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RTR-1437

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October 10, 1973

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LIMITS SENSITIVITY STUDY FOR MARK 16-30 CHARGE

INTRODUCTION

A parametric study was made to determine the effects of varying some of the input parameters for the BOTTLE, LIMITS II, and LIMITS III codes. The results of the study are presented graphically in Figures 1 to 86. These results can be used to determine the effect of errors[1] on thermal-hydraulic limits and reactor power.

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[1] Errors resulting from changes in the parameters after limits have been calculated or inadvertent errors.

Classified by C. J. Temple
Asst. Chief Supervisor, Reactor Tech.

SUMMARY

The parameters listed in Table I were varied individually in the BOTTLE[2], and LIMITS III[1] codes for subcycles P-1.1, P-1.3, and C-6.3. The results of this study are summarized in the table below.

EFFECT OF VARYING PARAMETER ON POWER

No Effect	Slight Effect	Major Effect
SRW Peaking Ratio	α_c Reactor Average	BOF
GRW Peaking Ratio	α_m Reactor Average	COF
$\dot{K}$ SRW	α_c Worst Cluster	PrBc
$\dot{K}$ GRW		PrBa
Fission Fraction		PrCa
α_m Worst Cluster		HCF
		DAC
		FRD
		DSB
		FRE1
		DBGR

The effects of varying input parameters to the BOTTLE code were carried through the LIMITS II and LIMITS III codes to determine the effects on temperature limits and reactor power.

It should be noted that the results presented in this RTR may change as the methods for analysis change. However, the results are valid as of June 1973.

DISCUSSION

Actual reactor limits for the P-1.1 (Reference 2), P-1.3 (Reference 3), and C-6.3 (Reference 4) subcycles were used for base cases. To determine the effect of each factor on the limits, parameters were varied individually, with all other input remaining constant. The ranges of values selected are shown in Table II.

[1] The BOTTLE, LIMITS II, and LIMITS III codes are based on Reference 1.

Per cent change in reactor was used as a common index to relate the effects of all parameters studied. Power was calculated from reactor powers estimated using equations A, B and C below. Per cent increase or decrease in power was determined using the base case powers listed in Table III.

REACTOR POWER EQUATIONS (Reference 5)

A. For Channel Effluent Temperature Limiting

$$R = \frac{T_o + T_W(K-1) - \pi_L}{\frac{AJ\chi}{NFS(1-M)} - \frac{(KZ_M - Z_L)}{C}}$$

where:

A	Ratio of assy-avg. ΔT for limiting assy. to avg. GI, GII assy. avg. ΔT
C	Avg. heat exchanger approach coefficient, MW/°C
C_L	Heat exchanger approach coefficient using limiting system, MW/°C
C_m	Heat exchanger approach coefficient using minimum system, MW/°C
F	Flow in primary zone, gpm
J	Ratio: hottest channel (or quadrant) ΔT to assy. avg. ΔT for limiting assembly
K	Change in operating limit per °C change in plenum inlet temperature
M	Fraction of sensible assembly power that is transferred from bulk moderator to outer annulus of assembly for avg. Gang I and II primary zone assembly
N	Number of effective tubes (based on avg. Gang I, Gang II primary zone assemblies, estimate from RDAP)
R	Estimated reactor power, MW
S	Ratio of cooling water power to sum of flow ΔT powers (corrected for heat transfer from bulk moderator)
T_o	Effluent temperature limit at 0°C plenum inlet temperature, °C
T_W	Average cooling water temperature, °C (both headers)
Z_L	Ratio of avg. C to C for system limiting reactor (C/C_L)
Z_M	Ratio of avg. C to C for system with minimum plenum inlet temperature (C/C_m)
π_L	Avg. difference between actual operating point and limit, effluent temperature limit
χ	Constant for calculating assembly heat in MW, gpm - °C/MW

B. For Assembly Average Effluent Temperature Limiting

$$R = \frac{T_O - T_W (K-1) - \pi_L}{\frac{A\chi}{NFS(1-M)} - \frac{(K Z_M - Z_L)}{C}}$$

See equation A for nomenclature.

C. For BOSFN Limiting

$$R = \frac{\alpha\sigma\varepsilon}{\phi \; [(B + \pi_B) \; \psi + .124 \; \sigma \; (\frac{\alpha}{\phi c} + m\psi)]}$$

where:

α	NFS(1-M)
ϕ	$AJ\chi$
ψ	$H_1 + H_2 \; \beta$
σ	$\frac{K(1 + .0515V)}{H_5VD \; (1 + H_6\beta)n}$
ε	$1 + 0.124 \; (T_s - T_W)$
B	BOSFN obtained from LIMITS III output
A	Ratio of assy-avg. ΔT for limiting assy. to avg. GI, GII assy. avg. ΔT
C	Avg. heat exchanger approach coefficient, MW/°C
D	Coefficient to account for heat transfer from bulk moderator (calculate from appropriate heat transfer and hydraulics document, Table 5)
F	Flow in primary zone, gpm
H_1,H_2	Factors to determine annulus ΔT from measured ΔT (from heat transfer and hydraulics document)
H_5,H_6	Factors to determine heat flux from fuel surface (from heat transfer and hydraulics document)
J	Ratio: hottest channel (or quadrant) ΔT to assy. avg. ΔT for limiting assembly
m	Sum of total assembly power generation down to a specific elevation
M	Fraction of sensible assembly power that is transferred from bulk moderator to outer annulus of assembly for avg. Gang I and II primary zone assembly
n	Ratio of heat flux to average heat flux

N	Number of effective tubes (based on avg. Gang I, Gang II primary zone assemblies, estimate from RDAP)
R	Estimated reactor power, MW
S	Ratio of cooling water power to sum of flow ΔT powers (corrected for heat transfer from bulk moderator)
T_S	Minimum saturation temperature in assembly, °C
T_W	Average cooling water temperature, °C (both headers)
V	Coolant velocity in annulus associated with limiting BOSFN surface, ft/sec.
β	Fractional fuel burnup (expressed as fraction)
κ	Burnout heat flux correlation constant (from heat transfer and hydraulics document)
ν	Ratio of $(T_i - T_W)$ for limiting system (for reactor effluent limit) to $(T_i - T_W)$ for avg. system
π_B	Avg. difference between actual operating point and limit, BOSFN limit
π_L	Avg. difference between actual operating point and limit, effluent temperature limit
χ	Constant for calculating assembly heat in MW, gpm - °C/MW

The values in the above equations were determined from RDAP data (References 6, 7, and 8) and RTR-1107 (Reference 5). Equations A and B were reduced to power as a function of T_o and κ and equation C was reduced to power as a function of BOSFN (B). The limits parameters were varied to obtain the T_o and κ or BOSFN which were then substituted into the appropriate equation to calculate power. The base case powers were obtained from RDAP data (References 6, 7 and 8) and are listed in Table III. The per cent increase or decrease in power from the base case was plotted versus the per cent change in the parameter (Figures 1 to 21).

When the limiting incident changed during variation of a parameter, the base case limiting incident was used in all cases. A list of the incidents is given in Table IV.

Figures 1 to 3 illustrate the effect of the incident C overshoot factor (COF) (see Table IV), the power rise to scram for incident B at 4-1/2°C RPM meter rise (PrBc) and the axial flux shapes (TWFM) on power as determined using the BOSFN limiting equation (C). For example: a 2% increase in COF would result in a 2% increase in power.

Figures 4 to 6 depict the effect of the Hot Subchannel Factor (HCF), the incident B and Incident C overshoot factors (BOF and COF), and the power rise to scram for incidents B and C at 3-1/2°C RPM (PrBa, PrCa) on power. These estimated powers were calculated from equation A using T_o and K values for the Channel Effluent Limit (CEL), Reactor Zone 1.

Figures 7 to 9 show the effect of the D and F_r factors on power for incidents D, E, and G-2. Estimated powers were calculated from equation B using T_o and K values for the Assembly Average Temperature limit (AAL), Reactor Zone 1.

Figures 10 to 12 show the effect of the worst cluster moderator temperature coefficient (α_m worst cluster) on power. This effect was determined by first varying α_m, worst cluster, and noting the per cent change in the D and F factors. Then, a per cent change in power was graphically estimated based on this calculated per cent change in the D and F factors. Figures 1 to 9 were used to estimate these power changes.

Figures 13 to 15 depict the effect of the worst cluster coolant temperature coefficient (α_c worst cluster) on power. This effect was determined using Figures 10 to 12.

Figures 16 to 18 illustrate the effect of reactor average α_c and α_m on power. This effect was determined in the same manner as described above with the exception that the effect on BOF and COF was used rather than the effect on the D and F factors. Figures 4 to 6 were used to estimate these power changes.

Figures 19 to 21 show the effect of the peaking ratios (for single and gang rod withdrawal, GRW, SRW), the fission fraction, and the $\dot{K}$ factor (the rate of increase in reactivity with time for SRW and GRW) on power. This effect was also determined by calculating the per cent change in BOF and COF and using Figures 4 to 6 to estimate the effect on power. Although these graphs indicate no effect, an actual range of variation in power of -0.12% to +0.09% was observed.

Figures 22 to 77 summarize all other data from this study including effects on CEL, AAL, BOSFN, BOF and COF, and the D and F factors.

The equation below was used to determine the effects of parameters on CEL (Channel Effluent Temperature limit) and AAL (Average Assembly Effluent Temperature limit).

D. CEL (or AAL) $= T_o + K\,(T_{in})$

where:

CEL Calculated Channel Effluent Limit

AAL Calculated Assembly Average Limit

T_o Effluent temperature limit at 0°C plenum inlet temperature, °C obtained from LIMITS II printout

K Change in operating limit per °C change in plenum inlet temperature. Obtained from LIMITS II printout

T_{in} Plenum inlet temperature. 30°C was used for all calculations

BOSFN values used were obtained directly from LIMITS III printouts. Values for BOF, COF, and the D and F factors were obtained directly from the BOTTLE printout.

REFERENCES

1. Effluent Temperature and BOSFN Limits For Fuel and Target Assemblies and Reactor Effluent Temperature Limits, DPSTM-110, Rev. 56, November 1972 (Secret).

2. Elley, D. W., Reactor Limits Data For P-1.1, Rev. 2, DPSP-72-1539, RLD-31, November 17, 1972.

3. Elley, D. W., Reactor Limits Data For P-1.3, DPSP-73-1111, RLD-37, February 26, 1973.

4. Metell, H. M., Reactor Limits Data for C-6.3, DPSP-73-1092, RLD-36, February 13, 1973.

5. Campbell, R. L., Estimating Reactor Operating Parameters, DPSP-71-1477, RTR-1107, December 13, 1971.

6. RDAP, DPSP-72-610-P-1.1, December 14, 1972.

7. RDAP, DPSP-73-610-P-1.3, April 5, 1973.

8. RDAP, DPSP-73-610-C-6.3, March 19, 1973.

Table I

Parameters Studied:

BOTTLE	LIMITS II	LIMITS III
α_c Rx Average	FRD	Histogram Groups
α_m Rx Average	FRE 1	COF
α_c Worst Cluster	FRG	PrBc
α_m Worst Cluster	DAC	TWFM (Axial Flux Shape)
Fission Fraction	DSB	
$\dot{K}$ SRW	DBGR	
$\dot{K}$ GRW	HCF	
SRW Peaking Ratio	PrCa	
GRW Peaking Ratio	PrBa	
PrBb	BOF	
PrCb	COF	
PrU	PrRx	

Table II

RANGE OF VALUES FOR PARAMETERS STUDIED

Parameter:	Range:		
BOF and COF	0.900	to	1.000
α_c and α_m (worst cluster and Rx Average)	0	to	-20
D Factors	1.000	to	1.100
F Factors	0.750	to	0.950
Pr Factors	1.050	to	1.150
$\dot{K}$ SRW	2.2×10^{-5}	to	2.6×10^{-5}
$\dot{K}$ GRW	6.2×10^{-5}	to	6.6×10^{-5}
SRW Peaking Ratio	90	to	100
GRW Peaking Ratio	20	to	28
HCF	1.000	to	1.200

Fission Fraction

	Uranium Fraction			
	235	238	239	241
P-1.1 and P-1.3	0.981	0.019	0	0
	0.900	0.019	0.081	0
	0.800	0.019	0.181	0
C-6.3	0.983	0.017	0	0
	0.900	0.017	0.083	0
	0.800	0.017	0.183	0

Table II (contd)

Axial Flux Shapes

Pl.1 Mark 16

Layer	Relative Heat Flux: No Saddle	Medium Saddle	Deep Saddle
1	0.39	0.47	0.63
2	0.64	0.79	0.88
3	0.81	0.99	1.06
4	0.92	1.10	1.17
5	0.99	1.13	1.21
6	1.05	1.10	1.33
7	1.14	1.06	1.21
8	1.20	1.04	1.15
9	1.24	1.02	1.10
10	1.28	1.02	1.02
11	1.31	1.02	1.10
12	1.32	1.03	1.15
13	1.33	1.05	1.21
14	1.33	1.08	1.33
15	1.21	1.13	1.21
16	1.04	1.17	1.17
17	0.90	1.15	1.15
18	0.76	1.06	1.06
19	0.61	0.88	0.88
20	0.42	0.63	0.63

Table II (contd)

Axial Flux Shapes (contd)

Pl.1 Mark 30 and Mark 53A

	Relative Heat Flux		
Layer	No Saddle	Medium Saddle	Deep Saddle
1	0.39	0.39	0.39
2	0.67	0.67	0.67
3	0.87	0.87	0.87
4	1.01	1.01	1.01
5	1.10	1.10	1.10
6	1.13	1.13	1.13
7	1.14	1.10	1.04
8	1.14	1.06	0.96
9	1.13	1.03	0.88
10	1.13	1.00	0.80
11	1.12	1.03	0.88
12	1.12	1.06	0.96
13	1.12	1.10	1.04
14	1.12	1.13	1.13
15	1.13	1.13	1.13
16	1.13	1.13	1.13
17	1.09	1.09	1.09
18	0.98	0.98	0.98
19	0.81	0.81	0.81
20	0.57	0.57	0.57

Table II (contd)

Axial Flux Shapes (contd)

Pl.3 Mark 16

Layer	Relative Heat Flux		
	No Saddle	Medium Saddle	Deep Saddle
1	0.39	0.39	0.40
2	0.66	0.66	0.66
3	0.85	0.88	0.88
4	0.97	0.99	1.07
5	1.06	1.07	1.14
6	1.14	1.14	1.33
7	1.19	1.21	1.17
8	1.20	1.15	1.15
9	1.21	1.09	1.09
10	1.20	1.03	0.97
11	1.20	1.12	1.07
12	1.18	1.17	1.20
13	1.17	1.21	1.27
14	1.14	1.17	1.32
15	1.11	1.14	1.25
16	1.09	1.11	1.18
17	1.02	1.02	1.06
18	0.90	0.90	0.93
19	0.72	0.72	0.71
20	0.50	0.50	0.52

Table II (contd)

Axial Flux Shapes (contd)

Pl.3 Mark 30 and Mark 53A*

Layer	Relative Heat Flux		
	No Saddle	Medium Saddle	Deep Saddle
1	0.59	0.59	0.63
2	0.72	0.92	0.92
3	0.85	1.09	1.09
4	0.92	1.15	1.15
5	0.93	1.13	1.19
6	0.95	1.08	1.25
7	0.99	1.05	1.18
8	1.05	0.99	1.13
9	1.08	0.95	1.06
10	1.13	0.93	0.94
11	1.15	0.92	0.87
12	1.09	0.93	0.99
13	1.06	0.95	1.11
14	0.99	0.99	1.17
15	0.95	1.06	1.25
16	0.92	1.14	1.16
17	0.90	1.17	1.09
18	0.74	1.13	1.01
19	0.70	0.99	0.99
20	0.58	0.74	0.74

*For Mark 53A Layers 1, 2, 19 and 20, use 0.0.

Table II (contd)

Axial Flux Shapes (contd)

C6.3 Mark 16 and Mark 30B

Layer	Relative Heat Flux: No Saddle	Medium Saddle	Deep Saddle
1	0.39	0.39	0.40
2	0.66	0.66	0.66
3	0.85	0.88	0.88
4	0.97	0.99	1.07
5	1.06	1.07	1.14
6	1.14	1.14	1.33
7	1.19	1.21	1.17
8	1.20	1.15	1.15
9	1.21	1.09	1.09
10	1.20	1.03	0.97
11	1.20	1.12	1.07
12	1.18	1.17	1.20
13	1.17	1.21	1.27
14	1.14	1.17	1.32
15	1.11	1.14	1.25
16	1.09	1.11	1.18
17	1.02	1.02	1.06
18	0.90	0.90	0.93
19	0.72	0.72	0.71
20	0.50	0.50	0.52

Table II (contd)

Axial Flux Shapes (contd)

C6.3 Mark 30A and Mark 53A*

Layer	Relative Heat Flux: No Saddle	Medium Saddle	Deep Saddle
1	0.59	0.59	0.63
2	0.72	0.92	0.92
3	0.85	1.09	1.09
4	0.92	1.15	1.15
5	0.93	1.13	1.19
6	0.95	1.08	1.25
7	0.99	1.05	1.18
8	1.05	0.99	1.13
9	1.08	0.95	1.06
10	1.13	0.93	0.94
11	1.15	0.92	0.87
12	1.09	0.93	0.99
13	1.06	0.95	1.11
14	0.99	0.99	1.17
15	0.95	1.06	1.25
16	0.92	1.14	1.16
17	0.90	1.17	1.09
18	0.74	1.13	1.01
19	0.70	0.99	0.99
20	0.58	0.74	0.74

*For Mark 53A Layers 1, 2, 19 and 20, use 0.0.

Table II (contd)

Histogram Groups

Pl.1 Mark 16

Original - Histogram Used For Limits

5	12	17	22	24	24	22	22	11	0
1	2	3	4	5	5	4	4	2	0
1	2	3	4	4	4	4	3	2	0
2	4	5	6	7	7	7	6	3	0

Case 1 - More Assemblies in Middle Of Histogram (Lower Reactor Power)

3	12	17	23	28	28	22	18	8	0
1	1	3	5	6	6	4	3	1	0
1	2	3	4	5	5	4	2	1	0
2	3	4	7	9	9	7	4	2	0

Case 2 - More Assemblies At Ends of Histogram (Higher Reactor Power)

15	15	17	18	20	20	18	18	18	0
2	3	3	4	4	4	4	3	3	0
2	3	3	3	4	4	3	3	2	0
3	4	6	6	7	7	6	5	3	0

Table II (contd)

Histogram Groups (contd)

Pl.1 Mark 30

5	9	13	18	18	18	18	18	18	12
1	1	2	2	3	2	3	2	3	2
1	2	3	3	4	4	3	3	1	0
3	4	7	7	8	8	8	7	2	0
3	5	7	10	9	10	9	10	9	7
1	0	0	1	0	1	0	0	0	0

4	10	14	17	18	20	20	18	16	10
1	1	2	2	3	4	4	2	1	1
1	2	2	3	5	5	3	2	1	0
2	5	6	6	8	10	10	6	1	0
3	5	6	8	10	12	12	9	8	6
1	0	0	1	0	1	0	0	0	0

8	13	15	15	16	17	17	16	16	14
1	2	2	2	3	3	3	2	2	1
1	2	3	3	3	4	3	3	2	0
4	5	6	6	7	7	7	7	5	0
6	7	7	8	8	9	9	9	8	8
1	0	0	1	0	1	0	0	0	0

Table II (contd)

Histogram Groups (contd)

Pl.3 Mark 16

5	11	16	21	22	22	21	21	11	0
1	3	4	5	5	5	5	5	3	0
1	2	3	4	4	4	4	3	2	0
1	3	5	6	6	6	6	6	3	0

5	10	14	20	24	24	22	20	11	0
1	1	3	5	7	7	6	4	1	0
1	2	2	4	5	5	4	3	1	0
1	2	4	6	8	8	7	4	2	0

10	11	17	19	20	20	20	18	15	0
3	3	4	4	5	5	4	4	3	0
2	3	3	3	4	4	3	3	2	0
3	4	4	5	6	6	5	5	4	0

Table II (contd)

Histogram Groups (contd)

Pl.3 Mark 30

7	12	19	22	22	22	22	22	5	0
2	3	6	6	6	6	6	6	1	0
3	4	6	8	8	8	8	7	2	0
3	5	7	10	10	10	9	9	9	7
1	1	1	0	0	0	0	0	0	0

9	13	15	21	24	24	22	20	5	0
2	3	6	7	8	8	8	4	2	0
1	2	5	8	10	10	9	6	3	0
4	6	8	11	12	12	10	8	6	2
1	1	1	0	0	0	0	0	0	0

10	16	18	19	20	20	19	18	13	0
3	4	5	5	6	6	5	5	3	0
5	5	6	6	7	7	7	6	5	0
7	7	8	9	9	9	8	8	7	7
1	1	1	0	0	0	0	0	0	0

Table II (contd)

Histogram Groups (contd)

C6.3 Mark 16

8	16	24	30	32	32	30	29	15	0
2	4	6	7	8	8	6	6	4	0
1	1	2	2	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	2	2	3	3	2	1	1	0	0

18	20	24	26	30	30	28	26	14	0
5	5	6	6	7	7	6	5	4	0
1	1	2	2	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	2	2	3	3	2	1	1	0	0

8	15	23	29	34	35	30	27	15	0
1	3	5	8	10	10	7	5	2	0
1	1	2	2	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0
1	2	2	3	3	2	1	1	0	0

Table II (contd)

Histogram Groups (contd)

C6.3 Mark 30A

3	6	9	12	12	12	12	12	0	0
12	0	0	0	0	0	0	0	0	0

7	9	10	10	11	11	10	10	0	0
12	0	0	0	0	0	0	0	0	0

6	7	8	12	15	14	9	7	0	0
12	0	0	0	0	0	0	0	0	0

Mark 30B

9	14	23	30	30	30	30	30	8	0
13	20	22	26	27	28	28	27	13	0
7	15	20	24	29	32	33	29	15	0

Table III

SUMMARY OF RDAP DATA USED

Subcycle:

P-1.1	DPSP-72-610-P-1.1 12/14/72	 Rx Power = 2141
P-1.3	DPSP-73-610-P-1.3 4/5/73	 Rx Power = 2005
C-6.3	DPSP-73-610-C-6.3 3/19/73	 Rx Power = 2419

Table IV

DEFINITION OF REACTOR INCIDENTS

Incident:

A.	Natural Uranium Fuel Failure
B.	Single Control Rod Withdrawn At The Control Rod Drive Speed
C.	Gang of Control Rods Withdrawn At The Control Rod Drive Speed
D.	Loss Of AC Motor Power
E.	Pump Failure (D_2O)
F.	Pump Failure (H_2O)
G-1	Leak - Slow Reduction In Blanket Gas Pressure
G-2	Blown Vacuum Breaker - Sudden Reduction In Blanket Gas Pressure
H.	Partial Pluggage Of Inlet Flow Passages

Table V

TABLE OF CONTENT FOR FIGURES

Table V (contd)

Table of Content for Figures (contd)

Table V (contd)

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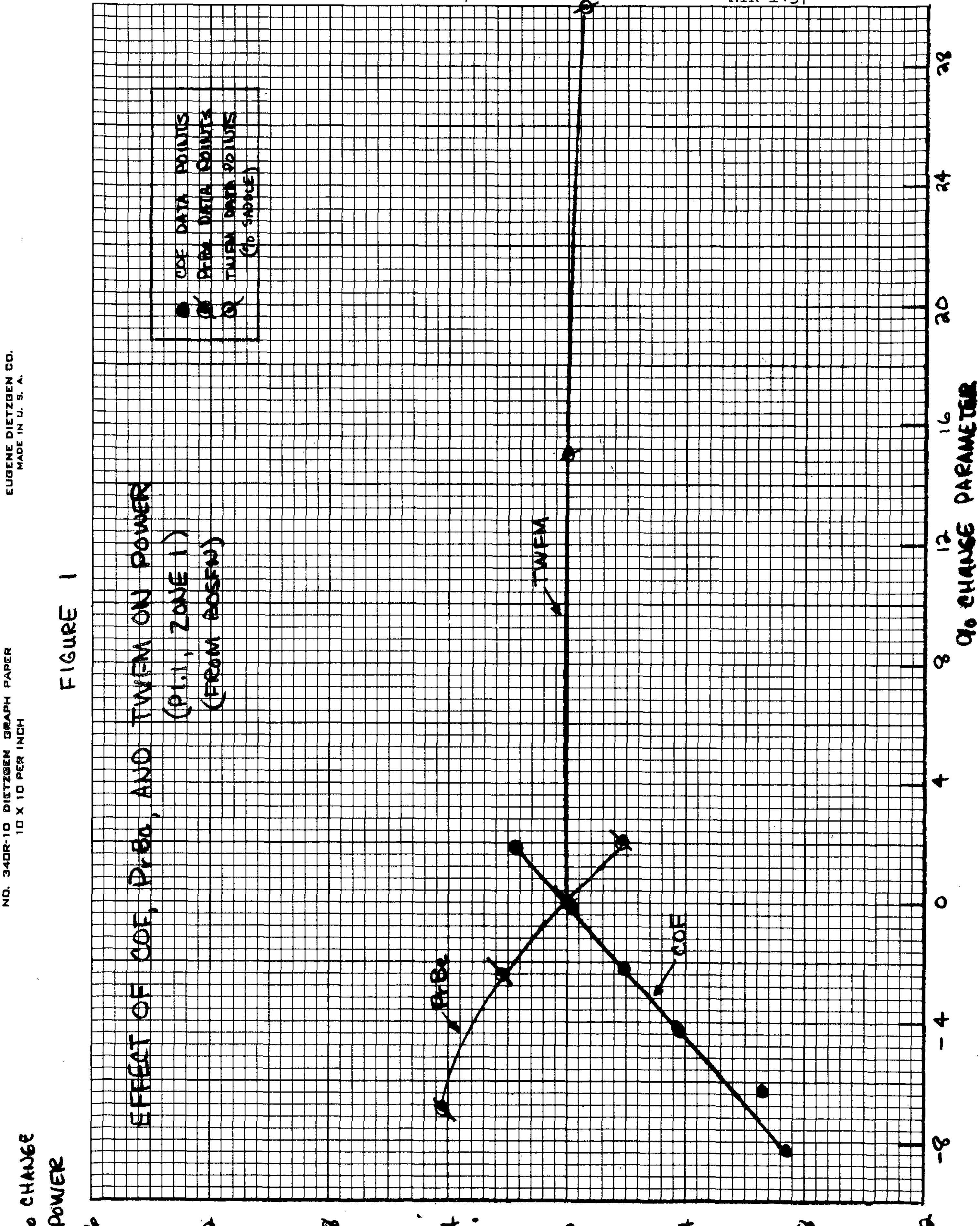
FIGURE 1
EFFECT OF COF, PrBa, AND TWEM ON POWER
(Pt.1, ZONE 1)
(FROM BOSFN)
COF DATA POINTS
PrBa DATA POINTS
TWEM DATA POINTS
(to SADDLE)
TWEM
COF
PrBa
% CHANGE PARAMETER
-8
-4
0
4
8
12
16
20
24
28
% CHANGE POWER
16
12
8
4
0
-4
-8
-12
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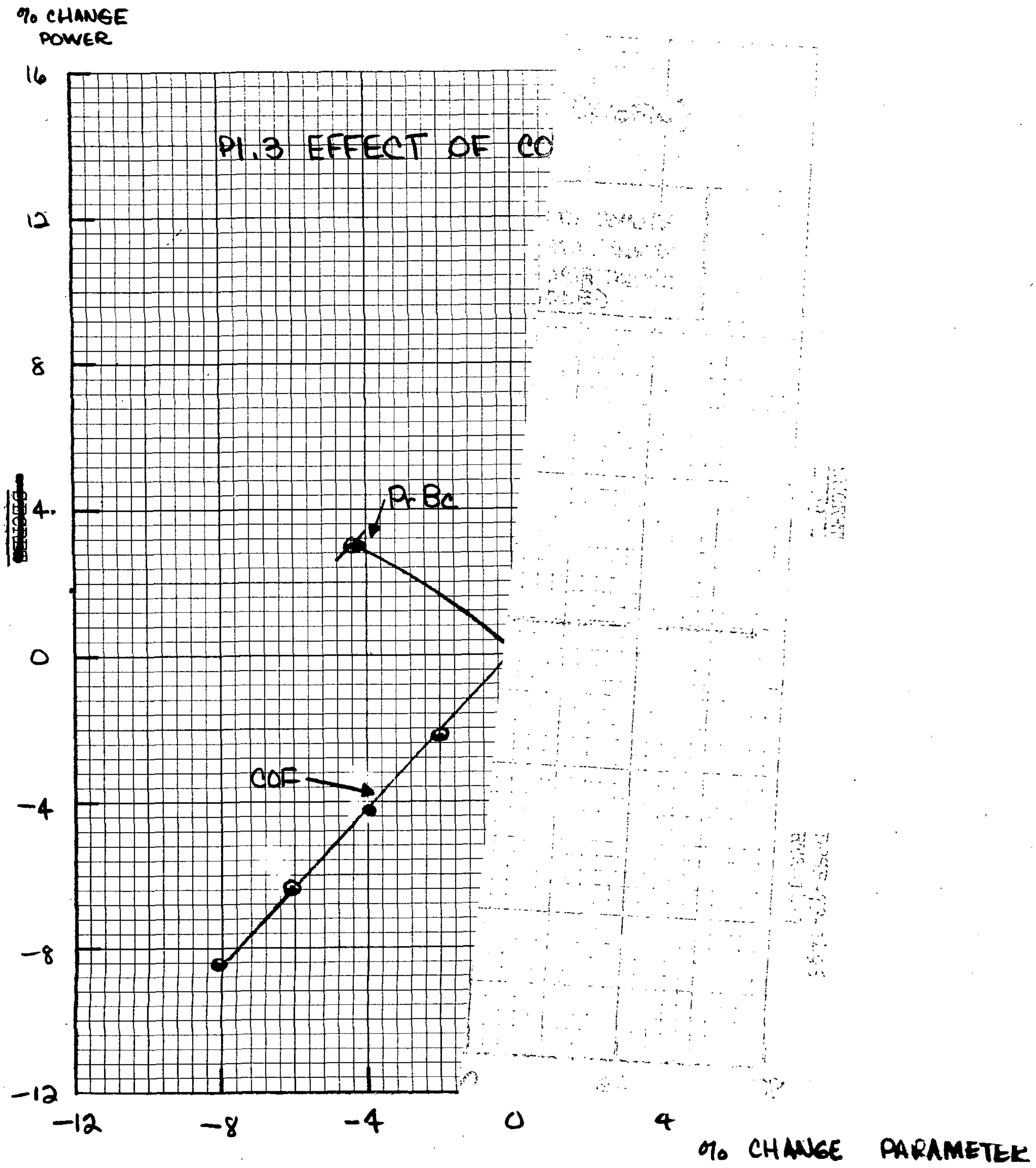

% CHANGE POWER
P1.3 EFFECT OF CO
Pr Bc
COF
16
12
8
4
0
-4
-8
-12
-12
-8
-4
0
4
% CHANGE PARAMETER

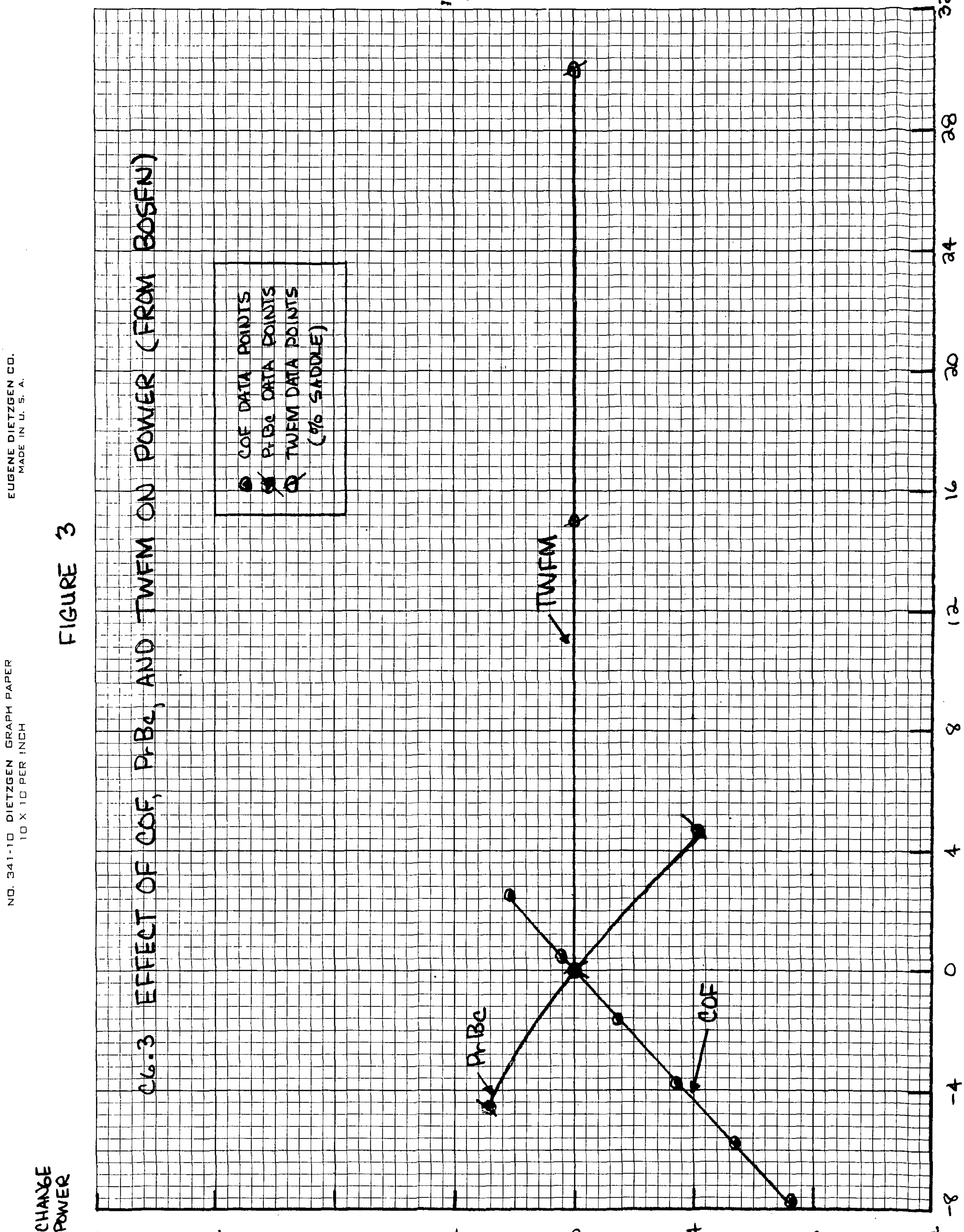
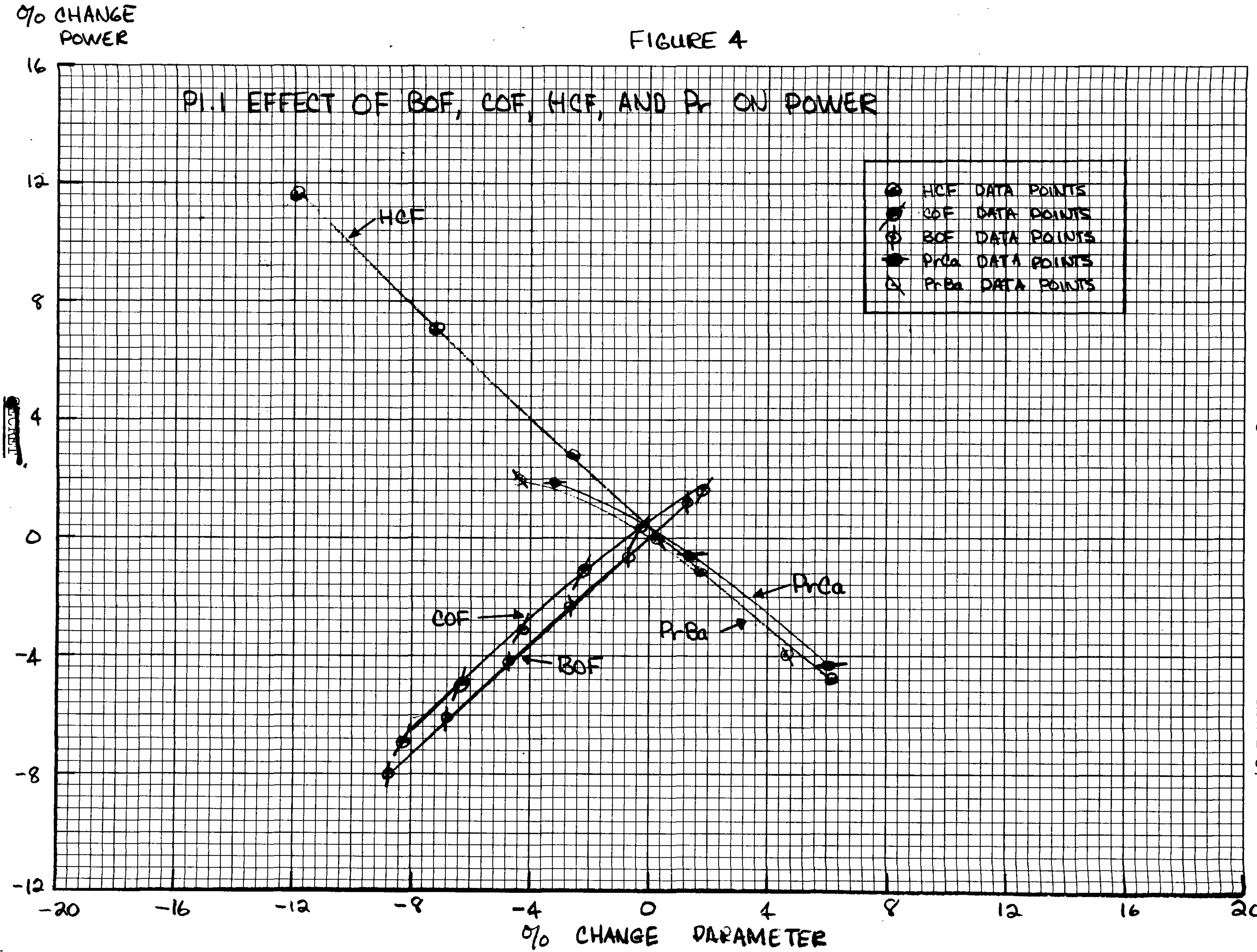


FIGURE 3

C6.3 EFFECT OF COF, P.-Bc, AND TWFM ON POWER (FROM BOSFN)

