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H. J. HALL ASSOCIATES, INC.
1250 STATE ROAD
PRINCETON, N.J. 08540
TEL. (609) 924-1933

HERBERT J. HALL
PRESIDENT

SCIENTIFIC CONSULTANTS
ELECTROSTATIC PRECIPITATION
AIR POLLUTION CONTROL
SYSTEMS & EQUIPMENT
AEROSOL PHYSICS

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TECHNICAL REPORT HAR86-431

SUMMARY ANALYSES ON PRECIPITATOR TESTS AND PERFORMANCE FACTORS, 13-15 MAY 1986 AT INCINERATOR UNITS 1, 2 - OCCIDENTAL CHEMICAL COMPANY

Prepared for

Occidental Chemical Company
Energy From Waste
P. O. Box 344
Niagara Falls, New York 14032

25 June 1985

H. J. Hall

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1250 STATE ROAD
PRINCETON, N.J. 08540
TEL. (609) 924-1933

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I. INTRODUCTION

1.1 Basic design data, performance analyses and recommendations for improvement on subject ESPs were discussed in a prior report, HAR86-426, 18 March 1986.

1.2 Some important improvements have been carried out and/or investigated since March, and a new series of tests in May 1986 were done at the stack. These tests showed some significantly improved performance where State regulations of 0.03 gr/SCFD @ 12% CO_2 emissions were well met with test levels [redacted]. Improvements were obtained via reduction in air inleakage through hoppers; preliminary tests with new linear reactors for better waveforms showed good results - only two TRs so far equipped; studies on rapping improvements are in process. Problems of reliability at sustained high ESP performance are of special current interest for long range operations. Improved gas flow distribution has been installed on Unit 1.

1.3 A major outage is scheduled early July and arrangements for Walter West, a senior Field Engineer, have been made for his arrival on site 8 July 1986. Careful internal inspections can be made; electrode alignment put in proper shape; further studies on status of gas distribution, air inleakage correction and necessary work carried out; improvement in rapping systems to maintain acceptable dust buildup control must also be looked at. Installation of proper linear reactors on all TR sets should be done - a high benefit to cost factor for improved performance, long-term reliability, and greater TR set stability.

1.4 This report summarizes analyses of recent test data and discusses recommendations for further improvement for sustained high performance and reliability.

II. SUMMARY RESULTS AND DISCUSSION

2.1 Summary Test Data and Analyses

1. Tables 1, 2 conveniently summarize operations and performance data for eight (8) stack tests on Unit 1 ESP and for three (3) tests on Unit 2 ESP. Raw data were supplied by Occidental Chemical Co. for period 13-15 May 1986. We note the following:

2. Stack opacities were very low ≈2% for all tests.

3. On Unit 1, outlet dust concentrations were in range 0.011 to 0.021 gr/SCFD @ 12% CO_2 corresponding with high ESP nominal efficiencies order 99.66-99.48% wgt, respectively. These levels are about 37 to 70% of State regulations of 0.03 gr/SCFD, 12% CO_2 maximum allowed.

4. On Unit 2, outlets on (3) tests ranged 0.012-0.031 gr/SCFD @ 12% CO_2, corresponding with nominal ESP efficiencies by weight of 99.6-99.0%, respectively - 40-103% of regulation with average ≈0.021, or ≈70% of regulation emissions. Increased rap-reentrainment losses over those in Unit 1 may be present, as well as some variations in optimimum boiler operations. We understand that gas flow distribution work has not get been completed on Unit 2.

2.2 Performance Comparisons Tests February 1986 and May 1986

The following basic data summarize results:

