ARCO Alaska, Inc.
Post Office Box 360
Anchorage, Alaska 99510
Telephone 907 277 5637

November 21, 1983

Mr. Mike Johnston
Chief, Air Operations Section
Region X
1200 Sixth Avenue
Seattle, Washington 98101

Mr. Doug Lowery
Regional Supervisor
Alaska Department of
Environmental Conservation
Pouch 1601
Fairbanks, Alaska 99707

SUBJECT: Compliance Test Results - Kuparuk River Unit
PSD-X82-01
8336-AA002

Dear Sirs:

Please find a copy of the NO_x compliance tests performed on a drill site heater (DS-14) and a 14,000 HP gas-fired turbine (C2101C) on September 20 and 21, 1983. Both units are included in the Central Production Facility's (CPF-1) air quality permits. The units were tested by Chemecology Corp. of Bakersfield, California, and witnessed by Robert Russel of Pedco, representing EPA Region X.

If you have any questions, please contact me at (907) 263-4307.

Sincerely,

Alan Schuyler

Alan J. Schuyler
Senior Engineer
Regulatory Compliance

AJS:tlh-0031

Attachment

cc: D. Estes, ADEC-Juneau - w/attachment
S. Torok, EPA-Juneau - w/attachment

USEPA REG
0000006

CHEMECOLOGY CORPORATION
18823 Porterville Hwy., Bakersfield, CA 93308 • (805) 399-9335
Mailing Address: P.O. Box 1193, Bakersfield, CA 93302

FIELD DATA SOURCE TEST

PREPARED FOR: ARCO ALASKA INC.
POST OFFICE BOX 100360
ANCHORAGE, ALASKA 99510

ATTENTION: ALAN SCHUYLER

REGARDING: NOx TESTING @ GAS FIRED HEATER AND TURBINE IN KUPARUK OIL FIELD, ALASKA

REGULATORY AGENCY: EPA REGION #10

PURPOSE: COMPLIANCE (PSD-X82-01)

TEST DATE: SEPTEMBER 20 & 21, 1983

UNIT TESTED: a) HEATER DS-1Y
b) TURBINE CPF-1(C2101C)

REPORT NUMBER: 1781(c)

TESTED BY: L.A. Johnson
L.A. JOHNSON

REVIEWED BY: JKS

CHEMECOLOGY CORPORATION

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INTRODUCTION

INTRODUCTION

On September 20 and 21, 1983 Chemecology Corporation performed an emissions source test for Arco Alaska Inc. on their Drillsite Heater (Drill Station 1-Y) and Turbine Compressor Unit (CPF-1), respectively. The purpose of the test was to document compliance with EPA Region X (PSD-X82-01) by monitoring flows, NOx and O_2.

The units tested consist of a Black, Sivalls & Bryson 10 MMBtu/hr Production Heater and a General Electric 14,000 HP Compressor Train Gas Turbine located on the Kuparuk Lease, North Slope, Alaska. Both units were fired on lease natural gas and were operating under normal conditions.

Emissions of NOx and O_2 of both units were determined by using the following methods:

Parameter	Method	# Runs/Unit
NOx	Chemiluminescent Analyzer	3
O_2	Paramagnetic Analyzer	3
Fixed Gases	EPA Method #3	3
H_2O	EPA Method #4	3
Flow Rate	EPA Method #1 & #2	3
Fuel Analysis	Gas Chromatograph	1

All sampling and analysis was performed by Chemecology personnel except for the fuel samples which were analyzed by Arco's lab.

Andy Winkler, Analyzer Technician and Leslie Johnson, Stack Sampler and Project Supervisor for Chemecology Corporation performed the source test. Robert Russel, of Pedco observed the test procedures for EPA Region X. Alan Schuyler of Arco Alaska Inc. directed the testing of the Heater and Turbine.

HEATER PROCESS DESCRIPTION

The drill site heater at Drill Site 1Y is used for heating produced fluids from the sixteen oil wells which are also located on the 1Y drill pad. The fluids from these wells are commingled on site and then passed through the heater. Once the fluids have been heated, the produced fluids flow through insulated pipelines to the central production facility where oil, gas, and water are separated. To assist in the production of these wells some of the gas which was separated at the central production facility is returned to the drill sites. This gas is used as the fuel for drill site heaters and is also reinjected in various wells to assist in fluid production. The 1Y drill site heater has two stacks which provide for two separate burners and exhaust streams. The heater can modulate between 0 and 100 percent of design capacity dependent on total fluid production. During the compliance test the heater was at 50 percent of capacity.

During the test on September 20, 1983 about 29,000 barrels per day of produced fluids were being produced from Drill Site 1Y.

During the test period the measured temperature of inlet fluids to the heater was 97.5°F and the exit fluids were measured at 117.5°F. Thus the heater accounted for a 20 degree change in fluid temperature.

TURBINE PROCESS DESCRIPTION

Turbine train 'C' (C2101C) was tested on September 21 at Central Production Facility 1 (CPF-1) for compliance with NO_x emission standards. The turbine is used as a prime mover for two Dresser-Clark centrifugal compressors which compress gas in two stages from 70 to 1400 psig (pound per square inch gauge). This compressed gas is then returned to the individual drill sites to assist in the production of fluids from the wells or reinjected into the gas cap of the Kuparuk reservoir. During the test period various operating parameters were measured to determine horsepower of the unit while at specific operating conditions. Turbine speed, inlet air temperature, inlet pressure losses, exhaust stack pressure losses, compressor performance data, and fuel rate were among the parameters measured.

The shaft horsepower into the compressors was calculated to be 14800. As a double check the turbine horsepower was estimated at 14600 HP using GE turbine performance curves.

SUMMARY OF RESULTS

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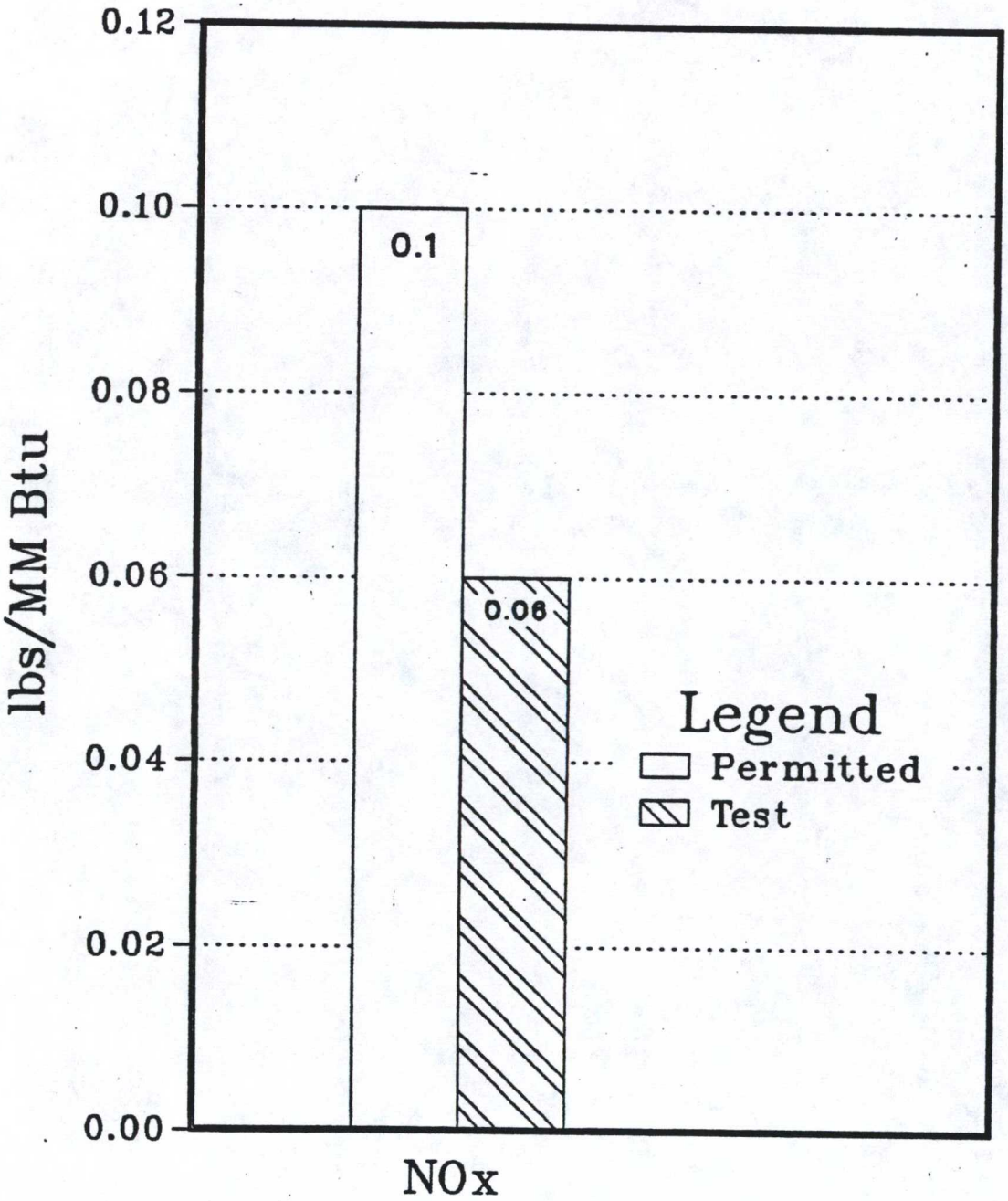
SUMMARY OF RESULTS: NOx Permit Conditions

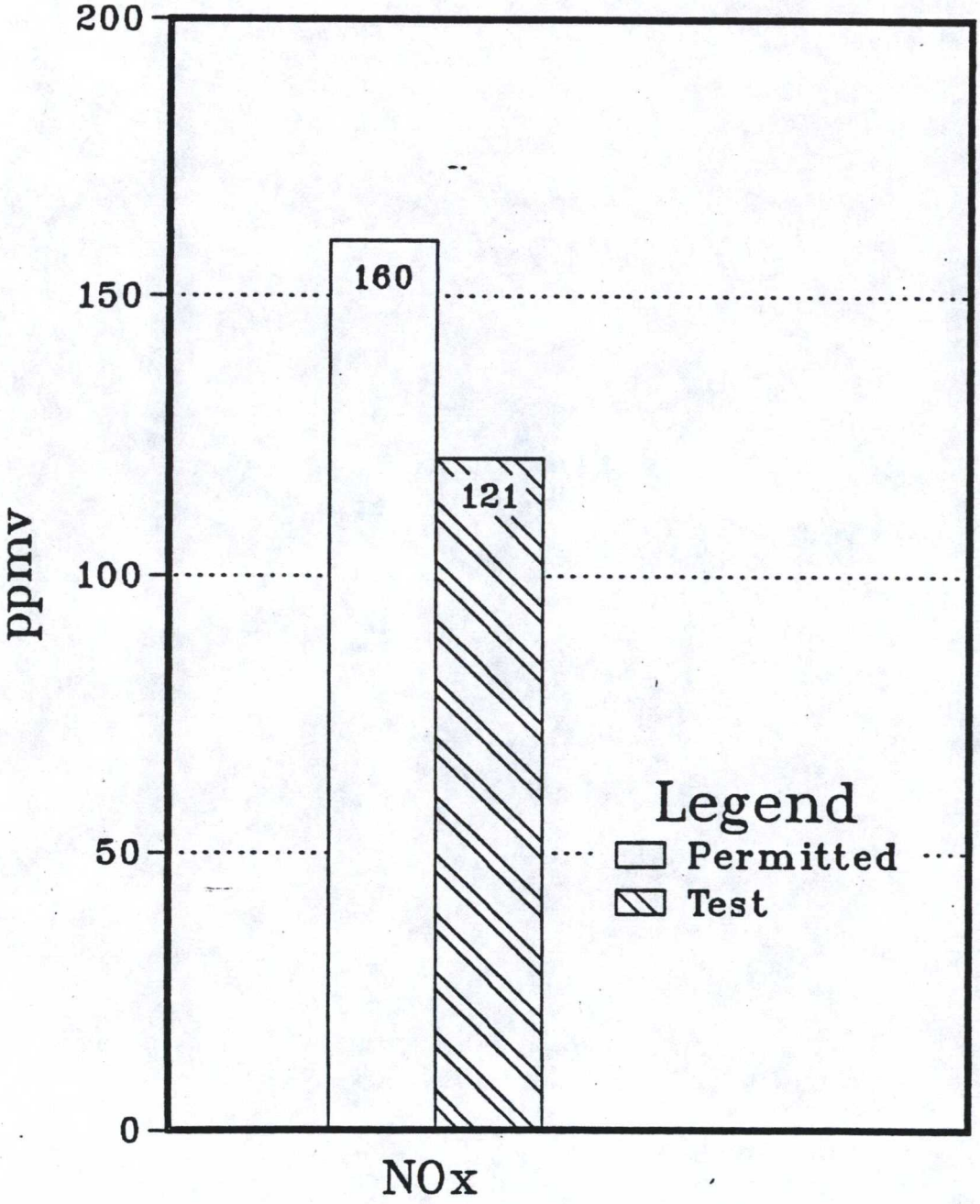
Unit	Allowable NOx Emissions	Actual NOx Emissions
Heater DS-1Y	0.10 $lb/10^6$ Btu	0.058 $lbs/10^6$ Btu
Turbine CPF-1 (C2101C)	160 ppm @ 15% O_2 1/	121 ppm @ 15% O_2

1/ See Appendix 2 for calculation of this permit condition.

NOx Emissions Summary
10 MM Btu/hr Heater
DS-1Y



NOx Emissions Summary
14,000 HP Turbine–C2101C
CPF–1



Arco Alaska

SUMMARY OF RESULTS: NOx Emissions

Actual Conditions

Source	ppm	English Units		Metric Units	
		lbs/MMBtu	lbs/hr	gms/joule	grms/sec
Heater DS-1Y	56	0.058	0.43	$2.5 * 10^{-8}$	$5.4 * 10^{-2}$
Turbine CPF-1 (C2101C)	96	0.445	61.4	$1.9 * 10^{-7}$	7.7

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SUMMARY OF RESULTS: Unit Operating Conditions (English Units)

Unit	$\%CO_2$(dry)	$\%O_2$(dry)	$\%H_2O$	Stack Temp(°F)	Stack Velocity (fps)	Volume Flow (DSCFM)
Heater DS-1Y	12.2	0.1	12.3	965	18	1,080
Turbine CPF-1 (C2101C)	1.5	16.2	4.4	895	143	89,600

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SUMMARY OF RESULTS: Unit Operating Conditions (Metric Units)

Unit	$\%CO_2$(dry)	$\%O_2$(dry)	$\%H_2O$	Stack Temp(°C)	Stack Velocity (mps)	Volume Flow (Cubic Meters/Sec)
Heater DS-1Y	12.2	0.1	12.3	518	5.5	0.51
Turbine CPF-1 (C2101C)	1.5	16.2	4.4	479	44	42.3

EPA METHOD #1/2/3/4/ DATA

COMPANY: ARCO ALASKA
UNIT: HEATER DS-1Y
DATE: 09-20-83

EPA METHOD #1/2/3/4 FIELD DATA

			#1	#2	#3
SITE :					
RUN# :					
TIME :			1620	1800	1835
V m	-	Dry sampled gas volume, dcf	20.15	18.50	17.95
Y	-	Meter calibration factor	0.986	0.986	0.986
P-bar	-	Barometric presure, in Hg	29.92	29.92	29.92
P-static	-	Stack static pressure, in H2O	-0.08	-0.06	-0.08
delta-H	-	Differential meter press, in H2O	0.00	0.00	0.00
T m	-	Meter tempurature, deg R	505	498	497
Vm(std)	-	Std sampled gas volume, dscf	20.78	19.35	18.81
V lc	-	Volume of water collected, gms	75.3	45.2	59.5
B ws	-	Water vapor fraction	0.144	0.098	0.128
MF	-	Moisture factor	0.856	0.902	0.872
CO2	-	% dry volume	12.0	12.3	12.4
O2	-	% dry volume	0.0	0.0	0.0
N2	-	% dry volume	88.0	87.7	87.6
MW-dry	-	Dry molecular weight	29.92	29.97	29.98
MW-wet	-	Wet molecular weight	28.20	28.80	28.45
C p	-	Pitot tube coefficient	0.80	0.80	0.80
$\sqrt{\text{delta-P}}$	-	Avg[sqrt(Pitot readings)], "H2O	0.17	0.22	0.20
T s	-	Stack temperature, deg R	1425	1430	1420
V s	-	Stack velocity, ft/sec	15.4	19.7	17.7
A s	-	Stack area, sq.ft.	3.14	3.14	3.14
Q s	-	Std volumetric flow rate, dscfm	919	1236	1079

COMPANY: ARCO ALASKA
UNIT: TURBINE CPF-1 (C2101C)
DATE: 09-21-83

EPA METHOD #1/2/3/4 FIELD DATA

SITE :					
RUN# :			#1	#2	#3
TIME :			1120	1215	1355
V m	-	Dry sampled gas volume, dcf	21.00	20.10	20.56
Y	-	Meter calibration factor	0.986	0.986	0.986
P-bar	-	Barometric presure, in Hg	29.65	29.65	29.65
P-static	-	Stack static pressure, in H2O	0.70	0.76	0.70
delta-H	-	Differential meter press, in H2O	0.00	0.00	0.00
T m	-	Meter tempurature, deg R	505	505	505
Vm(std)	-	Std sampled gas volume, dscf	21.46	20.54	21.01
V lc	-	Volume of water collected, gms	15.5	22.3	25.4
B ws	-	Water vapor fraction	0.032	0.048	0.053
MF	-	Moisture factor	0.968	0.952	0.947
CO2	-	% dry volume	1.5	1.5	1.4
O2	-	% dry volume	16.5	16.6	16.5
N2	-	% dry volume	82.0	81.9	82.1
MW-dry	-	Dry molecular weight	28.90	28.90	28.88
MW-wet	-	Wet molecular weight	28.55	28.38	28.31
C p	-	Pitot tube coefficient	0.80	0.80	0.80
√delta-P	-	Avg[sqrt(Pitot readings)], "H2O	1.64	1.66	1.64
T s	-	Stack temperature, deg R	1350	1355	1355
V s	-	Stack velocity, ft/sec	141.8	144.3	142.1
A s	-	Stack area, sq.ft.	28.27	28.27	28.27
Q s	-	Std volumetric flow rate, dscfm	90338	90130	88287

INITIAL MOLECULAR WEIGHT AND PERCENT WATER

REF: EPA, Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 3 and 4, 1981
: Conner, W. D. and J. S. Nader, Air Sampling with Plastic Bags, JAIHA 25:291-297, May - June, 1964

MOLECULAR WEIGHT:

Sampling Procedure:

A stainless steel probe with glass wool plug was inserted into the duct. A hand pump or an electric peristaltic pump was attached to the probe, followed by a rubber bladder sample container. The sampling lines were flushed with sample, then the bladder was filled by pumping duct gases into the bladder.

Analytical Procedure:

The bladder was analyzed by Orsat for dry percent CO_2, O_2 and N_2. The bulb of the analyzer was flushed with sample then filled at ambient temperature and pressure. Carbon dioxide was determined by absorption in potassium hydroxide; oxygen in Oxsorbent and nitrogen by difference. Replicate runs were made until agreement was reached. When indicated, ppm range CO was determined by Dräger tube.

PERCENT WATER:

Procedure 1: (EPA, Method 4, Condensation Method)

A tared condenser and drying tube were inserted in place of the spent molecular weight apparatus. Where possible the probe was heated above 225°F. A dry gas meter was attached downstream of the pump. Sampling was maintained at a constant rate of approximately 0.5 CFM. Percent water was determined by the increase in weight at the condenser and drying tube plus the meter data.

Procedure 2: (Saturated Duct Gas)

When at or above saturation, gaseous percent water was calculated directly from the average duct temperature and pressure by psychrometry.

Procedure 3: (Wet-Dry Bulb)

Two thermometers, one within a water saturated wick, were inserted into the duct gas stream. At equilibrium the two temperatures were recorded. Gaseous percent water was calculated from the wet and dry bulb temperatures by psychrometry.

VELOCITY TRAVERSE AND VOLUME FLOW RATE

REF: Environmental Protection Agency, Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 1 and 2, 1981
: Bay Area AQMD, Manual of Procedures, San Francisco, CA, Method St-17 January, 1982
: ASME Performance Test Code #27, New York, NY, 1957
: ASTM D-2928-71
: Western Precipitation Division of Joy Manufacturing, WP-50, 1968

PROCEDURE:

Duct temperature and velocity were read at each of several traverse points 1/ within the duct. The number and location of traverse points was chosen to aid in the extraction of a representative sample (i.e. by EPA Method 1). Velocity head was determined using a calibrated type "S" pitot tube and Magnehelic differential pressure gauge. Duct temperature was measured by means of a thermocouple attached to the pitot tube. Static pressure was measured with the Magnehelic and one leg of the pitot tube. Using the molecular weight and traverse data, velocity was calculated at each traverse point. From the average velocity, duct area, temperature, pressure and composition, actual and standard gas volume flow rate were calculated for the duct.

CALCULATIONS:

Performed by computer based on the following equations:

1/ Duct temperature was not measured at each traverse point. A temperature probe was inserted at each port and used for each traverse.

METHOD 2 STACK GAS VELOCITY AND VOLUMETRIC FLOWRATE

Average Stack Gas Velocity

$$P_g = \frac{\text{Static Pressure, "}H_2O\text{"}}{13.6}$$

$$P_s = P_{bar} + P_g \qquad \text{Eq. 2-6}$$

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

Average Stack Gas Dry Volumetric Flow Rate

$$Q_{std} = 60\,(1-B_{ws})\, v_s\, A \left(\frac{T_{std}}{T_s\,(avg)}\right)\left(\frac{P_s}{P_{std}}\right) \qquad \text{Eq. 2-10}$$

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

METHOD 3 DRY MOLECULAR WEIGHT OF STACK GAS

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

Wet Molecular Weight of Stack Gas

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

METHOD 4 DETERMINATION OF MOISTURE CONTENT IN STACK GASES (Use when a moisture train is run separately from other pollutant measurements.)

