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/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

BY-PRODUCT COKE PLANT
BATTERY P4

Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

Prepared for the

U.S. Environmental Protection Agency
Emission Measurement Branch
Research Triangle Park, North Carolina 27711

Prepared and compiled by

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EMB REPORT NO. 79-CKO-17

Work Assignment 14

Contract No. 68-02-2817

INTRODUCTION TO REPORT

Two firms prepared this report under contract to the U. S. Environmental Protection Agency. The report is presented in two sections. Section I was prepared by Clayton Environmental Consultants, Inc., Southfield, Michigan and includes test results for particulate, carbon monoxide, carbon dioxide, oxygen, and benzene, as well as visible emission data. Section II was prepared by TRW Energy Systems Group, Durham, North Carolina, and contains benzo(a)pyrene (B(a)P) sampling data only, and immediately follows Appendix I of the Clayton report.

TRW did all B(a)P sampling for this study and four other studies conducted for this coke oven battery stack series. At the time the initial work assignments were issued, TRW was the only contractor suitably equipped for B(a)P sampling.

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) retained Clayton Environmental Consultants, Inc. to determine various gas and particulate emissions from the P4 coke oven battery stack at the Jones and Laughlin Steel Corporation, Pittsburgh Coke Works, in Pittsburgh, Pennsylvania. The results of this study will be used in research and development efforts for supporting New Source Performance Standards for coke oven battery stacks in the iron and steel industry. This study was commissioned as EMB Project No. 79-CKO-17, Contract No. 68-02-2817, Work Assignment 14.

The testing program included the following:

(1) triplicate samples of particulate matter;

(2) integrated bag samples for benzene and Orsat analyses;

(3) continuous carbon monoxide measurement during the particulate runs (EPA Method 10, NDIR analyzer);

(4) sulfate analysis of the particulate samples; and,

(5) visible emission observations recorded for the duration of each particulate sample run.

Auxiliary data included exhaust gas velocities, temperatures, and flowrates as determined from the traverses. Figure 1.1 presents a schematic of the process/control system layout as tested.

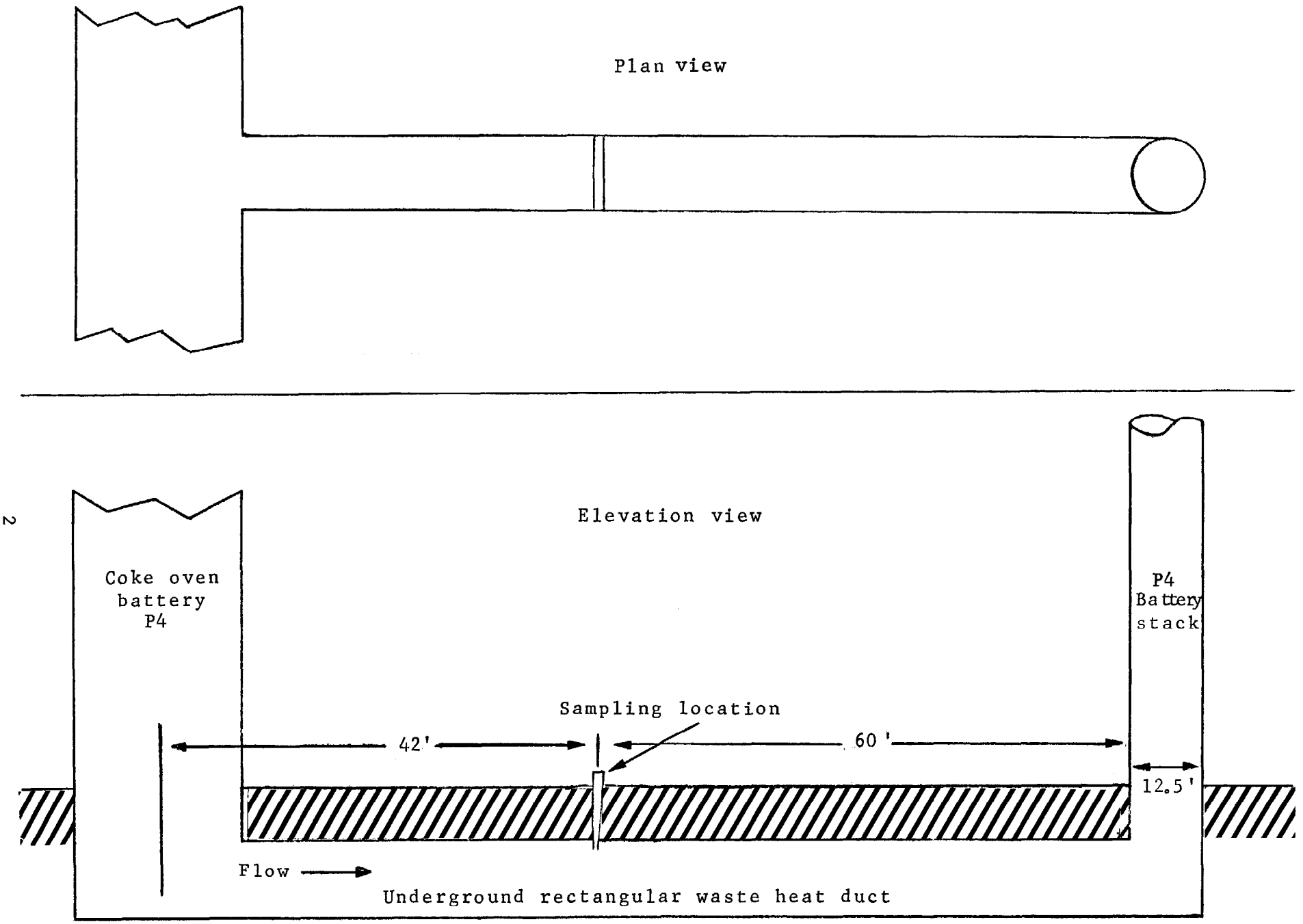

Figure 1.1. Process layout - waste heat flue duct.

2.0 SUMMARY AND DISCUSSION OF RESULTS

PARTICULATE EMISSIONS

Results of the particulate emission study are presented in Tables 2.1, 2.2, and 2.3. Tables 2.1 and 2.2 present the concentrations and emission rates of filterable and total particulate and sulfate, respectively. Concentrations are expressed as grains per dry standard cubic foot (gr/dscf) and milligrams per dry standard cubic meter (mg/dscm). Emission rates are expressed as pounds per hour (lb/hr) and kilograms per hour (kg/hr). Table 2.3 presents sulfate as a percent by weight of filterable and total particulate. Averages are presented for each sample run in all three tables.

Table 2.1 indicates the measured filterable concentrations of particulate in the waste heat duct ranged from 0.195 to 0.286 gr/dscf (446 to 655 mg/dscm) and averaged 0.234 gr/dscf (535 mg/dscm). Concentrations of total particulate ranged from 0.362 to 0.370 gr/dscf (829 to 847 mg/dscm) and averaged 0.365 gr/dscf (837 mg/dscm). Emission rates for filterable particulate ranged from 74.6 to 116 lb/hr (33.9 to 52.6 kg/hr) and averaged 89.3 lb/hr (40.5 kg/hr). Total particulate emission rates ranged from 123 to 150 lb/hr (55.6 to 68.1 kg/hr) and averaged 139 lb/hr (63.0 kg/hr).

TABLE 2.1. PARTICULATE CONCENTRATIONS AND EMISSION RATES
P4 BATTERY WASTE HEAT DUCT

Sample Number	Sample Date	Stack Gas Parameters		Concentration				Emission Rate			
		Flowrate	Temp	Filterable		Total		Filterable		Total	
		dscfm	F	gr/dscf	mg/dscm	gr/dscf	mg/dscm	lb/hr	kg/hr	lb/hr	kg/hr
1	5/1/79	46,200	599	0.195	446	0.364	834	77.2	35.0	144	65.4
2	5/2/79	39,500	603	0.220	505	0.362	829	74.6	33.9	123	55.6
3	5/3/79	47,300	604	0.286	655	0.370	847	116	52.6	150	68.1
Average		44,300	602	0.234	535	0.365	837	89.3	40.5	139	63.0

Total Particulate = Front half (filterable) + Back half.

Front Half = nozzle, probe, filter, and front half of filter holder.

Back Half = back half of filter holder, flexline, impingers, and connectors.

Filterable concentrations of sulfate (Table 2.2) ranged from 0.100 to 0.141 gr/dscf (228 to 324 mg/dscm) and averaged 0.117 gr/dscf (268 mg/dscm). Total sulfate concentrations ranged from 0.228 to 0.242 gr/dscf (522 to 554 mg/dscm) and averaged 0.235 gr/dscf (538 mg/dscm). Emission rates ranged from 37.2 to 57.3 lb/hr (16.9 to 26.0 kg/hr) for filterable sulfate and averaged 44.7 lb/hr (20.3 kg/hr). Total sulfate emission rates ranged from 79.8 to 95.8 lb/hr (36.2 to 43.4 kg/hr) and averaged 89.4 lb/hr (40.5 kg/hr). Table 2.3 indicates that sulfate as a percent by weight of filterable particulate ranged from 49.4 to 51.2 percent and averaged 50.1 percent. Sulfate as a percent by weight of total particulate ranged from 61.6 to 66.4 percent and averaged 64.4 percent.

Sulfate represents the major constituent of the filterable and total particulate fractions. This indicates that by reducing the sulfur content of the coke oven gas, the particulate concentrations should correspondingly drop. The planned gas desulfurization is, therefore, a noteworthy addition.

The general reproducibility of the particulate emission data collected for all three sample runs was good although magnitudes were somewhat higher than expected. Previous testing on Battery P4 had indicated an average

TABLE 2.2. SULFATE CONCENTRATIONS AND EMISSION RATES
P4 BATTERY WASTE HEAT DUCT

Sample Number	Sample Date	Stack Gas Parameters		Concentration				Emission Rate			
		Flowrate	Temp	Filterable		Total		Filterable		Total	
		dscfm	F	gr/dscf	mg/dscm	gr/dscf	mg/dscm	lb/hr	kg/hr	lb/hr	kg/hr
1	5/1/79	46,200	599	0.100	228	0.242	554	39.5	17.9	95.8	43.4
2	5/2/79	39,500	603	0.110	251	0.236	539	37.2	16.9	79.8	36.2
3	5/3/79	47,300	604	0.141	324	0.228	522	57.3	26.0	92.5	41.9
Average		44,300	602	0.117	268	0.235	538	44.7	20.3	89.4	40.5

Total Particulate = Front half (filterable) + Back half.

Front Half = nozzle, probe, filter, and front half of filter holder.

Back Half = back half of filter holder, flexline, impingers, and connectors.

TABLE 2.3. SULFATE AS PERCENT OF PARTICULATE BY WEIGHT

Sample Number	Filterable Percent	Total Percent
1	51.2	66.4
2	49.8	65.1
3	49.4	61.6
Average	50.1	64.4

filterable particulate concentration of 0.090[a] gr/dscf, 61.5 percent lower than this test series. These previous tests were performed at a less than ideal location. The heat canal was accessed through four randomly spaced ports. This random spacing did not permit sampling to be performed in accordance with Method 1 specifications for sample and velocity traverses of stationary sources. For this reason, the validity of the data from the previous testing program may be questionable.

The heat canal, for this study, was accessed through ports located in the top of a vertical cut-off damper slot. The location of these ports was in accordance with Method 1. Since the slot tapered towards the bottom, the possibility existed of accidentally picking up material by scraping the nozzle on the walls of the slot, as the probe was being raised or lowered through a port. This would have biased the sample values toward the high side. It is therefore unlikely that any random scraping was influential, since the test results are consistent and reproducible.

BENZENE EMISSIONS

Results of the benzene analyses are presented in Table 2.4. Benzene concentrations ranged from 0.6 to 1.6 ppm and averaged 1.1 ppm. Emission rates ranged

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[a]An average of 10 runs from a study conducted in April, 1975 by Betz Environmental.

TABLE 2.4. BENZENE CONCENTRATIONS AND EMISSION RATES

Sampling Location	Sample Number	Sample Date	Concentration	Emission Rate	
			ppm	lb/hr	kg/hr
P4 Battery Stack	1	5/1/79	0.6	0.3	0.1
	2	5/2/79	1.6	0.6	0.3
	3	5/3/79	1.1	0.5	0.2
	Average		1.1	0.5	0.2

from 0.3 to 0.6 lb/hr (0.1 to 0.3 kg/hr) and averaged 0.5 lb/hr (0.2 kg/hr). These results show a high degree of reproducibility, although they are lower than had been anticipated.

EXHAUST GAS COMPOSITION

Table 2.5 displays the results of the exhaust gas composition analysis. Determinations of carbon dioxide, oxygen, and carbon monoxide contents were made for each of the three sample runs. Moisture content is also presented and shows an average of 16.0-percent. The initial gas composition sample was voided due to a leaky bag. The results of Sample Nos. 2 and 3 were averaged and these averages were used for Sample No. 1 determination.

VISIBLE AND CARBON MONOXIDE EMISSIONS

Visible emissions from the coke oven Battery P4 stack were recorded for the duration of each particulate sample run, except Run No. 3, for which visible emissions were abbreviated due to inclement weather. The observations were performed in accordance with EPA Method 9 by a qualified visible emissions observer. A graphic summary of opacities is presented in Figures 2.1, 2.2, and 2.3. Additional visible emission data is

TABLE 2.5. EXHAUST GAS COMPOSITION - P4 BATTERY WASTE HEAT DUCT

Sample Number	Moisture Content Percent	Exhaust Gas Composition, Dry Basis Percent			
		Carbon Dioxide	Oxygen	Carbon Monoxide	Nitrogen and Inerts
1	16.3	3.6[a]	11.6[a]	0.2[a]	84.6
2	16.0	4.0	10.6	<0.1	85.4
3	15.6	3.1	12.5	0.3	84.1
Average	16.0	3.6	11.6	0.2	84.7

[a] Sample 1 was voided due to a leaky bag and an average of Samples 2 and 3 was used.

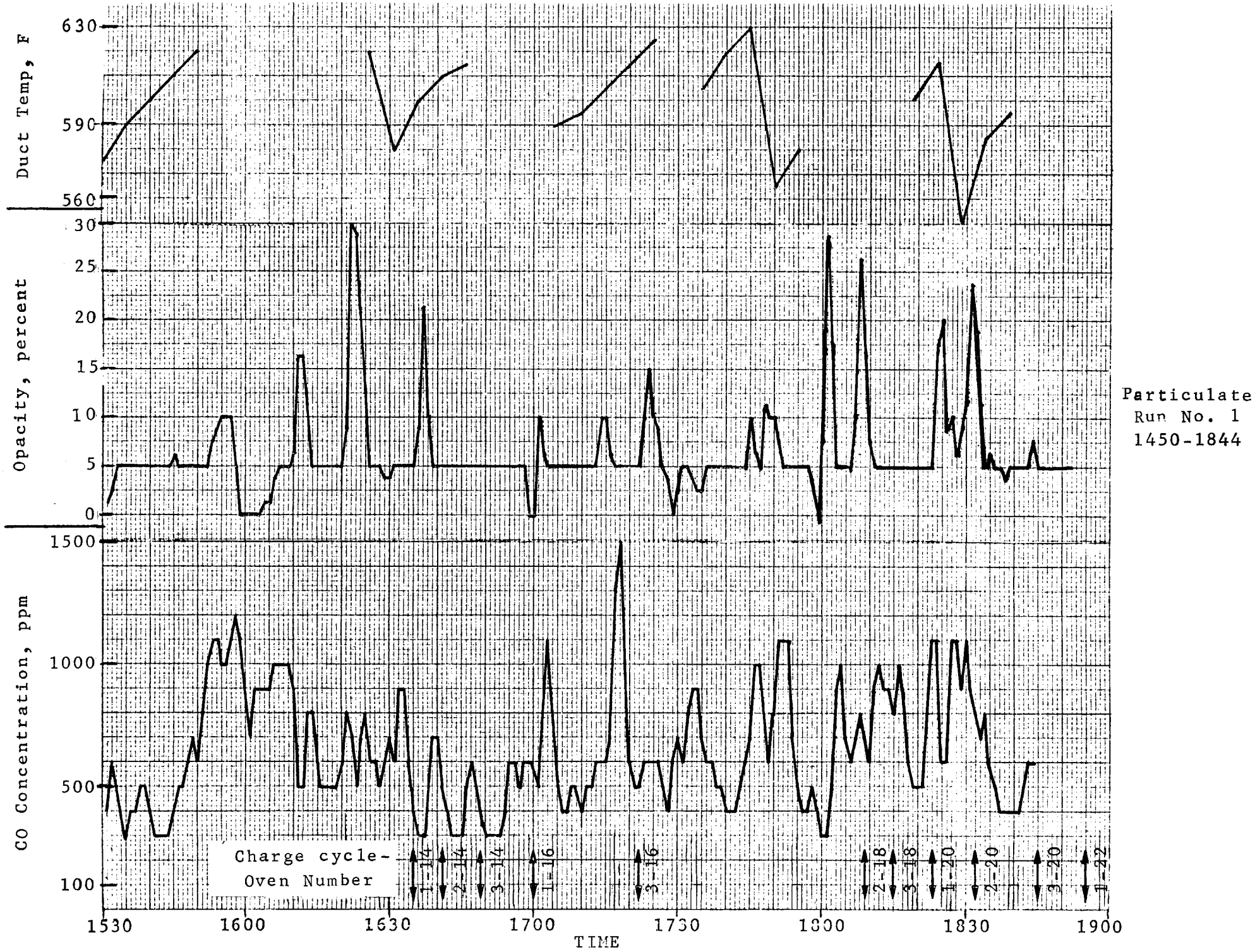
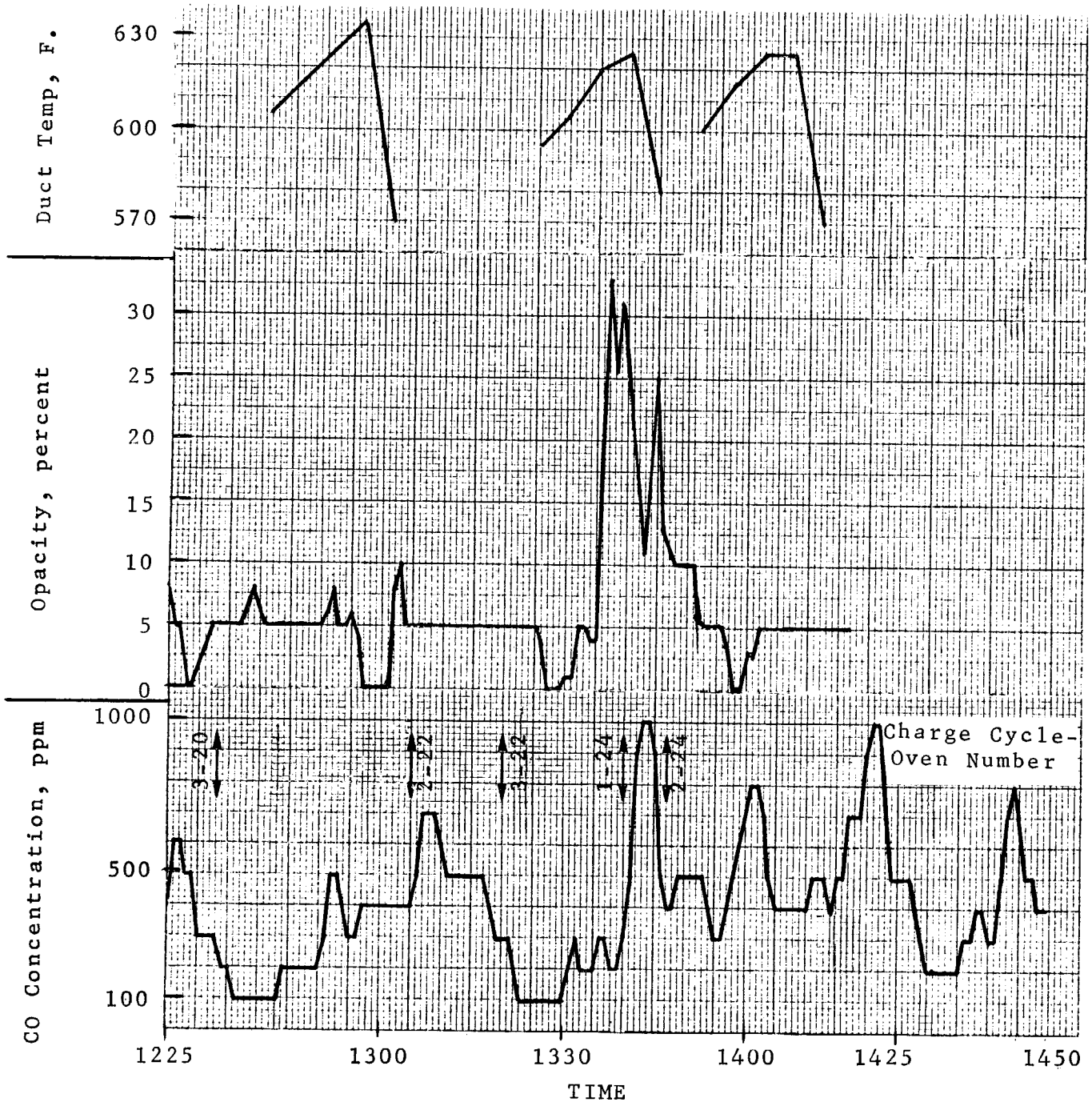


Figure 2.1. Relationship of CO concentrations, stack opacity, and duct temperature.



Particulate
Run No. 2
1045-1407

Figure 2.2. Relationship of CO Concentrations, stack opacity, and duct temperature.

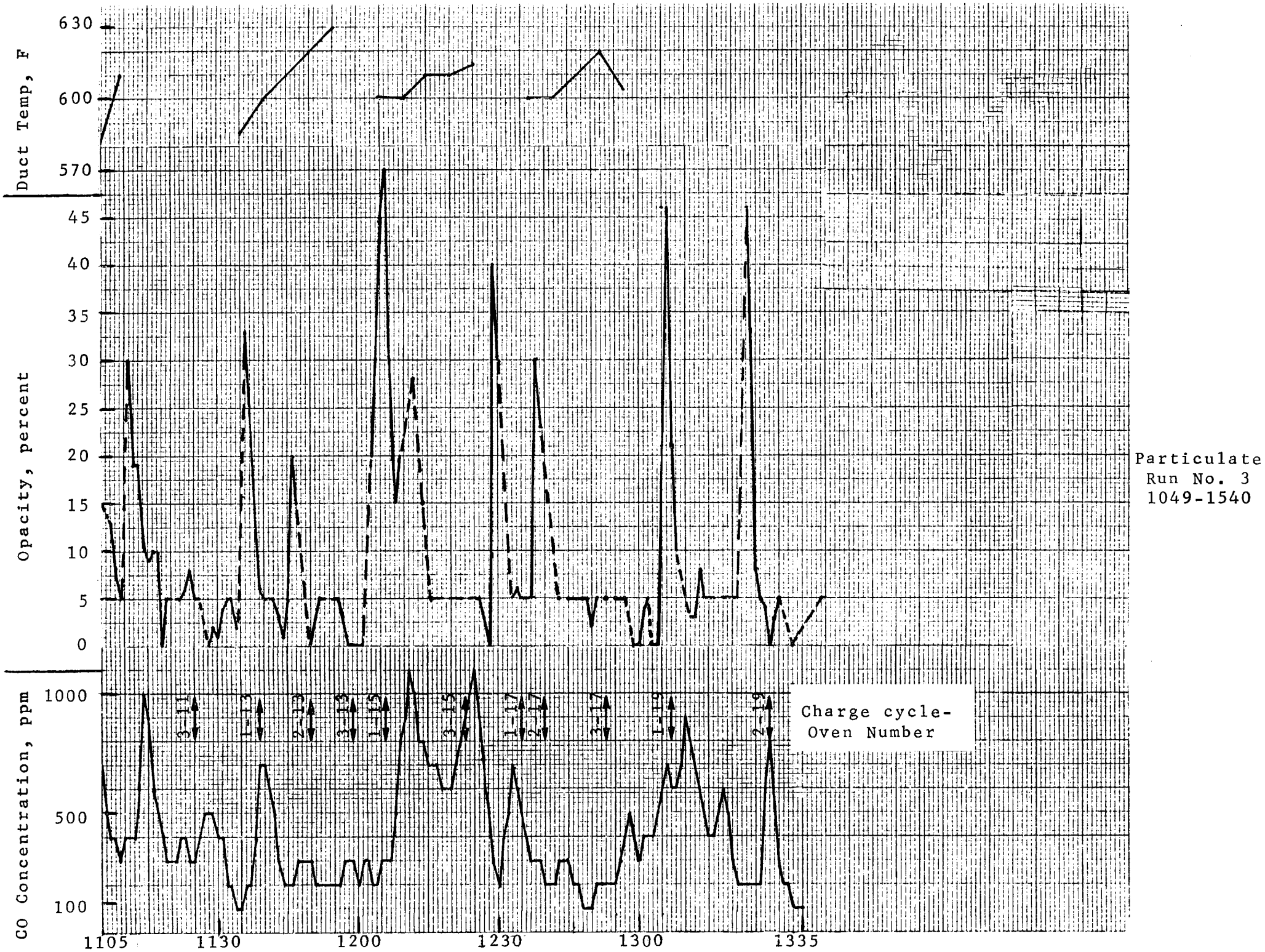


Figure 2.3 Relationship of CO Concentration to Opacity and Duct Temperature

included in Appendix B. Carbon monoxide concentrations are also plotted on Figures 2.1, 2.2, and 2.3.

Correlations seemed to exist between the continuously monitored concentrations of carbon monoxide (ppm), the actual charging operation of individual coke ovens (oven charges indicated by a vertical line above the axis), and opacity; thus, a linear regression and correlation analysis was performed on the data. Based on these statistical results, further statistical analyses of the data would be conducted if such information seemed beneficial to a better interpretation of the data. The following presents the methodology and results of these statistical analyses.

General Procedures

The time-concentration curves were reduced in the following manner: The carbon monoxide strip chart continuous readings were reduced to individual 15-second average concentrations to correspond with discrete 15-second opacity readings. A data file was then created which included time and each corresponding opacity and CO reading at that time. One such data file was created for each sample run.

Since subjective observations indicated that CO concentration peaks were generally preceded within a few minutes by a rise in opacity, a computer program was devised which would accommodate and adjust the data set pairings to any given lag time. The lag time

indicates the time, in minutes, before or after (negative or positive) the opacity for the associated CO reading. Each data file was then run through a linear regression program and correlation routine to determine if a valid relationship existed between the data for any given lag time. Different lag times (positive and negative) were used in determining the maximum correlation coefficient, beginning at whole minute intervals, then reducing it to quarter-minute intervals. This usually required five to ten runs per sample.

Several problems necessitated altering the data inputs to accommodate a more realistic analysis. For example, steam exiting the quench tower occasionally obscured the battery stack emissions. Therefore, for these points in time, there would be associated CO readings but no opacity readings. Thus, these data could not be counted as a valid data set. The number of complete pairs of data available for correlation then, i.e., the number of data sets used, was less than the total number of pairs first described (above). Therefore, a new data file was created based on the optimum time lag, using only complete data sets in the subsequent analysis.

Results

Table 2.6 presents the results of the correlation analyses. Each run showed an optimum lag time to produce a maximum correlation coefficient (r) which varied from

TABLE 2.6. SUMMARY OF CORRELATION RESULTS

Sample Number	Number of Data Sets	% of Data Used	Correlation Coefficient (r)	Linear Regression Equation	Lag Time,[a] Minutes
	810	100[b]	0.23	CO = 11.1 op + 570	
1		89.0	0.33	CO = 13.3 op + 505	2.5
		86.5	0.33	CO = 14.0 op + 497	
	478	100[b]	0.52	CO = 16.0 op + 270	
2		92.1	0.65	CO = 17.8 op + 226	5
		79.9	0.75	CO = 20.5 op + 176	
	394	100[b]	0.55	CO = 10.6 op + 298	
3		95.7	0.64	CO = 11.3 op + 270	4
		85.3	0.73	CO = 12.6 op + 227	

[a]Minutes from opacity reading to the carbon monoxide reading.

[b]100% of data implies total number of data sets. Other values are percentages of this number.

2.5 to 5 minutes. Using 100-percent of the data produced an r value of 0.55 or less for each sample. This may or may not be relevant, but does suggest that there could be factors affecting opacity other than CO and factors affecting CO other than opacity which may independently affect the results, in addition to any relationship shown to exist between CO and opacity.

The computer outputs also included a table showing the data distribution (Appendix E-2). Using the distribution and the file of correlated data points, it may be seen which pairs were most likely affected by other variables (i.e., the outliers on the distribution). Without sufficient operations data to interpret what other variables were affecting the distribution, it was impossible to logically eliminate outlying points. Therefore, certain data pairings were eliminated from further computer runs according to the following methodology: When CO readings were high (i.e., 500 ppm) during periods of low opacity (i.e., 0-percent), it was intuitively apparent that factors affecting CO levels were probably not affecting opacity at that time. Therefore, a certain percentage of data sets were deleted and the correlation analysis rerun using the same optimum lag time. This reduced the total data

sets considered (shown on Table 2.6 as a percentage of the total) and increased the correlation coefficient in each case.

In Samples 2 and 3, the r value was 0.7 using about 80-percent of the data. The r value from Sample 1 was extremely low (i.e., 0.23) using 100-percent of the data. Upon examination of the data distribution it was discovered that 72-percent of the opacity readings were 5-percent, showing very little relationship at all with CO readings.

In the next step, an additional variable, oven charge time, was introduced into the data file to further investigate the relationship of CO and opacity. The times of oven charging were marked with a "C" within the original data file. The program was structured to utilize various intervals around the charge period. The correlation analysis was then rerun based on the optimum time lag as determined from the first set of runs (Table 2.6).

The results are presented in Table 2.7. Optimum charge intervals varied from 0.25 to 2.75 minutes. Sample 3 was run at two intervals surrounding the charging activity, examining the paired CO and opacity data at both 15-seconds and 60-seconds before and after the charge. Samples 1 and 2 were based on 1.0 and 2.75

TABLE 2.7. CO AND OPACITY CORRELATION CONSIDERING OVEN CHARGE TIMES

Sample Number	Charge Interval, Minutes	Number of Data Sets	% of Data Used	Correlation Coefficient (r)	Linear Regression Equation	Lag Time,[a] Minutes
1	1	90	100[b]	0.48	CO = 21.0 op + 461	2.5
			94.4	0.47	CO = 22.6 op + 454	
			90.0	0.61	CO = 29.2 op + 377	
			76.7	0.74	CO = 27.6 op + 324	
2	2.75	112	100[b]	0.75	CO = 24.9 op + 160	5
			79.5	0.92	CO = 30.0 op + 19.3	
3	1	59	100[b]	0.78	CO = 12.3 op + 320	4
			84.8	0.88	CO = 13.6 op + 264	
	0.25	20	100[b]	0.90	CO = 15.2 op + 301	
			85.0	0.93	CO = 16.0 op + 270	

[a]Minutes from opacity reading to the carbon monoxide reading.

[b]100% of data implies total number of data sets. Other values are percentages of this number.

minute intervals surrounding the charge, respectively. Samples 2 and 3 (at the 1.0 minute interval) had correlation coefficients of 0.75 and 0.78, respectively. By reducing total data pairs to 79.5 and 84.8-percent, respectively, the same samples had respective correlation coefficients of 0.92 and 0.88. Sample 1 was again lowest with a coefficient of 0.48 based on 100-percent of the data, and 0.74 using 76.7-percent of the data.

Based on the results of Sample Nos. 2 and 3, for 80 percent of the time there is good correlation between opacity and carbon monoxide during the charge intervals. Additional information would be needed to validate this relationship, such as the occurrence of extraneous factors which influence either opacity or carbon monoxide, when these factors occur, and the magnitude of these influences. With this information, any given charge interval could be assessed for its independence from other factors, such as topside explosions and fires, which could then be isolated and rationally removed from the carbon monoxide and opacity data. The data used in the correlation analysis would then be more qualified and the correlation coefficient would be more meaningful. With this approach to the analysis, the correlation is both quantitative and qualitative. Based on the number of data pairs used, opacity and carbon monoxide can be related quantitatively over a percentage of time and the resulting correlation coefficient would indicate the quality of the relationship.

3.0 PROCESS DESCRIPTION AND OPERATION (supplied by Midwest Research Institute)

There are five coke oven batteries at the Jones and Laughlin Pittsburgh Works, designated as P1, P2, P3S, P3N, and P4. The Jones and Laughlin plant was selected for testing of battery stack emissions because the plant uses the silica dusting maintenance technique, coupled with spray patching and troweling. This technique was used on several of the batteries, including P4, which was selected for testing because it provided the best testing location: in the underground rectangular duct that carries the flue gases from the waste heat canal to the battery stack.

Battery P4 is a 79-oven Koppers underjet battery, underfired with undesulfurized coke oven gas. A gas desulfurization unit is nearing completion but was not in operation during the testing. The P4 battery was originally started up in 1953. It underwent a hot end-flue rehabilitation in 1976 and was placed back in operation in early 1977. The battery was operating on a 17-hr coking time during the testing. Other information about the battery is shown in Table 3.1.

Use of silica dusting on battery P4 was begun in early 1978 and has continued since then. Each oven has been "dusted" at least once and some as much as four times. The dates when each oven was dusted are shown in Table 3.2 along with the pressure rise in the oven, in inches of

TABLE 3.1 PLANT DESIGN AND OPERATION RECORD

Date Monday, April 30, 1979

Plant Name Jones and Laughlin

Plant Location Pittsburgh, Pennsylvania

Battery No. P-4

Name of Plant Contact Mr. Jim Saunders, Assistant Superintendent, By-Products Department

Type of Ovens and Designer Koppers - Underjet

Date Built Started up in 1953

Date of Last Rehabilitation Early 1977

Type of Last Rehabilitation Hot end flue rehabilitation

Number of Ovens Total 79 In Service 79, except 1 for dusting

Size of Ovens Height 13 ft, Width 17 in., Length 40 ft

Type of coke produced Metallurgical

Normal coking time (hr) 17

Coal charged per oven (tons) 16 to 16.5 Produce about 11.0 tons of coke

Reversal period (min) 30 min

Nozzle decarbonization method Part of flue gas is recirculated to decarbonize

Is flue gas recirculated? (See above)

Type of fuel gas COG Heating value _____ Btu/scf

Is fuel gas desulfurized? No.

Note use of stage charging, preheated coal, etc. Stage charging

Stack height and top diameter 225 ft 12.5 ft ID at bottom, 9.5 ft ID at top

Test location (stack or waste heat canal) 8 by 8 ft (provide sketch)

Control method used Patching and silica dusting

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			

JL-42768

TABLE 3.2. RECORD OF DUSTING AND PRESSURE RISE IN OVEN DURING DUSTING (IN. H_2O)

1	2	3	
6/15/78-7.8	3/19/78-5.0	3/3/78-4.2 8/11/78-7.6	1
6/19/78-8.4 9/9/78-7.7	5/16/78-4.2 11/5/78-6.0	2/10/78-2.9 11/16/78-6.0	2
5/17/78-6.1 8/9/78-8.0	5/11/78-4.9 8/31/78-4.0	5/26/78-4.0	3
3/12/78-7.9 8/24/78-8.6	3/6/78-4.9 7/30/78-6.4	5/22/78-5.0 4/1/79-5.1 7/1/78-7.2	4
6/1/78-5.0 7/12/78-8.0	4/14/78-6.1	4/19/78-6.4 8/14/78-6.0	5
5/7/78-7.4 11/26/78-4.0	3/22/78-5.4 12/2/78-6.4 7/6/78-5.8	4/26/78-3.0 7/13/78-6.0	6
6/10/78-5.0 7/26/78-7.4	4/26/78-5.5 11/14/78-6.0	5/15/78-5.0	7
5/25/78-5.0 8/16/78-6.0	5/5/78-6.0 8/6/78-6.4	6/22/78-7.6	8
6/6/78-4.5 10/20/78-7.8 7/3/78-6.0	5/21/78-6.1 3/27/79-2.8 8/1/78-7.6	6/13/78-6.6	9
6/25/78-4.0	5/10/78-4.2 6/30/78-6.0	6/17/78-8.1 8/29/78-8.4	10
6/23/78-7.3 7/18/78-7.4	8/25/78-4.3 8/19/78-7.4 7/4/78-5.0	6/27/78-6.8	11
3/14/78-4.1 7/25/78-8.4	4/18/78-6.0 11/24/78-7.4 9/22/78-3.0 4/4/79-2.8	5/14/78-5.2	12
6/27/78 11/11/78-6.5 10/30/78-8.8	4/5/78-6.3 7/16/78-6.2	6/18/78-5.1	13
6/20/78-3.1 9/20/78-7.4	5/20/78-6.1 11/13/78-7.2	6/24/78-7.6 1/2/79-4.5	14
6/26/78-4.2 7/20/78-5.0	5/4/78-7.5	6/11/78-8.4	15
6/12/78-6.3	5/26/78-6.5 11/3/78-7.6	6/25/78-7.2 11/7/78-7.0 10/14/78-8.0	16
6/14/78-8.5	5/13/78-5.0 7/5/78-5.4	6/22/78-7.2 10/18/78-7.0	17
6/3/78-4.2	5/18/78-6.2	6/8/78-4.0	18
4/2/78-5.4 7/21/78-6.5 7/11/78-5.5	6/4/78-5.0 10/28/78-6.8	4/8/78-5.9 4/3/79-3.8 7/24/78-9.0	19
3/3/78-3.9 7/23/78-8.2	4/28/78-7.4 3/28/79-4.0 7/14/78-8.7	3/2/78-5.7 10/2/78-7.0	20
2/7/78-1.0 11/12/78-7.2	6/8/78-4.3 7/9/78-6.0	3/16/78-3.7 11/22/78-4.0	21
3/30/78-5.3 7/10/78-7.2	4/21/78-8.0 11/8/78-9.7 9/13/78-5.0	3/24/78-4.1	22
4/15/78-5.0 5/23/78-6.2	6/6/78-3.9 11/18/78-5.0	3/8/78-4.3	23
4/28/78-4.0 10/8/78-7.0 7/7/78-7.8 11/1/78-7.2	5/1/78-7.0	4/4/78-6.0	24
3/1/78-4.2	5/31/78-5.0 9/6/78-7.0	5/2/78-5.0	25
5/8/78-3.9 10/27/78-7.4	6/12/78-5.0 4/30/79-4.0 8/3/78-7.2		26
7/26/78-5.0 8/27/78-7.8	3/19/78-5.0		27

water, that is measured during the dusting. This table shows only the dates when patching and dusting occurred, but not the dates when additional patching without dusting may have been carried out.

During 1978, the ovens were patched and dusted more frequently than in 1979, but on a random basis. Recently Jones and Laughlin has instituted a systematic maintenance technique utilizing computerized maintenance record keeping that includes observation of whether the stack "smoked" or did not "smoke" after charging of specific ovens. The computerized records show the type and date of any oven maintenance and the date the stack was observed and the number of minutes that the stack smoked after a specific oven was charged. These data are now used to select ovens which should be dusted, rather than the random basis on which ovens were previously selected for dusting. Jones and Laughlin personnel believe this computerized information system should enable them to achieve much better control of battery stack emissions.

The actual patching and dusting operation usually requires at least 24 hours in which an oven is out of service. During the first 8 hours, spray patching and troweling of the end flues is carried out by a three-man crew, on both the coke side and pusher side of the oven. During the next shift, a three-man crew "dusts"

the oven with all doors and lids closed and sealed. This takes 2 to 3 hours and uses about 100 lb of the silica dust. The dust is hand-fed into a small hopper that is air aspirated to disperse the dust and carry it into the oven through a special charging lid. Pressure rise in the oven is monitored during this operation and usually increases from 3 to 8 in. of water.

No "dusting" was carried out during the testing because of possible interference with the particulate tests. However, a dusting operation on one oven was observed on the day preceding the first test. It was observed that silica dust leaked out the chuck door at first. The chuck door was tightened, after which the dust began leaking out the coke-side door. We were told that this was an abnormal example of the dusting operation but it does demonstrate some of the problems that can occur when using this technique. Overall, the condition of the walls in the P4 ovens appeared to be very good, with few visible cracks in any of the ovens.

During each test day process operating data was obtained at approximately 1-hr intervals, and the time that each oven was pushed and leveled was recorded whenever possible. Copies of circular charts showing process data were obtained, along with coke and coal analyses done by Jones and Laughlin, and fuel gas analysis. Also,

some flue inspections were made and noted along with other observations or information. All of these records are shown in Appendix I.

Jones and Laughlin personnel cooperated with the test team during the testing, and appreciation is expressed for the help provided by Mr. Jim Saunders, Assistant Superintendent, and Mr. Ken Kobus, Heater Foreman.

4.0 LOCATION OF SAMPLING POINTS

The underground waste heat duct sampling location was accessed through a vertical cut-off damper slot, located approximately 42-feet downstream from the battery waste heat flue centerline and 60-feet upstream of the battery stack. The duct itself is located 4 - feet 3 - inches below ground level with an 8 x 8-foot (nominal) cross-section. This particular location was selected since there was no feasible method to install ports in the concrete battery stack. The damper slot measured approximately three inches across at the ground level elevation and tapered to one-inch across at the underground duct entry point.

The six sampling ports on top of the damper slot were spaced 16 inches on center. Each vertical traverse consisted of five sampling points; six were originally proposed but, due to an irregular build-up of deposit on the bottom of the duct, the sixth point was eliminated. Velocity pressures and temperatures were measured at each of the 30 sampling points. Figure 4.1 is a diagram of the sampling location showing each of the traverse points and their respective distances from the duct walls.

Points	Vertical Distance Inside Duct	
	feet	centimeters
1	0.7	21.3
2	2.1	64.0
3	3.5	106.7
4	4.9	149.4
5	6.3	192.0

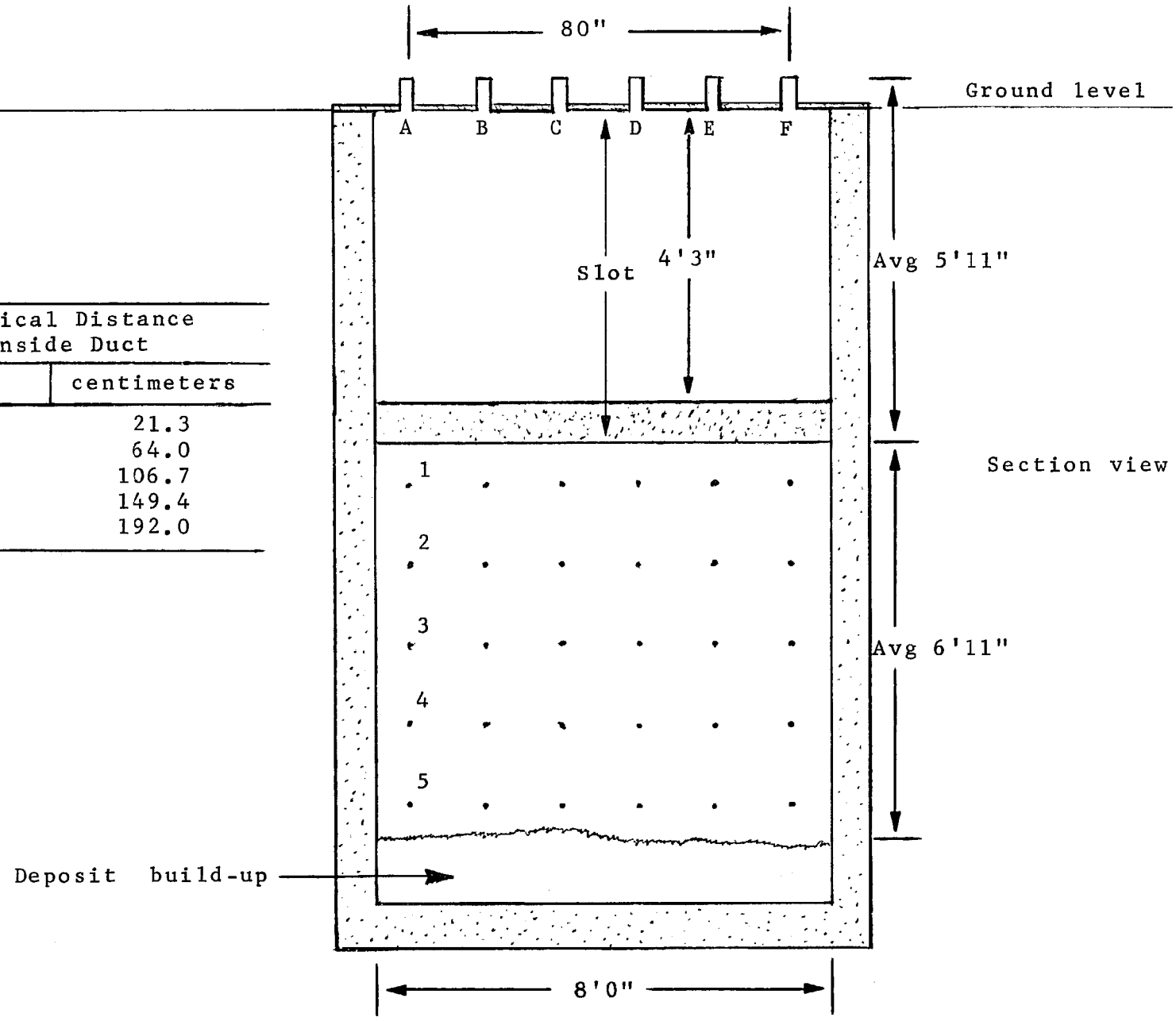


Figure 4.1. Sampling location - waste heat duct.

5.0 SAMPLING AND ANALYTICAL PROCEDURES

PARTICULATE EMISSIONS

Triplicate two and one-half hour particulate samples were extracted isokinetically for five minutes at each of 30 sampling points in the waste heat duct. During each test, the probe, Pitot tube, and thermocouple assembly were moved to each sampling point, the velocity pressure and temperature of the exhaust gas were measured, and isokinetic sampling flowrates were adjusted accordingly. An orifice-type meter was used to indicate instantaneous flowrates.

Proper nozzle alignment with the flue gas stream was maintained throughout the test by clamping the probe assembly at the top of each port. As a result of this vertical support system, there was no unusual difficulty in measuring the actual gas velocity pressures. The impinger assembly was moved as required to gain access to each vertical entry port. Some interference was anticipated from the push ram (on the pusher car) passing above the sampling location; however, proper synchronization of the push ram operation with the probe position eliminated this potential problem. All field data sheets are included in Appendix B.

The sampling train was checked for leaks before and after each sample run in accordance with the requirement that the initial leak rate shall not exceed 0.02 ft^3/min at 15 inches of mercury vacuum and the final leak rate shall not exceed 0.02 ft^3/min at the greatest vacuum incurred during the test.

A modified EPA Method 5 sampling train was used (Figure 5.1). The sampling train consisted of a sharp, tapered, stainless steel sampling nozzle; a 14-foot stainless steel probe assembly (instead of glass); a heated preweighed 110-mm glass-fiber filter; flexible Teflon® tubing leading to two Greenburg-Smith impingers, the first modified, the second standard, each containing 100-ml of distilled water; an empty modified Greenburg-Smith impinger; a modified Greenburg-Smith impinger containing approximately 400 grams of silica gel; a leakless pump with vacuum gauge; a calibrated dry gas meter equipped with bimetallic inlet and outlet thermometers; and, a calibrated orifice-type flowmeter that was connected to a 0-to-10-inch range inclined (water gauge) manometer. As a result of the unusual configuration of the underground sampling location, it was impossible to utilize a 14-foot glass probe for sample extraction, due to obvious difficulties with flexing and fracturing.

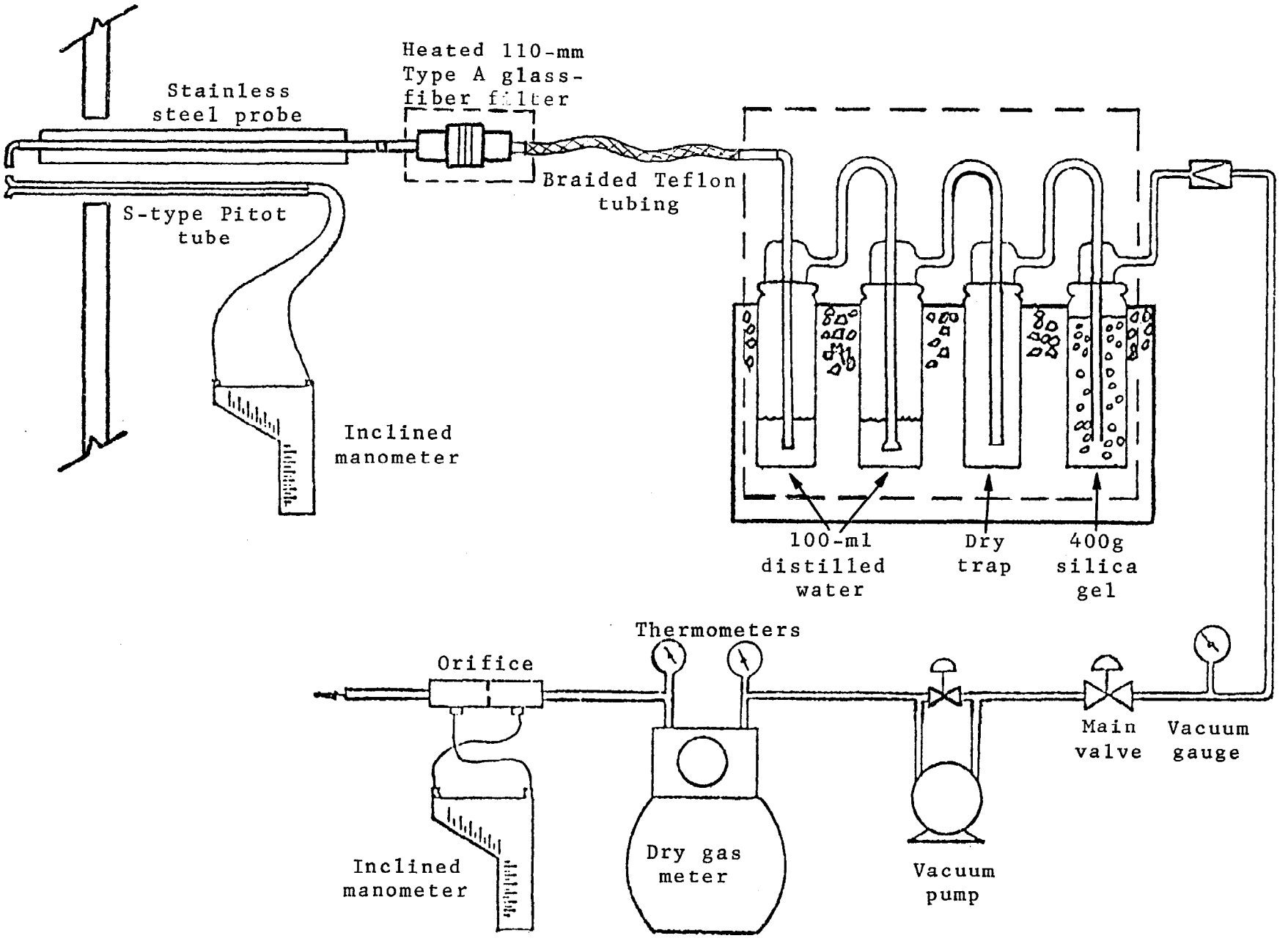


Figure 5.1. Particulate sampling train.

The impinger train was immersed in an ice bath to maintain the temperature in the last impinger at 70F or less. All of the sampling train glassware was connected by ground glass joints, sealed with stopcock grease, and clamped to prevent leakage. A calibrated S-type Pitot tube was connected to the sampling probe and velocity pressures were read on the inclined manometer. An iron-constantan (I/C) thermocouple, attached to the Pitot-probe assembly, was connected to a calibrated pyrometer. During the course of testing, the filter temperature was kept at 250 $\pm$ 25F.

Following each sample run, the entire sampling train was transferred to a sheltered clean-up area. The probe and nozzle assembly, and the front half of the filter holder were initially rinsed and brushed with water, then acetone. The two rinsings were collected in separate glass sample bottles with Teflon® -lined caps. The glass-fiber filter was returned to its original petri dish and sealed. The volumes of the impinger contents were measured and volume increases recorded. The solutions were placed in glass sample bottles with Teflon®-lined caps. The impingers were first rinsed with water, then acetone. The water rinsings were placed in the same sample bottle as the impinger solutions,

and the acetone rinsings were placed in a separate glass sample bottle. The flexline and back-half of the glass filter holder were brushed and rinsed with water, then acetone, and the rinsings placed in the respective sample bottles. The silica gel was weighed to determine the weight gain (as condensate).

Thus, five fractions were collected for each particulate sample:

(1) water rinsings of probe and nozzle assembly, and front-half of the filter holder;

(2) acetone rinsings of probe and nozzle assembly, and front-half of the filter holder;

(3) 110-mm type A glass-fiber filter;

(4) impinger contents and water rinsings of back-half of filter holder, flexline, and impingers; and

(5) acetone rinsings of back-half of filter holder, flexline, and impingers.

Filterable particulate was the sum of Fractions 1, 2, and 3. Total particulate was the sum of Fractions 1 through 5. The particulate weights by fraction are presented in Appendix C.

In the laboratory, the liquid fractions were measured volumetrically and placed in tared beakers. A five milliliter aliquot was taken from each fraction for sulfate analysis. The water fractions were then evaporated to residue at 105C and the particulate weight determined. The acetone fractions were evaporated at room temperature and weighed until constant. The filter was desiccated at room temperature and weighed until constant. All weight determinations were performed on an analytical balance having a sensitivity of 0.1 milligrams.

For the determination of sulfates in the liquid samples, the 5-ml aliquot was brought up to 25-mls with 80-percent IPA. The filter was also combined with 80-percent IPA. The acidity was adjusted with perchloric acid to a pH of between 2.5 and 4.0. Three to five drops of thorin indicator were then added and the solution titrated with standardized barium perchlorate. The results are reported as sulfuric acid (including sulfur trioxide), and as a percent of total particulate.

CARBON MONOXIDE SAMPLING

A sample of flue gas was drawn through a stainless steel probe, Teflon® tubing, and then through a particulate and condensate trap containing a glass wool plug, to a 3-way valve. This valve was used to

divide the gas sample into two streams; one for the continuous analysis of carbon monoxide and one to provide an integrated bag sample for the determinations of benzene content and exhaust gas composition by the Orsat method.

The gas stream used for carbon monoxide monitoring was then passed through two modified Greenburg-Smith impingers, the first containing approximately 250 grams of silica gel and the second containing approximately 500 grams of Ascarite®, for moisture and carbon dioxide removal, respectively. Finally, a leak-free diaphragm pump forced the sample through a needle valve to a rotameter and the Beckman Model 865 NDIR analyzer. At the sample interface, a flowrate of approximately 1.5 cfh with a delivery pressure of 10 psig was maintained for the duration of the continuous sampling. An analog strip chart recorder was used to record all instrument outputs. This sampling system is depicted in Figure 5.2.

The daily calibration sequence included passing a certified standard zero gas (dry nitrogen) and a certified standard span gas in concentrations of 9,900 ppm or 29,800 ppm carbon monoxide in nitrogen through the analyzer. The instrument output was calibrated for two anticipated ranges, 0-10,000 and 0-30,000 ppm carbon monoxide by adjustment of the

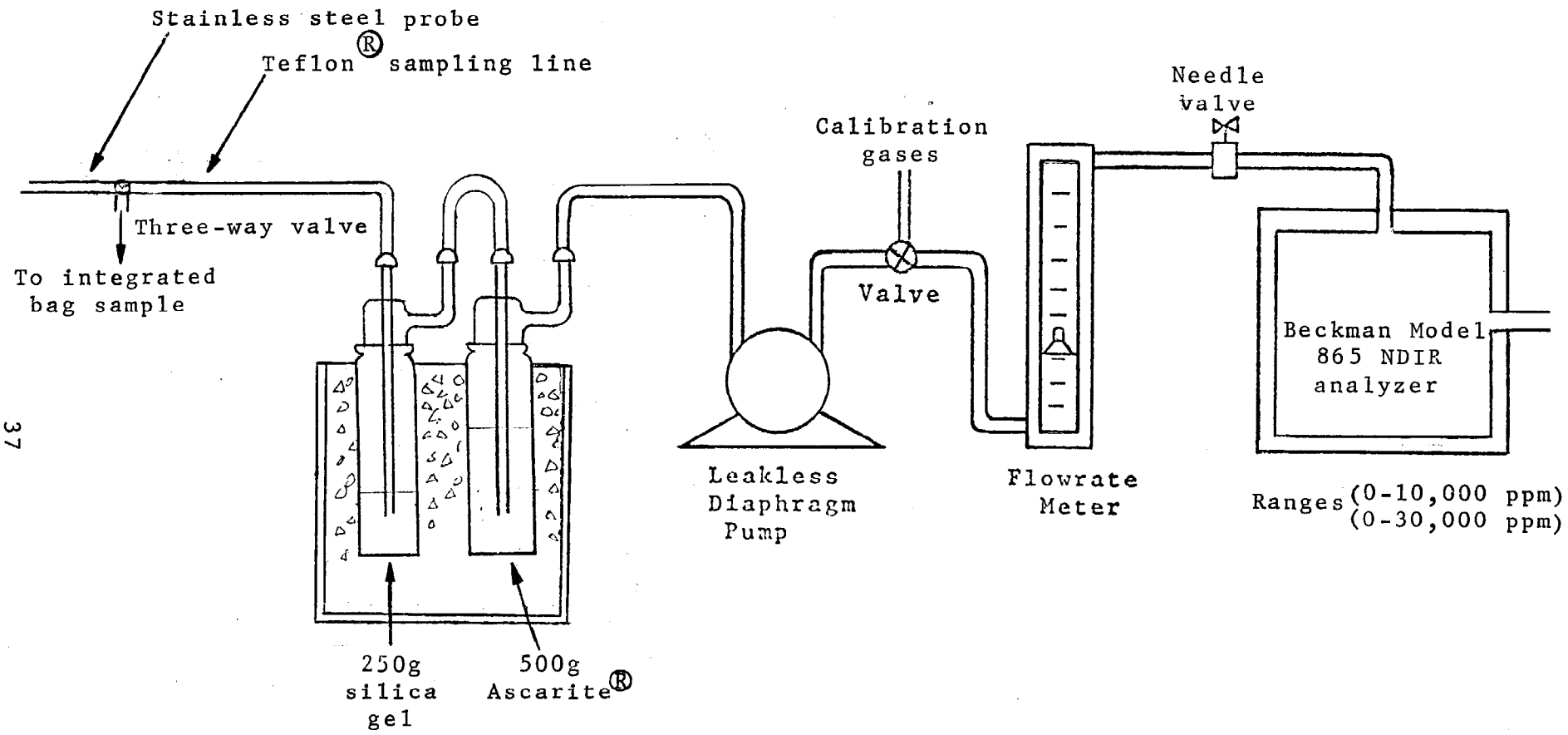


Figure 5.2. Sampling train for continuous monitoring of carbon monoxide.

zero and gain settings for the appropriate signal, as indicated on a calibration curve. The instrument operates by the Luft principle as specified in Reference Method 10. A 4-position valve allows the introduction of sample gas or any of the required standard calibration gases.

The actual measured concentrations of CO were determined by adjusting the recorded strip chart values with the factory calibration curve for the 16-mm cell, which had been adjusted to the standard gas concentrations used in the field.

INTEGRATED BAG SAMPLING (BENZENE AND ORSAT)

An integrated bag sample was withdrawn from the waste heat duct simultaneously with each particulate sampling run utilizing a train as depicted in Figure 5.3, and as described previously under Carbon Monoxide Sampling. An evacuated Tedlar® bag with a volume of 100 liters was placed inside an insulated steel drum. The drum was then gradually evacuated, thereby filling the Tedlar® bag at a controlled flowrate, using a rotameter and valve assembly as shown in Figure 5.3. When the bag was filled, it was removed and transferred to a laboratory for immediate gas chromatographic (GC) analysis of the benzene content and later, Orsat analysis.

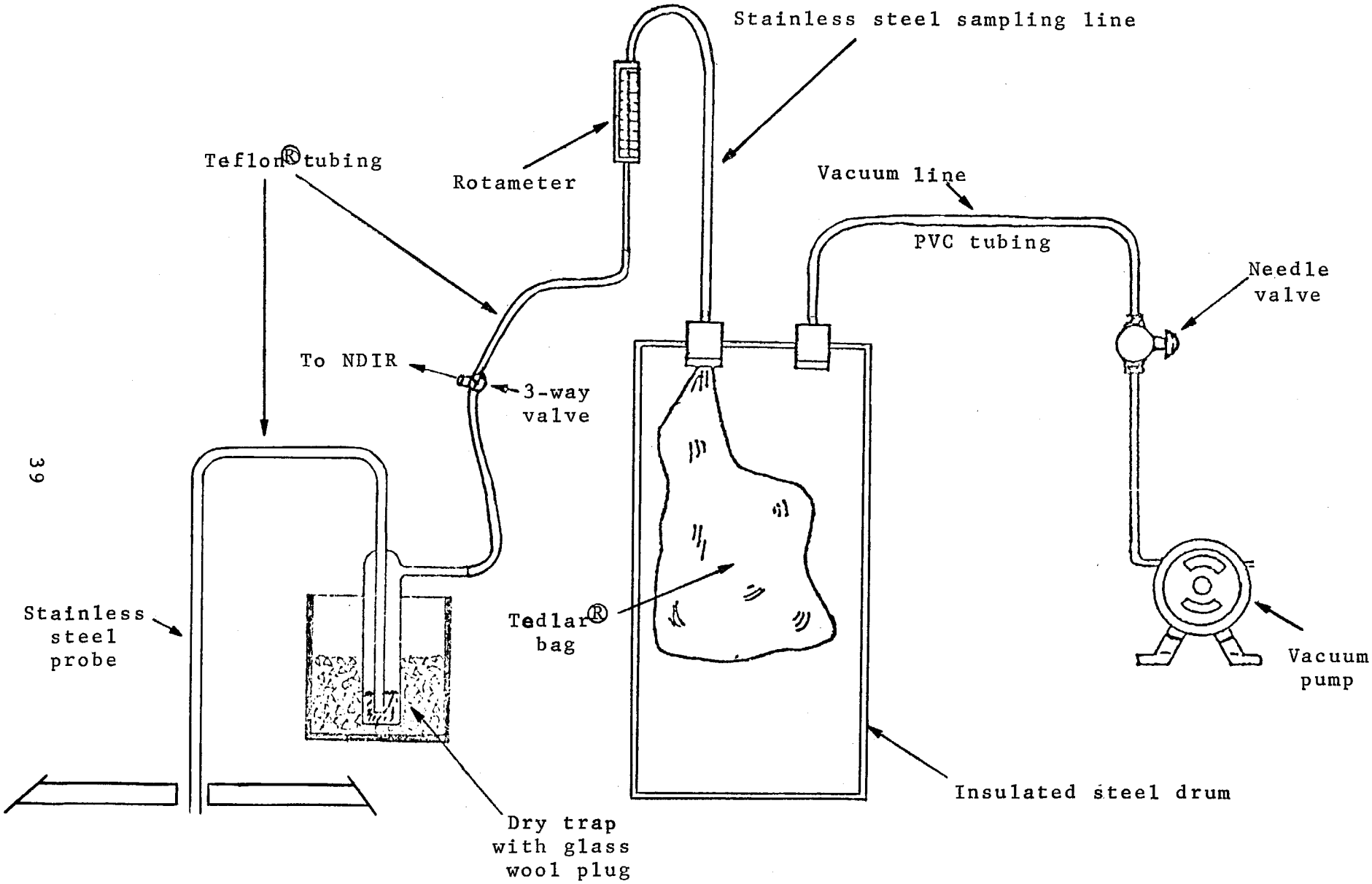


Figure 5.3. Integrated bag sampling train.

The method used for the determination of benzene concentrations is in accordance with the EPA gas chromatographic Method 110, "Determination of Benzene from Stationary Sources", delineated in Appendix F-1. Gas chromatographic field analyses were performed utilizing an Analytical Instrument Development (AID) Model 511, portable gas chromatograph with a flame ionization detector and a 6' x 1/8" stainless steel column packed with 1.75-percent Bentone and 5-percent SP1200 on 100/120 mesh Supelcoport. The following operating conditions were maintained for all analyses: 85C oven, 105C detector, 190F gas sampling loop with 1 ml capacity, and 16 ml/min zero nitrogen carrier gas. The samples were analyzed for benzene on the same day they were collected. Peak areas were measured using a compensating polar planimeter. The sample chromatograms had three apparent peaks, which were completely resolved.

Following the GC analyses, each integrated bag sample was analyzed by the Orsat method for carbon dioxide, oxygen, and carbon monoxide concentrations, as specified in EPA-Method 3. These results were used to calculate the molecular weight of the process gas.

Visible Emissions

Visible emissions from the P4 battery stack exhaust were recorded for the duration of each sample run except for Sample No. 3, for which visible emissions were abbreviated due to foul weather. The observations were performed in accordance with EPA Method 9 by a qualified visible emissions observer. A summary of the visible emission data is presented in Appendix B-4.

APPENDIX A

PROJECT PARTICIPANTS

PROJECT PARTICIPANTS

Clayton Environmental Consultants, Inc.

N.S. Walsh	Director, Air Resource Engineering
Timothy V. Mattson	Group Leader, Emission Measurement
Bruce G. Bird	Source Testing Specialist
Randy M. Knutson	Source Testing Specialist
J. Douglas Opthoff	Environmental Chemist
Donna L. Schick	Environmental Data Specialist
Dusanka Lazarevic	Environmental Data Specialist
William M. Ewing	Laboratory Technician
Justine H. Schroeder	Laboratory Technician
Nancy E. Calme	Laboratory Technician
Daryl P. Strandberg	Laboratory Technician
Corinne A. Conklin	Laboratory Aide Technician
Mary L. Fegan	Laboratory Aide Technician

Jones and Laughlin Steel Corporation

Jim Saunders

Ken Kobus

Midwest Research Institute

Paul Gorman

U.S. Environmental Protection Agency

Frank Clay

APPENDIX B

FIELD DATA SHEETS

B-1. Particulate Test Data Sheets

B-2. Sampling Summary Data

B-3. Visible Emission Data Sheets

B-4. Summary of Visible Emissions

APPENDIX B-1

Particulate Test Data Sheets

SAMPLING TRAIN DATA

Company: ~~J&L STEEL P.H.~~ U.S. EPA (J&L)
Source Designation: P-4 Coke Oven Duct Exhaust
Date: 5/1/79
Test Number: P-1
Field Person: RMK, BGB, TVM
Filter Number: A-108-23
Barometric Pressure ("Hg): 29.57
Stack Static Pressure ("H_2O): -0.95
Stack Dimensions: 8' X 8' (see dia)
Plume Appearance:
Ambient Temperature (°F): 55
Record all Data Every 5 Minutes

Filter Heater Setting:
Probe Heater Setting:
Nozzle Number: ____, Dia. (in.): .376
Pitot Tube No. 38, Corr. Factor: 818
Meter Box No. RAC 2, Corr. Factor: 1.011
Meter Isokinetic Factor: 1629 RAC 2
Assumed Moisture (%): 17
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Leak Rate 0.00 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O) STO 5	Stack Temp (°F) STO 4	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) STO 1 Inlet	Dry Gas Meter: Temp (°F) STO 2 Outlet	Orifice Pressure Differential ($\Delta M \rightarrow A$) ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
5	0	14:50	0.16	610	297.906	80	80	1.38	260	60	2
A (South) 4	5		0.16	620		65	72	1.33	250	56	1
3	10		0.18	570		72	74	1.59	240	56	2
2	15		0.18	580		77	74	1.58			2
1	20		0.12	595		80	75	1.05	215	63	1
	25				313.531						
	0	15:30	0.20	575	313.531	78	78	1.78	225	60	2
B	5		0.20	590		82	80	1.76	240	56	2
	10		0.21	600		88	80	1.89	240	58	3
	15		0.19	610		90	80	1.65	250	60	3
	20		0.14	620		94	83	1.22	260	61	2
	25				330.701						
AVERAGE (TOTAL)					( )						

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: USEPA (F&C) RTP

Source Designation: PA Coke Oven Duct Exhaust EPA Shipyard 541-22?

Date: 5/1/79

Test Number: P-1

Field Person: RMK et al.

Filter Number: A-108-23

Barometric Pressure ("Hg): 29.57

Stack Static Pressure ("H_2O): -0.95

Stack Dimensions: 8'x8

Plume Appearance:

Ambient Temperature (°F): 60

Record all Data Every 5 Minutes

Filter Heater Setting:

Probe Heater Setting:

Nozzle Number: ____, Dia. (in.): ____

Pitot Tube No. ____, Corr. Factor: ____

Meter Box No. ____, Corr. Factor: ____

Meter Isokinetic Factor:

Assumed Moisture (%):

Condensate Volume (ml):

Silica Gel Weight Gain (g):

Leak Rate ____ CFM at ____ "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp (°F): Inlet	Dry Gas Meter Temp (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
	0	16:26	.23	620	330.701	80	80	1.80	230	62	3
	5		.23	580		83	82	2.05	220	56	3
	10		.22	600		90	82	1.94			2
D	15		.20	610		93	83	1.75	220	60	2
	20		.15	615		95	85	1.31	245		2
	25 ~~26~~				348.710						
	0	17:05	0.18	590	348.710	85	83	1.59			
	5		0.17	595		88	85	1.51			
	10		0.18 ~~12-0.15~~	605		92	85	1.59 1.32	280	52	2
C	15		0.17	615		94	86	1.49	220	54	2
	20		0.15	625		98	88	1.32	255	59	2
	25				365.078						
						1704	1615				
AVERAGE (TOTAL)					( )						

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: US EPA (UEC)
Source Designation: P-4 coke oven duct exhaust
Date: 5/1/79
Test Number: D-1
Field Person: [illegible] et al
Filter Number: A-108-23
Barometric Pressure ("Hg): 29.57
Stack Static Pressure ("H_2O): -0.95
Stack Dimensions: 8'×8'
Plume Appearance:
Ambient Temperature (°F): 65
Record all Data Every _____ Minutes

Filter Heater Setting:
Probe Heater Setting:
Nozzle Number: ____, Dia. (in.):
Pitot Tube No. ____, Corr. Factor:
Meter Box No. ____, Corr. Factor:
Meter Isokinetic Factor:
Assumed Moisture (%):
Condensate Volume (ml): 371
Silica Gel Weight Gain (g): 28.1
Leak Rate 0.00 CFM at 10 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
	0	17:35	0.18	605	365.078	88	85	1.58	200	56	2
	5		0.18	620		90	88	1.56	175	59	2
5	10		0.20	630		95	88	1.73	220	56	2
	15		0.17	565		96	88	1.57	230	57	3
	20		0.12	580		98	90	1.09			
	25				381.690						
	0	18:19	0.15	600	381.690	90	90	1.33	300	58	2
	5		0.18	615		94	90	1.58	285	57	2
F	10		0.19	550		96	90	1.78	235	57	3
	15		0.16	585		100	92	1.46	210	57	3
	20		0.12	595		100	92	1.08			2
	25				398.021						
AVERAGE (TOTAL)				599	100.515 (~~101.215~~)	88.4	63.0	1.54			

Clayton Environmental Consultants, Inc.

DRY MOLECULAR WEIGHT DETERMINATION (M_d)

Plant: J+L STEEL
Date: 5-1-79
Sampling Time (24-hour Clock): T-1
Sampling Location:: Bellary PA

Sample Type (bag, integrated, continuous) _____
Analytical Method: ORSAT
Ambient Temperature: 78°
Operator: [illegible]

Comments:

Gas \ Run	1		2		3		Average Net Volume	Multiplier	Molecular Weight Of Stack Gas (dry basis) M_d, lb/lb-mole
	Actual Reading	Net	Actual Reading	Net	Actual Reading	Net			
CO_2	.6	.6	1.0	1.0	.6	.6	0.73	44/100	0.32
O_2 (Net is actual O_2 reading minus actual CO_2 reading)	18.7	18.1	18.6	17.6	18.7	18.1	17.93	32/100	5.74
CO (net is actual CO reading minus actual O_2 reading)	19.0	~.3	18.6	<.1	19.1	~.4	0.23	28/100	0.06
N_2 (Net is 100 minus actual CO reading)		81.0		81.4		80.9	81.11	28/100	22.71
								Total	28.83 = M_d

WET MOLECULAR WEIGHT DETERMINATION (M_s)

B_{wo} = Proportion by volume of water vapor in the gas stream

M_s = Molecular weight of stack gas (wet basis), lb/lb-mole = $M_d(1-B_{wo}) + 18(B_{wo})$

M_s = ( )(1-) + 18( ) =

$G_m = \frac{M_d}{28.96} = \frac{\quad}{28.96} =$, $G_s = \frac{M_s}{28.96} = \frac{\quad}{28.96} = 0.941$, $\frac{G_m}{G_s} = \frac{\quad}{\quad} =$

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: U.S. EPA (JiL)
Source Designation: P-4 Coke oven exhaust duct
Date: 5/2/79
Test Number: P-2
Field Person: RMK etal.
Filter Number: A-108-15
Barometric Pressure ("Hg): 29.58
Stack Static Pressure ("H_2O): -0.95
Stack Dimensions: 6'9 x 8
Plume Appearance:
Ambient Temperature (°F): 50
Record all Data Every 5 Minutes

Filter Heater Setting:
Probe Heater Setting:
Nozzle Number: ____, Dia. (in.): 0.375
Pitot Tube No. 38, Corr. Factor: 0.818
Meter Box No. R-2, Corr. Factor:
Meter Isokinetic Factor: 1629
Assumed Moisture (%): 17%
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Leak Rate 0.01 CFM at 15 "Hg
initial

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
	0	10:45	0.15	610	398.385	90	90	1.32	200	63	2
	5		0.15	620		95	92	1.31			2
	10		0.12	630		100	92	1.05	200	60	2
	15		0.12	560	407.7	100	93	1.12	220	62	2
	20		0.06	575	410.6	100	96	0.55	250	64	1
	25				412.930						
	0	11:24	0.13	615	412.930	90	90	1.14	260		2
	5		0.15	560	416.000	90	90	1.38	260	62	2
	10		0.14	590	419.200	94	90	1.26	230	61	2
	15		0.12	600	422.3	96	90	1.07	215	61	2
11:53	20		0.10	615	425.2	96	90	0.88	210	70	1
	25	11:58			427.797						
AVERAGE (TOTAL)					( )	95	90	11.08			

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: USEPA VSL
Source Designation: P-4 Coke oven duct exhaust
Date: 5/2/79
Test Number: P-2
Field Person: RMK
Filter Number: A-108-15
Barometric Pressure ("Hg): 29.58
Stack Static Pressure ("H_2O): -0.9
Stack Dimensions: 6'9 x 8
Plume Appearance:
Ambient Temperature (°F): 60
Record all Data Every 5 Minutes

Filter Heater Setting:
Probe Heater Setting:
Nozzle Number: ____, Dia. (in.): .375
Pitot Tube No. ____, Corr. Factor: 0.818
Meter Box No. ____, Corr. Factor:
Meter Isokinetic Factor: 1.629
Assumed Moisture (%):
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Leak Rate ____ CFM at ____ "Hg

	Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
	5	0	12:04	0.15	575	427.797	88	88	1.36			
	4	5		0.132 0.15	590	431.0	90	90	1.34 1.09	1.18		
D	3	7 10		0.12 0.13	600		95	90	1.16	265	62	2
	2	15		0.13	610	437.0	98	90	1.15	235	64	2
	1	20		0.09	620	440.0	98	92	0.79	235	65	2
		25				442.531						
	5	0	12:41	0.17	605	442.531	93	92	1.51	270	69	2
	4	5		0.15	615	445.9	94	92	1.32	260	66	2
C	3	10		0.14	625	449.1	98	92	1.22			
	2	15		0.13	635	552.2	100	92	1.13			2
	1	20		0.10	570	455.2	100	94	0.92	245	67	2
		25				457.844						
							1909					
AVERAGE (TOTAL)				11.84	603.18	( )	93		1.18			

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: USEPA USL
Source Designation: P-4 Cdeductex.
Date: 5/2/79
Test Number: P-2
Field Person: AMK
Filter Number: A-108-15
Barometric Pressure ("Hg): 29.58
Stack Static Pressure ("H_2O): -0.95
Stack Dimensions: 6'9 x 8
Plume Appearance:
Ambient Temperature (°F):
Record all Data Every 5 Minutes

Filter Heater Setting:
Probe Heater Setting:
Nozzle Number: ___, Dia. (in.): 0.375
Pitot Tube No. ___, Corr. Factor: 0.818
Meter Box No. 3, Corr. Factor:
Meter Isokinetic Factor: 1629
Assumed Moisture (%):
Condensate Volume (ml): 323g
Silica Gel Weight Gain (g): 17.6
Leak Rate 0.008 CFM at 10 "Hg
final

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
	0	13:25	0.15	595	457.844	98	92	1.35			
	5		0.16	605	461.1	98	94	1.43	280	67	3
	10		0.14	620	464.4	100	94	1.23	260	67	2
	15		0.14	625	467.5	102	96	1.23	230	67	2
	20		0.10	580	470.6	104	95	0.92	245	68	2
	25				473.301						
	0	13:52	0.12	600	473.301	100	96	1.08			2
	5		0.14	615	476.2	102	96	1.24	260	70	2
	10		0.12 (0.108)	625	479.3	104	98	1.06	250	70	2
	12 15		0.10 0.13	625	482.0	104	98	0.88 1.15	OFF		
	20		0.08	570	485.1	105	98	0.75	210	71	2
	25				487.573						
AVERAGE (TOTAL)				603	(89.546)	99.3	95.1	1.14			

Clayton Environmental Consultants, Inc.

DRY MOLECULAR WEIGHT DETERMINATION (M_d)

Plant: J&L Steel
Date: 5-3-79
Sampling Time (24-hour Clock): P-2 - 5/2/79
Sampling Location:: Battery P-4 waste heat duct

Sample Type (bag, integrated, continuous) _____
Analytical Method: ORSAT
Ambient Temperature: 75° F
Operator: BGB

Comments:

Gas \ Run	1 Actual Reading	1 Net	2 Actual Reading	2 Net	3 Actual Reading	3 Net	Average Net Volume	Multiplier	Molecular Weight Of Stack Gas (dry basis) M_d, lb/lb-mole
CO_2	4.1	4.1	4.0	4.0	3.9	3.9	4.0	44/100	1.76
O_2 (Net is actual O_2 reading minus actual CO_2 reading)	14.8	10.7	14.6	10.6	14.5	10.6	10.6	32/100	3.392
CO (net is actual CO reading minus actual O_2 reading)	14.8	0.0	14.6	0.0	14.5	0.0	<0.1	28/100	0.00
N_2 (Net is 100 minus actual CO reading)		85.2		85.4		85.5	85.4	28/100	23.91
								Total	29.06 = M_d

WET MOLECULAR WEIGHT DETERMINATION (M_s)

B_{wo} = Proportion by volume of water vapor in the gas stream

M_s = Molecular weight of stack gas (wet basis), lb/lb-mole = $M_d(1-B_{wo}) + 18(B_{wo})$

M_s = ( )(1-) + 18( ) =

$G_m = \frac{M_d}{28.96} = \frac{29.05}{28.96} = 1.00$, $G_s = \frac{M_s}{28.96} = \frac{29.52}{28.96} = \cancel{1.36}$ 0.904 , $\frac{G_m}{G_s} = \frac{1.00}{\cancel{1.36}\ 0.904} = \cancel{0.735}$ 1.106

Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

Company: Jones & Laughlin
Source Designation: P-4 Battery
Date: 5-3-79
Test Number: P-3
Field Person: RMK, TVM
Filter Number: A-108-24
Barometric Pressure ("Hg): 29.25
Stack Static Pressure ("H_2O): -0.95
Stack Dimensions: 6.9' x 8'
Plume Appearance:
Ambient Temperature (°F): 65
Record all Data Every 5 Minutes

Filter Heater Setting:
Probe Heater Setting:
Nozzle Number: 1, Dia. (in.): 0.376
Pitot Tube No. 38, Corr. Factor: 0.818
Meter Box No. RAC2, Corr. Factor:
Meter Isokinetic Factor: 1629
Assumed Moisture (%): 17
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Leak Rate 0.005 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp (°F) Inlet	Dry Gas Meter: Temp (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
5	0	10:49	0.21	615	487.956	74	74	1.76	270	58	3
4	5	5	0.20	625	491.6	75	76	1.67	200	56	3
3	10	10	0.20	565	495.2	80	76	1.77	200	60	3
2	15	15	0.21	575	498.7	86	78	1.86	200	62	4
1	20		0.12	610	502.4	82	80	1.20	250	62	2
	25	11:30			505.531						
	0	11:35	0.21	585	505.531	84	82	1.84	235	61	4
	5		0.20	600	509.2	90	84	1.74	230	59	4
	10		0.20	610	513.2	94	85	1.74	220	60	4
	15		0.20	620	516.5	96	86	1.72	220	60	4
	20		0.15	630	520.2	97	88	1.28	225	62	3
	25				523.292						
AVERAGE (TOTAL)			14.25	603.5	( )	85.2		1.66			

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Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

COMPANY:
SOURCE DESIGNATION: US EPA
REGULATING AUTHORITY: US EPA
DATE: 5/3/79
TEST NUMBER: P-3
Field Person(s): RMK et al.
Filter Number: A-108-24
Barometric Pressure ("Hg):
Stack Static Pressure ("H_2O):
Stack Dimensions:
Ambient Temperature (°F):
Record all Data Every 5 Minutes

Nozzle (Dia-in): 0.376 0.376 0.374 (Avg): .376
Pitot Tube No. ___, Corr. Factor: 0.818
Meter Box No. 2, Corr. Factor:
Meter Isokinetic Factor: 1.629
Assumed Moisture (%):
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Actual Moisture (%):
Leak Rate: Initial: ___ CFM at ___ "Hg; Final: ___ CFM at ___ "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter Temp. (°F): Inlet	Dry Gas Meter Temp. (°F): Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
5	0	12:05	0.20	600	523.292	92	88	1.75			4
4	5		0.20	600	526.9	96	90	1.76	225	62	4
3	10		0.19	610	530.6	100	92	1.67	175	60	4
2	15		0.18	610	534.2	102	92	1.60	200	64	4
1	20		0.15	615	537.7	102	94	1.32	220	64	3
	25				541.964						
5	0	12:37	0.22	600	541.964	96	94	1.94	250	62	4
4	5		0.20	600	544.8	100	94	1.78	250	62	4
3	10		0.19	610	548.5	102	94	1.67	240	62	4
2	15		0.17	620	552.1	104	94	1.49	235	63	4
1	20		0.14	500	555.6	94	92	1.36	230	6	
	25			604	558.802						
AVERAGE (TOTAL)			14.08	599.5	( )	89.35		1.65			

erroneous reading average of 604 used instead of 500

includes page one

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Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

COMPANY:
SOURCE DESIGNATION:
REGULATING AUTHORITY:
DATE: 5/3/79
TEST NUMBER: P-3
Field Person(s): RMK
Filter Number:
Barometric Pressure ("Hg):
Stack Static Pressure ("H_2O):
Stack Dimensions:
Ambient Temperature (°F): 65
Record all Data Every 5 Minutes

Nozzle(Dia-in): ___ ___ ___ (Avg): ___
Pitot Tube No. ___, Corr. Factor: ___
Meter Box No. ___, Corr. Factor: ___
Meter Isokinetic Factor:
Assumed Moisture (%): 143-20
Condensate Volume(ml): on bottle 196+214
Silica Gel Weight Gain(g): 35.4
Actual Moisture (%):
Leak Rate: Initial: 0.005 CFM at 15 "Hg; Final: 0.02 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F)	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp. (°F) Inlet	Dry Gas Meter: Temp. (°F) Outlet	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
5	0	14:45	0.19	600	558.802	92	92	1.67			
4	5		0.22	620	562.3	86	88	1.88	230	61	4
3	10		0.21	625	566.1	92	86	1.80	245	63	5
2	15		0.19	565	569.8	96	88	1.73	235	67	4
1	20		0.14	580	573.5	100	88	1.26	240	67	3
	25	15:10			576.698						
5	0	15:15	0.17	590	576.698	94	90	1.51	265	62	4
4	5		0.18	610	580.1	96	92	1.58	245	62	4
3	10										
2	15		0.18	605	586.7	88	86	1.56	250	60	5
1	20		0.10	610	590.2	92	88	0.87			3
	25				592.728						
			1392	599.8		89.8		1.61			
AVERAGE (TOTAL) for the complete test				600.3	105.190			1.61			

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Clayton Environmental Consultants, Inc.

DRY MOLECULAR WEIGHT DETERMINATION (M_d)

Plant: J+L Steel
Date:
Sampling Time (24-hour Clock): P-3
Sampling Location::

Sample Type (bag, integrated, continuous)
Analytical Method:
Ambient Temperature:
Operator:

Comments:

Gas \ Run	1		2		3		Average Net Volume	Multiplier	Molecular Weight Of Stack Gas (dry basis) M_d, lb/lb-mole
	Actual Reading	Net	Actual Reading	Net	Actual Reading	Net			
CO_2	3.2	3.2	3.2	3.2	3.0	3.0	3.13	44/100	1.377
O_2 (Net is actual O_2 reading minus actual CO_2 reading)	15.7	12.5	15.6	12.4	15.7	12.7	12.53	32/100	4.010
CO (net is actual CO reading minus actual O_2 reading)	16.1	0.4	15.9	0.3	15.9	0.2	0.3	28/100	0.084
N_2 (Net is 100 minus actual CO reading)		83.9		84.1		84.1	84.04	28/100	23.531
								Total	29.00 = M_d

WET MOLECULAR WEIGHT DETERMINATION (M_s)

B_{wo} = Proportion by volume of water vapor in the gas stream

M_s = Molecular weight of stack gas (wet basis), lb/lb-mole = $M_d(1-B_{wo}) + 18(B_{wo})$

M_s = ( )(1-) + 18( ) =

$G_m = \frac{M_d}{28.96} = \frac{\quad}{28.96} =$, $G_s = \frac{M_s}{28.96} = \frac{\quad}{28.96} =$, $\frac{G_m}{G_s} = \frac{\quad}{\quad} =$

Clayton Environmental Consultants, Inc.

APPENDIX B-2

Sampling Summary Data

SAMPLING SUMMARY SHEET

Plant Jones and Laughlin Steel, Corporation Location

Sampled Source P4 Battery

Run	Date	N_p	P_m	P_b	V_m	T_m	$V_{m_{std}}$	V_w	$V_{w_{gas}}$	%M	M_d
1	5/1/79	30	1.54	29.57	100.515	86.0	96.448	399.1	18.8	16.31	0.8369
2	5/2/79	30	1.14	29.58	89.545	95.0	84.473	340.6	16.0	15.96	0.8404
3	5/3/79	30	1.61	29.25	105.191	89.9	99.156	388.4	18.3	15.58	0.8442

Run	MW_d	MW	P_{st}	P_s	C_p	$\sqrt{\Delta P_s X (T_s+460)}$ [c]	V_s	T_s	T_t	D_n	%I
1	29.04	27.24	-0.070	29.50	0.830	13.566	2034	599	150	0.376	99.0
2	29.06	27.29	-0.070	29.51	0.830	11.590	1739	603	150	0.376	101.3
3	29.00	27.29	-0.070	29.18	0.830	13.921	2100	604	150	0.376	99.2

$$V_{m_{std}} = \frac{17.65 \times V_m \left(P_b + \frac{P_m}{13.6}\right)}{(T_m + 460)}$$

$$V_{w_{gas}} = 0.0471 \times V_w$$

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

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

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

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

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

$$V_s = 5129.4 \times Cp \times \sqrt{\Delta P_s \times (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

$$\%I = \frac{1,032 (T_s + 460) \times V_{m_{std}}}{V_s \times T_t \times P_s \times M_d \times (D_n)^2}$$

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, fpm.

T_s Average Stack Temperature °F

T_t Net Time of Test, Min.

