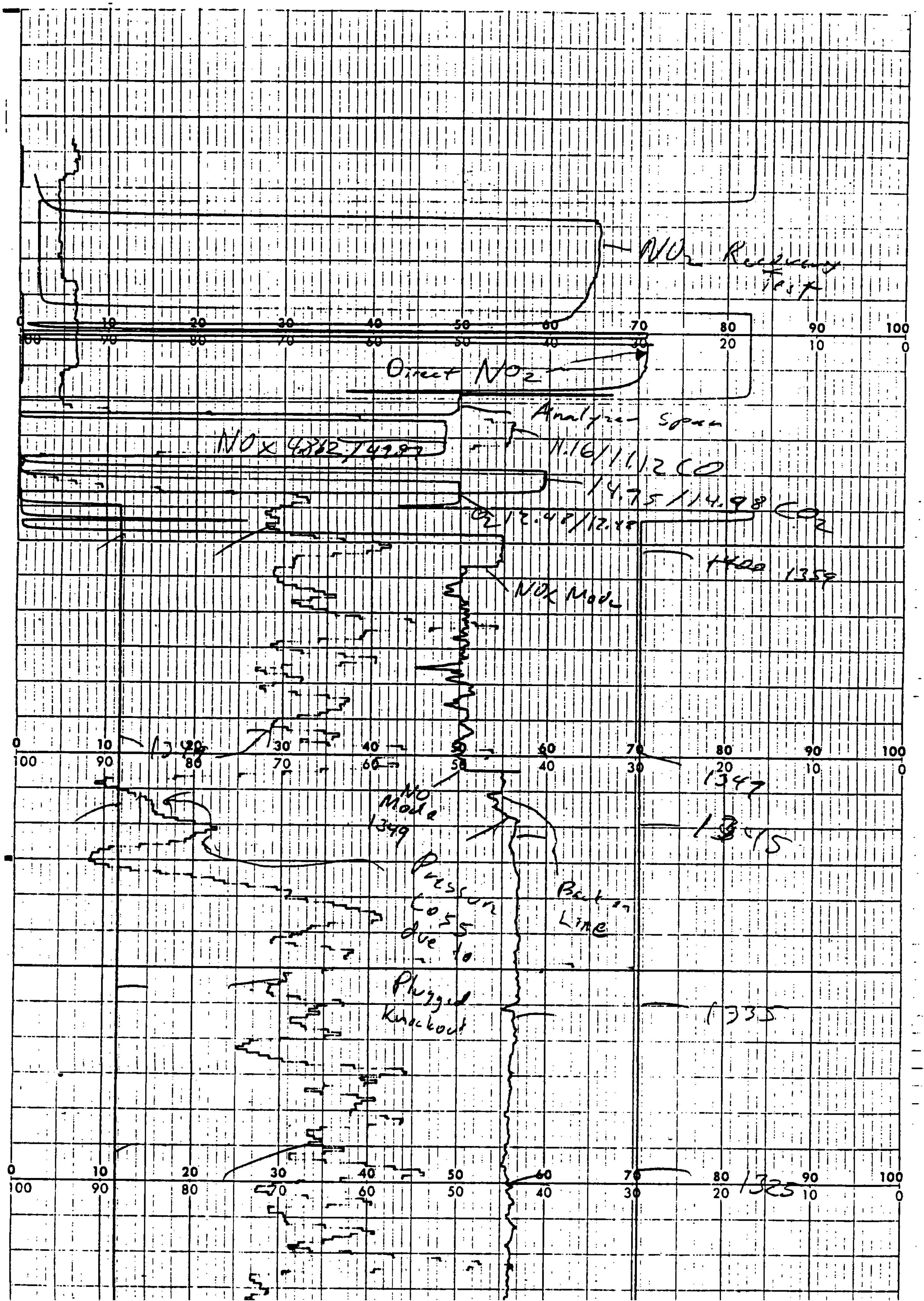
1240

NO Mode

1230

1220

1210


NO2 Recovery Test
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
Direct NO2
Analyzer Span
NOx 48.82/49.87
11.16/11.12 CO
14.75/14.98 CO2
O2 12.48/12.48
1400 1359
NOx Mode
1348
1347
NO Mode 1349
1345
Pressure Loss due to Plugged Knockout
Back on Line
1335
1325

Appendix C.5

CEM O_2 Linearity

CARNOT

PAGE ____ OF ____

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: O2 Teledyne

CONDITION: Serial No. 46124

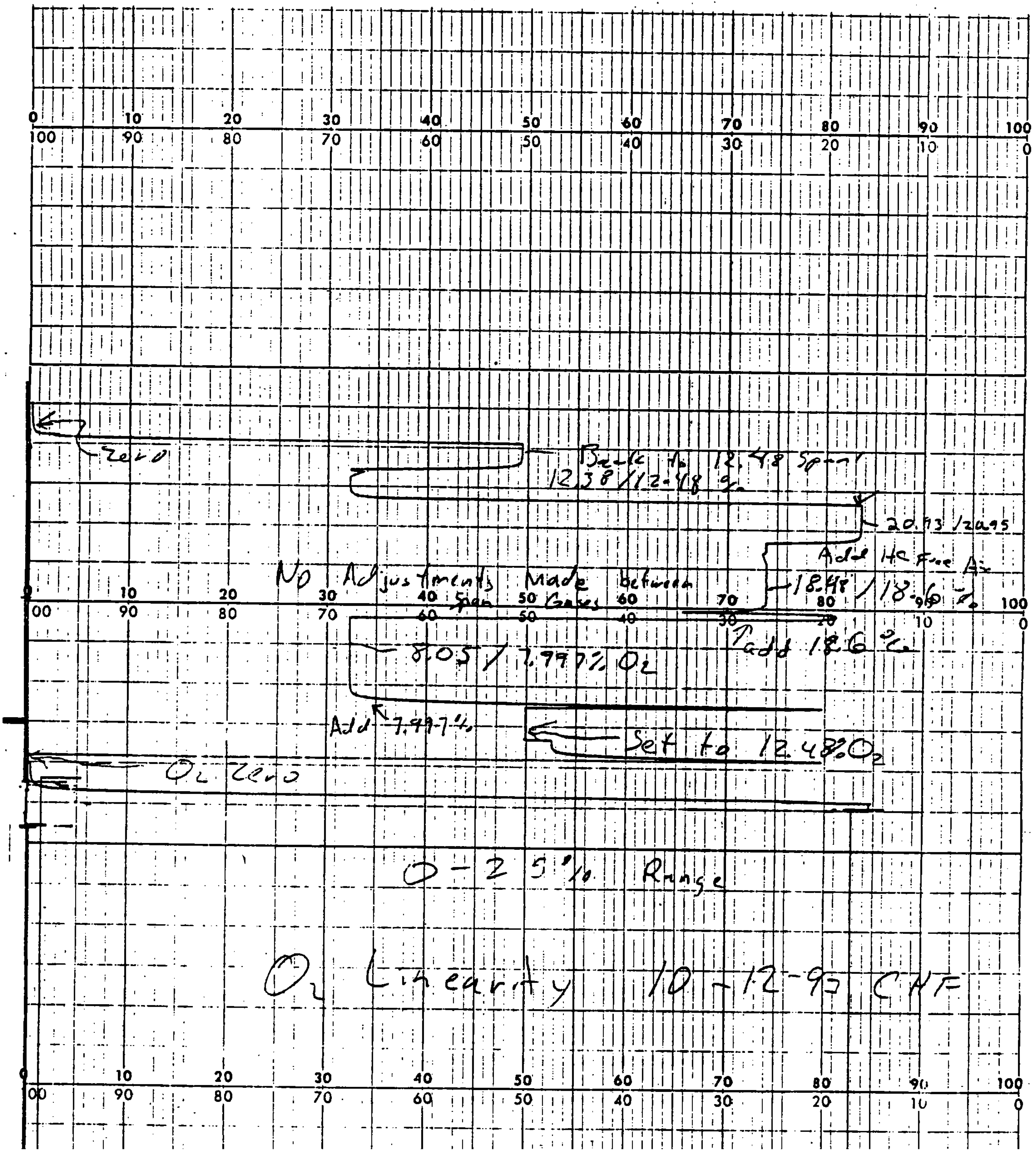
DATE: 10-12-93

OPERATOR: CHF

TEST NUMBER: O2 Linearity

TEST LOCATION: Isuzu

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													
			AS FOUND ANAL. SPAN										
			SYSTEM ZERO										
			SYSTEM SPAN										
	BEGIN END	----	Set to	12.48									
	BEGIN END	----	Span 7.997%	8.05									
	BEGIN END	----	Span 18.6%	18.48									
	BEGIN END	Zero ----	HC AIR 20.95%	20.93									
	BEGIN END	----											
	BEGIN END	----											
	BEGIN END	----											
	BEGIN END	----											
	BEGIN END	----											
	BEGIN END	----											
	BEGIN END	----											
	BEGIN END	----											
			SYSTEM ZERO										
			SYSTEM SPAN										
RAW AVERAGE													
CORRECTED AVERAGE													
COMMENTS:													



0-25% Range

O2 Linearity 10-12-97 CHF

CARNOT
SPAN GAS RECORD

CLIENT/LOCATION: Isuzu O_2 [illegible]

DATE: 10-12-[illegible]

BY: [illegible]

GAS	SPAN CYLINDER		AUX. SPAN CYLINDER	
	CYLINDER NO.	CONCENTRATION	CYLINDER NO.	CONCENTRATION
ZERO	ALM [illegible]	99.999% N_2		
NOx				
O_2	AAL 14106	12.48 %	AA[illegible]	7.997
O_2	ALM 27950	18.6 %		
HC Free Air	KO [illegible]	20.95 %		
SO_2				

CARNOT
INSTRUMENT LINEARITY

	ANALYZER				
	O_2	CO_2	CO	NOx	SO_2
ANALYZER RANGE					
SET TO HIGH STD (80-90% OF RANGE)					
ACTUAL VALUE OF LOW STD					
AS-FOUND LOW STD (50-60% OF RANGE)					
DIFFERENCE IN % OF FULL SCALE					

% 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).

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 #: 0202C3000701AL
DATE:10/28/92

CYLINDER #: AAL14106
FILL PRESSURE: 2000 PSIG
ANALYTICAL ACCURACY: +/-1%

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
CARBON DIOXIDE	15.	PCT	14.96	PCT
OXYGEN	12.5	PCT	12.48	PCT
NITROGEN		BAL		BAL

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: DLT
JOSEPH DE LA TORRE

APPROVED BY:
DR.ARMAND LANGE,PH.D

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 #: 02-22561
PO#: 9113 ITEM # 2
ITEM #: 0202C3013601AL
DATE:11/20/92

CYLINDER #: AAL1791
FILL PRESSURE: 1920 PSIG

ANALYTICAL ACCURACY: +/-1%

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
CARBON DIOXIDE	22.5	PCT	22.48	PCT
OXYGEN	8.	PCT	7.998	PCT
NITROGEN		BAL		BAL

CARNOT 11/23 BIN#3
CERTIFIED TO HAVE BEEN BLENDED

GRAVIMETRIC MASTER GAS -
AGAINST NIST CERTIFIED WEIGHTS

ANALYST: MJ
MAYNARD JOHNSON

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

Scott Specialty Gases, Inc.

Shipped From: 2330 HAMILTON BOULEVARD
SOUTH PLAINFIELD NJ 07080
Phone: 908-754-7700 Fax: 908-754-7303

CERTIFICATE OF ANALYSIS

CARNOT
ATT:G.SZYCHOSKI
C/O PUBLIC SERV ELECTRIC
W BROAD AND DEVLIN
BURLINGTON NJ 08016

PROJECT #: 07-16264
PO#: 8578
ITEM #: 0702C3000711AL
DATE: 7/13/92

CYLINDER #: ALM027950

ANALYTICAL ACCURACY: -

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
CARBON DIOXIDE	20.	PCT	20.0	PCT
OXYGEN	18.75	PCT	18.6	PCT
NITROGEN		BAL.		BAL

+/- 0.02% ABSOLUTE

ANALYST: ADELA SY

APPROVED BY: DONALD DUDICS

PLUMSTEADVILLE, PENNSYLVANIA / TROY, MICHIGAN / HOUSTON, TEXAS / DURHAM, NORTH CAROLINA
SOUTH PLAINFIELD, NEW JERSEY / FREMONT, CALIFORNIA / WAKEFIELD, MASSACHUSETTS / LONGMONT, COLORADO
BATON ROUGE, LOUISIANA

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, in Hg

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

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

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

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

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

3. Gaseous Emissions, lb/hr

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

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_{wo} = 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

Nomenclature (Continued):

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

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

Part of Ref. #22.

SAN MARCOS LANDFILL
GAS TURBINE
(PERMIT #870535)
8/93
- REPORT CONTAINS ERRORS

CARNOT

Post-it™ brand fax transmittal memo 7671

# of pages ▸	
To CRAIG FRY	From JANET CAWYER
Co. CARNOT	Co. APCD
Dept.	Phone # 619-694-3362
Fax # 714-259-0372	Fax # 619-694-2730

AIR POLLUTION CONTROL DISTRICT
COUNTY OF SAN DIEGO

Air Pollution Control Board
Brian P. Bilbray District 1
George F. Bailey District 2
Susan Golding District 3
Leon L. Williams District 4
John MacDonald District 5

Air Pollution Control Officer
R. J. Sommerville

October 6, 1993

Craig Fry
CARNOT
15991 Red Hill Ave., Suite 110
Tustin, CA 92680-7388

RE: Compliance Test Data for the San Marcos Landfill
Landfill Energy Partners Turbine No. 1 Test Date: 8/9/93

Dear Mr. Fry,

The source test results have been received and reviewed by the San Diego Air Pollution Control District. The report will be accepted by the district after the following corrections and additional information are provided.

1) An O2 high calibration was not performed at 85-90 percent of the analyzer range during the test. The high calibration concentration used was 12.48%. However the Oxygen concentration measured in the stack was an average of 17.5%. Therefore, the district will need additional data from that Oxygen analyzer that the 0 - 25% scale meets the three point calibration requirement. Please provide data from that analyzer that shows a three point calibration (zero, mid and high) as is specified in the San Diego APCD Method 20. This data must be data collected within two weeks of the test date and be from either other test data or in house calibration data.

2) The calculations for the correction of raw NOx and CO to 3% Oxygen are not correct. Please correct these values or provide the calculations used to determine these values.

If you have any questions you may contact me at 619-694-3362.

Sincerely,

Janet E Cawyer

Janet E. Cawyer
Associate Air Pollution Chemist

9150 Chesapeake Drive • San Diego • California 92123-1096 • (619) 694-3307
FAX (619) 694-2730 • Smoking Vehicle Hotline 1-800-28-SMOKE

GAS
TURBINE #870535
(PERMIT

SOURCE TEST RESULTS FOR EMISSION TESTING OF LANDFILL ENERGY PARTNERS ENGINE NO. 1 AT SAN MARCOS LANDFILL

Prepared For:

LANDFILL ENERGY PARTNERS I
Newark, California

For Submittal To:

COUNTY OF SAN DIEGO AIR POLLUTION CONTROL DISTRICT
San Diego, California

Prepared By:

Craig H. Fry

CARNOT
Tustin, California

AUGUST 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.

Date 8/23/93

Craig H. Fry
Field Measurement Specialist

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.

Date 8-23-93

Eric A. Mazzi
Senior Engineer

TABLE OF CONTENTS

SECTION PAGE

1.0 INTRODUCTION 1

2.0 UNIT DESCRIPTION 3

3.0 TEST DESCRIPTION 4
- 3.1 TEST CONDITIONS 4
- 3.2 SAMPLE LOCATION 4
- 3.3 TEST PROCEDURES 4
  - 3.3.1 Oxygen, Carbon Dioxide, Carbon Monoxide and Nitrogen Oxides 4

4.0 RESULTS 8

A MEASUREMENT PROCEDURES A-1

B QUALITY ASSURANCE B-1
- B.1 Quality Assurance Program Summary B-2
- B.2 ARB Certification B-7
- B.3 Calibration Data B-8

C FIELD DATA AND SOURCE TEST CALCULATIONS C-1
- C.1 Sample Locations C-2
- C.2 CEM Correction Spreadsheets C-3
- C.3 CEM Raw Data C-4
- C.4 CEM Strip Charts C-5

D CALCULATIONS D-1
- D.1 General Emissions Calculations D-2

SECTION 1.0

INTRODUCTION

Carnot has been contracted by Landfill Energy Partners I to perform source testing on the landfill gas fired turbine No. 1 located at San Marcos Landfill in San Marcos, California. The source testing is required to show compliance with the County of San Diego Air Pollution Control District (SDAPCD), Permit to Operate No. 870535.

On March 30 1993, the SDAPCD conducted source testing on Engine No. 1 and found the NO_x @ 3% O_2 emission to be in exceedance of the permit limit. Carnot repeated the NO_x testing at the same operating condition, but with only one turbine operating at the time of sampling as specified in the SDAPCD Permit to Operate test conditions. In addition, measurements of exhaust CO, O_2, and CO_2 were conducted on the turbine. A description of test methods and procedures is described in detail in Section 3.0

The source testing was conducted on August 9, 1993. The measurements were performed by Craig Fry and Robert Conklin of Carnot. Bruno Lukosz of Landfill Energy Partners was on site during testing to operate the turbines.

A summary of the results is presented in Table 1-1. The results of testing found the turbine NO_x emissions to be in exceedance of the SDAPCD permit conditions of 263 ppm @ 3% O_2. Table 4-1 presents detailed results of the testing conducted on the turbine. All field raw data is included in the appendices.

TABLE 1-1
SUMMARY OF TEST RESULTS
SAN MARCOS LANDFILL TURBINE NO. 1
STACK EXHAUST
AUGUST 9, 1993

Parameter	Exhaust	Permit Limit	Applicable SCAQMD Rule
O_2, % dry	17.5	$\frac{17.9}{3.65} = 5.265$	
CO_2, % dry	3.0		
		5.201	
CO, ppm	6.2		
CO, ppm @ 3% O_2	32.5	325	P/C
NO_x, ppm	57.1		
NO_x, ppm @ 3% O_2	301	263	P/C

NOTE: The results in this table are the averages of triplicate measurements. See Section 4.0 for complete emission test results. The NO_x concentration has been adjusted for NO_2 recovery.

P/C - SDAPCD Permit Operating Condition Application No. 870535

SECTION 2.0

UNIT DESCRIPTION

The Landfill Energy Partner Engine #1 is a Solar Saturn recuperated gas turbine Model GSC 1200 R. The turbine is a component of San Marcos Landfill Gas Recovery System which extracts the landfill gas and uses the turbine to incinerate the extracted vapor. The turbine burns 304 scfm of landfill gas and generates 710 KW of electrical power. The turbine uses only combustion optimization for emission control.

SECTION 3.0

TEST DESCRIPTION

3.1 TEST CONDITIONS

The turbine was operated at normal load during testing. Turbine No. 2 was shut off during testing as specified in the SDAPCD Permit to Operate. The turbine was burning approximately 304 scfm of landfill gas and produced 711 KW of electrical power during testing conditions.

3.2 SAMPLE LOCATION

Exhaust measurements were conducted at the stack sample location. Two ½ inch ports at 90° from each other are located 66 inches above the silencer and 78 inches below the stack exit. The stack diameter is 32 inches, which gives 2.1 duct diameters downstream and 2.4 duct diameters upstream from all flow disturbances. Figure 3-1 is a diagram of the stack sampling location.

3.3 TEST PROCEDURES

The test procedures used for the turbine testing are summarized in Table 3-1. The procedures selected are consistent with SDAPCD source test methods. Brief discussions of each procedure are given below in Section 3.3.1.

3.3.1 Oxygen, Carbon Dioxide, Carbon Monoxide and Nitrogen Oxides

Measurements of O_2, CO_2, CO, and NO_x at the exhaust were conducted following SDAPCD Methods 3A and 20 sampling techniques using continuous emission monitoring system (CEMS).

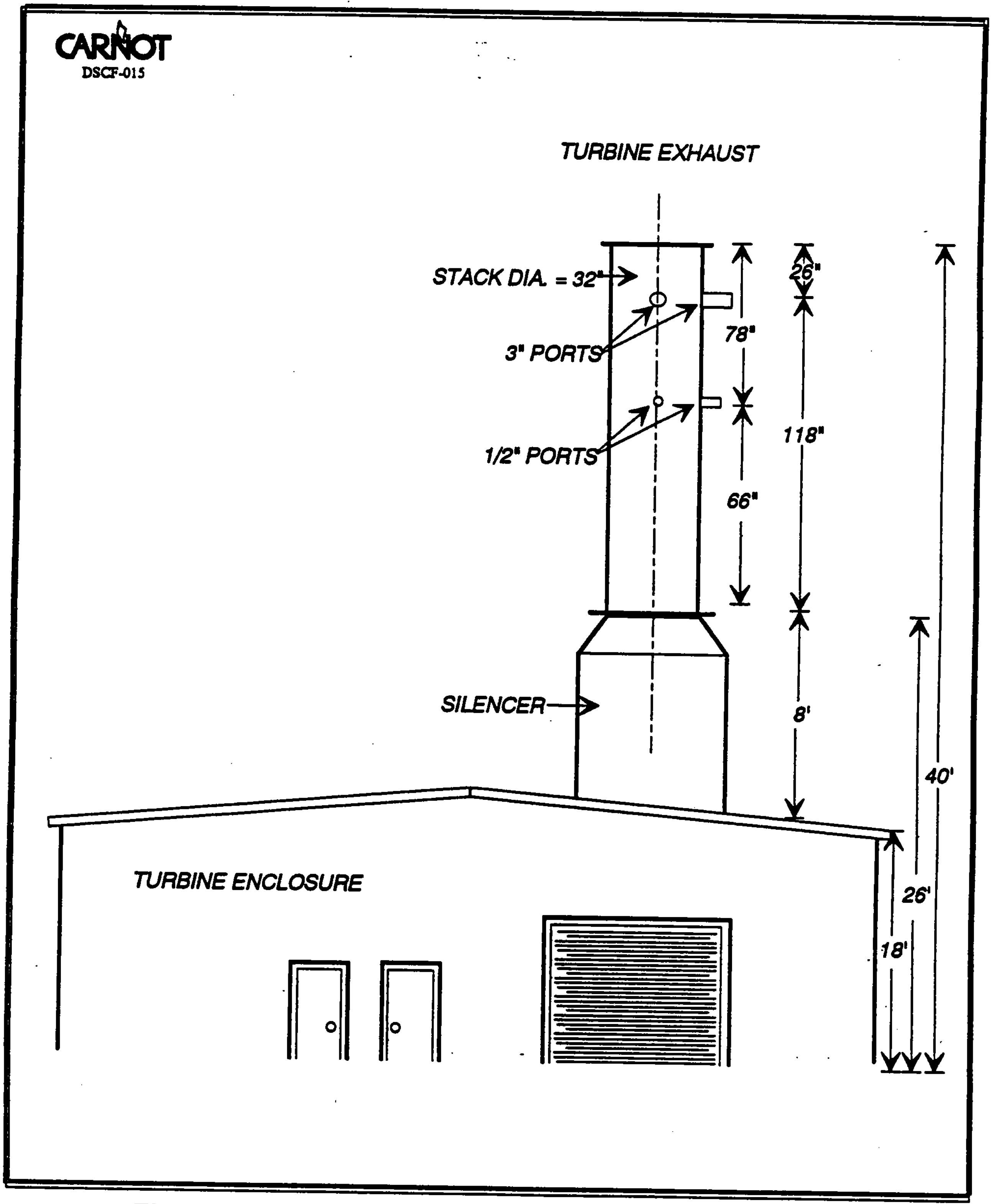


Figure 3-1. Diagram of Turbine No. 1 Exhaust Sampling Location

TABLE 3-1
TURBINE SOURCE TEST PROCEDURES

Parameter	Sampling Method	Analytical Technique	Reference Method
NO_x, NO, NO_2	CEMS	Chemiluminescent	SDAPCD 20
O_2	CEMS	Micro Fuel Call	SDAPCD 3A & 20
CO_2	CEMS	NDIR	SDAPCD 3A
CO	CEMS	NDIR/GFC	SDAPCD 20

These CEMS measurements were made using Carnot's continuous emissions monitoring system described in Appendix A. The sampling system uses a stainless steel probe connected to a 25' heated teflon line. The sample then travels through a moisture knockout cooled with dry ice. A peristaltic pump continuously drains the moisture knockout when not frozen. The sample is then transported to the mobile CEMS via teflon tubing to an additional conditioning and filtering system. Leak checks were conducted prior to and at the completion of the test project. The leak checks were conducted by operating the sample pump, plugging the probe inlet and all pressure side system exits except for one analyzer rotameter, then measuring the leakage rate on the rotameter.

For this testing project, the SDAPCD Method 20 for high NO_2 sampling procedures were used since it has been demonstrated that more than 5% of the NO_x emissions is NO_2. The testing procedure using this method is described below.

A pretest CEMS calibration series was conducted on site. A three point calibration was performed first using high, mid and zero span gas. Instrument linearity response of ±2% of span value is acceptable. A NO_x conversion efficiency test was performed by introducing NO_2 gas at a known concentration and recording the conversion to NO through the NO_x converter. The analyzer was switched from NO_x to NO mode of operation and the NO_2 concentration response is recorded. An efficiency of 90% conversion is acceptable. The NO_2 gas was then directed to the probe tip for an NO_2 system recovery test. An 85% recovery of NO_2 is required for acceptability.

Triplicate 40 minute tests were conducted. Each test was conducted for 30 minutes in NO_x operational mode and 10 minutes in the NO operational mode. NO_2 concentration was determined by difference.

EPA Protocol 1 Calibration Gas was used for CO and NO_x analyzer calibration. All other gases were manufacturer certified to be ±1% and traceable to NIST. A pre- and post-test system recovery check was conducted for each test run. The system recovery check was conducted by delivering zero and span gas to the CEMS probe tip and recording the as-found species concentration. No analyzer adjustments were made between these pre- and post-system recovery checks. Calculations for the correction of measured system recovery and instrument drift were applied to each test run. The allowable limit of system recovery deviation is 5% of instrument range.

A post test NO_2 recovery test was conducted similar to the NO_2 recovery pre-test. The NO_x concentrations are adjusted for NO_2 loss by applying the average NO_2 recovery results to the NO_2 concentration and adding them back to the NO_x concentration. O_2, CO_2 and CO concentrations were averaged for the 40-minute test duration and the NO_x concentration was averaged for the 30-minute period in the NO_x mode.

TABLE 4-1
GENERAL RESULTS
SAN MARCOS LANDFILL TURBINE NO. 1
STACK EXHAUST
AUGUST 9, 1993

[illegible] = 263

Parameter	First Run	Second Run	Third Run	Average
O_2, % dry	17.4 ✓ CF 5.06	17.5 ✓ CF 5.202[illegible]	17.6 ✓ CF	17.5 ✓
CO_2, % dry	3.0	3.0	3.0	3.0
CO, ppm	5.6 ✓	6.3 ✓	6.6 ✓	6.2 ✓
CO, ppm @ 3% O_2	28.6	33.2	35.8	32.5
NO_x, ppm	55.5 ✓	58.3 ✓	57.5 ✓	57.1
NO_2 ppm	5.4 ✓	6.5 ✓	5.1 ✓	5.7
NO_x, ppm @ 3% O_2	284	307	312	301

10% NO_2 [illegible]

$$\frac{20.9-3}{20.9-X} NO_x$$

NOTE: The NO_x and NO_2 concentration has been adjusted for NO_2 recovery.

O_2 = ± .25% NO ± 2 ppm.

R#1) BEST CASE NO_x = 53.5 ppm & O_2 = 17.15%
∴ CF = 4.72
uncorr limit = 55.7

2) best case NO_x = 56.3 & O_2 = [illegible]
∴ CF = 4.8514
uncorr NOx limit = 54.21 (54.9)

3) Best case NO_x = 55.5 & O_2 = 17.35
∴ CF = 4.[illegible]96
uncorr NOx limit = 52.75

[illegible] case [illegible] all.
NO_x = 55.1
O_2 = 17.25
CF = 4.8514

uncorr NO_x limit = 54.2 ppm

APPENDIX A
MEASUREMENT PROCEDURES

Continuous Emissions Monitoring System

Oxygen (O_2) by Continuous Analyzer

Carbon Dioxide (CO_2) by Continuous Analyzer

NO/NO_x by Continuous Analyzer

Carbon Monoxide (CO) by NDIR/Gas Filter Correlation

Continuous Emissions Monitoring System

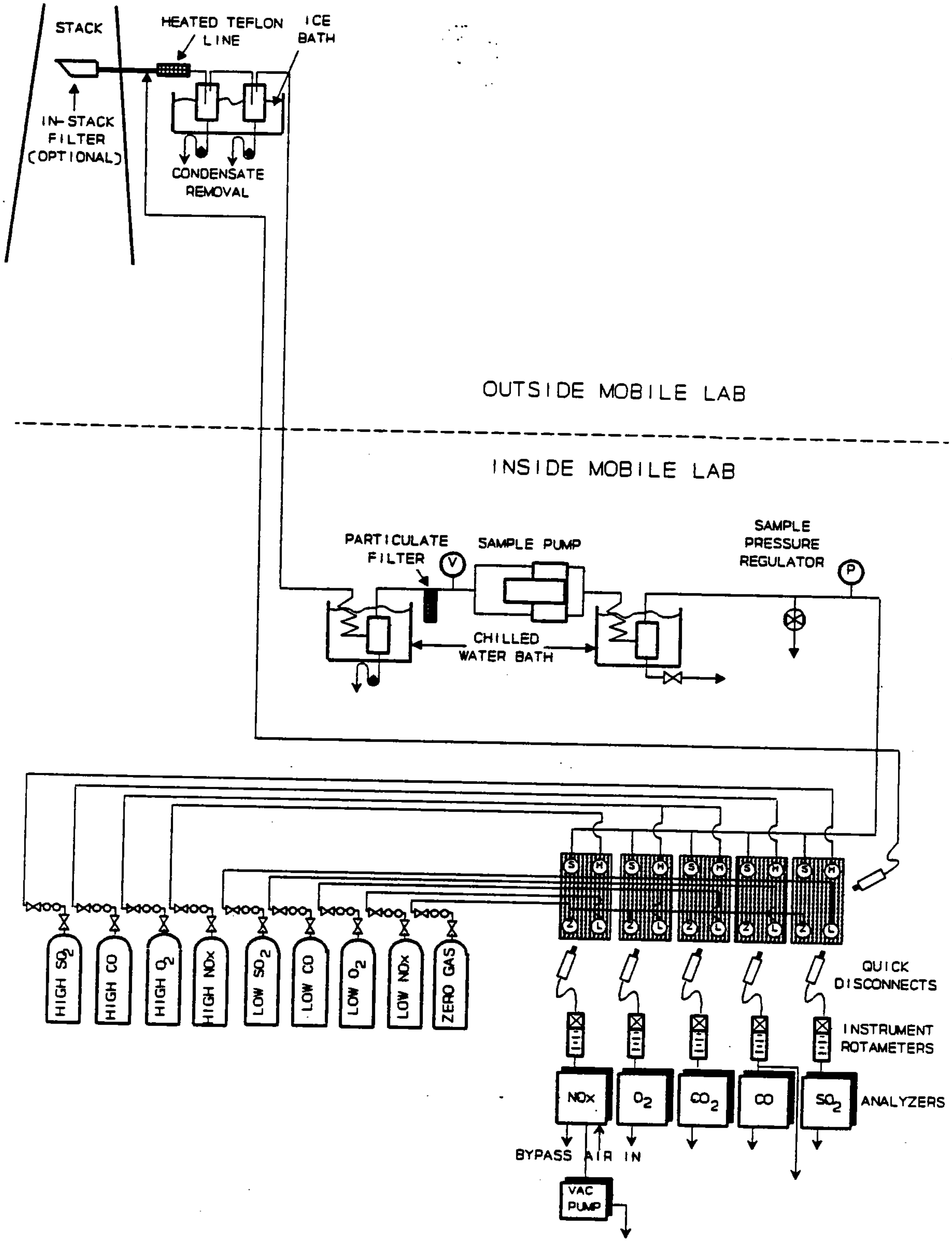
O_2, CO, CO_2, NO, NO_x and SO_2 are measured using an extractive continuous emissions monitoring (CEM) package, shown in the following figure. This package is comprised of three basic subsystems. They are: (1) the sample acquisition and conditioning system, (2) the calibration gas system, and (3) the 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 and/or SO_2 are 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 and SO_2 are 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 (± 2% of scale), the cell is replaced.