Volume of Water Vapor Condensed

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

Where K_1 = 0.04646 ft^3/ml @ 520°R
0.04717 @ 528°R

Volume of Water Vapor Collected in Silica Gel

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

Where K_2 = 0.04651 ft^3/g @ 520°R
0.04723 @ 528°R

Sample Gas Volume

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

Where K_3 = 17.38 °R/in Hg @ 520°R
17.65 @ 528°R

Moisture Content

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

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

$MF = 1 - B_{ws}$

NOMENCLATURE

A	=	Cross-sectional area of stack (ft^2)
A_n	=	Cross-sectional area of nozzle, (ft^2)
B_{ws}	=	Proportion of water vapor, by volume, in the gas stream
C_a	=	Acetone blank residue concentration, (mg/g)
C_p	=	Pitot tube coefficient, dimensionless
C_s	=	Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, (gr/dscf)
C_{SO_2}	=	Concentration of sulfur dioxide, dry basis corrected to standard conditions, (lb/dscf)
$C_{H_2SO_4}$	=	Sulfuric acid (including SO_3) concentration, corrected to standard conditions, (lb/dscf)
ΔH	=	Average pressure differential accross the orifice meter, (in H_2O)
K_p	=	Pitot tube constant, $85.49 \frac{ft}{sec}\left[\frac{(lb/lb\text{-}mole)(in\ Hg)}{(^\circ R)(in\ H_2O)}\right]^{1/2}$
L_p	=	Leakage rate observed during the post-test leak check, (cfm)
L_a	=	Maximum acceptable leakage rate, (0.02 cfm or 4% of average sampling rate, whichever is less)
L_i	=	Individual leakage rate observed during the leak check conducted prior to the "i^{th}" component change, (cfm)
m_a	=	Mass of residue of acetone after evaporation, mg.
M_d	=	Molecular weight of stack gas, dry basis, (lb/lb-mole)
m_n	=	Total weight of particulate matter collected, mg.
M_s	=	Molecular weight of stack gas, wet basis, (lb/lb-mole)
M_w	=	Molecular weight of water, 18 lb/lb-mole
N	=	Normality of barium perchlorate titrant, (milliequivalents/ml)
Δp	=	Velocity head of stack gas, (in. H_2O)
P_{bar}	=	Barometric pressure at measurement site (in Hg)
P_g	=	Stack static pressure, (in Hg)
P_m	=	Absolute pressure at the dry gas meter
P_s	=	Absolute stack gas pressure, (in Hg)
P_{std}	=	Standard absolute pressure, 29.92 in Hg
Q_{std}	=	Dry volumetric stack gas flow rate, standard conditions, (dscfm)
R	=	Ideal gas constant, 21.85 (in Hg)(ft^3)/(lb-mole)(°R)
t_s	=	Stack temperature, (°F)
T_m	=	Absolute temperature at meter,(°R)
T_{std}	=	Standard Absolute temperature, (520°R)
T_s	=	Absolute stack temperature, (460° + t_s)
V_a	=	Volume of sample aliquot titrated, (ml)
V_{ab}	=	Volume of acetone blank, ml
V_m	=	Dry gas volume measured by dry gas meter, (dcf)
$V_{m(std)}$	=	Dry gas volume measured by dry gas meter, corrected to standard conditions, (dscf)
$V_{wc(std)}$	=	Volume of water vapor condensed corrected to standard

conditions, (scf)

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

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

V_f = Final volume of condensed water, ml

V_i = Initial volume of condensed water, ml

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

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

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

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

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

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

Y = Dry gas meter calibration factor

ρ_w = Density of water, (0.002202 lb/ml @ 68°F)

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

MF = Moisture factor

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

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

%CO = Percent CO by volume (dry basis)

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

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

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

0.320 = Molecular weight of O_2, divided by 100

0.440 = Molecular weight of CO_2, divided by 100

60 = Conversion factor, (sec/min)

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

32.03 = Equivalent weight of sulfur dioxide

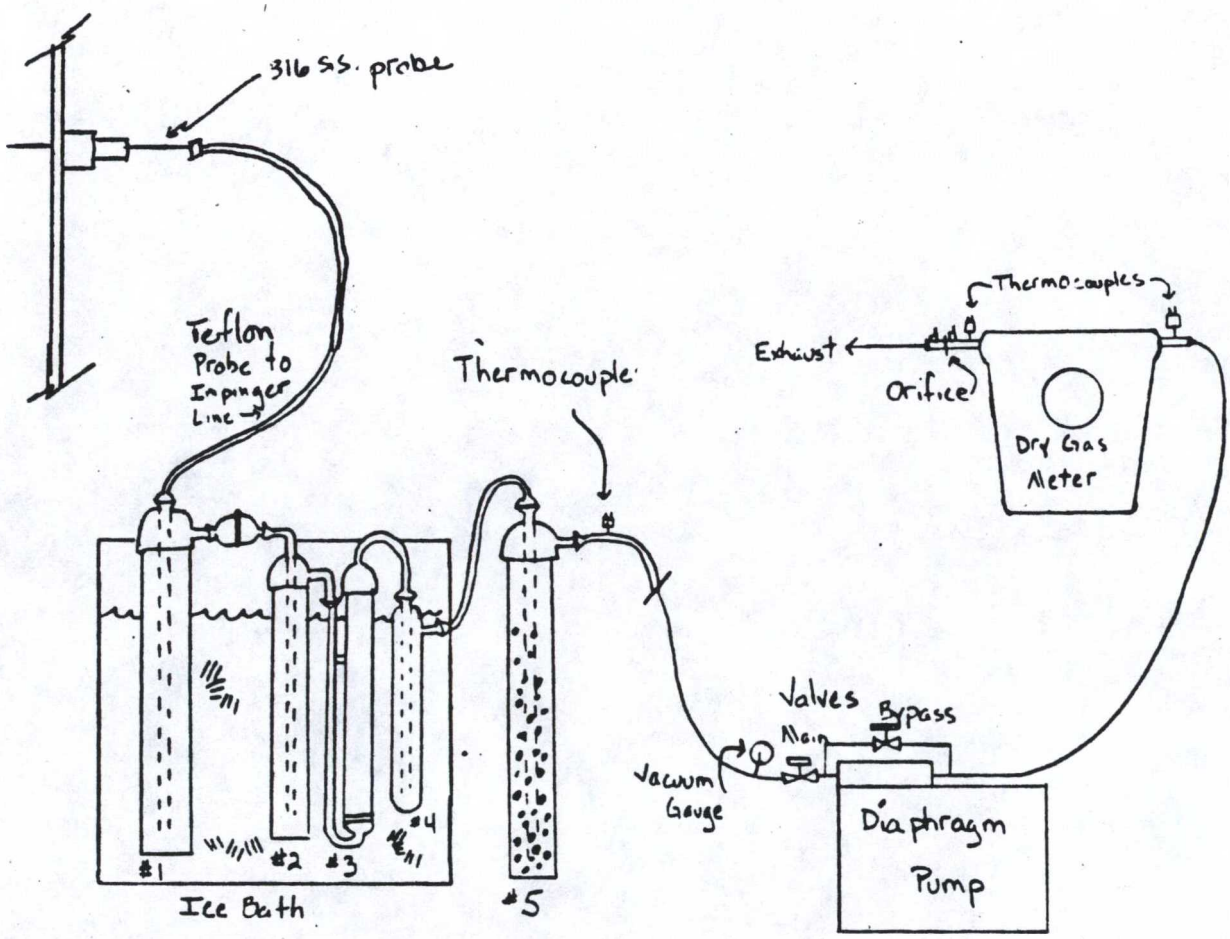
θ = Total sampling time (min)

θ_1 = Sampling time interval, from the run beginning until first component change, (min)

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

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

EPA Method #4
Condensation Train



Impinger #	Contents
1	100 mls Distilled Water
2	50 mls Distilled Water
3	50 mls Distilled Water
4	Empty
5	200-300 grms Silica Gel

NOx & O_2 BY INSTRUMENTATION

Arco Alaska

NOx & O_2 INSTRUMENT RESULTS

Unit	Date	Run #	Time	$\%O_2$	ppm NOx	SDCFM	lbs/hr	ppm corrected to 15% O_2
Heater 1-Y	9-20-83	1	16:45-17:15	0.1	53	920	0.35	-
		2	18:20-18:50	0.1	58	1,240	0.52	-
		3	19:05-19:35	0.1	56	1,080	0.43	-
			Average:	0.1	56	1,080	0.43	
Turbine CPF-1 C2101C	9-21-83	1A	11:15-12:00	16.1	94	90,300	60.8	116
		1B	12:20-13:05	16.3	96	90,300	62.1	123
		2	13:35-14:05	16.2	95	90,100	61.3	119
		3	14:20-14:50	16.3	97	88,300	61.3	124
			Average: 1/	16.2	96	89,600	61.4	121

1/ Note: Averages for turbine are calculated with Run 1A and 1B as a single test run.

COMPANY: ARCO ALASKA
UNIT NAME: HEATER DS-1Y
TEST DATE: 09-20-83

INSTRUMENT RUN #1

INTERVAL	START	FINISH	O2(%)	NOx (ppm)
#1	16.45	16.50	0.2	93.2
#2	16.50	16.55	0.1	93.0
#3	16.55	17.00	0.1	92.9
#4	17.00	17.05	0.1	93.7
#5	17.05	17.10	0.1	93.6
#6	17.10	17.15	0.0	93.4
AVERAGE:	16.45	17.15	0.1	93.3
Units:			(%)	(ppm)

CALIBRATION DATA:

Initial ZERO	0.0	0.0
Initial SPAN	21.0	92.0
Final ZERO	0.2	1.0
Final SPAN	21.0	93.0
RANGE (full scale, % or ppm)	25	500
SPAN GAS VALUE (% or ppm)	20.9	92.3
ZERO DRIFT (% of SPAN)	1.0%	1.1%
SPAN DRIFT (% of SPAN)	-1.0%	0.0%
ZERO DRIFT (% of RANGE)	0.8%	0.2%
SPAN DRIFT (% of RANGE)	-0.8%	0.0%

COMPANY: ARCO ALASKA
UNIT NAME: HEATER DS-1Y
TEST DATE: 09-20-83

INSTRUMENT RUN #2

INTERVAL	START	FINISH	O2(%)	NOx(ppm)
#1	18.20	18.25	0.1	56.2
#2	18.25	18.30	0.1	57.1
#3	18.30	18.35	0.1	57.1
#4	18.35	18.40	0.1	57.1
#5	18.40	18.45	0.1	58.1
#6	18.45	18.50	0.0	59.1
AVERAGE:	18.20	18.50	0.1	57.5
Units:			(%)	(ppm)

CALIBRATION DATA:

Initial ZERO	0.1	1.0
Initial SPAN	20.9	93.0
Final ZERO	0.2	3.0
Final SPAN	21.0	92.0
RANGE (full scale, % or ppm)	25	500
SPAN GAS VALUE (% or ppm)	20.9	92.3
ZERO DRIFT (% of SPAN)	0.5%	2.2%
SPAN DRIFT (% of SPAN)	0.0%	-3.3%
ZERO DRIFT (% of RANGE)	0.4%	0.4%
SPAN DRIFT (% of RANGE)	0.0%	-0.6%

COMPANY: ARCO ALASKA
UNIT NAME: HEATER DS-1Y
TEST DATE: 09-20-83

INSTRUMENT RUN #3

INTERVAL	START	FINISH	O2(%)	NOx(ppm)
#1	19.05	19.10	0.1	55.0
#2	19.10	19.15	0.1	55.9
#3	19.15	19.20	0.1	55.8
#4	19.20	19.25	0.0	55.6
#5	19.25	19.30	0.0	55.5
#6	19.30	19.35	0.0	55.3
AVERAGE:	19.05	19.35	0.1	55.5
Units:			(%)	(ppm)

CALIBRATION DATA:

Initial ZERO	0.0	0.0
Initial SPAN	20.9	92.0
Final ZERO	0.1	1.0
Final SPAN	21.0	93.0
RANGE (full scale, % or ppm)	25	500
SPAN GAS VALUE (% or ppm)	20.9	92.3
ZERO DRIFT (% of SPAN)	0.5%	1.1%
SPAN DRIFT (% of SPAN)	0.0%	0.0%
ZERO DRIFT (% of RANGE)	0.4%	0.2%
SPAN DRIFT (% of RANGE)	0.0%	0.0%

COMPANY: ARCO ALASKA
UNIT NAME: TURBINE CPF-1 (C2101C)
TEST DATE: 09-21-83

INSTRUMENT RUN #1A

INTERVAL	START	FINISH	O2(%)	NOx(ppm)
#1	11.15	11.20	16.2	94.8
#2	11.20	11.25	16.2	93.5
#3	11.25	11.30	16.1	93.1
#4	11.30	11.35	16.1	93.6
#5	11.35	11.40	16.2	94.2
#6	11.40	11.45	16.1	93.8
#7	11.45	11.50	16.1	93.5
#8	11.50	11.55	16.1	93.1
#9	11.55	12.00	16.1	93.6
AVERAGE:	11.15	12.00	16.1	93.7
Units:			(%)	(ppm)

CALIBRATION DATA:

Initial ZERO	0.0	0.0
Initial SPAN	20.8	96.0
Final ZERO	0.3	4.0
Final SPAN	21.3	100.0
RANGE (full scale, % or ppm)	25	500
SPAN GAS VALUE (% or ppm)	20.9	92.3
ZERO DRIFT (% of SPAN)	1.4%	4.2%
SPAN DRIFT (% of SPAN)	1.0%	0.0%
ZERO DRIFT (% of RANGE)	1.2%	0.8%
SPAN DRIFT (% of RANGE)	0.8%	0.0%

COMPANY: ARCO ALASKA
UNIT NAME: TURBINE CPF-1 (C2101C)
TEST DATE: 09-21-83

INSTRUMENT RUN #1B

INTERVAL	START	FINISH	O2(%)	NOx(ppm)
#1	12.20	12.25	16.3	97.8
#2	12.25	12.30	16.3	96.4
#3	12.30	12.35	16.4	92.1
#4	12.35	12.40	16.3	92.7
#5	12.40	12.45	16.2	96.2
#6	12.45	12.50	16.2	98.7
#7	12.50	12.55	16.2	97.3
#8	12.55	13.00	16.3	95.9
#9	13.00	13.05	16.3	97.5
AVERAGE:	12.20	13.05	16.3	96.1
Units:			(%)	(ppm)

CALIBRATION DATA:

Initial ZERO	0.0	1.0
Initial SPAN	21.0	95.0
Final ZERO	0.5	2.0
Final SPAN	21.4	99.0
RANGE (full scale, % or ppm)	25	500
SPAN GAS VALUE (% or ppm)	20.9	92.3
ZERO DRIFT (% of SPAN)	2.4%	1.1%
SPAN DRIFT (% of SPAN)	-0.5%	3.2%
ZERO DRIFT (% of RANGE)	2.0%	0.2%
SPAN DRIFT (% of RANGE)	-0.4%	0.6%

COMPANY: ARCO ALASKA
UNIT NAME: TURBINE CPF-1 (C2101C)
TEST DATE: 09-21-83

INSTRUMENT RUN # 2

INTERVAL	START	FINISH	O2(%)	NOx(ppm)
#1	13.35	13.40	16.2	95.3
#2	13.40	13.45	16.2	96.4
#3	13.45	13.50	16.2	95.6
#4	13.50	13.55	16.2	94.8
#5	13.55	14.00	16.2	94.0
#6	14.00	14.05	16.2	94.1
AVERAGE:	13.35	14.05	16.2	95.0
Units:			(%)	(ppm)

CALIBRATION DATA:

Initial ZERO	0.0	0.0
Initial SPAN	21.0	96.0
Final ZERO	0.2	0.0
Final SPAN	21.0	95.0
RANGE (full scale, % or ppm)	25	500
SPAN GAS VALUE (% or ppm)	20.9	92.3
ZERO DRIFT (% of SPAN)	1.0%	0.0%
SPAN DRIFT (% of SPAN)	-1.0%	-1.0%
ZERO DRIFT (% of RANGE)	0.8%	0.0%
SPAN DRIFT (% of RANGE)	-0.8%	-0.2%

COMPANY: ARCO ALASKA
UNIT NAME: TURBINE CPF-1 (C2101C)
TEST DATE: 09-21-83

INSTRUMENT RUN # 3

INTERVAL	START	FINISH	O2(%)	NOx(ppm)
#1	14.20	14.25	16.3	98.3
#2	14.25	14.30	16.3	97.5
#3	14.30	14.35	16.3	96.6
#4	14.35	14.40	16.3	96.8
#5	14.40	14.45	16.3	96.9
#6	14.45	14.50	16.3	96.1
AVERAGE:	14.20	14.50	16.3	97.0
Units:			(%)	(ppm)

CALIBRATION DATA:

Initial ZERO	0.0	0.0
Initial SPAN	21.0	95.0
Final ZERO	0.2	0.0
Final SPAN	21.0	94.0
RANGE (full scale, % or ppm)	25	500
SPAN GAS VALUE (% or ppm)	20.9	92.3
ZERO DRIFT (% of SPAN)	1.0%	0.0%
SPAN DRIFT (% of SPAN)	-1.0%	-1.1%
ZERO DRIFT (% of RANGE)	0.8%	0.0%
SPAN DRIFT (% of RANGE)	-0.8%	-0.2%

CONSTANT MONITORING

REF: Bay Area AQMD, Manual of Procedures, San Francisco, CA, Methods ST-5, ST-6, ST-13A, ST-14, ST-19A, January, 1982
: State of California, Air Resources Board, Draft Stationary Source Test Methods, Method 1-100, June, 1979

METHOD SUMMARY:

A representative sample of duct gas was extacted through a probe, filter, condenser and sample line by a pump. The sample was then pumped into a sampling manifold for distribution to one or more sample analyzers. The analyzers output a continuous analog recording of the concentrations of the analyzed gases in the sample. All analyzers were calibrated with EPA Protocol gases (traceable to National Bureau of Standards SRMs) or with recently analyzed gases (analysis by EPA Reference Methods).

SAMPLING SYSTEM:

A Pyrex glass or stainless steel probe with a Pyrex wool or glass fibre mat filter was positioned in the duct. The end of the probe was located at a point of average duct flow and average pollutant concentrations. The probe was connected with a short (about 2 feet) Teflon line to a sample conditioning train. The conditioning train included three glass knockout traps connected in series with Teflon lines and immersed in an ice bath. The train was connected with a Teflon line (¼ inch o.d.) to the pneumatic delivery system which was housed in the monitoring van.

PNEUMATIC DELIVERY SYSTEM:

The Teflon sample line delivered sample gas into a small glass knockout trap, then through an in-line Balston filter and a Hoke four-way selector valve to the Teflon-lined diaphragm sample pump (see accompanying diagram). The flow rate of the sample gas was regulated with main and bypass-flow needle valves and was read on the main flow meter (typical setting 10 SCFH). A 10 PSI pressure-relief valve kept the entire system pressure at a safe level. The manifold pressure was regulated with an exhaust needle valve and was read on the pressure gauge (typical setting 1 PSI). The sample in the manifold was delivered through needle valves and flow meters to the various analyzers.

LEAK CHECK PROCEDURE:

The sampling system was checked for leaks by plugging the end of the probe. The exhaust needle valve was closed and the entire sample flow was directed through one analyzer flow meter (range 0-1.0 SCFH). The bypass valve was closed until the vacuum gauge showed at least 15 inches Hg vacuum. The leak rate was observed at the analyzer flow meter (maximum allowable 2% of total sample flow). The system was checked for leaks before and after sampling.

CONSTANT MONITORING

CALIBRATION PROCEDURE:

Each analyzer was calibrated before and after each sample run. The Hoke four-way selector valve was used to direct the flow of the various calibration gases into the sample manifold. Each analyzer was calibrated with a zero gas (typically, ambient air or zero grade Nitrogen) and with a span gas (typical span gas concentration 60 to 90 percent of analyzer full scale and/or similar to expected sample concentration). All zero and span checks were recorded and noted on the recorder strip charts.

STRIP CHART DATA REDUCTION:

The analog recordings were averaged over time periods as shown on the data pages (typically 5 minutes, 15 minutes or 30 minutes). The data for each averaging period was digitized and recorded as average percent of full scale. These sample readings were then compared with the zero and span gas readings for calculation of the average concentration for each averaging period.

Any drift[1/] of the zero and span readings from the beginning to the end of a sampling period was corrected by calculating apparent zero and span readings for the midpoint of each averaging period. The sample average concentrations were then calculated from the sample readings and the apparent zero and span readings.

Instrument Data Reduction

Ref: State of California, Air Resources Board, Draft Stationary Source Test Methods, Method 1-100, June 1979

Definitions:

Z_o = initial zero reading (% full scale)

S_o = initial span reading (% full scale)

Z_f = final zero reading (%full scale)

S_f = final span reading (% full scale)

n = total # of intervals

i = identifier for ith interval

ΔZ = zero drift (% full scale)

ΔS = span drift (% full scale)

Range = ppm or % pollutant at 100% full scale

Z_i = calculated zero at mid-point of ith interval (% full scale)

S_i = calculated span at mid-point of ith interval (% full scale)

R_i = average pollutant reading for ith interval (% full scale)

C_i = drift corrected pollutant reading for ith interval (ppm or %)

SGV = span gas value (ppm or %)

Equations:

$$\Delta Z = Z_f - Z_o$$

$$\Delta S = S_f - S_o$$

$$Z_i = Z_o + i * (Z_f - Z_o)/(n + 1)$$

$$S_i = S_o + i * (S_f - S_o)/(n + 1)$$

$$C_i = (R_i - Z_i)/(S_i - Z_i) * SGV$$

EPA Method 20

Ref: EPA, Code of Federal Regulations; Title 40, Part 60, Appendix A, Method 20, 1981.

Method Summary:

The preliminary test were performed on the analyzer sampling system on day 1 or both days as indicated:

1) Systems Calibration Check - Both Days
2) NO/NO_2 Converter Check - Day 1
3) Response Time through entire sampling system - Day 1

Spanning and zeroing of the NOx and O_2 analyzers was done before and after each run. Ambient air drawn through Drierite was used for the NOx zero and the Oxygen span. An EPA Protocal gas (CAL-7232) was used to span the NOx analyzer and zero the Oxygen analyzer.

An oxygen stack traverse was performed on both the heater (1Y) and the Turbine (CPF-1). This traverse was done using the same sample points as the velocity profile. For the Turbine (CPF-1) the oxygen traverse was used as run number one (1A and 1B): traversing both ports, sampling for a minimum six (6) minutes per point, 12 points (1.5 minute response time plus 1 minute sampling). After proving no oxygen stratification exist two (2) additional thirty (30) minute runs were executed by sampling at eight selected points.

CONSTANT MONITORING

ANALYZERS:

Taylor Servomex OA250 or OA580 Oxygen Analyzer

The Taylor paramagnetic analyzer is used to measure the percent dry volume of oxygen in the sample gas. This analyzer contains a quartz-glass "dumb-bell" that is filled with nitrogen and suspended in a non-uniform magnetic field. The spheres at the ends of the dumb-bell are repelled from the strongest part of the field by their diamagnetic property. The dumb-bell therefore rotates to a position where the repellent force and the torque-resistance of the suspension are in equilibrium.

The sample gas flows into a sample cell which encases the dumb-bell. The paramagnetism of any oxygen in the sample gas reduces the intensity of the field and therefore alters the position of the dumb-bell. A small mirror at the center of the dumb-bell reflects a beam of light onto twin photocells (see schematic diagram). The output of the photocells is amplified and fed back to a coil around the dumb-bell. The current required to keep the dumb-bell at the zero position is a direct measure of the magnetic force and is therefore a measure of the oxygen content of the sample gas.

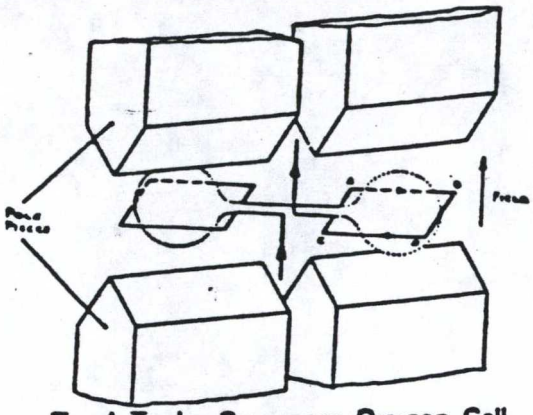


Fig. 1. Taylor Servomex Oxygen Cell — Schematic using Munday's principles

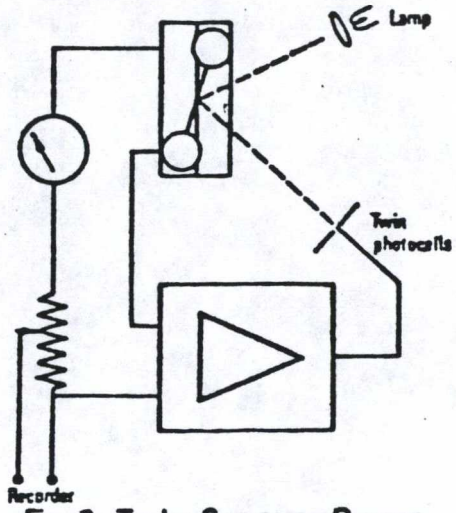


Fig. 2. Taylor Servomex Oxygen Analyser — Schematic

CONSTANT MONITORING

ANALYZERS:

Monitor Labs 8430 Nitrogen Oxides Analyzer

The Monitor Labs chemiluminescent analyzer is used to measure parts per million dry volume of Nitrogen Oxides in the sample gas. The analyzer measures the concentration of NO_x by converting NO_x to NO and then measuring the light emitted by the reaction of NO with ozone.

The sample gas is drawn into the analyzer by a vacuum pump which partially evacuates the reaction chamber. The sample flows through a NO2-to-NO converter1/ for NO_x analysis or may bypass the converter for NO analysis. The sample then flows through a temperature controlled critical orifice into the partially evacuated reaction chamber.

Ambient air is also drawn into the analyzer as an ozone carrier. The air flows through a desiccant cartridge for drying, then through an ozone generator which converts some of the oxygen in the air to ozone. The ozonated air then flows through a temperature-controlled critical orifice into the reaction chamber.

The sample gas and the ozonated air are mixed in the reaction chamber, where the following reaction takes place:

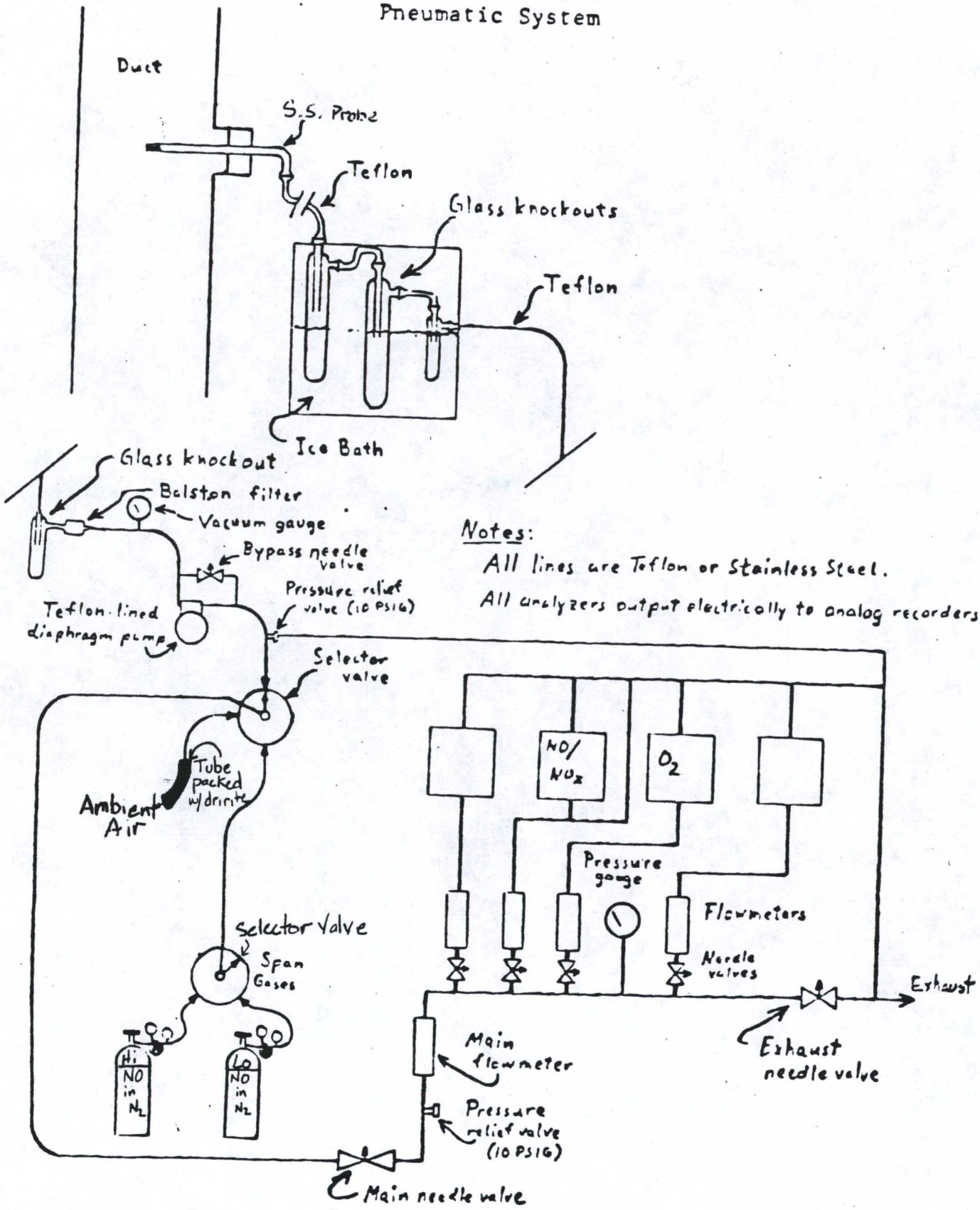
$$NO + O_3 \longrightarrow NO_2 + O_2 + h\nu$$

The intensity of the chemiluminescence is proportional to the concentration of NO in the reaction chamber. The light emitted by this chemiluminescent reaction shines through a window in the chamber onto a photomultiplier tube (PMT). A spinning light chopper wheel between the reaction chamber and the PMT allows the PMT output with no light to be compared electronically with the PMT output with light. The signal is processed electronically and output for recording of the concentration of NO (or NO_x if the converter is used).

