BK065

REPORT OF: COMPLIANCE SOURCE TEST THREE SUPERBURN ENGINES SOUTHEAST REGIONAL LANDFILL SELMA, CALIFORNIA

Prepared for:

J-W Operating Company
Post Office Box 305
Wray, Colorado 80758

For Submittal to:

San Joaquin Valley Unified Air Pollution Control District
1999 Tuolumne St., Suite 200
Fresno, California 93721

Test Date:

April 6, 1993

Publication Date:

May 25, 1993

Prepared by:

Engineering-Science, Inc.
2520 Pegasus Drive
Bakersfield, California 93308
(805)393-0272

TABLE OF CONTENTS

SECTION 1

INTRODUCTION

REPORT OF:
COMPLIANCE SOURCE TEST
THREE SUPERBURN ENGINES
SOUTHEAST REGIONAL LANDFILL
SELMA, CALIFORNIA

SECTION 1

INTRODUCTION

Engineering-Science, Inc. (ES), Bakersfield, California conducted air emissions testing of three landfill gas fired Engines/Generators located at the Southeast Regional Landfill, in Selma, California. This facility is operated by J-W Operating Company. Testing was conducted to demonstrate the facility's compliance with the Permit to Operate No's. 3040200102R1 (Superburn #1), 3040200103R1 (Superburn #2), and 3040200104R1 (Superburn #3). These permits were issued by the San Joaquin Valley Unified Air Pollution Control District.

Three identical SB-450-Superburn Heavy Duty Engines/Generators were tested. Each Superburn unit is comprised of a remanufactured AJAX 450 HP (at 450 RPM) engine coupled to a 240 KWE 60 cycle ODP Induction Generator (250 KVA). Emissions are minimized by optimizing the exhaust oxygen concentration and temperature, ignition timing, and air/fuel ratio. All testing was conducted on the exhaust stacks of each unit. The units were operated at base load conditions and fueled by landfill gas.

Table 1-1 summarizes the testing program performed on April 6, 1993. Triplicate 40-minute Continuous Emission Monitoring (CEM) was conducted for Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Carbon Dioxide (CO_2) and Oxygen (O_2) in accordance with CARB Method 100 on the Superburn #1 unit. Single 40-minute CEM runs were performed on Superburn #2 and #3 to verify similar operating conditions and emission parameters. All remaining tests were performed on the Superburn #1 unit only. Triplicate integrated hydrocarbon samples were collected in accordance with EPA Method 18 and analyzed for methane/non-methane by GC-FID.

TABLE 1-1
SUMMARY OF COMPLIANCE SOURCE TESTING
J-W OPERATING COMPANY
SOUTHEAST REGIONAL LANDFILL
SELMA, CALIFORNIA
APRIL 6, 1993

Source Test Parameters and Methodology											
Superburn Engine # 1 (APCD # 3040200102R1)								Superburn Engine # 2 (APCD # 3040200103R1) and Superburn Engine # 3 (APCD # 3040200104R1)			
Nitrogen Oxides NO_x	Carbon Monoxide CO	Carbon Dioxide CO_2	Oxygen O_2	Sulfur Dioxide SO_2	Methane / Non-methane Hydrocarbons	Volatile Organics[1]	Lead / Flow Rate / Moisture	Nitrogen Oxides NO_x	Carbon Monoxide CO	Carbon Dioxide CO_2	Oxygen O_2
Triplicate 40-minute runs for compliance determination.	Triplicate 40-minute runs for compliance determination.	Triplicate 40-minute runs for molecular weight determination.	Triplicate 40-minute runs for compliance determination.	Triplicate 40-minute runs for compliance determination.	Triplicate 40-minute runs for compliance determination.	Triplicate 40-minute runs for compliance determination.	Duplicate 60-minute runs for compliance determination.	Single 40-minute runs for compliance determination.	Single 40-minute runs for compliance determination.	Single 40-minute runs for for monitoring requirements	Single 40-minute runs for compliance determination.
CARB Method 100	CARB Method 100	CARB Method 100	CARB Method 100	EPA Method 6	EPA Method 18	CARB Method 410A Method 422 Method 106	CARB Method 12	CARB Method 100	CARB Method 100	CARB Method 100	CARB Method 100

[1] Volatile Organic compounds consist of Vinyl Chloride (CARB 106), Benzene, Toluene, Xylene (CARB 410A), 1,2-Dichloroethane, Methylene Chloride, Tetrachloroethane, 1,1,1-Trichloroethane, and Trichloroethylene (CARB 422).

Duplicate lead samples were collected in accordance with CARB Method 12 and analyzed by atomic absorption spectrophotometer. Exhaust gas flow and moisture determination of the Superburn # 1 unit was determined from the CARB Method 12 measurements. Triplicate sulfur dioxide samples were collected and analyzed in accordance with EPA Method 6. Triplicate CARB Method 410A samples were collected and analyzed for benzene, toluene, and xylenes. Triplicate CARB Method 422 samples were collected and analyzed for 1,2-Dichloroethane, Methylene Chloride, Tetrachloroethane, 1,1,1-Trichloroethane, and Trichloroethylene. Triplicate CARB Method 106 samples were collected and analyzed for vinyl chloride. A single fuel sample was collected and analyzed for Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen (N), Sulfur (S), and heating value (Btu) in accordance with ASTM Method D3588.

The test program was observed by Mr. Gary Martin of the District. Mssrs. Gordon Mandis, Dean Jarrett, and Tommy Archer of J-W Operating coordinated operation of the engines and were responsible for supplying ES with the operational data. ES project personnel were Mssrs. Troy Delfino (ES Project Manager), Jim Polhamus, and Tony King.

SECTION 2

SUMMARY OF RESULTS

SECTION 2

SUMMARY OF RESULTS

Emission measurements were made of the exhaust gases of three landfill gas fired I.C. Engines/Generators at the Southeast Regional Landfill in Selma, California. The District Permit No.'s are 3040200102R1 (Superburn # 1), 3040200103R1 (Superburn # 2), and 3040200104R1 (Superburn # 3). The results of the testing program are summarized in Tables 2-1 through 2-3.

Table 2-1 summarizes NO_x, CO, SO_2, and NMHC emissions of Superburn # 1. Emissions are expressed in units of parts per million (ppm), pounds per hour (lb/hr), and pounds per day (lbs/day) based on a 24-hour day. In addition, Table 2-1 summarizes percent (%) O_2 and Lead emissions of Superburn # 1 in units of grains per dry standard cubic feet (gr/dscf), lbs/hr, and lbs/day. VOC emissions from Superburn # 1 are summarized in Table 2-2 in units of parts per billion (ppb), lbs/hr, and lbs/day. The ten VOC compounds targeted for analysis are Benzene, Toluene, O-Xylene, P-Xylene + M-Xylene (CARB Method 410A), Vinyl Chloride (CARB Method 106), Methylene Chloride, 1,2-Dichloroethane, 1,1,1-Trichloroethane, Trichloroethylene, and Tetrachloroethylene (CARB Method 422).

Table 2-3 presents the NO_x and CO data for the single CARB Method 100 tests performed on Superburn # 2 and Superburn # 3. Exhaust gas flow rate for these engines was calculated based on generator KW-HR output and unit efficiency of Superburn # 1. These calculations are included in Appendix C.

TABLE 2-1
NO_x, CO, SO_2, NMHC, and Pb DATA SUMMARY
SUPERBURN # 1, DISTRICT PERMIT # 3040200102R1
JW OPERATING COMPANY
SOUTHEAST REGIONAL LANDFILL
SELMA, CALIFORNIA
APRIL 6, 1993

PARAMETER	RUN # 1	RUN # 2	RUN # 3	AVG	Permit Limit
Nitrogen Oxide (NO_x)					
ppm	82.33	89.66	81.41	84.47	
lb/hr	0.83	0.90	0.83	**0.85**	.90
lb/day	19.92	21.60	19.92	20.48	
Carbon Monoxide (CO)					
ppm	159.56	179.18	175.36	171.37	
lb/hr	0.98	1.10	1.09	**1.05**	1.29
lb/day	23.52	26.40	26.16	25.36	
Oxygen (O_2)					
%	13.60	13.02	13.09	13.24	
Sulfur Dioxide (SO_2)					
ppm	0.02	<0.01	<0.01	<0.02	
lb/hr	<0.01	<0.01	<0.01	**<0.01**	.04
lb/day	<0.24	<0.24	<0.24	<0.24	
Non-methane Hydrocarbons (NMHC)					
ppm	3.19	5.06	~~575.25~~	194.50	
lb/hr	0.01	0.02	~~2.01~~	[redacted]	.29
lb/day	0.24	0.48	~~48.24~~	16.32	
Lead (Pb)					
gr/dscf	9.93E-06	1.97E-06	--	5.95E-06	
lb/hr	1.18E-04	2.36E-05	--	7.06E-05	
lb/day	2.83E-03	5.66E-04	--	1.70E-03	

TABLE 2-2
VOC DATA SUMMARY
SUPERBURN # 1, DISTRICT PERMIT # 3040200102R1
JW OPERATING COMPANY
SOUTHEAST REGIONAL LANDFILL
SELMA, CALIFORNIA
APRIL 6, 1993

PARAMETER	RUN # 1	RUN # 2	RUN # 3	AVG
Vinyl Chloride				
ppb	2.10E+00	4.80E+00	7.50E+00	4.80E+00
lb/hr	2.87E-05	6.55E-05	1.04E-04	6.60E-05
lb/day	6.89E-04	1.57E-03	2.49E-03	1.58E-03
Methylene Chloride				
ppb	2.60E+00	4.10E+00	4.90E+00	3.87E+00
lb/hr	4.82E-05	7.61E-05	9.20E-05	7.21E-05
lb/day	1.16E-03	1.83E-03	2.21E-03	1.73E-03
1,2-Dichloroethane				
ppb	<1.20E+00	<1.20E+00	<1.20E+00	<1.20E+00
lb/hr	<2.59E-05	<2.59E-05	<2.63E-05	<2.61E-05
lb/day	<6.22E-04	<6.22E-04	<6.31E-04	<6.25E-04
1,1,1-Trichloroethane				
ppb	<9.00E-01	<9.00E-01	<9.00E-01	<9.00E-01
lb/hr	<2.62E-05	<2.62E-05	<2.66E-05	<2.63E-05
lb/day	<6.29E-04	<6.29E-04	<6.38E-04	<6.32E-04
Benzene				
ppb	4.80E+01	1.10E+02	1.20E+02	9.27E+01
lb/hr	8.19E-04	1.88E-03	2.07E-03	1.59E-03
lb/day	1.97E-02	4.51E-02	4.97E-02	3.82E-02

TABLE 2-2 (cont.)
VOC DATA SUMMARY
SUPERBURN # 1, DISTRICT PERMIT # 3040200102R1
JW OPERATING COMPANY
SOUTHEAST REGIONAL LANDFILL
SELMA, CALIFORNIA
APRIL 6, 1993

PARAMETER	RUN # 1	RUN # 2	RUN # 3	AVG
Trichloroethylene				
ppb	<9.10E-01	<9.10E-01	1.30E+00	<1.04E+00
lb/hr	<2.61E-05	<2.61E-05	3.78E-05	<3.00E-05
lb/day	<6.26E-04	<6.26E-04	9.07E-04	<7.20E-04
Tetrachloroethylene				
ppb	3.10E+00	1.10E+00	4.20E+00	2.80E+00
lb/hr	1.12E-04	3.99E-04	1.54E-04	2.22E-04
lb/day	2.69E-03	9.58E-03	3.70E-03	5.32E-03
P-Xylene + M-Xylene				
ppb	2.00E+01	3.60E+01	3.60E+01	3.07E+01
lb/hr	4.64E-04	8.35E-04	8.45E-04	7.15E-04
lb/day	1.11E-02	2.09E-02	2.03E-02	1.74E-02
O-Xylene				
ppb	6.70E+00	1.10E+01	3.60E+01	7.10E+00
lb/hr	1.55E-04	2.55E-04	8.45E-04	4.19E-04
lb/day	3.72E-03	6.12E-03	2.03E-03	3.96E-03
Toluene				
ppb	5.00E+01	9.60E+01	9.80E+01	8.13E+01
lb/hr	1.01E-03	1.93E-03	2.00E-03	1.65E-03
lb/day	2.42E-02	4.63E-02	4.80E-02	3.95E-02

TABLE 2-3
NO_x AND CO DATA SUMMARY
SUPERBURN # 2, DISTRICT PERMIT # 3040200103R1
SUPERBURN # 3, DISTRICT PERMIT # 3040200104R1
JW OPERATING COMPANY
SOUTHEAST REGIONAL LANDFILL
SELMA, CALIFORNIA
APRIL 6, 1993

PARAMETER	SUPERBURN # 2	SUPERBURN # 3	Permit Limit
Nitrogen Oxide (NO_x)			
ppm	73.81	85.20	
lb/hr	[redacted]	[redacted]	.90
lb/day	13.92	20.64	
Carbon Monoxide (CO)			
ppm	236.74	210.92	
lb/hr	[redacted]	[redacted]	1.29
lb/day	27.36	30.96	
Oxygen (O_2)			
%	13.53	14.67	

SECTION 3

SAMPLING AND ANALYSIS PROCEDURES

SECTION 3

SAMPLING AND ANALYSIS PROCEDURES

Continuous Emissions Monitoring

Sample Extraction and Conditioning

Sampling is performed using a system which delivers a conditioned, continuous gas sample to the gas analyzers. The gas sample is extracted through a stainless steel probe, then passes through a heated (250^{O}F) Teflon sample line, a sample condenser (for moisture removal), an in-line filter (for particulate removal), and a stainless steel pump. The clean, dry sample is then transported via unheated Teflon line to the analyzer manifold (located within the mobile van) for sample distribution to the continuous emissions monitors.

Continuous Emissions Monitors (CEMS)

Table 3-1 describes the CEMS used in the mobile van to analyze the exhaust gases. Calibrations of the CEMS are performed using EPA Protocol 1 or NIST certified calibration gases. Copies of gas certifications are included in the Report appendix.

Prior to performing the emissions testing, a leak check of the sample system is performed. A check of sampling system bias is performed by injecting calibration gas (for each parameter) at the sample probe and then observing instrument response. A response within $\pm$ 5 percent of instrument range is considered acceptable. The leak check is repeated at the conclusion of the test day to verify the validity of the tests.

Before each test run, an initial calibration of the analyzers is performed by introducing zero and span gases and making appropriate adjustments. During each test run, analyzer response data is recorded for each instrument. At the conclusion of the test run, a calibration check is performed to verify acceptable zero and span drift limits.

TABLE 3-1
CEM INSTRUMENT SPECIFICATIONS
CEM VAN # 3

PARAMETER	MANUFACTURER	MODEL NO.	ANALYZER PRINCIPLE	SENSITIVITY / ACCURACY	LINEARITY	SPECIAL NOTES	RESPONSE TIME	NOISE	PRECISION
O_2	MSA Instruments	4000	Electroconductivity Detection	+- 0.01%	< 2%	Galvanic Fuel Cell	90% Full Scale in 20 sec.	+- 1%	
CO_2	Infrared Industries	732	Non-Dispersive Infrared		< 2%		90% Full Scale in 20 sec.		
NO_x	Thermo Environmental Instruments Inc.	10	Chemiluminescent	0.05 ppm	+- 1% from 0.05 to 10,000	High range has 0_2 feed.	Approx. 1.5 sec NO mode Approx. 1.7 sec NO_x mode	< 1% of Full Scale	
CO	Thermo Environmental Instruments Inc.	48	Gas Filter Correlation	0.1 ppm	< +- 1%		95% Full Scale in < 60 sec.	< 0.05 ppm	> +- 0.1ppm
Gas Dilution System	Environics, Inc.	Series 2000	Computerized Mass Flow Controllers	+-0.05% Full Scale	NA	Operated between 10% and 90% of flow controller full scale operating range.	+-2.0% of target flow in 30 seconds	NA	+-0.2% Full Scale
CO_2 / High CO	Fuji - Milton Roy	ZRH	Non-Dispersive Infrared	2% of Full Scale / week	1% of Full Scale	CO_2 Range : 0-20 % CO Range : 0-1 %	90% Full Scale in 3 sec.	< 0.5% of Full Scale	CO_2: .5% Full Scale CO: 1% Full Scale

Inorganic Lead (EPA Method 12)

General

Inorganic lead emissions testing is conducted in accordance with EPA guidelines published in 40 CFR, Ch.1, Part 60, App.A, Method 12. Particulate and gaseous lead is withdrawn isokinetically from the source and collected on a glass fiber filter and in dilute nitric acid. Collected samples are digested in acid solution and analyzed by atomic absorption spectrometry using an air acetylene flame.

Sampling Train

Isokinetic sampling is performed using a nozzle with a calibrated tip diameter. The heated sampling probe is equipped with a calibrated S-type Pitot tube and a calibrated thermocouple to measure stack velocity, pressure, and temperature. The filter holder contains a 90-mm Whatman 934 AH glass fiber filter. The impinger train is kept in an icebath. Impingers 1 and 2 contain 100 milliliters of 0.1N Nitric Acid (HNO_3), impinger 3 is empty, and impinger 4 contains a tared amount of silica gel. The impingers are weighed before and after sampling to allow calculation of percent moisture in the gas stream. The probe and sample box are connected to the control module using an umbilical line. The control module consists of a vacuum pump, a calibrated dry gas meter, and a calibrated orifice meter. The control module components measure pressure, temperature, and flowrate throughout the train.

Sampling Procedure

A leak check is performed before sampling begins by heating the sample train and bringing it to 15-inches of mercury vacuum. Leakage has to be less than 0.02 cfm or 4% of the average sampling rate prior to beginning a test. A leak check is also performed on the S-type Pitot tube. The stack is then traversed using the predetermined test point locations in each test port. An isokinetic sampling rate is established for each test point throughout the test. After sampling is complete, a final leak check is performed on both the train and S-type Pitot tube. This leak check is performed at 15-inches of mercury vacuum or at the highest vacuum achieved during the test. All pertinent data is recorded on field data sheets.

Sample Recovery

The nozzle and probe are brushed and rinsed with 0.1N HNO_3. The rinses are collected into a labeled polyethylene sample bottle. The 90-mm filter is carefully removed and placed back into its labeled petri dish and sealed. Each impinger is removed from the icebath, wiped dry, and weighed to allow calculation of percent moisture in the gas stream. A polyethylene bottle labeled as BHW is used to collect the contents of the impingers and the 0.1N HNO_3 rinses of the impingers, connectors, and the filter holder. A chain-of-custody form is filled out with sample numbers for tracking purposes.

Sample Analysis for Lead

A spectrophotometer is used to determine the absorbance for each sample, the filter blank, and the 0.1N HNO_3 blank. Each sample is analyzed three times in this manner with the average value reported. Appropriate dilutions are made, as required, to bring all sample Pb concentrations into the linear absorbance range of the calibrated spectrophotometer. All spikes, duplicates, and linearity checks are performed as specified in the method.

Volatile Organic Compounds (CARB Methods 410A/422/106 and EPA Method 18)

Sampling and analysis was performed in accordance with CARB Methods 106 (Vinyl Chloride), 410A (Benzene, Toluene, and Xylenes), and 422 (all other listed VOC compounds), and EPA Method 18 (Methane and non-methane hydrocarbons). Integrated samples are collected through a 316 stainless steel probe and teflon line directly into a new Tedlar bag by utilizing an evacuated chamber to draw the exhaust gas into the bag. The Tedlar bags are purged twice with the exhaust gas before collecting each sample. At the conclusion of sampling, the Tedlar bag is closed off, labeled, and delivered to the laboratory along with a chain-of-custody form. The samples were analyzed by Gas Chromatography / Mass Spectrophotometer (GG/MS) utilizing thermal desorption/cryogenic concentration for Vinyl Chloride, Benzene, Toluene, Xylene, 1,2-Dichloroethane, Methylene Chloride, Tetrachloroethane, 1,1,1-Trichloroethane, and Trichloroethylene. In addition, the samples were analyzed for Methane and Non Methane Hydrocarbons in accordance with EPA Method 18 by Gas Chromatography (GC).

Sulfur Dioxide (EPA Method 6)

General

Sulfur dioxide (SO_2) emissions testing is conducted in accordance with EPA guidelines published in 40 CFR, Ch. 1, Part 60, App. A, Method 6. A gas sample was extracted from the sampling point in the stack. Sulfuric acid mist (including sulfur trioxide) and the sulfur dioxide are separated. The sulfur dioxide fraction is measured by the barium-thorin titration method.

Sampling Train

Sampling is performed using a heated glass sample probe, approximately 6-mm inside diameter, equipped with a heated filter to remove particulate matter. The sampling train has one midget bubbler with a medium-coarse glass frit and glass wool packed in the top to prevent sulfuric acid mist carryover, and three 30 ml midget impingers. The midget bubbler contains 15 ml of 80 percent isopropanol. The first two midget impingers contain 15 ml of 3 percent hydrogen peroxide. The third midget impinger is dry.

Sampling Procedure

A leak check is performed before sampling begins by heating the sample train and bringing it to 10-inches of mercury vacuum. Leakage must be less than 0.02 lpm. A sample rate of 1 lpm is maintained for the duration of the test. After sampling is complete, a final leak check is performed. This leak check is performed at 10-inches of mercury vacuum. All pertinent data is recorded on field data sheets. At the conclusion of each test run, the ice bath is drained and the sample train is purged with clean ambient air for 15 minutes at the sampling rate.

Sample Recovery

The bubbler and impingers are disconnected after purging. The contents of the midget bubbler are recovered separately from the midget impingers. Each portion is poured into a separate leak-free polyethylene bottle for shipment. The bubbler and impingers are rinsed with water and added to the appropriately labeled sample bottle. The fluid level is marked on each sample bottle. A chain-of-custody form is filled out with sample numbers for tracking purposes. Samples are kept chilled after recovery and during transportation to the laboratory for analysis.

Sample Analysis for Sulfur Dioxide

The peroxide sample is transferred to a 100 ml volumetric flask, brought to volume, and an aliquot is titrated using the barium-thorin titration method.

SECTION 4

CALCULATIONS

NOMENCLATURE

A_s	= Cross-sectional area of stack (ft^2)
A_n	= Cross-sectional area of nozzle (ft^2)
B_{ws}	= Water vapor in the gas stream, proportion by volume (dimensionless)
C_p	= Pitot tube coefficient (dimensionless)
dH	= Average pressure differential across the orifice meter (inches of water)
Md	= Dry molecular weight of stack gas (lb/lb-mole)
Ms	= Wet molecular weight of stack gas (lb/lb-mole)
N	= Normality of titrant (milliequivalents/ml)
dP	= Velocity pressure of stack gas (inches of water)
Pb	= Barometric pressure at sampling site (in. Hg)
Ps	= Absolute stack gas pressure (in. Hg)
Pstd	= Standard absolute pressure (29.92 in. Hg)
Qs(std)	= Dry volumetric stack gas flow rate, standard conditions (dscfm)
Ts	= Stack temperature (^oF)
Vm	= Dry gas volume as measured by dry gas meter (dcf)
Vm(std)	= Dry gas volume as measured by dry gas meter, corrected to standard conditions (dscf)
Vw(std)	= Volume of water vapor in the gas stream, corrected to standard conditions (scf)
Vlc	= Volume of water vapor condensed in impingers and silica gel (ml)
T(std)	= Standard temperature (^oF)
Tm	= Meter temperature (^oF)
SQ.RT.dP	= Square root of velocity pressure (dimensionless)
y	= Dry gas meter calibration factor (dimensionless)
Pstatic	= Static pressure of stack (in. H_2O)
Pstack	= Static pressure of stack (in. Hg)
I	= Isokinetic sample rate (percent)
vs	= Average velocity of the stack gas (ft/sec)
Qs	= Actual stack gas flow rate at stack conditions (ft^3/min)
Θ	= Total sampling time (min)
% O_2	= Percent oxygen by volume (dry basis)
% CO_2	= Percent carbon dioxide by volume (dry basis)
% CO	= Percent carbon monoxide by volume (dry basis)
% N_2	= Percent nitrogen by volume (dry basis)
Zcf	= Zero drift correction factor
Scf	= Span drift correction factor
Cz	= Zero correction concentration
MW	= Molecular weight (lb/lb-mole)
ppm	= Parts per million by volume

lb/MMBtu	= Emission concentration, pounds per million British thermal units
dscf/MMBtu	= Fuel factor, dry standard cubic feet per million British thermal units
gr/scf	= Emission concentration, grains per standard cubic foot
lb/hr	= Emission rate, pounds per hour
FHW	= Front Half Wash of sampling train
MF	= Mass Filter of sampling train
BHW	= Back Half Wash of Sampling train
gr/dscf	= Emission concentration, grains per dry standard cubic foot
ng	= Mass unit, nanograms
mg	= Mass unit, milligrams
g	= Mass unit, grams
ml	= Unit of volume, milliliters
L	= Unit of volume, liters
ul	= Unit of volume, microliters
H_2SO_4	= Chemical formula, sulfuric acid
$BaCl_2$	= Chemical formula, barium chloride
NaOH	= Chemical formula, sodium hydroxide
H_2S	= Chemical formula, hydrogen sulfide
FHS	= Front Half Sulfate of sampling train
BHS	= Back Half Sulfate of sampling train
F-Factor	= Fuel factor, volume of generated gases per unit of heat content (dscf/MMBtu)
^oF	= Degrees Fahrenheit
^oR	= Degrees Rankine
^oC	= Degrees Celsius
98.076	= Molecular weight of sulfuric acid
64.062	= Molecular weight of sulfur dioxide
46.006	= Molecular weight of nitrogen dioxide
28.010	= Molecular weight of carbon monoxide
60	= Conversion factor, minutes per hour
460	= Conversion factor, ^oF to ^oR
15.432	= Conversion factor, grains per gram
0.000143	= Converson factor, pounds per grain
32/98.076	= Conversion factor, equivalent weight of SO_2 to MW of H_2SO_4
1.60982	= Ideal Gas Law (lb-mole x dscf/ dscf/ ^oR x mg)
0.00000137	= Ideal Gas Law (lb-mole x $^oR/ft^3$)
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
18.0	= Molecular weight of H_2O
32.064	= Equivalent weight of SO_2
85.49	= Pitot tube constant, ft/sec x $[(lb/lb\text{-}mole) \times (in.Hg)/((^oR) \times (in.H_2O))]^{0.5}$
8.223E-05	= Ideal gas constant (1.37E-06 lb-mole $^oR/ft^3$) x (60 min/hr)

EMISSION CALCULATIONS
GAS COMPONENTS

JW OPERATING
SUPERBURN # 1

DATA :

	Run 1	Run 2	Run 3	Average
Date	06-Apr-93	06-Apr-93	06-Apr-93	
Oxygen (%)	13.60	13.02	13.09	13.24
Qs(std), dscfm	1,381	1,381	1,398	1,387
F-Factor, dscf/MMBtu	9,035.41	9,035.41	9,035.41	9,035.41
NOx, ppm	82.33	89.66	81.41	84.47
CO, ppm	159.56	179.18	175.36	171.37
SO2, ppm				
HC (non-methane), ppm				

CALCULATIONS :

	Run 1	Run 2	Run 3	Average
NOx, lb/hr	0.83	0.90	0.83	0.85
NOx, ppm @ 3 %O2	201.79	203.55	186.67	197.34
NOx, lb/MMBtu	0.2582	0.2605	0.2389	0.2525
CO, lb/hr	0.98	1.10	1.09	1.05
CO, ppm @ 3 %O2	391.08	406.79	402.10	399.99
CO, lb/MMBtu	0.3047	0.3169	0.3133	0.3117
SO2, lb/hr				
SO2, ppm @ 3 %O2				
SO2, lb/MMBtu				
HC, lb/hr				
HC, ppm @ 3 %O2				
HC, lb/MMBtu				

EQUATIONS :

lb/hr = (0.00000137 Lb-Mole °R / ft3) x 60 min/hr x Qs(std) x MW x ppm / [T(std) + 460]

ppm @ 3 %O2 = ppm measured x [(20.9 - 3 %O2) / (20.9 - %O2 measured)]

lb/MMBtu = F-Factor x MW x [(1.3711E-6 Lb-Mole °R / ft3) / (T(std) + 460)] x [20.9 / (20.9 - O2%)] x ppm

