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VOLUME IB



SELF-TENSIONING ACOUSTICAL
HORIZONTAL LINE ARRAY
(SPRAY)
DATA ANALYSIS (U)

v. 1A:00:00

FINAL REPORT OF BEARING STAKE TESTS
JANUARY THRU MARCH 1977

JANUARY 1979

LEVEL III

Prepared For
NAVAL AIR DEVELOPMENT CENTER
WARMINSTER, PENNSYLVANIA

UNDER CONTRACTS
N62269-77-C-0139
AND
N62269-78-M-6884
BY

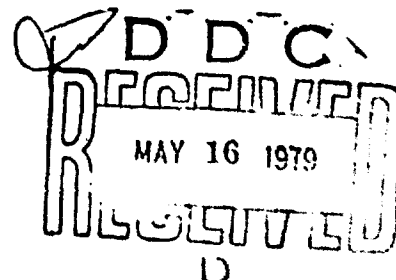
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NASHUA, NEW HAMPSHIRE 03061

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VOLUME IB

SELF-TENSIONING ACOUSTICAL
HORIZONTAL LINE ARRAY
(SPRAY)
DATA ANALYSIS. (S)

LEVEL III

B

FINAL REPORT OF BEARING STAKE TESTS
JANUARY THRU MARCH 1977,

JANUARY 1979

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VOLUME

IA	Overall Program Status and Test Results Summary
IB	Detailed Description, Test Results
II	Data Analysis Facility and Data Reduction Methodology
IIIA	Data Points 1, 2 and 3 Raw Data
IIIB	Data Points 4, 5 and 6 Raw Data
IVA	Data Points 7, 8 and 9 Raw Data
IVB	Data Points 10, 11 and 12 Raw Data

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2.0 DETAILED DISCUSSION OF TEST RESULTS (U)

(U) The contents of this Volume discuss in more detail the measured vs expected results for each of the following:

- System FOM
- Array Gain and Signal Gain
- Beamwidth
- Bearing Accuracy
- Summary and Comparisons

2.1 SYSTEM FIGURE OF MERIT AND RANGE PREDICTIONS (U)

(U) System figure of merit (FOM) is defined as the total signal transmission loss that the system can tolerate and is expressed as

$$\text{FOM} = \text{SL} - \text{NL} + \text{AG} - \text{DT} \text{ (dB)} \quad (2.1)$$

where

SL = threat source level (dBuPA)

NL = local ambient noise spectral level (dBuPA²/Hz)

AG = array gain (dB)

DT = detection threshold

(S) For the third generation threat, the detection threshold was computed for the 140 and 290 Hz lines as shown in Table 2-1 for a 1/32 analysis bandwidth (ABW). It is noted that in addition to a 1.3 dB mismatch loss, a processing loss of 2 dB was used to cover all other real processor degradations from ideal. A 5 minute integration time was assumed.

(S) Detection ranges for the third generation Soviet Nuclear Threat are estimated from the FACT-model-computed transmission loss (Volume IA, Figures 1-10, 1-11, 1-13, 1-14, 1-16, 1-17) based on FOM's computed from the measured data per equation (2.1).

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TABLE 2-1

DETECTION THRESHOLD CALCULATION FOR 3RD GEN THREAT,
1/328 ANALYSIS BANDWIDTH (U)

Frequency (Hz)	Signal Line Width (Hz)	ABW (Hz)	N_s	DT Ideal (dB)	$-L_M$ (dB)	Processing Loss (dB)	Total DT Degradation (dB)	DT Actual (dB)
140	0.044	0.044	13	-12.2	1.3	2.0	3.3	-8.9
290	0.10	0.091	27	-11.0	1.4	2.0	3.4	-7.6

$DT_{Ideal} = SNR(N_s) + 10 \log ABW =$ Signal-to-noise in one Hz band required at processor input

$SNR(N_s) \left\{ \frac{1}{2} \right\}$ Signal-to-noise required at the linear detector input for $P_D = 0.5, P_{FA} = 10^{-4}, T = 300$ sec integration time

n = Number of independent samples integrated

$L_M = 10 \log(1 - \beta/4)$ (dB) $0 \leq \beta \leq 2$ mismatch loss

$\beta = \frac{\text{Signal Line Width}}{ABW}$

$DT_{actual} = DT_I - L_M + \text{Proc Loss}$ (dB)

ABW = Analysis bandwidth of narrowband filter preceding detector

(1) Obtain from Robertson's curves, G. H. Robertson, "Operating Characteristics for a Linear Detector of CW Signals in Narrowband Gaussian Noise", Bell Sys. Tech. J., April 1967.

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(S) Table 2-2 contains the FOM and estimated range data for each data point in the three sites. Range zones (convergence zones) for greater than 50% detection probability are listed as well as the maximum 50% P_D range, which is averaged over the data points for each site (averages shown in last column). Data for 140 Hz as well as 290 Hz is provided. Note, however, that for a nominal $\sqrt{2}$ spacing, one would expect a nominal 3 dB gain improvement for the 140 Hz data, and thus expect range increases by approximately 1.5 to 2.0 times.

(S) The mean FOM for the 12 data points at 290 Hz is 89.8 dB; the greatest value is 92.9 for DP 9 in Site 4, and this corresponds to a continuous (no convergence zones) detection region out to 203 NM. Detection regions covered in the three sites are pictured in Volume IB, Figure 1-3, for the above conditions.

2.2 ARRAY GAIN AND SIGNAL GAIN (U)

(U) Measured array gain (SNR Gain) and signal gain are compared against theoretical reference curves vs number of elements in the aperture for all 12 data points in Figures 2-1 and 2-2. For comparison, the corresponding composite data for the deep MINYAKA site is contained in Figure 2-3. Individual data point presentation of gain data appear as Figures A-1 through A-24 in Appendix A.

(S) Measured signal gain clusters around the theoretical curve ($20 \log N$) except for the Gulf of Oman (DP 1 and 2, Figure 2-1). This site might be expected to show somewhat poorer signal gain due to the large depth deficiency (see Section 1.2), and thus larger expected signal decorrelation resulting from greater signal acoustic interaction with the bottom and the surface. It is noted that the 140 Hz signal gain values (Figure 2-2) tend to be larger than the 290 Hz values. This also is expected since the aperture contains fewer wavelengths at 140 Hz and signal will, therefore, tend to be more correlated.

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(S) Table 2-2 FOM and Range Predictions Based on Measured Data. 3rd Gen Threat Line Levels and Line Widths: 290 Hz 135 dbuPa 0.091 Hz 140 Hz 135 dbuPa 0.044 Hz

Site ID	DB (dbuPa ² /Hz)	AG	FOM	RECEIVER DEPTH 100' RANGE (RM) IN ZONES					Max R Range (RM)	P50
				1	2	3	4	5		
290 Hz DATA										
1A	65.7	10.0	86.9	0-45.9	54.8	73.7	96-97		85.7	98.3
2	64.7	11.1	89.1	0-50.2	54.8	71.2	110.8		110.8	
3	67.5	16.8	91.9	0-180					180.0	
4	65.6	9.8	86.8	0-27.6	41.2	47.4	55.7	74.8	83.7	
5	68.4	11.7	85.9	0-27.2	42.8	47.8	58.3	76.5	80.5	102.1
6	68.9	12.6	86.3	0-27.4	43.9	47.7	58.3	75.4	82.3	
7	62.2	7.1	87.5	0-27.7	43.5	47.4			84.0	
8	61.6	10.3	91.9	0-175					175.0	
9	65.2	15.5	92.9	0-203					203.0	
10	64.6	12.6	90.6	0-138					138.0	
11	62.2	12.1	92.5	0-194					194.0	150.7
12	65.5	6.7	83.8	0-27.6	49.6				43.6	
140 Hz DATA										
1A										
2										
3	74.5	15.5	84.9	0-43.4	58.7	73.3			73.3	
4	73.3	9.3	79.9	0-35.9					35.9	
5	76.6	14.9	82.2	0-38.1	48.6				53.6	54.2
6	76.0	14.8	82.7	0-38.1	47.7				54.4	
7	70.1	8.5	82.3	0-38.2	48.4				53.8	
8	67.3	11.4	88.0	0-108					108.0	
9	68.2	13.2	88.9	0-129					129.0	
10	74.2	10.5	80.2	0-22.3					22.5	60.8
11	70.2	7.2	80.9	0-22.3					22.8	
12	72.0	6.8	78.7	0-21.3					21.5	

(1) P50 = Range in RM for 50% of P

(2) P50 = Mean P50 for Site

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FIGURE 2-

COMPARISON OF SIGNAL GAIN
IN RELATION TO ARRAY GAIN
VS NUMBER OF ELEMENTS
MEASURED AT
200 MHz (U)

SIGNAL GAIN
20 LD5 A

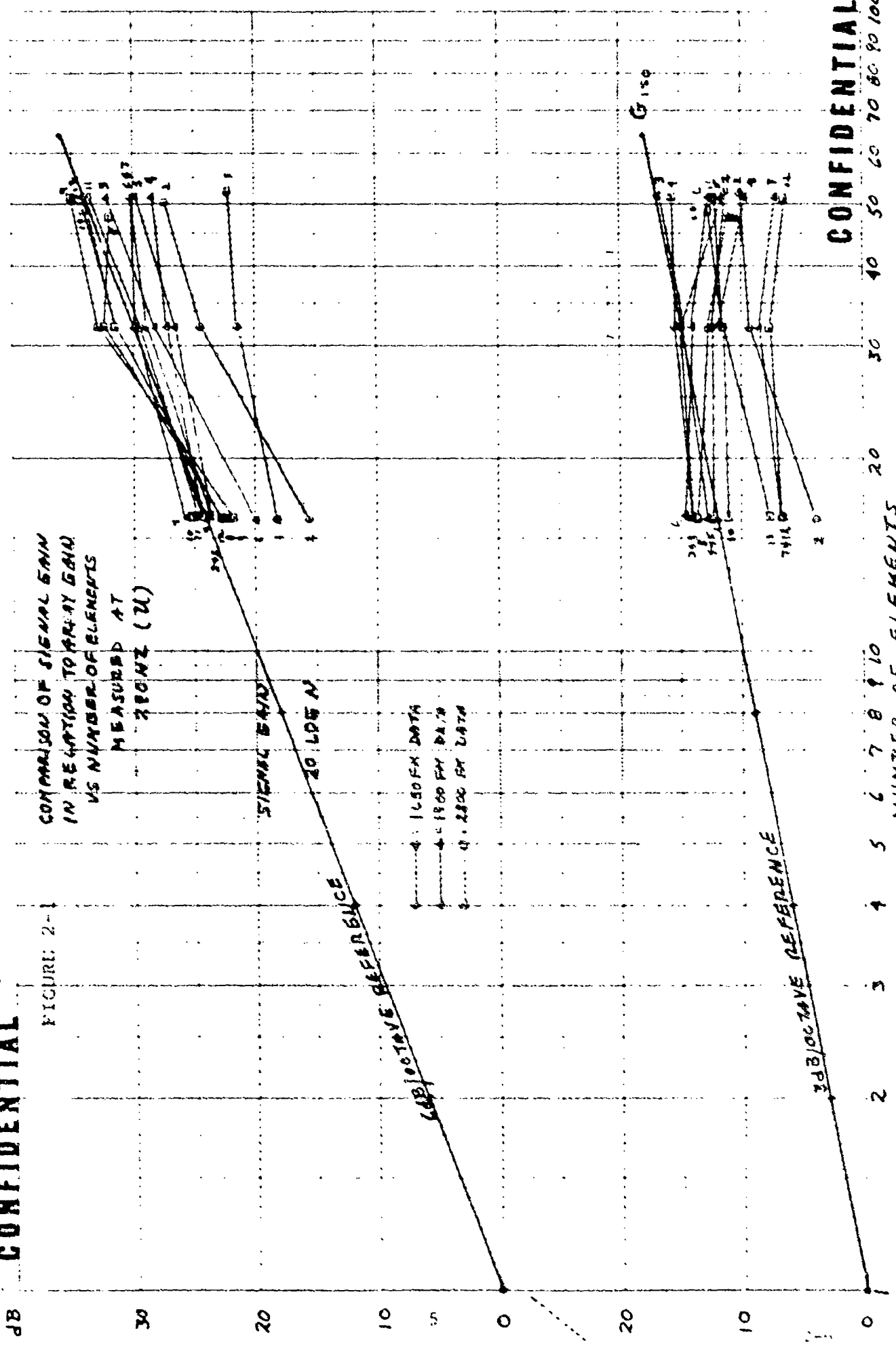
1dB/OCTAVE REFERENCE

- ▲ 1000 FT DATA
- ▲ 1500 FT DATA
- ▲ 2000 FT DATA

1dB/OCTAVE REFERENCE

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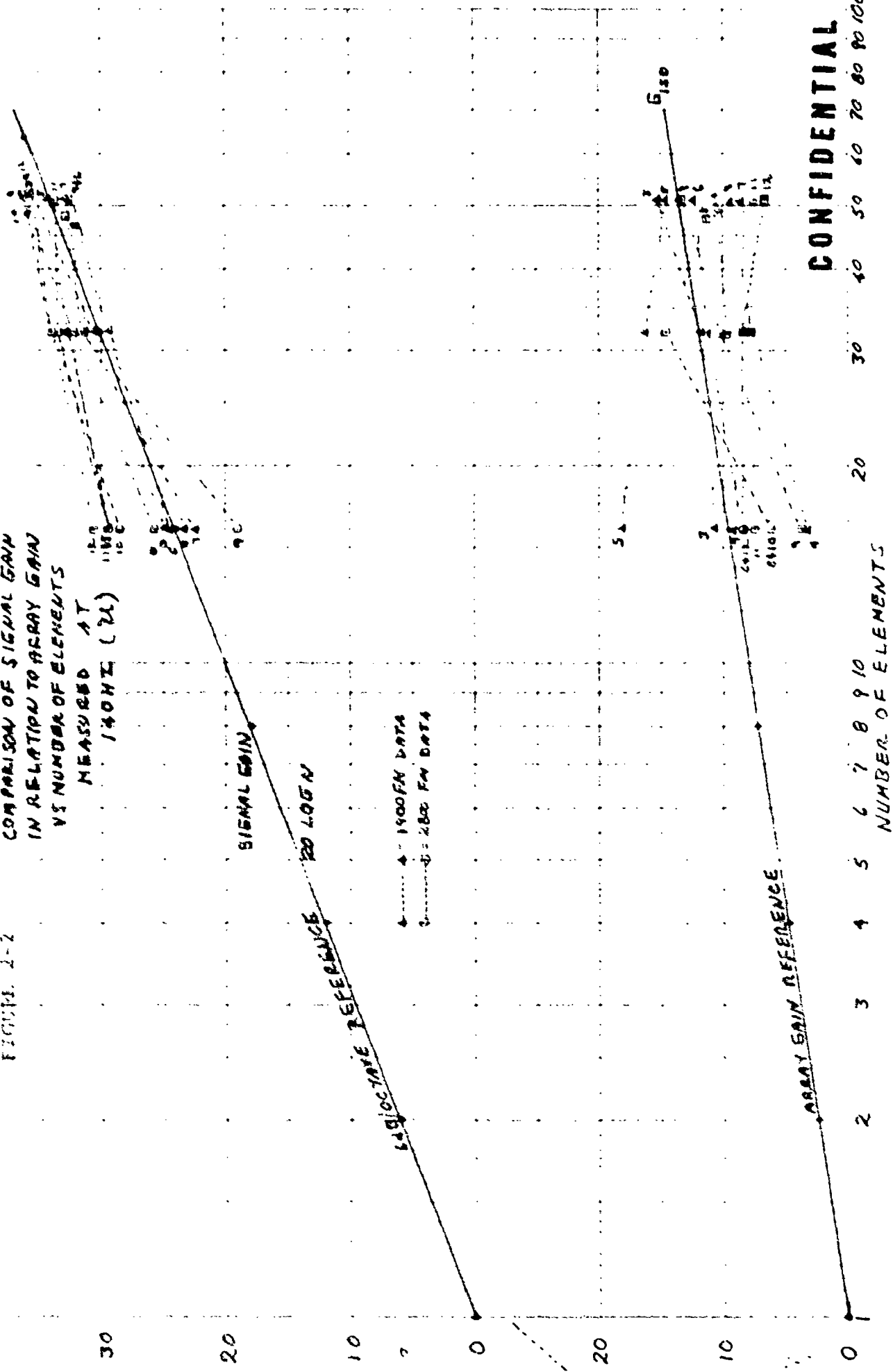
NUMBER OF ELEMENTS



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FIGURE 1-2

COMPARISON OF SIGNAL GAIN
IN RELATION TO ARRAY GAIN
VS NUMBER OF ELEMENTS
MEASURED AT
140 HZ (2L)



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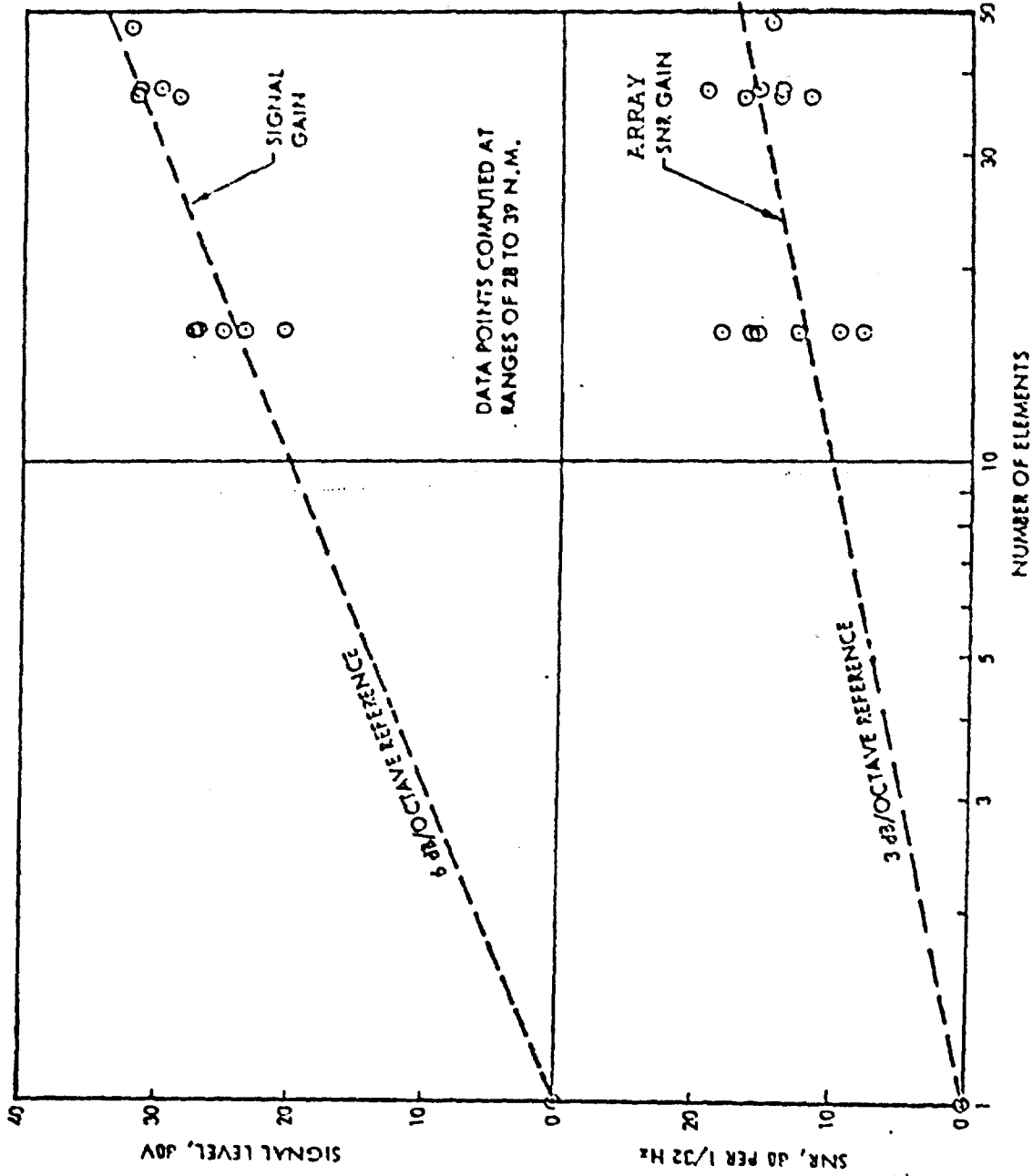


Figure 2-3 MIHYAKA Data - Comparison of Signal Gain in Relation to SNR Gain vs. Number of Elements Measured at 295 Hz (U)

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(S) Also apparent is a characteristic droop in signal gain between half (32 elements) and full aperture, which becomes more significant at 290 Hz. The indication is that the plane-wavefront model used to process the data is becoming inadequate between 16 and 25 wavelengths, at least for the subject environmental conditions. Of course, uncompensated array deformation could also be at least partially at fault, but the progressively improved signal gain with improving acoustic conditions (going from Site 1A to Site 4) places greater credibility in the decorrelation argument. This indicates a need for more sophisticated array processing, especially in "shallow" water, for apertures approaching 25 wavelengths.

(C) The array (signal to noise) gain correlates reasonably well with signal gain according to the above referenced set of figures. One exception is site 1A where the signal gain is much farther below theoretical than array gain. Given the fact that array gain depends not only on coherently summing the signal, but also on rejecting noise (array gain (AG) = signal gain (GS) - noise gain (GN)), a lack of close correlation in array gain with signal gain is plausible. However, there appears to be an anomaly in the large discrepancy between signal gain and array gain for the Gulf of Oman. Noise anisotropy information is not contained in this report, but would be useful in relating signal gain and array gain.

(S) Of particular interest is the relatively constant level of measured array gain, independent of aperture (number of elements), unlike the deep water MINYAKA tests. This is especially evident for 290 Hz is given in Table 2-3 supporting this observation. Therefore, a strong indication is that in order to achieve the full potential of drift arrays in depth deficient water, the beamforming must accommodate a more complex model than a plane wave arrival; that is, it must include techniques to compensate for correlation losses.

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Table 2-3 Array Gain Comparison for 290 Hz
vs. Number of Elements (C)

Mean Array Gain (dB) for Number of Elements Shown, 290 Hz			
Site	16	32	max
1A	9.7	11.2	10.6
3	12.7	13.4	12.7
4	11.4	12.4	12.4
Overall Mean	11.8	12.7	12.3

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2.3 BEAMWIDTH (U)

(C) Theoretical beam patterns for each frequency and aperture analyzed at each data point (which have random steer angles) were computed for comparison with MRA pattern response measurements. A typical pattern for the uniform-weighted* full aperture is shown in Figure 2-4 for DP 10 at 290 Hz. The rectangular pattern plot covers the full azimuth plane, and references azimuth angle from end fire, i.e., broadside on these plots appears at 90° and 270° . Thus the 151.5° horizontal steering corresponds to 61.5° off-broadside steering in the context of the present report. Also provided in the hard copy computer display are the 3 dB beamwidth (4.12°) and array azimuth gain (15.0 dB). All other such plots generated are contained in Appendix B for reference. A brief discussion of the effect on theoretical beam pattern of elements missing from the aperture and quantizing lobes created by sampling data at a rate lower than that required for quantizing lobe suppression was given in Volume IA.

(U) Direct measurement of beamwidth in the normal sense during a sea test is not practical. Instead (of either rotating the array or maneuvering the projector ship on a circumferential course), an estimate of the beam characteristics is obtained by steering the beam over a relatively small azimuth region centered in the target direction. The estimate is good only in the main beam region; it is clear that the greater the beam is steered away from the target direction, the greater is the pattern error.

* Uniform weighting was used in beamforming for the entire data reduction. No sidelobe suppression was attempted.

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S106B SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLEF 3.1
...: 3000 HZ. TUNED TO 300 HZ.
...: 3000 HZ. UNIFORM SPACING
...: 3000 HZ.

DP 10
UNIFORM WEIGHTING.
1500 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 49 ELEMENTS, -0.87 DB MAX., AC:S1362,SU:S1362,WT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.12 DEG. 3 DB BEAM, 15.00 DB AZ. GAIN, MAX. AT 208.5 DEG. HORIZ.

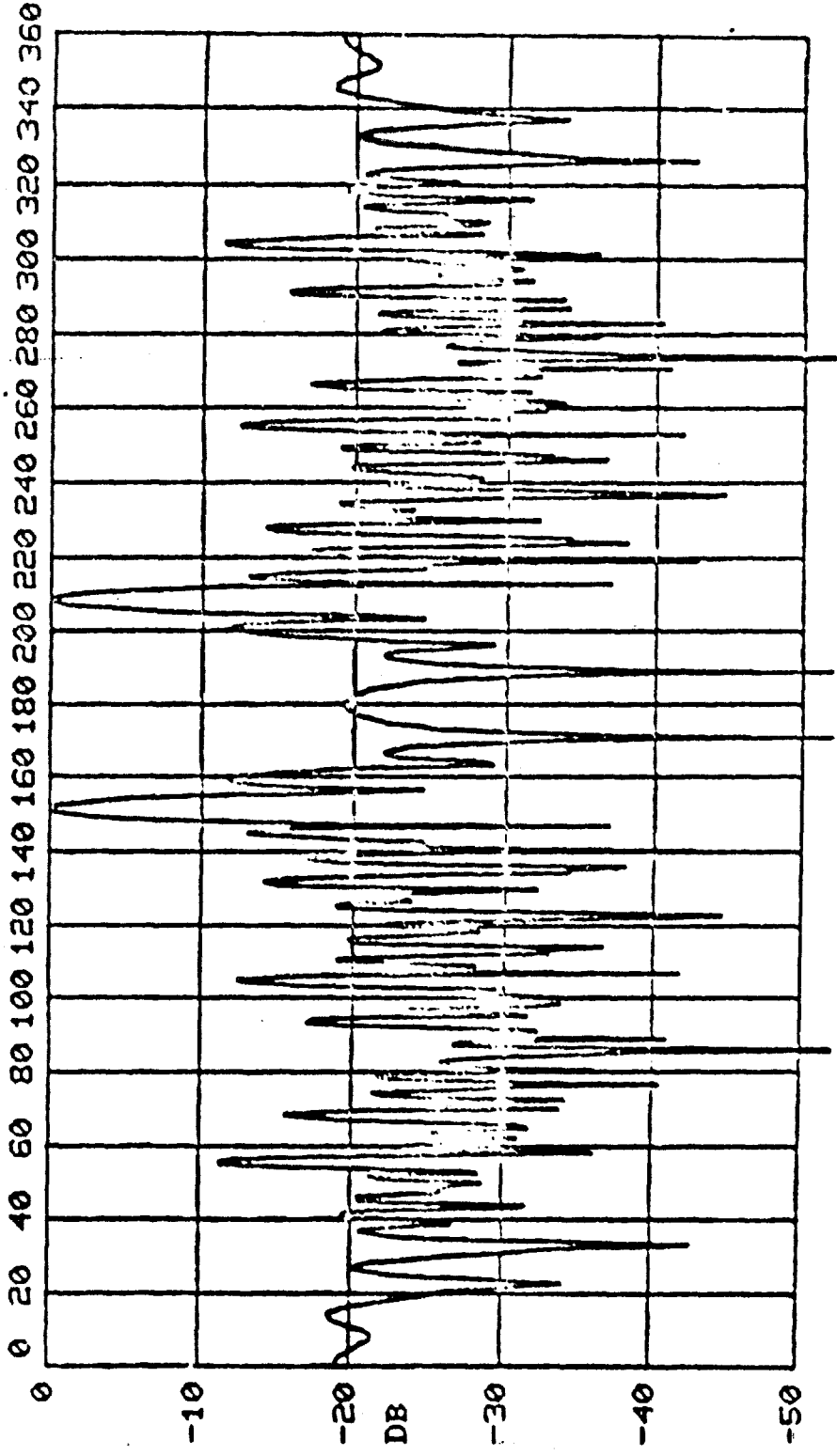


Figure 2-4 Theoretical Horizontal Plane Pattern for 49-Element Array @ 290 Hz
for Data Point 10, 61.5° off Broadside Steering. Beamwidth 4.12°,
Azimuth Gain 15.0 dB.

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(S) It is with this in mind that the "measured" pattern data should be viewed. Such a pattern appears in Figure 2-5 for DP 10 at 290 Hz, corresponding to the theoretical pattern of Figure 2-4. It represents one of the better examples of measured beam patterns, and is only 0.6° broader than theoretical. This corresponds to an array gain only 0.6 dB ($10 \log (4.1^\circ/4.7^\circ) = 0.6 \text{ dB}$) below theoretical. Unfortunately, the measured array gain suffered an actual degradation of 2.4 dB for this data point when the data was properly reduced.

(C) It is also noted that the presence of interfering sources, particularly in the vicinity of the main beam (or its image), has a degrading effect on the measured pattern quality, as well as on both signal and array gain. Either discrete tones radiated within an analysis bandwidth of the projector tone, or broadband noise radiated from such interference contaminates the data. Figure 2-6 is an example of a measured pattern at 290 Hz for full aperture in DP 7 where interference plays a significant, or probably a dominant role. The target (projector) was received on a beam steered to -22° (where the MRA occurs in the figure). However, at least 3 other smaller pattern peaks occur within 12° . It is felt these are associated with interfering sources in the near vicinity of the array emplacement.

(C) If one considers the 140 Hz data for this same data point (see Figure 2-7), the MRA has apparently shifted to -36° steering, indicating a possible array orientation change. But this is not possible because the same 5 minute segment of tape was analyzed for both 140 Hz and 290 Hz. The presence of at least one other source can, therefore, be deduced from this data comparison. The interfering source at -36° steering has a greater received energy at 140 Hz than is received from the projector.

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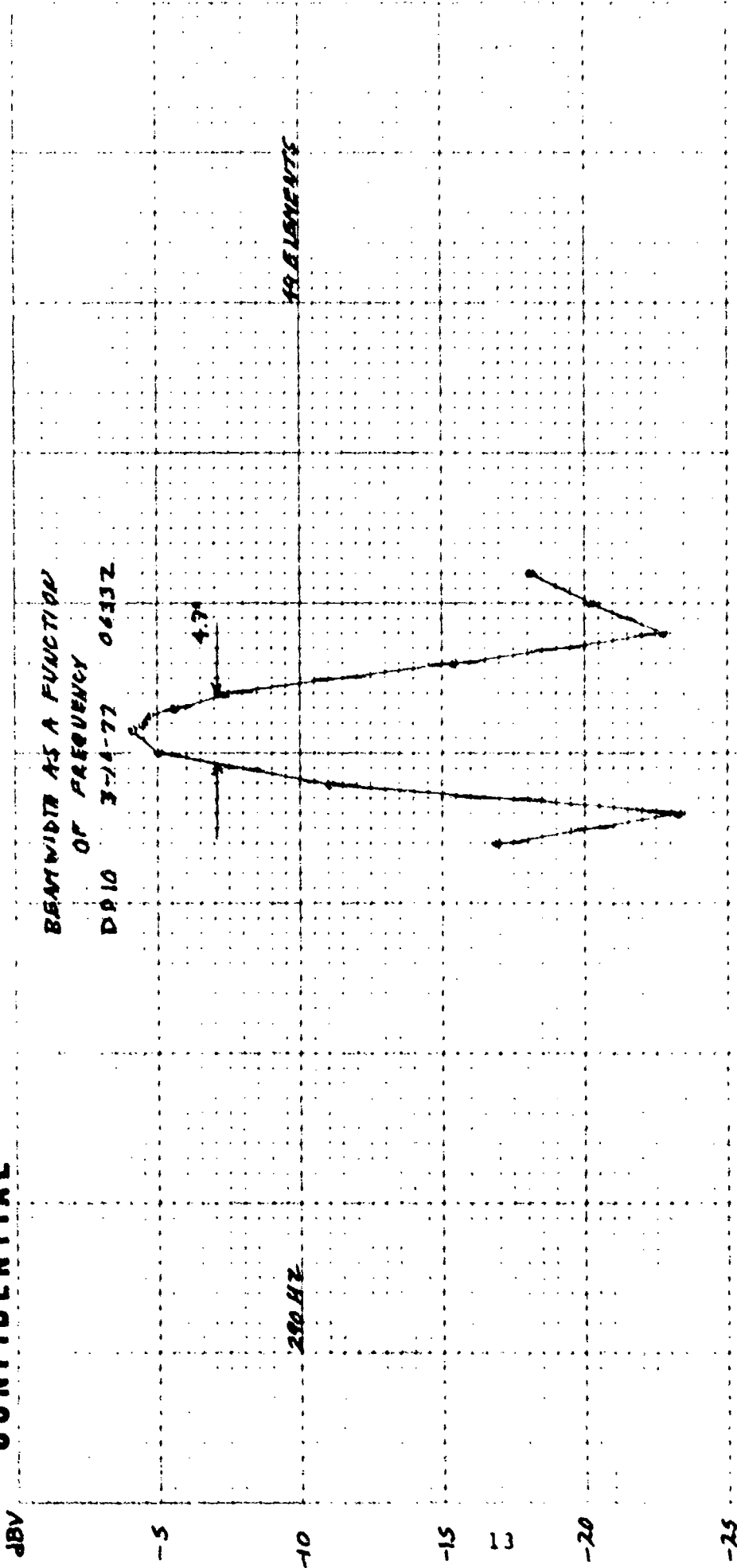


FIGURE 2-5 MEASURED MAIN LOBE PATTERN RESPONSE FOR 49-ELEMENT ARRAY @ 290 HZ FOR DATA POINT 10, IS WITHIN 0.6° OF THEORETICAL. REFERENCE FIGURE 2-4

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140 150 160 170 180
DEGREES OFF BROADSIDE

46 0/03

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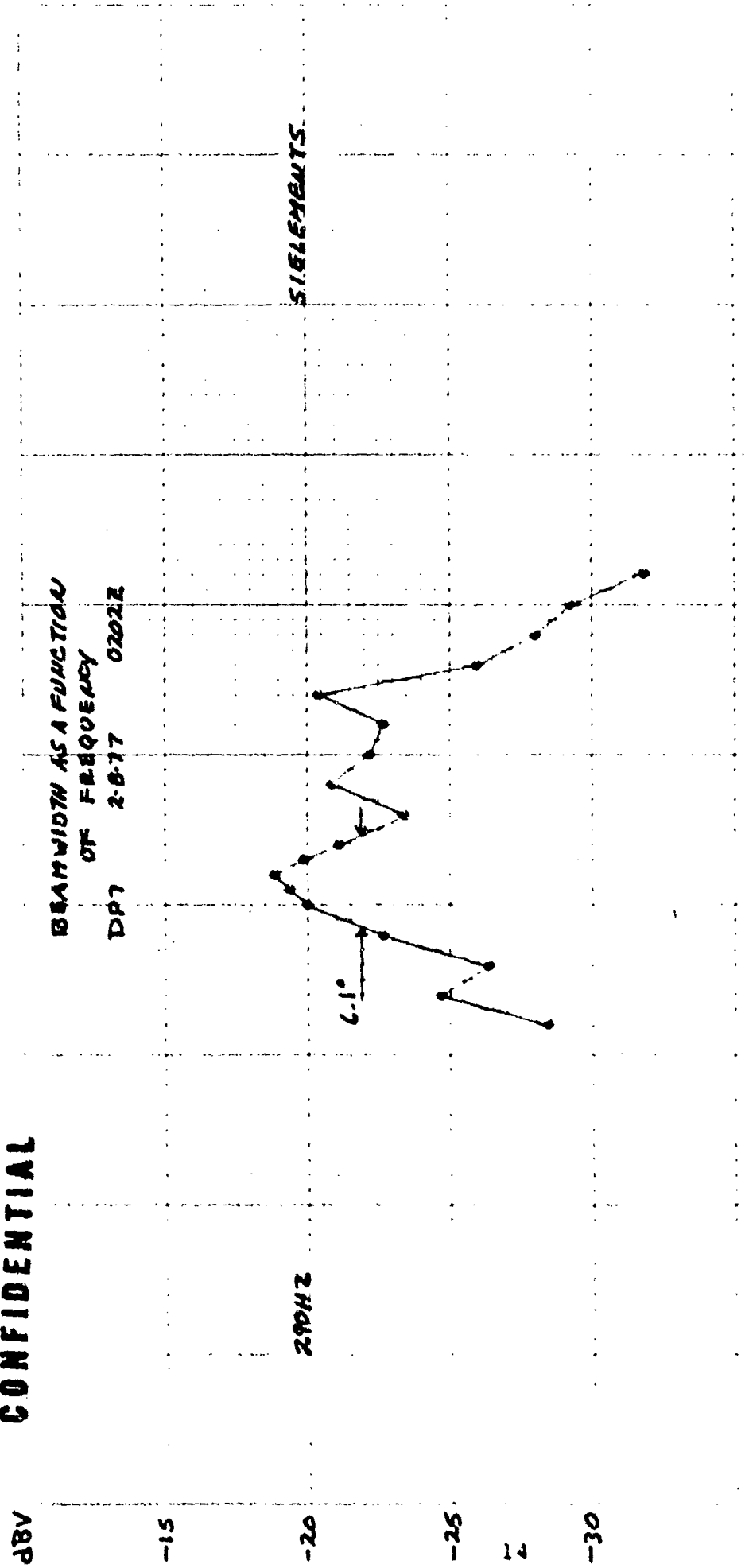


Figure 2-6 Measured Pattern Response for 51-Element Array @ 290 Hz for Data Point 7. Main Lobe is Almost 3 Times Theoretical - Other Interference is Evident

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-10 -20 -30 -40 -50
DEGREES OFF BROADSIDE

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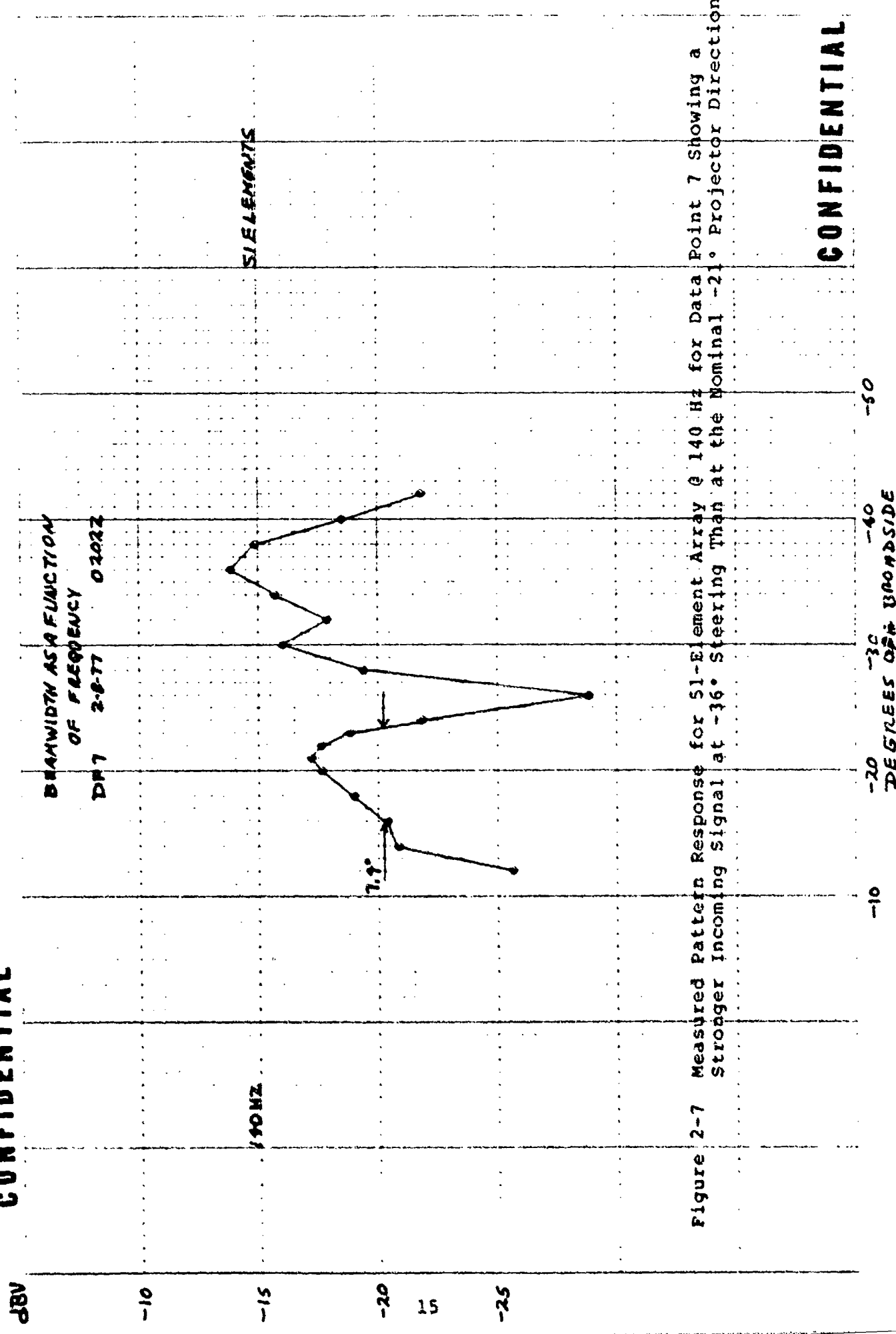


Figure 2-7 Measured Pattern Response for 51-Element Array @ 140 Hz for Data Point 7 Showing a Stronger Incoming Signal at -16° Steering Than at the Nominal -21° Projector Direction

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(S) On this assumption, it can be seen that the reported array gain of 8.5 dB (Ref Table 1-3, Vol Ia) at 140 Hz is pessimistic, and according to Figure 2-7, the measured gain should probably be stated as 11.9 dB based on considering the -36° steered "MRA" response.

(S) Observations of local interference in the Ship's log indicate the presence of six ships within a 10 NM radius of the array deployment including the monitoring ship (USNS Wilkes). Other traffic is included below:

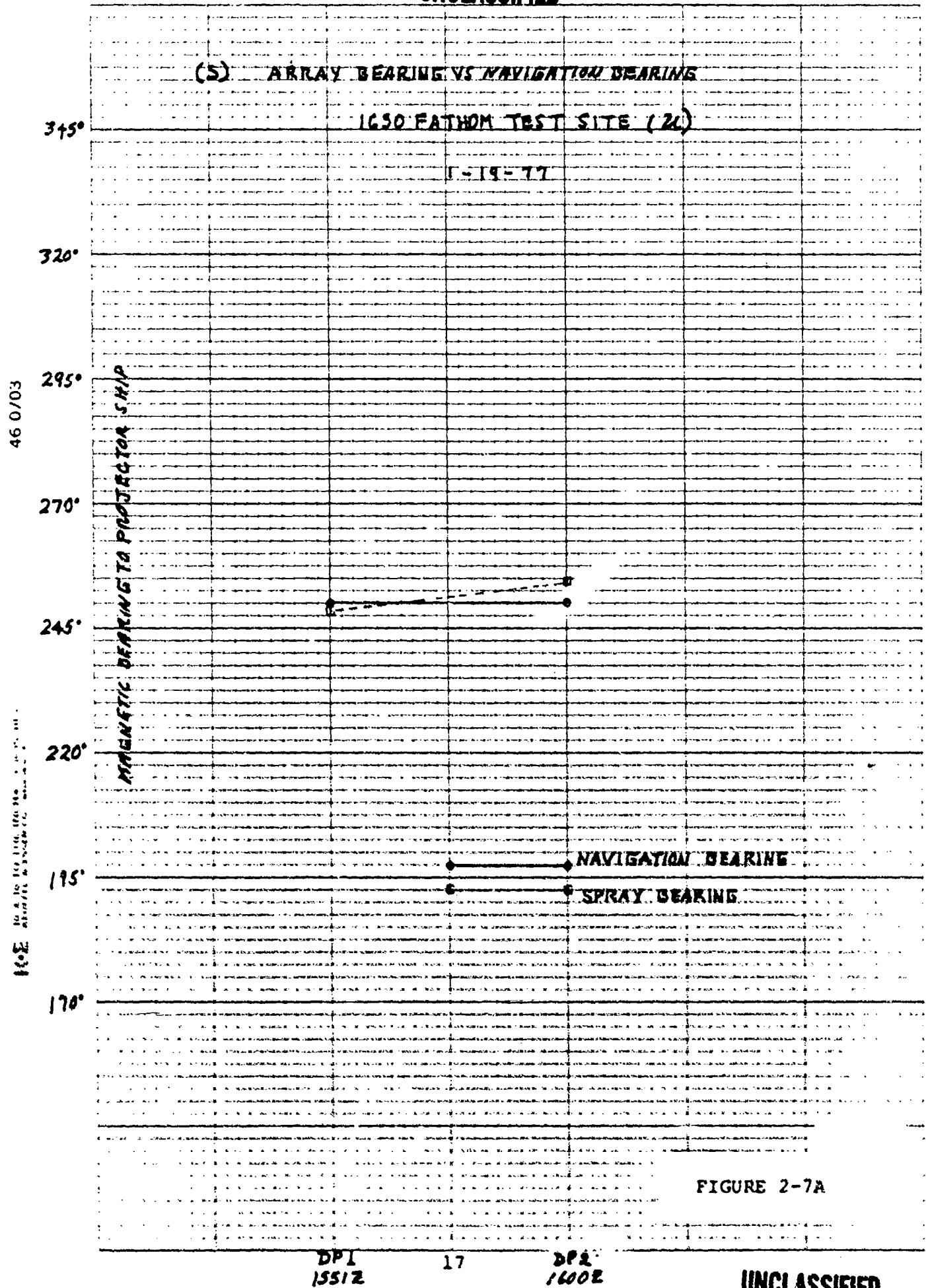
<u>True Bearing</u>	<u>Range</u>	<u>Vessel Description</u>
158 $^{\circ}$	3 NM	Soviet Oceanographic Ship Soviet Tender
178 $^{\circ}$	28 NM	USNS Kingsport
182 $^{\circ}$	9 NM	Two other Soviet Vessels (Destroyers?)
183 $^{\circ}$	7 NM	US Minesweeper
	1 NM	USNS Wilkes

All of the "measured" beamwidth plots appear in Appendix C for reference.

2.4 BEARING ACCURACY - COMPARISON WITH NAVIGATION DATA (U)

(S) Array bearing accuracy measurements were made using the navigation data as a reference for data points 1 through 7 in Sites 1A and 3. In Site 4, the array compass data was noisy and could not be used to generate array target bearings. Bearing accuracy data, summarized in Figures 2-7A and 2-7B, shows extremely good accuracy. This is displayed as bearing error in Table 2-4. Excluding DP 6 and 7, the mean absolute deviation bearing error measured less than 5° and the rms less than 7° . Including these data points during which time the array underwent rapid rotation, as if due to an ocean eddy, the mean absolute deviation and rms bearing errors for Site 3 increased to 26.2° and 33° .