1/ Either of two types of converter may be used-a 300°C Molybdenum-catalyst converter or a 900°C stainless steel converter.

CONSTANT MONITOR

Pneumatic System



Notes:

All lines are Teflon or Stainless Steel.

All analyzers output electrically to analog recorders.

FUEL ANALYSIS & EMISSION FACTORS

COMPANY: ARCO ALASKA, Inc.
UNIT ID: HEATER DS-1Y
DATE: 09-20-83

FUEL ANALYSIS & EMISSION FACTORS

POLLUTANT	% O2	PPM(dry)	LBS/DSCF	LBS/MMBTU
NOx RUN #1	0.1	53	6.33E-06	0.055
NOx RUN #2	0.1	58	6.92E-06	0.060
NOx RUN #3	0.1	56	6.69E-06	0.058
NOx AVERAGE	0.1	56	6.65E-06	0.058

FUEL GAS:	% H	% C	% S	% N	% O	Btu/lb	SDCF/MMBtu
Lease Gas	22.61	75.53	0.00	0.32	1.54	22648	8707

COMPANY: ARCO ALASKA, Inc.
UNIT ID: TURBINE CPF-1 (C2101C)
DATE: 09-21-83

FUEL ANALYSIS & EMISSION FACTORS

POLLUTANT	% O2	PPM(dry)	LBS/DSCF	LBS/MMBTU
NOx RUN #1	16.2	95	1.13E-05	0.439
NOx RUN #2	16.2	95	1.13E-05	0.439
NOx RUN #3	16.3	97	1.16E-05	0.458
NOx AVERAGE	16.2	96	1.14E-05	0.445

$$96\ ppm \left(\frac{20.9-15}{20.9-16.2}\right) = 121\ ppm$$

FUEL :	% H	% C	% S	% N	% O	Btu/lb	SDCF/MMBtu
Lease Gas	22.49	75.65	0.00	0.31	1.55	22596	8716

Company: ARCO ALASKA, INC
Unit: HEATER DS-1Y
Date: 09-20-83

F FACTOR FOR GASEOUS FUEL

COMPONENT	C	H	EXPAND	MOLE %	MW	MW°	WT. %	% C	% H	% N	% O
O2	0	0	1.000	0.000	32	0.00	0.00	0.00	0.00	0.00	0.00
N2	0	0	1.000	0.220	28	0.06	0.32	0.00	0.00	0.32	0.00
CO2	0	0	1.000	0.940	44	0.41	2.12	0.58	0.00	0.00	1.54
CO	1	0	2.893	0.000	28	0.00	0.00	0.00	0.00	0.00	0.00
H2	0	2	1.892	0.000	2	0.00	0.00	0.00	0.00	0.00	0.00
C1	1	4	8.569	85.340	16	13.65	69.90	52.43	17.48	0.00	0.00
C2	2	6	15.246	7.190	30	2.16	11.04	8.83	2.21	0.00	0.00
C2=	2	4	13.354	0.000	28	0.00	0.00	0.00	0.00	0.00	0.00
C3	3	8	21.923	3.780	44	1.66	8.51	6.97	1.55	0.00	0.00
C3=	3	6	20.031	0.000	42	0.00	0.00	0.00	0.00	0.00	0.00
C4	4	10	28.600	1.810	58	1.05	5.37	4.45	0.93	0.00	0.00
C4=	4	8	26.708	0.000	56	0.00	0.00	0.00	0.00	0.00	0.00
C5	5	12	35.277	0.550	72	0.40	2.03	1.69	0.34	0.00	0.00
C5=	5	10	33.385	0.000	70	0.00	0.00	0.00	0.00	0.00	0.00
C6+	6	14	41.954	0.160	86	0.14	0.70	0.59	0.11	0.00	0.00
TOTAL	-	-	-	99.990	-	19.53	100.00	75.53	22.61	0.32	1.54

COMPONENT	WT. %
CARBON	75.53
HYDROGEN	22.61
NITROGEN	0.32
OXYGEN	1.54
SULFER	0.00

SPECIFIC GRAVITY, (AIR=1) @ 60° F	0.678
SPECIFIC VOLUME, scf/LB @ 60° F	19.31
GROSS CALORIFIC VALUE, BTU/scf @ 60° F	1173
GROSS CALORIFIC VALUE, BTU/LB	22648

EPA F-FACTOR @ 68° F 8707 DSCF/MMBTU

Company: ARCO ALASKA, INC
Unit: TURBINE CPF-1 (C2101C)
Date: 09-21-83

F FACTOR FOR GASEOUS FUEL

COMPONENT	C	H	EXPAND	MOLE %	MW	MW°	WT. %	% C	% H	% N	% O
O2	0	0	1.000	0.000	32	0.00	0.00	0.00	0.00	0.00	0.00
N2	0	0	1.000	0.220	28	0.06	0.31	0.00	0.00	0.31	0.00
CO2	0	0	1.000	0.960	44	0.42	2.13	0.58	0.00	0.00	1.55
CO	1	0	2.893	0.000	28	0.00	0.00	0.00	0.00	0.00	0.00
H2	0	2	1.892	0.000	2	0.00	0.00	0.00	0.00	0.00	0.00
C1	1	4	8.569	84.160	16	13.47	67.97	50.98	16.99	0.00	0.00
C2	2	6	15.246	7.730	30	2.32	11.71	9.36	2.34	0.00	0.00
C2=	2	4	13.354	0.000	28	0.00	0.00	0.00	0.00	0.00	0.00
C3	3	8	21.923	4.210	44	1.85	9.35	7.65	1.70	0.00	0.00
C3=	3	6	20.031	0.000	42	0.00	0.00	0.00	0.00	0.00	0.00
C4	4	10	28.600	2.000	58	1.16	5.86	4.85	1.01	0.00	0.00
C4=	4	8	26.708	0.000	56	0.00	0.00	0.00	0.00	0.00	0.00
C5	5	12	35.277	0.570	72	0.41	2.07	1.73	0.35	0.00	0.00
C5=	5	10	33.385	0.000	70	0.00	0.00	0.00	0.00	0.00	0.00
C6+	6	14	41.954	0.140	86	0.12	0.61	0.51	0.10	0.00	0.00
TOTAL	-	-	-	99.990	-	19.81	100.00	75.65	22.49	0.31	1.55

COMPONENT	WT. %
CARBON	75.65
HYDROGEN	22.49
NITROGEN	0.31
OXYGEN	1.55
SULFER	0.00

SPECIFIC GRAVITY, (AIR=1) @ 60° F	0.688
SPECIFIC VOLUME, scf/LB @ 60° F	19.04
GROSS CALORIFIC VALUE, BTU/scf @ 60° F	1187
GROSS CALORIFIC VALUE, BTU/LB	22596

EPA F-FACTOR @ 68° F 8715 DSCF/MMBTU

ARCO ALASKA, INC.
PRUDHOE BAY CENTRAL LABORATORY
ANALYSIS REPORT
****

KCM	WPM	CVC	AJS	JMS	LWK
		24	SEP	19	
VM					SLP
TLA	SEP 27 1983				CC.
Info	RC/CE				File
Copy	Return	Seal Mo	Handle	Dis. card	Circ.

AMPLE# E26581 ARCHIVE# G69K81:ZA

LOCATION, COMPANY,
KUPARUK ARCO

SAMPLE MONTH,	DAY,	YEAR,	HOUR,	SAMPLE POINT DESCRIPTION
9	20	1983	2000	FUEL GAS SCRUBBER

SAMPLE DESCRIPTION
FUEL GAS AT DRILLSITE 1-Y SAMPLED AT SCRUBBER

TEMP,	SAMPLE PSIG,	LINE PSIG,	METER#
60	150	150	**

REQUESTOR
A. SCHUYLER

PROPERTY	VALUE		
NITROGEN	.22	MOL %	
#METHANE	85.34	MOL %	
CARBON DIOXIDE	.94	MOL %	
&ETHANE	7.19	MOL %	
PROPANE	3.78	MOL %	
ISO-BUTANE	.58	MOL %	
N-BUTANE	1.23	MOL %	
ISO-PENTANE	.27	MOL %	
N-PENTANE	.28	MOL %	
C6+	.16	MOL %	
HYDROGEN SULFIDE	0	PPM	PRESENT
GROSS DRY (IDEAL GAS)	1172.6	BTU/CF	
NET (IDEAL GAS)	1061.5	BTU/CF	
GROSS SATURATED IDEAL	1152.2	BTU/CF	
SP GRAVITY (CALC.)	.676	.....	
SP GRAVITY (MEAS.)	.679	.....	

BTU VALUES ARE ON AN IDEAL BASIS AT 14.696 PSIA AND 60 DEG F

OMMENTS:

COMPLETED BY.....JC.....

REVIEWED BY: DET.....

D.SAMPERT/L.MATSON
K.KEYS/F.LOVE
S.KRUSE/D.KILAND
LAB/PROJECT/FILE

ARCO ALASKA, INC.
PRUDHOE BAY CENTRAL LABORATORY
ANALYSIS REPORT
****

KCM	WPM	CVC	AJS	JMS	LWK
		24	SEP	1983	
VM					SLP
TLA	SEP 27 1983				CC.
Info	RC/CE				File
Copy	Re-turn	See Me	Han-dle	Dis-card	Chrn

SAMPLE# E26582 ARCHIVE# G69L82:ZA

LOCATION, COMPANY,
KUPARUK ARCO
SAMPLE MONTH, DAY, YEAR, HOUR, SAMPLE DESCRIPTION
9 21 1983 1500 GAS TO TURBINE 'C'
SAMPLE DESCRIPTION
KUPARUK FUEL GAS TO TURBINE 'C'
TEMP, SAMPLE PSIG, LINE PSIG, METER#
147 190 190 **
REQUESTOR
A. SCHUYLER ATO 1932

PROPERTY	VALUE		
NITROGEN	.22	MOL %	
#METHANE	84.16	MOL %	
CARBON DIOXIDE	.96	MOL %	
&ETHANE	7.73	MOL %	
PROPANE	4.21	MOL %	
ISO-BUTANE	.64	MOL %	
N-BUTANE	1.36	MOL %	
ISO-PENTANE	.28	MOL %	
N-PENTANE	.29	MOL %	
C6+	.14	MOL %	
HYDROGEN SULFIDE	1	PPM	PRESENT
GROSS DRY (IDEAL GAS)	1187.1	BTU/CF	
NET (IDEAL GAS)	1075.1	BTU/CF	
GROSS SATURATED IDEAL	1166.5	BTU/CF	
SP GRAVITY (CALC.)	.686	.....	
SP GRAVITY (MEAS.)	.687	.....	

BTU VALUES ARE ON AN IDEAL BASIS AT 14.696 PSIA AND 60 DEG F

COMMENTS:

COMPLETED BY.....

REVIEWED BY: DET

D.SAMPERT/L.MATSON
K.KEYS/F.LOVE
S.KRUSE/D.KILAND
LAB/PROJECT/FILE

Fuel Analysis, F Factor & Lbs/MMBtu

Reference: EPA, Code of Federal Regulations; 40 FCR 60.45

Method: EPA F factor was calculated from the fuel analysis for percent weight carbon, hydrogen, nitrogen, oxygen, sulfur and calorific value. The F factor was then used to calculate lbs/MMBtu emission factors.

Calculations:

$$F = (\text{SDCF @ } 68°\text{F/MMBtu}) = 10^6 * \frac{3.64(\%H)+1.53(\%C)+0.57(\%S)+0.14(\%N)-0.46(\%O)}{\text{Btu/lb fuel}}$$

$$\text{lbs/SDCF} = \text{ppm (dry)} * \text{MW} * 2.59 * 10^{-9}$$

$$\text{lbs/SDCF}_{\circ} \text{ (@ zero } \%O_2) = \text{lbs/SDCF} * \frac{20.9}{20.9-\%O_2}$$

$$\text{lbs/MMBtu} = \text{lbs/SDCF}_{\circ} * F$$

$$MW(NOx) = 46 \text{ grams/mole}$$

SOURCE OPERATION DATA

General Purpose Worksheet

Subject: DS 14 HEATER TEST

Page No. Of

File

By: AJS

Date: 9/20/83

TIME	TEMP IN	TEMP OUT	DESIGN
637	98°F	118°F	14.2 MSCF/HR
1905	97°F	117°F	

21 psig

DEW POINT - 27°

AMBIENT TEMP - 38°

PRESSURE: 29.88"

WRIO

WELL TEST REPORT

09/20/83 10:53:36

WELL	DATE	TIME COMP	PROD FTP PSIG	TEST FTP PSIG	TEST PRES PSIG	TEST PRD CHK	OIL STBD	WTR STBD	FORM. GAS MSCFD	TOTAL % WTR	FORM. GOR SCF/B	TOTAL GLR SCF/STB	LIFT GAS MSCFD	TEST TIME HRS	API OIL GRVTY	TYPE	SYMBOL	TALLY	ALLOW	SEP
1Y- 1	09-12-83	1715	280	280	245	176	906	0	640	0	706	706	0	24.0	24.1	N	M	N	N	
1Y- 2	09-03-83	0530	230	230	210	176	2634	0	2720	0	1033	1033	0	24.0	25.0	N	M	N	N	
1Y- 3	09-11-83	1450	340	350	285	176	3669	0	5651	0	1568	1568	0	12.0	24.4	N	M	N	N	
1Y- 4	09-04-83	0945	275	265	239	176	3347	0	4902	0	1465	1465	0	24.0	25.2	N	M	N	N	
1Y- 5	09-06-83	1600	280	289	253	176	1388	0	2117	0	1525	1525	0	8.0	24.6	N	M	N	N	
1Y- 6	09-11-83	0130	360	360	255	176	4160	0	4592	0	1104	1104	0	8.0	25.5	N	M	N	N	
1Y- 7	09-13-83	2100	280	320	262	176	3574	0	5980	0	1673	1673	0	12.0	25.0	N	M	N	N	
1Y- 8	09-13-83	0600	260	260	260	176	1260	0	1432	0	1137	1137	0	12.0	24.8	N	M	N	N	
1Y- 9	09-16-83	1130	280	285	262	176	1696	0	2027	0	1195	1195	0	12.0	25.9	N	M	N	N	
1Y-10	09-10-83	0215	250	280	260	176	2431	0	1857	0	764	764	0	12.0	25.5	N	M	N	N	
1Y-11	09-18-83	0220	280	225	265	176	2111	0	1203	0	570	570	0	8.0	25.1	N	M	N	N	
1Y-12	09-09-83	1020	270	280	250	176	3443	0	2751	0	799	799	0	8.0	25.2	N	M	N	N	
1Y-13	09-18-83	1000	300	320	260	176	1932	0	1148	0	594	594	0	12.0	25.8	N	M	N	N	
1Y-14	09-10-83	1530	180	190	280	176	313	2	658	1	2099	3702	509	10.0	25.4	N	M	N	N	
1Y-15	09-15-83	2100	280	270	240	176	2345	0	1183	0	505	505	0	24.0	25.2	N	M	N	N	
1Y-16	09-05-83	1700	230	240	235	176	1113	0	580	0	521	521	0	24.0	23.7	N	M	N	N	
**							29079	2												

3+7 production to be shut-in during test

fluid = 29,081 bbl/day
192,000 liter/hr.

SOURCE NAME: ARCO DS1Y

Start: 4:53 PM Stop: 5:10 PM

ADDRESS

CITY | STATE: Alaska | ZIP

PHONE | SOURCE ID NUMBER

PROCESS EQUIPMENT: Process Crude heater | OPERATING MODE: ~~[illegible]~~ Continuous

CONTROL EQUIPMENT: None | OPERATING MODE: ~~[illegible]~~ N/A

DESCRIBE EMISSION POINT

HEIGHT ABOVE GROUND LEVEL: 40 | HEIGHT RELATIVE TO OBSERVER: 40

DISTANCE FROM OBSERVER: 60 | DIRECTION FROM OBSERVER: NE

DESCRIBE EMISSIONS: none

EMISSION COLOR: Clear | PLUME TYPE: CONTINUOUS ☒ FUGITIVE ☐ INTERMITTENT ☐

WATER DROPLETS PRESENT: NO ☒ YES ☐ | IS WATER DROPLET PLUME ATTACHED ☐ N/A DETACHED ☐

AT WHAT POINT IN THE PLUME WAS OPACITY DETERMINED

DESCRIBE BACKGROUND: Blue Sky

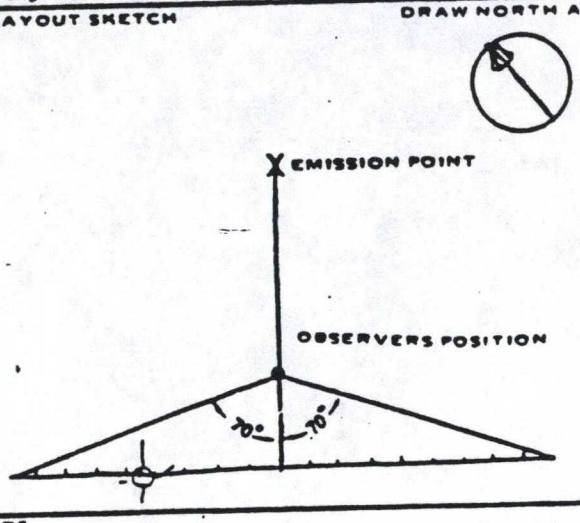
BACKGROUND COLOR: Blue Sky | SKY CONDITIONS: Clear

WIND SPEED: 0 | WIND DIRECTION: None

AMBIENT TEMPERATURE: ~30°F | RELATIVE HUMIDITY: ~20%

SOURCE LAYOUT SKETCH

DRAW NORTH ARROW



M \ sec	0	15	30	45	M \ sec	0	15	30	45
1	0	0	0	0	31				
2	0	0	0	0	32				
3	0	0	0	0	33				
4	0	0	0	0	34				
5	0	0	0	0	35				
6	0	0	0	0	36				
7	0	0	0	0	37				
8	0	0	0	0	38				
9	0	0	0	0	39				
10	0	0	0	0	40				
11	0	0	0	0	41				
12	0	0	0	0	42				
13	0	0	0	0	43				
14	0	0	0	0	44				
15	0	0	0	0	45				
16	0	0	0	0	46				
17	0	0	0	0	47				
18	0	0	0	0	48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30					60				

AVERAGE OPACITY FOR HIGHEST PERIOD: 0 | NUMBER OF READINGS ABOVE: 0 % WERE

RANGE OF OPACITY READINGS: 0 MINIMUM 0 MAXIMUM

COMMENTS

OBSERVER'S NAME (PRINT): Robert A. Ressl

OBSERVER'S SIGNATURE: Robert A. Ressl | DATE: 9/20/83

ORGANIZATION: PEDCo Environmental Inc

I HAVE RECEIVED A COPY OF THESE OPACITY OBSERVATIONS

SIGNATURE: [illegible]

TITLE: [illegible] | DATE: [illegible] 183

CERTIFIED BY | DATE

VERIFIED BY | DATE

General Purpose Worksheet

Subject: C TURBINE (C2101C)

Page No. Of

File

By

Date 9/21/83

TIME	INLET (°F)	EXHAUST (°F)	speed	RPM	GAS RATE (√)	
1110	38	898	99%	9011	(5.0)	807 MSC
1240	39	904	99.5%	9011	(5.1)	815.7 MSC
1335	38	928	99.5%	9011	(5.2)	823.7 MSC
1500	39	914	99.5	9011	(5.1)	815.7 MSC

TIME	INLET DUCT pressure	exhaust stack pressure
1110	4.2 " of water	1.5 " of water
1240	4.2	1.5
1335	4.2	1.5
1500	4.2	1.5

9A TAR 26°
D.P. 21°

29.72" = BAROMETRIC PRESSURE

ANALOG DAILY HISTORY DUMP 9/21/83 15:54:06

ONE-DAY ANALOG HISTORY
ONE-DAY ANALOG HISTORY

PID: 199 NAME:AI-S1011C

NOTE!! HI,AVG,AND LO=0.00 THEN SYSTEM WAS DOWN

TRB C HP SHFT SPEED

CURRENT VALUE 99.66 PCT

TIME	HIGH	AVERAGE	LOW	TIME	HIGH	AVERAGE	LOW
1500	100.04	99.55	99.06	!0300	99.74	99.33	98.99
1600	99.96	99.90	99.36	!0400	99.66	99.35	99.14
1700	99.96	99.94	99.89	!0500	99.66	99.31	99.06
1800	99.96	99.93	99.89	!0600	99.66	99.36	98.99
1900	100.26	99.91	99.51	!0700	99.59	99.34	98.99
2000	100.26	99.88	99.66	!0800	99.66	99.36	99.14
2100	101.16	99.45	94.71	!0900	99.51	99.36	99.14
2200	99.96	99.65	98.99	!1000	99.66	99.35	99.14
2300	99.81	99.37	99.14	!1100	99.66	99.37	99.21
0000	99.59	99.35	99.14	!1200	99.59	99.37	99.14
0100	99.59	99.33	99.14	!1300	99.66	99.40	99.06
0200	99.51	99.32	99.06	!1400	99.66	99.37	99.06

$\bar{x}$ = 99.38

ENTER POINT NAME OR NUMBER THEN PRESS FUNCTION KEY 1 FOR ANOTHER HISTORY
FUNCTION KEY 2 FOR HARD COPY
FUNCTION KEY 3 TO RETURN TO ANALOG HISTORY MENU

ANALOG DAILY HISTORY DUMP 9/21/83 15:54:28

ONE-DAY ANALOG HISTORY
ONE-DAY ANALOG HISTORY

PID: 201 NAME:AI-T1116C

NOTE!! HI,AVG,AND LO=0.00 THEN SYSTEM WAS DOWN

TRB C AVG EXHAUST TEMP

CURRENT VALUE 889.47 DEG F

TIME	HIGH	AVERAGE	LOW	TIME	HIGH	AVERAGE	LOW
1500	971.57	923.89	866.71	0300	889.47	874.14	854.51
1600	973.20	965.50	926.05	0400	889.47	876.12	861.83
1700	973.20	971.31	969.94	0500	878.09	869.66	856.95
1800	970.76	969.20	966.69	0600	891.91	875.57	851.26
1900	969.13	965.92	953.69	0700	885.40	870.51	847.20
2000	967.51	959.38	938.24	0800	891.09	875.69	848.82
2100	967.51	912.27	741.52	0900	912.23	892.15	878.09
2200	944.74	930.04	869.14	1000	904.10	890.10	852.89
2300	937.43	898.83	862.64	1100	904.91	894.83	876.46
0000	910.60	884.93	867.52	1200	915.48	898.00	878.90
0100	894.34	881.35	867.52	1300	924.42	911.28	895.97
0200	892.72	877.14	861.02	1400	917.11	904.15	890.28

$\bar{x}$ = 902.06

ENTER POINT NAME OR NUMBER THEN PRESS FUNCTION KEY 1 FOR ANOTHER HISTORY
FUNCTION KEY 2 FOR HARD COPY
FUNCTION KEY 3 TO RETURN TO ANALOG HISTORY MENU

2d Stage 4487 HP
1st Stage 9316 HP
~1500 Gen
14803

ONE-DAY ANALOG HISTORY
ONE-DAY ANALOG HISTORY

PNID: 192 NAME:AI-T1117C

NOTE!! HI,AVG,AND LO=0.00 THEN SYSTEM WAS DOWN

TRB C INLT AIR TEMP

CURRENT VALUE 39.83 DEG F

TIME	HIGH	AVERAGE	LOW	TIME	HIGH	AVERAGE	LOW
1500	48.27	46.84	44.21	!0300	37.64	36.02	34.51
1600	48.58	47.17	46.08	!0400	37.64	36.38	34.51
1700	48.27	46.69	45.14	!0500	36.08	34.87	33.26
1800	46.08	43.62	40.14	!0600	35.14	34.03	32.95
1900	40.45	39.89	39.20	!0700	35.45	34.90	34.51
2000	40.14	39.30	38.58	!0800	35.76	34.30	33.89
2100	39.52	38.84	37.95	!0900	39.20	37.42	35.45
2200	41.70	40.21	38.27	!1000	39.52	38.76	37.95
2300	41.08	39.87	37.95	1100	40.14	39.31	38.58
0000	41.39	40.13	36.08	1200	41.70	40.27	39.20
0100	40.77	38.58	35.76	1300	43.27	40.78	39.52
0200	39.20	37.62	36.08	1400	43.58	41.74	40.14

T=40.52

ENTER POINT NAME OR NUMBER THEN PRESS FUNCTION KEY 1 FOR ANOTHER HISTORY
FUNCTION KEY 2 FOR HARD COPY
FUNCTION KEY 3 TO RETURN TO ANALOG HISTORY MENU

NRCU.

