Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

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COKE OVEN EMISSION TESTING

BETHLEHEM STEEL CORPORATION

SPARROWS POINT, MARYLAND

by
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Contract No. 68-02-2812
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1. INTRODUCTION

In accordance with the U.S. Environmental Protection Agency's program for developing New Source Performance Standards, TRW Environmental Engineering Division participated in emission testing on a coke oven battery stack at Bethlehem Steel Corporation's Sparrows Point, Maryland facility. The testing was conducted the week of 9 July 1979. The results of this testing effort will be used in the development effort for supporting the New Source Performance Standards for Coke Oven Battery Stacks in the iron and steel industry.

Emission tests were conducted at the outlet of the battery stack to determine concentrations of the following constituents in the flue gas: particulate, benzo-α-pyrene (BαP), oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_x), visible emissions, and sulfates (SO_4). Particulate and BαP trains were run simultaneously. Continuous monitors were run throughout the test to measure concentrations of O_2, CO and NO_x. In addition to continuous monitoring, integrated bag samples were obtained for measuring O_2, CO, CO_2, and N_2. This analysis was used for molecular weight determination. EPA Method 7 was performed to measure NO_x. Visible emissions were read for the duration of each test by the prescribed procedure in EPA Method 9. Sulfate analysis was performed on the particulate train filter and water (H_2O) impinger collection.

Bethlehem Steel's Sparrows Point facility, manufacturing iron and steel, employs mobile gunning for control of battery stack emissions. Emission tests were conducted at the 80 foot level of Coke Oven Battery Stack No. 2. The test locations are described in Section 4.

This report presents the results of the testing program. The following sections of the report contain: a summary of the results, descriptions of the sampling points, a description of the process, and delineation of the sampling and laboratory analytical procedures. The appendices contain field data, sample calculations and a daily activity log.

2. SUMMARY AND DISCUSSION OF RESULTS

The results of the testing program at the Sparrow's Point facility are summarized in Tables 2-1 through 2-8. Table 2-1 presents the coding system used for the testing program.

Table 2-2 presents the concentrations and emission rates of particulates and sulfates. The stack parameters and test conditions are also shown. The total particulate concentrations ranged from 0.19614 to 0.34397 gm/scm and averaged 0.27741 gm/scm. Emission rates for particulates ranged from 37.13 lb/hr (16.84 kg/hr) to 65.82 lb/hr (29.86 kg/hr) with an average of 54.43 lb/hr (24.69 kg/hr).

SO_2 concentrations ranged from 19.34 mg/scm to 51.98 mg/scm and averaged 35.66 mg/scm. Sulfate concentrations ranged from 63.43 mg/scm to 151.56 mg/scm and averaged 106.16 mg/scm.

Table 2-3 presents the concentrations and emission rates of Benzo-α-Pyrene (BαP) as well as the stack parameters and test conditions for these tests. BαP emission rates ranged from 77.29×10^{-6} lb/hr (35.07×10^{3} μg/hr) to 371.8×10^{-6} lb/hr (169.0×10^{3} μg/hr) and averaged 267.0×10^{-6} lb/hr (121.3×10^{3} μg/hr).

Tables 2-4 through 2-6 present the results of continuous monitoring for Oxygen (O_2), Carbon Monoxide (CO), and Oxides of Nitrogen (NO_x). The results for O_2 are expressed as percent (%), and the results for CO and NO_x are expressed as parts per million (ppm). Percent O_2 ranged from 9 to 13 for Test #1 with an average of 11.2. Percent O_2 ranged from 10 to 14 for Test #2 with an average of 11.9. Percent O_2 ranged from 10 to 12 for Test #3 with an average of 10.9.

All concentration levels reported were calculated on a dry basis.

Integrated bag samples were taken and analysis was performed on a Gas Chromagraph (G.C.) as well as an Orsat Analyzer for comparative results (see Figure 2-1). The continuous results for O_2 are slightly high in comparison with the GC results. The higher concentrations of O_2 reported by the continuous monitors are due to O_2 variations that resulted during Coke Oven pushing cycles. The Orsat results are lower than both continuous monitoring and GC analysis. The lower results produced by the Orsat are suspect and were the results of weak chemicals used in the Orsat analyzer. Figure 2-1 presents a comparison of gas analysis by the various methods.

The results of continuous monitoring for CO for test No.'s 1, 2, and 3 also are presented in Tables 2-4 through 2-6. CO concentrations ranged from 35 to 285 ppm for Test #1, with an average of 72 ppm. CO concentrations ranged from 75 to 310 ppm for Test #2 with an average of 141 ppm. CO concentrations ranged from 40 to 400 ppm for Test #3 with an average of 112 ppm.

The Orsat and G.C. are not capable of measuring concentrations in this range so no comparative data could be obtained. Figures 2-2 through 2-4 present the relationship of CO, NO_x, percent Opacity and percent O_2 for the duration of each test. Peaks of CO occurred during monitoring, as a result of oven push cycles, and the average concentrations are high as a result of these peaks.

The results of the three tests using continuous monitoring for NO_x are also presented in Tables 2-4 through 2-6. NO_x concentrations ranged from 25 to 130 ppm for Test #1, with an average of 70 ppm. NO_x concentrations ranged from 30 to 90 ppm for Test #2, with an average of 65 ppm. NO_x concentrations ranged from 50 to 105 ppm for Test #3, with an average of 79 ppm.

EPA Method 7 was used to determine NO_x, in addition to continuous monitoring. The results are presented in Table 2-7. NO_x concentrations averaged 40 ppm for Test #3. The EPA Method 7 results are less than the results obtained by monitoring on a continuous basis. This is the result of peaks that occurred during oven push cycles which are presented in Figures 2-2 through 2-4.

Problems occurred with the continuous NO_x monitor. The continuous monitor used operates on internal pumps. Extreme heat during the test resulted in lost voltage rendering the pumps inoperative. After brief cooling periods, the pumps were reset and continuous monitoring was resumed. This should not affect the results of the data obtained since the instrument responded to the correct calibration values at the end of each test.

Visible emissions were recorded for the duration of Tests #1 and #2. No visible emissions were recorded for Test #3 due to darkness. A graphic summary of opacities is presented in Figures 2-2 and 2-3. Additional visible emission data is included in Tables 2-9 through 2-11.

The sulfate analysis on the particulate train water impingers is expressed as SO_2. It is believed that not all of the SO_2 gas was caught in the water impingers; therefore, the SO_2 emissions reported are likely to be less than actual. This is because there was no oxidizing agent other than oxygen in the stack gas to create a more reactive form of sulfur oxide such as SO_3.

TABLE 2-1. SAMPLE CODING SYSTEM

For Particulate		Date	Time
Test Number	Sample Code		
1	CKO-15-M5-1	7-11-79	1518-2012
2	CKO-15-M5-2	7-12-79	1145-1820
3	CKO-15-M5-3	7-12-79	2010-0055
For BAP			
Test Number	Sample Code		
1	CKO-15-BAP-1	7-11-79	1516-2008
2	CKO-15-BAP-2	7-12-79	1145-1825
3	CKO-15-BAP-3	7-12-79	2010-0105
For NO_x			
Test Number	Sample Code		
1	CKO-15-M7-1	7-11-79	1530-1630
2	CKO-15-M7-2	7-12-79	1215-1315
3	CKO-15-M7-3	7-13-79	2040-2110

TABLE 2-2. PARTICULATE AND SULFATE ANALYSIS

RUN NUMBER	1 CKO-15-M5-1		2 CKO-15-M5-2		3 CKO-15-M5-3		AVERAGE	
	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS
I DATE	7-11-79	7-11-79	7-12-79	7-12-79	7-12-79	7-12-79		
II STACK PARAMETERS								
Pst - Static Pressure, "Hg (mmHg)	-0.09	(-2.29)	-0.09	(-2.29)	-0.09	(-2.29)	-0.09	(-2.29)
Ps - Stack Gas Pressure, "Hg Absolute (mmHg)	29.9	(759.5)	29.9	(759.5)	29.9	(759.5)	29.9	(759.5)
% CO_2 - Volume % Dry	4.0		3.6		3.6		3.7	
% O_2 - Volume % Dry	9.0		8.9		9.4		9.1	
% CO - Volume % Dry	NIL		NIL		NIL		NIL	
% N_2 - Volume % Dry	87.0		87.5		87.0		87.2	
Ts - Average Stack Temperature °F (°C)	562	(294.4)	565	(296.1)	567	(297.2)	565	(295.9)
% M - % Moisture in Stack Gas, By Volume	12.87		14.95		12.70		-13.51	
As - Stack Area, ft^2 (m^2)	153.9	(14.30)	153.9	(14.30)	153.9	(14.30)	153.9	(14.30)
MWd - Molecular Weight of Stack Gas, Dry Basis	29.000		28.932		28.952		28.96	
MW - Molecular Weight of Stack Gas, Wet Basis	27.584		27.298		27.561		27.481	
Vs - Stack Gas Velocity, ft/sec, (m/sec)	12.184	(3.714)	12.652	(3.857)	13.334	(4.065)	12.723	(3.879)
Qa - Stack Gas Volumetric Flow at Stack Conditions, ACFM (m^3/min)	112,505	(3,186.2)	116,833	(3,308.8)	123,128	(3,487.0)	117,489	(3,327.3)
Qs - Stack Gas Volumetric Flow at Standard Conditions, DSCFM (m^3/min)	50,590	(1,431.7)	51,132	(1,447.0)	55,202	(1,562.2)	52,308	(1,480.3)
III TEST CONDITIONS								
Pb - Barometric Pressure, "Hg (mmHg)	30.0	(762.)	30.0	(762.)	30.0	(762.)	30.0	(762.)
Dn - Sampling Nozzle Diameter, in. (mm)	0.50	(12.7)	0.50	(12.7)	0.50	(12.7)	0.50	(12.7)
T - Sampling Time, min	128		160		160		149.3	
Vm - Sample Volume, ACF (m^3)	67.085	(1.900)	82.037	(2.323)	88.627	(2.510)	79.250	(2.244)
Np - Net Sampling Points	32		32		32		32	
Cp - Pitot Tube Coefficient	0.85		0.85		0.85		0.85	
Tm - Average Meter Temperature °F (°C)	88	(31.1)	98	(36.7)	100	(37.8)	95	(35.2)
Pm - Average Orifice Pressure Drop, "H_2O (mmH_2O)	0.89	(22.6)	0.94	(23.9)	1.05	(26.7)	0.96	(24.4)
Wc - Condensate Collected (Impingers and Gel), mls		(203.6)		(291.0)		(259.4)		(251.3)
IV TEST CALCULATIONS								
Vw_{gas} - Condensed Water Vapor, SCF (m^3)	9.590	(0.272)	13.706	(0.388)	12.218	(0.346)	11.838	(0.335)
Vm - Volume of Gas Sampled at Standard Conditions, DSCF (m^3)	64.925	(1.837)	77.982	(2.207)	83.968	(2.376)	72.625	(2.140)
% M - Percent Moisture, By Volume	12.87		14.95		12.70		13.51	
MW - Molecular Weight of Stack Gas, Wet Basis	27.584		27.298		27.561		27.481	
Vs - Stack Velocity, ft/sec (m/sec)	12.184	(3.714)	12.652	(3.857)	13.334	(4.065)	12.723	(3.879)
% I - Percent Isokinetic	112.8		107.5		107.2		109.2	
V ANALYTICAL DATA								
A) Particulates Front Half								
Probe, gr/DSCF (gm/m^3)	0.01070	(0.02450)	0.00810	(0.01854)	0.00805	(0.01844)	0.00542	(0.02049)
Filter, gr/DSCF (gm/m^3)	0.07038	(0.16116)	0.14021	(0.32109)	0.11657	(0.26695)	0.06699	(0.24973)
Particulates Front Half Total								
gr/DSCF, (mg/m^3)	0.08107	(0.18566)	0.14831	(0.33963)	0.12462	(0.28539)	0.11800	(0.27023)
#/hr, (kg/hr)	35.14987	(15.94398)	64.98926	(29.47913)	58.95697	(26.74288)	53.03203	(24.05533)
B) Particulates - Condensables								
Organic								
gr/DSCF, (mg/m^3)	0.00123	(0.00282)	0.00164	(0.00375)	0.00176	(0.00403)	0.00154	(0.00353)
#/hr, (kg/hr)	0.53476	(0.24256)	0.71826	(0.32580)	0.83295	(0.37782)	0.69532	(0.31539)
Inorganic								
gr/DSCF, (mg/m^3)	0.00334	(0.00766)	0.00026	(0.00059)	0.00117	(0.00269)	0.00159	(0.00365)
#/hr, (kg/hr)	1.45001	(0.65772)	0.11250	(0.05103)	0.55530	(0.25188)	0.70594	(0.32021)
C) Particulates - Total Condensables								
gr/DSCF, (mg/m^3)	0.00458	(0.01048)	0.00190	(0.00434)	0.00293	(0.00672)	0.00314	(0.00718)
#/hr, (kg/hr)	1.98476	(0.90029)	0.83075	(0.37683)	1.38824	(0.62971)	1.40125	(0.63561)
D) Total Particulates								
gr/DSCF, (mg/m^3)	0.08565	(0.19614)	0.15020	(0.34397)	0.12756	(0.29211)	0.12114	(0.27741)
#/hr, (kg/hr)	37.13464	(16.84427)	65.82001	(29.85596)	60.34521	(27.37259)	54.43329	(24.69094)
E) Sulfates								
ppm SO_2,(mg/m^3)	7.31	(19.34)	19.84	(51.98)	13.55	(35.50)	13.61	(35.66)
10^{-6} #/DSCF SO_2,(kg/m^3)	1.22	(19.34)	3.28	(51.98)	2.24	(35.50)	2.25	(35.66)
ppm SO_4,(mg/m^3)	25.96	(103.48)	15.92	(63.43)	38.03	(151.56)	26.64	(106.16)
10^{-6} #/DSCF SO_4,(kg/m^3)	6.46	(103.5)	3.68	(63.4)	9.45	(151.6)	6.53	(106.2)

TABLE 2-3. BαP RESULTS

RUN NUMBER	1 CKO-15-BAP-1		2 CKO-15-BAP-2		3 CKO-15-BAP-3		AVERAGE	
	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS
I DATE	7-11-79	7-11-79	7-12-79	7-12-79	7-12-79	7-12-79		
II STACK PARAMETERS								
Pst - Static Pressure, "Hg (mmHg)	-0.08	(-2.03)	-0.09	(-2.29)	-0.09	(-2.29)	-.09	(-2.20)
Ps - Stack Gas Pressure, "Hg Absolute (mmHg)	29.9	(759.5)	29.9	(759.5)	29.9	(759.5)	29.9	(759.5)
% CO_2 - Volume % Dry	4.0		3.6		3.6		3.7	
% O_2 - Volume % Dry	9.0		8.9		9.4		9.1	
% CO - Volume % Dry	NIL		NIL		NIL		NIL	
% N_2 - Volume % Dry	87.0		87.5		87.0		87.2	
Ts - Average Stack Temperature °F (°C)	555.3	(290.7)	569.0	(298.3)	567.0	(297.2)	563.8	(295.4)
% M - % Moisture in Stack Gas, By Volume	12.87		14.95		12.70		13.51	
As - Stack Area, ft^2 (m^2)	153.9	(14.30)	153.9	(14.30)	153.9	(14.30)	153.9	(14.30)
MWd- Molecular Weight of Stack Gas, Dry Basis	29.000		28.932		28.952		28.961	
MW- Molecular Weight of Stack Gas, Wet Basis	27.586		27.296		27.561		27.481	
Vs - Stack Gas Velocity, ft/sec, (m/sec)	12.316	(3.755)	11.963	(3.647)	14.199	(4.329)	12.826	(3.910)
Qa - Stack Gas Volumetric Flow at Stack Conditions, ACFM (m^3/min)	113,730	(3,221)	110,469	(3,128)	131,111	(3,713)	118,437	(3354)
Qs - Stack Gas Volumetric Flow at Standard Conditions, DSCFM (m^3/min)	51,485	(1,457.0)	48,147	(1,362.6)	58,782	(1,663.5)	52,805	(1494.4)
III TEST CONDITIONS								
Pb - Barometric Pressure, "Hg (mmHg)	30.0	(762.0)	30.0	(762.0)	30.0	(762.0)	30.0	(762.0)
Dn - Sampling Nozzle Diameter, in. (mm)	0.50	(12.7)	0.50	(12.7)	0.50	(12.7)	0.50	(12.7)
T_t - Sampling Time, min	128		160		165		151	
Vm - Sample Volume, ACF (m^3)	67.42	(1.91)	80.81	(2.29)	97.51	(2.76)	81.91	(2.32)
Np - Net Sampling Points	32		32		32		32	
Cp - Pitot Tube Coefficient	0.85		0.85		0.85		0.85	
Tm - Average Meter Temperature °F (°C)	89		98		95		94	
Pm - Average Orifice Pressure Drop, "H_2O (mmH_2O)	0.86	(21.8)	0.80	(20.3)	1.12	(28.4)	0.93	(23.6)
IV TEST CALCULATIONS								
Vw_{gas} Condensed Water Vapor, SCF (m^3)								
Vm - Volume of Gas Sampled at Standard Conditions, DSCF (m^3)	65.125	(1.844)	76.789	(2.175)	93.232	(2.640)	79.049	(2.239)
% M - Percent Moisture, By Volume	12.87*		14.95*		12.70*		13.51*	
MW - Molecular Weight of Stack Gas, Wet Basis	27.584		27.298		27.561		27.481	
Vs - Stack Velocity, ft/sec (m/sec)	12.316	(3.755)	11.963	(3.647)	14.199	(4.329)	12.826	(3.910)
% I - Percent Isokinetic	111.2		112.4		108.2		110.6	
V ANALYTICAL DATA - BαP EMISSIONS								
Probe Rinse, (μg)		(0.185)		(0.468)		(0.440)		(0.364)
XAD-2 Adsorbent (μg)		(3.20)		(0.200)		(3.20)		(2.20)
Filter, (μg)		(0.180)		(0.265)		(0.585)		(0.343)
BαP Total (μg)		(3.565)		(0.933)		(4.225)		(2.908)
BαP Total, 10^{-6} #/hr (10^3 μg/hr)	371.8	(169.0)	77.29	(35.07)	351.9	(159.7)	267.0	(121.3)
BαP Total, #/year (kg/year)	3.26	(1.48)	0.676	(0.307)	3.08	(1.40)	2.34	(1.06)

*Taken directly from particulate sample train.

Table 2-4.

Continuous Monitoring Data

Bethlehem Steel

Battery Stack #2

Test #1

Time	OXYGEN (O_2) (%)	CARBON MONOXIDE (CO) (ppm)	OXIDES OF NITROGEN (NO_X) (ppm)
15:15	10.6	65	70
15:30	11.0	285	65
15:45	11.8	70	106
16:00	11.1	60	65
16:15	11.0	110	65
16:30	11.0	60	65
16:45	12.1	35	130
17:00	12.0	60	61
17:15	FLOW INTERRUPTION	--	--
17:30	11.6	50	87
17:45	13.0	55	80
18:00	11.6	85	70
18:15	11.4	50	85
18:30	11.2	90	40
18:45	11.1	70	50
19:00	12.0	45	60
19:15	11.2	40	65
19:30	9.2	95	65
19:45	11.0	40	25
20:00	10.0	35	75
20:15	10.0	46	70

Table 2-5.

Continuous Monitoring Data
Bethlehem Steel
Battery Stack #2
Test #2

Time	OXYGEN (O_2) (%)	CARBON MONOXIDE (CO) (ppm)	OXIDES OF NITROGEN (NOX) (ppm)
11:45	12.8	90	30
12:00	13.0	95	65
12:15	12.0	100	70
12:30	12.0	105	68
12:45	12.5	310	80
13:00	12.2	210	50
13:15	11.5	130	50
13:30	11.8	120	80
13:45	11.5	130	90
14:00	11.5	150	50
14:15	12.0	75	52
14:30	11.3	75	70
14:45	13.0	100	60
	← Process Problems-2 hrs. hold →		
16:45	14.0	90	*
17:00	10.8	120	60
17:15	12.4	225	70
17:30	10.0	110	80
17:45	10.5	290	80
18:00	11.0	150	60
18:15	11.5	0	70

* NO_x pump tripped

Table 2-6.

Continuous Monitoring Data
Bethlehem Steel
Battery Stack #2
Test #3

Time	OXYGEN (O_2) (%)	CARBON MONOXIDE (CO) (ppm)	OXIDES OF NITROGEN (NO_X) (ppm)
20:15	11.0	65	65
20:30	11.1	85	55
20:45	11.4	85	75
21:00	11.1	180	100
21:15	11.1	180	95
21:30	11.2	160	100
21:45	12.0	65	105
22:00	10.5	60	105
22:15	10.7	80	50
22:30	11.0	110	90
22:45	10.6	200	95
23:00	10.6	110	60
23:15	10.5	65	50
23:30	11.0	400	*
23:45	10.0	140	105
24:00	11.0	50	65
00:15	10.5	55	63
00:30	11.0	60	57
00:45	11.0	55	85
01:00	10.5	40	85

*NO_X pump tripped

TABLE 2-7. NOx METHOD 7 RESULTS

RUN NUMBER	CKO-15-M7-1	CKO-15-M7-2	CKO-15-M7-3
Flask A	23 ppm	103 ppm	17 ppm
Flask B	60 ppm	37 ppm	59 ppm
Flask C	19 ppm	58 ppm	48 ppm
Flask D	58 ppm	77 ppm	47 ppm
Average	40 ppm	69 ppm	40 ppm

TABLE 2-8. SULFATE RESULTS

RUN NUMBER	CK-15-M5-1	CKO-15-M5-2	CKO-15-MF-3
Vm (DSCF)	64.925	77.982	83.968
SO_2, ppm (dry)	7.31	19.84	13.55
SO_2, pound/DSCF	1.22×10^{-6}	3.28×10^{-6}	2.24×10^{-6}
SO_2, pound/hr	3.70	10.1	7.42
SO_4, ppm (dry)	25.96	15.92	38.03
SO_4, pound/DSCF	6.46×10^{-6}	3.68×10^{-6}	9.45×10^{-6}
SO_4, pound/hr	19.6	11.3	31.3

Table 2-9. FACILITY: SPARROWS POINT

SUMMARY OF VISIBLE EMISSIONS: TEST #1

Date: 7-11-79

Type of Plant: Coke Oven

Type of Discharge: Exhaust Gas

Location of Discharge: #2 Battery Stack

Height of Point of Discharge: ≈150'

Description of Background: Clouds

Description of Sky: Cloudy

Wind Direction: Variable

Color of Plume: White

Duration of Observation: 1525-1757

Distance from Observer to Discharge Point: ≈150'

Height of Observation Point: ≈40'

Direction of Observer from Discharge Point: Nort

Wind Velocity: 0-5 mph

Detached Plume: No

SUMMARY OF AVERAGE OPACITY

Set Number	Start	End	Sum	Average
1	10	10	415	17.3
2	15	25	500	20.8
3	15	0	55	2.3
4	5	0	60	2.5
5	0	0	60	2.5
6	0	25	195	8.1
7	25	25	575	24.0
8	0	0	0	0.0
9	0	0	270	11.2
10	0	25	365	15.2
11	20	0	230	9.6
12	0	30	555	23.1
13	20	0	45	1.9
14	0	0	15	0.6
15	0	0	0	0.0
16	0	0	0	3.54
17	0	0	0	1.67
18	0	0	0	0.0
19	0	0	0	0.0
20	0	0	0	0.0

SUMMARY OF AVERAGE OPACITY

Set Number	Start	End	Sum	Average
21	0	0	0	0.0
22	0	0	0	0.0
23	0	0	0	0.0
24	0	0	0	0.0
25	0	0	0	0.0
26	0	0	0	0.0
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				

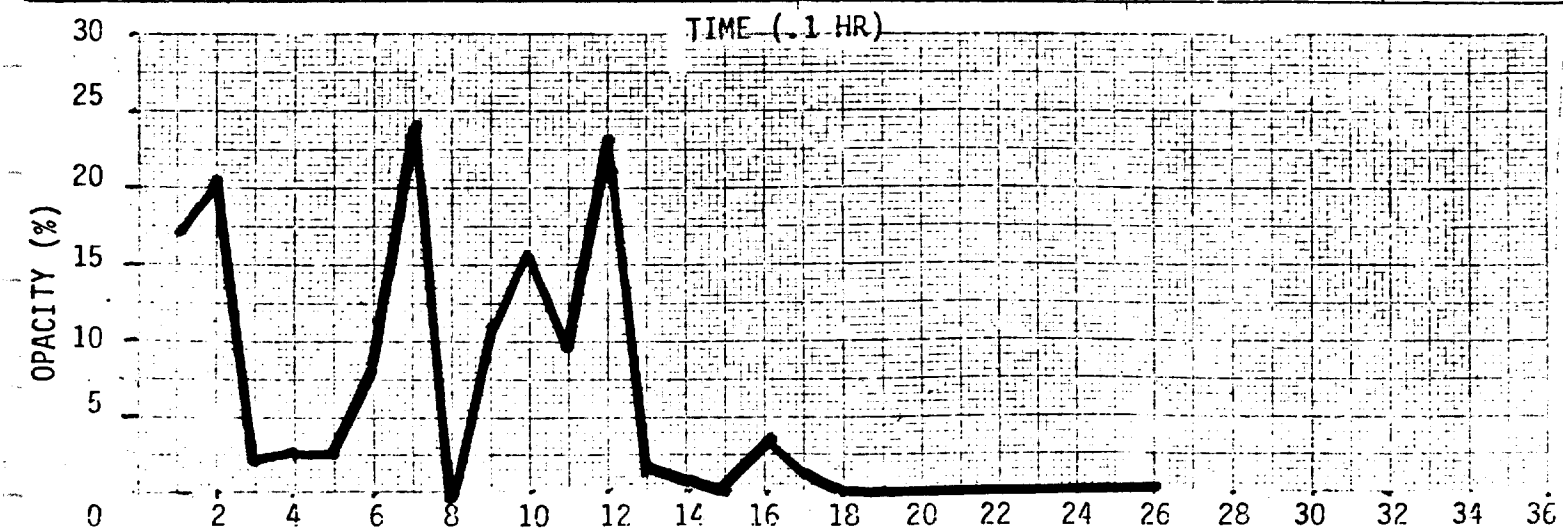


Table 2-10. FACILITY: SPARROWS POINT

SUMMARY OF VISIBLE EMISSIONS: TEST #2

Date: 7-12-79

Type of Plant: Coke Oven

Type of Discharge: Exhaust Gas

Location of Discharge: #2 Battery Stack

Height of Point of Discharge: ≈150'

Description of Background: Clouds

Description of Sky: Cloudy

Wind Direction: Variable

Color of Plume: White

Duration of Observation: 1135-1504

Distance from Observer to Discharge Point: ≈ 1'

Height of Observation Point: ≈ 40'

Direction of Observer from Discharge Point: No

Wind Velocity: 0-5 mph

Detached Plume: No

First Half of Test #2

SUMMARY OF AVERAGE OPACITY

Set Number	Start	End	Sum	Average
1	20	15	270	11.2
2	15	0	60	2.5
3	0	0	75	3.1
4	0	0	0	0.0
5	0	0	0	0.0
6	0	0	0	0.0
7	0	10	105	4.4
8	10	10	110	4.6
9	5	5	55	2.3
10	0	10	130	5.4
11	10	0	40	1.7
12	0	0	0	0.0
13	0	5	55	2.3
14	5	0	70	2.9
15	0	0	0	0.0
16	0	0	0	0.0
17	0	0	0	0.0
18	0	0	0	0.0
19	0	0	0	0.0
20	5	10	175	7.3

SUMMARY OF AVERAGE OPACITY

Set Number	Start	End	Sum	Average
21	15	0	55	2.3
22	0	0	0	0.0
23	0	0	0	0.0
24	0	0	0	0.0
25	0	0	0	0.0
26	0	0	0	0.0
27	0	15	95	4.0
28	20	20	520	21.7
29	20	0	245	10.2
30	0	0	0	0.0
31	0	0	0	0.0
32	0	0	0	0.0
33	0	0	0	0.0
34	0	0	0	0.0
35	0	0	0	0.0
36	PLANT WENT DOWN			
37				
38				
39				
40				

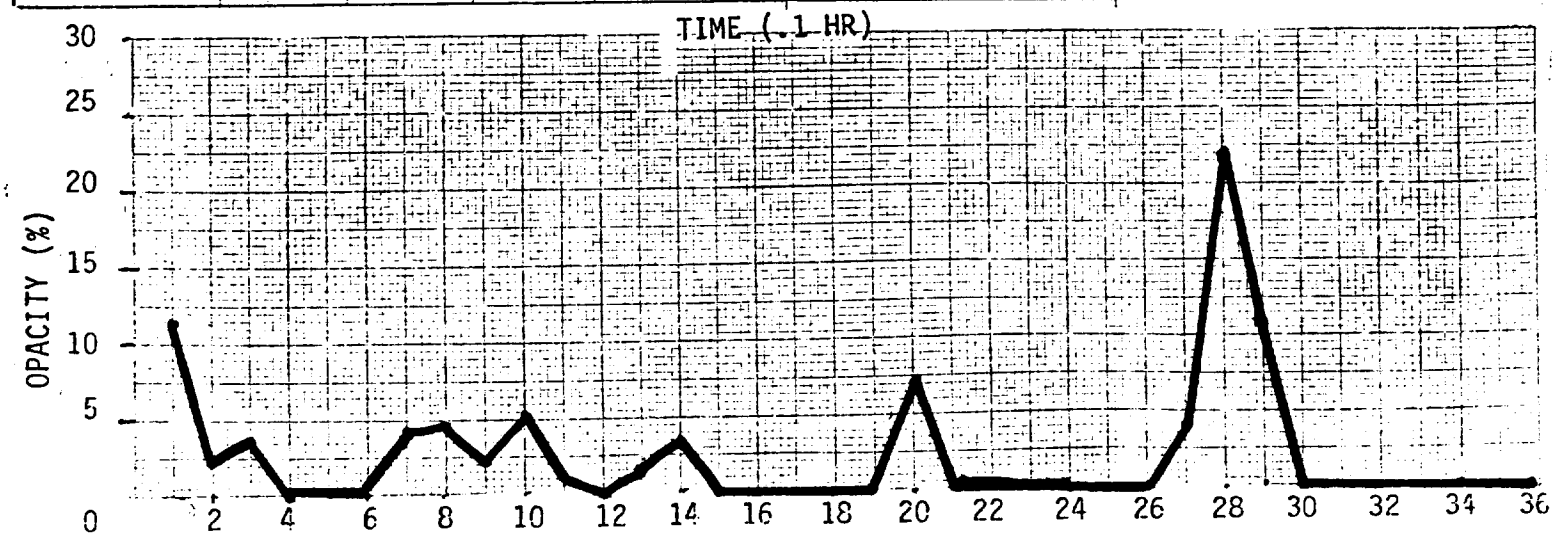


Table 2-11. FACILITY : SPARROWS POINT

SUMMARY OF VISIBLE EMISSIONS : TEST #2 (CONT.)

Date: 7-12-79

Type of Plant: Coke Oven

Type of Discharge: Exhaust Gas

Location of Discharge: #2 Battery Stack

Height of Point of Discharge: ≈150'

Description of Background: Clouds

Description of Sky: Cloudy

Wind Direction: Variable

Color of Plume: White

Duration of Observation: 1635-1829

Distance from Observer to Discharge Point: ≈150'

Height of Observation Point: ≈40'

Direction of Observer from Discharge Point: Nort

Wind Velocity: 0-5 mph

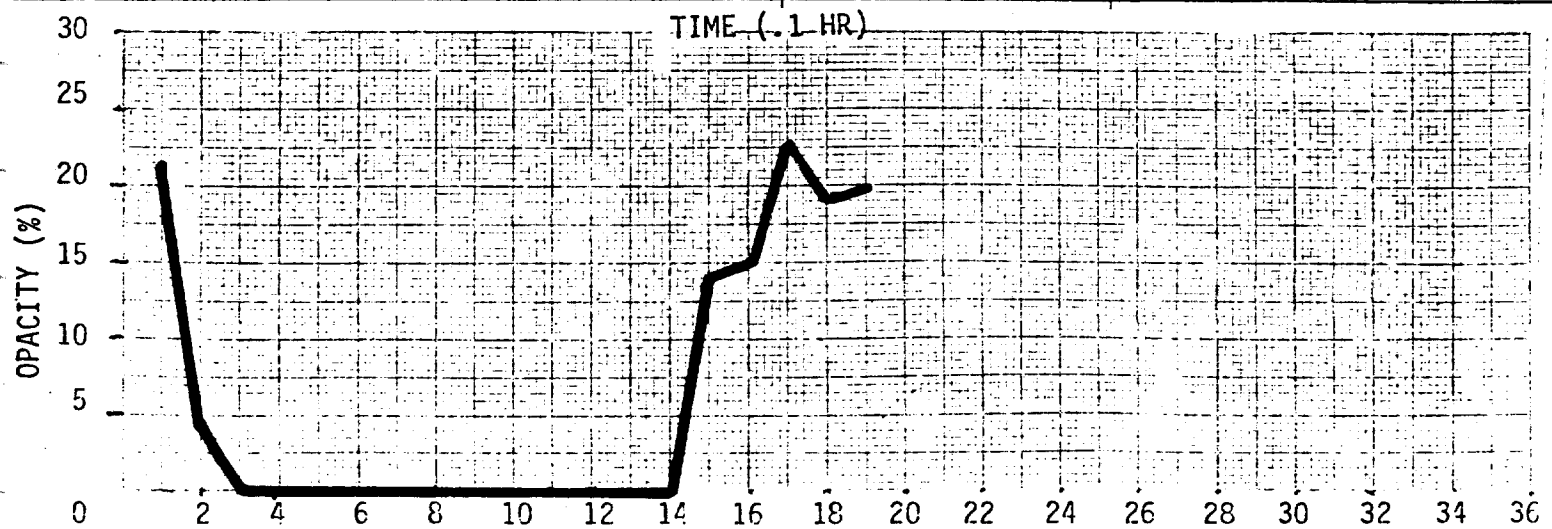
Detached Plume: No

SUMMARY OF AVERAGE OPACITY

Set Number	Start	End	Sum	Average
1	20	20	520	21.7
2	20	0	110	4.6
3	0	0	0	0.0
4	0	0	0	0.0
5	0	0	0	0.0
6	0	0	0	0.0
7	0	0	0	0.0
8	0	0	0	0.0
9	0	0	0	0.0
10	0	0	0	0.0
11	0	0	0	0.0
12	0	0	0	0.0
13	0	0	0	0.0
14	0	0	0	0.0
15	0	20	335	14.0
16	20	20	360	15.0
17	20	30	540	22.5
18	30	20	460	19.2
19	20	20	475	19.8
20				

SUMMARY OF AVERAGE OPACITY

Set Number	Start	End	Sum	Average
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				



