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PETRO CHEM ENVIRONMENTAL SERVICES

A Division of Cal State Electric Inc.

AIR EMISSIONS COMPLIANCE TEST REPORT

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DETERMINATION OF $NO_x/CO/O_2$ EMISSIONS for the PRUDHOE BAY UNIT OILFIELD

Units: 7,700 HP Suzler Turbine (#408-TCP-02-7704A)
67.2 MM BTU/hr Broach Heater (#1401)
29,100 HP Cooper Rolls Turbine (#GT-51-8002A)
320 MM BTU/hr Econotherm Heater (#H518002A)
29,100 HP Cooper Rolls Turbine (#31-15101)
200 MM BTU/hr Econotherm Heater (#31-14101)

EPA Permits #PSD-X80-09 and PSD-X81-01
and
ADEC Permit #AQC 8436-AA007 (GC-2)
ADEC Permit #AQC 8536-AA003 (SIPW)
ADEC Permit #AQC 8536-AA006 (SIPE)

Test Dates: September 3-5, 1985

Report #: 50-022 & 023

Tested by: L.A. Johnson
Reviewed by: TMB/CAS

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PETRO CHEM ENVIRONMENTAL SERVICES

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I. INTRODUCTION

INTRODUCTION

On September 3rd, 4th and 5th, 1985 Petro-Chem Environmental Services performed emissions source test on six (6) units at the request of Sohio Alaska Petroleum Co. and Arco Alaska, Inc. The purpose of the testing was to document compliance with EPA Region X permits # PSD-X80-09 and PSD-X81-01, and Alaska Department of Environmental Concervation (ADEC) permits, AQC-8436-AA007, AQC- 8536-AA003 and AQC-8436-AA006. All six (6) units are located in the Prudoe Bay Unit Oilfield.

On September 3, 1985 two (2) units were tested at Sohio Alaska Petroleum Company's facilities. The first unit was located at Gathering Center #2 (GC-2), a 7700 HP Sulzer Turbine (Tag #408-TCP-02-7704A). The second unit tested was a 29,100 HP Cooper Rolls Turbine (GT-51-8002A) located at the Seawater Injection Plant West (SIPW). This unit was tested to determine what portion of the combined system, turbine and supplementary fired waste heat recovery unit, emissions are attributed to the turbine. On September 4, 1985 the combined system, 29,100 HP Cooper Rolls Turbine (GT-51-8002A) and 320 MMBTU/hr Econotherm supplementary fired waste heater recovery unit (Tag #H518002A) with Zink burners, was tested. All units were monitored for NOx, Co and 02.

On September 5, 1985 three (3) units were tested at Arco Alaska's Seawater Injection Plant East (SIPE). The first of these units was a 67.2 MMBTU/hr broach heater (#1401). The second and third units tested were the Cooper Rolls 29,100 HP turbine (31-15101) and an Econotherm 200 MMBTU/hr waste heat recovery unit (31-14101) with Coen burners, respectively. The turbine units were monitored for NOx, CO, and 02. After allowing some time for downstream process changes; creating the demand for warmer sea water, the heater was put on line.

All units were monitored by facilities operations and fifteen minute print outs were made available. Using this data percent operation was calculated.

Emissions of NOx, CO and O2 were monitored at all turbines and NOx/O2 on the heaters using the following methods:

Parameter	Method	# Runs
NOx	Thermo Electron Chemiluminescent NO/NOX Analyzer	3
CO	Thermo Electron; NDIR CO Analyzer	3
O2	Fuel Cell O2 Analyzer	3
Unit Operations	15 minute computer read outs	-
Fuel Analysis	Gas Chromatography	1

An oxygen traverse was performed on a cross sectional grid using EPA method #1 to determine sample points. After confirming that no oxygen stratification existed eight sample points were used for run #2 and #3.

The source tests were conducted by Leslie A. Johnson and Andy Winkler of Petro-Chem Environmental Services. Observing the test for Alaska DEC was Jack Coutts. Lynn Billington and Erika Dippe of Sohio Alaska Petroleum Co. directed the testing at G.C. #2 and Sohio's SIPW. Jim Ives of Arco Alaska directed the testing at Arco's SIPE.

II. SUMMARY OF RESULTS

Summary of Results

NO_x/CO Emissions

	Date	NO_x ppm	NO_x ppm @ 15% O_2	CO ppm	CO lbs/10^6 scf
Sulzer Turbine (GC-2) 408-TC-02-7704A	9-3-85	108.5	143.4	5.91	18.8
Cooper Rolls Turbine (SIPW) GT-51-8002A	9-3-85	54.2	87.1	6.39	3.6
Cooper Rolls Turbine and Econotherm Waste Heat Recover Unit with Zink Burners (SIPW) GT-51-8002A & H 51-8002A	9-4-85	69.4	64.1	40.40	88.4
Cooper Rolls Turbine (SIPE) #31-15101	9-5-85	104.3	145.9	77.42	261.7
Cooper Rolls Turbine and Econotherm Waste Heat Recover Unit with Coen Burners (SIPE) #31-15101 & 31-14101	9-5-85	119.8	87.4	21.46	37.84
Broach Heater (SIPE) #1401	9-5-85	64.1	21.3	--	--

NO_x/CO Emissions Permit Conditions

	Rating	Allowable 1/ NO_x Emissions	Actual NO_x Emissions	Allowable CO Emissions	Actual CO Emissions
Sulzer Turbine (GC-2) 408-TCP-02-7704A	7700 hp	150 ppm @ 15% O_2	143.4ppm @ 15% O_2	109 lb/10^6scf (fuel)	18.8 lb/10^6scf
Cooper Rolls Turbine (SIPW) GT-51-8002A	29,100 hp	205ppm @ 15% O_2	87.1ppm @ 15% O_2	109 lb/10^6scf	3.6 lb/10^6scf
Cooper Rolls Turbine and Econotherm Waste Heat Recover Unit with Zink Burners (SIPW) GT-51-8002A & H518002A	29,100 hp 320 MMBTU/hr 302.5 MMBTU/hr	205 ppm @ 15% + 0.08 lbs/MMBTU	64.1 ppm @15% O_2 or 0.241 lbs/MMBTU	109 lb/10^6scf	88.4 lb/10^6scf
Cooper Rolls Turbine (SIPE) #31-15101	29,100 hp	205ppm @ 15% O_2	145.9 ppm @ 15% O_2	109 lb/10^6scf	261.7 lb/10^6scf
Cooper Rolls Turbine and Econotherm Waste Heat Recover Unit with Coen Burners (SIPE)	29,100 hp 200 MMBTU/hr	205 ppm @ 15% + 0.08 lbs/MMBTU	87.4 ppm @15% O_2 or 0.340 lbs/MMBTU	109 lb/10^6scf	37.84 lb/10^6scf
Broach Heater (SIPE) #1401	67.2 MMBTU/hr	0.08 lb/MMBTU	0.08 lb/MMBTU	---	---

1/ See Appendix C for calculations.

Sohio Alaska Petroleum
Arco Alaska, Inc.

FLOW RATES AND lb/hr EMISSIONS

UNIT	fuel rate MMscf/hr	f factor	cal value MMBtu/DSCF	%O2	NOx ppm	CO ppm	SDCFM	NOx lb/hr	CO lb/hr
Sulzer Turbine #408-TCP-02-7704A	0.075	9120.73	0.00103	16.4	108.5	5.91	54539	42.38	1.41
Cooper Turbine; SIPW GT-51-8002a	0.15	8619.14	0.001049	17.2	54.2	6.39	127680	49.56	3.56
Cooper Turbine & Econotherm Heater;SIPW GT-51-8002A & H518002A	0.405	8788.29	0.001049	14.5	69.4	40.4	203212	101.01	35.79
Broach Heater; SIPE #1401	0.06537	9074.04	0.001035	3.17	64.1	---	12065	5.54	--
Cooper Turbine; SIPE #31-15101	0.204	9074.04	0.001035	16.68	104.3	77.42	158190	118.17	53.39
Cooper Turbine & Econotherm; SIPE #31-15101 & #31-14101	0.3348	9074.04	0.001035	12.81	119.8	21.46	135425	116.20	12.67

Equations: SDCFM= [(fuelMMcf/hr*10^6cf/MMcf*f factor*cal value*1hr/60min)(20.9/(20.9-%O2))]
lb/hr= ppm*1.557*10^-7*MW*SDCFM

Sohio Alaska Petroleum Co
Arco Alaska, Inc.

PROCESS OPERATION PARAMETERS

I. Heaters

Unit	Fuel Rate 1/	Gross Fuel Btu/CF 2/	Actual MMBTU/hr	Rated MMBTU/hr	% Operation
Econotherm (SIPW) #H518002A	0.242 MMSCFH	1049.0	253.9	320 MMBTU.hr	79.3
Broach Heater (SIPE) #1401	65.37 MSCF/hr	1035.3	67.7	67.2 MMBTU/hr	100.7
Econotherm Heater (SIPE) #31-14101	3.16 MMSCFD	1035.3	136.3	200 MMBTU/hr	68

II. Turbines

Unit	Fuel Rate 1/	Gross Fuel Btu/CF 2/	Actual MMBTU/hr	Rated MMBTU/hr 3/	% Operation
Sulzer Turbine #408-TCP-02-7704A	1.8 MMSCFD	1030	77.25	78.2	98.8
Cooper Rolls (SIPW) GT-51-8002A	3.62 MMSCFD	1049	158.2	217.6	72.7
Cooper Rolls (SIPE) #31-15101	4.90 MMSCFD	1035.3	211	217.6	97.1

EQUATIONS: $\text{Actual MMBTU/hr} = \frac{\text{SCF}}{\text{Day}} * \frac{\text{Day}}{25\text{ hr.}} * \frac{\text{BTU}}{\text{SCF}} * \frac{\text{MMBTU}}{10^6\text{ BTU}}$

$\text{Rated Turbine MMBTU/hr} = \text{rated (hp)} * \text{heat rate BTU/hp-hr} * \frac{\text{MMBTU}}{10^6\text{ BTU}}$

1/ See section III subpart B for additional information.
2/ See Appendix B for fuel analysis results.
3/ See Appendix K for rating calculation sheets.

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III. SOURCE OPERATION

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A. UNIT DESCRIPTION

SUZLER TURBINE

The two produced water injection pumps located in Module 408 at Gathering Center Two (GC-2) are driven by Sulzer turbines (Type S3) that are part of the Produced Water Expansion Project (PWX). Each of these turbines are rated at 7700 HP at ISO conditions, and can pump 3300 GPM of water. One of these Suzler turbines was tested for NO_x and CO on September 3, 1985. The turbine unit tested was Tag No. GT-7704A (Pump Tag No. 7704A). Since produced water demands do not require that these units run at full capacity, 7700 HP, produced water was recycled during the test to bring this unit up to 90% or above the rated capacity. These units will need to operate at full capacity later when the amount of produced water increases as the field declines.

Water is produced with fluids from the oil formation and separated in the oil production and gas dehydration process. This water termed, "produced water" is pumped via turbine driven pumps into a common discharge header which feed the produced water injection manifold in Module 301. This manifold distributes produced water to injection wells.

Cooper Rolls Turbine and Supplemental Fired Waste Heat Recovery Unit

There are two Cooper-Rolls (Cooper-Rolls Coberra Model 6056) gas turbine driven injection pumps at the Seawater Injection Plant West (SIPW) that are part of the West Side Waterflood Project. The gas turbine pump driver in Module 308, Tag number GT-51-8002A, was tested on September 3, 1985 for compliance with the NO_x and CO emission standards. The rated horsepower of this unit under ISO conditions at sea level and ambient temperature of 15°C (59°F) is 29,100 BHP at 4950 RPM. The seawater injection pumps associated with these turbines deliver 11,700 GPM each. They are designed to pump treated, deaerated and heated seawater from the discharge of booster pumps to the injection wells.

A supplementary-fired Econotherm waste heat recovery unit with Zink burners is associated with each of the two Cooper-Rolls gas turbine units at the SIPW. The combined turbine (Tag number GT-51-8002A) and supplementary fired waste heat recovery unit (Tag # H518002A) was tested in Module 308 on September 4, 1985 for compliance with the NO_x and CO emission standards. These Econotherm waste heat recovery systems are rated to 320 MMBtu/hr each with the Zink burners rated at 302.5 MMBtu/hr.

These waste heat recovery units are designed primarily to remove as much waste heat from the exhaust of the injection pump gas turbine drivers as practical. This heat, and when necessary the heat from the supplementary firing of the heater, is used to raise a liquid heating medium of a 60/40 glycol solution contained in a network of piping, to 200°F. The heat from this piping network is then used to heat the seawater from the Seawater Treatment Plant (STP).

BROACH GLYCOL HEATER

One of two Broach heaters was retested on September 5, 1985 at the East Seawater Injection Plant (SIPE) for compliance with the NO_x emissions standards. The heaters are used for emergency supplementary heating needs only when heat recovery from the turbines is not possible.

The heater is a simple firebox with tubes circulating 60/40 glycol/water solution. THe heated glycol solution is pumped through the building heating unit and/or the seawater heat exchangers. The Broach heater is rated at 67.2 MMBtu/hr.

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COMBINED CYCLE SYSTEM
(Cooper Rolls Turbine and Supplementary
Fired Waste Heater Recovery Unit)

One of two combined cycle systems was tested on September 5, 1985 at the East Seawater Injection Plant (SIPE) for compliance with the NO_x and CO emissions standards. Each supplementary-fired, combined-cycle unit at the ESIP consists of a gas turbine with a duct burner and a heat recovery system. The turbine is a Cooper Rolls, aircraft derivative type with an axial compressor and annular combustor. The gas generator for the turbine is a model RB211-24 and the power turbine portion is a two stage, dual shaft RT56 unit. The Coen duct burners are placed in the exhaust gas stream and allow the firing of additional fuel. The combustion air source for the burner is the oxygen in the gas turbine exhaust.

The turbine is rated at 29100 HP. However, due to lower seawater discharge pressures, the injection pump power requirements are decreased. This limits pump configuration and the turbine operation to less than the design load. The turbine is currently operating between 18,000 to 22,000 HP (62 percent to 75 percent design load) with a maximum possible rate of approximately 25,000 HP (85 percent design load). This rate was achieved by throttling the pump discharge. However, throttling is not practical for continuous operation. The Coen duct burner has a maximum design heat duty of 200 MMBtu/hr.

The ESIP receives seawater from the Seawater Treatment Plant at the inlet manifold, heats the water and routes it to the inlet tank. Booster pumps then deliver the seawater to the main 400 MBWPD injection pumps for discharge to a manifold at up to 3200 psig. The main injection pump turbine-drivers are the Cooper Rolls units. The supplementary-fired WHRU (Coen burners) provide both process heat to heat the seawater.

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B. OPERATING CONDITIONS

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9/3/85
Prudoe Bay, Alaska

TURBINE OPERATING CONDITIONS

SULZER TURBINE: Tag #408-TCP-02-7704A

Time	RPM (GGT)	RPM (PT)	Fuel Gas (MMSCFD)	Pump Flow (GPM)	Pump Discharge(PSI)
1208	-	-	1.78	3651	2400
1214	-	-	1.82	3791	2405
1224	-	-	1.82	3694	2474
1235	10210	-	1.81	3693	2492
1243	-	10480	1.81	3632	2534
1253	-	-	1.70	3466	2579
1308	10200	-	1.81	3428	2581
1317	-	-	1.80	3536	2584
1331	10195	-	1.80	3432	2593
1342	-	-	1.82	3421	2593
1352	-	-	1.80	3504	2599
1358	10185	10550	1.80	3525	2598
1423	-	-	1.81	3541	2591
1430	-	-	1.80	3475	2591
Averages:	10198	10549	1.80	3556	2544

01FIC-02-7505	3651.GPM	HIA	SULZER	P7704A	MINIMUM	FLOW	H	3650.	L	1800.	←	SULZER " Pump flow
02PIC-02-7509	2402.PSIG		SULZER	INJWTR	PRESS	CONTRL	H	2800.	L	2000.		
03HIC-02-7509A	74.2PERCNT		SULZER	P7704A	MANUAL	SPEED	H	100.0	L	.0		
04HIC-2-7509AA	74.2PERCNT		SULZER	P7704A	BIAS	CONTRL	H	100.0	L	.0		
05FIC-02-7506	0.GPM	LOA	SULZER	P7704B	MINIMUM	FLOW	H	3650.	L	1800.		
06SAL-02-7512	1.OK		SULZER	TRIPPD	TO MIN	SPEED						
07HIC-02-7509B	74.2PERCNT		SULZER	P7704B	MANUAL	SPEED	H	100.0	L	.0		
08HIC-2-7509BA	74.2PERCNT		SULZER	P7704B	BIAS	CONTRL	H	100.0	L	.0		
09FI-02-7546	1.78MMSCFD		SULZER	P7704A	FUEL	GAS	H	2.88	L	.00	←	SULZER A Fuel Gas
10PI-02-7505	157.PSIG		SULZER	INJWTR	PUMPS	SUCTN	H	300.	L	115.		
11PI-02-7507	2400.PSIG		SULZER	P7704A	PUMP	DISCHG	H	3100.	L	1800.	←	SULZER A Pump DISC
12HS-02-7509	0.OFF	COS	SULZER	DISCHG	PT7509	SELECT						
13PI-02-7509A	2397.PSIG		SULZER	INJWTR	COMMON	DISCHG	H	4000.	L	0.		
14PI-02-7509B	2402.PSIG		SULZER	INJWTR	COMMON	DISCHG	H	4000.	L	0.		
15FI-02-7545	.00MMSCFD		SULZER	P7704B	FUEL	GAS	H	2.88	L	.00		
16PI-02-7510	156.PSIG	LOA	SULZER	P7704B	PUMP	DISCHG	H	3100.	L	1800.		

SULZER TURBINE
(#408-TCP-02-7704A)

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SULZER TURBINE - OPERATING CONDITIONS

(#408-TCP-02-7704A)

01FIC-02-7505	3475.GPM		SULZER	P7704A	MINMUM	FLOW	H	3650.	L	1800.
02PIC-02-7509	2589.PSIG		SULZER	INJWTR	PRESS	CONTRL	H	2800.	L	2000.
03MIC-02-7509A	100.0PERCNT		SULZER	P7704A	MANUAL	SPEED	H	100.0	L	.0
04MIC-2-7509AA	100.0PERCNT		SULZER	P7704A	BIAS	CONTRL	H	100.0	L	.0
05FIC-02-7506	0.GPM	LOA	SULZER	P7704B	MINMUM	FLOW	H	3650.	L	1800.
06SAL-02-7512	1.OK		SULZER	TRIPPD	TO MIN	SPEED				
07MIC-02-7509B	100.0PERCNT		SULZER	P7704B	MANUAL	SPEED	H	100.0	L	.0
08MIC-2-7509BA	100.0PERCNT		SULZER	P7704B	BIAS	CONTRL	H	100.0	L	.0
09FI-02-7548	1.80MMSCFD		SULZER	P7704A	FUEL	GAS	H	2.88	L	.00
10PI-02-7505	158.PSIG		SULZER	INJWTR	PUMPS	SUCTN	H	300.	L	115.
11PI-02-7507	2591.PSIG		SULZER	P7704A	PUMP	DISCHG	H	3100.	L	1800.
12HS-02-7509	0.OFF	COS	SULZER	DISCHG	PT7509	SELECT				
13PI-02-7509A	2596.PSIG		SULZER	INJWTR	COMMON	DISCHG	H	4000.	L	0.
14PI-02-7509B	2589.PSIG		SULZER	INJWTR	COMMON	DISCHG	H	4000.	L	0.
15FI-02-7545	.00MMSCFD		SULZER	P7704B	FUEL	GAS	H	2.88	L	.00
16PI-02-7510	156.PSIG	LOA	SULZER	P7704B	PUMP	DISCHG	H	3100.	L	1800.

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SIPW OPERATING CONDITIONS

Unit: Cooper Rolls Turbine- Tag #GT-51-8002A

Date: 9/3/85

Time	Fuel Gas (MMSCFD)	Pump Discharge Flow (MGPM)	Outlet Flow (MGPM)
1809	3.63	8.54	3.97
1821	3.60	7.75	3.98
1842	3.60	8.30	3.99
1857	3.63	8.52	4.08
1914	3.68	7.98	4.01
1928	3.62	8.50	4.03
1942	3.65	8.23	4.04
1958	3.61	8.39	3.92
2028	3.57	8.07	4.08
Average	3.62	8.25	4.01

Unit: Cooper Rolls Turbine - GT-51-8002A & Econotherm Heater #H518002A

Date: 9/4/85

Time	Turbine Fuel Gas (MMSCFD)	Heater Fuel Gas (MMSCFH)	Pump Discharge Tur. Flow(MGPM)	Outlet Flow (MGPM)
1130	3.90	0.232	10.71	4.80
1142	3.93	0.239	10.71	4.84
1215	3.88	0.249	11.24	4.75
1228	3.94	0.245'	11.34	4.75
1242	3.97	0.244	11.19	4.82
1259	3.91	0.238	10.81	4.79
1330	3.94	0.244	10.94	4.83
Average	3.92	0.242	10.99	4.80

COOPER ROLLS Turbine (SIPW)
solo Ave

01LIC-51-8440A	02FRB-51-8531	03FIC-51-8531 XXX	04PIC-51-8504
PV 63.5	PV 100.0	PV 8.24	PV 2959.
SP .0	RA 1.00	SP 6.53	SP 3000.
PERCNT	PERCNT	MGPM	PSIG
MANL	AUTO	CASC	AUTO
PID	R/B	PID	PID
OUTPUT 100. %	OUTPUT 100. %	OUTPUT 100. %	OUTPUT 100. %
INJWTR P8002A RECYCL VLVCTL	INJWTR P8002A RECYCL VLVPOS	INJWTR P8002A SUCTN FLOW	INJWTR P8002A DISCH PRESS

05LIC-51-8637	06P-51-8002A	07PIC-51-8503 XXX	08SI-51-8859
PV 63.3	PV .0	PV 2955.	PV 4440.
SP .0	RA 1.00	SP 0.	CL 2264.
PERCNT	PERCNT	PSIG	RPM
MANL	AUTO	MANL	CAL
PID	R/B	PID	
OUTPUT 0. %	OUTPUT 0. %	OUTPUT 0. %	OUTPUT 44. %
SEAWTR T8001 LEVEL	INJWTR P8002A SPEED CONTRL	INJWTR P8002A DISCH PRESS	INJWTR P8002A SPEED

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Cooper Rolls Turbine - SIPW

01FQI-51-8485A	0.X8192		BOOSTR	8001A	FLOW	TOTAL	H	8191.	L	0.
02FQI-51-8485	778.BBLS		BOOSTR	P8001A	FLOW	TOTAL	H	8191.	L	0.
03FQI-51-8486A	26.X8192		BOOSTR	P8001B	FLOW	TOTAL	H	8191.	L	0.
04FQI-51-8486	924.BBLS		BOOSTR	P8001B	FLOW	TOTAL	H	8191.	L	0.
05FQI-51-8496A	0.X8192		BOOSTR	P8001C	FLOW	TOTAL	H	8191.	L	0
06FQI-51-8496	0.BBLS		BOOSTR	P8001C	FLOW	TOTAL	H	8191.	L	0
07FQI-51-8531A	26.X8192		P8002A	SUCTN	FLOW	TOTAL	H	8191.	L	0
08FQI-51-8531	3020.BBLS		P8002A	SUCTN	FLOW	TOTAL	H	8191.	L	0
09FQI-51-8532A	1279.X8192		P8002B	SUCTN	FLOW	TOTAL	H	8191.	L	0
10FQI-51-8532	5632.BBLS		P8002B	SUCTN	FLOW	TOTAL	H	8191.	L	0
11FI-51-7866	.05MMSCFD		BOOSTR	P8001A	F.G.	FLOW	H	1.44	L	.0
12FIC-51-8485	.00MGPM	LOA	BOOSTR	P8001A	DISCH	FLOW	H	15.00	L	5.0
13FI-51-7865	.46MMSCFD		BOOSTR	P8001B	F.G.	FLOW	H	1.44	L	.0
14FIC-51-8486	8.04MGPM		BOOSTR	P8001B	DISCH	FLOW	H	15.00	L	5.0
15FI-51-7864	.00MMSCFD		BOOSTR	P8001C	F.G.	FLOW	H	1.44	L	.0
16FIC-51-8496	.00MGPM	LOA	BOOSTR	P8001C	DISCH	FLOW	H	15.00	L	5.0
17FI-51-7862	.15MMSCFD		INJWTR	P8002B	F.G.	FLOW	H	9.60	L	.0
18FIC-51-8532	1.73MGPM	LOA	INJWTR	P8002B	SUCTN	FLOW	H	15.00	L	7.0
19FI-51-7863	3.60MMSCFD	XXX	INJWTR	P8002A	F.G.	FLOW	H	9.60	L	.0
20FIC-51-8531	8.30MGPM	XXX	INJWTR	P8002A	SUCTN	FLOW	H	15.00	L	4.5

COPY

GROUP 820
11/70 3-SEP-85 18:42:35

Cooper Rolls Turbine -SIPW

01LIC-51-8612	59.5PERCNT		HT	GLY	VT8001	LEVEL		H	71.5	L	35.
02PDIC-51-8622	114.9PSID		HT	GLY	P8006A	DIFF	PRESS	H	200.0	L	.
03PDIC-51-8623	.0PSID		HT	GLY	P8006B	DIFF	PRESS	H	200.0	L	.
04PDIC-51-8624	103.9PSID		HT	GLY	P8006C	DIFF	PRESS	H	200.0	L	.
05FIC-51-8614	110.6GPM		HT	GLY	FILTER	RETURN	FLOW	H	350.0	L	95.
06TI-51-8615	177.DEGF		HT	GLY	PUMPS	DISCH	TEMP	H	190.	L	90
07TI-51-8801	193.DEGF		HT	GLY	HEADER	TEMP		H	210.	L	178
08PDIC-51-7313	51.2PSIG		IN-1		GLYCOL	HEADER	D.P.	H	150.0	L	.
09P-51-8006AR	0.OFF	COS	HT	GLY	P8006A	MOTOR	START				
10EI-51-8140	1.ON		HT	GLY	P8006A	MOTOR	STATUS				
11P-51-8006BR	0.OFF	COS	HT	GLY	P8006B	MOTOR	START				
12EI-51-8149	0.OFF	CFN	HT	GLY	P8006B	MOTOR	STATUS				
13P-51-8006CR	0.OFF	COS	HT	GLY	P8006C	MOTOR	START				
14EI-51-8150	1.ON		HT	GLY	P8006C	MOTOR	STATUS				
15UA-51-3335	1.OK		HT	GLY	PUMPS	TROUBL	COMMON				
16UA-51-3336	1.OK		HT	GLY	PUMPS	SHTDWN	COMMON				
17FI-51-8659	3.99MGPM	XXX	WHRU		H8002A	OUTLET	FLOW	H	10.00	L	4.0
18HIC-51-7276	.0PERCNT		WHRU		H8002A	OUTLET	VLVPOS	H	100.0	L	.
19TI-51-7277	201.DEGF		WHRU		H8002A	OUTLET	TEMP	H	205.	L	120
20FI-51-8674	2.71MGPM	LOA	WHRU		H8002B	OUTLET	FLOW	H	10.00	L	4.5
21HIC-51-7275	35.0PERCNT		WHRU		H8002B	OUTLET	VLVPOS	H	100.0	L	.
22TI-51-7310	181.DEGF		WHRU		H8002B	OUTLET	TEMP	H	205.	L	120

COPY

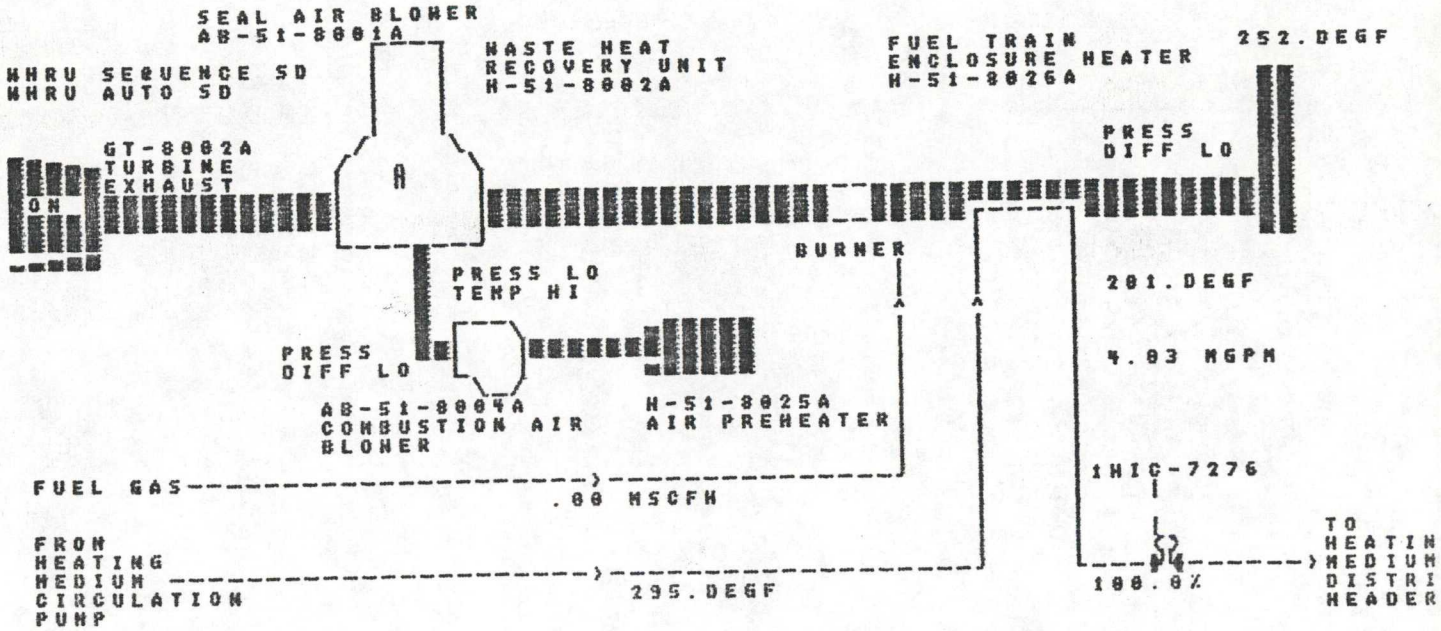
GROUP 006
11/78 3-SEP-85 18:42:48

Cooper Rolls Turbine - SIPW

WESTSIDE WATERFLOOD

DISPLAY 122
GROUP: 056,057
MOD 304 308

WASTE HEAT RECOVERY UNIT WHRU H-51-8002A



18:42:06 3-SEP-85

Cooper Rolls Turbine / Econotherm Heater - SIPW

01LIC-51-8440A	02FRB-51-8531	03FIC-51-8531 XXX	04PIC-51-8504
PV 57.3	PV 100.0	PV 11.15	PV 2669.
SP .0	RA 1.00	SP 6.52	SP 3000.
PERCNT	PERCNT	MGPH	PSIG
MANL	AUTO	CASC	AUTO
PID	R/B	PID	PID
OUTPUT 100. %	OUTPUT 100. %	OUTPUT 100. %	OUTPUT 100. %
OP CL	OP CL	OP CL	OP CL
INJWTR P8002A RECYCL VLVCTL	INJWTR P8002A RECYCL VLVPOS	INJWTR P8002A SUCTN FLOW	INJWTR P8002A DISCH PRESS
05LIC-51-8637	**06P-51-8002A**	**07PIC-51-8503 XXX**	**08SI-51-8859**
PV 57.0	PV .0	PV 2665.	PV 4434.
SP .0	RA 1.00	SP 0.	CL 2261.
PERCNT	PERCNT	PSIG	RPM
MANL	AUTO	MANL	CAL
PID	R/B	PID	
OUTPUT 0. %	OUTPUT 0. %	OUTPUT 0. %	OUTPUT 44. %
CL OP	CL OP	CL OP	CL OP
SEAWTR T8001 LEVEL	INJWTR P8002A SPEED CONTRL	INJWTR P8002A DISCH PRESS	INJWTR P8002A SPEED

COPY

GROUP 050
11/70 4-SEP-85 12:16:14

SIPW
Cooper Rolls Turbine & Supplementary Fire Heater

01FQI-51-8485A	0.X8192		BOOSTR	8001A	FLOW	TOTAL	H	8191.	L	0.
02FQI-51-8485	690.BBLS		BOOSTR	P8001A	FLOW	TOTAL	H	8191.	L	0.
03FQI-51-8486A	24.X8192		BOOSTR	P8001B	FLOW	TOTAL	H	8191.	L	0.
04FQI-51-8486	1132.BBLS		BOOSTR	P8001B	FLOW	TOTAL	H	8191.	L	0.
05FQI-51-8496A	0.X8192		BOOSTR	P8001C	FLOW	TOTAL	H	8191.	L	0.
06FQI-51-8496	0.BBLS		BOOSTR	P8001C	FLOW	TOTAL	H	8191.	L	0.
07FQI-51-8531A	22.X8192		P8002A	SUCTN	FLOW	TOTAL	H	8191.	L	0.
08FQI-51-8531	5538.BBLS		P8002A	SUCTN	FLOW	TOTAL	H	8191.	L	0.
09FQI-51-8532A	838.X8192		P8002B	SUCTN	FLOW	TOTAL	H	8191.	L	0.
10FQI-51-8532	5344.BBLS		P8002B	SUCTN	FLOW	TOTAL	H	8191.	L	0.
11FI-51-7866	.05MMSCFD		BOOSTR	P8001A	F.G.	FLOW	H	1.44	L	.00
12FIC-51-8485	.00MGPM	LOA	BOOSTR	P8001A	DISCH	FLOW	H	15.00	L	5.00
13FI-51-7865	.56MMSCFD		BOOSTR	P8001B	F.G.	FLOW	H	1.44	L	.00
14FIC-51-8486	11.90MGPM		BOOSTR	P8001B	DISCH	FLOW	H	15.00	L	5.00
15FI-51-7864	.00MMSCFD		BOOSTR	P8001C	F.G.	FLOW	H	1.44	L	.00
16FIC-51-8496	.00MGPM	LOA	BOOSTR	P8001C	DISCH	FLOW	H	15.00	L	5.00
17FI-51-7862	.26MMSCFD		INJWTR	P8002B	F.G.	FLOW	H	9.60	L	.00
18FIC-51-8532	1.75MGPM	LOA	INJWTR	P8002B	SUCTN	FLOW	H	15.00	L	7.0
19FI-51-7863	3.88MMSCFD	XXX	INJWTR	P8002A	F.G.	FLOW	H	9.60	L	.0
20FIC-51-8531	11.24MGPM	XXX	INJWTR	P8002A	SUCTN	FLOW	H	15.00	L	4.5

COPY

GROUP 028
11/78 4-SEP-85 12:16:28

SIPW

Cooper Rolls Turbine & Econotherm Heater

01LIC-51-8612	53.7PERCNT		HT	GLY	VT8001	LEVEL		H	71.5	L	35.0
02PDIC-51-8622	114.1PSID		HT	GLY	P8006A	DIFF	PRESS	H	200.0	L	.0
03PDIC-51-8623	.0PSID		HT	GLY	P8006B	DIFF	PRESS	H	200.0	L	.0
04PDIC-51-8624	104.2PSID		HT	GLY	P8006C	DIFF	PRESS	H	200.0	L	.0
05FIC-51-8614	109.7GPM		HT	GLY	FILTER	RETURN	FLOW	H	350.0	L	95.0
06TI-51-8615	133.DEGF		HT	GLY	PUMPS	DISCH	TEMP	H	190.	L	90.
07TI-51-8801	164.DEGF	LOA	HT	GLY	HEADER	TEMP		H	210.	L	178.
08PDIC-51-7313	31.9PSIG		IM-1		GLYCOL	HEADER	D.P.	H	150.0	L	.0
09P-51-8006AR	0.OFF	COS	HT	GLY	P8006A	MOTOR	START				
10EI-51-8140	1.ON		HT	GLY	P8006A	MOTOR	STATUS				
11P-51-8006BR	0.OFF	COS	HT	GLY	P8006B	MOTOR	START				
12EI-51-8149	0.OFF	CFM	HT	GLY	P8006B	MOTOR	STATUS				
13P-51-8006CR	0.OFF	COS	HT	GLY	P8006C	MOTOR	START				
14EI-51-8150	1.ON		HT	GLY	P8006C	MOTOR	STATUS				
15UA-51-3335	1.OK		HT	GLY	PUMPS	TROUBL	COMMON				
16UA-51-3336	1.OK		HT	GLY	PUMPS	SHTDWN	COMMON				
17FI-51-8659	4.75MGPM	XXX	WHRU		H8002A	OUTLET	FLOW	H	10.00	L	4.0
18HIC-51-7276	.0PERCNT		WHRU		H8002A	OUTLET	VLVPOS	H	100.0	L	.
19TI-51-7277	192.DEGF		WHRU		H8002A	OUTLET	TEMP	H	205.	L	120.
20FI-51-8674	3.48MGPM	LOA	WHRU		H8002B	OUTLET	FLOW	H	10.00	L	4.5
21HIC-51-7275	35.0PERCNT		WHRU		H8002B	OUTLET	VLVPOS	H	100.0	L	.
22TI-51-7310	127.DEGF		WHRU		H8002B	OUTLET	TEMP	H	205.	L	120.