	Unit 1 Feb 86			Unit 1 May 86			Unit 2 Feb 86	Unit 2 May 86
1. No. tests avg	3	2	2	2	2	4	2	3
2. Load, K#/hr	225	250	275	230	250	270	225	250
3. Avg nom eff, %	99.2	99.05	98.3	99.66	99.63	99.48	98.45	99.33
4. Out gr/SCFD,12% CO_2	0.027	0.031	0.07	0.011	0.013	0.021	0.043	0.021
5. Avg i/V, MA/K ACFM	11.8	9.9	9.0	10.7	11.0	10.6	10.2	13.2
6. KV_{av}	19.3	18	18.5	20.3	20.0	20.0	18.5	22.6
7. MA DC total	3317	3000	3100	4018	4027	4200	3470	4788
8. Avg J, $\mu a/ft^2$	23.9	21.6	22.3	27.4	27.4	28.6	29.1	32.6
9. K ACFM ESP	282	303	345	374	366	397	340	362
10. SCA test	491	457	402	393	401	370	351	405
11. Avg ω, ft/sec test	0.164	0.170	0.169	0.241	0.233	0.237	0.198	0.206
12. % active area	94.5	94.5	94.5	100	100	100	81.3	100
13. Inlet temp, F	580	587	636	600	603	620	659	603
14. SCA full ESP	521	485	426				432	
15. Eff % capab max	99.4	99.3	98.7				99.4	
16. P_c/V, test	227	178	166	218	220	213	189	299

It is seen that significant improvement has occurred from February to May tests.

2.3 Performance Factors

2.31 Corona Characteristics

1. Fig. 1 illustrates some characteristic data for the May tests.

2. Note that operating levels typically lie well to left of conservative calculated clean gas curve indicating very low corona starting voltages. Causes are usually asosciated with misalignment and/or with eroded wires due to excessive sparking causing necking down on diameter of wires. Close spacings may also be caused by bowed plates

or by excessive local dust buildups (poor rapping). It appears that worthwhile improvement could be obtained by alignment correction and careful inspection of wire diameter erosion, dust buildups, etc.

2.32 Efficiency vs Average Specific Power Density

1. Results for May 1986 tests are shown in Fig. 2.

2. Average data for the February 1986 tests are also shown for comparison.

3. Significantly improved results are evident with the upgrading work to date. Unit 1 performance shows up better than Unit 2, generally.

4. Results indicate dust loss reductions as follows:

	Unit 1			Unit 2	
Load	225/230	250	270/275	225	250
Loss Feb 86	0.068	0.0095	0.017	0.0155	
Loss May 86	0.0034	0.0037	0.005		0.0067
Loss reduction factor	2.35	2.57	3.4		2.31 at 11% incr loa

2.33 Outlet Stack Emissions vs Average Specific Power Density

1. Fig. 3 illustrates results for the February and May 1986 tests.

2. Note the strong dependence upon P_c/V in reducing outlet emissions with increased power input. This emphasizes the importance of high operating voltages and currents, and the value of good electrode alignment, as well as control of dust reentrainment losses.

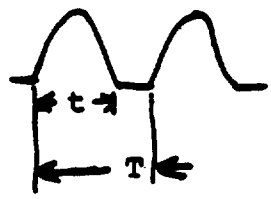
2.34 Performance vs SCA and Average Current Density

1. Fig. 4 shows results for February and May 1986 average tests.

2. Again, the improved results are evident. The important thing now is to provide sufficient reliability with as much performance capability as possible to maintain emissions well within State regulations on a long-term basis while coping with occasional process upsets and non-optimum boiler and general operating conditions.

III. RECOMMENDATIONS

3.1 Install additional linear reactors in all TR to increase nominal current conduction times under load to ≈70-86%. Check waveforms on high input inpedance oscillescope across the DC milliammeter on the control panel.



conduction = t/T

The present system appears to be badly mismatched with very low current conduction times. A check on test data indicated the following, assuming 480V primary tap:

	Fields 1, 2	Fields 3, 4
Rated pri current, amp	120	160
Nom max I_{av}, MA	≈640	≈650 available
Nom conduction, %	43	≈25
except TR 1A2, %	≈52	

This makes current and voltage waveforms very peaky and unnecessarily limits available ESP currents to low average levels while sparking can occur on the much higher peaks. Note the improvement in TR primary voltages and KV_{av} on sets tested with increased inductance. Increasing the current conduction time up to 70-86% should also raise useful I_{av} ESP current. The correct values of L must be determined by test for this case. Although normal inductance values expected would be ≈5.3 and 4.0 mh at full load ratings of 900 and 1200 MA, somewhat higher values might be needed due to the high gas temperatures and relatively low gas density in this application. Some experimentation should be done after electrode alignment has been properly corrected.