Method:	**Carbon Dioxide (CO_2) by Continuous Analyzer**
Applicable Reference Methods:	EPA 3A, ARB 100, BA ST-5, 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_2 concentration.
Analyzer:	Horiba PIR 2000
Measurement Principle:	Non-dispersive infrared (NDIR)
Accuracy:	1% of full scale
Ranges:	0-5, 0-10, 0-25%
Output:	0-10 mV
Interferences:	A possible interference includes water. Since the instrument receives dried sample gas, this interference is not significant.
Response Time:	1.2 seconds
Sampling Procedure:	A representative flue gas sample is collected and conditioned using the CEM system described previously.
Analytical Procedure:	Carbon dioxide concentrations are measured by short path length non-dispersive infrared analyzers. These instruments measure the differential in infrared energy absorbed from energy beams passed through a reference cell (containing a gas selected to have minimal absorption of infrared energy in the wavelength absorbed by the gas component of interest) and a sample cell through which the sample gas flows continuously. The differential absorption appears as a reading on a scale of 0 to 100%.

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.

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

McKinney
Laura McKinney, Manager
Investigation and Certification Section

Appendix B.3
Calibration Data

CARNOT
SPAN GAS RECORD

CLIENT/LOCATION: Landfill Energy

DATE: 8-9-93

BY: CHF

GAS	SPAN CYLINDER		AUX. SPAN CYLINDER	
	CYLINDER NO.	CONCENTRATION	CYLINDER NO.	CONCENTRATION
ZERO				
NOx	AAL 261	49,87	ALM035858	90.11
O_2	AAL 6069	8.015	ALM 5618	12.48
CO	AAL21065	11,12	AAL7964	16,17
CO_2	AAL 6089	22.41	ALM 5618	14,98
~~SO_2~~ NO_2	BL 4168	79,3		[illegible]

CARNOT
INSTRUMENT LINEARITY

	ANALYZER				
	O_2	CO_2	CO	NOx	SO_2
ANALYZER RANGE	0-25	0-25	0-20	0-100	
SET TO HIGH STD (80-90% OF RANGE)	12.48	22.41	16.17	90.11	
ACTUAL VALUE OF LOW STD	8.015	14.98	11,12	49,87	
AS-FOUND LOW STD (50-60% OF RANGE)	8,075	14.95	11,5	49,7	
DIFFERENCE IN % OF FULL SCALE					

% 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

RECEIV
AUG 1 0 19
CARNOT

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

15991 RED HILL AVE
SUITE 110
TUSTIN CA 92680

PROJECT #: 02-26734-001
PO#: 1101
ITEM #: 02023124 1BL
DATE: 8/04/93

CYLINDER #: BAL4168
FILL PRESSURE: 2000 PSIG
BLEND TYPE : GRAVIMETRIC MASTER GAS
ANALYTICAL ACCURACY: +/-1%

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
NITROGEN DIOXIDE	80.	PPM	79.30	PPM
NITROGEN		BAL		BAL

8/5 BIN#10 2000 PSIG
CERTIFIED TO HAVE BEEN BLENDED AND VERIFIED TO BE CORRECT BY ANALYSIS.

GRAVIMETRIC MASTER GAS -
AGAINST NIST CERTIFIED WEIGHTS
INDEPENDENT LABORATORY

ANALYST: GEORGE KING

APPROVED BY: Robert Shealy
ROBERT SHEALY

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

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

Purchase Order 9895
Project # 25797.006

ANALYTICAL INFORMATION

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

Cylinder Number ALM 035858
Cylinder Pressure 1950 psig
Certification Date 05-26-93
Previous Certification Dates NONE
Acid Rain Exp 11-26-94
General Exp 05-26-95

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
NITRIC OXIDE	89.26PPM	± 1 % NIST Traceable

Balance Gas: Nitrogen
NOX 90.11 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
CRM 1684B	09-94	ALM24490	95.30PPM NITRIC OXIDE

INSTRUMENTATION

Instrument/Model/Serial #	Last Date Calibrated	Analytical Principle
TECO / 10AR / 14853-150	04-30-93	Chemi-Luminescent

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

Components
NITRIC OXIDE

First Triad Analysis

Date: 04-12-93	Response Units: mv	
Z1= 0.00	R1= 95.20	T1= 89.40
R2= 94.89	Z2= 0.00	T2= 89.51
Z3= 0.00	T3= 89.52	R3= 95.12
Avg. Conc. of Cust Cyl.	89.69PPM	

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: 05-26-93	Response Units: mv	
Z1= 0.00	R1= 95.30	T1= 88.78
R2= 95.24	Z2= 0.00	T2= 88.80
Z3= 0.00	T3= 85.85	R3= 95.30
Avg. Conc. of Cust Cyl.	88.83 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.		

Calibration Curve

Concentration= Ax + B
A =1.003248165
B =0.65344292

Concentration=

Concentration=

Special Notes : If this product is used for Aicd Rain Rule Compliance, the Acid Rain Expiration Date noted above applies per 40 CFR Part 75, Appendix H. Otherwise the General Expiration Date applies

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

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

Purchase Order 9895
Project # 25796.004

ANALYTICAL INFORMATION

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

Cylinder Number AAL261
Cylinder Pressure 2000 psig
Certification Date 06-08-93
Previous Certification Dates NONE
Acid Rain Exp 12-08-94 | General Exp 06-08-95

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
NITRIC OXIDE	49.20 PPM	± 1 % NIST Traceable
NOX	49.87 PPM	

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
GMIS	05-11-93	AAL14822	89.20 ppm

INSTRUMENTATION

Instrument/Model/Serial #	Last Date Calibrated	Analytical Principle
TECO / 10AR / 38644-258	05-11-93	Chemi-Luminescent

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

Components
Nitric Oxide

First Triad Analysis

Date: 06-01-93 Response Units: mv
Z1= 0.00 R1= 88.64 T1= 48.82
R2= 88.71 Z2= 0.00 T2= 48.76
Z3= 0.00 T3= 48.80 R3= 88.65
Avg. Conc. of Cust Cyl. 49.03 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: 06-08-93 Response Units: mv
Z1= 0.00 R1= 89.23 T1= 49.35
R2= 89.22 Z2= 0.00 T2= 49.30
Z3= 0.00 T3= 49.29 R3= 89.20
Avg. Conc. of Cust Cyl. 49.30 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.

Calibration Curve

Concentration= Ax^2+Bx+C
A =-0.0005080
B =1.054
C =-0.1090

Concentration=

Concentration=

Special Notes : If this product is used for Aicd Rain Rule Compliance, the Acid Rain Expiration Date noted above applies per 40 CFR Part 75, Appendix H. Otherwise the General Expiration Date applies

Analyst Joseph De La Torre

Post-It™ brand fax transmittal memo 7671 | # of pages ▸ 2

To Rick Madrigal	From Nancy Wallace
Co. Carnot	Co. SSG
Dept.	Phone #
Fax # 714-259-0372	Fax #

Scott Specialty

2600 CAJON BLVD., SAN BERNARDIN

CARNOT
JIM MULLIGAN
15991 RED HILL AVE
SUITE 110
TUSTIN CA 92680

Shipped From: Scott SAN BERNARDINO, CA
Date Shipped 06/11/92
Our Project No: 19562
Your P.O. No: 8346
Page 1 of 1
Expiration Date: 12/93

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES

Certified Per Traceability Protocol No. 1 Procedure No. G1 Cylinder No. AAL21065 Cylinder Pressure 2000 PSIG Certified Accuracy ±1% % NIST Traceable

		REFERENCE STD			GAS ANALYZER		
COMPONENTS	CERTIFIED CONC	SRM/CRM NO.	CYL. NO.	CONC.	MAKE/MODEL/SERIAL NO.	LAST CAL. DATE	ANALYTICAL PRINCIPLE
CARBON MONOXIDE	11.12 PPM	SRM1677	CAL5078	9.900 PPM	HORIBA AIA-24 4564403	06/03/92	

BALANCE GAS NITROGEN

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

Component CARBON MONOXIDE
First Analysis Date 06/09/92 Units mv

Z	00.00	R	19.5	T	22.0
R	19.5	Z	00.01	T	22.0
Z	00.07	T	22.0	R	19.5

Mean Test Assay 11.15 PPM

Second Analysis Date 06/16/92 Units mv

Z	00.0	R	19.5	T	21.9
R	19.5	Z	00.0	T	21.9
Z	00.0	T	21.9	R	19.5

Mean Test Assay 11.09 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

JIM MULLIGAN
15991 RED HILL AVE
SUITE 110
TUSTIN CA 92680

Shipped From Scott [illegible]
Date Shipped 05/18/92
Our Project No: 19562
Your P.O. No: 8346
Page 1 of 1
Expiration Date: 11/93

Scott Specialty Gases, Inc.
2600 CAJON BLVD., SAN BERNARDINO, CA 92405
FAX: 714-887-0549
PHONE: 714-887-2571

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES

ertified Per Traceability Protocol No. 1 Procedure No. G1 Cylinder No. AAL7964 Cylinder Pressure 2015 PSIG Certified Accuracy ±1% % NIST Traceable

		REFERENCE STD			GAS ANALYZER		
COMPONENTS	CERTIFIED CONC	SRM/CRM NO.	CYL. NO.	CONC.	MAKE/MODEL/SERIAL NO.	LAST CAL. DATE	ANALYTICAL PRINCIPLE
CARBON MONOXIDE	16.17 PPM	CRM2635	AAL9760	24.30 PPM	HORIBA AIA-24 4564403	02/10/92	INFRA-RED

BALANCE GAS NITROGEN
ANALYZER READINGS: Z = Zero Gas T = Test Gas R = Reference Gas

omponent CARBON MONOXIDE
irst Analysis Date 05/05/92 Units mv

00.00	R	47.8	T	31.9	
47.8	Z	00.05	T	31.9	
00.06	T	31.9	R	47.8	

Mean Test Assay 16.17 PPM

econd Analysis Date 05/14/92 Units mv

00.00	R	47.8	T	31.9	
47.8	Z	00.04	T	31.9	
00.07	T	31.9	R	47.8	

Mean Test Assay 16.17 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 H. 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: RICH MADRIGAL
15991 RED HILL AVE
SUITE 110
TUSTIN CA 92680

PROJECT #: 02-20636
PO#: 8641
ITEM #: 0202C3013601AL
DATE: 7/15/92

CYLINDER #: AAL6069
FILL PRESSURE: 1950 PSIG

ANALYTICAL ACCURACY: +/-1%

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
CARBON DIOXIDE	22.5	PCT	22.41	PCT
OXYGEN	8.	PCT	8.015	PCT
NITROGEN		BAL		BAL

ERTIFI

ARNOT 7/16 BIN 1
ERTIFIED TO HAVE BEEN BLENDED
ND VERIFIED TO BE CORRECT BY
NALYSIS.

GRAVIMETRIC MASTER GAS -
AGAINST NIST CERTIFIED WEIGHTS
INDEPENDENT LABORATORY

NALYST: M.J.
MAYNARD JOHNSON

APPROVED BY:
DR ARMAND LANGE PHD

Scott Specialty Gases, Inc.

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

RECEI
NOV 13
CARNO

CERTIFICATE OF ANALYSIS

CARNOT
RICK MADRIGAL
15991 RED HILL AVE
TUSTIN CA 92680

PROJECT #: 02-22392
PO#: 9059
ITEM #: 0202C3000701AL
DATE:10/30/92

CYLINDER #: ALM005618
FILL PRESSURE: 2000 PSIG

ANALYTICAL ACCURACY: +/-1%

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
CARBON DIOXIDE	15.	PCT	14.98	PCT
OXYGEN	12.5	PCT	12.48	PCT
NITROGEN		BAL		BAL

CERTIFI

ARNOT 11/5 BIN#10
ERTIFIED TO HAVE BEEN BLENDED
ND VERIFIED TO BE CORRECT BY
NALYSIS.

GRAVIMETRIC MASTER GAS -
AGAINST NIST CERTIFIED WEIGHTS
INDEPENDENT LABORATORY

NALYST: JOSEPH DE LA TORRE

APPROVED BY: DR.ARMAND LANGE,PH.D

APPENDIX C

FIELD DATA AND SOURCE TEST CALCULATIONS

Appendix C.1

Sample Locations

CARNOT
SAMPLING POINT LOCATION DATA - EPA METHOD 1

PLANT: SAN MARCOS LANDFILL DATA BY: 3C

DATE: 3/4/93

TEST LOCATION: STACK

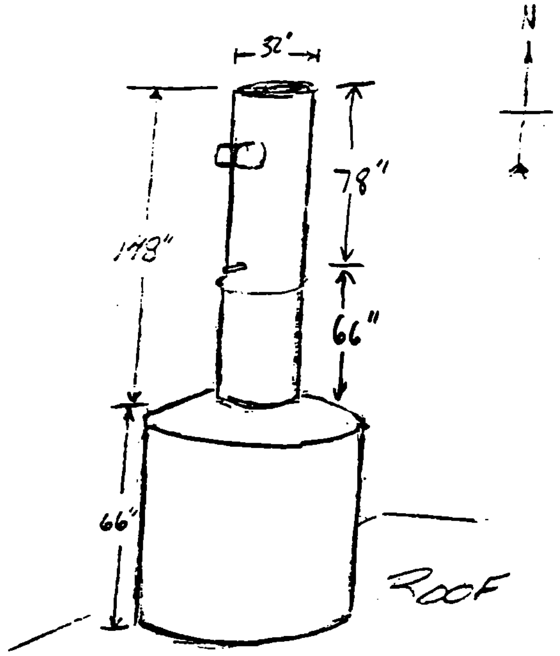


Diagram of Sampling Location

UPSTREAM DIST./DIA.: 2.44

DOWNSTREAM DIST./DIA.: 2.06

COUPLING LENGTH: 6"

NO. OF SAMPLING PTS.: 18

STACK DIMENSION: 32"

STACK AREA, FT²: 5.59

SAMPLE POINT	% OF DIAMETER	IN. FROM NEAR WALL	IN. FROM NOZZLE*
1	3.2	1.0	6.0
2	10.5	3.4	9.4
3	19.4	6.2	15.2
4	32.3	10.3	16.3
5	67.7	21.7	27.6
6	80.6	25.8	31.8
7	89.5	28.6	34.6
8	96.8	30.0	37.0

*INCHES FROM WALL PLUS COUPLING LENGTH

CARNOT

Appendix C.2

CEM Correction Spreadsheets

NO2 CORRECTION CALCULATIONS

NO2 RECOVERY %

	PRE TEST	POST TEST	AVERAGE
NO2 ppm	70.5	71	
NO2 RECOVERY ppm	63.2	66.5	
% RECOVERY	89.6	93.7	91.7

NO2 CORRECTION

	First Run	Second Run	Third Run
NO2 raw ppm	5.0 ✓	6.0 ✓	4.7 ✓
NO2 corr. ppm	5.4 ✓	6.5 ✓	5.1 ✓
NOx raw ppm	55.1 ✓	57.8 ✓	57.1 ✓
NOx corr. ppm	55.5 ✓	58.3 ✓	57.5 ✓

Ave NO_2 rec = 91.7

NO_2 converter $\frac{71}{79.3}$ = 89.5% limit - 90%

QC = ok (showed early NOx conv eff with ≈ 100% eff possibly NO_2 bottle incorrect)

CEM System Bias and Linearity Correction Calculations

Test No 1-CEM-1

	O2	CO2	CO	NOx	Acceptance Criteria	Ru Stat
Linearity						
Analyzer Range	25	25	20	100		
High Cal	12.48	22.41	16.17	90.11		
Low Cal	8.015	14.98	11.12	49.87		
Analyzer Reads	8.08	14.95	11.50	49.70		
Analyzer Cal. Error,%	0.2	-0.1	1.9	-0.2	< 2%	PASS
System Bias						
Pretest Bias						
Zero	0.08 ✓	0.00 ✓	0.70 ✓	0.30 ✓	< 5%	PASS
Span	12.50 ✓	14.75 ✓	11.16 ✓	49.10 ✓	< 5%	PASS
Posttest Bias						
Zero	0.13 ✓	0.00 ✓	0.20 ✓	0.80 ✓	< 5%	PASS
Span	12.40 ✓	14.80 ✓	11.00 ✓	50.00 ✓	< 5%	PASS
Span Value	12.48 ✓	14.98 ✓	11.16 ✓	49.87 ✓		
Zero Drift, %	0.18 ✓	0.00 ✓	-2.50 ✓	0.50 ✓	< ~~3~~% 2%	PASS
Span Drift, %	-0.40 ✓	0.20 ✓	-0.80 ✓	0.90 ✓	< ~~3~~% 2% F.S.	PASS
Test Ave.	17.32 ✓	2.95 ✓	5.80 ✓	54.70 ✓		
Corrected Ave.	17.40 ✓	2.99	5.62 ✓	55.11 ✓		

[illegible] 10%
[illegible] full scale

CEM System Bias and Linearity Correction Calculations

Test No 3-CEM-1

	O2	CO2	CO	NOx	Acceptance Criteria	Run Statu
			Linearity			
Analyzer Range	25	25	20	100		
High Cal	12.48	22.41	16.17	90.11		
Low Cal	8.015	14.98	11.12	49.87		
Analyzer Reads	8.08	14.95	11.50	49.70		
Analyzer Cal. Error,%	0.2	-0.1	1.9	-0.2	< 2%	PASS
			System Bias			
Pretest Bias						
Zero	0.00	0.00	0.00	0.20	< 5%	PASS
Span	12.52	14.98	11.20	49.90	< 5%	PASS
Posttest Bias						
Zero	0.00	0.00	0.00	0.20	< 5%	PASS
Span	12.48	14.95	11.16	48.20	< 5%	PASS
Span Value	12.48	14.98	11.16	49.87		
Zero Drift, %	0.00	0.00	0.00	0.00	< 3%	PASS
Span Drift, %	-0.16	-0.12	-0.20	-1.70	< 3%	PASS
Test Ave.	17.60	2.95	6.60	56.10		
Corrected Ave.	17.57	2.95	6.59	57.07		

CEM System Bias and Linearity Correction Calculations

Test No 2-CEM-1

	O2	CO2	CO	NOx	Acceptance Criteria	Run Statu
Linearity						
Analyzer Range	25	25	20	100		
High Cal	12.48	22.41	16.17	90.11		
Low Cal	8.015	14.98	11.12	49.87		
Analyzer Reads	8.08	14.95	11.50	49.70		
Analyzer Cal. Error,%	0.2	-0.1	1.9	-0.2	< 2%	PASS
System Bias						
Pretest Bias						
Zero	0.13	0.00	0.10	0.60	< 5%	PASS
Span	12.42	14.90	11.16	49.20	< 5%	PASS
Posttest Bias						
Zero	0.13	0.00	0.00	1.00	< 5%	PASS
Span	12.38	14.80	11.20	48.20	< 5%	PASS
Span Value	12.48	14.98	11.16	49.87		
Zero Drift, %	0.00	0.00	-0.50	0.40	< 3%	PASS
Span Drift, %	-0.16	-0.40	0.20	-1.00	< 3%	PASS
Test Ave.	17.33	2.95	6.35	56.30		
Corrected Ave.	17.49	2.98	6.32	57.78		

Appendix C.3

CEM Raw Data

CARNOT

PAGE ____ OF __

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: Landfill Energy

CONDITION: Full Load

DATE: 8-9-93

OPERATOR: CHF

TEST NUMBER: 1-CEM-1

TEST LOCATION: Turbine No 2 Sta

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												
		AS FOUND ANAL. SPAN										
		SYSTEM ZERO										
		SYSTEM SPAN										
	BEGIN 954 END	High	12.48	22.41	16.2	90.11						
	BEGIN --- END	Low	8.075	14.95	11.5	49.7						
	BEGIN --- END	Zero	.03	.03	.02	.1						
	BEGIN --- END	NO_2					0.0	70.5				
	BEGIN --- END	NO_2 Recovery						63.2		89.6% Recovery		
	BEGIN 1043 END	System Zero	.08	0.0	0.7	.3						
	BEGIN --- END	System Span	12.5	14.75	16.16	49.1						
	BEGIN 1100 END 1110	Start	17.33	2.95	5.0	54.3						
	BEGIN 1110 END 1120		17.35	2.95	5.2	54.9						
	BEGIN 1120 END 1130		17.3	2.95	6.4	54.8						
	BEGIN 1130 END 1140	NO_2	17.3	2.95	6.6	55.0	50.0	5.0				
	BEGIN 1140 END	End										
		SYSTEM ZERO	.125	.0	.2	.8						
		SYSTEM SPAN	12.4	14.8	11.0	500						
RAW AVERAGE			17.32	2.95	5.8	54.7		5.0				
CORRECTED AVERAGE												
COMMENTS:												

PMF-C39

CARNOT

O_2 CO_2 CO Test averaged for 40 mins

NOx Test average for 30 mins

NO_2 [illegible]

CARNOT

PAGE ____ OF ____

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: Landfill Energy

CONDITION:

ATE: 8-9-93

OPERATOR: CHF

TEST NUMBER: 2-CEM-1

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												
		AS FOUND ANAL. SPAN										
		SYSTEM ZERO	.13	.00	.1	.6						
		SYSTEM SPAN	12.42	14.9	11.16	49.2						
	BEGIN 1210 END 1220	Start	17.4	2.95	6.4	55.2						
	BEGIN 20 END 30		17.3	2.95	6.4	56.8						
	BEGIN 30 END 40		17.3	2.95	6.0	56.9						
	BEGIN 40 END 1250	NO_2	17.3	2.95	6.6	56.7	50.7	6.0				
	BEGIN END											
	BEGIN END											
	BEGIN END											
	BEGIN END											
	BEGIN END											
	BEGIN END											
	BEGIN END											
	BEGIN END											
		SYSTEM ZERO	.13	00	0.0	1.0						
		SYSTEM SPAN	12.38	14.8	11.2	48.2						
RAW AVERAGE			17.33	2.95	6.35	56.3		6.0				
CORRECTED AVERAGE												
COMMENTS:												

CARNOT

PAGE ____ OF ____

REFERENCE METHOD GASEOUS MEASUREMENTS

CLIENT/LOCATION: Landfill Energy

CONDITION: ____

DATE: 8-9-93

OPERATOR: CHF

TEST NUMBER: 3-CEM-1

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												
		AS FOUND ANAL. SPAN										
		SYSTEM ZERO	0.0	0.0	0.0	0.2						
		SYSTEM SPAN	12.52	14.98	11.2	49.9						
	BEGIN 1315 END 1325	Stack	17.6	2.95	7.0	55.7						
	BEGIN 1325 END 1335		17.6	2.95	6.8	56						
	BEGIN 1335 END 1345		17.6	2.95	6.2	56.5						
	BEGIN 1349 END 1359	NO_2	17.6	2.95	6.4	55	50.3	4.7				
	BEGIN END											
	BEGIN END	NO_2 Direct					.2	71				
	BEGIN END	NO_2 Recovery Test						66.5		93.7	%	recov
	BEGIN END											
	BEGIN END											
	BEGIN END											
	BEGIN END											
	BEGIN END											
		SYSTEM ZERO	0.0	0.0	0.0	.2						
		SYSTEM SPAN	12.48	14.95	11.16	48.2						
RAW AVERAGE			17.6	2.95	6.6	56.1		4.7				
CORRECTED AVERAGE											303	
COMMENTS:												

CARNOT

O_2, CO_2, CO Test averaged for 40 mins

NOx averaged for 30 min.

For all

CARNOT
CEM PERFORMANCE DATA

CLIENT/LOCATION: Landfill Energy
DATE: 8-9-93
BY: CHF

SYSTEM CONFIGURATION

ANALYZERS IN SERVICE

ANALYZERS:	O_2	CO_2	CO	NOx
MODEL:	Teledyne	Horiba 2000	Thermo 48	Thermo E 1C
SERIAL NO.:	46124	912017		10AR-30333-257

PROBE

LENGTH:	3'
LINER MATERIAL:	SS
HEATED PROBE (Y/N):	N
HEATED LINE (Y/N):	Y

SAMPLE CONDITIONER

CONDENSER-VACUUM SIDE (CHECK FLOW):	✓
CONDENSER-PRESSURE SIDE (CHECK FLOW):	✓
CONDENSER TEMPERATURE:	34
FILTER CONDITION (COND. OR DATE LAST CHANGED):	Good

SAMPLE LINE

LENGTH:	100
LINER MATERIAL:	Teflon
SYSTEM BIAS LINE:	Poly

SYSTEM LEAK CHECK

PRE-TEST (cfh):	0.00
POST-TEST (cfh):	0.00

LEAK RATE (%) =

$$\frac{\text{POST-TEST (cfh)}}{\text{SYSTEM FLOW RATE (cfm) x 60}} \times 100 = \_\_\_\_\_ \%$$

ON-STACK CONDITIONER

IN SERVICE (Y/N):	Y
KNOCK-OUT CONDITION (CHECK FLOW):	✓
COOLANT:	Dry Ice and Antifreeze

NOx CONVERSION EFFICIENCY See Data Sheet

HIGH CAL NOx	
HIGH CAL NO (AS FOUND)	/
LOW CAL NOx	
LOW CAL NO (AS FOUND)	/

OPERATING CONDITIONS

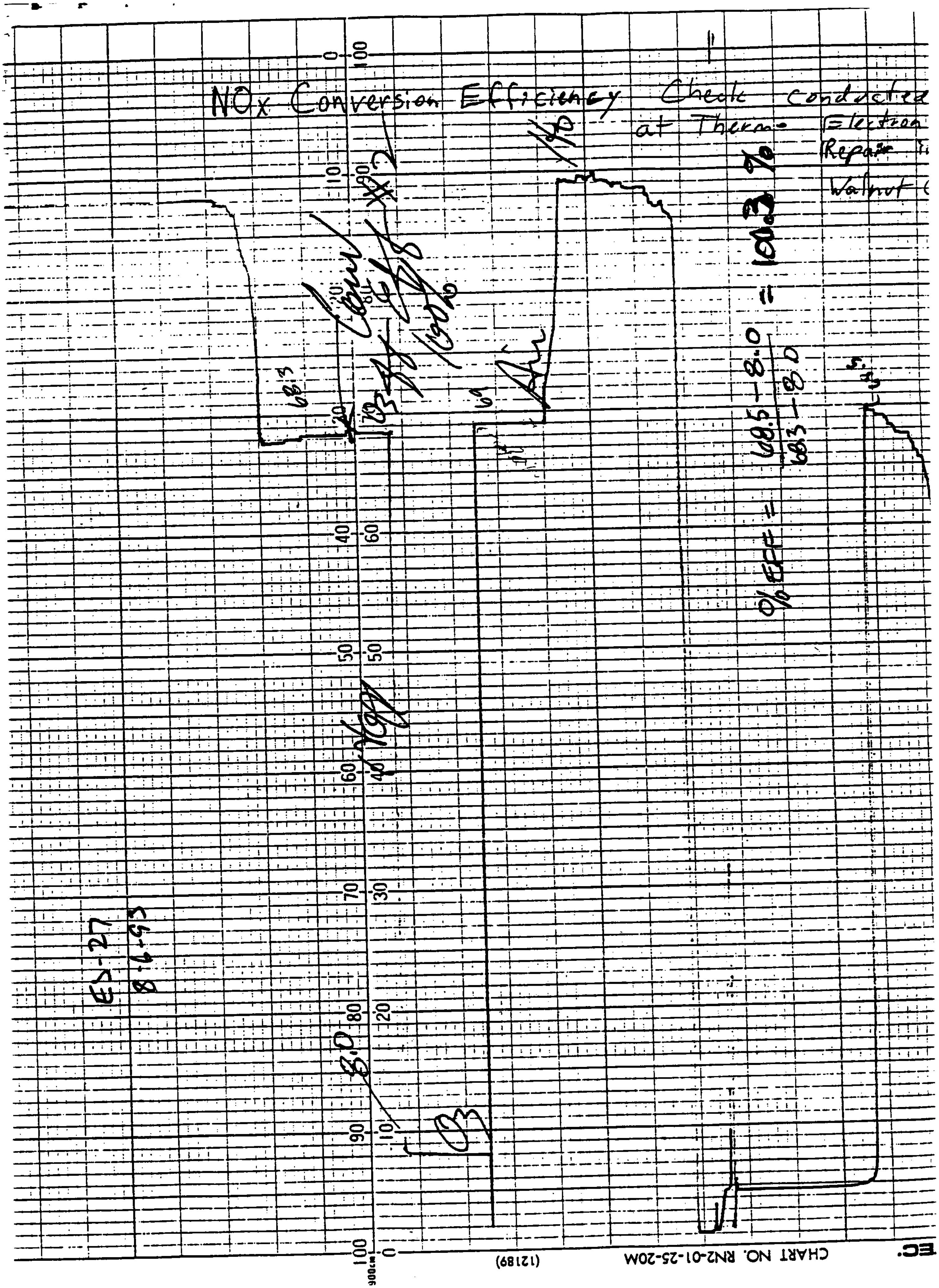
SAMPLE PRESSURE:	5
SAMPLE VACUUM:	10
NOx VACUUM:	29

SYSTEM RESPONSE TIME CHECK

UPSCALE:	30 sec.
DOWNSCALE:	sec.