COPY

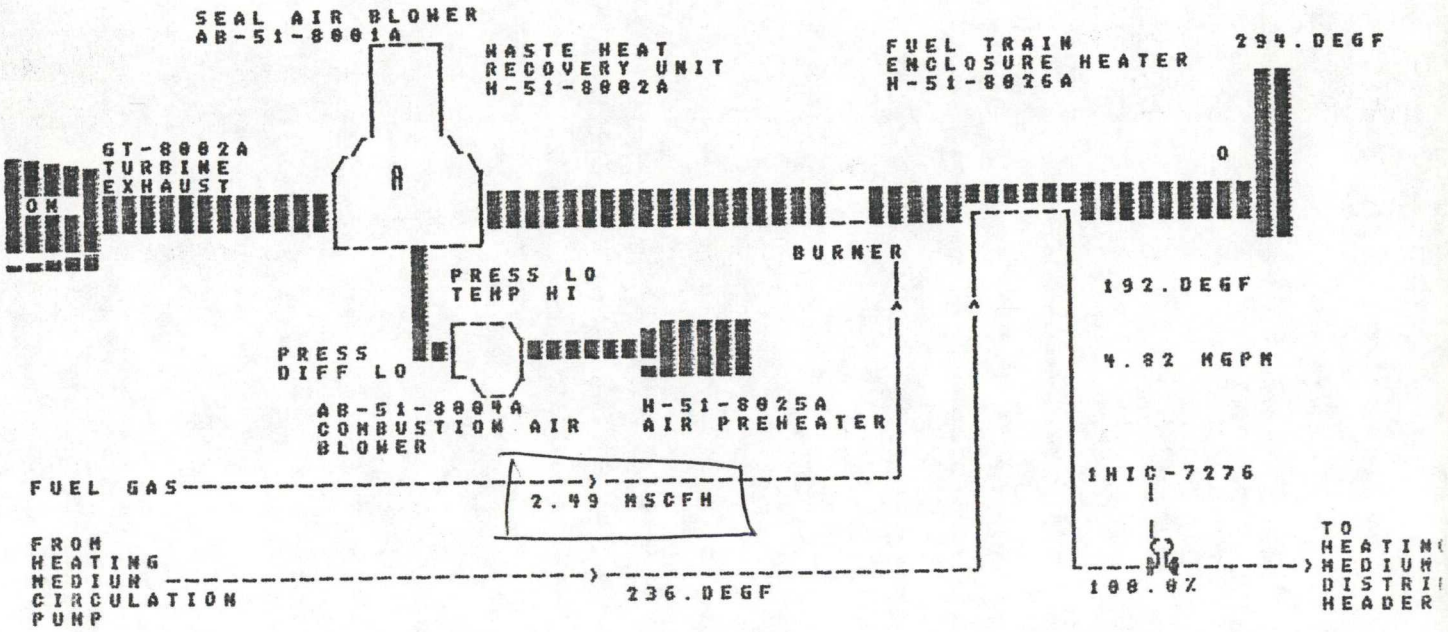
GROUP 006
11/78 4-SEP-85 12:16:42

SIPW
Cooper Bolls Turbine & Econotherm

DISPLAY 122
GROUP: 056,057
MOD 304 308

WESTSIDE WATERFLOOD

WASTE HEAT RECOVERY UNIT WHRU H-51-8002A



12:15:49 4-SEP-85

OPERATING CONDITIONS

Time	Fuel Usage IWC	Outlet Temp °F	Glycol Flow (gpm)	Fuel Roots Meter
1158	70.3	221	1660	8.3
1214	71.2	222	1660	8.3
1229	71.1	222	1660	8.3
1246	69.5	222	1660	8.3
1313	72.1	223	1660	8.3
1330	71.3	224	1660	8.3
1344	70.2	224	1660	8.3
1401	69.6	224	1660	8.3
1415	71.7	224	1660	8.3
Average	70.8	223	1660	8.3

92.33643 MSCF/hr @ 100 "H_2O 1/

$$\text{Actual MSCF/hr} = 92.33643 \text{ MSCF/hr} * \frac{70.8 \text{ "}H_2O}{100 \text{ "}H_2O}$$

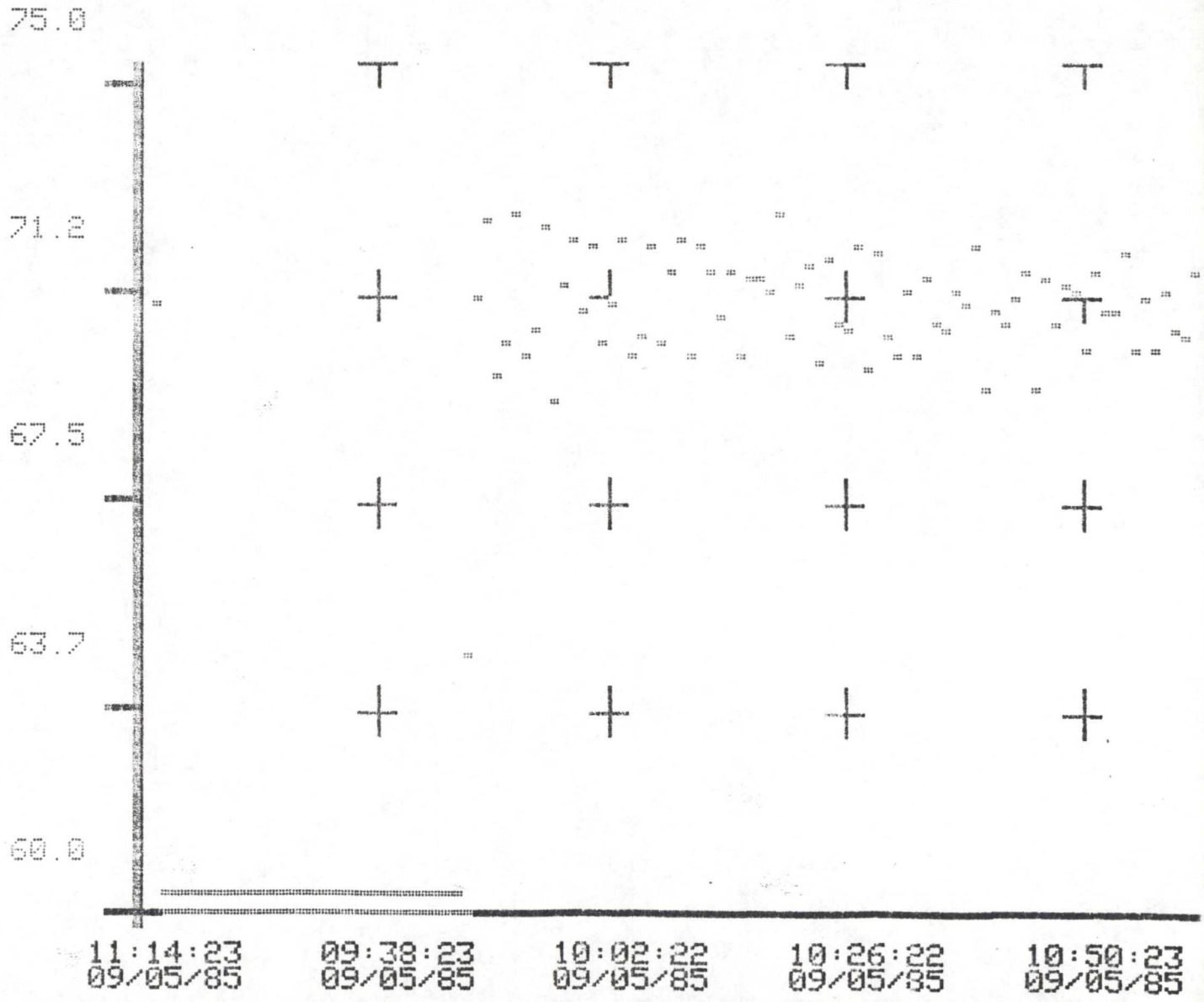
MSCF/hr = 65.37

1/ See Appendix J? orifice flow rate calculation.

Broach Heater - SIPE

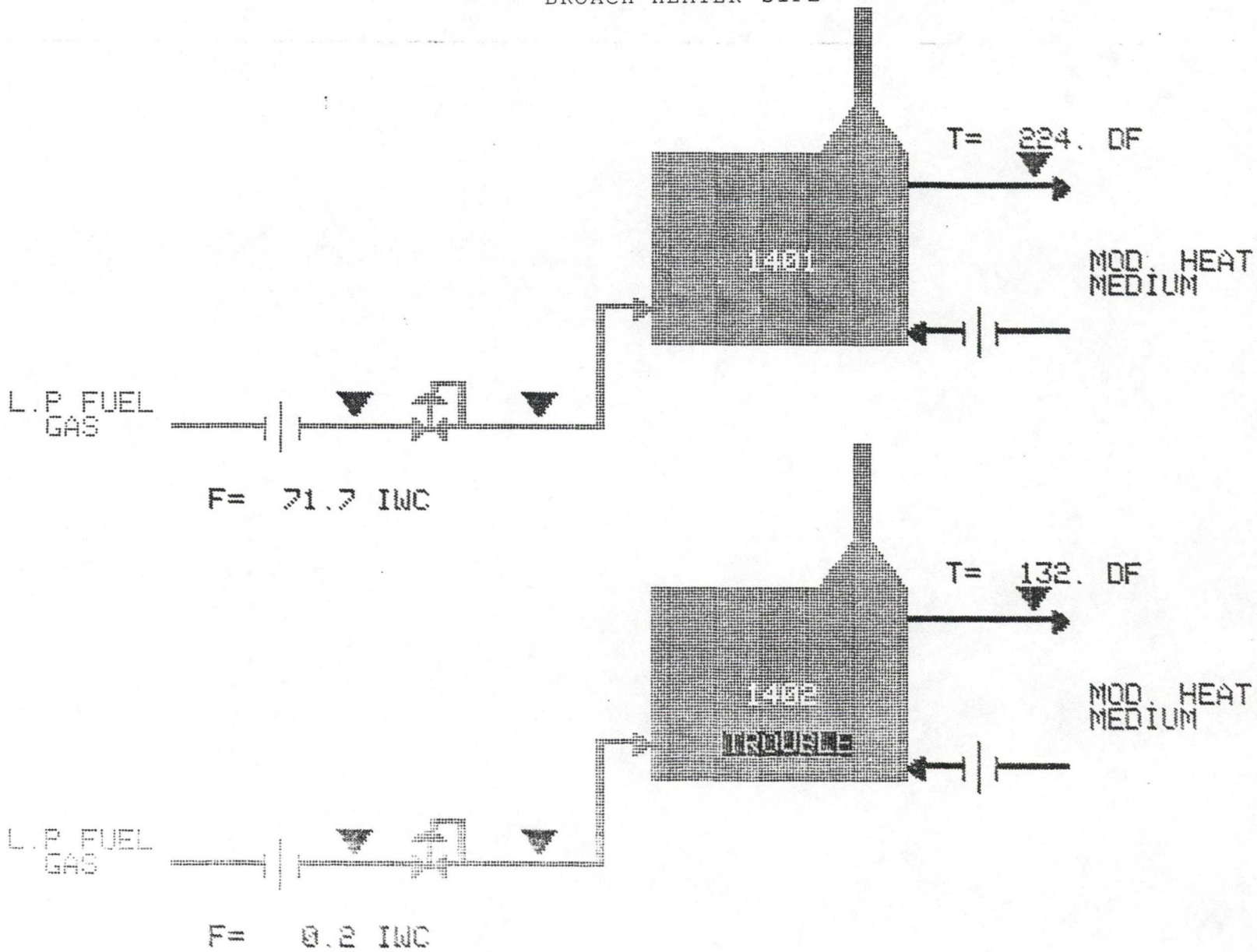
TREND OF 1 MINUTE VALUES OVER 2 HOURS

1:5F126BI 60.0- 75.0 IWC HTR 1 SUPPLY GAS FLOW



MODULE HEAT MEDIUM GLYCOL HEATERS

BROACH HEATER-SIPE



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5-SEP-85 14:15:51 HOST

UNIT OPERATION

Unit: Cooper Rolls Turbine - #31-15101

Date: 9/5/85

Time	Fuel MMSCFD	Turbine Gas Outlet °F	Turbine Out Gas Pres IWC	NI Turbine Speed RPM
1628	5.16	796	3.8	6500
1653	5.19	795	3.9	6500
1718	5.02	795	3.6	6500
1730	5.16	793	3.8	6500
1745	5.17	794	3.9	6500
1759	5.18	794	3.8	6500
1815	-	793	3.9	6495
1828	-	791	4.0	6500
1842	5.02	791	3.9	6500
1858	5.02	-	-	6500
1901	4.99	792	3.7	6500
Average	5.10 @88°F 4.90 MMCFD	793	3.8	6500

Unit: Cooper Rolls Turbine/Econotherm Heater

Date: 9/5/85

Time:	Turbine Fuel	Turbine Gas Outlet °F	Turbine NI Speed RPM	Heater Fuel MMFD	Fuel Temp °F
2200	5.12	790	6490	3.25	79
2215	4.99	790	6490	3.27	84
2230	5.12	790	6490	3.30	87
2247	5.13	789	6490	3.31	89
2300	5.15	788	6480	3.28	89
2318	5.03	786	6485	3.22	90
2329	5.00	787	6490	3.31	90
2343	5.01	786	6485	3.31	90
2359	5.06	789	6490	3.30	91
0017	5.02	788	6490	3.23	91
Average	5.06	788	6490	3.28	88
	4.88 MMSCFD			3.16 MMSCFD	

INJECTION PUMPS

INJECTION PUMP
CONTROLS

[1] TURB SPEED CONT
SP= 90.
PV= 90. OT= 90.3
AUTO

[2] PUMP SUCT. PRESS
SP= 240.
PV= 250. OT= 99.6
AUTO

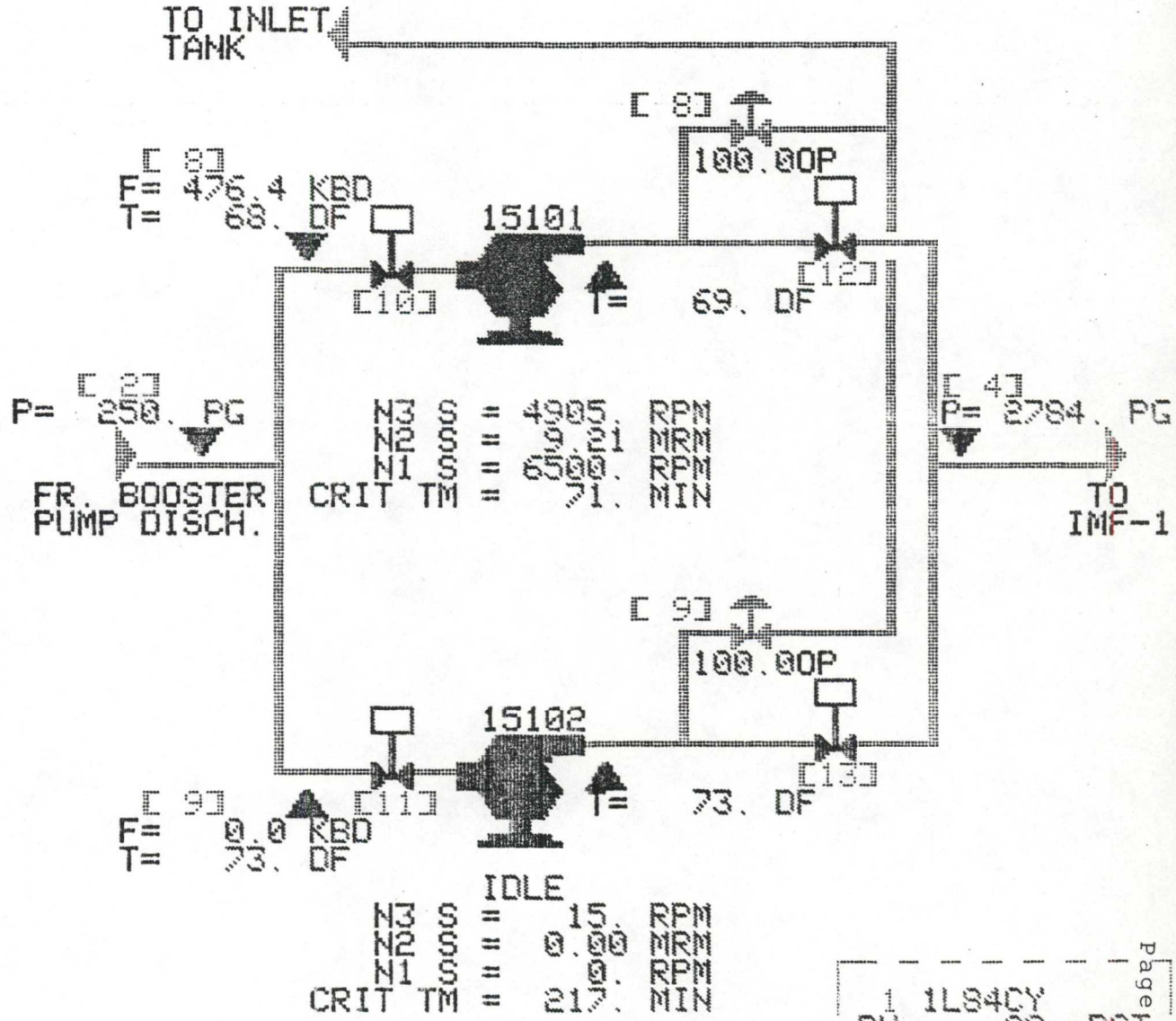
[3] INLET TANK LEVEL
SP= 34.0
PV= 33.3 OT= 90.0
MANL

[4] PUMP DISCH. PRESS
SP= 2882.
PV= 2784. OT=100.0
AUTO

[5] TIGHT LINE CONT
SP= 0.0
PV= 14.4 OT= 0.0
MANL

[6] INLET TK LO LEVEL
SP= 27.8
PV= 29.0 OT=100.0
AUTO

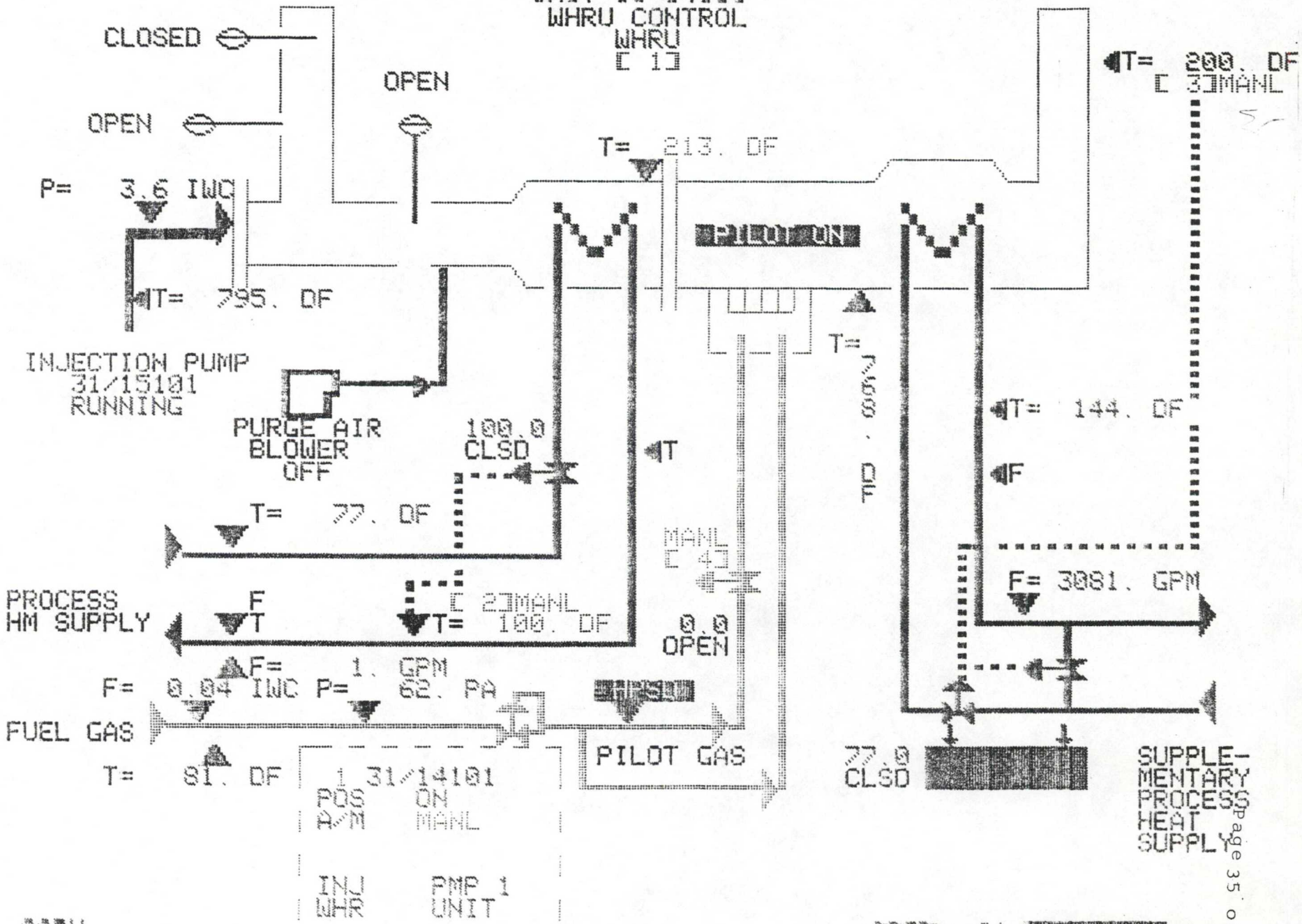
[7] INLET TK HI LEVEL
SP= 37.0
PV= 35.0 OT= 35.0
MANL



1 1LS4CY
PV 90. PC
SP 90.
OUT 90.3
A/M AUTO
SPEED CONTRL
LOW SELECT

COPY

INJECTION PUMP 1 WASTE HEAT RECOVERY
UNIT 31/14101



COPY

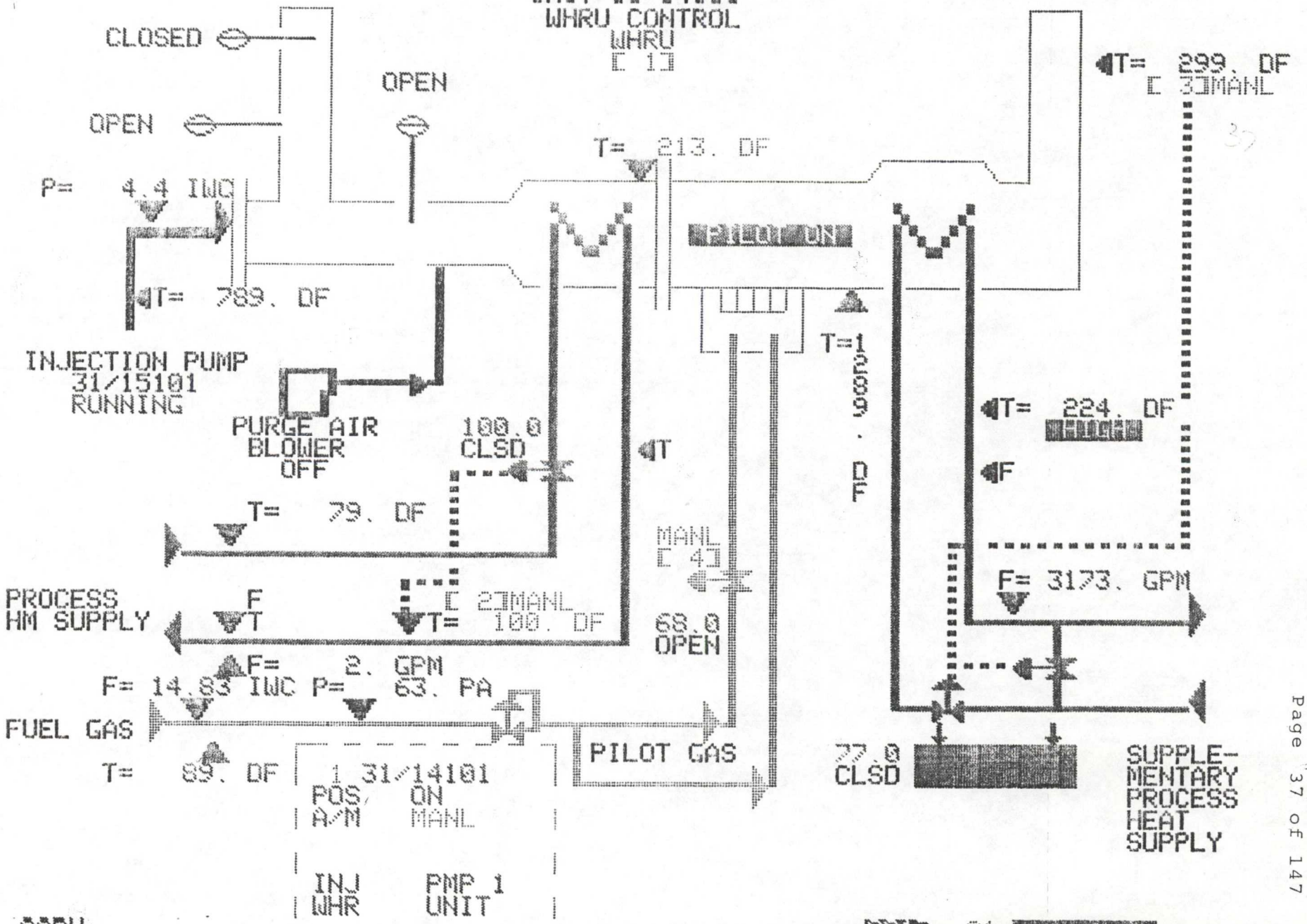
01
5-SEP-85 17:19:08 HOST 1

Turbine only

05-SEP-85 16:28:30 Seawater Injection Plant METER VOLUMES REPORT

---TAG---	--------DESCRIPTION--------				++++++++++++++++++++++++ -CURRENT-	EGU	05-SEP-85 ---LOW---	-AVERAGE-	--HIGH---	SAMP
1F1171IY	PUMP 1 FG	TOTAL	1805		5.16	MFD	3.57	4.21	5.16	986
1F1077IY	IP1WHR FG	TOTAL	1806		0.18	MFD	0.16	0.94	2.28	986
1F2171IY	PUMP 2 FG	TOTAL	1806		0.00	MFD	0.00	1.36	4.00	986
1F2077IY	IP2WHR FG	TOTAL	1808		0.23	MFD	0.21	0.24	0.34	986
3F1183IY	B PMP1 FG	TOTAL	1809		0.00	MFD	0.00	0.00	0.00	986
3F2183IY	B PMP2 FG	TOTAL	1810		0.00	MFD	0.00	0.19	0.54	986
3F3183IY	B PMP3 FG	TOTAL	1811		0.51	MFD	0.43	0.50	0.58	986
3F4183IY	B PMP4 FG	TOTAL	1812		0.48	MFD	0.38	0.46	0.56	986
4F160AIY	R/FGAS FLOW	TOTAL	1801		4.55	MFD	3.02	5.70	9.20	986
4F160BIY	F/FGAS FLOW	TOTAL	1800		0.00	MFD	0.00	0.00	0.00	986
4F194IY	WUPGAS FLOW	TOTAL	1803		0.00	MFD	0.00	0.00	0.00	986
4F230IY	DSPGAS FLOW	TOTAL	1804		0.00	MFD	0.00	0.00	0.00	986
7F18IY	R/FGAS INLET	TOTAL	1813		0.00	MFD	0.00	0.00	0.00	986
8F15AIY	R/FGAS INLET	TOTAL	1814		0.00	MFD	0.00	0.00	0.00	986
8F15BIY	F/FGAS INLET	TOTAL	1329		1.74	MFD	1.45	1.75	2.05	986
4F56BI	IMF1 DIST	LINES	FLOW		24.54	KBD	23.26	25.37	28.63	986
4F55BI	IMF2 XFER	LINE	FLOW		446.10	KBD	401.90	523.03	763.52	986
4F57BI	IMF3 XFER	LINE	FLOW		0.00	KBD	0.00	0.00	0.00	986
8F115AIC	TIELIN FLOW	FROM	SOHIO		141.48	KBD	109.38	134.17	165.79	986
8F115BIC	TIELIN FLOW	TO	SOHIO		0.00	KBD	0.00	0.00	0.00	986
1P424IC	INJPMP MANFLD	DISCH	PRES		2837.87	PG	1639.60	2529.06	2851.30	986
1P1030IC	INJPMP SUCTN	HEADER	PRES		249.88	PG	237.53	249.80	255.16	986
1S1229I	PUMP 1 GG N1	TURBIN	SPEED		6500.00	RPM	6065.93	6243.65	6500.00	986
1S1232I	PUMP 1 GG N2	TURBIN	SPEED		9.21	MRM	8.68	8.86	9.21	986
1T1239I	PUMP 1 PT EXH	AVG	TEMP		794.77	DF	701.38	728.66	794.77	986
1P1199I	PUMP 1 GGCOMP	DISCH	PRES		221.40	PG	178.49	194.98	222.26	986
1T1198I	PMP1GG COMP	DISCH	TEMP		256.01	DF	230.13	234.77	256.01	986
1T1218I	PUMP 1 AMBNT	AIR	TEMP		38.24	DF	32.20	36.51	43.08	986
1S1252I	PUMP 1 PT N3	TURBIN	SPEED		4901.62	RPM	4271.86	4556.10	4905.43	986
1P1211I	PUMP 1 TURBIN	EXAUST	PRES		3.78	IWC	0.90	2.35	4.29	986
1T1013I	PUMP 1 SEAWTR	SUCTN	TEMP		62.96	DF	61.97	69.60	76.70	986
1T1006I	PUMP 1 SEAWTR	DISCH	TEMP		64.06	DF	62.74	70.30	77.47	986
1F1016IRC	PUMP 1 SEAWTR	BYPASS	CONTRL		464.35	KBD	367.42	424.48	500.00	986
1S2229I	PUMP 2 GG N1	TURBIN	SPEED		0.00	RPM	0.00	1959.37	6010.38	986
1S2232I	PUMP 2 GG N2	TURBIN	SPEED		0.00	MRM	0.00	2.91	8.75	986
1T2239I	PUMP 2 PT EXH	AVG	TEMP		63.36	DF	63.36	297.23	685.81	986
1P2199I	PUMP 2 GGCOMP	DISCH	PRES		0.92	PG	0.73	62.22	195.46	986
1T2198I	PMP2 GGCOMP	DISCH	TEMP		58.60	DF	58.23	171.06	402.76	986
1T2218I	PUMP 2 AMBNT	AIR	TEMP		40.44	DF	31.54	35.53	43.52	986
1S2252I	PUMP 2 PT N3	TURBIN	SPEED		16.12	RPM	14.10	1511.51	4694.24	986
1P2211I	PUMP 2 TURBIN	EXAUST	PRES		0.00	IWC	0.00	0.91	3.51	986
1T2013I	PUMP 2 SEAWTR	SUCTN	TEMP		73.51	DF	73.51	76.06	78.24	986
1T2006I	PUMP 2 SEAWTR	DISCH	TEMP		73.29	DF	73.18	76.72	78.57	986
1F2016IRC	PUMP 2 SEAWTR	BYPASS	CONTRL		0.00	KBD	0.00	122.86	387.07	986
5T522I	LP SWR HT EX	1DISCH	TEMP		92.08	DF	55.60	87.41	102.96	986
5T525I	LP SWR HT EX	2DISCH	TEMP		91.09	DF	55.71	86.65	101.86	986
5T528I	LP SWR HT EX	3DISCH	TEMP		61.10	DF	55.49	74.89	101.75	986
5T531I	LP SWR HT EX	4DISCH	TEMP		61.10	DF	55.60	75.55	102.96	986
AF400SUMS	DS 3 SWI	FLOW	SUMCAL		129.65	KBD	113.91	150.41	213.34	986
AF04400IC	DS 3 WL 4	LINE	FLOW		12.11	KBD	5.32	13.03	19.42	986
AF06400IC	DS 3 WL 6	LINE	FLOW		23.44	KBD	19.59	24.22	31.55	986
AF07400IC	DS 3 WL 7	LINE	FLOW		0.00	KBD	0.00	0.00	0.10	986

INJECTION PUMP 1 WASTE HEAT RECOVERY
UNIT 31/14101



COPY

01
5-SEP-85 22:47:05 HOST 2

Turbine / Heater

05-SEP-85 23:43:33 Seawater Injection Plant - METER VOLUMES REPORT

---TAG---	--------DESCRIPTION--------				-CURRENT-	EGU	---LOW---	-AVERAGE-	--HIGH---	SAMP
					++++++++++++++++++++++++		05-SEP-85		++++++++++++++++++	
1F1171IY	PUMP 1 FG		TOTAL	1805	5.01	MFD	3.57	4.47	5.23	1421
1F1077IY	IP1WHR FG		TOTAL	1806	3.31	MFD	0.15	0.99	3.32	1421
1F2171IY	PUMP 2 FG		TOTAL	1806	0.62	MFD	0.00	1.00	4.00	1421
1F2077IY	IP2WHR FG		TOTAL	1808	0.24	MFD	0.21	0.24	0.34	1421
3F1183IY	B PMP1 FG		TOTAL	1809	0.00	MFD	0.00	0.00	0.00	1421
3F2183IY	B PMP2 FG		TOTAL	1810	0.00	MFD	0.00	0.14	0.54	1421
3F3183IY	B PMP3 FG		TOTAL	1811	0.52	MFD	0.43	0.50	0.58	1421
3F4183IY	B PMP4 FG		TOTAL	1812	0.48	MFD	0.38	0.46	0.56	1421
4F160AIY	R/FGAS	FLOW	TOTAL	1801	6.88	MFD	3.02	5.45	9.20	1421
4F160BIY	F/FGAS	FLOW	TOTAL	1800	0.00	MFD	0.00	0.00	0.00	1421
4F194IY	WUPGAS	FLOW	TOTAL	1803	0.00	MFD	0.00	0.00	0.00	1421
4F230IY	DSPGAS	FLOW	TOTAL	1804	0.00	MFD	0.00	0.00	0.00	1421
7F18IY	R/FGAS	INLET	TOTAL	1813	0.00	MFD	0.00	0.00	0.00	1421
8F15AIY	R/FGAS	INLET	TOTAL	1814	0.00	MFD	0.00	0.00	0.00	1421
8F15BIY	F/FGAS	INLET	TOTAL	1329	1.82	MFD	1.45	1.75	2.05	1421
4F56BI	IMF1	DIST	LINES	FLOW	24.97	KBD	23.26	25.20	28.63	1421
4F55BI	IMF2	XFER	LINE	FLOW	454.65	KBD	401.90	502.74	763.52	1421
4F57BI	IMF3	XFER	LINE	FLOW	0.00	KBD	0.00	0.00	0.00	1421
8F115AIC	TIELIN	FLOW	FROM	SOHIO	136.44	KBD	108.85	134.09	165.79	1421
8F115BIC	TIELIN	FLOW	TO	SOHIO	0.00	KBD	0.00	0.00	0.00	1421
1P4241C	INJPMP	MANFLD	DISCH	PRES	2789.65	PG	1639.60	2606.09	2851.30	1421
1P1030IC	INJPMP	SUCTN	HEADER	PRES	251.45	PG	237.53	250.06	255.16	1421
1S1229I	PUMP 1 GG	N1	TURBIN	SPEED	6484.13	RPM	6065.93	6320.20	6500.00	1421
1S1232I	PUMP 1 GG	N2	TURBIN	SPEED	9.18	MRM	8.68	8.96	9.22	1421
1T1239I	PUMP 1 PT	EXH	AVG	TEMP	785.62	DF	701.38	747.79	797.34	1421