---

CONSTANTS :

Standard Temp. T(std): 60 °F
Oxygen Correction : 3 % O2

NOx, MW = 46.005 lb/lb-mole
CO, MW = 28.010 lb/lb-mole
SO2, MW = 64.058 lb/lb-mole
HC, MW = 16.043 lb/lb-mole

EMISSION CALCULATIONS
GAS COMPONENTS

JW OPERATING
SUPERBURN # 3

DATA :

	Run 4	Average
Date	06-Apr-93	
Oxygen (%)	14.67	14.67
Qs(std), dscfm	1,382	1,382
F-Factor, dscf/MMBtu	9,035.41	9,035.41
NOx, ppm	85.20	85.20
CO, ppm	210.92	210.92
SO2, ppm		
HC (non-methane), ppm		

CALCULATIONS :

	Run 4	Average
NOx, lb/hr	0.86	0.86
NOx, ppm @ 3 %O2	244.94	244.94
NOx, lb/MMBtu	0.3135	0.3135
CO, lb/hr	1.29	1.29
CO, ppm @ 3 %O2	606.37	606.37
CO, lb/MMBtu	0.4724	0.4724
SO2, lb/hr		
SO2, ppm @ 3 %O2		
SO2, lb/MMBtu		
HC, lb/hr		
HC, ppm @ 3 %O2		
HC, lb/MMBtu		

EQUATIONS :

lb/hr = (0.00000137 Lb-Mole °R / ft3) x 60 min/hr x Qs(std) x MW x ppm / [T(std) + 460]

ppm @ 3 %O2 = ppm measured x [(20.9 – 3 %O2) / (20.9 – %O2 measured)]

lb/MMBtu = F-Factor x MW x [(1.3711E-6 Lb-Mole °R / ft3) / (T(std) + 460)] x [20.9 / (20.9 – O2%)] x ppm

---

CONSTANTS :

Standard Temp. T(std): 60 °F
Oxygen Correction : 3 % O2

NOx, MW = 46.005 lb/lb-mole
CO, MW = 28.010 lb/lb-mole
SO2, MW = 64.058 lb/lb-mole
HC, MW = 16.043 lb/lb-mole

EMISSION CALCULATIONS
GAS COMPONENTS

JW OPERATING
SUPERBURN # 2

DATA :

	Run 5	Average
Date	06-Apr-93	
Oxygen (%)	13.53	13.53
Qs(std), dscfm	1,087	1,087
F-Factor, dscf/MMBtu	9,035.41	9,035.41
NOx, ppm	73.81	73.81
CO, ppm	236.74	236.74
SO2, ppm		
HC (non-methane), ppm		

CALCULATIONS :

	Run 5	Average
NOx, lb/hr	0.58	0.58
NOx, ppm @ 3 %O2	179.36	179.36
NOx, lb/MMBtu	0.2295	0.2295
CO, lb/hr	1.14	1.14
CO, ppm @ 3 %O2	575.28	575.28
CO, lb/MMBtu	0.4482	0.4482
SO2, lb/hr		
SO2, ppm @ 3 %O2		
SO2, lb/MMBtu		
HC, lb/hr		
HC, ppm @ 3 %O2		
HC, lb/MMBtu		

EQUATIONS :

lb/hr = (0.00000137 Lb-Mole °R / ft3) x 60 min/hr x Qs(std) x MW x ppm / [T(std) + 460]

ppm @ 3 %O2 = ppm measured x [(20.9 - 3 %O2) / (20.9 - %O2 measured)]

lb/MMBtu = F-Factor x MW x [(1.3711E-6 Lb-Mole °R / ft3) / (T(std) + 460)] x [20.9 / (20.9 - O2%)] x ppm

CONSTANTS :

Standard Temp. T(std): 60 °F
Oxygen Correction : 3 % O2

NOx, MW = 46.005 lb/lb-mole
CO, MW = 28.010 lb/lb-mole
SO2, MW = 64.058 lb/lb-mole
HC, MW = 16.043 lb/lb-mole

GAS ANALYZER DATA

JW OPERATING
SUPERBURN # 1

Date : 06-Apr-93
Run No. : 1

	O2, %		CO2, %		NOx, ppm		CO, ppm		SO2, ppm	
Point #	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading
1	13.63	13.63	6.44	6.44	71.56	71.66	154.86	154.78		
2	13.59	13.60	6.45	6.45	82.61	82.96	164.21	163.94		
3	13.58	13.60	6.46	6.46	84.78	85.39	158.25	157.82		
4	13.59	13.62	6.45	6.45	82.52	83.35	157.41	156.81		
5	13.59	13.63	6.45	6.45	76.99	77.99	151.63	150.89		
6	13.56	13.60	6.47	6.47	85.26	86.61	162.48	161.51		
7	13.51	13.56	6.51	6.51	86.52	88.15	165.85	164.68		
8	13.47	13.53	6.56	6.56	80.80	82.56	167.44	166.08		
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
MEAN :		13.60		6.47		82.33		159.56		

	O2	CO2	NOx	CO
Zero Check	0.00	0.00	0.00	0.00
Span Check	14.95	15.95	198.00	415.00
Initial Span Value	15.02	15.95	202.60	411.40
Drift, Percent	−0.5	0.0	−2.3	0.9
Zero Drift, Zcf	0.00000	0.00000	0.00000	0.00000
Span Drift, Scf	−0.00058	0.00000	−0.00284	0.00109

Drift, Percent = [(Span Check − Zero Check) − Calib. Gas] / Calib. Gas x 100

Zero Drift Correction Factor, Zcf = Zero Check / # of Readings

Span Drift Correction Factor, Scf = (% Drift / 100) / # of Readings

Cz, Zero Corr. Concentration = measured value − [Zcf x (Point # − 0.5)]

Drift Corrected Reading = Cz / [1 + (Scf x (Point # − 0.5))]

GAS ANALYZER DATA

JW OPERATING
SUPERBURN # 1

Date : 06-Apr-93
Run No. : 2

	O2, %		CO2, %		NOx, ppm		CO, ppm		SO2, ppm	
Point #	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading
1	12.99	12.98	7.23	7.23	90.27	90.36	180.40	180.38		
2	13.10	13.06	7.14	7.14	95.93	96.21	172.71	172.66		
3	13.07	13.01	7.20	7.20	89.13	89.56	179.30	179.22		
4	13.08	12.99	7.20	7.20	92.74	93.37	180.01	179.90		
5	13.11	13.00	7.20	7.20	86.00	86.75	185.40	185.25		
6	13.14	13.00	7.20	7.20	91.69	92.66	187.63	187.44		
7	13.23	13.07	7.15	7.15	79.52	80.52	170.78	170.58		
8	13.20	13.01	7.21	7.21	86.61	87.87	178.28	178.04		
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
MEAN :		13.02		7.19		89.66		179.18		

	O2	CO2	NOx	CO
Zero Check	0.00	0.00	0.00	0.00
Span Check	15.25	15.95	199.50	412.00
Initial Span Value	15.02	15.95	202.60	411.40
Drift, Percent	1.5	0.0	−1.5	0.1
Zero Drift, Zcf	0.00000	0.00000	0.00000	0.00000
Span Drift, Scf	0.00191	0.00000	−0.00191	0.00018

Drift, Percent = [(Span Check − Zero Check) − Calib. Gas] / Calib. Gas x 100

Zero Drift Correction Factor, Zcf = Zero Check / # of Readings

Span Drift Correction Factor, Scf = (% Drift / 100) / # of Readings

Cz, Zero Corr. Concentration = measured value − [Zcf x (Point # − 0.5)]

Drift Corrected Reading = Cz / [1 + (Scf x (Point # − 0.5))]

GAS ANALYZER DATA

JW OPERATING
SUPERBURN # 1

Date : 06-Apr-93
Run No. : 3

	O2, %		CO2, %		NOx, ppm		CO, ppm		SO2, ppm	
	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading
Point #										
1	12.98	12.98	7.18	7.18	92.27	92.34	186.30	186.23		
2	13.02	13.02	7.16	7.17	88.39	88.60	186.06	185.84		
3	13.03	13.03	7.17	7.19	86.17	86.52	176.36	176.01		
4	13.13	13.13	7.06	7.08	78.72	79.16	172.59	172.11		
5	13.13	13.13	7.07	7.10	74.90	75.44	171.55	170.94		
6	13.11	13.11	7.07	7.10	75.20	75.87	174.06	173.31		
7	13.17	13.17	7.04	7.08	73.88	74.66	168.99	168.13		
8	13.18	13.18	7.06	7.11	77.71	78.66	171.31	170.30		
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
MEAN :		13.09		7.13		81.41		175.36		

	O2	CO2	NOx	CO
Zero Check	0.00	0.00	0.00	0.00
Span Check	15.02	15.84	200.00	414.00
Initial Span Value	15.02	15.95	202.60	411.40
Drift, Percent	0.0	−0.7	−1.3	0.6
Zero Drift, Zcf	0.00000	0.00000	0.00000	0.00000
Span Drift, Scf	0.00000	−0.00086	−0.00160	0.00079

Drift, Percent = [(Span Check − Zero Check) − Calib. Gas] / Calib. Gas x 100

Zero Drift Correction Factor, Zcf = Zero Check / # of Readings

Span Drift Correction Factor, Scf = (% Drift / 100) / # of Readings

Cz, Zero Corr. Concentration = measured value − [Zcf x (Point # − 0.5)]

Drift Corrected Reading = Cz / [1 + (Scf x (Point # − 0.5))]

GAS ANALYZER DATA

JW OPERATING
SUPERBURN # 3

Date : 06-Apr-93
Run No. : 4

	O2, %		CO2, %		NOx, ppm		CO, ppm		SO2, ppm	
Point #	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading
1	14.77	14.77	5.57	5.57	80.96	80.99	204.64	204.40		
2	14.65	14.65	5.61	5.61	83.58	83.68	205.54	204.83		
3	14.76	14.76	5.52	5.51	82.66	82.83	208.91	207.71		
4	14.71	14.71	5.62	5.61	83.01	83.25	217.16	215.42		
5	14.73	14.73	5.62	5.61	86.36	86.68	215.00	212.79		
6	14.62	14.62	5.62	5.61	86.66	87.06	216.91	214.19		
7	14.62	14.62	5.62	5.61	87.78	88.26	217.50	214.28		
8	14.53	14.53	5.67	5.65	88.27	88.82	217.40	213.70		
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
MEAN :		14.67		5.60		85.20		210.92		

	O2	CO2	NOx	CO
Zero Check	0.00	0.00	0.00	0.00
Span Check	15.02	16.00	201.25	419.00
Initial Span Value	15.02	15.95	202.60	411.40
Drift, Percent	0.0	0.3	−0.7	1.8
Zero Drift, Zcf	0.00000	0.00000	0.00000	0.00000
Span Drift, Scf	0.00000	0.00039	−0.00083	0.00231

Drift, Percent = [(Span Check − Zero Check) − Calib. Gas] / Calib. Gas x 100

Zero Drift Correction Factor, Zcf = Zero Check / # of Readings

Span Drift Correction Factor, Scf = (% Drift / 100) / # of Readings

Cz, Zero Corr. Concentration = measured value − [Zcf x (Point # − 0.5)]

Drift Corrected Reading = Cz / [1 + (Scf x (Point # − 0.5))]

GAS ANALYZER DATA

JW OPERATING
SUPERBURN # 2

Date : 06-Apr-93
Run No. : 5

	O2, %		CO2, %		NOx, ppm		CO, ppm		SO2, ppm	
Point #	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading	Instrument Reading	Drift Corrected Reading
1	13.73	13.73	6.54	6.54	69.22	69.15	237.68	237.68		
2	13.52	13.52	6.73	6.73	69.33	69.13	239.69	239.69		
3	13.59	13.59	6.69	6.68	70.20	69.86	238.25	238.25		
4	13.44	13.44	6.78	6.77	77.06	76.54	237.13	237.13		
5	13.36	13.36	6.90	6.89	82.96	82.24	250.18	250.18		
6	13.54	13.54	6.71	6.70	74.56	73.77	230.15	230.15		
7	13.51	13.51	6.71	6.69	76.16	75.21	231.86	231.86		
8	13.58	13.58	6.64	6.62	75.68	74.59	229.00	229.00		
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
MEAN :		13.53		6.70		73.81		236.74		

	O2	CO2	NOx	CO
Zero Check	0.00	0.00	0.00	0.00
Span Check	15.02	16.00	205.75	411.40
Initial Span Value	15.02	15.95	202.60	411.40
Drift, Percent	0.0	0.3	1.6	0.0
Zero Drift, Zcf	0.00000	0.00000	0.00000	0.00000
Span Drift, Scf	0.00000	0.00039	0.00194	0.00000

Drift, Percent = [(Span Check – Zero Check) – Calib. Gas] / Calib. Gas x 100

Zero Drift Correction Factor, Zcf = Zero Check / # of Readings

Span Drift Correction Factor, Scf = (% Drift / 100) / # of Readings

Cz, Zero Corr. Concentration = measured value – [Zcf x (Point # – 0.5)]

Drift Corrected Reading = Cz / [1 + (Scf x (Point # – 0.5))]

SO2 EMISSION CALCULATIONS

PLANT : JW OPERATING
SUPERBURN # 1

DATE : 06-Apr-93

Std. Temp. : 60 °F
Std. Pressure : 29.92 "Hg

F-Factor : 9,035 dscf/MMBtu

Run No.	Vm(std), dscf	lb/dscf	lb/MMBtu	ppm	ppm @3.0 %O2	lb/hr
1	40.845	3.03E-09	0.0001	0.02	0.04	0.00
2	39.832	0.00E+00	<0.0001	<0.01	<0.01	<0.01
3	39.873	0.00E+00	<0.0001	<0.01	<0.01	<0.01
Test Average	40.183	1.01E-09	<0.0001	<0.02	<0.02	<0.01

CALCULATIONS :

Vm(std), dscf = [T(std) + 460 / 29.92] x Vm x Y x (Pb + (dH / 13.6)) / (Tm + 460)

Lb/dscf = 7.061 E-05 lb/meq x [(Vt - Vtb) x N x (Vsoln / Va)] / Vm(std)

Lb/MMBtu = F-Factor x (lb/dscf) x [20.9 / (20.9 - %O2)]

ppm = lb/dscf x [6.024e6 ppm / (lb/dscf)]

ppm (Oxygen Corrected) = ppm x [(20.9 - Oxygen Corr.) / (20.9 - %O2 measured)]

Lb/hr = lb/dscf x dscfm x (60 min/hr)

EPA 6 WK3 PROGRAM

Company : JW OPERATING
Source/Unit : SUPERBURN # 1
Date : 06-Apr-93
Oxygen Corr.: 3.0 percent
F-Factor : 9,035 dscf/MMBtu
Std. Temp. : 60 dF

FIELD DATA, RUNS 1-6

	RUN 1	RUN 2	RUN 3	RUN	RUN	RUN
Meter Temp., Tm (dF)	85.70	87.60	97.30			
dH (in. H2O)	1.30	1.30	1.30			
Meter Vol.,Vm (ft3)	41.8300	41.0300	41.9240			
Meter Y	1.009	1.009	1.006			
Bar. Press.,Pb (in.Hg.)	30.29	30.22	30.22			
Oxygen, O2 (%)	13.60	13.02	13.09			
Gas Flow Rate, dscfm	1381	1381	1398			

PAGE DOWN FOR RUNS 7-12 FIELD DATA

FIELD DATA, RUNS 7-12

	RUN 7	RUN 8	RUN 9	RUN 10	RUN 11	RUN 12
Meter Temp., Tm (dF)						
dH (in. H2O)						
Meter Vol.,Vm (ft3)						
Meter Y						
Bar. Press.,Pb (in.Hg.)						
Oxygen, O2 (%)						
Gas Flow Rate, dscfm						

PAGE DOWN FOR LABORATORY RESULTS

LABORATORY RESULTS

	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5	RUN 6
Sample Volume, ml	100	100	100			
Sample Aliquot, ml	20	20	20			
Volume of Titer, ml	0.10	0.08	0.08			
Volume of Titer Blank, ml	0.08	0.08	0.08			

RUN 7	RUN 8	RUN 9	RUN 10	RUN 11	RUN 12

EMISSION CALCULATIONS – gr/dscf
MULTIPLE METALS

JW OPERATING
SUPERBURN # 1

06–Apr 93

Sample Weight (mg)

Run #	Arsenic	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Zinc	0 Barium
1					3.40E–02						
2					7.00E–03						
3											
Average					2.05E–02						
Blank					< 1.40E–02						

Emission Concentration (gr/dscf)

Run #	Arsenic	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Zinc	0 Barium
1					1.00E–05						
2					1.99E–06						
3											
Average					6.01E–06						
Blank					< 4.05E–06						

Sample Weight (mg)

Run #
1
2
3
Average
Blank

Emission Concentration (gr/dscf)

1
2
3
Average
Blank

" < " indicates a sample with a non–detectable concentration. Laboratory Detection Limit was used for emission calculation.

gr/dscf = 0.015432 grains/mg x mg / Vm(std)

	Run 1	Run 2	Run 3	Blank Value (avg)
Vm(std), ft³ =	52.322	54.337		53.329

EMISSION CALCULATIONS – lb/hr
MULTIPLE METALS

JW OPERATING
SUPERBURN # 1

06–Apr 93

Emission Concentration (gr/dscf)

Run #	Arsenic	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Zinc	Barium
1					1.00E–05						
2					1.99E–06						
3											
Average					6.01E–06						
Blank					< 4.05E–06						

Emission Rate (lb/hr)

Run #	Arsenic	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Zinc	Barium
1					1.19E–04						
2					2.38E–05						
3											
Average					7.12E–05						
Blank					< 4.82E–05						

Emission Concentration (gr/dscf)

Run #
1
2
3
Average
Blank

Emission Rate (lb/hr)

Run #
1
2
3
Average
Blank

" < " indicates a sample with a non–detectable concentration. Laboratory Detection Limit was used for emission calculation.

lb/hr = 0.00014286 lb/grain x 60 min/hr x gr/dscf x Qs(std)

	Run 1	Run 2	Run 3	Blank Value (Average)
Qs(std), ft³/min =	1,380	1,397		1,389

EMISSION CALCULATIONS – lb/MMBtu
MULTIPLE METALS

JW OPERATING
SUPERBURN # 1

06–Apr 93

gr/dscf

Run #	Arsenic	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Zinc	Barium
1					1.00E–05						
2					1.99E–06						
3											
Average					6.01E–06						
Blank					< 4.05E–06						

Emission Concentration (lb/MMBtu)

Run #	Arsenic	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Zinc	Barium
1					3.71E–05						
2					6.87E–06						
3											
Average					2.20E–05						
Blank					< 9.11E–06						

gr/dscf

Run #
1
2
3
Average
Blank

Emission Concentration (lb/MMBtu)

Run #
1
2
3
Average
Blank

" < " indicates a sample with a non–detectable concentration. Laboratory Detection Limit was used for emission calculation.

lb/MMBtu = F–Factor x 0.00014286 lb/grain x [20.9 / (20.9 – O2 %)] x gr/dscf

	Run 1	Run 2	Run 3	Blank
F–Factor, dscf/MMBtu =	9,035.41	9,035.41		9,035.41

EMISSION CALCULATIONS – mg/dscm
MULTIPLE METALS

JW OPERATING
SUPERBURN # 1

06–Apr 93

mg Sample

Run #	Arsenic	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Zinc	Barium
1					3.40E–02						
2					7.00E–03						
3											
Average					2.05E–02						
Blank					< 1.40E–02						

Emission Concentration (mg/dscm)

Run #	Arsenic	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Zinc	Barium
1					2.29E–02						
2					4.55E–03						
3											
Average					1.37E–02						
Blank					< 9.27E–03						

mg Sample

Run #
1
2
3
Average
Blank

Emission Concentration (mg/dscm)

Run #
1
2
3
Average
Blank

" < " indicates a sample with a non–detectable concentration. Laboratory Detection Limit was used for emission calculation.

mg/dscm = mg / [Vm(std) x 0.028317 m3/ft3]

	Run 1	Run 2	Run 3	Blank Value (avg)
Vm(std), ft^3 =	52.322	54.337		53.329

FIELD DATA SUMMARY

JW OPERATING
SUPERBURN # 1

06-Apr-93

	Run 1	Run 2
Vlc, Volume of water vapor condensed in impingers and silica gel	85.0	90.0
Vm, Dry gas volume as measured by dry gas meter (dcf)	54.099	55.250
y, Dry gas meter calibration factor (dimensionless)	0.988	0.988
Pb, Barometric Pressure at sampling site (in. Hg)	30.22	30.28
Ps, Absolute stack gas pressure (in. Hg.)	30.24	30.30
dH, Average pressure differential across the orifice meter (in. H2O)	2.05	2.04
Tm, Meter temperature (dR)	539.21	531.30
Vm(std), Dry gas volume as measured by dry gas meter, corrected to standard conditions (dscf)	52.322	54.337
Bws, Water vapor in the gas stream, proportion by volume (dimensionless)	0.070	0.071
%CO2, Percent carbon dioxide by volume (dry basis)	6.47	7.13
%O2, Percent oxygen by volume (dry basis)	13.60	13.09
Md, Dry molecular weight of stack gas (lb/lb-mole)	29.58	29.66
Ms, Wet molecular weight of stack gas (lb/lb-mole)	28.77	28.83
Cp, Pitot tube coefficient (dimensionless)	0.84	0.84
Sq.Rt. dP, Average square root of velocity pressure of stack gas (in. of H2O)	0.6361	0.6511
Ts, Stack temperature (dR)	1069.63	1090.6
As, Cross-sectional area of stack (ft2)	0.994	0.994
Qs(std), Dry volumetric stack gas flow rate, standard conditions (dscfm)	1,380	1,397
An, Cross-sectional area of nozzle (ft2)	5.98E-04	5.98E-04
Ø, Total sampling time (min)	60.0	60.0
I, Isokinetic sample rate (percent)	105.10	107.83

SOURCE TEST CALCULATIONS

JW OPERATING
SUPERBURN # 1

06–Apr 93
Run No. 1

FIELD DATA

Standard Temperature, T(std)	60	°F	Standard Pressure, Pstd	29.92	"Hg
Meter Temperature, Tm	79.2	°F	Static Pressure, Pstatic	0.21	"H2O
Stack Temperature, Ts	609.6	°F	Barometric Pressure, Pb	30.22	"Hg
SQ.RT. dP	0.6361		Condensate Volume, Vlc	85.0	mℓ
Meter Orfice, dH	2.05	"H2O	Stack I.D.	13.50	inch
Meter Volume, Vm	54.099	ft3	Duct Length	0.00	inch
Meter Correction, y	0.9880		Duct Width	0.00	inch
Stack Gas Oxygen	13.60	% O2	Stack Area, As	0.994	ft2
Stack Gas Carbon Dioxide	6.47	% CO2	Test Time, Ø	60.0	min.
Stack Gas Carbon Monoxide	0.00	% CO	Nozzle Diameter	0.331	inch
Stack Gas Nitrogen	79.93	% N2	Pitot Coefficient, Cp	0.84	

CALCULATIONS

Vm(std) = [T(std) + 460 / Pstd] x Vm x y x (Pb + (dH / 13.6)) / (Tm + 460)	52.322	dscf
Vw(std) = (8.9148E−05) x [T(std) + 460] x Vlc	3.940	scf
Bws = Vw(std) / [Vm(std) + Vw(std)]	0.070	
Bws @ Saturated Conditions = Vapor Press. of H2O @ Dew Point Temp. / (Pstack, in.Hg.)	Lower Bws Value Used 1.000	
% Excess Air = (%O2 − 0.5%CO) / [0.264%N2 − (%O2−0.5%CO)] x 100		%
Md = (0.44 x %CO2)+(0.32 x %O2)+[0.28 x (%N2 + %CO)]	29.58	lb/lb−mole
Ms = (Md x (1−Bws)) + (18.0 x Bws)	28.77	lb/lb−mole
P(stack) = Pb + [Pstatic / 13.6]	30.24	"Hg
vs = 85.49 x Cp x (Sq.Rt. dP) x [Sq.Rt.(Ts + 460) / (Ms x P(stack))]	50.65	ft/sec
Qs = vs x As x 60	3,021	acfm
Qs(std) = Qs x (1 − Bws) x [(T(std) + 460) / (Ts + 460)] x (P(stack) / Pstd)	1,380	dscfm
Area of sampling nozzle, An = [(Dn / 12)^2 x Pi] / 4	0.000598	ft2
I = (Ts+460) x [(0.002669 x Vlc) + [Vm(std) / ((T(std) + 460) / Pstd)]] x 100 / [Ø x P(stack) x An x vs x 60]	105.10	%

SOURCE TEST CALCULATIONS

JW OPERATING
SUPERBURN # 1

06–Apr 93
Run No. 2

FIELD DATA

Standard Temperature, T(std)	60	°F	Standard Pressure, Pstd	29.92	"Hg
Meter Temperature, Tm	71.3	°F	Static Pressure, Pstatic	0.21	"H2O
Stack Temperature, Ts	630.6	°F	Barometric Pressure, Pb	30.28	"Hg
SQ.RT. dP	0.6511		Condensate Volume, Vlc	90.0	mℓ
Meter Orfice, dH	2.04	"H2O	Stack I.D.	13.50	inch
Meter Volume, Vm	55.250	ft3	Duct Length	0.00	inch
Meter Correction, y	0.9880		Duct Width	0.00	inch
Stack Gas Oxygen	13.09	% O2	Stack Area, As	0.994	ft2
Stack Gas Carbon Dioxide	7.13	% CO2	Test Time, Ø	60.0	min.
Stack Gas Carbon Monoxide	0.00	% CO	Nozzle Diameter	0.331	inch
Stack Gas Nitrogen	79.78	% N2	Pitot Coefficient, Cp	0.84	

CALCULATIONS

Vm(std) = [T(std) + 460 / Pstd] x Vm x y x (Pb + (dH / 13.6)) / (Tm + 460)	54.337	dscf
Vw(std) = (8.9148E–05) x [T(std) + 460] x Vlc	4.172	scf
Bws = Vw(std) / [Vm(std) + Vw(std)]	0.071	
Bws @ Saturated Conditions = Vapor Press. of H2O @ Dew Point Temp. / (Pstack, in.Hg.)	Lower Bws Value Used 1.000	
% Excess Air =(%O2 – 0.5%CO) / [0.264%N2 – (%O2–0.5%CO)] x 100		%
Md = (0.44 x %CO2)+(0.32 x %O2)+[0.28 x (%N2 + %CO)]	29.66	lb/lb–mole
Ms = (Md x (1–Bws)) + (18.0 x Bws)	28.83	lb/lb–mole
P(stack) = Pb + [Pstatic / 13.6]	30.30	"Hg
vs = 85.49 x Cp x (Sq.Rt. dP) x [Sq.Rt.(Ts + 460) / (Ms x P(stack))]	52.24	ft/sec
Qs = vs x As x 60	3,116	acfm
Qs(std) = Qs x (1 – Bws) x [(T(std) + 460) / (Ts + 460)] x (P(stack) / Pstd)	1,397	dscfm
Area of sampling nozzle, An = [(Dn / 12)^2 x Pi] / 4	0.000598	ft2
I = (Ts+460) x [(0.002669 x Vlc) + [Vm(std) / ((T(std) + 460) / Pstd)]] x 100 / [Ø x P(stack) x An x vs x 60]	107.83	%

ANALYTICAL SUMMARY
MULTIPLE METALS

JW OPERATING
SUPERBURN # 1

06-Apr 93

SAMPLE WEIGHT (mg)

Run #	Arsenic	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Zinc	Barium
1					0.03400						
2					0.00700						
3											
Blank					ND						

ANALYTICAL DETECTION LIMIT (mg)

Run #	Arsenic	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Zinc	Barium
1											
2											
3											
Blank					0.014						

SAMPLE WEIGHT (mg)

Run #
1
2
3
Blank

ANALYTICAL DETECTION LIMIT (mg)

Run #
1
2
3
Blank

JW OPERATING
SUPERBURN # 1

ANALYTICAL SUMMARY
MULTIPLE METALS

06-Apr 93

Analytical Detection Limit (mg)