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(S) ARRAY BEARING VS NAVIGATION BEARING

1900 FATHOM TEST SITE

2-7-77 AND 2-8-77 (U)

46 U/03

140°E TO 100°E ON THE 1000M ISOBATH

MAGNETIC BEARING TO PROJECTILE SHIP

350°
325°
300°
275°
250°
225°
200°

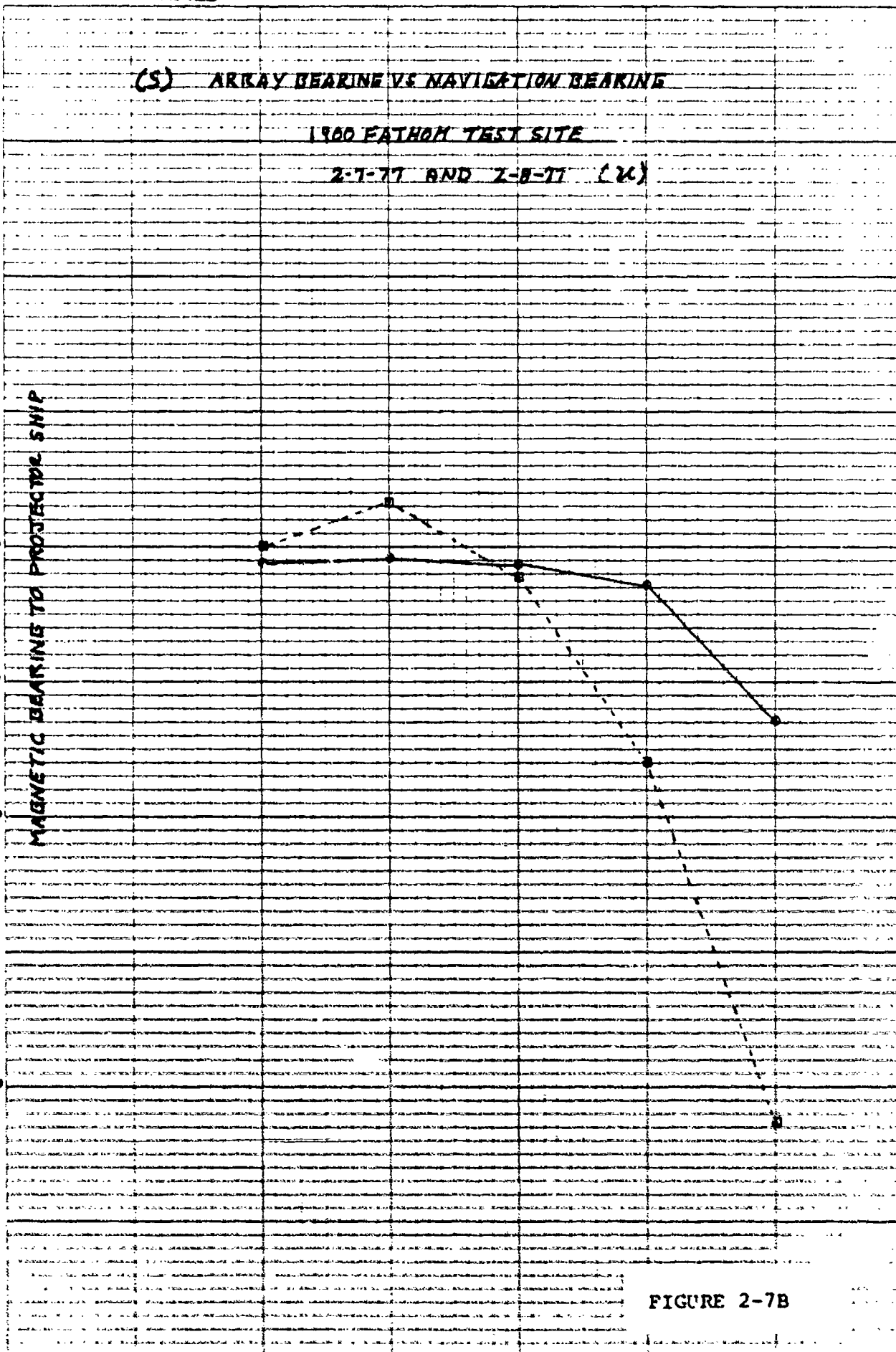


FIGURE 2-7B

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DP3
0934Z

DP4
1019Z 18

DP5
1549Z

DP6
2033Z

DP7
0202Z

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TABLE 2-4

BEARING ACCURACY SUMMARY (U)

Site	Data Point	Absolute Nav.		Array Bearing		Bearing Error	
		Data	Bearing	Error		MAE ²	rms
1A	1	250°		-1.5°		5.3°	6.5°
	2	250°		+9°			
3	3	372°		+2.5°			
	4	323°		+10°			
	5	322°		-3°			
	6	318°		-33°		-26.2°	33°
	7	393°		-65°			

(1)

4 Absolute bearing data available from array

(1) Excluding DP 6 and 7, during which time a relatively rapid rotation of the array was occurring, we have for Site 3

$$\begin{aligned} \text{MAE}^2 &= 4.6^\circ \\ \text{rms} &= 6.1^\circ \end{aligned}$$

(2) MAE = Mean Absolute Deviation

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(S) Figures 2.8 through 2.14 are the actual work sheets used in determining bearing errors. Array heading, array broadside and computed (from compass and steering data) projector bearing are plotted along with the navigation data of the projector.

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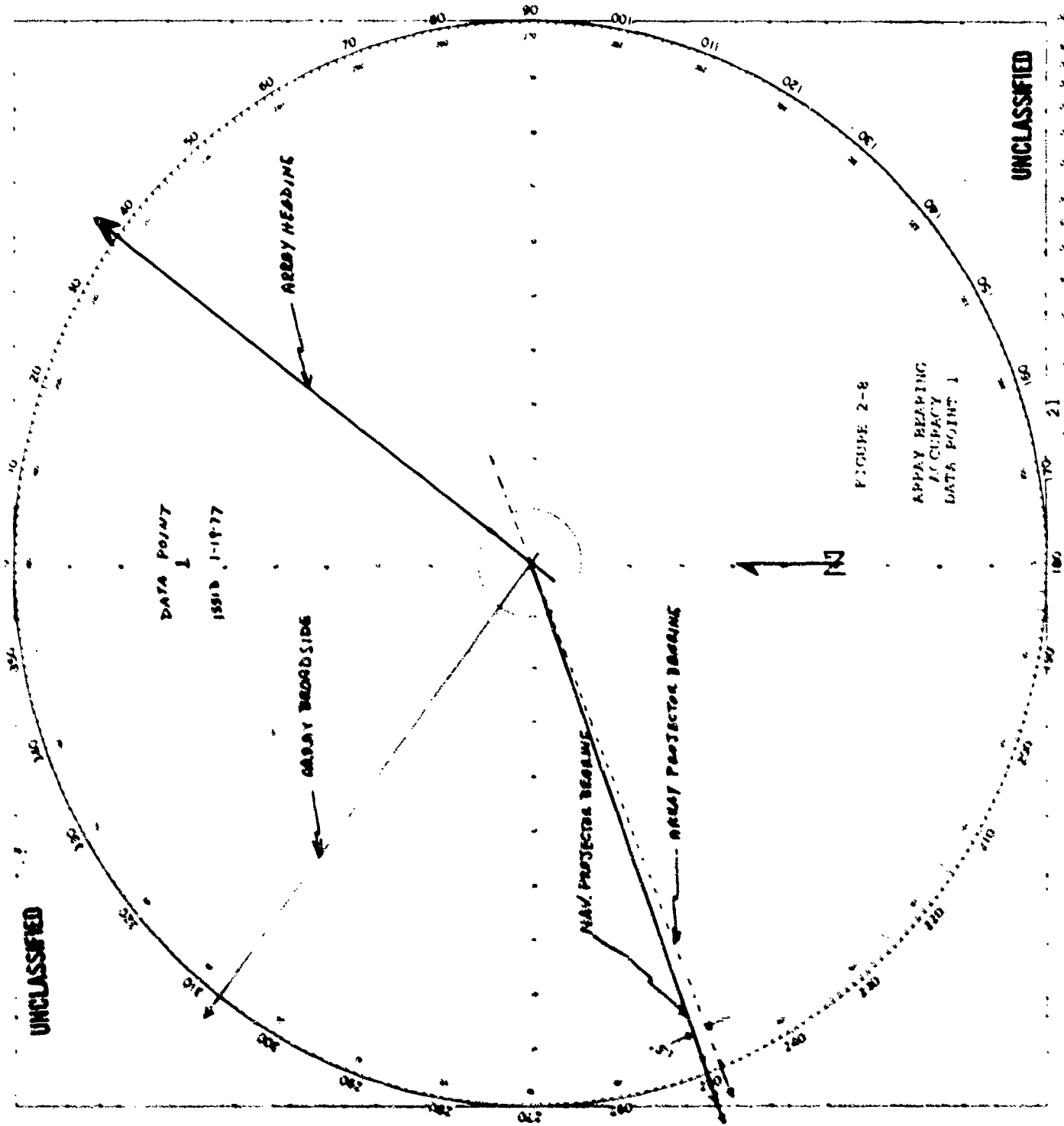


FIGURE 2-8

ARBY HEADING
ACCURACY
DATA POINT 1

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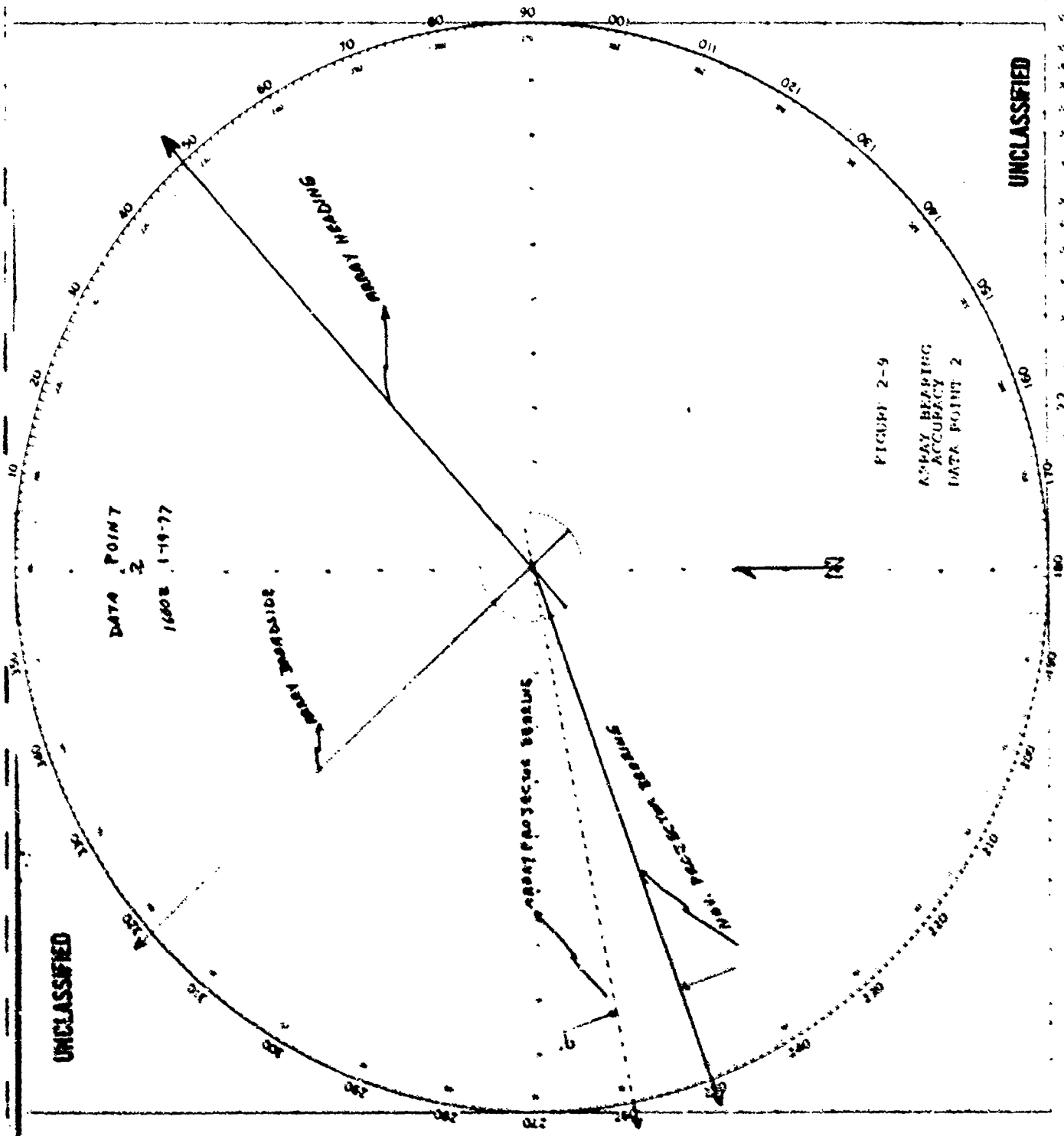
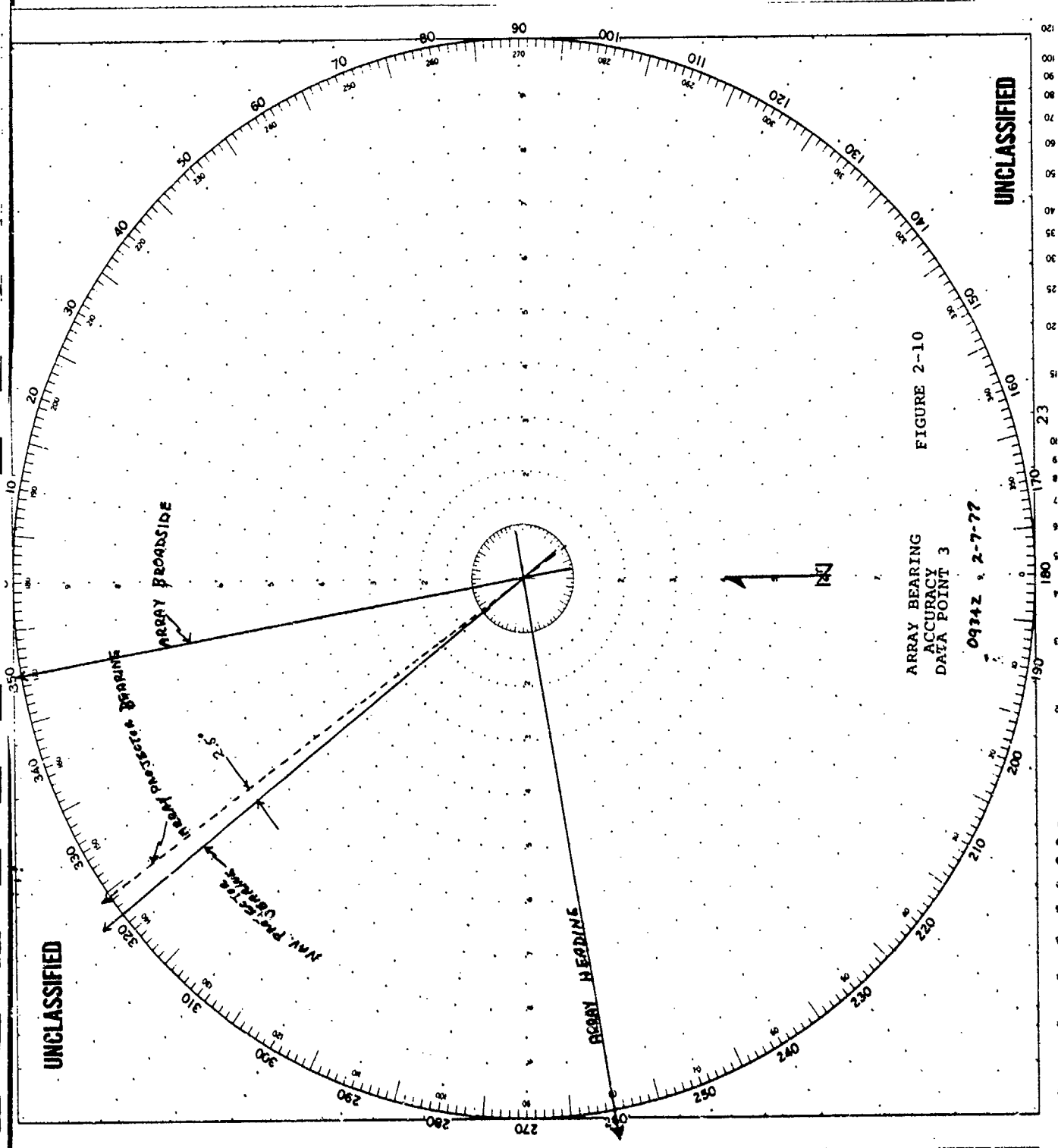
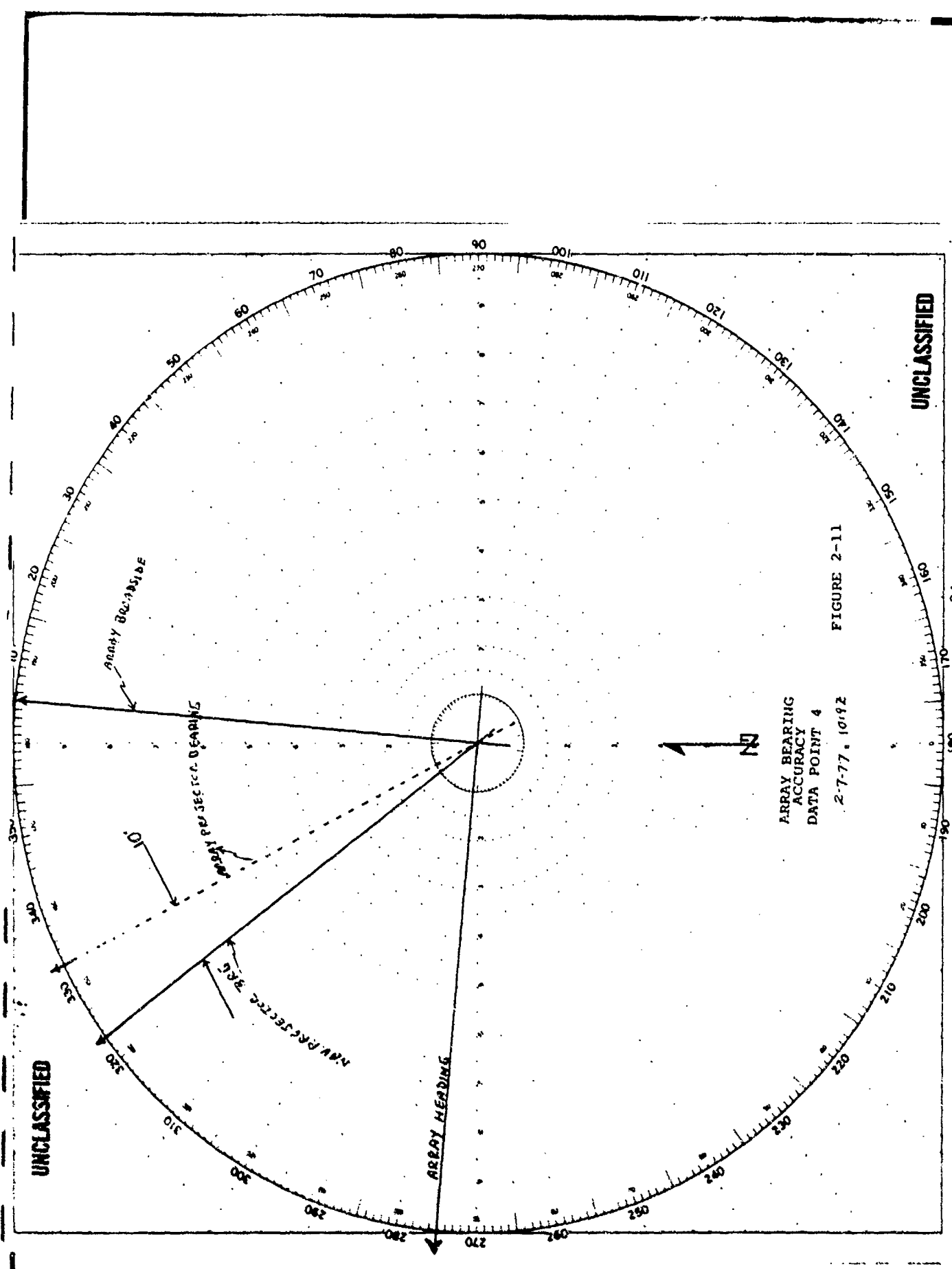


FIGURE 2-9
 ASWAY BEARING
 ACCURACY
 DATA POINT 2



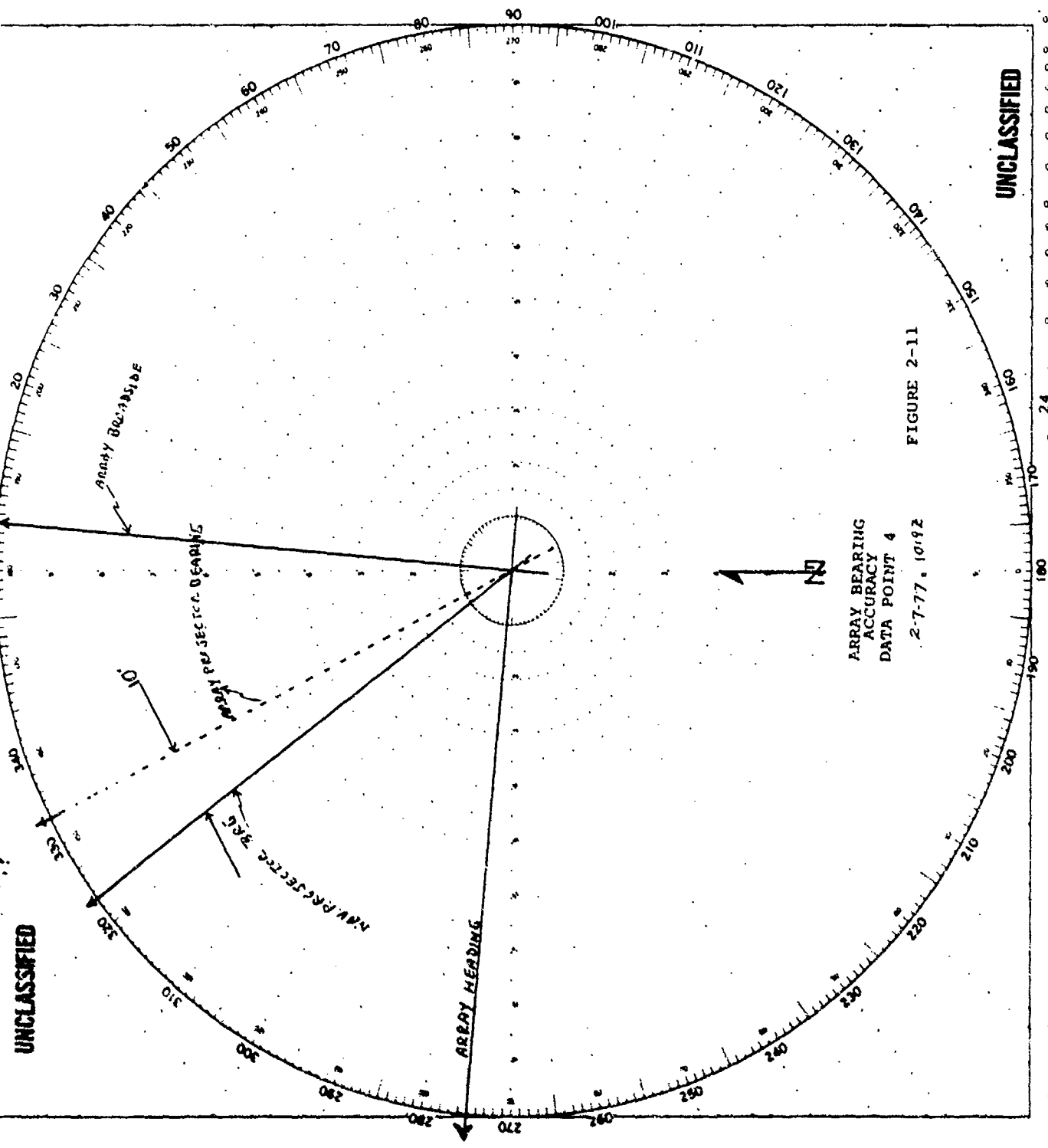


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ARRAY BEARING
ACCURACY
DATA POINT 4
2-7-77, 10:19Z

FIGURE 2-11



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ARRAY BEARING

ARRAY BEARING SECTORS BEARING

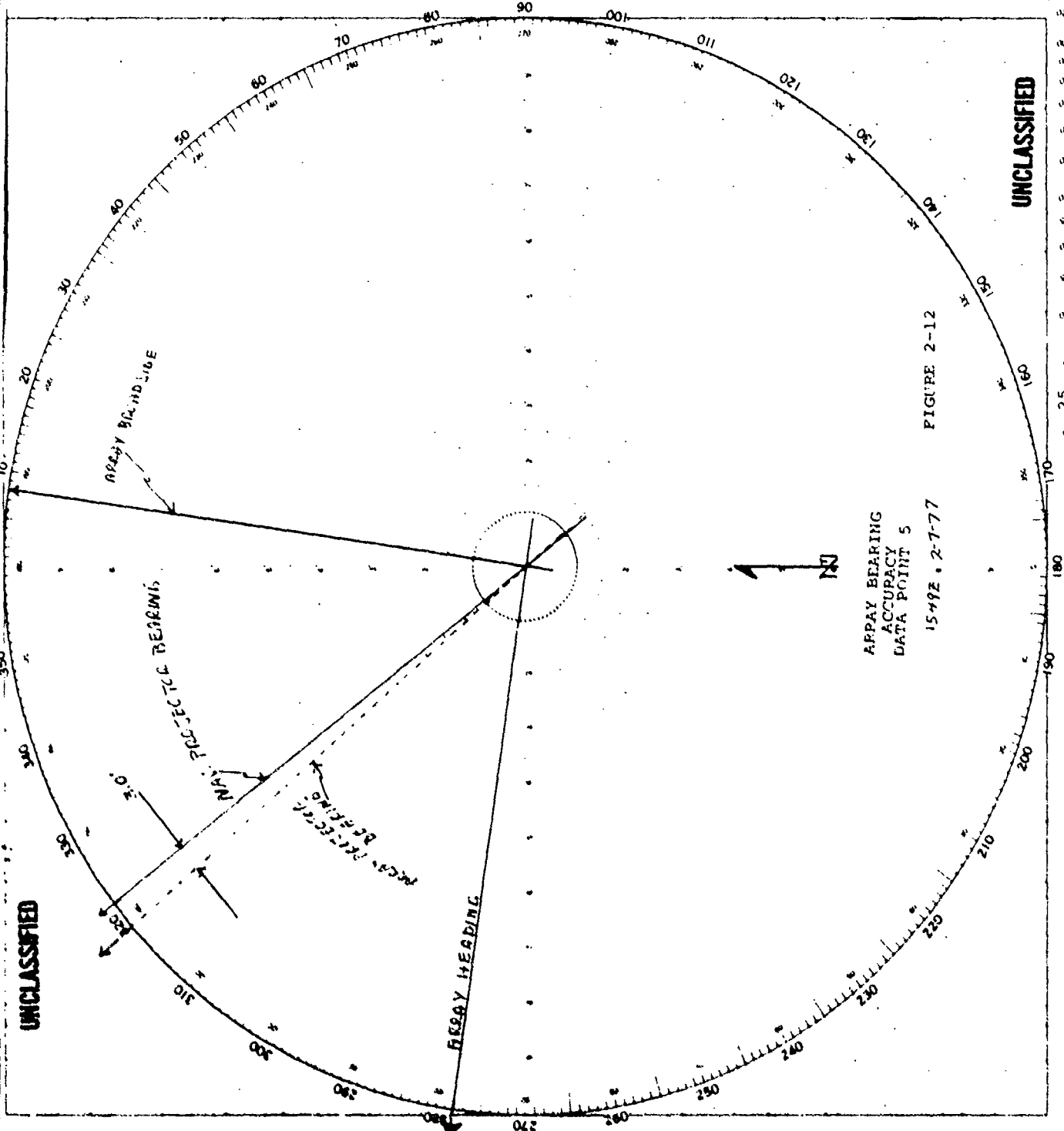
ARRAY BEARING SECTORS RANGE

10

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ARRAY BEARING
ACCURACY
DATA POINT 4
2-7-77, 10:19Z

FIGURE 2-11

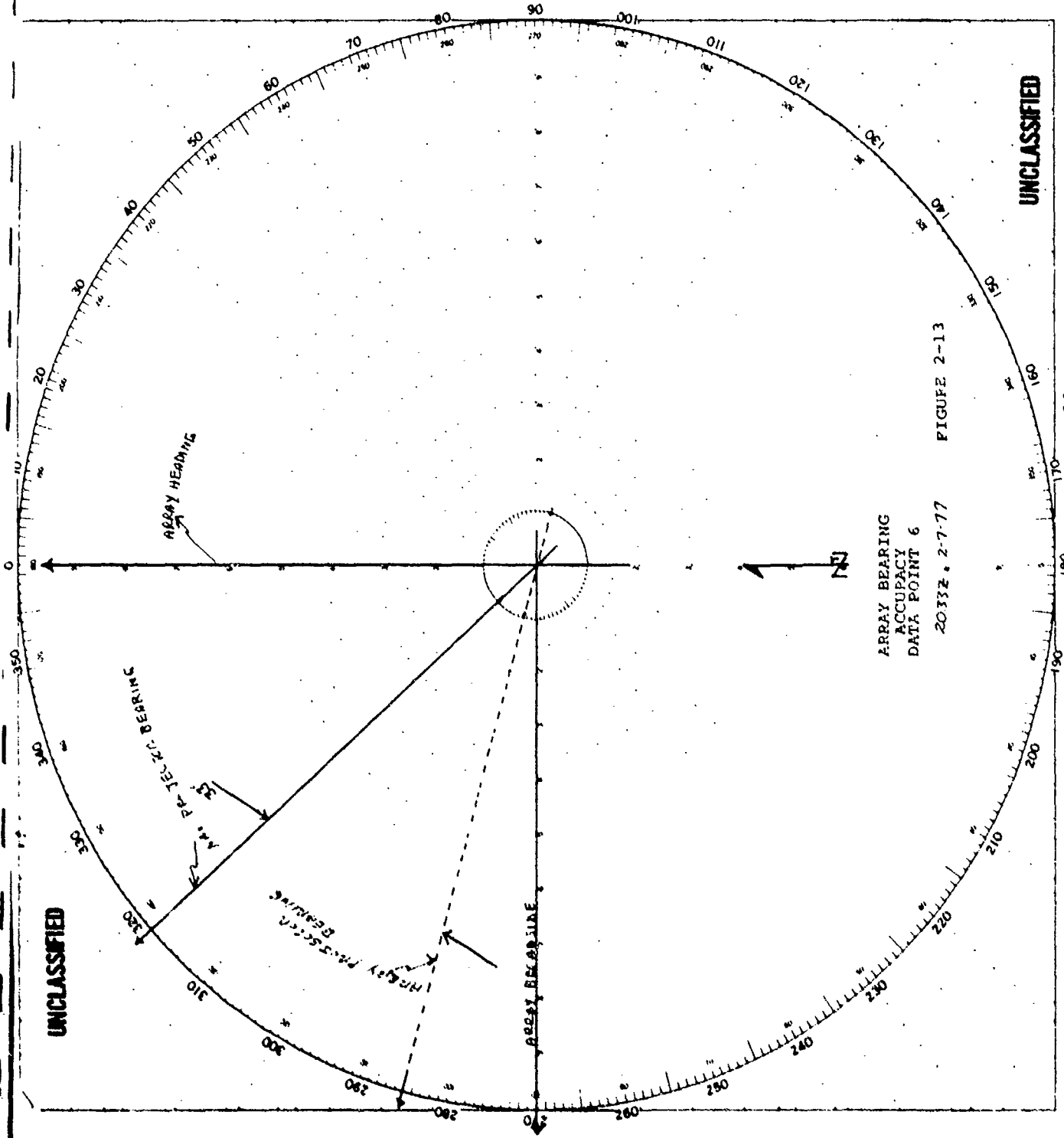


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APPAY BEARING
 ACCURACY
 DATA POINT 5
 1549Z, 2-7-77

FIGURE 2-12



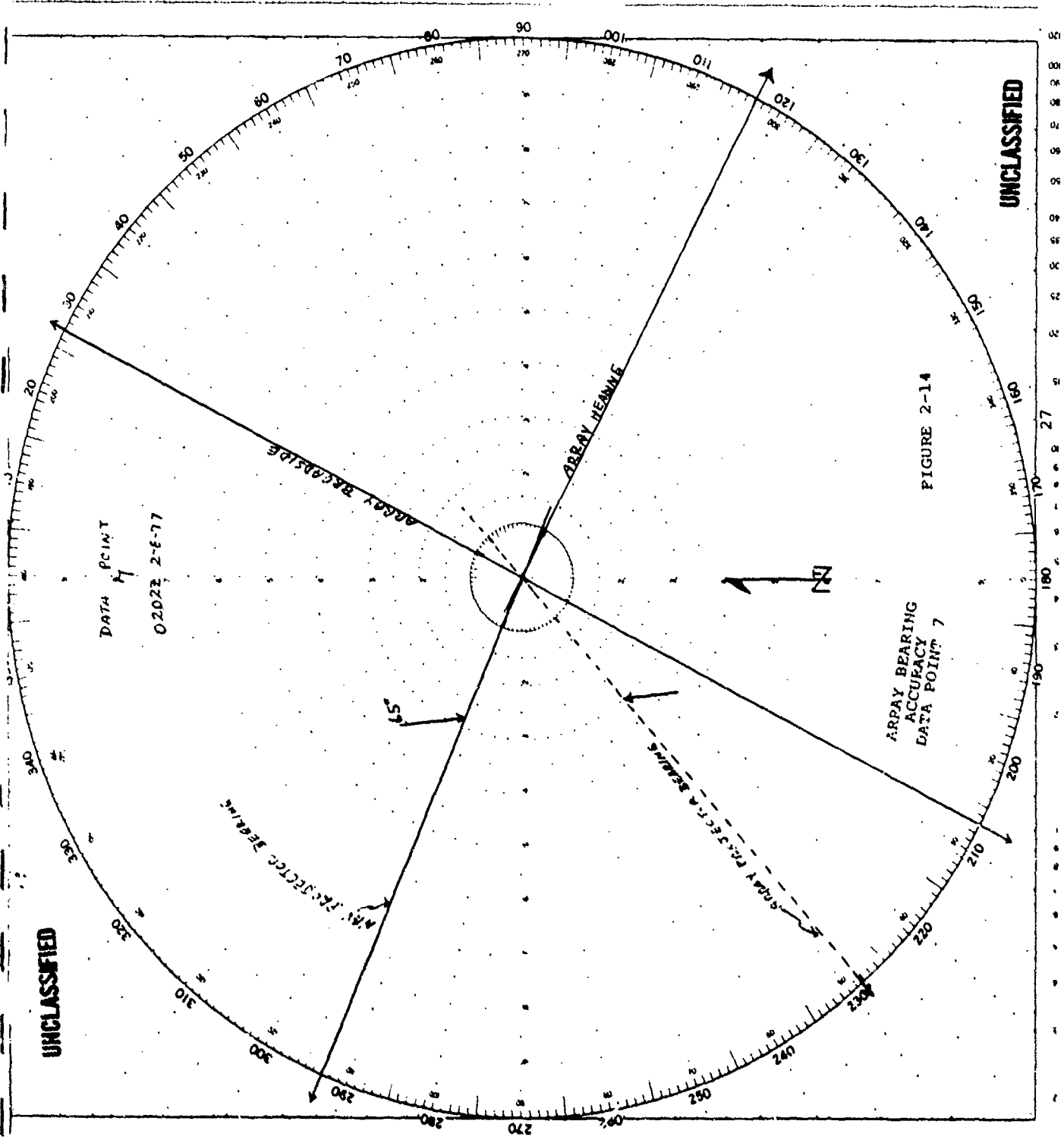
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ARRAY BEARING
ACCURACY
DATA POINT 6

20332-2-7-77

FIGURE 2-13



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FIGURE 2-14

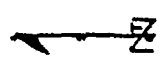
DATA POINT
02022 2-8-77

ARRAY BEARING
ACCURACY
DATA POINT 7

ARRAY BEARING

ARRAY BEARING

ARRAY BEARING ACCURACY DATA POINT 7



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2.5 SUMMARY AND COMPARISON OF ARRAY PERFORMANCE MEASURES (U)

(U) The purpose of this section is to summarize and compare all of the measured array data with theoretical performance. Table 1-2 (Vol IB) compiles results of all the measured data with the exception of signal gain which has a theoretical value of $20 \log$ (number of elements). Comparison of measured and theoretical signal gains are given in Figures 2-1 and 2-2, and on the figures in Appendix A, and will be summarized presently along with beamwidth and array gain data.

(U) Figures 2-15 through 2-23 compare measured array gain, AG, against two theoretical measures of array gain, G_{AZ} and G_{ISO} , under ideal conditions. The steps involved in the determination of measured array gain are discussed in detail in Volume II, Section 3 of this report.

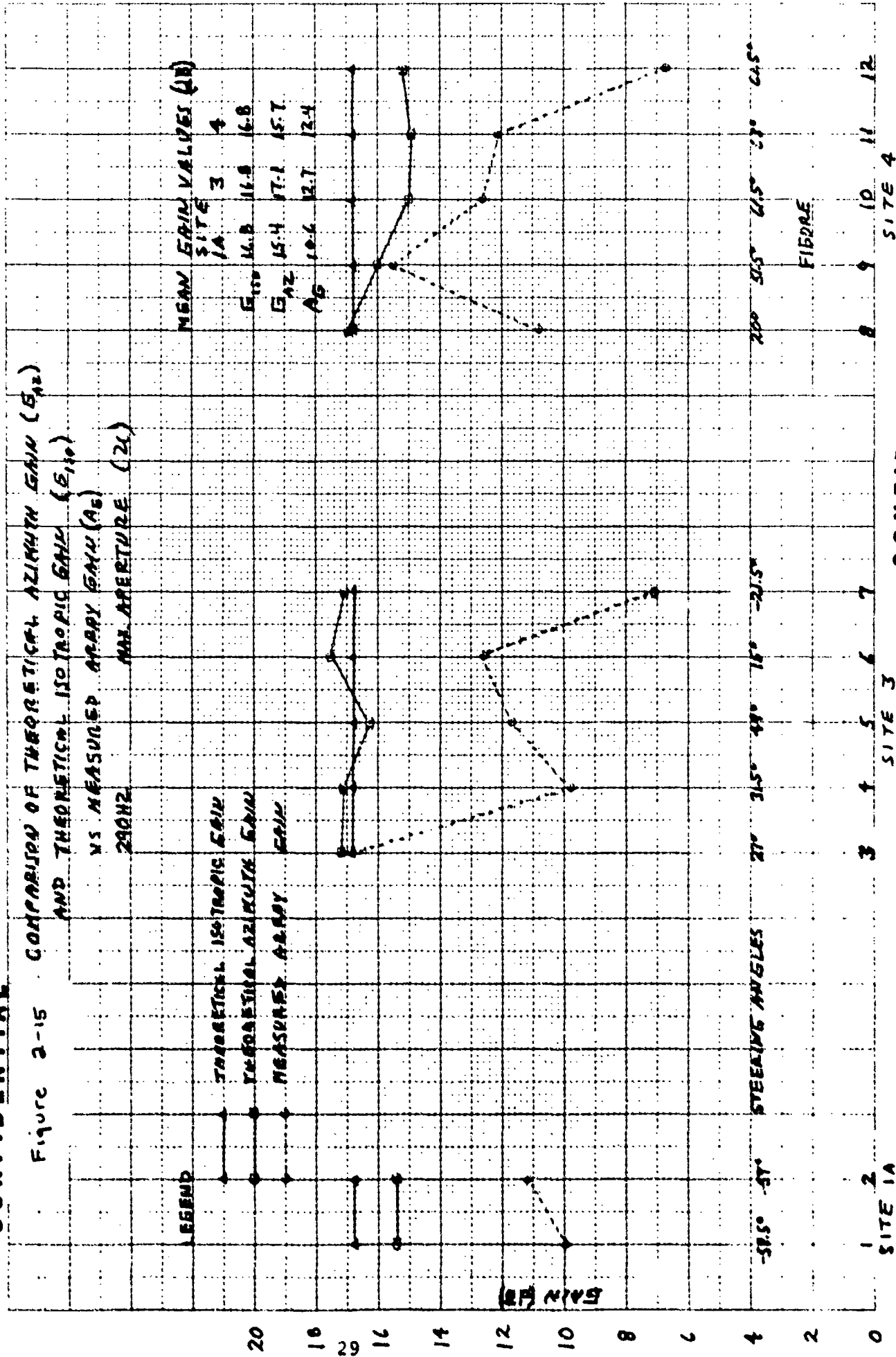
(U) A brief description of the theoretical measures is in order. Azimuth gain, G_{AZ} , is the array gain that results when a two dimensional isotropic noise field (lying entirely in the azimuth plane) is considered. The entire signal is assumed incident on the array maximum response axis MRA, and thus, G_{AZ} is a measure of the array's noise discrimination in the horizontal plane. Isotropic (noise) gain, G_{ISO} , is just the familiar directivity index (DI) of the array, defined similar to azimuth gain except that a three dimensional, isotropic noise field is hypothesized. G_{ISO} is, therefore, a measure of the array's noise rejection characteristic over a three dimensional uniform noise field.