FIGURE 4



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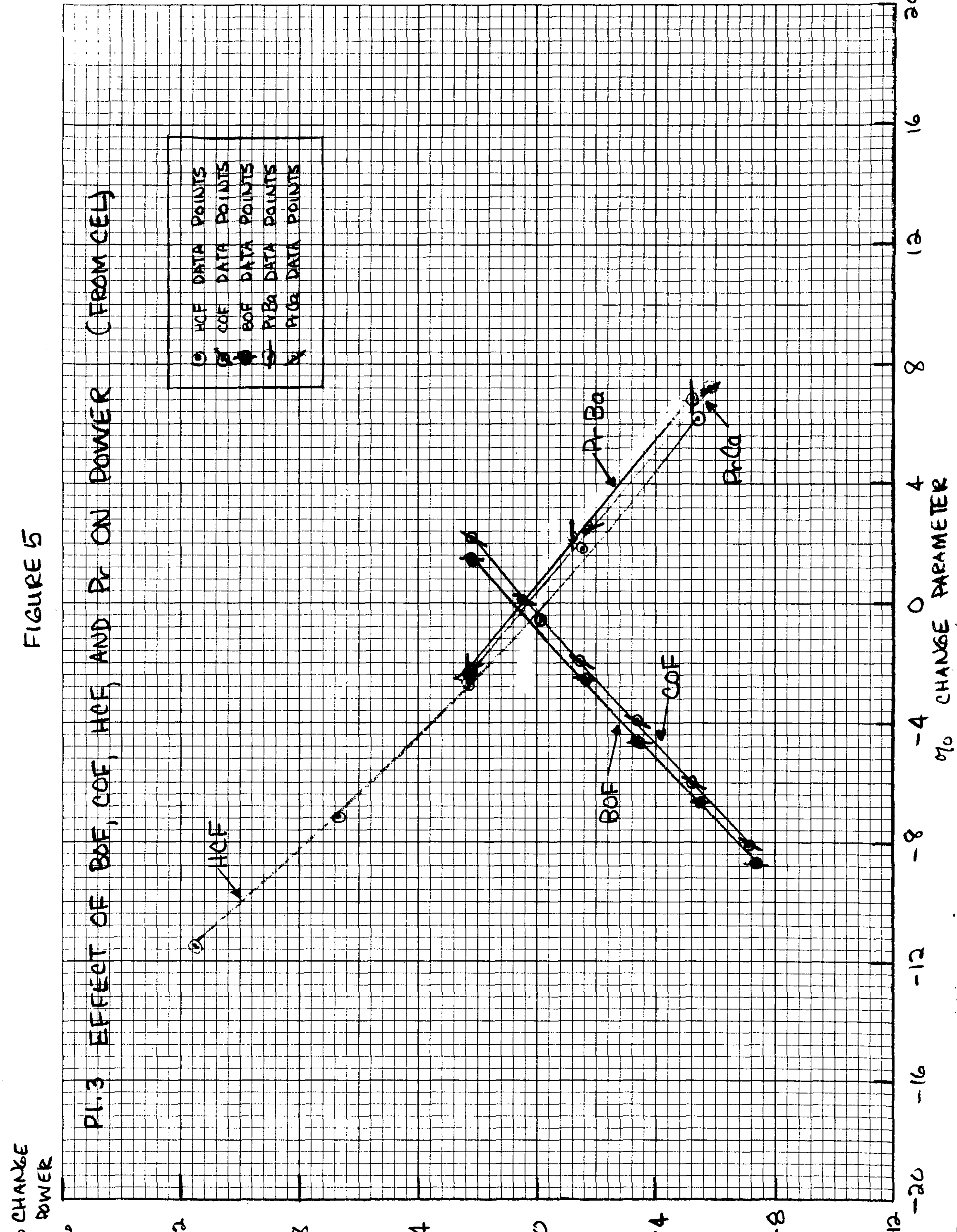
FIGURE 5
P1.3 EFFECT OF BOF, COF, HCF, AND Pr ON POWER (FROM CEL)
HCF DATA POINTS
COF DATA POINTS
BOF DATA POINTS
PrBa DATA POINTS
PrCa DATA POINTS
Pr-Ba
Pr-Ca
HCF
BOF
COF
% CHANGE PARAMETER
% CHANGE POWER
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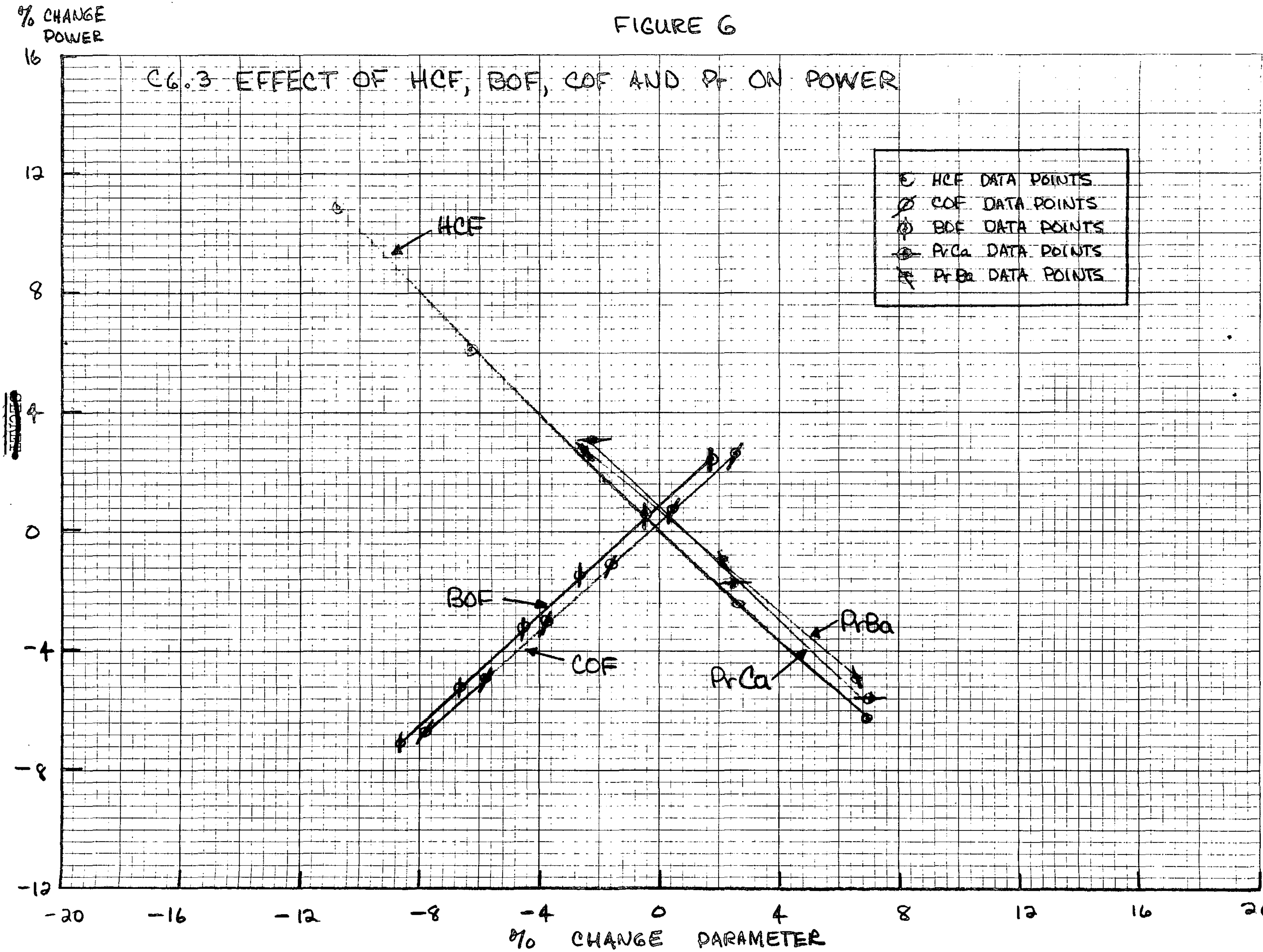
FIGURE 6



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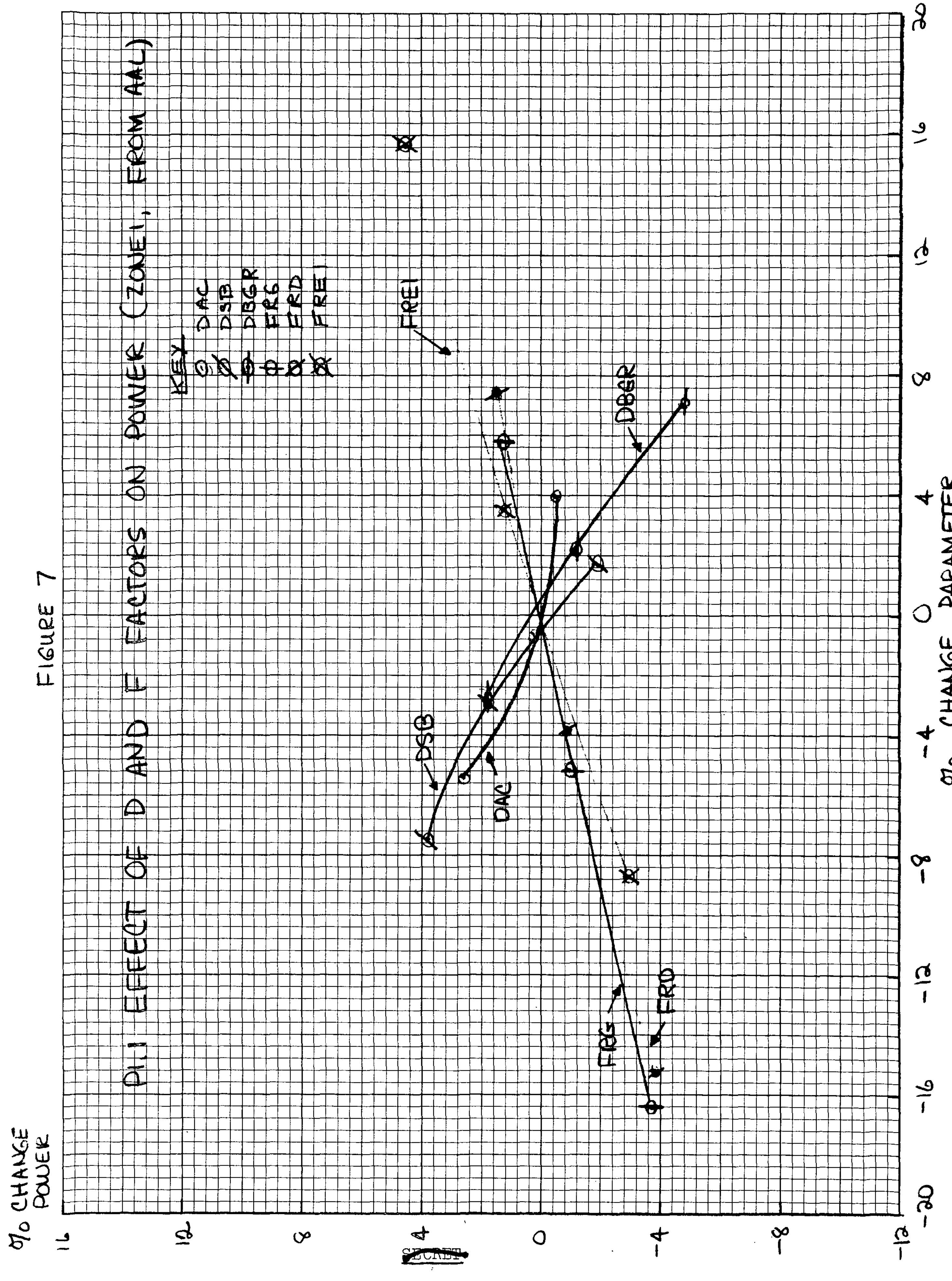
P11 EFFECT OF D AND F FACTORS ON POWER (ZONE1, FROM AAL)
KEY
DAC
DSB
DBGR
FRG
FRD
FRE1
FRE1
DBGR
DSB
DAC
FRG
FRD
% CHANGE POWER
% CHANGE PARAMETER
16
12
8
4
0
-4
-8
-12
-20
-16
-12
-8
-4
0
4
8
12
16
20

FIGURE 7

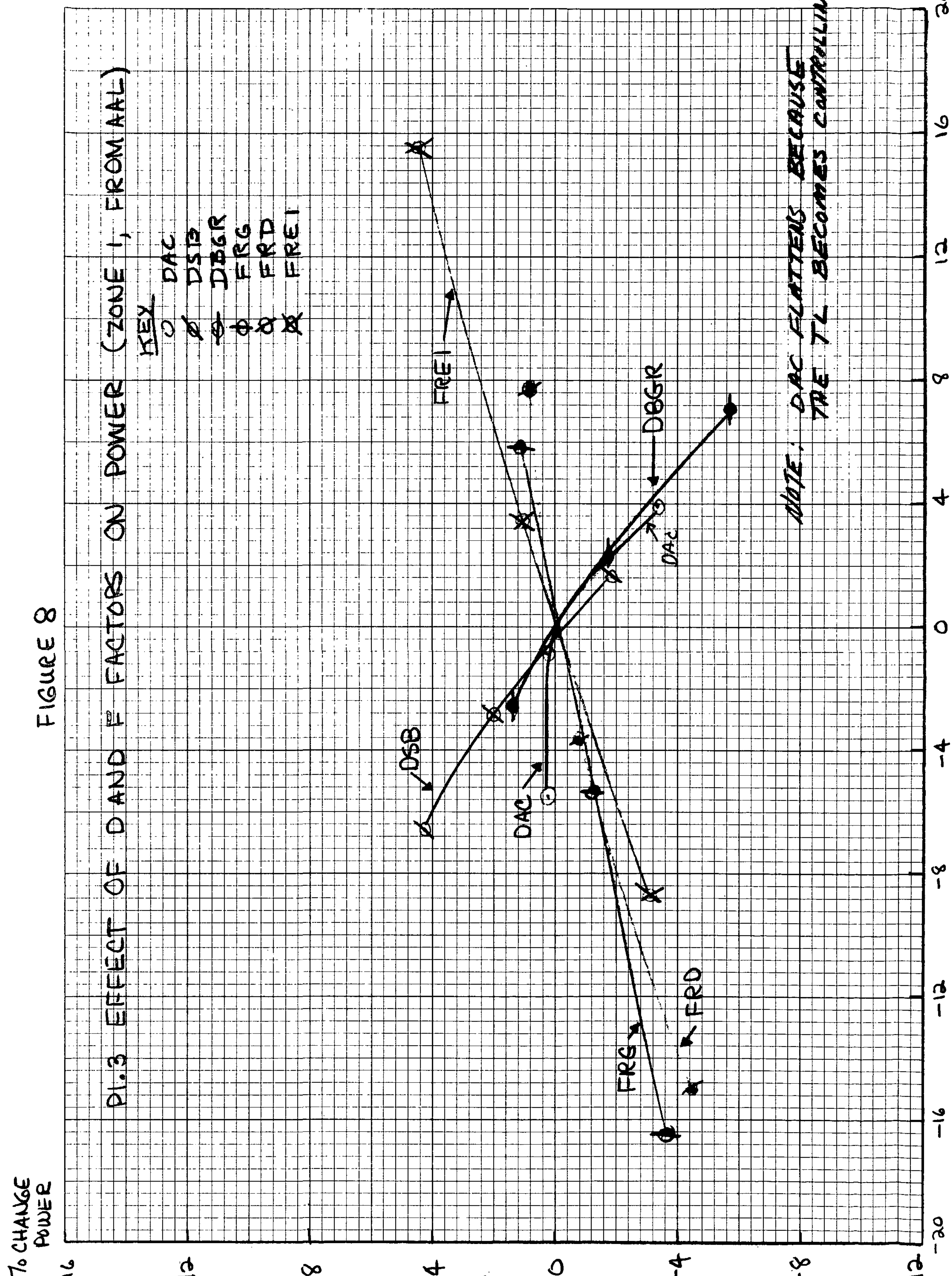
P1.3 EFFECT OF D AND F FACTORS ON POWER (ZONE 1, FROM AAL)
KEY
DAC
DSB
DBGR
FRG
FRD
FRE1
NOTE: DAC FLATTENS BECAUSE THE TL BECOMES CONTROLLING
FRE1
DBGR
DAC
DSB
DAC
FRG
FRD
% CHANGE PARAMETER
% CHANGE POWER
20
16
12
8
4
0
-4
-8
-12
-16
-20
16
12
8
4
0
-4
-8
-12

FIGURE 8

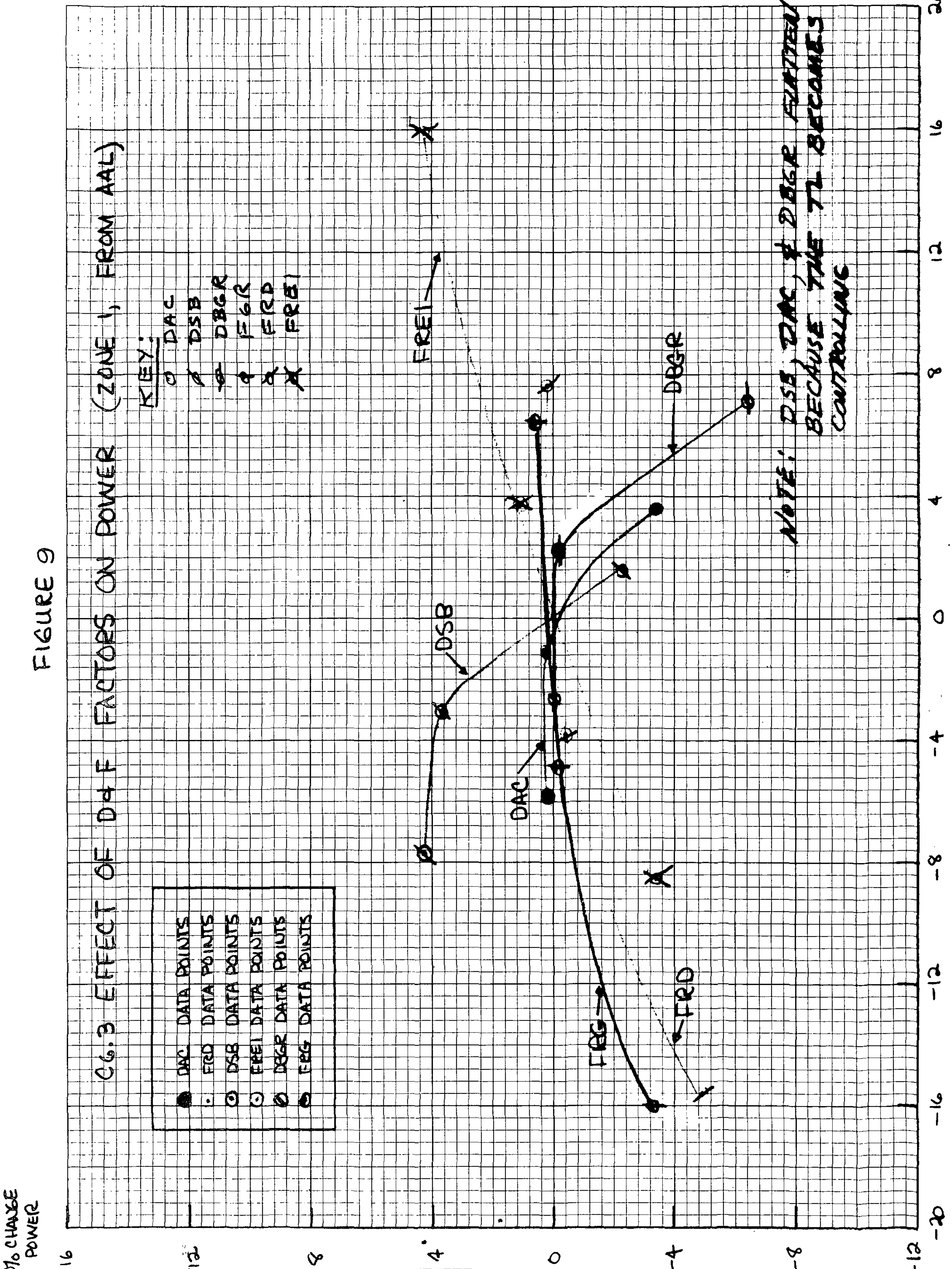

FIGURE 9

C6.3 EFFECT OF D&F FACTORS ON POWER (ZONE 1, FROM AAL)

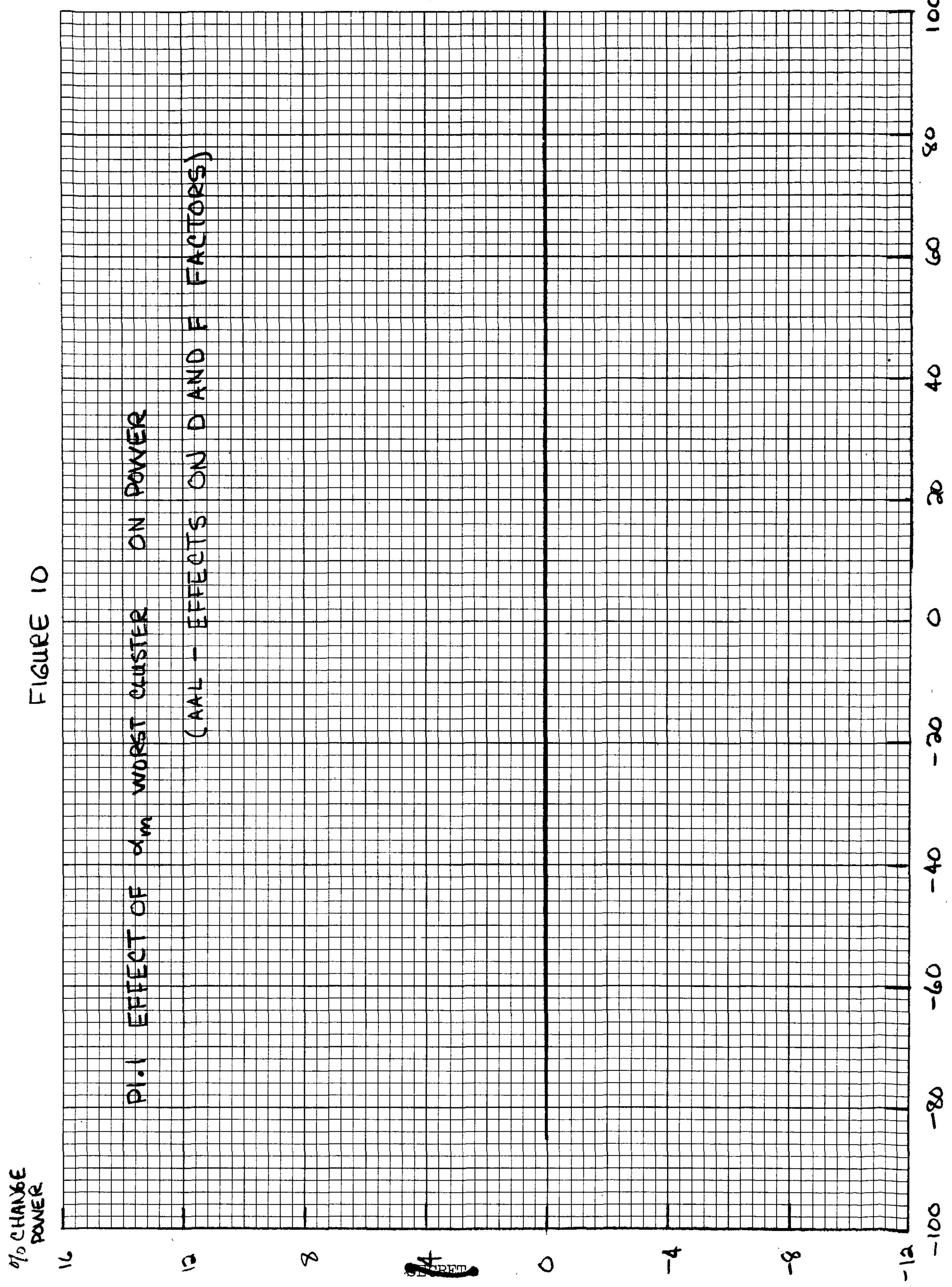
FIGURE 10
P1.1 EFFECT OF α_m WORST CLUSTER ON POWER
(AAL - EFFECTS ON D AND F FACTORS)
% CHANGE POWER
16
12
8
4
0
-4
-8
-12
100
80
60
40
20
0
-20
-40
-60
-80
-100

FIGURE 11

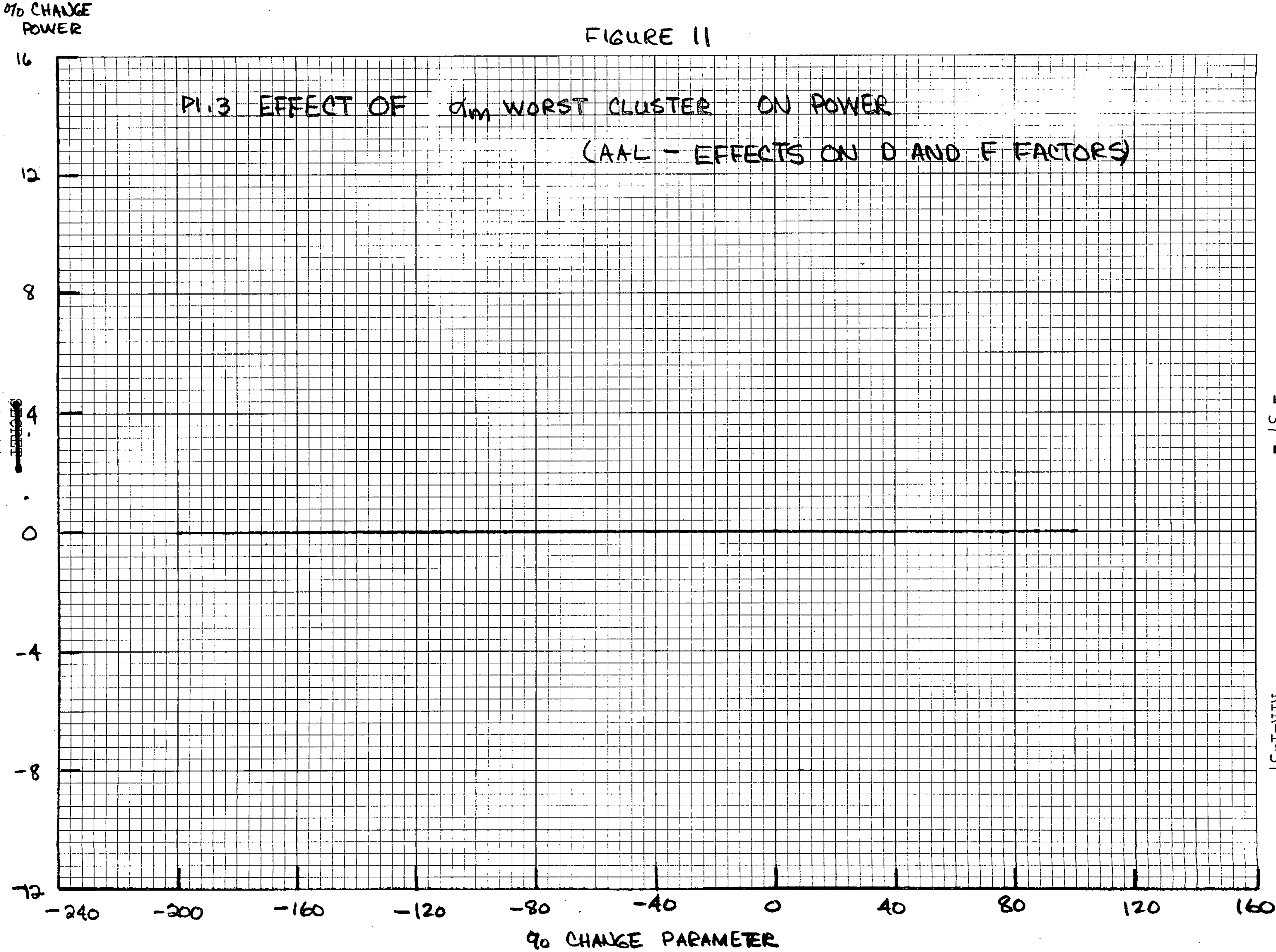
P1.3 EFFECT OF α_m WORST CLUSTER ON POWER
(AAL - EFFECTS ON D AND F FACTORS)
% CHANGE POWER
16
12
8
4
0
-4
-8
-12
-240
-200
-160
-120
-80
-40
0
40
80
120
160
% CHANGE PARAMETER

FIGURE 12

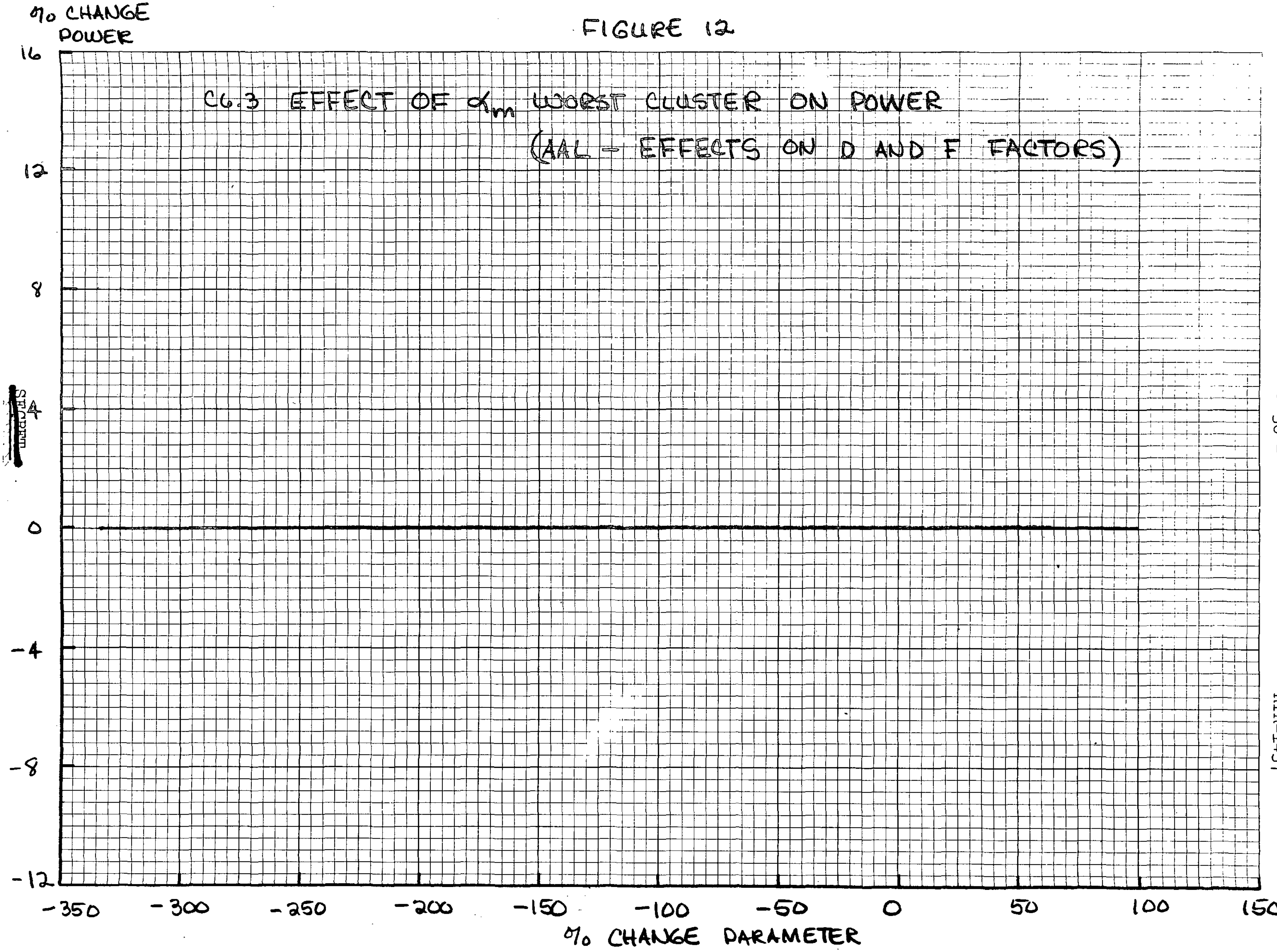

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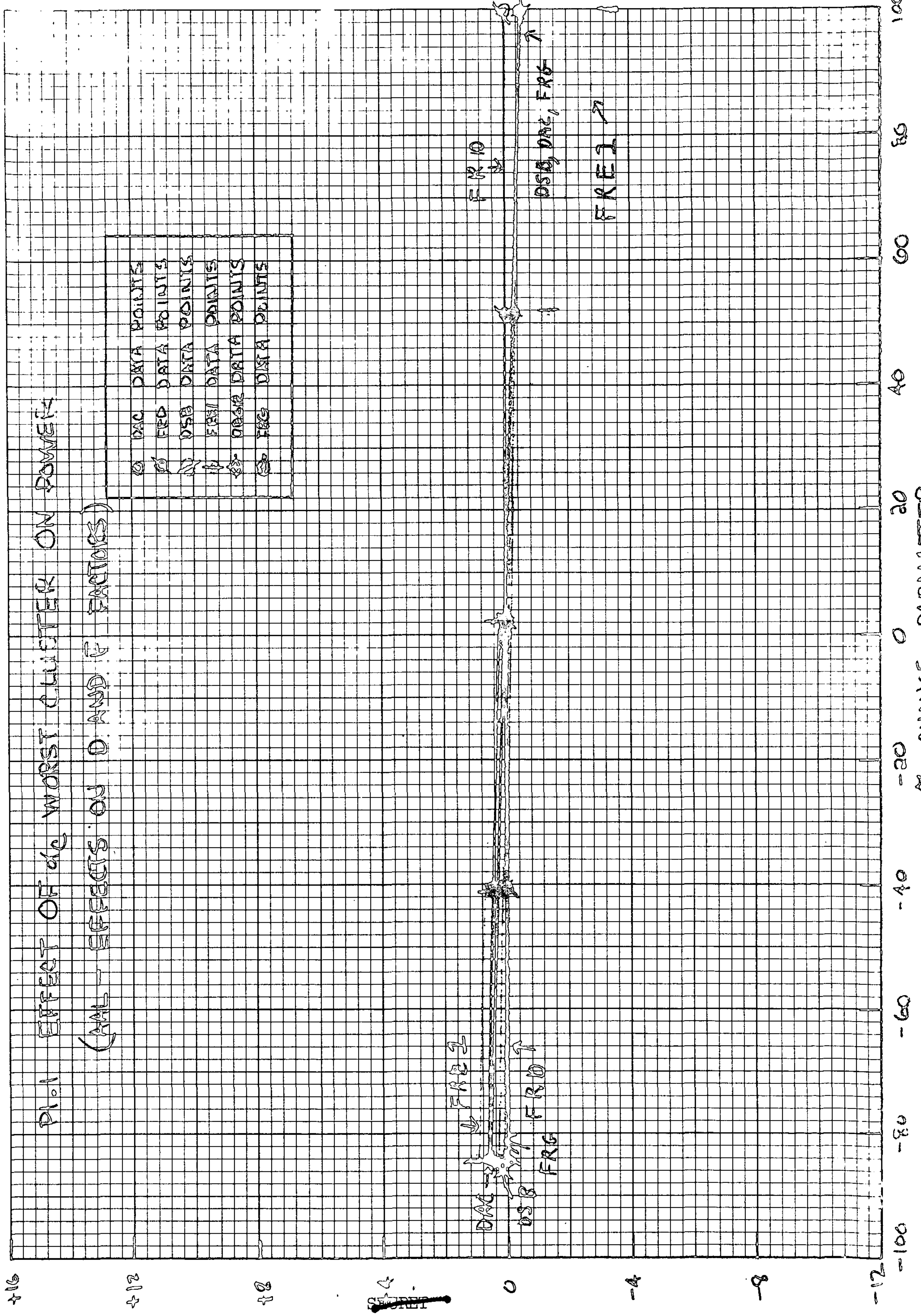
FIGURE 13



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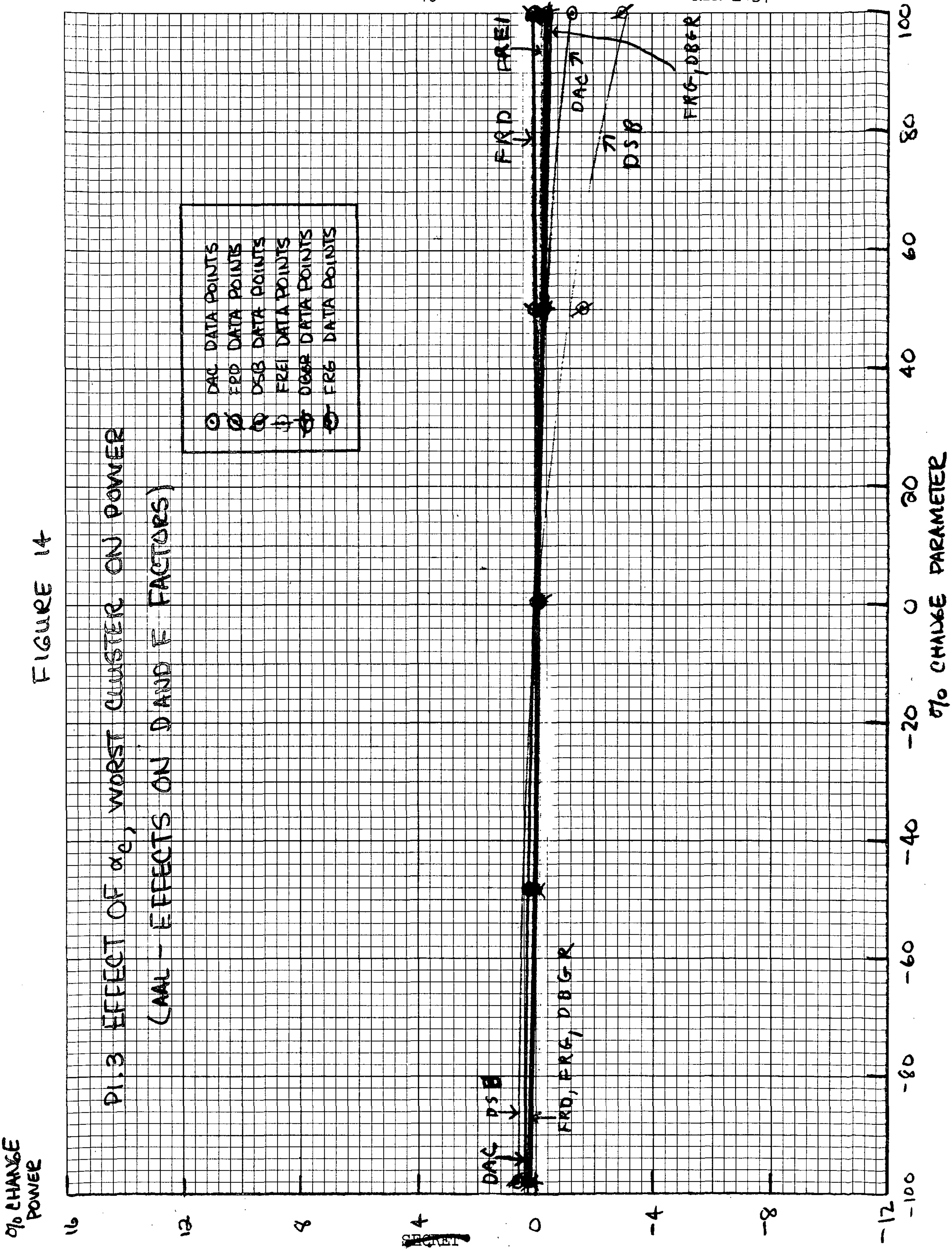

FIGURE 14

PI.3 EFFECT OF α_c, WORST CLUSTER ON POWER

(ALL - EFFECTS ON D AND F FACTORS)

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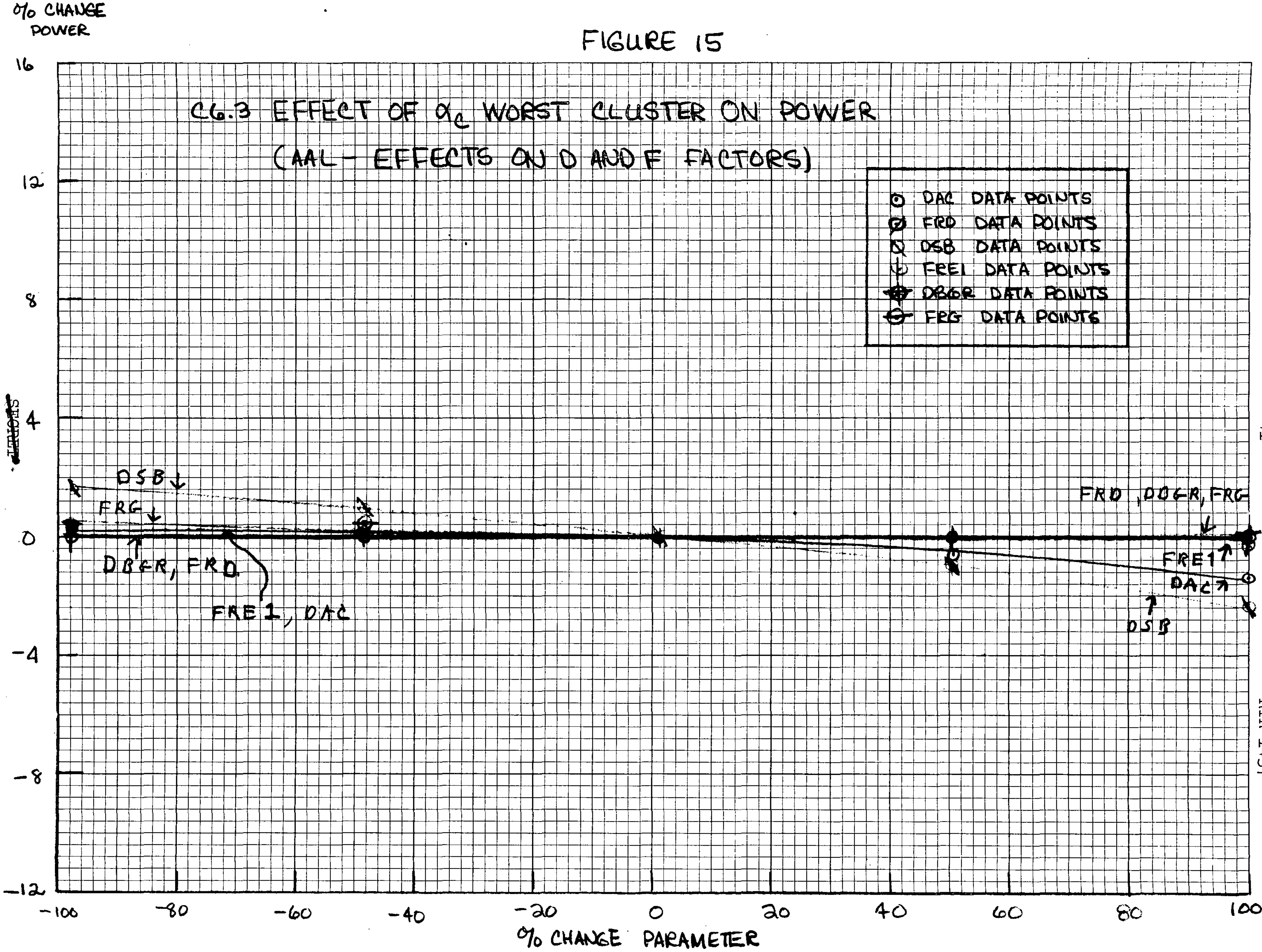