Run #	Arsenic	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Zinc	Barium
1											
2											
3											
Blank					0.014						

In-Stack Detection Limit (mg/dscm)

Run #	Arsenic	Beryllium	Cadmium	Copper	Lead	Manganese	Mercury	Nickel	Selenium	Zinc	Barium
1											
2											
3											
Blank					0.00001						

Analytical Detection Limit (mg)

Run #	Metal 12	Metal 13	Metal 14	Metal 15	Metal 16	Metal 17	Metal 18	Metal 19	Metal 20	Metal 21	Metal 22
1											
2											
3											
Blank											

In-Stack Detection Limit (mg/dscm)

Run #	Metal 12	Metal 13	Metal 14	Metal 15	Metal 16	Metal 17	Metal 18	Metal 19	Metal 20	Metal 21	Metal 22
1											
2											
3											
Blank											

mg/dscm In-Stack Detection Limit = mg Analytical Detection Limit / [Vm(std) x 0.028317 m3/ft3]

Run 1 Run 2 Run 3 Blank Value (avg)

EMISSION CALCULATIONS
HYDROCARBON COMPOUNDS

JW Operating / Southeast Regional Landfill
Superburn # 1
April 6, 1993

Hydrocarbon Compound		Molecular Weight	Molecular Formula	Laboratory Analysis, ppm as HC compound *			ppm HC as methane *		
				Run 1	Run 2	Run 3	Run 1	Run2	Run 3
C_1	Methane	16.04	CH_4	1203	1894	2197	1203.00	1894.00	2197.00
C_2	Ethane	30.07	C_2H_6	1.7	2.7	200	3.19	5.06	374.94
C_3	Propane	44.09	C_3H_8			61.8			169.87
C_4	Butane	58.12	C_4H_{10}			8.4			30.44
C_5	Pentane	72.15	C_5H_{12}						
C_6	Hexane	86.17	C_6H_{14}						
C_6+	as Hexane	86.17	C_6H_{14}						

	Run 1	Run 2	Run 3	Average	
Stack Parameters					
Stack Gas Oxygen, %	13.60	13.02	13.09	13.24	
Stack Gas Flowrate, dscfm	1,381	1,381	1,398	1,387	
F-Factor, dscf/MMBtu	9,035	9,035	9,035	9,035.41	
Total Hydrocarbons, THC as methane					
ppm	1206.19	1899.06	2772.25	1959.17	C_1-C_6+ HC
ppm @ Oxygen Correction	2957.64	4313.86	6353.81	4541.77	
lb/hr	4.22	6.65	9.71	6.86	
lb/MMBtu	1.3196	1.9248	2.8098	2.0181	
Reactive Organic Compounds, ROC as methane					
ppm	3.19	5.06	575.25	194.50	C_2-C_6+ HC
ppm @ Oxygen Correction	7.81	11.50	1318.43	445.91	
lb/hr	0.01	0.02	2.01	0.68	
lb/MMBtu	0.0035	0.0051	0.5830	0.1972	

Oxygen Correction : 3.0 %
Standard Temperature = 60 °F

Equations

HC corrected to methane, ppm = (MW of HC Compound / MW of Methane) x ppm value

ppm @ Oxygen Correction = ppm measured x [(20.9 – Oxygen Correction) / (20.9 – %Oxygen Measured)]

lb/hr = (0.00000137 lb–mole dR / ft3) x 60 min/hr x Qs(std) x (MW of Methane) x ppm / [T(std) + 460)]

lb/MMBtu = F–Factor x (MW of Methane) x [(1.3711E–06 lb–mole dR/ft3) / [T(std) + 460)] x [20.9 / 20.9 – O2%)] x ppm

VOLATILE ORGANIC COMPOUNDS
ANALYTICAL DATA

JW OPERATING
SUPERBURN # 1

06–Apr –93

VOC Compound	Molecular Weight	Sample Concentration (ppb) Run 1	Run 2	Run 3	Detection Limit (ppb) Run 1	Run 2	Run 3
Vinyl Chloride	62.500	2.1	4.8	7.5			
Hexane	86.170						
1,3–Butadiene	54.091						
Methylene Chloride	84.933	2.6	4.1	4.9			
Chloroform	119.378						
1,2–Dichloroethane	98.960	ND	ND	ND	1.2	1.2	1.2
1,1,1–Trichloroethane	133.405	ND	ND	ND	0.9	0.9	0.9
Benzene	78.113	48	110	120			
Carbon Tetrachloride	153.823						
Trichloroethylene	131.389	ND	ND	1.3	0.91	0.91	
1,2–Dibromoethane	187.862						
Tetrachloroethylene	165.834	3.1	11	4.2			
P–Xylene + M–Xylene	106.167	20	36	36			
Ethylbenzene	106.167						
O–Xylene	106.167	6.7	11	36			
Toluene	92.140	50	96	98			

VOLATILE ORGANIC COMPOUNDS
EMISSION CALCULATIONS (lb/hr)

JW OPERATING
SUPERBURN # 1

06–Apr –93

VOC	Molecular	Sample Concentration (ppb)			lb/hr			
Compound	Weight	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3	Average
Vinyl Chloride	62.500	2.10E+00	4.80E+00	7.50E+00	2.87E–05	6.55E–05	1.04E–04	6.60E–05
Hexane	86.170							
1,3–Butadiene	54.091							
Methylene Chloride	84.933	2.60E+00	4.10E+00	4.90E+00	4.82E–05	7.61E–05	9.20E–05	7.21E–05
Chloroform	119.378							
1,2–Dichloroethane	98.960	<1.20E+00	<1.20E+00	<1.20E+00	<2.59E–05	<2.59E–05	<2.63E–05	<2.61E–05
1,1,1–Trichloroethane	133.405	<9.00E–01	<9.00E–01	<9.00E–01	<2.62E–05	<2.62E–05	<2.66E–05	<2.63E–05
Benzene	78.113	4.80E+01	1.10E+02	1.20E+02	8.19E–04	1.88E–03	2.07E–03	1.59E–03
Carbon Tetrachloride	153.823							
Trichloroethylene	131.389	<9.10E–01	<9.10E–01	1.30E+00	<2.61E–05	<2.61E–05	3.78E–05	<3.00E–05
1,2–Dibromoethane	187.862							
Tetrachloroethylene	165.834	3.10E+00	1.10E+01	4.20E+00	1.12E–04	3.99E–04	1.54E–04	2.22E–04
P–Xylene + M–Xylene	106.167	2.00E+01	3.60E+01	3.60E+01	4.64E–04	8.35E–04	8.45E–04	7.15E–04
Ethylbenzene	106.167							
O–Xylene	106.167	6.70E+00	1.10E+01	3.60E+01	1.55E–04	2.55E–04	8.45E–04	4.19E–04
Toluene	92.140	5.00E+01	9.60E+01	9.80E+01	1.01E–03	1.93E–03	2.00E–03	1.65E–03

" < " indicates a sample with a non–detectable concentration. Laboratory Detection Limit was used for emission calculation.

lb/hr = (0.00000137 Lb–Mole °R / ft3) x 60 min/hr x Qs(std) x MW x (ppb / 1000) / [T(std) + 460]

Standard Temperature = 60 °F

	Run 1	Run 2	Run 3
Qs(std), ft3/min =	1,381	1,381	1,398

VOLATILE ORGANIC COMPOUNDS
EMISSION CALCULATIONS (lb/MMBtu)

JW OPERATING
SUPERBURN # 1

06–Apr –93

VOC Compound	Molecular Weight	lb/hr Run 1	lb/hr Run 2	lb/hr Run 3	lb/MMBtu Run 1	lb/MMBtu Run 2	lb/MMBtu Run 3	lb/MMBtu Average
Vinyl Chloride	62.500	2.87E–05	6.55E–05	1.04E–04	1.10E–05	2.26E–05	3.71E–05	2.36E–05
Hexane	86.170							
1,3–Butadiene	54.091							
Methylene Chloride	84.933	4.82E–05	7.61E–05	9.20E–05	1.84E–05	2.63E–05	3.30E–05	2.59E–05
Chloroform	119.378							
1,2–Dichloroethane	98.960	<2.59E–05	<2.59E–05	<2.63E–05	<9.92E–06	<8.96E–06	<9.41E–06	<9.43E–06
1,1,1–Trichloroethane	133.405	<2.62E–05	<2.62E–05	<2.66E–05	<1.00E–05	<9.06E–06	<9.51E–06	<9.53E–06
Benzene	78.113	8.19E–04	1.88E–03	2.07E–03	3.13E–04	6.48E–04	7.43E–04	5.68E–04
Carbon Tetrachloride	153.823							
Trichloroethylene	131.389	<2.61E–05	<2.61E–05	3.78E–05	<9.99E–06	<9.02E–06	1.35E–05	<1.08E–05
1,2–Dibromoethane	187.862							
Tetrachloroethylene	165.834	1.12E–04	3.99E–04	1.54E–04	4.30E–05	1.38E–04	5.52E–05	7.86E–05
P–Xylene + M–Xylene	106.167	4.64E–04	8.35E–04	8.45E–04	1.77E–04	2.88E–04	3.03E–04	2.56E–04
Ethylbenzene	106.167							
O–Xylene	106.167	1.55E–04	2.55E–04	8.45E–04	5.94E–05	8.81E–05	3.03E–04	1.50E–04
Toluene	92.140	1.01E–03	1.93E–03	2.00E–03	3.85E–04	6.68E–04	7.15E–04	5.89E–04

" < " indicates a sample with a non–detectable concentration. Laboratory Detection Limit was used for emission calculation.

lb/MMBtu = (lb/hr) / (MMBtu/hr)

	Run 1	Run 2	Run 3	Blank Value (avg)
Heat Input, MMBtu/hr =	2.62	2.90	2.79	2.77

FUEL BASED CALCULATIONS

JW OPERATING
SUPERBURN # 1

06-Apr-93

FUEL ANALYSIS DATA

Run #	Carbon	Hydrogen	Nitrogen	Oxygen	Sulfur	GCV BTU/lb,dry	ft3/lb	lb/gal
	Fuel Value (%), Moisture & Ash Free							
1	42.52	8.92	4.83	43.73	0.00	8,511	14.220	
2	42.52	8.92	4.83	43.73	0.00	8,511	14.220	
3	42.52	8.92	4.83	43.73	0.00	8,511	14.220	

CALCULATIONS

Run #	Stack Gas Oxygen %	Fuel Gas Flowrate lb/hr	Fuel Gas Flowrate ft3/hr	Fuel Oil Flowrate lb/hr	Fuel Oil Flowrate gal/hr	Solid Fuel lb/hr	Heat Input MMBTU/hr	F-Factor dscf/MMBTU	Qs(std) dscfm
1	13.60		4,369				2.615	9,035.41	
2	13.02		4,837				2.895	9,035.41	
3	13.09		4,664				2.792	9,035.41	

Heat Input, MMBTU/hr = (lb/hr fuel gas) x BTU/lb x MM/1E+06

= (ft3/hr fuel gas) x BTU/lb / (ft3/lb fuel gas) x MM/1E+06

= (lb/hr fuel oil) x BTU/lb x MM/1E+06

= (gal/hr fuel oil) x lb/gal x BTU/lb x MM/1E+06

= (lb/hr solid fuel) x BTU/lb x MM/1E+06

F-Factor, dscf/MMBTU = 1E+06 [(3.64 scf/lb)/% x (% H) + (1.53 scf/lb)/% x (% C) + (0.57 scf/lb)/% x (% S) + (0.14 scf/lb)/% x (% N) - (0.46 scf/lb)/% x (% O2)] / (BTU/lb) x [(Tstd + 460) / 528]

Qs(std), dscfm = MMBTU/hr x [F-Factor x (20.9 / (20.9 - %O2)) x (hr / 60 min)]

GCV = Gross Calorific Value of fuel, Btu/lb, dry

Standard Temperature = 60 °F

FUEL BASED CALCULATIONS

JW OPERATING
SUPERBURN # 2

06-Apr-93

FUEL ANALYSIS DATA

Run #	Carbon	Hydrogen	Nitrogen	Oxygen	Sulfur	GCV BTU/lb,dry	ft3/lb	lb/gal
	Fuel Value (%), Moisture & Ash Free							
5	42.52	8.92	4.83	43.73	0.00	8,511	14.220	

CALCULATIONS

Run #	Stack Gas Oxygen %	Fuel Gas Flowrate lb/hr	Fuel Gas Flowrate ft3/hr	Fuel Oil Flowrate lb/hr	Fuel Oil Flowrate gal/hr	Solid Fuel lb/hr	Heat Input MMBTU/hr	F-Factor dscf/MMBTU	Qs(std) dscfm
5	13.53		4,252				2.545	9,035.41	1,087

Heat Input, MMBTU/hr = (lb/hr fuel gas) x BTU/lb x MM/1E+06

= (ft3/hr fuel gas) x BTU/lb / (ft3/lb fuel gas) x MM/1E+06

= (lb/hr fuel oil) x BTU/lb x MM/1E+06

= (gal/hr fuel oil) x lb/gal x BTU/lb x MM/1E+06

= (lb/hr solid fuel) x BTU/lb x MM/1E+06

F-Factor, dscf/MMBTU = 1E+06 [(3.64 scf/lb)/% x (% H) + (1.53 scf/lb)/% x (% C) + (0.57 scf/lb)/% x (% S) + (0.14 scf/lb)/% x (% N) − (0.46 scf/lb)/% x (% O2)] / (BTU/lb) x [(Tstd + 460) / 528]

Qs(std), dscfm = MMBTU/hr x [F-Factor x (20.9 / (20.9 − %O2)) x (hr / 60 min)]

GCV = Gross Calorific Value of fuel, Btu/lb, dry

Standard Temperature = 60 °F

FUEL BASED CALCULATIONS

JW OPERATING
SUPERBURN # 3

06-Apr-93

FUEL ANALYSIS DATA

Run #	Carbon	Hydrogen	Nitrogen	Oxygen	Sulfur	GCV BTU/lb,dry	ft3/lb	lb/gal
	Fuel Value (%), Moisture & Ash Free							
4	42.52	8.92	4.83	43.73	0.00	8,511	14.220	

CALCULATIONS

Run #	Stack Gas Oxygen %	Fuel Gas Flowrate lb/hr	Fuel Gas Flowrate ft3/hr	Fuel Oil Flowrate lb/hr	Fuel Oil Flowrate gal/hr	Solid Fuel lb/hr	Heat Input MMBTU/hr	F-Factor dscf/MMBTU	Qs(std) dscfm
4	14.67		4,571				2.736	9,035.41	1,382

Heat Input, MMBTU/hr = (lb/hr fuel gas) x BTU/lb x MM/1E+06

= (ft3/hr fuel gas) x BTU/lb / (ft3/lb fuel gas) x MM/1E+06

= (lb/hr fuel oil) x BTU/lb x MM/1E+06

= (gal/hr fuel oil) x lb/gal x BTU/lb x MM/1E+06

= (lb/hr solid fuel) x BTU/lb x MM/1E+06

F-Factor, dscf/MMBTU = 1E+06 [(3.64 scf/lb)/% x (% H) + (1.53 scf/lb)/% x (% C) + (0.57 scf/lb)/% x (% S) + (0.14 scf/lb)/% x (% N) – (0.46 scf/lb)/% x (% O2)] / (BTU/lb) x [(Tstd + 460) / 528]

Qs(std), dscfm = MMBTU/hr x [F-Factor x (20.9 / (20.9 – %O2)) x (hr / 60 min)]

GCV = Gross Calorific Value of fuel, Btu/lb, dry

Standard Temperature = 60 °F

SECTION 5

QUALITY ASSURANCE

SECTION 5

QUALITY ASSURANCE

The report is reviewed for technical and editorial quality and for compliance with project requirements. Calculations are performed by computer programs designed for source testing. At least one set of calculations are performed manually to check results.

All equipment used in testing has been checked for proper maintenance and calibrated prior to testing. Test equipment calibrations are included in the Report appendix. The dry gas meter accuracy is expressed as gamma and is determined as the difference between the meter box dry gas meter and the wet test meter used for calibration. The results of the orifice calibration are expressed as the delta H@ (dH@) at various pressure drops (inches of water), as specified in EPA publication APTD-0576. EPA Quality Assurance Branch annual audits are performed with an orifice check of each of the dry gas meters used for volumetric sampling.

Exhaust gas, filter, meter and impinger temperatures are monitored using a type-K thermocouple connected to a digital readout. The temperature readout and thermocouples are calibrated against an NIST certified digital thermometer. The calibrations are performed every six months using the procedures specified in the EPA Quality Assurance Handbook For Air Pollution Measurement Systems, 600/4-77-027b, Volume III, Stationary Source Methods.

Exhaust gas velocity is monitored for establishing isokinetic sampling rates and volumetric flow using a S-type or Standard Pitot tube attached to the probe as specified in EPA Reference Method 2. An S-type Pitot tube calibration factor of 0.84 is used for calculating stack gas velocity. This standard reference number is applicable after the S-type Pitot tube passes a dimensional calibration test for construction specifications. Standard pitot tubes are constructed according to ASTM and EPA Method 2 design and are assigned a calibration factor of 0.99.

At the conclusion of each test run the sampling train is leak checked at a vacuum equal to or greater than the highest vacuum observed during the test. The sampling train is considered leak free if the leak rate is less than 0.02 CFM, or 4% of sampling rate, whichever is less.

The analyzers employed for continuous monitoring of NO_x, CO, SO_2, CO_2, O_2, and HC are California Air Resources Board (CARB) approved instruments. Sampling system bias checks of the continuous monitor sampling system are performed using either EPA protocol 1 or NIST certified calibration gases. Calibration certificates are included in the report. All other required checks of the continuous monitor system are also performed.

All field samples are labeled and logged in on a chain-of-custody sheet. Chain-of-custody sheets remain with samples and document sample movement. All laboratory data are recorded in bound laboratory notebooks. All analytical weights are conducted on a calibrated Sartorius digital balance. All particulate samples are conditioned and desiccated before weighing and a constant weight is defined as $\pm$0.5mg between consecutive weighings with an elapsed time between weighing greater than 6 hours. Wherever possible, duplicates and spikes are performed on the samples and a Quality Control check is performed. Applicable EPA Quality Assurance Branch audits such as SO_2 are performed. All analytical glassware used is NIST Class A. All reagents used in the field and in the laboratory are at least ACS reagent grade. Blanks of these reagents are evaluated for every set of tests.

SAMPLE SYSTEM BIAS CHECK

COMPANY: J W OPERATING DATE: 4-6-92

TEST LOCATION: UNIT 1, 2, 3 OPERATOR: JP

COMMENTS:

Parameter	Instrument Full Scale	Span Gas Value	Scale	Internal Response	System Response	Percent Difference
O_2 (%)	0-25	0.00	Zero	0.0		
		15.02	Upscale	15.02	14.93	-.36
CO_2 (%)	0-20	0.00	Zero	0.0		
		15.95	Upscale	16.0	15.7	-1.5
NOx (ppm)	0-250	0.00	Zero	0.0		
		202.6	Upscale	205.75	201.5	-1.7
CO (ppm)	0-500	0.00	Zero	0.0		
		411.4	Upscale	411.4	403	-1.68
SO_2 (ppm)		0.00	Zero			
			Upscale			
HC (ppm)		0.00	Zero			
			Upscale			
		0.00	Zero			
			Upscale			

Percent Difference = [(System Response – Internal Response) / Instrument Full Scale] x 100

DRY GAS METER AND ORIFICE CALIBRATION

Meter Box # Brown IV Barometric Press. 29.38 IN. HG.

Date 18-Jan-93 Performed by T. Delfino

Calibration Meter Y 1.00014

	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5	RUN 6
VACUUM ("Hg)	3	5	5	5	5	5
dHw ("H2O)	0.00	0.00	0.00	0.00	0.00	0.00
dHd ("H2O)	0.50	1.00	1.50	2.00	3.00	4.00
INITIAL WTM	866.883	873.433	931.482	833.099	947.264	977.798
FINAL WTM	873.178	931.327	946.881	866.342	977.357	1011.223
INITIAL DGM	918.813	925.631	986.853	884.158	3.643	36.108
FINAL DGM	925.371	986.665	1003.242	918.243	35.647	71.736
TEMP. WTM (°F)	62.0	58.0	58.0	59.0	57.0	57.0
TEMP. DGM (°F)	75.0	82.0	83.0	76.0	87.0	88.0
TEST TIME (MIN.)	15.0	101.0	22.0	41.0	31.0	30.0
CALCULATIONS :						
NET VOLUME WTM (Vw)	6.296	57.902	15.401	33.248	30.097	33.430
NET VOLUME DGM (Vd)	6.558	61.034	16.389	34.085	32.004	35.628
Y	0.983	0.990	0.981	1.002	0.988	0.985
ACCEPTABLE Y RANGE = 0.968 TO 1.008						
dH@	1.56	1.63	1.63	1.65	1.68	1.70
ACCEPTABLE dH@ RANGE = 1.49 TO 1.79						

AVERAGE Y = 0.988

AVERAGE dH@ = 1.64

CALCULATIONS :

Y = (Vw (Pb – (dHw / 13.6)) x (Td + 460)) / (Vd (Pb + (dHd / 13.6)) x (Tw + 460)

dH@ = 0.0317 x dHd / (Pb (Td + 460)) x ((Tw + 460) x time) / Vw) ^ 2

POST TEST METER CALIBRATION

Meter Box # Box No. BR IV   Barometric Press. 30.11 IN. HG.

Date 07-Apr-93   Performed by Gary McRae

	RUN 1	RUN 2	RUN 3
VACUUM ("Hg)	7	7	7
dHw ("H2O)	0.00	0.00	0.00
dHd ("H2O)	1.50	1.50	1.50
INITIAL WTM	61.883	68.677	75.459
FINAL WTM	68.677	75.459	82.249
INITIAL DGM	154.883	161.911	168.949
FINAL DGM	161.911	168.949	176.004
TEMP. WTM (°F)	63.0	64.0	65.0
TEMP. DGM (°F)	66.5	68.5	70.0
TEST TIME (MIN.)	10.0	10.0	10.0
CALCULATIONS :			
NET VOLUME WTM (Vw)	6.794	6.782	6.790
NET VOLUME DGM (Vd)	7.028	7.038	7.055
Y	0.970	0.968	0.968

AVERAGE Y = 0.969

PRETEST Y = 0.988

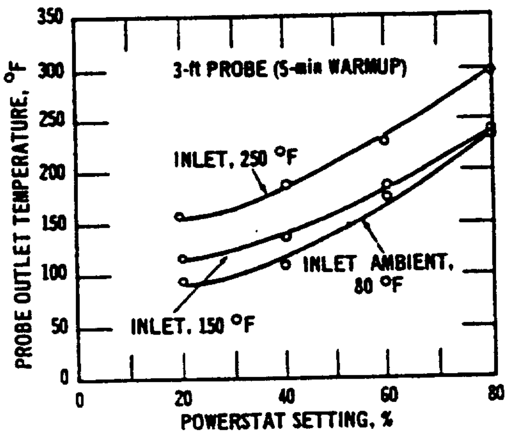
DIFFERENCE, % = 1.9%

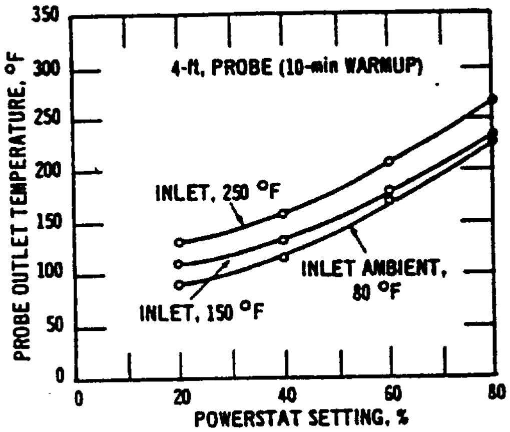
WHERE :

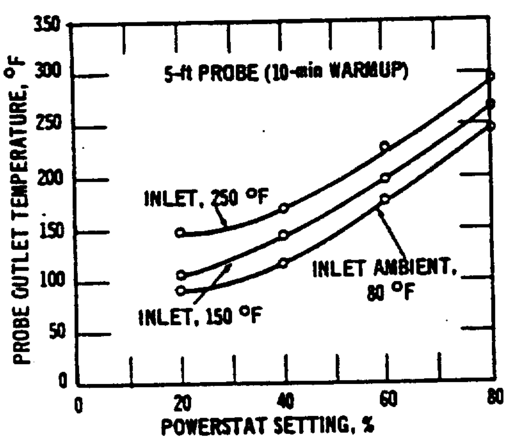
Y = (Vw (Pb – (dHw / 13.6)) x (Td + 460)) / (Vd (Pb + (dHd / 13.6)) x (Tw + 460))

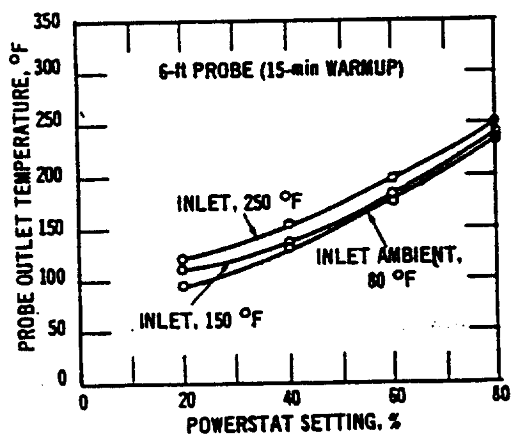
PROBE HEAT CALIBRATION

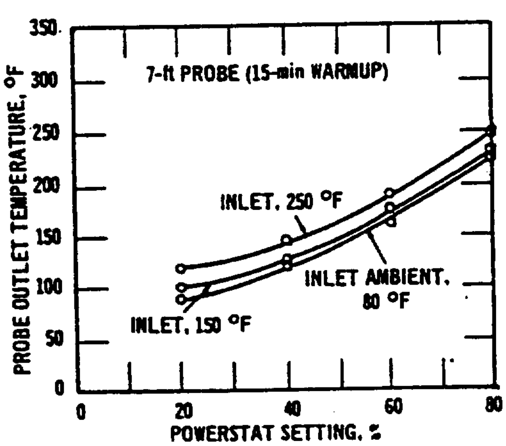
Sample probes are constructed as outlined in EPA publication PB–209 022 "Maintenance, Calibration, and Operation of Isokinetic Source Sampling Equipment". The Figures below from this publication are used to determine probe heat settings to maintain a probe temperature of 250 °F.







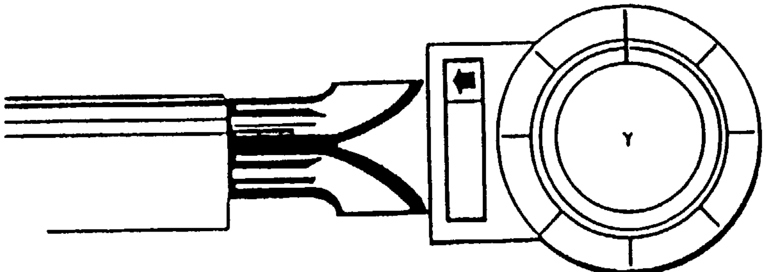




NOTE: Flow rate held constant at 0.75; 50% change in flow rate has little effect on probe temperature.

Pitot Tube Calibration

Serial No. BK010 Calibrated by B. McRae Date 6/18/92

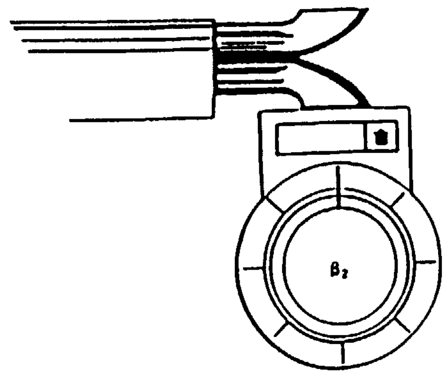


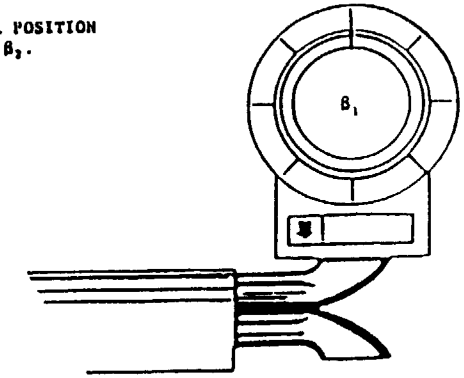
γ = 1.5 °

DEGREE INDICATING LEVEL POSITION FOR DETERMINING γ, THEN CALCULATING Z.