(U) Convenient approximate expressions for azimuth and isotropic gain for a line array of omni directional elements are given as follows:

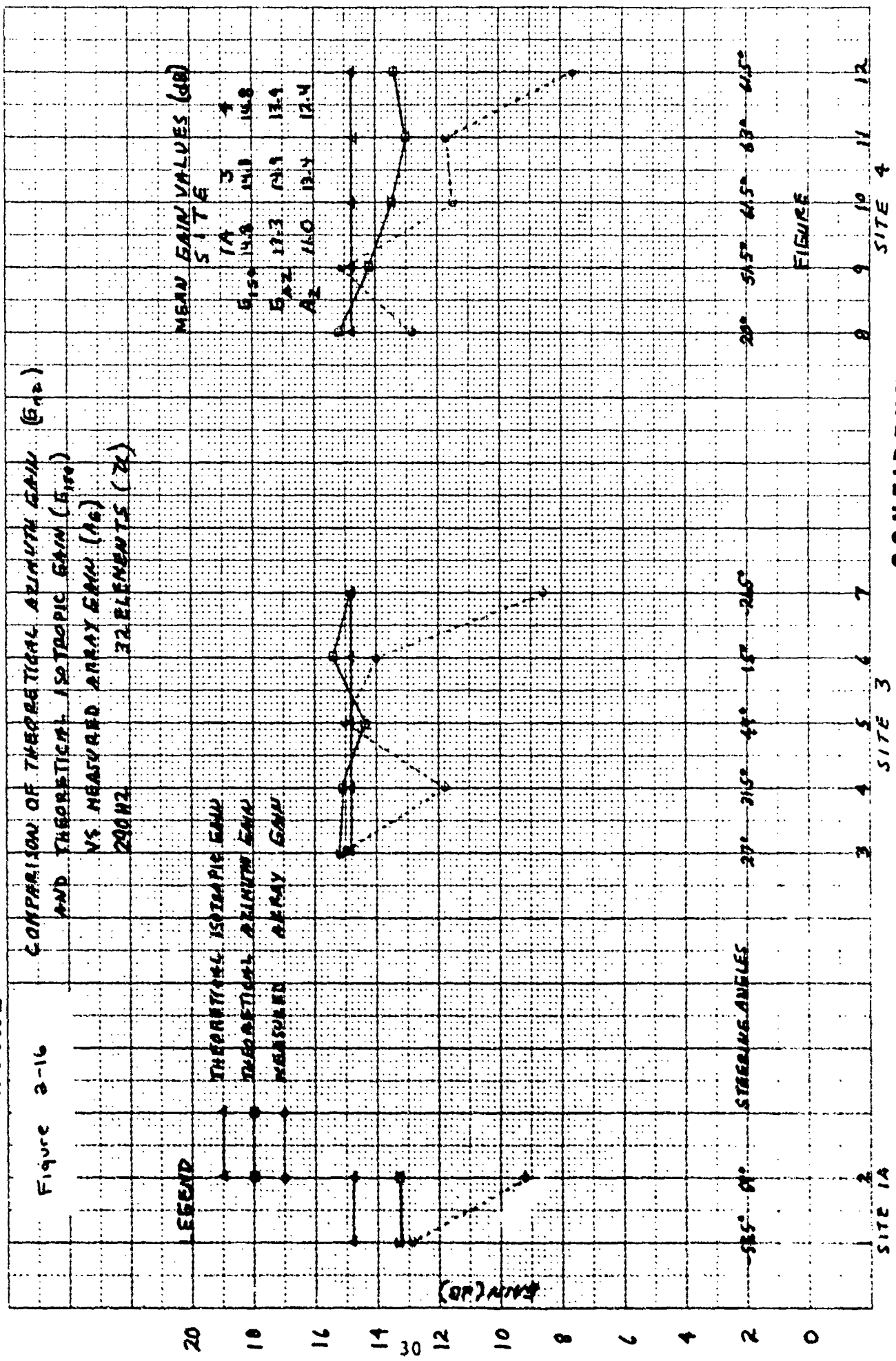
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Figure 2-15 COMPARISON OF THEORETICAL AZIMUTH GAIN (G_{AZ}) AND THEORETICAL ISOTROPIC GAIN (G_{I10}) VS MEASURED ARRAY GAIN (A_G) MAX APERTURE (24)

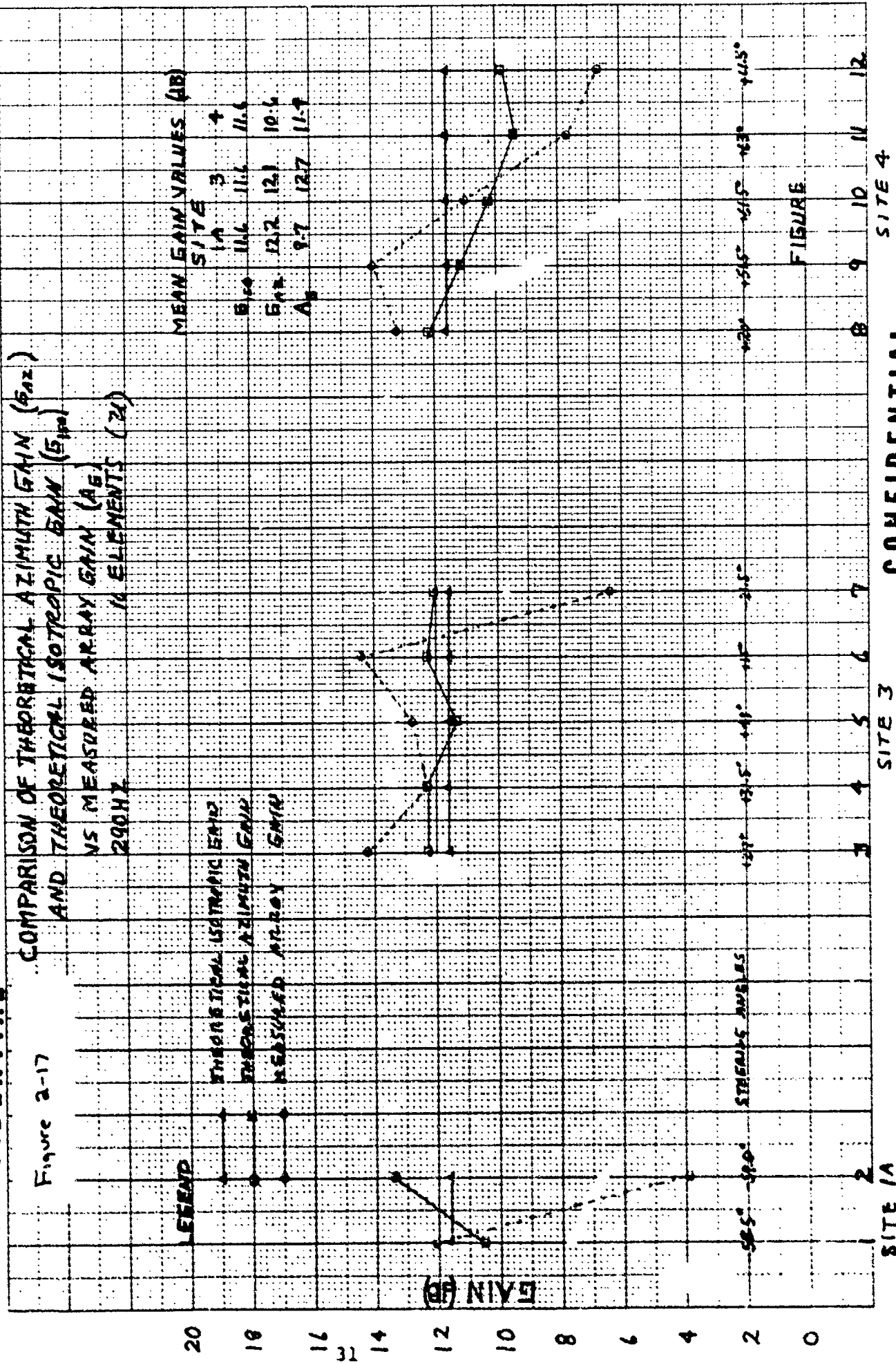


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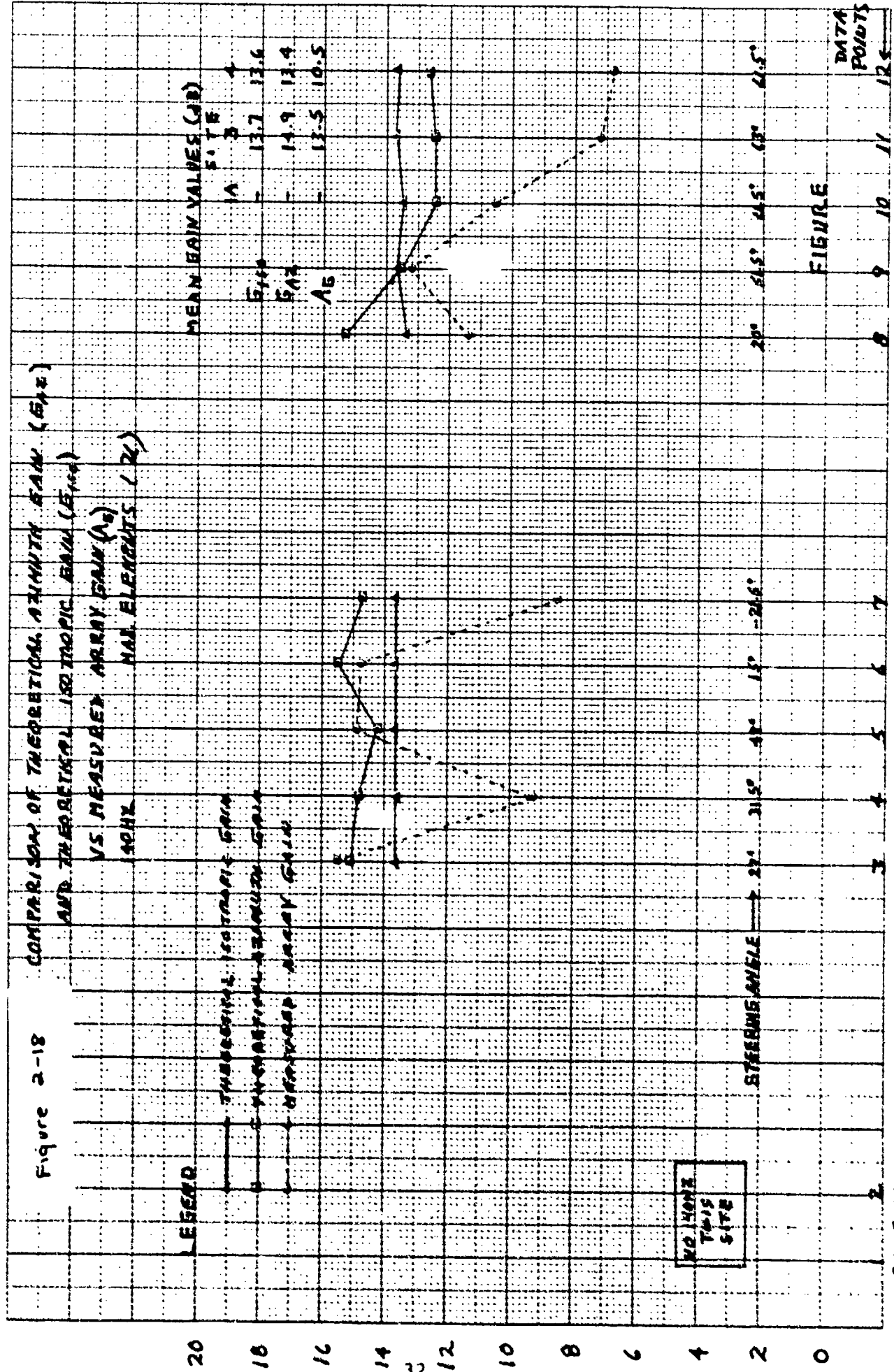
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SITE 1A

SITE 3

SITE 4

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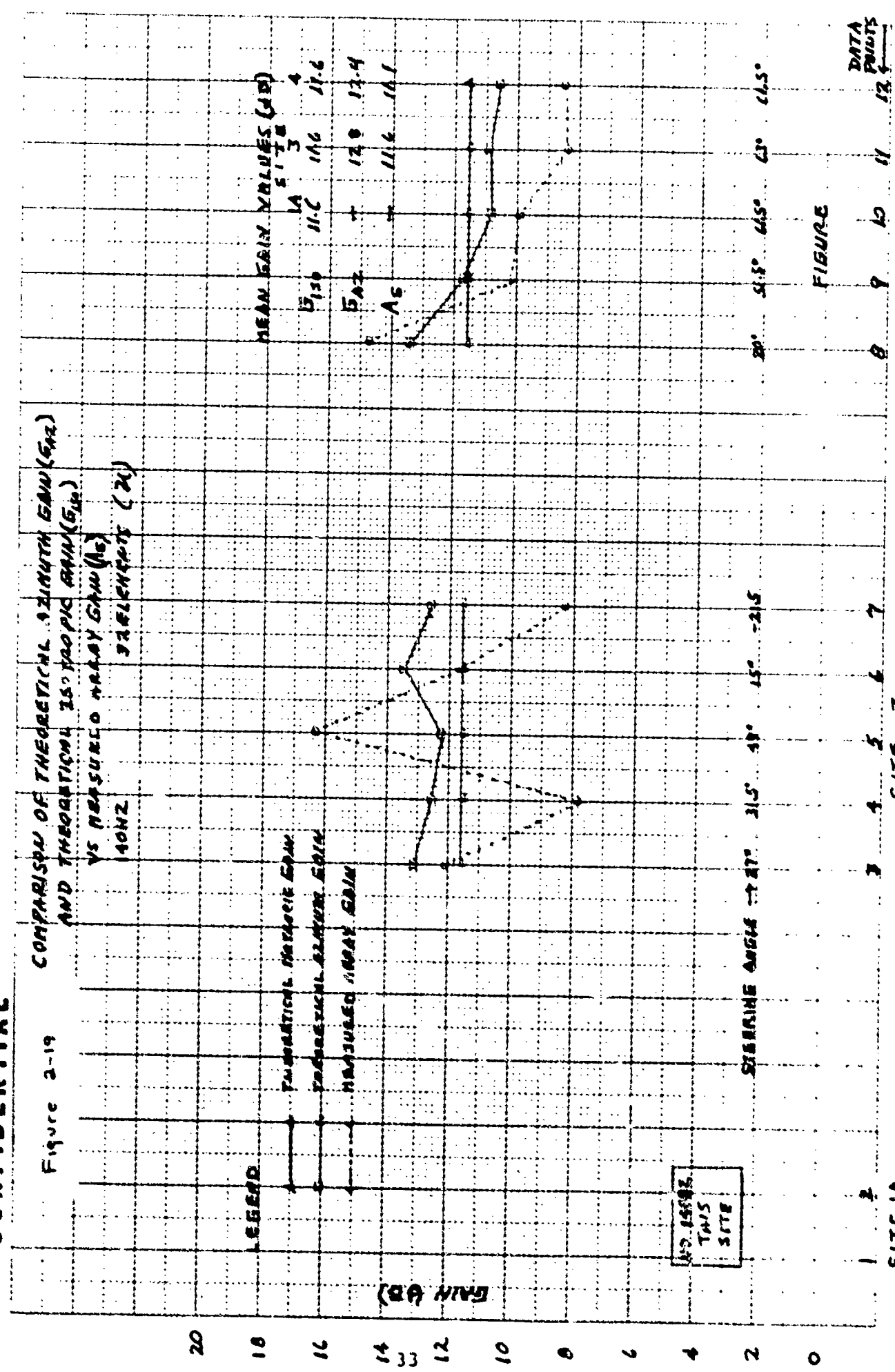
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Figure 2-19
COMPARISON OF THEORETICAL AZIMUTH GAIN (G_{AZ})
AND THEORETICAL ISOTROPIC GAIN (G_{IS})
VS MEASURED ARRAY GAIN (G_A)
ELEMENTS (20)

40HZ

LEGEND

- THEORETICAL ISOTROPIC GAIN
- THEORETICAL AZIMUTH GAIN
- MEASURED ARRAY GAIN



NO. 15503
THIS
SITE

STEARNS ANGLE: 27° 31.5' 49" 15' -21.5'

20° 51.8' 45" 63" 41.5°

FIGURE

DATA
POINTS

9 10 11 12

SITE 1A

SITE 3

SITE 4

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Figure 2-20
COMPARISON OF THEORETICAL AZIMUTH GAIN (G_{AZ})
AND THEORETICAL ISOTROPIC GAIN (G_{TH})
VS MEASURED ARRAY GAIN (G_A)
16 ELEMENTS (2L)

RAIN (dB)

LEGEND

- THEORETICAL ISOTROPIC GAIN
- THEORETICAL AZIMUTH GAIN
- MEASURED ARRAY GAIN

NO. 1-1002
THIS
SITE

STEERING ANGLE \rightarrow 21° 21.5° 15° 11° 7°

1 2
SITE 1A

3 4 5 6 7
SITE 3

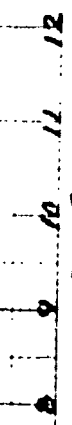
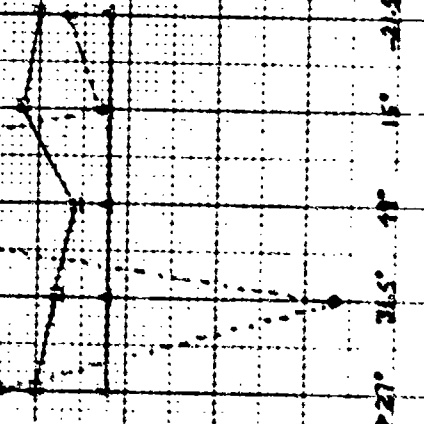
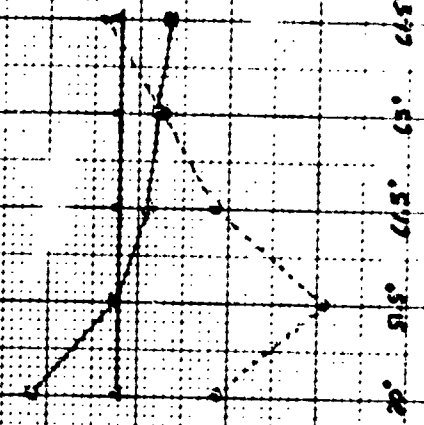
FIGURE

CONFIDENTIAL

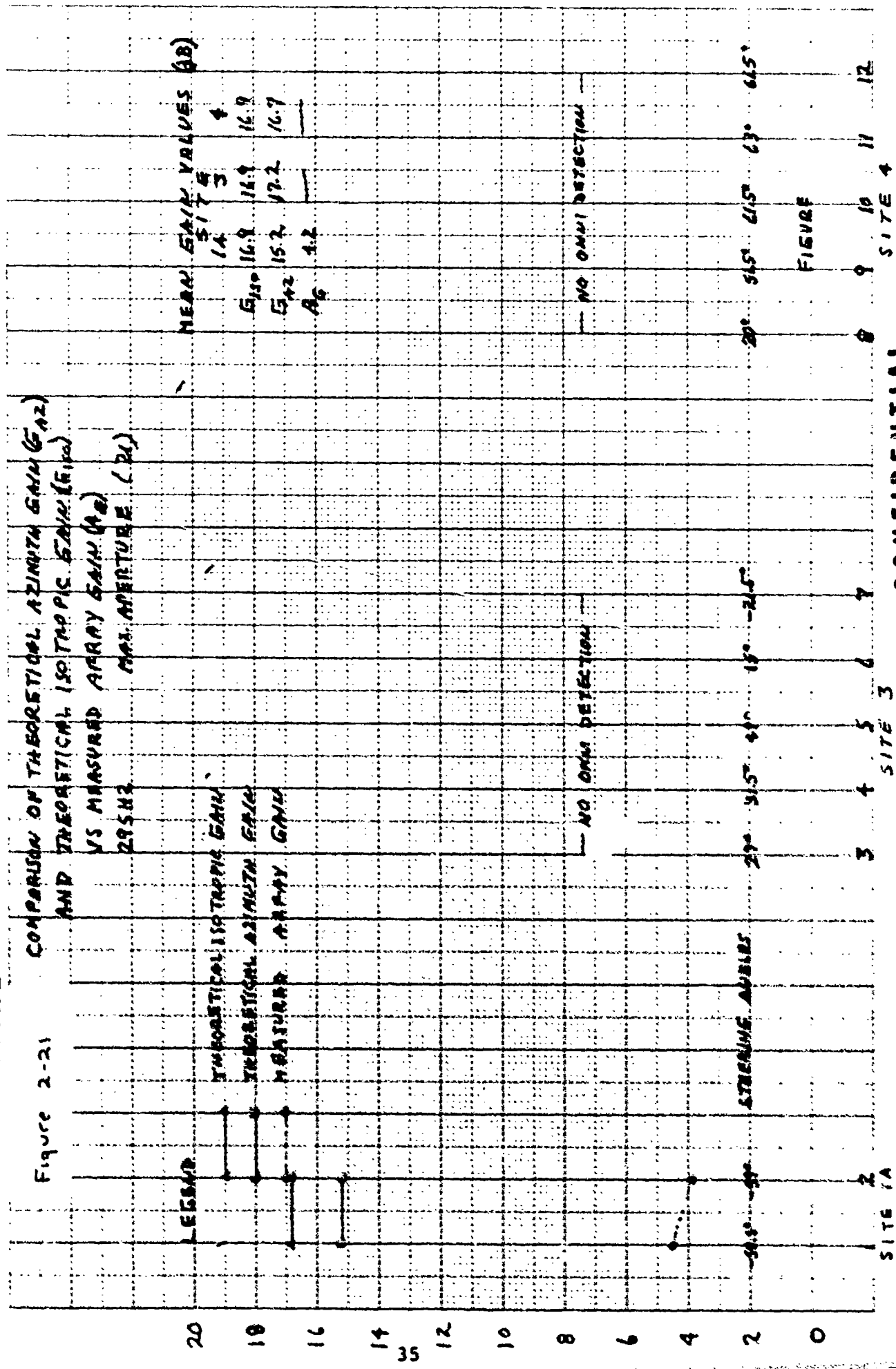
DATA
POINTS

MEAN GAIN VALUES (dB)

Site	1A	3	4
G_{TH}	0.5	0.5	0.5
G_{AZ}	9.9	0.5	
G_A	12.0	0.8	



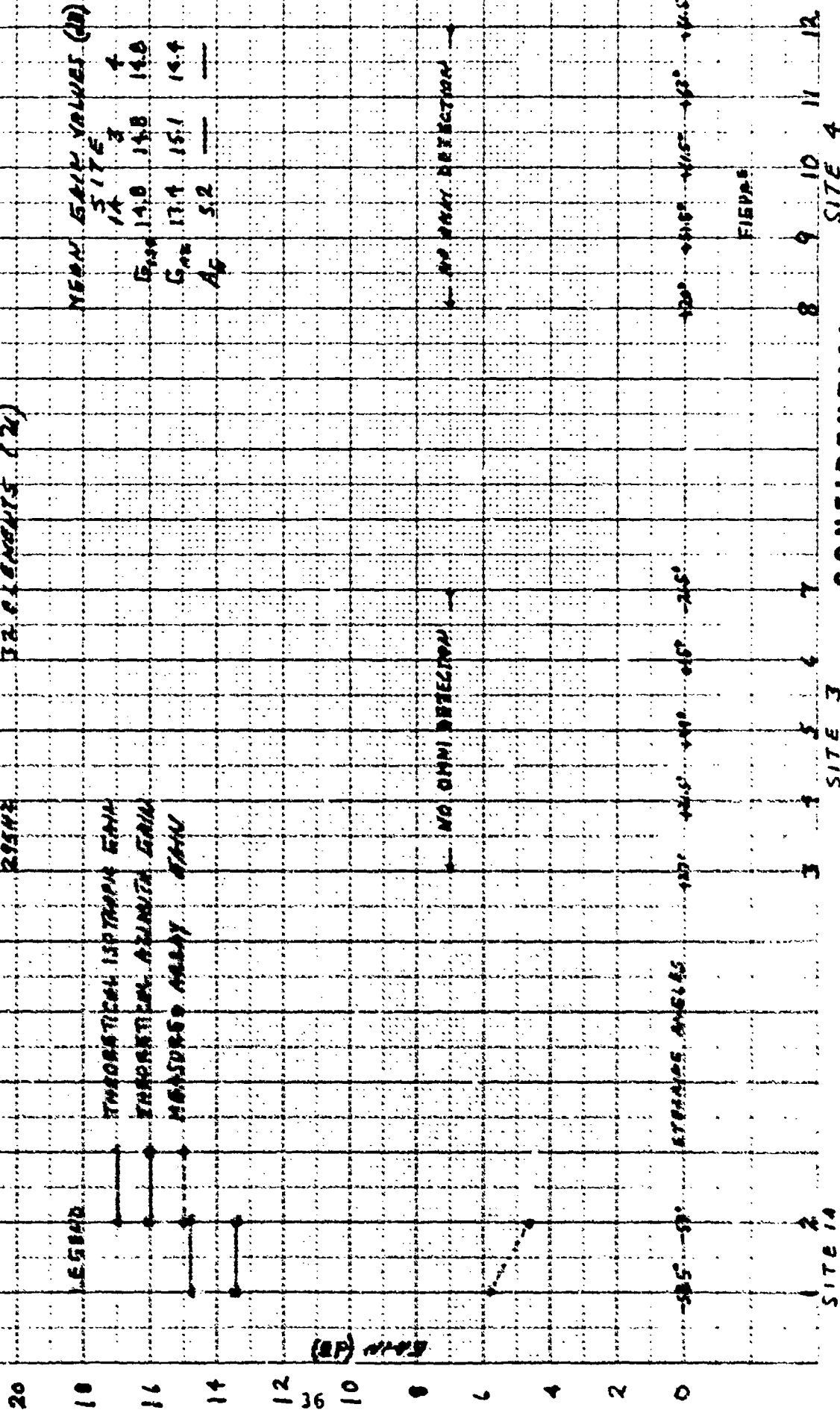
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Figure 2-22 COMPARISON OF THEORETICAL AZIMUTH GAIN (G_{AZ}) AND THEORETICAL ISOTROPIC GAIN (G_{ISO}) VS MEASURED ARRAY GAIN (A_G) IN DB ELEMENTS (Z)



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Figure 2-23
COMPARISON OF THEORETICAL AZIMUTH GAIN (E_{AZ})
AND THEORETICAL ISOTROPIC GAIN (E_{ISO})
VS MEASURED ARRAY GAIN (A_G)
ELEMENTS (N)

295HZ

LEGEND

THEORETICAL ISOTROPIC GAIN
THEORETICAL AZIMUTH GAIN
MEASURED ARRAY GAIN

MEAN GAIN VALUES (dB)

SITE 3

E_{ISO} 11.7 11.7 11.7

E_{AZ} 10.4 15.1 14.9

A_G 11.6

SITE 4

E_{ISO} 11.7 11.7 11.7

E_{AZ} 10.4 15.1 14.9

A_G 11.6

NO GAIN DETECTION

NO GAIN DETECTION

STEARNS ANGLES

27° 31.5° 40° 15° 45°

20° 31.5° 41.5° 43° 45°

FLEURE

SITE 1A

SITE 3

SITE 4

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20

18

16

14

12

37

10

8

6

4

2

0

12

11

10

9

8

7

6

5

4

3

2

1

0

0

0

0

0

0

0

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$$G_{\text{ISO}} = 10 \log (2 L/\lambda) = 10 \log (101.6^\circ/\theta_{3\text{B}}^\circ) \text{ dB} \quad (2-2)$$

$$G_{\text{AZ}} = 10 \log \left[\pi (L/\lambda) \cos \theta_0 \right] = 10 \log (159.6^\circ/\theta_3^\circ) \text{ dB} \quad (2-3)$$

where

L = array length

λ = acoustic wavelength

$\theta_{3\text{B}}^\circ$ = the 3 dB beamwidth in degrees when the array is steered to broadside

θ_3° = the 3 dB beamwidth in degrees independent of the steering imposed

and

θ_0 is the beam steering angle off broadside.

(U) In addition to plotted gain, the summary figures contain mean theoretical and measured gain values for each site, and steering angles, which affect azimuth gain. These figures show that the measured array gain tends to correlate somewhat better with azimuth gain than isotropic gain (against which it was compared in Figures 2-1, 2-2 and the figures in Appendix A).

(U) In summarizing beamwidth measurements, it was found convenient to plot broadside equivalent beamwidth, obtained from measured values by adjusting for the steer angle:

$$\hat{\theta}_{3\text{B}} = \hat{\theta}_3 \cos \hat{\theta}_0, \quad (2-4)$$

where

$\hat{\theta}_3$ = measured beamwidth at measured steer angle $\hat{\theta}_0$.

$\hat{\theta}_{3\text{B}}$ = broadside equivalent beamwidth.

This provides a better theoretical reference for visualization of deviations from theoretical, as shown in Figures 2-24 through 2-32.

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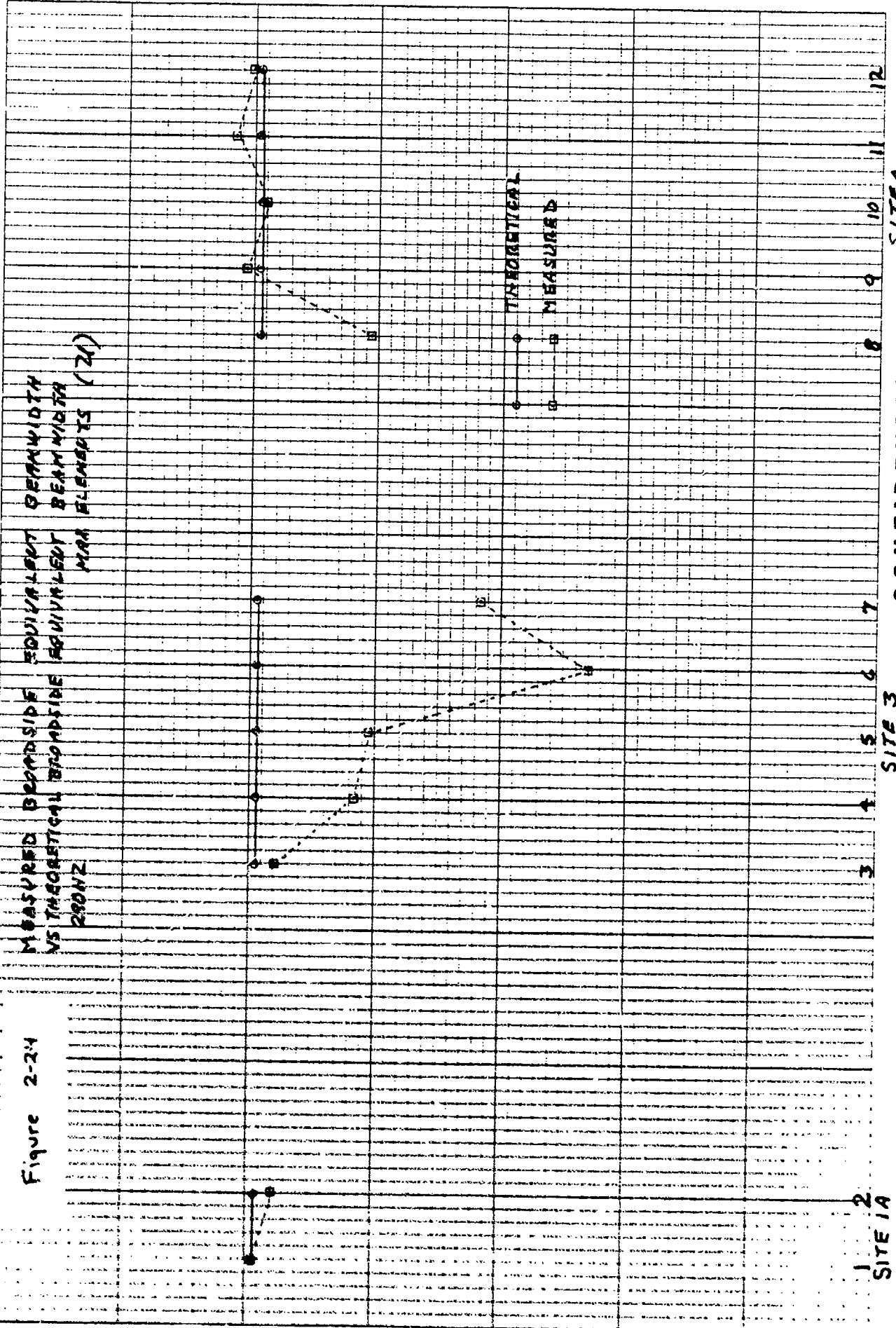
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Figure 2-24

MEASURED BEARDSIDE
VS THEORETICAL BEARDSIDE
280HZ

EQUIVALENT
MMA ELEMENTS (24)

BEAMWIDTH
BEAMWIDTH
MMA ELEMENTS (24)



SITE 4

SITE 3

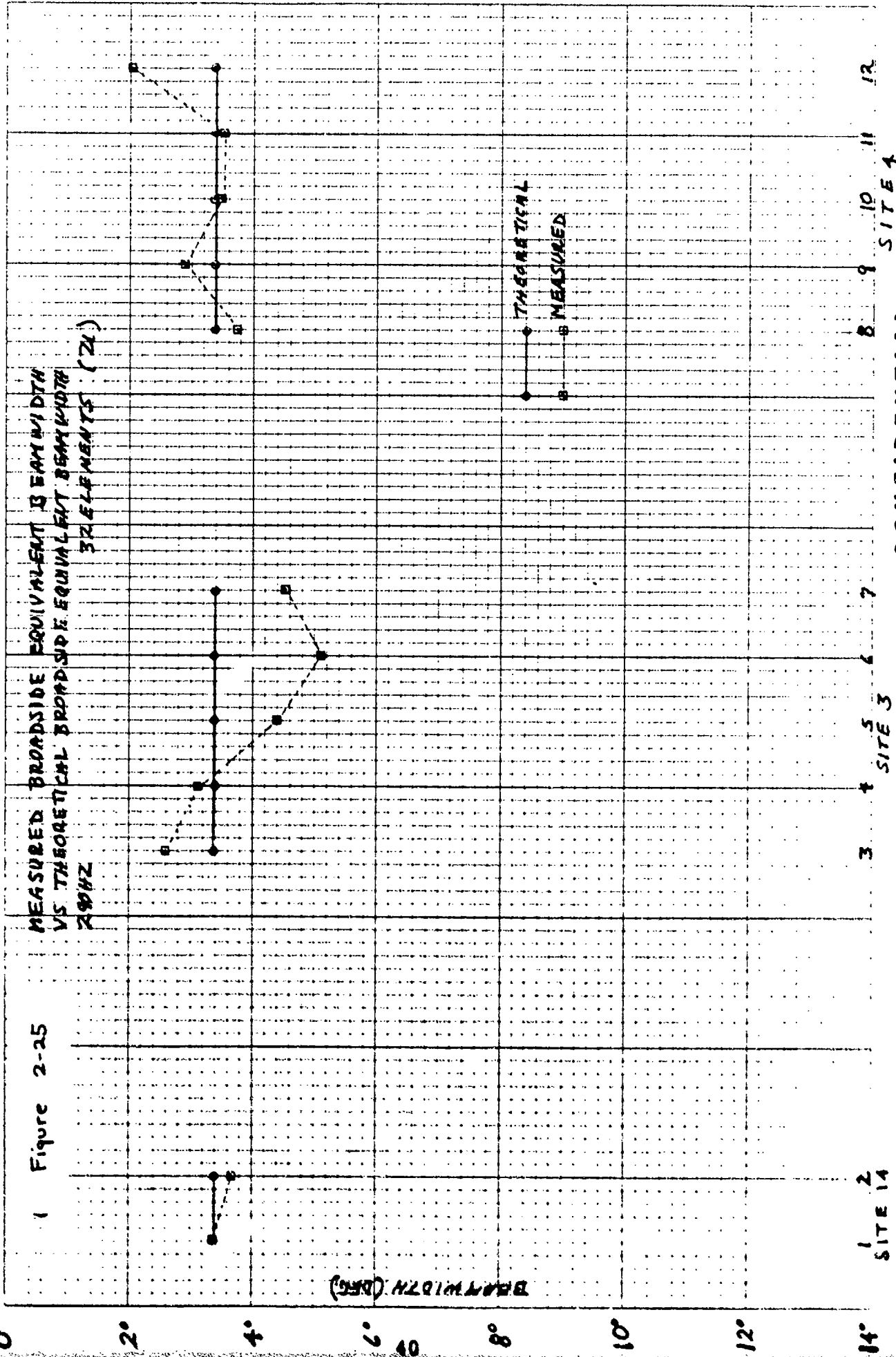
SITE 1A

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Figure 2-25

MEASURED BROADSIDE EQUIVALENT BEAM WIDTH
VS THEORETICAL BROADSIDE EQUIVALENT BEAM WIDTH
ELEMENTS (24)

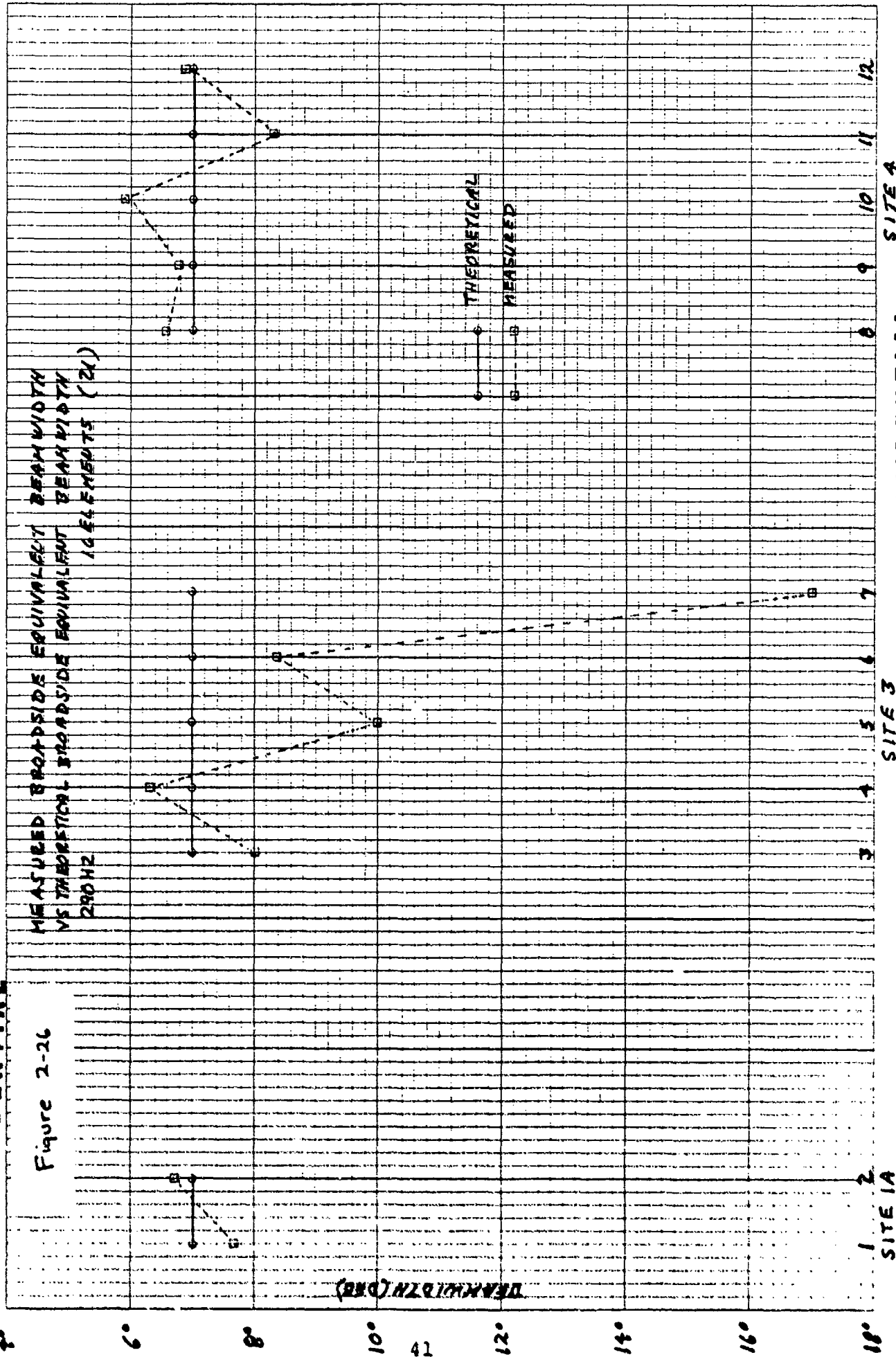


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Figure 2-26

MEASURED BROADSIDE EQUIVALENT BEAM WIDTH
VS THEORETICAL BROADSIDE EQUIVALENT
BEAM WIDTH
290 MHZ
16 ELEMENTS (2X)



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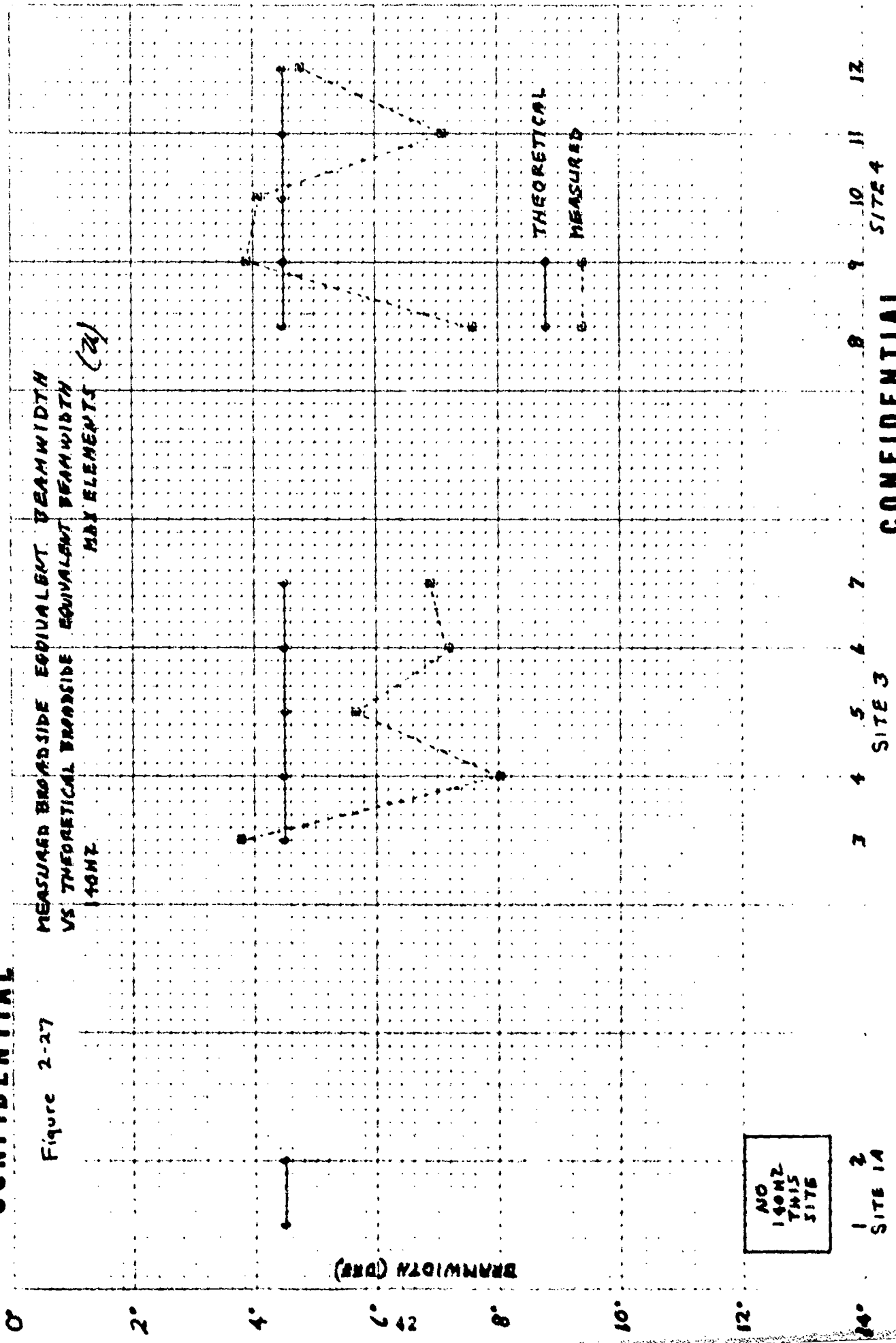
SITE 1A

SITE 3

SITE 4

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Figure 2-27 MEASURED BROADSIDE EQUIVALENT BEAMWIDTH VS THEORETICAL BROADSIDE EQUIVALENT BEAMWIDTH MAX ELEMENTS (2)



NO 140MHZ THIS SITE

1 2 SITE 14

3 4 5 SITE 3

6 7

8 9 10 SITE 4

11 12

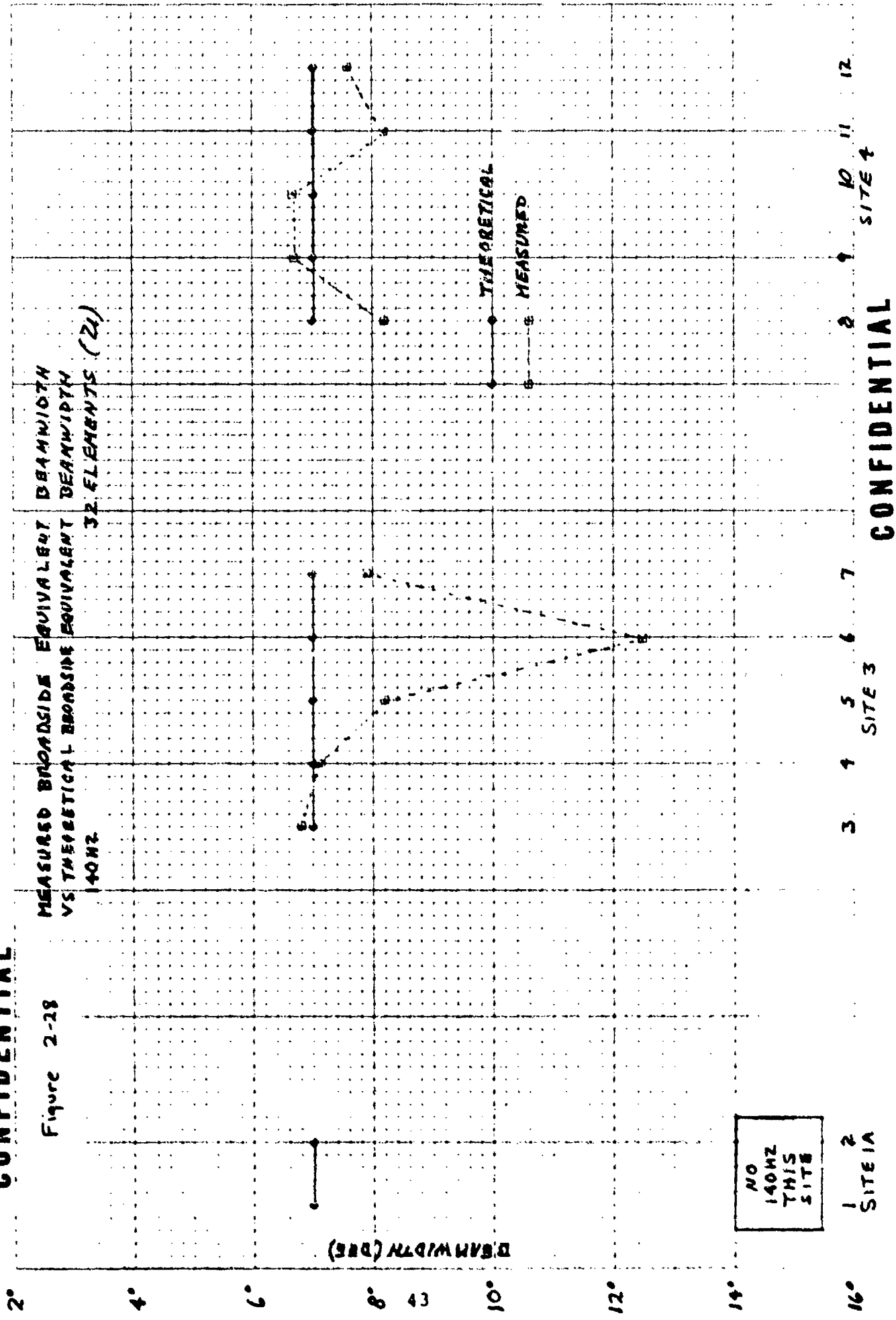
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Figure 2-28

