BY-PRODUCT COKE PLANT

Granite City Steel
Division of National Steel
Granite City, Illinois

Prepared for the

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

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EMB REPORT NO. 79-CKO-18

Work Assignment 17

Contract No. 68-02-2817

FOREWARD

Two firms prepared this report under contract to the U.S. Environmental Protection Agency, therefore, it is presented in two sections. Section I was prepared by Clayton Environmental Consultants, Inc., Southfield, Michigan and includes testing results for particulate, sulfate, benzene, continuous CO monitoring and O_2, CO, CO_2, as well as visible emission data for the battery stack exhaust. Section II was prepared by TRW Energy Systems Group, Durham, N.C. and contains benzo(a)pyrene (B(a)P) sampling data only, and immediately follows Appendix H of the Clayton report.

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) retained Clayton Environmental Consultants, Inc. to determine various gaseous and particulate emissions on the C-battery at Granite City Steel, Division of National Steel, in Granite City, Illinois. Sampling was conducted at the inlet and outlet of a United-McGill dry electrostatic precipitator (ESP) which cleans the C-battery underfire flue waste gas. 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-18, Contract No. 68-02-2817, Work Assignment 17.

The testing program included the following:

(1) triplicate samples from the ESP inlet and outlet for particulate and sulfate analyses;

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

(3) continuous carbon monoxide monitoring at the inlet during the particulate runs (by EPA-Method 10, NDIR analyzer); and,

(4) visible emission recordings for the duration of each particulate sample run, read at the battery stack exhaust.

Auxiliary data included exhaust gas temperatures and flowrates as determined from the traverses. Figure 1.1 presents a plan view of the process/control system layout as tested. A list of the project participants is included as Appendix A.

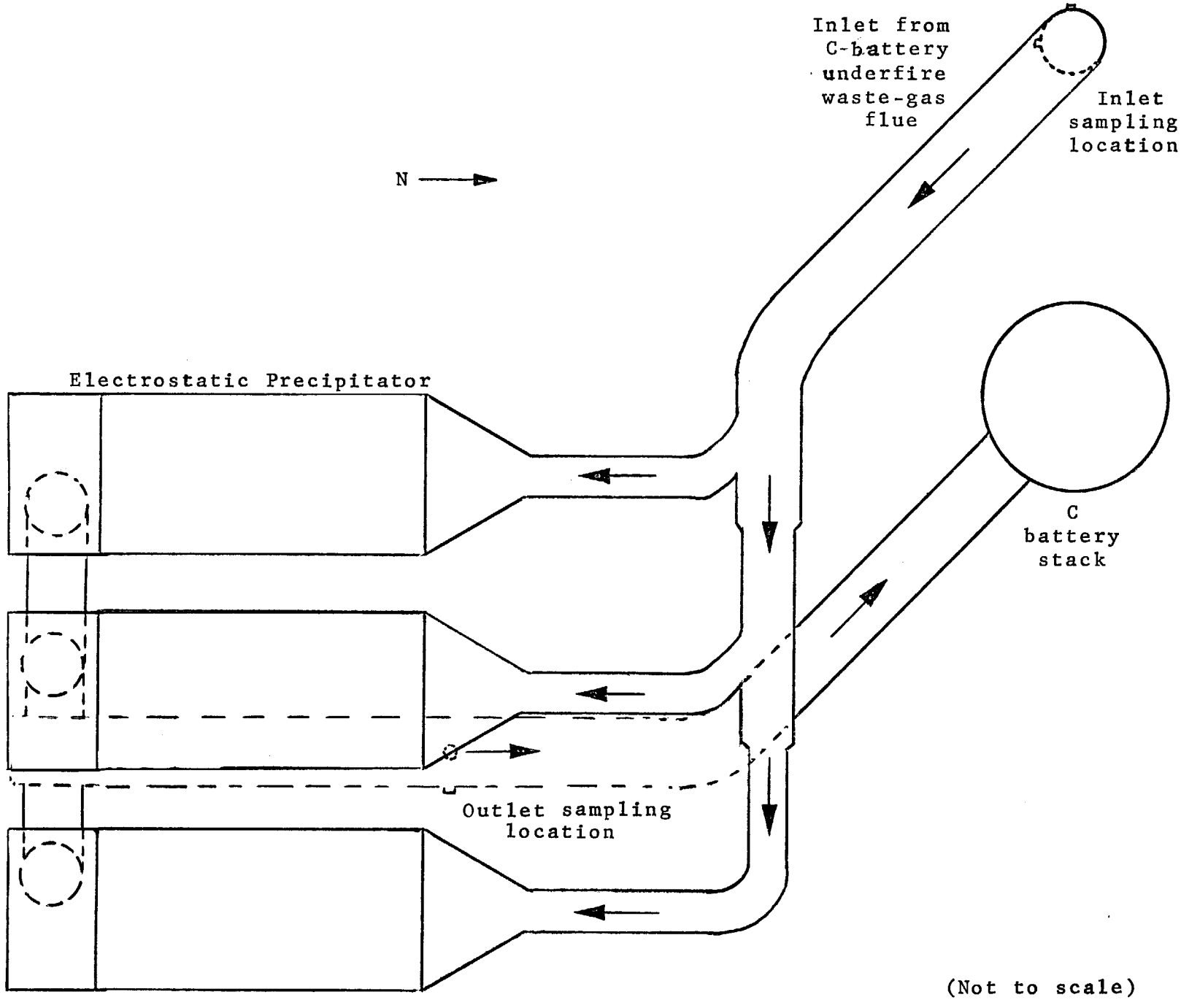

Figure 1.1. Plan view of process/control system layout.

2.0 SUMMARY AND DISCUSSION OF RESULTS

Particulate weights, by fraction, are presented in Table 2.1. Comparing the weight gain of the same fraction for the different runs can be misleading since stack flowrates, sampled gas volumes and possible differences in process operations should also be considered when comparing different runs.

Tables 2.2 and 2.3 present the filterable and total concentrations and emission rates for particulate and sulfate, respectively. Total particulate concentrations were determined by weighing the impinger contents and water and acetone rinses after evaporation, and did not include an ether/chloroform extraction.

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). Stack gas flowrates in dry standard cubic feet per minute (dscfm) and temperature (F) are also presented. Table 2.4 presents sulfate as a percent of particulate based on the filterable and total emission rates. No averaged data for Run 3 at the inlet were included in the discussion because an undetermined amount of the front acetone wash was spilled when the sample bottle was accidentally broken in the field.

TABLE 2.1. PARTICULATE WEIGHT BY FRACTION, MILLIGRAMS

Sampling Location	Sample Number	Front Acetone Wash	110-mm Type A Glass-Fiber Filter	Filterable Particulate	Back Acetone Wash	Impinger Contents and Water Wash	Total Particulate
Inlet C Battery	1	1137.3	1145.9	2283.2	195.7	235.7	2714.6
	2	551.8	341.6	893.4	5.9	57.7	957.0
	3	191.2[a]	383.6	574.8	20.9	35.7	631.4
Outlet C Battery	1	1040.7	1420.9	2461.6	856.8	674.9	3993.3
	2	927.8	178.3	1106.1	15.1	23.0	1144.2
	3	329.5 38.4[b] 127.1[c]	193.9	688.9	3.2	14.6	706.7

[a] An undetermined amount of the acetone wash was spilled when the sample bottle was accidentally broken.

[b] Methylene chloride rinse.

[c] Benzene rinse.

PARTICULATE RESULTS

Inlet

Filterable particulate concentrations at the inlet (Table 2.2) were 0.403 and 0.162 gr/dscf (923 and 371 mg/dscm), respectively and averaged 0.283 gr/dscf (647 mg/dscm). Total particulate concentrations were 0.479 and 0.173 gr/dscf (1100 and 398 mg/dscm, respectively) and averaged 0.326 gr/dscf (749 mg/dscm).

Filterable particulate emission rates were 141 and 55.2 lb/hr (63.8 and 25.1 kg/hr), respectively, and averaged 98.1 lb/hr (44.5 kg/hr). Total particulate emission rates were 167 and 59.1 lb/hr (75.9 and 26.8 kg/hr), respectively, averaging 113 lb/hr (51.4 kg/hr).

Outlet

Concentrations of filterable particulate at the outlet (Table 2.2) ranged from 0.105 to 0.370 gr/dscf (240 to 847 mg/dscm) and averaged 0.213 gr/dscf (487 mg/dscm). Concentrations of total particulate ranged from 0.107 to 0.601 gr/dscf (246 to 1370 mg/dscm) and averaged 0.292 gr/dscf (668 mg/dscm).

Emission rates for filterable particulate ranged from 42.0 to 155 lb/hr (19.1 to 70.4 kg/hr) and averaged 88.8 lb/hr (40.3 kg/hr). Total particulate emis-

TABLE 2.2. PARTICULATE CONCENTRATIONS AND EMISSION RATES

Sample Number and Location	1979 Sample Date	Stack Gas Parameters		Concentration				Emission Rate			
				Filterable		Total		Filterable		Total	
		Flowrate dscfm	Temp F	gr/dscf	mg/dscm	gr/dscf	mg/dscm	lb/hr	kg/hr	lb/hr	kg/hr
Inlet											
1	7-26	40,700	756	0.403	923	0.479	1100	141	63.8	167	75.9
2	7-27	39,700	734	0.162	371	0.173	398	55.2	25.1	59.1	26.8
3[a]	7-28	39,200	726	0.108	248	0.119	272	36.4	16.5	40.0	18.1
Average		39,900	739	0.283	647	0.326	749	98.1	44.5	113	51.4
Outlet											
1	7-26	48,900	627	0.370	847	0.601	1370	155	70.4	252	114
2	7-27	49,500	620	0.164	375	0.169	388	69.5	31.5	71.9	32.6
3	7-28	46,800	620	0.105	240	0.107	246	42.0	19.1	43.1	19.6
Average		48,400	622	0.213	487	0.292	668	88.8	40.3	122	55.4

[a]An undetermined amount of the acetone wash was spilled when the sample bottle was accidentally broken; results were not included in the average.

sion rates ranged from 43.1 to 252 lb/hr (19.6 to 114 kg/hr) and averaged 122 lb/hr (55.4 kg/hr).

SULFATE RESULTS

Inlet

Filterable concentrations of sulfate at the inlet (Table 2.3) were 0.015 and 0.055 gr/dscf (35.2 and 126 mg/dscm, respectively) and averaged 0.035 gr/dscf (80.6 mg/dscm). Total sulfate concentrations were 0.045 and 0.062 (102 and 141 mg/dscm), respectively, averaging 0.054 gr/dscf (122 mg/dscm).

Filterable sulfate emission rates were 5.36 and 18.7 lb/hr (2.43 and 8.50 kg/hr, respectively) and averaged 12.0 lb/hr (5.47 kg/hr). Total sulfate emission rates were 15.6 and 21.0 lb/hr (7.07 and 9.54 kg/hr), respectively, and averaged 18.3 lb/hr (8.31 kg/hr).

Sulfates as a percent (by emission rate) of filterable particulate (Table 2.4) were 3.8 and 33.9 percent and averaged 18.9 percent. Sulfates as a percent of total particulate were 9.3 and 35.5 percent and averaged 22.4 percent.

Aliquots of inlet Sample Nos. 1 and 2 liquid fractions were analyzed for sulfate, whereas Sample No. 3 at the inlet and all outlet samples were analyzed from dried residue remaining following the particulate determination. The percentage sulfate retained was

TABLE 2.3. SULFATE CONCENTRATIONS AND EMISSION RATES

Sample Number and Location	1979 Sample Date	Stack Gas Parameters		Concentration				Emission Rate			
				Filterable		Total		Filterable		Total	
		Flowrate dscfm	Temp F	gr/dscf	mg/dscm	gr/dscf	mg/dscm	lb/hr	kg/hr	lb/hr	kg/hr
Inlet											
1	7-26	40,700	756	0.015	35.2	0.045[a]	102[a]	5.36	2.43	15.6[a]	7.07[a]
2[a]	7-27	39,700	734	0.055	126	0.062	141	18.7	8.50	21.0	9.54
3[b]	7-28	39,200	726	0.023	52.2	0.028	63.0	7.66	3.48	9.25	4.20
	Average	39,900	739	0.035	80.6	0.054	122	12.0	5.47	18.3	8.31
Outlet											
1	7-26	48,900	627	0.010	22.4	0.016	36.5	4.10	1.86	6.68	3.03
2	7-27	49,500	620	0.061	141	0.062	143	26.1	11.8	26.4	12.0
3	7-28	46,800	620	0.027	60.9	0.027	62.6	10.7	4.84	11.0	4.98
	Average	48,400	622	0.033	74.8	0.035	80.7	13.6	6.17	14.7	6.67

[a] An aliquot of the original sample was used for sulfate determinations; all other determinations were made on the residue remaining after the sample was dried and weighed for the particulate determination.

[b] An undetermined amount of the acetone wash was spilled when the sample bottle was accidentally broken; results were not included in the average.

TABLE 2.4. SULFATE AS PERCENT OF PARTICULATE
(Based on Emission Rates)

Sample Number	Inlet		Outlet	
	Filterable Percent	Total Percent	Filterable Percent	Total Percent
1	3.8	9.3[a]	2.6	2.7
2	33.9[a]	35.5[a]	37.6	36.7
3	21.0[b]	23.1[b]	25.5	25.5
Average	18.9	22.4	21.9	21.6

[a]Original sample aliquot was used for sulfate determination, all other determinations were made on the residue.

[b]An undetermined amount of the acetone wash was spilled when the sample bottle was accidentally broken; results were not included in the average.

much lower for Sample No. 1 (inlet and outlet) than Sample Nos. 2 and 3. despite the different analytical methods used for the determinations at each location. Therefore, the reason for this difference may lie in the process itself.

Outlet

Filterable concentrations of sulfate at the outlet (Table 2.3) ranged from 0.010 to 0.061 gr/dscf (22.4 to 141 mg/dscm) and averaged 0.033 gr/dscf (74.8 mg/dscm). Total sulfate concentrations ranged from 0.016 to 0.062 gr/dscf (36.5 to 143 mg/dscm) and averaged 0.035 gr/dscf (80.7 mg/dscm).

Filterable sulfate emission rates ranged from 4.10 to 26.1 lb/hr (1.86 to 11.8 kg/hr) and averaged 13.6 lb/hr (6.17 kg/hr). Total sulfate emission rates ranged from 6.68 to 26.4 lb/hr (3.03 to 12.0 kg/hr) and averaged 14.7 lb/hr (6.67 kg/hr).

Sulfates as a percent (by emission rate) of filterable particulate at the outlet (Table 2.4) ranged from 2.6 to 37.6 percent and averaged 21.9 percent. Sulfates as a percent of total particulate ranged from 2.7 to 36.7 percent and averaged 21.6 percent.

REMOVAL EFFICIENCY

The removal efficiencies for the filterable portion of both particulate and sulfate are presented in Table 2.5. The filterable particulate efficiencies were -9.9 and -25.9 percent and averaged -17.9 percent,

TABLE 2.5. ESP REMOVAL EFFICIENCIES

Sample Number	1979 Sample Date	Percent Efficiency	
		Filterable Particulate	Filterable Sulfate
1	7-26	- 9.9	23.5
2	7-27	- 25.9	- 39.6
3	7-28	a	a
Average		- 17.9	- 8.1

[a] An undetermined amount of the acetone probe wash at the inlet was spilled when the sample bottle was accidentally broken making efficiency determination unreliable.

while filterable sulfate efficiencies were 23.5 and -39.6 percent and averaged -8.1 percent.

In view of the unusual efficiency results, several checks of all data were made including all calibrations, field procedures, sampling methods and calculations. It may be noted that the average percent isokinecity at the inlet and outlet were 100.0 and 101.2, respectively. Transfer procedures were all performed in a dust-free area. All sample log-in and analytical procedures were also reviewed, which indicated no inconsistancies. Calculations were reviewed by several persons, again indicating consistent results. Furthermore, a TRW test group sampled the same locations simultaneously for benzene(a)pyrene (B(a)P). Results from the TRW runs corroborated with the Clayton results. It is highly unlikely that two source sampling firms working independently of each other would achieve similar results if sampling techniques were in error.

In light of these quality assurance reviews, the test results appear to be valid. It is difficult to draw conclusions with respect to the performance of the ESP based on the data obtained, except that the ESP removal efficiency of battery stack particulate is poor. However, several observations are presented.

The project was initially plagued with repeated power failures, as evidenced by the disruptions in sampling time, making correlations between CO data, opacities, and stack temperatures sometimes impossible for Run No. 1. These problems are noted in Appendix B-6. All oven activity that occurred during each test is also detailed in Appendix B-5.

When correlating the process operating data with Figures 2.1, 2.2, and 2.3 on pages 16, 17, and 18, respectively, which illustrates all reversal and charging activity times during each run, several observations can be made.

The field data in Appendix B-1 shows that when an inlet filter would become suddenly blinded (plugged or clogged), a charge had generally preceded this event by several minutes. This may indicate poor conditions of some oven walls in this battery. There were several distinct temperature drops noted at the outlet sampling points which were located closed to the stack wall (outer points are cooler than the inner points). The largest temperature drop generally appears on the last (bottom) point of the vertical port. At this point, the temperature is influenced by the cooler stack wall and also, the convection of the hot stack gases which tend to rise to the top of the horizontal duct.

The data reflect an average 21-percent increase in the outlet flowrate over the inlet flowrate (dscfm), which indicates possible air inleakage between the two sampling locations. This leak could be a possible source of particulate material being introduced into the ESP system downstream of the inlet sampling location. However, this leakage is not likely to contribute to higher grain loadings at the outlet since ambient particulate concentrations would have to be significantly higher than those found in the inlet gas. Another possible explanation for the higher outlet loadings is reentrainment of particulate within the ESP itself.

VISIBLE EMISSION AND CARBON MONOXIDE RESULTS

Visible emissions from the coke oven battery stack were recorded for the duration of each particulate run, except Run 1, when visible emissions were abbreviated due to darkness. The observations were performed in accordance with EPA Method 9 by a qualified visible emission observer. A graphic summary of one minute average opacity readings is presented in Figures 2.1, 2.2, and 2.3 for the three test runs, respectively. Additional visible emission data is included in Appendix B-4. Carbon monoxide (CO) was monitored continuously during each of the particulate runs. Linear recordings were averaged

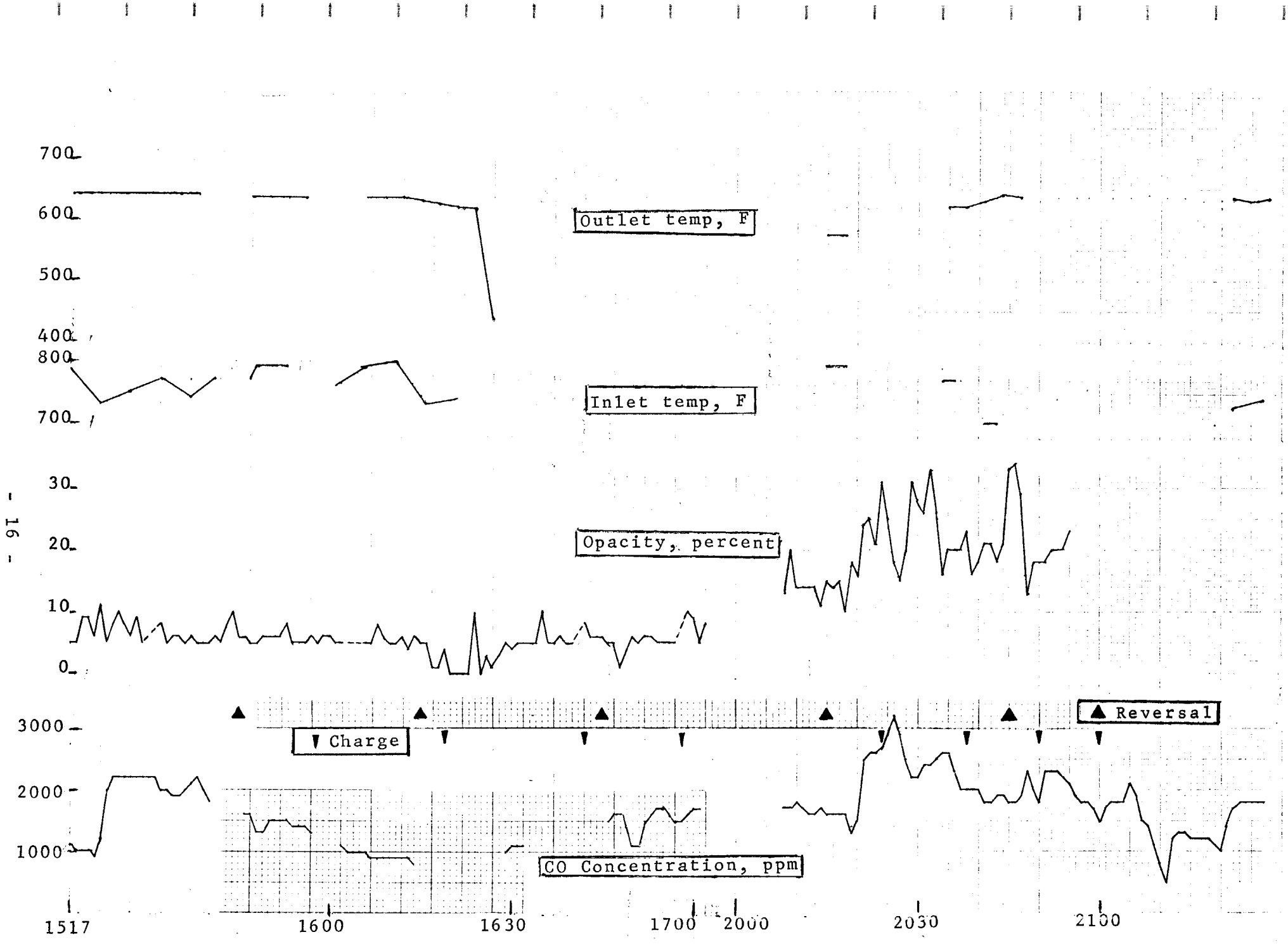

Figure 2.1. Relationship of CO concentrations, stack opacity, and duct temperature Run 1

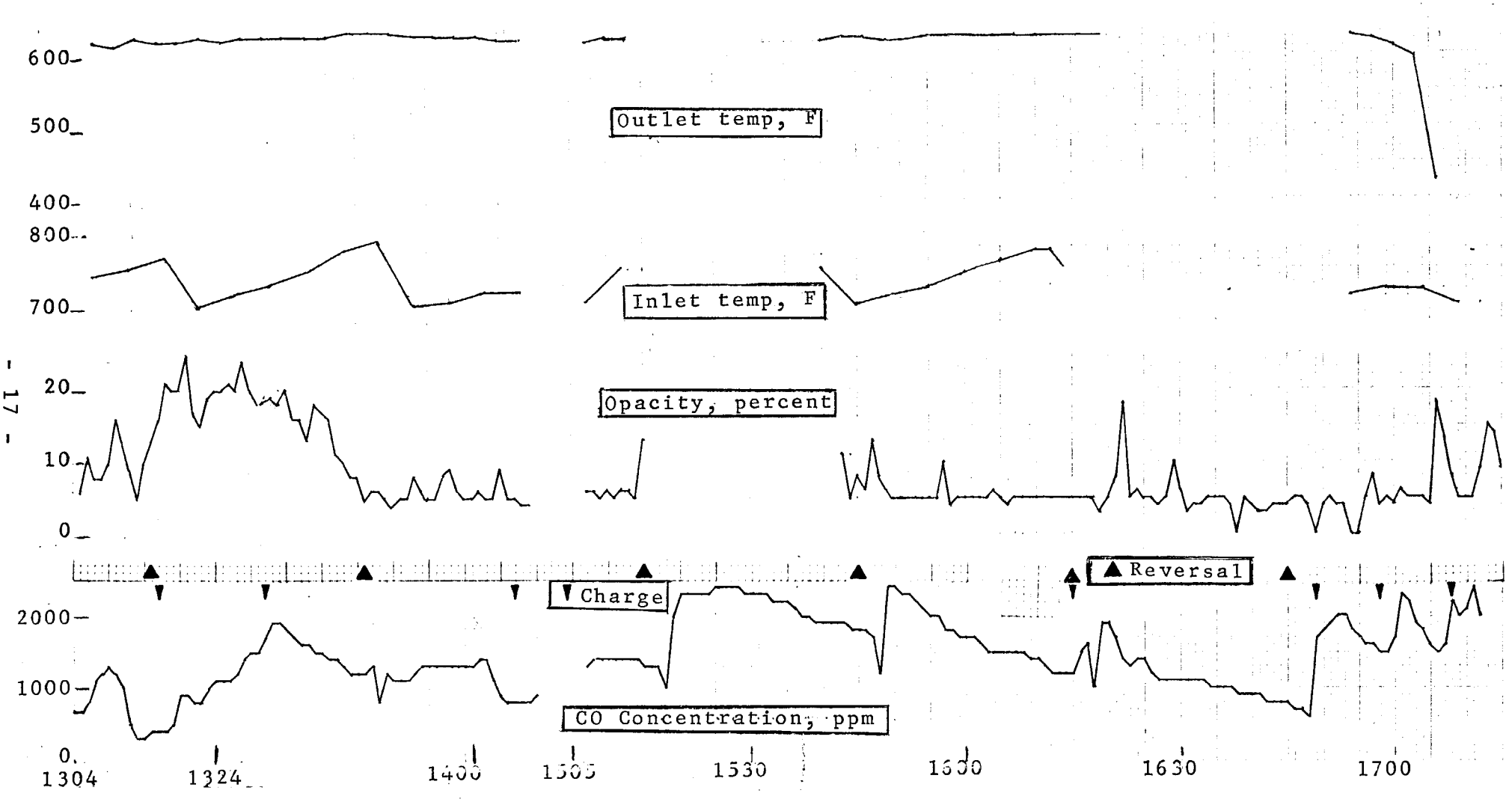

Figure 2.2. Relationship of CO concentrations, stack opacity and duct temperature

Run 2

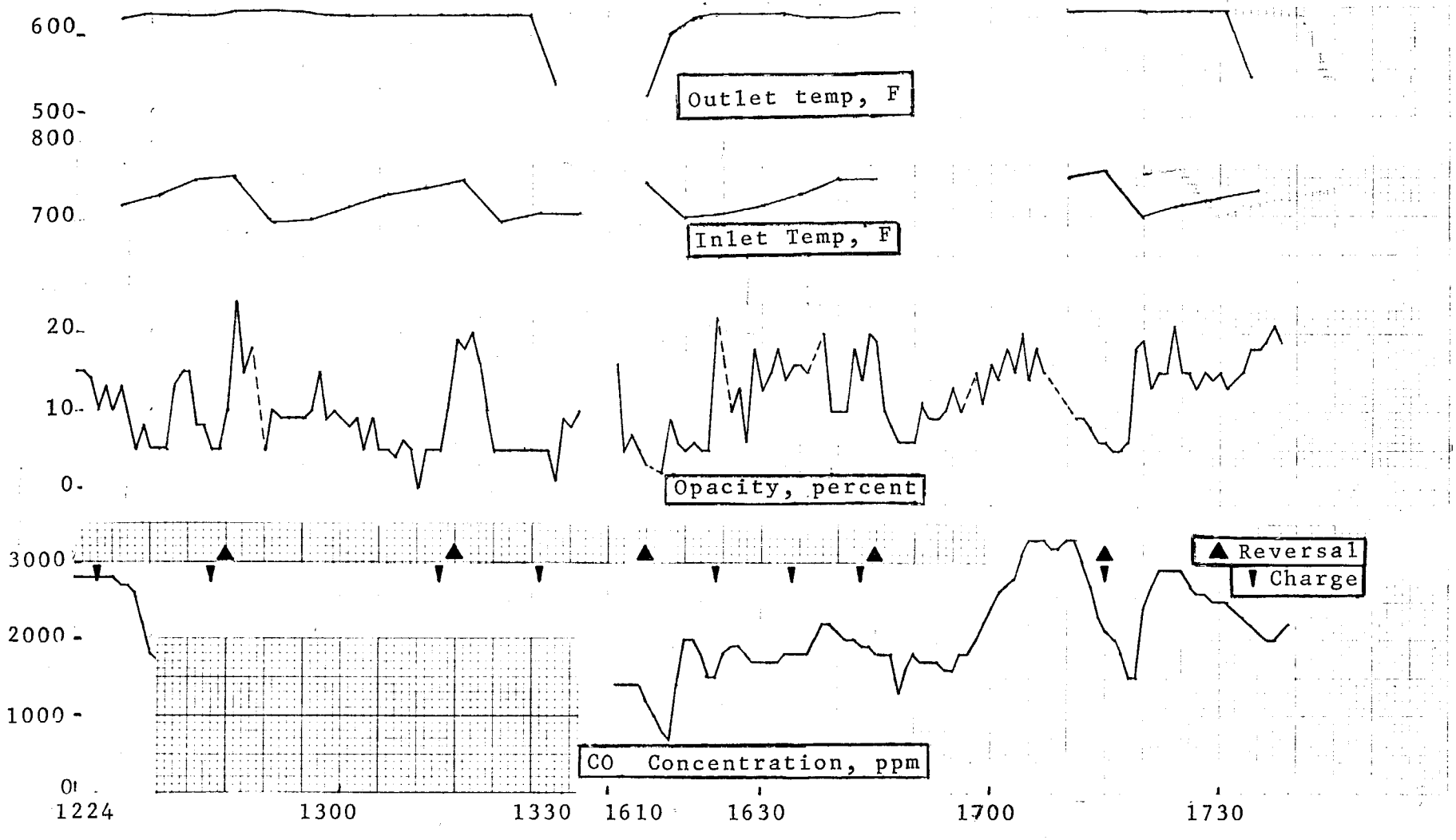

Figure 2.3. Relationship of CO concentrations, stack opacity, and duct temperature

Run 3

over one minute intervals and the results also presented graphically in Figures 2.1, 2.2, and 2.3. In addition to the above data, inlet and outlet stack temperatures and charge and reversal cycles are also presented on these graphs. Appendix E-2 presents 1-minute averages of CO concentration.

In each test the rise and fall in CO concentrations is generally preceded within a few minutes by a corresponding rise or fall in stack opacity. Since CO was monitored continuously and opacity was read every 15-seconds, some fluctuations in CO may not be correlated directly with opacity fluctuations. However, a general trend seems to be apparent. On Run 3, pump problems in the CO train were encountered from 1235 to 1335, which invalidates the CO data for this time period. Data for this period was not displayed in Figure 2.3.

BENZENE RESULTS

Results of the benzene analyses are presented in Table 2.6. Following the completion of Run 2, the bag sample collected had developed a leak and the sample was voided. Benzene concentrations were 0.11 and 0.16 ppm and averaged 0.14 ppm. Emission rates were 0.05 and 0.08 lb/hr (0.03 and 0.04 kg/hr), respectively, and averaged 0.07 lb/hr (0.04 kg/hr). These results showed a high reproducibility although they were lower than had been anticipated.

TABLE 2.6. BENZENE CONCENTRATIONS AND EMISSION RATES

Sampling Location	Sample Number	Sample Date	Concentration	Emission Rate	
			ppm	lb/hr	kg/hr
Battery C Inlet	1	7/26/79	0.11	0.05	0.03
	2[a]	7/27/79	—	—	—
	3	7/28/79	0.16	0.08	0.04
Average			0.14	0.07	0.04

[a] Inadequate sample collected for Run 2, therefore no data reported.

Exhaust Gas Composition

Table 2.7 presents the results of the exhaust gas composition and moisture content analyses. Carbon dioxide, oxygen, and carbon monoxide concentrations averaged 3.6, 13.8, and 0.3-percent, respectively, over the three sample runs. The Orsat CO concentration confirms the low continuous CO values.

TABLE 2.7. EXHAUST GAS COMPOSITION (INLET)

Sample Number	Moisture Content Percent	Exhaust Gas Composition, Dry Basis Percent			
		Carbon Dioxide	Oxygen	Carbon Monoxide	Nitrogen and Inerts
1	13.1	3.7	16.0	0.6	79.7
2	15.3	3.6	12.1	0.2	84.1
3	15.8	3.6	13.4	0.1	82.9
Average	14.7	3.6	13.8	0.3	82.2

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

As part of the work being conducted for the development of national emission standards for air pollutants emitted from coke oven battery stacks, emission tests are being performed on various well-controlled sources. Such tests were conducted on Battery C at National Steel Corporation's Granite City, Illinois facility because an electrostatic precipitator (ESP) had recently been installed and began operating in March 1979. With all three of the parallel ESP modules on-line, the Granite City Steel ESP has the highest specific collection area of any ESP applied to coke oven battery stack emissions. Therefore, the ESP serving Battery C at Granite City, Illinois, was selected for these emission tests.

There are three coke oven batteries at Granite City Steel's integrated steel plant, designated as Batteries A,B, and C. Only Batteries B and C are operating. Battery A was torn down and is presently being completely rebuilt with 18 additional ovens. Future plans include rebuilding Battery B with four less ovens which is tentatively scheduled for June 1980. After both reconstructed batteries are on-line, Battery C will be shutdown and rebuilt with 14 less ovens.

Battery C is a 61-oven Koppers-Becker gun-flue battery, underfired with undesulfurized coke oven gas supplied by the by-product plant. During the period covering the emission tests, 36 coke ovens were operating on a coking period of 17.5 hr with two ovens (Nos. 155 and 163) on an extended coking cycle. The other 25 ovens (Nos. 123-126, 131, 132, 144, 146, 147, 154, 157, 161, 162, 174-177, 181, and 193) were bricked-up or out of service.

The C Battery started operating in 1961 and was rehabilitated in 1976. This cold end-flue rehabilitation included gun flue, crossover flue and end flue repairs. Plant design and operational data for Battery C are presented in Table 3.1. Maintenance techniques used on Battery C were spray patching, cleaning steam aspirators and stand pipes, and brushing gun-flue nozzles.

A hand-held slurry spraying gun is used to patch the end flues and door jambs of the ovens. The spray patching occurs after an oven has been pushed and before the doors are replaced on the oven. This procedure is employed more frequently to the coke side of the oven than to the pusher side because more wear occurs on that side.

An oxygen lance is used to decarbonize the steam aspirators and coke oven standpipes. This procedure will either burn the carbon deposits or just knock them

TABLE 3.1. PLANT DESIGN AND OPERATION RECORD

Date _____

Plant Name Granite City Steel
Plant Location Granite City, IL.
Battery No. C
Name of Plant Contact Dr. John Manda

Type of Ovens and Designer Gun Flue, Koppers-Becker
Date Built 1961
Date of Last Rehabilitation 1976
Type of Last Rehabilitation End flue, Crossover Flue, and gun flue repairs

Number of Ovens Total 61 In Service 36
Size of Ovens Height 13', Width 17", Length 40'

Type of coke produced Blast furnace coke
Normal coking time (hr) 20
Coal charged per oven (tons) 16.6
Reversal period (min) 30

Nozzle decarbonization method Air aspirated through open carbon caps
Is flue gas recirculated? no

Type of fuel gas coke oven Heating value 450 Btu/scf
Is fuel gas desulfurized? no
Note use of stage charging, preheated coal, etc. stage charging is used
Stack height and top diameter 261' 4" Ht. 10' diam.
Test location (stack or waste heat canal) inlet & outlet ESP(provide sketch)

Control method used electrostatic precipitator

Fuel gas analysis (1978 avg.)		Coal analysis (April 1979)	
Component	Vol.%	Component	Vol.%
CO_2	3.6	Ash	6.76
Ill.	1.3	S	1.25
O_2	1.6	H_2O	9.53
CO	9.1	VM	25.47
H_2	53.0		
CH_4	19.3		
N_2	12.1		
H_2S			

off. The other maintenance procedure uses a wire brush on a 20-foot long rod which fits inside the gun-flue nozzles and cleans any carbon build-up on the nozzle which may restrict fuel gas flow.

The new ESP on Battery C stack began operating in March 1979. The ESP was built by United McGill using a point-to-plane design. The ESP is divided into three units operating in parallel. Each unit has four separate sets of electrical fields, numbered 1, 2, 3, and 4. For each unit two electrical controls serve fields 1 and 3 together and fields 2 and 4 together.

The ESP installed on Battery C was designed for a total gas flow rate of 2,600 actual cubic meters per minute (92,000 acfm). It has three parallel modules and the design gas velocity, with two modules on-line, was 0.88 m/sec (2.9 ft/sec). Each module has a collection area of 2,550 m^2 (27,440 ft^2) and all three modules together have a collection area of 7,650 m^2 (82,320 ft^2). Therefore, the design specific collection area, with all three modules in service, was 2,942 m^2/1,000 acm/min (895 ft^2/1,000 acfm).

In June 1979 United McGill made minor adjustments to all three units to prevent reentrainment during the cleaning mode. Instead of cleaning fields 1 and 2 together, United McGill staggered the fields being rapped.

This new arrangement of rapping fields 1 and 3 and fields 2 and 4 maintains a collecting field in operation at all times during the cleaning mode. A United McGill field engineer was present during the testing to monitor the performance of the ESP. However, no adjustments were made to the ESP while sampling activities were being conducted.

During each test day, process operating data were obtained at approximately 1-hour intervals. The time that each oven was pushed and charged was recorded whenever possible. All process operating logs and charts are included in Appendix B-5[a]. The Battery C oven push and charge log sheets and ESP log sheets are also presented in Appendix B-5.

Granite City Steel's personnel, who provided assistance during the testing were Dr. Manda, Mr. Hoffman, Mr. Piatt and Mr. Siebenberger. Mr. MacDonald from United McGill monitored the ESP performance.

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[a]Note: Process operating data and copies of operating charts have not been included, since National Steel has claimed them to be confidential.

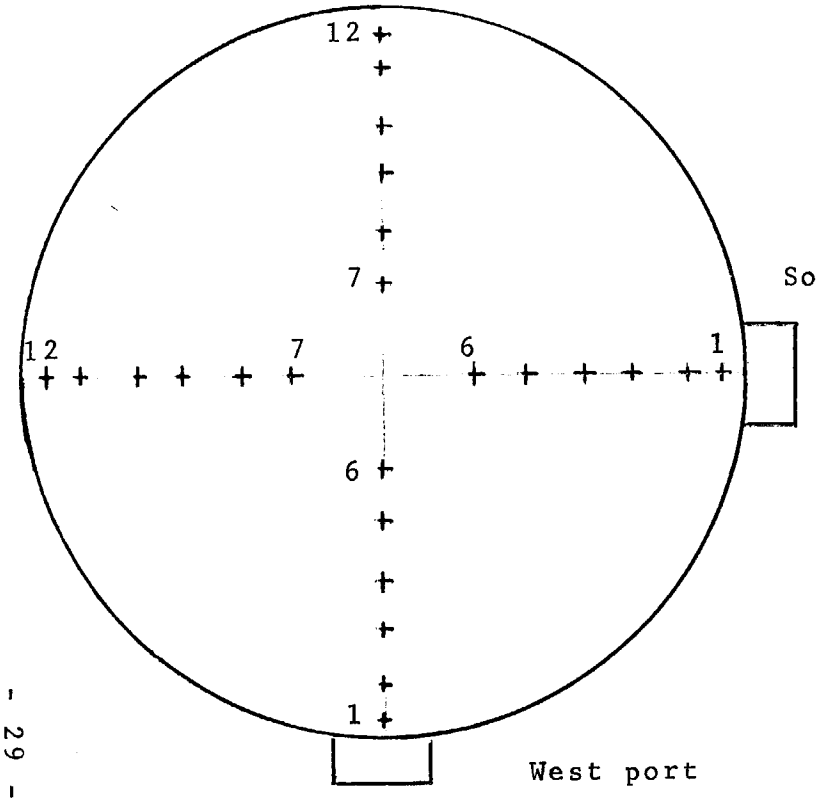
4.0 LOCATION OF SAMPLING POINTS

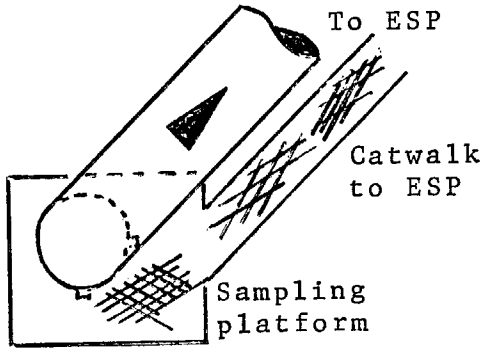
Inlet

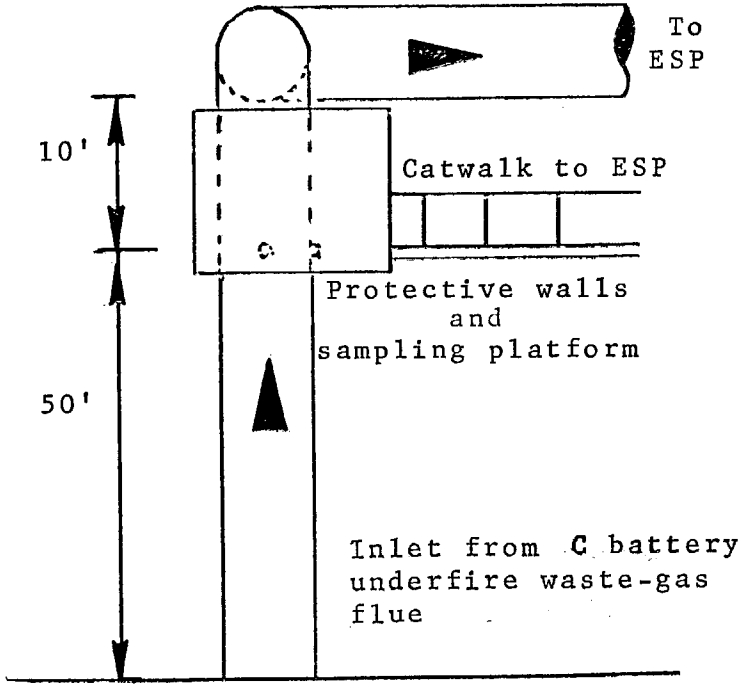
The ESP inlet sampling location was a 59.4-inch (150.1-cm) I.D. duct from the battery-C waste heat flue, located approximately 50 feet (15.2 meters) above ground, and 10 feet (3.0 meters) upstream of a 90-degree bend, which provided adequate upstream/downstream distances to disturbances. The duct was accessed through two three-inch ports located at a 90-degree separation about the stack circumference.

Each traverse (two) consisted of 12 points. Velocity pressures and temperatures were measured at each of the 24 sampling points. Figure 4.1 is a diagram of the inlet sampling location showing each of the traverse points and their respective distances from the duct wall.

The inlet sampling site was located very close to the battery and coke oven quench car, exposing sampling personnel to major hazards, i.e., heat, smoke, and flames. To minimize these hazards, a sheet steel platform with three walls was erected at the inlet duct, along with an insulation pad on the platform floor. Additionally, a steel catwalk connecting the precipitator outlet site to the inlet location was constructed. This allowed the sampling crew a quick evacuation of the inlet area, and also permitted a safe location for the sampling equipment.





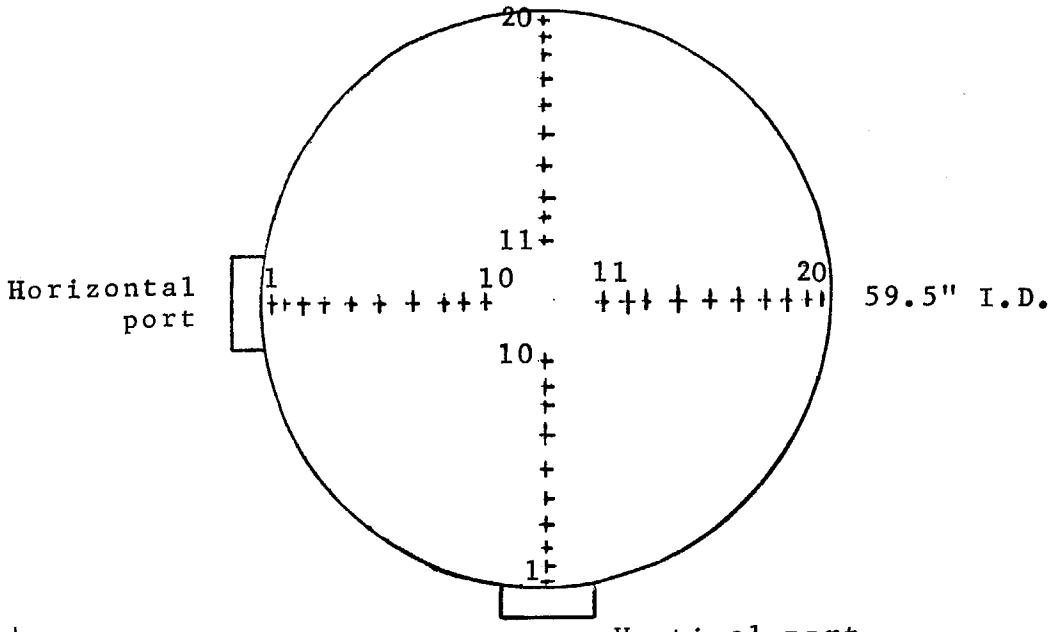


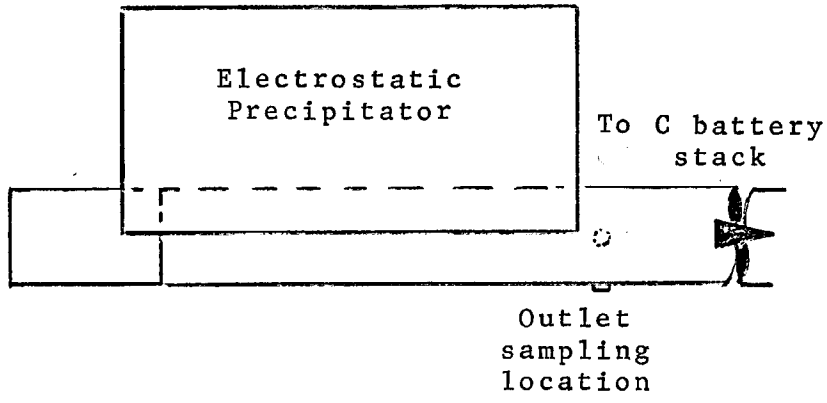
Point	Distance (Inches)
1	1.3
2	4.0
3	7.0
4	10.5
5	14.9
6	21.1
7	38.3
8	44.5
9	48.9
10	52.4
11	55.4
12	58.1

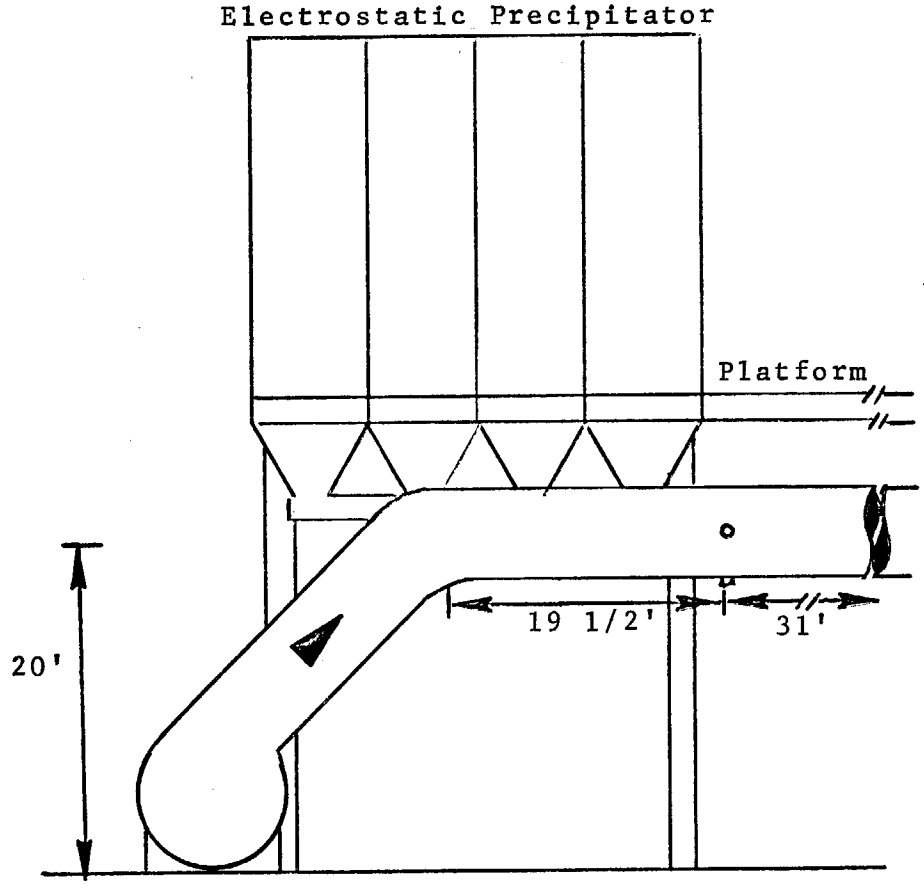
Figure 4.1. Inlet sampling location.

Outlet

At the ESP oulet sampling location, two three-inch ports were used to gain access to the 59.5-inch (151.1-cm) I.D. duct which extends horizontally from the ESP to the battery stack. The port located at the top of the duct did not provide sufficient vertical clearance to maneuver the probe. Thus, an additional port was installed at the bottom of the duct. Scaffolding was used to gain access to this port location. Each traverse (two) consisted of 20 points. Velocity pressures and temperatures were measured at each of the 40 sampling points. Figure 4.2 is a diagram of the outlet sampling location showing each of the traverse points and their respective distances from the duct wall.







Point	Distance (inches)	Point	Distance (inches)
1	0.8	11	36.4
2	2.3	12	41.3
3	4.0	13	44.6
4	5.8	14	47.4
5	7.7	15	49.7
6	9.8	16	51.8
7	12.1	17	53.7
8	14.9	18	55.5
9	18.2	19	57.2
10	23.1	20	58.7

Figure 4.2. Outlet sampling location.

5.0 SAMPLING AND ANALYTICAL PROCEDURES

Triplicate two-hour particulate samples were extracted isokinetically and simultaneously at both inlet and outlet locations of the ESP. Twenty-four points were sampled at the inlet location for five minutes per point while forty points were sampled at the outlet location for three minutes per point. During each run, the probe, Pitot tube, and thermocouple assembly were moved to each sampling point, the velocity pressure and temperatures of the exhaust gas were measured, and isokinetic sampling flowrates were adjusted accordingly using an orifice-type meter to indicate instantaneous flowrates.

Proper nozzle alignment with the flue-gas stream was maintained throughout the test at both testing locations without difficulty. The bottom port at the outlet sampling location required a special vertical support system which was constructed by Clayton Environmental Consultants, Inc. The impinger assembly was moved as required at the outlet location to gain access to the bottom port. 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 cfm at 15-inches of mercury vacuum. The final leak rate shall not exceed 0.02 cfm at the greatest vacuum occurring during the test.

A modified EPA Method 5 sampling train was used at both locations (Figure 5.1). The sampling train consisted of a sharp, tapered, stainless steel sampling nozzle; an unheated glass probe assembly (Method 5 modification); flexible unheated Teflon® tubing (Method 5 modification) leading to a heated cyclone assembly (Method 5 modification) including a 110-mm glass-fiber filter; 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 300-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.

For the first half of Run 1 at the inlet and the entire first run at the outlet, the cyclone was not

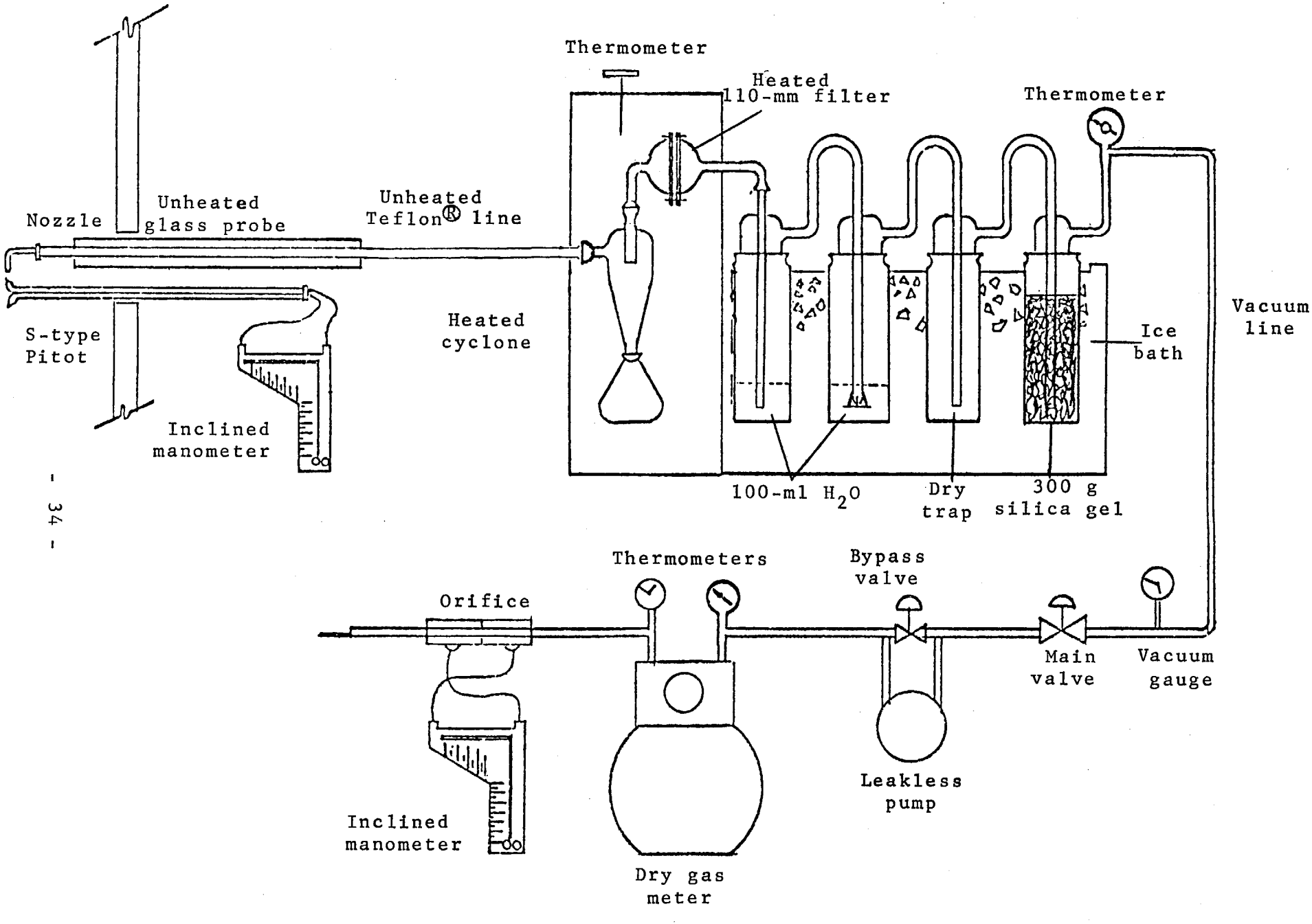


Figure 5.1. Particulate sampling train.

used. Due to the unusual resinous character of the particulate in the exhaust gas, which caused the filters to blind (plug or clog), difficulty in maintaining the sampling rate was experienced. It was decided by the Clayton project leader and the EPA Technical Manager that modifying the train by adding a cyclone upstream of the filter would prevent this situation. An unheated probe and Teflon® flex-line was used because of the extremely hot stack gas (740F inlet and 620F outlet).

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 stop-cock 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 average filter and cyclone temperature was kept at 250 $\pm$ 25 F.

Following the leak check at the end of each 120-minute test period, the sampling trains were transferred to a sheltered clean-up area. Any conden-

sate in the cyclone and impingers was measured and volume increases recorded. The solutions were then placed in separate glass sample bottles and sealed with Teflon®-lined caps. The silica gel was weighed to determine the weight gain. Only acetone was used for rinses of the probe, nozzle, and Teflon® flex-line on approval of the EPA Technical Manager because water had no observable effect on the accumulation of the unusual particulate matter. An undetermined amount of sample was lost in the field on Run 3 of the inlet when a front-half acetone rinse sample bottle was accidentally broken.

All rinsings were collected in glass sample bottles with Teflon®-lined caps. Initial probe rinses appeared deep black in color. The particulate collected on the filters at both locations had a black, oily appearance throughout the testing program. The impinger assembly was thoroughly rinsed with water, and these water rinsings were placed in the impinger solution bottles. Following the water wash of the impingers, the entire impinger assembly was then rinsed with acetone. The impinger catch at the outlet location for Run 2 had a cloudy, milky appearance and the impinger catch for Run 3 attained an amber appearance. Run 1 at the outlet and all runs at the inlet displayed no unusual colors in the impinger

catch. Benzene and methylene chloride rinses were required on the probe, nozzle, Teflon® flex-line, cyclone and front-half of the filter assembly for Run 3 at the outlet. Acetone rinses had failed to totally clean the assembly.

Thus, at the end of each run, the following four-fractions had been collected from both the inlet and outlet for particulate and sulfate analyses:

(1) acetone rinsings of the nozzle, probe, Teflon® tubing, cyclone and front-half of the glass-filter holder. For Run 3, at the outlet only, methylene chloride and benzene rinses were performed in addition to the acetone on these same components;

(2) 110-mm glass-fiber filter;

(3) impinger contents and water rinsings of the back-half of the filter holder, impingers, and connecting glassware; and,

(4) acetone rinsings of the back-half of the filter holder, impingers, and the connecting glassware.

In the laboratory, the liquid fractions were measured volumetrically and these fractions were then placed in beakers. The water fractions were evaporated to residue at 105C and the particulate weight determined (ether/chloroform extractions were not performed on impinger water). The acetone, methylene chloride, and benzene fractions were evaporated at room temperature and weighed until constant. Filters were desiccated at room temperature for 24-hours and weighed, with at least 6-hours of desiccation time between weighings, until constant. All weight determinations were performed on an analytical balance having a sensitivity of 0.1 milligrams.

Sulfates were determined from the residues of each liquid fraction. These residues were brought up to 100-ml with 80-percent isopropanol, and a 30-ml aliquot was taken from each. Due to interferences from the residues of Fraction 3 from Run 1 at the inlet and Fraction 1 from Run 2 at the inlet, a 5-ml aliquot from the original sample was taken and brought up to 25-ml with 100-percent isopropanol. The filters were also combined with 80-percent isopropanol.