FIGURE 15

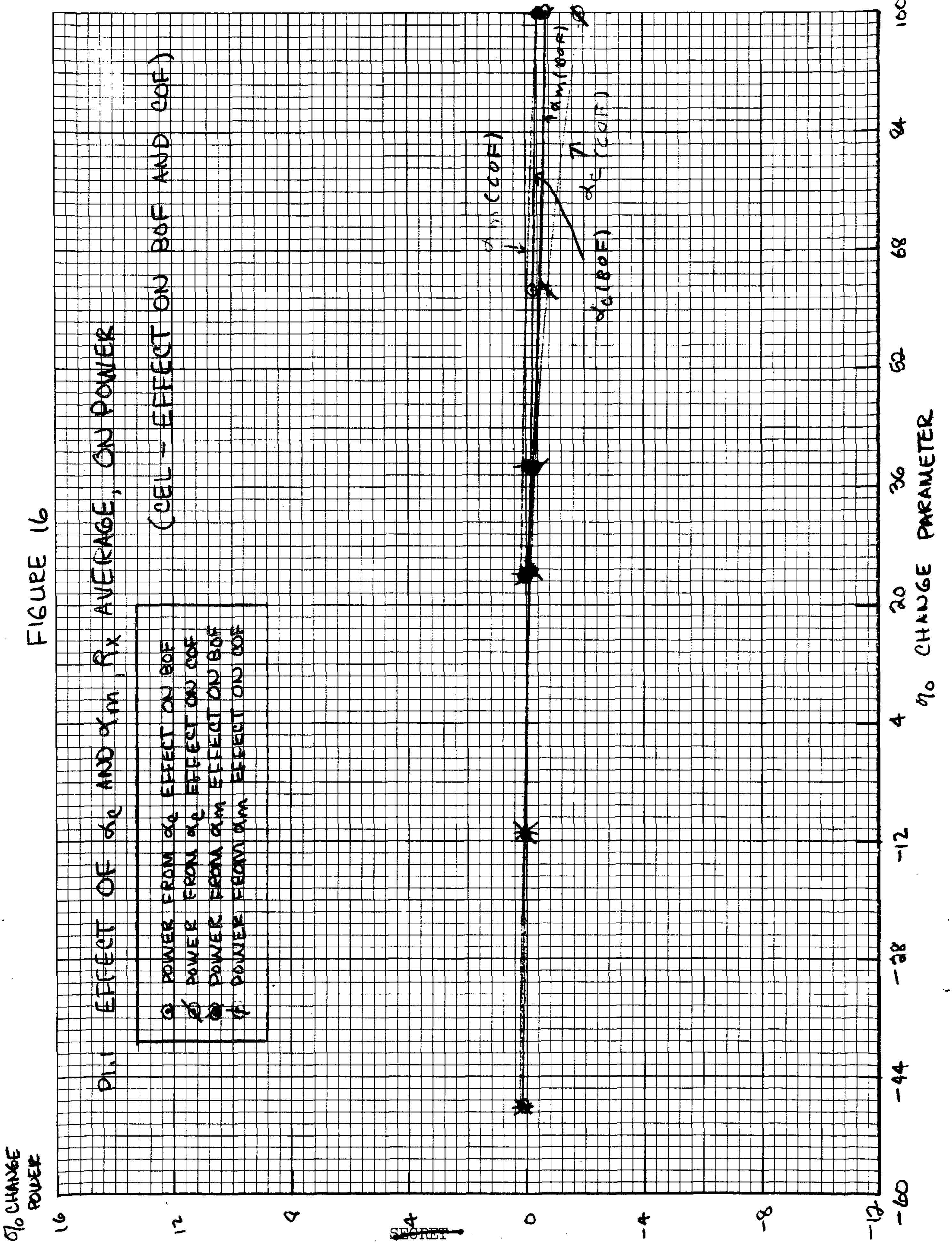
FIGURE 16
Pl.I EFFECT OF αc AND αm Rx AVERAGE, ON POWER
(CEL - EFFECT ON BOF AND COF)
POWER FROM αc EFFECT ON BOF
POWER FROM αc EFFECT ON COF
POWER FROM αm EFFECT ON BOF
POWER FROM αm EFFECT ON COF
αm (COF)
αm (BOF)
αc (BOF)
αc (COF)
% CHANGE PARAMETER
% CHANGE POWER
-60
-44
-28
-12
4
20
36
52
68
84
100
16
12
8
4
0
-4
-8
-12

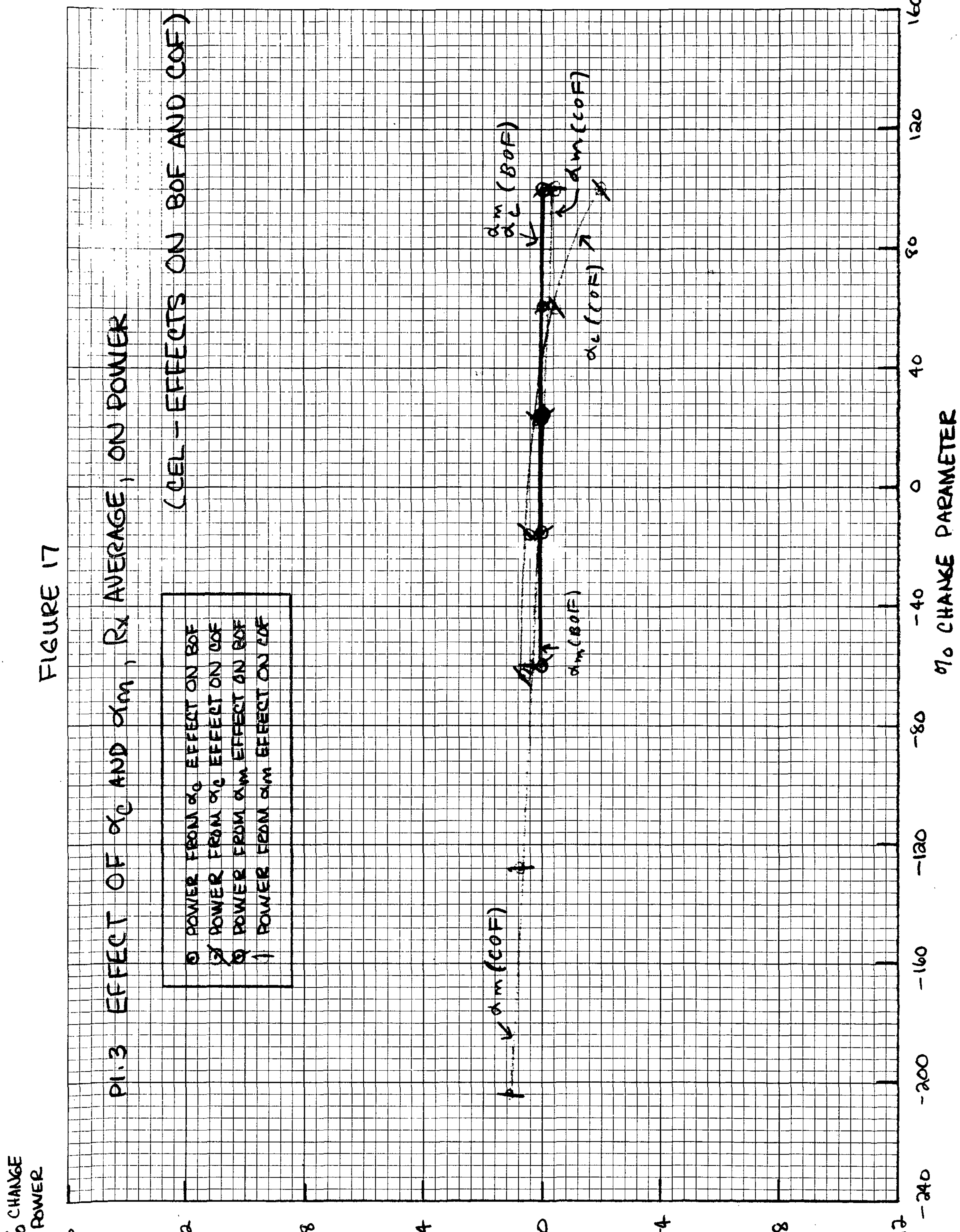
FIGURE 17
P1.3 EFFECT OF αc AND αm, Rx AVERAGE, ON POWER
(CEL - EFFECTS ON BOF AND COF)
POWER FROM αc EFFECT ON BOF
POWER FROM αc EFFECT ON COF
POWER FROM αm EFFECT ON BOF
POWER FROM αm EFFECT ON COF
αm (BOF)
αc
αm (COF)
αc (COF)
αm (BOF)
αm (COF)
% CHANGE POWER
16
12
8
4
0
-4
-8
-12
% CHANGE PARAMETER
-240
-200
-160
-120
-80
-40
0
40
80
120
160

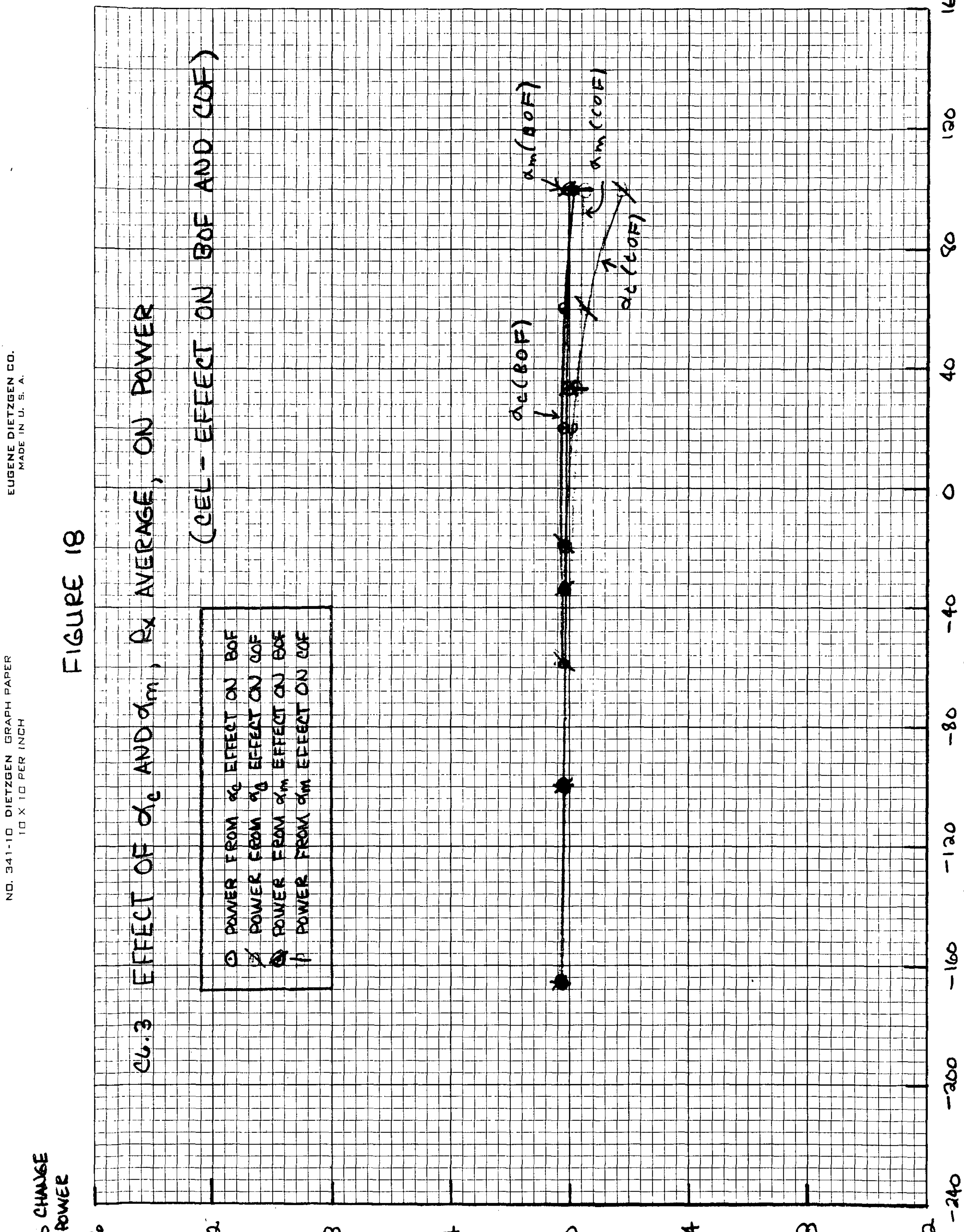
FIGURE 18
CL.3 EFFECT OF α_c AND α_m, ℓ_x AVERAGE, ON POWER
(CEL - EFFECT ON BOF AND COF)
POWER FROM α_c EFFECT ON BOF
POWER FROM α_c EFFECT ON COF
POWER FROM α_m EFFECT ON BOF
POWER FROM α_m EFFECT ON COF
α_m(BOF)
α_m(COF)
α_c(COF)
α_c(BOF)
% CHANGE PARAMETER
% CHANGE POWER
16
12
8
4
0
-4
-8
-12
-240
-200
-160
-120
-80
-40
0
40
80
120
160
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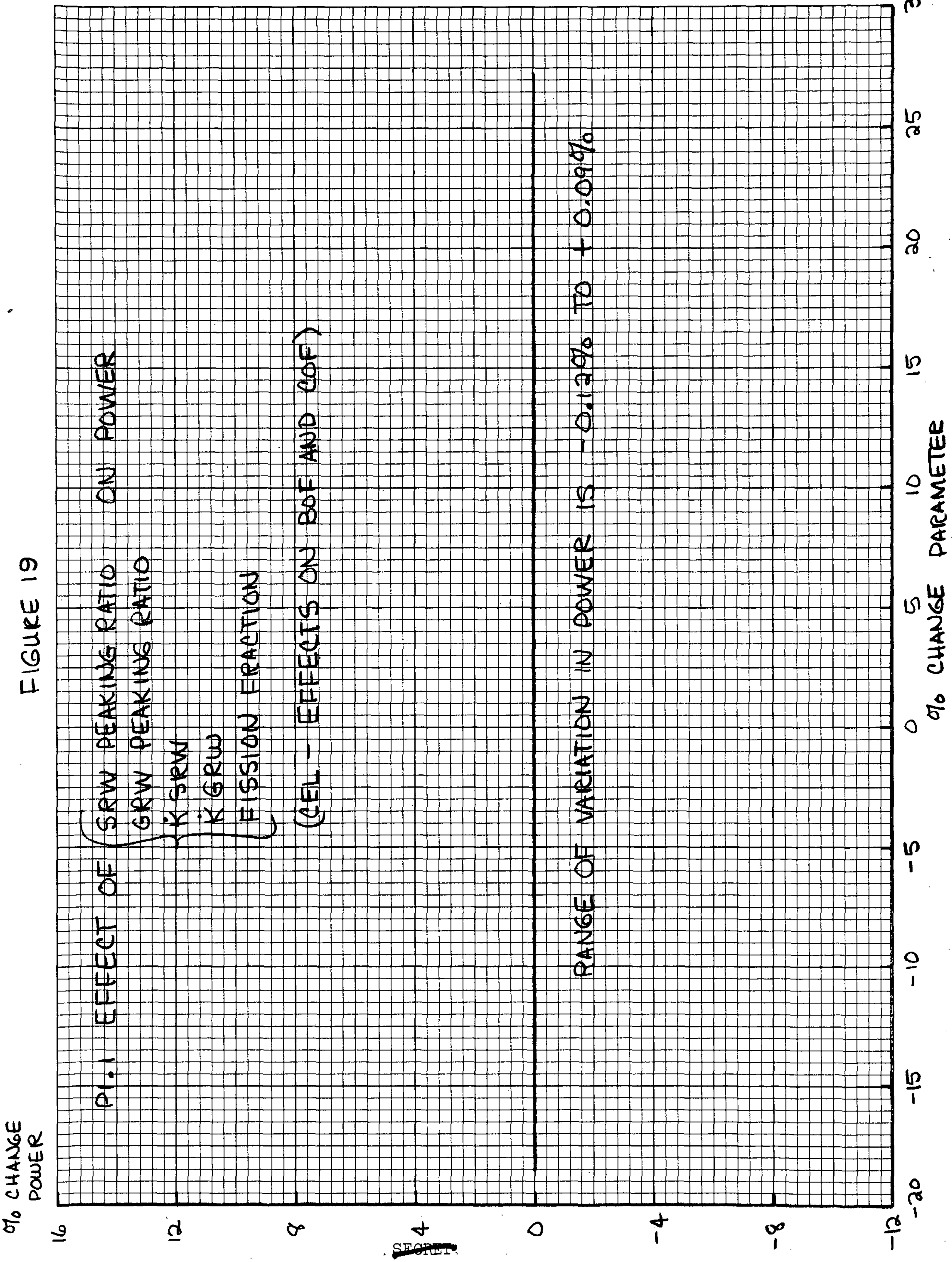
FIGURE 19
P1.1 EFFECT OF
SRW PEAKING RATIO
GRW PEAKING RATIO
K SRW
K GRW
FISSION FRACTION
ON POWER
(CEL - EFFECTS ON BOE AND COF)
RANGE OF VARIATION IN POWER IS -0.12% TO +0.09%
% CHANGE POWER
16
12
8
4
0
-4
-8
-12
% CHANGE PARAMETER
-20
-15
-10
-5
0
5
10
15
20
25
30

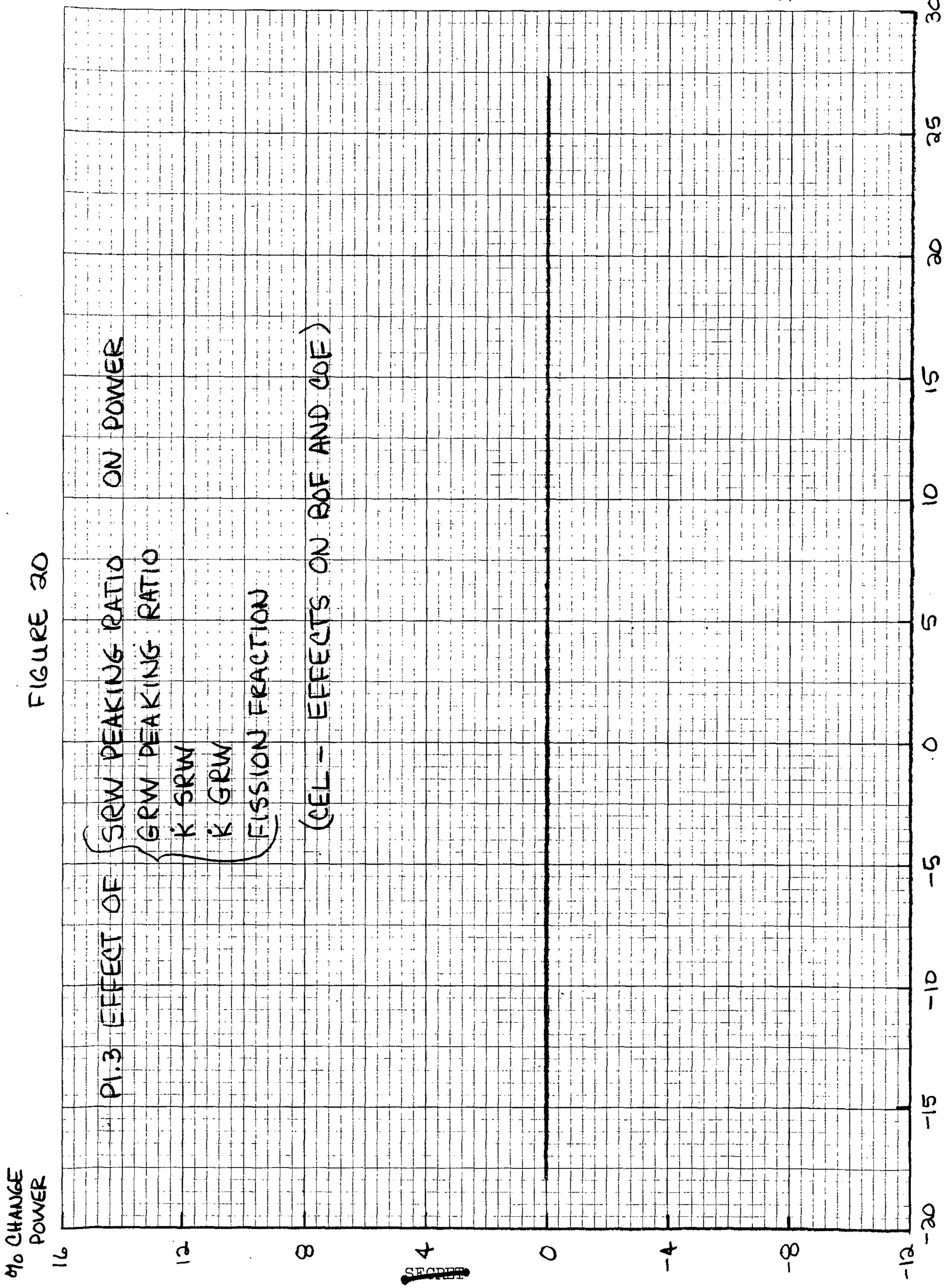
P1.3 EFFECT OF
SRW PEAKING RATIO
GRW PEAKING RATIO
k SRW
k GRW
FISSION FRACTION
ON POWER
(CEL - EFFECTS ON BOF AND COF)
% CHANGE POWER
16
12
8
4
0
-4
-8
-12
% CHANGE PARAMETER
-20
-15
-10
-5
0
5
10
15
20
25
30

FIGURE 20

FIGURE 21

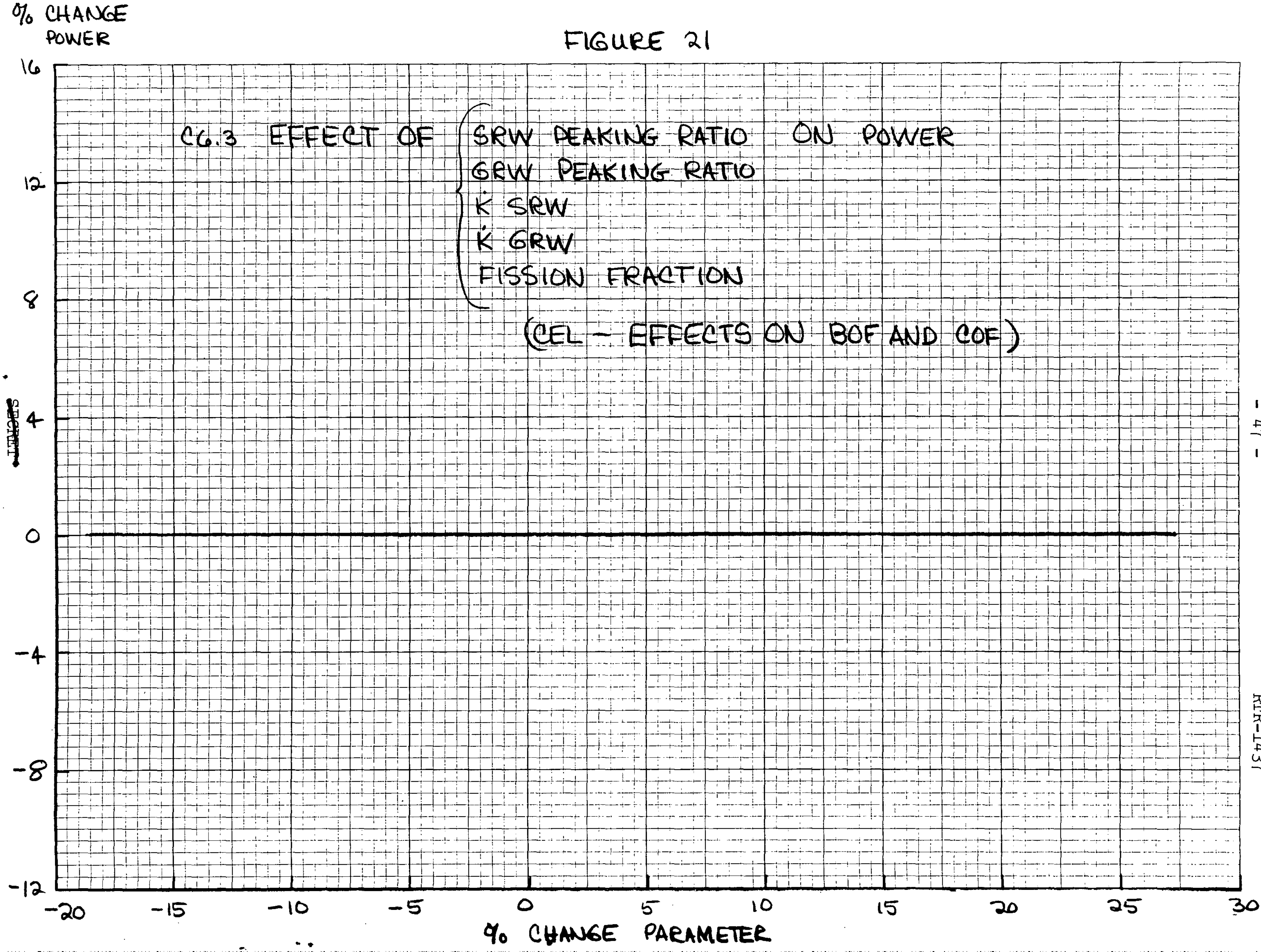

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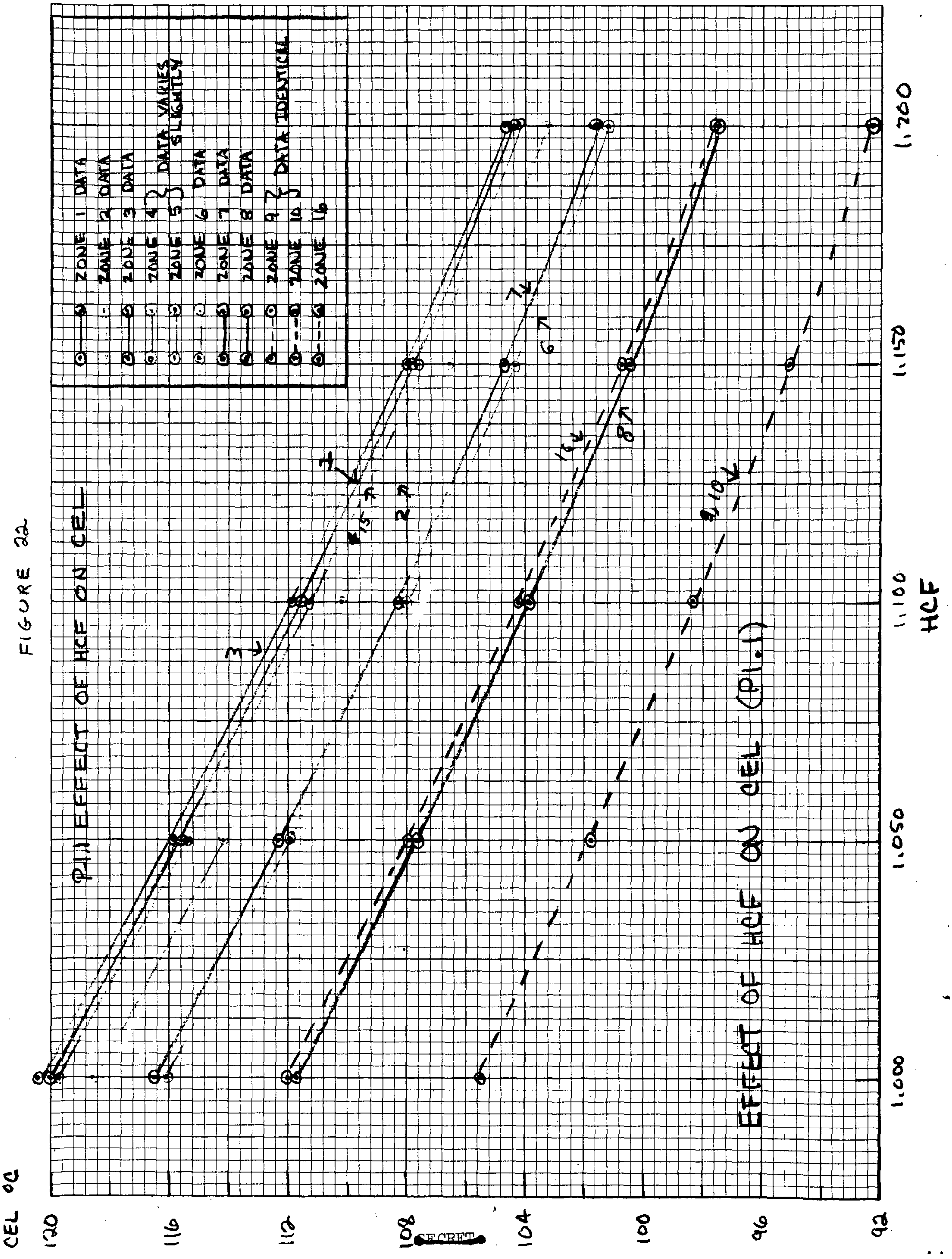
FIGURE 22


P11 EFFECT OF HCF ON CEL
ZONE 1 DATA
ZONE 2 DATA
ZONE 3 DATA
ZONE 4
ZONE 5
DATA VARIES SLIGHTLY
ZONE 6 DATA
ZONE 7 DATA
ZONE 8 DATA
ZONE 9
ZONE 10
DATA IDENTICAL
ZONE 16
EFFECT OF HCF ON CEL (P1.1)
CEL °C
120
116
112
108
104
100
96
92
1.000
1.050
1.100
1.150
1.200
HCF

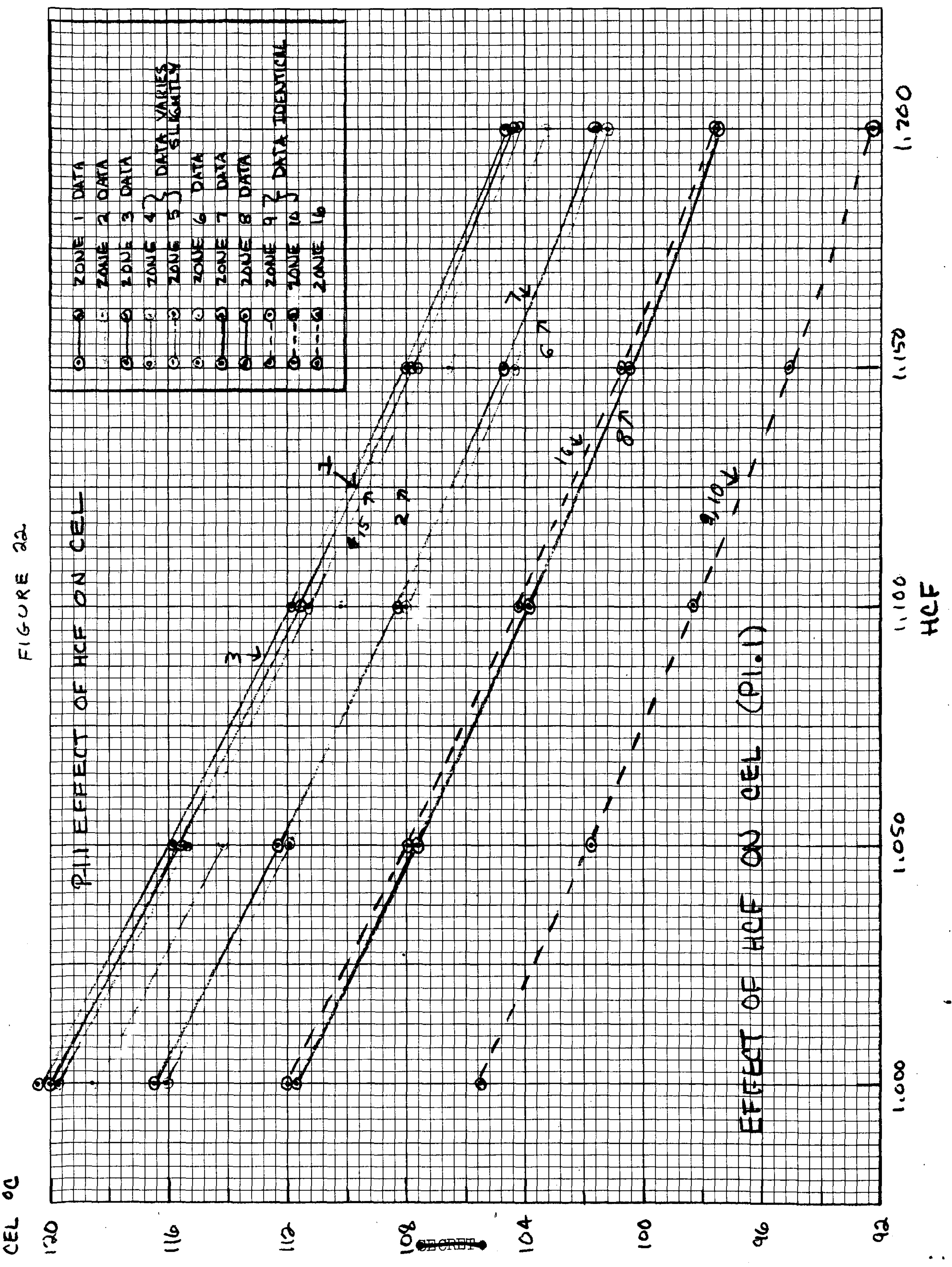


FIGURE 22
PI.I EFFECT OF HCF ON CEL
ZONE 1 DATA
ZONE 2 DATA
ZONE 3 DATA
ZONE 4 } DATA VARIES SLIGHTLY
ZONE 5 }
ZONE 6 DATA
ZONE 7 DATA
ZONE 8 DATA
ZONE 9 } DATA IDENTICAL
ZONE 10 }
ZONE 16
EFFECT OF HCF ON CEL (PI.I)
CEL °C
120
116
112
108
104
100
96
92
HCF
1.000
1.050
1.100
1.150
1.200

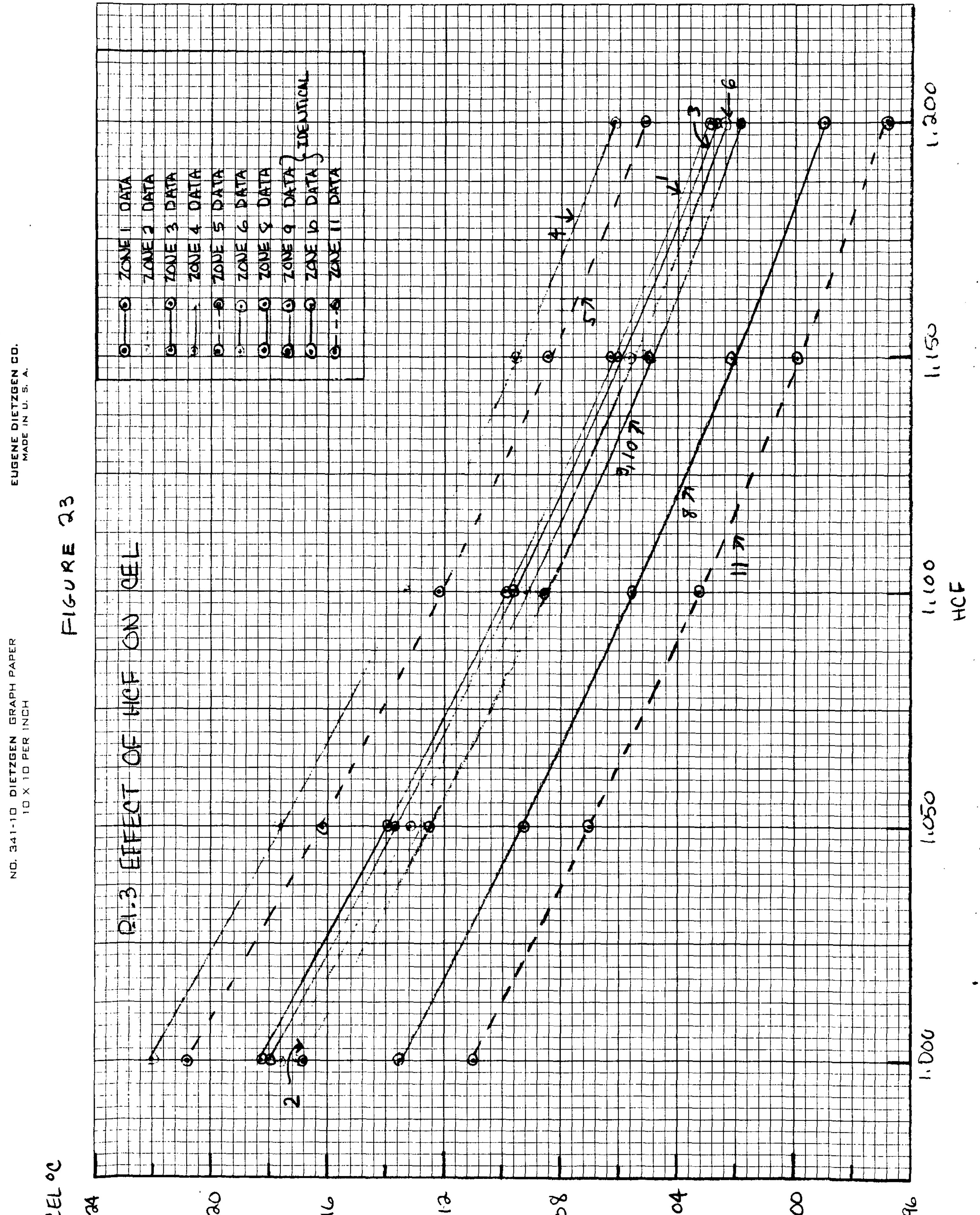


FIGURE 23
Q1.3 EFFECT OF HCF ON CEL
ZONE 1 DATA
ZONE 2 DATA
ZONE 3 DATA
ZONE 4 DATA
ZONE 5 DATA
ZONE 6 DATA
ZONE 8 DATA
ZONE 9 DATA
ZONE 10 DATA
ZONE 11 DATA
IDENTICAL
CEL °C
124
120
116
112
108
104
100
96
HCF
1.000
1.050
1.100
1.150
1.200
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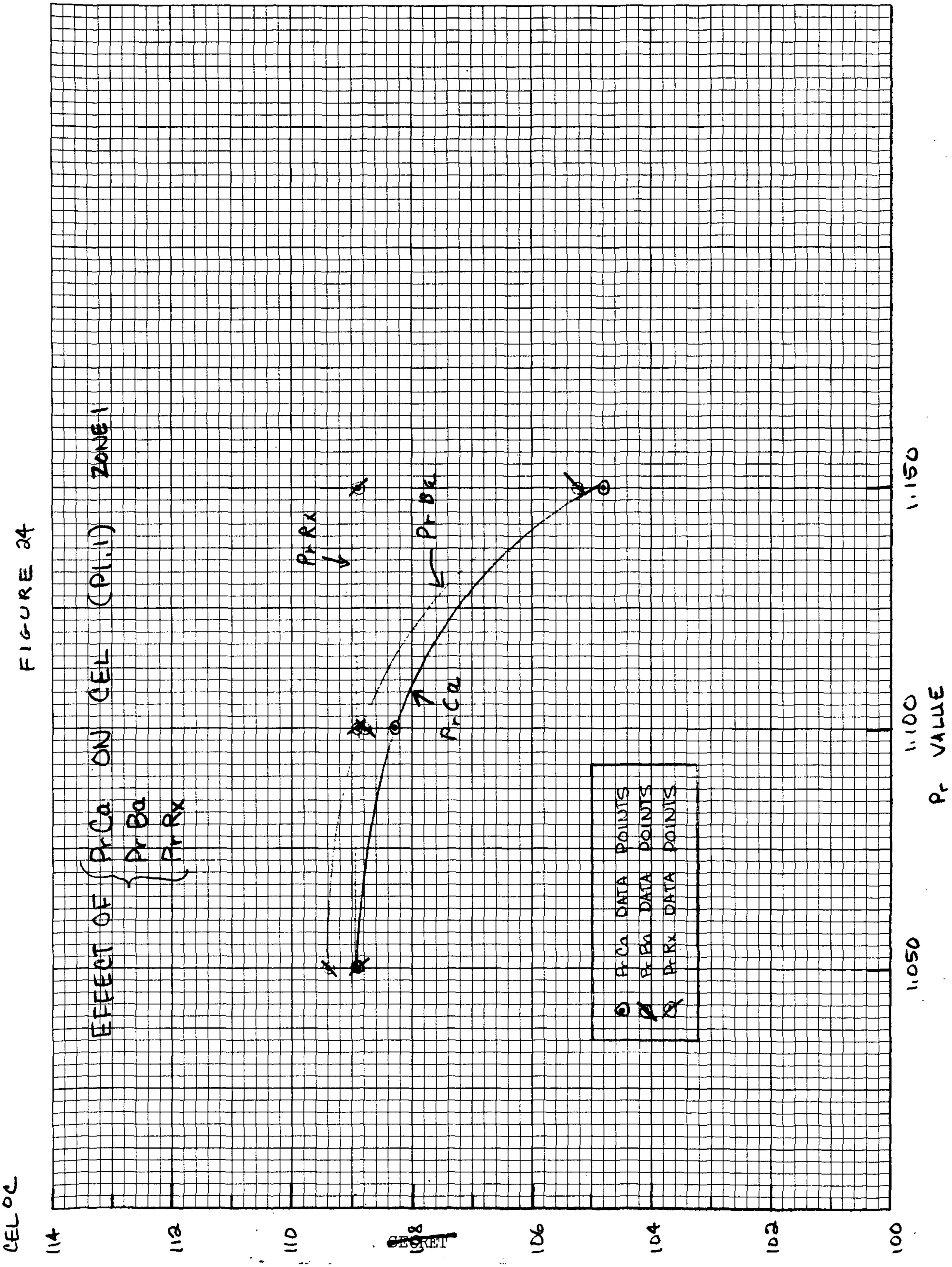
FIGURE 24
EFFECT OF Pr Ca / Pr Ba / Pr Rx ON CEL (P1,1) ZONE 1
Pr Rx
Pr Ba
Pr Ca
Pr Ca DATA POINTS
Pr Ba DATA POINTS
Pr Rx DATA POINTS
CEL °C
114
112
110
108
106
104
102
100
1.050
1.100
1.150
Pr VALUE