1T1198I	PMP1GG	COMP	DISCH	TEMP	254.18	DF	230.13	241.08	258.82	1421
1T1218I	PUMP 1	AMBNT	AIR	TEMP	33.08	DF	32.20	36.25	43.08	1421
1S1252I	PUMP 1	PT N3	TURBIN	SPEED	4907.34	RPM	4271.86	4662.38	4919.40	1421
1P1211I	PUMP 1	TURBIN	EXAUST	PRES	4.18	IWC	0.90	2.86	4.99	1421
1T1013I	PUMP 1	SEAWTR	SUCTN	TEMP	80.76	DF	61.97	70.63	80.87	1421
1T1006I	PUMP 1	SEAWTR	DISCH	TEMP	82.08	DF	62.74	71.43	82.08	1421
1F1016IRC	PUMP 1	SEAWTR	BYPASS	CONTRL	473.02	KBD	367.42	439.41	500.00	1421
1S2229I	PUMP 2	GG N1	TURBIN	SPEED	0.00	RPM	0.00	1359.57	6010.38	1421
1S2232I	PUMP 2	GG N2	TURBIN	SPEED	0.00	MRM	0.00	2.02	8.75	1421
1T2239I	PUMP 2	PT EXH	AVG	TEMP	59.70	DF	59.52	224.98	685.81	1421
1P2199I	PUMP 2	GGCOMP	DISCH	PRES	0.85	PG	0.67	43.41	195.46	1421
1T2198I	PMP2	GGCOMP	DISCH	TEMP	57.50	DF	57.38	136.51	402.76	1421
1T2218I	PUMP 2	AMBNT	AIR	TEMP	32.86	DF	31.54	35.98	43.52	1421
1S2252I	PUMP 2	PT N3	TURBIN	SPEED	16.12	RPM	14.10	1053.48	4694.24	1421
1P2211I	PUMP 2	TURBIN	EXAUST	PRES	0.00	IWC	0.00	0.63	3.51	1421
1T2013I	PUMP 2	SEAWTR	SUCTN	TEMP	70.98	DF	70.98	74.87	78.24	1421
1T2006I	PUMP 2	SEAWTR	DISCH	TEMP	70.22	DF	70.22	75.18	78.57	1421
1F2016IRC	PUMP 2	SEAWTR	BYPASS	CONTRL	0.00	KBD	0.00	85.25	387.07	1421
5T522I	LP SWR	HT EX	1DISCH	TEMP	118.12	DF	55.60	91.66	119.66	1421
5T525I	LP SWR	HT EX	2DISCH	TEMP	116.14	DF	55.71	90.64	116.47	1421
5T528I	LP SWR	HT EX	3DISCH	TEMP	53.62	DF	52.20	69.69	101.75	1421
5T531I	LP SWR	HT EX	4DISCH	TEMP	53.62	DF	52.20	70.17	102.96	1421
AF400SUMS	DS 3	SWI	FLOW	SUMCAL	137.53	KBD	113.91	146.56	213.34	1421
AF04400IC	DS 3	WL 4	LINE	FLOW	12.31	KBD	5.32	12.66	19.42	1421
AF06400IC	DS 3	WL 6	LINE	FLOW	23.84	KBD	19.59	24.20	31.55	1421
AF07400IC	DS 3	WL 7	LINE	FLOW	0.00	KBD	0.00	0.00	0.10	1421
AF10400IC	DS 3	WL 10	LINE	FLOW	24.64	KBD	18.25	28.08	46.23	1421
AF11400IC	DS 3	WL 11	LINE	FLOW	6.02	KBD	2.96	6.72	14.69	1421
AF12400IC	DS 3	WL 12	LINE	FLOW	10.82	KBD	9.52	10.78	12.25	1421
AF13400IC	DS 3	WL 13	LINE	FLOW	8.46	KBD	6.64	10.12	16.99	1421
AF16400IC	DS 3	WL 16	LINE	FLOW	22.52	KBD	15.85	24.21	35.34	1421
AF17400IC	DS 3	WL 17	LINE	FLOW	20.57	KBD	15.11	23.55	39.66	1421
AF18400IC	DS 3	WL 18	LINE	FLOW	9.84	KBD	0.00	6.34	10.92	1420
BF400SUMS	DS 4	SWI	FLOW	SUMCAL	80.70	MBD	54.33	76.82	82.10	1420
BF400SUMP	DS 4	PWI	FLOW	SUMCAL	60.55	MBD	15.20	65.33	100.84	1420
BF06400IC	DS 4	WL 6	LINE	FLOW	43.54	KBD	30.83	43.10	46.09	1420
BF08400IC	DS 4	WL 8	LINE	FLOW	2.47	KBD	0.05	3.94	11.76	1420
BF09400IC	DS 4	WL 9	LINE	FLOW	7.54	KBD	5.46	7.33	7.79	1420
BF10400IC	DS 4	WL 10	LINE	FLOW	11.57	KBD	0.15	12.18	16.48	1420
BF11400IC	DS 4	WL 11	LINE	FLOW	9.40	KBD	6.91	9.01	9.50	1420
BF13400IC	DS 4	WL 13	LINE	FLOW	18.69	KBD	11.43	17.38	18.90	1420
BF14400IC	DS 4	WL 14	LINE	FLOW	21.62	KBD	0.58	22.95	37.03	1420
BF15400IC	DS 4	WL 15	LINE	FLOW	24.67	KBD	8.59	26.14	36.53	1420
CF400SUMS	DS 9	SWI	FLOW	SUMCAL	102.06	KBD	79.78	136.46	245.27	1420
CF08400IC	DS 9	WL 8	LINE	FLOW	0.01	KBD	0.00	0.00	0.04	1420
CF10400IC	DS 9	WL 10	LINE	FLOW	6.78	KBD	0.00	6.35	7.20	1420
CF12400IC	DS 9	WL 12	LINE	FLOW	7.65	KBD	0.00	10.86	26.04	1420
CF14400IC	DS 9	WL 14	LINE	FLOW	13.04	KBD	0.00	16.03	28.61	1420
CF15400IC	DS 9	WL 15	LINE	FLOW	18.54	KBD	0.00	26.53	46.40	1420
CF16400IC	DS 9	WL 16	LINE	FLOW	13.33	KBD	0.00	14.13	20.90	1420
CF17400IC	DS 9	WL 17	LINE	FLOW	4.10	KBD	3.82	7.41	19.14	1420
CF18400IC	DS 9	WL 18	LINE	FLOW	8.16	KBD	5.48	12.76	30.41	1420
CF19400IC	DS 9	WL 19	LINE	FLOW	8.40	KBD	7.12	11.84	25.83	1420
CF20400IC	DS 9	WL 20	LINE	FLOW	11.40	KBD	3.36	14.23	26.88	1420
CF22400IC	DS 9	WL 22	LINE	FLOW	3.61	KBD	0.00	10.92	50.00	1420
CF25400IC	DS 9	WL 25	LINE	FLOW	5.52	KBD	4.29	6.63	12.08	1420
DF400SUMS	DS 11	SWI	FLOW	SUMCAL	30.28	MBD	14.35	47.26	99.38	1420
DF02400IC	DS 11	WL 2	LINE	FLOW	17.07	KBD	0.00	23.96	49.38	1420
DF07400IC	DS 11	WL 7	LINE	FLOW	15.24	KBD	11.41	23.21	50.00	1420
EF400SUMS	DS 16	SWI	FLOW	SUMCAL	62.02	KBD	40.53	58.88	63.00	1420
EF01400IC	DS 16	WL 01	LINE	FLOW	30.61	KBD	20.14	29.01	31.32	1420
EF02400IC	DS 16	WL 02	LINE	FLOW	9.10	KBD	6.72	8.91	9.44	1420
EF03400IC	DS 16	WL 03	LINE	FLOW	2.33	KBD	1.77	2.31	2.56	1420
EF05400IC	DS 16	WL 05	LINE	FLOW	1.95	KBD	1.44	1.91	2.39	1420
EF10400IC	DS 16	WL 10	LINE	FLOW	2.20	KBD	1.39	2.18	2.42	1420

EF16400IC	DS 16	WL 16	LINE	FLOW	7.42	KBD	4.62	7.07	7.76	1420
FF400SUMS	DS 17	SWI	FLOW	SUMCAL	26.25	KBD	19.05	25.08	26.74	1420
FF06400IC	DS 17	WL 6	LINE	FLOW	13.76	KBD	9.39	13.04	13.94	1420
FF08400IC	DS 17	WL 8	LINE	FLOW	7.75	KBD	5.50	7.47	8.31	1420
FF10400IC	DS 17	WL 10	LINE	FLOW	4.96	KBD	3.75	4.56	5.06	1420
HF400SUMS	DS 12	SWI	FLOW	SUMCAL	40.78	KBD	39.56	40.96	42.12	1420
HF400SUMP	DS 12	PWI	FLOW	SUMCAL	13.19	KBD	0.00	11.99	14.47	1420
HF19400IC	DS 12	WL 19	LINE	FLOW	13.21	KBD	0.01	11.99	14.43	1420
HF20400IC	DS 12	WL 20	LINE	FLOW	4.02	KBD	3.54	4.13	4.59	1420
HF23400IC	DS 12	WL 23	LINE	FLOW	10.49	KBD	9.46	10.35	11.21	1420
HF25400IC	DS 12	WL 25	LINE	FLOW	12.62	KBD	11.92	12.77	13.56	1420
HF27400IC	DS 12	WL 27	LINE	FLOW	13.69	KBD	13.28	13.72	13.94	1420
IF400SUMS	DS 13	SWI	FLOW	SUMCAL	35.28	KBD	0.00	32.48	36.75	1420
IF400SUMP	DS 13	PWI	FLOW	SUMCAL	64.09	KBD	0.00	71.68	82.53	1420
IF06400IC	DS 13	WL 6	LINE	FLOW	5.81	KBD	5.27	7.33	11.21	1420
IF09400IC	DS 13	WL 9	LINE	FLOW	3.52	KBD	3.27	3.62	4.19	1420
IF15400IC	DS 13	WL 15	LINE	FLOW	6.39	KBD	4.64	5.77	6.39	1420
IF16400IC	DS 13	WL 16	LINE	FLOW	9.61	KBD	9.35	9.70	10.07	1420
IF17400IC	DS 13	WL 17	LINE	FLOW	10.84	KBD	9.81	10.84	11.48	1420
IF18400IC	DS 13	WL 18	LINE	FLOW	10.33	KBD	8.33	8.93	10.60	1420
IF19400IC	DS 13	WL 19	LINE	FLOW	14.17	KBD	12.20	12.73	15.55	1420
IF20400IC	DS 13	WL 20	LINE	FLOW	5.46	KBD	5.35	6.59	9.89	1420
IF21400IC	DS 13	WL 21	LINE	FLOW	0.18	KBD	0.09	0.17	0.24	1420
IF22400IC	DS 13	WL 22	LINE	FLOW	6.06	KBD	6.06	11.40	21.27	1420
IF23400IC	DS 13	WL 23	LINE	FLOW	13.91	KBD	0.00	13.51	15.35	1420
IF24400IC	DS 13	WL 24	LINE	FLOW	13.37	KBD	13.14	13.62	14.01	1420
IF25400IC	DS 13	WL 25	LINE	FLOW	0.15	KBD	0.00	0.14	0.19	1420
IF32400IC	DS 13	WL 32	LINE	FLOW	0.09	KBD	0.00	0.11	0.18	1420
JF400SUMS	DS 14	SWI	FLOW	SUMCAL	38.76	MBD	29.97	40.11	41.51	1420
JF13400IC	DS 14	WL 13	LINE	FLOW	10.34	KBD	10.16	10.40	10.60	1420
JF14400IC	DS 14	WL 14	LINE	FLOW	10.20	KBD	7.52	8.13	10.93	1420
JF25400IC	DS 14	WL 25	LINE	FLOW	6.26	KBD	3.38	5.37	6.57	1420
JF27400IC	DS 14	WL 27	LINE	FLOW	5.35	KBD	0.00	9.60	10.56	1420
JF36400IC	DS 14	WL 36	LINE	FLOW	6.57	KBD	5.78	6.60	7.22	1420

End of report

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IV. SAMPLING AND ANALYSIS PROCEDURES

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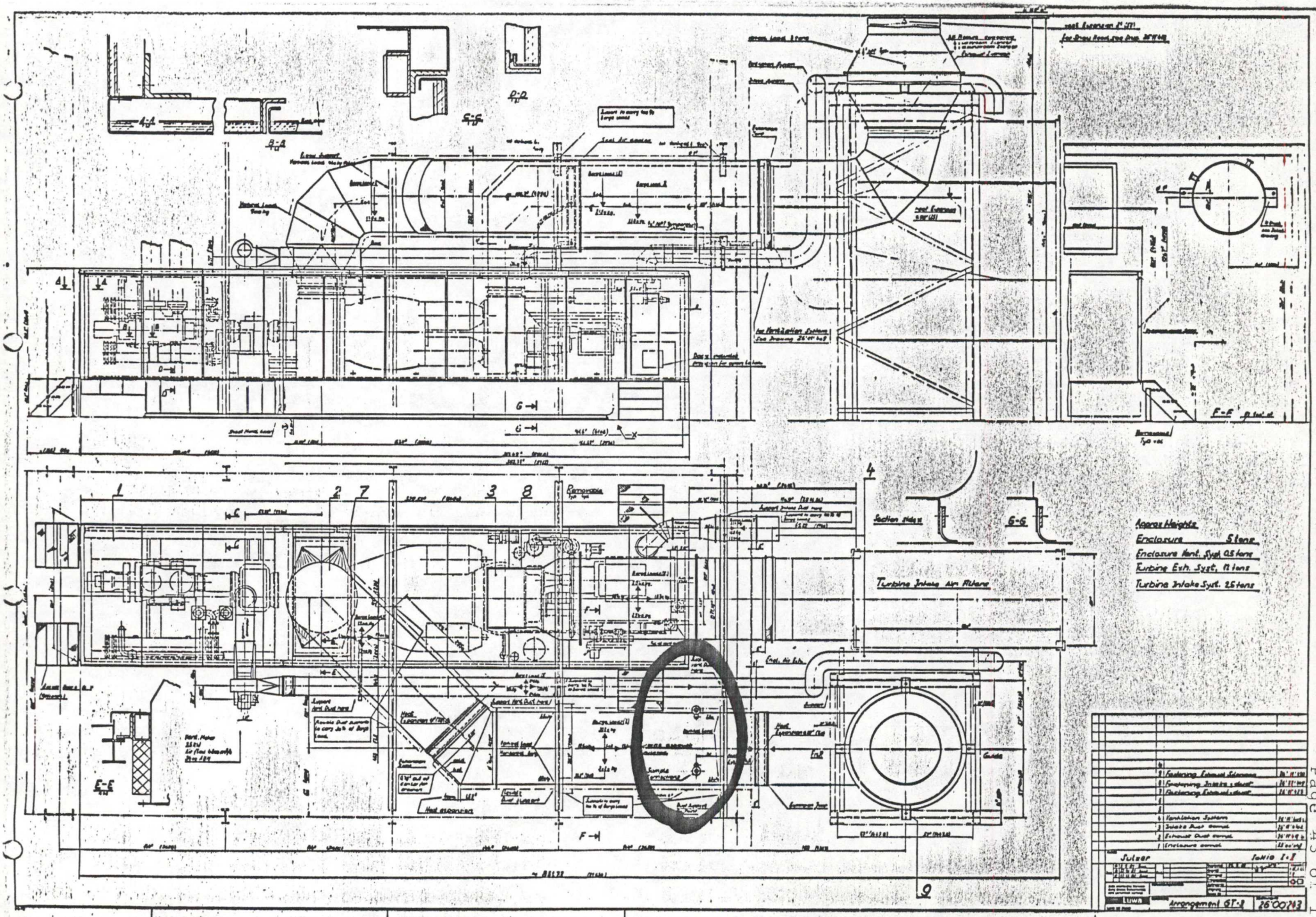
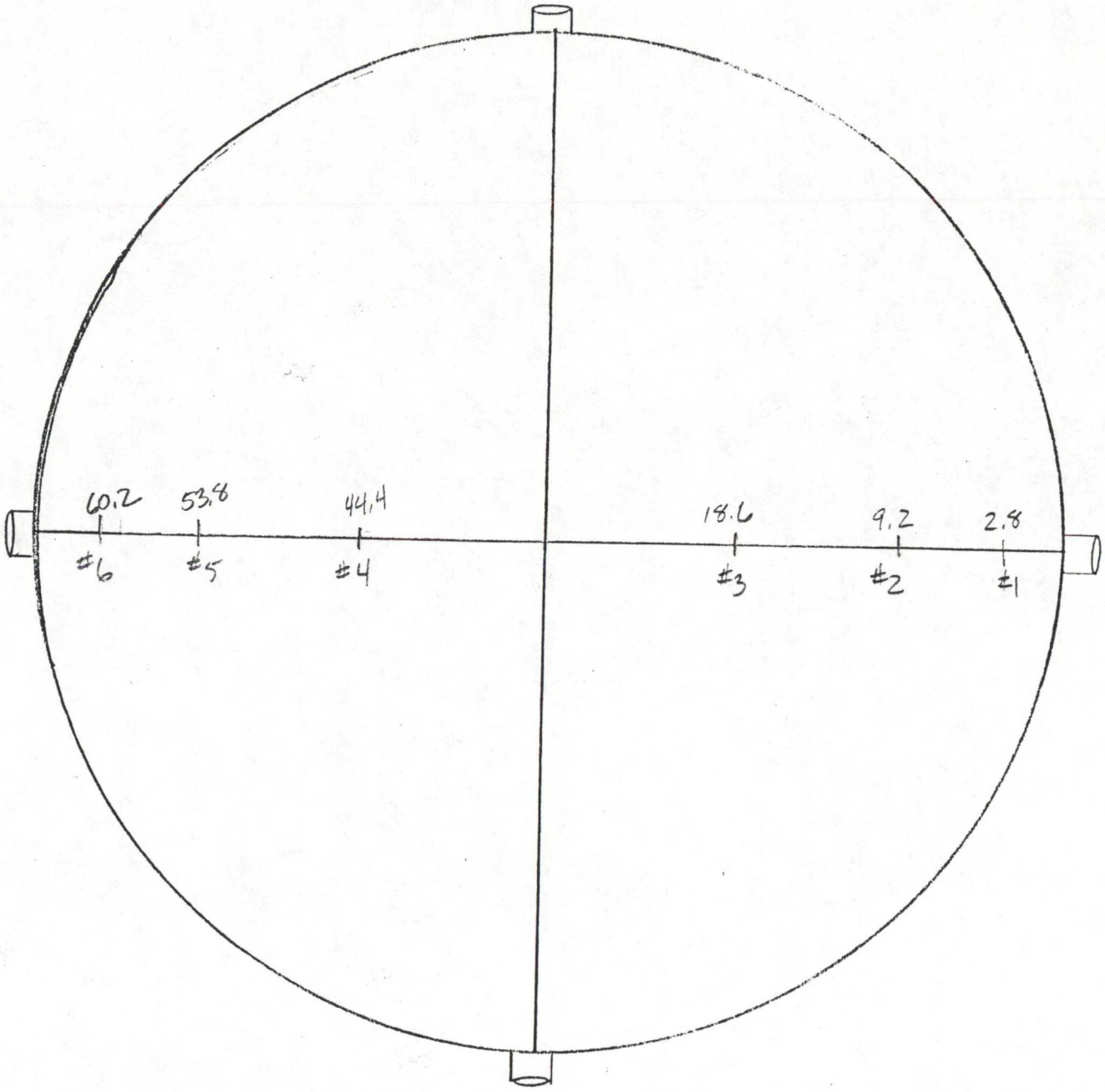
A. SAMPLING PORT LOCATIONS

SULZER TURBINE: port locations



POINT LOCATIONS

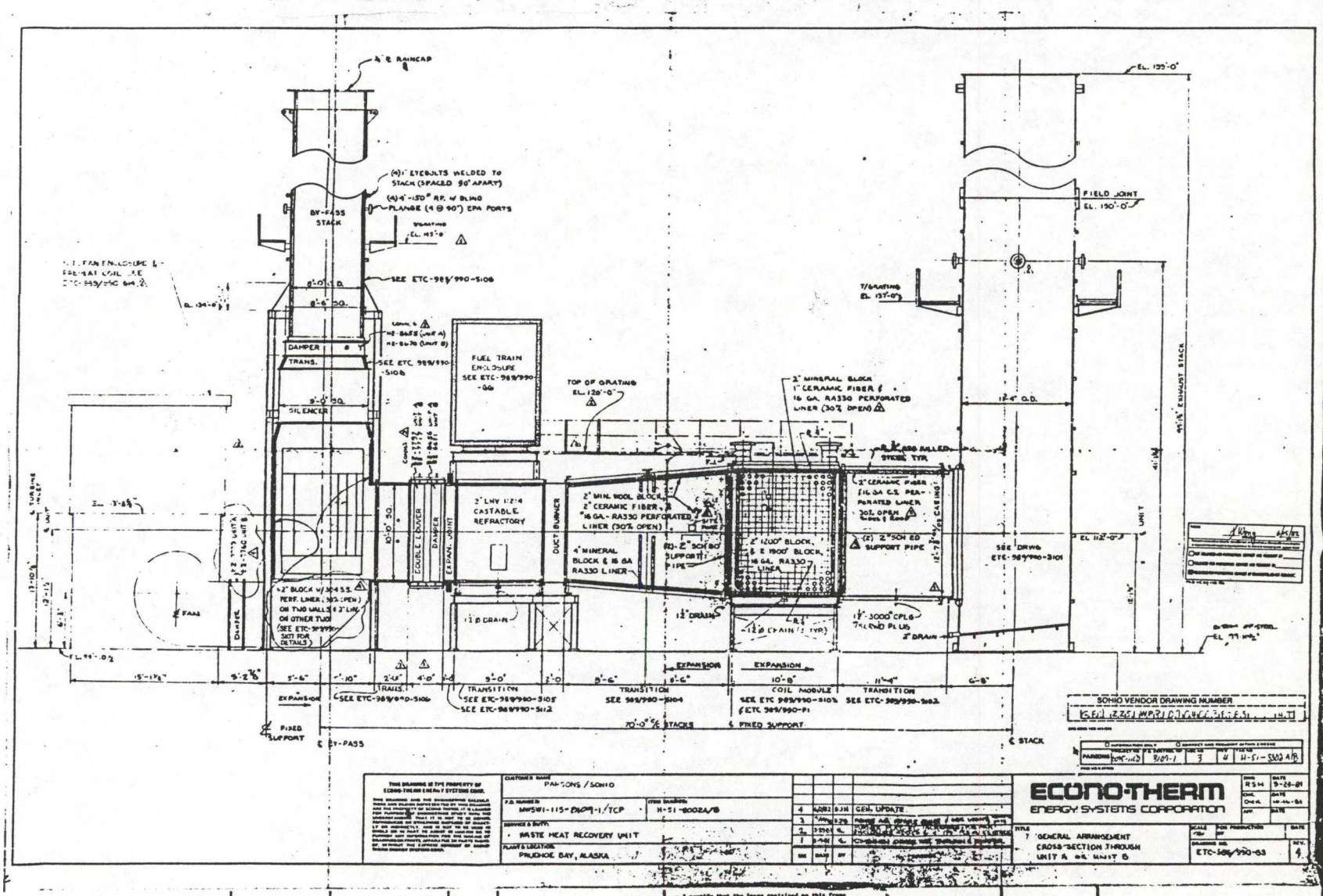
Sulzer Turbine
#408-TCP-02-7704A



Point #	inches from edge
1	2.8
2	9.2
3	18.6
4	44.4
5	53.8
6	60.2
~~7~~	
~~8~~	
~~9~~	
~~10~~	

Stack Diameter 63 inches
Stack Area 21.65 ft^2
Diameters before 2.5
Diameters after 2.5
a disturbance.

SIPW TURBINE and SUPPLEMENTARY FIRED WASTE HEAT RECOVERY UNIT

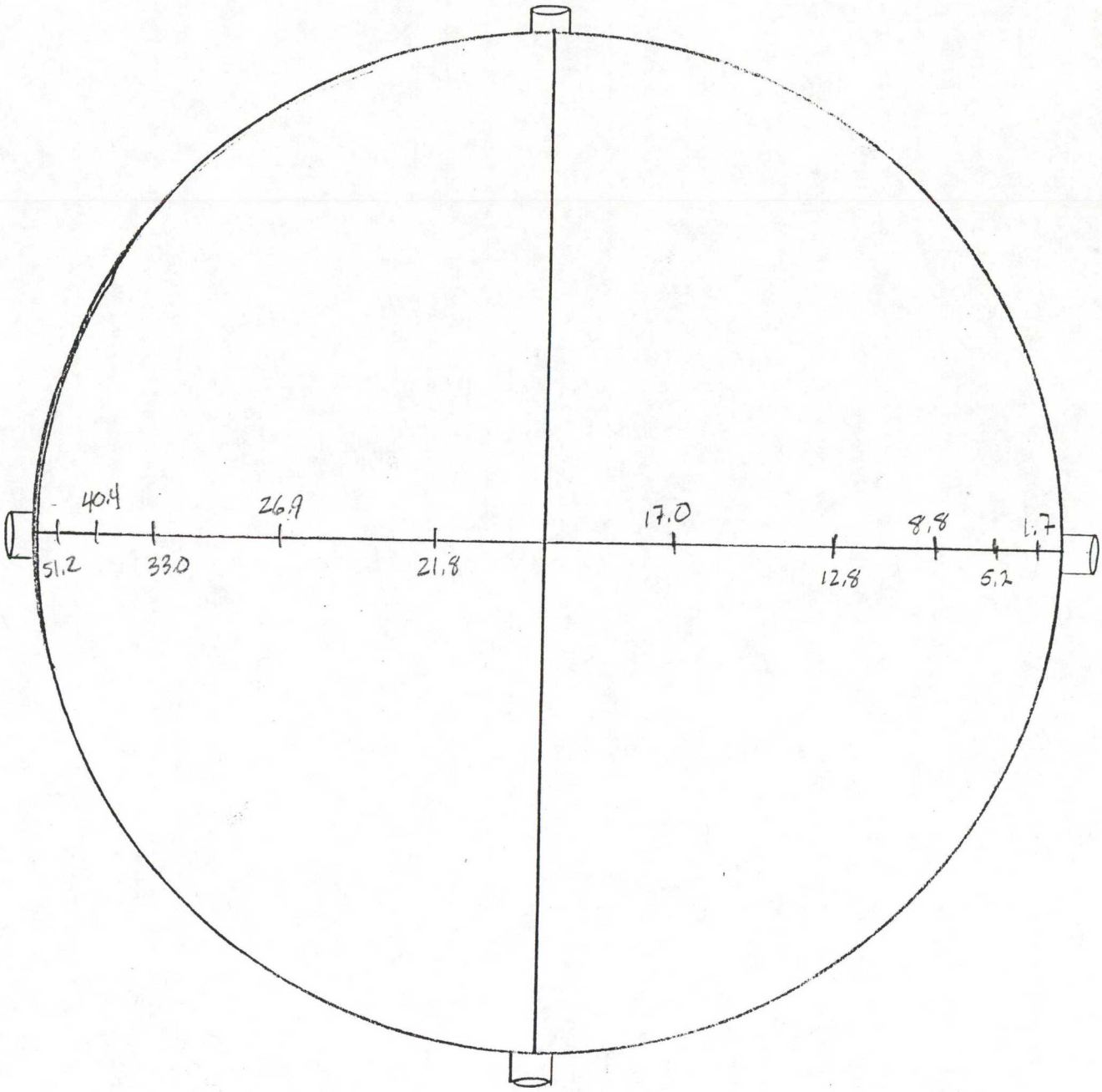


POINT LOCATIONS

SIPW

Cooper Rolls / Econotherm

#P8001A



Point #	inches from edge
1	1.72
2	5.15
3	8.8
4	12.8
5	17.0
6	21.8
7	26.9
8	33.0
9	40.4
10	51.2

Stack Diameter 132 inches

Stack Area 95.03 ft^2

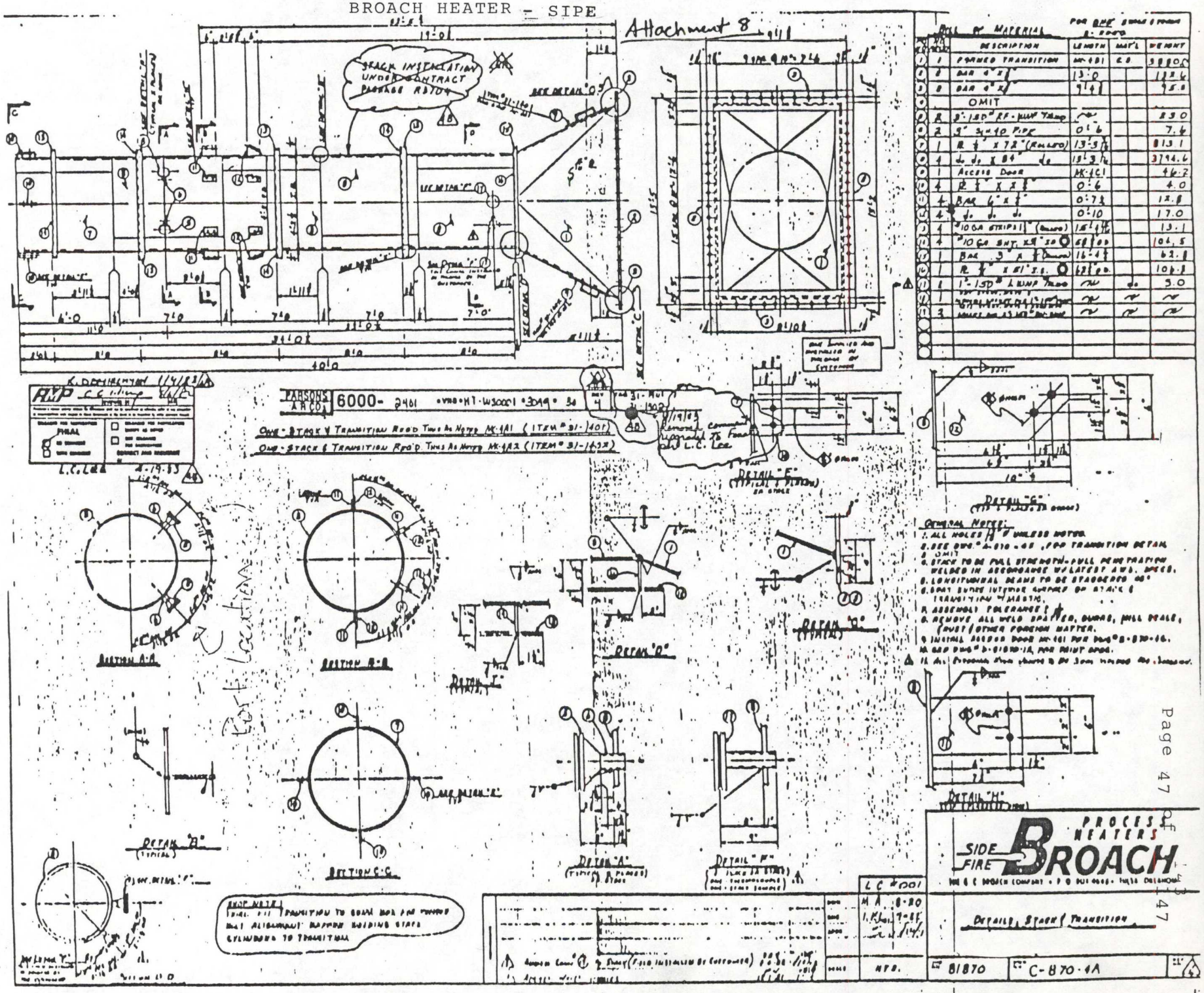
Diameters before 2

Diameters after 8

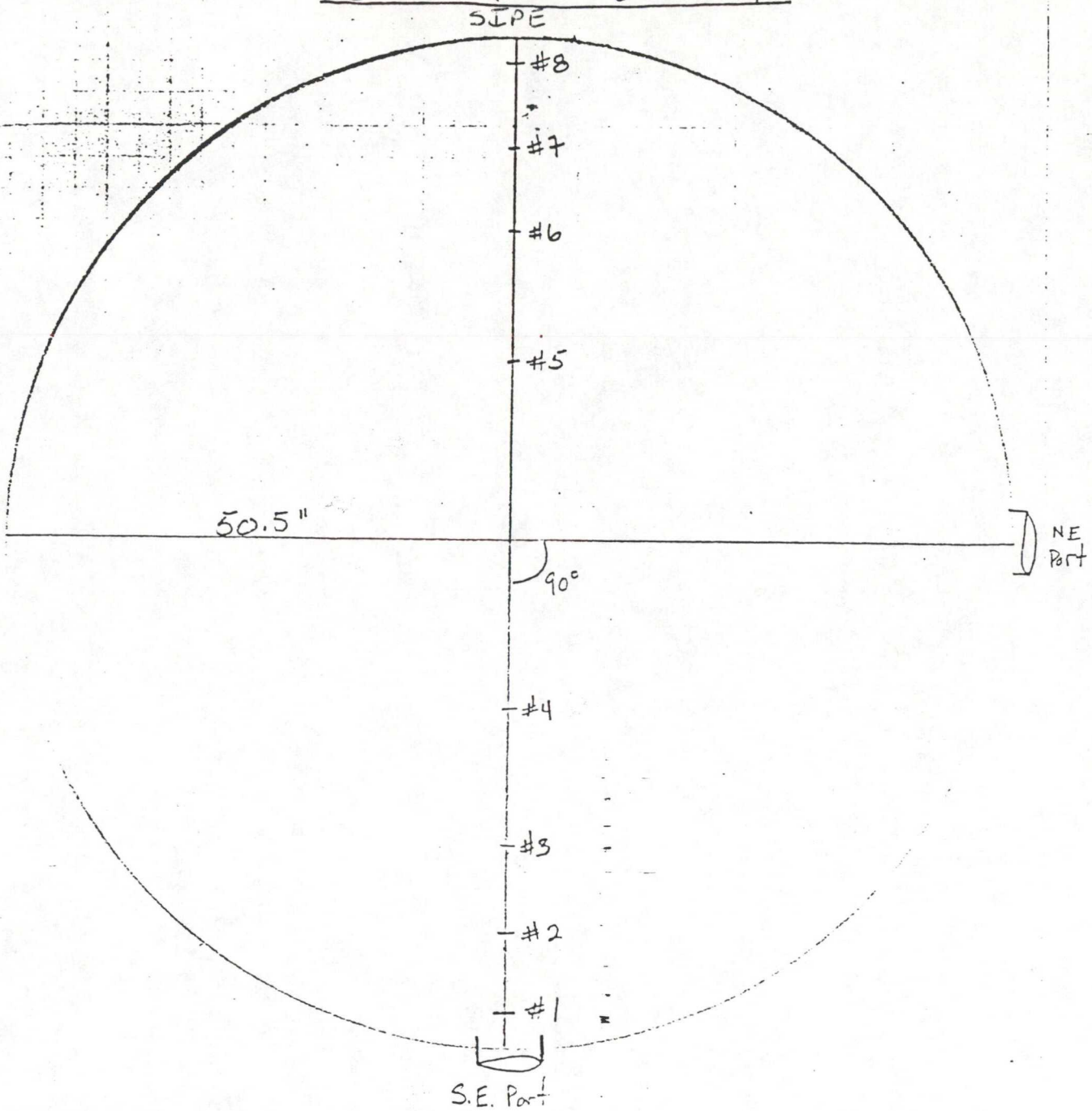
a disturbance.