D_n Sampling Nozzle Diameter, i

% 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 (ΔPs) and the absolute

TABLE B-2.1. SUMMARY OF STACK GAS TEMPERATURES AND FLOWRATES

Sampling Location	Sample Number	Date 1979	Temperature		Flowrate			
			F	C	dscfm	acfm	$\frac{dsm^3}{min}$	$\frac{asm^3}{min}$
P4 Battery Stack	1	5-1	599	315	46,200	112,000	1,310	3,180
	2	5-2	603	317	39,500	96,000	1,120	2,720
	3	5-3	604	318	47,300	116,000	1,340	3,280
Average			602	317	44,300	108,000	1,260	3,060

APPENDIX B-3

Visible Emission Data Sheets

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 5-1-79

Company Name J&L Hours of Observation _____

Plant Address Pittsburg Observer Schick

Type of Discharge STACK OTHER _____

Discharge Location P-4 Battery Exhaust

Height of Point of Discharge 270'

Observer's Location:

Distance to Discharge Point 500'

Height of Observation Point ground level

Direction from Discharge Point see map

Background Description blue sky

Weather: Clear Overcast Partly Cloudy Other _____ Color _____

Wind Direction see map Wind Velocity 5-10 mi/hr

Plume Description:

Detached: Yes No

Color: Black White Other usually bluish white occasionally black

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other _____

Estimated Distance Plume Visible _____

Summary of Observations:

Opacity	Aggregate Time @ Opacity		Opacity	Aggregate Time @ Opacity
	min.	sec.		
0			55	
5			60	
10			65	
15			70	
20			75	
25			80	
30			85	
35			90	
40			95	
45			100	
50				

RECORD OF VISIBLE EMISSIONS

Company Name J&L

Date

Plant Address

Observer

Stack Location

Observer's Location

Weather Conditions

HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
1556	00	5	5	5	5	Start Test 1
	01	5	5	5	5	
	02	0	0	5	5	
	03	5	5	0	0	
	04	5	0	0	0	
	05	0	0	0	0	Ave = 2.7
	06	0	0	0	5	
	07	5	5	5	5	
	08	5	5	5	5	
	09	5	5	10	10	
	10	10	10	5	5	
	11	5	5	5	5	Ave = 5.2
	12	10	20	20	20	
	13	20	15	15	20	
	14	15	10	10	5	
	15	5	5	5	5	
	16	5	5	5	5	
	17	5	5	5	5	Ave = 10.0
	18	5	5	10	25	
	19	35	35	40	30	
	20	30	30	30	25	
	21	20	20	20	15	
	22	15	15	15	10	
	23	10	10	10	10	Ave = 19.6
	24	10	5	5	5	
	25	5	5	5	5	
	26	5	5	5	5	
	27	5	5	5	5	
	28	5	5	5	5	
	29	5	5	5	5	Ave = 5.2

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
1526	30	5	5	5	5	P-1 page 2
	31	5	5	5	5	
	32	0	0	5	5	
	33	5	0	0	0	
	34	0	5	0	0	
	35	5	0	0	5	Ave = 2.2 ← N → STACK
	36	5	5	5	5	
	37	5	5	5	5	
	38	5	5	5	5	
	39	5	5	5	5	
	40	5	5	5	5	Ave = 5.0
	41	5	5	5	5	BATTERY
	42	5	5	5	5	
	43	5	5	5	5	
	44	5	5	5	5	
	45	5	5	5	5	
	46	5	5	5	5	Ave = 5.0
	47	5	5	5	5	
	48	5	5	10	5	* OPACITY OBSERVER
	49	5	5	5	5	
	50	5	5	5	5	COKE PILES
	51	5	5	5	5	
	52	5	5	5	5	
	53	5	5	5	5	Ave = 5.2
	54	5	5	5	5	
	55	5	5	5	5	
	56	10	5	10	5	
	57	5	10	10	10	
	58	10	10	10	10	
	59	10	10	10	10	Ave = 7.1

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
1556	00	10	10	10	10	
	01	5	5	5	5	
	02	0	0	0	0	
	03	0	0	0	0	
	04	0	0	0	0	
	05	0	0	0	0	Ave: 2.5
	06	0	0	0	0	
	07	0	0	0	5	
	08	0	0	0	5	
	09	0	5	5	5	
	10	5	5	5	5	
	11	5	5	5	5	Ave = 2.7
	12	5	5	5	5	
	13	5	5	10	15	
	14	15	15	20	15	
	15	20	15	15	15	
	16	15	10	10	10	
	17	5	5	5	5	Ave = ~~11.3~~ 10.4
	18	5	5	5	5	
	19	5	5	5	5	
	20	5	5	5	5	
	21	5	5	5	5	
	22	5	5	5	5	
	23	5	5	5	5	Ave = 5.0
	24	5	5	5	20	
	25	30	40	35	30	
	26	30	30	30	25	
	27	25	25	20	15	
	28	15	15	10	10	
	29	5	5	5	5	Ave = 18.3

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
1626	30	5	5	5	5	
	31	5	5	5	5	
	32	5	0	5	5	
	33	0	5	5	5	
	34	5	5	5	5	
	35	5	5	5	5	Ave = 4.6
	36	5	5	5	5	
	37	5	5	5	5	
	38	5	5	5	5	
	39	5	5	10	15	
	40	25	25	20	15	
	41	15	10	10	5	Ave = 9.2
	42	5	5	5	5	
	43	5	5	5	5	
	44	5	5	5	5	
	45	5	5	5	5	
	46	5	5	5	5	
	47	5	5	5	5	Ave = 5.0
	48	5	5	5	5	
	49	5	5	5	5	
	50	5	5	5	5	
	51	5	5	5	5	
	52	5	5	5	5	
	53	5	5	5	5	Ave = 5.0
	54	5	5	5	5	
	55	5	5	5	5	
	56	5	5	5	5	
	57	5	5	5	5	
	58	5	5	5	5	
	59	5	5	5	5	Ave = 5.0

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
1654	00	5	5	5	5	
	01	5	5	5	5	
	02	0	0	0	0	
	03	0	0	0	0	
	04	10	10	10	10	
	05	10	5	5	5	ave = 4.4
	06	5	5	5	5	
	07	5	5	5	5	
	08	5	5	5	5	
	09	5	5	5	5	
	10	5	5	5	5	
	11	5	5	5	5	ave = 5.0
	12	5	5	5	5	
	13	5	5	5	5	
	14	5	5	5	5	
	15	5	5	5	5	
	16	5	5	5	5	
	17	5	10	15	10	ave = 5.8
	18	10	10	10	10	
	19	10	5	5	5	
	20	5	5	5	5	
	21	5	5	5	5	
	22	5	5	5	5	
	23	5	5	5	5	ave = 6.0
	24	5	5	5	5	
	25	5	5	5	5	
	26	5	10	10	15	
	27	15	15	15	15	
	28	10	10	10	10	
	29	10	10	10	5	ave = 8.96

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
1726	30	5	5	5	5	
	31	5	5	5	0	
	32	0	0	0	0	
	33	0	0	5	5	
30	34	5	5	5	5	
	35	5	5	5	5	Ave = 3.5
	36	5	0	5	5	
	37	0	5	5	0	
	38	5	0	0	5	
35	39	5	5	5	5	
	40	5	5	5	5	
	41	5	5	5	5	Ave = 3.96
	42	5	5	5	5	
	43	5	5	5	5	
40	44	5	5	5	5	
	45	5	5	5	5	
	46	5	5	5	5	
	47	5	5	5	5	Ave = 5.0
	48	10	10	10	10	
45	49	10	5	5	5	
	50	5	5	5	5	
	51	10	15	15	15	
	52	10	10	10	10	
	53	10	10	10	10	Ave = 9.2
50	54	10	10	5	5	
	55	5	5	5	5	
	56	5	5	5	5	
	57	5	5	5	5	
	58	5	5	5	5	
55	59	5	5	5	5	Ave = 5.4

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	TIME					COMMENTS
HR	MIN	SECONDS 00	15	30	45	
1760	00	5	5	5	5	
	01	5	5	5	0	
	02	0	0	0	0	
	03	0	0	10	20	
1800	04	30	30	30	25	
	05	25	20	15	10	Avg = 10.4
	06	5	5	5	5	
	07	5	5	5	5	
	08	5	5	5	5	
1805	09	5	5	5	5	
	10	5	5	10	20	
	11	25	30	25	25	9.4
	12	20	20	15	10	
	13	10	10	5	5	
10	14	5	5	5	5	
	15	5	5	5	5	
	16	5	5	5	5	
	17	5	5	5	5	7.3
	18	5	5	5	5	
15	19	5	5	5	5	
	20	5	5	5	5	
	21	5	5	5	5	
	22	5	5	5	5	
	23	5	5	5	5	5.0
20	24	5	5	5	5	
	25	5	5	5	5	
	26	5	5	5	5	
	27	5	15	25	25	
	28	30	20	15	15	
25	29	10	10	10	5	10.2

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1826	30	10	10	10	10	
	31	10	5	5	5	
	32	10	10	10	5	
	33	5	5	10	25	
1830	34	25	25	20	25	
	35	20	20	20	15	13.1
	36	15	10	10	10	
	37	5	5	5	5	
	38	10	5	5	5	
1835	39	5	5	5	5	
	40	5	5	5	5	
	41	5	0	5	5	6.0
	42	5	5	5	5	
	43	5	5	5	5	
1840	44	5	5	5	5	
	45	5	5	5	5	
	46	5	5	5	5	
	47	10	5	10	5	5.4
	48	5	5	5	5	
1845	49	5	5	5	5	
	50	5	5	5	5	
	51	5	5	5	5	
	52	5	5	5	5	
	53	5	5	5	5	5.0
1850	54	5	5	5	5	
	55	5	5	5	5	
	56	5	5			
	57					
	58					
1855	59					

SUMMARY
RECORD OF VISIBLE EMISSIONS

P-2

Type of Plant _____ Date 5-2-79

Company Name _____ Hours of Observation _____

Plant Address _____ Observer _____

Type of Discharge STACK OTHER _____

Discharge Location _____

Height of Point of Discharge _____

Observer's Location:

Distance to Discharge Point _____

Height of Observation Point _____

Direction from Discharge Point _____

Background Description Blue Sky

Weather: Clear Overcast Partly Cloudy Other _____ Color _____

Wind Direction variable Wind Velocity 0-5 mi/hr

Plume Description:

Detached: Yes No

Color: Black White Other _____

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other _____

Estimated Distance Plume Visible _____

Summary of Observations:

Opacity	Aggregate Time @ Opacity		Opacity	Aggregate Time @ Opacity
	min.	sec.		
0			55	
5			60	
10			65	
15			70	
20			75	
25			80	
30			85	
35			90	
40			95	
45			100	
50				

RECORD OF VISIBLE EMISSIONS

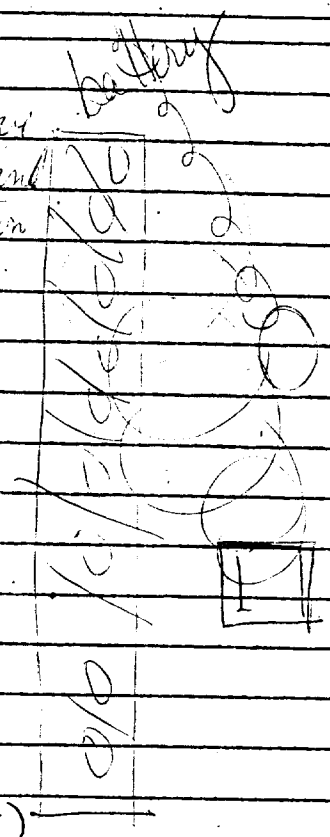
Company Name _____ Date 5/2/79

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	HR	MIN	SECONDS 00	15	30	45	COMMENTS
5	1030	00	5	5	5	5	
5		01	5	5	5	5	must move due to wind direction to B
-		02					
-		03					
-		04					
-		05					
-		06					
-	45	07					
-		08					
-		09					
-		10					
-		11		/	X	X	Quench
5	50	12	X	X	5	5	exhaust
5		13	5	5	5	5	totally
5		14	5	5	5	5	blocking
5		15	5	5	5	5	view (X)
5		16	5	5	5	5	
5	55	17	5	5	5	5	variable winds making
5		18	5	5	5	5	
0		19	0	0	0	0	
0		20	0	0	0	0	
0		21	0	0	0	0	
0	1100	22	0	0	0	10	X B
10		23	10	10	10	10	
5		24	5	5	5	5	
5		25	5	5	5	5	
8		26	5	10	10	5	
5	1105	27	5	5	5	5	
5		28	5	5	5	5	
5		29	5	5	5	5	



RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
5	1108	30	5	5	5	5	
5		31	5	5	5	5	
6	10	32	5	5	5	10	
21		33	20	20	25	20	
13		34	20	10	10	10	
5		35	5	5	5	5	
5		36	5	5	5	5	
5	1115	37	5	5	5	5	
5		38	5	5	5	5	
5		39	5	5	5	5	
5		40	5	5	5	5	
11		41	5	10	15	15	
11		42	15	10	10	10	
5		43	5	5	5	5	
5		44	5	5	5	5	
5		45	5	5	5	5	
5		46	5	5	5	5	
5		47	5	5	5	5	
4		48	5	5	5	0	
0		49	0	0	0	0	
9		50	10	10	10	5	
5		51	5	5	5	5	
5		52	5	5	5	5	
5		53	5	5	5	5	
6		54	10	5	5	5	
10		55	10	10	10	10	
5		56	5	5	5	5	
10		57	10	10	10	10	
13		58	10	10	10	20	
21		59	30	25	20	10	

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
6	1138	00	10	5	5	5	
5		01	5	5	5	5	
5		02	5	5	5	5	
5		03	5	5	5	5	
5		04	5	5	5	5	
5		05	5	X	X	X	much steam obstructing view
-		06	X	X	X	X	
5		07	X	X	X	5	
5		08	5	5	5	5	
5		09	5	5	5	5	
5		10	5	5	5	5	
5		11	5	5	5	5	
6		12	10	5	5	5	
5		13	5	5	5	5	
8		14	5	10	5	10	
9		15	10	10	10	5	
5		16	5	5	5	5	
6		17	5	5	5	10	
6		18	5	5	5	0	
0		19	0	0	0	0	
0		20	0	0	0	10	
0		21	0	0	0	0	
0		22	0	0	0	0	
0		23	0	0	0	0	
0		24	0	0	0	0	
1 5		25	0	0	0	5	
5		26	5	5	5	5	
5	1208	27	5	5	5	5	
5		28	5	5	5	5	
16		29	10	20	20	15	

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
8	1208	30	10	10	5	5	
5		31	5	5	5	5	
5	10	32	5	5	5	5	
5		33	5	5	5	5	
5		34	5	5	5	5	
5		35	5	5	5	5	
5		36	5	5	5	5	
5	15	37	5	5	5	5	
5		38	5	5	5	5	
5		39	5	5	5	5	
5		40	5	5	5	5	
8		41	10	5	5	10	
29	20	42	20	35	30	30	
24		43	25	25	25	20	
19		44	20	15	20	20	
14		45	20	15	10	10	
10		46	10	10	10	10	
8	25	47	10	10	5	5	
5		48	5	5	5	5	
5		49	5	5	5	5	
0		50	0	0	0	0	
0		51	0	0	0	0	
–		52	X	X	X	X	
3		53	0	0	5	5	
5		54	5	5	5	5	
5		55	5	5	5	5	
5		56	5	5	5	5	
5		57	5	5	5	5	
5		58	5	5	5	5	
5		59	5	5	5	5	

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	HR	MIN	SECONDS 00	15	30	45	COMMENTS
6	1230	00	5	5	5	10	
8		01	5	5	10	10	
6	40	02	10	5	5	5	
5		03	5	5	5	5	
5		04	5	5	5	5	
5		05	5	5	5	5	
-		06	X	X	X	X	
5	49	07	5	X	5	5	
5		08	5	5	5	X	
-		09	X	X	X	X	
-		10	X	X	X	X	
5		11	5	5	5	5	
5	50	12	5	5	5	5	
6		13	5	10	5	5	
8		14	10	5	10	5	
5		15	5	5	5	5	
5		16	5	5	5	5	
6	55	17	5	5	5	10	
4		18	5	5	5	0	
0		19	0	0	0	0	
0		20	0	0	0	0	
0		21	0	0	0	0	
0	1300	22	0	0	0	0	
0		23	0	0	0	0	
8		24	0	10	10	10	
10		25	10	10	10	10	
5		26	5	5	5	5	
5	1305	27	5	5	5	5	
5		28	5	5	5	5	
5		29	5	5	5	5	

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	HR	MIN	SECONDS 00	15	30	45	COMMENTS
5	1308	30	5	5	5	5	
5		31	5	5	5	5	
5	10	32	5	5	5	5	
5		33	5	5	5	5	
5		34	5	5	5	5	
5		35	5	5	5	5	Ave = 5.0
5		36	5	5	5	5	
5	15	37	5	5	5	5	
5		38	5	5	5	5	
5		39	5	5	5	5	
5		40	5	5	5	5	
5		41	5	5	5	5	Ave = 5.0
5	20	42	5	5	5	5	
5		43	5	5	5	5	
5		44	5	5	5	5	
5		45	5	5	5	5	
5		46	5	5	5	5	
5	25	47	5	5	5	5	5.0
4		48	5	5	5	0	
0		49	0	0	0	0	
0		50	0	0	0	0	
0		51	0	0	0	0	
1	30	52	0	0	0	5	
1		53	0	0	5	0	1.0
5		54	5	5	5	5	
5		55	5	5	5	5	
4		56	5	5	5	0	
4	35	57	0	5	5	5	
20		58	5	10	25	40	
33	37	59	35	30	35	30	

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
26	1328	00	30	25	25	25	
31		01	25	30	35	35	
25	40	02	30	25	25	20	
21		03	20	25	20	20	
16		04	20	15	15	15	
11		05	15	10	10	10	21.9
16		06	10	10	20	25	
25	45	07	25	25	25	25	
13		08	15	15	10	10	
11		09	10	10	10	15	
10		10	10	10	10	10	
10		11	10	10	10	10	~~6.9~~ 14
10	50	12	10	10	10	10	
10		13	10	10	10	10	
6		14	10	5	5	5	
5		15	5	5	5	5	
5		16	5	5	5	5	
5	55	17	5	5	5	5	6.9
5		18	5	5	5	5	
3		19	0	10	0	0	
0		20	0	0	0	0	
0		21	0	0	0	0	
3	1400	22	0	5	5	0	
3		23	0	0	5	5	2.1
5		24	5	5	5	5	
5		25	5	5	5	5	
5		26	5	5	5	5	
5		27	5	5	5	5	
5		28	5	5	5	5	
5		29	5	5	5	5	5.0

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
5	1408	30	5	5	5	5	
5		31	5	5	5	5	
5	10	32	5	5	5	5	
5		33	5	5	5	5	
5		34	5	5	5	5	
5		35	5	5	5	5	5.0
5		36	5	5	5	5	
5	15	37	5	5	5	5	
5		38	5	5	5	5	
5		39	5				5.0
5		40					
5		41					
5		42					
5		43					
		44					
		45					
		46					
		47					
		48					
		49					
		50					
		51					
		52					
		53					
		54					
		55					
		56					
		57					
		58					
		59					

1030 - 1110

SUMMARY
RECORD OF VISIBLE EMISSIONS P-3

Type of Plant _____ Date _____

Company Name _____ Hours of Observation _____

Plant Address _____ Observer _____

Type of Discharge STACK OTHER _____

Discharge Location _____

Height of Point of Discharge _____

Observer's Location:

Distance to Discharge Point _____

Height of Observation Point _____

Direction from Discharge Point _____

Background Description _____

Weather: Clear Overcast Partly Cloudy Other _____ Color _____

Wind Direction variable Wind Velocity 5-10 mi/hr

Plume Description:

Detached: Yes No

Color: Black White Other _____

Plume Dispersion Behavior: Looping Coning Fanning

Lofting Fumigating Other _____

Estimated Distance Plume Visible _____

Summary of Observations:

Opacity	Aggregate Time @ Opacity		Opacity	Aggregate Time @ Opacity
0	min.	sec.	55	
5			60	
10			65	
15			70	
20			75	
25			80	
30			85	
35			90	
40			95	
45			100	
50				

RECORD OF VISIBLE EMISSIONS

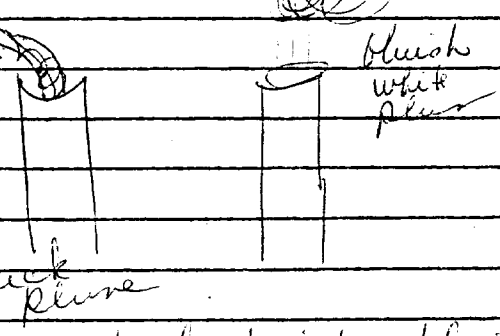
Company Name _____ Date 5/3/79

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	HR	MIN	SECONDS 00	15	30	45	COMMENTS
5	1050	00	5	5	5	5	Overcast gray sky the plume
5		01	5	5	5	5	is a brownish yellow today
5		02	5	5	5	5	making an adequate contrast
6		03	5	5	10	5	variable winds however are
4		04	5	0	5	5	causing me to move from
3		05	5	5	0	0	4.6 A yesterday to B or P-1
0		06	0	0	0	0	position
0		07	0	0	0	0	
0	1100	08	0	0	0	10	
50		09	50	60	40	50	
30		10	40	45	35	X	
11		11	25	X	20	X	17.9
5		12	X	X	X	20	
15	5	13	25	20	15	X	
–		14	X	X	X	X	
13		15	15	15	10	10	
8		16	10	10	5	5	plume is back to its bluish white
5		17	5	5	5	5	nature
–		18	X	X	X	X	quenching
black 30		19	X	X	30	30	
19		20	X	30	25	20	This plume is detatched
19		21	20	20	15	20	generally except when it turns
11		22	20	15	15	15	black. Generally then 5's
9		23	10	10	10	5	are bluish white detatched
yellow brown 5		24	5	5	5	5	plume when it turns black
5		25	5	5	5	5	it is no longer detatched but
0		26	0	0	0	0	I can see black smoke
white 5		27	5	5	5	5	leaving the stack
5		28	5	5	X	X	
–		29	X	X	X	X	



RECORD OF VISIBLE EMISSIONS

Company Name _____ Date 5/3/79

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

plume color	HR	MIN	TIME SECONDS 00	15	30	45
5	1:22	30	X	X	5	5
6		31	5	0	10	10
yellow 8		32	10	10	5	5
5		33	5	5	5	5
5		34	5	5	5	X
—		35	X	X	X	X
0		36	X	X	0	0
2		37	X	0	0	5
1	30	38	0	0	5	0
4		39	0	5	5	5
5		40	5	5	5	5
5		41	5	5	5	5
black 2		42	5	0	0	X
—		43	X	X	X	X
33		44	X	X	30	35
25		45	30	25	25	20
14		46	20	15	10	10
6		47	10	5	5	5
5	40	48	5	5	5	5
blue-ish 5		49	5	5	5	5
white 5		50	5	5	5	5
3		51	5	5	0	0
1		52	0	0	0	5
yellow 5		53	5	5	X	5
black 20		54	X	X	X	20
15		55	20	15	10	X
—		56	X	X	X	X
—		57	X	X	X	X
blue-ish 0	50	58	0	0	0	0
white 3		59	0	0	5	5

COMMENTS

sun is shining making reading easier yet still overcast

~~Due~~ The nature of the plume is what makes it easy to read even on today You see it gathers at the top of the stack so if I see a gather spot but nothing in the stream I call it a 5 if I see something in the stream (generally black) I can give it an opacity if nothing gathers & streams off I can call it 0 Rarly (tho it has occured) has the white smoke itself had an opacity of greater than 5 and rarly has the black smoke had an opacity of less than 10

quenching steam is more of a problem to day due to low clouds and stronger winds

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date 5/3/79

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	HR	MIN	SECONDS 00	15	30	45	COMMENTS
5	1152	00	5	5	5	5	start second hour
5		01	5	5	5	5	
—		02	X	X	X	X	
5		03	X	X	X	5	
yellow 5		04	5	5	5	5	
3		05	5	0	X	X	4.7
0		06	X	X	X	0	
0		07	X	0	0	0	
0	1200	08	0	0	0	0	
0		09	0	X	X	X	
—		10	X	X	X	X	
black 20		11	X	X	10	30	3.4
30		12	30	X	X	X	
45	5	13	X	X	X	45	
50		14	X	50	50	50	
30		15	40	30	25	25	
15		16	10	10	20	20	
20		17	20	20	20	X	29.1
—	10	18	X	X	X	X	
—		19	X	X	X	X	
28		20	X	25	30	X	
—		21	X	X	X	X	
15		22	X	X	X	15	
—	15	23	X	X	X	X	23.3
yellow 5		24	5	5	5	5	
5		25	5	5	5	5	
5		26	5	5	X	X	
—		27	X	X	X	X	
5	20	28	X	X	X	5	
5		29	5	5	5	5	5.0

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date 5/3/79

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
5	222	30	5	5	X	X	
1		31	X	X	X	X	
5		32	X	/	[illegible]	5	
5		33	[illegible]	5	5	[illegible]	
5		34	[illegible]	[illegible]	[illegible]	[illegible]	
3		35	5	[illegible]	[illegible]		
0		36		X	[illegible]	X	
40		37	[illegible]	X	40	40	
	30	38	X	35	35	40	
		39	X	X	X	X	
1		40	X	X	X	X	
5		41	5	5	5	5	
6		42	5	10	5	5	
5	5	43	5	5	5	5	
5		44	5	5	X	X	
5		45	X	X	5	5	
30		46	X	/	25	25	
23		47	25	25	15	X	
1	40	48	X	X	X	X	
1		49	X	X	X	X	
1		50	X	X	X	X	
5		51	5	X	X	X	
1		52	X	X	X	X	
5		53	X	X	X	5	5.0
5		54	5	5	5	5	
5		55	5	5	5	5	
5		56	5	5	5	5	
5		57	5	5	5	5	
2	50	58	5	0	0	X	
5		59	5	5	X	X	

yellow

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date 3/3/79

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

	HR	MIN	TIME SECONDS 00	15	30	45	COMMENTS
–	1252	00	X	X	X	X	Begin 3.1 [illegible]
5		01	5	5	5	X	
–		02	X	X	X	X	
5		03	[illegible]	[illegible]	5	5	
5		04	[illegible]	[illegible]	5	5	
5		05	5	X	X	X	5.0
–		06	X	X	X	X	
0		07	X	0	0	0	
0	1300	08	0		0	0	
4		09	[illegible]	[illegible]	5	[illegible]	
5		10	[illegible]	[illegible]	X	X	
–		11	X	X	X	X	
0		12	X	X	X	0	
21		13	0	5	20	45	
46		14	45	60	50	30	
21		15	25	20	20	20	
10		16	10	X	X	X	
–		17	X	X	X	X	
–	10	18	X	X	X	X	
3		19	X	5	5	5	
3		20	0	0	5	5	
8		21	5	5	10	10	
5		22	5	5	5	5	
5	15	23	5	5	5	5	
5		24	5	5	X	X	
–		25	X	X	X	X	
5		26	X	X	X	5	
5		27	5	5	5	5	
5	20	28	5	5	5	5	
5		29	5	X	X	X	

RECORD OF VISIBLE EMISSIONS

Company Name _____ Date 5/3/79

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

HR	MIN	SECONDS 00	15	30	45	COMMENTS
1322	30	X	X	X	X	
57	31	60	55	50	40	
33	32	40	35	35	20	
25	33	10	10	5	5	
5	34	5	5	5	5	
4	35	5	5	5	0	
0	36	0	0	0	0	Stop test
3	37	0	0	5	5	
5 30	38	5	5	X	X	
	39	X	X	X	X	
	40	X	X	X	X	
0	41	0	0	X	X	
	42	X	X	X	X	
35	43	X	X	X	X	
	44	X	X	X	X	
	45	X	X	X	X	
	46	X	X	X	X	
5	47	X	X	5	5	
5 40	48	5				
	49					
	50					
	51					
	52					
	53					
	54					
	55					
	56					
	57					
	58					
	59					

APPENDIX B-4

Summary of Visible Emissions

SUMMARY OF VISIBLE EMISSIONS
RUN No. 1

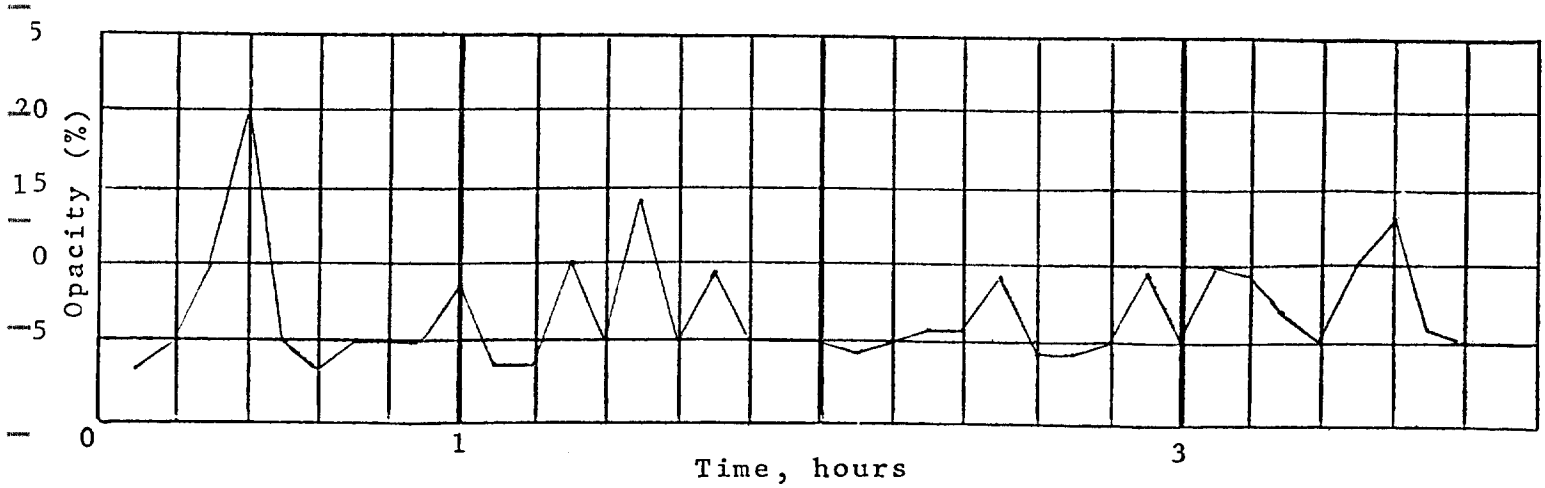
Date: 5-1-79
Type of Discharge:
Height of Point of Discharge: 270'
Wind Direction: NW
Color of Plume: white-yellow-black
Observer No.: D. Schick
Distance from Observer to Discharge Point: 400'
Direction of Observer from Discharge Point: WSW
Height of Observation Point: 10'
Description of Background: blue sky

Type of Plant: Coke
Location of Discharge: P4 Battery Exhaust
Description of Sky: Clear
Wind Velocity: 5-10 mph
Detached Plume: when white
Duration of Observation: 3 hr 57 min

SUMMARY OF AVERAGE OPACITY

Set Number	Time		Opacity		Set Number	Time		Opacity	
	Start	End	Sum	Average		Start	End	Sum	Average
1	1456	1501	65	3	21	1656	1701	105	4
2	1502	1507	125	5	22	1702	1707	120	5
3	1508	1513	240	10	23	1708	1713	140	6
4	1514	1519	470	20	24	1714	1719	145	6
5	1520	1525	125	5	25	1720	1725	215	9
6	1526	1531	70	3	26	1726	1731	85	4
7	1532	1537	120	5	27	1732	1737	95	4
8	1538	1543	120	5	28	1738	1743	120	5
9	1544	1549	125	5	29	1744	1749	220	9
10	1550	1555	185	8	30	1750	1755	130	5
11	1556	1601	60	3	31	1756	1801	250	10
12	1602	1607	65	3	32	1802	1807	225	9
13	1608	1613	250	10	33	1808	1813	175	7
14	1614	1619	120	5	34	1814	1819	120	5
15	1620	1625	440	18	35	1820	1825	245	10
16	1626	1631	110	5	36	1826	1831	315	13
17	1632	1637	220	9	37	1832	1837	145	6
18	1638	1643	120	5	38	1838	1843	130	5
19	1644	1649	120	5	39	1844	1849	120	5
20	1650	1655	120	5	40	1850	1852	50	5

Sketch Showing How Opacity Varied With Time:



SUMMARY OF VISIBLE EMISSIONS
Run No. 2

Date: 5-2-79
Type of Discharge:
Height of Point of Discharge: 270'
Wind Direction: SSE
Color of Plume: white-yellow-black
Observer No.: D. Schick
Distance from Observer to Discharge Point: 350'
Direction of Observer from Discharge Point: SSW
Height of Observation Point: 10'
Description of Background: Blue sky

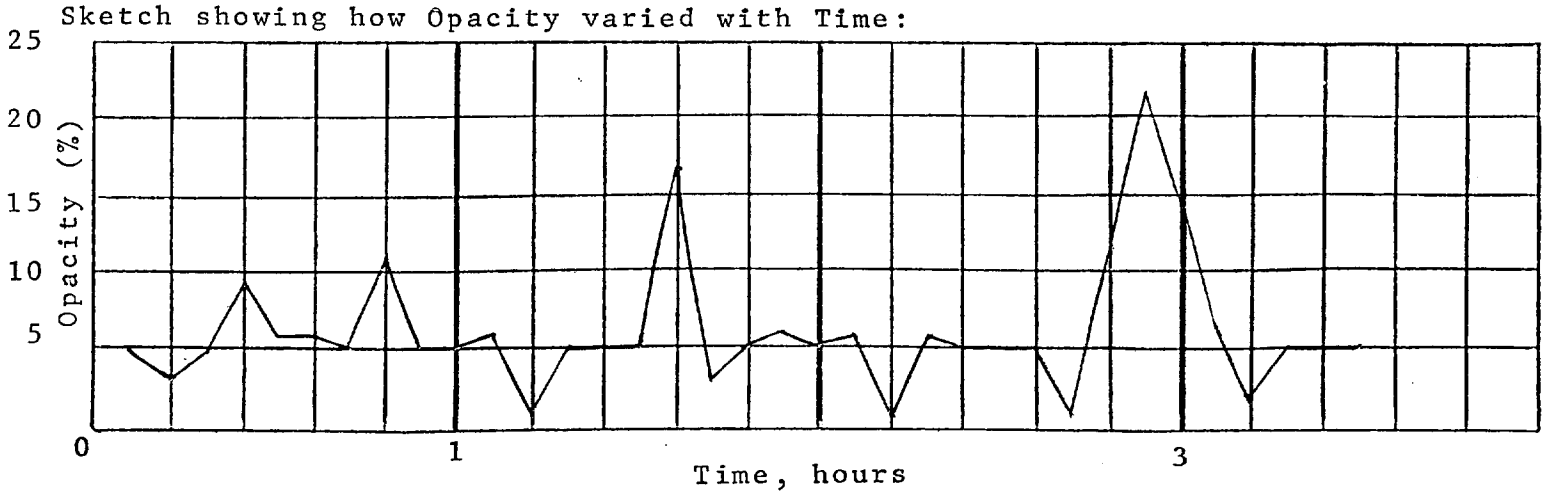
Type of Plant: Coke
Location of Discharge: P4 Battery Exha
Description of Sky: Clear
Wind Velocity: 0-5 mph
Detached Plume: when white
Duration of Observation: 3 hr 26 min

SUMMARY OF AVERAGE OPACITY

Set Number	Time		Opacity		Set Number	Time		Opacity	
	Start	End	Sum	Average		Start	End	Sum	Average
1	1050	1055	110	5*	21	1250	1255	140	6
2	1056	1101	70	3	22	1256	1301	15	1
3	1102	1107	130	5	23	1302	1307	150	6
4	1108	1113	220	9	24	1308	1313	120	5
5	1114	1119	145	6	25	1314	1319	120	5
6	1120	1125	145	6	26	1320	1325	120	5
7	1126	1131	110	5	27	1326	1331	25	1
8	1132	1137	260	11	28	1332	1337	280	12
9	1138	1143	110	5*	29	1338	1343	525	22
10	1144	1149	85	5*	30	1344	1349	340	14
11	1150	1155	155	6	31	1350	1355	165	7
12	1156	1201	15	1	32	1356	1401	50	2
13	1202	1207	130	5	33	1402	1407	120	5
14	1208	1213	130	5	34	1408	1413	120	5
15	1214	1219	130	5	35	1414	1416	60	5
16	1220	1225	410	17	36				
17	1226	1231	50	3*	37				
18	1232	1237	120	5	38				
19	1238	1243	140	6	39				
20	1244	1249	50	5*	40				

*Number of readings during six minute period is less than 24 due to interferer of quenching steam exhaust.

Sketch showing how Opacity varied with Time:



SUMMARY OF VISIBLE EMISSIONS
Run No. 3

Date: 5-3-79
Type of Discharge:
Height of Point of Discharge: 270'
Wind Direction: variable
Color of Plume: white-yellow-black
Observer No.: D. Schick
Distance from Observer to Discharge Point: 400'
Direction of Observer from Discharge Point: WSW
Height of Observation Point: 10'
Description of Background: gray overcast sky

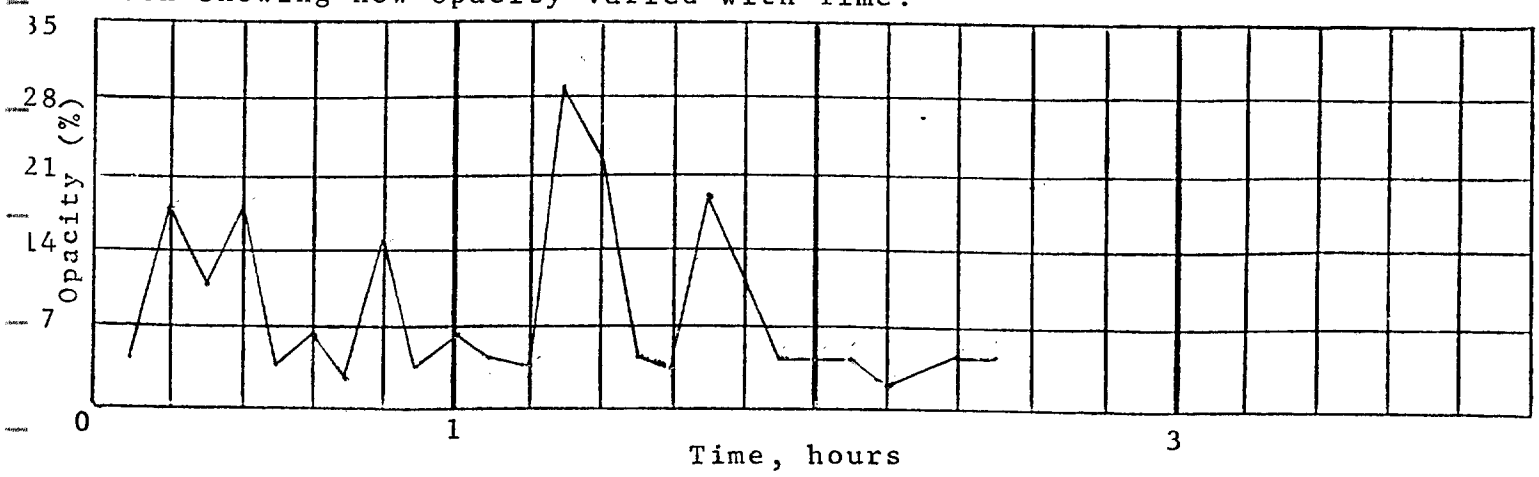
Type of Plant: Coke
Location of Discharge: P4 Battery Exhaus
Description of Sky: overcast
Wind Velocity: 5-10 mph
Detached Plume: when white
Duration of Observation: 2 hr 36 min

SUMMARY OF AVERAGE OPACITY

Set Number	Time		Opacity		Set Number	Time		Opacity	
	Start	End	Sum	Average		Start	End	Sum	Average
1	1052	1057	110	5	21	1252	1257	50	5*
2	1058	1103	375	18*	22	1258	1303	25	2*
3	1104	1109	180	11*	23	1304	1309	365	26*
4	1110	1115	310	18*	24	1310	1315	90	5*
5	1116	1121	70	4*	25	1316	1321	60	5*
6	1122	1127	100	6*	26	1322	1327	400	20*
7	1128	1133	65	3*	27				
8	1134	1139	250	15*	28				
9	1140	1145	90	4*	29				
10	1146	1151	75	6*	30				
11	1152	1157	70	5*	31				
12	1158	1203	40	4*	32				
13	1204	1209	465	29*	33				
14	1210	1215	70	23*	34				
15	1216	1221	75	5*	35				
16	1222	1227	70	4*	36				
17	1228	1233	190	19*	37				
18	1234	1239	195	11*	38				
19	1240	1245	10	5*	39				
20	1246	1251	95	5*	40				

* Number of readings during six minute period is less than 24 due to interference of quenching steam exhaust.

Sketch showing how Opacity varied with Time:



APPENDIX C

FRACTION WEIGHTS

C-1. Particulate Weight by Fraction

C-2. Sulfate Weight by Fraction

TABLE C-1. PARTICULATE WEIGHT BY FRACTION, GRAMS

Sampling Location	Sample Number	Acetone Nozzle Wash	Front Acetone Wash	Front Water Wash	110-mm Type A Glass-Fiber Filter	Filterable Particulate	Back Acetone Wash	Back Water Wash	Total Particulate
P4 Battery Stack	1	0.0111	0.0234	0.8176	0.3666	1.2187	0.0207	1.0377	2.2771
	2	a	0.0533	0.7725	0.3813	1.2071	0.0153	0.7602	1.9826
	3	a	0.0704	1.2302	0.5381	1.8387	0.0225	0.5186	2.3798

[a]Acetone nozzle wash was combined with the front acetone wash.

TABLE C-2. SULFATE WEIGHT BY FRACTION, GRAMS

Sampling Location	Sample Number	Acetone Nozzle Wash	Front Acetone Wash	Front Water Wash	110-mm Type A Glass-Fiber Filter	Filterable Sulfate	Back Acetone Wash	Back Water Wash	Total Sulfate
P4 Battery Stack	1	0.0021	0.022	0.410	0.190	0.624	0.0079	0.880	1.512
	2	a	0.011	0.380	0.210	0.601	0.0090	0.680	1.290
	3	a	0.009	0.650	0.250	0.909	0.0067	0.550	1.466

[a]Acetone nozzle wash was combined with the front acetone wash.

APPENDIX D

GAS CHROMATOGRAPH DATA

Benzene

EPA 6399-14

Date	Test	Benzene ppm *	Room Temp
5-1-79	P1	0.5 (0.4726)	78°F
5-2-79	P2	1.3 (1.3251)	77°F
5-3-79	P3	0.9 (0.9305)	80°F

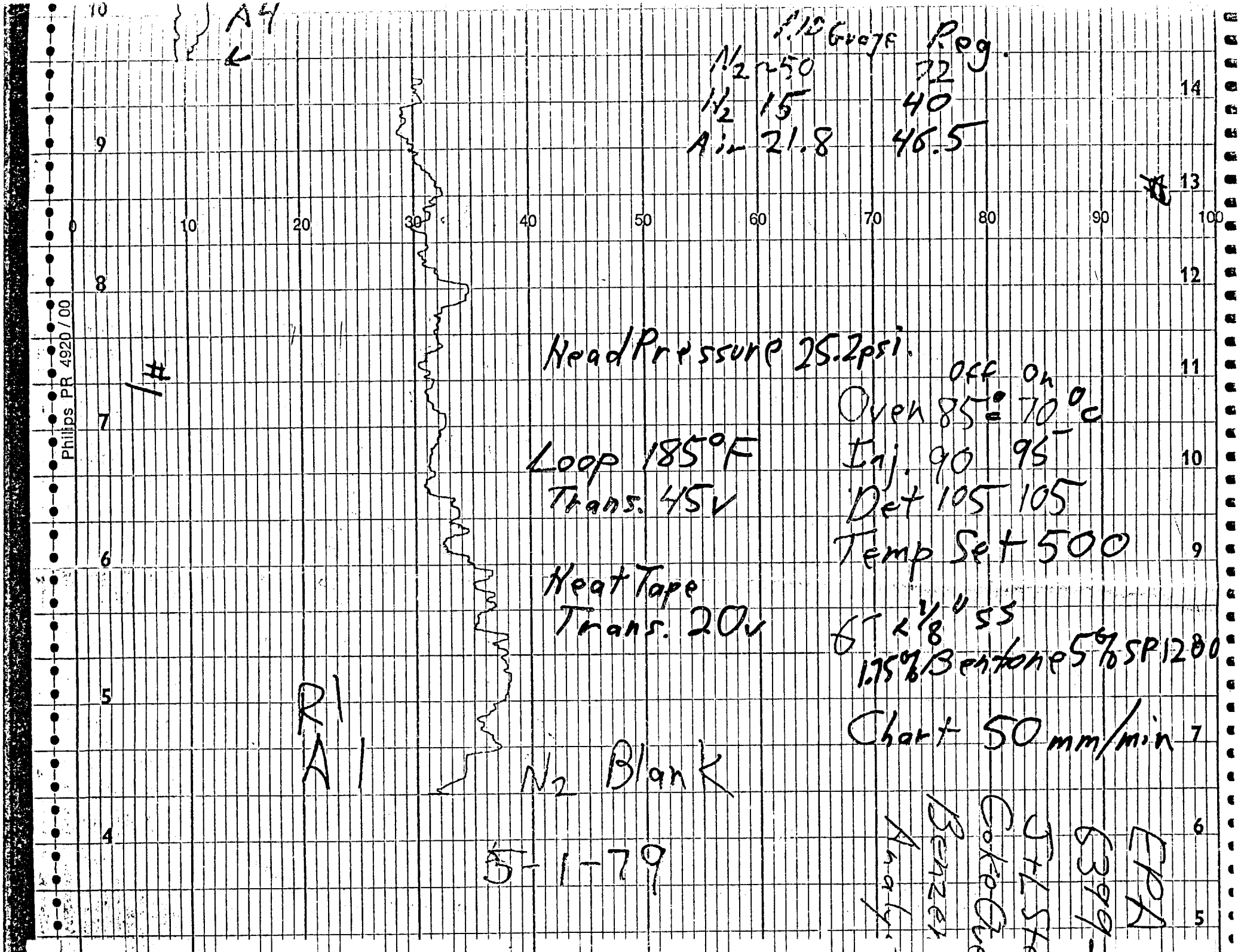
	% O2	lbs/hr	kg/hr
P-1	16.3	0.3	0.1
P-2	16.0	0.6	0.3
P-3	15.6	0.5	0.8

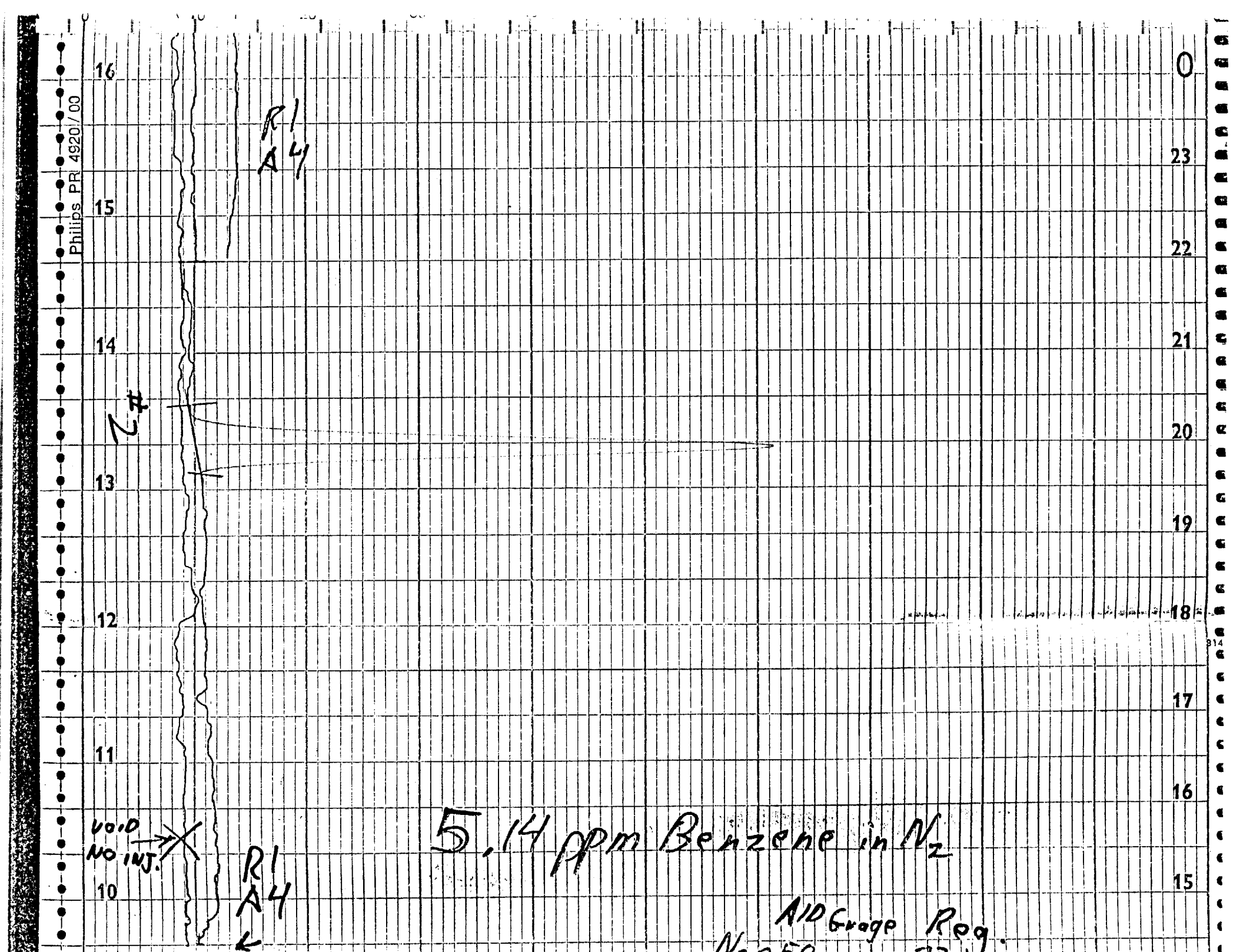
* Pressure and temperature corrected

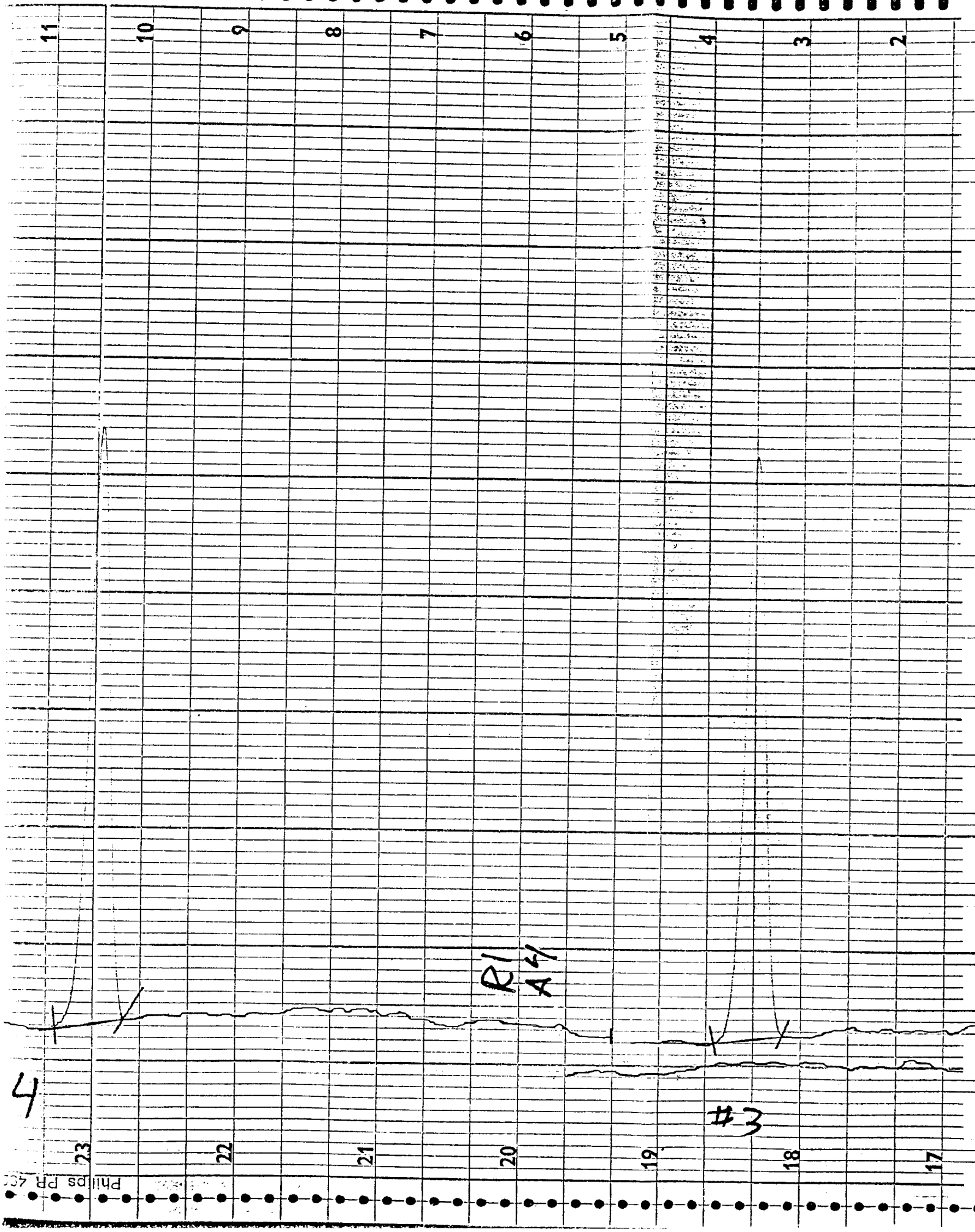
Summary Table

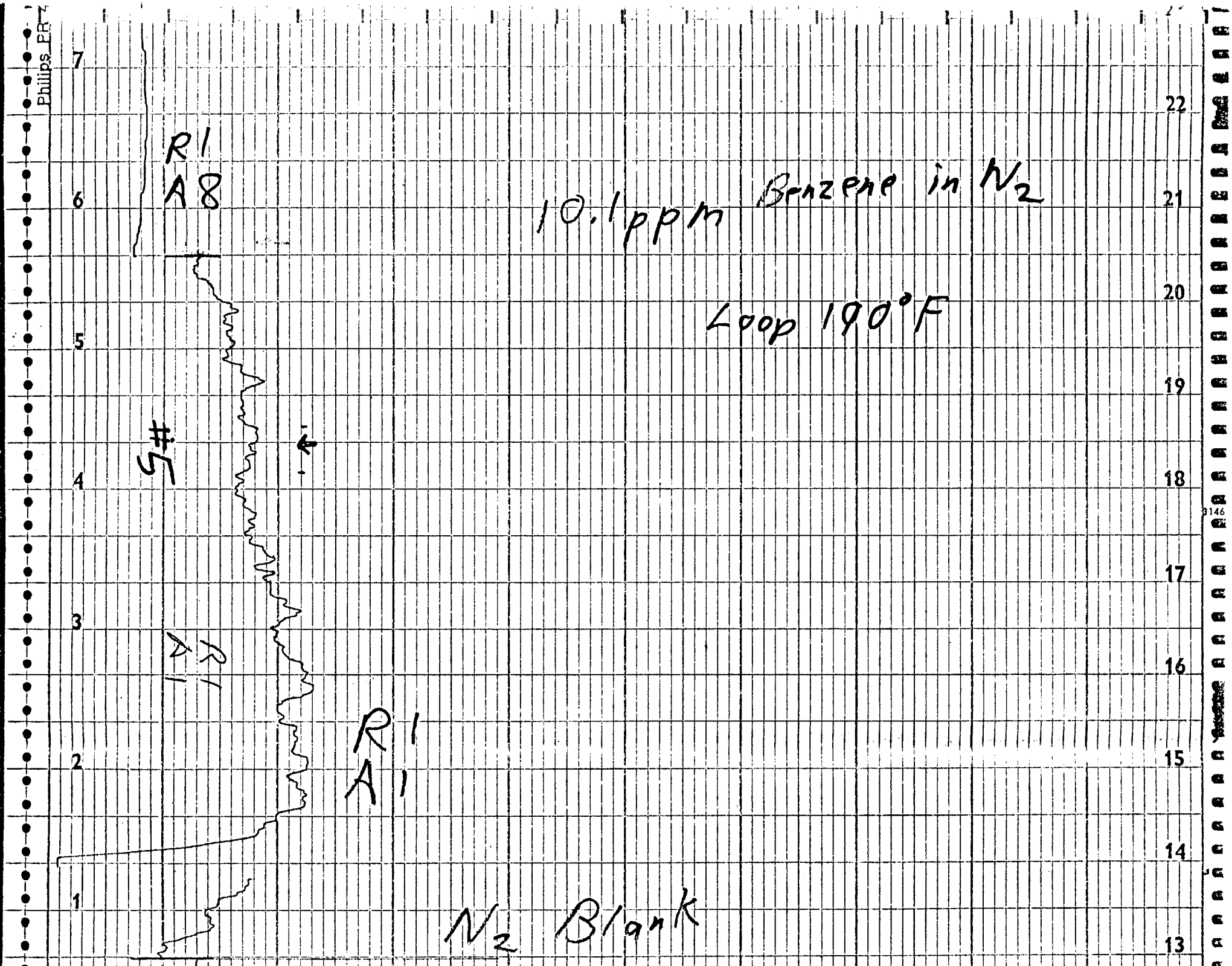
ID	Ave Area	5.14/Std Area Factor	PPM Benzene	Bag Temp	Date
5.14ppm P-1	108.75 10	0.04726437	(5.14) 0.47 (0.4726)	78°F	5-1-79 ↓
5.14ppm P-2	89.214 23	0.05761428	(5.14) 1.3 (1.3251)	77°F	5-2-79 ↓
5.14ppm P-3	82.8564 15	0.06203503	(5.14) 0.93 (0.9305)	80°F	5-3-79 ↓
0 (N_2 Blank)	0				5-1 to 5-3

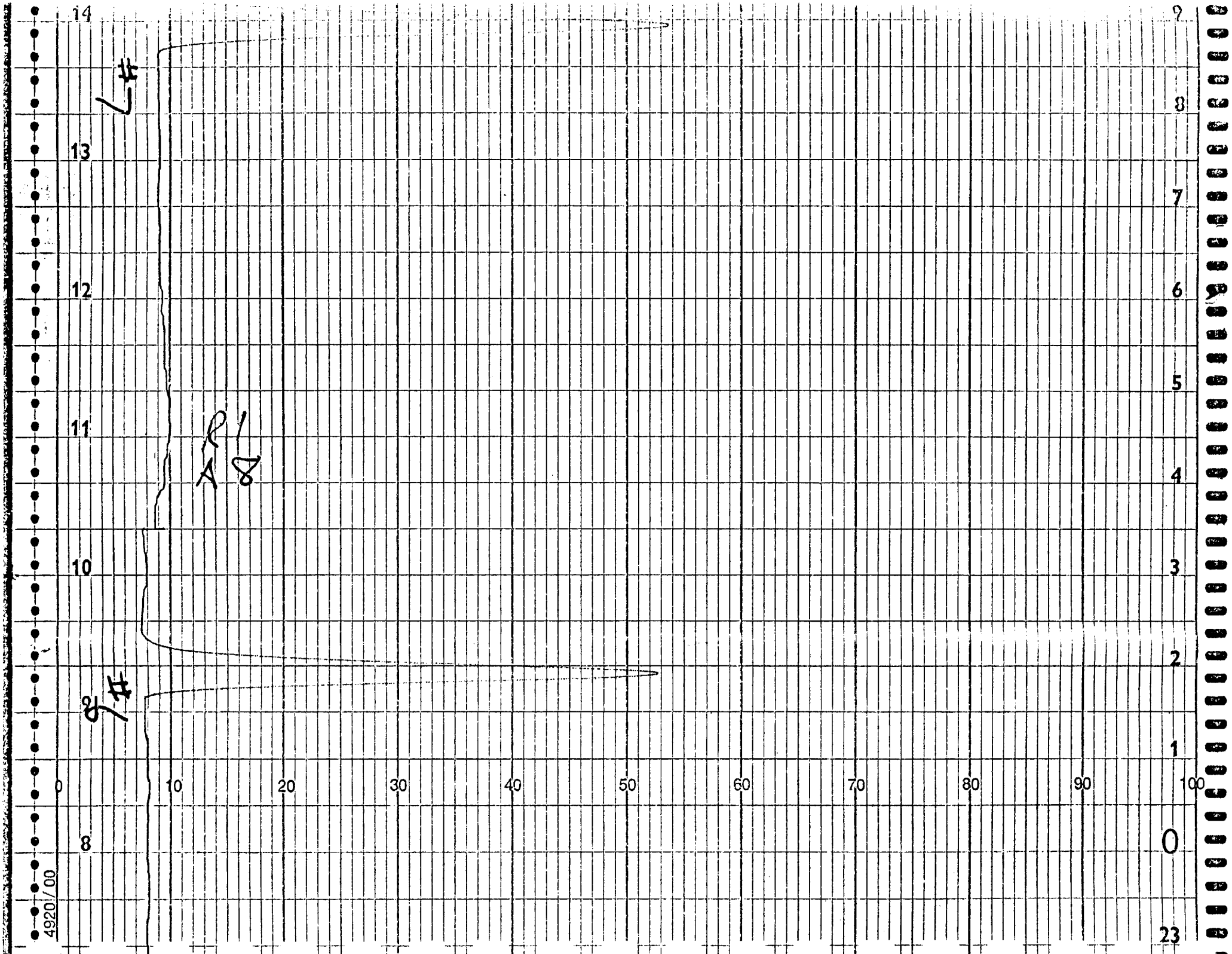
$$\text{PPM Benzene (sample)} = \frac{\text{Area Sample}}{\text{Area Standard}} \times \text{PPM Benzene Std}$$


A4
Flow Gauge Reg.
N2 ~50 22
H2 15 40
Air 21.8 46.5
Head Pressure 25.2psi.
Off On
Oven 85 70 °C
Loop 185°F
Inj. 90 95
Trans. 45V
Det 105 105
Temp Set 500
Heat Tape
Trans. 20v
6' x 1/8" SS
1.75% Bentone 5% SP1200
Chart 50 mm/min
R1
A1
N2 Blank
5-1-79
Philips PR 4920 / 00


Philips PR 4920/00
16
15
14
13
12
11
10
0
23
22
21
20
19
18
17
16
15
R1
A4
#2
VOID
NO INJ.
R1
A4
5.14 ppm Benzene in N2
AID Grage Reg.


11
10
9
8
7
6
5
4
3
2
RI
AH
4
#3
23
22
21
20
19
18
17
Philips PR 450


Philips PR
7
6
5
4
3
2
1
22
21
20
19
18
17
16
15
14
13
R1
A8
10.1ppm Benzene in N2
Loop 190°F
#5
R1
A1
R1
A1
N2 Blank


14
13
12
11
10
8
9
0
10
20
30
40
50
60
70
80
90
100
9
8
7
6
5
4
3
2
1
0
23
4920/00
#7
#8
R1
A8

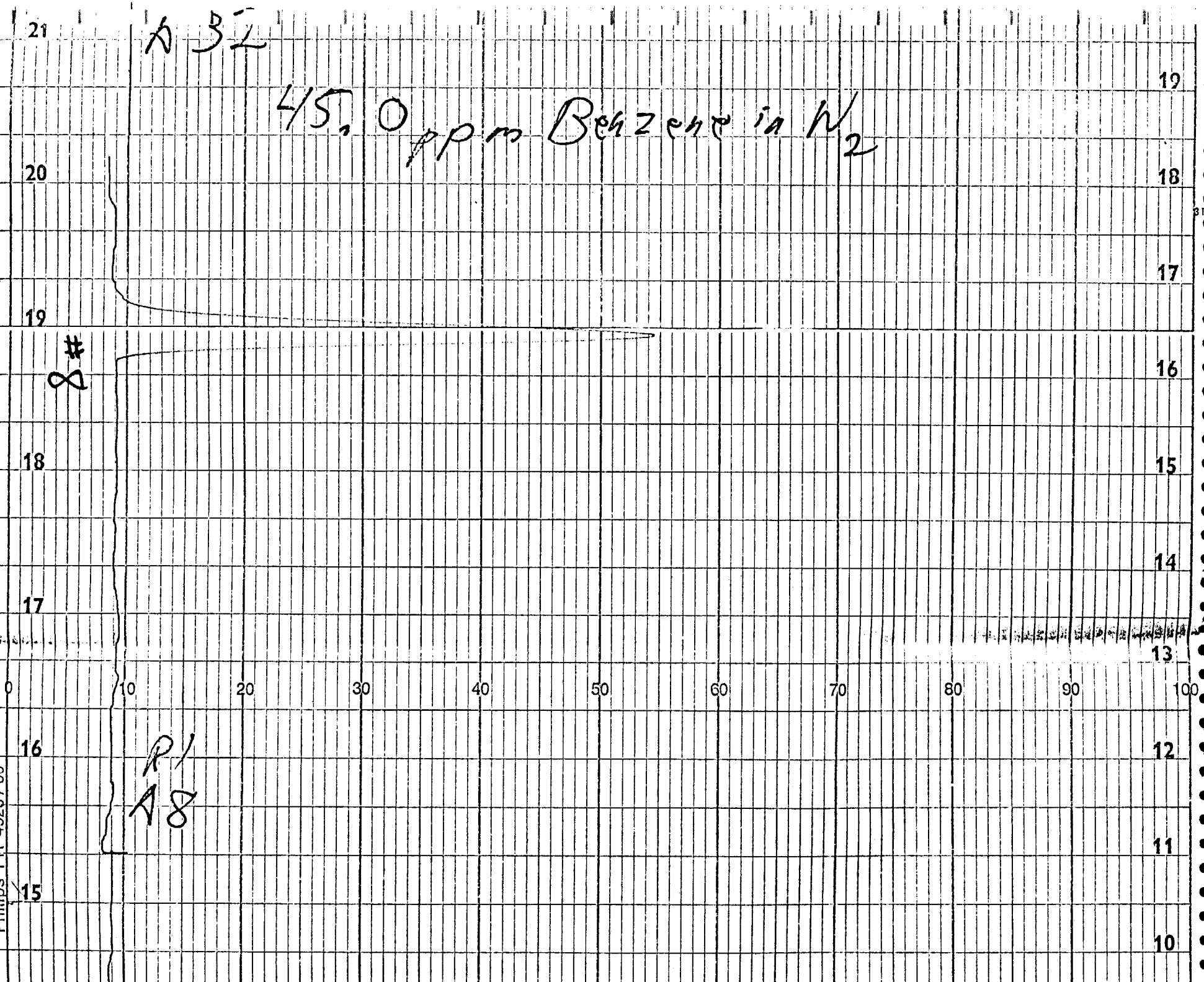
A 32

45.0 ppm Benzene in N_2

#8

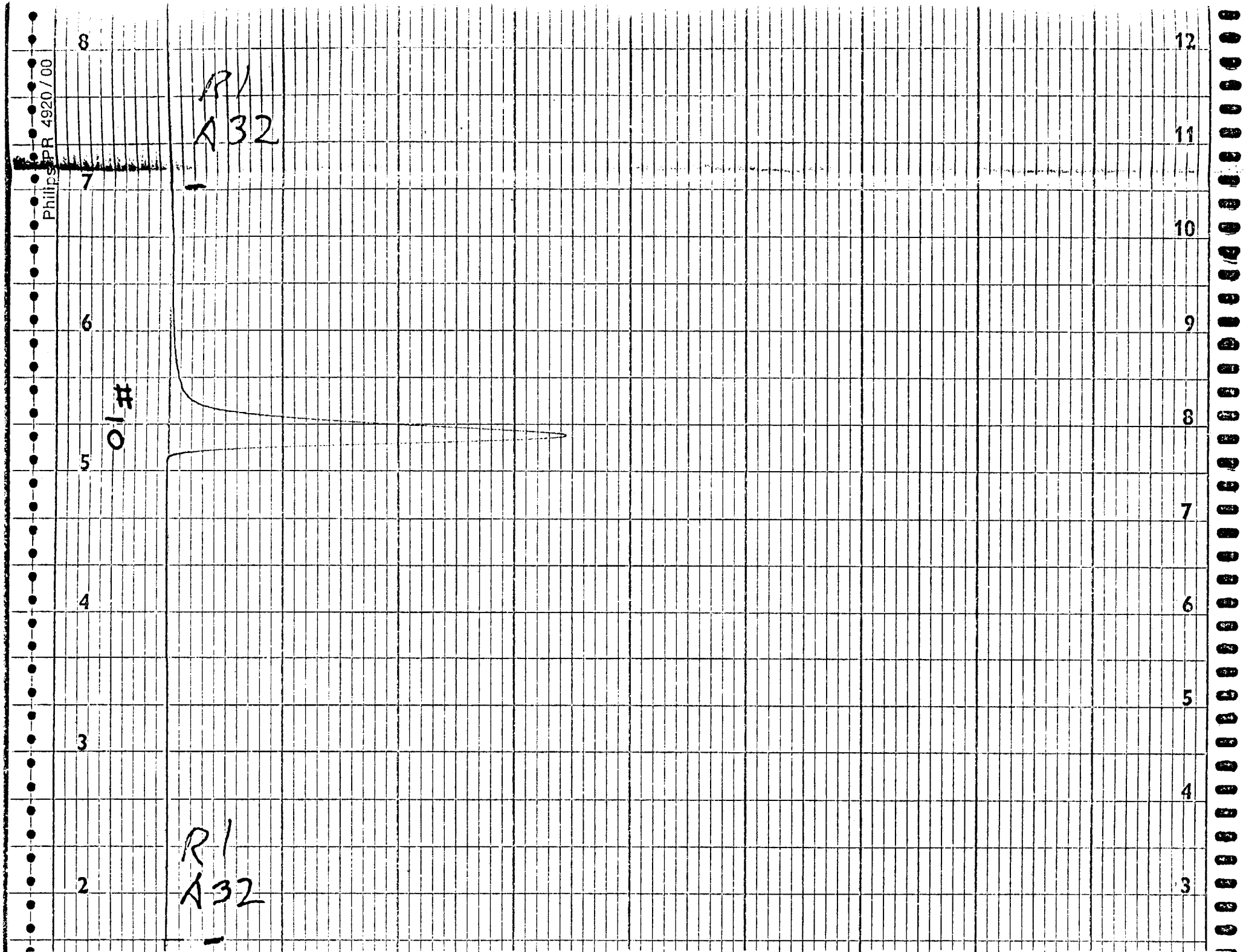
R1

A8

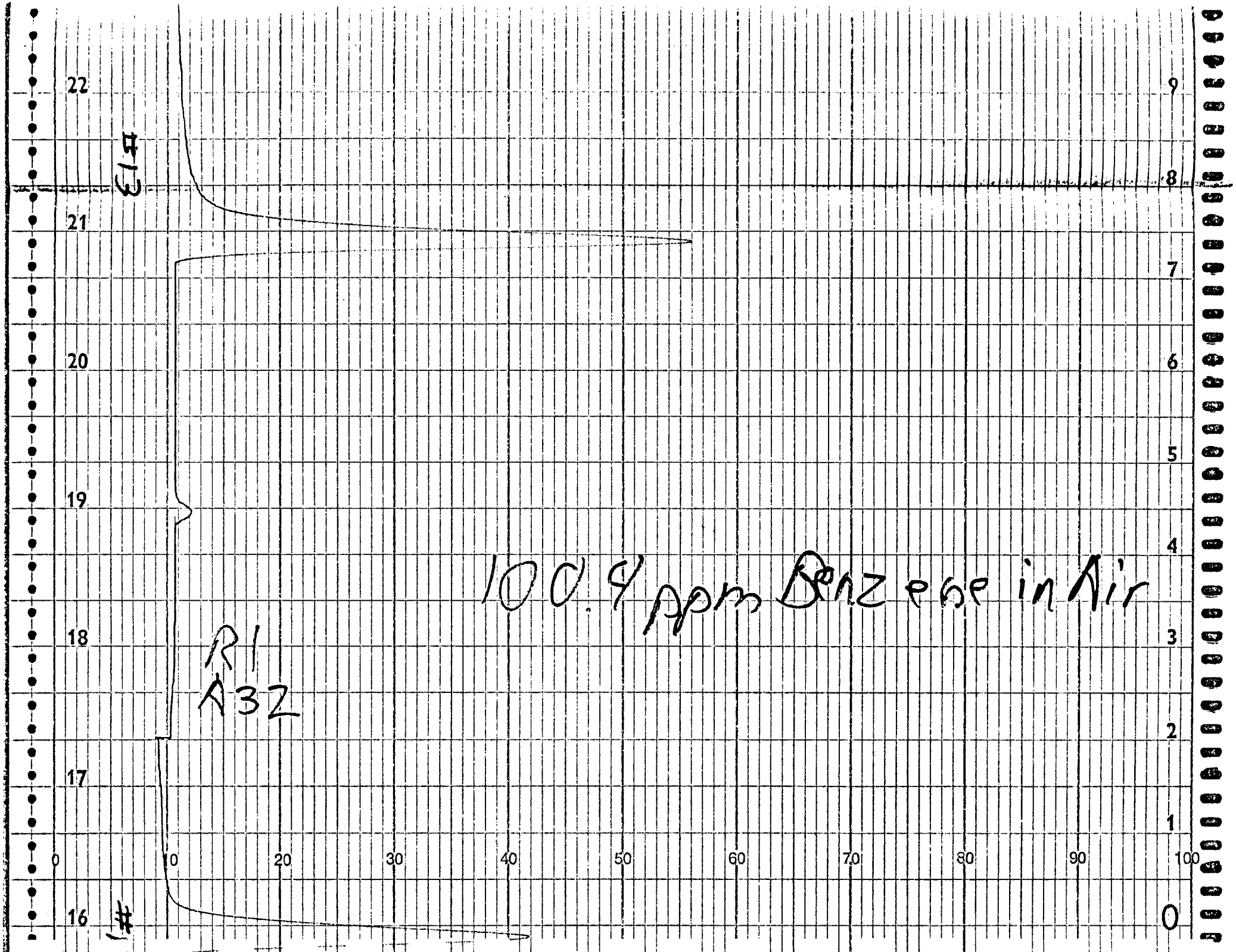


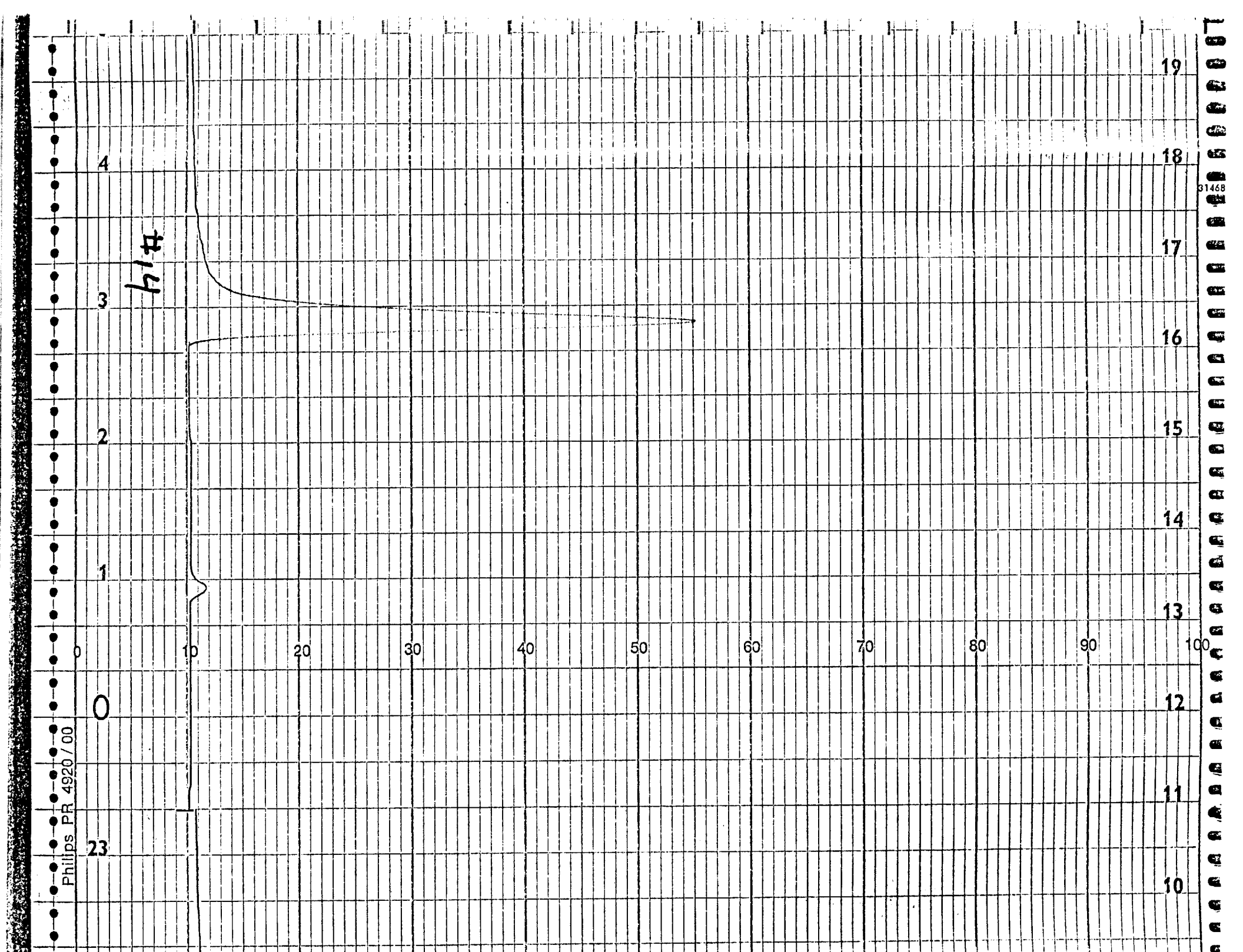
Philips PR 4920 / 00

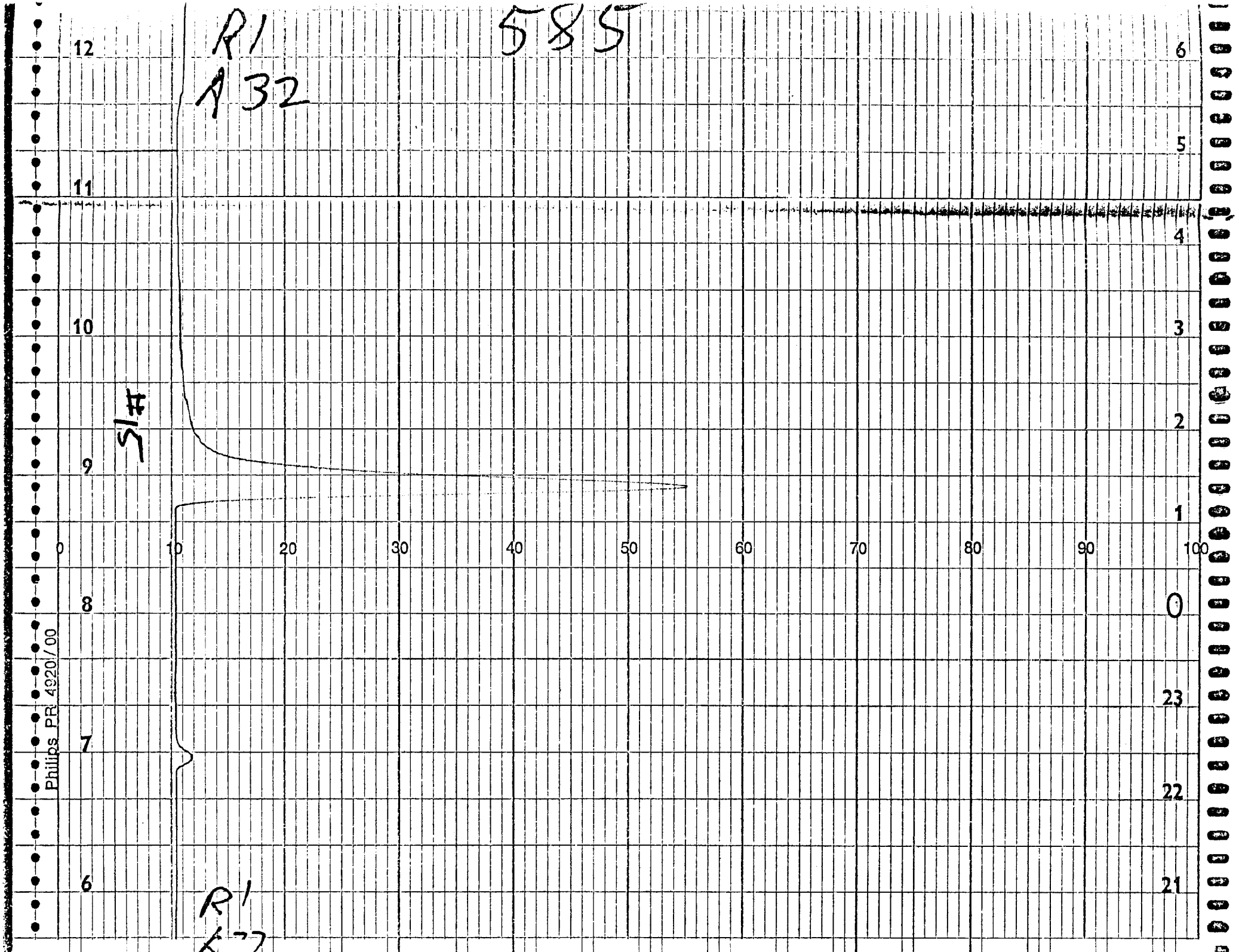
31408


Philips PR 4920 / 00
8
7
6
5
4
3
2
12
11
10
9
8
7
6
5
4
3
R1
A32
O #
R1
A32

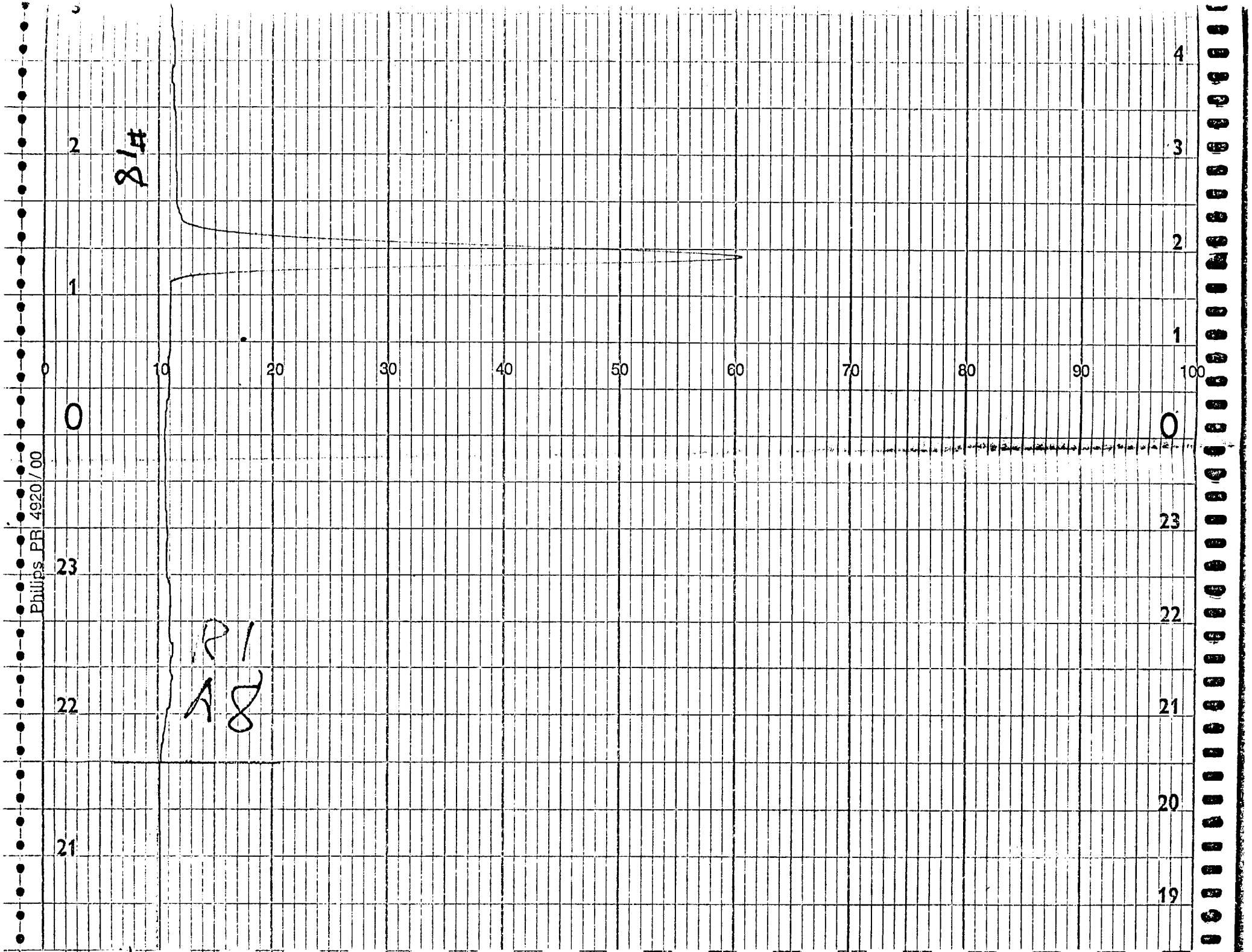
23
22
21
20
19
18
17
16
15
14
R1
A32
#11
15
14
13
12
11
10
9
Philips PR 49


22
21
20
19
18
17
16
9
8
7
6
5
4
3
2
1
0
0
10
20
30
40
50
60
70
80
90
100
#13
R1
A32
100.4 ppm Benzene in Air


Philips PR 4920 / 00
3146B
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
10
11
12
13
14
15
16
17
18
19
23
414

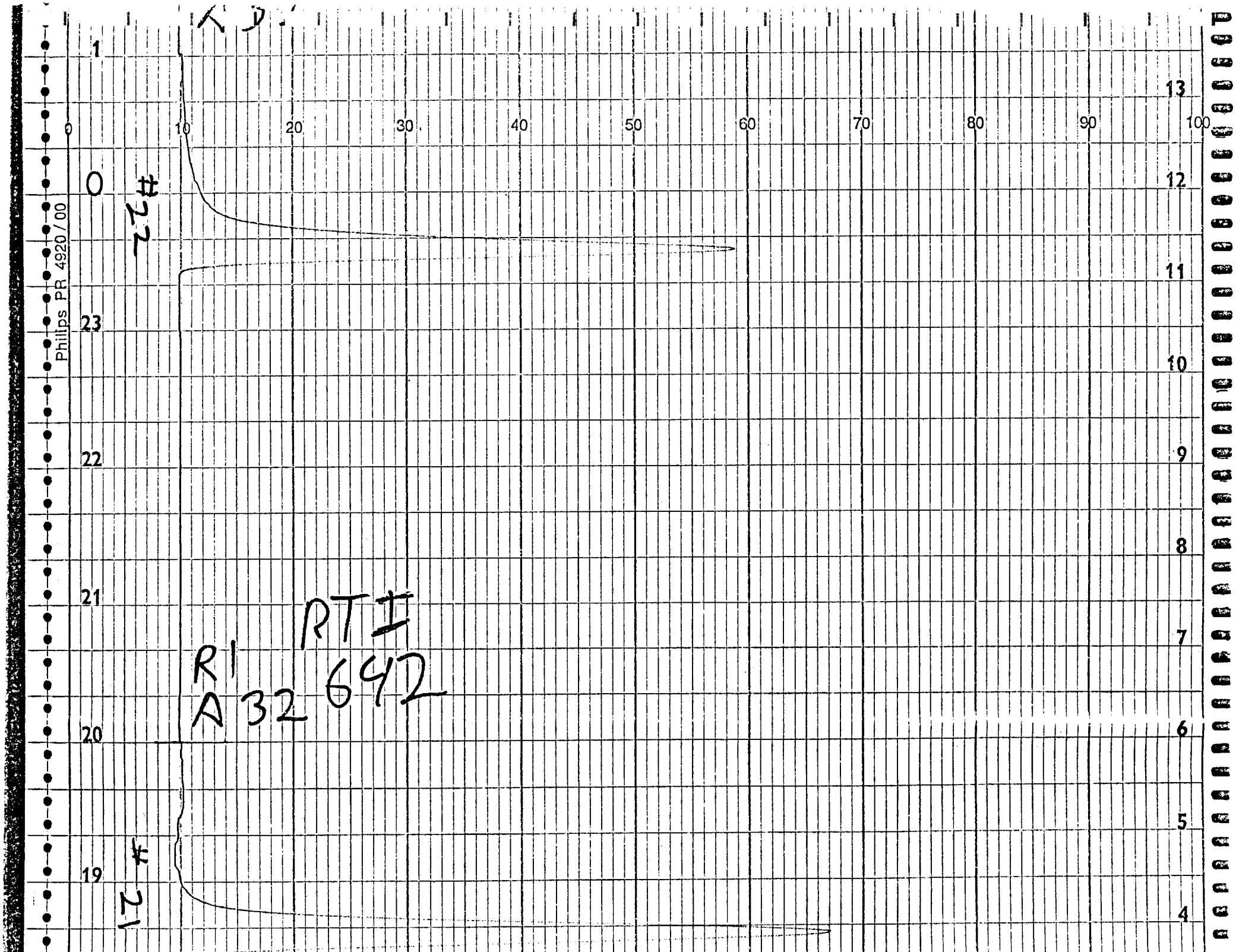

R1
A32
585
SIT#
R1
12
11
10
9
8
7
6
6
5
4
3
2
1
0
23
22
21
0
10
20
30
40
50
60
70
80
90
100
Philips PR 4920/00