3.2 Careful inspection by Walter West. (See notes in Report HAR86-426.)

1. Correct alignment to ±1/4" wires centered in all ducts when hot gas flows. Check for reduced diameter wires due to localized spark erosion.

2. Straighten any bowed plates or remove a few wires if necessary. Relieve any thermal stress problems.

3. Check on rapping situation for possible improvement as previously discussed. Need reliable, effective rappers.

√ 3.3 Seal all hopper outlets - no air inleakage via ash conveying system - very important.

√√ 3.4 Check all access doors for air inleakage and fix if necessary. EPSCO has very good doors available (check with Walter West).

3.5 Check purge air system for HT insulators - adequate clean, hot (≈250F), dry air.

3.6 Review and check all items on recommendations discussed in prior Report HAR86-426. Check air load corona data after repairs. No sparking should be present up to full TR set ratings - voltage and/or current.

H. J. Hall

H. J. Hall

TABLE 1

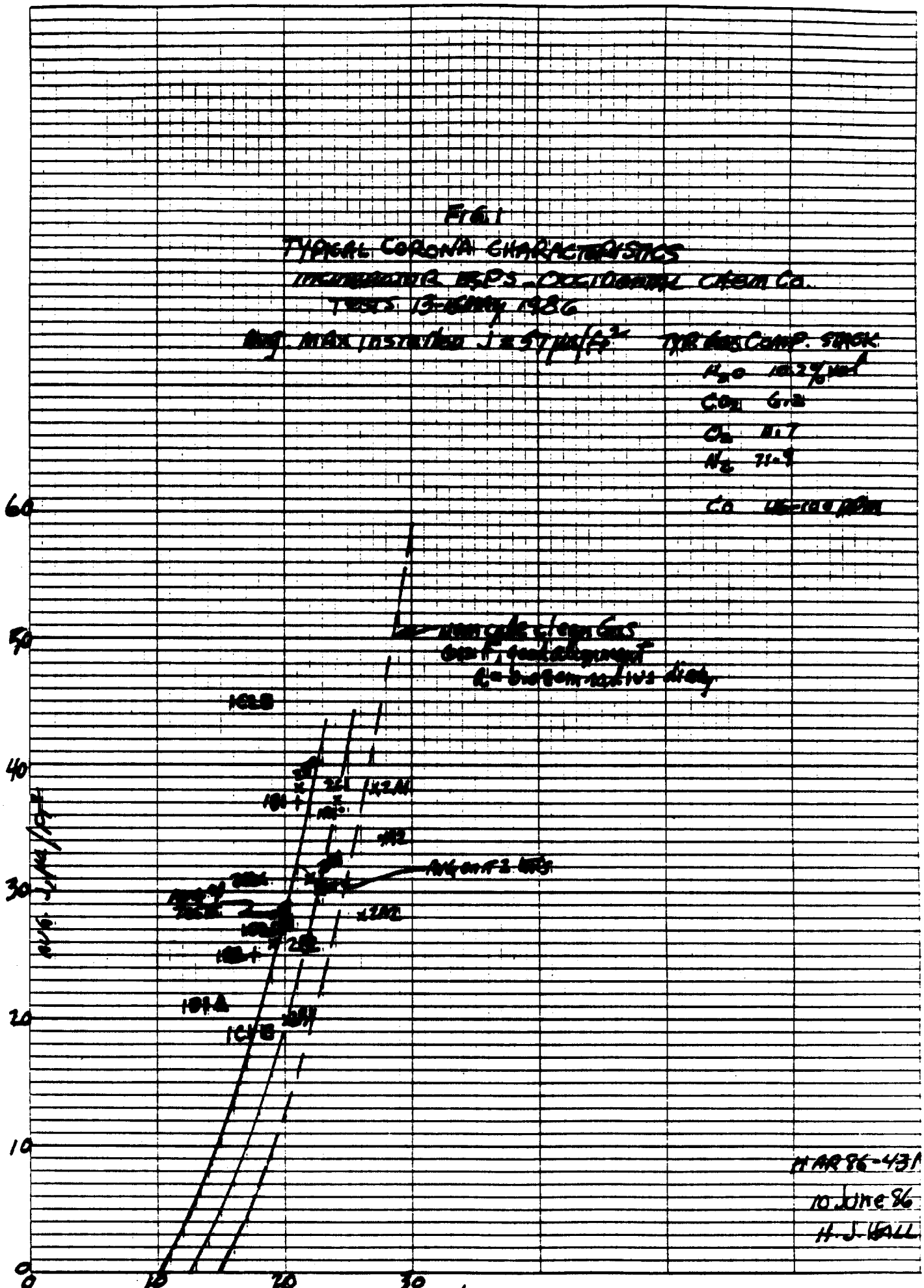
SUMMARY ANALYSES ESP TESTS BOILER #1 STACK
OCCIDENTAL CHEMICAL CO. (13-15 MAY 86)