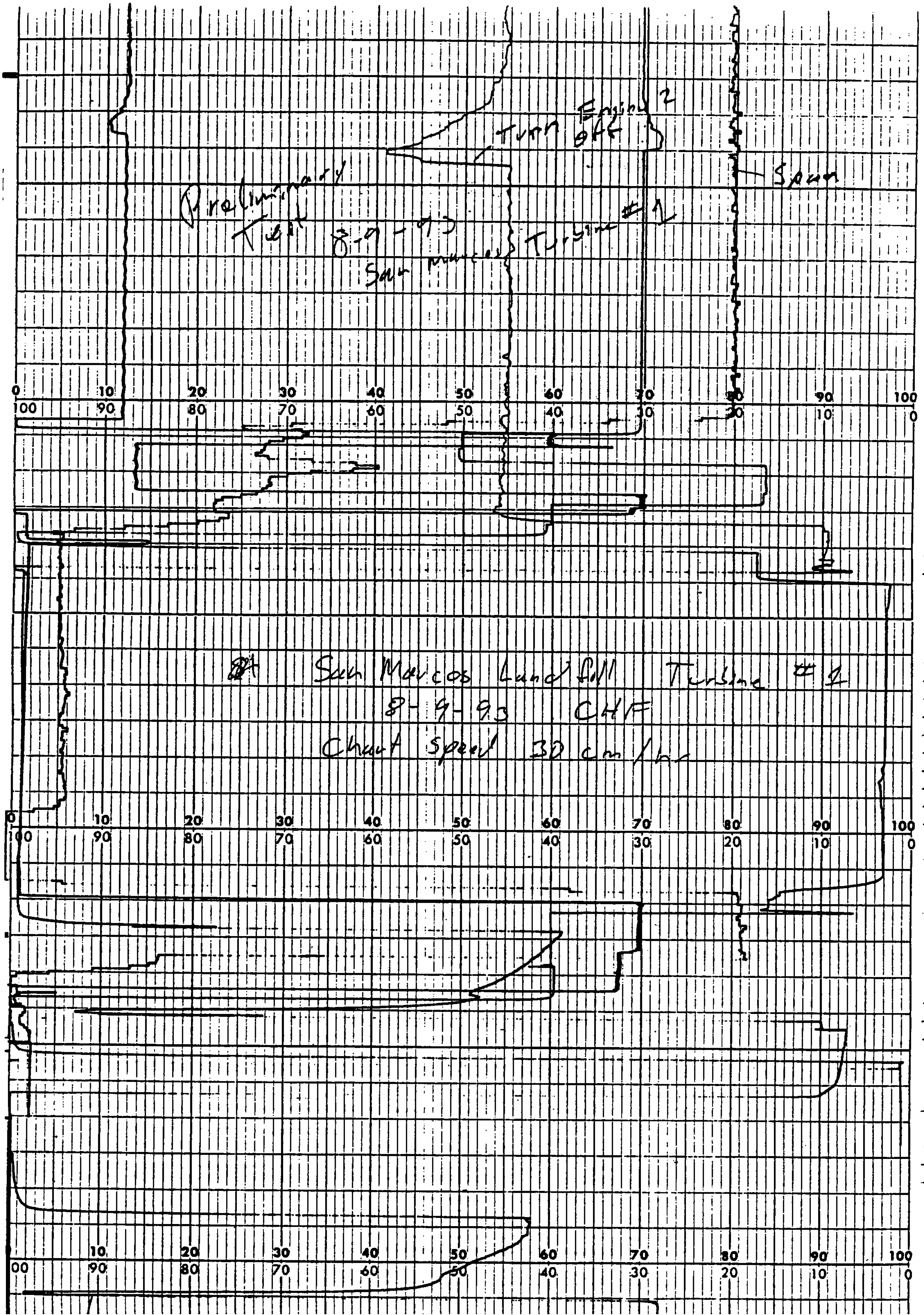
Appendix C.4

CEM Strip Charts



NOx Conversion Efficiency Check conducted at Thermo Electron Repair
Walnut

$$\% \text{ Eff} = \frac{68.5 - 8.0}{68.3 - 8.0} = 100.3\ \%$$

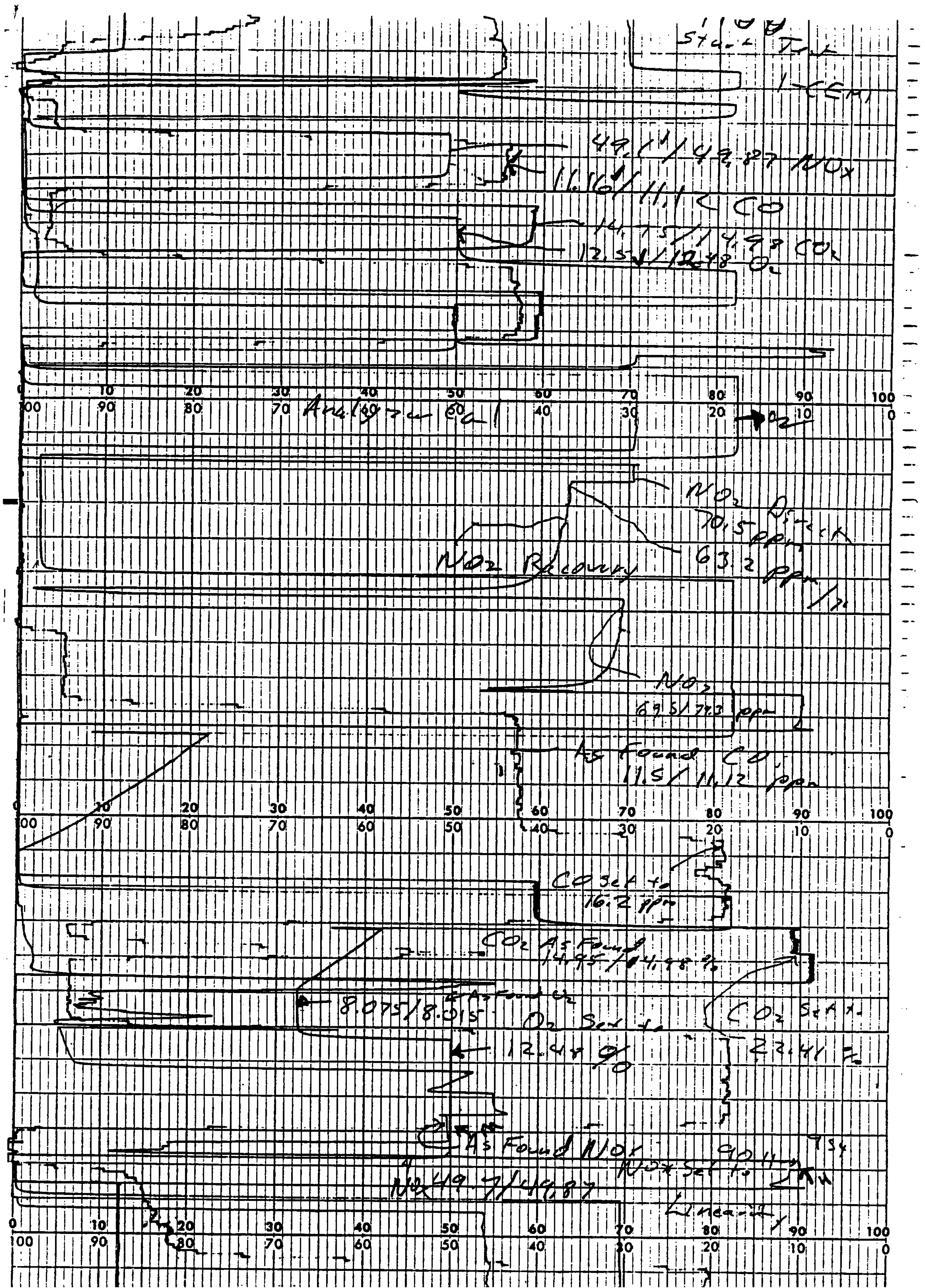


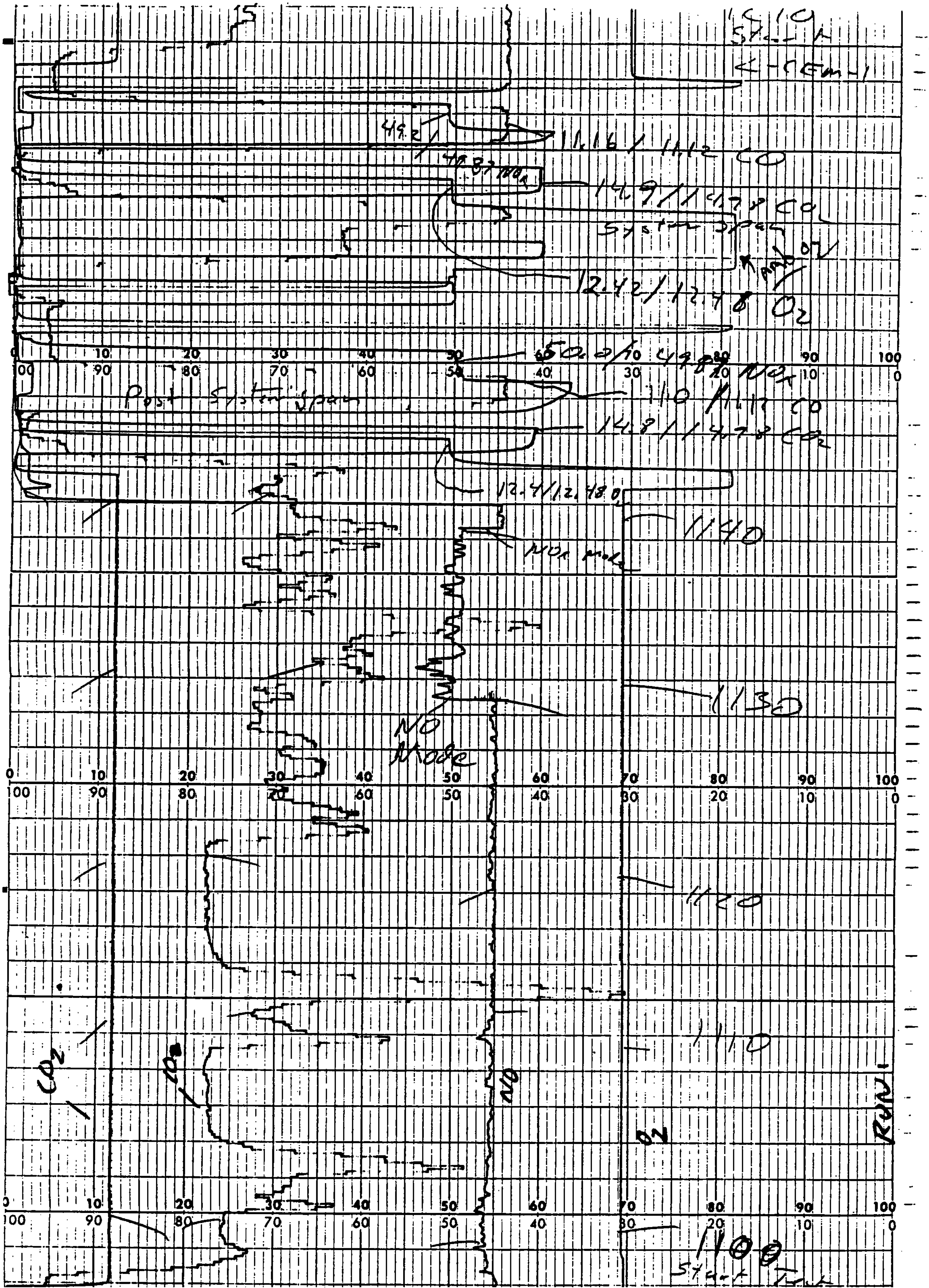
Preliminary Test 8-9-93
San Marcos Turbine #1

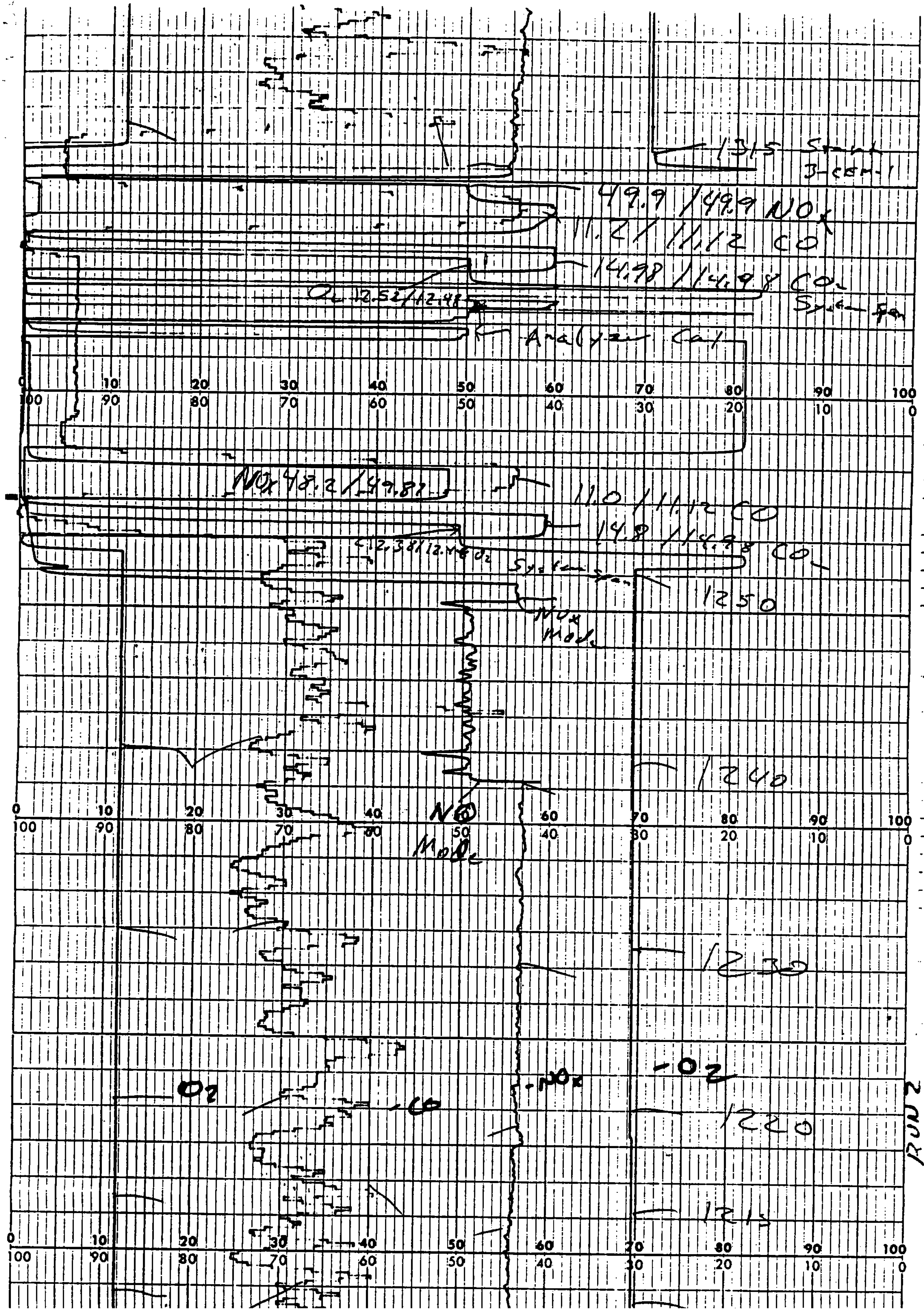
Turn Engine 2 off

Span

San Marcos Landfill Turbine #1
8-9-93 CHF
Chart Speed 30 cm/hr


Start Test
1-CEM
49.11/49.87 NOx
11.16/11.1 CO
14.75/14.98 CO2
12.5/12.48 O2
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
Analyzer Cal
O2
NO2 Direct
70.5 ppm
63.2 ppm
NO2 Recovery
NO2
69.5/79.3 ppm
As Found CO
11.5/11.12 ppm
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
CO Set to
16.2 ppm
CO2 As Found
14.95/14.98 %
As Found O2
8.075/8.015
O2 Set to
12.48 %
CO2 Set to
22.41 %
As Found NOx
90.11
NOx Set to
NOx 49.7/49.87
Linearity
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0


1510
Stop
← CEM-1
49.2
48.7 NOx
11.16 / 11.12 CO
14.9 / 14.78 CO2
System Span
and O2
12.42 / 12.48 O2
50.0 / 49.8 NOx
Post System Span
11.0 / 11.13 CO
14.8 / 14.78 CO2
12.4 / 12.48 O2
1140
NOx mode
1130
NO Mode
1120
1110
CO2
CO
NO
O2
RUN 1
1100
Start Test
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0



1315 Start
3-CEM-1

49.9 / 49.9 NOx

11.21 / 11.12 CO

14.98 / 14.98 CO2

O2 12.52 / 12.48

System Span

Analyzer Cal

NOx 48.2 / 49.82

11.0 / 11.12 CO

14.8 / 14.98 CO2

12.38 / 12.48 O2

System Span

1250

NOx Mode

1240

NO Mode

1230

O2

CO

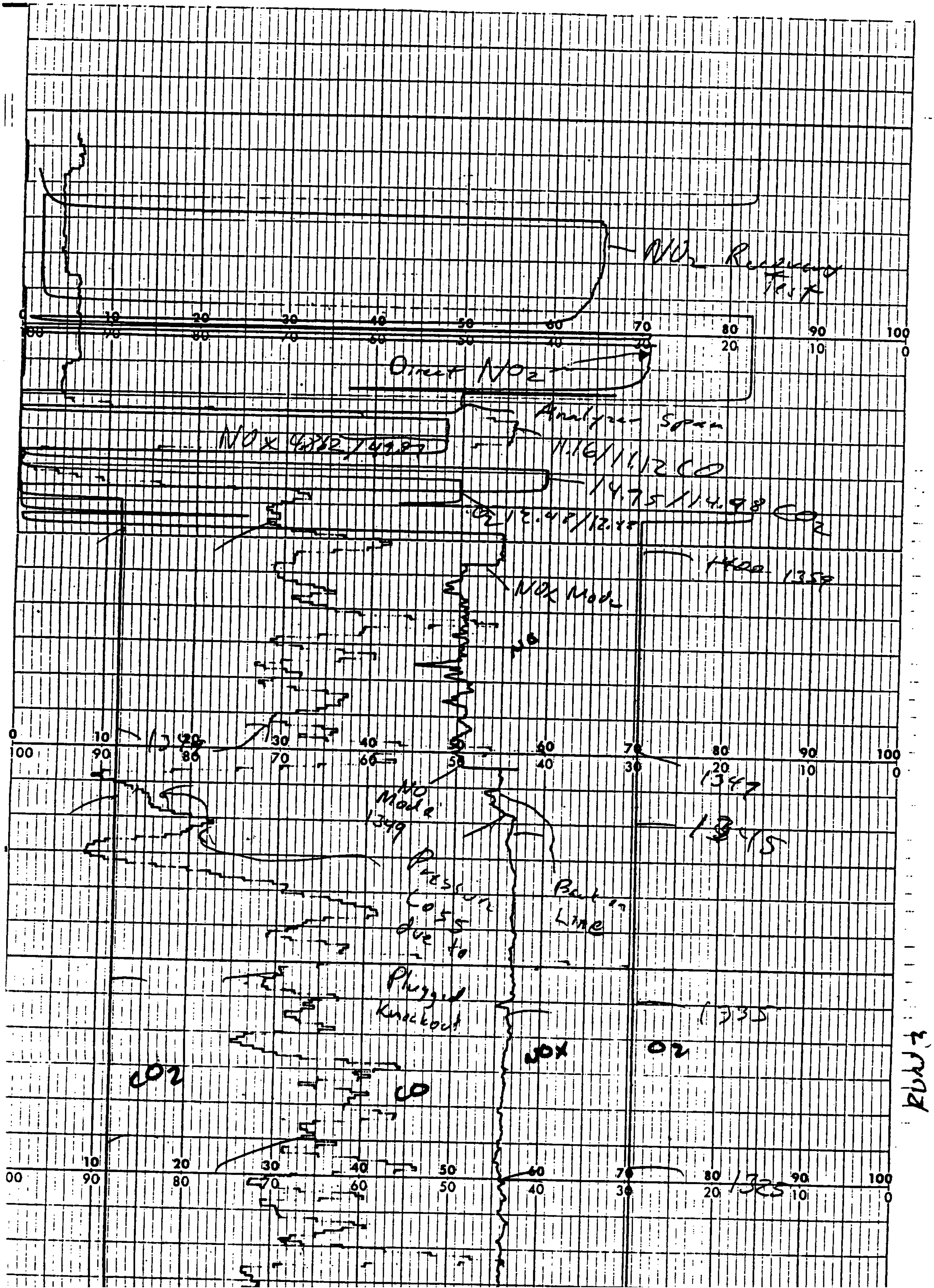
NOx

O2

1220

1213

RUN 2


NO2 Recovery Test
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0
Direct NO2
Analyzer Span
NOx 48.32/49.87
11.16/11.12 CO
14.75/14.98 CO2
O2 12.48/12.45
1400 1358
NOx Mode
NO
1329
NO Mode 1349
1347
1345
Pressure Loss due to Plugged Knockout
Back on Line
1335
NOX
O2
CO2
CO
1325
RDW

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, in Hg

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

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

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

3. Gaseous Emissions, lb/hr

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

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_{wo} = 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 (NO_2)
CO : 28
SO_x : 64
HC : 16

Nomenclature (Continued):

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

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

Ref. 22b
Data Qual.=C
Little Backup data
Exhaust flow not clear.
+ Data on Plant Eff.

SAN MARCOS LANDFILL
GAS TURBINE
(PERMIT #870535)

NOTE: 2 TURBINES ON SITE.

San Diego Air Pollution Control District
Monitoring and Technical Services
9150 Chesapeake Dr.
San Diego, CA 92123

Nitrogen Oxides & Carbon Monoxide
Emissions Summary Report

TEST WITNESS

SITE: Landfill Energy Partners (San Marcos Landfill) Turbine #1

P/O NUMBER: 870535

TEST #: 93221

TEST DATE: 9-Aug-93

EQUIPMENT: Landfill Gas Turbine - One Solar Saturn Recuperated Gas Turbine, Model GSC 1200R, 10.8 MMBTU/HR, Gas Processing Equipment and fuel flow meter. Landfill gas from recovery system.

REPORT BY: CARNOT

DATE: 14-Oct-93

APCD PERSONNEL: Janet Cawyer

SITE PERSONNEL: Bruno Lukosz

APPROVED BY: Robert Yelenosky
Robert Yelenosky, Senior Chemist

Table 1. Summary of Results- average NOx and CO stack emissions corrected to 3% O2

	TEST (ppm)	PERMIT LIMITS (ppm)	PERFORMANCE	HOURS OF TEST
NOx	297	263	**EXCEEDANCE**	1.5
CO	32	325	**PASS**	1.5

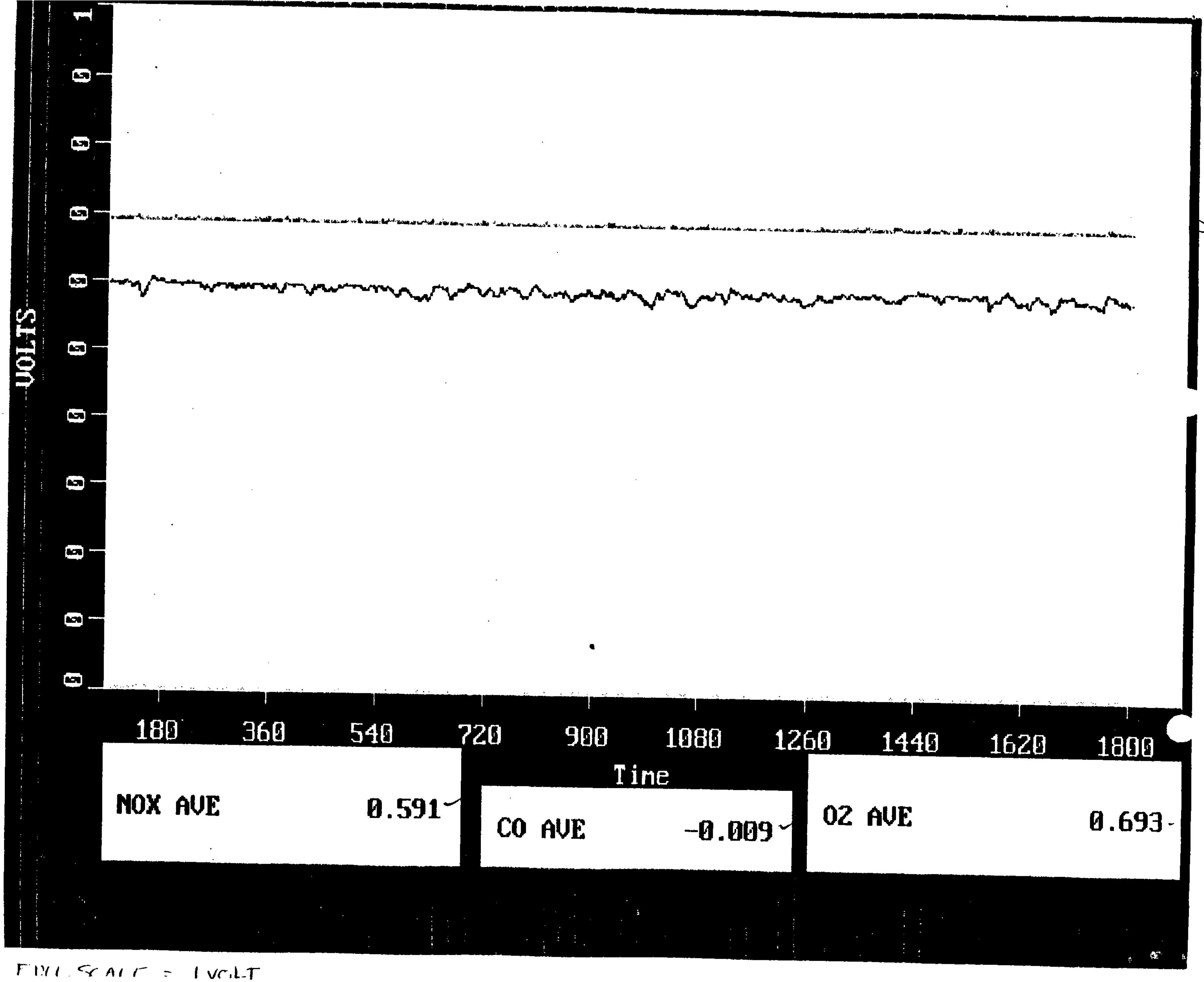
TEST REFERENCE: This testing was performed in accordance with the San Diego Air Pollution Control District Method 20: "Test Procedures For The Determination of Nitrogen Oxides, Carbon Monoxide and Diluent Gases by Continuous Emission Monitoring"

TABLE 4-1
GENERAL RESULTS
SAN MARCOS LANDFILL TURBINE NO. 1
STACK EXHAUST
AUGUST 9, 1993

Parameter	First Run	Second Run	Third Run	Average
O_2, % dry	17.4	17.5	17.6	17.5
CO_2, % dry	3.0	3.0	3.0	3.0
CO, ppm	5.6	6.3	6.6	6.2
CO, ppm @ 3% O_2	28.3	32.8	35.4	32.3
NO_x, ppm	55.5	58.3	57.5	57.1
NO_2 ppm	5.4	6.5	5.1	5.7
NO_x, ppm @ 3% O_2	281	303	308	297

NOTE: The NO_x and NO_2 concentration has been adjusted for NO_2 recovery.

[illegible] 3/5/97 [illegible]



NOX AVE 0.591

CO AVE -0.009

O2 AVE 0.693

FULL SCALE = 1 VOLT

PLANT H.RT B/KWH	15160	15350	15332	15043	15278	14684	15054	[illegible]	N/A	N/A

SAN MARCOS DATA

DATA P	20	21	22	23	24	25	26	27	28	29
DATA TAKEN:										
YEAR										
MONTH										
DAY										
HOUR										
MINUTE										
DOWN TIME - HRS										
---TG 1---										
SCHEDULED										
UNSCHEDULED										
DIRECTED										
---TG 2---										
SCHEDULED										
UNSCHEDULED										
DIRECTED										
METER READINGS										
IMPORT										
EXPORT										
SEC./60 REV.										
CONDENSATE COUNT										
---TG 1---										
T1 - F										
T2 - F										
Inlet DP,ins H2O										
Exh. DP,ins H2O										
Pcd - PSIG										
T5 AVG - F										
OUTPUT - KW										
HOUR METER										
START COUNTER										
---TG 2---										
T1 - F										
T2 - F										
Inlet DP,ins H2O										
Exh. DP,ins H2O										
Pcd - PSIG										
T5 AVG - F										
OUTPUT - KW										
HOUR METER										
START COUNTER										
BARO, Ins HgA										
--FUEL GAS DATA-										
HYDROGEN - %Vol										
C.DIXODE - %Vol										
OXYGEN - % Vol										
NITROGEN - %Vol										
METHANE - %Vol										
GAS TEMP - F										
PRESSURE - PSIG										
FLOW METER - MA										
FLOW - SCFH	0	0	0	0	0	0	0	0	0	0
LHV - Btu/SCF	0	0	0	0	0	0	0	0	0	0
TG1,COMP.EFFIC %	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR
TG1. REL. KW %	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0

PLANT H.RT B/KWH	14695	4916	14832	15518	15294	14744	1 [illegible]	14732	15229

SAN MARCOS DATA

DATA P	10	11	12	13	14	15	16	17	18	19
DATA TAKEN:										
YEAR	93	93	93	93	93	93	93			
MONTH	2	2	2	2	2	2	3			
DAY	16	17	19	22	23	26	1			
HOUR	10	10	11	8	10	15	8			
MINUTE	0	0	0	0	0	0	0			
DOWN TIME - HRS										
---TG 1---										
SCHEDULED	0	0	0	0	0	0	0			
UNSCHEDULED	0	0	5.3	0	0	0	0			
DIRECTED	0	0	0	0	0	0	0			
---TG 2---										
SCHEDULED	0	0	0	0	0	0	0			
UNSCHEDULED	17.4	0	4.4	0	0	0	0			
DIRECTED	0	0	0	0	0	0	0			
METER READINGS										
IMPORT	53.1	53.1	53.3	53.3	53.3	53.3	53.3			
EXPORT	37,455.0	37,487.0	37,543.0	37,635.0	37,669.0	37,771.0	37,859.0			
SEC./60 REV.	198	205	205	192	200	196	197			
CONDENSATE COUNT	26015	26031	26060	26101	26118	26152	26203			
---TG 1---										
T1 - F	57	68	65	55	63	57	59			
T2 - F	468	476	475	465	472	466	465			
Inlet DP,ins H2O	2.50	2.50	2.50	2.50	2.50	2.5	2.60			
Exh. DP,ins H2O	2.00	2.00	2.00	2.00	2.00	2	2.00			
Pcd - PSIG	78	77	77	80	78	79	79			
T5 AVG - F	1,200	1,200	1,200	1,200	1,200	1200	1,200			
OUTPUT - KW	757	732	733	776	748	758	764			
HOUR METER	29,868	29,892	29,940	30,009	30,035	30112	30,177			
START COUNTER	603	603	605	605	605	605	605			
---TG 2---										
T1 - F	57	68	65	55	63	57	59			
T2 - F	464	476	472	462	468	461	465			
Inlet DP,ins H2O	2.70	2.70	2.70	2.70	2.70	2.7	2.80			
Exh. DP,ins H2O	2.00	2.00	2.00	2.00	2.00	2	2.00			
Pcd - PSIG	79	78	77	80	79	79	80			
T5 AVG - F	1200	1200	1200	1200	1200	1200	1200			
OUTPUT - KW	744	714	719	757	732	746	746			
HOUR METER	29698	29722	29770	29839	29866	29942	30007			
START COUNTER	697	697	698	698	698	698	698			
BARO, Ins HgA	29.1	29.1	29.1	29.1	29.1	29.1	29.1			
--FUEL GAS DATA-										
HYDROGEN - %Vol	0.26	0.26	0.27	0.25	0.26	0.25	0.26			
C.DIXODE - %Vol	42.61	42.61	42.75	42.58	42.75	42.78	42.61			
OXYGEN - % Vol	0.12	0.12	0.04	0.12	0.04	0.04	0.12			
NITROGEN - %Vol	0.64	0.64	0.31	0.47	0.29	0.27	0.64			
METHANE - %Vol	56.36	56.36	56.63	56.58	56.65	56.66	56.26			
GAS TEMP - F	95	98	96	87	95	108	95			
PRESSURE - PSIG	111	111	111	111	111	111	111			
FLOW METER - MA	10.45	10.2	10.1	10.6	10.35	10.25	10.45			
FLOW - SCFH	38,692	37,839	37,613	39,441	38,404	37,660	38,684	0	0	0
? LHV - Btu/SCF	513	513	515	515	516	516	512	0	0	0
TG1,COMP.EFFIC %	85.3	87.1	86.2	86.5	86.7	86.4	87.4	ERR	ERR	ERR
TG1, REL. KW %	-10.8	-9.6	-10.6	-9.3	-9.5	-10.6	-9.2	-100.0	-100.0	-100.0

SAN MARCOS DATA 03/30/93 11:25 AM [revision date 01/08/91]

DATA POINTS >>		1	2	3	4	5	6	7	8	9
DATA TAKEN:	LAST CLOSING									
YEAR	93	93	93	93	93	93	93	93	93	93
MONTH	2	2	2	2	2	2	2	2	2	2
DAY	1	2	3	4	5	8	9	10	11	12
HOUR	8	10	10	10	10	8	10	10	10	10
MINUTE	0	0	0	0	0	0	0	0	0	0
DOWN TIME - HRS										
---TG 1---										
SCHEDULED	5.0	0	0	0	0	0	0	0	0	0
UNSCHEDULED	12.0	0	0	0	0	0	0	0	0	0
DIRECTED	0.5	0	0	0	0	0	0	0	0	0
---TG 2---										
SCHEDULED	5.0	0	0	0	0	0	0	0	0	0
UNSCHEDULED	0.3	0	0	0	0	0	0	0	0	0
DIRECTED	0.5	0	0	0	0	0	0	0	0	0
METER READINGS										
IMPORT	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1
EXPORT	36,998.0	37,032.0	37,063.0	37,093.0	37,125.0	37,215.0	37,249.0	37,281.0	37,313.0	37,345.0
SEC./60 REV.	-	197	198	199	208	205	193	191	192	200
CONDENSATE COUNT	25775	25794	25811	25828	25846	25895	25911	25926	25943	25959
---TG 1---										
T1 - F	60	64	63	70	64	61	58	56	57	57
T2 - F	472	476	475	480	476	469	467	467	468	468
Inlet DP,ins H2O	3	2.50	2.50	2.60	2.60	2.50	2.40	2.40	2.40	2.50
Exh. DP,ins H2O	2	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Pcd - PSIG	79	78	78	77	78	77	78	79	79	79
T5 AVG - F	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
OUTPUT - KW	763	747	736	727	740	746	762	770	771	766
HOUR METER	29,506	29,532	29,556	29,580	29,604	29,674	29,700	29,724	29,748	29,772
START COUNTER	603	603	603	603	603	603	603	603	603	603
---TG 2---										
T1 - F	60	64	63	70	64	61	58	56	57	57
T2 - F	469	475	472	479	474	467	466	465	465	465
Inlet DP,ins H2O	2	2.60	2.60	2.70	2.70	2.70	2.60	2.60	2.60	2.70
Exh. DP,ins H2O	2	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Pcd - PSIG	80	78	78	78	78	78	80	80	80	80
T5 AVG - F	1,200	1200	1200	1200	1200	1200	1200	1200	1200	1200
OUTPUT - KW	750	721	724	705	726	721	744	753	750	751
HOUR METER	29,356	29382	29406	29430	29454	29524	29550	29574	29598	29622
START COUNTER	696	696	696	696	696	696	696	696	696	696
BARO, Ins HgA	29.1	29.1	29.1	29.1	29.1	29.1	29.1	29.1	29.1	29.1
--FUEL GAS DATA--										
HYDROGEN - %Vol	0.3	0.3	0.26	0.28	0.27	0.26	0.26	0.26	0.26	0.26
C.DIXODE - %Vol	43.0	42.2	42.62	42.4	42.31	42.46	42.42	42.41	42.46	42.51
OXYGEN - % Vol	0.2	0.2	0.09	0.13	0.21	0.23	0.2	0.15	0.19	0.18
NITROGEN - %Vol	1.5	1.1	0.73	0.87	1.04	0.9	1	0.92	0.89	0.78
METHANE - %Vol	54.9	56.2	56.56	56.31	56.18	56.16	56.12	56.26	56.21	56.28
GAS TEMP - F	101	109	109	112	108	98	97	100	105	104
PRESSURE - PSIG	111	111	111	111	111	111	111	111	111	111
FLOW METER - MA	11	10.3	10.35	10.3	10.3	10.2	10.5	10.65	10.63	10.5
FLOW - SCFH	39,075	37,795	37,934	37,692	37,820	37,836	38,770	39,120	38,878	38,532
LHV - Btu/SCF	500	512	515	513	511	511	511	512	512	512
TG1,COMP.EFFIC %		86.3	86.1	87.0	86.3	86.0	85.9	85.8	86.0	86.0

How Calculated?