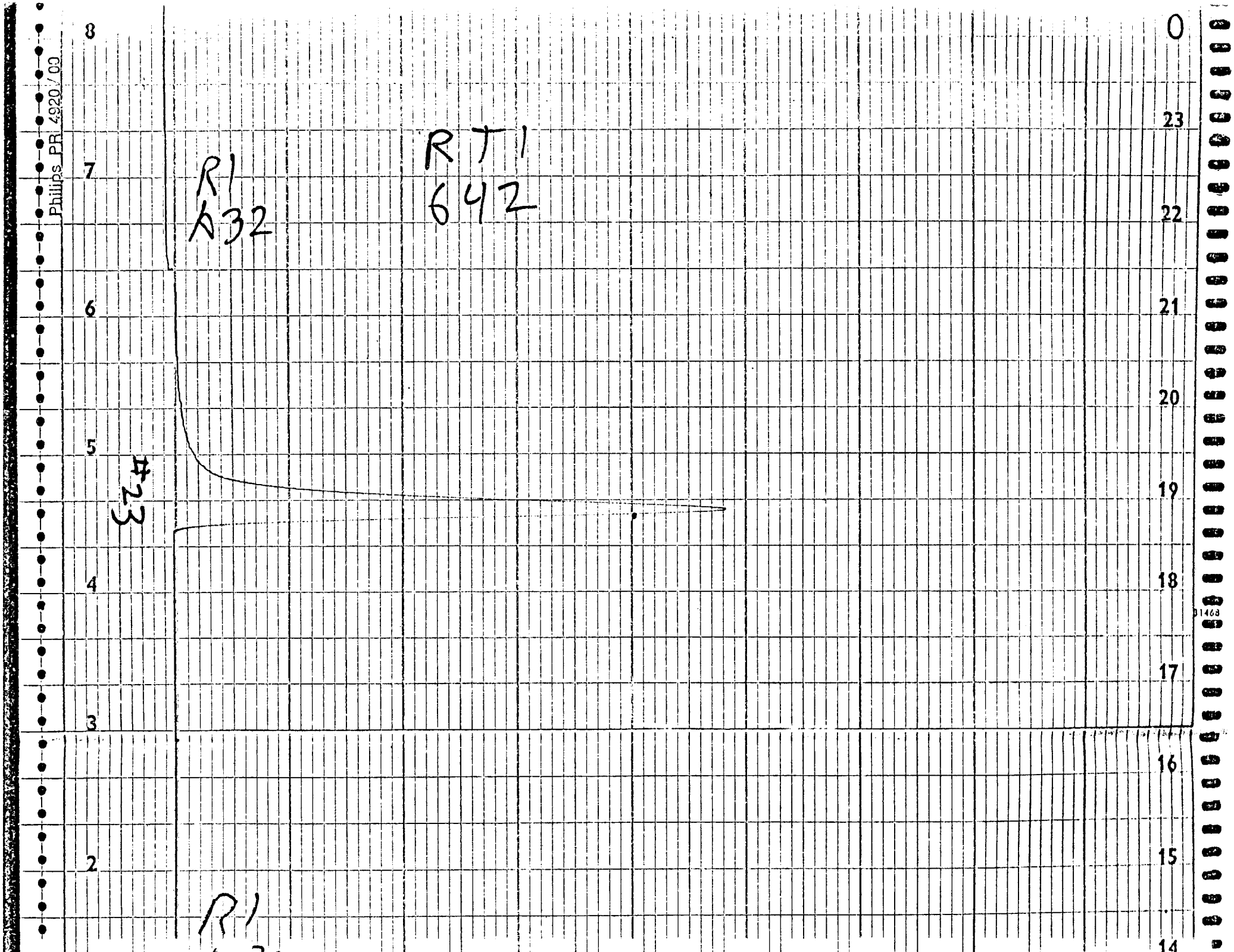
16
15
14
13
12
11
10
9
8
7
100
90
80
70
60
50
40
30
20
10
0
18
17
16
15
14
13
Philips PR 4920/00
R1
A32
#16
RITT
RLS

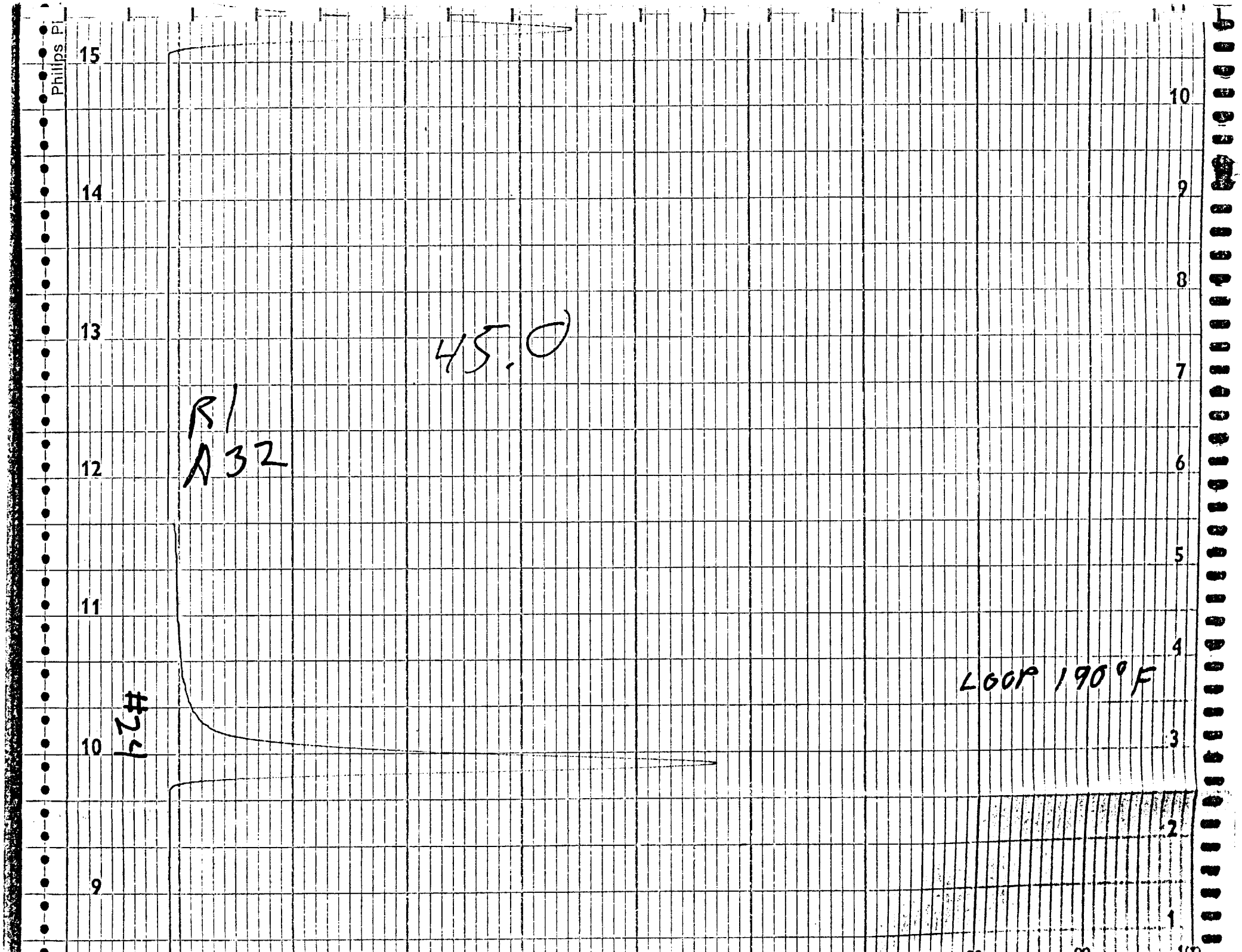

Philips PR 4920/00
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
19
20
21
22
23
0
1
2
21
22
23
0
#18
181
18

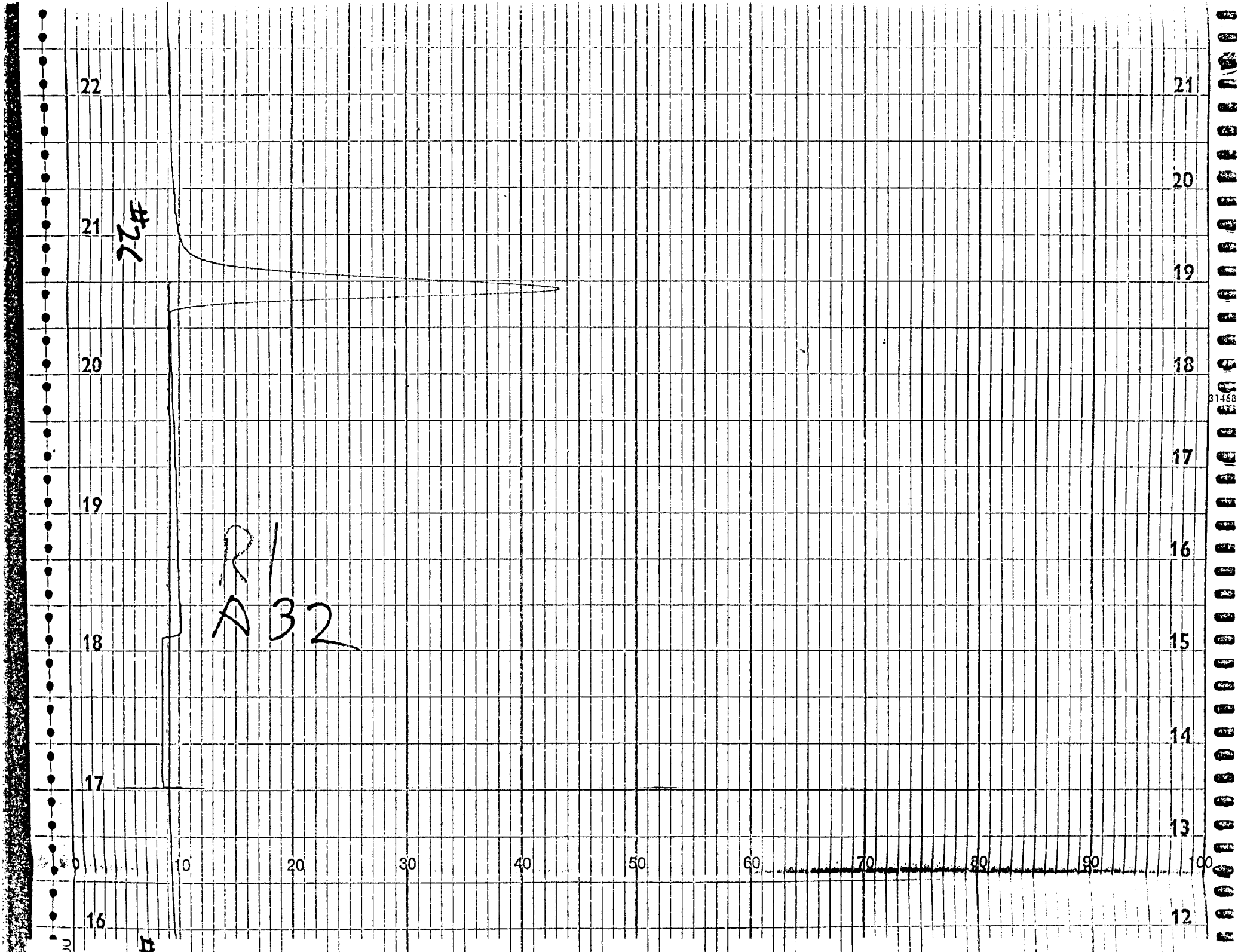
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
VOID
#19
RIX
10
9
8
7
6
5
4
Philips PR 4920/00

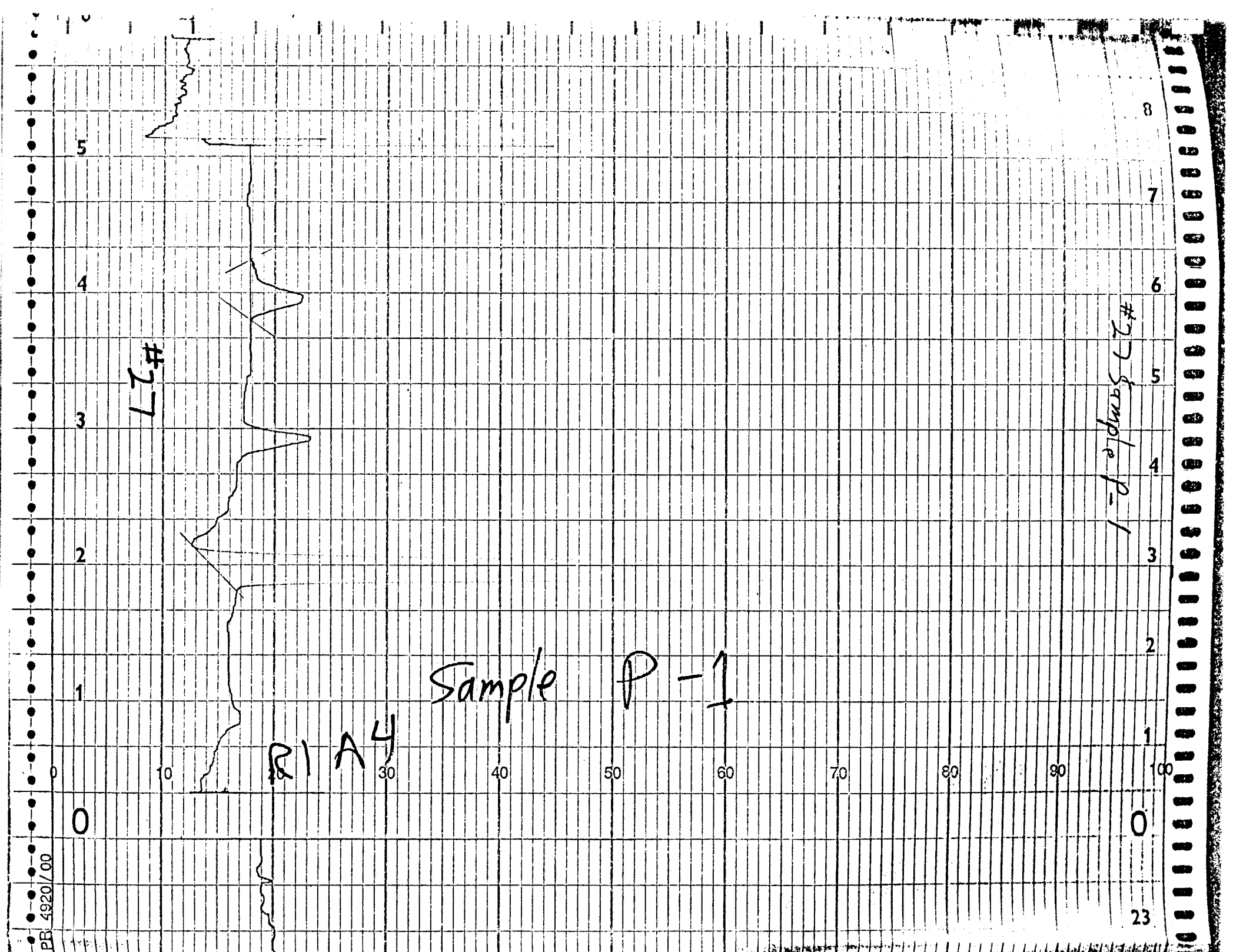
R1
A8
RT1
585
#20
Philips PR 4920/00
31468


Phillips PR 4920 / 00
0
10
20
30
40
50
60
70
80
90
100
1
23
22
21
20
19
13
12
11
10
9
8
7
6
5
4
#22
#21
RT#
RI
A32 642


Philips PR 4920/00
8
7
6
5
4
3
2
0
23
22
21
20
19
18
17
16
15
14
R1
A32
RT1
642
#23
R1

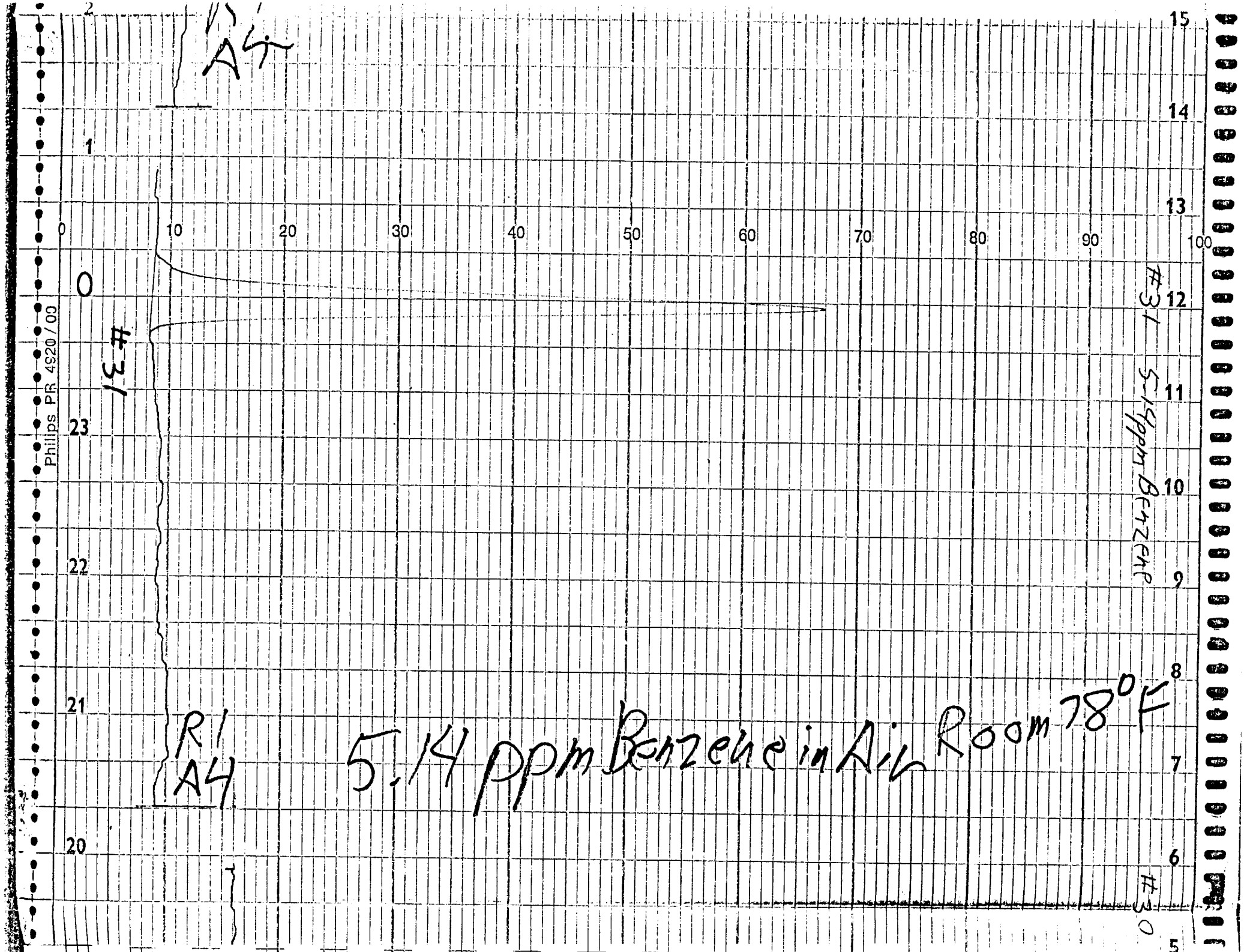

Phillips
15
14
13
12
11
10
9
10
9
8
7
6
5
4
3
2
1
45.0
R1
A32
#24
LOOP 190°F

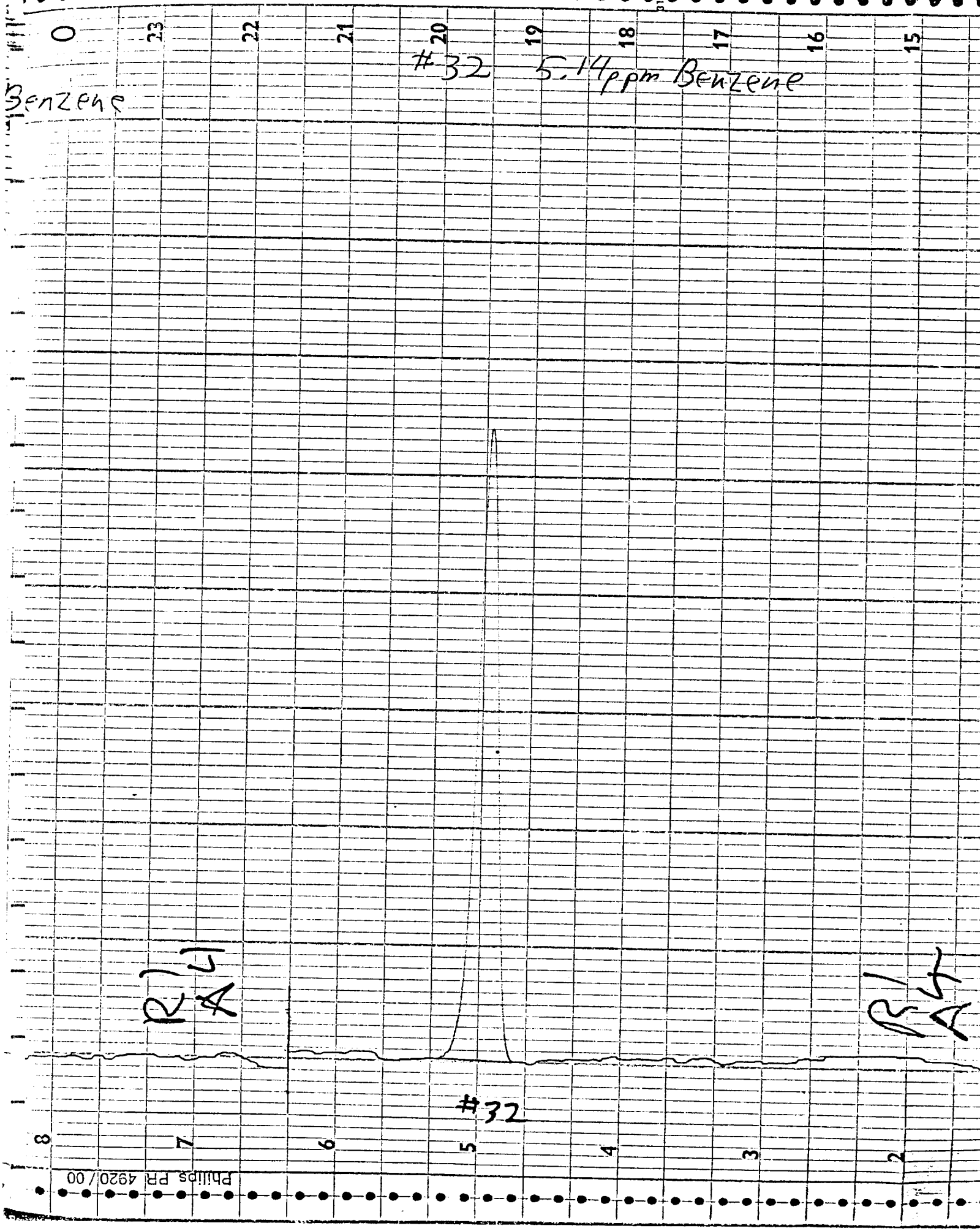

22
21
20
19
18
17
16
21
20
19
18
17
16
15
14
13
12
0
10
20
30
40
50
60
70
80
90
100
#24
R1
A32

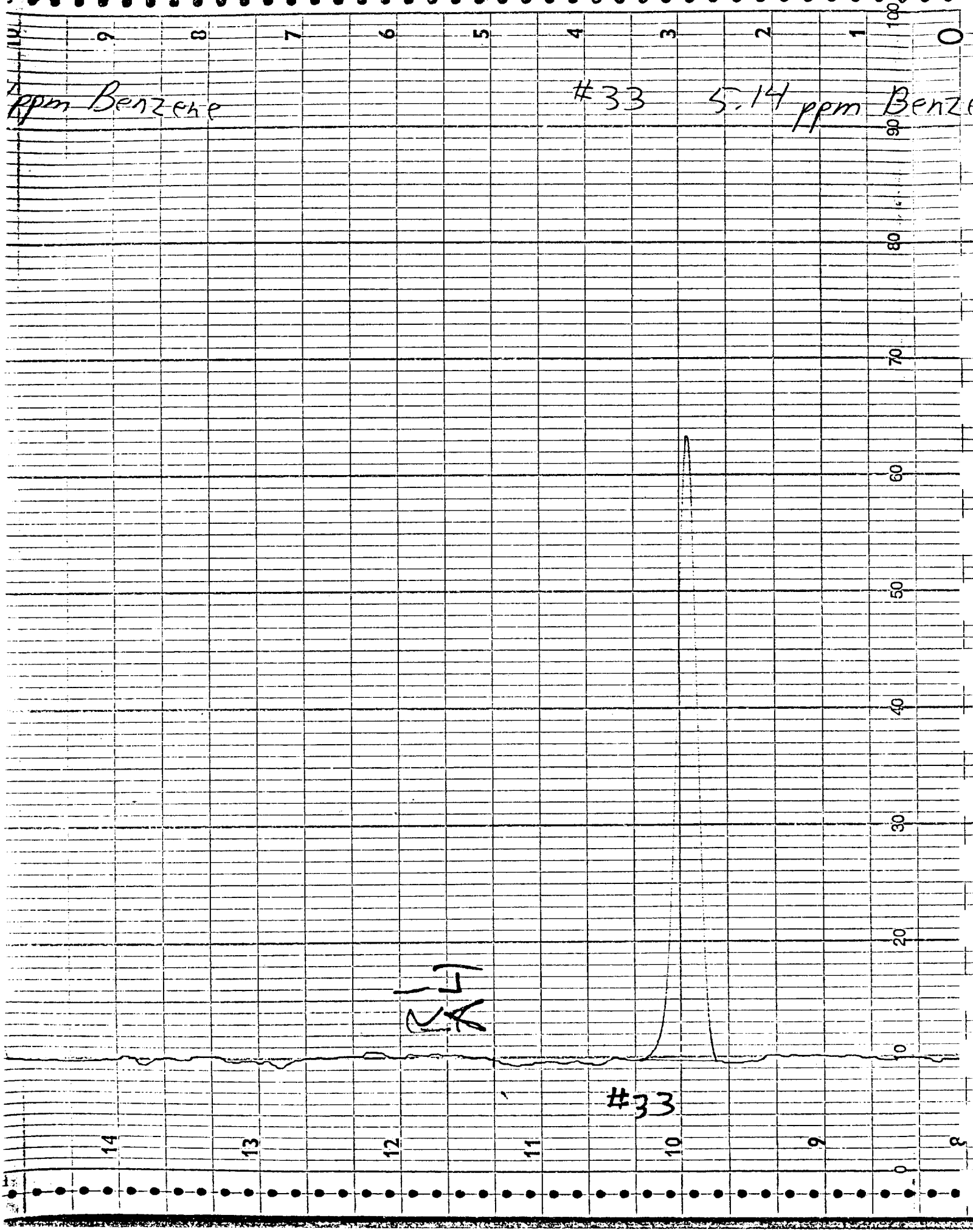

#27
#27 Sample P-1
Sample P-1
RIA4
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
6
7
8
23
PB 4920/00

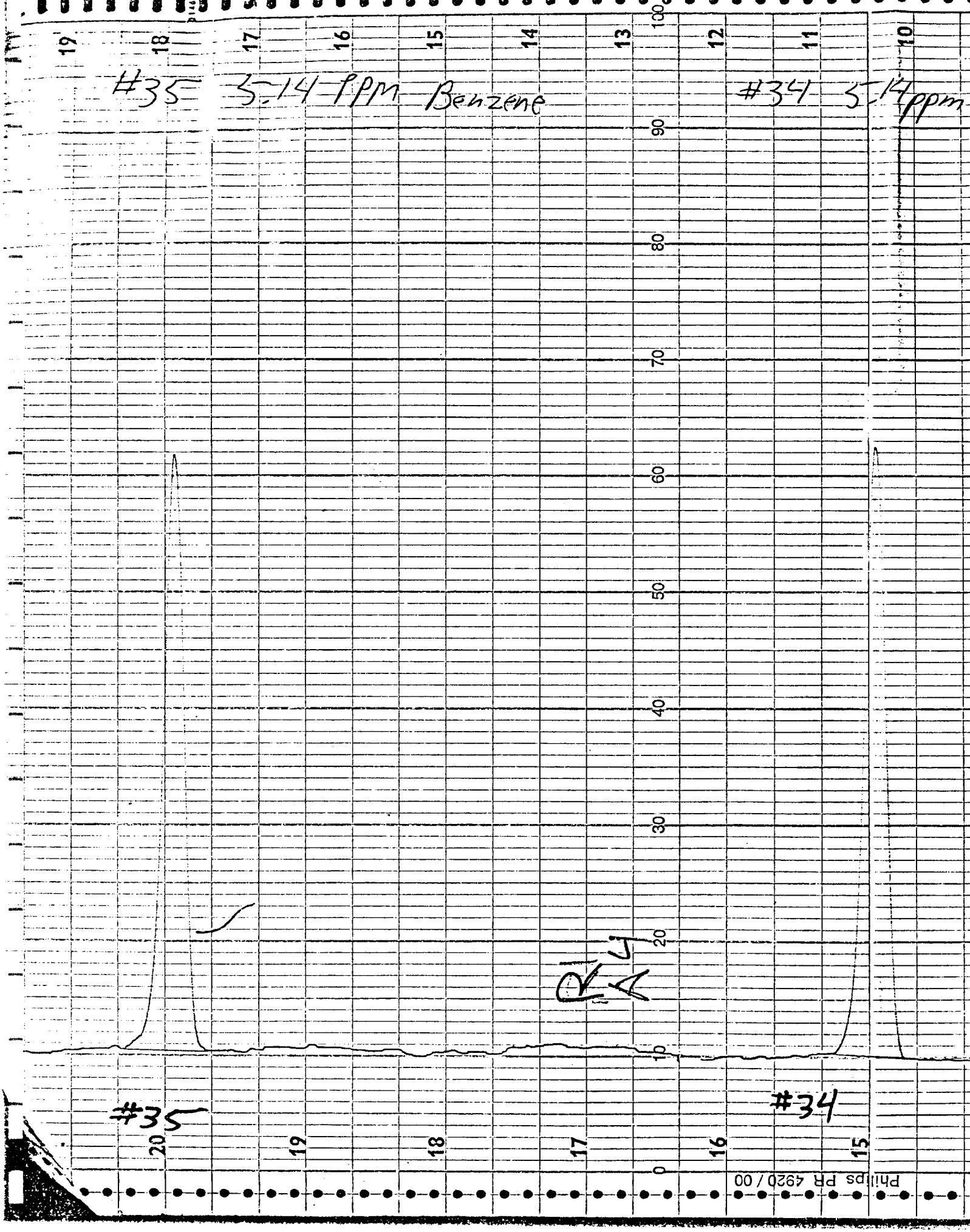
#28 Sample P-1
ample P-1
P-1
RAH
RAH
#28
Philips PR 4920/00

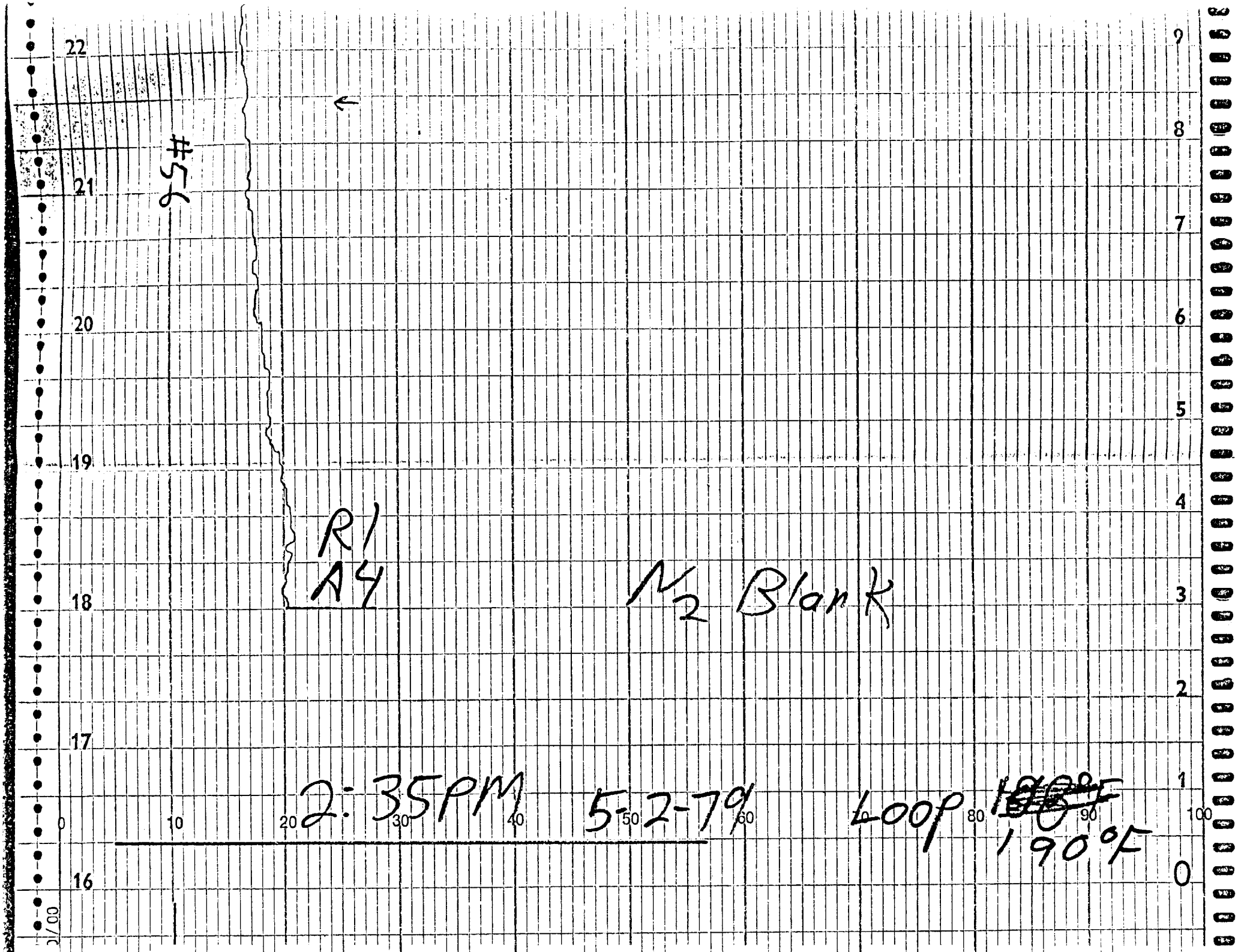
Sample P-1
#29
#30
#29
Philips PR 4920/00

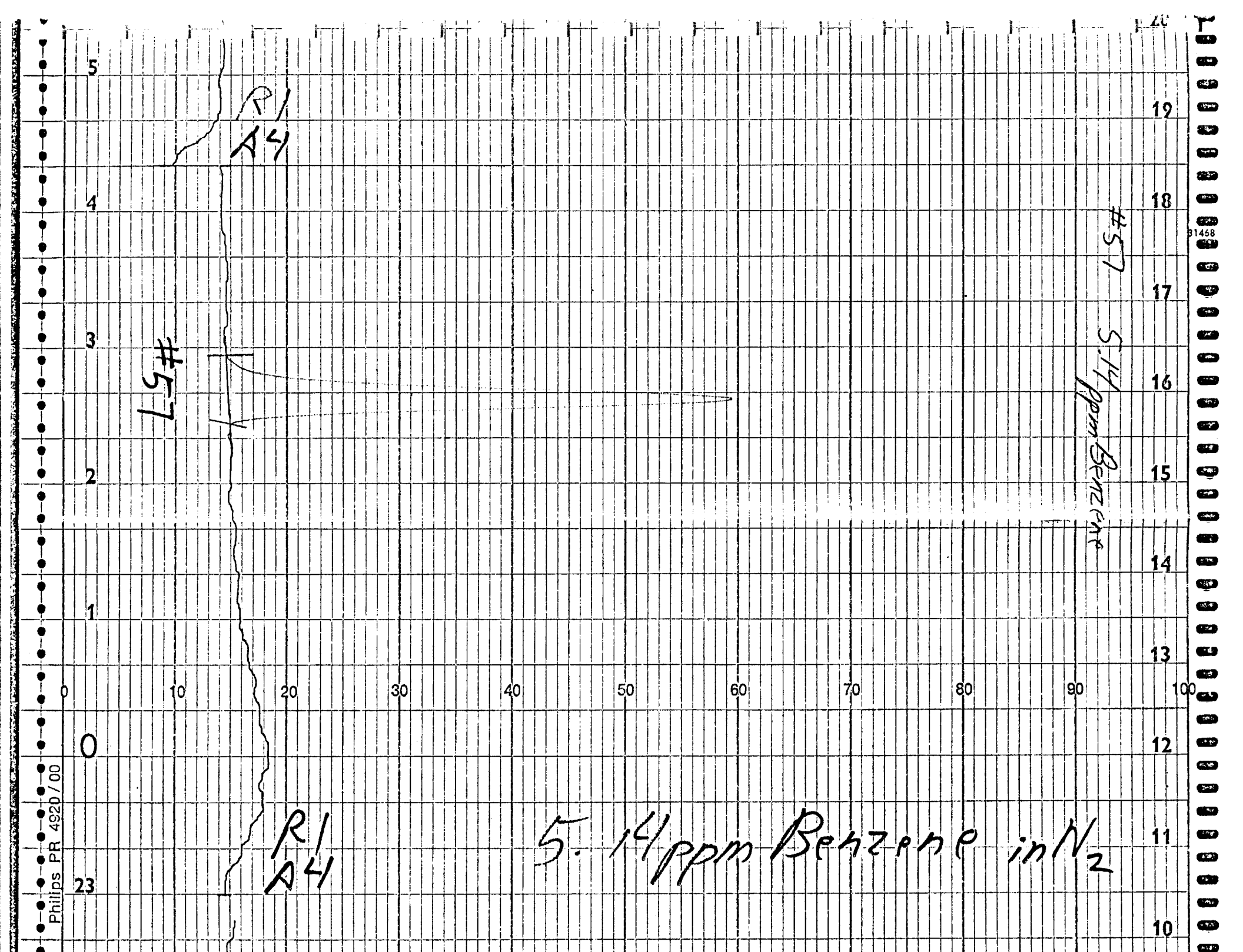

Air
#31
R1
A4
5.14 ppm Benzene in Air Room 78°F
#31 5.14 ppm Benzene
#30
Philips PR 4920/00


0
23
22
21
20
19
18
17
16
15
#32 5.14ppm Benzene
Benzene
RT
RT
#32
8
7
6
5
4
3
2
Philips PR 4920/00

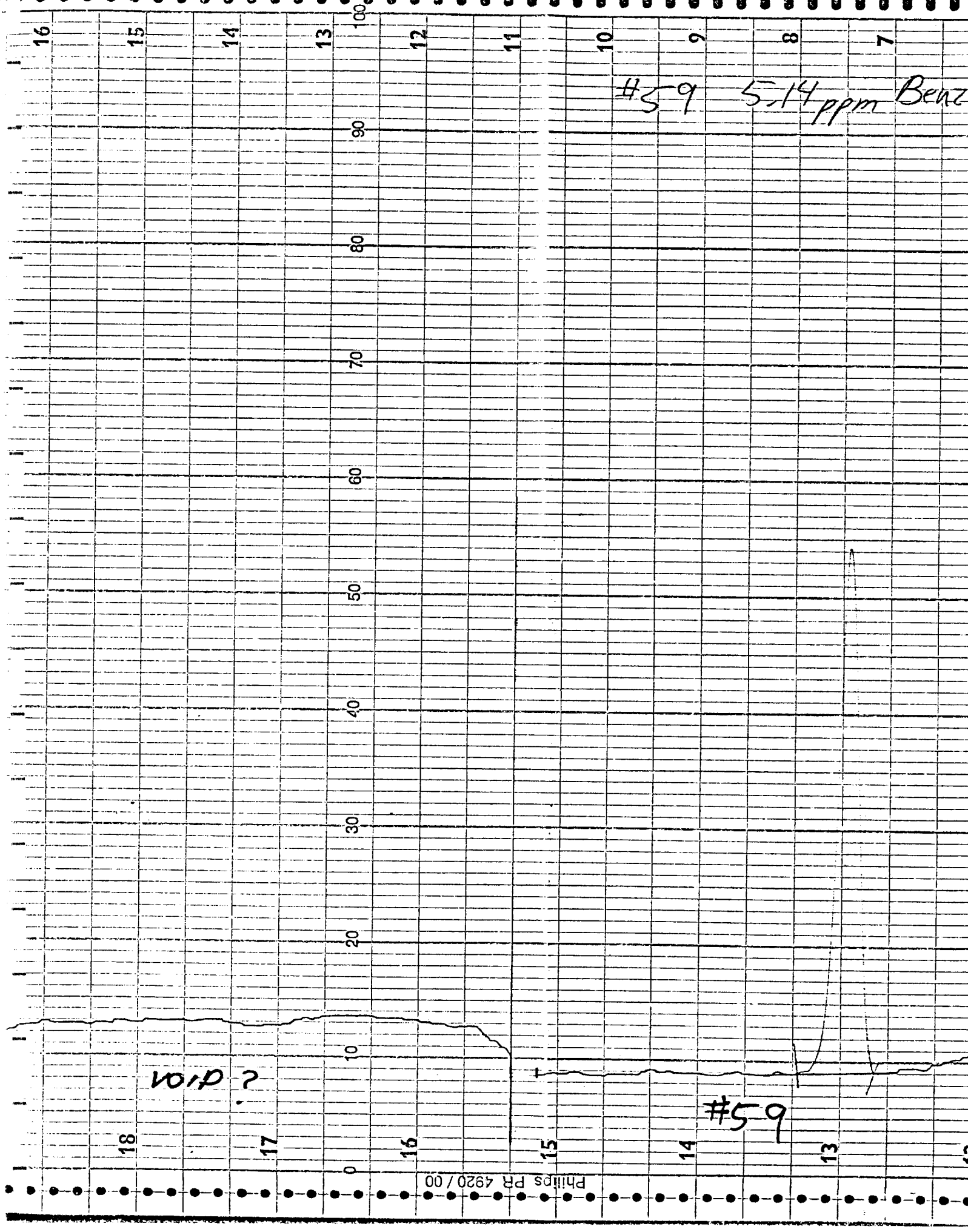

ppm Benzene
#33 5.14 ppm Benze
#33


#35 5.14 PPM Benzene
#34 5.14ppm
#35
#34
Philips PR 4920 / 00


22
21
20
19
18
17
16
0
10
20
30
40
50
60
70
80
90
100
9
8
7
6
5
4
3
2
1
0
25#
R1
A4
N2 Blank
2:35PM
5-2-79
Loop
190°F


5. 14 ppm Benzene in N2
#57
R1
A4
#57
5.14 ppm Benzene
R1
A4
Philips PR 4920/00
31468

#58 5.14 ppm Benzene
RI
AH
#58
Philips PR 4920/00


#59 5.14 ppm Benz
void ?
#59
Philips PR 4920/00

Loop 190°F

Sample P-2
Collected 5-2-79

R1
A4

0 10 20 30 40 50 60 70 80 90 100

0

23

22

21

20

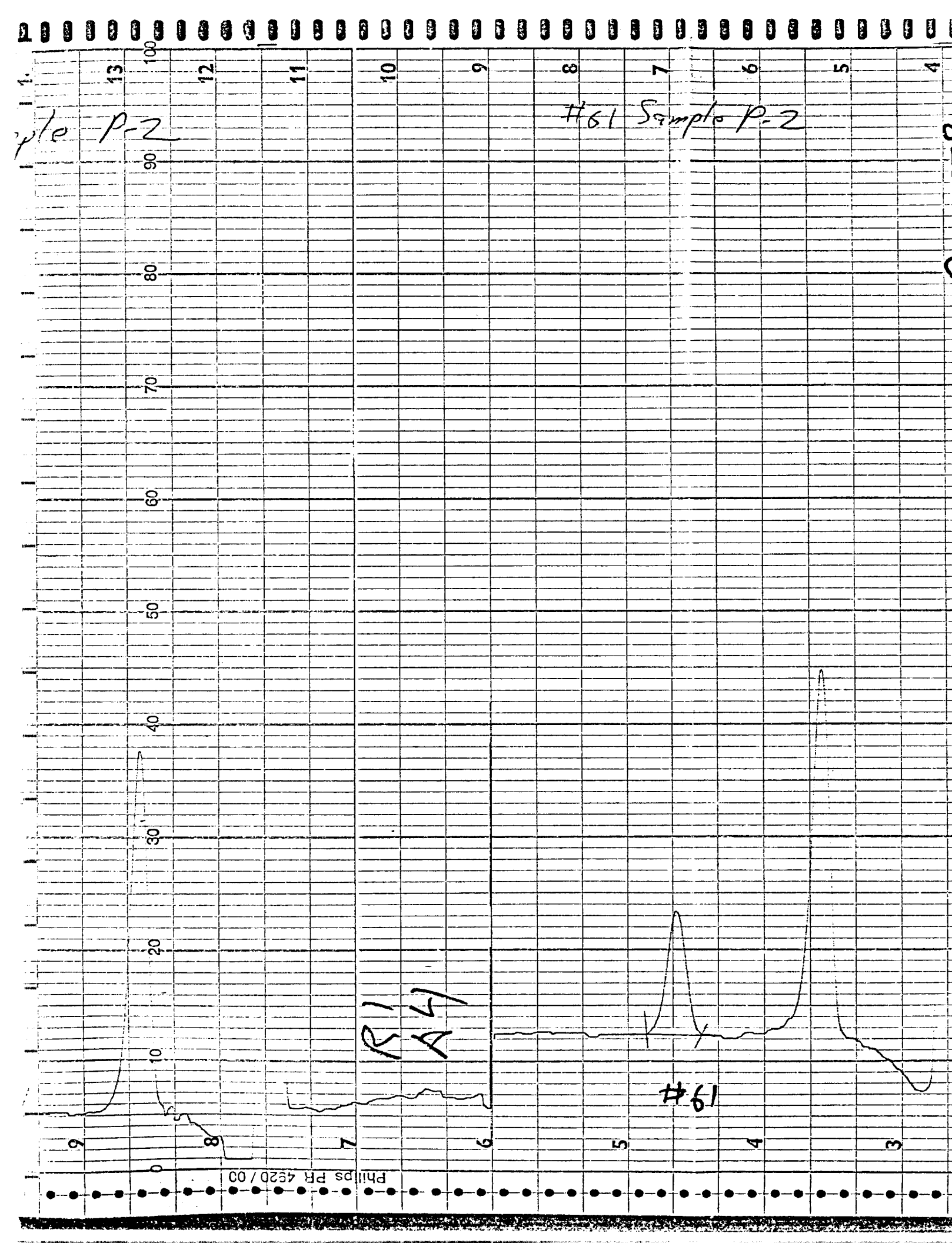
0977

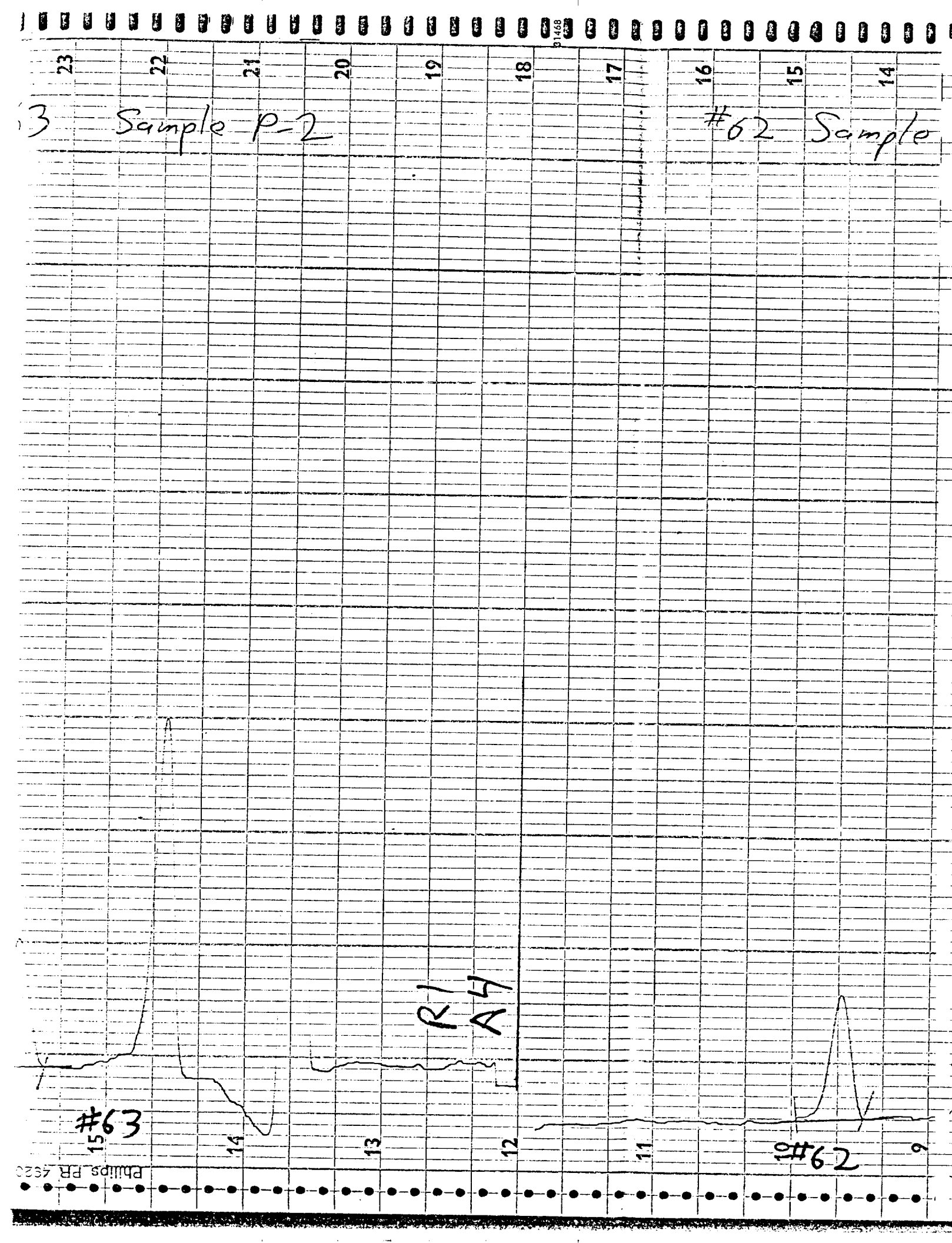
R1
A4

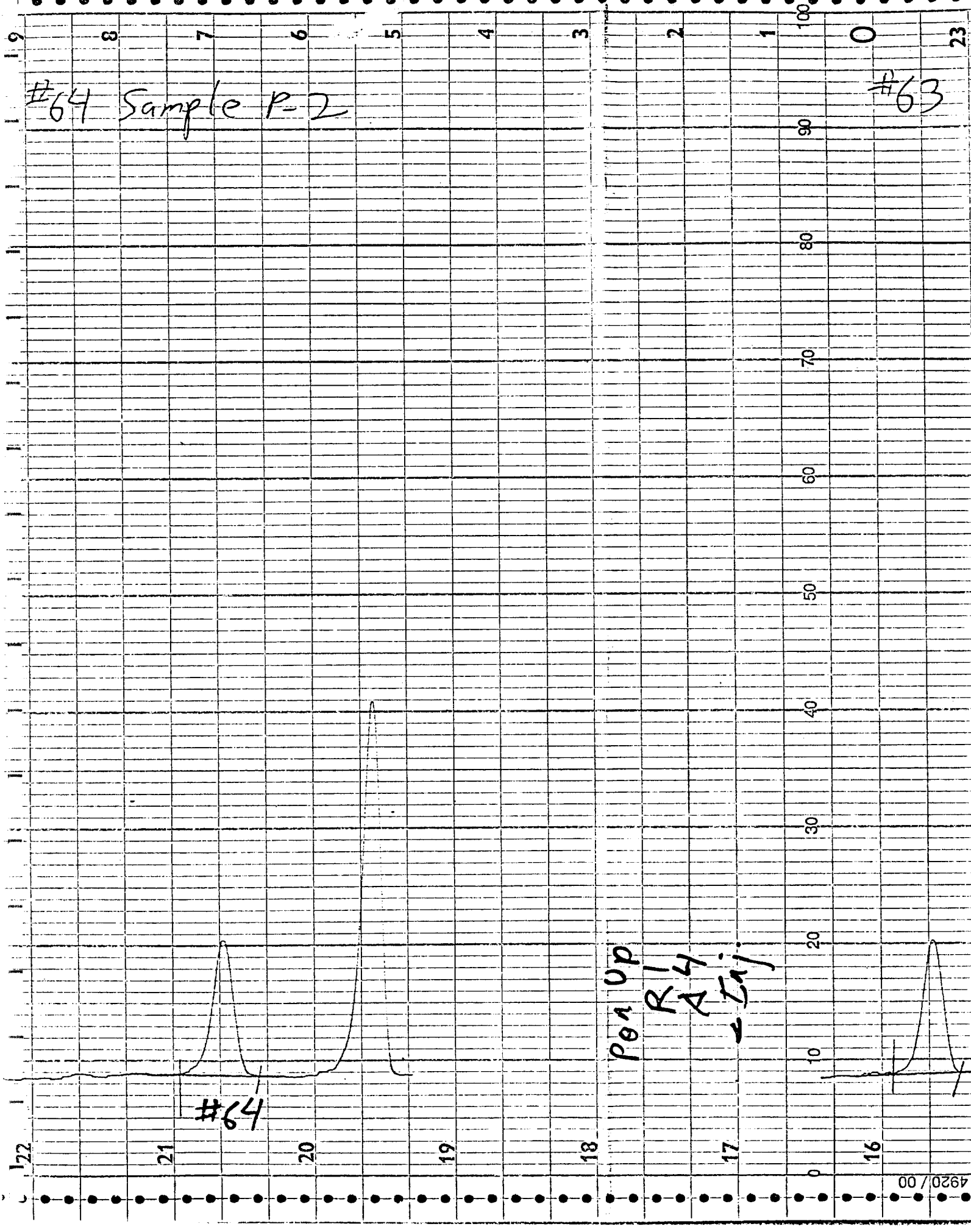
N2

Philips PR 4920/00

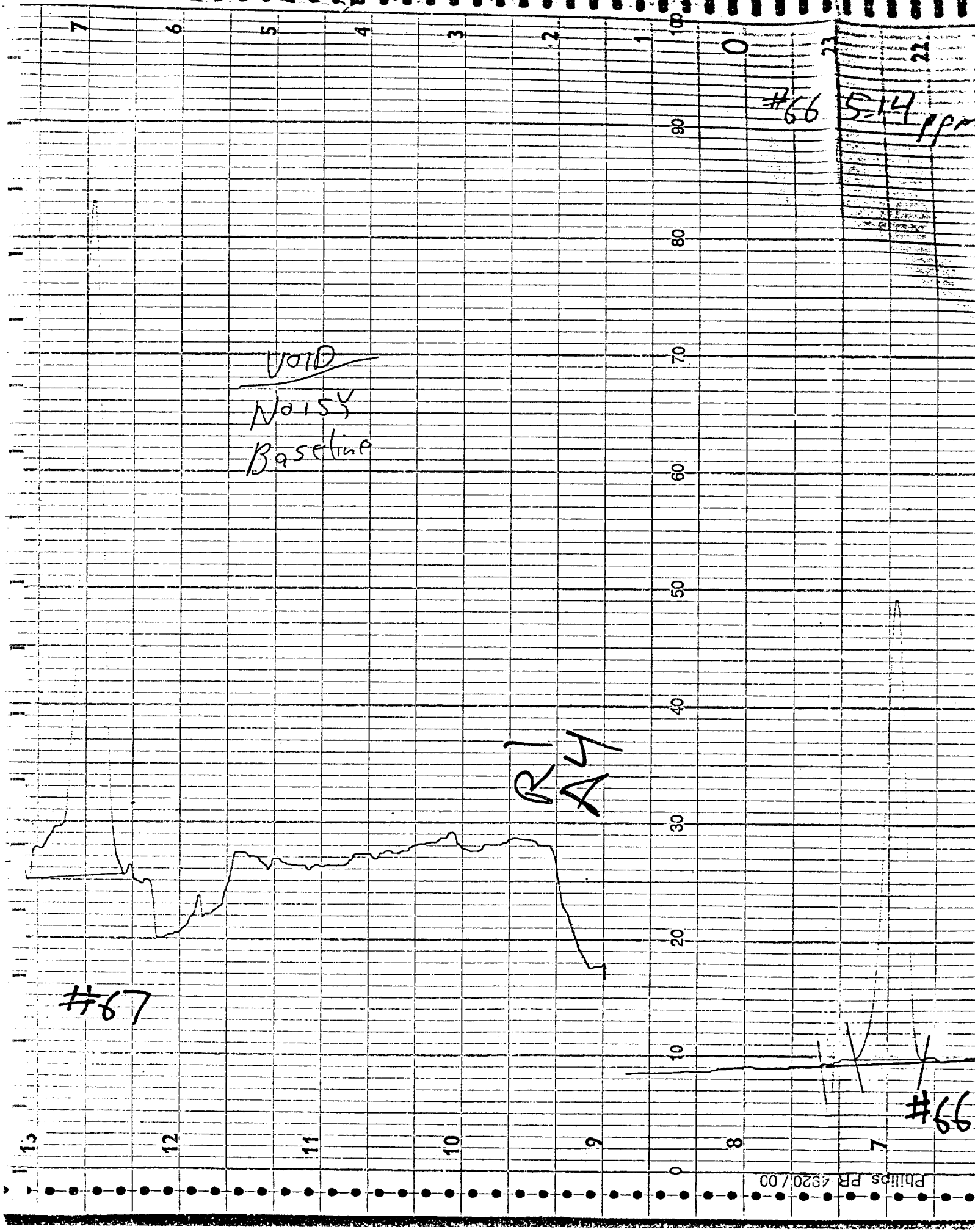
31468

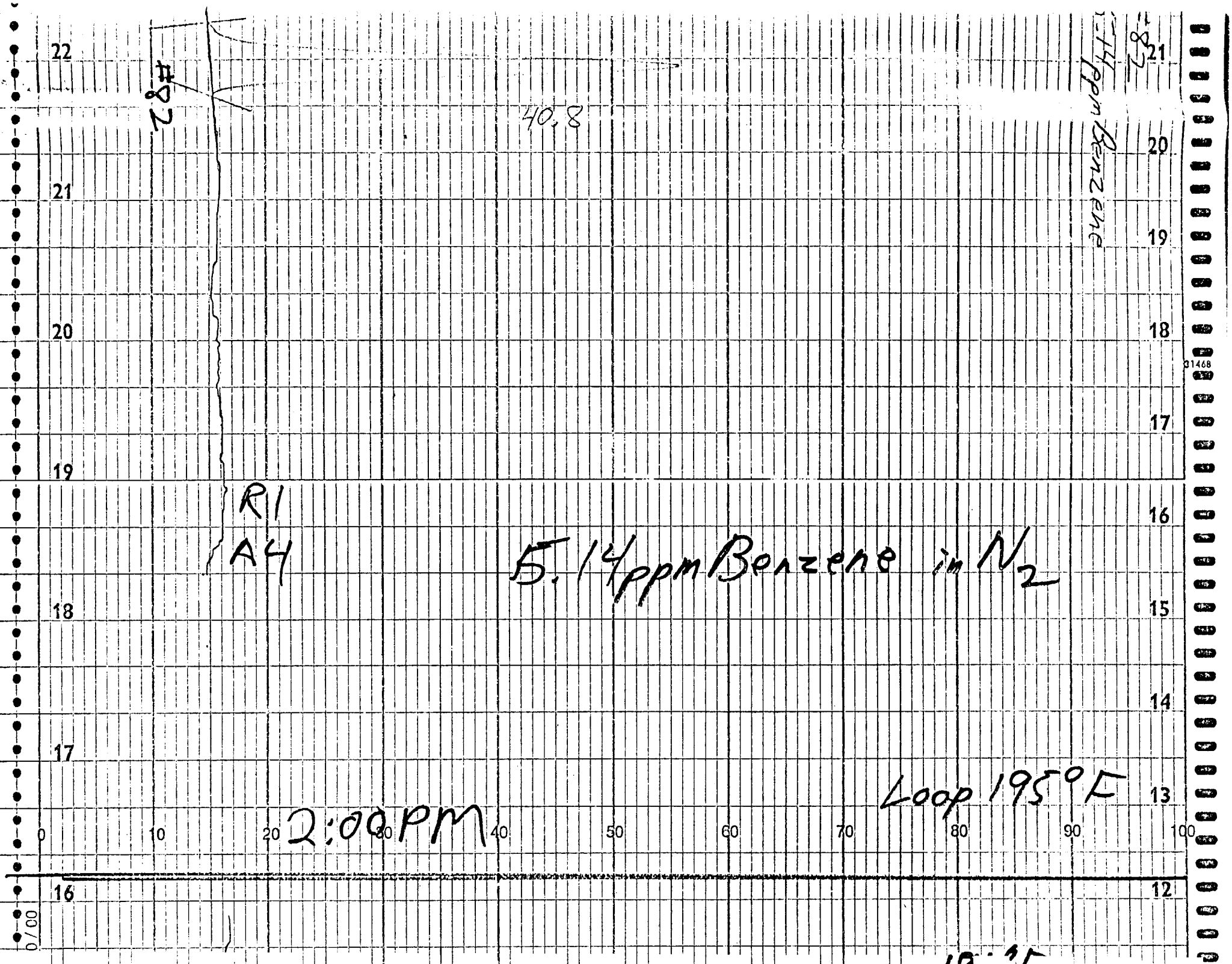

#61 Sample P-2
ple P-2
#61
Philips PR 4920/00


23
22
21
20
19
18
17
16
15
14
3 Sample P-2
#62 Sample
RH
AH
#63
15
14
13
12
11
10
9
#62
Philips PR 4320

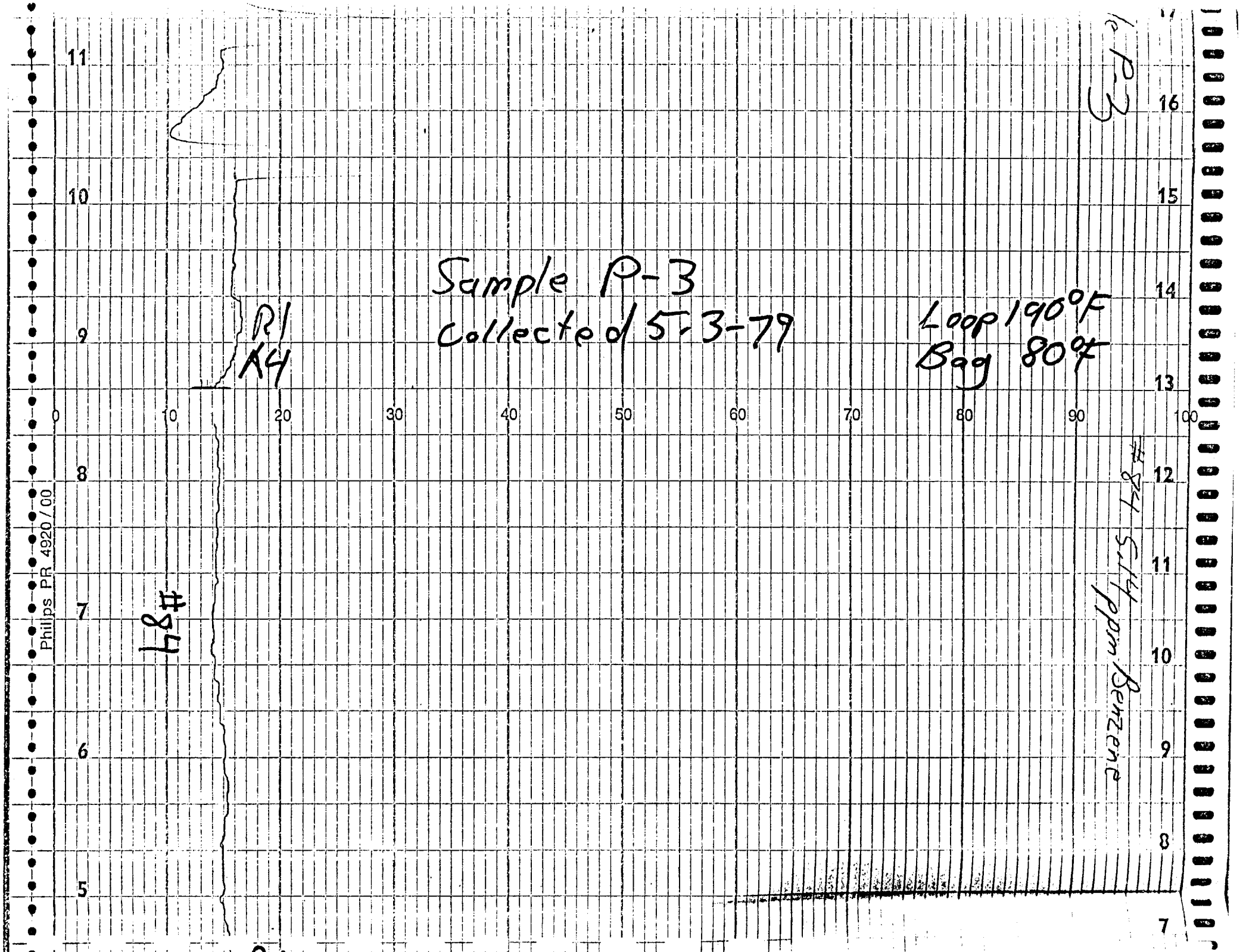

#64 Sample P-2
#63
#64
Pen UP
RH
Inj
4920/00

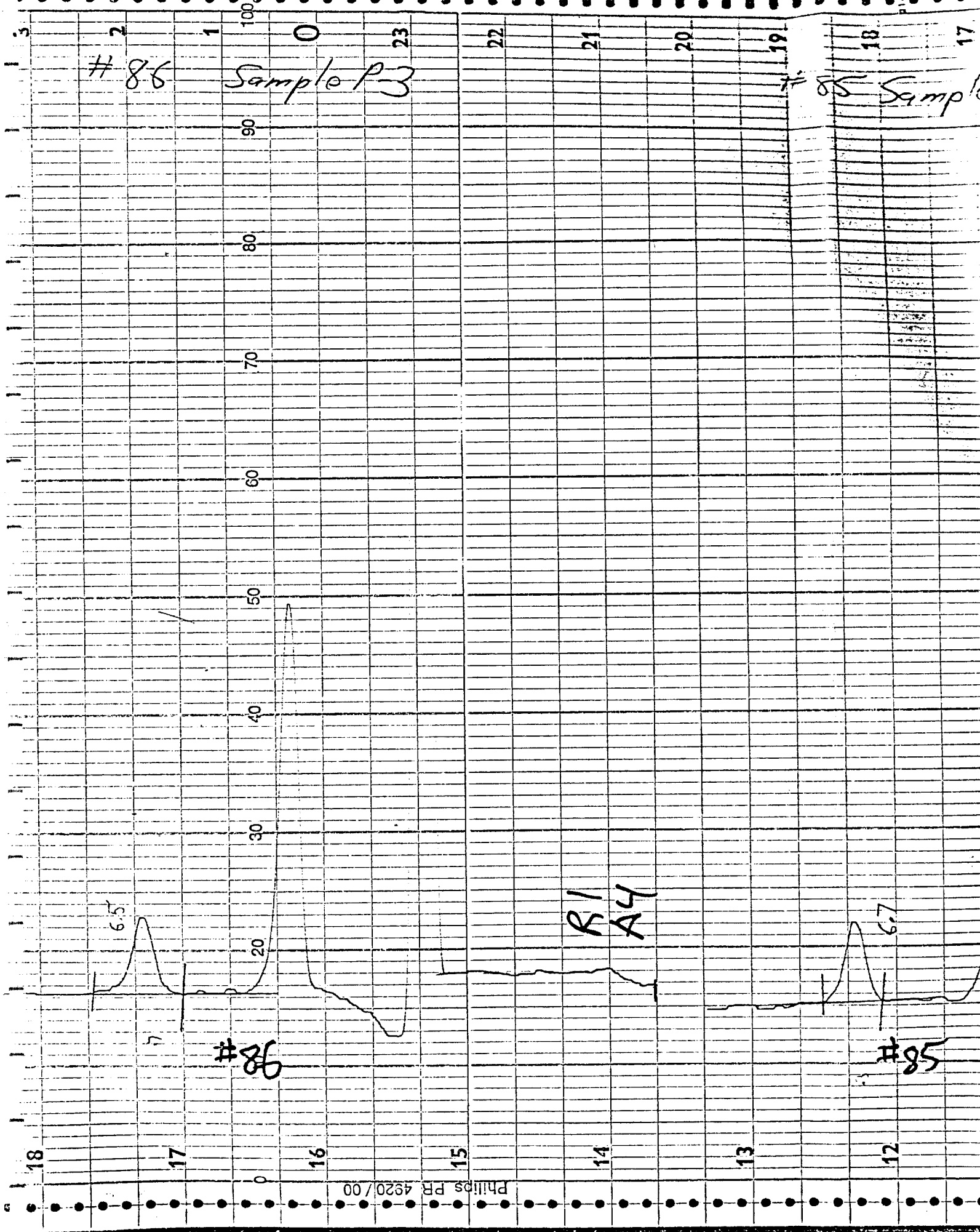
5
4
3
2
1
0
23
19
18
17
16
15
14
13
12
11
10
0
10
20
30
40
50
60
70
80
90
100
R1
A4
S9#
R1
A4
5.14 ppm Benzene in N2
#65 5.14 ppm Benzene
Philips PR 4920/00
314

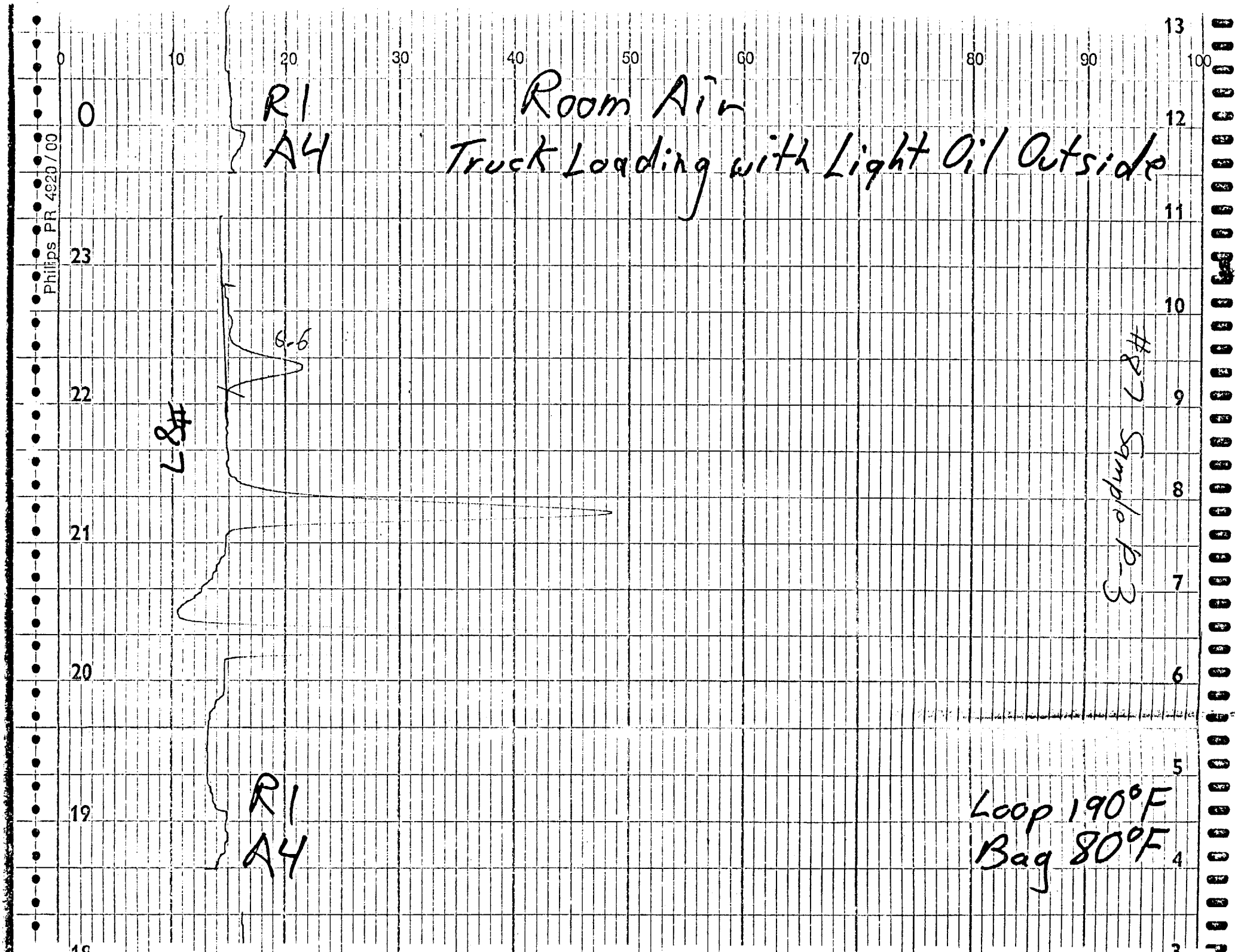

#66 5.14 ppm
VOID
Noisy
Baseline
RT
AA
#67
#66
Philips PR 4920/00


#8
40.8
R1
A4
5.14ppm Benzene in N_2
Loop 195°F
2:00PM
10:15
5.14ppm Benzene
#8
0
10
20
30
40
50
60
70
80
90
100
16
17
18
19
20
21
22
12
13
14
15
16
17
18
19
20
21

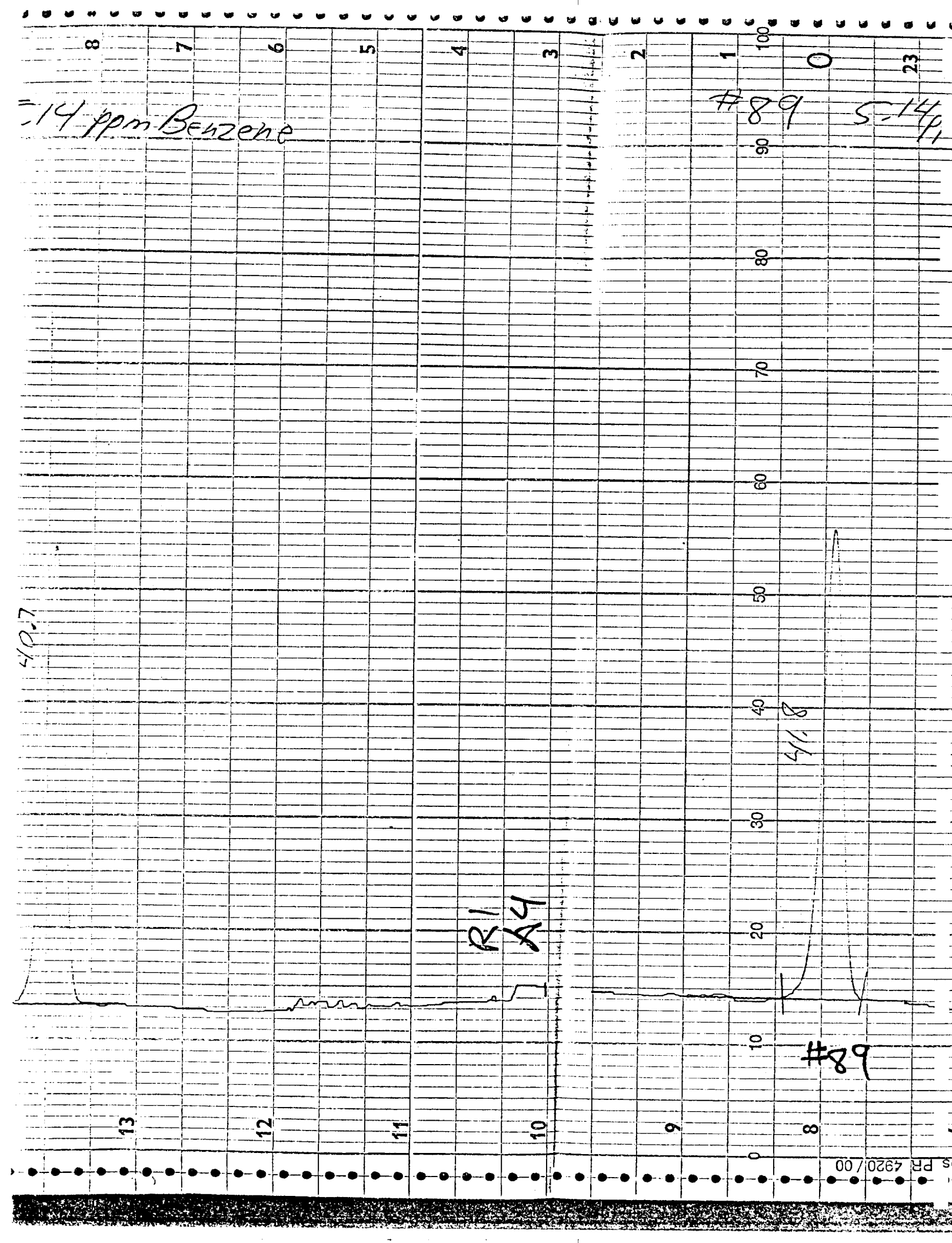
#83 5-14ppm Benzene
#82
5-14ppm
N2 Blank
40.8
#83
RA
RA
Philips PR 4920/00


Sample P-3
Collected 5-3-79
Loop 190°F
Bag 80°F
R1
A4
48#
Philips PR 4920/00
0
10
20
30
40
50
60
70
80
90
100
5
6
7
8
9
10
11
12
13
14
15
16
17
P-3
ppm Benzene
FATS 48#


#86 Sample P3
#85 Sample
6.5
6.7
RI
A4
#86
#85
Philips PR 4920/00


Room Air
Truck Loading with Light Oil Outside
R1
A4
L8#
6-6
R1
A4
Sample #3 L8#
Loop 190°F
Bag 80°F
Philips PR 4920/00
0
10
20
30
40
50
60
70
80
90
100
0
23
22
21
20
19
18
13
12
11
10
9
8
7
6
5
4
3

4ppm Benzene
5/4 ppm Benzene in Air
RI
AH
#88
Philips PR


=14 ppm Benzene
#89 5-14
4.7
4.8
RI
RA
#89
PR 4920/00

#90 5.14
40.3-40.7
40.7
#91
#90
Philips PR 4920 / 00

APPENDIX E

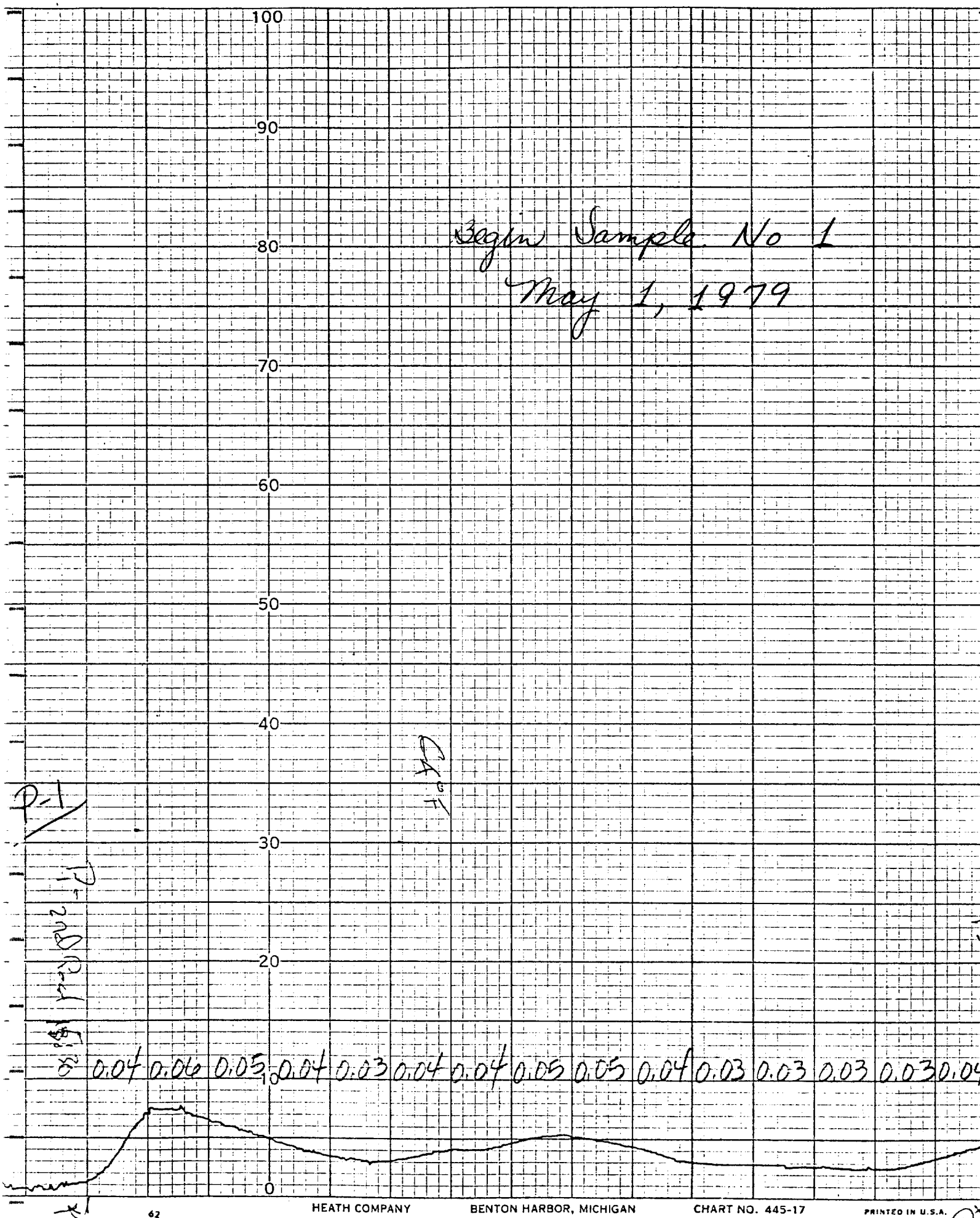
CARBON MONOXIDE DATA

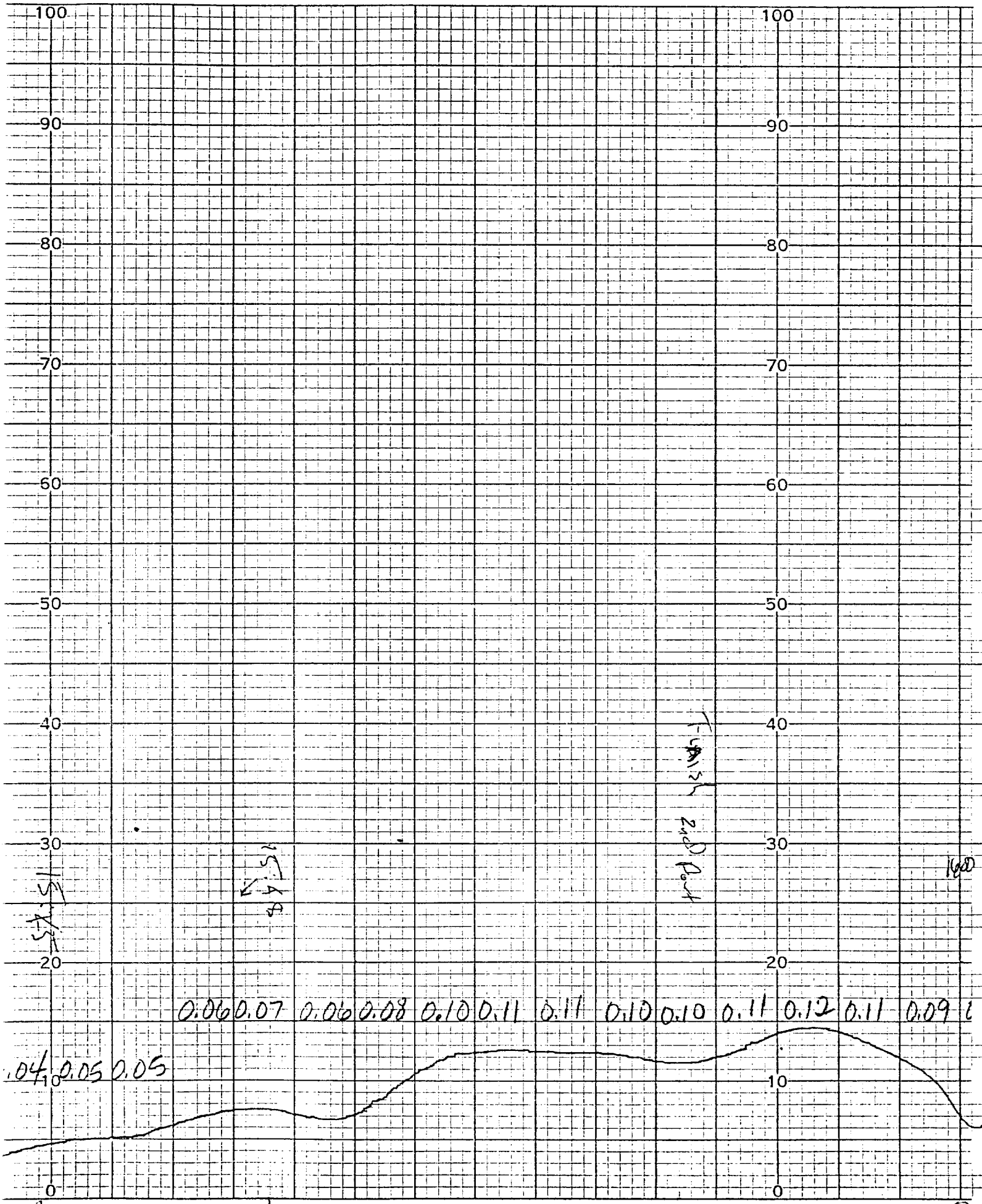
E-1. Continuous Sampling Charts

E-2. Opacity and Carbon Monoxide Correlation Data

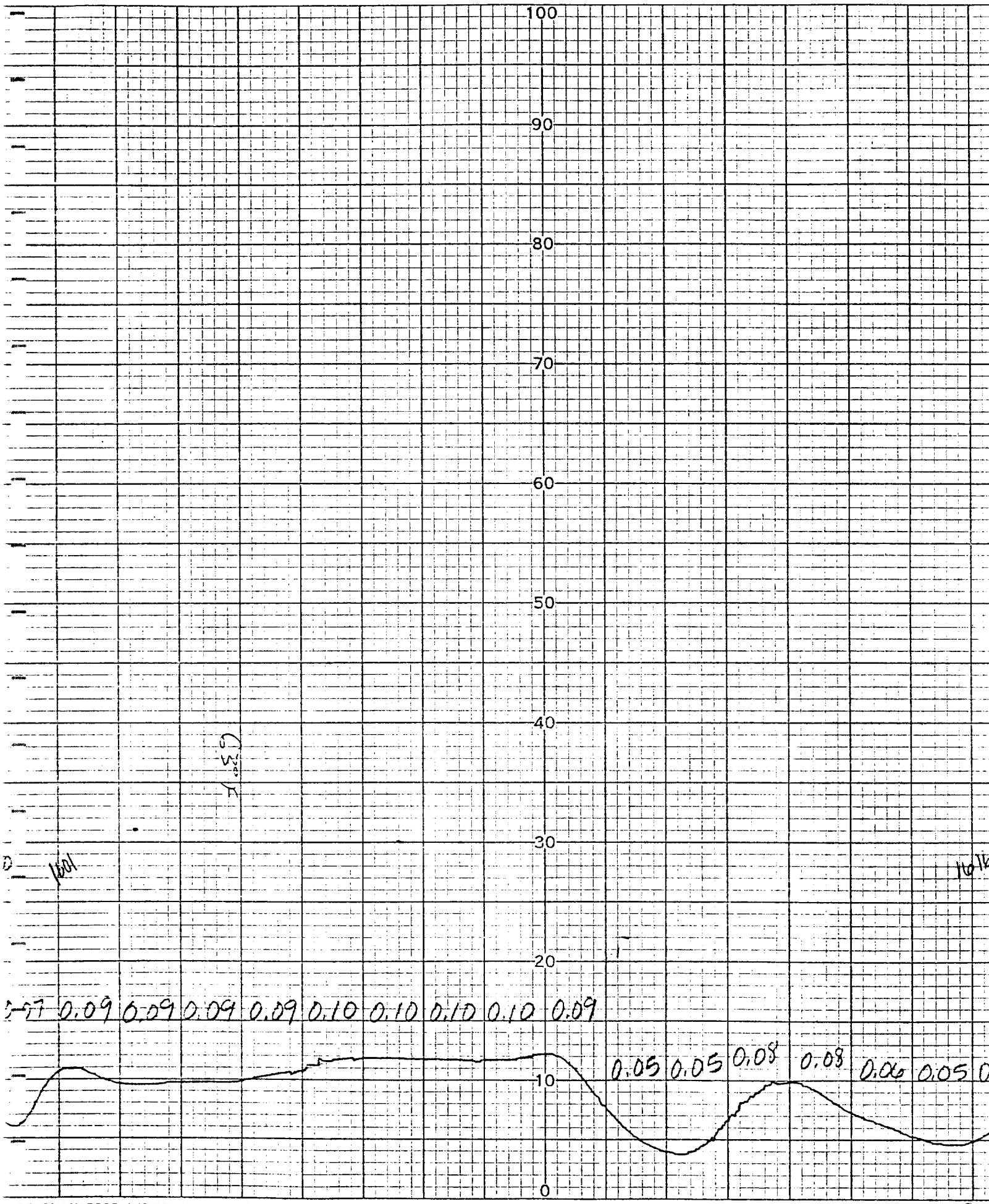
APPENDIX E-1

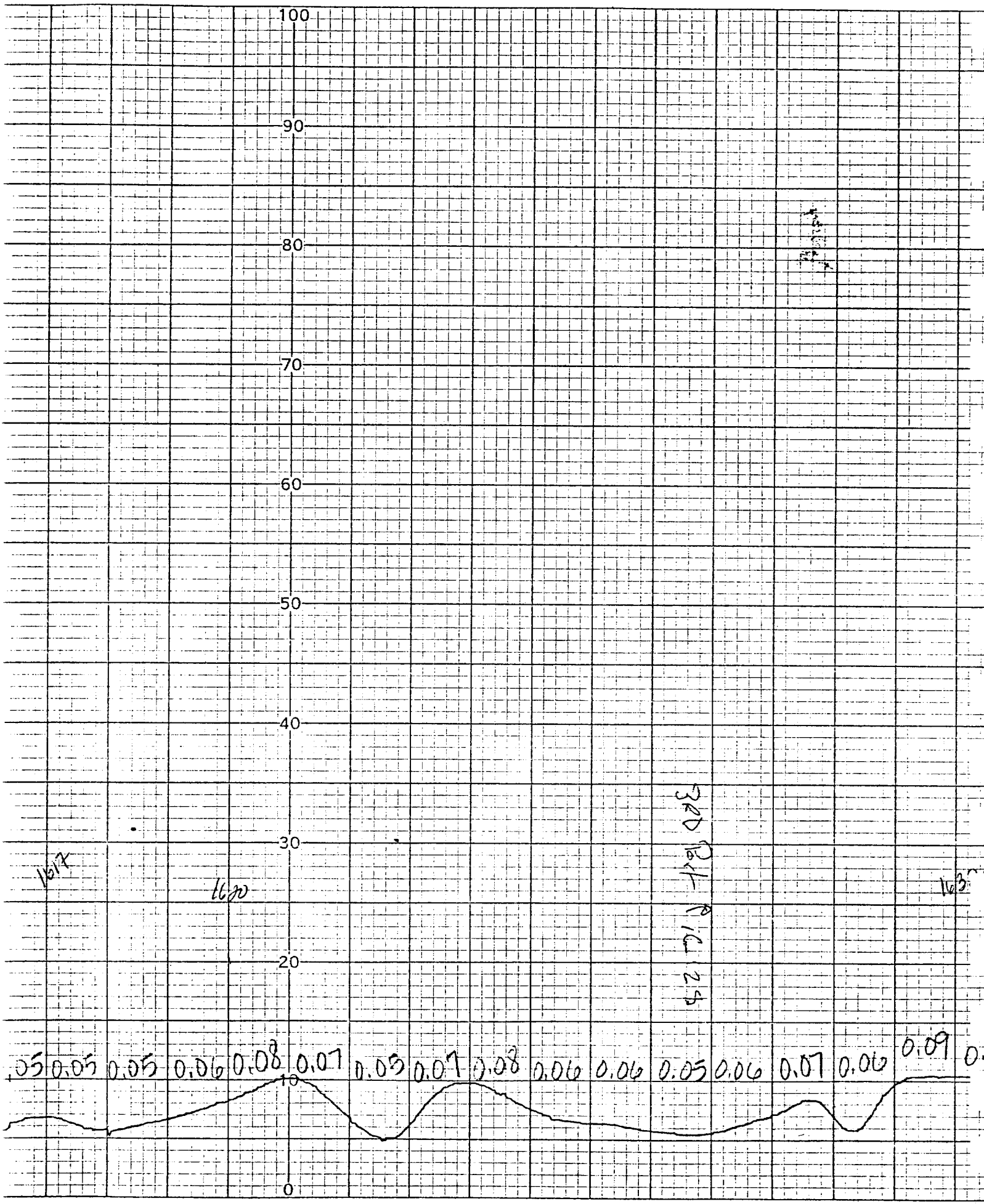
Continuous Sampling Charts


100
90
80
70
60
50
40
30
20
10
0
Begin Sample No 1
May 1, 1979
P-1
0.04 0.06 0.05 0.04 0.03 0.04 0.04 0.05 0.05 0.04 0.03 0.03 0.03 0.03 0.04
HEATH COMPANY
BENTON HARBOR, MICHIGAN
CHART NO. 445-17
PRINTED IN U.S.A.