Item	Boiler #1		
1. Test nos. avg	1-4	5-6	7-8
2. Date May 86	13	14	14
3. Steam, K#/hr	270	250	230
4. K SCFMD stack	167.950	160.6	162.5
5. K ACFM stack	302.110	281.6	286.3
6. Barometer, "Hg	29.26	29.52	29.56
Stack gas, "Hg	29.20	29.47	29.51
7. Stack gas, F/δ	371/.622	361/.636	362/.636
8. % H_2O vol	10.4	10.0	10.4
O_2	12.2	13.1	13.2
CO_2	7.5	6.9	6.7
PPM CO	46	66	72
9. gr/SCFD stack	0.013	0.007	0.006
@ 12% CO_2	0.021	0.013	0.011
10. Stack opacity, %	2	1-2	2
11. Under grate air, %	56	53	50
a. Boiler O_2. % avg	8.4	8.6	8.6
12. OFA fan amp	36.5	37	36.7
13. ESP inlet temp, F	620	603	600
14. Avg ESP press, "H_2O	-5.5	-5.1	-5.2
15. Rel gas density, δ (=1 @ 70F, 29.92)	0.473	0.49	0.487
16. Nom inlet @ 12% CO_2 gr/SCFD (Feb 86 tests)	4.07	3.5	3.2
17. Nom ESP eff, % avg	99.48	99.63	99.66
18. Nom ESP K ACFM	397	366	374
19. SCA, ft^2/1000 ACFM	370	401	393
20. Nom ω, ft/sec	0.237	0.233	0.241
21. KV_{av}	20	20	20.3
22. MA DC total	4200	4027	4018
23. Avg J, μa/ft^2	28.6	27.4	27.4
24. i/V, MA/1000 ACFM	10.6	11.0	10.7
25. P_c/V, watts/1000 ACFM	212	220	218

TABLE 2

SUMMARY ANALYSES ESP TESTS BOILER #2 STACK
OCCIDENTAL CHEMICAL CO., MAY 1986

Item	Parameter		
1. Test no.	1	2	3
2. Date	←15 May 1986→		
3. Steam, K#/hr	250	250	250
4. K SCFMD stack	160.22	152.63	163.4
5. K ACFM stack	288.9	276.8	288.0
6. Barometer, "Hg	29.60	29.57	30.56
a. Stack gas, "Hg	29.54	29.52	30.51
7. Stack gas temp F/δ	386/.619	385/.619	394/.632
8. % H_2O vol	10.0	10.5	10.0
O_2	13.1	13.0	12.8
CO_2	6.6	6.6	6.8
PPM CO	123	98	80
9. gr/SCFMD stack	0.017	0.010	0.007
" @ 12% CO_2	0.031	0.019	0.012
#/hr	23.4	13.1	9.8
10. Stack opacity, %	2	2	2
11. Under grate air/boiler O_2 %	25/10	24.5/10	50/9
12. OFA fan amp	37	37	36.5
13. ESP inlet temp, F	607	579	625
14. Avg ESP press, "H_2O	-5.3	-5.3	-5.4
15. Rel gas density (δ=1 @ 70F, 29.92)	0.48	0.50	0.49
16. Nom inlet gr/SCFD @ 12% CO_2	3.2	3.2	3.2
17. Nom ESP eff., % wgt	99.0	99.4	99.6
18. Nom ESP K ACFM	373	342.6	371.5
19. SCA, ft^2/1000 ACFM	394	429	395
20. Nom ω, ft/sec test	0.195	0.204	0.232
21. KV_{av}/MA DC	22.4/4710	22.9/4815	22.9/4040
22. Avg J, μa/ft^2	32	33	33
23. i/V, MA/1000 ACFM	12.6	14	13
24. P_c/V, watts per 1000 ACFM	283	322	298