MEASURED BROADSIDE EQUIVALENT BEAMWIDTH
VS THEORETICAL BROADSIDE EQUIVALENT BEAMWIDTH

32 ELEMENTS (21)



NO
140HZ
THIS
SITE

1 SITE 1A

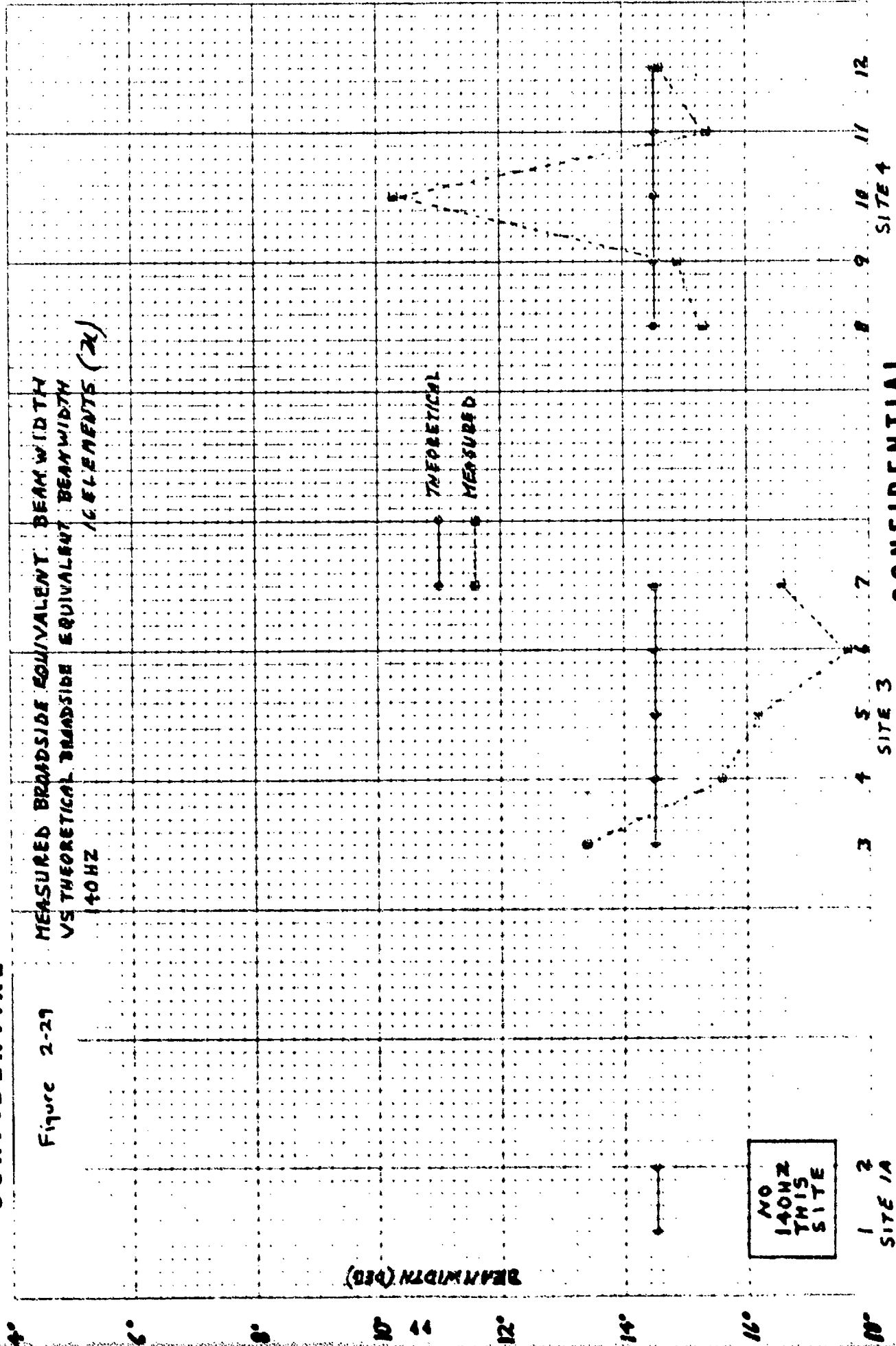
2 SITE 2

3 SITE 3

4 SITE 4

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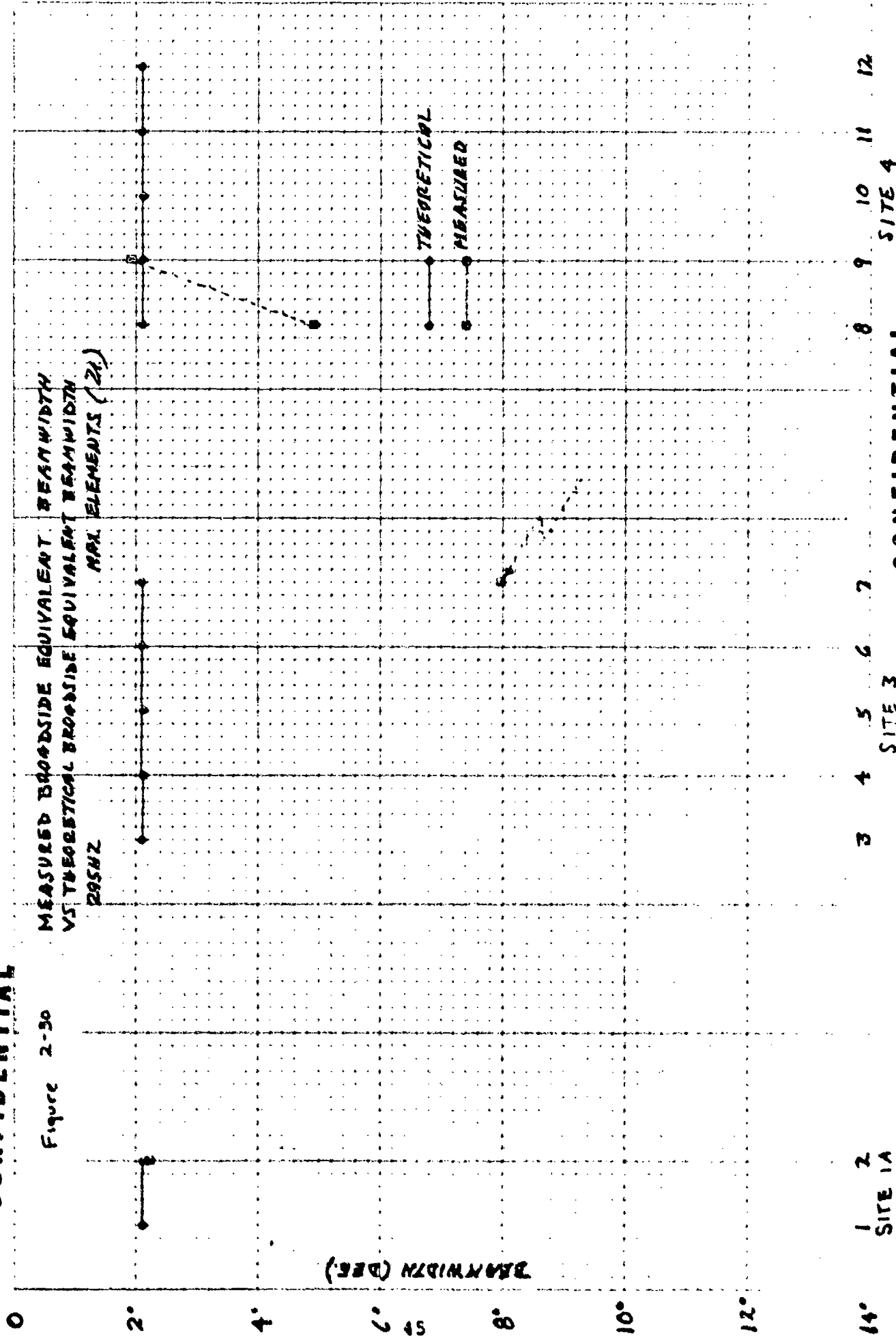
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CONFIDENTIAL

Figure 2-30
MEASURED BOARDSIDE EQUIVALENT BEAMWIDTH
VS THEORETICAL BROADSIDE EQUIVALENT BEAMWIDTH
295HZ
MAX ELEMENTS (24)



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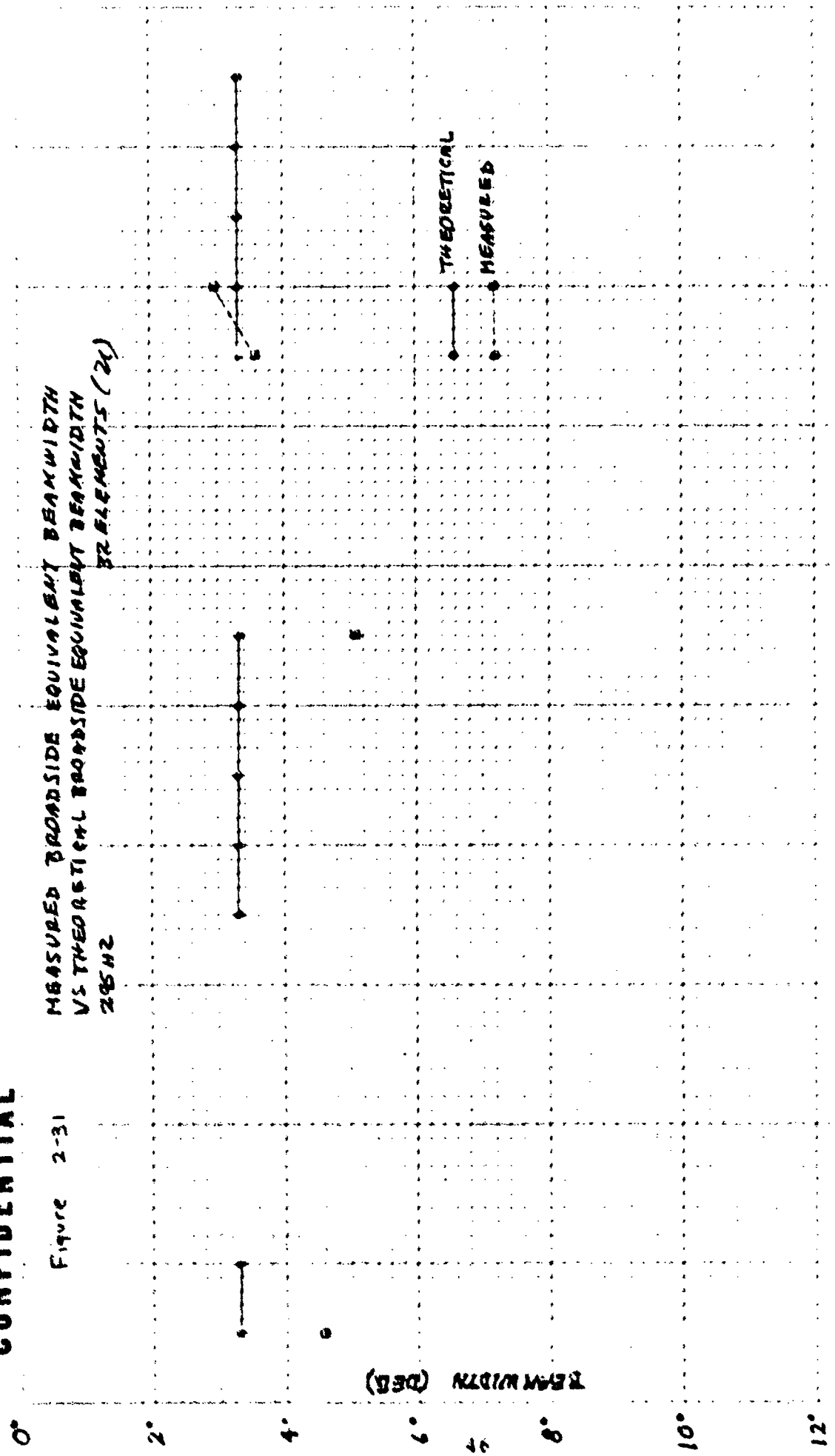
46 0103

NO. 2000 2000 2000

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Figure 2-31

MEASURED BROADSIDE EQUIVALENT BEAMWIDTH
VS THEORETICAL BROADSIDE EQUIVALENT BEAMWIDTH
285 MHz
BR ELEMENTS (24)



14° 1 SITE 2
3 4 5 SITE 3
6 7
8 9 10 11 12
SITE 4

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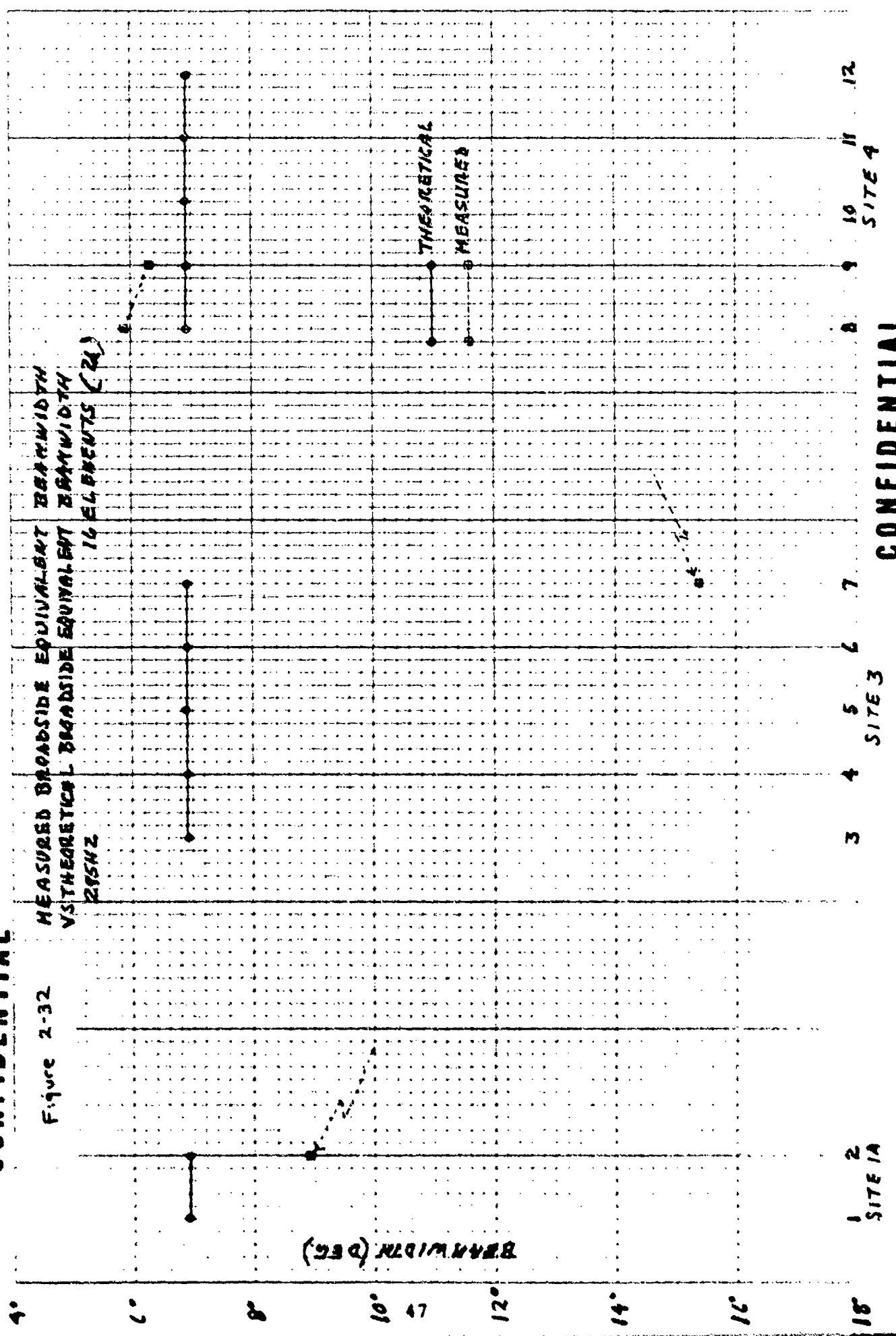


Figure 2-32

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(U) The overall array performance summary is presented in a series of tables which contain the differences in measured performance vs theoretical. Tables 2-5 through 2-7 show beam-width differences from theoretical, and indicate mean and rms differences as a function of site and aperture size. Tables 2-8 through 2-10 summarize signal gain differences from theoretical with mean differences noted. Tables 2-11 through 2-13 list array gain differences.

(U) These last nine tables are further compressed into three array performance summary tables which present ready visualization of the BEARING STAKE results. Tables 2-14, 2-15 and 2-16 correspond to frequencies 290, 140 and 295 Hz respectively.

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(S) Table 2-5 Summary of Measured Beamwidth vs Theoretical (U)

Frequency = 290 Hz

		Beamwidth difference from theoretical for number of elements shown		
Site	DP#	16	32	MAX
1A	1	2.3°	0.7°	0.3°
	2	-0.4°	1.2°	0.9°
Mean Error		0.95°	0.95°	0.6°
rms Error		1.65°	1.0°	0.7°
3	3	1.7°	-0.6°	0.6°
	4	-0.7°	-0.1°	2.1°
	5	2.9°	2.0°	2.9°
	6	1.9°	2.1°	5.8°
	7	11.0°	1.4°	4.0°
Mean Error		3.36°	1.0°	3.1°
rms Error		5.22°	1.5°	3.5°
4	8	0°	0.7°	1.3°
	9	0.2°	-0.3°	-0.1°
	10	0.8°	1.2°	0.6°
	11	3.1°	0.9°	-0.5°
	12	0°	-2.2°	0.1°
Mean Error		0.82°	0.1°	0.3°
rms Error		1.43°	1.2°	0.7°

2.58° rms error for 36 points

2.1° rms error for full aperture (max.)

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(S) Table 2-6 Summary of Measured Beamwidth vs Theoretical (U)

Frequency = 140 Hz

		Beamwidth difference from theoretical for number of elements shown		
Site	DP#	16	32	MAX
1A	1	140 Hz not projected in Site 1A		
Mean Error				
rms Error				
3	3	-0.1°	0.3°	-0.3°
	4	1.0°	0.9°	5.1°
	5	1.4°	2.2°	2.3°
	6	3.9°	6.1°	3.3°
	7	2.2°	0.4°	2.4°
Mean Error		1.68°	2.0°	2.6°
rms Error		2.15°	2.9°	3.1°
4	8	2.2°	1.9°	3.9°
	9	1.8°	0.4°	-0.1°
	10	-2.3°	1.5°	0.1°
	11	3.8°	3.1°	6.5°
	12	-5.8°	2.1°	1.5°
Mean Error		-0.1°	1.8°	2.4°
rms Error		3.5°	2.0°	3.5°

2.91° rms error for 30 points

3.28° rms error for full aperture (Max)

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(S) Table 2-7 Summary of Measured Beamwidth vs Theoretical (U)

Frequency = 295 Hz

		Beamwidth difference for theoretical for number of elements shown		
Site	DP #	16	32	MAX
1A	1	-	3.0 ⁰	0.4 ⁰
	2	4.0 ⁰	-	-
Mean Error		4.0 ⁰	3.0 ⁰	0.4 ⁰
rms Error		4.0 ⁰	3.0 ⁰	0.4 ⁰
3	3	-	-	-
	4	-	-	-
	5	-	-	-
	6	-	-	-
	7	9.6 ⁰	2.2 ⁰	6.5 ⁰
Mean Error		9.6 ⁰	2.2 ⁰	6.5 ⁰
rms Error		9.6 ⁰	2.2 ⁰	6.5 ⁰
4	8	-0.3 ⁰	0.7 ⁰	1.2 ⁰
	9	-0.3 ⁰	-0.1 ⁰	0 ⁰
	10	-	-	-
	11	-	-	-
	12	-	-	-
Mean Error		-0.3 ⁰	0.3 ⁰	1.6 ⁰
rms Error		0.3 ⁰	0.5 ⁰	2.26 ⁰

3.82⁰ rms error for 12 points

3.63⁰ rms error for full aperture (MAX)

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(S) Table 2-8 Summary of Measured Signal Gain
vs Theoretical (U)

Frequency = 290 Hz

		Signal gain difference from theoretical in dB for number of elements shown		
Site	DP#	16	32	MAX
1A	1	-6.1	-8.7	-12.2
	2	-8.8	-5.5	- 6.6
Mean Differ.		-7.2	-6.8	- 8.5
3	3	-0.2	-1.9	-2.1
	4	+0.2	-3.0	-5.7
	5	-0.5	-3.4	-4.1
	6	-4.2	-1.5	-4.4
	7	+1.6	-0.3	-4.7
Mean Differ.		-0.2	-1.9	-4.0
4	8	-1.9	+2.2	-1.6
	9	-2.3	+2.8	+1.0
	10	+0.9	+1.0	+0.1
	11	+0.7	-1.1	-0.4
	12	+3.4	+1.6	+0.1
Mean Differ.		+0.7	+1.5	-0.1

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(S) Table 2-9 Summary of Measured Signal Gain vs. Theoretical (U)

Frequency = 140 Hz

		Signal gain difference from theoretical in dB for number of elements shown		
Site	DP#	16	32	MAX
1A	1 2	140 Hz not projected in Site 1A		
	Mean Differ.			
3	3	+0.4	0	+1.1
	4	-0.9	-0.9	-1.95
	5	+5.1	+2.8	-0.2
	6	+0.1	-1.0	-2.1
	7	+3.3	+1.0	-1.8
	Mean Differ.	+2.2	+0.6	- .8
4	8	+1.4	+2.3	-1.0
	9	-5.1	+1.6	+1.9
	10	+4.6	+3.8	+2.1
	11	+5.1	+3.3	-0.6
	12	+6.2	+4.0	+1.3
	Mean Differ.	+3.8	+3.1	+0.9

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(S) Table 2-10 Summary of Measured Signal Gain
vs. Theoretical (U)

Frequency = 295 Hz

		Signal gain difference from theoretical in dB for number of elements shown		
Site	DP#	16	32	Max
1A	1	-11.6	-13.	-17.3
	2	-10.7	-11.4	-14.2
Mean Differ.		-11.1	-12.1	-15.5
3	3			
	4			
	5			
	6			
	7			
Mean Differ.				
4	8			
	9			
	10			
	11			
	12			
mean difference				

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(S) Table 2-11 Summary of Measured Array Gain vs. Theoretical(U)

Frequency = 290 Hz

		Array gain difference from theoretical azimuth gain (dB) for number of elements shown		
Site	DP#	16	32	Max
1A	1	+1.6	-1.1	-5.4
	2	-9.6	-3.4	-4.3
Mean Differ.		-1.1	-2.1	-4.8
3	3	+1.9	-0.3	-0.4
	4	0	-3.2	-7.3
	5	+1.5	+0.6	-4.6
	6	+1.9	-1.3	-4.9
	7	-5.6	-6.1	-10.0
Mean Differ.		0.6	-1.5	-4.3
4	8	+1.1	-2.4	-6.1
	9	+2.9	-0.9	-0.5
	10	+0.8	-1.9	-2.4
	11	-1.7	-1.3	-2.8
	12	-3.1	-5.8	-8.5
mean difference		+0.5	-1.6	-3.2

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(S) Table 2-12 Summary of Measured Array Gain
vs. Theoretical(U)

Frequency = 140 Hz

		Array gain difference from theoretical azimuth gain (dB) for number of elements shown		
Site	DP#	16	32	Max
1A	1 2	140 Hz not projected in Site 1A		
	Mean Differ.			
3	3	-10.8	-1.0	+0.4
	4	-6.2	-4.8	-5.5
	5	+9.0	+4.2	+0.7
	6	-1.8	-2.0	-0.7
	7	-0.0	-4.3	-6.2
	Mean Differ.	+3.4	-0.2	-1.4
4	8	-4.1	+1.3	-3.9
	9	-4.7	-1.5	-0.4
	10	-1.5	-0.9	-1.9
	11	-0.2	-2.5	-5.2
	12	+1.3	-2.1	-5.8
	mean difference	-1.3	-0.9	-3.0

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(S) Table 2-13 Summary of Measured Array Gain vs Theoretical(U)

Frequency = 295 Hz

		Array gain difference from theoretical azimuth gain (dB) for number of elements shown		
Site	DP#	16	32	Max.
1A	1	-2.5	-5.1	-11.0
	2	-7.9	-8.8	-11.5
Mean Differ.		-4.4	-6.6	-11.2
3	3			
	4			
	5			
	6			
	7			
4	8			
	9			
	10			
	11			
	12			
mean difference				

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TABLE 2-14 ARRAY PERFORMANCE SUMMARY, 290 Hz (U)

deg (dB)

MEAN BEAMWIDTH DIFFERENCE FROM THEOR			
SITE	16 EL	32EL	MAX APER
1A	0.95° (-.3dB)	0.95° (-0.7dB)	0.6° (-0.6dB)
3	3.36° (-1.6dB)	1.0° (-1.0dB)	3.1° (-3.7dB)
4	0.82° (-0.3dB)	0.1° (-0.1dB)	0.3° (-0.3dB)

(dB)

MEAN SIGNAL GAIN DIFF. FROM THEOR. (dB)			
SITE	16EL	32EL	MAX APER
1A	-7.2	-6.8	-8.5
3	-0.2	-1.9	-4.0
4	+0.7	+1.5	-0.1

(dB)

MEAN ARRAY GAIN DIFF FROM THEOR GAZ			
SITE	16EL	32EL	MAX APER
1A	-1.1	-2.1	-4.8
3	+0.6	-1.5	-4.4
4	+0.5	-1.6	-3.2

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TABLE 2-15 ARRAY PERFORMANCE SUMMARY, 140 Hz (U)

deg (dB)

SITE	MEAN BEAMWIDTH DIFFERENCE FROM THEOR		
	16EL	32EL	MAX APER
1A	-	-	-
3	1.68° (-0.4dB)	+2.0° (-1dB)	+2.6° (-1.9dB)
4	-0.1° (0dB)	+1.8° (-0.6dB)	-2.4° (-1.2dB)

(dB)

SITE	MEAN SIGNAL GAIN DIFF. FROM THEOR (dB)		
	16EL	32EL	MAX APER
1A	-	-	-
3	2.2	0.6	-0.8
4	3.8	3.1	0.9

(dB)

SITE	MEAN ARRAY GAIN DIFF FROM THEOR GAZ		
	16EL	32EL	MAX APER
1A	-	-	-
3	3.4	-0.2	-1.4
4	-1.3	-0.9	-3.0

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TABLE 2-16 ARRAY PERFORMANCE SUMMARY, 295 Hz (U)

SITE	MEAN BEAMWIDTH DIFFERENCE FROM THEOR		
	16EL	32EL	MAX APER
1A	4.0° (-1.1dB)	3.0° (-1.8dB)	0.4° (-.5dB)
3			
4			

SITE	SIGNAL GAIN DIFF. FROM THEOR (dB)		
	16EL	32EL	MAX APER
1A	-11.1	-12.1	-15.5
3			
4			

SITE	ARRAY GAIN DIFF. FROM THEOR GAZ		
	16EL	32EL	MAX APER
1A	-4.4	-6.6	-11.2
3			
4			

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2.6(C) ARRAY PERFORMANCE AT 295 Hz (U)

(C) Only a limited and somewhat dubious data base (2 data points) for array gain is reported for the 295 Hz line. (see Table 2-17) Because the low 295 Hz signal levels radiated were detected on omni channels only in Site 1A (DP 1 and 2), array gain is reported only for these data points. The beamformed array output, however, indicated detections of the 295 Hz line in all three sites.

(C) Comparison of 290 and 295 Hz measured signal levels on omni channels (Table 2-17) show poor agreement with radiated levels. On the other hand, agreement of beamformed signal level is in good agreement (except for DP 2) with radiated levels. Further, one observes that measured SNR values for beamformed data are quite small (2.5 to 3.2 dB) in the analysis bandwidth for DP 1 and 2, making it implausible that the omni SNR's reported are accurate. The conclusion drawn is that measured omni signal levels are suspect, and the resulting SNR and AG values in Table 2-17, and in other data presented is questionable.

(C) It is noted from Table 2-17 that the AG for data points 8 and 9 must exceed 9.7 and 11.7 dB respectively, since presumably the omni SNR for these points is zero dB or less.

TABLE 2-17
COMPARISON OF SIGNAL LEVELS, SNR AND AG FOR 295 HZ DATA (U)

Site	DP	Range	Proj Signal		Δ Sig Level (dB)	Meas Sig Level 290Hz	Omni (dBV) 295Hz	Omni Δ Sig Level (dB)	Meas BF Sig		BF Δ Sig Level (dB)	Meas SNR @ 295 Hz BF (dB) Omni (dB)	AG @ 295 Hz (dB)	
			Level (dBuPa)	Level (dB)					Level (dBV)	Level (dB)				
1A	1	91	155	145	-10	-49.7	-53.3	-3.6	-27.6	-36.3	-8.7	2.5	-2.0	4.5
	2	91	155	140	-15	-51.5	-51.2	+0.2	-24.2	-31.4	-7.2	3.2	-0.7	3.9
3	7	28	180	143	-37	-17.5	*	*	12.0	-24.2	-36.2	3.3	*	*
	8	22	182	143	-39	-15.2	*	*	16.8	-19.2	-36.0	9.7	*	*
	9	72	182	143	-39	-12.5	*	*	20.4	-17.8	-38.2	11.7	*	*
<p>(1) These are in good agreement with projected signal levels.</p> <p>(2) These are in poor agreement with projected signal levels.</p> <p>* Signal not detected on individual omni channels. Therefore, SNR and AG cannot be computed from measured data.</p>														
<p>CONCLUSION: Omni measured signal levels and, therefore, SNR's are questionable and thus the very low measured array gain (AG) values reported (3) are unreliable.</p>														

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Appendix A

Comaprison of Signal Gain & Array Gain Vs. Number
of Elements (U)

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FIG. A-1:
COMPARISON OF SIGNAL GAIN
IN RELATION TO ARRAY GAIN
VS NUMBER OF ELEMENTS
MEASURED AT
200 MHz (20)

DPI 1-14-77 15512

SIGNAL GAIN

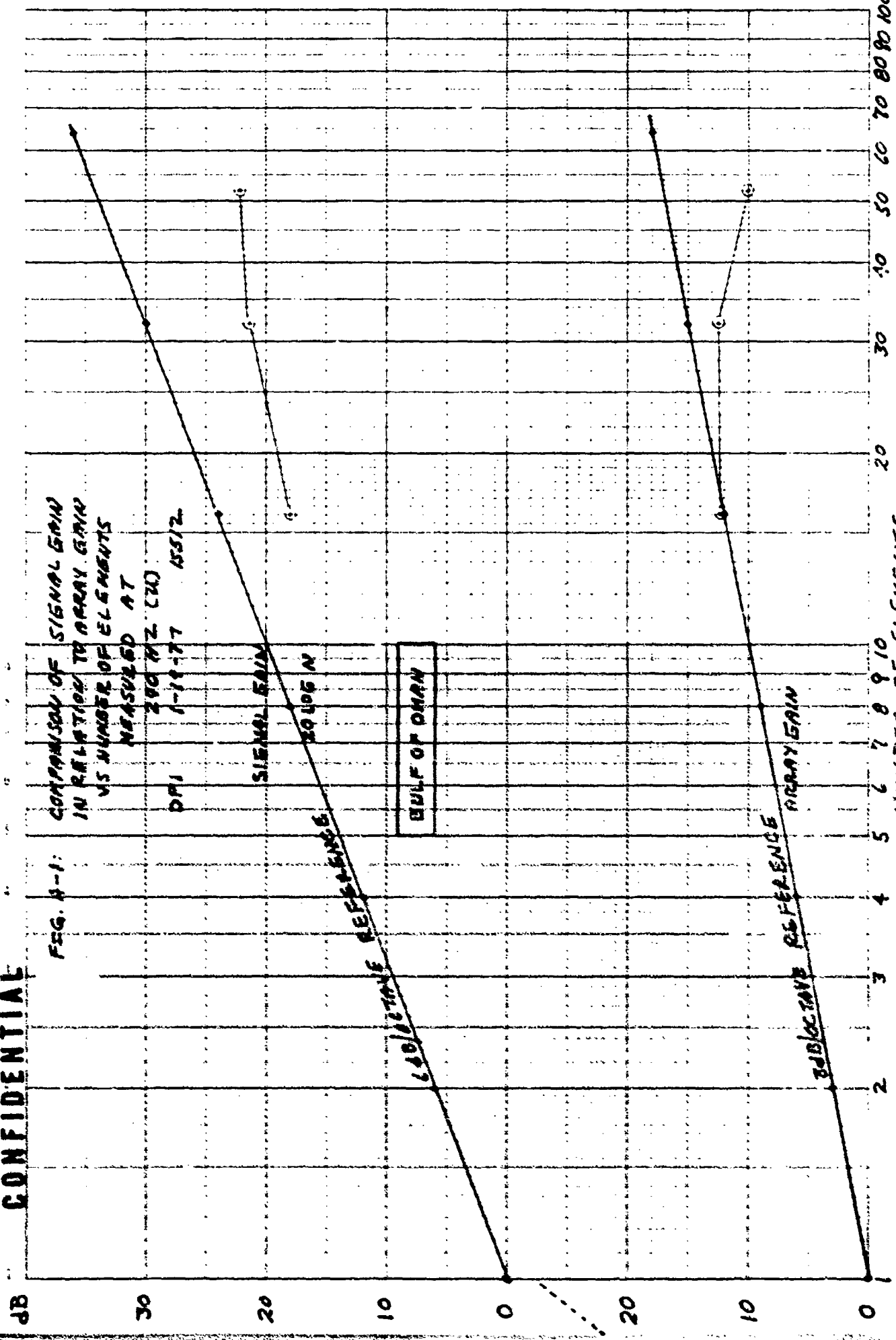
30 LOG N

30 LOG N

30 LOG N

30 LOG N

NUMBER OF ELEMENTS



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FIG. A-2: COMPARISON OF SIGNAL GAIN IN RELATION TO ARRAY GAIN VS NUMBER OF ELEMENTS MEASURED AT

2957Z (2L)
1551Z

DPI 1-11-77

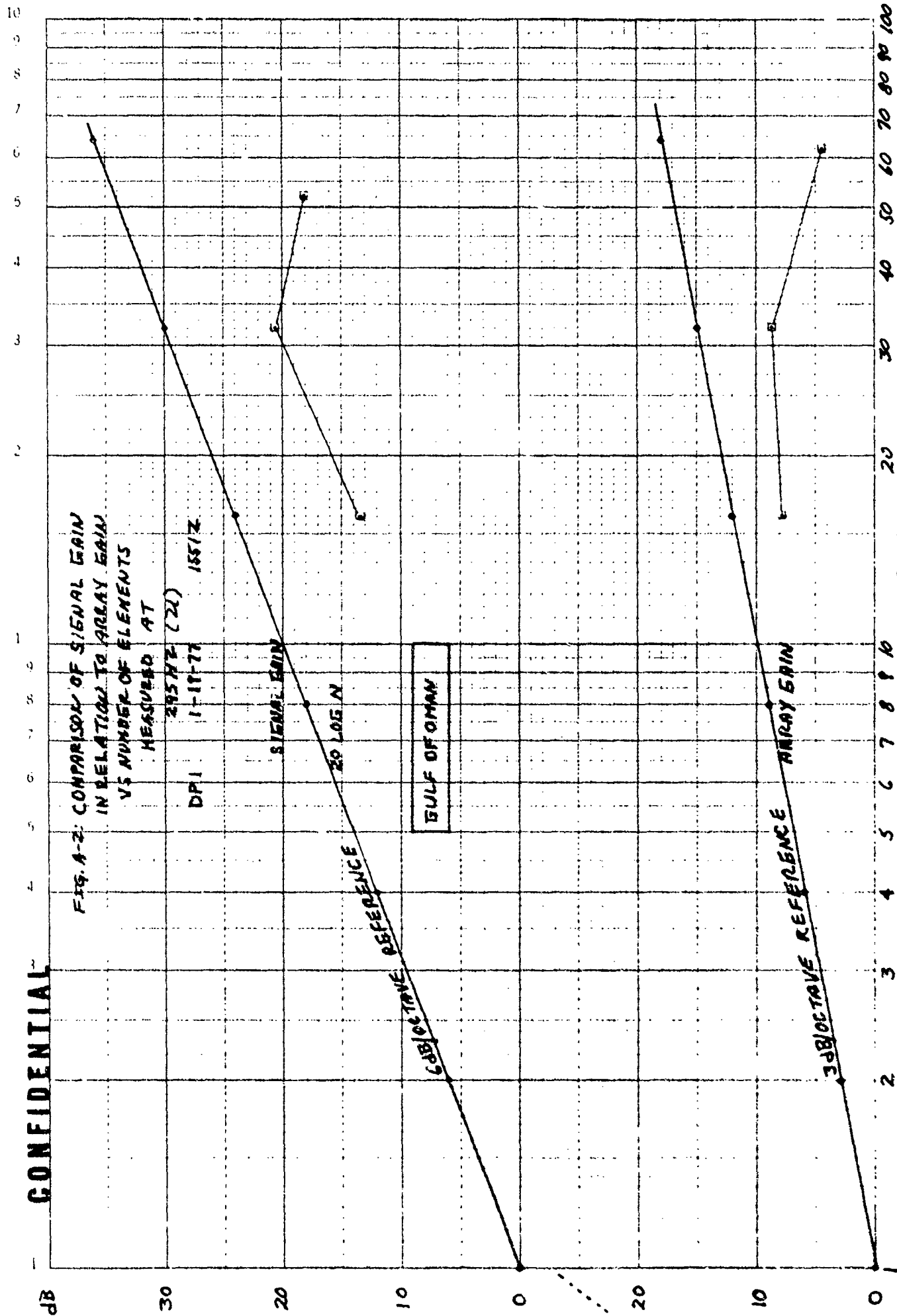
SIGNAL GAIN

20 LOG N

3dB/OCTAVE REFERENCE

GULF OF OMAN

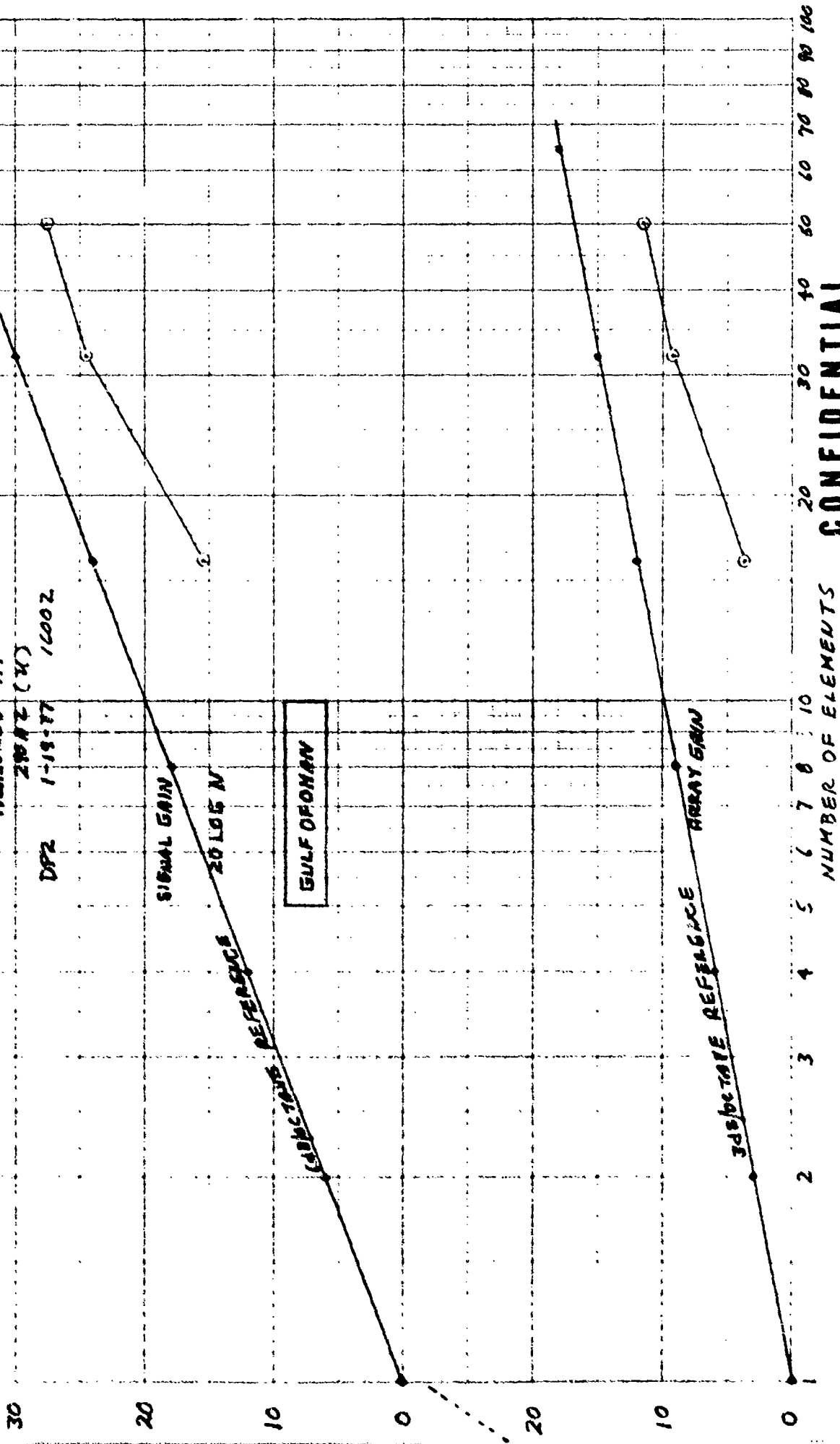
3dB/OCTAVE REFERENCE ARRAY GAIN



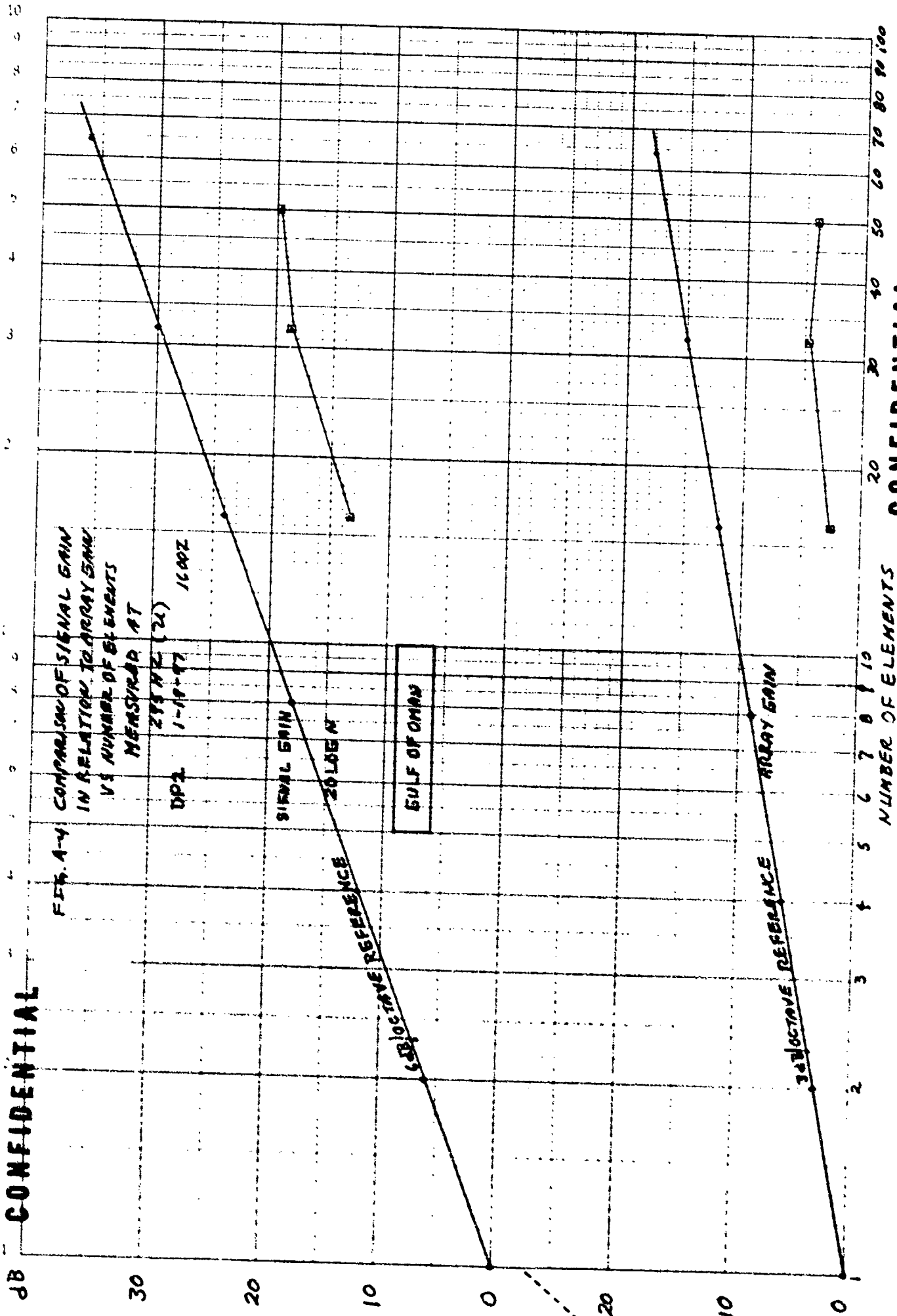
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CONFIDENTIAL

FIG. A-3: COMPARISON OF SIGNAL GAIN IN RELATION TO ARRAY GAIN VS NUMBER OF ELEMENTS MEASURED AT



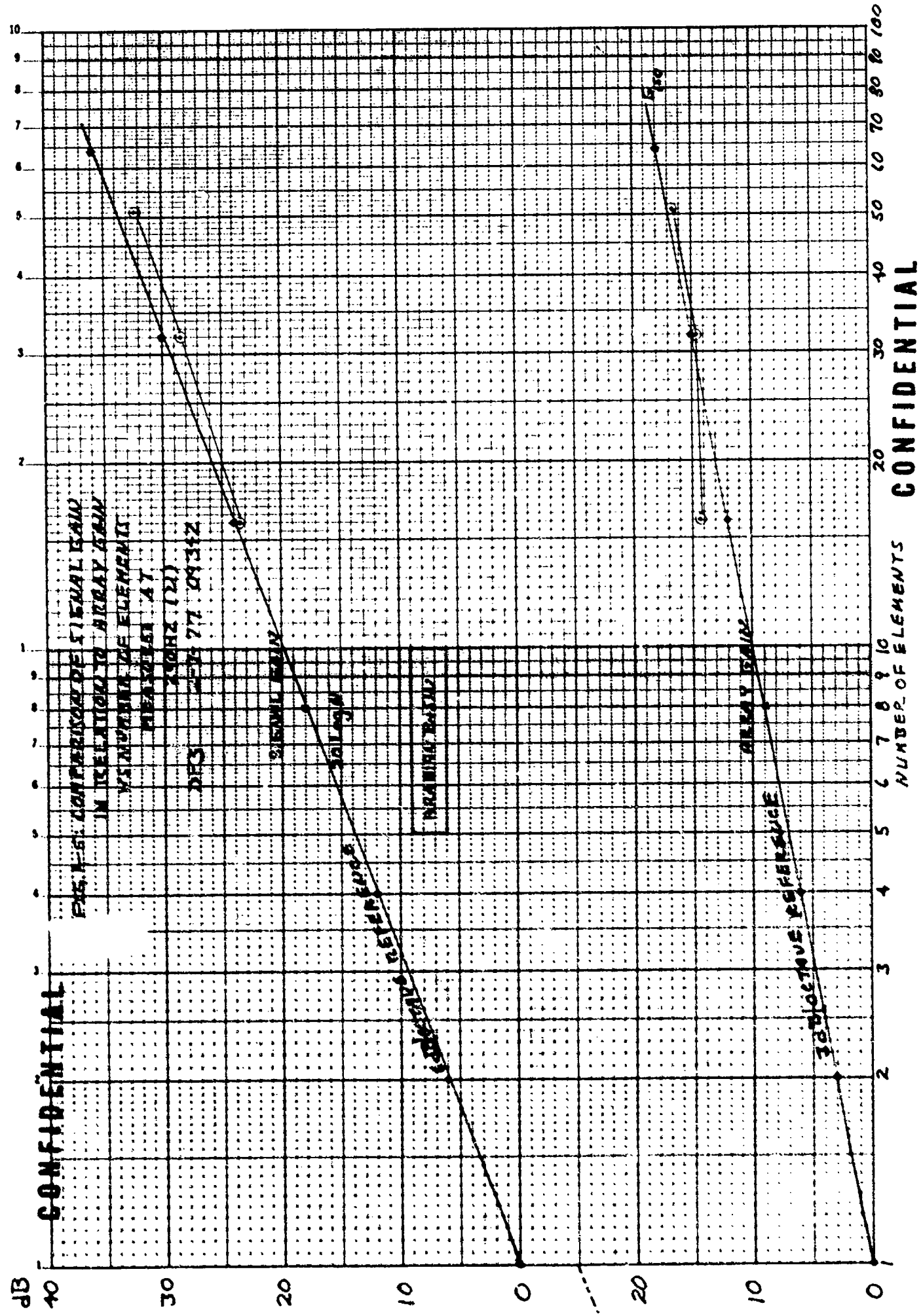
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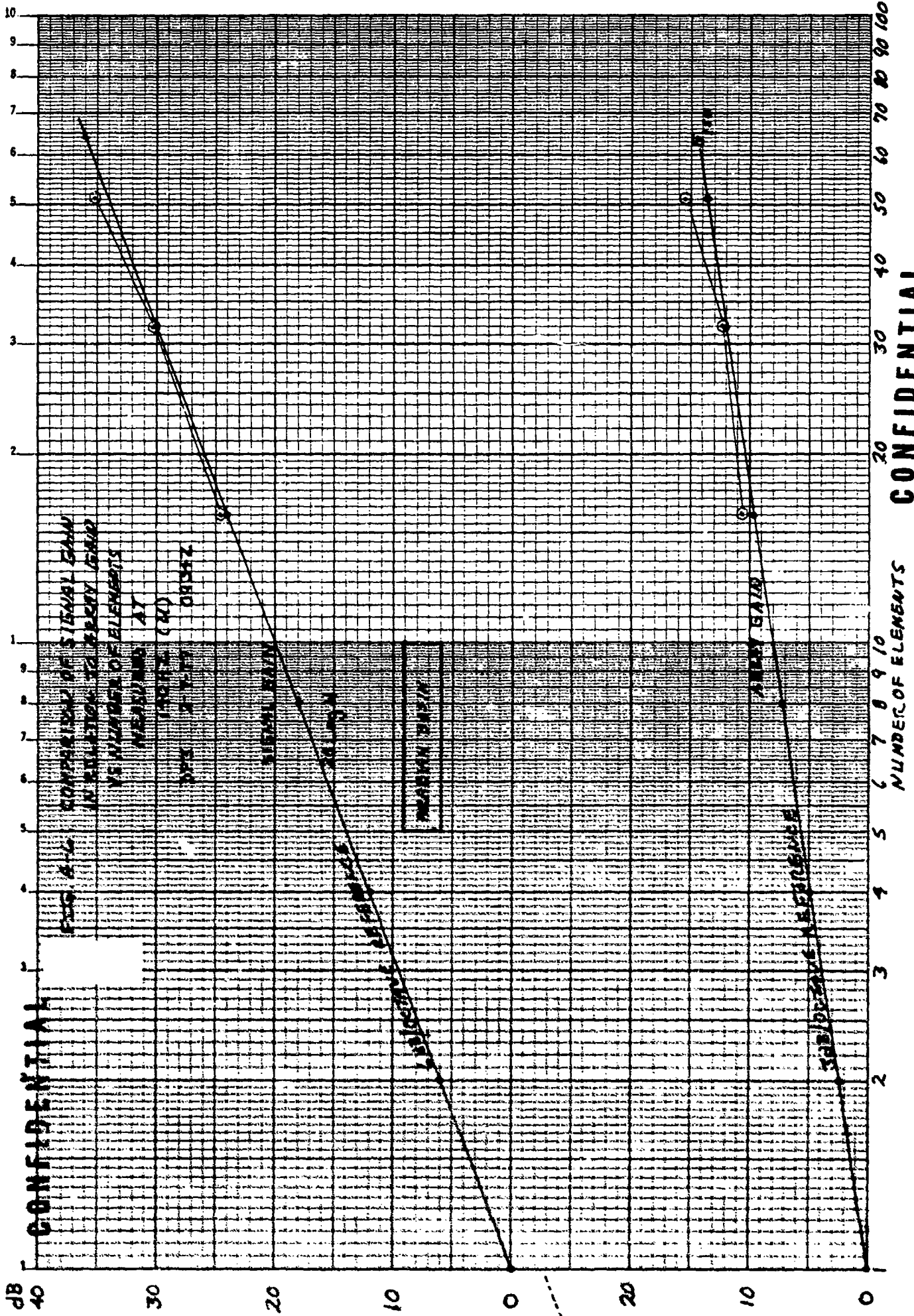
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REF ID: A681073
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WASHINGTON, D.C. 20540