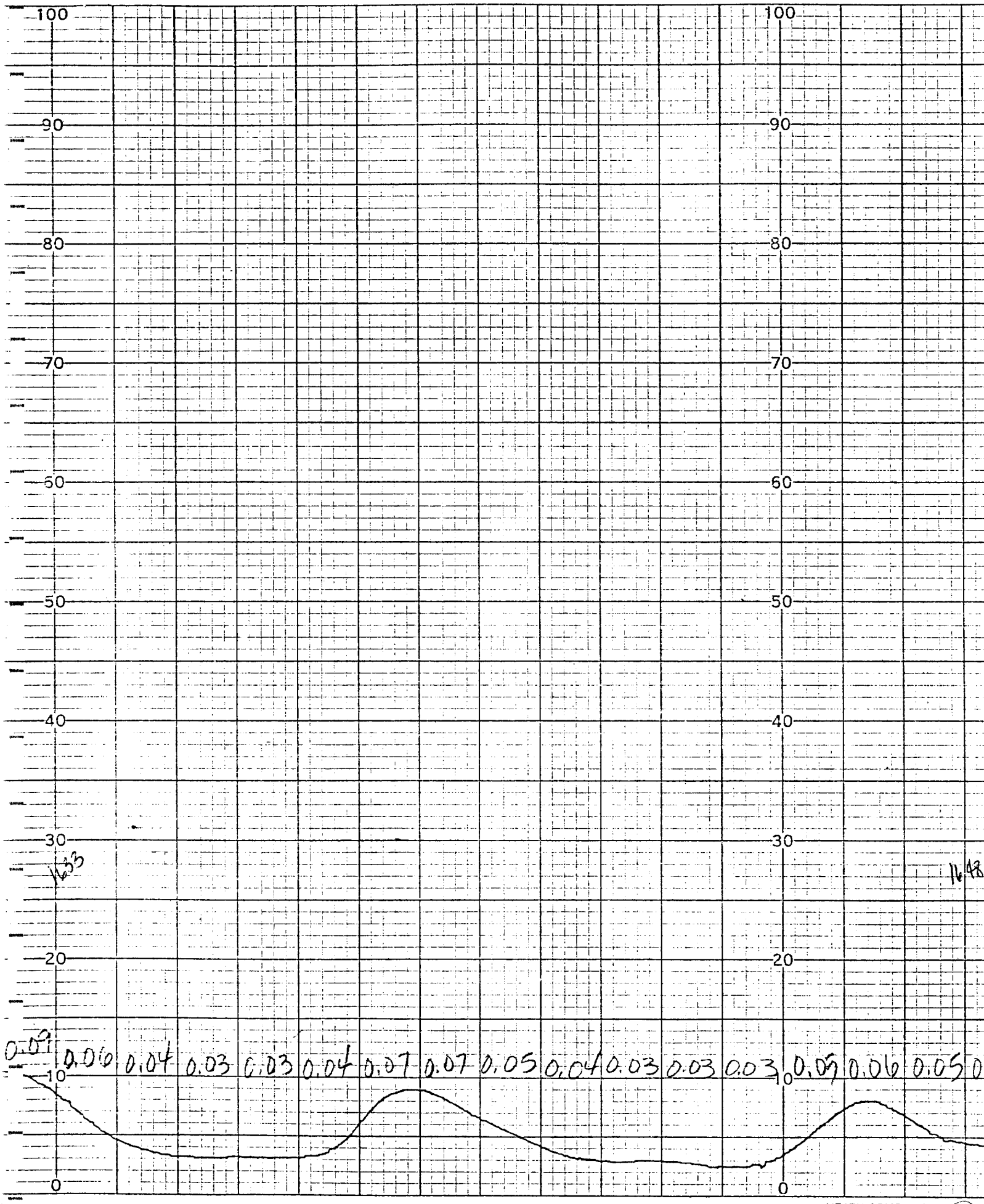


HEATH COMPANY


100
90
80
70
60
50
40
30
20
10
0
0.09 0.09 0.09 0.09 0.10 0.10 0.10 0.10 0.09
0.05 0.05 0.08 0.08 0.06 0.05
1601
1614
BENTON HARBOR, MICHIGAN
CHART NO. 445-17
PRINTED IN U.S.A.

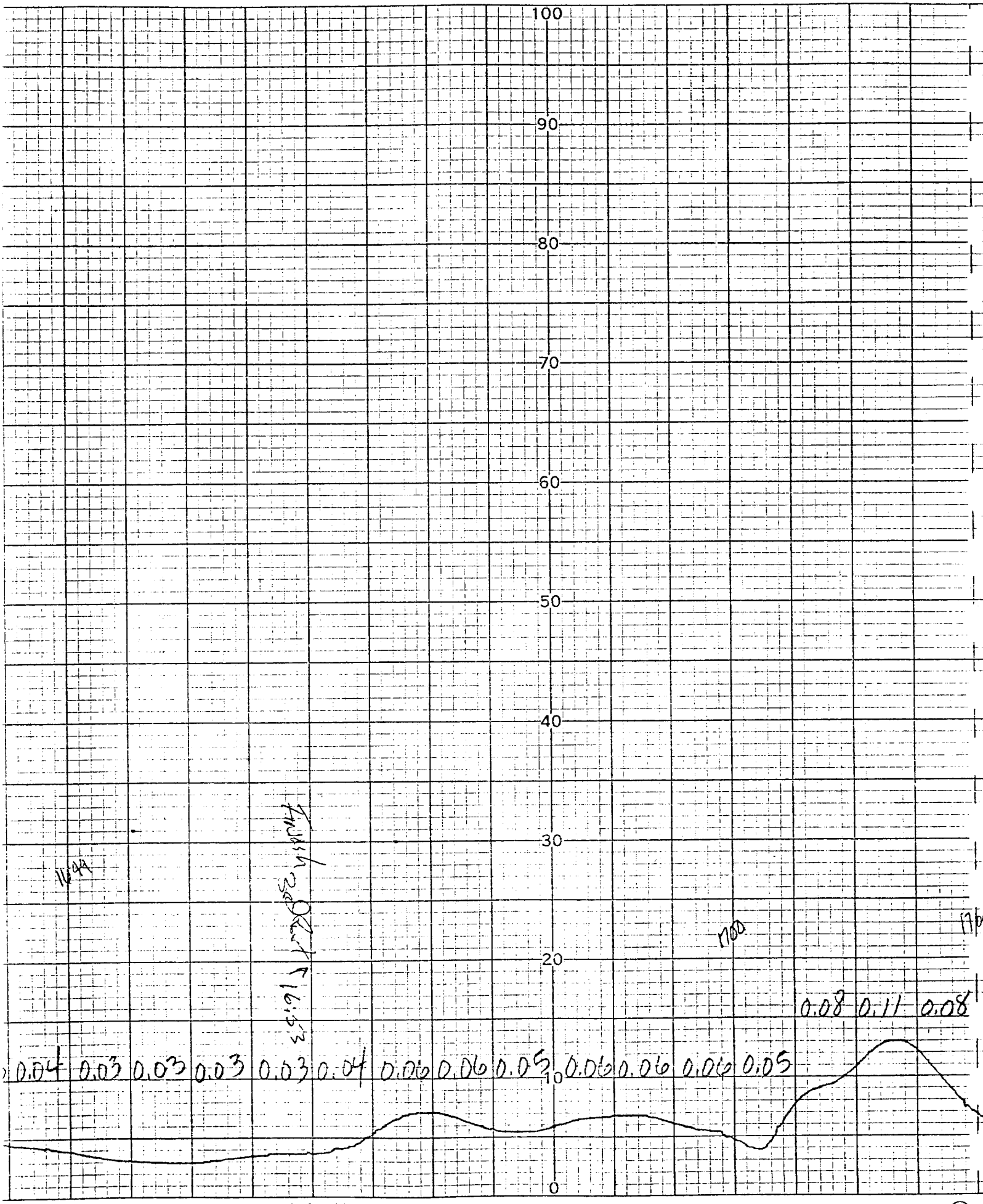


HEATH COMPANY BENTON HARBOR, MICHIGAN * CHART NO. 445-17 PRINTED IN U.S.A.

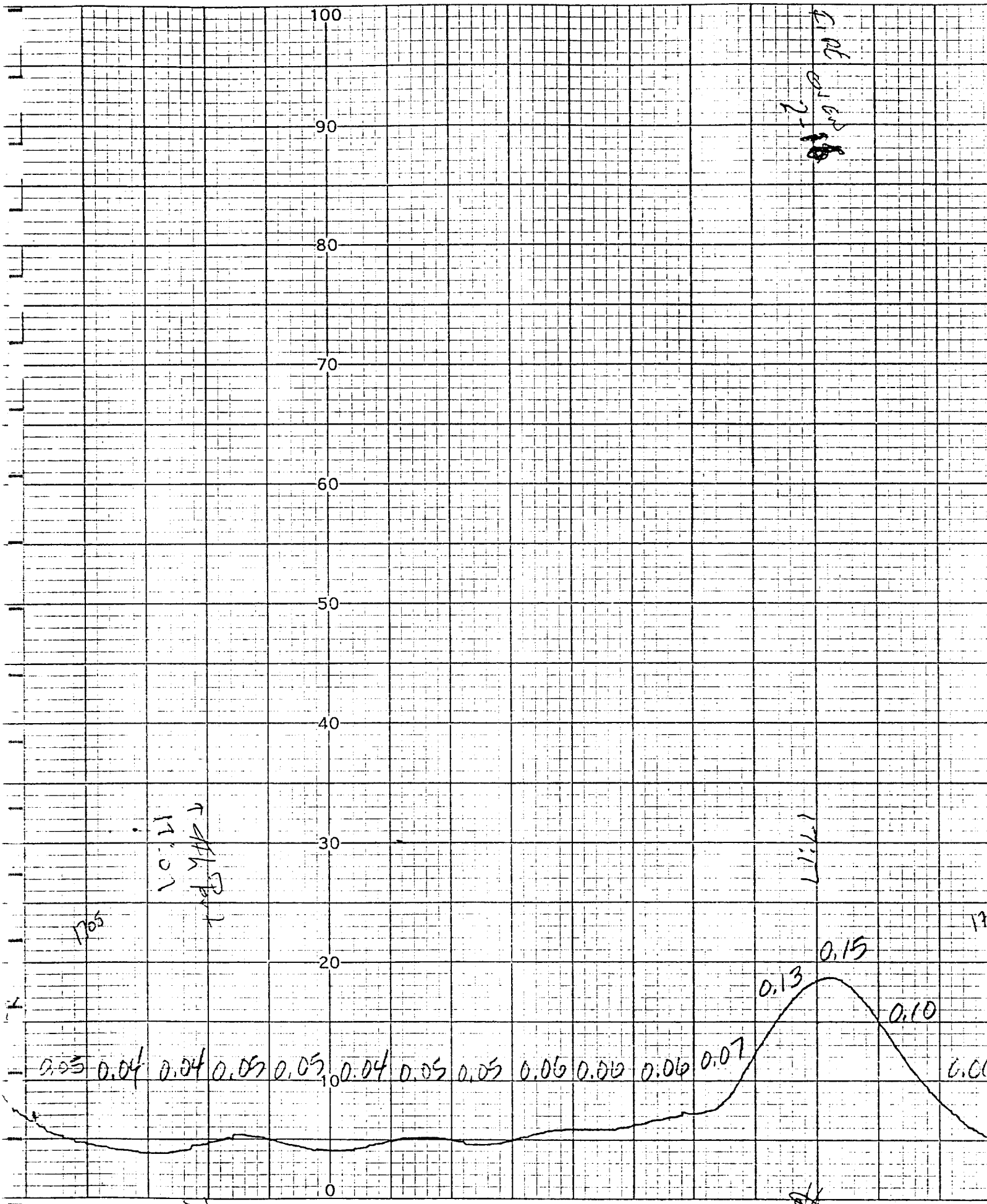


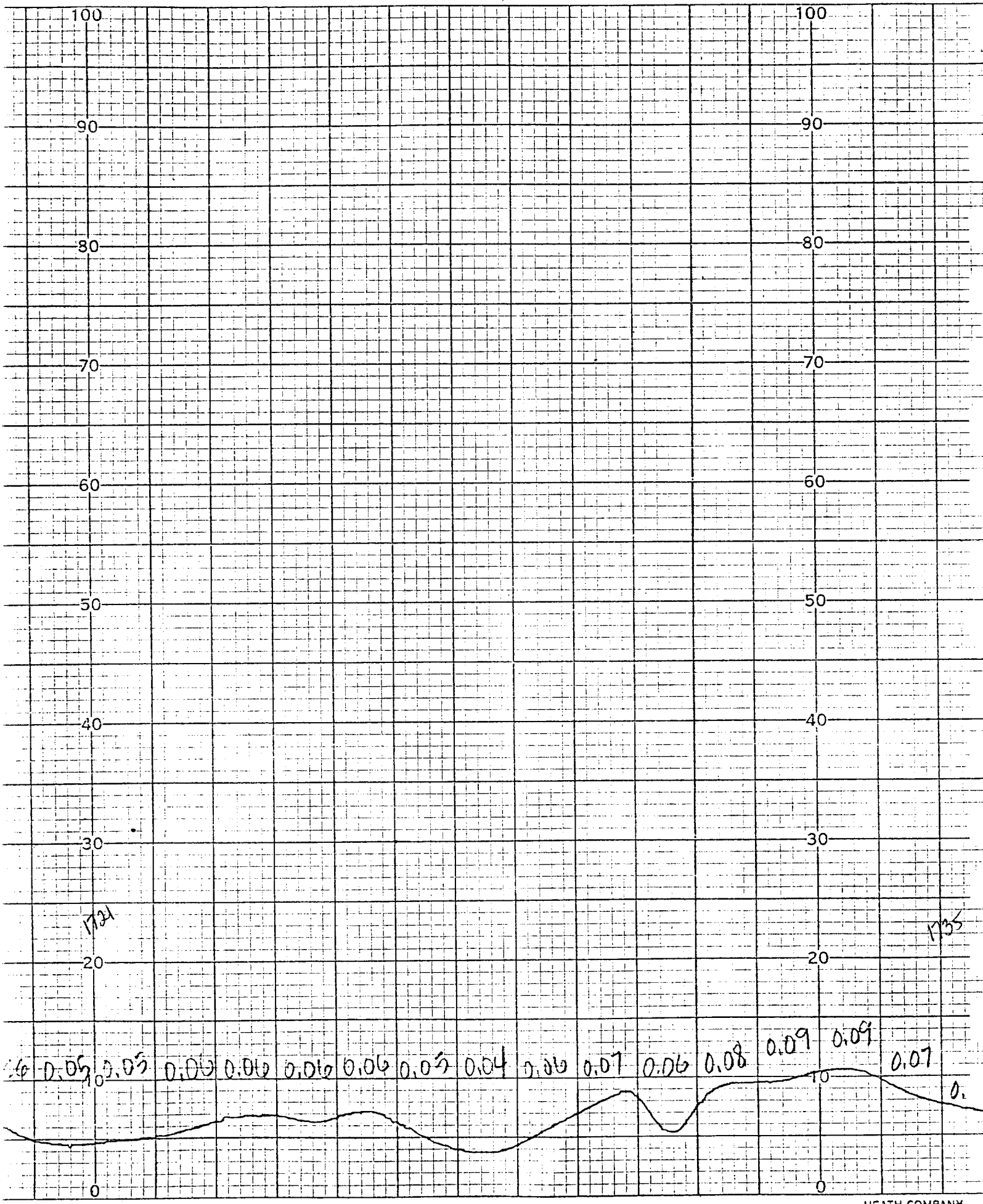
62 HEATH COMPANY

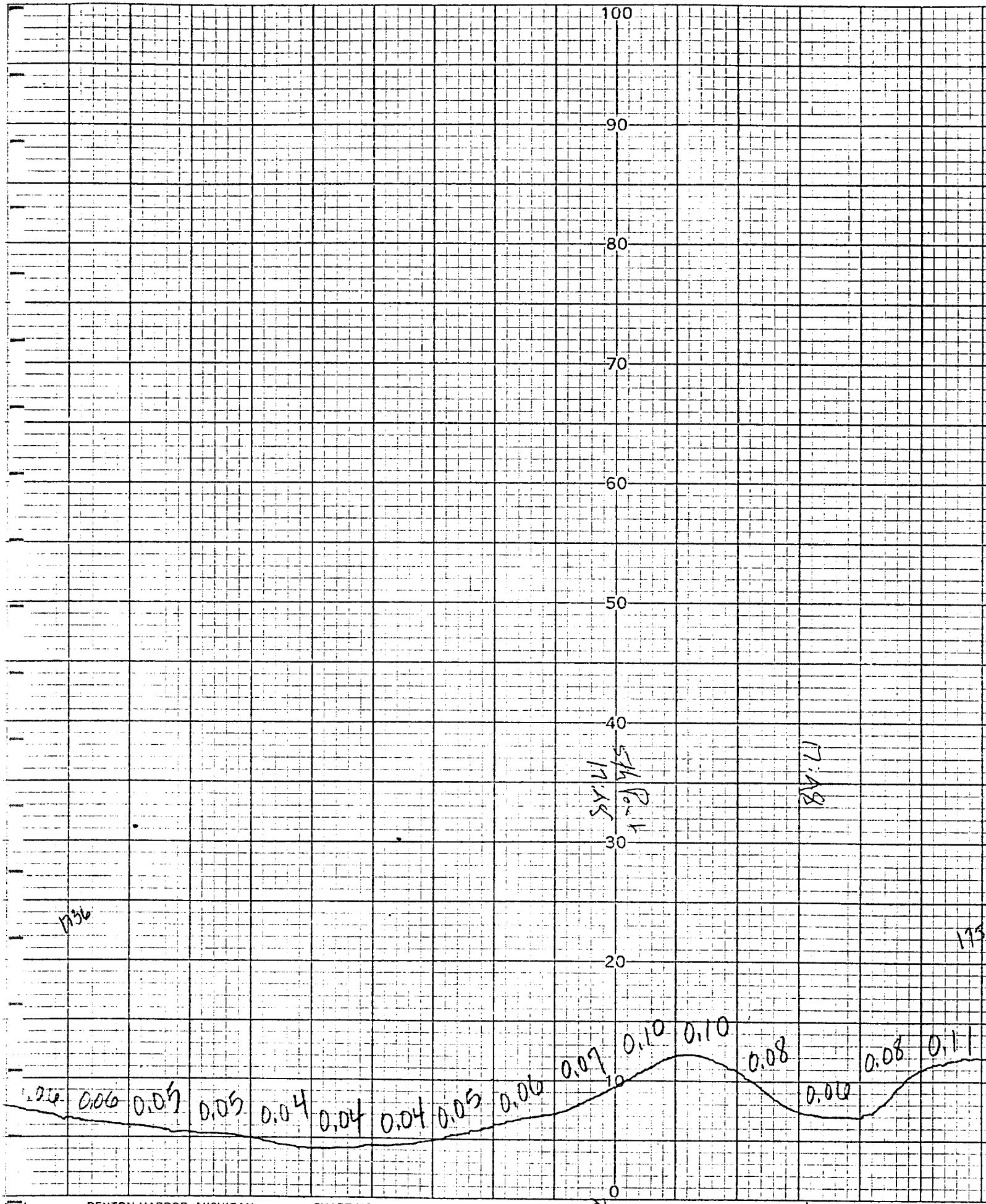
5

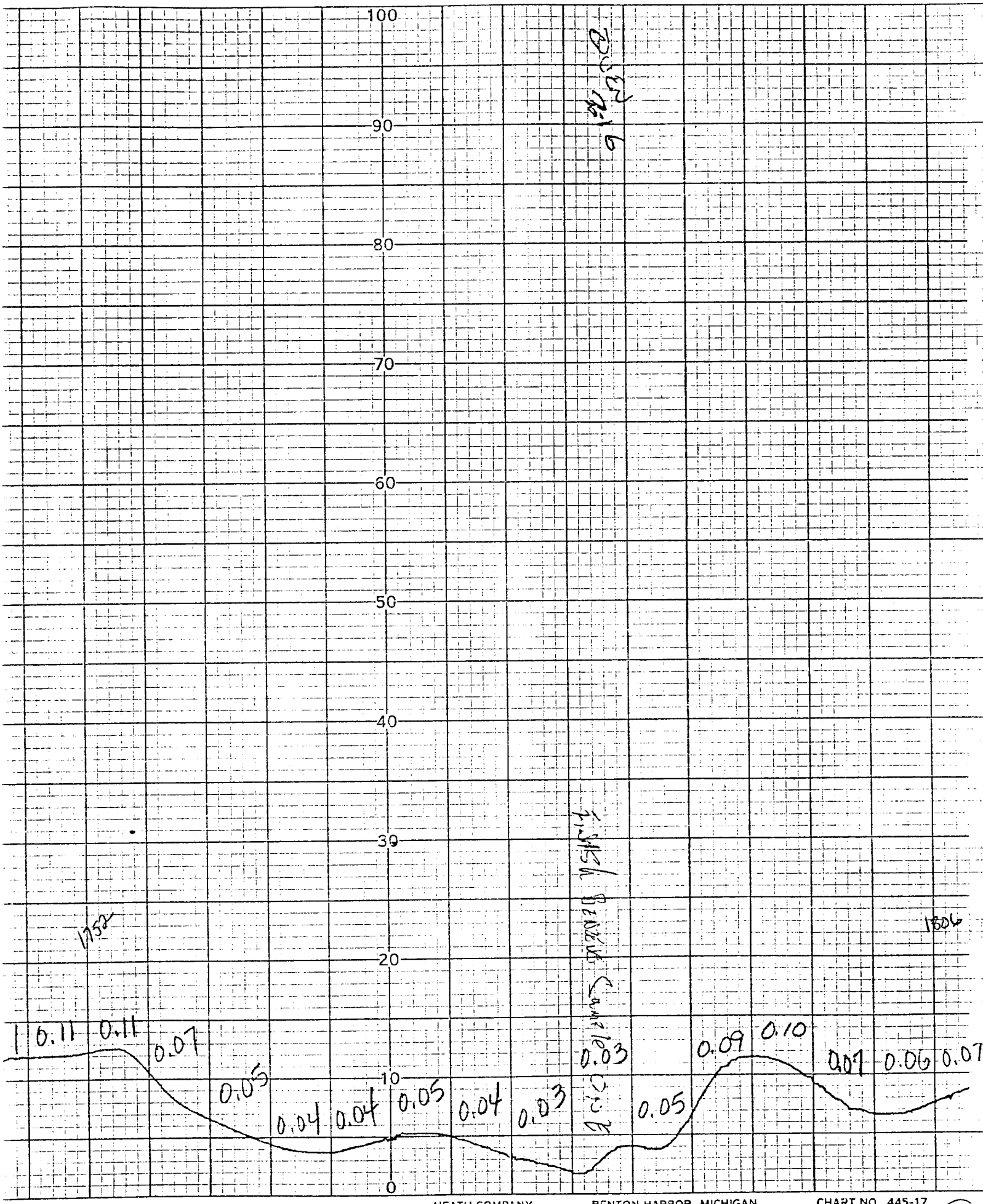


BENTON HARBOR, MICHIGAN CHART NO. 445-17 PRINTED IN U.S.A.

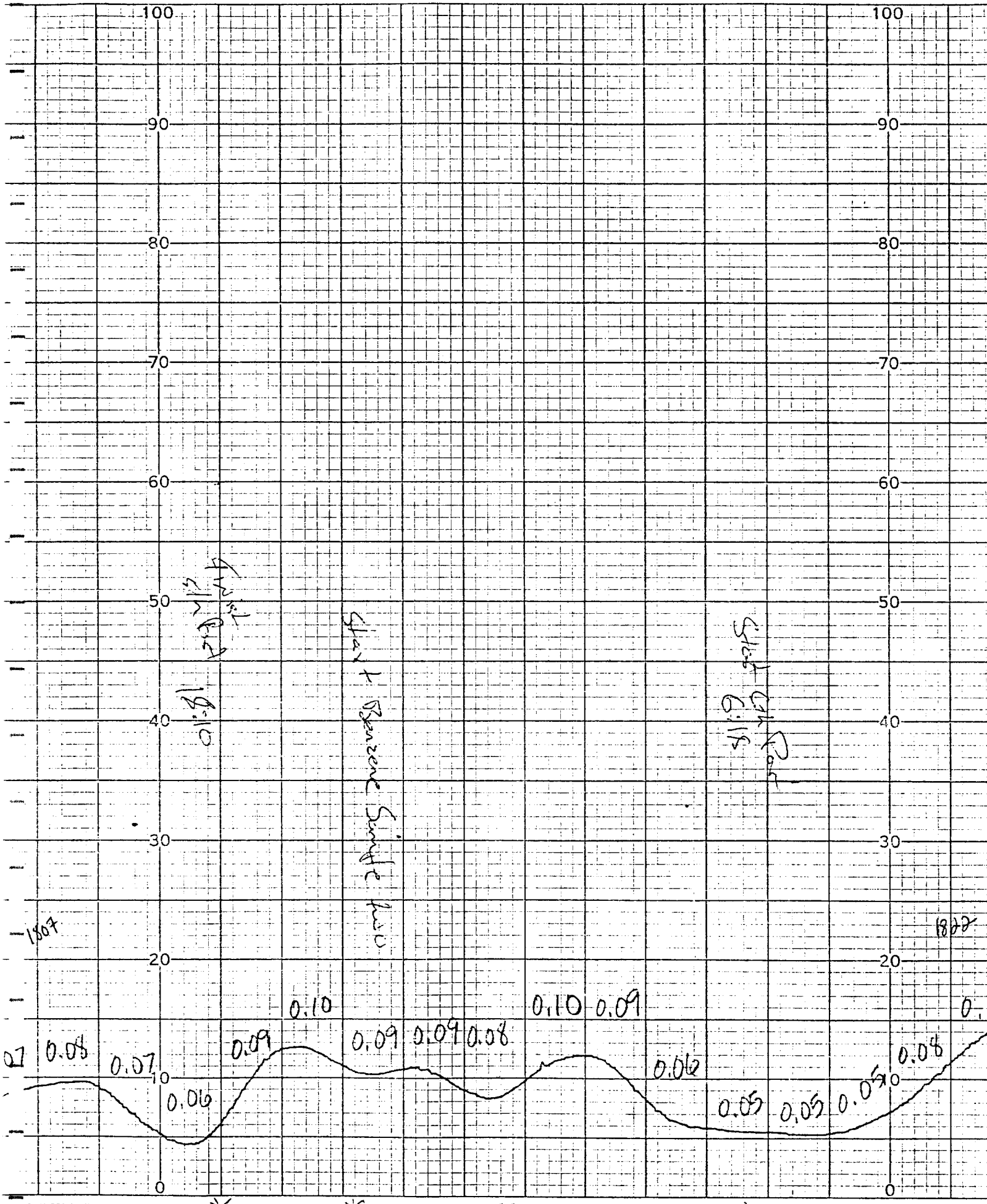

100
90
80
70
60
50
40
30
20
10
0
0.05 0.04 0.04 0.05 0.05 0.04 0.05 0.05 0.06 0.06 0.06 0.07
0.13
0.15
0.10
HEATH COMPANY
BENTON HARBOR, MICHIGAN
CHART 445-17

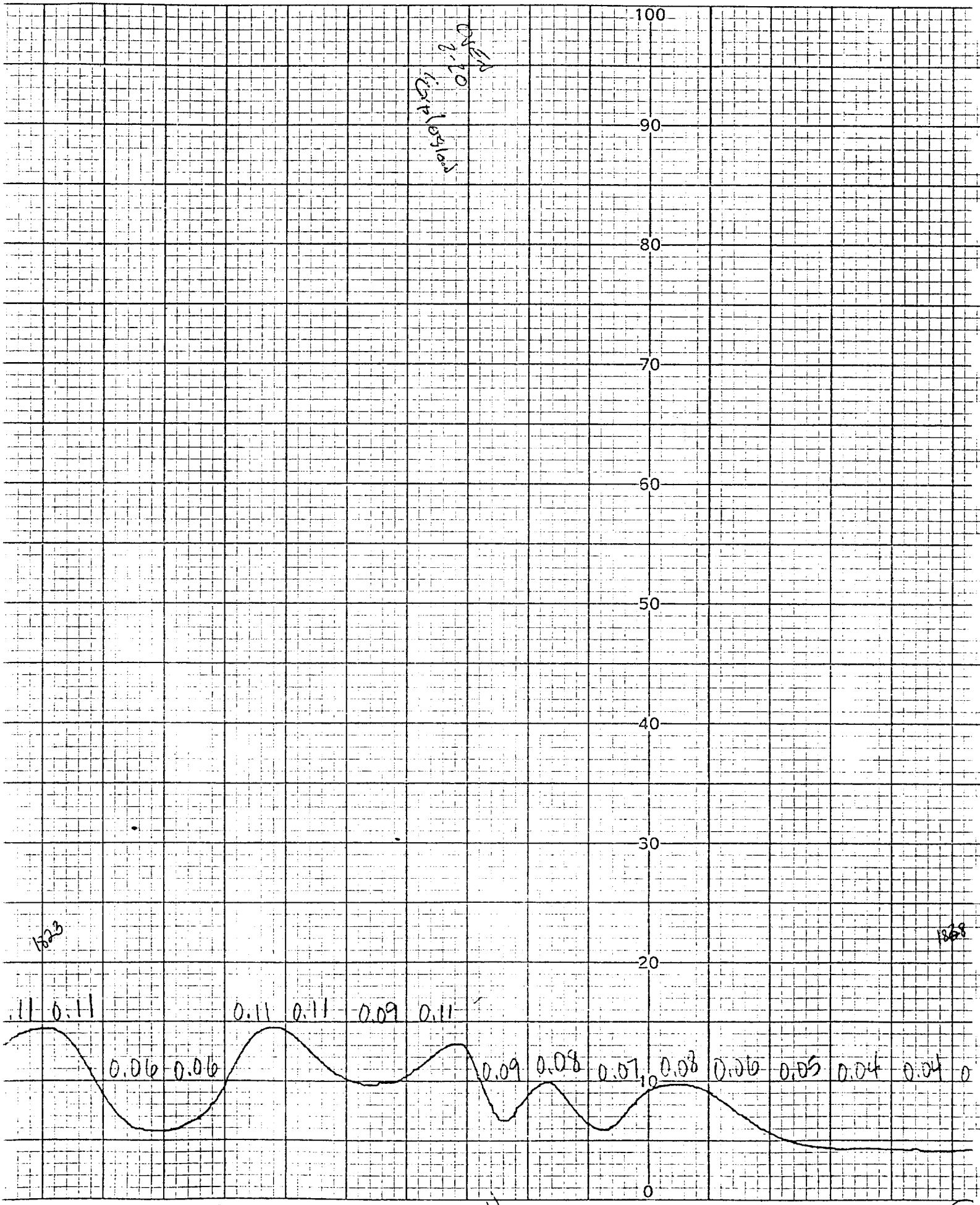

100
90
80
70
60
50
40
30
20
10
0
1721
1735
0.05 0.05 0.06 0.06 0.06 0.06 0.05 0.04 0.06 0.07 0.06 0.08 0.09 0.09 0.07


100
90
80
70
60
50
40
30
20
10
0
0.06
0.05
0.05
0.04
0.04
0.04
0.05
0.06
0.07
0.10
0.10
0.08
0.06
0.08
0.11
BENTON HARBOR, MICHIGAN
CHART NO. 445-17
PRINTED IN U.S.A.

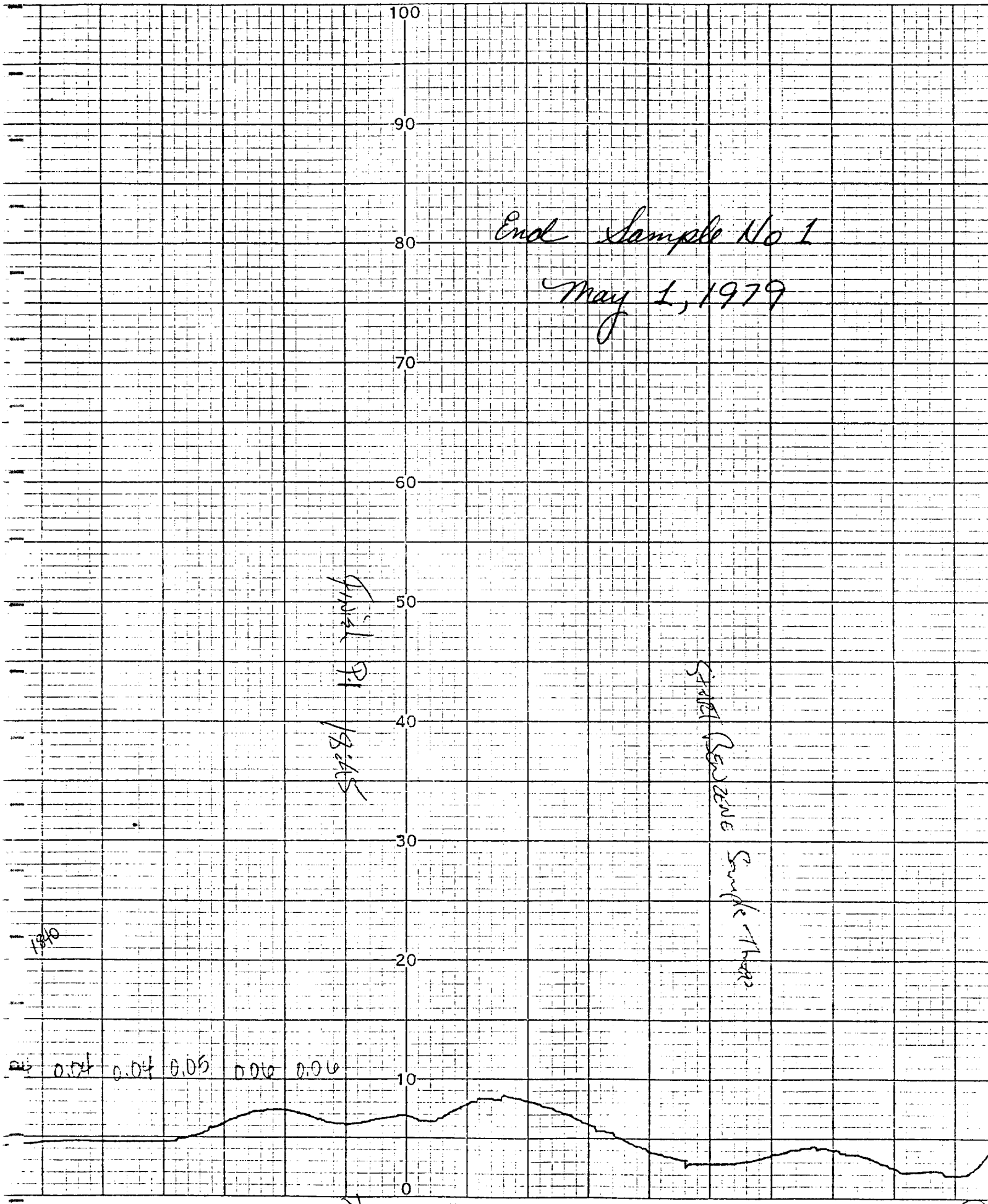


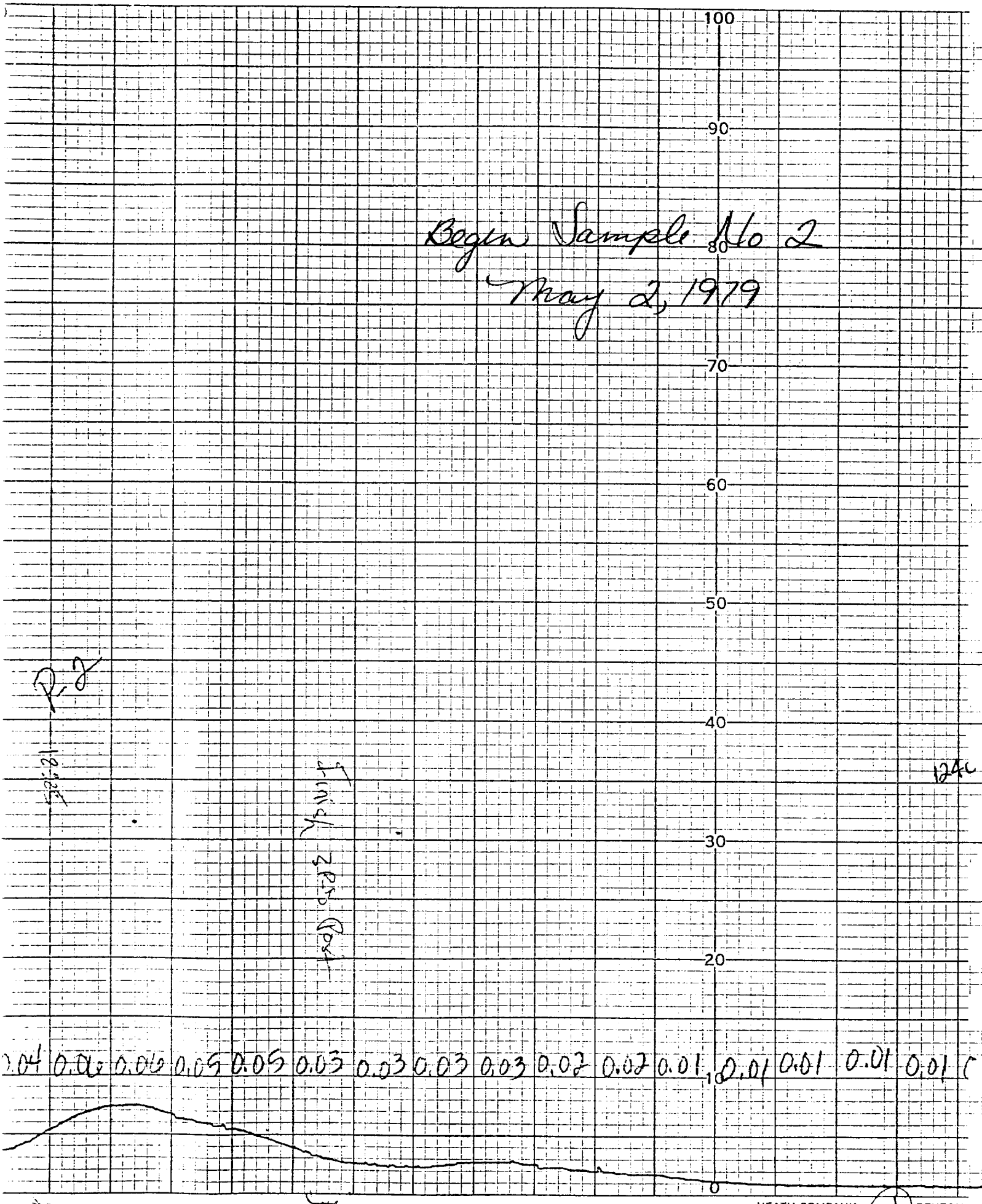
HEATH COMPANY BENTON HARBOR, MICHIGAN CHART NO. 445-17

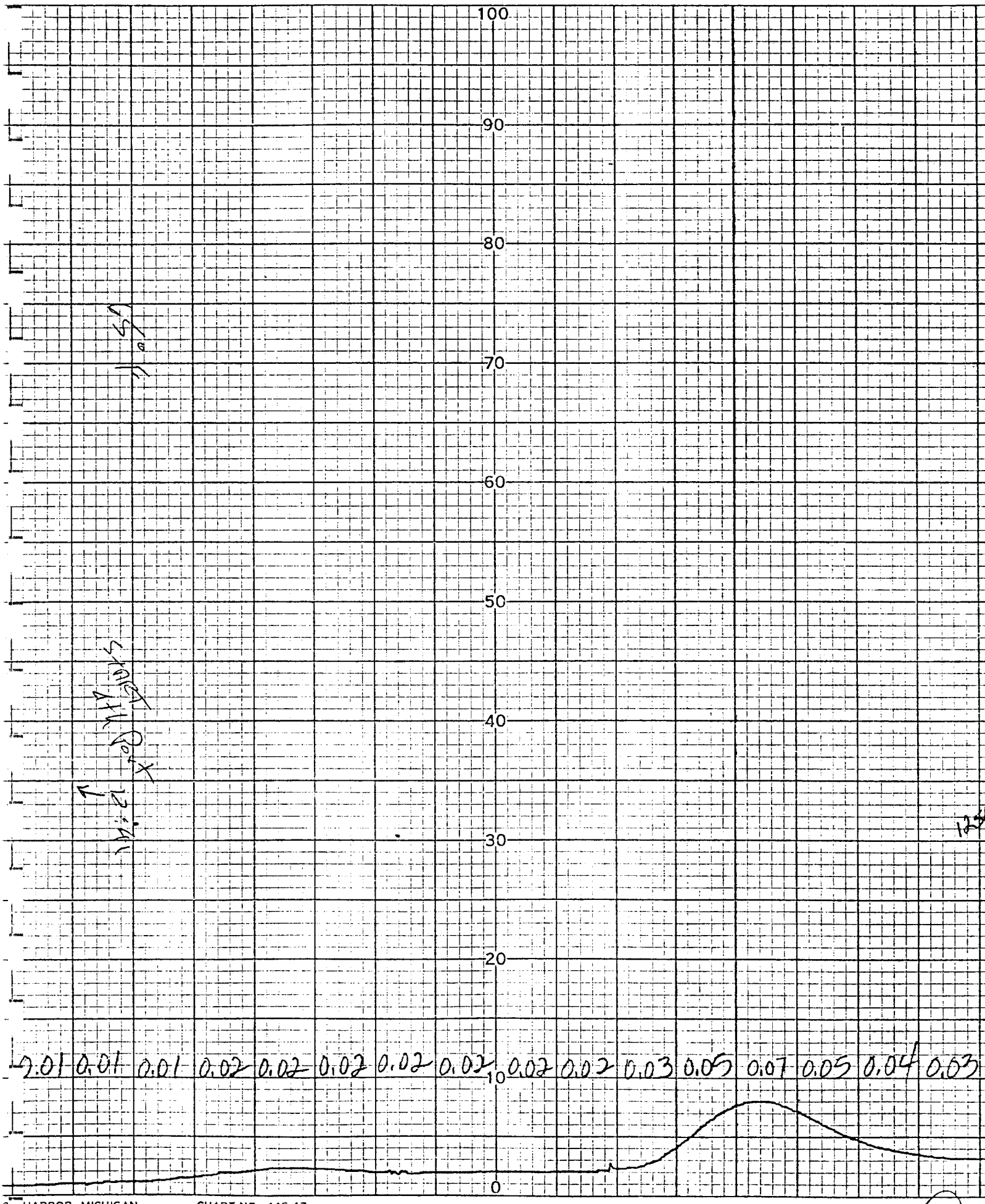

100
90
80
70
60
50
40
30
20
10
0
Start Reference Sample Run
1807
1807
0.05
0.07
0.06
0.09
0.09
0.09
0.08
0.10
0.10
0.09
0.06
0.05
0.05
0.05
0.08

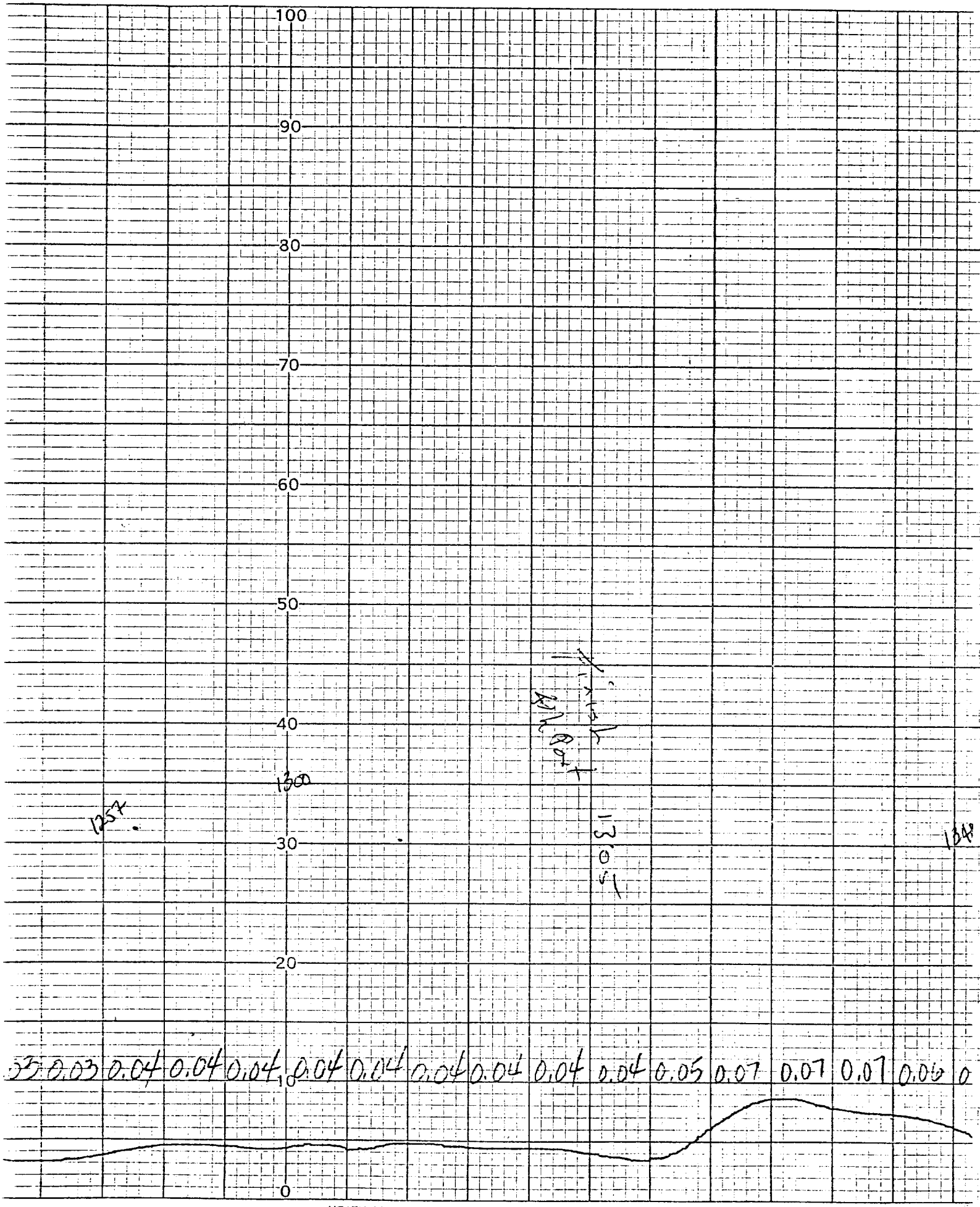


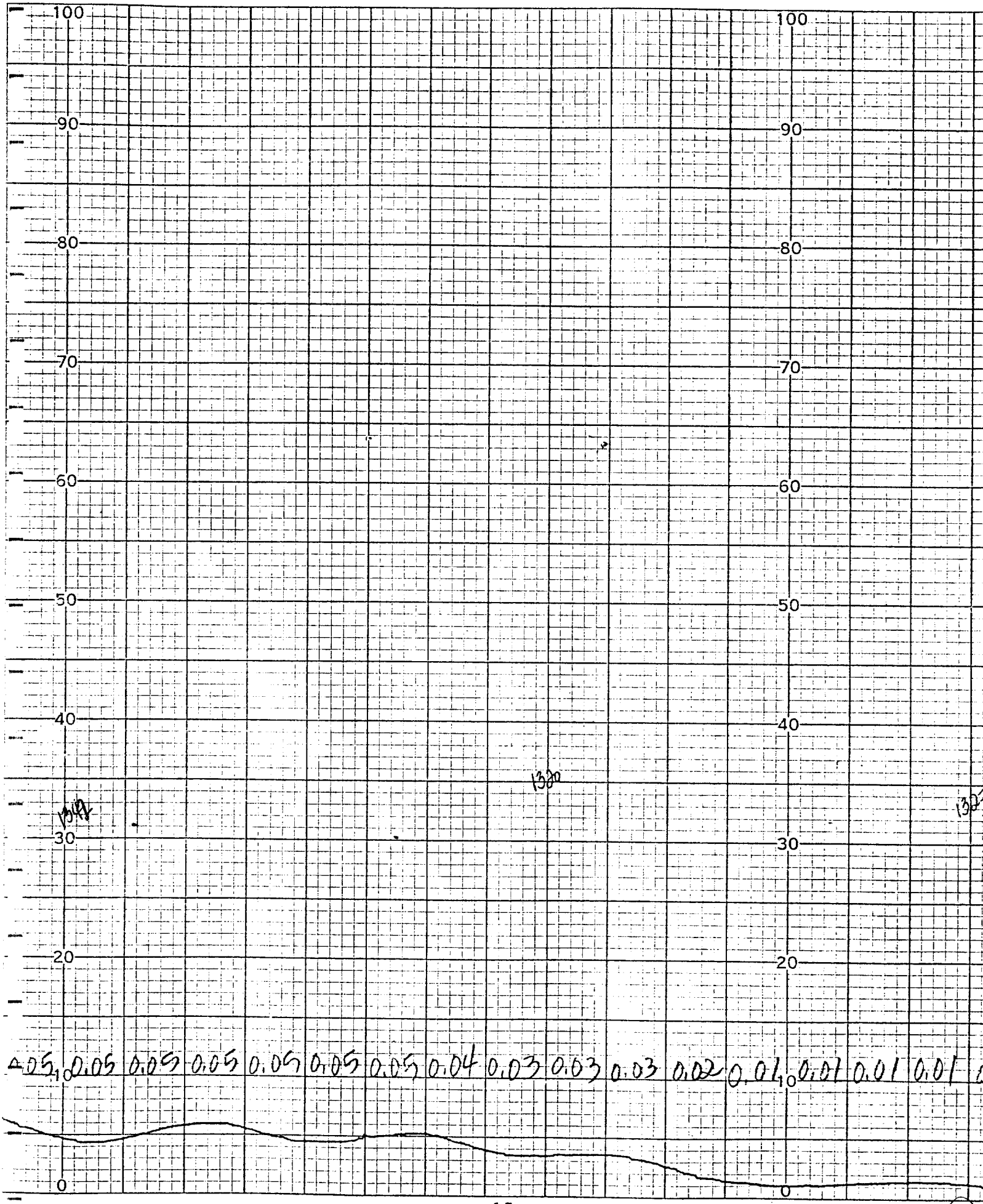
COMPANY BENTON HARBOR, MICHIGAN CHART NO. 445-17 PRINTED IN U.S.A.


100
90
80
70
60
50
40
30
20
10
0
End Sample No 1
May 1, 1979
Start Benzene Sample May 1, 1979
0.04 0.04 0.05 0.06 0.06
HEATH COMPANY
BENTON HARBOR, MICHIGAN
CHART NO. 445-17


100
90
80
70
60
50
40
30
20
10
0
Begin Sample No 2
May 2, 1979
0.04 0.06 0.06 0.05 0.05 0.03 0.03 0.03 0.03 0.02 0.02 0.01 0.01 0.01 0.01 0.01
HEATH COMPANY
BENTON

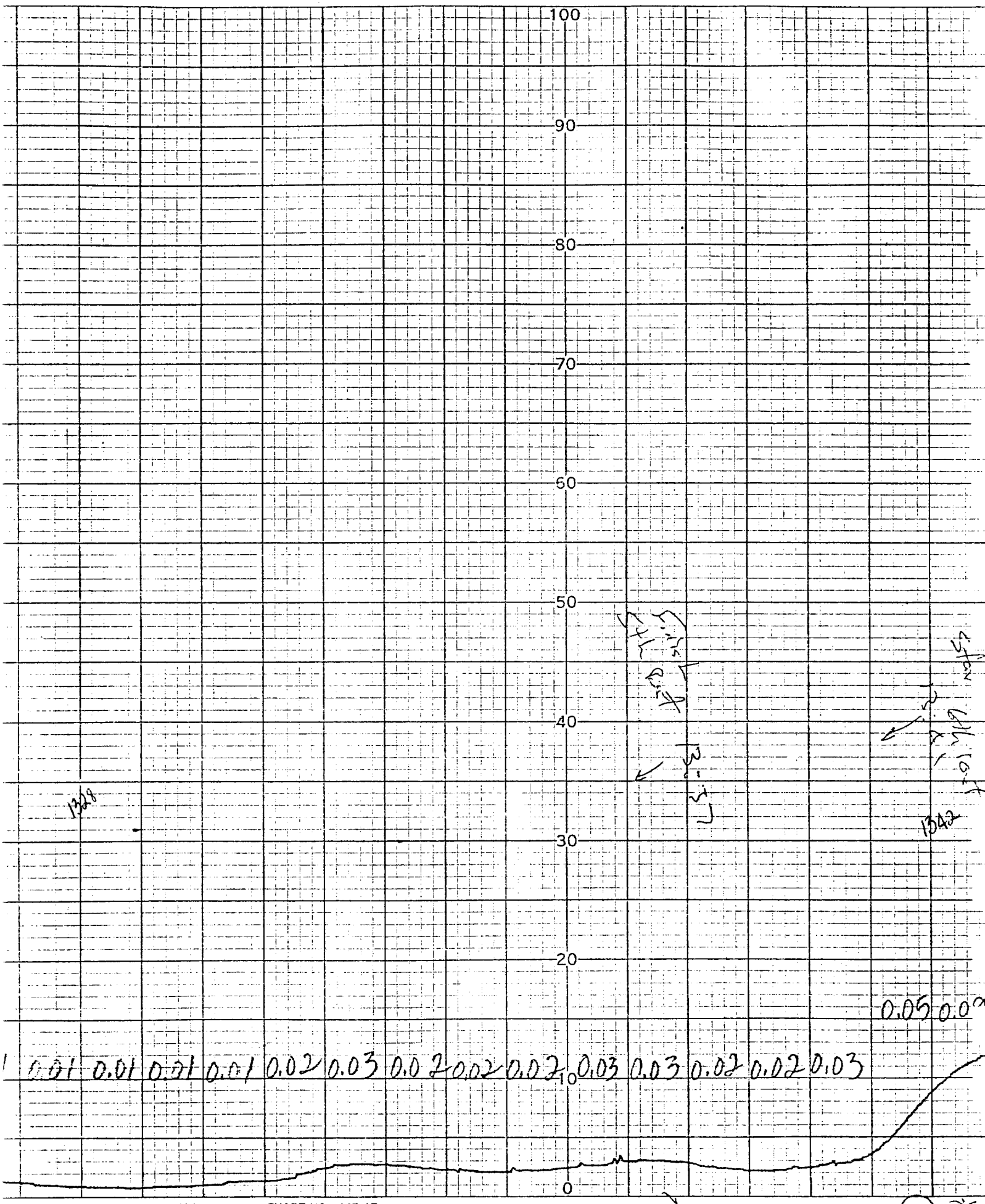

100
90
80
70
60
50
40
30
20
10
0
0.01 0.01 0.01 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.03 0.05 0.07 0.05 0.04 0.03
HARBOR, MICHIGAN
CHART NO. 445-17
PRINTED IN U.S.A.


100
90
80
70
60
50
40
30
20
10
0
1300
1257
1340
0.03 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.04 0.05 0.07 0.07 0.07 0.06

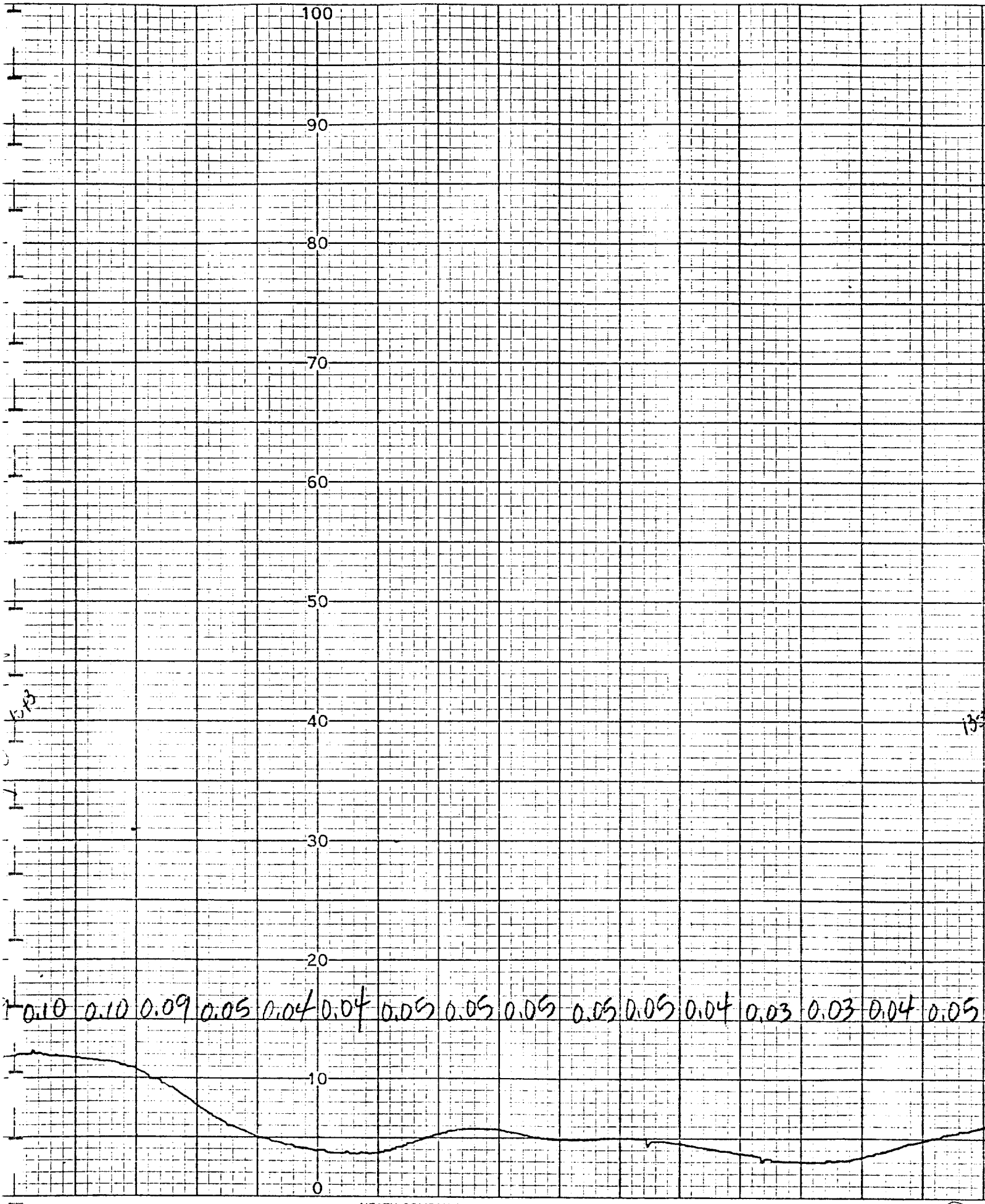


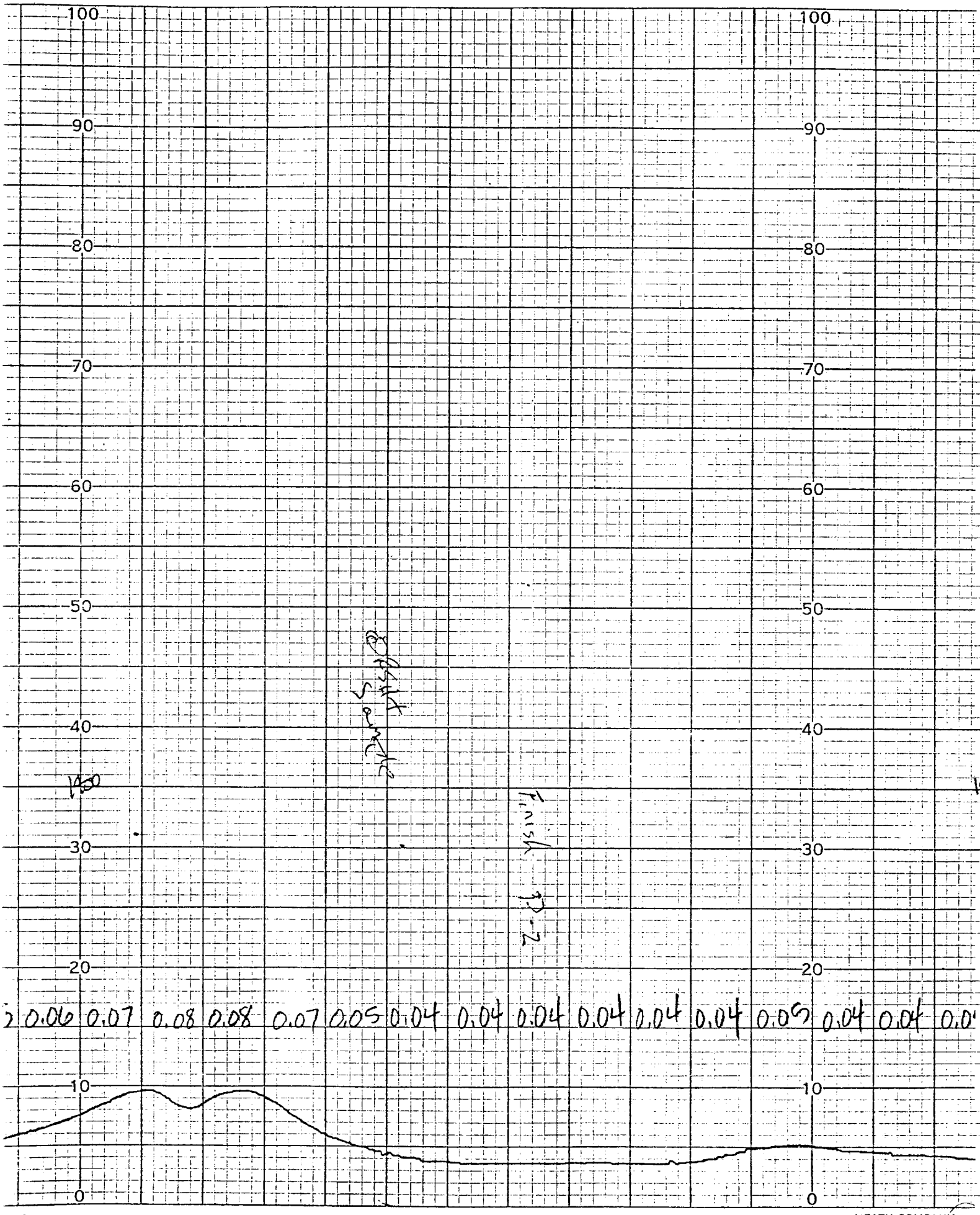
62 HEATH COMPANY

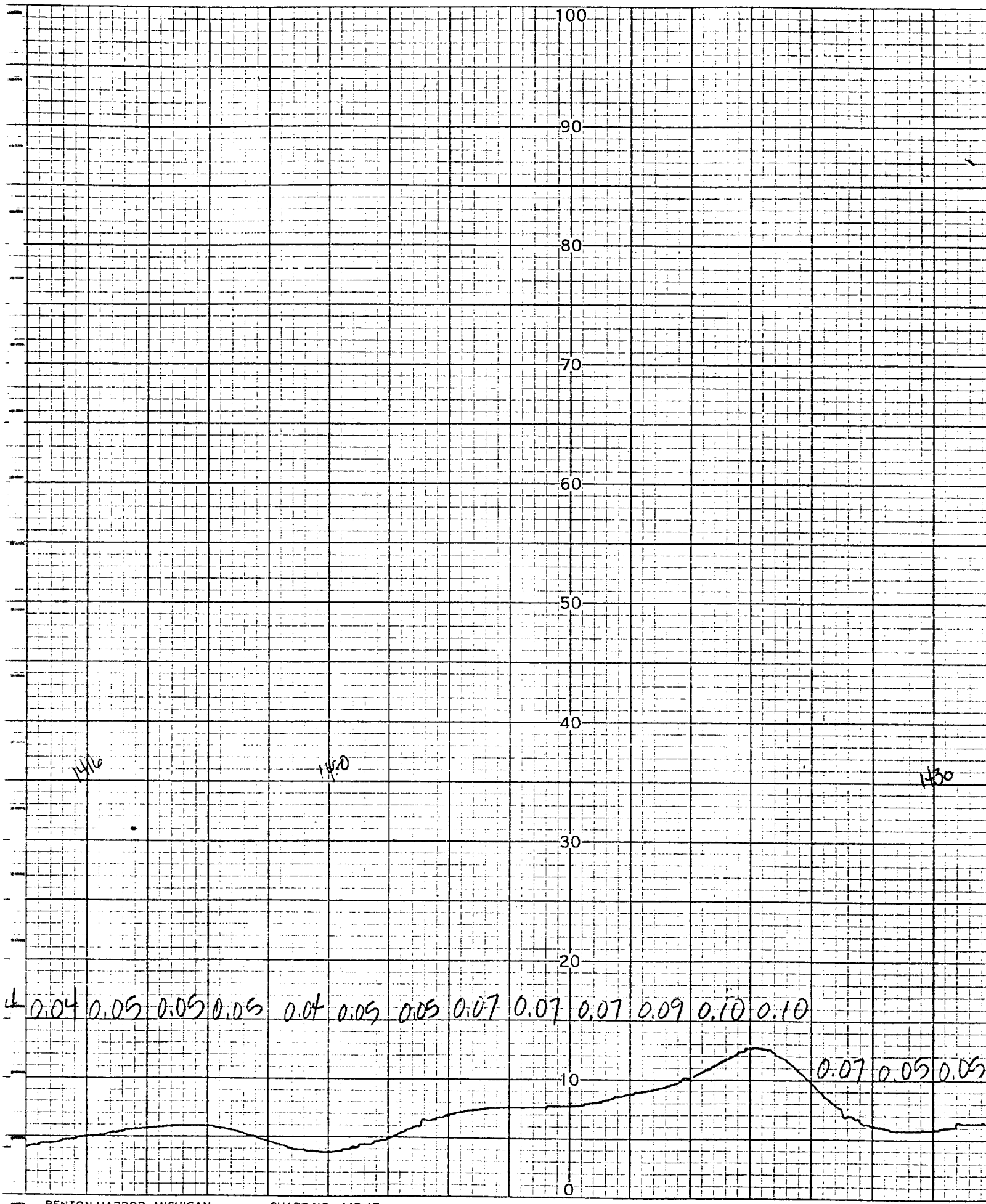
17



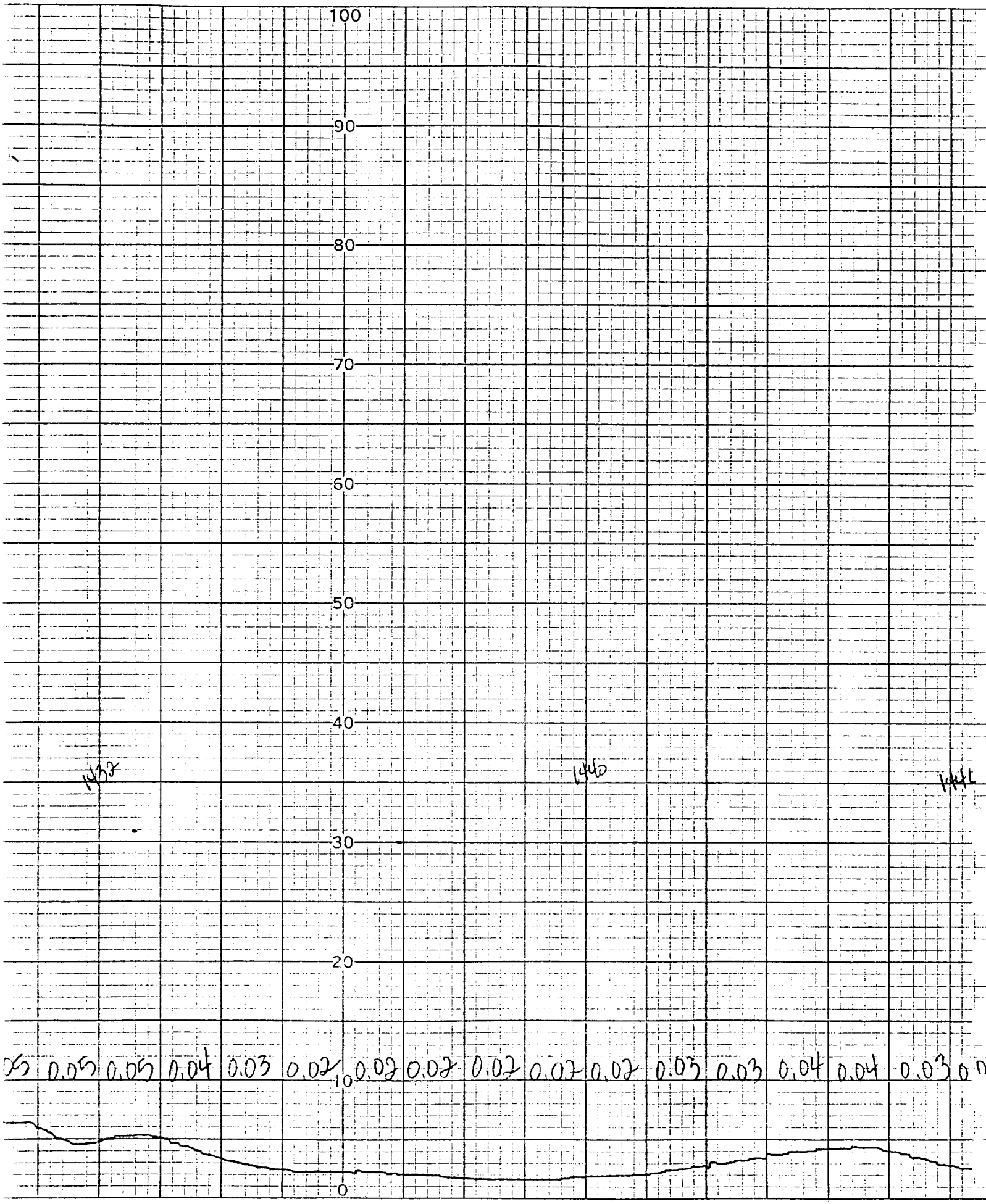
BENTON HARBOR, MICHIGAN CHART NO. 445-17 PRINTED IN U.S.A.

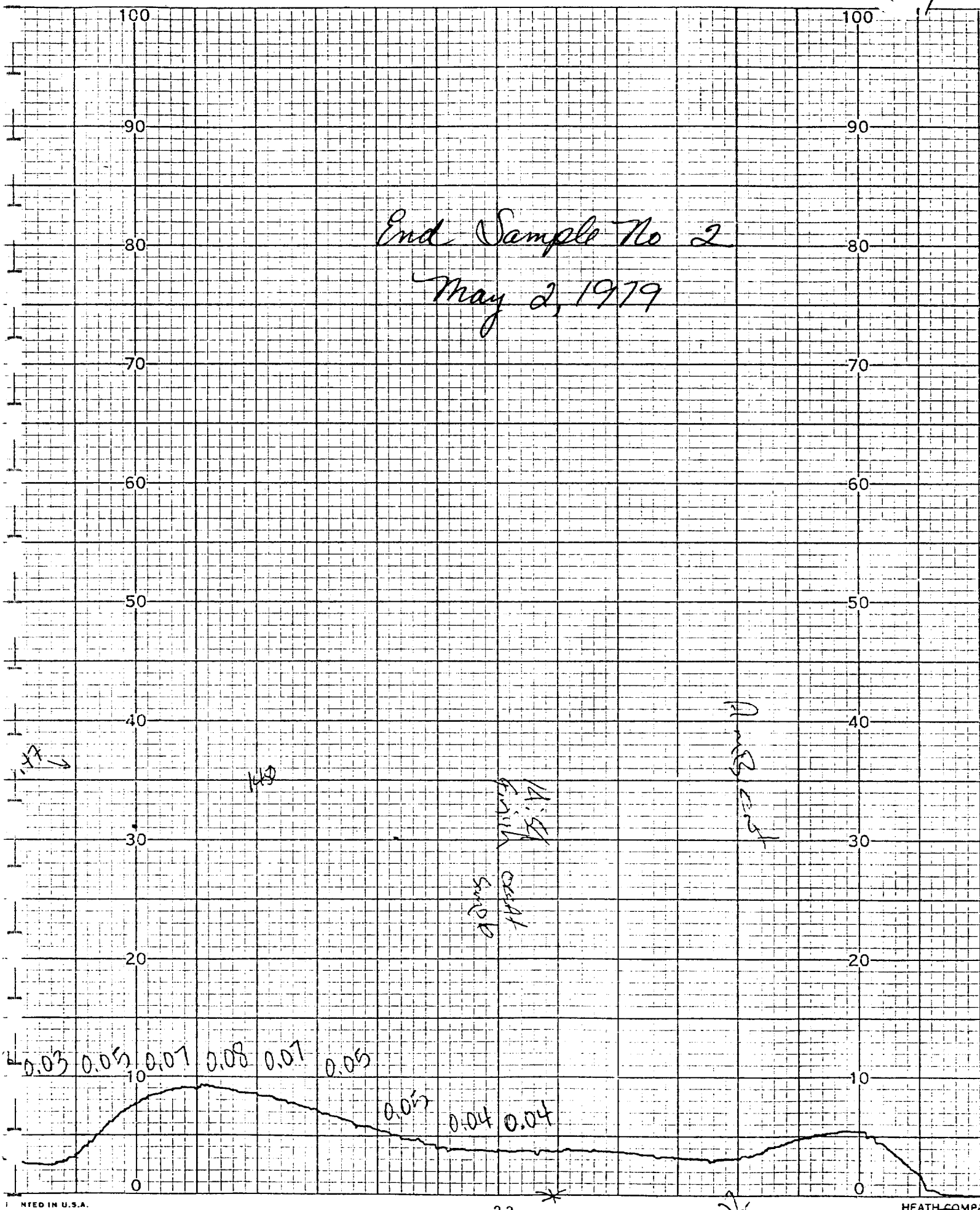

100
90
80
70
60
50
40
30
20
10
0
0.10 0.10 0.09 0.05 0.04 0.04 0.05 0.05 0.05 0.05 0.05 0.04 0.03 0.03 0.04 0.05
HEATH COMPANY
BENTON HARBOR, MICHIGAN
CHART NO. 445-17

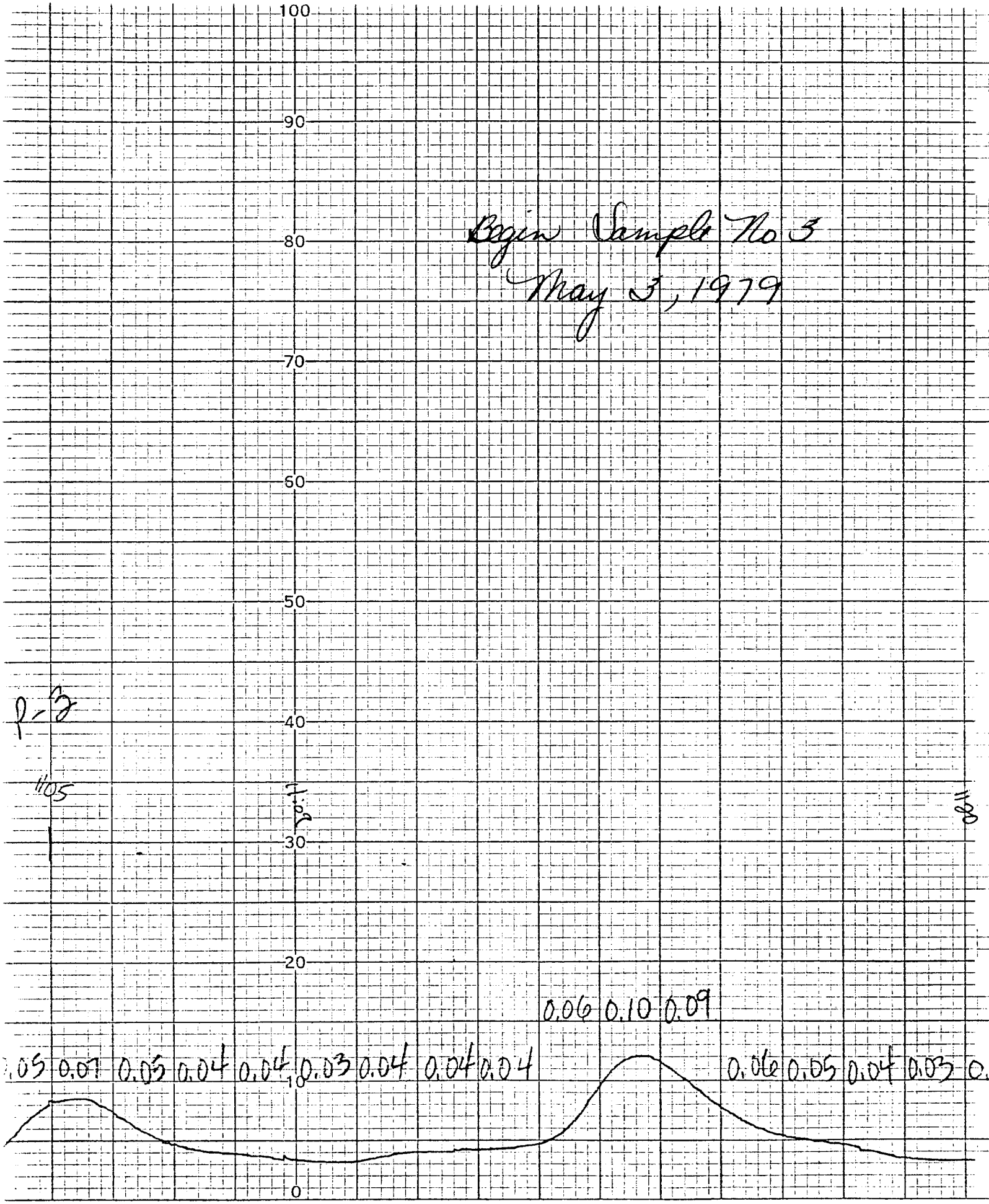

100
90
80
70
60
50
40
30
20
10
0
0.06 0.07 0.08 0.08 0.07 0.05 0.04 0.04 0.04 0.04 0.04 0.04 0.05 0.04 0.04
Finish 2.2
Start 2.2

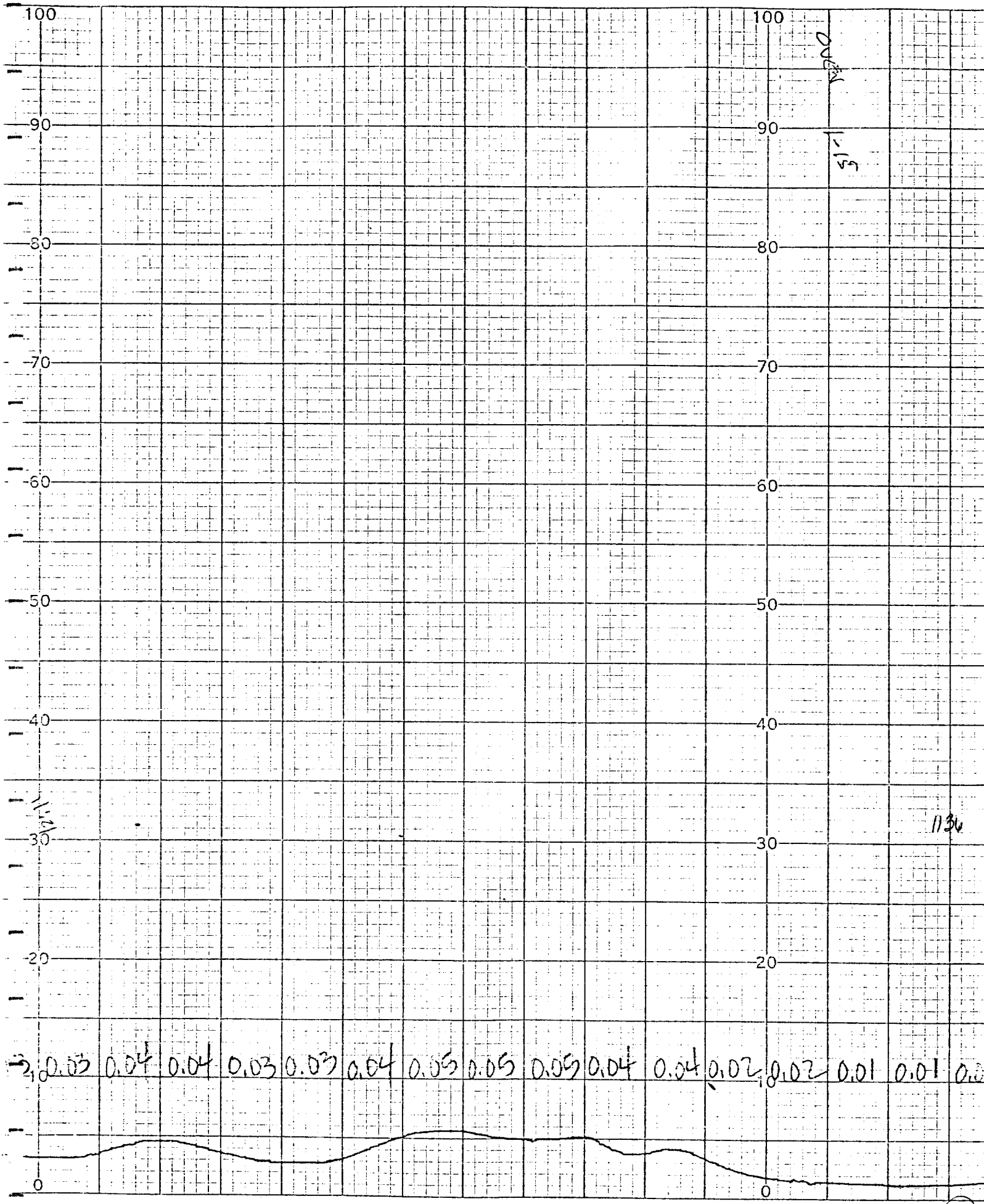


BENTON HARBOR, MICHIGAN CHART NO. 445-17 PRINTED IN U.S.A.