BROACH HEATER - SIDE

Attachment 8



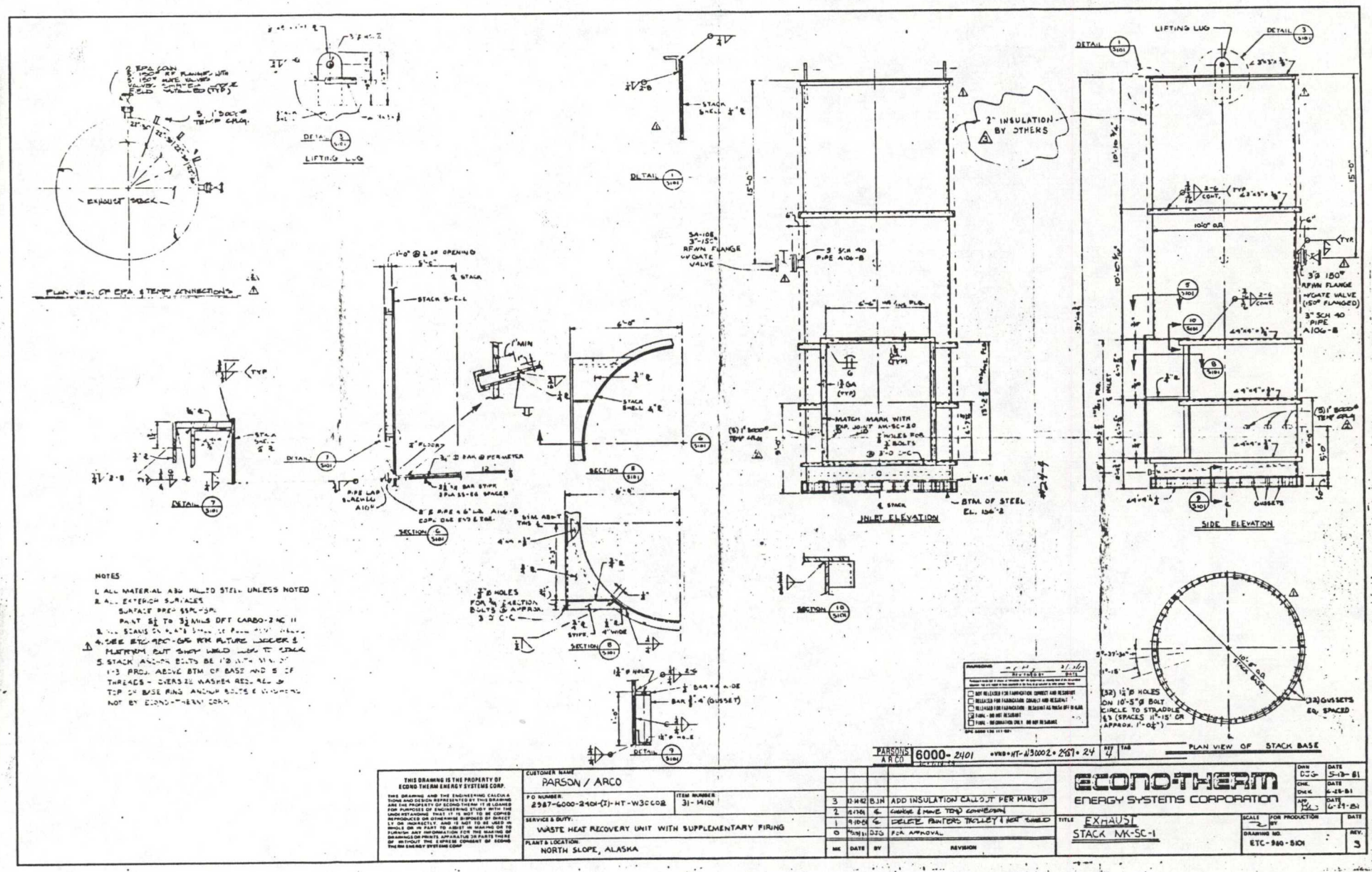
Broach Heater 67.2 mmBtu/hr



Two ports located five (5) diameters before a disturbance and three (3) diameters after a disturbance in the flow.

Point #	Inches from edge
1	1.6
2	5.3
3	9.8
4	16.3
5	34.2
6	40.7
7	45.2
8	48.9

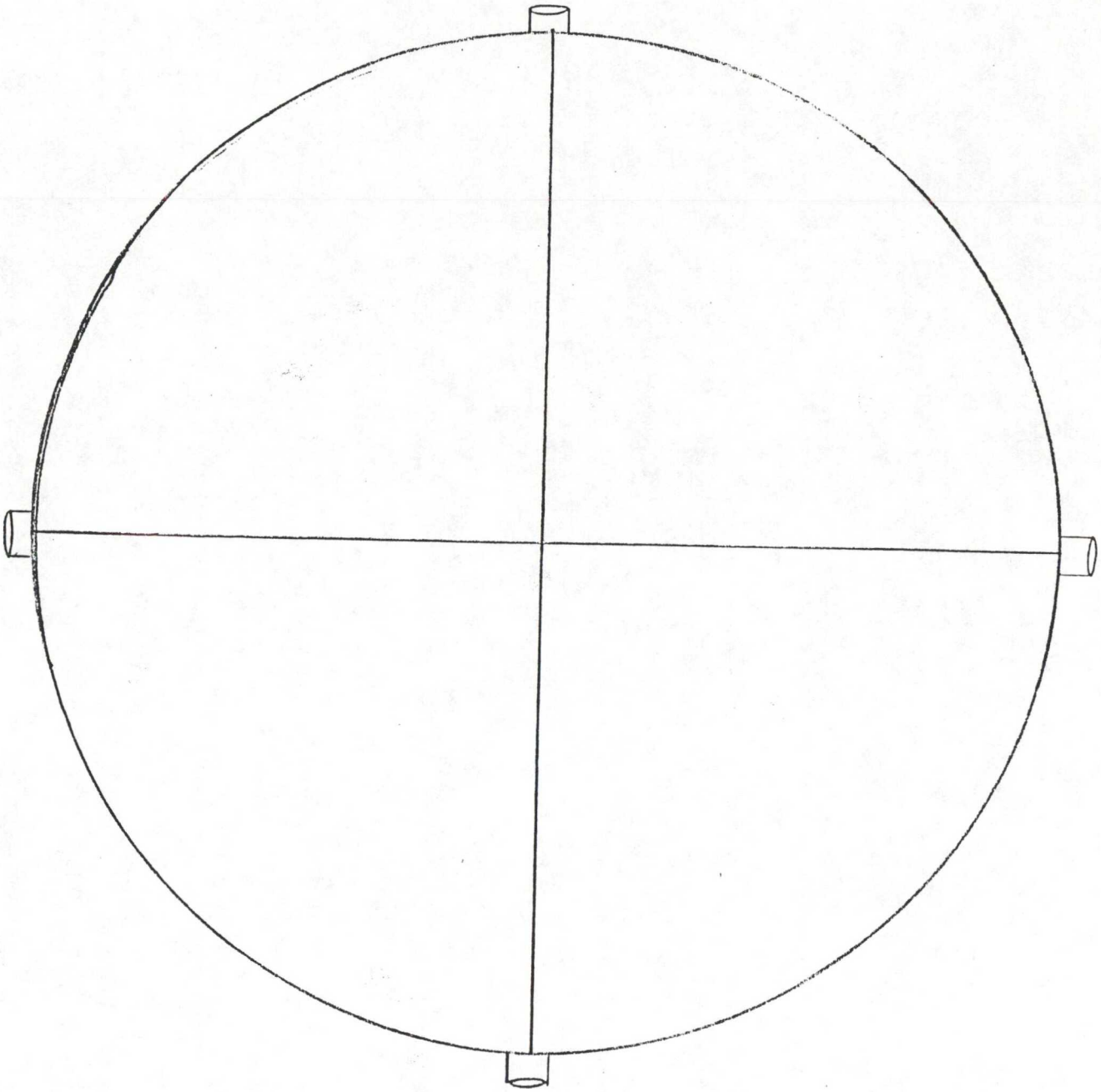
NOx and O_2 measurements were done from the South east port.


PLAN VIEW OF EPA & TEMP CONNECTIONS
EXHAUST STACK
LIFTING LUG
DETAIL 1 S101
DETAIL 3 S101
DETAIL 7 S101
SECTION 6 S101
SECTION 8 S101
SECTION 9 S101
SECTION 10 S101
2" INSULATION BY OTHERS
INLET ELEVATION
SIDE ELEVATION
PLAN VIEW OF STACK BASE
NOTES
1. ALL MATERIAL A36 KILLED STEEL UNLESS NOTED
2. ALL EXTERIOR SURFACES
SURFACE PREP SSPC-SP
PAINT 5½ TO 3½ MILS DFT CARBO-ZINC 11
4. SEE ETC-980-GF FOR FUTURE LADDER & PLATFORM, BUT SHOP WELD LUGS TO STACK
5. STACK ANCHOR BOLTS BE 1"Ø WITH MIN. OF 1-3 PROJ. ABOVE BTM OF BASE AND 5 OF THREADS - OVERSIZE WASHER REQ. REQ. TOP OF BASE RING. ANCHOR BOLTS & WASHERS NOT BY ECONO-THERM CORP.
PARSONS ARCO 6000-2401 • VND • HT-W30002 • 2987 • 24 REV 4
THIS DRAWING IS THE PROPERTY OF ECONO THERM ENERGY SYSTEMS CORP.
CUSTOMER NAME PARSON / ARCO
P.O. NUMBER 2987-6000-2401-(I)-HT-W30002
ITEM NUMBER 31-14101
SERVICE & DUTY WASTE HEAT RECOVERY UNIT WITH SUPPLEMENTARY FIRING
PLANT & LOCATION NORTH SLOPE, ALASKA
3 12-14-82 BJN ADD INSULATION CALLOUT PER MARKUP
2 12-17-81 G CHANGE & MOVE TEMP CONNECTION
1 9-10-81 G DELETE PAINTERS TROLLEY & HEAT SHIELD
0 DJG FOR APPROVAL
MK DATE BY REVISION
ECONO-THERM ENERGY SYSTEMS CORPORATION
DWN DJG DATE 5-13-81
CHK DATE 6-25-81
APP DATE 6-29-81
TITLE EXHAUST STACK MK-SC-1
SCALE 2 FOR PRODUCTION BY DATE
DRAWING NO. ETC-980-S101 REV. 3

POINT LOCATIONS

SIPE -WHRU

Cooper Rolls / Coen Heater



Point #	inches from edge
1	1.7
2	5.3
3	9.0
4	13.1
5	17.5
6	22.3
7	28.3
8	35.5
9	45.8
10	74.2
11	84.5
12	91.7
13	97.4
14	102.5
15	106.9
16	111.0
17	114.7
18	118.3

Stack Diameter 10 inches

Stack Area 78.52 ft^2

Diameters before 2

Diameters after 2

a disturbance.

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B. METHODS AND EQUATIONS

CONTINUOUS EMISSION MONITORING SYSTEM (CEMS)

Reference: BAAQMD, Manual of Procedures; ST-13A, St-19A, Jan 1982 State of California, Air Resources Board, Test Methods 1-100, June 1979.
EPA CFR Title 40, Pt. 60, Appendix A, Method 20

INSTRUMENTATION SUMMARY:

A constant sample of flue gas was extracted, dried, filtered and delivered to an instrument manifold system for distribution to one or more analyzers. Instrument results are recorded on an analog strip chart recorder. System calibration checks are performed as well as calibration check at the beginning and end of each test run. Final data reduction includes zero and calibration drift corrections.

SAMPLE CONDITIONING SYSTEM:

Consists of a borosilicate glass tube or 316 grade stainless steel probe fitted with a cindered stainless steel or pyrex glass wool particulate filter. The probe is fitted with a teflon (TFE) sample line which connects to a water condensation system located at the sources. The condensation system consists of three 500 ml short stem glass impingers connected in a series, immersed in an ice bath. The gas is delivered to the instrument trailer witha teflon line (3/8" O.D.) through an in-line Balston particulate filter drawn by a teflon coated disphram pump. The sample system is leak checked prior to sampling by plugging the end of the sample probe and adjusting the sample pump to it's maximum rate (apprximately 22"Hg). The manifold is bypassed and the leak rate monitored through a gas meter or low range flow meter.

MANIFOLD SYSTEM:

Sample gas is delivered to each analyzer through a five (5) way valve and regulated with a needle valve flowmeter. Manifold pressure is controlled by a back pressure regulator which is typically set at three (3) psi. Zero gas (N_2) and calibration gases are delivered to the analyzers using the same five-way valve and flowmeter. All manifold parts are glass, stainless steel, or teflon materials.

CALIBRATION PROCEDURES:

A. System Calibration Procedures:

System calibration checks are performed to insure against sample system leaks or contamination. Calibration gas is introduced at the sample probe tip at a normal sample rate and vacuum, the final instrument value must be within +5% of the calibration gas value.

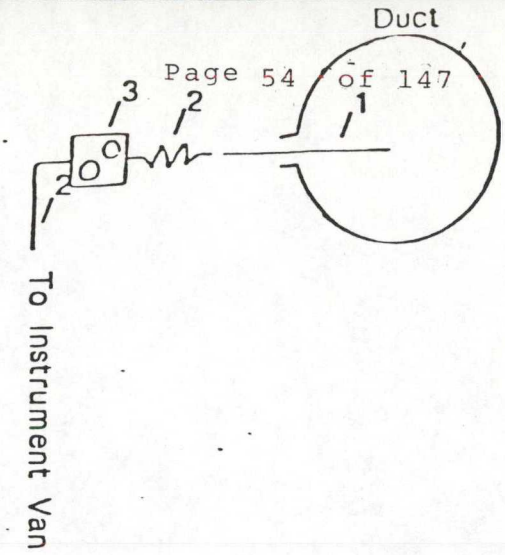
B. Manifold Calibration:

Instrument calibration checks are performed and adjustments made before and after each test run. Each analyzer is checked with a zero grade nitrogen gas for a zero baseline and then with a calibration gas similar to the expected sample concentration (60-90% of full scale). Calibration gases used in both manifold and system calibrations are with EPA protocol No. 1 gas (traceable to National Bureau of Stnadards SRM) or with gases recently analyzed by EPA Reference Methods. All zero and calibration checks are documented and noted on the recorder strip charts.

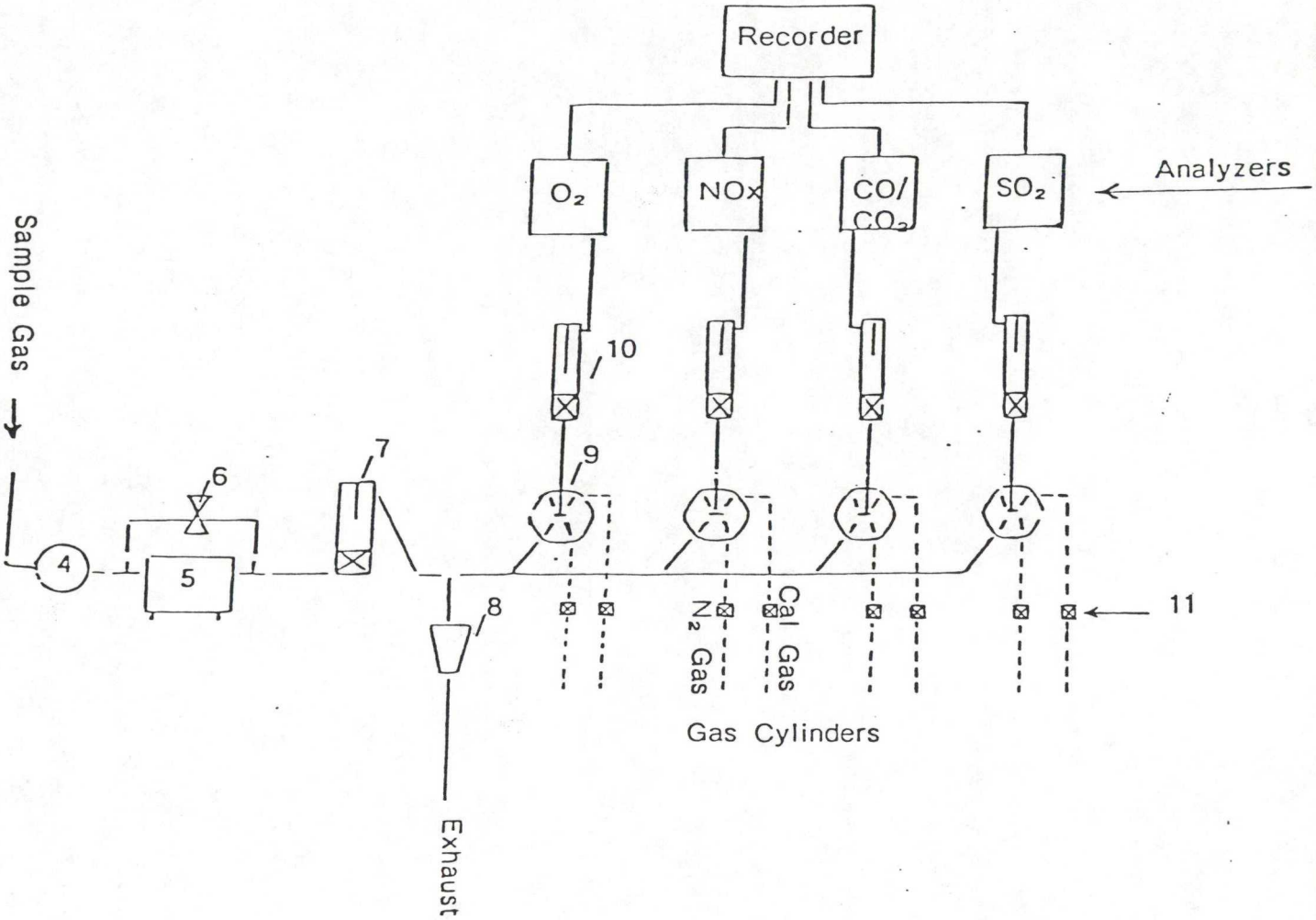
ANALOG STRIP CHART DATA REDUCTION:

Analog recordings were averaged of time increments as shown on the data pages (typically 5, 10, or 20 minute increments). Data for each incriment was recorded at an average percent of full scale. The readings were then compared with the zero and calibration readings for calculation of the average concentration for each time increment. Any deviation of the zero and calibration readings from the start to the end of a test period was corrected by calculating apparent zero and calibration readings for the mid-point or each time incriment. The average concentrations were then calculated from the sample readings and the apparent zero and span readings.

PNEUMATIC DIAGRAM



1) 316 Stainless Steel Probe
2) Teflon Sample Line
3) Sample Gas Conditioner
4) Filter
5) Teflon Coated Diaphram Pump
6) By-Pass Control Valve
7) Sample Flowmeter
8) Back-Pressure Regulator
9) 5-Way Gas Selection Valve
10) Instrument Flowmeter
11) Metering Valves



F FACTOR FOR GASEOUS FUELS

References: 1) Code of Federal Regulations 40 CFR 60.45

2) Handbook of Chemistry and Physics; CRC Press

METHOD: The EPA F Factor for gaseous fuels is determined from a fuel analysis for individual components by gas chromatography and an analysis for heating value. The equation for the stoichiometric combustion of the individual components is used to determine the final exhaust volume contribution of each component and the total exhaust volume per cubic foot of gaseous fuel to the combustion device.

STOICHIOMETRIC COMBUSTION OF HYDROCARBONS:

The exhaust volume concentration of each fuel gas component is determined by the general equation for the stoichiometric combustion of a gaseous hydrocarbon CxHy in air:

$$CxHy + AIR \rightarrow x\ CO_2 + y/2\ H_2O + 3.785\ (x + y/4)\ N_2$$

or

$$CxHy + (x + y/4)(O_2 + 3.785\ N_2) \rightarrow x\ CO_2 + y/2\ H_2O + 3.785\ (x + y/4)\ N_2$$

Therefore, for each mole (or standard cubic foot) of each fuel gas component CxHy, there will be:

1) $x + y/2 + 3.785\ (x + y/4)$ moles (or SCF) of "wet" exhaust flow

2) $x + 3.785\ (x + y/4)$ moles (or SDCF) of "dry" exhaust flow

or

1 SCF of CxHy produces $4.785x + 0.946y$ $SDCF_o$ flue gas

where: x = # of carbon atoms in component CxHy

y = # of hydrogen atoms in component CxHy

If non-combustible components such as N_2, O_2 or CO_2 are present in the gaseous fuel, these will not participate in the combustion process.

1 SCF Non-Combustible component produces 1 SCF_o flue gas

STOICHIOMETRIC COMBUSTION OF HYDROCARBONS (CON'T)

Hydrogen (H_2) combustion procedes according to the reaction:

$$\underline{1}\ H_2 + \tfrac{1}{2}(O_2 + 3.785\ N_2) \longrightarrow \underline{1}\ H_2O + \underline{1.893}\ N_2$$

Carbon Monoxide (CO) combustion in air procedes according to the reaction:

$$CO + AIR \longrightarrow CO_2 + N_2 \text{ (stoichiometric combustion)}$$

or

$$\underline{1}\ CO + \tfrac{1}{2}(O_2 + 3.785\ N_2) \rightarrow \underline{1}\ CO_2 + \underline{1.893}\ N_2$$

1 SCF CO produces 2.893 $SDCF_o$ flue gas

The total exhaust gas volume at stoichiometric combustion (zero % excess O_2) is the summation of the individual component's contribution. The actual total exhaust gas volume is greater and depends on the % O_2 in the exhaust gas.

$$\text{Actual SDCF} = SDCF_o \text{ (@ Stoichiometric combustion)} * \frac{20.9}{20.9 - \%O_2 \text{ in exhaust gas}}$$

BTU HEATING CONTENT OF GASEOUS FUELS:

The Btu/SCF of the gaseous fuel is determined either by actual measurement of a sample combustion in a calorimeter or from a summation of the known heating value of the components multiplied by the mole fraction of the components.

EPA F FACTOR:

The F Factor is the ratio of the total exhaust volume ($SDCF_o$) produced by the stoichiometric combustion of 1 SCF of the gaseous fuel and the Btu content of the same 1 SCF of gaseous fuel.

$$F\ (SDCF_o/MMBtu) = 10^6 * [SDCF_o/SCF\ fuel] \div [Btu/SCF\ fuel]$$

C. RESPONSE TIME

RESPONSE TIME

Date of Test: September 2, 1985

Analyzer Type: NO/NOx Thermo Electron Analyzer

Span Gas Concentration: 100 (ppm or %)

Zero Gas Source: Ambient Air

Upscale:

1) 45 seconds
2) 50 seconds
3) 50 seconds

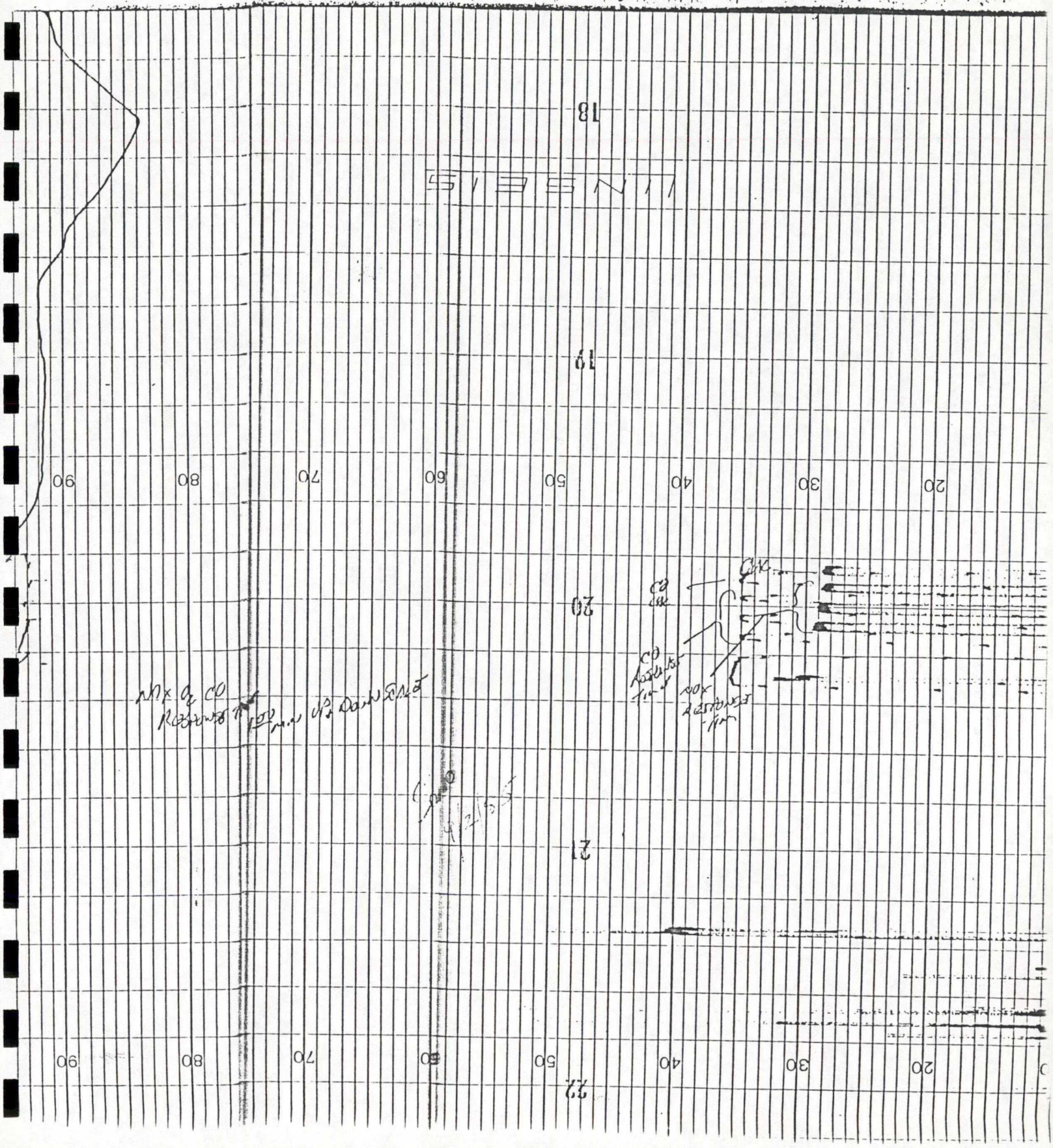
Average upscale response 48.3 seconds.

Downscale:

1) 45 seconds
2) 45 seconds
3) 40 seconds

Average downscale response 43.3 seconds.

Systems response time 60 seconds.


18
19
20
21
22
90
80
70
60
50
40
30
20
CO
CHK
NOx
CO
RESPONSE
NOx
RESPONSE
NOx & CO
RESPONSE
100 MIN UP & DOWN SCALE

PETRO
CHEM
ENVIRONMENTAL
SERVICES

APPENDIX A

NOx/CO/O_2 DATA

$NOx/CO/O_2$ SUMMARY

Unit: Sulzer Turbine - Tag #408-TCP-02-770A

Time:	% O_2	NOx ppm	NOx ppm @ 15% O_2	CO ppm
1215-1255	16.3	114.9	147.0	5.66
1305-1335	16.3	105.6	136.2	6.03
1345-1415	16.7	104.9	147.0	6.03
Average	16.4	108.5	143.4	5.91

Unit: Cooper Rolls Turbine - Tag # GT-518992A - SIPW

Time:	% O_2	NOx ppm	NOx ppm @ 15% O_2	CO ppm
1815-1855	17.2	55.0	88.4	6.61
1905-1945	17.1	55.0	84.8	6.16
1950-2032	17.4	52.5	88.0	6.40
Average	17.2	54.2	87.1	6.39

Unit: Cooper Rolls Turbine and Econotherm Supplementary Heater -#GT-51-8002A & H518002A

Time:	% O_2	NOx ppm	NOx ppm @ 15% O_2	CO ppm
1105-1145	14.5	69.4	64.4	40.21
1150-1230	14.4	70.6	64.6	38.85
1240-1329	14.5	68.2	63.2	42.15
Average	14.5	69.4	64.1	40.40

NOx/CO/O_2 SUMMARY

Unit: Broach Heater - #31-1401

Time	% O_2	NOx ppm	NOx ppm @ 15% O_2
1155-1237	3.02	64.96	21.44
1240-1322	3.00	64.96	21.41
1330-1409	3.49	62.46	21.17
Average	3.17	64.13	21.34

Unit: Cooper Rolls Turbine - #31-15101 - SIPE

Time	% O_2	NOx ppm	NOx ppm @ 15% O_2	CO ppm
1635-1715	16.53	108.43	146.40	81.02
1725-1805	16.67	103.44	144.26	77.65
1815-1855	16.85	100.94	147.16	73.58
Average	16.68	104.27	145.94	77.42

Unit: Cooper Rolls and Coen Supplementary Heater- #31-15101 and #31-14101 - SIPE

Time	% O_2	NOx ppm	NOx ppm @ 15% O_2	CO ppm
2200-2240	12.78	119.93	87.15	21.05
2245-2325	12.67	119.93	85.99	21.55
2335-2415	12.98	119.83	89.15	21.79
Average	12.81	119.83	87.43	21.46

COMPANY: SOHIO ALASKA PETROLEUM
DATE: 9-3-85
UNIT: Sulzar Turbine Tag#408-TCP-02-7704A

RUN # 1
NOX/CO/02 DATA

	TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm	CO;ppm
1	1215	1220	75	33	15.5	16.26	115.17	5.53
2	1220	1225	75	32.5	15.5	16.27	112.90	5.53
3	1225	1230	75	33	15.5	16.28	115.65	5.53
4	1230	1235	75	32.5	15.5	16.29	113.37	5.53
5	1235	1240	75	33	15.5	16.30	116.13	5.53
6	1240	1245	75	33	15.5	16.31	116.37	5.53
7	1245	1250	75.5	32.5	16	16.45	114.07	6.03
8	1250	1255	75.5	32.5	16	16.46	114.31	6.03
	1215	1255	75.00	32.83	15.50	16.29	114.93	5.66
	Averages:							

	02	NOX	CO
INITIAL ZERO (%fs)	10	10	10
INITIAL SPAN (%fs)	94	30	35
FINAL ZERO (%fs)	10	10	10
FINAL SPAN (%fs)	94.5	30.5	35
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	0.53	1.67	0.00
CAL GAS (ppm or %)	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN # 1

	%02	NOx,ppm	NOx ppm@ 15%02
NOx	16.29	114.93	147.02

RUN # 1

	%02	CO,ppm
CO	16.29	5.66

COMPANY: SOHIO ALASKA PETROLEUM
DATE: 9-3-85
UNIT: Sulzar Turbine Tag#408-TCP-02-7704A

RUN # 2
NOX/CO/O2 DATA

TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm	CO;ppm
1	1305	1310	76	31	16	16.49	102.38 6.03
2	1310	1315	76	31	16	16.47	102.38 6.03
3	1315	1320	75.5	32	16	16.33	107.25 6.03
4	1320	1325	75.5	32	16	16.32	107.25 6.03
5	1325	1330	75	32	16	16.18	107.25 6.03
6	1330	1335	75	32	16	16.16	107.25 6.03
	1305	1335	75.50	31.67	16.00	16.32	105.63 6.03
	Averages:						

	O2	NOX	CO
INITIAL ZERO (%fs)	10	10	10
INITIAL SPAN (%fs)	94	30.5	35
FINAL ZERO (%fs)	10	10	10
FINAL SPAN (%fs)	93.5	30.5	35
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	-0.53	0.00	0.00
CAL GAS (ppm or %)	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN # 2

	%O2	NOx,ppm	NOx ppm@ 15%O2
NOx	16.32	105.63	136.20

RUN # 2

	%O2	CO,ppm
CO	16.32	6.03

COMPANY: SOHIO ALASKA PETROLEUM
DATE: 9-3-85
UNIT: Sulzar Turbine Tag#408-TCP-02-7704A

RUN # 3
NOX/CO/O2 DATA

TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm	CO;ppm
1 1345	1350	77	31	16	16.75	104.94	6.03
2 1350	1355	77	31	16	16.75	104.94	6.03
3 1355	1400	77	31	16	16.75	104.94	6.03
4 1400	1405	76.5	31	16	16.63	104.94	6.03
5 1405	1410	76.5	31	16	16.63	104.94	6.03
6 1410	1415	76.5	31	16	16.63	104.94	6.03
1345	1415	76.75	31.00	16.00	16.69	104.94	6.03
Averages:							

	O2	NOX	CO
INITIAL ZERO (%fs)	10	10	10
INITIAL SPAN (%fs)	94	30	35
FINAL ZERO (%fs)	10	10	10
FINAL SPAN (%fs)	94	30	35
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	0.00	0.00	0.00
CAL GAS (ppm or %)	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN # 3

	%O2	NOx,ppm	NOx ppm@ 15%O2
NOx	16.69	104.94	146.97

RUN # 3

	%O2	CO,ppm
CO	16.69	6.03

COMPANY:SOHIO ALASKA PETROLEUM
DATE: 9-3-85
UNIT: Cooper Rolls Turbine #Gt-51-8002A-SIPW

RUN# 1
NOX/CO/O2 DATA

	TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm	CO;ppm
1	1815	1817	79	21	16.5	17.25	54.97	6.59
2	1817	1819	79	21	16.5	17.24	54.97	6.59
3	1819	1821	79.5	21	16.5	17.36	54.97	6.59
4	1821	1823	80	21	17	17.49	54.97	7.09
5	1823	1825	79.5	21	17	17.36	54.97	7.09
6	1825	1827	79	21	16.5	17.23	54.97	6.59
7	1827	1829	79	21	16.5	17.22	54.97	6.59
8	1829	1831	79	21	16.5	17.22	54.97	6.59
9	1831	1833	79	21	16.5	17.22	54.97	6.59
10	1833	1835	79	21	16.5	17.21	54.97	6.59
11	1835	1837	79	21	16.5	17.21	54.97	6.59
12	1837	1839	79	21	16.5	17.21	54.97	6.59
13	1839	1841	79	21	16.5	17.20	54.97	6.59
14	1841	1843	78.9	21	17	17.17	54.97	7.09
15	1843	1845	79	21	17	17.19	54.97	7.09
16	1845	1847	79	21	17	17.19	54.97	7.09
17	1847	1849	79	21	16	17.19	54.97	6.08
18	1849	1851	79	21	16	17.18	54.97	6.08
19	1851	1853	78.9	21	16	17.16	54.97	6.08
20	1853	1855	78.9	21	16	17.15	54.97	6.08
	1815	1855	79.33	21.00	16.67	17.23	54.97	6.61
	Averages							

	O2	NOx	CO
INITIAL ZERO(%fs	10	10	10
INITIAL SPAN(%fs	94	30	34.8
FINAL ZERO(%fs)	10	10	10
FINAL SPAN(%fs)	93.6	30	34.8
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	-0.43	0.00	0.00
CAL GAS ppm or %	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN 1

	%O2	NOx,ppm	NOx ppm @ 15%O2
NOx	17.23	54.97	88.43

RUN 1

	%O2	CO,ppm
CO	17.23	6.61

COMPANY:SOHIO ALASKA PETROLEUM
DATE: 9-3-85
UNIT: Cooper Rolls Turbine #Gt-51-8002A-SIPW

RUN# 2
NOX/CO/O2 DATA

	TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm	CO;ppm
1	1905	1907	79	21	16	17.33	54.97	6.08
2	1907	1909	79	21	16	17.32	54.97	6.08
3	1909	1911	78.5	21	16	17.19	54.97	6.07
4	1911	1913	78.5	21	16.3	17.18	54.97	6.38
5	1913	1915	78.3	21	16.3	17.13	54.97	6.37
6	1915	1917	78.3	21	16.5	17.12	54.97	6.58
7	1917	1919	78.2	21	16.5	17.09	54.97	6.57
8	1919	1921	78.2	21	16	17.09	54.97	6.07
9	1921	1923	78	21	16	17.03	54.97	6.06
10	1923	1925	78	21	16	17.03	54.97	6.06
11	1925	1927	78	21	16	17.02	54.97	6.06
12	1927	1929	78	21	16	17.02	54.97	6.06
13	1929	1931	78	21	16	17.01	54.97	6.06
14	1931	1933	78	21	16	17.00	54.97	6.06
15	1933	1935	78	21	16	17.00	54.97	6.05
16	1935	1937	78	21	16	16.99	54.97	6.05
17	1937	1939	78	21	16.2	16.99	54.97	6.25
18	1939	1941	78	21	16.2	16.98	54.97	6.25
19	1941	1943	78	21	16	16.98	54.97	6.05
20	1943	1945	78	21	16	16.97	54.97	6.04
	1905	1945	78.60	21.00	16.18	17.07	54.97	6.16
	Averages							

	O2	NOx	CO
INITIAL ZERO(%fs	10	10	10
INITIAL SPAN(%fs	93.6	30	34.8
FINAL ZERO(%fs)	10	10	10
FINAL SPAN(%fs)	93	30	34.6
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	-0.64	0.00	-0.57
CAL GAS ppm or %	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN 2