Each of these samples 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 percent of the filterable and total emission rates.

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 (by GC analysis) 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 scfh 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.

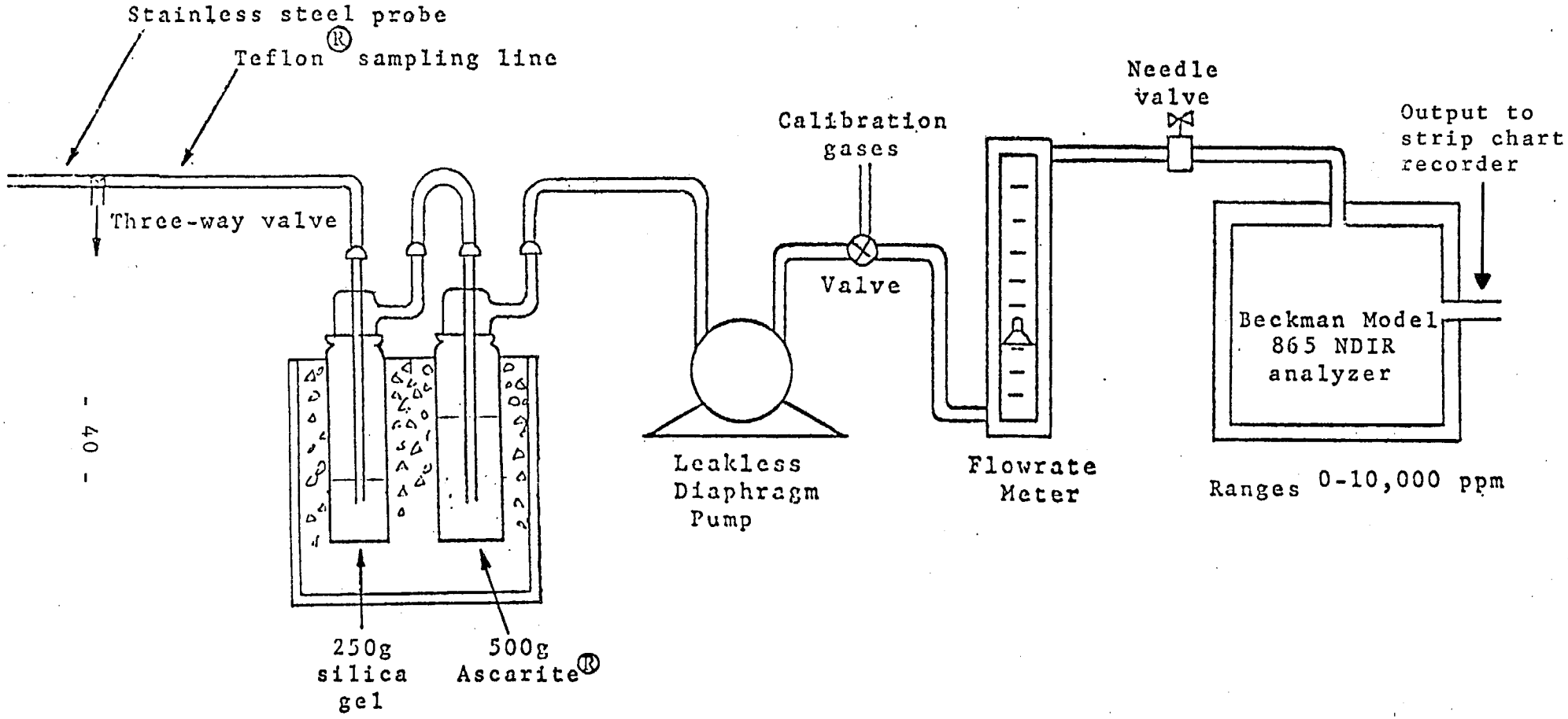


Figure 5.2. Sampling train for continuous monitoring of carbon monoxide.

The daily calibration sequence included passing a certified standard zero gas (dry nitrogen) and a certified standard span gas concentration (9900 ppm carbon monoxide in nitrogen) through the analyzer. The instrument output was calibrated for the anticipated range of 0-10,000 ppm carbon monoxide by adjustment of the zero and gain settings to the appropriate signal, as indicated on a calibration curve. The instrument, which operates by the Luft principle as specified by Reference Method 10, was equipped with a 4-position valve to allow introduction of sample gas or any of the required standard calibration gases, as depicted in Figure 5.2.

The measured CO concentrations were determined by adjusting the recorded strip chart values with the factory calibration curve for the 16-mm cell, which was adjusted to the standard gas concentrations used in the field. The data was then reduced to one-minute intervals.

Integrated Bag Sampling (Benzene and Orsat)

An integrated bag sample was withdrawn from the ESP inlet duct simultaneously with each particulate sampling run utilizing the train depicted in Figure 5.3 (described previously under Carbon Monoxide Sampling). An evacuated Saran® bag, especially treated to reduce permeability, with a volume

of 96-liters was placed inside an insulated steel drum. The drum was then gradually evacuated, filling the Saran® 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 field laboratory for immediate gas chromatographic (GC) analysis for benzene content and later, Orsat analysis for gaseous composition.

The method used for the determination of benzene concentrations is in accordance with EPA 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, 99C gas sampling loop with 1-ml capacity, and 15-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.

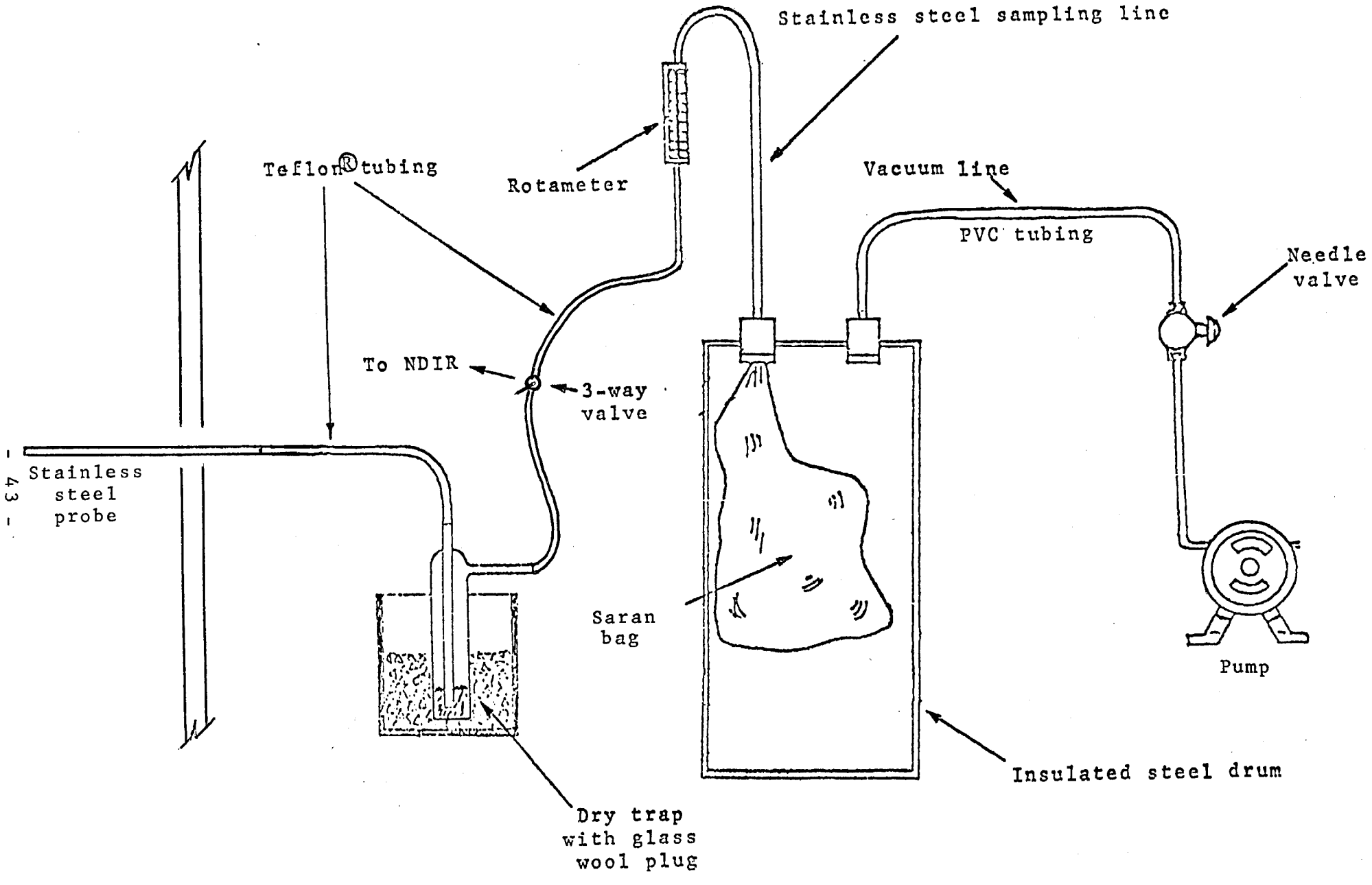


Figure 5.3. Integrated bag sampling train.

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 and the percent excess air of the process gas.

Visible Emissions

Visible emissions from the C battery stack exhaust were recorded for the duration of each sample run. 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.

August H. Baecker	Laboratory Technician
Bruce G. Bird	Source Testing Specialist
Ellen E. Held	Environmental Chemist
Randy M. Knutson	Source Testing Specialist
Timothy V. Mattson	Group Leader, Emission Measurement
Donna L. Opthoff	Environmental Data Specialist
J. Douglas Opthoff	Environmental Chemist
Timothy J. Palmer	Environmental Control Specialist
George M. Santorilla	Technical Design Specialist
Daryl P. Strandberg	Laboratory Technician

U.S. Environmental Protection Agency

Frank Clay

Granite City Steel

Larry Siebenberger

Dan Hoffman

Midwest Research Institute

Pat Reider

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

B-5. Process Data

B-6. Project Delays

APPENDIX B-1

PARTICULATE TEST DATA SHEETS

M = 3.54 Ts/Ts H

GTO A .013 w/PEG

SAMPLING TRAIN DATA

COMPANY: Granite City Steel

SOURCE DESIGNATION: Inlet

REGULATING AUTHORITY: U.S.EPA

DATE: 7-26-79

TEST NUMBER: P-1

Field Person(s): RMK TVM

Filter Number: A-199-07

Barometric Pressure ("Hg): 29.68

Stack Static Pressure ("H2O): -3.0

Stack Dimensions: 59.4" ID

Ambient Temperature (°F): 85°

Record all Data Every 5 Minutes

Nozzle (Dia-in): 0.249 0.249 0.25 (Avg): 0.249

Pitot Tube No. 40, Corr. Factor: 0.823

Meter Box No. R-4, Corr. Factor: 1.016

Meter Isokinetic Factor: 1641

Assumed Moisture (%): 9

Condensate Volume (ml): 252

Silica Gel Weight Gain (g): 27.1

Actual Moisture (%):

Leak Rate: Initial: .016 CFM at 17 "Hg; Final: .017 CFM at 15 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O) 5	Stack Temp (°F) 4	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp. (°F) Inlet 1	Dry Gas Meter: Temp. (°F) Outlet 2	Orifice Pressure Differential ("H_2O) A	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
S-12	0	15:17	1.2	785	325.790	90	90	1.88			0
11	5	:22	1.3	730		90	90	1.7	275	75	0
10	10	:27	1.3	750	333.8	96	90	2.1			2
9	15	:32	1.1	730	344.5	100	95	1.81	225	73	7
5	20	:37	1.3	740		106	96	2.1	270	68	8
7	25		1.2	770		100	90	1.92	~~215~~	67	
4	30	15:41 15:47	1.2	790		106	92	1.55	265	70	7.5
5	35	16:01 16:06	1.3	760		112	98	2.1			9
4	40		1.2	790	355.9	110	100	1.93	215	67	10
3	45		1.2	800	359.8	116	100	1.91	225	67	12
2	50		1.1	730	363.5	120	102	1.87	225	69	12
1	55		0.85	740	367.4	122	114	1.44			13
	60				370.618						
AVERAGE (TOTAL)					( )			1.97			

234 x 139 169 164 78 122

Revised 11-83

Clayton Environmental Consultants, Inc.

3.54 Tm/Ts ΔH

SAMPLING TRAIN DATA

COMPANY: Granite City Steel
SOURCE DESIGNATION: ~~Bell 17~~ Batt 17 INLET
REGULATING AUTHORITY: USEPA
DATE: 7/26/79
TEST NUMBER: P-1
Field Person(s): RMK TJW
Filter Number: A-79-05 / 79-10
Barometric Pressure ("Hg): 29.68
Stack Static Pressure ("H2O):
Stack Dimensions:
Ambient Temperature (°F):
Record all Data Every 5 Minutes

Nozzle(Dia-in): ___ ___ ___ (Avg):
Pitot Tube No. ___, Corr.Factor:
Meter Box No. ___, Corr.Factor: 1.012
Meter Isokinetic Factor:
Assumed Moisture (%):
Condensate Volume(ml):
Silica Gel Weight Gain(g):
Actual Moisture (%):
Leak Rate } Initial: 0.01 CFM at 15 "Hg
Final: <0.08 CFM at 4 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H2O) 5	Stack Temp (°F) 4	Dry Gas Meter Volume (ft³)	Dry Gas Meter Temp. (°F) Inlet 1	Dry Gas Meter Temp. (°F) Outlet 2	Orifice Pressure Differential ("H2O) A	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
W-12	0	20:15	1.3	795	372.948	100	100	2.05			0
11	5		1.4	770	376.9	96	96	2.24	210	65	0
10 (filter change)	10	20.93 / 11:21	~~1.4~~ 1.32	~~785~~ 717	380.8 / 381.598	~~102~~ 92.4	96 / 91.2	~~2.23~~ 2.19			
9	15		1.3	725	385.6	90	90	2.14	225	63	2
8	20		1.3	740	89.6	98	90	2.12	~~272~~		2
7	25	21:32 / 22:07	1.3	755	93.6	102	92	2.11			
6	30		1.3	780	97.3	90	90	2.04	240	65	2
5	35		1.3	795	401.3	96	90	2.03	235	67	2
4	40	22:22	1.3	720	405.2	102	90	2.17	235	70	2
3	45		1.3	730	409.2	105	90	2.16			
2	50		1.2	750	413.3	110	92	1.97	245	71	2
1	55		1.0	760	417.1	110	94	1.63			2
	60				420.659						2
	21/21	11:21 / 15:00	1.3	700	~~381.598~~ 382.892	90	90	2.18			0
						~~90~~	90				
C AVERAGE (TOTAL)				753.5	(93.705)	1025	94.3	1.97			

Revised 11-78

Clayton Environmental Consultants, Inc.

$\Delta m = 3.28 \frac{Tm}{Ts} H$

SAMPLING TRAIN DATA

COMPANY: Granite City Steel
SOURCE DESIGNATION: Inlet
REGULATING AUTHORITY: EPA
DATE: 7-27-79
TEST NUMBER: P-2
Field Person(s): RMK, TVM
Filter Number: A-199-03
Barometric Pressure ("Hg): 29.74
Stack Static Pressure ("H_2O): -3.0
Stack Dimensions: 59.4
Ambient Temperature (°F): 90
Record all Data Every 5 Minutes

Nozzle (Dia-in): ___ ___ ___ (Avg): 0.249
Pitot Tube No. 40, Corr. Factor: 0.823
Meter Box No. R-4, Corr. Factor: 1.016
Meter Isokinetic Factor: 1641
Assumed Moisture (%): 13.190
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Actual Moisture (%):
Leak Rate } Initial: 0.017 CFM at 15 "Hg
Final: 0.015 CFM at 9 "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O) 5	Stack Temp (°F) 4	Dry Gas Meter: Volume (ft^3)	Dry Gas Meter: Temp. (°F) Inlet 1	Dry Gas Meter: Temp. (°F) Outlet 2	Orifice Pressure Differential ("H_2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
12	0	13:07	1.3	745	423.205	88	88	1.94			0
11	5		1.4	755	27.0	90	88	2.07	240	62	0
10	10		1.4	770	31.0	95	90	2.06			0
9	15		1.3	760	34.9	100	90	2.04	251	64	0
8	20		1.3	730	38.8	101	90	2.01	245	62	0
7	25		1.2	730	42.6	100	92	1.86	255	65	0
6	30		1.3	750	46.5	114	94	1.99	250	66	0
5	35		1.4	775	450.4	116	96	2.1			0
4	40		1.4	790	54.2	116	100	1.94			3
3	45		1.3	700	57.4	115	100	2.09			7
2	50		1.2	705	61.3	120	102	1.93	250	66	9
1	55		0.95	720	65.8	120	104	1.51			9
	60	14:07			469.298						
AVERAGE (TOTAL)					( )						

SAMPLING TRAIN DATA

COMPANY: GRANITE CITY STEEL
SOURCE DESIGNATION: INLET
REGULATING AUTHORITY: EPA
DATE: 7/27/79
TEST NUMBER: P-2
Field Person(s): (2nd) RMIC TUM (1st)
Filter Number: A-199-08
Barometric Pressure ("Hg): 29.74
Stack Static Pressure ("H_2O): -3.0
Stack Dimensions: 59.4"
Ambient Temperature (°F): 90
Record all Data Every 5 Minutes

Nozzle(Dia-in): ___ ___ ___ (Avg): 0.249
Pitot Tube No. 40, Corr. Factor: 0.823
Meter Box No. R4, Corr. Factor: 1.0116
Meter Isokinetic Factor: 1691
Assumed Moisture (%): 13.1%
Condensate Volume(ml): 305 + 138 - 20 + 10
Silica Gel Weight Gain(g): 13.9
Actual Moisture (%): ___
Leak Rate: Initial: 0.017 CFM at 16 "Hg; Final: 0.018 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)
West 1	0	15:07	0.90	705	469.506	94	95	1.41	240		9 "
12	5	x1 →	~~1.3~~	~~725~~	~~472.7~~	~~98~~	~~96~~	~~2.00~~			15"
	:40	15:13	1.14	753	~~473.144~~	96.4	94.4	1.71			
Filter Change	~~:00~~	15:40 x4 →	~~1.1~~	~~760~~	~~473.368~~	~~96~~	~~94~~	~~1.64~~	245	70	0
11	10		1.3	770	76.9	98	94	1.93			0
10	15		1.2	700	80.3	104	96	1.79	245	70	0
9	20		1.2	715	84.0	110	98	1.89	255	67	0
8	25		1.2	725	87.8	114	100	1.88			0
7	30		1.1	745	91.6	118	100	1.70	250	61	0
6	35		1.3	760	95.2	120	102	2.00			0 "
5	40	2x →	~~1.3~~	~~775~~	~~99.1~~	~~122~~	~~104~~	~~1.98~~			15"
Filter change	42:07	16:12	1.3	736	500.676	110	102.8	Leak check 0.016 cfm @ 15"	2.02		
	3x →	16:54	~~1.3~~	~~770~~	~~501.103~~	~~102~~	~~102~~	~~2.05~~			0
4	45		1.1	720	503.4	102	102	1.72			
3	50		0.78	720	07.0	110	102	1.23			
2	55		0.78	700	10.1	112	102	1.25			0
	60	17:13			513.214		Leak check		<0.01	3" Hg	
AVERAGE (TOTAL)				733.1	(12.576)	107.5	96.8	1.84			

* started at 1 then had to move to 12 and go down 11, 10, 9, 8, etc. SORRY ABOUT THAT (clockwise in)

SAMPLING TRAIN DATA

3.28 $\frac{Tm}{Ts}$ H

Company: GRANITE CITY STEEL
Source Designation:
Date: 7/28/79
Test Number: D-3
Field Person: RMK TVM
Filter Number: A-159-01
Barometric Pressure ("Hg): 29.65
Stack Static Pressure ("H_2O): ~~-3.0~~ -3.22
Stack Dimensions: 59.4
Plume Appearance:
Ambient Temperature (°F): 90
Record all Data Every 5 Minutes

Filter Heater Setting: -
Probe Heater Setting: -
Nozzle Number: ~~4~~, Dia. (in.): 0.249
Pitot Tube No. ~~4~~, Corr. Factor: 0.823
Meter Box No. 4, Corr. Factor: 1.016
Meter Isokinetic Factor:
Assumed Moisture (%): 13
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Leak Rate (START/END) <0.01 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)
South 12	0	~~12:30~~	~~1.2~~ 1.4	715	513.557	85	85	~~2.03~~ 2.03	265		0
11	5		1.4	730	17.2	90	86	2.11	210	85	0
10	10		1.4	750	21.2	95	86	2.09	260	75	0
9	15		1.4	755	25.1	100	90	2.10	210	84	0
8	20		1.2	695	29.1	103	90	1.90	250	82	0
7	25		1.1	700	32.8	106	92	1.74	280	82	0
6	30		1.2	715	36.5	110	95	1.88	255	82	0
5	35		1.2	730	40.3	110	95	1.86	260	82	0
4	40		1.1	740	44.1	110	97	1.69	210	83	0
3	45		1.2	750	47.7	110	98	1.83	265	84	0
2	50		1.3	695	51.5	112	100	2.09	280	82	2
1	55	~~13:24~~	1.1	705	55.3	115	100	1.76	150	82	2
	60	~~13:30~~ 13:30			559.249						
					leak check before port change						
								0.012	at 15" Hg		
AVERAGE (TOTAL)					( )						

Pb 29.45, 29.87, .986, 29.96

SAMPLING TRAIN DATA

Company: GRANITE CITY STEEL
Source Designation: BATT STACK C INLET
Date: 7/28/79
Test Number: P-3
Field Person: RMK TVM
Filter Number: A-159-02
Barometric Pressure ("Hg): 29.65
Stack Static Pressure ("H_2O): -3.0
Stack Dimensions: 59.4"
Plume Appearance:
Ambient Temperature (°F): 90
Record all Data Every 5 Minutes

Filter Heater Setting:
Probe Heater Setting:
Nozzle Number: , Dia. (in.): 0.249
Pitot Tube No. 40, Corr. Factor:
Meter Box No. 4, Corr. Factor:
Meter Isokinetic Factor:
Assumed Moisture (%):
Condensate Volume (ml): 50 + 244.2
Silica Gel Weight Gain (g): 32.9
Leak Rate start 0.012 end <0.010 CFM at 15 "Hg 5"

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)
WEST 12	0	16:15	~~1.0~~	745	559.463	90	90	1.65	290	~~290~~	2
11	5		1.3	700	63.0	95	92	2.03	245		2
10	10		1.4	705	66.9	98	92	2.19	275	85	2
9	~~15~~		1.3	715	70.9	102	92	2.02	245	79	2
8	20		1.1	730	74.8	105	94	1.70	240	80	2
7	25	16:45	1.1	750	578.442	108	95	1.67	245	80	2
16:48 filter chg A-159-02 6	30	17:00	1.1	~~750~~ 755	~~582.170~~ 582.184	100	100	1.06			0+
5	35		1.1	765	85.7	102	100	1.65	235	82	0+
4	40		1.1	700	89.4	110	100	1.76	250	82	0+
3	45		1.1	715	93.1	116	104	1.75	245	82	0+
2	50		0.95	725	96.8	118	104	1.50	250	83	
1	55		0.73	735	0.3	118	108	1.15			
	60				603.333						
AVERAGE (TOTAL)				1356	(87.193)	104.5	95.2	1.82			

SAMPLING TRAIN DATA

$\Delta M = 3.67 \frac{T_m}{T_S} H$

COMPANY: Granite City Steel
SOURCE DESIGNATION: Outlet to ESP
REGULATING AUTHORITY: U.S. EPA
DATE: 7-26-79
TEST NUMBER: P-1 Pg 1 of 4
Field Person(s): TVP GMS
Filter Number: A-199-016
Barometric Pressure ("Hg): 29.68
Stack Static Pressure ("H_2O): -2.5
Stack Dimensions: 59.5" ID
Ambient Temperature (°F): 85°
Record all Data Every 3 Minutes

Nozzle (Dia-in): 0.248 0.248 0.249 (Avg): 0.248
Pitot Tube No. 21, Corr. Factor: 0.827
Meter Box No. R-1, Corr. Factor: 0.985
Meter Isokinetic Factor: 1.079
Assumed Moisture (%): 9.90
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Actual Moisture (%):
Leak Rate: Initial: 0.01 CFM at 15 "Hg; Final: CFM at "Hg

Traverse Point No.	Time: Sampling (min)	Time: Clock	Velocity Pressure ("H_2O)	Stack Temp (°F) (40=110	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)
V-20	0	1517	1.55	640	917.828	100	100	2.89			2.0
V-19	3	1520	1.70	640	920.610	102	100	3.18	235	70	2.0
V-18	6	1523	1.70	640	923.495	108	100	3.20			7.0
V-17	9	1526	1.65	640	926.470	113	100	3.11	275	70	7.0
V-16	12	1529	1.6	640	929.425	117	102	3.04			7.0
V-15	15	1532	1.4	640	932.340	119	102	2.66	220	75	7.0
V-14	18	1535	1.5	640	935.000	120	103	2.86			7.0
V-13	21	1538	1.5	640	937.880	122	104	2.87			7.0
	22'27.5"	Electricity out			939.188	110	103	2.83			
12	24	1547	1.4	635	940.170	112	104	2.66			8.0
11	27	1550	1.4	635	943.103	115	104	2.62			8.0
10	30	1553	1.6	635	945.495	118	104	3.06	220	72	8.5
9	33	1556	1.6	635	948.385	120	104	3.07	274		8.5
8	35'25"	1559			950.810						
8	36	1606	1.6	633	951.150	108	102	3.03	180	74	8.5
7	39	1609	1.55	635	954.290	114	104	2.96			
6	42	1612	1.5	635	957.070	116	104	2.86			8.5
AVERAGE (TOTAL)					( )	1704	1537	44.12			

SAMPLING TRAIN DATA

COMPANY: Granite City Steel
SOURCE DESIGNATION: outlet to ESP
REGULATING AUTHORITY: U.S. EPA
DATE: 7/26/79
TEST NUMBER: P-1 pg 2 of 4
Field Person(s): TJP/BMS
Filter Number: A-199-06
Barometric Pressure ("Hg): 29.68
Stack Static Pressure ("H_2O): -2.5
Stack Dimensions: 59.5" ID
Ambient Temperature (°F): 85
Record all Data Every 3 Minutes

Nozzle (Dia-in): 0.247 0.248 0.249 (Avg): 0.248
Pitot Tube No. 21, Corr. Factor:
Meter Box No. P-1, Corr. Factor:
Meter Isokinetic Factor: 1.029
Assumed Moisture (%): 9
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Actual Moisture (%):
Leak Rate: Initial: 0.01 CFM at 15 "Hg; Final: CFM at "Hg

Vertical port

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)
V-5	045	1615	1.4	630	959,940	120	104	2.70	270	74	8.5
V-4	48	1619	1.4	625	962.790	120	104	2.71			8.5
3	51	1622	1.2	620	965.580	120	104	2.33	230	74	8.0
2	54	1625	1.3	618	968.260	121	104	2.54			8.5
1	57	1628	0.75	435	970.995	121	105	1.76	250	74	7.5
	60	1631			973.277						
AVERAGE (TOTAL)					( )	2306	2058	56.16			

SAMPLING TRAIN DATA

COMPANY: Granite City Steel
SOURCE DESIGNATION: Outlet to ESP
REGULATING AUTHORITY: U.S. EPA
DATE: 7/26/79
TEST NUMBER: A-1 Pg 3 of 4
Field Person(s): TJP GMS
Filter Number: A-199-06
Barometric Pressure ("Hg): 29.68
Stack Static Pressure ("H_2O): -2.5
Stack Dimensions: 59.5" ID
Ambient Temperature (°F): 85
Record all Data Every 3 Minutes
Horizontal port

Nozzle (Dia-in): 0.247 0.248 0.249 (Avg): 0.248
Pitot Tube No. 21, Corr. Factor: .827
Meter Box No. BAC1, Corr. Factor:
Meter Isokinetic Factor: 1.679
Assumed Moisture (%): 9
Condensate Volume (ml):
Silica Gel Weight Gain (g):
Actual Moisture (%):
Leak Rate } Initial: _____ CFM at _____ "Hg
Leak Rate } 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)
A-1	60	2015	0.98	675	973.524	86	86	1.90	230	74	7.5
A-2	63	2018 2035	1.1	620	975.758	88	85	2.04			7.0
A-3	66	2038	1.3	620	978.220	91	87	2.43	220	68	7.5
A-4	69	2041	1.35	630	980.690	96	88	2.51			7.5
A-5	72	2044	1.4	640	983.335	102	88	2.59			7.5
A-6	75	2047 2122	1.4	635	985.998	86	87	2.56	250	68	7.5
A-7	78	2125	1.5	630	988.660	89	86	2.76			7.5
A-8	81	2128	1.4	635	991.410	93	86	2.58			7.5
A-9	84	2131	1.45	635	994.115	97	86	2.68			7.5
A-10	87 (80-22")	2133 2210	1.5	633	996.188 996.630	86	86	2.75	210	70	7.5
A-11	90	2213	1.55	635	999.510	93	86	2.86			7.5
A-12	93	2216	1.5	635	1002.275	97	86	2.77			7.5
A-13	96	2219	1.4	640	1005.040	100	87	2.59			8.0
A-14	99	2222	1.6	635	1007.730	102	88	2.98			8.5
A-15	102	2225	1.7	633	1010.600	104	89	3.17			8.5
A-16	105	2228	1.6	630	1013.605	107	90	3.00			8.5
A-17	108	2231	1.85	630	1016.550	107	90	3.48	250	70	
AVERAGE (TOTAL)					( )	3930	3539	101.81			

SAMPLING TRAIN DATA

COMPANY: Granite City Steel
SOURCE DESIGNATION: Outlet of ESP
REGULATING AUTHORITY: U.S. EPA
DATE: 7/26/79
TEST NUMBER: P-1 PS 4074
Field Person(s): TJP GMS
Filter Number: A-199-06
Barometric Pressure ("Hg): 29.68
Stack Static Pressure ("H_2O): -2.5
Stack Dimensions: 59.5" DD
Ambient Temperature (°F): 78
Record all Data Every 3 Minutes

Nozzle (Dia-in): .247 .248 .249 (Avg): .248
Pitot Tube No. 21, Corr. Factor: _____
Meter Box No. BAC 1, Corr. Factor: _____
Meter Isokinetic Factor: 1679
Assumed Moisture (%): 9
Condensate Volume (ml): 230 178 (-200)
Silica Gel Weight Gain (g): 33.8
Actual Moisture (%): _____
Leak Rate } Initial: _____ CFM at _____ "Hg
Leak Rate } Final: 0.012 CFM at 10.5 "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)
H-18	111	2234	1.85	630	1019.560	109	91	3.48	250	70	9.0
H-19	114	2237	1.8	630	1022.705	110	91	3.39			9.0
H-20	117	2240	1.6	620	1025.820	111	92	3.05			
	120	2243			1028.824						
					109.142						
					~~109.592~~						
AVERAGE (TOTAL)				626.6	( )	106.5	95.3	2.79			

SAMPLING TRAIN DATA

COMPANY: Granite City Steel
SOURCE DESIGNATION: Outlet to ESP
REGULATING AUTHORITY: U.S. EPA
DATE: 7/27/79
TEST NUMBER: P-2 Pg 1 of 4
Field Person(s): TJP GMS
Filter Number: A-199-02
Barometric Pressure ("Hg): 29.74
Stack Static Pressure ("H_2O): -2.5
Stack Dimensions: 59.5
Ambient Temperature (°F): 80
Record all Data Every 30 Minutes
Horizontal port

Nozzle (Dia-in): .247 .24 (Avg): .248
Pitot Tube No. 21, Corr. Factor: 0.827
Meter Box No. R-1, Corr. Factor: 0.985
Meter Isokinetic Factor: 679
Assumed Moisture (%): 9
Condensate Volume (ml): 99+97=196
Silica Gel Weight Gain (g): 32.9
Actual Moisture (%):
Leak Rate: Initial: <0.0025 CFM at 15 "Hg
Final: CFM at "Hg
$\Delta H = 3.69 \frac{Tm}{Ts} H$

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 ("H2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
H-1	0	1307	1.2	625	030.706	91	91	2.44	240	80	<2.0
H-2	3	1310	1.2	620	033.440	92	91	2.27			<2.0
H-3	6	1313	1.4	630	035.885	94	90	2.62			<2.0
H-4	9	1316	1.4	625	038.575	95	90	2.60			<2.0
H-5	12	1319	1.4	625	41.510	99	90	2.69			<2.0
H-6	15	1322	1.5	630	43.975	102	90	2.82			<2.0
H-7	18	1325	1.5	625	46.810	104	91	2.83	260	70	<2.0
H-8	21	1328	1.3	630	49.585	105	92	2.46			<2.0
H-9	24	1331	1.6	630	52.250	106	92	2.83			2.0
H-10	27	1334	1.7	630	55.040	108	93	3.22	275	65	2.0
H-11	30	1337	1.7	630	58.000	110	94	3.23			2.0
H-12	33	1340	1.65	630	60.995	110	95	3.13			2.0
H-13	36	1343	1.50	635	63.985	109	94	2.84	250	65	2.0
H-14	39	1346	1.4	635	66.860	108	95	2.65			2.0
H-15	42	1349	1.6	635	69.610	106	95	3.02			2.0
16	45	1352	1.85	630	72.520	106	95	3.51			2.0
17	48	1355	1.90	630	75.590	106	95	3.61			2.5
AVERAGE (TOTAL)					( )						

SAMPLING TRAIN DATA

COMPANY: Granite City Steel
SOURCE DESIGNATION: Outlet of ESP
REGULATING AUTHORITY: U.S EPA
DATE: 7/27/79
TEST NUMBER: P-2 pg 2 of 4
Field Person(s): TSP Crew
Filter Number: A-199-02
Barometric Pressure ("Hg): 29.74
Stack Static Pressure ("H_2O): -2.5
Stack Dimensions: 59.5" ID
Ambient Temperature (°F): 75
Record all Data Every 3 Minutes
Horizontal Port

Nozzle(Dia-in): ___ ___ ___ (Avg): .248
Pitot Tube No. 21, Corr.Factor: ____
Meter Box No. #1, Corr.Factor: ____
Meter Isokinetic Factor: 1679
Assumed Moisture (%): 9
Condensate Volume(ml): 99+92=196
Silica Gel Weight Gain(g): 32.9
Actual Moisture (%): ____
Leak Rate } Initial: ~~.00025~~ CFM at 15 "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)
A-18	51	1358	1.95	630	78.755	106	94	3.70	245	66	2.5
A-19	54	1401	1.6	630	82.000	107	94	3.03			2.0
A-20	57	1404	1.6	625	84.930	107	94	3.05			2.0
	60	1407			87.851						
AVERAGE (TOTAL)					( )						

1.33 Hours

SAMPLING TRAIN DATA

COMPANY: Granite City Steel — Granite City, Ill
SOURCE DESIGNATION: Outlet to ESP
REGULATING AUTHORITY: U.S. EPA
DATE: 7/27/79
TEST NUMBER: P-2 pg 3 of 4
Field Person(s): TJP GMS
Filter Number: 4-199-02
Barometric Pressure ("Hg): 29.74
Stack Static Pressure ("H_2O): -2.5
Stack Dimensions: 59.5" ID
Ambient Temperature (°F): 75
Record all Data Every 3 Minutes
Vertical port

Nozzle (Dia-in): ___ ___ ___ (Avg): .248
Pitot Tube No. 21, Corr. Factor: ___
Meter Box No. DAC 1, Corr. Factor: ___
Meter Isokinetic Factor: 1679
Assumed Moisture (%): 9
Condensate Volume (ml): 99+97 = 196
Silica Gel Weight Gain (g): 32.9
Actual Moisture (%): ___
Leak Rate: Initial: +0.0025 CFM at 15 "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 ("H2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
V-1	60	1507	1.4	620	87.851	85	85	2.61	225	80	2.0
V-2	63	1510	1.6	625	90.485	89	84	2.98			2.0
V-3	66	1513			93.287	Inlet Filter Blinded					
V-3	66	1540	1.6	620	93.287	86	85	2.98		78	2.5
V-4	69	1543	1.5	625	96.040	88	84	2.74	250	60	2.5
V-5	72	1546	1.5	625	98.780	92	84	2.80			2.5
V-6	75	1549	1.4	620	101.535	95	85	2.64	240	58	2.5
V-7	78	1552	1.45	620	104.185	96	85	2.73			2.5
V-8	81	1555	1.4	625	106.960	98	86	2.63			2.5
V-9	84	1558	1.3	625	109.705	100	86	2.44	240	64	2.5
V-10	87	1601	1.25	625	112.350	100	86	2.35			2.5
V-11	90	1604	1.55	625	114.960	101	87	2.92			3.0
V-12	93	1607	1.6	625	117.775	102	88	3.02	240	66	3.0
V-13	96	1610	1.55	625	120.525	103	88	2.92			3.0
V-14	99	1613	1.5	625	123.330	103	88	2.83			3.0
V-15	102	1616	1.45	625	126.100	104	89	2.74			3.0
V-16	105	1619 / 1654	1.45	625	128.818	84	86	2.69	278	70	3.0
AVERAGE (TOTAL)					( )						

SAMPLING TRAIN DATA

COMPANY: Granite City Steel
SOURCE DESIGNATION: Outlet to ESP
REGULATING AUTHORITY: U.S. EPA
DATE: 7/27/79
TEST NUMBER: P-2 pg 4 of 6
Field Person(s): TJP GMS
Filter Number: A-199-02
Barometric Pressure ("Hg): 29.74
Stack Static Pressure ("H2O): -2.5
Stack Dimensions: 59.5" ID
Ambient Temperature (°F): 75
Record all Data Every 3 Minutes

Nozzle(Dia-in): ___ ___ ___ (Avg): .248
Pitot Tube No. 21, Corr. Factor: ___
Meter Box No. EAC 1, Corr. Factor: ___
Meter Isokinetic Factor: 1679
Assumed Moisture (%): 9
Condensate Volume (ml): 132+167=299/200
Silica Gel Weight Gain (g): 32.9
Actual Moisture (%): ___
Leak Rate Initial: <0.0025 CFM at 15 "Hg
Leak Rate Final: <0.0025 CFM at 8 "Hg

Vertical port

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 ("H2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
V-17	108	1657	1.35	620	131.535	85	84	2.51			3.0
V-18	111	1700	1.2	610	134.145	88	84	2.26	245	70	3.0
V-19	114	1703	1.25	595	136.770	92	84	2.40			3.0
V-20	117	1706	0.78	425	139.430	94	84	1.78			2.5
	120	1709			141.603						
AVERAGE (TOTAL)				1203	(101.234)	47.9	19.2	2.7?			

Revised 11-78 Clayton Environmental Consultants, Inc.

SAMPLING TRAIN DATA

COMPANY: Granite City Steel — Granite City, Ill
SOURCE DESIGNATION: Outlet to ESP
REGULATING AUTHORITY: U.S. EPA
DATE: 7/28/79
TEST NUMBER: P-3 Pg 1 of 4
Field Person(s): TJP GHS
Filter Number: A-199-09
Barometric Pressure ("Hg): 29.65
Stack Static Pressure ("H_2O): -2.5
Stack Dimensions: 59.5" ID
Ambient Temperature (°F): 78
Record all Data Every 3 Minutes

Nozzle (Dia-in): ___ ___ ___ (Avg): .248
Pitot Tube No. 21, Corr. Factor: 0.827
Meter Box No. RAC1, Corr. Factor: 0.985
Meter Isokinetic Factor: 1679
Assumed Moisture (%): 9
Condensate Volume (ml): ___
Silica Gel Weight Gain (g): ___
Actual Moisture (%): ___
Leak Rate: Initial: 0.016 CFM at 15 "Hg; Final: < 0.0025 CFM at 7 "Hg

Vertical Port — Asbestos yarn for seal

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)
V-1	0	1230	1.5	620	145.282	101	100	2.87	280	84	< 2.0
V-2	3	1233	1.65	625	148.170	104	102	3.15			< 2.0
V-3	6	1236	1.6	625	151.115	110	102	3.08	270	60	< 2.0
V-4	9	1239	1.5	625	154.210	114	103	2.90			< 2.0
V-5	12	1242	1.5	625	156.950	116	104	2.89			< 2.0
V-6	15	1245	1.45	630	159.825	116	104	2.78			< 2.0
V-7	18	1248	1.45	630	162.695	116	104	2.78			< 2.0
V-8	21	1251	1.5	630	165.520	118	105	2.88			< 2.0
V-9	24	1254	1.25	630	168.380	118	105	2.40	260	57	< 2.0
V-10	27	1257	1.25	625	171.115	118	106	2.43			< 2.0
V-11	30	1300	1.5	625	173.780	118	107	2.92			< 2.0
V-12	33	1303	1.55	625	176.650	119	107	3.02			< 2.0
V-13	36	1306	1.55	625	179.590	119	107	3.02	260	70	2.0
V-14	39	1309	1.5	625	182.550	119	107	2.92			2.0
V-15	42	1312	1.5	625	185.510	118	107	2.92			2.0
V-16	45	1315	1.4	625	188.465	119	108	2.73			< 2.0
V-17	48	1318	1.4	625	191.215	120	108	2.73	260	78	< 2.0
AVERAGE (TOTAL)					( )		mw	Δ0.92			

SAMPLING TRAIN DATA

COMPANY: Granite City Steel — Granite City, Illa.
SOURCE DESIGNATION: Outlet to ESP
REGULATING AUTHORITY: U.S EPA
DATE: 7/28/79
TEST NUMBER: P-3 Pg 2 of 4
Field Person(s): TJP GMS
Filter Number: A-199-09
Barometric Pressure ("Hg): 29.65
Stack Static Pressure ("H_2O): -2.5
Stack Dimensions: 59.5
Ambient Temperature (°F): 80
Record all Data Every 3 Minutes
Vertical Port

Nozzle(Dia-in): ___ ___ ___ (Avg): .248
Pitot Tube No. 21, Corr.Factor: ____
Meter Box No. Ptc 1, Corr.Factor: ____
Meter Isokinetic Factor: 1679
Assumed Moisture (%): 9
Condensate Volume(ml): ____
Silica Gel Weight Gain(g): ____
Actual Moisture (%): ____
Leak Rate: Initial: 0.016 CFM at 15 "Hg; Final: <0.005 CFM at 7 "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)
V-18	51	1321	1.45	625	193.995	120	108	2.83			2.0
V-19	54	1324	1.1	625	196.875	121	108	2.15	255	78	<2.0
V-20	57	1327	1.0	585	199.460	121	109	2.03			<2.0
	60	1330			201.939						
AVERAGE (TOTAL)					( )						

SAMPLING TRAIN DATA

COMPANY: Granite City Steel
SOURCE DESIGNATION: Outlet to ESP
REGULATING AUTHORITY: U.S. EPA
DATE: 7/28/79
TEST NUMBER: P-3 Ps 3 of 4
Field Person(s): TJP BMS
Filter Number: A-199-04
Barometric Pressure ("Hg): 29.65
Stack Static Pressure ("H_2O): -2.5
Stack Dimensions: 59.5" ID
Ambient Temperature (°F): 98
Record all Data Every 3 Minutes

Nozzle (Dia-in): ___ ___ ___ (Avg): .248
Pitot Tube No. 21, Corr. Factor: ___
Meter Box No. #1, Corr. Factor: ___
Meter Isokinetic Factor: 1679
Assumed Moisture (%): 9
Condensate Volume (ml): ___
Silica Gel Weight Gain (g): ___
Actual Moisture (%): ___
Leak Rate } Initial: 0.018 CFM at 16 "Hg
Leak Rate } 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)
			0.85		202.576			1.78			
H-1	60	1615	~~0.87~~	520	202.576	96	96	~~2.09~~	245	86	<2.0
H-2	63	1618	1.1	600	204.870	102	98	2.14			<2.0
H-3	66	1621	1.4	620	207.315	105	98	2.68	295	74	<2.0
H-4	69	1624	1.45	625	210.055	107	98	2.80			<2.0
H-5	72	1627	1.5	623	212.875	110	99	2.88	235	70	<2.0
H-6	75	1630	1.35	625	215.730	112	100	2.60			<2.0
H-7	78	1633	1.3	625	218.505	114	101	2.51			<2.0
H-8	81	1636	1.25	620	221.230	114	102	2.42			<2.0
H-9	84	1639	1.25	620	223.920	115	103	2.43	280	72	<2.0
H-10	87	1642	1.25	620	226.580	117	104	2.44			<2.0
H-11	90	1645	1.4	625	229.235	119	105	2.72			<2.0
H-12	93	1648/1710	1.3	625	232.069	107	105	2.50	275	84	<2.0
H-13	96	1713	1.25	625	234.730	109	106	2.41			<2.0
H-14	99	1716	1.2	625	237.400	113	106	2.32			<2.0
H-15	102	1719	1.5	625	240.025	116	107	2.92	270	75	2.0
H-16	105	1722	~~1.6~~	625	242.880	119	108	3.12			2.0
H-17	108	1725	1.65	625	245.870	121	108	3.23			2.0
AVERAGE (TOTAL)					( )						

SAMPLING TRAIN DATA

COMPANY: Granite City Steel
SOURCE DESIGNATION: Outlet to ESP
REGULATING AUTHORITY: U.S. EPA
DATE: 7/28/77
TEST NUMBER: P-3 pg 4 of 4
Field Person(s): TJP GMS
Filter Number: A-199-09
Barometric Pressure ("Hg): 29.65
Stack Static Pressure ("H_2O): -2.5
Stack Dimensions: 59.5" ID
Ambient Temperature (°F): 100 (at precips)
Record all Data Every 3 Minutes

Nozzle (Dia-in): ___ ___ ___ (Avg): .248
Pitot Tube No. 21, Corr. Factor: ____
Meter Box No RAC 1, Corr. Factor: ____
Meter Isokinetic Factor: 1679
Assumed Moisture (%): 9
Condensate Volume (ml): 51 + 210
Silica Gel Weight Gain (g): 29.5
Actual Moisture (%): ____
Leak Rate: Initial: 0.018 CFM at 16 "Hg; Final: 0.003 CFM at 8.5 "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 ("H2O)	Filter Box Temp (°F)	Last Imp. Gas Temp (°F)	Sampling Train Static Pressure ("Hg)
H-18	111	1728	1.4	625	248.895	123	109	2.74	280 ~~275~~	~~80~~ 75	2.0
H-19	114	1731	1.3	625	~~251.810~~	124	110	2.55			2.0
H 20	117	1734	1.4	590	254.550	124	111	2.84	265	75	2.0
	120	1737			257.377						
AVERAGE (TOTAL)			619.7		(101.764)	114.6	104.0	2.61			

DRY MOLECULAR WEIGHT DETERMINATION (M_d)

Plant: Granite City Steel
Date: 7-26-79
Sampling Time (24-hour Clock): P-1 2nd ½
Sampling Location:: Inlet

Sample Type (bag, integrated, continuous) _____
Analytical Method: OSAT
Ambient Temperature: Rm
Operator: B.B

Comments:

Preferred run

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	3.5	3.5	4.0	4.0	3.7	3.7	3.7	44/100	
O_2 (Net is actual O_2 reading minus actual CO_2 reading)	19.5	16.0	20.0	16.0	19.8	16.1	16.0	32/100	
CO (net is actual CO reading minus actual O_2 reading)	20.2	.7	20.5	.5	20.5	.7	0.6	28/100	
N_2 (Net is 100 minus actual CO reading)	100	79.5	100	79.5	100	79.5	79.7	28/100	
								Total 29.23	= M_d

This orsat was used for G_s determination

WET MOLECULAR WEIGHT DETERMINATION (M_s)

B_{wo} = Proportion by volume of water vapor in the gas stream .131

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

$M_s = (29.23)(1-.869) + 18(.131) = 27.76$

$G_m = \frac{M_d}{28.96} = \frac{}{28.96} =$, $G_s = \frac{M_s}{28.96} = \frac{27.76}{28.96} = .959$, $\frac{G_m}{G_s} = \_\_\_\_ =$

DRY MOLECULAR WEIGHT DETERMINATION (M_d)

Plant: Granite City Steel
Date: 2-27-79
Sampling Time (24-hour Clock):
Sampling Location:: P-2

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	3.7	3.7	3.5	3.5	3.5	3.5	3.6	44/100	1.584
O_2 (Net is actual O_2 reading minus actual CO_2 reading)	15.7	12.0	15.5	12.0	15.8	12.3	12.1	32/100	3.872
CO (net is actual CO reading minus actual O_2 reading)	16.0	0.3	15.6	0.1		0.2	0.2	28/100	0.056
N_2 (Net is 100 minus actual CO reading)							85.4	28/100	23.912
								Total	29.424 = M_d

WET MOLECULAR WEIGHT DETERMINATION (M_s)

B_{wo} = Proportion by volume of water vapor in the gas stream .0988

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

M_s = ( )(1-) + 18( ) = 28.02

$G_m = \frac{M_d}{28.96} = \frac{\quad}{28.96} =$, $G_s = \frac{M_s}{28.96} = \frac{29.02}{28.96} = 0.968$, $\frac{G_m}{G_s} = \quad =$

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DRY MOLECULAR WEIGHT DETERMINATION (M_d)

Plant: Granite City Steel
Date: 7-28-79
Sampling Time (24-hour Clock): 8-3
Sampling Location:: [redacted]" Inlet to ESP
Comments:

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

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	3.7	3.7	3.5	3.5	3.7	3.7	3.6	44/100	1.584
O_2 (Net is actual O_2 reading minus actual CO_2 reading)	17.0	13.3	17.0	13.5	17.1	13.4	13.4	32/100	4.288
CO (net is actual CO reading minus actual O_2 reading)	17.1	0.1	17.2	0.2	17.1	<0.1	0.1	28/100	0.028
N_2 (Net is 100 minus actual CO reading)							82.9	28/100	23.211
								Total	29.112 = M_d

WET MOLECULAR WEIGHT DETERMINATION (M_s)

B_{wo} = Proportion by volume of water vapor in the gas stream .159

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

$M_s = (29.112)(1-.841) + 18(.159) = 27.36$

$G_m = \frac{M_d}{28.96} = \frac{}{28.96} =$, $G_s = \frac{M_s}{28.96} = \frac{}{28.96} = .945$, $\frac{G_m}{G_s} = \frac{}{} =$

APPENDIX B-2

SAMPLING SUMMARY DATA

SAMPLING SUMMARY SHEET

Plant Granite City Steel **Location** Electrostatic Precipitator Inlet

Sampled Source Coke Battery Exhaust

Run	Date	N_p	P_m	P_b	V_m	T_m	$V_{m_{std}}$	V_w	$V_{w_{gas}}$	%M	M_d
1	7-26-79	24	1.97	29.68	92.705	98.4	87.39	279.1	13.15	13.1	0.869
2	7-27-79	24	1.84	29.74	90.576	102.2	84.95	324.9	15.30	15.3	0.847
3	7-28-79	24	1.82	29.65	87.193	99.9	81.86	326.9	15.40	15.8	0.842

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	29.23	27.76	-0.221	29.46	0.823	38.66	5697	756.3	120	0.249	101.1
2	29.06	27.37	-0.221	29.52	0.823	37.65	5582	733.7	120	0.249	100.7
3	29.11	27.35	-0.221	29.43	0.823	37.23	5530	725.8	120	0.249	98.3

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

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

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

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

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

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

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

$$V_s = 5120.8 \times Cp \times \sqrt{\Delta P_s \times (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

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

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, in

%I Percent Isokinetic

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

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

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

SAMPLING SUMMARY SHEET

Plant Granite City Steel Location Electrostatic Precipitator Outlet

Sampled Source Coke Battery Exhaust

Run	Date	N_p	P_m	P_b	V_m	T_m	$V_{m_{std}}$	V_w	$V_{w_{gas}}$	%M	M_d
1	7-26-79	40	2.79	29.68	109.088	100.9	102.6	241.8	11.39	10.0	0.900
2	7-27-79	40	2.77	29.74	109.234	94.1	104.2	228.9	10.78	9.4	0.906
3	7-28-79	40	2.69	29.65	109.786	109.7	101.5	290.5	13.68	11.9	0.881

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	29.23	28.11	-0.184	29.50	0.827	39.99	5881	626.6	120	0.248	99.8
2	29.06	28.02	-0.184	29.56	0.827	39.81	5858	620.3	120	0.248	100.3
3	29.11	27.79	-0.184	29.47	0.827	38.57	5708	619.7	120	0.248	103.4

$$V_{m_{std}} = \frac{17.65 \times V_m \left(P_b + \frac{P_m}{13.6}\right)}{(T_m + 460)} \qquad \%M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}}$$

$$V_{w_{gas}} = 0.0471 \times V_w \qquad M_d = \frac{100 - \%M}{100}$$

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

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

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

$$V_s = 5120.8 \times Cp \times \sqrt{\Delta P_s \times (T_s + 460)} \left[\frac{1}{P_s \times MW}\right]^{1/2}$$

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

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, in.