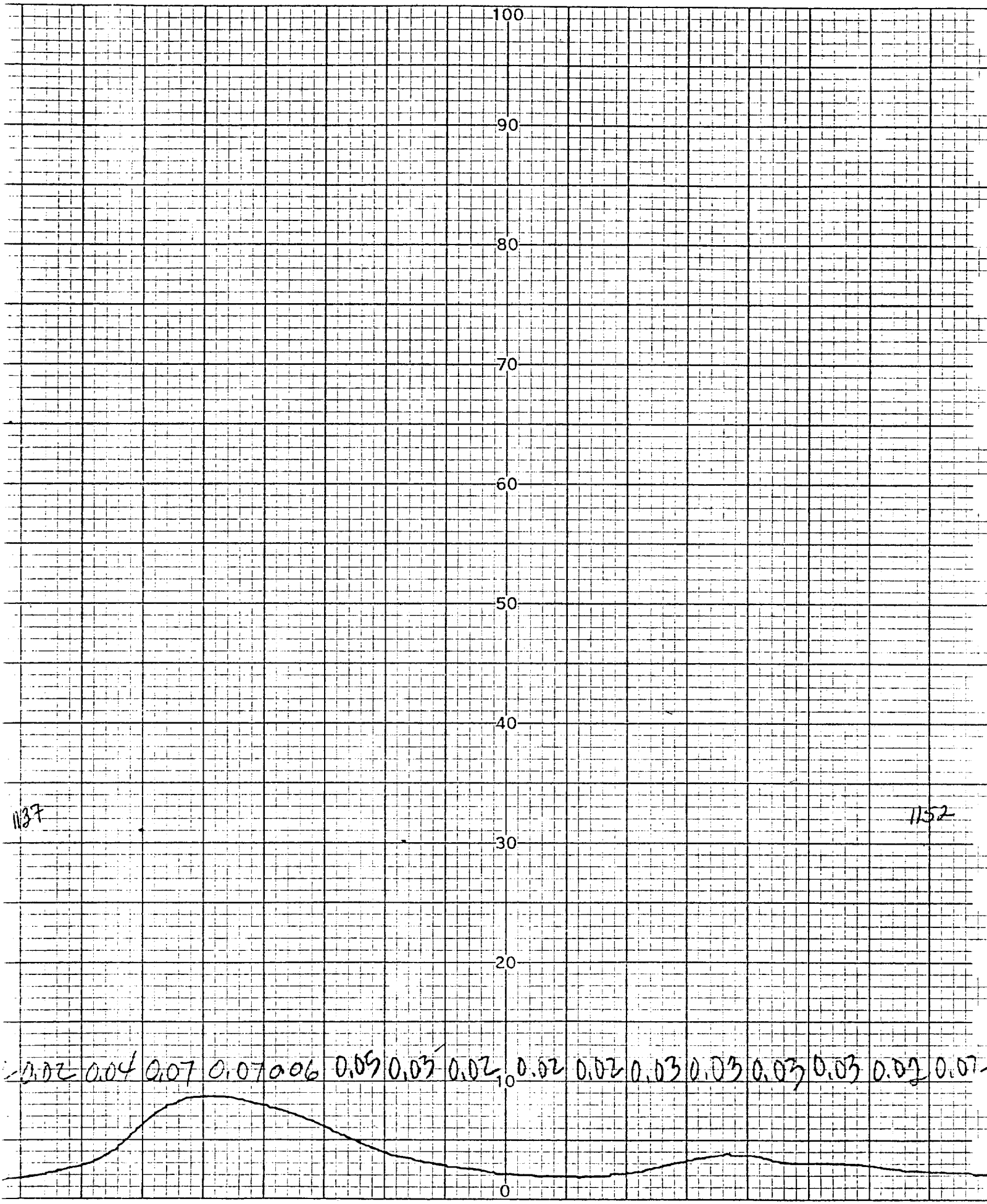

100
90
80
70
60
50
40
30
20
10
0
1432
1440
1448
0.05 0.05 0.04 0.03 0.02 0.02 0.02 0.02 0.02 0.02 0.03 0.03 0.04 0.04 0.03


End Sample No 2
May 2, 1979
100
90
80
70
60
50
40
30
20
10
0
0.03 0.05 0.07 0.08 0.07 0.05
0.05 0.04 0.04

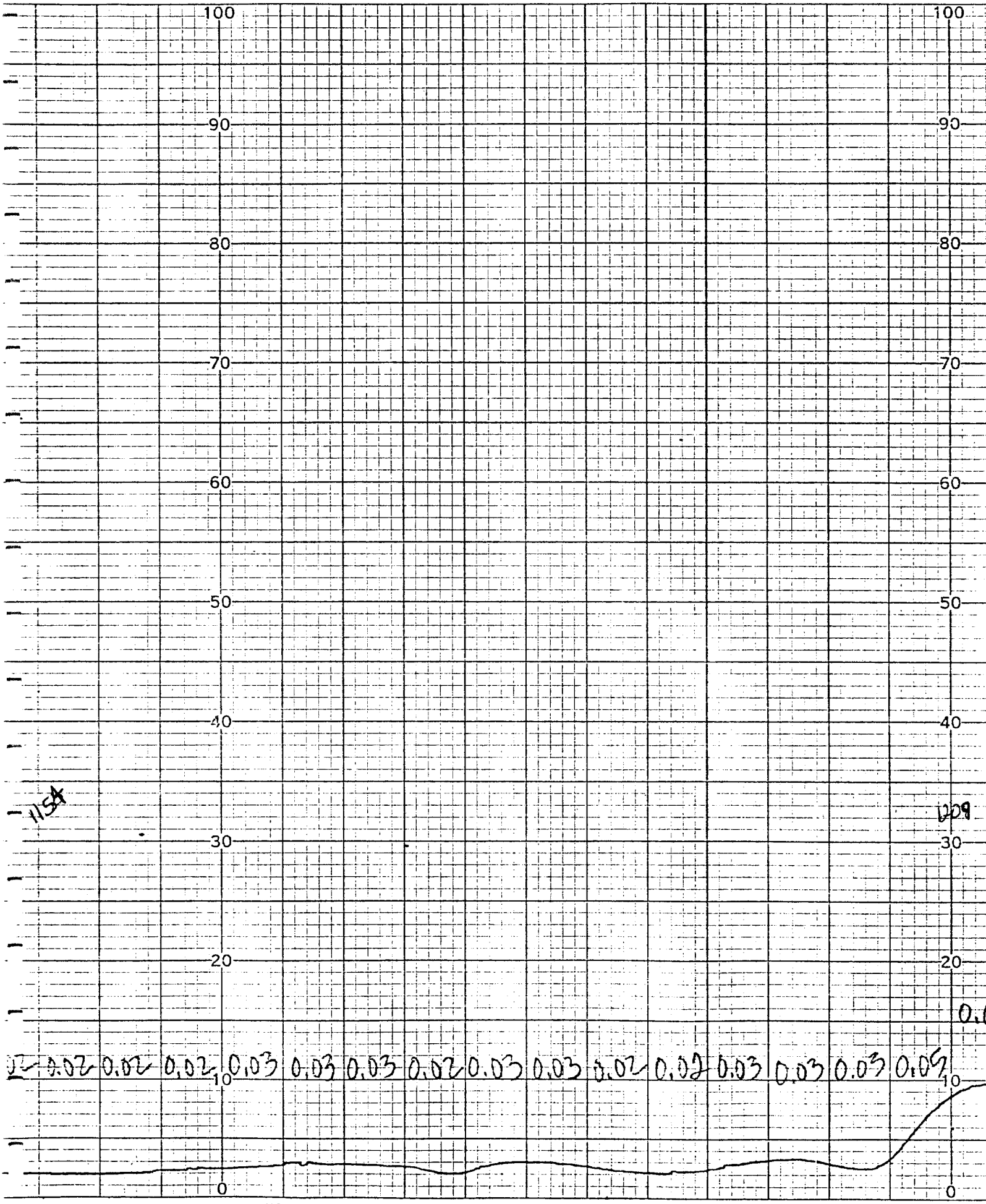

100
90
80
70
60
50
40
30
20
10
0
Begin Sample No 3
May 3, 1979
P-3
1105
1120
0.06 0.10 0.09
.05 0.07 0.05 0.04 0.04 0.03 0.04 0.04 0.04
0.06 0.05 0.04 0.03



62 HEATH COMPANY


100
90
80
70
60
50
40
30
20
10
0
1137
1152
0.02 0.04 0.07 0.07 0.06 0.05 0.03 0.02 0.02 0.02 0.02 0.03 0.03 0.03 0.03 0.02 0.07

gle


100
90
80
70
60
50
40
30
20
10
0
0.02 0.02 0.02 0.03 0.03 0.03 0.02 0.03 0.03 0.02 0.02 0.03 0.03 0.03 0.05
HEATH COMPANY
BENTON HARBOR, MICHIGAN
CHART NO. 445-17
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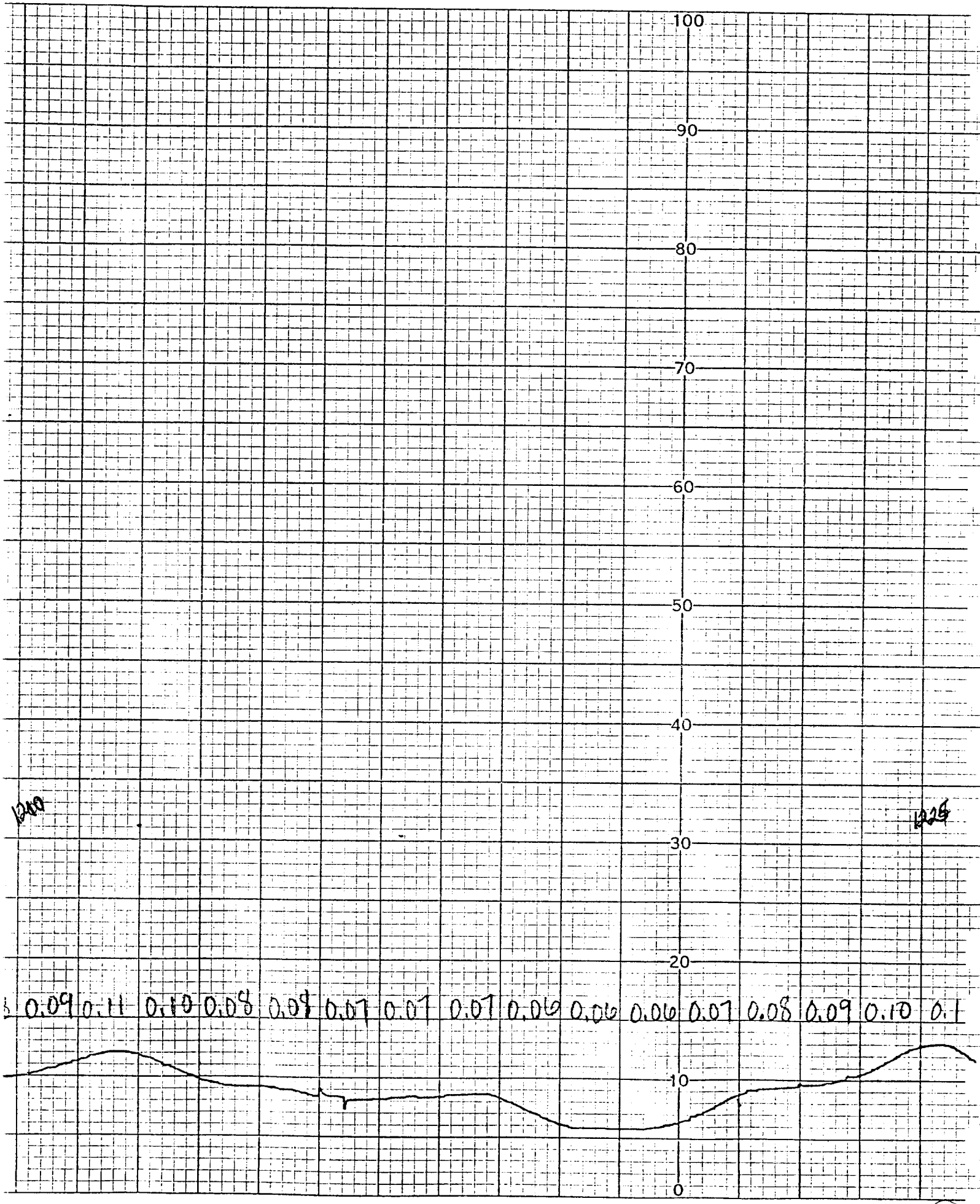
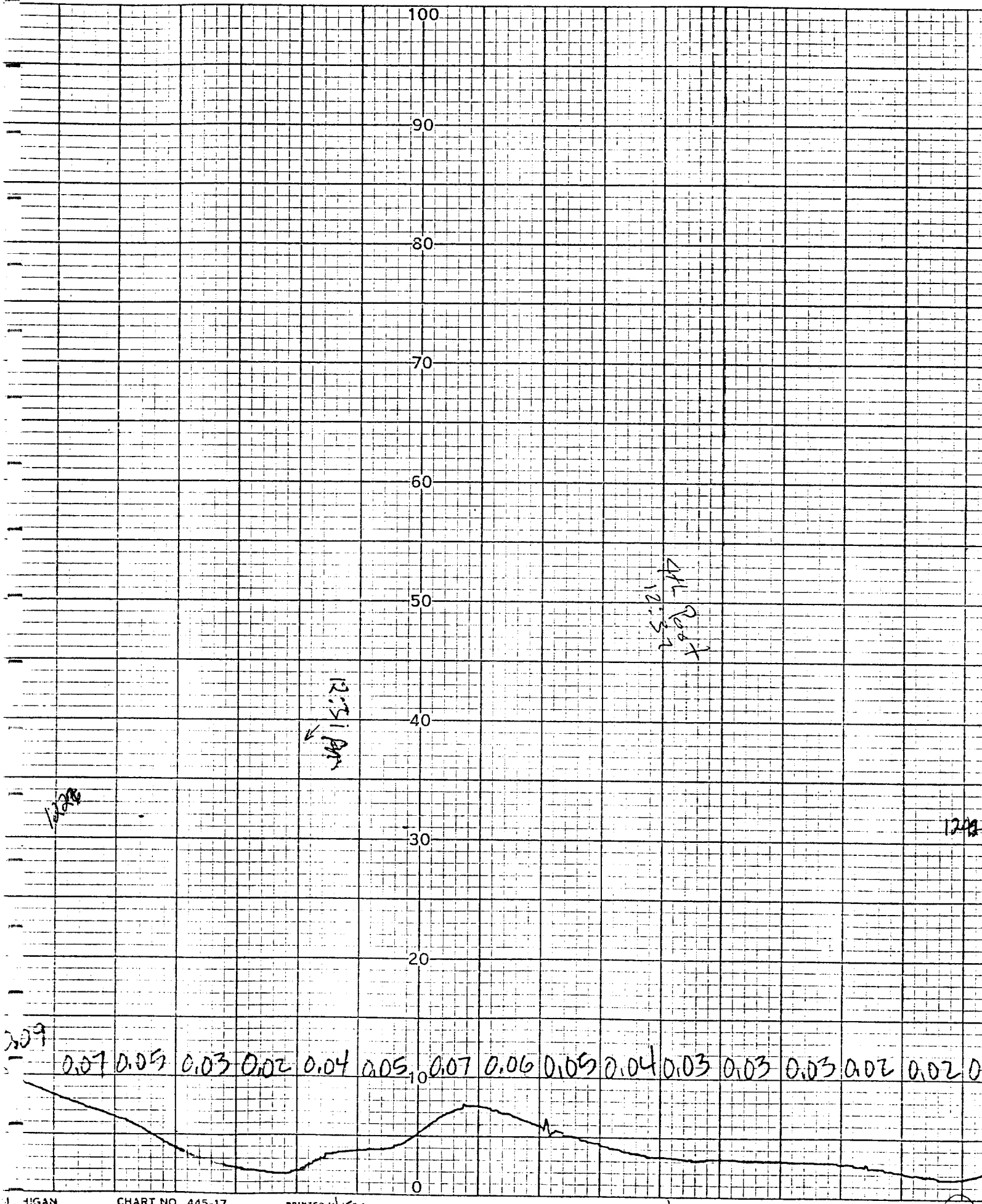
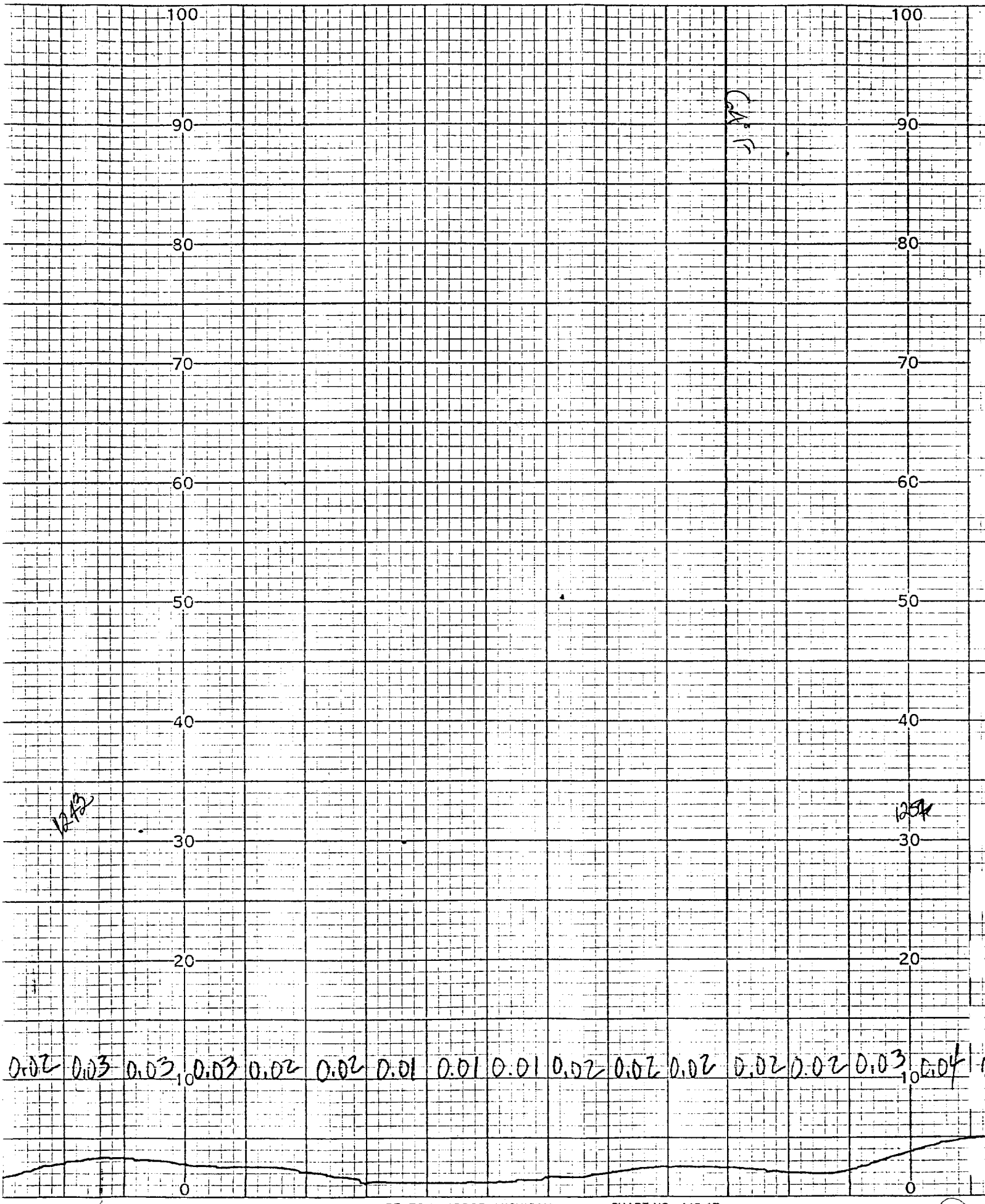
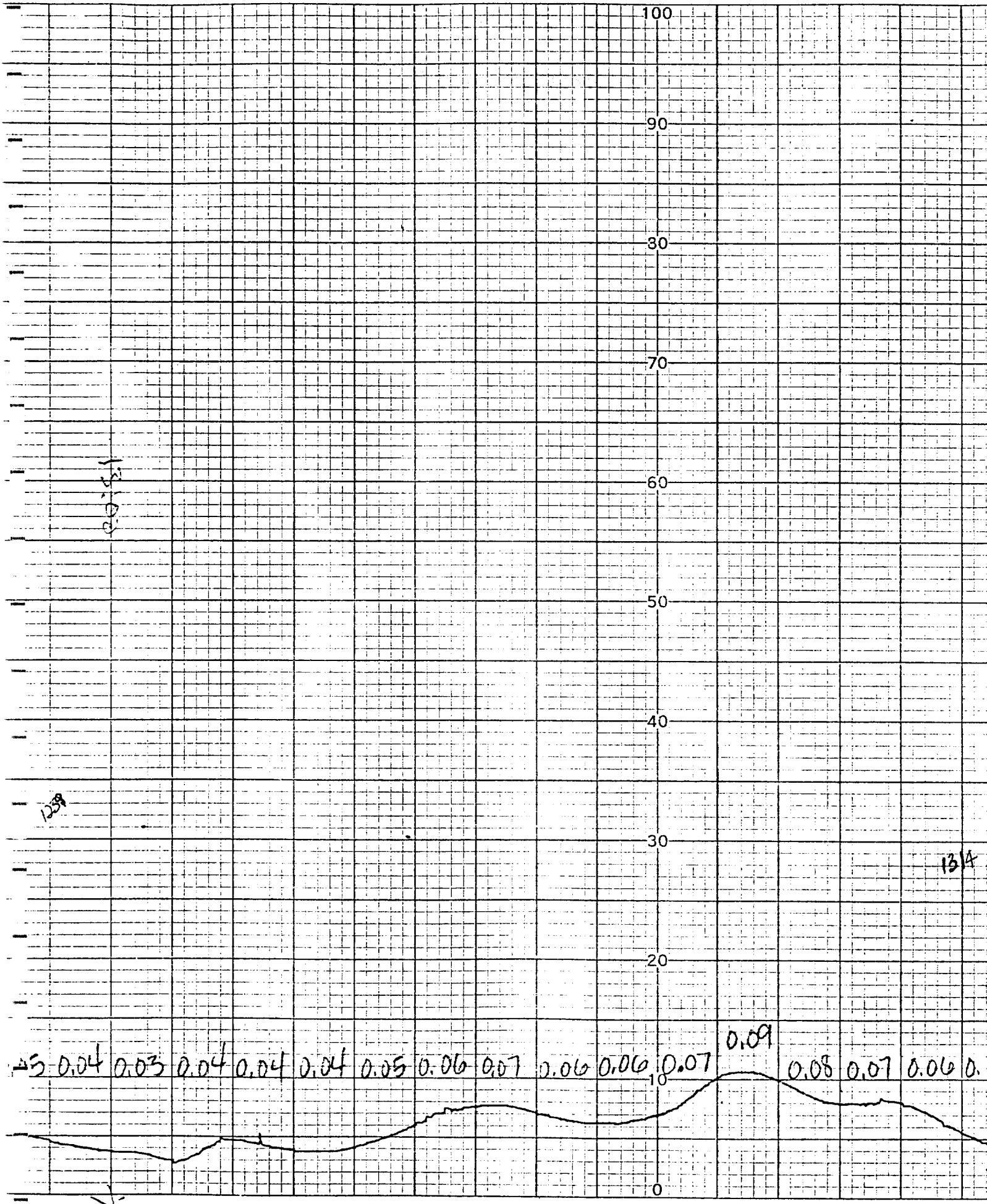


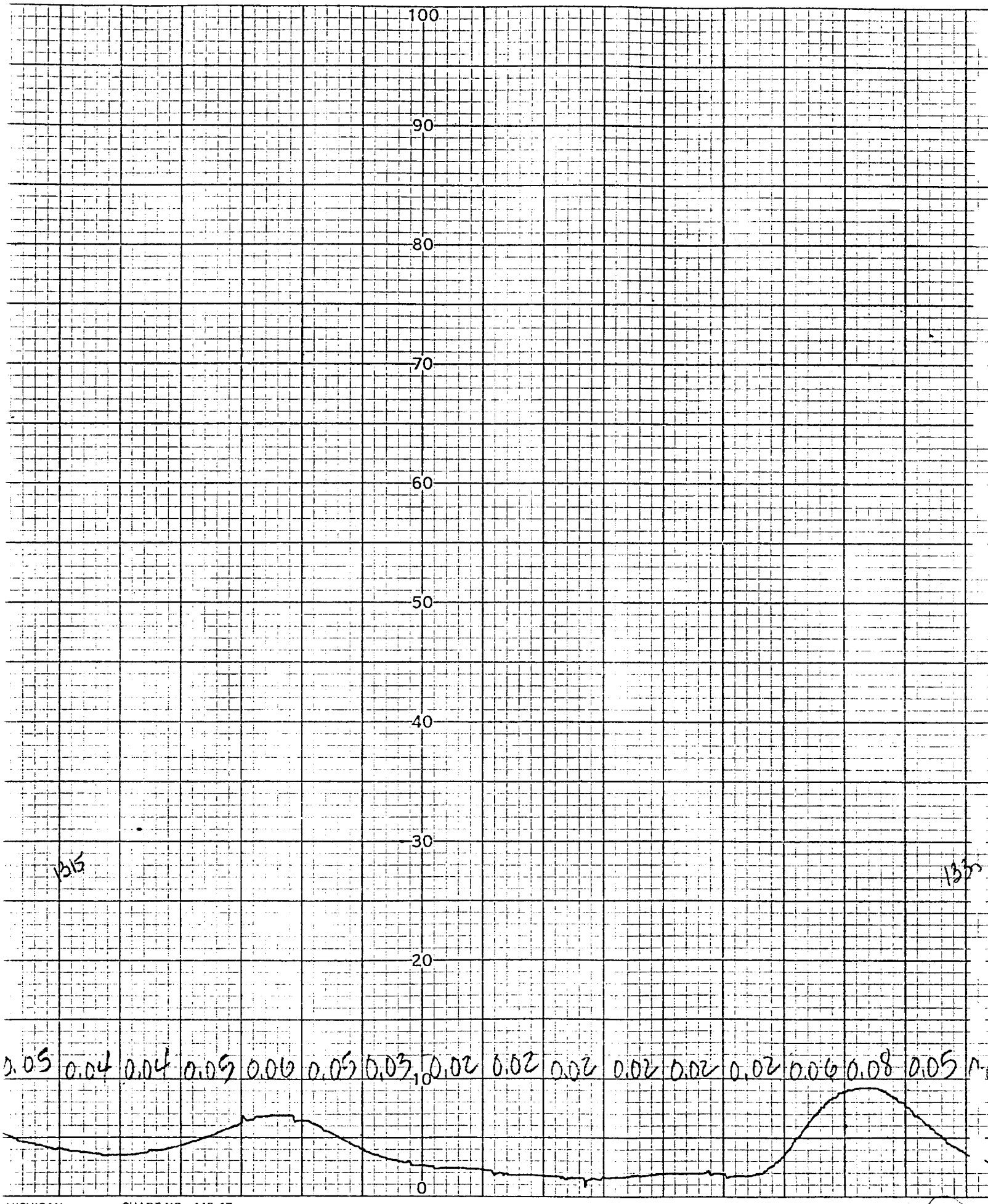
HEATH COMPANY BENTON HARBO


100
90
80
70
60
50
40
30
20
10
0
0.07 0.05 0.03 0.02 0.04 0.05 0.07 0.06 0.05 0.04 0.03 0.03 0.03 0.02 0.02
CHART NO. 445-17
PRINTED IN U.S.A.

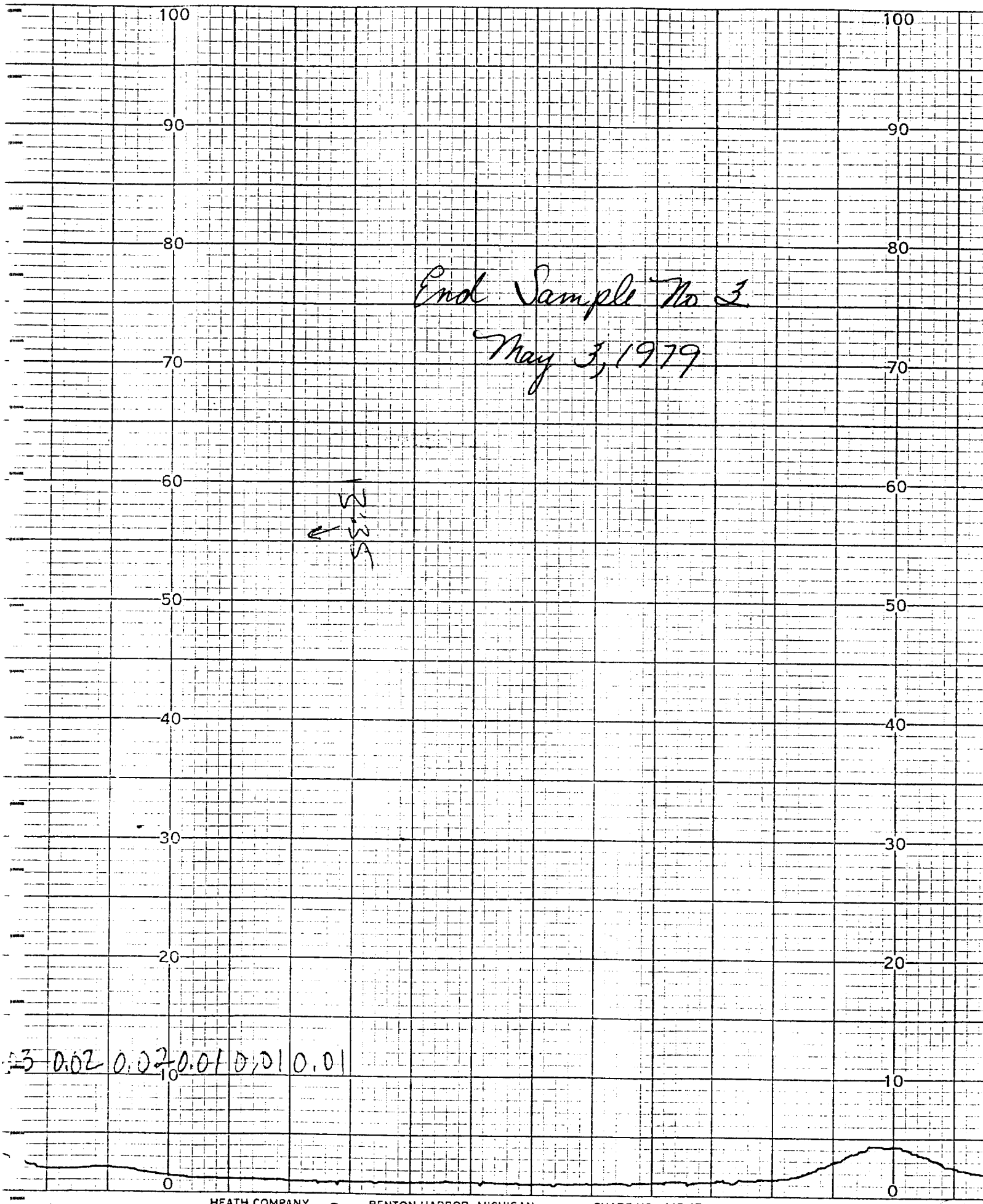

100
90
80
70
60
50
40
30
20
10
0
1243
1257
0.02 0.03 0.03 0.03 0.02 0.02 0.01 0.01 0.01 0.02 0.02 0.02 0.02 0.02 0.03 0.04



HEATH COMPANY BENTON HARBOR, MIC



MICHIGAN CHART NO. 445-17 PRINTED IN U.S.A.


100
90
80
70
60
50
40
30
20
10
0
End Sample No 3
May 3, 1979
0.02 0.02 0.01 0.01 0.01

APPENDIX E-2

Opacity and Carbon Monoxide Correlation Data

Sample 1 Run 1

Desired lag time from opacity reading to co reading 2.5
Based on 100.00 percent of 800 usable data sets (from a total of 824); for a total of 660 data points
The Coefficient of Correlation is ~~.0520~~ .2302
The Linear Regression Coefficients: CO = 11.131 Opacity + 569.794

DISTRIBUTION OF READINGS

	Opacities										
	0	5	10	15	20	25	30	35	40	45	50<
<150	0	1	0	0	0	0	0	0	0	0	0
<250	1	22	0	0	0	0	0	0	0	0	0
<350	3	62	0	0	0	0	0	0	0	0	0
<450	7	108	8	0	1	1	0	0	0	0	0
<550	8	133	11	6	0	1	1	0	0	0	0
<650	3	91	9	6	1	5	1	0	0	0	0
<750	4	63	6	7	4	2	2	0	0	0	0
20 ppm <850	10	22	3	2	3	2	2	1	0	0	0
<950	16	35	10	2	4	3	1	0	1	0	0
<1050	9	25	13	1	1	0	2	0	0	0	0
<1150	1	11	11	2	0	1	0	0	0	0	0
<1250	2	5	5	1	1	0	1	0	0	0	0
<1350	0	0	3	0	0	0	0	0	0	0	0
<1450	0	1	1	0	0	0	0	0	0	0	0
1450<	0	0	4	0	0	0	0	0	0	0	0
stop gru's:7.0	62	586	88	30	15	16	10	1	1		

!list 8

72%

Boxed area represents points which do not seem to correlate. These points were the target of elimination

Points eliminated for the next run

1558.0 - 1607.0, 1548.2 - 1557.2, 1713.0 - 1716.1

(1)

Sample 1 Run 2

Desired lag time from opacity reading to co reading 2.5
based on 89.01 percent of 810 usable data sets (from a total of 824); for a total of 721 data points
The Coefficient of Correlation is ~~.1[illegible]~~ .3294
The Linear Regression Coefficients: CO = 13.253 Opacity + 505.145

DISTRIBUTION OF READINGS

	Opacities										
	0	5	10	15	20	25	30	35	40	45	50<
<150	0	0	0	0	0	0	0	0	0	0	0
<250	1	23	0	0	0	0	0	0	0	0	0
<350	3	68	0	0	0	0	0	0	0	0	0
<450	7	108	3	0	1	1	0	0	0	0	0
<550	8	133	11	6	0	1	1	0	0	0	0
<650	3	90	8	6	1	5	1	0	0	0	0
<750	3	62	6	7	4	2	0	0	0	0	0
CO ppm <850	6	19	3	3	3	2	2	1	0	0	0
<950	2	33	8	3	4	3	1	0	1	0	0
<1050	1	9	13	1	1	0	2	0	0	0	0
<1150	1	2	7	2	0	1	0	0	0	0	0
<1250	0	4	0	1	1	0	1	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

Points eliminated for the 3rd run

1741.3 - 1743.3, 1829.2 - 1832.0

Sample 1 Run 3

Desired lag time from opacity reading to co reading; 2.5
Based on 86.54 percent of 810 usable data sets (From a total of 924); for a total of 701 data points
The Coefficient of Correlation is ~~.1122~~ .3360
The Linear Regression Coefficients: CO = 13.053 Opacity + 426.910

DISTRIBUTION OF READINGS

	Opacities										
	0	5	10	15	20	25	30	35	40	45	50<
<150	0	0	0	0	0	0	0	0	0	0	0
<250	1	23	0	0	0	0	0	0	0	0	0
<350	3	68	0	0	0	0	0	0	0	0	0
<450	7	108	8	0	1	1	0	0	0	0	0
<550	8	133	10	6	0	0	1	0	0	0	0
<650	3	90	0	5	1	4	1	0	0	0	0
<750	3	60	6	6	3	1	2	0	0	0	0
00 ppm <850	6	13	3	3	0	2	2	1	0	0	0
<950	2	30	0	0	4	3	1	0	1	0	0
<1050	1	5	13	1	1	0	2	0	0	0	0
<1150	1	2	7	2	0	1	0	0	0	0	0
<1250	0	4	0	1	1	0	1	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

stop

↑ 77 90

(3)

Sample 1 based on charge interval

Control location from [illegible]

Charge interval: 1 minute

[illegible] on 100.00 percent of [illegible] model data sets (from a total of [illegible]): [illegible] points

The Coefficient of Correlation is [illegible] 0.4782

The Linear Regression Coefficients: [illegible] = [illegible] Capacity = 460.[illegible]

Do you wish to see the point distribution?y

Distribution of Residuals

	Residuals										
	0	5	10	15	20	25	30	35	40	45	50<
<150	0	0	0	0	0	0	0	0	0	0	0
<250	0	5	0	0	0	0	0	0	0	0	0
<350	0	17	0	0	0	0	0	0	0	0	0
<450	0	0	0	0	0	0	0	0	0	0	0
<550	0	12	0	0	0	0	0	0	0	0	0
<650	0	0	0	0	0	0	0	0	0	0	0
<750	0	0	1	3	1	1	0	0	0	0	0
<850	1	0	0	0	2	0	0	0	0	0	0
<950	1	4	1	0	1	1	0	0	0	0	0
<1050	1	0	0	0	1	0	0	0	0	0	0
<1150	1	0	0	1	0	1	0	0	0	0	0
<1250	0	0	0	0	0	0	1	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

Again? n

Stop

Points eliminated for next run are those eliminated for the 3rd run of the last set.

Sample 1

[illegible]

Change interval=1

Based on 94.44 percent of [illegible] usable data sets (from a total of [illegible]); for a total of [illegible] data points.

The Coefficient of Correlation is ~~[illegible]~~ .4735

The Linear Regression Coefficients: [illegible] = [illegible] Velocity + 454.037

Do you wish to see the point distribution?y

DISTRIBUTION OF POINTS

Velocities

	0	5	10	15	20	25	30	35	40	45	50<
<150	0	0	1	0	0	0	0	0	0	0	1
<250	0	5	0	0	0	0	0	0	0	0	0
<350	0	17	0	0	0	0	0	0	0	0	0
<450	0	3	0	0	0	0	0	0	0	0	0
<550	0	12	3	0	0	0	0	0	0	0	1
<650	0	0	0	2	0	0	0	0	0	0	0
<750	0	5	1	2	0	1	0	0	0	0	1
00 pm <850	1	0	0	0	0	0	0	0	0	0	0
<950	1	4	1	0	1	1	0	0	0	0	0
<1050	1	0	0	0	1	0	0	0	0	0	0
<1150	1	0	0	1	0	1	0	0	0	0	0
<1250	0	0	0	0	0	0	1	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	1
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

351	n,1657.2,5,.662
352	n,1657.3,5,.665
353	n,1658.0,0,.065
354	n,1658.1,0,.065
355	n,1659.2,0,.060
356	n,1659.3,0,.060
357	n,1660.0,0,.055
358	n,1660.1,0,.050
359	n,1660.2,0,.050
360	n,1660.3,0,.050

these points elemenated for next run

5

Sample 1

[illegible] time from [illegible] to [illegible]

Change interval=1

Based on [illegible] percent of [illegible] usable data sets (from a total of [illegible]); for a total of [illegible] data points

The Coefficient of Correlation is ~~.7791~~ .6100

The Linear Regression Coefficients: [illegible] = 29.1[illegible] Opacity + 27[illegible]

Do you wish to see the point distribution?

Frequency of [illegible]

	Opacities										
	0	5	10	15	20	25	30	35	40	45	50<
<150	0	0	0	0	0	0	0	0	0	0	0
<250	0	5	0	0	0	0	0	0	0	0	0
<350	0	17	0	0	0	0	0	0	0	0	0
<450	0	3	0	0	0	0	0	0	0	0	0
<550	0	12	0	0	0	0	0	0	0	0	0
<650	0	0	0	0	0	0	0	0	0	0	0
<750	0	0	1	0	0	1	0	0	0	0	0
<850	0	0	0	0	0	0	0	0	0	0	0
<950	0	4	1	0	1	1	0	0	0	0	0
<1050	0	0	0	0	1	0	0	0	0	0	0
<1150	0	0	0	1	0	1	0	0	0	0	0
<1250	0	0	0	0	0	0	1	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

6

Sample 1

Desired location from opacity reading to be [illegible]
Change interval=1
Based on 74.17 percent of 99 usable data sets (from a total of 99): for a total of 69 data points
The Coefficient of Correlation is ~~[illegible]~~ .7359
The Linear Regression Coefficients: [illegible] = 27.593 Opacity + 324.463
Do you wish to see the point distribution?y

DISTRIBUTION OF READINGS

	Opacities										
	0	5	10	15	20	25	30	35	40	45	50<
<150	0	0	0	0	0	0	0	0	0	0	0
<250	0	5	0	0	0	0	0	0	0	0	0
<350	0	17	0	0	0	0	0	0	0	0	0
<450	0	3	6	0	0	0	0	0	0	0	0
<550	0	12	3	0	0	0	0	0	0	0	0
<650	0	0	3	2	0	0	0	0	0	0	0
<750	0	6	1	2	0	1	0	0	0	0	0
850 ppm <850	0	0	0	0	0	0	0	0	0	0	0
<950	0	0	0	0	1	1	0	0	0	0	0
<1050	0	0	0	0	1	0	0	0	0	0	0
<1150	0	0	0	0	0	1	0	0	0	0	0
<1250	0	0	0	0	0	0	1	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	1	0	0	0	0	0	0	0	0

(4)

Sample 2 Run 1

Desired lag time from opacity reading to co reading 5
Based on 100.00 percent of 478 usable data sets (from a total of 516): for a total of 478 data points

The Coefficient of Correlation is ~~.2711~~ .5197
The Linear Regression Coefficients: CO = 16.010 Opacity + 209.571

DISTRIBUTION OF READINGS

	Opacities										
	0	5	10	15	20	25	30	35	40	45	50<
≤150	2	84	0	0	0	0	0	0	0	0	0
≤250	24	46	7	0	0	0	0	0	0	0	0
≤350	9	57	14	0	0	0	0	0	0	0	0
≤450	13	54	15	4	1	0	0	0	0	0	0
<550	7	43	10	5	7	5	0	0	0	0	0
<650	3	8	0	0	2	3	1	1	0	0	0
<750	2	8	7	0	2	2	1	0	1	0	0
CO ppm <850	3	4	1	0	0	1	0	1	0	0	0
<950	0	0	0	0	0	1	2	2	0	0	0
<1050	0	0	0	0	0	4	3	1	0	0	0
<1150	0	0	0	0	0	0	0	0	0	0	0
<1250	0	0	0	0	0	0	0	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	~~2~~	0	0	0	0	0	0	0	0	0

Boxed area represents target of elimination. Points eliminated for 2nd Run 1302.0 – 1305.3, 1354.1 – 1359.2

(8)

Sample 2 Run 2

Desired lag time from opacity reading to co reading: 5
Based on 92.05 percent of 478 usable data sets (from a total of 516); for a total of 440 lag points.
The Coefficient of Correlation is ~~.4196~~ .6419
The Linear Regression Coefficients: CO = 17.782 Opacity + 226.284

DISTRIBUTION OF READINGS

	Opacities										
	0	5	10	15	20	25	30	35	40	45	50<
<150	2	85	0	0	0	0	0	0	0	0	0
<250	24	46	7	0	0	0	0	0	0	0	0
<350	9	57	14	0	0	0	0	0	0	0	0
<450	18 14	55	15	4	1	0	0	0	0	0	0
<550	~~4~~	43	10	5	7	5	0	0	0	0	0
<650	0	1	0	0	2	3	1	1	0	0	0
<750	0	0	0	0	2	2	1	0	1	0	0
CO ppm <850	0	0	0	0	0	1	0	1	0	0	0
<950	0	0	0	0	0	1	2	2	0	0	0
<1050	0	0	0	0	0	4	3	1	0	0	0
<1150	0	0	0	0	0	0	0	0	0	0	0
<1250	0	0	0	0	0	0	0	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

Points eliminated 1256.3 - 1301.3,

1306.0 - 1313.1, 1353.0 - 1354.0, 1359.3 - 1400.0

6

Sample 2 Run 3

Desired lag time from opacity reading to co reading: 5
Based on 79.92 percent of 478 usable data sets (from a total of 516); for a total of 982 data sets.
The Coefficient of Correlation is ~~.5594~~ .7477
The Linear Regression Coefficients: CO = 20.522 Opacity + 176.114

DISTRIBUTION OF READINGS

	Opacities										
	0	5	10	15	20	25	30	35	40	45	50<
<150	2	85	0	0	0	0	0	0	0	0	0
<250	24	46	7	0	0	0	0	0	0	0	0
<350	6	57	14	0	0	0	0	0	0	0	0
<450	2	47	15	4	1	0	0	0	0	0	0
<550	0	16	10	5	7	5	0	0	0	0	0
<650	0	1	0	0	2	3	1	1	0	0	0
<750	0	0	0	0	2	2	1	0	1	0	0
CO ppm <850	0	0	0	0	0	1	0	1	0	0	0
<950	0	0	0	0	0	1	2	2	0	0	0
<1050	0	0	0	0	0	4	3	1	0	0	0
<1150	0	0	0	0	0	0	0	0	0	0	0
<1250	0	0	0	0	0	0	0	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

Sample 2 Based on Charge interval

Desired lag time from opacity reading to [illegible]
Charge interval=[illegible]
Based on 100.00 percent of 112 usable data sets (from a total of 115); for a total of 112 [illegible]
The Coefficient of Correlation is: ~~.5[illegible]~~ .7503
The Linear Regression Coefficients: [illegible] = 35.213 [illegible] = 133.352
Do you [illegible] to see the point distribution?

DISTRIBUTION OF READINGS

	Opacities										
	0	5	10	15	20	25	30	35	40	45	50<
<150	2	43	0	0	0	0	0	0	0	0	0
<250	0	1	0	0	0	0	0	0	0	0	0
<350	0	0	0	0	0	0	0	0	0	0	0
<450	0	4	3	3	1	0	0	0	0	0	0
<550	0	4	0	2	2	5	0	0	0	0	0
<650	0	4	0	0	0	1	0	0	0	0	0
<750	0	4	7	0	2	0	0	0	0	0	0
0.8 sgn. <850	0	0	0	0	0	1	0	0	0	0	0
<950	0	0	0	0	0	1	0	0	0	0	0
<1050	0	0	0	0	0	1	0	2	0	0	0
<1150	0	0	0	0	0	4	3	1	0	0	0
<1250	0	0	0	0	0	0	0	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

220 n,1304.0,5,.045
221 n,1304.1,5,.045
222 n,1304.2,5,.040
223 n,1304.3,5,.040
224 n,1305.0,5,.040
225 n,1305.1,5,.040
226 n,1305.2,5,.035
227 n,1305.3,5,.035
228 n,1306.0,5,.035
229 n,1306.1,5,.040
230 n,1306.2,5,.045

231 n,1306.3,5,.[illegible]
232 n,1307.0,5,.040
233 n,1307.1,5,.070
234 n,1307.2,5,.070
235 n,1307.3,5,.075
236 n,1308.0,5,.075
237 n,1308.1,5,.075
238 n,1308.2,5,.075
239 n,1308.3,5,.070
240 n,1309.0,5,.070
241 n,1309.1,5,.070
242 n,1309.2,5,.070
243 n,1309.3,5,.070
244 n,1310.0,5,.065
245 n,1310.1,5,.065
247 n,1310.3,5,.065
248 n,1310.3,5,.065

200 n,1259.0,0,.045
201 n,1259.1,0,.045
202 n,1259.2,0,.040
203 n,1259.3,0,.040
204 n,1300.0,0,.045
205 n,1300.1,0,.045
206 n,1300.2,0,.045
207 n,1300.3,0,.045
208 n,1301.0,0,.040
209 n,1301.1,0,.040
210 n,1301.2,0,.045
211 n,1301.3,0,.050
212 n,1302.0,0,.050

213 n,1302.1,10,.05[illegible]
214 n,1302.2,10,.045
215 n,1302.3,10,.045
216 n,1303.0,10,.045
217 n,1303.1,10,.045
218 n,1303.2,10,.045
219 n,1302.3,10,.045

these points eliminated for 2nd run

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Sample 2

Delayed lag time from opacity reading to [illegible]

Chart Interval=0.75

Based on 73.45 percent of 112 usable data sets (from a total of 115); for a total of [illegible] data points

The Coefficient of Correlation is ~~.8544~~ .9243

The Linear Regression Coefficients: CO = 20.031 Opacity + 10.330

DISTRIBUTION OF RESULTS

	Opacities										
	0	5	10	15	20	25	30	35	40	45	50<
<150	2	40	0	0	0	0	0	0	0	0	0
<250	0	1	0	0	0	0	0	0	0	0	0
<350	0	0	0	0	0	0	0	0	0	0	0
<450	0	0	6	3	1	0	0	0	0	0	0
<550	0	0	0	3	3	5	0	0	0	0	0
<650	0	0	0	0	0	1	0	0	0	0	0
<750	0	0	0	0	2	0	0	0	0	0	0
CO ppm <850	0	0	0	0	0	1	0	0	0	0	0
<950	0	0	0	0	0	1	2	2	0	0	0
<1050	0	0	0	0	0	4	3	1	0	0	0
<1150	0	0	0	0	0	0	0	0	0	0	0
<1250	0	0	0	0	0	0	0	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	[illegible]	0	0	0	0	0	0	0	0	0	0

Sample 3 Run 1

[illegible] LAG TIME FROM OPACITY MONITOR TO [illegible] 4
based on 100.00 percent of 394 sample data sets (from a total of 634); [illegible] of 394 data points.
THE COEFFICIENT OF CORRELATION IS ~~[illegible]~~ .9162
THE LINEAR REGRESSION COEFFICIENTS: CO = 10.534 OPACITY + 297.913

DISTRIBUTION OF READINGS

	OPACITIES										
	0	5	10	15	20	25	30	35	40	45	50<
<150	7	39	1	0	0	0	0	0	0	0	0
<250	29	63	2	1	0	1	0	0	0	0	0
<350	11	47	4	3	4	2	2	1	0	0	0
<450	13	20	7	4	2	1	1	0	0	0	1
<550	4	20	7	2	6	1	0	1	0	1	1
<650	4	0	1	1	1	1	1	2	2	0	0
<750	0	8	2	0	3	2	4	1	3	0	4
CO PPM <850	0	3	0	0	4	1	1	3	1	0	0
<950	0	1	1	0	2	0	1	0	0	3	5
<1050	0	1	1	0	0	2	1	0	1	0	0
<1150	0	4	0	0	0	0	0	0	0	0	0
<1250	0	0	0	0	0	0	0	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

Boxed Area represents target of elimination
Points eliminated for Run 2
1216.0 - 1218.1, 1220.3 - 1222.1

Sample 3 Run 2

DESIRED LAG TIME FROM OPACITY READING TO CO READING 4
BASED ON 95.69 PERCENT OF 394 USABLE DATA SETS (FROM A TOTAL OF 434); FOR A TOTAL OF 377 DATA POINTS
THE COEFFICIENT OF CORRELATION IS ~~.4342~~ .6359
THE LINEAR REGRESSION COEFFICIENTS: CO = 11.261 OPACITY + 270.472

DISTRIBUTION OF READINGS

	OPACITIES										
	0	5	10	15	20	25	30	35	40	45	50<
<150	7	39	1	0	0	0	0	0	0	0	0
<250	29	63	2	1	0	1	0	0	0	0	0
<350	11	47	4	3	4	2	2	1	0	0	0
<450	13	20	7	4	2	1	1	0	0	0	1
<550	4	16	7	2	6	1	0	1	0	1	1
<650	4	7	1	1	1	1	1	2	2	0	0
<750	0	6	2	0	3	2	4	1	3	0	4
CO PPM <850	0	0	0	0	4	1	1	3	1	0	0
<950	0	0	1	0	2	0	1	0	0	3	5
<1050	0	0	1	0	0	2	1	0	1	0	0
<1150	0	0	0	0	0	0	0	0	0	0	0
<1250	0	0	0	0	0	0	0	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

Points eliminated for the 3rd run

1100.0 - 1100.3, 1109.0 - 1109.3,
1122.2 - 1123.1, 1124.2 - 1126.2,
1259.1 - 1202.1, 1304.3 - 1305.1,
1314.0 - 1315.0

Sample 3 Run 3

Desired lag time from opacity reading to co reading 4
Based on 85.28 percent of 394 usable data sets (from a total of 634); for a total of 336 data points
The Coefficient of Correlation is ~~.5320~~ .7294
The Linear Regression Coefficients: CO = 12.575 Opacity + 227.054

DISTRIBUTION OF READINGS

	Opacities										
	0	5	10	15	20	25	30	35	40	45	50<
<150	7	39	1	0	0	0	0	0	0	0	0
<250	20	63	2	1	0	1	0	0	0	0	0
<350	11	47	4	3	4	2	2	1	0	0	0
<450	7	17	7	4	2	1	1	0	0	0	1
<550	0	5	7	2	6	1	0	1	0	1	1
<650	0	0	1	1	1	1	1	2	2	0	0
<750	0	0	2	0	3	2	4	1	3	0	4
CO ppm <850	0	0	0	0	4	1	1	3	1	0	0
<950	0	0	1	0	2	0	1	0	0	3	5
<1050	0	0	1	0	0	2	1	0	1	0	0
<1150	0	0	0	0	0	0	0	0	0	0	0
<1250	0	0	0	0	0	0	0	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

Sample 3 Based on Charge interval

Desired lag time from opacity reading to co reading 4
Charge interval=1
Based on 100.00 percent of 53 usable data sets (from a total of 53); for a total of 53 data points
The Coefficient of Correlation is ~~.8771~~ .7792
The Linear Regression Coefficients: CO = 13.340 Opacity + 312.060
Do you wish to see the point distribution?y

DISTRIBUTION OF READINGS

	Opacities										
	0	5	10	15	20	25	30	35	40	45	50<
<150	0	0	0	0	0	0	0	0	0	0	0
<250	10	0	0	0	0	0	0	0	0	0	0
<350	0	12	1	1	0	1	1	0	0	0	0
<450	0	3	2	0	0	0	0	0	0	0	0
<550	0	7	0	1	1	0	0	0	0	0	0
<650	0	0	0	0	0	0	0	0	0	0	0
<750	0	0	1	0	2	0	0	0	0	0	0
00 pm <850	0	1	0	0	1	1	0	0	0	0	0
<950	0	1	0	0	0	0	1	0	0	2	5
<1050	0	0	0	0	0	0	0	0	1	0	0
<1150	0	0	0	0	0	0	0	0	0	0	0
<1250	0	0	0	0	0	0	0	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

rerun? y
Desired lag time from opacity reading to co reading 4
Charge interval=.5
Based on 100.00 percent of 33 usable data sets (from a total of 55); for a total of 33 data points
The Coefficient of Correlation is .7993
The Linear Regression Coefficients: CO = 13.051 Opacity + 300.010
Do you wish to see the point distribution?n
rerun? y
Desired lag time from opacity reading to co reading 4
Charge interval=.25
Based on 100.00 percent of 20 usable data sets (from a total of 33); for a total of 20 data points
The Coefficient of Correlation is ~~.8157~~ .9030
The Linear Regression Coefficients: CO = 15.242 Opacity + 320.212
Do you wish to see the point distribution?n
rerun? n
enter

!edit A
^r 122-125,121-130,12533:5
^r 126 lt 99:0
^r 256-362,531,533-517-521 lt 99:5
^r 327 [illegible]
^r 331-362,531-533,517-521 lt 99:5

16

Sample 3

Desired lag time from opacity reading to co reading 4
Change interval=.25
Based on 85.00 percent of 23 usable data sets (from a total of [illegible]); for a total of 17 data points
The Coefficient of Correlation is ~~.9626~~ .9288
The Linear Regression Coefficients: CO = 15.[illegible] Opacity + 263.543
Do you wish to see the point distribution?:
Enter? y
Desired lag time from opacity reading to co reading 4
Change interval=1
Based on 84.75 percent of 59 usable data sets (from a total of [illegible]); for a total of 50 data points
The Coefficient of Correlation is ~~.7[illegible]~~ .8772
The Linear Regression Coefficients: CO = 17.[illegible] Opacity + 263.022
Do you wish to see the point distribution?y

DISTRIBUTION OF POINTS

CO (ppm)	Opacity 0	5	10	15	20	25	30	35	40	45	50<
<150	0	0	0	0	0	0	0	0	0	0	0
<250	10	0	0	0	0	0	0	0	0	0	0
<350	0	12	1	1	0	1	1	0	0	0	0
<450	0	0	0	0	0	0	0	0	0	0	0
<550	0	0	0	1	1	0	0	0	0	0	0
<650	0	0	0	0	0	0	0	0	0	0	0
<750	0	0	1	0	0	0	0	0	0	0	0
<850	0	0	0	0	1	1	0	0	0	0	0
<950	0	0	0	0	0	0	1	0	0	0	5
<1050	0	0	0	0	0	0	0	0	1	0	0
<1150	0	0	0	0	0	0	0	0	0	0	0
<1250	0	0	0	0	0	0	0	0	0	0	0
<1350	0	0	0	0	0	0	0	0	0	0	0
<1450	0	0	0	0	0	0	0	0	0	0	0
1450<	0	0	0	0	0	0	0	0	0	0	0

APPENDIX F

DETAILED SUMMARY OF SAMPLING AND ANALYTICAL PROCEDURES

F-1. Method 110 - Determination of Benzene from Stationary Sources

F-2. Method 10 - Determination of Carbon Monoxide Emissions from Stationary Sources

APPENDIX F-1

METHOD 110
Determination of Benzene From Stationary Sources

BENZENE

METHOD ~~111~~. DETERMINATION OF BENZENE

FROM STATIONARY SOURCES

INTRODUCTION

Performance of this method should not be attempted by persons unfamiliar with the operation of a gas chromatograph, nor by those who are unfamiliar with source sampling, as there are many details that are beyond the scope of this presentation. Care must be exercised to prevent exposure of sampling personnel to benzene, a carcinogen.

1. Principle and Applicability

1.1 Principle. An integrated bag sample of stack gas containing benzene and other organics is subjected to gas chromatographic (GC) analysis, using a flame ionization detector (FID).

1.2 Applicability. The method is applicable to the measurement of benzene in stack gases only from specified processes. It is not applicable where the benzene is contained in particulate matter.

2. Range and Sensitivity

The procedure described herein is applicable to the measurement of benzene in the 0.1 to 70 ppm range. The upper limit may be extended by extending the calibration range or by dilution of the sample.

3. Interferences

The chromatograph columns and the corresponding operating parameters herein described have been represented as being useful for producing an adequate resolution of benzene. However, resolution interferences may be encountered on some sources. Also, the chromatograph operator may know of a column that will produce a superior resolution of benzene without reducing the response to benzene as specified in Section 4.3.1.

In any event, the chromatograph operator shall select a column which is best suited to his particular analysis problem, subject to the approval of the Administrator. Such approval shall be considered automatic provided that confirming data produced through a demonstrably adequate supplemental analytical technique, such as analysis with a different column or G.C./mass spectroscopy, is available for review by the Administrator.

4. Apparatus

4.1 Sampling (see Figure III-1).

4.1.1 Probe. Stainless steel, Pyrex[1] glass, or Teflon tubing according to stack temperature, each equipped with a glass wool plug to remove particulate matter.

4.1.2 Sample Line. Teflon, 6.4 mm outside diameter, of sufficient length to connect probe to bag. A new unused piece is employed for each series of bag samples that constitutes an emission test.

4.1.3 Male (2) and female (2) stainless steel quick connects, with ball checks (one pair without) located as shown in Figure III-1.

4.1.4 Tedlar or aluminized Mylar bags, 100 liter capacity. To contain sample.

4.1.5 Rigid leakproof containers for 4.1.4, with covering to protect contents from sunlight.

4.1.6 Needle Valve. To adjust sample flow rate.

4.1.7 Pump--Leak-free. Minimum capacity 2 liters per minute.

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[1]Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

4.1.8 Charcoal Tube. To prevent admission of benzene and other organics to the atmosphere in the vicinity of samplers.

4.1.9 Flow Meter. For observing sample flow rate; capable of measuring a flow range from 0.10 to 1.00 liters per minute.

4.1.10 Connecting Tubing. Teflon, 6.4 mm outside diameter, to assemble sample train (Figure III-1).

4.2 Sample Recovery.

4.2.1 Tubing. Teflon, 6.4 mm outside diameter, to connect bag to gas chromatograph sample loop. A new unused piece is employed for each series of bag samples that constitutes an emission test, and is to be discarded upon conclusion of analysis of those bags.

4.3 Analysis.

4.3.1 Gas Chromatograph. With FID, potentiometric strip chart recorder and 1.0 to 2.0 ml sampling loop in automatic sample valve. The chromatographic system shall be capable of producing a response to 0.1 ppm benzene that is at least as great as the average noise level. (Response is measured from the average value of the baseline to the maximum of the waveform, while standard operating conditions are in use.)

4.3.2 Chromatographic Columns. Columns other than those listed below can be used, provided that the precision and accuracy of the analysis of benzene standards are not impaired. Information confirming that adequate resolution of the benzene peak is accomplished should be available. Adequate resolution is defined as an area overlap of not more than 10 percent of the benzene peak. Calculation of area overlap is explained in Appendix E, Supplement A: "Determination of Adequate Chromatographic Peak Resolution."

4.3.2.1 Column A: Benzene in the Presence of Aliphatics. Stainless Steel, 2.44 m x 3.2 mm, containing 10 percent 1, 2, 3,tris (2-cyanoethoxy) propane (TCEP) on 80/100 Chromosorb P AW.

4.3.2.2 Column B: Benzene With Separation of the Isomers of Xylene. Stainless steel, 1.83 m x 3.2 mm, containing 5 percent SP 1200/1.75 percent Bentone 34 on 100/120 Supelcoport.

4.3.3 Flow Meters (2). Rotameter type, 0 to 100 ml/min capacity.

4.3.4 Gas Regulators. For required gas cylinders.

4.3.5 Thermometer. Accurate to one degree centigrade, to measure temperature of heated sample loop at time of sample injection.

4.3.6 Barometer. Accurate to 5 mm Hg, to measure atmospheric pressure around gas chromatograph during sample analysis.

4.3.7 Pump--Leak-free. Minimum capacity 100 ml/min.

4.3.8 Recorder. Strip chart type, optionally equipped with disc integrator or electronic integrator.

4.3.9 Planimeter. Optional, in place of disc or electronic integrator, for 4.3.8 to measure chromatograph peak areas.

4.4 Calibration. 4.4.2 through 4.4.6 are for section 7.1 which is optional.

4.4.1 Tubing. Teflon, 6.4 mm outside diameter, separate pieces marked for each calibration concentration.

4.4.2 Tedlar or Aluminized Mylar Bags. 50-liter capacity, with valve; separate bag marked for each calibration concentration.

4.4.3 Syringe. 1.0 µl, gas tight, individually calibrated, to dispense liquid benzene.

4.4.4 Syringe. 10 µml, gas tight, individually calibrated, to dispense liquid benzene.

4.4.5 Dry Gas Meter, With Temperature and Pressure Gauges. Accurate to ±2 percent, to meter nitrogen in preparation of standard gas mixtures, calibrated at the flowrate used to prepare standards.

4.4.6 Midget Impinger/Hot Plate Assembly. To vaporize benzene.

5. Reagents

It is necessary that all reagents be of chromatographic grade.

5.1 Analysis.

5.1.1 Helium Gas or Nitrogen Gas. Zero grade, for chromatographic carrier gas.

5.1.2 Hydrogen Gas. Zero grade.

5.1.3 Oxygen Gas or Air as Required by the Detector. Zero grade.

5.2 Calibration. Use one of the following options: either 5.2.1 and 5.2.2, or 5.2.3.

5.2.1 Benzene, 99 Mol percent pure benzene certified by the manufacturer to contain a minimum of 99 Mol percent benzene; for use in the preparation of standard gas mixtures as described in Section 7.1.

5.2.2 Nitrogen Gas. Zero grade, for preparation of standard gas mixtures as described in Section 7.1.

5.2.3 Cylinder Standards (3). Gas mixture standards (50, 10, and 5 ppm benzene in nitrogen cylinders) for which the gas composition has been certified with an accuracy of ±3 percent or better by the manufacturer. The manufacturer must have recommended a maximum shelf life for each cylinder so that the concentration does not change by greater than ±5 percent from the certified value. The date of gas cylinder preparation, certified benzene concentration and recommended maximum shelf life must have been affixed to the cylinder before shipment from the gas manufacturer

to the buyer. These gas mixture standards may be directly used to prepare a chromatograph calibration curve as described in Section 7.2.2.

5.2.3.1 Cylinder Standards Certification. The concentration of benzene in nitrogen in each cylinder must have been certified by the manufacturer by a direct analysis of each cylinder using an analytical procedure that the manufacturer had calibrated on the day of cylinder analysis. The calibration of the analytical procedure shall, as a minimum, have utilized a threepoint calibration curve. It is recommended that the manufacturer maintain two calibration standards and use these standards in the following way: (1) a high concentration standard (between 50 and 100 ppm) for preparation of a calibration curve by an appropriate dilution technique; (2) a low concentration standard (between 5 and 10 ppm) for verification of the dilution technique used. If the difference between the apparent concentration read from the calibration curve and the true concentration assigned to the low concentration standard exceeds 5 percent of the true concentration, determine the source of error and correct it, then repeat the three-point calibration.

5.2.3.2 Establishment and Verification of Calibration Standards. The concentration of each calibration standard must have been established by the manufacturer using reliable procedures. Additionally, each calibration standard must have been verified by the manufacturer by one of the following procedures, and the agreement between the initially determined concentration value and the verification concentration value must be within ±5 percent: (1) verification value determined by comparison with a gas mixture prepared in accordance with the procedure described in Section 7.1.1 and using 99 Mol percent benzene, or (2) verification value obtained by having the calibration standard analyzed

by the National Bureau of Standards. All calibration standards must be reverified on a time interval consistent with the shelf life of the cylinder standards sold.

5.2.4 Audit Cylinder Standards (2). Gas mixture standards identical in preparation to those in Section 5.2.3 (benzene in nitrogen cylinders), except the concentrations are only known to the person supervising the analysis of samples. The concentrations of the audit cylinders should be: one low concentration cylinder in the range of 5 to 20 ppm benzene, and one high concentration cylinder in the range of 100 to 300 ppm benzene. When available, audit cylinders may be obtained by contacting: EPA, Environmental Monitoring and Support Laboratory, Quality Assurance Branch (MD-77), Research Triangle Park, North Carolina 27711. If audit cylinders are not available at EPA, an alternate source must be secured.

6. Procedure

6.1 Sampling. Assemble the sample train as in Figure III-1. Perform a bag leak check according to Section 7.3.2. Join the quick connects as illustrated, and determine that all connections between the bag and the probe are tight. Place the end of the probe at the centroid of the stack and start the pump with the needle valve adjusted to yield a flow of 0.5 lpm. After a period of time sufficient to purge the line several times has elapsed, connect the vacuum line to the bag and evacuate the bag until the rotameter indicates no flow. At all times, direct the gas exiting the rotameter away from sampling personnel. Then reposition the sample and vacuum lines and begin the actual sampling, keeping the rate constant. At the end of the sample period, shut off the pump, disconnect the sample line from the bag, and disconnect the

vacuum line from the bag container. Protect the bag container from sunlight.

6.2 Sample Storage. Sample bags must be kept out of direct sunlight. Analysis must be performed within 4 days of sample collection.

6.3 Sample Recovery. With a new piece of Teflon tubing identified for that bag, connect a bag inlet valve to the gas chromatograph sample valve. Switch the valve to receive gas from the bag through the sample loop. Arrange the equipment so the sample gas passes from the sample valve to a 0-100 ml/min rotameter with flow control valve followed by a charcoal tube and a 0-1 inch w.g. pressure gauge. Sample flow may be maintained either by a vacuum pump or container pressurization if the collection bag remains in the rigid container. After sample loop purging is ceased, allow the pressure gauge to return to zero before activating the gas sampling valve.

6.4 Analysis. Set the column temperature to 80°C for column A or 75°C for column B, and the detector temperature to 225°C. When optimun hydrogen and oxygen flow rates have been determined, verify and maintain these flow rates during all chromatograph operations. Using zero helium or nitrogen as the carrier gas, establish a flow rate in the range consistent with the manufacturer's requirements for satisfactory detector operation. A flow rate of approximately 20 ml/min should produce adequate separations. Observe the base line periodically and determine that the noise level has stabilized and that base line drift has ceased. Purge the sample loop for thirty seconds at the rate of 100 ml/min, then activate the sample valve. Record the injection time (the position of the pen on the chart at the time of sample injection), the sample number, the sample loop temperature, the column temperature, carrier gas flow

rate, chart speed and the attenuator setting. Record the laboratory pressure. From the chart, note the peak having the retention time corresponding to benzene, as determined in Section 7.2.1. Measure the benzene peak area, A_m, by use of a disc integrator, electronic integrator, or a planimeter. Record A_m and the retention time. Repeat the injection at least two times or until two consecutive values for the total area of the benzene peak do not vary more than 5 percent. The average value for these two total areas will be used to compute the bag concentration.

6.5 Measure the ambient temperature and barometric pressure near the bag. From a water saturation vapor pressure table, determine and record the water vapor content of the bag as a decimal figure. (Assume the relative humidity to be 100 percent unless a lesser value is known.)

7. Standards, Calibration and Quality Assurance

7.1 Standards.

7.1.1 Preparation of Benzene Standard Gas Mixtures. (Optional--delete if cylinder standards are used.) Assemble the apparatus shown in Figure III-2. Evacuate a 50-liter Tedlar or aluminized Mylar bag that has passed a leak check (described in Section 7.3.2) and meter in about 50 liters of nitrogen. Measure the barometric pressure, the relative pressure at the dry gas meter, and the temperature at the dry gas meter. While the bag is filling use the 10 µl syringe to inject 10 µl of 99 + percent benzene through the septum on top of the impinger. This gives a concentration of approximately 50 ppm of benzene. In a like manner, use the other syringe to prepare dilutions having approximately 10 and 5 ppm benzene concentrations. To calculate the specific concentrations, refer to section 8.1. These gas mixture standards may be used for seven days

from the date of preparation, after which time preparation of new gas mixtures is required. (Caution: Contamination may be a problem when a bag is reused if the new gas mixture standard is a lower concentration than the previous gas mixture standard.)

7.2 Calibration.

7.2.1 Determination of Benzene Retention Time. This section can be performed simultaneously with Section 7.2.2. Establish chromatograph conditions identical with those in section 6.3, above. Determine proper attenuator position. Flush the sampling loop with zero helium or nitrogen and activate the sample valve. Record the injection time, the sample loop temperature, the column temperature, the carrier gas flow rate, the chart speed and the attenuator setting. Record peaks and detector responses that occur in the absence of benzene. Maintain conditions, with the equipment plumbing arranged identically to section 6.3, and flush the sample loop for 30 seconds at the rate of 100 ml/min with one of the benzene calibration mixtures and activate the sample valve. Record the injection time. Select the peak that corresponds to benzene. Measure the distance on the chart from the injection time to the time at which the peak maximum occurs. This distance divided by the chart speed, is defined as the benzene peak retention time. Since it is quite likely that there will be other organics present in the sample, it is very important that positive identification of the benzene peak be made.

7.2.2 Preparation of Chromatograph Calibration Curve. Make a gas chromatographic measurement of each standard gas mixture (described in Section 5.2.3 or 7.1.1) using conditions identical with those listed in

Sections 6.3 and 6.4 . Flush the sampling loop for 30 seconds at the rate of 100 ml/min with one of the standard gas mixtures and activate the sample valve. Record C_c, the concentration of benzene injected, the attenuator setting, chart speed, peak area, sample loop temperature, column temperature, carrier gas flow rate, and retention time. Record the laboratory pressure. Calculate A_c, the peak area multiplied by the attenuator setting. Repeat until two consecutive injection areas are within 5 percent, then plot the average of those two values vs C_c. When the other standard gas mixtures have been similarly analyzed and plotted, draw a straight line through the points. Perform calibration daily, or before and after each set of bag samples, whichever is more frequent.

7.3 Quality Assurance.

7.3.1 Analysis Audit. Immediately after the preparation of the calibration curve and prior to the sample analyses, perform the analysis audit described in Appendix E, Supplement B: "Procedure for Field Auditing GC Analysis."

7.3.2 Bag Leak Checks. While performance of this section is required subsequent to bag use, it is also advised that it be performed prior to bag use. After each use, make sure a bag did not develop leaks as follows: to leak check, connect a water manometer and pressurize the bag to 5-10 cm H_2O (2-4 in. H_2O). Allow to stand for 10 minutes. Any displacement in the water manometer indicates a leak. Also, check the rigid container for leaks in this manner. (Note: an alternative leak

check method is to pressurize the bag to 5-10 cm H_2O or 2-4 in. H_2O and allow to stand overnight. A deflated bag indicates a leak.) For each sample bag in its rigid container, place a rotameter in line between the bag and the pump inlet. Evacuate the bag. Failure of the rotameter to register zero flow when the bag appears to be empty indicates a leak.

8. Calculations

8.1 Optional Benzene Standards Concentrations. Calculate each benzene standard concentration prepared in accordance with Section 7.1.1 as follows:

$$C_c = \frac{B\mu l \; \frac{.8787\ mg}{\mu l} \; \frac{10^3\ \mu g}{mg} \; \frac{\mu g\ mole}{78.11\ \mu g} \; \frac{24.055\ \mu l}{\mu g\ mole} \; 10^6}{V_m \; Y \; \frac{10^6\ \mu l}{l} \; \frac{293}{T_m} \; \frac{P_m}{760}}$$

$$= \frac{B\ (270.6)}{V_m \; Y \; \frac{293}{T_m} \; \frac{P_m}{760}} \qquad \text{Equation 111-1}$$

Where:

C_c = Benzene standard concentration in ppm.

B = Number of µl of benzene injected.

V_m = Gas volume measured by dry gas meter in liters.

Y = Dry gas meter calibration factor.

P_m = Absolute pressure of the dry gas meter, mm Hg.

T_m = Absolute temperature of the dry gas meter, °A.

.8787 = Density of benzene at 293°A.

78.11 = Molecular weight of benzene.

24.055= Ideal gas at 293°A, 760 mm Hg.

10^6 = Conversion factor, ppm.

8.2 Benzene Sample Concentrations. From the calibration curve described in Section 7.2.2 above, select the value of C_c that corresponds to A_c. Calculate C_s as follows:

$$C_s = \frac{C_c P_r T_i}{P_i T_r (1-S_{wb})} \qquad \text{Equation III-2}$$

where:

S_{wb} = The water vapor content of the bag sample, as analyzed.

C_s = The concentration of benzene in the sample in ppm.

C_c = The concentration of benzene indicated by the gas chromatograph, in ppm.

P_r = The reference pressure, the laboratory pressure recorded during calibration, mm Hg.

T_i = The sample loop temperature on the absolute scale at the time of analysis, °A.

P_i = The laboratory pressure at time of analysis, mm Hg.

T_r = The reference temperature, the sample loop temperature recorded during calibration, °A.

9. References

1. Feairheller, W. R.; Kemmer, A. M.; Warner, B. J.; and Douglas, D. Q. "Measurement of Gaseous Organic Compound Emissions by Gas Chromatography," EPA Contract No. 68-02-1404, Task 33 and 68-02-2818, Work Assignment 3. Jan., 1978.

2. Knoll, Joseph E.; Penny, Wade H.; Midgett, M.Rodney. "The Use of Tedlar Bags to Contain Gaseous Benzene Samples at Source-Level Concentrations." Environmental Monitoring Series, EPA-600/4-78-057, Environmental Protection Agency, Research Triangle Park, North Carolina. October, 1978.

3. Bulletins 743A, 740C, and 740D. "Separation of Hydrocarbons" 1974. Supelco, Inc. Bellefonte, Pennsylvania 16823.

4. Volume 10, No. 1 "Current Peaks," 1977. Carle Instruments, Inc., Fullerton, California 92631.

5.

6.

couple of memos from J. Knoll.

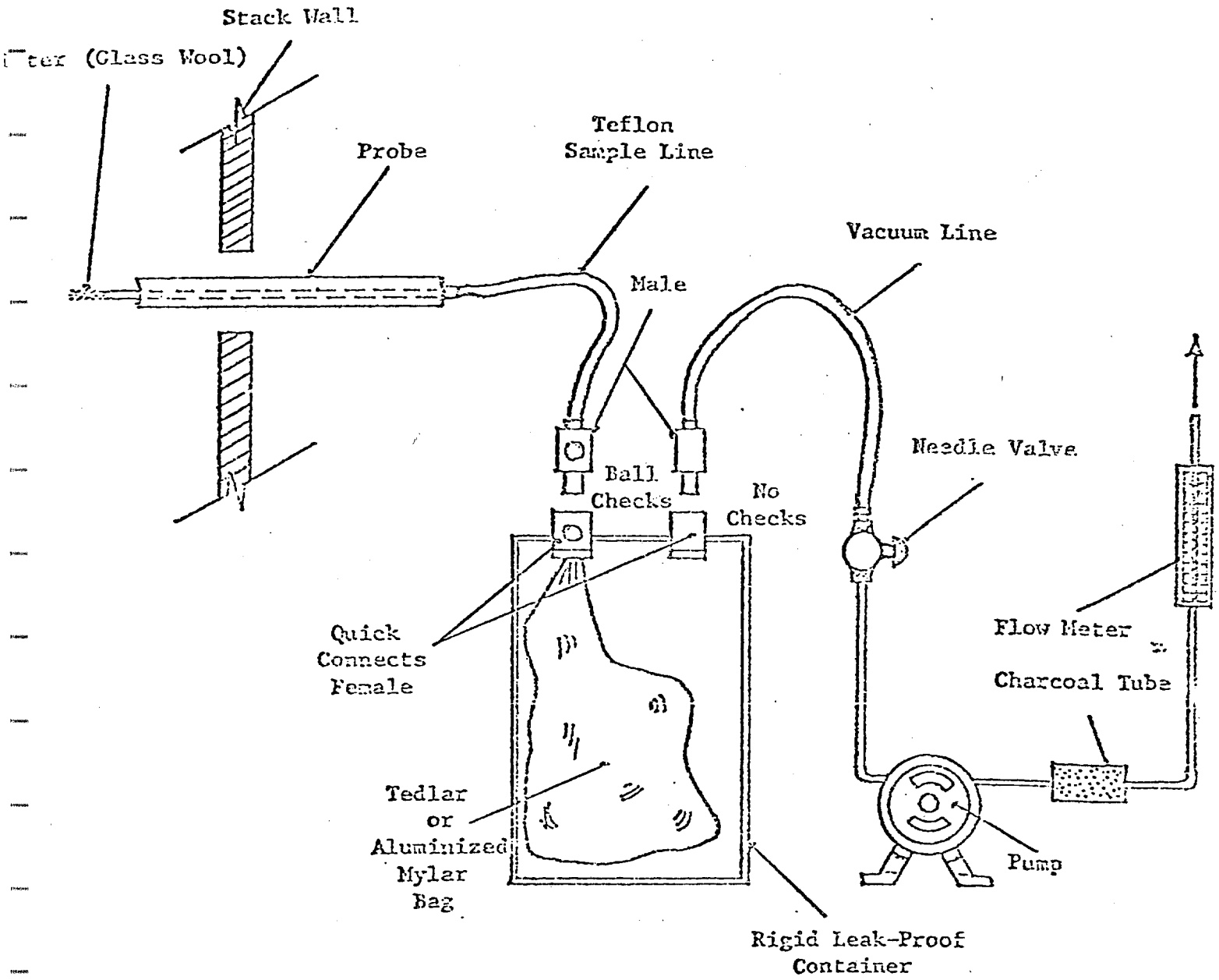

Figure III-1. Integrated-bag sampling train. (Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.)

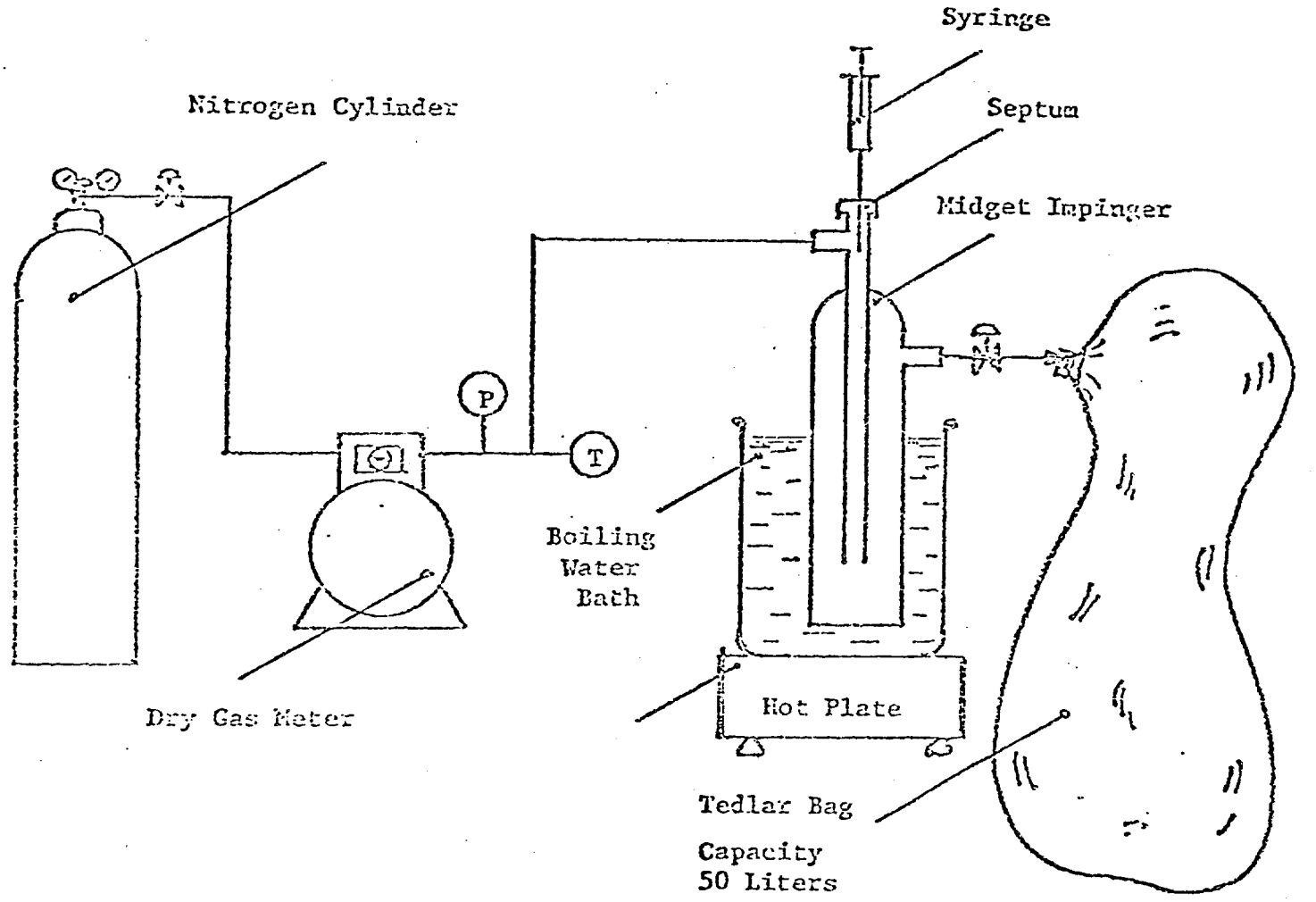

Figure III-2. Preparation of Benzene Standards.
(optional)

APPENDIX F-2

METHOD 10 -
Determination of Carbon Monoxide Emissions from Stationary Sources

METHOD 10—DETERMINATION OF CARBON MONOXIDE EMISSIONS FROM STATIONARY SOURCES

1. *Principle and Applicability.*

1.1 *Principle.* An integrated or continuous gas sample is extracted from a sampling point and analyzed for carbon monoxide (CO) content using a Luft-type nondispersive infrared analyzer (NDIR) or equivalent.

1.2 *Applicability.* This method is applicable for the determination of carbon monoxide emissions from stationary sources only when specified by the test procedures for determining compliance with new source performance standards. The test procedure will indicate whether a continuous or an integrated sample is to be used.

2. *Range and sensitivity.*

2.1 *Range.* 0 to 1,000 ppm.

2.2 *Sensitivity.* Minimum detectable concentration is 20 ppm for a 0 to 1,000 ppm span.

3. *Interferences.* Any substance having a strong absorption of infrared energy will interfere to some extent. For example, discrimination ratios for water (H_2O) and carbon dioxide (CO_2) are 3.5 percent H_2O per 7 ppm CO and 10 percent CO_2 per 10 ppm CO, respectively, for devices measuring in the 1,500 to 3,000 ppm range. For devices measuring in the 0 to 100 ppm range, interference ratios can be as high as 3.5 percent H_2O per 25 ppm CO and 10 percent CO_2 per 50 ppm CO. The use of silica gel and ascarite traps will alleviate the major interference problems. The measured gas volume must be corrected if these traps are used.

4. *Precision and accuracy.*

4.1 *Precision.* The precision of most NDIR analyzers is approximately ±2 percent of span.

4.2 *Accuracy.* The accuracy of most NDIR analyzers is approximately ±5 percent of span after calibration.

5. *Apparatus.*

5.1 *Continuous sample* (Figure 10–1).

5.1.1 *Probe.* Stainless steel or sheathed Pyrex[1] glass, equipped with a filter to remove particulate matter.

5.1.2 *Air-cooled condenser or equivalent.* To remove any excess moisture.

5.2 *Integrated sample* (Figure 10–2).

5.2.1 *Probe.* Stainless steel or sheathed Pyrex glass, equipped with a filter to remove particulate matter.

5.2.2 *Air-cooled condenser or equivalent.* To remove any excess moisture.

5.2.3 *Valve.* Needle valve, or equivalent, to to adjust flow rate.

5.2.4 *Pump.* Leak-free diaphragm type, or equivalent, to transport gas.

5.2.5 *Rate meter.* Rotameter, or equivalent, to measure a flow range from 0 to 1.0 liter per min. (0.035 cfm).

5.2.6 *Flexible bag.* Tedlar, or equivalent, with a capacity of 60 to 90 liters (2 to 3 ft^3). Leak-test the bag in the laboratory before using by evacuating bag with a pump followed by a dry gas meter. When evacuation is complete, there should be no flow through the meter.

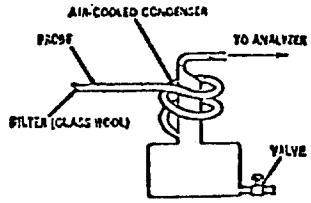

Figure 10-1. Continuous sampling train.

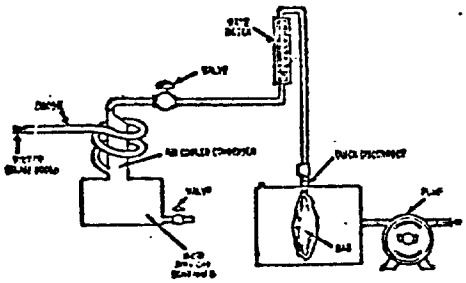

Figure 10-2. Integrated gas-sampling train.

5.2.7 *Pitot tube.* Type S, or equivalent, attached to the probe so that the sampling rate can be regulated proportional to the stack gas velocity when velocity is varying with the time or a sample traverse is conducted.