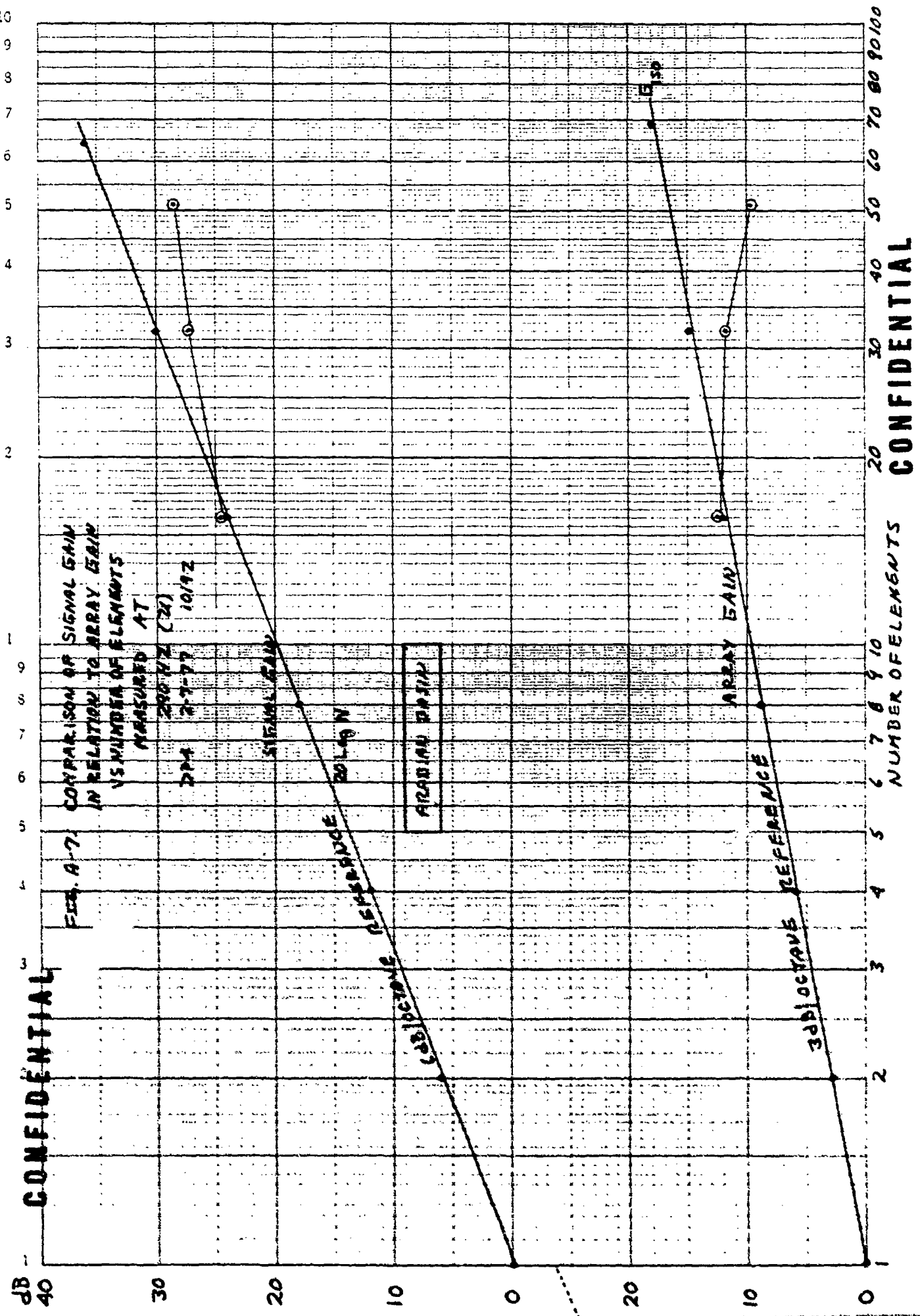


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 2 CYCLES A DIVISION 20 IN U.S.A.
 HENFFEL & COOPER CO



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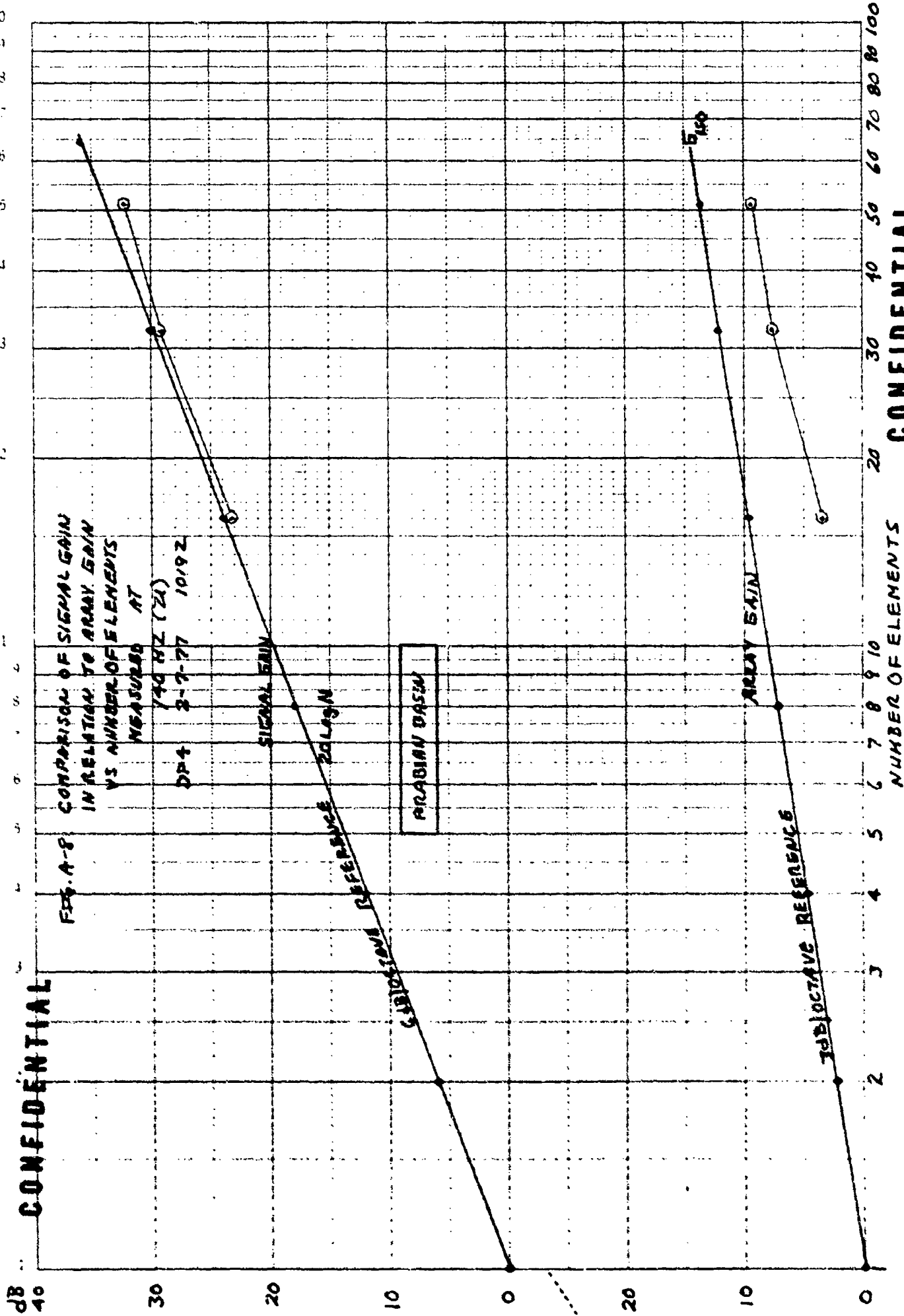


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NUMBER OF ELEMENTS

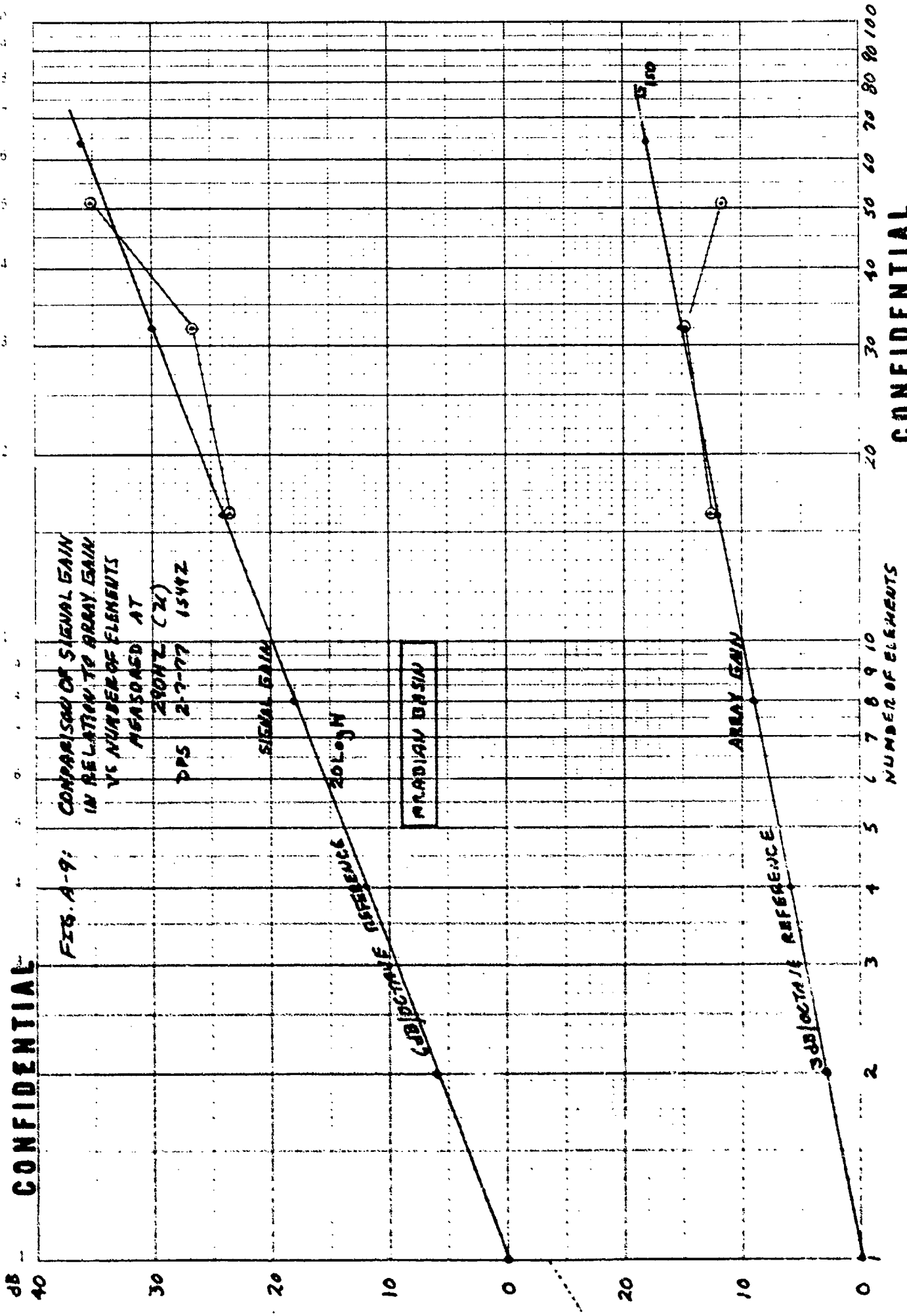
dB

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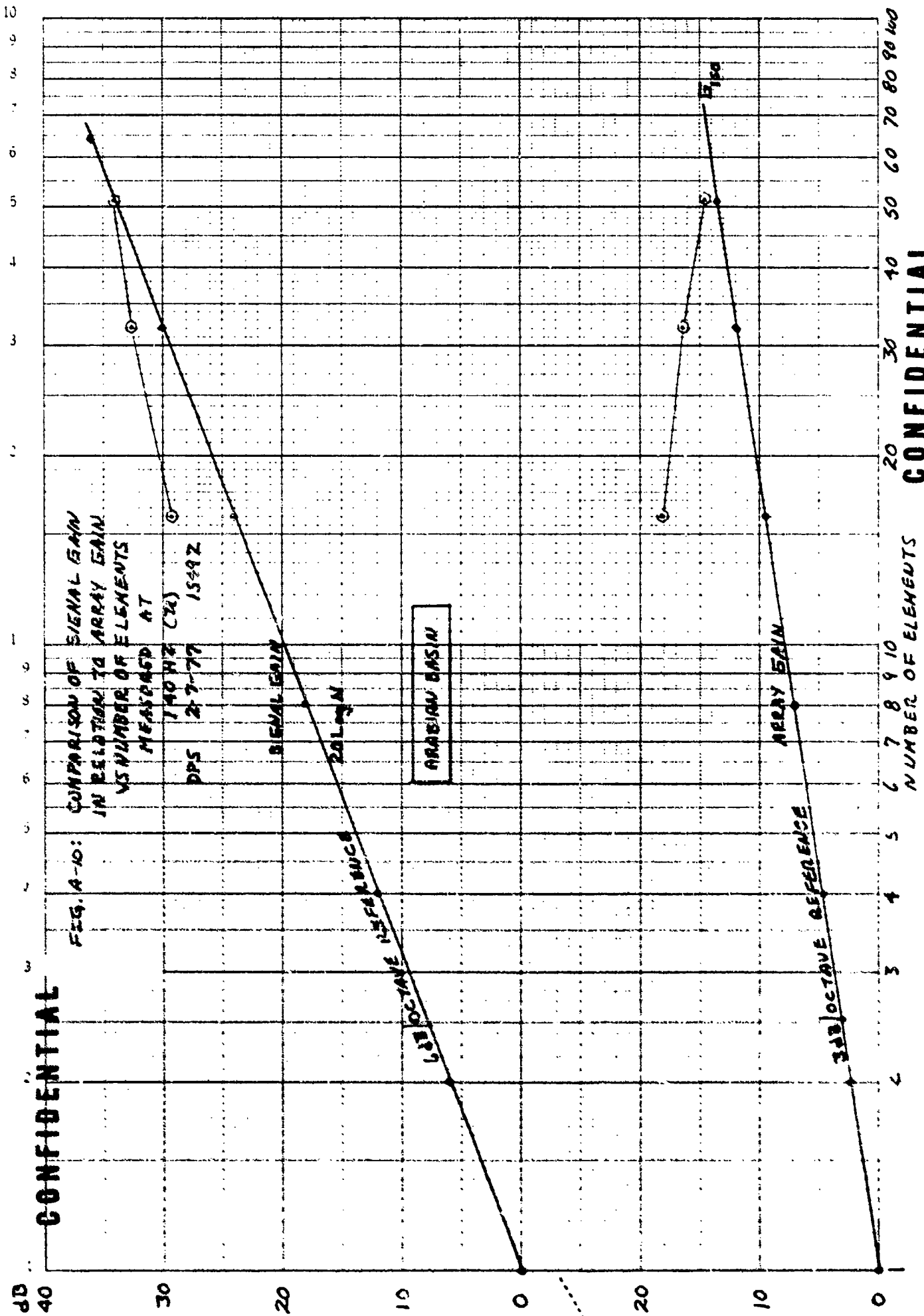
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CONFIDENTIAL

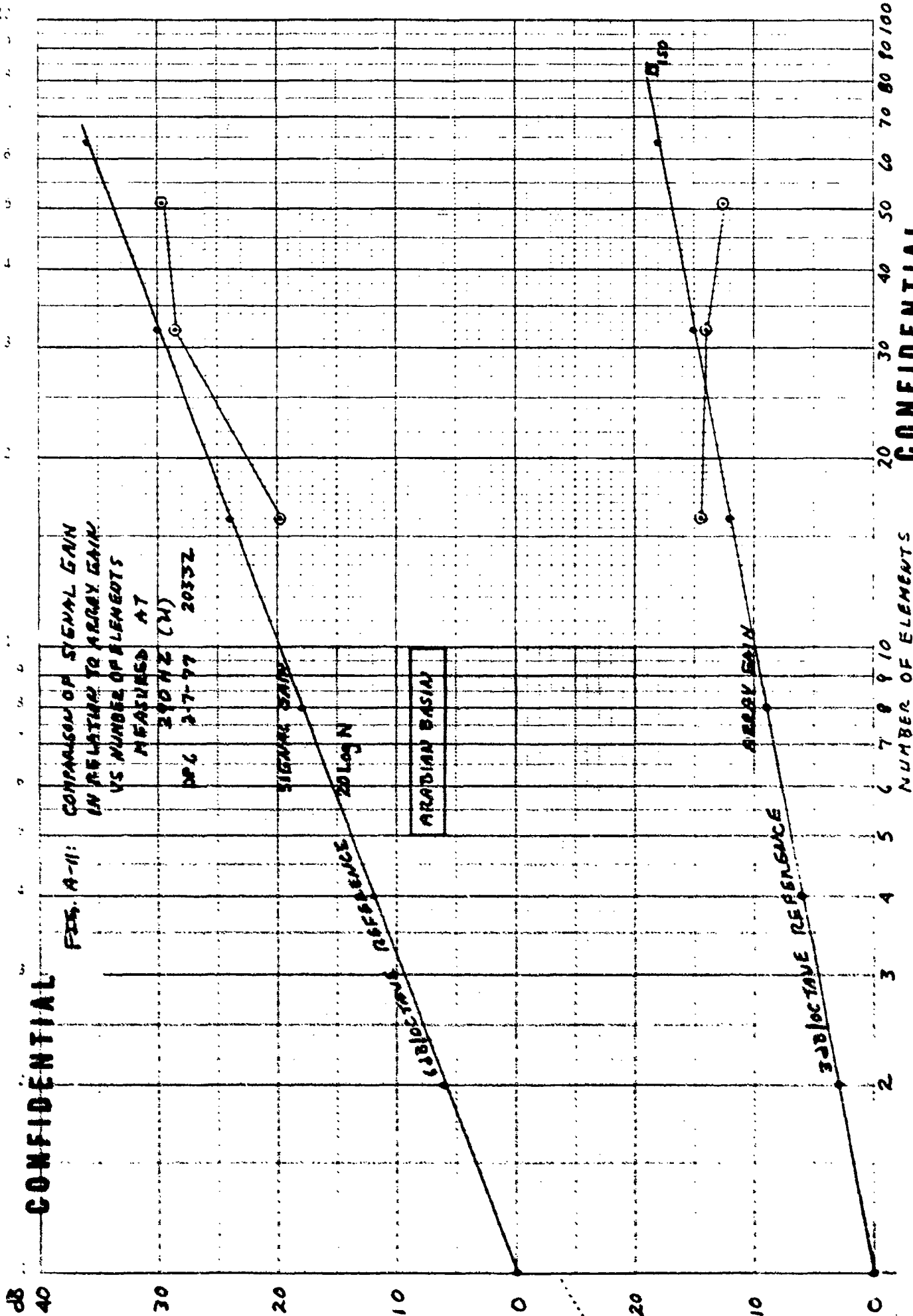


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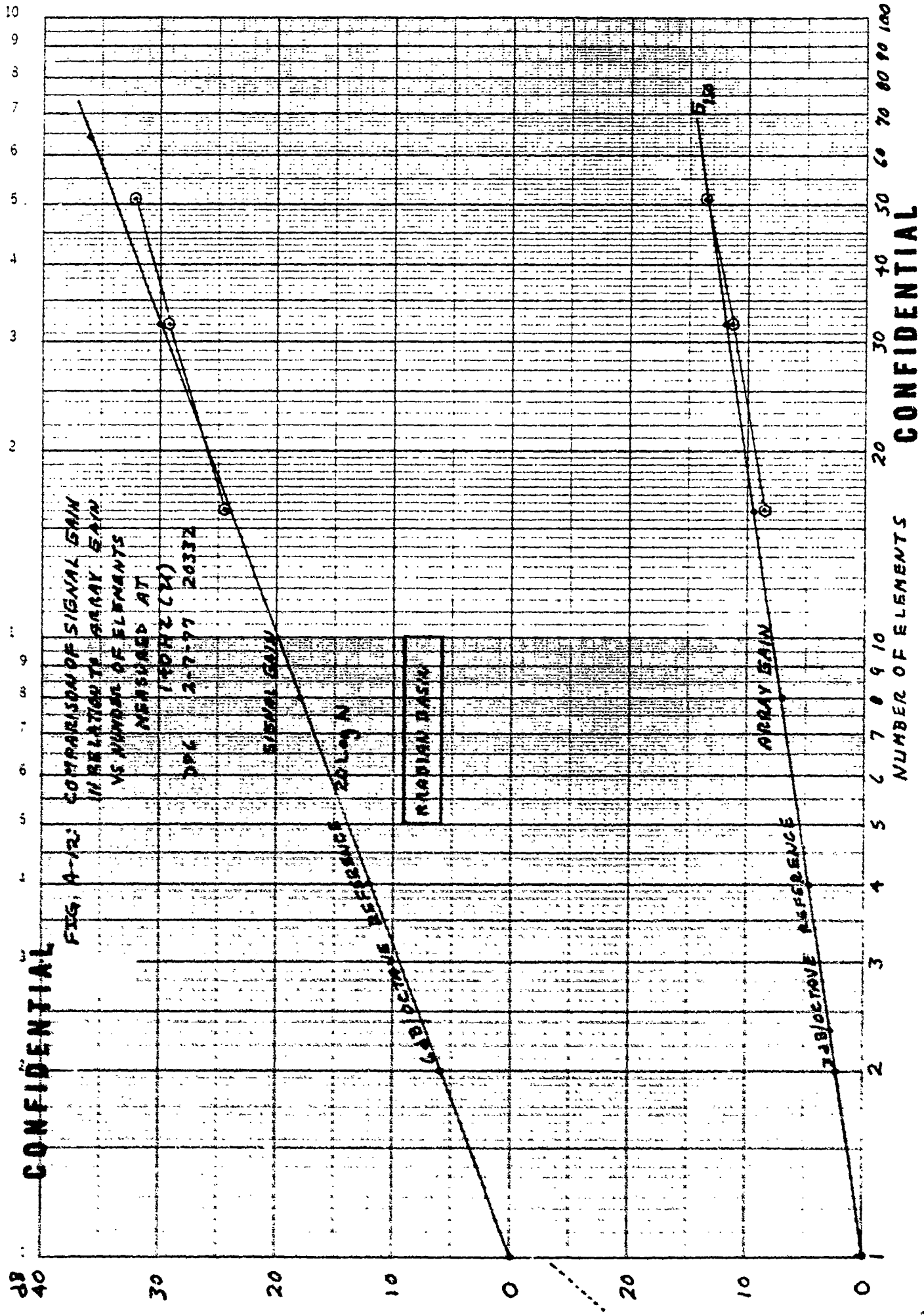
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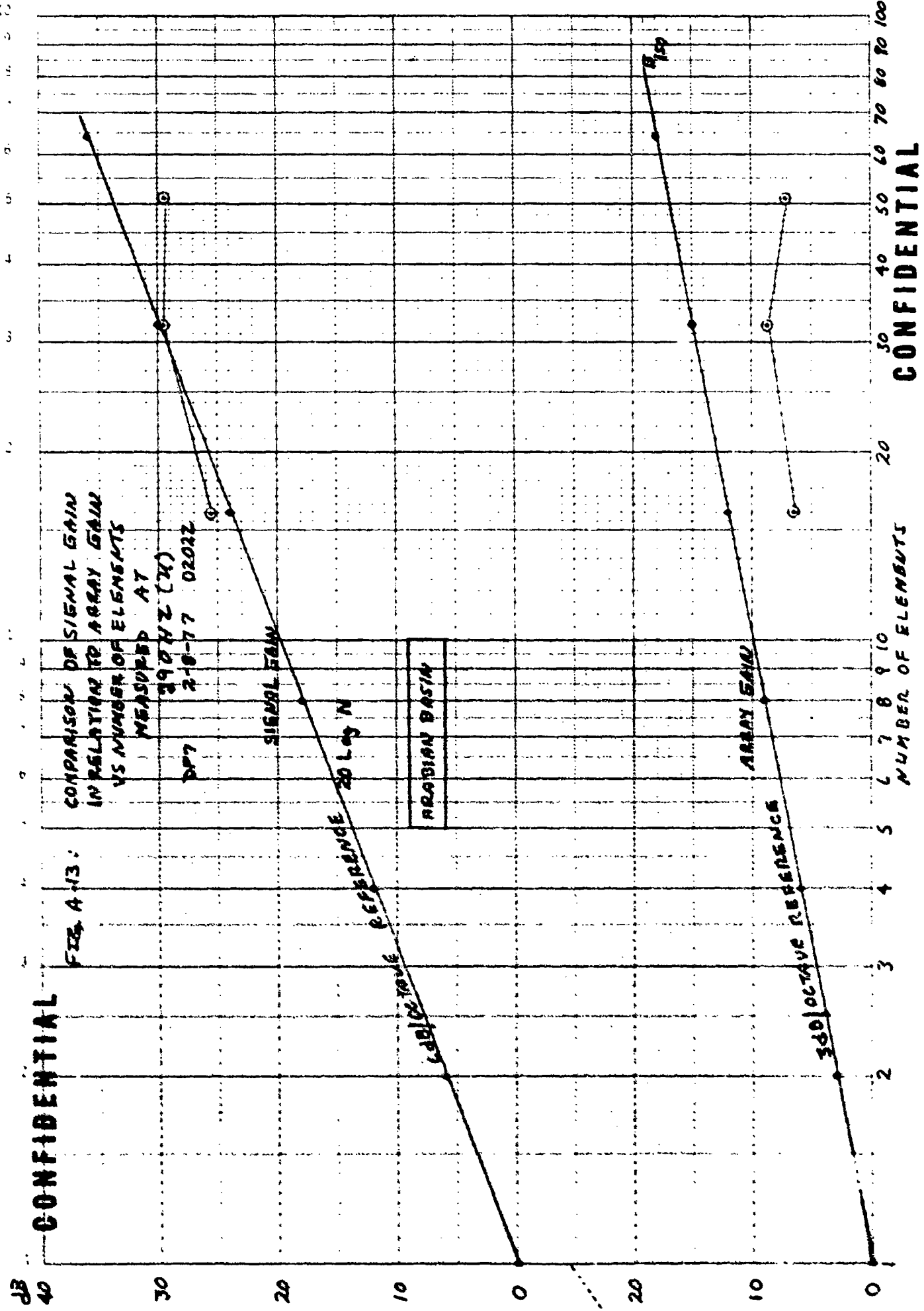
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46 4973

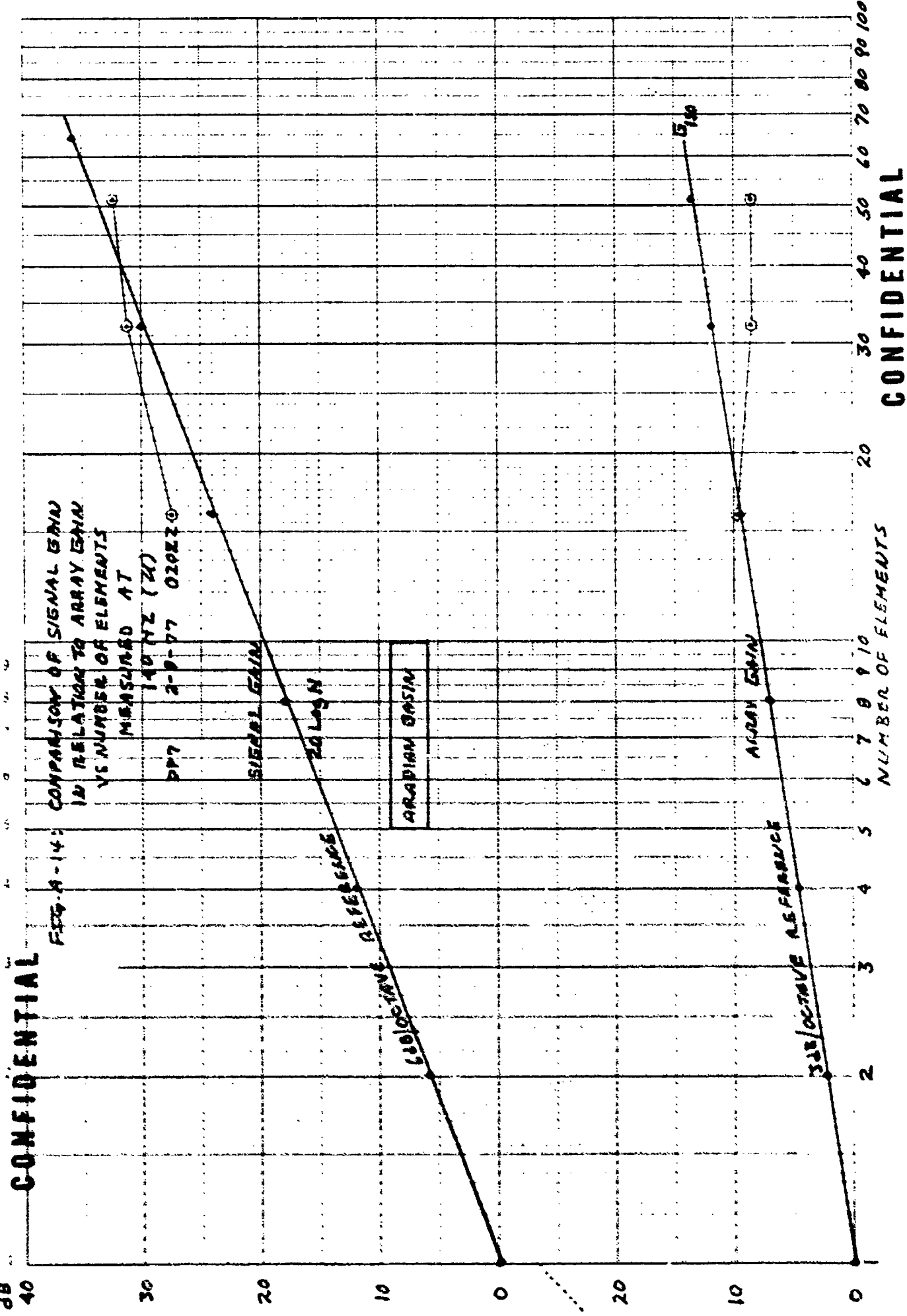
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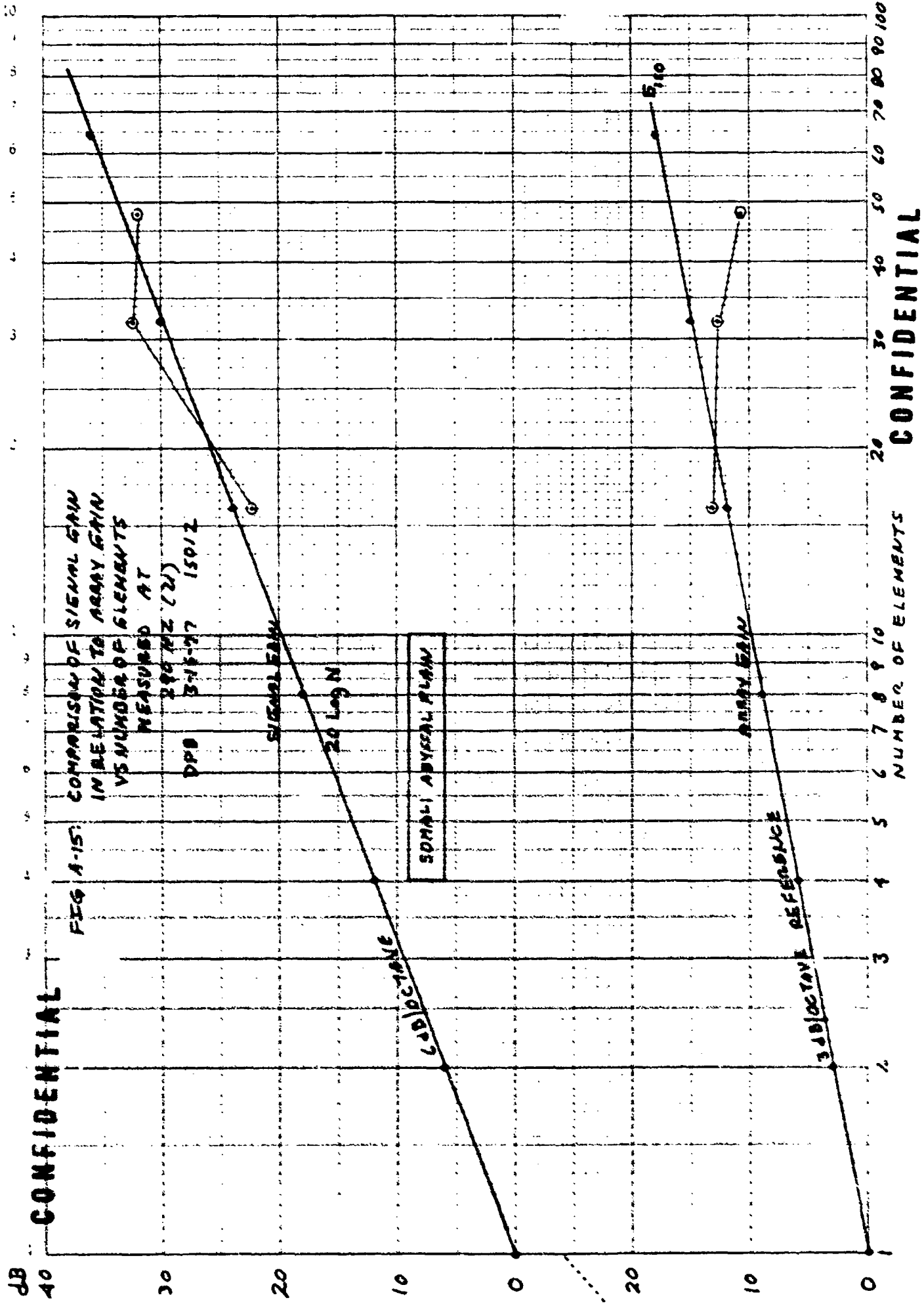


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FIG. A-16: COMPARISON OF SIGNAL GAIN IN RELATION TO ARRAY GAIN VS NUMBER OF ELEMENTS MEASURED AT