%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 prod[illegible] the [illegible]city [illegible] ΔPs) [illegible] the a[illegible]

TABLE B-2.1. STACK GAS PARAMETERS

Sampling Location	Sample Number	Date 1979	Temperature		Flowrate			
			F	C	dscfm	acfm	$\frac{dsm^3}{min}$	$\frac{am^3}{min}$
Inlet C Battery	1	7-26	756	402	40,700	109,600	1,150	3,100
	2	7-27	734	390	39,700	107,400	1,130	3,040
	3	7-28	726	386	39,200	106,400	1,110	3,010
Average			739	393	39,900	107,800	1,130	3,050
Outlet C Battery	1	7-26	627	331	48,900	113,500	1,390	3,220
	2	7-27	620	327	49,500	113,100	1,400	3,200
	3	7-28	620	327	46,800	110,200	1,320	3,120
Average			622	328	48,400	112,300	1,370	3,180

APPENDIX B-3

VISIBLE EMISSION DATA SHEETS

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant Coke Battery Date 7-26-79

Company Name Granite City Steel Hours of Observation

Plant Address Granite City, Illinois Observer Schick ~~Schick~~/Opthoff

Type of Discharge STACK OTHER

Discharge Location Battery Stack Exhaust

Height of Point of Discharge

N ↗

Observer's Location:

Distance to Discharge Point

Height of Observation Point ground level

Direction from Discharge Point S

Background Description Mostly Cloudy Sky

Weather: Clear (Overcast mostly) Partly Cloudy Other Color

Wind Direction SW 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

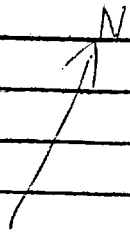
Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1515	00	10	15	10	10	11 P-1 Dark 1
	01	10	10	10	5	9 1 0
	02	5	5	5	5	5
	03	5	5	5	5	5
	04	10	10	10	5	9 Steam
1520	05	5	10	10	10	7.9 190
21	06	5	5	5	10	
	07	10	10	15	10	
	08	5	5	5	5	
	09	10	10	5	5	8
	10	5	10	15	10	10
26	11	5	15	5	5	7.9 8 190
27	12	5	5	5	10	6
	13	10	10	10	5	9
	14	5	5	5	*	5 Train blocking view of stack
	15	*	*	*	*	-
	16	*	*	*	*	-
32	17	5	10	10	5	7.0 105
33	18	5	5	5	5	5
	19	10	5	5	5	6
	20	5	10	5	5	6
	21	5	5	5	5	5
	22	5	5	5	10	6
38	23	5	5	5	5	5 5.6 135
39	24	5	5	5	5	5
	25	5	5	5	5	5
	26	5	5	10	5	6
	27	5	5	5	5	5
	28	10	5	5	10	7
44	29	10	10	15	5	10 6.5 155



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
1545	30	5	5	5	10	P-1 pass 2 Sh 0
	31	10	5	5	5	
	32	5	5	5	5	
	33	5	5	5	5	
	34	5	5	10	5	
50	35	5	5	5	10	5.8 ✓ 140
51	36	5	10	5	5	
	37	5	10	5	5	
	38	10	10	5	5	8
	39	5	5	5	5	
	40	5	5	5	5	
56	41	5	5	5	5	5.8 ✓ 140
57	42	5	5	10	5	
	43	5	5	5	5	
	44	5	5	5	10	
1600	45	5	5	10	5	~~4.8~~ (5.8) ✓ 110
1601	46	5	5	5		~~5~~ Dust has stopped
	47			5	5	← did not include in 6 min average
1606	48	5	5	5	5	Opacity reserved
	49	5	5	5	5	
	50	5	10	5	10	8
	51	10	5	5	5	
	52	5	5	5	5	
11	53	5	5	5	5	5.6 ✓ 135
12	54	5	10	5	5	
	55	5	5	5	0	
	56	5	10	5	5	
	57	5	5	5	5	
	58	5	5	5	5	
17	59	5	0	0	0	4.6 ✓ 110

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
16 18	00	0	5	0	0	1 p-1 page 2
	01	0	5	5	5	4
	02	0	0	0	0	0
	03	0	0	0	0	0
	04	0	0	0	0	0
23	05	0	0	0	0	0 0.83 ←
24	06	0	25	15	0	10 20 sharp spike (chat)
	07	0	0	0	0	0
	08	5	0	0	5	3
	09	0	0	5	0	1
	10	0	5	5	0	3
29	11	5	5	5	5	3.5 ← 5 x5
30	12	5	5	5	0	4
	13	5	5	5	5	5
	14	5	5	5	5	5
	15	5	5	5	5	5
	16	5	5	5	5	5
35	17	5	20	10	5	5.6 ← 135 spike longer than other 10
36	18	5	5	5	5	5
	19	5	5	5	5	5
	20	5	10	5	5	6
	21	5	5	5	5	5
	22	5	5	*	*	5 smoke from battery engulfing stack
41	23	*	*	*	*	5.3 ← 95
42	24	10	5	5	10	8
	25	5	5	10	5	6
	26	5	5	5	10	6
	27	5	5	5	10	6
	28	5	5	5	5	5
47	29	5	5	5	5	5 6.0 ← 145

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
1448	30	5	0	0	0	1
	31	0	5	5	5	4
	32	5	5	5	10	6
	33	5	5	5	5	5
	34	5	5	5	10	6
53	35	10	5	5	5	6 4.8 ✓
54	36	5	5	5	5	5 115
	37	5	5	5	5	5
	38	5	5	5	5	5
	39	5	5	5	5	5
	40	*	*	*	*	- whole area engulfed in smoke from
59	41	*	*	10	10	5.6 ✓ push 10 100
1700	42	10	10	5	10	9
01	43	5	5	5	5	5 ✓
1702 ~~1703~~	44	5	10	10		13 test stopped 80
	45					
2008	46	10	10	15	15	13 test resumed sun is setting
	47	20	15	20	25	20
2010 ~~2011~~	48	15	15	10	15	14
	49	15	15	15	10	14
	50	10	15	15	15	14
2052	51	15	15	15	10	14 14.6 ✓
2053	52	10	10	15	10	11 350
	53	15	15	15	15	15
	54	15	10	10	20	14
	55	15	15	15	15	15
	56	5	5	10	20	10
2057	57	15	20	15	20	13.8 ✓ 18
2058	58	20	15	15	15	16
	59	20	20	25	30	24

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
2052	00	35	20	20	25	25
	01	20	20	20	25	21
	02	25	35	35	30	31
203	03	30	25	25	20	23.8 ~ 25 5'10
25	04	20	20	15	15	18
26	05	15	15	15	15	15
	06	20	20	20	20	20
	07	30	35	30	30	31
	08	25	25	30	30	28
27	09	25	25	30	25	22.9 ~ 26 5'0
31	10	30	30	35	35	33
	11	30	30	25	20	26 getting quite dark
	12	20	15	15	15	16
	13	20	20	20	20	20
	14	25	20	20	15	20
21	15	15	20	20	25	20 22.5 ~ 5'4'0
21	16	25	25	20	20	23 I believe that it is too dark
3K	17	20	15	15	15	16 to read now but I can continue
	18	15	15	20	20	18 so I can still determine
	19	20	20	20	25	21 peaks to compare with
	20	25	20	20	20	21 CO monitors
45	21	15	20	15	20	18 19.4 ~ 4'6'5
41	22	20	20	20	25	21
43	23	25	30	40	35	33
46	24	30	30	35	40	34
40	25	30	25	30	30	29
43	26	10	10	20	10	13
50	27	20	20	20	10	24.4 ~ 18 5'3
41	28	20	10	20	20	18
41	29	20	10	20	20	18

2055

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
	30	20	20	20	20	20
	31	20	*	20	20	20 interference from other plume
	32	20	20	20	20	20
2033-54	33	[illegible]	20	20	20	[illegible] 20 ↙ 450
	34					
	35					
	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					
	50					
	51					
	52					
	53					
	54					
	55					
	56					
	57					
	58					
	59					

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant Coke Battery Date 7-27-79

Company Name Granite City Steel Hours of Observation _____

Plant Address Granite City Illinois Observer Schick (Opthoff)

Type of Discharge STACK OTHER _____

Discharge Location Battery Stack Exhaust p-2

Height of Point of Discharge _____

Observer's Location: Same spot as yesterday

Distance to Discharge Point _____

Height of Observation Point _____

Direction from Discharge Point South

Background Description grey cloudy sky

Weather: Clear (Overcast) Partly Cloudy Other _____ Color _____

Wind Direction SW 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
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 _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

TIME HR	MIN	SECONDS 00	15	30	45		COMMENTS
1305	00	5	5	5	10	6	P-2
	01	10	10	10	15	11	
	02	10	5	5	10	8	
	03	10	5	5	10	8	
	04	5	10	10	15	10	
1310	05	20	15	20	10	~~9.8~~ ✓ 16	235
1311	06	10	15	15	10	12	
	07	10	10	10	5	9	
	08	5	5	5	5	5	
	09	10	10	10	10	10	pouring rain
	10	10	10	15	15	13	
1316	11	15	15	15	20	~~10.8~~ ✓ 16	260
1317	12	20	20	20	25	21	
	13	20	20	20	*	20	* means stack is engulfed
	14	20	*	20	20	20	in other smoke
	15	*	*	*	25	25	
	16	*	15	15	20	17	
1322	17	20	15	15	10	15	~~18.9~~ ✓ 340
1323	18	15	25	20	15	19	
	19	15	20	25	20	20	
	20	20	20	20	20	20	
	21	20	20	20	25	21	
	22	20	20	20	20	20	
1328	23	20	25	25	25	~~20.6~~ ✓ 24	495
1329	24	15	20	25	20	20	
	25	20	15	20	*	18	
	26	*	*	*	*	—	
	27	20	15	15	25	19	
	28	20	20	10	20	18	
1334	29	20	20	20	20	~~18.9~~ ✓ 20	360

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
1335	30	20	15	15	15	16
	31	20	15	15	15	16
	32	15	10	10	15	13
	33	20	20	15	*	18
	34	*	15	15	20	17
1340	35	20	15	15	15	15.9 ~ 16 350
1341	36	15	10	10	10	11
	37	10	10	10	10	10
	38	10	5	5	10	8
	39	10	10	5	5	8
	40	5	5	5	5	5
1346	41	5	5	10	5	6.9 ~ 6 190
1347	42	5	10	5	5	6
	43	5	5	5	5	5
	44	5	5	5	0	4
	45	5	5	5	5	5
	46	5	5	5	5	5
1352	47	5	10	10	5	5.4 ~ 8 130
1353	48	5	5	10	5	6
	49	5	5	5	5	5
	50	5	5	5	5	5
	51	5	10	5	10	8
	52	10	10	10	5	9
1358	53	5	10	5	5	6.5 ~ 6 155
1359	54	5	5	5	5	5
1400	55	5	5	5	5	5
	56	10	5	5	5	6
	57	5	5	5	5	5
	58	5	5	5	5	5
1404	59	5	15	10	5	5.8 ~ 9 140

RECORD OF VISIBLE EMISSIONS

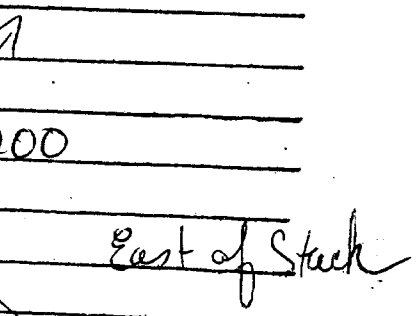
Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1405	00	5	5	5	5	5
1406	01	5	5	5	5	5
1411	02	5	0	5	5	4.4 ✓ 4 70
	03	0	5	5	5	test stopped for port change 4
	04					—
	05					—
1507	06	5	10	5	5	test resumed 6
	07	5	5	10	5	6
	08	5	5	5	5	5
	09	5	5	5	10	6
	10	5	5	5	5	5
1512	11	5	10	5	5	5.8 ✓ 6
1513	12	5	5	5	10	6 140
	13	5	5	5	5	5.0 ✓ 5
1515	14	15	10		15	10 test stopped plugged filter.
	15					
1538	16	10	10	15	10	11 new position due to wind switching
	17	5	5	5	5	5 plume direction
	18	5	10	5	10	8
	19	10	5	5	5	6
	20	10	15	15	10	13
43	21	10	10	5	5	8.3 ✓ 8
44	22	5	10	5	5	6
	23	5	5	5	5	5
	24	5	5	5	5	5
	25	5	5	5	5	5
	26	5	5	5	5	5
49	27	5	5	5	5	5.2 ✓ 5
56	28	5	5	5	5	5
	29	5	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
52	30	5	20	10	5	10
	31	5	5	0	5	4
	32	5	5	5	5	5
55	33	5	5	5	5	5.0 — 5 135
56	34	5	5	5	5	5
	35	5	0	5	10	5
	36	5	5	5	5	5
	37	5	5	10	5	6
	38	5	5	5	5	5
1601	39	5	0	5	5	5.0 — 4 120
02	40	5	5	5	5	5
	41	5	5	5	5	5
	42	5	5	5	5	5
	43	5	5	5	5	5
	44	5	5	5	5	5
07	45	5	5	5	5	5.0 — 5 120
08	46	5	5	5	5	5
	47	5	5	5	5	5
	48	5	5	5	5	5
	49	5	5	5	5	5
	50	5	5	5	5	5
13	51	5	5	5	5	5.0 — 5 120
14	52	0	0	5	5	3
	53	5	5	5	5	5
	54	5	5	5	15	8
	55	10	25	20	15	18
	56	5	5	5	5	5
19	57	5	5	5	10	7.3 — 6 175
20	58	5	5	5	5	5
	59	5	5	5	5	5

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
22	00	5	5	5	0	4
	01	5	5	5	5	5
	02	5	25	5	5	10
25	03	10	5	5	5	5.8 ← 6
26	04	0	5	0	5	2
	05	5	5	5	0	4
	06	0	5	5	5	4
	07	5	5	5	5	5
	08	5	5	5	5	5
31	09	5	5	5	5	4.2 ← 5
32	10	5	5	5	0	4
	11	0	0	0	0	0
	12	5	5	5	5	5
	13	0	5	5	5	4
	14	5	0	5	0	3
37	15	0	0	5	5	2.9 ← 3
38	16	0	5	5	5	4
	17	5	5	0	5	4
	18	5	5	5	0	4
	19	5	5	5	5	5
	20	5	5	5	5	5
43	21	5	0	5	5	4 ← 5
44	22	0	0	0	0	4.2 ← 0
	23	0	5	5	5	4
	24	5	5	5	5	5
	25	5	5	0	5	4
	26	5	5	5	0	4
49	27	0	0	0	0	2.7 ← 0
50	28	0	0	0	0	0
	29	5	5	5	5	5

140

100

70

100

65

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
52	30	5	15	5	5	8
	31	5	0	5	5	4
	32	5	5	5	5	5
55	33	5	5	0	5	4.2 ⌐ 4 100
56	34	5	5	5	10	6
	35	5	5	5	5	5
	36	5	5	5	5	5
	37	5	5	5	5	5
1700	38	10	0	5	0	4
01	39	10	10	25	25	17.1 ⌐ 18 170
02	40	20	20	5	5	13
	41	10	5	5	10	8
	42	5	5	5	5	5
	43	5	5	5	5	5
	44	5	5	5	5	5
07	45	5	5	5	20	9.3 ⌐ 9 175
08	46	15	15	15	15	15
	47	15	15	15	10	14
	48	10	5	10	10	9
	49	20	20	10	10	15
	50	10	5	5	5	8
13	51	5	5	10	5	10.8 ⌐ 8 260
14	52					
	53					
	54					
	55					
	56					
	57					
	58					
	59					

SUMMARY
RECORD OF VISIBLE EMISSIONS

Type of Plant _____ Date 1-28-79

Company Name _____ Hours of Observation _____

Plant Address _____ Observer Opthoff (Schick)

Type of Discharge STACK OTHER _____

Discharge Location _____

Height of Point of Discharge: _____ P-3

Observer's Location:

Distance to Discharge Point _____

Height of Observation Point 10'

Direction from Discharge Point SW

Background Description Mostly Sunny Skys

Weather: (Clear) Overcast (Partly Cloudy) Other _____ Color _____

Wind Direction NNE 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 _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
1225	00	15	15	15	15	P-3
	01	15	15	15	10	
	02	10	10	10	10	
	03	15	*	*	10	Quench steam obscuring view
	04	10	10	10	10	
30	05	10	15	15	10	12.3 ✓ 270
31	06	10	10	10	5	9 Test beginning
	07	5	5	5	5	5
	08	10	10	5	5	8
	09	5	5	5	5	5
	10	5	5	5	5	5
	11	5	5	5	5	6.0 ✓ 5 145
36	12	15	10	10	15	13
37	13	15	15	15	15	15
	14	15	20	10	15	15
	15	10	5	5	10	8
	16	5	10	10	5	8
42	17	5	5	5	5	5 10.4 ✓ 250
43	18	5	5	5	5	5
	19	5	10	10	15	10
	20	30	20	25	20	24
	21	20	10	15	15	15
	22	20	15	*	*	18 quench
48	23	*	*	*	*	13.9 ✓ 250
49	24	*	*	5	5	5
	25	10	10	10	10	10
	26	10	10	10	5	9
	27	5	10	10	10	9
	28	10	10	10	5	9
54	29	5	10	10	10	9 6.6 ✓ 190

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
55	30	10	10	10	10	10
	31	10	10	15	25	15
	32	10	10	10	5	9
	33	10	10	15	5	10
	34	5	5	15	10	9
1300	35	5	10	10	5	10 ~~8~~ 240
01	36	5	10	10	10	
	37	5	5	5	5	5
	38	5	10	10	10	9
	39	5	5	5	5	5
	40	5	5	5	5	5
06	41	5	5	0	5	A 6.0 145
07	42	5	5	10	5	6
	43	10	5	5	0	5
	44	0	0	0	0	0
	45	5	5	5	5	5
	46	5	5	5	5	5
12	47	5	5	5	5	5 4.4 105
13	48	5	5	15	20	11
	49	20	20	15	20	19
	50	20	20	15	15	18
	51	20	25	20	15	20
	52	15	20	15	15	16
18	53	15	10	10	5	10 15.6 375
19	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
1324	59	5	5	5	5	5 5.0 120

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
1325	00	5	5	5	5	
	01	5	5	5	5	
	02	5	0	0	0	
	03	0	5	15	15	
	04	5	10	5	10	150
1330	05	10	15	10	5	6.3 port change time
	06					
1611	07	5	40	15	5	16 after lunch, meter repair
	08	5	5	5	5	5 and port change
	09	10	5	5	*	7 same location as from first
14	10	*	5	5	5	5 hall
	11	5	*	*	0	5 switch steam
16	12	*	*	*	*	7.8 ~ 125
17	13	*	0	5	0	2
	14	5	10	10	10	9
	15	10	5	5	5	6
	16	5	5	5	5	5
	17	5	10	5	5	6
22	18	5	5	5	5	5 5.7 ~ 130
23	19	5	5	5	5	15
	20	*	30	20	15	23 * means interference from push smoke
	21	*	*	*	*	—
	22	*	10	10	10	10
	23	15	15	10	10	15
28	24	5	5	5	10	10.6 ~ 190
29	25	20	20	15	15	16
	26	20	10	10	10	12
	27	15	15	20	10	15
	28	20	15	15	20	18
33	29	15	15	15	10	14

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
34	30	15	15	15	20	15.4 ~ 16 ~ 370
35	31	10	10	25	20	16
	32	15	*	*	*	Quenching 15
	33	*	*	*	*	— 0
	34	*	*	20	*	20
	35	15	10	5	10	10
40	36	5	10	15	10	10 12.9 ~ 180 ~
41	37	10	10	15	5	10
	38	10	20	25	15	18
	39	15	10	10	20	14
	40	20	20	20	20	20
	41	15	20	20	20	19
46	42	10	10	10	10	10 ~~15.0~~ 15.0 ~ 3160
47	43	15	5	5	5	8
	44	5	5	10	5	6
	45	10	5	5	5	6
	46	5	5	5	10	6
	47	10	5	15	15	11
52	48	15	10	5	5	7.7 ~ ~~8~~ 9 185
53	49	10	5	5	15	9
	50	10	10	10	10	10
	51	10	10	15	15	13
	52	10	10	*	*	10
	53	*	*	*	*	—
56	54	*	*	*	15	10.7 ~ 15 160
59	55	10	10	15	10	11
	56	15	15	20	15	16
	57	15	10	10	20	14
	58	20	15	15	20	18
MD3	59	15	15	15	15	15

Company Name _____ Date _____

Plant Address _____ Observer _____

Stack Location _____ Observer's Location _____

Weather Conditions _____

TIME HR	MIN	SECONDS 00	15	30	45	COMMENTS
04	00	20	20	20	20	15.4 ~ 20 — 375
05	01	15	10	10	20	
	02	25	15	15	15	
	03	15	15	20	10	
	04	*	*	*	*	—
	05	*	*	*	*	—
10	06	*	*	*	*	15.4 ~ — 185
11	07	5	5	10	15	
	08	10	10	10	5	
	09	10	10	5	5	
	10	10	5	5	5	
	11	10	5	5	5	
16	12	5	5	5	5	7.1 ~ 5 — 170
17	13	5	5	5	5	
	14	5	5	5	10	
	15	15	15	20	20	
	16	20	20	20	15	
	17	15	15	10	10	
22	18	15	*	*	*	12.1 ~ 15 — 255
23	19	10	15	15	20	
	20	20	25	20	20	
	21	15	*	*	*	
	22	15	15	15	15	
	23	15	15	10	10	
28	24	15	10	15	20	~~12.9~~ 15.7 ~ 15 — 330
29	25	15	15	15	10	
	26	15	15	15	15	
	27	10	10	15	15	
	28	15	15	15	10	
33	29	15	15	15	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
34	30	15	15	20	20	14.6 IE - 350
35	31	15	15	20	20	" -
	32	20	20	20	15	" -
	33	20	20	20	25	" -
1738	34	25	15	15	20	last over 19 - 305
	35					19.1
	36					
	37					
	38					
	39					
	40					
	41					
	42					
	43					
	44					
	45					
	46					
	47					
	48					
	49					
	50					
	51					
	52					
	53					
	54					
	55					
	56					
	57					
	58					
	59					

APPENDIX B-4

SUMMARY OF VISIBLE EMISSIONS

SUMMARY OF VISIBLE EMISSIONS
Run 1

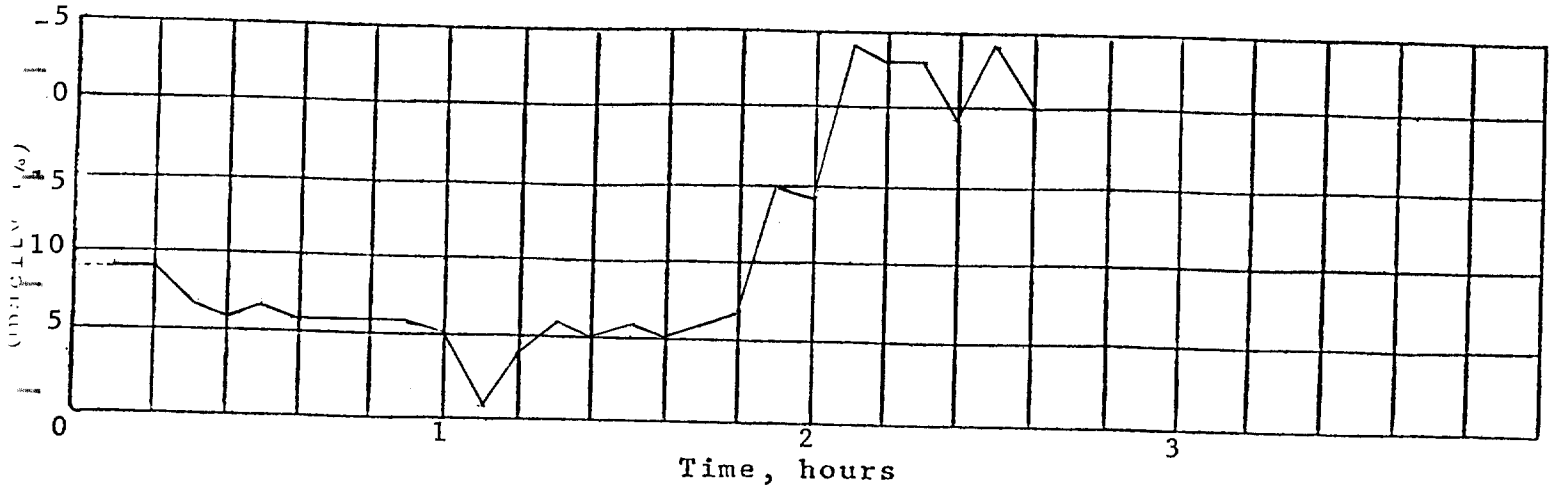
Date: 7/26/79
Type of Discharge: Exhaust stack
Height of Point of Discharge: 150 ft
Wind Direction: Southwest
Color of Plume: Black
Observer's Name: D. Opthoff
Distance from Observer to Discharge Point: 200 ft
Direction of Observer from Discharge Point: South
Height of Observation Point: Ground Level
Description of Background: Mostly cloudy sky

Type of Plant: Coke plant
Location of Discharge: Battery C
Description of Sky: Mostly cloudy
Wind Velocity: 0-5 mph
Detached Plume: No
Duration of Observation: 2 hrs. 31 min.

SUMMARY OF AVERAGE OPACITY

Set Number	Time		Opacity		Set Number	Time		Opacity	
	Start	End	Sum	Average		Start	End	Sum	Average
1	1515	1520	190	8	21	2020	2025	570	24
2	1521	1526	190	8	22	2026	2031	550	23
3	1527	1532	105	7	23	2032	2037	540	23
4	1533	1538	135	6	24	2038	2043	465	19
5	1539	1544	155	7	25	2044	2049	585	24
6	1545	1550	140	6	26	2050	2055	450	20
7	1551	1556	140	6	27				
8	1557	1600	110	6	28				
9	1606	1611	135	6	29				
10	1612	1617	110	5	30				
11	1618	1623	20	1	31				
12	1624	1629	85	4	32				
13	1630	1635	135	6	33				
14	1636	1641	95	5	34				
15	1642	1647	145	6	35				
16	1648	1653	115	5	36				
17	1654	1659	100	6	37				
18	1700	1702	80	7	38				
19	2008	2013	350	15	39				
20	2014	2019	330	14	40				

Sketch Showing How Opacity Varied With Time:



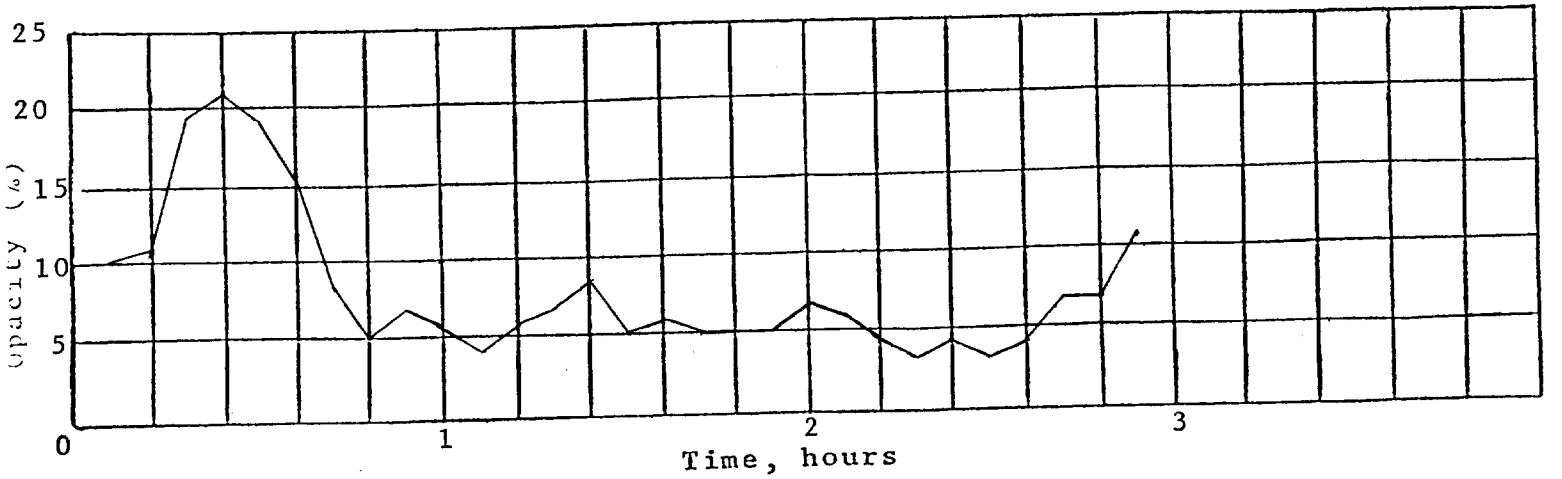
SUMMARY OF VISIBLE EMISSIONS
Run 2

Date: 7/27/79
Type of Discharge: Exhaust stack
Height of Point of Discharge: 150 ft
Wind Direction: Southwest
Color of Plume: Black
Observer's Name: D.Opthoff
Type of Plant: Coke plant
Location of Discharge: Battery C
Description of Sky: Overcast
Wind Velocity: 0-5 mph
Detached Plume: No
Duration of Observation: 2 hrs. 45 min.
Distance from Observer to Discharge Point: 200 ft
Direction of Observer from Discharge Point: South
Height of Observation Point: Ground Level
Description of Background: Grey Sky

SUMMARY OF AVERAGE OPACITY

Set Number	Time		Opacity		Set Number	Time		Opacity	
	Start	End	Sum	Average		Start	End	Sum	Average
1	1305	1310	235	10	21	1620	1625	140	6
2	1311	1316	260	11	22	1626	1631	100	4
3	1317	1322	340	19	23	1632	1637	70	3
4	1323	1328	495	21	24	1638	1643	100	4
5	1329	1334	360	19	25	1644	1649	65	3
6	1335	1340	350	16	26	1650	1655	100	4
7	1341	1346	190	8	27	1656	1701	170	7
8	1347	1352	130	5	28	1702	1707	175	7
9	1353	1358	155	7	29	1708	1713	260	11
10	1359	1404	140	6	30				
11	1405	1408	70	4	31				
12	1507	1512	140	6	32				
13	1513	1515	70	7	33				
14	1538	1543	200	8	34				
15	1544	1549	125	5	35				
16	1550	1555	135	6	36				
17	1556	1601	120	5	37				
18	1602	1607	120	5	38				
19	1608	1613	120	5	39				
20	1614	1619	175	7	40				

Sketch Showing How Opacity Varied With Time:



SUMMARY OF VISIBLE EMISSIONS
Run 3

Date: 7/28/79
Type of Discharge: Exhaust stack
Height of Point of Discharge:
Wind Direction: North-Northeast
Color of Plume: Mostly Sunny
Observer's Name: D. Opthoff

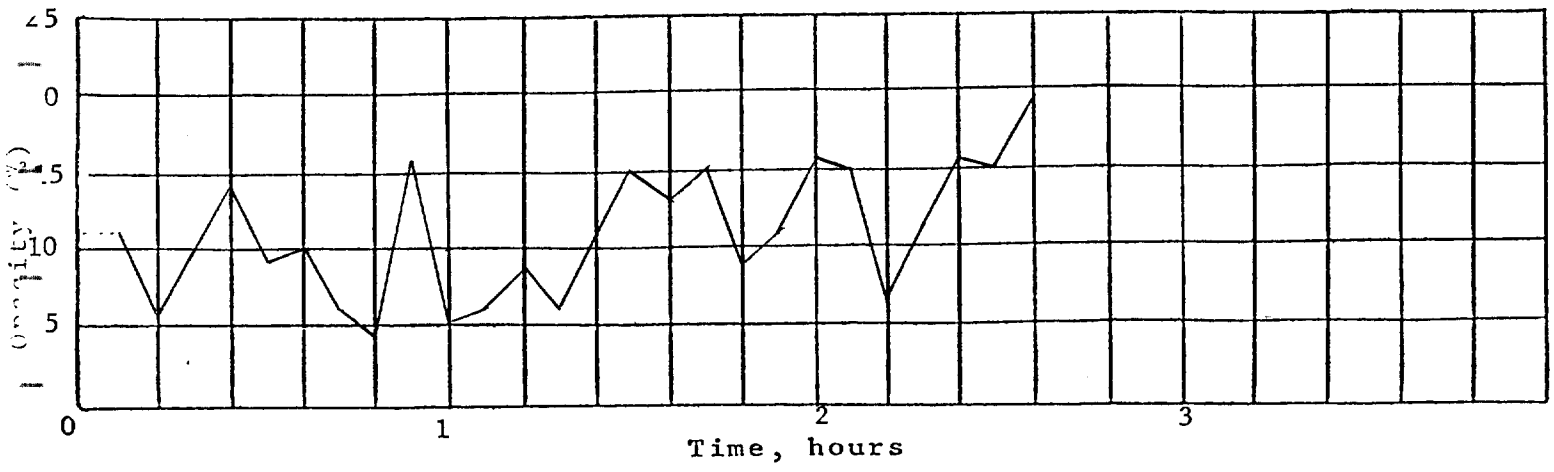
Type of Plant: Coke plant
Location of Discharge: Battery C
Description of Sky: Mostly Sunny
Wind Velocity: 5-10 mph
Detached Plume: No
Duration of Observation: 2 hrs. 34 min.

Distance from Observer to Discharge Point: 300 ft.
Direction of Observer from Discharge Point: Southwest
Height of Observation Point: 10 ft
Description of Background: Mostly sunny to partly cloudy sky

SUMMARY OF AVERAGE OPACITY

Set Number	Time		Opacity		Set Number	Time		Opacity	
	Start	End	Sum	Average		Start	End	Sum	Average
1	1225	1230	270	12	21	1705	1710	185	15
2	1231	1236	145	6	22	1711	1716	170	7
3	1237	1242	250	10	23	1717	1722	255	12
4	1243	1248	250	14	24	1723	1728	330	16
5	1249	1254	190	9	25	1729	1734	350	15
6	1255	1300	240	10	26	1735	1738	305	19
7	1301	1306	145	6	27				
8	1307	1312	105	4	28				
9	1313	1318	375	16	29				
10	1319	1324	120	5	30				
11	1325	1330	150	6	31				
12	1611	1616	125	8	32				
13	1617	1622	130	6	33				
14	1623	1628	190	11	34				
15	1629	1634	370	15	35				
16	1635	1640	180	13	36				
17	1641	1646	360	15	37				
18	1647	1652	185	8	38				
19	1653	1658	160	11	39				
20	1659	1704	375	16	40				

Sketch Showing How Opacity Varied With Time:



APPENDIX B-5

PROCESS DATA*

* Note: Process operating data and copies of operating charts have not been included in this Appendix, since National Steel has claimed them to be confidential.

TEST NO. 1

JULY 26, 1979

Run #1

Date 7/26/79 Run # 1
Plant Name Granite City Steel
Location Granite City, ILL.
Battery No. C

COKE OVEN BATTERY LOG SHEET

Oven Pushing Data			Oven Charging Data		
Oven No.	Time Pushed	Push Greenness*	Oven No.	Time ~~Charged~~ Leveled	Comments
194	428 PM	5	184	4:20 PM	B&P Sampling Started 3:05 PM
116	440	4	194	442 PM	
136	457	5	116	458	
156	513	5	136	513	
186	611	5	156	524	
141	~8:20	N.R.	141	~8:24	
171	8:30	4	171	8:38	Nite time Ratings
191	8:39	5	191	8:50	
113	8:49	5	113	~9:00	
~~185~~	~~N.R.~~	~~N.R.~~			
133	10:11 PM	3	133	1023	CO ½% O_2 13%, CO_2 -3½%
143	1022	4	143	1034	
173	1032	5			1045 All Sampling Completed
183					

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

N.R. — No Reading Taken

ESP OPERATING DATA

Unit 1

Time test started _____ Date 7/26/79

Time test ended _____ Plant personnel _____

Hold periods _____

						ESP No. 1															ESP No. 2									
						Inlet Unit #1	Fields 1+3					Fields 2+4					For Unit #1	F 1+3					F 2+4						
	Transmissometer Reading	Stack Gas Temp.	Stack Gas - System Pressure	FAN Amperage #1	ESP Inlet #1 Pressure	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	Rapping Period	Rapping Frequency	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	AC Voltage	AC Current	DC Current	DC Voltage	Spark Rate	Rapping Period	Rapping Frequency	Stack Gas Temp.
Units	%	°F	in H2O	AMP	in.w.c	V	AMP	KV	mA	No. Rapping	SAME	SAME	KV	mA		Sec.	min	V	AMP	KV	mA	#/min	Same		mA	KV	#/min	Sec.	min	°F
Time																														
9:51 AM	62	720	3.1	120	.055	360	13.2	21	242	55			19.8	165		5	30	350	13.5	21.8	230	20			207	20.8	10	5	30	745
1230	62	760	3.1	140	.065	360	13.5	22	240	85			19.8	173	85	5	30	370	16.0	21.3	250	30			220	19.3	20	5	30	780
256 PM	62	720	3.2	135	.060	350	13.0	21.5	230	50			19.5	180	88	5	30	365	18.0	20.5	270	40			250	20.0	20	5	30	740
355	62	725	3.2	135	.06	350	14	20.5	240	60			19.0	178	86	5	30	360	17	20.5	250	25			235	19.8	28	5	30	725
556	63	750	2.9	132	.06	360	14	22	220	45			19.5	160	85	5	30	375	16	21	250	35			220	20	25	5	30	760
735	62	770	3.2	132	.055	370	11	23.5	180	45			20.5	140	85	5	30	405	12.5	22.5	205	23			190	22	15	5	30	780

ESP OPERATING DATA

Time test started 3:05 PM
Time test ended 10:45 PM
Hold periods ~6 hrs

Date 7/26/79
Plant personnel Mike MacDonald - Monitoring ESP for United McGill

ESP No. 3

	Transmissometer Reading	Stack Gas Temp.	Stack Gas Pressure	FAN Amperage	ESP Inlet Pressure	Unit #3 F1+3 AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	Unit #3 F2+4 AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	Rapping Period	Rapping Frequency	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	AC Voltage	AC Current	DC Current	DC Voltage	Spark Rate	Rapping Period	Rapping Frequency
Units		°F			in WC	V	Amp	KV	mA	no/min	V	Amp	KV	mA	no/min	sec	min												
Time																													
1010		755	SAME	SAME	.01	320	11	18	190	30	SAME		14.1	120	30	5	30												
1238		755			.015	310	8	18.2	193	45			19.5	90	30	5	30												
3:05		725			.010	305	8	18.5	187	28			19.0	90	25	5	30												
4:00		745			.01	308	7.8	18	220	26			18.8	88	20	5	30												
6:01		740			.01	310	7.3	19	180	35			19.2	80	20	5	30												
741		760			.01	340	6.1	19.2	145	25			14.2	70	28	5	30												

TEST NO. 2

July 27, 1979

R #2

Date 7/27/79
Plant Name Granite City Steel
Location Granite City, Ill.
Battery No. C

COKE OVEN BATTERY LOG SHEET

Run #2

Oven Pushing Data			Oven Charging Data		
Oven No.	Time Pushed	Push Greenness*	Oven No.	Time ~~Charged~~ Leveled	Comments
121	1:05 PM	N.R.	121	~ 1:20 PM	Start 1:07 PM
141	1:20 PM	4	141	~ 1:35	
171	2:01	5	171	207	
191	2:07	5	191	220	
113	N.R	N.R	113	N.R.	Port Change
133	~ 4:00	N.R	133	4:15	
143	4:13	4	143	449	
155	448	3	~~155~~	458	Near top of oven coke with flame looks like a [redacted] crack or scratch
173	458	3	173	508 PM	
183	505	6 1/2			Stop 5:12 PM

24 hr. Push → 155

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

ESP OPERATING DATA

Time test started 1:07 PM
Time test ended 5:12 PM
Hold periods

Date 7/27/79
Plant personnel Mike MacDonald - O. McG.
Columbus - Ohio

						#1 ESP F1+3						#1 ESP F2+4								#2 F1+3						#2 F2+4						
	Transmissometer Reading	Stack Gas Temp.	Stack Gas - System Pressure	FAN Amperage	ESP Inlet Pressure	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	Rapping Period	Rapping Frequency	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	AC Voltage	AC Current	DC Current	DC Voltage	Spark Rate	Rapping Period	Rapping Frequency	Gas Temp
Units	%	°F		Amp	in WC	V	Amp	KV	mA	#/min			KV	mA	#/min	sec		V	Amp	KV	mA	#/min				KV	#/min	sec	Min	°F
Time											STACK												STACK								
11:45	62	700	3.3	137	.06	350	14.5	21	275	50			18.5	165	85	5	30	360	18.5	20.5	300	22			270						
2:30	35	720	3.1	135	.05	380	15.5	22	260	40			20.5	195	80	5	30	380	18	21	260	22			240	21	20	5	30	740
4:30	30	695	3.2	135	.05	375	15.5	22	270	45			20.5	200	85	5	30	380	19.5	21.5	270	22			260	20.5	20	5	30	715

ESP OPERATING DATA

Time test started 1:07 PM
Time test ended 5:12 PM
Hold periods

Date 7/27/79
Plant personnel

Unit #3

Note: Unit #2 indicator isn't working.

	Transmissometer Reading	Stack Gas Temp.	Stack Gas Pressure	FAN Amperage	ESP Inlet Pressure	#3 AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	#3 AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	Rapping Period	Rapping Frequency	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	AC Voltage	AC Current	DC Current	DC Voltage	Spark Rate	Rapping Period	Rapping Frequency
Units		°F			in WC	V	Amp	KV	mA	PPS/min			KV	mA	PPS/min	Sec.	min												
Time			Source								SAME																		
1:55		710			.01	320	12.5	18	220	25			14.5	160	32	5	30												
2:36		720			.01	320	9	19	200	40			19	80	20	5	30												
		700																											

TEST NO. 3

July 28, 1979

Run #3

Date 7/28/79
Plant Name Granite City Steel
Location Granite City, Ill.
Battery No. C

COKE OVEN BATTERY LOG SHEET

Oven Pushing Data			Oven Charging Data		
Oven No.	Time Pushed	Push Greenness*	Oven No.	Time Leveled	Comments
115	NR	NR	183	11:00 AM	I can't make my initial chart recording because Da[...] not [...]
135	12:23	5	115	12:27	12:30 Sampling Started
145	12:43	5	135	12:42	
155	1:05	2-3	145	1:14	
185	1:13	~~3~~ 5	155	1:27	1:36 Port 1 Runs Finished
					Lunch Today-Yea!!
		~~4:10~~			
167	4:10	4	167	4:24	Port 2 - Started 4:15 PM
187	4:22	5	187	4:34	
112	4:30	NR	112	4:43	Filter change and Port [...]
142	4:53	N.R.	142	~5:15 PM	Checked Flues on oven 112 3 out of 7 ~~leaked~~
					5:39 Finished Sampling

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

Run #3

ESP OPERATING DATA

Time test started _____

Time test ended _____

Hold periods _____

Date 7/28/79

Plant personnel Don Hoffman

ESP Unit 1 | ESP Unit 2

Fields 1+3 | Fields 2+4 | Fields 1+3 | Fields 2+4

	Transmissometer Reading * - Doesn't work	Stack Gas Temp.	Stack Gas Pressure - Whole system	FAN Amperage	ESP Inlet Pressure - ESP #1	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	Rapping Period	Rapping Frequency	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	AC Voltage	AC Current	DC Current	DC Voltage	Spark Rate	Rapping Period	Rapping Frequency	Gas Temp. - Unit #2 ESP
Units	%	°F	in WC	Amp	in WC	V	Amp	KV	mA	NO./min			KV	mA	NO./min	S	min	V	Amp	KV	mA	NO./min			mA	KV	NO./min	S	Min	°F
Time											SAME												SAME							
10:52A	16	68	2.9	135	.05	380	16.5	22	260	55		21	220	85	5	30	370	18.5	22	290	27			260	18	40	5	30	700
12:14	44	750	2.9	135	.06	400	16	23	250	50			21	240	85	5	30	320	16.3	21	250	27			220	19.5	20	5	30	760
1:39	17	720	2.85	135	.055	380	15.5	22.5	280	55			20.5	200	85	5	30	350	17.5	21.2	240	30			250	21	17	5	30	730
5:17	69	700	2.85	135	.055	410	16	23.5	210	40			22	220	85	5	30	400	13.5	22	220	30			230	21.5	20	5	30	710

ESP OPERATING DATA

Time test started ______ Date 7/28/79

Time test ended ______ Plant personnel ______

Hold periods ______

ESP Unit 3

					ESP #3	F 1+3					F 2+4																		
	Transmissometer Reading	Stack Gas Temp.	Stack Gas Pressure	FAN Amperage	ESP Inlet Pressure	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	Rapping Period	Rapping Frequency	AC Voltage	AC Current	DC Voltage	DC Current	Spark Rate	AC Voltage	AC Current	DC Current	DC Voltage	Spark Rate	Rapping Period	Rapping Frequency
Units		°F	SAME		in. WC	V	Amp	kV	mA	no./min	SAME		KV	mA	no./min	s	min												
Time																													
1057		685			.005	310	8.2	19	210	30			14	80	20	5	30												
12:19		745			.01	320	7.0	20	200	25			20	80	22	5	30												
1:42		716			.005	295	7.0	19	190	32			18	80	22	5	30												
5:26		695			.01	320	7.0	20	170	28			19	70	27	5	30												

APPENDIX B-6

PROJECT DELAYS

TABLE B-6.1. PROJECT DELAYS

Sample Number	1979 Date	Time Interval	Delay
1	7/26	1541-1547	Lost power
		1552-1601	Lost power
		1630-2015	Port change and coordination
		2018-2034	Lost power
		2043-2047	Filter change - Inlet
		2132	Lost power
2	7/27	1409-1507	Port change and coordination
		1513-1540	Filter change - Inlet
		1612-1654	Filter change - Inlet
3	7/28	1330-1615	Port change and coordination
		1645-1710	Filter change - Inlet
			Power problems

APPENDIX C

SULFATE WEIGHT BY FRACTION

TABLE C-1. SULFATE WEIGHT BY FRACTION, MILLIGRAMS

Sampling Location	Sample Number	Front Acetone Wash	110-mm Type A Glass-Fiber Filter	Filterable Particulate	Back Acetone Wash	Impinger Contents and Water Wash	Total Particulate
Inlet C Battery	1	32	55	87	21	145 [a]	253
	2	194	109	303	<0.2	37	340
	3	39 [b]	82	121	1.0	24	146
Outlet C Battery	1	47	18	65	5.9	35	106
	2	350	65	415	0.3	6.0	421
	3	62 <0.2 [c] 30 [d]	83	175	0.6	4.5	180

[a] Original sample of aliquot was used for sulfate determination, all other determinations were made on the residue.

[b] An undetermined amount of the acetone wash was spilled when the sample bottle was accidentally broken.

[c] Methylene chloride rinse.

[d] Benzene rinse.

APPENDIX D

BENZENE DATA

EPA 6399-17
Granite City Steel

Benzene P-1
7-26-79

Chromatogram	ID	Area, × Attenuation	R.T.	Loop Temp
#1	N_2 Blank	0 × 4	—	210°F
4	5.14 ppm Benzene	102.5 × 16	2.22	
5	↓	103 × 16	2.22	
6	N_2 Blank	0 × 16	—	
9	Sample P-1	9.0 × 4	2.22	
10	↓	9.0 × 4	2.22	210°F
13	5.14 ppm Benzene	107.5 × 16	2.22	

Chromatogram	ID	Area × Atten	R.T.	Loop Temp
17	5.14 ppm Benzene	107.5 × 16	2.23 min	210°F
18	↓	106 × 16	2.23	
19	↓	109 × 16	2.23	210°F
20	↓	105 × 16	2.23	
21	N_2 Blank	0 × 4	—	
22	Sample P-3	12.5 × 4	2.23	
23	↓	13.5 × 4	2.22	210°F
27	5.14 ppm Benzene	103 × 16	2.22	
28	↓	100 × 16	2.22	
29	100.4 ppm Benzene	124 × 256	2.21	210°F
30	↓	126.5 × 256	2.21	
31	↓	129 × 256	2.21	

Results:

Sample	Benzene	Area	Factor	Bag Temp
P-1	0.11 ppm	36	ac=0 0.00307907 ppm/Area	79°F
P-3	0.16 ppm	52	ac=0 0.003057095 ppm/Area	79°F

Test P=1

Chromatograms

Attn=4 N_2 Blank

Head P. 24.8 psi

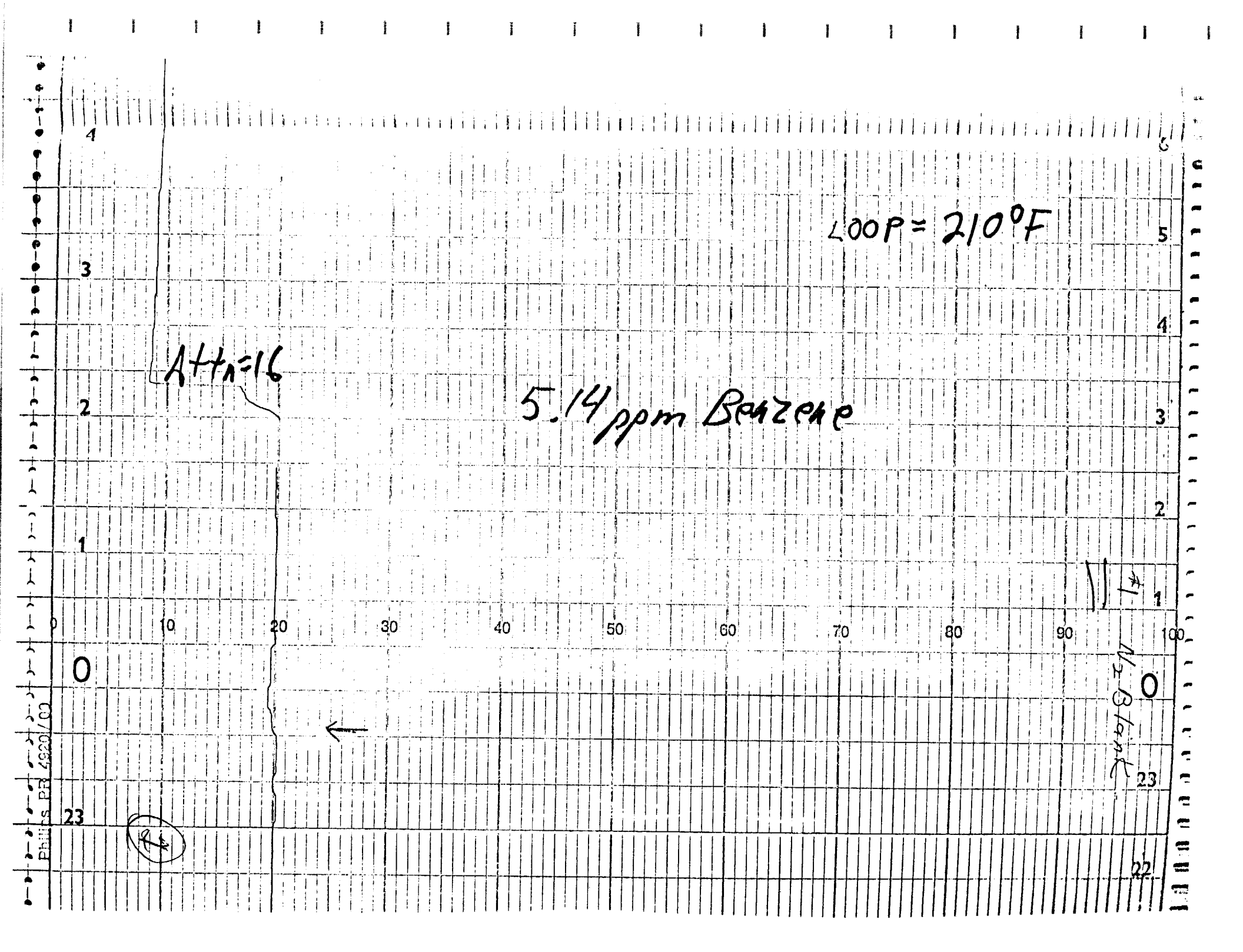
	ON	OFF
Oven	20	85
Inj.	131	85
Det.	105	105

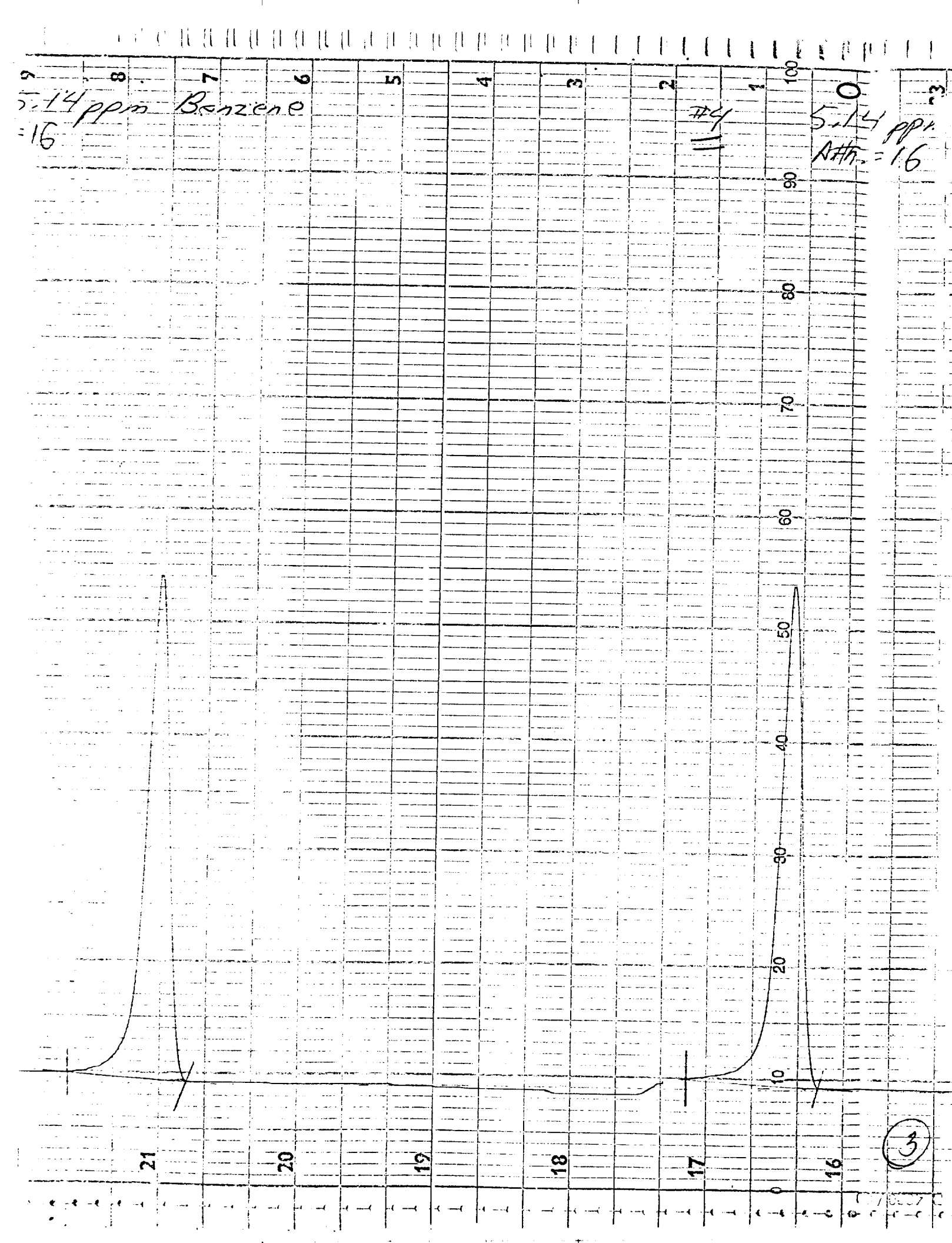
Range 1

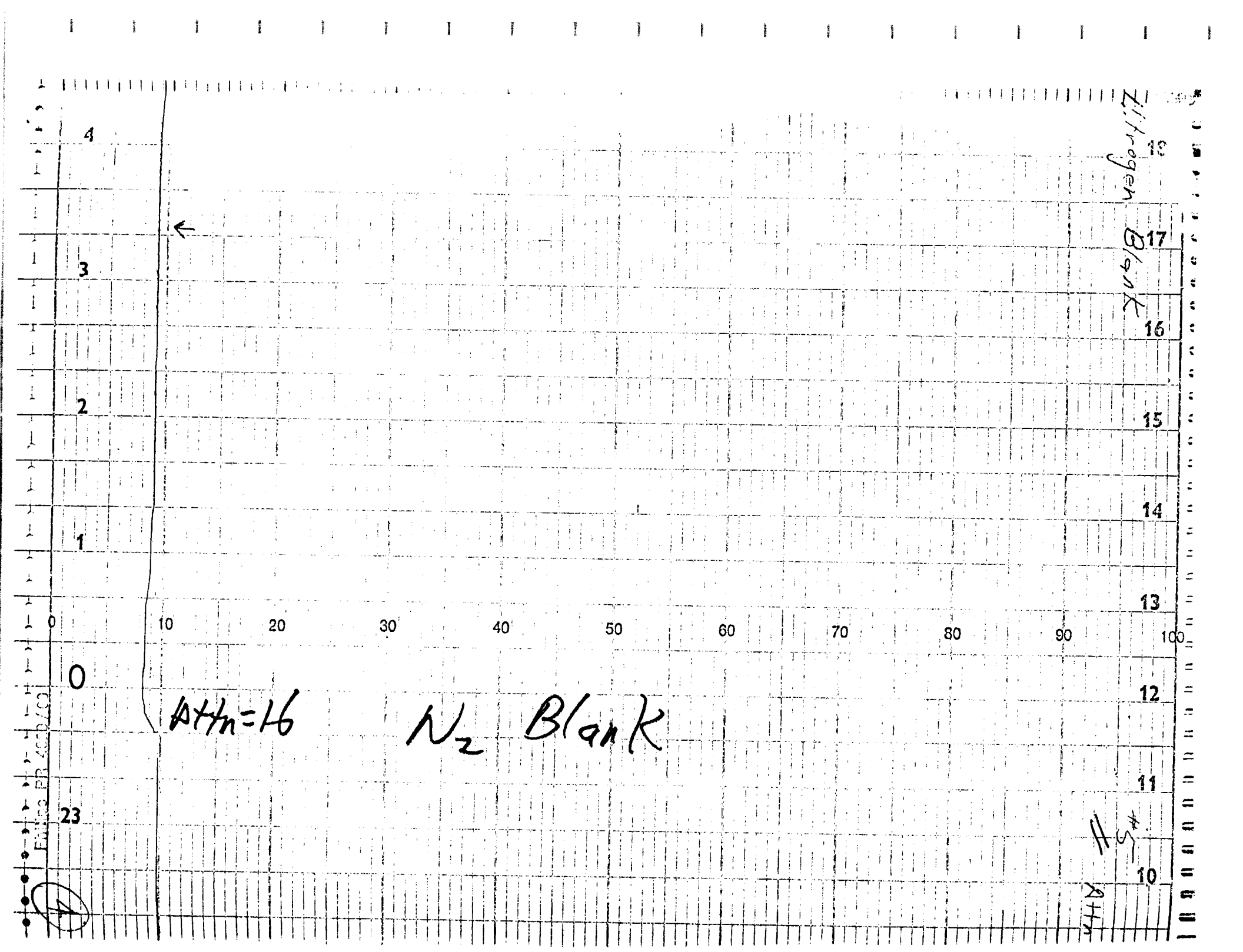
Chart 50mm/min

EPA Granite City Task #17

7-26-79


LOOP = 210°F
Attn=16
5.14 ppm Benzene
0
10
20
30
40
50
60
70
80
90
100
Phillips PR 4920/00