5.3 *Analysis* (Figure 10–3).

[1] Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

5.3.1 *Carbon monoxide analyzer.* Nondispersive infrared spectrometer, or equivalent. This instrument should be demonstrated, preferably by the manufacturer, to meet or exceed manufacturer's specifications and those described in this method.

5.3.2 *Drying tube.* To contain approximately 200 g of silica gel.

5.3.3 *Calibration gas.* Refer to paragraph 6.1.

5.3.4 *Filter.* As recommended by NDIR manufacturer.

5.3.5 *CO_2 removal tube.* To contain approximately 500 g of ascarite.

5.3.6 *Ice water bath.* For ascarite and silica gel tubes.

5.3.7 *Valve.* Needle valve, or equivalent, to adjust flow rate

5.3.8 *Rate meter.* Rotameter or equivalent to measure gas flow rate of 0 to 1.0 liter per min. (0.035 cfm) through NDIR.

5.3.9 *Recorder* (*optional*). To provide permanent record of NDIR readings.

6. *Reagents.*

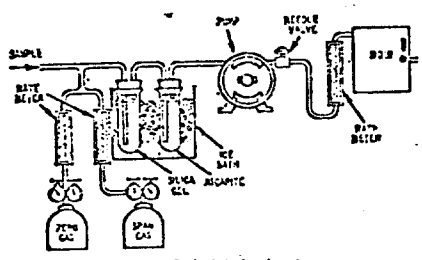

Figure 10-3. Analytical equipment.

6.1 *Calibration gases.* Known concentration of CO in nitrogen (N_2) for instrument span, prepurified grade of N_2 for zero, and two additional concentrations corresponding approximately to 60 percent and 30 percent span. The span concentration shall not exceed 1.5 times the applicable source performance standard. The calibration gases shall be certified by the manufacturer to be within ±2 percent of the specified concentration.

6.2 *Silica gel.* Indicating type, 6 to 16 mesh, dried at 175° C (347° F) for 2 hours.

6.3 *Ascarite.* Commercially available.

7. *Procedure.*

7.1 *Sampling.*

7.1.1 *Continuous sampling.* Set up the equipment as shown in Figure 10–1 making sure all connections are leak free. Place the probe in the stack at a sampling point and purge the sampling line. Connect the analyzer and begin drawing sample into the analyzer. Allow 5 minutes for the system to stabilize, then record the analyzer reading as required by the test procedure. (See ¶ 7.2 and 8). CO_2 content of the gas may be determined by using the Method 3 integrated sample procedure (36 FR 24886), or by weighing the ascarite CO_2 removal tube and computing CO_2 concentration from the gas volume sampled and the weight gain of the tube.

7.1.2 *Integrated sampling.* Evacuate the flexible bag. Set up the equipment as shown in Figure 10–2 with the bag disconnected. Place the probe in the stack and purge the sampling line. Connect the bag, making sure that all connections are leak free. Sample at a rate proportional to the stack velocity. CO_2 content of the gas may be determined by using the Method 3 integrated sample procedures (36 FR 24886), or by weighing the ascarite CO_2 removal tube and computing CO_2 concentration from the gas volume sampled and the weight gain of the tube.

7.2 *CO Analysis.* Assemble the apparatus as shown in Figure 10–3, calibrate the instrument, and perform other required operations as described in paragraph 8. Purge analyzer with N_2 prior to introduction of each sample. Direct the sample stream through the instrument for the test period, recording the readings. Check the zero and span again after the test to assure that any drift or malfunction is detected. Record the sample data on Table 10–1.

8. *Calibration.* Assemble the apparatus according to Figure 10–3. Generally an instrument requires a warm-up period before stability is obtained. Follow the manufacturer's instructions for specific procedure. Allow a minimum time of one hour for warm-up. During this time check the sample conditioning apparatus, i.e., filter, condenser, drying tube, and CO_2 removal tube, to ensure that each component is in good operating condition. Zero and calibrate the instrument according to the manufacturer's procedures using, respectively, nitrogen and the calibration gases.

TABLE 10-1.—*Field data*

Location	Comments:
Test	
Date	
Operator	

Clock time	*Rotameter setting, liters per minute (cubic feet per minute)*

9. *Calculation—Concentration of carbon monoxide.* Calculate the concentration of carbon monoxide in the stack using equation 10-1.

$$C_{CO_{stack}} = C_{CO_{NDIR}}(1 - F_{CO_2}) \qquad \text{equation 10-1}$$

where:

$C_{CO_{stack}}$ = concentration of CO in stack, ppm by volume (dry basis).

$C_{CO_{NDIR}}$ = concentration of CO measured by NDIR analyzer, ppm by volume (dry basis).

F_{CO_2} = volume fraction of CO_2 in sample, i.e., percent CO_2 from Orsat analysis divided by 100.

[39 FR 13776, April 17, 1974]

10. *Bibliography.*

10.1 McElroy, Frank, The Intertech NDIR-CO Analyzer, Presented at 11th Methods Conference on Air Pollution, University of California, Berkeley, Calif., April 1, 1970.

10.2 Jacobs, M. B., et al., Continuous Determination of Carbon Monoxide and Hydrocarbons in Air by a Modified Infrared Analyzer, J. Air Pollution Control Association, 9(2):110-114, August 1959.

10.3 MSA LIRA Infrared Gas and Liquid Analyzer Instruction Book, Mine Safety Appliances Co., Technical Products Division, Pittsburgh, Pa.

10.4 Models 215A, 315A, and 415A Infrared Analyzers, Beckman Instruments, Inc., Beckman Instructions 1635-B, Fullerton, Calif., October 1967.

10.5 Continuous CO Monitoring System, Model A5611, Intertech Corp., Princeton, N.J.

10.6 UNOR Infrared Gas Analyzers, Bendix Corp., Ronceverte, West Virginia.

ADDENDA

A. Performance Specifications for NDIR Carbon Monoxide Analyzers.

Range (minimum)	0-1000ppm.
Output (minimum)	0-10mV.
Minimum detectable sensitivity	20 ppm.
Rise time, 90 percent (maximum)	30 seconds.
Fall time, 90 percent (maximum)	30 seconds.
Zero drift (maximum)	10% in 8 hours.
Span drift (maximum)	10% in 8 hours.
Precision (minimum)	± 2% of full scale.
Noise (maximum)	± 1% of full scale.
Linearity (maximum deviation)	2% of full scale.
Interference rejection ratio	CO_2—1000 to 1, H_2O—500 to 1.

B. *Definitions of Performance Specifications.*

Range—The minimum and maximum measurement limits.

Output—Electrical signal which is proportional to the measurement; intended for connection to readout or data processing devices. Usually expressed as millivolts or milliamps full scale at a given impedance.

Full scale—The maximum measuring limit for a given range.

Minimum detectable sensitivity—The smallest amount of input concentration that can be detected as the concentration approaches zero.

Accuracy—The degree of agreement between a measured value and the true value; usually expressed as ± percent of full scale.

Time to 90 percent response—The time interval from a step change in the input concentration at the instrument inlet to a reading of 90 percent of the ultimate recorded concentration.

Rise Time (90 percent)—The interval between initial response time and time to 90 percent response after a step increase in the inlet concentration.

Fall Time (90 percent)—The interval between initial response time and time to 90 percent response after a step decrease in the inlet concentration.

Zero Drift—The change in instrument output over a stated time period, usually 24 hours, of unadjusted continuous operation when the input concentration is zero; usually expressed as percent full scale.

Span Drift—The change in instrument output over a stated time period, usually 24 hours, of unadjusted continuous operation when the input concentration is a stated upscale value; usually expressed as percent full scale.

Precision—The degree of agreement between repeated measurements of the same concentration, expressed as the average deviation of the single results from the mean.

Noise—Spontaneous deviations from a mean output not caused by input concentration changes.

Linearity—The maximum deviation between an actual instrument reading and the reading predicted by a straight line drawn between upper and lower calibration points.

METHOD 11—DETERMINATION OF HYDROGEN SULFIDE CONTENT OF FUEL GAS STREAMS IN PETROLEUM REFINERIES

1. *Principle and applicability.* 1.1 *Principle.* Hydrogen sulfide (H_2S) is collected from a source in a series of midget impingers and absorbed in pH 3.0 cadmium sulfate ($CdSO_4$) solution to form cadmium sulfide (CdS). The latter compound is then measured iodometrically. An impinger containing hydrogen peroxide is included to remove SO_2 as an interfering species. This method is a revision of the H_2S method originally published in the FEDERAL REGISTER, Volume 39, No. 47 dated Friday, March 8, 1974.

1.2 *Applicability.* This method is applicable for the determination of the hydrogen sulfide content of fuel gas streams at petroleum refineries.

2. *Range and sensitivity.* The lower limit of detection is approximately 8 mg/m³ (6

APPENDIX G

EXAMPLE CALCULATIONS

Nomenclature

A_s = Stack area, inches^2

C_f = Front half (probe & filter) particulate concentration, gr/DSCF

C_p = Pitot tube correction factor, dimensionless

C_t = Total particulate concentration, gr/DSCF

CM_f = Front half (probe & filter) particulate concentration, mg/DSm^3

CM_t = Total particulate concentration, mg/DSm^3

D_n = Sampling nozzle diameter, inches

ER_f = Emission rate of front half particulate, lb/hr

ER_t = Emission rate of total particulate, lb/hr

ERM_f = Emission rate of front half particulate, kg/hr

ERM_t = Emission rate of total particulate, kg/hr

M_d = Mole fraction of dry gas, g/g-mole

MW = Molecular weight of wet stack gas

MW_d = Molecular weight of dry stack gas

P_b = Barometric pressure, inches mercury

P_m = Average orifice pressure drop, inches water

P_s = Absolute stack gas pressure, inches mercury

P_{st} = Static pressure of stack gas, inches mercury

Q_{am} = Actual stack gas flowrate at stack conditions, Am^3/min

Q_m = Dry stack gas flowrate at standard conditions, DSm^3/min

Q_s = Dry stack gas flowrate at standard conditions, DSCFM

SW_f = Front half sample weight, mg

SW_t = Total sample weight, mg

T_m = Average meter temperature, °F

T_s = Stack temperature, °F

T_t = Net time of test, minutes

V_m = Volume of dry gas at meter conditions, ft^3

$V_{m_{std}}$ = Volume of dry gas at standard conditions, DSCF

V_s = Stack gas velocity at stack conditions, fpm

V_w = Total condensate collected in sampling train, ml

$V_{w_{gas}}$ = Volume of water vapor at standard conditions, SCF

ΔP_s = Velocity pressure, inches water

%I = Percent of isokinetic variation, dimensionless

%M = Percent moisture, dimensionless

Calculation of Particulate Emissions

The dry volume of sampled gas corrected to standard conditions of 20°C and 760 mm Hg (29.92 in. Hg) is calculated as follows:

$$V_{m_{std}} = \frac{17.65 * V_m * P_b + \left(\frac{P_m}{13.6}\right)}{T_m + 460}$$

The dry stack gas flowrate corrected to standard conditions is calculated using the following set of equations sequentially:

$$V_{w_{gas}} = 0.0471 * V_w$$

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

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

$$MW_d = (\%CO_2 * 44/100) + (\%O_2 * 32/100) + \left[(\%CO + \%N_2)*28/100\right]$$

$$MW = (MW_d * M_d) + 18(1 - M_d)$$

$$P_s = P_b + P_{st}$$

$$V_s = 5120.8 * C_p * \sqrt{\Delta P_s * (T_s + 460)} * \sqrt{\frac{1}{P_s * MW}}$$

$$Q_s = \frac{0.1225 * V_s * A_s * M_d * P_s}{T_s + 460}$$

Stack gas flowrate may be expressed metrically as dry normal cubic meters per minute (DNm^3/min), in terms of actual cubic feet per minute (ACFM), and metrically as actual cubic meters per minute (Am^3/min) with use of the following equations:

$$Q_m = Qs * 0.02832$$

$$Qa = \frac{0.05667 * Qs * (T_s + 460)}{P_s * M_d}$$

$$Qam = Qa * 0.02832.$$

The equation employed to determine percent of isokinetic variation is:

$$\%I = \frac{1032 * (T_s + 460) * V_{m_{std}}}{V_s * T_t * P_s * M_d * (D_n)^2}$$

To determine the concentration of particulate matter in grains per dry standard cubic foot (gr/DSCF), one of the following equations is used:

$$C_f = 0.01543 * \frac{SW_f}{V_{m_{std}}} \quad \text{and}$$

$$C_t = 0.01543 * \frac{SW_t}{V_{m_{std}}} \quad .$$

When metric units are desired, the concentration is calculated in milligrams per dry standard cubic meter (mg/DSm^3) as follows:

$$CM_f = \frac{SW_f}{(0.02832)(V_{m_{std}})} \quad \text{and}$$

$$CM_t = \frac{SW_t}{(0.02832)(V_{m_{std}})} \quad .$$

Front half particulate concentrations are obtained by summing the weight of particulate matter collected on the filter and all portions of the train preceding it. Total particulate concentration includes, in addition, any particulate matter collected in the impingers.

The emission rate of particulate matter can be calculated from the filterable or total particulate concentration using one of the following equations:

$$ER_f = 0.00857 * C_f * Q_s \quad \text{and}$$

$$ER_t = 0.00857 * C_t * Q_s \quad .$$

For metric units,

$$ERM_f = ER_f * 0.4536$$

$$ERM_t = ER_t * 0.4536$$

To avoid rounding errors it is preferable to carry out the calculation of concentration and emission rate in one operation.

Concentrations and emission rates for sulfuric acid including sulfur trioxide were determined utilizing the same formulae as for particulate using the weights in milligrams as determined in the laboratory.

Example Calculation

Using the data from Run 1 the sample volume is calculated using the formula on page 2.

Given:

V_m = 100.5 ft^3

P_b = 29.57 in Hg

P_m = 1.54 in H_2O

T_m = 86.0

then:

$V_{m_{std}}$ = 96.4 dscf

Percent moisture in the stack during the test is then determined from the measured condensate volume.

Given:

V_w = 399.1 ml

Then:

$V_{w_{gas}}$ = 18.8

%M = 16.3

M_d = 0.8369

Using the data from the Orsat analyses conducted during this run, the molecular weight of the stack gas can be determined.

Given:

$\%CO_2$ = 0.73

$\%O_2$ = 17.93

%CO = 0.23

$\%N_2$ = 81.11

then:

MW_d = 28.83

MW = 27.06

The flowrate in dry standard cubic feet can then be calculated using the formulae on page 3.

Given:

P_{st} =-0.070 in H_2O

Cp = 0.830

$\sqrt{\Delta P_s * (T_s + 460)} = 13.57$

A_s = 7949 in^2

T_s = 599F

Then:

P_s = 29.50

V_s = 2044

Q_s = 46400

Q_m = 1314

Q_a = 112,790

Q_{am} = 3194

APPENDIX H

CALIBRATION DATA

METER AND ORIFICE CALIBRATION

Date 3-20-79 Client Repair Meter Box Number RAC 2

Barometric Pressure Pb ("Hg) 29.55 Calibrator TVM Gas Meter Number

	Orifice Manometer Setting, Δm (in. H_2O)	Gas Volume Wet Test Meter V_w (ft^3)	Gas Volume Dry Gas Meter V_d (ft^3)	Temperature: Wet Test Meter t_w (°F)	Temperature: Dry Gas Meter Inlet t_{di} (°F)	Temperature: Dry Gas Meter Outlet t_{do} (°F)	Temperature: Dry Gas Meter Average t_d (°F)	Vacuum Wet Test Meter p_w (in. H_2O)	Time θ (min)	γ	K_m
Stop	0.5	9076.000	167.484	71.5	79	73		0.10	14:57	1.012	0.134
Start	29.59	9070.000	161.522	69.5	76	70		0.10			
Average		(5) 6.000	5.962	70.5		71.5		29.54	14.95		
Stop	1.0	9087.000	178.525	70.0	76	78		0.10	19:45	1.009	0.131
Start	29.62	9076.000	167.484	71.5	79	73		0.10			
Average		(5) 11.000	11.041	70.75		79		29.54	19.75		
Stop	2.0	9101.000	192.676	70.5	91	82			18:06	1.010	0.129
Start	29.70	9087.000	178.525	70.0	86	78		0.10			
Average		(10) 14.000	14.151	70.25		80.5		29.54	18.10		
Stop	3.0	9118.000	209.907	69.5	92	84			17:58	1.011	0.129
Start	29.72	9101.000	192.676	70.5	91	82		0.10			
Average		(10) 17.000	17.231	70		87.5		29.54	17.97		
Stop	4.0	9134.000	226.120	69.0	94	84			14:49	1.012	0.128
Start	29.54	9118.000	209.907	69.5	92	84		0.15			
Average		(10) 16.000	16.213	69.25		84		29.54	14.82		
Stop	5.0	9145.000	237.270	69.0	94	83			9:09	1.011	0.127
Start	29.92	9134.000	226.120	69.0	94	84		0.15			
Average		(10) 11.000	11.150	69.5		83.5		29.54	9.15		
								AVERAGE		1.011	0.130

$$P_w = P_b - \frac{p_w}{13.6} \qquad P_d = P_b + \frac{\Delta m}{13.6} \qquad K_m = \frac{V_w}{\theta}\sqrt{\frac{p_w}{T_w\,\Delta m}}$$

$$\gamma = \frac{V_w\,P_w\,(t_d + 460)}{V_d\,P_d\,(t_w + 460)}$$

Factor in isokinetic equation $= \frac{27.40}{(\overline{K}_m)^2} = \frac{27.40}{(\quad)^2} =$ 1629

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METER AND ORIFICE CALIBRATION

Date 5/8/97 Client [illegible] Meter Box Number [illegible]#2

Barometric Pressure Pb ("Hg) [illegible] Calibrator TJP Gas Meter Number

	Orifice Manometer Setting, Δm (in. H_2O)	Gas Volume Wet Test Meter V_w (ft^3)	Gas Volume Dry Gas Meter V_d (ft^3)	Temperature: Wet Test Meter t_w (°F)	Temperature: Dry Gas Meter Inlet t_{di} (°F)	Temperature: Dry Gas Meter Outlet t_{do} (°F)	Temperature: Dry Gas Meter Average t_d (°F)	Vacuum Wet Test Meter p_w (in. H_2O)	Time θ (min)	γ	K_m
Stop	0.5	9473.245	599.712	26.0	[illegible]	[illegible]	28.5				
Start		9464.157	593.658	25.8	[illegible]	[illegible]	[illegible]	0.0	10.0	0.997	0.134
Average	29.30	(5) [illegible]	4.954	[illegible]	[illegible]	[illegible]	[illegible]	29.26	10.0		
Stop	1.0	9478.945	[illegible]	[illegible]	[illegible]	[illegible]					
Start		9473.340	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.0	0.996	0.131
Average	29.33	(5) 5.605	5.081	[illegible]	[illegible]	[illegible]	[illegible]	29.26	10.0		
Stop	2.0	9482.006	611.463	[illegible]	[illegible]	[illegible]				0.996	
Start		9472.223	[illegible]	76.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		0.129
Average	29.41	(10) [illegible]	[illegible]	76.4	[illegible]	[illegible]	[illegible]	29.26	10.0		
Stop	3.0	9497.674	622.752	[illegible]	104	[illegible]	95.5			0.997	
Start		9487.285	[illegible]	76.6	96	[illegible]	[illegible]	[illegible]	11.0		0.127
Average	29.48	(10) 10.391	10.301	76.8	[illegible]	[illegible]	[illegible]	29.26	11.0		
Stop	4.0	9507.861	633.277	[illegible]	107	97	[illegible]			0.997	
Start		9498.115	623.218	77.0	101	[illegible]	[illegible]	0.05	9.0		0.126
Average	29.55	(10) 9.746	[illegible]	[illegible]	104	[illegible]	[illegible]	29.26	9.0		
Stop	5.0	9518.844	644.688	77.3	110	98	104			0.996	
Start		9508.053	633.494	77.1	104	96	100	[illegible]	10.0		0.113
Average	29.63	(10) 10.791	11.194	77.2	[illegible]	97	[illegible]	29.25	10.0		
									AVERAGE	0.996	0.127

$$P_w = P_b - \frac{p_w}{13.6} \qquad P_d = P_b + \frac{\Delta m}{13.6} \qquad K_m = \frac{V_w}{\theta}\sqrt{\frac{p_w}{T_w\,\Delta m}}$$

$$\gamma = \frac{V_w\ P_w\ (t_d + 460)}{V_d\ P_d\ (t_w + 460)}$$

Factor in isokinetic equation $= \frac{27.40}{(\overline{K}_m)^2} = \frac{27.40}{(0.12658)^2} =$ 1710

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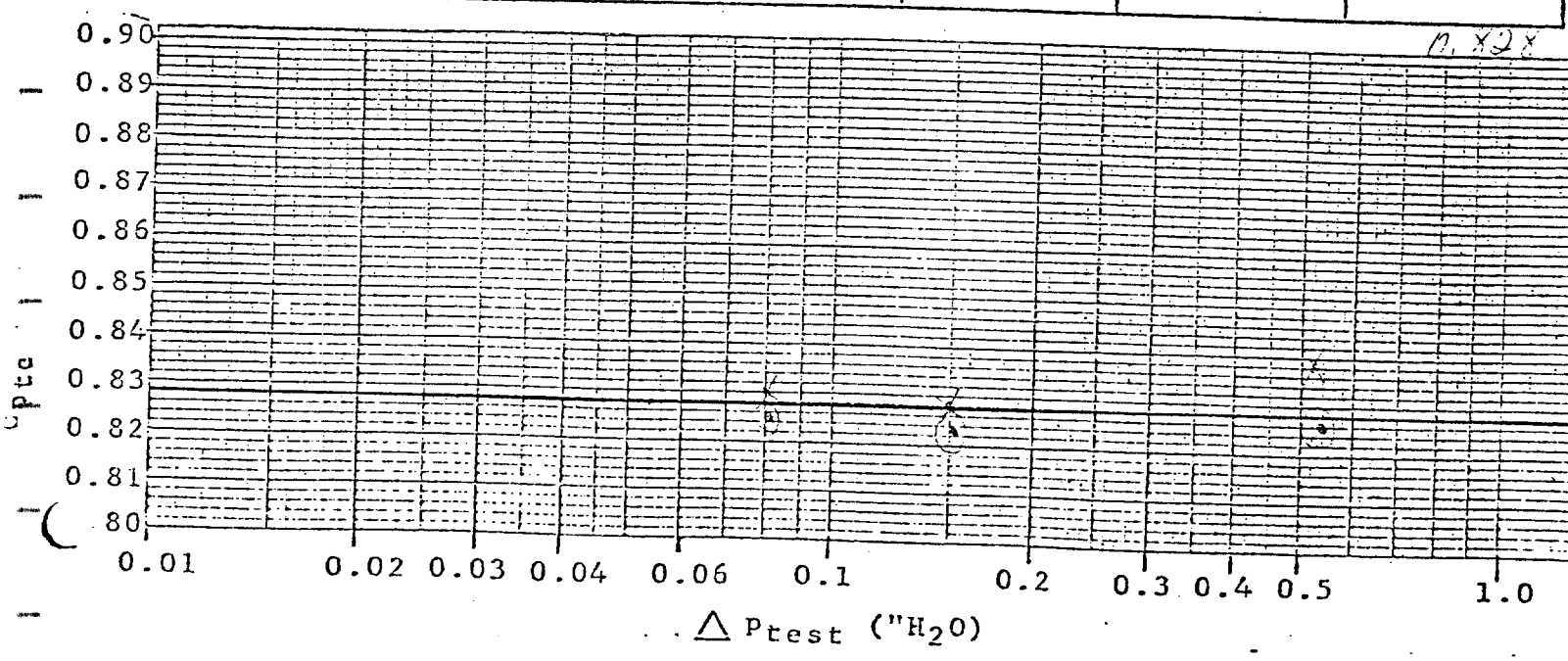
$$C_{ptest} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

Pitot Tube Type S Pitot Tube No. 34

Standard Pitot Tube No. —

Calibrator: TVM Date: 11-30-77 Client:

Anticipated ΔP_{std}	ΔP_{std}	A		B	
		ΔP_{test}	ΔC_{ptest}	ΔP_{test}	ΔC_{ptest}
0.02	0.	0.	0.	0.	0.
0.04	0.	0.	0.	0.	0.
0.06	0.057	0.081	0.830	0.082	0.825
0.08	0.	0.	0.	0.	0.
0.10	0.105	0.150	0.828	0.152	0.823
0.12	0.	0.	0.	0.	0.
0.16	0.	0.	0.	0.	0.
0.20	0.	0.	0.	0.	0.
0.30	0.372	0.5175	0.839	0.535	0.826
0.50	0.	0.	0.	0.	0.
0.70	0.	0.	0.	0.	0.
0.80	1.008	1.440	0.828	1.450	0.825



Clayton Environmental Consultant

34

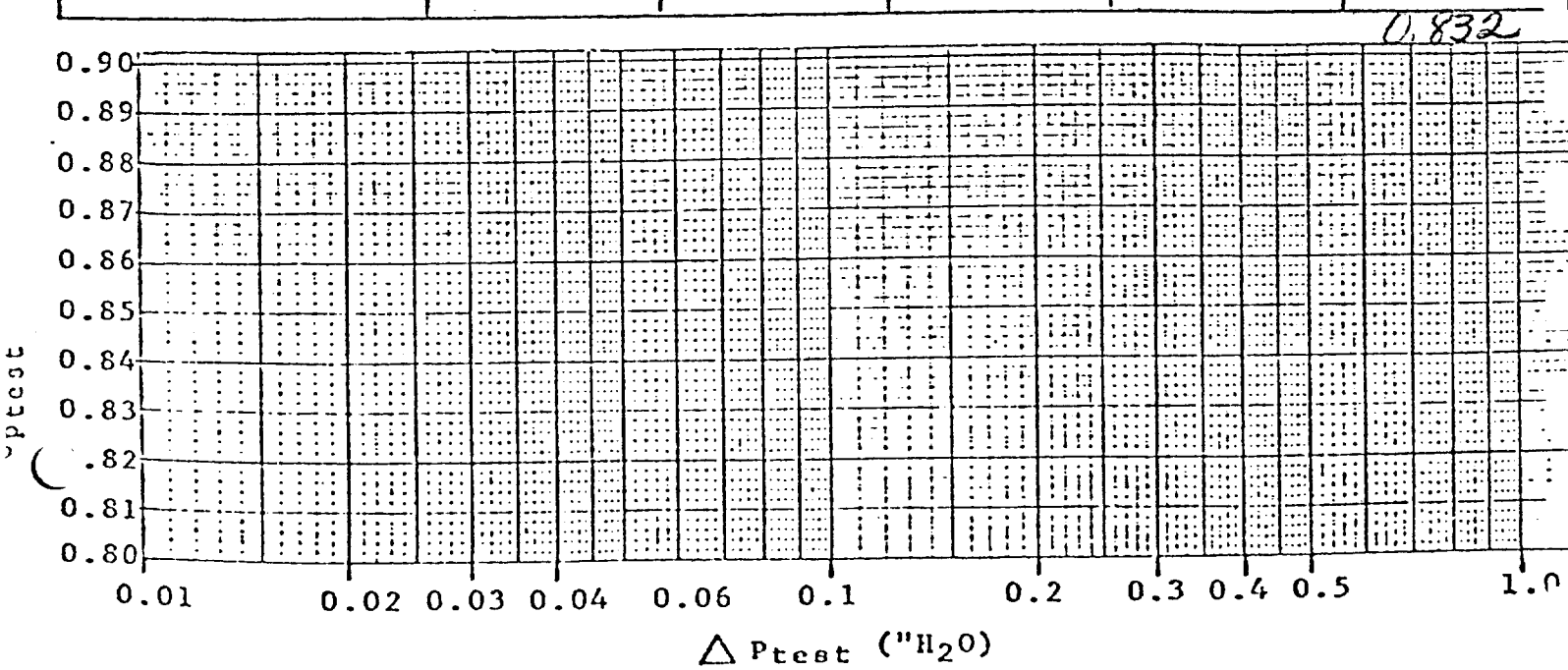
$$C_{ptest} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

Pitot Tube Type _____ Pitot Tube No. ~~[illegible]~~

Standard Pitot Tube No. _____

Calibrator: BFE Date: 5 June 79 Client: JGL STEEL (EPA)

Anticipated ΔP_{std}	ΔP_{std}	A		B	
		ΔP_{test}	ΔC_{ptest}	ΔP_{test}	ΔC_{ptest}
0.02	0.0~~[illegible]~~96	0.134	0.8379	0.139	0.822
0.04	0.096	0.134	0.8379	0.134	0.8579
0.06	0.096	0.1372	0.8281	0.136	0.831
0.08	0.____	0.____	0.____	0.____	0.____
0.10	0.____	0.____	0.____	0.____	0.____
0.12	0.____	0.____	0.____	0.____	0.____
0.16	0.____	0.____	0.____	0.____	0.____
0.20	0.____	0.____	0.____	0.____	0.____
0.30	0.____	0.____	0.____	0.____	0.____
0.50	0.____	0.____	0.____	0.____	0.____
0.70	0.____	0.____	0.____	0.____	0.____
0.80	0.____	0.____	0.____	0.____	0.____



Beckman INSTRUMENTS, INC.
PROCESS INSTRUMENTS DIVISION
FULLERTON, CALIFORNIA • 92634

INFRARED ANALYZER CALIBRATION & DATA SHEET

CUSTOMER:	S.O. NO.:
ADDRESS:	P.O. NO.:
APPLICATION: CARBON MONOXIDE	MODEL NO.:
RANGES: 0-1% By VOLUME CALIBRATION PRESSURE	SERIAL NO.:

	ATMOSPHERIC ✓	OTHER
1.		
2.		
3.		
4.		
5.		

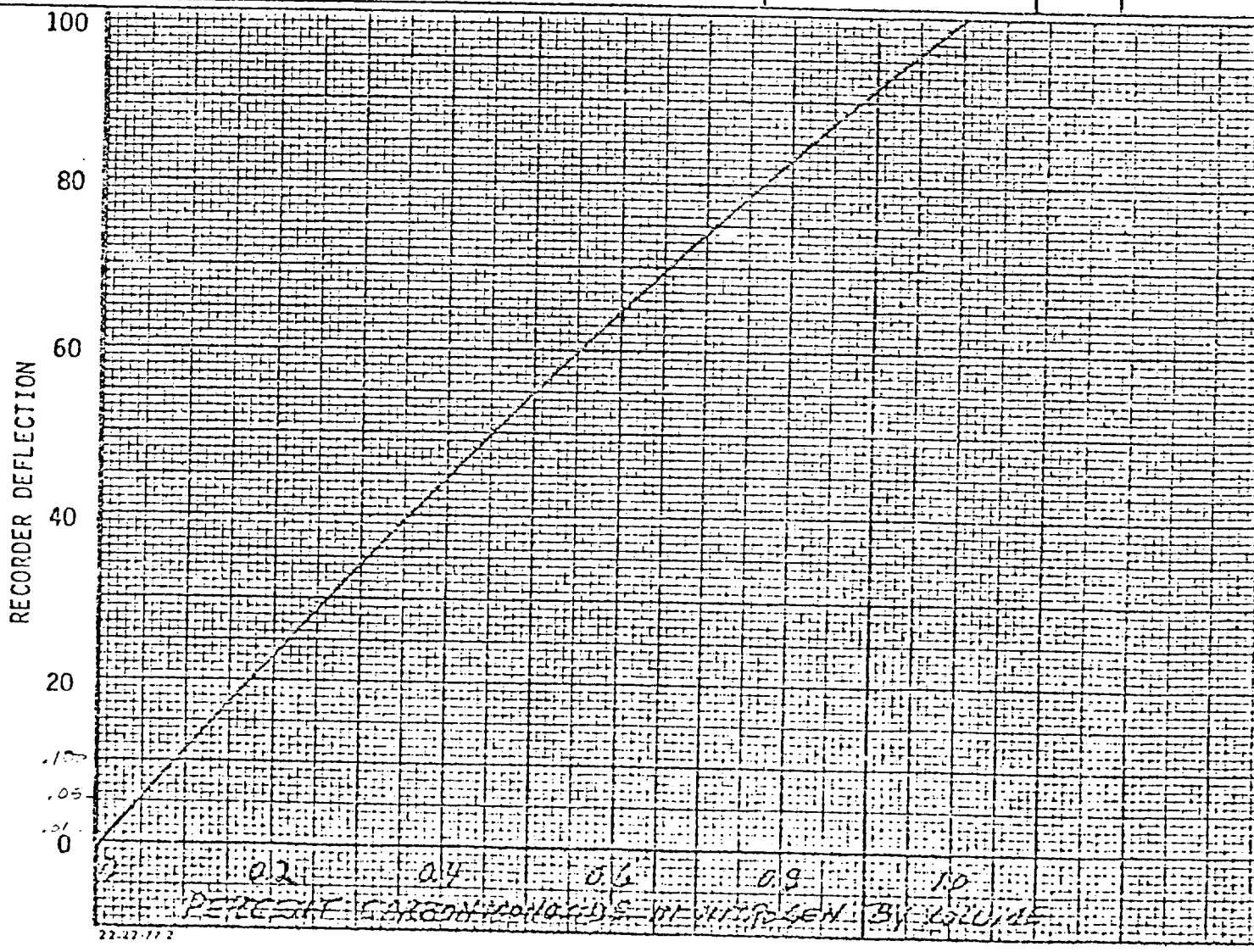
DETECTOR SER. NO.:
DETECTOR PART NO.:
TAG NO.:
CONFIGURATION NO.: 12

REPEATABILITY: (IN % OF F.S.)	
RANGE 1:	% RANGE 3:
RANGE 2:	% RANGE 4:

MODIFICATIONS AND REMARKS:
TYPICAL CALIBRATION CURVE.

INTERFERENCE GAS	MOL %	RESP. EQ

ENGINEER: HPH. DATE:



22-27-77 2

INSTRUMENTS, INC.
PROCESS INSTRUMENTS DIVISION
FULLERTON, CALIFORNIA • 92634

INFRARED ANALYZER CALIBRATION & DATA SHEET

CUSTOMER:	S.O. NO.:
ADDRESS:	P.O. NO.:
APPLICATION: CARBON MONOXIDE	MODEL NO.:
RANGES: 0-5.0 % BY VOLUME CALIBRATION PRESSURE	SERIAL NO.:

	ATMOSPHERIC ✓	OTHER
1.		
2.		
3.		
4.		
5.		

DETECTOR SER. NO.:	
DETECTOR PART NO.:	
TAG NO.:	
CONFIGURATION NO.: 22	

REPEATABILITY: (IN % OF F.S.)

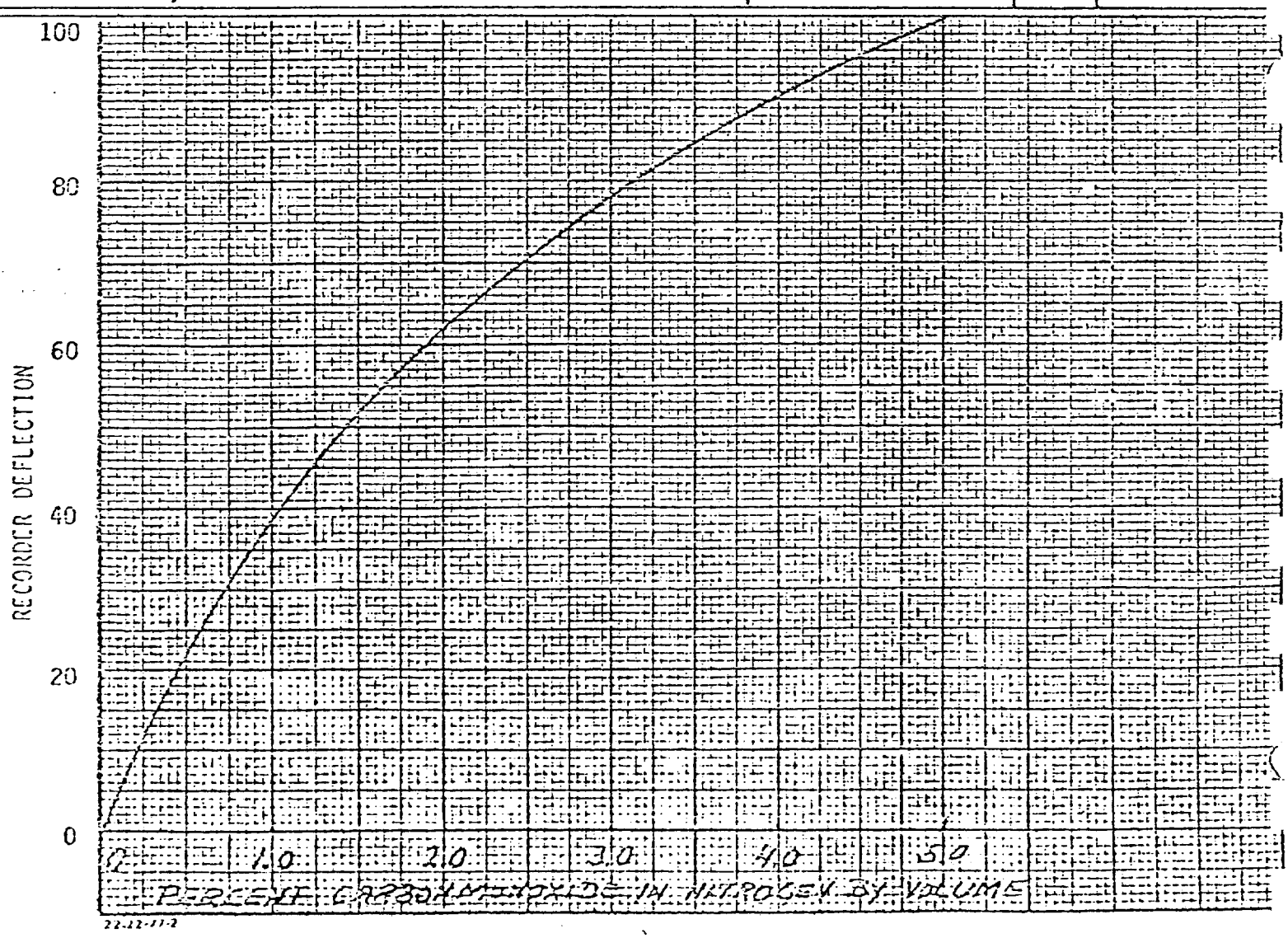
RANGE 1:	%	RANGE 3:	%
RANGE 2:	%	RANGE 4:	%

MODIFICATIONS AND REMARKS:

TYPICAL CALIBRATION CURVE.

INTERFERENCE GAS	MOL %	RESP. EQUIV.

ENGINEER: WPH DATE:



22-22-17-2

APPENDIX I

PROCESS DATA

TEST 1

Tuesday, May 1, 1979

Time of Charge or Level

JL-42768

P4 5-1-79 8-4 Tuesday

2-1 to 2-27
3-1 to 3-25

BY PRODUCT COKE OVENS

Paul Washington

	Push 1	Level	Push 2	Level	Push 3	Level	
1			20 hr coke				1
2	NR	Leveling 1:17	PUSH AT APPROX 10:15 AM CHANGE IN SERIES 10:21	Leveling 1:25	NR	Leveling 1:34	2
3							3
4	1:06	Charging 1:41	1:24	Leveling 1:53	1:34	Leveling 1:58	4
5							5
6	1:44 NG #1	Charging 2:10	1:54	Leveling 2:21	2:00	Leveling 2:29	6
7							7
8	2:11 #2	Leveling 2:42	2:24	missed	2:33	missed	8
9							9
10	2:40	?		Leveling 3:17	2:58	Leveling 3:23	10
11							11
12	3:07	Charging 4:09	3:18	Leveling 4:16	LAST PUSH 3:26	Leveling 4:26	12
13							13
14							14
15			FIRST PUSH				15
16							16
17		~~Leveling 10:16~~				Leveling 10:16	17
18							18
19	9:54 - ?	Leveling 10:27	9:58	Leveling 10:36	10:08	Leveling 10:47	19
20							20
21	10:26	Leveling 10:57	~10:40	Leveling 11:02	10:46	Leveling 11:16	21
22							22
23	10:54	Leveling 11:26	11:05	Leveling 11:34	11:19	Leveling 11:49	23
24							24
25	11:28	Leveling 11:59	11:40		11:53		25
26							26
27	12:02	Leveling 12:55 to 1:05	NR				27

A-1

JL-42768

P4 May 1st 4-12-mm Test #1

a1

BY PRODUCT COKE OVENS

	Push	Bogeness #	Charge or Level	Push	2	Charge or Level	3	
1								1
2								2
3								3
4								4
5								5
6								6
7								7
8								8
9								9
10								10
11								11
12								12
13								13
14	4:12	First Push on 4-12 mm #1	4:35	4:20		Leveling 4:41	4:28	Leveling 4:49
15			charging					
16	4:36	#2	charging 5:00	4:45		?	4:56	Leveling 5:22
17								
18	5:04	#2	?	5:17		Leveling 6:09	5:34	Leveling 6:15
19								
20	5:55	End only #2-#5	Charging 6:23	?		Leveling 6:32	6:18	Leveling 6:45
21								
22	6:27	#3	charging 6:55	6:40		?	6:48	Leveling 7:20
23								
24	6:58	End only #3-#5		7:08		Leveling 7:14	7:17	
25								
26				Due at 5:30. Out of sequence 5:42 #3		5:47	X X X X	
27							X X X X	

A-2

TABLE 4. PROCESS OPERATING LOG

Time test started 2:55 pm
Time test ended 7:30 pm
Hold periods none
Coking Time 17 hr

Date Tues May 1, 1979
Plant personnel Ken Kolvat - Ass Foreman 8-4
Paul Washington - " " 4-12

	Transmissometer reading	Fuel gas flow rate 1000 SCFH	No. of oven charged	No. of oven pushed	Greenness of push a/	Collecting main pressure mm H2O	Stack draft - mm H2O	O2 in flues Continuous O2	Flue temperatures Min.	Max.	Avg.	Coke temp. when pushed b/	Wall No.	Wall temperatures b/ Min.	Max.	Avg.	Flue pressure	Flue temperature	Stack temperature	Ambient temperature	Weather conditions	Fuel Gas Pressure	Bunk Bed Tube in	out
Units	%	SCFH						%	°F	°F	°F	°F		°F	°F	°F		°F	°F	°F		mm	°F	°F
Time																								
10:50	0	340			5.5 6.0	22	12		8-4 Shift									620	NR	Cl	275		78	138
11:55	0	350	See		5.5 6.0	22	11		Pusher Side					Not				626	NR		275		78	138
1:00	22	340	Other		5.5 6.0	22	12		avg 2343°F					Available				570	~50	PC	275		82	143
1:57	10	350	Sheet		6.0 6.0	22	11.5		Coke Side avg 2400									618	~50	PC	275		82	142
3:02	0	350			6.0 6.0	22	11.0		Low 2270	High ~2490								570	56	PC	275		84	144 ~~142~~
3:50	7	350			6.0 5.5	22	9.0											618	~55	PC	275		84	144
5:07	0	350			6.0 6.0	22	10.0		Pusher Side avg 2380°F									590	~60	PC	275		84	144
6:00	70	350			NR	23	11.0											565	~60	PC	275		85	144
7:01	10	350			6.0 6.0	23	9.0		Coke Side avg 2398°F									575	~60	PC	275		84	142
									Low 2250°F	High 2490														

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.

A-3

0

J ner 5/1/79

Notes for test days #1

Transmissometer is supposed to be self-calibrating
Doesn't have any record as to when it might have been checked or worked on

Instr men said they calibrated O_2 monitor. Now reading 9-10%

Hefr stack opacity (VE) at 7:30 pm, shortly after chrg over 1-6
Oven 1-6 had leak at wall 1-6 flue #4 coke side

check tomorrow → ~~Got~~ high CO (1650 ppm) at about the time over 2÷16 was chrgd ~5:17

Transmissometer spiked to 70% at 6:01 pm – ?

I didn't see anyone spray patch ~~on~~ only over today, except on one oven
No oven was silica dusted today

Test #1 over at 7:30 pm
alot of trouble getting integrated sample in bag
for benzene & O_2 analyses

Ed Yurkovich – Hr Foreman on Wed – ?

~ 1/2 ppm benzene

A-4

JL-43844 Date: 5-1-79 J&L Pgh. By-Product Laboratory

"C" Belt - Coal Mix to Ovens

% Moisture 6.02
Wt./Cu. Ft. 45.43 Lbs.
Sample: Automatic [X] Hand Sample [ ]

Screen Test

	%	Cumulative %
On 3/4" Screen	.4	.4
1/2"	1.5	1.9
1/4"	9.5	11.4
1/8"	24.9	36.3
Minus 1/8".....	63.7	
On 10 Mesh	10.3	46.6
14	5.7	52.3
20	15.8	68.1
28	5.4	73.5
35	9.7	83.2
48		
65		
100	10.4	93.6
Minus 100 Mesh.....	6.4	
On 200 Mesh	3.4	97.0
Minus 200 Mesh	3.0	

COKE

Conditions when Sampling:

Coke Appearance: Normal [X] Wet [ ] Dry [ ]
Wharf Condition: Full [ ] % Full 1/2
Coke Size: Large [ ] Small [ ] Normal [X]
Belt Condition: OK
Fire Spray: OK
Weather: Clear [ ] Cold [ ] Hot [ ] Damp [ ]
Sampling Location P4 Boom Belt

	Total	Daily Ave.	3 Day Ave.
Daily reported Moisture.....	5.83	5.83	5.63
Boom Belt Coke % Moisture			
+1-1/2" Coke H_2O			
1-1/2" x 7/8" Coke H_2O			
Bulk Density(Lbs)			

A.S.T.M. Shatter Test + 2" DAILY AVE 61.3
P 4 Wharf Sample 60.3

APPARENT GRAVITY

Proximate Analysis

COAL		COKE	3 Day Ave.
% Volatile Matter	32.33	0.92	0.92
% Fixed Carbon	60.17	89.14	89.16
% Ash	7.50	9.94	9.92
% Sulfur	1.33	0.91	0.91

MOISTURES - COAL BARGES SAMPLES

Date	Shift	Type of Coals	Barge No.	% H_2O BP Lab	% H_2O Mines
		V.S.G. Blend			
		V.S.G. Blend			
5/1/79	3	[illegible]	1317 1329 1425 1323	5.77	
5/1/79	3	GAULEY EAGLE	1369	5.03	
5/1/79	3	BECKLEY	1461	9.39	
5/1/79	3	LANCASHIRE	1047	6.71	
5/2/79	1	LANCASHIRE	1013	7.34	

Tumbler Tests

Screening Station P1

Stability - Total % + 1"	1	2	Ave.
	56.9	54.2	55.6
	8.8	11.2	10.0
Hardness Total + ¼"	65.7	65.4	65.6

Screening Station P4

Stability - Total % + 1"	1	2	Ave.
	52.3	52.9	52.6
	14.2	14.4	14.3
Hardness Total + ¼"	66.5	67.3	66.9

Screen Test

P 4 Sample
Total on 2" 87.0

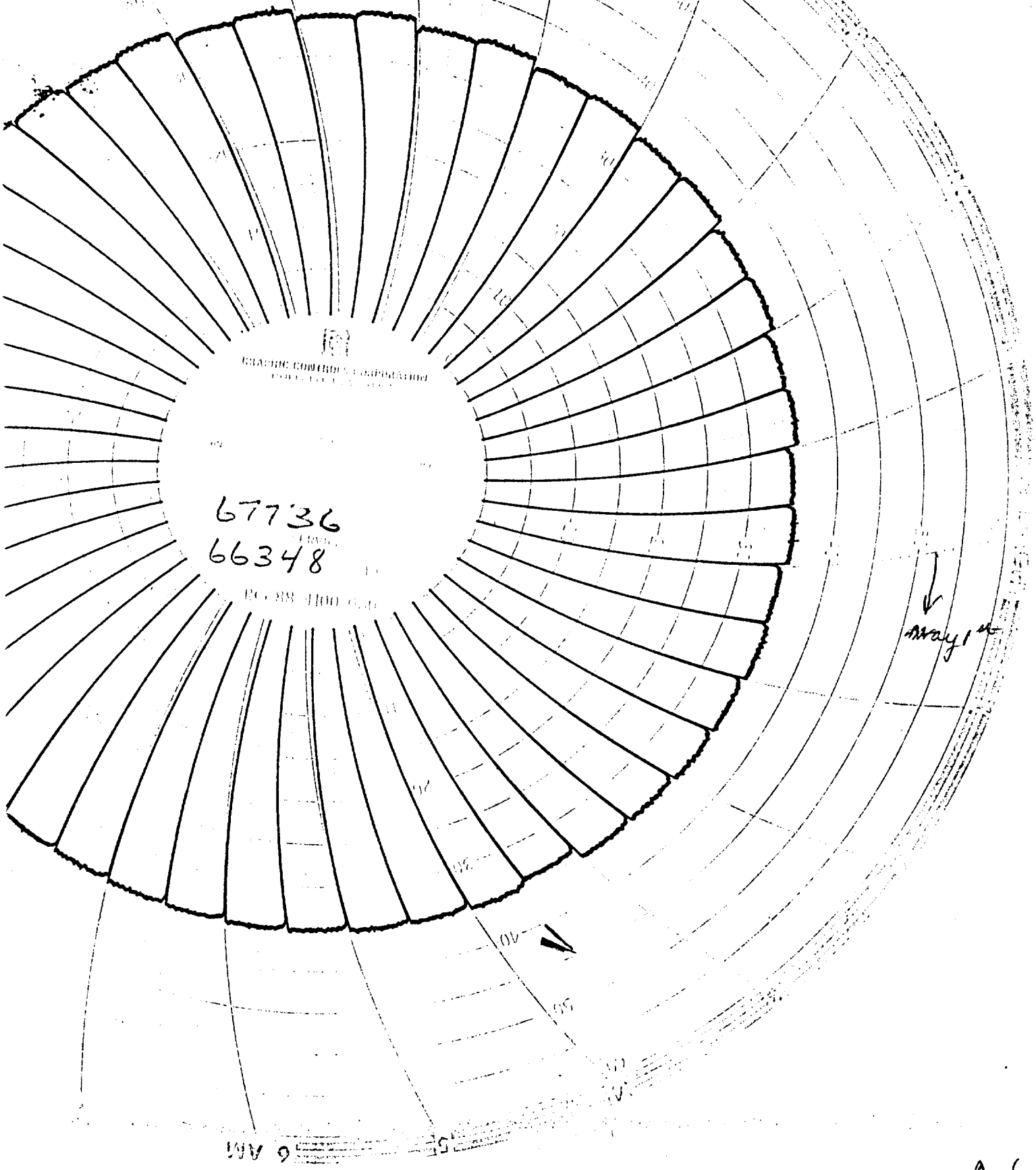
	% on 4" Screen
3"	9.9
2"	42.9
1	34.2
Minus 1"	8.7
	4.3

A-5

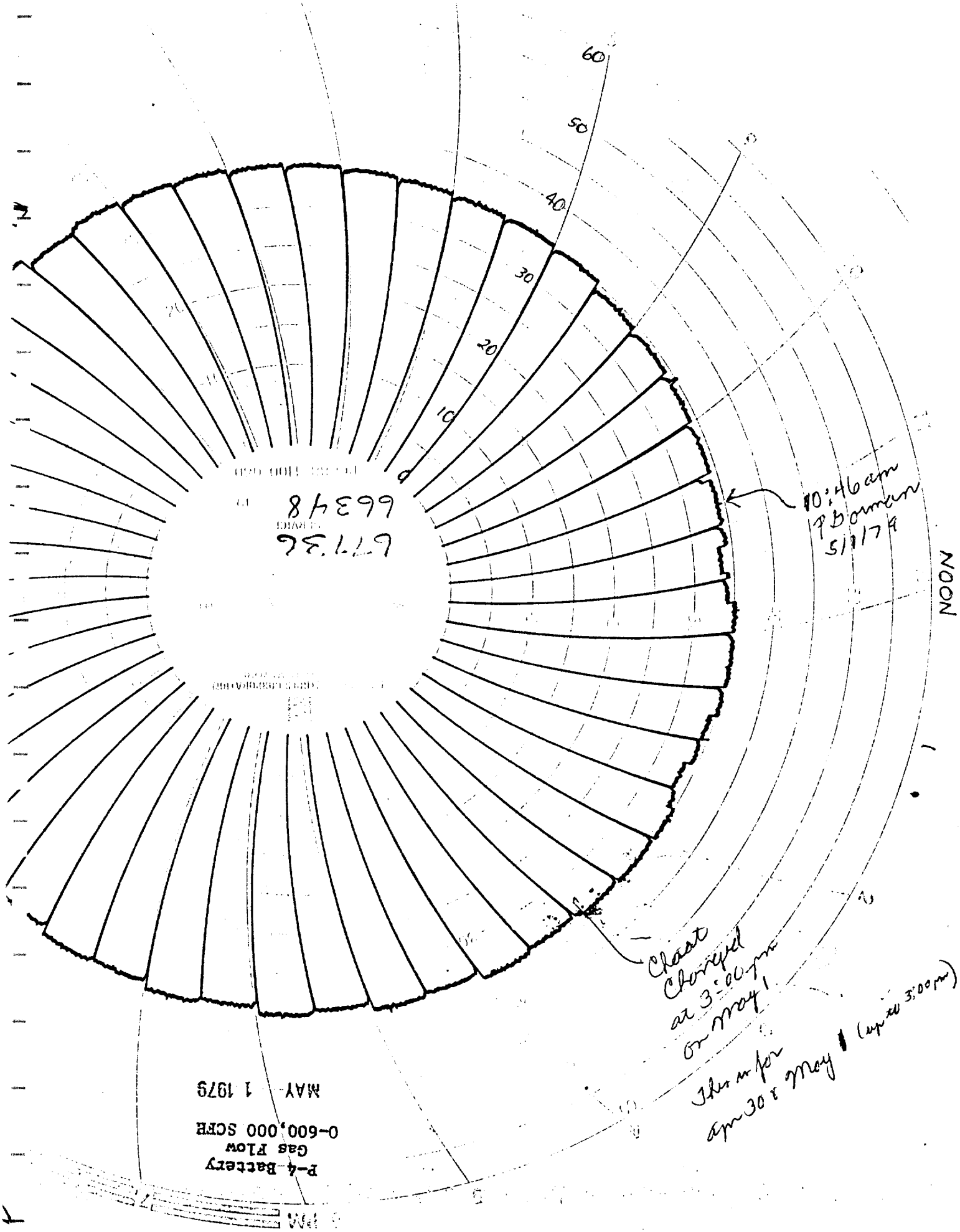
P-4 Battery
Gas Flow
0-600,000 SCFH

MAY 1 1979

67736
66348



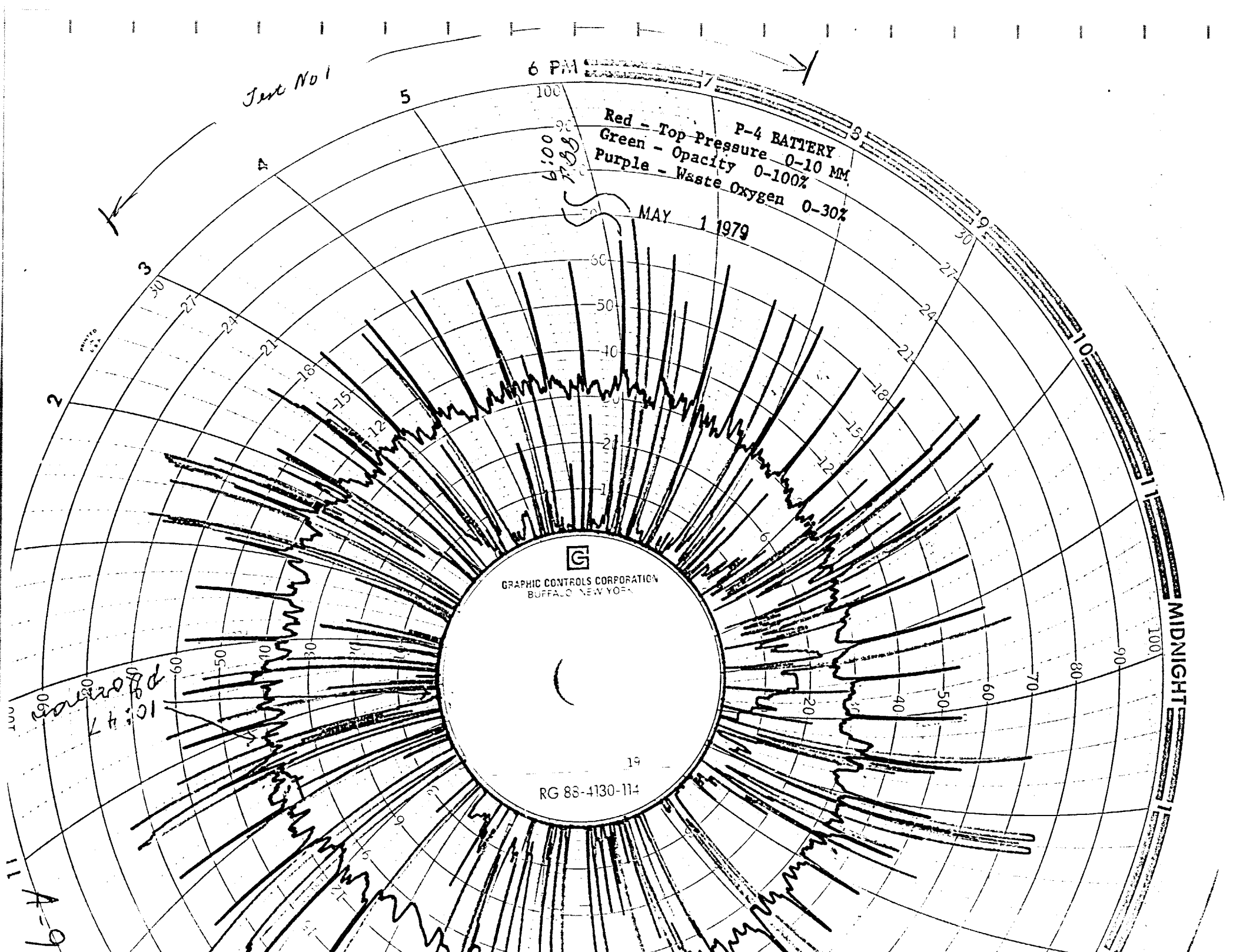
A-6

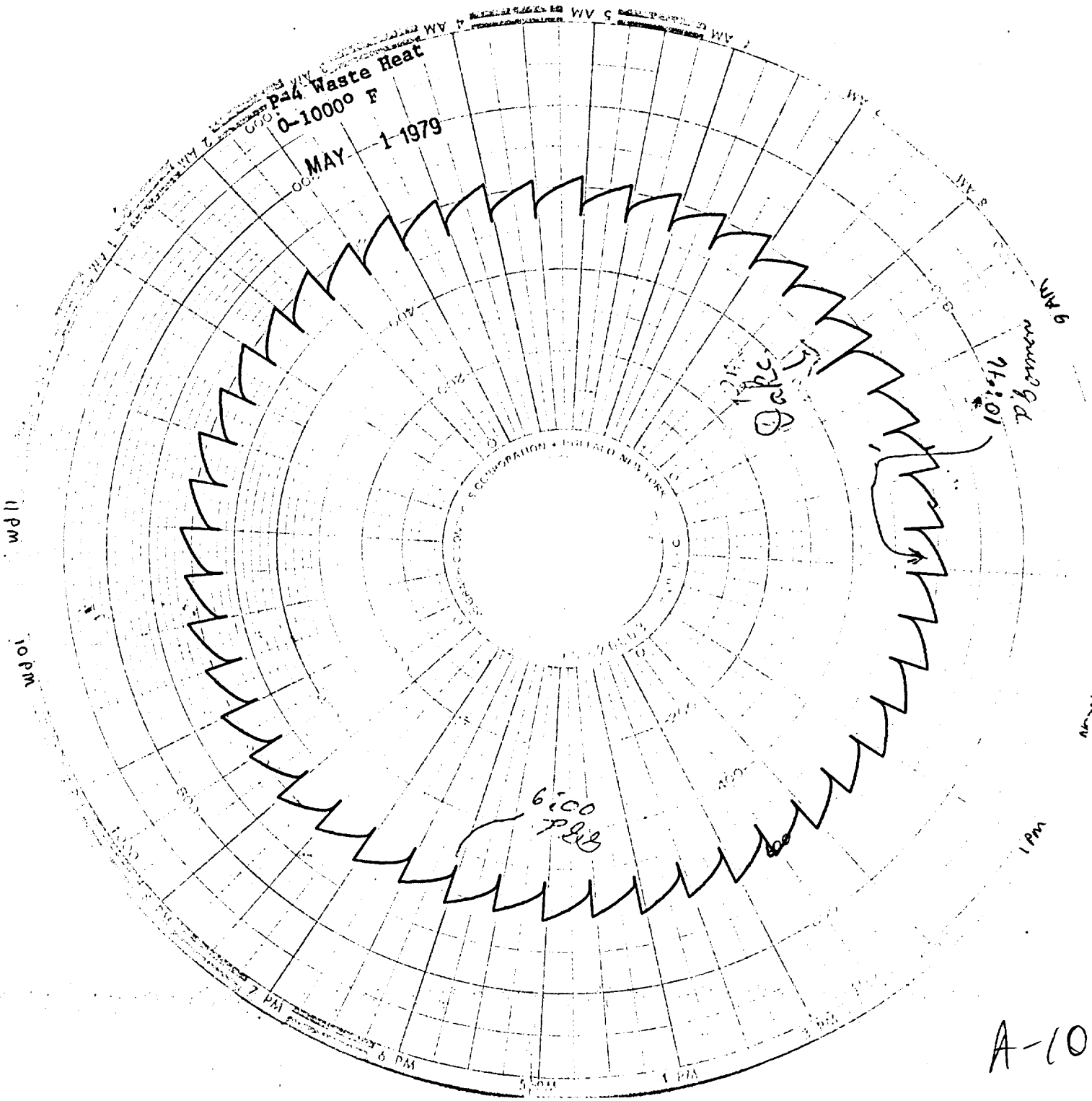

P-4 Battery
Gas Flow
0-600,000 SCFH
MAY 1 1979
6 PM
6 AM
NOON
0
10
20
30
40
50
60
10:46am
P Bowman
5/1/79
Chart
Changed
at 3:00pm
on May 1
Thru for
Apr 30 & May 1 (up to 3:00pm)

A-7

NOON
10:45
5/7/79
Test
NO 2
5/7/79
2:45 pm
P.S.B.
Test
No 1
5/1/79
6 Fin
P-A Battery
Gas Flow
0-600,000 SCFE
MAY 2 1979
5/1/79
91227
6736

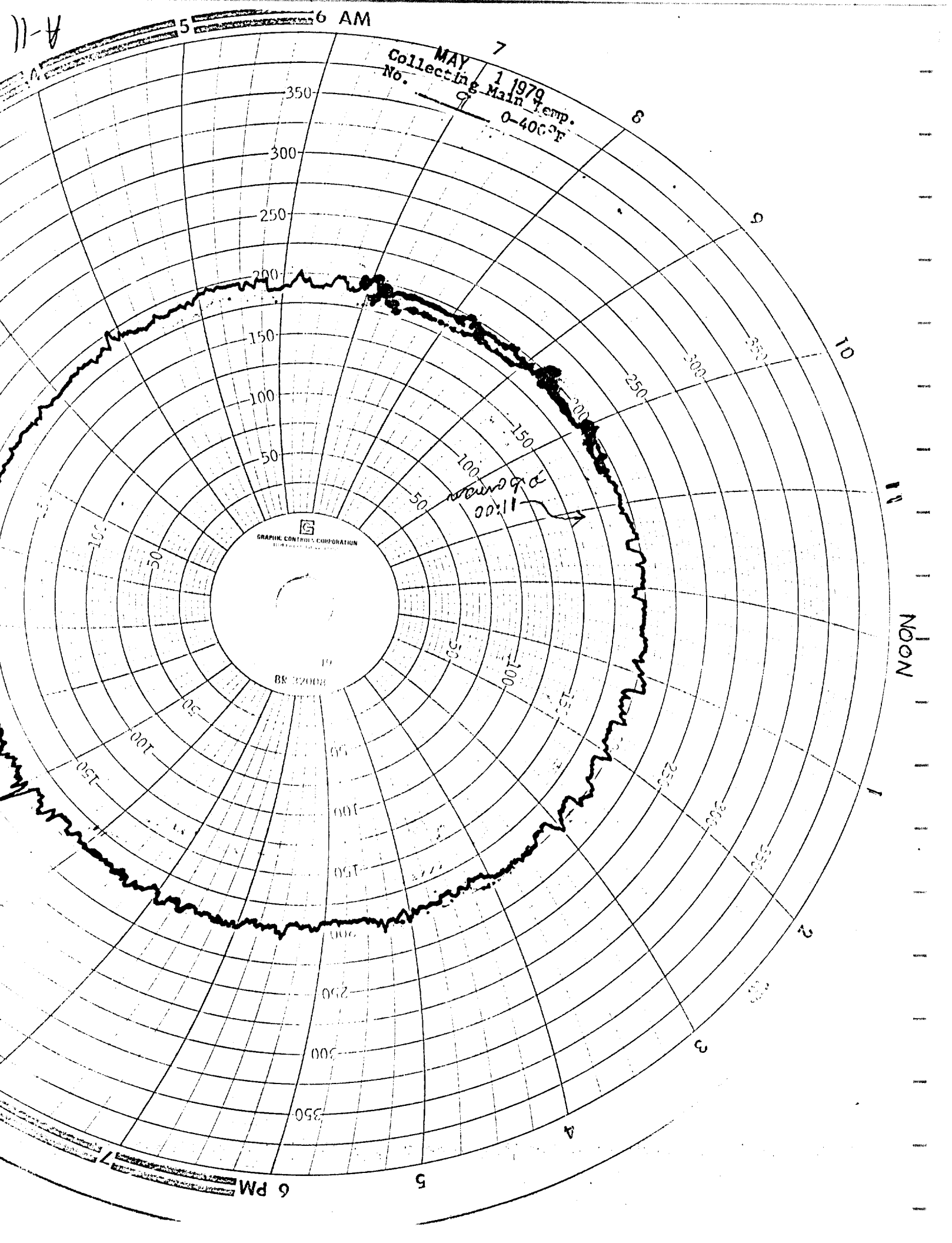
A-8

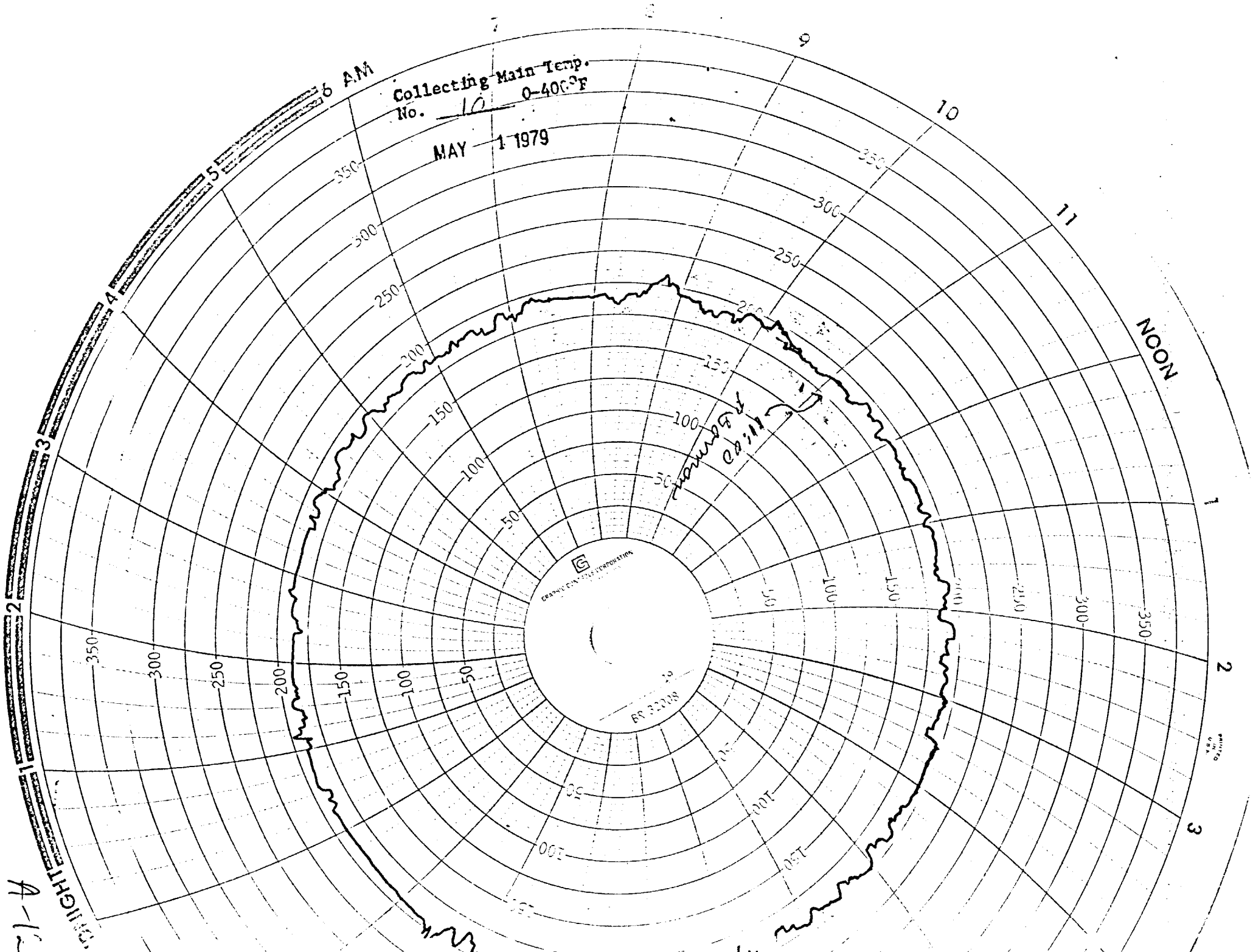

Test No 1
6 PM
P-4 BATTERY
Red - Top Pressure 0-10 MM
Green - Opacity 0-100%
Purple - Waste Oxygen 0-30%
MAY 1 1979
6:00
MIDNIGHT
GRAPHIC CONTROLS CORPORATION
BUFFALO NEW YORK
RG 88-4130-114
A-9


P-4 Waste Heat
0-1000° F
MAY 1 1979
6:00 PM
10:00 PM
9 AM
11 PM
10 PM
1 PM
7 PM
8 PM
5 PM
4 PM

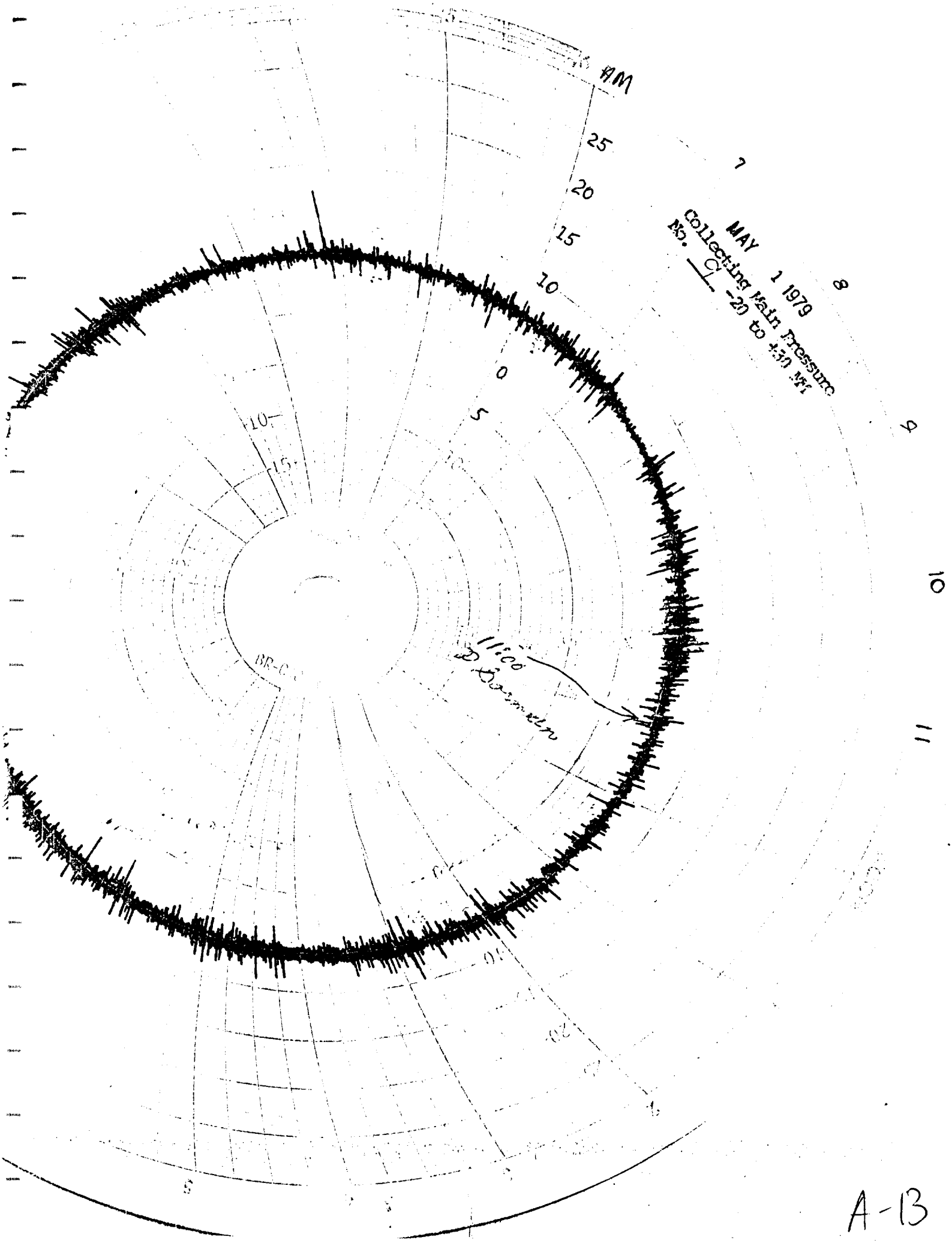
A-10

A-11

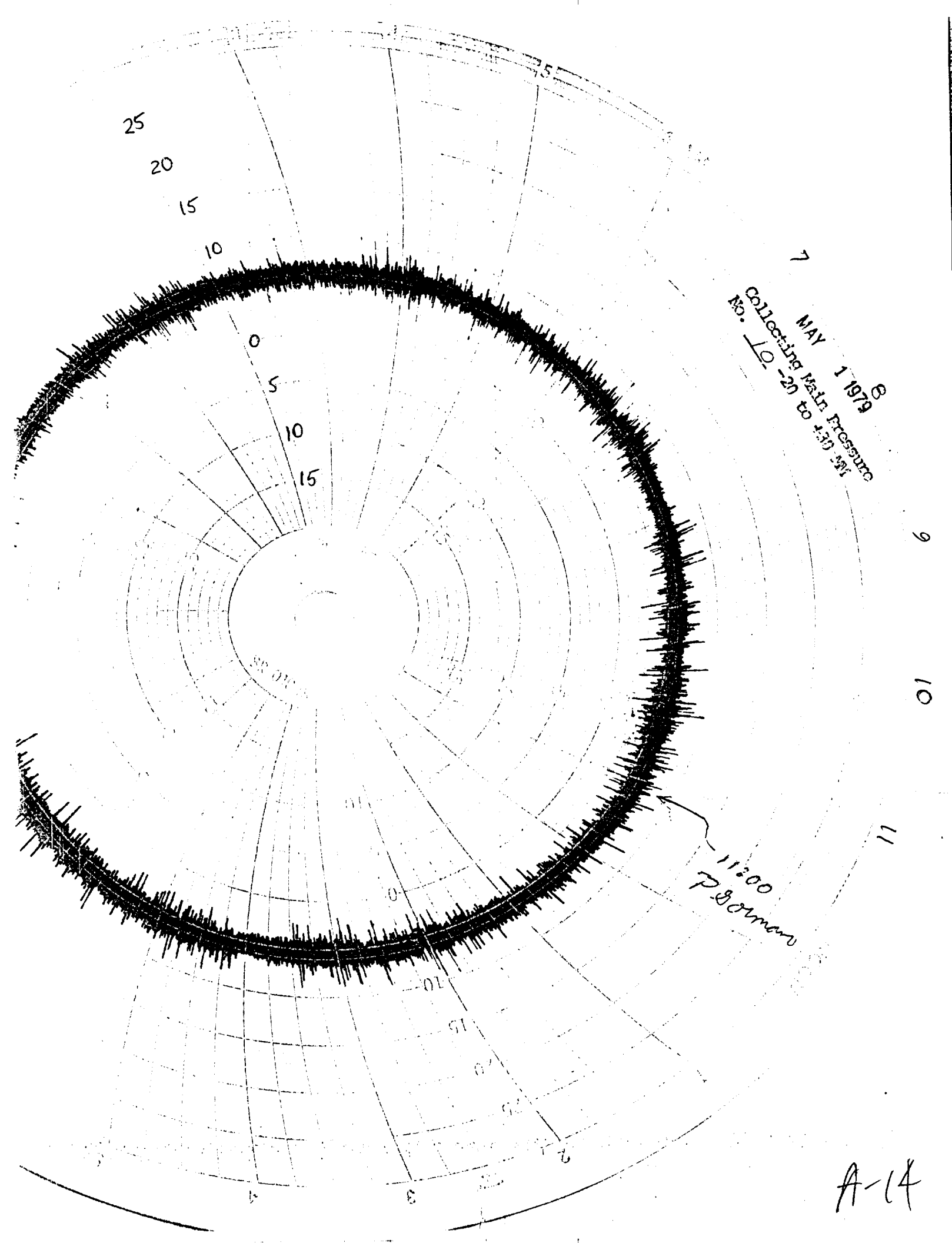

6 AM
7
8
9
10
11
NOON
1
2
3
4
5
6 PM
MAY 1 1979
Collecting Main Temp.
No. 9
0-400°F
350
300
250
200
150
100
50
GRAPHIC CONTROLS CORPORATION
11:00

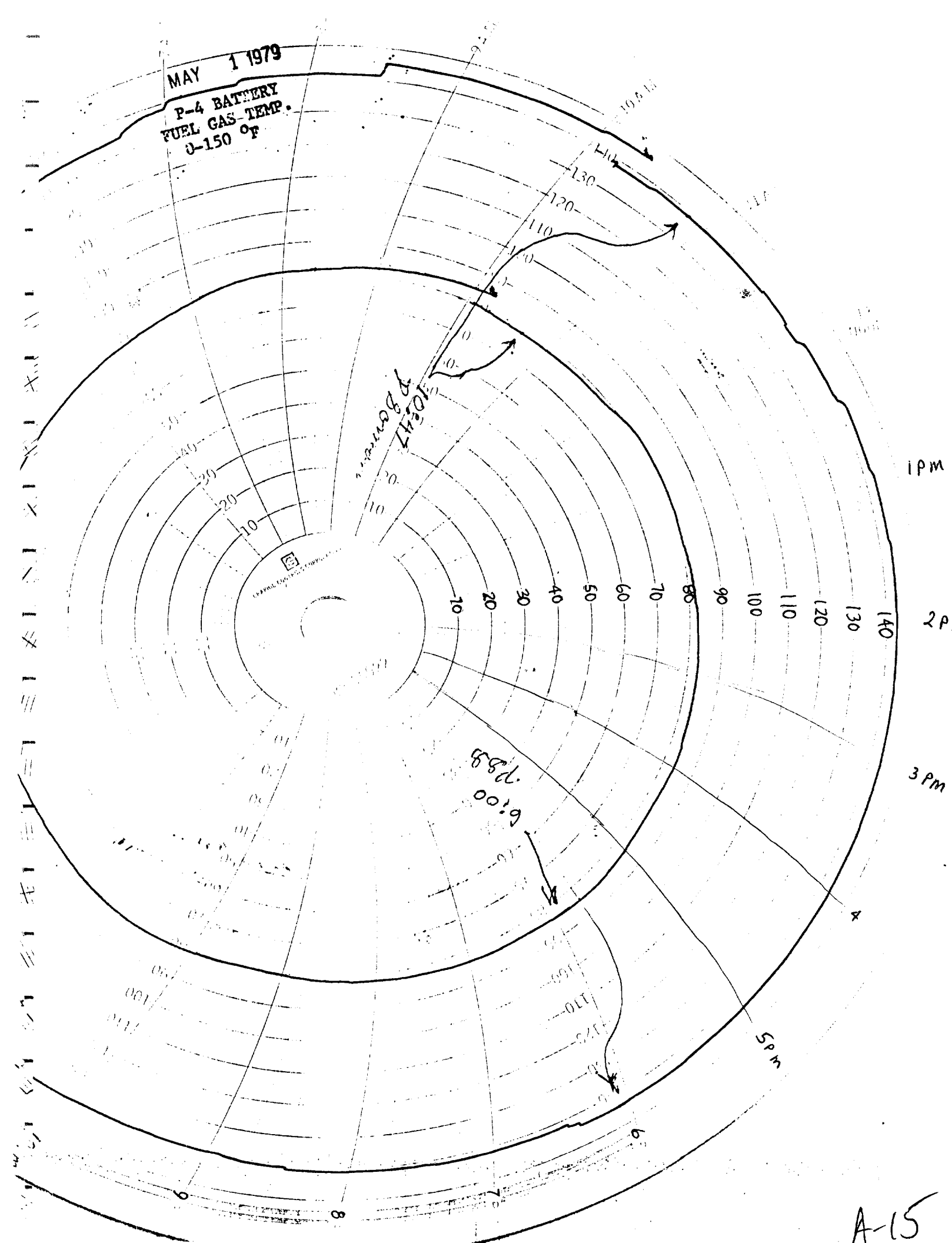

Collecting Main Temp.
No. 10 0-400°F
MAY 1 1979
6 AM
NOON
MIDNIGHT
GRAPHIC CONTROLS CORPORATION
BUFFALO, N.Y.
PRINTED IN U.S.A.

A-12


AM
25
20
15
10
0
5
10
15
7
8
9
10
11
MAY 1 1979
Collecting Main Pressure
No. C1 -20 to +30 MT
11:00
D Bassett

A-13

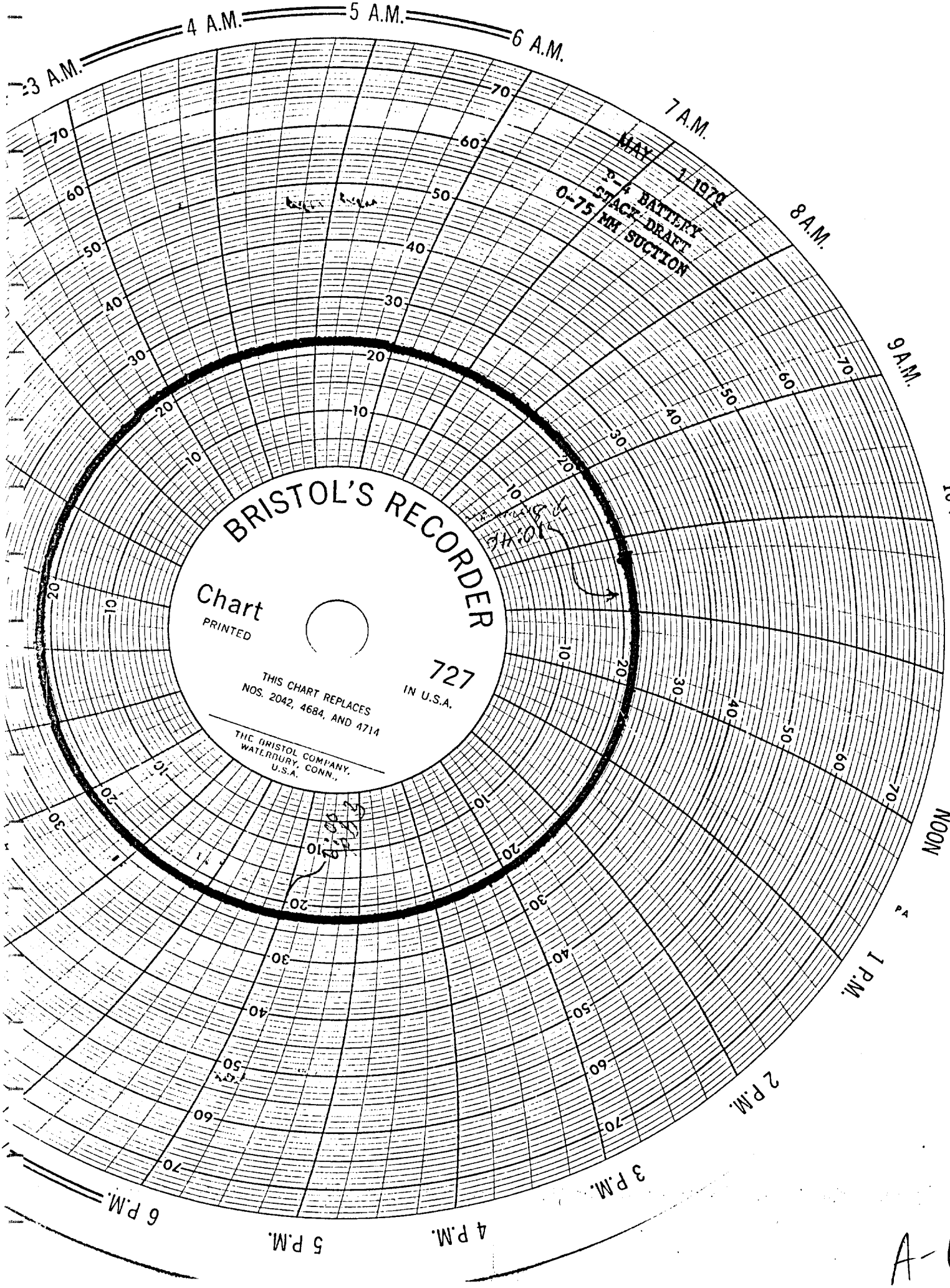

MAY 1 1979
Collecting Main Pressure
No. 10 -20 to 130 MV
11:00
P Gorman
A-14


MAY 1 1979
P-4 BATTERY
FUEL GAS TEMP.
0-150 °F
1PM
2P
3PM
4
5PM
6
7
8
9
10
11
10:47
6:00
P.M.

A-15

6 PM
5
4
3
2
1
NOON
11
10
9
8
7
6 AM
5
350
300
250
200
150
100
50
MAY 1 1979
T-4 BATTERY
GAS PRESSURE
FUEL
10:46
P'Bormen
Bake RA

A-16


BRISTOL'S RECORDER
Chart
PRINTED
727
IN U.S.A.
THIS CHART REPLACES
NOS. 2042, 4684, AND 4714
THE BRISTOL COMPANY,
WATERBURY, CONN.,
U.S.A.
MAY 1 1979
5-4 BATTERY
STACK DRAFT
0-75 MM SUCTION
3 A.M.
4 A.M.
5 A.M.
6 A.M.
7 A.M.
8 A.M.
9 A.M.
10 A.M.
11 A.M.
NOON
1 P.M.
2 P.M.
3 P.M.
4 P.M.
5 P.M.
6 P.M.