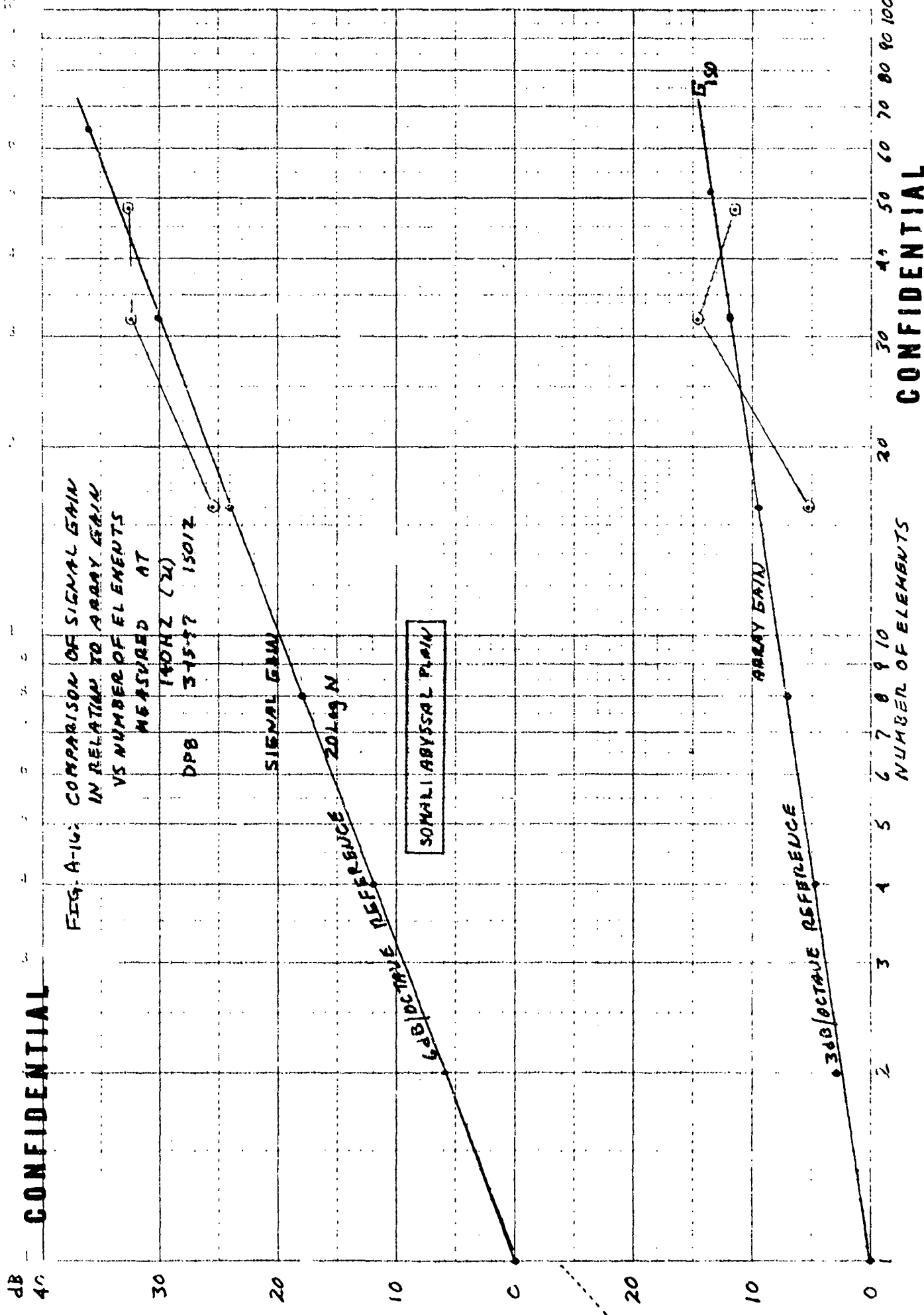
1400Z (24)
DPB 3-15-77 1501Z

SIGNAL GAIN
20.49 N

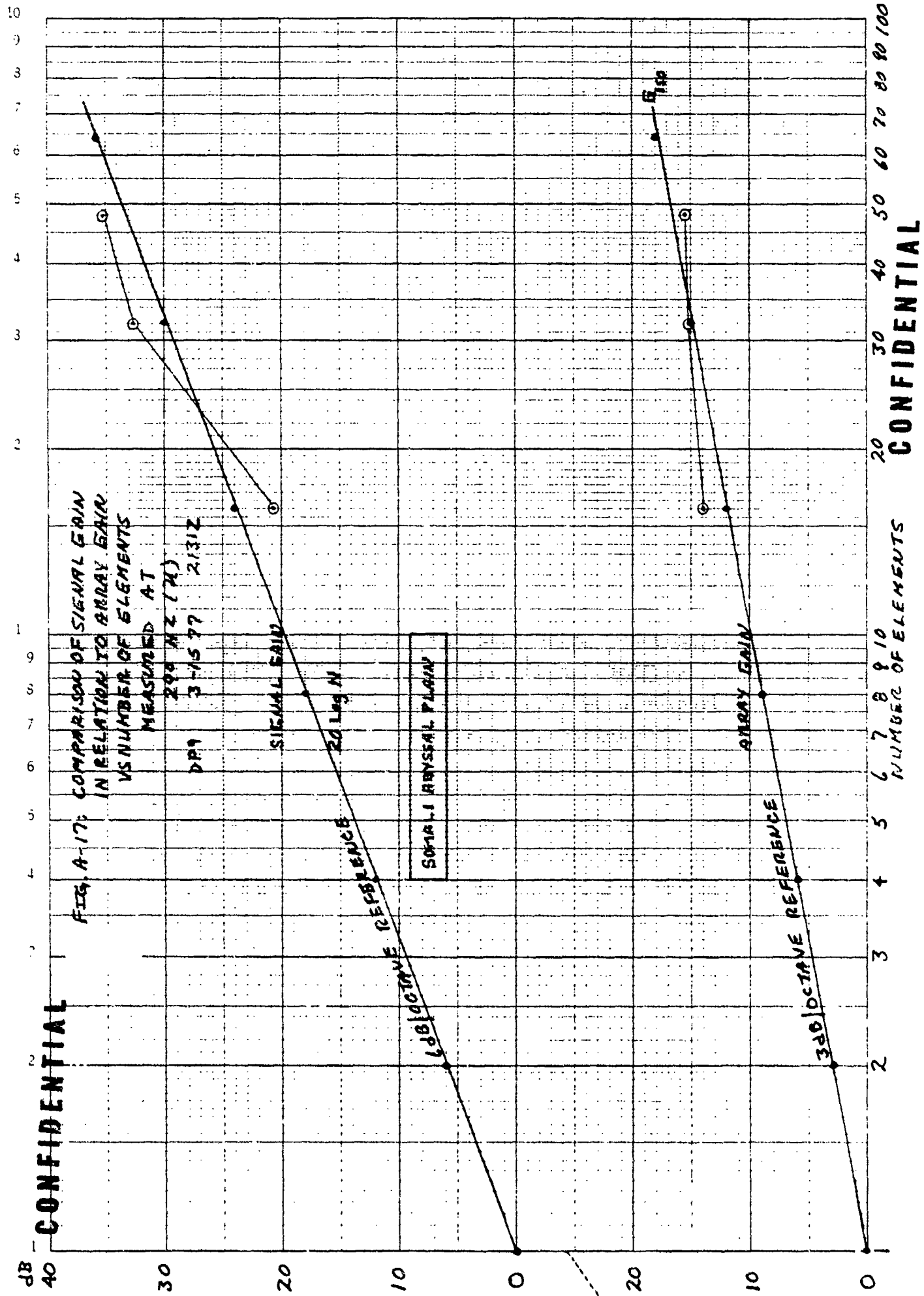
SOMALI ABYSSAL PLAIN

ARRAY GAIN

3dB/OCTAVE REFERENCE

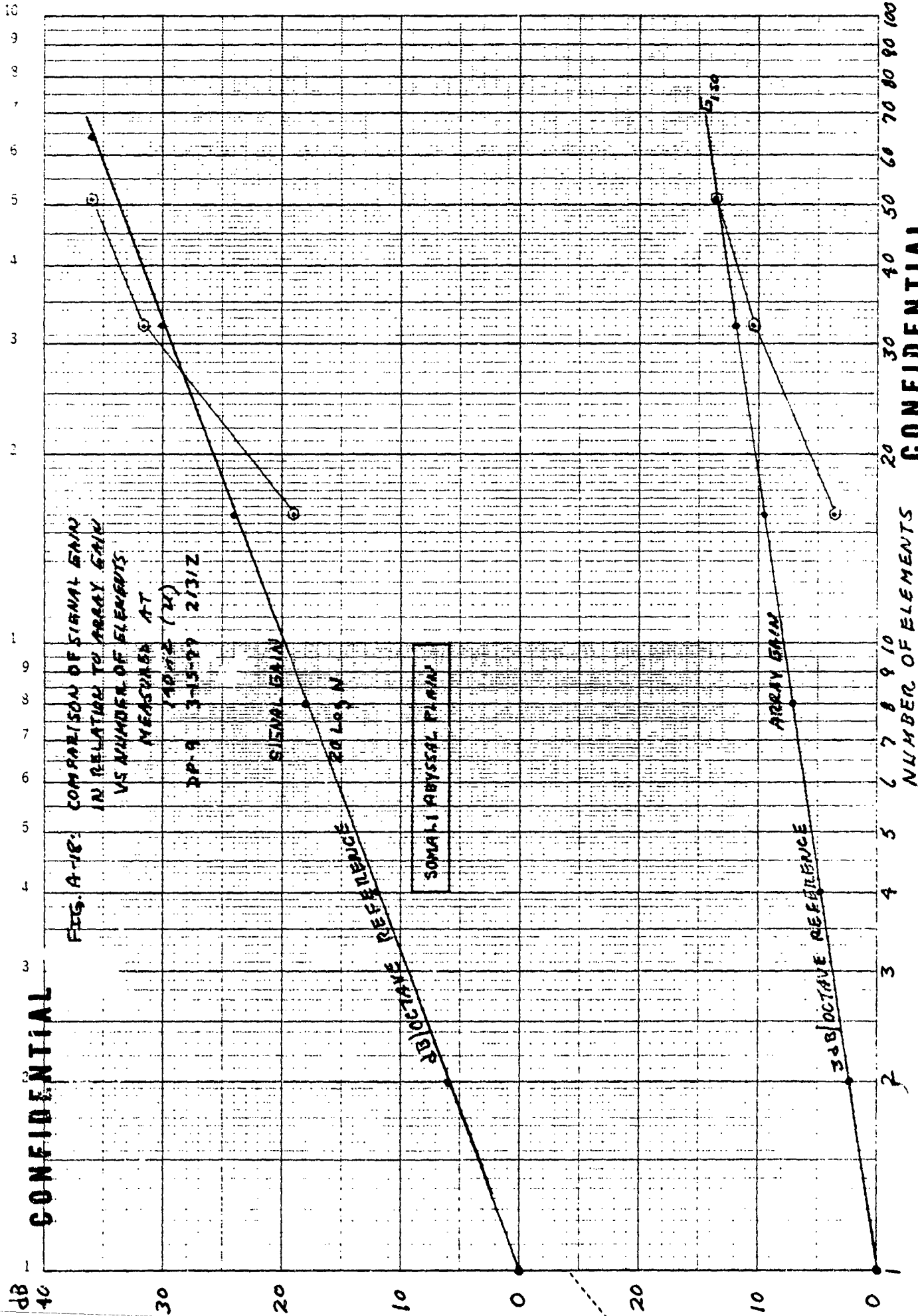


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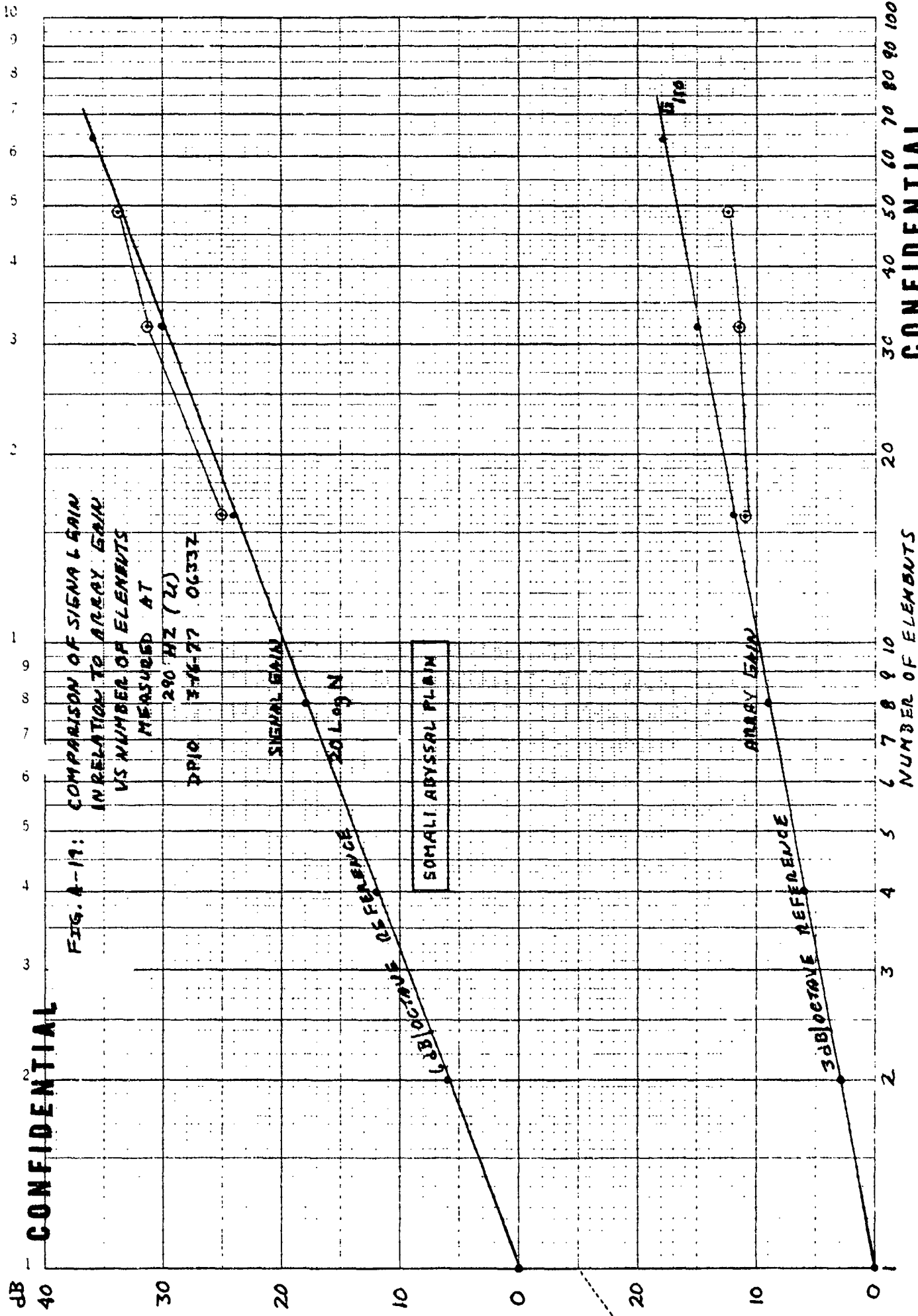
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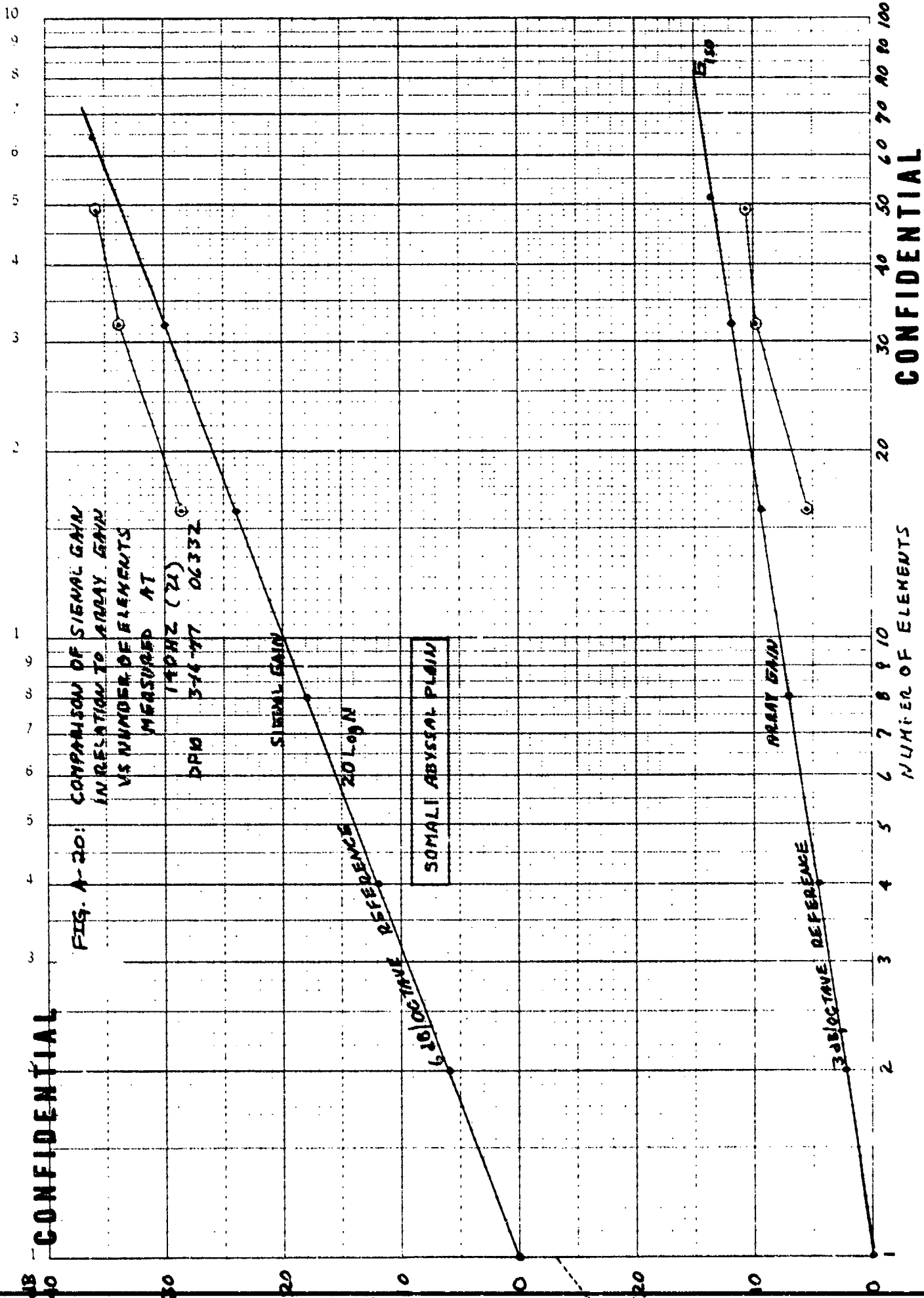
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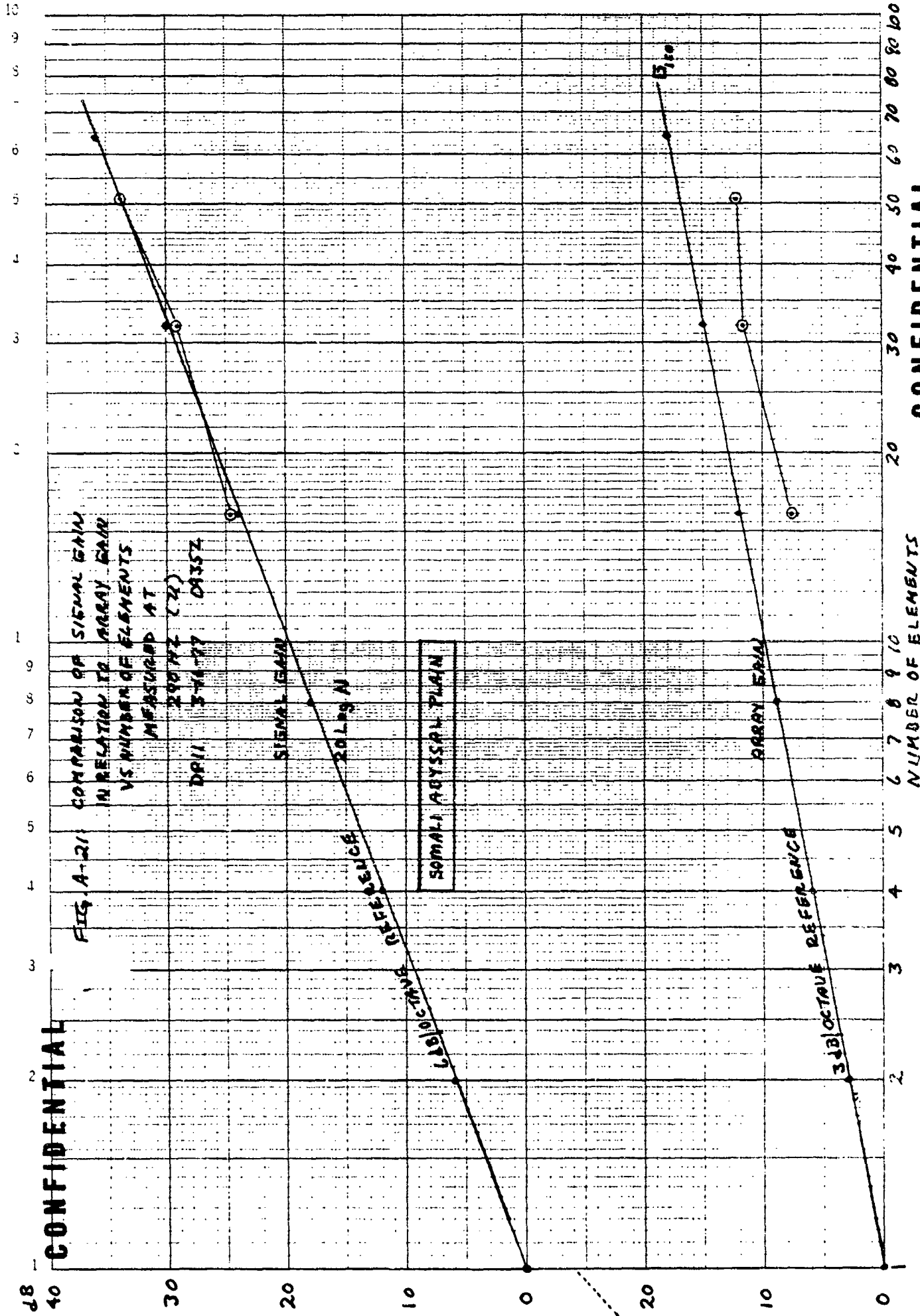
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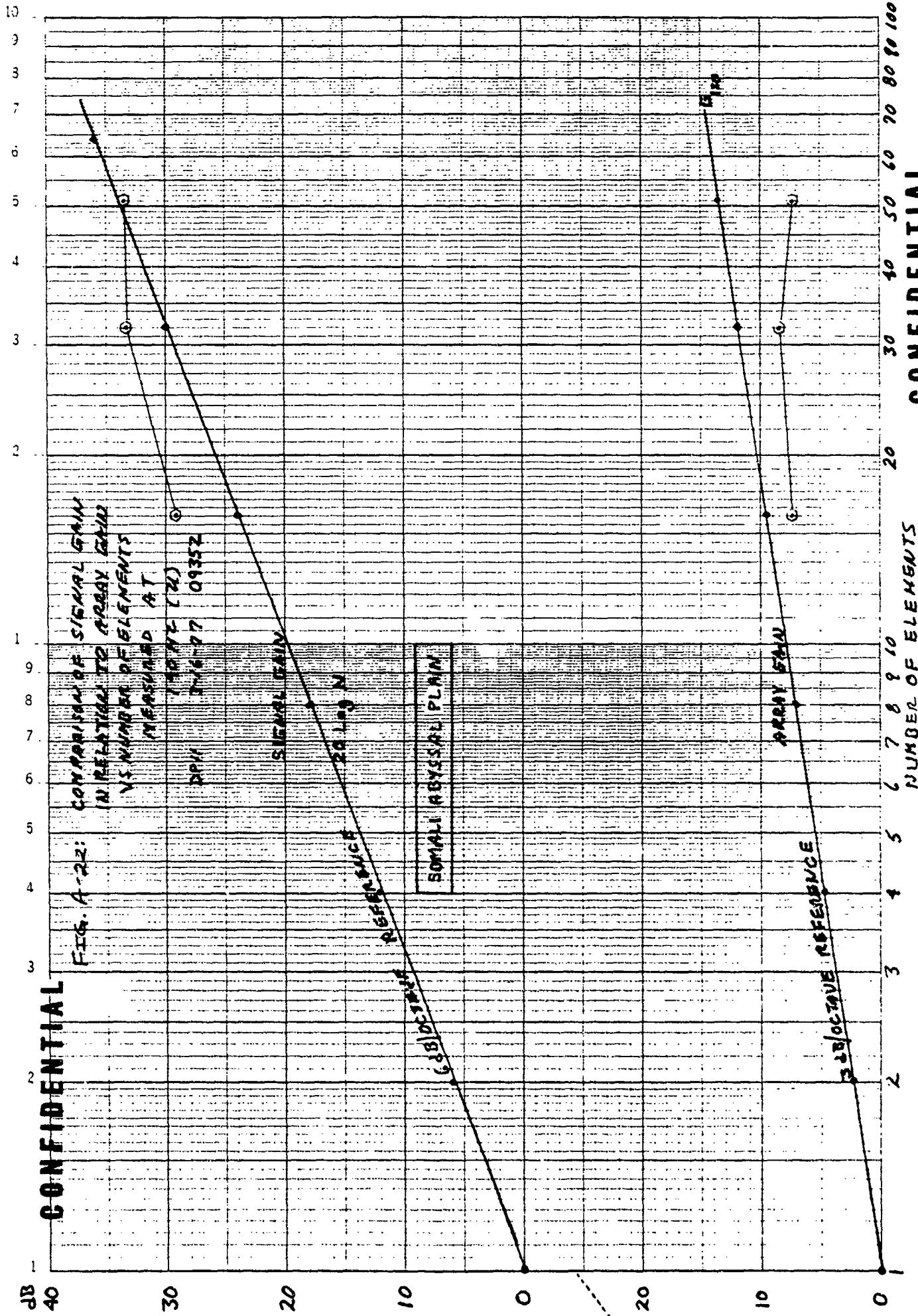




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NUMBER OF ELEMENTS

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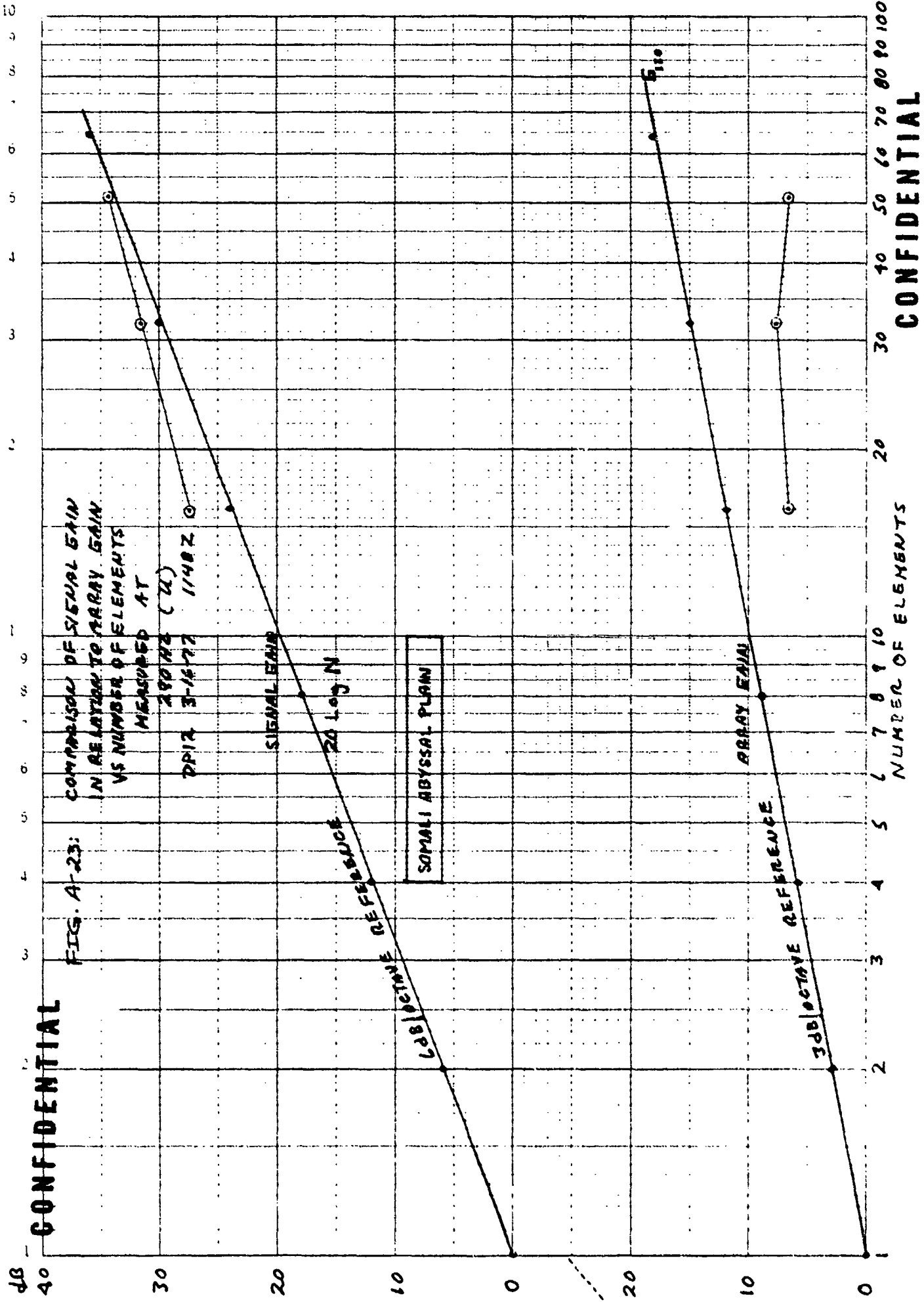


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NUMBER OF ELEMENTS

CONFIDENTIAL

dB

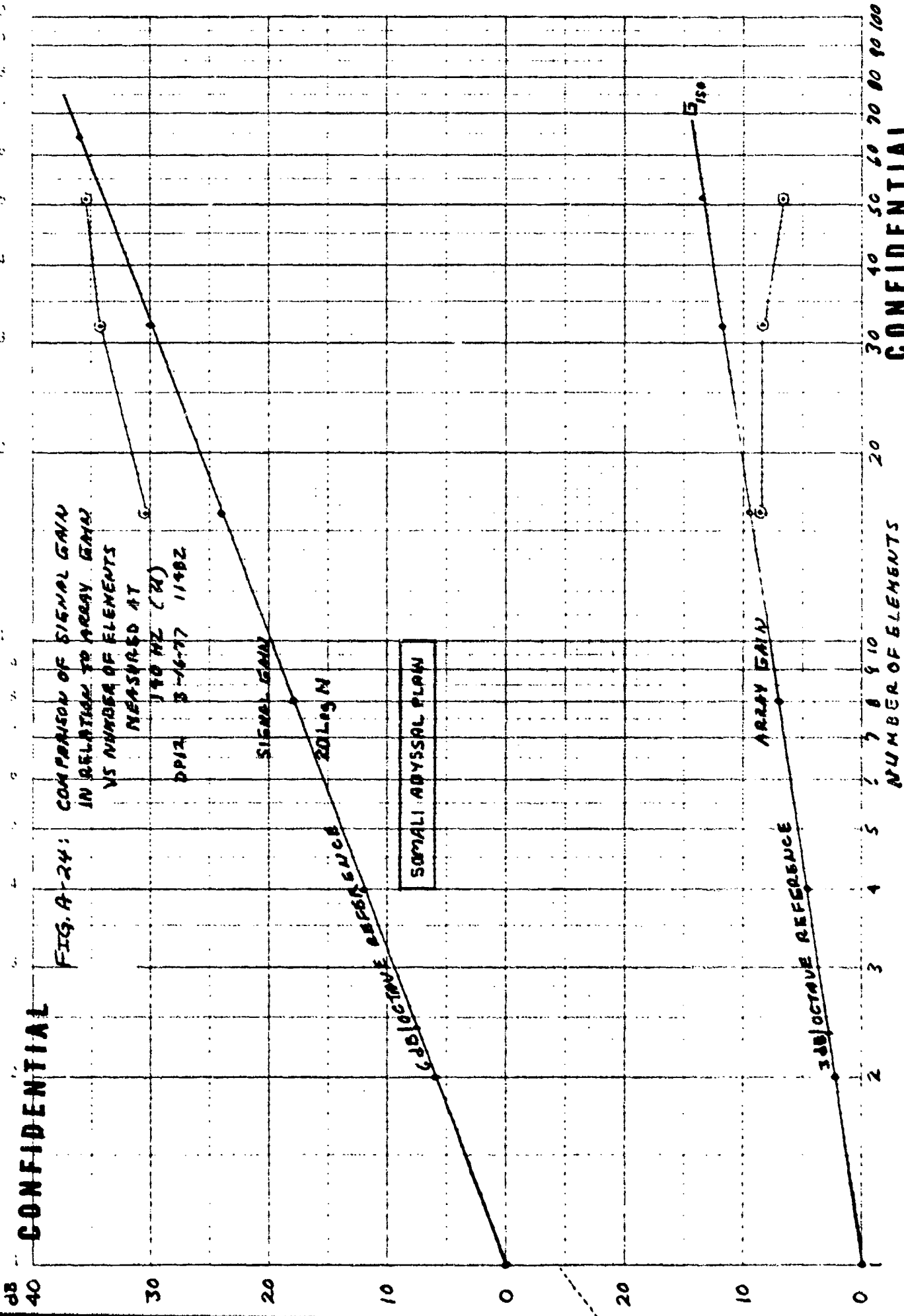


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COMPARISON OF SIGNAL GAIN
 IN RELATION TO ARRAY GAIN
 VS NUMBER OF ELEMENTS
 MEASURED AT
 170 HZ (22)
 DP12 3-16-77 1140Z



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**APPENDIX B THEORETICAL BEAM PATTERN &
ARRAY GAIN DATA (U)**

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51237 SANDERS BEAM PATTERN PROGRAM (T.MORAN) 24-JAN-76 ONTLP 3.1
A: 53 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
S: ELEMENT 16 DELETED FROM APERTURE
S: SAME

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DATA POINT 1
1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
290.0 HZ., 92 ELEMENTS, -0.03 DB MAX., AC:51843, SU:51843, UT:
90.0 DEG. VERT. RESP., 149.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
3.05 DEG. 3 DB BEAM. 15.41 DB AZ. GAIN. MAX. AT 149.0 DEG. HORIZ.

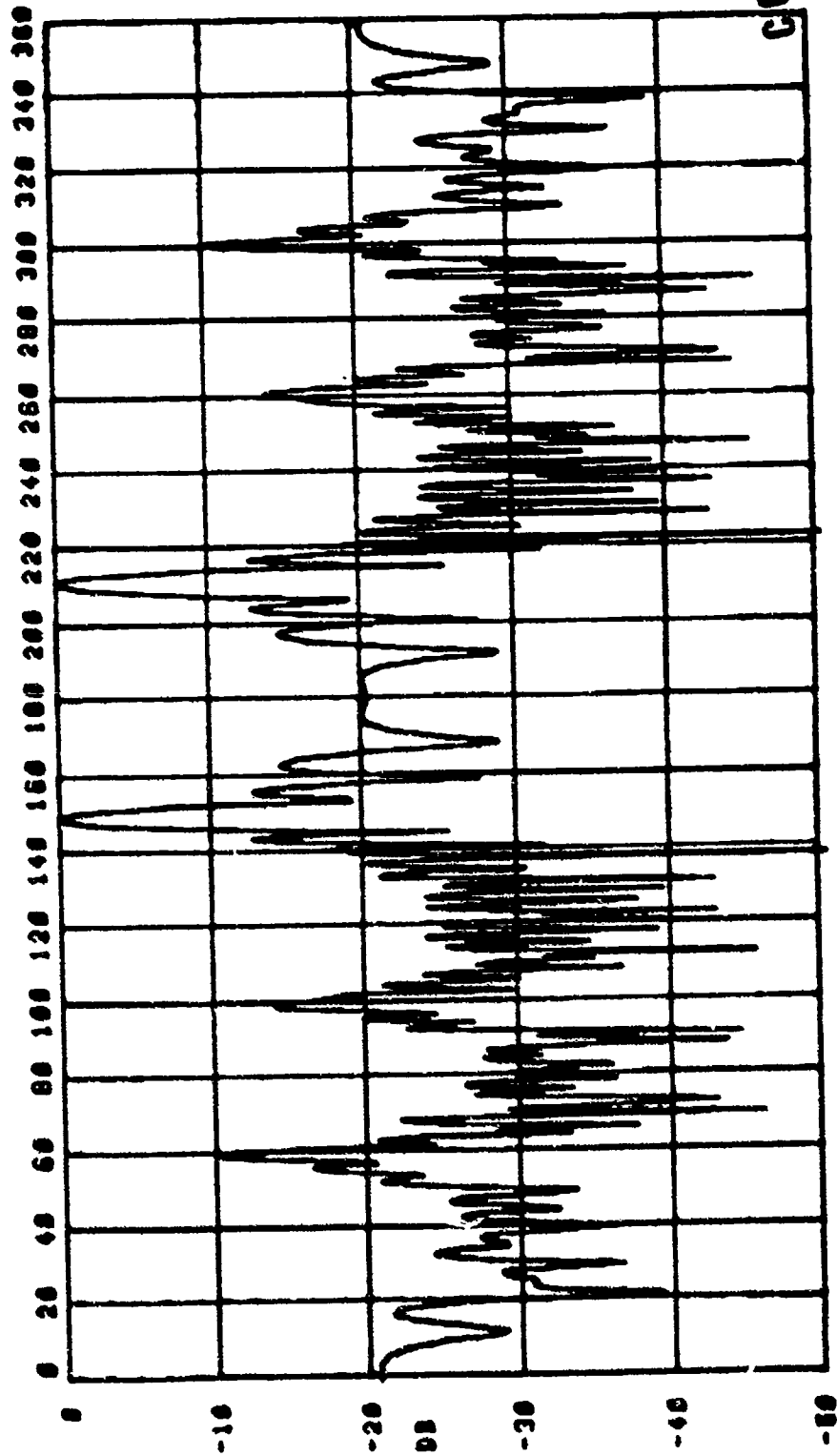


Figure B-27 Theoretical Horizontal Plane Pattern for 52 Element Array @ 290 Hz for Data Point 1, 59 Off Broadside Steering. Beamwidth 3.85°, Azimuth Gain 15.4 dB.

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S1233 SANDERS BEAM PATTERN PROGRAM (T. HOGAN) 84-Jan-78 ONTLP 3.1
A: 32 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
ELEMENTS 27 AND 28 DELETED FROM APERTURE.
B: SAME

DATA POINTS 1 & 2
1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
290.0 HZ. 32 ELEMENTS. -9.84 DB MAX. AC: S1542, SU: S1642, MT:
90.0 DEG. VERT. RESP. 149.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
5.03 DEG. 3 DB BEAM. 13.32 DB AZ. GAIN. MAX. AT 211.0 DEG. HORIZ.

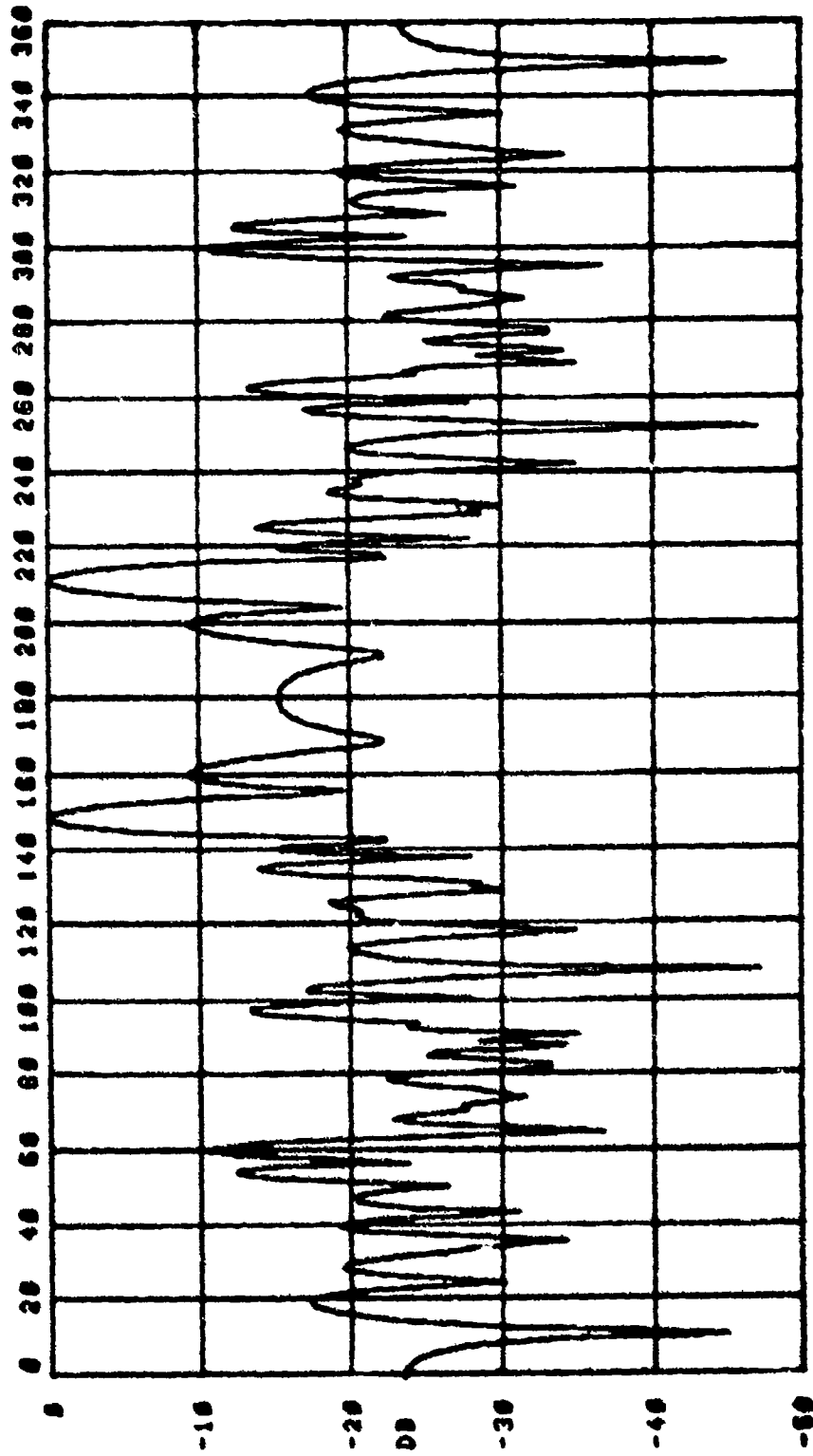


Figure B-28 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 290 Hz for Data Point #2, 59 Off Broadside
Steering. Beamwidth 5.83°, Azimuth Gain 13.3dB.

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61231 SANDERS BEAM PATTERN PROGRAM (I.MOGAM) 24-Jan-70 ONYLP 3.1
A: 16 ELEMENT SPRAY ARRAY. UNIFORMLY SPACED 0.23 FT.
B: NO ARRAY DEFORMATION
S: SAME

DATA POINT 1

1200 HZ. SAMPLING FREQ. DEGRADES PATTERN

290.0 HZ.: 16 ELEMENTS, -0.70 DB MAX., AC: S1541, SU: S1841, UT:

90.0 DEG. VERT. RESP.: 149.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER

13.16 DEG. 3 DB BEAM, 10.46 DB AZ. GAIN, MAX. AT 150.0 DEG. HORIZ.

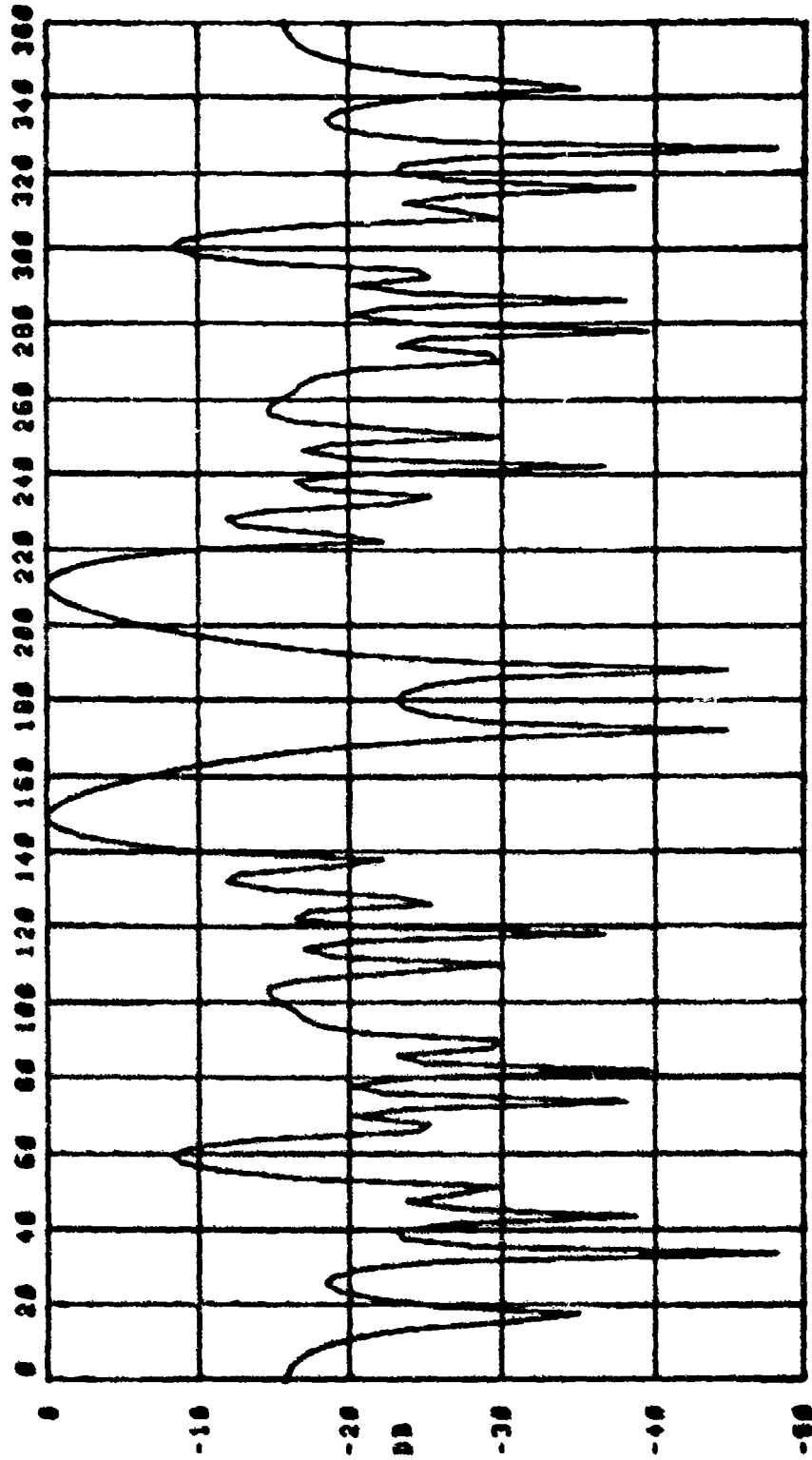


Figure B-29 Theoretical Horizontal Plane Pattern for 16 Element Array @ 290 Hz for Data Point 1, 59 Off Broadside Steering. Beamwidth 3.1°, Azimuth Gain 10.4 dB.

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61238 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 84-Jan-70 OUTLDP 3.1
A: 52 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
ELEMENT 18 DELETED FROM APERTURE
S: SAME

DATA POINT 1
1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
293.0 HZ.: 52 ELEMENTS. -0.04 DB MAX.: AC:81543.SU:81543.MT:
90.0 DEG. VERT. RESP.: 149.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
3.77 DEG. 3 DB BEAM. 15.50 DB AZ. GAIN. MAX. AT 149.0 DEG. HORIZ.

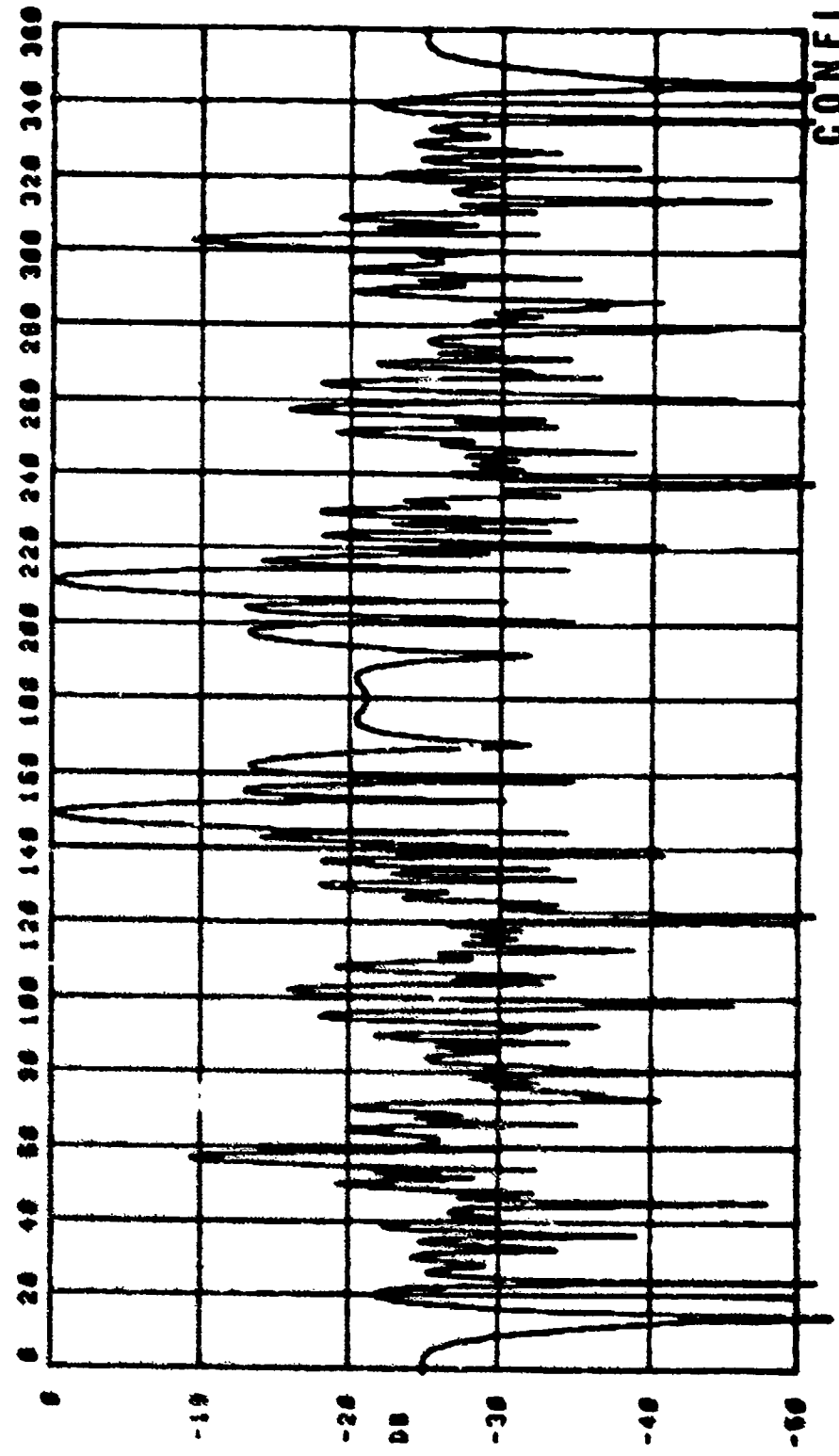


Figure 2-30 Theoretical Horizontal Plane Pattern for 52 Element Array @ 295 Hz for Data Point /, 59 Off Broadside Steering. Beamwidth 3.77°, Azimuth Gain 10.4 db.

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61236 SANDERS BEAM PATTERN PROGRAM (T. HOGAN) 24-Jan-79 ONTLP 3.1
A: 53 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
ELEMENTS 15, 27 & 28 DELETED FROM APERTURE.
S: SAME

DATA POINTS 1 & 2
1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
295.0 HZ., 50 ELEMENTS, -0.83 DB MAX., AC:91544, SU:91544, MT:
90.0 DEG. VERT. RESP., 149.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.89 DEG. 3 DB BEAM, 15.36 DB AZ. GAIN, MAX. AT 211.0 DEG. HORIZ.