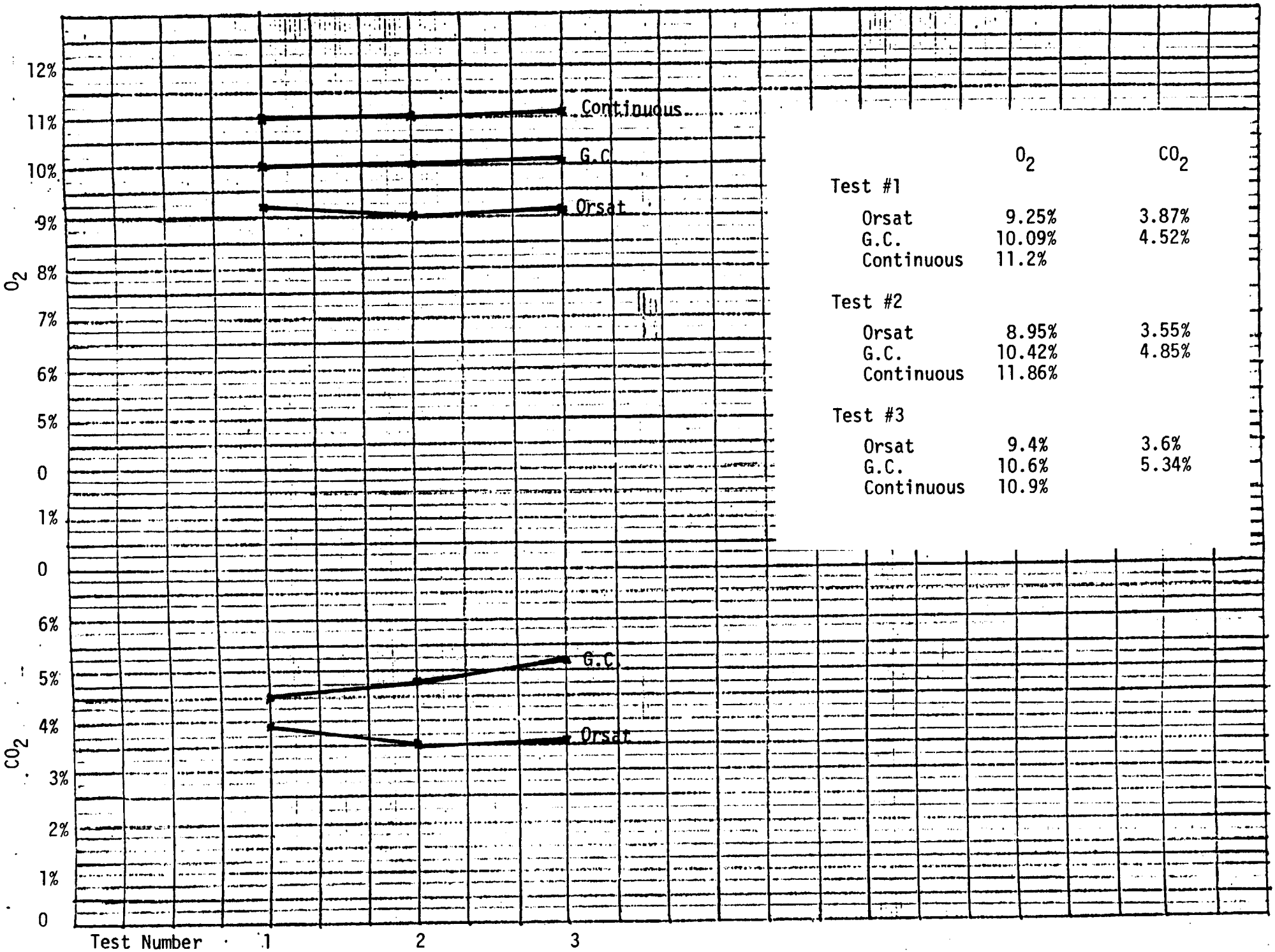


FIGURE 2-1. COMPARATIVE RESULTS OF GAS ANALYSIS

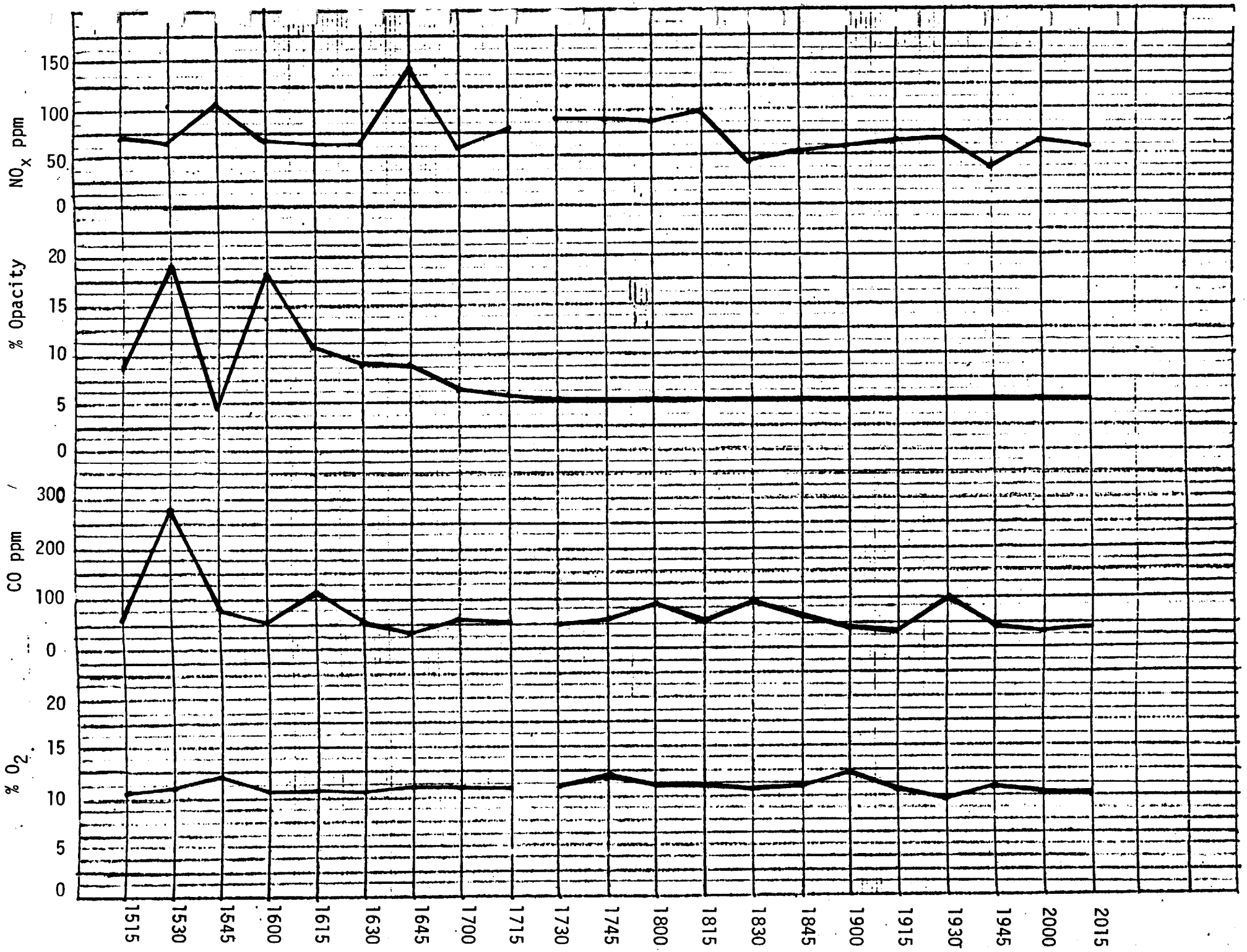


FIGURE 2-2. TEST #1 RELATIONSHIP OF CO, NO_x CONENTRATIONS, % OPACITY AND % OXYGEN

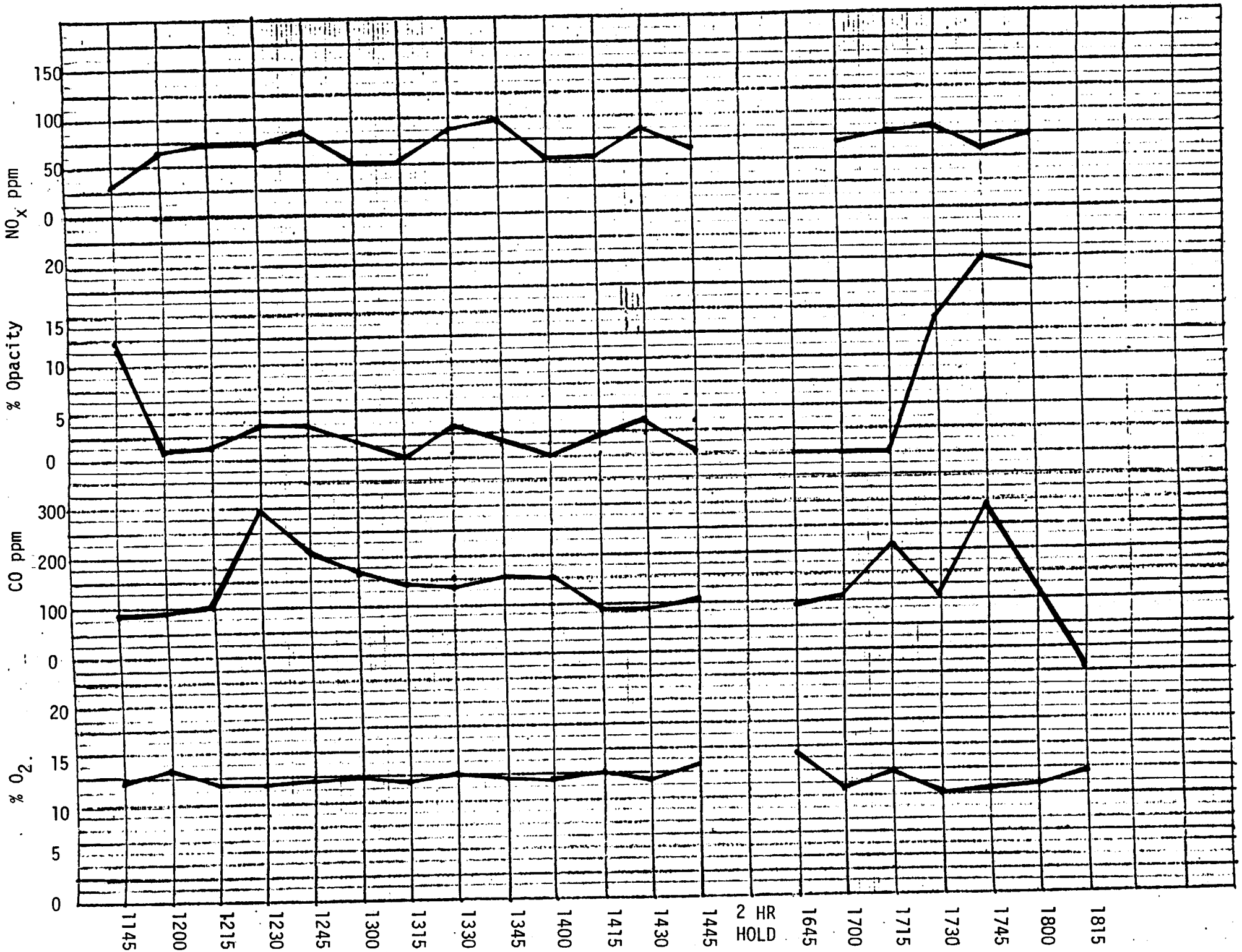


FIGURE 2-3. TEST #2 RELATIONSHIP OF CO, NO_x CONCENTRATIONS, % OPACITY AND % OXYGEN

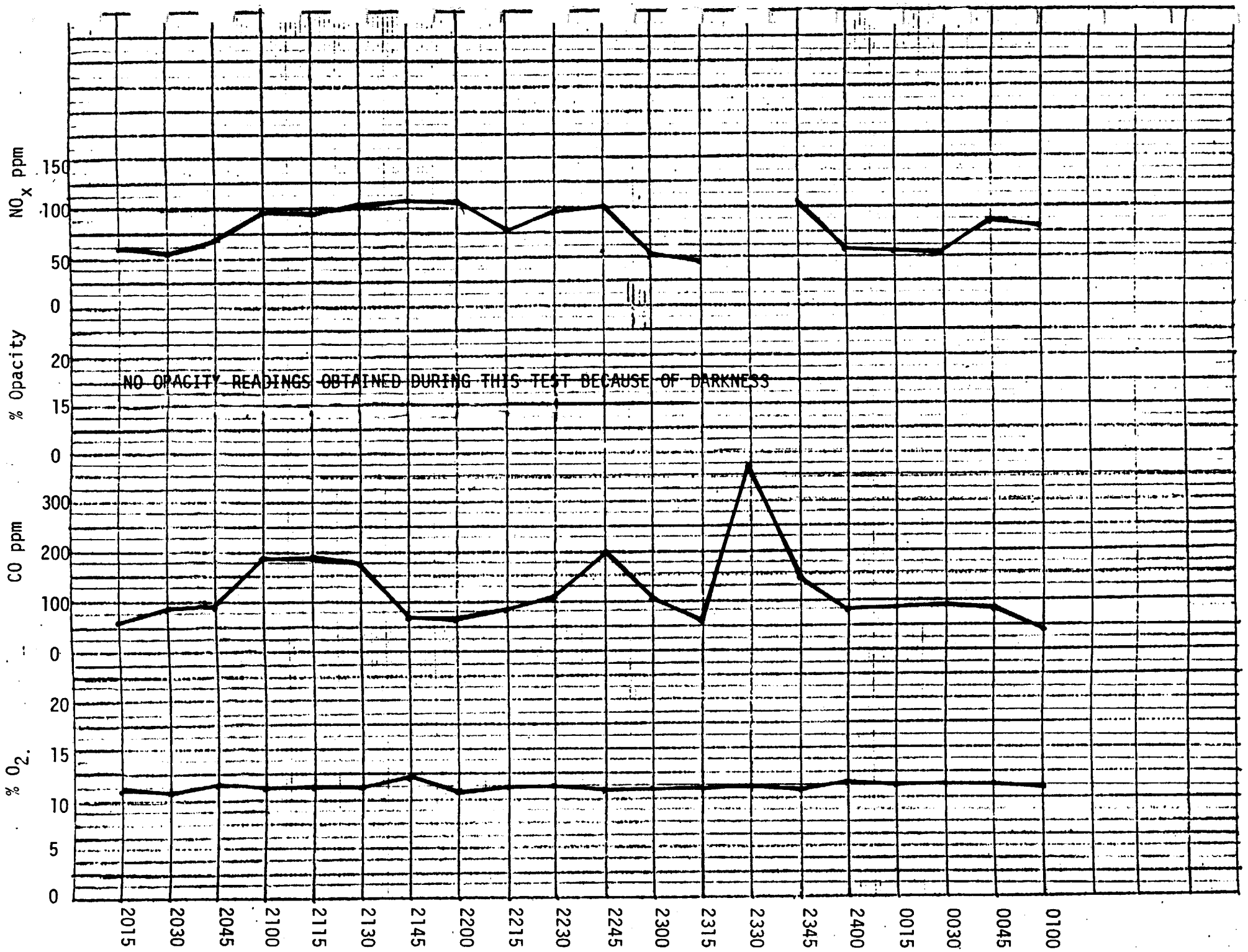


FIGURE 2-4. TEST #3 RELATIONSHIP OF CO, NO$_x$ CONCENTRATIONS, % OPACITY AND % OXYGEN

3. PROCESS DESCRIPTION

There are twelve coke oven batteries (No. 1 through No. 12) at Bethlehem Steel's Sparrows Point, Maryland integrated steel plant. Presently, there are 10 batteries operating with two batteries (Nos. 7 and 8) permanently shutdown. Future plans include the construction of a new 6-m battery and discontinuing operations of some existing batteries after the new battery is on-line.

Only two of the coke oven battery stacks (No. 2 and No. 12) had appropriate sampling ports and platforms for stack sampling. Of these, only Battery No. 2 was fired with coke oven gas (COG). Therefore, the battery stack serving Battery No. 2 at Sparrows Point, Maryland was selected to carry out emission tests of a coke oven facility where mobile gunning is employed.

Battery No. 2 is a 60-oven Koppers gun-flue battery, fired with undesulfurized coke oven gas from the by-product plant. No. 2 Battery began operations in 1961 and has not been rehabilitated since start-up. Additional plant design and operational data are presented in Table 3-1. Maintenance techniques used on Battery No. 2 are mobile-gunning and hand-held gun slurry patching.

The mobile gunning device is a 200 gallon refractory slurry spraying system with a 50 foot water-cooled spraying boom mounted on a 50,000 GVW truck. It is used to spray the oven roofs and the top portion of the oven walls. The mobile-gun spray patching was started on Battery No. 2 in July 1978 and stopped in early September 1978. During this 2 to 3 month period, all ovens except for Ovens No. 245 and No. 228, had the entire upper region of the oven above the coke line sprayed at least once with the mobile-gunner.

During February and March of 1979, the mobile gun sprayer was used to patch 14 additional ovens (Nos. 201, 202, 206, 208, 211, 221, 246, 248, 249, 256, 258, 259, 264 and 266) on Battery No. 2. On May 3, 1979, use of the mobile gunner was restarted on Battery No. 2. The dates when each oven was sprayed since that time are shown in Table 3-2.

In addition to oven spraying with the mobile gun truck, hand-held slurry

spraying guns were used to patch the end flues and door jambs of the ovens. This procedure has been employed frequently for a long time. For example, in the first half of 1979 each oven (door jambs and end flues) in No. 2 Battery has been patched at least four times. The actual hand-held gun patching occurred after an oven was pushed and before the door-machines replaced the doors on the oven. This maintenance technique takes 10 to 15 minutes for each door.

During each test day, process operating data was obtained at approximately 1-hour intervals. The time that each oven was pushed and charged was recorded whenever possible. Bethlehem Steel performed daily coke oven fuel gas and coal analysis. The daily average fuel gas and coal analysis results during the testing period are reported in Table 3-3. Copies of circular charts recording the daily process data were obtained along with the flue inspection sheets and the wall temperature logs. All process operating logs and charts obtained during the tests are presented in Appendix E.

3.1 PROCESS DESCRIPTION

The process description that follows was supplied by

Midwest Research Institute
425 Volker Boulevard
Kansas City, Missouri 64110

Table 3-1. PLANT DESIGN AND OPERATION RECORD

Date 7/9/79

Plant Name Bethlehem Steel
Plant Location Sparrows Pt., MD
Battery No. 2
Name of Plant Contact George Thomas (Heater Foreman)

Type of Ovens and Designer Koppers-Gunflue
Date Built 1960 - started 1961
Date of Last Rehabilitation None
Type of Last Rehabilitation N/A

Number of Ovens Total 60 In Service 60
Size of Ovens Height 10 ft, Width 19.75in,,Length 37 ft

Type of coke produced Met. Coke
Normal coking time (hr) 20.25
Coal charged per oven (tons) 13.8
Reversal period (min) 30

Nozzle decarbonization method Carbon Caps
Is flue gas recirculated? No

Type of fuel gas Coke Oven Gas Heating value 490-500 Btu/scf
Is fuel gas desulfurized? No
Note use of stage charging, preheated coal, etc. Stage charging w/ single stand pipe loading
Stack height and top diameter 250 ft 16 ft 6½ in. ID bottom 11 ft 0 in. ID at top
Test location (stack or waste heat canal) Stack (provide sketch)

Control method used Mobile Gunning

Fuel gas analysis		Coal analysis	
Component	Vol.%	Component	Vol.%
CO_2		Ash	
Ill.		S	
O_2		H_2O	
CO		VM	
H_2			
CH_4			
N_2			
H_2S			

Table 3-2. MOBILE GUN SPRAYING LOG FOR BATTERY NO. 2

SLUR TRUCK #6260

#2 BATTERY

OVEN	BEGAN SLURRING 5/3/79		OVEN		
01	6/22/79		45	6/8/79	
11	5/10/79	6/22/79	55	7/2/79	
21	5/10/79		65	7/2/79	
31	5/11/79	6/8/79	06	5/9/79	
41	5/11/79	6/7/79	16	5/9/79	
51	5/4/79	6/13/79	26	5/3/79	6/18/79
61	5/4/79	6/13/79	36	6/18/79	
~~71~~			46	6/12/79	
02	5/8/79		56	6/12/79	6/19/79
12	5/8/79		66	6/6/79	6/19/79
22			07	5/14/79	
32			17	6/25/79	
42			27	7/2/79	
52	6/11/79		37	7/3/79	
62	6/11/79		47	7/2/79	
~~72~~			57	7/3/79	
03	6/22/79		[redacted]		
13	6/22/79		08	6/12/79	6/21/79
23	5/11/79	6/14/79	18	6/12/79	6/21/79
33	5/11/79	6/7/79	28	5/10/79	6/13/79
43	6/14/79		38	5/4/79	6/13/79
53	6/8/79		48	5/4/79	
63			58	5/10/79	
04	5/8/79	6/11/79	[redacted]		
14	5/8/79	6/11/79	09	6/25/79	
24	5/9/79	6/18/79	19	6/25/79	
34	5/9/79	6/18/79	29		
44	5/3/79		39		
54	5/3/79	6/19/79	49		
64	6/19/79		59		
05			[redacted]		
15					
25					
35					

REMARKS: TRUCK OUT OF SERVICE - 5/7/79 - OPERATIONAL - ALL UNITS.
5/14/70

Table 3-3. DAILY AVERAGE FUEL GAS ANALYSIS AND COAL ANALYSIS

Fuel Gas Component (vol. %)	7/10/79	7/11/79	7/12/79
CO_2	2.5	2.5	2.1
Ill.	2.7	2.7	2.6
O_2	0.4	0.2	0.3
CO	5.4	6.6	6.5
H_2	56.3	56.8	56.0
CH_4	26.9	26.7	27.0
N_2	5.8	4.5	5.5
H_2S $\left(\frac{\text{grains}}{100\ \text{scf}}\right)$	310	298	293
Coal Component (wt. %)			
Ash	6.7	6.7	6.9
S	1.04	1.03	1.00
H_2O	7.2	6.6	6.4
VM	31.5	32.3	32.0
Bulk Density (lb/ft^3)	46.8	46.7	46.6

4. SAMPLING LOCATIONS AND LOCATION OF TRAVERSE POINTS

The sample locations were at the eighty (80') foot level of Battery Stack No. 2. Access to the testing platform was gained by way of a caged ladder. Equipment was transported to the testing platform by means of a pulley and davit. Cummunications were established by citizen band radio between the testing location and the mobile laboratory. Figure 4-1 is a generalized schematic of Battery Stack No. 2.

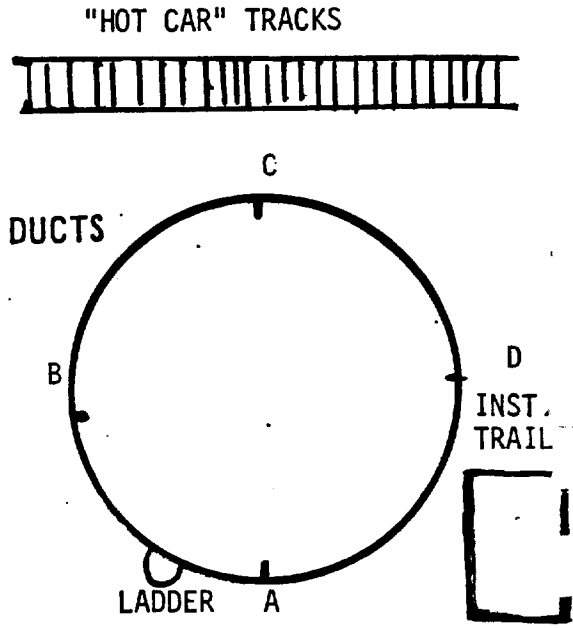
Table 4-1 lists the traverse point location as calculated and utilized in the field. The normal procedure of two perpendicular traverses was modified in order to facilitate easier sampling. Therefore, eight (8) points at four (4) locations were utilized rather than sixteen (16) points at two (2) locations. These traverse points at all four ports were used for preliminary velocity traverse, the particulate, and the benzo-α-pyrene sampling. Port D was used for the continuous monitoring. Port A was used for the Method 7 sampling.

TRW / ENVIRONMENTAL ENGINEERING DIVISION

Table 4-1.

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT Bethelem Steel - Sparrows Point
DATE 7/10/79
SAMPLING LOCATION Battery Stack #2
INSIDE OF FAR WALL TO OUTSIDE OF NIPPLE, (DISTANCE A) 16.83'
INSIDE OF NEAR WALL TO OUTSIDE OF NIPPLE, (DISTANCE B) 2.83'
STACK I.D., (DISTANCE A - DISTANCE B) 14.00'
NEAREST UPSTREAM DISTURBANCE >2 I.D.
NEAREST DOWNSTREAM DISTURBANCE ~ 6.4 I.D.
CALCULATOR JONGLEUX



SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	1.6	14 ft.	.224' ft	34"	36.7"
2	4.9	14 ft.	.686 ft.	34"	42.2"
3	8.5	14 ft.	1.19 ft.	34"	48.3"
4	12.5	14 ft.	1.75	34"	55.0"
5	16.9	14 ft.	2.366	34"	62.4"
6	22.0	14 ft.	3.08 ft.	34"	71.0"
7	28.3	14 ft.	3.962 ft	34"	81.5"
8	37.5	14 ft.	5.25 ft.	34"	107.0"
9	62.5	14 ft.	8.75 ft.	34"	--
10	71.7	14 ft.	10.038 ft.	34"	--
11	78.0	14 ft.	10.92 ft.	34"	--
12	83.1	14 ft.	11.634 ft.	34	--
13	87.5	14 ft.	12.25 ft.	34"	--
14	91.5	14 ft.	12.81 ft.	34"	--
15	95.1	14 ft.	13.314 ft.	34"	--
16	98.4	14 ft.	13.776 ft.	34"	--

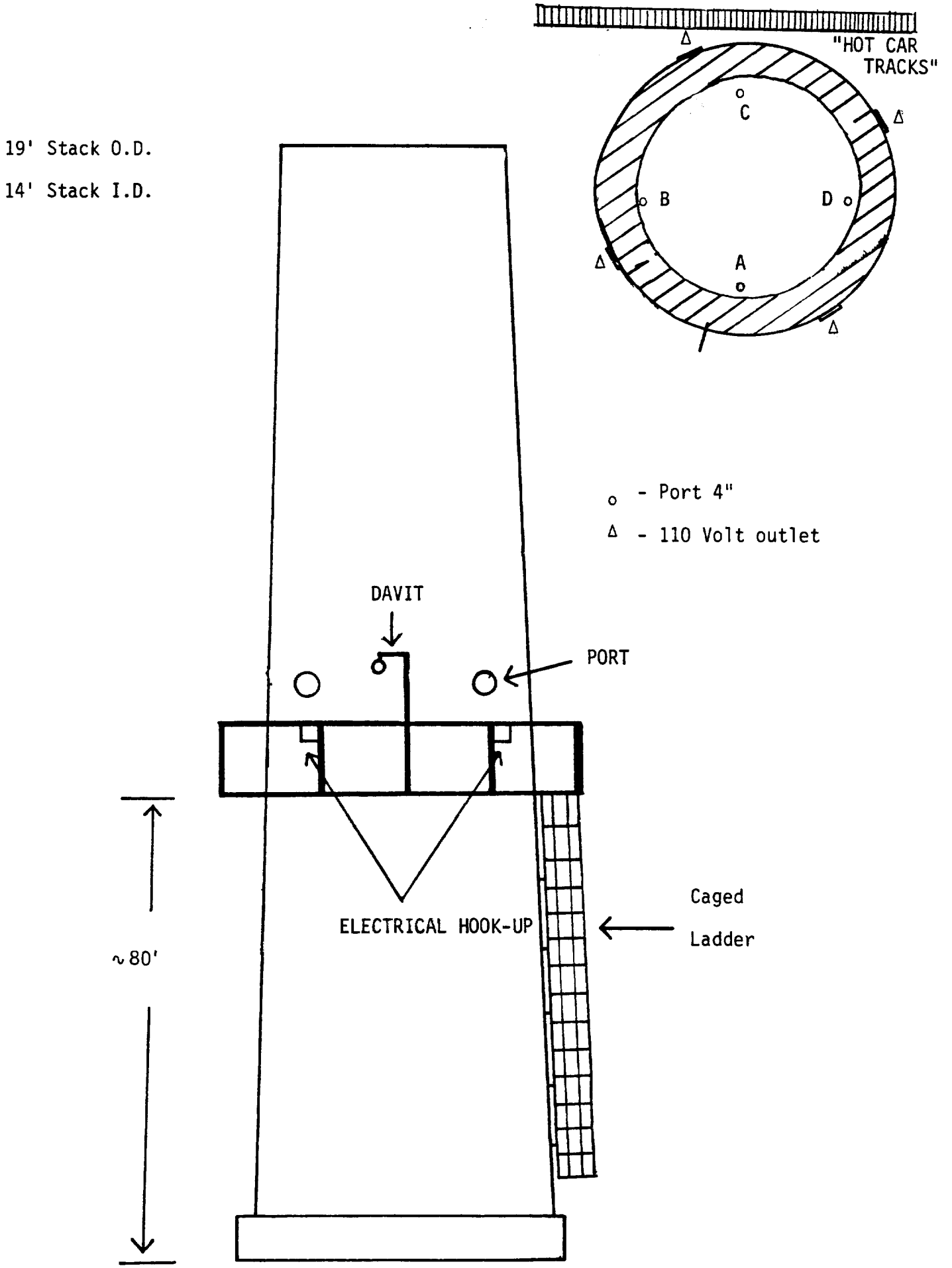


FIGURE 4-1. SCHEMATIC OF BATTERY STACK #2.

5. SAMPLING AND ANALYTICAL PROCEDURES

PARTICULATE SAMPLING

Flue gas particulate concentrations were measured at the outlet of the battery stack. The sampling procedure used was EPA Method 5 as outlined in the Federal Register (40 CFR, Part 60, Appendix A). The only deviation from Method 5 was in the analysis and is discussed under Sulfate Analysis and Ether Chloroform extraction. The prescribed Method 5 analysis was performed prior to the Sulfate analysis and Ether chloroform extraction. A diagram of the Sampling train is shown in Figure 5-1.

The particulate and BαP trains were run simultaneously. A process upset occured midpoint of Test No. 2 which resulted in a 2-hour hold before testing could be resumed. The particulate train sampled four minutes at thirty-two points during Test No. 1. The time sampled at each point was increased to five minutes for the next two tests to assure that adequate volumes would be sampled.

SULFATE ANALYSIS OF PARTICULATE SAMPLES

After analysis of the particulate samples, a 25ml portion of the H_2O collection was removed for sulfate analysis. Analysis was performed by titrating with 0.0100 N Barium perchlorate. The filter was soaked in 80% Isopropyl alcohol and titrated for sulfate analysis.

ETHER CHLOROFORM EXTRACTION

Ether and chloroform extraction was performed on the H_2O portion of the particulate samples for condensibles. This was performed on the H_2O collection minus the 25ml portion used for sulfate analysis. The remaining portion of the H_2O samples was evaporated and the residue weighed and included in the particulate emissions.

BαP SAMPLING

The BαP train and the particulate train were run simultaneously. A process upset occurred midpoint of Test No. 2 which resulted in a 2-hour hold before testing could be resumed. The BαP train sampled four minutes at thirty-two points during Test No. 1. The time sampled at each point was increased to five minutes for the next two tests to assure that adequate volumes would be sampled.

Testing was conducted to determine concentrations of BαP at the outlet of the battery stack. The sampling procedure used consisted of an EPA Method 5 train, modified in the following manner (see Figure 5-2). A Battelle trap was used as an adsorbent sampler and was inserted between the heated filter and first impinger. A thermostatically controlled water bath was used to control the temperature of the adsorbent sampler at 127°F. The Battelle trap was shielded from visible and ultraviolet light during sampling by wrapping with aluminum foil. The adsorbent sampler was capped after sampling and remained covered until analysis was performed (see Figure 5-3). Methylene Chloride was used for rinsing the probe, filter holder, and connecting glass-ware up to the Battelle trap. Acetone was used for rinsing the remainder of the train.

The adsorbent sampler consists of a length of 8mm pyrex tubing wound for approximately eight coils. The adsorbent is retained by an extra coarse Pyrex frit and a spring loaded glass wool plug. The adsorbent section has dimensions equal to a 15mm radius and 70mm in length. Analysis was performed by extracting the BαP from the XAD-2 resin using Cyclohexane. The samples were refrigerated until analysis was performed. Final analysis was performed by measuring the wavelength of the extracted BαP.

Since the adsorbent trap is located in the train prior to the impingers and is cooled to 127°F, some condensation occurs in the trap prior to the impingers. Impingers and silica gel moisture catches do not reflect the total moisture in the stack gas. For this reason, moisture content values from Method 5 runs were used for BαP calculations.

ANALYSIS PROCEDURE FOR BαP

A fluorescence spectrophotometry analysis was used to determine concentrations of BαP. The equipment used for this analysis was the Aminco Model SPF125 Spectrofluorometer with a 7mm lightpath cell. This instrument accurately measures concentrations of BαP as low as 0.001 ppm. The wavelength settings were 378 nm excitation and 403 nm emission with respective slit width openings of 1mm and 5mm. All the samples were in a liquid state, so the only preparations involved with examining each sample was diluting in Cyclohexane any sample which was darkly colored, contained abundant suspended material, or was extremely viscous. This was necessary because any particles or opacity will affect the absorbence. This instrument (the Spectrofluorometer) becomes extremely substance specific at very narrow slit widths, as were used in this analysis.

Filtered particulates and solid samples required an eight hour extraction period in Cyclohexane before analysis could be performed. A Cyclohexane blank was run and taken into account on all extracted and diluted samples in the final calculations.

The quality control procedures taken for this analysis included preparation of a series of BαP standards, exclusion from light, and spiking. A set of standards were prepared for each range (high, medium, and low concentrations) by serial dilutions. Each set was analyzed for linearity by continual measurement throughout the days testing. Since BαP is light sensitive, standards and sample aliquots were discarded after analysis and the samples were kept in closed, dark containers. Lastly, a spiking procedure was used to determine recovery efficiencies on solid and filtered samples, and on samples with very low BαP concentrations. A spiking procedure was followed to assure accurate detection near the limits of the instrument.

No major problems were encountered with the fluorescence spectrophotometric procedure for BαP analysis. This method is preferred over the thin layer chromatographic (TLC) method for low level BαP analysis, as the TLC method had only about 0.01 the sensitivity of direct liquid measurement. The benzo-α-pyrene method was tailored to these samples.

The method originally chosen was intended to be a thin layer chromatography separation with measurement by scanning in situ with a scanning attachment for the fluorescence spectrophotometer. This method lacks the sensitivity required for the analyses. The samples were to be preconcentrated using Kuderna-Danish concentrators with a nitrogen stream flowing over them. It was found, reviewing the literature, that no compound expected to be present in these samples had similar excitation/ emission spectrum to benzo-α-pyrene. Previous analyses by GC/MS on similar samples were the basis of the compounds to be considered as interferences. In addition, a general compendium of polyorganic materials and other organics showed no similar spectrum.[1] It was, therefore, decided to go to a direct in situ method as previously described.

Analysis for BαP was also conducted in the water impingers, but no significant concentrations were found.

[1] Fluorescence and Phosphorescence Data Compendium, Donald L. Helman, American Instrument Co., 1977.

SAMPLING FOR NITROGEN OXIDES

Oxides of Nitrogen (NO_x) were sampled according to EPA Method 7 and by continuous monitoring. One sample flask (CK-15-M7-2B) was opened inadvertently by the sampler, and low concentrations are suspected for that flask. Method 7 uses a grab sample of the flue gas which is collected in an evacuated 2-liter flask containing 25 ml. of a dilute Sulfuric acid-Hydrogen peroxide absorbing solution. Four NO_x samples were taken during each test run. A diagram of the sampling train is shown in Figure 5-4.

ANALYSIS

Nitrogen oxides, except nitrous oxide, were measured colorimetrically using the phenoldisulfonic acid (PDS) procedure which is the Federal Register Method.

GAS SAMPLING AND ANALYSIS

Two grab bag samples were taken for each test. The samples were analyzed for CO_2, O_2, N_2, and CO. Two methods were employed for determining gas composition. Samples of each bag were analyzed on a Gas Chromatograph (GC) using the thermal conductivity principle, and then the bag samples were analyzed using an Orsat analyzer. The GC concentrations were slightly higher than the Orsat concentrations. The Orsat analyzer was suspected of having weak chemicals which would result in the lower concentrations. This would be substantiated by the greater than normal number of passes required before complete absorption occurred. The Orsat analyzer was used, in addition to the GC, for the purpose of maintaining program continuity. The bag sample analysis was used for determining molecular weight and for providing supportive data for the continuous monitors.

CONTINUOUS MONITORS

Continuous monitors were run throughout each test to measure O_2, CO, and NO_x. A stainless steel probe was inserted into the centroid of the stack for removal of flue gas for the continuous monitors (see Figure 5-5). The probe was followed by an ice bath moisture trap for removal of moisture. A pump followed the ice bath moisture trap and supplied flue gas to a mobile laboratory located adjacent to the Battery stack. A second ice bath moisture trap was located inside of the mobile laboratory and was followed by a filter for

removal of particulate. Each continuous monitor was equipped with a flow meter to control flows to the desired operating range of the equipment (see Figure 5-6). The electrical output of the continuous monitors was connected to recorders and recordings were made of emission levels throughout each test.

The continuous monitors were conditioned prior to field testing to verify the accuracy of the instruments. Calibration gases certified as traceable to National Bureau of Standards (NBS) were applied to analyzers to determine analyzer response, drift, linearity, and traceability of calibration gases. The instruments were operated in the field prior to testing and data was obtained to determine the arithmetic mean value and 95% confidence interval of the equipment. The calibration error determination for these instruments can be found in Appendix D.

Oxides of Nitrogen were sampled by EPA Method 7 and by continuous monitoring. Problems occurred with the continuous monitor used for monitoring NO_x periodically. The continuous monitor used operates on internal pumps. Extreme heat at the sampling location resulted in lost voltage which rendered the pumps inoperative. After brief cooling periods, the pumps were reset and continuous monitoring was resumed. This should not affect the results of the data obtained, since the instrument responded to the correct calibration values at the end of each test.

Continuous monitors were run to monitor O_2 and CO in addition to NO_x. Comparative results for the O_2 and CO continuous monitoring were obtained by the GC and Orsat analysis. The averages of the concentrations obtained by the CO continuous monitor are high in comparison with the bag sample analysis. The higher concentrations are the result of peaks of CO that occurred during monitoring on a continuous basis. This is shown in Figure 2-1.

OPACITY

Visible determination of Opacity was performed for the duration of tests No. 1 and No. 2. Test No. 3 was performed at night and no visible determination could be obtained. The observations were performed in accordance with EPA Method 9 by a qualified visible emission person.