A = DISTANCE BETWEEN TIPS, $(P_a + P_b)$, cm. = 2.41.

Z = A sin γ = 0.06 cm; (<0.32 cm).

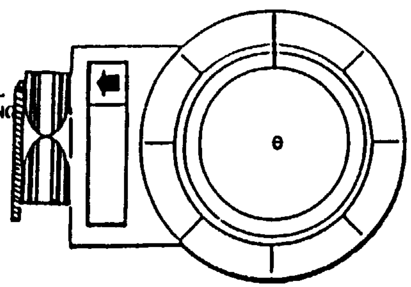




DEGREE INDICATING LEVEL POSITION FOR DETERMINING β_1 and β_2.

β_1 = 1.5 °(<5°)

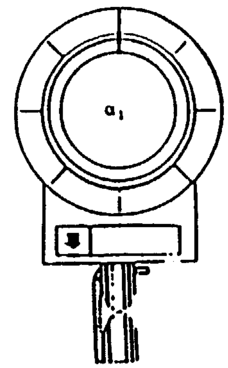
β_2 = 1.0 °(<5°)

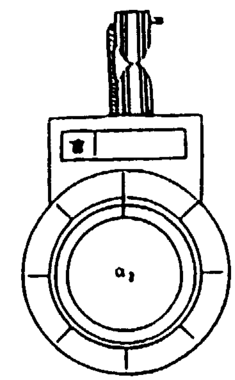


DEGREE INDICATING LEVEL POSITION FOR DETERMINING θ, THEN CALCULATING W.

θ = 1.0 °

W = A sin θ = 0.04 cm; (<0.08 cm).

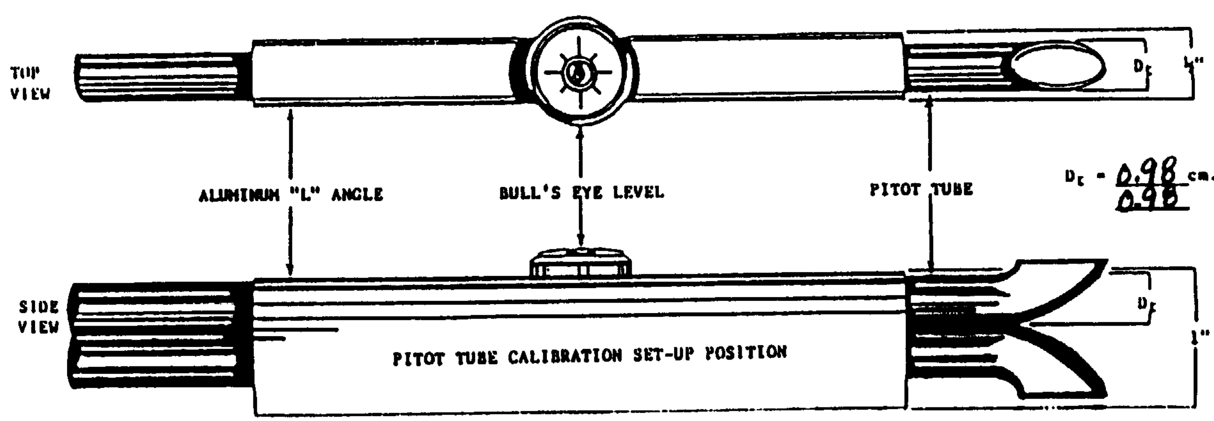




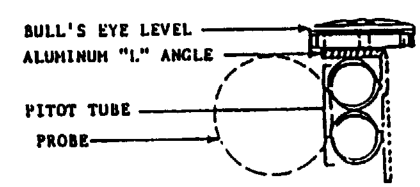
DEGREE INDICATING LEVEL POSITION FOR DETERMINING α_1 and α_2.

α_1 = 1.0 °(<10°)

α_2 = 1.5 °(<10°)



D_t = 0.98 cm. A
0.98 B



Thermometer / Pyrometer Calibration

Date : 18–Jan–93
Calibrated by : T. Delfino

I.D. : Brown IV Pyrometer

Reference Point #	Reference * Temperature °F	Pyrometer Temperature °F	Temperature difference ** %
1	10	10	0.00
2	32	33	−3.13
3	60	60	0.00
4	100	100	0.00
5	200	200	0.00
6	300	300	0.00
7	400	399	0.25
8	500	498	0.40
9	700	700	0.00
10	900	899	0.11
11	1000	998	0.20
12	1200	1197	0.25
13	1400	1396	0.29
14	1600	1595	0.31
15	1700	1693	0.41
16	1900	1895	0.26

* Digital Calibrator Thermometer, S/N 28494/991
−60 °F to 1999 °F

** Allowable % difference = 5 %

SINGER DRY GAS METER CALIBRATION

Meter Box #	V1, Model 280.01	Bar. Press.	29.62 IN. HG.
Meter Box I.D.	S/N 8263	Performed by	G. McRae
		Date :	19-Oct-92

Calibration Meter S/N M900487
Calibration Meter Y 0.99880

Pretest / Posttest

	RUN 1	RUN 2	RUN 3
ROTAMETER (liter/min)			
METER	3.0	2.0	1.0
ACTUAL	3.1	2.1	1.1
dHw ("H2O)	−0.04	−0.02	−0.01
dHd ("H2O)	4.20	2.45	1.38
INITIAL CAL. METER (WTM)	276.369	323.009	367.018
FINAL CAL. METER (WTM)	322.898	364.429	406.812
NET	46.529	41.420	39.794
INITIAL DGM	733.116	780.213	822.847
FINAL DGM	779.030	821.261	862.477
NET	45.914	41.048	39.630
TEMP. WTM (°F)	79.0	80.0	80.0
TEMP. DGM (°F)	84.0	84.0	84.0
TEST TIME (MIN.)	15.0	20.0	35.0
CALCULATIONS :			
NET VOLUME WTM (Vw)	46.473	41.370	39.746
NET VOLUME DGM (Vd)	45.914	41.048	39.630
Y	1.011	1.009	1.007
	ACCEPTABLE Y RANGE = 0.989 TO 1.029		

AVERAGE Y = $\boxed{1.009}$

CALCULATIONS :

Y = (Vw (Pb − (dHw / 13.6)) x (Td + 460)) / (Vd (Pb + (dHd / 13.6)) x (Tw + 460))

SINGER DRY GAS METER CALIBRATION

Meter Box #	VOC CONSOLE	Bar. Press.	30.11 IN. HG.
Meter Box I.D.	V1	Performed by	G. McRae
		Date :	07-Apr-93

Calibration Meter S/N M900487

Calibration Meter Y 0.99880

POST TEST

	RUN 1	RUN 2	RUN 3
ROTAMETER (liter/min)			
METER	3.0	2.0	1.0
ACTUAL	3.0	2.1	1.1
dHw ("H2O)	0.09	0.05	0.02
dHd ("H2O)	3.10	2.45	1.30
INITIAL CAL. METER (WTM)	862.248	923.367	964.909
FINAL CAL. METER (WTM)	922.411	964.638	987.032
NET	60.163	41.271	22.123
INITIAL DGM	208.058	269.056	311.374
FINAL DGM	268.218	311.045	334.028
NET	60.160	41.989	22.654
TEMP. WTM (°F)	63.0	65.0	67.0
TEMP. DGM (°F)	64.5	72.0	79.0
TEST TIME (MIN.)	20.0	20.0	20.0
CALCULATIONS :			
NET VOLUME WTM (Vw)	60.091	41.221	22.096
NET VOLUME DGM (Vd)	60.160	41.989	22.654
Y	**0.994**	**0.989**	**0.994**

ACCEPTABLE Y RANGE = 0.972 TO 1.012

AVERAGE Y = 0.992

PRETEST Y = 1.009

DIFFERENCE, % = 1.6 (5 % ALLOWABLE)

CALCULATIONS :

Y = (Vw (Pb – (dHw / 13.6)) x (Td + 460)) / (Vd (Pb + (dHd / 13.6)) x (Tw + 460)

Difference, % = [(Pretest – Posttest) / Pretest] x 100

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
ENGINEERING SCIENCE
2520 PEGAUS
BAKERSFIELD, CA 93308

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

Purchase Order WA346
Project # 24273.001

ANALYTICAL INFORMATION

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

Cylinder Number ALM008255 **Certification Date** 03/01/93 **Expiration Date** 09/01/93
Cylinder Pressure ~~1900 psig~~ **Previous Certification Dates** NONE

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
CARBON DIOXIDE	15.95 %	± 1 % NIST Traceable
OXYGEN	8.018 %	

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
CRM1675	10/93	ALM001136	14.02 %
CRM2658	05/94	ALM015888	9.656 %

INSTRUMENTATION

Instrument/Model/Serial #	Last Date Calibrated	Analytical Principle
Horiba / OPE-135C / 56553902	09/17/92	NDIR
Horiba / OPE-335 / 850557042	12/29/92	Magnetopneumatic

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

Components	First Triad Analysis	Second Triad Analysis	Calibration Curve
Carbon Dioxide	Date: 03/01/93 Response Units: mv Z1= 0.00 R1= 82.7 T1= 88.7 R2= 82.7 Z2= 0.00 T2= 88.7 Z3= 0.00 T3= 88.7 R3= 82.7 Avg. Conc. of Cust Cyl. 15.95 %	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration= $Ax^4+Bx^3+Cx^2+DX+E$ A =0.00000008 B =-0.00000895 C =0.001340700 D =0.0729330838 E =0.0027195015
Oxygen	Date: 03/01/93 Response Units: mv Z1= 0.00 R1= 95.7 T1= 80.3 R2= 95.1 Z2= 0.00 T2= 80.3 Z3= 0.00 T3= 80.3 R3= 95.7 Avg. Conc. of Cust Cyl. 8.018 %	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration= Ax + B A =0.99865981 B =-0.00162902
	Date: Response Units: Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Date: Response Units: Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=

Special Notes

Analyst Joseph De La Torre

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
ENGINEERING SCIENCE
2520 PEGAUS
BAKERSFIELD, CA 93308

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

Purchase Order WA346
Project # 24273.002

ANALYTICAL INFORMATION

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

Cylinder Number AAL12850 **Certification Date** 03/01/93 **Expiration Date** 09/01/93
Cylinder Pressure 2000 psig **Previous Certification Dates** NONE

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
CARBON DIOXIDE	7.862 %	± 1 % NIST Traceable
OXYGEN	15.02 %	

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
CRM1675	10/93	ALM001136	14.02 %
CRM2659	05/94	ALM017573	20.63 %

INSTRUMENTATION

Instrument/Model/Serial #	Last Date Calibrated	Analytical Principle
Horiba / OPE-135C / 56553902	08/19/92	NDIR
Horiba / OPE-335 / 850557042	12/28/92	Magnetopneumatic

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

Components	First Triad Analysis	Second Triad Analysis	Calibration Curve
Carbon Dioxide	Date: 03/01/93 Response Units: mv Z1= 0.00 R1= 82.7 T1= 57.6 R2= 82.7 Z2= 0.00 T2= 57.6 Z3= 0.00 T3= 57.6 R3= 82.7 Avg. Conc. of Cust Cyl. 7.862 %	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration= $Ax^4+Bx^3+Cx^2+DX+E$ A =0.000000083 B =-0.000008955 C =0.001340700 D =0.072933083 E =0.0027195015
Oxygen	Date: 03/01/93 Response Units: mv Z1= 0.00 R1= 82.6 T1= 60.1 R2= 82.6 Z2= 0.00 T2= 60.1 Z3= 0.00 T3= 60.1 R3= 82.6 Avg. Conc. of Cust Cyl. 15.02 %	Date: Response Units: mv Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration= Ax + B A =0.249921410 B =-0.004490785
	Date: Response Units: Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Date: Response Units: Z1= R1= T1= R2= Z2= T2= Z3= T3= R3= Avg. Conc. of Cust Cyl.	Concentration=

Special Notes

Analyst Joseph De La Torre

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
ENGINEERING SCIENCE
2520 PEGASUS
BAKERSFIELD, CA 93308-2200

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

Purchase Order BK034
Scott Project # 23659.002

ANALYTICAL INFORMATION

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

Cylinder Number ALM-035654 **Certification Date** 01-19-93 **Expiration Date** 08-93
Cylinder Pressure 1900psig **Previous Certification Dates** NONE

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
Carbon Monoxide	411.4 ppm	± 1 % NIST Traceable
Nitric Oxide	417.2 ppm	
NOX	417.2 ppm	
Balance Gas:	Nirogen	

*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
CRM1680	12-12-94	ALM013394	475.0 ppm
CRM1686b	09-93	AAL8564	480.2 ppm

INSTRUMENTATION

Instrument/Model/Serial #	Last Date Calibrated	Analytical Principle
Horiba / OPE-135D / 56565502	12-16-92	NDIRNDIR
TECO / 10AR / 14853-150	10-29-92	Chemi-Luminescent

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

Components | **First Triad Analysis** | **Second Triad Analysis** | **Calibration Curve**

Carbon Monoxide

First Triad Analysis — Date: 01-19-93 Response Units: MV

Z1= 0.00	R1= 57.6	T1= 51.2
R2= 57.6	Z2= 0.00	T2= 51.2
Z3= 0.00	T3= 51.3	R3= 57.6

Avg. Conc. of Cust Cyl. 411.7 ppm

Second Triad Analysis — Date: 01-26-93 Response Units: MV

Z1= 0.00	R1= 57.6	T1= 51.2
R2= 57.6	Z2= 0.00	T2= 51.2
Z3= 0.00	T3= 51.2	R3= 57.6

Avg. Conc. of Cust Cyl. 411.0 ppm

Calibration Curve — Concentration= Ax^3+Bx^2+Cx+D
A =0.0002154
B =0.01916
C =6.4896
D =-0.3895

Nitric Oxide

First Triad Analysis — Date: 01-19-93 Response Units: MV

Z1= 0.00	R1= 47.85	T1= 41.61
R2= 47.82	Z2= -0.01	T2= 41.59
Z3= 0.00	T3= 41.58	R3= 47.80

Avg. Conc. of Cust Cyl. 417.7 ppm

Second Triad Analysis — Date: 01-26-93 Response Units: MV

Z1= 0.00	R1= 48.21	T1= 41.85
R2= 48.20	Z2= 0.02	T2= 41.84
Z3= 0.02	T3= 41.84	R3= 48.23

Avg. Conc. of Cust Cyl. 416.8 ppm

Calibration Curve — Concentration= Ax^2+Bx+C
A =-0.0005043
B =1.0490
C =-0.2925

First Triad Analysis — Date: Response Units:

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

Avg. Conc. of Cust Cyl.

Second Triad Analysis — Date: Response Units:

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

Avg. Conc. of Cust Cyl.

Calibration Curve — Concentration=

Special Notes

Analyst Joseph De La Torre

Scott Specialty Gases, Inc.

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

CERTIFICATE OF ANALYSIS

ENGINEERING SCIENCE

P O BOX 2007

IRWINDALE CA 91706

PROJECT #: 02-20451
PO#: BK030
ITEM #: 02021453 2AL
DATE: 6/23/92

CYLINDER #: AAL8533 ANALYTICAL ACCURACY: +/-1%
FILL PRESSURE: 2000 PSIG

COMPONENT	REQUESTED GAS CONC MOLES	ANALYSIS (MOLES)
CARBON MONOXIDE	800. PPM	800.0 PPM
NITROGEN	BAL	BAL

ENGINEERING SCIENCE 6/23

ANALYST: F.V.
FRANK VILIMAS

APPROVED BY:
DR ARMAND LANGE PHD

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	Assay Laboratory	
Engineering Science	Scott Specialty Gases	Purchase Order BK042
ATTN: Jim Polhamus	2600 Cajon Boulevard	Project # 23951.002
2520 Pegasus	San Bernardino, CA 92411	
Bakersfield CA 93308		

ANALYTICAL INFORMATION

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

... Number: [illegible] Certification Date: 02-15-93 Expiration Date: 08-15-93

... Pressure ... Previous Certification Date: ...

ANALYZED CYLINDER

Components	Certified Concentration	Analytical Uncertainty*
Nitric Oxide	191.0 ppm	± 1 % NIST Traceable

Balance Gas: Nitrogen

NOX 282.6 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
[illegible]1685	02-94	AAL14213	248.0 ppm Nitric Oxide

INSTRUMENTATION

Instrument/Model/Serial #	Last Date Calibrated	Analytical Principle
[illegible]10AR 14853-150	1-29-93	Chemi-Luminescent

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

Components — **First Triad Analysis** — **Second Triad Analysis** — **Calibration Curve**

Nitric Oxide

First Triad Analysis		
Date: [illegible] Response Units: mv		
Z1= 0.00	R1= 96.46	T1= 75.34
R2= 96.39	Z2= 0.00	T2= 75.25
Z3= 0.00	T3= 75.22	R3= 96.42
Avg. Conc. of Cust Cyl. 191.2 ppm		

Second Triad Analysis		
Date: [illegible] Response Units: mv		
Z1= 0.00	R1= 96.46	T1= 75.20
R2= 96.68	Z2= 0.00	T2= 75.32
Z3= 0.00	T3= 75.30	R3= 96.65
Avg. Conc. of Cust Cyl. 190.8 ppm		

Calibration Curve: Concentration= Ax^2+Bx+C

A =-0.001564

B =2.6492

C =-0.068928

First Triad Analysis		
Date: Response Units: mv		
Z1=	R1=	T1=
R2=	Z2=	T2=
Z3=	T3=	R3=
Avg. Conc. of Cust Cyl.		

Second Triad Analysis		
Date: Response Units: mv		
Z1=	R1=	T1=
R2=	Z2=	T2=
Z3=	T3=	R3=
Avg. Conc. of Cust Cyl.		

Concentration=

First Triad Analysis		
Date: Response Units:		
Z1=	R1=	T1=
R2=	Z2=	T2=
Z3=	T3=	R3=
Avg. Conc. of Cust Cyl.		

Second Triad Analysis		
Date: Response Units:		
Z1=	R1=	T1=
R2=	Z2=	T2=
Z3=	T3=	R3=
Avg. Conc. of Cust Cyl.		

Concentration=

Special Notes

Analyst Joseph De La Torre

PROTOCOL

Scott Specialty Gases, Inc.

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

2600 CAJON BLVD., SAN BERNARDINO, CA 92411

ENGINEERING SCIENCE
2520 PEGASUS
BAKERSFIELD CA 93308

Shipped From: Scott SAN BERNARDII CA
Date Shipped 08/07/92
Our Project No: 20782
Your P.O. No: BFI0008
Page 1 of 1
Expiration Date: 2/94

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES

Certified Per Traceability Protocol No. 1 Procedure No. G1 Cylinder No. ALM011600 Cylinder Pressure 1820 PSIG Certified Accuracy ±1% % NIST Traceable

COMPONENTS	CERTIFIED CONC	REFERENCE STD: SRM/CRM NO.	CYL. NO.	CONC.	GAS ANALYZER: MAKE/MODEL/SERIAL NO.	LAST CAL DATE	ANALYTICAL PRINCIPLE
NITRIC OXIDE	795.7 PPM	CRM1687	ALM016039	965.5 PPM	THERMO-ELECTRON	07/30/92	CHEMI-LUMINESCENT
					10AR 14853-150		
NOX	814.7 PPM						

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

Component NITRIC OXIDE
First Analysis Date 07/31/92 Units mv

Z 0.00	R 95.00	T 78.39
R 95.00	Z 0.13	T 78.38
Z 0.05	T 78.45	R 94.95

Mean Test Assay 797.0 PPM

Second Analysis Date 08/06/92 Units mv

Z 0.00	R 94.90	T 77.98
R 94.50	Z 0.04	T 77.63
Z -0.03	T 77.72	R 94.19

Mean Test Assay 794.4 PPM

Component
Date Units mv
Z R T
R Z T
Z T R
Mean Test Assay
Date Units mv
Z R T
R Z T
Z T R
Mean Test Assay

Component
Date Units mv
Z R T
R Z T
Z T R
Mean Test Assay
Date Units mv
Z R T
R Z T
Z T R
Mean Test Assay

Chronology: Date
Assay

Analyst G. KING

Approved By: [signature]
A.F. LANGE, Ph.D., MANAGER, QA

Scott Specialty Gases, Inc.

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

2600 CAJON BLVD., SAN BERNARDINO, CA 92411

ENGINEERING SCIENCE
2520 PEGASUS
BAKERSFIELD, CA 93308-5003

Shipped From: Scott SAN BERNARDINO, CA
Date Shipped 10/5/92
Our Project No: 0221822
Your P.O. No: BKG0001
Page 1 of 1
Expiration Date: 4/94

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES

Certified Per Traceability Protocol No. 1 Procedure No. G1 Cylinder No. ALM027375 Cylinder Pressure 1800 PSIG Certified Accuracy ±1% % NIST Traceable

COMPONENTS	CERTIFIED CONC	REFERENCE STD SRM/CRM NO.	CYL. NO.	CONC.	GAS ANALYZER MAKE/MODEL/SERIAL NO.	LAST CAL. DATE	ANALYTICAL PRINCIPLE
CARBON DIOXIDE	3.994 %	SRM2626A	CAL-7539	3.9198%	HORIBA PRI2000 406004	6/3/92	INFRA RED
OXYGEN	4.002 %	CRM2657	AAL-20176	2.002 %	BECKMAN 755 100410	6/3/92	PARAMAGNETIC

BALANCE GAS NITROGEN

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

Component CARBON DIOXIDE
First Analysis Date 10/5/92 Units mv

Z 00.0	R 78.2	T 79.4
R 78.2	Z 00.0	T 79.4
Z 00.0	T 79.4	R 78.2

Mean Test Assay 3.994%

Second Analysis Date ______ Units mv

Z	R	T
R	Z	T
Z	T	R

Mean Test Assay ______

Component OXYGEN
Date 10/5/92 Units mv

Z 00.0	R 40.0	T 80.0
R 40.0	Z 00.0	T 80.0
Z 00.0	T 80.0	R 40.0

Mean Test Assay 4.002 %

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 F. VILLAMAS

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

ENGINEERING SCIENCE, INC.
2520 Pegasus Drive
Bakersfield, CA 93308
(805) 393-0272

#5105

CHAIN OF CUSTODY RECORD

Project No.	Project Name	Project Manager	Samples Sent To:
BK065	JW operating	Troy Delfino	oilwell Research BKFLD, CA
Samples Collected By: T Delfino	Regulatory Agency (EPA, CARB, SCAQMD, etc.) SJVUAPCD, Fresno Region		By: T. Delfino

ES Lab Control No.	Test Date	Field Sample ID (Method-Run#-Sample Source)	Sample Amount	Sample Medium	Comments	Analysis Required: CARB 410 A	EPA-18	[illegible]		
BK9304209	4-6-93	Integrated bag -1- Superburn engine			9301143	X	X			
BK9304210	↓	-2-			9301144	X	X			
BK9304211	↓	-3-			9301145	X	X			
BK9304212	4-6-93	grab bag -1- LANDFILL GAS Fuel line			Landfill gas			X		
					PERFORMANCE ANALYTICAL					

Relinquished By: (Sign & Print)	Date/Time	Received By: (Sign & Print)	Comments:
Troy Delfino Troy Delfino Phone: 393-0272	4-~~7~~-93/1125	Heather West Of:	
Victor V Martinez Victor V Martinez Phone: 392-8811	4/7/93 1215	Of: PAI	
Phone:		Of:	

ENGINEERING SCIENCE, INC.
2520 Pegasus Drive
Bakersfield, CA 93308
(805) 393-0272

CHAIN OF CUSTODY RECORD

Project No.	Project Name	Project Manager	Samples Sent To:
BK065	FW Operating Selma	T. Delfino	ES Bakersfield LAB
Samples Collected By: T. Delfino	Regulatory Agency (EPA, CARB, SCAQMD, etc.): SJVAPCD		By: T.D.