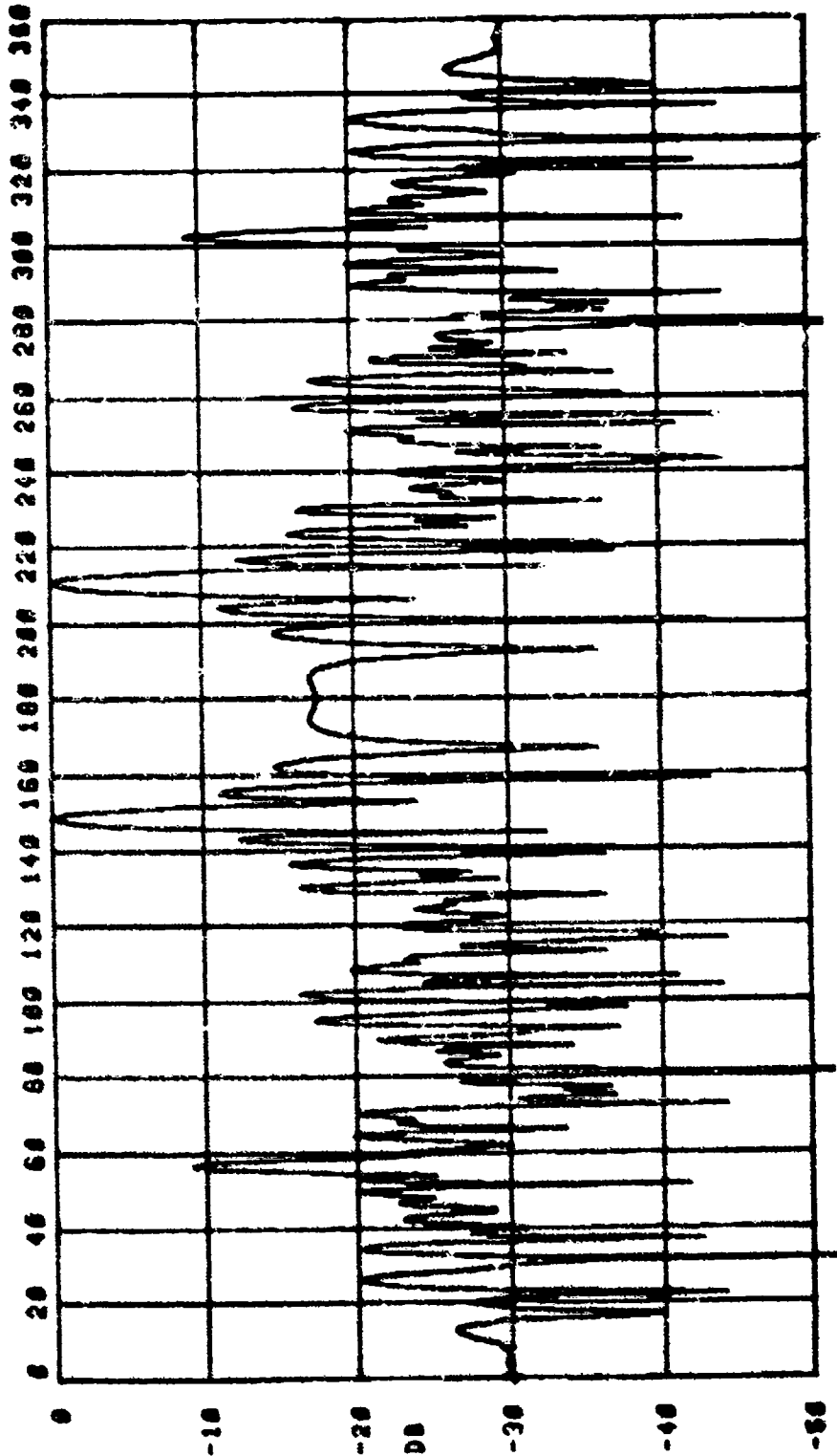


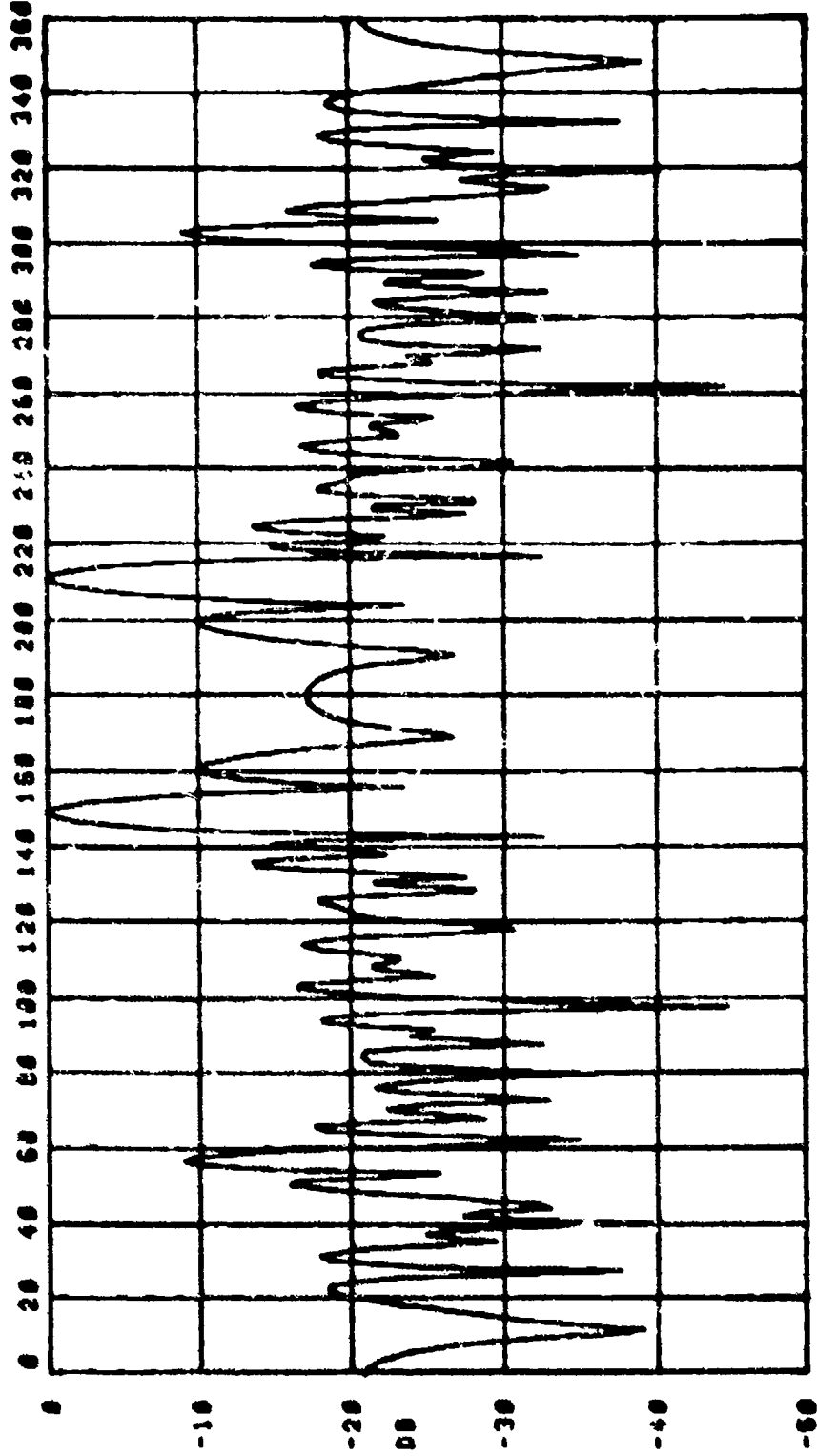
Figure B-3/ Theoretical Horizontal Plane Pattern for 50 Element Array @ 295 Hz for Data Point 2, 57 Off Broadside Steering. Beamwidth 3.49°, Azimuth Gain /5.3 dB.

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81234 SAMBERS BEAM PATTERN PROGRAM (T. MORGAN) 24-JAN-70 ONTLP 3.1
A: 32 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
ELEMENTS 27 AND 28 DELETED FROM APERTURE.
S: SAME

DATA POINTS 1 & 2
1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
295.0 HZ., 32 ELEMENTS, -0.02 DB MAX., AC: S1542, SU: S1542, NT:
90.0 DEG. VERT. RESP., 149.0 DEG. HORIZ. STEER, 50.0 DEG. VERT STEER
5.79 DEG. 3 DB BEAM, 13.44 DB AZ. GAIN, MAX. AT 149.0 DEG. HORIZ.



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FIGURE E-32 THEORETICAL HORIZONTAL PLANE PATTERN FOR 32 ELEMENT
ARRAY 1200 HZ FOR DATA POINT #2, 59 DBE BROADSIDE
STEERING. BEAMWIDTH 5.79°, AZIMUTH GAIN 13.44 DB.

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81232 SAMBERS BEAM PATTERN PROGRAM (T.MOGAN) 24-Jan-70 0M4LDF 3.1
A: 16 ELEMENT SPRAY ARRAY. UNIFORMLY SPACED 0.33 FT.
NO ARRAY DEFORMATION
S: SAME

DATA POINT 1
1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
295.0 HZ., 16 ELEMENTS, -0.90 DB MAX., AC:81541.SU:81541.MT:
90.0 DEG. VERT. RESP., 149.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
13.07 DEG. 3 DB BEAM, 10.33 DB AZ. GAIN, MAX. AT 150.0 DEG. HORIZ.

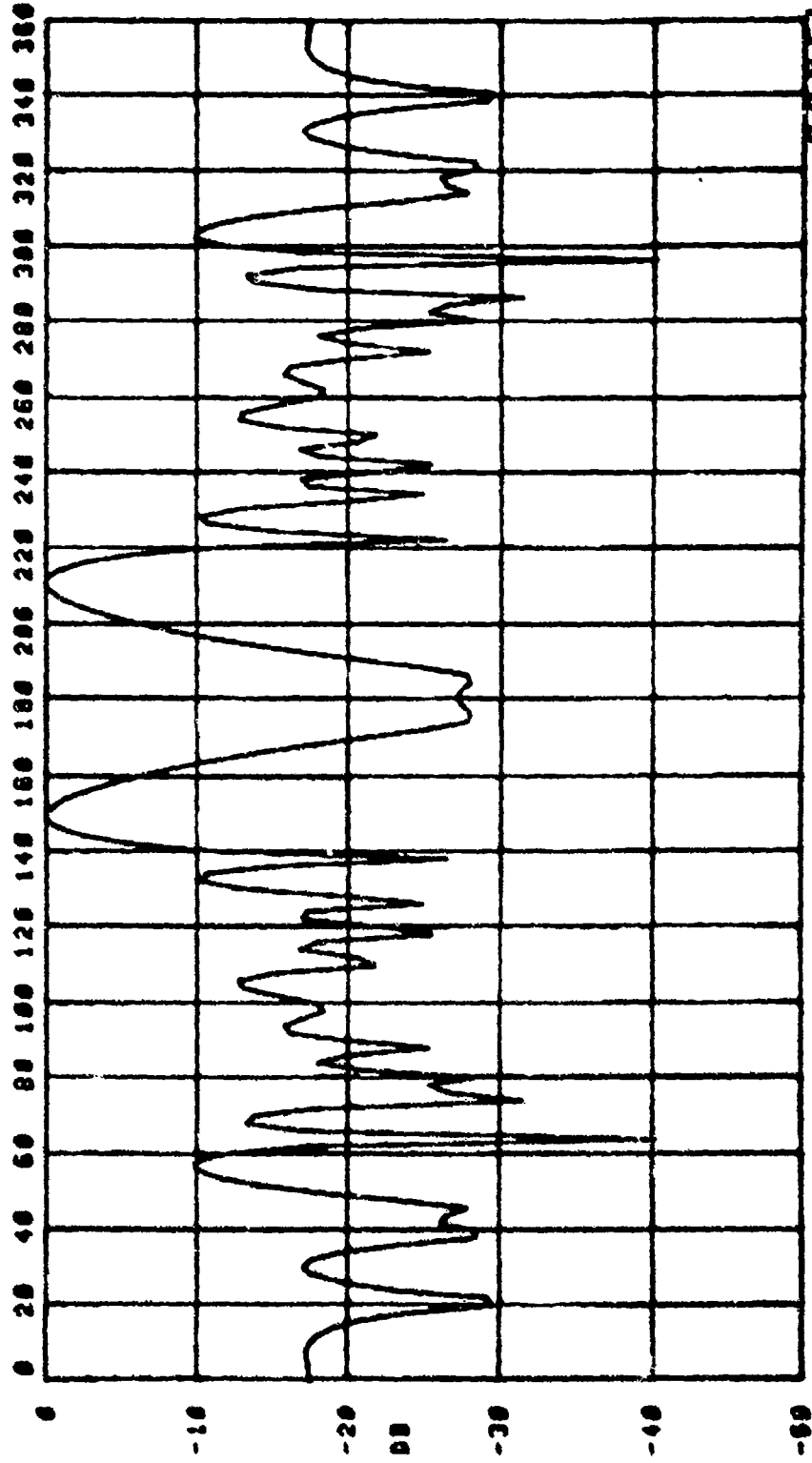


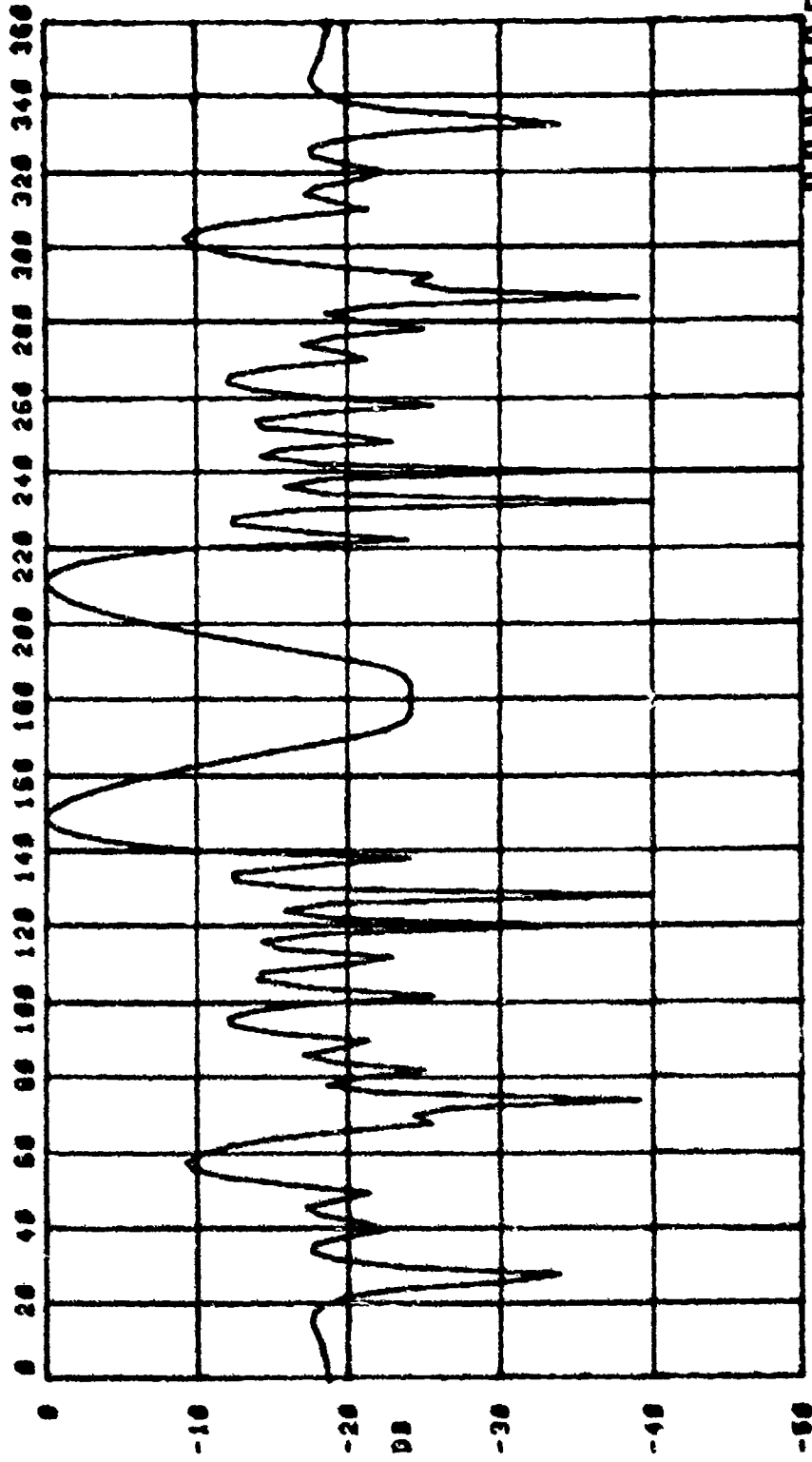
Figure B-33 Theoretical Horizontal Plane Pattern for 16 Element
Array at 295 Hz for Data Point 1, 59 Off Broadside
Steering. Beamwidth 13.07°, Azimuth Gain 10.3 dB.

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61239 SANDERS BEAM PATTERN PROGRAM (T.MOGAM) 24-JAN-70 ONTLP 3.1
A: 63 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
ELEMENT 15 DELETED FROM APERTURE
B: SAME

DATA POINT 2
1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
200.0 HZ., 16 ELEMENTS, -0.07 DB MAX., AC:51543.SU:51543.MT:
90.0 DEG. VERT. RESP., 149.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
12.70 DEG. 3 DB BEAM, 10.37 DB AZ. GAIN, MAX. AT 212.0 DEG. HORIZ.



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Figure B-34 Theoretical Horizontal Plane Pattern for 16 Element Array @ 290 Hz for Data Point 2, 59 Off Broadside Steering. Beamwidth /2.7°, Azimuth Gain /0.3 dB.

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5122A SAMBERS BEAM PATTERN PROGRAM (T. NOGAM) 24-JUN-70 ONTLOP 3.1
A: 53 ELEMENT SPRAY ARRAY SPACED 0.3333 FT.
ELEMENT IS DELETED FROM APERTURE
S: SAME

DATA POINT 2
1200 HZ. SAMPLING FREQ. DEGRADES PATTERN
255.0 HZ. 16 ELEMENTS. -0.06 DB MAX., AC:51543, SU:51543, WT:
90.9 DEG. VERT. RESP., 149.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
12.31 DEG. 3 DB BEAM, 10.44 DB AZ. GAIN, MAX. AT 212.0 DEG. HORIZ.

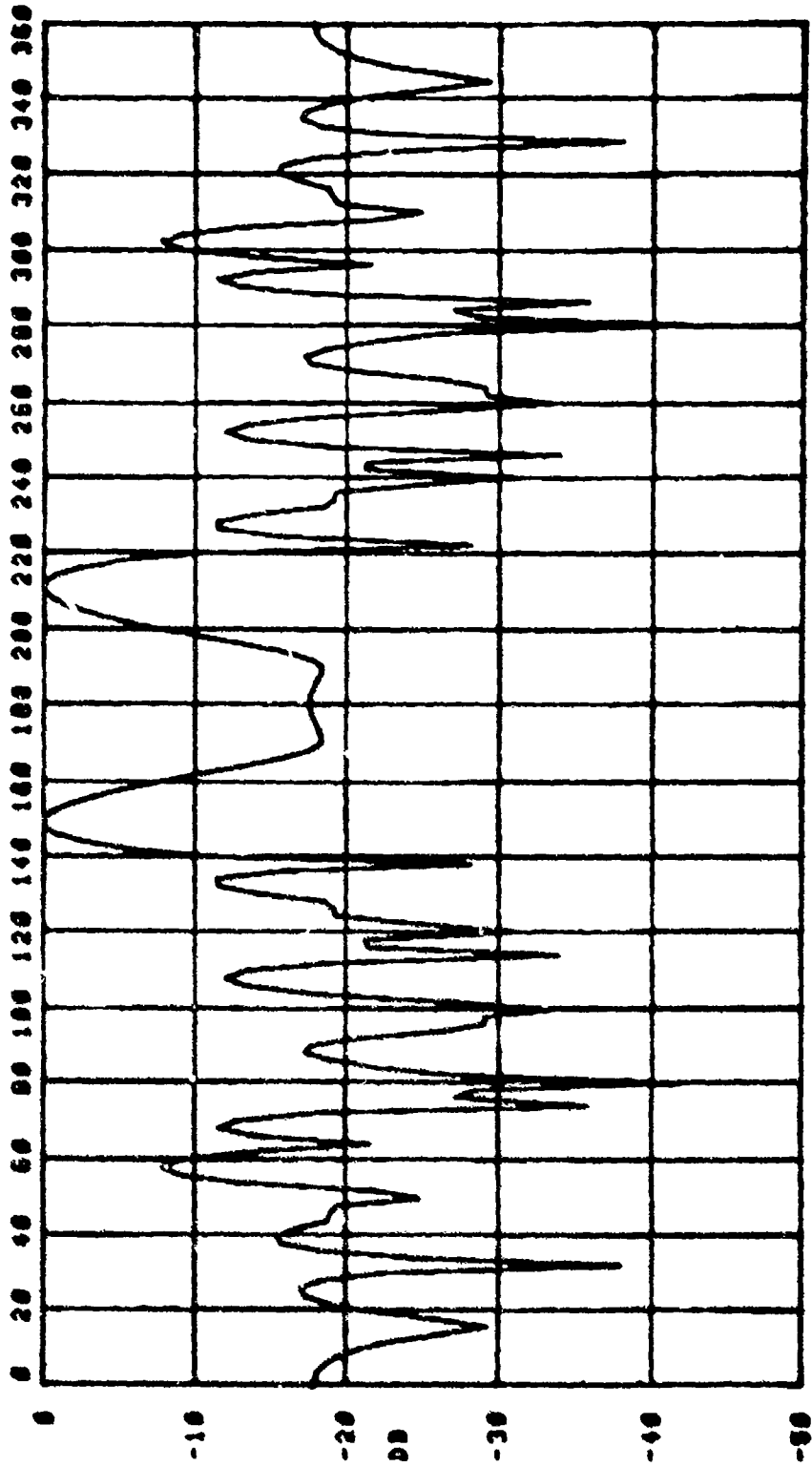


Figure B-35 Theoretical Horizontal Plane Pattern for 16 Element Array @ 295 Hz for Data Point 2, 59 Off Broadside Steering. Beamwidth / 2.31°, Azimuth Gain 10.4 dB.

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66278 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 28-Feb-78 ONTLP 3.1
4: SFARM ARRAY TUNED TO 300 HZ.
6.3233 FT. UNIFORM SPACING.
8: SAME

DATA POINT 3
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
292.0 HZ., 81 ELEMENTS, -0.82 DB MAX., AC:52581.5U:52581.4Y:
90.0 DEG. VERT. RESP., 115.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
2.15 DEG. 3 DB BEAM, 17.24 DB AZ. GAIN, MAX. AT :16.0 DEG. HORIZ.

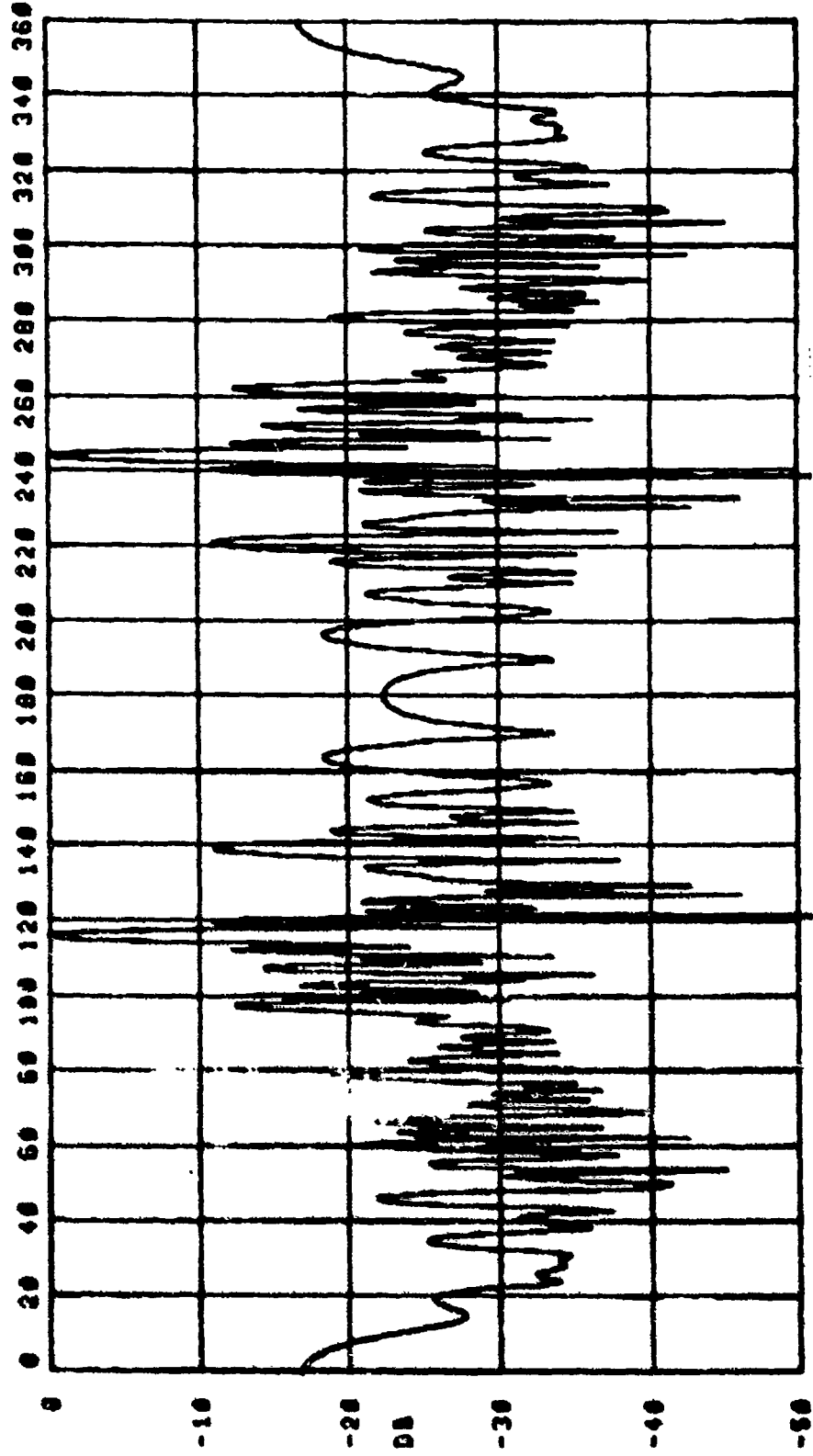


Figure B-16 Theoretical Horizontal Plane Pattern for 51 Element Array @ 290 Hz for Data Point 3, 26 Off Broadside Steering. Beamwidth 2.16°, Azimuth Gain 17.2 dB.

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6: 32.5 SAMBERS BEAM PATTERN PROGRAM (T. HOGAN) 20-Feb-78 ONTLP 3.1
A: 2RAY ARRAY TUNED TO 300 MHz.
S: 3233 FT. UNIFORM SPACING.
S: SMTS

DATA POINT 3
1200 MC SAMPLING FREQUENCY DISTORTS PATTERN.
100.0 HZ., 32 ELEMENTS, -8.02 DB MAX., AC: S2501, SU: S2501, MT:
90.0 DEG. VERT. RESP., 118.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.65 DEG. 3 DB BEAM, 15.20 DB AZ. GAIN, MAX. AT 116.0 DEG. HORIZ.

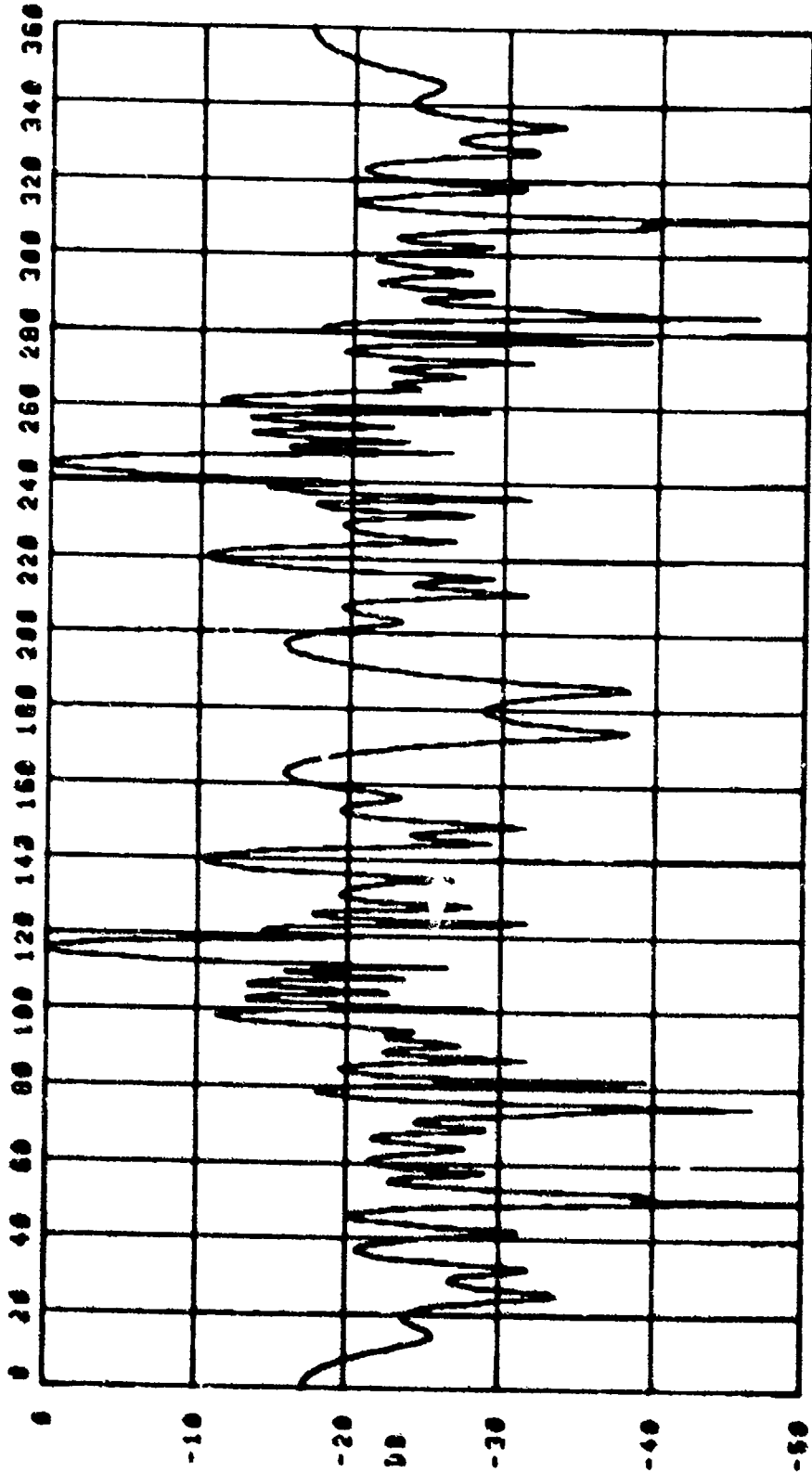


Figure E-27 Theoretical Horizontal Plane Pattern for 32 Element Array at 290 MHz for Data Point 3, 26 Off Broadside Steering. Beamwidth 3.45°, Azimuth Gain /5.2 dB.

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S4278 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 20-Feb-78 ONTLP 3.1
A: SPEAK ARRAY TUNED TO 300 MHz.
S: 5.3233 FT. UNIFORM SPACING.
S: SAME

DATA POINT 3
1200 MHz SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 MHz. 16 ELEMENTS, -0.76 IS MAX., AC:52581.6U:52581.4T:
90.0 DEG. VERT. RESP., 116.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
7.27 DEG. 3 DB BEAM, 12.26 DB AZ. GAIN, MAX. AT 116.0 DEG. HORIZ.

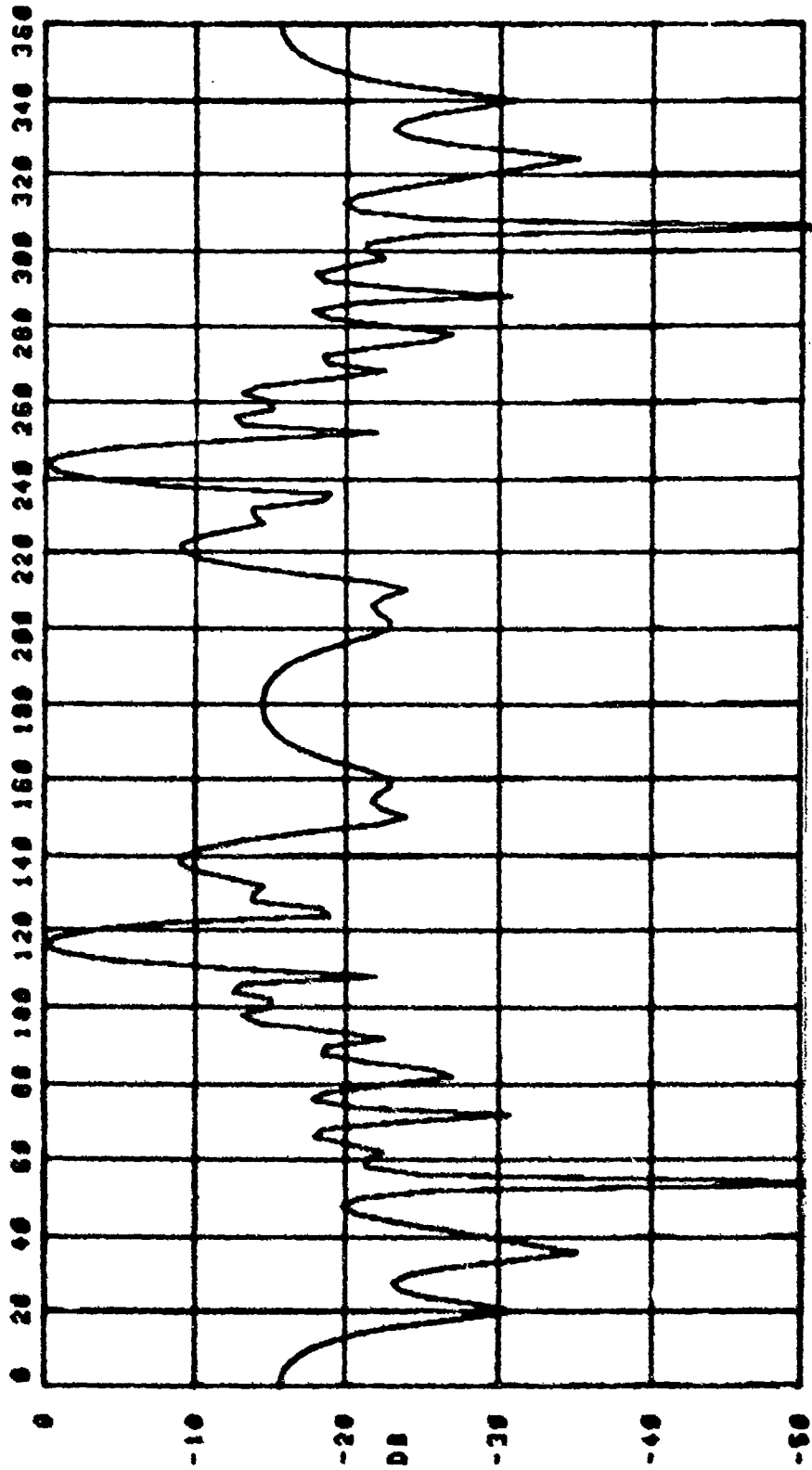


Figure B-38 Theoretical Horizontal Plane Pattern for 16 Element Array @ 290 MHz for Data Point 3, 26 Off Broadside Steering. Beamwidth 7.27°, Azimuth Gain 12.26 dB.

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5:277 SAMBERS BEAM PATTERN PROGRAM (T.MCGAM) 20-FEB-70 ONTLP 3.1
A: SFR61 AREA) TUNED TO 300 MZ.
B: 3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 3
1200 MZ SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 MZ., 51 ELEMENTS, -0.19 DB MAX., AC:52501, SU:52501, UT:
96.0 DEG. VERT. RESP., 116.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.47 DEG. 3 DB BEAM. 15.12 DB AZ. GAIN, MAX. AT 116.0 DEG. HORIZ.

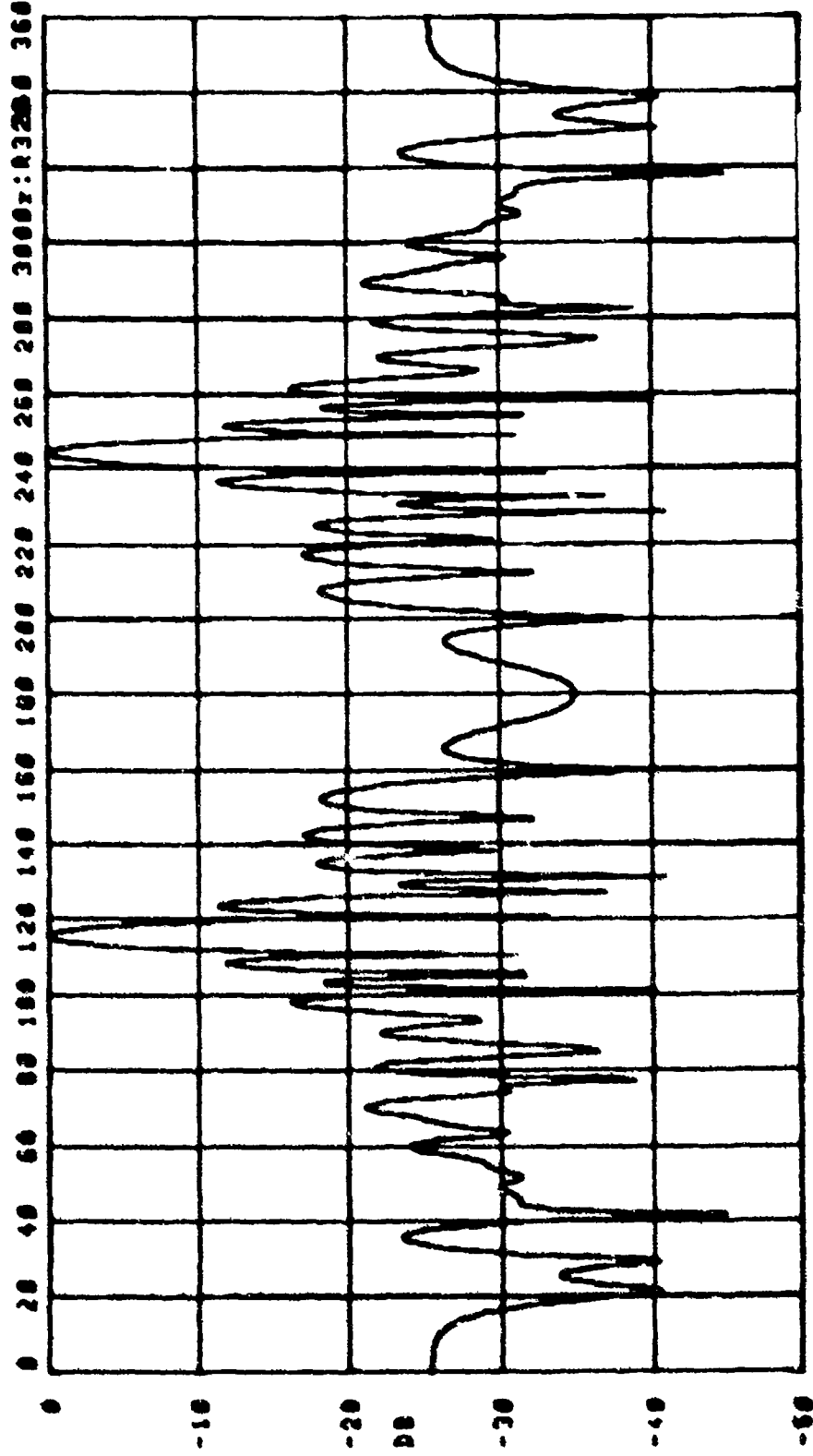


Figure 2-39 Theoretical Horizontal Plane Pattern for 5/Element Array @ 140 MZ for Data Point 3, 26 Steering. Beamwidth 4.47°, Azimuth Gain 15.1 dB.

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5424 SANDERS BEAM PATTERN PROGRAM (T.MOEAN) 20-FEB-78 ONTLP 3 1
A: SPERM AREA) TUNED TO 300 HZ.
B: 333 FT. UNIFORM SPACING.
C: SAME

DATA POINT 3
1200 HZ SAMPLING FREQUENCY DISTCATS PATTERN.
100.0 HZ., 32 ELEMENTS, -0.10 DB MAX., AC:52801, SU:52801, MT:
90.0 DEG. VERT. RESP., 116.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
7.16 DEG. 3 DB BEAF. 13.13 DB AZ. GAIN. MAX. AT 115.8 DEG. HORIZ.

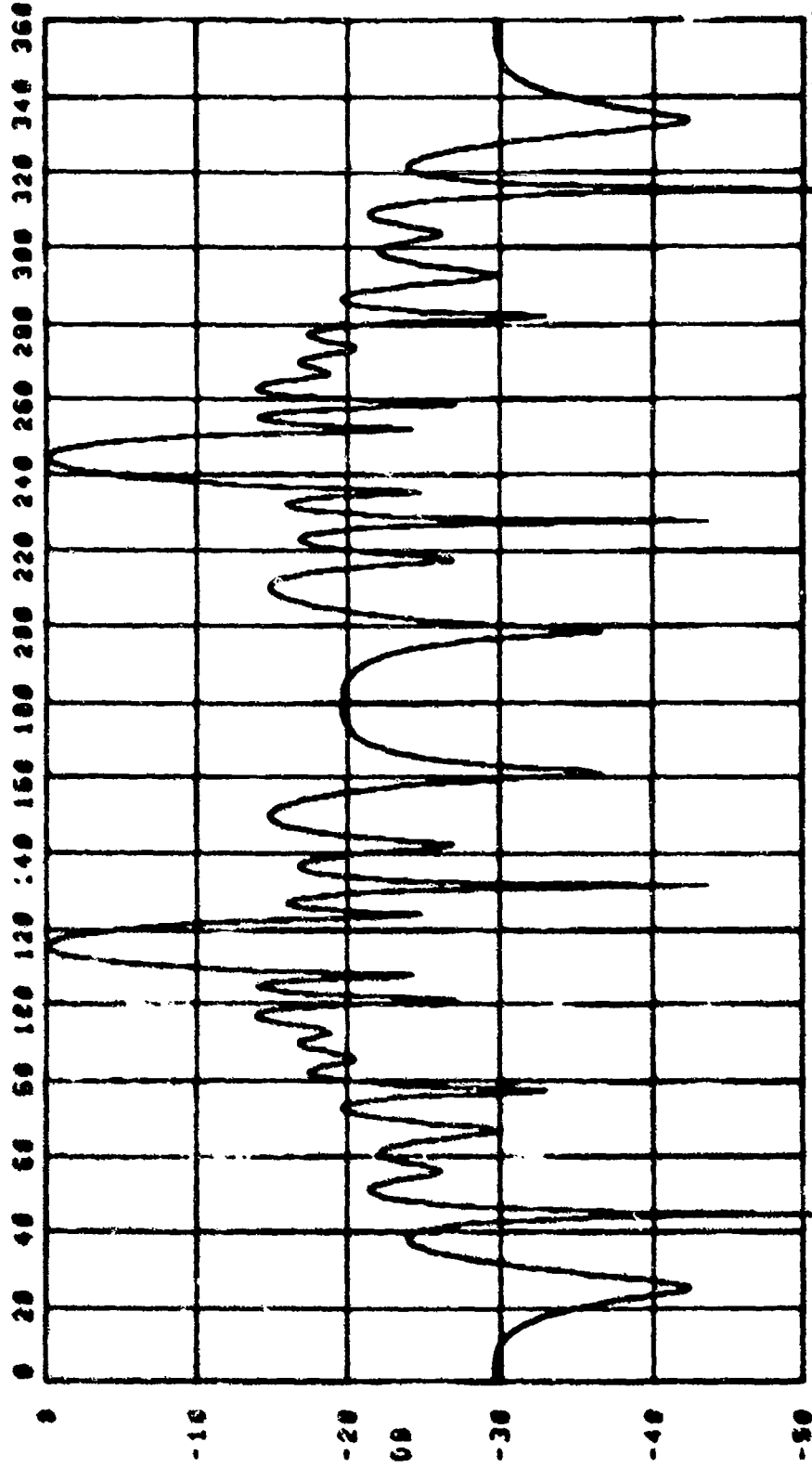


Figure B-40 Theoretical Horizontal Plane Pattern for 32 Element Array @ 140 Hz for Data Point 3, 26° Off Broadside Steering. Beamwidth 7.16°, Azimuth Gain 13.1 dB.

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54471 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 20-Feb-70 ONTLP 3.1
A: SP84) GREAT TUNED TO 200 HZ.
6.2332 FT. UNIFORM SPACING.
S: SARE

DATA POINT 2
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 16 ELEMENTS, -0.16 DB MAX., AC: S2501-SU: S2601, MT:
50.0 DEG. VERT. RESP., 116.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
15.10 DEG. 3 DB BEAM. 10.01 DB AZ. GAIN, MAX. AT 116.0 DEG. HORIZ.

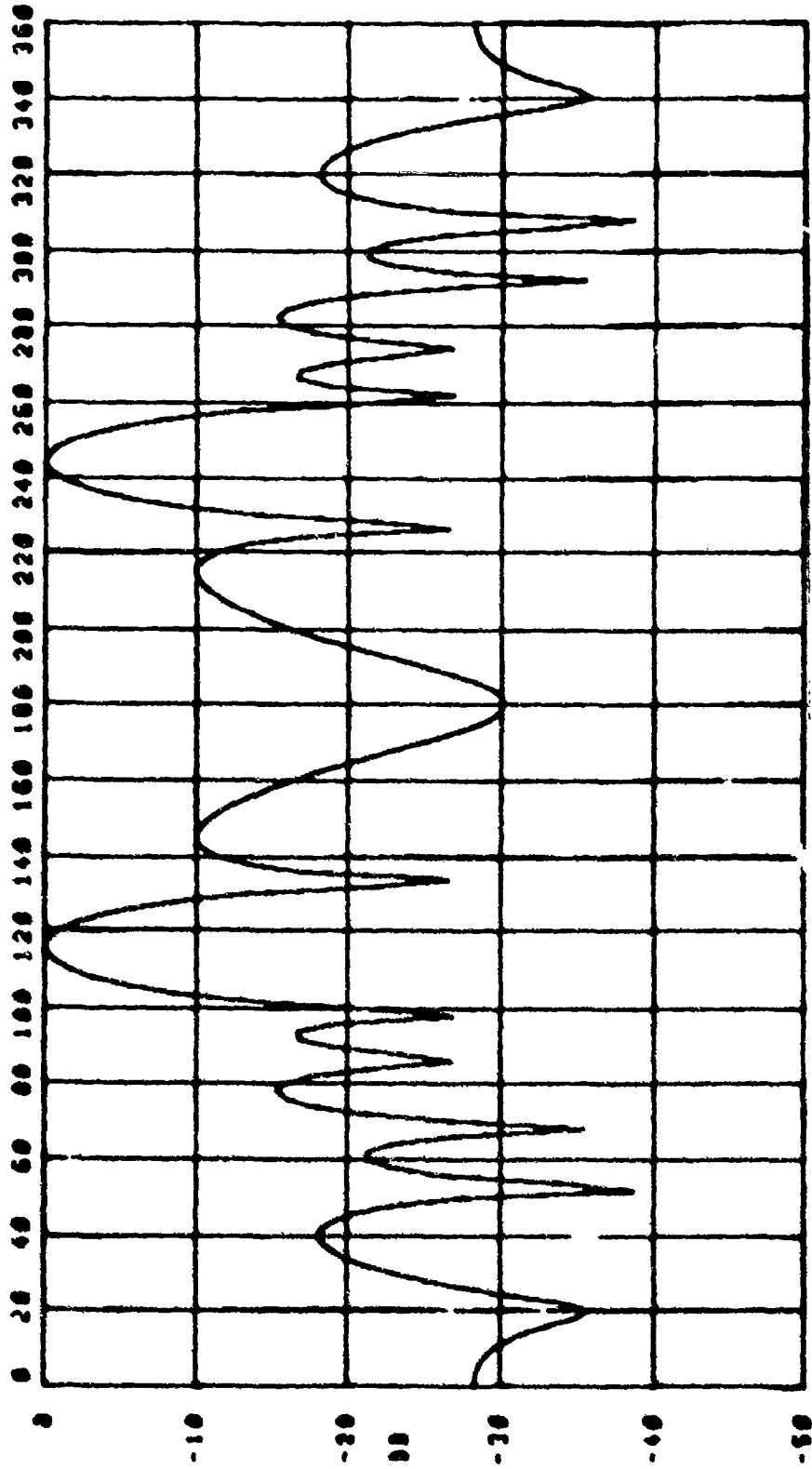


Fig. 20 B-41 Theoretical Horizontal Plane Pattern for 16 Element
Array & 140 Hz for Data Point 3, 26 Off Broadside
Steering. Beamwidth 15.1°, Azimuth Gain 10.0 dB.