ADDRESS: CPF / Station C

CITY | STATE | ZIP

PHONE | SOURCE ID NUMBER

PROCESS EQUIPMENT | OPERATING MODE: Cont

CONTROL EQUIPMENT: None | OPERATING MODE: ~~Cont~~ N/A

DESCRIBE EMISSION POINT: Stack

HEIGHT ABOVE GROUND LEVEL | HEIGHT RELATIVE TO OBSERVER

DISTANCE FROM OBSERVER: ~30' | DIRECTION FROM OBSERVER: N

DESCRIBE EMISSIONS: —

EMISSION COLOR: clear | PLUME TYPE: CONTINUOUS ☑ FUGITIVE ☐ INTERMITTENT ☐

WATER DROPLETS PRESENT: NO ☑ YES ☐ | IS WATER DROPLET PLUME ATTACHED ☐ DETACHED ☐ N/A

AT WHAT POINT IN THE PLUME WAS OPACITY DETERMINED: N/A

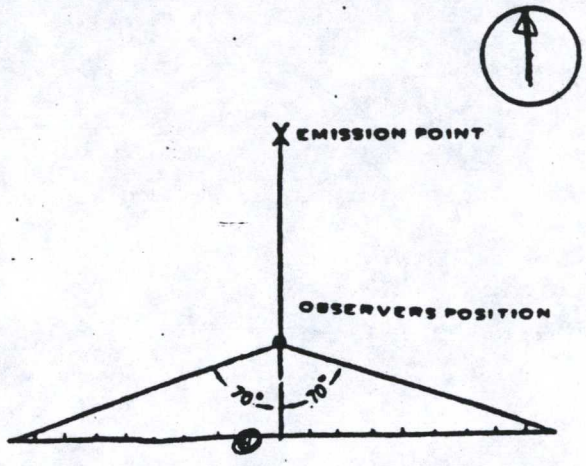
DESCRIBE BACKGROUND: Blue sky

BACKGROUND COLOR: Blue | SKY CONDITIONS: clear

WIND SPEED: ~10 mph | WIND DIRECTION: NE

AMBIENT TEMPERATURE: ~30°F | RELATIVE HUMIDITY: ~20%

SOURCE LAYOUT SKETCH — DRAW NORTH ARROW



	12:30				12:45:45				
M \ SEC	0	15	30	45	M \ SEC	0	15	30	45
1					31	0	0	0	0
2					32	0	0	0	0
3					33	0	0	0	0
4					34	0	0	0	0
5					35	0	0	0	0
6					36	0	0	0	0
7					37	0	0	0	0
8					38	0	0	0	0
9					39	0	0	0	0
10					40	0	0	0	0
11					41	0	0	0	0
12					42	0	0	0	0
13					43	0	0	0	0
14					44	0	0	0	0
15					45	0	0	0	0
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				
30	0	0	0	0	60				

AVERAGE OPACITY FOR HIGHEST PERIOD: 0

NUMBER OF READINGS ABOVE ___ % WERE

COMMENTS

RANGE OF OPACITY READINGS: 0 MINIMUM — 0 MAXIMUM

OBSERVER'S NAME (PRINT): Robert A. Ressl

OBSERVER'S SIGNATURE: [signature] | DATE: 9/21/83

ORGANIZATION

I HAVE RECEIVED A COPY OF THESE OPACITY OBSERVATIONS

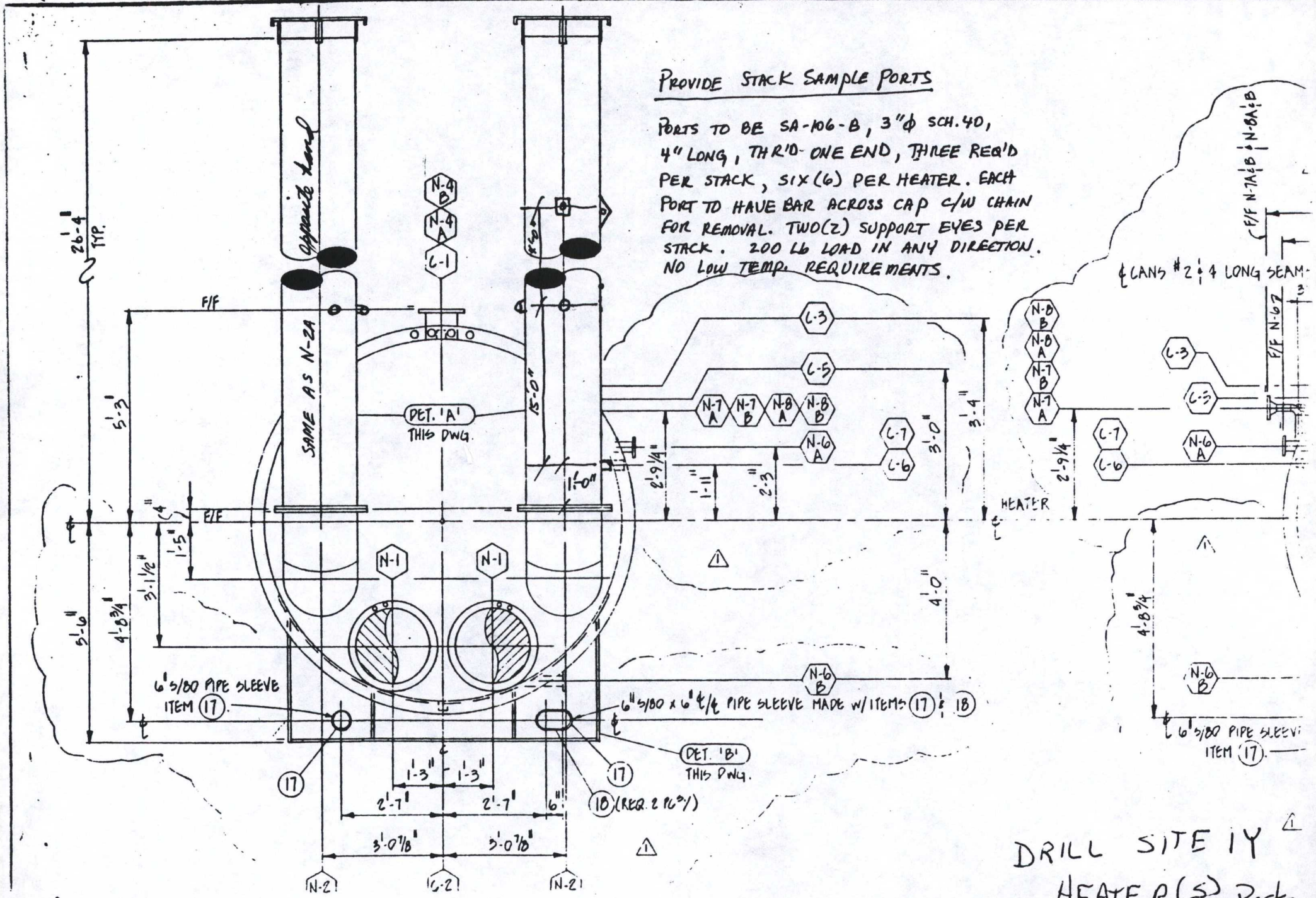
SIGNATURE: [signature]

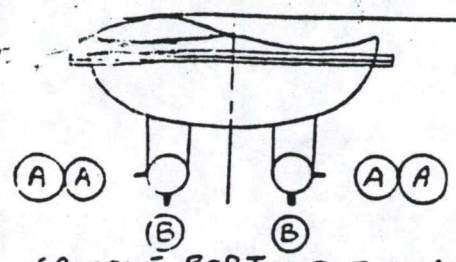
TITLE | DATE: 9/21/83

CERTIFIED BY | DATE

VERIFIED BY | DATE

SAMPLING PORT AND POINT DESCRIPTION

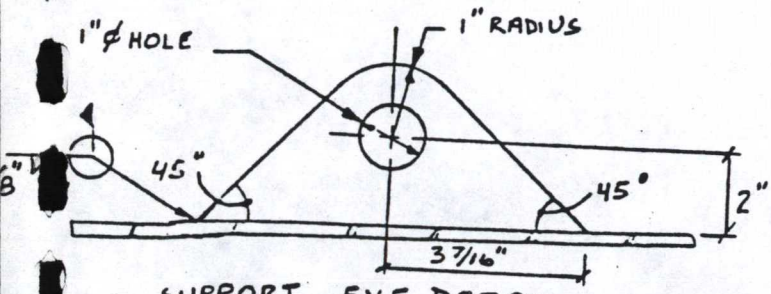

PROVIDE STACK SAMPLE PORTS
PORTS TO BE SA-106-B, 3"ϕ SCH. 40, 4" LONG, THR'D ONE END, THREE REQ'D PER STACK, SIX (6) PER HEATER. EACH PORT TO HAVE BAR ACROSS CAP C/W CHAIN FOR REMOVAL. TWO(2) SUPPORT EYES PER STACK. 200 LB LOAD IN ANY DIRECTION. NO LOW TEMP. REQUIREMENTS.
SAME AS N-2A
DET. 'A' THIS DWG.
DET. 'B' THIS DWG.
6" S/80 PIPE SLEEVE ITEM 17
6" S/80 x 6" ℄/℄ PIPE SLEEVE MADE W/ ITEMS 17 & 18
18 (REQ. 2 PC'S)
HEATER
℄ CANS #2 & 4 LONG SEAM
F/F N-7A & B & N-8A & B
F/F N-6B
DRILL SITE 1Y
HEATER(S) Ports



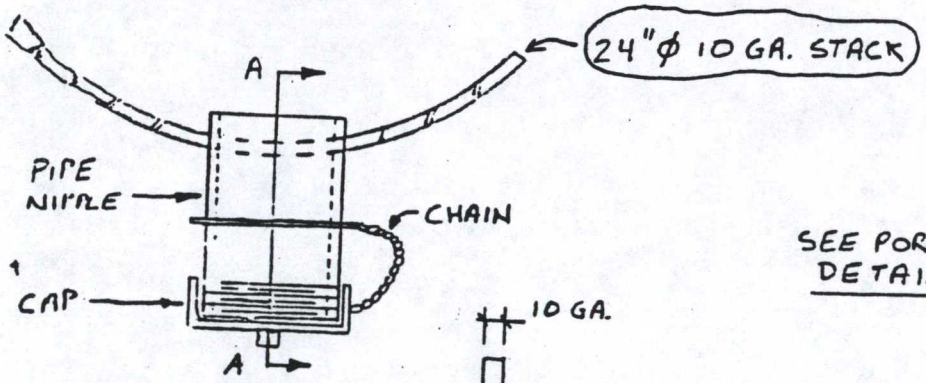
TWO PORTS AT (A)
ONE PORT AT (B)

SAME
FOR
TYPICAL

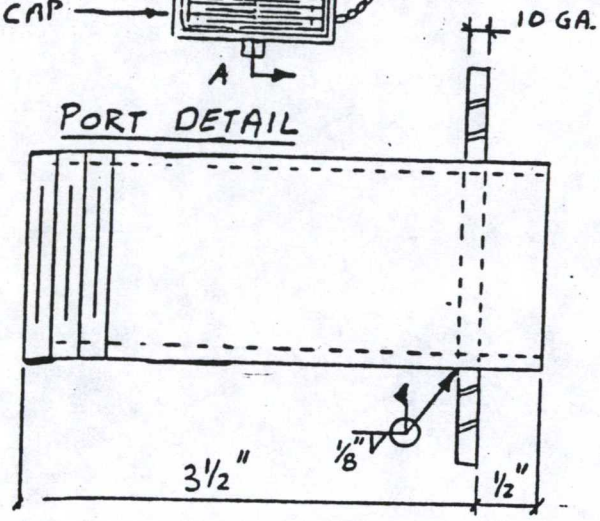
SAMPLE PORT ORIENTATIONS



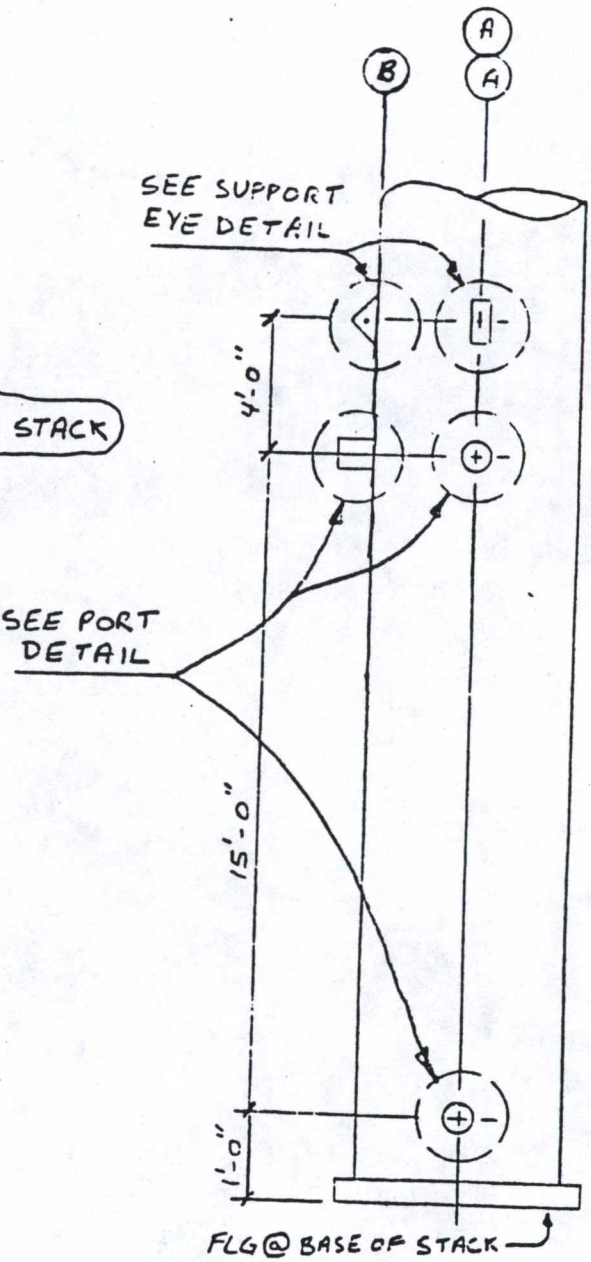
SUPPORT EYE DETAIL



PORT DETAIL



VIEW 'A-A'



ELEVATION

NOTES:

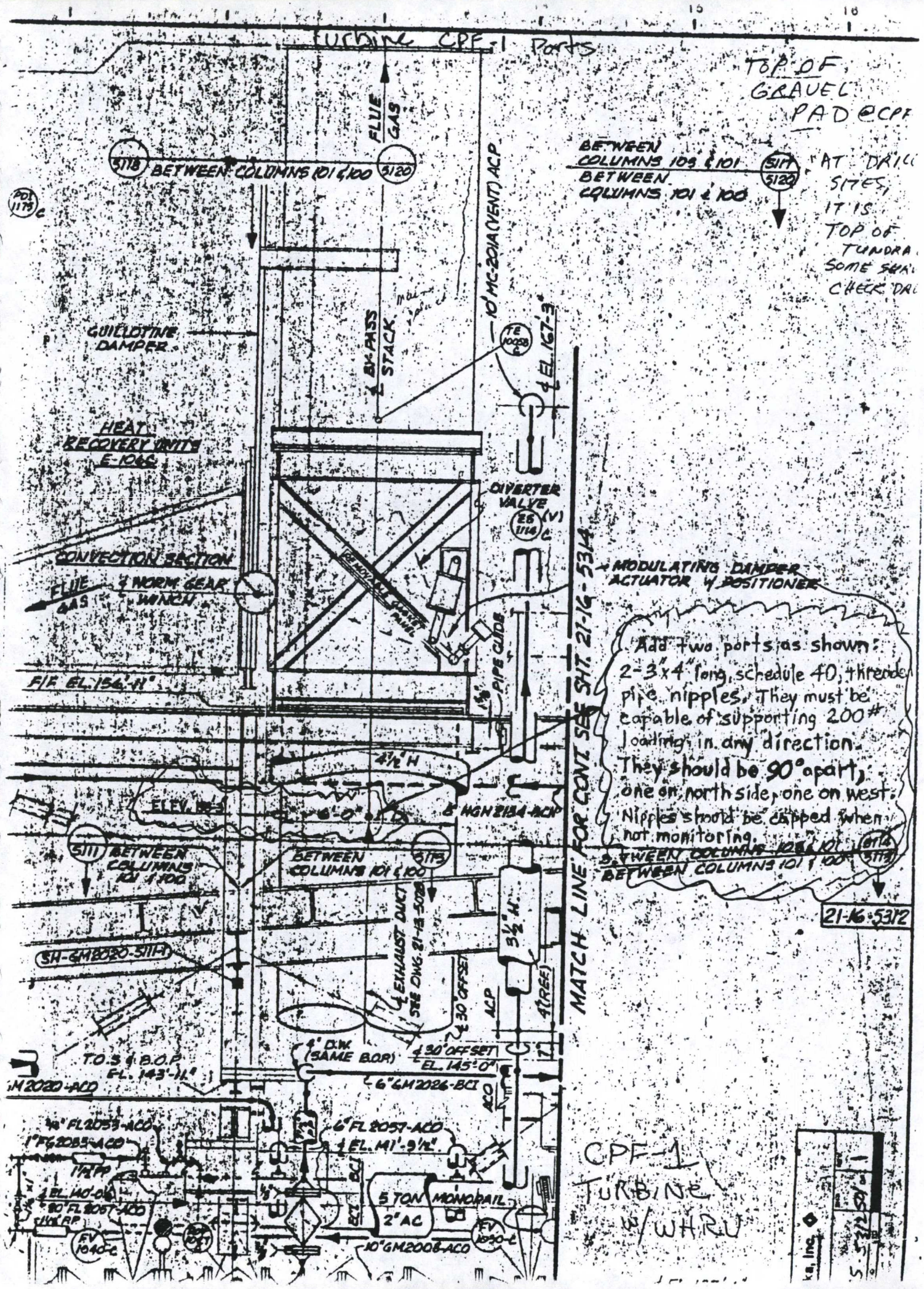
1) PORTS ARE TO BE SA-106 GRB, 3"ϕ SCH 40, 4" LONG, THREADED ONE END, THREE REQ'D PER STACK, SIX PER HEATER. EACH PORT TO BE CAPPED. EACH CAP TO HAVE BAR ACROSS CAP FOR REMOVAL, AND CHAIN.

SUPPORT EYE TO BE 1/2" THICK A-36 PLATE, TWO PER STACK.

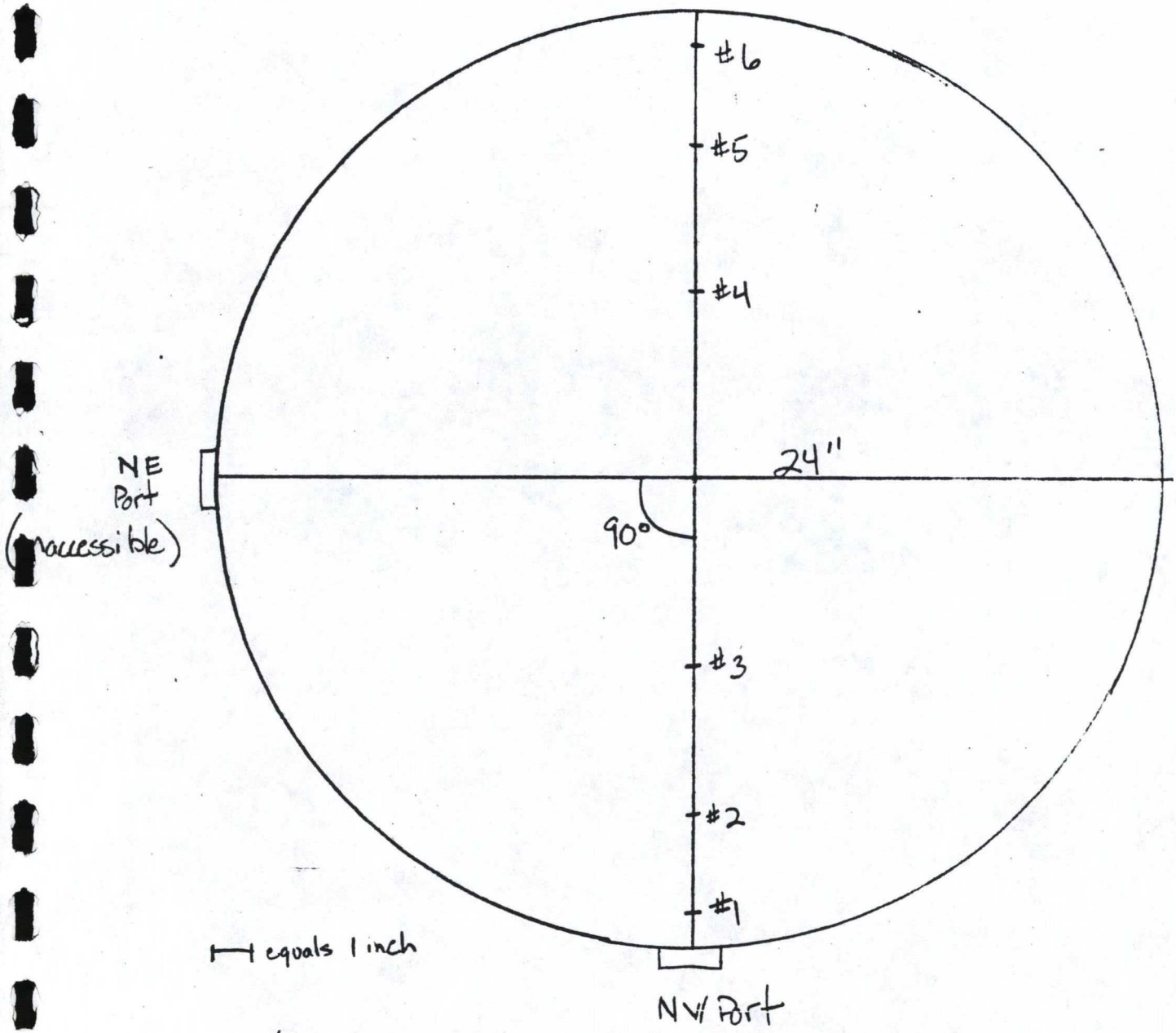
MATERIAL TO BE SUPPLIED BY AND INSTALLED AT MFS.

REFERENCE BS&B DWG. 32-SRX-A043-02 (P.O. 2244-

PRODUCTION HEATER STACK SAMPLE PORTS FIELD MODIFICATION
ARCO KUPARUK PROJ. C-24750 DRILLSITES 1G, ~~1E~~ 1Y, 1F STEARNS-ROGER '82 SERIES


Turbine CPF-1 Ports
TOP OF GRAVEL PAD @ CPF
AT DRILL SITES, IT IS TOP OF TUNDRA SOME SUR CHECK DR
FLUE GAS
BETWEEN COLUMNS 101 & 100
BETWEEN COLUMNS 103 & 101
BETWEEN COLUMNS 101 & 100
10" MC-201A (VENT) ACP
BY-PASS STACK
EL. 167'-3"
GUILLOTINE DAMPER
HEAT RECOVERY UNITS E-106C
DIVERTER VALVE
CONVECTION SECTION
FLUE GAS
WORM GEAR WINCH
MODULATING DAMPER ACTUATOR W/ POSITIONER
PIPE GUIDE
F/F EL. 156'-11"
4½" H
ELEV. 155'-3"
6'-0"
8" HGN 2134-ACP
BETWEEN COLUMNS 101 & 100
BETWEEN COLUMNS 101 & 100
BETWEEN COLUMNS 103 & 101
BETWEEN COLUMNS 101 & 100
MATCH LINE FOR CONT. SEE SHT. 21-16-5314
21-16-5312
SH-GM2020-5111-1
EXHAUST DUCT SEE DWG. 21-13-5078
3½" H
30° OFFSET
ACP
4" (REF)
4" D.W. (SAME B.O.P.)
30° OFFSET EL. 145'-0"
T.O.S. & B.O.P. EL. 143'-11"
GM2020-ACO
6" GM2026-BCI
ACO
6" FL 2057-ACO
EL. 141'-9½"
5 TON MONORAIL
2" AC
10" GM2008-ACO
CPF-1 TURBINE W/WHRU

Drillsite Heater 1·Y Points

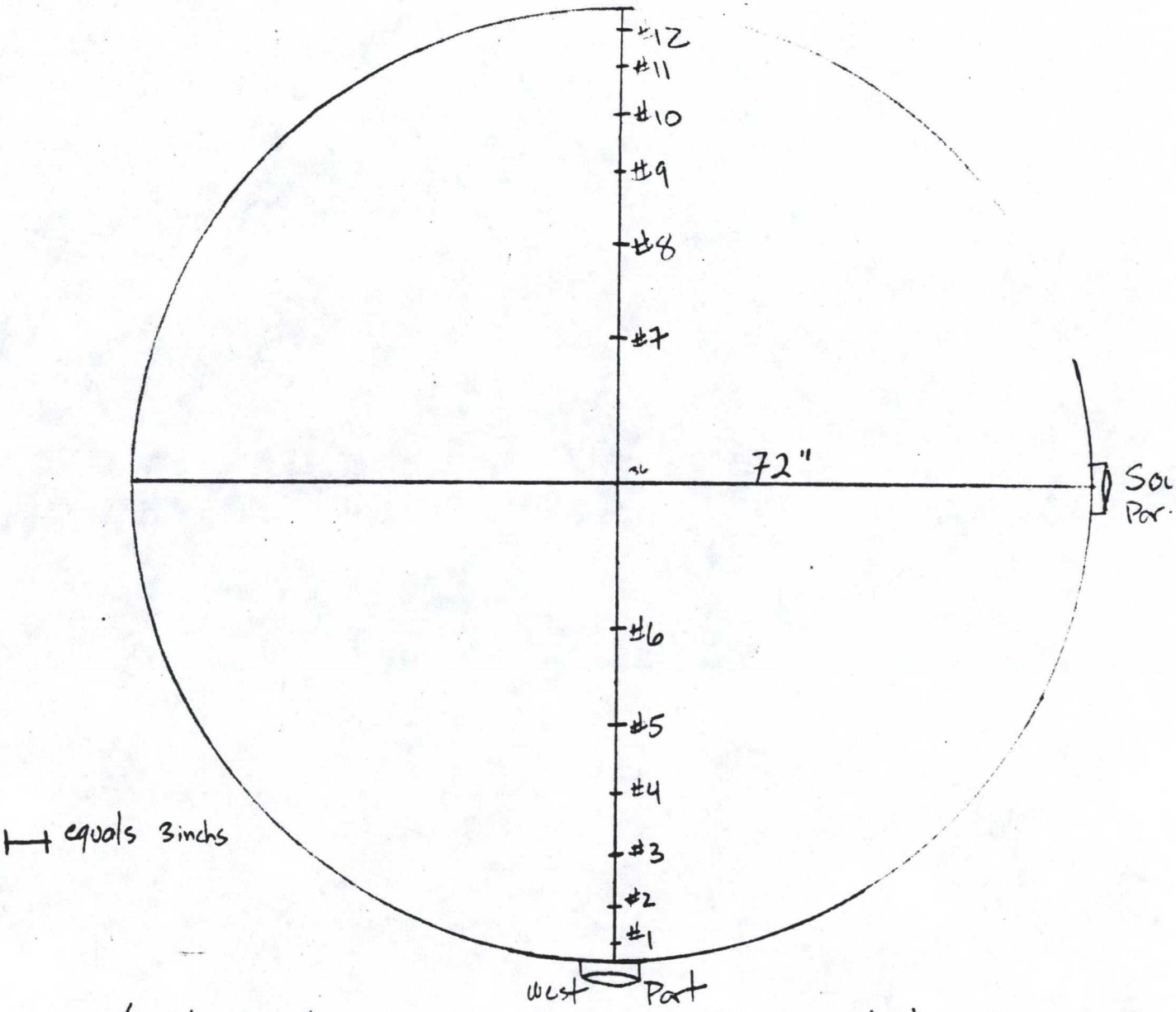


(7 dia. down stream, 4 dia upstream a disturbance)