5.14 ppm Benzene
=16
#4
5.14 ppm
Ath. = 16
3


Zirkrogen Blank
Δttn=16
N_2 Blank
#5
Δttn
0
10
20
30
40
50
60
70
80
90
100

mple P-1
= 16

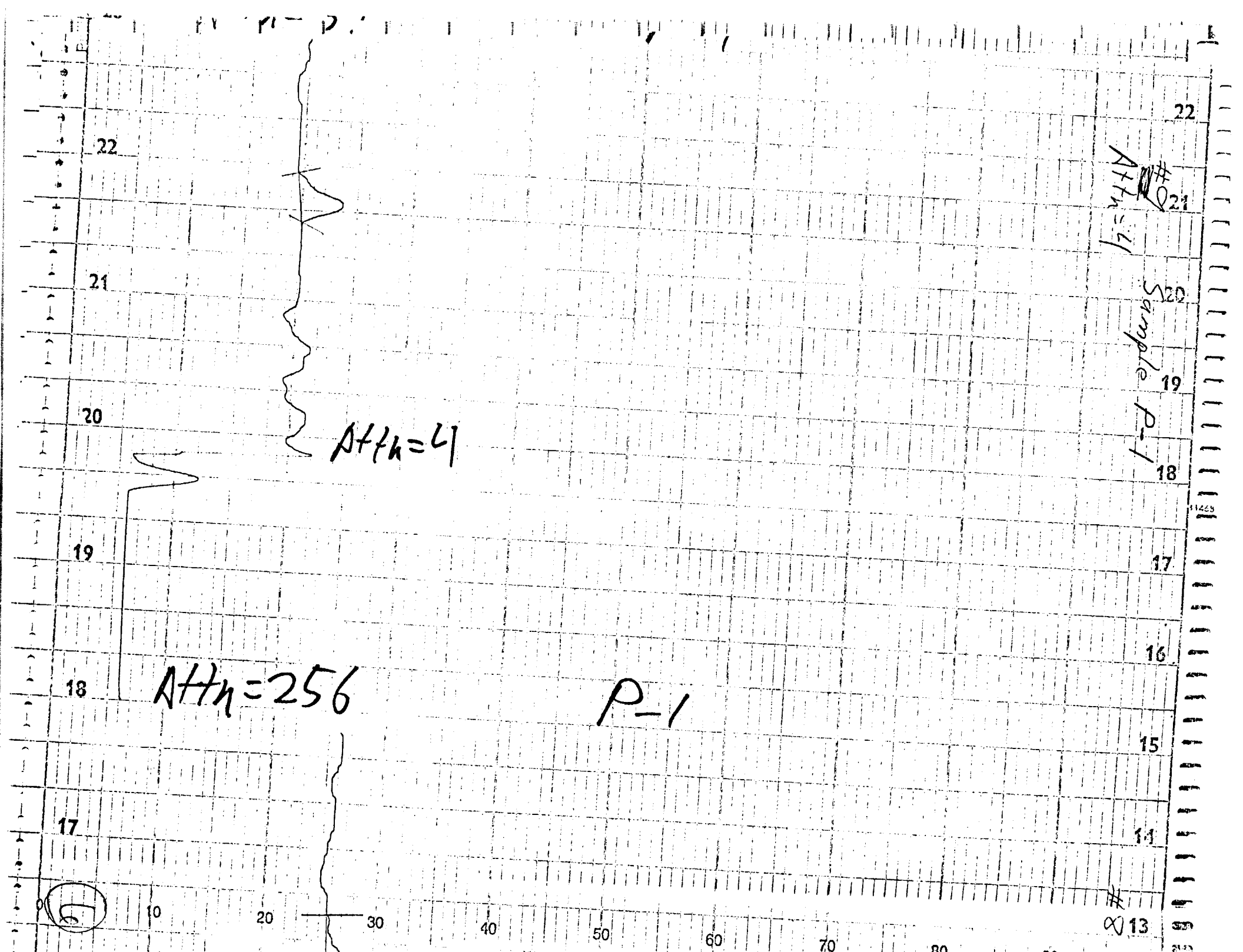
#6

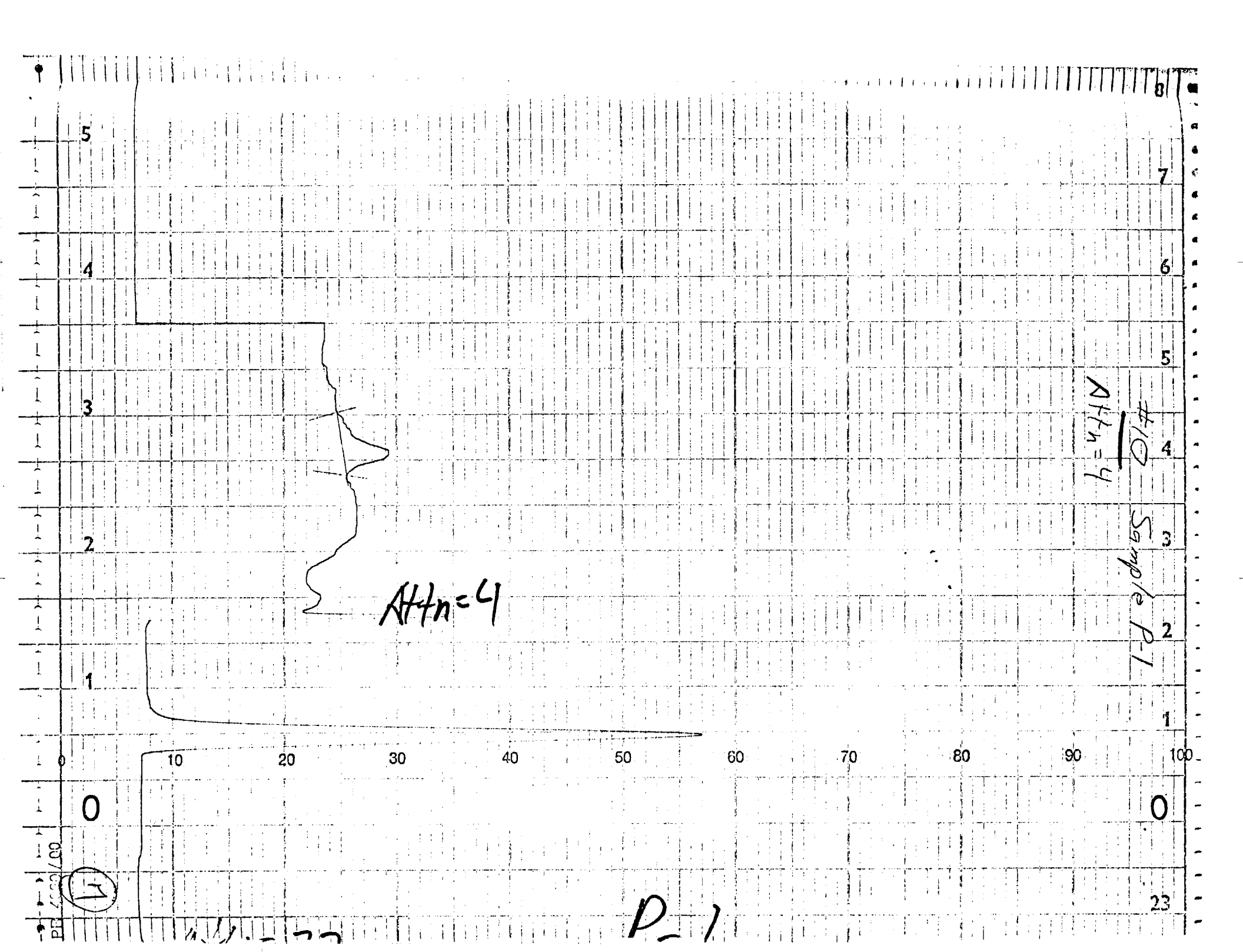
Nitro

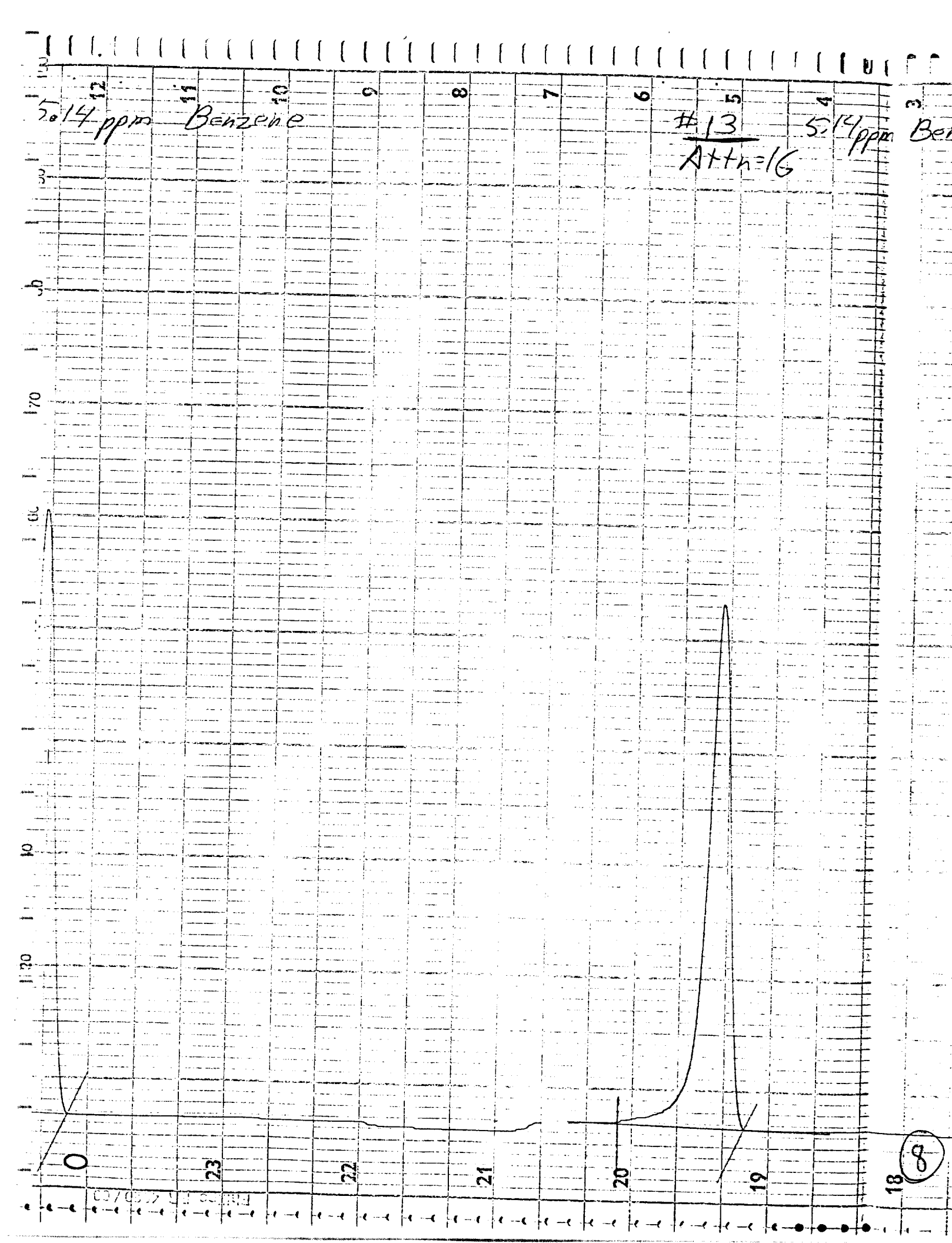
Sample P-1
7-26-79

ATH=16

(5)


Atth=4
Atth=256
P_1
Atth=4
Sample P_1
#Q
#13


#10
Sample P-1
ΔHn=4
ΔHn=4
P-1


5.14 ppm Benzene
#13
A+n=16
5.14 ppm Ben
12
11
10
9
8
7
6
5
4
3
170
140
120
23
22
21
20
19
18
8

Sample 23

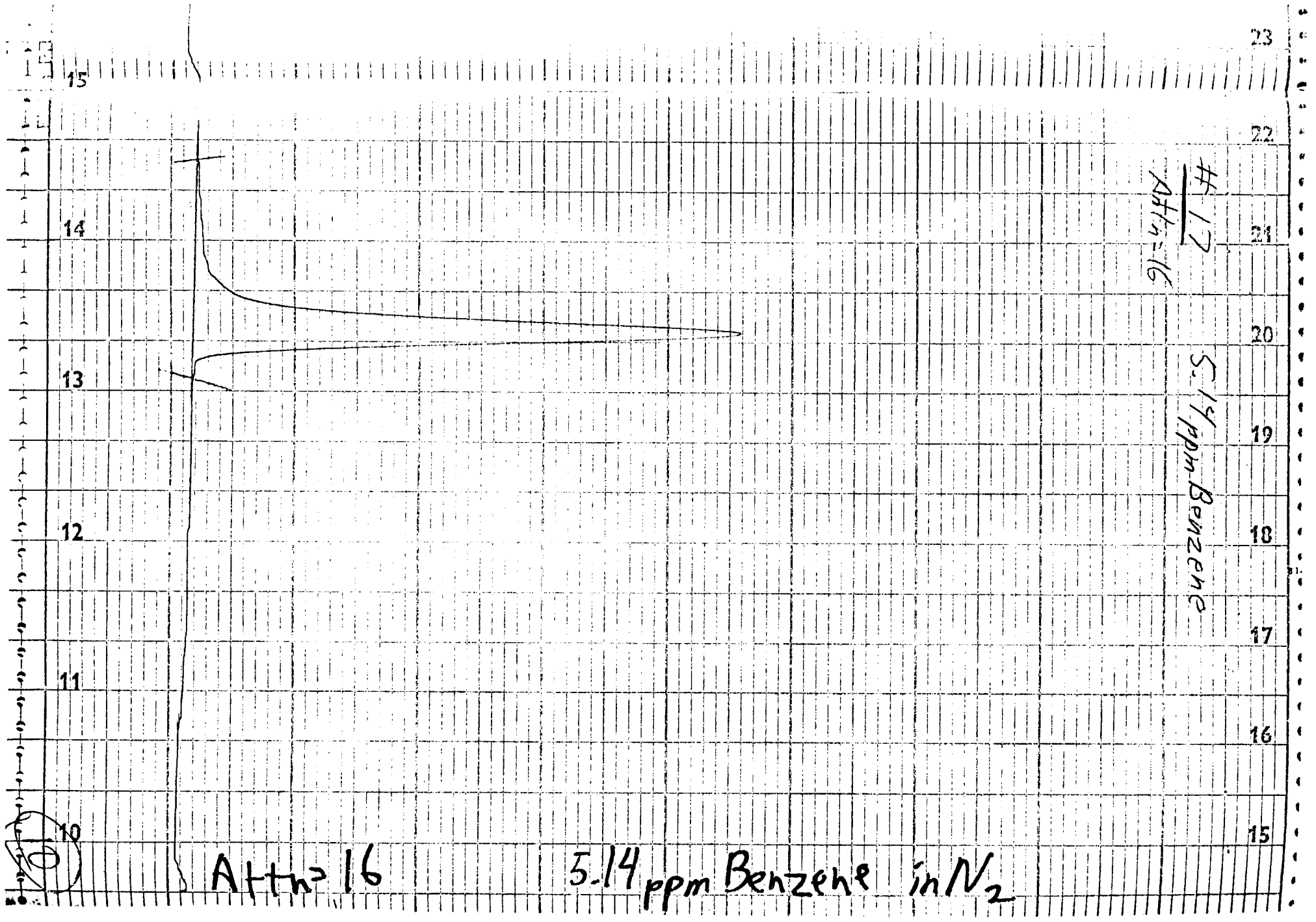
Chromatograms

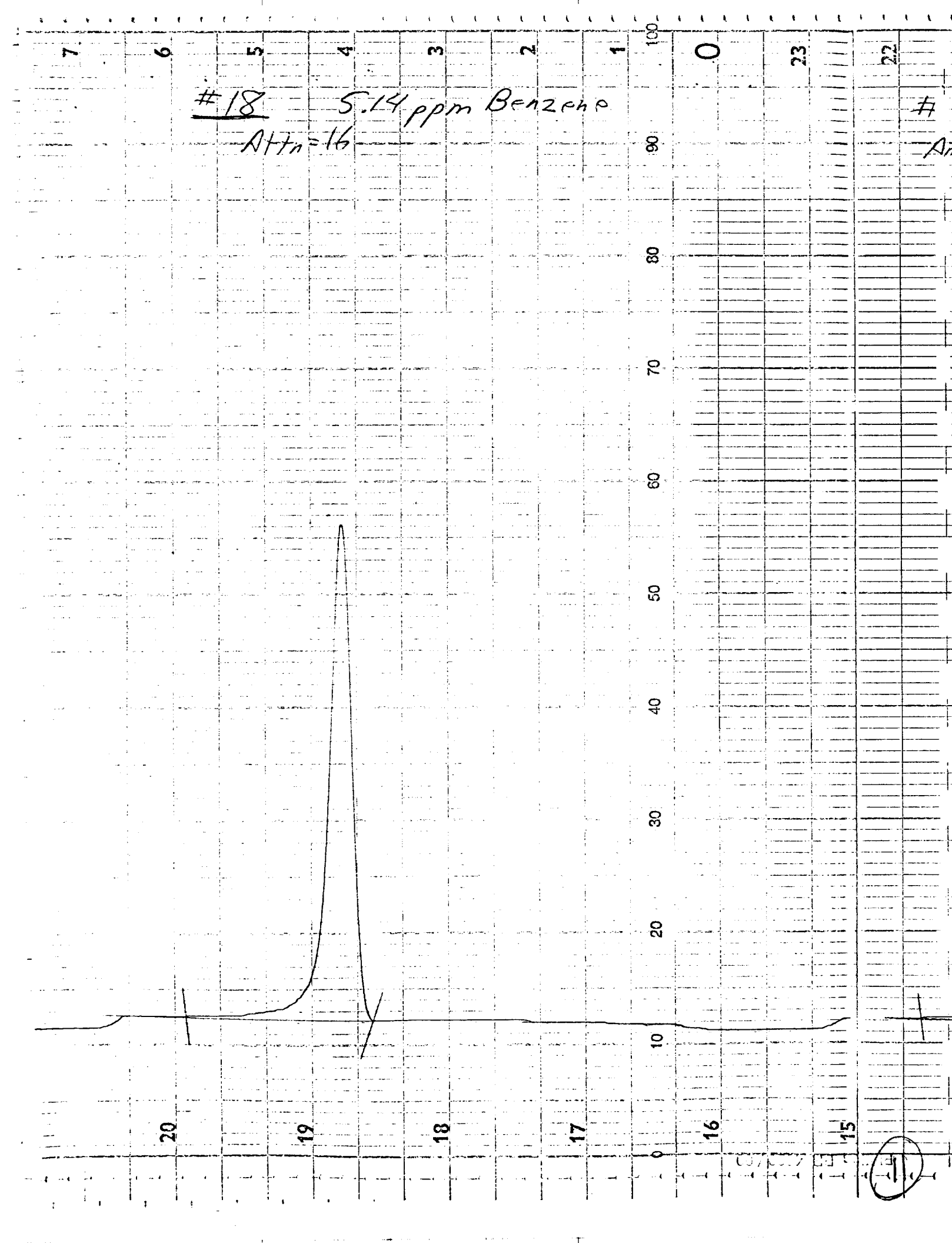
	Tank	Aid	Flow
N_2	38	~38 (24.6 Head)	10ml / 38.8sec
H_2	19	9.8	25 / 33.2
Air	35	19	25 / 11.2

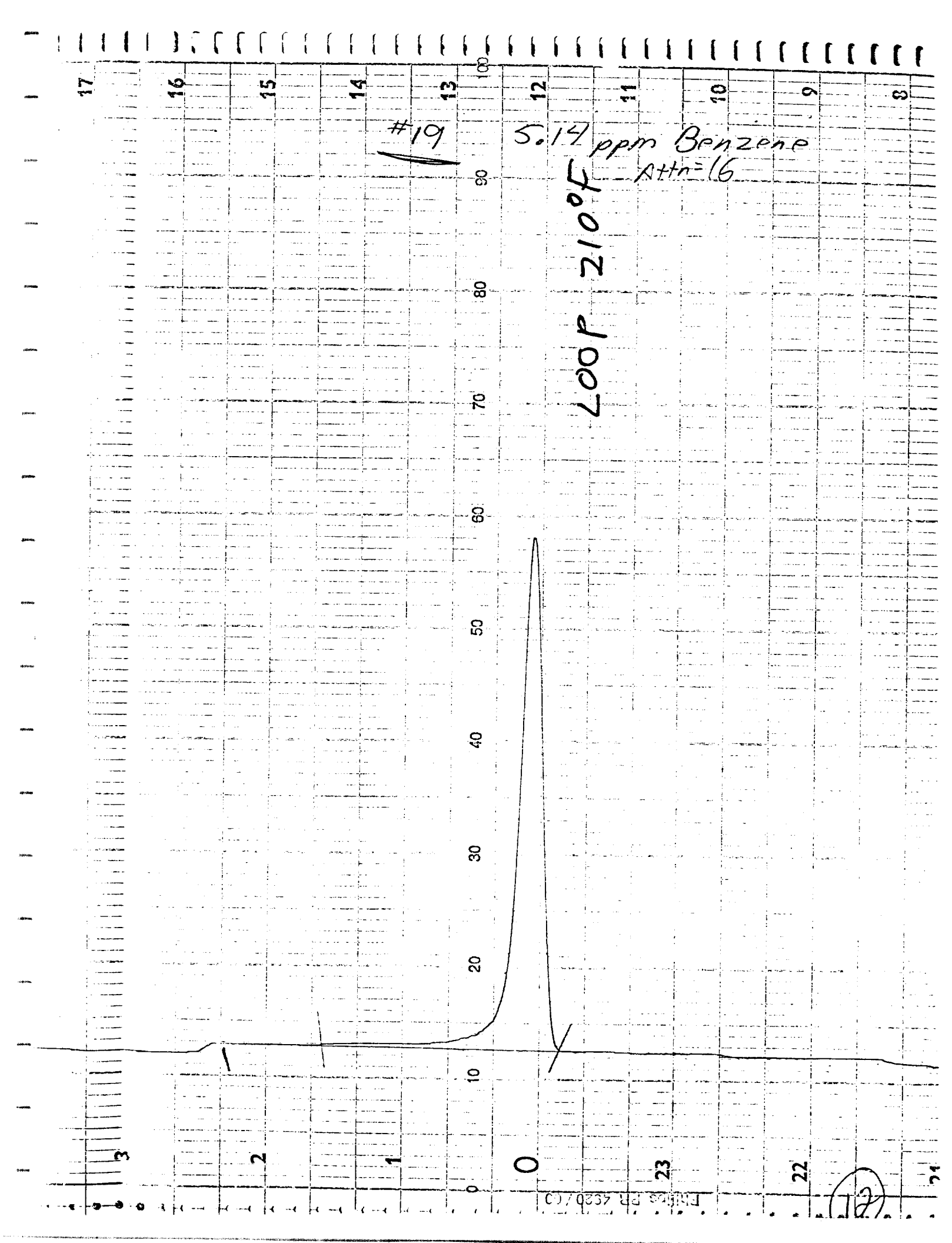
	ON	OFF
OVEN	30°-55	85
Inj.	120-105	85
Det.	105-105	105

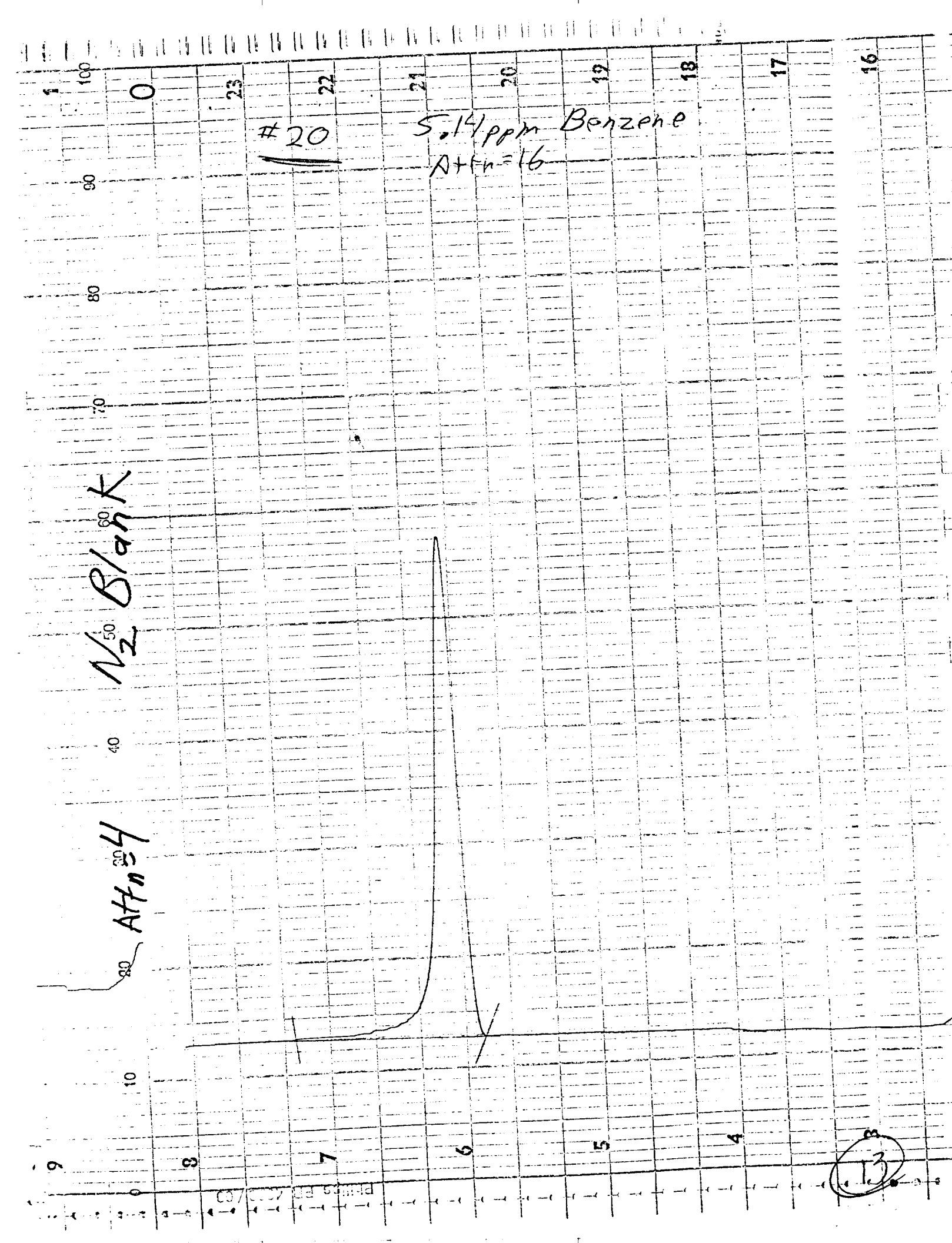
Head 24.6 psi
Chart 50mm/min
Loop 210°F @ 45v
Temp Set 500
Range = 1

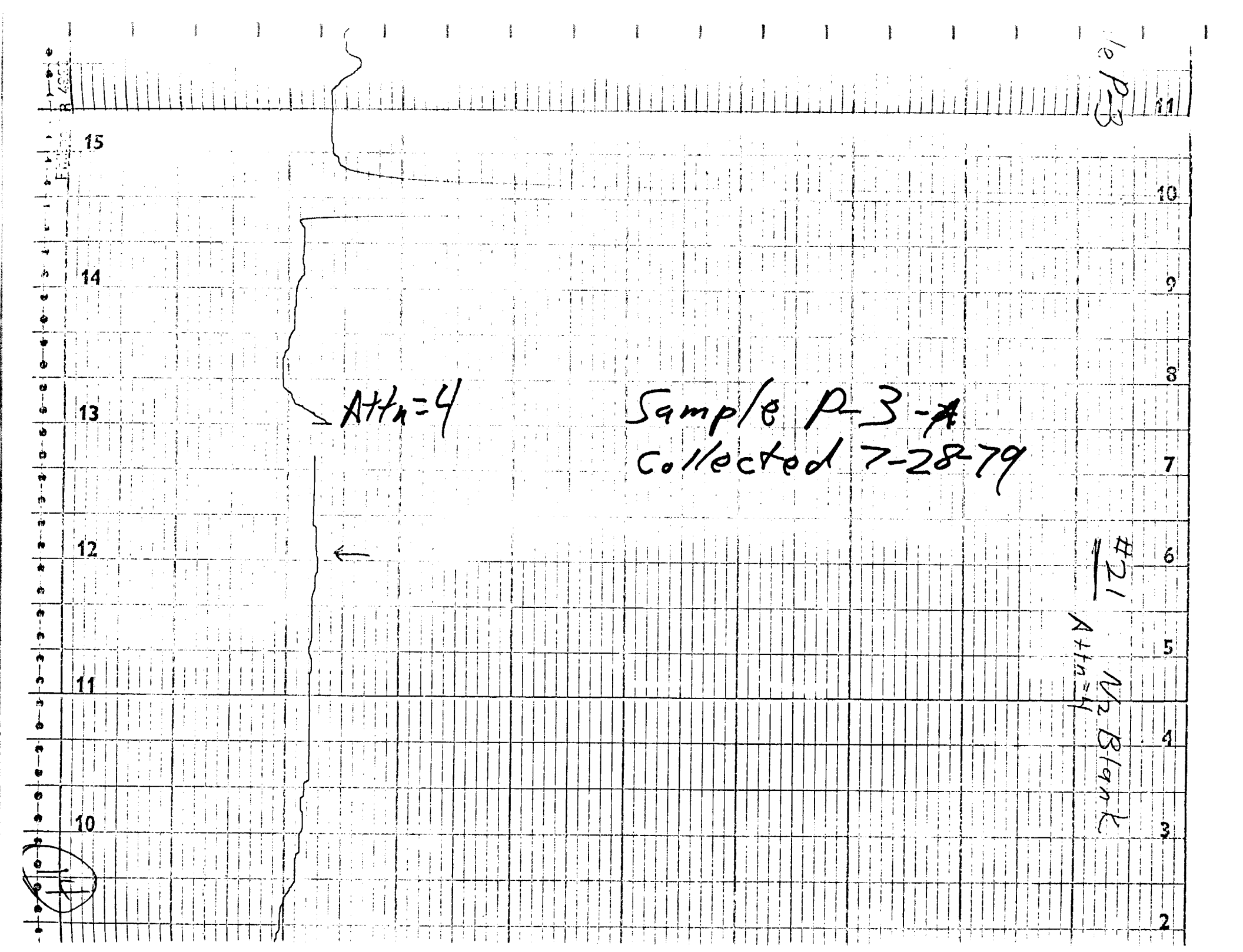
EPA 6399-17
Granite City Steel
7-28-79

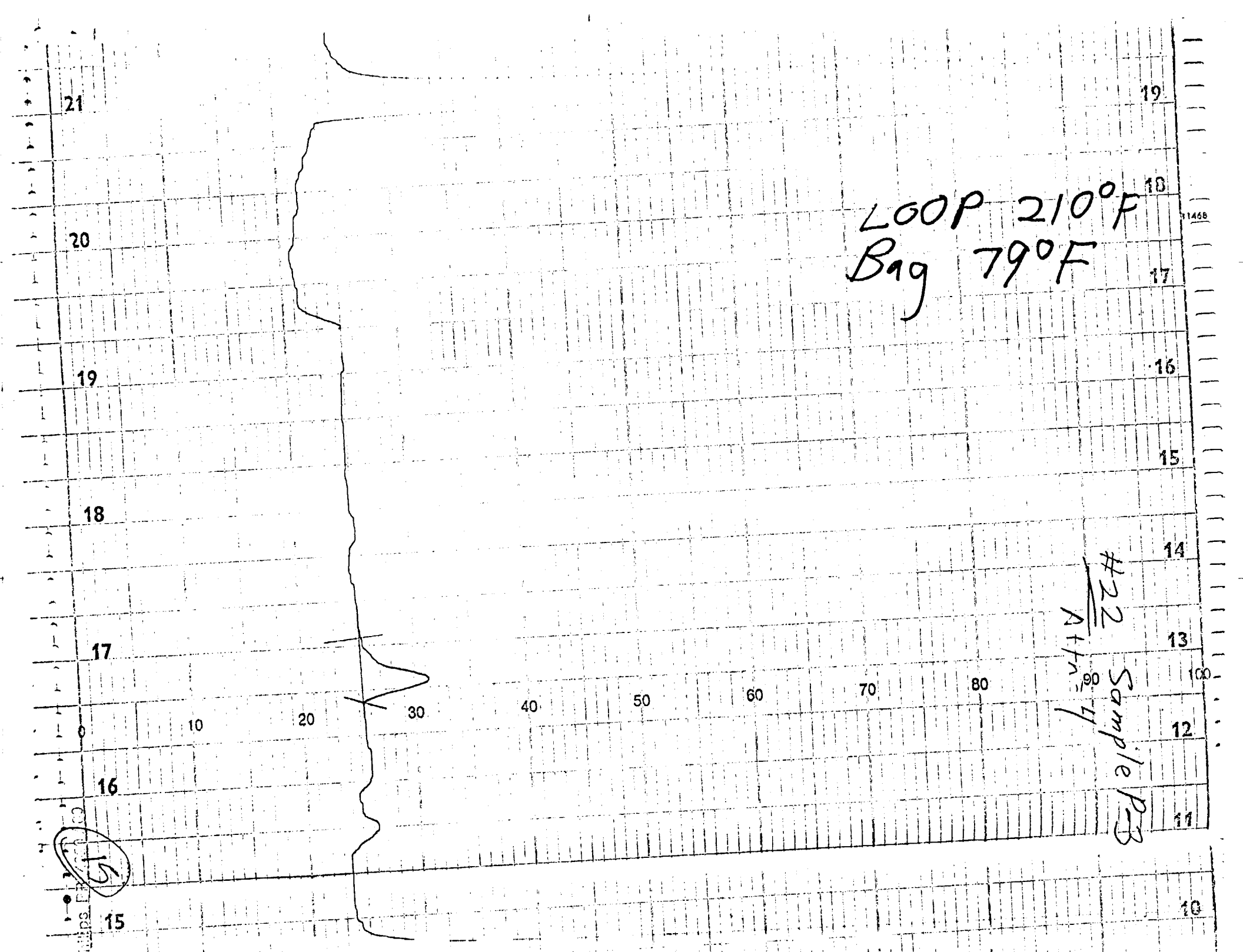

#17
Attn=16
5.14 ppm Benzene
Attn=16
5.14 ppm Benzene in N_2

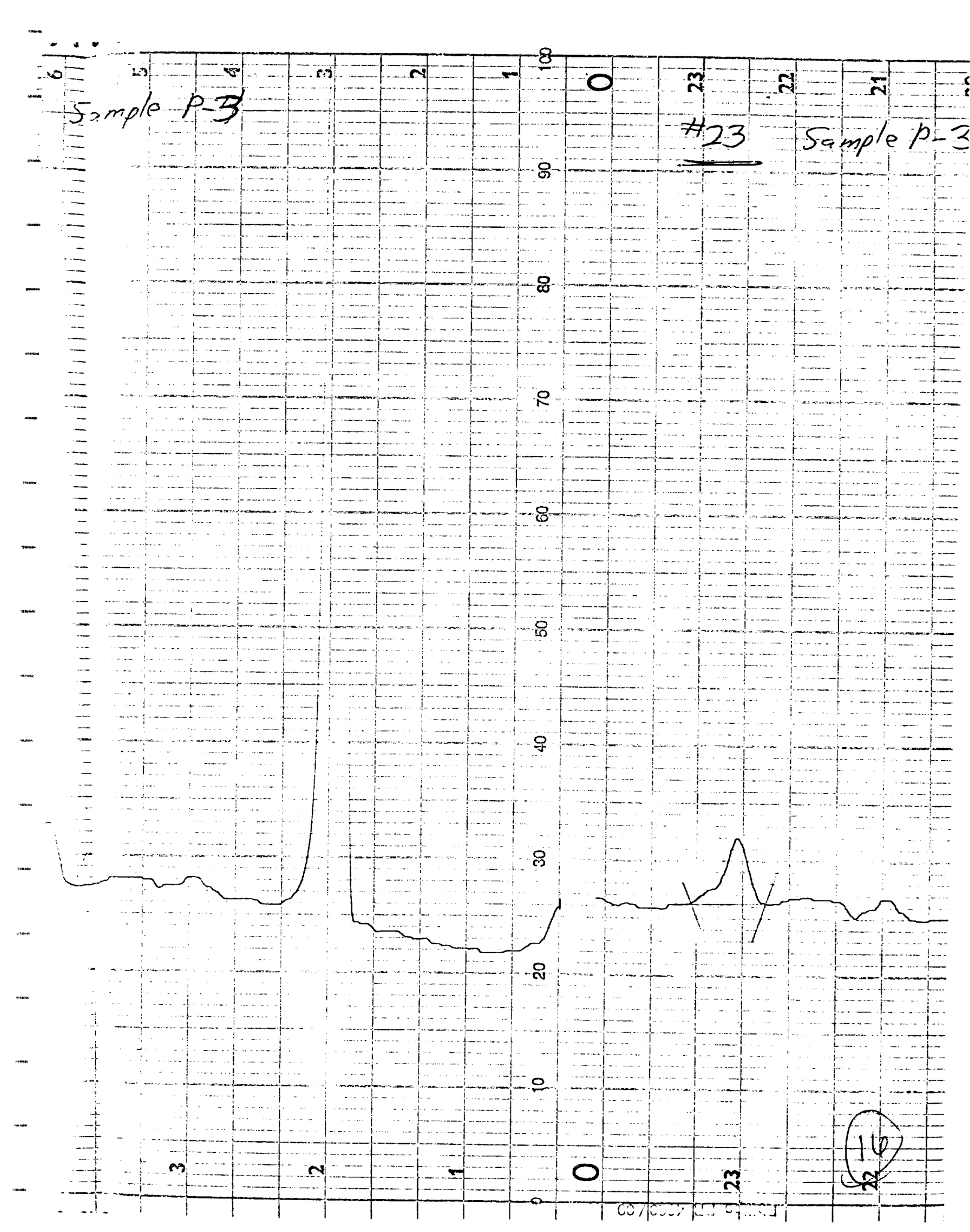

#18 5.14 ppm Benzene
Attn=16

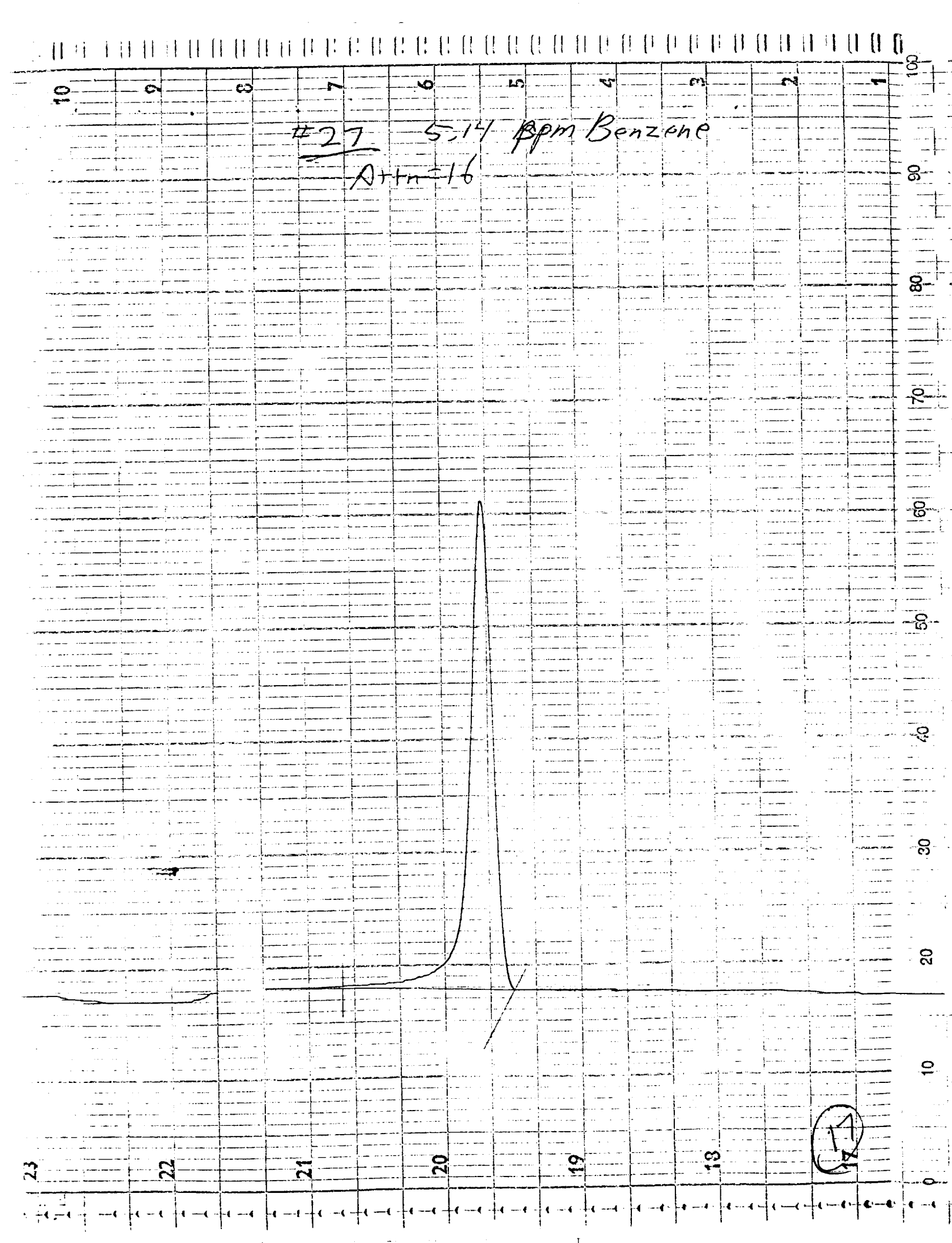

#19
5.14 ppm Benzene
Attn=16
Loop 210°F

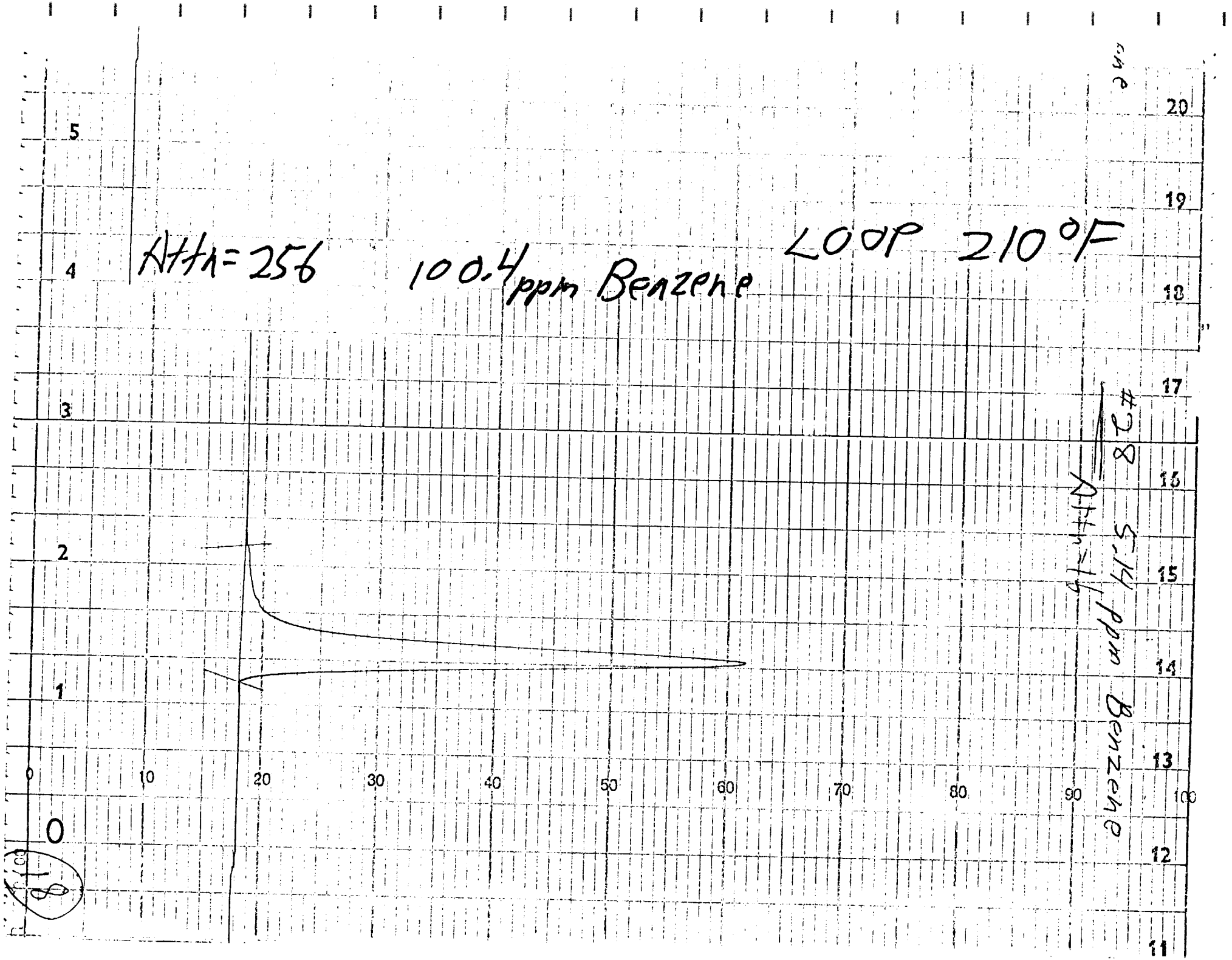

#20
5.14 ppm Benzene
Attn=16
1/2 Blank
Attn=4


Atten=4
Sample P-3-A
Collected 7-28-79
#21
N2 Blank
Atten=4


LOOP 210°F
Bag 79°F
#22
Ath
Sample B
0
10
20
30
40
50
60
70
80
90
100
11468


Sample P-3
#23
Sample P-3


#27 5.14 ppm Benzene
A+n=16


Area = 256
100.4 ppm Benzene
Loop 210°F
#28
Area = 14
5.14 ppm Benzene
0
0
10
20
30
40
50
60
70
80
90
100
1
2
3
4
5
11
12
13
14
15
16
17
18
19
20

APPENDIX E

CARBON MONOXIDE DATA

E-1. CARBON MONOXIDE FIELD DATA

E-2. SUMMARIES OF CARBON MONOXIDE DATA

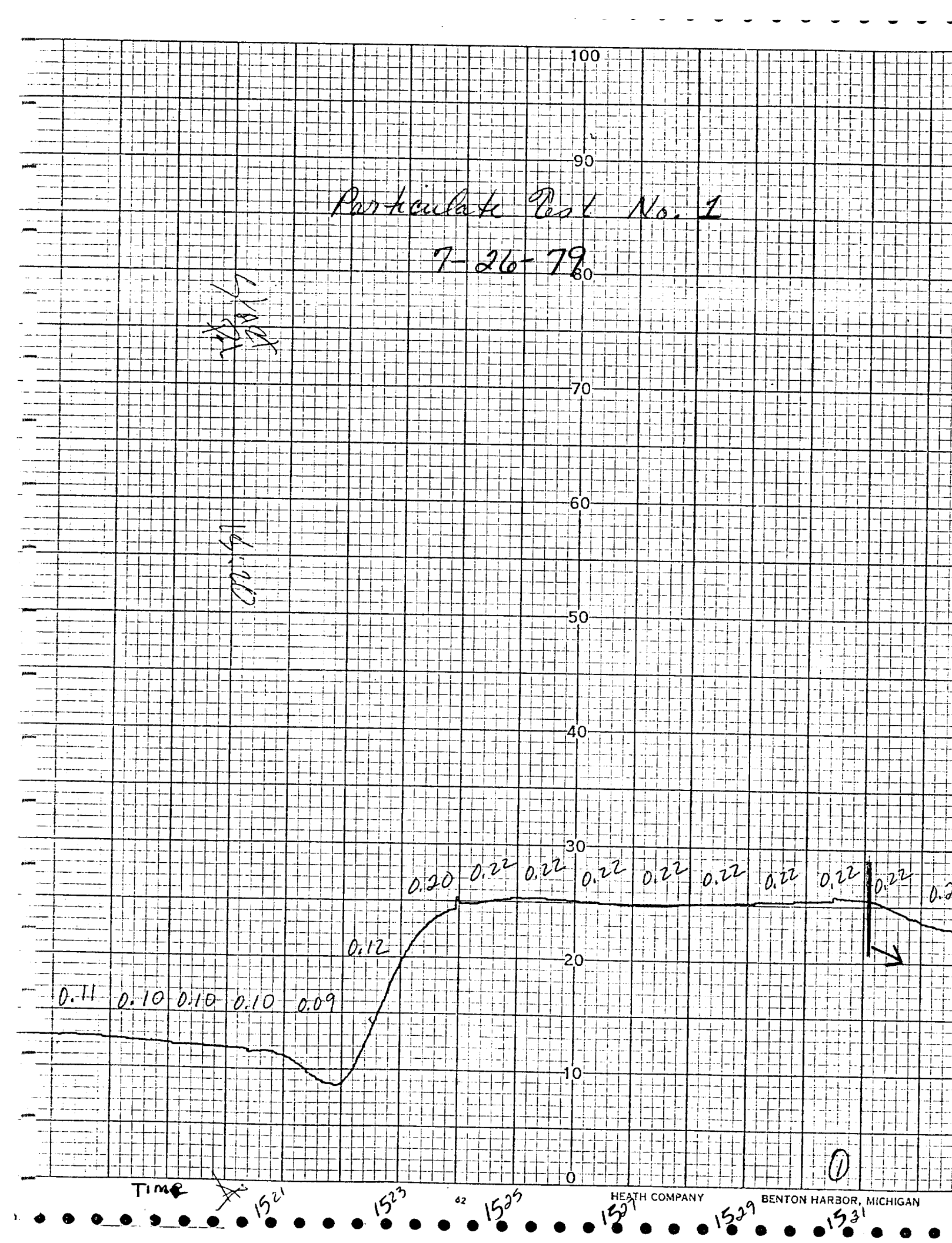
PREFACE TO CONTINUOUS CO RECORD

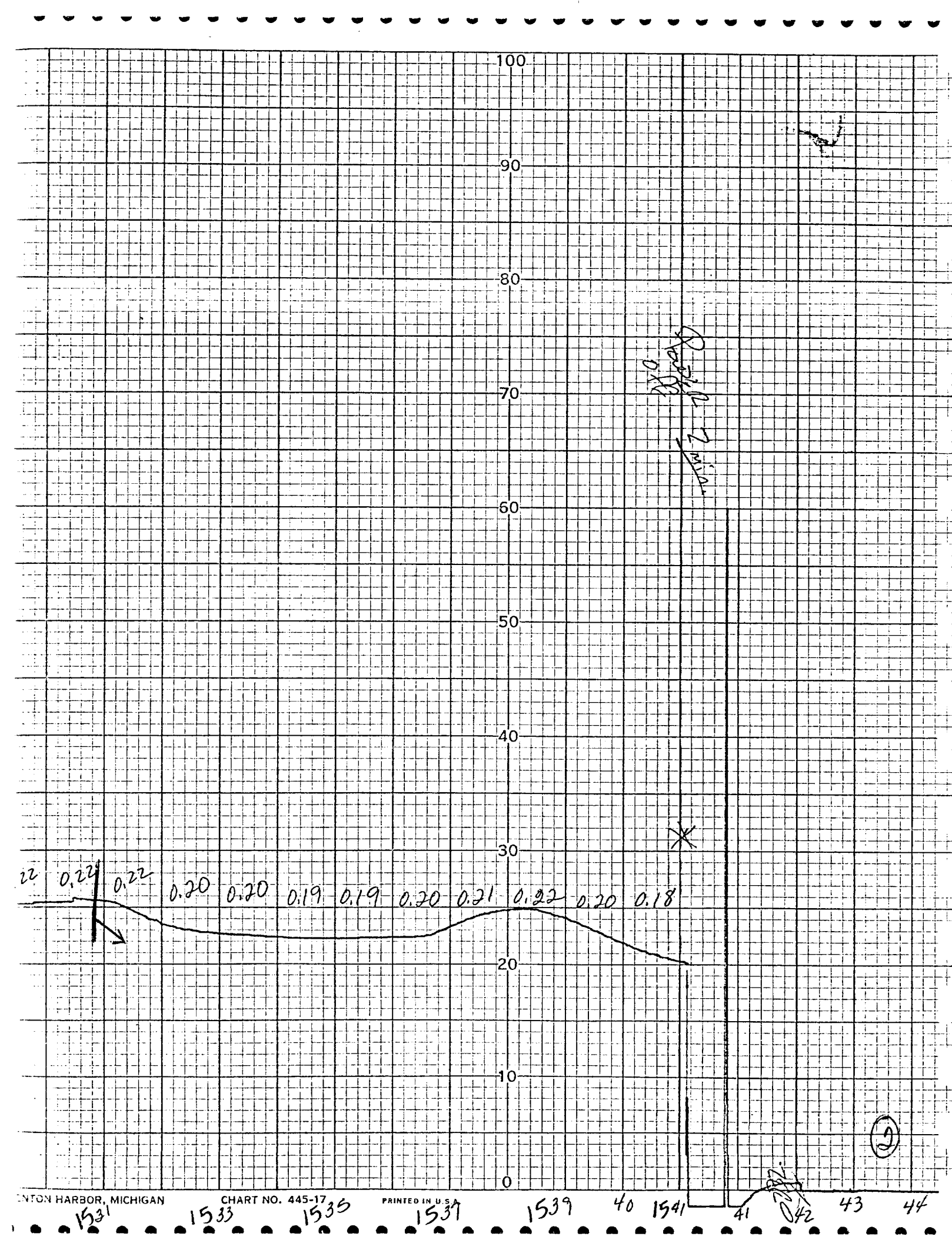
The carbon monoxide concentration recorded continuously as an analog response on the chart paper was averaged over one minute intervals and hand written directly above the continuous line as the percent by volume of CO in nitrogen. This initially is only a meter reading or recorder deflection rather than an actual concentration and must be referred to the calibration curve for the nonlinear response of the detector, found following the chart pages. This results in a percent of carbon monoxide in nitrogen by volume which when multiplied by $10^4 \left[\frac{10^6}{10^2}\right]$ yields the concentration of CO in parts per million (ppm) by volume.

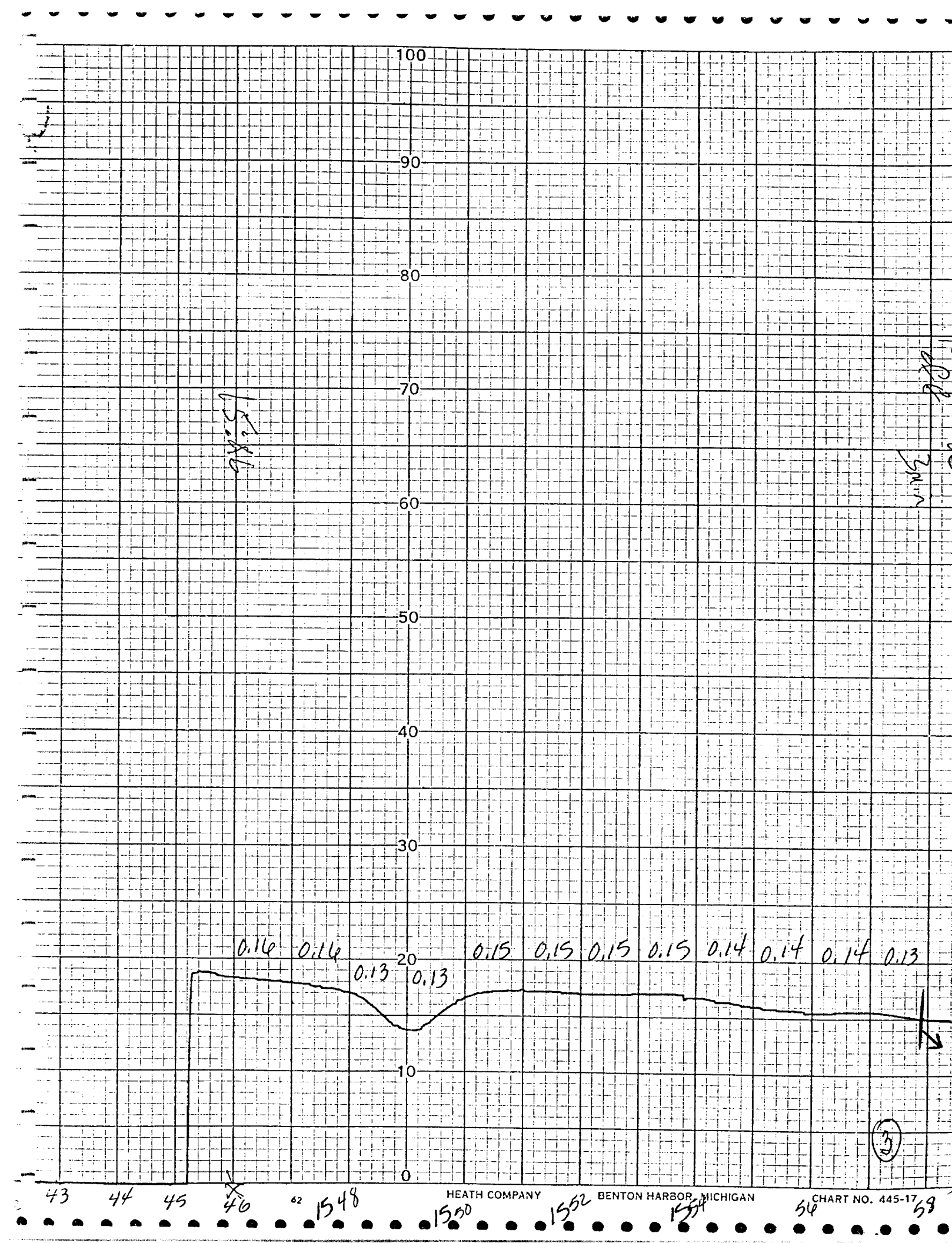
Additionally the time base is hand written directly below the zero concentration line.