ES Lab Control No.	Test Date	Field Sample ID (Method-Run#-Sample Source)	Sample Amount	Sample Medium	Comments	Analysis Required: SO_2 EPA-6				
BK9304 221	4-6-93	EPA-6 -1- Superburn engine	Marked			X				
BK9304 222	↓	↓ -2- ↓	↓			X				
BK9304 223	↓	↓ -3- ↓	↓			X				
BK9304 224	↓	↓ -blank ↓	↓			X				

Relinquished By: (Sign & Print)	Date/Time	Received By: (Sign & Print)	Comments:
[signature] Troy Delfino Phone: 393-0272	4/7/93/1000	[signature] 4/12/93 Of:	
Relinquished By: (Sign & Print) Phone:	Date/Time	Received By: (Sign & Print) Of:	Comments:
Relinquished By: (Sign & Print) Phone:	Date/Time	Received By: (Sign & Print) Of:	Comments:

ENGINEERING SCIENCE, INC.
2520 Pegasus Drive
Bakersfield, CA 93308
(805) 393-0272

CHAIN OF CUSTODY RECORD

Project No.	Project Name	Project Manager	Samples Sent To:
BK065	J-W Operating	Troy Delfino	Oilwell Research BKFLD, CA

Samples Collected By	Regulatory Agency (EPA, CARB, SCAQMD, etc.)	
T. Delfino	SJVUAPCD, Fresno Region	By: T. Delfino

ES Lab Control No.	Test Date	Field Sample ID (Method-Run#-Sample Source)	Sample Amount	Sample Medium	Comments	Analysis Required: EPA-12 Inorganic Lead				
BK9304201	4-6-93	EPA 12 - 1 - Superburn Engine	1		Filter	X				
BK9304202		- 1 -	123 ml		Probe wash	X				
BK9304203		- 1 -	331 ml	added 50 ml	impingers	X				
BK9304204		- 2 -	1		Filter	X				
BK9304205		- 2 -	113 ml ~~[illegible]~~		Probe wash	X				
BK9304206		- 2 -	310 ml	added 107 ml	impingers	X				
BK9304207		- blank -	1		blank Filter	X				
BK9304208		- blank -	320 ml	~~320 ml~~	blank 0.1N HNO_3	X				

Relinquished By: (Sign & Print)	Date/Time	Received By: (Sign & Print)	Comments:
Troy Delfino Troy Delfino Phone: 393-0272	4-7-93/1125	Of: Heather West	
Relinquished By: (Sign & Print) Phone:	Date/Time	Received By: (Sign & Print) Of:	Comments:
Relinquished By: (Sign & Print) Phone:	Date/Time	Received By: (Sign & Print) Of:	Comments:

APPENDIX A

FIELD DATA

ENGINEERING–SCIENCE, INC.
CEM FIELD DATA SHEET

PLANT: JW OPERATING — CEM VAN NO. 3 — DATE: 4-6-93
TEST LOCATION: UNIT — OPERATOR: JP

O_2, % 0-25%
Calibration Gases :

	Value	Cyl. #
High	15.02	AAL12850
Mid	8.01	ALM008255
Low	4.002	ALM027375

CO_2, % 0-20%
Calibration Gases :

	Value	Cyl. #
High	15.95	ALM008255
Mid	7.862	AAL 12850
Low	3.994	ALM027375

NOx, ppm 0-1000ppm
Calibration Gases :

	Value	Cyl. #
High	814.7	ALM011600
Mid	417.2	ALM035654
Low	202.6	IL2596

CO, ppm 0-1000ppm
Calibration Gases :

	Value	Cyl. #
High	800	AAL8533
Mid	411.4	ALM035654
Low	84.71	ALM008231

SO_2, ppm
Calibration Gases :

	Value	Cyl. #
High		
Mid		
Low		

Calibration Gases :

	Value	Cyl. #
High		
Mid		
Low		

TIME	SAMPLE POINT	O2 (%)	CO2 (%)	NOx (ppm)	CO (ppm)	SO2 (ppm)		COMMENTS / RUN #
								Span gas values used for test.
								CALIBRATION
		0.0	0.0	0.0	0.0			ZERO ADJ
		15.02	15.95	814.7	800.0			SPAN ADJ
								LINEARITY ✓
		15.02	15.95		800.0			HIGH
		8.1	8.08		410.0			MID
		4.05	4.00		85.0			LOW
		0.0	0.0		0.0			ZERO
								CHANGE RANGE ON NOX & CO
								CO=0-500ppm, NOX=0-250ppm
								Calibration
				0.0	0.0			ZERO
				202.6	411.4			SPAN
								Leak ✓ @ 20"HG=0.0

ENGINEERING–SCIENCE, INC.
CEM FIELD DATA SHEET

PLANT JW OPERATING
TEST LOCATION UNIT 1
CEM VAN NO. 3
DATE 4-6-93
OPERATOR JP

TIME	SAMPLE POINT	O2 (%)	CO2 (%)	NOx (ppm)	CO (ppm)	SO2 (ppm)		COMMENTS / RUN #
		15.02	15.95	202.6	411.4			Span gas values used for test.
1000-1005		13.63	6.44	71.56	154.86			START RUN 1 UNIT 1
1005-1010		13.59	6.45	82.61	164.21			
1010-1015		13.58	6.46	84.78	158.25			
1015-1020		13.59	6.45	82.52	157.41			
1020-1025		13.59	6.45	76.99	151.63			
1025-1030		13.56	6.47	85.26	162.48			
1030-1035		13.51	6.51	86.52	165.85			
1035-1040		13.47	6.56	80.80	167.44			
Calibrate		0.0	0.0	0.0	0.0			ZERO check
		14.95	15.95	198	415			SPAN check
1110-1115		12.99	7.23	90.27	180.40			START RUN 2 UNIT 1
1115-1120		13.10	7.40	95.93	172.91			
1120-1125		13.07	7.20	89.13	179.30			
1125-1130		13.08	7.20	92.74	180.01			
1130-1135		13.11	7.20	86.0	185.40			
1135-1140		13.14	7.20	91.69	187.63			
1140-1145		13.23	7.15	79.52	170.78			
1145-1150		13.20	7.21	86.61	178.28			
Calibrate		0.0	0.0	0.0	0.0			zero check
		15.25	15.95	199.5	412			SPAN check
1315-1320		12.98	7.18	92.27	186.30			START RUN 3 UNIT 1
1320-1325		13.02	7.16	88.39	186.06			
1325-1330		13.03	7.17	86.17	176.36			
1330-1335		13.13	7.06	78.72	172.59			

ENGINEERING–SCIENCE, INC.
CEM FIELD DATA SHEET

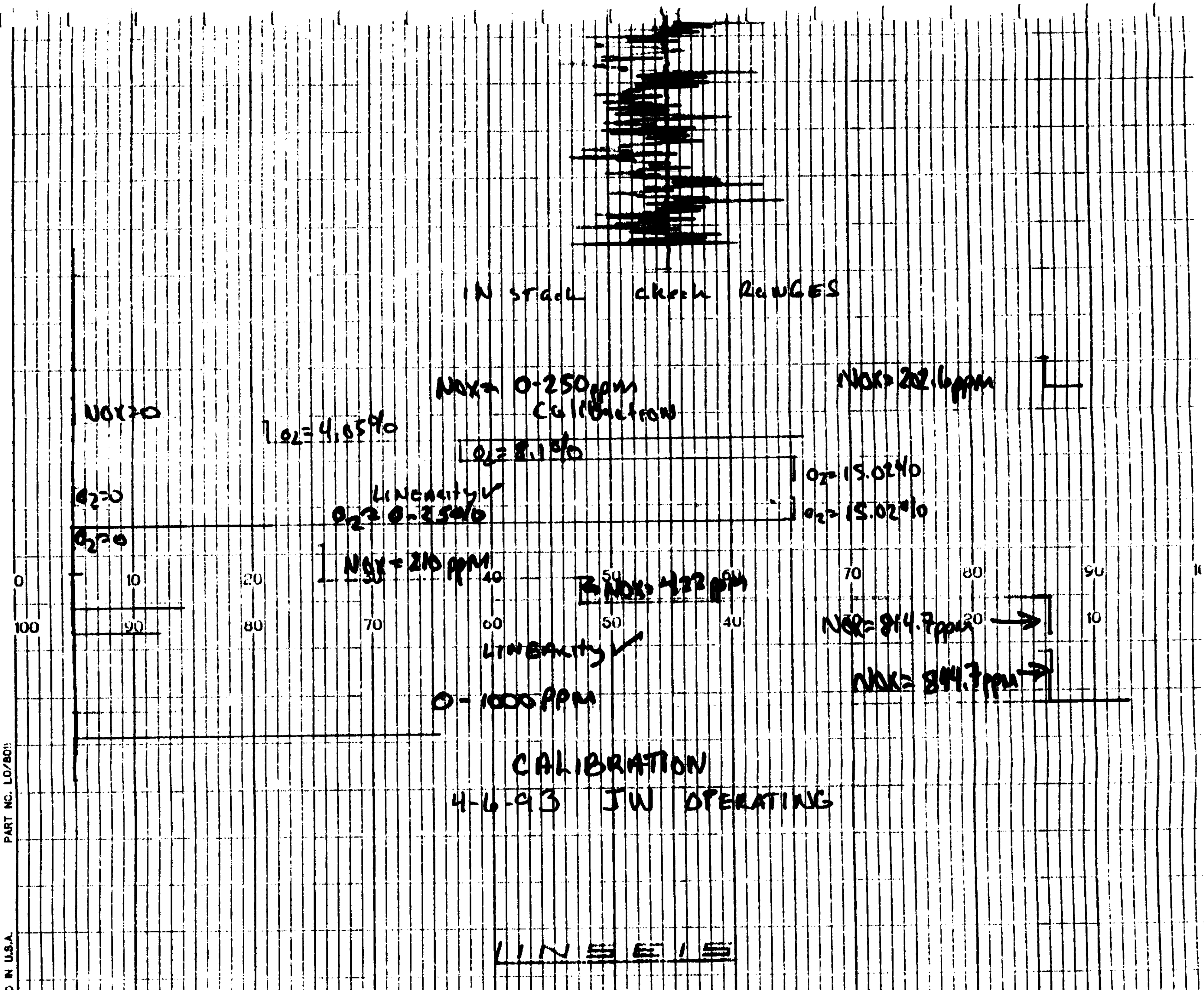
PLANT: JW OPERATING
TEST LOCATION: UNIT 1, 3, 2
CEM VAN NO. 3
DATE: 4-6-93
OPERATOR: JP

TIME	SAMPLE POINT	O2 (%)	CO2 (%)	NOx (ppm)	CO (ppm)	SO2 (ppm)		COMMENTS / RUN #
		15.02	15.95	202.6	411.4			Span gas values used for test.
1335-1340		13.13	7.07	74.90	171.55			
1340-1345		13.11	7.07	75.20	174.06			
1345-1350		13.17	7.04	73.58	168.99			
1350-1355		13.18	7.06	77.71	171.31			
Calibrate		0.0	0.0	0.0	0.0			Zero Check
		15.02	15.84	200.0	414			SPAN check
1435-1440		14.77	5.57	80.96	204.64			START RUN 4 UNIT 3
1440-1445		14.65	5.61	83.58	205.54			
1445-1450		14.76	5.52	82.66	208.91			
1450-1455		14.71	5.62	83.01	217.16			
1455-1500		14.73	5.62	86.36	215.0			
1500-1505		14.62	5.62	86.6	216.91			
1505-1510		14.62	5.62	87.78	217.5			
1510-1515		14.53	5.67	88.27	217.4			
Calibrate		0.0	0.0	0.0	0.0			ZERO Check
		15.02	16.0	201.25	419			SPAN Check
1620-1625		13.73	6.54	69.22	237.68			START RUN 5 UNIT 2
1625-1630		13.52	6.73	69.33	239.69			
1630-1635		13.59	6.69	70.20	238.25			
1635-1640		13.44	6.78	77.06	237.13			
1640-1645		13.36	6.90	82.96	250.18			
1645-1650		13.54	6.71	74.56	230.15			
1650-1655		13.51	6.71	76.16	231.86			
1655-1700		13.58	6.64	75.68	229.00			

ENGINEERING–SCIENCE, INC.
CEM FIELD DATA SHEET

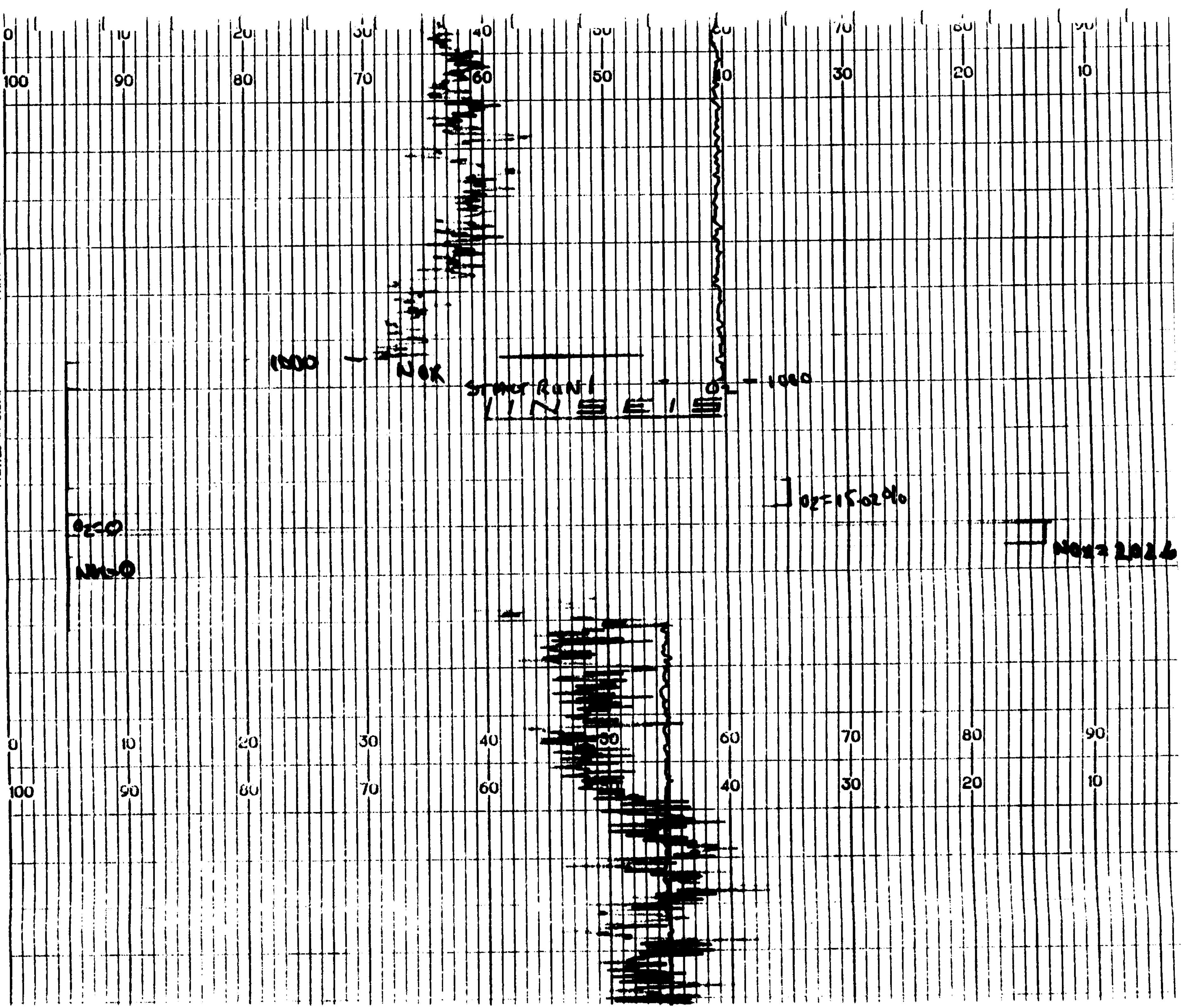
PLANT JW OPERATING CEM VAN NO. 3 DATE 4-6-93
TEST LOCATION UNIT 2 OPERATOR JP

TIME	SAMPLE POINT	O2 (%)	CO2 (%)	NOx (ppm)	CO (ppm)	SO2 (ppm)		COMMENTS / RUN #
		15.02	15.95	202.6	411.4			Span gas values used for test.
Calibrate		0.0	0.0	0.0	0.0			Zero Check
		15.02	16.0	205.75	411.4			SPAN CHECK
		14.93	15.7	201.5	403			System Bias ✓



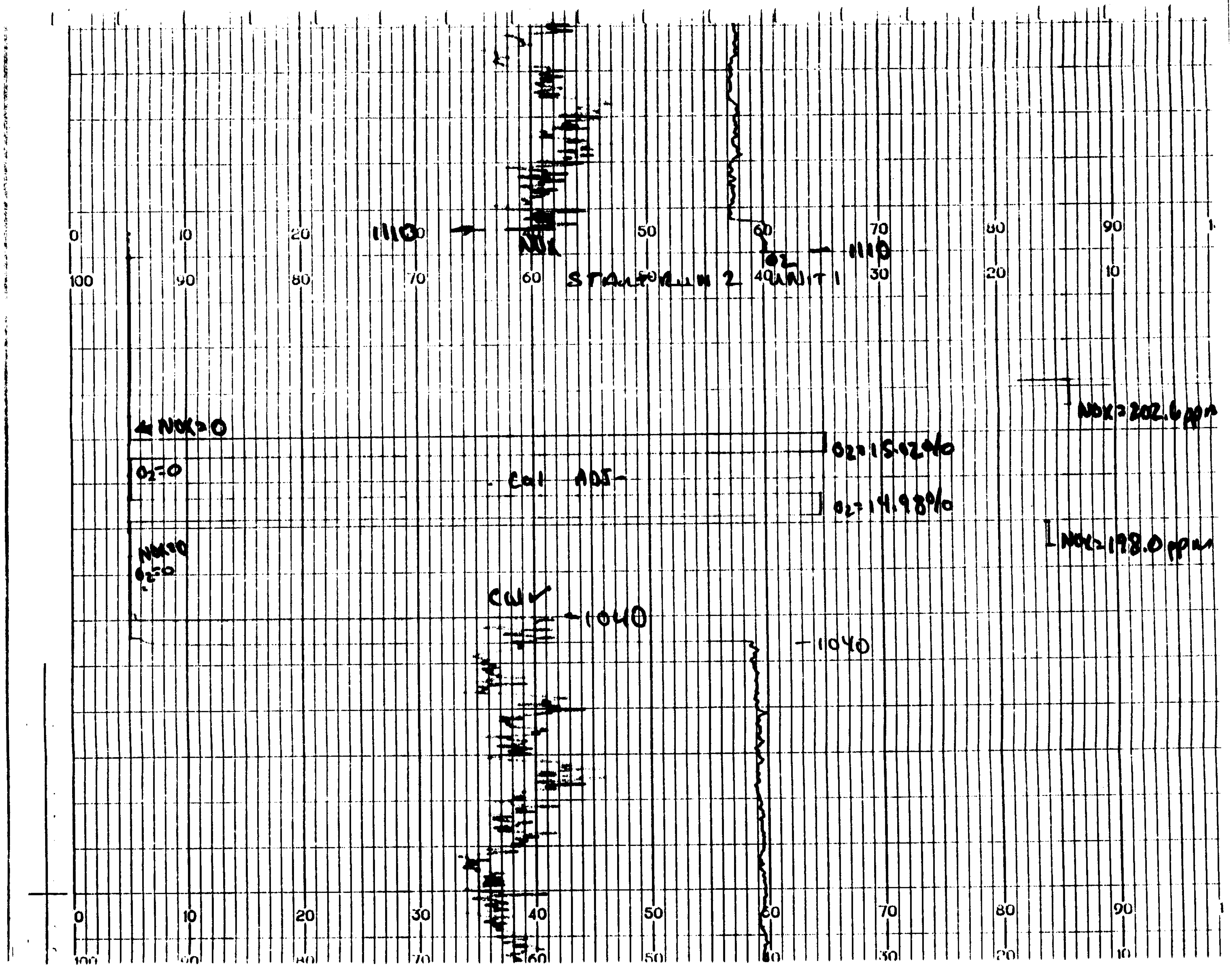
PART NO. LO/8011

ED IN U.S.A.

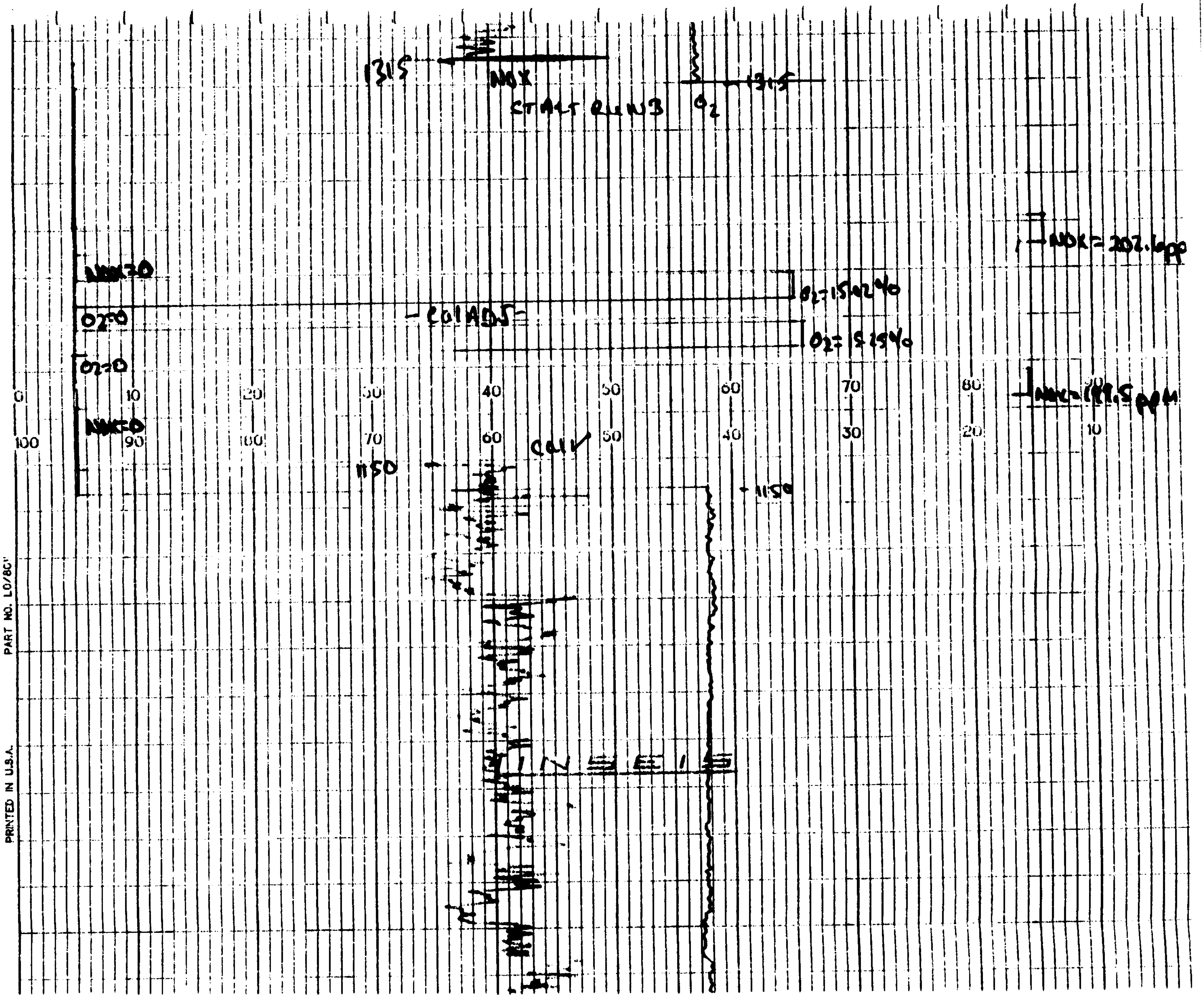


PART NO. LO/8011

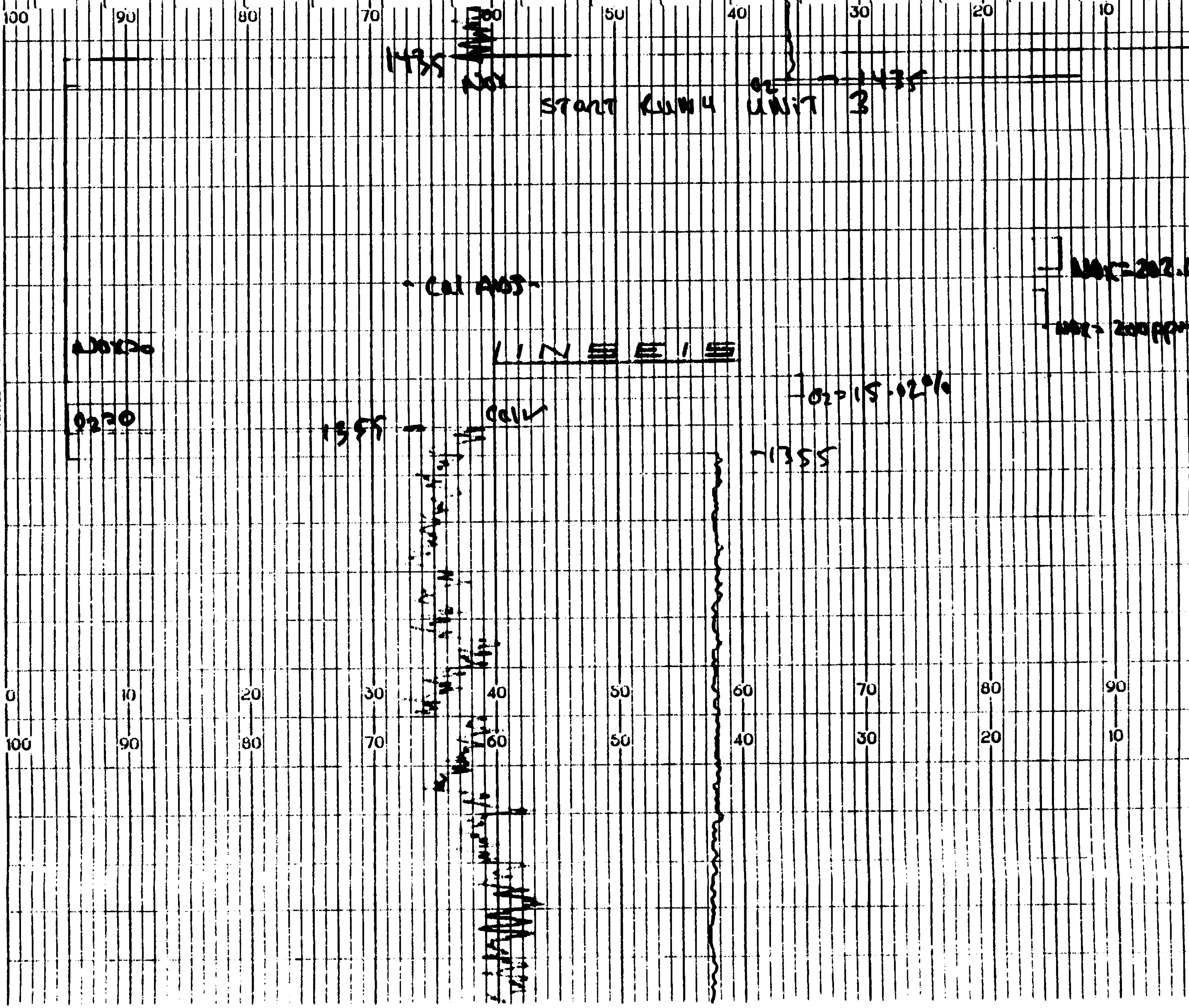
PRINTED IN U.S.A.



1110
NOX
O2
1110
STA. RUN 2 UNIT 1
NOX = 202.6 ppm
NOX = 0
O2 = 15.02%
O2 = 0
Cal ADJ
O2 = 14.98%
NOX = 198.0 ppm
NOX = 0
O2 = 0
CW
1040
1040

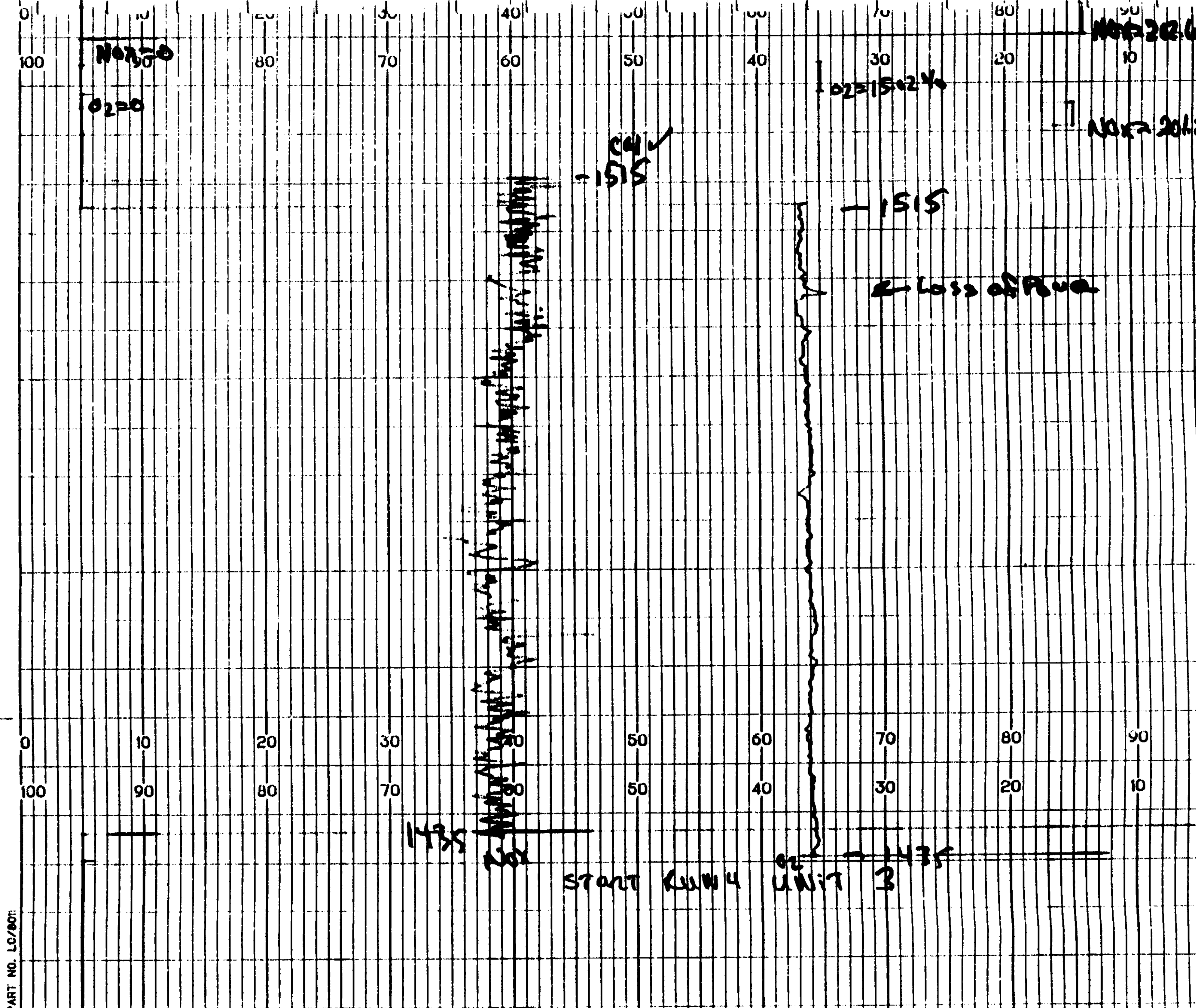


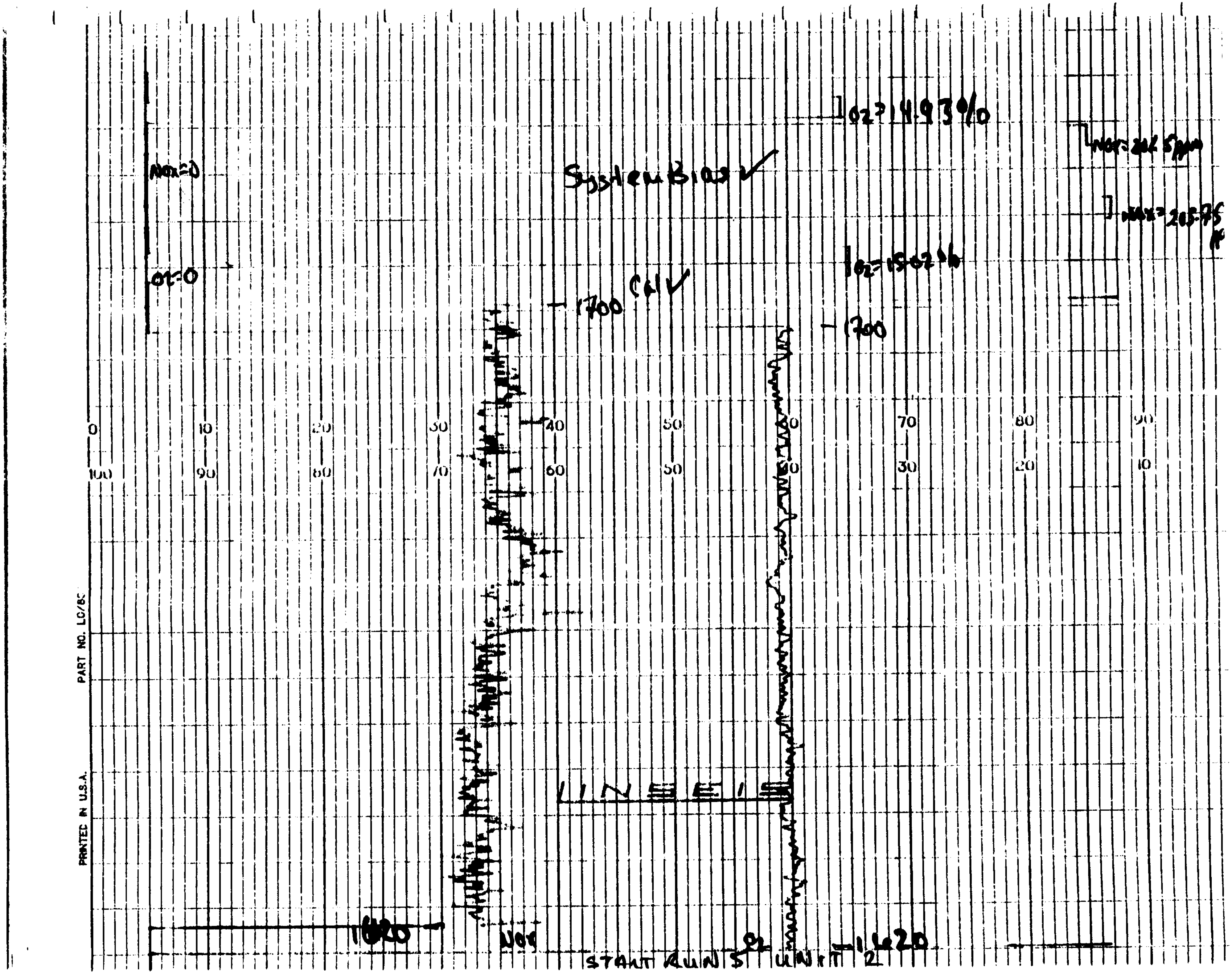
1315
NOX
START RUN 3
O2
1315
NOX=0
O2=0
O2=0
NOX=0
CO1 ADJ
O2=15.02%
O2=5.25%
NOX=202.6 ppm
NOX=199.5 PPM
CAL ✓
1150
1150
PART NO. LO/80
PRINTED IN U.S.A.