Average 38,359.1
60

Both

Avg = 38560
60
= 642.7

MECHANICAL ENGINEERING
SOURCE TEST REPORT
PERMIT RENEWAL TEST

Test Date: 03/30/93 **Engineer** : Evariste Haury

Site: SAN MARCOS LANDFILL

UNIT #1

P.O. # 870535
Equipment : LANDFILL GAS COMBUSTION TURBINE : SOLAR SATURN RECUPERATED GAS TURBINE, MODEL GSC 1200R, 10.8 MM BTU/HR, GAS FIRED.

Test Results:

- Ambient air conditions: 60% Relative Humidity;

- Engine power 707 KW

-Turbine speed : 22100 RPM

-Visible emissions were less than 5% @ the exhaust stack

? -Natural Gas fuel rate 19,346 SCFH supplemental fuel? one turbine

- Engine exhaust temperature 500 °F

-Hours: beginning : 30879

-Oxygen : 0.1%

- Compressor outlet pressure : 120 psi

- Composition of the natural gas is given on the computer printout provided by Landfill Gen. Partners I.

- The gas turbine was (@ 707 KW) running below its full rated capacity.

Performance Analytical Inc.
Environmental Testing and Consulting

20954 Osborne Street
Canoga Park, California 91304
Phone 818 709-1139
Fax 818 709-2915

Chain of Custody Record
Analytical Services Request

Client/Project Name	San Diego APCD
Address/Phone	9150 Chesapeake Dr. San Diego CA 92123
PAI Project No.	5093
Project Location	San Marcos Landfill
Client Project No.	
Contact	J. Cawyer
Sampler (Signature)	Janet Cawyer
P.O. No.	59788

Sample Identification No.	Date	Time	Lab Sample No.	Type of Sample	EPA M18 C1-C9 NMHC as CH4						Expected Turnaround Time	Remarks
Eng 1 cyl# 112	3/30/93	11:00	112	HC							904	9301093
Eng 1 cyl# 49	↓	12:00	49	↓							931	9301094
Eng 1 cyl# 48		1:00	48								907	9301095
Eng 2 cyl# 185	3/31/93	10:30	185								923	9301096
Eng 2 cyl# 93	↓	11:30	93								934	9301097
Eng 2 cyl# 146		12:30	146								929	9301098

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Janet Cawyer	4/1/93	1:30 pm	Robert D. [illegible]	4/2/93	9:00 A.M.

Disposal Method

Disposed by: (Signature) Date Time

White Copy : Accompanies Samples
Yellow Copy : Sampler

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF ANALYSIS

Client: San Diego Air Pollution Control District

Client Sample ID: Eng. 1 Cyl. #48 (03/30/93) (1:00)
PAI Sample ID: 9301095

Test code: EPA 18
Analyst: Ku-Jih Chen
Instrument ID: HP5890/FID #3
Verified by: Michael Tuday

Matrix: Summa Canister
Date Received: 04/02/93
Date Analyzed: 04/05/93
Volume Analyzed: 1.0 ml
P_i = -5.7 P_f = +2.0 DF= 1.86

Analyte	Result (ppm)	Detection Limit (ppm)
C_1 as Methane	4.8	1.0
C_2 as Ethane	ND	1.0
C_3 as n-Propane	ND	0.80
C_4 as n-Butane	ND	0.60
C_5 as n-Pentane	ND	0.40
C_6 as n-Hexane	ND	0.20
C_7 as n-Heptane	ND	0.20
C_8 as n-Octane	ND	0.20
C_9 as n-Nonane	ND	0.20

ND = Not Detected - Less Than Indicated Detection Limit

Analyte	Result (ppmc/v,v)	Detection Limit (ppmc/v,v)
Total Non-Methane Organics (as Methane)	ND	2.0

ND = Not Detected - Less Than Indicated Detection Limit

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF ANALYSIS

Client: San Diego Air Pollution Control District

Client Sample ID: N/A
PAI Sample ID: PAI Method Blank

Test code: EPA 18
Analyst: Ku-Jih Chen
Instrument ID: HP5890/FID #3
Verified by: Michael Tuday

Matrix: Summa Canister
Date Received: N/A
Date Analyzed: 04/05/93
Volume Analyzed: 1.0 ml

Analyte	Result (ppm)	Detection Limit (ppm)
C_1 as Methane	ND	0.50
C_2 as Ethane	ND	0.50
C_3 as n-Propane	ND	0.40
C_4 as n-Butane	ND	0.30
C_5 as n-Pentane	ND	0.20
C_6 as n-Hexane	ND	0.10
C_7 as n-Heptane	ND	0.10
C_8 as n-Octane	ND	0.10
C_9 as n-Nonane	ND	0.10

ND = Not Detected - Less Than Indicated Detection Limit

Analyte	Result (ppmc/v,v)	Detection Limit (ppmc/v,v)
Total Non-Methane Organics (as Methane)	ND	1.0

ND = Not Detected - Less Than Indicated Detection Limit

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF ANALYSIS

Client: San Diego Air Pollution Control District

Client Sample ID: Eng. 1 Cyl. #49 (03/30/93) (12:00)
PAI Sample ID: 9301094

Test code: EPA 18
Analyst: Ku-Jih Chen
Instrument ID: HP5890/FID #3
Verified by: Michael Tuday

Matrix: Summa Canister
Date Received: 04/02/93
Date Analyzed: 04/05/93
Volume Analyzed: 1.0 ml
P_i = -5.0 P_f = +2.0 DF= 1.72

Analyte	Result (ppm)	Detection Limit (ppm)
C_1 as Methane	4.0	1.0
C_2 as Ethane	ND	1.0
C_3 as n-Propane	ND	0.80
C_4 as n-Butane	ND	0.60
C_5 as n-Pentane	ND	0.40
C_6 as n-Hexane	ND	0.20
C_7 as n-Heptane	ND	0.20
C_8 as n-Octane	ND	0.20
C_9 as n-Nonane	ND	0.20

ND = Not Detected - Less Than Indicated Detection Limit

Analyte	Result (ppmc/v,v)	Detection Limit (ppmc/v,v)
Total Non-Methane Organics (as Methane)	ND	2.0

ND = Not Detected - Less Than Indicated Detection Limit

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF ANALYSIS

Client:	San Diego Air Pollution Control District
Client Sample ID:	Eng. 1 Cyl. #112 (03/30/93) (11:00)
PAI Sample ID:	9301093

Test code:	EPA 18	Matrix:	Summa Canister
Analyst:	Ku-Jih Chen	Date Received:	04/02/93
Instrument ID:	HP5890/FID #3	Date Analyzed:	04/05/93
Verified by:	Michael Tuday	Volume Analyzed:	1.0 ml
		P_i = -5.1 P_f = +2.0	DF= 1.74

Analyte	Result (ppm)	Detection Limit (ppm)
C_1 as Methane	4.3	1.0
C_2 as Ethane	ND	1.0
C_3 as n-Propane	ND	0.80
C_4 as n-Butane	ND	0.60
C_5 as n-Pentane	ND	0.40
C_6 as n-Hexane	ND	0.20
C_7 as n-Heptane	ND	0.20
C_8 as n-Octane	ND	0.20
C_9 as n-Nonane	ND	0.20

ND = Not Detected - Less Than Indicated Detection Limit

Analyte	Result (ppmc/v,v)	Detection Limit (ppmc/v,v)
Total Non-Methane Organics (as Methane)	ND	2.0

ND = Not Detected - Less Than Indicated Detection Limit

P/O NUMBER: 870535

3/30/93

ANALYZER CHECK LIST

	YES	NO	COMMENTS
NOx Analyzer			
analyzer calibrated	x		
analyzer set to zero	x		
zero drift ≤ 2% of span	x		
reset zero		x	
span drift ≤ 2%	x		
reset span		x	
response time within limits	x		
CO Analyzer			
analyzer calibrated	x		
analyzer set to zero	x		
zero drift ≤ 2% of span	x		
reset zero		x	
span drift ≤ 2%	x		
reset span		x	
Oxygen Analyzer			
high calibration set to 20.95%	x		
low calibration set to exhaust gas	x		
zero drift ≤ 2% of span	x		
reset zero		x	
span drift ≤ 2%	x		
reset span		x	
CO2 Analyzer			
analyzer calibrated	x		
analyzer set to zero	x		
zero drift ≤ 2% of span	x		
reset zero		x	
span drift ≤ 2%		x	SPAN RESET AFTER RUN #1 & #2
reset span	x		VALUES CORRECTED FOR DRIFT.
System Integrity/ Leak Check			
Pre-testing: performed with NO/NO2	x		
Post-testing: performed with NO/NO2	x		
System Assembly			
Probe installed	x		
Moisture removal trap used	x		
Particulate filter used	x		
Probe heated		x	
Sample manifold pressure set	x		
Data Recording			
Annotated	x		
Electronic zero set on each pen	x		
Chart Speed set	x		
Converter efficiency: NO2 to NO	x		
Certificates of calibration gases	x		

SCALES:		RUN 1			RUN 2 & 3
NOx:	0-	250	ppm	0-	100
CO:	0-	600	ppm		
O2:	0-	25	%		Adjusted NOx for NO2

Recovery % = 90 %

Test Hrs	Sub-test #	Avg Raw NOx ch div	Avg Raw NOx ppm	Avg Raw NO ch div	Avg. Raw NO ppm	Avg. Raw NO2 ppm	Adj. NO2 ppm	Adj. Raw NOx ppm	Avg Raw CO ch div	Avg. Raw CO ppm	Raw O2 ch div	Raw O2 %	Corr NOx ppm @ 3% O2	Corr CO ppm @ 3% O2
11:08 11:48	1* AVG	22.6	56.5	21.0	52.5	4.0	4.4	56.9	0.0	0.0	69.2	17.30	280.0	0.0
	PK 1	0.0	0	0.0	0.0	0	0	0	0.0	0.0	0.0	0.00	0	0.0
	PK 2	0.0	0	0.0	0.0	0	0	0	0.0	0.0	0.0	0.00	0	0.0
12:07 12:47	2 AVG	59.1	59.1	54.0	54.0	5.1	5.7	59.7	0.0	0.0	69.3	17.33	295.5	0.0
	PK 1	0.0	0	0.0	0.0	0	0	0	0.0	0.0	0.0	0.00	0	0.0
	PK 2	0.0	0	0.0	0.0	0	0	0	0.0	0.0	0.0	0.00	0	0.0
13:00 13:40	3 AVG	58.7	58.7	54.0	54.0	4.7	5.2	59.2	0.2	1.2	69.4	17.35	295.3	6.0
	PK 1	0	0	0.0	0.0	0	0	0	0.0	0.0	0.0	0.00	0	0.0
	PK 2	0	0	0.0	0.0	0	0	0	0.0	0.0	0.0	0.00	0	0.0

Footnote: Adjusted Raw NOx = Raw NO + Adjusted Raw NO2

1. The last three columns are the overview, or summary columns, that form the essence of the final numbers and the essence of the report.

2. For tests that do not require a separate determination of NO2, only the column "Average Raw NOx ppm" is used to report any raw NOx values.

P/O NUMBER: 870535 3/30/93

Nitrogen Oxides and Carbon Monoxide Emissions Summary Report

Table 2. Intermediate data

Subtest	Raw Adj NOx*	Raw CO	O2	Corr NOx @ 3% O2	Corr CO @ 3% O2
1	56.9	0.0	17.30	280.0	0.0
PK1	0.0	0.0	0.00	0.0	0.0
PK2	0.0	0.0	0.00	0.0	0.0
2	59.7	0.0	17.33	295.5	0.0
PK1	0.0	0.0	0.00	0.0	0.0
PK2	0.0	0.0	0.00	0.0	0.0
3	59.2	1.2	17.35	295.3	6.0
PK1	0.0	0.0	0.00	0.0	0.0
PK2	0.0	0.0	0.00	0.0	0.0
AVERAGE	58.6	0.4	17.33	290.3	2.0
LGST PK	0.0	0.0	0.00	0.0	0.0

*Raw adj. = Raw NOx on sites where no NO2 corrections are made.

Reporting NOx and CO values: If the corrected average is an exceedance, the average is reported. When the corrected average is not an exceedance, yet two or more excursions above the permit limit occur during three subtests, the largest corrected peak is reported. When both corrected averages and corrected peaks are below the limit, the corrected average is reported.

Table 3. Calibration Gases.

	Cylinder	Manufacturer	Concentration (ppm)
N O	CC116716	Scott-Marrin	204.1
N O2	L2273	Scott-Marrin	141.5
C O	L2366	Scott-Marrin	427
O2	CC103733	Scott-Marrin	7.89%
ZERO AIR	462786	Scott Specialty	-
N2	CC91331	Scott-Marrin	-

Ref. 22d
Use NMHC from ~~this~~ report.
Data Qual. C

San Marcos Landfill
Gas Turbine
(Permit # 870535)

San Diego Air Pollution Control District
Monitoring and Technical Services
9150 Chesapeake Dr.
San Diego, CA 92123

Nitrogen Oxides & Carbon Monoxide Emissions Summary Report

need exhaust flow and LFG analysis for NMOC.

SITE: LANDFILL ENERGY PARTNER ENGINE #1

P/O NUMBER: 870535

TEST # : 93089.3

TEST DATE: 30-Mar-93

EQUIPMENT: LANDFILL GAS COMBUSTION TURBINE-ONE SOLAR SATURN GAS TURBINE, MODEL GSC 1200R, 10.8 MMBTU/HR, MISC. PIPING, DUCTING, INSTRUMENTATION, GAS PROCESSING EQUIPMENT AND FUEL FLOW METER.

REPORT BY: L. TWADDLE

DATE: 1-Apr-93

APCD PERSONNEL: JANET CAWYER, LINDA TWADDLE, GRAHAM MORTIMORE, E. HAURY

SITE PERSONNEL: BRUNO LUKOSZ

APPROVED BY: Robert Yelenosky
Robert Yelenosky, Senior Chemist

Table 1. Summary of Results- NOx and CO stack emissions corrected to 3% O2

	TEST	PERMIT LIMITS	PERFORMANCE	HOURS OF TEST
NOx (PPM)	290	263	**EXCEEDANCE**	1.5
CO (PPM)	2	325	**PASS**	1.5
NMHC (PPM)	ND	337	**PASS**	3.0

TEST REFERENCE: This testing was performed in accordance with the San Diego Air Pollution Control District Method 20: "Test Procedures For The Determination of Nitrogen Oxides, Carbon Monoxide and Diluent Gases by Continuous Emission Monitoring"

SCOTT-MARRIN, INC.
2001 THIRD ST. • UNIT H • RIVERSIDE, CA 92507
TELEPHONE (714) 784-1240

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REPORT OF ANALYSIS
EPA PROTOCOL GAS MIXTURES

SOCE01
TO: RUSS LOGAN
SOUTH COAST ENVIRONMENTAL CORP
1915 MCKINLEY AVE.
SUITE E
LAVERNE, CA 91750

DATE : 08/30/91

CUSTOMER ORDER NUMBER: 343

PAGE 1

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COMPONENT	CONCENTRATION (v/v)	REFERENCE STANDARD	ANALYZER MAKE, MODEL, S/N, DETECTION	EXPIRATION DATE	REPLICATE ANALYSIS DATA	
CYLINDER NO.:	CC67219					
			Carle Insts Model 8000		07/28/89	08/29/91
Carbon Monoxide	476 ± 5 ppm	GMIS	S/N 8249	02/29/93	475 ppm	475 ppm
		Cylinder #	Methanation/FID		473 ppm	477 ppm
Nitrogen	Balance	CC28362	Gas Chromatography		473 ppm	481 ppm
Cylinder Pressure: 2000 psig		@ 496 ppm	Last Cal Date: 07/19/91	Mean:	474 ppm	478 ppm

ppm = umole/mole   % = mole-%

The above analyses were performed in accordance with EPA-1987 Traceability Protocol # 1, Section 3.0.4, Procedure G1.

Analyst: Mark Monson
M.J. Monson

Approved:
J.T. Marrin

STANDARD CALIBRATION GASES IN ALUMINUM CYLINDERS

SCOTT-MARRIN, INC.
2001 THIRD ST. • UNIT H • RIVERSIDE, CA 92507
TELEPHONE (714) 784-1240

REPORT OF ANALYSIS
EPA PROTOCOL GAS MIXTURES

SOCE01

TO:

KEITH SHANNON
SOUTH COAST ENVIRONMENTAL CORP
1915 MCKINLEY AVE., ST. E
LA VERNE, CA 91750

DATE : 05/14/91

CUSTOMER ORDER NUMBER: 294

PAGE 1

COMPONENT	CONCENTRATION(v/v)	REFERENCE STANDARD	ANALYZER MAKE,MODEL,S/N,DETECTION	EXPIRATION DATE	REPLICATE ANALYSIS DATA	
CYLINDER NO.:	CC7297					
			Monitor Labs Model 8440		05/06/91	05/14/91
Nitric Oxide	214.2 ± 2.1 ppm	GMIS	S/N 136	11/14/92	213.2 ppm	215.0 ppm
		Cylinder #	Continuous		214.9 ppm	214.4 ppm
Nitrogen,O2-Free Balance		CC7341	Chemiluminescence		213.3 ppm	214.5 ppm
Cylinder Pressure: 2000 psig		@ 247.6 ppm	Last Cal Date: 05/01/91	Mean:	213.8 ppm	214.6 ppm

ppm = umole/mole % = mole-%

The above analyses were performed in accordance with EPA-1987 Traceability Protocol # 1, Section 3.0.4, Procedure G1.

Analyst: B.E. Gross

Approved: J.T. Marrin

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

COMPANY: LANDFILL ENERGY
DATE: MARCH 27, 1992
UNIT: TURBINE 2
REPORT #:T 1393-14B

NO2 - NOx ADJUSTMENTS

					NOx ADJUSTED VALUES	
RUN #	NOX	NO ppm	NO2 ppm	% Recovery	NO2 ppm	NOX ppm
#1	52.5	45.75	6.75	88.6	7.62	53.37
#2	52	45.75	6.25	88.6	7.05	52.80
#3	52.5	46.5	6	88.6	6.77	53.27
				AVERAGE	7.15	53.15

P/O NUMBER: 870536 DATE: 3/27/92

ANALYZER CHECK LIST

	YES	NO	COMMENTS
NO$_x$ Analyzer			
analyzer calibrated	X		
analyzer set to zero	X		
zero drift < or = 2% of span	X		
reset zero		X	
span drift < or = 2%	X		
reset span	X		
response time within limits	X		
CO Analyzer			
analyzer calibrated	X		
analyzer set to zero	X		
zero drift < or = 2% of span	X		
reset zero		X	
span drift < or = 2%	X		
reset span	X		
O$_2$ Analyzer			
high calibration set to 20.95%	X		
low cal. set to exhaust gas		X	Set at 8.4% Gas
zero drift < or = 2% of span	X		
reset zero		X	
span drift < or = 2%	X		
reset span	X		
System Integrity/Leak Check			
pre-testing: performed w/NO	X		
post testing: performed w/NO	X		
System Assembly			
probe installed	X		
moisture removal trap used	X		
particulate filter used	X		
sample manifold pressure set	X		
Data Recording			
annotated	X		
electronic zero set on each pen	X		
chart speed set	X		
convertor efficiency: NO$_2$ to NO	X		
certificates of cal. gases	X		

P/O NUMBER: 870536 DATE: 5/27/92

Table 2. Stack Emissions of NO_x, CO, and O_2

RUN	SCALE	NO_x 0-250 ppm			CO 0-1000 ppm			O_2 0-25%	
	TIME	CHART (div)	UNCORR (ppm)	CORR 3%O_x (ppm)	CHART (div)	UNCORR (ppm)	CORR 3% O_2 (ppm)	CHART (div)	%
R1 Avg.	13:10 13:50	21.35	53.37	279.33	0.0	0.0	0.0	69.9	17.48
PK1									
PK2									
R2 Avg.	13:55 14:35	21.12	52.80	273.95	0.0	0.0	0.0	69.8	17.45
PK1									
PK2									
R3 Avg.	14:40 15:20	21.31	53.27	261.24	0.0	0.0	0.0	69.0	17.25
PK1									
PK2									
Peak =									
Overall =		21.26	53.15	271.51	0.0	0.0	0.0	69.6	17.39

NO_x and CO:

- The value reported is the average concentration value at 3% O_2, when:
  The average pollutant concentration exceeds the permit limit, or the average value is within the permit limit and there are less than two excursions above the limit.

- The value reported is the highest excursion value at 3% O_2, when: There are two or more excursions above the permit limit during the three subtests.

- If it has been determined that stratification exists, the average concentration values of NO_x and CO, at 3% O_2, are then reported.

Table 3. Calibration Gases

	CYLINDER	MANUFACTURER	CONCENTRATION (ppm)
NO_x	CC7297	Scott-Marrin	214.2
CO	CC67219	Scott-Marrin	476.0
O_2	CC106786	Scott-Marrin	8.40%
NO_2	CC648	Scott Marrin	176.0

SAN DIEGO AIR POLLUTION CONTROL DISTRICT
MONITORING AND TECHNICAL SERVICES
9150 CHESAPEAKE DRIVE
SAN DIEGO, CA 92123

NITROGEN OXIDES & CARBON MONOXIDE EMISSIONS SUMMARY REPORT

SITE: Landfill Energy @ San Marcos Landfill
San Marcos, CA 92069

P/O NUMBER: 870536

JOB NO: T1393-14B

TEST DATE: 3/27/92

EQUIPMENT: Landfill gas combustion turbine - one (1) Solar Saturn recuperated gas turbine, Model GSC 1200R, 10.8 MMBtu/hr, misc. piping, ducting, instrumentation, and gas processing equipment.

REPORT BY: Russ P Logan by JMLak
Russ P. Logan - SCEC

DATE: 4/1/92

APCD PERSONNEL:

SITE PERSONNEL: Bruno Lukosz

APPROVED BY: JMLak

DATE: 4/12/92

Table 1. Summary of Results - average NO_x and CO stack emissions corrected to 3% O_2

TURBINE #2	TEST (ppm)	PERMIT LIMITS (ppm)	PERFORMANCE	HOURS OF TEST
NO_x	271.5	263.0	Fail	1.9
CO	0.0	325.0	Pass	1.9

TEST REFERENCE: This testing was performed in accordance with the San Diego Air Pollution Control District Method 20: "Test Procedures For The Determination of Nitrogen Oxides, Carbon Monoxide and Diluent Gases by Continuous Emission Monitoring"

P/O NUMBER: 87.536 3/27/92

TURBINE #1)

Average line from three points: zero, mid, high
start: y = 1.03 x - 1.116
end: y = 1.034 x - .725

Run #1) O2 = 17.80 %	CF at 3% O2=	5.56
Run #2) O2 = 17.78 %		
Run #3) O2 = 17.57 %	NOx corr 3% O2 =	290.9 ppm
	CO corr 3% O2 =	0 ppm
Ave O2 = 17.72 %		

The NO2 recovery was not completed for this testing. Therefore, unseen NO2 due to system loss, was not calculated and added to the total NOx.
290.9 ppm NOx uncorrected is 52.33 ppm of NOx.
The uncorrected limit of 263 ppm is 47.30 ppm.
The difference 5.03 ppm, is within the measurement error of the testing. Thus, this test is inconclusive as far as determining an exceedance.

Because the NO2 recovery was not completed properly and the O2 calibrations were off, needing data corrections, I reccomend that the site be retested.

O_2 calibrations s/b w/in 40-90% of measured value

Janet Cawyer
Assistant Chemist

INITIAL NO_2 RECOVERY = 88.6

$52.33\left(\frac{100}{88.6}\right) = 59.06$ ppm

Uncorr limit = 47.30 ppm

DIF = 11.76 ppm

4% FS on 0-250 = 10 ppm

Ref. 22d.

SAN MARCOS LANDFILL
GAS TURBINE
(PERMIT # 870536)

San Diego Air Pollution Control District
Monitoring and Technical Services
9150 Chesapeake Dr.
San Diego, CA 92123

Nitrogen Oxides & Carbon Monoxide Emissions Summary Report

SITE: LANDFILL ENERGY - SAN MARCOS

P/O NUMBER: 87.536

TEST # : 92087.2

TEST DATE: 27-Mar-92

EQUIPMENT: Landfill gas combustion turbine - one (1) Solar Saturn recuperated gas turbine, Model GSC 1200R, 10.8 MMBtu/hr, misc. piping, ducting, instrumentation, and gas processing equipment.

REPORT BY: SCEC - Russ Logan

DATE: 1-Apr-92

APCD PERSONNEL:

SITE PERSONNEL: Bruno Lukosz

APPROVED BY: Thake - test will be repeated

DATE: 5/4/92

Table 1. Summary of Results- average NOx and CO stack emissions corrected to 3% O2

	TEST (ppm)	PERMIT LIMITS (ppm)	PERFORMANCE	HOURS OF TEST
*#NOx	291	263	**INCONCLUSIVE**	1.5
*C O	0	325	**PASS**	1.5

Value is within calibration error of the testing proceedure.

* Values corrected for low O2 span.

TEST REFERENCE: This testing was performed in accordance with the San Diego Air Pollution Control District Method 20: "Test Procedures For The Determination of Nitrogen Oxides, Carbon Monoxide and Diluent Gases by Continuous Emission Monitoring"

SCOTT-MARRIN, INC.
6531 BOX SPRINGS BLVD. • RIVERSIDE, CA 92507
TELEPHONE (714) 653-6780 • FAX (714) 653-2430

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REPORT OF ANALYSIS
EPA PROTOCOL GAS MIXTURES

SOCE01

TO:
KEITH SHANNON
SCEC
15882-1 NORTH BATAVIA
ORANGE, CA 92667-

DATE : 03/02/92

CUSTOMER ORDER NUMBER: 446

PAGE 1

COMPONENT	CONCENTRATION (v/v)	REFERENCE STANDARD	ANALYZER MAKE, MODEL, S/N, DETECTION	EXPIRATION DATE	REPLICATE ANALYSIS DATA
CYLINDER NO.:	CC29002				
Carbon Dioxide	12.16 ± 0.12 %	GMIS Cylinder # CC60263 @ 17.61 0	Varian Model 1860 S/N None Thermal Conductivity Gas Chromatography Last Cal Date: 12/06/91	08/26/93	02/26/92 12.23 % 11.99 % 12.25 % Mean: 12.16 %
Oxygen	4.08 ± 0.04 %	GMIS Cylinder # CC81219 @ 5.10 0	Varian Model 1860 S/N None Thermal Conductivity Gas Chromatography Last Cal Date: 12/30/91	08/25/93	02/25/92 4.09 % 4.08 % 4.08 % Mean: 4.08 %
Nitrogen	Balance				
Cylinder Pressure:	2000 psig				
CYLINDER NO.:	CC106786				
Oxygen	8.40 ± 0.08 %	GMIS Cylinder # CC62350 @ [illegible]	Varian Model 1860 S/N None Thermal Conductivity Gas Chromatography Last Cal Date: [illegible]	08/25/93	02/25/92 8.42 % 8.38 % 8.40 % Mean: [illegible]
Carbon Dioxide	13.47 ± 0.13 %	GMIS Cylinder # CC60263 @ 17.61 0	Varian Model 1860 S/N None Thermal Conductivity Gas Chromatography Last Cal Date: 12/06/91	08/26/93	02/26/92 13.42 % 13.46 % 13.53 % Mean: 13.47 %
Nitrogen	Balance				
Cylinder Pressure:	2000 psig				

ppm = umole/mole % = mole-%

The above analyses were performed in accordance with EPA-1987 Traceability Protocol # 1, Section 3.0.4, Procedure G1.

Analyst:
M.S. Calhoun

Approved:
J.T. Marrin

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

SCOTT-MARRIN, INC.
2001 THIRD ST. • UNIT H • RIVERSIDE, CA 92507
TELEPHONE (714) 784-1240

REPORT OF ANALYSIS
EPA PROTOCOL GAS MIXTURES

SOCE01

TO:

DATE : 09/06/91

RUSS LOGAN
SOUTH COAST ENVIRONMENTAL CO.
1915 MCKINLEY AVE. STE. E
LAVERNE, CA 91750

CUSTOMER ORDER NUMBER: 340

PAGE 1

COMPONENT	CONCENTRATION(v/v)	REFERENCE STANDARD	ANALYZER MAKE,MODEL,S/N,DETECTION	EXPIRATION DATE	REPLICATE ANALYSIS DATA	
CYLINDER NO.:	CC86177					
			Carle Insts Model 8000		08/27/91	09/05/91
Carbon Monoxide	705 ± 7 ppm	GMIS	S/N 8249	03/05/93	703 ppm	706 ppm
		Cylinder #	Methanation/FID		708 ppm	703 ppm
Nitrogen	Balance	L382	Gas Chromatography		705 ppm	703 ppm
Cylinder Pressure: 2000 psig		@ 1043 ppm	Last Cal Date: 08/02/91	Mean:	705 ppm	704 ppm

ppm = umole/mole % = mole-%

The above analyses were performed in accordance with EPA-1987 Traceability Protocol # 1, Section 3.0.4, Procedure G1.