	%O2	NOx,ppm	NOx ppm @ 15%O2
NOx	17.07	54.97	84.76

RUN 2

	%O2	CO,ppm
CO	17.07	6.16

COMPANY: SOHIO ALASKA PETROLEUM
DATE: 9-3-85
UNIT: Cooper Rolls Turbine #Gt51-8002A-SIPW

RUN# 3
NOX/CO/02 DATA

	TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm	CO;ppm
1	1950	1956	79	20.5	16	17.55	52.47	6.28
2	1956	2002	79	20.5	16.5	17.54	52.47	6.81
3	2002	2008	78.7	20.5	16	17.45	52.47	6.28
4	2008	2014	78.5	20.5	16	17.38	52.47	6.28
5	2014	2020	78.3	20.5	16	17.32	52.47	6.28
6	2020	2026	78	20.5	16	17.23	52.47	6.28
7	2026	2032	78	20.5	16.3	17.22	52.47	6.60
	1950	2032	78.58	20.50	16.08	17.38	52.47	6.40
	Averages							

	02	NOx	CO
INITIAL ZERO(%fs	10	10	10
INITIAL SPAN(%fs	92.5	30	34
FINAL ZERO(%fs)	10	10	10
FINAL SPAN(%fs)	92	30	34
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	-0.54	0.00	0.00
CAL GAS ppm or %	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN 3

	%02	NOx,ppm	NOx ppm @ 15%02
NOx	17.38	52.47	88.01

RUN 3

	%02	CO,ppm
CO	17.38	6.40

COMPANY:SOHIO ALASKA PETROLEUM-SIPW
DATE: 9-4-85
UNIT: Cooper Rolls & Econotherm Heater-Gt-51-8002A & H518002A

RUN# 1
NOX/CO/O2 DATA

	TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm	CO;ppm
1	1105	1107	67.5	23.4	44	14.55	66.96	35.60
2	1107	1109	68	23.4	43	14.67	66.96	34.55
3	1109	1111	68	23.5	44	14.67	67.46	35.60
4	1111	1113	67.5	23.6	44.5	14.54	67.96	36.12
5	1113	1115	67.5	24	45	14.54	69.96	36.65
6	1115	1117	67.5	24	45.5	14.53	69.96	37.17
7	1117	1119	67.5	24	46	14.53	69.96	37.69
8	1119	1121	67.5	24	45	14.53	69.96	36.65
9	1121	1123	68	24	47	14.65	69.96	38.74
10	1123	1125	67.5	24	48	14.52	69.96	39.79
11	1125	1127	68	24	49	14.65	69.96	40.84
12	1127	1129	67.8	24	50	14.60	69.96	41.88
13	1129	1131	67.8	24	51	14.59	69.96	42.93
14	1131	1133	67.5	24	52	14.52	69.96	43.98
15	1133	1135	67.5	24	53	14.51	69.96	45.02
16	1135	1137	67.5	24	53	14.51	69.96	45.02
17	1137	1139	67.5	24	54	14.51	69.96	46.07
18	1139	1141	67	24	53	14.38	69.96	45.02
19	1141	1143	67	24	51	14.38	69.96	42.93
20	1143	1145	67	24	50	14.38	69.96	41.88
	1105	1145	67.67	23.65	44.33	14.54	69.43	40.21
	Averages							

	O2	NOx	CO
INITIAL ZERO(%fs	10	10	10
INITIAL SPAN(%fs	93	30	34
FINAL ZERO(%fs)	10	10	10
FINAL SPAN(%fs)	92.7	30	34
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	-0.32	0.00	0.00
CAL GAS ppm or %	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN 1

	%O2	NOx,ppm	NOx ppm @ 15%O2
NOx	14.54	69.43	64.39

RUN 1

	%O2	CO,ppm
CO	14.54	40.21

COMPANY:SOHIO ALASKA PETROLEUM-SIPW
DATE: 9-4-85
UNIT: Cooper Rolls & Econotherm Heater-Gt-51-8002A & H518002A

RUN# 2
NOX/CO/O2 DATA

	TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm	CO;ppm
1	1150	1152	66.5	24	50	14.30	70.02	41.88
2	1152	1154	66.5	24	50	14.30	70.07	41.88
3	1154	1156	66.5	24	50	14.30	70.13	41.88
4	1156	1158	66.5	24	50	14.30	70.19	41.88
5	1158	1200	66.5	24	49	14.30	70.25	40.84
6	1200	1202	66.5	24	48.5	14.30	70.31	40.31
7	1202	1204	66.5	24	48	14.30	70.37	39.79
8	1204	1206	67	24	48	14.42	70.42	39.79
9	1206	1208	67	24	47.5	14.42	70.48	39.27
10	1208	1210	67	24	47	14.42	70.54	38.74
11	1210	1212	67.5	24	46	14.55	70.60	37.69
12	1212	1214	67.5	24	45	14.55	70.66	36.65
13	1214	1216	67.5	24	44.5	14.55	70.72	36.12
14	1216	1218	67.5	24	45	14.55	70.77	36.65
15	1218	1220	67.5	24	45	14.55	70.83	36.65
16	1220	1222	67.5	24	45.5	14.55	70.89	37.17
17	1222	1224	67.5	24	46	14.55	70.95	37.69
18	1224	1226	67.8	24	45.5	14.62	71.01	37.17
19	1226	1228	67.8	24	45.5	14.62	71.07	37.17
20	1228	1230	67.8	24	46	14.62	71.12	37.69
	1150	1230	66.50	24.00	49.58	14.45	70.57	38.85
	Averages							

	O2	NOx	CO
INITIAL ZERO(%fs	10	10	10
INITIAL SPAN(%fs	93	30	34
FINAL ZERO(%fs)	10	10	10
FINAL SPAN(%fs)	93	30.5	34
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	0.00	1.67	0.00
CAL GAS ppm or %	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN 2

	%O2	NOx,ppm	NOx ppm @ 15%O2
NOx	14.45	70.57	64.57

RUN 2

	%O2	CO,ppm
CO	14.45	38.85

COMPANY:SOHIO ALASKA PETROLEUM
DATE: 9-4-85
UNIT: C88per Rolls & Econotherm Heater - Gt-51-8002A & H518002A

RUN# 3
NOX/CO/O2 DATA

	TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm	CO;ppm
1	1240	1247	67.5	24	52	14.46	68.25	43.98
2	1247	1254	68	24	51	14.59	68.25	42.93
3	1254	1301	68	24	52	14.59	68.25	43.98
4	1301	1308	68	24	50	14.59	68.25	41.88
5	1308	1315	68	24	49.8	14.59	68.25	41.67
6	1315	1322	67.5	24	47	14.46	68.25	38.74
7	1322	1329	67.5	24	50	14.46	68.25	41.88
	1240	1329	67.83	24.00	50.30	14.53	68.25	42.15
	Averages							

	O2	NOx	CO
INITIAL ZERO(%fs	10	10	10
INITIAL SPAN(%fs	93.5	30.5	34
FINAL ZERO(%fs)	10	10	10
FINAL SPAN(%fs)	93.5	30.5	34
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	0.00	0.00	0.00
CAL GAS ppm or %	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN 3

	%O2	NOx,ppm	NOx ppm @ 15%O2
NOx	14.53	68.25	63.24

RUN 3

	%O2	CO,ppm
CO	14.53	42.15

COMPANY:ARCO ALASKA , INC.
DATE: 9-5-85
UNIT: SIPE ; Broach Heater #31-1401

RUN# 1
NOX/O2 DATA

	TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm
1	1155	1202	22.5	23	3.13	64.96
2	1202	1209	22.3	23	3.08	64.96
3	1209	1216	21.5	23	2.88	64.96
4	1216	1223	21.2	23	2.80	64.96
5	1223	1230	22.5	23	3.13	64.96
6	1230	1237	22.5	23	3.13	64.96
	1155	1237	22.08	23.00	3.02	64.96
	Averages					

	O2	NOx
INITIAL ZERO(%fs	10	10
INITIAL SPAN(%fs	94	30
FINAL ZERO(%fs)	10	10
FINAL SPAN(%fs)	94	30
% ZERO DRIFT:	0.00	0.00
% SPAN DRIFT:	0.00	0.00
CAL GAS ppm or %	21	99.94
RANGE (ppm or %)	25	500

RUN 1

	%O2	NOx,ppm	NOx ppm @ 15%O2
NOx	3.02	64.96	21.44

COMPANY:ARCO ALASKA , INC.
DATE: 9-5-85
UNIT: SIPE, Broach Heater #31-1401

RUN# 2
NOX/CO/O2 DATA

	TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm
1	1240	1247	22	23	3.00	64.96
2	1247	1254	22	23	3.00	64.96
3	1254	1301	22	23	3.00	64.96
4	1301	1308	22	23	3.00	64.96
5	1308	1315	22	23	3.00	64.96
6	1315	1322	22	23	3.00	64.96
	1240	1322	22.00	23.00	3.00	64.96

Averages

	O2	NOx
INITIAL ZERO(%fs	10	10
INITIAL SPAN(%fs	94	30
FINAL ZERO(%fs)	10	10
FINAL SPAN(%fs)	94	30
% ZERO DRIFT:	0.00	0.00
% SPAN DRIFT:	0.00	0.00
CAL GAS ppm or %	21	99.94
RANGE (ppm or %)	25	500

RUN 2

	%O2	NOx,ppm	NOx ppm @ 15%O2
NOx	3.00	64.96	21.41

COMPANY:ARCO ALASKA , INC.
DATE: 9-5-85
UNIT: SIPE; Broach Heater #31-1401

RUN# 3
NOX/O2 DATA

	TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm
1	1330	1337	23.5	22.5	3.34	62.46
2	1337	1341	24	22.5	3.46	62.46
3	1341	1348	24	22.5	3.47	62.46
4	1348	1355	24	22.5	3.47	62.46
5	1355	1402	24.5	22.5	3.60	62.46
6	1402	1409	24.5	22.5	3.60	62.46
	1330	1409	24.08	22.50	3.49	62.46

Averages

	O2	NOx
INITIAL ZERO(%fs	10	10
INITIAL SPAN(%fs	95	30
FINAL ZERO(%fs)	10	10
FINAL SPAN(%fs)	95.5	30
% ZERO DRIFT:	0.00	0.00
% SPAN DRIFT:	0.53	0.00
CAL GAS ppm or %	21	99.94
RANGE (ppm or %)	25	500

RUN 3

	%O2	NOx,ppm	NOx ppm @ 15%O2
NOx	3.49	62.46	21.17

COMPANY:ARCO ALASKA, INC.
DATE: 9-5-85
UNIT: Cooper Rolls Turbine #31-15101 - SIPE

RUN 1
NOX/CO/O2 DATA

	TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCAL O2;fs	NOx;fs	CO;fs	CONCENTRATION;CORRECTED O2;%	NOx;ppm	CO;ppm
1	1635	1639	76	31.5	87.5	16.50	107.44	77.90
2	1639	1643	76.3	31.5	88	16.58	107.44	78.41
3	1643	1647	76.5	31.5	90	16.63	107.44	80.42
4	1647	1651	77	31.5	91	16.75	107.44	81.42
5	1651	1655	77	31.5	92	16.75	107.44	82.43
6	1655	1659	76.5	31.5	92	16.63	107.44	82.43
7	1659	1703	76	32	92	16.50	109.93	82.43
8	1703	1707	75.5	32	91.5	16.38	109.93	81.92
9	1707	1711	75.3	32	91	16.33	109.93	81.42
10	1711	1715	75.1	32	91	16.28	109.93	81.42
	1635	1715	76.55	31.50	90.08	16.53	108.43	81.02
	Averages							

	O2	NOX	CO
INITIAL ZERO(%fs	10	10	10
INITIAL SPAN(%fs	94	30	35
FINAL ZERO(%fs)	10	10	10
FINAL SPAN(%fs)	94	30	35
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	0.00	0.00	0.00
CAL GAS ppm or %	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN 1

	%O2	NOx,ppm	NOx ppm@ 15%O2
NOx	16.53	108.43	146.40

RUN 1

	%O2	CO,ppm
CO	16.53	81.02

COMPANY:ARCO ALASKA,INC.
DATE: 9-5-85
UNIT: Cooper Rolls Turbine #31-15101 - SIPE

RUN 2
NOX/CO/O2 DATA

	TIME INTRVAL BEGIN	END	CONCENTRATION;FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION;CORRECTED O2;%	NOx;ppm	CO;ppm
1	1725	1729	76.2	31	88	16.57	104.94	78.41
2	1729	1733	76.2	31	88	16.59	104.94	78.41
3	1733	1737	76.2	31	88	16.60	104.94	78.41
4	1737	1741	76.2	31	87.5	16.62	104.94	77.90
5	1741	1745	76.2	30.5	87.5	16.64	102.44	77.90
6	1745	1749	76.2	30.5	88	16.66	102.44	78.41
7	1749	1753	76.3	30.5	87	16.70	102.44	77.40
8	1753	1757	76.4	30.5	86.5	16.74	102.44	76.90
9	1757	1801	76.5	30.5	86	16.78	102.44	76.40
10	1801	1805	76.5	30.5	86	16.80	102.44	76.40
	1725	1805	76.20	30.83	87.83	16.67	103.44	77.65
	Averages							

	O2	NOX	CO
INITIAL ZERO(%fs	10	10	10
INITIAL SPAN(%fs	94	30	35
FINAL ZERO(%fs)	10	10	10
FINAL SPAN(%fs)	95	30	35
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	1.06	0.00	0.00
CAL GAS ppm or %	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN 2

	%O2	NOx,ppm	NOx ppm@ 15%O2
NOx	16.67	103.44	144.26

RUN 2

	%O2	CO,ppm
CO	16.67	77.65

COMPANY:ARCO ALASKA, INC
DATE: 9-5-85
UNIT: Cooper Rolls Turbine- #31-15101 - SIPE

RUN 3
NOX/CO/O2 DATA

	TIME INTRVAL BEGIN	END	CONCENTRATION;FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION;CORRECTED O2;%	NOx;ppm	CO;ppm
1	1815	1820	77.2	30.2	85.3	16.80	100.94	75.69
2	1820	1825	77.2	30.2	85.3	16.80	100.94	75.69
3	1825	1830	77.2	30.2	85.4	16.80	100.94	75.79
4	1830	1835	77.3	30.2	85	16.83	100.94	75.39
5	1835	1840	77.4	30.2	81	16.85	100.94	71.37
6	1840	1845	77.5	30.2	81.3	16.88	100.94	71.67
7	1845	1850	77.6	30.2	81.3	16.90	100.94	71.67
8	1850	1855	77.9	30.2	81	16.98	100.94	71.37
	1815	1855	77.30	30.20	83.88	16.85	100.94	73.58
	Averages							

	O	NO	C
INITIAL ZERO(%fs	10	10	10
INITIAL SPAN(%fs	94	30	35
FINAL ZERO(%fs)	10	10	11
FINAL SPAN(%fs)	94	30	35
% ZERO DRIFT:	0.00	0.00	1.00
% SPAN DRIFT:	0.00	0.00	-2.86
CAL GAS ppm or %	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN 3

	%O2	NOx,ppm	NOx ppm@ 15%O2
NOx	16.85	100.94	147.16

RUN 3

	%O2	CO,ppm
CO	16.85	73.58

COMPANY: ARCO ALASKA, INC.
DATE: 9-5-85
UNIT: Cooper Rolls Turbine & Econotherm Heater-SIP
#31-15101 & #31-14101

RUN # 1
NOX/CO/O2 DATA

TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm	CO;ppm
1	2200	2205	61	34	29.5	12.75	119.93 19.6
2	2205	2210	61.5	34	32	12.88	119.93 22.11
3	2210	2215	61.3	34	31	12.83	119.93 21.11
4	2215	2220	61.2	34	31	12.80	119.93 21.11
5	2220	2225	61	34	31	12.75	119.93 21.11
6	2225	2230	61	34	31	12.75	119.93 21.11
7	2230	2235	61	34	31	12.75	119.93 21.11
8	2235	2240	61	34	31	12.75	119.93 21.11
	2200	2240	61.17	34.00	30.92	12.78	119.93 21.05
	Averages:						

	O2	NOX	CO
INITIAL ZERO (%fs)	10	10	10
INITIAL SPAN (%fs)	94	30	35
FINAL ZERO (%fs)	10	10	10
FINAL SPAN (%fs)	94	30	35
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	0.00	0.00	0.00
CAL GAS (ppm or %)	21	99.94	25.13
RANGE (ppm or %)	25	500	100

RUN # 1

	%O2	NOx,ppm	NOx ppm@ 15%O2
NOx	12.78	119.93	87.15

RUN # 1

	%O2	CO,ppm
CO	12.78	21.05

COMPANY: ARCO ALASKA, INC.
DATE: 9-5-85
UNIT: Cooper Rolls Turbine & Econotherm Heater - SIPE
#31-15101 & #31-14101

RUN # 2
NOX/CO/O2 DATA

TIME INTERVAL BEGIN	END	CONCENTRATION; FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm	CO;ppm
1	2245	2250	61	34	31	12.75	120.00 21
2	2250	2255	61	34	31.5	12.75	120.00 21.5
3	2255	2300	61	34	31.5	12.75	120.00 21.5
4	2300	2305	60.5	34	31.5	12.63	120.00 21.5
5	2305	2310	60.5	34	31.5	12.63	120.00 21.5
6	2310	2315	60.5	34	31.5	12.63	120.00 21.5
7	2315	2320	60.5	34	31.5	12.63	120.00 21.5
8	2320	2325	60.5	34	31.5	12.63	120.00 21.5
	2245	2325	60.75	34.00	31.42	12.67	120.00 21.4375

Averages:

	O2	NOX	CO
INITIAL ZERO (%fs)	10	10	10
INITIAL SPAN (%fs)	94	30	35
FINAL ZERO (%fs)	10	10	10
FINAL SPAN (%fs)	94	30	35
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	0.00	0.00	0.00
CAL GAS (ppm or %)	21	100	25
RANGE (ppm or %)	10	500	100

RUN # 2

	%O2	NOx,ppm	NOx ppm@ 15%O2
NOx	12.67	120.00	86.05

RUN # 2

	%O2	CO,ppm
CO	12.67	21.44

COMPANY:ARCO ALASKA, INC
DATE: 9-5-85
UNIT: Cooper Rolls Turbine & Econotherm Heater-SIPE
#31-15101 & #31-14101

RUN# 3
NOX/CO/O2 DATA

TIME INTERVAL BEGIN	END	CONCENTRATION;FULL SCALE O2;fs	NOx;fs	CO;fs	CONCENTRATION; CORRECTED O2;%	NOx;ppm	CO;ppm
1 2335	2340	61	34	32	12.77	119.93	22.15
2 2340	2345	61.5	34	31	12.91	119.93	21.18
3 2345	2350	61.5	34	31	12.93	119.93	21.22
4 2350	2355	62	33.5	31	13.07	117.43	21.26
5 2355	2400	62.5	34	34	13.21	119.93	24.34
6 2400	2405	61.5	34	31	12.98	119.93	21.34
7 2405	2410	61.5	34	31	12.99	119.93	21.37
8 2410	2415	61.5	34	31	13.01	119.93	21.41
2335	2415	61.67	33.92	31.67	12.98	119.62.	21.79
Averages							

	O2	NOX	CO
INITIAL ZERO(%fs	10	10	10
INITIAL SPAN(%fs	94	30	35
FINAL ZERO (%fs)	10	10	10
FINAL SPAN (%fs)	95	30	35.5
% ZERO DRIFT:	0.00	0.00	0.00
% SPAN DRIFT:	1.06	0.00	1.43
CAL GAS(ppm or %	21	99.94	25.13
RANGE (ppm or%)	25	500	100

RUN 3

	%O2	NOx,ppm	NOx ppm@ 15% O2
NOx	12.98	119.62	89.15

RUN 3

	%O2	CO,ppm
CO	12.98	21.79

PETRO
CHEM
ENVIRONMENTAL
SERVICES

APPENDIX B

FUEL GAS AND f FACTOR

CLIENT:SOHIO Alaska Petroleum Co.
UNIT:GC-2 Sulzer Turbine
REPORT#:50-023
DATE: 9-03-85

EPA "F" FACTOR FOR FUEL GAS

FUEL COMPONENT	C	H	EXPANSION FACTOR	COMPONENT MOLE %	EXHAUS DSCF (SCF FU
METHANE	1	4	8.57	75.268	6.45
ETHANE	2	6	15.25	6.452	0.98
PROPANE	3	8	21.92	3.41	0.75
(ISO-BUTANE)	4	10	28.6	0.44	0.13
NORM-BUTANE	4	10	28.6	1.02	0.29
(ISO-PENTANE)	5	12	35.28	0.18	0.06
NORM-PENTANE	5	12	35.28	.22	0.08
HEXANE +	6	14	41.95	0.09	0.04
AIR (N2+O2)	-	-	1	1.16	.01161
CO2	-	-	1	11.76	.11764
H2S	-	2	1	0	0
			TOTAL	100	8.91

9.25	DSCF EXHAUST PER SCF OF FUEL GAS AT ZERO % OXYGEN
932	NET BTU/SCF OF FUEL GAS
1030	GROSS BTU/SCF OF FUEL GAS
8983.92	DSCF/MMBTU (EPA "F" FACTOR @ 60 'F & ZERO % OXYGEN)
9120.73	DSCF/MMBTU (EPA "F" FACTOR @ 68 'F & ZERO % OXYGEN)

CLIENT:SOHIO Alaska Petroleum Co.
UNIT: Cooper Rolls Turbine - SIPW
REPORT#:50-023
DATE: 9-03-85

EPA "F" FACTOR FOR FUEL GAS

FUEL COMPONENT	C	H	EXPANSION FACTOR	COMPONENT MOLE %	EXHAUS DSCF (SCF FU
METHANE	1	4	8.57	73.515	6.30
ETHANE	2	6	15.25	6.926	1.06
PROPANE	3	8	21.92	3.696	0.81
(ISO-BUTANE)	4	10	28.6	0.49	0.14
NORM-BUTANE	4	10	28.6	1.16	0.33
(ISO-PENTANE)	5	12	35.28	0.23	0.08
NORM-PENTANE	5	12	35.28	.318	0.11
HEXANE +	6	14	41.95	0.28	0.12
AIR (N2+O2)	-	-	1	0.53	.00533
CO2	-	-	1	12.86	.12858
H2S	-	2	1	0	0
			TOTAL	100	9.08

8.91	DSCF EXHAUST PER SCF OF FUEL GAS AT ZERO % OXYGEN
950	NET BTU/SCF OF FUEL GAS
1049	GROSS BTU/SCF OF FUEL GAS
8489.85	DSCF/MMBTU (EPA "F" FACTOR @ 60 'F & ZERO % OXYGEN)
8619.14	DSCF/MMBTU (EPA "F" FACTOR @ 68 'F & ZERO % OXYGEN)

CLIENT:SOHIO Alaska Petroleum Co.
UNIT: Cooper Rolls Turbine & Econotherm Heater - SIPW
REPORT#:50-023
DATE: 9-04-85

EPA "F" FACTOR FOR FUEL GAS

FUEL COMPONENT	C	H	EXPANSION FACTOR	COMPONENT MOLE %	EXHAUS DSCF (SCF FU
METHANE	1	4	8.57	74.029	6.34
ETHANE	2	6	15.25	6.829	1.04
PROPANE	3	8	21.92	3.621	0.79
(ISO-BUTANE)	4	10	28.6	0.48	0.14
NORM-BUTANE	4	10	28.6	1.129	0.32
(ISO-PENTANE)	5	12	35.28	0.24	0.08
NORM-PENTANE	5	12	35.28	.312	0.11
HEXANE +	6	14	41.95	0.28	0.12
AIR (N2+O2)	-	-	1	0.57	.00573
CO2	-	-	1	12.50	.12504
H2S	-	2	1	0	0
			TOTAL	100	9.08

9.08	DSCF EXHAUST PER SCF OF FUEL GAS AT ZERO % OXYGEN
950	NET BTU/SCF OF FUEL GAS
1049	GROSS BTU/SCF OF FUEL GAS
8656.47	DSCF/MMBTU (EPA "F" FACTOR @ 60 'F & ZERO % OXYGEN)
8788.29	DSCF/MMBTU (EPA "F" FACTOR @ 68 'F & ZERO % OXYGEN)

CLIENT:ARCO Alaska
UNIT: SIPE Broach Heater & WHRU
REPORT#:50-040
DATE:9-5-85

EPA "F" FACTOR FOR FUEL GAS

FUEL COMPONENT	C	H	EXPANSION FACTOR	COMPONENT MOLE %	EXHAUST DSCF (0)/ SCF FUEL
METHANE	1	4	8.57	75.13	6.44
ETHANE	2	6	15.25	6.51	0.99
PROPANE	3	8	21.92	3.34	0.73
(ISO-BUTANE)	4	10	28.6	0.45	0.13
NORM-BUTANE	4	10	28.6	1.08	0.31
(ISO-PENTANE)	5	12	35.28	0.30	0.11
NORM-PENTANE	5	12	35.28	.24	0.08
HEXANE +	6	14	41.95	0.12	0.05
AIR (N2+02)	-	-	1	0.49	.0049
CO2	-	-	1	12.34	.1234
H2S	-	2	1	0	0
			TOTAL	100	8.97

9.25	DSCF EXHAUST PER SCF OF FUEL GAS AT ZERO % OXYGEN
937.2	NET BTU/SCF OF FUEL GAS
1035.3	GROSS BTU/SCF OF FUEL GAS
8937.93	DSCF/MMBTU (EPA "F" FACTOR @ 60 'F & ZERO % OXYGEN)
9074.04	DSCF/MMBTU (EPA "F" FACTOR @ 68 'F & ZERO % OXYGEN)

SAPC PRODUCTION LAB

ANALYSIS REPORT

Natural Gas Composition

Requestor: Lynn Billington

Facility:	GC-2	WSW
Location:	Skid 408	Skid 302
Date:	09/03/85	09/03/85
Sample No:	0210	0211
Temp, (F):	100	85
PSIG:	175	610
Mole %'s		
Methane,	75.268	73.515
Ethane,	6.452	6.926
Propane,	3.410	3.696
n Butane,	1.020	1.160
i Butane,	0.439	0.492
n Pentane,	0.220	0.318
i Pentane,	0.176	0.227
C-6 +,	0.090	0.275
CO2,	11.764	12.858
Nitrogen,	1.161	0.533
Oxygen,	0.000	0.000
H2S, ppm by vol	N/R	N/R
H2O,	N/R	N/R
SpG Calculated	0.7706	0.7941
SpG Measured	0.774	0.794
BTU/SCF, gross	1030	1049
BTU/SCF, net	932	950

Comments:

Analyst: D. Bank

Date: 09/04/85

Reviewed by: Drew Holt

SAPC PRODUCTION LAB

ANALYSIS REPORT
Natural Gas Composition

Requestor: Lynn Billington

Facility:	WSW
Location:	Skid 301
Date:	09/04/85
Sample No:	0276
Temp, (F):	90
PSIG:	610

Mole %'s

Methane,	74.029
Ethane,	6.829
Propane,	3.621
n Butane,	1.129
i Butane,	0.482
n Pentane,	0.312
i Pentane,	0.240
C-6 +,	0.281
CO2,	12.504
Nitrogen,	0.573
Oxygen,	0.000
H2S, ppm by vol	~~0~~ N/R
H2O,	~~0.00~~ N/R

SpG Calculated	0.7892
SpG Measured	0.793
BTU/SCF, gross	1049
BTU/SCF, net	950

Comments:

Analyst: David T Bak

Date: 09/04/85

Reviewed by: [signature]

ANALYSIS REPORT

****

JVPS - 1932
4307

06 SEP 1985

SAMPLE# 024828 ARCHIVE# 0X9528:7A

location,	company,			
S.I.P.	ARCO			
sample month,	day,	year,	hour,	sample point description
9	5	1985	830	DOWNSTREAM MPKU DRUM

sample description
RESID. GAS

temp,	sample PSIG,	line PSIG,	meter#
**	**	50	**

requestor
*

PROPERTY	VALUE	
SAMPLE TIME	830	HOURS
TEMPERATURE	***	
LINE PRESSURE	50	PSIG
NITROGEN	.49	MOL %
#METHANE	75.13	MOL %
CARBON DIOXIDE	12.34	MOL %
%ETHANE	6.51	MOL %
PROPANE	3.34	MOL %
ISO-BUTANE	.45	MOL %
N-BUTANE	1.08	MOL %
ISO-PENTANE	.3	MOL %
N-PENTANE	.24	MOL %
C6+	.12	MOL %
HYDROGEN SULFIDE	***	
GROSS DRY (IDEAL GAS)	1035.3	BTU/CF
NET (IDEAL GAS)	937.2	BTU/CF
GROSS SATURATED IDEAL	1019.6	BTU/CF
SP GRAVITY (CALC.)	.775	.....
SP GRAVITY (MEAS.)	***	

COMMENTS:

COMPLETED BY: [signature]

REVIEWED BY: [signature]

SIP OPER SUPERVISOR
SIP FACILITY ENGINEER
TOM GILES/ BOB MOFLEY

FS #1 PROD SUPERINTENDENT
OPERATIONS ENGINEERING COORD
LAB FILE

FROM ARCO AK PRB 09/11/85 14:54 P. 2

PETRO
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SERVICES

APPENDIX C

CAlCULATED NOx TURBINE EMISSIONS

PETRO CHEM ENVIRONMENTAL SERVICES

CALCULATED ALLOWABLE NOx EMISSION FOR STATIONERY GAS TURBINES

Ref: Environmental Protection Agency, Code of Federal Regulations, Title 40, Part 60. Subpart G, 60.332, 1983.

Equation:

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

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) Y cannot exceed 14.4.

F = NOx emission allowance for fuel-bound nitrogen ($N > 0.25 = 0.005$)

Calculations:

7460 BTU/Hphr = manufacture rating Cooper Rolls 29,100 hp Turbine 1/

13,621 BTU/Kwhr = manufacture rating Sulzer 7700 hp Turbine 1/

$1.4139 * 10^{-3}$ (hphr) (kilojoules)/(BTU)(w-hr)
$1.0544 * 10^{-3}$ (kwhr) kilojoules /(BTU)(w-hr)

$$\text{Cooper STD} = 150 \left(\frac{14.4}{7460 * 1.4139 * 10^{-3}}\right) + 0.005 = 204.8\text{ppm @ 15\% } O_2$$

$$\text{Sulzer STD} = 150 \left(\frac{14.4}{13{,}621 * 1.0544 * 10^{-3}}\right) + 0.005 = 150.4\text{ppm @ 15\% } O_2$$

1/ This rating based on manufacturers efficiency performance data, Appendix K.

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APPENDIX D

RAW FIELD DATA

Sohio - G. C. #2 Date: 9-3-85

Sulzar Turbine #8 Pump Tag # 408-TCP-02-7704A P_{Bar} 30.00" Hg

Flow Ref No MPWX-3-117-17221/DWS/485107-4-0601 Ambient: 34°F

GGT 9535 Rpm @

PT 9130 RPM 0815

Port locations -- Vertical plane 2.5 dia upstream and ___ dia downstream

Stack diameter 63" 2.62' 21.65 ft² Area

static +0.28

Pts	in from edge	coupling 24"	ΔP	Tgas °F
1	2.8	26.8	1.6	742
2	9.2	33.2	1.5	"
3	18.6	42.6	1.4	"
4	44.4	68.4	1.2	"
5	53.8	77.8	1.0	"
6	60.2	84.2	0.9	"

Present at time of testing:

Jack Kouts DEC

Lynn Billington Sohio

Erica Sipe "

Run #1 (+ O_2 Traverse)

Begin 1215

Finish 1245

Testers:

Leslie Johnson

Andy Winkler

FIELD MOISTURE DETERMINATION REFERENCE METHOD

Client: Solio Report#: 50-023
Location: GL#2 Solar Turbine #02-7704A
Operator: [illegible]
Date: 9-3-85
Run No.: 1

%CO2 3.0
%O2 16.2
MW 28.82
%H2O 3.0

Ambient Temperature: 84
Barometric Pressure: 30.00
Meter Box No: — C Factor: —
Probe #: 12 SS Cp 0.84
Stack Diameter: 63" corp 24

Traverse Point No. #	Time (0) min	Stack Temperature (°F)	Pressure Differencial Across Orifice ~~Meter~~ Stack ΔP (in) H_2O	Meter Reading Gas Sample Volume ~~(ft³)~~ (fps)	Δ Vm (ft³)	Gas Sample Temperature at Dry Gas Meter inlet (Tm_{in}) (°F)	outlet (Tm_{out}) (°F)	Temperaturem of Gas Leaving Condensor or Last Impinger (°F)
1 2.8	1240	845	1.6					
2 9.2	1235	844	1.5					
3 16.6	1230	844	1.4					
4 44.4	1225	844	1.2					
5 53.8	1220	~~836~~ 844	1.0					
6 60.2	1215	816 840	0.9					
	Total	844			ACFM	avg.	avg.	
	Average	844	1.27 NOP 1.12	98.74	128,265	avg.		

(Sohio)
Seawater injection ~~Waterflood~~ Plant west 9/3/85

Amb Temp 33°F

~~Turbi~~ Copper Rolls Gas Turbine (WHRU) P_{Bar} 30.00

29.1 MHp Serial # P8001A Relative Humidity 91%

static -0.45

Stack Temp 246°F

Stack dia 11' Area 95.03 ft²

Ports located on a horizontal plane 2 dia downstream 8 dia upstream of dist

1814 hr Pts	inches from edge	Pts	inches from edge
1	1.72	11	80.8
2	5.15	12	91.6
3	8.8	13	99.0
4	12.8	14	105.1
5	17.0	15	110.2
6	21.8	16	115.0
7	26.9	17	119.2 →
8	33.0	18	123.2
9	40.4	19	126.9
10	51.2	20	130.3

Present:

Lynn Billington Sohio
Erica Dippe "
Jack Kouts DEC
Leslie Johnson ~~Ex~~ Petro-Chem
Andy Winkler Petro-chem

Waste Heat Recovery Unit WHRU 9/4/85

Tag No: H-51-8002A P_{Bar} 30.15" Hg

32,000 MMBTU/HR Heater Amb. Temp 33°F

Dew Point 32°F

Stack Temp = 295 out Impinger: 48°F @ 1120 37° 1212

Static = -0.55 38°F @ 1138

Stack dia: 11' Area: 95.03 ft^2

Ports located on a horizontal Plane 2 diameters downstream 8 diameters upstream from a disturbance. Four 8 hole flange ports; two were used for sampling (N.E. & NW port)

Pt #	Inches from edge	Pt #	inches from edge
1	1.7	11	80.8
2	5.2	12	91.6
3	8.8	13	99.0
4	12.8	14	105.1
5	17.0	15	110.2
6	21.8	16	115.0
7	26.9	17	119.2
8	33.0	18	123.2
9	40.4	19	126.9
10	51.2	20	130.3

Present:

Lynn Billington SOHIO

Erica Dippé "

Jack Coutts Alaska DEC

Leslie Johnson Petro Chem

Andy Winkler Petro Chem

Orifice: 2.224"

Arco: SIP

9/5/85

Broach Heater

P_{Bar} = 30.51

Serial #31-146 R

Relative Humidity: 92%

Rated @ 67.2 mmBtu/hr

Amb. Temp. 35°F

Duct diameter 50.5" Area 13.9 ft²

Two ports located on the same horizontal plane 90° apart 5 diameters downstream 3 diameters upstream from a disturbance.

Pt #	inchs from edge	Imp. outlet °F	Glycol flow gpm
1	2.2	39	7.45 + 200
2	7.4	37	
3	14.9	36	
4	35.6	33	
5	43.1	36	
6	48.3	35	

Temp Duct 416°F ΔP Average = 0.40

Static + 0.04

Present:

Jim Ives Arco Environmental Eng.