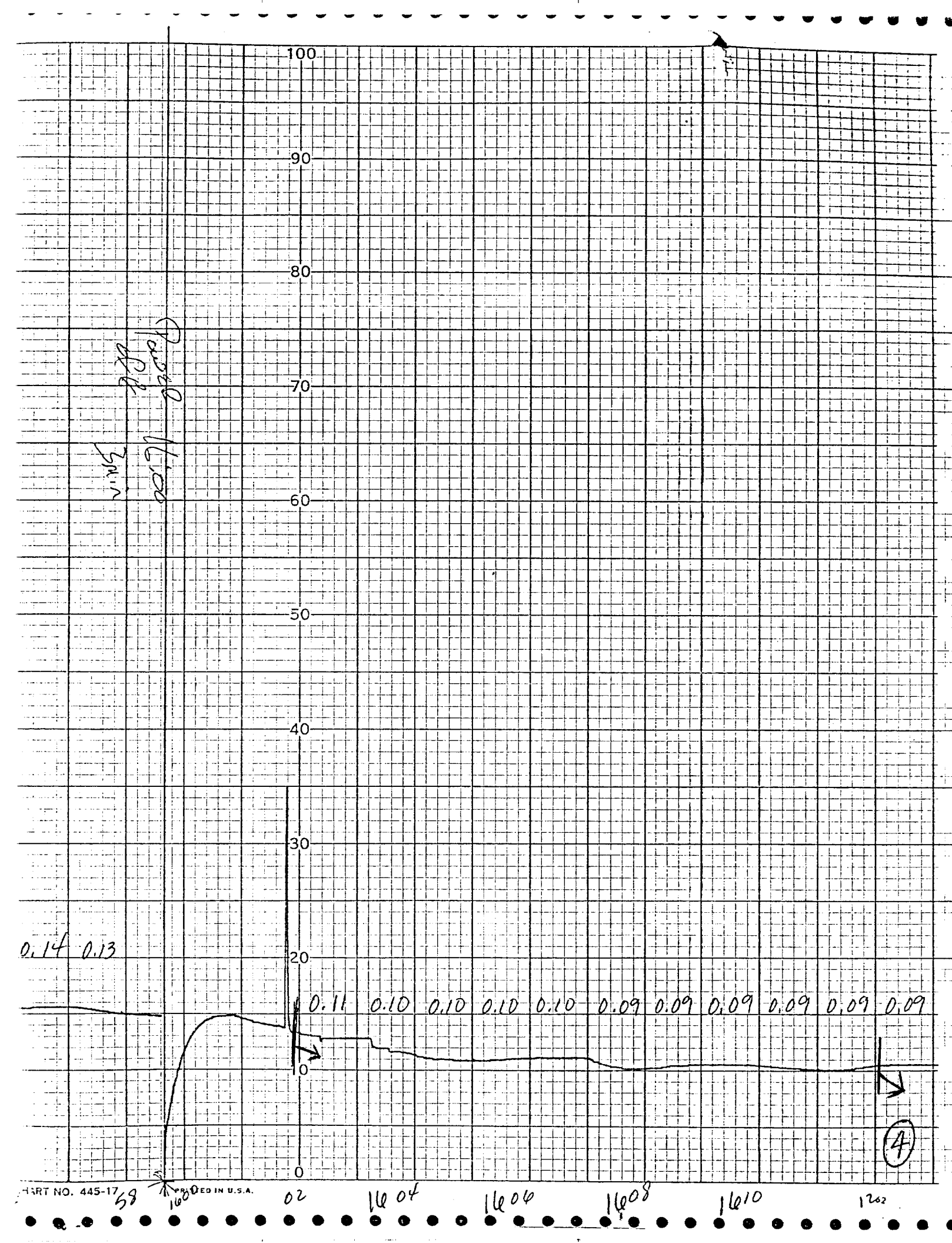
APPENDIX E-1

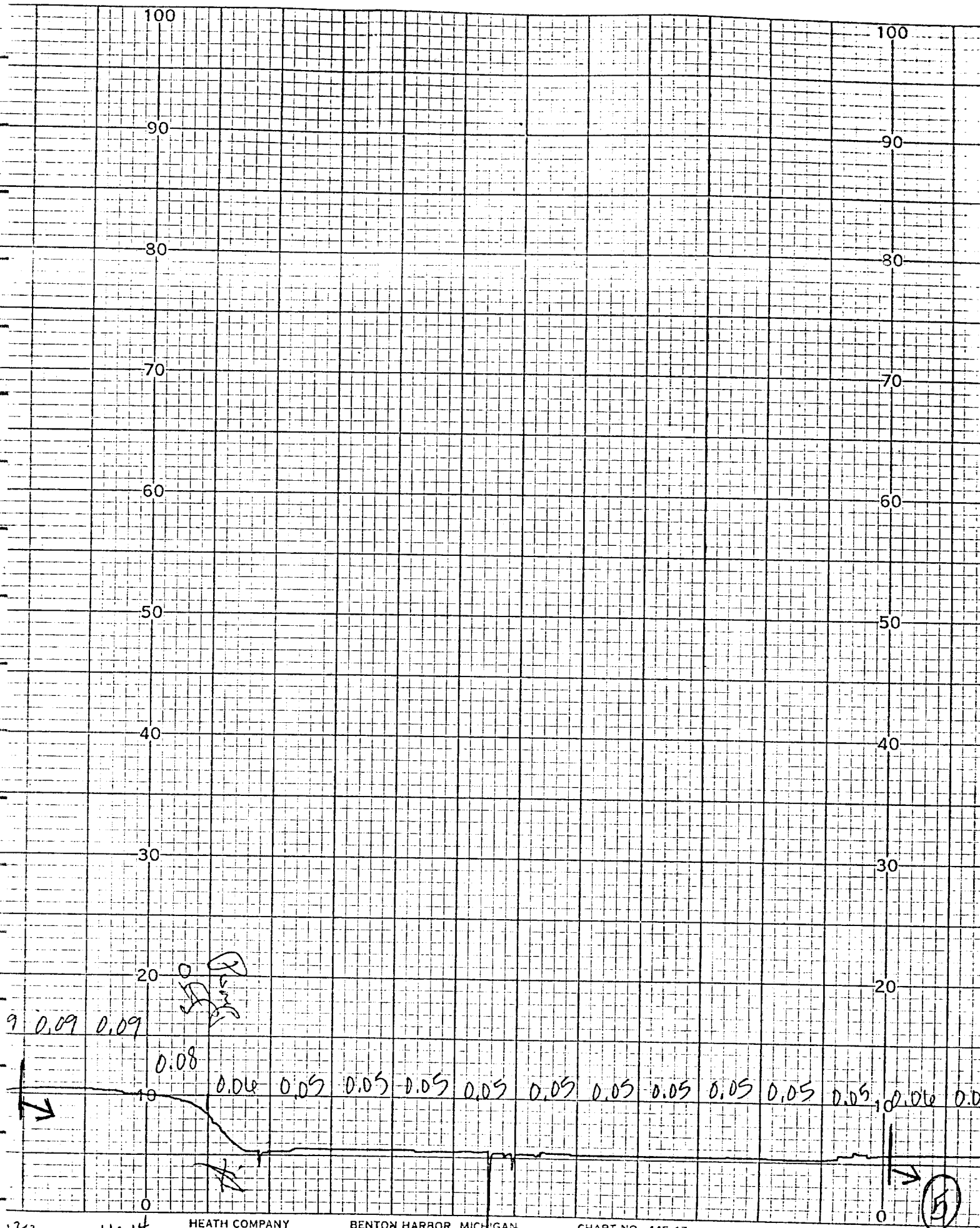
CARBON MONOXIDE FIELD DATA

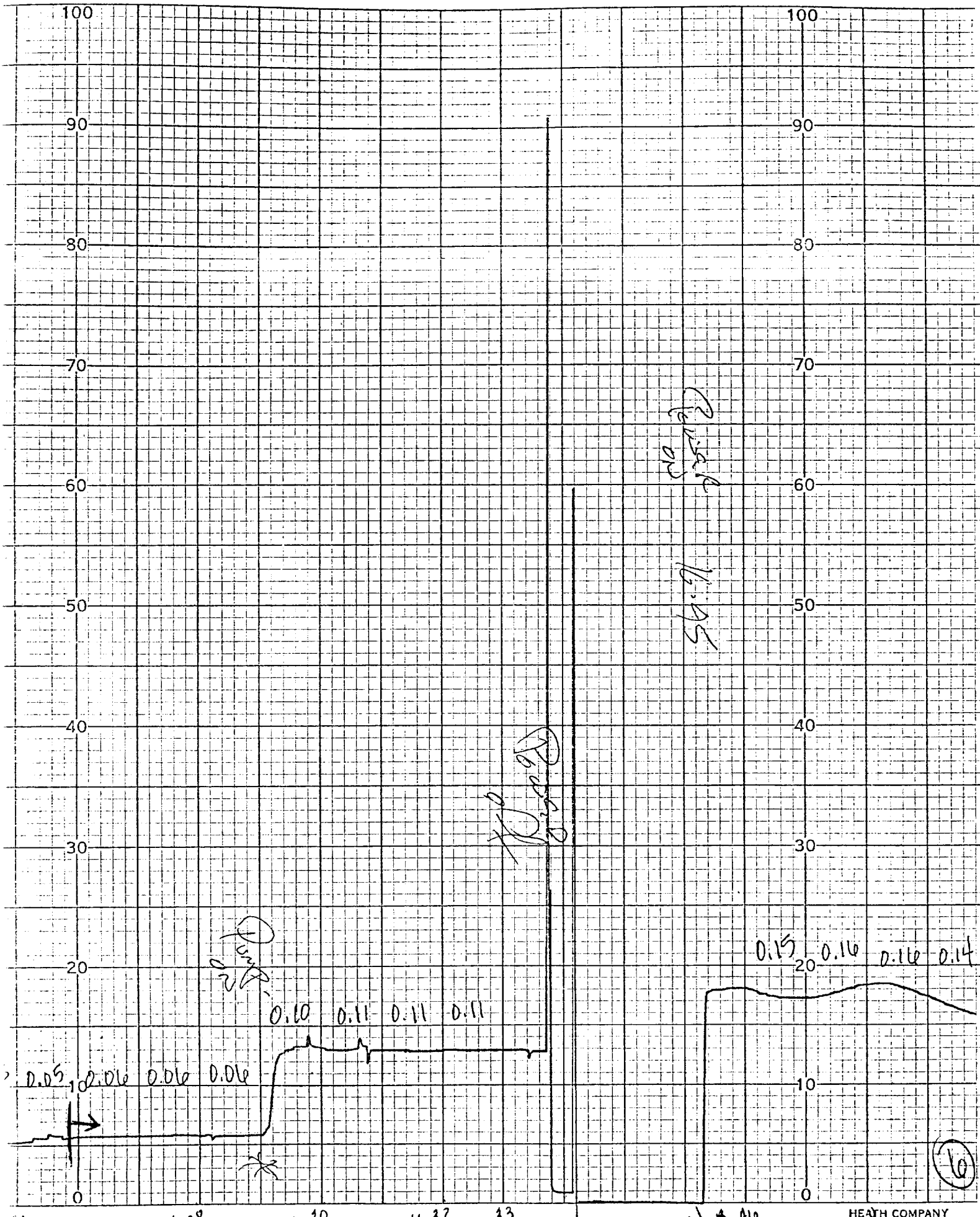

Particulate Test No. 1
7-26-79
Opacity
100
90
80
70
60
50
40
30
20
10
0
0.11
0.10
0.10
0.10
0.09
0.12
0.20
0.22
0.22
0.22
0.22
0.22
0.22
0.22
0.22
Time
1521
1523
1525
1527
1529
1531
HEATH COMPANY
BENTON HARBOR, MICHIGAN

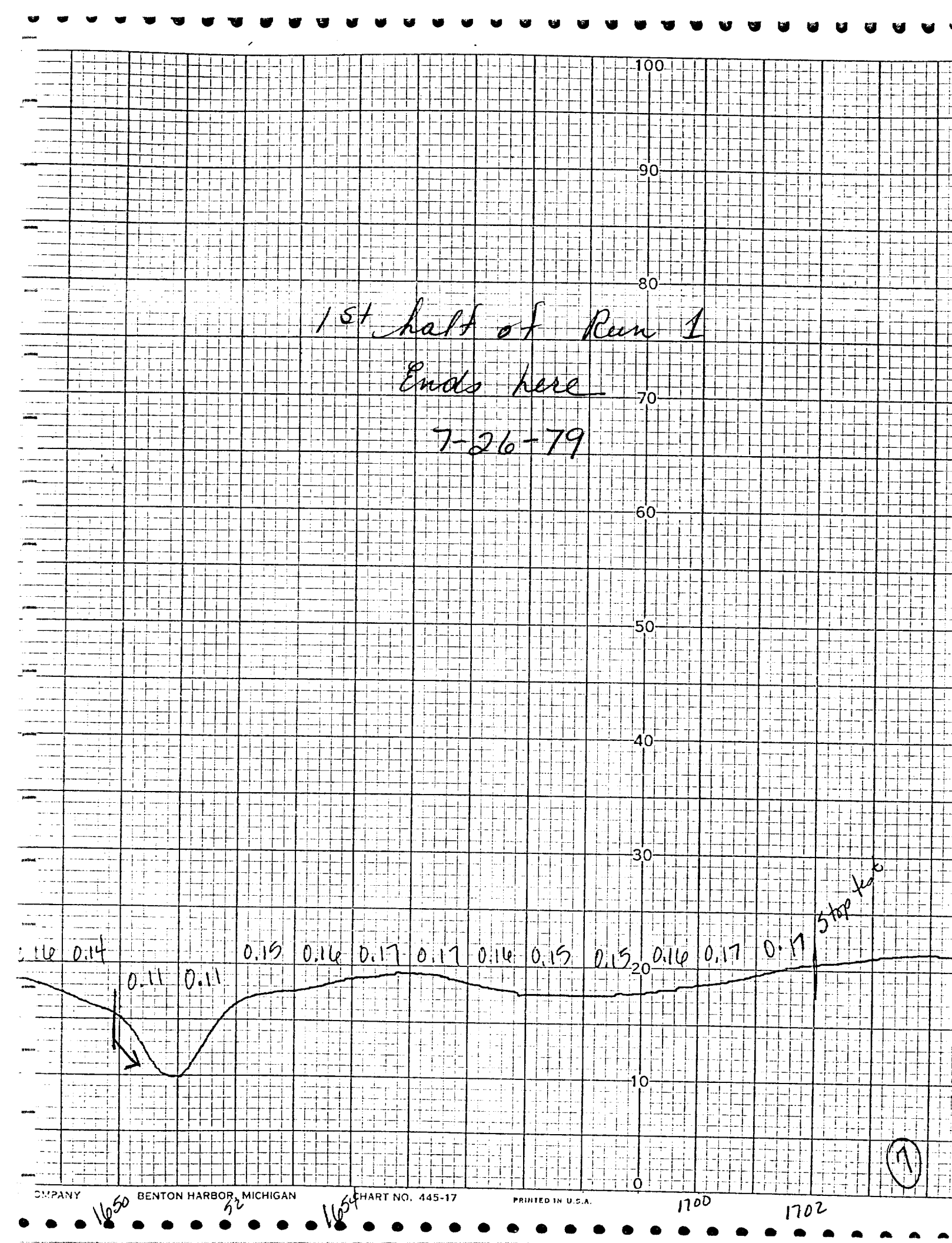

100
90
80
70
60
50
40
30
20
10
0
22
0.22
0.22
0.20
0.20
0.19
0.19
0.20
0.21
0.22
0.20
0.18
1531
1533
1535
1537
1539
40
1541
41
042
43
44
2
CHART NO. 445-17
PRINTED IN U.S.A.

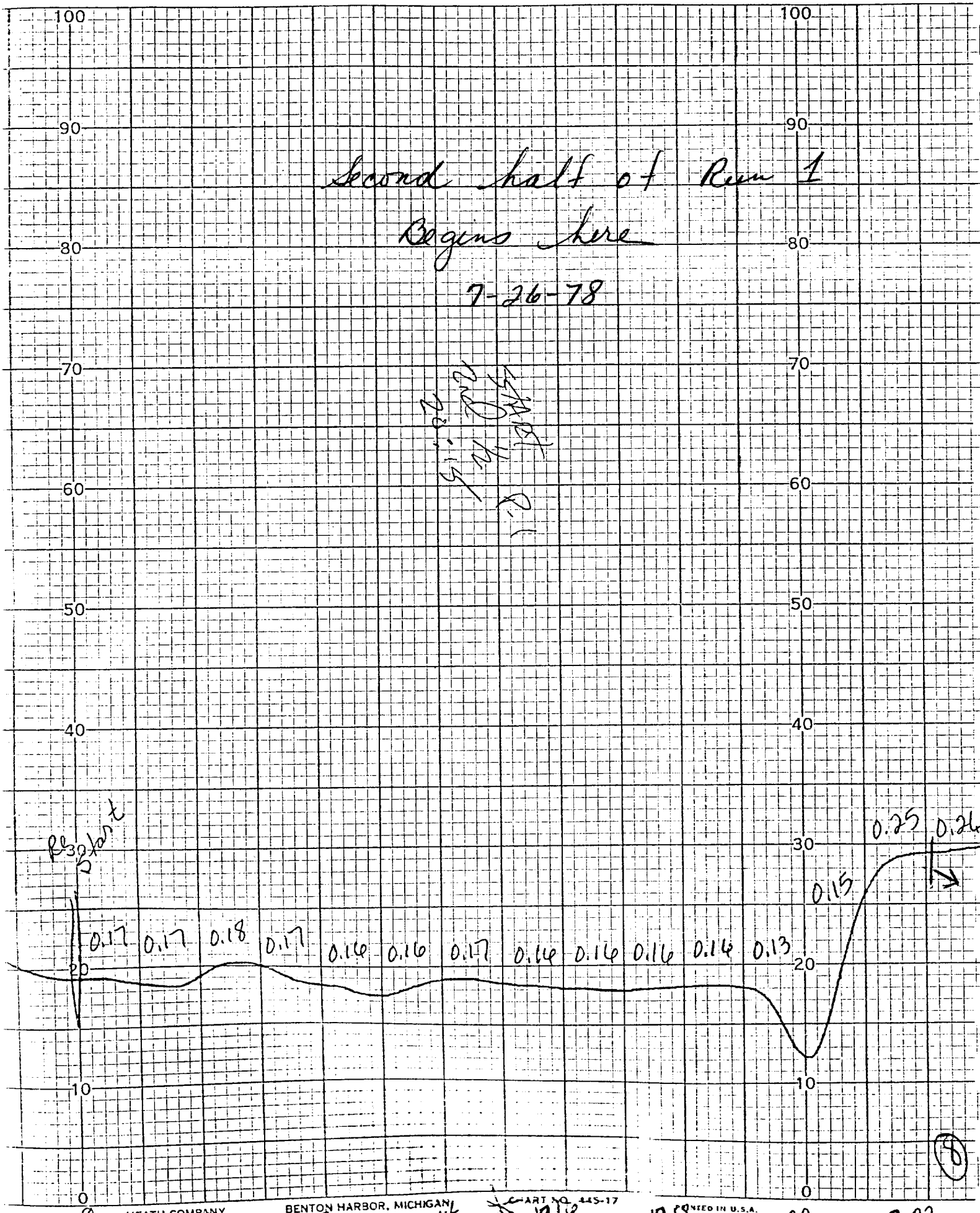

100
90
80
70
60
50
40
30
20
10
0
0.16
0.16
0.13
0.13
0.15
0.15
0.15
0.15
0.14
0.14
0.14
0.13
43
44
45
46
62
1548
1550
1552
1554
56
58
HEATH COMPANY
BENTON HARBOR, MICHIGAN
CHART NO. 445-17

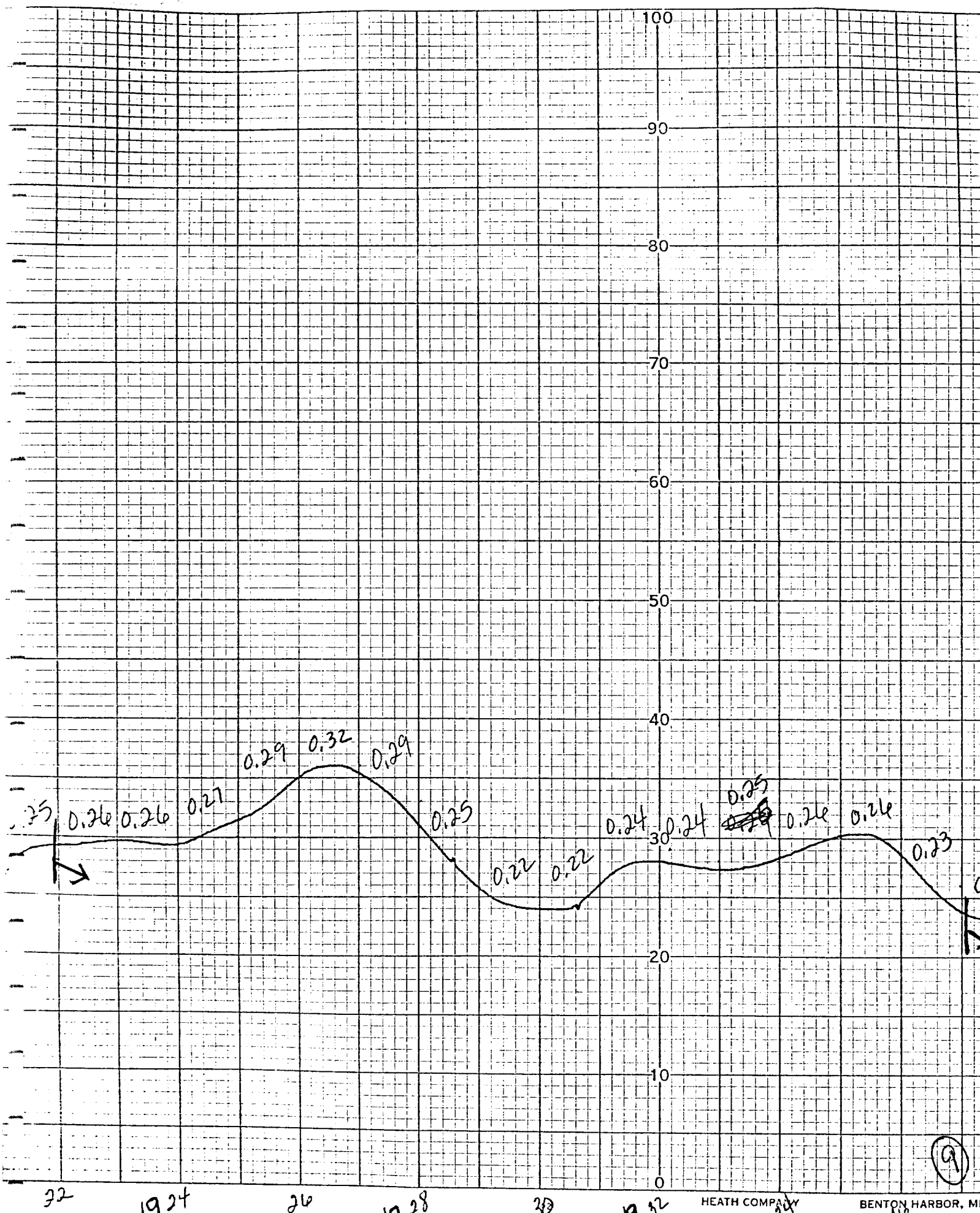

100
90
80
70
60
50
40
30
20
10
0
Pao2 (mm Hg)
0.14 0.13 0.11 0.10 0.10 0.10 0.10 0.09 0.09 0.09 0.09 0.09 0.09
4
58
1602
02
1604
1606
1608
1610
1262

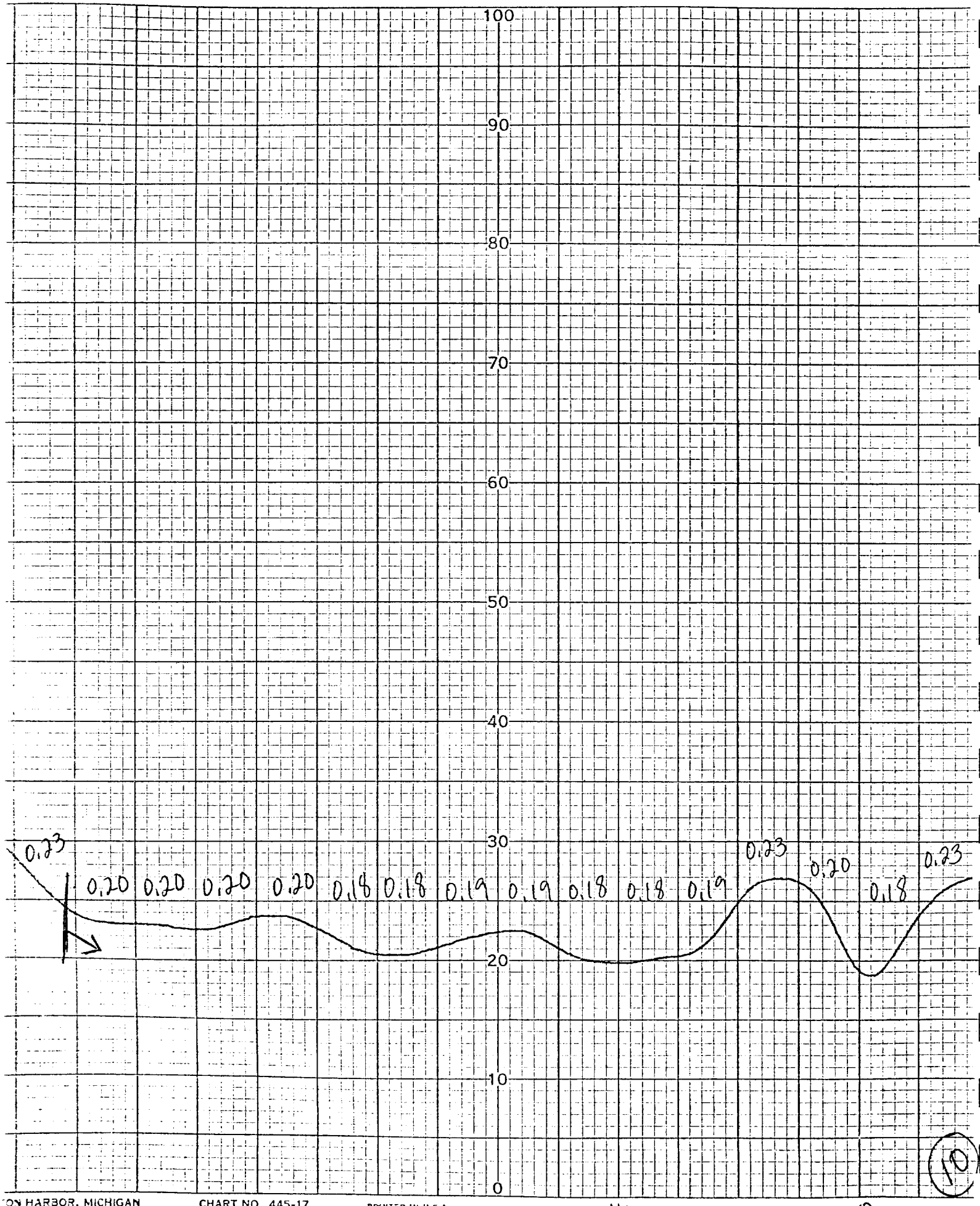

100
90
80
70
60
50
40
30
20
10
0
0.09
0.09
0.08
0.06
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.05
0.06
HEATH COMPANY
BENTON HARBOR, MICHIGAN
CHART NO. 445-17
PRINTED IN U.S.A.

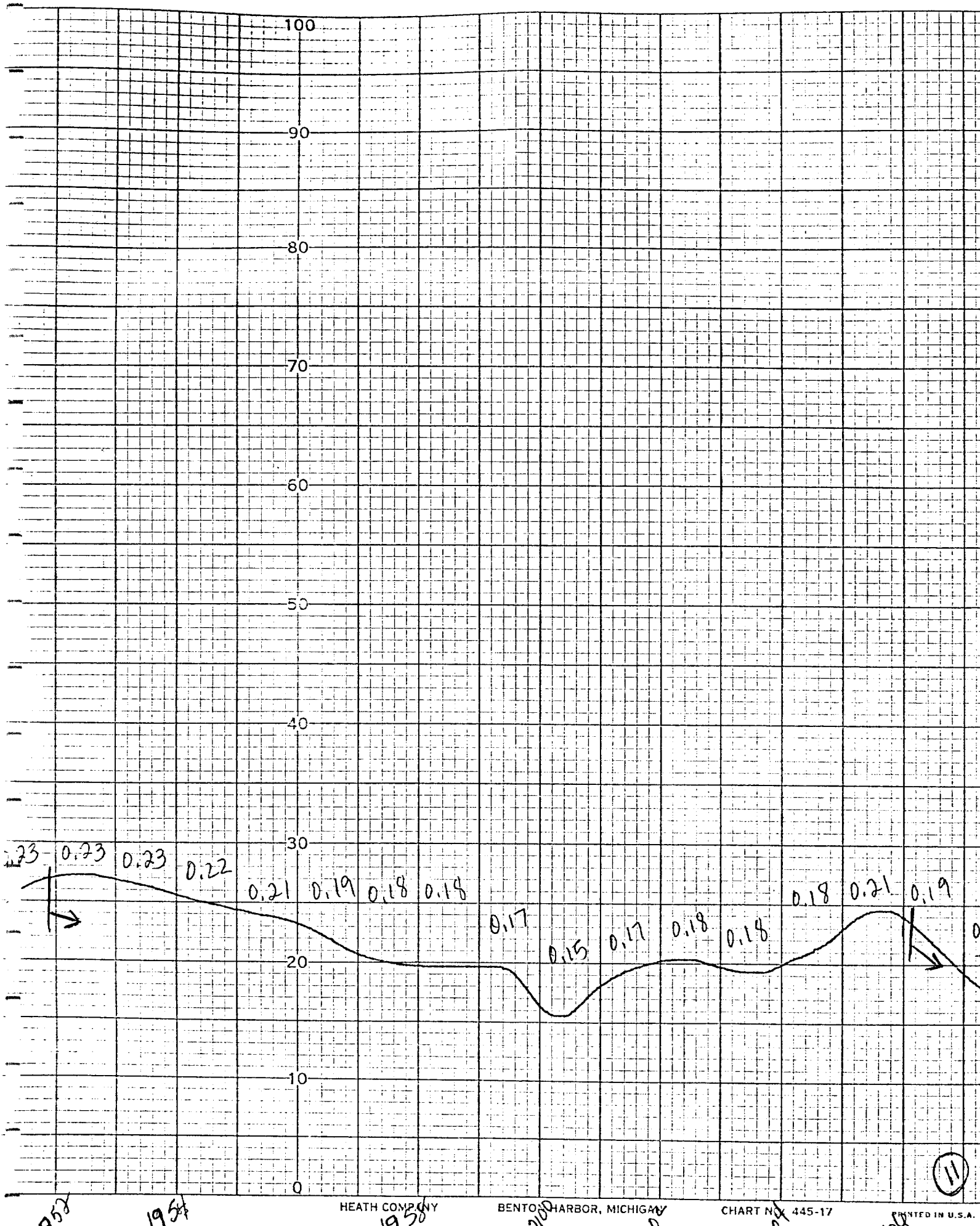

100
90
80
70
60
50
40
30
20
10
0
0.05
0.06
0.06
0.06
0.10
0.11
0.11
0.11
0.15
0.16
0.16
0.14
Pump on
Pump off
24
1628
1630
1632
33
46
1648
HEATH COMPANY
10

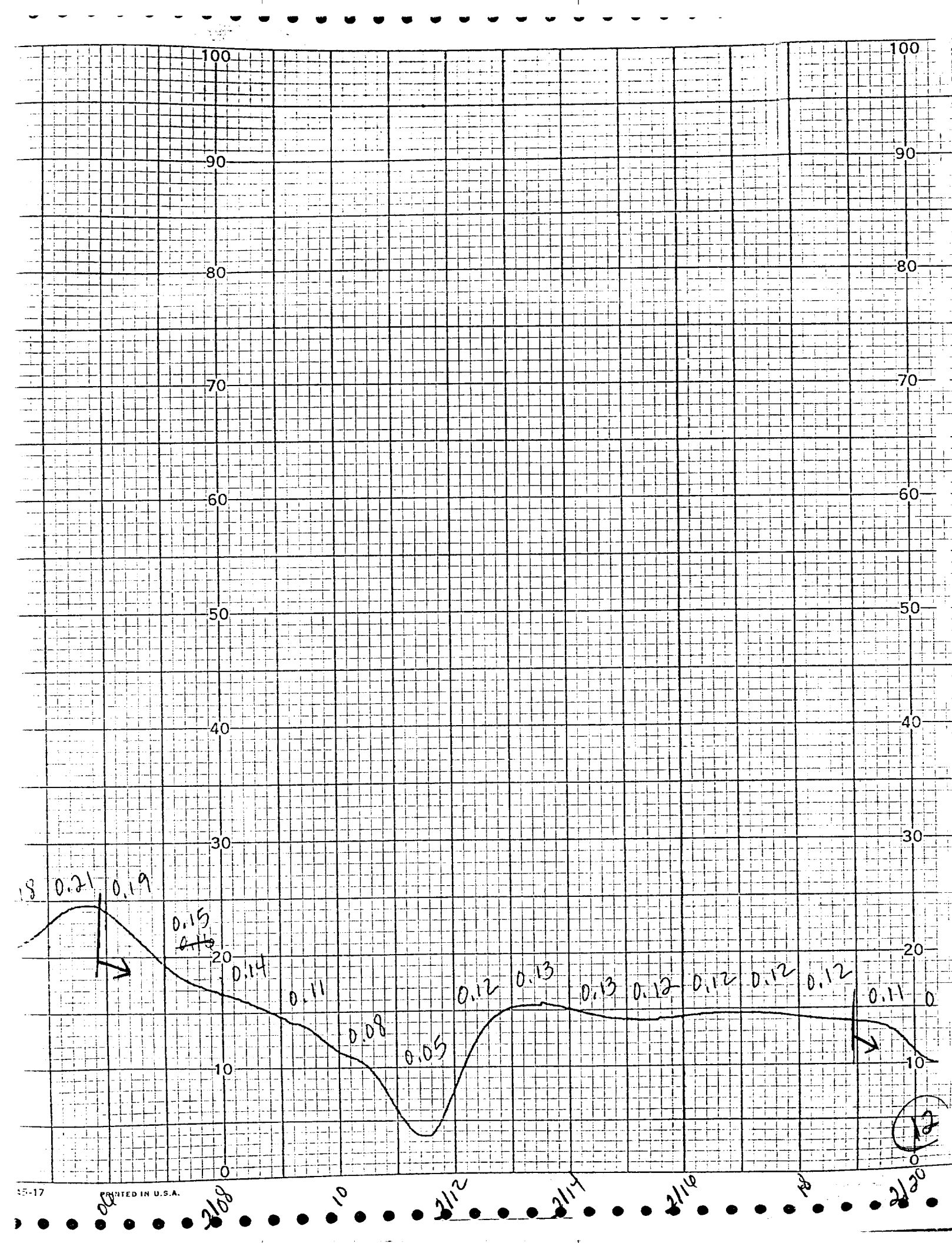

100
90
80
70
60
50
40
30
20
10
0
1st half of Run 1
Ends here
7-26-79
0.14
0.11
0.11
0.15
0.16
0.17
0.17
0.16
0.15
0.15
0.16
0.17
0.17
stop feed
1650
52
1654
1700
1702
(1)
COMPANY
BENTON HARBOR, MICHIGAN
CHART NO. 445-17
PRINTED IN U.S.A.

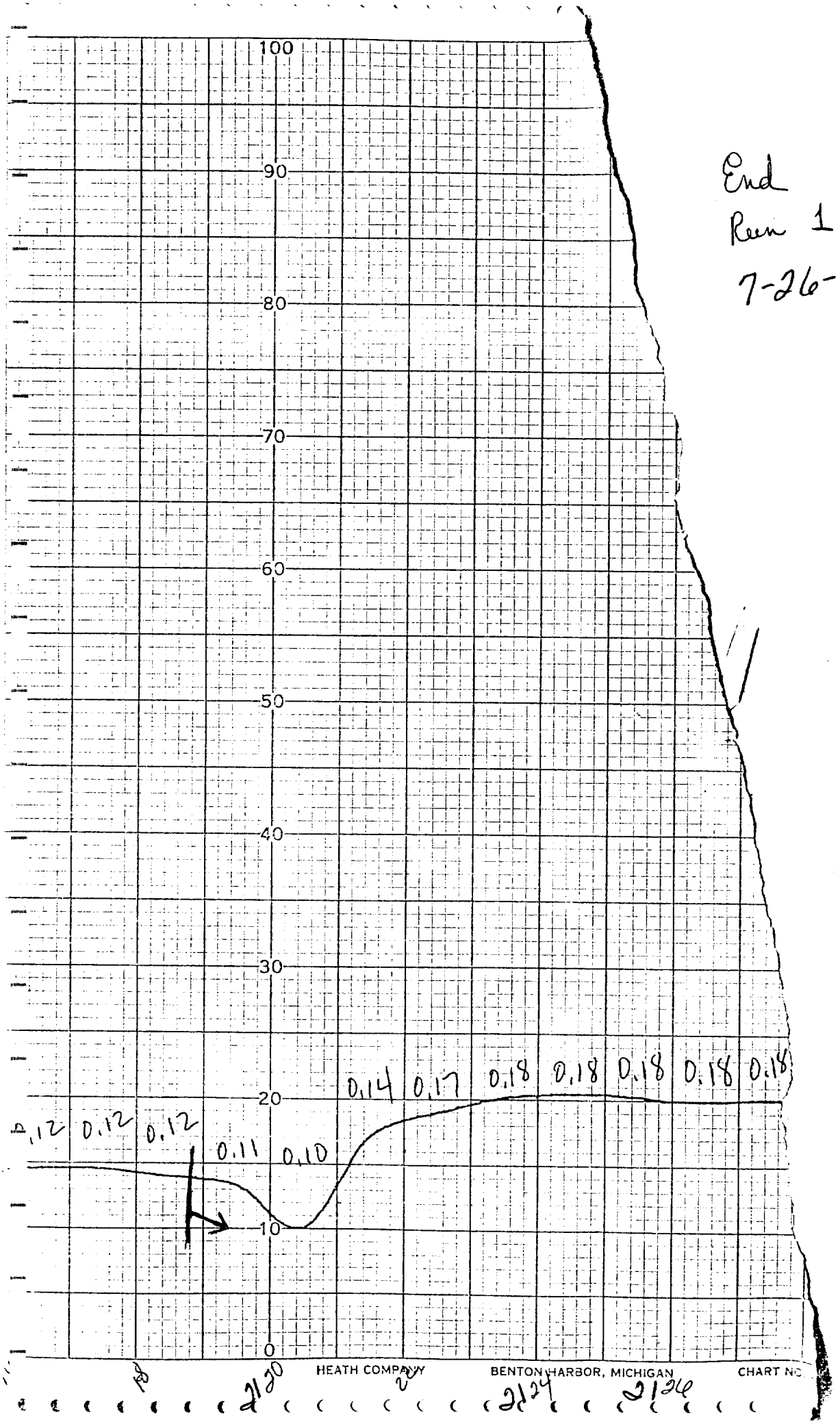

Second half of Run 1
Begins here
7-26-78
Start 2nd Run P.M.
0.17 0.17 0.18 0.17 0.16 0.16 0.17 0.14 0.16 0.16 0.14 0.13
0.15 0.25 0.24
100 90 80 70 60 50 40 30 20 10 0
1908 10 1912 14 1916 1918 20 1922


100
90
80
70
60
50
40
30
20
10
0
.75
0.26
0.26
0.27
0.29
0.32
0.29
0.25
0.22
0.22
0.24
0.24
0.25
0.26
0.26
0.23
22
1924
26
1928
30
1932
34
1936
HEATH COMPANY
BENTON HARBOR, MI


100
90
80
70
60
50
40
30
20
10
0
0.23
0.20
0.20
0.20
0.20
0.18
0.18
0.19
0.19
0.18
0.18
0.19
0.23
0.20
0.18
0.23
1938
40
1942
1946
1950
CHART NO. 445-17
PRINTED IN U.S.A.


100
90
80
70
60
50
40
30
20
10
0
0.23
0.23
0.23
0.22
0.21
0.19
0.18
0.18
0.17
0.15
0.17
0.18
0.18
0.18
0.21
0.19
1952
1954
1956
1958
2100
0
0
2100
HEATH COMPANY
BENTON HARBOR, MICHIGAN
CHART NO. 445-17
PRINTED IN U.S.A.
11

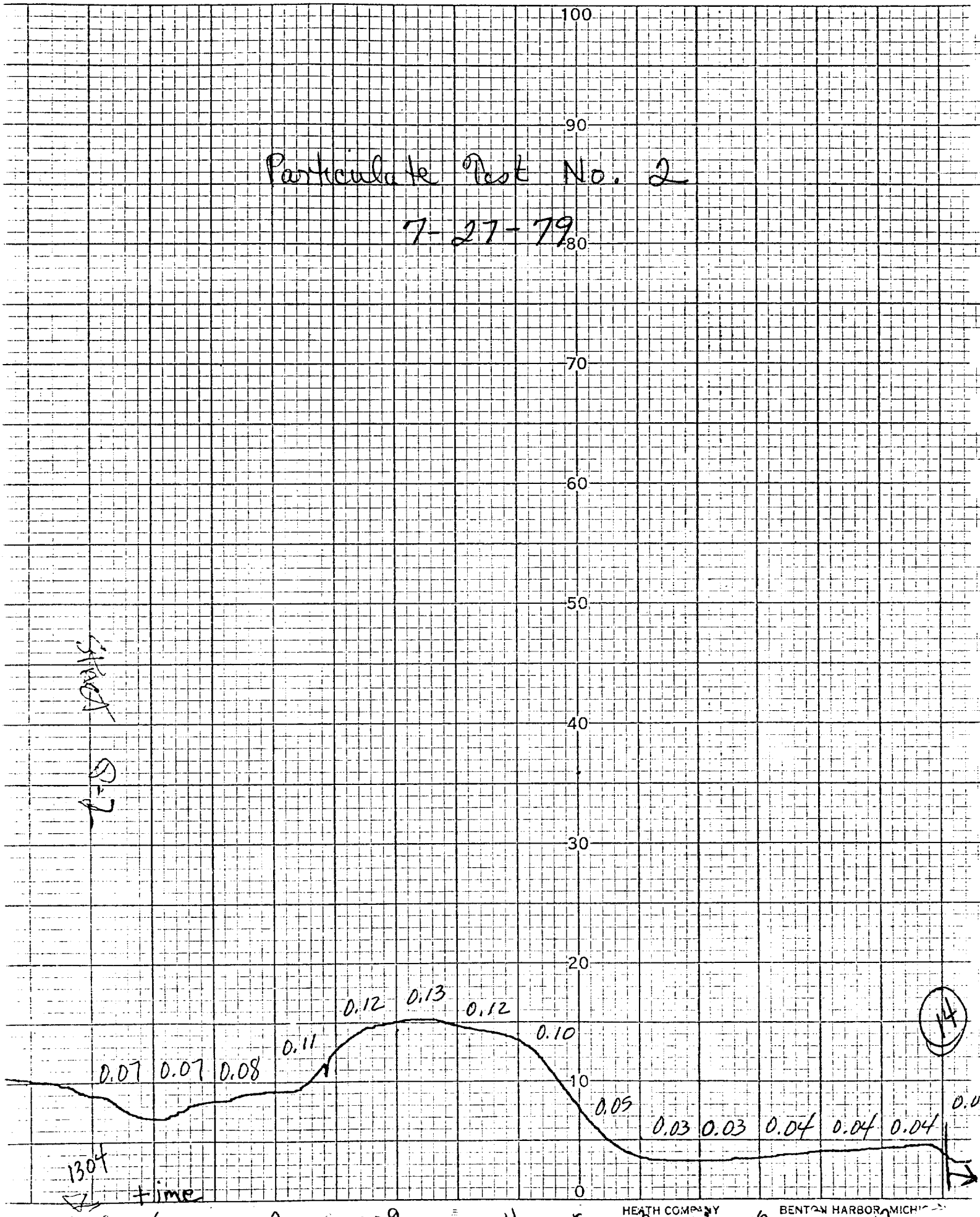

100
90
80
70
60
50
40
30
20
10
0
0.18
0.21
0.19
0.15
0.14
0.11
0.08
0.05
0.12
0.13
0.13
0.12
0.12
0.12
0.12
0.11
0
12
2/8
10
2/12
2/14
2/16
18
2/20

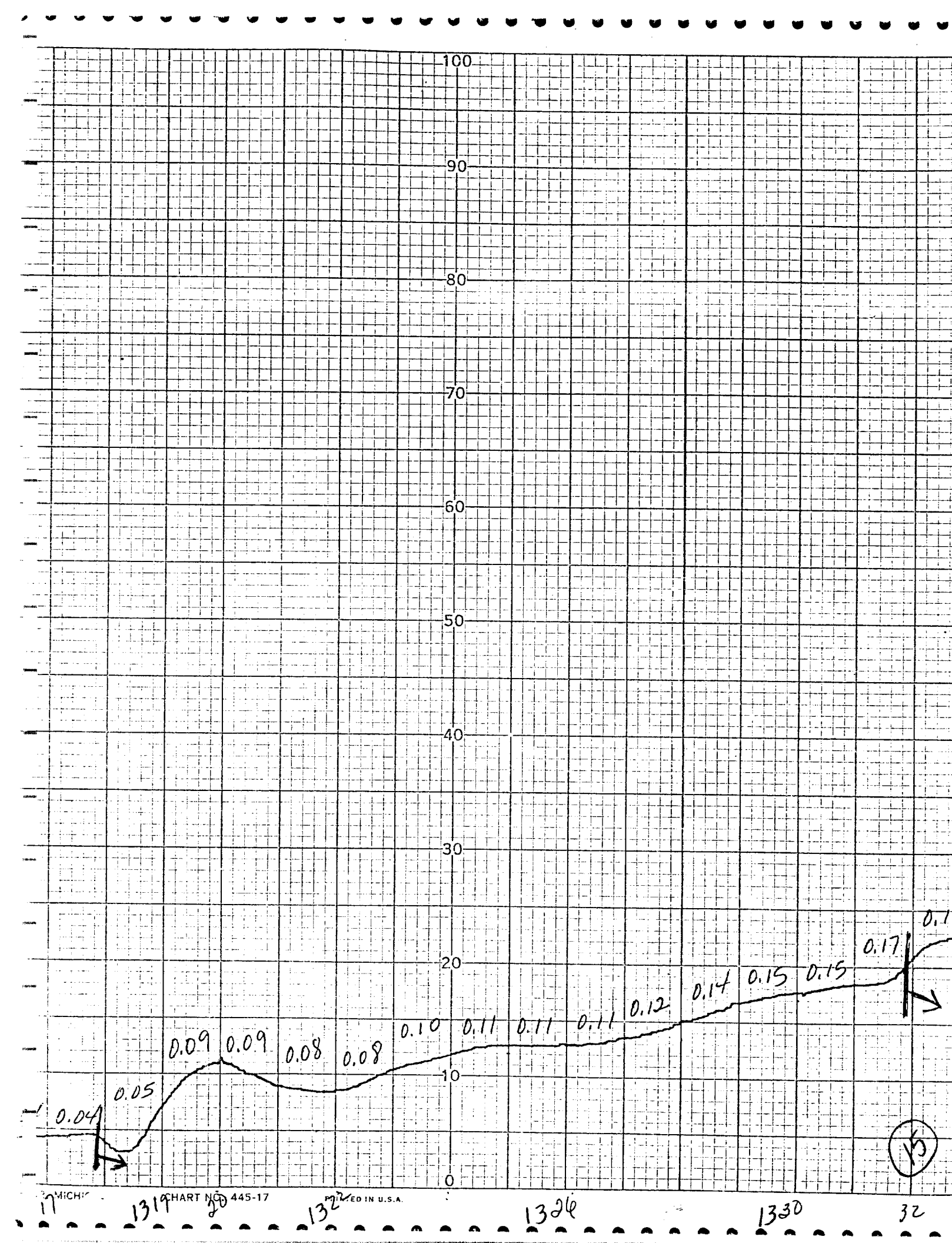


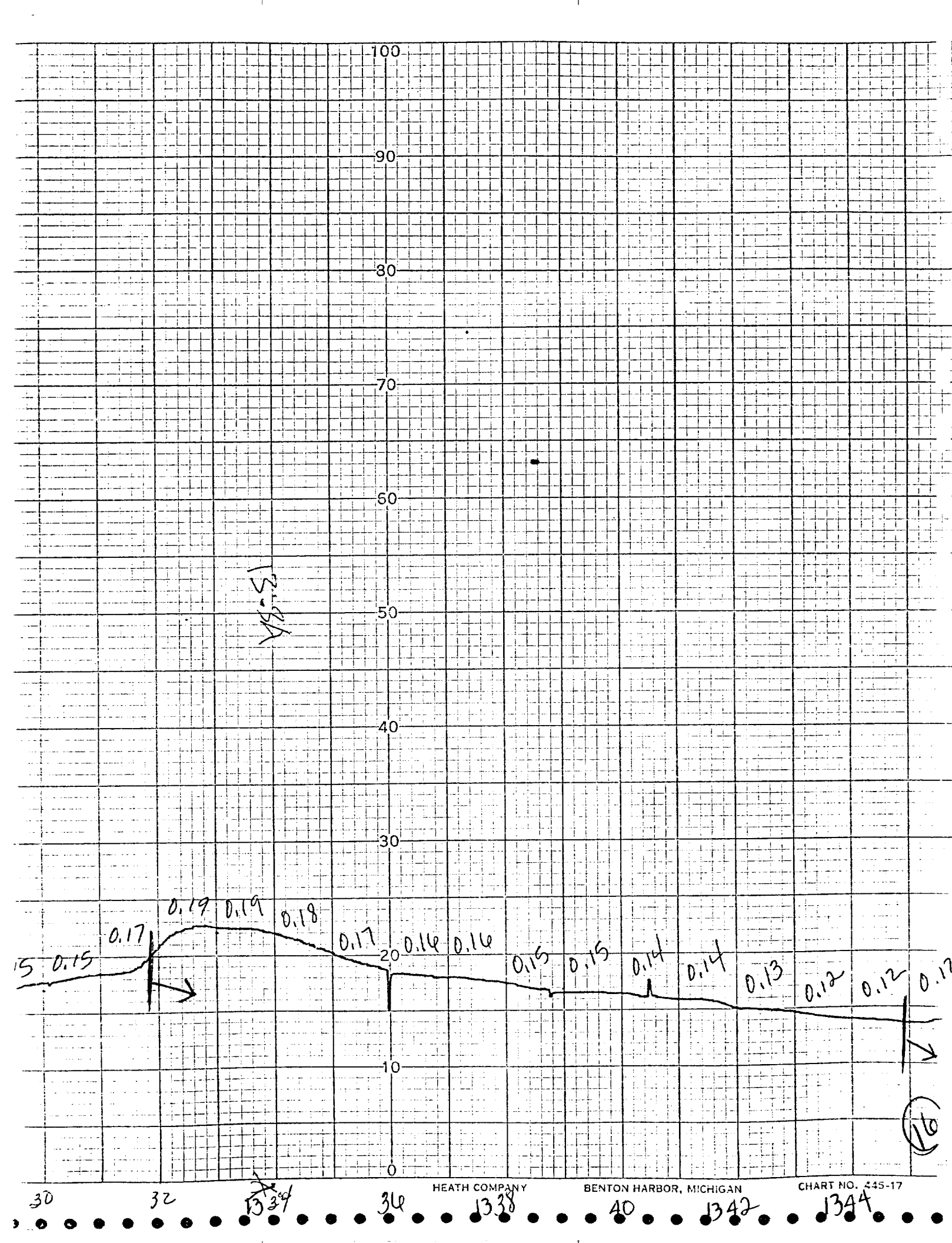
End
Rem 1
7-26-79

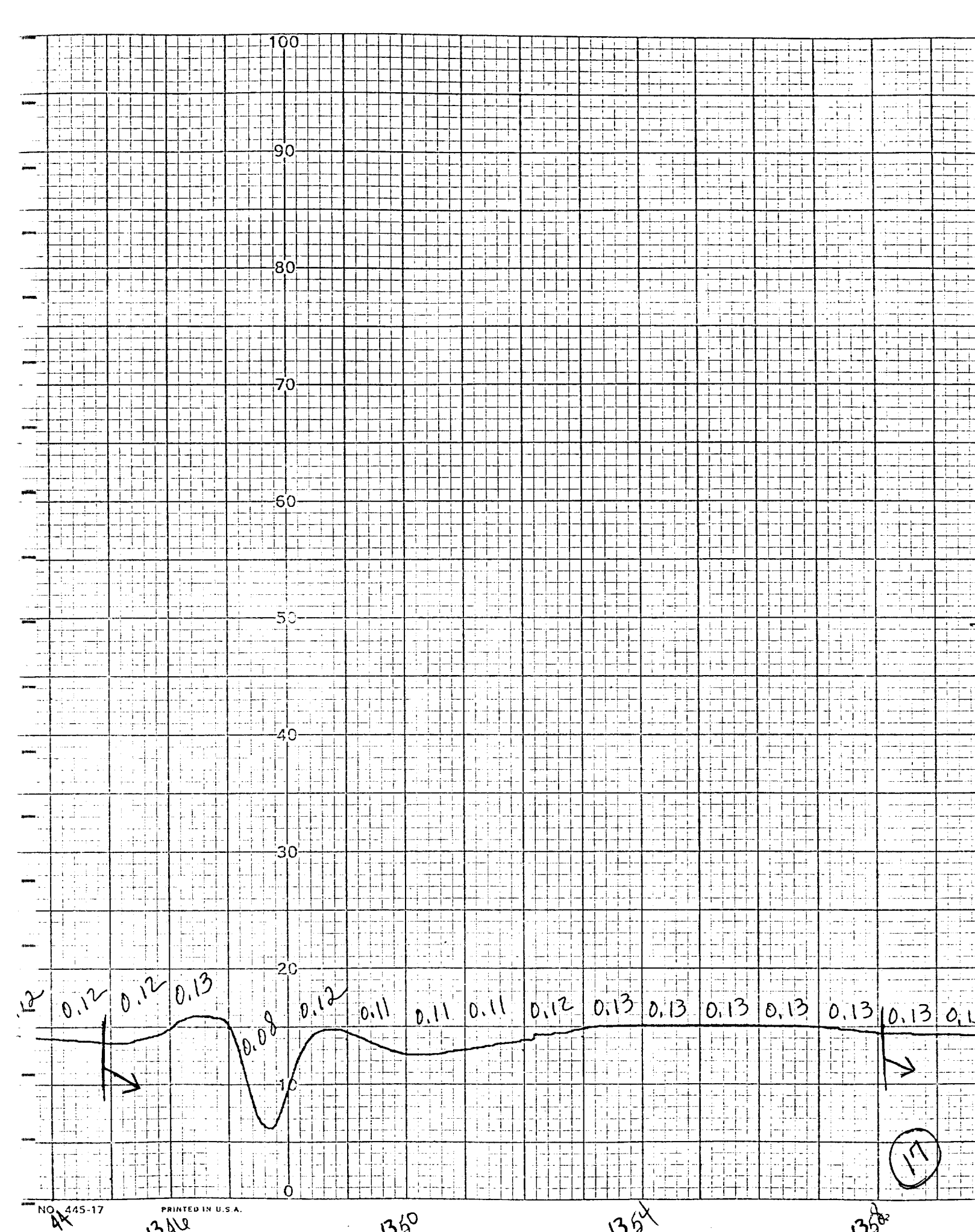
Particulate Test No. 2

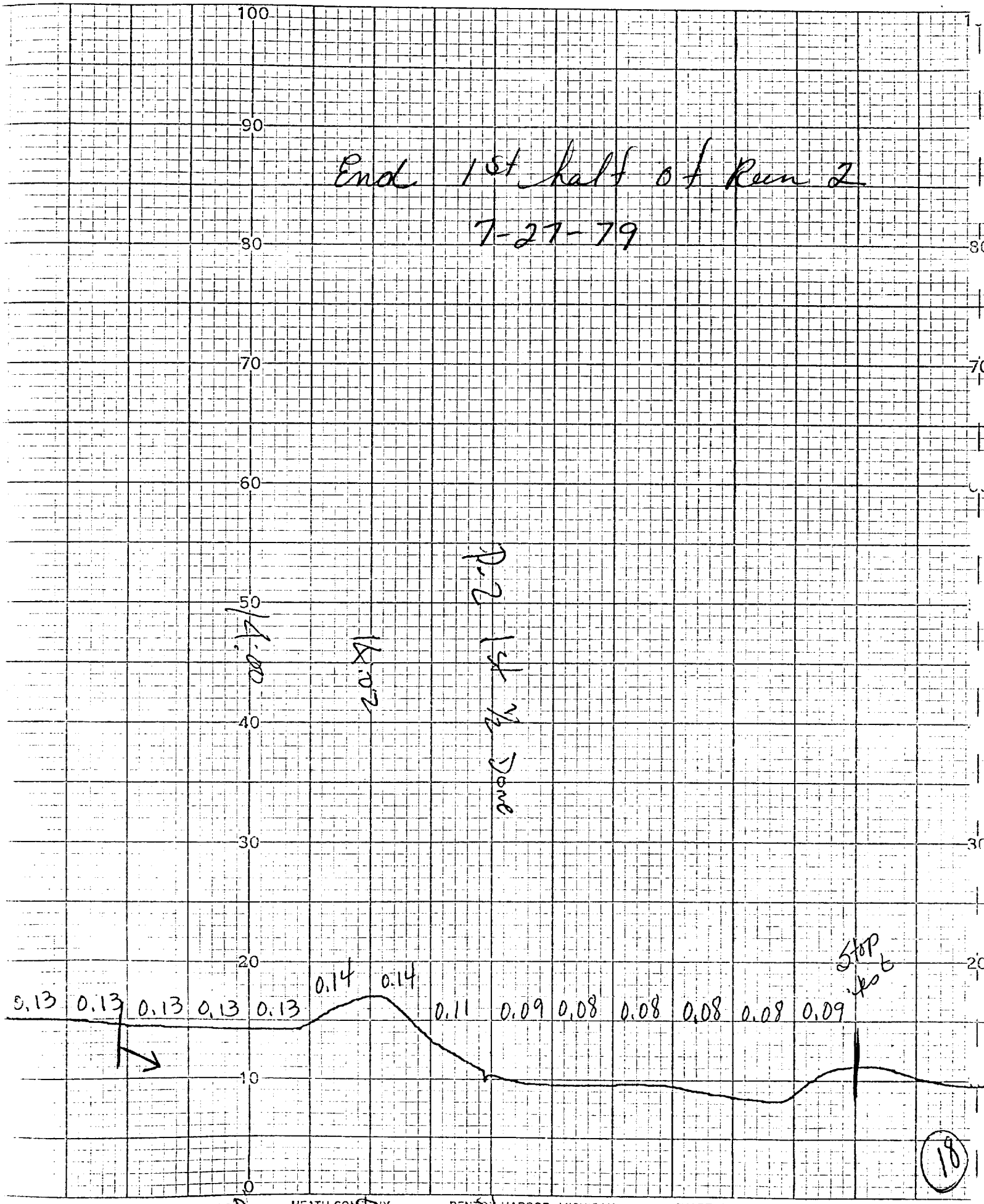
7-27-79

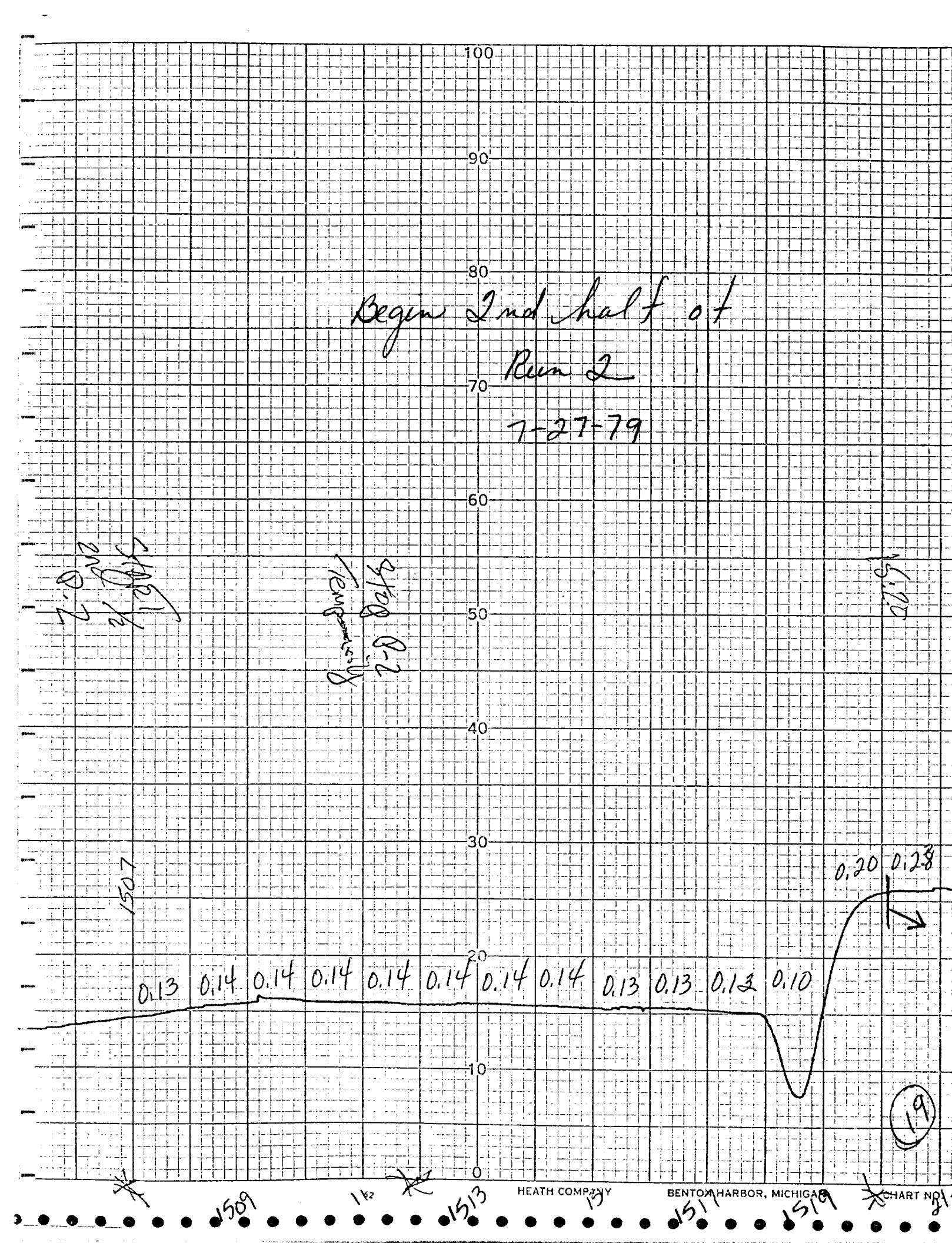


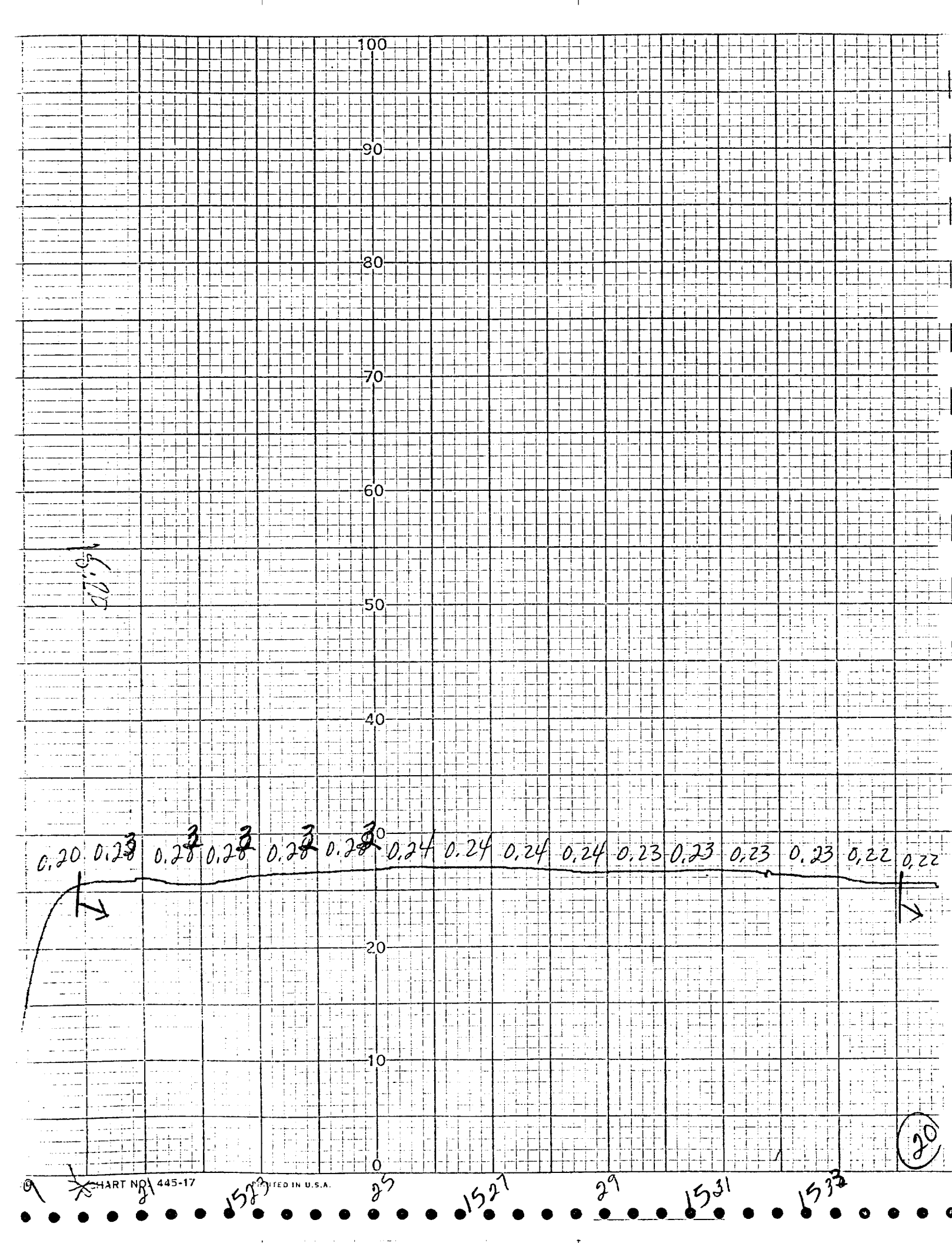

100
90
80
70
60
50
40
30
20
10
0
0.04
0.05
0.09
0.09
0.08
0.08
0.10
0.11
0.11
0.11
0.12
0.14
0.15
0.15
0.17
0.1
CHART NO. 445-17
PRINTED IN U.S.A.
1319
1326
1330
32