Analyst: Mark Monson
M.J. Monson

Approved:
J.T. Marrin

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

SCOTT-MARRIN, INC.
2001 THIRD ST. • UNIT H • RIVERSIDE, CA 92507
TELEPHONE (714) 784-1240

REPORT OF ANALYSIS
EPA PROTOCOL GAS MIXTURES

SOCE01
TO:
LESLIE JOHNSON
SO. COAST ENVIRONMENTAL CO.
1528-1 N. BATAVIA ST.
ORANGE, CA 92667-

DATE : 01/02/92

CUSTOMER ORDER NUMBER: 389

PAGE 1

COMPONENT	CONCENTRATION(v/v)	REFERENCE STANDARD	ANALYZER MAKE,MODEL,S/N,DETECTION	EXPIRATION DATE	REPLICATE ANALYSIS DATA	
CYLINDER NO.:	CC28160					
			Monitor Labs Model 8440		12/18/91	12/27/91
Nitric Oxide	233.2 ± 2.3 ppm	GMIS	S/N 136	06/27/93	233.1 ppm	233.6 ppm
		Cylinder #	Continuous		232.7 ppm	233.2 ppm
Nitrogen,O2-Free	Balance	CC7341	Chemiluminescence		232.8 ppm	233.5 ppm
Cylinder Pressure: 2000 psig		@ 250.6 ppm	Last Cal Date: 11/25/91	Mean:	232.9 ppm	233.4 ppm
CYLINDER NO.:	CC86187					
			Varian Model 1200		12/17/91	12/26/91
Carbon Monoxide	2498 ± 25 ppm	GMIS	S/N None	06/26/93	2500 ppm	2479 ppm
		Cylinder #	Methanation/FID		2521 ppm	2491 ppm
Nitrogen	Balance	FF5397	Gas Chromatography		2503 ppm	2492 ppm
Cylinder Pressure: 2000 psig		@ 2419 ppm	Last Cal Date: 12/11/91	Mean:	2508 ppm	2488 ppm

ppm = umole/mole % = mole-%

The above analyses were performed in accordance with EPA-1987 Traceability Protocol # 1, Section 3.0.4, Procedure G1.

Analyst: Steve Kozy
S.B. Kozy

Approved:
J.T. Marrin

```
PLANT H.RT B/KWH  15034   15270   15258   14788   14874   15696   15006   14728   15243     N/A




SAN MARCOS DATA

          DATA P     20      21      22      23      24      25      26      27      28      29
DATA TAKEN:
           YEAR
          MONTH
            DAY
           HOUR
         MINUTE
DOWN TIME - HRS
 ---TG 1---
   SCHEDULED
   UNSCHEDULED
   DIRECTED
 ---TG 2---
   SCHEDULED
   UNSCHEDULED
   DIRECTED
METER READINGS
  IMPORT
  EXPORT
  SEC./60 REV.
CONDENSATE COUNT
 ---TG 1---
  T1 - F
  T2 - F
Inlet DP,ins H20
 Exh. DP,ins H20
  Pcd - PSIG
  T5 AVG - F
  OUTPUT - KW
  HOUR METER
  START COUNTER
 ---TG 2---
  T1 - F
  T2 - F
Inlet DP,ins H20
 Exh. DP,ins H20
  Pcd - PSIG
  T5 AVG - F
  OUTPUT - KW
  HOUR METER
  START COUNTER
  BARO, Ins HgA
 --FUEL GAS DATA-
  HYDROGEN - %Vol
  C.DIXODE - %Vol
   OXYGEN - % Vol
  NITROGEN - %Vol
   METHANE - %Vol
  GAS TEMP - F
  PRESSURE - PSIG
  FLOW METER - MA
  FLOW - SCFH         0       0       0       0       0       0       0       0       0       0
  LHV - Btu/SCF       0       0       0               0       0       0       0       0       0
 TG1,COMP.EFFIC %   ERR     ERR     ERR     ERR     ERR     ERR     ERR     ERR     ERR     ERR
  TG1, REL. KW %  -100.0  -100.0  -100.0  -100.0  -100.0  -100.0  -100.0  -100.0  -100.0  -100.0
 TG2.COMP.EFFIC %   ERR     ERR     ERR     ERR     ERR     ERR     ERR     ERR     ERR     ERR
```

TG2, REL. KW %	-8.8	-9.8	-9.3	[illegible]	[illegible]	[illegible]			
PLANT H.RT B/KWH	14954	14918	14915	15015	14764	15238	15052	15033	15094

SAN MARCOS DATA

DATA P	10	11	12	13	14	15	16	17	18	19
DATA TAKEN:										
YEAR	92	92	92	92	92	92	92	92	92	
MONTH	5	5	5	5	5	5	5	5	6	
DAY	15	18	19	20	21	22	26	29	1	
HOUR	10	15	15	11	9	10	10	10	13	
MINUTE	0	0	0	0	0	0	10	10	0	
DOWN TIME - HRS										
---TG 1---										
SCHEDULED	0	0	0	0	0	0	0	34.5	5	
UNSCHEDULED	0	4.75	0	0	0.75	0	0	0	0	
DIRECTED	0	0	0	0	0	0	0	0.0	0	
---TG 2---										
SCHEDULED	0	0	0	0	0	0	0	34.5	5	
UNSCHEDULED	0	0	0	0	0	0	0	0.0	0	
DIRECTED	0	0	0	0	0	0	0	0.0	0	
METER READINGS										
IMPORT	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.2	
EXPORT	29,494.0	29,589.0	29,620.0	29,646.0	29,674.0	29,705.0	29,827.0	29,875.0	29,967.0	
SEC./60 REV.	204	210	208	203	203	216	208	193	207	
CONDENSATE COUNT	19948	20024	20047	20067	20090	20118	20228	20270	20346	
---TG 1---										
T1 - F	64	71	70	66	66	69	66	65	71	
T2 - F	473	479	478	473	473	478	476	476	481	
Inlet DP, ins H2O	2.60	2.60	2.60	2.60	2.60	2.6	2.40	2.60	2.60	
Exh. DP, ins H2O	2.00	2.00	2.00	2.00	2.00	2	2.00	2.00	2.00	
Pcd - PSIG	76	74	75	75	75	74	74	78	76	
T5 AVG - F	1,200	1,200	1,200	1,200	1,200	1200	1,200	1,200	1,200	
OUTPUT - KW	735	707	712	720	725	720	715	767	726	
HOUR METER	23,708	23,780	23,804	23,824	23,846	23871	23,967	24,004	24,074	
START COUNTER	546	547	547	547	549	549	549	550	551	
---TG 2---										
T1 - F	64	71	70	66	66	69	66	65	71	
T2 - F	471	476	473	473	473	475	473	472	478	
Inlet DP, ins H2O	2.40	2.40	2.40	2.40	2.40	2.4	2.20	2.40	2.40	
Exh. DP, ins H2O	2.00	2.00	2.00	2.00	2.00	2	2.00	2.00	2.00	
Pcd - PSIG	78	76	76	76	76	76	76	80	77	
T5 AVG - F	1200	1200	1200	1200	1200	1200	1200	1200	1200	
OUTPUT - KW	730	713	718	723	724	717	712	764	727	
HOUR METER	23437	23514	23538	23558	23580	23605	23701	23739	23809	
START COUNTER	674	674	674	674	674	674	674	676	677	
BARO, Ins HgA	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	
--FUEL GAS DATA--										
HYDROGEN - %Vol	0.35	0.41	0.35	0.37	0.34	0.35	0.34	0.39	0.35	
C.DIXODE - %Vol	42.75	42.93	42.73	42.82	42.74	42.78	42.76	42.81	42.76	
OXYGEN - % Vol	0.17	0.11	0.1	0.14	0.14	0.15	0.16	0.12	0.15	
NITROGEN - %Vol	0.84	0.6	0.66	0.67	0.79	0.72	0.76	0.64	0.72	
METHANE - %Vol	55.88	55.96	56.16	56	55.99	56.01	55.97	56.04	56.01	
GAS TEMP - F	115	128	127	122	115	125	123	114	128	
PRESSURE - PSIG	111	111	111	111	111	111	111	111	111	
FLOW METER - MA	10.3	10.25	10.3	10.2	10.2	10.2	10.1	10.7	10.4	
FLOW - SCFH	37,540	36,976	37,181	37,025	37,252	36,931	36,694	38,753	37,424	0
LHV - Btu/SCF	509	510	511	510	510	510	510	510	510	0
TG1, COMP. EFFIC %	85.6	85	86.1	85.7	85.7	85.1	84.4	86.7	86.6	ERR
TG1, REL. KW %	-11.1	-11.	-11.5	-12.1	-11.5	-11.0	-12.9	-6.8	-9.4	-100.0
TG2, COMP. EFFIC %	87.4	87.6	87.9	86.4	86.4	87.1	86.4	88.8	87.9	ERR

SAN MARCOS DATA 06/08/92 11:11 AM [revision date 01/08/91]

DATA POINTS))		1	2	3	4	5	6	7	8	9
DATA TAKEN:	LAST CLOSING									
YEAR	92	92	92	92	92	92	92	92	92	92
MONTH	5	5	5	5	5	5	5	5	5	5
DAY	1	4	5	6	7	8	11	12	13	14
HOUR	9	10	10	8	8	7	9	10	10	14
MINUTE	10	0	0	0	0	40	10	10	20	0
DOWN TIME - HRS										
---TG 1---										
SCHEDULED	104.0	0	0	0	0	0	0	0	0	0
UNSCHEDULED	11.5	1	0	3.25	0	0	0	0	0	0
DIRECTED	3.0	0	0	0	0	0	0	0	0	0
---TG 2---										
SCHEDULED	104.0	0	0	0	0	0	0	0	0	0
UNSCHEDULED	11.5	0	0	0	0	0	0	0	0	0
DIRECTED	3.0	0	0	0	0	0	0	0	0	0
METER READINGS										
IMPORT	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0
EXPORT	29,056.0	29,152.0	29,184.0	29,210.0	29,242.0	29,273.0	29,369.0	29,401.0	29,432.0	29,468.0
SEC./60 REV.	-	200	198	199	198	197	205	209	204	208
CONDENSATE COUNT	19634	19708	19731	19748	19770	19790	19853	19877	19902	19930
---TG 1---										
T1 - F	67	67	63	64	65	62	69	74	67	70
T2 - F	477	476	474	473	473	472	479	485	475	479
Inlet DP, ins H2O	3	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
Exh. DP, ins H2O	2	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Pcd - PSIG	76	76	76	76	76	76	76	74	76	75
T5 AVG - F	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
OUTPUT - KW	728	749	751	750	749	750	733	714	732	720
HOUR METER	23,375	23,447	23,471	23,490	23,514	23,538	23,611	23,636	23,660	23,688
START COUNTER	544	545	545	546	546	546	546	546	546	546
---TG 2---										
T1 - F	67	67	63	64	65	62	69	74	67	70
T2 - F	474	472	471	473	471	467	476	480	472	478
Inlet DP, ins H2O	3	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
Exh. DP, ins H2O	2	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Pcd - PSIG	77	78	78	78	78	78	77	76	77	76
T5 AVG - F	1,200	1200	1200	1200	1200	1200	1200	1200	1200	1200
OUTPUT - KW	722	745	751	749	751	752	727	717	735	723
HOUR METER	23,100	23173	23197	23219	23243	23267	23340	23365	23389	23417
START COUNTER	674	674	674	674	674	674	674	674	674	674
BARO, Ins HgA	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2
--FUEL GAS DATA--										
HYDROGEN - %Vol	0.4	0.3	0.34	0.37	0.34	0.35	0.37	0.34	0.34	0.37
C.DIXODE - %Vol	42.7	42.9	42.77	42.76	42.12	42.81	42.24	42.88	42.88	42.68
OXYGEN - % Vol	0.2	0.1	0.16	0.2	0.16	0.12	0.17	0.18	0.18	0.1
NITROGEN - %Vol	0.7	0.6	0.64	0.66	0.67	0.61	0.76	0.71	0.71	0.65
METHANE - %Vol	56.1	56.0	56.09	56.02	56.71	56.12	56.47	55.9	55.9	56.2
GAS TEMP - F	121	119	112	108	112	110	116	123	124	127
PRESSURE - PSIG	111	111	111	111	111	111	111	111	111	111
FLOW METER - MA	10	10.5	10.5	10.4	10.4	10.4	10.25	10.1	10.4	10.15
FLOW - SCFH	37,307	37,994	38,240	38,080	38,069	38,015	37,465	36,676	37,528	36,751
LHV - Btu/SCF	511	510	511	510	516	511	514	509	509	512
TG1,COMP.EFFIC %		86.1	85.0	85.6	86.0	85.1	86.2	85.5	86.3	85.9
TG1, REL. KW %		-8.2	-9.5	-9.3	-8.9	-10.0	-9.3	-9.7	-10.3	-10.5
TG2,COMP.EFFIC %		88.3	87.0	86.9	87.7	87.5	87.5	87.9	87.6	86.8

COMPANY: LANDFILL ENERGY
DATE: JUNE 8, 1992
UNIT: TURBINE #2
REPORT #:T 1393-14b

NO2 - NOx ADJUSTMENTS

					NOx ADJUSTED VALUES	
RUN #	NOX	NO ppm	NO2 ppm	% Recovery	NO2 ppm	NOX ppm
#1	52	47.50	4.5	96.2	4.68	52.18
#2	52	47.5	4.5	96.2	4.68	52.18
#3	51.5	47	4.5	96.2	4.68	51.68
				AVERAGE	4.68	52.01

SAN DIEGO AIR POLLUTION CONTROL DISTRICT
MONITORING AND TECHNICAL SERVICES
9150 CHESAPEAKE DRIVE
SAN DIEGO, CA 92123

NITROGEN OXIDES & CARBON MONOXIDE EMISSIONS SUMMARY REPORT

SITE: Landfill Energy @ San Marcos Landfill
San Marcos, CA 92069

P/O NUMBER: 870536 JOB NO: T1393-14C
(T1393-14B Repeat)

TEST # 921609L

TEST DATE: 6/8/92

EQUIPMENT: Landfill gas combustion turbine - one (1) Solar Saturn recuperated gas turbine, Model GSC 1200R, 10.8 MMBtu/hr, misc. piping, ducting, instrumentation, and gas processing equipment, and fuel flow meter. Landfill gas from recovery system.

REPORT BY: Russ P. Logan - SCEC DATE: 6/19/92

APCD PERSONNEL: Janet Cawyer

SITE PERSONNEL: Bruno Lukosz

APPROVED BY: ________ DATE: ________

Table 1. Summary of Results - average NO_x and CO stack emissions corrected to 3% O_2

TURBINE #2	TEST (ppm)	PERMIT LIMITS (ppm)	PERFORMANCE	HOURS OF TEST
NO_x	275.2	263.0	Fail	1.9
CO	10.7	325.0	Pass	1.9

inconclusive

TEST REFERENCE: This testing was performed in accordance with the San Diego Air Pollution Control District Method 20: "Test Procedures For The Determination of Nitrogen Oxides, Carbon Monoxide and Diluent Gases by Continuous Emission Monitoring"

P/O NUMBER: 870536 DATE: 6/8/92

ANALYZER CHECK LIST

	YES	NO	COMMENTS
NO_x Analyzer			
analyzer calibrated	X		
analyzer set to zero	X		
zero drift < or = 2% of span	X		
reset zero		X	
span drift < or = 2%	X		
reset span		X	
response time within limits	X		
CO Analyzer			
analyzer calibrated	X		
analyzer set to zero	X		
zero drift < or = 2% of span	X		
reset zero		X	
span drift < or = 2%	X		
reset span		X	
O_2 Analyzer			
high calibration set to 20.95%	X		
low cal. set to exhaust gas		X	Set at 8.4% Gas
zero drift < or = 2% of span	X		
reset zero		X	
span drift < or = 2%	X		
reset span		X	
System Integrity/Leak Check			
pre-testing: performed w/NO	X		
post testing: performed w/NO	X		
System Assembly			
probe installed	X		
moisture removal trap used	X		
particulate filter used	X		
sample manifold pressure set	X		
Data Recording			
annotated	X		
electronic zero set on each pen	X		
chart speed set	X		
convertor efficiency: NO_2 to NO	X		
certificates of cal. gases	X		

P/O NUMBER: 870536 DATE: 6/8/92

Table 2. Stack Emissions of NO$_x$, CO, and O$_2$

RUN	SCALE	NO$_x$ 0-250 ppm			CO 0-1000 ppm			O$_2$ 0-25%	
	TIME	CHART (div)	UNCORR (ppm)	CORR 3%O$_2$ (ppm)	CHART (div)	UNCORR (ppm)	CORR 3% O$_2$ (ppm)	CHART (div)	%
R1 Avg.	10:00 10:40	20.9	52.18	292.7	0.3	3.0	16.8	71.0	17.75
PK1									
PK2									
R2 Avg.	10:43 11:23	20.9	52.18	271.5	0.2	2.0	10.4	70.0	17.50
PK1									
PK2									
R3 Avg.	11:25 12:05	20.7	51.68	261.3	0.1	1.0	5.0	69.5	17.40
PK1									
PK2									
Peak =									
Overall =		20.8	52.01	275.2	0.2	2.0	10.7	70.2	17.55

NO$_x$ and CO:

- The value reported is the average concentration value at 3% O$_2$, when:
  The average pollutant concentration exceeds the permit limit, or the average value is within the permit limit and there are less than two excursions above the limit.

- The value reported is the highest excursion value at 3% O$_2$, when:
  There are two or more excursions above the permit limit during the three subtests.

- If it has been determined that stratification exists, the average concentration values of NO$_x$ and CO, at 3% O$_2$, are then reported.

Table 3. Calibration Gases

	CYLINDER	MANUFACTURER	CONCENTRATION (ppm)
NO$_x$	CC28160	Scott-Marrin	233.2
CO	CC86177	Scott-Marrin	705.0
O$_2$	CC106786	Scott-Marrin	8.40%
NO$_2$	CC648	Scott-Marrin	176.0

San Diego Air Pollution Control District
Monitoring and Technical Services
9150 Chesapeake Dr.
San Diego, CA 92123

Nitrogen Oxides & Carbon Monoxide Emissions Summary Report

SITE: Landfill Energy @ San Marcos Landfill

P/O NUMBER: 870536 TEST # : 92160

SCEC JOB NO. T1393-14C TEST DATE: 8-Jun-92
(T1393-14B) repeat

EQUIPMENT: Landfill gas combustion turbine - one (1) Solar Saturn recuperated gas turbine, Model GSC 1200R, 10.8 MMBtu/hr, misc. piping, ducting, instrumentation, and gas processing equipment, and fuel flow meter. Landfill gas from recovery system.

INITAL REPORT BY: SCEC - RUSS LOGAN DATE: 6/23/92

REPORT BY: Janet Cawyer DATE: 1-Jul-92

APCD PERSONNEL: Janet Cawyer J. Cawyer

SITE PERSONNEL: Bruno Lukosz

APPROVED BY: Judith M Lak

Table 1. Summary of Results- Average NOx and CO stack emissions corrected to 3% O2
**NOx emissions are within calibration error and are thus inconclusive data in an exceedence determination.

	TEST (ppm)	PERMIT LIMITS (ppm)	PERFORMANCE	HOURS OF TEST
NOx	275.2	263	INCONCLUSIVE	1.5
CO	10.7	325	PASS	1.5

TEST REFERENCE: This testing was performed in accordance with the San Diego Air Pollution Control District Method 20: "Test Procedures For The Determination of Nitrogen Oxides, Carbon Monoxide and Diluent Gases by Continuous Emission Monitoring"

AIR POLLUTION CONTROL DISTRICT
COUNTY OF SAN DIEGO

See Ref. [illegible] 22C
later reports.

SAN MARCOS LANDFILL
GAS TURBINE (PERMIT # 870536)
TYPICAL FUEL INLET: 320 SCFM LFG
@ 510 BTU/SCF
(NOTE: 2 TURBINES ON SITE)

July 24, 1992

Landfill Energy Partners
c/o Catpac Two Inc.
39899 Balantine Dr. #275
Newark, CA 94560

SUBJECT: **RENEWAL TEST REPORTS**

The enclosed test reports are the result of testing done at your facilities.

If you have any questions, please call me at (619) 694-3359.

Robert Yelenosky

Robert Yelenosky
Senior Air Pollution Chemist

Enclosures

9150 Chesapeake Drive • San Diego • California 92123-1096 • (619) 694-3307
FAX (619) 694-2730 • Smoking Vehicle Hotline 1-800-28-SMOKE

COMPANY: LANDFILL ENERGY
DATE: MARCH 27, 1992
UNIT: TURBINE 1
REPORT #:T 1393-14

NO2 - NOx ADJUSTMENTS

					NOx ADJUSTED VALUES	
RUN #	NOX	NO ppm	NO2 ppm	% Recovery	NO2 ppm	NOX ppm
#1	60.75 ✓	54.50	6.25	88.6	7.05	61.55
#2	60.5 ✓	54.25	6.25	88.6	7.05	61.30
#3	62 ✓	55.75	6.25	88.6	7.05	62.80
				AVERAGE	7.05	61.89

P/O NUMBER: 870535 DATE: 3/27/92

ANALYZER CHECK LIST

	YES	NO	COMMENTS
NO_x Analyzer			
analyzer calibrated	X		
analyzer set to zero	X		
zero drift < or = 2% of span	X		
reset zero		X	
span drift < or = 2%	X		
reset span	X		
response time within limits	X		
CO Analyzer			
analyzer calibrated	X		
analyzer set to zero	X		
zero drift < or = 2% of span	X		
reset zero		X	
span drift < or = 2%	X		
reset span	X		
O_2 Analyzer			
high calibration set to 20.95%	X		
low cal. set to exhaust gas		X	Set at 8.4% Gas
zero drift < or = 2% of span	X		
reset zero		X	
span drift < or = 2%	X		
reset span	X		
System Integrity/Leak Check			
pre-testing: performed w/NO	X		
post testing: performed w/NO	X		
System Assembly			
probe installed	X		
moisture removal trap used	X		
particulate filter used	X		
sample manifold pressure set	X		
Data Recording			
annotated	X		
electronic zero set on each pen	X		
chart speed set	X		
convertor efficiency: NO_2 to NO	X		
certificates of cal. gases	X		

P/O NUMBER: 870535 DATE: 3/27/92

Table 2. Stack Emissions of NO_x, CO, and O_2

RUN	SCALE TIME	NO_x 0-250 ppm CHART (div)	UNCORR (ppm)	CORR 3%O_2 (ppm)	CO 0-1000 ppm CHART (div)	UNCORR (ppm)	CORR 3% O_2 (ppm)	O_2 0-25% CHART (div)	%
R1 Avg.	11:05 11:45	24.62	61.55	307.75	0.0	0.0	0.0	69.3	17.32 ✓
PK1									
PK2									
R2 Avg.	11:50 12:30	24.52	61.30	303.44	0.0 ✓	0.0	0.0	69.1	17.28 ✓
PK1									
PK2									
R3 Avg.	12:30 13:10	25.12	62.80	302.18	0.0	0.0	0.0	68.7	17.18 ✓
PK1									
PK2									
Peak =									
Overall =		24.75	61.88	304.46	0.0	0.0	0.0	69.0	17.26

NO_x and CO:

- The value reported is the average concentration value at 3% O_2, when:
  The average pollutant concentration exceeds the permit limit, or the average value is within the permit limit and there are less than two excursions above the limit.

- The value reported is the highest excursion value at 3% O_2, when: There are two or more excursions above the permit limit during the three subtests.

- If it has been determined that stratification exists, the average concentration values of NO_x and CO, at 3% O_2, are then reported.

Table 3. Calibration Gases

	CYLINDER	MANUFACTURER	CONCENTRATION (ppm)
NO_x	CC7297	Scott-Marrin	214.2
CO	CC67219	Scott-Marrin	476.0
O_2	CC106786	Scott-Marrin	8.40%
NO_2	CC648	Scott Marrin	176.0

SAN DIEGO AIR POLLUTION CONTROL DISTRICT
MONITORING AND TECHNICAL SERVICES
9150 CHESAPEAKE DRIVE
SAN DIEGO, CA 92123

NITROGEN OXIDES & CARBON MONOXIDE EMISSIONS SUMMARY REPORT

SITE: Landfill Energy @ San Marcos Landfill
San Marcos, CA 92069

P/O NUMBER: 870535 JOB NO: T1393-14A

TEST DATE: 3/27/92

EQUIPMENT: Landfill gas combustion turbine - one (1) Solar Saturn recuperated gas turbine, Model GSC 1200R, 10.8 MMBtu/hr, misc. piping, ducting, instrumentation, and gas processing equipment.

REPORT BY: DATE: 4/1/92
Russ P. Logan - SCEC

APCD PERSONNEL:

SITE PERSONNEL: Bruno Lukosz

APPROVED BY: DATE: 4/12/92

Table 1. Summary of Results - average NO_x and CO stack emissions corrected to 3% O_2

TURBINE #1	TEST (ppm)	PERMIT LIMITS (ppm)	PERFORMANCE	HOURS OF TEST
NO_x	304.5	263.0	Fail	1.9
CO	0.0	325.0	Pass	1.9

TEST REFERENCE: This testing was performed in accordance with the San Diego Air Pollution Control District Method 20: "Test Procedures For The Determination of Nitrogen Oxides, Carbon Monoxide and Diluent Gases by Continuous Emission Monitoring"

P/O NUMBER: 870535 3/27/92

TURBINE #1)

Average line from three points: zero, mid, high
start: y = 1.073 x - .595
end: y = 1.048 x - .57

Run #1) O2 = 17.78 % CF at 3% O2= 5.56
Run #2) O2 = 17.74 %
Run #3) O2 = 17.64 % NOx corr 3% O2 = 339.4 ppm
CO corr 3% O2 = 0 ppm

Ave O2 = 17.72 %

The NO2 recovery was not completed for this testing. Therefore, unseen NO2 due to system loss, was not calculated and added to the total NOx.

Ref. 22c

San Marcos Landfill
Gas Turbine
(Permit # 870535)

San Diego Air Pollution Control District
Monitoring and Technical Services
9150 Chesapeake Dr.
San Diego, CA 92123

Nitrogen Oxides & Carbon Monoxide Emissions Summary Report

SITE: LANDFILL ENERGY - SAN MARCOS

P/O NUMBER: 870535

TEST # : 92087.1

TEST DATE: 27-Mar-92

EQUIPMENT: Landfill gas combustion turbine - one (1) Solar Saturn recuperated gas turbine, Model GSC 1200R, 10.8 MMBtu/hr, misc. piping, ducting, instrumentation, and gas processing equipment.

REPORT BY: SCEC - Russ Logan

DATE: 1-Apr-92

APCD PERSONNEL: JC

SITE PERSONNEL: Bruno Lukosz

APPROVED BY:

DATE: 5/13/92

Table 1. Summary of Results- average NOx and CO stack emissions corrected to 3% O2

	TEST (ppm)	PERMIT LIMITS (ppm)	PERFORMANCE	HOURS OF TEST
**NOx	339	263	**EXCEEDANCE**	1.9
**C O	0	325	**PASS**	1.9

** Values corrected for low O2 span.

TEST REFERENCE: This testing was performed in accordance with the San Diego Air Pollution Control District Method 20: "Test Procedures For The Determination of Nitrogen Oxides, Carbon Monoxide and Diluent Gases by Continuous Emission Monitoring"

08/13/93 12:16 PM [revision date 01/08/91]

	POINTS))	1	2	3	4	5	6	7	8	9
DATA TAKEN:	LAST CLOSING									
YEAR	93	93	93	93	93	93	93	93	93	
MONTH	8	8	8	8	8	8	8	8	8	
DAY	1	2	3	4	5	6	9	9	10	
HOUR	8	8	8	8	8	8	8	11	8	
MINUTE	0	0	0	0	0	0	0	5	0	
DOWN TIME - HRS										
---TG 1---										
SCHEDULED	11.0	0	0	1.25	0	0	0	0	0	
UNSCHEDULED	0.0	0	0	0	0	0	0	0	0	
DIRECTED	0.0	0	0	0	0	0	0	0	0	
---TG 2---										
SCHEDULED	11.0	0	0	0	0	0	0	0	5	
UNSCHEDULED	0.0	0	0	0	0	0	0	0	0	
DIRECTED	0.0	0	0	0	0	0	0	0	0	
METER READINGS										
IMPORT	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	
EXPORT	42,267.0	42,296.0	42,327.0	42,357.0	42,357.0	42,416.0	42,504.0	42,508.0	42,531.0	
SEC./60 REV.	-	200	209	208	208	203	205	452	205	
CONDENSATE COUNT	29697	29725	29755	29785	29815	29845	29934	29938	29961	
---TG 1---										
T1 - F	67	69	72	69	70	69	67	74	67	
T2 - F	474	476	481	476	481	479	475	483	475	
Inlet DP,ins H2O	3	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	
Exh. DP,ins H2O	2	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	
Pcd - PSIG	75	78	76	76	76	76	76	75	76	
T5 AVG - F	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,198	1,200	
OUTPUT - KW	719	750	723	742	729	735	732	710	731	
HOUR METER	1,706	1,731	1,755	1,779	1,801	1,826	1,897	1,901	1,921	
START COUNTER	617	617	617	618	618	618	618	618	618	
---TG 2---										
T1 - F	67	69	72	69	70	69	67	74	67	
T2 - F	472	474	478	475	476	474	472		471	
Inlet DP,ins H2O	3	2.60	2.60	2.60	2.60	2.60	2.60		2.60	
Exh. DP,ins H2O	2	2.00	2.00	2.00	2.00	2.00	2.00	S/D	2.00	
Pcd - PSIG	76	79	77	78	77	77	77		77	
T5 AVG - F	1,200	1200	1200	1200	1200	1200	1200		1200	
OUTPUT - KW	702	730	712	724	708	710	712		715	
HOUR METER	1,539	1563	1587	1611	1635	1659	1731	1731	1750	
START COUNTER	707	707	707	707	707	707	707	707	708	
BARO, Ins HgA	29.1	29.1	29.1	29.1	29.1	29.1	29.1	29.1	29.1	
--FUEL GAS DATA--										
HYDROGEN - %Vol	0.2	0.2	0.21	0.21	0.21	0.21	0.19	0.21	0.21	
C.DIXODE - %Vol	42.6	42.6	43.4	42.83	42.88	42.82	42.88	42.83	42.82	
OXYGEN - % Vol	0.1	0.1	0.04	0.12	0.05	0.09	0.08	0.12	0.07	
NITROGEN - %Vol	0.2	0.1	0.1	0.26	0.13	0.15	0.25	0.26	0.19	
METHANE - %Vol	56.9	56.9	56.54	56.59	56.73	56.73	56.6	56.59	56.7	
GAS TEMP - F	119	118	120	120	120	120	120	112	120	
PRESSURE - PSIG	111	111	111	111	111	111	111	111	111	
FLOW METER - MA	10	10.4	10.1	10.4	10.1	10.1	10.1	5.55	10.1	
FLOW - SCFH	36,452	37,809	36,741	37,690	36,810	36,815	36,795	18,732	36,813	0
LHV - Btu/SCF	518	518	514	515	516	516	515	515	516	0
TG1,COMP.EFFIC %		88.2	86.9	86.8	86.2	86.2	86.3	86.6	86.3	ERR
TG1, REL. KW %		-6.9	-9.1	-7.9	-9.1	-8.8	-10.0	-9.9	-10.1	-100.0
TG2,COMP.EFFIC %		89.3	88.2	88.4	87.9	87.9	87.6	1.7	87.8	ERR
TG2, REL. KW %		-9.2	-10.4	-10.1	-11.6	-11.8	-12.3	-100.0	-11.9	-100.0
PLANT H.RT B/KWH		15104	15240	15572	15246	14882	14984	16818	15020	N/A

4lb/hr NOx

200lbs/day NOx limit

LANDFILL GENERATING PARTNERS - I, SAN MARCOS (619) 471-8608

DATE: August 13, 1993

TO: Janet Cawyer, Air Pollution Chemist

FROM: B. Lukosz, Operator

SUBJECT: SAN MARCOS LANDFILL TO ENERGY FACILITY

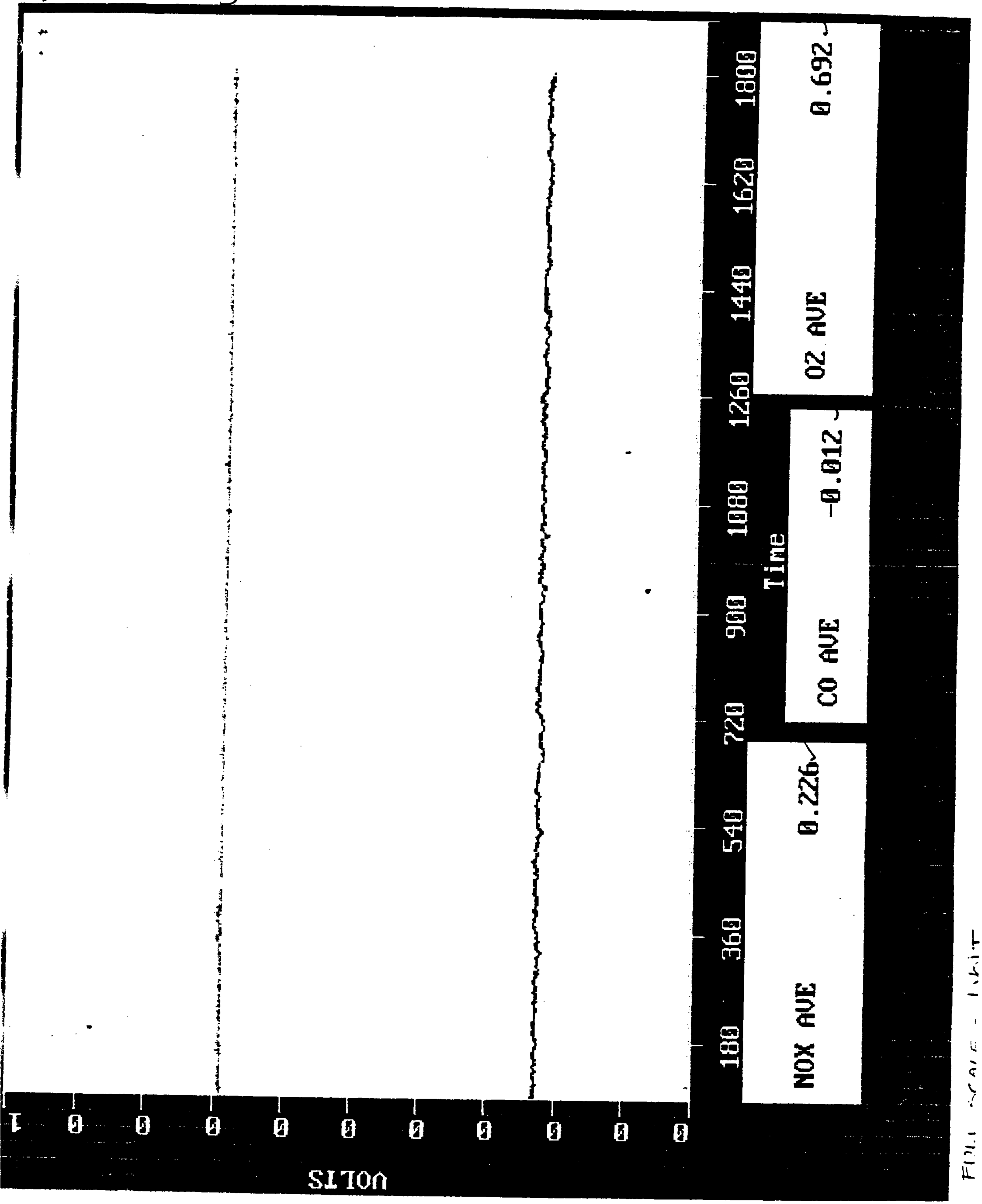
At your request I am sending you a DATA taken during emission test on TG-1 on August 09, 1993.