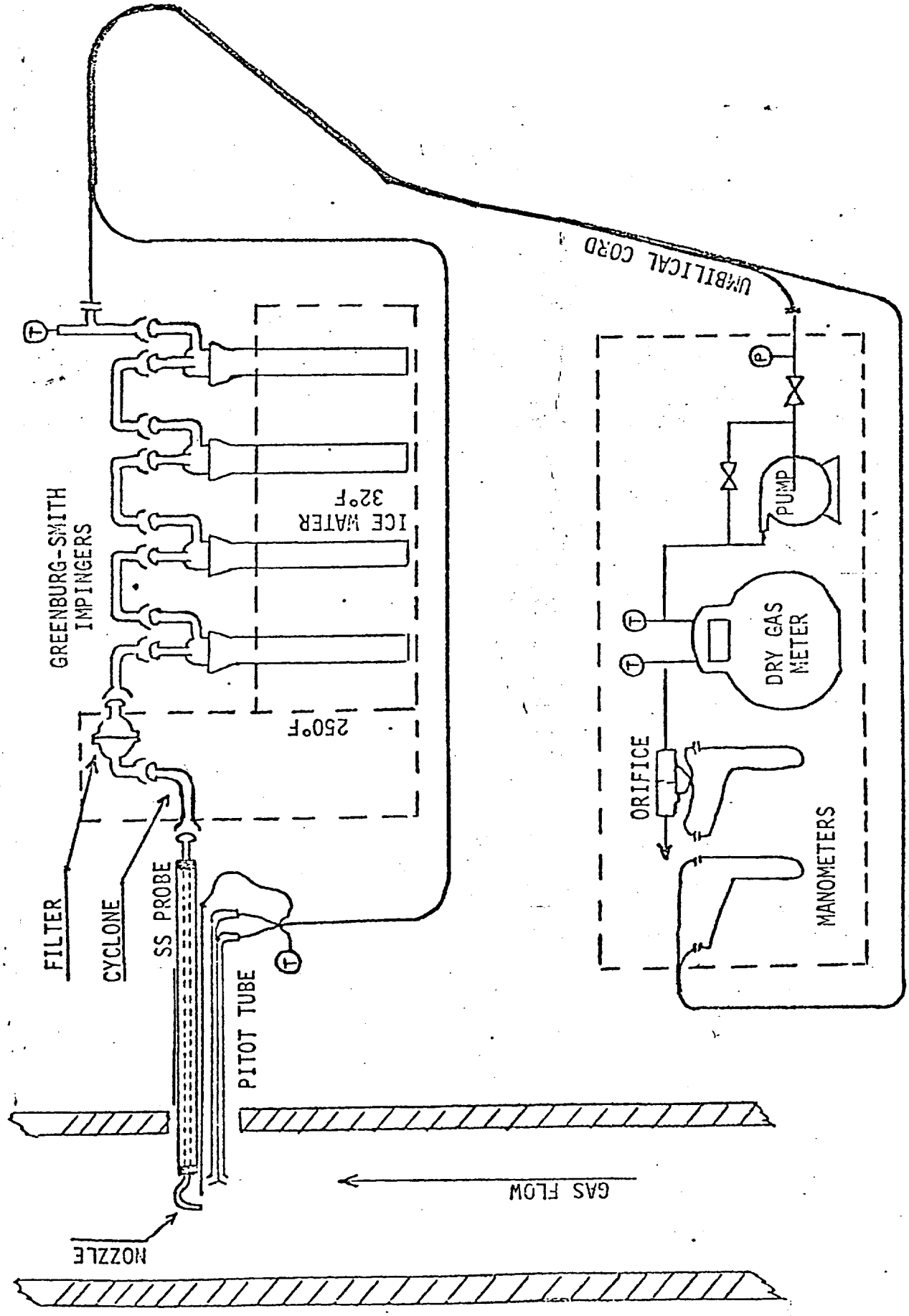


Figure 5-1 Particulate Sampling Train

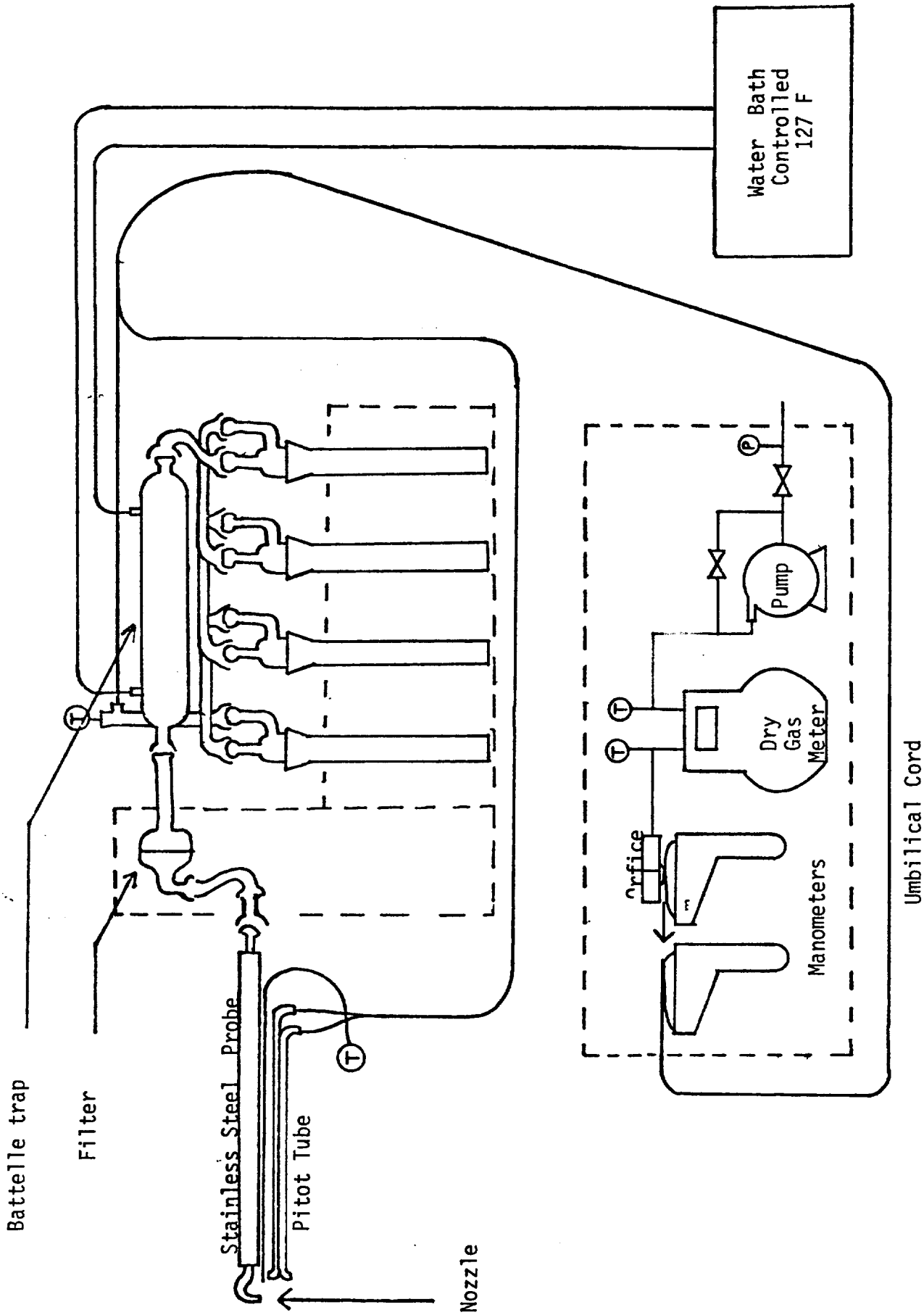


Figure 5-2 BAP Sampling Train

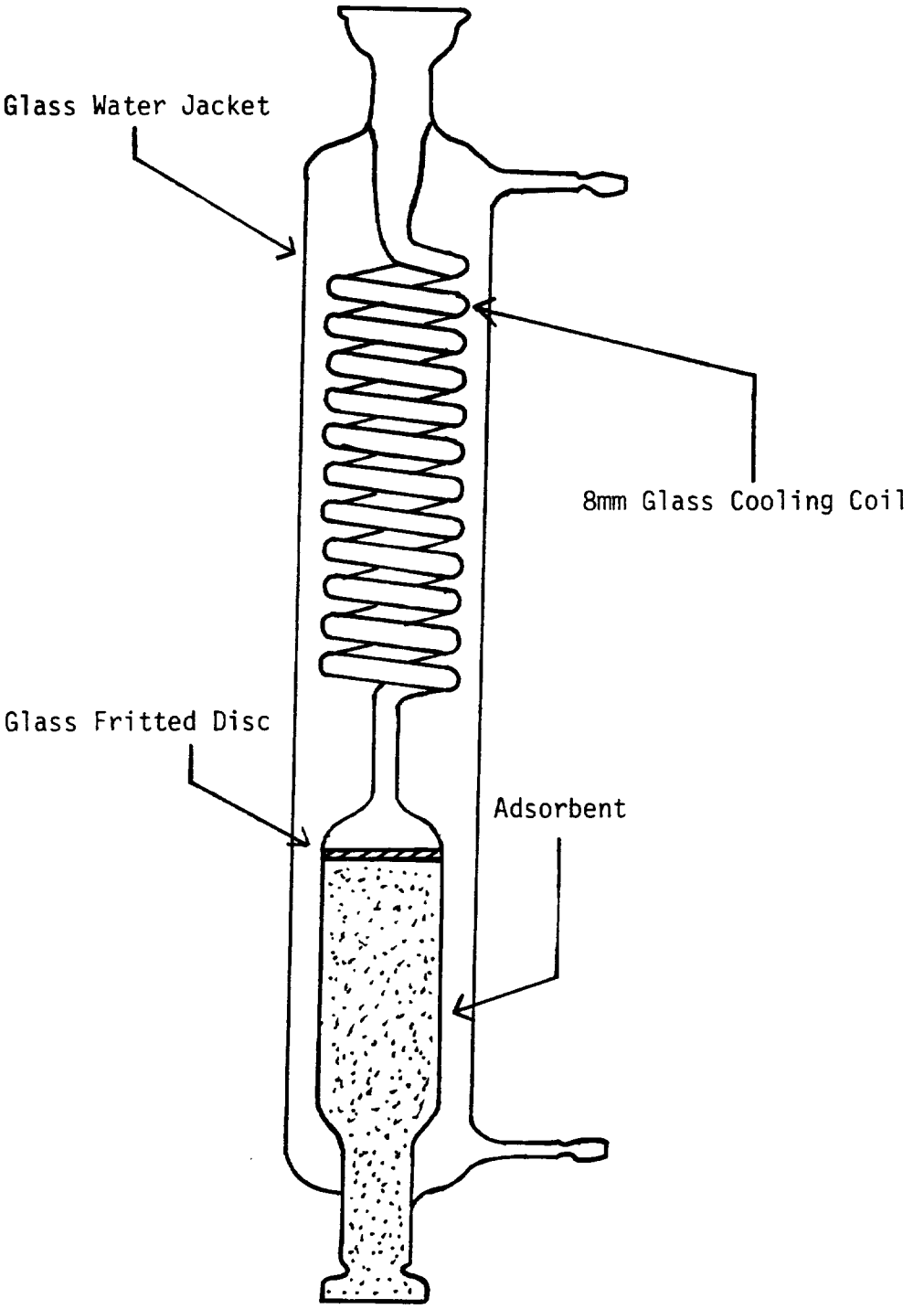
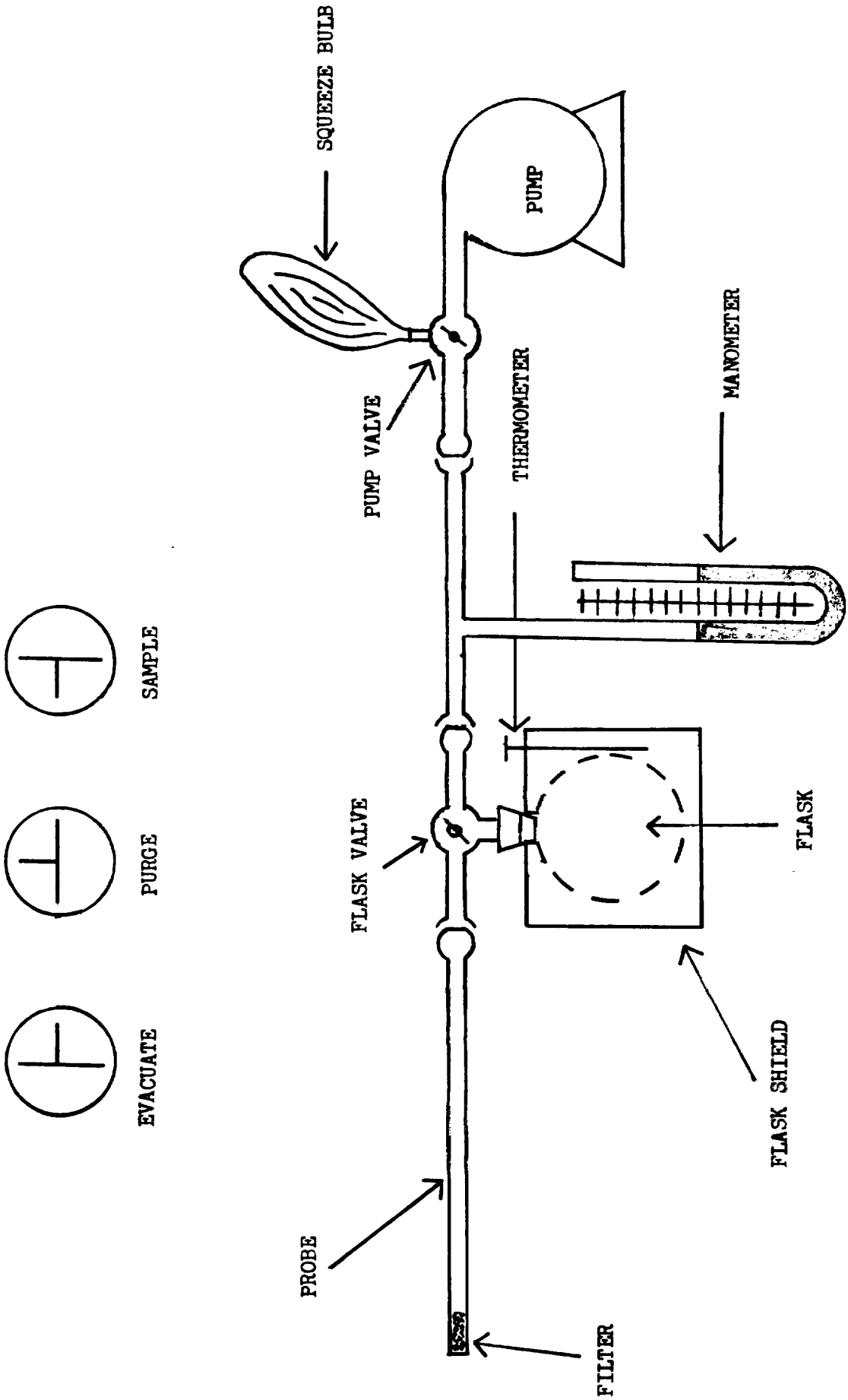


Figure 5-3 Battelle Trap



METHOD 7 SAMPLE TRAIN
FIGURE 5-4

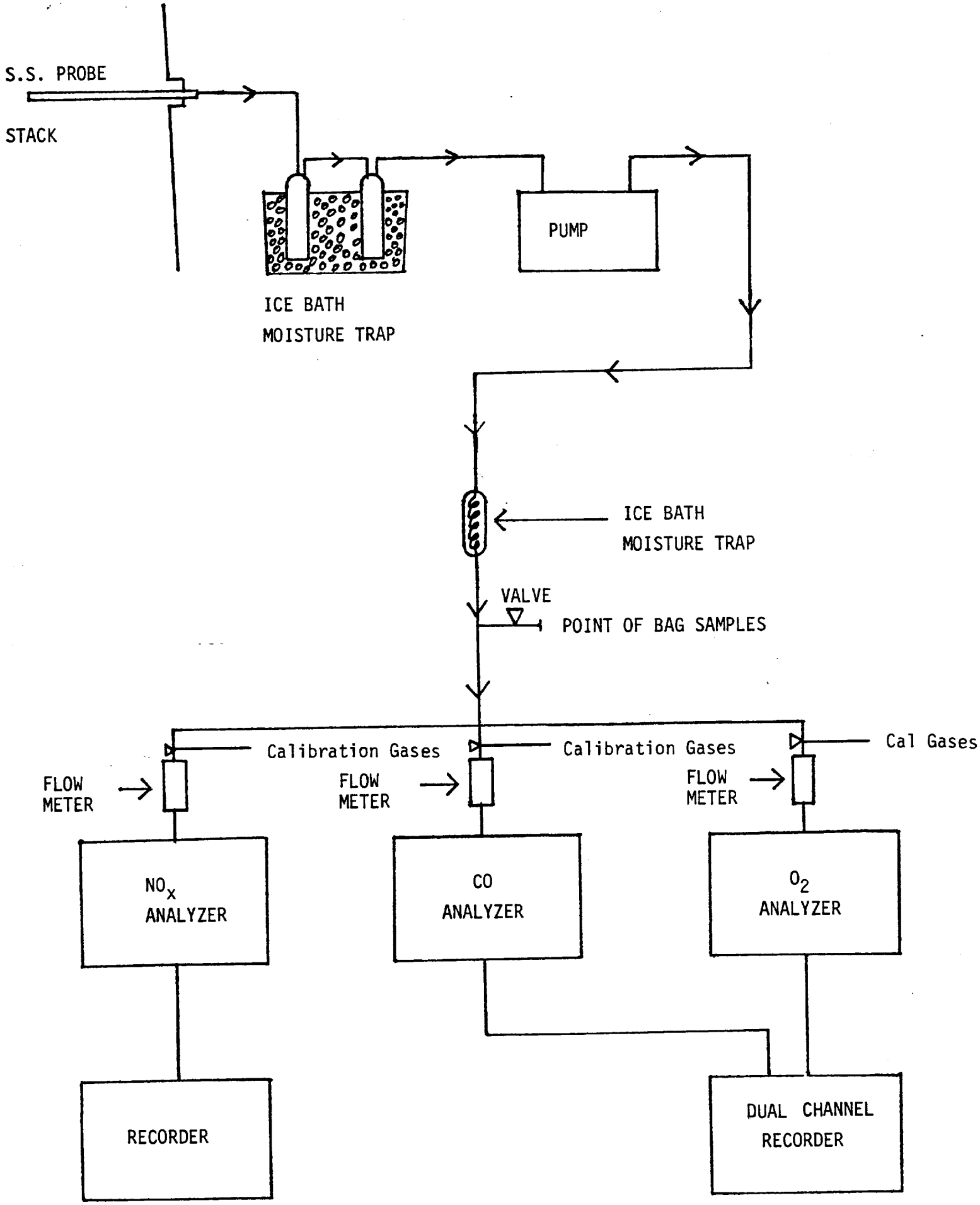


Figure 5-5 Continuous Monitor Schematic

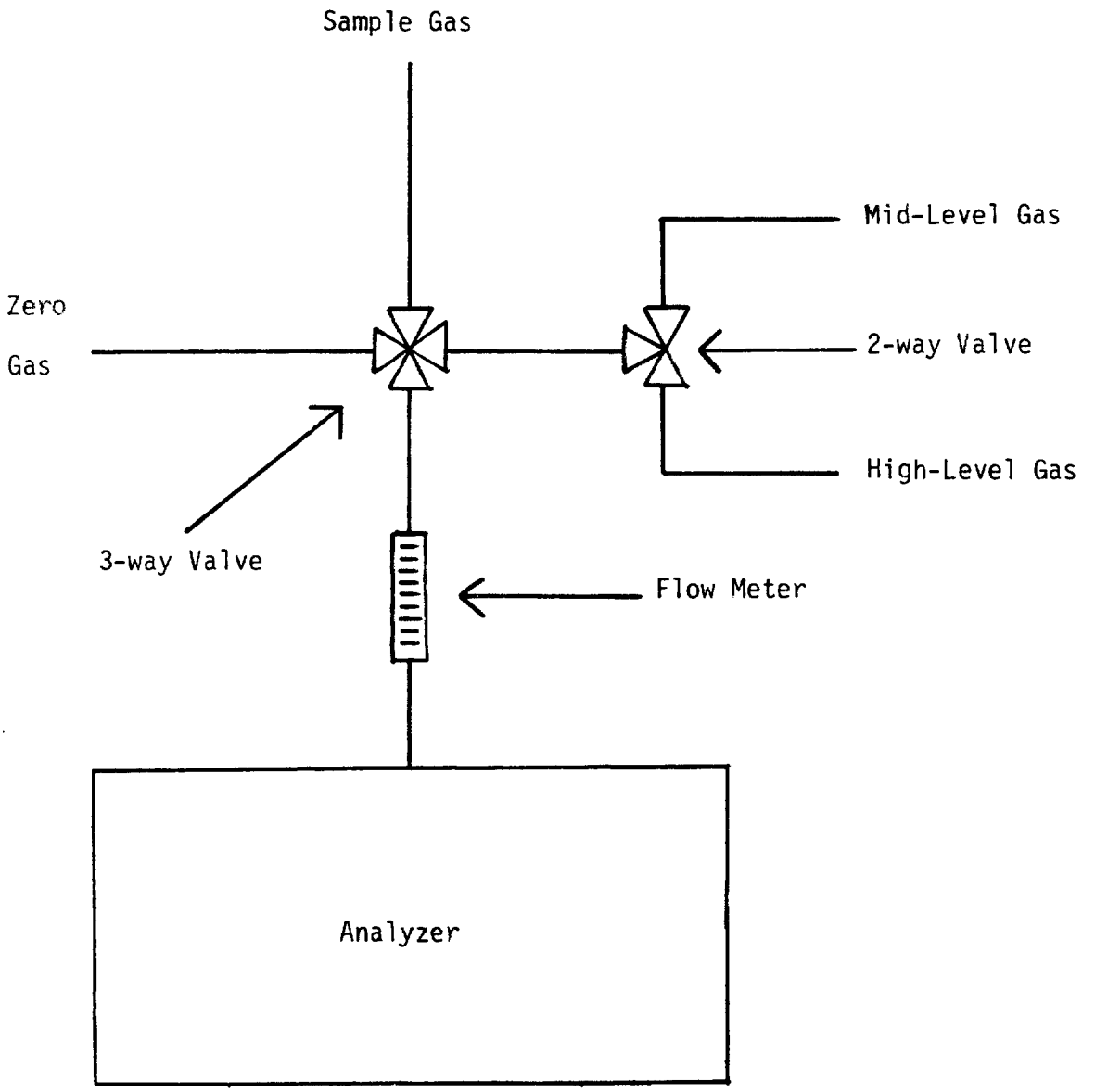


Figure 5-6
Schematic of Calibration Gas Injection
For Continuous Monitors

APPENDIX A

FIELD DATA

FIELD DATA SHEETS

- METHOD 5 - PARTICULATE
- BAP
- METHOD 9 - VISIBLE EMISSIONS
- GAS ANALYSIS
- PRELIMINARY VELOCITY TRAVERSE
- FIELD MOISTURE DETERMINATION

METHOD 5

FIELD DATA SHEETS

SAMPLING SUMMARY SHEET

Plant Bethlehem Steel Location Sparrows Point, MD.

source By Product Coke Oven Battery Stack #2 PARTICULATE-RUNS

Run	Date	N_p	P_m	P_b	V_m	T_m	$V_{m_{std}}$	V_w	$V_{w_{gas}}$	%M	M_d
MS-1	July 11, 1979	32	0.89	30.00	67.085	88	64.925	203.6	9.59	12.87	0.871
-2	July 12, 1979	32	0.94	30.00	82.037	98	77.982	291.0	13.71	14.95	0.850
-3	July 12, 1979	32	1.05	30.00	88.627	100	83.968	259.4	12.22	12.70	0.873

Run	MW_d	MW	P_{st}	P_s	C_p	$\sqrt{\Delta P_s \times (T_s+460)}$ [c]	V_s	T_s	T_t	D_n	%I
MS-1	29.000	27.584	-1.2 / -.088	29.91	0.85	4.815	12.18	562	128	0.5	112.8
-2	28.932	27.298	-1.2 / -.088	29.91	0.85	4.974	12.65	565	160	0.5	107.5
-3	28.952	27.561	-1.2 / -.088	29.91	0.85	5.268	13.33	567	160	0.5	107.2
			H_2O / H_s								

$$V_{m_{std}} = \frac{17.64 \times V_m \left(P_b + \frac{P_m}{13.6}\right)}{(T_m + 460)}$$

$$\% M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}}$$

$$V_{w_{gas}} = .0471\ V_w$$

$$M_d = \frac{100 - \% M}{100}$$

$$MW_d = (\%CO_2 \times \tfrac{44}{100}) + (\%O_2 \times \tfrac{32}{100}) + (\%CO + \%N_2) \times \tfrac{28}{100}$$

$$MW = MW_d \times M_d + 18\,(1 - M_d)$$

$$P_s = P_b \pm P_{st}$$

$$V_s = 85.49\ C_p \times \sqrt{\Delta P_s \times (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\%I = \frac{.09450\ (T_s + 460) \times V_{m_{std}}}{V_s \times T_t \times P_s \times M_d \times A_n}$$

N_p Total No. of Sampling Points

P_m Average Orifice Pressure Drop, in. H_2O

P_b Barometric Pressure, in. Hg. Absolute

V_m Volume of Dry Gas at Meter Conditions, DCF

T_m Average Meter Temperature, °F

$V_{m_{std}}$ Volume of Dry Gas at STP, DSCF[a]

V_w Total H_2O Collected in Impingers and Silica Gel, ml

$V_{w_{gas}}$ Volume of Water Vapor Collected at STP, SCF[b]

% M % Moisture by Volume

M_d Mole Fraction of Dry Gas

$\%CO_2$ Volume % Dry

$\%O_2$ Volume % Dry

% CO Volume % Dry

$\%N_2$ Volume % Dry

MW_d Molecular Weight of Stack Gas, Dry Basis

MW Molecular Weight of Stack Gas, Wet Basis

P_{st} Static Pressure of Stack Gas, in. Hg

P_s Stack Gas Pressure, in. Hg. Absolute

C_p Pitot Tube Coefficient

V_s Stack Gas Velocity at Stack Conditions, fps

T_s Average Stack Temperature °F

T_t Net Time of Test, Min.

A_n Sampling Nozzle Area, ft

% I Percent Isokinetic

[a] Dry standard cubic feet at 68°F, 29.92 in. Hg.

[b] Standard conditions at 68°F, 29.92 in. Hg.

[c] $\sqrt{\Delta P_s \times (T_s + 460)}$ is determined by averaging the square root of the product of the velocity head (ΔP_s) and the absolute stack temperature from each sampling point.

SAMPLING SUMMARY SHEET

Plant Bethlehem Steel Location Sparrows Point, MD.

Source By Product Coke Oven Battery Stack # 2 BAP-RUNS

Run	Date	N_p	P_m	P_b	V_m	T_m	$V_{m_{std}}$	V_w	$V_{w_{gas}}$	%M	M_d
BAP-1	July 11, 1979	32	0.86	30.00	67.42	89	65.125			12.87	0.871
-2	July 12, 1979	32	0.80	30.00	80.81	98	76.789			14.95	0.850
-3	July 12, 1979	32	1.12	30.00	97.51	95	93.232			12.70	0.873

Run	MW_d	MW	P_{st}	P_s	C_p	$\sqrt{\Delta P_s \times (T_s+460)}$ [c]	V_s	T_s	T_t	D_n	%I
BAP-1	29.000	27.58	-1.2 / -0.88	29.1	0.85	4.868	12.31	555	128	0.5	111.2
-2	28.932	27.30	-1.2 / -0.88	29.1	0.85	4.703	11.96	569	160	0.5	112.4
-3	28.952	27.56	-1.2 / -0.88	29.1	0.85	5.610	14.20	567	165	0.5	108.2
			H_2O / H_s								

$$V_{m_{std}} = \frac{17.64 \times V_m \left(P_b + \frac{P_m}{13.6}\right)}{(T_m + 460)}$$

$$\% M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}}$$

$$V_{w_{gas}} = .0471\ V_w$$

$$M_d = \frac{100 - \% M}{100}$$

$$MW_d = (\%CO_2 \times \tfrac{44}{100}) + (\%O_2 \times \tfrac{32}{100}) + (\%CO + \%N_2) \times \tfrac{28}{100}$$

$$MW = MW_d \times M_d + 18\,(1 - M_d)$$

$$P_s = P_b \pm P_{st}$$

$$V_s = 85.49\ C_p \times \sqrt{\Delta P_s \times (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\%I = \frac{.09450\ (T_s + 460) \times V_{m_{std}}}{V_s \times T_t \times P_s \times M_d \times A_n}$$

N_p Total No. of Sampling Points

P_m Average Orifice Pressure Drop, in. H_2O

P_b Barometric Pressure, in. Hg. Absolute

V_m Volume of Dry Gas at Meter Conditions, DCF

T_m Average Meter Temperature, °F

$V_{m_{std}}$ Volume of Dry Gas at STP, DSCF[a]

V_w Total H_2O Collected in Impingers and Silica Gel, ml

$V_{w_{gas}}$ Volume of Water Vapor Collected at STP, SCF[b]

% M % Moisture by Volume

M_d Mole Fraction of Dry Gas

$\%CO_2$ Volume % Dry

$\%O_2$ Volume % Dry

% CO Volume % Dry

$\%N_2$ Volume % Dry

MW_d Molecular Weight of Stack Gas, Dry Basis

MW Molecular Weight of Stack Gas, Wet Basis

P_{st} Static Pressure of Stack Gas, in. Hg

P_s Stack Gas Pressure, in. Hg. Absolute

C_p Pitot Tube Coefficient

V_s Stack Gas Velocity at Stack Conditions, fps

T_s Average Stack Temperature °F

T_t Net Time of Test, Min.

A_n Sampling Nozzle Area, ft

% I Percent Isokinetic

[a] Dry standard cubic feet at 68°F, 29.92 in. Hg.

[b] Standard conditions at 68°F, 29.92 in. Hg.

[c] $\sqrt{\Delta P_s \times (T_s + 460)}$ is determined by averaging the square root of the product of the velocity head (ΔP_s) and the absolute stack temperature from each sampling point.

LOAD SHEET
STACK TEST - PARTICULATE

Test #CKO-15-M5-1

Part 1

F ter	(Initial	y Only)
	Value	Location
	0.0283	04
	17.64	05
	.0471	06
	1032	07
F(Min)	128	09
(in²)	.250	10
S(in Hg)	29.9	11
(ft³)	67.085	12
(ml)	203.6	13
CO_2	4.0	14
O_2	9.0	15
N_2	87.0	16
N	20994.27	17
s(ft²)	153.9	18
T +460)	1022.0	19
	Part 2	
F (mg)	341.8	00
t (mg)	361.1	01
D(f³)	64.925	02
S ("Hg)	29.9	03
d	0.871	04
Ts+460)	1022.0	05
scfm)	50,589.7	06
m	88	
	.89	
M		
b	30.0	

Test #M5-2

Enter	Value	Location
Tf(Min)	160	09
(DN)²(in²)	.250	10
PS(in Hg)	29.9	11
VM(ft³)	82.037	12
VW(ml)	291	13
% CO_2	3.6	14
% O_2	8.9	15
% N_2	87.5	16
~~4350~~ 4360	21686.43	17
As(ft²)	153.9	18
(Ts+460)	1025	19
	Part 2	
mf (mg)	751.0	00
mt (mg)	760.6	01
VMSTD(f³)	77.982	02
Ps ("Hg)	29.9	03
Md	0.851	04
(Ts+460)	1025	05
Qs(scfm)	51,132.2	06
	98	
	.94	
	30.0	

Test #M5-3

Enter	Value	Location
Tf(Min)	160	09
(DN)²(in²)	.250	10
PS(in Hg)	29.9	11
VM(ft³)	88.627	12
VW(ml)	259.4	13
% CO_2	3.6	14
% O_2	9.4	15
% N_2	87.0	16
~~4350~~ 4360	22966.72	17
As(ft²)	153.9	18
(Ts+460)	1027	19
	Part 2	
mf (mg)	679.5	00
mt (mg)	695.5	01
VMSTD(f³)	83.968	02
Ps ("Hg)	29.9	03
Md	0.873	04
(Ts+460)	1027	05
Qs(scfm)	55,202.4	06
	100	
	1.05	
	30.0	

RESULTS

STACK TEST - PARTICULATE

Test # CKO-15-MS-1		Test # MS-2		Test # MS-3	
Value		Value		Value	
Vm (SCF)	64 ~~69~~.925	Vm (SCF)	77.982	Vm (SCF)	83.968
Vm (SCM	1.837	Vm (SCM)	2.207	Vm (SCM)	2.376
Vw gas (CF)	9.590	Vw gas (CF)	13.706	Vw gas (CF)	12.218
% Moisture	12.849	% Moisture	14.949	% Moisture	12.702
Md	0.871	Md	0.851	Md	0.873
MWd	29.000	MWd	28.932	MWd	28.952
MW	27.584	MW	27.298	MW	27.561
Vs (fpm)	731.027	Vs (fpm)	759.152	Vs (fpm)	800.050
ACFM	112,505.124	ACFM	116,833.440	ACFM	123,127.676
Flow (SCFM)	50,589.673	Flow (SCFM)	51,132.207	Flow (SCFM)	55,202.426
Flow (SCMM)	1431.668	Flow (SCMM)	1447.041	Flow (SCMM)	1562.229
% I	112.8	% I	107.5	% I	107.2
% EA	63.64	% EA	61.913	% EA	68.403
Front gr/scf	0.05107	Front gr/scf	0.14831	Front gr/scf	0.12462
Front gm/scm	0.18566	Front gm/scm	0.33963	Front gm/scm	0.28539
Total gr/scf	0.08565	Total gr/scf	0.15020	Total gr/scf	0.12756
Total gm/scm	0.19614	Total gm/scm	0.34397	Total gm/scm	0.29211
Front gr/acf	0.03657	Front gr/acf	0.06517	Front gr/acf	0.05606
Front gm/acm	0.08374	Front gm/acm	0.14923	Front gm/acm	0.12839
Total gr/acf	0.03863	Total gr/acf	0.06600	Total gr/acf	0.05738
Total gm/acm	0.08847	Total gm/acm	0.15114	Total gm/acm	0.13141
Front lb/hr	35.14987	Front lb/hr	64.98926	Front lb/hr	58.95697
Front kg/hr	15.94398	Front kg/hr	29.47913	Front kg/hr	26.74288
Total lb/hr	37.13464	Total lb/hr	65.82001	Total lb/hr	60.34521
Total kg/hr	16.84427	Total kg/hr	29.85596	Total kg/hr	27.37259

LOAD SHEET
STACK TEST - PARTICULATE

Test # BAP-1

Enter	Part 1 (Initially Only) Value	Location
	0.0283	04
	17.64	05
	.0471	06
	1032	07
[illegible]	128	09
[illegible]^2(in^2)	.25	10
S [illegible] n Hg)	29.91 ~~29.930.0~~	11
M(ft^3)	67.42	12
[illegible] ml)	≈ ~~205~~ 204	13
CO_2	4.0	14
		15
N_2	87.0	16
[illegible]	[illegible]223.347	17
[illegible](ft^2)	153.9	18
[illegible]	1015.3	19
	Part 2	
f (mg)		00
[illegible]		01
[illegible]TD(f^3)		02
s ("Hg)		03
d		04
[illegible] +460)		05
s(scfm)		06

Test # BAP-2

Enter	Value	Location
Tf(Min)	160	09
(DN)^2(in^2)	.25	10
PS(in Hg)	29.91	11
VM(ft^3)	80.81	12
VW(ml)	≈ ~~289~~ 287	13
% CO_2	3.6	14
% O_2	8.9	15
% N_2	87.5	16
~~4350~~ 4360 $\sqrt{\ }$	20506.082	17
As(ft^2)	153.9	18
(Ts+460)	1029	19
	Part 2	
mf (mg)		00
mt (mg)		01
VMSTD(f^3)		02
Ps ("Hg)		03
Md		04
(Ts+460)		05
Qs(scfm)		06

Test # BAP-3

Enter	Value	Location
Tf(Min)	165	09
(DN)^2(in^2)	.25	10
PS(in Hg)	29.91	11
VM(ft^3)	97.51	12
VW(ml)	~~265~~ ~~275~~ 288	13
% CO_2	3.6	14
% O_2	9.4	15
% N_2	87.0	16
~~4350~~ 4360 $\sqrt{\ }$	24455.732	17
As(ft^2)	153.9	18
(Ts+460)	1027	19
	Part 2	
mf (mg)		00
mt (mg)		01
VMSTD(f^3)		02
Ps ("Hg)		03
Md		04
(Ts+460)		05
Qs(scfm)		06

T_M	89			98			95	
P_m	.86			.80			1.12	
P_b	30.0			30.0			30.0	

202.25

RESULTS

STACK TEST - PARTICULATE

Test # BAP-1		Test # BAP-2		Test # BAP-3		
Value		Value		Value		
Vm (SCF)	65.125	Vm (SCF)	76.789	Vm (SCF)	93.232	
Vm (SCM	1.843	Vm (SCM)	2.173	Vm (SCM)	2.638	
Vw gas (CF)	9.608	Vw gas (CF)	13.518	Vw gas (CF)	~~12.953~~	13.565
% Moisture	12.857	% Moisture	14.969	% Moisture	~~12.198~~	12.701
Md	0.871	Md	0.850	Md	~~0.878~~	0.873
MWd	29.000	MWd	28.932	MWd	28.952	
MW	27.586	MW	27.296	MW	~~27.616~~	27.561
Vs (fpm)	738.985	Vs (fpm)	717.795	Vs (fpm)	~~851.075~~	851.926
ACFM	113729.861	ACFM	110468.669	ACFM	~~130,980.469~~	131,111.3
Flow (SCFM)	51485.302	Flow (SCFM)	48147.409	Flow (SCFM)	~~59,062.213~~	58782.2
Flow (SCMM)	1457.034	Flow (SCMM)	1362.572	Flow (SCMM)	~~1671.461~~	1663.539
% I	111.2	% I	112.4	% I	~~107.7 108.2~~	108.
% EA	63.640	% EA	61.913	% EA	68.403	
Front gr/scf		Front gr/scf		Front gr/scf		
Front ~~gm/scm~~		Front gm/scm		Front gm/scm		
Total gr/scf		Total gr/scf		Total gr/scf		
Total gm/scm		Total gm/scm		Total gm/scm		
Front gr/acf		Front gr/acf		Front gr/acf		
Front gm/acm		Front gm/acm		Front gm/acm		
Total gr/acf		Total gr/acf		Total gr/acf		
Total gm/acm		Total gm/acm		Total gm/acm		
Front lb/hr		Front lb/hr		Front lb/hr		
Front kg/hr		Front kg/hr		Front kg/hr		
Total lb/hr		Total lb/hr		Total lb/hr		
Total kg/hr		Total kg/hr		Total kg/hr		

ENVIRONMENTAL ENGINEERING DIVISION

FIELD DATA

PLANT BETHLEHEM STEEL - SPARROWS POINT
DATE 7/11
SAMPLING LOCATION BATTERY STACK
SAMPLE TYPE PARTICULATE
RUN NUMBER 0-15-M5-1
OPERATOR TAYLOR
AMBIENT TEMPERATURE 80
BAROMETRIC PRESSURE 30.0
STATIC PRESSURE, (P_s) -1.2
FILTER NUMBER (s) 070

PROBE LENGTH AND TYPE 10'
NOZZLE I.D. .203
ASSUMED MOISTURE, % 10.5
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$ 1.9
C FACTOR .96
PROBE HEATER SETTING 250
HEATER BOX SETTING 250
REFERENCE Δp .054

SCHEMATIC OF TRAVERSE POINT LAYOUT

FINAL LEAK TEST

READ AND RECORD ALL DATA EVERY 4 MINUTES

INT. LEAK TEST .01

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	00	1518	347.312									
A-1	04	1522	349.89	.03 ✓	1.1	1.1	550	82	80		250	60
2	08	1526	352.19	.03 ✓	1.1	1.1	555	86	80			62
3	12	1530	354.46	.03 ✓	1.1	1.1	560	90	82			62
4	16	1534	357.01	.04 ✓	1.4	1.4	560	90	82			62
5	20	1538	359.54	.04 ✓	1.4	1.4	550	94	84			64
6	24	1542	362.14	.04 ✓	1.4	1.4	555	96	84			68
7	28	1546	364.46	.03 ✓	1.1	1.1	550	100	86			70
8	32	1550	366.725	.02 ✓	.78	.78	560	100	86			70
START	00	1640	366.725									
B-1	04	1644	368.99	.02 ✓	.78	.78	560	84	80			68
2	08	1648	370.33	.02 ✓	.78	.78	560	86	80			70
3	12	1652	372.47	.03 ✓	1.1	1.1	565	88	82			70
4	16	1656	374.86	.03 ✓	1.1	1.1	560	90	82			70
5	20	1700	376.74	.02 ✓	.78	.78	565	92	84			68
6	24	1704	378.18	.02 ✓	.78	.78	560	92	84			70
7	28	1708	381.12	.02 ✓	.78	.78	565	94	84			70
8	32	1712	383.979	.02 ✓	.78	.78	555	94	84			70

COMMENTS:

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ENVIRONMENTAL ENGINEERING DIVISION

PAGE 4 OF 4

FIELD DATA

2ND SHEET

PLANT BETH. STEEL
DATE 7-11-79
SAMPLING LOCATION BATH. STACK
SAMPLE TYPE PART.
RUN NUMBER M5-1
OPERATOR Jerry Taylor
AMBIENT TEMPERATURE 32
BAROMETRIC PRESSURE 30.0
STATIC PRESSURE, (P_s) 1.2
FILTER NUMBER (s) 070

PROBE LENGTH AND TYPE 10'
NOZZLE I.D. .5"
ASSUMED MOISTURE, % 12.5
SAMPLE BOX NUMBER 8H
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING 250
REFERENCE Δp .054

SCHEMATIC OF TRAVERSE POINT LAYOUT

FINAL LEAK TEST .01

READ AND RECORD ALL DATA EVERY 4 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	00	1830	383.777									
C-1	04	1834	384.95	.02 ✓	.78	.78	570	74	80		250	65
2	08	1838	386.97	.02 ✓	.78	.78	570	76	82			68
3	12	1842	389.14	.03 ✓	1.1	1.1	555	70	82			70
4	16	1846	391.22	.02 ✓	.78	.78	560	74	84			70
5	20	1850	393.15	.02 ✓	.78	.78	565	96	84			68
6	24	1854	395.11	.02 ✓	.78	.78	565	76	84			70
7	28	1858	396.85	.01	.45	.45	560	96	88			68
8	32	1902	398.418	.01	.45	.45	570	98	88			68
START	00	1940	398.418									
D-1	04	1944	400.25	.02 ✓	.78	.78	560	88	86			60
2	08	1948	402.33	.02 ✓	.78	.78	550	88	86			60
3	12	1952	403.94	.01	.45	.45	565	90	86			62
4	16	1956	405.52	.01	.45	.45	560	92	86			62
5	20	2000	407.68	.03 ✓	1.1	1.1	575	92	86			64
6	24	2004	409.78	.03 ✓	1.1	1.1	570	96	86			64
7	28	2008	412.32	.02 ✓	.78	.78	580	98	88			66
8	32	2012	414.317	.02 ✓	.78	.78	570	98	88			66
	128		67.085			.89	562	88				

COMMENTS: START PURGE [illegible]

EPA (Dur) 235

ENVIRONMENTAL ENGINEERING DIVISION

CKO-15-21

FIELD DATA

PLANT SPARROWS POINT
DATE 7/12/79
SAMPLING LOCATION BATTERY STACK
SAMPLE TYPE PARTICULATE
RUN NUMBER CKO-15-M5-2
OPERATOR TAYLOR
AMBIENT TEMPERATURE 90
BAROMETRIC PRESSURE 30.0
STATIC PRESSURE, (P_s) -1.2" H_2O
FILTER NUMBER (s) 103

PROBE LENGTH AND TYPE 10' S/S
NOZZLE I.D. .5
ASSUMED MOISTURE, % 12.5%
SAMPLE BOX NUMBER —
METER BOX NUMBER —
METER $\Delta H_@$ 1.9
C FACTOR .96
PROBE HEATER SETTING 250
HEATER BOX SETTING 250
REFERENCE Δp .054

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES INT. LEAK TEST .014

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	00	1145	422.734									
D-1	05	1150	425.17	.02	.76	.76	560	88	84		250	60
2	10	1155	427.65	.02	.76	.76	550	94	88			58
3	15	1200	430.55	.03	1.1	1.1	575	100	90			60
4	20	1205	433.67	.03	1.1	1.1	570	106	92			60
5	25	1210	435.64	.03	1.1	1.1	555	106	92			62
6	30	1215	438.17	.02	.76	.76	565	106	94			60
7	35	1220	440.59	.02	.76	.76	560	106	96			62
8	40	1225	443.399	.03	1.1	1.1	565	106	96			66
START	00	1400	443.377									
C-1	05	1405	446.07	.03	1.1	1.1	590	90	88			68
2	10	1410	448.76	.03	1.1	1.1	555	92	88			70
3	15	1415	451.74	.03	1.1	1.1	560	94	88			70
4	20	1420	454.05	.02	.76	.76	565	100	90			70
5	25	1425	456.43	.02	.76	.76	560	100	90			72
6	30	1430	458.92	.02	.76	.76	550	104	94			70
7	35	1435	461.42	.02	.76	.76	570	104	94			68
8	40	1440	464.214	.03	1.1	1.1	560	106	96			70

COMMENTS:

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ENVIRONMENTAL ENGINEERING DIVISION

FIELD DATA

CKD-15-21(A) (CONT.)