Point #	inches Away from edge
1	1.0
2	3.5
3	7.1
4	16.9
5	20.5
6	23.0

Further discussion of sampling points in Appendix 6

Turbine CPF-1 (C2101C)



(3.5 dia downstream, 8 dia upstream a disturbance in flow)

Point #	inchs from edge	Point #	inchs from edge
1	1.5	7	46.4
2	4.8	8	54.0
3	8.5	9	59.2
4	12.8	10	63.5
5	18.0	11	67.2
6	25.6	12	70.2

Further discussion of sampling points in App. #6

APPENDIX

1 - 7

APPENDIX I

Example Calculations

Example Calculations

Heater DS-14 : RUN # 1 @ 16:20 on 09-20-87

Vm(std): (@ 68°F & 29.92" Hg std & K_3 = 17.65 °R/in Hg)

V_m = 20.15 dsf

P-bar = 29.92 " Hg

delta H = 0.0 " H_2O

T_m = 45 °F = 505 °R

Meter calibration coefficient = 0.9862

$$\boxed{V_m(std)} = 20.15\ dsf * 0.9862 * 17.65 * \frac{(29.92 + 0/13.6)}{505\ °R} = \boxed{20.78\ dscf}$$

$$\boxed{\%H_2O} = 100 * B_{ws} = 100 * \frac{0.04717 * 75.3\ gms\ H_2O}{0.04717 * 75.3\ gms\ H_2O + 20.78} = \boxed{14.5\ \%H_2O}$$

$$\boxed{MW(dry)} = 44 * \frac{12.0\%}{100} + 32 * \frac{0.0\%}{100} + 28 * \frac{88.0\%}{100} = \boxed{29.92\ gms/mole}$$

$$\boxed{MW(wet)} = \left[29.92 * \frac{[100 - 14.5\%H_2O]}{100}\right] + \left[18 * \frac{14.5\%H_2O}{100}\right] = \boxed{28.19\ gms/mole}$$

$$\boxed{V_s\ (fps)} = 85.49 * 0.80 * 0.17 * \sqrt{\frac{965\ °F + 460\ °F}{(29.92 - \frac{0.08}{13.6})(28.19)}} = \boxed{15.1\ fps}$$

$$\boxed{As\ (ft^2)} = \left(\frac{24"\ dia}{24}\right)^2 * \pi = \boxed{3.14\ ft^2}$$

$$\boxed{Q\ s\ (DSCFM)} = 60(1-0.145)(15.1)(3.14)(17.65)\left[\frac{29.92 + \frac{-0.08}{13.6}}{985 + 460}\right] = \boxed{889\ DSCF}$$

Note: Actual calculations by computer maintain all #'s to 12 siginifi figures while some examples include only 2 sig figs.

Example Calculations (Con't)

(Heater DS-14: RUN #1)

$$\boxed{\text{lbs/hr } (NO_x)} = \text{ppm} * \text{DSCFM} * \text{MW} * 1.605 * 10^{-7}$$

$$= 53 * 920 * 46 * 1.605 * 10^{-7} = \boxed{0.36 \text{ lbs/hr}}$$

$$\boxed{\text{F-factor (DSCF/MMBtu)}} = \frac{(3.64)\%H + (1.53)\%C + (0.57)\%S + (0.14)\%N - (0.46)\%O}{\text{Btu/lb}} * 10^6$$

$$= \frac{(3.64)(22.61) + (1.53)(75.53) + (0.57)(0) + (0.14)(0.32) - (0.46)(1.54)}{22{,}648} * 10^6$$

$$= \boxed{8707 \text{ SDCF/MMBtu}}$$

$$\boxed{\text{lbs/MMBtu}} = \text{ppm} * \left[\frac{20.9}{20.9 - \%O_2}\right] * \text{MW} * F * 2.59 * 10^{-9} = \boxed{0.055 \text{ lbs/MMB}}$$

$$= 53 * \left[\frac{20.9}{20.9 - 0.1}\right] * 46 * 8707 * 2.59 * 10^{-9}$$

APPENDIX 2

NOx Emission Standard For Gas Turbine

Calculated Allowable NOx Emission for Stationery Gas Turbines

Ref: Environmental Protection Agency, Code of Federal Regulations, Title 40, Part 60. Subpart GG, 60.332, 1981

Equation:

$$STD = 150 \left(\frac{14.4}{Y}\right)$$

where: STD = allowable NOx emissions (percent by volume at 15% O_2 and on a dry basis)

Y = manufacturer's rated heat rate at manufacturer's rated load (kilojoules per watt hour)

Calculations:

9550 BTU/Hphr = manufacture rating 1/

$1.4137 * 10^{-3}$(hphr) (kilojoules)/(BTU)(w-hr)

$$STD = 150\left(\frac{14.4}{9550-(1.4137 * 10^{-3})}\right)$$

STD = 159.9 ppm @ 15% O_2

1/ This rating provided by Alan Schuyler of Arco based on manufacturers efficiency graphs and actual operating conditions.

GENERAL ELECTRIC MODEL M3142(J) 14600 HP* GAS TURBINE 2

ESTIMATED PERFORMANCE

COMPRESSOR INLET TEMPERATURE 30°F (-1.1°C)

COMPRESSOR INLET PRESSURE 14.7 PSIA (1.0133 BAR)

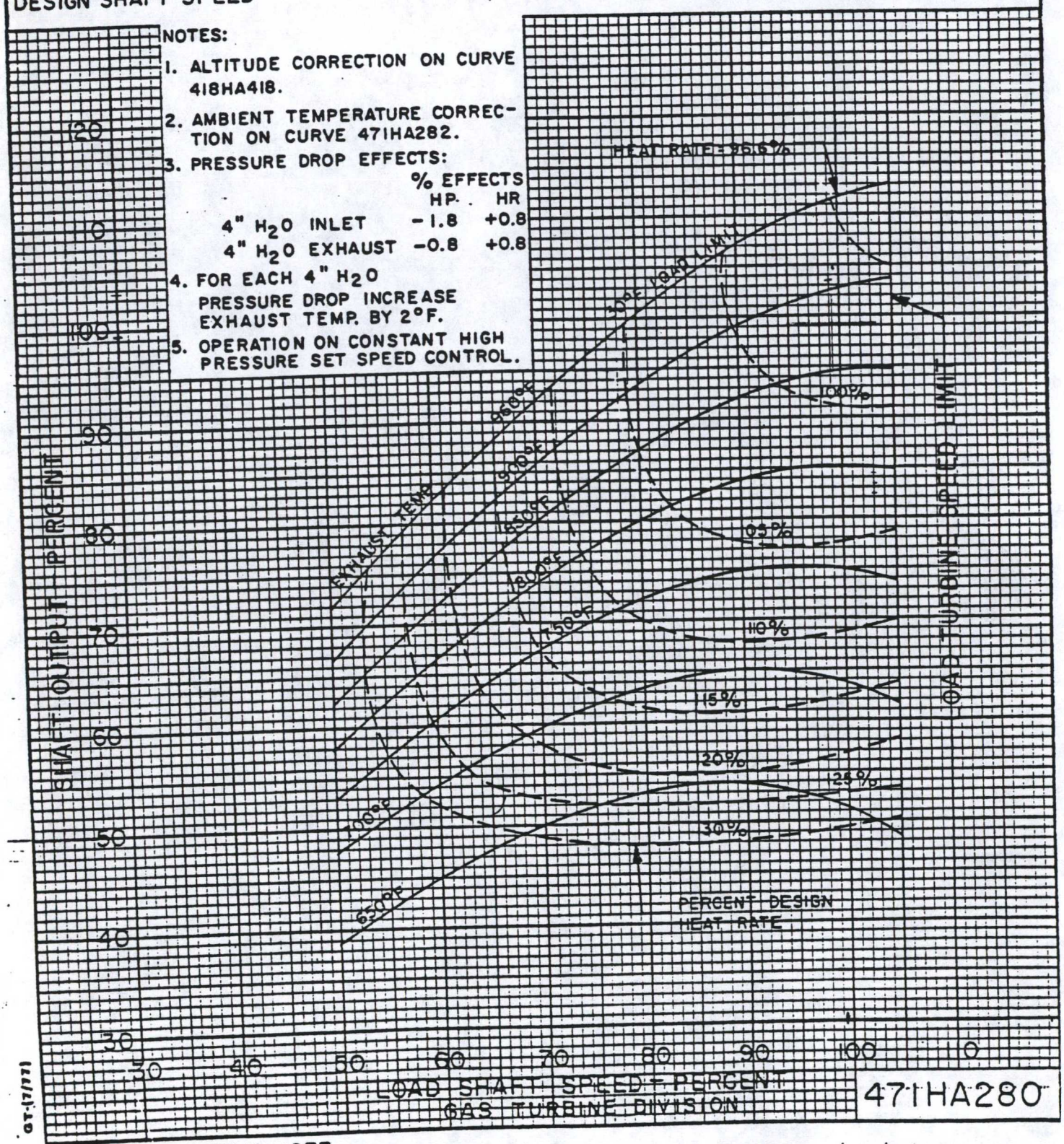
		*NATURAL GAS	DISTILLATE OIL
FUEL			
DESIGN SHAFT OUTPUT	HP	14 600	14 250
DESIGN HEAT RATE (LHV)	BTU/HP-HR	9 530	9 680
DESIGN HEAT CONSUMPTION (LHV)	BTU/HR	139.1×10^6	137.9×10^6
DESIGN AIR FLOW	LBS/HR	415,000	
DESIGN SHAFT SPEED	RPM	6 500	

NOTES:

1. ALTITUDE CORRECTION ON CURVE 418HA418.
2. AMBIENT TEMPERATURE CORRECTION ON CURVE 471HA282.
3. PRESSURE DROP EFFECTS:

	% EFFECTS HP	% EFFECTS HR
4" H_2O INLET	-1.8	+0.8
4" H_2O EXHAUST	-0.8	+0.8

4. FOR EACH 4" H_2O PRESSURE DROP INCREASE EXHAUST TEMP. BY 2°F.
5. OPERATION ON CONSTANT HIGH PRESSURE SET SPEED CONTROL.



471HA280

K. D. KNAPP NOV. 3, 1977
K. D. KNAPP MAR 10, 1978, REV. A

GENERAL ELECTRIC MODEL M3142(J) 14600 HP* GAS TURBINE 2

ESTIMATED PERFORMANCE
COMPRESSOR INLET TEMPERATURE 59°F (15°C)
COMPRESSOR INLET PRESSURE 14.7 PSIA (1.0133 BAR)

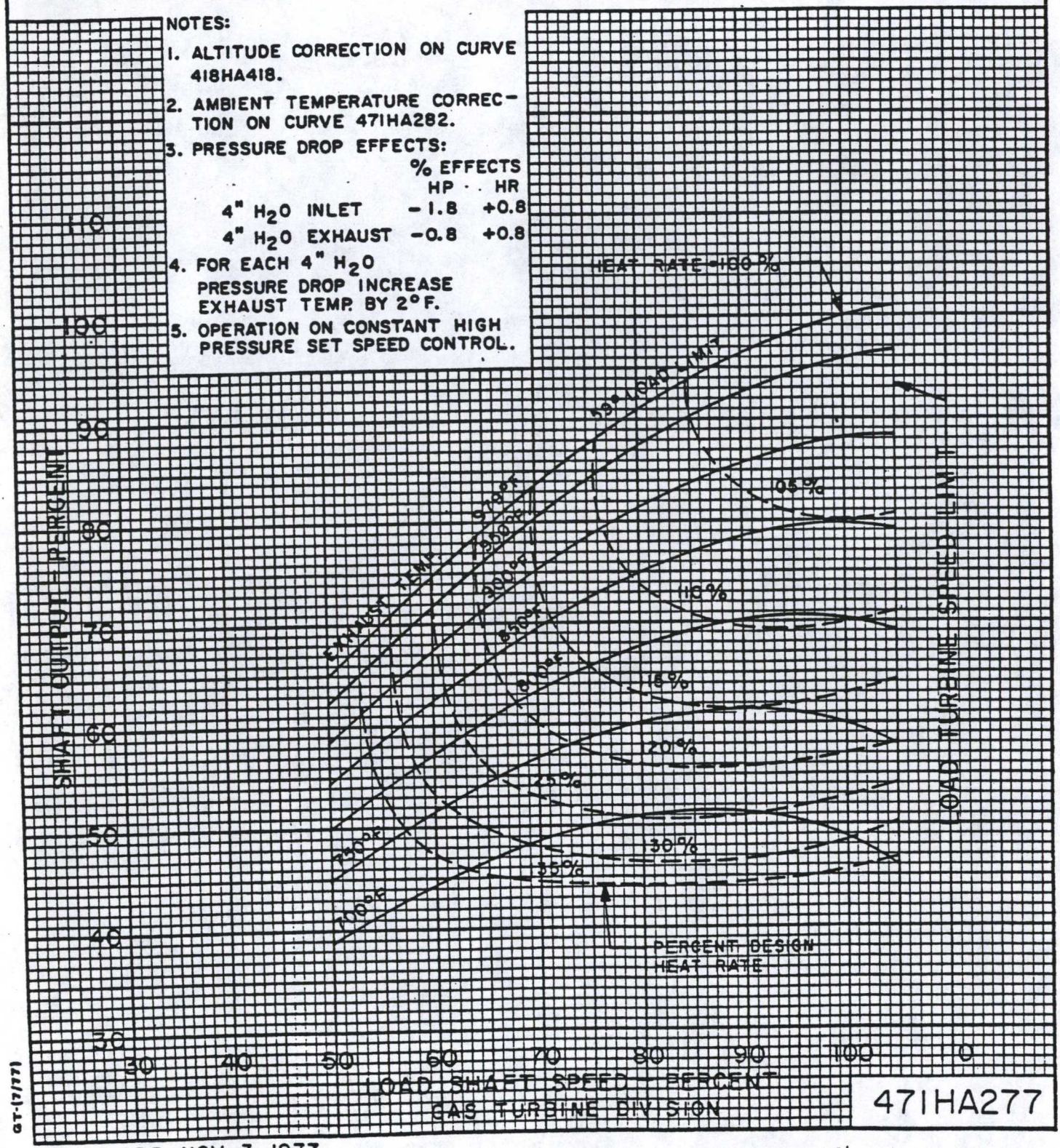
FUEL		*NATURAL GAS	DISTILLATE OIL
DESIGN SHAFT OUTPUT	HP	14600	14250
DESIGN HEAT RATE (LHV)	BTU/HP-HR	9530	9680
DESIGN HEAT CONSUMPTION (LHV)	BTU/HR	139.1×10^6	137.9×10^6
DESIGN AIR FLOW	LBS/HR	415,000	
DESIGN SHAFT SPEED	RPM	6500	

NOTES:

1. ALTITUDE CORRECTION ON CURVE 418HA418.
2. AMBIENT TEMPERATURE CORRECTION ON CURVE 471HA282.
3. PRESSURE DROP EFFECTS:

	% EFFECTS HP	% EFFECTS HR
4" H_2O INLET	-1.8	+0.8
4" H_2O EXHAUST	-0.8	+0.8

4. FOR EACH 4" H_2O PRESSURE DROP INCREASE EXHAUST TEMP. BY 2°F.
5. OPERATION ON CONSTANT HIGH PRESSURE SET SPEED CONTROL.



GT-(7/77)

K.D. KNAPP NOV. 3, 1977
K.D. KNAPP MAR 10 1978 REV A

GENERAL ELECTRIC MODEL M3142(J) 14600 HP* GAS TURBINE [2]

ESTIMATED PERFORMANCE

COMPRESSOR INLET TEMPERATURE 90°F (32.2°C)

COMPRESSOR INLET PRESSURE 14.7 PSIA (1.0133 BAR)

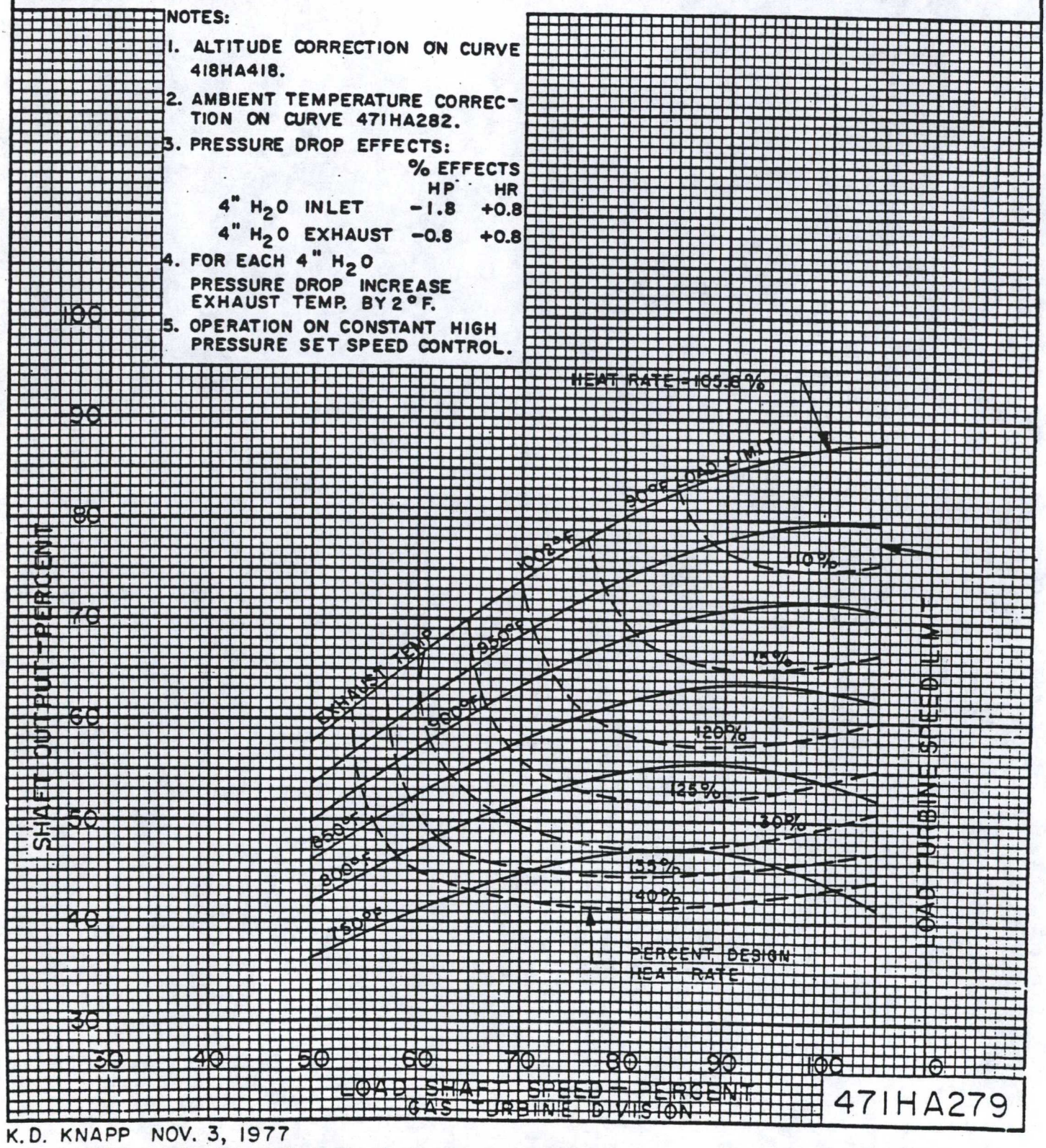
FUEL		*NATURAL GAS	DISTILLATE OIL
DESIGN SHAFT OUTPUT	HP	14 600	14 250
DESIGN HEAT RATE (LHV)	BTU/HP-HR	9 530	9 680
DESIGN HEAT CONSUMPTION (LHV)	BTU/HR	139.1×10^6	137.9×10^6
DESIGN AIR FLOW	LBS/HR	415,000	
DESIGN SHAFT SPEED	RPM	6 500	

NOTES:

1. ALTITUDE CORRECTION ON CURVE 418HA418.
2. AMBIENT TEMPERATURE CORRECTION ON CURVE 471HA282.
3. PRESSURE DROP EFFECTS:

	% EFFECTS HP	% EFFECTS HR
4" H_2O INLET	-1.8	+0.8
4" H_2O EXHAUST	-0.8	+0.8

4. FOR EACH 4" H_2O PRESSURE DROP INCREASE EXHAUST TEMP. BY 2°F.
5. OPERATION ON CONSTANT HIGH PRESSURE SET SPEED CONTROL.



GAS TURBINE DIVISION

471HA279

K.D. KNAPP NOV. 3, 1977

K.D. KNAPP MAR. 10, 1978 REV. A

GT-(7/77)

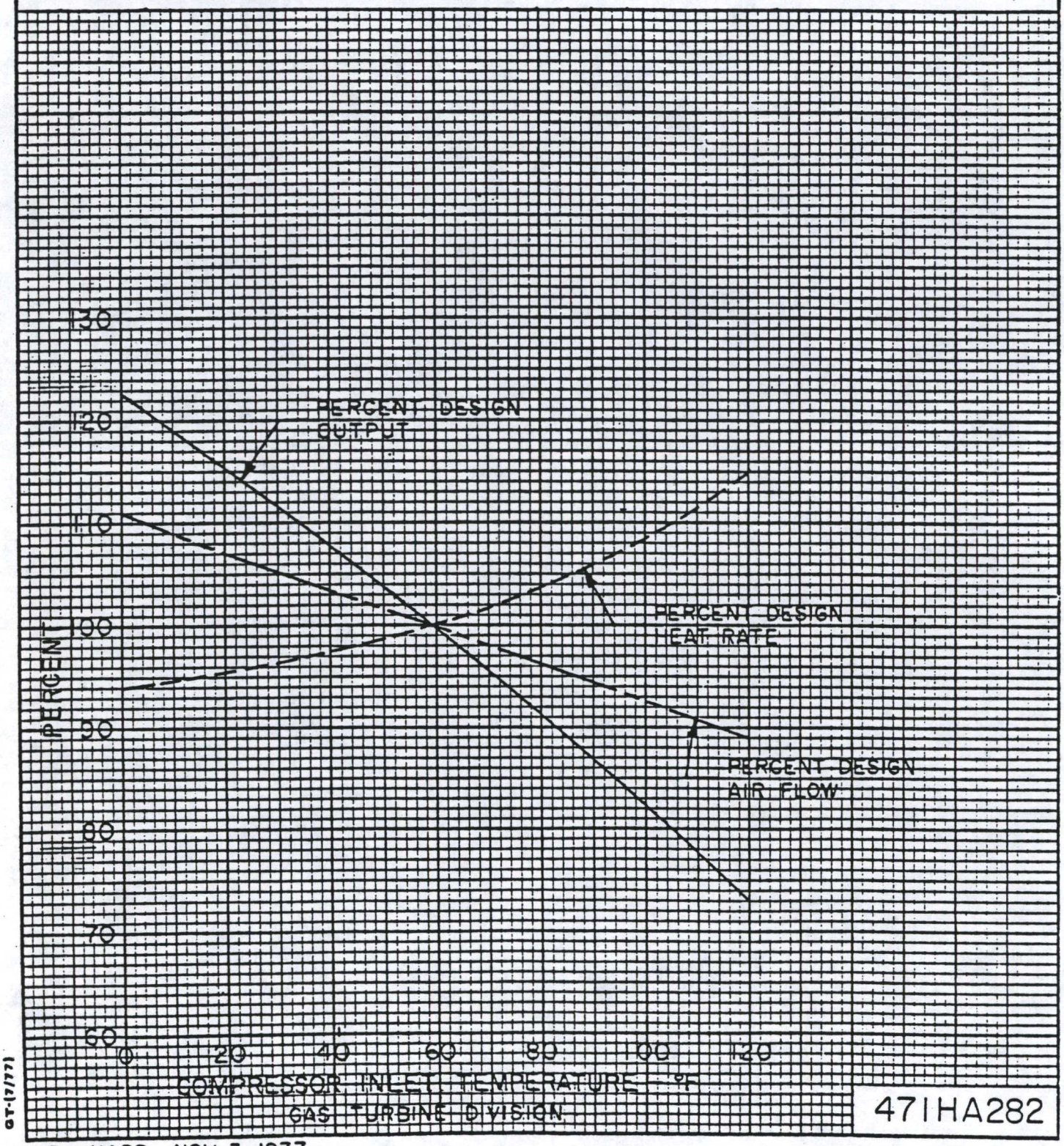
GENERAL ELECTRIC MODEL M3142(J) GAS TURBINE

2

EFFECT OF COMPRESSOR INLET TEMPERATURE ON MAXIMUM OUTPUT, AIR FLOW AND HEAT RATE AT 100% SPEED

NOTES:

1. HP SHAFT DESIGN SPEED - 7107 RPM
2. LOAD TURBINE DESIGN SPEED - 6500 RPM
3. OPERATION AT CONSTANT HIGH PRESSURE SET SPEED CONTROL.