A-17

TEST 2

Wednesday, May 2, 1979

JL-42768

P4 Wed 5/2/79 am Test 2

BY PRODUCT COKE OVENS

	Push 1	Last Charge	Push 2	Level	Push 3	Level
1	2:40 #2					
2						
3						
4						
5						
6						
7						
8						
9						
10			First Push			
11						
12						
13						
14	Leveling flues (see notes)					Leveling 10:53
15						
16		Charging 11:00		Leveling 11:15	Push 10:55 am	Leveling 11:22
17						
18	Push 11:06 #2-3	Bareness Charging 11:28	11:12 am	NR?	11:23 am	Leveling 11:55 am
19						
20	11:34 #2, 5 (End only)	Charging 12:08	? NR	NR?	12:03 pm	Leveling 12:33
21						
22	12:16 #2	NR	? NR	Leveling 1:05	12:43 pm	Leveling 1:20
23						
24	~~#2~~ 12:58 # NR	Charging 1:40	1:14 pm	1:47	1:23 pm	NR
25						
26	1:40 #2		Delay ~2:30			
27						A-18

TABLE 4. PROCESS OPERATING LOG

Time test started ~10:45 am
Time test ended 2:10 for method 5 test
Hold periods
Coking Time 17 hr

all done by 3:00 pm

Date Wed 5/2/79 Test # 2
Plant personnel Ed Yurkovich - Tom Foumer

	Transmissometer reading	Fuel gas flow rate 1.62 SCFH	No. of oven charged	No. of oven pushed	Greenness of push a/	Collecting main pressure	Stack draft	O_2 in flues Continuous O_2	Flue temperatures Min.	Max.	Avg.	Coke temp. when pushed b/	Wall No.	Wall temperatures b/ Min.	Max.	Avg.	Flue pressure	Flue temperature	Stack temperature	Ambient temperature	Weather conditions	Fuel Box Pressure	Fuel Box Pressure
Units	%	SCFH				mm	mm	%	°F	°F	°F	°F		°F	°F	°F		°F	°F	°F		mm	In	Cm
Time																								
10:44	0	350			9 10	5.5 6.0	22	11.5	Push Side avg 2379°F									610	50	Cl	275	85	146
11:28	0	350			9 10	5.5 5.5	22	11.5	Coke Side avg 2416°F									595	62	Cl	275	84	146
12:45	2	350			9 10	6.0 5.5	22	10.3										610	63	Cl	275	90	146
01:50	15	350	fuel Other			6.0 5.5	22	9.5				Not available		Not available				618	66	Cl	276	92	138
2:42	2	350	flue			6.0 5.5	22	9.0										606	70	Cl	275	90	140

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.

A-19

C

P-4

Notes Test # 2 5/2/79

10:20 am Smoky Stack - Just charged 3-12
Check flue on 3-12 no flue leak
Checked over 1-14 Several flues leaking
Wall 1-14 4th flue pusher side
Wall 1-15 4, 5 & 6 pusher side, and #10 coke side flue

Transmissometer went to 60% at 2:45 pm
CO went from 300-400 ppm up to about 900 ppm

Opr says ESP in byproducts plant is down and has been for 6 month
COB fuel is dirtier than it used to be

All testing over by 3:00 pm

No ovens were sprayed today (and no silica dusting)

→ Meet w Mr Sandre at 9:00 am on Thurs

A-20

JL-43844 Date: 5-2-79 J&L Pgh. By-Product Laborator

"C" Belt - Coal Mix to Ovens

% Moisture 6.50
Wt./Cu. Ft. 45.36 Lbs.
Sample: Automatic [X] Hand Sample [ ]

Screen Test

	%	Cumulative %
On 3/4" Screen	1.2	1.2
1/2"	2.2	3.4
1/4"	9.7	13.1
1/8"	20.4	33.5
Minus 1/8".....	66.5	
On 10 Mesh	12.0	45.5
14	5.4	50.9
20	16.4	67.3
28	7.3	74.6
35	6.3	80.9
48		
65		
100	13.1	94.0
Minus 100 Mesh.....	6.0	
On 200 Mesh	4.2	98.2
Minus 200 Mesh	1.8	

98

OXIDATION

COKE

Conditions when Sampling:

Coke Appearance: Normal [ ] Wet [ ] Dry [X]
Wharf Condition: Full [X] % Full
Coke Size: Large [ ] Small [ ] Normal [X]
Belt Condition: OK
Fire Spray:
Weather: Clear [ ] Cold [ ] Hot [ ] Damp [ ]
Sampling Location P1 BOOM BELT

		Total	DAILY AVE	3 Day Ave.
Daily reported Moisture.....	4.37	10.20	5.10	5.49
Boom Belt Coke % Moisture				
+1-1/2" Coke H_2O				
1-1/2" x 7/8" Coke H_2O				
Bulk Density(Lbs)	26.27			

DAILY-AVE 61.2

A.S.T.M. Shatter Test + 2"
P 1 Wharf Sample 60.9

APPARENT GRAVITY

Proximate Analysis

	COAL	COKE	3 Day Ave.
% Volatile Matter	32.84	0.86	0.89
% Fixed Carbon	59.80	89.31	89.22
% Ash	7.36	9.83	9.89
% Sulfur	1.34	0.92	0.92

MOISTURES - COAL BARGES SAMPLES

Date	Shift	Type of Coals	Barge No.	% H_2O BP Lab	% H_2O Mines
5/2	4-12	~~V.S.G. Blend~~ NEMACOLIN	1438 1302 1408	6.06	
		V.S.G. Blend			
		V.S.G. Blend			
5/3	12-8	LANCASHIRE	1354	7.50	
5/2	4-12	BAULEY EAGLE	1349	4.21	
5/3	12-8	BAULEY EAGLE	1311	4.75	
5/2	4-12	BECKLEY	7803	7.53	

Tumbler Tests

Screening Station P1

Stability - Total % + 1"

	1	2	Ave.
	53.5	53.7	53.6
	13.3	13.8	13.6
Hardness Total + ½"	66.8	67.5	67.2

Screening Station P4

Stability - Total % + 1"

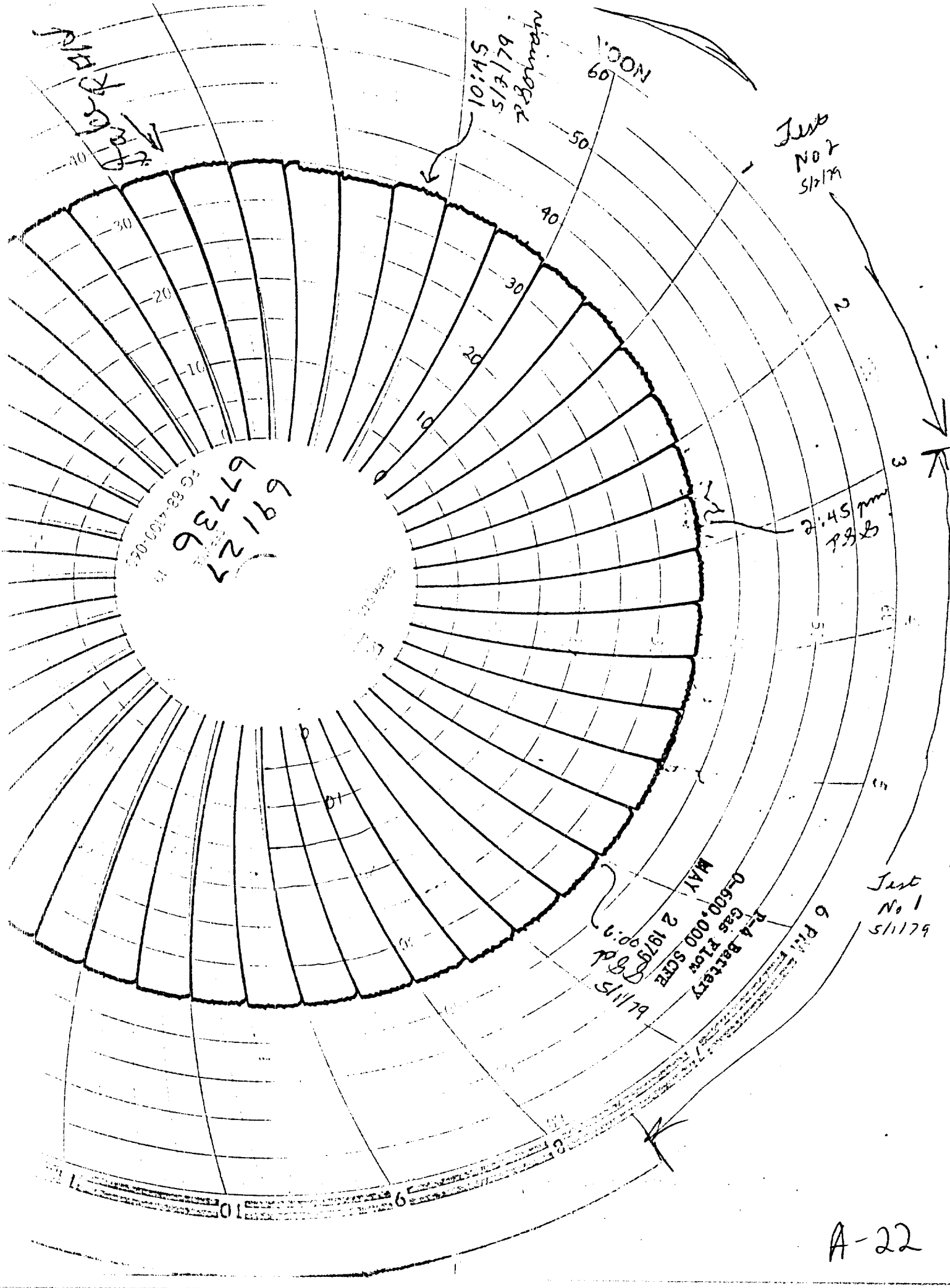
	1	2	Ave.
	53.9	54.1	54.0
	11.0	10.0	10.5
Hardness Total + ½"	64.9	64.1	64.5

Screen Test

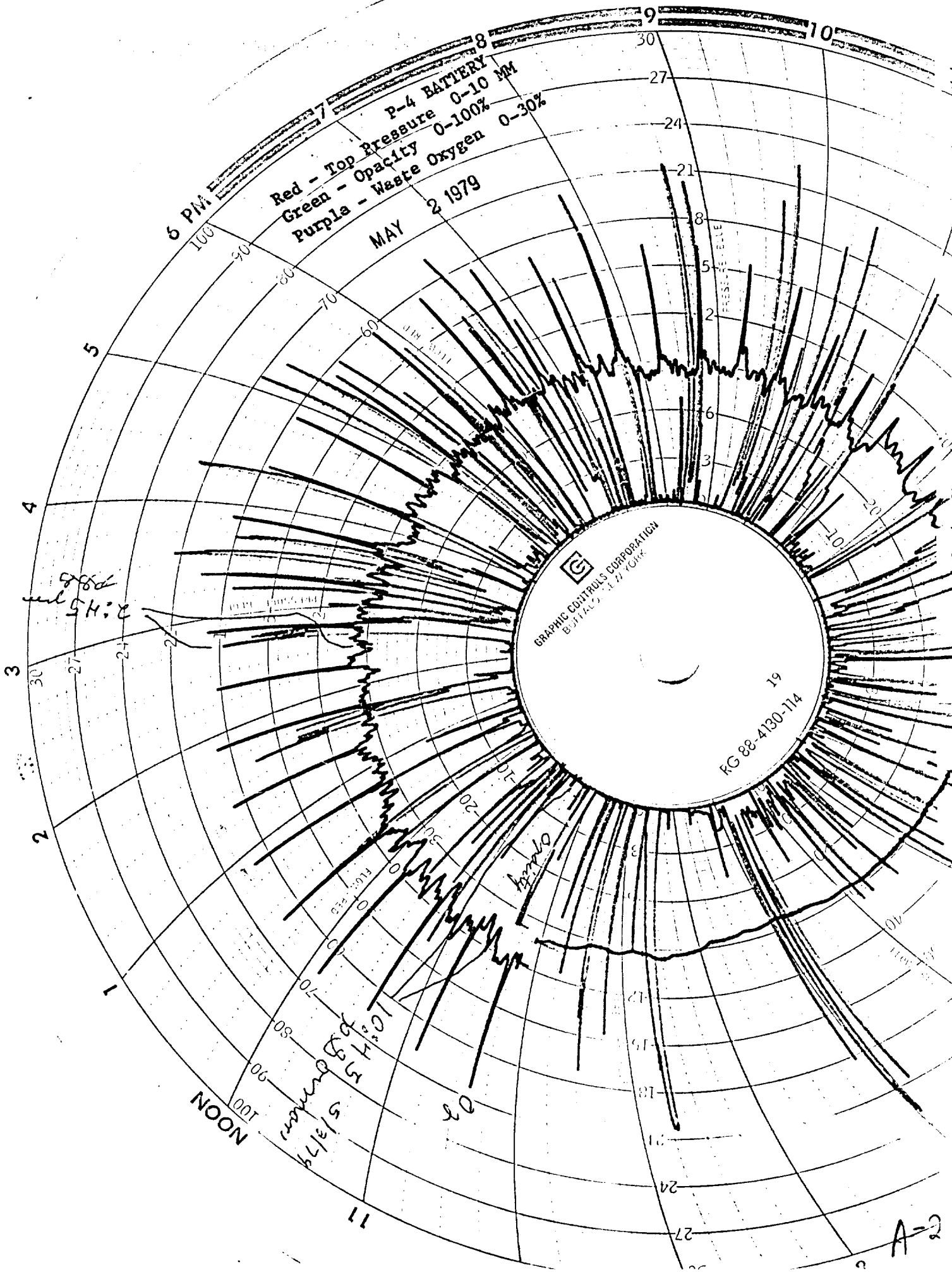
P 1 Sample
(Total on 2" 72.8

% on 4" Screen	4.2
3"	23.0
2"	45.6
1	20.4
Minus 1'	6.8

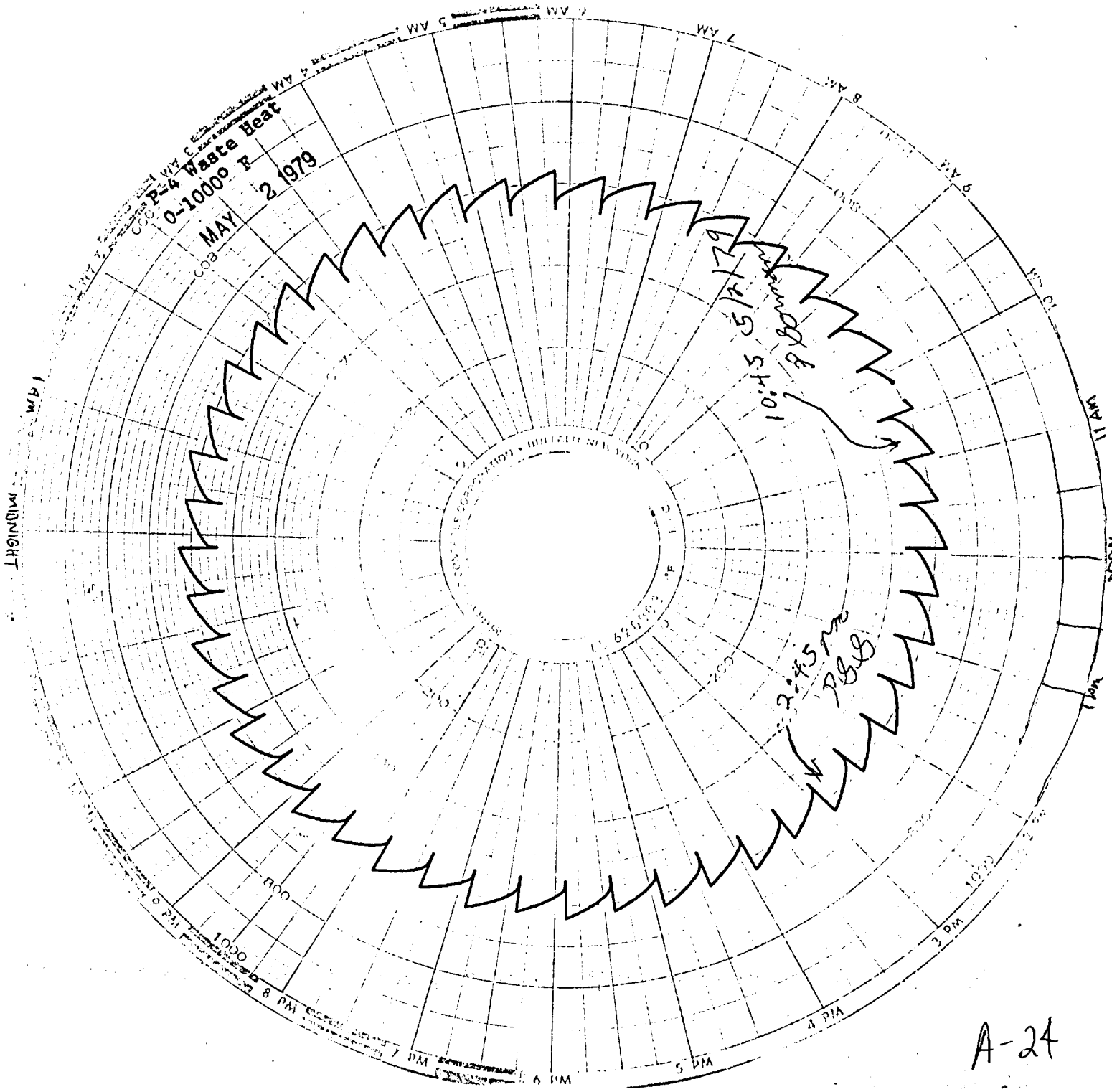
A-21


10:45
5/3/79
NOON
Test
No 2
5/2/79
2:45 pm
Test
No 1
5/1/79
6 PM
5/1/79
P-A Battery
Gas Flow
0-600,000 SCFE
MAY 2 1979
6173
6127

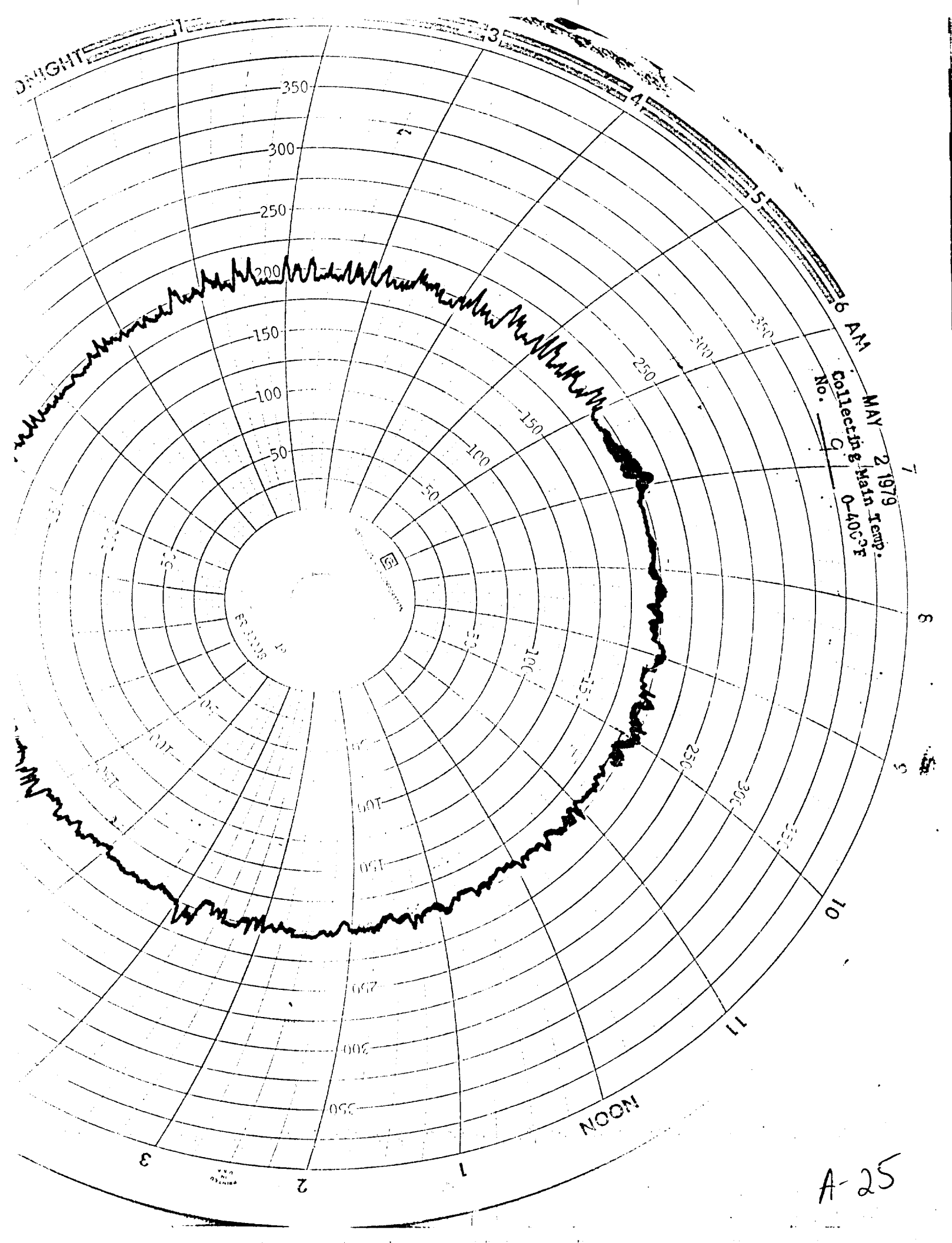
A-22


P-4 BATTERY
Red - Top Pressure 0-10 MM
Green - Opacity 0-100%
Purple - Waste Oxygen 0-30%
MAY 2 1979
6 PM
NOON
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
19
RG 88-4130-114

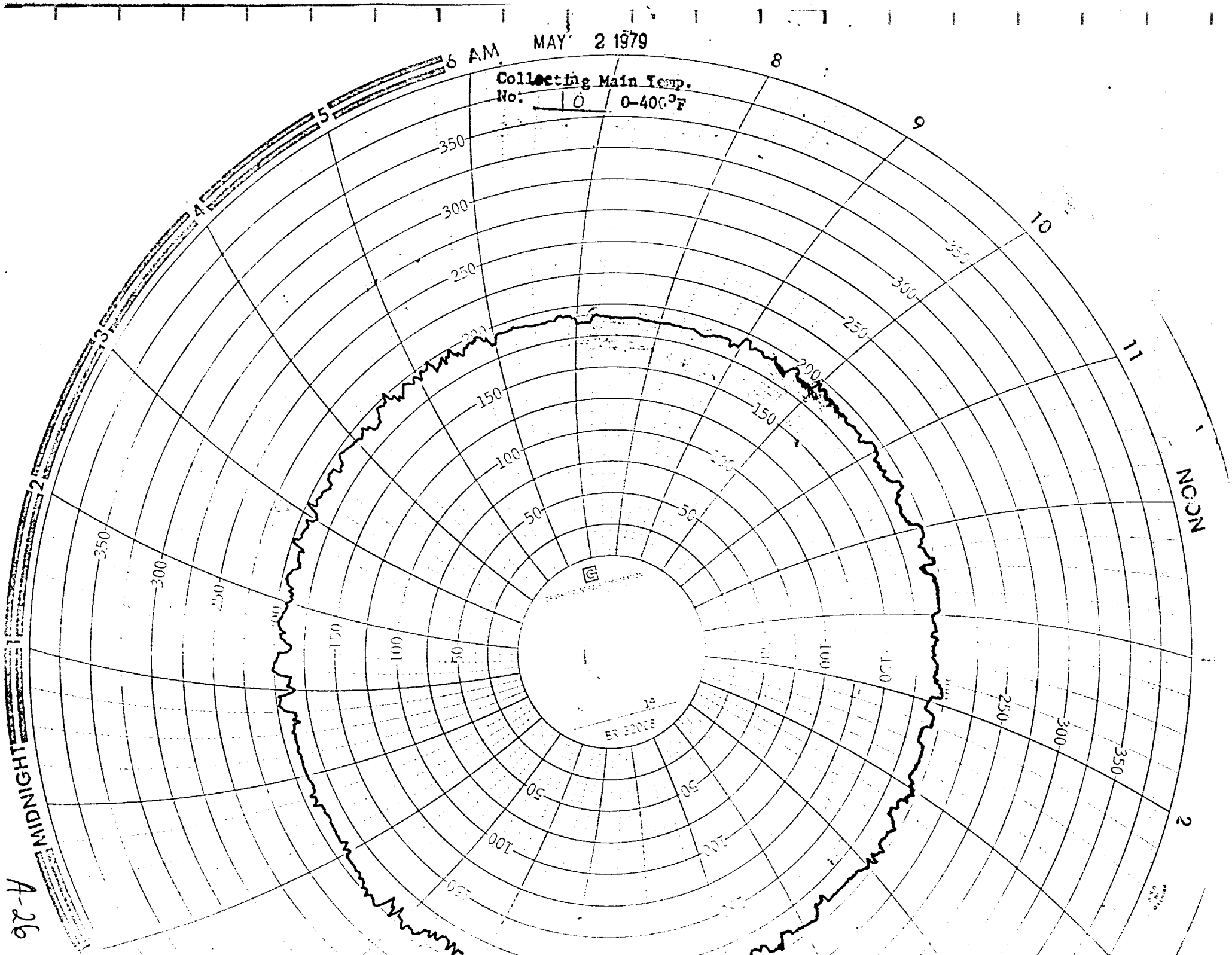
A-2


P-4 Waste Heat
0-1000 F
MAY 2 1979
10:45 5/1/79
2:45 pm
MIDNIGHT
1 AM
11 AM
1 PM
7 PM
6 PM
5 PM
4 PM
3 PM
2 PM
1 PM
10 PM
9 PM
8 PM
7 PM
6 PM
5 AM
4 AM
3 AM
2 AM
1 AM
800
1000

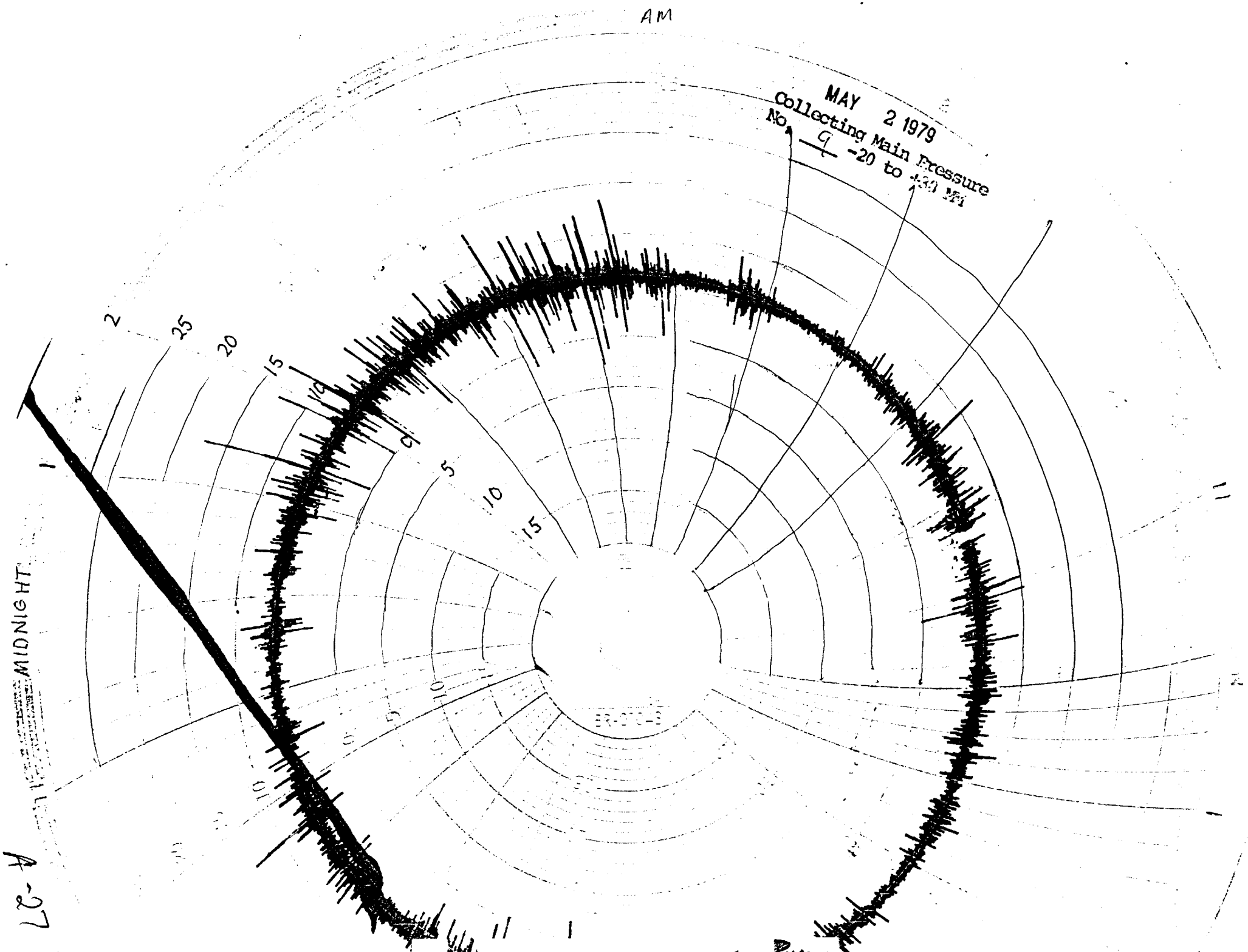
A-24


MAY 2 1979
Collecting Main Temp.
No. C
0-400°F
6 AM
7
8
9
10
11
NOON
1
2
3
4
5
MIDNIGHT
350
300
250
200
150
100
50

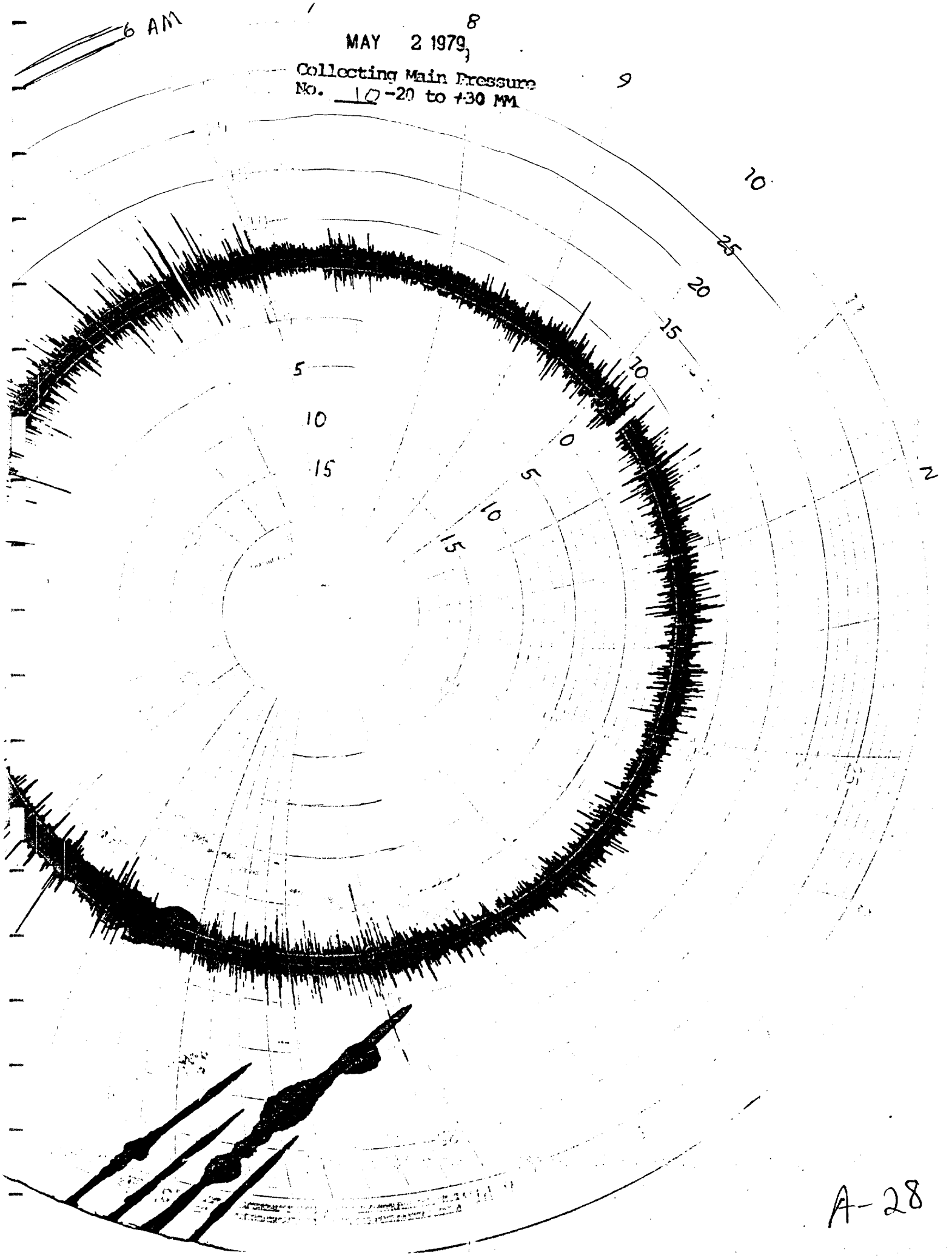
A-25


MAY 2 1979
Collecting Main Temp.
No: 0 0-400°F
NOON
MIDNIGHT
6 A.M.
8
9
10
11
2
1
2
3
4
5
350
300
250
200
150
100
50

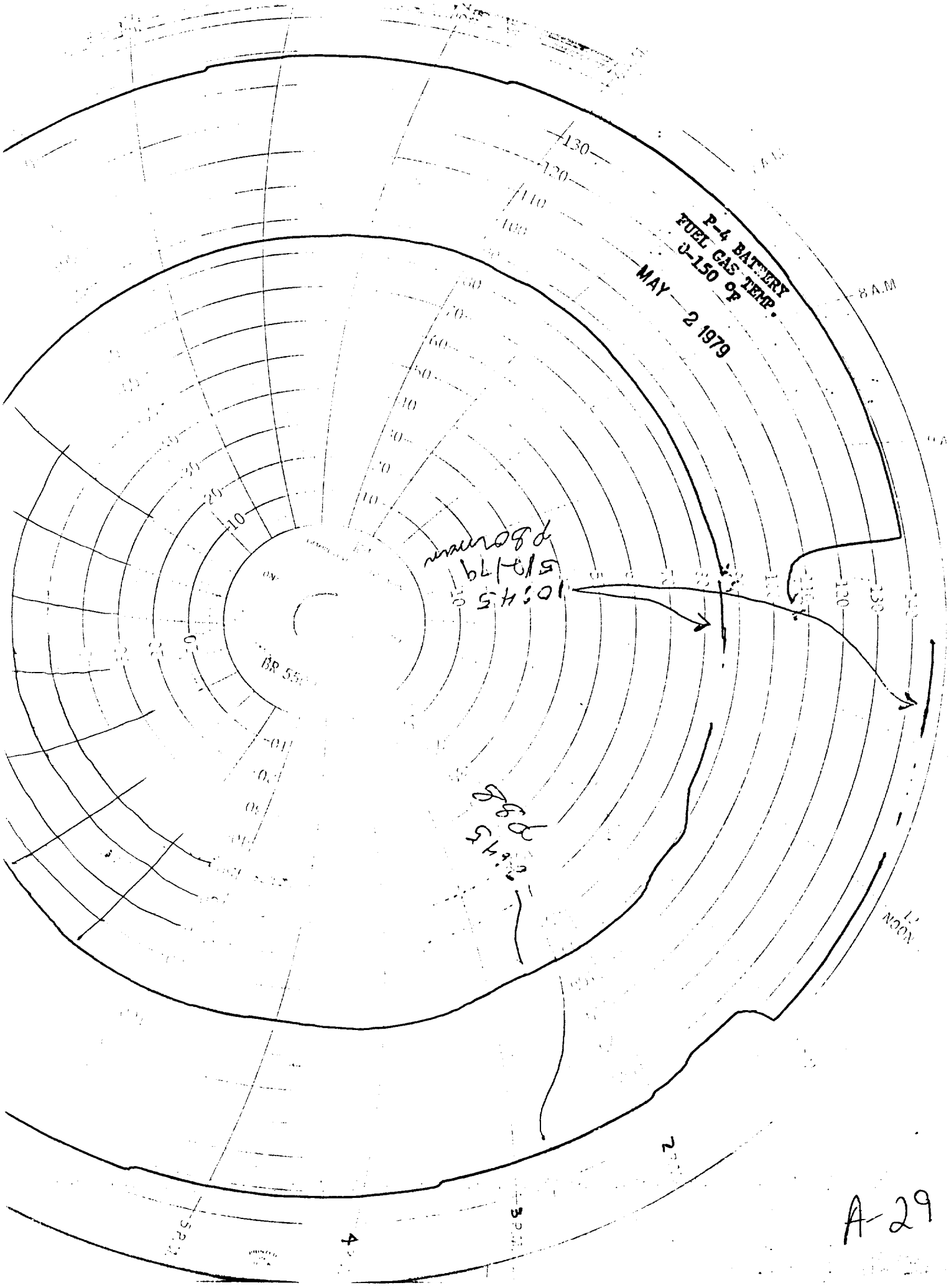
A-26


AM
MAY 2 1979
Collecting Main Pressure
No. 9 -20 to +30 MM
MIDNIGHT
2
25
20
15
10
5
10
15
10
5
5
10
11
1

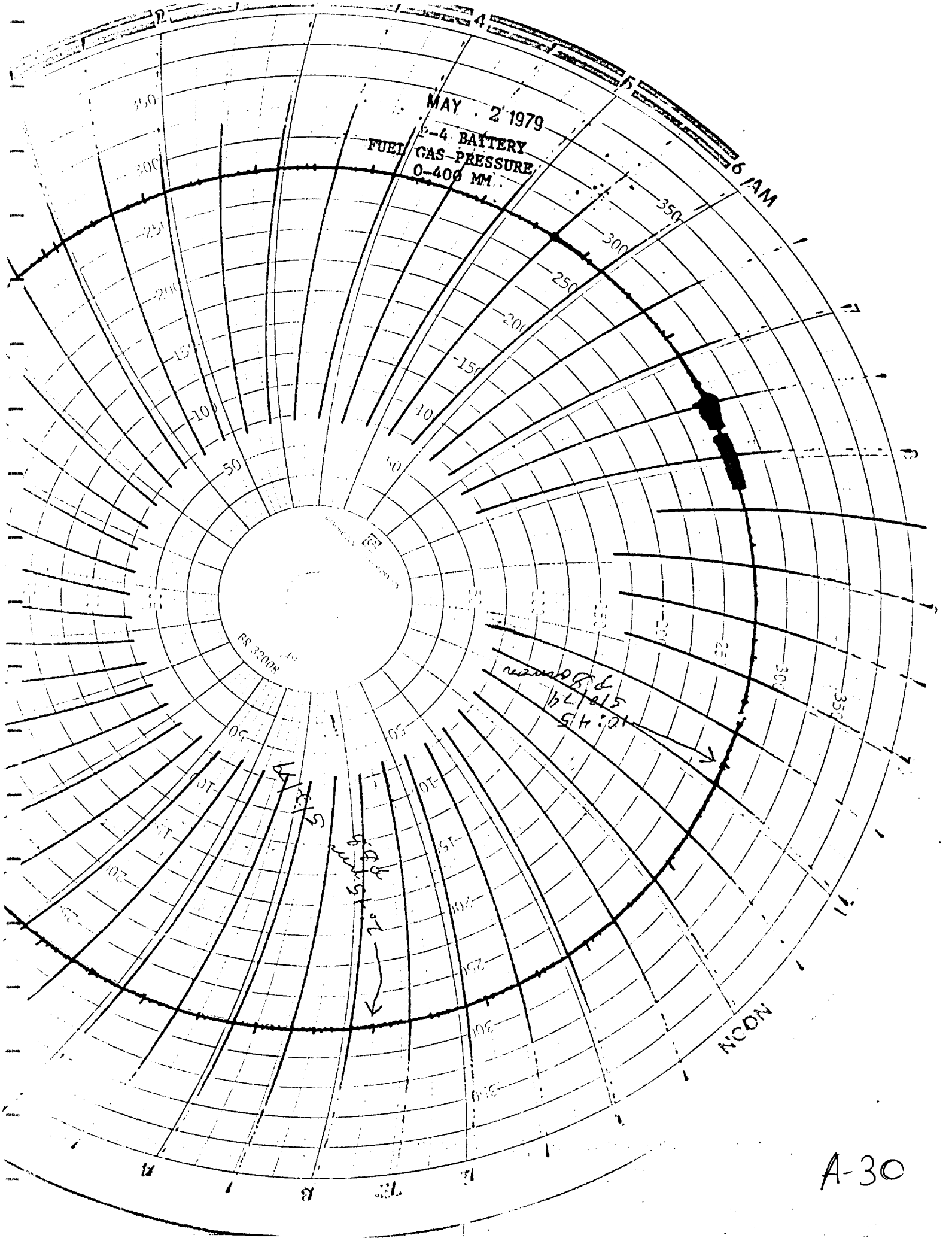
A-27


6 AM
MAY 2 1979
Collecting Main Pressure
No. 10 -20 to +30 MM
8
9
10
25
20
15
10
0
5
10
15
5
10
15
N

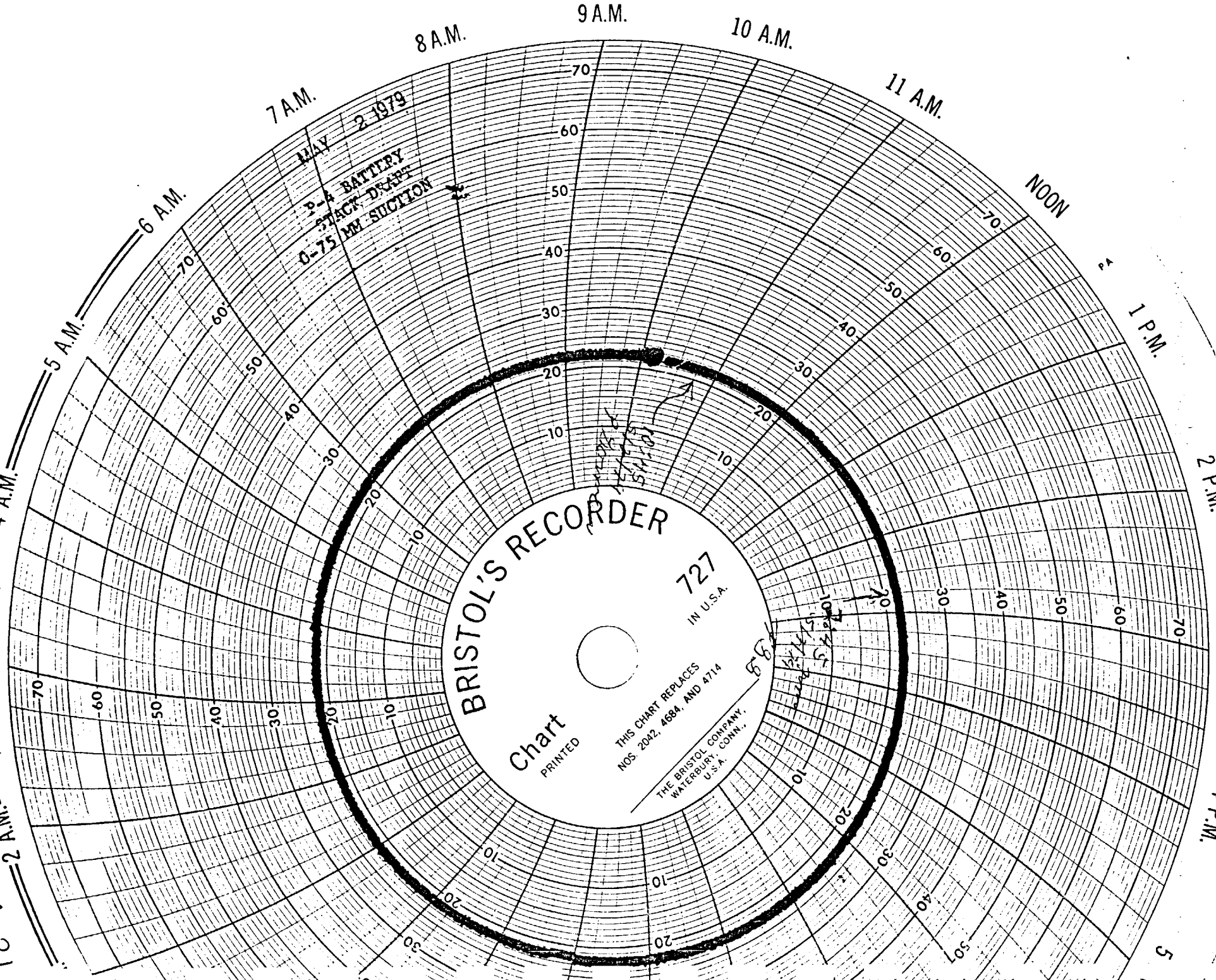
A-28


P-4 BATTERY
FUEL GAS TEMP.
0-150 °F
MAY 2 1979
8 A.M
NOON
BR 55
10:45
5/10/79
10:45
5/9/79

A-29


MAY 2 1979
E-4 BATTERY
FUEL GAS PRESSURE
0-400 MM
6 AM
NOON
350
300
250
200
150
100
50

A-30


MAY 2 1979
P-4 BATTERY
STACK DRAFT
0-75 MM SUCTION
BRISTOL'S RECORDER
727
IN U.S.A.
Chart
PRINTED
THIS CHART REPLACES
NOS. 2042, 4684, AND 4714
THE BRISTOL COMPANY,
WATERBURY, CONN.,
U.S.A.
2 A.M.
3 A.M.
4 A.M.
5 A.M.
6 A.M.
7 A.M.
8 A.M.
9 A.M.
10 A.M.
11 A.M.
NOON
1 P.M.
2 P.M.
3 P.M.
4 P.M.

A-31

TEST 3

Thursday, May 3, 1979

JL-42768

P4 Thus 5/3/79 am Test 3

Brewer

BY PRODUCT COKE OVENS

	Push 1	Level Charge	Push 2	Level	Push 3	Level
1						
2	3:36 #2					
3					First Push	
4						
5						
6						
7						
8						
9		Charging 10:17	10:00	Leveling 10:29		Leveling 10:33
10						
11	10:18 #2	Charg 11:01	~10:24	NR	10:35	Leveling 11:25
12						
13	11:01 #2	Leveling 11:39	NR	Leveling 11:50	11:30	Leveling 11:59
14						
15	11:45 #2	Charging 12:06	11:53 ~~11:47~~	NR	12:02	Leveling 12:23
16						
17	12:11 #3, 5 End only	Charg 12:35	NR	Leveling 12:40	12:27	Leveling 12:53
18						
19	12:36 #2	Chrg 1:07	12:49	1:28	01:03	Leveling 1:45
20						
21	1:21 #2, 5 End only	Charg 1:57	1:30	Leveling 2:06	1:48	Leveling 2:16
22						
23	1:56 #1	Charging 2:25	2:09	NR	2:19	Leveling 2:52
24						
25	2:34 #2	NR	2:46	Leveling 3:25	3:00	
26						
27	3:16 #NR		3:24			

TABLE 4. PROCESS OPERATING LOG

Time test started 10:49 am
Time test ended ~ 4:00 pm
Hold periods
Coking Time 17 hr

Date Thurs 5/3/79 Test 3
Plant personnel Ed Yurkovich

Time	Transmissometer reading %	Fuel gas flow rate 1000 SCFH	No. of oven charged	No. of oven pushed	Greenness of push a/	Collecting main pressure mm	Stack draft mm	O_2 in flues %	Flue temperatures Min. °F	Flue temperatures Max. °F	Flue temperatures Avg. °F	Coke temp. when pushed b/ °F	Wall No.	Wall temperatures b/ Min. °F	Wall temperatures b/ Max. °F	Wall temperatures b/ Avg. °F	Flue pressure	Flue temperature °F	Stack temperature °F	Ambient temperature °F	Weather conditions	Fuel Pressure mm	Fuel Box Temp In	Fuel Box Temp Out
10:05	0	345			NR	22	10		Pusher Side Avg 2363										585	~50	R	27.5	86	105
11:33	0	340			9 5.5 10 5.5	22	9												585	NR	Cldy	27.5	86	144
12:30	60	340			5.5 5.5	22	9		Coke Side Avg 2405										570	NR	R	27.5	84	138
1:50	0	340	See Other Sheet		5.5 6.0	22	10.5					Not Used	Not Used						622	57	R	27.5	84	143
2:38	4	340			NR	22	10												595	NR	R	27.5	85	140
3:42	0	340			6.0 5.5	22	10												608	58	R	27.5	85	140

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.

Fuel Box flow down some due to cleaning nozzles
O_2 meter doesn't look like its operating properly
2:00 pm - Collecting main pressure varying a little more widely
no apparent affect on stack emissions

Clayton has to do 2½ more points because something plugged up in the train + impingers backed up, Charging done out at 2:45

A-33

notes
7-4 Test 3 5/3/79

Door on coke side is off of oven 1-3, to be spray patched

Done → Get copy of opacity sheets for Ted ~~Stg~~ Szczepanski

Ironmissonite went to 60% opacity at 12:31 pm
My observation of stack indicated this was probably right but it only lasted for about 1 minute
CO monitor increased from ~200-300 up to ~700 ppm

Spray + patch over 1+3, working on pusher side at 2:10 pm

No obvious cracks in any of the oven walls, at least to the extent I have seen them.

J & L lab man pulled Orsat samples off of our sample line at my request. Results were:

	9:40 am	9:45 am	Recent avg
CO_2	5.8%	6.1%	6.0
O_2	8.2	7.9%	8.1
CO	0.3	0.6%	0.7

Meet w Jim Saunders at 3:30 on Tue to put up all remaining copies of charts and fuel gas + coal analyses (Bring copies of opacity sheets)

JL-43844 Date: 5-3-79 J&L Pgh. By-Product Laborator

"C" Belt - Coal Mix to Ovens

% Moisture 8.15
Wt./Cu. Ft. 45.03 Lbs.
Sample: Automatic ☐ Hand Sample ☐

Screen Test

	%	Cumulative %
On 3/4" Screen	.7	.7
1/2"	1.1	1.8
1/4"	7.0	8.8
1/8"	19.5	28.3
Minus 1/8".....	71.7	
On 10 Mesh	11.0	39.3
14	5.2	44.5
20	20.3	64.8
28	8.0	72.8
35	8.4	81.2
48	—	—
65	—	—
100	12.2	93.4
Minus 100 Mesh.....	6.6	
On 200 Mesh	5.0	98.4
Minus 200 Mesh	1.6	

OXIDATION 96

COKE

Conditions when Sampling:

Coke Appearance: Normal ☒ Wet ☐ Dry ☐
Wharf Condition: Full ☐ % Full 1/3
Coke Size: Large ☐ Small ☒ Normal ☐
Belt Condition: OK
Fire Spray:
Weather: Clear ☐ Cold ☐ Hot ☐ Damp ☒
Sampling Location P-4 BOOM BELT

		Total		3 Day Ave.
Daily reported Moisture.....	4.62	14.22	4.94	4.9
Boom Belt Coke % Moisture				
+1-1/2" Coke H_2O				
1-1/2" x 7/8" Coke H_2O				
Bulk Density(Lbs)				

DAILY AVE 61.2

A.S.T.M. Shatter Test + 2"
P 4 Wharf Sample 61.2

APPARENT GRAVITY

Proximate Analysis

	COAL	COKE	3 Day Ave.
% Volatile Matter	32.71	0.83	0.87
% Fixed Carbon	59.72	89.46	89.30
% Ash	7.57	9.71	9.83
% Sulfur	1.37	0.91	0.91

MOISTURES - COAL BARGES SAMPLES

Date	Shift	Type of Coals	Barge No.	% H_2O BP Lab	% H_2O Mines
5/3	4-12	V ~~S.G. Blend~~ NEMACOLIN	1331 1437	8.35	
5/4	12-8	V ~~S.G. Blend~~ NEMACOLIN	1370 1380	9.34	
		V.S.G. Blend			
5/3	4-12	LANCASHIRE	1319	8.70	
5/3	4-12	GAULEY EAGLE	1421	7.48	
5/4	12-8	LANCASHIRE	1007	6.86	
5/4	12-8	BECKLEY	1468	12.42	

Tumbler Tests

Stability - Total % + 1" Screening Station P-1

	1	2	Ave.
	51.6	51.0	51.3
	12.7	13.4	13.1
Hardness Total + ½"	64.3	64.4	64.4

Stability - Total % + 1" Screening Station P-4

	1	2	Ave.
	52.6	53.4	53.0
	13.1	12.9	13.0
Hardness Total + ½"	65.7	66.3	66.0

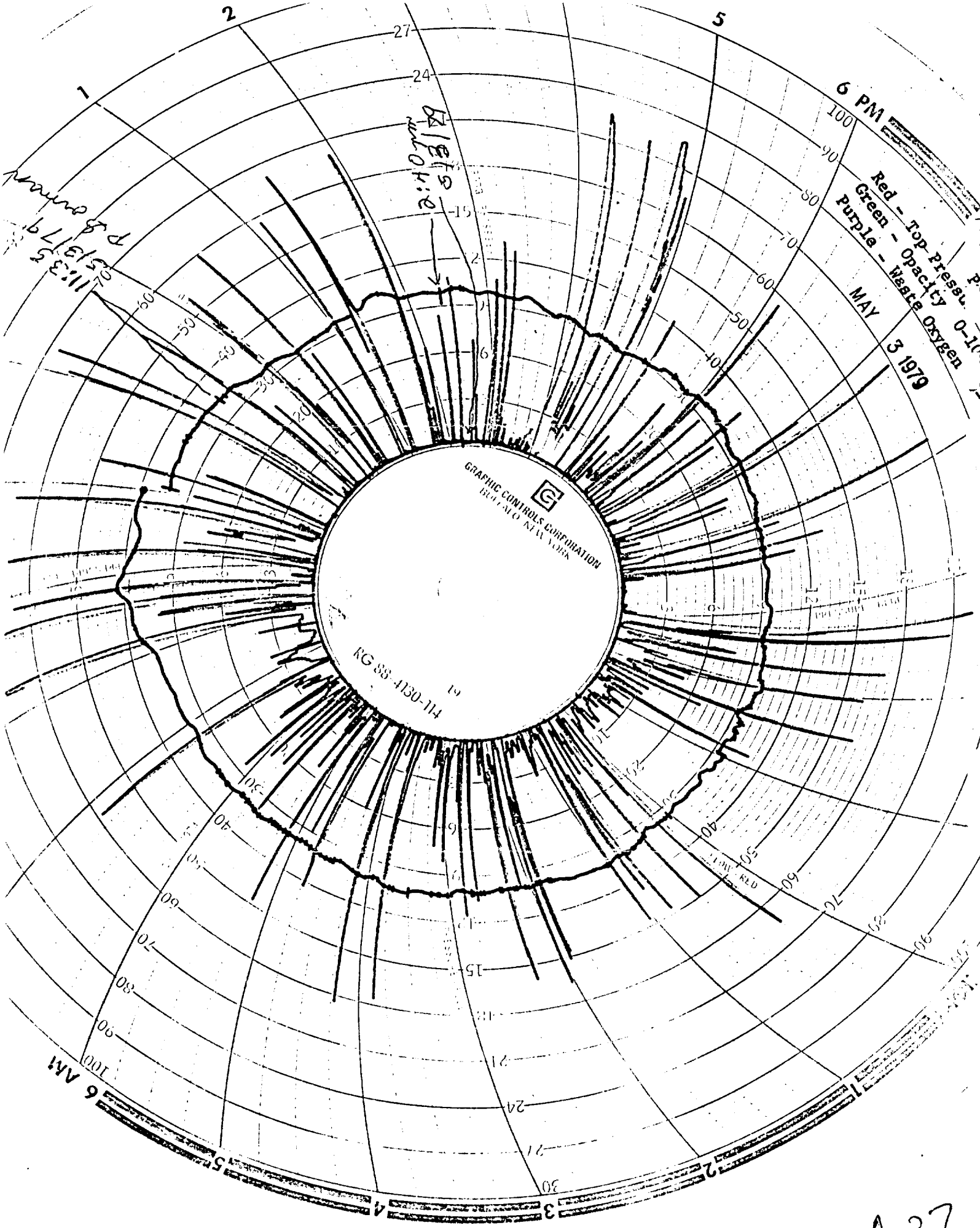
Screen Test

P 4 Sample
(Total on 2" 67.3)

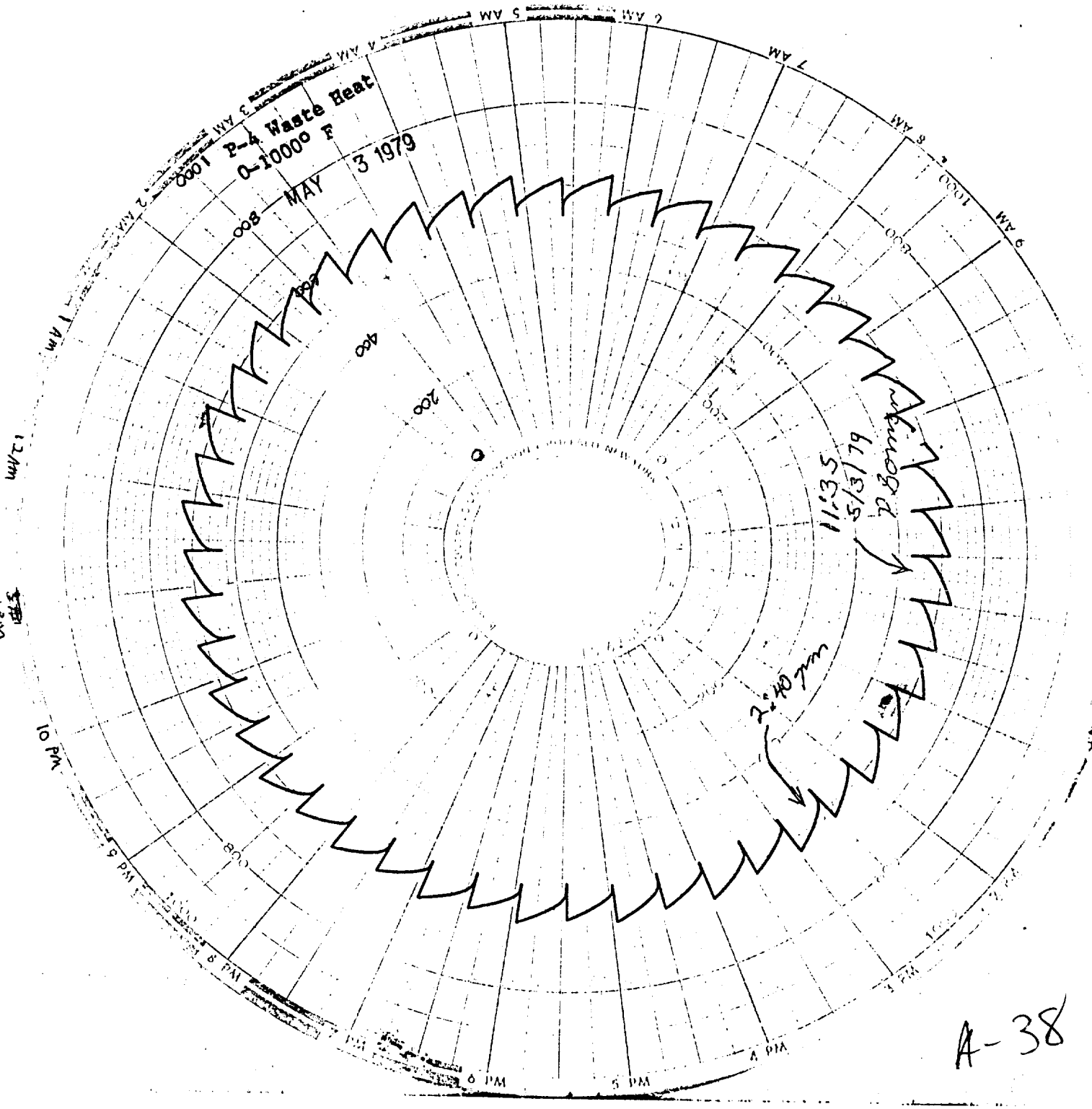
	% on 4" Screen
3"	4.3
2"	20.4
1	42.6
Minus 1"	23.3
	9.4

P-4 Battery
Gas Flow
0-600,000 SCFH
MAY 3 1979
6 PM
NOON
11:35
5/3/79
2:42 pm
5/3/79
70503
69127
RG 88-4100-060

A-36


6 AM
Red - Top Pressu
Green - Opacity 0-10
Purple - Waste Oxygen
MAY 3 1979
6 PM
GRAPHIC CONTROLS CORPORATION
BUFFALO NEW YORK
RG 88-4130-114

A-37



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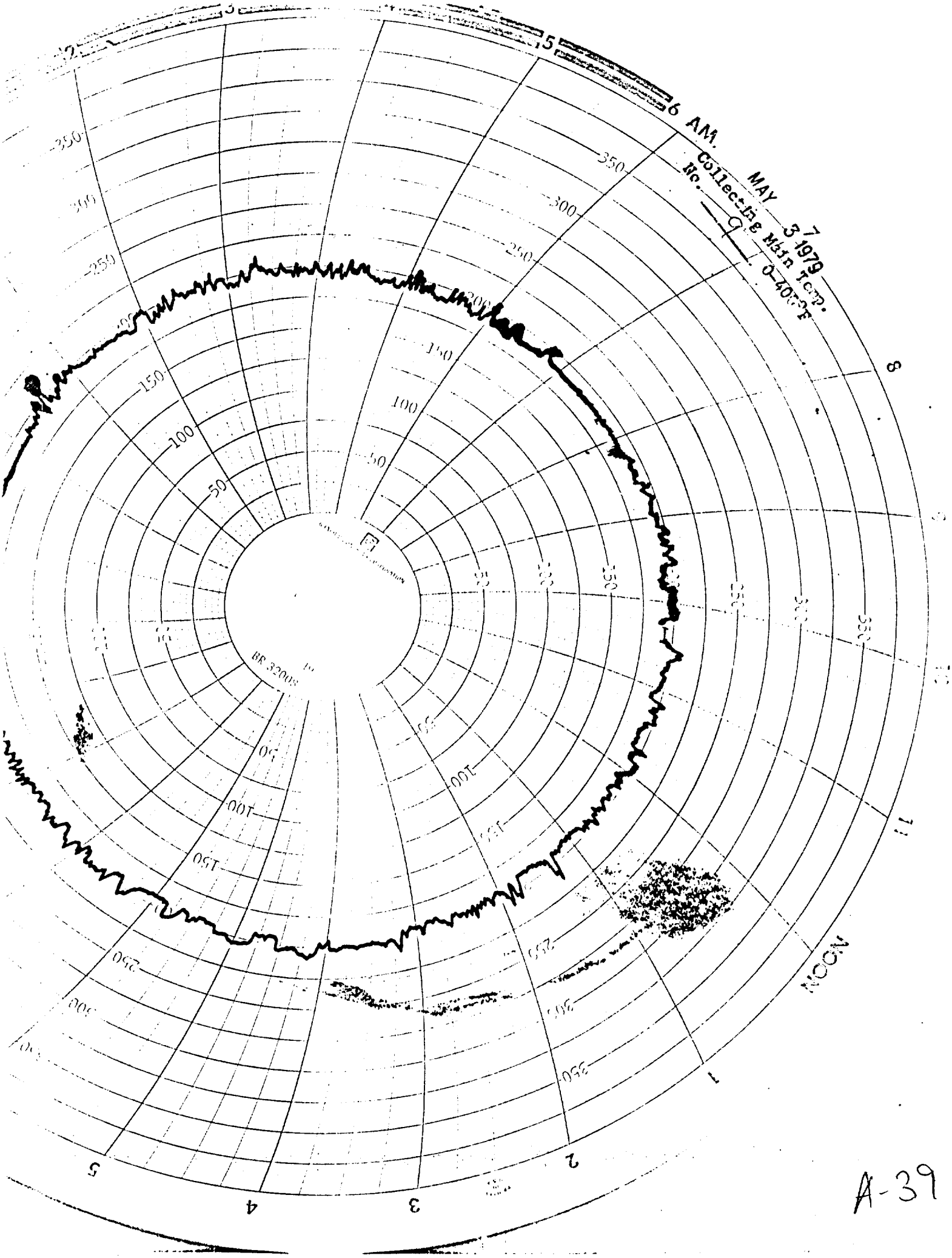

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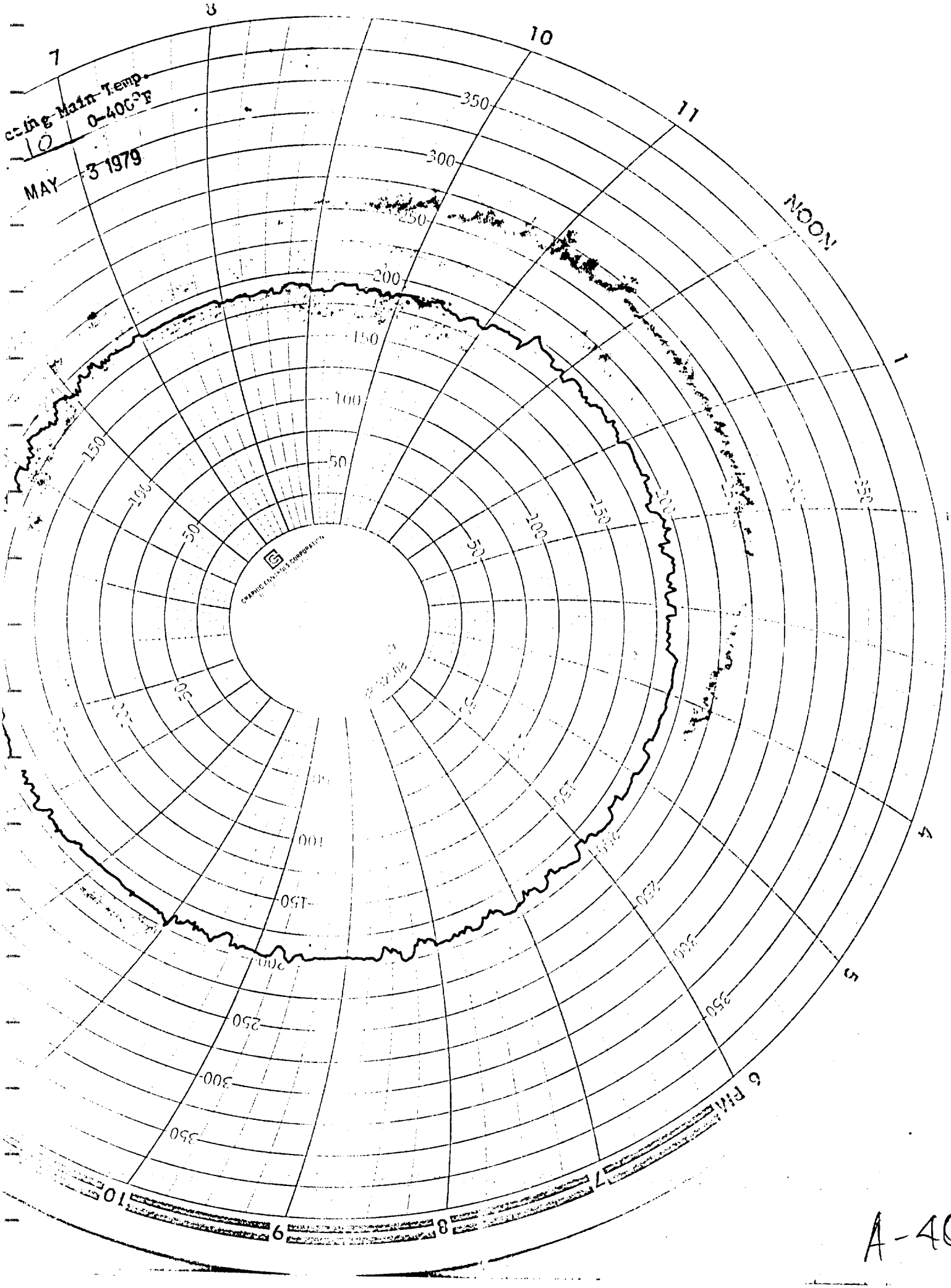
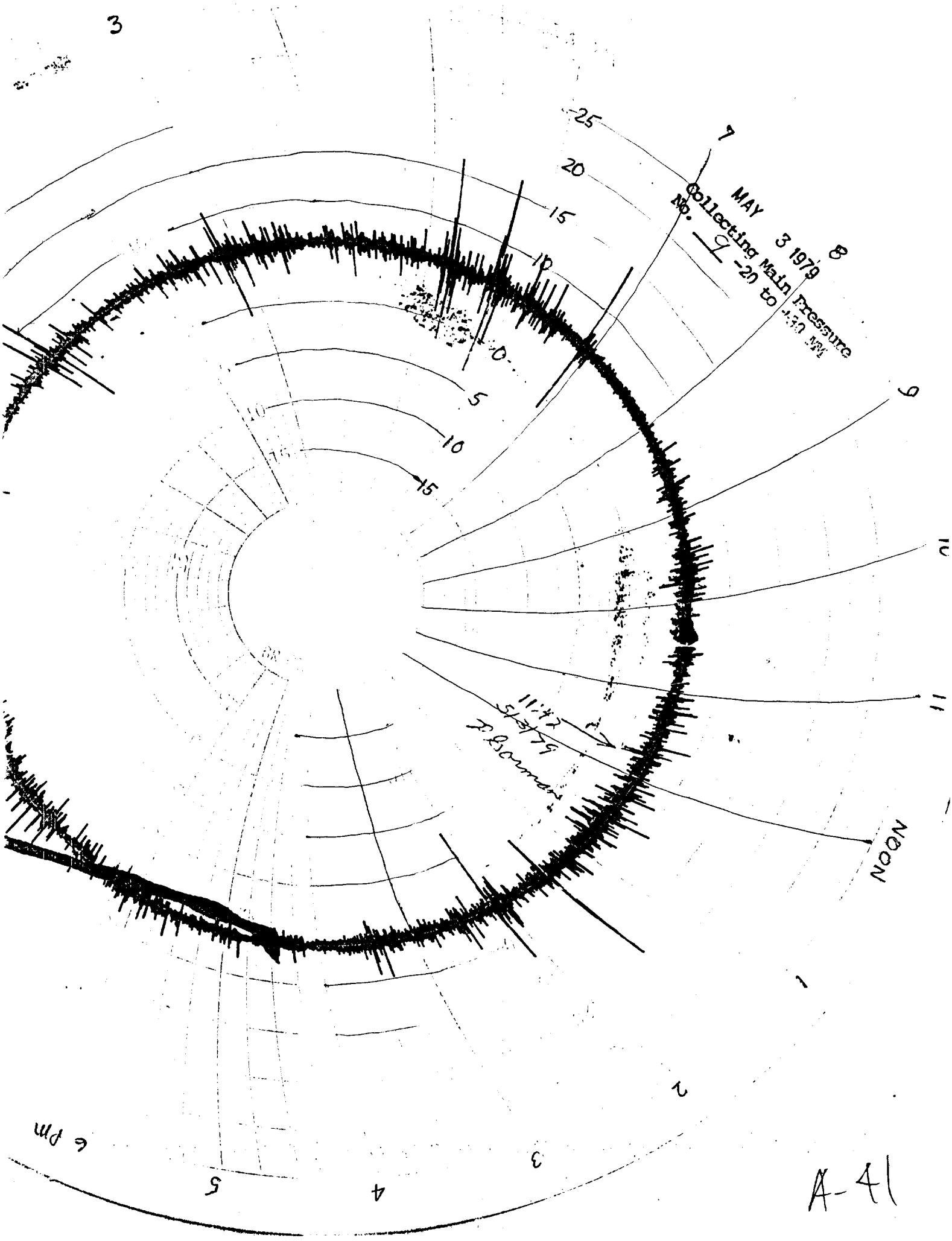
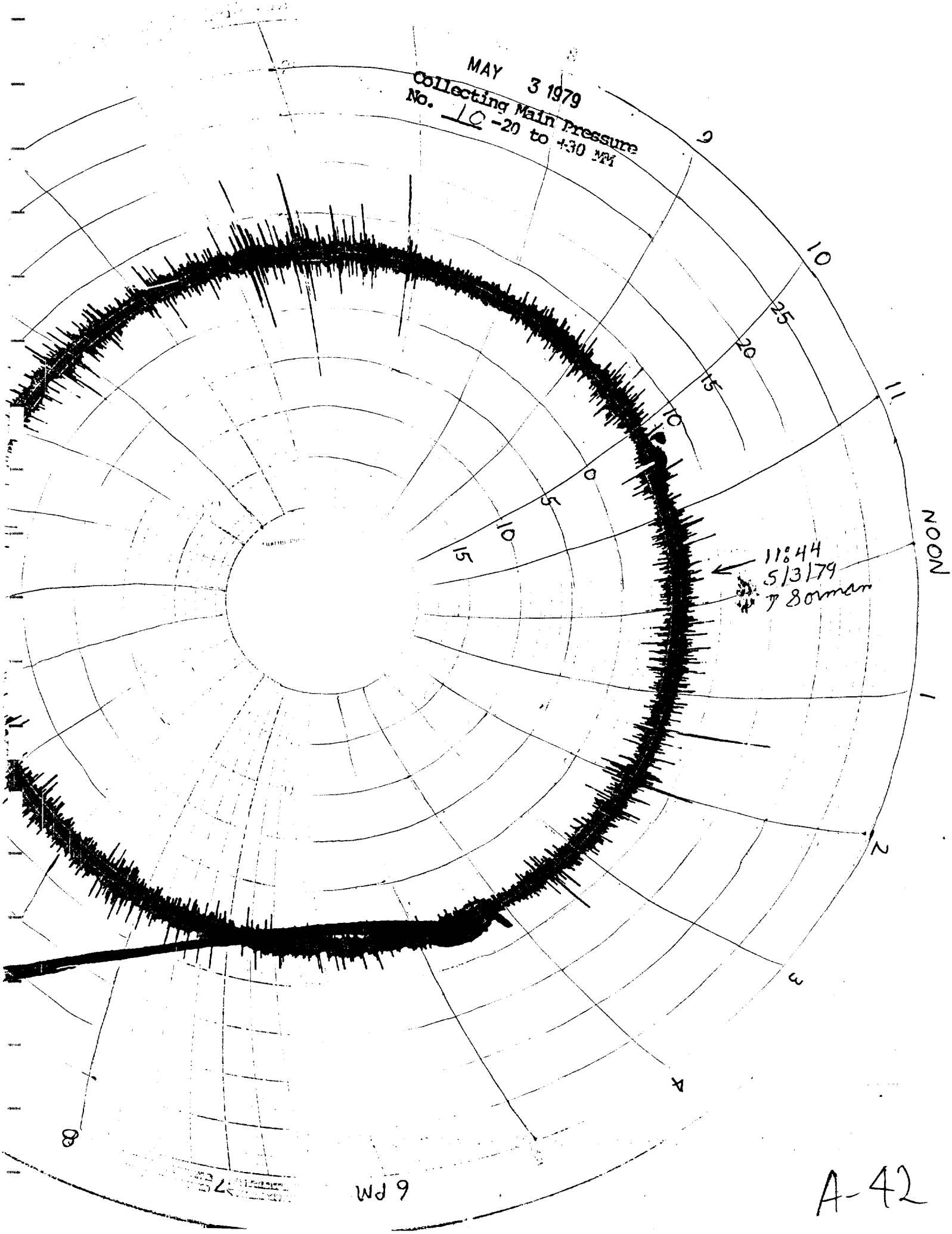

Cooling Main Temp.
0-400°F
10
MAY 3 1979
7
8
10
11
NOON
1
5
6 PM
9
8
7
6
350
300
250
200
150
100
50

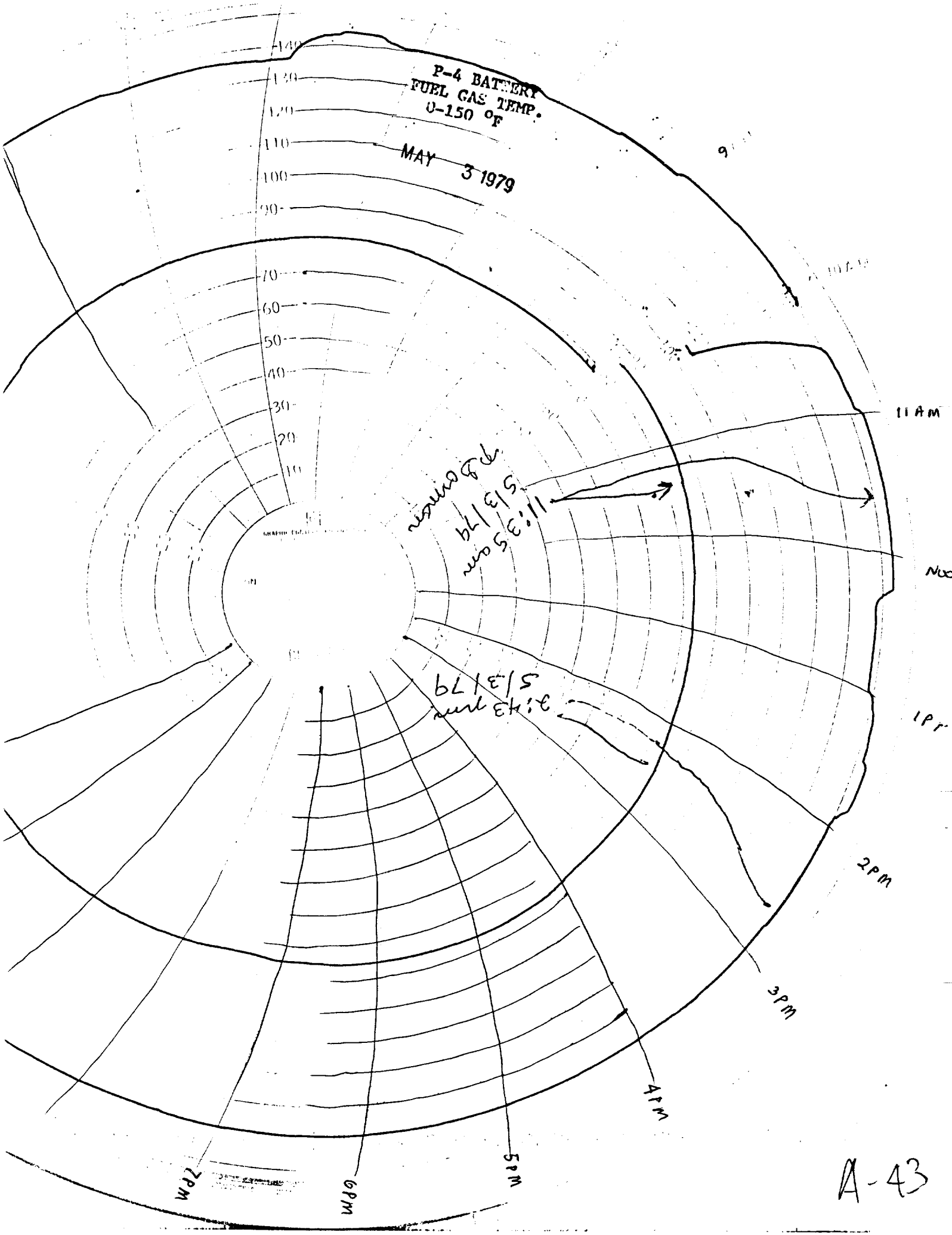
A-40


3
MAY 3 1979
Collecting Main Pressure
No. 9 -20 to +50 MM
25
20
15
10
0
5
10
15
7
8
9
10
11
NOON
1
2
3
4
5
6 PM
11:42
Sept 79
F. Bowman

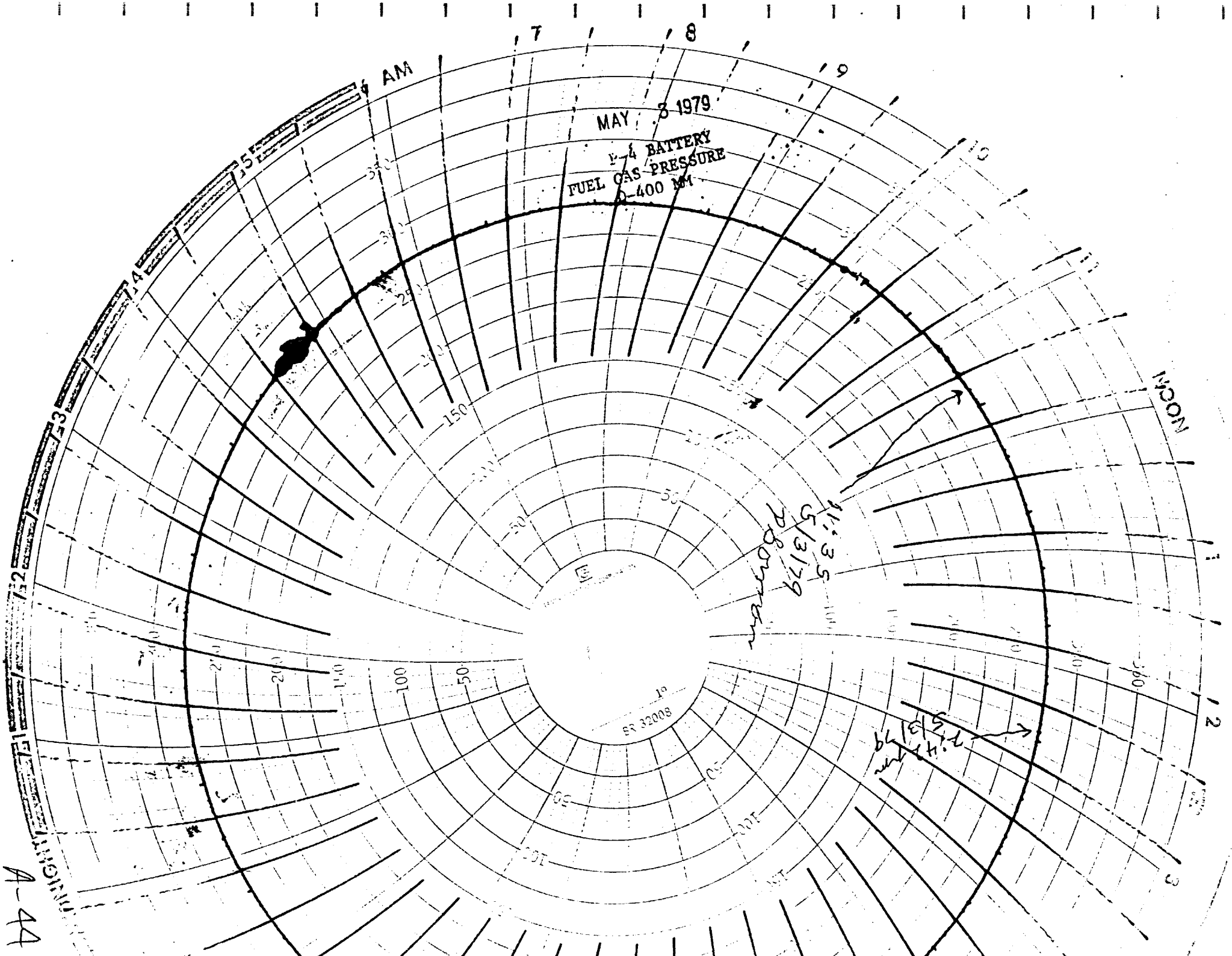
A-41


MAY 3 1979
Collecting Main Pressure
No. 10 -20 to +30 MM
9
10
11
NOON
1
2
3
4
8
25
20
15
10
0
5
10
15
11:44
5/3/79
7 Bowman
Wd 9

A-42


P-4 BATTERY
FUEL GAS TEMP.
0-150 °F
MAY 3 1979
140
130
120
110
100
90
70
60
50
40
30
20
10
11 AM
NOO
1PM
2PM
3PM
4PM
5PM
6PM
7PM
11:35 am
5/3/79
3:45 pm
5/3/79

A-43


MAY 8 1979
V-4 BATTERY
FUEL GAS PRESSURE
0-400 MM
AM
MOON
NIGHT
ES 32008

A-44

A-45

BRISTOL'S RECORDER

Chart 727

PRINTED IN U.S.A.

THIS CHART REPLACES NOS. 2042, 4684, AND 4714

THE BRISTOL COMPANY, WATERBURY, CONN., U.S.A.

P-4 BATTERY
STACK DRAFT
0-75 MM SUCTION
MAY 3 1979

4 A.M. 5 A.M. 6 A.M. 7 A.M. 8 A.M. 9 A.M. 10 A.M. 11 A.M. NOON 1 P.M. 2 P.M. 3 P.M. 4 P.M. 5 P.M. 6 P.M. 7 P.M.

11:35 5/3/79

2:45 pm 5/3/79

TEST 4

Friday, May 4, 1979

JL-42768

PUSHING SCHEDULE 8-4 TURN 5-4-79 Test 4

BY PRODUCT COKE OVENS

	Push 1	Level	Push 2	Level	Push 3	Level	
1							1
2	NR		NR		NR		2
3	PUSH @ APPROX 2:00 pm 1 CHARGE NR	2:55					3
4	NR		NR		NR		4
5							5
6	NR		NR		NR		6
7							7
8		Level 11:34 am		Level 11:38 am		11:46	8
9							9
10	NR	11:56	11:42 am	NR	Screen Push 11:48	NR	10
11							11
12	12:23	NR	12:38	1:50	NR	1:57	12
13							13
14	1:41	2:09	1:50	2:18	1:58		14
15							15
16	NR	3:00	NR	3:06	NR	3:13	16
17							17
18	3:00 pm	NR	3:07	NR	3:13	NR	18
19							19
20	NR meeting w/ J. Lunder	NR	NR	4:30	NR	4:37	20
21							21
22	NR ~~4:33~~		LAST PUSH 4:31				22
23							23
24							24
25			1st PUSH NR		NR		25
26							26
27	NR		NR				27

JL-42768

4-12 Info 5/4/79 P4

BY PRODUCT COKE OVENS

	Push 1	Level	Push 2	Level	Push 3	Level	
1	NR		NR		NR		1
2							2
3	PASS		NR		NR	7:05	3
4							4
5	Green Push 7:05	NR	NR	7:36	NR	7:49 pm	5
6							6
7	NR	7:55	7:30 pm	8:30	7:45 pm	9:34	7
8							8
9	8:25	9:11	8:32	9:17	9:05	9:30	9
10							10
11	PASS		9:16	9:45	9:31	9:53	11
12							12
13	9:40	NR	9:48	NR	9:58	10:25	13
14							14
15	NR	10:32	NR	10:40	10:28	10:55	15
16							16
17	10:35	11:05	10:48	11:12	10:56	11:21	17
18							18
19	11:06	11:30	11:16	11:28	11:24		19
20							20
21	11:31		LAST PUSH on 4-12 11:39				21
22		5:17	FIRST PUSH	NR	4:56		22
23							23
24	NR	5:46	NR		5:31	5:36	24
25							25
26	5:54						26
27							27

TABLE 4. PROCESS OPERATING LOG

Time test started ~11:10
Time test ended
Hold periods
Coking Time 17 hr

Date Fri 5/4/79 Test 4 (Bat'only)
Plant personnel Ken Kotus

	Transmissometer reading %	Fuel gas flow rate 1000 SCFH	No. of oven charged	No. of oven pushed	Greenness of push a/	Collecting main pressure	Stack draft	O_2 in flues	Flue temperatures Min.	Flue temperatures Max.	Flue temperatures Avg.	Coke temp. when pushed b/	Wall No.	Wall temperatures b/ Min.	Wall temperatures b/ Max.	Wall temperatures b/ Avg.	Flue pressure	Flue temperature	Stack temperature	Ambient temperature	Weather conditions	Fuel pressure	Fuel Jump In	Fuel Jump Out
Units	%	SCFH					mm	%	°F	°F	°F	°F		°F	°F	°F		°F	°F	°F		mm		
Time																								
12:24 pm	6	340	See Other Stack		9	6.0 6.0	22	10.5	Pusher Side avg 2357			Not Clear						616	40	R	275	77	140	
1:17 pm	0	340				NR	22	11										605	NR	LR	275	77	139	
2:23 pm	8	340				6.0 6.0	22	11.5	Coke Side avg 2396									610	46	R	275	77	140	
3:17	0	340				6.0 7.0	22	11.0										600	46	LR	275	77	142	
5:12	10	340				6.0 6.0	22	10.5										590	50	Cdy	275	77	143	
7:15	0	340				5.5 6.0	22	10.5										595	49	R	275	75	143	
8:15	4	340				NR	22	10.5										595	NR	LR	275	74	142	
9:20	6	340				5.5 5.5	22	10										605	40	R	275	73	140	
10:20	15	340				NR	22	10.5										605	NR	R	275	71	140	
11:41 pm	0	340				5.5 6.0	22	10.5										600	41	LR	275	74	141	

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.