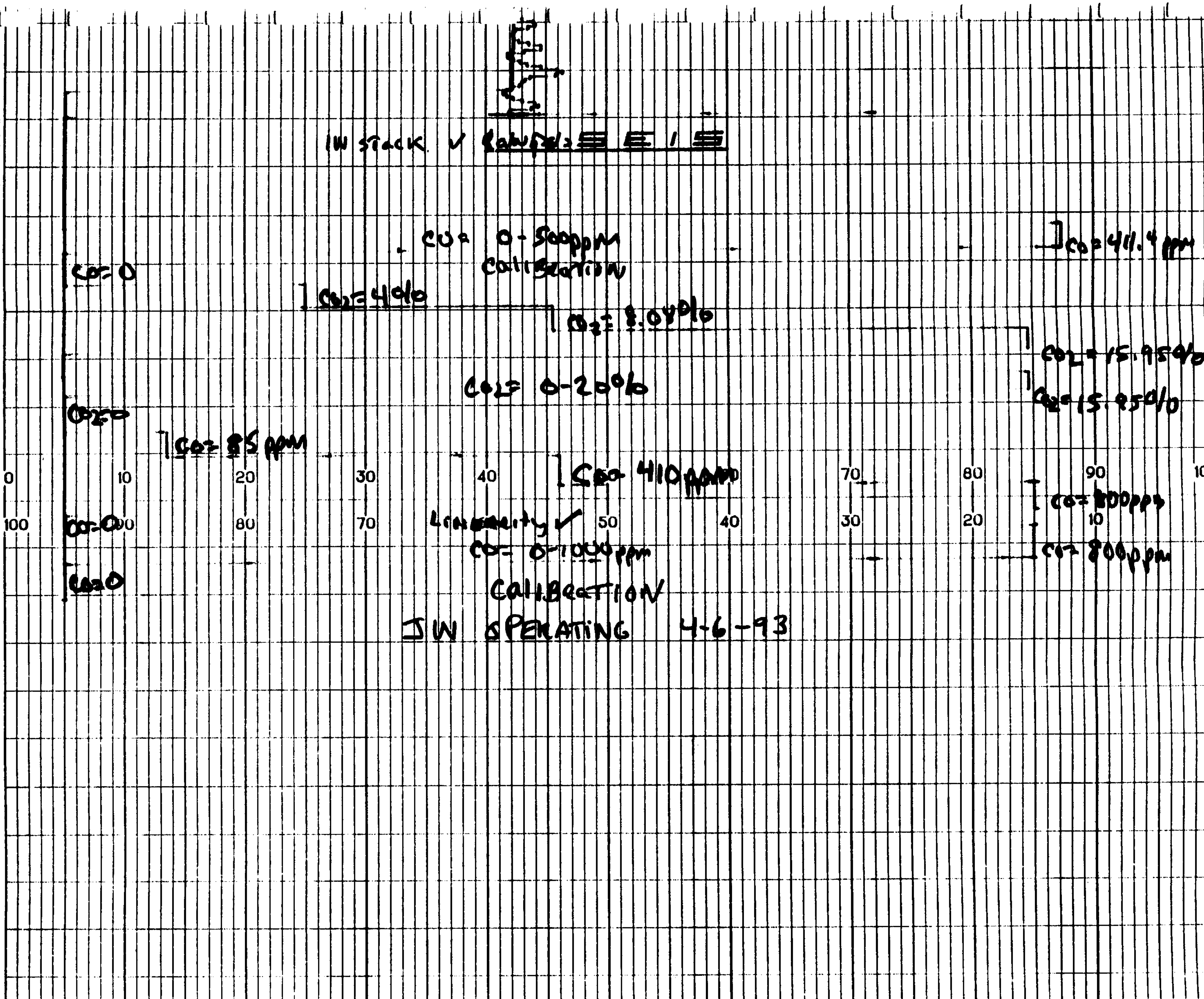
PART NO. LC/8011

PRINTED IN U.S.A.

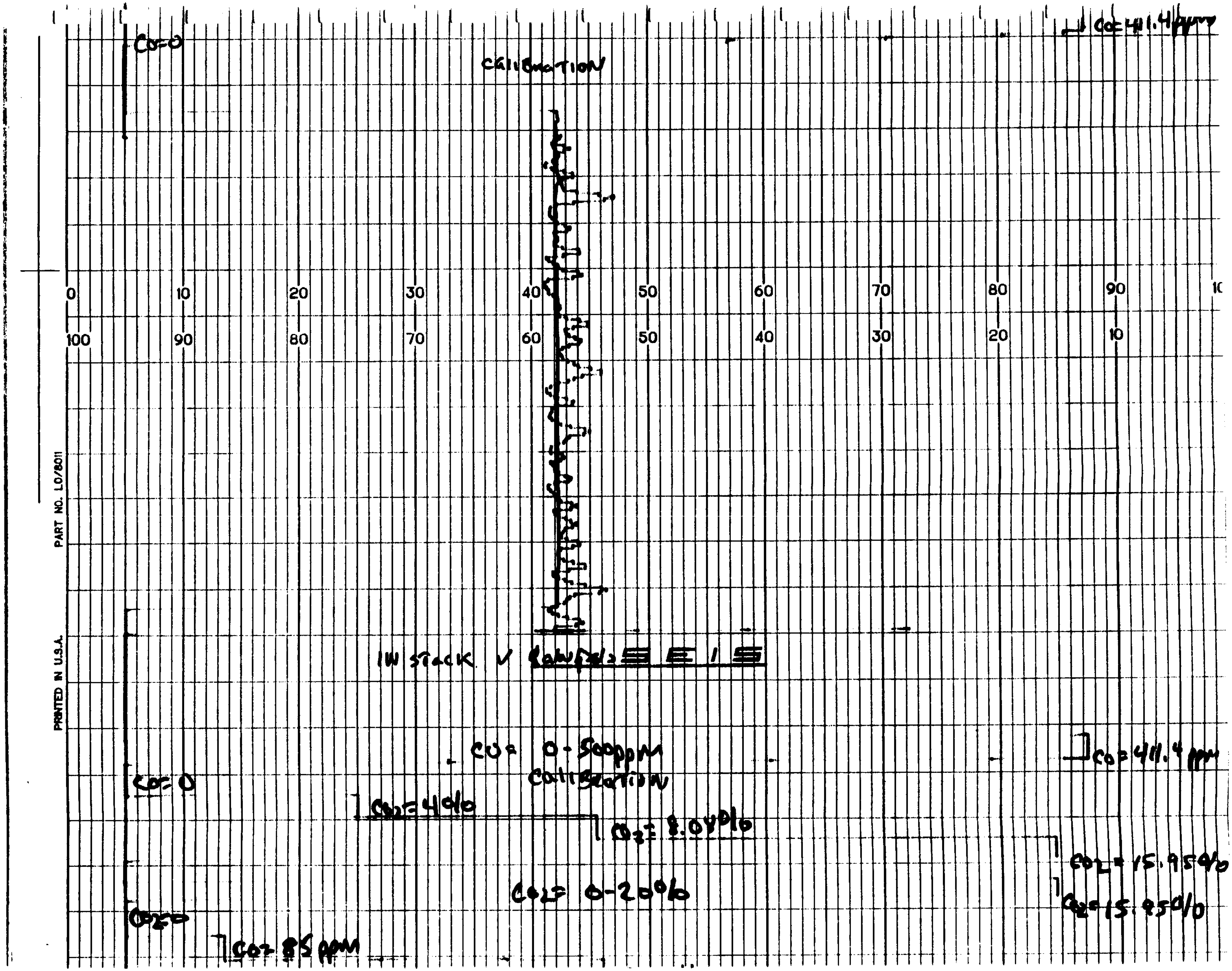

NOx=20.6
NOx=0
O2=15.2%
O2=0
NOx=20.2
CAL
1515
Loss of Flue
1435
NOx
O2
START RUN 4 UNIT 3
PART NO. LC/80



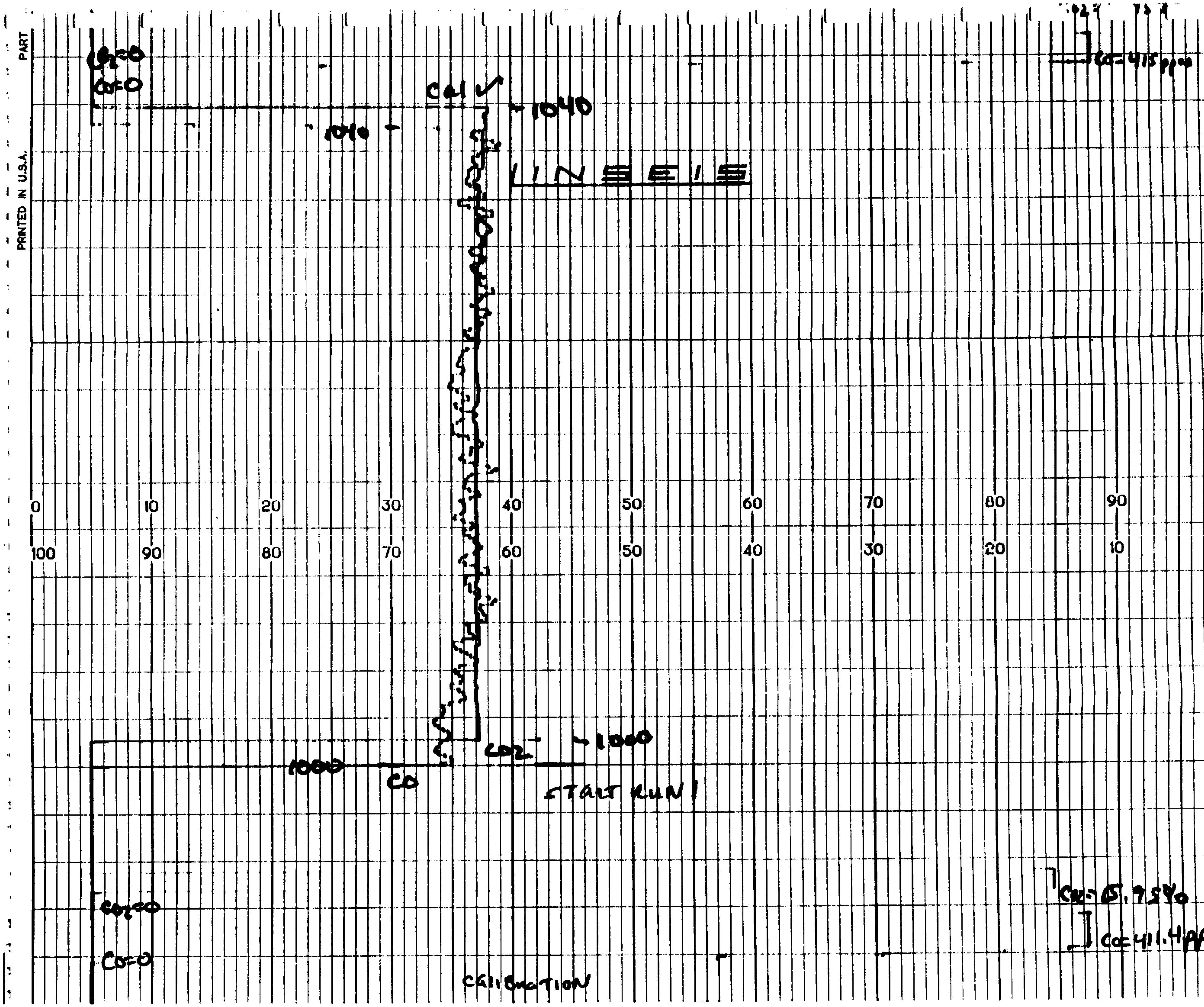
NOx=0
O2=0
System Bias ✓
Cal ✓
1700
1700
O2 = 14.93%
O2 = 15.02%
NOx = 206.5 ppm
NOx = 205.75
0 10 20 30 40 50 60 70 80 90
100 90 80 70 60 50 40 30 20 10
LINE 1
NOx
1620
START RUNS 2 UNIT 2
1620
PART NO. LC/8C
PRINTED IN U.S.A.

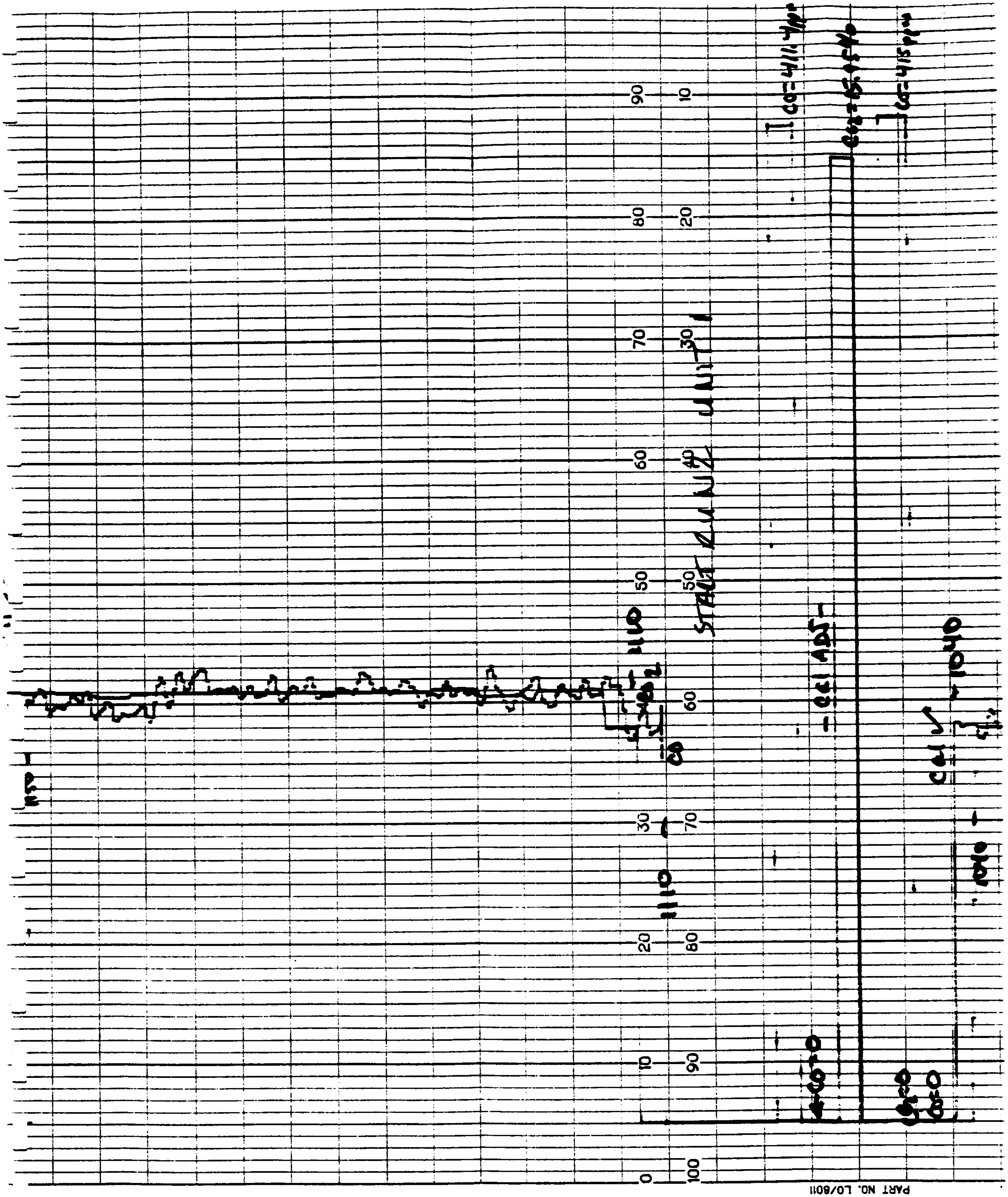


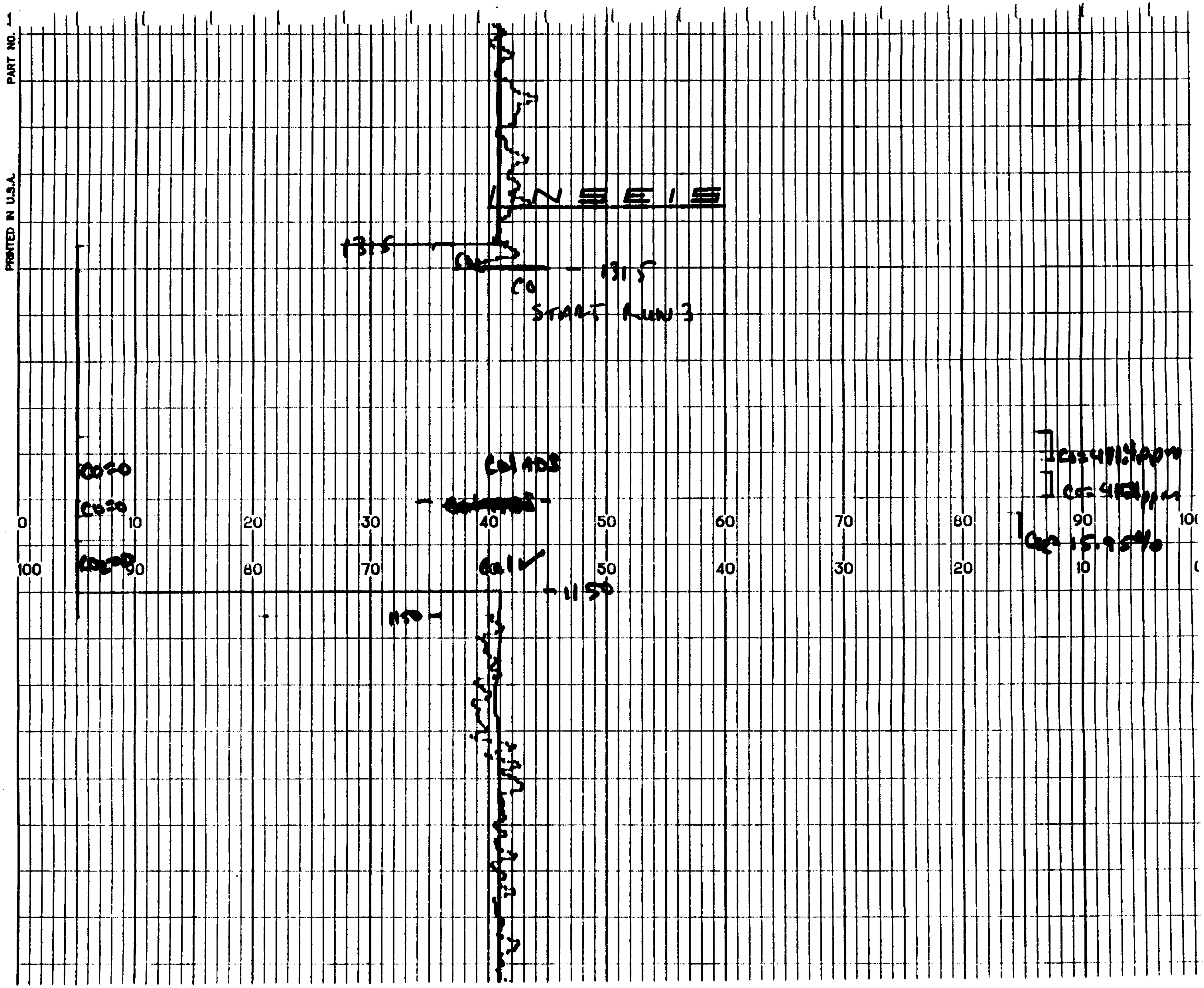
IW STACK ✓ RANGES E I S
CO = O-5000ppM CALIBRATION
CO=0
CO2=4%
O2 = 8.04%
CO2 = 0-20%
CO2=0
CO = 85 ppm
CO = 410 ppm
CO = 411.4 ppm
CO2 = 15.95%
O2 = 15.95%
CO=1000ppm
CO = 800ppm
O2=0
Linearity ✓
CO= 0-1000 ppm
CALIBRATION
JW OPERATING 4-6-93
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10 0



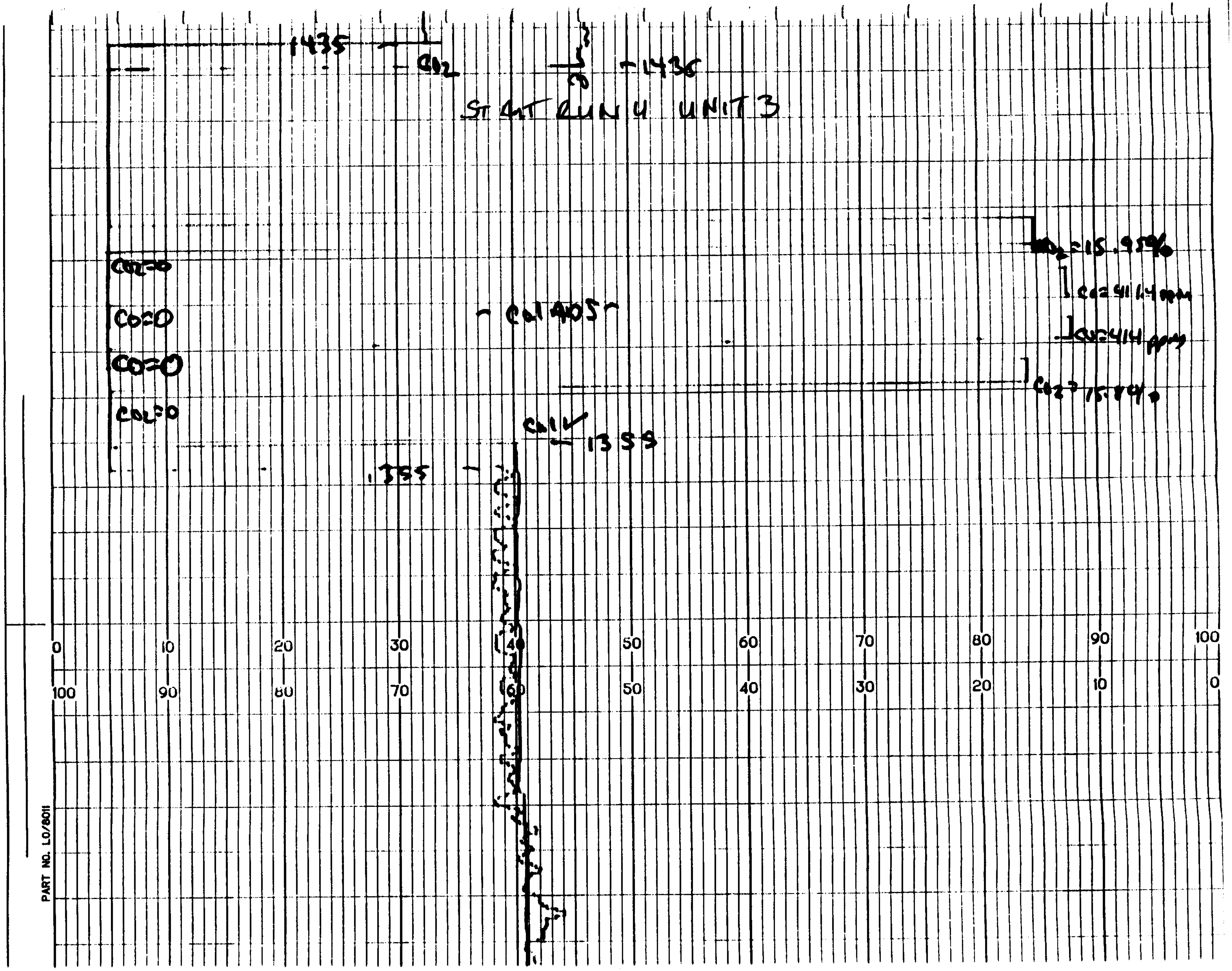
CO=0
CALIBRATION
CO=41.4 ppm
0 10 20 30 40 50 60 70 80 90 100
100 90 80 70 60 50 40 30 20 10
IN STACK
CO= 0-500ppM
CALIBRATION
CO=0
CO=41.4 ppm
CO2=4%
O2= 8.0%
CO2=15.95%
CO2=0-20%
CO2=15.95%
CO2=0
CO2 85 ppm
PART NO. LO/8011
PRINTED IN U.S.A.