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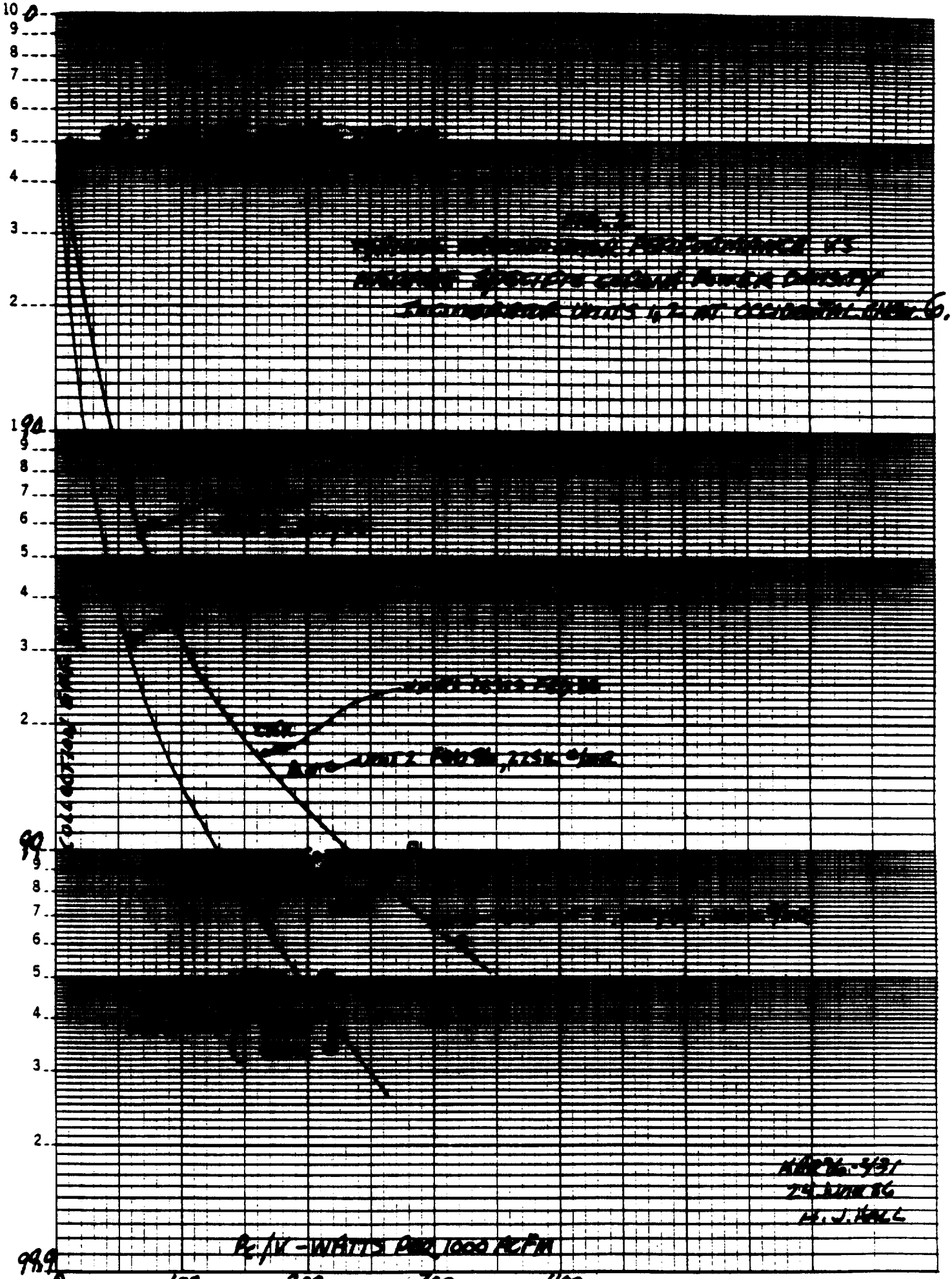