PLANT [illegible] STEE
DATE 7-12-77
SAMPLING LOCATION BATT. [illegible]
SAMPLE TYPE PART.
RUN NUMBER 510-15-M5-2
OPERATOR [illegible]
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE 10' [illegible]
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING ✓
HEATER BOX SETTING
REFERENCE Δp

SCHEMATIC OF TRAVERSE POINT LAYOUT

FINAL LEAK TEST .01

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	00	1640	464.215									
B-1	05	1645	466.44	.03	1.1	1.1	540	10	88		250	64
2	10	1650	469.25	.03	1.1	1.5	565	94	90			64
3	15	1655	471.61	.02	.76	.76	570	98	92			66
4	20	1700	473.97	.02	.76	.76	575	104	92			68
5	25	1705	475.86	.01	.45	.45	575	104	94			70
6	30	1710	477.68	.01	.45	.45	580	104	96			70
7	35	1715	480.04	.02	.76	.76	555	106	96			72
8	40	1720	482.437	.02	.76	.76	550	110	98			72
START	00	1740	482.437									
A-1	05	1745	485.05	.03	1.1	1.1	560	98	86			64
2	10	1750	487.87	.03	1.1	1.1	565	104	96			66
3	15	1755	490.76	.03	1.1	1.1	570	110	98			68
4	20	1800	493.53	.02	.76	.76	575	112	100			70
5	25	1805	495.94	.02	.76	.76	580	114	102			72
6	30	1810	498.32	.02	.76	.76	570	116	104			72
7	35	1815	501.57	.04	1.5	1.5	565	116	104			72
8	40	1820	504.821	.04	1.5	1.5	570	118	106			70
	160		82.037			.94	565	98				

COMMENTS:

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ENVIRONMENTAL ENGINEERING DIVISION

FIELD DATA

1 of 2

PLANT SPARROWS POINT
DATE 7/12/79
SAMPLING LOCATION BATTERY STACK.
SAMPLE TYPE PARTICULATE
RUN NUMBER RKO-15-M5-3
OPERATOR TAYLOR
AMBIENT TEMPERATURE 80
BAROMETRIC PRESSURE 30.0
STATIC PRESSURE, (P_s) -1.2" H_2O
FILTER NUMBER (s) 102

PROBE LENGTH AND TYPE 10' S S
NOZZLE I.D. .500
ASSUMED MOISTURE, % 12.5
SAMPLE BOX NUMBER —
METER BOX NUMBER —
METER $\Delta H_@$ 1.9
C FACTOR .96
PROBE HEATER SETTING 250
HEATER BOX SETTING 250
REFERENCE Δp .057

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

INT LEAK TEST .008

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	00	2010	505.741									
A-1	05	2015	508.42	.02	.78	.78	560	92	90		250	65
2	10	2020	510.78	.02	.78	.78	565	96	92			66
3	15	2025	513.12	.02	.78	.78	570	100	92			66
4	20	2030	516.06	.03	1.1	1.1	570	104	94			68
5	25	2035	518.96	.03	1.1	1.1	560	106	96			68
6	30	2040	521.92	.03	1.1	1.1	565	110	96			66
7	35	2045	524.73	.04	1.5	1.5	560	110	98			68
8	40	2050	528.357	.04	1.5	1.5	575	112	100			70
START	00	2140	528.357									
B-1	05	2145	530.72	.02	.78	.78	565	96	96			60
2	10	2150	533.32	.02	.78	.78	560	98	96			64
3	15	2155	535.68	.02	.78	.78	570	104	96			66
4	20	2200	537.73	.01	.45	.45	575	106	98			66
5	25	2205	539.67	.01	.45	.45	580	108	98			68
6	30	2210	542.61	.03	1.1	1.1	570	110	100			68
7	35	2215	545.72	.03	1.1	1.1	555	112	100			70
8	40	2220	548.941	.04	1.5	1.5	560	112	104			64

COMMENTS:

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ENVIRONMENTAL ENGINEERING DIVISION

FIELD DATA

CKO-10-55
2 of 2

PLANT SPARROWS POINT
DATE 7/12/79.
SAMPLING LOCATION BATTERY STACK.
SAMPLE TYPE PARTICULATE
RUN NUMBER
OPERATOR
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

SCHEMATIC OF TRAVERSE POINT LAYOUT

FINAL LEAK TEST .012

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	00	2310	548.742									
C-1	05	2315	551.72	.03	1.1	1.1	550	98	96		750	60
2	10	2320	554.42	.03	1.1	1.1	560	98	94			60
3	15	2325	557.38	.04	1.5	1.5	570	100	94			62
4	20	2330	560.63	.04	1.5	1.5	580	102	94			62
5	25	2335	563.32	.02	.78	.78	565	106	96			64
6	30	2340	565.71	.02	.78	.78	570	106	96			64
7	35	2345	568.58	.03	1.1	1.1	565	108	96			66
8	40	2350	571.424	.02	.78	.78	575	108	96			66
START	00	2215	571.424									
D-1	05	2220	573.998	.03	1.1	1.1	565	94	90			60
2	10	2225	576.65	.03	1.1	1.1	560	98	94			60
3	15	2230	579.28	.02	.78	.78	570	100	94			62
4	20	2235	581.68	.02	.78	.78	575	102	94			64
5	25	2240	584.93	.04	1.5	1.5	580	104	94			66
6	30	2245	588.33	.04	1.5	1.5	570	106	96			66
7	35	2250	591.22	.03	1.1	1.1	565	106	96			68
8	40	2255	594.368	.04	1.5	1.5	560	105	95			68
	160		88.627			105	567	100				

COMMENTS:

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CKO-15-005

ENVIRONMENTAL ENGINEERING DIVISION

ANALYTICAL DATA

PLANT SPARROWS POINT
DATE 7/11/89
SAMPLING LOCATION BATTERY STACK #2
SAMPLE TYPE METHOD 5
RUN NUMBER CKO-15-M5-1
SAMPLE BOX NUMBER
CLEAN-UP MAN JONGLEUY

FRONT HALF

		LABORATORY RESULTS
ACETONE WASH OF NOZZLE, PROBE, CYCLONE FLASK, FRONT HALF OF FILTER HOLDER	CONTAINER 40	45.1 mg
FILTER NUMBER 070	CONTAINER	296.7 mg
FRONT HALF SUBTOTAL		341.8 mg

BACK HALF

IMPINGER CONTENTS AND WATER WAS OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER	CONTAINER 7	5.0 mg
	ETHER-CHLOROFORM EXTRACTION 1	5.2 mg
ACETONE WAS OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER	CONTAINER 17	9.1 mg
BACK HALF SUBTOTAL		19.3 mg
TOTAL WEIGHT		361.1 mg

MOISTURE

IMPINGERS
FINAL VOLUME 388 ml
INITIAL VOLUME 200 ml
NET VOLUME 188 ml

SILICA GEL

FINAL WEIGHT	215.6 g	g	g
INITIAL WEIGHT	200 g	g	g
NET WEIGHT	15.6 g	g	g

TOTAL MOISTURE 203.6 g

IKW

ENVIRONMENTAL ENGINEERING DIVISION

CKO-15-20

ANALYTICAL DATA

PLANT SPARROWS POINT
DATE 7/12/79
SAMPLING LOCATION BATTERY STACK
SAMPLE TYPE PARTICULATE
RUN NUMBER CKO-15-M5-2
SAMPLE BOX NUMBER
CLEAN-UP MAN JONGLEUX

LABORATORY RESULTS

FRONT HALF

ACETONE WASH OF NOZZLE, PROBE, CYCLONE FLASK, FRONT HALF OF FILTER HOLDER — CONTAINER 13 — 41.0 mg

FILTER NUMBER 103 — CONTAINER — 710.0 mg

FRONT HALF SUBTOTAL 751.0 mg

BACK HALF

IMPINGER CONTENTS AND WATER WAS OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER — CONTAINER 5 — 1.3 mg

ETHER-CHLOROFORM EXTRACTION 6 — 8.3 mg

ACETONE WAS OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER — CONTAINER NA — NA mg RJ

BACK HALF SUBTOTAL 9.6 mg

TOTAL WEIGHT 760.6 mg

MOISTURE

IMPINGERS
FINAL VOLUME 471 ml
INITIAL VOLUME 200 ml
NET VOLUME 271 ml

SILICA GEL
FINAL WEIGHT 220 g
INITIAL WEIGHT 200 g
NET WEIGHT 20 g

TOTAL MOISTURE 291 g

TRW

ENVIRONMENTAL ENGINEERING DIVISION

CKO-15-30

ANALYTICAL DATA

PLANT SPARROWS POINT
DATE 7/12/79
SAMPLING LOCATION BATTERY STACK #2
SAMPLE TYPE PARTICULATE.
RUN NUMBER CKO-15-M5-3
SAMPLE BOX NUMBER
CLEAN-UP MAN JOHGLEUX

FRONT HALF

		LABORATORY RESULTS
ACETONE WASH OF NOZZLE, PROBE, CYCLONE FLASK, FRONT HALF OF FILTER HOLDER	CONTAINER 19	43.9 mg
FILTER NUMBER 102	CONTAINER	635.6 mg
FRONT HALF SUBTOTAL		679.5 mg

BACK HALF

IMPINGER CONTENTS AND WATER WAS OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER	CONTAINER 2	0.3 mg
	ETHER-CHLOROFORM EXTRACTION 9	9.6 mg
ACETONE WAS OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER	CONTAINER 8	6.1 mg
BACK HALF SUBTOTAL		16.0 mg
TOTAL WEIGHT		695.5 mg

MOISTURE

IMPINGERS
FINAL VOLUME 435 ml
INITIAL VOLUME 200 ml
NET VOLUME 235 ml

SILICA GEL

FINAL WEIGHT	224.4 g	g	g
INITIAL WEIGHT	200 g	g	g
NET WEIGHT	24.4 g	g	g

TOTAL MOISTURE 259.4 g

C100-15-006

TRW

ENVIRONMENTAL ENGINEERING DIVISION

NOMOGRAPH DATA

PLANT SPARROWS POINT

DATE JULY 11 1979

SAMPLING LOCATION BATTERY STACK #2 (METHOD 5)

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	2.0
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m_{avg.}}$	100
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	12.5
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	30.09
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	30.00
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	.997
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	555
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.0198
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	.03
C FACTOR		
CALCULATED NOZZLE DIAMETER, in.		
ACTUAL NOZZLE DIAMETER, in.	.5	
REFERENCE Δp, in. H_2O		

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BENZO -α- PYRENE

FIELD DATA SHEETS

PLANT: PAROWS POINT
LOCATION: BATTERY STACK #2
OPERATOR: McREYNOLDS
DATE: 7-11-79
RUN NO.: E CKO-15-EXP-1
SAMPLE BOX NO.: 2E
METER BOX NO.: 10E
METER ΔH@: 2.0
C FACTOR: 1.02
PITOT TUBE COEFFICIENT, C_p: .85

ENVIRONMENTAL ENGINEERING DIVISION

SCHEMATIC OF STACK CROSS SECTION

Page 1 of 2

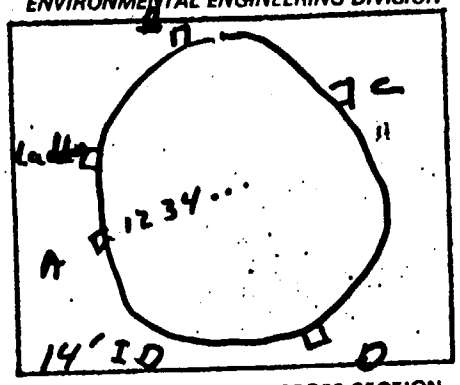
AMBIENT TEMPERATURE: 0°
BAROMETRIC PRESSURE: 30.0
ASSUMED MOISTURE, %: 12.5
PROBE LENGTH, m (ft): 10'
NOZZLE IDENTIFICATION NO.:
AVERAGE CALIBRATED NOZZLE DIAMETER, mm (in.): .5
PROBE HEATER SETTING: 60
LEAK RATE, m^3/min. (cfm): .02 CFM at 15" Hg
PROBE LINER MATERIAL: 316 SS
STATIC PRESSURE, mm Hg (in. Hg): -1.1" H_2O
FILTER NO.: 105 ~~100~~

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	VACUUM mm Hg (in Hg)	STACK TEMPERATURE (T_S) °C (°F)	VELOCITY HEAD (ΔP_S), mm(in.)H_2O	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER mm H_2O (in. H_2O)	GAS SAMPLE VOLUME m^3 (ft^3)	GAS SAMPLE TEMPERATURE AT DRY GAS METER: INLET °C (°F)	GAS SAMPLE TEMPERATURE AT DRY GAS METER: OUTLET °C (°F)	FILTER HOLDER TEMPERATURE, °C (°F)	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °C (°F)	Organic Trap Temperatur °C (°F)
											Water Ba
START	0 / 1500					378.93	~~60~~	~~80~~			
B - 8	4 20	6	550	.02	.69	380.1	80	80	250	65	136
7	8 24	7	550	.02	.69	382.63	82	80	250	65	142
6	12 28	7	550	.02	.69	384.69	84	80	250	65	142
5	16 32	9	550	.03	1.05	386.90	86	80	250	65	140
4	20 36	10	550	.03	1.05	389.32	88	80	250	70	140
3	24 40	10	550	.03	1.05	391.33	90	82	250	70	140
2	28 44	8	550	.02	.69	393.37	90	82	250	70	140
START 1635 1	32 48	8	550	.02	.69	395.50	90	82	250	70	140
C - 8	36 42	15	560	.03	1.05	397.94	84	84	250	60	140
7	40 46	15	550	.03	1.05	400.4	88	84	250	60	140
6	44 50	12	550	.03	1.05	402.80	92	84	250	55	140
TOTAL 5	48 54	12	550	.03	1.05	405.30	Avg. 92	Avg. 86	250	55	140
AVERAGE 4	52 58	11	550	.03	1.05	407.64	Avg. 94	86	250	60	140
3	56 1702	10	550	.03	1.05	410.02	96	86	250	60	144
2	60 06	10	550	.03	1.05	412.48	96	86	250	60	146
1	64 1710	10	550	.02	.69	414.35	96	86	250	60	150

Benzo-a-pyrene DATA SHEET

ENVIRONMENTAL ENGINEERING DIVISION

PLANT Beth Steel
LOCATION Beth Stack #2
OPERATOR J. McReynolds
DATE 7-11-79
RUN NO. CKO-15-BAP-1
SAMPLE BOX NO. 2E
METER BOX NO. 10E
METER ΔH@ 2.0
C FACTOR 1.02
PITOT TUBE COEFFICIENT, C_p .85



SCHEMATIC OF STACK CROSS SECTION

AMBIENT TEMPERATURE 80
BAROMETRIC PRESSURE 30.00
ASSUMED MOISTURE, % 12.5
PROBE LENGTH, m (ft) 10'
NOZZLE IDENTIFICATION NO.
AVERAGE CALIBRATED NOZZLE DIAMETER, cm (in.) .52
PROBE HEATER SETTING
LEAK RATE, m^3/min. (cfm)
PROBE LINER MATERIAL
STATIC PRESSURE, mm Hg (in. Hg) 1.1 H_2O
FILTER NO.

2ND SHEET

Page 2 of 2

TRAVERSE POINT NUMBER	SAMPLING TIME 64.7936	VACUUM mm Hg (in Hg)	STACK TEMPERATURE (T_s) °C (°F)	VELOCITY HEAD (ΔP_s) mm(in.)H_2O	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER mm H_2O (in. H_2O)	GAS SAMPLE VOLUME 419.185	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET °C (°F)	GAS SAMPLE TEMPERATURE AT DRY GAS METER OUTLET °C (°F)	FILTER HOLDER TEMPERATURE °C (°F)	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °C (°F)	Organic Trap Temperature °C (°F)
D-8	68 30	10	560	.03	1.05	416.65	82	82	250	65	144
7	72 34	10	560	.03	1.05	419.15	86	82	250	65	144
6	76 38	10	570	.03	1.05	421.60	90	84	250	65	150
5	80 42	11	570	.03	1.05	423.87	94	84	250	65	154
4	84 46	8	570	.02	.69	425.92	96	84	250	65	154
3	88 50	8	565	.02	.69	427.85	98	86	250	70	160
2	92 54	5	565	.01	.45	429.38	98	88	250	70	158
1	96 58	5	550	.01	.45	430.88	100	88	250	70	150
A-8	100 1946	10	580	.03	1.05	433.30	89	88	250	70	140
7	104 44	10	550	.03	1.05	435.30	92	88	250	65	138
6	108 48	10	550	.03	1.05	437.42	96	88	250	65	136
5	112 52	10	550	.03	1.05	439.71	98	90	250	65	136
TOTAL	116 56	9	550	.02	.69	441.65	Avg. 102	Avg. 90	250	65	138
AVERAGE	120 2000	6	560	.01	.45	443.22	Avg. 102	90	250	65	134
2	124 09	7	580	.01	.45	444.80	102	90	250	65	134
1	128 08	7	580	.01	.45	446.35	102	92	250	65	134

START 1936

Final Leak Rate at 15" .015

128 556 .86 6742 89

Benzo-a-pyrene DATA SHEET

PLANT SPARROWS POINT
LOCATION Coke Oven #2
OPERATOR McREYNOLDS
DATE 7/12/79
RUN NO. CKO-15-BAP-2
SAMPLE BOX NO. 4E
METER BOX NO. 10E
METER ΔH@ 1.9
C FACTOR ~~.96~~ 1.02
PITOT TUBE COEFFICIENT, C_p .85

SCHEMATIC OF STACK CROSS SECTION

AMBIENT TEMPERATURE 8
BAROMETRIC PRESSURE 30.0
ASSUMED MOISTURE, % 12.5
PROBE LENGTH, m (ft) 10'
NOZZLE IDENTIFICATION NO. -
AVERAGE CALIBRATED NOZZLE DIAMETER, cm (in.) .5
PROBE HEATER SETTING Not used
LEAK RATE, m^3/min.(cfm) START .02 Final .03 at 18"
PROBE LINER MATERIAL STAINLESS STEEL
STATIC PRESSURE, mm Hg (in. Hg) -1.2" H_2O
FILTER NO. ~~105~~ 10

W.B = Water Bath Temp.
T.E. = Organic Trap Exit Temp

Page 1 of 2

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min	VACUUM mm Hg (in Hg)	STACK TEMPERATURE (T_s), °C (°F)	VELOCITY HEAD (ΔP_s), mm(in.)H_2O	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER mm H_2O (in. H_2O)	GAS SAMPLE VOLUME m^3 (ft^3)	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET °C (°F)	GAS SAMPLE TEMPERATURE AT DRY GAS METER OUTLET °C (°F)	FILTER HOLDER TEMPERATURE, °C (°F)	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °C (°F)	Water Bath Organic Trap Temperature °C (°F)
A-8	0 1145 / 5 50	12	580	.04	1.4	459.24	88	88	250	70	145
7	10 1250	7	570	.02	.69	461.70	92	92	250	70	160
6	15 55 05	7	575	.02	.69	464.10	96	94	250	70	135 Trap Exit
5	20 1300	8	580	.02	.69	466.54	100	94	250	70	139 T.E.
4	25 05	5	585	.01	.35	468.40	102	98	250	70	135 T.E.
3	30 10	10	554	.03	1.05	471.28	102	94	250	70	140 W.B.
2	35 15	5	560	.01	.35	473.20	106	96	250	70	140 W.B.
1	40 20	5	550	.01	.35	474.96	100	96	250	70	140 W.B.
D-8	45 1355	7	580	.02	.69	477.34	88	88	250	65	113 T.E.
7	50 1400	5	585	.01	.35	479.21	92	90	250	65	120 T.E.
6	55 05	5	590	.01	.35	481.00	96	90	250	65	120 T.E.
5	60 10	5	555	.01	.35	482.72	96	90	250	65	120 T.E.
TOTAL 4	65 15	5	560	.01	.35	484.48	Avg 96	Avg. 92	250	70	146 W.B.
AVERAGE 3	70 20	5	565	.01	.35	486.23	Avg. 98	92	250	70	146 W.B.
2	75 25	5	565	.01	.35	487.95	100	94	250	70	148 W.B.
1	80 30	5	550	.01	.35	489.77	102	94	250	70	

Lost Power

START 1245

START 1350

Benzo-a-pyrene DATA SHEET

ENVIRONMENTAL ENGINEERING DIVISION

PLANT
LOCATION
OPERATOR
DATE
RUN NO. CKO-15-BAP-2
SAMPLE BOX NO.
METER BOX NO.
METER ΔH@
C FACTOR
PITOT TUBE COEFFICIENT, C_p

SCHEMATIC OF STACK CROSS SECTION
Page 2 of 2

AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
ASSUMED MOISTURE, %
PROBE LENGTH, m (ft)
NOZZLE IDENTIFICATION NO.
AVERAGE CALIBRATED NOZZLE DIAMETER, cm (in.)
PROBE HEATER SETTING
LEAK RATE, m^3/min.(cfm)
PROBE LINER MATERIAL
STATIC PRESSURE, mm Hg (in.Hg)
FILTER NO.

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	VACUUM mm Hg (in Hg)	STACK TEMPERATURE (T_S) °C (°F)	VELOCITY HEAD (ΔP_S), mm(in.)H_2O	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER mm H_2O (in. H_2O)	GAS SAMPLE VOLUME m^3 (ft^3)	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET °C (°F)	GAS SAMPLE TEMPERATURE AT DRY GAS METER OUTLET °C (°F)	FILTER HOLDER TEMPERATURE, °C (°F)	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER, °C (°F)	Organic Trap Temperatur °C (°F)
	80 1646					489 (ft³) 77					
C - 8	85 45	10	565	.03	1.05	492.60	92	92	250	70	110 T.
7	90 50	11	565	.03	1.05	495.37	98	92	250	70	125 T.
6	95 55	12	570	.03	1.05	498.46	102	94	250	70	126 T.
5	100 1700	12	575	.03	1.05	501.48	106	96	250	70	129 T.
4	105 05	10	575	.02	~~1.05~~ .69	504.30	108	96	250	70	129 T.
3	110 10	12	580	.03	1.05	507.05	108	98	250	70	129 T.
2	115 15	12	555	.03	1.05	510.04	108	98	250	70	129 T.
1	120 20	12	550	.03	1.05	513.02	110	100	250	70	129 T.
START	120 1745										
B - 8	125 50	12	565	.04	1.4	516.0	96	96	250	70	124 T.
7	130 55	17	575	.05	1.75	519.69	106	98	250	65	126 T.
6	135 1800	12	575	.03	1.05	522.78	110	100	250	65	125 T.
TOTAL 5	140 05	12	580	.03	1.05	525.84	Avg. 110	Avg. 100	250	65	125 T.
AVERAGE 4	145 10	12	586	.03	1.05	528.88	Avg. 112	100	250	65	124 T.
3	150 15	12	560	.03	1.05	532.02	114	102	250	65	125 T.
2	155 20	8	565	.02	.69	534.42	112	102	250	65	124 T.
1	160 25	8	550	.02	.69	536.86	108	102	250	65	124 T.
	160		569		.80	80.81		98			

Benzo-a-pyrene DATA SHEET

PLANT SPARROWS POINT
LOCATION BATTERY STACK #2
OPERATOR McREYNOLDS
DATE 7/12/79
RUN NO. CKO-15-BAP-3
SAMPLE BOX NO. 4E
METER BOX NO. 10 E
METER ΔH@ 1.9
C FACTOR 1.02
PITOT TUBE COEFFICIENT, C_p

SCHEMATIC OF STACK CROSS SECTION

AMBIENT TEMPERATURE 8 CK-15-B4
BAROMETRIC PRESSURE 30.0
ASSUMED MOISTURE, % 12.5
PROBE LENGTH, m (ft) 10'
NOZZLE IDENTIFICATION NO.
AVERAGE CALIBRATED NOZZLE DIAMETER, cm (in.) .5
PROBE HEATER SETTING NOT USED
LEAK RATE, m^3/min.(cfm) START .02 FINAL .001 at 15"Hg
PROBE LINER MATERIAL S.S.
STATIC PRESSURE, mm Hg (in.Hg) -1.2" H_2O
FILTER NO. 104

Page 1 of 2

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min	VACUUM mm Hg (in Hg)	STACK TEMPERATURE (T_s) °C (°F)	VELOCITY HEAD (ΔP_s), mm(in.)H_2O	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER mm H_2O (in. H_2O)	START 537.39 GAS SAMPLE VOLUME m^3 (ft^3)	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET °C (°F)	OUTLET °C (°F)	FILTER HOLDER TEMPERATURE, °C (°F)	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER, °C (°F)	EXIT Organic Trap Temperatur °C (°F)
B-8	5 15	13	560	.06	2.1	541.50	88	88	250	70	124
7	10 20	12	567	.05	1.8	545.90	94	88		70	124
6	15 25	17	570	.05	1.8	548.75	100	90		70	124
5	20 30	10	573	.04	1.4	552.11	102	90		70	124
4	25 35	10	579	.04	1.4	555.90	102	90		70	124
3	30 40	10	556	.04	1.4	558.90	102	92		70	124
2	35 45	8	555	.03	1.05	562.00	102	92		70	124
1	40 50	8	555	.03	1.05	564.93	104	92		70	
START	40 2140					564.93					
C-8	45 45	12	564	.05	1.8	568.45	88	88		60	112
7	50 50	10	568	.04	1.4	571.75	94	88		60	118
6	55 55	10	576	.04	1.4	575.16	100	90		60	125
TOTAL 5	60 2200	11	574	.04	1.4	578.0	Avg. 104	Avg. 90		60	125
AVERAGE 4	65 05	9	580	.03	1.05	581.46	Avg. 104	92		65	125
3	70 10	9	580	.03	1.05	584.45	104	94		65	125
2	75 15	9	555	.03	1.05	587.32	104	94		65	125
1	80 20	9	540	.03	1.05	590.36	106	94		65	125

Benzo-a-pyrene DATA SHEET

ENVIRONMENTAL ENGINEERING DIVISION

CKO-15 35

FIELD DATA

PLANT SPARROWS POINT
DATE 3/12/79
SAMPLING LOCATION BATTERY STACK
SAMPLE TYPE B AP
RUN NUMBER CKO-15-BAP-3-
OPERATOR
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_s)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE
NOZZLE I.D.
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

Page 2 of 2

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY _____ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	TRAP
D	80	2315	590.36										
D-8	85	20	593.30	.03	1.05	1.05	563	86	86	8	250	65	120
7	90	25	596.50	.04	1.4	1.4	575	92	88	12		65	124
6	95	30	599.00	.02	.69	.69	582	98	88	6		65	128
5	100	35	602.20	.03	1.05	1.05	584	100	88	8		65	126
4	105	40	604.90	.03	1.05	1.05	560	102	88	8		65	125
3	110	45	608.00	.03	1.05	1.05	560	102	88	8		65	125
2	115	50	611.10	.03	1.05	1.05	565	104	92	8		65	120
1	120	55	613.38	.02	.69	.69	570	106	94	6		65	120
STOP		2420	613.38										
START	120	25	616.78	.05	1.8	1.8	570	90	90	12		65	122
A-8	125	30	619.25	.02	.69	.69	570	98	92	6		65	123
7	130	35	621.70	.02	.69	.69	570	98	92	6		65	123
6	135	40	624.15	.02	.69	.69	570	100	92	6		65	122
5	140	45	626.00	.01	.35	.35	570	100	92	5		65	133
4	145	50	627.75	.01	.35	.35	570	100	92	5		65	125
3	150	55	630.10	.02	.69	.69	570	100	92	6		65	125
2	155	0100	632.50	.02	.69	.69	560	100	92	6		65	125
1	160	05	634.90	.02	.69	.69	560	100	92	6		65	126

COMMENTS: 165 97.51 1.12 567 95

EPA (Dur) 235

CKO-15 -007

TRW

ENVIRONMENTAL ENGINEERING DIVISION

NOMOGRAPH DATA

PLANT SPARROWS POINT

DATE JULY 11, 1979

SAMPLING LOCATION Battery STACK #2 (BAP)

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.9
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m_{avg.}}$	100
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	12.5
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	30.09 ~~30.00~~
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	30.00
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	.997
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	555
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.0198
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	.03
C FACTOR		
CALCULATED NOZZLE DIAMETER, in.		
ACTUAL NOZZLE DIAMETER, in.		.5
REFERENCE Δp, in. H_2O		

EPA (Dur) 234
4 72

IRW

ENVIRONMENTAL ENGINEERING DIVISION

CKO-15-004

ANALYTICAL DATA

PLANT SPARROWS POINT

DATE 7/11/79

SAMPLING LOCATION BATTERY STACK #1

SAMPLE TYPE BAP

RUN NUMBER CKO-15-BAP-1

SAMPLE BOX NUMBER

CLEAN-UP MAN JONGLEUX.

LABORATORY RESULTS

FRONT HALF

ACETONE WASH OF NOZZLE, PROBE, CYCLONE FLASK, FRONT HALF OF FILTER HOLDER — CONTAINER _____ NA. mg

FILTER NUMBER ~~100~~ _____ — CONTAINER _____ _____ mg

105 _____

_____ _____

FRONT HALF SUBTOTAL NA mg

BACK HALF

IMPINGER CONTENTS AND WATER WAS OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER — CONTAINER _____ _____ mg

ETHER-CHLOROFORM EXTRACTION _____ mg

ACETONE WAS OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER — CONTAINER _____ _____ mg

BACK HALF SUBTOTAL NA mg

TOTAL WEIGHT NA mg

MOISTURE

IMPINGERS

FINAL VOLUME 386 ml

INITIAL VOLUME 200 ml

NET VOLUME 186 ml

SILICA GEL

FINAL WEIGHT 230.4 g _____ g _____ g

INITIAL WEIGHT 200 g _____ g _____ g

NET WEIGHT 30.4 g _____ g _____ g

TOTAL MOISTURE 216.4 g

CKO-15-22

ENVIRONMENTAL ENGINEERING DIVISION

ANALYTICAL DATA

PLANT SPARROWS POINT
DATE 7/12/79
SAMPLING LOCATION BATTERY STACK
SAMPLE TYPE B&P
RUN NUMBER CKO-15-BAP-2
SAMPLE BOX NUMBER
CLEAN-UP MAN JONGLEUY

FRONT HALF		LABORATORY RESULTS
ACETONE WASH OF NOZZLE, PROBE, CYCLONE FLASK, FRONT HALF OF FILTER HOLDER	CONTAINER	NA mg
FILTER NUMBER 101	CONTAINER	mg
FRONT HALF SUBTOTAL		NA mg

BACK HALF		
IMPINGER CONTENTS AND WATER WAS OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER	CONTAINER	mg
	ETHER-CHLOROFORM EXTRACTION	mg
ACETONE WAS OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER	CONTAINER	mg
BACK HALF SUBTOTAL		NA mg
TOTAL WEIGHT		NA mg

MOISTURE

IMPINGERS
FINAL VOLUME 438 ml
INITIAL VOLUME 200 ml
NET VOLUME 238 ml

SILICA GEL

FINAL WEIGHT	234.5 g	g	g
INITIAL WEIGHT	200 g	g	g
NET WEIGHT	34.5 g	g	g

TOTAL MOISTURE 272.5 g

TRW

ENVIRONMENTAL ENGINEERING DIVISION

CKO-15-31

ANALYTICAL DATA

PLANT SPARROWS POINT

DATE 3/12/79

SAMPLING LOCATION BATTERY STACK

SAMPLE TYPE BOT

RUN NUMBER CKO-15-BAP-3

SAMPLE BOX NUMBER

CLEAN-UP MAN JONGLEUX

LABORATORY RESULTS

FRONT HALF

ACETONE WASH OF NOZZLE, PROBE, CYCLONE FLASK, FRONT HALF OF FILTER HOLDER — CONTAINER _____ NA mg

FILTER NUMBER 104 — CONTAINER _____ NA mg

FRONT HALF SUBTOTAL NA. mg

BACK HALF

IMPINGER CONTENTS AND WATER WASH OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER — CONTAINER _____ _____ mg

ETHER-CHLOROFORM EXTRACTION _____ mg

ACETONE WAS OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER — CONTAINER _____ _____ mg

BACK HALF SUBTOTAL NA mg

TOTAL WEIGHT NA. mg

MOISTURE

IMPINGERS

FINAL VOLUME ~~435~~ 491 ml

INITIAL VOLUME 200 ml

NET VOLUME ~~235~~ 291 ml

SILICA GEL

FINAL WEIGHT ~~224.4~~ 234.4 g _____ g _____ g

INITIAL WEIGHT 200 g _____ g _____ g

NET WEIGHT ~~24.4~~ 34.4 g _____ g _____ g

TOTAL MOISTURE 325.4 g

METHOD 9

VISIBLE EMISSIONS

OBSERVATION RECORD

COMPANY Bethlehem Steel
LOCATION #2 STACK Exhaust
TEST NUMBER 1
DATE 7-11-79

OBSERVER GARY D HENDAY
TYPE FACILITY COKE PLANT
POINT OF EMISSIONS BATTERY STACK

	Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
✓	1525	0	10	15	15	20	N/A	N/A	
✓	26	1	20	15	20	25	N/A	N/A	
17.3 ✓	27	2	25	20	15	10	N/A	N/A	* Conditions Poor
✓	28	3	20	20	15	15	N/A	N/A	(white smoke blends
*	29	4	15	15	15	20	N/A	N/A	in with clouds)
*	30	5	20	20	20	10	N/A	N/A	
*	31	6	15	15	15	15	N/A	N/A	
*	32	7	10	20	15	15	N/A	N/A	✓ Conditions Fair
*	33	8	15	25	20	20	N/A	N/A	
20.8 ✓	34	9	20	25	25	25	N/A	N/A	
✓	35	10	26	25	25	30	N/A	N/A	
✓	36	11	25	25	25	25	N/A	N/A	
*	37	12	15	15	10	5	N/A	N/A	
*	38	13	5	5	0	0	N/A	N/A	
*	39	14	0	0	0	0	N/A	N/A	
2.3 *	40	15	0	0	0	0	N/A	N/A	
*	41	16	0	0	0	0	N/A	N/A	
*	42	17	0	0	0	0	N/A	N/A	
*	43	18	5	5	0	0	N/A	N/A	
*	44	19	0	0	0	0	N/A	N/A	
*	45	20	5	0	0	15	N/A	N/A	
2.5 *	46	21	0	0	0	0	N/A	N/A	
*	47	22	0	10	10	10	N/A	N/A	
*	48	23	0	0	0	0	N/A	N/A	
*	49	24	0	0	10	0	N/A	N/A	
*	50	25	0	0	0	0	N/A	N/A	
*	51	26	0	0	10	10	N/A	N/A	
2.5 *	52	27	10	10	10	0	N/A	N/A	
*	53	28	0	0	0	0	N/A	N/A	
*	54	29	0	0	0	0	N/A	N/A	

OBSERVATION RECORD
(Continued)

COMPANY Bethlehem Steel
LOCATION #2 STACK Exhaust
TEST NUMBER 1
DATE 7-11-79

OBSERVER GARY D. HENRY
TYPE FACILITY COKE PLANT
POINT OF EMISSIONS BATTERY STACK

	Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
*	1555	30	0	0	0	0	N/A	N/A	
*	56	31	0	0	0	0	N/A	N/A	
*	57	32	0	0	0	0	N/A	N/A	* VERY POOR CONDITIONS
*	58	33	0	0	0	15	N/A	N/A	(White Smoke Blends with clouds
✓	59	34	20	20	20	20	N/A	N/A	✓ FAIR CONDITIONS
✓	1600	35	25	25	25	25	N/A	N/A	
✓	01	36	25	30	25	25	N/A	N/A	
✓	02	37	20	20	15	25	N/A	N/A	
✓	03	38	25	25	30	30	N/A	N/A	
✓	04	39	25	25	20	25	N/A	N/A	
✓	05	40	30	30	25	15	N/A	N/A	
✓	06	41	20	20	20	25	N/A	N/A	
*	07	42	0	0	0	0	N/A	N/A	
*	08	43	0	0	0	0	N/A	N/A	
*	09	44	0	0	0	0	N/A	N/A	
*	10	45	0	0	0	0	N/A	N/A	
*	11	46	0	0	0	0	N/A	N/A	
*	12	47	0	0	0	0	N/A	N/A	
*	13	48	0	0	0	10	N/A	N/A	
✓	14	49	30	30	25	25	N/A	N/A	
✓	15	50	25	20	20	15	N/A	N/A	
*	16	51	15	0	0	10	N/A	N/A	
*	17	52	0	15	15	5	N/A	N/A	
*	18	53	5	5	0	0	N/A	N/A	
*	19	54	0	0	0	10	N/A	N/A	
*	20	55	0	10	10	15	N/A	N/A	
*	21	56	15	15	15	15	N/A	N/A	
✓	22	57	20	20	20	20	N/A	N/A	
✓	23	58	20	20	20	25	N/A	N/A	
✓	24	59	20	25	25	25	N/A	N/A	

8.1

24.0

0.0

11.2

15.2

OBSERVATION RECORD

COMPANY Bethlehem Steel
LOCATION #2 STACK Exhaust
TEST NUMBER 1
DATE 7-11-79

OBSERVER B. O. HENRY
TYPE FACILITY COKE PLANT
POINT OF EMISSIONS BATTERY STACK

	Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
✓	1625	0	20	20	20	20	N/A	N/A	
✓	26	1	20	20	15	10	N/A	N/A	
*	27	2	10	5	5	5	N/A	N/A	
*	28	3	10	10	10	10	N/A	N/A	
*	29	4	10	10	0	0	N/A	N/A	* Very poor Conditions
*	30	5	0	0	0	0	N/A	N/A	(white smoke BLENDS with
*	31	6	0	0	0	0	N/A	N/A	the Clouds)
✓	32	7	20	25	25	25	N/A	N/A	
✓	33	8	30	30	35	30	N/A	N/A	
✓	34	9	30	25	30	30	N/A	N/A	✓ Fair Conditions
✓	35	10	30	25	25	25	N/A	N/A	
✓	36	11	25	30	30	30	N/A	N/A	
*	37	12	20	15	0	0	N/A	N/A	
*	38	13	0	0	0	0	N/A	N/A	
*	39	14	0	0	0	0	N/A	N/A	
*	40	15	0	0	0	0	N/A	N/A	
*	41	16	0	5	5	0	N/A	N/A	
*	42	17	0	0	0	0	N/A	N/A	
*	43	18	0	5	5	5	N/A	N/A	
*	44	19	0	0	0	0	N/A	N/A	
*	45	20	0	0	0	0	N/A	N/A	
*	46	21	0	0	0	0	N/A	N/A	
*	47	22	0	0	0	0	N/A	N/A	
*	48	23	0	0	0	0	N/A	N/A	
*	49	24	0	0	0	0	N/A	N/A	
*	50	25	0	0	0	0	N/A	N/A	
*	51	26	0	0	0	0	N/A	N/A	
*	52	27	0	0	0	0	N/A	N/A	
*	53	28	0	0	0	0	N/A	N/A	
*	54	29	0	0	0	0	N/A	N/A	

9.6

23.1

1.9

0.6

0.0

OBSERVATION RECORD
(Continued)

Continued on Back

COMPANY Bethlehem Steel
LOCATION #2 Stack Exhaust
TEST NUMBER 1
DATE 7/11/79

OBSERVER G. O. Henry
TYPE FACILITY Coke Plant
POINT OF EMISSIONS Battery Stack

	Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
3.54 *	1655	30	0	0	0	0	N/A	N/A	
*	56	31	0	0	0	0	N/A	N/A	
*	57	32	15	15	0	0	N/A	N/A	* Very Poor Conditions
*	58	33	0	15	20	20	N/A	N/A	(White Smoke is Blending
*	59	34	0	0	0	0	N/A	N/A	with the clouds)
*	1700	35	0	0	0	0	N/A	N/A	✓ Fair Conditions
1.67 *	01	36	0	0	0	0	N/A	N/A	
*	02	37	0	0	0	0	N/A	N/A	
*	03	38	5	5	5	5	N/A	N/A	
*	04	39	5	5	5	5	N/A	N/A	
*	05	40	0	0	0	0	N/A	N/A	
*	06	41	0	0	0	0	N/A	N/A	
0.0 *	07	42	0	0	0	0	N/A	N/A	
*	08	43	0	0	0	0	N/A	N/A	
*	09	44	0	0	0	0	N/A	N/A	
*	10	45	0	0	0	0	N/A	N/A	
*	11	46	0	0	0	0	N/A	N/A	
*	12	47	0	0	0	0	N/A	N/A	
0.0 *	13	48	0	0	0	0	N/A	N/A	
*	14	49	0	0	0	0	N/A	N/A	
*	15	50	0	0	0	0	N/A	N/A	
*	16	51	0	0	0	0	N/A	N/A	
*	17	52	0	0	0	0	N/A	N/A	
*	18	53	0	0	0	0	N/A	N/A	
0.0 *	19	54	0	0	0	0	N/A	N/A	
*	20	55	0	0	0	0	N/A	N/A	
*	21	56	0	0	0	0	N/A	N/A	
*	22	57	0	0	0	0	N/A	N/A	
*	23	58	0	0	0	0	N/A	N/A	
*	24	59	0	0	0	0	N/A	N/A	

	0	15	30	45	
* 1725	0	0	0	0	
* 26	0	0	0	0	
* 27	0	0	0	0	0.0
* 28	0	0	0	0	
* 29	0	0	0	0	
* 30	0	0	0	0	
* 31	0	0	0	0	
* 32	0	0	0	0	
* 33	0	0	0	0	
* 34	0	0	0	0	0.0
* 35	0	0	0	0	
* 36	0	0	0	0	
* 37	0	0	0	0	
* 38	0	0	0	0	
* 39	0	0	0	0	
* 40	0	0	0	0	0.0
* 41	0	0	0	0	
* 42	0	0	0	0	
* 43	0	0	0	0	
* 44	0	0	0	0	
* 45	0	0	0	0	
* 46	0	0	0	0	0.0
* 47	0	0	0	0	
* 48	0	0	0	0	
* 49	0	0	0	0	
* 50	0	0	0	0	
* 51	0	0	0	0	
* 52	0	0	0	0	0.0
* 53	0	0	0	0	
* 54	0	0	0	0	
* 55	0	0	0	0	
* 56	0	0	0	0	0.0
* 57	0	0	0	0	