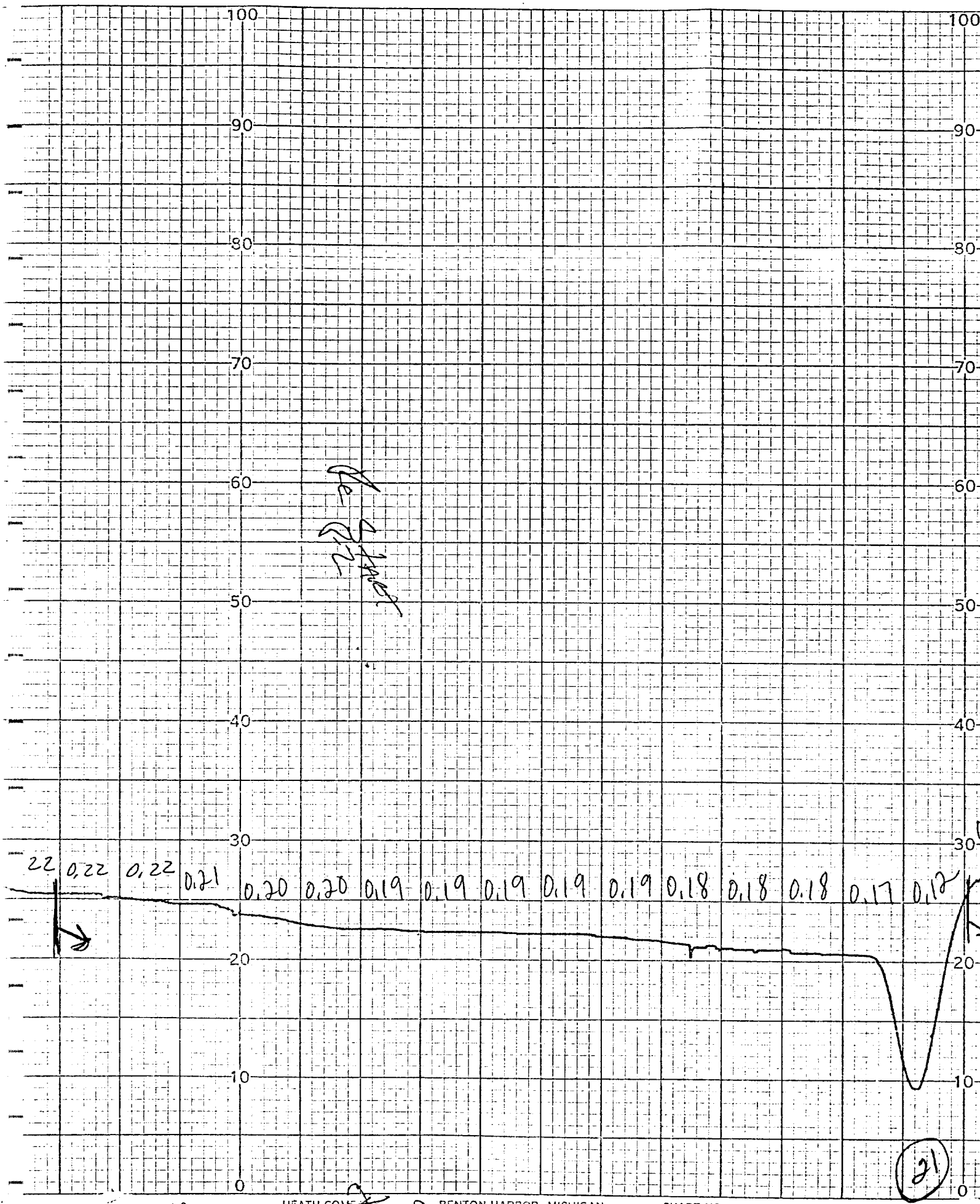

100
90
80
70
60
50
40
30
20
10
0
0.15
0.15
0.17
0.19
0.19
0.18
0.17
0.16
0.16
0.15
0.15
0.14
0.14
0.13
0.12
0.12
0.17
30
32
34
36
38
40
42
44
1334
1338
1342
1344
HEATH COMPANY
BENTON HARBOR, MICHIGAN
CHART NO. 445-17

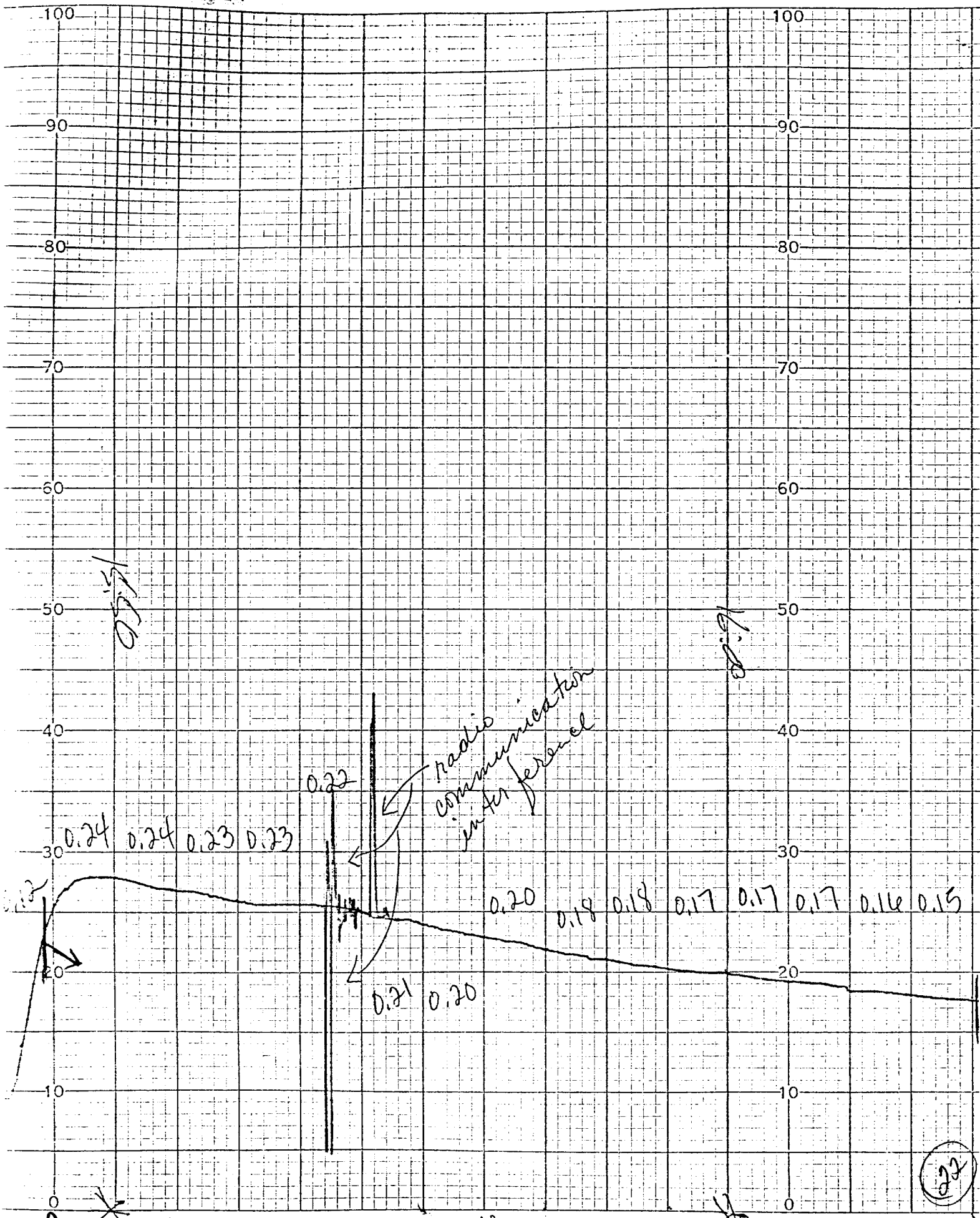

100
90
80
70
60
50
40
30
20
10
0
12
0.12
0.12
0.13
0.08
0.12
0.11
0.11
0.11
0.12
0.13
0.13
0.13
0.13
0.13
0.13
17
NO. 445-17
PRINTED IN U.S.A.
44
1340
1350
1354
1358

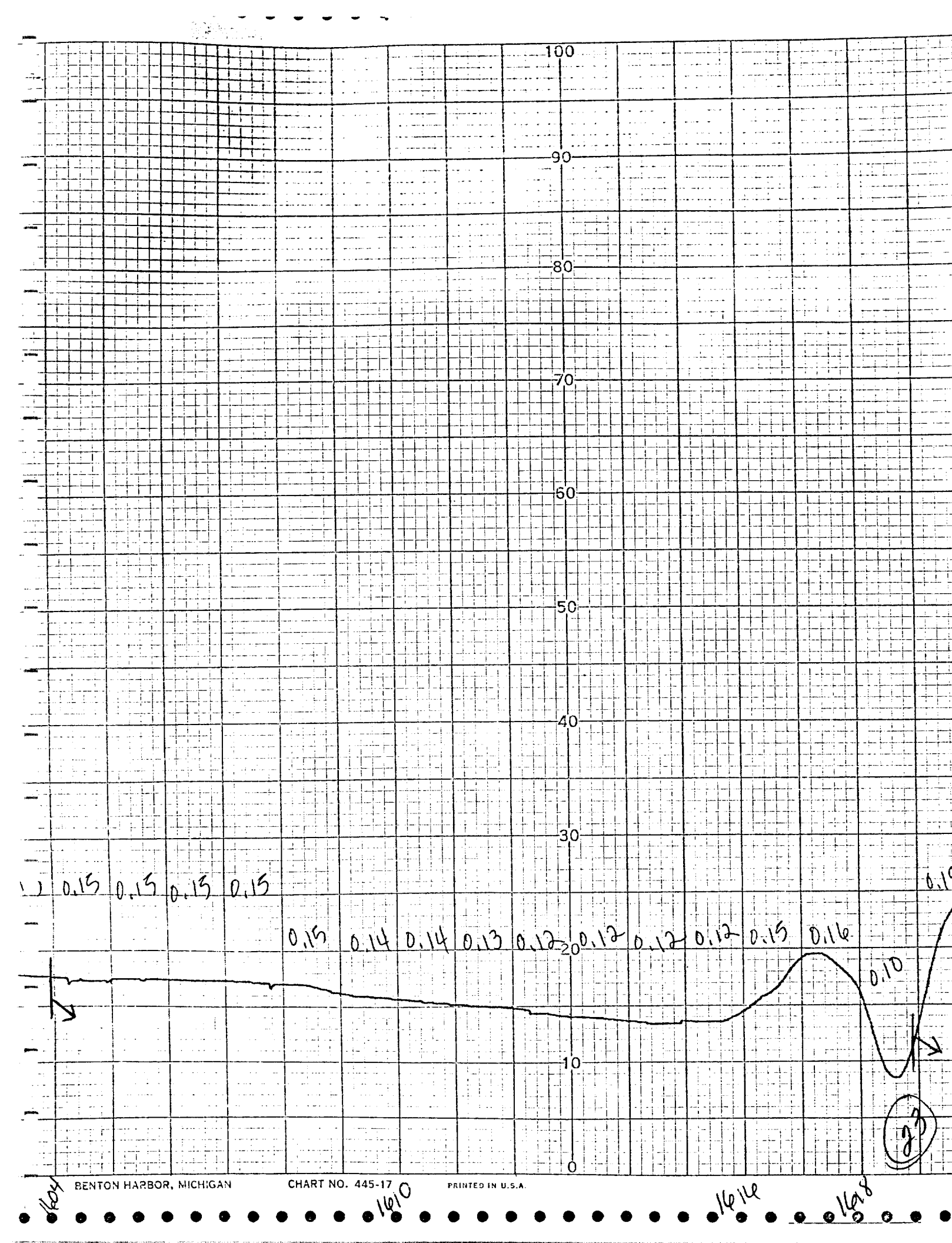

End 1st half of Rem 2
7-27-79
100
90
80
70
60
50
40
30
20
10
0
0.13
0.13
0.13
0.13
0.13
0.14
0.14
0.11
0.09
0.08
0.08
0.08
0.08
0.09
Stop
1400
1410
HEATH CO
BENTON HARBOR, MICHIGAN
CHART NO. 445-17
PRINTED IN U.S.A.

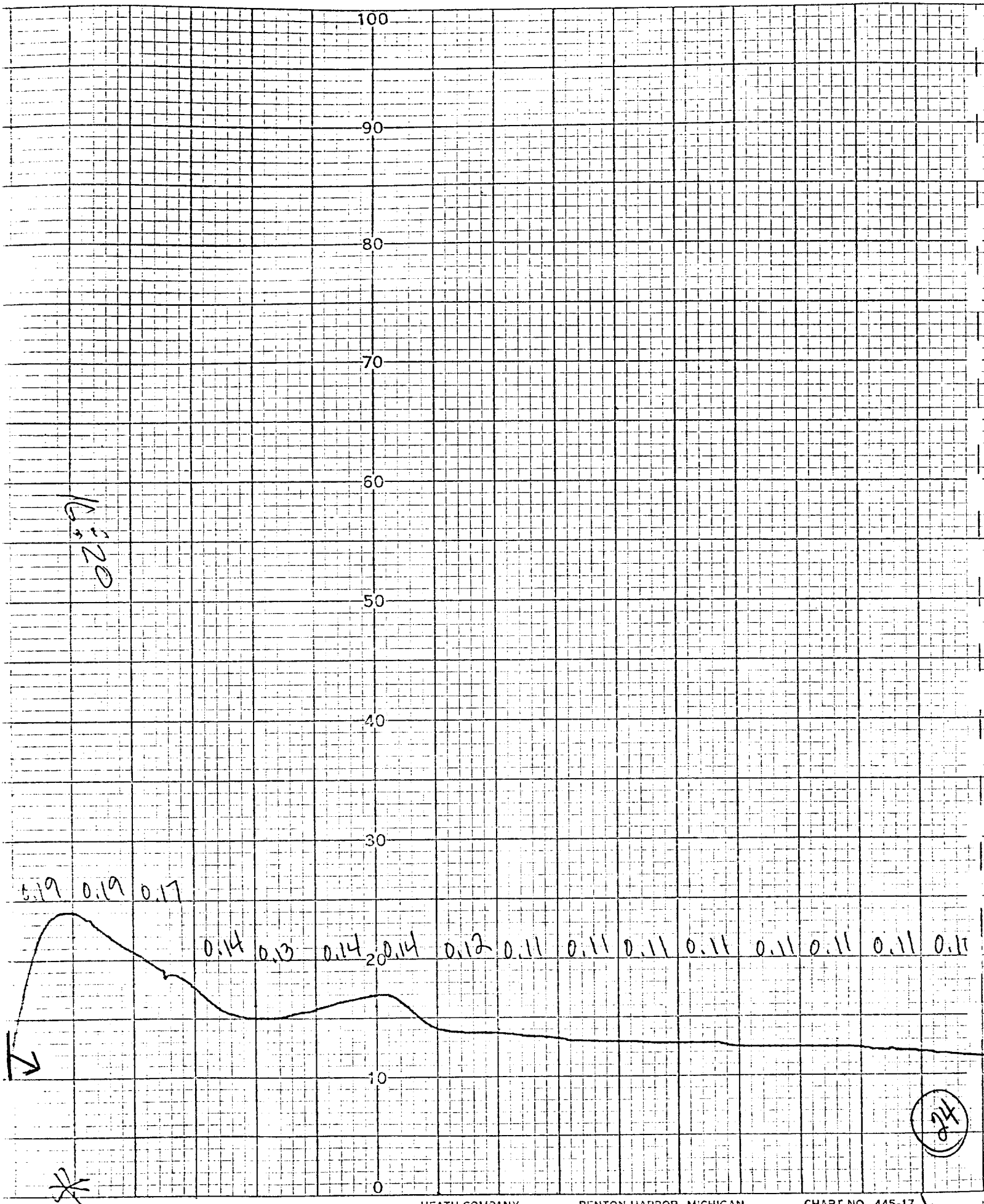

100
90
80
70
60
50
40
30
20
10
0
Begin 2nd half of
Run 2
7-27-79
Stage 1, 2nd
Temporarily
1507
0.13 0.14 0.14 0.14 0.14 0.14 0.14 0.14 0.13 0.13 0.12 0.10
0.20 0.28
19
1509
1513
1517
1519
HEATH COMPANY
BENTON HARBOR, MICHIGAN
CHART NO.


100
90
80
70
60
50
40
30
20
10
0
0.20 0.28 0.28 0.28 0.28 0.28 0.24 0.24 0.24 0.24 0.23 0.23 0.23 0.23 0.22 0.22
20
CHART NO. 445-17
1523
25
1527
29
1531
1533

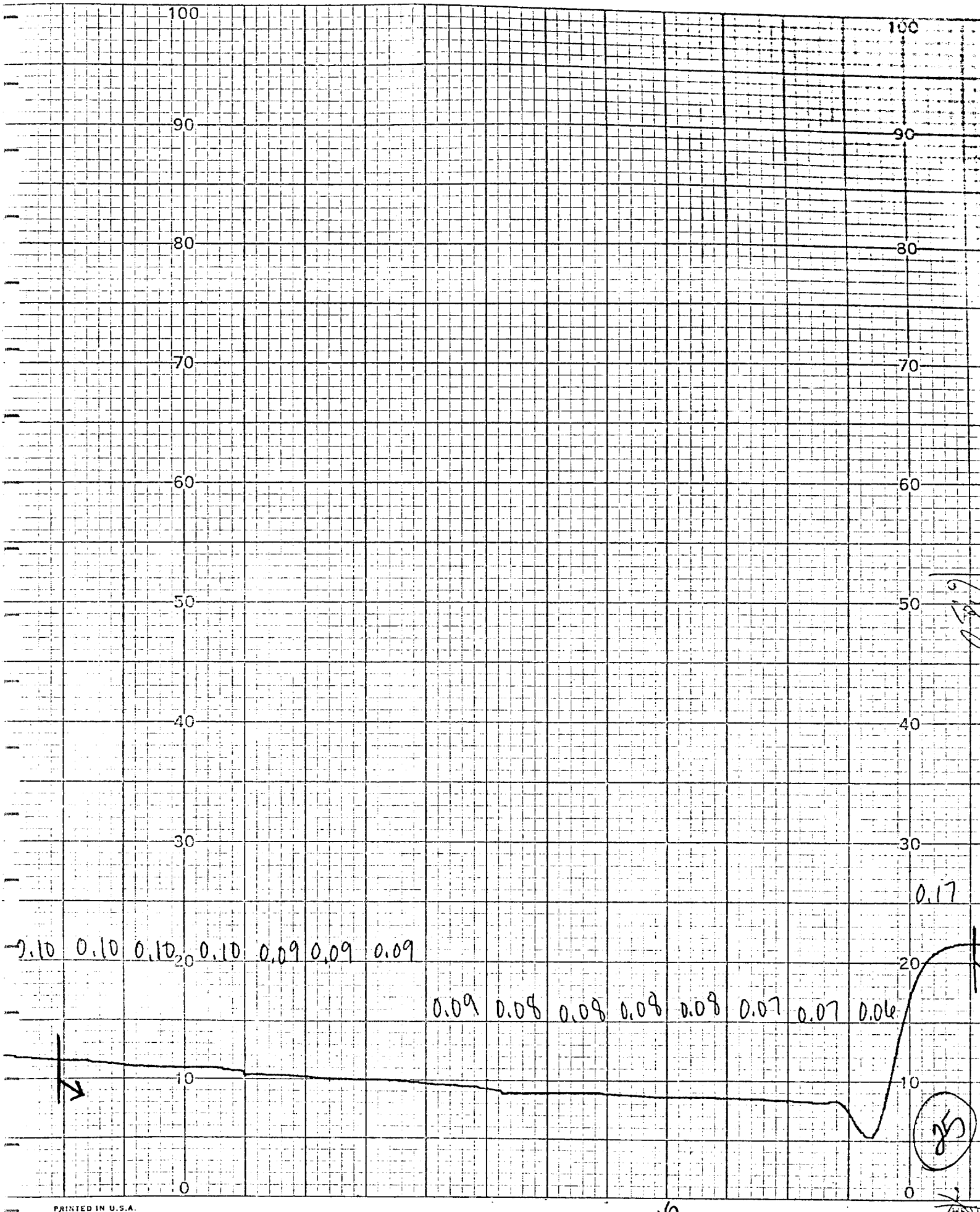

100
90
80
70
60
50
40
30
20
10
0
22 0.22 0.22 0.21 0.20 0.20 0.19 0.19 0.19 0.19 0.19 0.18 0.18 0.18 0.17 0.12
21

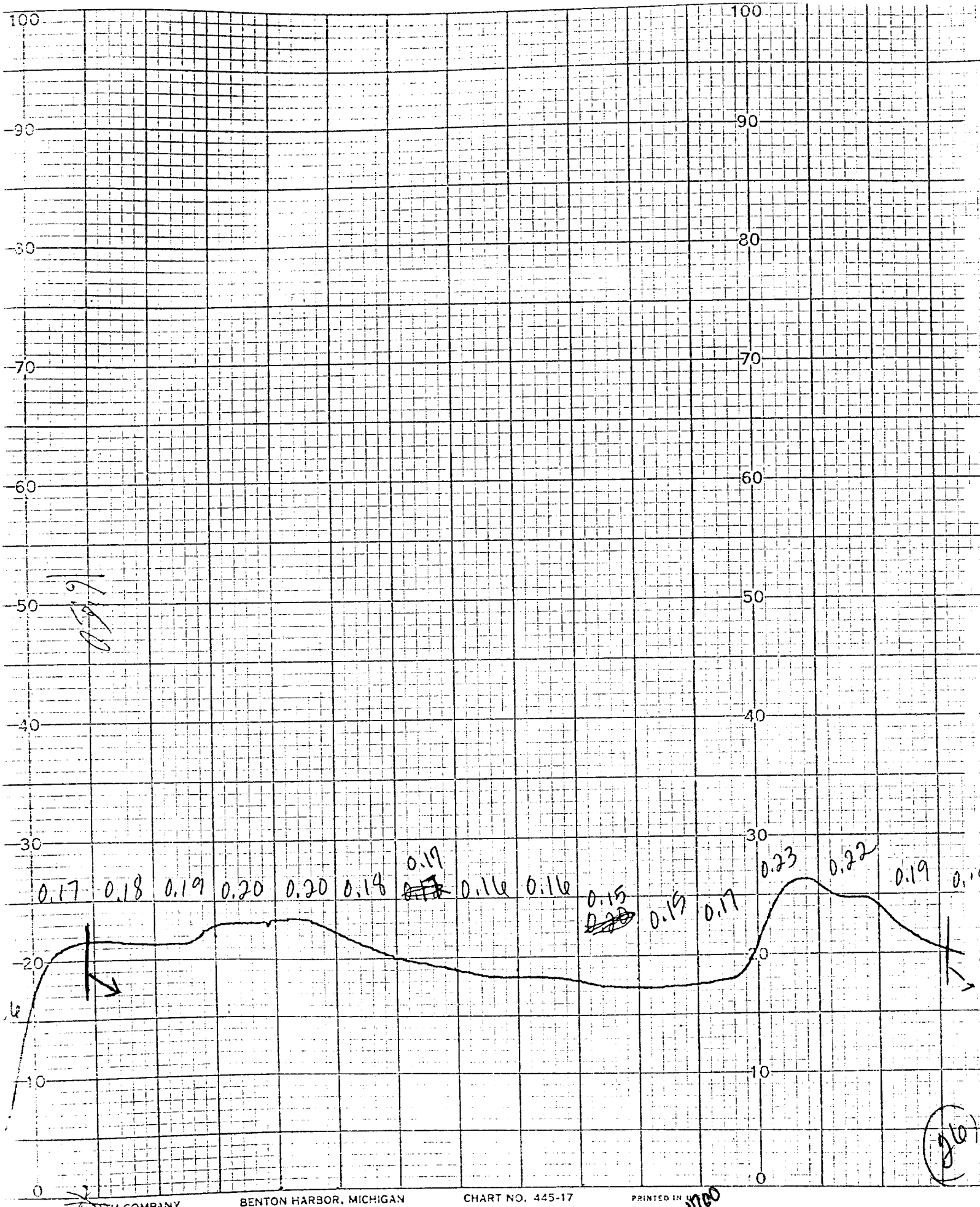

100
90
80
70
60
50
40
30
20
10
0
0.24
0.24
0.23
0.23
0.22
0.21
0.20
0.19
0.18
0.17
0.17
0.17
0.16
0.15
0.21
0.20
radio communication interfered
HEATH COMPANY

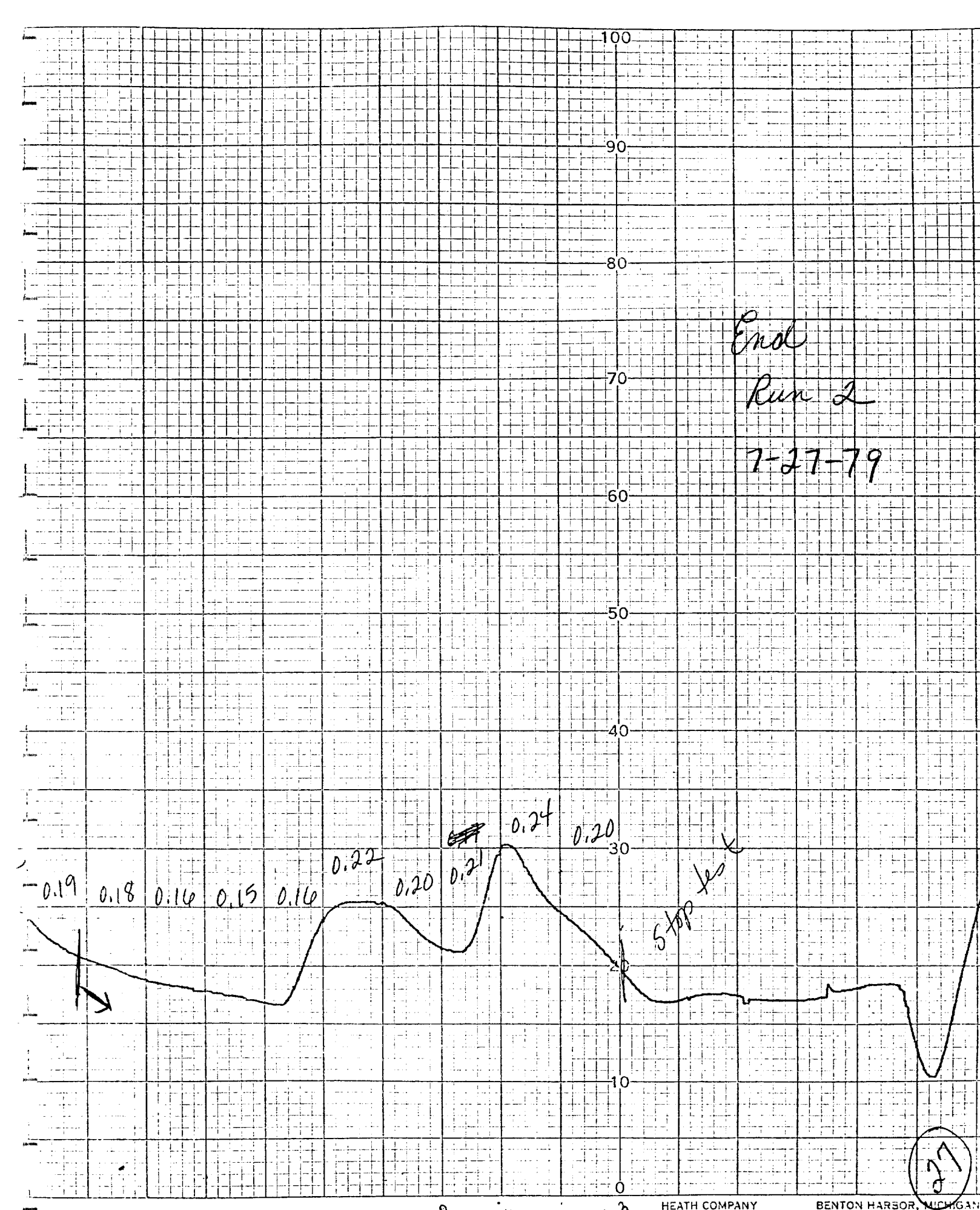

100
90
80
70
60
50
40
30
20
10
0
0.15 0.15 0.15 0.15
0.15 0.14 0.14 0.13 0.12 0.12 0.12 0.12 0.15 0.16
0.10
BENTON HARBOR, MICHIGAN
CHART NO. 445-17
PRINTED IN U.S.A.
1604
1610
1614
1618

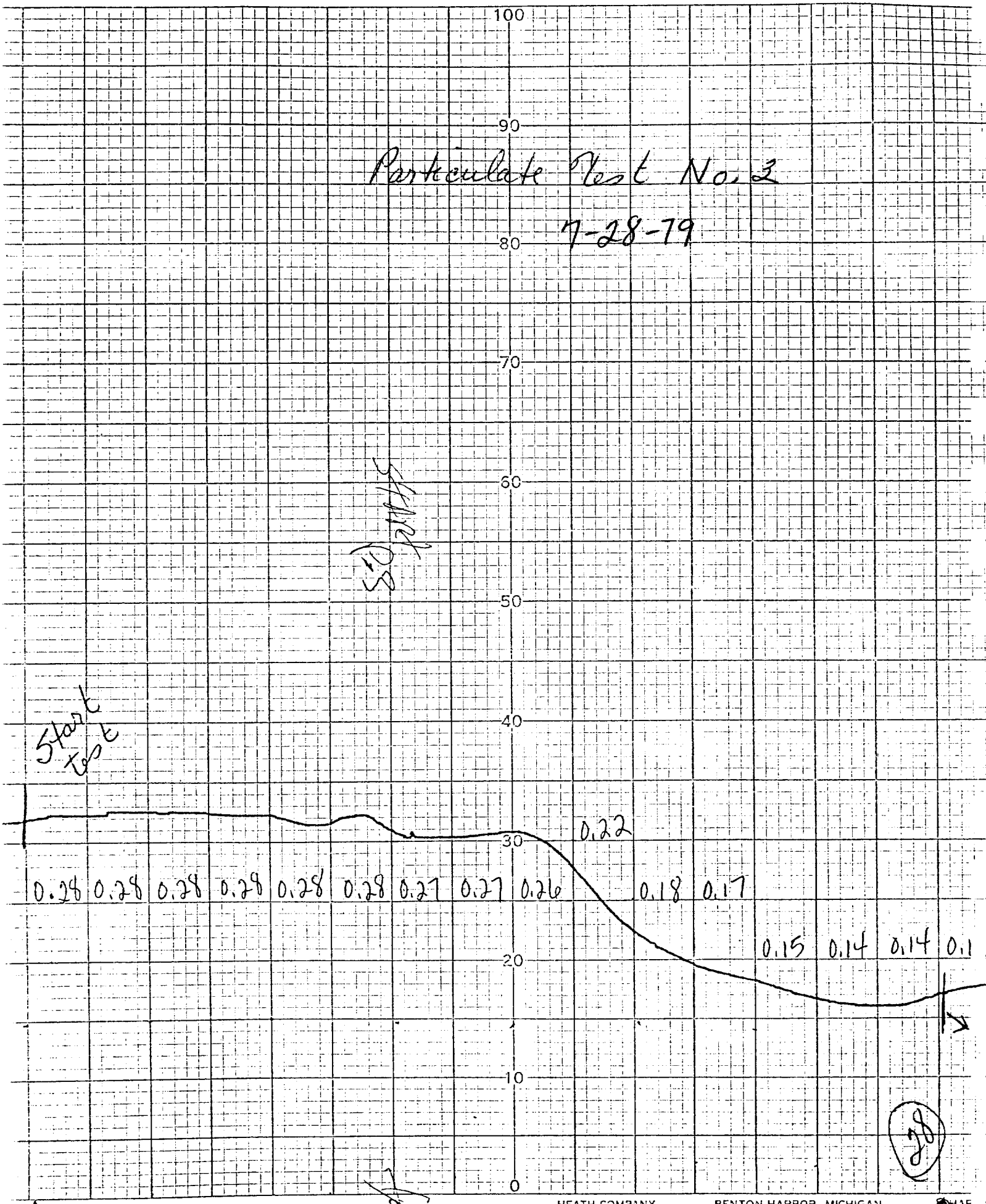


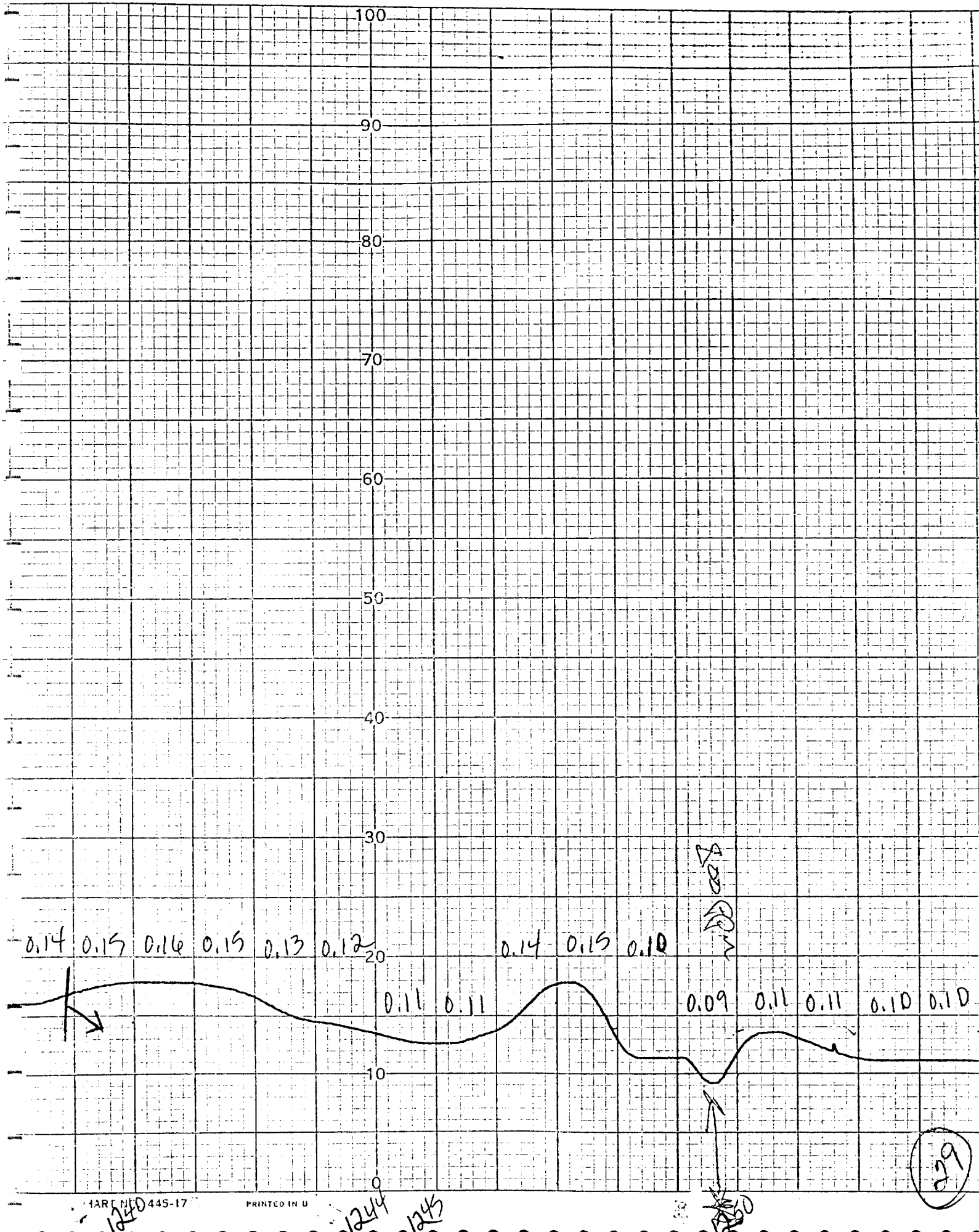
HEATH COMPANY BENTON HARBOR, MICHIGAN CHART NO. 445-17

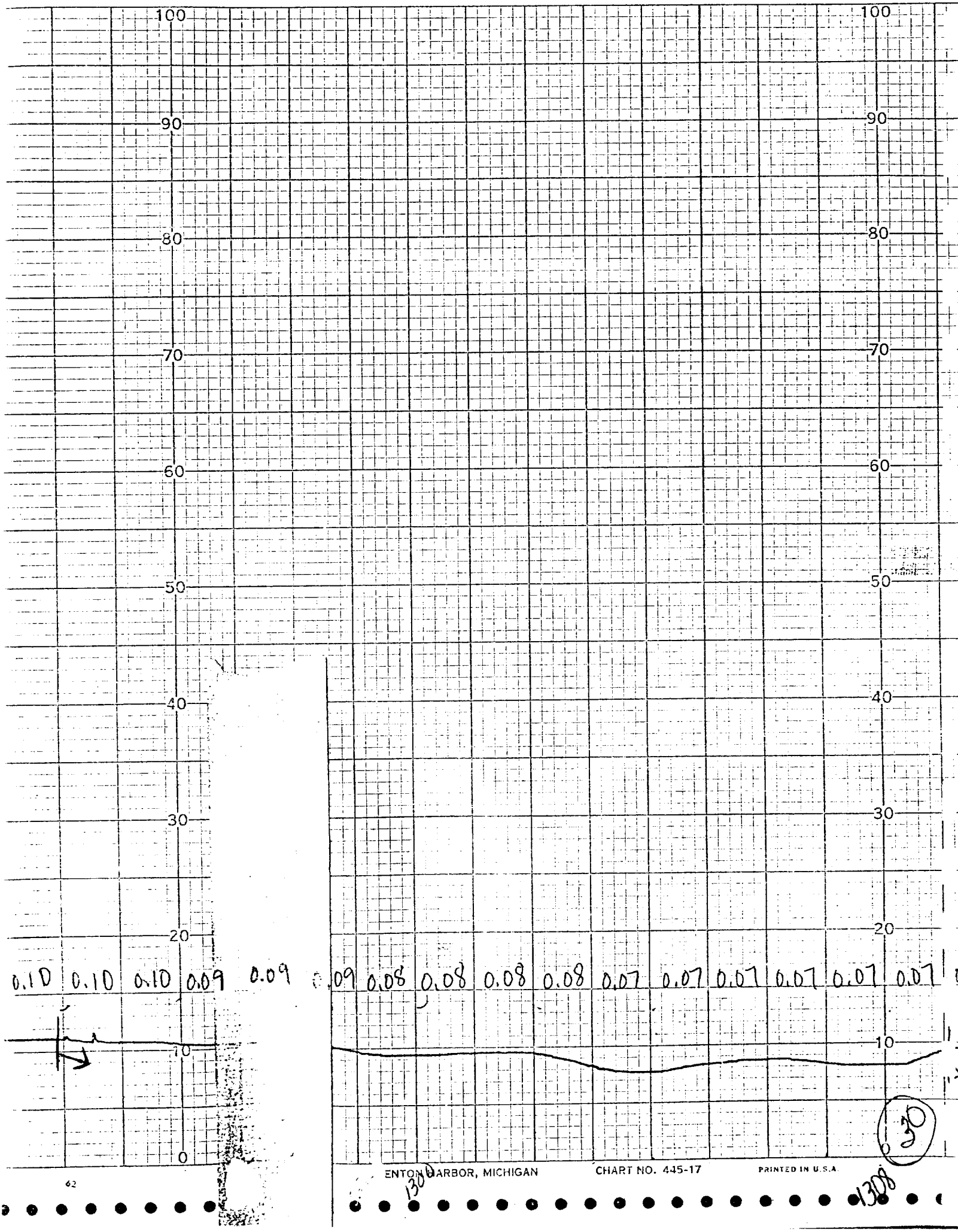

100
90
80
70
60
50
40
30
20
10
0
0.10 0.10 0.10 0.10 0.09 0.09 0.09
0.09 0.08 0.08 0.08 0.08 0.07 0.07 0.06
0.17
85

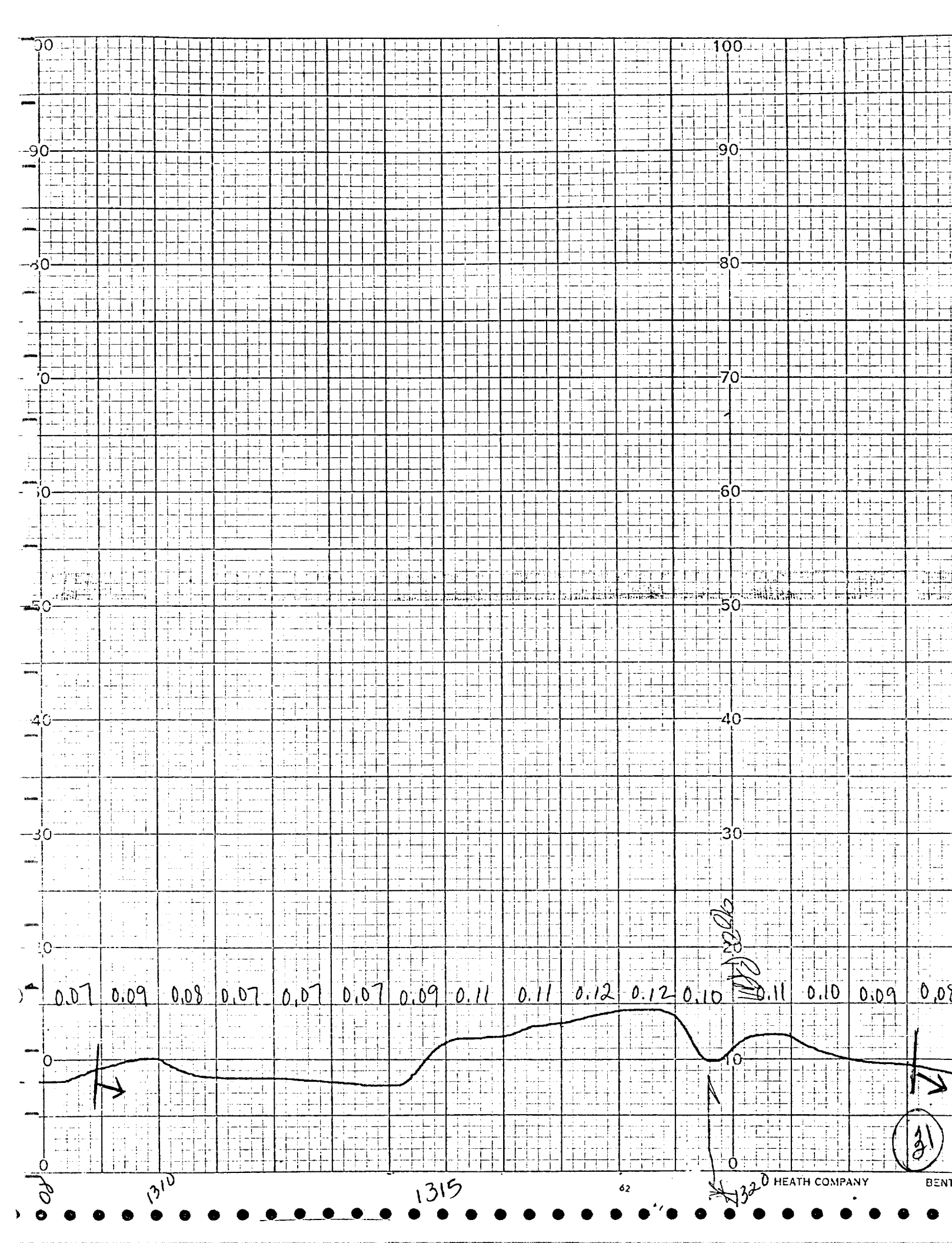

0.17 0.18 0.19 0.20 0.20 0.18 0.17 0.16 0.16 0.15 0.15 0.17 0.23 0.22 0.19
HEATH COMPANY BENTON HARBOR, MICHIGAN CHART NO. 445-17

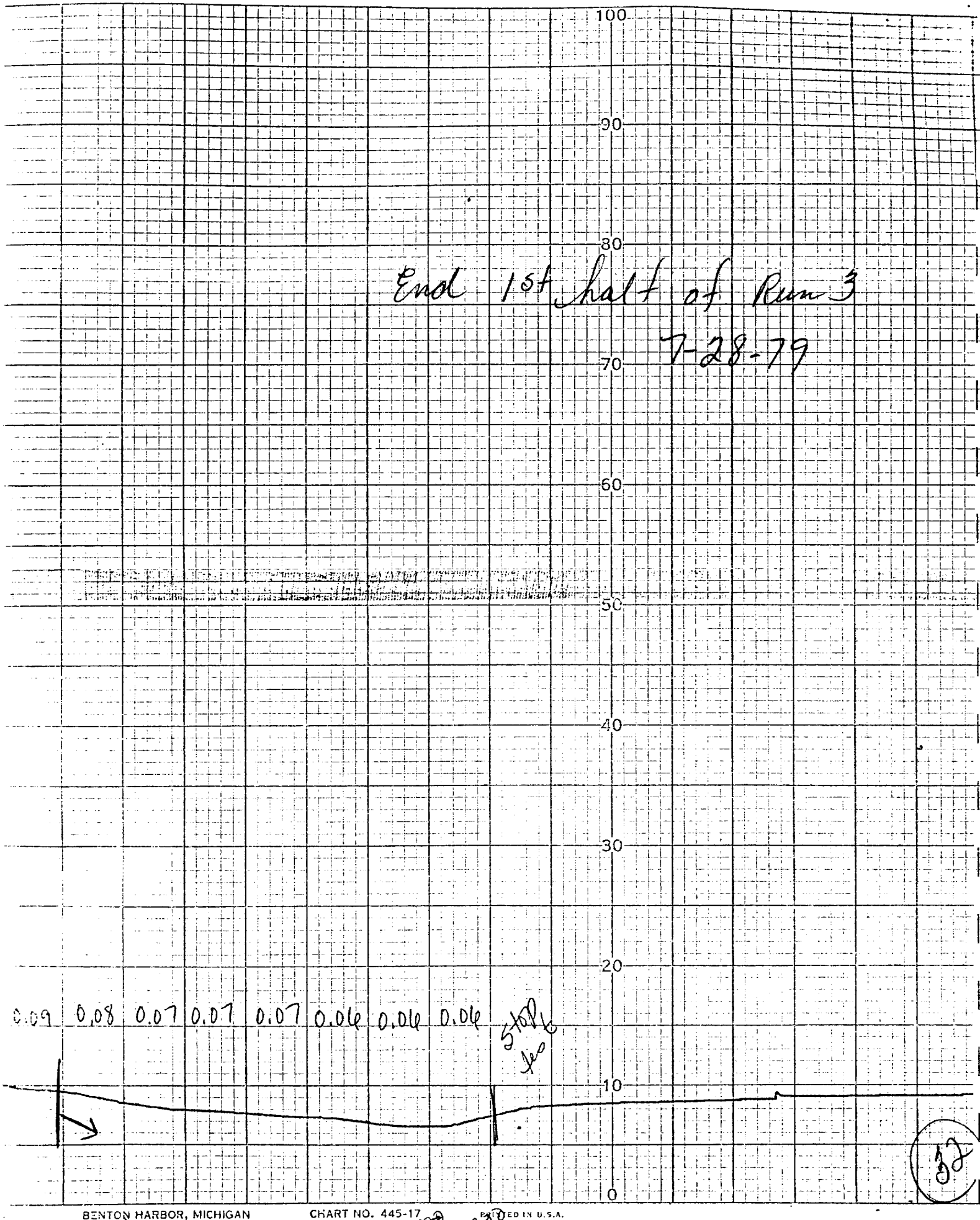

100
90
80
70
60
50
40
30
20
10
0
End
Run 2
7-27-79
0.19
0.18
0.16
0.15
0.16
0.22
0.20
0.21
0.24
0.20
Stop
27
1710
62
1713
HEATH COMPANY
BENTON HARBOR, MICHIGAN


Particulate Test No. 2
7-28-79
Stability
Start test
100
90
80
70
60
50
40
30
20
10
0
0.28 0.28 0.28 0.28 0.28 0.28 0.27 0.27 0.26 0.22 0.18 0.17 0.15 0.14 0.14 0.1
28
HEATH COMPANY
BENTON HARBOR, MICHIGAN


100
90
80
70
60
50
40
30
20
10
0
0.14 0.15 0.16 0.15 0.13 0.12
0.11 0.11
0.14 0.15 0.10
0.09 0.11 0.11 0.10 0.10
DOSE
1240
1244
1245
1250


100
90
80
70
60
50
40
30
20
10
0
0.10 0.10 0.10 0.09 0.09 0.09 0.08 0.08 0.08 0.08 0.07 0.07 0.07 0.07 0.07 0.07
ENTON HARBOR, MICHIGAN
CHART NO. 445-17
PRINTED IN U.S.A.
62
1300
1308
30

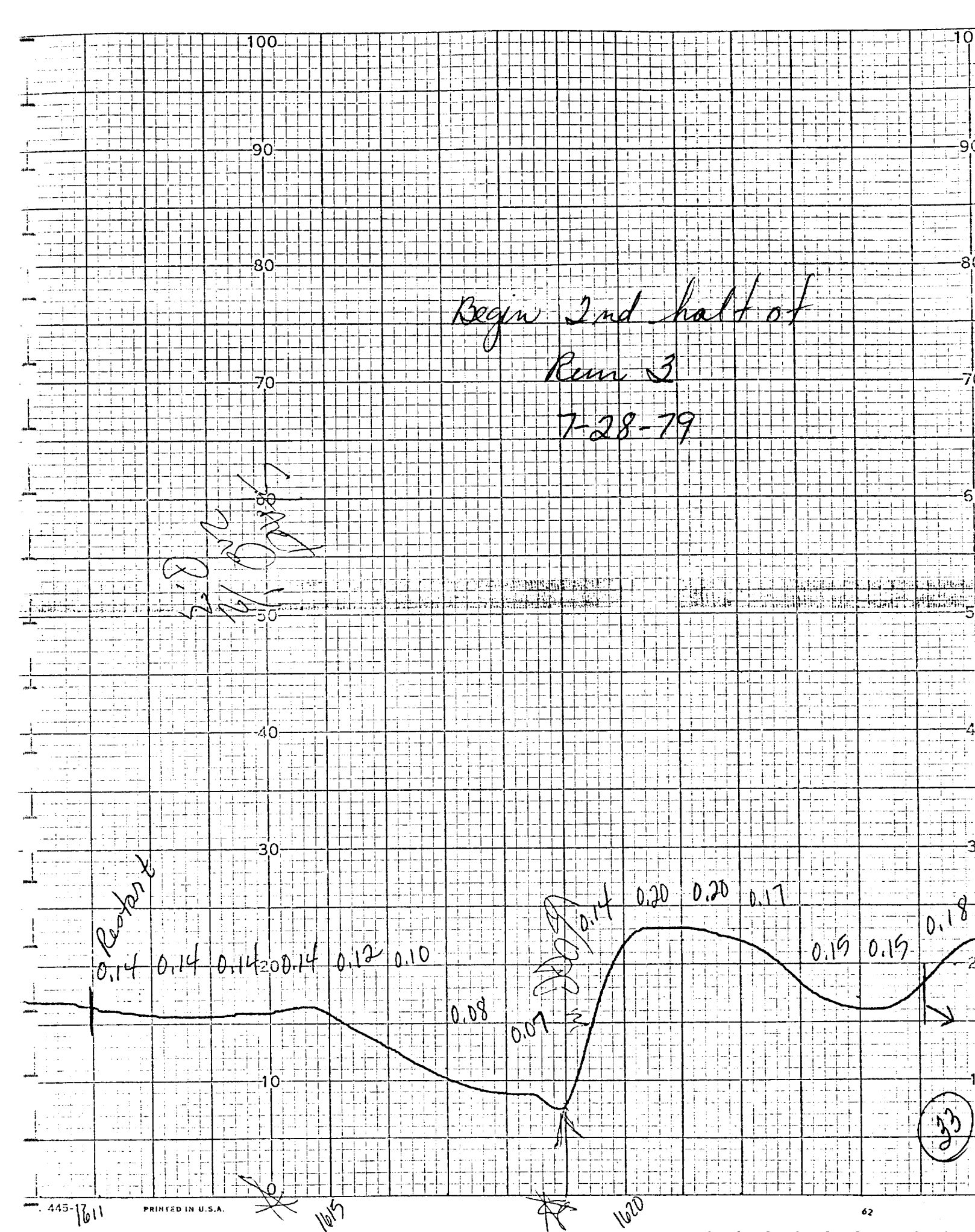

100
90
80
70
60
50
40
30
0.07 0.09 0.08 0.07 0.07 0.07 0.09 0.11 0.11 0.12 0.12 0.10 0.11 0.10 0.09
0
1310
1315
1320
HEATH COMPANY

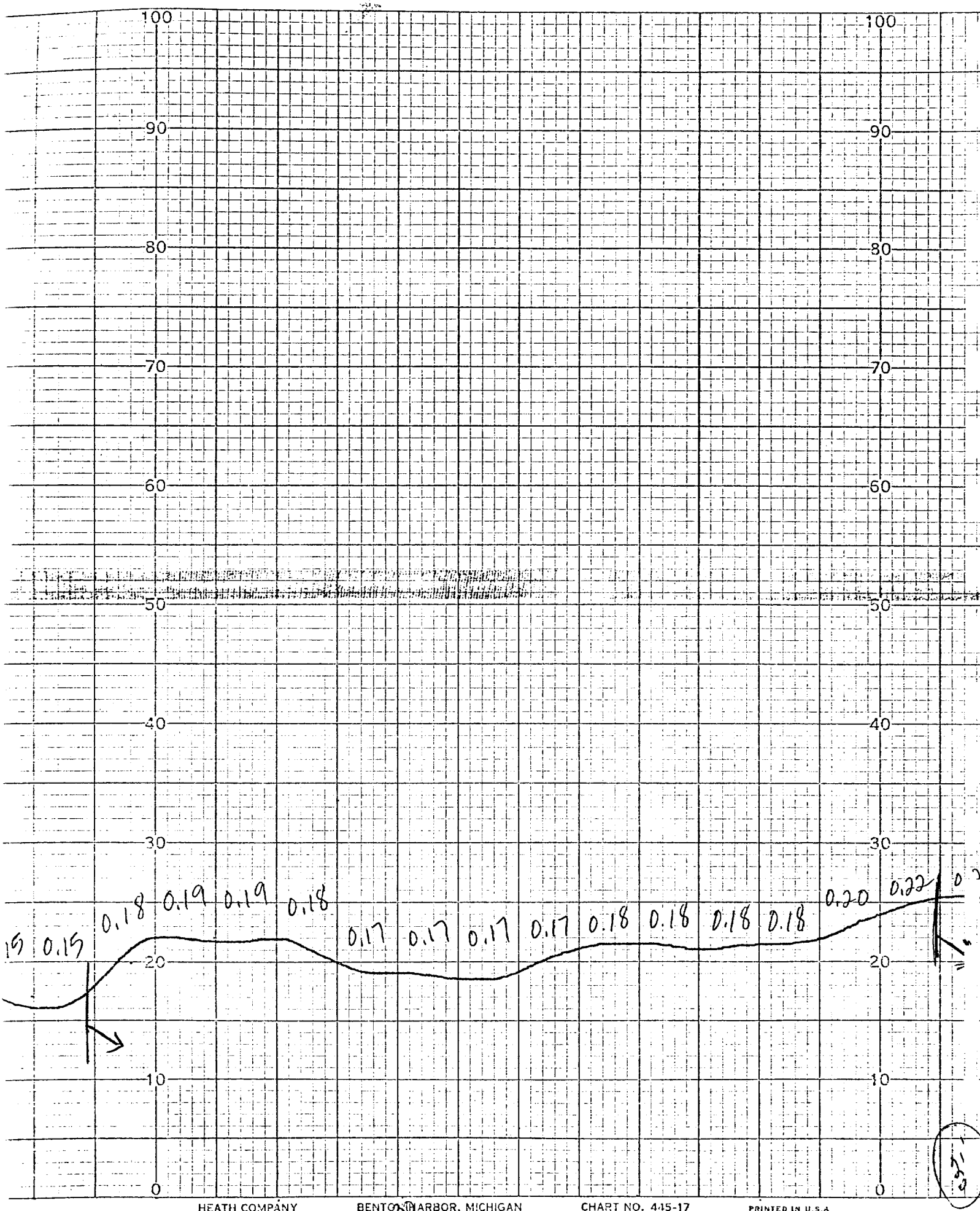


BENTON HARBOR, MICHIGAN CHART NO. 445-17 PRINTED IN U.S.A.

