

MONARCH
ANALYTICAL LABORATORIES, INC.
(Formerly Owens-Illinois Analytical Services)
P.O. BOX 2990 • TOLEDO, OH 43606 • (419) 535-1780

**COGENERATION PARTNERS
RIVERSIDE HOSPITAL COGENERATION UNIT
TOLEDO, OHIO
EMISSION TEST REPORT**

REQUEST NO.: COM89E1270

DATE: June 15, 1989

PREPARED BY:

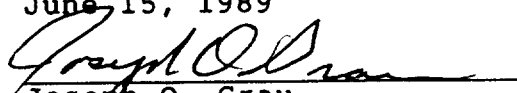

Joseph O. Grau

TABLE OF CONTENTS

	<u>PAGE</u>
1. <u>INTRODUCTION</u>	
1.1 Plant Location	1
1.2 Source Tested and Date	1
1.3 Testing Organization	1
1.4 Sampling Personnel	1
1.5 Purpose of Tests	1
1.6 Pollutants Measured	1
1.7 Test Methods Used	1
1.8 Agency Observers Present	1
2. <u>SUMMARY</u>	
2.1 Process Operation	2
2.2 Emissions	2
3. <u>PROCESS DESCRIPTION</u>	3
4. <u>SAMPLING PROCEDURE</u>	
4.1 Sampling Location	4
4.2 Waste Gas Velocity	4
4.3 Waste Gas Composition	4
4.4 Gas Monitoring	4
5. <u>RESULTS</u>	
5.1 Operation	6
5.2 Emissions	6

LIST OF TABLES

<u>TABLE 1</u>	- RIVERSIDE HOSPITAL COGENERATION SYSTEM EMISSION SUMMARY
----------------	--

LIST OF FIGURES

<u>FIGURE 1</u>	- SCHEMATIC OF RIVERSIDE HOSPITAL COGENERATION SYSTEM DUCTWORK
<u>FIGURE 2</u>	- SCHEMATIC OF GAS MONITORING SYSTEM

LIST OF APPENDICES

<u>APPENDIX 1</u>	- GAS MONITOR RECORDS
<u>APPENDIX 2</u>	- OPERATING DATA
<u>APPENDIX 3</u>	- COMPUTER SUMMARIES

1. INTRODUCTION

1.1 PLANT LOCATION

Riverside Hospital
1600 N. Superior Street
Toledo, OH 43604

1.2 SOURCE TESTED AND DATE

Cogeneration System
May 18, 1989

1.3 TESTING ORGANIZATION

Monarch Analytical Laboratories, Inc.
P. O. Box 2990
Toledo, OH 43606
(419) 535-1780

1.4 SAMPLING PERSONNEL

Joseph O. Grau

1.5 PURPOSE OF TESTS

The tests were conducted to document the emission rates of the regulated pollutants as required by the Ohio EPA.

1.6 POLLUTANTS MEASURED

Oxides of Nitrogen (NO_x)
Carbon Monoxide (CO)
Nonmethane Volatile Organic Compounds (NMVOC's)

1.7 TEST METHODS USED

USEPA Method 1	- Determination of velocity traverse point locations
USEPA Method 2	- Determination of gas velocity
USEPA Method 3	- Determination of oxygen, carbon dioxide and dry molecular weight
USEPA Method 7E	- Determination of Oxides of Nitrogen concentration
USEPA Method 10	- Determination of Carbon Monoxide concentration
USEPA Method 25A	- Determination of Nonmethane Volatile Organic Compounds

1.8 AGENCY OBSERVER PRESENT

Dale Krygielski	- Toledo Environmental Services
Jeff Ridley	- Toledo Environmental Services

2. SUMMARY

2.1 PROCESS OPERATION

The operating data of the cogeneration system is summarized below.

Test	1	2	3
Fuel Usage (cfh)	9272	9182	9178

2.2 EMISSIONS

The emission rates of the pollutants are summarized below.

Test	1	2	3
NO _x (lb/10 ⁶ Btu)	0.067	0.070	0.075
CO (lb/10 ⁶ Btu)	0.398	0.397	0.395
NM VOC's (lb/10 ⁶ Btu)	0.067	0.081	0.046

3. PROCESS DESCRIPTION

The Cogeneration System at Riverside Hospital is a natural gas internal combustion engine and boiler used to generate electricity, steam and hot water.

4. SAMPLING PROCEDURE

4.1 SAMPLING LOCATION

Two ports, 90° apart, were located in the exhaust stack near the exit. The distances with respect to up and downstream flow disturbances exceeded the 7 and 2 diameter criteria in Method 1 for an ideal location. A schematic of the ductwork and the velocity traverse point locations can be found in Figure 1.

4.2 WASTE GAS VELOCITY

The gas velocity was measured at each of the 12 traverse points using an "S" type pitot tube, inclined manometer and thermocouple.