* VERY POOR CONDITIONS
(white SMOKE is Blending into clouds MAKING it Impossible to ACCURATLY Determine the opacity)

TRW

ENVIRONMENTAL ENGINEERING DIVISION

TIME	OPACITY 0	15	30	45		TIME	OPACITY 0	15	30	45		TIME	OPACITY 0	15	30	45
1135	20	20	20	20		58	0	0	0	0		21	5	5	5	5
36	20	20	20	20		59	0	0	0	0		22	5	5	10	10
37	15	10	10	10		1200	0	0	0	0		23	5	0	0	0
38	5	0	10	10		01	0	0	0	0		24	0	0	0	0
39	0	0	5	5		02	0	0	0	0		25	0	0	0	0
40	5	0	10	15		03	0	0	0	0		26	5	5	5	5
41	15	15	10	0		04	0	0	0	0		27	5	5	5	5
42	0	0	0	0		05	0	0	0	0		28	0	0	5	5
43	0	0	5	5		06	0	0	0	0		29	0	5	0	0
44	5	5	0	0		07	0	0	0	0		30	5	0	0	0
45	0	0	0	0		08	0	0	0	0		31	0	0	0	5
46	0	0	0	0		09	0	0	0	0		32	10	10	5	10
47	0	0	0	0		10	0	0	0	0		33	10	10	10	10
48	0	5	5	5		11	0	0	0	0		34	10	10	10	10
49	5	5	0	5		12	0	0	0	0		35	10	5	5	5
50	10	10	5	10		13	0	0	0	0		36	5	5	5	0
51	10	0	0	0		14	5	5	5	5		37	0	0	0	0
52	0	0	0	0		15	5	10	10	15		38	0	0	0	0
53	0	0	0	0		16	15	10	10	10		39	0	0	0	0
54	0	0	0	0		17	10	5	5	5		40	0	0	0	0
55	0	0	0	0		18	5	5	5	5		41	0	0	0	0
56	0	0	0	0		19	0	0	0	0		42	0	0	0	0
57	0	0	0	0		20	5	0	5	5		43	0	0	0	0

PLANT Bethlehem Steel (Sparrows Point)

LOCATION #2 STACK

OBSERVER Gary D Henry

DATE 7-12-79

DISTANCE TO STACK 150'

WIND DIRECTION

WIND SPEED

SUM OF NUMBERS RECORDED

TOTAL NO. OF READINGS

NOTES: Run No 2

✓ = FAIR CONDITIONS.

x = POOR CONDITIONS (WHTE SMOKE BLENDING IN with Clouds making it Impossible To determine the opacity Accurate

Opacity = Sum of No.s recorded / Total No. of readings

= _____ =

TRW

ENVIRONMENTAL ENGINEERING DIVISION

	TIME	OPACITY		TIME	OPACITY		TIME	OPACITY
	1243	0 15 30 45		07	0 15 30 45		31	0 15 30 45
x	1244	0 0 0 0 x		08	0 0 0 0 x		32	5 10 10 10
x	45	0 0 0 0 x		09	0 0 0 0 ✓		33	10 10 10 10
	46	0 0 0 0 x		10	0 0 0 0 ✓		34	10 10 10 10
x	47	0 0 0 0 x		11	0 0 0 0 ✓		35	15 15 10 10
x	48	0 0 0 0 x		12	0 0 0 0 x		36	5 0 0 0
x	49	2.3 0 0 0 0 x		13	0.0 0 0 0 x		37	2.3 0 0 0 0
x	50	0 5 5 5 x		14	0 0 0 0 x		38	0 0 0 0
x	51	5 5 5 5 x		15	0 0 0 0 x		39	0 0 0 0
	52	5 5 5 5 x		16	0 0 0 0 x		40	0 0 0 0
x	53	5 5 5 5 x		17	0 0 0 0 x		41	0 0 0 0
x	54	5 5 5 5 x		18	0 0 0 0 x		42	0.0 0 0 0
x	55	2.9 5 10 10 5 x		19	0.0 0 0 0 x		43	0.0 0 0 0
x	56	0 0 0 0 x		20	0 0 0 0 x		44	0 0 0 0
	57	0 0 0 0 x		21	0 0 0 0 x		45	0 0 0 0
x	58	0 0 0 0 x		22	0 0 0 0 x		46	0 0 0 0
	59	0 0 0 0 x		23	0 0 0 0 x		47	0 0 0 0
x	1300	0 0 0 0 x		24	0 0 0 0 x		48	0 0 0 0
x	01	0.0 0 0 0 x		25	0.0 0 0 0 x		49	0.0 0 0 0
	02	0 0 0 0 x		26	0 0 0 0 x		50	0 0 0 0
x	03	0 0 0 0 x		27	0 0 0 0 x		51	0 0 0 0
	04	0 0 0 0 x		28	0 0 0 0 x		52	0 0 0 0
	05	0 0 0 0 x		29	5 5 5 0 x		53	0 0 0 0
x	06	0.0 0 0 0 x		30	2.3 5 0 5 0 x		54	0.0 0 0 0
x	07	0 0 0 0 x		31	0 5 10 10			

PLANT Bethlehem Steel (Sparrow's Point)

LOCATION #2 STACK

OBSERVER Gary D. Henry

DATE 7-12-79

DISTANCE TO STACK 150'

WIND DIRECTION

WIND SPEED

SUM OF NUMBERS RECORDED

TOTAL NO. OF READINGS

NOTES: Run No 2

x = Very poor Conditions (clouds color blends in with white smoke)

✓ = Fair Conditions

$$\text{Opacity} = \frac{\text{Sum of No.s recorded}}{\text{Total No. of readings}}$$

= _____ =

TRW

ENVIRONMENTAL ENGINEERING DIVISION

TIME	OPACITY	TIME	OPACITY	TIME	OPACITY
1354	0 15 30 45		0 15 30 45		0 15 30 45
55	0 0 0 0	19	25 25 20 25	43	0 0 0 0
56	0 0 0 0	20	30 25 25 20	44	0 0 0 0
57	0 0 0 0	21	20 20 20 20	45	0 0 0 0
	0 0 0 0	22	20 25 20 20	46	0 0 0 0
59	0 0 0 0	23	20 20 20 20	47	0 0 0 0
	0 0 0 0	24	30 30 25 20	48	0 0 0 0
	0 0 0 0	25	20 15 5 5	49	0 0 0 0
	0 0 0 0	26	0 0 0 0	50	0 0 0 0
03	0 0 0 0	27	0 0 0 0	51	0 0 0 0
	0 0 0 0	28	0 0 0 0	52	0 0 0 0
	0 0 0 0	29	0 0 0 0	53	0 0 0 0
	0 0 0 0	30	0 0 0 0	54	0 0 0 0
	0 0 0 0	31	0 0 0 0	55	0 0 0 0
	0 0 0 0	32	0 0 0 0	56	0 0 0 0
	0 0 0 0	33	0 0 0 0	57	0 0 0 0
10	0 0 0 0	34	0 0 0 0	58	0 0 0 0
11	0 0 0 0	35	0 0 0 0	59	0 0 0 0
	0 0 0 0	36	0 0 0 0	1500	0 0 0 0
13	0 0 0 0	37	0 0 0 0	01	0 0 0 0
14	0 0 0 0	38	0 0 0 0	02	0 0 0 0
15	10 10 10 10	39	0 0 0 0	03	0 0 0 0
16	15 10 15 15	40	0 0 0 0	04	0 0 0 0
17	20 20 20 20	41	0 0 0 0	05	0 0 0 0
18	20 20 20 20	42	0 0 0 0		

0.0 10.2 0.0 0.0 0.0 0.0 0.0 4.0 0.0 0.0 22.2 0.0

PLANT Bethlehem Steel (Sparrows Point)

LOCATION #2 STACK

OBSERVER GARY D. HENRY

DATE 7-12-79

DISTANCE TO STACK 150'

WIND DIRECTION

WIND SPEED

SUM OF NUMBERS RECORDED

TOTAL NO. OF READINGS

NOTES: * RUN NO. 2

*** PLANT DOWN

Opacity = Sum of No.s recorded / Total No. of readings

*** = _____ =

TRW

ENVIRONMENTAL ENGINEERING DIVISION

TIME	OPACITY	TIME	OPACITY	TIME	OPACITY
1635	0 15 30 45	—	0 15 30 45	—	0 15 30 45
38	20 20 20 20	59	0 0 0 0	22	0 0 0 0
39	25 25 25 20	1700	0 0 0 0	23	0 0 0 0
40	20 25 30 35	01	0 0 0 0	24	0 0 0 0
39	25 25 25 25	02	0 0 0 0	25	0 0 0 0
40	20 15 15 15	03	0 0 0 0	26	0 0 0 0
41	15 15 20 20	04	0 0 0 0	27	0 0 0 0
42	20 20 20 20	05	0 0 0 0	28	0 0 0 0
43	10 10 5 5	06	0 0 0 0	29	0 0 0 0
44	0 0 0 0	07	0 0 0 0	30	0 0 0 0
45	0 0 0 0	08	0 0 0 0	31	0 0 0 0
46	0 0 0 0	09	0 0 0 0	32	0 0 0 0
47	0 0 0 0	10	0 0 0 0	33	0 0 0 0
48	0 0 0 0	11	0 0 0 0	34	0 0 0 0
49	0 0 0 0	12	0 0 0 0	35	0 0 0 0
50	0 0 0 0	13	0 0 0 0	36	0 0 0 0
51	0 0 0 0	14	0 0 0 0	37	0 0 0 0
52	0 0 0 0	15	0 0 0 0	38	0 0 0 0
53	0 0 0 0	16	0 0 0 0	39	0 0 0 0
54	0 0 0 0	17	0 0 0 0	40	0 0 0 0
55	0 0 0 0	18	0 0 0 0	41	0 0 0 0
56	0 0 0 0	19	0 0 0 0	42	0 0 0 0
57	0 0 0 0	20	0 0 0 0	43	0 0 0 0
58	0 0 0 0	21	0 0 0 0	44	0 0 0 0

17

0.0

0.0

46

0.0

0.0

0.0

0.0

0.0

0.0

PLANT Bethlehem Steel (Sparrows Point)

LOCATION #2 stack

OBSERVER Gary D. Henry

DATE 7-12-79

DISTANCE TO STACK 150'

WIND DIRECTION

WIND SPEED

SUM OF NUMBERS RECORDED

TOTAL NO. OF READINGS

NOTES: Run No. 2

* Poor Conditions

✓ Fair Conditions

Opacity = $\frac{\text{Sum of No.s recorded}}{\text{Total No. of readings}}$

= _____ = [ ]

CKO-15-25
5 of 6

OBSERVATION RECORD PAGE ___ OF ___

COMPANY Bethlehem
LOCATION SPARROWS POINT
TEST NUMBER 2
DATE 7/12/79

OBSERVER B. D. HENRY
TYPE FACILITY COKE OVEN
POINT OF EMISSIONS BATTERY STACK

P

	Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
x	1744	0	0	0	0	0			
x	45	1	0	0	0	0			
x	46	2	0	0	0	0			
x	47	3	0	0	0	0			
x	48	4	0	0	0	0			
x	49	5	0	0	0	0			
x	50	6	0	0	0	0			
x	51	7	0	0	0	0			
x	52	8	0	0	0	0			
x	53	9	0	0	0	0			
x	54	10	0	0	0	0			
x	55	11	0	0	0	0			
x	56	12	0	0	0	0			
x	57	13	0	0	0	0			
x	58	14	0	0	0	0			
x	59	15	0	0	0	0			
x	1800	16	0	0	0	0			
x	01	17	0	0	0	5			
✓	02	18	[illegible]	[illegible]	10	20			
✓	03	19	20	20	25	25			
✓	04	20	25	25	25	30			
✓	05	21	30	25	20	20			
✓	06	22	20	20	20	20			
✓	07	23	10	15	20	15			
✓	08	24	15	15	15	15			
✓	09	25	10	10	15	10			
✓	10	26	10	10	10	10			
✓	11	27	10	20	20	20			
✓	12	28	20	25	25	20			
✓	13	29	25	25	25	25			

00

00

140

150

CKO-15-25(B)

OBSERVATION RECORD
(Continued)

COMPANY Bethlehem Steel
LOCATION SPARROWS POINT
TEST NUMBER 2
DATE 7/12/79

OBSERVER G.D. HENRY
TYPE FACILITY COKE OVEN
POINT OF EMISSIONS BATTERY STACK

Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
14	30	20	20	20	20			
15	31	20	20	20	20			
16	32	20	20	20	20			
17	33	25	25	30	30			
18	34	30	30	20	20			
19	35	20	15	20	20			
20	36	[illegible]	20	20	20			
21	37	20	15	15	15			
22	38	10	15	15	20			
23	39	20	20	20	20			
24	40	20	20	20	20			
25	41	20	20	20	20			
26	42	15	20	15	15			
27	43	15	15	10	20			
28	44	20	20	25	25			
29	45	25	25	20	20			
30	46	20	15	10	10			
	47							
	48							
	49							
	50							
	51							
	52							
	53							
	54							
	55							
	56							
	57							
	58							
	59							

22.5

19.8

19.8

NOTATION

NO METHOD 9 - VISIBLE EMISSIONS

TAKEN DURING THIRD RUN.

(NIGHT TESTING)

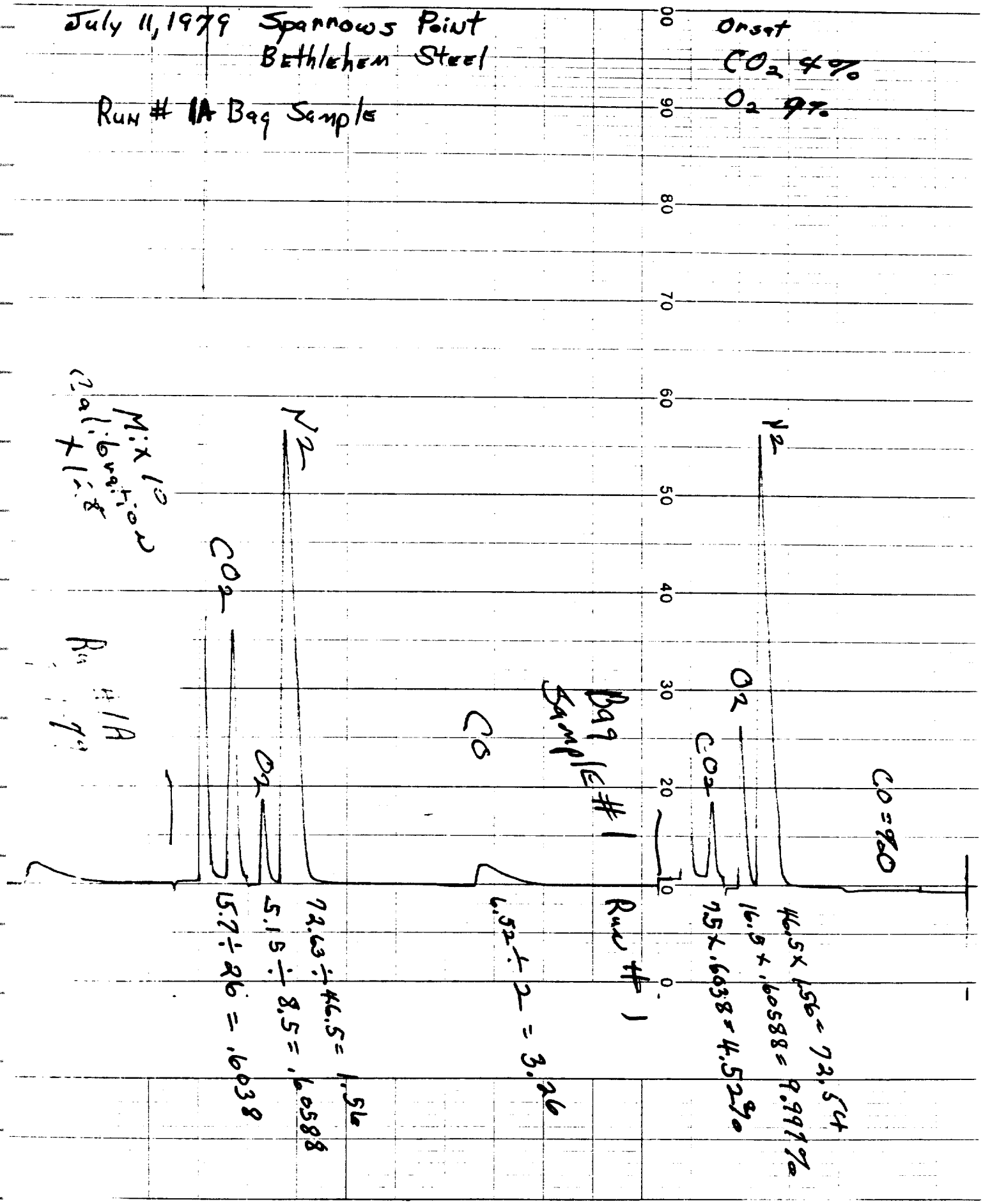
GAS ANALYSIS STRIPCHART
(BAG SAMPLES)

A.I.D. GAS CHROMATOGRAPHY

(THERMAL CONDUCTIVITY PRINCIPLE)

July 11, 1979 Sparrows Point
Bethlehem Steel

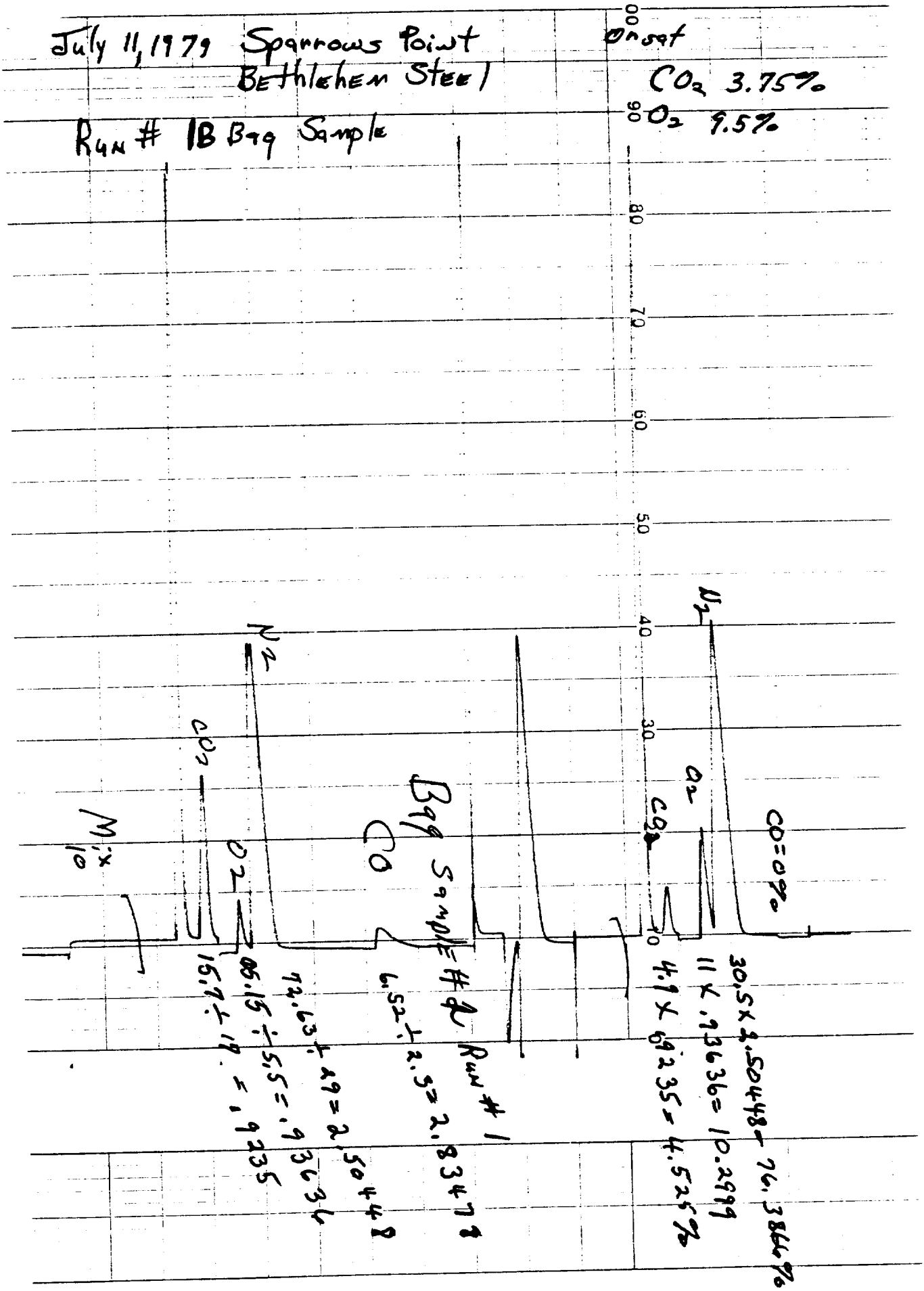
Run # 1A Bag Sample

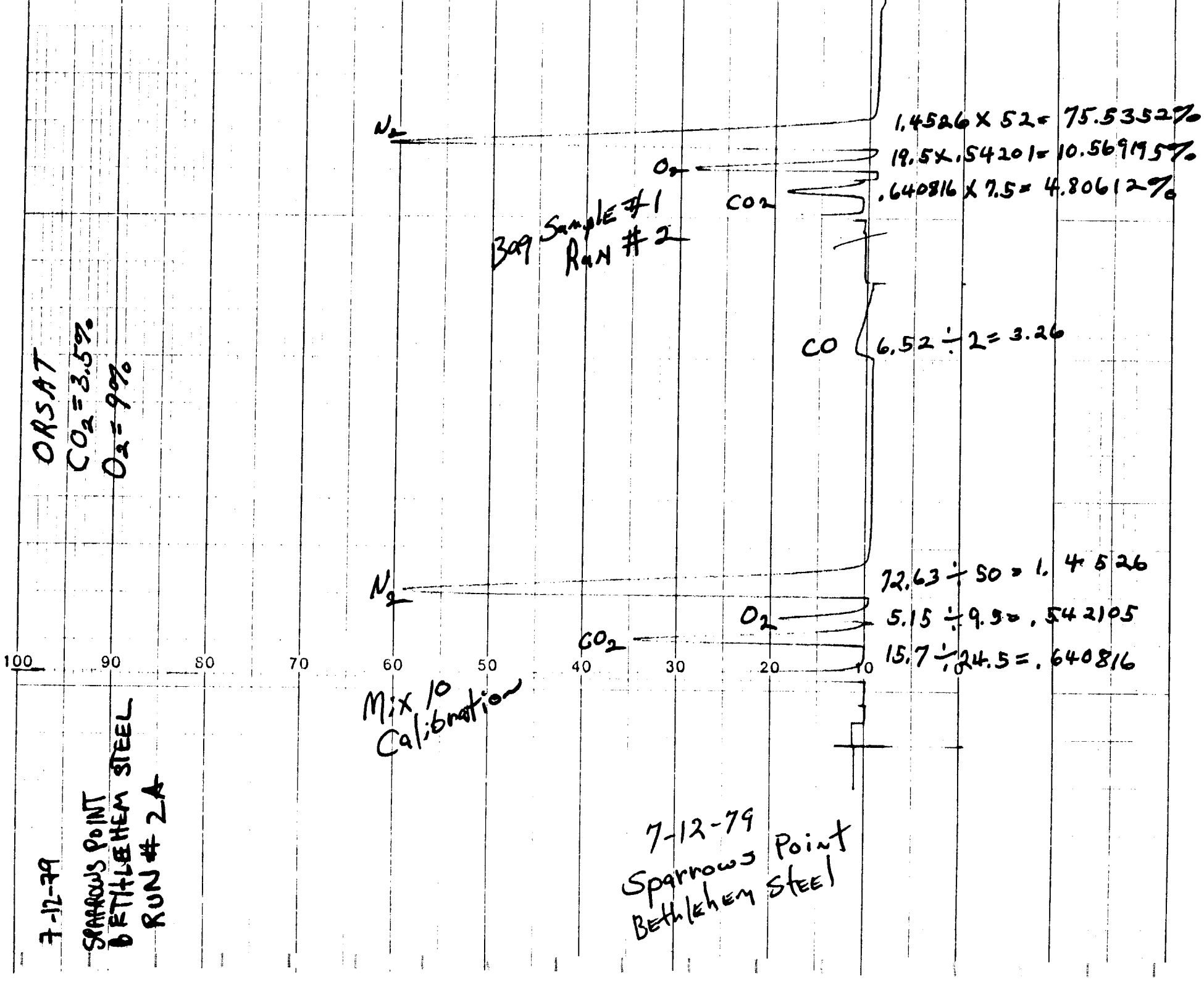


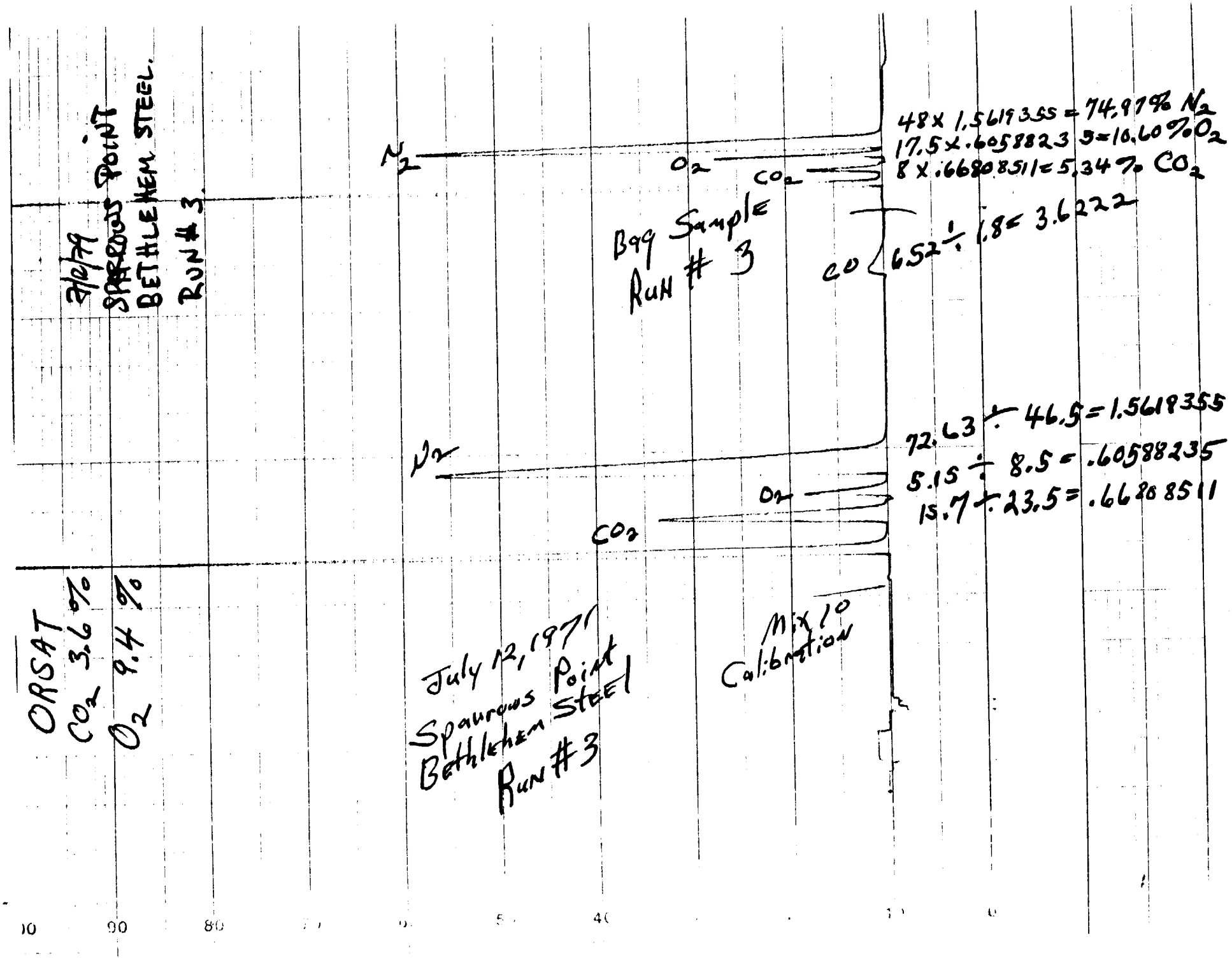
July 11, 1979 Sparrows Point
Bethlehem Steel

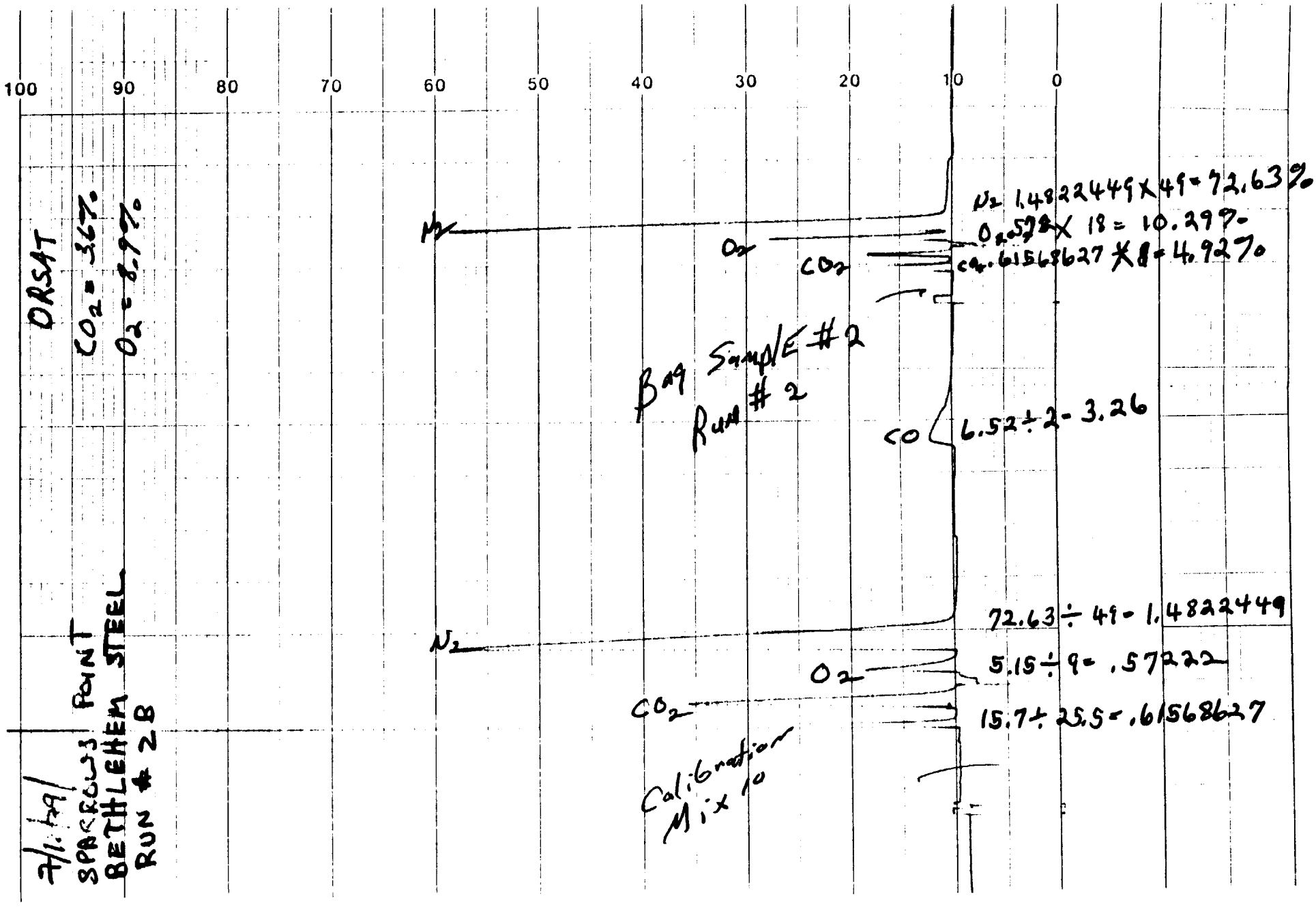
Run # 1B Bag Sample

Onsat
CO_2 3.75%
O_2 9.5%




ORSAT
CO_2 = 3.5%
O_2 = 9%
7-12-79
SPARROWS POINT
BETHLEHEM STEEL
RUN # 2A
100
90
80
70
60
50
40
30
20
10
N_2
O_2
CO_2
Mix 10
Calibration
N_2
O_2
CO_2
CO
309 Sample #1
RUN # 2
1.4526 X 52 = 75.5352%
19.5 X .54201 = 10.56917%
.640816 X 7.5 = 4.80612%
6.52 ÷ 2 = 3.26
72.63 ÷ 50 = 1.4526
5.15 ÷ 9.5 = .542105
15.7 ÷ 24.5 = .640816
7-12-79
Sparrows Point
Bethlehem Steel


7/10/79
SPARROWS POINT
BETHLEHEM STEEL.
RUN # 3
ORSAT
CO2 3.6 %
O2 9.4 %
N2
O2
CO2
Bag Sample
RUN # 3
CO
652 ÷ 1.8 = 3.6222
48 x 1.5619355 = 74.97% N2
17.5 x .6058823 = 10.60% O2
8 x .6680851 = 5.34% CO2
N2
O2
CO2
72.63 ÷ 46.5 = 1.5619355
5.15 ÷ 8.5 = .60588235
15.7 ÷ 23.5 = .6680851
July 12, 1971
Sparrows Point
Bethlehem Steel
RUN #3
Mix 10
Calibration
90
80
40

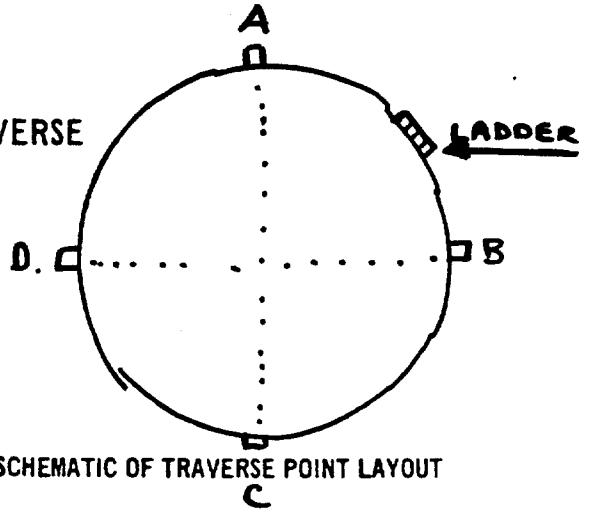

100
90
80
70
60
50
40
30
20
10
0
ORSAT
CO_2 = 36%
O_2 = 8.9%
7/1/79
SPARROWS POINT
BETHLEHEM STEEL
RUN # 2B
N_2
O_2
CO_2
BAG SAMPLE #2
RUN # 2
CO
N_2 1.4822449 X 49 = 72.63%
O_2 .572 X 18 = 10.29%
CO_2 .61568627 X 8 = 4.92%
6.52 ÷ 2 = 3.26
N_2
O_2
CO_2
72.63 ÷ 49 = 1.4822449
5.15 ÷ 9 = .57222
15.7 ÷ 25.5 = .61568627
Calibration
Mix 10

PRELIMINARY VELOCITY TRAVERSE
FIELD DATA SHEETS

TRW
ENVIRONMENTAL ENGINEERING DIVISION

PRELIMINARY VELOCITY TRAVERSE

PLANT BETHLEHEM STEEL (SPARROWS POINT)
DATE 7/10/79.
LOCATION BATTERY STACK #2.
STACK I.D. 14 ft.
BAROMETRIC PRESSURE, in. Hg 30.10
STACK GAUGE PRESSURE, in. H_2O -1.1" H_2O
OPERATORS McReynolds / TAYLOR.



SCHEMATIC OF TRAVERSE POINT LAYOUT

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
A-1	.01	540
A-2	.01	540
A-3	.01	540
A-4	.01	552
A-5	.01	550
A-6	.01	558
A-7	.02	560
A-8	.035	560
C-1	.04	550
C-2	.04	560
C-3	.04	560
C-4	.03	560
C-5	.025	560
C-6	.02	570
C-7	.02	570
C-8	.02	577
AVERAGE	0.022	556.7

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
B-1	.02	550
B-2	.02	550
B-3	.02	564
B-4	.01	554
B-5	.01	545
B-6	.01	565
B-7	.02	564
B-8	.03	567
D-1	.01	540
D-2	.01	540
D-3	.01	550
D-4	.015	550
D-5	.02	550
D-6	.02	555
D-7	.02	555
D-8	.02	557
AVERAGE	0.017	553.5

.020	555.1

EPA (Dur) 233
4/72

FIELD MOISTURE DETERMINATION
FIELD DATA SHEETS

TRW
ENVIRONMENTAL ENGINEERING DIVISION

FIELD MOISTURE DETERMINATION

Location BATTERY STACK #2 Operator M-R / RFJ

Test MOISTURE DETERMINATION. By Absorption: SILCA GEL / IMPINGER

Date 7/10/79 Barometric Pressure 30.18

Clock Time	Meter (Ft^3)	Flow Meter Setting (CFH)	Meter Temperature, Tm °F (IN)	(OUT)
0 1315	337.65		78	78
10 1325	—	.73	-	-
20 1335	352.26	.73	90	80
30 1345	359.49	.72	92	82
40 1355	367.03		92	84
TOTAL	29.38			83.6 AVE.

Tube No.	Weight, grams		
	Final	Initial	Difference

(W) = weight of moisture collected = 56

$$\% \text{ Moisture by Volume} = \frac{100 \cdot W}{\left(\frac{375 \cdot P_B \cdot V_m}{T_m + 460}\right) + W}$$

12.5% moisture

% Moisture by Volume = _____

By Wet and Dry Bulb Temperatures:

Wet Bulb Temp. _____ °F % Moisture From Psychometric Chart

Dry Bulb Temp. _____ °F _____

APPENDIX B

SAMPLE EQUATIONS

EQUATIONS USED FOR PARTICULATE CALCULATIONS

1. Volume of dry gas sampled at standard conditions -68 °F, 29.92" Hg, ft^3.

$$V_{m_{std}} = \frac{17.64 \times V_m \left(P_B + \frac{P_m}{13.6}\right)}{(T_m + 460)} = Ft.^3 =$$

2. Volume of water vapor at 68°F and 29.92" Hg, $Ft.^3$

$$V_{w_{gas}} = 0.0471 \times V_w = ft.^3$$

3. % moisture in stack gas

$$\%M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} = \%$$

4. Mole fraction of dry gas

$$M_d = \frac{100 - \%M}{100}$$

5. Average molecular weight of dry stack gas

$$M\,W_d = (\%CO_2 \times \frac{44}{100}) + (\%O_2 \times \frac{32}{100}) + (\%N_2 \times \frac{28}{100})$$

6. Molecular weight of stack gas

$$M\,W = M\,W_d \times M_d + 18\,(1 - M_d)$$

7. Stack velocity @ stack conditions, fps

$$V_s = 85.49 \times C_p \times \sqrt{\Delta P_s \times (T_s + 460)} \left[\frac{1}{P_s \times M\,W}\right]^{1/2} = \text{fps}$$

8. Stack gas volume @ standard conditions, SCFM, dry.

$$Q_s = \frac{1059 \times V_s \times A_s \times M_d \times P_s}{(T_s + 460)} = \text{SCFM}$$

9. Percent isokinetic

$$\%I = \frac{17.3 \times (T_s + 460) \times V_{m\ std}}{V_s \times T_t \times P_s \times M_d \times (D_n)^2} = \%$$

10. Particulate - probe, cyclone, and filter, gr/SCF, dry

$$C_{an} = 0.0154 \times \frac{M_f}{V_{m_{std}}} = \text{gr/scf}$$

11. Particulate total, gr/SCF, dry

$$C_{ao} = 0.0154 \times \frac{M_t}{V_{m_{std}}} = \text{gr/SCF}$$

12. Particulate - probe, cyclone and filter, gr/CF at stack conditions

$$C_{at} = \frac{17.64 \times C_{an} \times P_s \times M_d}{(T_s + 460)} = \text{gr/CF}$$

13. Particulate - total, gr/CF @ stack conditions

$$C_{au} = \frac{17.64 \times C_{ao} \times P_s \times M_d}{(T_s + 460)} = \text{gr/CF}$$

14. Particulate - probe, cyclone filter filter, lb/hr.

$$C_{aw} = 0.00857 \times C_{an} \times Q_s = \text{lb/hr.}$$

15. Particulate - total, lb/hr.

$$C_{ax} = 0.00857 \times C_{ao} \times Q_s = \text{lb/hr.}$$

EQUATIONS USED FOR CONTINUOUS MONITOR CALCULATIONS

For Mean Value

16. $$\bar{X} = \frac{1}{N} \sum_{i=1}^{N} X_i$$

For 95 Percent Confidence Interval

17. $$C.I._{95} = \frac{t_{.975}}{N\sqrt{N-1}} \sqrt{N\left(\sum X_i^2\right) - \left(\sum X_i\right)^2}$$

For Instrument Linearity and Traceability of True Concentrations of Calibration Gases

18. $$\text{True Conc. of Cyl, Gas} = \text{Apparent Conc. of Cyl. Gas} \times \frac{\text{True Conc. of SRM (or GMPS)}}{\text{Apparent Conc. of SRM (or GMPS)}}$$

For Response

19. $$\text{\% Deviation from slower system average} = \frac{\text{average upscale minus average downscale}}{\text{slower time}} \times 100\%$$

For Zero and Calibration Drift

20.