Ellen Arco Supervisor

Jack Coutts DEC

Leslie Johnson Petro-Chem

Andy Winkler " "

Orifice
3.551"

Cooper Rolls Turbine
Waste Heat recovery system Injection
Pump #1

P_{Bar}: 30.51 "Hg
Relative Humid: 39%
Temp: 32°F
9/5/85

Stack dia. 10 ft Area 78.54 ft²

Pt #	inches from edge	Pt #	inches from edge
1	1.7	10	74.2
2	5.3	11	84.5
3	9.0	12	91.7
4	13.1	13	97.4
5	17.5	14	102.5
6	22.3	15	106.9
7	28.3	16	111.0
8	35.5	17	114.7
9	45.8	18	118.3

	Turbine only	Turbine + Heater
T_d	195	296
Hi ΔP	0.85	-
Lo ΔP	0.35	-
Ave ΔP	0.65	0.16
Static	-0.4	0.0

General Purpose Worksheet

Subject	Page No.	Of
File	By	Date 9-5-85

Atmospheric conditions from tower.

broach	10:00 AM	34.8°F	30.503 bar press	81% rel hum
turbine	4:30 PM	35.4°F	30.513	84% rel hum
supplementary	6:00PM	34°F	30.50	dewpt 31

10:00pm at FS1 = 33°F

PETRO
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APPENDIX E

QUALITY ASSURANCE

PETRO-CHEM ENVIRONMENTAL SERVICES

INSTRUMENT LINEARITY TEST

DATE: October 9, 1985

OPERATOR: A. Winkler

MANUFACTURER: Thermo-Electron

ANALYZER: CO

MODEL: 48

SERIAL #: 48-17394-169

CALIBRATION GASES: EPA Protocal 1

HIGH CONCENTRATION:

LOW CONCENTRATION: 64 ppm CO

DILUTION GAS: N_2 (zero grade)

INSTRUMENT RANGE: 0 - 100 ppm

INSTRUMENT MODE SETTING: 0 - 30 sec. time constant

GAS BLENDER SETTINGS:		INSTRUMENT RESULTS		
Blend Gas (L/Min)	Dilution Gas (L/Min)	Blended Value	Instrument Value	% Deviation
0.0	2.0	0	0	0.0
2.0	0.0	64	64	0.0
1.5	0.5	48	47	0.2
1.0	1.0	32	32	0.0
0.5	1.5	16	16	0.0
0.0	2.0	0	0	0.0
2.0	0.0	64	64	0.0

PETRO-CHEM ENVIRONMENTAL SERVICES

INSTRUMENT LINEARITY TEST

DATE: October 9, 1985

OPERATOR: A. Winkler

MANUFACTURER: Teledyne

ANALYZER: Oxygen

MODEL: 320 AX

SERIAL #: 90840

CALIBRATION GASES: EPA Protocal 1

HIGH CONCENTRATION:

LOW CONCENTRATION: 21 (ambient)

DILUTION GAS: N_2 (zero grade)

INSTRUMENT RANGE: 0 - 25%

INSTRUMENT MODE SETTING:

GAS BLENDER SETTINGS:		INSTRUMENT RESULTS		
Blend Gas (L/Min)	Dilution Gas (L/Min)	Blended Value	Instrument Value	% Deviation
0.0	2.0	0	0	0.0
2.0	0.0	21	21	0.0
1.5	0.5	15.7	15.5	1.0
1.0	1.0	10.5	10.7	0.8
0.5	1.5	5.2	5.2	0.0
0.0	2.0	0	0	0.0
2.0	0.0	21	21	0.0

PETRO-CHEM ENVIRONMENTAL SERVICES

INSTRUMENT LINEARITY TEST

DATE: October 9, 1985

OPERATOR: A. Winkler

MANUFACTURER: Thermo-Electron

ANALYZER: NOx

MODEL: 10

SERIAL #: 10A/R-17380-169

CALIBRATION GASES: EPA Protocal 1

HIGH CONCENTRATION:

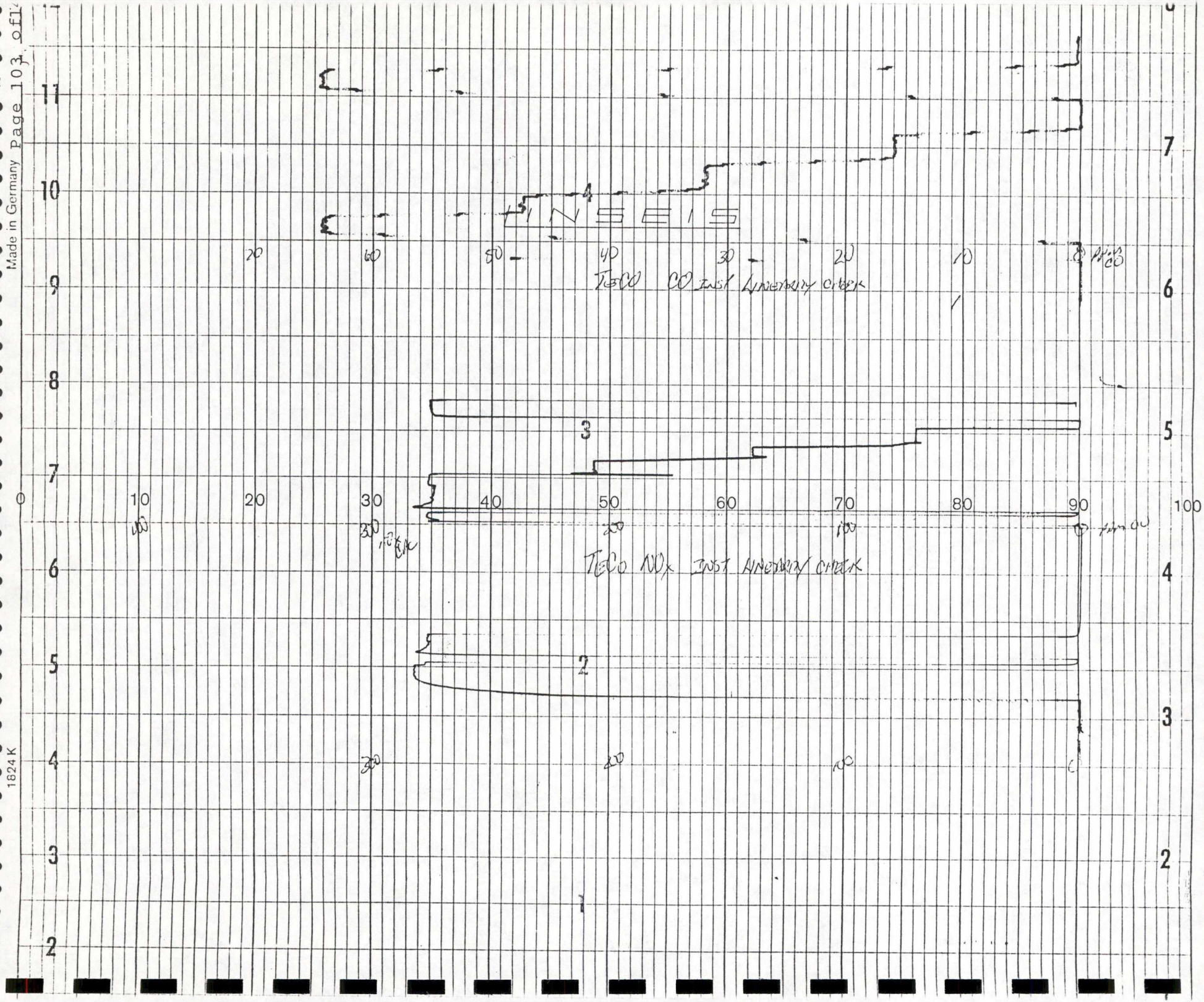
LOW CONCENTRATION: 277 ppm NOx

DILUTION GAS: N_2 (zero grade)

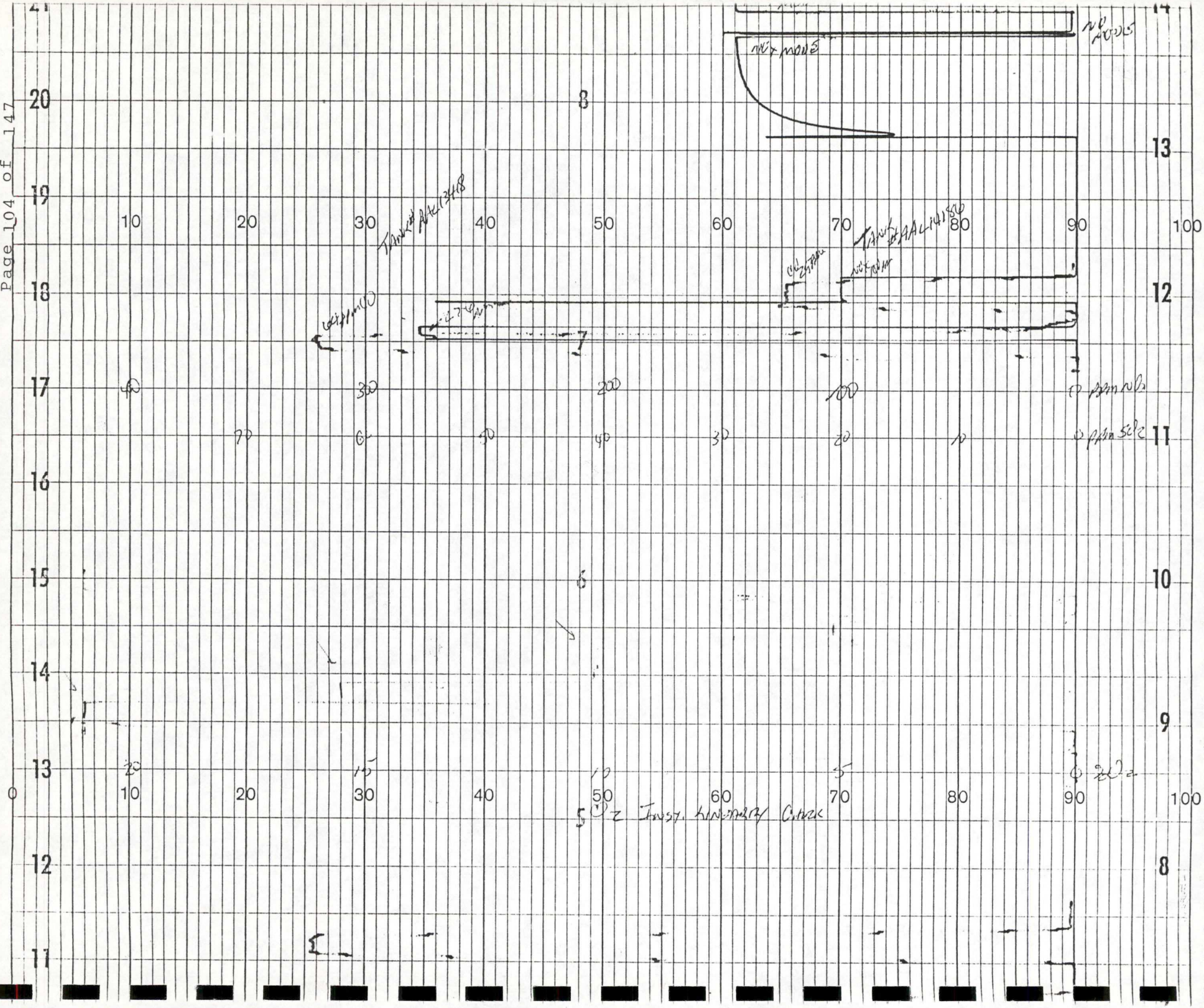
INSTRUMENT RANGE: 0 - 500 ppm

INSTRUMENT MODE SETTING: Converter temperature at 650°C, NOx

GAS BLENDER SETTINGS:		INSTRUMENT RESULTS		
Blend Gas (L/Min)	Dilution Gas (L/Min)	Blended Value	Instrument Value	% Deviation
0.0	2.0	0	0	0.0
2.0	0.0	277	277	0.0
1.5	0.5	208	207	0.2
1.0	1.0	138	138	0.0
0.5	1.5	69	70	0.2
0.0	2.0	0	0	0.0
2.0	0.0	277	276	0.0



Made in Germany Page 103 of 1
1824 K


NO MODE
NOx MODE
TANK # AAL1348
TANK # AAL14186
0 ppm NO2
0 ppm SO2
0 SO2
5 O2 INST. LINEARITY CHECK

INSTRUMENT AND CALIBRATION DATA

ANALYZER		RANGE	ZERO GAS	SPAN GAS
TYPE:	NO/NOx			
MANUFACTURER:	Thermo Electron	0-500	Ambient Air	99.94 1/
MODEL:	10			
SERIAL #:	10 A/R-17380-169			
TYPE:	O_2			
MANUFACTURER:	Teledyne	0-25%	N_2 1/	Ambient Air
MODEL:	320 AX			
SERIAL #:	90840			
TYPE:	CO			
MANUFACTURER:	Thermo Electron	0-100	Ambient Air	25.13 1/
MODEL:	48			
SERIAL #:	48-17394-169			

1/ Cylinder AAL-14186 (see certification data Appendix D)

Scott Specialty Gases

a division of Scott Environmental Technology, Inc.

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

PETRO CHEM ENV.
ATTN: JIM MARCHESINI
3207 ANTONINO
BAKERSFIELD, CA 93308

Date Shipped 9/27/85
Our Project No: 330404
Your P.O. No: VERBAL
Page 1 of 2

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES*

(Concentrations are in mole % or ppm)

Cylinder Number AAL-14186 Certified Accuracy ±1 % NBS Traceable Analysis Dates: First 9/18/85 Last 9/26/85

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
SULFUR DIOXIDE	22.66 ppm	3/26/86	ELECTROCHEMICAL	1694/1693	22.65 ppm	22.66 ppm
NITROGEN	BALANCE				22.62 ppm	22.66 ppm
					22.56 ppm	22.68 ppm

Cylinder Number AAL-14186 Certified Accuracy ±1 % NBS Traceable Analysis Dates: First 9/16/85 Last 9/23/85

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
NITRIC OXIDE	99.94 ppm	3/23/86	CHEMILUMINESCENCE	1684/1683	99.92 ppm	99.85 ppm
NITROGEN	BALANCE				99.42 ppm	99.99 ppm
					99.69 ppm	99.99 ppm

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

Analyst GREG WIM MER Approved By FRANCIS E. NEVILLE

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

Scott Specialty Gases a division of Scott Environmental Technology, Inc.
PLUMSTEADVILLE, PA. 18949 PHONE: 215-766-8861 TWX: 510-665-9344

PETRO CHEM
ATTN: JIM MARCHESINI

Date Shipped 9/27/85
Our Project No: 330404
Your P.O. No: VERBAL
Page 2 of 2

CERTIFICATE OF ANALYSIS – EPA PROTOCOL GASES*

(Concentrations are in mole % or ppm)

Cylinder Number AAL-14186 Certified Accuracy ±1 % NBS Traceable Analysis Dates: First 9/18/85 Last 9/26/85

COMPONENTS	CERTIFIED CONC	EXPIRATION DATE	ANALYTICAL PRINCIPLE	PRIMARY STANDARD NBS/SRM's	REPLICATE CONCENTRATIONS FIRST	SECOND
CARBON MONOXIDE	25.13 ppm	3/26/86	NDIR	1679c/2614	25.17 ppm	25.16 ppm
NITROGEN	BALANCE				25.04 ppm	25.12 ppm
					25.09 ppm	25.11 ppm

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 Greg Wimmer
GREG WIMMER

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

PETRO
CHEM
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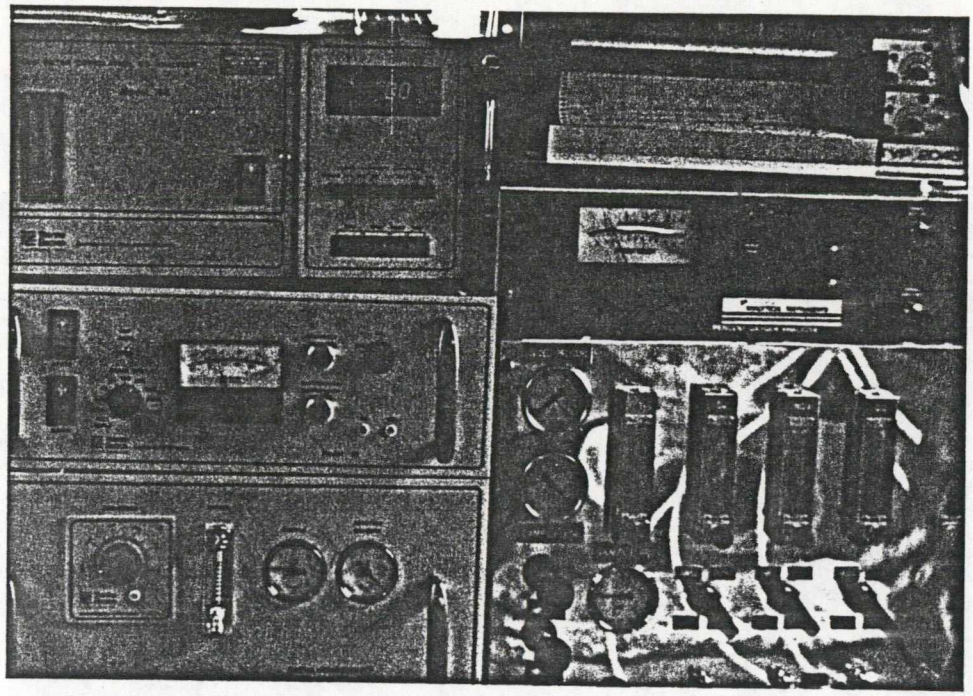
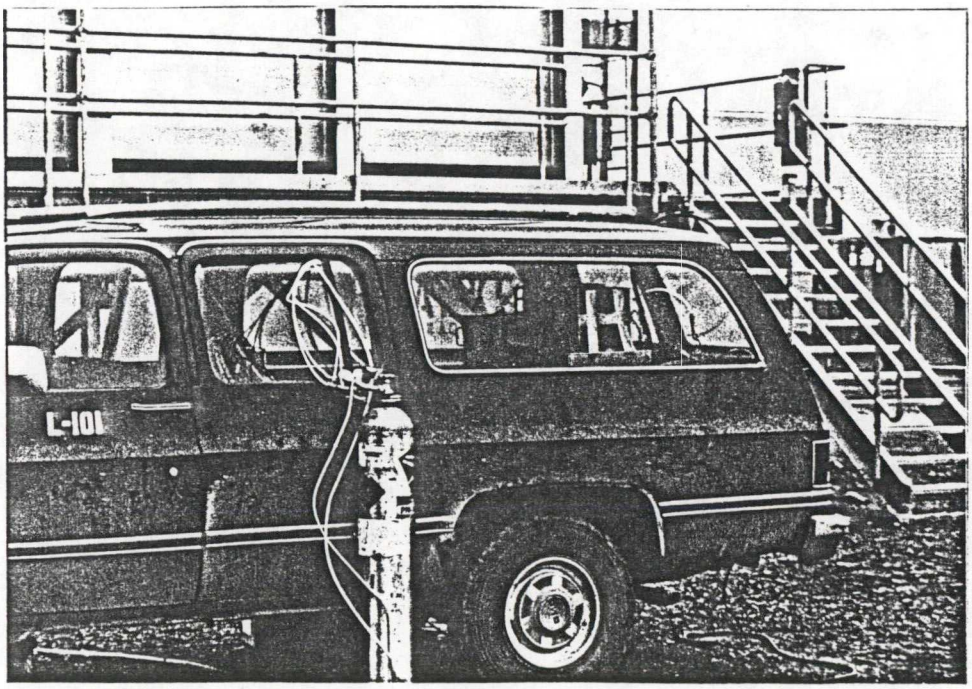
SERVICES

APPENDIX F

SITE PHOTOS

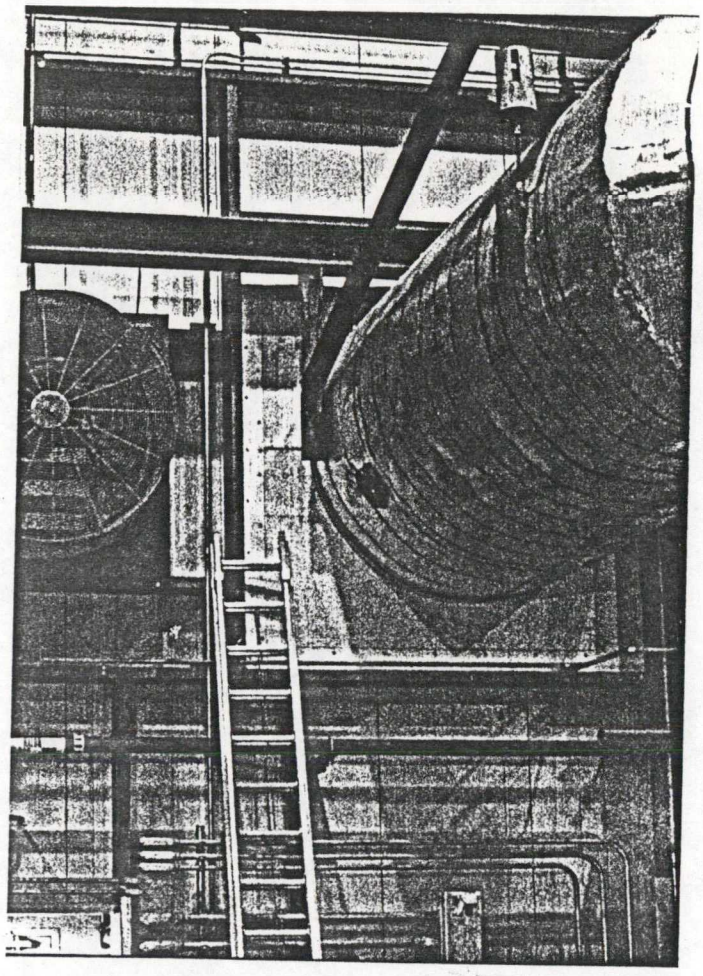


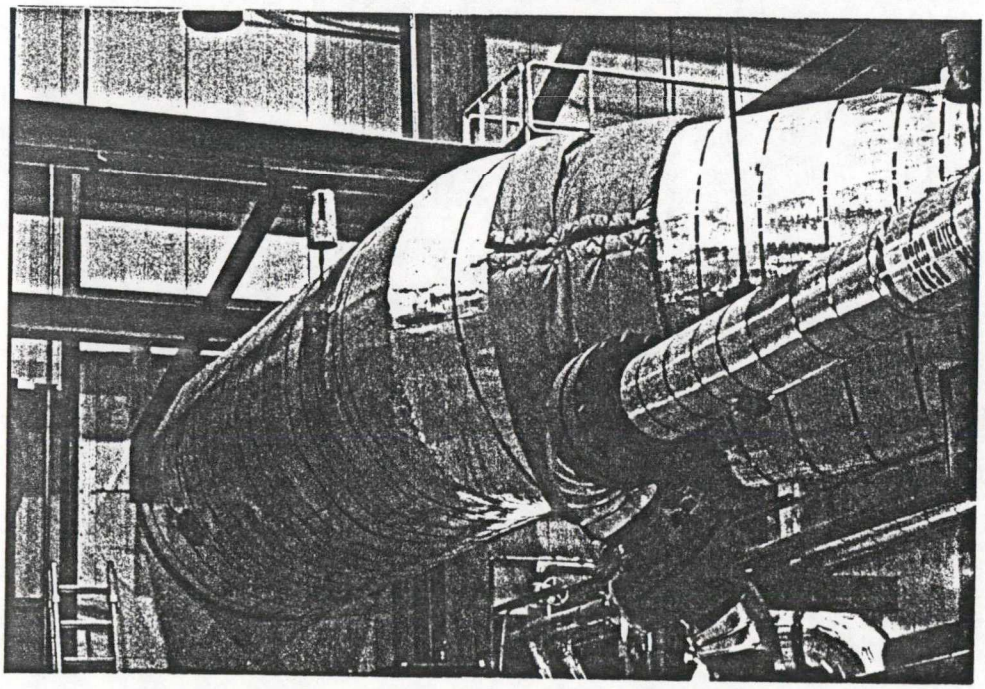
Instrument set-up



Instrument vehicle &calibration gases

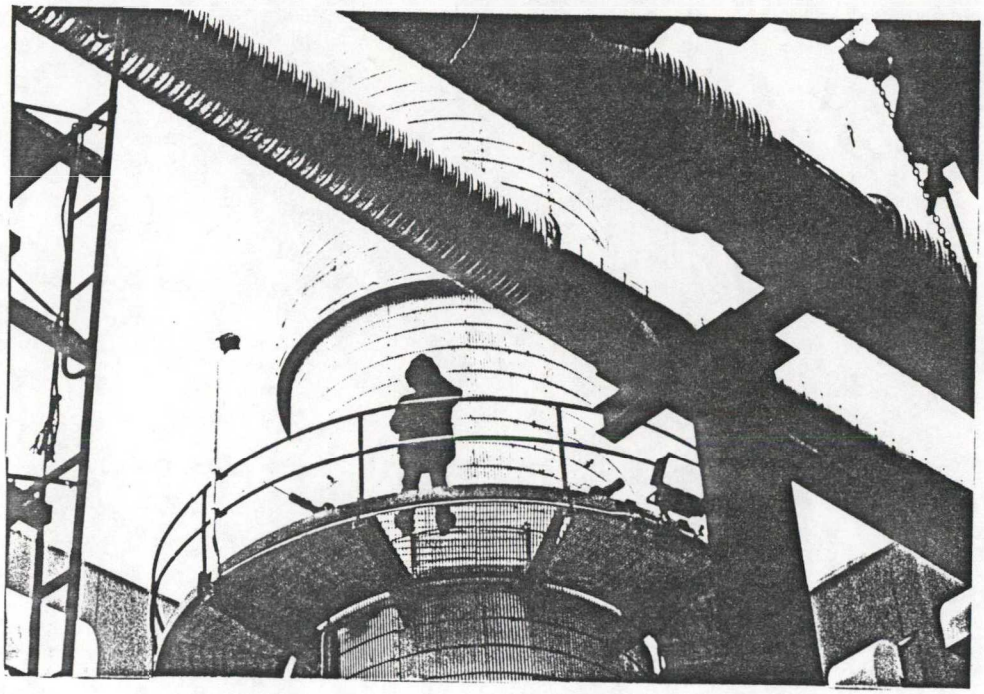
Sulzer Turbine Tag #408-TCP02-7704A

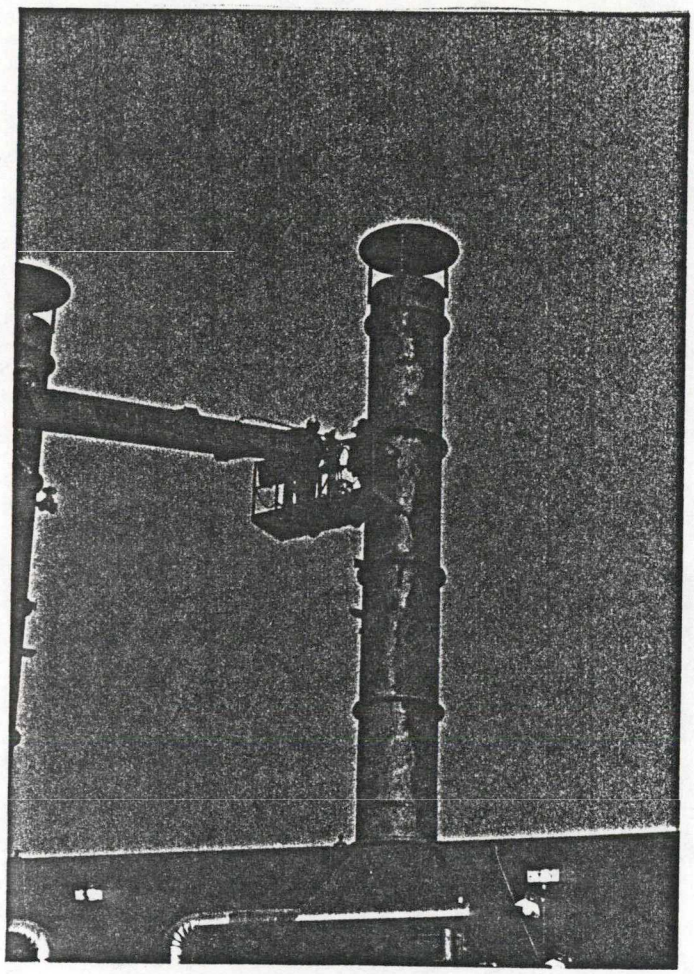




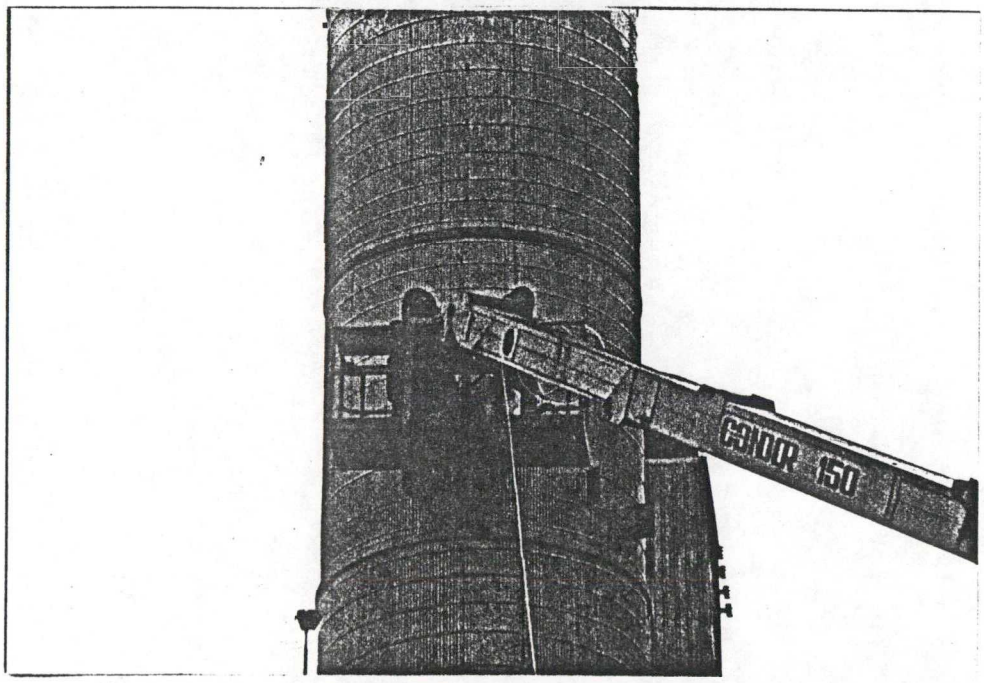
SOHIO ALASKA

West Side Waterflood Project





Broach Glycol Heater



Cooper Rolls Turbine & Supplementary Rired WHRU

PETRO
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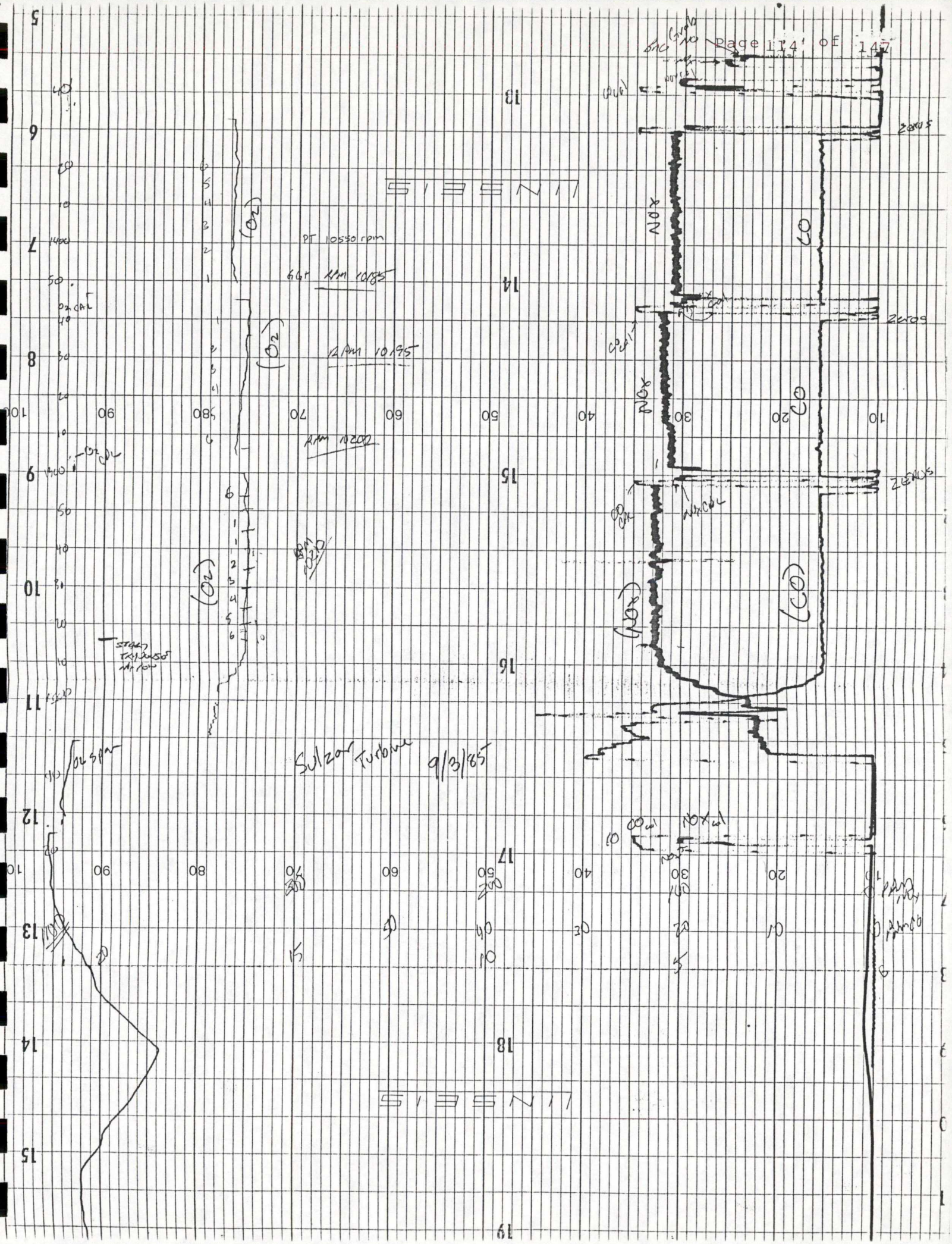
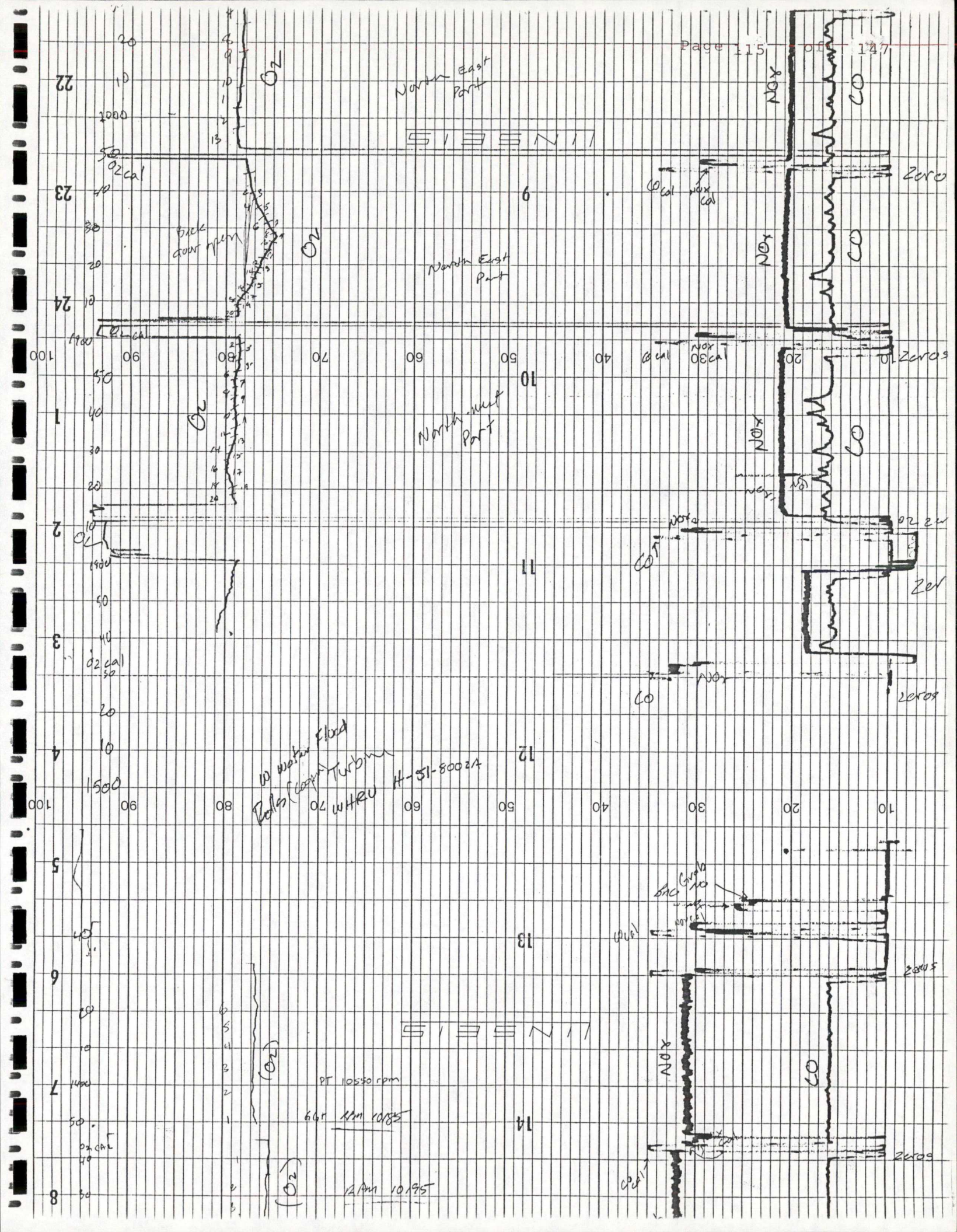
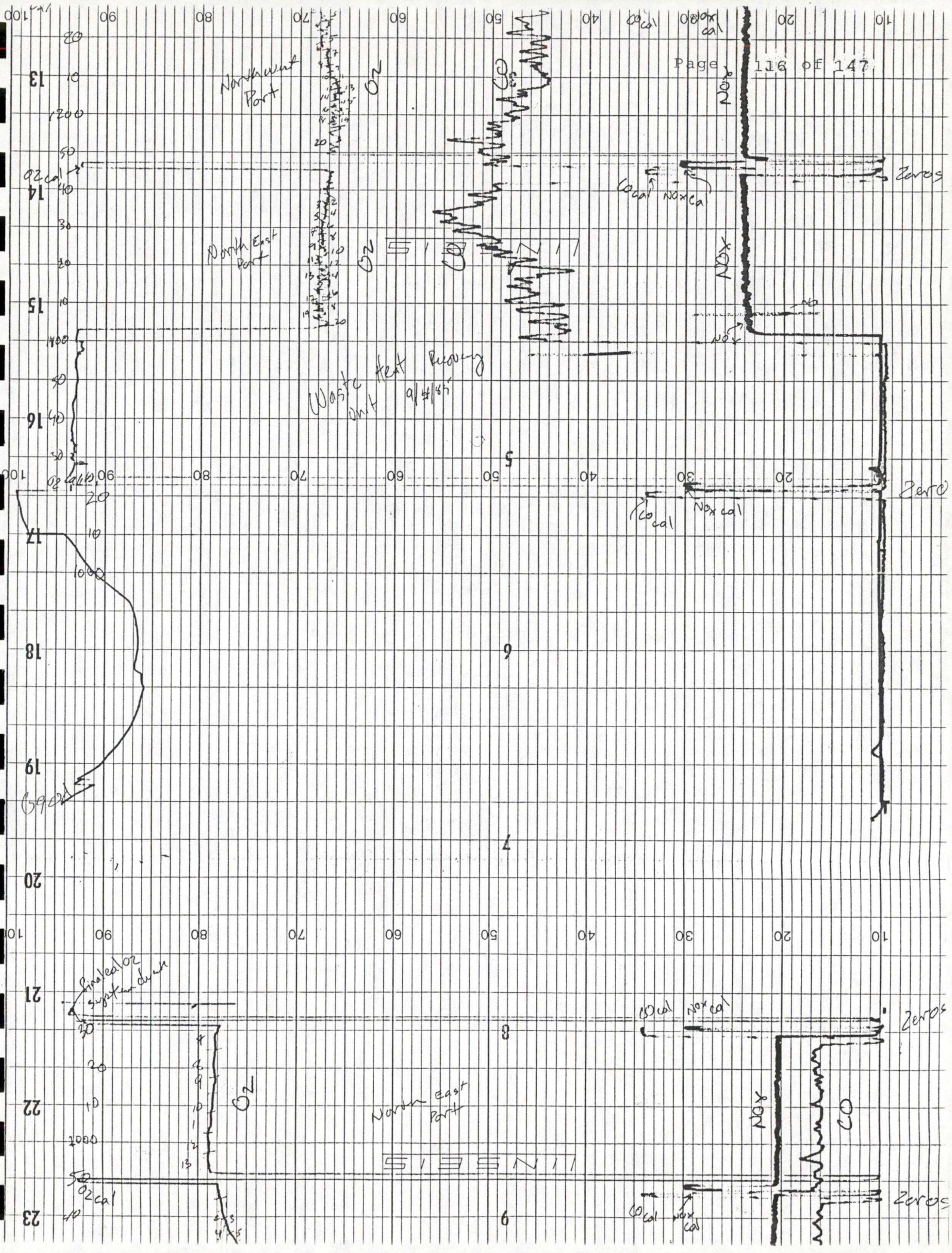
ENVIRONMENTAL
SERVICES