A-48

JOL 74

Notes for Test 4 Fri 5/4/79

Spray patchery over 1-12 pusher side @ 1:25

Stack smoked again after charging oven #1-14.
air rotameter were up to 80%

Checked about 25 flues at random - no leaks

→ Send copy of final report at JOL to:
Ken Kolus
Box 427, Old State Road
R.D. 1 Gibsonia Pa 15044

Bot dusting record

9:30 pm Bot opacity spike after charging oven 1-9
Checked flues - found one small leak (4th flue cote side)

Opacity chart appears to show about 5 peaks per hour which is just about the number of ovens charged per hour

Took data until midnight. TRW got almost all samples but may come in on Sat. to make one more 1 hr sample run. However, I will not stay to take process data since I don't think it is required for these types of samples.

A-49

GAS ANALYSES

DATE	TIME - PLACE SAMPLED	%CO_2	%Ill.	%O_2	%CO	%H_2	%CH_4	%N_2	B.T.U. Gross	B.T.U. Net	Sp. Gr.
3/7/79	SNAP GAS HOLDER										
3/9/79	" " "										
3/12/79	" "										
3/13/79	"										
3/14/79	" " "										
3/15/79	" " "										
3/19/79	" " "										
3/20/79	" " "										
3/21/79	" " "										
3/23/79	" " "										
[illegible]	[illegible]										
3/26/79	" " "										
3/27/79	" " "										
3/28/79	" " "										
3/30/79	" " "										
4/2/79	" " "										
4/3/79	" " "										
4/4/79	" " 12:										
4/6/79	" " 12:										
4/9/79	" " 12:4										
4/10/79	" " 12:4										
4/11/79	" " 12:4										
4/16/79	" " 12:4										
4/17/79	" " 12:4										
4-18-79	" "										
4-19-79	" "										
4/20/79	" " 12:										
4/23/79	Gas Holder										
4/24/79	Gas Holder										
4/25/79	" " 12:										
[illegible]											
4/27/79	Gas Holder 12:30 PM	2.0	2.8	1.2	6.0	50.4	28.4	8.8	515	467	0.41
4/30/79	Gas Holder [illegible]	2.5	4.0	0.8	6.1	49.7	27.0	9.3	528	480	[illegible]
5/1/79	" " 12:45	2.5	2.0	1.5	6.0	49.4	29.1	9.5	503	455	0.42
5-2-79	" "	2.8	3.2	1.0	6.3	51.9	29.1	5.7	533	484	0.40
5-3-79	not analyzed										
5-4-79		2.2	2.7	1.4	6.0	52.2	31.0	4.5	543	492	0.39

JL-23479

JONES & LAUGHLIN STEEL CORPORATION
Pittsburgh By-Product Laboratory

GAS ANALYSIS

Date 5-4-79 Time 2:30 PM

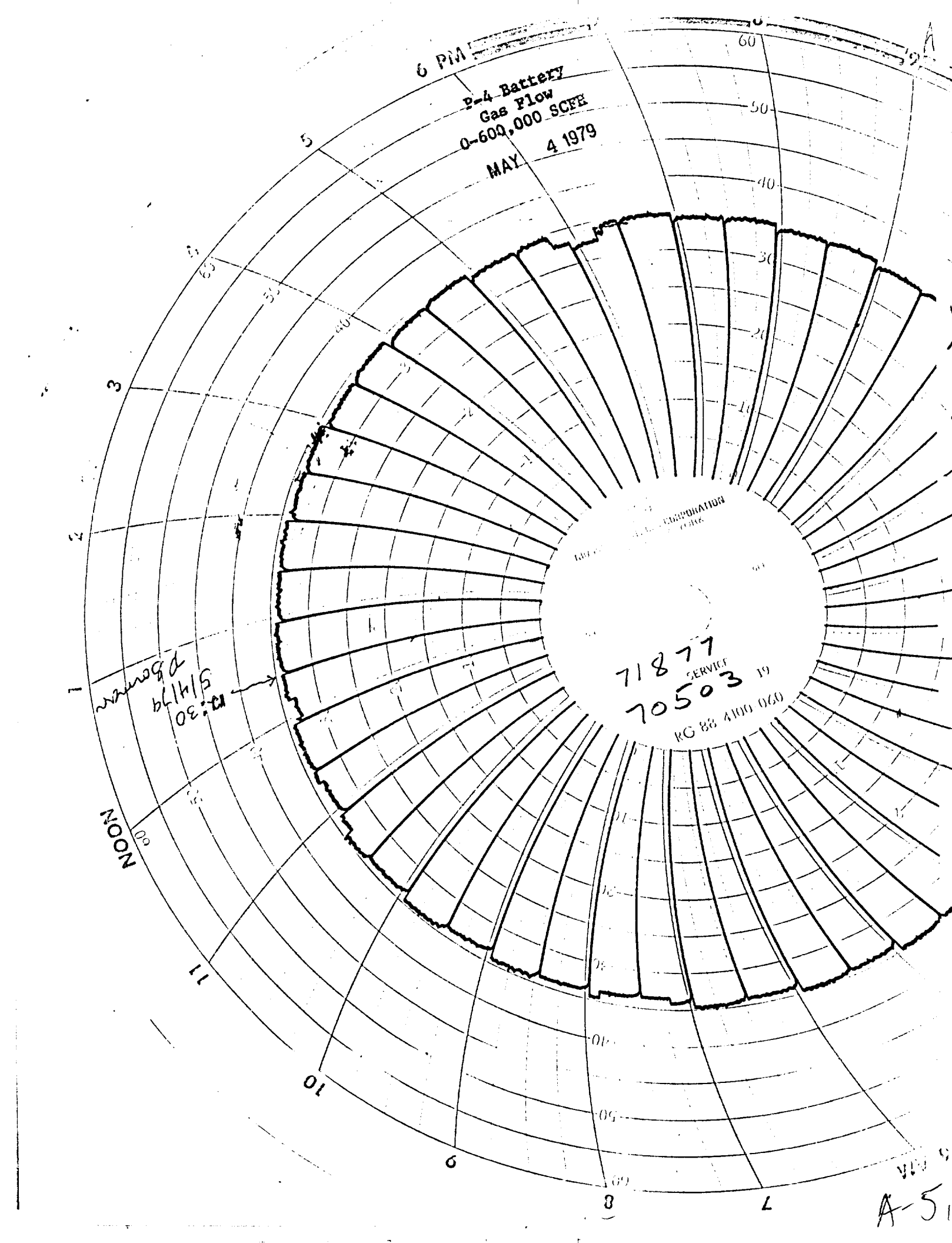
Sample SNAP @ Knockout Drum

Volumn - Original Sample	cc	100.0		
" After KOH Absorption	cc	97.8	CO_2	2.2
" " LUSORBENT	cc	75.1	Ill	2.7
" " OXSORBENT	cc	93.7	O_2	1.4
" " COSORBENT	cc	87.7	CO	6.0
Volumn for Explosion	cc	13.0	Factor	6.746
Gas and Air	cc	99.5		
Residue After Explosion	cc	78.7		
Contraction				20.8
Volumn After KOH Absorption		74.1		
CO_2 Formed				4.6

ANALYSIS

	%	GROSS B.T.U.	NET B.T.U.
CO_2	2.2		
Ill	2.7	49.16	46.98
O_2	1.4		
CO	6.0	19.04	19.38
H_2	52.2	166.7	143.55
CH_4	31.0	308.26	282.41
N_2	4.5		
Total		543.2	492.32
Sp.Gr.		0.3865	

Remarks Avail H_2S 301 grains/100 scf avg

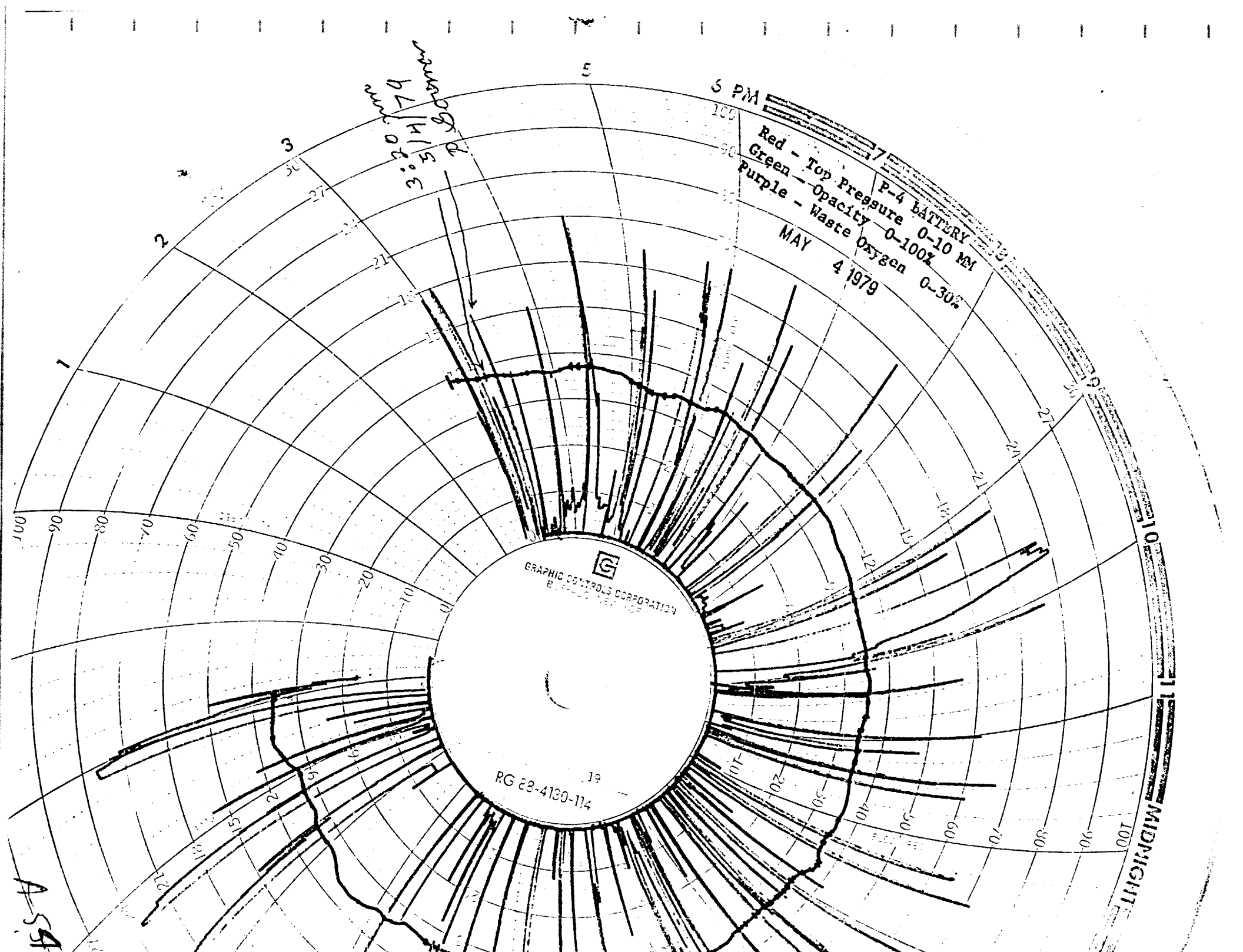

6 PM
P-4 Battery
Gas Flow
0-600,000 SCFH
MAY 4 1979
NOON
71877
70503
RG 88 4100 060
5/4/79
12:30 PM

A-5

MAY 5 1979
P-4 Battery
Gas Flow
0-600,000 SCFE
3:15 pm
5/4/79
P Bowman
132448
71877
RG 88-4100-060
MIDNIGHT
6 PM

A-52

P-4 BATTERY
Red - Top Pressure 0-10 MM
Green - Opacity 0-100%
Purple - Waste Oxygen 0-30%
MAY 4 1979
6 PM
NOON
GRAPHIC CONTROLS CORPORATION
RG 88-4130-114
Changed chart 1-14
Date 5-14-79
A-5

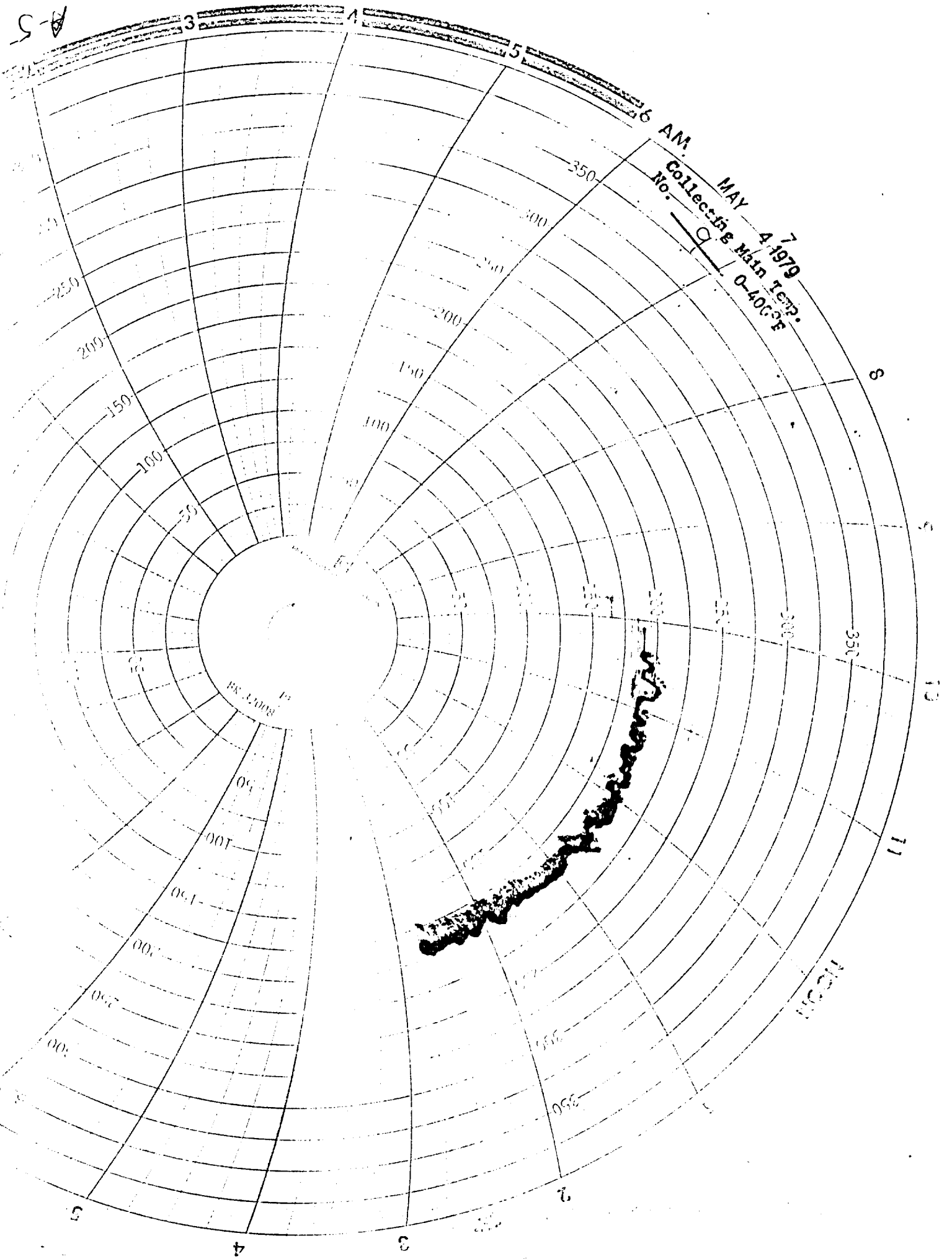

6 PM
P-4 BATTERY
Red - Top Pressure 0-10 MM
Green - Opacity 0-100%
Purple - Waste Oxygen 0-30%
MAY 4 1979
MIDNIGHT
GRAPHIC CONTROLS CORPORATION
RG 28-4130-114
3:20 PM
3:45 PM

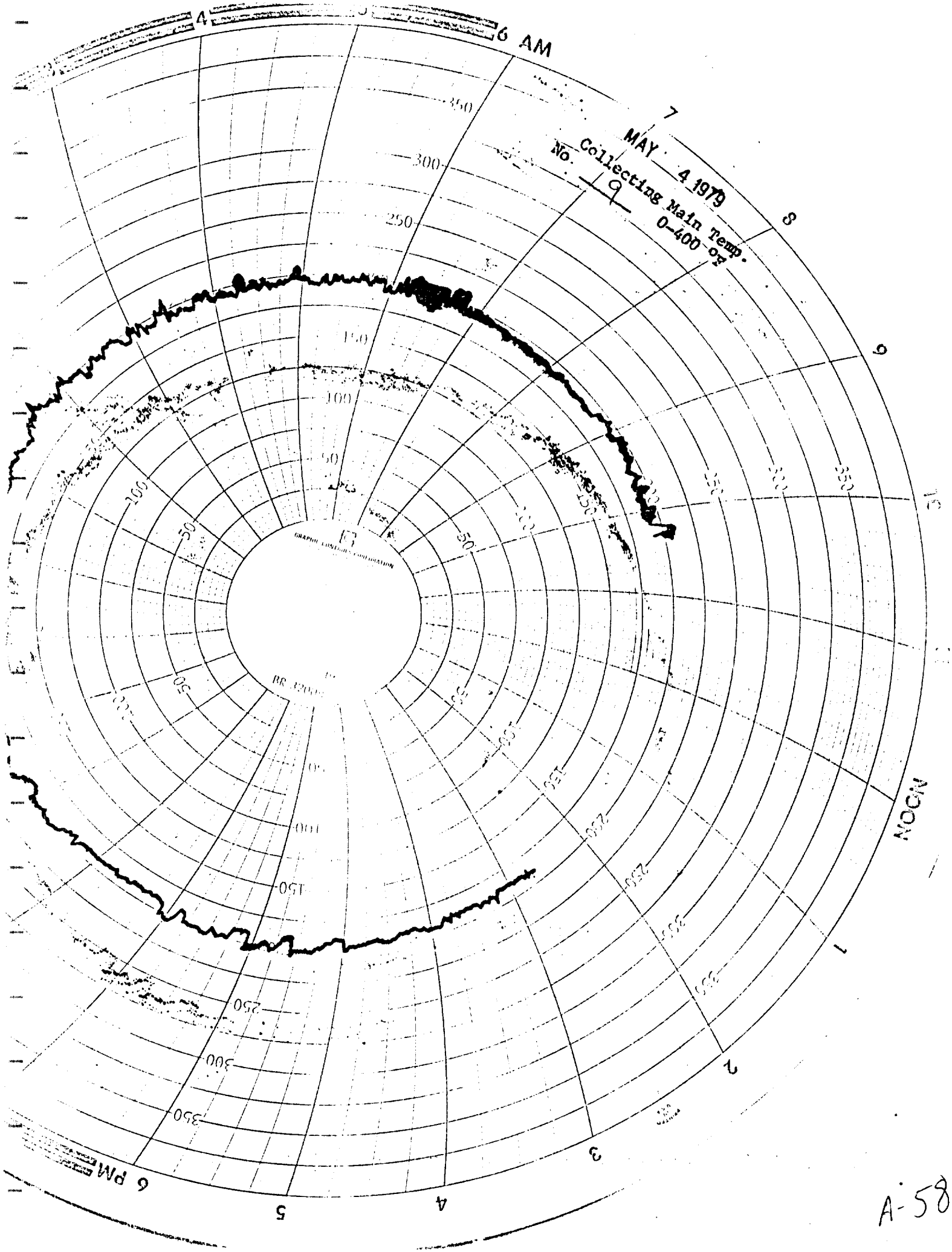
A-54

MAY 4 1979
P-4 Waste Heat
0-1000° F
0
200
400
600
800
1000
5 AM
6 AM
7 AM
8 AM
9 AM
10 AM
11 AM
1 pm
2 pm
3 pm
1430
5/4/79
maxpage

A-55

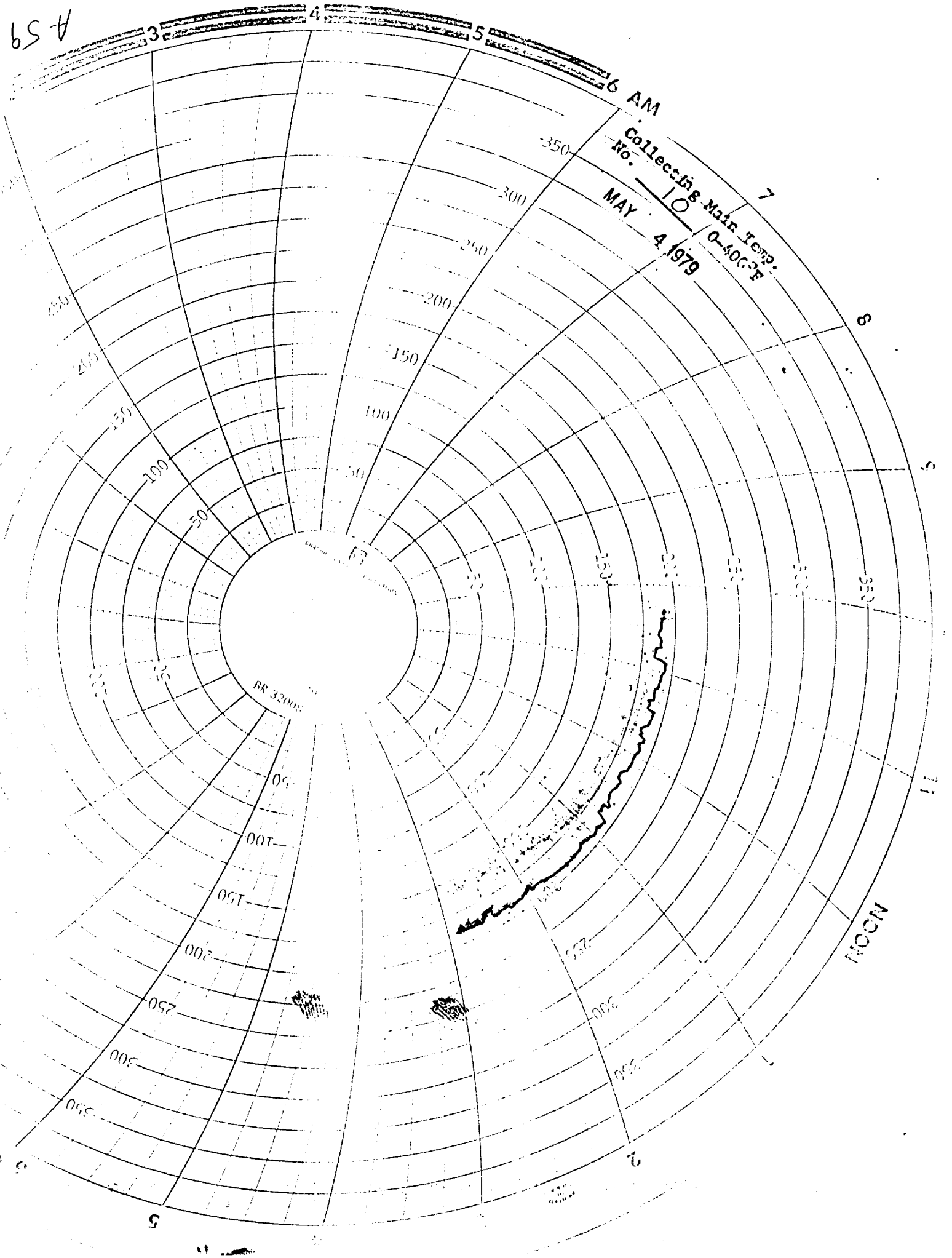
A-56

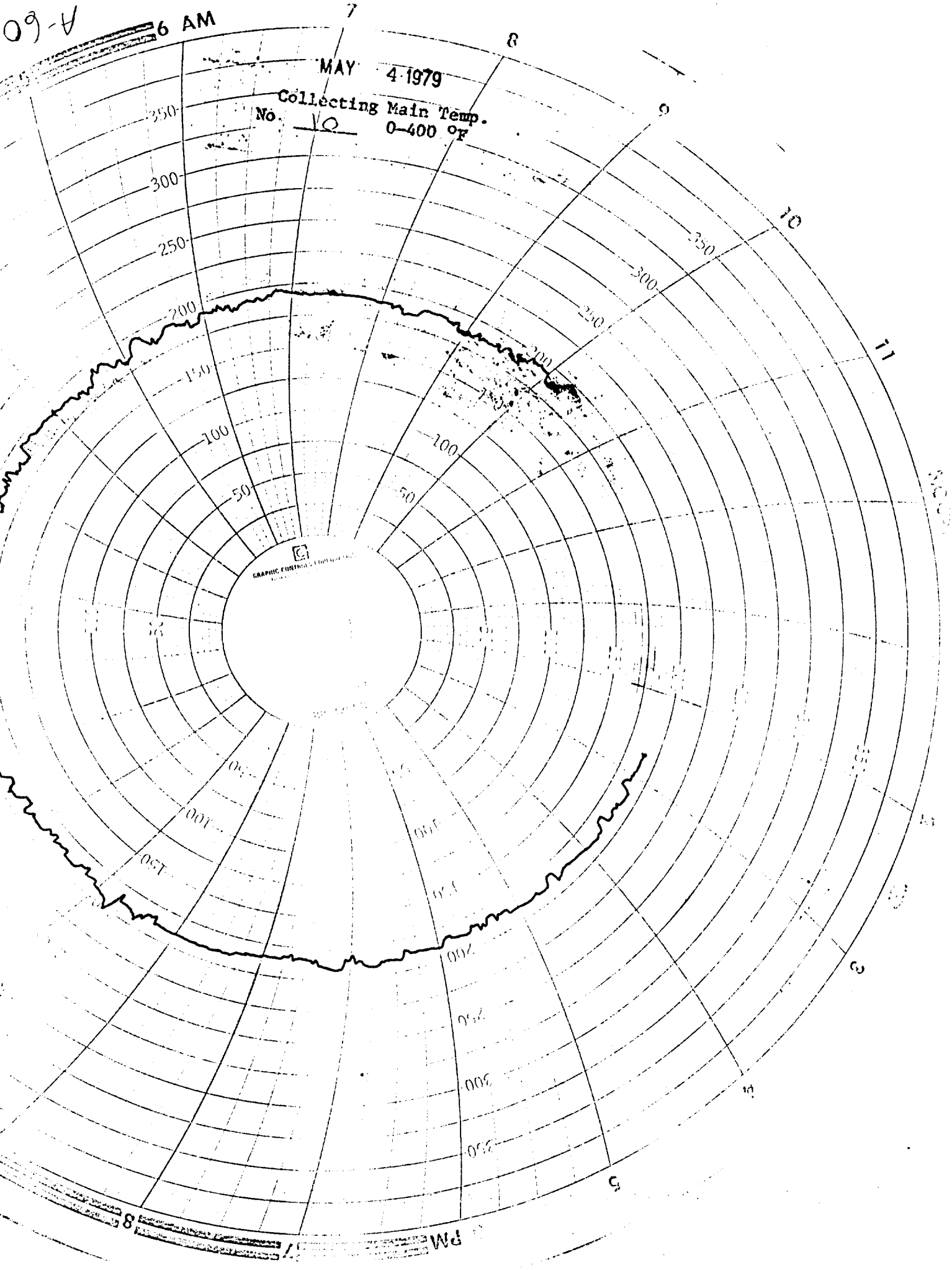

A-5
AM.
MAY 7 1979
Collecting Main Temp.
No. 0-400°F
350
300
250
200
150
100
50
8
9
10
11
NOON
1
2
3
4
5
6



A-58

A-59


3
4
5
6 AM
7
8
9
11
NOON
1
2
3
4
5
Collecting Main Temp.
No. 10
0-400°F
MAY 4 1979
350
300
250
200
150
100
50
BR 32005


6 AM
7
8
9
10
11
12
1
2
3
4
5
6
7
8
PM
MAY 4 1979
Collecting Main Temp.
No. 10
0-400 °F
350
300
250
200
150
100
50

MAY 4 1979
Collecting Main Pressure
No. 9 -20 to 4:30 PM

A-61

MAY 4 1979
Collecting Main Pressure
No. 9 -20 to +30 in
NOON
3:25 pm
5/4/79
28 amp

A-62

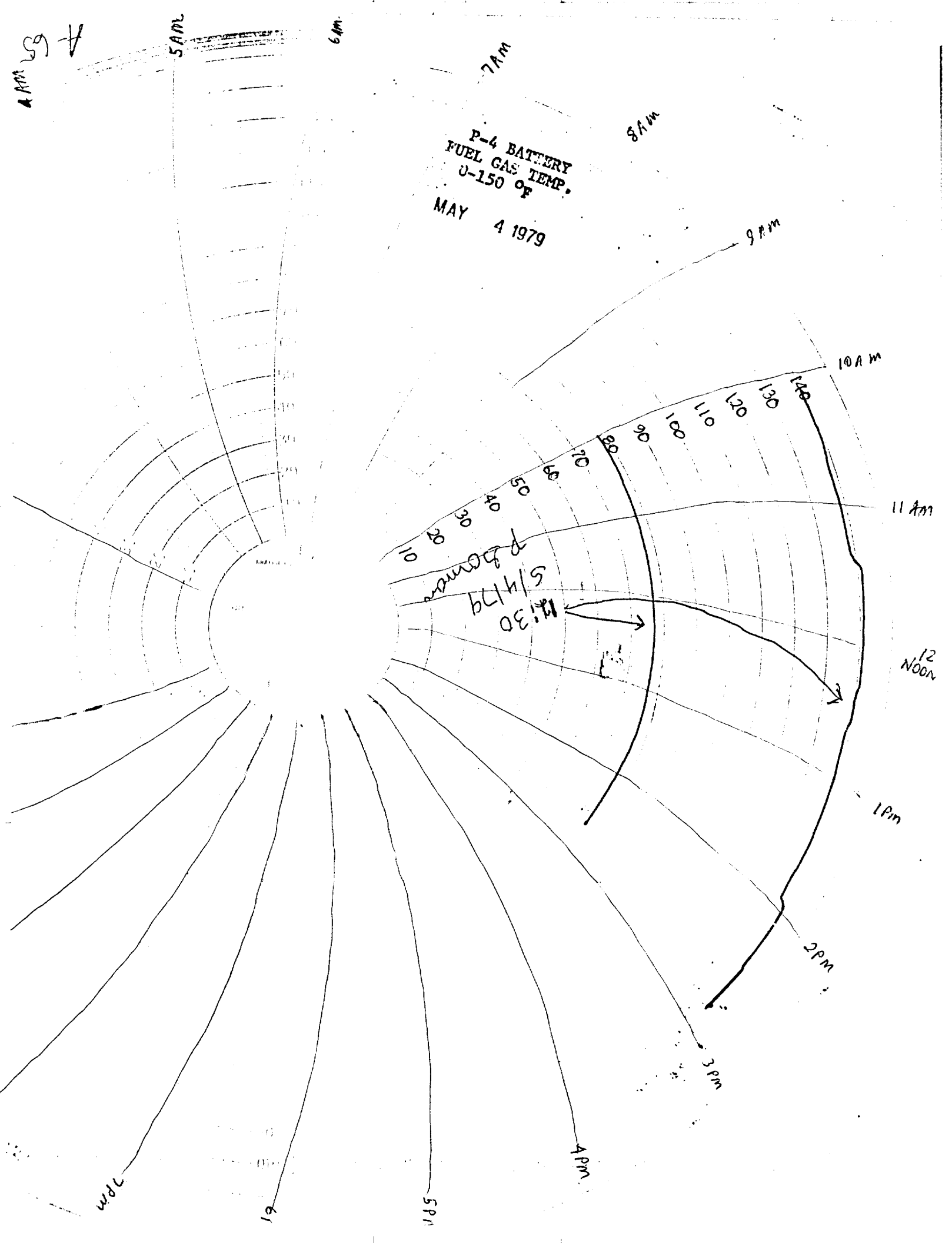
MAY 4 1979

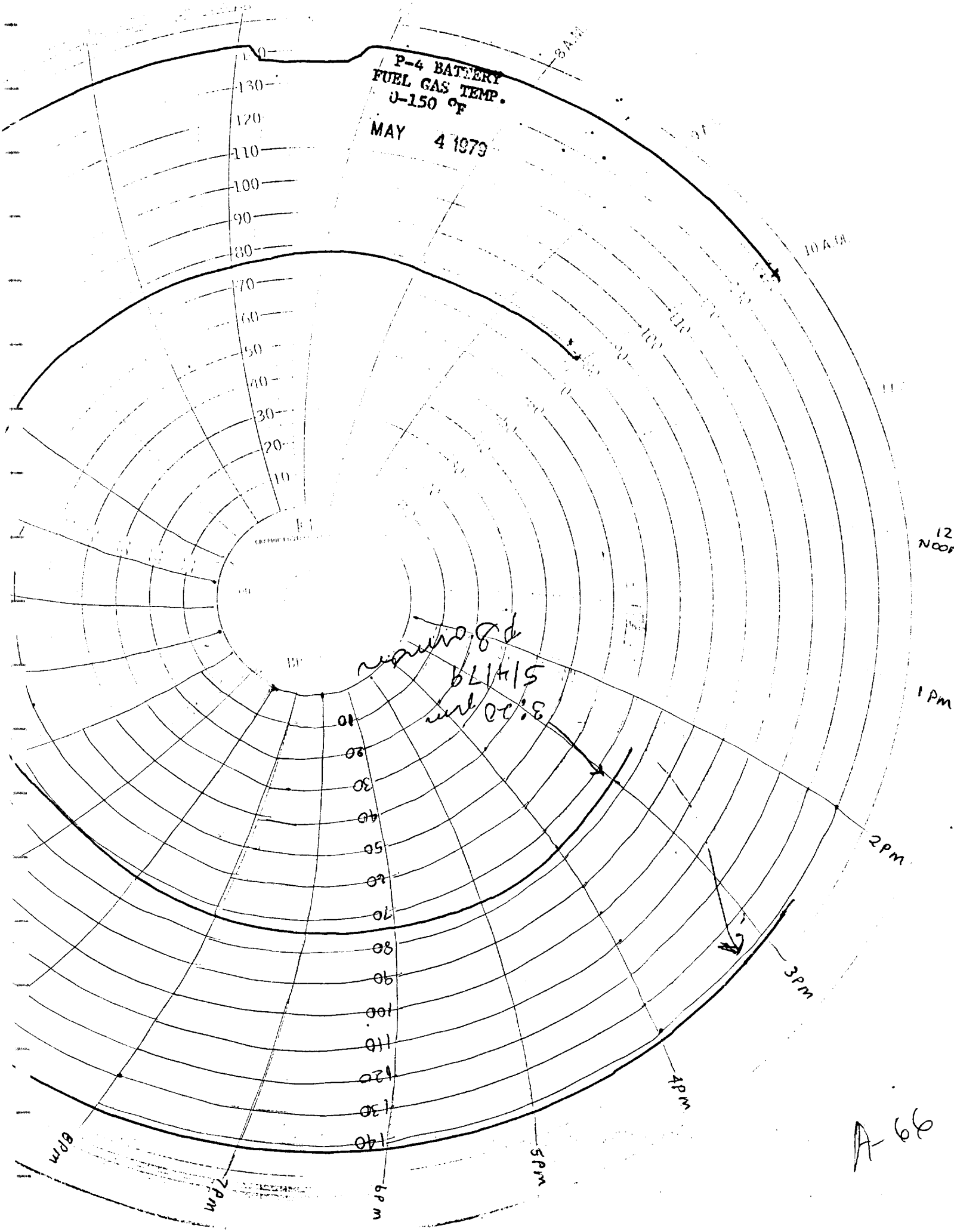
Collecting main processors
No. LO -20 to 420 PM

A-63

MAY 4 1979
Collecting Main Pressure
No. 10 -20 to +30 MM
6 AM
6 PM
Noon
3:25 pm
5/4/79
P Downen

A-64

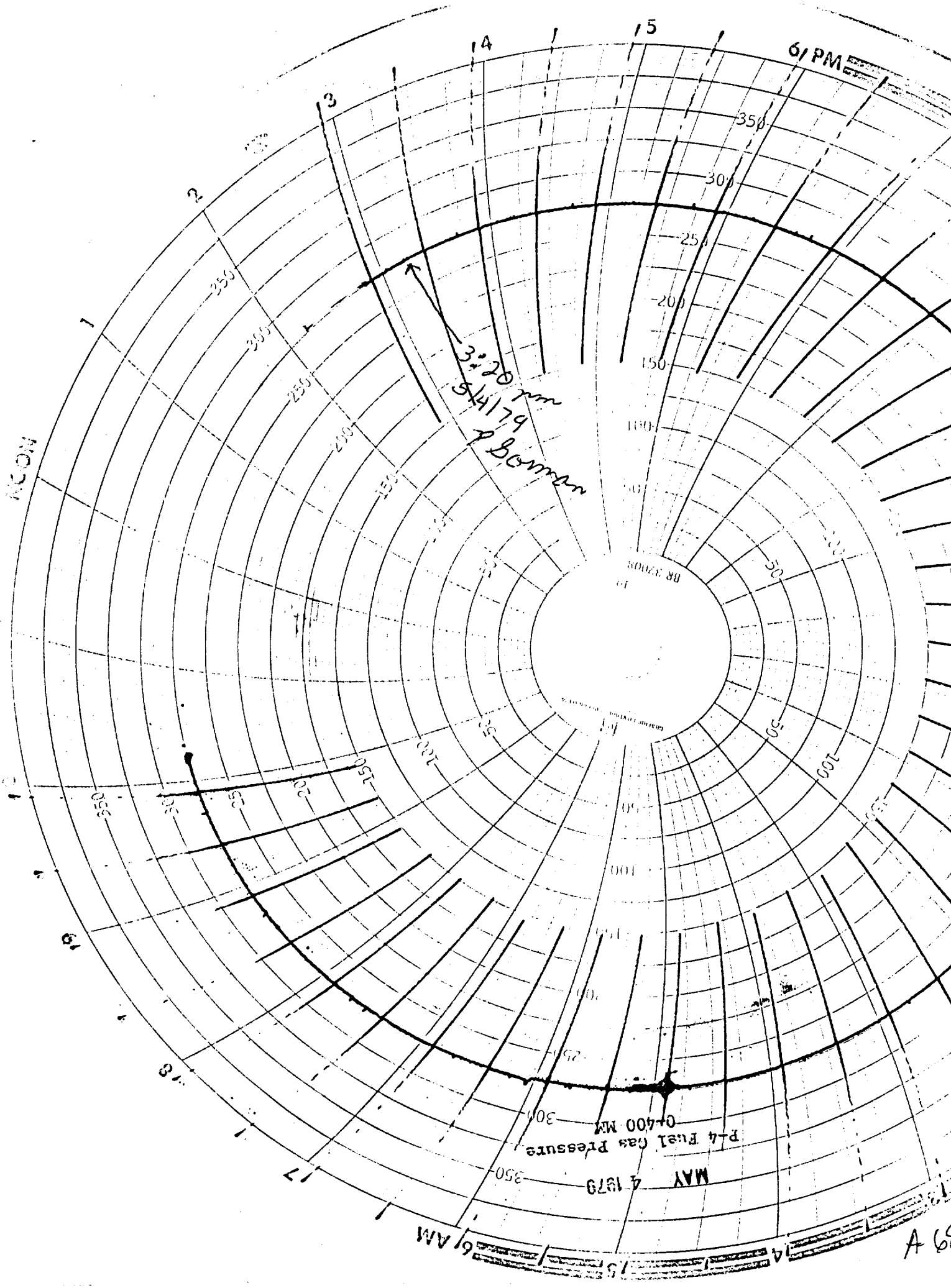

P-4 BATTERY
FUEL GAS TEMP.
0-150 °F
MAY 4 1979
4AM
5AM
6AM
7AM
8AM
9AM
10AM
11AM
12 NOON
1PM
2PM
3PM
4PM
5PM
6PM
7PM
10
20
30
40
50
60
70
80
90
100
110
120
130
140
11:30
5/4/79
pbonne


P-4 BATTERY
FUEL GAS TEMP.
0-150 °F
MAY 4 1979
130
120
110
100
90
80
70
60
50
40
30
20
10
8AM
10AM
12 NOON
1PM
2PM
3PM
4PM
5PM
6PM
7PM
8PM
10
20
30
40
50
60
70
80
90
100
110
120
130
140
signature 8d
6/14/5
3:20 pm

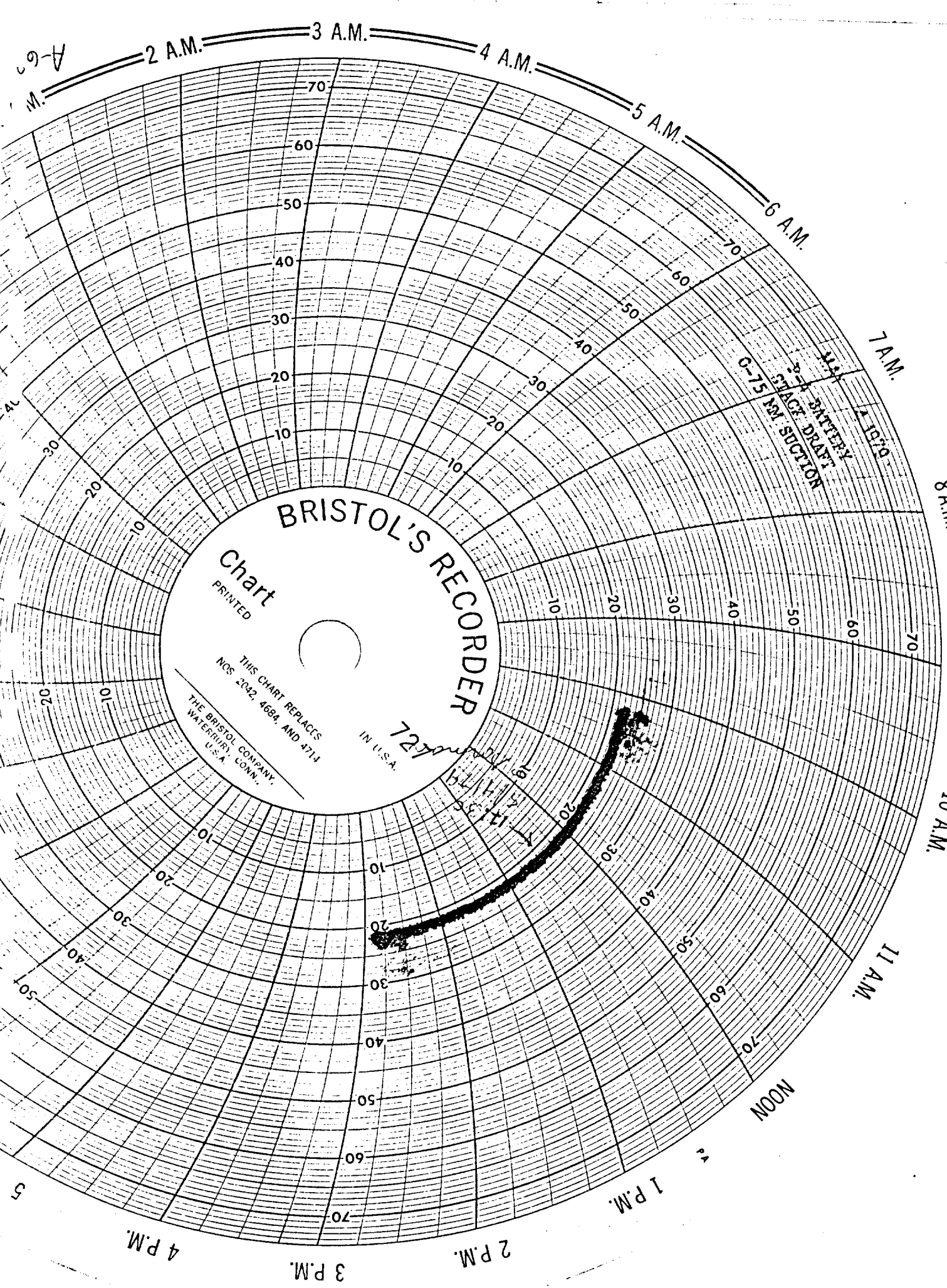
A-66

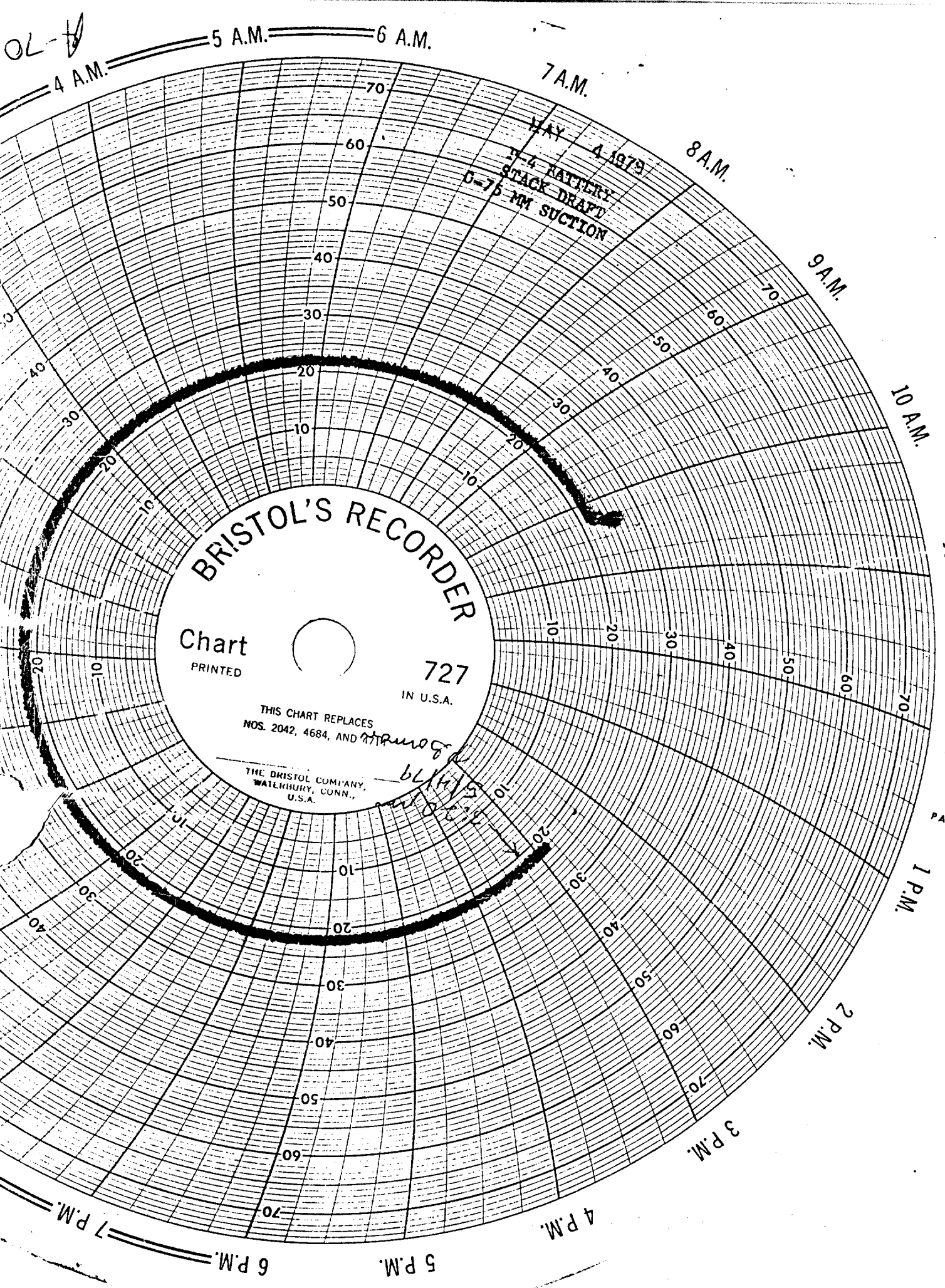
MAY 4 1979
FUEL CAS BATTERY
0-400 MM
6 AM
5
4
3
2
1
12
350
300
250
200
150
100
50
1730
5/4/79
PBonner

A67


MAY 4 1979
P-4 Fuel Gas Pressure
0-400 MM
6 AM
7
8
9
10
11
12
1
2
3
4
5
6 PM
NOON
3:20 pm
5/4/79
P Bowman

A 69


BRISTOL'S RECORDER
Chart
PRINTED
THIS CHART REPLACES
NOS. 2042, 4684, AND 4714
THE BRISTOL COMPANY,
WATERBURY, CONN.,
U.S.A.
IN U.S.A.
727
2 A.M.
3 A.M.
4 A.M.
5 A.M.
6 A.M.
7 A.M.
8 A.M.
9 A.M.
10 A.M.
11 A.M.
NOON
1 P.M.
2 P.M.
3 P.M.
4 P.M.
1010
BATTERY
STACK DRAFT
0-75 IN. SUCTION


MAY 4 1979
T-4 BATTERY
STACK DRAFT
0-75 MM SUCTION
BRISTOL'S RECORDER
Chart
PRINTED
727
IN U.S.A.
THIS CHART REPLACES
NOS. 2042, 4684, AND
THE BRISTOL COMPANY,
WATERBURY, CONN.,
U.S.A.
4 A.M.
5 A.M.
6 A.M.
7 A.M.
8 A.M.
9 A.M.
10 A.M.
11 A.M.
NOON
1 P.M.
2 P.M.
3 P.M.
4 P.M.
5 P.M.
6 P.M.
7 P.M.

SECTION II - TRW REPORT

Log of B(a)P tests the Product Coke Oven Battery Stack, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania plant.

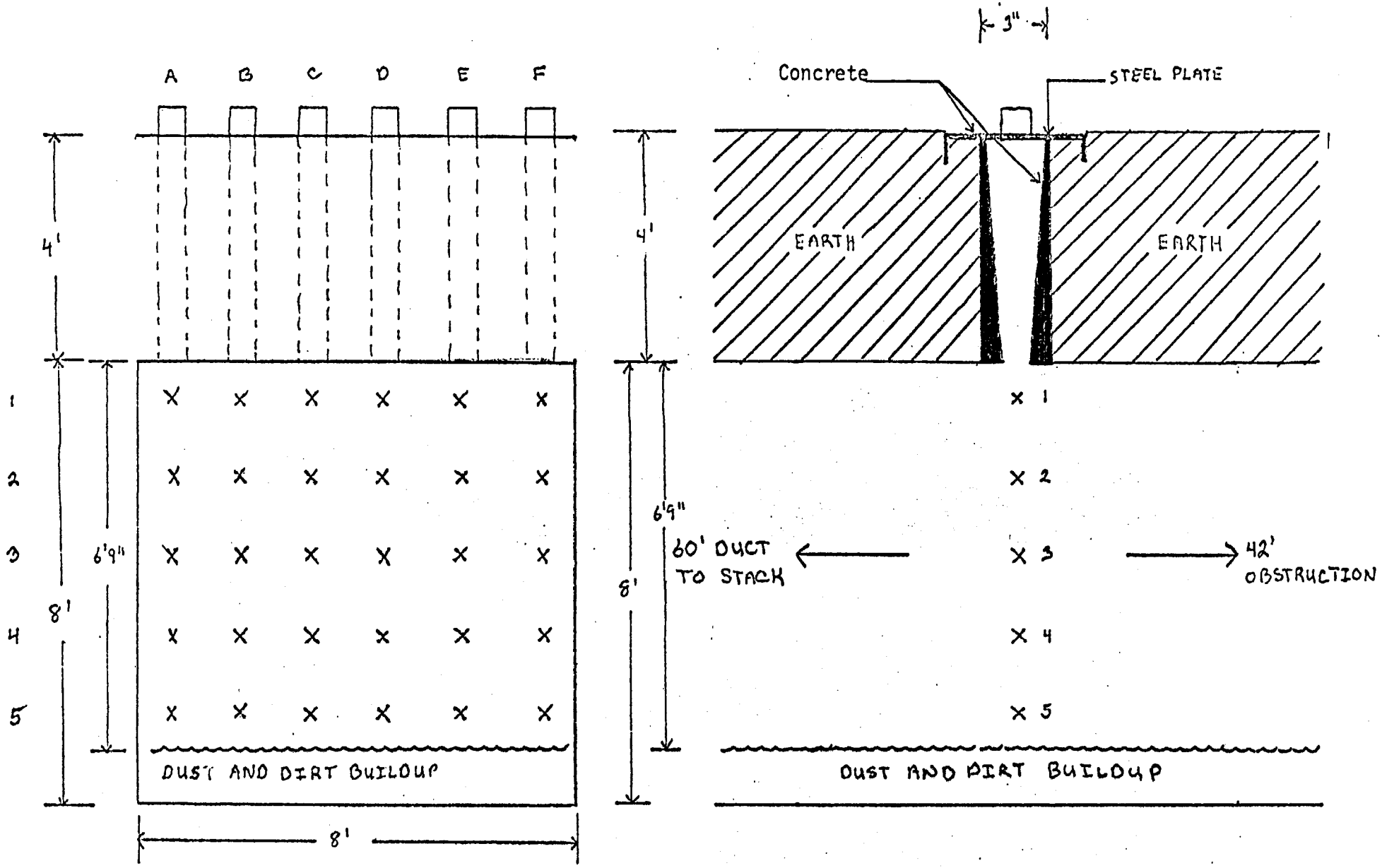
Monday, April 30, 1979

TRW spent the day preparing for the first B(a)P test which was to be run simultaneously with the Clayton Environmental Consultant's particulate test. It was considered that TRW would follow Clayton and use Clayton's pitot values for TRW's run since TRW did not have their own pitot of sufficient length.

EPA's Technical Manager, Mr. Frank Clay requested TRW to try and rig a temporary pitot for the three B(a)P runs. The pitot was constructed with a 10-foot stainless pitot and a 6-foot of Teflon tube which was connected to the metal tube by rubber hose and taped. Clayton checked the duct and found a dust and dirt build-up at the bottom which naturally changed the effective duct size (Figure 1).

TRW cleaned the sampling train after which blanks were taken from each of the train's components, the same as after a normal sampling run. After this, all major components were leak checked and capped ready for the first test. See Figure 2 for sampling train configuration.

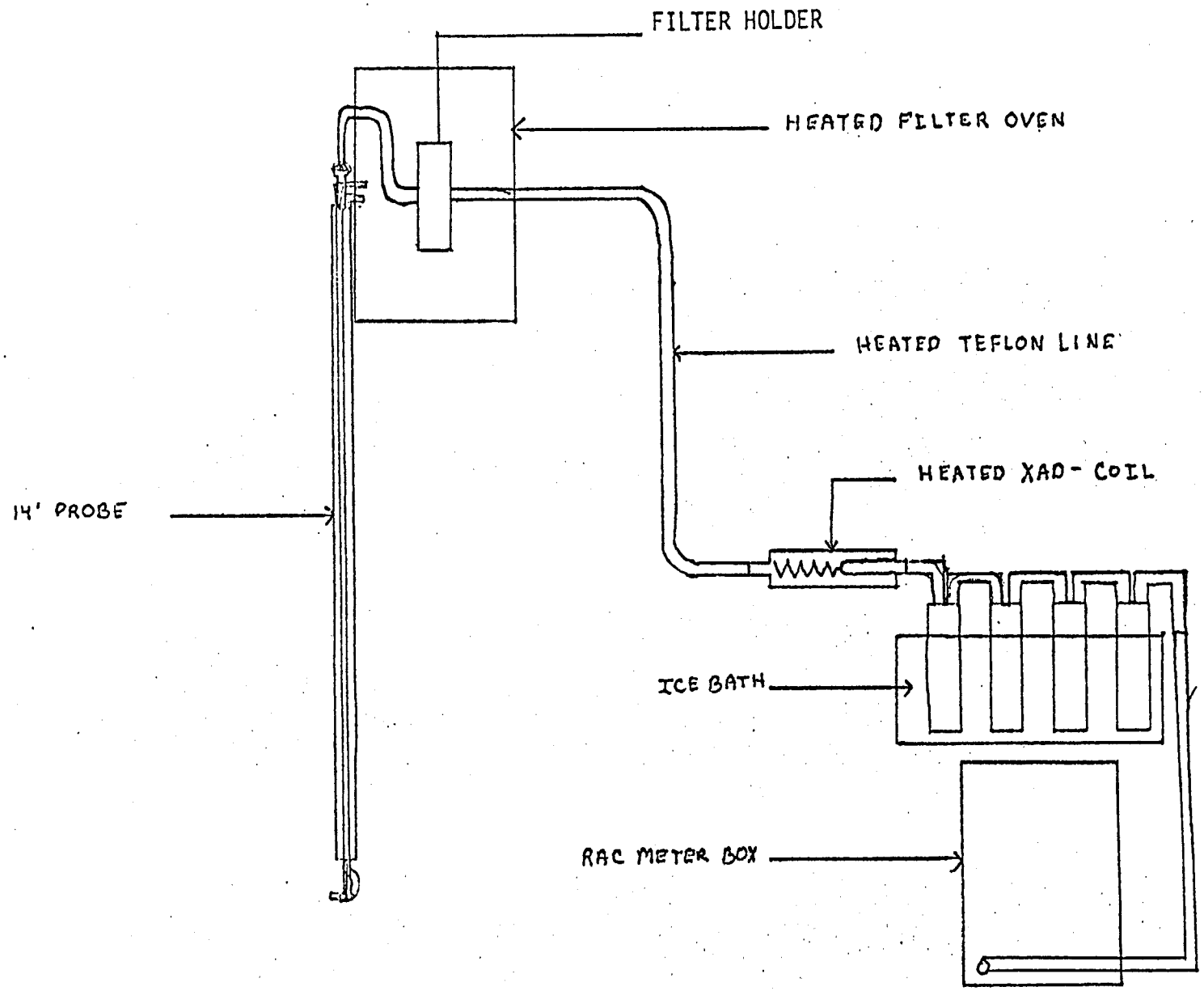
FIGURE 1



FRONT VIEW WITH OBSERVERS BACK TO THE EXHAUST STACK

SIDE VIEW

FIGURE 2


FILTER HOLDER
HEATED FILTER OVEN
HEATED TEFLON LINE
HEATED XAD - COIL
14' PROBE
ICE BATH
RAC METER BOX

Tuesday, May 1, 1979

TRW arrived at site and set up the train for the first test. During the leak check the heated Teflon hose collapsed. The heated hose was replaced and sampling started at 1450. At 1555 it was discovered that the female inlet to the XAD-2 coil was cracked. It was leak checked to be airtight but it was expected that it would start leaking later so it was replaced. While the coil was being replaced it is thought that the taped tubing of the pitot developed a leak which affected pitot reading on the last three points of the remaining ports and the same points on the first three ports of the second test.

No problems were encountered except for trying to keep the gas temperature at the exit of the XAD-coil at 127F. The temperature tended to fluctuate, and at times, it was impossible to reach 127F. The final leak check was .02 at 15" of mercury. The test was completed at 1842.

While recovering the sample it was noticed that the water in the first impinger was discolored, a mixed tan and brown color.

Wednesday, May 2, 1979

Second test started at 1043 with no problems, and finished at 1356. The impinger water was not discolored at the end of the test.

Thursday, May 3, 1979

Testing started at 1049 and finished 1442. No major problems were encountered. It was still impossible to hold the XAD-2 coil's exit gas to 127F but it was possible to hold in a ±20F range of 120-127F.

Discussion of Tests

For results of the tests see Table 1 and 2. Since TRW's pitot readings were somewhat questionable it was decided to use both TRW's and Clayton's pitot results to calculate the duct flow rates.

Due to the electric shock hazard caused by the high temperatures of the duct burning off the probes insulation it was decided not to heat the probe. The filter oven temperature was monitored by taping a thermocouple to the inlet of the filter. The flex line was heated using heat tapes controlled by a Variac, and the XAD-2 coil was heated using a water bath system. The temperature was monitored by taping a thermocouple to the outlet of the XAD-2 coil. It was possible to maintain the filter temperature at 248F± 25 F during most of the testing period. The XAD-2 coil was controlled at 122F± 18 F during most of the testing period.

TABLE 1

BαP - TEST RESULTS

TEST #	BαP-JL-1	BαP-JL-2	BαP-JL-3	3 RUN AVERAGE
DATE	5/1/79	5/2/79	5/3/79	
TRW DATA				
METER VOLUME DSCF	88.025	74.032	98.539	86.8695
METER VOLUME DSCM	2.493	2.097	2.791	2.460
DUCT VOLUME ACFM	94,856	79,337	113,243	95,812
DUCT VOLUME DSCFM	40,548	33,498	47,282	40,442
DUCT VOLUME DSCMM	1148.3	948.7	1339.0	1145.3
% ISOCKINETIC	105	108	104	
CLAYTON'S DATA				
DUCT FLOW ACFM	112,607	96,020	115,503	108,043
DUCT FLOW DSCFM	47,626	40,088	48,176	45,297
DUCT FLOW DSCMM	1348.8	1135.3	1364.4	1,282.8
% ISOKINETIC USING TRW METER VOLUME AND CLAYTON DUCT FLOW	89	91	102	

TABLE 2

J & L - BαP TEST RESULTS

SAMPLE	μg/FILTER	μg/PROBE RINSE	μg/HEATED HOSE	μg/XAD-2	μg/TOTAL	DUCT FLOW *DSCMM	METER VOLUME DSCM	μg/DSCM	gm/HR	DUCT FLOW DSCFM	METER VOLUME DSCF
BαP-JL-1	< 0.002	1.6170	0.4674	<0.001	2.0874	1345.8	2.493	8.35×10^{-4}	0.0672	47,626	88.025
BαP-JL-2	<0.002	0.4329	0.3150	<0.001	0.7509	1135.3	2.097	3.58×10^{-4}	0.0241	40,088	74.032
BαP-JL-3	0.050	0.1710	0.3780	<0.001	0.6100	1364.4	2.791	2.18×10^{-4}	0.0177	48,176	98.539
3 RUN AVERAGE	< 0.021	0.7403	0.3868	<0.001	1.1494	1282.8	2.462	2.70×10^{-4}	0.0363	45,296	86.940

SAMPLE	LBS/DSCF	LBS/HR	LBS/24 HR DAY	LBS/365 DAYS	*** YEARS/LB
BαP-JL-1	5.21×10^{-11}	1.48×10^{-4}	3.55×10^{-3}	1.29	0.78
BαP-JL-2	2.23×10^{-11}	0.53×10^{-4}	1.27×10^{-3}	0.46	2.18
BαP-JL-3	1.36×10^{-11}	0.39×10^{-4}	0.94×10^{-3}	0.34	2.94
3 RUN AVERAGE	2.93×10^{-11}	0.80×10^{-4}	1.92×10^{-3}	0.70	1.43**

* Based on Clayton Environmental Consultants' pitot and temperature readings

** lbs/365 days must be used to derive years/lb.

*** Years required to emit one pound

Due to the minute quantities of B(a)P present in the stack gas relative to the total volume of stack gas, it is difficult to conceive the concentrations in perspective. If the average weight in pounds of B(a)P emitted per dry standard cubic foot (dscf) of stack gas is used with the average dscf per minute stack gas volume, then it is possible to calculate the number of days of continuous operation needed to emit one pound of B(a)P. Based on the data in this report, the time required to emit one pound of B(a)P from the battery stack is 526 days, or 1.44 years (1 year, 5 months, 8 days approximately).

APPENDIX

LOAD SHEET

STACK TEST - PARTICULATE

TRW

Test # BAP-JL-1

Part 1

Enter	(Initial	y Only)
	Value	Location
	0.0283	04
	~~17.71~~ 12.64	05
	~~0.0474~~ .0471	06
	1032	07
f(Min)	150	09
$^{-2}$(in^2)	.1406	10
S(in Hg)	29.4	11
^{4}ft^3)	91.28	12
,ml)	280.4	13
CO_2 ?	0.7	14
$_2$?	17.9	15
N_2 ?	81.4	16
0√	49870.5554	17
s(ft^2)	54	18
÷460)	1055.2	19
	Part 2	
(mg)		00
(mg)		01
TD(f^3)		02
("Hg)		03
		04
Ts÷460)		05
scfm)		06

TM 81.6

m 1.2

Pb 29.52

Test # BAP-JL-2

Enter	Value	Location
Tf(Min)	150	09
(DN)^2(in^2)	.1406	10
PS(in Hg)	29.4	11
VM(ft^3)	78.04	12
VW(ml)	252.5	13
% CO_2 ?	4.0	14
% O_2 ?	10.6	15
% N_2 ?	85.4	16
4350√	41800.2637	17
As(ft^2)	54	18
(Ts+460)	1058.3	19
	Part 2	
mf (mg)		00
mt (mg)		01
VMSTD(f^3)		02
Ps ("Hg)		03
Md		04
(Ts+460)		05
Qs(scfm)		06

TM 89.6

PM 0.9

Pb 29.49

Test # BAP-JL-3

Enter	Value	Location
Tf(Min)	150	09
(DN)^2(in^2)	.1406	10
PS(in Hg)	29.2	11
VM(ft^3)	105.70	12
VW(ml)	336.1	13
% CO_2 ?	3.1	14
% O_2 ?	12.5	15
% N_2 ?	84.4	16
4350√	59397.9848	17
As(ft^2)	54	18
(Ts+460)	1062.9	19
	Part 2	
mf (mg)		00
mt (mg)		01
VMSTD(f^3)		02
Ps ("Hg)		03
Md		04
(Ts+460)		05
Qs(scfm)		06

TM = 96.5

PM = 1.5

Pb = 29.30

7057 6591 6594

RESULTS

STACK TEST - PARTICULATE

TRW

Test # BAP-JL-1		Test # BAP-JL-2		Test # BAP-JL-3	
Value		Value		Value	
Vm (SCF)	88.025	Vm (SCF)	74.032	Vm (SCF)	98.539
Vm (SCM	2.491	Vm (SCM)	2.095	Vm (SCM)	2.789
Vw gas (CF)	13.207	Vw gas (CF)	11.893	Vw gas (CF)	15.830
% Moisture	13.046	% Moisture	13.841	% Moisture	13.841
Md	0.870	Md	0.862	Md	0.862
MWd	28.828	MWd	29.064	MWd	28.996
MW	27.415	MW	27.533	MW	27.474
Vs (fpm)	1756.603	Vs (fpm)	1469.202	Vs (fpm)	2097.101
ACFM	94856.580	ACFM	79336.896	ACFM	113243.454
Flow (SCFM)	40538.512	Flow (SCFM)	33497.565	Flow (SCFM)	47282.532
Flow (SCMM)	1147.240	Flow (SCMM)	947.981	Flow (SCMM)	1338.096
% I	104.96	% I	108.59	% I	104.20
% EA	477.03	% EA	87.48	% EA	125.62
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	

85% TRW as % of Clayton SCFM

84%

98%

Possible problem with TRW pitot

LOAD SHEET

STACK TEST - PARTICULATE

Clayton Values ΔP and [illegible]

Test # BAP-1

Part 1

Enter	(Initial	y Only)
	Value	Location
	0.0283	04
	~~17.71~~ 17.64	05
	0.0474 .0471	06
	1032	07
f(Min)	150	09
^{2}(in^2)	.1406	10
S(in Hg)	29.4	11
(ft^3)	91.28	12
(ml)	280.4	13
CO_2	0.7	14
$_2$	17.9	15
N_2	81.4	16
3 $\sqrt{}$	59001.2704	17
s(ft^2)	54	18
T +460)	1059	19
	Part 2	
f (mg)		00
t (mg)		01
ID(f^3)		02
s ("Hg)		03
d		04
Ts+460)		05
scfm)		06

Test # BAP-2

Enter	Value	Location
Tf(Min)	150	09
(DN)^2(in^2)	.1406	10
PS(in Hg)	29.4	11
VM(ft^3)	78.04	12
VW(ml)	252.5	13
% CO_2	4.0	14
% O_2	10.6	15
% N_2	85.4	16
4350$\sqrt{}$	50417.9993	17
As(ft^2)	54	18
(Ts+460)	1063	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 # B[illegible]3

Enter	Value	Location
Tf(Min)	150	09
(DN)^2(in^2)	.1406	10
PS(in Hg)	29.2	11
VM(ft^3)	105.70	12
VW(ml)	336.1	13
% CO_2	3.1	14
% O_2	12.5	15
% N_2	84.4	16
4350$\sqrt{}$	60583.[illegible]	17
As(ft^2)	54	18
(Ts+460)	1064	19
	Part 2	
mf (mg)		00
mt (mg)		01
VMSTD(f^3)		02
Ps ("Hg)		03
Md		04
(Ts+460)		05
Qs(scfm)		06

RESULTS

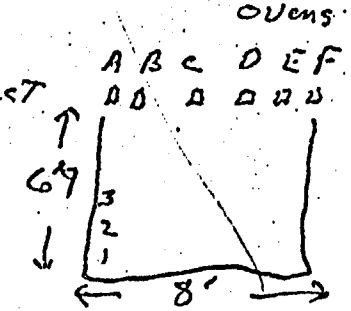
STACK TEST - PARTICULATE

Clayton

Test # BAP-1		Test # BAP-2		Test # BAP-3	
Value		Value		Value	
Vm (SCF)	88.025	Vm (SCF)	74.032	Vm (SCF)	98.539
Vm (SCM	2.491	Vm (SCM)	2.095	Vm (SCM)	2.789
Vw gas (CF)	13.207	Vw gas (CF)	11.893	Vw gas (CF)	15.830
% Moisture	13.046	% Moisture	13.841	% Moisture	13.841
Md	0.870	Md	0.862	Md	0.862
MWd	28.828	MWd	29.064	MWd	28.996
MW	27.415	MW	27.533	MW	27.474
Vs (fpm)	2085.321	Vs (fpm)	1778.158	Vs (fpm)	2138.945
ACFM	112607.32	ACFM	96020.515	ACFM	115503.024
Flow (SCFM)	47625.68	Flow (SCFM)	40087.882	Flow (SCFM)	48176.113
Flow (SCMM)	1347.807	Flow (SCMM)	1134.487	Flow (SCMM)	1363.384
% I	89.34	% I	90.74	% I	102.27
% EA	477.02	% EA	87.48	% EA	125.62
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	

FIELD DATA Stack in Front ovens To the back

PLANT Jones and Laughlin
DATE 4-31
SAMPLING LOCATION Battery Exhaust Duct
SAMPLE TYPE BAP
RUN NUMBER BAP-1
OPERATOR Jim and Ken
AMBIENT TEMPERATURE 54
BAROMETRIC PRESSURE ~~29.95~~ 29.52
STATIC PRESSURE, (P_s) 0.95" H_2O
FILTER NUMBER (s) 130



SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 14' SS
NOZZLE I.D. 3/8"
ASSUMED MOISTURE, %
SAMPLE BOX NUMBER 3E
METER BOX NUMBER Gold box
METER $\Delta H_@$ 1.84
C FACTOR ~~.84~~ .78
PROBE HEATER SETTING 60%
HEATER BOX SETTING 60%
REFERENCE Δp .22

READ AND RECORD ALL DATA EVERY _____ 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	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 Problems 1	IMPINGER TEMPERATURE, °F	XAD Coil
	0	1450	948.99										
B-1	5	55	952.55	.19	1.75	1.75	627	70	70	10	134	50	119
2	10	1500	956.29	.23	2.0	2.0	628	74	68	12	134	50	125
3	15	05	960.09	.22	1.95	1.95	576	82	70	12	134	50	132
4	20	10	963.69	.19	1.7	1.7	582	88	72	10	120	58	128
5	25	15	967.17	.16	1.4	1.4	593	90	72	9	134	64	127
		1530	967.17										
A-1	30	35	970.37	.16	1.4	1.4	579	74	64	20	249	54	122
2	35	40	974.00	.20	1.8	1.8	588	90	74	13	199	58	129
3	40	45	977.72	.20	1.8	1.8	600	90	76	11	210	60	125
Leak rate 4	45	50	981.40	.18	1.6	1.6	605	94	78	10	240	60	131
Broke XAD-2 5	50	55	984.70	.13	1.15	1.15	613	98	80	8	252	62	125
Leak Check													
	START	1627	985.34										
C-1	55	32	989.22	.20	1.8	1.8	580	78	78	11	251	50	120
2	60	37	993.01	.22	1.9	1.9	583	86	78	11	248	50	128
3	65	42	995.20	.05	.45	.45	602	90	80	4	249	56	128
4	70	47	997.39	.05	.45	.45	605	88	80	4	250	58	~~124~~
5	75	52	999.45	.05	.45	.45	614	90	80	4	254	62	118
		506	999.45										
D-1	80	11	1003.15	.17	1.5	1.5	587	80	80	11	240	50	105
2	85	16	1006.60	.18	1.6	1.6	598	84	78	11	245	55	110
3	90	21	1009.40	.09	.8	.8	606	90	78	6	248	59	113
4	95	26	1011.04	.02	.19	.19	618	90	80	3	256	60	115
COMMENTS 5	100	31	1012.75	.04	.35	.35	565	84	80	4	240	60	120

BAP-1 Jones and L

Final L.C. - .02 of 15"

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	XAD Coil
	100	1744	1012.75	.07	.64	.64							
FB-1	105	49	1015.10	~~.04~~	~~.37~~	~~.37~~	606	74	76	5	255	56	118
2	110	54	1018.20	.19	1.7	1.7	623	82	76	12	240	56	118
3	115	59	1021.99	.15	1.3	1.3	559	88	78	10	240	58	118
4	120	1804	1024.60	.08	.72	.72	570	92	78	7	243	60	120
5	125	09	1025.66	.01	.09	.09	582	92	78	2	256	65	136
			1025.66										
E-1	130	1822	1029.12	.19	1.7	1.7	602	82	78	11	270	60	124
2	135	2722	1033.15	.22	1.9	1.9	618	88	80	14	261	58	129
3	140	3227	1036.40	.12	1.1	1.1	562	96	80	8	251	61	124
4	145	3732	~~1036.40~~ 1039.00	.09	.82	.82	588	98	82	8	256	62	130
5	150	1882	1040.91	~~.09~~ .04	~~.82~~	~~.82~~	597	96	84	4	259	64	132
	150		91.28			1.2	595.2	81.6					123.0

4350 ft³ × (13.40) = 49870.5854

FIELD DATA

PLANT Jones and Laughlin
DATE 5-2-79
SAMPLING LOCATION Battery Exhaust Duct
SAMPLE TYPE BAP
RUN NUMBER BAP-SL-2
OPERATOR Jim Ken
AMBIENT TEMPERATURE 66
BAROMETRIC PRESSURE 29.49
STATIC PRESSURE, (P_s) -.95" H_2O
FILTER NUMBER (s) 131

PROBE LENGTH AND TYPE 14' SS
NOZZLE I.D. 3/8
ASSUMED MOISTURE, % 17
SAMPLE BOX NUMBER
METER BOX NUMBER 85
METER $\Delta H_@$ 1.70
C FACTOR .78
PROBE HEATER SETTING 0/8
HEATER BOX SETTING 258
REFERENCE Δp .21

SCHEMATIC OF TRAVERSE POINT LAYOUT XAD-127

READ AND RECORD ALL DATA EVERY _____ MINUTES

on port A B C point 3 are not correct pick

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	XAD Coi ous
	0	1043	42.27										
B-1	5	48	46.40	.18	1.6	1.6	613	70	70	14	276	44	10
2	10	53	49.46	.20	1.75	1.75	619	76	70	16	248	48	11
3	15	58	—	.03	.26	.26	556	86	72	4	257	51	15
4	20	1103	52.80	.01	.10	.10	564	86	74	2	271	57	15
5	25	08	53.80	.01	.10	.10	579	86	74	2	273	57	13
		1122	53.80										
A-1	30	27	57.12	.15	1.4	1.4	608	82	80	11	274	50	11
2	35	32	60.66	.18	1.6	1.6	573	92	80	14	237	47	12
3	40	37	62.09	.01	.10	.10	585	100	82	2	252	45	11
4	45	42	62.92	.01	.10	.10	597	90	84	2	262	56	10
5	50	1147	63.87	.01	.10	.10	620	86	84	2	285	64	10
		1153	63.87										
C-1	55	58	67.03	.15	1.4	1.4	584	88	84	11	211	49	12
2	60	1203	70.60	.18	1.6	1.6	588	94	84	15	199	48	12
3	65	08	72.01	.01	.10	.10	604	96	86	2	199	50	12
4	70	13	73.00	.01	.10	.10	609	94	86	2	254	50	11
5	75	18	75.65	.11	1.0	1.0	619	96	88	12	254	52	13
		1230	75.65										
B-1	80	35	78.77	.13	1.2	1.2	600	90	88	12	270	50	10
2	85	40	81.59	.10	.90	.90	609	94	84	9	268	51	110
3	90	45	84.69	.12	1.1	1.1	622	96	88	13	249	52	117
4	95	50	87.84	.12	1.1	1.1	628	102	88	13	244	54	117
5	100	55	90.14	.06	.54	.54	567	104	90	7	243	56	117

COMMENTS:

BHP-JL-2

Post Leak was in Flex Connector before Test
Leak Rate .0562 15"

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	
	100 1301	90.14										
E-1	105 06	93.40	.17	1.55	1.55	594	96	90	15	268	55	118
2	110 11	96.48	.18	1.6	1.6	606	100	92	16	238	56	121
3	115 16	99.72	.13	1.15	1.15	614	104	92	12	243	58	121
4	120 21	102.65	.11	.98	.98	621	104	92	10	245	59	125
5	125 26	105.37	.09	.82	.82	584	102	92	8	251	60	133
	1331	105.37										
D-1	130 36 ~~1331~~	108.92	.18	1.6	1.6	602	94	90	15	269	58	120
2	135 41 ~~36~~	112.63	.20	1.8	1.8	622	102	92	17	265	60	109
3	140 4697	115.79	.12	1.1	1.1	630	104	92	12	254	60	116
4	145 5146	118.22	.07	.62	.62	556	104	92	7	255	60	120
5	150 1356	120.31	.05	.45	.45	577	102	92	6	254	60	110
	150	78.04			.09	598.3	89.6					120

4350 $\sqrt{\Delta P}$ $\sqrt{\frac{T_s}{T_m+460}}$ = 41800.2637

EPA-Dwr 236
4-72

FIELD DATA

PLANT Jones and Laughlin
DATE 5-3-77
SAMPLING LOCATION [illegible] Exhaust Duct
SAMPLE TYPE BAP
RUN NUMBER BAP-37-3
OPERATOR Jim Kon
AMBIENT TEMPERATURE 68
BAROMETRIC PRESSURE 29.30
STATIC PRESSURE, (P_s) -.95" H2O
FILTER NUMBER (s) 133

PROBE LENGTH AND TYPE 14' SS
NOZZLE I.D. 3/8
ASSUMED MOISTURE, % 14
SAMPLE BOX NUMBER EAST
METER BOX NUMBER 8 E
METER $\Delta H_@$ 1.70
C FACTOR .880
PROBE HEATER SETTING 44
HEATER BOX SETTING 250
REFERENCE Δp .30

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), 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	XAD Coil
	0	1049	121.48										
F-1	5	54	124.70	.10	1.35	1.35	623	70	70	14	278	50	151
2	10	59	128.25	.17	1.5	1.5	630	78	70	15	274	50	143
3	15	1104	131.41	.15	1.3	1.3	573	86	72	13	270	50	139
STOP 4	20	09	134.02	.12	1.2	1.2	583	94	74	13	245	50	134
5	25	14	137.67	.13	1.1	1.1	616	82	80	11	208	52	125
		1134	137.67										
E-1	30	39	141.13	.17	1.5	1.5	577	90	84	15	235	61	130
2	35	45	144.88	.20	1.75	1.75	604	100	86	20	235	55	134
3	40	49	148.53	.19	1.65	1.65	611	104	88	20	249	55	134
4	45	55	152.95	.19	1.65	1.65	622	106	90	20	255	57	126
5	50	1201	155.64	.16	1.4	1.4	631	108	90	15	267	58	123
		1200	155.64										
D-1	55	11	160.00	.18	1.55	1.55	589	100	92	19	275	54	120
2	60	17	163.20	.19	1.65	1.65	599	104	92	21	260	55	127
3	65	22	166.40	.19	1.65	1.65	609	110	94	21	257	57	124
4	70	27	170.47	.19	1.65	1.65	615	110	94	20	255	58	131
5	75	33	173.84	.15	1.3	1.3	625	112	96	16	260	58	142

COMMENTS:

B11 - OL-3

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	XAD Coil
	85	1238	173.84										
C - 1	80	43		.19	1.65	1.65	603	104	96	19	270	54	123
2	85	48	181.28	.20	1.7	1.7	606	112	98	21	247	56	132
3	90	53		.19	1.65	1.65	621	112	98	21	281	57	134
stop 4	95	58	188.91	.18	1.6	1.6	627	112	98	21	255	58	136
5	100	1306	192.27	.15	1.35	1.35	590	114	100	15	290	56	132
		1346	192.27										
B - 1	105	51	195.90	.19	1.65	1.65	618	96	94	21	218	54	124
2	110	56	199.55	.21	1.80	1.80	630	104	96	21	212	56	130
3	115	1401	203.17	.19	1.65	1.65	636	104	98	21	236	58	131
4	120	06	206.82	.20	1.7	1.7	581	108	98	21	235	60	138
5	125	11	210.35	.17	1.5	1.5	590	100	94	21	246	60	128
		1417	210.35										
A - 1	130	22	213.96	.18	1.6	1.6	604	106	94	20	273	60	122
2	135	27	217.48	.21	1.7	1.7	579	108	96	21	253	60	133
3	140	32	221.07	.19	1.7	1.7	570	110	96	22	265	62	136
4	145	37	224.67	.18	1.6	1.6	589	112	96	22	266	64	136
5	150	1442	227.18	.10	.92	.92	598	112	98	24	249	65	121
	150		105.20			1.5	602.9	96.5					131.7

4350 1/ΔPS (Ts+460) = 59397.9848

EPA-Dwn 236
4-72

25
12.5

NOMOGRAPH DATA

PLANT Jones and Laughlin

DATE 4-31-79

SAMPLING LOCATION Battery Exhaust Duct

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m_{avg.}}$	75
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	17
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	29.52
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	−.95" H_2O
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	~~29.51~~
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	600
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.16 ~~.20~~
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	.25
C FACTOR	.84	
CALCULATED NOZZLE DIAMETER, in.	3/8	
ACTUAL NOZZLE DIAMETER, in.	3/8	
REFERENCE Δp, in. H_2O	.2	

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4/72

ANALYTICAL DATA

PLANT JONES + LAUGHLIN

DATE 5-1-79

SAMPLING LOCATION

SAMPLE TYPE BAP

RUN NUMBER 1

SAMPLE BOX NUMBER

CLEAN-UP MAN KC + J. McR.

COMMENTS:

FRONT HALF

		LABORATORY RESULTS
~~ACETONE~~ WASH OF NOZZLE, PROBE, CYCLONE (BYPASS), FLASK, FRONT HALF OF FILTER HOLDER	CONTAINER	~~[illegible]~~ mg
FILTER NUMBER 130	CONTAINER	mg
	FRONT HALF SUBTOTAL	mg

BACK HALF

IMPINGER CONTENTS AND WATER WASH OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER	CONTAINER	450 mg mG
	~~ETHER-CHLOROFORM EXTRACTION~~	mg
~~ACETONE~~ WASH OF IMPINGERS, CONNECTORS, AND BACK HALF OF FILTER HOLDER	CONTAINER	mg
	BACK HALF SUBTOTAL	mg
	TOTAL WEIGHT	mg

MOISTURE

IMPINGERS

FINAL VOLUME	450	ml
INITIAL VOLUME	200	ml
NET VOLUME	250	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 280.4 g

EPA (Dur) 231
4/72

TRW

ANALYTICAL DATA

PLANT Jones and Laughlin

DATE 5-2-79

SAMPLING LOCATION Battery Exhaust Duct

SAMPLE TYPE BAP ✓

RUN NUMBER BAP-BL-2

SAMPLE BOX NUMBER —

CLEAN-UP MAN Tim, Ken

COMMENTS:

FRONT HALF

		LABORATORY RESULTS
ACETONE WASH OF NOZZLE, PROBE, CYCLONE (BYPASS), FLASK, FRONT HALF OF FILTER HOLDER	CONTAINER _____	_____ mg
FILTER NUMBER 131 _____ _____	CONTAINER _____	_____ mg
	FRONT HALF SUBTOTAL	_____ mg

BACK HALF

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

MOISTURE

IMPINGERS

FINAL VOLUME 432 ml

INITIAL VOLUME 200 ml

NET VOLUME 232 ml

SILICA GEL

FINAL WEIGHT	220.5 g	_____ g	_____ g
INITIAL WEIGHT	200 g	_____ g	_____ g
NET WEIGHT	20.5 g	_____ g	_____ g

TOTAL MOISTURE 252.5 g

EPA (Dur) 231

ANALYTICAL DATA

PLANT Jones and Laughlin

DATE 5-3-79

SAMPLING LOCATION Battery Exhaust Duct

SAMPLE TYPE BAP

RUN NUMBER BAP-5L-3

SAMPLE BOX NUMBER

CLEAN-UP MAN McR

COMMENTS:

FRONT HALF

		LABORATORY RESULTS
ACETONE WASH OF NOZZLE, PROBE, CYCLONE (BYPASS), FLASK, FRONT HALF OF FILTER HOLDER	CONTAINER	mg
FILTER NUMBER 133	CONTAINER	mg
FRONT HALF SUBTOTAL		mg

BACK HALF

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

MOISTURE

IMPINGERS

FINAL VOLUME 504 ml

INITIAL VOLUME 200 ml

NET VOLUME 304 ml

SILICA GEL

FINAL WEIGHT	232.1 g	g	g
INITIAL WEIGHT	200 g	g	g
NET WEIGHT	32.1 g	g	g

TOTAL MOISTURE 336.1 g

EPA (Dur) 231
4/72

O_2 [illegible]

CO .2

Clayton Run veloc.

	BAP-1		BAP-2		BAP-3	
A-1	.16	610	.12	600	.21	615
2	.16	620	14	615	20	625
3	.18	570	11	625	20	565
4	.18	580	13	625	21	575
5	.12	595	08	570	12	610
B-1	.20	575	.15	595	.21	585
2	.20	590	14	605	20	600
3	.21	600	14	620	20	610
4	.19	610	14	625	20	620
5	.14	620	10	580	15	630
C-1	.18	620	.17	605	20	600
2	.17	580	15	615	20	600
3	.16	600	14	625	19	610
4	.17	610	13	635	18	610
5	.15	615	10	570	15	615
D-1	23	590	.15	575	22	600
2	23	595	13	590	20	600
3	22	605	13	600	19	610
4	20	615	13	610	17	620
5	15	625	09	620	14	605
E-1	.18	605	.13	615	.19	600
2	18	620	15	560	22	620
3	20	630	14	590	21	625
4	17	565	12	600	19	565
5	12	580	10	615	14	580
F-1	.15	600	.15	610	17	590
2	18	615	15	620	18	610
3	19	550	12	630	19	605
4	16	585	12	560	18	605
5	12	595	06	575	10	610

Ts 599
59001.2704

Ts 603
50417.9993

604
60583.165

TRW

ACCOUNTABILITY LOG

CLIENT EPA LOCATION Jones and Laughlin

TYPE SAMPLE(S) BAP

REMARKS:

DATE/TIME	MASTER CONTROL #	ACTIVITY	INITIALS
4-30	Blanks	Filter Blank #127	
		Front M/C Rinse Blank	
		Back M/C Rinse Blank	
		Heated Hose M/C Rinse Blank	
		Back Water Blank	
5-1	BAP-JL-1	Back M/C ~~Rinse~~ Wash	
		Heated Hose M/C Rinse	
		Filter #130	
		Back Water 2nd 3rd Imp.	
		Front M/C Rinse	
		Silica Gel	
		Back Water 1st Imp. discobred	
		XAD-2 1 of 2	
		XAD-2 2 of 2	
5-2	BAP-JL-2	Back M/C Rinse	
		Back Water	
		Heated Hose Water	
		Filter # 131	
		Heated Hose M/C Rinse	
		Front M/C Rinse	
		XAD-2	
		Silica Gel	

TRW

ACCOUNTABILITY LOG

CLIENT EPA LOCATION Jones and Laughlin

TYPE SAMPLE(S) BAP

REMARKS:

DATE/TIME	MASTER CONTROL #	ACTIVITY	INITIALS
5-3-79	BAP-JL-3	Front M/C Rinse	
		Back M/C Rinse	
		Heated Hose Rinse	
		Filter #133	
		Back Water	
		XAD-2	
		Silica Gel	
		BaP-JL-FR = Front M/C Rinse	
		" " Filter = Filter	
		SG = Silica Gel	
		HHR = Heated Hose M/C Rinse	
		BMCR = Back M/C Rinse	
		BW = Back Water	
		XAD = XAD-2	