GAS TURBINE DIVISION

471HA282

GT-(7/77)

K. D. KNAPP NOV. 3, 1977
K. D. KNAPP MAR. 10, 1978, REV. A

APPENDIX 3

Test Log

15% O_2

68°F

Arco Alaska 9-20-83 FS YI

Present: Andy Winkler - Analyzer Van
Leslie Johnson - stack
Bob Russel - Peteo for EPA
A.D.E.C.

12.30 All back from Lunch
Running calibrations & system Calibrations
1600 Begin stratification check
1620 Begin first EPA #2 & #4
1745 Begin Run # 2 method #2
1800 Begin Run # 2 method #4
1835 Begin Run #3 method #2 Traverse
1918 Begin Run #3 method #4
1930 #3 Gas Grab
1948 Off stack

Analyzer log

1640 Begin Run #1 NO_x O_2
1715 Run # 1 Completed
1730 Begin Run # 2 NO_x, O_2
1735 Crane operator radio interference pen jumped chart
1815 Begin Run#2 second try
1845 End " NO_x & O_2
Calibrate
1900 Begin Run # 3 NO_x & O_2
1935 fini

F = 0 (No tra
Y = 14.14 usual

Arco Alaska 9/21/83 ~~Compressor I~~

Present Robert A. Ressl PEDCo Environ Inc. Gas Lift Compressor C

0800 on-site CPF I site

Hot permits issued

1111 Begin sampling O_2 traverse plus run #1 6min/point 16 tot points

1116 Begin Run #1 EPA #4 H_2O tram

1120 " " " Traverse

1305 Finished O_2 stratification / Run #1 A:B Traverse (both ports)

1215 Begin Run #2 EPA #4 H_2O tram

(snowing) 1235 " " " " #2 Velocity traverse

1325 Begin NOx & O_2 traverse Run #2 (west port)

1354 #2 H_2O tram begin

1400 Run #2 NOx & O_2 finished

1412 Run #3 Velocity profile

1415 Run #3 NOx & O_2 traverse (west port) begun

1430 1435 " " " finished

1500 off stack (-23°F w/ chill factor)

Pack up all equipment shipped through Arco.

APPENDIX 4

Raw Field Data

Field Data Sheet

Client: ARCO Alaska Unit: Heater-Y1 Report #: 1781 Date: 9-20-83

Site # 1 Time: 16:20 - 16:50

Pitot # 5330 Cp 0.80 meter # 635 mcf 0.9862

Temp Unit # ___ Mag # 376 Td ___ Hi ΔP/LoΔP ___/___

Duct dia 24.0 (ins) Coup ___ (ins) Bef/Aft ___/___ Static -0.08

(3.14 ft²)

Impingers	Final	Tare	Net
1			
2	497.68	422.35	75.33
3 Lg. Grnby	170	100	
4 Sm. Grnb	52	50	
5 K.O.		-	
6 Silica Gel	275.68	272.35	
		Total	75.33

Integrated Gas Bag # ___

CO_2	12.0
O_2	0.0
N_2	
CO	

Vmstd ___
%H₂O ___
mL(wet) ___
% Iso ___

SDCFM ___

V_m 20.15 * mcf = V_m corrected ___

Time (min)	–
Noz	–
P_{bar}	29.92
P_d	–
Td	965
ΔP	0.03
V_d	–
Tm	45
ΔH	0.0

U_m (initial) = 575.95

U_m (final) = 596.10

20.15

Site # 2 Time: 18:00 - 18:25

Pitot # 5330 Cp 0.80 meter # 635 mcf 0.9862

Temp Unit # ___ Mag # 376 Td ___ Hi ΔP/LoΔP ___/___

Duct dia. 24.0 (ins) Coup ___ (ins) Bef/Aft ___/___ Static -0.06

Impingers	Final	Tare	Net
1			
2			
3			
4 Lg Grnby	128.0	100.0	28.0
5 Sm Grnby	53.0	50.0	3.0
6 Silica Gel	290.0	275.8	14.2
		Total	45.2

Integrated Gas Bag # ___

CO_2	12.3
O_2	0.0
N_2	
CO	

Vmstd ___
%H₂O ___
mL(wet) ___
% Iso ___

SDCFM ___

V_m ~~21.50~~ 18.50 * mcf = V_m corrected ___

Time (min)	–
Noz	–
P_{bar}	29.92
P_d	–
Td	970
ΔP	0.05
V_d	–
Tm	38
ΔH	0.0

U_m (initial) = 596.50

U_m (final) = 615.00

18.50

Field Data Sheet

Client: Arco Alaska Unit: 1781 Report #: Heater Y1 Date: 9-20-83

Site _____ # 3 Time: 18:35-19:10

Pitot # 5330 Cp 0.80 meter # 635 mcf 0.9862

Temp Unit # ____ Mag # 376 Td ____ Hi ΔP/Lo ΔP ____/____

Duct dia 24.0 (ins) Coup ____ (ins) Bef/Aft 5/7 Static -0.07

Impingers		Final	Tare	Net
1		474.75	415.25	59.50
2				
3	Lg Grnbg	152	100	
4	Sm Grnbg	54	50	
5	K.O.	–	–	
6	Silica Gel	279.8	276.3	
			Total	59.5

Integrated Gas Bag # ____

CO_2	12.4	
O_2	0.0	
N_2		
CO		

$V_{m\,std}$ ____
% H_2O ____
MW(wet) ____
% Iso ____

SDCFM ____

V_m 17.95 * mcf = $V_{m\,corrected}$ ____
Time(min) –
NO_2 –
P_{bar} 29.92
P_d –
T_d 960
ΔP 0.04
V_d
T_m 37
ΔH 0.0

V_m (final) = 634.00
V_m (initial) = 616.05
17.95

Site _____ # ____ Time: _____

Pitot # ____ Cp ____ meter # ____ mcf ____

Temp Unit # ____ Mag # ____ Td ____ Hi ΔP/Lo ΔP ____/____

Duct dia. ____ (ins) Coup ____ (ins) Bef/Aft ____/____ Static ____

Impingers		Final	Tare	Net
1				
2				
3				
4				
5	K.O			
6	Silica Gel			
			Total	

Integrated Gas Bag # ____

CO_2		
O_2		
N_2		
CO		

$V_{m\,std}$ ____
% H_2O ____
MW(wet) ____
% Iso ____

SDCFM ____

V_m ____ * mcf = $V_{m\,corrected}$ ____
Time(min) ____
NO_2 ____
P_{bar} ____
P_d ____
T_d ____
ΔP ____
V_d ____
T_m ____
ΔH ____

INITIAL MOLECULAR WEIGHT & PERCENT WATER

CLIENT: Arco Alaska

SITE: DS Y1 (Drill site) South Stack West Port

DATE: September 20, 1983 1620 hr begin

Pressure

Barometric	29.92	"Hg
Static	+0.08	"H_2O
Duct (absolute)		"Hg
Orifice (ΔH)	0.0	"H_2O

Temperature

Standard	68	°F
Duct	972	°F
Wet Bulb	—	°F
Meter	45	°F 47 45 42
Meter #	635	M_{cF} 1.007

M_F 538.75 596.10

M_I 575.95 95 ≈ 0.72 CFM

Meter Volume ~~20.00~~ 20.15 × 1.007 = 20.3 CF 0.011 cfm, 5" Hg

Vmstd _____ CF

Water Collection

Final Weight	497.68	g
Tare Weight	422.35	g
Net	75.33	g

	Final	Tare	Net
Lg grnbg	170	100	70
Smgrnbg	52	50	
KO.	—		
	275.68	272.35	
	272.35	Tare	

272.35 grm net

RESULTS:

Orsat Analysis

CO_2 (120)	12.0	% Volume (Dry)
O_2 (0)	0.0	% Volume (Dry)
CO	-	% Volume (Dry)
N_2	88.0	% Volume (Dry)

CO _____ ppm Volume (Dry) by Dräger tube

Initial Water (By Procedure # ____)

H_2O _____ % Volume

MW _____ (wet)

Dew Point Temp. _____ °F

INITIAL MOLECULAR WEIGHT & PERCENT WATER

CLIENT: Arco Alaska

SITE: Flow station Y1

DATE: 9/20/83 Begin 1800 hr

Pressure

Barometric	29.92	"Hg
Static	(-) +0.06	"H_2O
Duct (absolute)		"Hg
Orifice (ΔH)	0.0	"H_2O

Temperature

Standard	68	°F
Duct	972	°F
Wet Bulb	—	°F
Meter	40 36 38	°F

Water Collection

Final Weight	471.0	g
Tare Weight	425.8	g
Net	45.2	g

MF 615.00

MI 596.50 18.50 * 1.00 = 1.50

Meter Volume _____ CF Leak check 0.005 CFM @ 10" Hg

Vmstd _____ CF

	Final	Tare
LRC	12[illegible]	100
SM	52	50
KO	1	—
Silica	290.0	275.8

RESULTS:

Orsat Analysis

CO_2	12.3 12.3	% Volume (Dry)
O_2	0 0.0	% Volume (Dry)
CO		% Volume (Dry)
N_2	87.7	% Volume (Dry)

CO _____ ppm Volume (Dry) by Dräger tube

Initial Water (By Procedure # ____)

H_2O _____ % Volume

MW _____ (wet)

Dew Point Temp. _____ °F

INITIAL MOLECULAR WEIGHT & PERCENT WATER

CLIENT: Arco Alaska

SITE: Flow Station Y1 - South ~~Ba~~ Stack

DATE: 9/20/83 1918hr Run#3

Pressure

Barometric	29.92	"Hg
Static	-0.07	"H_2O
Duct (absolute)	28.91	"Hg
Orifice (ΔH)	0	"H_2O

Temperature

Standard	68	°F
Duct	960	°F
Wet Bulb	—	°F
Meter	39 37	°F

Water Collection

Final Weight	474.75	g
Tare Weight	415.25	g
Net	59.50	g

MF 634.00
MI 616.05 17.95

Meter Volume 18.11 CF Leak Chk. 0.008 cfm

Vmstd _____ CF @ 7" Hg

0.5

RESULTS:

Orsat Analysis 1930hr

CO_2	12.4	% Volume (Dry)
O_2	0.0	% Volume (Dry)
CO		% Volume (Dry)
N_2	87.6	% Volume (Dry)

CO _____ ppm Volume (Dry) by Dräger tube

Initial Water (By Procedure # ____)

H_2O _____ % Volume

MW _____ (wet)

Dew Point Temp. _____ °F

N
W E
S

DATA: Arco Alaska - Drill site Y 1

Date 9/20/83 Time 1615 Run # 1

Description: 2, Four (4) inch male ports correctly located 90° apart on a horizontal plane, approximately 7 dia. after and 5 dia before a disturbance in the fl.

Duct Diameter 24 inches Area 3.14 ft²

Rectangular duct _____ X _____

%H2O _____ MW _____

Duct Static Pressure -0.08 inches H2O Pitot Tube # 5330

Standard Conditions 68 °F & 29.92 "Hg Mag Box # 376

Pitot Tube Coefficient 0.798 Handitemp # 553

38
24
14 cup

South stack North stack +0.01 static

Trav. Pt.	Ins. From Edge	N West Port Temp °F	ΔP In.	Vd ft/sec	N East Temp °F	ΔP In.	Vd ft/sec	S. West Port Temp °F	ΔP In.	Vd ft/sec	Temp °F	ΔP In.	Vd ft/sec
1	1.0 ~~0.5~~	963	0.03					892	0.02				
2	3.5							892	0.05				
3	7.8		0.03					892	0.05				
16.1 4	15.9		0.04					892	0.05				
5	20.5	963	0.04					892	0.05				
6	23.0	963	0.03					892	0.04				
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													

RESULTS:

Average Velocity (Vd) _____ FPS Average duct temp. _____ °F

Average Volume Flow Rate Qd _____ ACFM at _____ °F & _____ "Hg

Volume Flow Rate Qstd(wet) _____ SCFM at standard conditions

Volume Flow Rate Qstd(dry) _____ SDCFM at standard conditions

DATA: Arco Alaska - FS-Y1

Date 9/20/83 Time 1745 Run # 2

Description: See Run #1

Duct Diameter 24 inches Area 3.14 ft^2

Rectangular duct _____ X _____

%H_2O _____ MW _____

Duct Static Pressure +0.06 inches H_2O Pitot Tube # 5330

Standard Conditions 68 °F & 29.92 "Hg Mag Box # 376

Pitot Tube Coefficient 0.798 Handitemp # Newport 264-1

South Stack North Stack +0.07 static

Trav. Pt.	Ins. From Edge	N. West Port Temp °F	ΔP In.	Vd ft/sec	Temp °F	ΔP In.	Vd ft/sec	S. West Port Temp °F	ΔP In.	Vd ft/sec	S. East Port Temp °F	ΔP In.	Vd ft/sec
1	1.0	972	0.03					969	0.03		899		
2	3.5	972	0.04						0.04				
3	7.1	972	0.06					969	0.05				
4	16.9	|	0.07					|	0.05				
5	20.5	|	0.05					|	0.04				
6	23.0	972	0.04					969	0.04				
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													

RESULTS:

Average Velocity (V_d) _____ FPS Average duct temp. _____ °F

Average Volume Flow Rate Qd _____ ACFM at _____ °F & _____ "Hg

Volume Flow Rate Qstd(wet) _____ SCFM at standard conditions

Volume Flow Rate Qstd(dry) _____ SDCFM at standard conditions

DATA: Arco Alaska - Drill site Y1

Date 9/29/83 Time 1835 Run # 3

Description:

Duct Diameter 24.0 inches Area _____ ft^2

Rectangular duct _____ X _____

%H_2O _____ MW _____

Duct Static Pressure +0.07 inches H_2O Pitot Tube # 5330

Standard Conditions 68 °F & 29.92 "Hg Mag Box # 376

Pitot Tube Coefficient 0.798 Handitemp # NW Port 264.1

1900hr South Stack 1015hr North Stack +0.08

Trav. Pt.	Ins. From Edge	N. West Port Temp °F	N. West Port ΔP In.	N. West Port Vd ft/sec	Temp °F	ΔP In.	Vd ft/sec	S. West Port Temp °F	S. West Port ΔP In.	S. West Port Vd ft/sec	Temp °F	ΔP In.	Vd ft/sec
1	1.0	960	0.03					946	0.03				
2	3.5	↓	0.04					946	0.04				
3	7.1		0.05					946	0.05				
4	16.9		0.04					1	0.05				
5	20.5		0.03						0.04				
6	23.0		0.03					946	0.03				
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													

RESULTS:

Average Velocity (V_d) _____ FPS Average duct temp. _____ °F

Average Volume Flow Rate Qd _____ ACFM at _____ °F & _____ "Hg

Volume Flow Rate Qstd(wet) _____ SCFM at standard conditions

Volume Flow Rate Qstd(dry) _____ SDCFM at standard conditions

Field Data Sheet

Client: ARCO Alaska Unit: Turbine C-CPF1 Report #: 1781 Date: 9-21-83

Site ____ # 1 Time: 11:20 - 12:35

Pitot # 5330 Cp 0.80 meter # 635 mcf 0.9862

Temp Unit # ____ Mag # 376 Td ____ Hi ΔP/Lo ΔP ____/____

Duct dia 72.0 (ins) Coup ____ (ins) Bef/Aft 3.5/8 Static 0.70

(28.27 ft²)

Impingers	Final	Tare	Net
1	459.61	444.16	15.45
2			
3 Lg Grnby	108	100	
4 Sm Grnby	52	50	
5 K.O.	–	–	
6 Silica Gel	299.61	294.26	
		Total	15.45

Integrated Gas Bag # ____

CO_2	1.5
O_2	16.5
N_2	
CO	

$V_{m\,std}$ ____
% H_2O ____
MU(wet) ____
% Iso ____

SDCFM ~~(93,545)~~

V_m 21.00 * mcf = $V_{m\,corrected}$ ____
Time (min) –
NO_2 –
P_{Bar} 29.65
P_d
T_d 890
ΔP 2.70
V_d (148.7)
T_m 45
ΔH 0.0

V_m (final) = 656.15
V_m (initial) = 635.15
21.00

Site ____ # 2 Time: 12:15 - 12:35

Pitot # 5330 Cp 0.80 meter # 635 mcf 0.9862

Temp Unit # ____ Mag # 376 Td ____ Hi ΔP/Lo ΔP ____/____

Duct dia. 72.0 (ins) Coup ____ (ins) Bef/Aft ____/____ Static 0.76

Impingers	Final	Tare	Net
1			
2	470.91	448.61	22.3
3 Lg Grnby	119	100	
4 Sm Grnby	52	50	
5 K.O	–	–	
6 Silica Gel	299.81	298.61	
		Total	22.3

Integrated Gas Bag # ____

CO_2	1.5
O_2	16.6
N_2	
CO	

$V_{m\,std}$ ____
% H_2O ____
MU(wet) ____
% Iso ____

SDCFM ~~(93,305)~~

V_m 20.10 * mcf = $V_{m\,corrected}$ ____
Time (min) –
NO_2 –
P_{Bar} 29.65
P_d
T_d 895
ΔP 2.77
V_d (151.4)
T_m 45
ΔH 0.0

V_m (final) = 676.55
V_m (initial) = 656.45
20.10

Field Data Sheet

Client: ARCO Alaska Unit: Turbine C-CPF1 Report #: 1781 Date: 9-21-83

Site ____ # 3 Time: 13:55 - 14:30

Pitot # 5330 Cp 0.80 meter # 635 mcf 0.9862

Temp Unit # ____ Mag # 376 Td ____ Hi ΔP/Lo ΔP ____/____

Duct dia 72.0 (ins) Coup. ____ (ins) Bef/Aft ____/____ Static 0.70

Impingers		Final	Tare	Net
1				
2		469.8	444.4	25.4
3		120	100	
4		51	50	
5	K.O.	—	—	
6	Silica Gel	298.8	294.40	
			Total	25.4

Integrated Gas Bag # 3

CO_2	1.9
O_2	16.5
N_2	
CO	

V_{mstd} ____
$\%H_2O$ ____
MW(wet) ____
% Iso ____

SDCFM ____

V_m 20.56 * mcf = V_m corrected ____

Time (min) —
Noz —
P_{bar} 29.65
P_d ____
T_d 895
ΔP 2.68
V_d ____
T_m 45
ΔH 0.0

V_m (final) = 698.16
V_m (initial) = 677.60
20.56

Site ____ # ____ Time: ____

Pitot # ____ Cp ____ meter # ____ mcf ____

Temp Unit # ____ Mag # ____ Td ____ Hi ΔP/Lo ΔP ____/____

Duct dia. ____ (ins) Coup ____ (ins) Bef/Aft ____/____ Static ____

Impingers		Final	Tare	Net
1				
2				
3				
4				
5	K.O			
6	Silica Gel			
			Total	

Integrated Gas Bag # ____

CO_2	
O_2	
N_2	
CO	

V_{mstd} ____
$\%H_2O$ ____
MW(wet) ____
% Iso ____

SDCFM ____

V_m ____ * mcf = V_m corrected ____

Time (min) ____
Noz ____
P_{bar} ____
P_d ____
T_d ____
ΔP ____
V_d ____
T_m ____
ΔH ____

INITIAL MOLECULAR WEIGHT & PERCENT WATER

CLIENT: Arco Alaska

SITE: Gas lift Compressor C - CPF1

DATE: 9/21/83 1116 hr - 1235 Run #1

Pressure

Barometric	29.65	"Hg
Static	+0.70	"H_2O
Duct (absolute)	29.70	"Hg
Orifice (ΔH)	0	"H_2O

Temperature

Standard	68	°F
Duct	372	°F
Wet Bulb	~~45~~	°F
Meter	45	°F

Water Collection

Final Weight	459.61	g
Tare Weight	444.16	g
Net	15.45	g

150 160

M_F	656.15	
M_I	635.15	
Meter Volume	20.0	CF
Vmstd		CF

RESULTS: 1149 hr

Orsat Analysis

CO_2	1.5	% Volume (Dry)
O_2	16.5	% Volume (Dry)
CO	32.0	% Volume (Dry)
N_2		% Volume (Dry)

CO _____ ppm Volume (Dry) by Dräger tube

Initial Water (By Procedure # _____)

H_2O _____ % Volume

MW _____ (wet)

Dew Point Temp. _____ °F

INITIAL MOLECULAR WEIGHT & PERCENT WATER

CLIENT: Arco Alaska

SITE: Gas lift Compressor C CPF

DATE: 9/21/83 1215hr - 1250 Run #2

Pressure

Barometric	29.65	"Hg
Static	+0.76	"H_2O
Duct (absolute)	29.71	"Hg
Orifice (ΔH)	0.0	"H_2O

Temperature

Standard	68	°F
Duct		°F
Wet Bulb	—	°F
Meter	46	°F

Mcf 0.9762

Water Collection

Final Weight	470.91	g
Tare Weight	448.61	g
Net	22.30	g

M_1 676.55

M_2 656.45 20.10

Meter Volume 19.62 CF 0.010 CF @ 6" Hg

Vmstd _____ CF

RESULTS:

Orsat Analysis

CO_2	1.5	% Volume (Dry)
O_2	16.6	% Volume (Dry)
CO		% Volume (Dry)
N_2	81.9	% Volume (Dry)

CO _____ ppm Volume (Dry) by Dräger tube

Initial Water (By Procedure # ____)

H_2O _____ % Volume

MW _____ (wet)

Dew Point Temp. _____ °F

INITIAL MOLECULAR WEIGHT & PERCENT WATER

CLIENT: Arco Alaska

SITE: CPF1 Gas Lift Compressor

DATE: 9/21/83 1354hr -1430 Run #3

Pressure

Barometric	29.65	"Hg
Static	10.70	"H_2O
Duct (absolute)		"Hg
Orifice (ΔH)	0.0	"H_2O

Temperature

Standard	68	°F
Duct		°F
Wet Bulb	–	°F
Meter	45 / 48	°F

Water Collection

Final Weight	469.75	g
Tare Weight	444.4	g
Net	25.35	g

M_{cf} = 0.9762

ML	698.16 / 677.60	20.50
Meter Volume	20.07	CF
Vmstd		CF

RESULTS:

Orsat Analysis

CO_2	1.4	% Volume (Dry)
O_2	16.5	% Volume (Dry)
CO	82	% Volume (Dry)
N_2		% Volume (Dry)

CO _____ ppm Volume (Dry) by Dräger tube

Initial Water (By Procedure # ____)

H_2O _____ % Volume

MW _____ (wet)

Dew Point Temp. _____ °F

DATA: Gas Lift Compressor L - CPFI

Date 7/21/83 Time 1120 Run # 1

Description: Two 3" ports properly located 3.5 diameters after and approximately 8 diameters before a disturbance

Duct Diameter 720 inches Area 28.27 ft^2

Rectangular duct _____ X _____

%H2O _____ MW _____

Duct Static Pressure +0.70 inches H2O

Standard Conditions 68° °F & 29.92 "Hg

Pitot Tube Coefficient 0.798

Pitot Tube # 5[illegible]0

Mag Box # 376

Handitemp # NewPort 264-1

+0.76

Trav. Pt.	Ins. From Edge	South Port Temp °F	South Port ΔP In.	South Port Vd ft/sec	Temp °F	ΔP In.	Vd ft/sec	West Port Temp °F	West Port ΔP In.	West Port Vd ft/sec	Temp °F	ΔP In.	Vd ft/sec
1	1.5	892	1.70					892	0.80				
2	4.8		2.40					892	2.40				
3	8.5		2.50					892	[illegible]				
4	12.[illegible]		2.50					892	3.20				
5	1[illegible].0		2.60					892	3.20				
6	[illegible]		2.60					892	3.20				
7	46.4		2.60					892	4.20				
8	5[illegible].0		2.60					892	3.[illegible]				
9	[illegible]1.2		2.60					892	[illegible].40				
10	63.5		2.70					892	[illegible].40				
11	[illegible]7.2		2.90						2.20				
12	70.5		2.80					892	[illegible]				
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													

RESULTS:

Average Velocity (Vd) _____ FPS Average duct temp. _____ °F

Average Volume Flow Rate Qd _____ ACFM at _____ °F & _____ "Hg

Volume Flow Rate Qstd(wet) _____ SCFM at standard conditions

Volume Flow Rate Qstd(dry) _____ SDCFM at standard conditions

DATA: Gas Lift Compressor C-CPF I

Date 7/21/83 Time 1235 Run # 2

Description:
See Run #1

Duct Diameter 72.0 inches Area 28.27 ft^2

Rectangular duct _____ X _____

%H2O _____ MW _____

Duct Static Pressure +0.76 inches H2O

Standard Conditions 68 °F & 29.92 "Hg

Pitot Tube Coefficient 0.798

Pitot Tube # 5330

Mag Box # 376

Handitemp # Newport 264-1

Trav. Pt.	Ins. From Edge	West Temp °F	West ΔP In.	West Vd ft/sec	Temp °F	ΔP In.	Vd ft/sec	South Temp °F	South ΔP In.	South Vd ft/sec	Temp °F	ΔP In.	Vd ft/sec
1	1.5	895	1.20					894	1.80				
2	4.8		2.40						2.20				
3	8.5		3.00						2.30				
4	12.8	895	3.40						2.70				
5	18.0		[illegible]						2.70				
6	25.6		3.40					894	2.70				
7	46.4		4.40						2.70				
8	54.0		[illegible]					894	2.70				
9	59.2	895	3.40						2.50				
10	63.5		3.10						2.50				
11	67.2		3.00						2.70				
12	70.5	895	2.70						2.90				
13								894	2.90				
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													