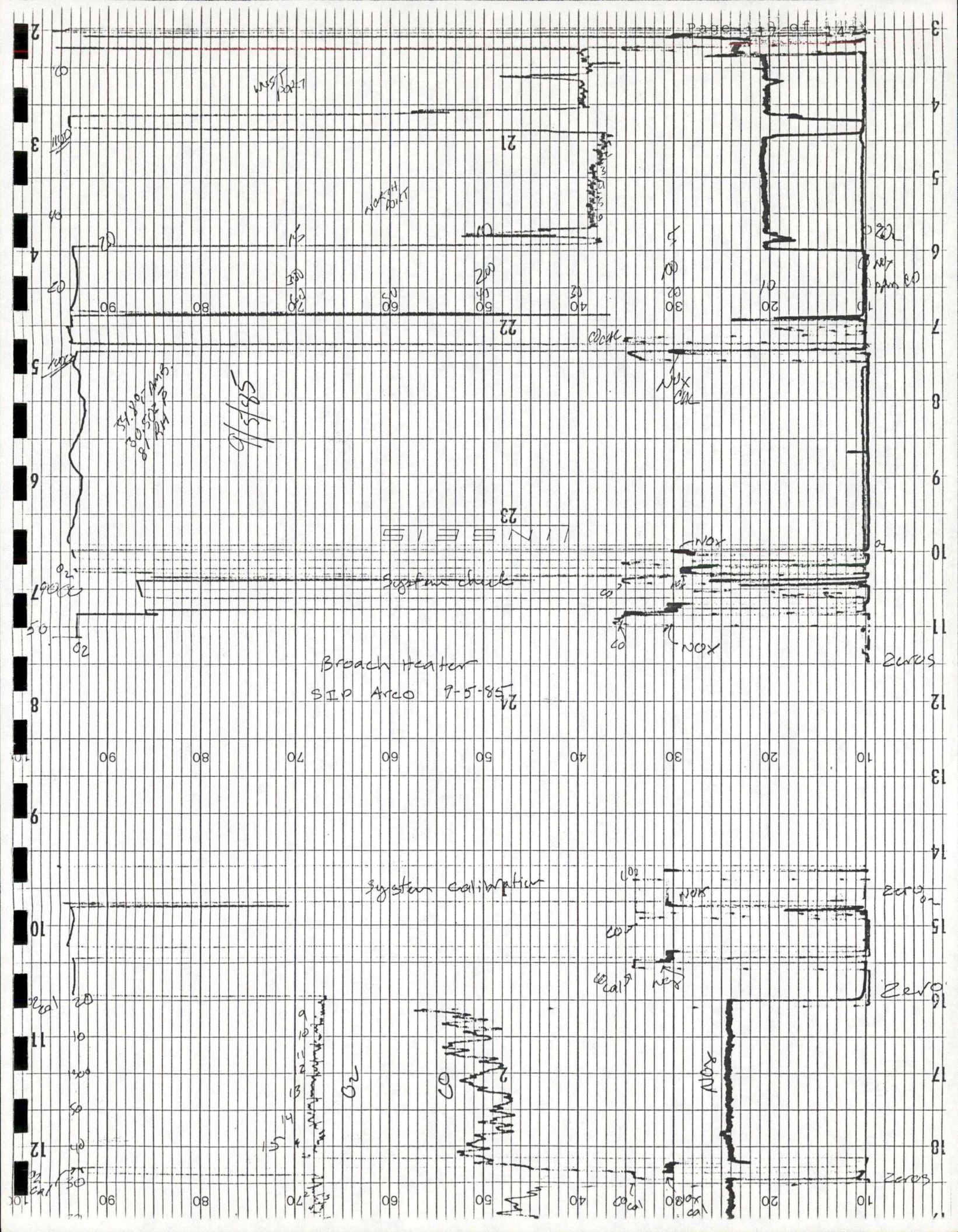
APPENDIX G

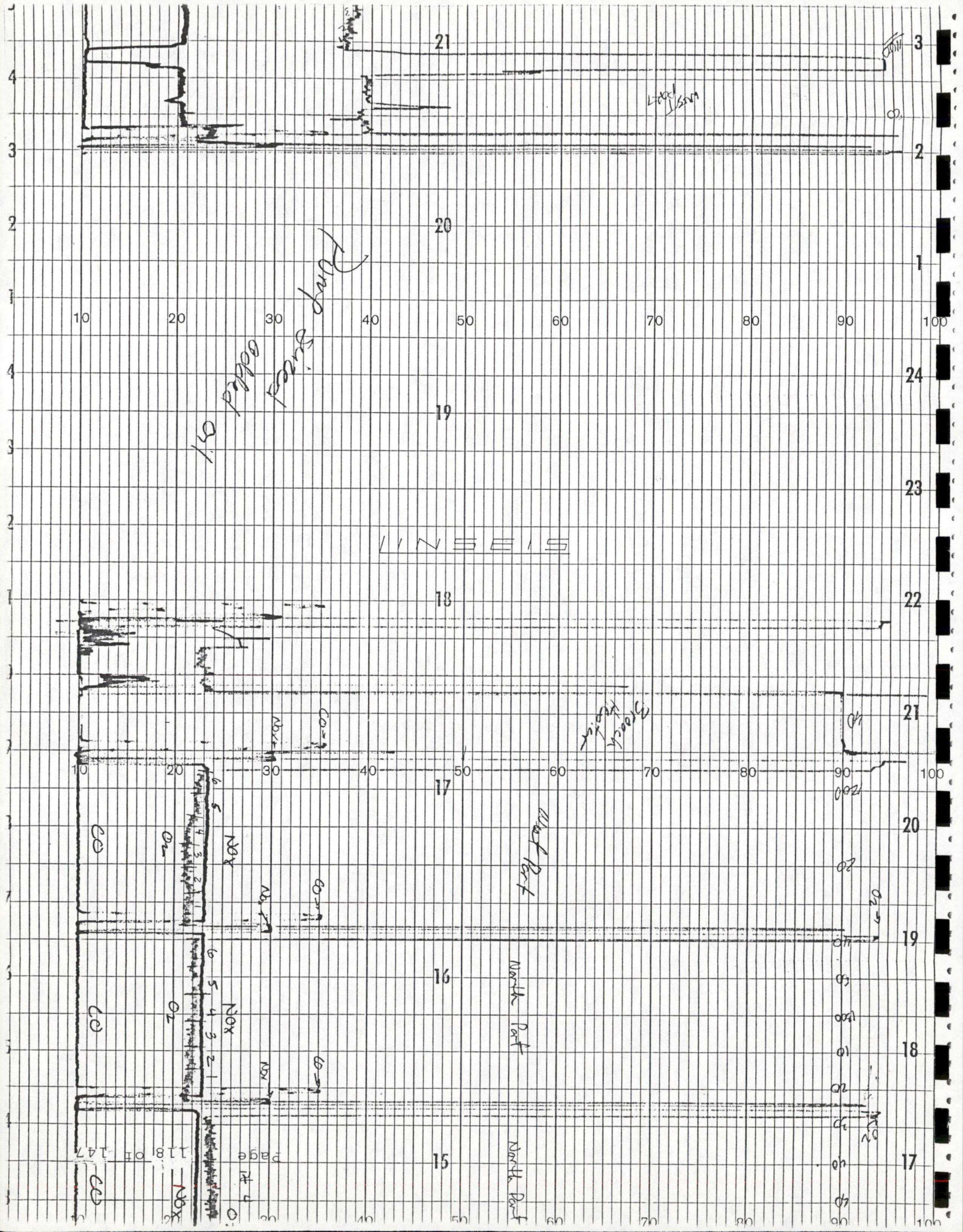
STRIP CHARTS


Sulzer Turbine 9/3/85
PT 10550 rpm
GGT RPM 10185
RPM 10195
RPM 10200
(O2)
(CO)
NOx
CO
ZEROS
O2 CAL
O2 span
NOx CAL
CO CAL
RPM NOx
RPM CO

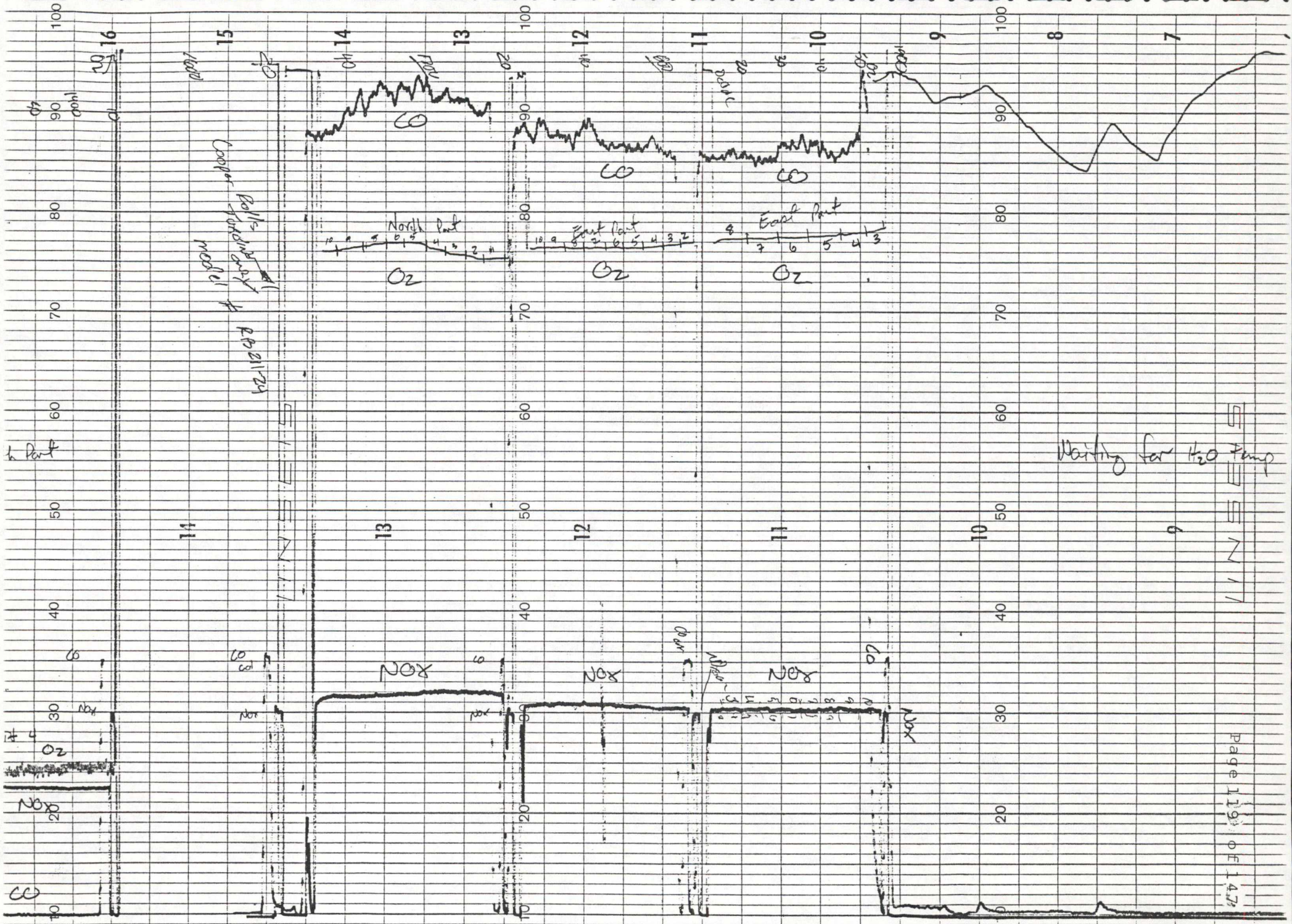

North East Part
North East Part
North-west Part
Back door open
O2
O2 cal
NOx
CO
Zero
Zeros
W water Flood
Rolls (Cooper) Turbine
WHRU H-51-8002A
PT 10550 rpm
GGT RPM 10185
RPM 10195
(O2)
Bnc Grab No
NOx cal
CO cal


Northwest Port
O2
CO
NOx
Zeros
CO cal
NOx cal
O2 cal
North East Port
Waste Heat Recovery Unit 9/4/97
Zero
Signal O2 system down
North East Port

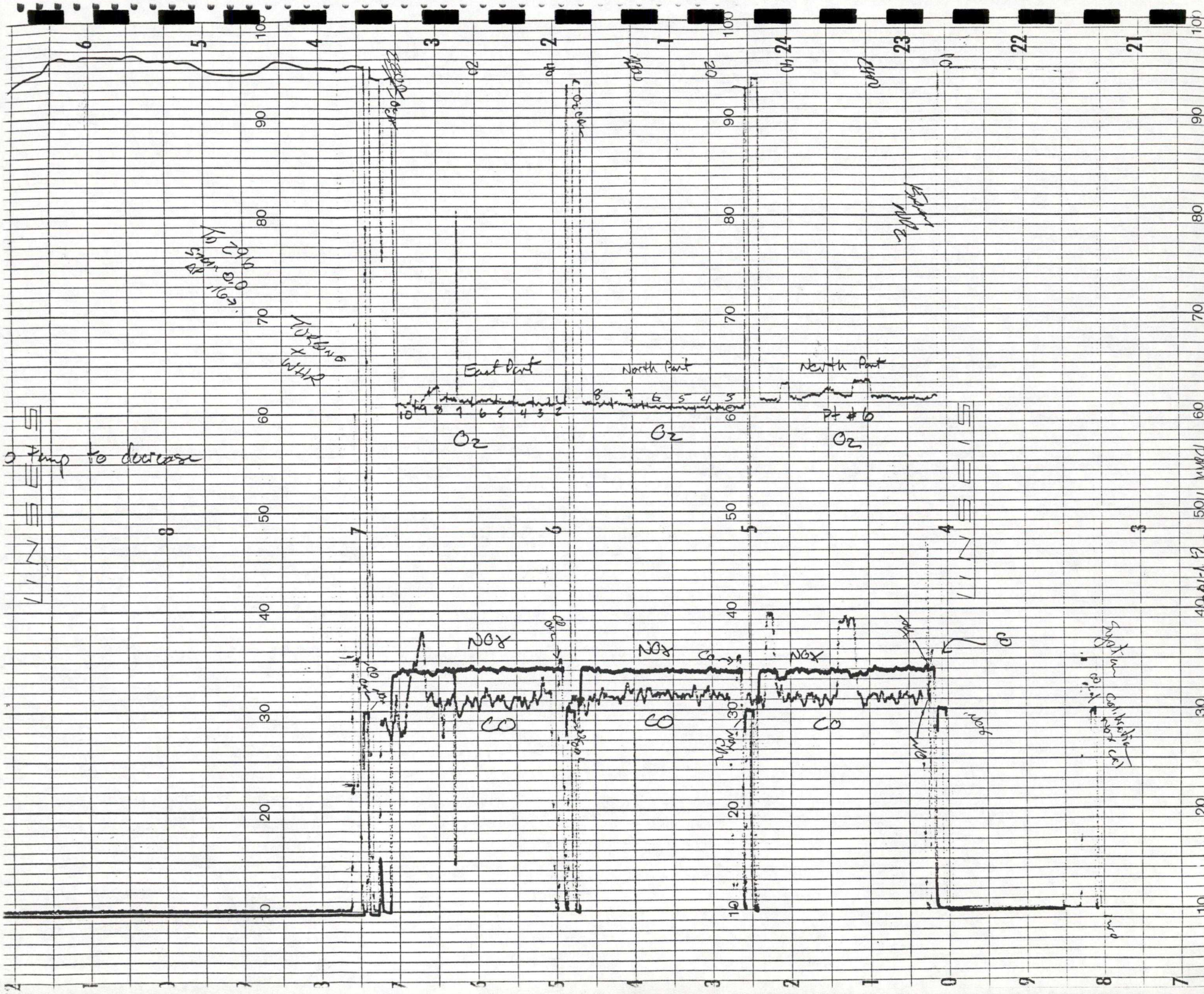

Broach Heater
SIP Arco 9-5-85
System check
System calibration
zeros
zero
NOx
CO
O2
9/5/85



Pump Sized added oil
LINSEIS
Mat Part
North Part
North Part
CO
O2
NOx
Page 118 of 147



Cooper Rolls Turbine
model # RB211-24
North Part
East Part
East Part
CO
O2
NOx
Waiting for H2O Temp



LINSEIS
LINSEIS
Bohn Heater G 1-140
East Port
North Port
North Port
Pt #6
O2
O2
O2
NOx
NOx
NOx
CO
CO
CO
Turbine x WHR
To 296 Stack 0.0 ΔP 1167
Temp to decrease

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APPENDIX H

RELATED CORRESPONDENCE

SOHIO ALASKA PETROLEUM COMPANY

900 EAST BENSON BOULEVARD
ANCHORAGE, ALASKA

TELEPHONE (907) 561-5111

P.O. BOX 6612
ANCHORAGE, ALASKA 99502-0612

September 23, 1985

Ms. Leslie Johnson
Petro Chem
P.O. Box 5126
3207 Antonio Avenue
Bakersfield, CA 93388

Re: 1985 Prudhoe Bay Unit Stack Testing

Dear Leslie:

I have attached the process equipment descriptions, the fuel gas analysis report and the emission limitations for the Western Operating Area units.

The emission limitations per the EPA PERMITS PSD-X80-09 & PSD X81-01 and ADEC PERMITS AQC 8436-AA007 (for GC-2) and AQC 8536-AA003 (for SIPW) are as follows:

Gas Turbines	NO_x	150 (14.4/Y) ppm*
	CO	109 lb/10^6 scf (fuel)
Heaters	NO_x	0.08 lb/10^6 Btu
	CO	0.018 lb/10^6 Btu NO

*NO_x emissions factor for gas-fired turbines is modified by an efficiency factor (Y) which cannot exceed 14.4 Kilojoules/watt hour (manufacture's rated heat at rated peak load). Based on 15% oxygen on a dry basis.

Please contact me if you need any other informtion.

Sincerely,

Lynn Billington

Lynn Billington
Environmental Engineer

5071V/LMB

Attachment

cc: D. Dias w/o

ARCO Alaska, Inc.
Post Office Box 100360
Anchorage, Alaska 99510
Telephone 907 276 1215

September 12, 1985

Ms. Leslie Johnson
Petro Chem
P.O. Box 5126
3207 Antonio Avenue
Bakersfield, CA 93388

SUBJECT: 1985 Stack Testing

Dear Leslie:

Attached you will find the process descriptions for the Prudhoe SIP equipment and the Kuparuk heater. Also included are the fuel analysis results.

In regard to the applicable emission limitations, they are as follows:

PRUDHOE (per EPA Permit #PSD-X81-01)

Turbines:	NO_x	= 150 (14.4/Y) ppm @ 15% O_2
	CO	= 109 lb/10^6 scf (fuel)
	Opacity	= 10%
Heaters:	NO_x	= 0.08 lb/10^6 BTU
	CO	= 0.018 lb/10^6 BTU
	Opacity	= 5%

(We intend to request from ADEC a single emission limitation for the combined cycle unit rather than independent limits on turbine and on WHRU).

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APPENDIX I

RESUME OF QUALIFICATIONS

LESLIE A. JOHNSON — Resume' of Qualifications

EDUCATION:

1974-1978	California Polytechnic State University San Luis Obispo, CA School of Natural Resource Management B.S. Environmental Science/Natural Resource Management

WORK EXPERIENCE:

August 1980 to December 1984	Chemecology Corporation 18823 Porterville Highway Bakersfield, CA 93308
January 1985 to Present	Petro-Chem Environmental Services 3207 Antonino Avenue Bakersfield, CA 93308

JOB CLASSIFICATION:

Project Supervisor/Air Quality Consultant/Division Manager

Job Description: Ms. Johnson has had extensive experience in field source testing, technical report writing and administrative organization of a source testing company. She has compiled approximately 250 technical reports for both engineering and compliance testing for EPA regions IX and X, CARB, Kern County APCD, South Coast AQMD, Bay Area APCD, and other California Agencies.

The job requirements include bidding, test supervision, and report compilation while maintaining an intimate contact with the client and regulatory agency. In order to insure proper testing methodoligy and report documentation. Ms. Johnson's out-of-state testing experience includes Prudoe Bay-Alaska, Hawaii, and the Netherlands.

Specific areas of expertise include EPA reference methods 1-8, continuous instrument sampling, analytical chemistry, personnel training and business management.

LESLIE A. JOHNSON — Resume' of Qualifications

EDUCATION:

1974-1978	California Polytechnic State University San Luis Obispo, CA School of Natural Resource Management B.S. Environmental Science/Natural Resource Management

WORK EXPERIENCE:

August 1980 to December 1984	Chemecology Corporation 18823 Porterville Highway Bakersfield, CA 93308
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The job requirements include bidding, test supervision, and report compilation while maintaining an intimate contact with the client and regulatory agency. In order to insure proper testing methodoligy and report documentation. Ms. Johnson's out-of-state testing experience includes Prudoe Bay-Alaska, Hawaii, and the Netherlands.

Specific areas of expertise include EPA reference methods 1-8, continuous instrument sampling, analytical chemistry, personnel training and business management.

ANDY WINKLER — Resume' of Qualifications

EDUCATION:

1974-1976	Bakersfield Junior College Bakersfield, California Concentration: General Education
1977-1980	Chico State University Chico, California School of Agriculture B.S. Agriculture Concentration: Range Management, Plant & Soil Science

WORK EXPERIENCE:

August 1980 to January 1985	Chemecology Corporation of Bakersfield 18823 Porterville Highway Bakersfield, CA 93308
January 1985 to Present	Petro-Chem Environmental Services 3207 Antonino Avenue Bakersfield, CA 93308

JOB CLASSIFICATION:

Source Test Team Leader/Air Quality Specialist

Job Responsibilities- Supervision of test teams during both compliance and engineering testing. Mr. Winkler has worked closely with clients from initial contact to the review of final reports. Since 1980 he has compiled and written approximately 150 reports for such agencies as: Environmental Protection Agency - Region IX and X, Kern County APCD, Monterey Bay Unified APCD, Fresno County APCD, Santa Barbara County APCD, and South Coast APCD.

Specific areas of expertise include: Extensive testing with continuous instruments, EPA reference method source sampling, analytical chemistry, equipment calibration and personnel training in continuous instruments, instrument manifold fabrication, and field sampling techniques. Some of Mr. Winkler's testing areas include Coopers Engineering-Germany, Sun Production, Texaco Inc., and extensive testing in the Prudoe Bay Area for both Sohio Alaska and Arco Alaska Companies.

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APPENDIX J

FLOW METER CALIBRATION DATA

SOHIO CONSTRUCTION COMPANY

SOHIO

TRANSMITTER/INDICATOR CALIBRATION RECORD

INSTRUMENT TAG No. FT-51-9595 MANUFACTURER ROSEMOUNT

MODEL No. 115-1HP5E22B1 SERIAL No. 444636

MOD. 304

TEST EQUIPMENT	MODEL No.	SERIAL No.
ROSEMOUNT FIELD CALIBRATOR	262	12709
AMETEK E/P CALIBATOR	93 CP	33922-1-1

0-200 INPUTS IN H2O		4-20 OUTPUTS MA		
%	VALUE	DESIRED	AS FOUND	AS LEFT
0	0.00	4.00 MA	4.05 MA	4.00 MA
25	50	8.00	8.01	7.98
50	100	12.00	11.99	11.98
75	150	16.00	15.99	15.98
100	200	20.00	20.01	20.00
75	150	16.00	16.01	15.99
50	100	12.00	12.01	11.98
25	50	8.00	8.03	7.98
0	0.00	0.00	4.07	4.00

MANUFACTURER'S ACCURACY .25 %

SPEC. No.

SPEC. CHECK

DATE

BURNOUT

The instruments listed above have been checked & calibrated & have been found to perform satisfactorily.

WITNESSED BY

SCC [signature]

S/C [signature]

DATE 1-25-84

REMARKS

SOHIO CONSTRUCTION COMPANY

SOHIO

TRANSMITTER/INDICATOR CALIBRATION RECORD

130

INSTRUMENT TAG No. FT-51-9596 MANUFACTURER ROSEMOUNT

MODEL No. 115 1HP5E22B1 SERIAL No. 444637

MOD. 304

TEST EQUIPMENT	MODEL No.	SERIAL No.
ROSEMOUNT FIELD CALIBRATOR	262	12709
AMETEK E/P CALIBATOR	93CP	33922-1-1

0-200 INPUTS IN H2O 4-20 OUTPUTS MA

%	VALUE	DESIRED	AS FOUND	AS LEFT
0	0.00 IN H2O	4.00 MA	4.03 MA	4.00 MA
25	50	8.00	7.98	7.99
50	100	12.00	11.95	11.99
75	150	16.00	15.90	15.99
100	200	20.00	19.93	20.00
75	150	16.00	15.93	15.99
50	100	12.00	11.95	11.98
25	50	8.00	7.99	7.99
0	0.00	0.00	4.03	4.00

MANUFACTURER'S ACCURACY .25 %

SPEC. No.

SPEC. CHECK

DATE

BURNOUT

The instruments listed above have been checked & calibrated & have been found to perform satisfactorily.

WITNESSED BY

SCC R.C. Saunders

S/C Jerry Johnson

DATE 1-25-84

REMARKS

SOHIO CONSTRUCTION COMPANY

SOHIO

TRANSMITTER/INDICATOR CALIBRATION RECORD

INSTRUMENT TAG No. FT-51-7862 MANUFACTURER ROSEMOUNT

MODEL No. 115 1HP5E22B1 SERIAL No. 444634

MOD. 304

TEST EQUIPMENT	MODEL No.	SERIAL No.
ROSEMOUNT FIELD CALIBRATOR	262	12709
AMETEK E/P CALIBATOR	93CP	33922-1-1

0-200 INPUTS IN H2O		4-20 OUTPUTS MA		
%	VALUE	DESIRED	AS FOUND	AS LEFT
0	0.00	4.00 MA	4.02 MA	4.00 MA
25	50	8.00	7.99	7.98
50	100	12.00	11.97	11.98
75	150	16.00	15.98	15.98
100	200	20.00	19.97	20.00
75	150	16.00	15.98	15.99
50	100	12.00	11.98	11.98
25	50	8.00	7.99	7.98
0	0.00	0.00	4.01	4.00

MANUFACTURER'S ACCURACY .25 %

SPEC. No.

SPEC. CHECK

DATE

SURNOUT

The instruments listed above have been checked & calibrated & have been found to perform satisfactorily.

WITNESSED BY

SCC [illegible]

S/C Jerry [illegible]

DATE 01-25-84

EMARKS

SOHIO CONSTRUCTION COMPANY

SOHIO

TRANSMITTER/INDICATOR CALIBRATION RECORD

INSTRUMENT TAG No. FT-51-7863 MANUFACTURER ROSEMOUNT

MODEL No. 115 11AP5E22B1 SERIAL No. 444635

MOD. 304

TEST EQUIPMENT	MODEL No.	SERIAL No.
ROSEMOUNT FIELD CALIBRATOR	262	12709
AMETEK E/P CALIBATOR	93 CP	33922-1-1

0-200 INPUTS IN H2O 4-20 OUTPUTS MA

%	VALUE	DESIRED	AS FOUND	AS LEFT
0	0.00	4.00 MA	4.01 MA	4.00 MA
25	50	8.00	7.96	7.98
50	100	12.00	11.96	11.98
75	150	16.00	15.96	15.99
100	200	20.00	19.97	20.00
75	150	16.00	15.96	15.99
50	100	12.00	11.96	11.98
25	50	8.00	7.97	7.98
0	0.00 Y	0.00 Y	4.01 Y	4.00 Y

MANUFACTURER'S ACCURACY .25 %

SPEC. No.

SPEC. CHECK

DATE

BURNOUT

The Instruments listed above have been checked & calibrated & have been found to perform satisfactorily.