4.3 WASTE GAS COMPOSITION

The oxygen concentration was measured with a Teledyne Model 320 oxygen analyzer and carbon dioxide with a Fryrite carbon dioxide analyzer. The water vapor was determined from the oxygen concentration of the gas.

4.4 GAS MONITORING

The sampling system consisted of a short stainless steel and Teflon probe, ice water cooled condenser, particulate filter, Teflon sample line, sample pump, flow meters and gas monitors. The sample was extracted from a single point in the center of the stack and presented to the following gas analyzers:

Thermo Environmental Model 10 Chemiluminescent
NO-NO_x Analyzer

Ecoloyzer Series 3000 Carbon Monoxide Analyzer

Beckman 400 Total Hydrocarbon Analyzer

Teledyne Model 320 Oxygen Analyzer

The NO-NO_x analyzer was operated in the NO_x mode. The carbon monoxide analyzer was operated with a filter designed to remove the NO interference. The hydrocarbon analyzer alternately sampled the gas directly for total hydrocarbons and through charcoal for methane, the difference being the non-methane volatile organic compounds. A schematic of the monitoring system can be found in Figure 2.

4. SAMPLING PROCEDURE (Cont'd.)

Prior to the testing, the end of the probe was plugged and a leak free state was verified by the sample flow dropping to zero. The span gases were then transported to a "T" at the probe inlet and the instruments zeroed and spanned. This was performed before and after each of three one-hour monitoring periods.

The average concentration of each of the pollutants was calculated from the indicated average and the pre- and post-test zeros and spans as prescribed in the Federal Register.

The strip chart record of the testing and calculations can be found in Appendix 1.

5. RESULTS

5.1 OPERATION

The cogeneration system was operating normally during the testing period. The average fuel usage was 9211 cfh of gas and the electric output was 751 kw. The operating data is summarized in Table 1 and appears in Appendix 2.

5.2 EMISSIONS

The pollutant emission rates are summarized in Table 1 and the computer outputs for each test can be found in Appendix 3. The emission rate of each of the pollutants were substantially lower than the allowable rates.

TABLE 1
RIVERSIDE HOSPITAL
COGENERATION SYSTEM EMISSION SUMMARY

<u>TEST</u>	1	2	3	Avg.
<u>DATE</u>	----	5/18/89	----	
<u>TIME</u>				
Start				
End	0930 1030	1050 1150	1210 1310	
<u>OPERATING DATA</u>				
Fuel Usage (cfh)	9272	9182	9178	9211
Load (kw)	755	748	751	751
Heat Input @ 1030 Btu/ cf(10 ⁶ Btu/hr)	9.74	9.64	9.64	9.67
<u>WASTE GAS</u>				
Volumetric Flow (dscfm)	2720	2720	2720	2720
Oxygen (%)	13	13	13	13
Carbon Dioxide (%)	5	5	5	5
Moisture (%)	9	9	9	9
<u>EMISSIONS</u>				
NO _x				
(ppm)	34	35	37	35
(lb/hr)	0.66	0.68	0.72	0.69
(lb/10 ⁶ Btu)	0.067	0.070	0.075	0.071
CO				
(ppm)	327	323	321	324
(lb/hr)	3.88	3.83	3.81	3.84
(lb/10 ⁶ Btu)	0.398	0.397	0.395	0.397
NMVOC's				
(ppm)	98	117	65	93
(lb/hr)	0.66	0.79	0.44	0.63
(lb/10 ⁶ Btu)	0.067	0.081	0.046	0.065
<u>ALLOWABLE EMISSIONS</u>				
NO _x				
(lb/hr)	5.92	5.92	5.92	5.92
(lb/10 ⁶ Btu)	0.68	0.68	0.68	0.68
CO				
(lb/hr)	6.48	6.48	6.48	6.48
(lb/10 ⁶ Btu)	0.74	0.74	0.74	0.74
NMVOC's				
(lb/hr)	1.82	1.82	1.82	1.82
(lb/10 ⁶ Btu)	0.21	0.21	0.21	0.21