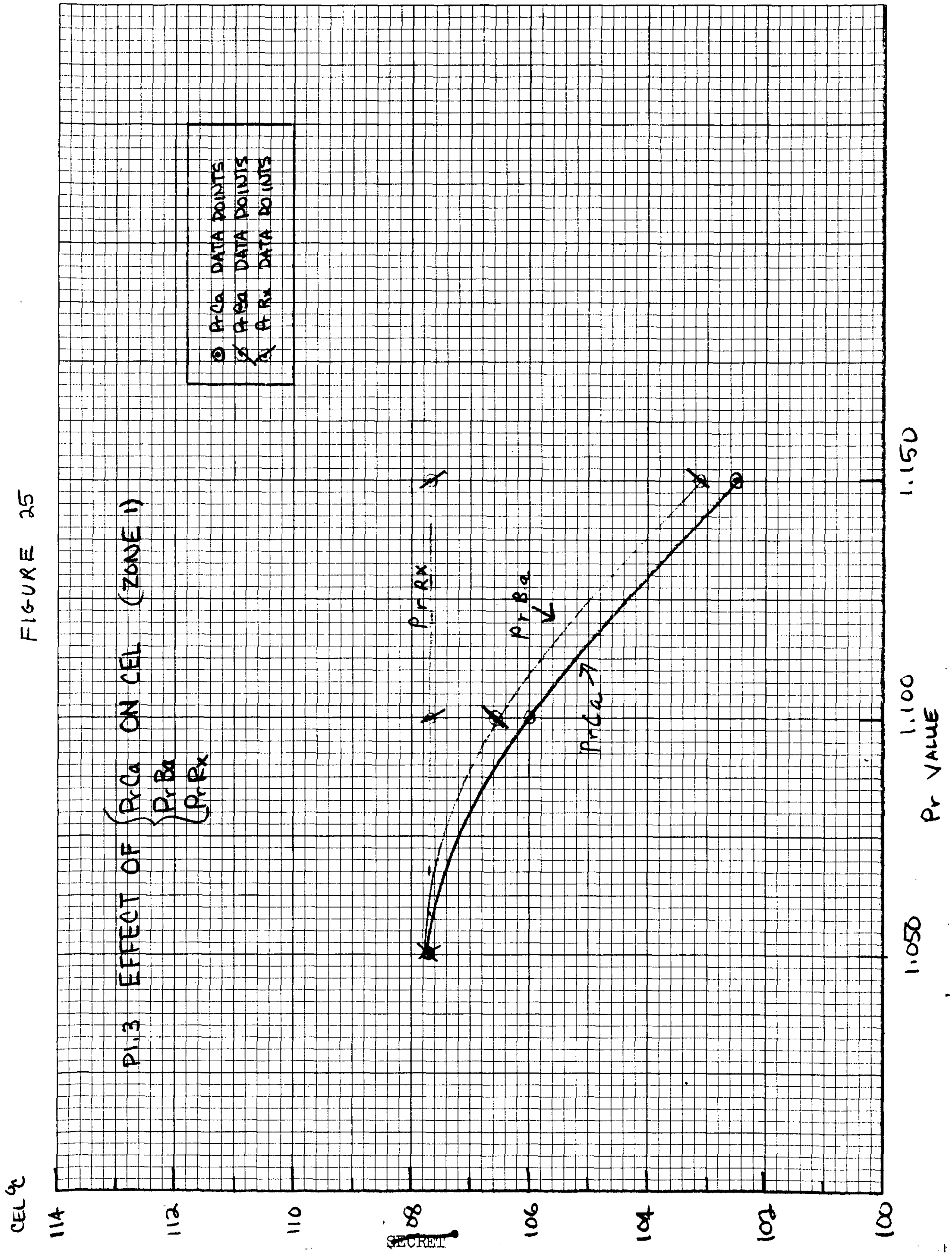
FIGURE 25
P1.3 EFFECT OF {PrCa, PrBa, PrRx} ON CEL (ZONE 1)
⊙ PrCa DATA POINTS
PrBa DATA POINTS
PrRx DATA POINTS
PrRx
PrBa
PrCa
1.050
1.100
1.150
Pr VALUE
CEL °C
114
112
110
108
106
104
102
100

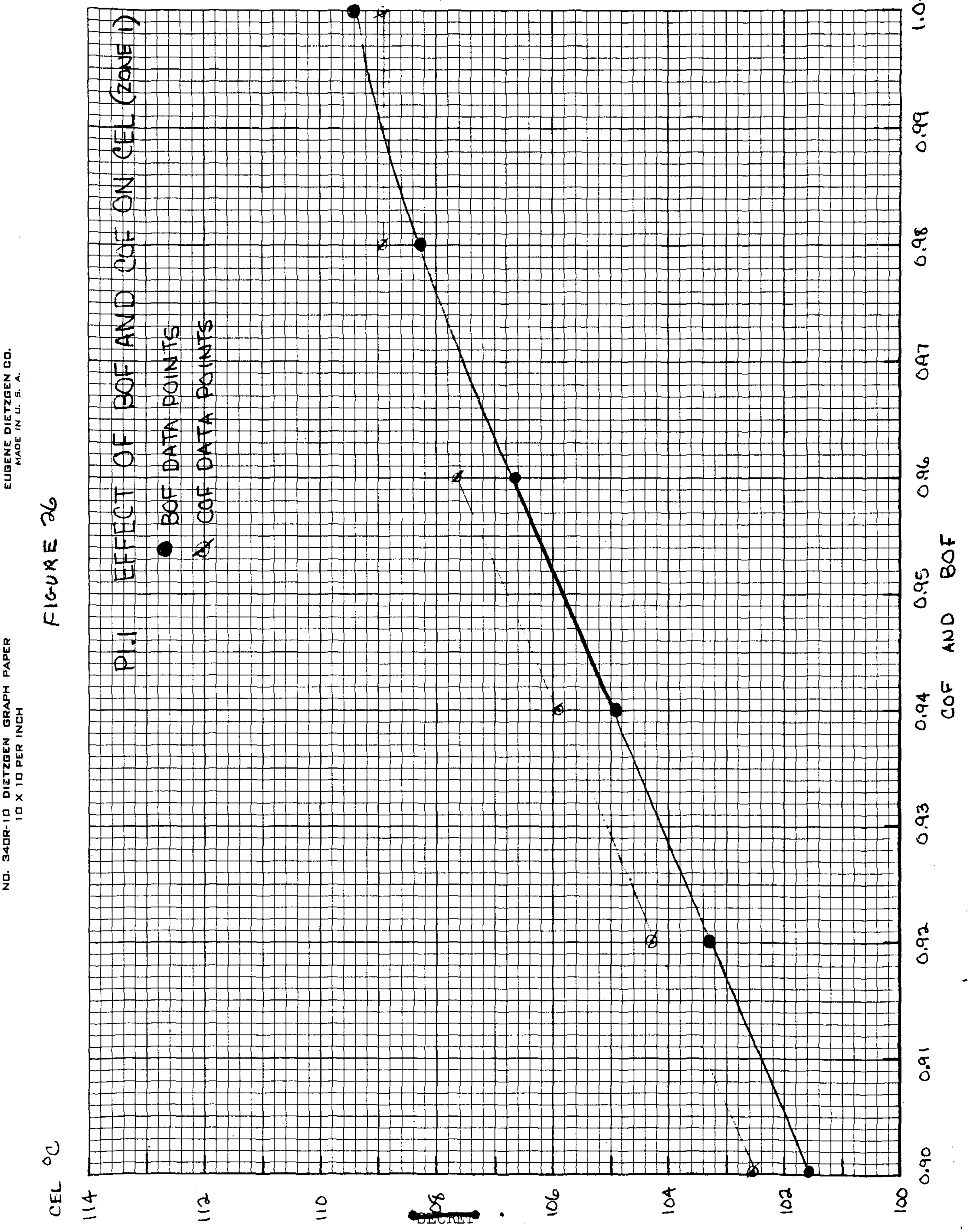
FIGURE 26
P.I. EFFECT OF BOF AND COF ON CEL (ZONE I)
BOF DATA POINTS
COF DATA POINTS
CEL °C
114
112
110
108
106
104
102
100
0.90
0.91
0.92
0.93
0.94
0.95
0.96
0.97
0.98
0.99
1.00
COF AND BOF
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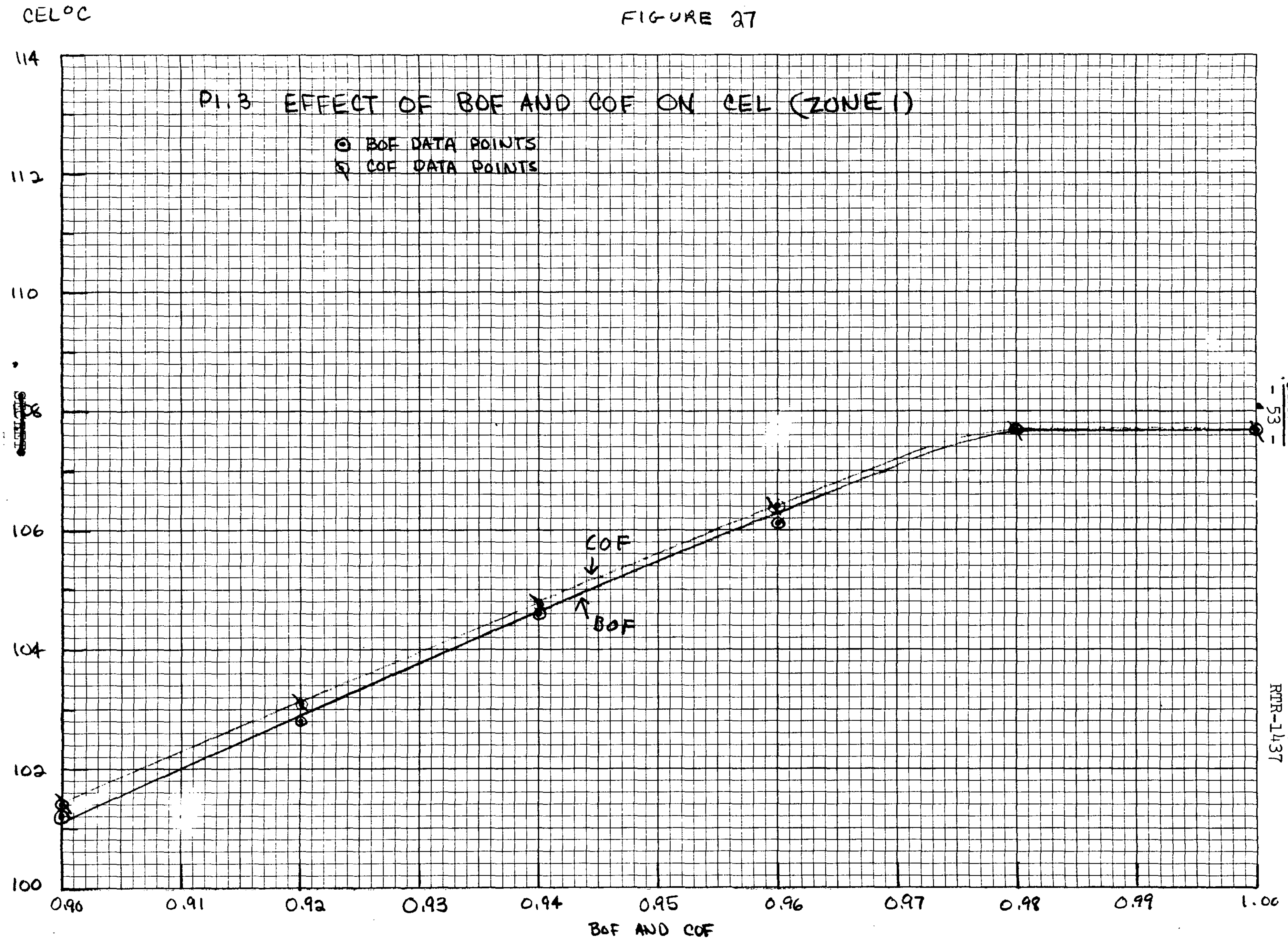
FIGURE 27


CEL°C
P1.3 EFFECT OF BOF AND COF ON CEL (ZONE I)
BOF DATA POINTS
COF DATA POINTS
COF
BOF
114
112
110
106
104
102
100
0.90
0.91
0.92
0.93
0.94
0.95
0.96
0.97
0.98
0.99
1.00
BOF AND COF

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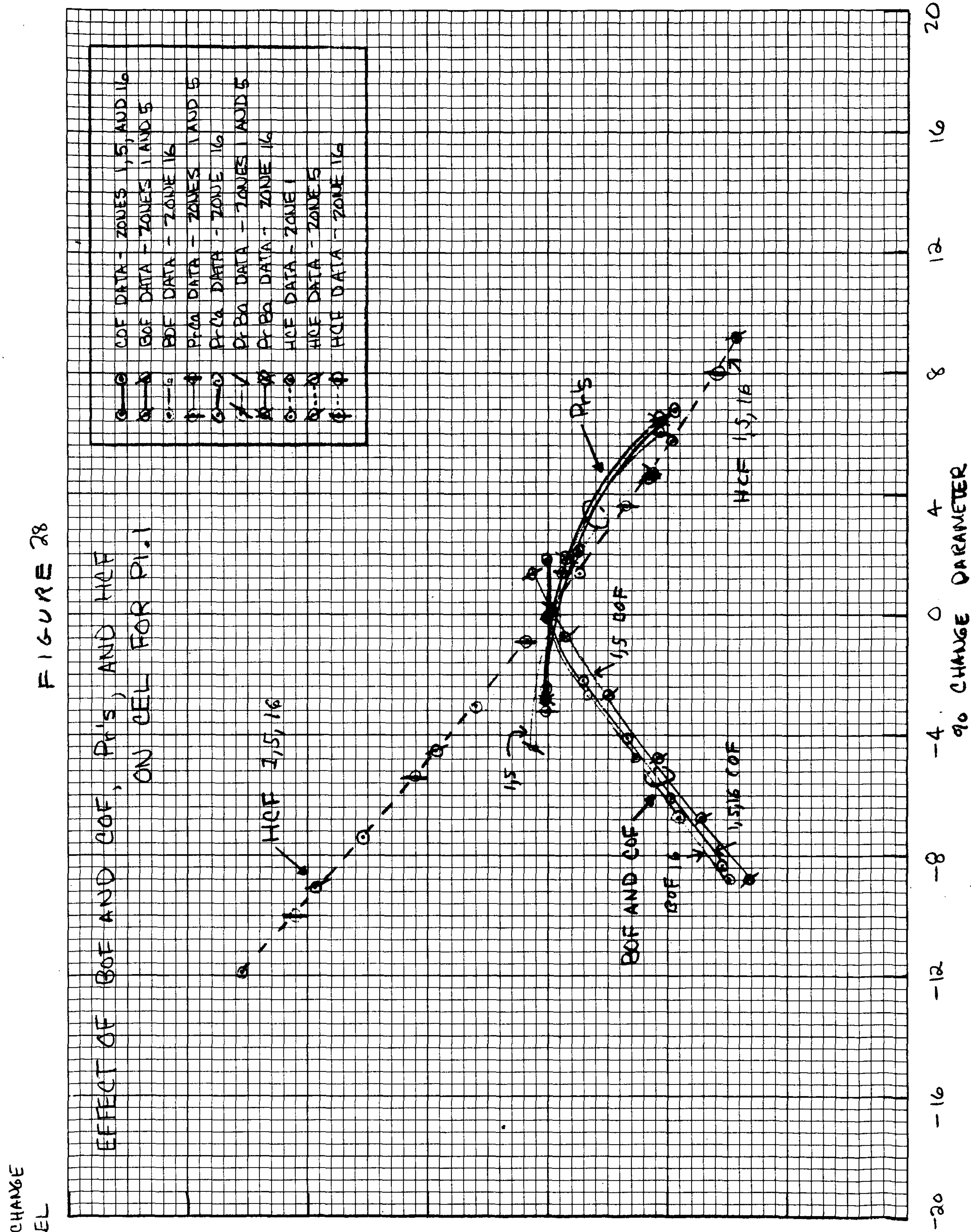
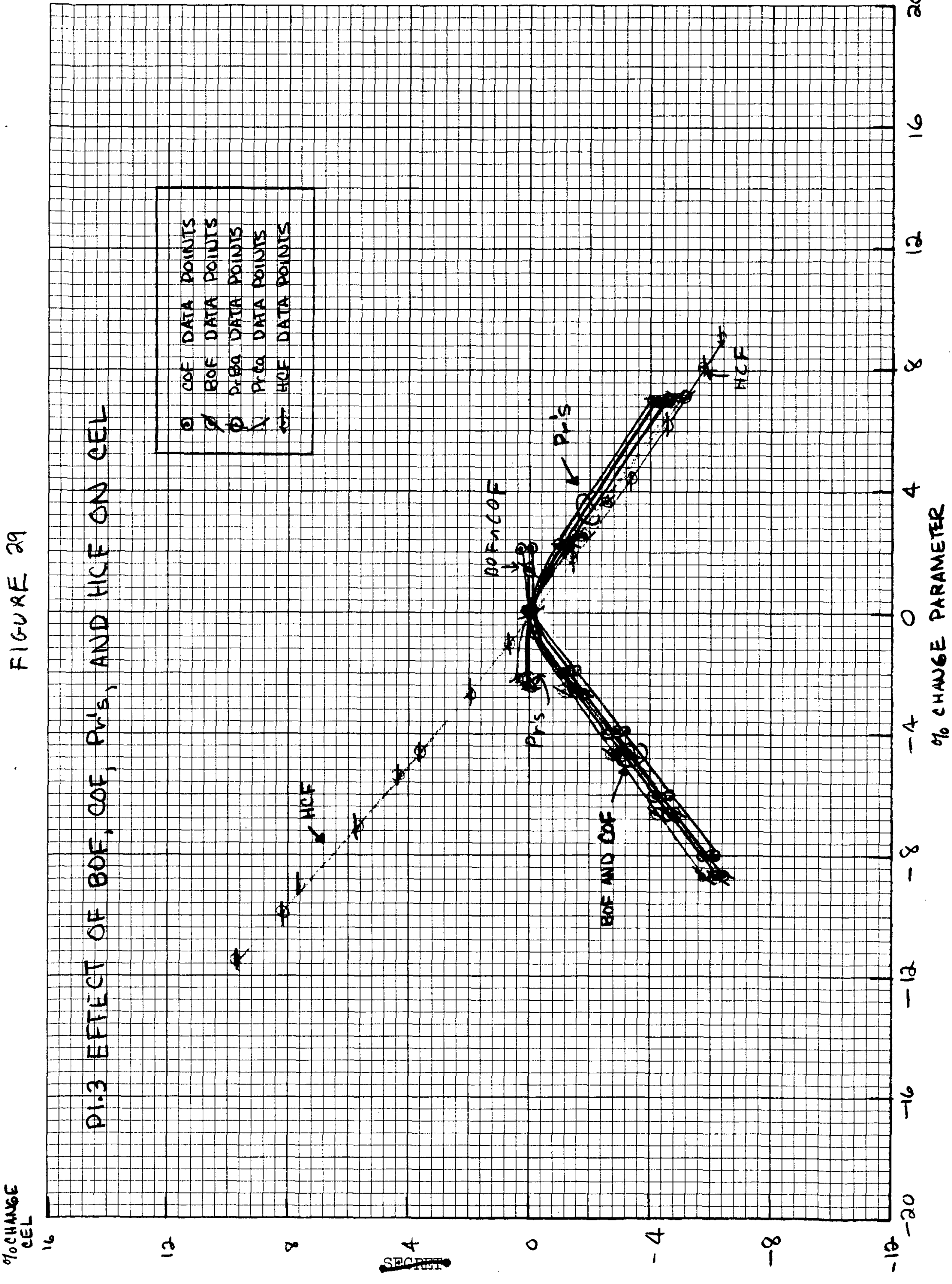


FIGURE 29

D1.3 EFFECT OF BOE, COE, Pr's, AND HCF ON CEL



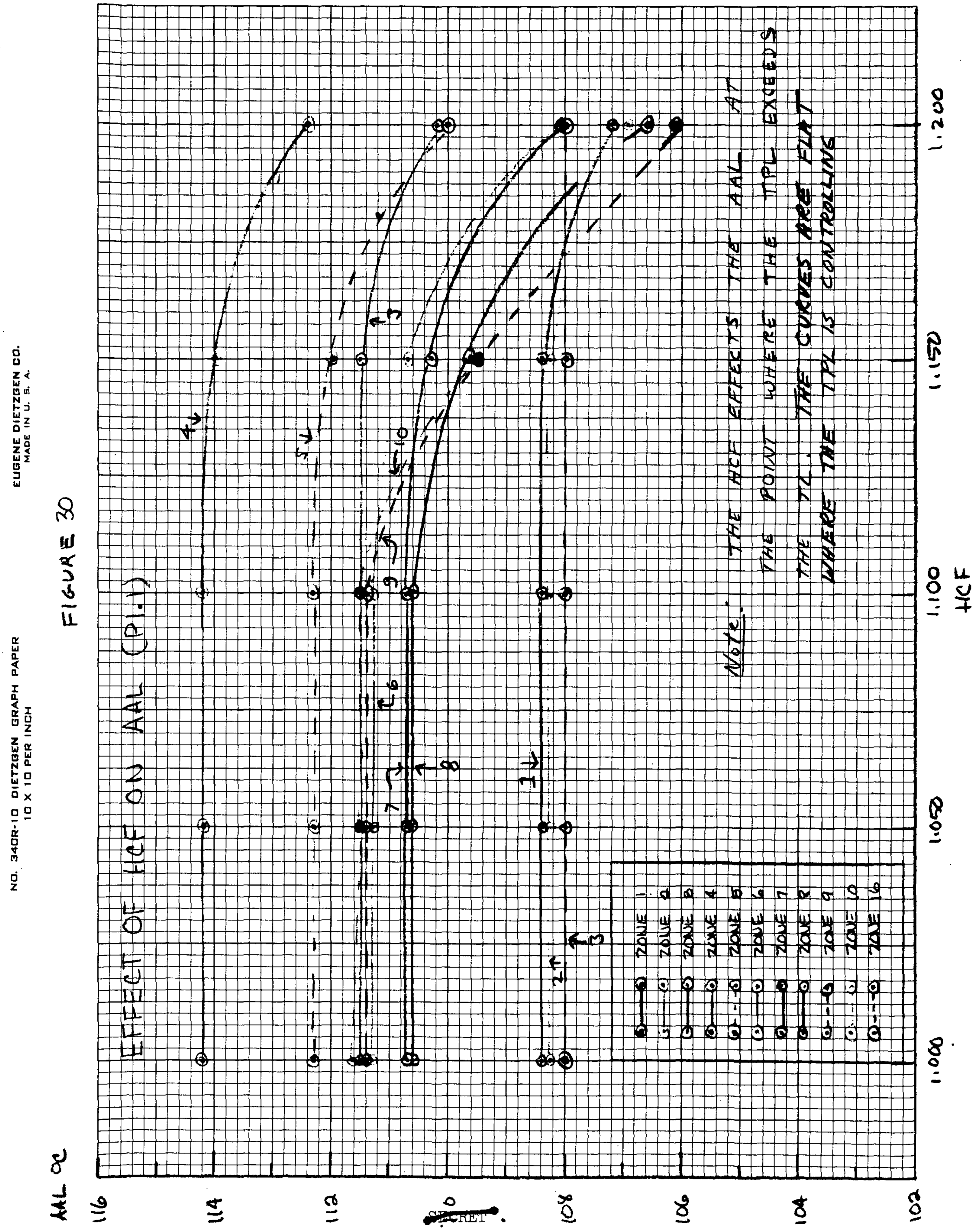


FIGURE 30
EFFECT OF HCF ON AAL (Pl.1)
Note: THE HCF EFFECTS THE AAL AT THE POINT WHERE THE TPL EXCEEDS THE TL. THE CURVES ARE FLAT WHERE THE TPL IS CONTROLLING
ZONE 1
ZONE 2
ZONE 3
ZONE 4
ZONE 5
ZONE 6
ZONE 7
ZONE 8
ZONE 9
ZONE 10
ZONE 16
AAL ∝
116
114
112
110
108
106
104
102
HCF
1.000
1.050
1.100
1.150
1.200
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AAL °C

FIGURE 31

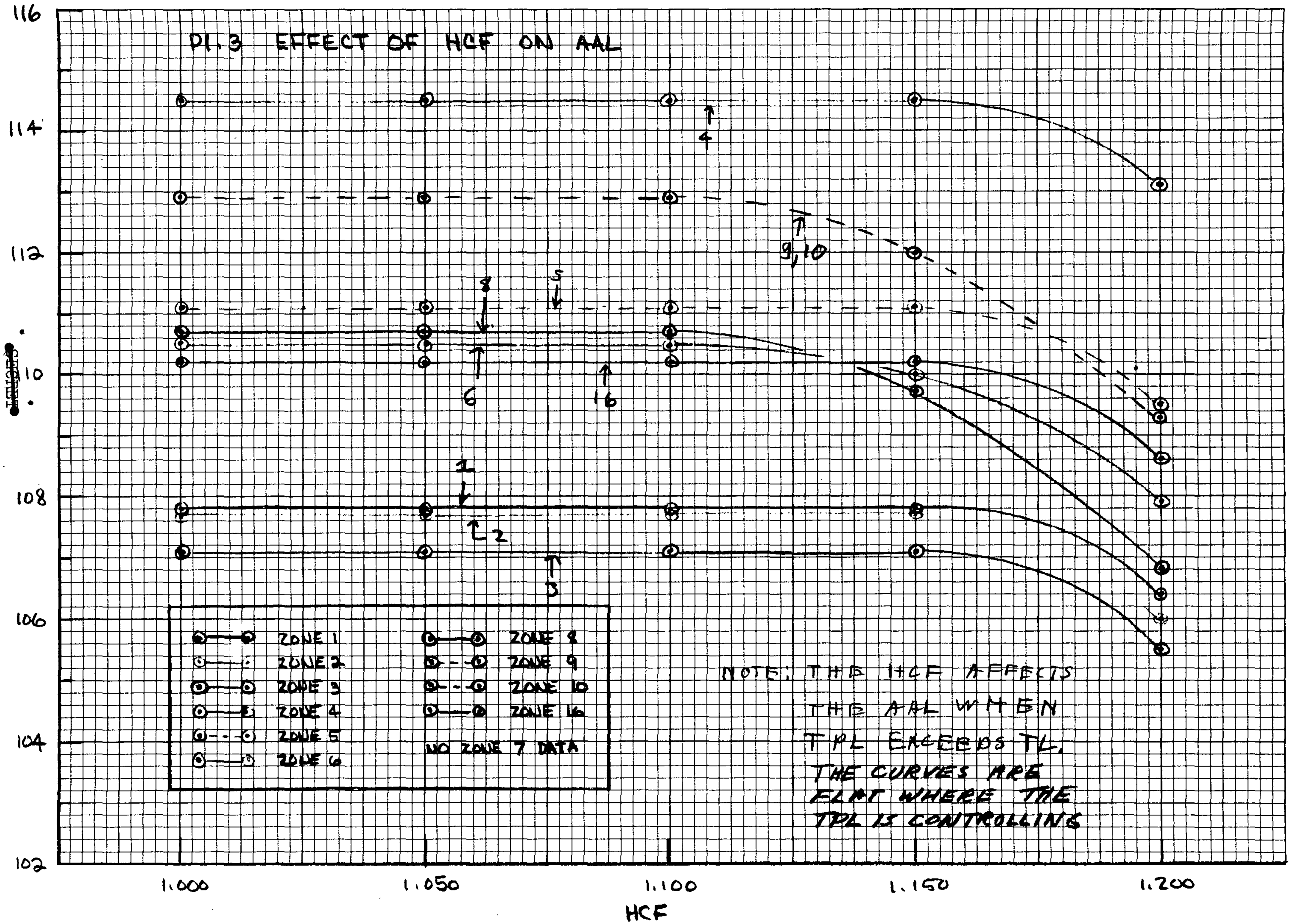

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FIGURE 32

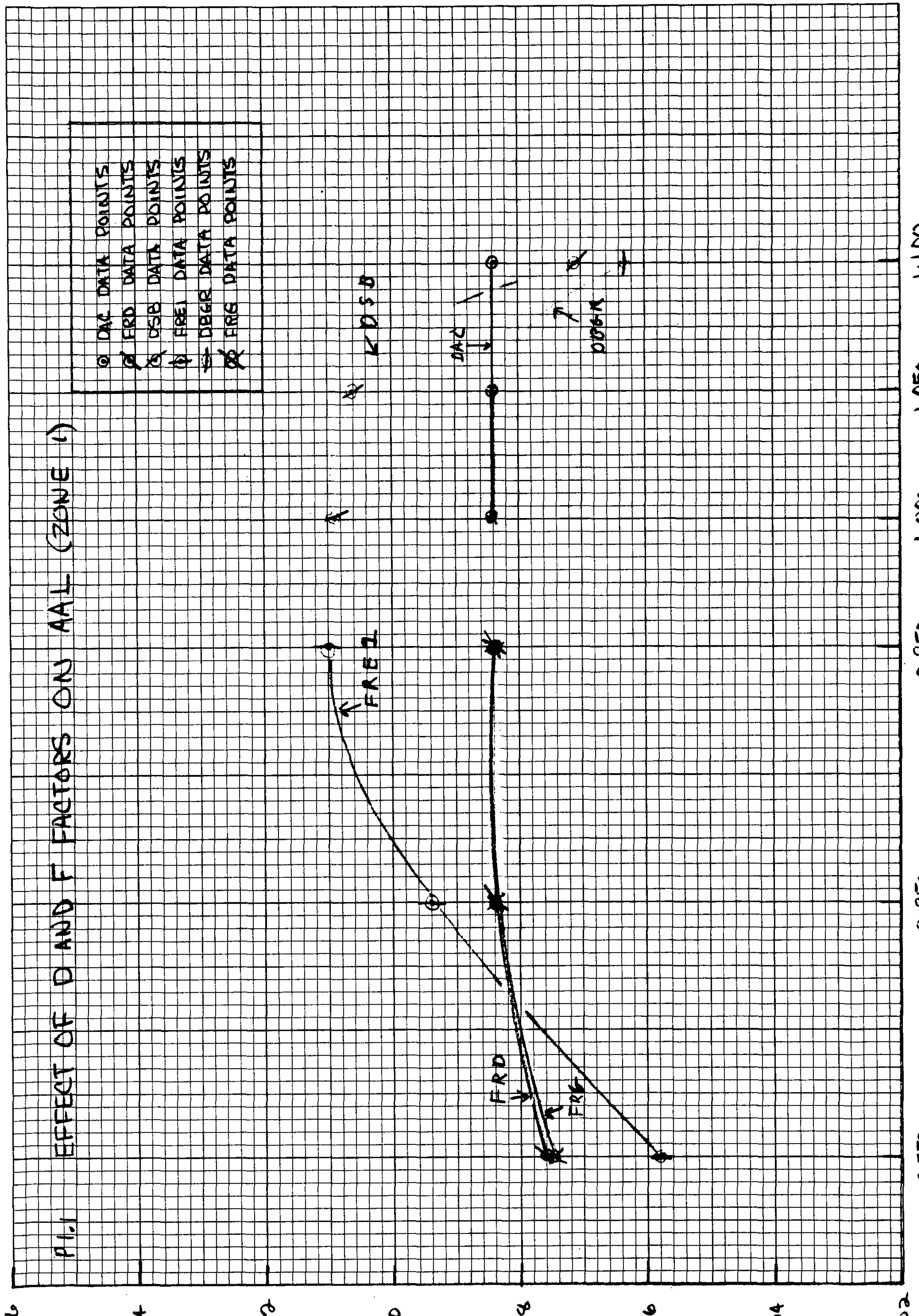
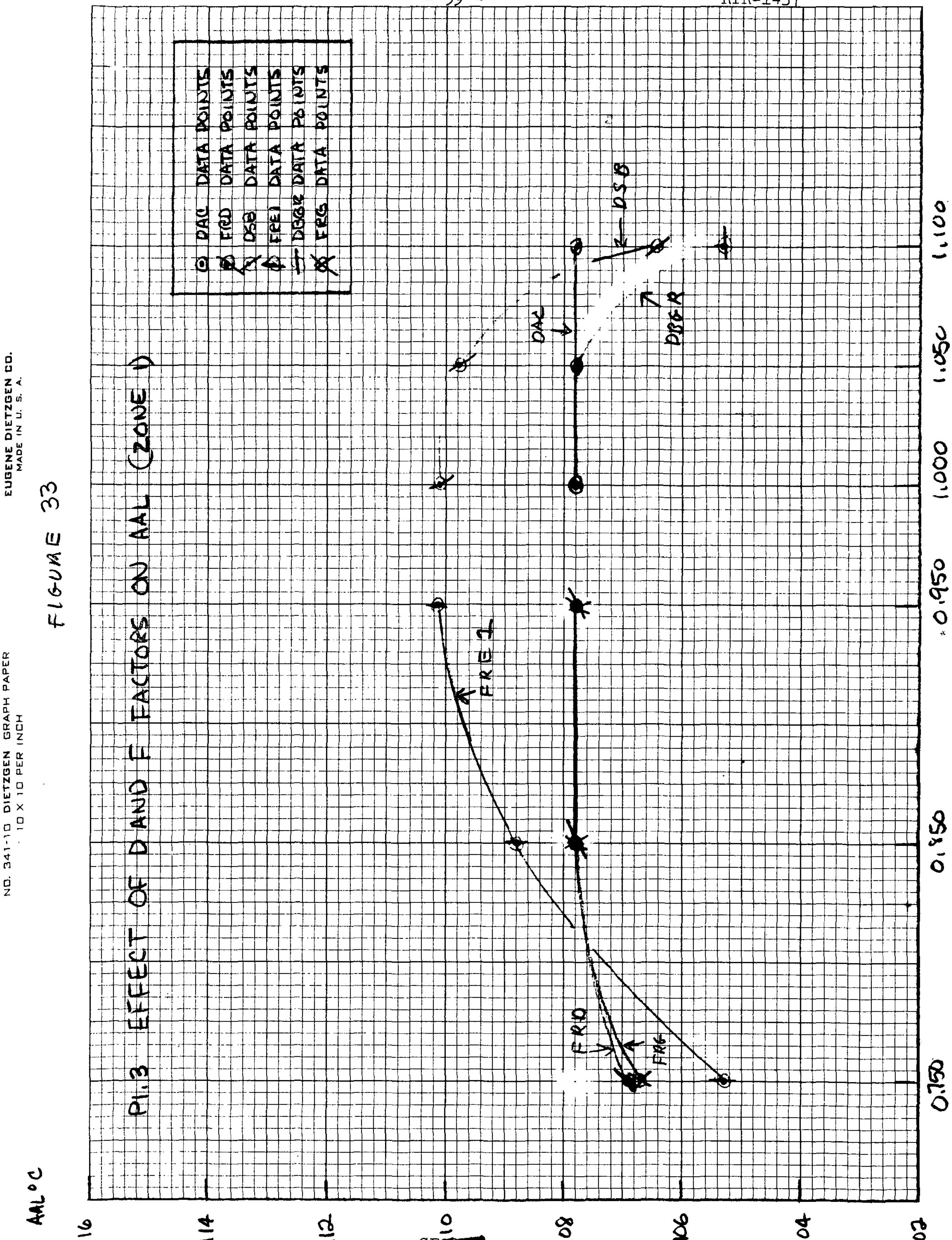

P1.1 EFFECT OF D AND F FACTORS ON AAL (ZONE 1)
⊙ DAC DATA POINTS
FRD DATA POINTS
DSB DATA POINTS
FREI DATA POINTS
DBGR DATA POINTS
FRG DATA POINTS
DSB
DAC
DBGR
FREI
FRD
FRG
0.750
0.850
0.950
1.000
1.050
1.100
D AND F FACTORS
AAL °C
116
114
112
110
108
106
104
102

FIGURE 33


P1.3 EFFECT OF D AND F FACTORS ON AAL (ZONE 1)
DAC DATA POINTS
FRD DATA POINTS
DSB DATA POINTS
FRE1 DATA POINTS
DBGR DATA POINTS
FRG DATA POINTS
FRE1
DAC
DSB
DBGR
FRD
FRG
AAL °C
116
114
112
110
108
106
104
102
0.750
0.850
0.950
1.000
1.050
1.100

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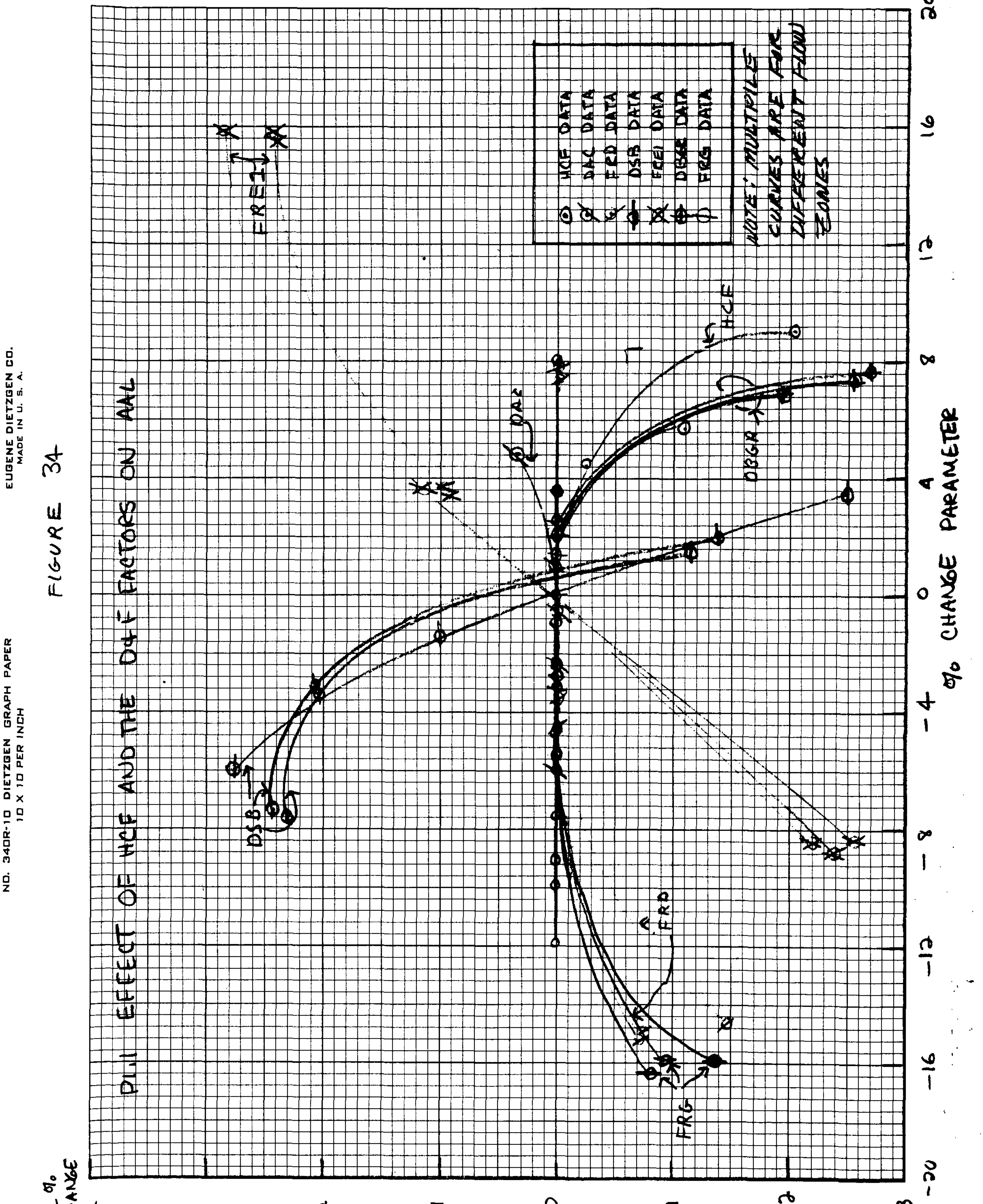