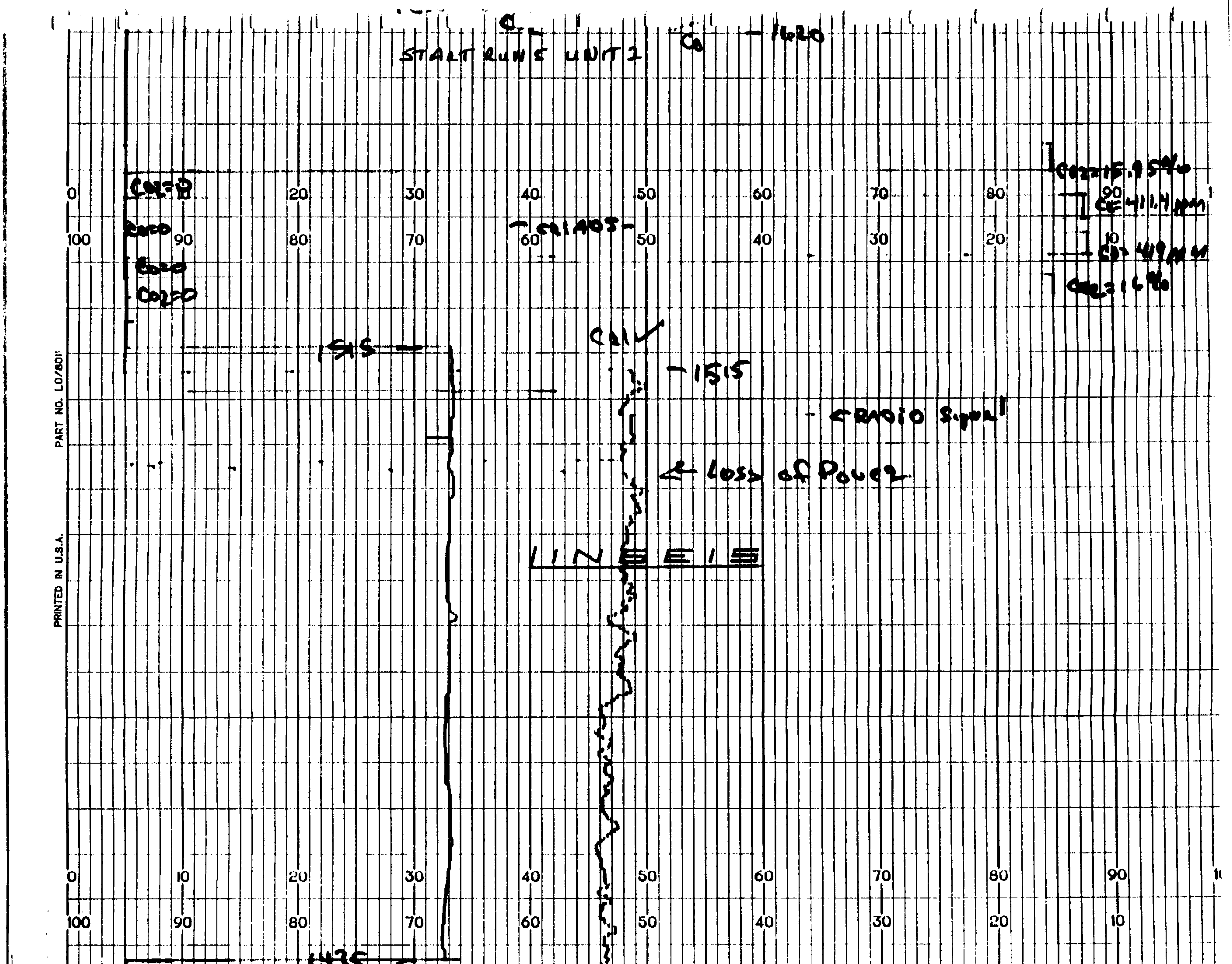

PART
PRINTED IN U.S.A.
CO_2=0
CO=0
Cal ✓
1040
1010
LINSEIS
CO2
1000
CO
START RUN 1
CO_2=0
CO=0
CALIBRATION
CO=415 ppm
CO2=13.9%
CO=411.4 ppm


CAL ADJ
1110
1040
1010
PART NO. LO/8011

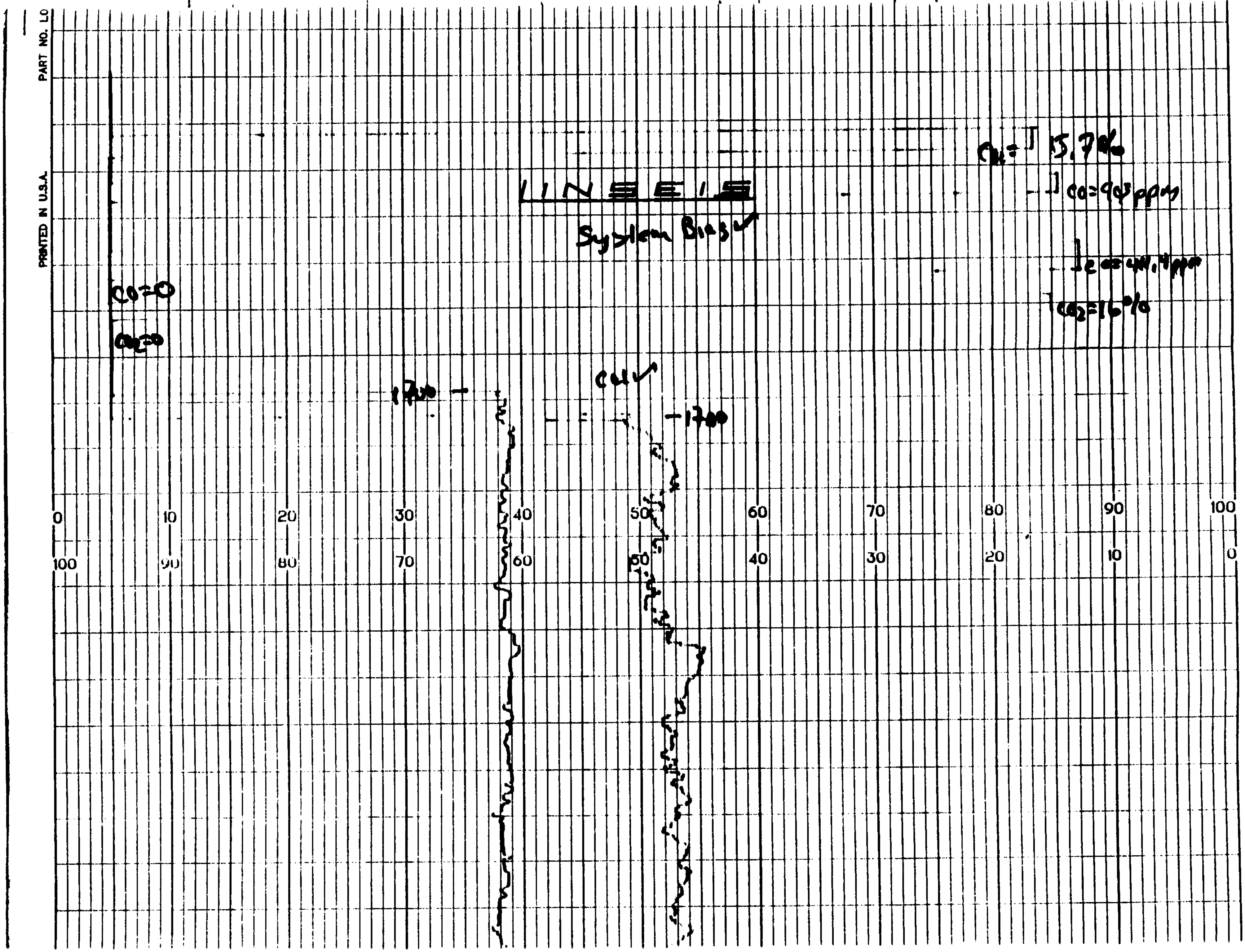


PART NO.
PRINTED IN U.S.A.
1315
1315
START RUN 3
CAL ADS
CAL
1150
1150


1435
CO_2
1436
START RUN 4 UNIT 3
CO_2=0
CO=0
CO=0
CO_2=0
Cal 1405
CO_2 = 15.95%
CO = 414 ppm
CO = 414 ppm
CO_2 = 15.84%
Cal
1359
1355
0
10
20
30
40
50
60
70
80
90
100
100
90
80
70
60
50
40
30
20
10
0
PART NO. LO/8011



START RUNS UNIT 2
1620
CAL
1515
RADIO Signal
Loss of Power
LINE 15
1435
PART NO. LO/8011
PRINTED IN U.S.A.


PART NO. LO
PRINTED IN U.S.A.
LINE 15
System Bias ✓
O_2 = 15.7%
CO = 903 ppm
C = 441.4 ppm
CO_2 = 16%
CO = 0
CO_2 = 0
Cal ✓
1700
1700
0
10
20
30
40
50
60
70
80
90
100
100
90
80
70
60
50
40
30
20
10
0

SO_2

FIELD DATA

PLANT NAME JW OPERATING
SAMPLE LOCATION SUPER BURN 1-3
OPERATOR T. KING
BAROMETRIC PRESSURE (IN. HG) 30.29
PROBE MATERIAL TFE
METER BOX NUMBER V1
AMBIENT TEMPERATURE 65 °F
INITIAL LEAK CHECK 0.000 ℓ/min @ 5" Hg
FINAL LEAK CHECK 0.000 ℓ/min @ 5" Hg

CITY FRESNO, CA.
DATE 4-6-93
SAMPLE NUMBER 1 of 3, EPA M.6, SO_2
PROBE LENGTH 4½'
PROBE HEATER SETTING 200 °F
METER GAMMA 1.009
SAMPLE POINT LOCATION CENTROID
SAMPLE PURGE TIME 15 min.

$\Delta H = 1.3$ "H_2O

SAMPLING TIME (MINUTES)	CLOCK TIME (24 HOUR)	GAS METER READING	SAMPLE FLOW RATE SETTING LITRES/MINUTE	DRY GAS METER TEMP. DEGREES F.	IMPINGER TEMP. DEGREES F.
0	1010	2018.50	1 ℓ/min	79	<68
5	1015	2023.7	"	82	<68
10	1020	2029.4	"	84	<68
15	1025	2034.7	"	86	<68
20	1030	2040.1	"	86	<68
25	1035	2045.3	"	87	<68
30	1040	2050.2	"	88	<68
35	1045	2055.4	"	89	<68
40	1050	2060.33	"	90	<68
TOTAL 40 min.	—	TOTAL 41.830 ℓ	1.0 ℓ/min	AVERAGE 85.7 °F	MAX. TEMP. < 68 °F

SO_2

FIELD DATA

PLANT NAME JW OPERATING
SAMPLE LOCATION SUPER BURN 1-3
OPERATOR T. KING
BAROMETRIC PRESSURE (IN. HG) 30.22
PROBE MATERIAL TFE
METER BOX NUMBER V1
AMBIENT TEMPERATURE 65 °F
INITIAL LEAK CHECK 0.000 l/min. @ 5" Hg
FINAL LEAK CHECK 0.000 l/min. @ 5" Hg

CITY FRESNO, CA.
DATE 4-6-93
SAMPLE NUMBER 2 of 3, EPA M-6, SO_2
PROBE LENGTH 4½'
PROBE HEATER SETTING 200 °F
METER GAMMA 1.009
SAMPLE POINT LOCATION CENTROID
SAMPLE PURGE TIME 15 MIN

$\Delta H = 1.3$ " H_2O

SAMPLING TIME (MINUTES)	CLOCK TIME (24 HOUR)	GAS METER READING	SAMPLE FLOW RATE SETTING LITRES/MINUTE	DRY GAS METER TEMP. DEGREES F.	IMPINGER TEMP. DEGREES F.
0	1110	2076.80	1 l/min.	82	<68
5		2081.5	"	84	<68
10		2086.9	"	84	<68
15		2092.3	"	88	<68
20		2097.5	"	88	<68
25		2102.5	"	89	<68
30		2107.8	"	90	<68
35		2112.9	"	91	<68
40	1150	2117.83	"	92	<68
TOTAL 40 min.	—	TOTAL 41.030.	1 l/min.	AVERAGE 87.6 °F	MAX. TEMP. <68 °F

SO_2

FIELD DATA

PLANT NAME J W OPERATING
SAMPLE LOCATION SUPER BURN 1-3
OPERATOR T. KING
BAROMETRIC PRESSURE (IN. HG) 30.22
PROBE MATERIAL TFE
METER BOX NUMBER V1
AMBIENT TEMPERATURE 65 °F
INITIAL LEAK CHECK 0.000 ℓ/MIN. @ 5" Hg
FINAL LEAK CHECK 0.050 ℓ/MIN. @ 5" Hg

CITY FRESNO, CA.
DATE 4-6-93
SAMPLE NUMBER 3 of 3, EPA M-6, SO_2
PROBE LENGTH 4½'
PROBE HEATER SETTING 200 °F
METER GAMMA 1.009
SAMPLE POINT LOCATION CENTROID
SAMPLE PURGE TIME 15 MIN.

$\Delta H = 1.3"H_2O$

SAMPLING TIME (MINUTES)	CLOCK TIME (24 HOUR)	GAS METER READING	SAMPLE FLOW RATE SETTING LITRES/MINUTE	DRY GAS METER TEMP. DEGREES F.	IMPINGER TEMP. DEGREES F.
0	1315	2135.092	1 ℓ/MIN.	93	<68
5		2140.2	"	94	<68
10		2145.5	"	95	<68
15		2150.8	"	96	<68
20		2156.1	"	98	<68
25		2161.3	"	100	<68
30		2166.5	"	101	<68
35		2171.8	"	101	<68
40	1355	2177.016	"	~~102~~	<68
TOTAL 40 MIN.	—	TOTAL 41.924 ℓ	1.0 ℓ/MIN.	AVERAGE 97.3	MAX. TEMP. < 68 °F

FIELD DATA SHEET

ENGINEERING–SCIENCE, INC.

Company: JW OP. @ Fresno Regio Landfill
Test Location: Superburn Engine # 1
Test Method / Parameter: EPA-12 / Lead

Run #: 1
Date: 4/6/93
Operator: T Delfino

K-FACTOR: ~~5.6377~~ 4.7258

Stack Dimensions: 13.5"
Barometric Pressure: 30.28 "Hg
Static Pressure: + 0.21 "H_2O
Pitot Coeff.: 0.84
Filter #: UNTARED
Control Box #: BR IV
Orifice dH@ / y: 1.64 / 0.988
Probe Type / Length: GL / 4'
Nozzle # / Size: QTZ / 0.381

IMPINGER CONTENTS, grams				
Impinger	Contents	Final	Initial	Net
1	0.1N HNO_3	669.9	599.3	70.6
2	0.1N HNO_3	598.8	587.6	11.2
3	Dry	493.7	492.7	1.0
4				
5	Add 30 mls for Rinse; Add 20 mls For line Rinse (HNO_3)			
Silica Gel		858.1	850.9	7.2
			TOTAL:	90.0

GAS COMPOSITION			
Time	O2	CO2	CO
	12.50	7.0	

LEAK RATE	~~cfm~~ / lpm	"Hg Vacuum
Initial	0.003	15"
Final	0.005	15"

Sample Point	Time (1010)	Gas Meter (ft³ or liters)	dP "H2O	dH "H2O	Temperature, °F Meter	Stack	Probe	Oven	Impinger	Vacuum "Hg	Rotameter (liters/min)	Comments
A-1	0	4.209	0.58	2.97	65	622	250	241	59	15.0	N/A	
2		7.1	0.52	2.48	64	633		240	58	15.0		
3	5	9.5	0.55	2.63	64	634		237	56	15.0		
4		12.0	0.52	2.48	66	637		239	56	15.0		
5	10	14.6	0.47	2.25	70	641		247	55	15.0		
6		17.1	0.42	2.01	71	643		233	55	13.0		
7	15	19.4	0.38	1.82	71	642		237	56	13.0		
8		21.7	0.38	1.82	72	642		235	55	13.0		
9	20	23.9	0.33	1.58	70	641		238	55	13.0		
10		25.3	0.35	1.67	72	646		243	56	13.0		
11	25	27.8	0.37	1.77	73	645		242	55	11.0		
12		30.1	0.37	1.77	74	643		241	54	11.0		
	30 (1040)	32.348			~~75~~	~~644~~						

RUN - 1 EPA - 12 Lead

K: 4.7758

Sample Point	Time	Gas Meter (ft3 liters)	dP "H2O	dH "H2O	Temperature, °F Meter	Stack	Probe	Oven	Impinger	Vacuum "Hg	Rotameter (liters/min)	Comments
	1105											
B - 1	30.0	32.348	0.42	2.01	67	620	250	231	57	11	N/A	
2	32.5	34.7	0.40	1.91	70	622		237	56	11		
3	35.0	36.6	0.37	1.78	71	623		241	58	10		
4	37.5	39.1	0.39	1.86	72	619		242	57	11		
5	40.0	41.4	0.43	2.05	73	622		241	56	11		
6	42.5	43.6	0.42	2.01	73	623		243	55	11		
7	45.0	45.9	0.48	2.29	74	622		239	56	12		
8	47.5	48.6	0.49	2.34	74	624		241	56	12		
9	50.0	51.2	0.43	2.05	74	622		243	57	11		
10	52.5	53.4	0.41	1.96	76	621		245	58	11		
11	55.0	56.0	0.38	1.82	77	623		247	57	10		
12	57.5	58.9	0.37	1.78	78	625		251	58	10		
	60.0	59.459										
	60 MIN.	55.250	0.6511	2.04	71.3	630.6	250					

FIELD DATA SHEET

ENGINEERING–SCIENCE, INC.

Company	JW OPERATING
Test Location	SUPER BURN #1
Test Method / Parameter	EPA-12 / LEAD
Run #	2 of 2
Date	4-6-93
Operator	TD

K–FACTOR : ~~4.7758~~ 5.0377

Stack Dimensions	13.5"
Barometric Pressure	30.22 "Hg
Static Pressure	+0.21 "H_2O
Pitot Coeff.	0.84
Filter #	UNTARED
Control Box #	BR IV
Orifice dH@ / y	1.64 / 0.988
Probe Type / Length	GL / 4'
Nozzle # / Size	QT2. / 0.331

IMPINGER CONTENTS, grams

Impinger	Contents	Final	Initial	Net
1	0.1N HNO_3	681.4	608.4	73.0
2	"	591.9	584.1	7.8
3	DRY	486.1	484.8	1.3
4				
5				
Silica Gel		778.8	775.9	2.9
			TOTAL :	85.0g

GAS COMPOSITION

Time	O2	CO2	CO

LEAK RATE	(cfm) lpm	"Hg Vacuum
Initial	0.006	15
Final	0.002	7

Sample Point	Time (1315)	Gas Meter (ft³ or liters)	dP "H2O	dH "H2O	Temperature, °F Meter	Stack	Probe	Oven	Impinger	Vacuum "Hg	Rotameter (liters/min)	Comments
A-1	0	91.118	0.57	2.87	71	607	250	241	46	5	NA	
2	2.5	93.6	0.49	2.47	71	609		243	46	4		
3	5	96.4	0.51	2.57	76	608		245	46	5		
4	7.5	98.9	0.46	2.32	76	609		246	48	4		
5	10	101.3	0.42	2.12	78	612		246	50	4		
6	12.5	103.7	0.41	2.07	79	611		244	51	4		
7	15	106.0	0.37	1.86	78	612		246	52	4		
8	17.5	108.1	0.36	1.81	78	613		244	53	4		
9	20	110.2	0.32	1.61	80	612		243	53	4		
10	22.5	112.2	0.34	1.71	80	611		242	55	4		
11	25	114.3	0.35	1.76	81	610		247	56	4		
12	27.5	116.8	0.32	1.61	81	611		248	57	4		
	30	118.570										

RUN - 2 Pb

Sample Point	Time	Gas Meter (ft3/ liters)	dP "H2O	dH "H2O	Temperature, °F Meter	Stack	Probe	Oven	Impinger	Vacuum "Hg	Rotameter (liters/min)	Comments
	1350											
B-1	30.0	118.578	0.49	2.47	80	611	250	231	57	5	N/A	
2	32.5	120.8	0.47	2.37	81	612		236	57	4		
3	35.0	123.1	0.42	2.12	81	611		237	57	4		
4	37.5	125.4	0.39	1.96	80	610		239	55	4		
5	40.0	127.4	0.43	2.17	80	609		241	55	4		
6	42.5	129.7	0.41	2.07	81	608		243	56	4		
7	45.0	132.0	0.32	1.61	81	607		245	57	4		
8	47.5	134.2	0.39	1.96	82	606		247	58	4		
9	50.0	136.6	0.39	1.96	82	607		248	57	4		
10	52.5	138.8	0.41	2.07	81	608		247	57	4		
11	55.0	141.1	0.38	1.91	81	609		246	58	4		
12	57.5	143.1	0.35	1.76	82	608		245	59	3		
	60.0 1420	145.217										
	60 min.	54.099	0.6361	2.05	79.21	609.63						

SOURCE SAMPLING DATA SHEET

SOURCE : SUPER BURN 1 DATE : 4-6-93

I. PRETEST DETERMINATIONS

1. Number of sample points determination : **#PTS** Program *
   Calculate equivalent diameter for rectangular stacks : **EQIV** Program

Stack diameter (Equiv. dia.)	13.5	in / ft		
Upstream Disturbance	6.25	in / ft	1/2	diameter
Downstream Disturbance	165.0	in / ft	12	diameter
Number of sample points	24			

2. Sample point locations. For circular stacks : **LOC** Program

Port Length 8 in. Port I.D. 3 in. Port Type 3" NIP.

pt. 1 = 8 1/2"

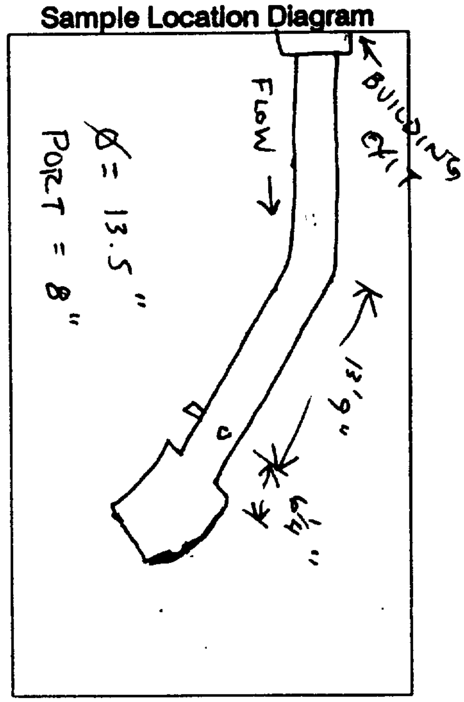
Pt. # 1	8.4"	Pt. # 4	10 3/8"	Pt. # 7	16 5/8"	Pt. # 10	19 7/8"	inch
2	8 7/8"	5	11 7/8"	8	18 3/8"	11	20 1/2"	
3	9 1/2"	6	12 3/4"	9	19 1/8"	12	21 1/4"	= 21"

3. Velocity traverse data : dP Max 0.60 "H2O; dP Avg 0.468 "H2O; Ts 664 °F

4. Other estimated/measured data : Tm 80 °F; Bws 0.1 fraction; dH@ 1.64; O2 12.50 %; CO2 7.00 %; Pb 30.28 "Hg

	+5	
1	0.6	661
2	0.57	669
3	0.56	675
4	0.53	676
5	0.49	675
6	0.47	674
7	0.42	670
8	0.39	665
9	0.38	650
10	0.39	650
11	0.41	650
12	0.41	650

Sample Location Diagram



5. Sampling nozzle selection : **NOZZ** Program

Suggested Nozzle : ______ inch
Actual Nozzle : ______ inch

Field Nozzle Calibration :

1		inch
2		
3		
Average	0.330	

0.331

6. K factor determination : K factor : 4.778 **KFAC** Program

II. TEST PROCEDURES

1. Sample point dH determinations : **DH** Program
2. Calculate average test values at end of test run : **AVG** Program

III. POST TEST CALCULATIONS

1. Calculate sample run values : **ISO** Program

* Program refers to HP–42S calculator programs.

INTEGRATED BAG GAS SAMPLING
FIELD DATA SHEET

Company: Southeast Regional Landfill, Selma

Date: 4-6-93

Test Location: Superburn # 1 stack

Test Method / Parameter: EPA 18, CARB 410 A / HC, VOC

ENGINEERING–SCIENCE, INC.

Run No.	Laboratory No.	Start Time	Rotameter (liter/min)	End Time	Rotameter (liter/min)	Total Time (min)	Leak Rate (liter/min)	Comments
1	BK9304209	1010	0.33	1040	0.33	30.0	0.0	Integrated tedlar bag samples
2	BK 9304 210	1110	0.33	1140	0.33	↓	0.0	
3	BK 9304 211	1315	0.33	1345	0.33	↓	0.0	

Note: Using a 10 liter sample bag, set the flowrate as follows: 15 min sample = 0.67 l/min; 30 min sample = 0.33 l/min; 60min sample = 0.17 l/min.

APPENDIX B

LABORATORY DATA

Project # BK065

H2O2 SO2

Company: J-W Operating

Pg #

Sample Dates:

Source:

Method and Handling: Analyzed according to EPA Method 6 using digital buret.

(see next page for standardization and Quality Control)

Sample ID Number	Run Number	Original Volume, ml	Evaporated Volume, ml	Brought up to Volume, ml	Titrated Aliquot Volume, ml	Final Buret Reading, ml	Initial Buret Reading, ml	Titer (Final−Initial)	Average Titer For Duplicates	% Duplicate	% Recovery	Comments
	1			100	20	0.10	0.00	0.10				
Duplicate	1			100	20	0.10	0.00	0.10	0.10	100%		
	2			100	20	0.08	0.00	0.08				
	3			100	20	0.08	0.00	0.08				
	BLK			100	20	0.08	0.00	0.08				
	BLK			100	20	0.08	0.00	0.08	0.08	100%		

Analyst: [signature]

Date 4/12/93

Project # BK065

Company: - JW Operating

Standardization and Quality Control — SO_2

Analyst	G. McRae
Date	4/12/93

Sample Dates: 4/6/93

Source:

Method and Handling: EPA Method 6, SO_2

Standardization

1.) Standard Used 0.02 N H_2SO_4

A.) Milliliters used 20.0

B.) Normality 0.02

2.) Titrant Used BaCL

C.) Titer (ml) Used 22.83, 22.85 } 22.84

D.) Normality 0.017513

Equation: ~~D = AxB/C~~

$N = (0.02)(20) / \text{mL Titer}$
$= 0.017513$

Comments :

Quality Control

3.) Quality Control Used Lot 0590, 6XXY

E.) Known Value $C_{SO_2} = 550$ mg/dscm ~~mg H2SO4*~~

F.) Quality Control Titer 4.18 ml

G.) QC Blank Titer 0.00 ml

H.) Lab Calculated Value 558.27 mg/dscm ~~mg H2SO4*~~

Equation: ~~H = (F-G) x D x (98/2) x (100/10)~~

$$C_{SO_2} = \frac{32.03\,(\text{Titer} - \text{Titer Blank})\,N\,\left(\frac{100}{20}\right)}{21 \times 10^{-3}}$$

$$= 558.27 \text{ mg/dscm}$$

I.) % Confidence 101.5 %

Equation: I = H / E x 100

$$I = 558.27/550 \times 100$$
$$= 101.5$$

~~* Assuming 100 ml volume, 10 ml aliquot.~~

oilwell research, inc.
ANALYTICAL LABORATORIES

PRECISION ANALYSIS / QUALITY SERVICE

Established 1949

California State Approved
Testing Laboratory

3161 Pegasus Drive
P.O. Box 80475
Bakersfield, CA
93380-0475
805 392-8811

NPDES Permit Analysis
Injection Water Quality
Reservoir Fluid Analysis
Natural Gas Analysis
Enhanced Recovery
Drilling & Production Support

April 13, 1993

Attention: Mr. Troy Delfino
ENGINEERING SCIENCE, INC.
2520 Pegasus Drive
Bakersfield, CA 93308

Ref: Lab No. 93-1911

Enclosed please find your report of analysis performed on the samples submitted to our lab on April 7, 1993.

We thank you for this opportunity to be of service. If you should have any questions concerning this report, or require further analysis, please do not hesitate to call.