FIGURE 1
SCHEMATIC OF RIVERSIDE HOSPITAL COGENERATION
SYSTEM DUCTWORK

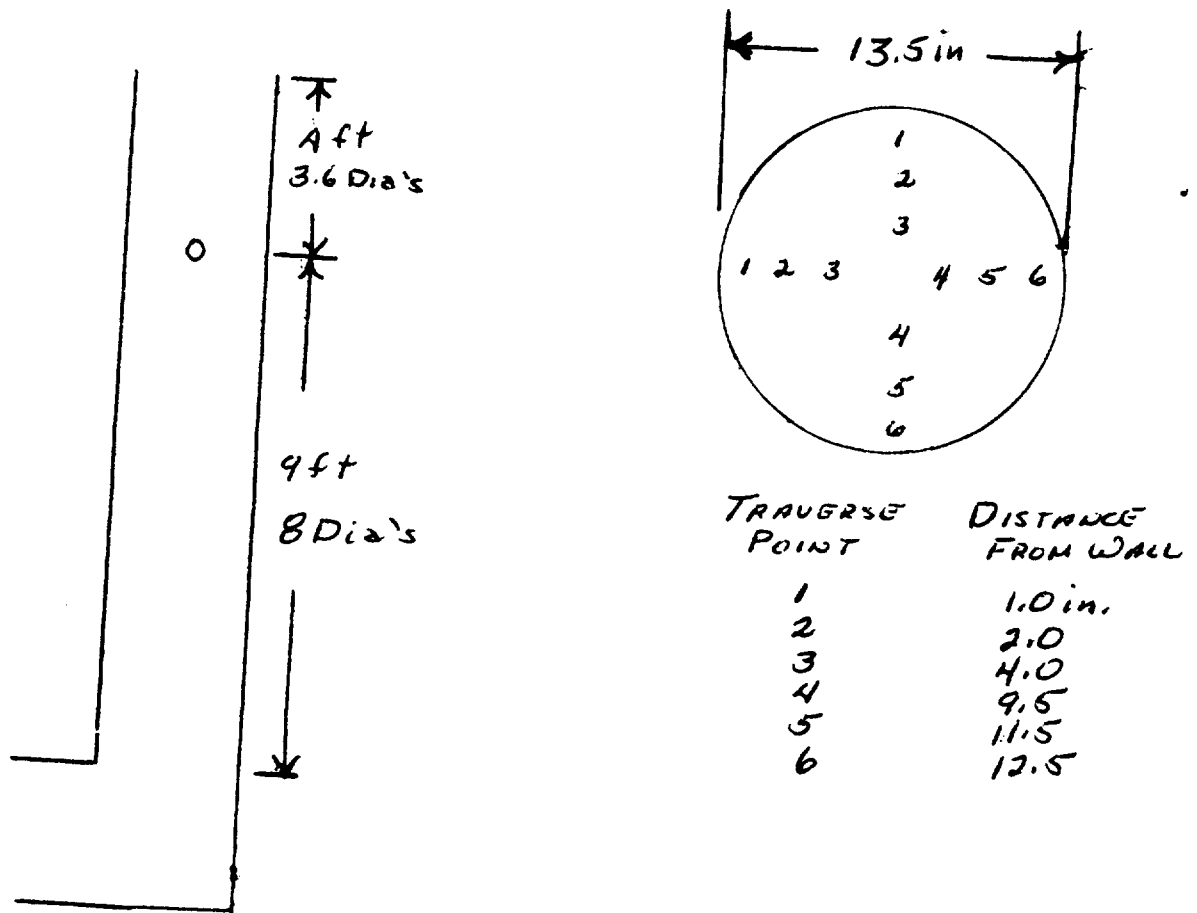
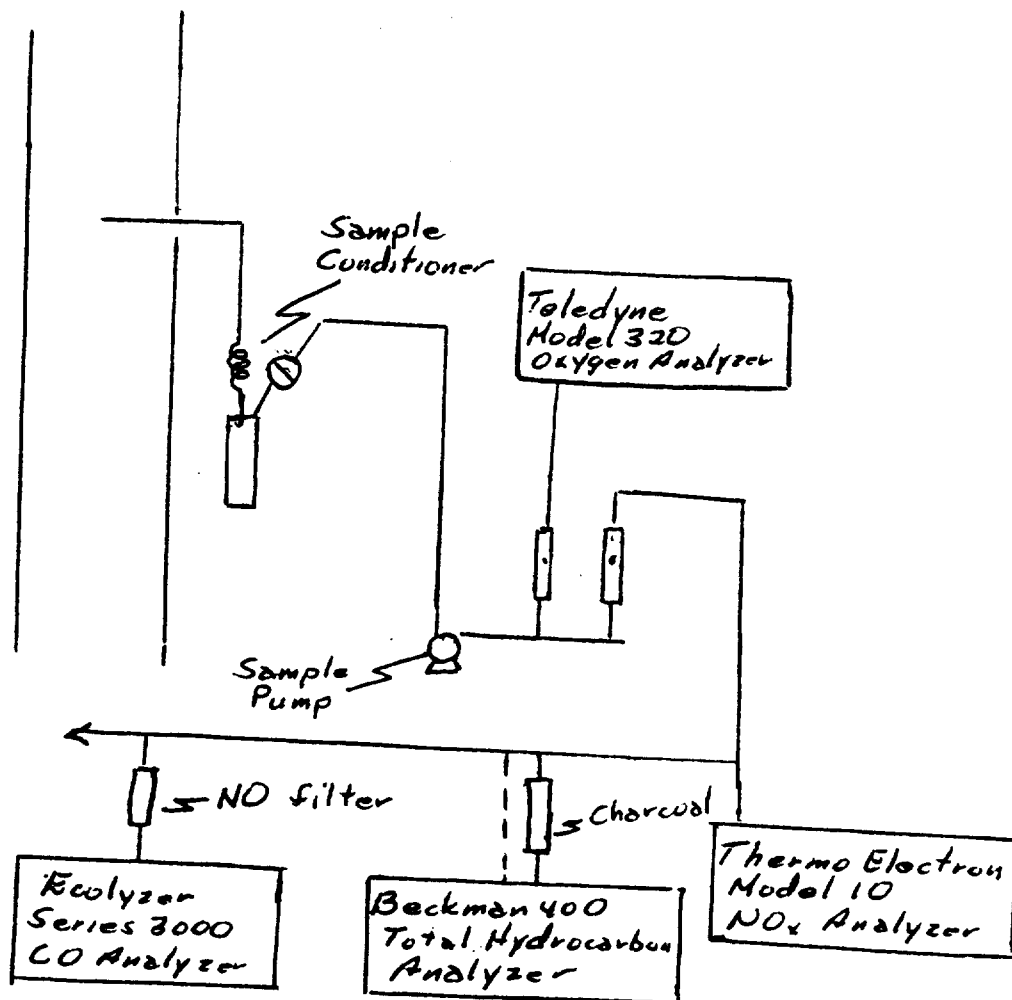