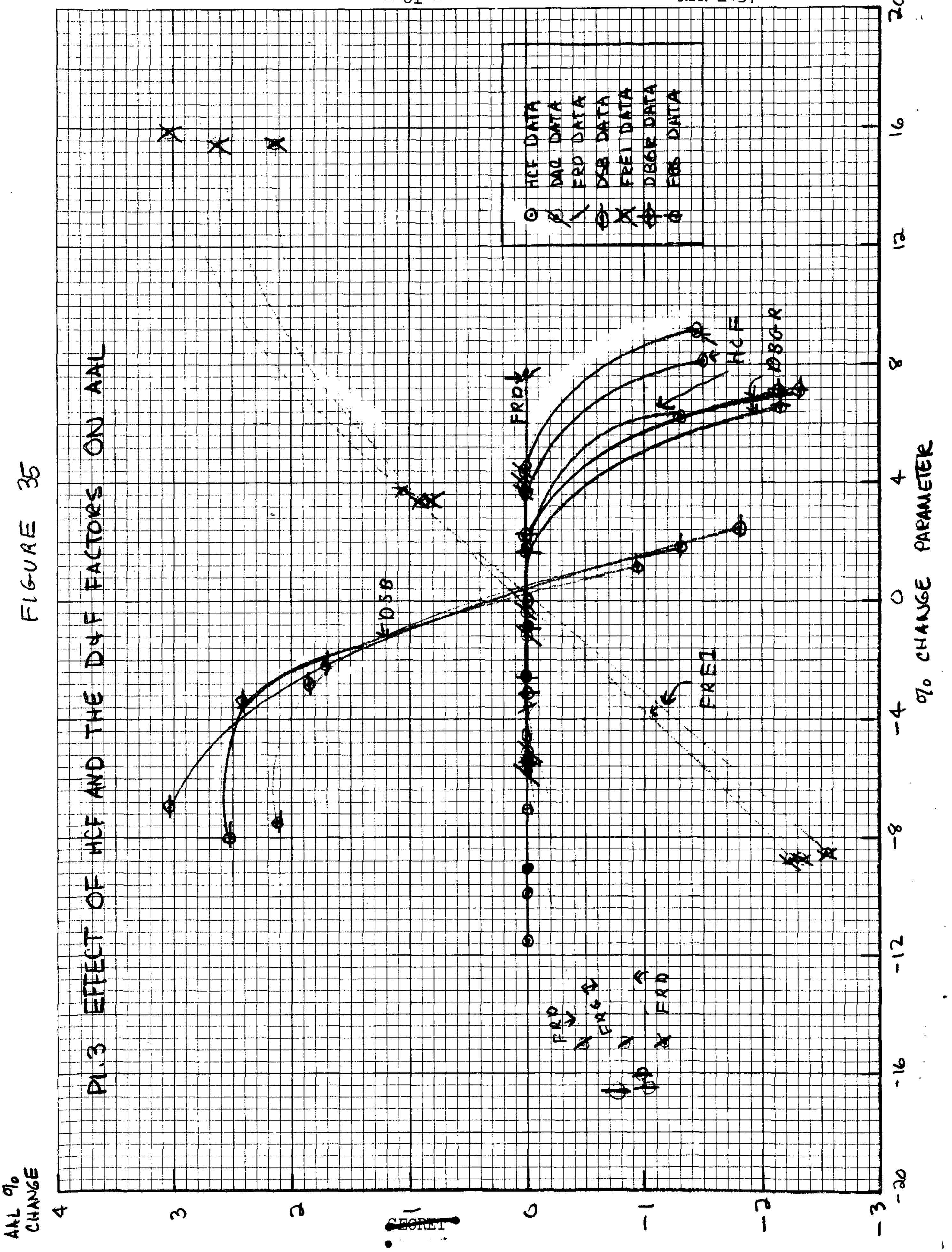

FIGURE 35

P1.3 EFFECT OF HCF AND THE D&F FACTORS ON AAL

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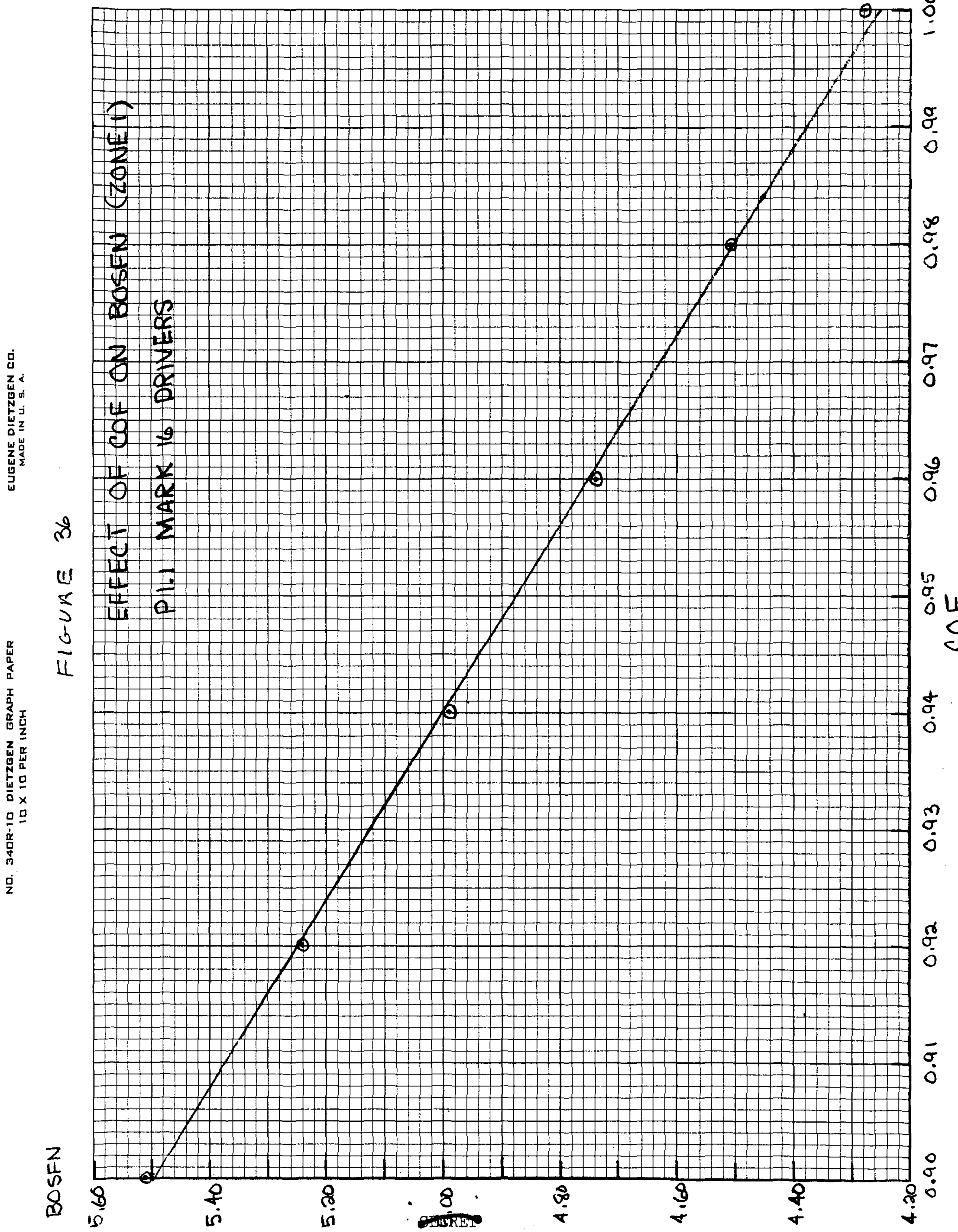


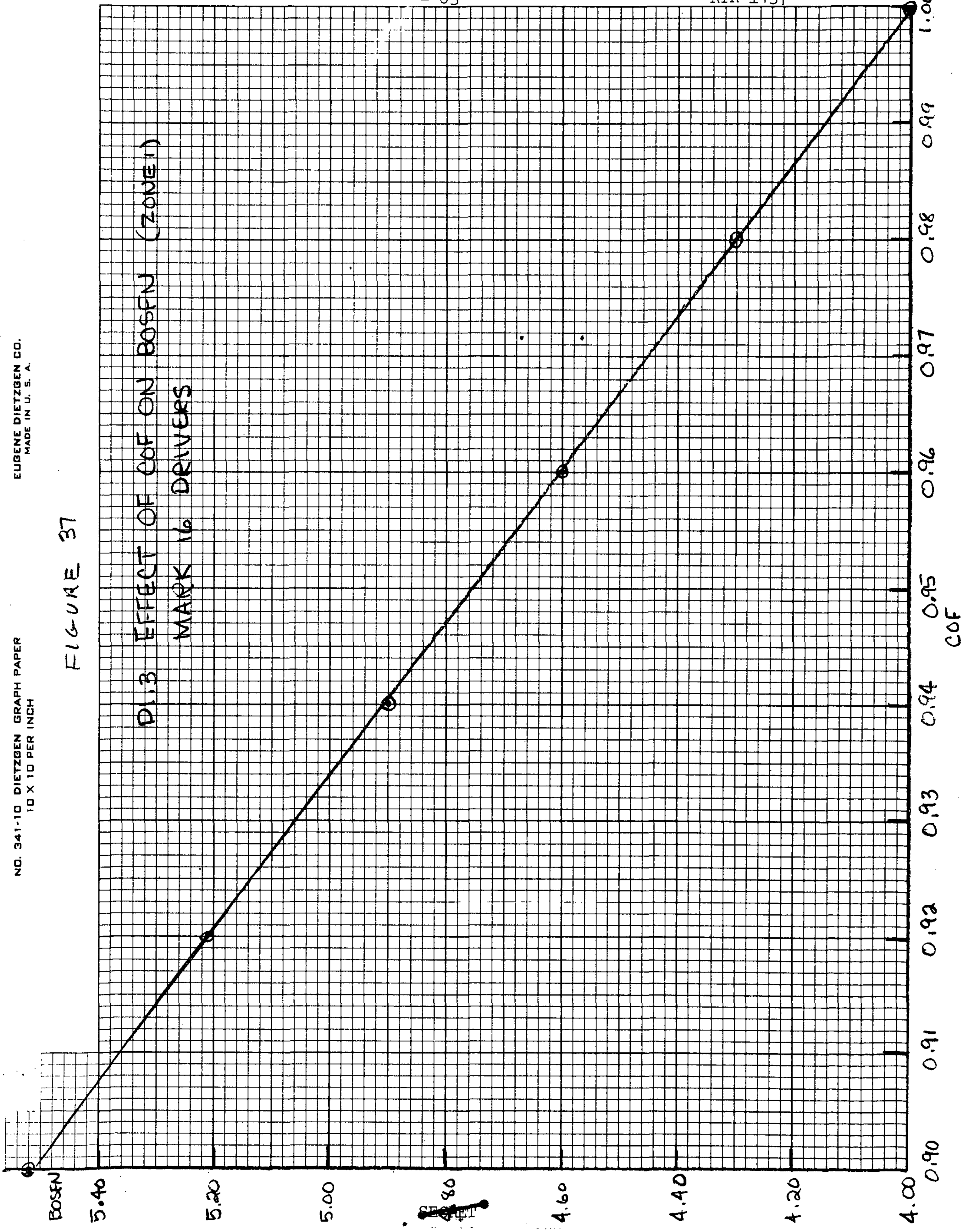


FIGURE 37

D1.3 EFFECT OF COF ON BOSFN (ZONE I)
MARK 16 DRIVERS

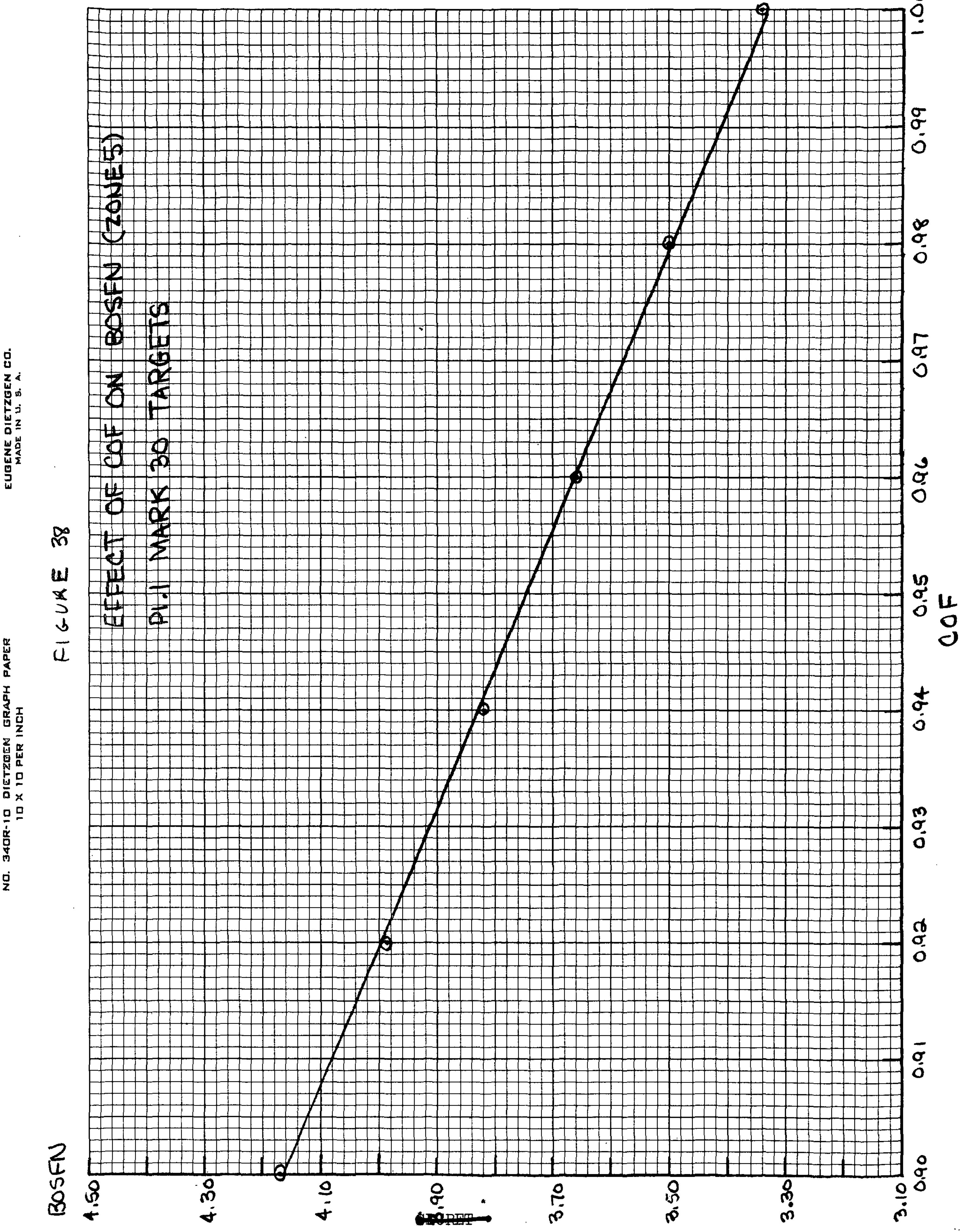
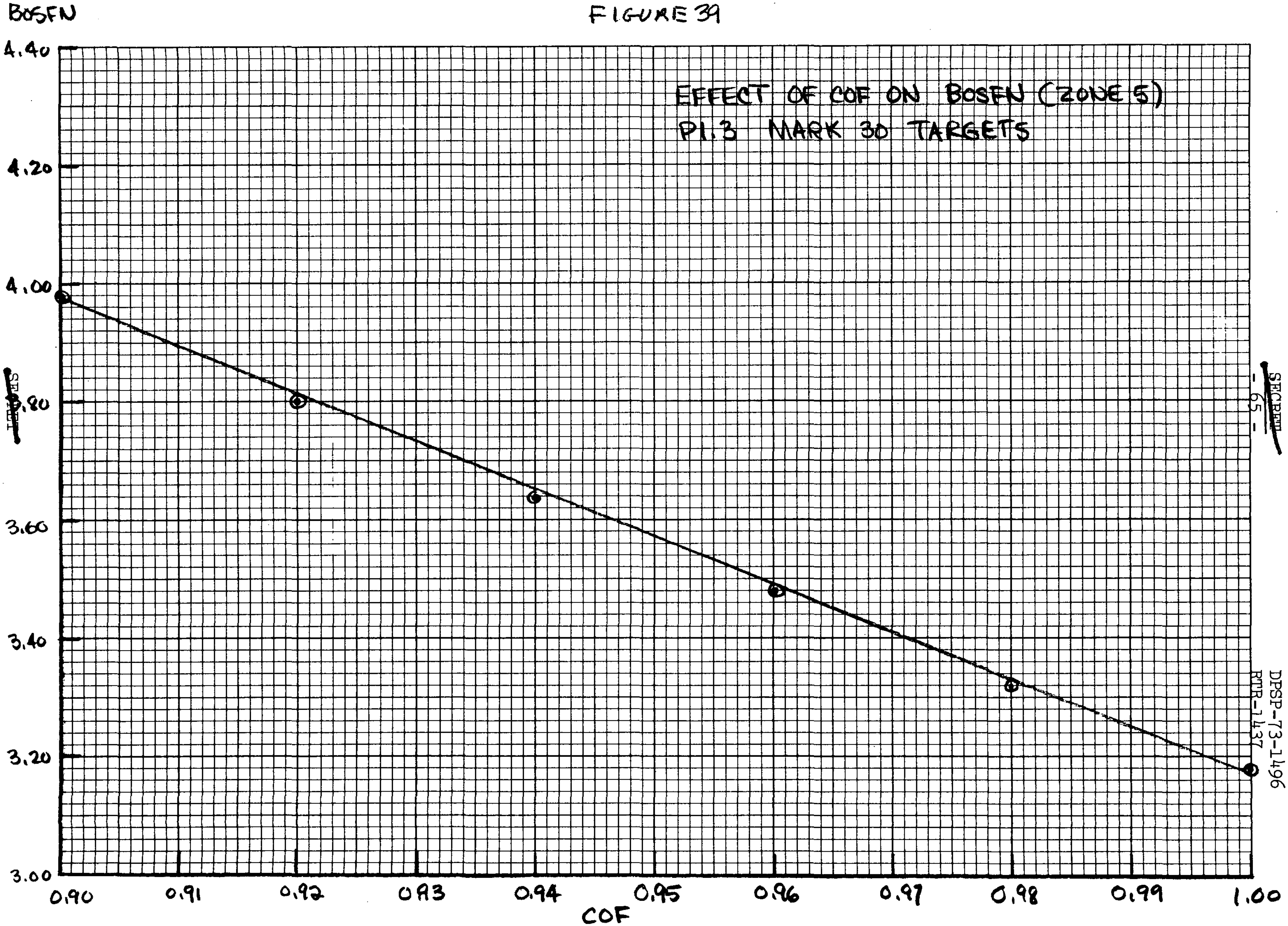


FIGURE 38
EFFECT OF COF ON BOSFN (ZONE 5)
PU.1 MARK 30 TARGETS

FIGURE 39



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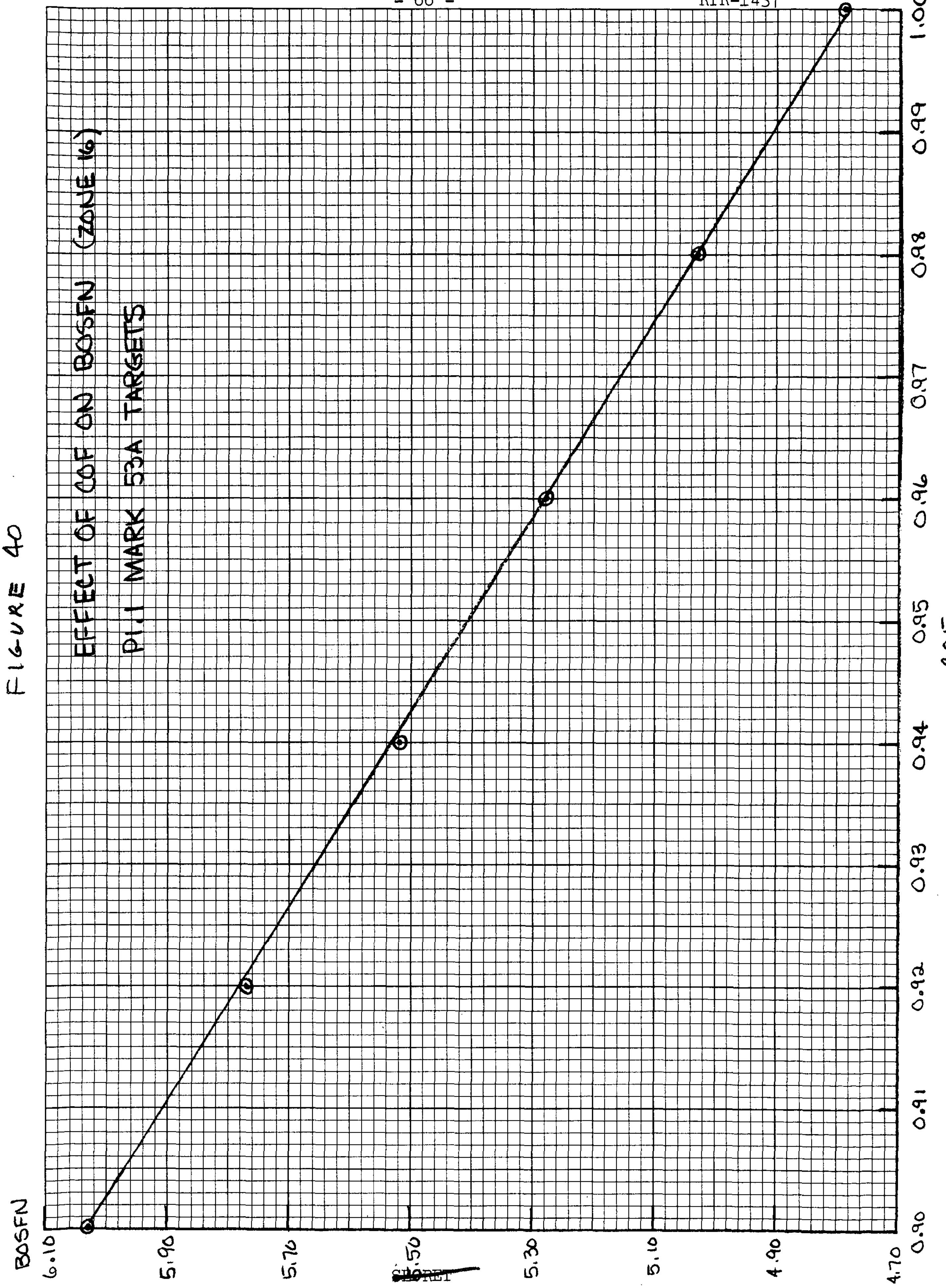
FIGURE 40
EFFECT OF COF ON BOSFN (ZONE 16)
Pl.1 MARK 53A TARGETS
COF
BOSFN
0.90
0.91
0.92
0.93
0.94
0.95
0.96
0.97
0.98
0.99
1.00
6.10
5.90
5.70
5.50
5.30
5.10
4.90
4.70

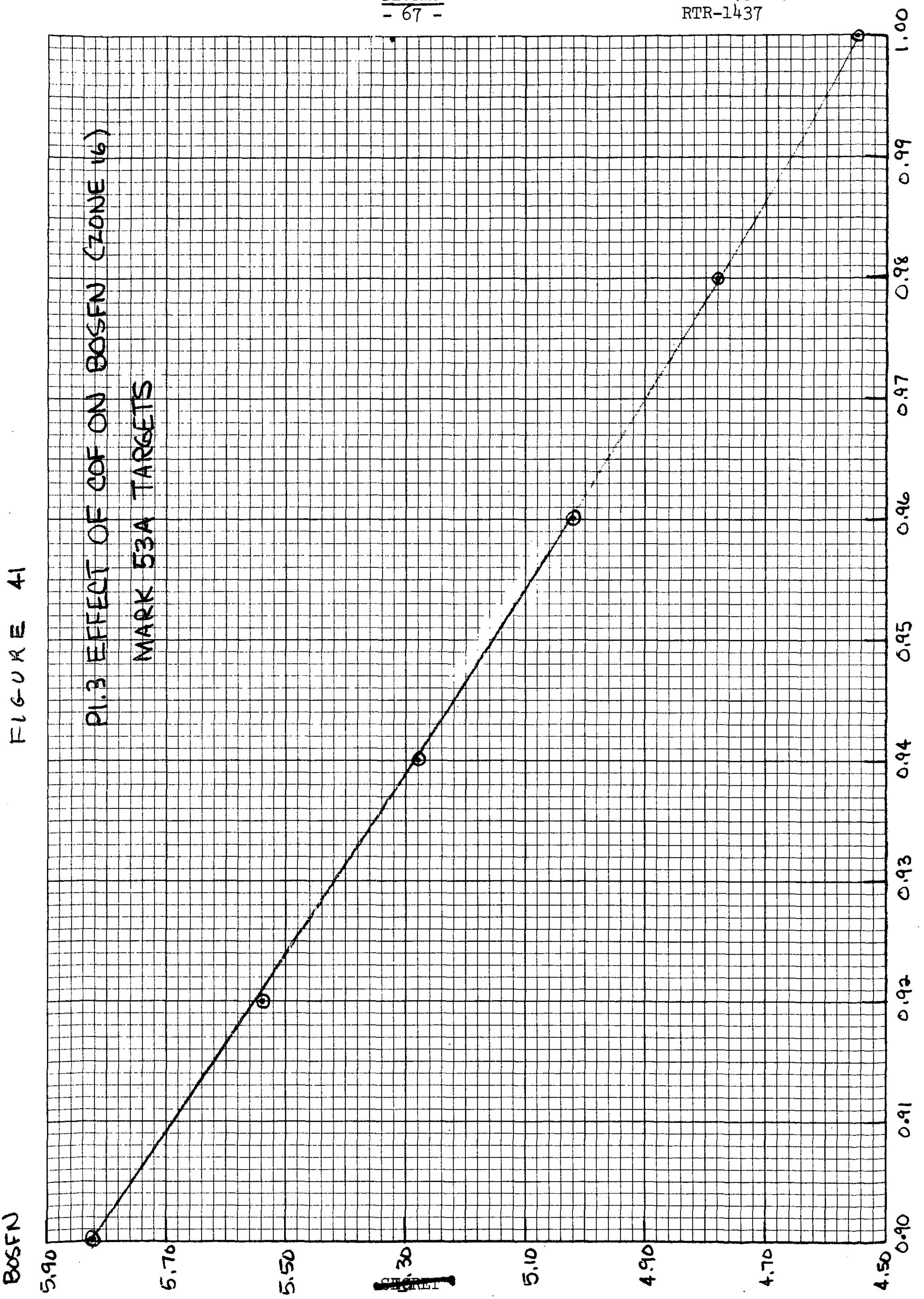
FIGURE 41
P1.3 EFFECT OF COF ON BOSFN (ZONE 16)
MARK 53A TARGETS
BOSFN
5.90
5.70
5.50
5.30
5.10
4.90
4.70
4.50
0.90
0.91
0.92
0.93
0.94
0.95
0.96
0.97
0.98
0.99
1.00
COF
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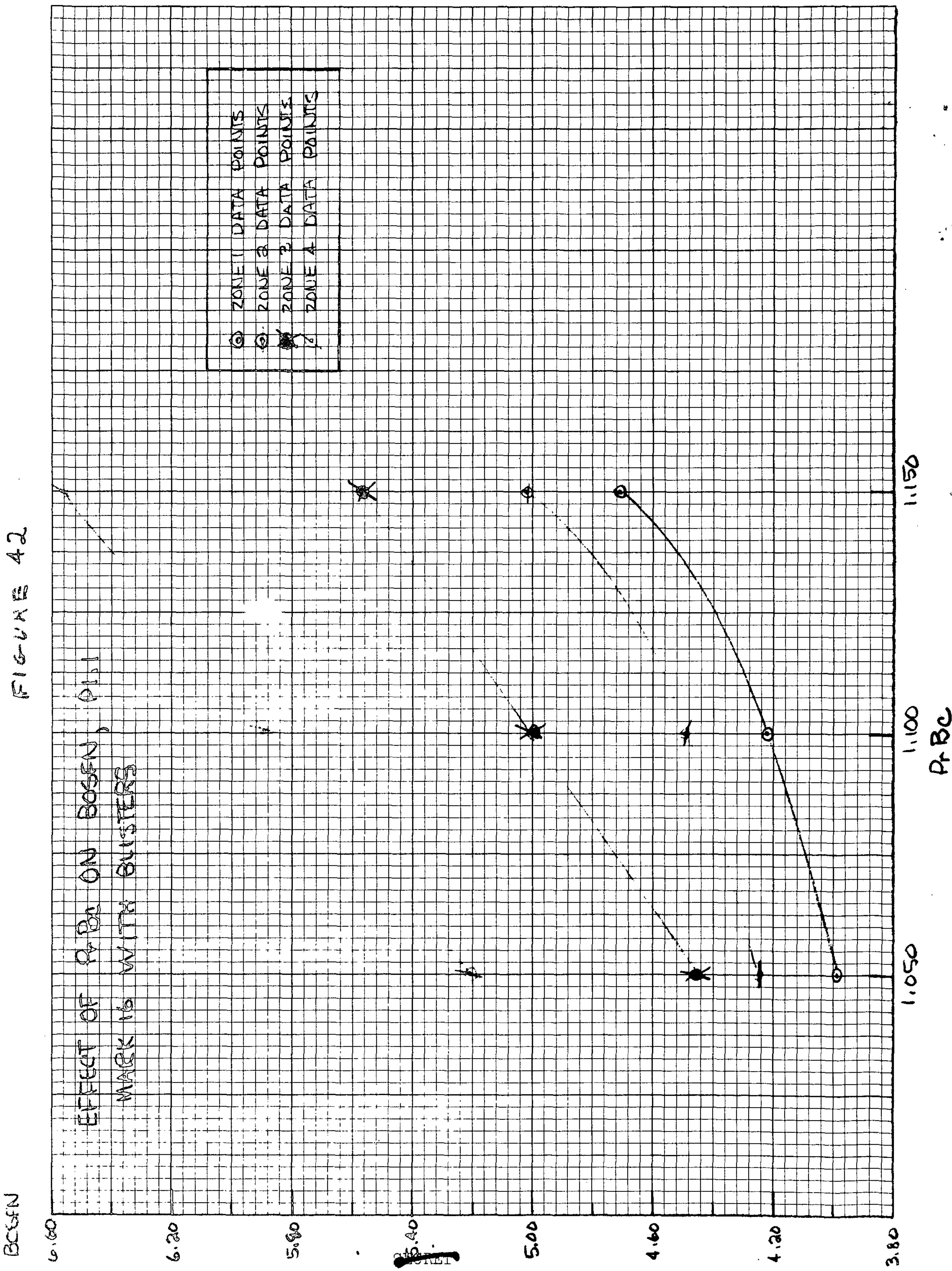

FIGURE 42

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FIGURE 43

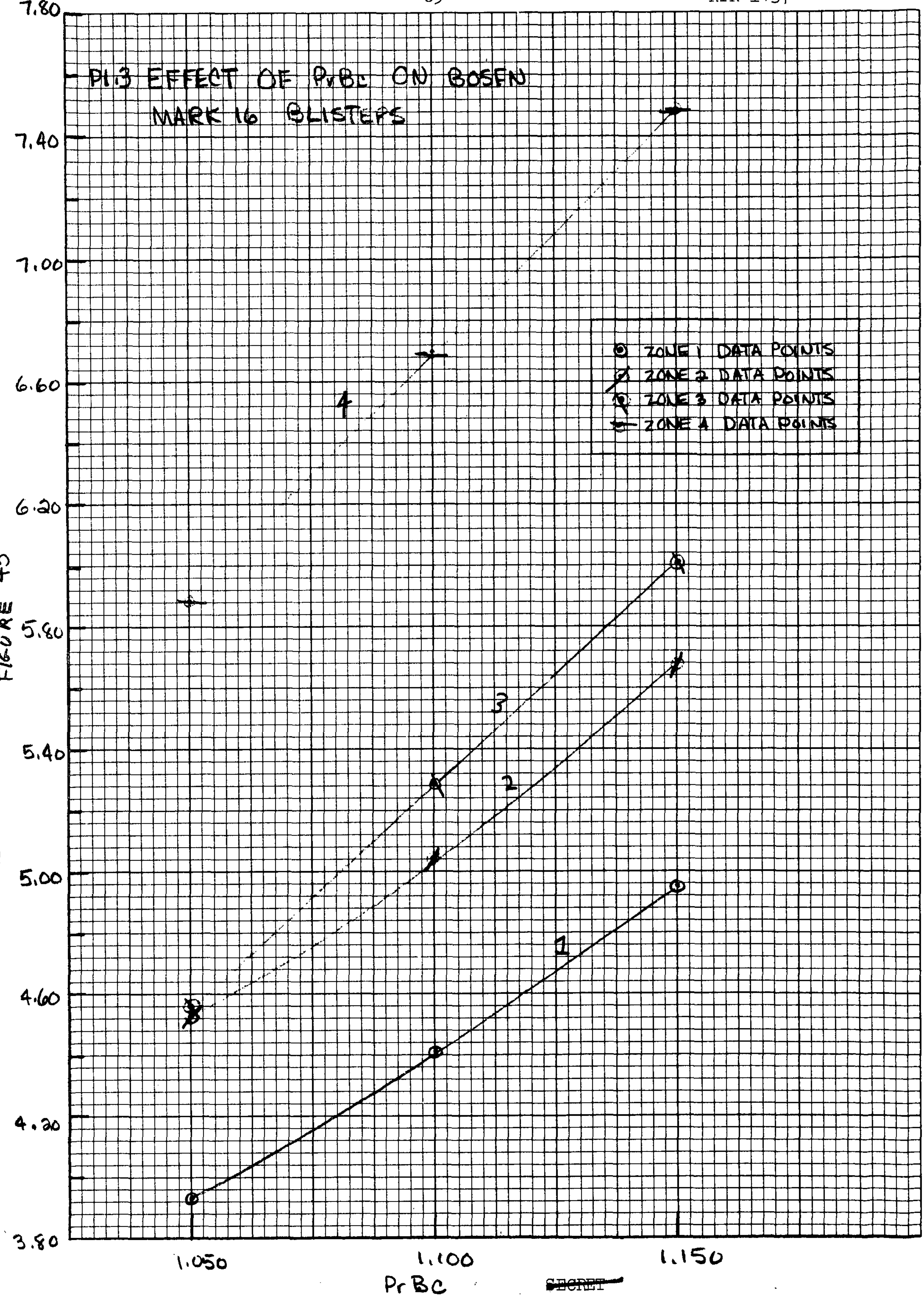


FIG. 44

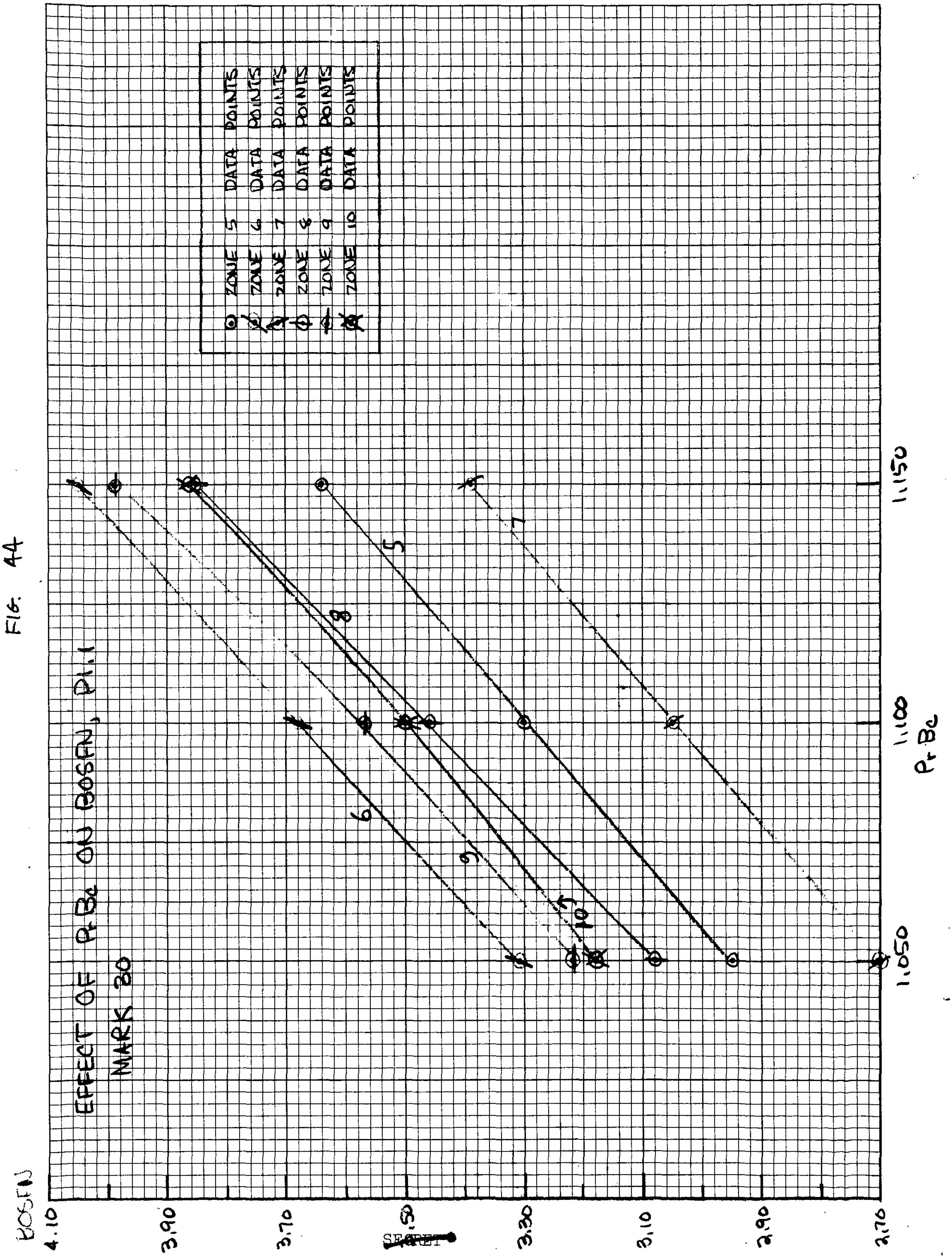
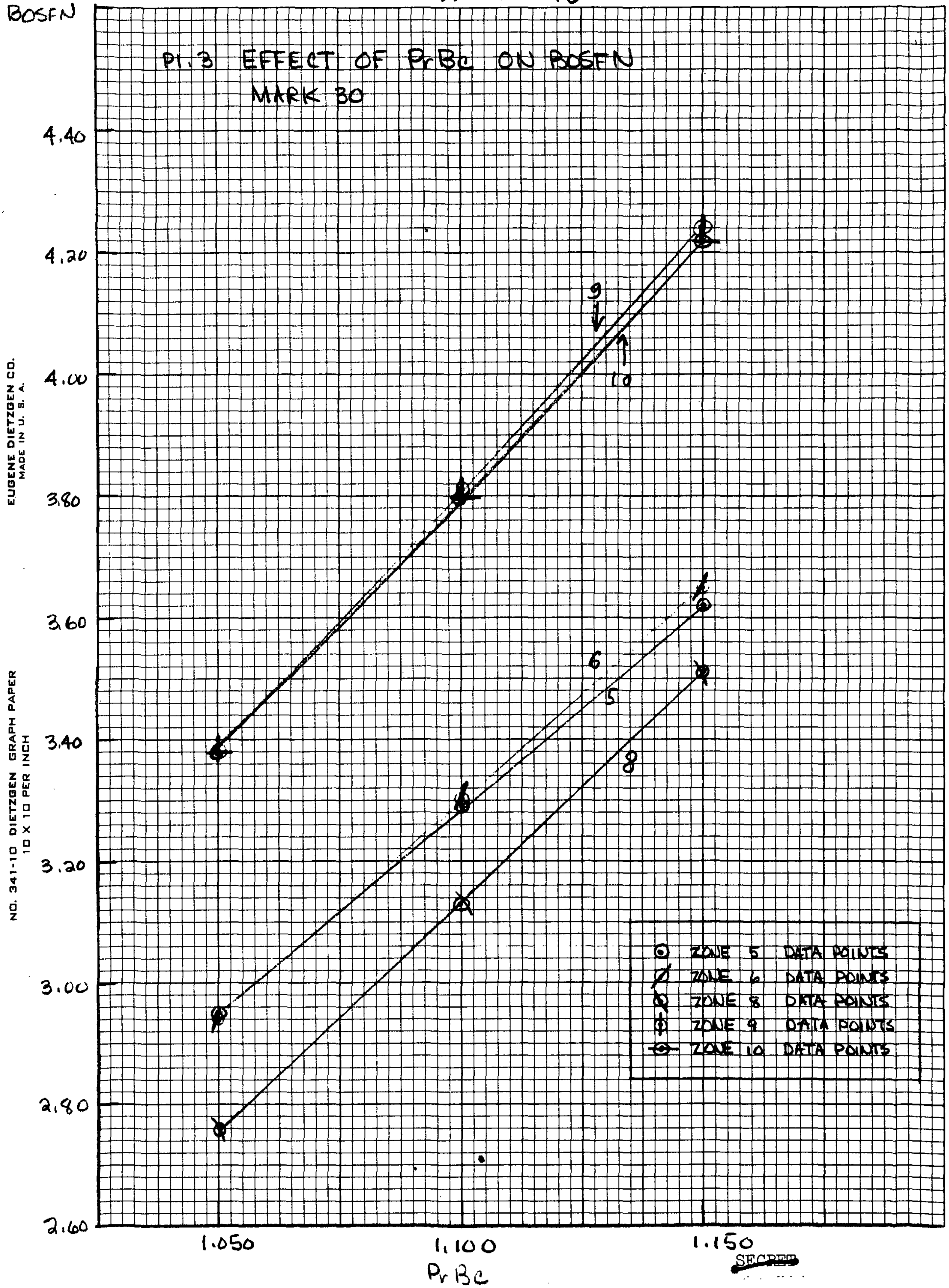

EFFECT OF PrBc ON BOSFN, Pt.1
MARK 30
ZONE 5 DATA POINTS
ZONE 6 DATA POINTS
ZONE 7 DATA POINTS
ZONE 8 DATA POINTS
ZONE 9 DATA POINTS
ZONE 10 DATA POINTS
BOSFN
4.10
3.90
3.70
3.50
3.30
3.10
2.90
2.70
1.050
1.100
1.150
PrBc
5
6
7
8
9
10