32

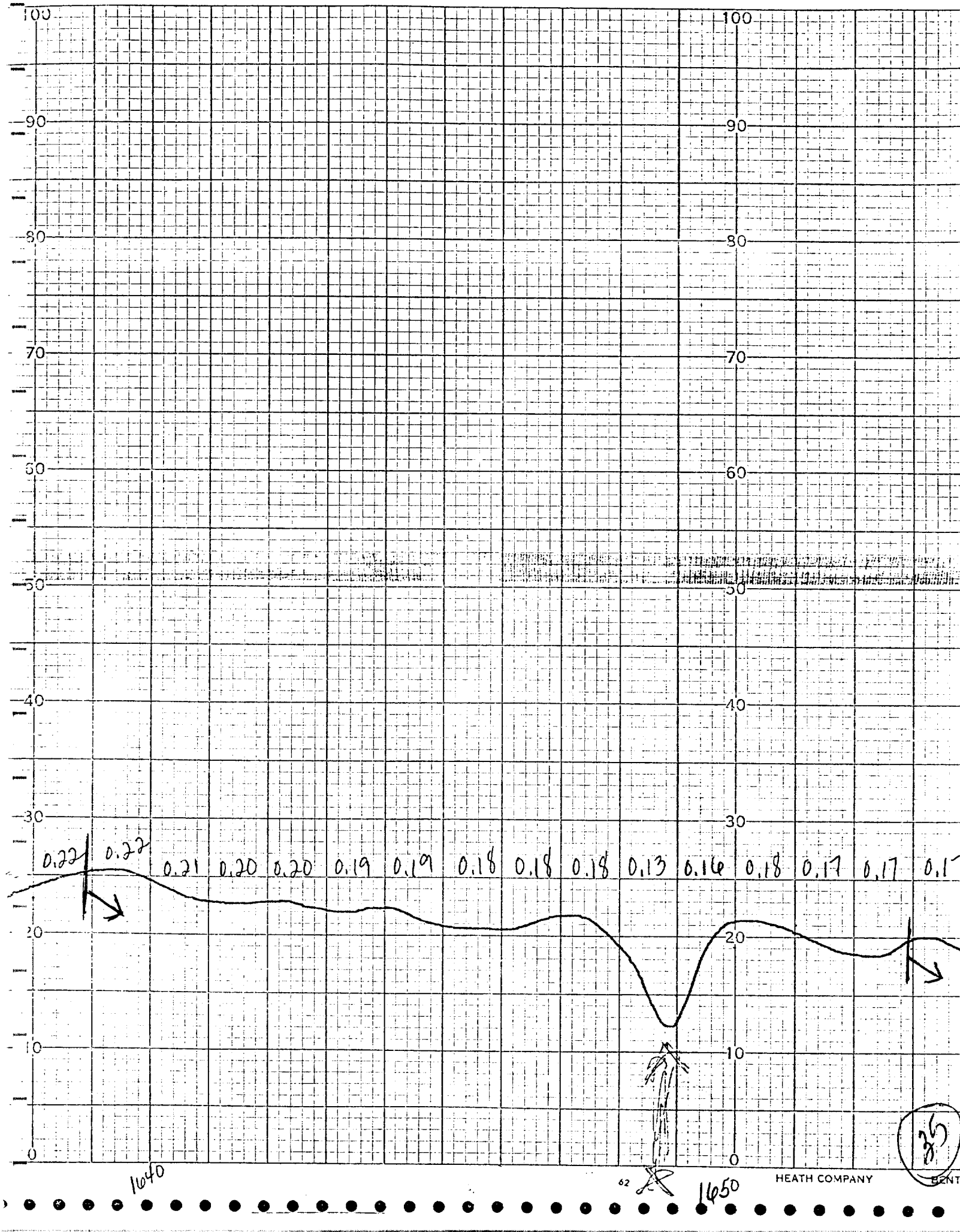
1324 1330

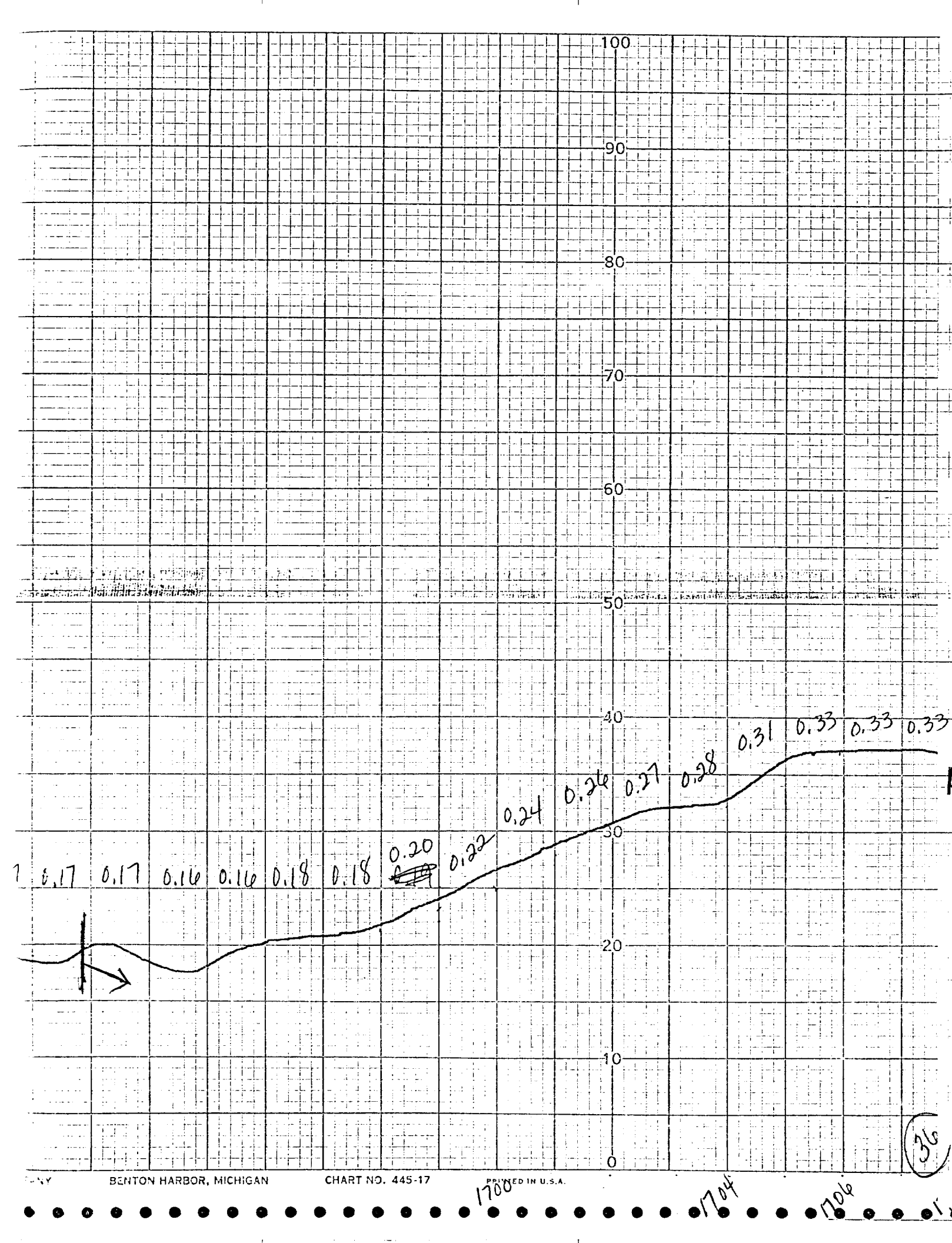

Begin 2nd half of
Run 3
7-28-79
Restart
0.14 0.14 0.14 0.14 0.12 0.10
0.08
0.07
0.14 0.20 0.20 0.17
0.15 0.15 0.18
33
1615
1620

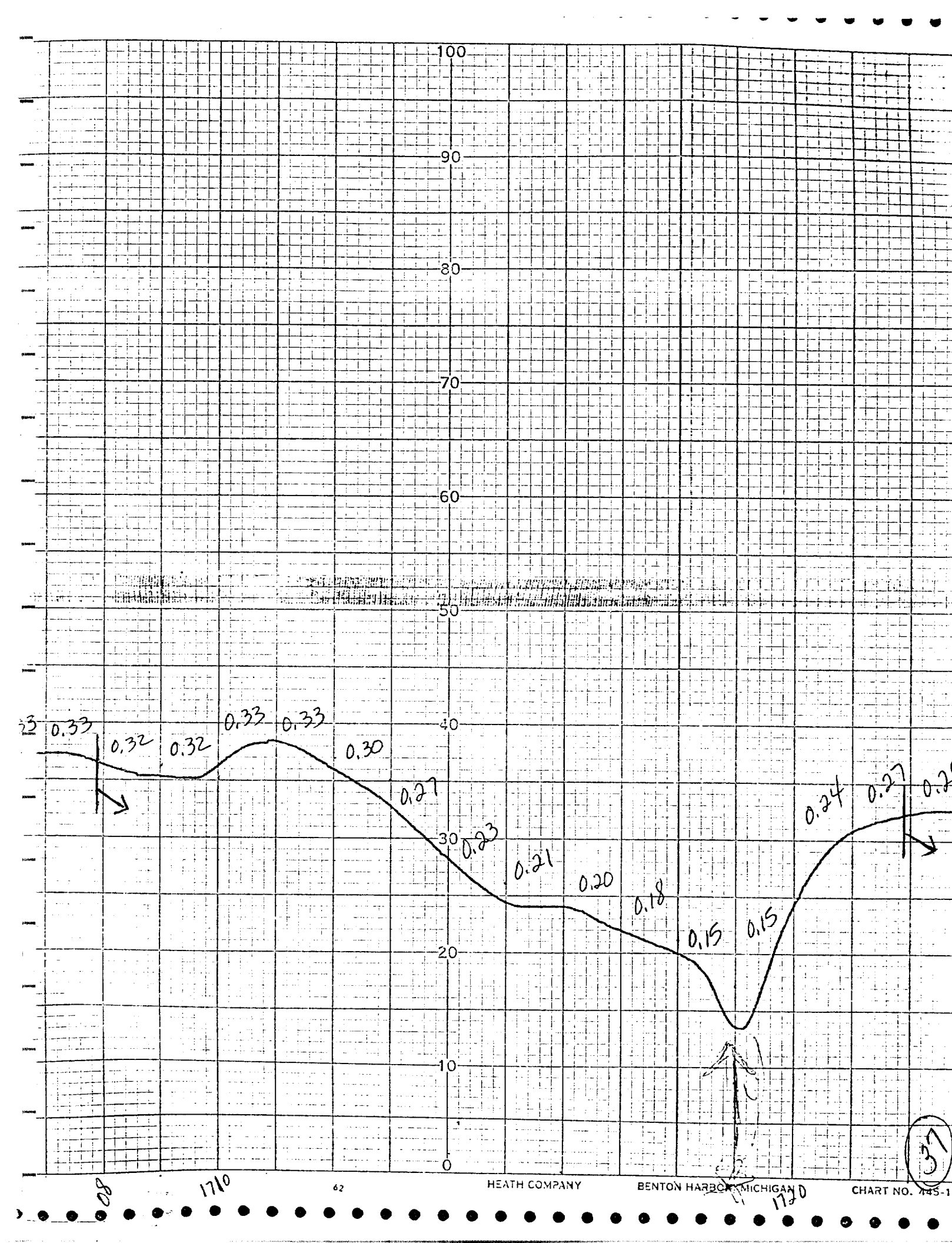


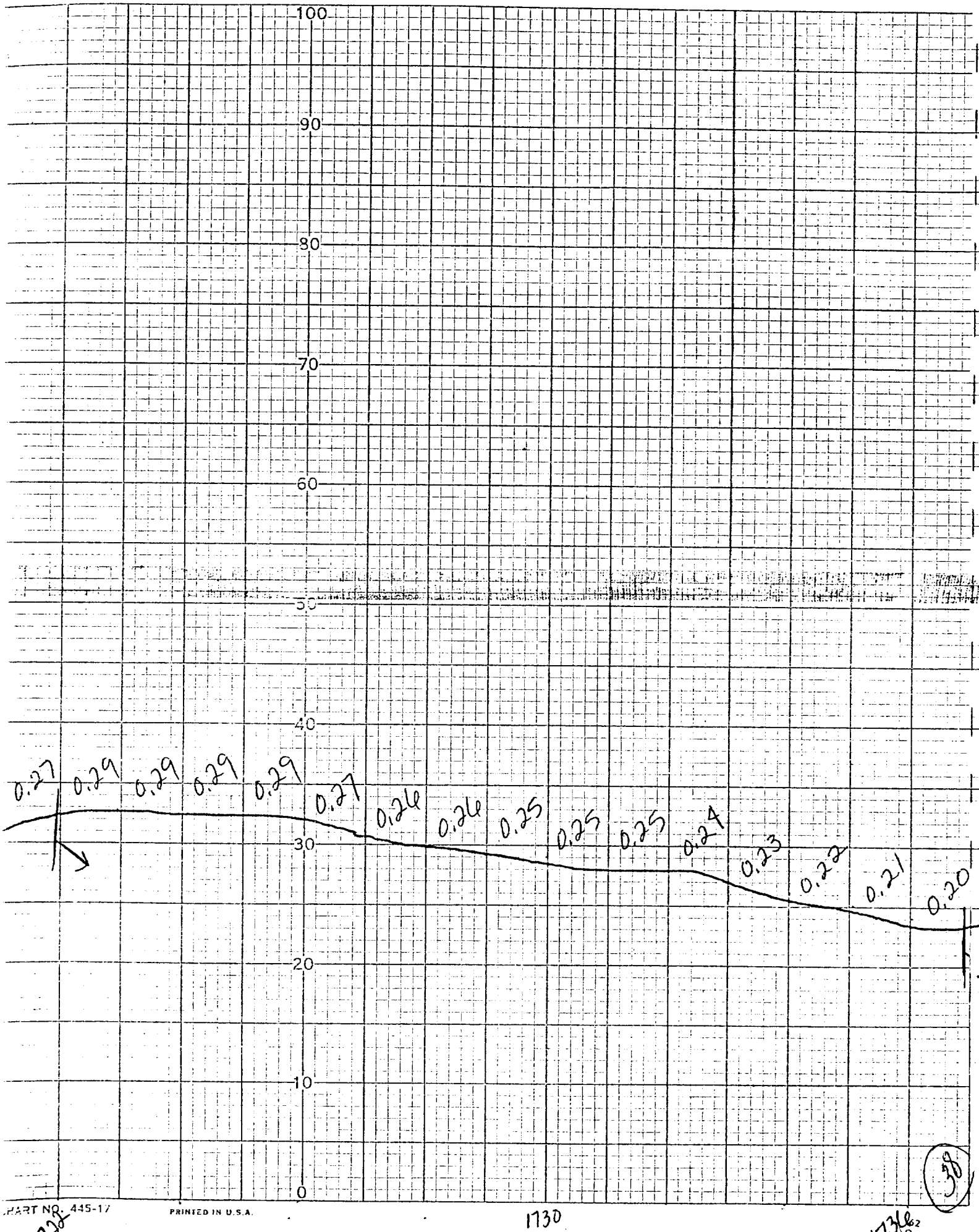
HEATH COMPANY BENTON HARBOR, MICHIGAN CHART NO. 445-17 PRINTED IN U.S.A.

1650

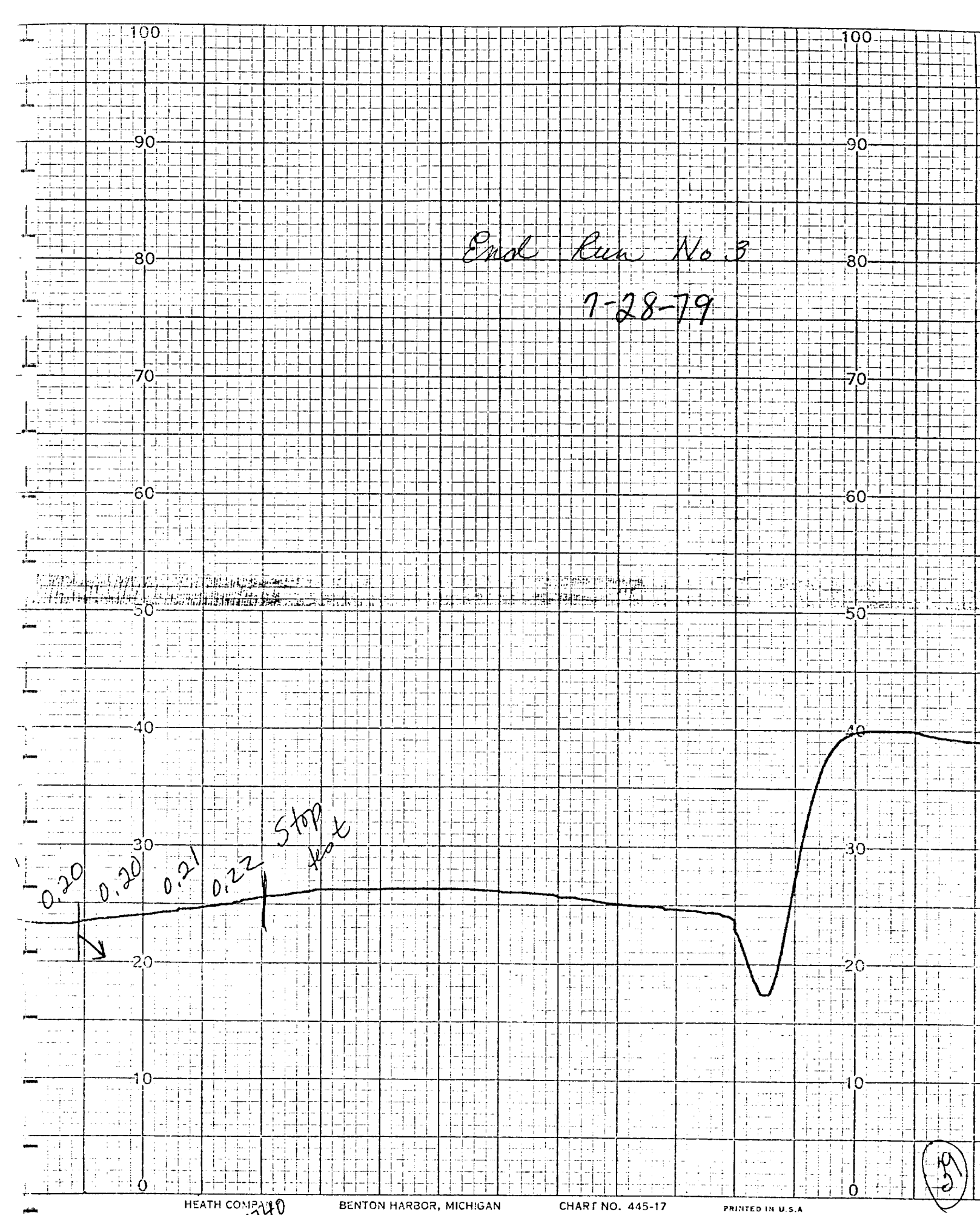

100
90
80
70
60
50
40
30
20
10
0
0.22
0.22
0.21
0.20
0.20
0.19
0.19
0.18
0.18
0.18
0.13
0.16
0.18
0.17
0.17
1040
1650
HEATH COMPANY


100
90
80
70
60
50
40
30
20
10
0
0.17
0.17
0.16
0.16
0.18
0.18
0.20
0.22
0.24
0.26
0.27
0.28
0.31
0.33
0.33
0.33
BENTON HARBOR, MICHIGAN
CHART NO. 445-17
PRINTED IN U.S.A.
1700
1704
1706


100
90
80
70
60
50
40
30
20
10
0
0.33
0.32
0.32
0.33
0.33
0.30
0.27
0.23
0.21
0.20
0.18
0.15
0.15
0.24
0.27
1710
1720
HEATH COMPANY
BENTON HARBOR, MICHIGAN
CHART NO. 445-1


100
90
80
70
60
50
40
30
20
10
0
0.27
0.29
0.29
0.29
0.29
0.27
0.26
0.26
0.25
0.25
0.25
0.24
0.23
0.22
0.21
0.20

1730


100
90
80
70
60
50
40
30
20
10
0
End Run No. 3
7-28-79
0.20
0.20
0.21
0.22
Stop
Heat
HEATH COMPANY
BENTON HARBOR, MICHIGAN
CHART NO. 445-17
PRINTED IN U.S.A.

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.		

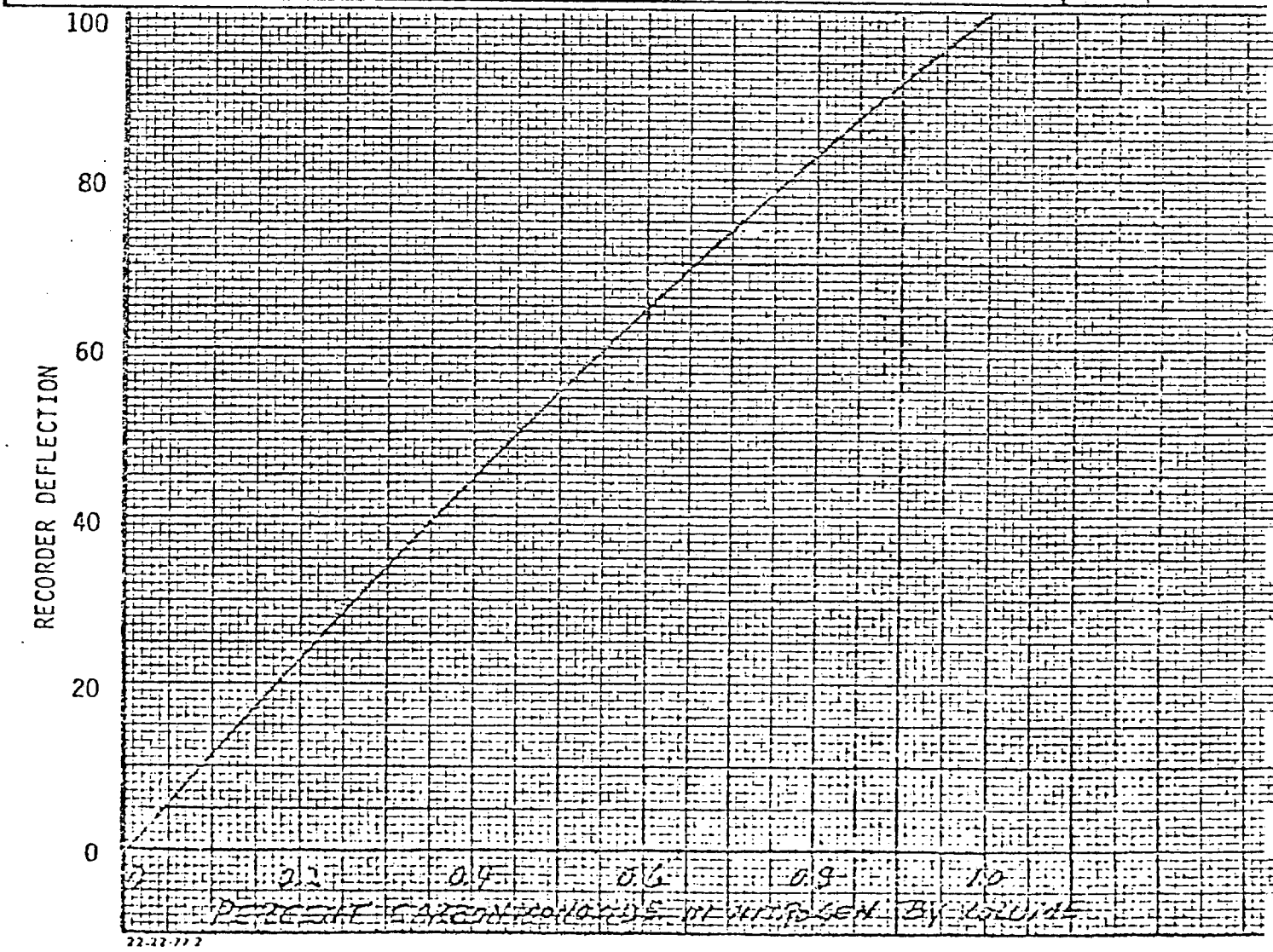
DETECTOR SER. NO.:	
DETECTOR PART NO.:	
TAG NO.:	
CONFIGURATION NO.: 12	

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:



22-22-772

APPENDIX E-2

SUMMARIES OF CARBON MONOXIDE DATA

TABLE E-2.1. SUMMARY OF ONE-MINUTE CO READINGS
RUN 1
July 26, 1979

Time	CO %
1517	0.11
1518	0.10
1519	0.10
1520	0.10
1521	0.09
1522	0.12
1523	0.20
1524	0.22
1525	0.22
1526	0.22
1527	0.22
1528	0.22
1529	0.22
1530	0.22
1531	0.22
1532	0.22
1533	0.20
1534	0.20
1535	0.19
1536	0.19
1537	0.20
1538	0.21
1539	0.22
1540	0.20
1541 thru 1545 Power off	
1546	0.16
1547	0.16
1548	0.13
1549	0.13
1550	0.15
1551	0.15
1552	0.15
1553	0.15
1554	0.14
1555	0.14
1556	0.14
1557	0.13
1558 thru 1601 Power off	
1602	0.11
1603	0.10
1604	0.10
1605	0.10
1606	0.10
1607	0.09
1608	0.09
1609	0.09
1610	0.09
1611	0.09
1612	0.09
1613	0.09
1614	0.08
1615 thru 1628 Power off	
1629	0.10
1630	0.11
1631	0.11
1632	0.11
1633 thru 1645 Power off	
1646	0.15
1647	0.16
1648	0.16
1649	0.14
1650	0.11
1651	0.11
1652	0.15
1653	0.16
1654	0.17
1655	0.17
1656	0.16
1657	0.15
1658	0.15
1659	0.16
1700	0.17
1701	0.17
End first half of Run 1	
2008	0.17
2009	0.17
2010	0.18
2011	0.17
2012	0.16
2013	0.16
2014	0.17
2015	0.16
2016	0.16

TABLE E-2.1. SUMMARY OF ONE-MINUTE CO READINGS (CONTINUED)
RUN 1
July 26, 1979

Time	CO %	Time	CO %
2017	0.16	2101	0.17
2018	0.16	2102	0.18
2019	0.13	2103	0.18
2020	0.15	2104	0.18
2021	0.25	2105	0.21
2022	0.26	2106	0.19
2023	0.26	2107	0.15
2024	0.27	2108	0.14
2025	0.29	2109	0.11
2026	0.32	2110	0.08
2027	0.29	2111	0.05
2028	0.25	2112	0.12
2029	0.22	2113	0.13
2030	0.22	2114	0.13
2031	0.24	2115	0.12
2032	0.24	2116	0.12
2033	0.25	2117	0.12
2034	0.26	2118	0.12
2035	0.26	2119	0.11
2036	0.23	2120	0.10
2037	0.20	2121	0.14
2038	0.20	2122	0.17
2039	0.20	2123	0.18
2040	0.20	2124	0.18
2041	0.18	2125	0.18
2042	0.18	2126	0.18
2043	0.19	2127	0.18
2044	0.19		
2045	0.18		
2046	0.18		
2047	0.19		
2048	0.23		
2049	0.20		
2050	0.18		
2051	0.23		
2052	0.23		
2053	0.23		
2054	0.22		
2055	0.21		
2056	0.19		
2057	0.18		
2058	0.18		
2059	0.17		
2100	0.15		

TABLE E-2.2. SUMMARY OF ONE-MINUTE CO READINGS
RUN 2
July 27, 1979

Time	CO %	Time	CO %
1304	0.07	1347	0.08
1305	0.07	1348	0.12
1306	0.08	1349	0.11
1307	0.11	1350	0.11
1308	0.12	1351	0.11
1309	0.13	1352	0.12
1310	0.12	1353	0.13
1311	0.10	1354	0.13
1312	0.05	1355	0.13
1313	0.03	1356	0.13
1314	0.03	1357	0.13
1315	0.04	1358	0.13
1316	0.04	1359	0.13
1317	0.04	1400	0.13
1318	0.05	1401	0.14
1319	0.09	1402	0.14
1320	0.09	1403	0.11
1321	0.08	1404	0.09
1322	0.08	1405	0.08
1323	0.10	1406	0.08
1324	0.11	1407	0.08
1325	0.11	1408	0.08
1326	0.11	1409	0.09
1327	0.12	End first half of Run 2	
1328	0.14		
1329	0.15	1507	0.13
1330	0.15	1508	0.14
1331	0.17	1509	0.14
1332	0.19	1510	0.14
1333	0.19	1511	0.14
1334	0.18	1512	0.14
1335	0.17	1513	0.14
1336	0.16	1514	0.14
1337	0.16	1515	0.13
1338	0.15	1516	0.13
1339	0.15	1517	0.13
1340	0.14	1518	0.10
1341	0.14	1519	0.20
1342	0.13	1520	0.23
1343	0.12	1521	0.23
1344	0.12	1522	0.23
1345	0.12	1523	0.23
1346	0.13	1524	0.23

TABLE E-2.2. SUMMARY OF ONE-MINUTE CO READINGS (CONTINUED)
RUN 2
July 27, 1979

Time	CO %	Time	CO %
1525	0.24	1607	0.15
1526	0.24	1608	0.15
1527	0.24	1609	0.14
1528	0.24	1610	0.14
1529	0.23	1611	0.13
1530	0.23	1612	0.12
1531	0.23	1613	0.12
1532	0.23	1614	0.12
1533	0.22	1615	0.12
1534	0.22	1616	0.15
1535	0.22	1617	0.16
1536	0.21	1618	0.10
1537	0.20	1619	0.19
1538	0.20	1620	0.19
1539	0.19	1621	0.17
1540	0.19	1622	0.14
1541	0.19	1623	0.13
1542	0.19	1624	0.14
1543	0.19	1625	0.14
1544	0.18	1626	0.12
1545	0.18	1627	0.11
1546	0.18	1628	0.11
1547	0.17	1629	0.11
1548	0.12	1630	0.11
1549	0.24	1631	0.11
1550	0.24	1632	0.11
1551	0.23	1633	0.11
1552	0.23	1634	0.10
1553	0.22	1635	0.10
1554	0.21	1636	0.10
1555	0.20	1637	0.10
1556	0.20	1638	0.09
1557	0.18	1639	0.09
1558	0.18	1640	0.09
1559	0.17	1641	0.09
1600	0.17	1642	0.08
1601	0.17	1643	0.08
1602	0.16	1644	0.08
1603	0.15	1645	0.08
1604	0.15	1646	0.07
1605	0.15	1647	0.07
1606	0.15	1648	0.06

TABLE E-2.2. SUMMARY OF ONE-MINUTE CO READINGS (CONTINUED)
RUN 2
July 27, 1979

Time	CO %
1649	0.17
1650	0.18
1651	0.19
1652	0.20
1653	0.20
1654	0.18
1655	0.17
1656	0.16
1657	0.16
1658	0.15
1659	0.15
1700	0.17
1701	0.23
1702	0.22
1703	0.19
1704	0.18
1705	0.16
1706	0.15
1707	0.16
1708	0.22
1709	0.20
1710	0.21
1711	0.24
1712	0.20

TABLE E-2.3. SUMMARY OF ONE-MINUTE CO READINGS
RUN 3
July 28, 1979

Time	CO %	Time	CO %
1224	0.28	1638	0.22
1225	0.28	1639	0.22
1226	0.28	1640	0.21
1227	0.28	1641	0.20
1228	0.28	1642	0.20
1229	0.28	1643	0.19
1230	0.27	1644	0.19
1231	0.27	1645	0.18
1232	0.26	1646	0.18
1233	0.22	1647	0.18
1234	0.18	1648	0.13
1235 - to end of 1st half of Run 3 pump did not operate properly		1649	0.16
		1650	0.18
		1651	0.17
		1652	0.17
1611	0.14	1653	0.17
1612	0.14	1654	0.16
1613	0.14	1655	0.16
1614	0.14	1656	0.18
1615	0.12	1657	0.18
1616	0.10	1658	0.20
1617	0.08	1659	0.22
1618	0.07	1700	0.24
1619	0.14	1701	0.26
1620	0.20	1702	0.27
1621	0.20	1703	0.28
1622	0.17	1704	0.31
1623	0.15	1705	0.33
1624	0.15	1706	0.33
1625	0.18	1707	0.33
1626	0.19	1708	0.32
1627	0.19	1709	0.32
1628	0.18	1710	0.33
1629	0.17	1711	0.33
1630	0.17	1712	0.30
1631	0.17	1713	0.27
1632	0.17	1714	0.23
1633	0.18	1715	0.21
1634	0.18	1716	0.20
1635	0.18	1717	0.18
1636	0.18	1718	0.15
1637	0.20	1719	0.15

TABLE E-2.3. SUMMARY OF ONE-MINUTE CO READINGS (CONTINUED)
RUN 3
July 28, 1979

Time	CO %
1720	0.24
1721	0.27
1722	0.29
1723	0.29
1724	0.29
1725	0.29
1726	0.27
1727	0.26
1728	0.26
1729	0.25
1730	0.25
1731	0.25
1732	0.24
1733	0.23
1734	0.22
1735	0.21
1736	0.20
1737	0.20
1738	0.21
1739	0.22

APPENDIX F

DETAILED SUMMARY OF SAMPLING AND ANALYTICAL PROCEDURES

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

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

APPENDIX F-1

DETERMINATION OF BENZENE FROM STATIONARY SOURCES - METHOD 110

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 111-1).

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 111-1.

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.

---

[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 111-1. 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 111-2. 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:

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

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

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:

$$C_s = \frac{C_c P_r T_i}{P_i T_r (1-S_{wb})}$$ Equation 111-2

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. Fearheller, W. R.; Kemmer, A. N.; 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 more from J. Hall.

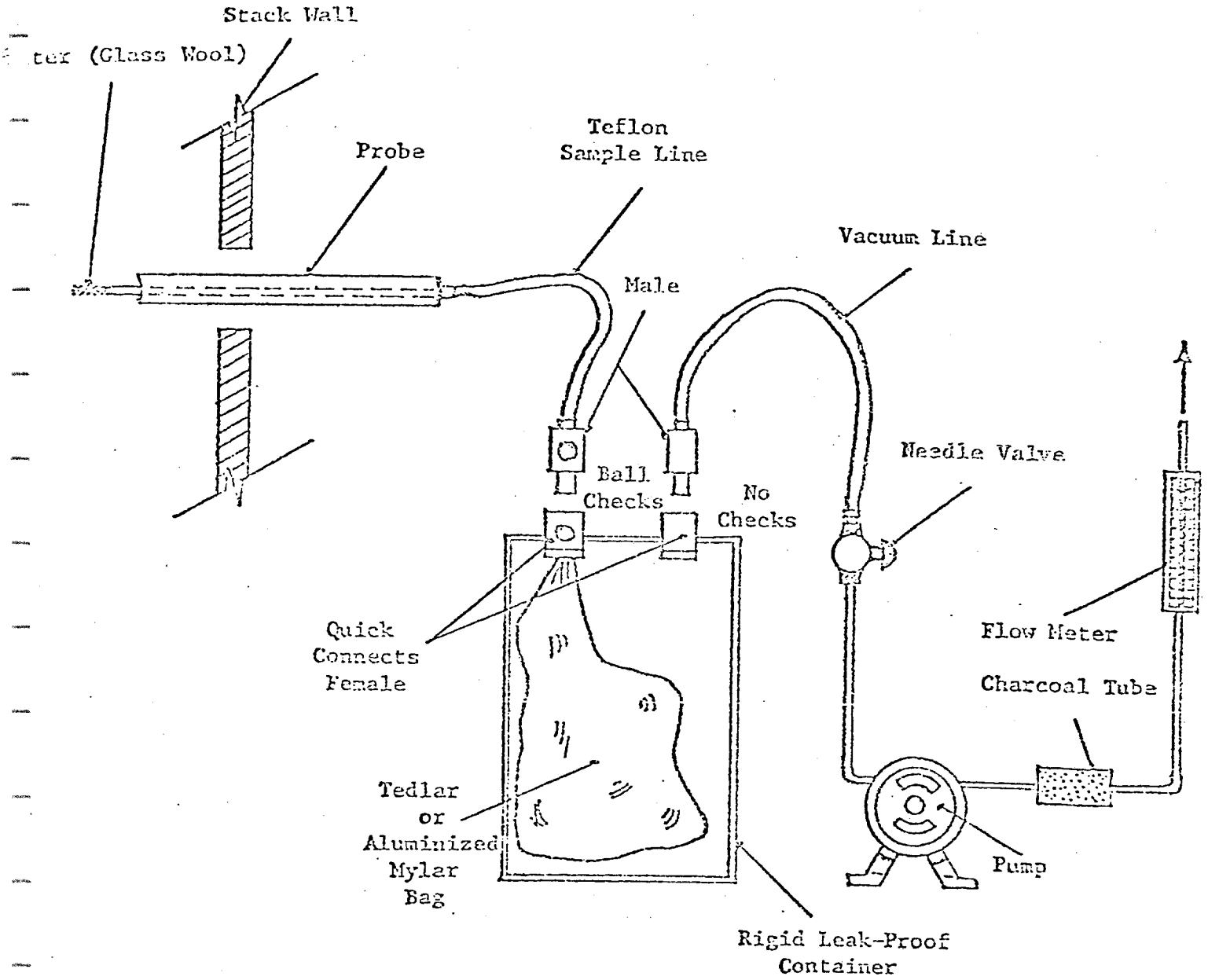


Figure III-1. Integrated-bag sampling train. (Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.)

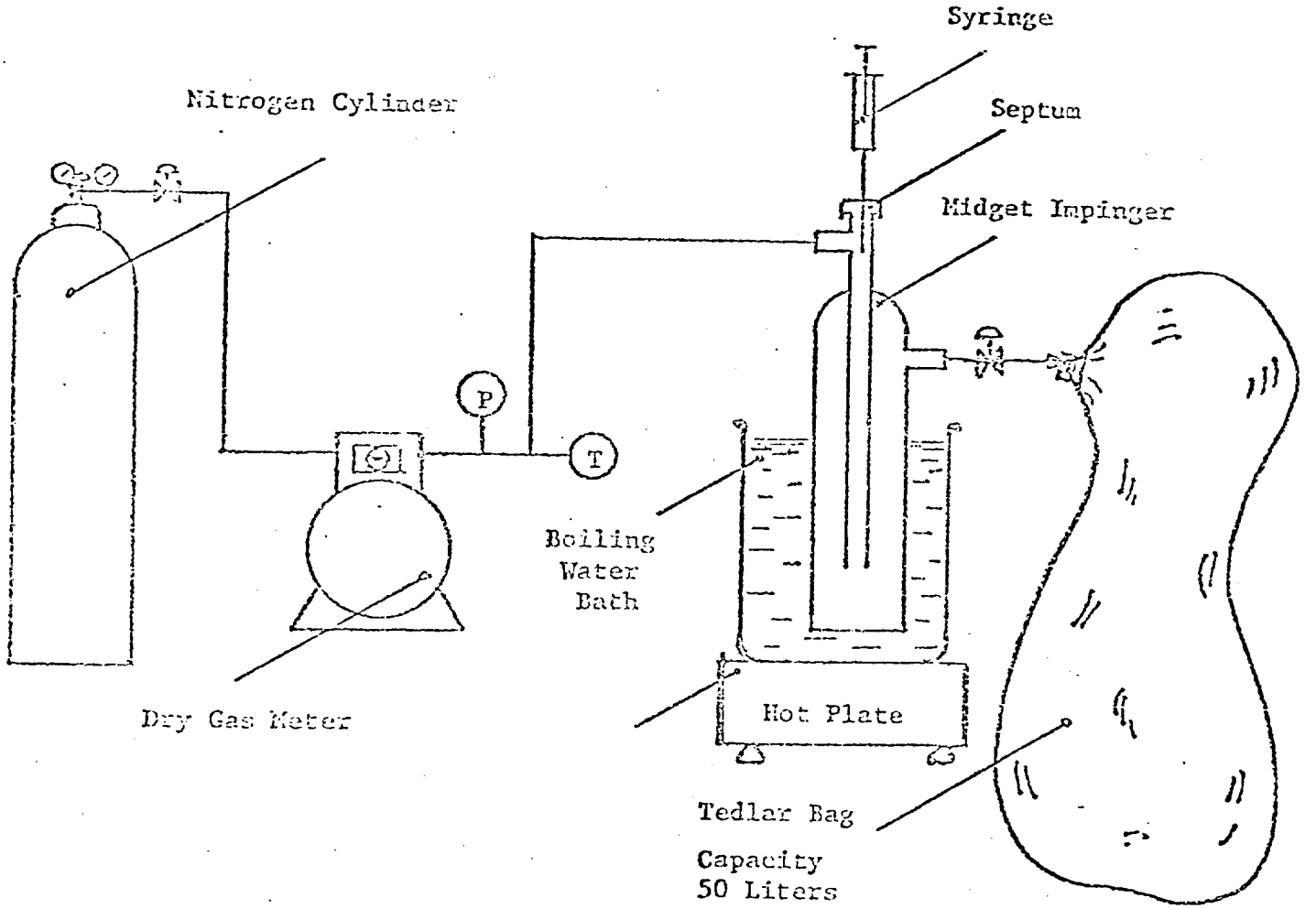


Figure 111-2. Preparation of Benzene Standards. (optional)

Method III

SUPPLEMENT A

DETERMINATION OF ADEQUATE CHROMATOGRAPHIC PEAK RESOLUTION

In this method of dealing with resolution, the extent to which one chromatographic peak overlaps another is determined.

For convenience, consider the range of the elution curve of each compound as running from $-2\sigma_s$ to $+2\sigma$. This range is used in other resolution criteria, and it contains 95.45 percent of the area of a normal curve. If two peaks are separated by a known distance, b, one can determine the fraction of the area of one curve that lies within the range of the other. The extent to which the elution curve of a contaminant compounds overlaps the curve of a compound that is under analysis is found by integrating the contaminant curve over the limits $b-2\sigma_s$ to $b+2\sigma_s$, where σ_s is the standard deviation of the sample curve.

There are several ways this calculation can be simplified. Overlap can be determined for curves of unit area and then actual areas can be introduced. The desired integration can be resolved into two integrals of the normal distribution function for which there are convenient calculation programs and tables. An example would be Program 15 in Texas Instruments Program Manual ST1, 1975, Texas Instruments Inc., Dallas, Texas 75222.

$$\frac{1}{\sqrt{2\pi}\,\sigma_c}\int_{b-2\sigma_s}^{b+2\sigma_s} e^{-\frac{t_c^2}{2\sigma_c}}\,dt = \frac{1}{\sqrt{2\pi}}\int_{\frac{b-2\sigma_s}{\sigma_c}}^{\infty} e^{-\frac{x^2}{2}}\,dx - \frac{1}{\sqrt{2\pi}}\int_{\frac{b+2\sigma_s}{\sigma_c}}^{\infty} e^{-\frac{x^2}{2}}\,dx.$$

The following calculation steps are required:*

1. $2\sigma_s = t_s/\sqrt{2 \ln 2}$

2. $\sigma_c = t_c/2\sqrt{2 \ln 2}$

3. $x_1 = (b-2\sigma_s)/\sigma_c$

4. $x_2 = (b+2\sigma_s)/\sigma_c$

5. $$Q(x_1) = \frac{1}{\sqrt{2\pi}} \int_{x_1}^{\infty} e^{-\frac{x^2}{2}} dx$$

6. $$Q(x_2) = \frac{1}{\sqrt{2\pi}} \int_{x_2}^{\infty} e^{-\frac{x^2}{2}} dx$$

7. $I_o = Q(x_1) - Q(x_2)$.

8. $A_o = I_o A_c/A_s$

9. % overlap = $A_o \times 100$

* (Note: In most instances, $Q(x_2)$ is very small and may be neglected.)

Where:

A_s = The area of the sample peak of interest determined by electronic integration, or by the formula $A_s = h_s t_s$.

A_c = The area of the contaminant peak, determined in the same manner as A_s.

b = The distance on the chromatographic chart that separates the maxima of the two peaks.

h_s = The peak height of the sample compound of interest, measured from the average value of the baseline to the maximum of the curve.

t_s = The width of the sample peak of interest at 1/2 of peak height.

t_c = The width of the contaminant peak at 1/2 of peak height.

σ_s = The standard deviation of the sample compound of interest elution curve.

σ_c = The standard deviation of the contaminant elution curve.

$Q(x_1)$ = The integral of the normal distribution function from x_1 to infinity.

$Q(x_2)$ = The integral of the normal distribution function from x_2 to infinity.

I_o = The overlap integral.

A_o = The area overlap fraction

In judging the suitability of alternate gas chromatographic columns, or the effects of altering chromatographic conditions, one can employ the area overlap as the resolution parameter with a specific maximum permissible value.

The use of Gaussian functions to describe chromatographic elution curves is widespread. However, some elution curves are highly asymetric. In those cases where the sample peak is followed by a contaminant that has a leading edge that rises sharply but the curve then tails off, it may be possible to define an effective width for t_c as "twice the distance from the leading edge to a perpendicular line through the maxim of the contaminant curve, measured along a perpendicular bisection of that line."

SUPPLEMENT B

PROCEDURE FOR FIELD AUDITING GC ANALYSIS

Responsibilities of audit supervisor and analyst at the source sampling site include the following:

A. Check that audit cylinders are stored in a safe location both before and after the audit to prevent vandalism of same.

B. At the beginning and conclusion of the audit, record each cylinder number and cylinder pressure. Never analyze an audit cylinder when the pressure drops below 200 psi.

C. During the audit, the analyst is to perform a minimum of two consecutive analyses of each audit cylinder gas. The audit must be conducted to coincide with the analysis of source test samples. Normally, it will be conducted immediately after the GC calibration and prior to the sample analyses.

D. At the end of the audit analyses, the audit supervisor requests the calculated concentrations from the analyst, and then compares the results with the actual audit concentrations. If each measured concentration agrees with the respective actual concentration within $\pm$ 10 percent, he then directs the analyst to begin the analysis of source samples. Audit supervisor judgment and/or supervisory policy determines course of action when agreement is not within $\pm$ 10 percent. Where a consistent bias in excess of 10 percent is found, it may be possible to proceed with the sample analyses, with a corrective factor to be applied to the results at a later time. However, every attempt should be made to locate the cause of the discrepancy, as it may be misleading. The audit

supervisor is to record each cylinder number, cylinder pressure (at the end of the audit) and all calculated concentrations. The individual being audited must not under any circumstance be told the actual audit concentrations until the calculated concentrations have been submitted to the audit supervisor.

FIELD AUDIT REPORT

PART A - To be filled out by organization supplying audit cylinders

1. Organization supplying audit sample(s) and shipping address

   _____

2. Audit supervisor, organization, and phone number

   _____

   _____

3. Shipping instructions - Name, Address, Attention

   _____

   _____

   _____

4. Guaranteed arrival date for cylinders_____

5. Planned shipping date for cylinders_____

6. Details on audit cylinders from last analysis

	Low Conc.	High Conc.
a. Date of last analysis	_____	_____
b. Cylinder number	_____	_____
c. Cylinder pressure, PSI	_____	_____
d. Audit gas(es)/balance gas	_____	_____
e. Audit gas(es) ppm	_____	_____
f. Cylinder construction	_____	_____

PART B - To be filled out by audit supervisor

1. Process sampled _____

_____

2. Location of audit _____

_____

3. Name of individual audited _____

4. Audit date _____

5. Audit results

	Low Conc. Cylinder	High Conc. Cylinder
a. Cylinder number	_____	_____
b. Cylinder pressure before audit, psi	_____	_____
c. Cylinder pressure after audit, psi	_____	_____
d. Measured concentration, ppm		
Injection #1*	_____	_____
Injection #2*	_____	_____
Average *	_____	_____
e. Actual audit concentration, ppm (Part A, 6e)	_____	_____

* Results of two consecutive injections which meet the sample analysis criteria of the test method.

f. Audit accuracy*

Low Conc. Cylinder _____

High Conc. Cylinder _____

* Percent accuracy = $\frac{\text{Measured Conc. - Actual Conc.}}{\text{Actual Conc.}} \times 100$

g. Problems detected (if any)_____

_____

_____

_____

APPENDIX F-2

DETERMINATION OF CARBON MONOXIDE EMISSIONS FROM STATIONARY SOURCES - METHOD 10

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.

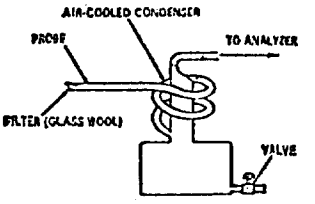


Figure 10-1. Continuous sampling train.

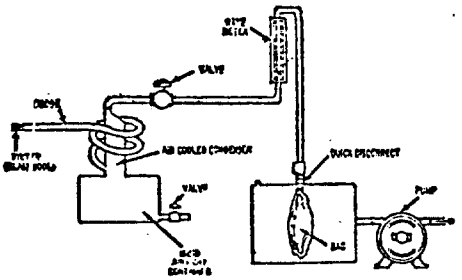


Figure 10-2. Integrated gas-sampling train.

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.*

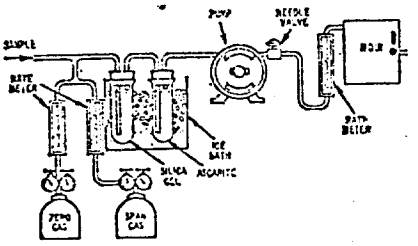


Figure 10-3. Analytical equipment.

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 A, Method 11]

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

Qa = Actual stack gas flowrate at stack conditions, acfm

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

%E = Percent removal efficiency, dimensionless

%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:

$$Q_m = Qs * 0.02832$$

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

$$Qam = Qa * 0.02832.$$

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,

$$ERM_f = (1.70 * 10^{-6}) * CM_f * Q_s \quad \text{and}$$

$$ERM_t = (1.70 * 10^{-6}) * CM_t * Q_s \quad .$$

Once the emission rate at the inlet and the outlet has been calculated the percent removal efficiency can be calculated using the following equation:

$$\%E = \frac{ER_{inlet} - ER_{outlet}}{ER_{inlet}}$$

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 at the inlet, the sample volume is calculated using the formula on page 2.

Given:

V_m = 92.705

P_b = 29.68

P_m = 1.97 in H_2O

T_m = 98.4

then:

Vm_{std} = 87.39 dscf

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

Given:

V_w = 279.1 ml

Then:

V_{wgas} = 13.15

%M = 13.1

M_d = 0.869

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

Given:

$\%CO_2 = 3.7$

$\%O_2 = 16.0$

$\%CO = 0.6$

$\%N_2 = 79.7$

then:

$MW_d = 29.23$

$MW = 27.76$

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

Given:

$P_{st} = -0.221$ in H_2O

$C_p = 0.823$

$\sqrt{\Delta P_s * (T_s + 460)} = 38.66$

$A_s = 2771\ in^2$

$T_s = 756.3$

Then:

$P_s = 29.46$

$V_s = 5697$

$Q_s = 40700$

$Q_m = 1150$

$Q_a = 109600$

$Q_{am} = 3100$

Utilizing the sampled volume and the flowrate, the percent of isokinetic variation can be calculated.

Given:

T_t = 120 min

D_n = 0.249 in

Then:

%I = 101.1

Given the analytical data, the concentrations and emission rates may then be calculated for both particulate and sulfate.

Given for particulate:

SW_f = 2283.2 mg

SW_t = 2714.6 mg

Then:

C_f = 0.403 gr/dscf

C_t = 0.479 gr/dscf

CM_f = 923 mg/dscm

CM_t = 1100 mg/dscm

ER_f = 141 lb/hr

ER_t = 167 lb/hr

ERM_f = 63.8 kg/hr

ERM_t = 75.9 kg/hr

Given similarily for sulfates:

SW_f = 87 mg

SW_t = 253 mg

Then:

C_f = 0.015 gr/dscf

C_t = 0.045 gr/dscf

CM_f = 35.2 mg/dscm

CM_t = 102 mg/dscm

ER_f = 5.36 lb/hr

ER_t = 15.6 lb/hr

ERM_f = 2.44 kg/hr

ERM_t = 7.06 kg/hr

Given the filterable outlet emission rate for the simultaneous particulate test, the percent removal efficiency can be calculated.

Given:

ER_f outlet = 155

Then:

%E = 9.9

Given similarly for sulfate:

ER_f outlet = 4.10 lb/hr

Then:

%E = 23.5

APPENDIX H

CALIBRATION DATA

METER AND ORIFICE CALIBRATION

Date 7/19/79 Client _____ Meter Box Number _____

Barometric Pressure Pb ("Hg) 29.54 Calibrator GEH Gas Meter Number RAC # 1

	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	0615.00	868.972		86	78	82				
Start		0610.00	863.910	74	78	74	76	.05	12:22		
Average	29.58	(5) 5.00	5.062	74			79	29.54	12.37	0.996	0.134
Stop	1.0	0620.06	874.082		90	78	84				
Start		0615.00	868.972	74	86	78	82	.05	9:07		
Average	29.61	(5) 5.00	5.110	74			83.0	29.54	9.12	0.992	0.129
Stop	2.0	0630.00	884.400		100	80	90				
Start		0620.00	874.082	74	90	78	84	.05	12:56		
Average	29.69	(10)10.00	10.318	74			87	29.54	12.93	0.988	0.129
Stop	3.0	0640.00	894.775		102	84	93				
Start		0630.00	884.400	74	100	80	90	.05	10:46		
Average	29.76	(10) 10.00	10.375	74			91.5	29.54	10.77	0.988	0.126
Stop	4.0	0650.00	905.173		104	85	94.5				
Start		0640.00	894.775	74	102	84	93	.05	9:27		
Average	29.83	(10)10.00	10.398	74			93.75	29.54	9.45	0.987	0.124
Stop	5.0	0660.00	915.573		106	88	97.				
Start		0650.00	905.173	74	104	85	94.5	.10	8:29		
Average	29.91	(10)10.00	10.400	74			95.75	29.53	8.48	0.988	0.124
									AVERAGE	0.990	0.128

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

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

Factor in isokinetic equation = $\frac{27.40}{(K_m)^2} = \frac{27.40}{(\quad)^2} =$ 1679

METER AND ORIFICE CALIBRATION

Date 7/30/79 Client U.S. EPA. Granite City Meter Box Number PAC-1

Barometric Pressure Pb ("Hg) 29.39 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	810.320	336.607	74.3	102	94					
Start		804.410	330.306	74.2	101	94		<0.025	15.0		
Average	29.43	(5) 5.91	6.301	74.3			97.8	29.39	15.0	0.978	0.131
Stop	1.0	804.037	329.908	74.1	104	94					
Start		795.857	321.203	74.0	103	93		0.025	15.0		
Average	29.46	(5) 8.180	8.705	74.1			98.5	29.39	15.0	0.980	0.128
Stop	2.0	795.625	320.956	74.0	106	93					
Start		783.800	308.403	74.1	101	91		0.05	15'30"		
Average	29.54	(10) 11.825	12.553	74.1			97.8	29.39	15.5	0.979	0.127
Stop	3.0	783.388	307.968	74.0	106	90					
Start		773.186	297.197	73.6	101	87		0.05	11.0		
Average	29.61	(10) 10.202	10.771	73.8			96.0	29.39	11.0	0.979	0.126
Stop	4.0	771.318	295.232	73.5	104	88					
Start		759.633	283.004	73.4	97	84		0.075	11.0		
Average	29.68	(10) 11.685	12.228	73.5			93.3	29.38	11.0	0.981	0.125
Stop	5.0	759.227	282.587	73.4	101	84			12'30"		
Start		744.484	267.310	73.8	90	80		0.1	12.5		
Average	29.76	(10) 14.743	15.277	73.6			88.8	29.38		0.980	0.124
									AVERAGE	0.980	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 $= \frac{27.40}{(\overline{K_m})^2} = \frac{27.40}{(\quad)^2} =$ 1711

la[illegible] E[illegible]ro[illegible]nta[illegible]ion[illegible]tar[illegible]

METER AND ORIFICE CALIBRATION

Date 7/12/79 Client _____ Meter Box Number PAC #4

Barometric Pressure Pb ("Hg) 29.45 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	494.849	263.092	74.6	83	73					
Start		494.930	258.176	74.1	73	71		<0.025	12.0	1.001	0.136
Average	29.49	(5) 4.919	4.916	74.1			75.0	29.45			
Stop	1.0	505.296	268.556	74.1	94	78					
Start		500.265	263.504	74.0	83	74		<0.025	9.0	1.009	0.131
Average	29.52	(5) 5.031	5.052	74.1			82.25	29.45			
Stop	2.0	517.491	280.902	74.1	108	87					
Start		505.837	269.101	74.1	93	79		0.025	15.0	1.015	0.129
Average	29.60	(10) 11.654	11.801	74.1			91.75	29.45			
Stop	3.0	528.153	291.787	74.5	113	93					
Start		517.792	281.208	74.2	105	88		0.05	11.0	1.018	0.128
Average	29.67	(10) 10.361	10.579	74.4			99.75	29.45			
Stop	4.0	539.272	303.223	74.2	116	97					
Start		528.562	292.208	74.5	110	93		0.05	10.0	1.016	0.126
Average	29.74	(10) 10.710	11.015	74.4			104.0	29.45			
Stop	5.0	551.696	316.054	74.6	118	100					
Start		539.741	303.708	74.2	112	96		0.075	10.0	1.014	0.125
Average	29.82	(10) 11.955	12.346	74.4			106.5	29.44			
									AVERAGE	1.012	0.129

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

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

Factor in isokinetic equation = $\frac{27.40}{(K_m)^2} = \frac{27.40}{(\quad)^2} = 1641$

Clayton Environmental Consultants, Inc.