Regards,

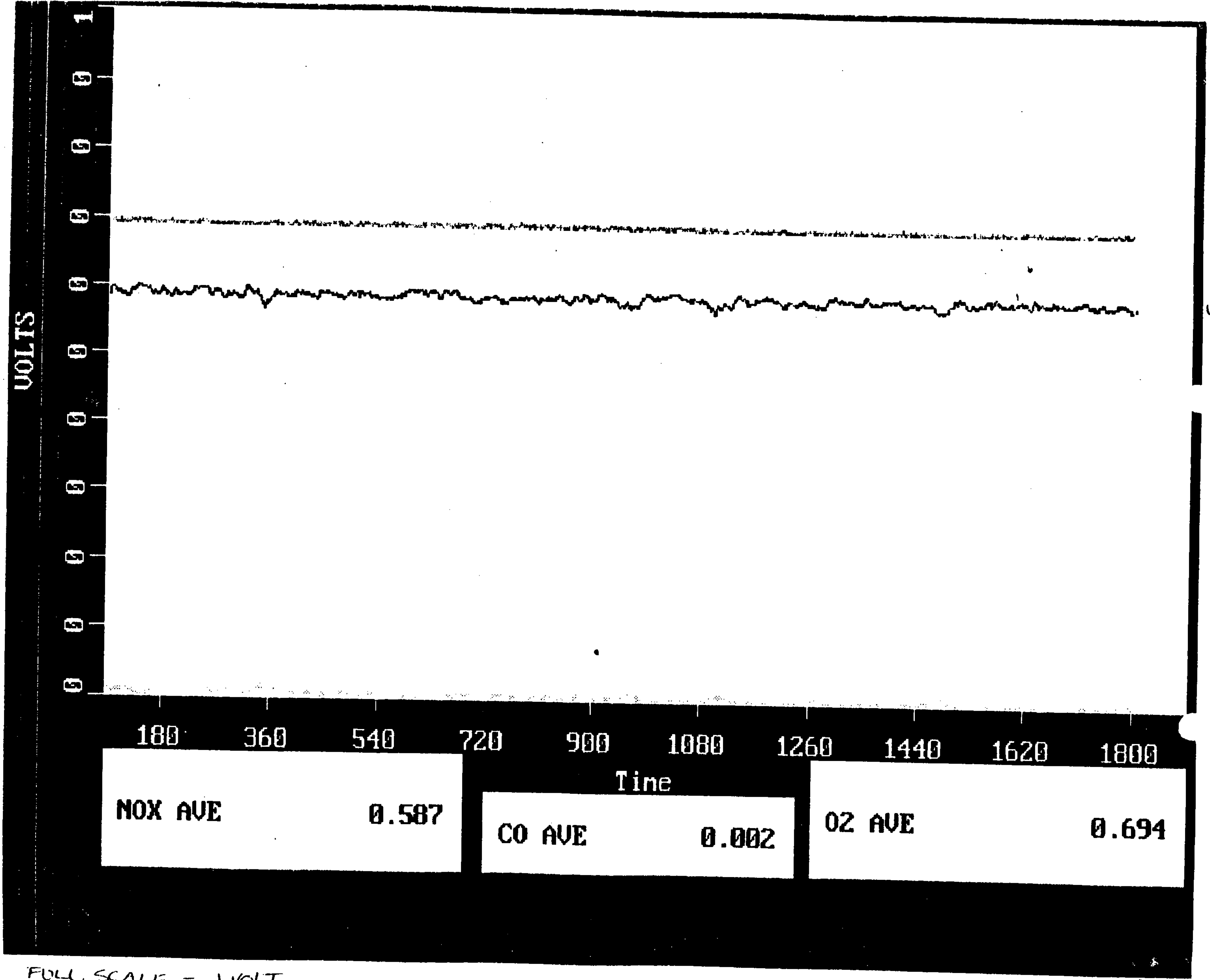
Bruno Lukosz

ec: SM0893

R#1 3/30/93 Eng #1



FULL SCALE - UNIT



NOX AVE 0.587

CO AVE 0.002

O2 AVE 0.694

FULL SCALE = 1 VOLT.

~~0-250~~ 0-100

ENGEL
93089
3-30-93
PO # 87053

CALIBRATION VALUES: ✓**CHART DIVISIONS (CH DIV)**

NO: HIGH = 81.64 | 81.64 (40%) CO: HIGH = 71.2 ✓ O2: HIGH = 83.8 ✓
NO2 80% MID = 40.8 | MID = 7.1 ✓ 10/10% MID = 31.56 ✓
LOW = | 20.4 (x%) LOW = ≤10% LOW =
56.6 NO2 = 8.2 | 61.2 (30%) CO2

SCALES: **NOX 0- PPM**		**CO 0- PPM**		**02 0- %**	
	CAL GAS	**CAL CH DIV**	**% DIFF FS FLAG**	**ZERO CH DIV**	**% DIFF FS FLAG**
INITIAL CAL (3 PTS)	NO/	81.4	–	0 0	–/–
	NO2/R	81.4 ✓			
	CO	71/18.8	–/–	0/0	–/–
	O2/mid	82.4/31.6 ✓	–/–	0/0	–/–
	NO/	81/77.9 ✓	–/–	-2/-2	–/–

Converter	**Eff. Check**	**CH DIV**	
NO2 CONV	**NOX MODE**	55.1 ✓	
Direct	**NO MODE**	0 ✓	**% EFF**
	NET NO2	55.1 ✓	97.3 ✓

SYST NO	
CH DIV	**% RECOVERY**
78.5 ✓	96.4

NO2(probe) Recovery Check			**% RECOVERY**
	NO2 system	49.5 ✓	90

	CAL GAS	**CAL CH DIV**	**% DIFF FS FLAG**	**ZERO CH DIV**	**% DIFF FS FLAG**
POST SUBTEST #1 CAL	~~CO/ADJ~~	67.4/70.8	3.8/–	-3/-5 ✓	~~+/+~~
	Co 10%	7.7 ✓	–	0/0	–/–
	O2/mid	84/31.8 ✓	–/–	.2/.0	–/–
	NO/10%	80.4/7.8 ✓	–/–	-.5/1.1	–/–
~~0-100~~	NO2/10%	81.3/20.8 ✓	–/–	.8/.9	–/–
	CO ADJ/10%	71/8.0 ✓	–/–	0/0 ✓	–/–

SUBTEST #1	**GAS**	**VALUE CH DIV**	**CORR FACTOR**	**CORR VALUE CH DIV**
	NOX:	22.6 ✓	–	22.6
TIME: 1105	**NO:**	21.0 ✓	–	21.0
1148	**CO:**	0 ✓	1.0289	0
	O2:	69.2 ✓	–	69.2

	CAL GAS	**CAL CH DIV**	**% DIFF FS FLAG**	**ZERO CH DIV**	**% DIFF FS FLAG**
POST SUBTEST #2 CAL	CO/ADJ	68.8/70.2 ✓	2.4/–	-2.3/0 ✓	+/–
	10%	8.4 ✓	–	~~.2/0~~	~~–/–~~
	O2/mid	83.6/31.5 ✓	–/–	~~0/-.3~~	~~–/–~~
	NO/30%)	81/61.3	–/–	~~1.0~~ ~~/1.1~~	~~–/–~~
	NO [illegible]	30.8 ✓	–	.1/1.1	–/–

SUBTEST #2	GAS	VALUE CH DIV	CORR FACTOR	CORR VALUE CH DIV
TIME: 1207 1247	NOX:	59.1 ✓	—	59.1 ✓
	NO:	54.0 ✓	—	54.0 ✓
	CO:	0 ✓	1.0186	0 ✓
	O2:	69.3 ✓	—	69.3 ✓

POST SUBTEST #3 CAL FINAL	CAL GAS	CAL CH DIV	% DIFF FS FLAG	ZERO CH DIV	% DIFF FS FLAG
	Co /10%	70.8/78.0 ✓	– / –	0 / 0	– / –
	[illegible] / pub	83.6/73.15 ✓	– / –	0 / -.4	– / –
	NO 49/10%	81.1/70.8 ✓	– / –	+1 / +1	– / –
	NO DIR	81.2 ✓			

SUBTEST #3	GAS	VALUE CH DIV	CORR FACTOR	CORR VALUE CH DIV
TIME: 1320 13[illegible]	NOX:	58.7	—	58.7
	NO:	54.0	—	54.0
	CO:	0.2	—	0.2
	O2:	69.4	—	69.4

SYST NO	
CH DIV	% RECOVERY
78.2 ✓	96.3

Final NO2

NO2 DIRECT

* if conv eff > 90%

NO2 SYST

Recovery	CH DIV	% RECOVERY
NOX MODE	54.0 ✓	
=NO2 Direct*	54.0 ✓	95 ✓
NO2 System	42.8 ✓	90 ✓

NO2 CONVERTER EFF CHECK: 97 % ✓

AVERAGE NO SYSTEM RECOVERY: 96.3 % ✓

AVERAGE NO2 SYSTEM RECOVERY: 90 % ✓

NO % RECOVERY = (NO SYST/NO CAL)*100
NO2 CONV % EFF = (NET NO2 CONV / NO2 ACTUAL)*100
NO2 DIRECT % RECOVERY = (NET NO2 DIRECT/NO2 ACTUAL)
NO2 % RECOVERYY = (NO2 SYST/NET NO2 CONV)*100

FLAG % DIFF - IF THE CAL CH DIV ARE TWO OR MORE CH DIV GREATER THAN THE ACTUAL CAL VALUE.

AVERAGE CAL VALUE = THE AVERAGE OF THE CALS JUST BEFORE AND AFTER THE SUBTEST
CORR FACTOR = (ACTUAL CAL VALUE/AVERAGE CAL VALUE)

San Marcos Landfill.
2 Gas Turbines

PETRO
CHEM
ENVIRONMENTAL
SERVICES

P O Box 5126
3207 Antonino Avenue
Bakersfield, California 93388
(805) 327-7300

P O Box 40097
Long Beach, California 90804
(213) 439-2217

SOURCE TEST PLAN

A. Source Company:

SOLAR TURBINES, INC.
9250 Sky Park Ct.
San Diego, CA 92123

Attn: Mr. Jim Kennelly
(619) 694-6077 or
(213) 424-7250

B. Sources:

Two (2) recuperated gas turbines model GSC 1200R
Unit #1 - APCD #: AC870535
Unit #2 - APCD #: AC8870536

C. Testing Company:

Petro-Chem Environmental Services
3300 Cherry Ave.
Long Beach, CA 90807

Attn: Ms. Leslie Johnson
(213) 427-8994

D. Testing Date: May 18 & 19, 1989

E. Governing Agency:

San Diego County APCD
Application #: 870535 & 870536

F. Testing Approach:

Testing two (2) Solar Turbines Co. recuperated gas turbines, model GSC 1200R, each with a gross heat input rating of 10.8 MMBtu/hr and 933 KW electrical generator. Both units are located at San Marcos Landfill, CA.

PETRO
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P.O. Box 40097
Long Beach, California 90804
(213) 439-2217

SOLAR TURBINES, INC.
SAN DIEGO, CA

PROPOSAL FOR TESTING

Project Summary:

Determinations of NOx, CO, SO2, Hydrocarbons (NMHC) concentrations and emissions from the outlet of two (2) 933 KW solar gas turbine generator sets. Both units are locatd at the San Marcos Landfill in San Diego County, California. Monitoring for NOx, CO and O2 will be monitored using continuous analyzers with all concentations documented on a strip chart recorder. Hydrocarbons will be sampled by EPA Method #18 and analyzed in our Bakersfield, California laboratory by G.C. FID. The exhaust emission rates and destruction efficiencies of Benzene, vinyl chloride, and vinylidene chloride will be sampled in treated cannisters and analyzed by Central Coast Laboratories. Three samples will be taken at the one turbine inlet and outlet. In addition one blank, a high spike and a low spike, simulating the inlet and outlet, respectively, will be analyzed.

Parameters	**Methods**	**Test Runs/Turbine** #1	#2
NOx	A	3	3-1/2 hr runs
CO	B	3	3-1/2 hr runs
SO2	C	3	3-1/2 hr runs
O2	D	3	3-1/2 hr runs
Volume Flow	E	3	3
NMHC	F	3	3
Benzene vinyl chloride vinylidene chloride	G	6	-

Methods

A.	(NOx)	CARB Method 1-100; Chemiluminescent NO/NOx analyzer; Thermo Electron model 10
B.	(CO)	CARB Method 1-100; Thermo Electron gas filter correlation NDIR model 48 CO analyzer
C.	(SO2)	EPA Method #6; Incorporated with condensate train, Barium Chloride Titration
D.	(%O2)	CARB Method 1-100; fuel cell O2 analyzer; Teledyne model 320ax
E.	(Volume Flow)	EPA Method 1,2,3,4; Pitot tube traverse, condensation method
F.	(NMHC)	EPA Method #18; integrated bag sample, G.C. FID analysis
G.	(C6H6,CH2:CHCl Vinylidene Cl)	Treated cannister sampling method, 0.2ppbv low level detection

SOLAR TURBINES, INC.,
San Diego, CA
Attn: Jim Kennelly

METHOD DEVIATIONS

I. CARB 1-100:

A. The condensate train will be immersed in dry ice.

B. A ten minute NO run will be performed for each run

C. A NO2 special recovery check will be performed at the end of each one-half hour test.

II. Benzene, Vinyl Chloride and Vinylidene Chloride:

A. Analysis will be subcontracted out to Central Coast Analytical Services, Inc. Please see attached methods and quality assurance write-up.

B. Passivated stainless steel canisters will be used to collect samples at both the Turbine inlet and outlet.

UNIT SPECIFICATIONS

The Turbines to be tested are identical; size, output, fuel etc. The stack diameter is 40" with an expected velocity of 41.5fps at 560'F stack temperature, and percent moisture of 8%.

CALIBRATION PROCEDURES:

A. System calibration Procedures:
System calibration checks are performed at the beginning and end of each test day to insure against sample system leaks or contamination. Calibration gas is introduced at the sample probe tip at a normal sample rate and vacuum, the final instrument value must be within +/- 5% of the calibration gas value full scale.

B. Manifold Calibration:
Instrument calibration checks are performed and adjustments made before and after each test run. Each analyzer is checked with a zero grade nitrogen gas for a zero baseline and then with a calibration gas similar to the expected sample concentration (60-90% of full scale).

Caliabration gases used in both manifold and system calibrations are EPA protocol No. 1 gases recently analyzed by EPA Standards SRM, or with gases recently analyzed by EPA Reference Methods. All zero and calibration checks are documented and noted on the recorder strip charts.

DATA REDUCTION:

Concentrations are read as % full scale directly from the strip charts. % full scale zero and span readings and calibration gas values are all entered into the computer which calculates actual, corrected concentrations. The following equation is used:

[(%fs-Zi)*Cal.gas(Si-Zi)]*[1+((Si-SFf/Si)/#increments]*[1+((Zi-Zf)/Zi)/#increments]

INSTRUMENTS:

The following instruments will be employed to measure the various compounds:

NOx: Thermo Electron model 10 NO/NOx analyzer
CO: Thermo Electron model 48 CO Analyzer or Automated Custom Systems model 3300 Analyzer
O2: Teledyne Fuel Cell model 320ax O2 analyzer

EQUATIONS:

NOx and CO @ 15% O2 = NOx/CO ppm * (20.9-15%O2)/(20.9-%O2)

NOx and CO @ 3% O2 = NOx/CO ppm * (20.9-3.0%O2)/(20.9-%O2)

NOx or CO lb/hr = NOx/CO ppm * DSCFM * MW * 1.581 * 10-7

MW NOx = 46 grams/mole
MW CO = 28 grams/mole

1.581 * 10-7 = 10 mg/gram * moles /10 moles * 1.195 mole/cf * 2.2046 * 10 lb/mg * 60 min/hr

SAMPLING AND ANALTICAL PROCEDURES

REF: EPA code of Federal Regulations, Title 40, Part 60, Appendix A Methods 1, 2, 3, 4 and 6.

SAMPLING PROCEDURE

The sampling apparatus consisted of a probe connected to a sample line, teflon. A series of impingers (see data sheet for type and contents) were connected in tandem and immersed in an ice bath. The absorption train was followed by a gas pump, dry test meter and a calibrated restriction orifice fitted with a magnehelic differential pressure gauge. A type "S" pitot tube and temperature probe was positioned along side the probe terminating at the sample nozzle for monitoring duct conditions throughout the test.

After a successful pre-test leak check is run, the probe is positioned in the stack and the pump engaged. A minimum of twenty (20) cubic feet is drawn through the impinger train. After a final meter volume is recorded a post-leak check is performed at the highest vacuum documented during the test. The sample train is then purged for approximately ten (10) minutes.

EPA Method #1: Sampling and Velocity Traverses for Stationary Sources:

Prior to the source test a site acessment was performed in order to locate sample points for obtaining the best representative measurements of pollution concentrations and volumetric flow rates. EPA Method #1 takes into account duct area, straight run and cyclonic or stratified flow patterns.

EPA Method #2: Velocity and Volumetric Flow Rate:

A computer was used in selection of suitable sample/traverse points. The calibrated pitot tube was connected to a magnehelic gauge and leak checked. A temperature and delta-P was recorded at each traverse point and a duct static pressure was measured and recorded. A volume flow rate was calculated from the measured required traverse points.

EPA Method #3; %CO2, %O2, Dry Molecular Weight:

Concurrent with each condensate/SO2 sampling, an intergrated gas sample was withdrawn from the summation of the traverse points through the train and collected at the outlet of the meter into a sample bag. The contents of the sample bag were analyzed by Orsat for fixed gas composition.

EPA Method #4; Percent Water:

Tare weights of the charged individual impingers were recorded. After sampling, the final weights were recorded. Percent water was calculated from the weight of water collected and the dry gas volume sampled.

EPA Method #6; SO2:

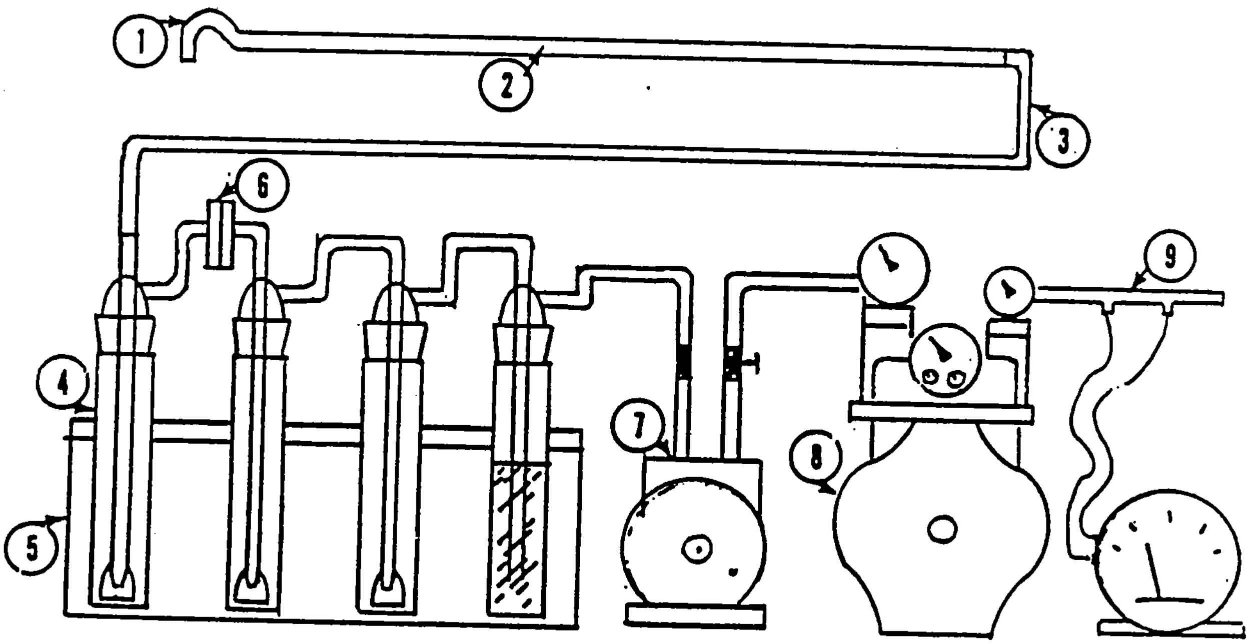
The second and third impinger were combined with the impinger washings, bottled and brought back to the laboratory for analysis. In the laboratory the impinger contents were made up to a known volume. An aliquot was taken and titrated with Barium Chloride to a Thorin (xylene) endpoint.

Quality Control:

All sampling equipment, pitot tubes, dry gas meters and thermocouples, are calibrated in-house, on a quarterley basis. Calibration sheets can be found in the "Quality Control" section of the test report.

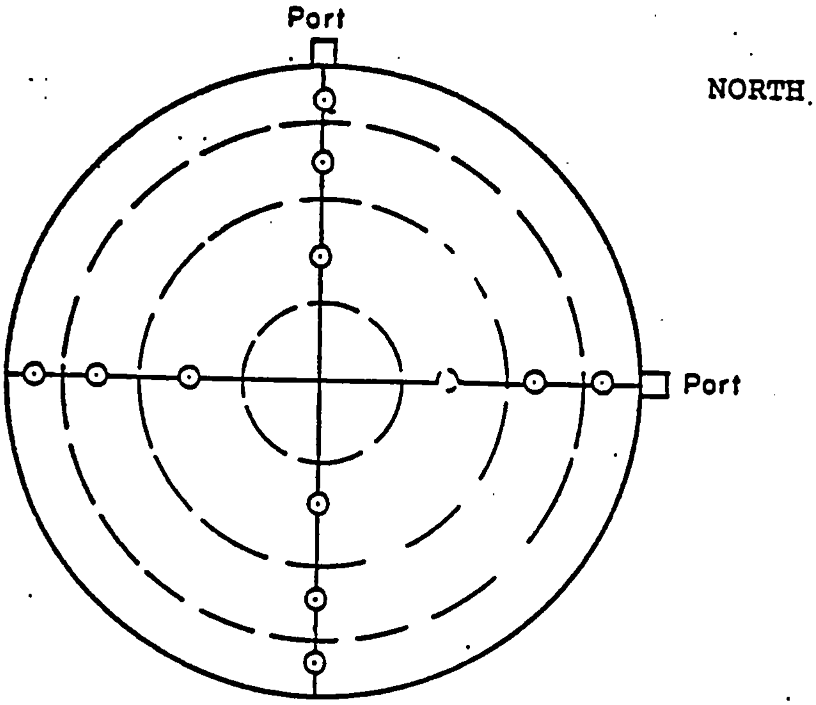
CONDENSATE/SULFUR DIOXIDE

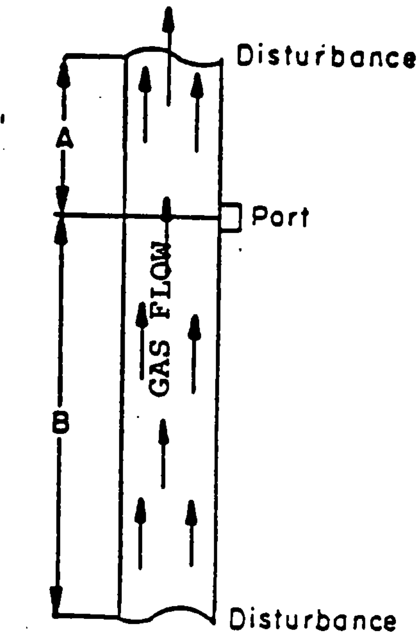
SAMPLING TRAIN



(1) Nozzle
(2) Probe
Metallic
(3) Flexible Vacuum Tubing
(4) Greenburg-Smith Impingers: first with 100 ml 80% isopropyl alcohol; second and third with 100 ml ~~3~~6% hydrogen peroxide solution; fourth with 200 g. silica gel, 6-16 mesh, indicating. (optional)
(5) Ice Water Bath
(6) Glass Fiber Filter
(7) Vacuum Pump with check valve and flow control (air tight)
(8) Dry Gas Meter, with inlet and outlet thermometers (or temp.-comp.)
(9) Orifice Flowmeter and Differential Pressure Gauge

SAMPLE POINTS DESCRIPTION





The illustration shows some of the points and their location at the centroid of equal areas of the sampled cross-section

General view of sampled source.
Diameter= 40"
A= 1
B= 3.5
Area = 8.73 ft^2

Distances to sampled points from inside of stack wall

Point	Calculated	Actual
1	0.84	
2	2.68	
3	4.72	
4	7.08	
5	10.00	
6	14.24	
7	25.78	
8	30.00	
9	32.92	
10	35.28	
11	37.32	
12	39.16	

Point	Calculated	Actual
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		

METHOD 2 STACK GAS VELOCITY AND VOLUMETRIC FLOWRATE

Average Stack Gas Velocity

$$Pg = \frac{\text{Static Pressure, "H}_2\text{O"}}{13.6}$$

$$Ps = P_{bar} + Pg \qquad \text{Eq. 2-6}$$

$$Vs = K_p C_p \left(\sqrt{\Delta p}\right) \text{avg} \sqrt{\frac{T_{s(avg)}}{P_s M_s}} \qquad \text{Eq. 2-9}$$

Average Stack Gas Dry Volumetric Flow Rate

$$\underset{\text{(DSCFM)}}{Q_{std}} = 60\,(1-B_{ws})\, v_s A \left(\frac{T\ std}{Ts\ (avg)}\right) \left(\frac{Ps}{Pstd}\right) \qquad \text{Eq. 2-10}$$

$$\frac{Q_{std}}{MF} = \text{scfm}_{\text{wet}}$$

METHOD 3 DRY MOLECULAR WEIGHT OF STACK GAS

$$Md = 0.440\,(\%CO_2) + 0.320\,(\%O_2) + 0.280\,(\%N_2 + \%CO) + 0.64\,(\%SO2)^{*} \qquad \text{Eq. 3-2}$$

Wet Molecular Weight of Stack Gas

$$M_s = Md\,(1-B_{ws}) + 18\,(B_{ws})$$

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* %SO2 will be included in the computation only if a significant concentration is found to be present.

METHOD 4 DETERMINATION OF MOISTURE CONTENT IN STACK GASES

(Use when a moisture train is run separately from other pollutant measurements.)

Volume of Water Vapor Condensed

$$V_{wc(std)} = \frac{(V_f - V_i)\,\rho_w\,R\,T_{(std)}}{P_{std}\,M_w} = K_1\,(V_f - V_i) \qquad \text{Eq. 4-1}$$

Where $K_1 = 0.04646\ ft^3/ml$ @ 520°R

Volume of Water Vapor Collected In Silica Gel

$$V_{wsg(std)} = \frac{(W_f - W_i)\ R\ Tstd}{P\ std\ M_w\ (453.6\ g/lb)} = K_2(W_f - W_i) \qquad \text{Eq. 4-2}$$

Where $K_2 = 0.04651\ ft^3/g$ @ 520°R

Sample Gas Volume

$$V_{m(std)} = V_m Y\,\frac{(Pm)\ (Tstd)}{(Pstd)\ (Tm)} = K_3 Y\,\frac{Vm\ Pm}{Tm} \qquad \text{Eq. 4-3}$$

Where $K_3 = 17.38$ °R/in Hg @ 520°R

Moisture Content

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(stg)}}{V_{wc(std)} + V_{wsg(stg)} + V_{m(stg)}} \qquad \text{Eq. 4-4}$$

$B_{ws} \times 100 = \%H_2O$ in gas stream

$MF = 1 - B_{ws}$

EPA METHOD 6 DETERMINATION OF SULFUR DIOXIDE EMISSIONS FROM STATIONARY SOURCES.