FIGURE 45


BOSFN
P1.3 EFFECT OF PrBc ON BOSFN
MARK 30
4.40
4.20
4.00
3.80
3.60
3.40
3.20
3.00
2.80
2.60
9
10
6
5
8
ZONE 5 DATA POINTS
ZONE 6 DATA POINTS
ZONE 8 DATA POINTS
ZONE 9 DATA POINTS
ZONE 10 DATA POINTS
1.050
1.100
1.150
PrBc
EUGENE DIETZGEN CO.
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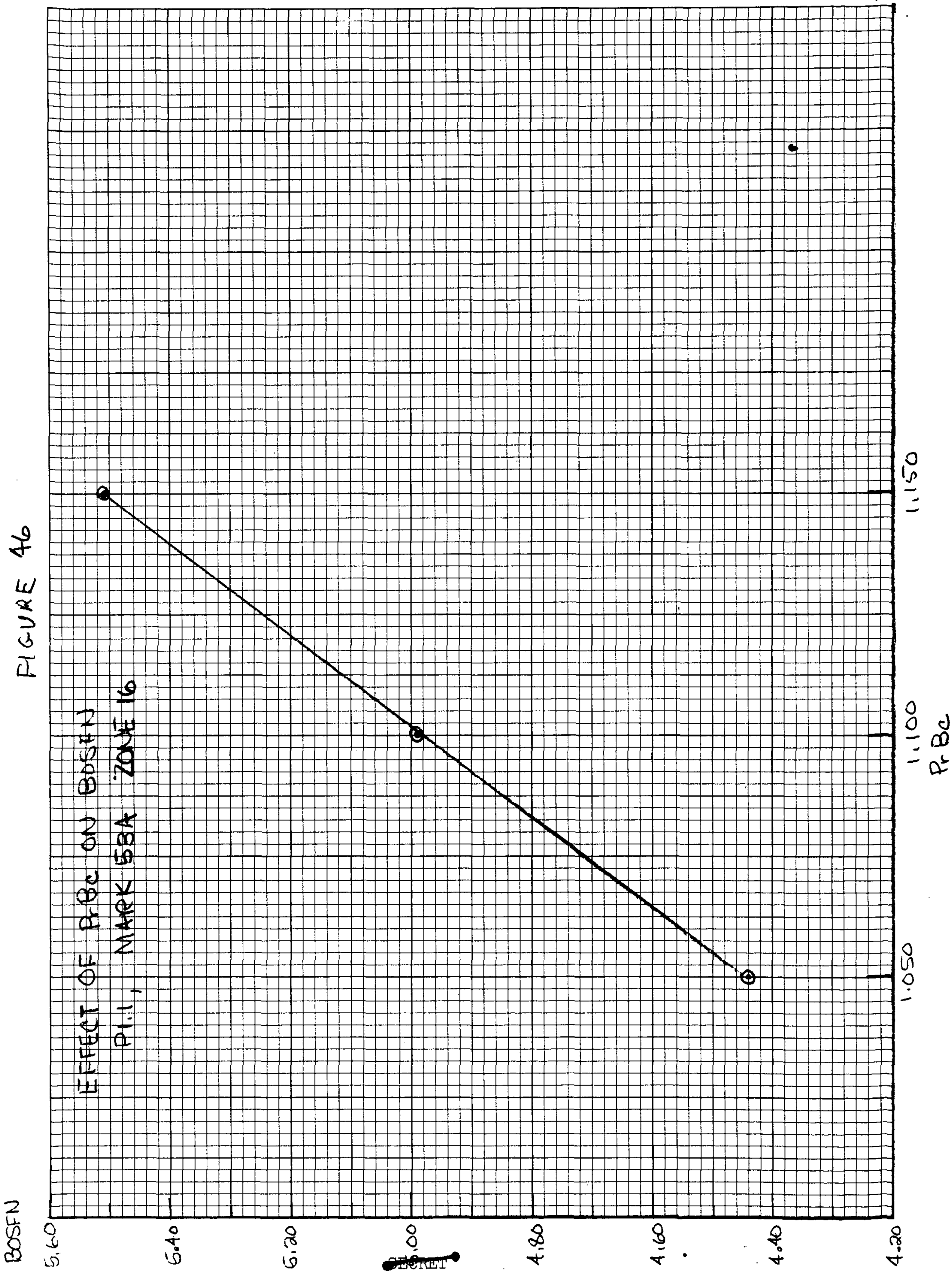
FIGURE 46
EFFECT OF PrBc ON BOSFN
Pu, MARK 53A ZONE 16
BOSFN
5.60
5.40
5.20
5.00
4.80
4.60
4.40
4.20
1.050
1.100
1.150
PrBc

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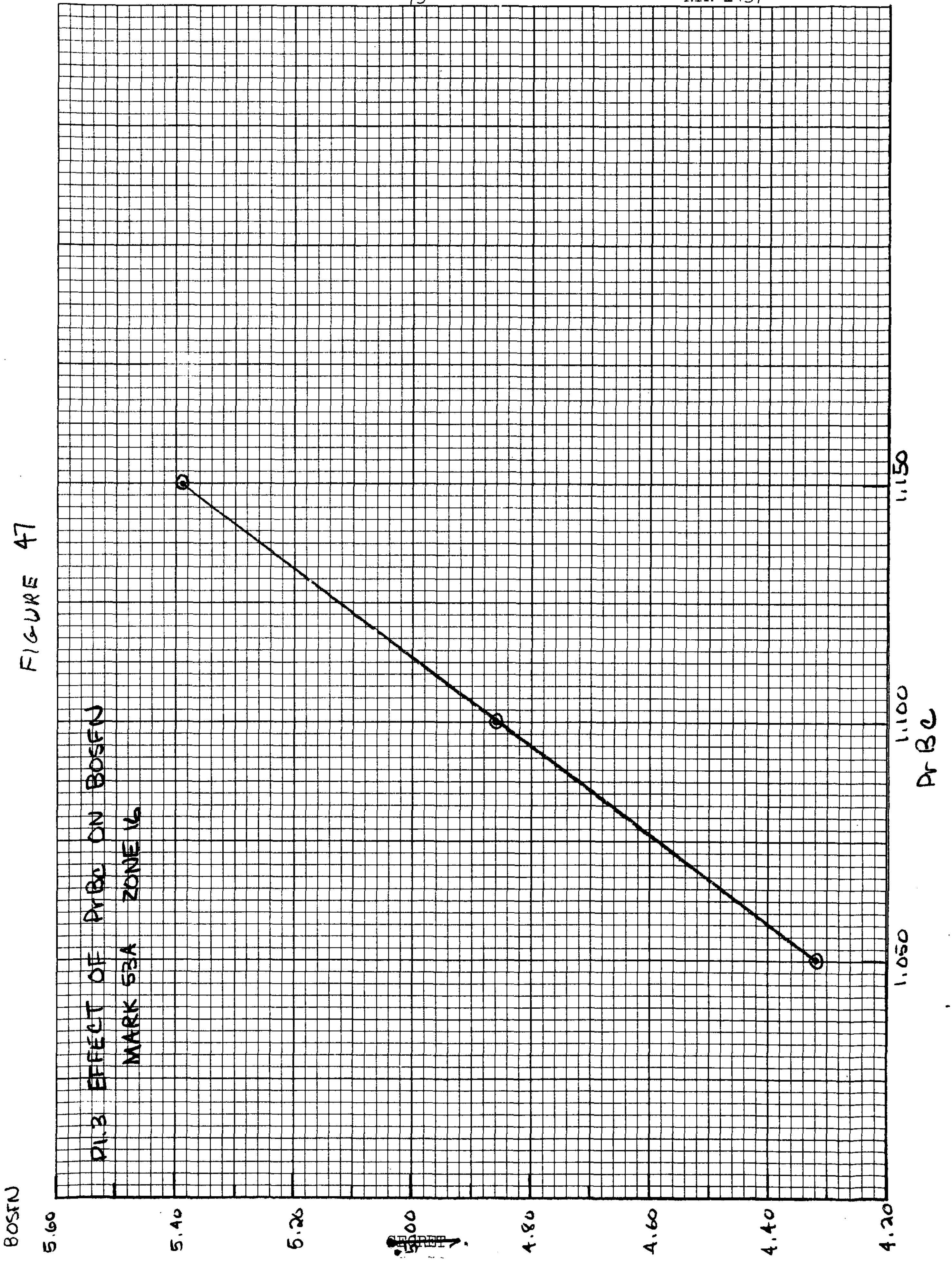

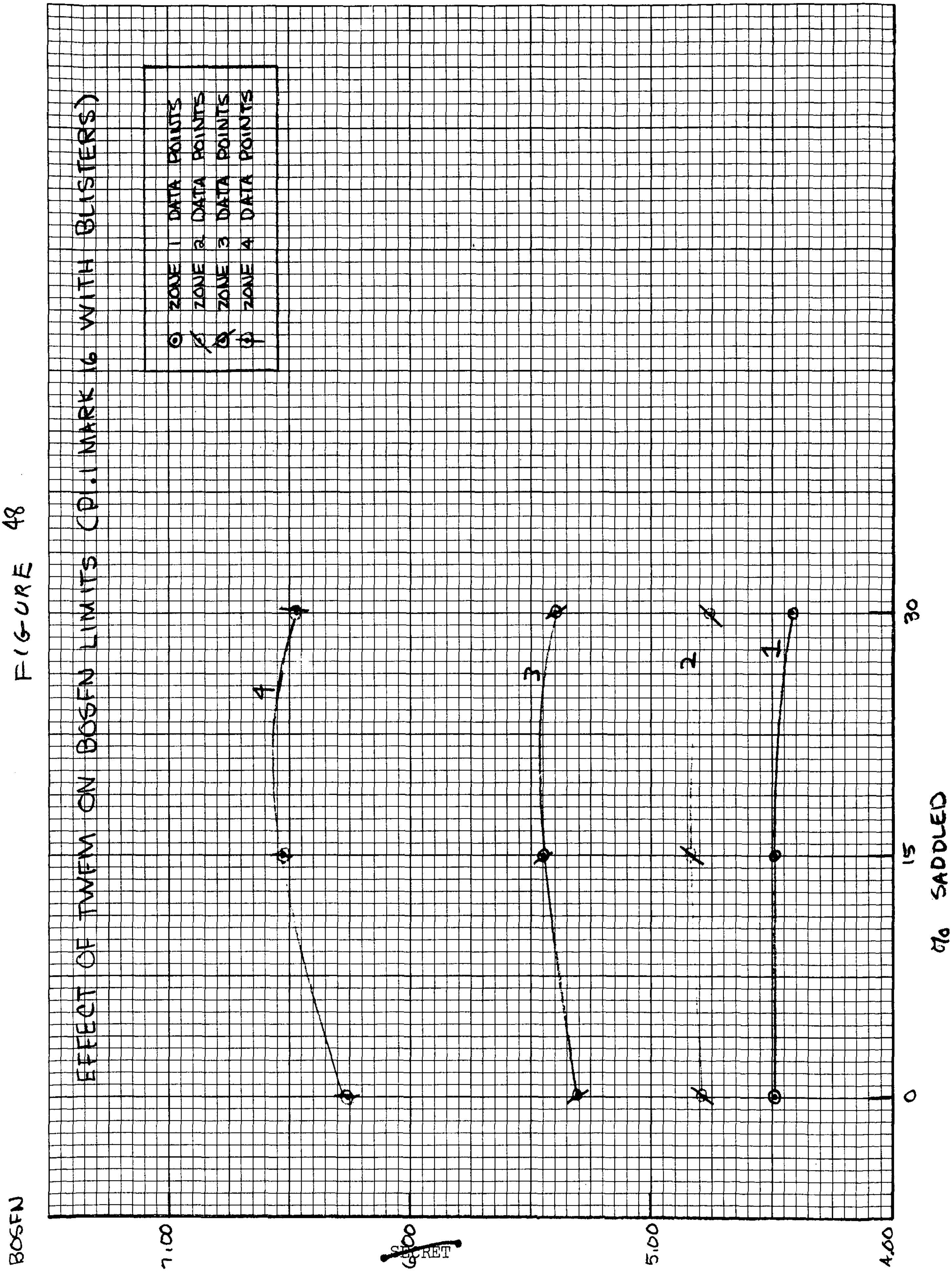
FIGURE 48
EFFECT OF TMEM ON BOSFN LIMITS (D.I. MARK 16 WITH BLISTERS)
⊙ ZONE 1 DATA POINTS
ZONE 2 DATA POINTS
ZONE 3 DATA POINTS
ZONE 4 DATA POINTS
1
2
3
4
BOSFN
7.00
6.00
5.00
4.00
0
15
30
% SADDLED

BOSFN

FIGURE 49

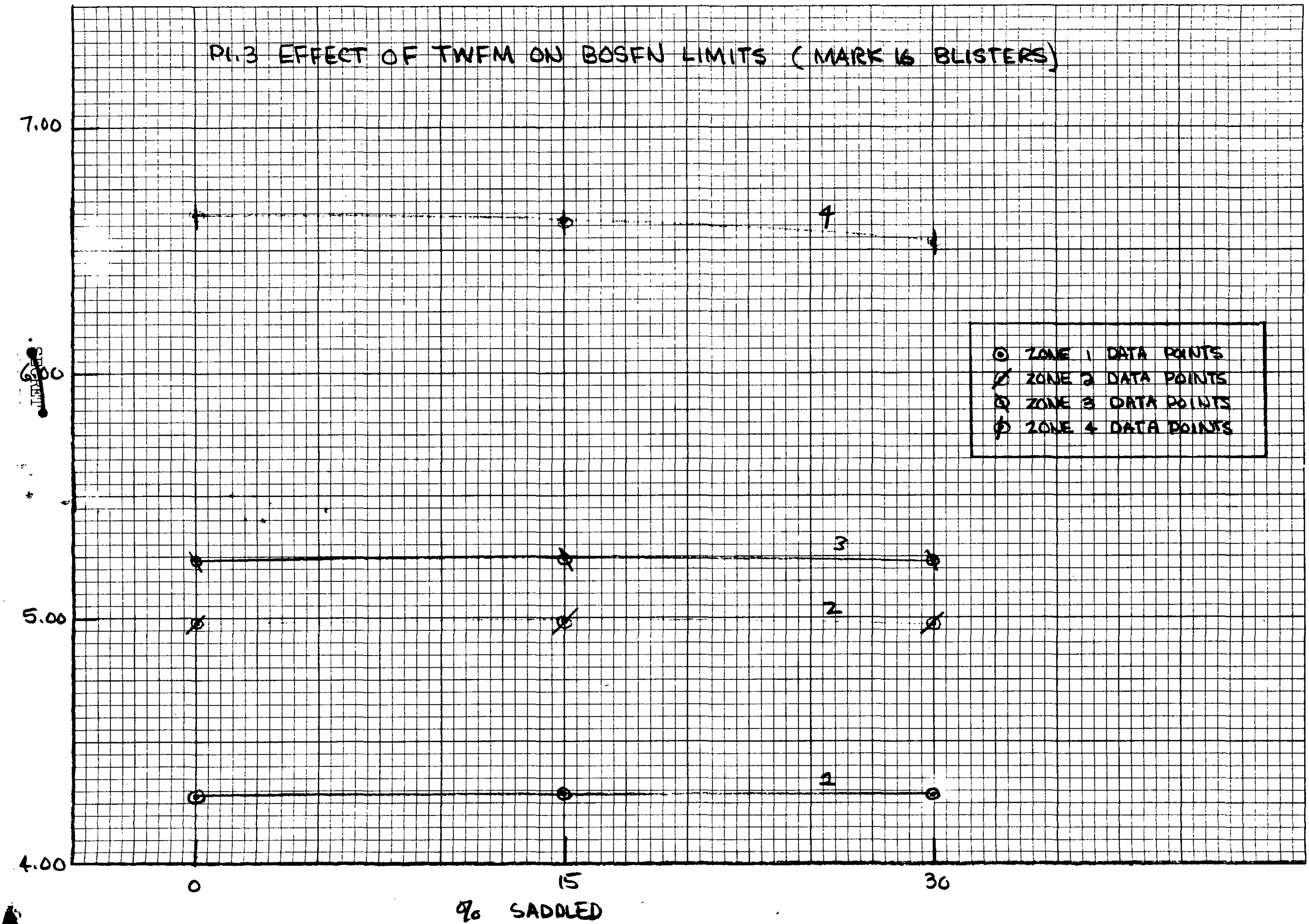

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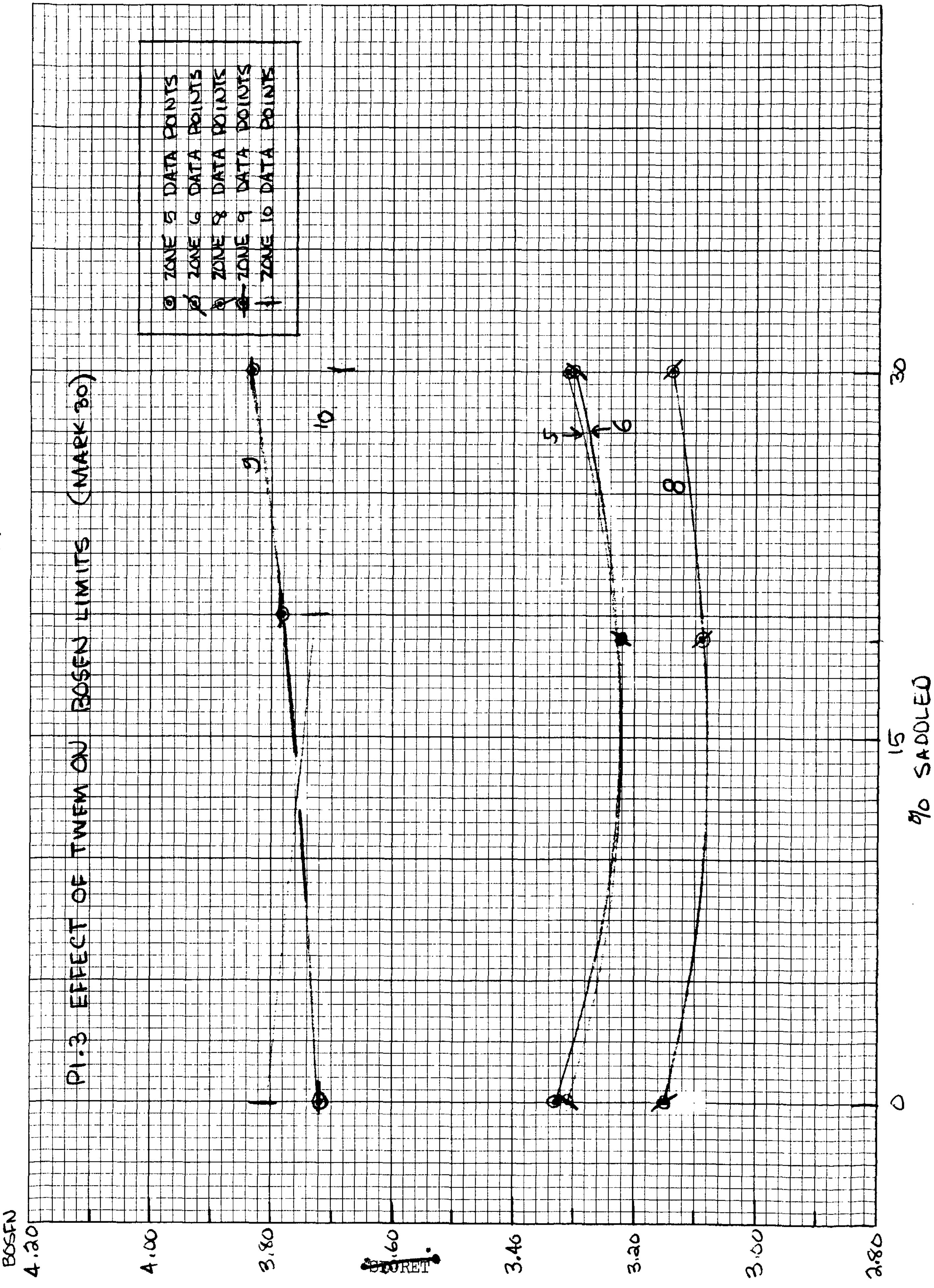
FIGURE 51


P1.3 EFFECT OF TWEM ON BOSEN LIMITS (MARK 30)
ZONE 5 DATA POINTS
ZONE 6 DATA POINTS
ZONE 8 DATA POINTS
ZONE 9 DATA POINTS
ZONE 10 DATA POINTS
9
10
5
6
8
BOSEN
4.20
4.00
3.80
3.60
3.40
3.20
3.00
2.80
0
15
30
% SADDLED

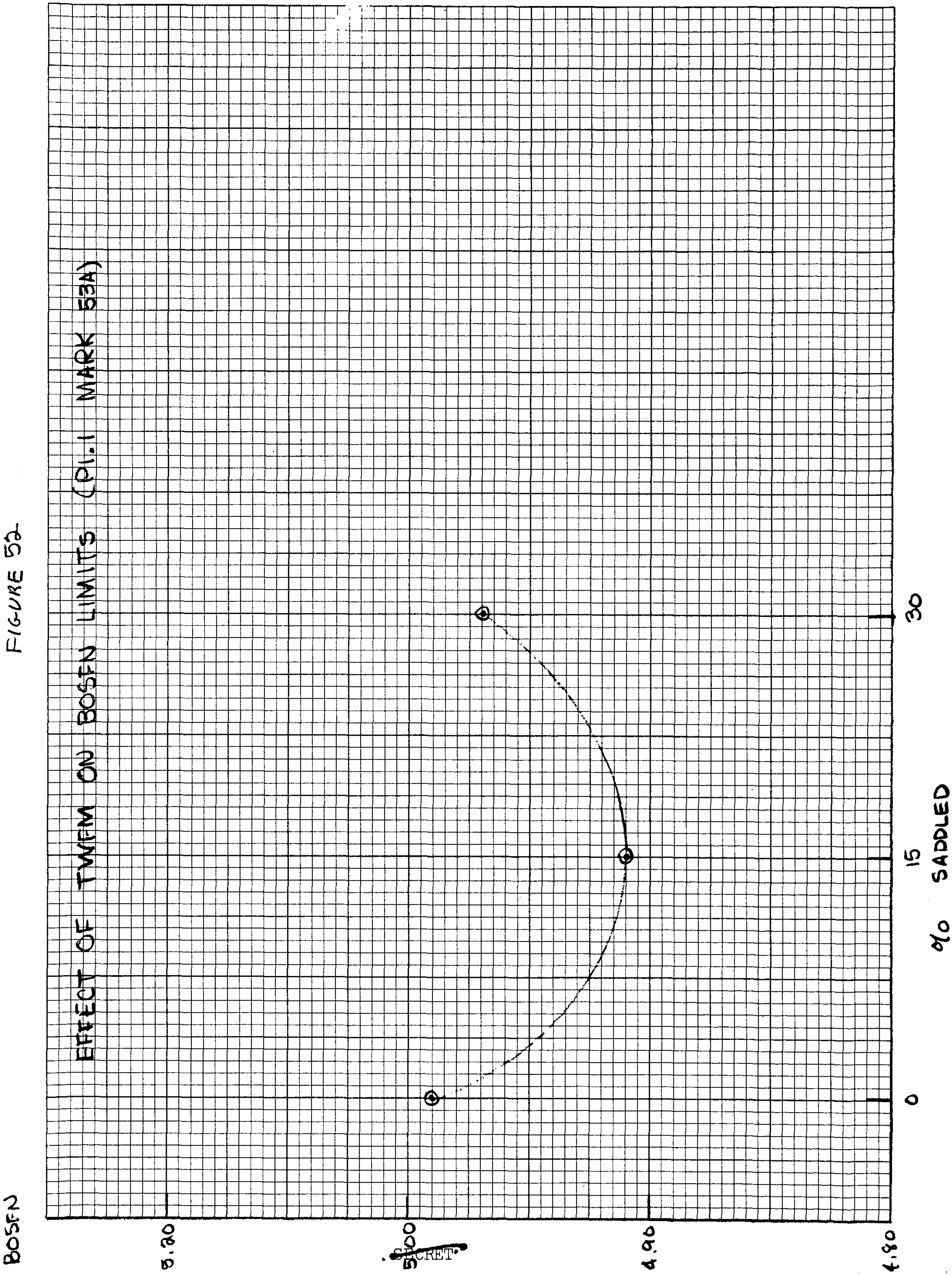


FIGURE 52
EFFECT OF TWFM ON BOSFN LIMITS (Pl.1 MARK 53A)
0
15
30
% SADDLED
BOSFN
5.20
5.00
4.90
4.80

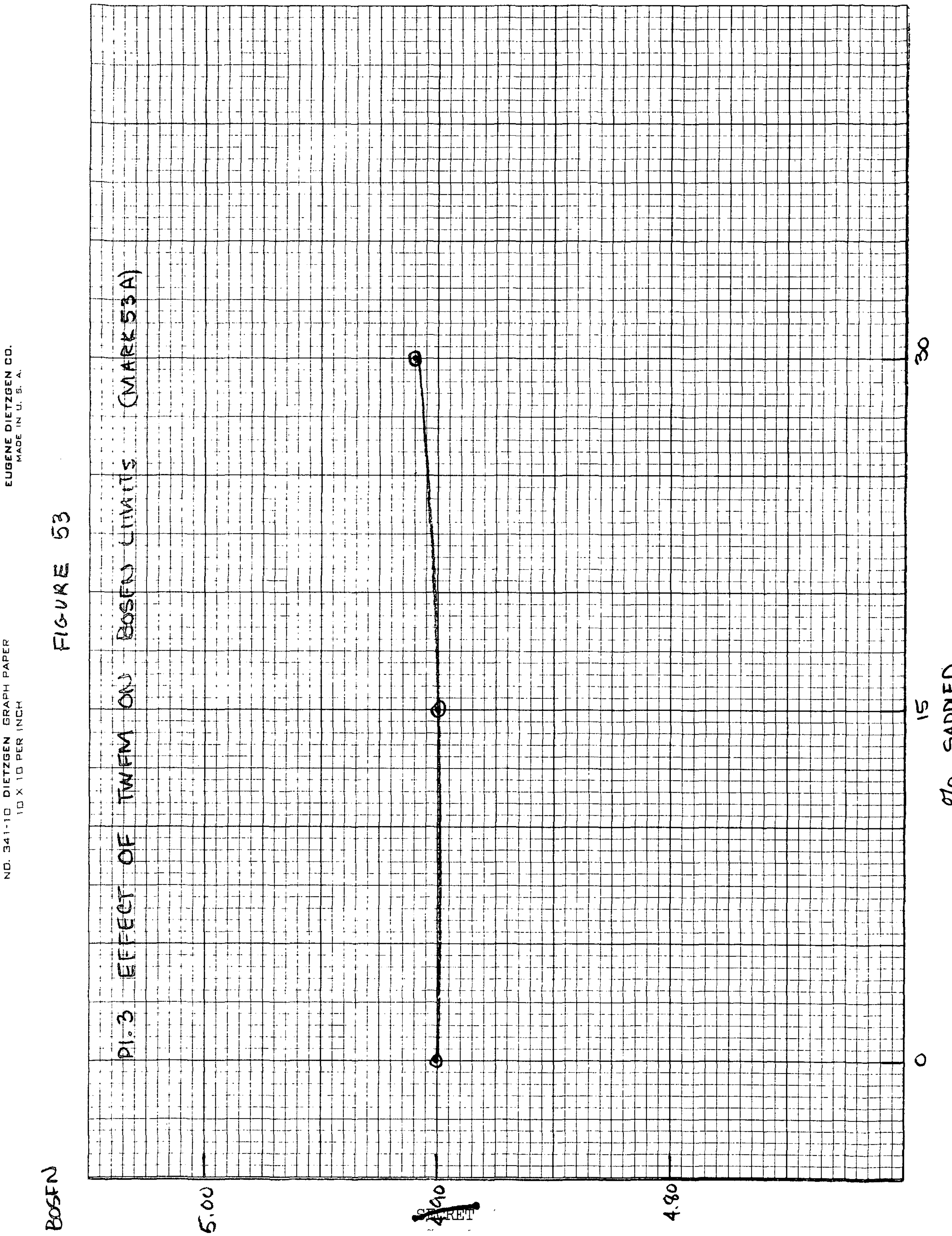

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FIGURE 53
PI.3 EFFECT OF TWFM ON BOSEN LIMITS (MARK 53A)
0
15
30
% SADDED
BOSEN
5.00
4.90
4.80

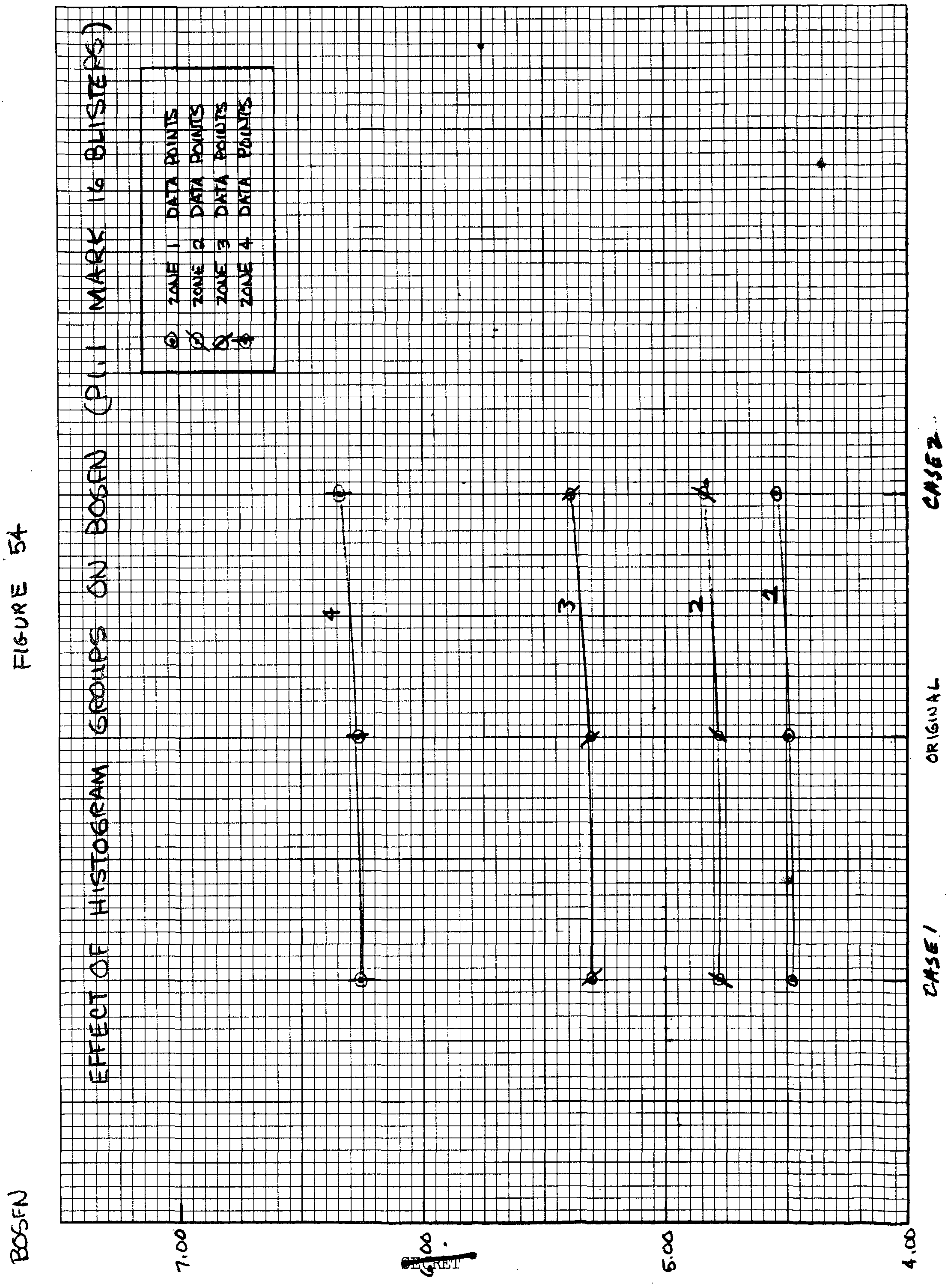

EFFECT OF HISTOGRAM GROUPS ON BOSEN (PU MARK 16 BLISTERS)
ZONE 1 DATA POINTS
ZONE 2 DATA POINTS
ZONE 3 DATA POINTS
ZONE 4 DATA POINTS
1
2
3
4
CASE 1
ORIGINAL
CASE 2
BOSEN
7.00
6.00
4.00

FIGURE 54

FIGURE 55

P1.3 EFFECT OF HISTOGRAM ON BOSFN (MARK 16 BLISTERS)

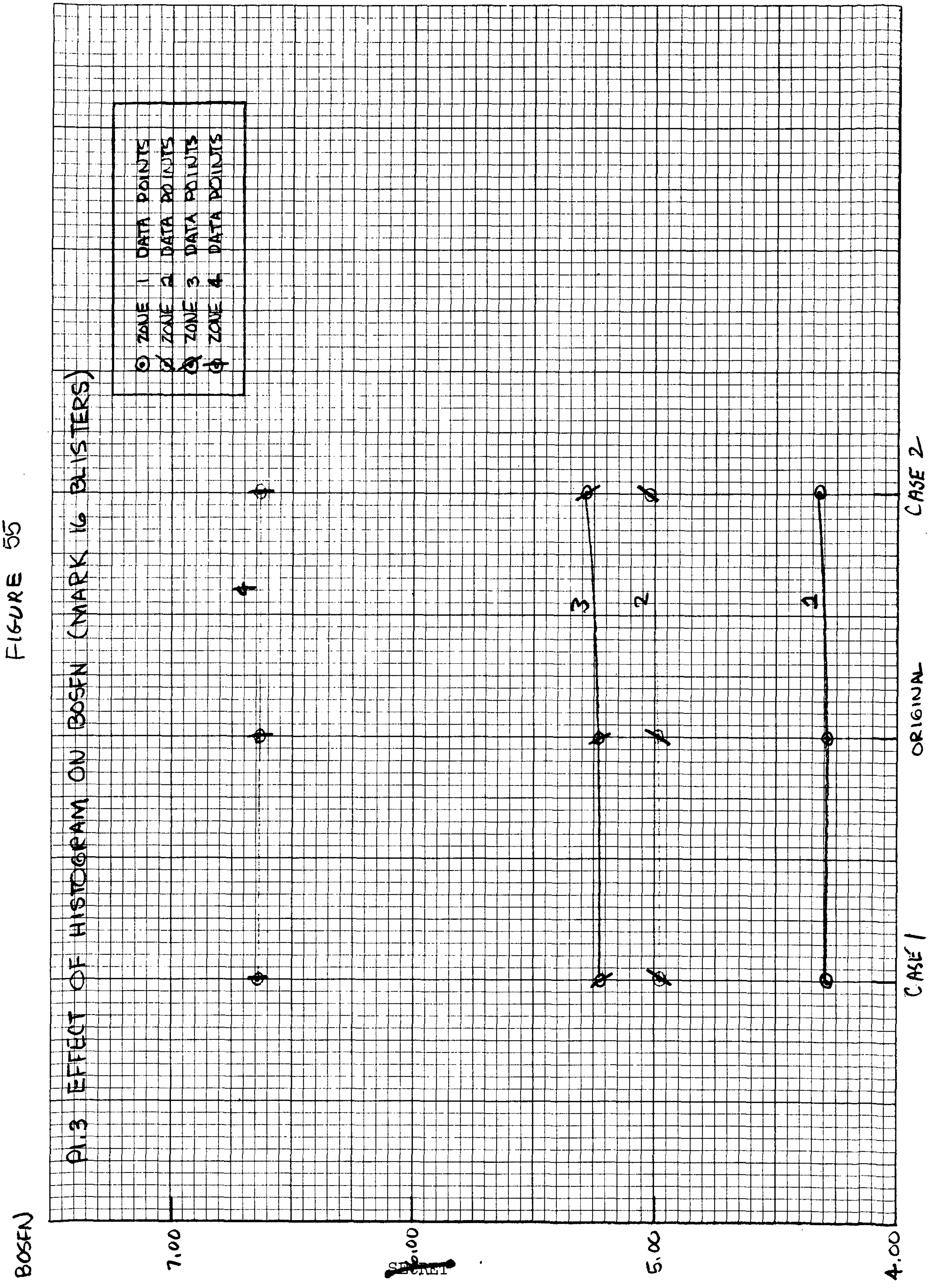
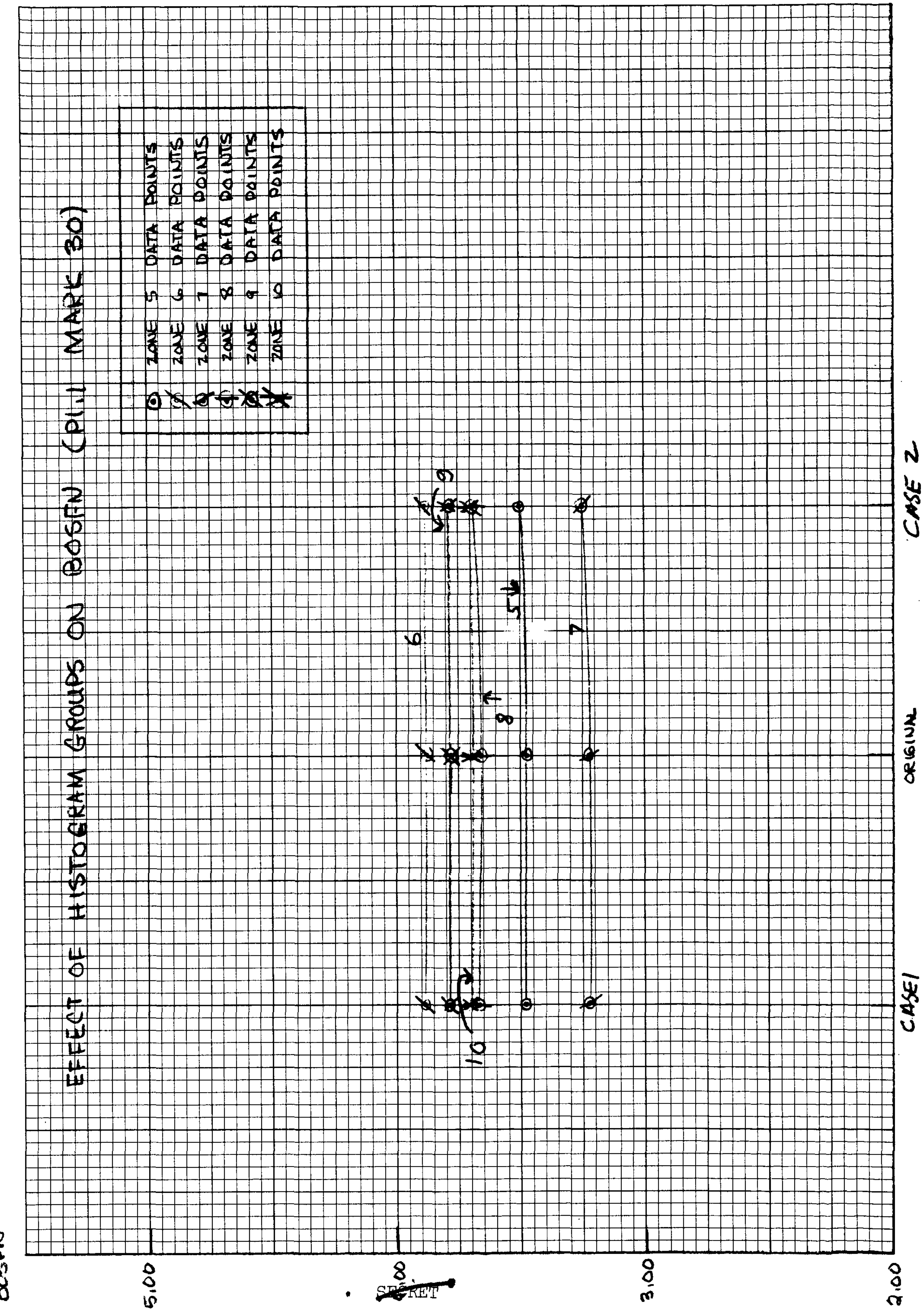


FIGURE 56


EFFECT OF HISTOGRAM GROUPS ON BOSFN (PU MARK 30)
ZONE 5 DATA POINTS
ZONE 6 DATA POINTS
ZONE 7 DATA POINTS
ZONE 8 DATA POINTS
ZONE 9 DATA POINTS
ZONE 10 DATA POINTS
CASE 1
ORIGINAL
CASE 2
BOSFN
5.00
3.00
2.00