WITNESSED BY

SCC G C Knudsen

S/C Jerry Nelson

DATE 1-25-84

REMARKS

REQUISITION NO. _____ VENDOR F RY

	ORIFICE PLATE		ORIFICE FLANGE
1	Concentric: ☒ Other	7	Taps: Flange ☒ Pipe ☐ Other
2	Make to ASME Standard ☒ Other	8	Rating & Facing 300# RFSF
3	Plate Material: 316 SS ☒ Other	9	Type: Weld Neck ☒ Other
4	RTJ Ring Matl & Type	10	Material: Steel ☒ Other
5	Bore Maximum Rate ☒ Nearest 1/8 in. ☐	11	Tap Size 1/2 in. NPT ☒ Other
6	Stamp to ISA Standard ☒ Other	12	Flanges by Mat'l Control ☒ ☐

13	Tag Number			FE-51-7862		FE-51-7863				
14	Item Number									
15	Service			IPMPB TURB FG FLOW		IPMPA TURB FG FLOW				
16	Line No.			51-1130-J-3"		51-1138-J-3"				
17	P&ID No. ~~Section~~ MODULE			PI-51-WP0005-4/304		PI-51-WP0005-6/304				
	SERVICE CONDITIONS									
18	Fluid			FUEL GAS		FUEL GAS				
19	Flow Units			SCFH		SCFH				
20	Full Scale Flow	Opr	Base		400,000		400,000			
21	Norm Flow	Opr	Base		296,242		296,242			
22	Press (psia)	Opr	Base	542	14.7	542	14.7			
23	Barometric Pressure (psia)			14.7		14.7				
24	Temperature °F	Opr	Base	80	60	80	60			
25	sp gr @ 60° F & Base Press			0.79		0.79				
26	sp gr @ Opr Conditions			—		—				
27	Supercomp Factor @ Opr Press			—		—				
28	Vapor, Gas Mol. Wt.			22.8		22.8				
29	Viscosity @ Opr Temp (cp)			0.012		0.012				
30	Steam Qual	Superheat °F		—	—	—	—			
31	Weep Hole Required			—		—				
32	Viscosity Correction (Fc)			—		—				
33	Liquid Compressibility Factor (Fp)			—		—				
34	Density (lbs/ft3)	Opr	Base	—	—	—	—			
35	Compressibility	Opr	Base	0.74	—	0.74	—			
36	Cp/Cv			—		—				
37	Specific Volume (ft3/lb)			—		—				
	MEASURING STATION DATA									
38	Actual Orifice ID in.			*		*				
39	Line Flange ID in.			3.068"		3.068"				
40	Orifice Plate Thickness in.			1/8"		1/8"				
41	Seal sp gr @ 60° F			—						
42	Meter Type			D/P DIAPHRAGM		D/P DIAPHRAGM				
43	Diff Range in H_2O Dry			200"		200"				
44	Static Range psia			—		—				
45	Chart or Scale Range			—		—				
46	Chart Multiplier (C)			—		—				
47	Beta Ratio d/D			*		*				
48	Manometer Correction (Fm)			—		—				
49	Flow Equals			—		—				
50	Line:	Size	Sched	3"	40	3"	40			

Notes:

1. Volume rates of flow are expressed at 60° F for liquids and on base conditions for gases and vapors.
2. Vents and drains (weep holes) when specified shall conform to ¶20 (i) of the ASME "Flow Measurement" Chap 4, PTC 19.5; 4-1959
3. "F" equals flow pen reading; "P" equals static pressure pen reading.
4. * BY VENDOR

OT-1810

RMP SPECIFICATION	ORIFICE PLATES	SHEET 121	JOB NUMBER 6095

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REQUISITION NO. _____ VENDOR PE

ORIFICE PLATE		ORIFICE FLANGE	
1	Concentric: ☒ Other _____	7	Taps: Flange ☒ Pipe ☐ Other _____
2	Make to ASME Standard ☒ Other _____	8	Rating & Facing 300# RFSF
3	Plate Material: 316 SS ☒ Other _____	9	Type: Weld Neck ☒ Other _____
4	RTJ Ring Matl & Type _____	10	Material: Steel ☒ Other _____
5	Bore Maximum Rate ☒ Nearest 1/8 in. ☐	11	Tap Size 1/2 in. NPT ☒ Other _____
6	Stamp to ISA Standard ☒ Other _____	12	Flanges by Mat'l Control ☒ _____ ☐

13	Tag Number			FE-51-9595		FE-51-9596						
14	Item Number											
15	Service			WHRU-A FUEL GAS FLOW		WHRU-B FUEL GAS FLOW						
16	Line No.			51-1140-H-6"		51-1141-H-6"						
17	P&ID No./~~Section~~ MODULE			1 PI-51-WP0010-4/304		PI-51-WP0010-7/304						
	SERVICE CONDITIONS											
18	Fluid			FUEL GAS		FUEL GAS						
19	Flow Units			SCFH		SCFH						
20	Full Scale Flow	Opr	Base		500,000		500,000					
21	Norm Flow	Opr	Base		320,000		320,000					
22	Press (psia)	Opr	Base	65	14.7	65	14.7					
23	Barometric Pressure (psia)			14.7		14.7						
24	Temperature °F	Opr	Base	105	60	105	60					
25	sp gr @ 60° F & Base Press			.79		.79						
26	sp gr @ Opr Conditions			.79		.79						
27	Supercomp Factor @ Opr Press			—		—						
28	Vapor, Gas Mol. Wt.			22.93		22.93						
29	Viscosity @ Opr Temp		(cp)	0.010		0.010						
30	Steam Qual		Superheat °F	—	—	—	—					
31	Weep Hole Required			—		—						
32	Viscosity Correction (Fc)			—		—						
33	Liquid Compressibility Factor		(Fp)	—		—						
34	Density (lbs/ft3)	Opr	Base	—	—	—	—					
35	Compressibility	Opr	Base	—	—	—	—					
36	Cp/Cv			—		—						
37	Specific Volume (ft3/lb)			—		—						
	MEASURING STATION DATA											
38	Actual Orifice ID in.			*		*						
39	Line Flange ID in.			6.065"		6.065"						
40	Orifice Plate Thickness in.			1/8"		1/8"						
41	Seal sp gr @ 60° F			—		—						
42	Meter Type			D/P DIAPHRAGM		D/P DIAPHRAGM						
43	Diff Range in H_2O Dry			200"		200"						
44	Static Range psia			—		—						
45	Chart or Scale Range			—		—						
46	Chart Multiplier		(C)	—		—						
47	Beta Ratio d/D			*		*						
48	Manometer Correction		(Fm)	—		—						
49	Flow Equals			—		—						
50	Line:	Size	Sched	6"	40	6"	40					

Notes:

1. Volume rates of flow are expressed at 60° F for liquids and on base conditions for gases and vapors.
2. Vents and drains (weep holes) when specified shall conform to ¶20 (i) of the ASME "Flow Measurement" Chap 4, PTC 19.5; 4-1959
3. "F" equals flow pen reading; "P" equals static pressure pen reading.
4. * BY VENDOR

RMP SPECIFICATION	ORIFICE PLATES	SHEET 1 of 1	JOB NUMBER 6095
		DOCUMENT NUMBER	REV

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REPAIR JOB ORDER R42901 FOR WEEK 32
PRIORITY: 1

LOC: GATHERING CENTER #2
TRAIN: DISTRIBUTED CONTROL SYSTEM
RESP GROUP: INSTR., GENERAL

ORIGINATED: 08/14/85
STATUS CODE: 2CM
STATUS DATE: 08/21/85

****
CHARGE CODE
* K21070 *
****

FI 027546
(FI 027546)
M/M 247120

DESC: FLOW INDICATOR
MANF: EMC
MODL: DCS
SERV: LTS FUEL GAS TO P 7704A

CRITICALITY:
SKID: 407

DRAWING NO: *IL03FA37222

FI 027545
(FI 027545)
M/M 247120

DESC: FLOW INDICATOR
MANF: EMC
MODL: DCS
SERV: LTS FUEL GAS TO P 7704B

CRITICALITY:
SKID: 407

DRAWING NO: *IL03FA37221

INIT/DATE	TASK	INSTRUCTIONS	GROUP	TECHS
----------	01	PLEASE CALIBRATE BOTH FUEL GAS METERS ON GT-7704A AND B, UPCOMING ENVIRONMENTAL TEST.	IG	1/ 6.0

NOTE: THIS JOB REQUEST REPLACES R42894.

FEEDBACK INFORMATION

HOURS: IG	MCBRIDE	27.3	----------	6.0

GROUP	NAME	SOHIO HRS	CONTRACT HRS	SCHEDULED HRS

ORIGINATOR: F WEISE (RR/SL) AUTHORIZER: J PRATT
NOTIFY: FAC. SUPER UPON: COMP.

REMARKS: 814 WOULD NOT SPAN OVER 10-12 MA. CHANGED CORSE SPAN ADJUSTMENT STILL WOULD NOT SPAN OUT. ORDERED PARTS FROM STORES. (S PIGGOTT)
GETTING PARTS. (C STRZELEWICZ)
8/17/85 - REPLACED CARDS IN BOTH TRANSMITTERS, CALIBRATED AND ADJUSTED 0-100"/4-20 MA. JOB COMPLETED.

FAIL# COMMENTS

COST CODE: A20860 CHARGE CODE: K21070 ACCEPTED BY: R HAMMACK (KM)

FT-51-9595	0-200 "WC
FOUND	LEFT
0 % 3,987	4.00
25 % 8.604	8.00
50 % 12.137	11.99
75 % 16.214	15.99
100 % 20.28	20.00

FT-51-9596	0-200 "WC
FOUND	LEFT
0 % 3.99	4.00
25 % 7.954	7.99
50 % 11.901	11.99
75 % 15.849	15.99
100 % 19.787	19.99

PAGE 1-2

Turbine A

	Found	Left
FT-51-7862		
0	4.024	4.00
25%	8.060	8.022
50%	12.073	12.016
75%	16.096	16.017
100%	20.11	2.00

FT-51-7863		
0	3.993	4.00
25%	8.007	8.00
50%	12.030	11.99
75%	16.076	15.99
100%	20.05	19.99

COMPLETED 9-2-85
Melvin H. McLaughlin
Roger E. Banning

PAGE 2-2

BROACH HEATER - SIPE

09-05-85 1833 METER ORIFICE FLOW RATE CALCULATION (MT55)

FS1 RESIDUE GAS TO SIP (154) VOL CAL# 181701 GFC OR EST# 181719

METER TYPE IS FLANGE TAP WITH UPSTREAM READING

ORIFICE DIAMETER	=*	2.2240	INCHES
PIPE DIAMETER	=*	4.0260	INCHES
SPECIFIC GRAVITY	=*	0.7750	
FLOWING PRESSURE	=*	62.0000	PSIA
FLOWING TEMPERATURE	=*	80.0000	DEG F
PRESSURE DIFFERENTIAL	=*	100.0000	IN. H2O
TEMPERATURE BASE	=	60.0000	DEG F
PRESSURE BASE	=	14.6500	PSI
VISCOSITY	=	0.0000069	LB/FT-SEC
MOLE % NITROGEN	=*	0.4900	
MOLE % CARBON DIOXIDE	=*	12.3400	
MOLE % METHANE	=	75.8300	
C PRIME FOR CF/HR	=	1172.674	
FLOW RATE	=	92.33643	MSCF/HR OR 2216.074 MSCF/D

* INDICATES DATA ENTERED WITH THE FUNCTION CODE

PETRO
CHEM
ENVIRONMENTAL
SERVICES

APPENDIX K

UNIT OUTPUT DESIGN LOADS

APPENDIX K
Unit Output Design Loads

Cooper Rolls Turbine - SIPE
(#15101)

Cooper Rolls Turbine:

Gas Generator	=	Rolls Royce RB-211
Power Turbine	=	Coberra 6056

Gas Horsepower Rating:

Site Rated @ 59°F	=	34,400 HP
Normal Rating	=	31,233 HP

Shaft Horsepower Rating:

• ISO Rated	=	* 29,072 HP *
- Output Shaft Speed	=	4950 RPM
• Site Rated @59°F	=	28,306 HP
- Heat Rate	=	* 7485 Btu/hp-hr *
- Output Shaft Speed	=	4950 RPM
- Air Flow	=	193.2 lbs/sec.
• Guaranteed Rating	=	25,500 HP
- Heat Rate	=	(7670 Btu/hp-hr+4%) = 7977 Btu/hp-hr
• Normal Rating	=	24142 HP
- Output Shaft Speed	=	4950 RPM

Given Conditions During Compliance Testing

Gas Generator Inlet air temp.	=	60°F
Ambient Pressure	=	30.50 in Hg
Exhaust Temperature	=	790°F
N_1	=	6495 RPM
N_2	=	9240 RPM
N_3	=	4905 RPM
Compressor Discharge Pressure	=	221 psi
Turbine Exhaust Pressure	=	4.1 IWC
Shaft Horsepower	=	27,732 HP
Gas Horsepower	=	32,419 HP
Anti-ice System Operating (recycle of exhaust)		

Cooper Rolls - SIPE

REVISIONS NO.	DATE	BY	CK	APP	DESCRIPTION
0	2-4-81	MEW	PNH		INITIAL ISSUE
1	3-23-81	MEW	PNH		VENDOR INFO.

For ARCO OIL & GAS CO. Site PRUDHOE BAY ALASKA
Unit EAST SOURCE WATER INJECTION PLANT Service SEA WATER INJECTION
Item No. 31-15101T, 15102T & 15201T Quantity 3
Mfr COOPER ROLLS Size/Type COBERRA 6056 Serial No. M0586, 587, 588
Other ~~NEMA~~ Rated (ISO) 29072 Horsepower @ 4950 rpm

TYPE (OPEN), (~~CLOSED~~), (SIMPLE) (~~REGENERATIVE~~) NO. OF SHAFTS [~~ONE, TWO~~] THREE
FUEL GAS LOAD GEAR NONE DRIVEN EQUIP. CENTRIFUGAL PUMP
NOTE: ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER; ☐ BY MANUFACTER
APPLICABLE STD. *API 616, API 615, API 613, ● OTHER SPC-RE-0021, API 610, 611, 612, 614, 670 & 671
*2ND EDITION (3RD DRAFT) 9-79 GENERAL [ALL INFORMATION BY PURCHASER] (FINAL DRAFT 2-2-80)

APPLICATION ○ GENERATOR DRIVE ● MECHANICAL DRIVE
○ _____ ○ DESIRED MIN. HP _____ (~~5b~~)

DRIVEN EQUIPMENT NORMAL 24142 [SHP, KW] 4950 RPM
RATED 24142 [SHP, KW] 4950 RPM
GAS TURBINE ● SIMPLE CYCLE ○ REGEN.
NO. SHAFTS ○ SINGLE ○ TWO THREE
○ STEAM INJECTION (~~5f~~) ○ HELPER DRIVE

EQUIPMENT TO BE SUITABLE FOR (~~10a~~)
● INDOORS (2.1.17) ● HEATED ○ UNDER ROOF
○ OUTDOORS ○ UNHEATED ○ PARTIAL SIDES
● CONTINUOUS SERVICE ○ _____ SERVICE
○ ATTENDED ● UNATTENDED OPERATION
○ FIELD BALANCING (~~6f~~) ○ INSUL. FOR HEAT CONSERV. (~~17a~~)
○ TROPICALIZATION (~~46d~~) ● WINTERIZATION TO (2.1.17) °F (~~18a~~)
TEFC 3 PHASE MOTOR ENCLOSURES (TYPE) (~~46a~~)
XP 1 PHASE MOTOR ENCLOSURES
XP DC MOTOR ENCLOSURES
SEE NOTE (1) ● CLASS 1 GR D DIV. 2 HAZARD CLASS FOR BASEPLATE
● CLASS 1 GR D DIV. 2 FOR PANELS (BASE MOUNTED ONLY)

SITE & ATMOSPHERIC CONDITIONS (~~5c, 25~~) (2.1.3 & 3.5.6.4)
ELEV. 50 FT., BAROMETER 14.7 PSIA
RANGE OF SITE AMBIENT TEMPS. (~~5a, c, 25d~~)

	DRY BULB	WET BULB
SITE RATED °F	59	
NORMAL °F	40	
MAXIMUM °F	+75	
MINIMUM °F	-70	

SEE SPC-RE-0021 SECTION 4.01 & 4.02

⚠ ALLOWABLE SITE RATED PRESSURE DROP, IN. H_2O (~~5c-1, 25c~~) 2.1.3
INLET 11" EXHAUST 8" SYSTEMS

ATMOSPHERIC AIR (~~5a, c, 25d, 26d~~)
DUST: BELOW 10 MICRON NIL PPM
10 MICRON AND ABOVE NIL PPM
CORROSIVE CONSTITUENTS
○ SULPHUR ○ SALT OR SEACOAST
○ AMMONIA ● ARCTIC SEACOAST
○ AMMONIUM SALTS ○ _____

NOISE SPECIFICATIONS SEE
APPLICABLE TO MACHINE SPC-RE-0021 SECT 4.91
AREA _____ EXPOSURE TIME _____ HR/WK (~~19a~~)
APPLICABLE TO NEIGHBORHOOD
AREA _____ (~~19a~~)
UNIT SHALL BE UNLAGGED

NOTE (1) ALL CONTROL PANELS REMOTELY LOCATED SHALL BE UNCLASSIFIED
NOTE: PARAGRAPH NUMBERS WITHIN ( ) REFER TO APPLICABLE PARTS OF API STANDARD 616.

UTILITIES

~~STEAM FOR (5f)~~	STARTING	STEAM INJECTION	LUBE PUMP	HEATING
MAX. PRESS. PSIG				
NORM. PRESS. PSIG				
MIN. PRESS. PSIG				
MAX. TEMP. °F tt				
NORM. TEMP. °F tt				
MIN. TEMP. °F tt				
EXH. MAX. PRESS. psig/in. Hg abs.				
EXH. NORM. PRESS. psig/in. Hg abs.				
EXH. MIN. PRESS. psig/in. Hg abs.				

ELECTRICITY FOR: (~~45a~~)

MOTORS	AC/DC	VOLTS	PHASE	CYCLES
3/4 HP & OVER	AC	460	3	60
HP TO HP				
1/2 HP & SMALLER	AC	115	1	60
CONTROL	AC	115	1	60
HEATERS	AC	460	3	60
	DC	125		

COOLING WATER: ○ WELL ○ COOLING TOWER
○ _____ ● QUALITY 70% GLYCOL
SUPPLY TEMP. MAX. 90 °F MIN. _____ °F 30% TO WATER
SUPPLY PRESS. 70 PSIG, RETURN _____ PSIG
MAX. RETURN 120 °F
MECH. DESIGN PRESS. 150 PSIG

INSTRUMENT AIR: PRESS. 130 PSIG, TEMP. 100 °F
○ TURBINE AIR EXTRACTION REQUIRED
(~~15-1~~) VENDOR SCFM TO ADVISE

GAS FOR EXPANSION TURBINES: SUPPLY 250 PSIG, 60-10 °F 20.54 MW, EXHAUST 20 PSIG

COUPLING ● TAPER ● CYLINDER FIT REQUIRED (~~34f~~) 3.2.2

TESTS REQ'D (~~50b, c~~) HYDRO. OBSERVED WITNESSED (~~50b~~)
● MECHANICAL RUN ⊗ ●
● PERFORMANCE ● ●
● LOAD EQUIP. OPERATION ● ●
● HYDROSTATIC ● ●
● DISMANTLE-REASSEMBLY ● ●
○ RUN SPARE ROTOR ○ ○
SEE SPC-RE-0021 4.99 - 4.102

RMP DATA SHEET
THE RALPH M. PARSONS COMPANY

COMBUSTION GAS TURBINE (API 616)

SHEET	OF	JOB NUMBER
1	9	6000-2401

DOCUMENT NUMBER DAS-RE-31-15001 REV 2

ENG-RE-303A DC-

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GAS TURBINE CHARACTERISTICS — POWER TURBINE

PERFORMANCE [BY MANUFACTURER]

GAS TURBINE EXCLUDING LOAD GEAR ~~NEW~~ HP

GAS TURBINE *	SITE RATED	NORMAL	MAX.	MIN.
D.B. TEMP. °F	59	40	+75	-75
OUTPUT, [~~KW~~, HP]	28306 *	31233	26012	32675
HEAT RATE, BTU/ [~~KW~~, HP] HR., LHV	7495	7285 **	7676	6723
OUTPUT SHAFT SPEED, RPM	4950	4950	4950	4950
AIR FLOW LBS/SEC	193.2	205.1	183.8	247.4
EXHAUST FLOW LBS/SEC				
EXHAUST TEMP. °F	856.4	841.1	870	564.8
ISO FIRING TEMP. °F				
HELPER TURBINE ***				
OUTPUT, HP				
GAS ~~STEAM~~ FLOW LBS/HR				
SPEED, RPM				
STEAM INJECTION				
INCREMENTAL OUTPUT, HP				
FLOW, LBS/HR				
LOAD GEAR LOSSES, HP				
NET HP				

TOTAL UTILITY CONSUMPTION

COOLING WATER	86	GPM
ELECTRIC POWER		KW,AC
		KW,DC
~~STEAM~~ NORMAL		~~LBS/HR~~
MAX.		LBS/HR
FUEL NORMAL		
MAX.		
~~INSTRUMENT~~ AIR		~~SCFM~~

REMARKS: 1. VENDORS PROPOSAL SHALL STATE EMISSION LEVEL (NO_x, SO_2, CO_2, UHC) FOR ISO H.P., DRIVEN PUMP RATED H.P. & POTENTIAL MAX. H.P.
2. COMPLIANCE TO EXISTING AND OR PROPOSED E.P.A. REGULATIONS IS REQUIRED.
3. REFER TO SHEET 4 FOR GAS FUEL ANALYSIS
4. MECHANICAL TRAIN SHALL BE CAPABLE OF TRANSMITTING 38000 HP AT 4950 RPM

* OUTPUT HP GUARANTEE. 25,500
** HEAT RATE GUARANTEE 7670 BTU + 4 % = 7977 BTU
*** IF REQUIRED BY VENDOR USE API STD. 615 DATA SHEET.
4" INLET LOSS, 8" EXHAUST LOSS, 50' ELEV., 59°F
4950 RPM - THESE ARE SITE CONDITIONS

CONSTRUCTION FEATURES [BY MANUFACTURER]

MODEL COB 6056 TYPE SIMPLE CYCLE
SHAFTS ☐ SINGLE ☒ TWO ☐
ROTATION [FACING OUTPUT COUPLING] ☒ CW ☐ CCW

CRITICAL SPEEDS	LATERAL ~~COMP.~~	LATERAL TURB.	SYSTEM TORSIONAL
1ST, RPM		1500	
2ND, RPM		7120	
3RD, RPM		N/A	

~~AIR COMPRESSOR STAGES ____, MAX. TIP SPEED ____ FPS~~
~~TYPE ____ RATIO ____~~
~~CASING SPLIT ☐ HORIZONTAL, ☐ VERTICAL~~
~~ROTOR: ☐ SOLID ☐ BUILT UP~~
~~MAX. ALLOWABLE TEMP. ____ °F, PRESS. ____ PSIG~~
~~TRIP SPEED ____ RPM~~
~~MIN. OPERATING SPEED ____ RPM~~

TURBINE (S) STAGES 2, MAX. TIP SPEED 1280 FPS
CASING SPLIT ☐ HORIZONTAL, ☒ VERTICAL
ROTOR ☐ SOLID ☒ BUILT UP
MAX. ALLOWABLE TEMP. 1275 °F, PRESS. 38 PSIG
TRIP SPEED 5500/5600 RPM
MIN. OPERATING SPEED 3000 RPM

~~COMBUSTORS ☐ SINGLE ☐ MULTIPLE ____ NO.~~
~~☐ GAS ☐ OIL ☐ DUAL FUEL~~
~~EXPECTED TEMP. STRATIFICATION ____ °F. (9d)~~
~~FUEL NOZZLES PER COMBUSTOR ____~~

BEARINGS RADIAL TYPE BABBIT TILTING PAD (11A)
THRUST TYPE KINGSBURY AREA 84.8 IN.²
MAX. THRUST LOAD 28,000 LBS.
THRUST CAPACITY 38,000 LBS.
DRAIN SYSTEM ☐ PRESS. ☐ VACUUM ☒ ATMOSPHERIC

FLANGE ORIENTATION OPTIONS
INLET ☐ UP, ☐ DOWN, ☐ SIDE FRONT ☒
EXHAUST ☒ UP, ☐ DOWN, ☐ SIDE
SIZE INLET FROM GG EXHAUST 4800 IN²

TURBINE MATERIALS
~~AIR COMP. ROTOR BLADES~~ SEE SHEET 2C
~~AIR COMP. STATOR BLADES~~
~~COMBUSTION LINER(S)~~

~~TURBINE STG.~~	1	2	3	4	5
~~STATOR BLADES~~					
~~ROTOR BLADES~~					
~~WHEEL~~					

COUPLING MFR. ZURN TYPE GEAR

SHIPPING DATA

	TURBINE	AUX. ITEMS
SHIPPING WT. TONS		
MAX. ERECTION WT. TONS		
MAX. MAINT. WT. TONS		
LENGTH FT-IN.		
WIDTH FT-IN.		
HEIGHT FT-IN.		

SEE SHEET 2d

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FLUOR

SPECIFICATION SHEET

COMBUSTION GAS TURBINE DATA SHEET (Cont'd)

Sulzer Turbine

JOB NO. 482904 ITEM NO. 04-PT-03-770-1 A/B

PAGE 2 OF 18 BY ME

DATE 10/8/80 REVISION 0

REV 2 3 APRIL 81
REV 3 7 MAY 82

GAS TURBINE CHARACTERISTICS

PERFORMANCE [BY MANUFACTURER]

GAS TURBINE PERFORMANCE INCLUDING 2% GEAR LOSS
SITE 4.72" H_2O INLET, 1.77" H_2O OUTLET LOSS

GAS TURBINE	RATED	NORMAL	MAX.	MIN.
D.B. TEMP. °F	59	+6	80	-60
OUTPUT, [KW]	5503 *	6549	4843	6274
HEAT RATE, BTU/[KW] HR., LHV	13 821	13 098**	14115	12 973
OUTPUT SHAFT SPEED, RPM	10 600	10 600	10600	10600
AIR FLOW M^3 ~~LBS~~/SEC	26	26	26	26
EXHAUST FLOW KG ~~LBS~~/SEC	31.7	35.4	30.0	38.0
EXHAUST TEMP. °F	945	912	955	793
FIRING TEMP. °F	1778			

HELPER TURBINE ***				
OUTPUT, HP				
STEAM FLOW LBS/HR				
SPEED, RPM				
STEAM INJECTION				
INCREMENTAL OUTPUT, HP				
FLOW, LBS/HR				
LOAD GEAR LOSSES, HP	2% OF OUTPUT HP			
NET HP				

TOTAL UTILITY CONSUMPTION

COOLING WATER	265	GPM
ELECTRIC POWER	65 MAX	KW, AC 460V
	.6	KW, DC
STEAM NORMAL		LBS/HR
MAX.		LBS/HR
FUEL NORMAL	75,009 SCFH	* 300 KW
MAX.	80,346 SCFH	@ 4140 V
INSTRUMENT AIR	(PULSE FILTER) 30	SCFM

REMARKS:

THE VENT FAN FOR THE ENCLOSURE SHALL BE ON THE OUTLET OF THE ENCLOSURE. THE VENT FAN SHALL BE ARTIC DUTY AND BE CAPABLE OF 12 ENCLOSURE AIR CHANGES PER HOUR.

* OUTPUT HP GUARANTEE.
** HEAT RATE GUARANTEE
*** IF REQUIRED BY VENDOR USE API STD. 615 DATA SHEET.

CONSTRUCTION FEATURES [BY MANUFACTURER]

MODEL S-3 TYPE

SHAFTS ☐ ~~SINGLE~~ ☒ TWO ☐

ROTATION [FACING OUTPUT COUPLING] ☐ ~~CW~~ ☒ CCW

CRITICAL SPEEDS	LATERAL COMP.	LATERAL TURB.	SYSTEM TORSIONAL
1ST, RPM	2,400	2000	4989
2ND, RPM	3,200	3600	8057
3RD, RPM	7,100	13,100	16,907

AIR COMPRESSOR STAGES 17, MAX. TIP SPEED 1074 FPS
TYPE AXIAL RATIO 8.85
CASING SPLIT ☒ HORIZONTAL, ☐ ~~VERTICAL~~
ROTOR: ☒ SOLID ☐ ~~BUILT UP~~
MAX. ALLOWABLE TEMP. ____ °F, PRESS. ____ PSIG
TRIP SPEED 11,500 RPM
MIN. OPERATING SPEED 8500 RPM

TURBINE (S) STAGES 3, MAX. TIP SPEED 1490 FPS
CASING SPLIT ☒ HORIZONTAL, ☐ VERTICAL
ROTOR ☐ ~~SOLID~~ ☒ BUILT UP
MAX. ALLOWABLE TEMP. 1800 °F, PRESS. 170 +10 -0 PSIG
TRIP SPEED 11,500 RPM
MIN. OPERATING SPEED 4500 RPM

COMBUSTORS ☐ ~~SINGLE~~ ☒ MULTIPLE 4 NO.
☒ GAS ☐ ~~OIL~~ ☐ ~~DUAL FUEL~~
EXPECTED TEMP. STRATIFICATION ____ °F. (9d)
FUEL NOZZLES PER COMBUSTOR 7

BEARINGS RADIAL TYPE BABBITT (11A)
THRUST TYPE GLACIER AREA ____ IN.²
MAX. THRUST LOAD 4400 LBS. } POWER TURBINE
THRUST CAPACITY 6400 LBS. }
DRAIN SYSTEM ☒ PRESS. ☒ VACUUM ☐ ~~ATMOSPHERIC~~

FLANGE ORIENTATION OPTIONS
INLET ☒ UP, ☐ ~~DOWN~~, ☐ ~~SIDE~~
EXHAUST ☒ UP, ☐ ~~DOWN~~, ☐ ~~SIDE~~
SIZE INLET 51" x 30" EXHAUST 89 x 39 IN

TURBINE MATERIALS
AIR COMP. ROTOR BLADES X 20 CR 13
AIR COMP. STATOR BLADES X 20 CR 13
COMBUSTION LINER(S) NIM PE 13

TURBINE STG.	1	2	3	4	5
STATOR BLADES	IN 939	939	738		
ROTOR BLADES	IN 738				
WHEEL	NIM 901				

COUPLING MFR. BENDIX TYPE DIAPHRAM

SHIPPING DATA

	TURBINE	AUX. ITEMS
SHIPPING WT. TONS	50	
MAX. ERECTION WT. TONS	50	
MAX. MAINT. WT. TONS	4	
LENGTH ~~FT~~-IN.	351"	
WIDTH ~~FT~~-IN.	125"	
HEIGHT ~~FT~~-IN.	131"	

Sulzer Turbine

FLUOR

SPECIFICATION SHEET

COMBUSTION GAS TURBINE DATA SHEET (Cont'd)

JOB NO. 482904 ITEM NO. 04-PT-03-7704 A/B

PAGE 4 OF 18 BY ME

DATE 10/8/80 REVISION 0

REV 3 7 MAY 82
REV 2 3 APRIL 81

INSTRUMENTS & CONTROLS [Cont'd]

INFORMATION BY PURCHASER

TEMPERATURE INSTRUMENTS

INDICATORS MFR. ASHCROFT 5"

RECORDER [S] MFR. ELEMES (3)

NO. EXTRA POINTS FOR PURCHASER'S USE 6

LOCATION TURBINE CONTROL PANEL

PROVIDE * ⊗ THERMOCOUPLES (3) ○ THERMOMETERS

AND ○ ~~RECORDER FOR:~~ (41a)

	Indicating	Recording
TURBINE EXHAUST [4 POINTS MIN.]	○	⊗
[2 POINTS MIN.]	⊗	○
INTERTURBINE [2 SHAFT ONLY]	○	○
GAS TURBINE AIR COMP., INLET	○	○
DISCH.	○	○
OIL COOLER INLET	⊗	○
OUTLET	⊗	○
OIL OUTLET EA. BEARING [NO. ____]	⊗	○
FUEL MANIFOLD	⊗	○
OIL RESERVOIR	⊗	○
OTHER PUMP SUCTION PRESS. (3)	○	⊗
PUMP DISCHARGE PRESS. (3)	○	⊗
PUMP SPEED (3)	○	⊗
* RTD 100Ω PLATINUM @ 32°F	○	○
	○	○
	○	○

THOMETERS NO. REQ'D. 2 TYPE DIGITAL (43)

MOUNTING LOCATIONS ON TURBINE CONTROL PANEL (3)

VIBRATION DETECTORS NO. REQ'D ____ MFR. BENTLY NEVADA (44)

TYPE NON-CONTACTING LOCATIONS EACH JOURNAL BRG. (3)
EACH THRUST BRG.

STARTING SYSTEM (36a) ○ MANUAL ○ SEMIAUTO

⊗ AUTOMATIC

⊗ AUTO PURGE, TIME ____ MIN. (36b)

5 TIMES VOLUME OF EXHAUST SYSTEM

⊗ CASING CONNECTIONS REQ'D PER PAR. (14b)

ALL PURCHASERS CONNECTIONS TO BE ASTM. (3)

FUEL SYSTEM

INFORMATION BY PURCHASER

TYPES ⊗ GAS, ~~○ LIQUID,~~ ~~○ DUAL (5c, 47a)~~

○ MANUAL TRANSFER ○ SHUTDOWN TO TRANSFER

○ AUTO (47a) ○ TRANSFER @ RATED LOAD

○ TRANSFER @ ____ % LOAD

MAX. TIME ALLOWED TO COMPLETE TRANSFER ____ SEC.

LIQUID FUEL TREATMENT REQUIRED ○ YES ○ NO (47c)

TREATMENT SYSTEM SUPPLIED BY ○ VENDOR

○ OTHERS (47c)

FUEL ANALYSIS [MOL %] (48a, b, c, d)

COMPOSITION	M.W.	NORMAL	STARTING	ALT.
AIR	29			
OXYGEN	32			
NITROGEN	28	0.41		0.1
WATER VAPOR	18			
CARBON MONOXIDE	28			
CARBON DIOXIDE	44	13.48		36.5
HYDROGEN SULFIDE	34			
HYDROGEN	2			
METHANE	16	71.25		37.7
ETHYLENE	28			
ETHANE	30	7.8		16.2
PROPYLENE	42			
PROPANE	44	4.27		8.8
i – BUTANE	58	0.58		0.3
n – BUTANE	58	1.39		0.3
i – PENTANE	72	0.25		0.1
n – PENTANE	72	0.29		
HEXANE PLUS		0.28		
CONTAMINANTS	H_2S	11 PPM		22 PPM
TOTAL		100.01		100.0
AVG. MOL. WT.				
C_p/C_v @ ____ °F ____ PSIG				
HHV BTU/SCF		1054		
LHV BTU/SCF		954		825
FUEL PRESS. MAX/MIN., PSIG		500/225		
FUEL TEMP. ~~MAX~~/MIN., °F		59 (3)		32 (3)

FOR LIQUID FUELS (49b)

○ ASTM GRADE NO. 1-GT

○ ASTM GRADE NO. 2-GT

○ ASTM GRADE NO. 3-GT

○ ASTM GRADE NO. 4-GT

○ OTHER, INDICATE COMPOSITION ____

INSPECTION

⊗ SHOP INSPECTION BY ⊗ CONTRACTOR

⊗ CUSTOMER (57a)

SHIPPING

BOX FOR ○ DOMESTIC ⊗ EXPORT SHIPMENT (63c)

ANTICIPATED STORAGE PERIOD 6 MONTHS (63d)

OTHER APPLICABLE SPECIFICATIONS

PETRO
CHEM
ENVIRONMENTAL
SERVICES

APPENDIX L

EXAMPLE CALCULATIONS

PETRO CHEM ENVIRONMENTAL SERVICES

EXAMPLE CALCULATIONS

I. NOx:

A. MW NOx = 46 grms/mole

B. NOx ppm @ 15% O_2 = ppm * $\frac{5.9}{(20.9 - \%O_2)}$ (20.9-15)

C. NOx lbs./MMBTU = ppm * MW * F factor * $10^{-9} * \left[\frac{20.9}{20.9 - \%O_2}\right]$

II. CO: (carbon monoxide)

A. MW CO = 28 grms/mole

B. CO lbs/hr = ppm * 1.557 * 10^{-7} * SDCFM * MW

1. $1.557 * 10^{-7} = \frac{\text{moles}}{10^6 \mu\text{moles}} * \frac{10^3 \text{mg}}{\text{grm}} * \frac{1.77 \text{ mole}}{\text{cf}}$

$* \frac{2.2046 * 10^{-6} \text{lbs}}{\text{mg}} * \frac{60 \text{ min}}{\text{hr.}}$

2. SDCFM = $\left[\text{fuel MMCF/H} * \frac{10^6 \text{CF}}{\text{MMCF}} * \text{F factor}\left(\frac{\text{DSCF}}{\text{MMBTU}}\right)\right.$

$\left. * \text{Cal-value}\left(\frac{\text{MMBTU}}{\text{DSCF}}\right) * \frac{1 \text{ hr}}{60\text{min}}\right] \frac{20.9}{(20.0 - \%O_2)}$

C. CO lbs/10^6 SDCF = CO lbs/hr/MMSDCF/hr.

III. Process Operations:

Actual MMBTU/hr $* \frac{\text{SCF}}{\text{DAY}} * \frac{1 \text{ day}}{24 \text{ hr}} * \frac{\text{BTU}}{\text{SCF}} * \frac{\text{MMBTU}}{10^6 \text{BTU}}$

Rated Turbine MMBTU/hr = rated (hp) * heatrate BTU/hp-hr

$* \frac{\text{MMBTU}}{10^6 \text{ BTU}}$

* All calculations done by computer (see printouts) maintain 12 significant figures, while the examples included use of 2 significant figures.

Example Calculations

Solzer Turbine: 7700 hp (13,621 BTU/kw-hr)

$\%O_2 = 16.4$ f factor = 9120.73 $\frac{DSCF}{mmBTU}$

NOx ppm = 108.5 Cal value = 0.00103 mmBtu/DSCF

CO ppm = 5.91 fuel rate = 0.075 mmscf/hr

* NOx ppm @ 15%O_2 = $108.5 * \left(\frac{5.9}{20.9-16.4}\right) = \boxed{143.4}$

* NOx lbs/mmBTU = $108.5 * 46 * 9120.73 * 2.635 * 10^{-9} * \left(\frac{20.9}{(20.9-16.4)}\right)$

$= \boxed{0.557 \text{ lbs/mmBTU}}$

CO lbs/10^6SDCF = CO lbs/hr / mmSCF/hr

* CO lbs/hr = $\left[0.075 * \frac{10^6 cf}{mmcf} * 9120.73 * 0.00103 * \frac{1 hr}{60 mm}\right] \frac{20.9}{(20.9-16.4)}$

$= \boxed{1.41 \text{ lbs/hr}}$

* CO lbs/10^6SDCF = $\frac{1.41 \text{ lbs/hr}}{0.075 \text{ mmSCF/hr}}$

$= \boxed{18.8 \text{ lbs/mmSCF (fuel)}}$

* Rated Turbine mmBTU/hr = $7{,}700 \text{ hp} * 13{,}621 \text{ BTU/kw-hr} * \frac{1 \text{ kw-hr}}{1.341 \text{ hp-hr}} * \frac{\text{mmBTU}}{10^6 \text{ BTU}}$

$= \boxed{78.2 \text{ mmBTU/hr}}$

* Actual mmBTU/hr = $1.8 \text{ mmSCF/D} * \frac{1 \text{ day}}{24 \text{ hr}} * \frac{1030 \text{ BTU}}{\text{SCF}} * \frac{\text{mmBTU}}{10^6 \text{ BTU}} * \frac{10^6 \text{ SCF}}{\text{mmSCF}}$

$= \boxed{77.25 \text{ mmBTU/hr}}$