Sulfur Dioxide Concentration

$$C_{SO_2} = K_1 N \frac{\left(V_t - V_{tb}\right)\left(\frac{V\ soln}{Va}\right)}{V_{m(std)}} = \text{lb/dscf} \qquad \text{Eq. 6-2}$$

Where $K_1 = 7.061 \times 10^{-5}$ lb/meq

(lb/dscf) (MF) = lb/scf

Dry ppm SO_2 = $\left(C_{SO_2}\right)\left(3.795 \times 10^8\right)\left(\frac{1}{64}\right)$

Wet ppm SO_2 = $\left(\text{lb/scf}\right)\left(3.795 \times 10^8\right)\left(\frac{1}{64}\right)$

$lb_{SO_2/hr}$ = $\left(C_{SO_2}\right)\left(Q_{std}\right)\left(60 \text{ min/hr.}\right)$

NOMECLATURE

A = Cross-sectional area of stack (ft^2)

A_n = Cross-sectional area of nozzle, (ft^2)

B_{ws} = Proportion of water vapor, by volume, in the gas stream

C_a = Acetone blank residue concentration, (mg/g)

C_p = Pitot tube coefficient, dimensionless

C_s = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, (gr/dscf).

C_{SO_2} = Concentration of sulfur dioxide, dry basis corrected to standard conditions, (lb/dscf)

$C_{H_2SO_4}$ = Sulfuric acid (including SO_3) concentration, corrected to standard conditions, (lb/dscf)

ΔH = Average pressure differential across the orifice meter, (in H_2O)

K_p = Pitot tube constant, 85.49 $\frac{ft}{Sec}\left[\frac{(lb/lb\text{-}mole)(in\ Hg)}{(°R)\ (in\ H_2O)}\right]^{\frac{1}{2}}$

L_p = Leakage rate observed during the post-test leak check, (cfm)

L_a = Maximum aceptable leakage rate, (0.02 cfm or 4% of average sampling rate, whichever is less)

L_i = Individual leakage rate observed during the leak check conducted prior to the "i^{th}" component change, (cfm)

m_a = Mass of residue of acetone after evaporation, mg.

M_d = Molecular weight of stack gas, dry basis, (lb/lb-mole)

m_n = Total weight of particulate matter collected, mg.

M_s = Molecular weight of stack gas, wet basis, (lb/lb-mole)

M_w = Molecular weight of water, 18 lb/lb-mole

N = Normality of barium perchlorate titrant, (milliequivalents/ml)

Δp = Velocity head of stack gas, (in H_2O)

P_{bar} = Barometric pressure at measurement site (in Hg)

P_g = Stack static pressure, (in Hg)

P_m = Absolute pressure at the dry gas meter

P_s = Absolute stack gas pressure, (in Hg)

$P_{std)}$ = Standard absolute pressure, 29.92 in Hg

Q_{std} = Dry volumetric stack gas flow rate, standard conditions, (dscfm)

R = Ideal gas constant, 21.85 (in Hg) (ft^3)/(lb-mole)(°R)

t_s = Stack temperature, (°F)

T_m = Absolute temperature at meter, (°R)

T_{std} = Standard absolute temperature, (520°R)

T_s = Absolute stack temperature, (460° + t_s)

V_a = Volume of sample aliquot titrated, (ml)

V_{ab} = Volume of acetone blank, ml

V_m = Dry gas volume measured by dry gas meter, (dcf)

$V_{m(std)}$ = Dry gas volume measured by dry gas meter, corrected to standard conditions, (dscf)

$V_{wc(std)}$ = Volume of water vapor condensed corrected to standard conditions, (scf)

$V_{wsg(std)}$ = Volume of water vapor collected in silica gel corrected to standard conditions (scf)

V_{lc} = Volume of water vapor condensed in impingers and silica gel, (ml)

V_f = Final volume of condensed water, ml

V_i = Initial volume of condensed water, ml

v_s = Average stack gas velocity, (ft/sec)

V_{soln} = Total volume of solution in which the sulfur dioxide sample is contained (ml)

V_t = Volume of barium perchlorate titrant used for the sample, (ml)

V_{tb} = Volume of barium perchlorate titrant used for the blank, (ml)

W_f = Final weight of silica gel or silica gel plus impinger, (g)

W_i = Initial weight of silica gel or silica gel plus impinger, (g)

Y = Dry gas meter calibration factor

ρ_w = Density of water, (0.002202 lb/ml @ 60°F)

ρ_a = Density of acetone, (g/ml)(see bottle label)

MF = Moisture factor

$\%CO_2$ = Percent CO_2 by volume (dry basis)

$\%O_2$ = Percent O_2 by volume (dry basis)

%CO = Percent CO by volume (dry basis)

$\%N_2$ = Percent N_2 by volume (dry basis)

0.264 = Ratio of O_2 to N_2 in air v/v

0.280 = Molecular weight of N_2 or CO, divided by 100

0.320 = Molecular weight of O_2, divided by 100

0.440 = Molecular weight of CO_2, divided by 100

60 = Conversion factor, (sec/min)

18.0 = Molecular weight of water, (lb/lb-mole)

32.03 = Equivalent weight of sulfur dioxide

0 = Total sampling time (min)

O_i = Sampling time interval, between two successive component changes, beginning with the interval between the first and second changes, (min)

O_1 = Sampling time interval, from the run beginning until first component change, (min)

O_p = Sampling time interval, from the final (n^{th}) component change until the end of the sampling run, (min)

HYDROCARBON EMISSIONS

REF: Kern County APCD, guidelines for compliance test reports, Hydrocarbon testing and methodology. CFR 40 Parts 53 to 80 test methods #18.

SAMPLING PROCEDURES:

An integrated sample was extracted from the source. The sample was extracted by evacuating a rigid leakproof container. The sampling train was first leak checked, the sampling bag was purged three times after which the actual sample was extracted. All sample bags are analyzed within 72 hours.

PRELIMINARY QUALITY CONTROL:

All tedlar bags are cleaned five times with nitrogen. The fifth nitrogen purge is analyzed by Gas Chromatography FID, the results are logged and attached to the cleaned tedlar bag.

CALCULATIONS:

Symbol Identification = i = carbon #; $i = 1$ to 6
s = refers to standard for that carbon #
Rx_i = response factor for C_i
MW = molecular weight - g/mole
SDCFM = average volume flow rate of unit tested

Equations:

$$Rx_i = \text{ppm std}/(\text{Area}_s) \qquad Rx_i = \frac{\text{Area std}}{\text{ppm std}}$$

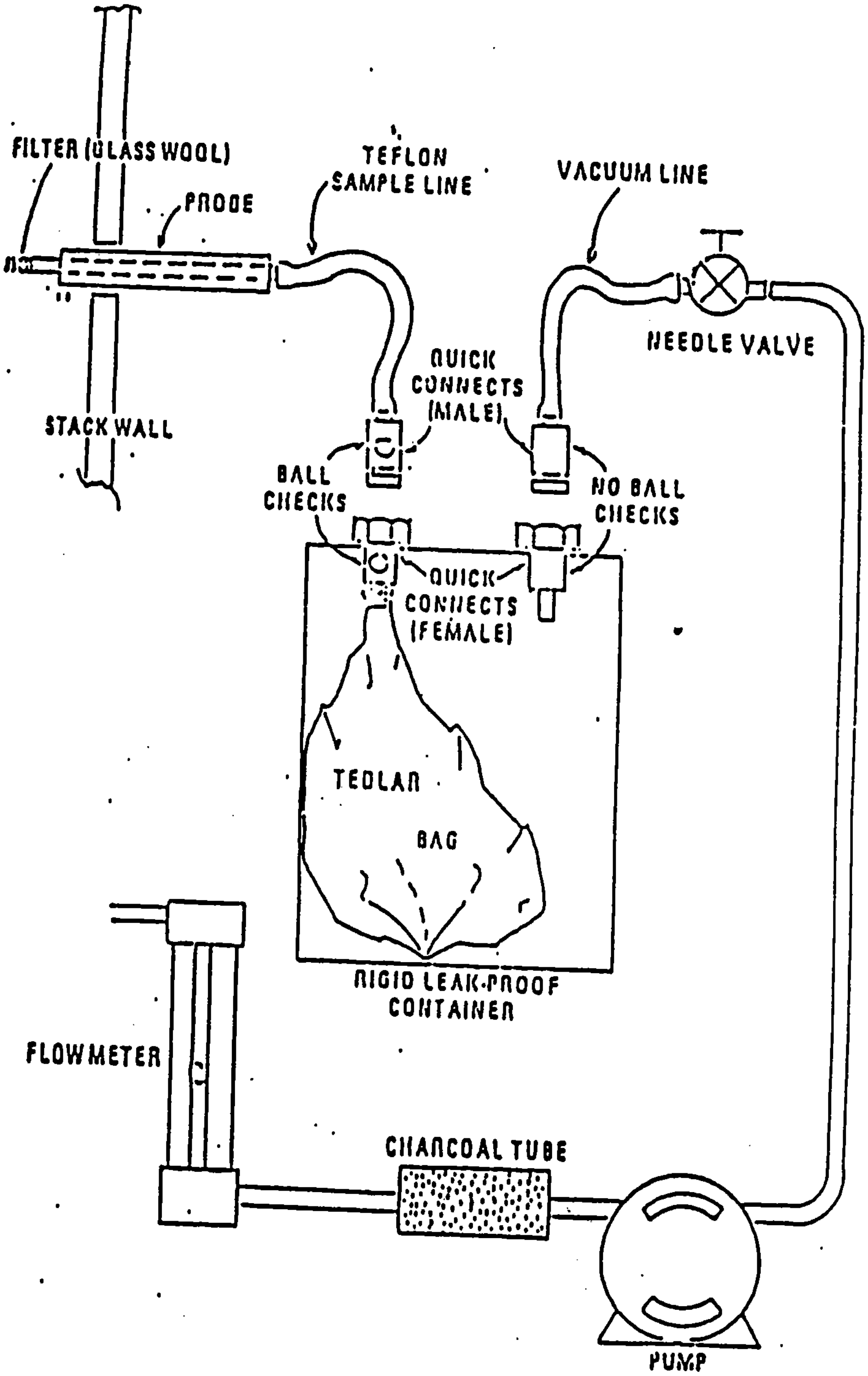
$$\text{sample ppm}_i = \frac{1}{Rx_i} * \text{Area}_i$$

$$\text{lbs/hr}_i = \text{ppm}_i * MW_i * \text{SDCFM} * 1.581 * 10^{-7}$$

$$\text{total non-methane lbs/hr} = \sum_{2}^{6+} \text{lbs/hr}_i$$

Note: If lbs/hr as methane is required, MW; will equal 16.0 (MW of methane)

EPA METHOD #18



II. OUTSIDE LABORATORY INFORMATION

AMBIENT AIR MONITORING

The sampling techniques we recommend for air monitoring projects for trace organics employ Tedlar bags, specially passivated steel containers, solvent desorbable cartridges and thermally desorbable cartridges. The analytical methods employed to determine the very low levels of trace organics collected by these techniques are described in the paragraphs which follow.

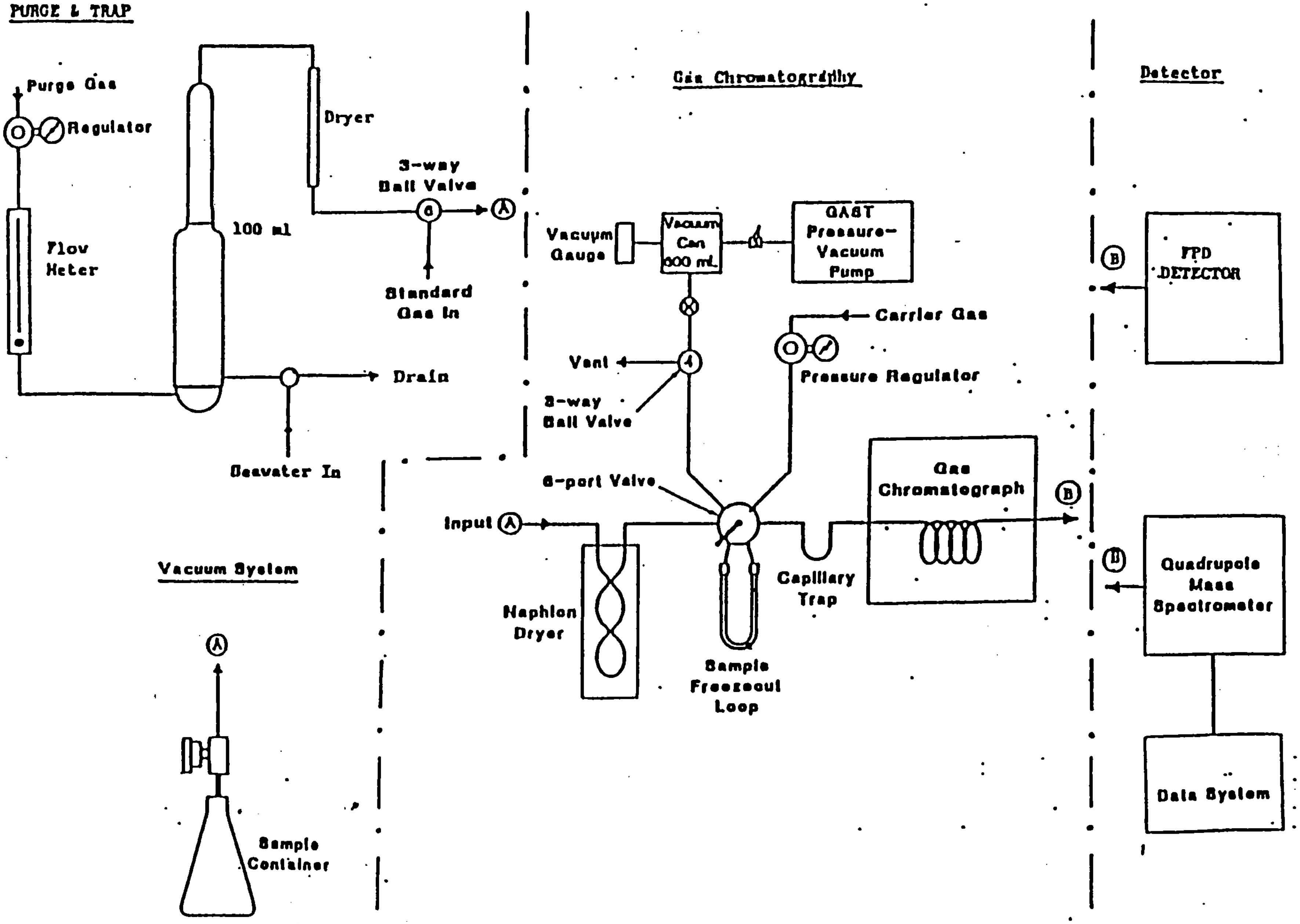
ANALYTICAL TECHNIQUES

The preferred analytical technique employs a freezeout technique to separate the trace organics in ambient air from major air components such as oxygen and nitrogen. Dr. Havlicek, Mr. Hutchison and Ms. Richards of the project team have considerable prior experience in the application of this technique to air samples collected in Tedlar bags and passivated steel containers such as were employed in connection with our recent studies at Casmalia Resources and at another active hazardous waste disposal site in the Central Valley. A schematic diagram of this apparatus is presented in Figure 1 (Hoyt, 1985).

An evacuated reservoir of known volume is used to pull air from the sample bag or passivated steel container through the sample freezeout loop which is immersed in liquid argon. A vacuum guage attached to the reservoir is used to measure the pressure drop caused by the transfer of air from the sample container to the reservoir. Since the volume of the reservoir is known, the amount of air pulled through the freezeout loop can be calculated. Since the freezeout loop is at liquid argon temperature, oxygen and nitrogen cannot condense. Because the loop is packed with tiny inert glass beads, trace organic constituents have a large contact surface upon which to condense.

Since atmospheric water vapor will also condense and since water can cause problems with the subsequent analysis, a Nafion dryer is placed between the sample and the freezeout loop. This inert material is selectively permeable to water which is then swept away by a flow of dry nitrogen on the outside of the Nafion

Figure 1



Apparatus Used to Transfer Trace Organics from Air to GC/MS System tube. Since the trace organics being determined have almost no tendency to permeate the Nafion, they pass through at their original concentrations.

Once the desired volume of air has been collected, the six port valve is rotated and the freezeout loop is heated. This action isolates the freezeout loop from the vacuum reservior and from the sample container while admitting a flow of carrier gas which then sweeps the revolatilized organics from the loop to a capillary trap.

The capillary trap is itself immersed in a cryogenic fluid. This is necessary since the volume of the freezeout loop is large when compared with the flow through the analyzing column. This second freezing out serves to focus the materials collected on the original freezeout loop into a very sharp band which can be readily accommodated by and rapidly transfered to the remainder of the capillary column within the gas chromatograph.

Capillary columns are preferred because they not only provide better separation but can be positioned directly within the source of the mass spectrometer. Since there is no need for a separator to remove excess carrier gas (as would be necessary for packed columns), all of the material originally present in the sample is introduced directly into the source of the mass spectrometer. Since this introduction of separated sample components takes place over a very short time interval, more sample is presented to the analytical detector per unit time than would otherwise be possible. This factor contributes significantly to the low detection limits which we are able to reach.

CARTRIDGE SAMPLES

The analytical system employed for for the analysis of cartridge samples is much like that used for bag and canister samples. In this case, the freezeout loop is replaced by a thermal desorption mini-furnace (actually a conventional purge-and-trap apparatus).

The furnace is then heated while being swept by an inert carrier gas. Since the volume of carrier gas required to sweep the desorbed organics from the cartridge is large compared to the flow through the analytical column, a capillary trap is again necessary. Because water can still cause problems, a Nafion dryer is placed between the mini-furnace and the capillary trap.

ADVANTAGES PASSIVATED STEEL CONTAINERS

A major reservation regarding the use of steel containers for the collection of ambient air samples has been the belief that sensitive compounds would be destroyed by contact with metallic surfaces within the container. Fortunately for CCAS, the development of passivation techniques designed to render the inner surfaces of stainless steel containers sufficiently inert to eliminate these problems has now reached a sufficiently advanced stage of development so that these specialized containers are commercially available. CCAS has nearly 100 such containers in stock. We are now using these containers in Santa Barbara County for the collection of samples to be analyzed for carbonyl sulfide, carbon disulfide, hydrocarbons and volatile Priority Pollutants. We are also using electropolished stainless steel containers for compliance analyses in and around domestic landfills.

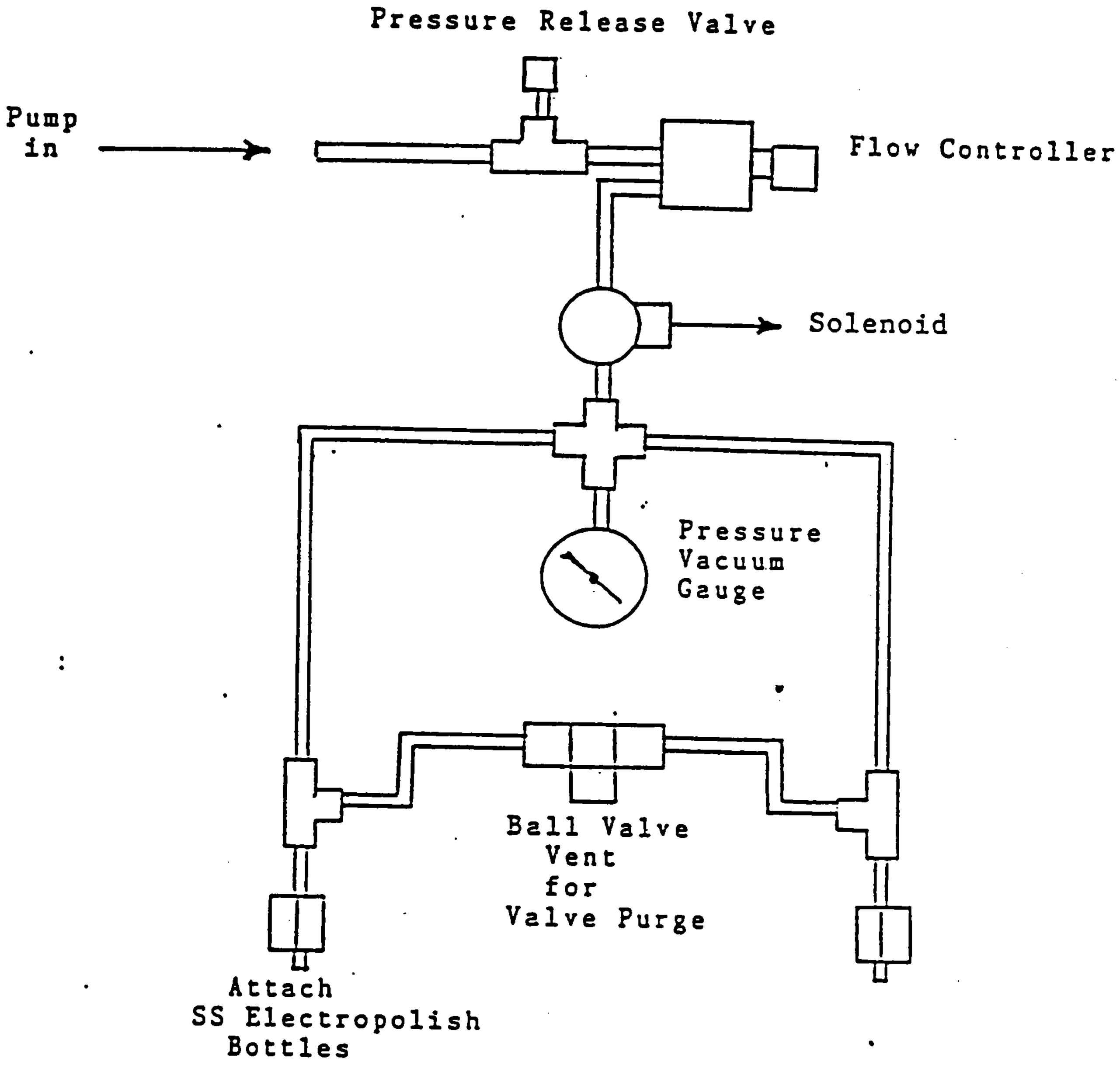
Recent inquiries from other experts in the field requesting that we supply them with these specially passivated canisters indicates that their inherent superiority over bags is becoming more widely recognized. For example, canisters can be pressurized for more convenient leak testing. The CCAS canisters are sealed both by the needle valve and by a Swagelok cap to doubly prevent losses while bags have only a single seal. Bag samples must be overwrapped to protect the samples from light while cans are opaque. Bags are fragile while cans are not. Bags cannot withstand air shipment in a depressurized environment while cans are readily shipped by air.

Although bags are cheaper than cans, they are difficult to clean while canisters can be rigorously cleaned using moist zero air, heating, flushing and evacuation. Since bags really should not be reused at all, overall costs are actually cheaper if canisters are used in blace of bags.

INTEGRATED SAMPLING PROCEDURE

This sampling procedure is applied when regulatory requirements or program needs mandate continuous sampling over an extended period of time such as is the case with Calderon monitoring. The sampling system is controlled by a programmable timer which, in turn, activates a stainless steel/Teflon pump and a solonoid valve. The system incorporates a relief valve and a flow controller in order to ensure a constant flow of air into the sampling manifold. The arrangement of components within the all-stainless steel/Teflon system is provided in figure 2. CCAS is presently developing a second integrated sampling system modeled after a very similar EPA apparatus in which a restrictor is placed ahead of the pump in the sampling train. Both systems deal effectively with the problem of drawing samples into a canister which begins under vacuum and finishes under pressure.

FIGURE 2


Pressure Release Valve
Pump in
Flow Controller
Solenoid
Pressure Vacuum Gauge
Ball Valve Vent for Valve Purge
Attach SS Electropolish Bottles

Prior to initialization of sampling, an electropolished steel canister (preferred) or cartridge or Teflon/Tedlar bag is connected to the manifold. The manifold is then flushed with ambient air through the three-way ball valve/vent shown in figure 2. The connections to the sampling container is then opened and the system is ready to be activated by the timer.

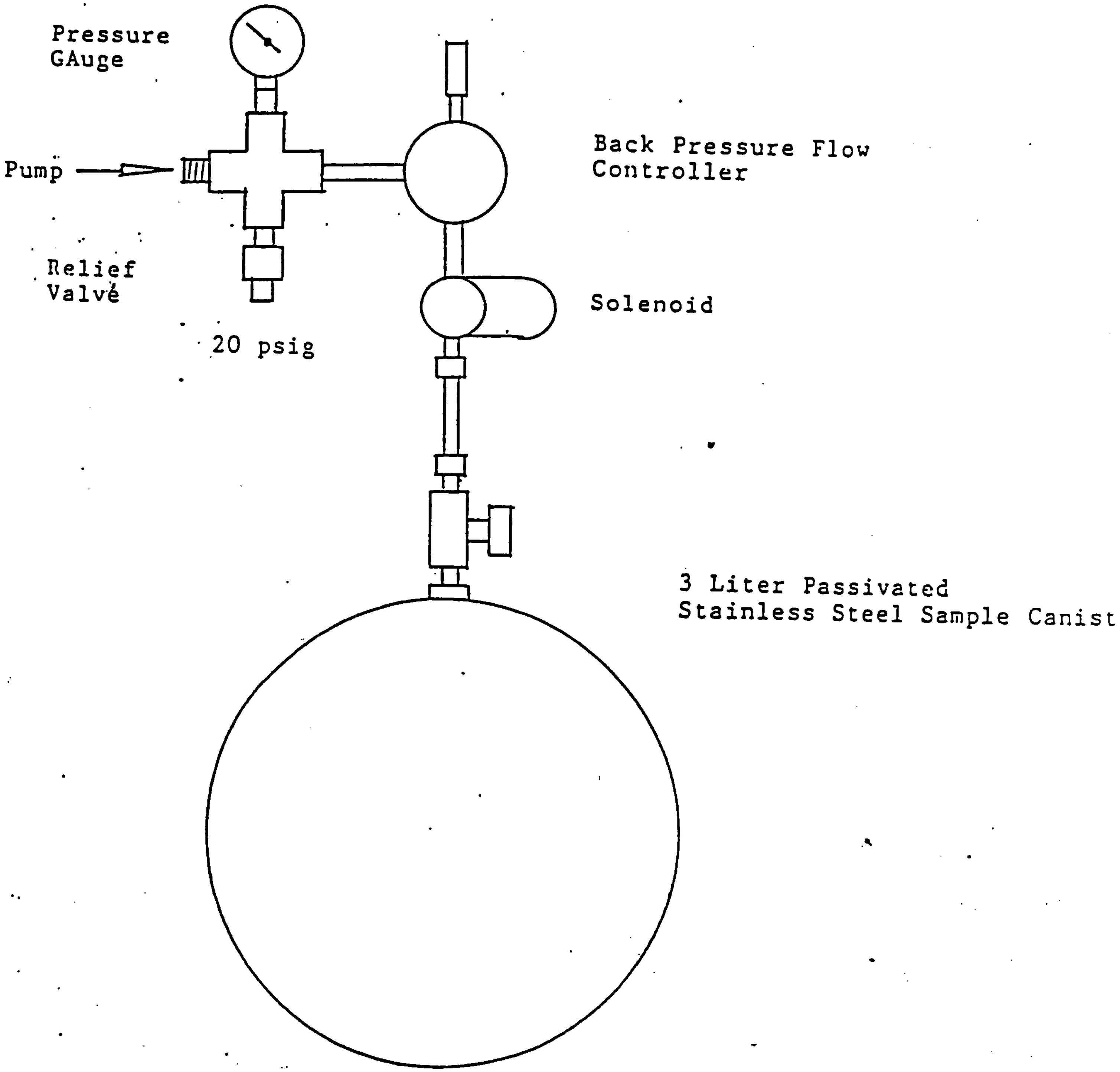
For example, if a 24 hour sampling period is desired, the timer would turn on the pump just prior to the desired time (ie 10:00 AM). A few seconds later the solenoid valve would open to admit the sample to the containers or cartridges. If canisters are employed, progress may be monitored by means of the pressure/vacuum guage positioned on the manifold. Flow may be regulated via the controller to ensure that the capacity of the sampling system is not exceeded during the desired sampling period. In this way sampling periods as long as 24 hours can easily be accommodated. Furthermore, the solenoid valve may be connected to a wind direction sensor so as to trigger an automatic valve closure in the event of an inappropriate wind shift. The systems may be set up to start and stop without the presence of an operator so that extra labor is not required in order to tend multiple samplers.

When the sampling period is to be concluded, the timer first closes the solenoid valve and then turns off the pump. At this time the sample containers or cartridges are sealed and removed for laboratory analysis. New containers or cartridges may be installed if additional sampling is desired such as would be the case with the 10-day sampling programs mandated for hazardous waste disposal facilities.

In response to the need for sampling while walking a grid across the surface of a landfill or patrolling the perimeter of an impoundment, a more portable version of the sampler described above has been designed. A diagram of this sampler is shown in Figure 3. Again, all components are stainless steel and Teflon. This sampling system has been designed to meet the sampling requirements of the Calderon landfill monitoring bill (AB 3525) for collecting ambient air samples. A Teflon and glass snorkle can be attached to enable the sampling technician to conveniently draw air from just above the surface of the landfill. Such sampling, however, is not presently part of your program requirements.

If stationary use is planned, the sampling system can be controlled by a programmable timer that allows the system to be set up the day before sampling is to take place. A Teflon-faced stainless steel diaphram pump capable of providing six liters per minute at no load is used to supply the system from a six foot intake line. The outlet of the pump is connected to a stainless steel four-way fitting configured with a 0-60 psig pressure guage, a 10-15 psig excess flow vent and a stainless steel line connected to the "Back Pressure Flow Controller". The flow

Figure 3: Integrated Sampler



controller can be adjusted to fill the can at a rate which is approprate for the intended sampling period -ie. 25 minutes. The flow controller maintains a constant downstream flow rate so that the sample cans can be filled at the same rate over the course of the entire sampling period.

The solenoid valves which are part of both types of integrated samplers are the stainless steel magnelatch type and therefore do not require power to hold them open once they have been opened. This prevents outgassing such as is sometimes observed in other types of solenoid valves.

After passing through the solenoid valve, the sample is directed to the canister. The sampling line is preflushed with site air prior to being connected to the system therby removing any contamination which might have been acquired during shipment and storage. If timed operation is planned, the sampler can then be turned on and off by means of an automatic timer. Thus the sampling technician needs only to place the sampler and collect the canister afterwards.

ADVANTAGES AND DISADVANTAGES OF THE METHODS

Bag samples involve less contact with reactive surfaces than do cartridges. If properly passivated, the same is true for the steel containers. Therefore there is less chance of irreversible adsorptive losses with these two container types. Bags are more fragile, however, and have shorter holding times than do cartridges. The steel container is again a good compromise between the bag and the cartridge. Air shipment of bags is not advised. Reanalysis from the same bag or canister is convenient. This degree of flexibility can be important when samples containing unexpectedly high or low levels of trace organics are encountered or when several different types of analysis are required.

Gas phase reactions taking place as the bag or steel container is collected will continue during shipment and storage. Since many of these reactions are accelerated by light, CCAS recommends that bags be wrapped in foil or immediately overbagged with a dark plastic bag upon collection. Overbagging also provides a buffer of air similar to the collected air so that diffusional exchange with dissimilar air is reduced.

Cartridge samples, once collected, are inherently more stable than bag or canister samples. We have seen virtually identical gas chromatographic patterns when comparing archived cartridge samples with companion samples analyzed a year earlier. Furthermore, thermally desorbable cartridges destined for analysis with legal implications should be preanalyzed to avoid questions arising from the use of contaminated cartridges. Even fresh cartridges supplied by commercial sources require rigorous precleaning.