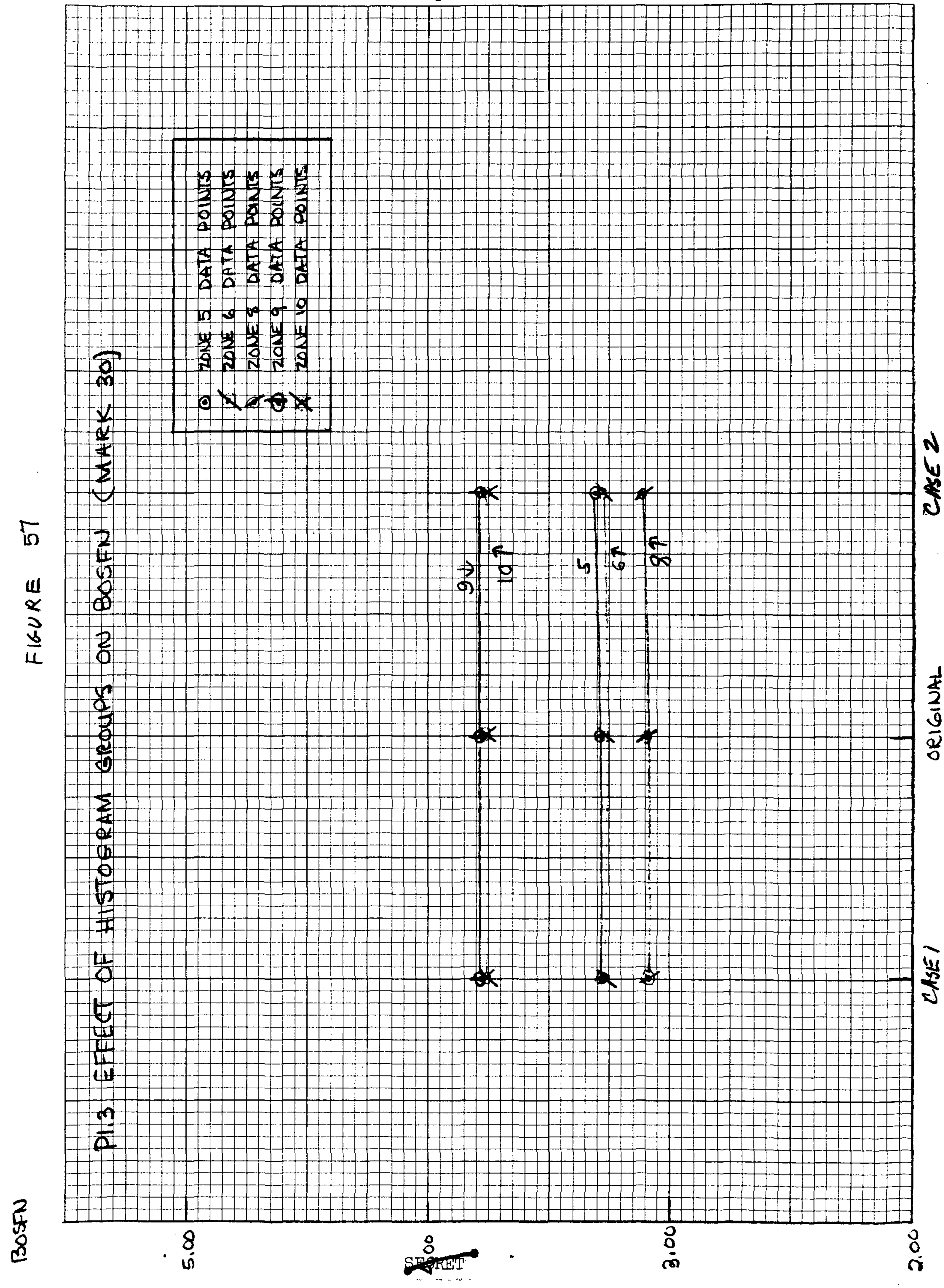

P1.3 EFFECT OF HISTOGRAM GROUPS ON BOSFN (MARK 30)
ZONE 5 DATA POINTS
ZONE 6 DATA POINTS
ZONE 8 DATA POINTS
ZONE 9 DATA POINTS
ZONE 10 DATA POINTS
9↓
10↑
5
6↑
8↑
CASE 1
ORIGINAL
CASE 2
5.00
4.00
3.00
2.00
BOSFN

FIGURE 57

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FIGURE 58

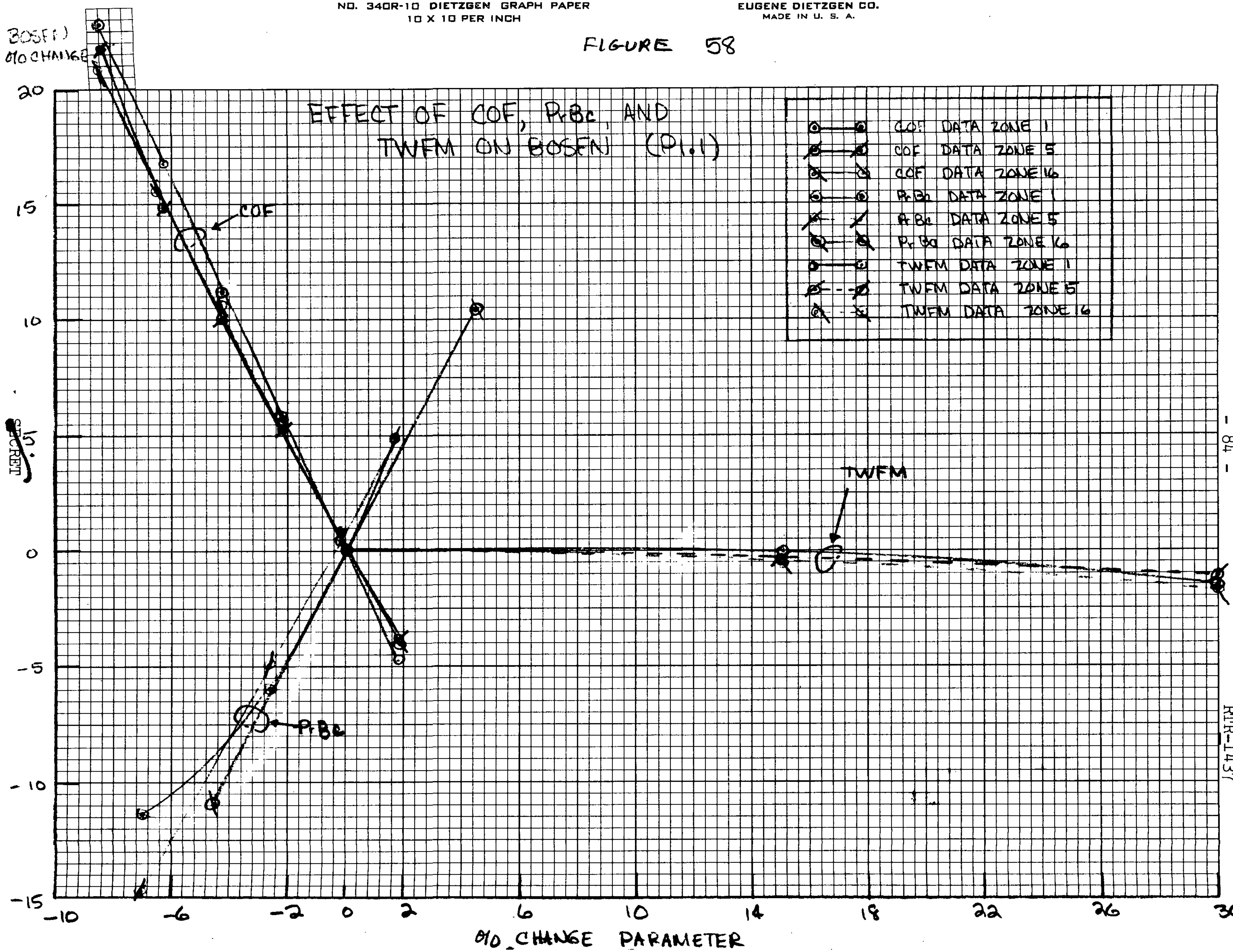

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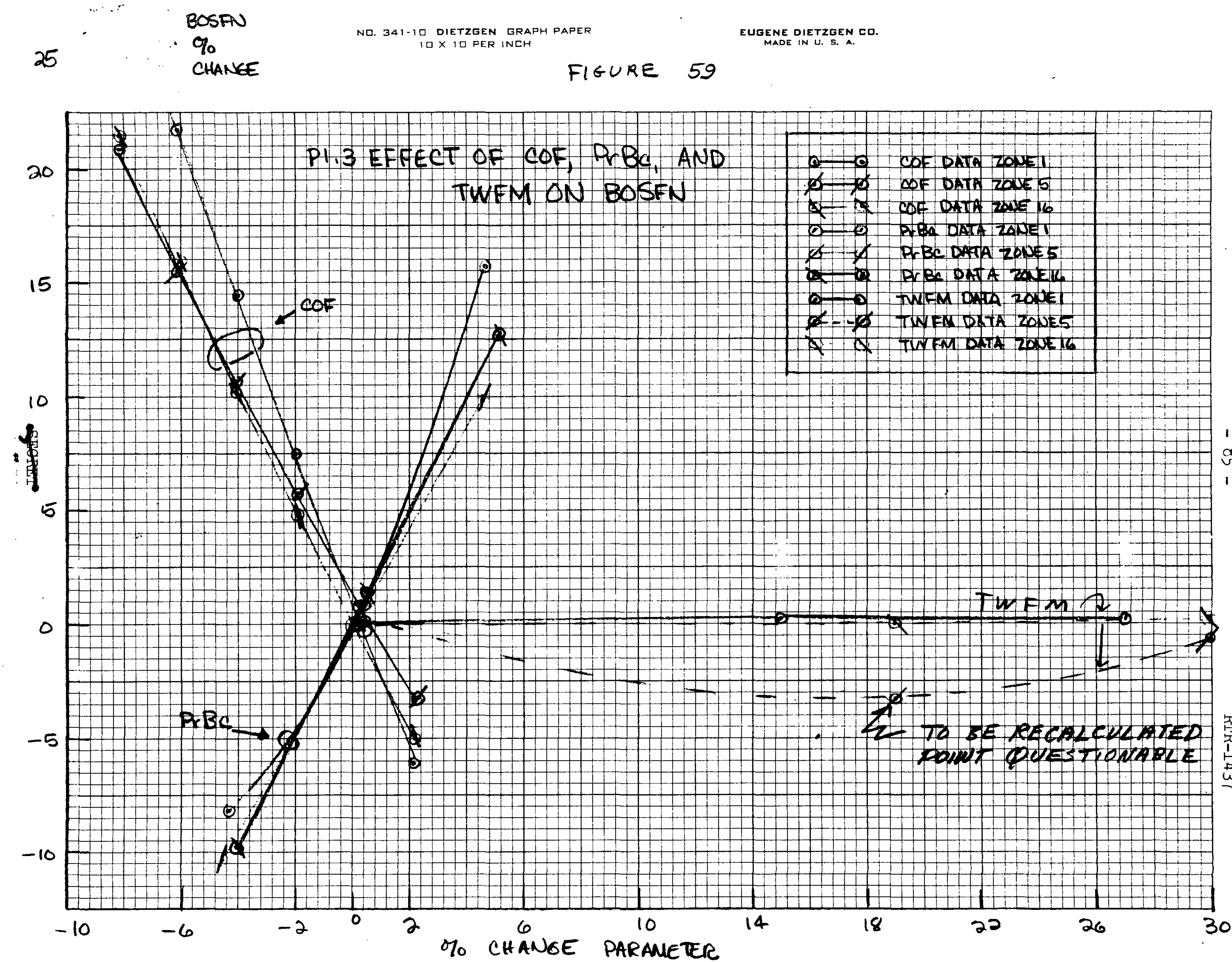
FIGURE 59


BOSFN % CHANGE
P1.3 EFFECT OF COF, PrBc, AND TWFM ON BOSFN
COF DATA ZONE 1
COF DATA ZONE 5
COF DATA ZONE 16
PrBc DATA ZONE 1
PrBc DATA ZONE 5
PrBc DATA ZONE 16
TWFM DATA ZONE 1
TWFM DATA ZONE 5
TWFM DATA ZONE 16
COF
PrBc
TWFM
TO BE RECALCULATED
POINT QUESTIONABLE
25
20
15
10
5
0
-5
-10
-10
-6
-2
0
2
6
10
14
18
22
26
30
% CHANGE PARAMETER

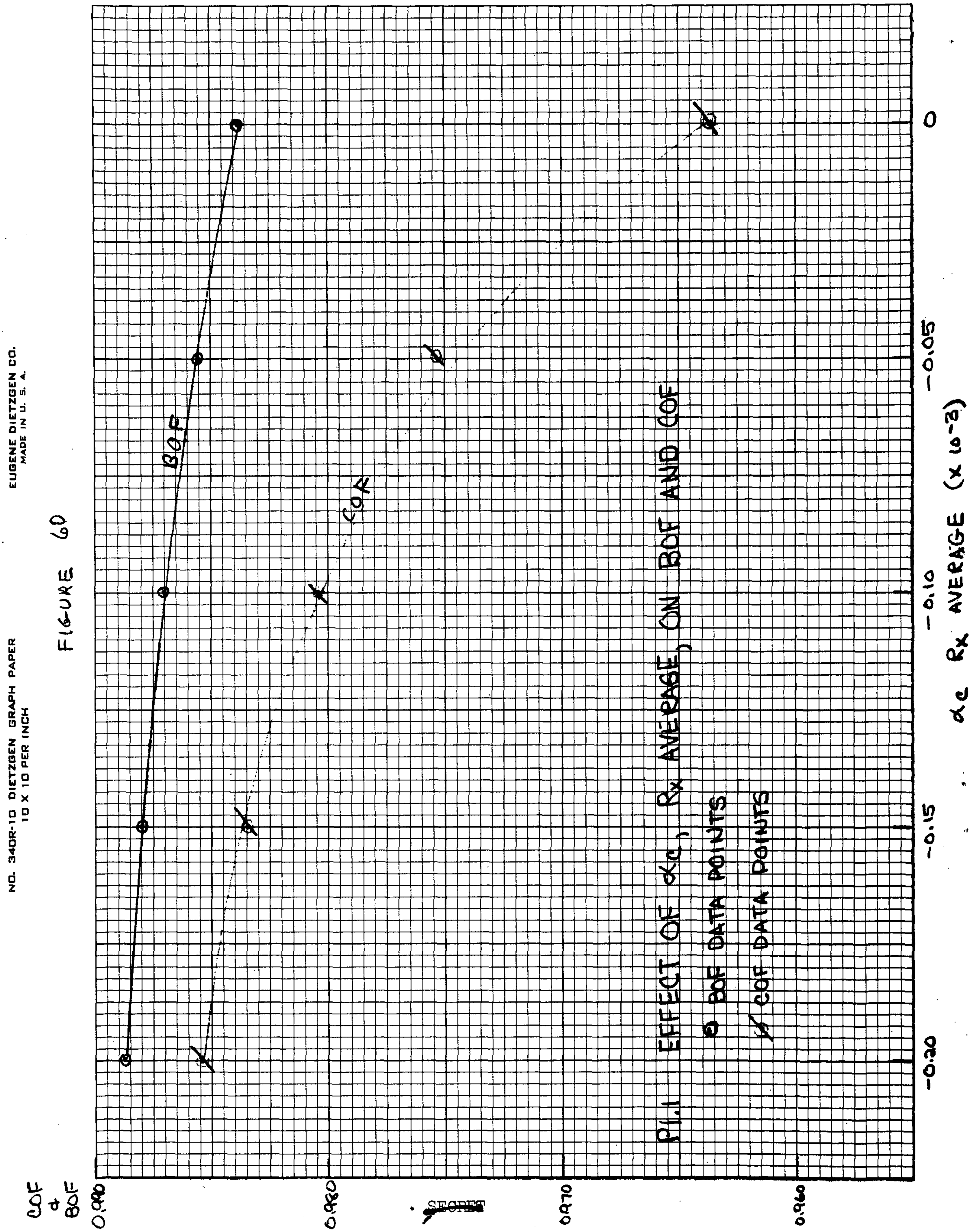

NO. 340R-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH
EUGENE DIETZGEN CO.
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FIGURE 60
P1.1 EFFECT OF αc, Rx AVERAGE, ON BOF AND COF
BOF DATA POINTS
COF DATA POINTS
BOF
COF
0
-0.05
-0.10
-0.15
-0.20
αc Rx AVERAGE (x 10^-3)
COF & BOF
0.990
0.980
0.970
0.960

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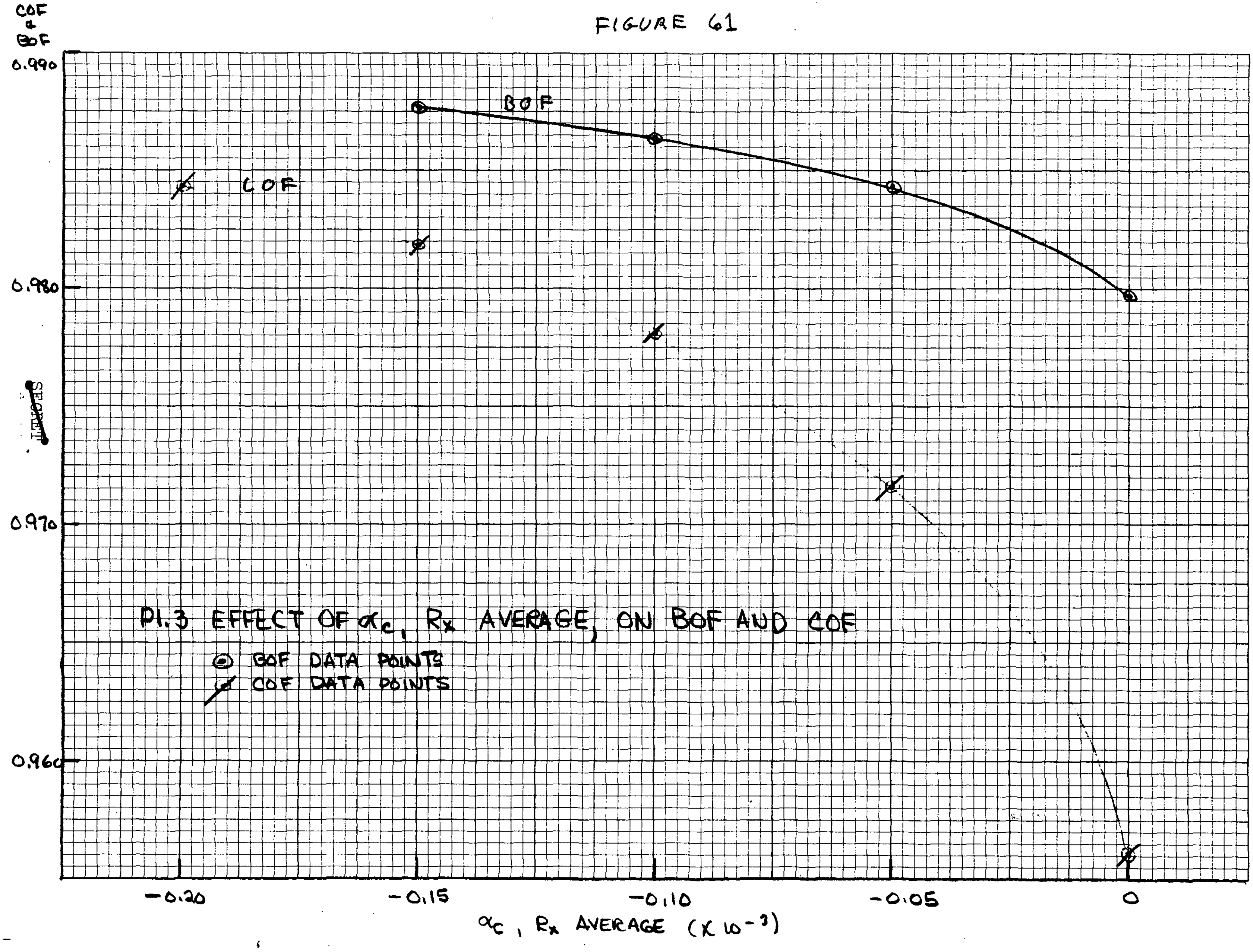
EUGENE DIETZGEN CO. MADE IN U. S. A.

FIGURE 61



SECRET

SECRET
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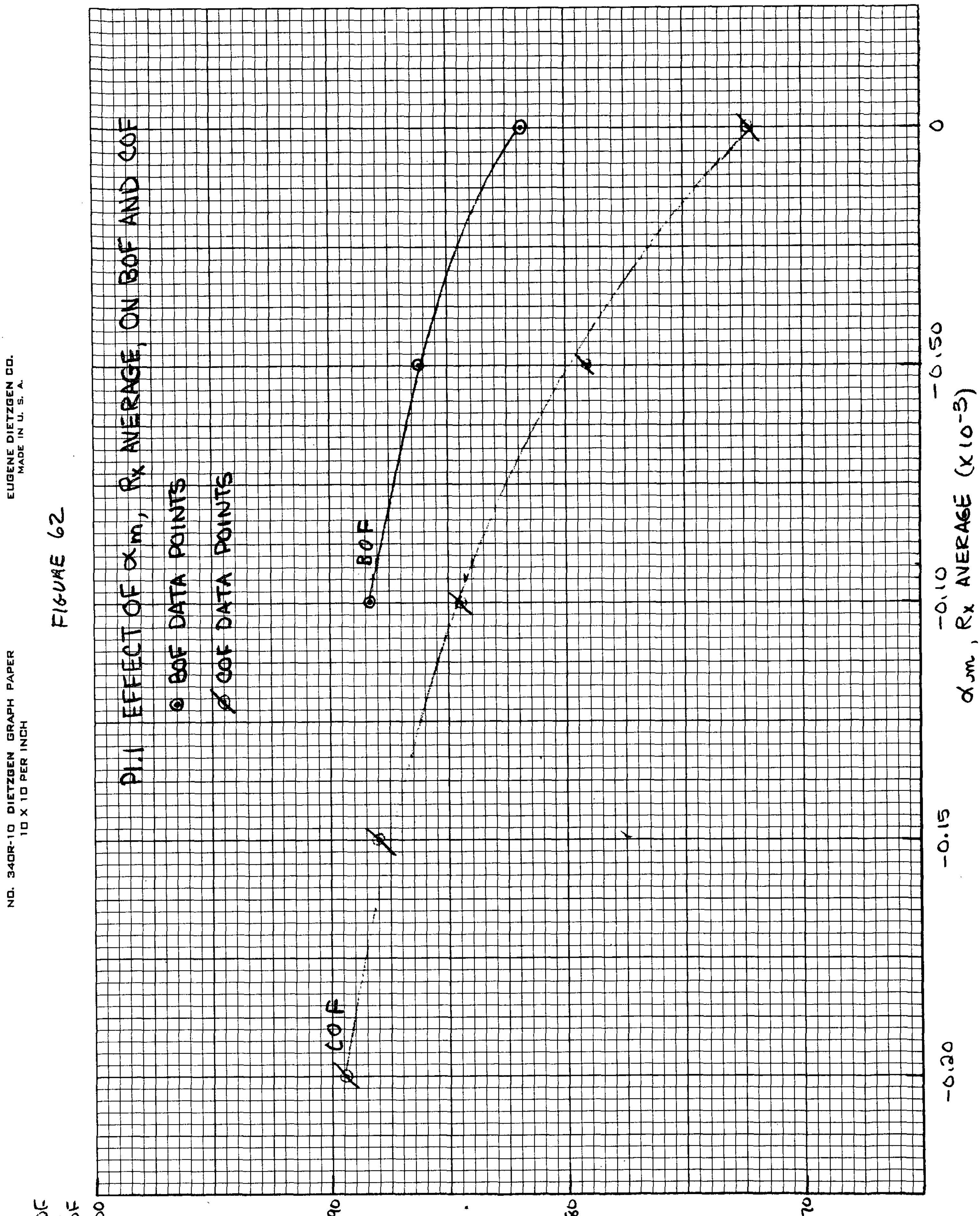
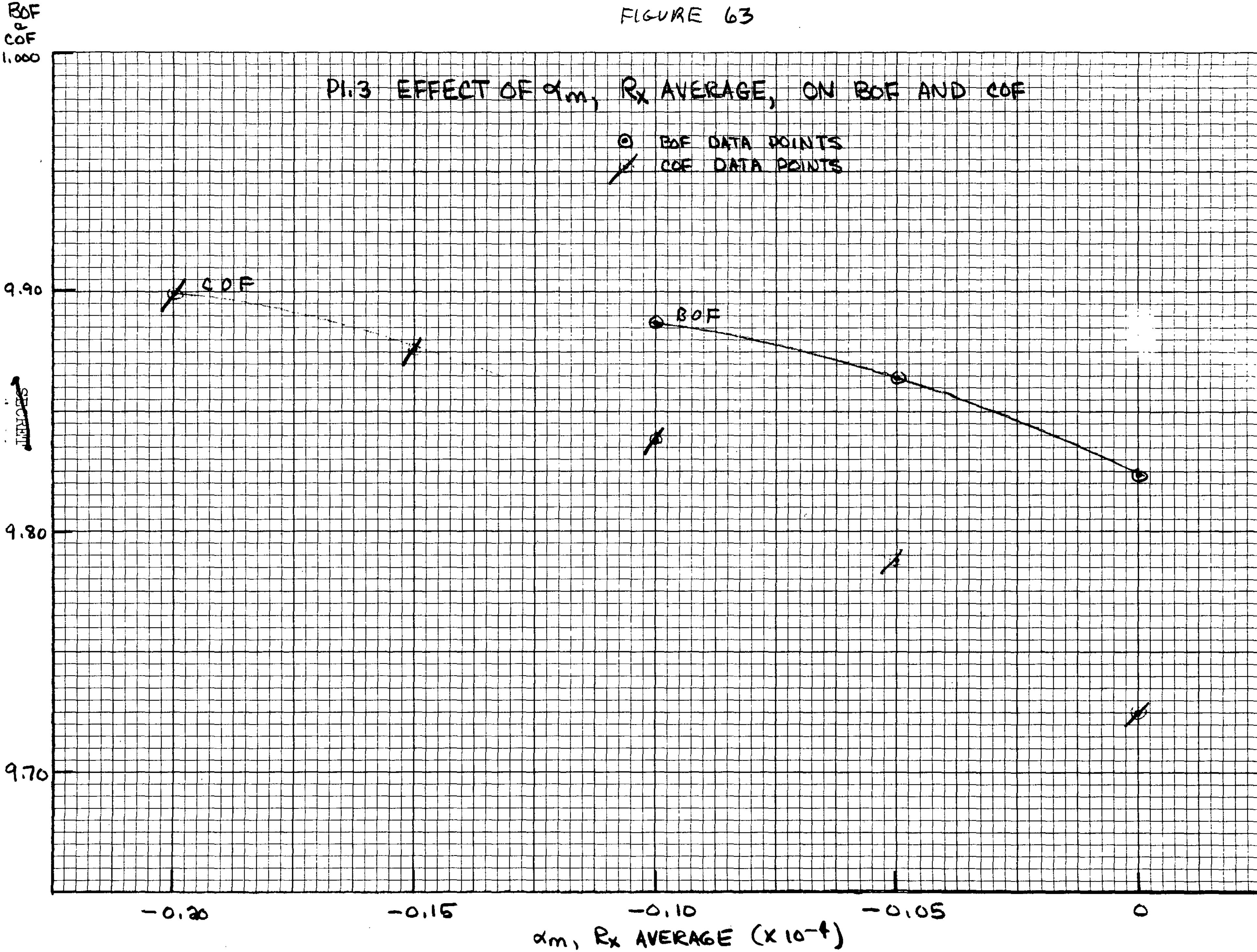


FIGURE 63



SECRET

SECRET

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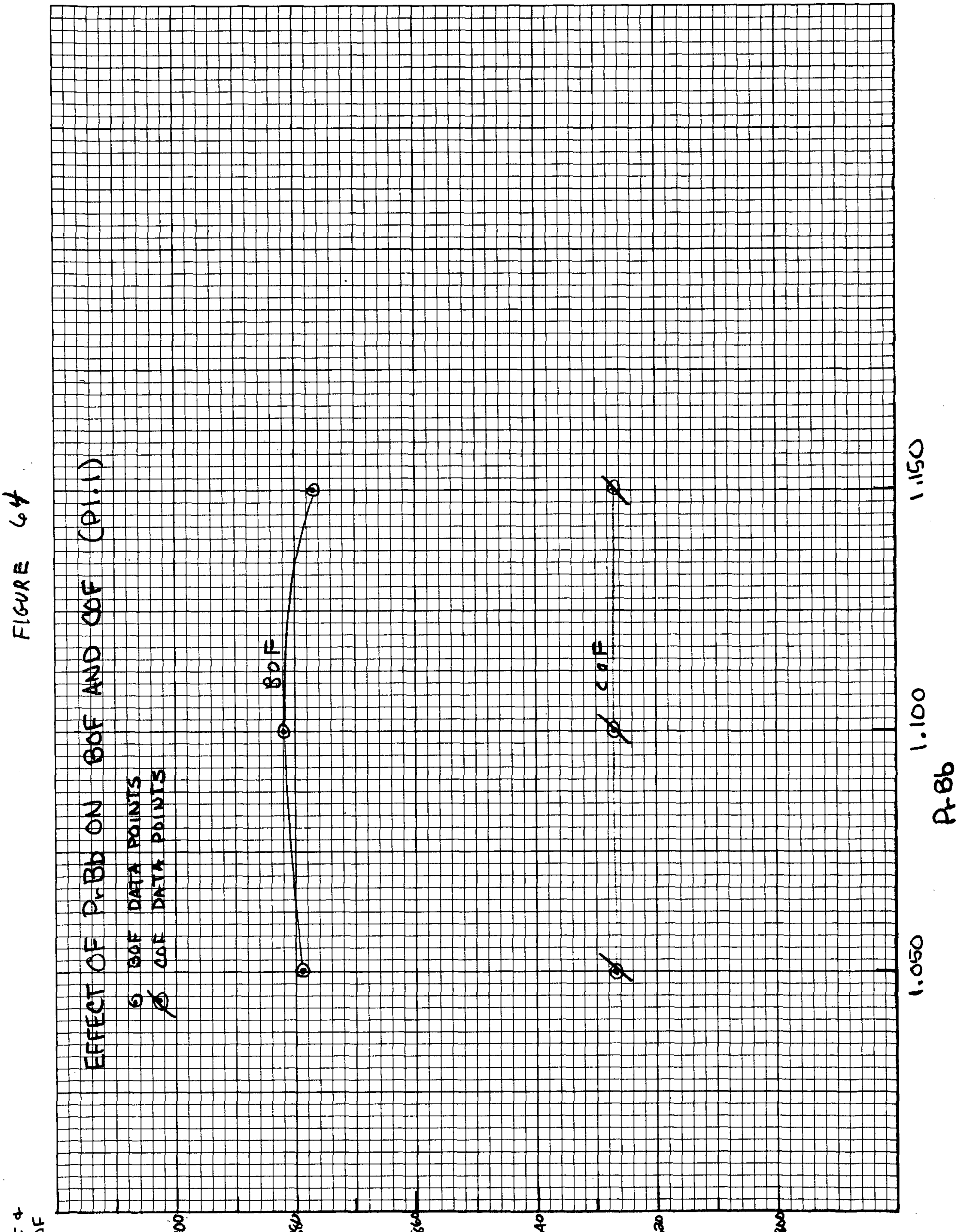
FIGURE 64
EFFECT OF Pr-Bb ON BOF AND COF (P1.1)
BOF DATA POINTS
COF DATA POINTS
BOF
COF
1.050
1.100
1.150
Pr-Bb
BOF & COF
0.9900
0.9840
0.9820
0.9800

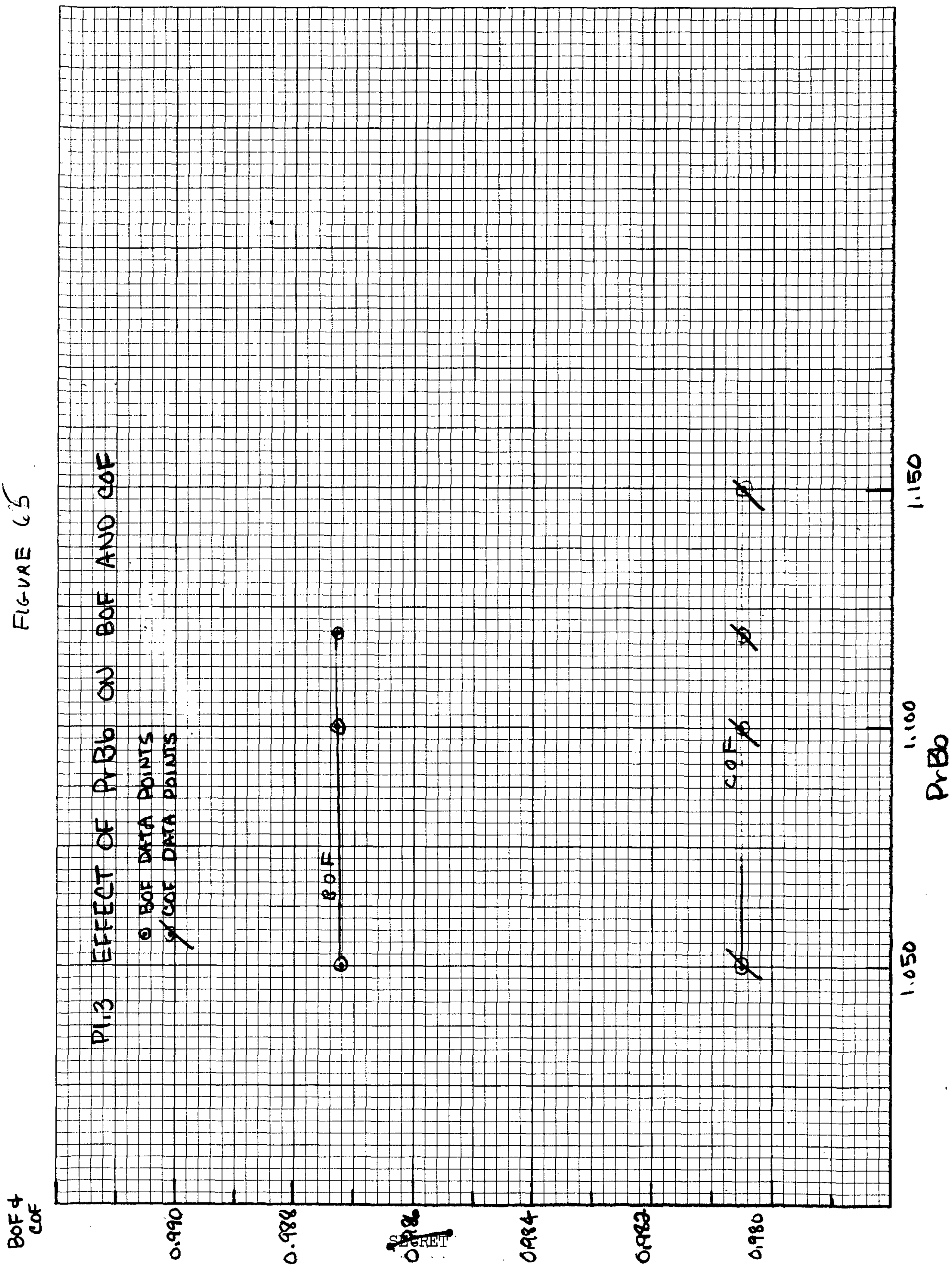
FIGURE 65
P1.3 EFFECT OF PrBo ON BOF AND COF
⊙ BOF DATA POINTS
COF DATA POINTS
BOF
COF
1.050
1.100
1.150
PrBo
BOF & COF
0.990
0.988
0.986
0.984
0.982
0.980

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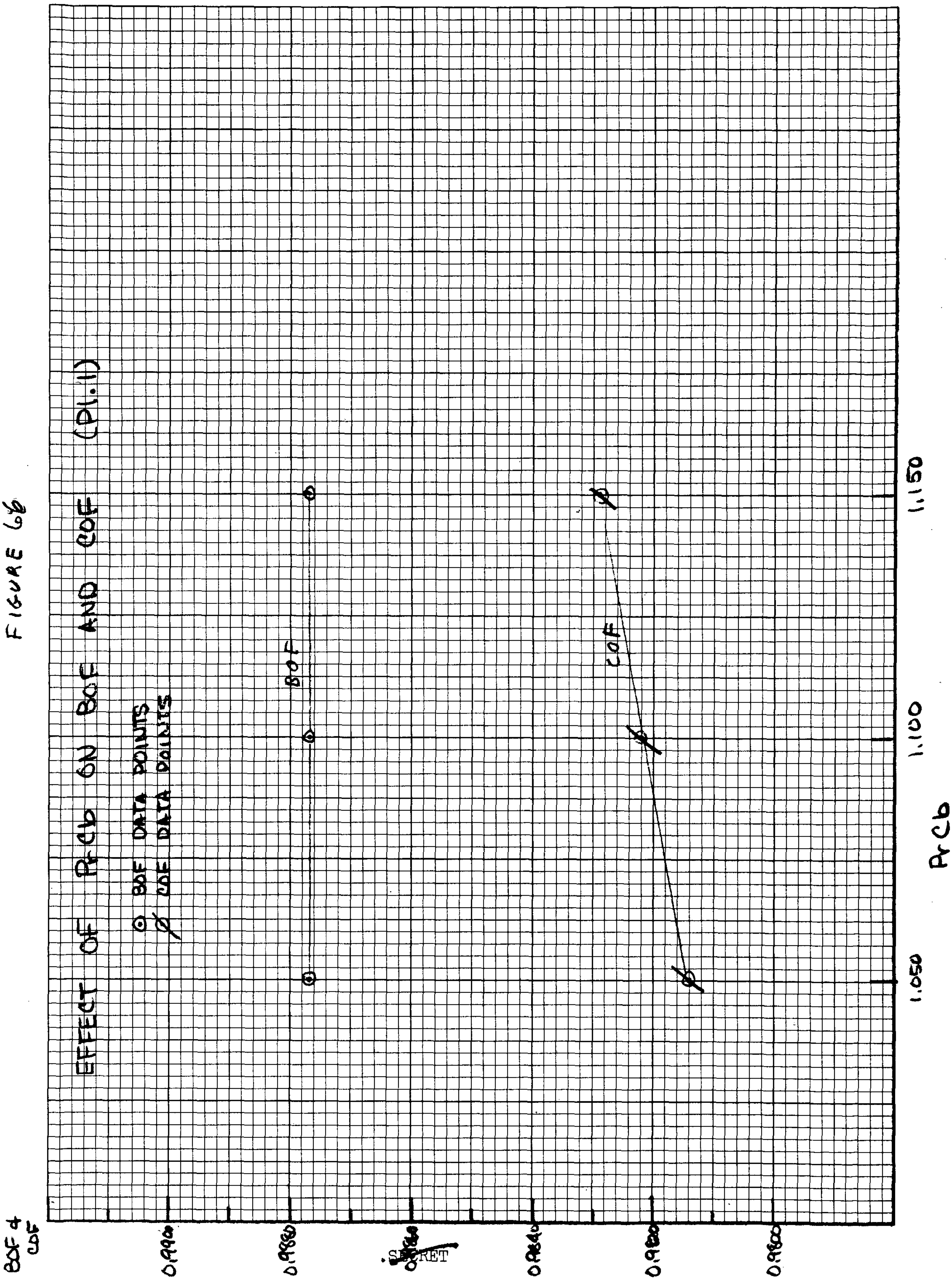