Zero Drift = (Mean Zero Drift)_____ + CI (Zero)_____ = _____

Calibration Drift = (Mean Span Drift)_____ + CI (Span)_____ = _____

For NO_x

21. For spectrophotometer calibration

$$K_c = 100 \frac{A_1 + 2A_2 + 3A_3 + 4A_4}{A_1^2 + A_2^2 + A_3^2 + A_4^2}$$

22. For sample volume, dry basis, corrected to standard conditions

$$V_{sc} = \frac{Tstd}{Pstd} (Vf - Va) \left[\frac{Pf}{Tf} - \frac{Pi}{Ti}\right]$$

$$= K_1 (Vf - 25ml) \left[\frac{Pf}{Tf} - \frac{Pi}{Ti}\right]$$

$$K_1 = 0.3858 \frac{^oK}{mmHg} \text{ for metric units}$$

23. For total mg NO_2 per sample

$$M = 2K_cAF$$

For Sulfates

4. For sulfate/ acid mist (including SO_3) concentration. lb/dscf

$$C\,SO_4 = K_2 \frac{N(V_t - V_{tb})\left(\frac{V_{soln}}{Va}\right)}{V_m(std)}$$

5. For sulfur dioxide concentration. lb/dscf

$$CSO_2 = K_3 \frac{N(V_t - V_{tb})\left(\frac{V_{soln}}{Va}\right)}{V_m(std)}$$

K_2 = 0.04800 g/milliequivalents for metric
= 1.058×10^{-4} lb/meq for English units

K_3 = 0.03203 g/milliequivalents for metric
= 7.061×10^{-5} lb/meq for English units

APPENDIX C

ANALYTICAL DATA

TRW

PROJECT Sparrows Point (#CKO-15-79)

A	B	C	D	E	F	G	H	J	K	
Sample #	Container #	Sample Volume	Aliquot	Gross -Tare / Net	Gross -Tare / Net		C/D x Net = Total Wt Gn	C/N x S = Blank	H-J = Final Wt	Final Wt
CKO-M5-1	Filter #70	.6964		15.8511 14.8580 .9931	15.8610	15.8575	15.8370	.9931 .6964 .2967		0.2967
CKO-M5-2	103	.6725		16.3470 14.9645 1.3825	16.3508	16.3450		1.3825 .6725 .7100		0.7100
CKO-M5-3	102	.6846		61.4122 60.0920 1.3202	61.4394	61.4482	61.4095	1.3202 .6846 .6356		0.6356

L	M	N	P	Q	R	S
Blank	Container #	Volume	Gross -Tare / Net	Gross -Tare / Net		Blank Wt

Date 7/26/79

Analyst McR

Wt Units Grams

NOTE: Filters

ENERGY SYSTEMS GROUP OF TRW INC.
NORTH CAROLINA OFFICE • SUITE 200 201 N. ROXBORO STREET
DURHAM, NORTH CAROLINA 27701 (919) 682-8661

TRW

PROJECT Sparrows Point (#CKO-15-79)

A	B	C	D	E	F	G	H	J	K
Sample #	Container #	Sample Volume	Aliquot	Gross -Tare / Net	Gross -Tare / Net		$\frac{C}{D}$ x Net = Total Wt Gn	$\frac{C}{N}$ x S = Blank	H-J = Final Wt	Final Wt
CKO-M5-1	1	120		66.8954 66.8890 .0064				0.0012		0.0052
CKO-M5-2	6	130		66.8528 66.8432 0.0096				0.0013		0.0083
CKO-M5-2	9	130		66.9162 66.9053 0.0109				0.0013		0.0096

L	M	N	P	Q	R	S
Blank	Container #	Volume	Gross -Tare / Net	Gross -Tare / Net		Blank Wt
E/C		140	67.1063 67.1048 0.0015			0.0015

Date 7/26/79

Analyst McR

Wt Units Grams

NOTE: ETHER/CHLOROFOPM EXTRACTION

ENERGY SYSTEMS GROUP OF TRW INC.
NORTH CAROLINA OFFICE • SUITE 200 201 N. ROXBORO STREET
[illegible] H CA NA (91 [illegible]-966

TRW

PROJECT SPARROWS POINT (#CKO-15-79)

A	B	C	D	E	F	G	H	J	K	
Sample #	Container #	Sample Volume	Aliquot	Gross -Tare / Net	Gross -Tare / Net		C/D x Net = Total Wt Gn	C/N x S = Blank	H-J = Final Wt	Final Wt
CKO-1F	4	232		149.8622 149.8087 0.0535				0.0084		0.0451
1B	17	160		149.1115 148.0966 0.0149				0.0058		0.0091
CKO-2F	13	194		142.6391 142.5911 0.0480				0.0070		0.0410
CKO-3F	19	112		62.9599 62.9120 0.0479				0.0040		0.0439
3B	8	75		66.9958 66.9870 0.0088				0.0027		0.0061

L	M	N	P	Q	R	S
Blank	Container #	Volume	Gross -Tare / Net	Gross -Tare / Net		Blank Wt
	12	195	150.3720 150.3048 0.0072			0.0072

Date 7-26-79

Analyst MCR

Wt Units GRAMS

NOTE: Front/Back Half Acetone Wash

ENERGY SYSTEMS GROUP OF TRW INC.
NORTH CAROLINA OFFICE • SUITE 200 201 N. ROXBORO STREET

TRW

PROJECT SPARROWS POINT (#CKO-15-79)

A	B	C	D	E	F	G	H	J	K
Sample #	Container #	Sample Volume	Aliquot	Gross -Tare / Net	Gross -Tare / Net		$\frac{C}{D}$ x Net = Total Wt Gn	$\frac{C}{N}$ x S = Blank	H-J = Final Wt	Final Wt
CKO-M5-1	7	565		147.6021 147.5931 0.0090				0.0040		0.0050
CKO-M5-2	5	670		148.9493 148.9433 0.0060				0.0047		0.0013
CKO-M5-3	2	655		146.6531 146.6482 0.0049				0.0046		0.0003

L	M	N	P	O	R	S
Blank	Container #	Volume	Gross -Tare / Net	Gross -Tare / Net		Blank Wt
H_2O	42	200	148.4764 148.4749 0.0015			0.0015

Date 7-26-79

Analyst MCR

Wt Units GRAMS

BETHLEHEM STEEL
Sparrows Point
BαP Lab Analysis

Run ID	Concentration Measurement	Solvent Extraction (ml)	TOTAL Micrograms (BαP)
CKO-15-BAP-1-F	.0018 ug/ml BAP	100	0.180
CKO-15-BAP-2-F	.00265 ug/ml BAP	100	0.265
CKO-15-BAP-3-F	.00585 ug/ml BAP	100	0.585
CKO-15-BAP-1-PR	.0025 ug/ml BAP	74	0.185
CKO-15-BAP-2-PR	.002 ug/ml BAP	234	0.468
CKO-15-BAP-3-PR	.002 ug/ml BAP	220	0.440
CKO-15-BLANK	<.002 ug/ml BAP	134	
CKO-15-BAP-1-IMP.	<.002 ug/ml BAP		
CKO-15-BAP-2-IMP.	0		
CKO-15-BAP-3-IMP.	0		
CKO-15-BAP-3-BT	.016 ug/ml BAP	200	3.20
CKO-15-BAP-2-BT	<.001 ug/ml BAP	200	0.200
CKO-15-BAP-1-BT	.016 ug/ml BAP	200	3.20

	K1	VF-25ml	PI	SPARROWS POINT TI		PF	TF	VF	µg NO2 Total	PPM
CKO-15-M7-1A	17.64	2077	4	545		27.1	538	1576	70.0	23
CKO-15-M7-1B	17.64	2091	3.9	547	Avg 40	27.2	538	1567	180.0	60
CKO-15-M7-1C	17.64	2064	3.8	549		27.3	538	1553	56.6	19
CKO-15-M7-1D	17.64	2089	4	548		27.1	538	1555	173.0	58
CKO-15-M7-2A	17.64	2084	7.4	543		22.7	539	1535	303.0	103
CKO-15-M7-2B	17.64	2085	0	543	Avg 69	22.76	540	1550	111.0	37
CKO-15-M7-2C	17.64	2097	0	543		2261	540	1538	170.0	58
CKO-15-M7-2D	17.64	2075	0	543		2261	539	1522	223.0	77
CKO-15-M7-3A	17.64	2085	0	543		2261	540	1542	50.0	17
CKO-15-M7-3B	17.64	2063	0	543	Avg 43	2261	541	1526	173.0	59
CKO-15-M7-3C	17.64	2059	0	543		2261	540	1520	140.0	48
CKO-15-M7-3D	17.64	2075	0	543		2261	541	1532	137.0	47

CUSTOMER: BETHLEHEM STEEL Analysis: NO_2 Analyst: [illegible] MJO:

Collection Date (Exposure Period) Analysis Completed:

SAMPLE NO.	SAMPLE WEIGHT (VOLUME) ml	TIT. ALIQ.	ABS. READING	FACTOR	pH	NET ABS.		µg NO_2 total		
CKO-15-M7-1A 25ml	100 m	20ml	.029 ~~.029~~	5	11	.021		70.0		
CKO-15-M7-1B 25ml			.062	5	11	.054		180.		
CKO-15-M7-1C 25ml			.025	5	12.5	.017		56.6		
CKO-15-M7-1D 25ml			.060	5	12.5	.052		173.		
CKO-15-M7-2A Absorbing Sol.			.099	5	10.0	.091		303.		
CKO-15-M7-2B Absorbing Sol.			.041 ~~.030~~	5	11.	.033		111.0		
CKO-15-M7-2C Absorbing Sol			.059	5	11.	.051		170.		
CKO-15-M7-2D Absorbing Sol			.075	5	11	.067		223.		
CKO-15-M7-3A Absorbing Sol.			.020	5	>12.*	.015		50.0		
CKO-15-M7-3B Absorbing Sol.			.060	5	10.5	.052		173.		
CKO-15-M7-3C Absorbing Sol.			.040	5	10.*	.042		140.		
CKO-15-M7-3D Absorbing Sol.			.049	5	10.*	.041		137.		

µg NO_2 total = FACTOR × 666.4 × NET ABS.

TRW
TRANSPORTATION AND ENVIRONMENTAL OPERATIONS OF [illegible] INC.

CUSTOMER: BETHLEHEM [illegible] Analysis: [illegible] Analyst: [illegible] MJO: _____

Collection Date (Exposure Period) [illegible] Analysis Completed:

SAMPLE NO.	SAMPLE WEIGHT (VOLUME)	TIT.* ALIQ.	READING	DIL. FACTOR	$Ba(ClO_4)_2$ ml	TIT-BLK NET	Total mg SO_2	Gas Vol $V_{m\,std}$ DSCF	lb SO_2 / DSCF	ppm (Vol/Vol)
CKO-15-M5-1 IMPINGERS	565 ml	10		565/10	1.95	1.90	35.79	64.925	1.22×10^{-6}	7.31
CKO-15-M5-2 IMPINGERS	670	10		670/10	5.25	5.20	116.17	77.982	3.28×10^{-6}	19.84
CKO-15-M5-3 IMPINGERS	655	10		655/10	3.95	3.90	85.18	83.968	2.24×10^{-6}	13.55
CKO-15 D.I H_2O BLK	25	10			0.00	–				
	Total mg SO_2 = ml $Ba(ClO_4)_2$ × N × DIL FAC × $\frac{64}{2}$ =						Total mg SO_4		lb SO_4 / DSCF	
CKO-15-M5 1F	200	5	5/50	400	0.95	0.95	190.1	64.925	6.46×10^{-6}	25.96
2F	200	5	5/50	400	0.70	0.70	140.0	77.982	3.68×10^{-6}	15.92
3F	200	5	5/50	400	1.80	1.80	360.1	83.968	9.45×10^{-6}	38.03
BLK	200	5	5/50	400	0.0	–				
	Total mg SO_4 = ml $Ba(ClO_4)_2$ × N × DIL FAC × $\frac{96}{2}$ =									
	# SO_2 / DSCF = $\frac{mg\ SO_2}{1000\ mg/g}$ × $\frac{1\ \#}{453.6\ g}$ × $\frac{1}{V_{m\,std}}$ =									

APPENDIX D

CALIBRATION ERROR DETERMINATIONS FOR CONTINUOUS MONITORS

Equipment Specifications

Beckman Model 705 Oxygen Analyzer

Flow rate	4-Lpm
System accuracy	1% of full scale
Response time	90% in 20 seconds
Measuring technique	Paramagnetic

Carbon Monoxide Analyzer

Infrared Industries Model	1R703
Flow rate	2-Lpm
System accuracy	1% of full scale
Response time	90% in 2 seconds
Measuring technique	NDIR

S.G.A. Model 90-03 NO/NO_x Analyzer

Flow rate	1-Lpm
System accuracy	1% of full scale
Response time	90% in 5 seconds
Measuring technique	Chemiluminescence

Calibration Error Determination

Reference CO analyzer

Run No.	Calibration Gas Concentration ppm		Measurement System Reading ppm		Arithmetic Differences ppm	
	Zero	Low	Zero	Low	Zero	Low
1	0	186	0	186	0	0
2	0	186	0	186	0	0
3	0	186	0	186	0	0
4	0	186	-1	186	-1	0
5	0	186	-1	185	-1	1
6	0	186	-1	185	-1	1
7	0	186	-1	185	-1	1
8	0	186	-1	186	-1	0
9	0	186	-1	185	-1	1
10	0	186	-2	185	-2	1
11	0	186	-2	186	-2	0
12	0	186	-2	185	-2	1
13	0	186	-2	185	-2	1
14	0	186	-2	184	-2	2
15	0	186	-2	184	-2	2
Arithmetic Mean (Eq. 2-1)					1.2	185.267
Confidence Interval (Eq. 2-2)					.428	.3897

Calibration Error Determination

Reference CO analyzer

Run No.	Calibration Gas Concentration ppm		Measurement System Reading ppm		Arithmetic Differences ppm	
	Mid	High	Mid	High	Mid	High
1	412	609	412	609	0	0
2	412	609	412	609	0	0
3	412	609	412	609	0	0
4	412	609	411	608	1	1
5	412	609	411	608	1	1
6	412	609	411	608	1	1
7	412	609	411	608	1	1
8	412	609	411	608	1	1
9	412	609	411	608	1	1
10	412	609	410	607	2	2
11	412	609	410	607	2	2
12	412	609	410	607	2	2
13	412	609	410	607	2	2
14	412	609	410	608	2	1
15	412	609	410	607	2	2
Arithmetic Mean (Eq. 2-1)					411.450	608.324
Confidence Interval (Eq. 2-2)					.4289	.0382

Zero and Calibration Drift

Reference CO analyzer

Data Set No.	Zero Reading	Zero Drift (Δ Zero)	Span Reading	Span Drift (Δ Span)	Calibration Drift (Δ Span-Zero)
1	0	0	609	0	0
2	0	0	609	0	0
3	0	0	609	0	0
4	-1	1	608	-1	0
5	-1	1	608	-1	0
6	-1	1	608	-1	0
7	-1	1	608	-1	0
8	-1	1	608	-1	0
9	-1	1	608	-1	0
10	-2	2	607	-2	0
11	-2	2	607	-2	0
12	-2	2	607	-2	0
13	-2	2	607	-2	0
14	-2	2	608	-1	1
15	-2	2	607	-2	0

Zero Drift = (Mean Zero Drift 1.2 + CI (Zero) .428 = 1.628

Calibration Drift = (Mean Span Drift 1.13 + CI (Span) .0382 = 1.168

Response Time

Reference CO analyzer

Test Run	Upscale min/sec	Downscale min/sec
1	17	17
2	17	18
3	16	17
Average	A= 16.67	B= 17.33

System Response Time (slower of A and B) = 17.33 min/sec.

$$\text{\% deviation from slower system average response} = \frac{\text{average upscale minus average downscale}}{\text{slower time}} \times 100\%$$

03.8% deviation

Calibration Error Determination

Reference NOx analyzer

Run No.	Calibration Gas Concentration ppm		Measurement System Reading ppm		Arithmetic Differences ppm	
	High		High		High	
1	260		260		0	
2	260		260		0	
3	260		261		1	
4	260		261		1	
5	260		261		1	
6	260		262		2	
7	260		262		2	
8	260		263		3	
9	260		264		4	
10	260		264		4	
11	260		263		3	
12	260		263		3	
13	260		264		4	
14	260		265		5	
15	260		264		4	
Arithmetic Mean (Eq. 2-1)					262.467	
Confidence Interval (Eq. 2-2)					1.659	

Calibration Error Determination

Reference NOx analyzer

Run No.	Calibration Gas Concentration ppm		Measurement System Reading ppm		Arithmetic Differences ppm	
	Low	Mid	Low	Mid	Low	Mid
1	0	150	0	150	0	0
2	0	150	0	150	0	0
3	0	150	0	150	0	0
4	0	150	1	151	1	1
5	0	150	1	151	1	1
6	0	150	1	151	1	1
7	0	150	2	151	2	1
8	0	150	2	152	2	2
9	0	150	3	152	3	2
10	0	150	3	154	3	4
11	0	150	3	154	3	4
12	0	150	3	155	3	5
13	0	150	4	155	4	5
14	0	150	4	154	4	4
15	0	150	4	154	4	4
Arithmetic Mean (Eq. 2-1)					2.07	152.27
Confidence Interval (Eq. 2-2)					1.124	1.035

Zero and Calibration Drift

Reference NO_x analyzer

Data Set No.	Zero Reading	Zero Drift (Δ Zero)	Span Reading	Span Drift (Δ Span)	Calibration Drift (Δ Span-Zero)
1	0	0	260	0	0
2	0	0	260	0	0
3	0	0	261	1	1
4	1	1	261	1	0
5	1	1	261	1	0
6	1	1	262	2	1
7	2	2	263	3	1
8	2	2	263	3	1
9	3	3	263	3	0
10	3	3	263	3	0
11	3	3	264	4	1
12	3	3	264	4	1
13	4	4	264	4	0
14	4	4	264	4	0
15	4	4	265	5	1

Zero Drift = (Mean Zero Drift 2.067 + CI (Zero) 1.124 = 3.191

Calibration Drift = (Mean Span Drift 2.8 + CI (Span) 1.659 = 4.459

Response Time

Reference NO_x analyzer

Test Run	Upscale min/sec	Downscale min/sec
1	20	22
2	21	21
3	20	21
Average	A= 20.33	B= 21.33

System Response Time (slower of A and B) = 21.33 min/sec

$$\text{\% deviation from slower system average response} = \frac{\text{average upscale minus average downscale}}{\text{slower time}} \times 100\%$$

04.688 % deviation

Calibration Error Determination

Reference O_2 analyzer

Run No.	Calibration Gas Concentration % conc.		Measurement System Reading % conc.		Arithmetic Differences % conc.	
	Low	High	Low	High	Low	High
1	0	20.9	0	20.9	0	0
2	0	20.9	0	20.9	0	0
3	0	20.9	0	20.9	0	0
4	0	20.9	0	20.7	0	.2
5	0	20.9	0	20.7	0	.2
6	0	20.9	0	20.9	0	0
7	0	20.9	0	20.9	0	0
8	0	20.9	0	21.0	0	.1
9	0	20.9	0	21.0	0	.1
10	0	20.9	1	22.0	1	1.1
11	0	20.9	1	20.9	1	0
12	0	20.9	0	20.9	0	0
13	0	20.9	0	20.9	0	0
14	0	20.9	1	20.9	1	0
15	0	20.9	0	20.9	0	0
Arithmetic Mean (Eq. 2-1)					0.2	20.96
Confidence Interval (Eq. 2-2)					.229	.166

Zero and Calibration Drift

Reference O_2 analyzer

Data Set No.	Zero Reading	Zero Drift (Δ Zero)	Span Reading	Span Drift (Δ Span)	Calibration Drift (Δ Span-Zero)
1	0	0	20.9	0	0
2	0	0	20.9	0	0
3	0	0	20.9	0	0
4	0	0	20.9	0	0
5	0	0	20.9	0	0
6	0	0	20.9	0	0
7	0	0	20.9	0	0
8	0	0	20.9	0	0
9	0	0	20.9	0	0
10	0	0	21.0	.1	.1
11	0	0	21.0	.1	.1
12	0	0	21.5	.6	.6
13	0	0	21.3	.4	.4
14	1	1	21.1	.2	.1
15	1	1	21.3	.4	.3

Zero Drift = (Mean Zero Drift .133 + CI (Zero) .229 = .362

Calibration Drift = (Mean Span Drift .12 + CI (Span) .166 = .286

Response Time

Reference O_2 analyzer

Test Run	Upscale min/sec	Downscale min/sec
1	24	25
2	25	25
3	26	26
Average	A= 25	B= 25.33

System Response Time (slower of A and B) = 25.33 min/sec.

$$\text{\% deviation from slower system average response} = \frac{\text{average upscale minus average downscale}}{\text{slower time}} \times 100\%$$

1.3% deviation

APPENDIX E

PROCESS OPERATION DATA

APPENDIX E

PROCESS DATA

TEST NO. 1

JULY 11, 1979

ok JPR

Date 7/11/79
Plant Name Bethlehem Steel
Location Sparrows Pt., MD
Battery No. 2

COKE OVEN BATTERY LOG SHEET

Oven Pushing Data			Oven Charging Data		
Oven No.	Time Pushed	Push Greenness*	Oven No.	Time ~~Leveled~~ charged	Comments
229	1041	2	219	1040	
239	1050	2	229	1051	
249	1103	1	239	1103	
259	1112	2	249	1114	
202	1238	2	259	1120	
212	1245	2	202	1242	
222	1253	1	212	1254	
232	1301	1	222	1303	
242	1312	1	232	1314	No Difference in Stack Plume
252	1321	1	242	1328	Slight Plume Diff.
262	1330	1	252	1337	
			262	1344	
204	1445	1			Sampling Started
214	1453	2	204	1455	
224	1503	1	214	1521	
234	1531	1	224	1538	
244	1545	1	234	1547	CO peak (sharp spike) — 1545
254	1556	1	244	1557	
264	1606	1	254	1607	
			264	1628	

* Coke Greenness Rating: 1 - denotes coke is not green;
5 - denotes very green coke pushed.

Date 7/11/79
Plant Name Bethlehem Steel
Location Sparrows Pt., MD.
Battery No. 2

COKE OVEN BATTERY LOG SHEET

Oven Pushing Data			Oven Charging Data		
Oven No.	Time Pushed	Push Greenness*	Oven No.	Time Leveled	Comments
206	NR	NR	206	NR	
216	NR	NR	216	1805	No Diff. in Plume
226	1804	1	226	1816	No. Diff. in Plume
236	1814	2	236	1825	
246	1825	2	246	~ 1845	Missed Exact Reading of Begin to Charge
256	1850	1	256	1901	
266	1905	1	266	1917	
	Sampling Run Completed ~ 20:20. before				
	any additional battery activity occurred.				

* Coke Greenness Rating: 1 - denotes coke is not green;
5 - denotes very green coke pushed.

NR - No Reading Taken

East | No 2 Battery | West
Coke Side

TABLE 4. PROCESS OPERATING LOG

Samples Time test started ~3 PM
Time test ended 2020
Hold periods
Coking Time

Date 7/11/79
Plant personnel Bob Kilwell
Joe Driscoll - Heat Rm OP.

	Transmissometer reading	Fuel gas flow rate X 1000 SCFH	No. of oven charged	No. of oven pushed	Greenness of push a/	Collecting main pressure	Stack draft (negative) East West	O2 in flues - not from stack	Flue temperatures Min.	Max.	Avg.	Coke temp. when pushed b/	Wall No.	Wall temperatures b/ Min.	Max.	Avg.	Flue pressure	Flue temperature	Stack temperature (West)	Ambient temperature	Weather conditions	CAS Reading mm H2O
Units	%	SCFH					%		°F	°F	°F	°F		°F	°F	°F		°F	°F	°F		
Time	NA											NA										
1017		215				3.5 3.6	21.5	NA											575		CLD	87
1125		217				3.5 3.7	22.0												598		CLD	87
1220		217				3.7 3.7	22.0												580		CLD	94
1258		213				3.6 3.3	23												596		CLD	83
1530		223				3.5 3.6	22												608		Cly	100
1635		226				3.2 3.2	22.3												618		Cly	103
[illegible]		214				NR	23.1												579		Cly	88
1923		221				3.2 3.2	22.2												598		Cly	95
2025		218				NR	22.2												598		Cly	90

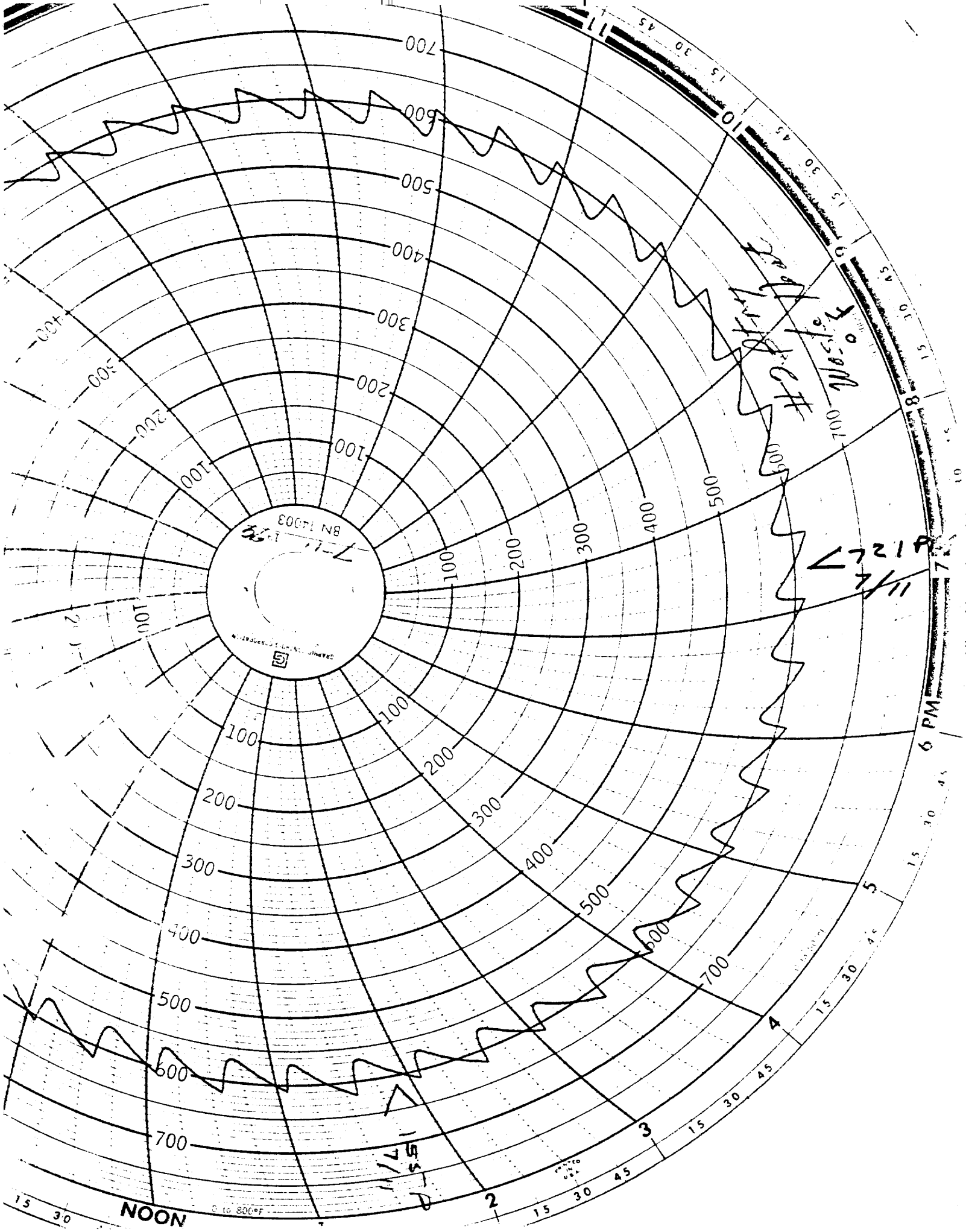
Push
Push
Push
Push
Coke
CS
PS
CS
CS

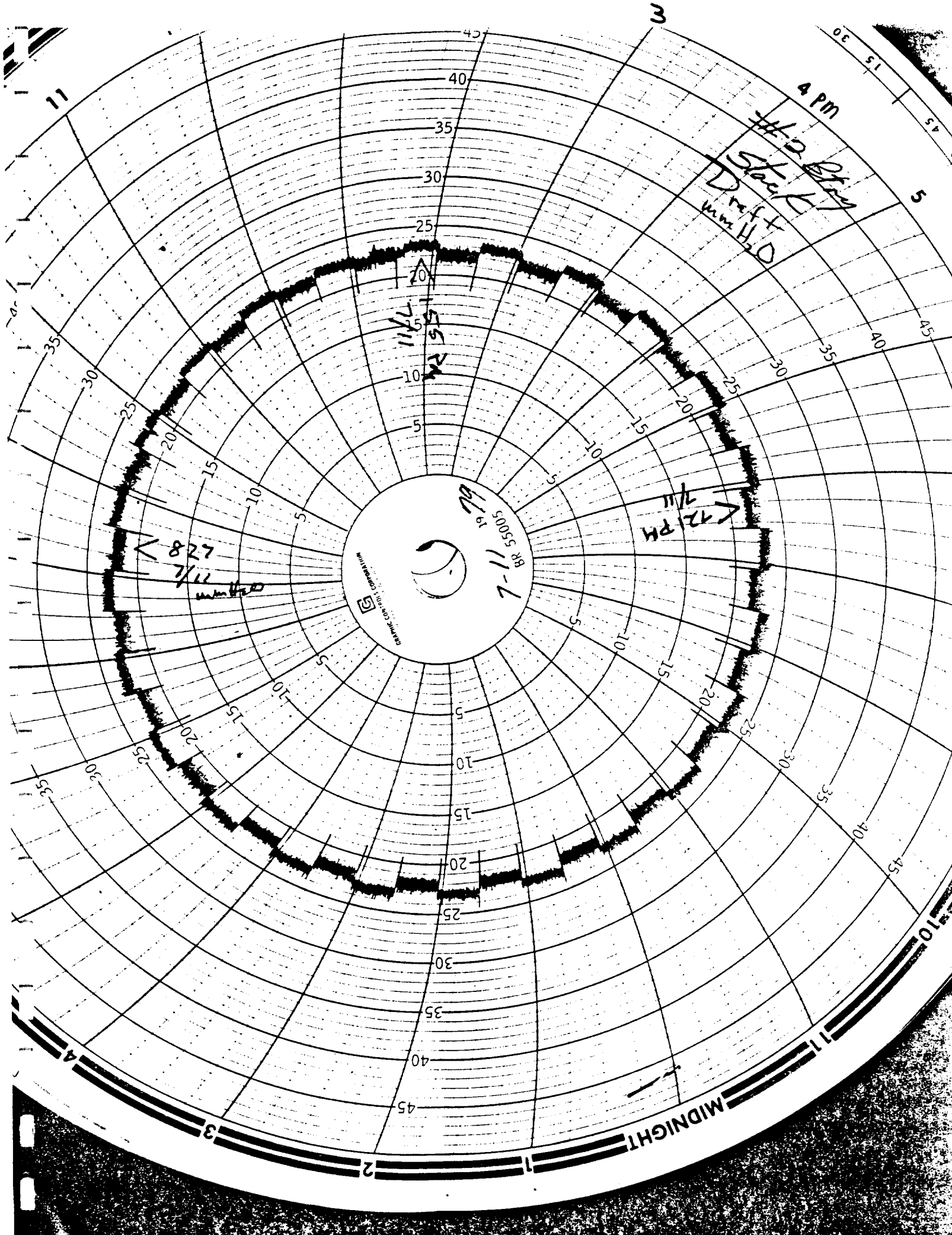
a/ Greenness rated from 1 to 3 with 1 - not green, 3 - very green (obtain as time permits).
b/ Obtain this data, if feasible.

Can operators identify any specific wall leak locations, and their severity?

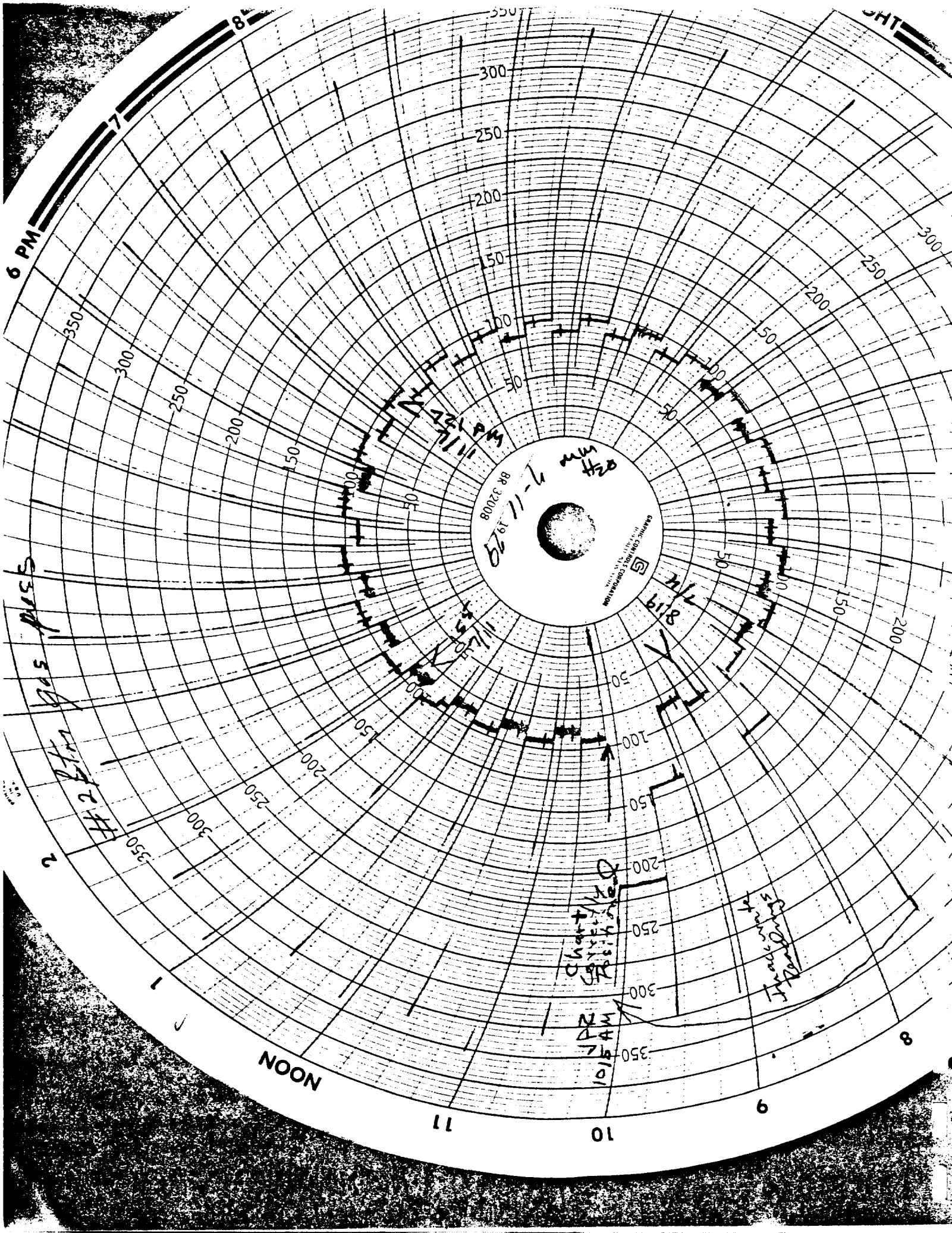
Other comments that may bear on emission test results.