FIGURE 2
SCHEMATIC OF GAS MONITORING SYSTEM



APPENDIX 1
GAS MONITOR RECORDS

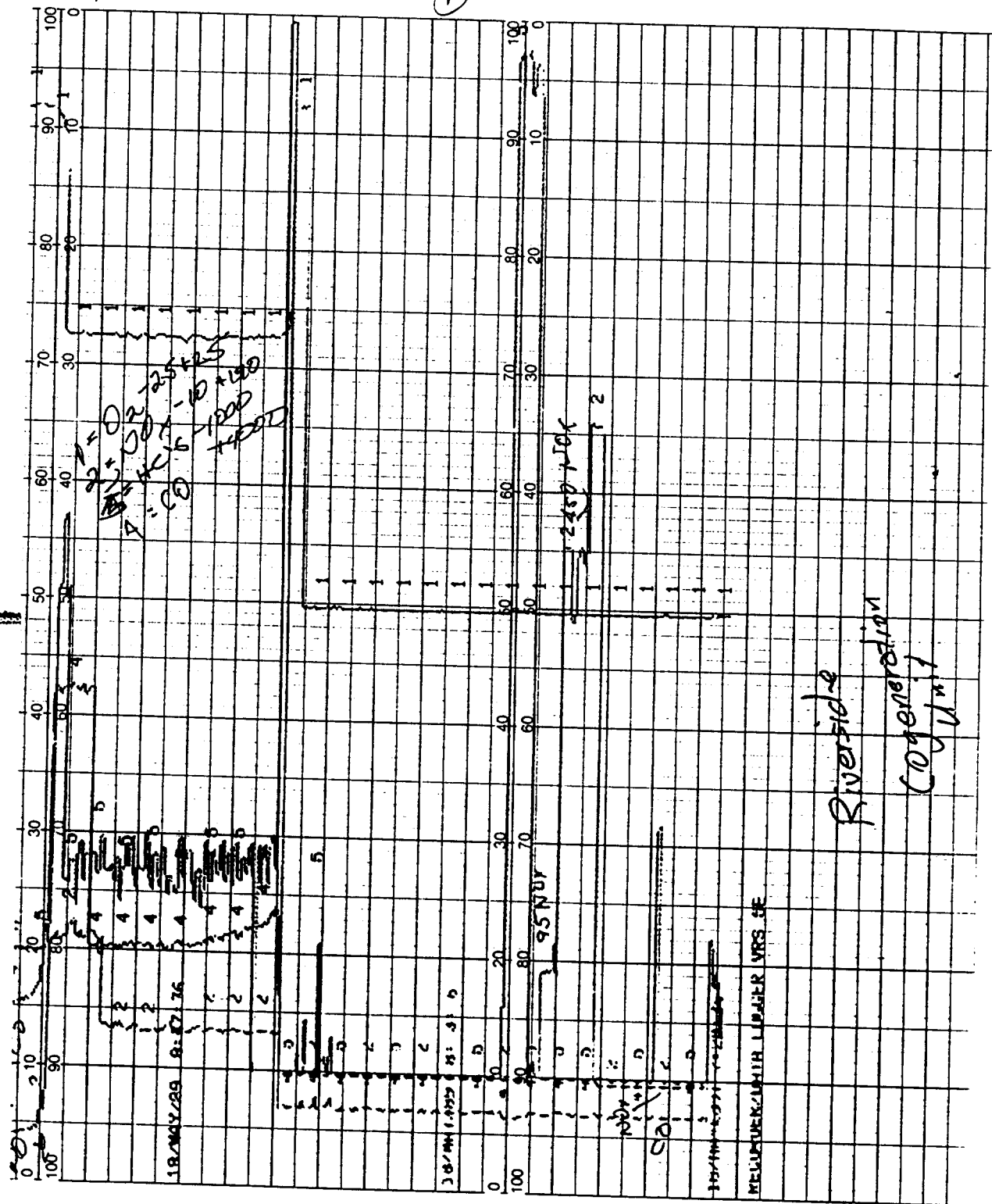
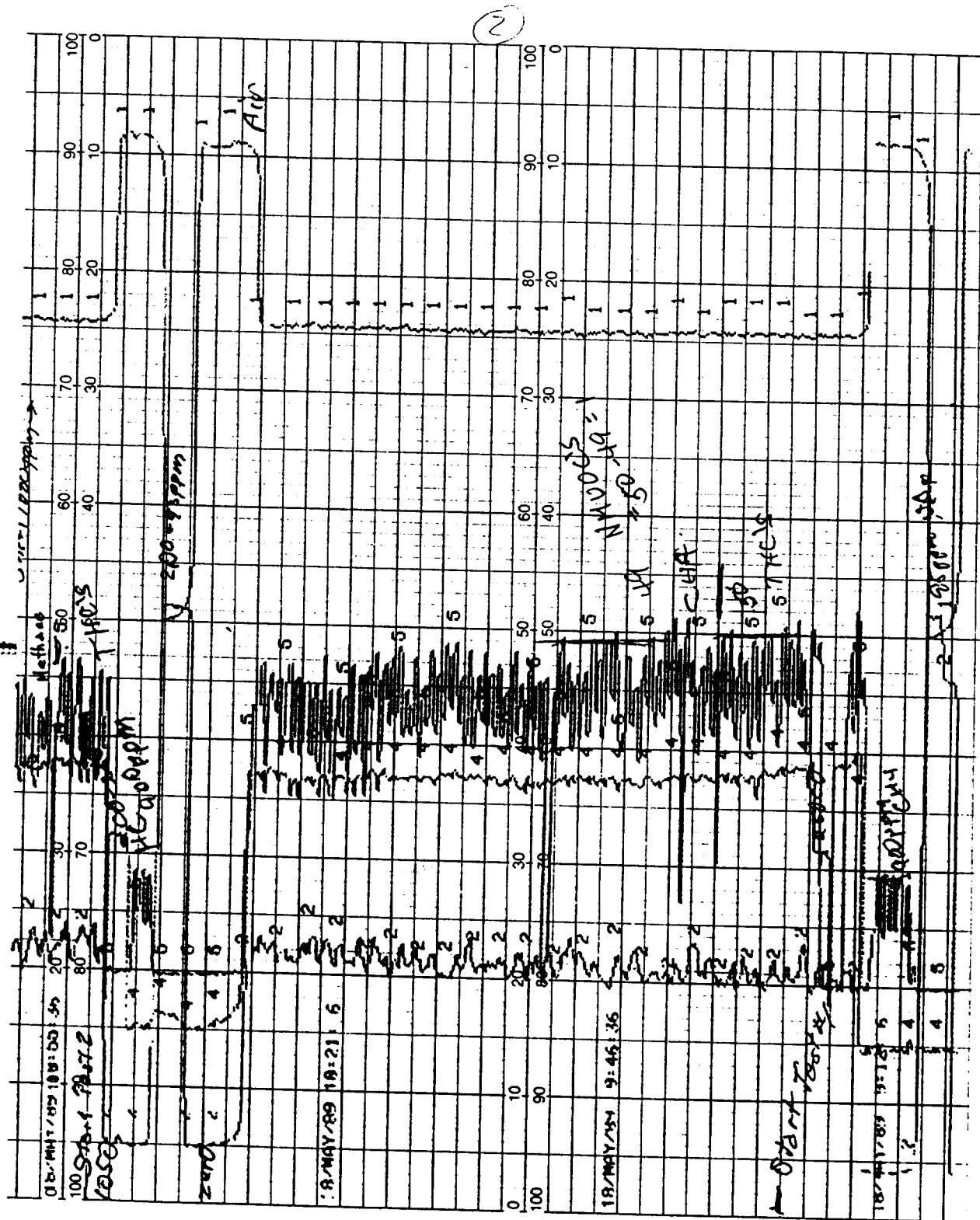