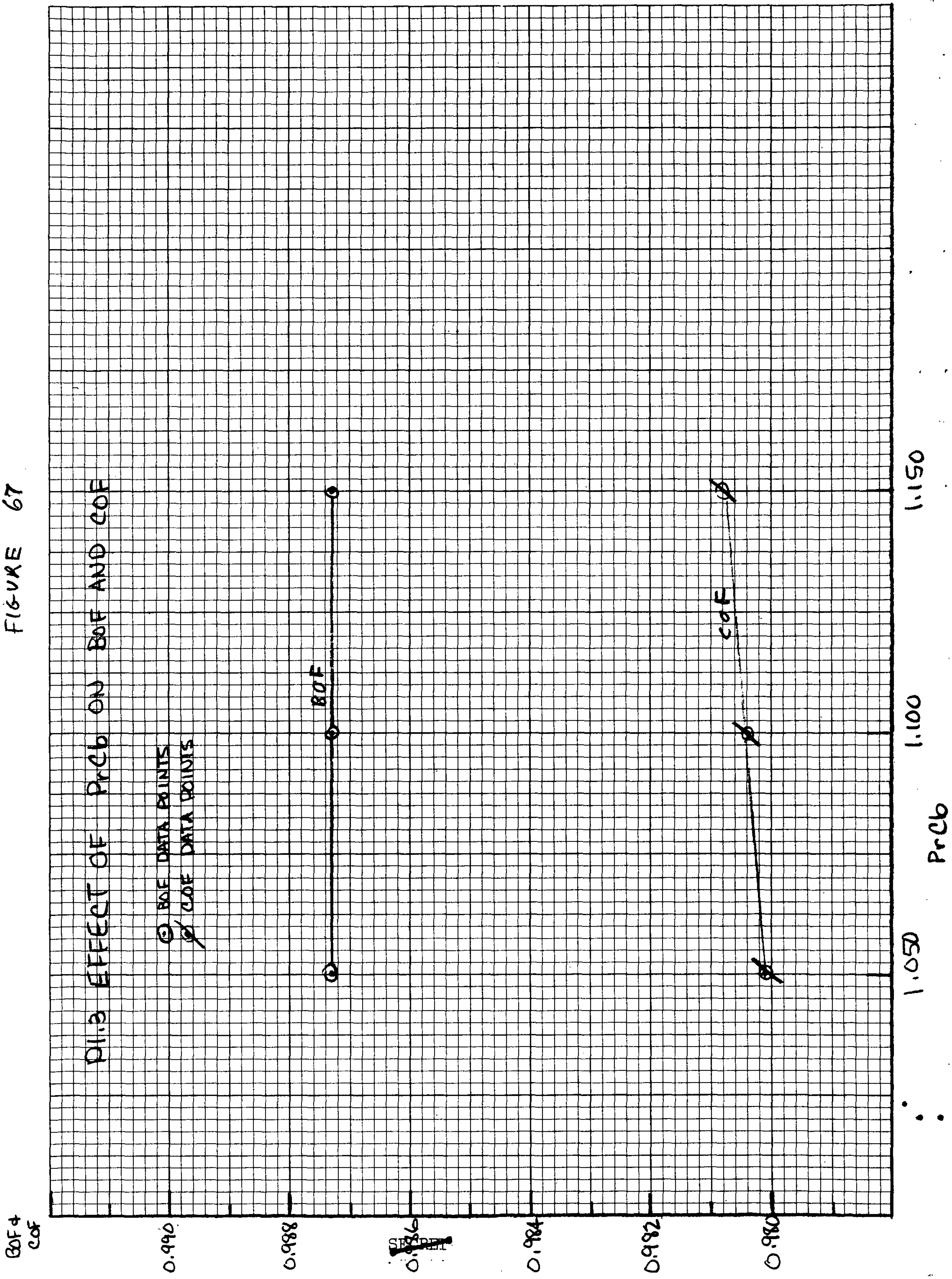

FIGURE 67

D11.3 EFFECT OF PrCb ON BOF AND COF

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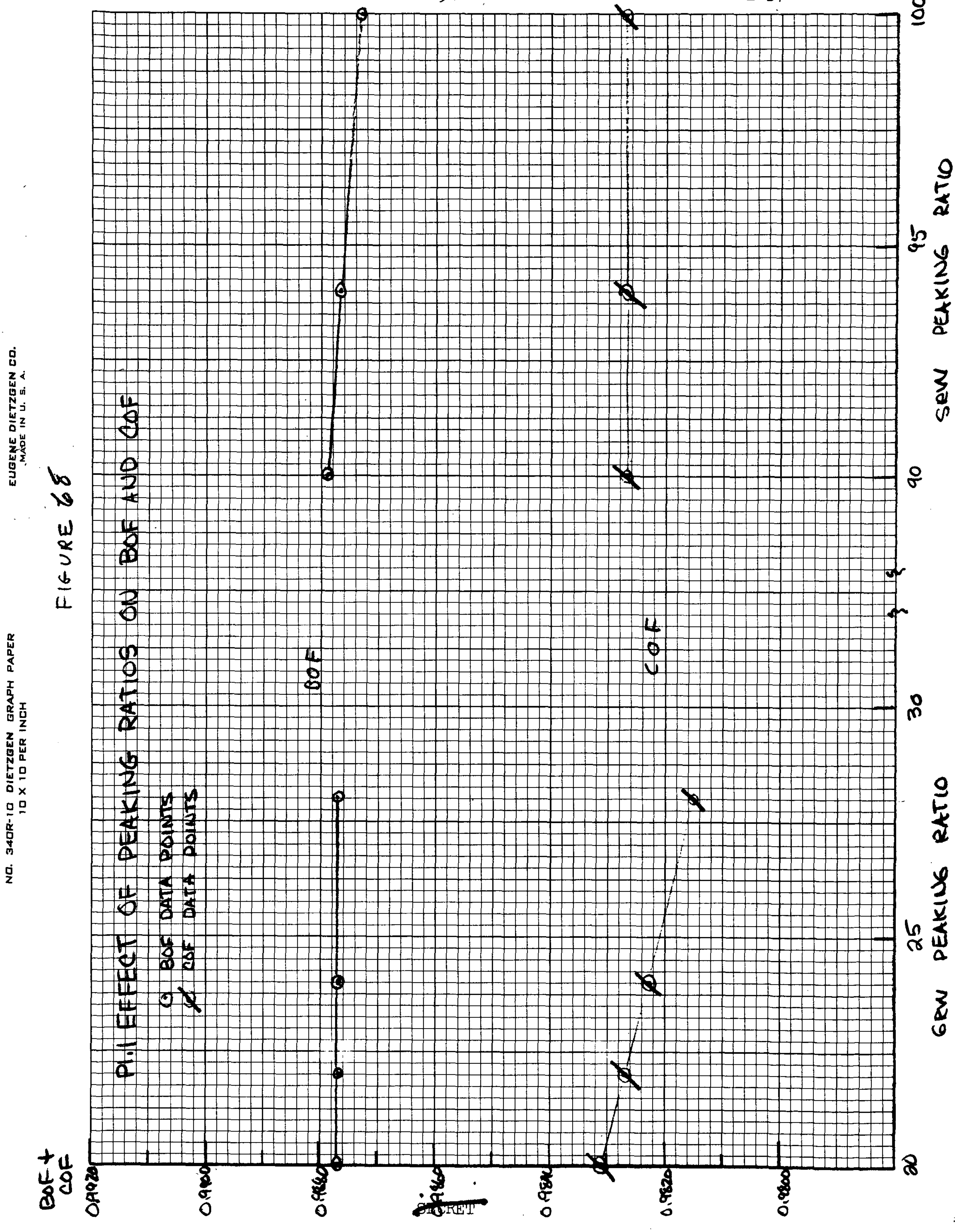
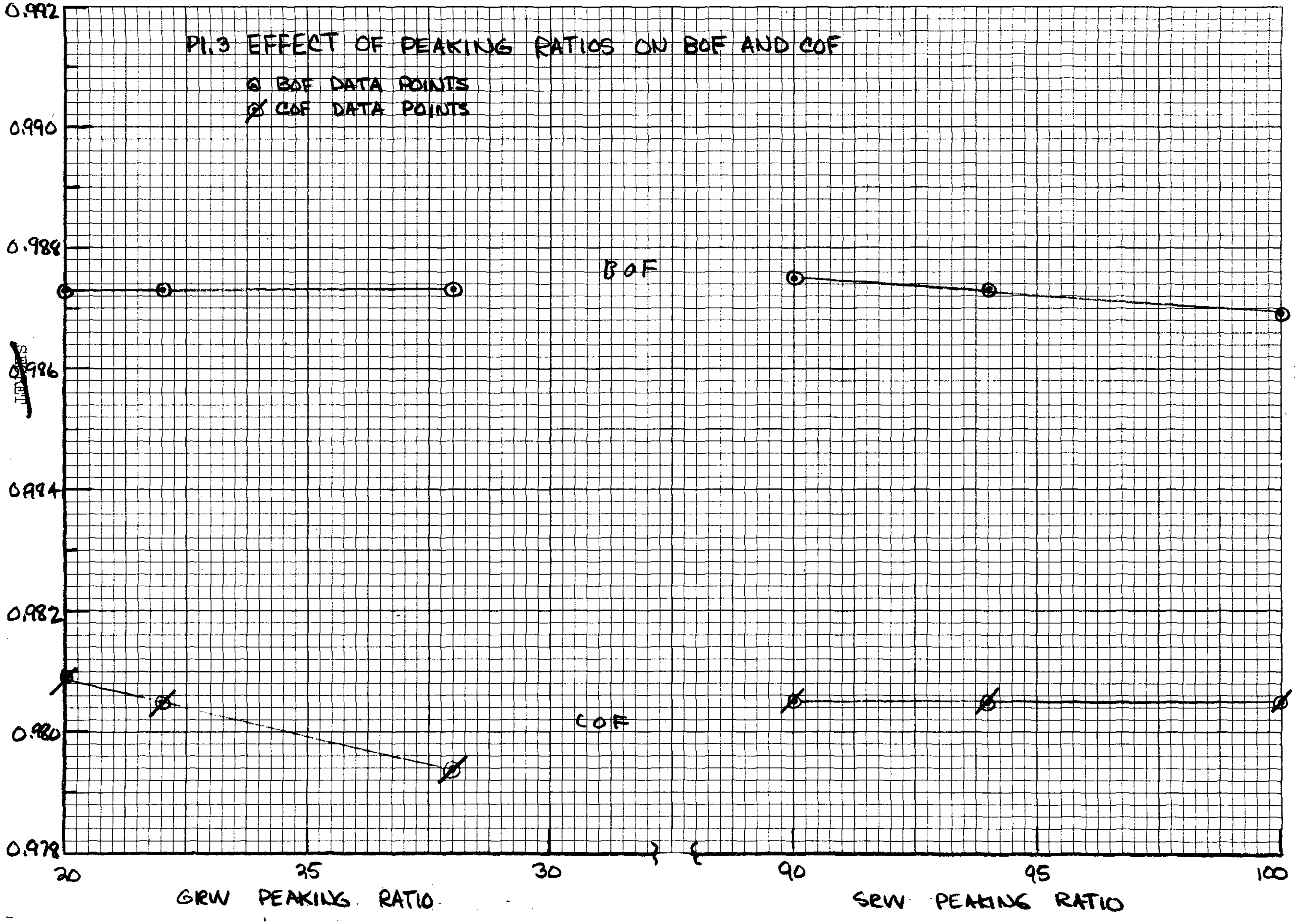


FIGURE 69



SECRET

SECRET
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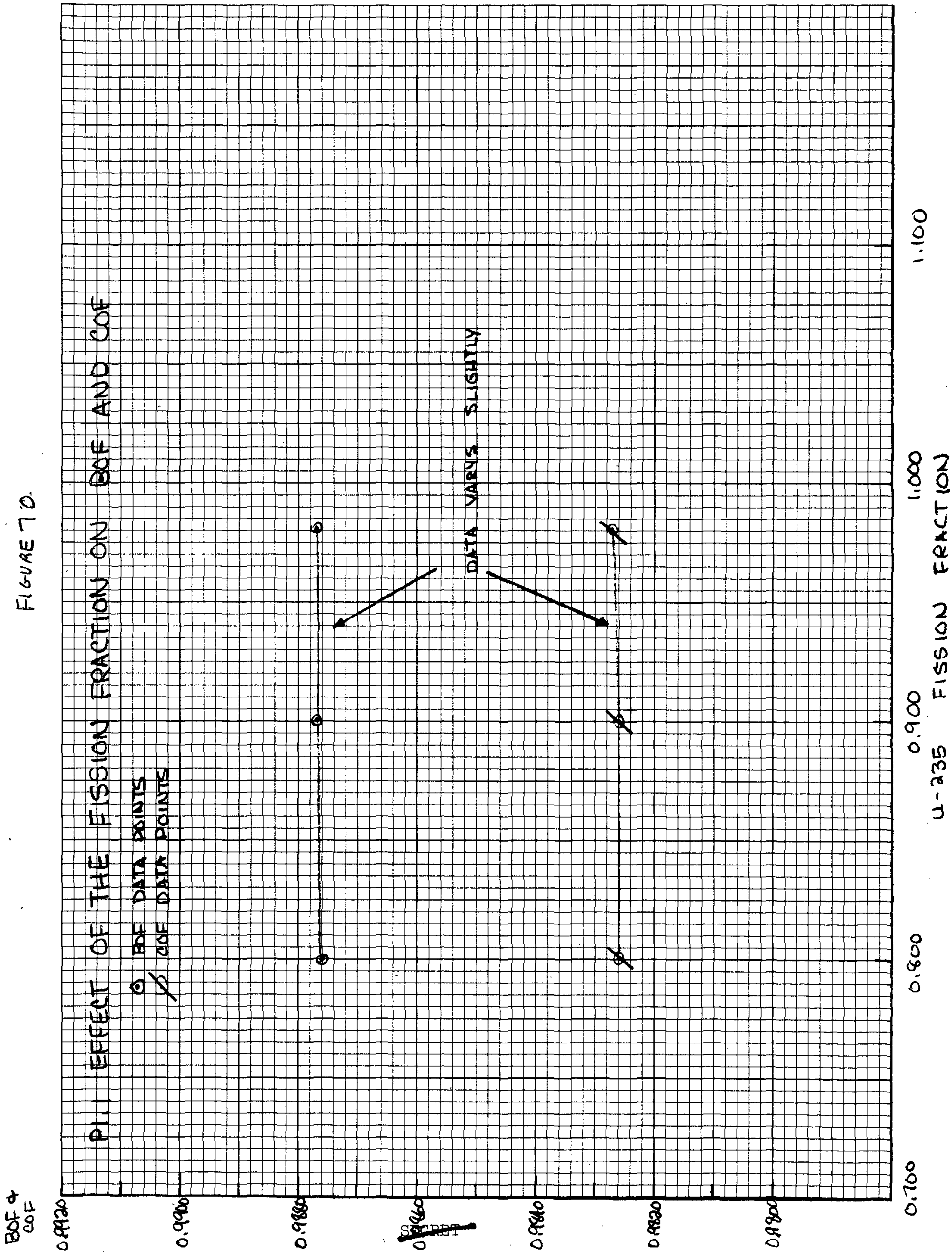


FIGURE 7D.
PU EFFECT OF THE FISSION FRACTION ON BOF AND COF
⊙ BOF DATA POINTS
⊘ COF DATA POINTS
DATA VARYS SLIGHTLY
U-235 FISSION FRACTION
0.700
0.800
0.900
1.000
1.100
BOF & COF
0.9920
0.9900
0.9880
0.9860
0.9840
0.9820
0.9800

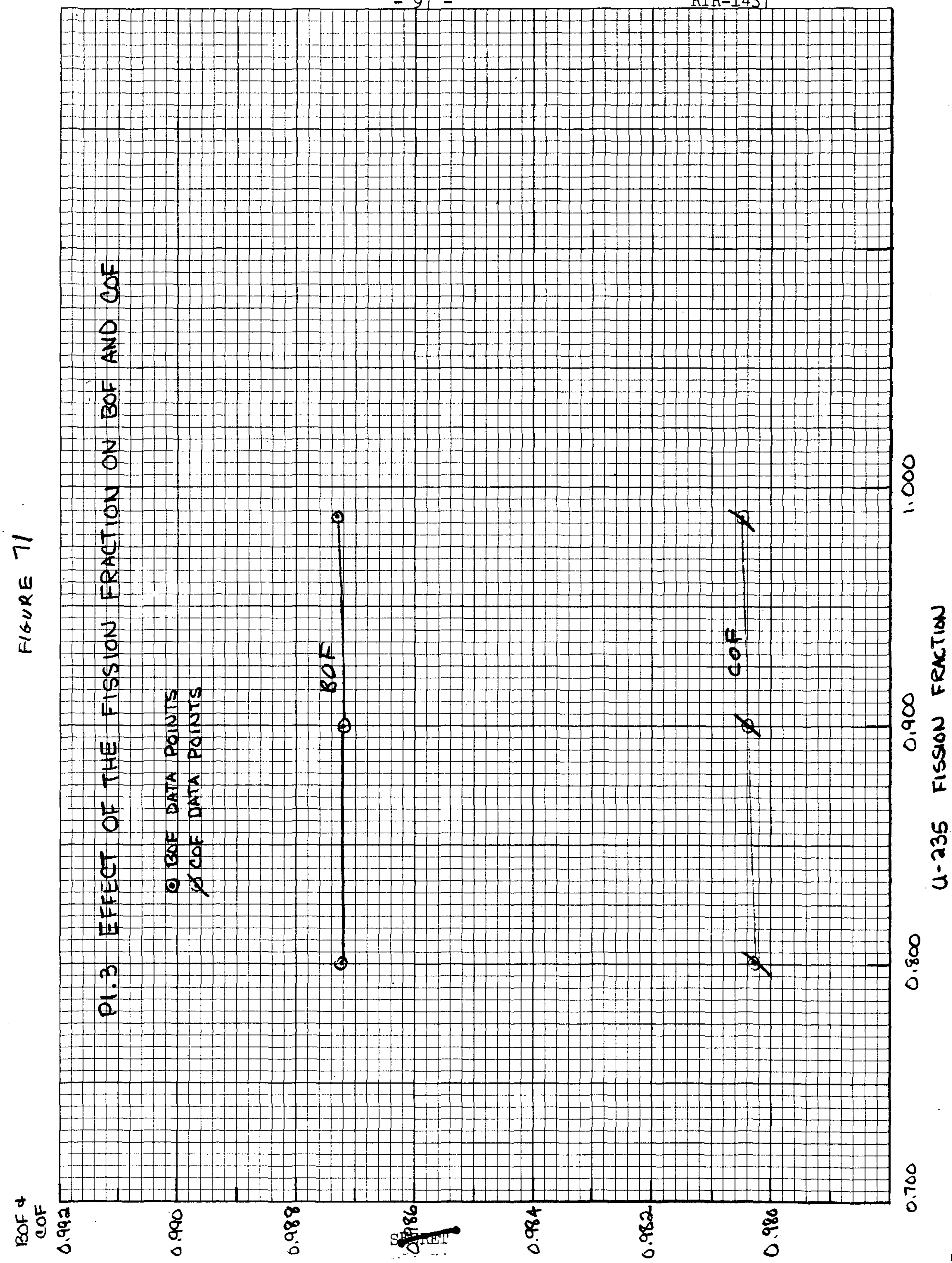
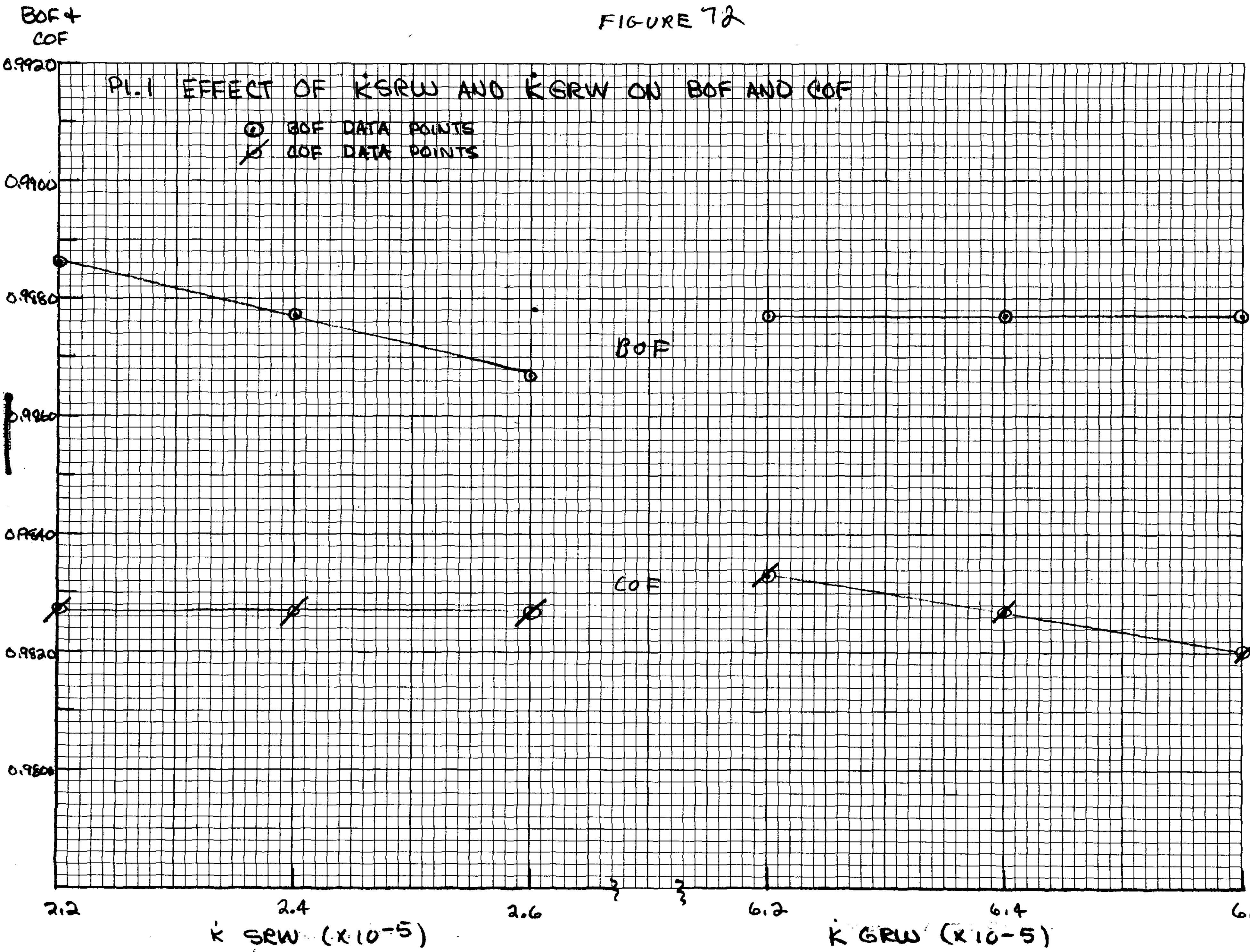


FIGURE 71
P1.3 EFFECT OF THE FISSION FRACTION ON BOF AND COF
⊙ BOF DATA POINTS
⌀ COF DATA POINTS
BOF
COF
BOF & COF
0.992
0.990
0.988
0.986
0.984
0.982
0.980
0.700
0.800
0.900
1.000
U-235 FISSION FRACTION

FIGURE 72



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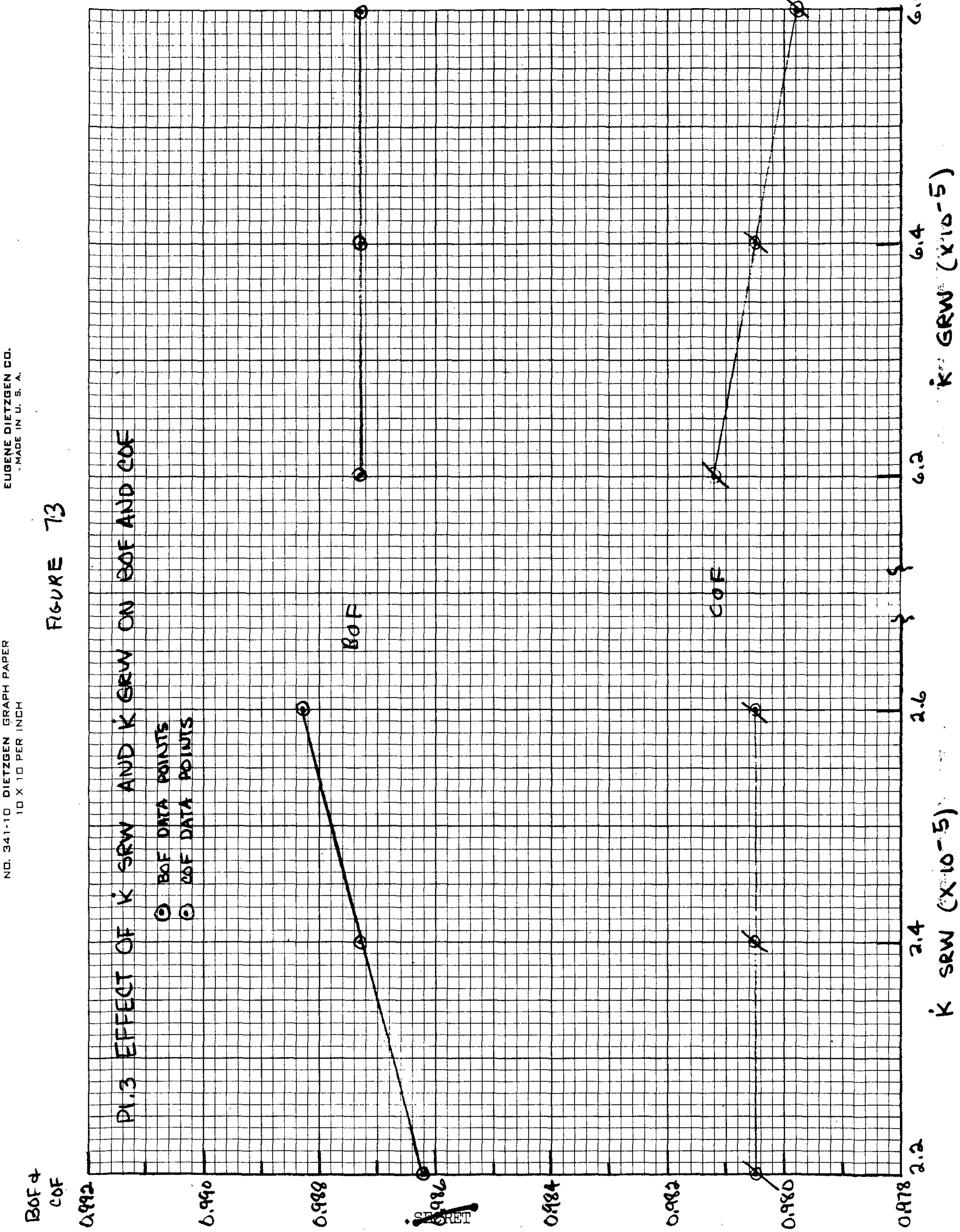
DPSP-73-1496
RTR-1437



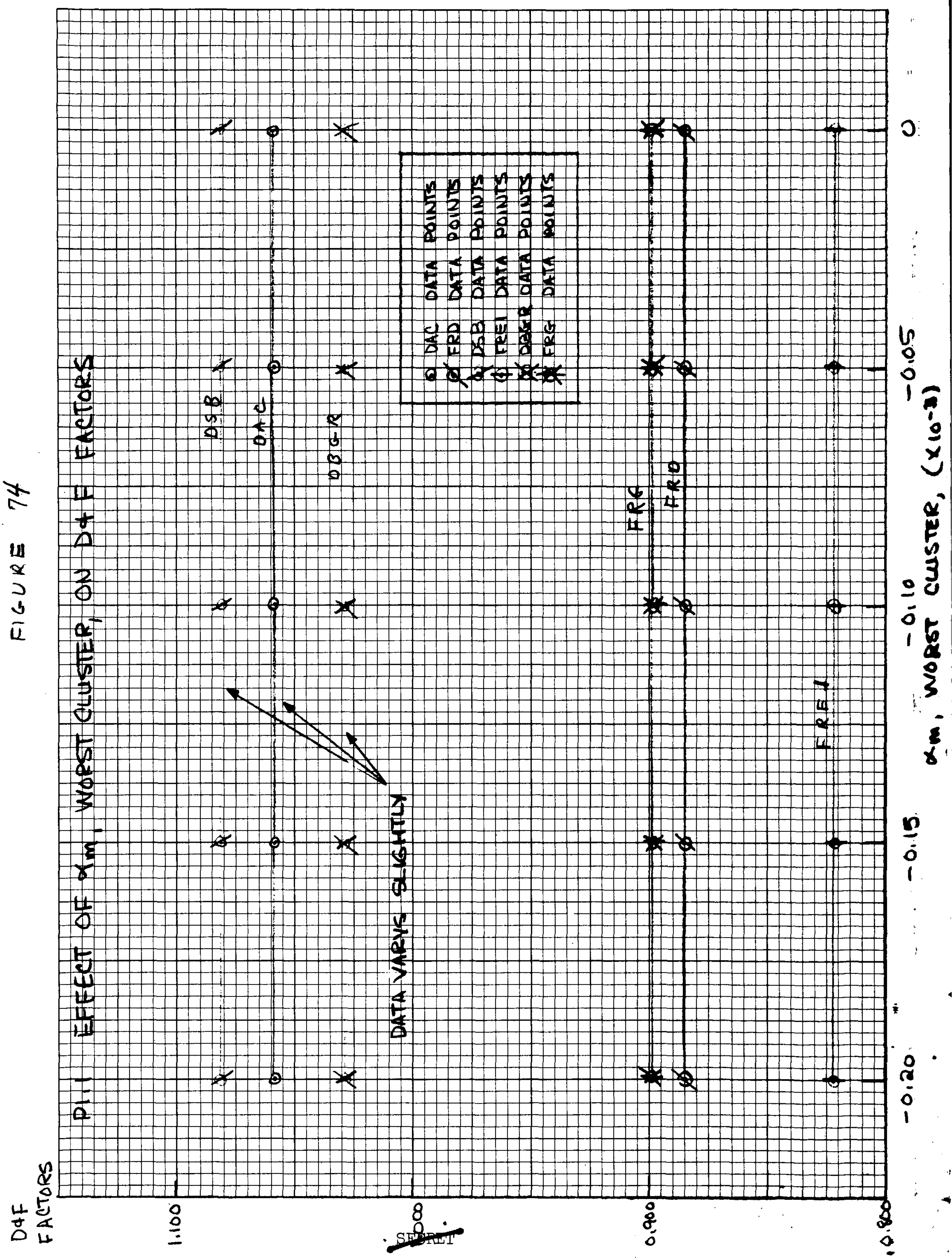


FIGURE 74
P1.1 EFFECT OF αm, WORST CLUSTER, ON D+F FACTORS
DAC DATA POINTS
FRD DATA POINTS
DSB DATA POINTS
FREI DATA POINTS
DBG-R DATA POINTS
FRG DATA POINTS
DSB
DAC
DBG-R
FRG
FRD
FREI
DATA VARYS SLIGHTLY
D+F FACTORS
1.100
1.000
0.900
0.800
0
-0.05
-0.10
-0.15
-0.20
αm, WORST CLUSTER, (X10-3)
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FIGURE 75

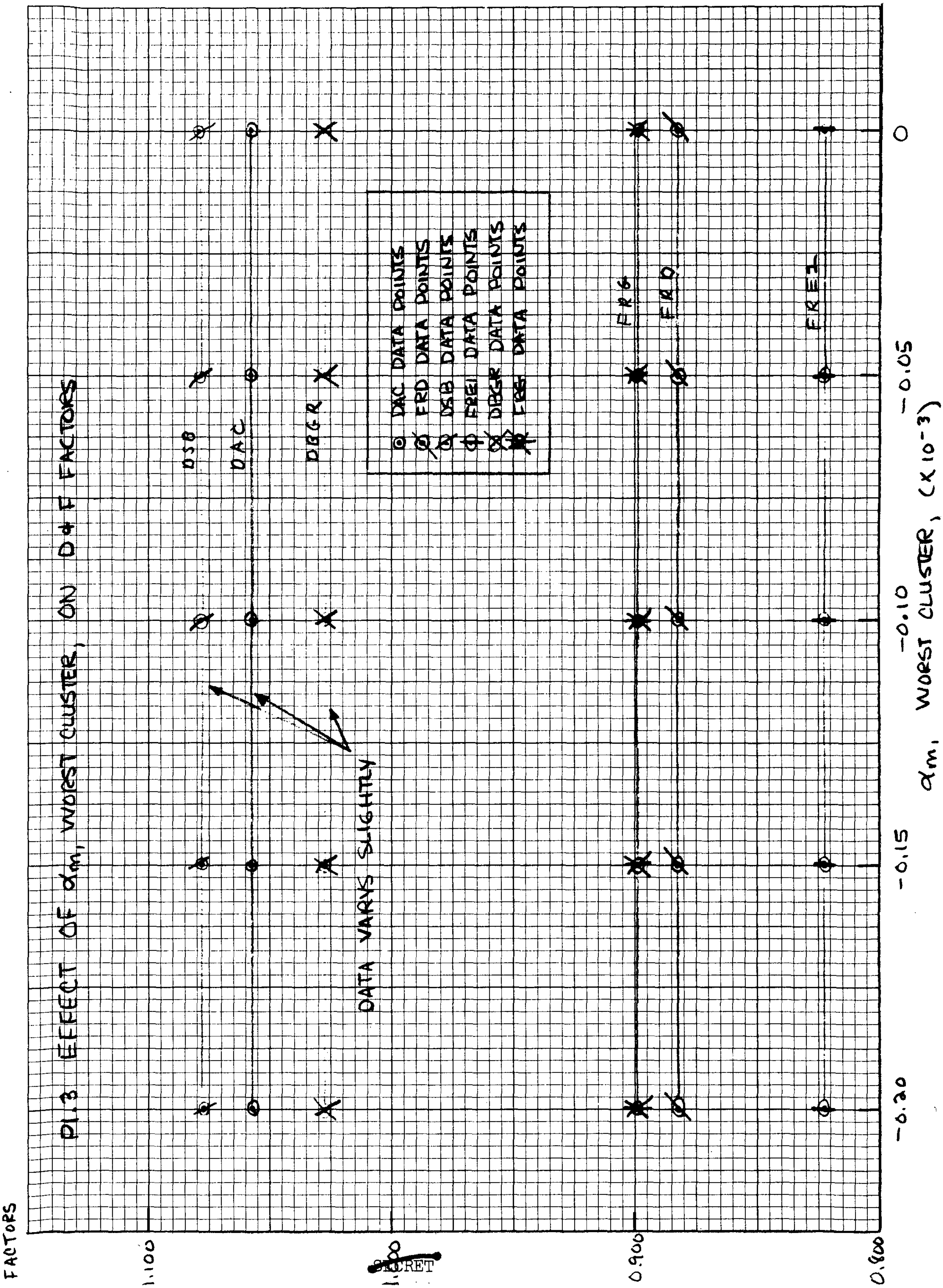
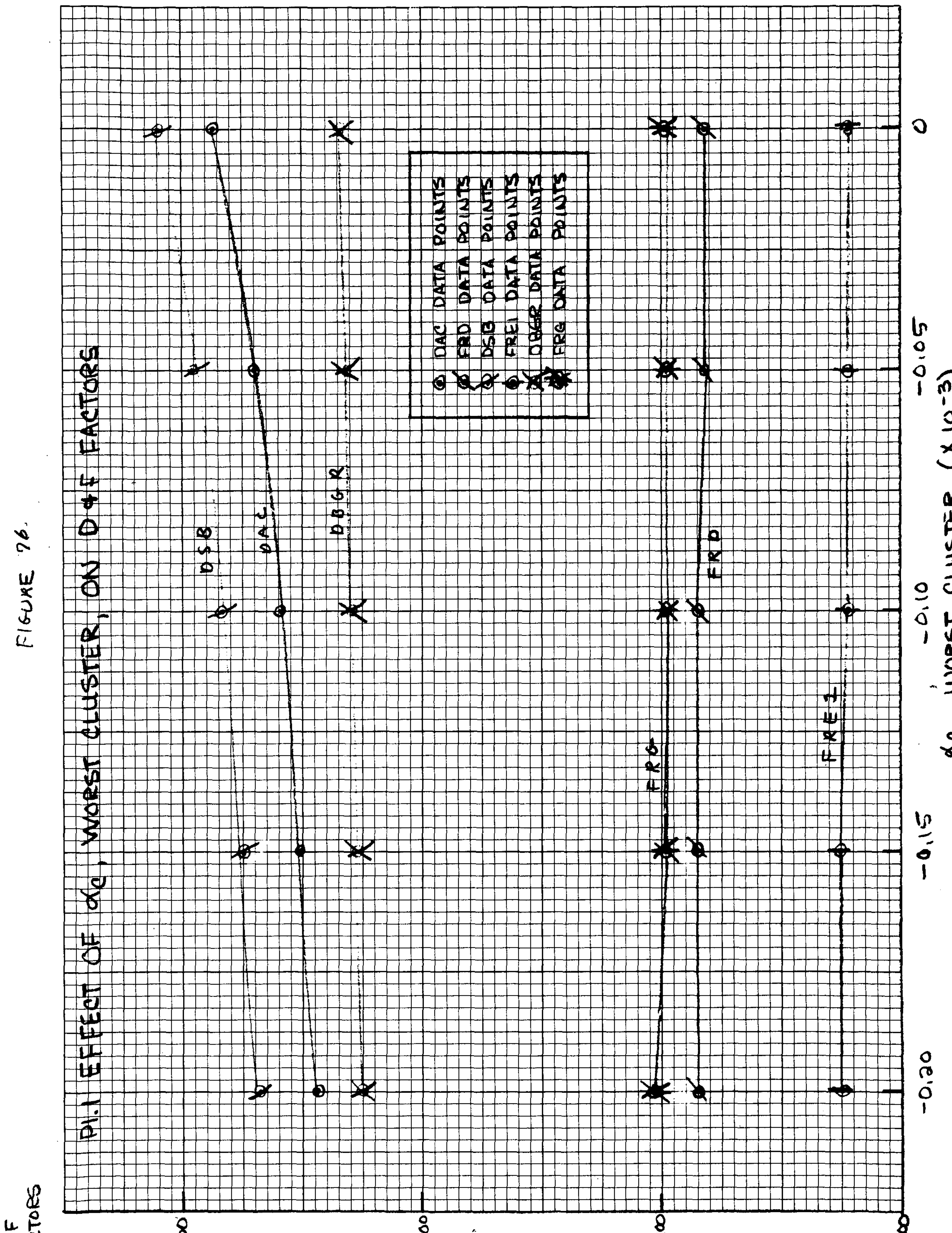
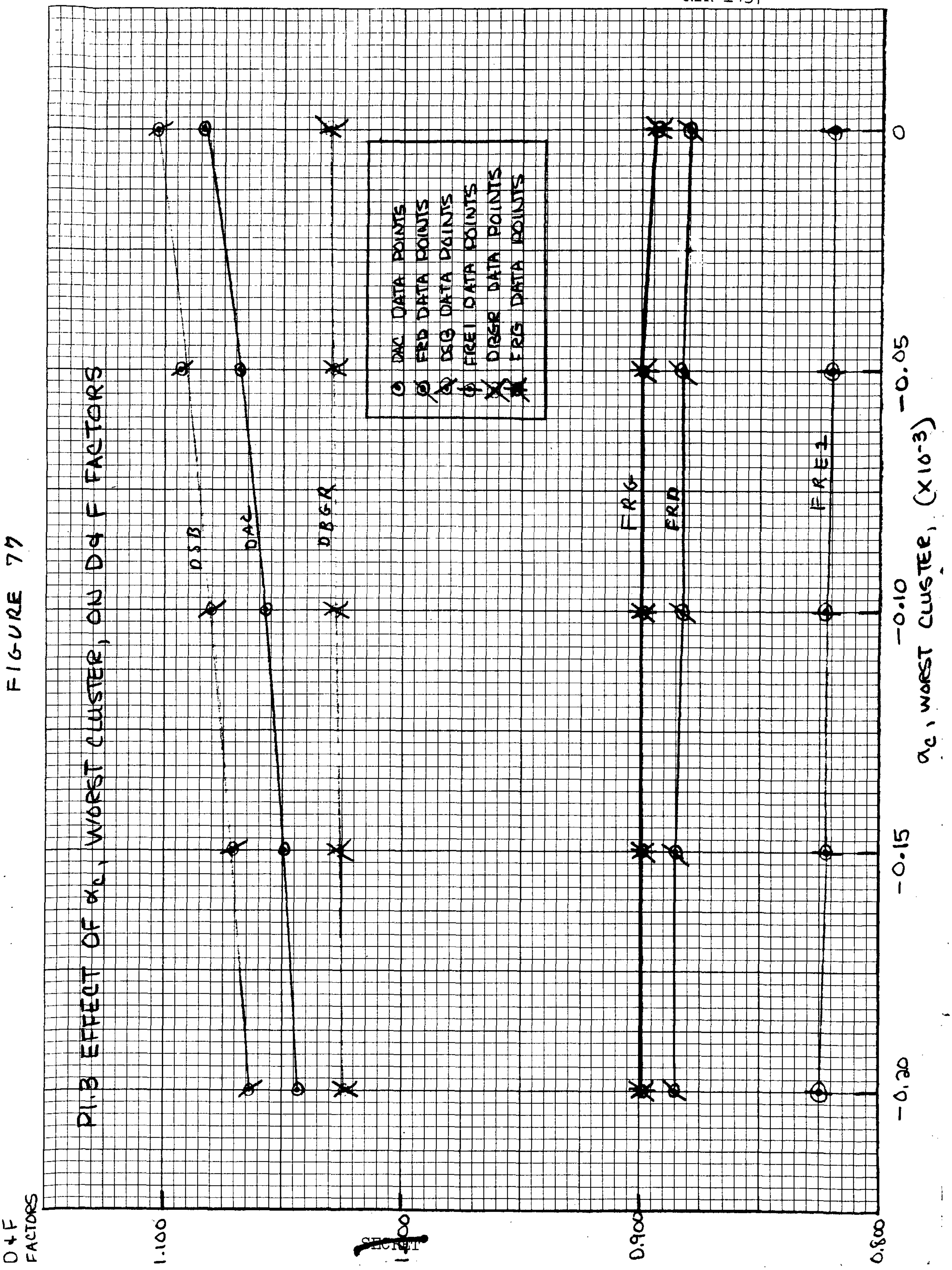

PL 3 EFFECT OF α_m, WORST CLUSTER, ON D+F FACTORS
DSB
DAC
DBGR
FR6
FRD
FRE1
⊙ DAC DATA POINTS
FRD DATA POINTS
DSB DATA POINTS
FRE1 DATA POINTS
DBGR DATA POINTS
FR6 DATA POINTS
DATA VARYS SLIGHTLY
D+F FACTORS
1.100
1.000
0.900
0.800
0
−0.05
−0.10
−0.15
−0.20
α_m, WORST CLUSTER, $(\times 10^{-3})$

FIGURE 76.


Pl.I EFFECT OF α_C, WORST CLUSTER, ON D4F FACTORS
DAC DATA POINTS
FRD DATA POINTS
DSB DATA POINTS
FREI DATA POINTS
DBGR DATA POINTS
FRG DATA POINTS
DSB
DAC
DBGR
FRD
FRG
FREI
0
-0.05
-0.10
-0.15
-0.20
α_C, WORST CLUSTER, (X 10^{-3})
D4F FACTORS
1.100
1.000
0.900
0.800


P1.3 EFFECT OF α_c, WORST CLUSTER, ON D+F FACTORS
FIGURE 77
DAC DATA POINTS
FRD DATA POINTS
DSB DATA POINTS
FRE1 DATA POINTS
DBGR DATA POINTS
FRG DATA POINTS
DSB
DAC
DBGR
FRG
FRD
FRE1
0
-0.05
-0.10
-0.15
-0.20
α_c, WORST CLUSTER, $(\times 10^{-3})$
D+F FACTORS
1.100
1.000
0.900
0.800