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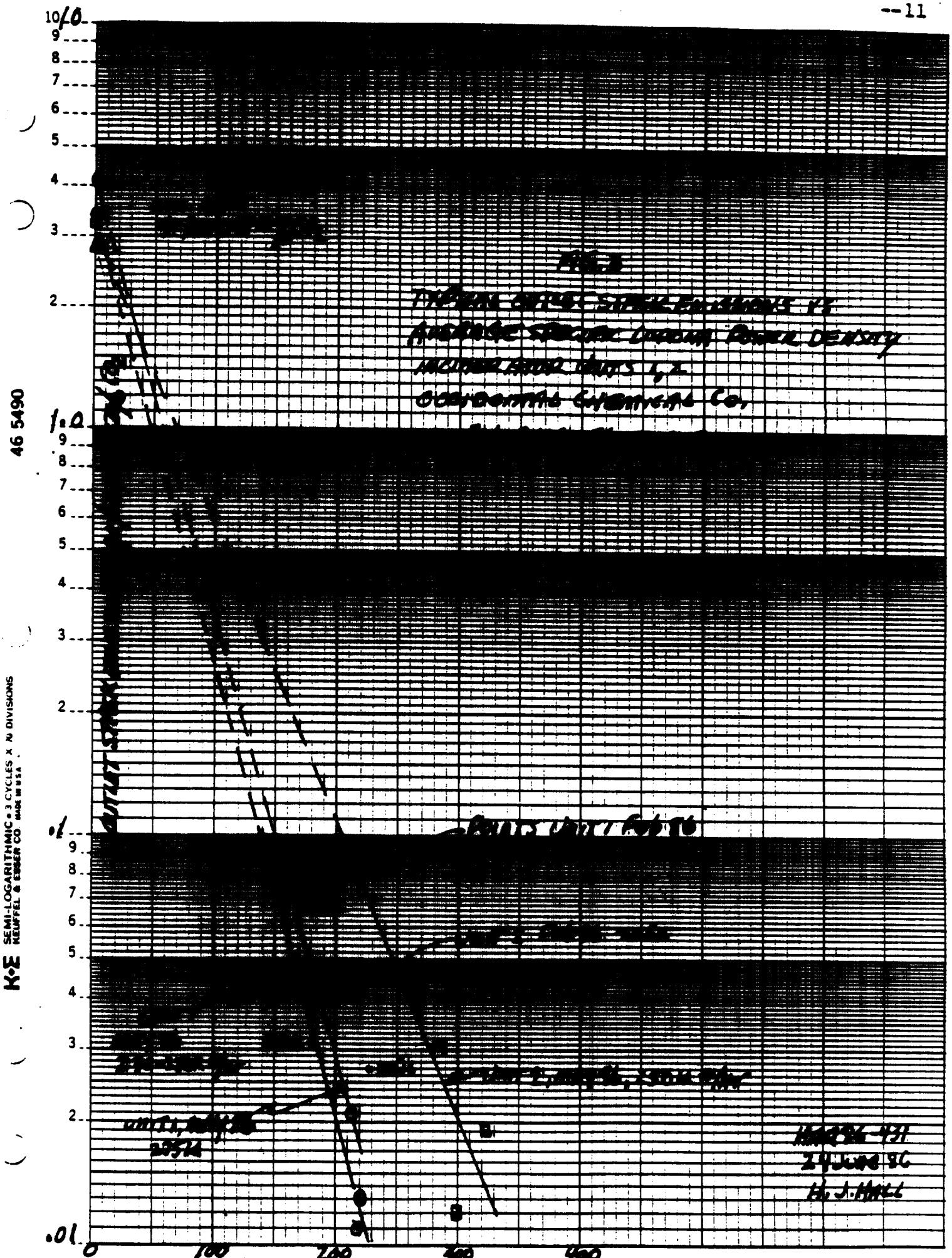
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