CHART NO 414460



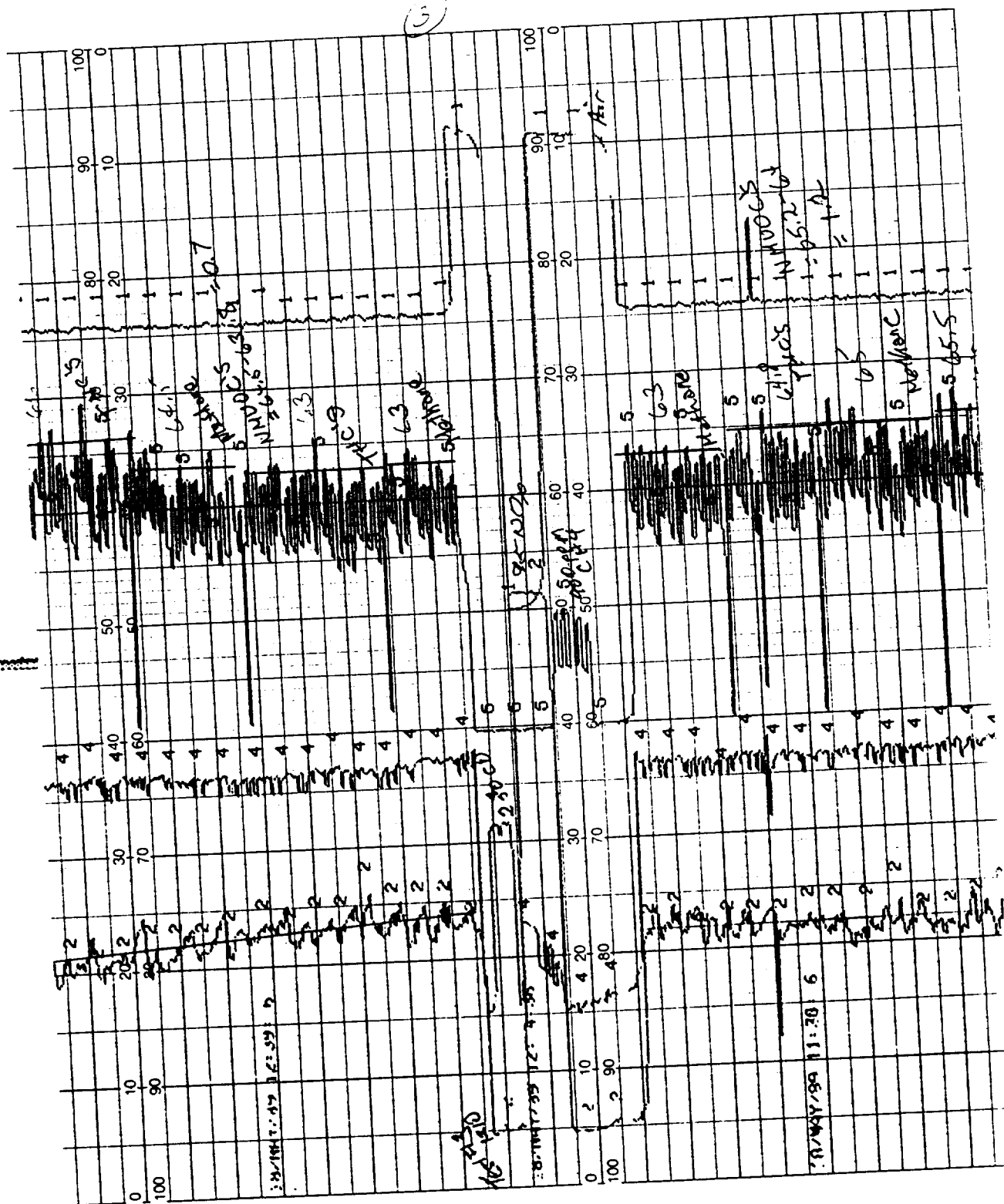


CHART NO 414460

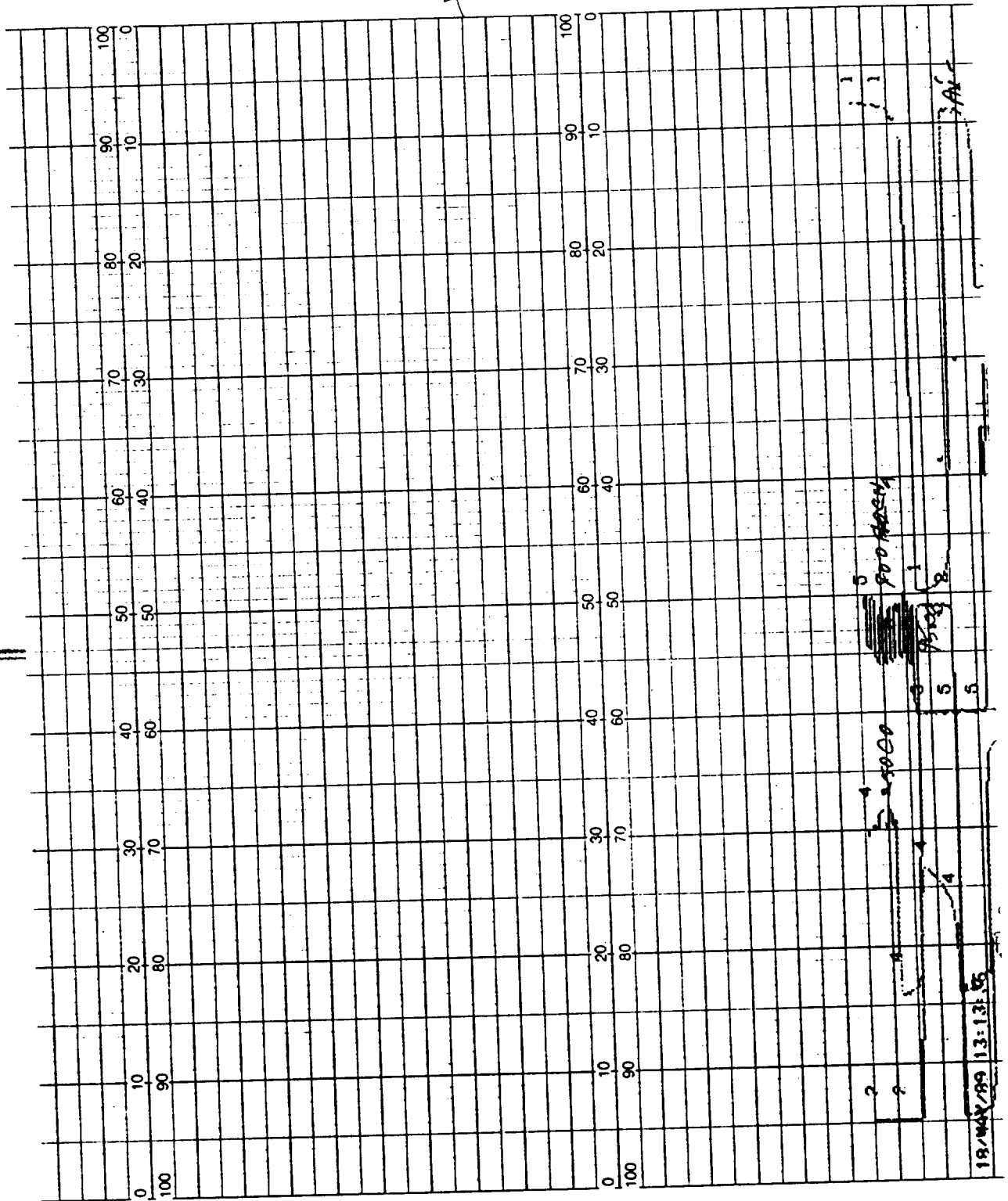


CHART NO 414460

18/04/09 13:13:55

LITHO PRINTED IN U.S.A. (JASON WESLEY PUBL.) HING COMPANY, INC. READING, MASS. V Dataform. 54

TEST	1	2	3
<u>NO_x</u>			
Coi (0ppm)	4.0	5.0	4.8
Cof	5.0	4.8	5.1
Co	4.5	4.9	5.0
Csi (95ppm)	52.0	51.3	51.5
Csf	51.3	51.5	49.0
Cs	51.65	51.40	50.25
Ca	21.5	22.0	22.4
CNO _x (ppm)	34	35	37
<u>CO</u>			
Coi (0ppm)	14.6	15.0	15.2
Cof	15.0	15.2	16.0
Co	14.8	15.1	15.6
Csi (250ppm)	31.7	31.8	31.5
Csf	31.8	31.5	31.5
Cs	31.75	31.65	31.5
Ca	31.0	36.5	36.0
Cco (ppm)	327	323	321
<u>HC's</u>			
Coi (0ppm)	19.9	39.8	39.8
Cof	19.8	39.8	39.8
Co	19.85	39.8	39.8
Csi (900ppm)	29.5	49.5	49.5