It is planned that canisters will be used exclusively in connection with the proposed study.

DETECTION LIMITS

Quantitation from full-scan mass spectrometric data is based upon area counts for one or more extracted ions. Since noise levels for extracted ions are typically are 100 area counts, a signal of 1000 would provide a signal-to-noise ratio of 10 to 1. Detection limits can then be calculated from calibration data on the basis of this signal to noise ratio. Some examples are provided in Table 1. Frequent experimental verification, of course, is required. Please note that all detection levels are less than or match your program requirements.

Since the data are collected by full scan GC/MS, absolute confirmation of identity is practiced. This extra measure of quality assurance is not even possible with the selective detector methods. Furthermore the inspection of the data for additional compounds is possible so that reanalysis would not be necessary even if the list of target compounds is extended AFTER measurements have already been completed at a given site. Since only one run is required for both aromatic and halogenated components, this better technology does not require the incurrence of higher costs. Therefore, it would seem unlikely that the use of equivalent, but slightly less satisfactory techniques would be required.

STAFF EXPERIENCE

In 1987 CCAS has undertaken the analysis of landfill gases and ambient air samples at a number of domestic landfills in the western United States. These analyses have involved fixed gases, methane/non-methane hydrocarbons, halogenated solvents, refrigerants and hydrocarbons. In those cases in which Calderon testing was involved, most of the listed compounds were found in most of the samples. CCAS detection limits are generally well below those which are considered necessary for compliance.

In 1985 and 1986, Central Coast Analytical Services participated in a major sampling and analysis program at Casmalia Resources. Sulfur-containing organics, aromatics, chlorinated solvents, ketones and a variety of hydrocarbons were monitored at levels ranging from 0.02 to several thousand ppbv. These data were reviewed and accepted by the county, the state, EPA and the site owner even though the separate parties had very different points of view regarding the interpretation of the results. Ancillary data from treatment processes, waste materials and groundwater samples were all mutually reinforcing. Since then a second hazardous waste site has been studied. This other site accepted many materials in common with the site which is the subject of this proposal thereby providing our project team with valuable experience directly relevant to the task at hand. For example, several waste impondments covered with crude oil were present. Upwind/downwind sampling was a major aspect of the project. The logical relationship of the data was a major strength of the project.

In 1986, stack emissions of an unusual and difficult nature were monitored by CCAS at a "Fortune 500" manufacturing facility. In this case, special care was required in the transfer of only slightly volatile components from the sampling container to the analytical instrumentation.

In 1985, CCAS monitored ambient air for sulfur gases and hydrocarbons as part of a major study performed for another "Fortune 500" company. Documentation was provided regarding levels near natural and anthropogenic sources under a variety of weather conditions.

An on-going program for the monitoring of sulfur-containing organics, chlorinated hydrocarbons, and aromatic hydrocarbons has been in progress for more than a year in Santa Barbara county.

In 1978 Dr. Stephen Havlicek managed a project for the Georgia Department of Natural Resources which involved the analysis of ambient air samples for trace organics (Havlicek, 1981). Samples were transferred from Teflon bags to the head of a support-coated open tubular column for gas chromatographic separation prior to analysis by mass spectrometry. The transfer mechanism involved the use of a six-port valve, a vacuum reservoir and a freezeout loop much like the one illustrated earlier in Figure 1.

More recently, Dr. Stephen Havlicek managed a project which required the analysis of synfuels stack gases collected on charcoal tubes (Havlicek, 1982). The tubes were double sealed on site since air transportation was required. Following desorption with carbon disulfide, analyses were performed by GC/MS. Analysis of an archived reserve samples nearly a year later produced the same characteristic pattern of chromatographic peaks as had been noted when the samples were first analyzed. This method of archiving samples could be useful in connection with many projects.

In 1982 Dr. Mary Havlicek examined glass bottle samples taken in the vicinity of an oil refinery for trace organics. In this case, a packed column was used to separate the components of this complex mixture prior to analysis by GC/MS. Glass sampling bottles are generally not recommended for low-level analyses due to problems associated with leakage and adsorption to the container walls. Since the project in question involved levels approaching those associated with fire hazard, the choice of sampling containers was quite appropriate.

Dr. Larry Hilpert, the newest member of the CCAS project team has devoted several years to the analysis of trace organics in air pollution samples. Included among this work was the development of a certified reference material for the National Bureau of Standards. Dr. Hilpert has 10 years of work experience with the National Bureau of Standards where he has participated in methods development using GC/MS and HPLC. He has more than 20 publications to his credit and is expected to provide major inputs to the project in question.

QUALITY ASSURANCE

Quality assurance at CCAS serves two important functions. The first function is the establishment of quality control activities relating to sample collection, siting of sampling stations, analytical protocols and data validation. The second function is the provision of such data quality information as precision, accuracy and completeness.

Sampling Methods

The sampling equipment intended for use on site consists of electropolished stainless steel canisters, the sampling manifolds described earlier in the text and presented in figures 2 and 3, Teflon and stainless steel pumps and three meteorological monitoring stations.

Canisters and manifolds through which samples are to be passed are leak tested before being brought into the field. Timers, pumps etc. are similarly inspected to verify that they are in good operating condition. Prior to removal of a sample from the sampling manifold, pressure is recorded in the field sampling record book. Meterological conditions are noted. The time at which sample collection ceased is recorded as is the actual time of sample pickup. The samplers initials and can number are also entered in the field notebook. While the can and the sampler are still at the sampling station, the location is marked on the site map summarizing the day's sampling activities. The needle valve is then closed and the canister removed from the sampling manifold. A Swagelok cap is then securely fastened over the sample connector.

All relevant information is then transferred to the chain of custody document. An example of a chain of custody form is appended to the proposal. Security tape is then placed over the needle valve and the end cap. All samples taken in a given day are then placed in a cushioned box for shipment to the laboratory. The box is then sealed with security tape. The generous use of security tape requires very little time yet provides a certain verification of the integrity of the sample.

At CCAS, accountability is a key factor in quality assurance. Personnel are required to initial or sign the field sample record book, the chain of custody document, the analytical request sheet, the sample injection record, the data processing worksheet and the final report which is then reviewed for release by a Ph.D. chemist. In this way personal responsibility for the sample is established so that appropriate individuals can be questioned should the need arise.

Field sample numbers are uniquely assigned in the field and recorded both in the field notebook and on the chain of custody record. These become part of the sample description as each sample is assigned a unique log number upon arrival in the laboratory. The assignment of laboratory numbers, completion of the chain of custody document and filling out the analytical requests are the responsibility of our full-time Sample Control Officer, Ms. Shellie Noller. Her job is made easier through the use of Nelson Analytical's RLAB sample tracking software.

Canisters are cleaned between each use with moist zero air. Since the cans are numbered, it is a relatively simple matter to maintain a can history record. In this way, canisters which become exposed to high level samples can be shifted to source testing in order to avoid problems associated with sample carryover.

Major analytical equipment such as the GC/MS systems and the data processing systems are under preventative maintenance contracts in order to minimize downtime. Six GC/MS systems are available for use in connection with the proposed testing program. Four selective detector gas chromatographs are available.

Use of Certified Standards

Central Coast Analytical Services employs the Research Triangle Institute Certified Series 1 standard as the primary gas standard for Calderon analyses. These standards have only recently become available and are ordered but have not actually been delivered as of the time this proposal is written. However, delivery has been assured prior to project initiation. A Scott-Marrin Calderon Blend is used as a control gas standard. The two standards are used as a check on each other and are run with every batch of samples. Differences in response factors are averaged, if necessary to provide the best overall response factors which, in turn, are used to calculate the results for the day's analytical runs. Because the volume of these standards is very large relative to the amount used during daily standard runs, the same standards can be used for the duration of long projects. Typical results are appended to this document.

Spiked Samples

Spiked samples are prepared from commercially available standard mixtures in methanol. These are prepared by injecting 500 ng of each component into an electropolished canister containing zero air at ambient pressure. The container is then pressurized with additional zero air. The pressure is recorded and used, together with the volume of the canister, to calculate the concentration of the spike. Spiked samples prepared in this way are stable for a month or more and can therefore be used to develop acceptance criteria. We believe that field spiking, particularly if done at ambient pressure, is itself an unacceptable source of error. Representative spiking data are appended.

Accuracy is defined as the difference between the measured concentration and the actual concentration divided by the actual concentration and expressed as a percentage. In this case, the measurement is described as the percent relative error of the measurement. Smaller values, of course, represent better accuracy.

Duplicate Samples

Duplicate integrated samples will be taken during the course of the proposed program. In order to ensure a greater abundance of non-zero values, it is recommended that all of the duplicates be downwind samples. Colocated samplers will be employed. Precision is calculated from duplicate sample data as the difference between the two results divided by the mean of the two results, expressed as a percentage. As in the case of the accuracy measurements, smaller values indicate greater precision. If more than two replicates are available, the standard deviation provides a statistically more valid means of expressing precision.

Blanks

A zero air blank accompanies every set of samples. This blank is run first in order to verify that the valves and cryogenic systems are free from contamination. Unsatisfactory blanks are a cause for shutdown and system cleaning. Canisters pressurized with zero air and sent into the field as field blanks are returned to the laboratory unopened and analyzed to provide a measure of residual contamination which might escape removal during cleaning and subsequently desorb from the interior of the container during shipment and storage.

METHODS

The GC/MS method is in a real sense more accurate than alternate methods because it is virtually interference free. It is the only method in which the identities of sample constituents can be confirmed by comparison with such multivariate data as authentic fragmentation patterns. Recoveries are typically 80 to 120 percent. Representative data have been appended. These are established by means of spiked samples.

When calibration curves such as are appended to this document are available, linear regression analysis provides a further measure of precision as well as an estimate of the detection limit. The curves shown not extended far enough to determine the upper limit of the linear range. Unlike other methods, samples suspected of being beyond the linear range for the extracted ion area normally employed for the analysis of a given compound can be reexamined by extracting a less abundant ion from both the standards and the samples. In this way reruns can often be avoided without compromising accuracy. The extraction of more than one ion for quantitation is yet another example of how the quality of the data can be improved when mass spectrometry is employed as the analytical tool. We intend to employ two ions per compound (where possible) for the purposes of the proposed study. In this way ion ratios can be checked in addition to retention times. The data processing step has been set up in such a way that independent results are calculated for each ion. The two results are then averaged to provide the answer presented in the reports. If the two answers are not similar, the matter is investigated. If a reason for the difference is not discovered, the lower of the two answers is presented. Typical results are appended.

Standard operating procedures such as are provided in the ARB Guidelines have been developed by CCAS for Calderon procedures. These step-by-step instructions are made available to our analysts for quick reference as in the event they encounter an unusual situation. New analysts are required to study the written operating procedures as a part of their training. These are periodically updated by senior staff as improvements are made.

Use of Appropriate Sampling Containers

In the analysis of the listed organics, hydrocarbons, and fixed gases, extremely reactive species such as sulfides and mercaptans are not to be determined. Accordingly, samples destined for these types of analyses may be collected in specially passivated steel containers. Passivation and electropolishing are necessary in order to minimize degradation and memory effects from previous samples prior to analysis.

The steel containers are steam cleaned and baked repeatedly under vacuum between uses. Unused containers are rebaked frequently. When Tedlar bags are used, they are flushed with zero air just prior to use. Bags are brought to the point of sampling in an inflated condition by surface transport. Unused bags are reflushed weekly. Bags are not reused. Canisters are numbered and usage logged so that those canisters known to have been used for source sampling may be segregated from those used for ambient sampling.

Use of Appropriate Sampling Techniques

In order to further minimize contact of sampling gases with reactive surfaces, grab samples are collected by immersing the sampling container in liquid nitrogen and allowing an appropriate volume of sample air to liquefy within the container. The containers are then withdrawn from the liquid nitrogen and vented twice prior to retention of the sample. This flushing technique serves to remove any materials which may have leached out of the sample container enroute to the point of sampling. Pressurized samples are obtained even though no pumps or manifolds are employed. CCAS has employed this method extensively for the collection of grab samples in the vicinity of impoundments. It is especially convenient for the simultaneous collection of matched upwind/downwind samples. Since approximately 5 minutes are required to collect samples, some integration is achieved. If the ARB permits this type of sampling in the vicinity of the on-site sources, it will conserve the limited supply of integrated samplers and thereby speed the completion of the project. The granting of such permission is, however, not essential to the CCAS proposal.

Use of Mass Spectrometric Methods

Even with the higher resolution of fused silica capillary gas chromatography, coelution of sample components is not a rare event. The mass spectrometer, however, permits independent measurements to be made even in a case of triple coelution such as is observed for cyclohexane, benzene and carbon tetrachloride under some conditions of analysis.

Compound identities are certified by comparison with authentic spectra contained in the EPA/NBS mass spectral data base. This data base of more than 40,000 mass spectra is a part of the software available with the CCAS instrumentation. The quality of this searching has been recently upgraded by the use of our new Hewlett/Packard RTE-1000 central data processing station equipped with the powerful Aquarius software. All data system matches are reviewed before being included in our reports. Our analysts closely compare retention times with daily standard runs. Assignments which are "out of step" with the rest of the chromatogram are rejected on the basis of these comparisons.

Because CCAS has six GC/MS systems, we are able to dedicate one of the instruments exclusively to air analysis. In this way contamination from other sample types is avoided. All instruments are less than two years old, are under service contract and are subjected to frequent in-house maintenance.

Use of Jerome Instruments Gold Foil Hydrogen Sulfide Analyzer

CCAS has a gold foil hydrogen sulfide analyzer manufactured by Jerome Instruments. This is an on-site, portable or mountable analyzer which can take readings on a minute-by-minute basis. We have taken readings ranging from 0.1 ppbv to >5000 ppbv on the same site over a five minute period and found that these compare favorably with data obtained from bag samples analyzed by mass spectrometry. The instrument is returned to the manufacturer periodically for recalibration under dynamic conditions. The use of this instrument is not planned in connection with this project unless odor complaints again become a factor.

Internal Review of All Data

All data are reviewed at some stage by Dr. Larry Hilpert, Dr. Stephen Havlicek, or Dr. Mary Havlicek. This review by at least one Ph.D. chemist having extensive experience in the collection and evaluation of air data further reduces the opportunity for unsatisfactory data to leave the laboratory. Data are reviewed for internal consistency, compatibility with expectations at a given sampling location and are compared with data from similar areas if applicable. Unusual data are critically examined prior to presentation. Reruns are requested if applicable.

1. Hoyt, S. D. and R. A. Rasmussen (1985), "The Analysis of Trace Gases in Air and Seawater", ACS Advances in Chemistry, American Chemical Society, Washington, D.C ., 1985.

2. Havlicek, S. C. and J. D. Lupton (1981), "Photochemical Oxidants in Urban Atlanta", final report submitted to State of

Georgia, November, 1981.

3. Havlicek, S. C. and C. P. Oliveros, "Collection and Analysis of Wastewater and Gas Samples at a Major Synfuels Operation", final report, May, 1982.

QUALITY ASSURANCE DATA

Typical Results Showing Agreement for Two Ion Method

Component Determined (ion)	Standard in ug/cu M	Area Std Run	Area of Run	Area Ratio	Result in ppbv
Methylene Chloride (84)	21.0	22000	51623	2.35	54.38
(86)	21.0	13500	31819	2.36	54.63
TCA (97)	34.5	45500	3206	0.07	2.68
(85)	34.5	29000	1938	0.07	2.54
Carbon Tetrachloride (117)	34.8	43000	1029	0.02	0.91
(119)	34.8	42000	979	0.02	0.90
Benzene (78)	19.3	67000	16955	0.25	5.39
(50)	19.3	18500	4504	0.24	5.19

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April 23, 1987

QUALITY ASSURANCE PROOF
Duplicate Samples
AMBIENT AIR ANALYSIS
(Results in ppbv)

Dichlorodifluoromethane	2.2	2.0
Methyl Chloride	2.8	3.9
1,1-DCA	2.8	6.4
1,1,1-Trichloroethane	12.	13.
Ethylene Dichloride	0.2	0.2
Carbon Tetrachloride	0.5	0.5
Benzene	1.4	1.4
Trichloroethylene	1.7	2.0
Tetrachloroethylene	1.2	2.7
Ethylbenzene	0.7	0.9
Xylenes	4.4	5.5
Carbonyl Sulfide	6.0	6.0
Butane	0.4	0.8
Carbon Disulfide	6.7	3.6

NOTE: Grab samples collected in sequence. Actual time difference about 5 minutes. Greatest contributor to differences in results is the difference in time.

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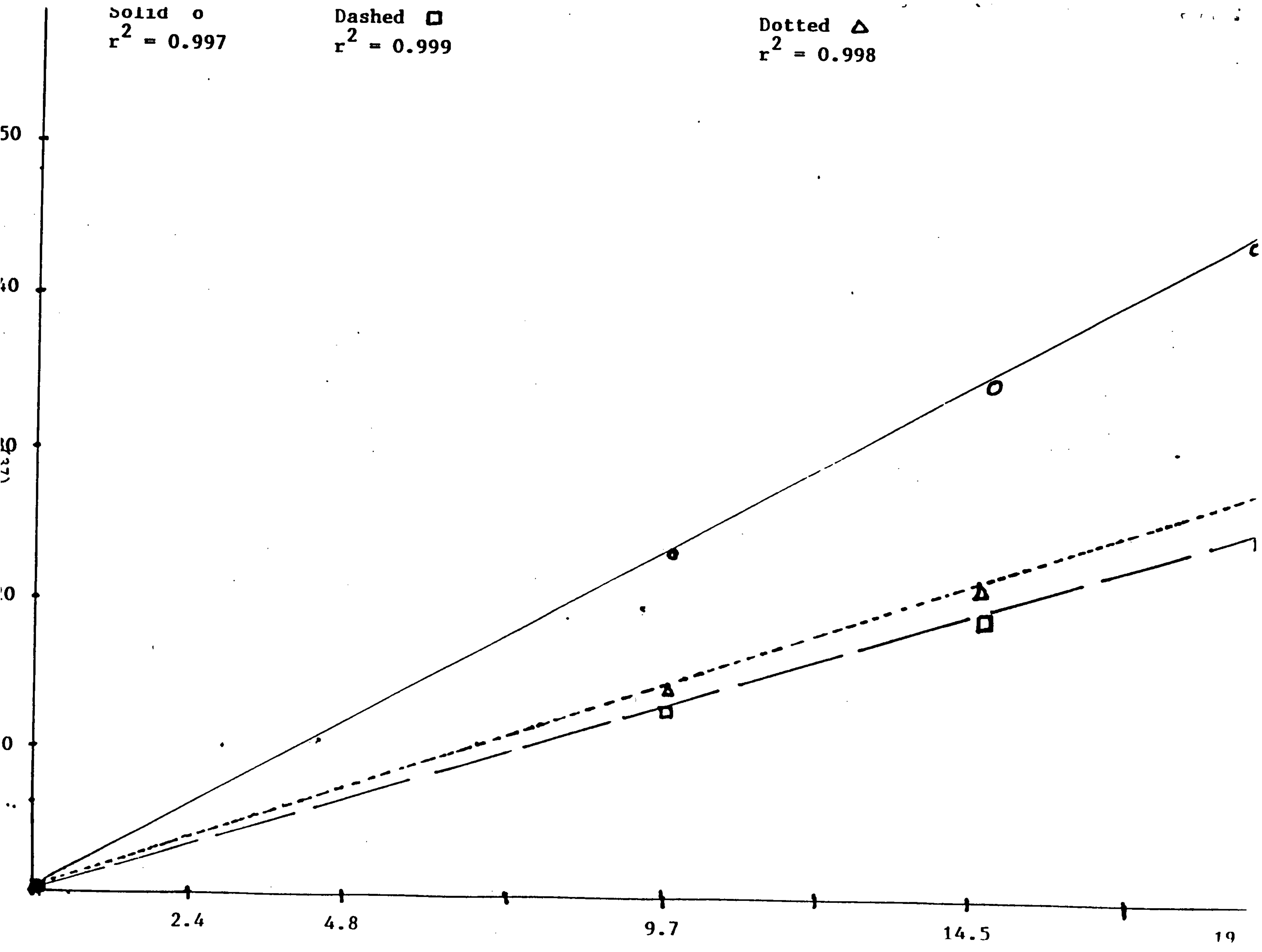
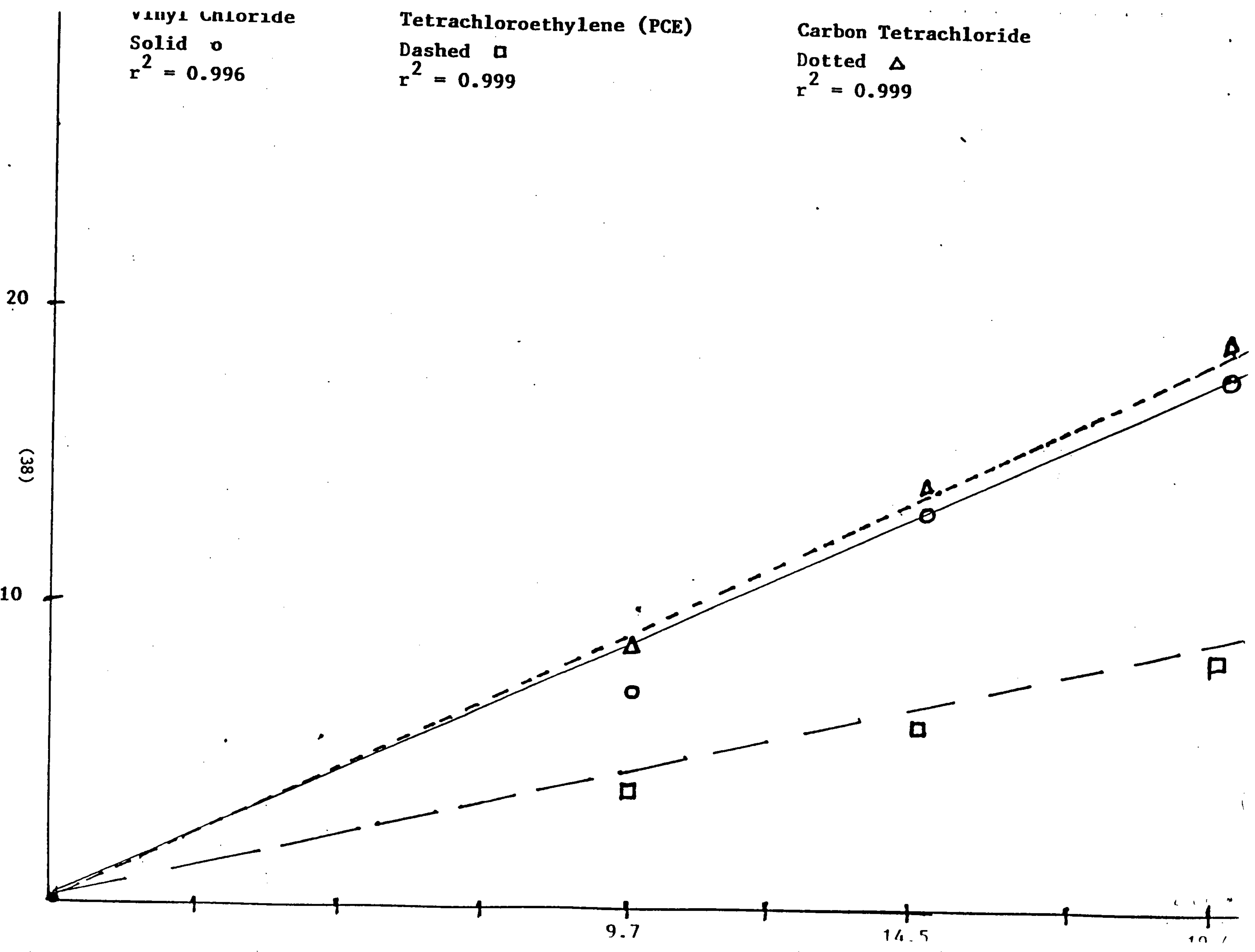
QUALITY ASSURANCE PROOF
AMBIENT AIR ANALYSIS

Examples of Logical Sample Relationships
(ppbv)

COMPONENT	UPWIND Site A	DOWNWIND	UPWIND Site B	DOWNWIND
Dichlorodifluoromethane	1.3	6.6	1.9	2.2
Methyl Chloride	2.5	3.0	1.8	2.2
Methylene Chloride	<1.2	8.8	<1.2	90.
Trichlorofluoromethane	1.1	1.5	1.6	6.9
Freon 113	0.5	6.7	0.2	9.9
Chloroform	0.07	0.6	0.07	6.6
Ethylene Dichloride	0.1	0.2	<0.02	0.2
Carbon Tetrachloride	1.0	1.3	0.5	0.5
Benzene	0.8	1.1	0.4	1.4
Toluene	0.5	0.7	0.3	9.2
Carbonyl Sulfide	0.7	1.0	4.8	6.0
Butane	2.0	4.7	0.7	0.8
Hexane	0.2	1.3	0.8	31.
Carbon Disulfide	0.09	0.23	0.3	5.1
Methylethyl Ketone	1.4	1.7	120.	250.


Solid o
r^2 = 0.997
Dashed □
r^2 = 0.999
Dotted △
r^2 = 0.998
50
2.4
4.8
9.7
14.5
19


Vinyl Chloride
Solid o
$r^2 = 0.996$
Tetrachloroethylene (PCE)
Dashed □
$r^2 = 0.999$
Carbon Tetrachloride
Dotted △
$r^2 = 0.999$
20
10
9.7
14.5

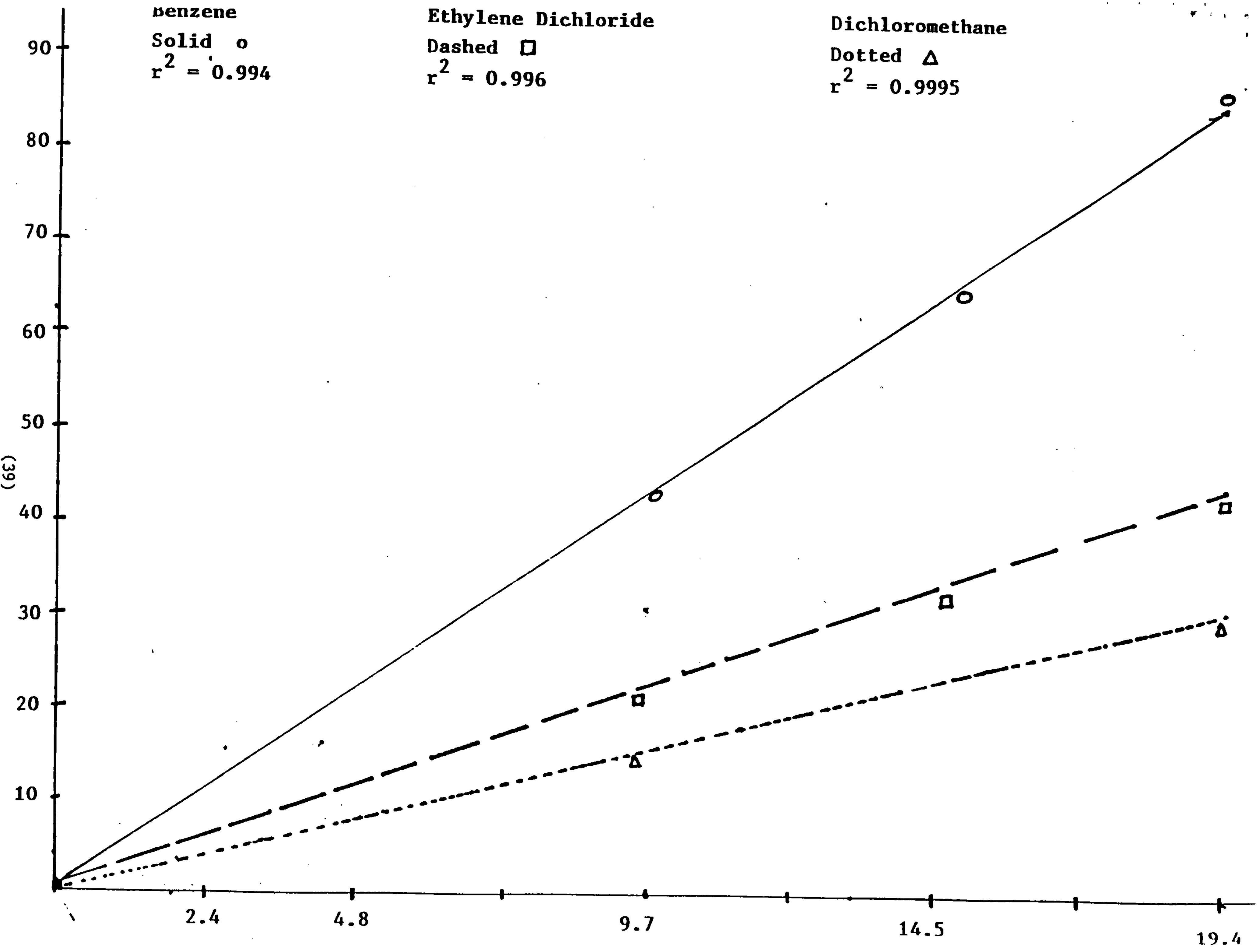

Benzene
Solid o
$r^2 = 0.994$
Ethylene Dichloride
Dashed □
$r^2 = 0.996$
Dichloromethane
Dotted △
$r^2 = 0.9995$
90
80
70
60
50
40
30
20
10
2.4
4.8
9.7
14.5
19.4

TABLE 2 FROM ATTACHMENT 2

HAZARDOUS WASTE DISPOSAL SITE TESTING GUIDELINES

JANUARY 1987

SPECIFIED AIR CONTAMINANTS

COMPOUND		CCAS DETECTION limits *	REQUIRED DETECTION LIMITS, ppb	
			Air	Disposal site
Chloroethene (Vinyl Chloride)	CH2 CHl	0.3	2	500
Benzene	C6 H6	0.3	2	500
1,2 Dibromoethane (Ethylene Dibromide)	BrCH2 CH2 Br	0.5	0.5	1
1,2-Dichloroethane (Ethylene Dichloride)	ClCH2 CH2 Cl	0.2	0.2	20
Dichloromethane (Methylene Chloride)	CH2 Cl2	0.3	1	60
Tetrachloroethene (Perchloroethylene)	Cl2 C:CCl2	0.2	0.2	10
Tetrachloromethane (Carbon Tetrachloride)	CCl4	0.2	0.2	5
1,1,1-Trichloroathene (Methyl Chloroform)	CH3 CCl3	0.2	0.2	10
Trichloroethylene	HClC:CCl2	0.2	0.6	10
Trichloromethane (Chloroform)	CHCl3	0.2	0.8	2

*Full scan GC/MS with minimum 5:1 signal to noise.

ELKTAB2 SCH/dm

TABLE 1 REPRESENTATIVE SPIKE DATA

mg/m3

COMPONENT	EXPECT	FOUND	PERCENT RECOVERY
Chloroform	9.7	9.2	95
	14.5	15.2	105
	19.4	19.2	99
1,1,1-TCA	9.7	9.5	98
	14.5	14.5	100
	19.4	19.8	102
TCE	9.7	9.2	95
	14.5	14.5	100
Vinyl Chloride	9.7	8.2	85
	14.5	14.5	100
	19.4	19.4	100
PCE	9.7	8.7	90
	14.5	13.7	94
	19.4	20.4	105
Carbon Tetrachloride	9.7	9.2	95
	14.5	14.7	99
	19.4	19.6	101
Benzene	9.7	8.9	92
	14.5	14.1	97
	19.4	20.4	105
Ethylene Dichloride	9.7	8.9	92
	14.5	15.0	103
	19.4	19.4	100
Dichloromethane	9.7	9.7	100
	19.4	19.4	100

elktab1 SCH/dm