RESULTS:

Average Velocity (Vd) _____ FPS Average duct temp. _____ °F

Average Volume Flow Rate Qd _____ ACFM at _____ °F & _____ "Hg

Volume Flow Rate Qstd(wet) _____ SCFM at standard conditions

Volume Flow Rate Qstd(dry) _____ SDCFM at standard conditions

DATA: Gas Lift Compressor C-CPF 1

Date 9/21/8[illegible] Time 1412 Run # 3

Description: see Run #1

Duct Diameter 72.0 inches Area 28.27 ft^2

Rectangular duct _____ X _____

%H_2O _____ MW _____

Duct Static Pressure +0.30 inches H_2O

Standard Conditions 68 °F & 29.92 "Hg

Pitot Tube Coefficient 0.798

Pitot Tube # [illegible]

Mag Box # 276

Handitemp # Newport 264-1

Trav. Pt.	Ins. From Edge	Inlet Port Temp °F	Inlet Port ΔP In.	Inlet Port Vd ft/sec	[illegible] Temp °F	[illegible] ΔP In.	[illegible] Vd ft/sec	Outlet Port Temp °F	Outlet Port ΔP In.	Outlet Port Vd ft/sec	[illegible] Temp °F	[illegible] ΔP In.	[illegible] Vd ft/sec
1	1.5	892	1.0					894	1.80				
2	4.8	892	2.4					894	2.40				
3	8.5	892	2.80					894	2.40				
4	12.8	892	3.20					894	2.40				
5	18.0	892	3.20						[illegible]				
6	25.0	892	3.20					894	[illegible]				
7	46.4	892	3.80						[illegible]				
8	54.0	892	3.60						2.40				
9	59.2	892	3.20					894	2.50				
10	63.5	892	3.20					894	2.70				
11	67.2	892	3.00					894	2.80				
12	70.5	892	2.80					894	2.90				
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													

RESULTS:

Average Velocity (V_d) _____ FPS Average duct temp. _____ °F

Average Volume Flow Rate Qd _____ ACFM at _____ °F & _____ "Hg

Volume Flow Rate Qstd(wet) _____ SCFM at standard conditions

Volume Flow Rate Qstd(dry) _____ SDCFM at standard conditions

APPENDIX 5

Wet Test Equipment Calibration Data

PITOT TUBE CALIBRATION DATA

PITOT TUBE IDENTIFICATION NUMBER 5330

PITOT TUBE TYPE 9ft initial

CALIBRATED BY WJB/FL

DATE 9/14/83 $\bar{C}_p = \frac{\bar{C}_{pA} + \bar{C}_{pB}}{2} = 0.798$

A SIDE CALIBRATION

RUN	ΔP_{STD}	$\Delta P_{(S)}$	$C_{P(S)}$	DEV.
1	0.13	0.20	0.798	0.002
2	0.50	0.79	0.788	-0.008
3	0.79	1.20	0.803	0.007
			$\bar{C}_{PA}$ = 0.796	AVG. = 0.006

STANDARD DEVIATION OF AVG. DEV. = 0.003 (Must be <.02)

B SIDE CALIBRATION

RUN	ΔP_{STD}	$\Delta P_{(S)}$	$C_{P(S)}$	DEV.
1	0.13	0.20	0.798	-0.001
2	0.50	0.77	0.797	-0.002
3	0.79	1.20	0.803	0.004
			$\bar{C}_{PB}$ = 0.799	AVG. = 0.002

STANDARD DEVIATION OF AVG. DEV. = 0.002 (Must be <.02)

$|\bar{C}_{P\,a} - \bar{C}_{P\,B}|$ = 0.003 (Must be <.01)

CALCULATIONS:

$$\text{AVERAGE DEVIATION} = \frac{\sum_{i}^{3} \left| C_{P\,(S)} - \bar{C}_{P\,(A\text{ or }B)} \right|}{3} \quad \text{(Must be <.01)}$$

$$\text{DEVIATION (DEV.)} = C_{P\,(S)} - \bar{C}_{P\,(A\text{ or }B)}$$

$$C_{P\,(S)} = C_{P\,(STD)} \sqrt{\frac{\Delta P_{STD}}{\Delta P_{S}}} \quad \text{Where } C_{P\,(STD)} = 0.99$$

MADE PRIOR TO TEST

PUMP METER TEST & CALIBRATION

METER	3.635	STD		STD		STD		STD		ST
DATE	9-14-83									
POTEN	3553									
MAG G.	10C/MAN									
PBAR	29.78									
M.F.	575.209	3.201								
M.I	571.800	∞								
ACF	3.409	3.201								
T°F	115	91								
R°	575	551								
P "H2O	2.8	1.4								
P" Hg	.21	.10								
P" Hg	29.99	29.88								
SCFM	3.0902	3.0169								
%	-1.48									
ERFACTOR	0.9862									
ON										
OFF										

ETER		STD		STD		STD		STD		STI
DATE										
POTENT.										
MAG G.										
BAR										
M.F.										
M.I.										
ACF										
T°F										
R°										
"H2O										
P" Hg										
P" Hg										
SCFM										
%										
ERFACTOR										
ON										

Σ = AVE
$\bar{x}$ = CORR

MAGNEHELIC GAUGE BOXES

INCLINE MANOMETER	# 3-376	CORREC. FACTOR	#	CORREC. FACTOR	#	CORREC FACTOR	#	CORREC FACTOR	#	COR FA
DATE	9-14-83									
					0 - 5					
5.00	4.85	1.03								
4.50	4.40	1.02								
4.00	3.95	1.02								
3.50	3.48	1.01								
3.00	2.98	1.01								
2.50	2.49	1.01								
2.00	1.99	1.01								
1.74	1.74	1.00								
1.48	1.48	1.00								
1.24	1.24	1.00								
1.08	1.08	1.00								
1.0	1.00	1.00								
Σ		12.11								
$\bar{x}$		1.01								
$\sqrt{x}$		1.00								
					0 — 1					
1.00	.96	1.04								
.88	.84	1.05								
.65	.62	1.05								
.52	.50	1.04								
.30	.29	1.03								
.22	.21	1.05								
.12	.12	1.00								
Σ		7.26								
$\bar{x}$		1.04								
$\sqrt{x}$		1.02								

MAGNEHELIC GAUGE READINGS WERE COMPARED TO READINGS ON WALL MOUN
DWYER INCLINE MANOMETER AS A STANDARD & CALCULATED A CORRECTION
INCLINE MANOMETER

APPENDIX 6

Instrument Calibration Data and Recorder Strip Charts

INSTRUMENT AND CALIBRATION DATA

Analyzer		Range	Zero Gas	Span Gas
Type:	NO/NOx			
Manufacturer:	Monitor Labs	0-500 ppm	Ambient Air 1/	92.35 2/
Model:	8430			
Serial #:	66			
Type:	O_2			
Manufacturer:	Taylor	0-25%	NOx	Ambient Air
Model:	580			
Serial #:	580110100-63			

1/ Ambient Air (Drierite packed tube)

2/ Cylinder #CAL7232 (See certification data)

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

Date Shipped 8-4-83

Our Project No: 321116

Your P.O. No: 3814

Page 1 of 1

CHEMECOLOGY
15[illegible] PORTERVILLE HWY
BAKERSFIELD, CA 93308

ATTN: LESLIE JOHNSON

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES*

(Concentrations are in mole % or ppm)

Cylinder Number CAL-7232 Certified Accuracy 1 % NBS Traceable Analysis Dates: First 4/14/83 Last 8/3/83

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
SULFUR DIOXIDE	48.80 ppm	2/3/84	ELECTRO-CHEMICAL	1694, 1693	48.80 ppm	48.80 ppm
NITRIC OXIDE	92.35 ppm	2/3/84	CHEMILUMINESCENCE	1683, 1684	92.34 ppm	92.36 ppm
NITROGEN	BALANCE					

Attachment #7

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

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

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

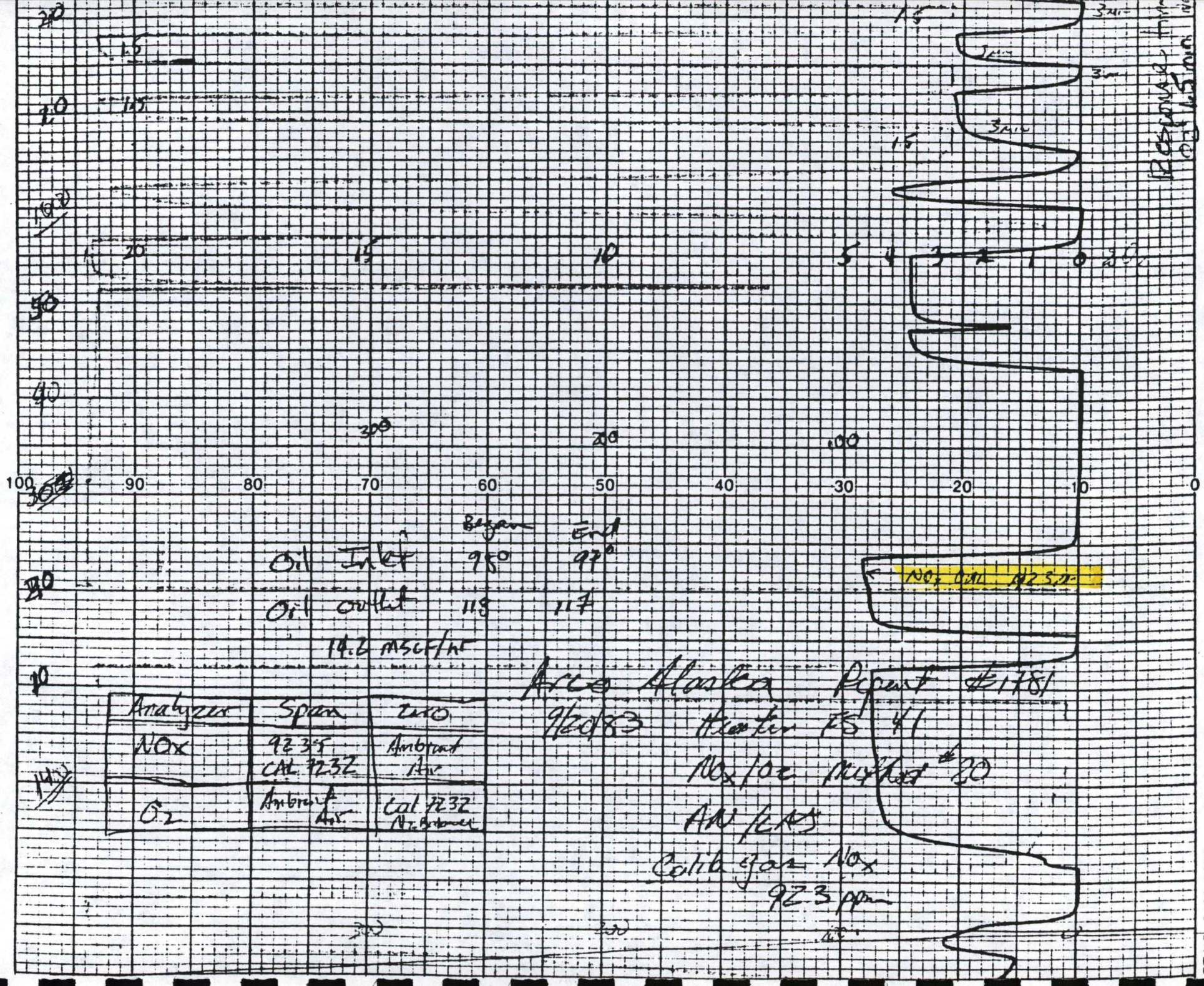
Analyst Penrose Hallowell Jr. PENROSE HALLOWELL, JR.

Approved By FRANCIS E. NEVILL

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

CERTIFIED REFERENCE MATERIALS ■ EPA PROTOCOL GASES ■ ACUBLEND® ■ CALIBRATION & SPECIALTY GAS MIXTURES
PURE GASES ■ ACCESSORY PRODUCTS ■ CUSTOM ANALYTICAL SERVICES

TROY, MICHIGAN / SAN BERNARDINO, CALIFORNIA



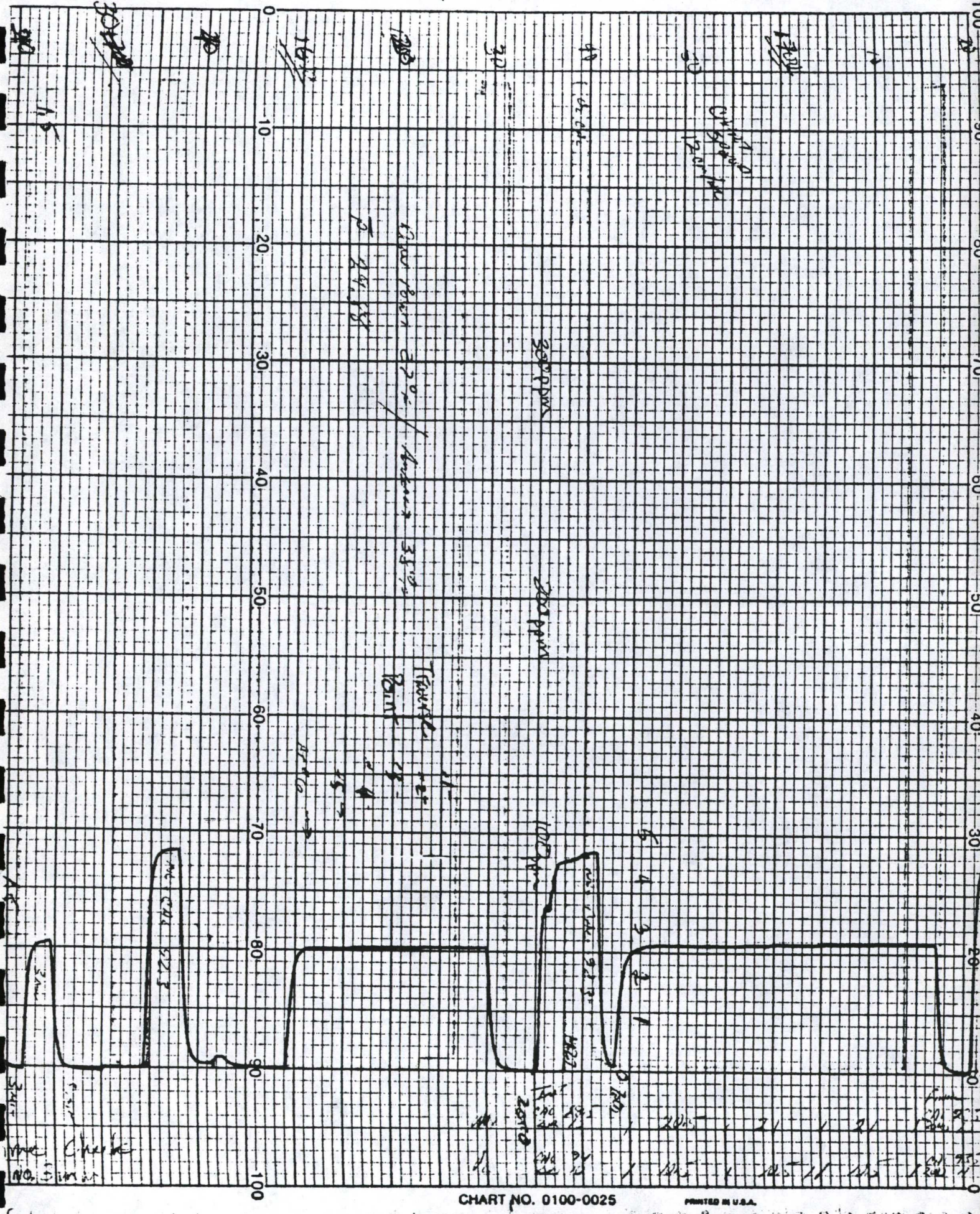
	Began	End
Oil Inlet	98°	97°
Oil outlet	118	117

14.2 MSCF/hr

Analyzer	Span	Zero
NOx	9235 CAL 7232	Ambient Air
O_2	Ambient Air	Cal 7232 N_2 Balance

Arco Alaska Report #1781
9/20/83 Heater FS 41
NOx/O2 Method #20
AN/LAS
Calib gas NOx
923 ppm

PART NO. 0100-0025 PRINTED IN U.S.A.



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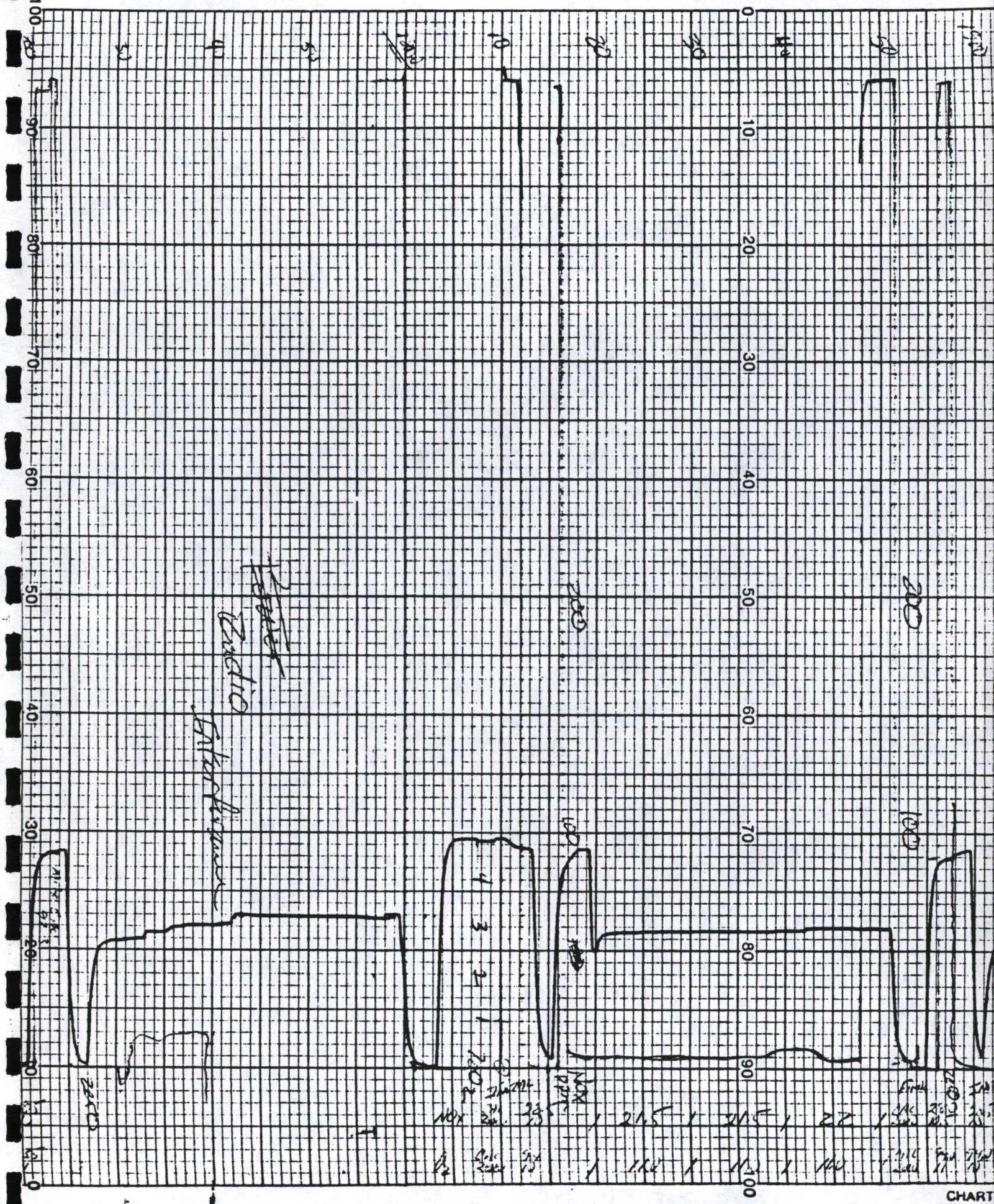
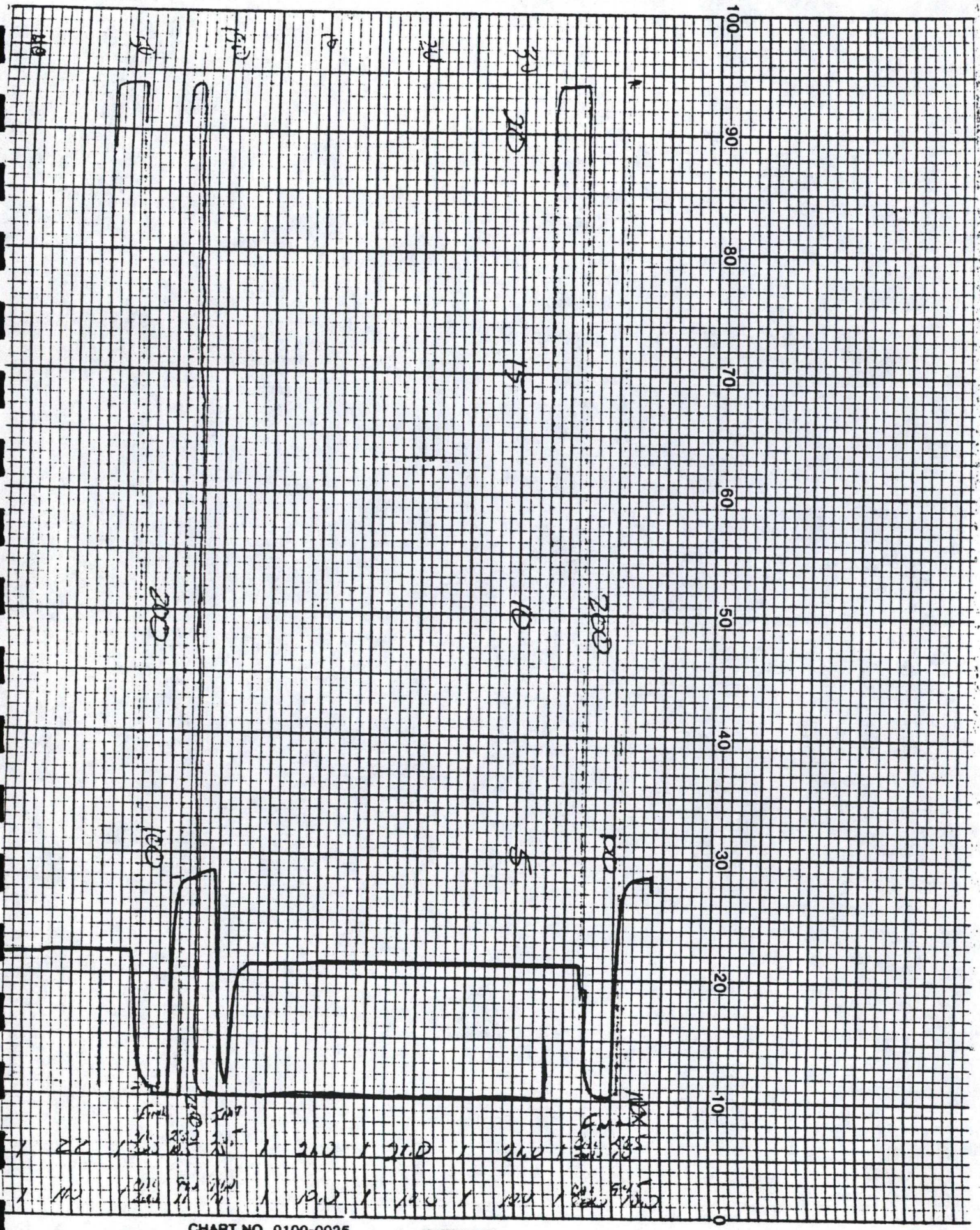

Radio
Interference
200
100
CHART



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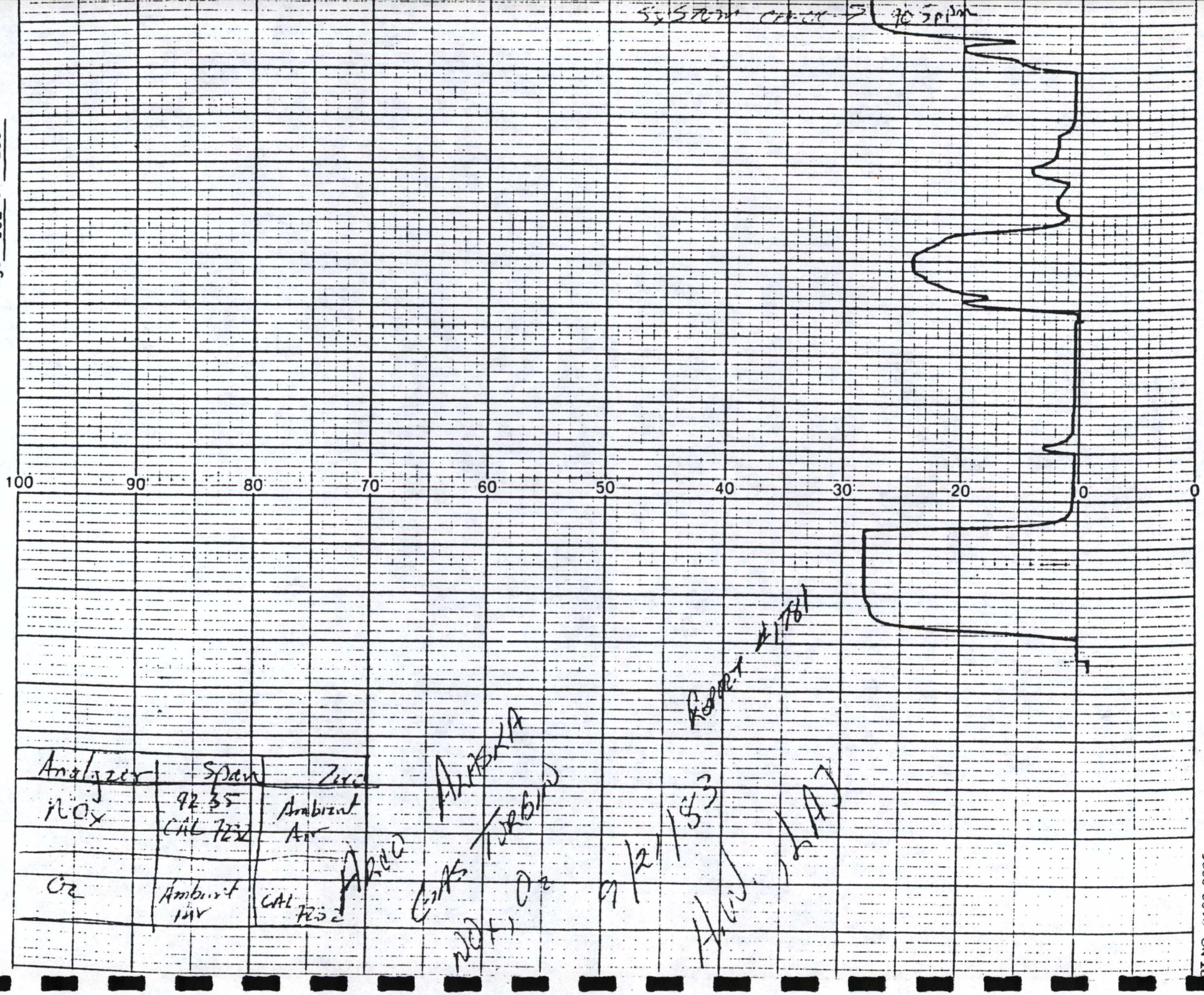
PRINTED IN U.S.A.