Csf	28.5	49.5	49.5
Cs	29.0	49.0	49.5
Ca	1	1.2	0.7
CUNNELS	98	117	65

5/18/89

Riverside Cageration
Unit

13 1/2" 3 1/2" offset
1 1/2"

1.65	1.46	
1.62	1.55	484 of
1.60	1.50	
1.52	1.50	
1.45	1.45	
0.90	1.00	

Area = 0.994 512

APPENDIX 2
OPERATING DATA

5/18/89 RIVERSIDE HOSPITAL STACK TEST

<u>TIME</u>	<u>GAS FUEL RATE</u> (CCFH)		<u>KW</u>
9:26 AM	93.6		744.4
9:41 AM	92.6		752.9
9:56 AM	92.6	Test #1 9272 cfh	757.1
10:11 AM	92.2		752.9
10:26 AM	92.6		765.5
10:41 AM	91.7		752.9
10:56 AM	92.2		748.6
11:11 AM	92.2	Test #2 9182 cfh	752.9
11:26 AM	91.7		744.4
11:41 AM	91.2		744.4
11:56 AM	91.7		740.2
12:11 PM	91.2		744.4
12:26 PM	91.7	Test #3 9178 cfh	757.1
12:41 PM	91.7		765.5
12:56 PM	91.7		731.6
1:11 PM	92.6		757.1