O_2	11.1%	14	11.1	12	10.3
CO	40 ppm	55 ppm	70	70	65
NO_x	No Reading (Instrument not operating)		NA	NA	60? ppm
16:43 - Time		1760	1845	1909	2020

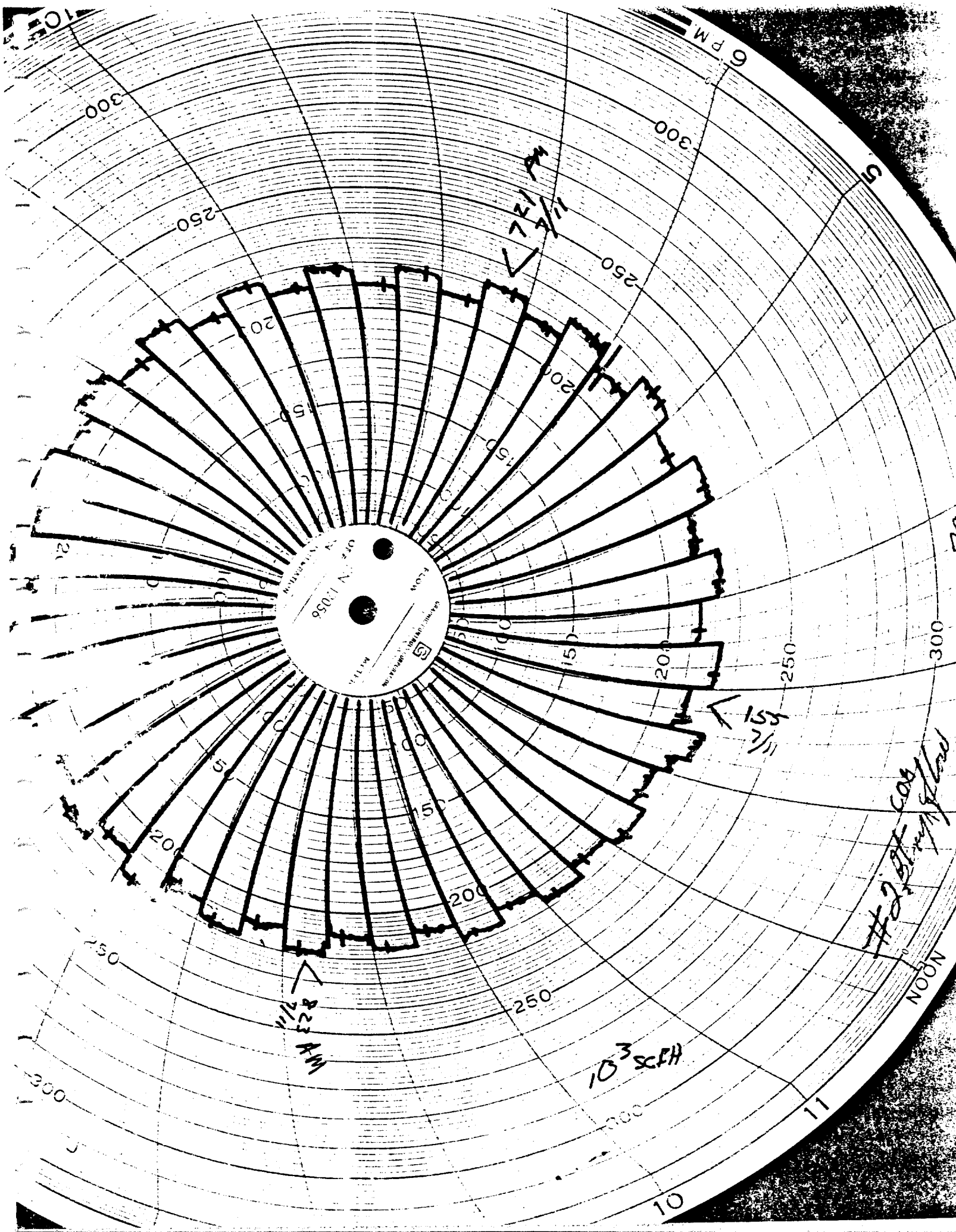

NOON
6 PM
0 to 800°F
BN 14003



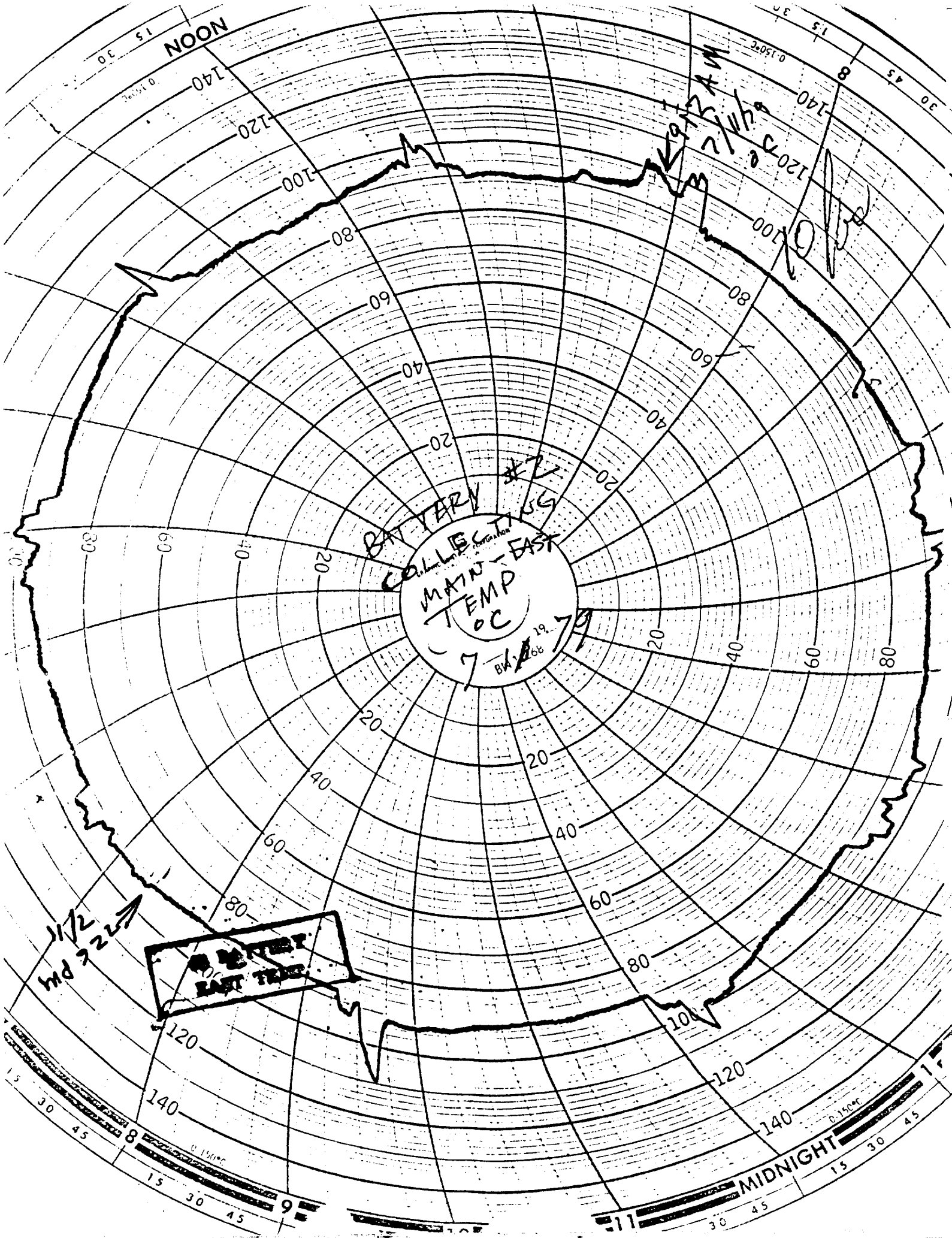
3
4 PM
5
11
MIDNIGHT
BR 55005
GRAPHIC CONTROLS CORPORATION

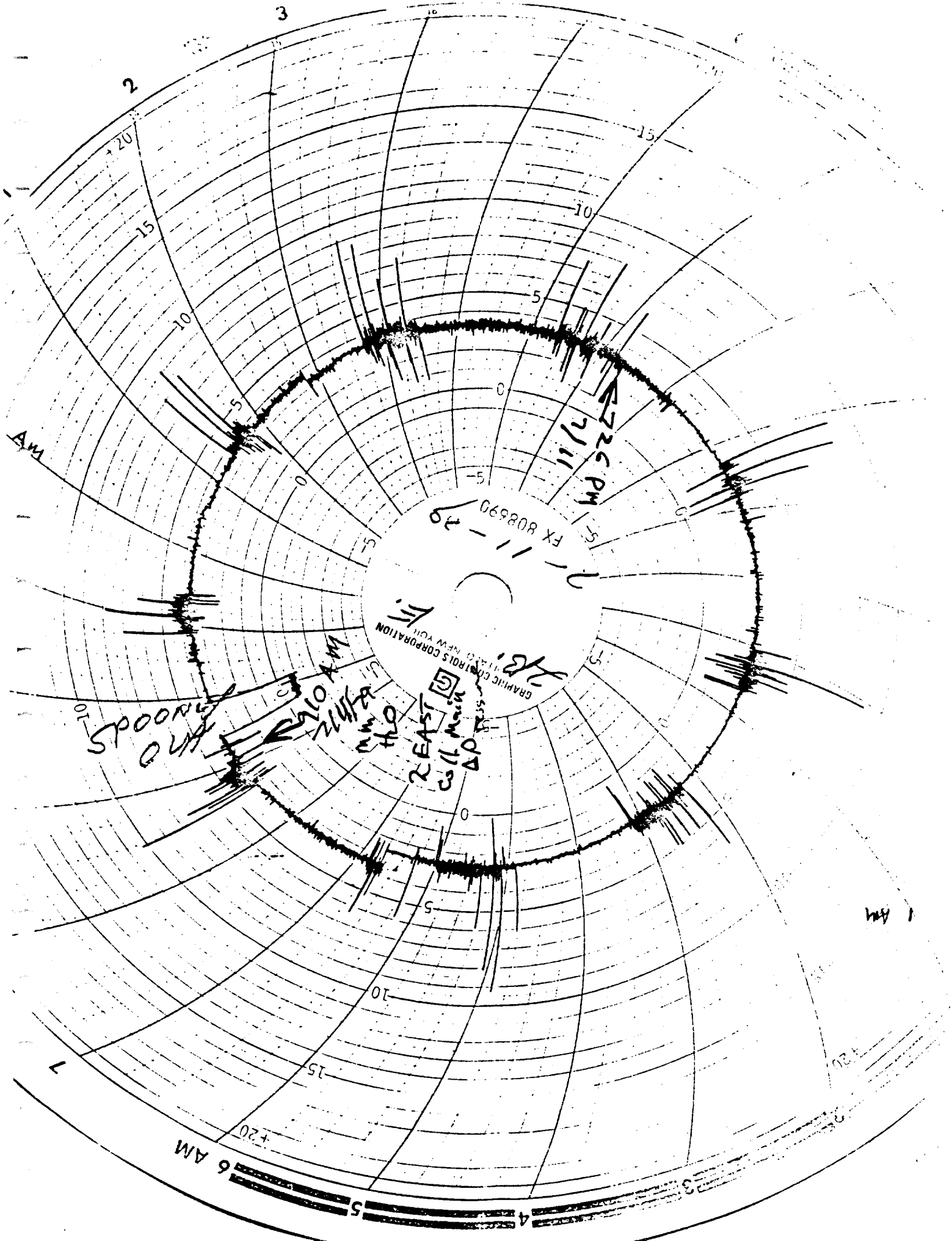


6 PM
7
8
NOON
1
2
8
9
10
11
BR 32008
GRAPHIC CONTROLS CORPORATION

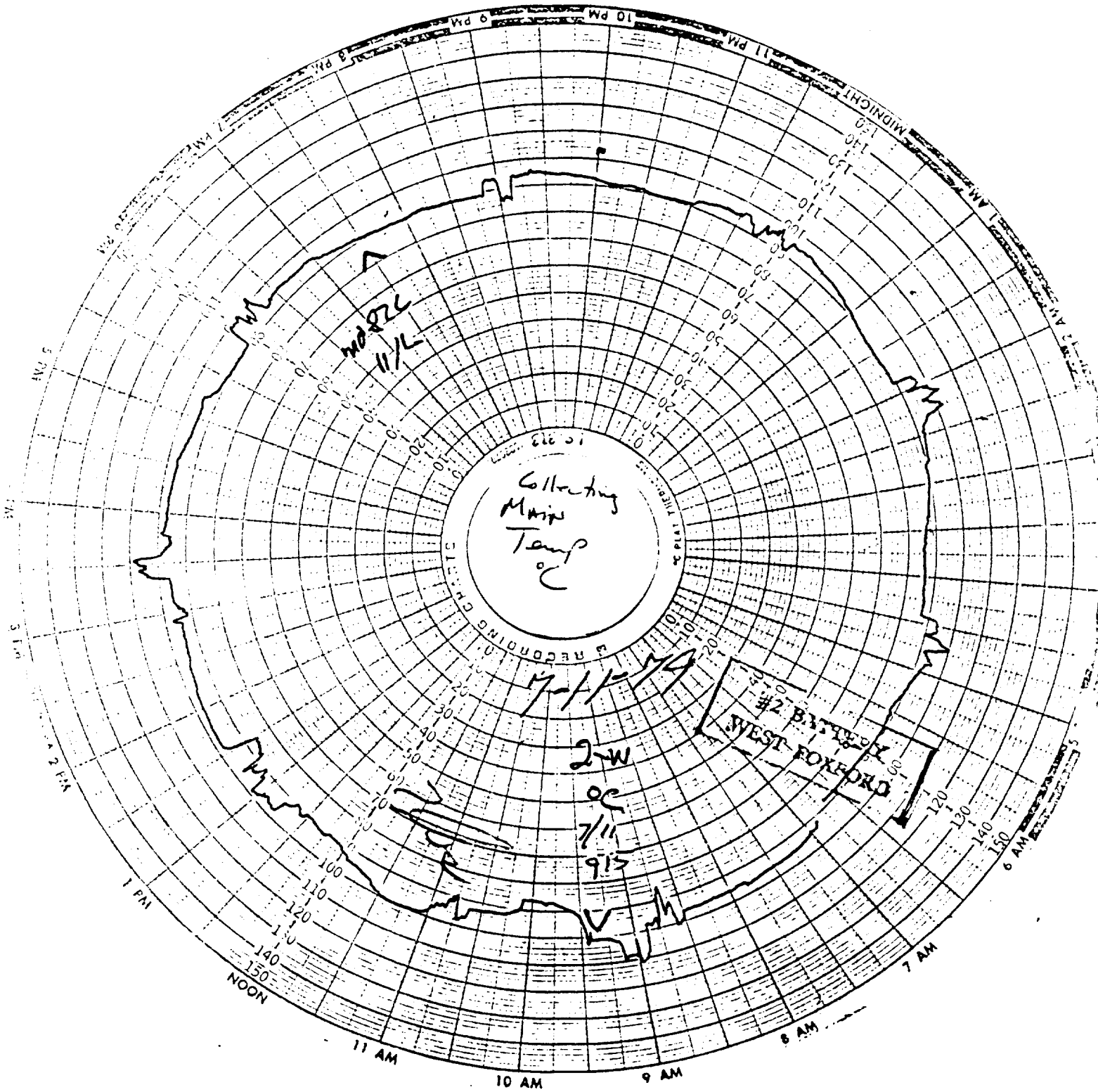


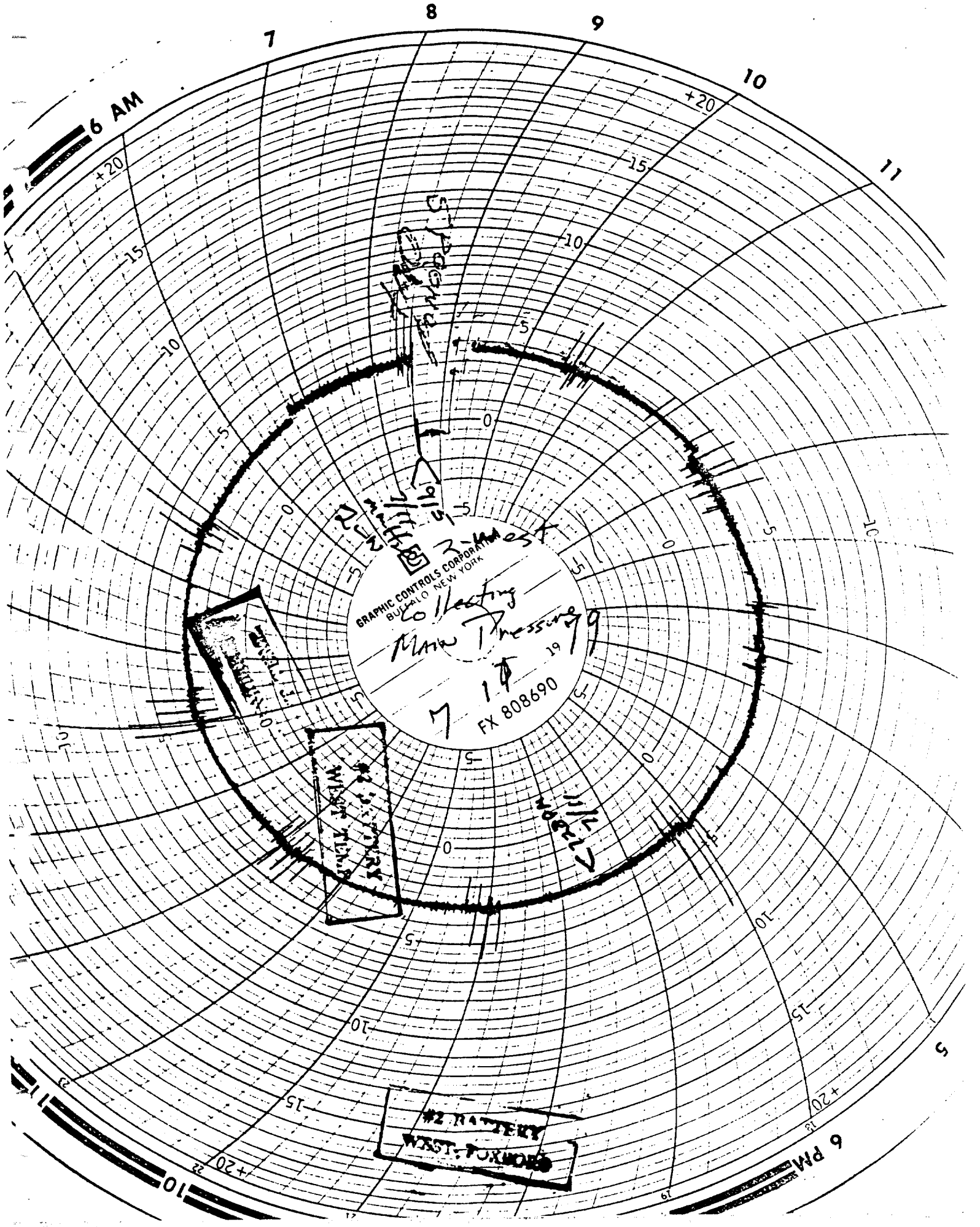
6 PM
5
NOON
11
10
300
250
200
150
100
50
7/11 AM
7/11
155
7/11
823
7/11
AM
10^3 SCFH
#2 Bt cos


NOON
MIDNIGHT
BATTERY #2
COLLECTING
MAIN - EAST
TEMP
°C
BATTERY
EAST TEMP



GRAPHIC CONTROLS CORPORATION
FX 808690
2-11-29
2 EAST
Coll Main
ΔP
10 AM
6 AM
1 AM


Collecting
Main
Temp
°C
#2 BATTERY
WEST FOXFORD
NOON
1 PM
2 PM
3 PM
4 PM
5 PM
6 PM
7 PM
8 PM
9 PM
10 PM
11 PM
MIDNIGHT
1 AM
2 AM
3 AM
4 AM
5 AM
6 AM
7 AM
8 AM
9 AM
10 AM
11 AM


6 AM
7
8
9
10
11
6 PM
GRAPHIC CONTROLS CORPORATION
BUFFALO NEW YORK
FX 808690
#2 BATTERY
WEST FOXBORO

TEST NO. 2

JULY 12, 1979

Date 7/12/79
Plant Name Bethlehem Steel
Location Sparrows Pt. MD.
Battery No. 2
Sample Run #2

COKE OVEN BATTERY LOG SHEET

Oven Pushing Data			Oven Charging Data		
Oven No.	Time Pushed	Push Greenness*	Oven No.	Time ~~Leveled~~ Charged	Comments
			209	9:58	
219	954	1	219	10:06	
229	1003	1	229	1014	
239	1012	1	239	1024	No. Diff. in Plume
249	1021	1	249	1034	
259	1034	2	259	1044	No Visible Diff. of Plume
202	~1215	NR	202	1220	Sampling Started 1145
212	1223	1	212	1235	
222	1234	1	222	1244	C.S. Door Machine Inoperable
232	1533	1	232	1546	Resumed Pushing 3 hrs. later
242	1544	2	242	1558	
252	1558	1	252	1610	
262	1607	1	262	1619	
204	1629	2	204	1638	
214	1636	1	214	1645	
224	1643	2	224	1652	
234	1651	1	234	1702	
244	1700	2	244	1709	
254	1709	2	254	1717	
264	1717	1	264	NR	

* Coke Greenness Rating: 1 - denotes coke is not green;
5 - denotes very green coke pushed.

NR – No Reading Taken

Date 7/12/79
Plant Name Bethlehem Steel
Location Sparrows Pt., MD.
Battery No. 2

COKE OVEN BATTERY LOG SHEET

Sample Run #2

Oven Pushing Data			Oven Charging Data		
Oven No.	Time Pushed	Push Greenness*	Oven No.	Time Leveled	Comments
206	1732	NR	206	1735	
216	1742	1	216	1750	
226	1749	1	226	1759	*N.D. Start Plume
236	1759	1	236	1808	
246	1807	2	246	1816	
256	1816	2	256	1825	
266	1824	3	266	1834	Sampling ~~Sta~~ End S
					1830

* Coke Greenness Rating: 1 - denotes coke is not green;
5 - denotes very green coke pushed.

NR - No Reading taken

Run #2

TABLE 4. PROCESS OPERATING LOG

Time test started 1145
Time test ended 1830
Hold periods ~ 2 hrs.
Coking Time

Date 7/12/79
Plant personnel J Driscoll
Hughes

	Transmissometer reading	Fuel gas flow rate 103	No. of oven charged	No. of oven pushed	Greenness of push a/	Collecting main pressure EAST WEST mm H2O	Stack draft mm H2O	O2 in flues	Flue temperatures Min.	Max.	Avg.	Coke temp. when pushed b/	Wall No.	Wall temperatures b/ Min.	Max.	Avg.	Flue pressure	Flue temperature (Waste Heat)	Stack temperature	Ambient temperature	Weather conditions	Gas Rate mm H2O	
Units	%	SCFH						%	°F	°F	°F	°F		°F	°F	°F		°F	°F	°F			
Time																							
1054		212				-0.9 3.3	22.6											592			Cly	75	
1215		221				3.5 3.5	22.0											585			Cly	95	CS
1318		217				3.6 3.4	22.2											585			Cly	90	CS
1447		195				3.7 3.5	23.0											578			Cly	88	PS
1620		210				4.0 3.6	22.2											592			Cly	93	
1725		215				4.3 3.6	22.2											599			Cly	93	CS
1832		218				4.2 4.2	22.0											615				95	CS

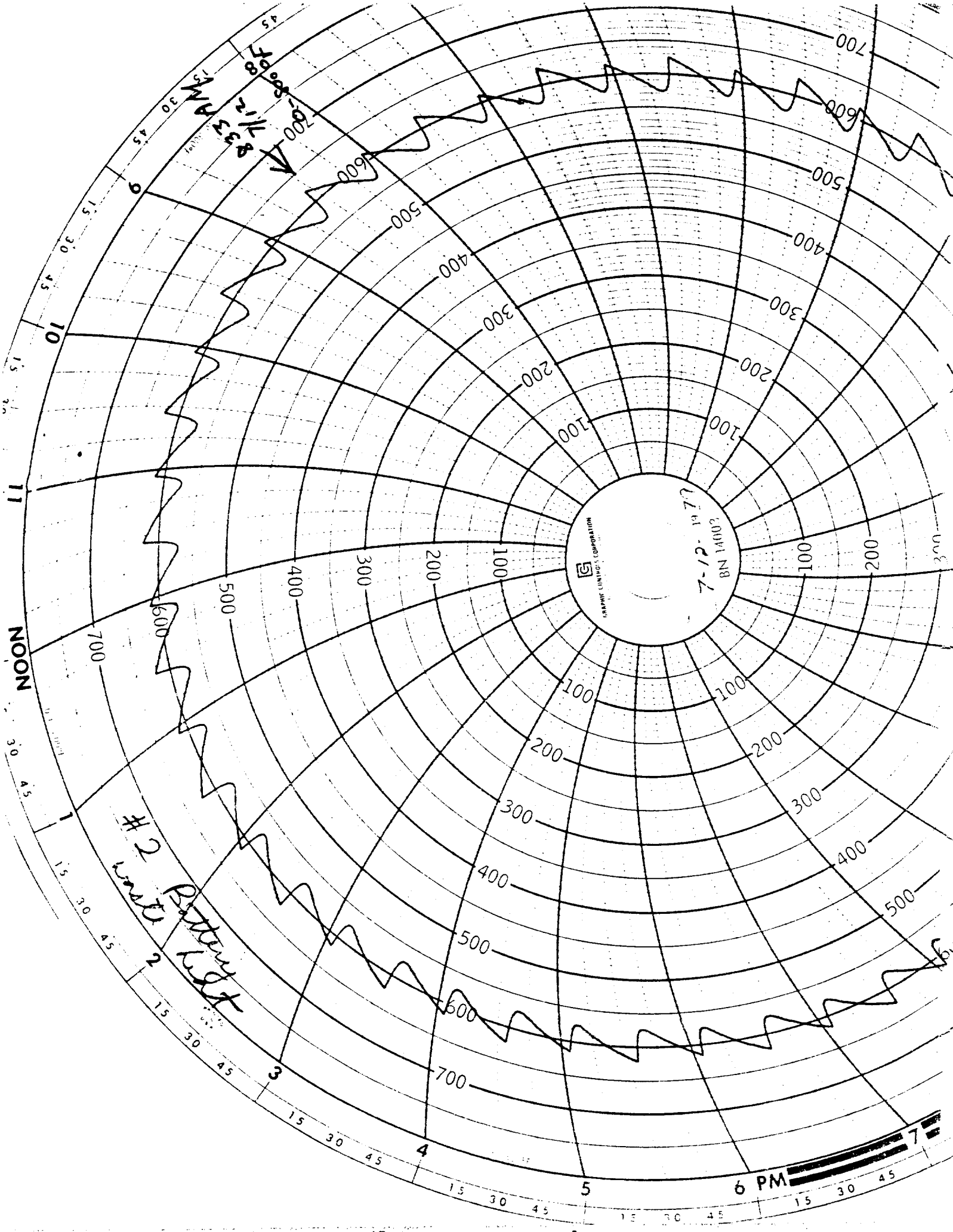
a/ Greenness rated from 1 to 3 with 1 - not green, 3 - very green (obtain as time permits).
b/ Obtain this data, if feasible.

Can operators identify any specific wall leak locations, and their severity?

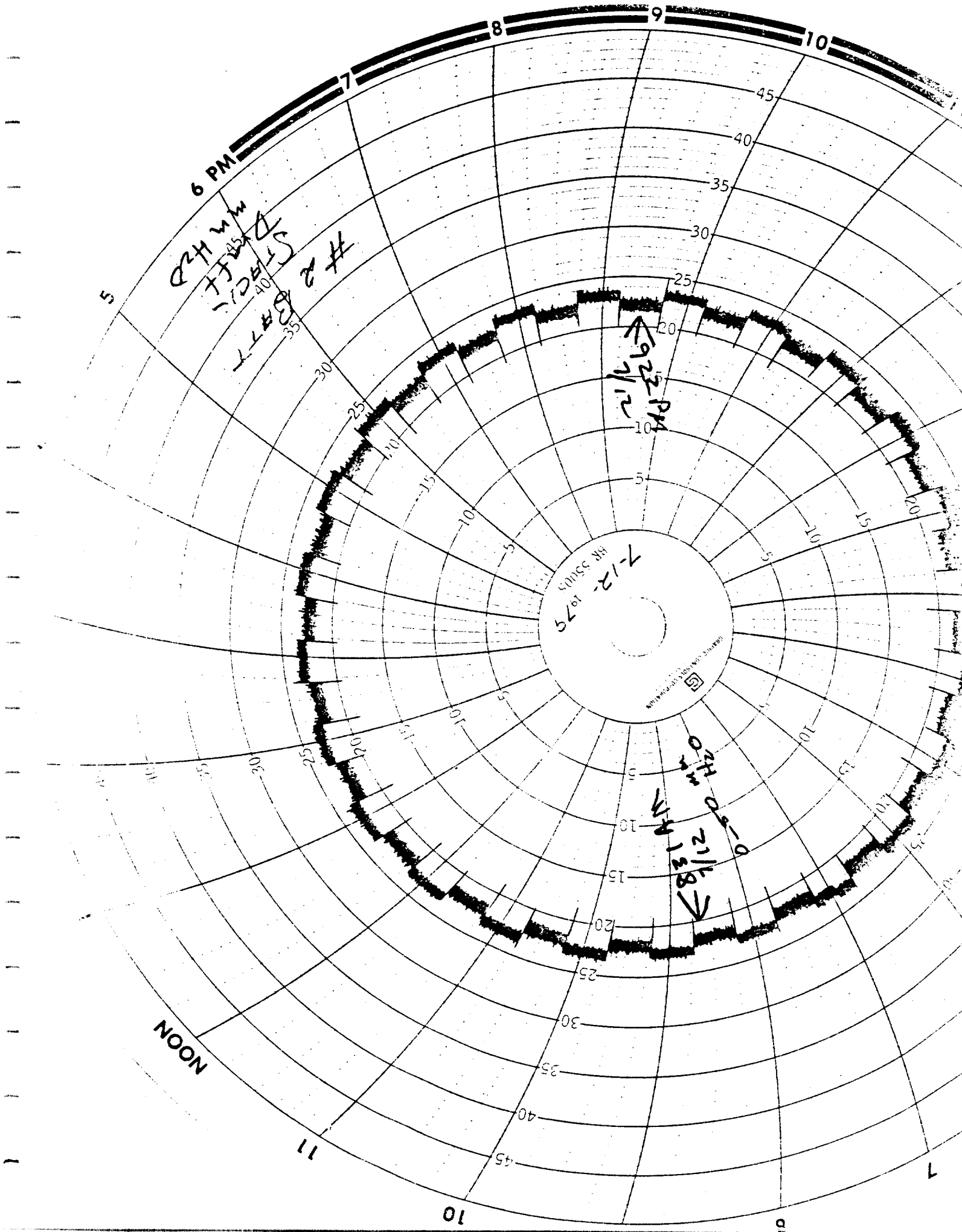
Other comments that may bear on emission test results.

O_2	12%	11%
CO	85 ppm	150
NO_x	40 ppm	Inoperable

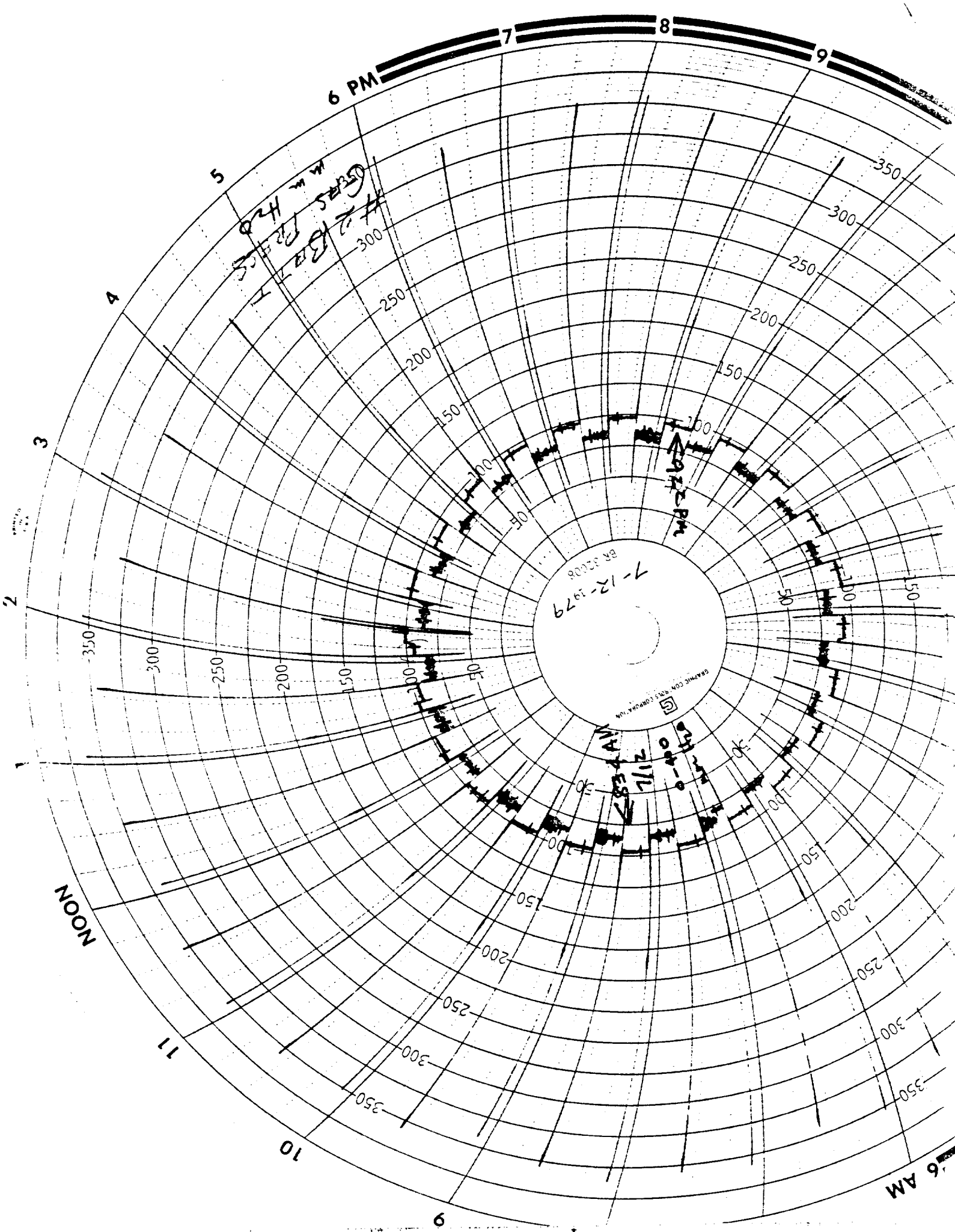
1152 - Dry Time
1153 - Monitor Time 17-5



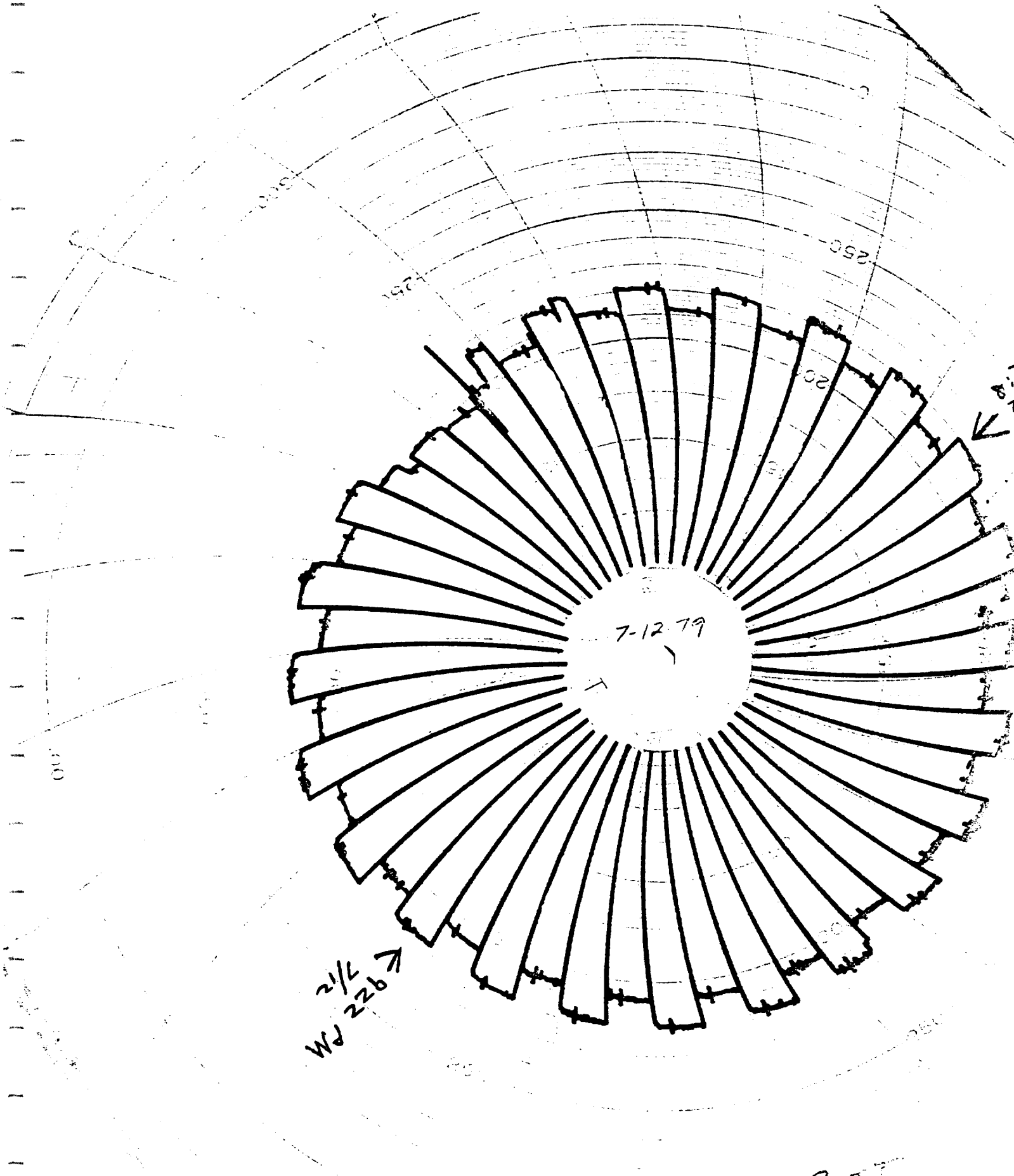
NOON
6 PM
7
8
9
10
11
1
2
3
4
5
100
200
300
400
500
600
700
GRAPHIC CONTROLS CORPORATION
BN 14003
7-12-1977
#2 Battery
waste heat



6 PM
7
8
9
10
NOON
11
10
7
5
45
40
35
30
25
20
15
10
5
BR 55005
7-12-1979

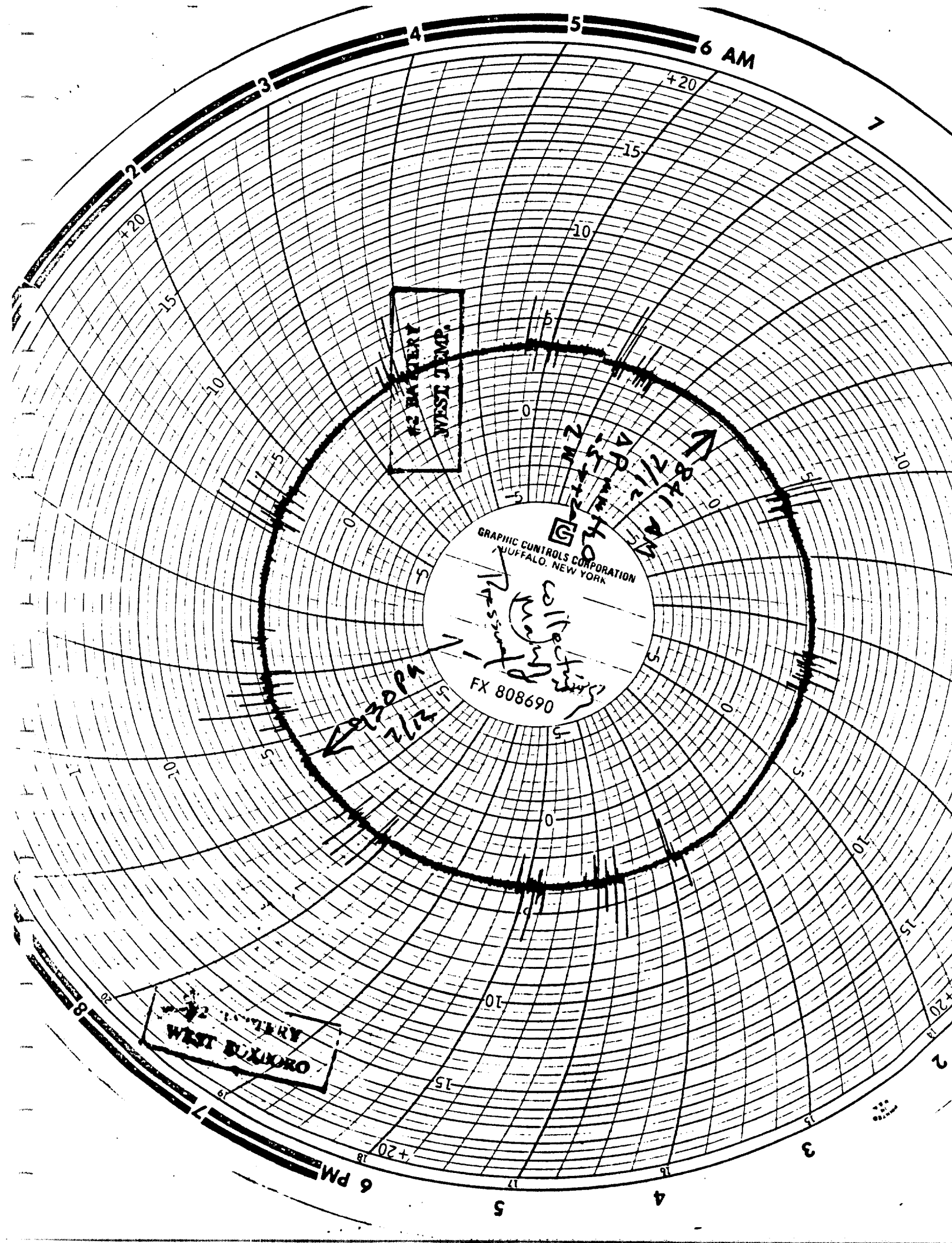


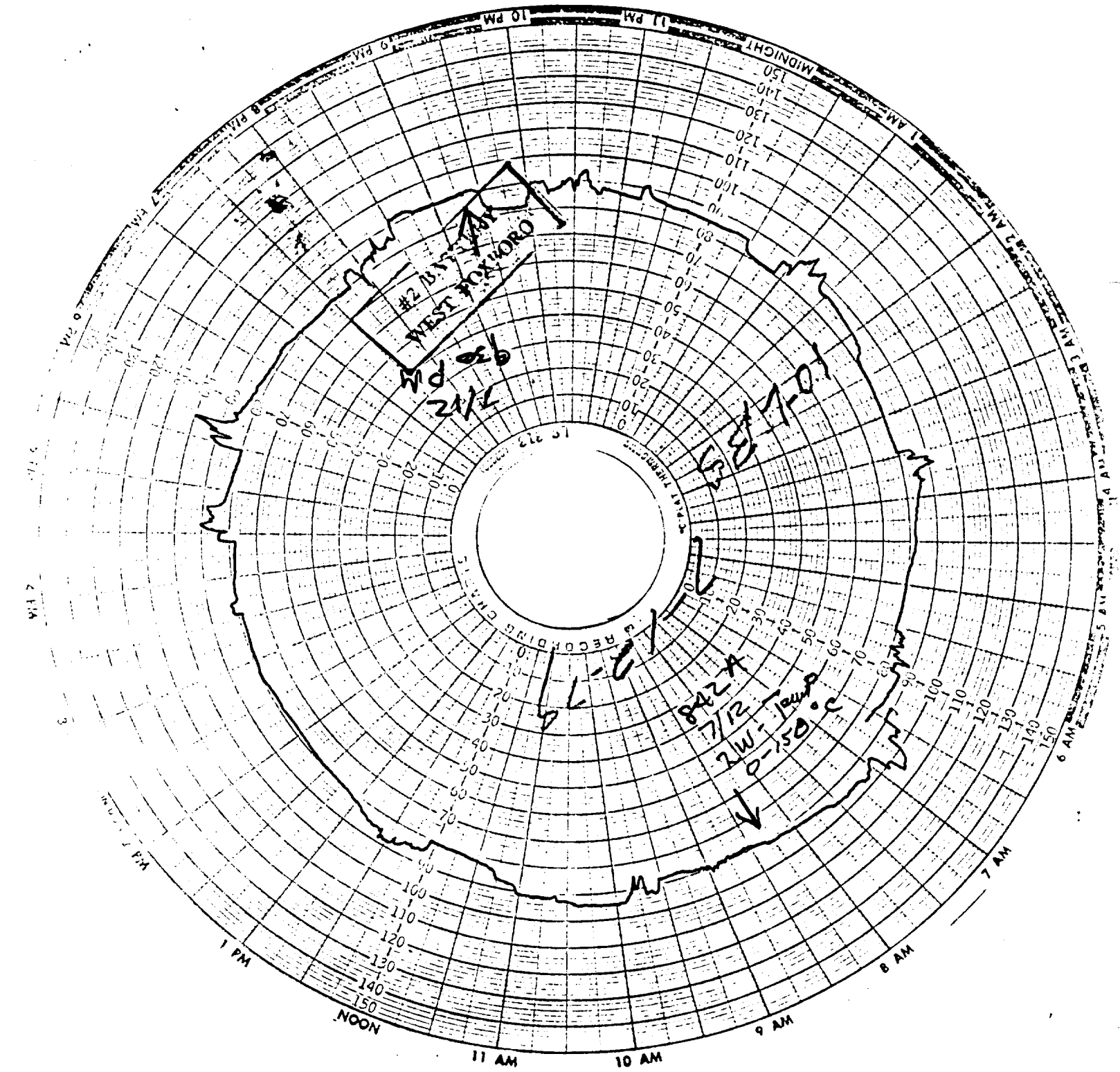
6 PM
7
8
9
5
4
3
2
1
NOON
11
10
9
6 AM
350
300
250
200
150
100
50
7-12-1979
BR 32008
GRAPHIC CONTROLS CORPORATION