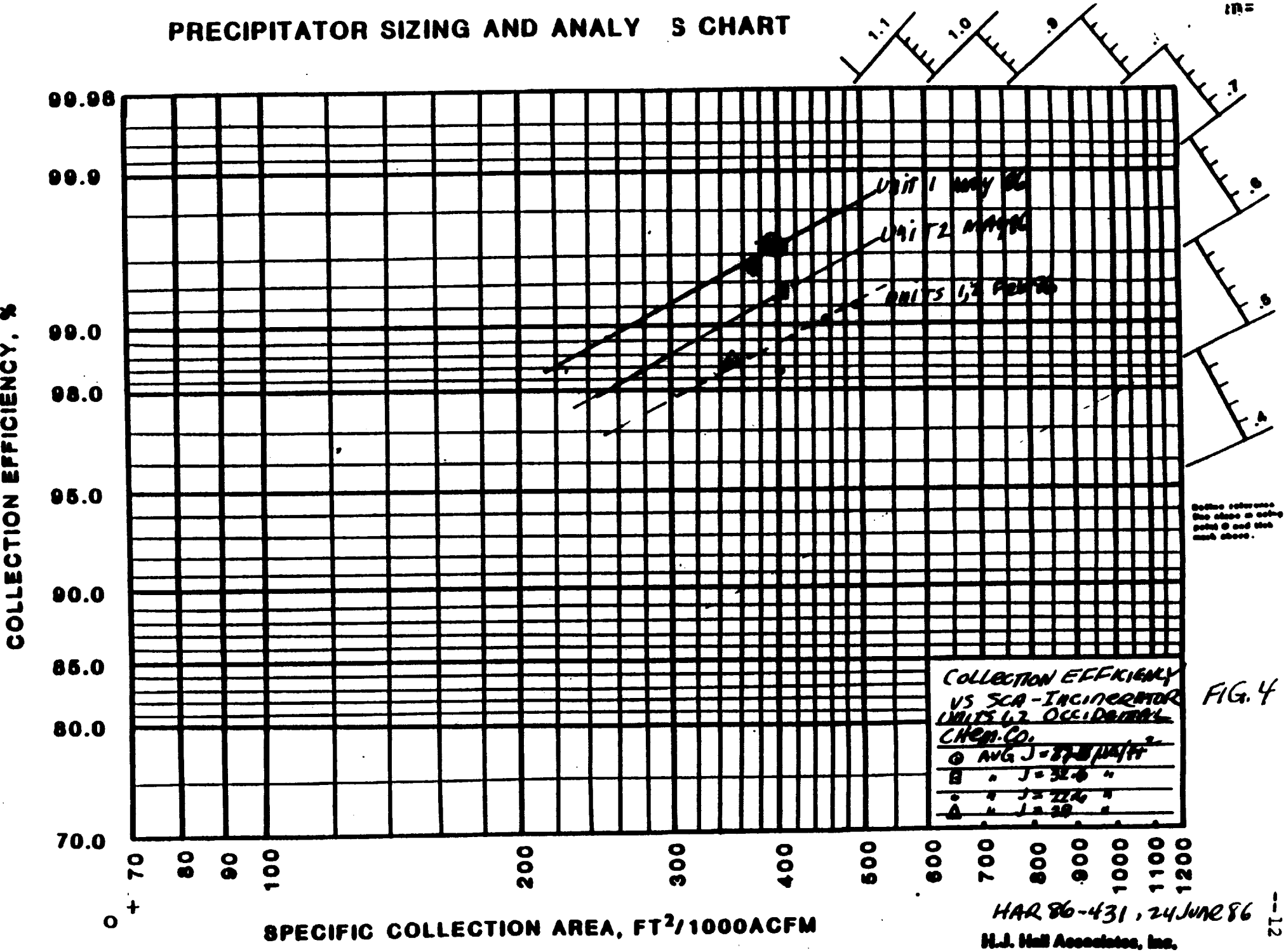

FIG. 4

HAR 86-431, 24 JUNE 86

H.J. Hall Associates, Inc.
1250 State Road
Princeton, N.J. 08540