Mary Palmer
 Dr. Edwin M. M.
 i-generation Partners of America

APPENDIX 3
COMPUTER SUMMARIES

MONARCH ANALYTICAL LABORATORIES

RIVERSIDE HOSPITAL
5-18-89

TESTED: COGENERATION UNIT TEST #1

VELOCITY HEAD (in H2O)	FLUE GAS TEMPERATURE		FLUE GAS VELOCITY	
	(K)	(F)	(mps)	(fps)
1.650	524.	484.	29.9	98.3
1.620	524.	484.	29.7	97.4
1.600	524.	484.	29.5	96.8
1.520	524.	484.	28.7	94.3
1.450	524.	484.	28.1	92.1
0.900	524.	484.	22.1	72.6
1.460	524.	484.	28.2	92.4
1.550	524.	484.	29.0	95.2
1.500	524.	484.	28.6	93.7
1.500	524.	484.	28.6	93.7
1.450	524.	484.	28.1	92.1
1.000	524.	484.	23.3	76.5
AVERAGE	524.	484.	27.8	91.2

PRESSURE = 29.40 in Hg
DIAMETER = 13.5 in
AREA = 0.99 sq ft
= 5.0

PITOT CF
METER CF
ORIFICE PRESSURE
BAROMETRIC PRESSURE

= 0.840
= 1.000
= 0.0 in H2O
= 29.40 in Hg

0.0
13.0

IL. WT. = 82.0
= 29.32

METER VOLUME
MOL. WEIGHT

= 0.000 cu ft
= 28.30

PPM MEASURED

34.

327.

IC'S

98.

MONARCH ANALYTICAL LABORATORIES

PLANT: RIVERSIDE HOSPITAL
 DATE: 5-18-89
 SOURCE TESTED: COGENERATION UNIT TEST #1

	CONCENTRATION			EMISSION RATE	
	g/dscm	sr/dscf	PPM	g/sec	lb/hr
NOX	0.0651	0.0284	34.0	0.083	0.66
CO	0.3811	0.1662	327.0	0.488	3.88
NM VOC'S	0.0653	0.0285	98.0	0.084	0.66

FLUE GAS VOLUME 2.57 acms (5440. acfm)
 1.28 dscms(2720. dscfm)

MOISTURE 9.00%

STANDARD CONDITIONS- 68. F, 29.92 in Hg

MONARCH ANALYTICAL LABORATORIES

PLANT: RIVERSIDE HOSPITAL
 DATE: 5-18-89
 SOURCE TESTED: COGENERATION UNIT TEST #3

SAMPLE POINT	VELOCITY HEAD (in H ₂ O)	FLUE GAS TEMPERATURE		FLUE GAS VELOCITY	
		(K)	(F)	(mps)	(fps)
1	1.650	524.	484.	29.9	98.3
2	1.620	524.	484.	29.7	97.4
3	1.600	524.	484.	29.5	96.8
4	1.520	524.	484.	28.7	94.3
5	1.450	524.	484.	28.1	92.1
6	0.900	524.	484.	22.1	72.6
7	1.460	524.	484.	28.2	92.4
8	1.550	524.	484.	29.0	95.2
9	1.500	524.	484.	28.6	93.7
10	1.500	524.	484.	28.6	93.7
11	1.450	524.	484.	28.1	92.1
12	1.000	524.	484.	23.3	76.5
AVERAGE		524.	484.	27.8	91.2

FLUE PRESSURE	=	29.40 in Hg	PITOT CF	=	0.840
FLUE DIAMETER	=	13.5 in	METER CF	=	1.000
FLUE AREA	=	0.99 sq ft	ORIFICE PRESSURE	=	0.0 in H ₂ O
ZCO ₂	=	5.0	BAROMETRIC PRESSURE	=	29.40 in Hg
ZCO = 0.0					
ZO ₂ = 13.0					
ZN ₂	=	82.0	METER VOLUME	=	0.000 cu ft
DRY MOL. WT.	=	29.32	MOL. WEIGHT	=	28.30

PPM MEASURED

NOX	37.
CO	321.
NMVOC'S	65.

MONARCH ANALYTICAL LABORATORIES

PLANT: RIVERSIDE HOSPITAL
 DATE: 5-18-89
 SOURCE TESTED: COGENERATION UNIT TEST #3

	CONCENTRATION			EMISSION RATE	
	g/dscm	gr/dscf	PPM	g/sec.	lb/hr
NOX	0.0708	0.0309	37.0	0.091	0.72
CO	0.3741	0.1632	321.0	0.479	3.81
NMVOC'S	0.0433	0.0189	65.0	0.055	0.44

FLUE GAS VOLUME 2.57 acms (5440. acfm)
 1.28 dscms(2720. dscfm)

MOISTURE 9.00%

STANDARD CONDITIONS- 68. F, 29.92 in Hg