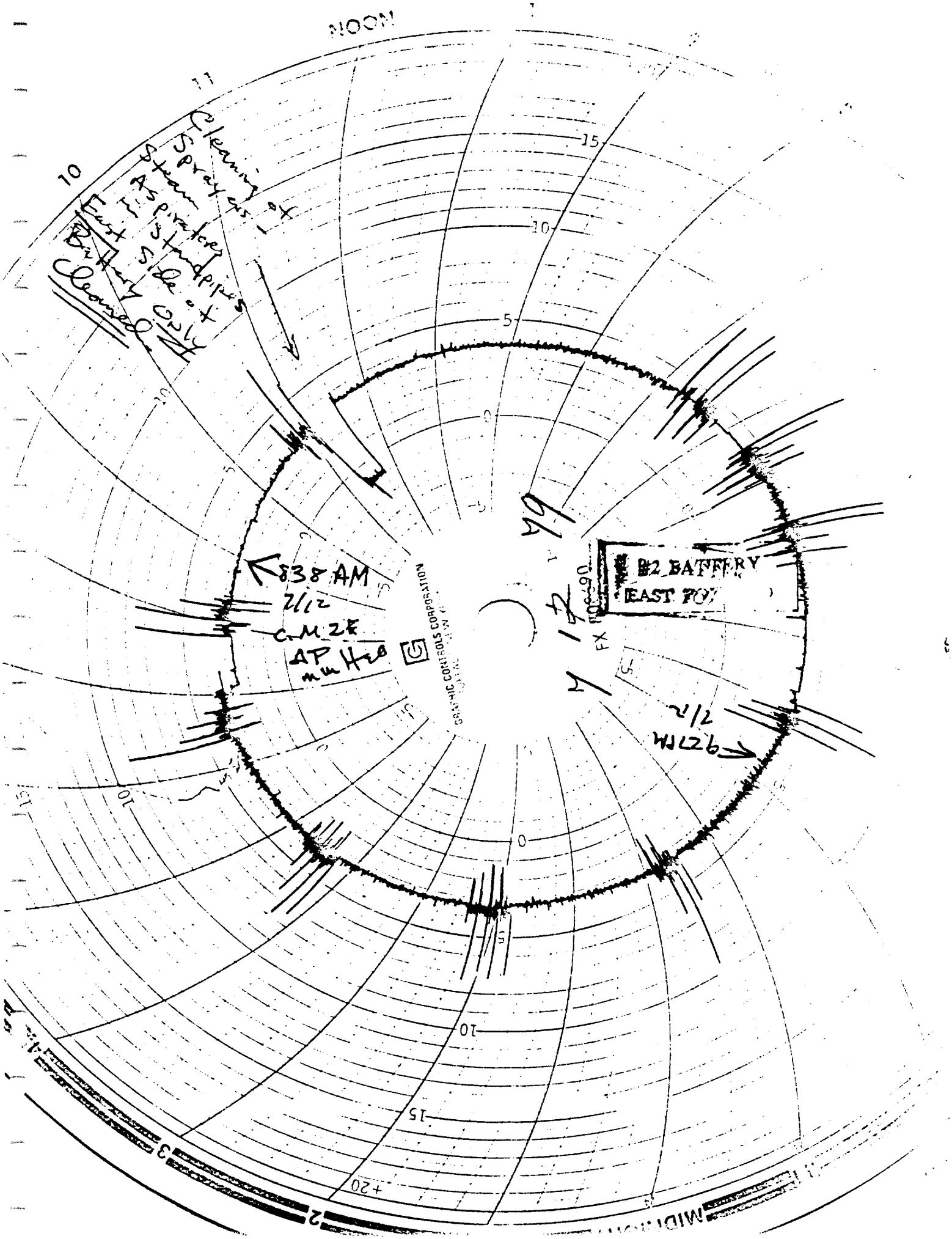
#2 BAT
GAS FLOW
X10³ SCFM

NOON
PM
AM
GRAPHIC CONTROLS CORPORATION
BN 14268


6 AM
6 PM
#2 BATTERY
WEST TEMP.
#2 BATTERY
WEST BUXBORO
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
FX 808690



#2 BNY WEST FOXBORO
842A
7/12
2W - Temp
0-150°C
MIDNIGHT
1 AM
2 AM
3 AM
4 AM
5 AM
6 AM
7 AM
8 AM
9 AM
10 AM
11 AM
NOON
1 PM
10 PM
11 PM


NOON
Cleaning of Sprayers
Steam Aspirators
Standpipes
East Side of Battery Only
Cleaned
838 AM
2/12
C.M.2E
ΔP mm H2O
GRAPHIC CONTROLS CORPORATION
#2 BATTERY
EAST FO
2/12
MIDNIGHT

TEST NO. 3

JULY 12, 1979

Date 7/12/79
Plant Name Bethlehem Steel
Location Sparrows Pt., MD.
Battery No. 2
Sample Run 3

COKE OVEN BATTERY LOG SHEET

Oven Pushing Data			Oven Charging Data		
Oven No.	Time Pushed	Push Greenness*	Oven No.	Time Leveled	Comments
208	~ 1945	NR	208	2000	
218	~1955	NR	218	2029	Sampling Started ~2015 Run #3
228	2019	3	228	2029	Rating Pushes at night are different.
238	2029	2	238	2038	
248	2038	2	248	2047	
258	2047	2	258	2055	
201	2203	2	201	2214	Can't tell if plume
211	2213	4	211	2230	changes due to night conditions.
221	2230	2	221	2240	
231	2238	2	231	2248	
241	2246	3	241	2311	
251	2257	2	251	2318	
261	2311	2	261	2328	
203	2455	3	203	102	
213	103	2	213	111	
223					
	Sampling Completed ~ 1:10 AM 7/13/79				

* Coke Greenness Rating: 1 - denotes coke is not green;
5 - denotes very green coke pushed.

Run 3

TABLE 4. PROCESS OPERATING LOG

Time test started 2024 ~~PM~~
Time test ended ~1110 AM
Hold periods
Coking Time

Date 7/12/79
Plant personnel
John Bartock

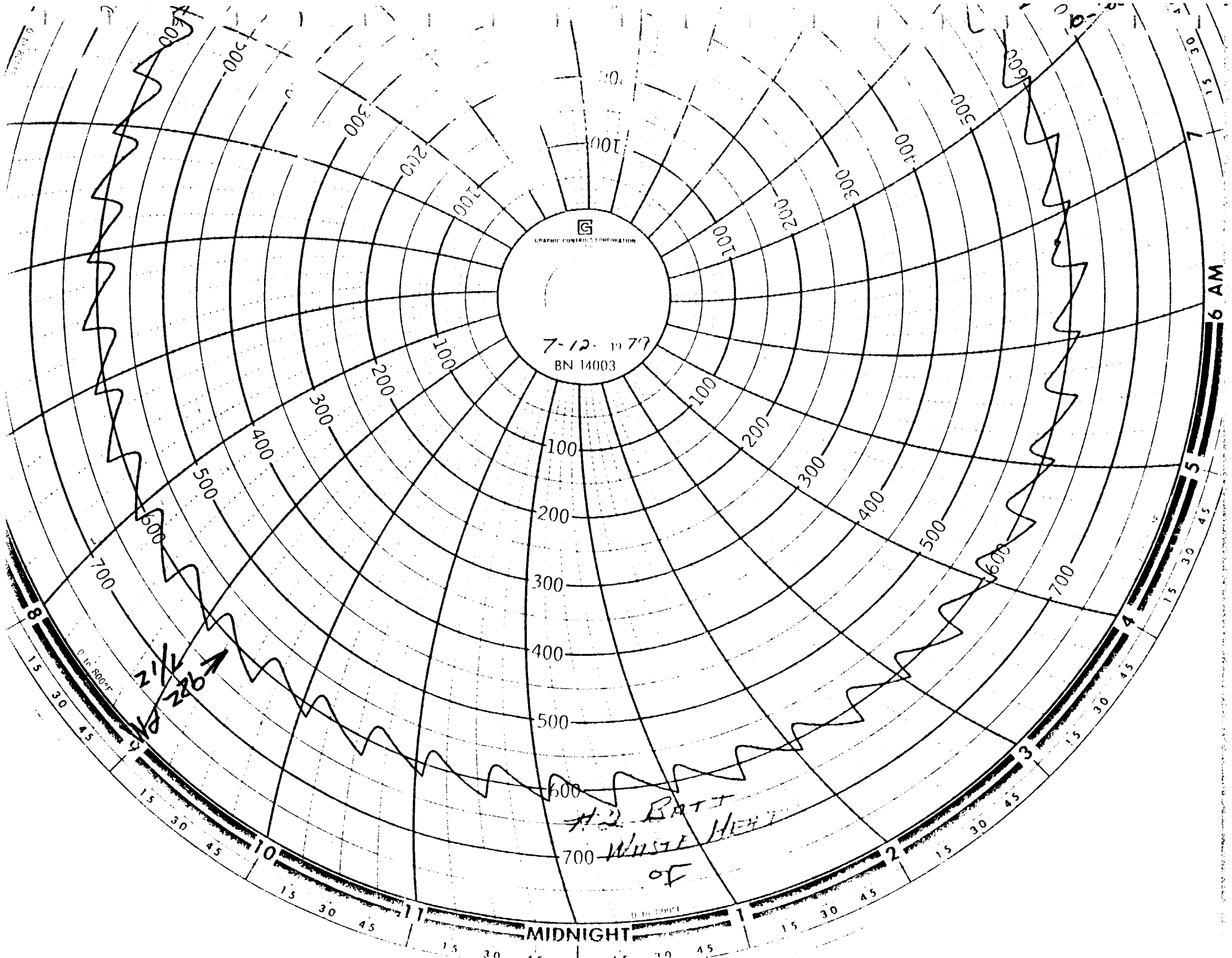
	Transmissometer reading	Fuel gas flow rate 103	No. of oven charged	No. of oven pushed	Greenness of push a/	Collecting main pressure EAST WEST	Stack draft	O_2 in flues	Flue temperatures Min.	Max.	Avg.	Coke temp. when pushed b/	Wall No.	Wall temperatures b/ Min.	Max.	Avg.	Flue pressure	Flue temperature (Gas Heat)	Stack temperature	Ambient temperature	Weather conditions	GAS PRESSURE
Units	%	SCFH						%	°F	°F	°F	°F		°F	°F	°F		°F	°F	°F		
Time																						
2011		219				4.0 3.5	22.0											578				98 CS
2120		28				3.8 3.4	22.0											592				95 CS
2330		218				3.4 3.5	22.2											605				95
116		217				3.3 3.6	22.4											582				95

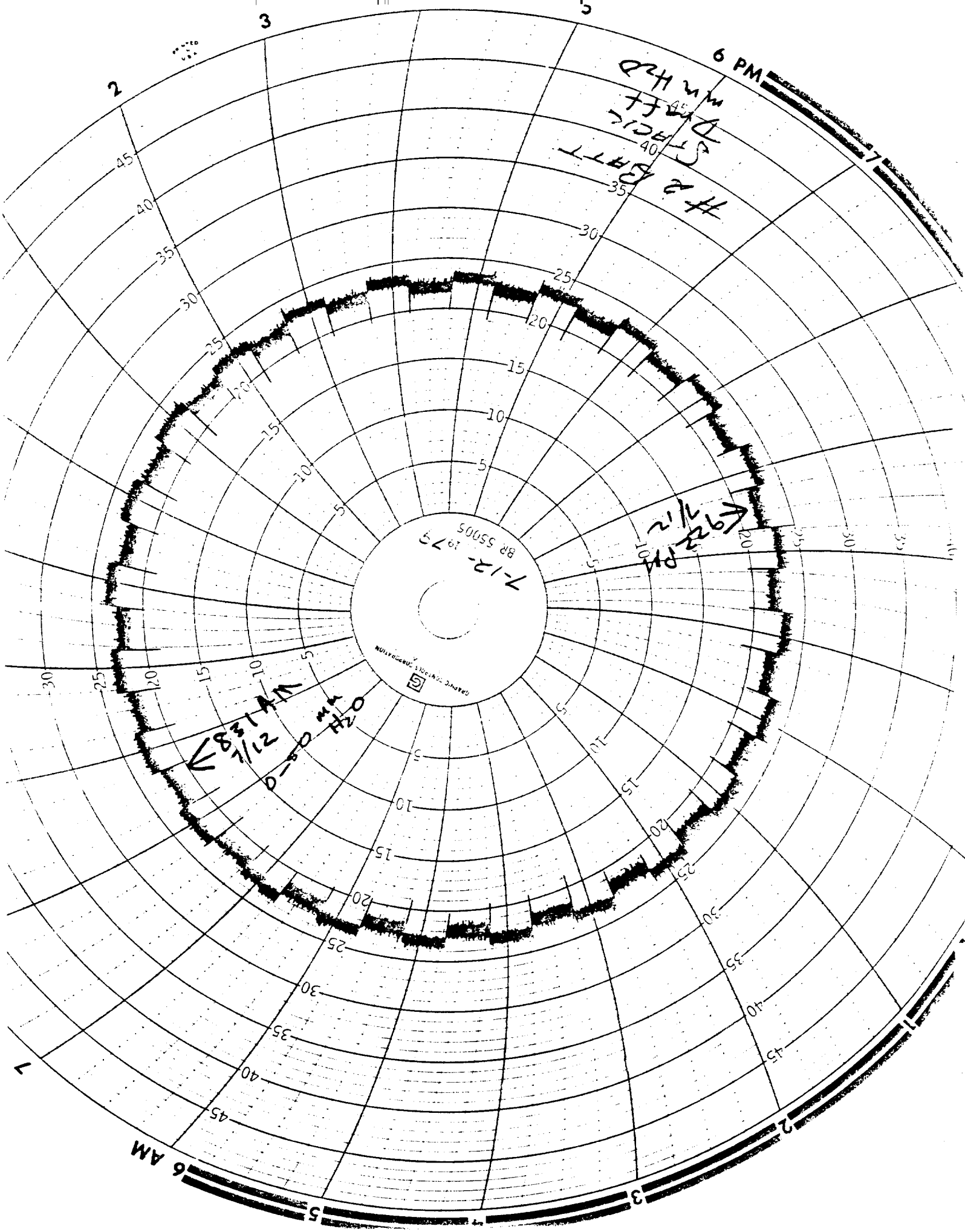
a/ Greenness rated from 1 to 3 with 1 - not green, 3 - very green (obtain as time permits).
b/ Obtain this data, if feasible.

Can operators identify any specific wall leak locations, and their severity?

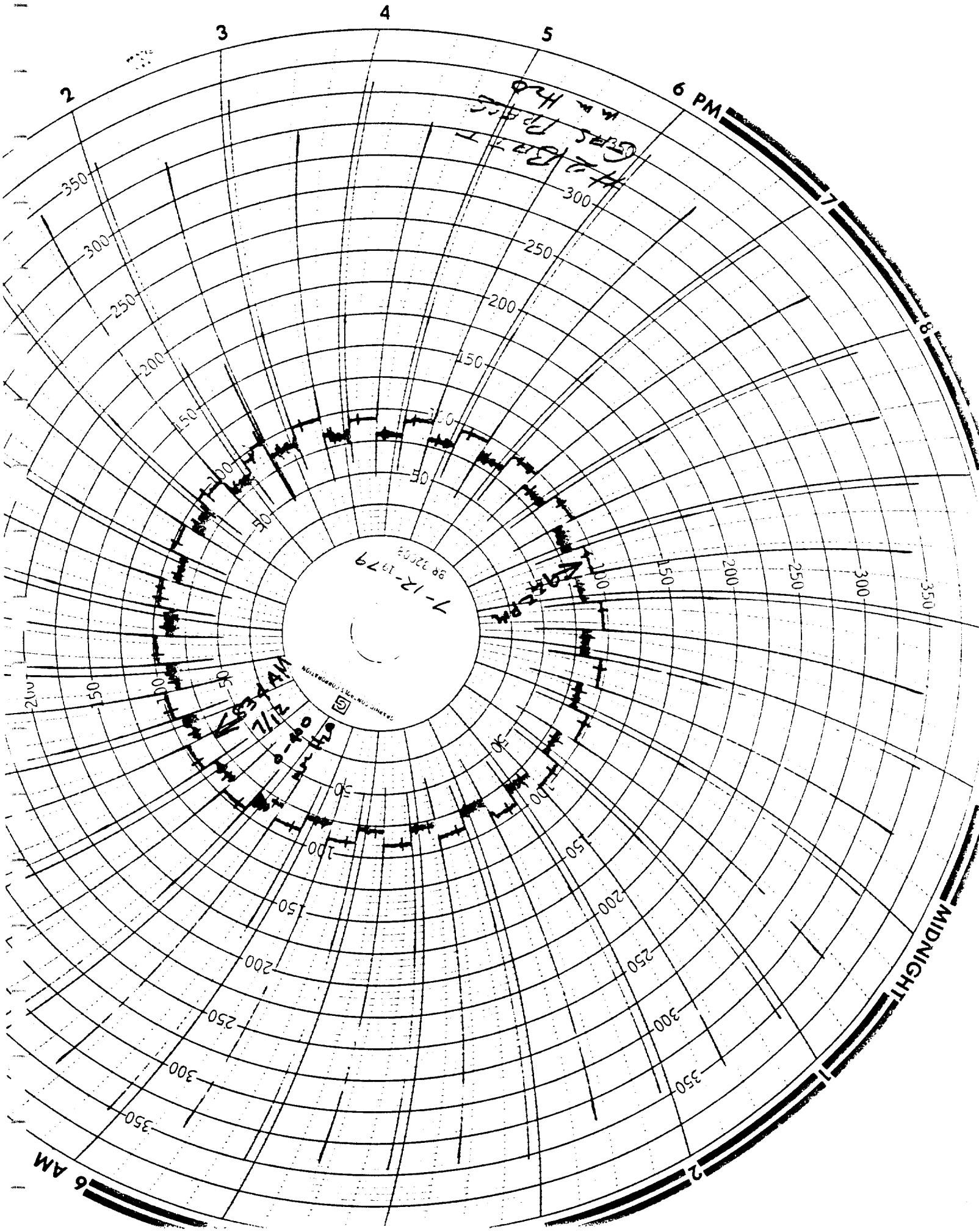
Other comments that may bear on emission test results.

O_2 11.0%
CO 150 ppm
NO_x 155 ppm

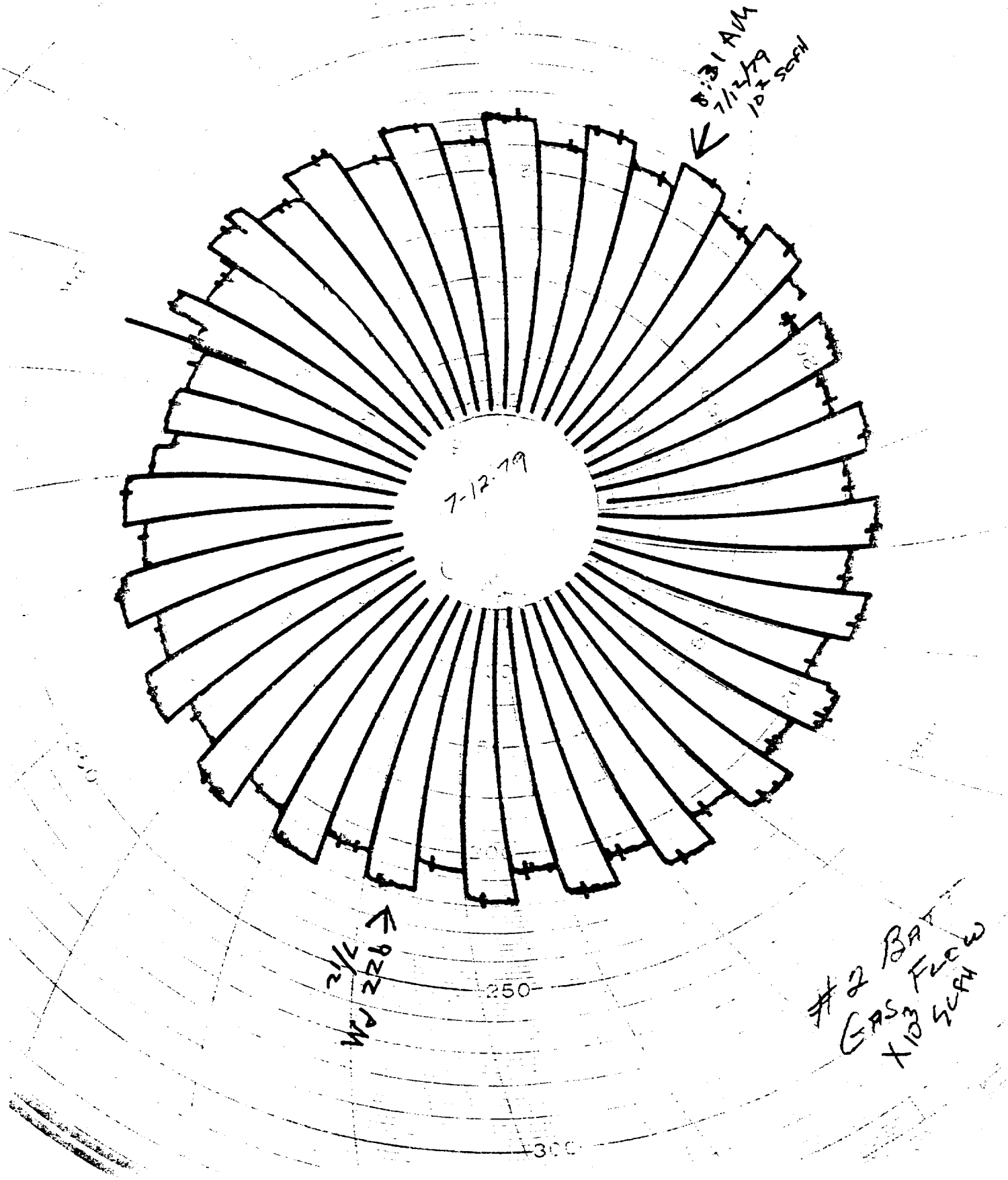

7-12-1979
BN 14003
MIDNIGHT
6 AM
#2 BATT
WASTE HEAT
OF



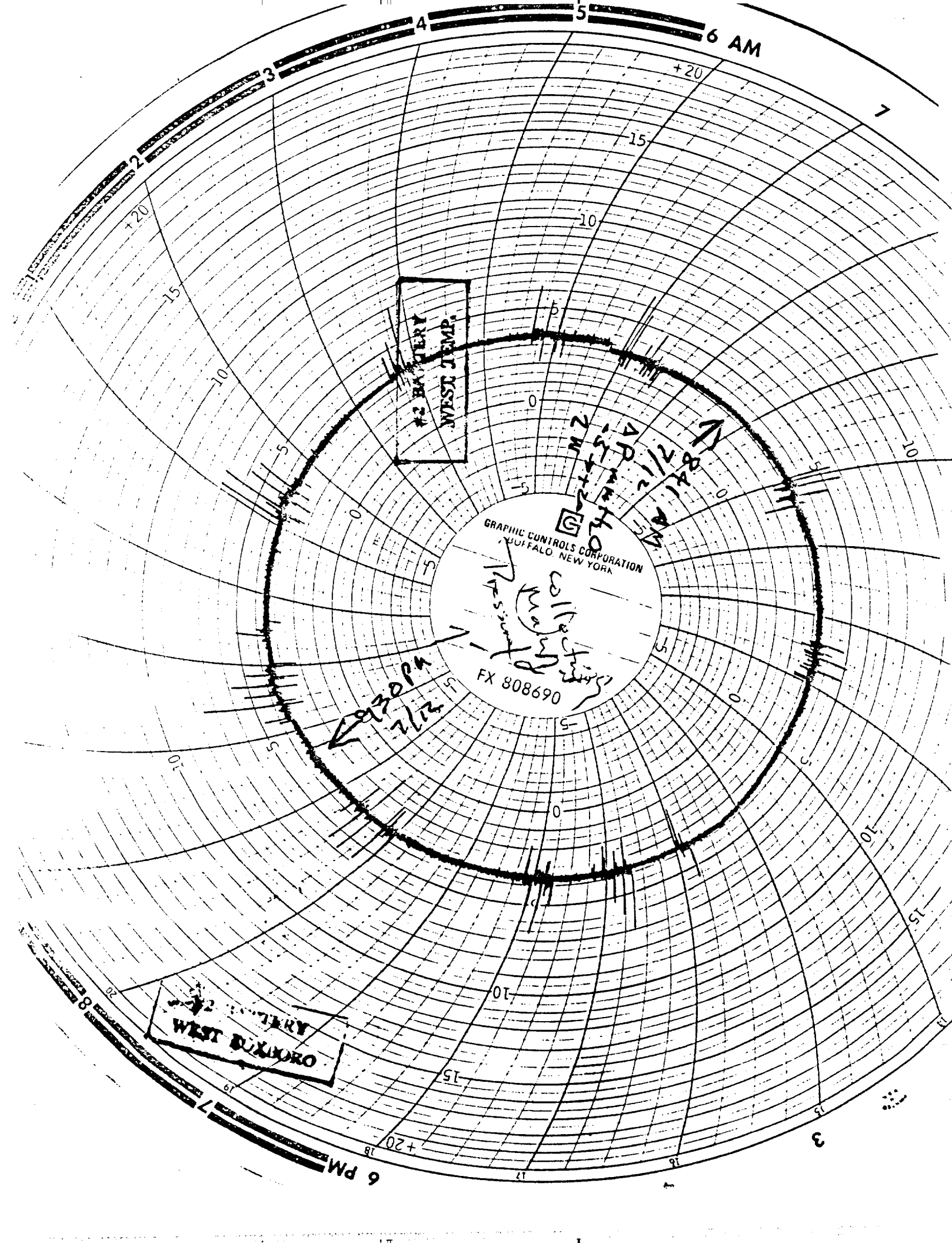
6 PM
6 AM
7-12-79
BR 55005
H2 BATT
Static
Draft
mm H2O
9:22 PM
7/12
8:31 AM
7/12
0-50 mm H2O

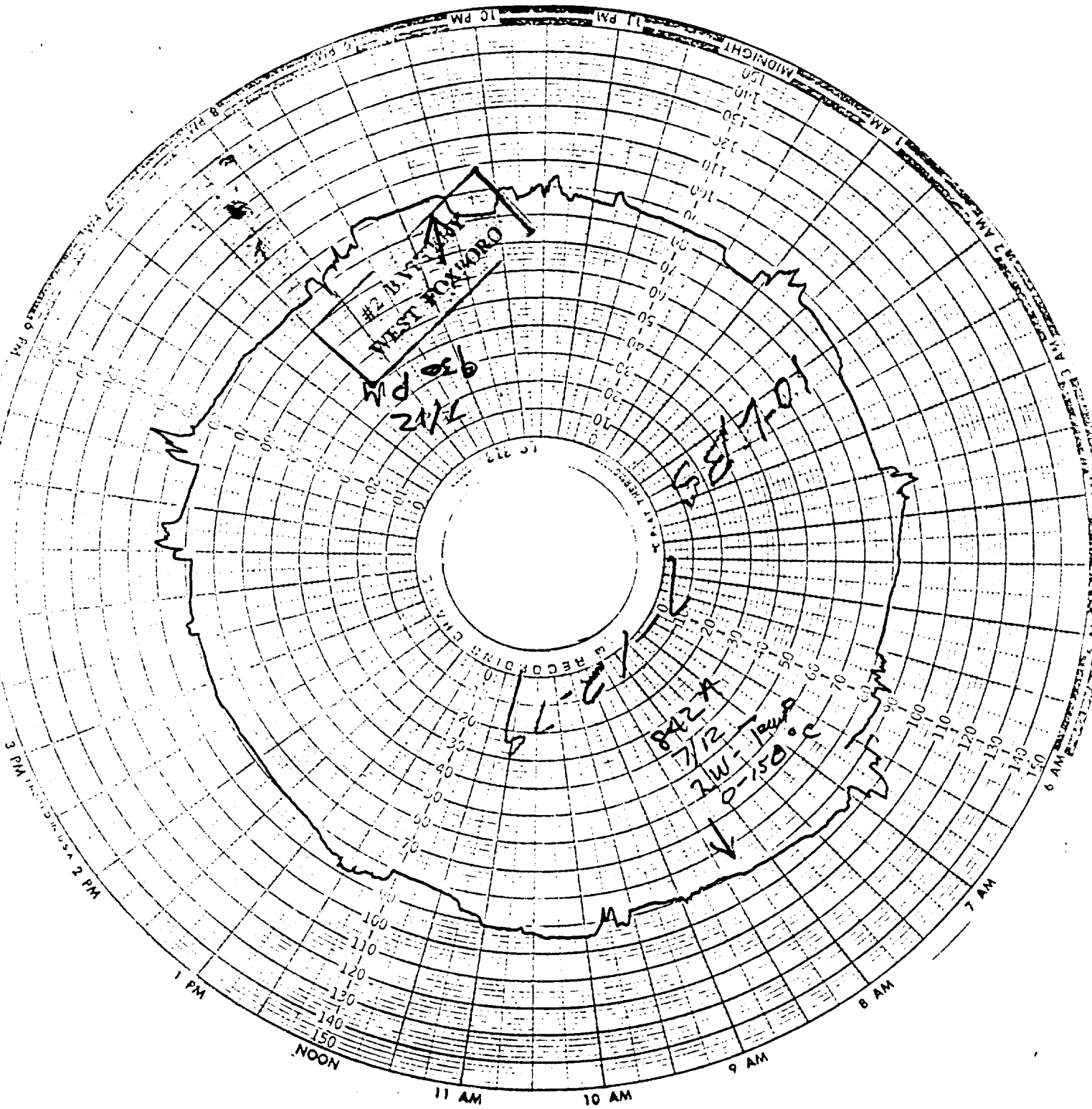


2
3
4
5
6 PM
7
8
MIDNIGHT
1
2
6 AM
7-12-1979

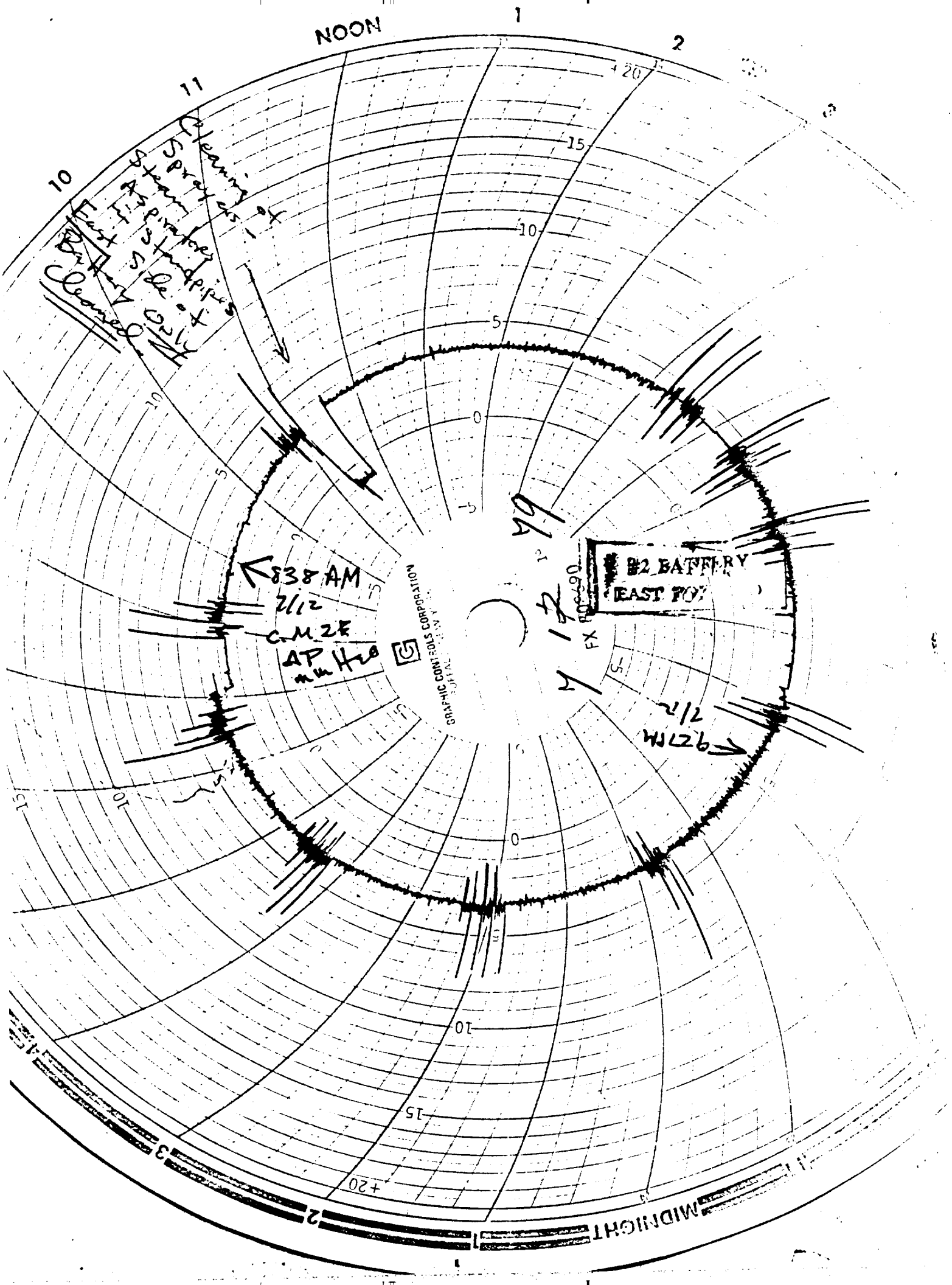

8:31 AM
7/12/79
10² SCFH
7-12-79
Wd 2/2 226
250
300
#2 BAT
GAS FLOW
X10³ SCFH

NOON
AM
PM
GRAPHIC CONTROLS CORPORATION
BN 14268


#2 BATTERY
WEST TEMP.
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
FX 808690
6 AM
6 PM



#2 BYPASS
WEST FOXBORO
842A
7/12
2W - Temp
0-150°C
MIDNIGHT
1 AM
2 AM
3 AM
4 AM
5 AM
6 AM
7 AM
8 AM
9 AM
10 AM
11 AM
NOON
1 PM
2 PM
3 PM
10 PM
11 PM


NOON
1
2
11
10
Cleaning of Sprayers - Steam Aspirators & Standpipes East Side of Battery Only Cleaned
838 AM
2/12
C.M.2E
ΔP mm H2O
GRAPHIC CONTROLS CORPORATION
#2 BATTERY
EAST FO
2/12
MIDNIGHT
+20
15
10
5
0
-5

APPENDIX F

PROJECT PARTICIPANTS

FRANK CLAY.....E.P.A./EMB-TECHNICAL MANAGER

KEN CONSTANTINE.....TRW-CONTINUOUS MONITORS

PAUL GORMAN.....MRI-PROCESS INFORMATION

GARY D. HENRY.....TRW-VISIBLE EMISSIONS

ROBERT F. JONGLEUX.....TRW-TRAIN COORDINATOR

JAMES McREYNOLDS.....TRW-BAP TRAIN OPERATOR

PAT REIDER.....MRI-PROCESS INFORMATION

JERRY TAYLOR.....TRW-METHOD 5/TRAIN OPERATOR

MACK L. WEBSTER.....TRW-FIELD SUPERVISOR

APPENDIX G

Daily Activity Log

APPENDIX G

Daily Activity Log

July 9, 1979

05:00 hrs	Departed Durham, NC units EED4, EED6 enroute to Sparrows Point, Maryland.
12:30 hrs	Arrived Sparrows Point, Maryland.
13:00 hrs	Obtained passes from plant security and attended briefing.
14:00 hrs	Spotted equipment at test site and began set-up.
17:30 hrs	Left site for the day.

July 10, 1979

08:00 hrs	Arrived at plant and continued set-up of instruments and equipment.
12:00 hrs	Began continuous monitoring and ran method for moisture determination.
17:15 hrs	Left site for the day.

July 11, 1979

08:00 hrs	Arrived at plant and began preparation for Test #1.
10:15 hrs	Pump supplying flue gas to continuous monitors burned out. Replaced pump.
15:18 hrs	Began Test #1.
20:12 hrs	Concluded Test #1 and began recovery of samples.
21:30 hrs	Left site for the day.

July 12, 1979

08:00 hrs	Arrived at plant and began preparation for Test #2.
11:50 hrs	Started Test #2.
14:30 hrs	Discontinued sampling due to process upset.
16:30 hrs	Resumed testing.
19:00 hrs	Concluded Test #2 and began recovery of Test #2 and preparation for Test #3.
20:20 hrs.	Began Test #3.

July 13, 1979

01:30 hrs	Concluded Test #3 and left site.
09:00 hrs	Arrived at plant and began recovery of Test #3, lowered equipment from stack, and began packing equipment.

July 13, 1979 (cont'd)

12:45 hrs	Completed packing and departed Sparrows Point enroute to Durham, NC.
20:30 hrs	Arrived TRW lab.