Respectfully submitted,

Ronald P. Hoff
RPH/sj

enclosures

oilwell research, inc.
ANALYTICAL LABORATORIES

Established 1949

Attention: Mr. Troy Delfino
ENGINEERING SCIENCE, INC.
2520 Pegasus Drive
Bakersfield, CA 93308

Report Date: April 13, 1993
Sampled: April 6, 1993
Submitted: April 7, 1993
Lab No. 93-1911

LABORATORY TEST REPORT

Project Name: JW Operating Fresno
Project No.: BK065

Analyzed For: Lead
Method: EPA 12

Sample ID	Control No.	Sample Vol. mL	Found	Units	MDL
Filter	BK9304201	--	12	µg	10
Probe Wash	BK9304202	123	8	µg	2
Impingers	BK9304203	331	14	µg	4
Filter	BK9304204	--	ND	µg	10
Probe Wash	BK9304205	113	2	µg	2
Impingers	BK9304206	390	5	µg	4
Blank Filter	BK9304207	--	ND	µg	10
Blank 0.1 N HNO3	BK9304208	320	ND	µg	4

µg: Microgram
MDL: Method Detection Limit
ND: None Detected

Date Analyzed: 12-Apr-93
Analyst: R. Hoff

3161 Pegasus Drive P.O. Box 80475 Bakersfield, CA 93380-0475
805 392-8811

Attention: Ms. Linda McRae
ENGINEERING SCIENCE, INC.
2520 Pegasus Drive
Bakersfield, CA 93308

Report Date: April 30, 1993
Sampled: April 6, 1993
Submitted: April 7, 1993
Lab No. 93-1911

QC SUMMARY REPORT

Project Name: JW Operating Fresno
Project No.: BK065
Control No(s): BK9304201 - 208

Analyzed For: Lead
Method: EPA 12

Date Analyzed:	Apr 12, 1993
Analyst:	RPH

<u>Calibration Curve</u>

Date Performed:	Apr 12, 1993
Correlation Coefficient:	0.997
Method Detection Limit:	10 µg/L
Replicate Standard Recovery:	97.5%
Ext. Ref. Standard Recovery:	104.9%

<u>Sample QC Data</u>

Replicate Sample Recovery:	96.8%
Spiked Sample Recovery:	107.1%

oilwell research, inc.
ANALYTICAL LABORATORIES

Established 1949

Attention: Mr. Troy Delfino
ENGINEERING SCIENCE, INC.
2520 Pegasus Drive
Bakersfield, CA 93308

Report Date: April 12, 1993
Sampled: April 6, 1993
Submitted: April 7, 1993
Lab No. 93-1911-9

LABORATORY TEST REPORT

Project Name: JW Operating Fresno
Project No.: BK065
Sample ID: Superburn Engine - Integrated Bag 1
Control No. BK9304209

Analyzed For: Trace Hydrocarbons
Method: EPA 18

Component	Found	Units	MDL
Methane	1203.0	ppm	1.0
Ethane	1.7	ppm	1.0
Propane	ND	ppm	1.0
Butane	ND	ppm	1.0
Pentane	ND	ppm	1.0
Hexanes +	ND	ppm	1.0

ND: None Detected
MDL: Method Detection Limit

Date Analyzed: 8-Apr-93
Analyst: S. Harris

3161 Pegasus Drive P.O. Box 80475 Bakersfield, CA 93380-0475
805 392-8811

oilwell research, inc.
ANALYTICAL LABORATORIES

Established 1949

Attention: Mr. Troy Delfino
ENGINEERING SCIENCE, INC.
2520 Pegasus Drive
Bakersfield, CA 93308

Report Date: April 12, 1993
Sampled: April 6, 1993
Submitted: April 7, 1993
Lab No. 93-1911-10

LABORATORY TEST REPORT

Project Name: JW Operating Fresno
Project No.: BK065
Sample ID: Superburn Engine - Integrated Bag 2
Control No. BK9304210

Analyzed For: Trace Hydrocarbons
Method: EPA 18

Component	Found	Units	MDL
Methane	1894.0	ppm	1.0
Ethane	2.7	ppm	1.0
Propane	ND	ppm	1.0
Butane	ND	ppm	1.0
Pentane	ND	ppm	1.0
Hexanes +	ND	ppm	1.0

ND: None Detected
MDL: Method Detection Limit

Date Analyzed: 8-Apr-93
Analyst: S. Harris

3161 Pegasus Drive P.O. Box 80475 Bakersfield, CA 93380-0475
805 392-8811

oilwell research, inc.
ANALYTICAL LABORATORIES

Established 1949

Attention: Mr. Troy Delfino
ENGINEERING SCIENCE, INC.
2520 Pegasus Drive
Bakersfield, CA 93308

Report Date: April 12, 1993
Sampled: April 6, 1993
Submitted: April 7, 1993
Lab No. 93-1911-11

LABORATORY TEST REPORT

Project Name: JW Operating Fresno
Project No.: BK065
Sample ID: Superburn Engine - Integrated Bag 3
Control No. BK9304211

Analyzed For: Trace Hydrocarbons
Method: EPA 18

Component	Found	Units	MDL
Methane	2197.0	ppm	1.0
Ethane	200.0	ppm	1.0
Propane	61.8	ppm	1.0
Butane	8.4	ppm	1.0
Pentane	ND	ppm	1.0
Hexanes +	ND	ppm	1.0

ND: None Detected
MDL: Method Detection Limit

Date Analyzed: 8-Apr-93
Analyst: S. Harris

3161 Pegasus Drive P.O. Box 80475 Bakersfield, CA 93380-0475
805 392-8811

Attention: Ms. Linda McRae
ENGINEERING SCIENCE, INC.
2520 Pegasus Drive
Bakersfield, CA 93308

Report Date: April 30, 1993
Sampled: April 6, 1993
Submitted: April 7, 1993
Lab No. 93-1911

QC SUMMARY REPORT

Project Name: JW Operating Fresno
Project No.: BK065
Control No(s): BK9304209 - 11

Analyzed For: Trace Hydrocarbons
Method: EPA 18

Date Analyzed: Apr 8, 1993

Analyst: SEH

Calibration Curve

Date Performed: Apr 8, 1993

Correlation Coefficient: 0.999

Method Detection Limit: 1.0 ppm

Replicate Standard Recovery: 99.6% *

Sample QC Data

Replicate Sample Recovery: 103.3% *

Method Blank Verification: < MDL *

* Summary / Average of Six Compounds (C1 - C6)

ENGINEERING SCIENCE, INC.
2520 Pegasus Drive
Bakersfield, CA 93308
Attention: Mr. Troy Delfino

oilwell research, inc.
ANALYTICAL LABORATORIES
Established

Gas Analysis by GC - ASTM D 3588-81

Sample ID: BK9304212 Landfill Gas Fuel Line
Collected By: Troy Delfino 4/6/93
Date Submitted: 04-07-93
Date Analyzed: 04-12-93
Report Date: April 13, 1993
OWR Lab No.: 93-1911-1

Component	Mole %	Weight %	GPM	Gross BTU/ft³	Net BTU/ft³	Gross BTU/lb	Net BTU/lb
Hydrogen	0.000	0.00		0.00	0.00	0.00	0.00
Oxygen	1.063	1.28					
Nitrogen	4.597	4.83					
Carbon Dioxide	35.379	58.39					
Carbon Monoxide	0.000	0.00					
Hydrogen Sulfide	0.000	0.00		0.00	0.00	0.00	0.00
Methane	58.929	35.45		596.36	536.96	8479.16	7634.60
Ethane	0.013	0.01		0.22	0.21	3.19	2.92
Propano	0.014	0.02	0.004	0.34	0.32	4.90	4.51
Iso-Butane	0.003	0.01	0.001	0.10	0.10	1.47	1.36
n-Butane	0.003	0.01	0.001	0.08	0.08	1.16	1.07
Iso-Pentane	0.000	0.00	0.000	0.00	0.00	0.00	0.00
n-Pentane	0.000	0.00	0.000	0.00	0.00	0.00	0.00
Hexanes Plus	0.000	0.00	0.000	0.00	0.00	0.00	0.00
Totals	100.000	100.00	0.006	597.11	537.65	8489.89	7644.46

Specific Gravity (Calculated)		0.9207	Air = 1.000 @ 760 mm Hg, 60 °F dry	
Specific Gravity - Corrected		0.9229		
BTU/ft³ Gross - Corrected	Dry:	598.6	Wet:	588.2
BTU/ft³ Net - Corrected	Dry:	539.0	Wet:	529.6
BTU/lb Gross - Corrected	Dry:	8510.7	Wet:	8362.6
BTU/lb Net - Corrected	Dry:	7663.2	Wet:	7529.8
Specific Volume, ft³/lb	Dry:	14.22	Wet:	13.97
"F" Factor @ 60 °F, dscf/MMBTU	Dry:	9035	Wet:	8878
"F" Factor @ 68 °F, dscf/MMBTU	Dry:	9174	Wet:	9015

Composition by Weight	
42.520	% Carbon
8.919	% Hydrogen
43.731	% Oxygen
4.830	% Nitrogen
0.000	% Sulfur
100.000	Sum

Performance Analytical Inc.
Environmental Testing and Consulting

LABORATORY REPORT

Client:	ENGINEERING-SCIENCE, INC.	Date of Report:	04/15/93
Address:	2520 Pegasus Drive	Date Received:	04/08/93
	Bakersfield, CA 93308	PAI Project No:	5105
Contact:	Mr. Troy Delfino	Purchase Order:	Verbal
Client Project:	JW Operating #BK065		

Three (3) Tedlar Bag Samples labeled: "BK9304209" through "BK9304211"

The samples were received by the laboratory under chain of custody on April 8, 1993. The samples were received intact. The dates of analysis are indicated on the attached data sheet.

CARB Methods 106, 410 and 422 Analysis

The samples were analyzed for ten Volatile Organic Compounds using CARB Methods 106, 410 and 422. The analyses were performed by gas chromatography/mass spectrometry utilizing thermal desorption/ cryogenic concentration. The instrumentation used for sample analysis was comprised of a Finnigan Model 4500 GC/MS/DS interfaced to a Tekmar 5010 Automatic Desorber. A thick film (5 micron) crossbonded 100% Dimethylpolysiloxane megabore column (RT_x-1, Restek Corporation, Bellefonte, PA) was used to achieve chromatographic separation.

The results of analyses are included on the attached data sheets.

Data Release Authorization:

Chris Parnell
Senior Chemist

Reviewed and Approved:

Michael Tuday
Laboratory Director

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF VINYL CHLORIDE ANALYSIS

Client : Engineering Science, Inc.
Client Project No : BK065
PAI Project ID : #5105

Test Code : CARB 106
Analyst : Chris Parnell
Instrument ID : Finnigan 4500C/Tekmar 5010
Verified by : Michael Tuday

Matrix : Tedlar Bags
Date Received : 04/08/93
Date Analyzed : 04/09/93
Volume Analyzed: 1.00 Liter

CLIENT SAMPLE ID	PAI SAMPLE ID	RESULT (UG/M^3)	DETECTION LIMIT (UG/M^3)	RESULT (PPB)	DETECTION LIMIT (PPB)
BK9304209 (04/06/93)	9301143	5.6	5.0	2.1	1.9
BK9304210 (04/06/93)	9301144	12	5.0	4.8	1.9
BK9304211 (04/06/93)	9301145	20	5.0	7.5	1.9
N/A (04/09/93)	Method Blank	ND	5.0	ND	1.9

ND = Not Detected TR = Trace Level - Below Indicated Detection Limit

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

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF ANALYSIS

Client: Engineering Science, Inc.

Client Sample ID: N/A

PAI Sample ID: PAI Method Blank

Test Code: Modified CARB 410A
Analyst: Chris Parnell
Instrument ID: Finnigan 4500C/Tekmar 5010
Verified by: Michael Tuday

Matrix: Tedlar Bag
Date Received: N/A
Date Analyzed: 04/09/93
Volume Analyzed: 1.00 Liter

CAS #	COMPOUND	RESULT (UG/M^3)	DETECTION LIMIT (UG/M^3)	RESULT (PPB)	DETECTION LIMIT (PPB)
71-43-2	Benzene	ND	5.0	ND	1.5
108-88-3	Toluene	ND	5.0	ND	1.3
1330-20-7	m- & p-Xylenes	ND	5.0	ND	1.1
95-47-6	o-Xylene	ND	5.0	ND	1.1

ND = Not Detected TR = Trace Level - Below Indicated Detection Limit

20954 Osborne Street, Canoga Park, CA 91304 • Phone 818 709-1134 • Fax 818 709-2915

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF ANALYSIS

Client: Engineering Science, Inc.

Client Sample ID: BK9304209 (04/06/93)

PAI Sample ID: 9301143

Test Code: Modified CARB 410A
Analyst: Chris Parnell
Instrument ID: Finnigan 4500C/Tekmar 5010
Verified by: Michael Tuday

Matrix: Tedlar Bag
Date Received: 04/08/93
Date Analyzed: 04/09/93
Volume Analyzed: 1.00 Liter

CAS #	COMPOUND	RESULT (UG/M^3)	DETECTION LIMIT (UG/M^3)	RESULT (PPB)	DETECTION LIMIT (PPB)
71-43-2	Benzene	160	5.0	48	1.5
108-88-3	Toluene	190	5.0	50	1.3
1330-20-7	m- & p-Xylenes	91	5.0	20	1.1
95-47-6	o-Xylene	30	5.0	6.7	1.1

ND = Not Detected TR = Trace Level - Below Indicated Detection Limit

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

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF ANALYSIS

Client: Engineering Science, Inc.

Client Sample ID: BK9304210 (04/06/93)

PAI Sample ID: 9301144

Test Code: Modified CARB 410A
Analyst: Chris Parnell
Instrument ID: Finnigan 4500C/Tekmar 5010
Verified by: Michael Tuday

Matrix: Tedlar Bag
Date Received: 04/08/93
Date Analyzed: 04/09/93
Volume Analyzed: 1.00 Liter

CAS #	COMPOUND	RESULT (UG/M^3)	DETECTION LIMIT (UG/M^3)	RESULT (PPB)	DETECTION LIMIT (PPB)
71-43-2	Benzene	360	5.0	110	1.5
108-88-3	Toluene	370	5.0	96	1.3
1330-20-7	m- & p-Xylenes	160	5.0	36	1.1
95-47-6	o-Xylene	50	5.0	11	1.1

ND = Not Detected TR = Trace Level - Below Indicated Detection Limit

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF ANALYSIS

Client: Engineering Science, Inc.

Client Sample ID: BK9304211 (04/06/93)

PAI Sample ID: 9301145

Test Code: Modified CARB 410A
Analyst: Chris Parnell
Instrument ID: Finnigan 4500C/Tekmar 5010
Verified by: Michael Tuday

Matrix: Tedlar Bag
Date Received: 04/08/93
Date Analyzed: 04/09/93
Volume Analyzed: 1.00 Liter

CAS #	COMPOUND	RESULT (UG/M^3)	DETECTION LIMIT (UG/M^3)	RESULT (PPB)	DETECTION LIMIT (PPB)
71-43-2	Benzene	400	5.0	120	1.5
108-88-3	Toluene	380	5.0	98	1.3
1330-20-7	m- & p-Xylenes	160	5.0	36	1.1
95-47-6	o-Xylene	52	5.0	12	1.1

ND = Not Detected TR = Trace Level - Below Indicated Detection Limit

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

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF ANALYSIS

Client: Engineering Science, Inc.

Client Sample ID: N/A

PAI Sample ID: PAI Method Blank

Test Code:	CARB 422	Matrix:	Tedlar Bag
Analyst:	Chris Parnell	Date Received:	N/A
Instrument ID:	Finnigan 4500C/Tekmar 5010	Date Analyzed:	04/09/93
Verified by:	Michael Tuday	Volume Analyzed:	1.00 Liter

CAS #	COMPOUND	RESULT (UG/M^3)	DETECTION LIMIT (UG/M^3)	RESULT (PPB)	DETECTION LIMIT (PPB)
75-09-2	Methylene Chloride	ND	5.0	ND	1.4
107-06-3	1,2-Dichloroethane	ND	5.0	ND	1.2
71-55-6	1,1,1-Trichloroethane	ND	5.0	ND	0.90
79-01-6	Trichloroethene	ND	5.0	ND	0.91
127-18-4	Tetrachloroethene	ND	5.0	ND	0.72

ND = Not Detected   TR = Trace Level - Below Indicated Detection Limit

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

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF ANALYSIS

Client: Engineering Science, Inc.

Client Sample ID: BK9304209 (04/06/93)

PAI Sample ID: 9301143

Test Code: CARB 422
Analyst: Chris Parnell
Instrument ID: Finnigan 4500C/Tekmar 5010
Verified by: Michael Tuday

Matrix: Tedlar Bag
Date Received: 04/08/93
Date Analyzed: 04/09/93
Volume Analyzed: 1.00 Liter

CAS #	COMPOUND	RESULT (UG/M^3)	DETECTION LIMIT (UG/M^3)	RESULT (PPB)	DETECTION LIMIT (PPB)
75-09-2	Methylene Chloride	9.3	5.0	2.6	1.4
107-06-3	1,2-Dichloroethane	ND	5.0	ND	1.2
71-55-6	1,1,1-Trichloroethane	ND	5.0	ND	0.90
79-01-6	Trichloroethene	ND	5.0	ND	0.91
127-18-4	Tetrachloroethene	21	5.0	3.1	0.72

ND = Not Detected TR = Trace Level - Below Indicated Detection Limit

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF ANALYSIS

Client: Engineering Science, Inc.

Client Sample ID: BK9304210 (04/06/93)

PAI Sample ID: 9301144

Test Code: CARB 422
Analyst: Chris Parnell
Instrument ID: Finnigan 4500C/Tekmar 5010
Verified by: Michael Tuday

Matrix: Tedlar Bag
Date Received: 04/08/93
Date Analyzed: 04/09/93
Volume Analyzed: 1.00 Liter

CAS #	COMPOUND	RESULT (UG/M^3)	DETECTION LIMIT (UG/M^3)	RESULT (PPB)	DETECTION LIMIT (PPB)
75-09-2	Methylene Chloride	14	5.0	4.1	1.4
107-06-3	1,2-Dichloroethane	ND	5.0	ND	1.2
71-55-6	1,1,1-Trichloroethane	ND	5.0	ND	0.90
79-01-6	Trichloroethene	ND	5.0	ND	0.91
127-18-4	Tetrachloroethene	80	5.0	11	0.72

ND = Not Detected TR = Trace Level - Below Indicated Detection Limit

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

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF ANALYSIS

Client: Engineering Science, Inc.

Client Sample ID: BK9304211 (04/06/93)

PAI Sample ID: 9301145

Test Code: CARB 422
Analyst: Chris Parnell
Instrument ID: Finnigan 4500C/Tekmar 5010
Verified by: Michael Tuday

Matrix: Tedlar Bag
Date Received: 04/08/93
Date Analyzed: 04/09/93
Volume Analyzed: 1.00 Liter

CAS #	COMPOUND	RESULT (UG/M^3)	DETECTION LIMIT (UG/M^3)	RESULT (PPB)	DETECTION LIMIT (PPB)
75-09-2	Methylene Chloride	18	5.0	4.9	1.4
107-06-3	1,2-Dichloroethane	ND	5.0	ND	1.2
71-55-6	1,1,1-Trichloroethane	ND	5.0	ND	0.90
79-01-6	Trichloroethene	7.0	5.0	1.3	0.91
127-18-4	Tetrachloroethene	29	5.0	4.2	0.72

ND = Not Detected TR = Trace Level - Below Indicated Detection Limit

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

PERFORMANCE ANALYTICAL INC.

SURROGATE SPIKE RECOVERY RESULTS

Client: Engineering Science, Inc.

Client Job ID: #BK065

PAI Job ID: #5105

Test Code: CARB 106, 410 & 422
Analyst: Chris Parnell
Instrument ID: Finnigan 4500C/Tekmar 5010
Verified by: Michael Tuday

Matrix: Tedlar Bags
Date Received: 04/08/93
Date Analyzed: 04/09/93
Volume Analyzed: 1.00 Liter

CLIENT SAMPLE ID	PAI SAMPLE ID	PERCENT RECOVERY		
		1,2-DICHLORO-ETHANE-d4	TOLUENE-d8	BROMOFLUORO-BENZENE
N/A (04/09/93)	Method Blank	97.5	115	90.3
BK9304209 (04/06/93)	9301143	101	101	93.0
BK9304210 (04/06/93)	9301144	96.6	103	93.6
BK9304211 (04/06/93)	9301145	96.1	99.1	98.7

Performance Analytical Inc.
Environmental Testing and Consulting

PERFORMANCE ANALYTICAL INC.

RESULTS OF INITIAL CALIBRATION

Client: Engineering Science, Inc.

Client Project ID: JW Operating #BK065

Test Code: CARB 106, 410 & 422
Instrument ID: Finnigan 4500C/Tekmar 5010
Analyst: Chris Parnell
Verified By: Michael Tuday

Matrix: Tedlar Bags
Date Received: N/A
Date Analyzed: 04/09/93
Volume Analyzed: N/A

CAS #	COMPOUND	RRF 1	RRF 2	RRF 3	AVE RRF	% RSD
75-01-4	VINYL CHLORIDE	2.280	2.328	2.400	2.336	2.6
75-09-2	METHYLENE CHLORIDE	1.890	1.638	2.135	1.888	13.2
107-06-3	1,2-DICHLOROETHANE	3.050	3.258	3.376	3.228	5.1
71-55-6	1,1,1-TRICHLOROETHANE	0.680	0.630	0.653	0.654	3.9
71-43-2	BENZENE	1.090	1.058	1.105	1.084	2.2
79-01-6	TRICHLOROETHENE	0.370	0.369	0.386	0.375	2.5
108-88-3	TOLUENE	1.280	1.334	1.321	1.312	2.1
127-18-4	TETRACHLOROETHENE	0.360	0.413	0.412	0.395	7.5
1330-20-7	m- & p-XYLENES	1.060	1.210	1.164	1.145	6.7
95-47-6	o-XYLENE	1.010	1.111	1.012	1.044	5.5

RRF # - Relative Response Factor
AVE RRF - Average Relative Response Factor
% RSD - Percent Relative Standard Deviation

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

APPENDIX C

ENGINE OPERATING DATA

IC Engine Source Test Data

SOUTHEAST REGIONAL DISPOSAL SITE
Selma, California

April 6, 1993

J–W Unit #1453 Superburn #1

55 min. 43 min. 40 min.

	10:00 am	10:30 am	10:55 am	11:07 am	11:30 am	11:50 am	1:20 pm	1:35 pm	2:00 pm	2:15 pm
Ambient Temp	62	62	62	62	60	60	72	72	73	72
RPM	398	398	398	398	398	398	398	398	397	397
KWH	220	220	220	220	220	220	220	215	220	220
Amps 1	330	330	330	330	330	325	325	310	310	315
Amps 2	320	320	310	310	310	310	310	310	310	310
Amps 3	330	330	330	330	330	340	330	320	320	310
Fuel Meter:										
Reading acf	15330600	15331600	15332100	15332500	15333200	15333800	15336600	15337100	15337800	15338400
Pressure	25	25	25	25	25	25	25	25	25	25
Temperature	64	64	64	64	64	66	66	66	66	66
Cylinder EGT:										
Cyl. #1	660	666	690	690	690	680	670	690	690	690
Cyl. #2	669	670	740	740	740	740	710	710	710	710

$4368.9\ ft^3/hr$ Run #1

$4836.9\ ft^3/hr$ Run #2

$4787.5\ ft^3/hr$ Run #3

$$\text{Fuel Rate} = \frac{(15332100 - 15330600)\,ft^3\ 520°R}{(64°F + 460)°R} \times \frac{25_{psia} + 14.63}{14.73}$$

$4004.84\ ft^3/55\ min$

$4004.84 \div 55 \times 60 =$

$4368.9\ ft^3/hr$

$$\frac{(15333800 - 15332500)\,ft^3\ 520°R}{(64.67°F + 460)°R} \times \frac{25_{psia} + 14.63}{14.73}$$

$3466.42\ ft^3/43\ min$

$3466.42 \div 43 \times 60$

$4836.9\ ft^3/hr$

$$\frac{(15337800 - 15336600)\,ft^3\ 520°R}{(66°F + 460)°R} \times \frac{25_{psia} + 14.63}{14.73}$$

$3191.69\ ft^3/40 min$

$3191.69 \div 40 \times 60$

$4787.5\ ft^3/hr$

$Avg = 4664.4\ ft^3/hr$

IC Engine Source Test Data

SOUTHEAST REGIONAL DISPOSAL SITE
Selma, California

April 6, 1993

J–W Unit #1455 Superburn # 3

45 minutes

	2:35 pm	2:50 pm	3:10 pm	3:20 pm	
Ambient Temp	74	74	74	74	
RPM	398	398	398	398	
KWH	215	215	215	215	
Amps 1	310	310	310	310	
Amps 2	310	310	310	310	
Amps 3	320	320	320	320	
Fuel Meter:					
Reading acf	13798900	13799400	13800000	13800300	
Pressure psia	26	26	26	26	
Temperature °F	74	74	74	74	
Cylinder EGT:					
Cyl. #1	710	710	710	710	
Cyl. #2	720	720	720	720	

5013 ft³/hr

Run #4

$$\text{Fuel Rate} = \frac{(13800300 - 13798900)\,ft^3 \times 520°R}{(74°F + 460)°R} \times \frac{26\,psia + 14.6}{14.73}$$

$3760\ ft^3/45\,min$

$3760 \div 45 \times 60 = 5013\ ft^3/hr$

IC Engine Source Test Data

SOUTHEAST REGIONAL DISPOSAL SITE
Selma, California

April 6, 1993

J-W Unit #1454 Superburn #2

45 minutes

	4:20 pm	4:35 pm	4:50 pm	5:05 pm	
Ambient Temp	72	74	68	68	
RPM	401	401	401	401	
KWH	200	200	200	200	
Amps 1	180	180	180	180	
Amps 2	190	190	190	190	
Amps 3	170	170	170	170	
Fuel Meter:					
Reading acf	18697100	18697600	18698000	18698400	
Pressure	27	27	27	27	
Temperature	76	76	76	76	
Cylinder EGT:					
Cyl. #1	680	680	680	680	
Cyl. #2	730	730	730	730	

4752.5 ft³/hr

Run #5

$$\text{Fuel Rate} = \frac{(18698400 - 18697100)\,ft^3 \times 520^\circ R}{(76^\circ F + 460)^\circ R} \times \frac{27\,psia + 14.63}{14.73} =$$

$3564.39\ ft^3/45$ minutes

$3564.39 \div 45 \times 16 = 4752.52\ ft^3/h$

Engine Efficiency Determination (Superburn #1)

KWH = 219.44 for the 3 test runs

Fuel Rate = 4,664.4 ft^3/hr, from fuel meter (77.74 std ft^3/min)

BTU/ft^3, Gross = 598.6 from fuel analysis

$$\frac{2.93 \times 10^{-4}\ KW\text{-}HR}{BTU} \times \frac{598.6\ BTU}{ft^3} \times \frac{77.74\ ft^3}{min} \times \frac{60\ min}{hr}$$

= 818.09 KW Theoretical Value @ 100% Effieiency

$$\frac{219.44}{818.09} \times 100 = 26.82\ \%$$ Unit Efficiency

Fuel Rate Calculation (Superburn #2)

$$\text{Fuel Rate, } ft^3/min = \frac{BTU}{2.93 \times 10^{-4}\ KW\text{-}HR} \times \frac{ft^3}{598.6\ BTU} \times \frac{hr}{60\ min}$$

$$\times \left[\frac{\overset{200}{\text{Actual KWHR}}}{\underset{26.82}{\text{Unit Efficiency}}} \times 100 \right] = 70.86\ ft^3/min$$

Fuel Rate Calculation (Superburn #3)

$$\text{Fuel Rate, } ft^3/min = \frac{BTU}{2.93 \times 10^{-4}\ KW\text{-}HR} \times \frac{ft^3}{598.6\ BTU} \times \frac{hr}{60\ min}$$

$$\times \left[\frac{\text{Actual KW-HR (215)}}{\text{Unit Efficiency (26.82)}} \times 100 \right] = 76.18\ ft^3/min$$