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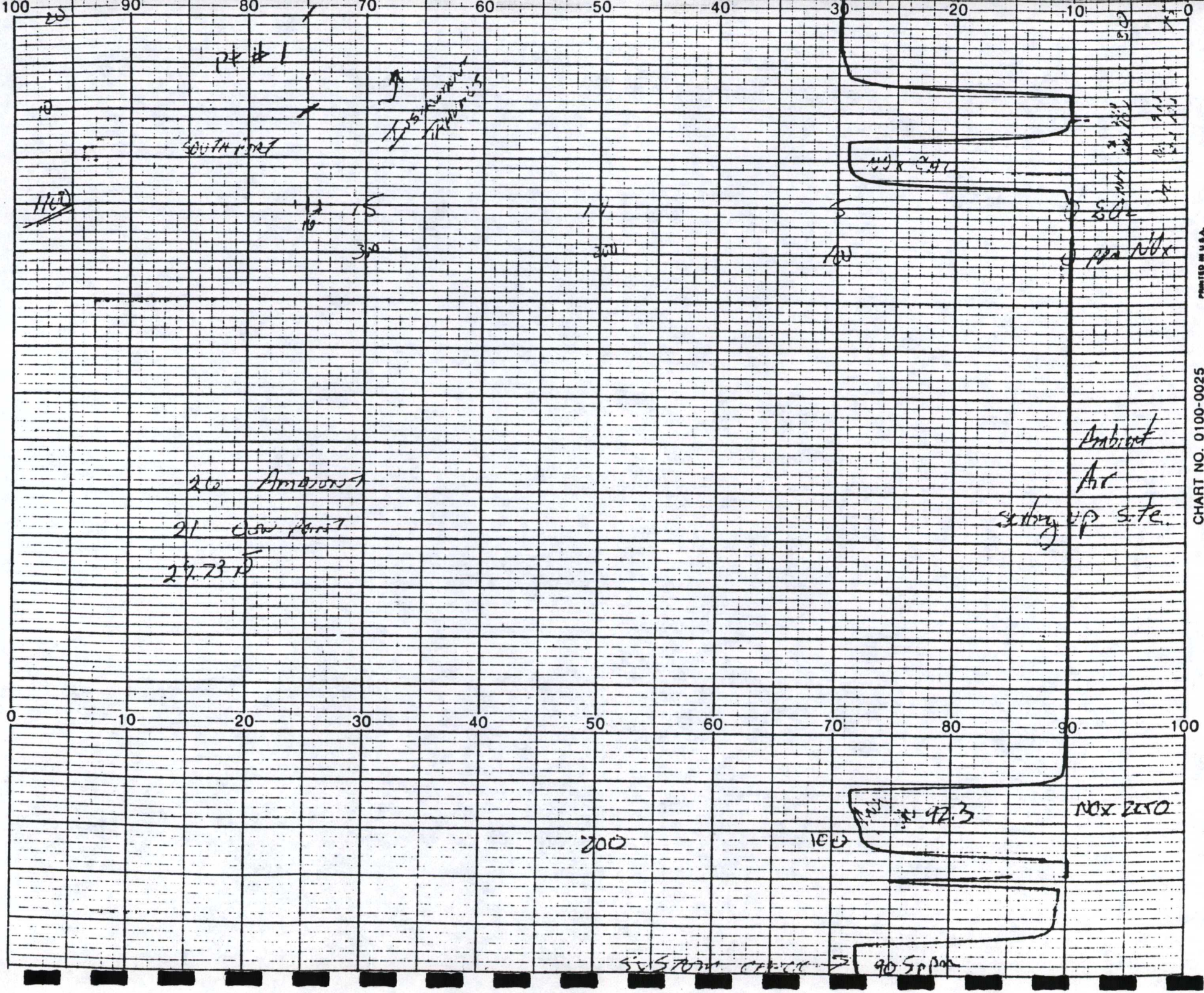
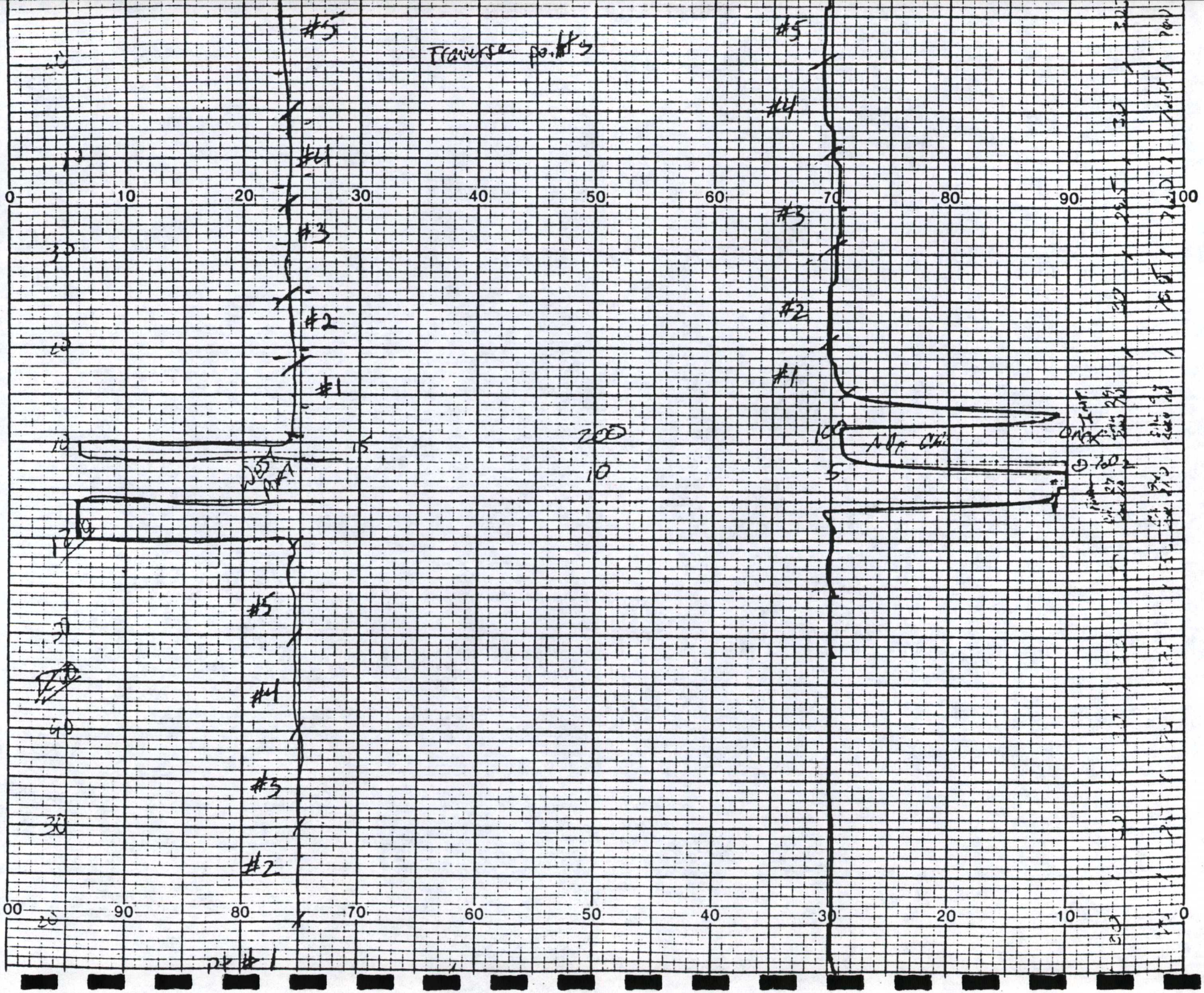
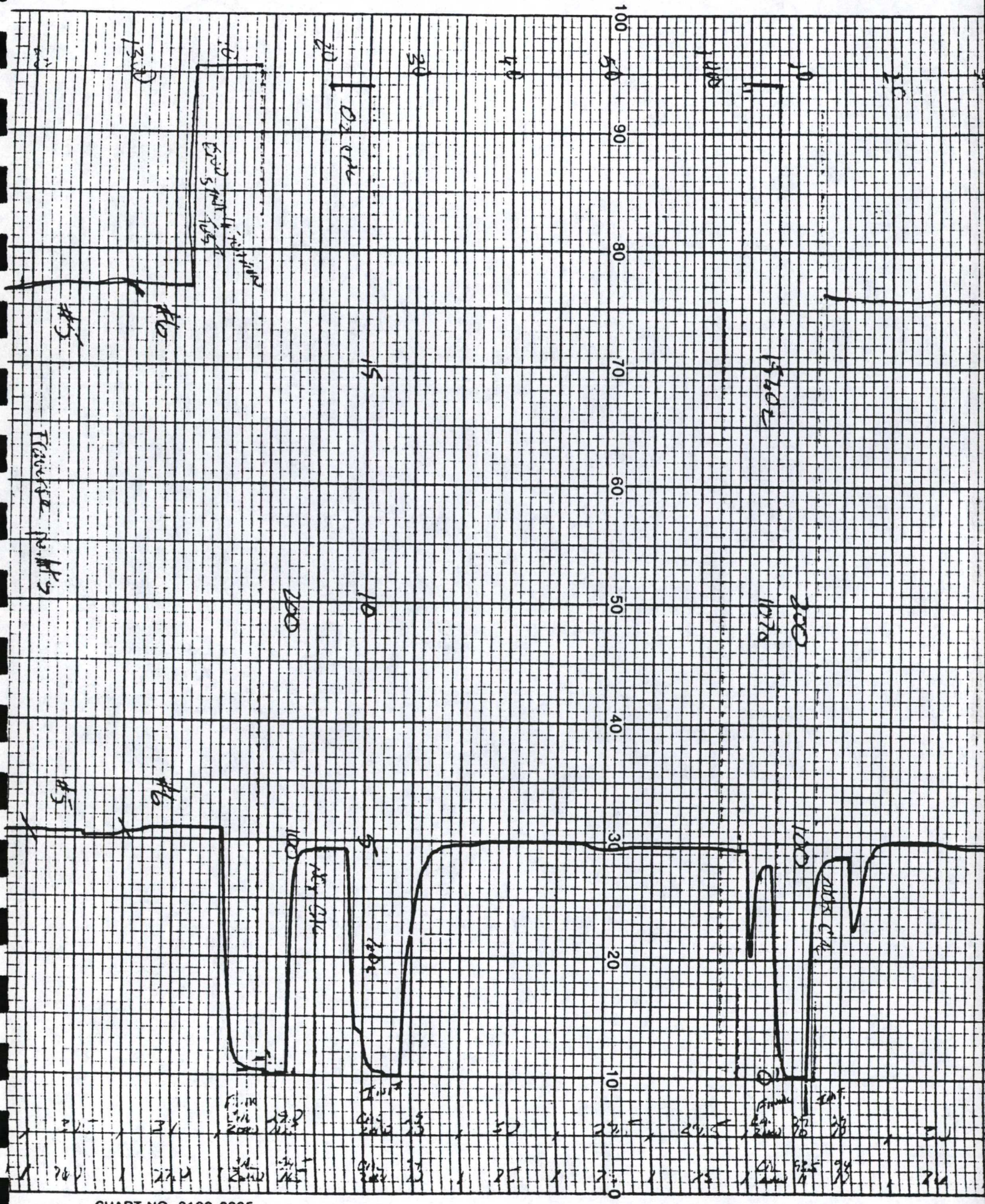


CHART NO. 0100-0025
PRINTED IN U.S.A.


Traverse pt. #3
#5
#4
#3
#2
#1
0
10
20
30
40
50
60
70
80
90
100
200
10
15
100
5
pt #1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90
80
70
60
50
40
30
20
10
0

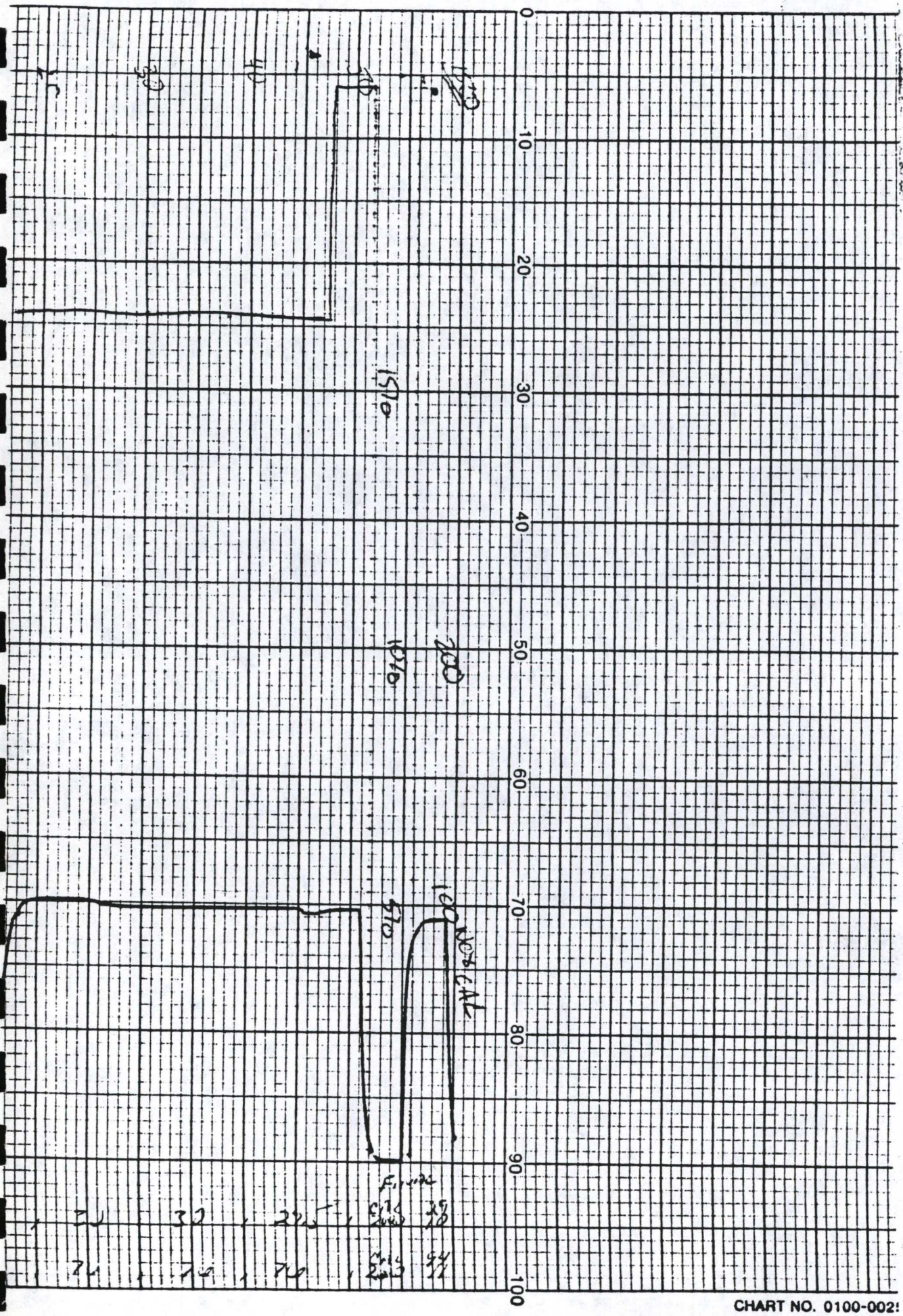
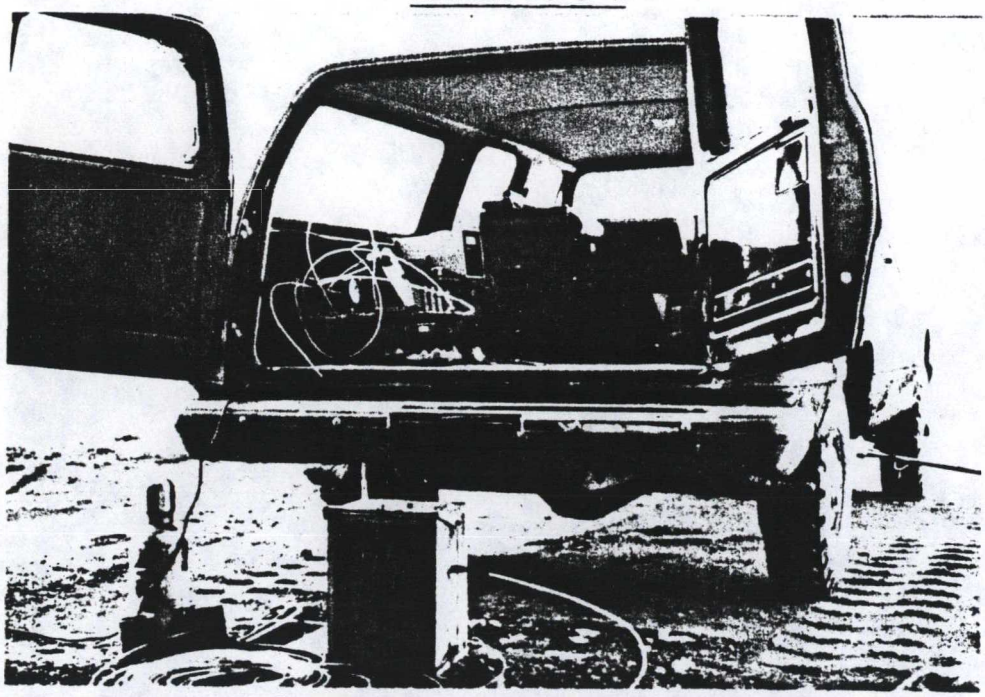


CHART NO. 0100-0025

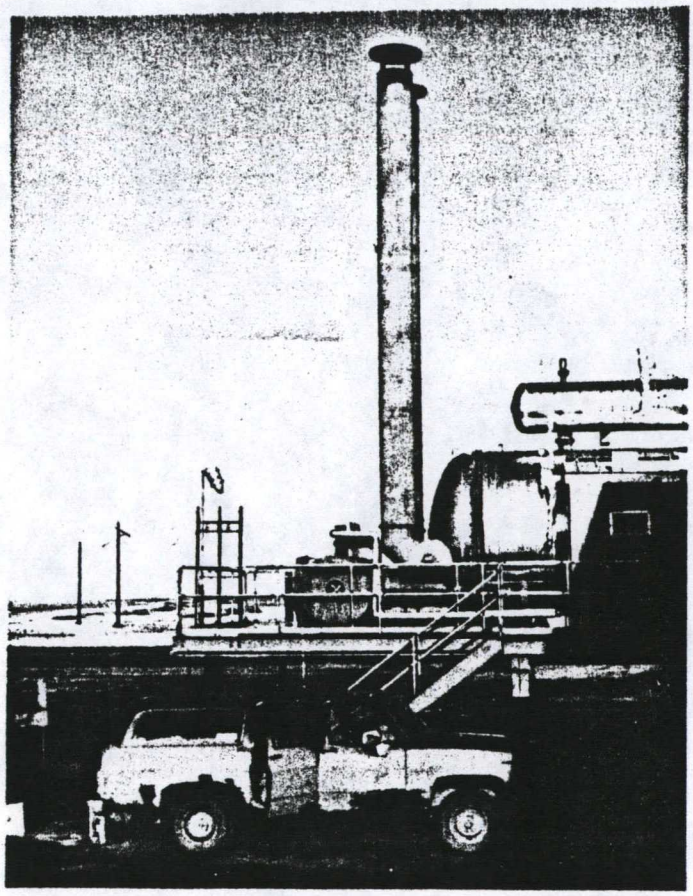
APPENDIX 7

Sampling Photos

HEATER DS 1-Y

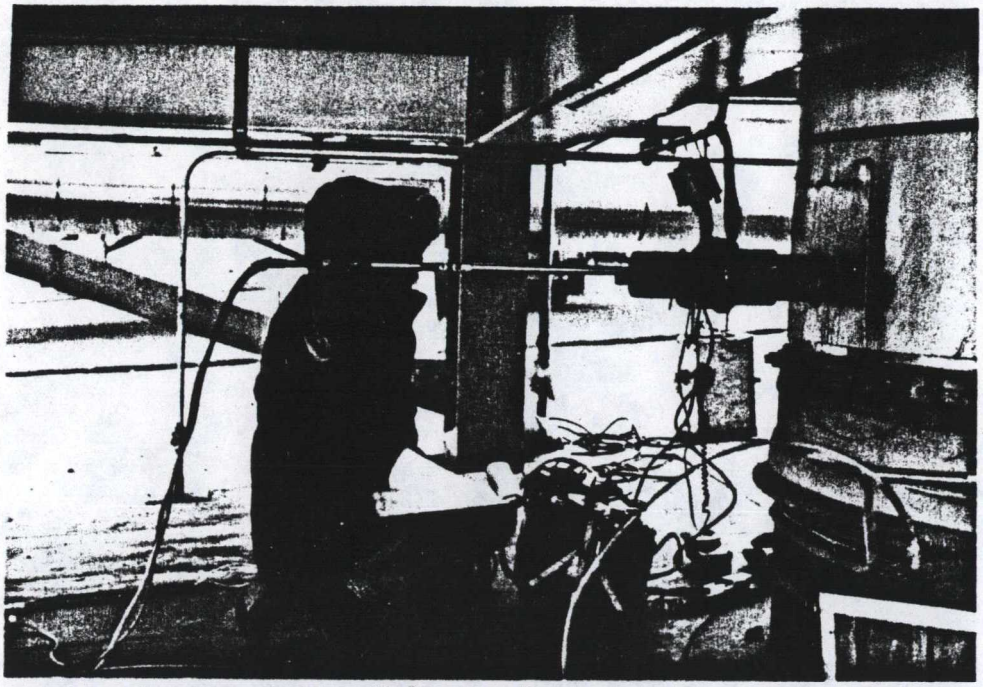


Analyzers, manifold and conditioning train (bottom)

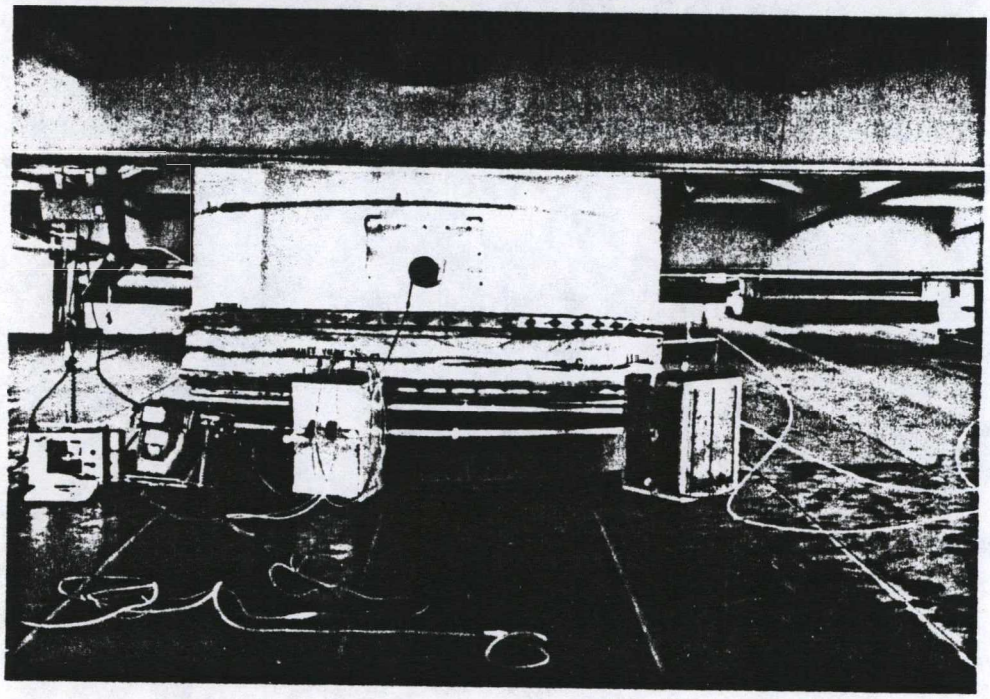


Heater stack, Analyzer van below

TURBINE CPF-1 (C2101C)



Velocity Traverse



Wet Sampling Equipment (L) and Analyzer Conditioning Train (R)