METER AND ORIFICE CALIBRATION

Date 7/30/79 Client U.S. EPA Meter Box Number RAC 4

Barometric Pressure Pb ("Hg) 29.40 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	710.086	656.873	73.5	109	99					
Start		701.360	646.003	73.5	108	97		<0.025	24.0		
Average	29.44	(5) 9.726	10.870	73.5			103.3	29.40	24.00	1.008	0.135
Stop	1.0	673.920	617.966	73.1	102	86					
Start		668.312	612.293	73.4	92	81		<0.025	10.0	1.018	0.132
Average	29.47	(5) 5.608	5.673	73.3			90.3	29.40	10.0		
Stop	2.0	687.513	631.803	73.5	113	94					
Start		674.260	618.307	73.1	99	86		<0.025	17.0		
Average	29.55	(10) 13.253	13.496	73.3			98.0	29.40	17.0	1.022	0.129
Stop	3.0	701.139	645.772	73.2	117	98					
Start		687.901	632.202	73.6	108	94		0.025	14.0		
Average	29.62	(10) 13.238	13.57	73.4			104.3	29.40	14.0	1.024	0.128
Stop	4.0	730.025	675.587	73.1	118	101					
Start		711.607	656.603	73.5	106	98		0.05	17.25		
Average	29.69	(10) 18.418	18.984	73.3			105.8	29.40	17.25	1.019	0.125
Stop	5.0	742.509	688.469	73.5	120	102					
Start		730.629	676.209	73.2	115	100		0.075	10.0		
Average	29.77	(10) 11.880	12.260	73.4			109.3	29.39	10.0	1.021	0.125
									AVERAGE	1.019	0.129

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

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

Factor in isokinetic equation = $\frac{27.40}{(\bar{K}_m)^2} = \frac{27.40}{(\quad)^2} =$ 1647

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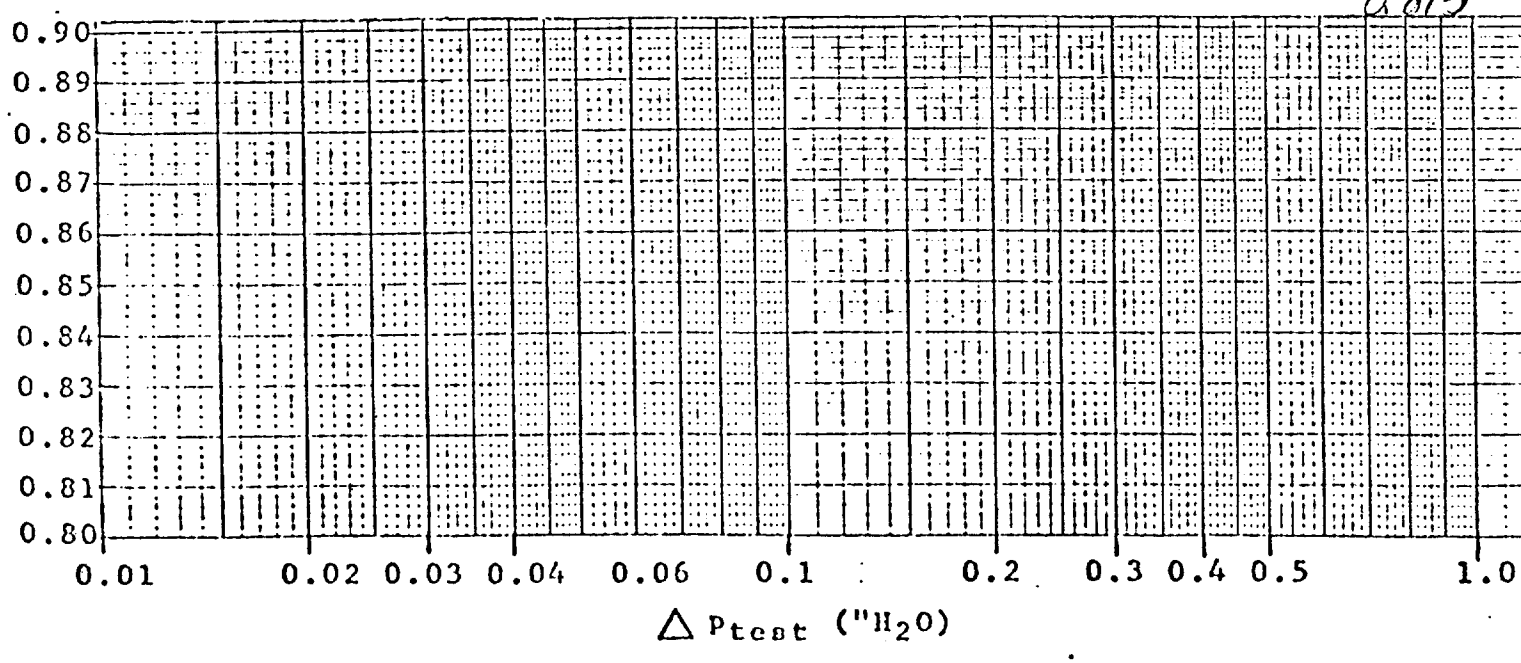
$C_{ptest} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$

Pitot Tube Type "S" Pitot Tube No. 40

Standard Pitot Tube No. _____

Calibrator: TJP Date: 6/21/79 Client: U.S. EPA G.C.

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._____	0._____	0._____	0._____	0._____
0.08	0._____	0._____	0._____	0._____	0._____
0.10	0.098	0.148	0.814	0._____	0._____
0.12	0.097	0.149	0.807	0._____	0._____
0.16	0.098	0.149	0.811	0._____	0._____
0.20	0.098	0._____	0._____	0.146	0.819
0.30	0.098	0._____	0._____	0.147	0.816
0.50	0.099	0._____	0._____	0.147	0.821
0.70	0._____	0._____	0._____	0._____	0._____
0.80	0._____	0._____	0._____	0._____	0._____



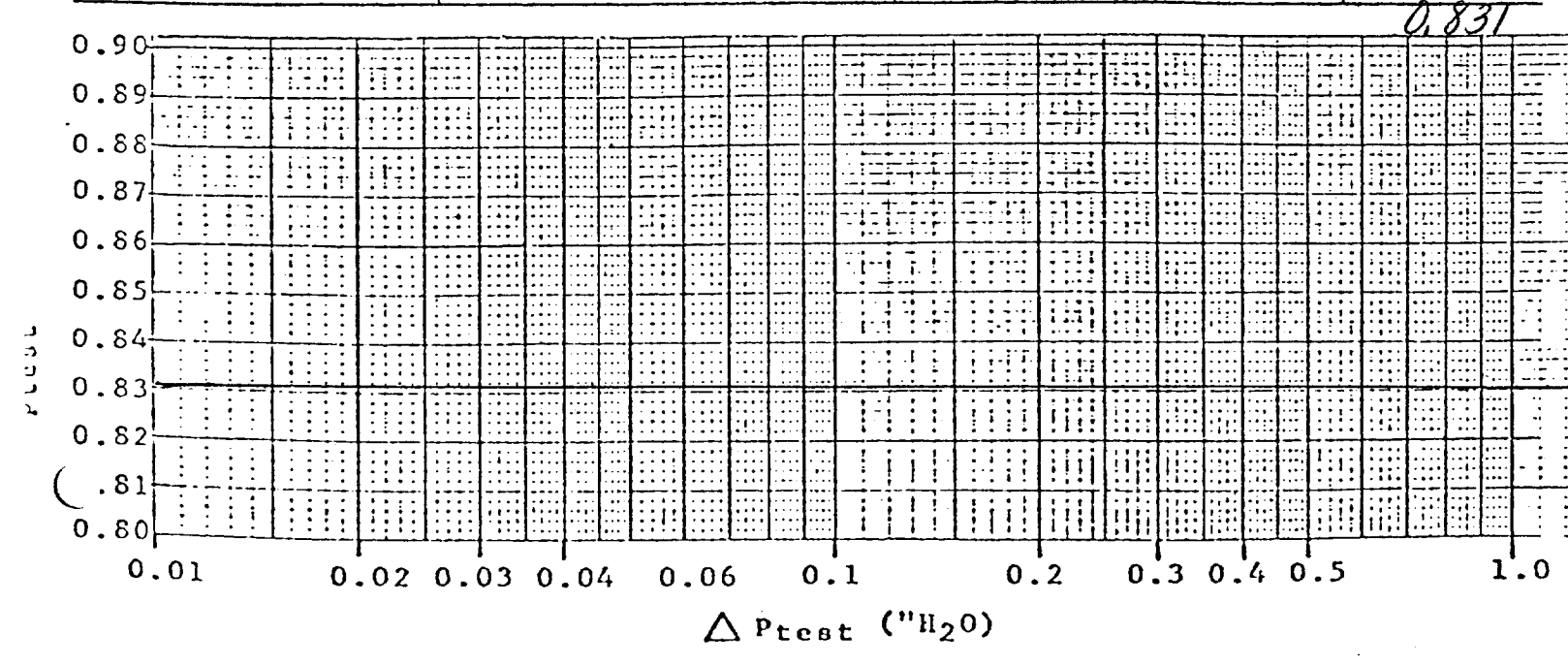
$C_{ptest} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$

Pitot Tube Type S Pitot Tube No. 40

Standard Pitot Tube No. —

Calibrator: BGB Date: 8/16/79 Client: US EPA (Granite G

Anticipated ΔP_{std}	ΔP_{std}	A		B	
		ΔP_{test}	ΔC_{ptest}	ΔP_{test}	ΔC_{ptest}
0.02	0.111	0.156	0.835	0.159	0.827
0.04	0.	0.	0.	0.	0.
0.06	0.	0.	0.	0.	0.
0.08	0.110	0.156	0.831	0.159	0.826
0.10	0.	0.	0.	0.	0.
0.12	0.111	0.154	0.840	0.159	0.827
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.



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

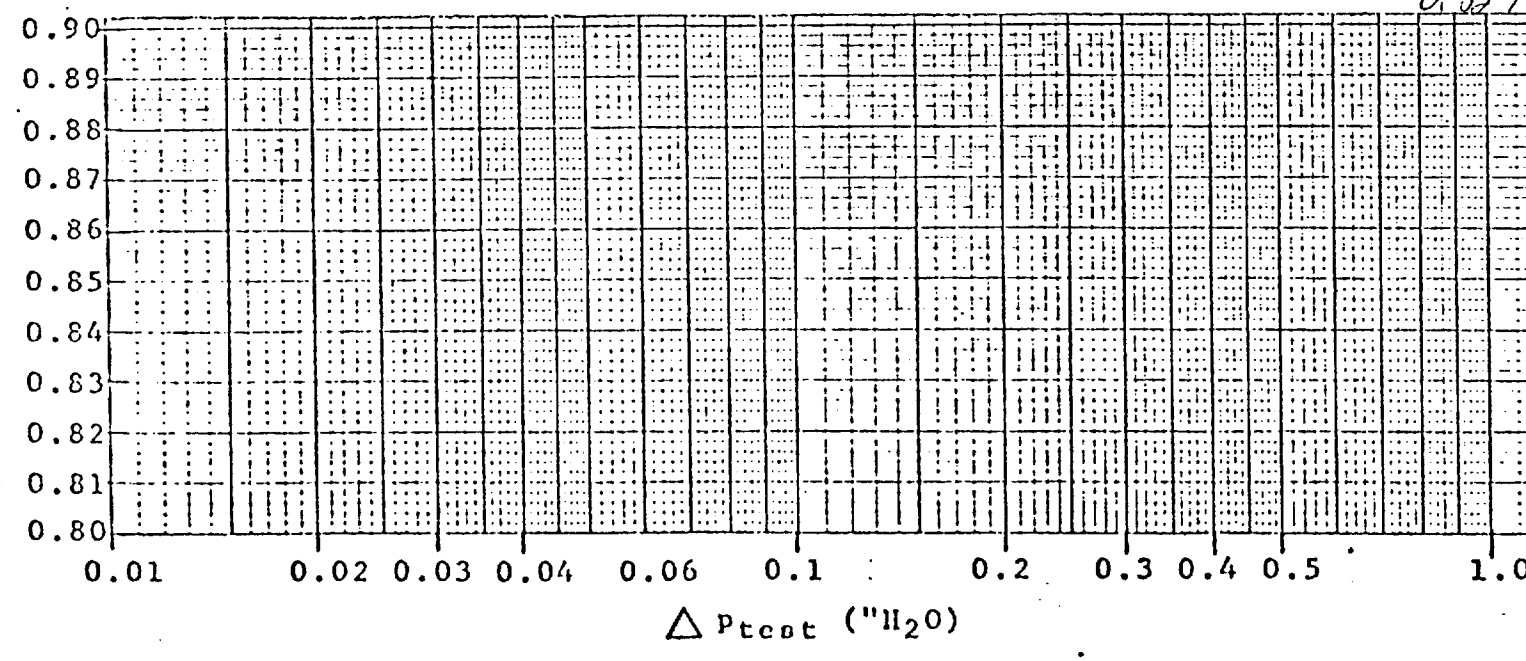
Pitot Tube Type "S" Pitot Tube No. 21

Standard Pitot Tube No. _____

Calibrator: TJP Date: 6/21/79 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._____	0._____	0._____	0._____	0._____
0.08	0._____	0._____	0._____	0._____	0._____
0.10	0.099	0.142	0.835	0._____	0._____
0.12	0.098	0.142	0.831	0._____	0._____
0.16	0.099	0.142	0.835	0._____	0._____
0.20	0.098	0._____	0._____	0.145	0.822
0.30	0.098	0._____	0._____	0.146	0.819
0.50	0.097	0._____	0._____	0.145	0.818
0.70	0._____	0._____	0._____	0._____	0._____
0.80	0._____	0._____	0._____	0._____	0._____

0.827



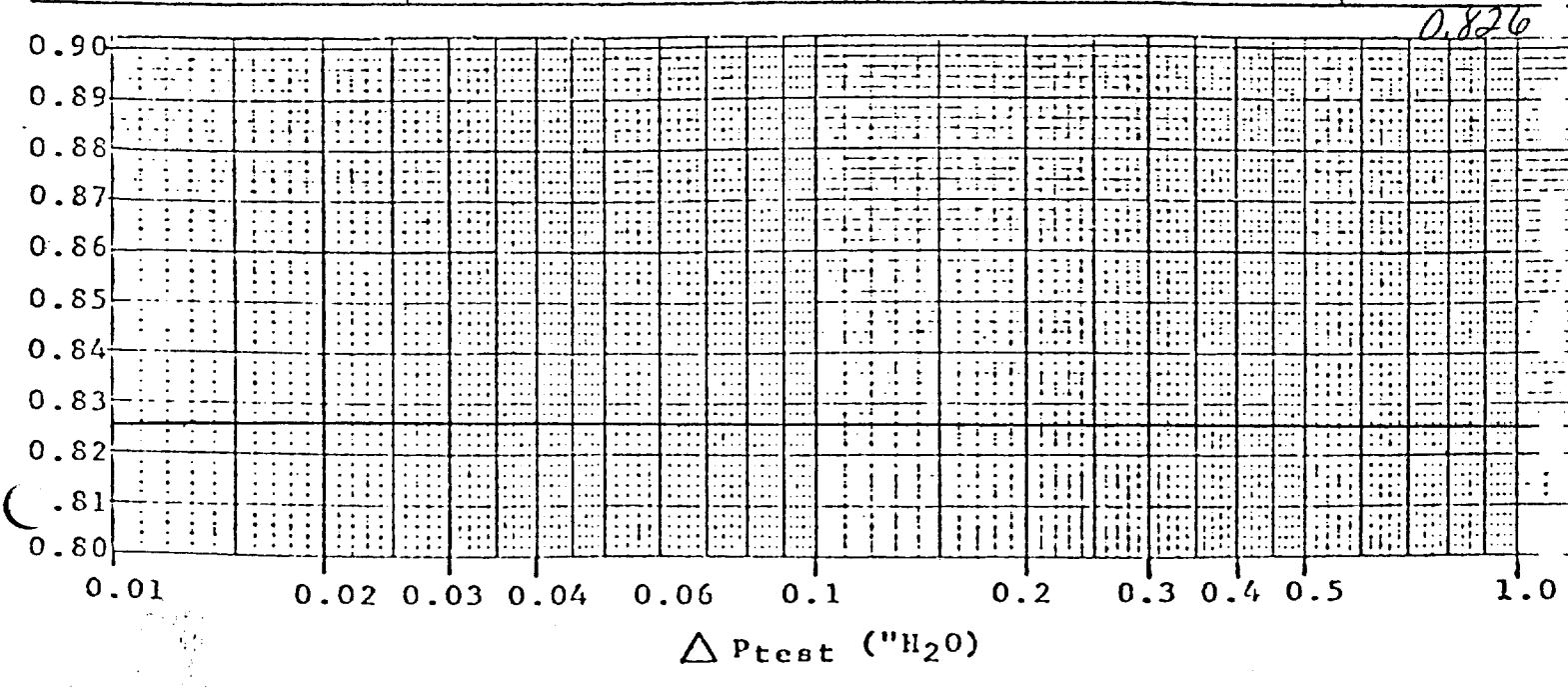
$C_{ptest} = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$

Pitot Tube Type S Pitot Tube No. Z1

Standard Pitot Tube No. —

Calibrator: BCB Date: 8/16/79 Client: US EPA (Granite Cty.

Anticipated ΔP_{std}	ΔP_{std}	A		B	
		ΔP_{test}	ΔC_{ptest}	ΔP_{test}	ΔC_{ptest}
0.02	0.____	0.____	0.____	0.____	0.____
0.04	0.111	0.158	0.830	0.158	0.830
0.06	0.____	0.____	0.____	0.____	0.____
0.08	0.110	0.159	0.823	0.158	0.826
0.10	0.____	0.____	0.____	0.____	0.____
0.12	0.110	0.158	0.826	0.159	0.823
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.____



SECTION II - TRW REPORT

1.0 PRESENTATION OF B(a)P PROCEDURES AND DATA

The B(a)P train is a modified Method 5 train, having an adsorbent trap placed between the heated filter box and the impingers. The adsorbent trap is water-cooled to 127F and as a result, condensation will take place in the trap prior to the impingers. For this reason, the moisture content determined from the impinger water and silica gel is not accurate since all the water collected in the train is not measured. For B(a)P data reduction, the moisture content from the Clayton particulate train was used for the B(a)P trains.

APPENDIX A

FIELD DATA SHEETS AND SAMPLING SUMMARY DATA

Granite City

BaP - Inlet Test Results

RUN	1	2	3	Average
DATE	7-26-79	7-27-79	7-28-79	
Meter Volume (DSCF)	68.5	52.3	43.4	54.7
Meter Volume (DSCM)	1.94	1.48	1.23	1.55
Stack Volume (ACFM)	117,720	124,655	121,392	121,255
Stack Volume (DSCFM)	44,003	45,914	44,476	44,793
Stack Volume (DSCMM)	1246.2	1300.3	1259.6	1268.7
%Isokinetic	81.9	106.2	104.1	97.4
mg/Filter	<0.001	<0.001	<0.001	<0.001
mg/Rinse	1.128	4.114	28.112	11.118
mg/XAD-2	0.925	0.500	0.462	0.629
mg/Impingers	0.722	Not Done	Not Done	----
mg/Total	2.775	4.614	28.574	11.988
mg/DSCM	0.0014	0.0031	0.0232	0.0092
kg/Hour	0.0001	0.0002	0.0018	0.0007
lbs/DSCF	8.74×10^{-11}	19.35×10^{-11}	144.83×10^{-11}	57.43×10^{-11}
lbs/Hour	2.308×10^{-4}	5.331×10^{-4}	3.865×10^{-3}	1.542×10^{-3}
lbs/24 Hour Day	5.538×10^{-3}	1.279×10^{-2}	9.276×10^{-2}	3.701×10^{-2}
lbs/365 Days	2.02	4.67	33.85	13.51

GRANITE CITY

G.C. INLET

RUN NUMBER	1		2		3		AVERAGE	
	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC U
TE		7/26		7/27		7/28		
STACK PARAMETERS								
Pst - Static Pressure, "Hg (mmHg)	-.07	-1.78	-.07	-1.78	-.07	-1.78	-.07	-1.7
Ps - Stack Gas Pressure, "Hg Absolute (mmHg)	29.6	753.1	29.67	753.6	29.58	751.5	29.62	752
% CO_2 - Volume % Dry	3.71	3.71	3.60	3.60	3.60	3.6	3.64	3.6
% O_2 - Volume % Dry	16.0	16.0	15.7	15.7	17.0	17.0	16.2	16.
% CO - Volume % Dry	0.6	0.6	0.2	0.2	0.13	0.13	0.31	0.
% N_2 - Volume % Dry	79.	79.69	80.2	80.5	79.27	79.32	79.67	79.
Ts - Average Stack Temperature °F (°C)	754	401.7	745	396.1	746.15	396.8	748.7	398
% H_2O - % Moisture in Stack Gas, By Volume	13.15	13.15	15.30	15.30	15.40	15.40	14.62	14.
As - Stack Area, ft^2 (dm^2)	20.97	1.95	20.97	1.95	60.97	1.95	20.97	1.9
Md - Molecular Weight of Stack Gas, Dry Basis	29.28	29.28	29.20	29.20	29.26	29.26	29.28	29.
Ms - Molecular Weight of Stack Gas, Wet Basis	27.75	27.75	27.49	27.49	27.53	27.53	27.59	27.
Vs - Stack Gas Velocity, ft/sec, (m/sec)	93.6	28.54	99.2	30.22	96.6	29.43	96.5	29.
Qa - Stack Gas Volumetric Flow at Stack Conditions, ACFM (Nm^3/min)	117720	3333.7	124644	3530.3	121372	3437.9	121255	343
Qs - Stack Gas Volumetric Flow at Standard Conditions, DSCFM (Nm^3/min)	44003	1246.2	45917	1300.3	44476	1259.6	44798	126
% EA - Percent Excess Air								
TEST CONDITIONS								
Pb - Barometric Pressure, "Hg (mmHg)	29.69	753.9	29.74	755.4	29.65	75.31	29.69	75
Dn - Sampling Nozzle Diameter, in. (mm)	.250	6.35	.187	4.67	.184	4.67	.206	5.
T - Sampling Time, min	105	105	120	120	105	105	113	11
Vm - Sample Volume, ACF (m^3)	73.158	2.07	55.198	1.56	47.71	1.35	58.01	1.6
Np - Net Sampling Points	24	24	24	24	24	24	24	2
Cp - Pitot Tube Coefficient	.84	.84	.84	.84	.84	.84	.84	.8
Tm - Average Meter Temperature °F (°C)	102.100	39.1	93.87	34.37	117.2	47.33	104.7	39
Pm - Average Orifice Pressure Drop, "H_2O (mmH_2O)	2.33	59.18	0.58	14.73	0.60	15.24	1.17	29
Vlc - Condensate Collected (Impingers and Gel), ml		148.9		121.6		131.0		13
Δp - Velocity Head "H_2O (mmH_2O)	1.15	29.21	1.29	32.77	1.22	36.99	1.22	32
TEST CALCULATIONS								
Vw - Condensed Water Vapor, SDCF (Nm^3)	5.3	0.15	5.6	0.16	6.0	0.17	5.6	0.
Vm - Volume of Gas Sampled at Standard Conditions, DSCF (Nm^3)	68.5	1.94	52.3	1.48	43.4	1.23	54.7	1.
Si - H_2O - Percent Moisture, By Volume	13.15	13.15	15.30	15.30	15.40	15.40	14.62	14
Ms - Molecular Weight of Stack Gas, Wet Basis	27.75	27.75	27.49	27.49	27.53	27.53	27.59	27
Vs - Stack Velocity, ft/sec (m/sec)	93.6	28.54	99.2	30.22	96.6	29.43	96.5	29
% I - Percent Isokinetic	81.9	81.9	106.2	106.2	104.1	104.1	97.4	9

Duct #1

FIELD DATA

PLANT GRANITE CITY
DATE 7/26/79
SAMPLING LOCATION DUCT
SAMPLE TYPE STD
RUN NUMBER #1
OPERATOR ROONEY-STACKHOUSE
AMBIENT TEMPERATURE 95
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_s)
FILTER NUMBER (S)

PROBE LENGTH AND TYPE 5' GLASS
NOZZLE I.D. .250
ASSUMED MOISTURE, % 9%
SAMPLE BOX NUMBER
METER BOX NUMBER
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
				DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
		345.172									
1	05 15:05	346.13	.88	1.9	1.9	250	86	86	10	250	95
2	10 15:10	348.48	.98	1.9	1.9	"	88	88	10	250	95
3	15 15:15	350.21	1.2	2.3	2.3	"	98	90	17	250	95
4	20 15:20	351.92	1.2	2.3	2.3		98	90	17	250	95
5	25 15:25	355.82	1.5	2.9	2.3		110	92	23	250	95
6	30 15:30	360.01	1.5	2.9	2.3		110	92	23	250	95
7	35 15:35	364.45	1.2	2.3	2.3		118	102	23	250	95
8	40 15:40	368.12	1.2	2.3	2.3		120	106	23	250	95
9	45 15:45	372.08	1.3	2.6	2.3		124	110	23	250	95
10	50 15:50	376.13	1.5	2.9	2.1		124	106	23	250	95
11	55 15:55	380.23	1.4	2.7	2.1		124	104	23	250	95
12	60 16:00	383.84	1.4	3.1	2.1	↓	124	104	23	250	95

COMMENTS:

INLET #1

FIELD DATA

PLANT: GRANITE CITY
DATE: 7/30/79
SAMPLING LOCATION: INLET
SAMPLE TYPE: [illegible]
RUN NUMBER: RUN 1
OPERATOR: [illegible]
AMBIENT TEMPERATURE: [illegible]
BAROMETRIC PRESSURE: ______
STATIC PRESSURE, (P_s): ______
FILTER NUMBER (s): ______

PROBE LENGTH AND TYPE: 5' GLASS
NOZZLE I.D.: .250
ASSUMED MOISTURE, %: 9%
SAMPLE BOX NUMBER: ______
METER BOX NUMBER: ______
METER $\Delta H_@$: ______
C FACTOR: ______
PROBE HEATER SETTING: ______
HEATER BOX SETTING: ______
REFERENCE Δp: ______

Page 2/2

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	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
	0	844	390.4									
1	5	849	394.60	.95	2.1	2.1	750	95	92	25	250	80
2	10	854	398.52	1.01	2.1	2.1	760	95	92	25	250	80
3	15	859	402.18	1.01	2.1	2.1	760	95	92	25	250	80
4	20	9.03	404.95	1.01	2.1	2.1	760	106	96	23	250	80
5	25	9.08	407.83	1.01	2.1	2.1	760	110	98	23	250	80
6	30	913	410.12	1.02			760	110	98	23	250	80
7	35	918	413.57	1.02			760	110	98	23	250	80
8	40	923	417.71	1.01	2.1	2.1	760	114	100	23	250	80
9	45	928	420.83	1.01	2.1	2.1	760	112	100	23	250	80
10	50	931	422.38	1.05		1.7	760	112	102	25	250	80
11	53	933	423.01	1.05		0.9	760	110	98	23	250	80
12												
	(RESTART) 953											
11	55	9:55	424.16	1.03	2.1	1.2	760	94	92	23	250	80
12	60	9:58	426.04	1.01	2.1	.82	760	94	94	25	250	80
								107.24	96.88			
	55											
.94	115		33.158	1.15	2.33	2.33	755		102.06			

COMMENTS: .33 Pot - Cr. li

INLET #2

FIELD DATA

PLANT Granite City Steel
DATE 2/27/7?
SAMPLING LOCATION inlet
SAMPLE TYPE BAP
RUN NUMBER 2
OPERATOR Dowd/Stockhouse
AMBIENT TEMPERATURE 25
BAROMETRIC PRESSURE 29.5
STATIC PRESSURE, (P_s) 0
FILTER NUMBER (s) —

PROBE LENGTH AND TYPE 6' glass
NOZZLE I.D. 0.?2?
ASSUMED MOISTURE, % 9
SAMPLE BOX NUMBER
METER BOX NUMBER 2315
METER $\Delta H_@$ 1.76
C FACTOR 1.0
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp 3.11 @ Δp=1.84

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	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	Exit Bottle
	1:09	0	440.409										127
1	1:14	5	442.3	0.5	.25	.25	335	90	92	5.0	250	62	127
2	1:19	10	443.?	0.85	.42	.42	774	90	90	5.0	250	62	128
3	1:24	15	445.7	0.92	.46	.46	713	90	90	5.2	250	62	127
4	1:29	20	448.3	1.2	.62	.62	722	90	90	7.0	250	62	127
5	1:34	25	450.4	1.4	.71	.71	747	90	90	8.0	250	62	127
6	1:39	30	453.2	1.5	.72	.72	767	90	90	8.5	250	62	128
7	1:44	35	455.6	1.4	.??	.??	782	90	90	9.2	250	62	128
8	1:49	40	457.9	1.25	.58	.58	782	91	91	8.0	250	60	128/127
9	1:54	45	460.1	1.25	.58	.58	785	91	91	8.0	250	60	127
10	1:59	50	462.2	1.4	.65	.65	770	91	91	8.5	250	60	127
11	2:04	55	464.1	1.25	.58	.58	725	91	91	8.2	250	60	
12	2:09	60	466.652	1.6	.74	.74	750	91	91	10.1	250	60	
	3:35	0	466.914 leak check										
1	3:41	5	468.70	1.80	0.51	.51	330	85	85	12	250	60	127
2	3:46	10	471.3	1.20	.55	.52	780	82	82	24	250	60	127
3	3:51	15	473.6	1.3	.59	.55	752	82	82	25	250	60	127
4	3:56	20	475.8	1.3	.66	.60	650	100	82	9.0	250	72	127
5	4:01	25	478.3	1.5	.71	.71	650	104	84	9.5	250	66	127
6	4:06	30	480.7	1.4	.65	.65	750	104	84	9.5	250	64	127
7	4:11	35	483.5	1.4	[illegible]	.65	765	110	88	9.5	250	64	127
8	4:16	40	487.6	1.3	.61	.61	780	112	90	10.0	250	64	127
9	4:21	45	491.2	1.3	.65	.65	710	112	90	14.0	250	64	127
10	4:26	50		1.5	.73	.64	735	115	95	23.0	250	64	125

COMMENTS: Initial leak check <0.02 cfm @ 20" Hg

INLET #2

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
			491.7									
11	4:36	35	493.4	1.6	.78	.46	750	115	95	26	250	65
12	4:41	60	495.607	1.5	.73	0.40	750	115	95	26	250	65
	60		55.198	1.288		.582	775	93	87			
			AVG ΔP =	1.125								

INLET #3

FIELD DATA

PLANT Granite City Steel
DATE 7/23/74
SAMPLING LOCATION Inlet
SAMPLE TYPE SAP
RUN NUMBER BC - BAP - IN - 3
OPERATOR Russell / Stackhouse
AMBIENT TEMPERATURE 96
BAROMETRIC PRESSURE 29.65
STATIC PRESSURE, (P_s) —
FILTER NUMBER (s)

PROBE LENGTH AND TYPE 6' glass
NOZZLE I.D. 0.184
ASSUMED MOISTURE, % 10
SAMPLE BOX NUMBER W-23
METER BOX NUMBER 2315 2188
METER $\Delta H_@$ 1.76
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING 250
REFERENCE Δp

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 5 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	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	Bottle trap temp
	12:28 / 0	549.876										
1	12:33	551.9	0.9	0.42	0.42	727	100	100	5.2	250	75	130
2	12:38	553.8	1.1	0.52	0.52	740	100	100	6.0	250	75	127
3	12:43	557.1	1.1	0.52	0.52	746	112	102	6.5	250	75	127
4	12:48	559.5	1.2	0.56	.56	765	120	105	6.8	250	75	127
5	12:53	562.7	1.2	0.6	.6	710	125	105	6.9	250	75	127
6	12:58	565.2	1.2	0.6	.6	750	128	118	6.9	250	75	127
7	1:03	567.3	1.2	0.6	.6	755	123	118	6.9	250	75	127
8	1:08	569.3	1.2	0.6	.6	740	132	112	6.9	250	75	127
9	1:13	570.641	1.3	0.64	.64	740	134	115	10.0	250	75	127
	change filter off at 1:17 pm — pump in meter box stopped											
	new meter box at traverse point change											
10	4:17	117.258		0.64	.64	750	110	105	8.5	250	75	127
1	4:22	119.5	1.3	0.64	.64	745	120	107	10.5	250	75	127
2	4:27	122.0	1.4	0.69	.69	750	125	107	12.0	250	75	127
3	4:32	124.6	1.4	0.69	0.69	745	128	110	17.0	250	75	127
4	4:37	126.6	1.4	0.69	.69	750	128	112	22.0	250	73	127
5	4:42	128.2	1.3	0.66	0.44	740	130	114	24	250	73	127
6	4:47	129.557	1.2	0.6	0.6							
	stopped to change filter — leak check <0.02 @ 25 in. Hg	130.104										
7	5:03					760	120	115	6.0	250	75	127
7	5:08	132.3	1.1	0.52	0.52	745	125	115	6.5	250	72	127
8	5:13	134.7	1.1	0.56	0.56	755	123	118	7.0	250	72	127
9	5:18	130.5	1.1	0.56	0.56	745	130	118	7.0	250	72	127
10	5:23	140.5	1.25	0.6	0.6	760	132	120	7.0	250	72	127
11	5:28		1.25	0.6	0.6							

COMMENTS: pretest leak check <0.02 @ 20" Hg
leak check at port change <0.02 @ 20" Hg

INLET #3

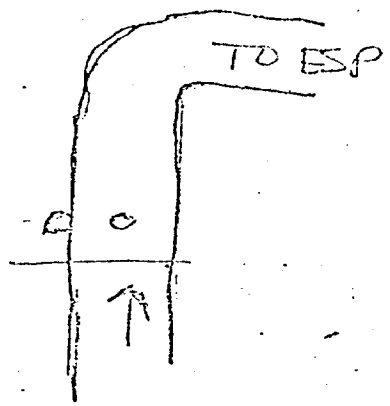
TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	Batt. Temp °F
				DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F				
12	5:35	143.4	1.35	[illegible]	0.69	745	132	120	8.0	250	72	72
		144.950										
		47.71	1.02	0.60	0.60	746.5	132.0	111.2				
		49.257						111.2				
	104											
	105											

must turn in check <0.02 cfm @ 22 in Hg

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT Granite City Steel
DATE 7/25/91
SAMPLING LOCATION INLET
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A)
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) 9.4
STACK I.D., (DISTANCE A - DISTANCE B) 68 3/4
NEAREST UPSTREAM DISTURBANCE
NEAREST DOWNSTREAM DISTURBANCE
CALCULATOR J.K.G.

$\Delta P = 1.0$
$T_S = 700°$
$P_{ST} = -1.0$ "H$_2$O



SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	2.1				10.86
2	6.7				14.01
3	11.8				17.52
4	17.7				21.59
5	25.0				26.59
6	35.5				33.85
7	64.5				53.20
8	75.0				60.96
9	82.3				65.96
10	88.3				70.03
11	93.3				73.54
12	97.9				76.69

GRANITE CITY

BαP - OUTLET TEST RESULTS

RUN	1	2	3	AVERAGE
DATE	7-26-79	7-27-79	7-28-79	
Meter Volume (DSCF)	69.21	16.374/14.554	60.49	53.55
Meter Volume (DSCM)	1.96	.46/.41	1.71	1.51
Stack Volume (ACFM)	160,635	164,837/155,169	150,168	156,935
Stack Volume (DSCFM)	68,241	70,381/66,313	64,421	67,003
Stack Volume (DSCMM)	1931	1992/1877	1823	1896
% Isokinetic	115.9	116.5/50.2	107.3	102.2
mg/Filter	7.500	9.500	0.175	5.725
mg/Rinse	0.644	8.922	4.099	4.555
mg/XAD-2	1.085	5.000	0.450	2.178
mg/Impingers	0.908	Not Done	Not Done	-------
mg/Total	10.137	23.422	4.724	12.761
mg/DSCM	.0052	.051/.057	.0028	.0085
kg/Hour	.0006	.0029/.0029	.0003	.0017
lbs/DSCF	32.46×10^{-11}	$87.51 \times 10^{-11}/77.79 \times 10^{-11}$	17.51×10^{-11}	53.82×10^{-11}
lbs/Hour	1.305×10^{-3}	$3.547 \times 10^{-2}/3.153 \times 10^{-3}$	6.640×10^{-4}	2.167×10^{-3}
lbs/24 Hour Day	3.133×10^{-2}	$8.513 \times 10^{-2}/7.567 \times 10^{-2}$	1.593×10^{-2}	5.201×10^{-2}
lbs/365 Days	11.43	31.07/27.62	5.81	18.98

Granite City

GC. OUTLET

RUN NUMBER	1		2		3		AVERAGE	
	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRIC UNITS	ENGLISH UNITS	METRI
DATE		7/26		7/27		7/28		
STACK PARAMETERS								
Pst - Static Pressure, "Hg (mmHg)	-.07	-1.78	-0.07	-1.78	-0.07	-1.78	-0.07	-1.
Ps - Stack Gas Pressure, "Hg Absolute (mmHg)	29.61	752.1	29.67	753.6	29.58	751.3	29.62	752
% CO_2 - Volume % Dry	3.71	3.71	3.60	3.60	3.60	3.60	3.64	3.6
% O_2 - Volume % Dry	16.0	16.0	15.3	15.7	17.0	17.0	16.2	16.
% CO - Volume % Dry	0.6	0.6	0.2	0.2	0.13	0.13	0.31	0.3
% N_2 - Volume % Dry	79.09	79.09	80.5	80.5	79.27	79.27	79.67	79.
Ts - Average Stack Temperature °F (°C)	651.27	341.9	650.5	343.6	612.1	322.3	636.7	336
% H_2O - % Moisture in Stack Gas, By Volume	10.0	10.0	9.4	9.4	11.9	11.9	10.4	10.
As - Stack Area, ft^2 (ph^2)	25.78	2.39	25.78	2.39	25.78	2.39	25.78	2.3
Ms - Molecular Weight of Stack Gas, Dry Basis	29.23	29.23	29.20	29.20	29.26	29.26	29.23	29.
Ms - Molecular Weight of Stack Gas, Wet Basis	28.11	28.11	28.15	28.15	27.92	27.92	28.16	28.
Vs - Stack Gas Velocity, ft/sec, (m/sec)	108.9	31.68	104.1	31.74	97.5	29.72	101.9	31.
Qa - Stack Gas Volumetric Flow at Stack Conditions, ACFH (Nm^3/min)	168625	4916	164837/155169	4436/4391	159168	4250	156935	447
Qs - Stack Gas Volumetric Flow at Standard Conditions, DSCFH (Nm^3/min)	68241	1931	70331/66613	1992/1877	64421	1823	67003	189
% EA - Percent Excess Air								
TEST CONDITIONS								
Pb - Barometric Pressure, "Hg (mmHg)	29.68	753.9	29.44	755.11	29.65	753.1	29.69	759
Dn - Sampling Nozzle Diameter, in. (mm)	0.185	4.70	.125/.185	3.2/4.7	0.185	4.70	0.185	4.7
T - Sampling Time, min	120	120	60/60	60/60	120	120	120	12
Vm - Sample Volume, ACF (m^3)	75.226	2.13	17.685/15.391	.48/.44	65.331	1.85	57.86	1.6
Np - Net Sampling Points	50	40	20/20	20/20	40	40	—	—
Cp - Pitot Tube Coefficient	0.84	0.84	6.84	0.84	0.84	0.84	0.84	0.
Tm - Average Meter Temperature °F (°C)	110.65	43.7	105.3/95	40.7/35	106.0	41.1	105.6	40.
Pm - Average Orifice Pressure Drop, "H_2O (mmH_2O)	0.82	20.83	—	—	0.804	20.42	—	—
Vlc - Condensate Collected (Impingers and Gel), mls	—	—	—	—	—	—	—	—
Δp - Velocity Head "H_2O (mmH_2O)	1.565	39.75	1.665/1.47	42.3/37.3	1.41	35.81	1.51	38
TEST CALCULATIONS								
Vwc - Condensed Water Vapor, SDCF (Nm^3)	—	—	—	—	—	—	—	—
Vm std - Volume of Gas Sampled at Standard Conditions, DSCF (Nm^3)	69.21	1.96	16.374/14.554	.40/.41	60.38	1.71	—	—
%H_2O - Percent Moisture, By Volume	10.0	10.0	9.4	9.4	11.9	11.9	10.4	10
Ms - Molecular Weight of Stack Gas, Wet Basis	28.11	28.11	28.15	28.15	27.92	27.92	28.1	28
Vs - Stack Velocity, ft/sec (m/sec)	108.9	31.68	106.6/100.3	32.49/30.58	97.5	29.72	101.6	30.
% I - Percent Isokinetic	115.9	115.9	116.5/50.2	116.5/50.2	107.3	107.3	102.2	102

OUTLET #1

FIELD DATA

PLANT GRANITE SHOT
DATE 7/20/89
SAMPLING LOCATION OUTLET
SAMPLE TYPE Bag
RUN NUMBER 1
OPERATOR TODD/CY
AMBIENT TEMPERATURE 95
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_g) - 1.0" H2O
FILTER NUMBER (s)

PROBE LENGTH AND TYPE 5' GLASS
NOZZLE I.D. .250 .185
ASSUMED MOISTURE, % 5%
SAMPLE BOX NUMBER
METER BOX NUMBER 2189
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING 250
HEATER BOX SETTING 250
REFERENCE Δp 1.0

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 3 MINUTES

Pre leak test 4.0 CFM

TRAVERSE POINT NUMBER	CLOCK TIME (24-hr CLOCK) SAMPLING TIME, min	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
				DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	0	4947									
H 1	3 335	5.27	1.2	.45	.45	639	110	100	22	250	89
2	6 338	6.90	1.4	.49	.49	640	116	102	23	250	95
3	9 341	8.290	1.3	.50	.50	640	118	104	23	250	90
4	12 344	9.30	1.2	.5	.5	640	118	106	24	250	90
5	15 347	10.05	1.1	.47	.47	648	118	110	22	250	90
6	18 350	11.60	1.1	.47	.47	650	118	110	22	250	90
7	21 353	13.00	1.0	.43	.43	658	118	112	24	250	90
8	24 356	14.400	1.0	.45	.45	650	120	114	24	250	90
9	27 359	15.590	1.0	.45	.45	643	120	114	24	250	85
10	30 402	17.000	1.0	.45	.45	642	120	114	24	250	85
11	33 405	20.80	1.0	.45	.45	642	120	114	24	250	85
12	36 408	22.25	1.0	.45	.45	650	120	114	24	250	85
13	39 411	23.54	1.0	1.5	1.5	650	120	114	24	250	90
14	42 414	25.490	1.0	1.5	1.5	658	122	114	17	250	90
15	45 417	28.00	1.0	1.4	1.4	645	120	114	17	250	95
16	48 420	30.001	1.5	1.4	1.4	644	120	118	17	250	95
17	51 423	31,900	1.0	1.4	1.4	644	120	118	17	250	95
18	54 426	34.5	1.0	1.4	1.4	640	120	118	17	250	95
19	57 429	36.100	1.0	1.4	1.4	650	120	118	17	250	95
20	60 432	38.657	1.50	1.4	1.4	644	128	114	17	254	95

COMMENTS: Only ran one point at ΔH of 1.50 inch.

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		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	0	817	40.65									
12	3	819	41.0	1.5	.65	.65	645	88	88	17	250	80
11	6	821	42.4	1.6	.72	.70	645	90	90	17	250	80
10	9	824	44.30	1.6	.70	.70	655	96	96	17	250	80
9	12	827	46.70	1.8	.68	.68	647	98	98	17	250	80
8	15	830	48.90	1.8	.68	.68	640	98	98	17	250	80
7	18	833	50.7	1.7	.68	.68	645	97	100	17	250	80
6	21	836	52.95	1.8	.68	.68	654	110	98	18	260	80
5	24	839	55.81	1.4	.60	.60	648	110	98	18	270	80
12	27	842	57.28	1.7	.68	.68	1.49	114	98	18	270	85
11	30	845	59.47	1.7	.70	.65	1.48	116	98	18	270	85
10	33	848	61.52	1.7	.68	.68	1.48	116	100	18	270	85
9	36	851	63.62	1.9	.68	.68	645	116	100	18	270	85
8	39	854	65.15	1.7	.68	.68	648	116	100	18	270	85
7	42	857	66.85	1.6	.68	.68	650	118	102	18	270	85
6	45	900	69.00	1.7	.94	.94	655	120	105	20	260	80
5	48	903	72.15	1.7	.94	.94	656	120	105	20	255	78
4	51	906	73.70	1.6	.94	.94	655	120	111	20	250	78
3	54	909	75.35	1.7	.94	.94	649	118	104	20	250	78
2	57	912	77.6.10	1.5	.94	.94	650	119	106	19	250	78
1	60	915	80.172	1.5	.94	.94	648	118	104	19	250	78
	120		75,225	1.565		.82	647.37	110.6				

OUTLET #2

FIELD DATA

PLANT Greenville City
DATE 1/23/91
SAMPLING LOCATION OUTLET
SAMPLE TYPE EPA
RUN NUMBER 3
OPERATOR RECOVERY
AMBIENT TEMPERATURE 50s
BAROMETRIC PRESSURE
STATIC PRESSURE, (P_g) -1.0 "H_2O
FILTER NUMBER (s)

PROBE LENGTH AND TYPE 5' Glass
NOZZLE I.D. .125 +.185 ±
ASSUMED MOISTURE, % 9.2
SAMPLE BOX NUMBER
METER BOX NUMBER 2188
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 3 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		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
				DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	0 1000	87.675									
20	3 1011	89.60	1.7	.12	1.2	650	99	99	14	250	70
19	6 1014	99.50	1.7	.16	.16	648	102	98	8	250	70
18	9 1017	90.1	1.7	.16	.16	650	103	99	6	250	70
17	12 1020	91.0	1.7	.20	.20	650	103	100	10	250	70
16	15 1023	91.75	1.8	.21	.21	645	103	100	10	250	70
15	18 1026	92.75	1.8	.20	.20	650	110	100	10	250	70
14	21 1029	93.65	1.75	.26	.20	655	110	100	10	250	78
13	24 1032	94.50	1.70	.20	.20	654	108	104	10	250	70
12	27 1035	95.60	1.4	.16	.16	650	110	104	10	250	75
11	30 1038	96.40	1.6	.18	.18	645	110	106	10	250	75
10	33 1041	97.20	1.4	.18	.18	648	110	104	10	250	76
9	36 1044	98.10	1.9	.24	.24	654	110	106	9	260	75
8	39 1047	99.10	1.9	.24	.24	650	112	108	9	260	70
7	42 1050	100.200	1.7	.21	.21	650	110	104	9	260	75
6	45 1053	101.00	1.9	.25	.25	660	112	106	9	260	75
5	48 1056	102.0	1.9	.24	.26	650	109	102	9	260	75
4	51 1059	102.85	1.6	.26	.26	655	110	104	9	260	75
3	54 1102	103.75	1.85	.20	.20	655	112	104	9	260	75
2	57 1105	104.650	1.90	.18	.18	650	110	104	9	260	75
1	60 1108	105.30	.90	.R	.R	655	108	102	2	260	75
			1.665	.2085		651.2	105.3				
				.21							

COMMENTS: Pre Run Leak Test: 1.30 · SEM

OUTLET #3

FIELD DATA

PLANT GRANITE CITY
DATE 12/15/92
SAMPLING LOCATION OUTLET
SAMPLE TYPE 12 HR
RUN NUMBER #3
OPERATOR MARTIGNEY
AMBIENT TEMPERATURE 40
BAROMETRIC PRESSURE 29.65
STATIC PRESSURE, (P_g)
FILTER NUMBER (s)

PROBE LENGTH AND TYPE 5' SS
NOZZLE I.D. .180
ASSUMED MOISTURE, % 8
SAMPLE BOX NUMBER
METER BOX NUMBER 2235
METER $\Delta H_@$
C FACTOR
PROBE HEATER SETTING 350
HEATER BOX SETTING 350
REFERENCE Δp .54

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 3 MINUTES

TRAP 127

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
				DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
-	1229	466.757									
1	1230	467.64	.97	.56	.56	605	92	90	8	250	74
2	1233	469.39	1.2	.69	.69	605	92	90	7	250	71
3	1236	470.87	1.1	.63	.63	605	97	90	9	250	70
4	1239	471.89	1.3	.75	.75	605	97	90	8	250	69
5	1242	473.67	1.4	.80	.80	612	109	93	9	250	66
6	1245	475.01	1.4	.80	.80	611	111	94	9	250	66
7	1248	476.11	1.3	.75	.75	611	116	95	9	250	66
8	1251	478.94	1.5	.86	.86	613	119	96	8.5	250	66
9	1254	480.24	1.4	.91	.91	611	120	98	9.5	250	65
10	1257	481.98	1.6	.91	.91	612	120	98	10	250	65
11	1300	483.21	1.5	.86	.86	612	125	100	10.5	250	65
12	1303	485.39	1.6	.91	.91	611	126	102	10	250	65
13	1306	2186.82	1.4	.80	.80	609	127	102	10	250	65
14	1309	488.46	1.3	.74	.74	609	127	102	9	250	65
15	1312	490.09	1.2	.69	.69	608	126	104	8	250	65
16	1315	491.61	1.3	.74	.74	610	126	104	8	250	65
17	1318	493.24	1.3	.74	.74	611	125	105	9	250	65
18	1321	494.83	1.3	.74	.74	609	125	105	9	250	63
19	1324	illegible	1.4	.80	.80	611	127	107	9	250	63
20	1327	498.312	1.3	.74	.74	610	12[illegible]	108	9	250	63

COMMENTS: Pre-Run Test Leak Check

OUTLET #2

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)		STACK TEMPERATURE (T_s, °F)	DRY GAS METER TEMPERATURE		PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
				DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	0 / 3:30	435,000									
1	3 / 3:41	435.75	.79	.10	.09	650	89	84	27.5	275	60
2	6 / 3:44	436.25	1.0	.12	.12	650	91	85	1	"	"
3	9 / 3:47	436.95	1.3	.16	.16	"	87	83	1.5	"	"
4	12 / 3:50	437.47	1.4	.17	.17	"	97	88	1.5	"	"
5	15 / 3:53	438.43	1.5	.18	.18	"	98	88	2.0	"	"
6	18 / 3:56	439.01	1.5	.18	.18	"	94	89	2.0	"	"
7	21 / 3:59	439.72	1.5	.18	.18	"	100	90	2.0	"	"
8	24 / 4:02	440.50	1.4	.17	.17	"	100	98	2.0	"	"
9	27 / 4:05	441.37	1.5	.18	.18	"	101	91	2.0	"	"
10	30 / 4:08	442.14	1.5	.18	.18	"	101	92	2.0	"	"
11	33 / 4:11	443.01	1.5	.18	.18	"	101	92	2.0	"	"
12	36 / 4:14	443.91	1.3	.16	.16	"	101	92	2.0	"	"
13	39 / 4:17	444.72	1.6	.20	.20	"	100	93	2.0	"	"
14	42 / 4:20	445.55	1.6	.20	.20	"	100	94	2.0	"	"
15	45 / 4:23	446.34	1.7	.21	.21	"	102	95	2.0	"	"
16	48 / 4:26	447.34	1.7	.21	.21	"	104	95	2.0	"	"
17	51 / 4:29	448.15	1.7	.21	.19	"	104	96	2.0	"	"
18	54 / 4:32	448.77	1.7	.21	.19	"	102	95	2.0	"	"
19	57 / 4:35	449.59	1.7	.21	.19	"	102	95	2.0	"	"
20	60 / 4:38	450.391	1.7	.21	.19	"	102	96	2.0	"	"
			1.57	.181		650	95.0				
	60	23.026	1.5722		.191	650.0	100.1				

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		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	0	915	492.312									
20	03	918	500.00	1.5	.86	.81	611	92	92	10	250	70
19	06	921	501.95	1.5	.86	.86	615	96	92	7	240	72
18	09	924	503.9	1.6	.91	.91	615	96	92	7	240	70
17	12	927	505.90	1.6	.91	.91	615	100	92	7	240	70
16	15	930	506.70	1.6	.91	.91	620	100	94	7	240	70
15	18	933	508.6	1.6	.91	.90	1015	100	94	7	240	72
14	21	936	510.6	1.6	.91	.91	615	110	96	7	240	72
13	24	939	512.2	1.4	.77	.77	612	112	96	7	250	74
12	27	942	513.8	1.4	.78	.78	614	110	96	7	250	74
11	30	945	515.4	1.4	.78	.79	614	114	98	7	250	75
10	33	948	517.0	1.4	.78	.78	610	116	98	7	250	75
9	36	951	519.0	1.5	.85	.85	620	118	100	7	250	76
8	39	954	520.9	1.5	.85	.85	625	120	100	7	250	76
7	42	957	522.9	1.5	.85	.85	613	120	100	7	250	76
6	45	960	523.9	1.5	.85	.86	619	120	100	7	250	76
5	48	963	526.0	1.5	.85	.85	613	120	100	7	250	76
4	51	966	527.2	1.5	.85	.85	615	120	100	7	250	76
3	54	969	528.9	1.5	.85	.85	611	120	100	7	250	76
2	57	972	530.4	1.5	.85	.85	610	120	100	7	250	76
1	60	975	532.086	1.5	.85	.85	610	122	104	5	250	78
						.833						
							612.1	119.1	99.9			
	120		65.331	1.41					100.0			

W.W

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT Granite City Steel

DATE 7/15/79

SAMPLING LOCATION [illegible] Outlet

INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) ____

INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) 4"

STACK I.D., (DISTANCE A - DISTANCE B) 62

NEAREST UPSTREAM DISTURBANCE ____

NEAREST DOWNSTREAM DISTURBANCE ____

CALCULATOR ____

ΔP = 1.3

Ts = 600

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	2.1	62"		4"	5.32
2	6.7	62"			8.15
3	11.8				11.32
4	17.7				14.99
5	25.0				19.50
6	35.6				26.05
7	64.4				43.95
8	75.0				50.50
9	82.3				55.01
10	88.2				58.68
11	93.3				61.85
12	97.9				64.68

SAMPLING SUMMARY SHEET

Plant National Steel Granite City Location Outlet (ESP)

Sampled source By-Product Coke Oven Battery Stack ESP Inlet & Outlet

Run	Date	N_p	P_m	P_b	V_m	T_m	$V_{m_{std}}$	V_w	$V_{w_{gas}}$	%M	M_d
1	7-26-77	40	.82	29.68	75.225	110.7	69.21			10.0	.9
2a	7-27-77	20	.21	29.74	17.635	105.3	16.374			9.4	.906
2b	7-27-77	20	.181	29.74	15.3	95.0	14.554			9.4	.906
3	7-28-77	40	.804	29.65	65.331	106.0	60.49			11.9	.881

Run	MW_d	MW	P_{st}	P_s	C_p	$\sqrt{\Delta P_s \times (T_s+460)}$ [c]	V_s	T_s	T_t	D_n	%I
1	29.23	28.11	-.07	29.61	84	41.72	6231	647	120	.185	115.9
2a	2920	28.15	-.07	29.67	84	42.89	6394	651	60	.125	116.5
2b	2920	28.15	-.07	29.67	84	40.37	6019	650	60	.155	50.2
3	29.26	27.[illegible]	-.07	29.58	84	38.35	5825	612	120	.185	107.3

102.2 AVG

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

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

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

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

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

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

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

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

$$\%I = \frac{1.032 \times (T_s + 460) \times V_{m_{std}}}{V_s \times T_t \times P_s \times M_d \times (D_n)^2}$$

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

%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, in.

%I Percent Isokinetic

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

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

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