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S2279 SANDERS BEAM PATTERN PROGRAM (T.MOGAM) 20-FEB-70 ONTLP 3.1
A: SFRAT (ARRAY) TUNED TO 300 HZ.
S: 3.333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 3
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
205.0 HZ., 51 ELEMENTS, -0.01 DB MAX., AC:52501, SU:52501, HT:
50.0 DEG. VERT. BEEP., 116.0 DEG. HORIZ. STEER., 90.0 DEG. VERT STEER
2.12 DEG. 3 DB BEAM, 17.35 DB AZ. GAIN. MAX. AT 116.0 DEG. HORIZ.

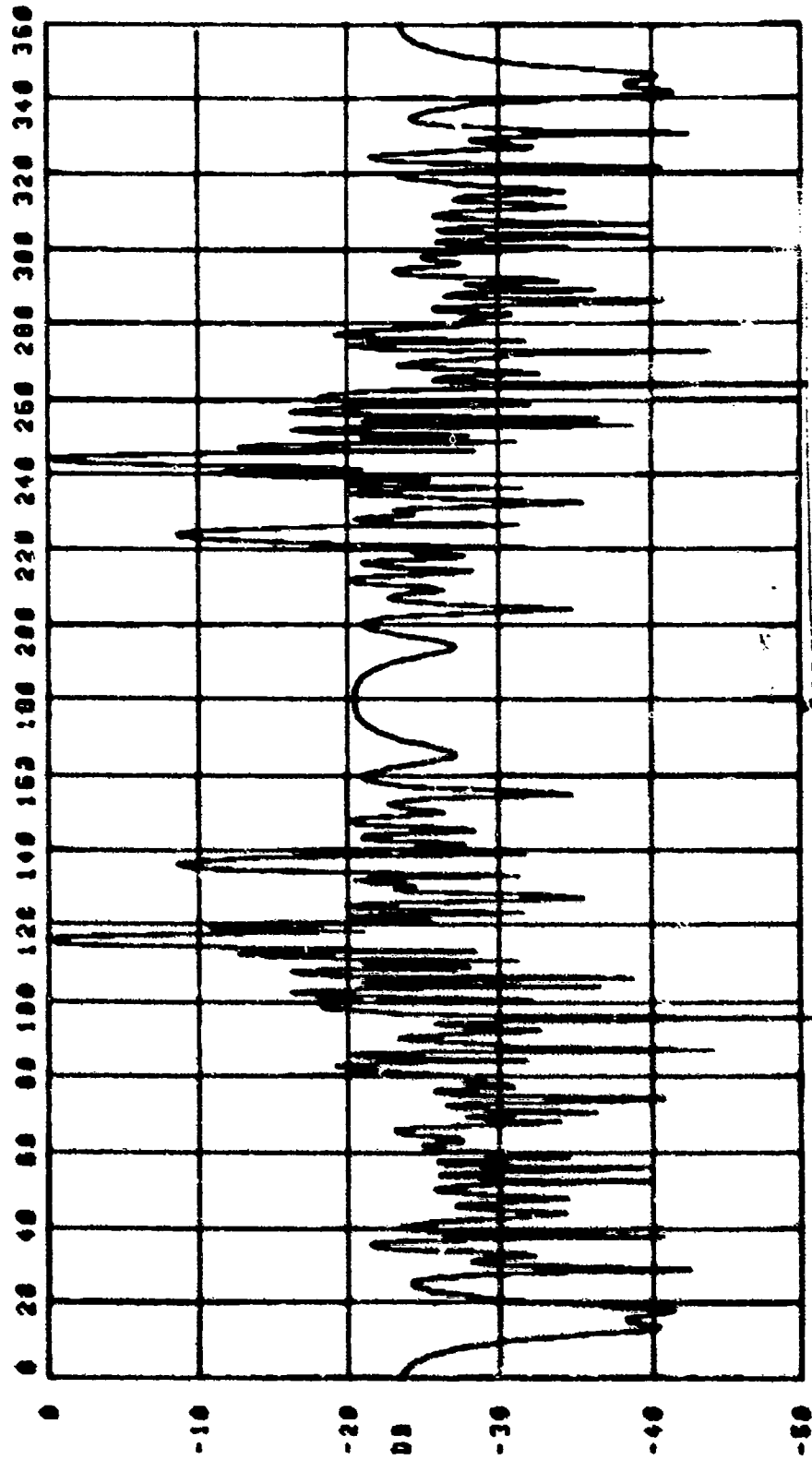


Figure B-42 Theoretical Horizontal Plane Pattern for 51 Element
Array @ 295 Hz for Data Point 3, 26
Steering. Beamwidth 2.12°, Azimuth Gain 17.3 dB.

CONFIDENTIAL

52476 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 20-Feb-70 ONTLEP 3.1
A: SF561 ARRAY TUNED TO 300 HZ.
S: 5.3323 FT. UNIFORM SPACINGS.
S: SAME

DATA POINT 3
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ. 32 ELEMENTS. -0.82 DB MAX.. AC: S2581, SU: S2581, HT:
90.0 DEG. VERT. RESP.. 116.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
3.42 DEG. 3 DB BEAM, 15.29 DB AZ. GAIN, MAX. AT 116.0 DEG. HORIZ.

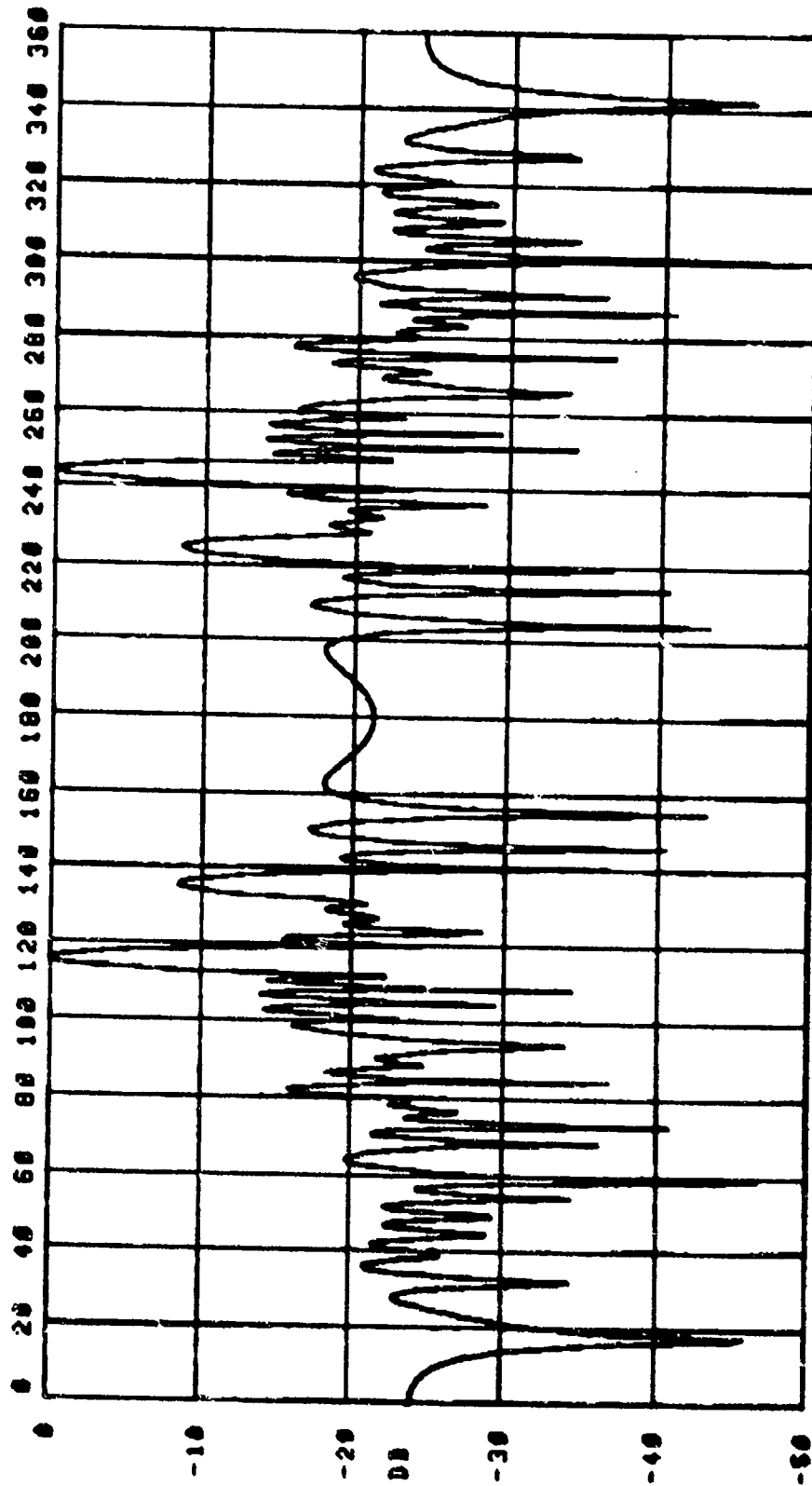


Figure B-43 Theoretical Horizontal Plane Pattern for 32 Element Array @ 295 Hz for Data Point 3, 26 Off Broadside Steering. Beamwidth 3.42°, Azimuth Gain 15.29 dB.

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S2271 SAMBERS BEAM PATTERN PROGRAM (T.MOGAN) 20-FEB-70 ONTLP 3.1
A: SPRAY ARRAY TUNED TO 300 MHZ.
S: 3323 FT. UNIFORM SPACING.
S: SAME

DATA POINT 3
1200 MC SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 MHZ., 16 ELEMENTS, -0.77 DB MAX., AC: S2581, SU: S2581, MT:
50.0 DEG. VERT. RESP., 116.8 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
7.05 DEG. 3 DB BEAM, 12.39 DB AZ. GAIN, MAX AT 116.0 DEG. HORIZ.

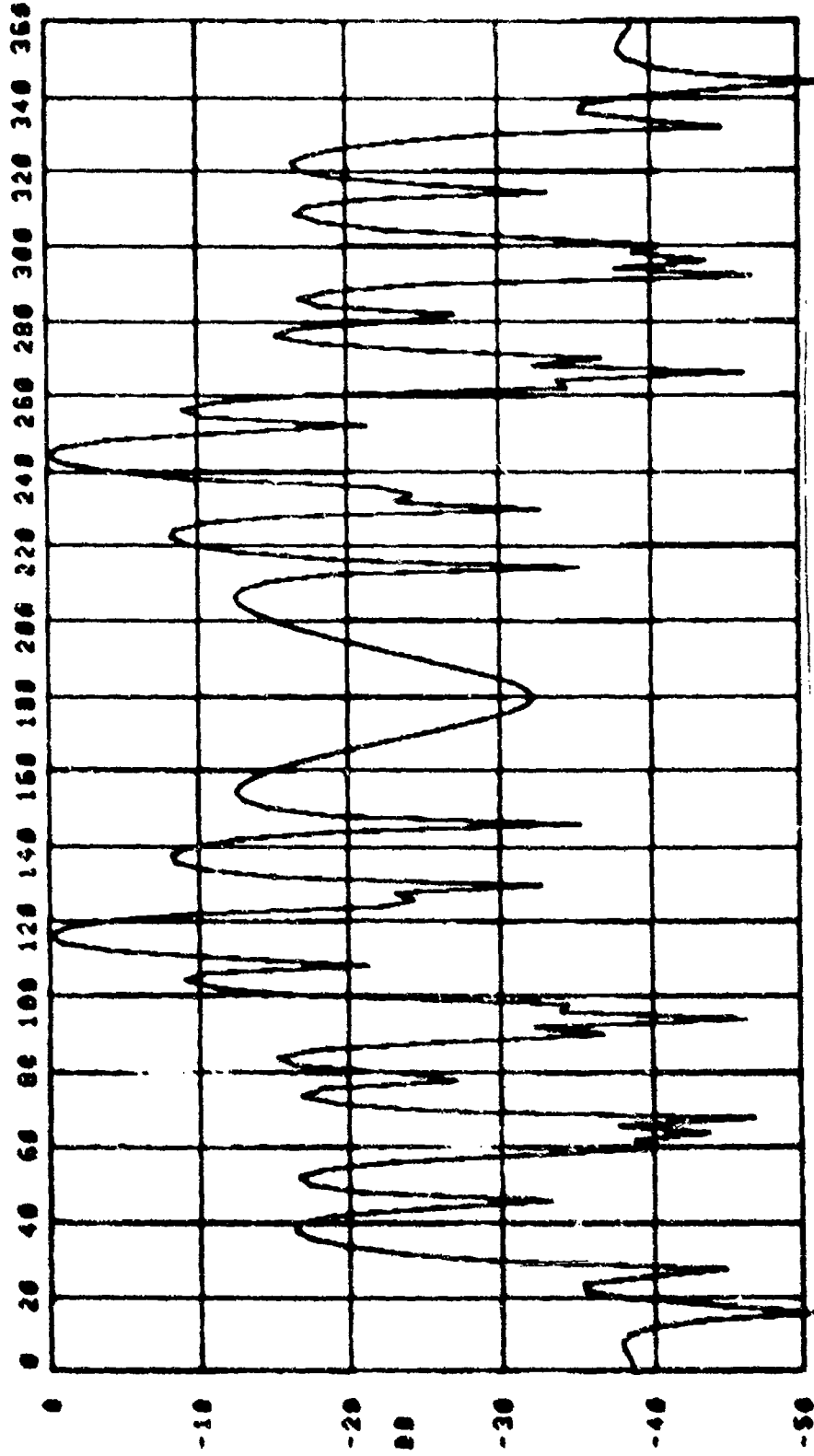


FIG. 28 E-44 THEORETICAL HORIZONTAL PLANE PATTERN FOR 16 ELEMENT
ARRAY AT 295 MHz FOR DATA POINT 3, 26.05 DB BROADSIDE
STEERING, BEAMWIDTH 7.05, AZIMUTH GAIN 12.39 DB.

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5227M SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 26-FEB-70 0N1LBP 3.1
A: SFRQY AREA) TUNED TO 300 HZ.
S: 3333 FT. UNIFORM SPACING.

S: SAME

34

DATA POINT 4
1200 HZ SAMPLING FREQUENCY) DISTORTS PATTERN.
250.0 HZ., 51 ELEMENTS, 10.79 DB MAX., AC:52581, SU:52581, MT:
50.0 DEG. VERT. RESP., 124.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
2.33 DEG. 3 DB BEAM, 17.15 DB AZ. GAIN, MAX. AT 236.0 DEG. HORIZ.

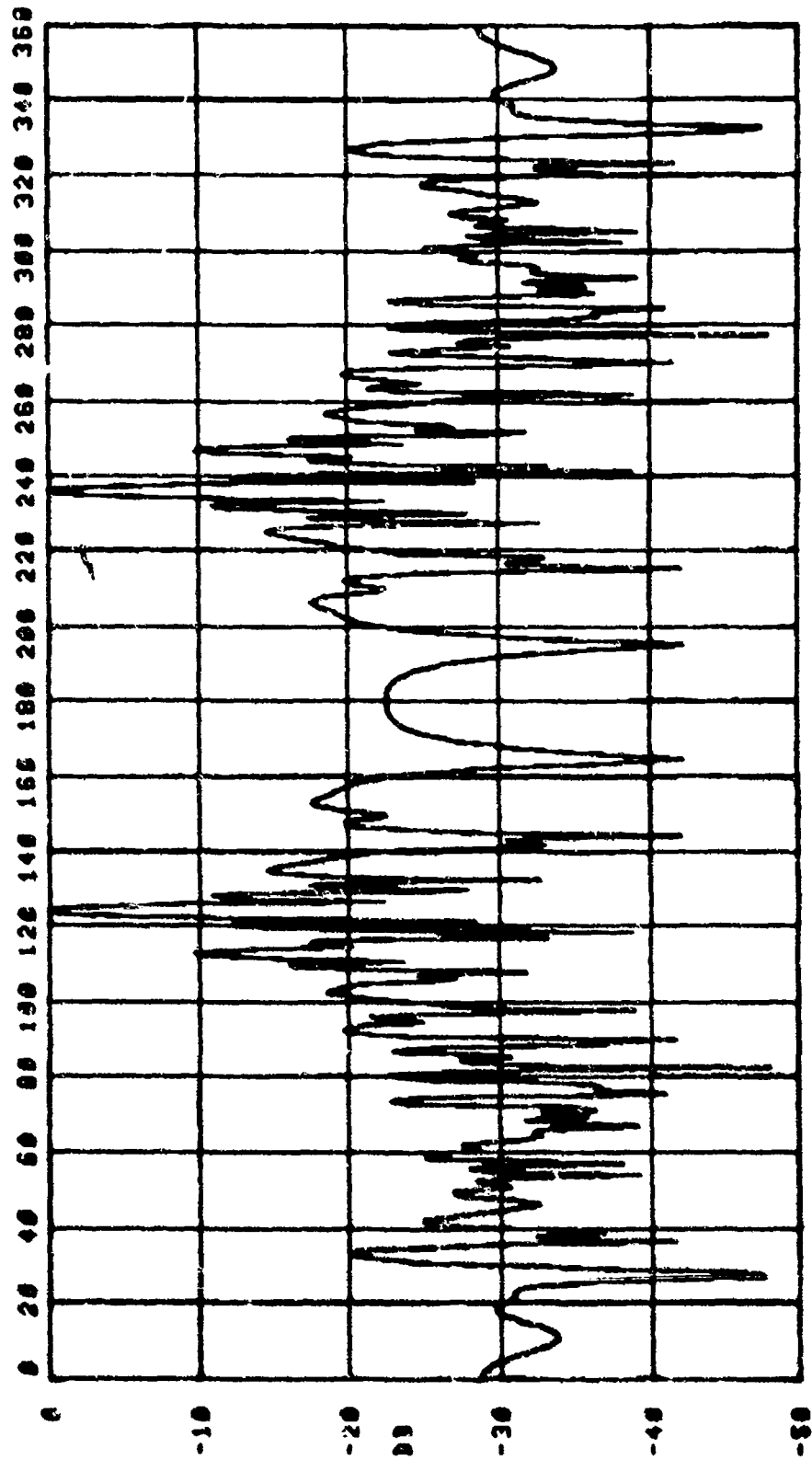


Figure B-45 Theoretical Horizontal Plane Pattern for 51 Element
Array @ 290 Hz for Data Point 4, 34 Off Broadside
Steering. Beamwidth 2.33°, Azimuth Gain 17.15 dB.

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SIZE SAMBERS BEAM PATTERN PROGRAM (Y.HOGAN) 20-FEB-70 ONTLEP 3.1
A: 5FE63 (ARM) TUNED TO 300 MZ.
S: 6.3333 FT. UNIFORM SPACING.
S: SAFE

DATA POINT 4
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 MZ., 32 ELEMENTS, -0.96 DB MAX., AC:52581.5U:52581.4T:
50.0 DEG. VERT. RESP., 124.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.00 DEG. 3 DB BEAM, 14.56 DB AZ. GAIN, MAX. AT 124.5 DEG. HORIZ.

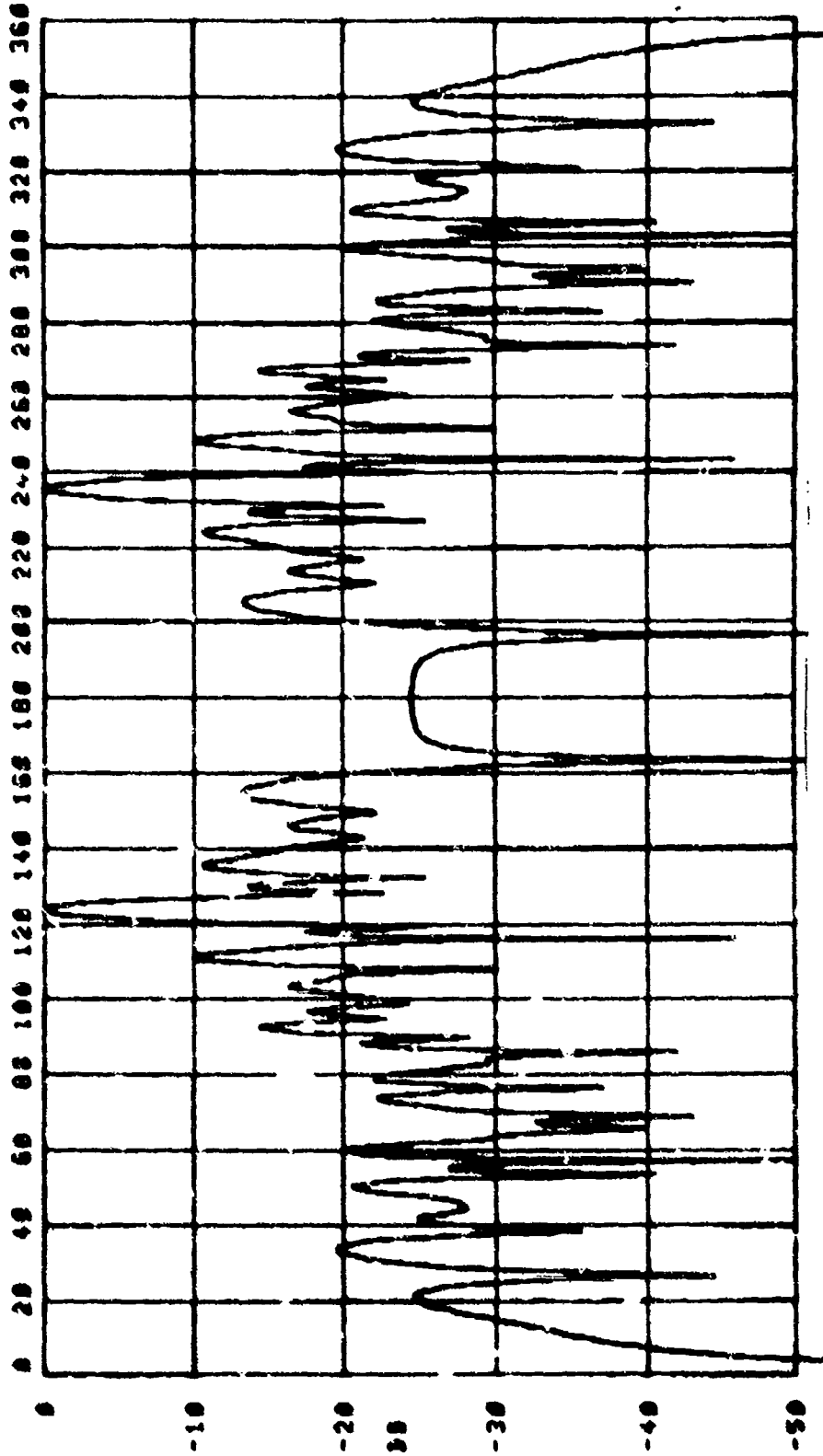


FIGURE 3-46 THEORETICAL HORIZONTAL PLANE PATTERN FOR 32 ELEMENT
ARRAY @ 290 MZ FOR DATA POINT 4, 34 SEE BRADSHAW
STEERING. BEAMWIDTH 3.80, AZIMUTH GAIN 14.9 DB.

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S:2278 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 20-Feb-78 ONTLP 3.1
A: SFRM1 ARRAY TUNED TO 300 MZ.
S: 3.333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 0
1200 MZ SAMPLING FREQUENCY DISTORTS PATTERN.
296.0 MZ., 16 ELEMENTS, -0.55 DB MAX., AC:S2581,SU:S2581,MT:
90.0 DEG. VERT. RESP., 124.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
7.90 DEG. 3 DB BEAM, 12.25 DB AZ. GAIN, MAX. AT 236.0 DEG. HORIZ.

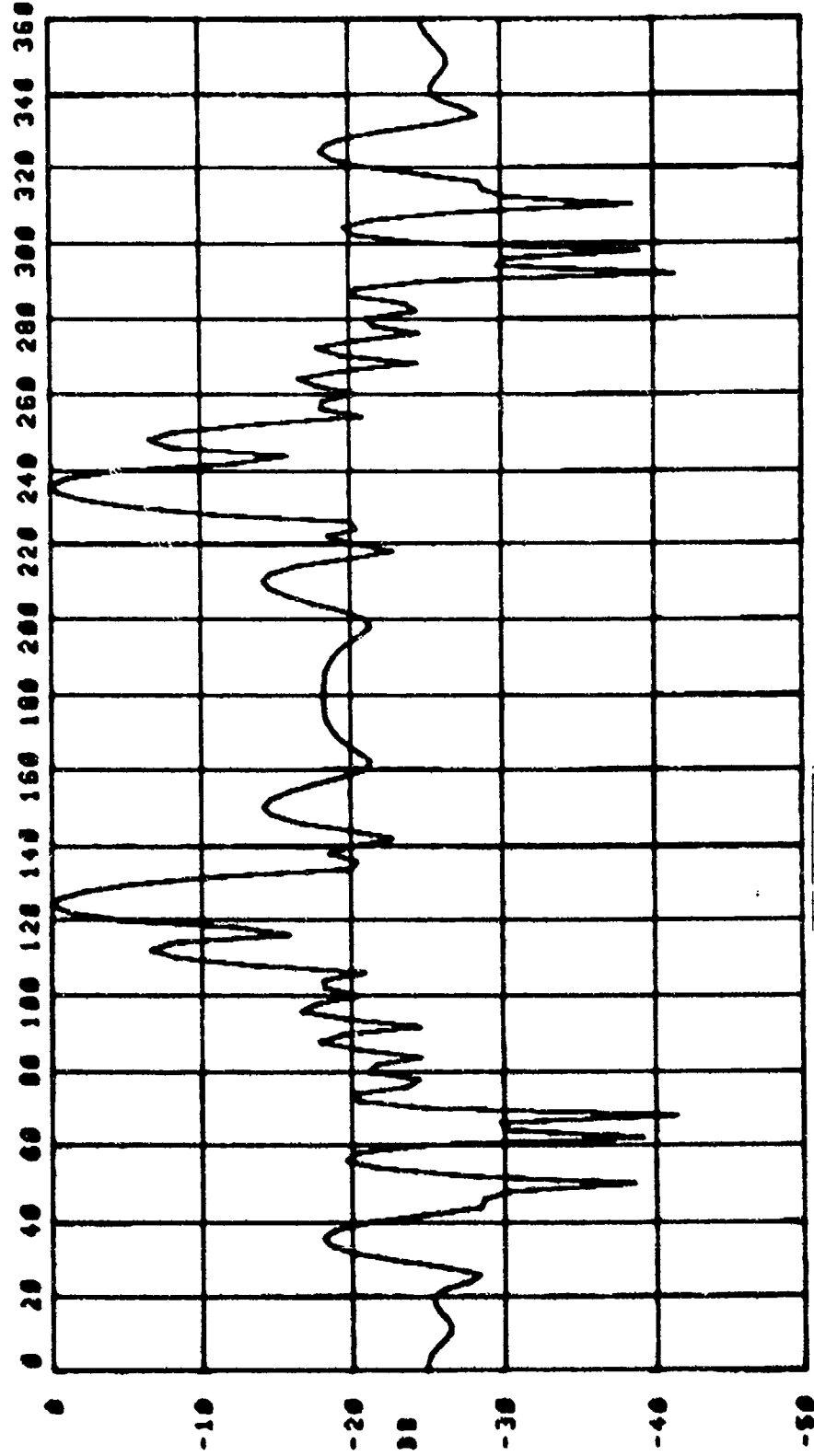


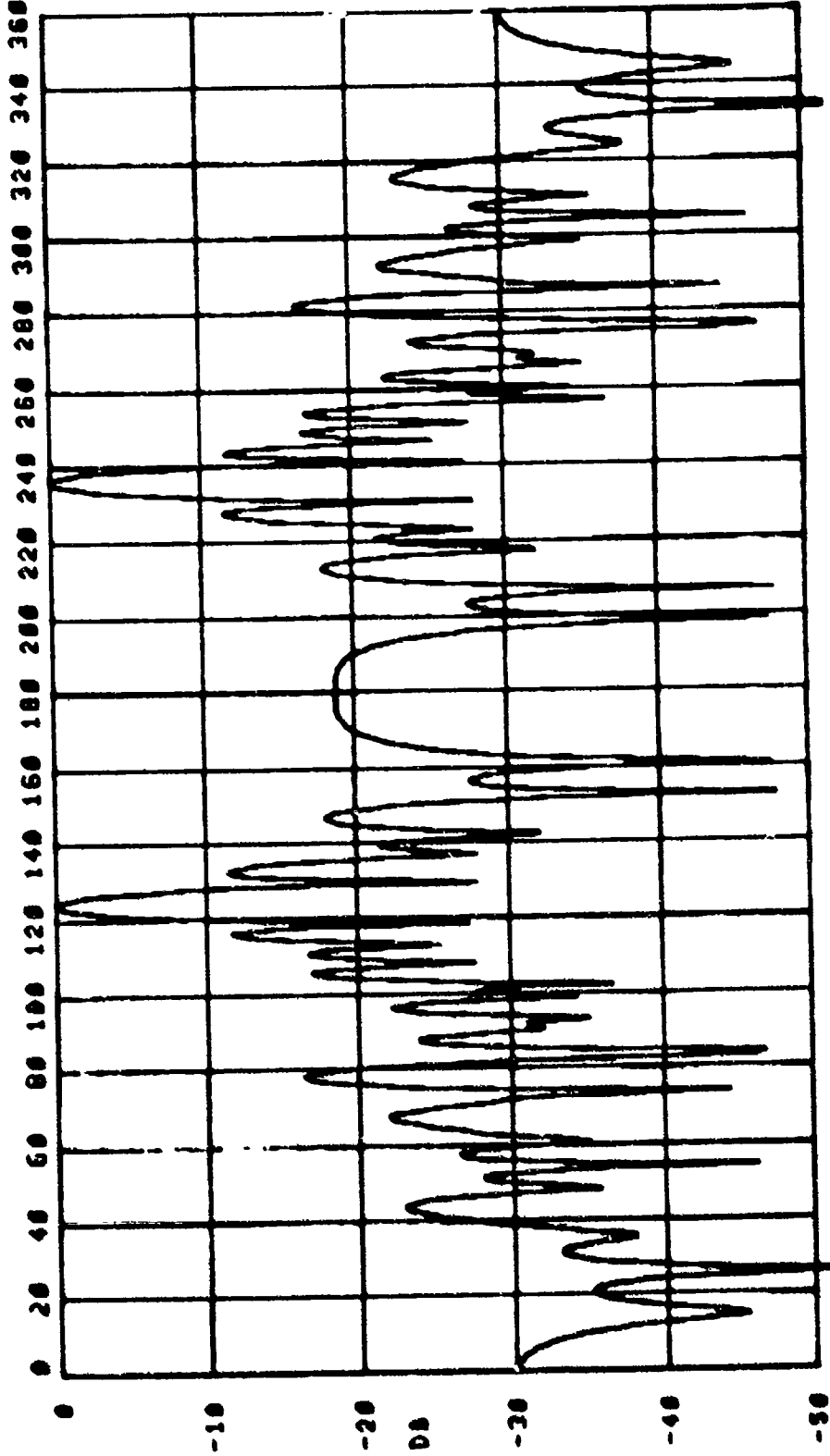
Figure B-47 Theoretical Horizontal Plane Pattern for 16 Element Array & 290 Hz for Data Point 4, 34 Off Broadside Steering. Beamwidth 7.90, Azimuth Gain 12.2 db.

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5:22:26 SAMBERS BEAM PATTERN PROGRAM (Y. MCGAN) 28-Feb-78 ONTLBP 3.1
A: SFRM1 ARRAY TUNED TO 388 HZ.
S: 6.3353 FT. UNIFORM SPACING.
S: SAME

DATA POINT 4
:200 HZ SAMPLING FREQUENCY: DISTORTION PATTERN.
140.0 HZ. 51 ELEMENTS, -0.17 DB MAX., AC:52501.SU:52501.WT:
50.0 DEG. VERT. RESP., 124.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.04 DEG. 3 DB BEAM, 14.77 DB AZ. GAIN, MAX. AT 236.0 DEG. HORIZ.



Page 2-48 Theoretical: Horizontal Plane Pattern for 5 Element
Array @ 140 Hz for Data Point 4, 34
Steering. Beamwidth 4.84, Azimuth Gain 14.7 dB.

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SC279 SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 28-FEB-78 ONTLP 3.1
4: SFRAT AREA) TUNED TO 300 MZ.
6-3333 FT. UNIFORM SPACING.
8: SAME

DATA POINT 4
1200 MZ SAMPLING FREQUENCY DISTORTS PATTERN.
149.0 MZ., 32 ELEMENTS, -0.18 DB MAX., AC:52581, SU:52681, MT:
90.0 DEG. VERT. RESP., 124.0 DEG. HORIZ. STEER, 30.0 DEG. VERT STEER
7.79 DEG. 3 DB BEAM. 12.57 DB AZ. GAIN. MAX. AT 236.0 DEG. HORIZ.

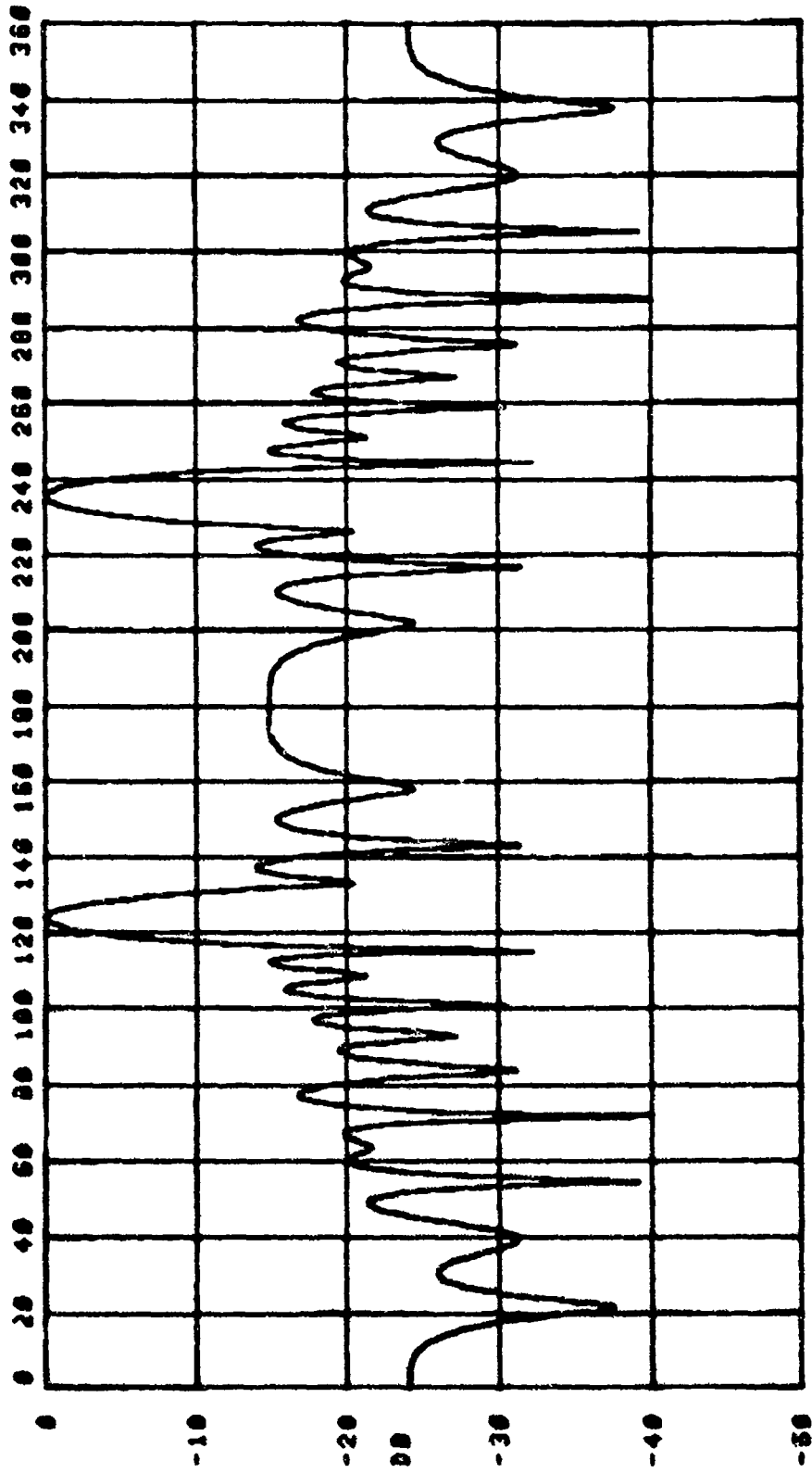


Figure B-49 Theoretical Horizontal Plane Pattern for 32 Element Array @ 140 Hz for Data Point 4, 34 Off Broadside Steering. Beamwidth 7.79°, Azimuth Gain 12.6dB.

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SC227A SANDERS BEAM PATTERN PROGRAM (T.MOGAN) 28-Feb-70 ONTLEP 3.1
A: SFR41 AREA) TUNED TO 300 HZ.
S: 5.3333 FT. UNIFORM SPACING.
S: SAFE

DATA POINT 4
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 16 ELEMENTS, -0.21 DB MAX., AC:52501, SU:52501, MT:
90.0 DEG. VERT. RESP., 124.0 DEG. HORIZ. STEER. 90.0 DEG. VERT STEER
16.76 DEG. 3 DB BEAM. 9.59 DB AZ. GAIN, MAX. AT 236.0 DEG. HORIZ.

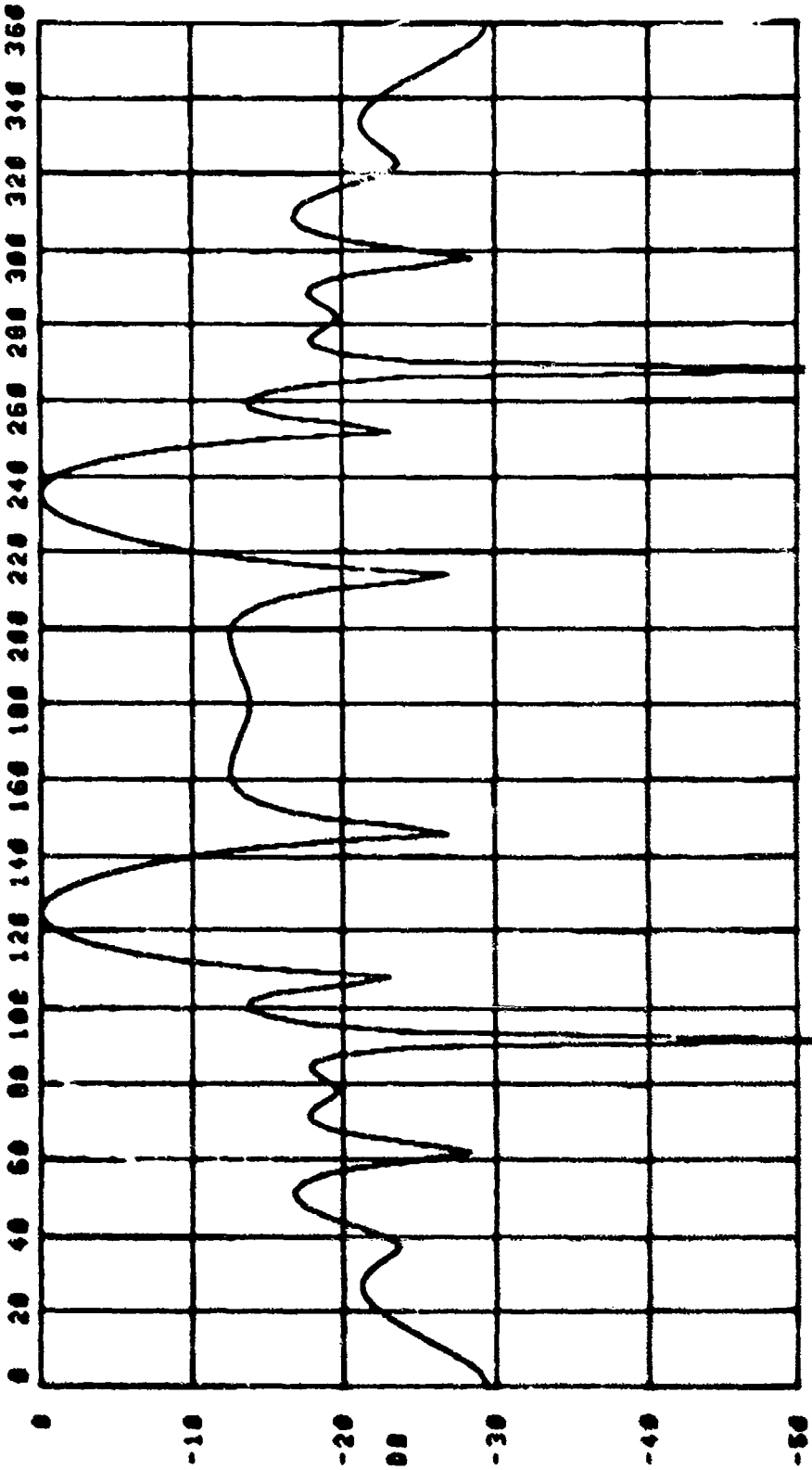


Figure B-50 Theoretical Horizontal Plane Pattern for 16 Element Array @ 140 Hz for Data Point 4, 34 Off Broadside Steering. Beamwidth 6.76°, Azimuth Gain 9.5 dB.

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6: S4271 SANDERS BEAM PATTERN PROGRAM (T.MOGAM) 20-Feb-78 ONTLDP 3.1
6: SFEW) ARRAY TUNED TO 300 HZ.
6: J3J3 FT. UNIFORM SPACING.
6: SAME

LATA POINT 4
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
298.0 HZ.. 51 ELEMENTS, -0.02 DB MAX., AC:52581, SU:52581, MT:
90.0 DEG. VERT. RESP., 124.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
2.30 DEG. 3 DB BEAM, 17.23 DB AZ. GAIN, MAX. AT 124.0 DEG. HORIZ.

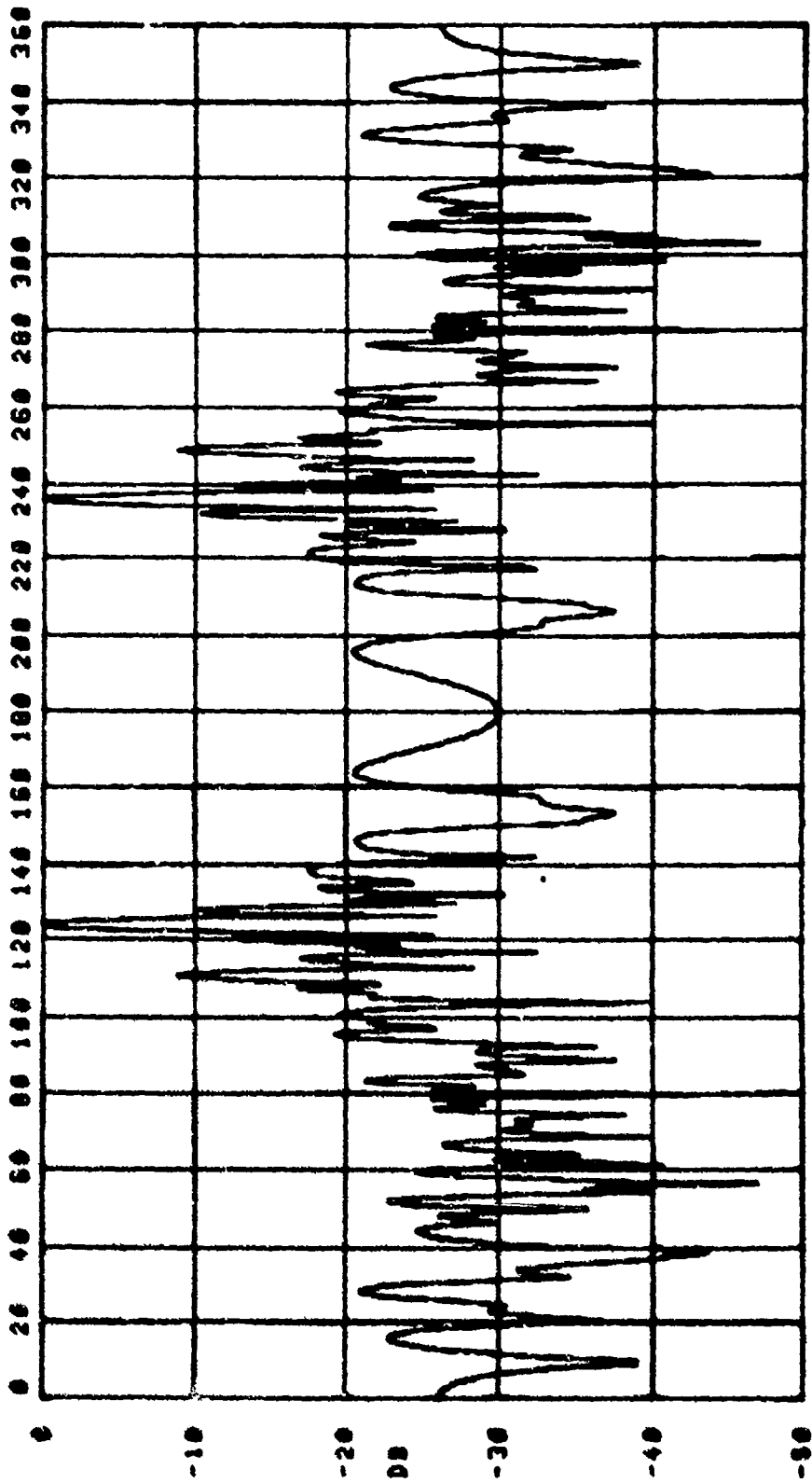


Figure B-5/ Theoretical Horizontal Plane Pattern for 51 Element Array @ 295 Hz for Data Point 4, 34 Off Broadside Steering. Beamwidth 2.30°, Azimuth Gain 17.2 dB.

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8427F SAMBERS BEAM PATTERN PROGRAM (T.MOGAN) 28-FEB-78 ONTLP 3.1
A: SFEAT AREA) TUNED TO 300 HZ.
S: 6.3233 FT. UNIFORM SPACING.

DATA POINT 4
1.00 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ., 32 ELEMENTS, -0.77 DB MAX., AC:92501, SU:52501, UT:
90.0 DEG. VERT.: 124.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.65 DEG. 3 DB BEAM. 15.19 DB AZ. GAIN, MAX. AT 124.0 DEG. HORIZ.

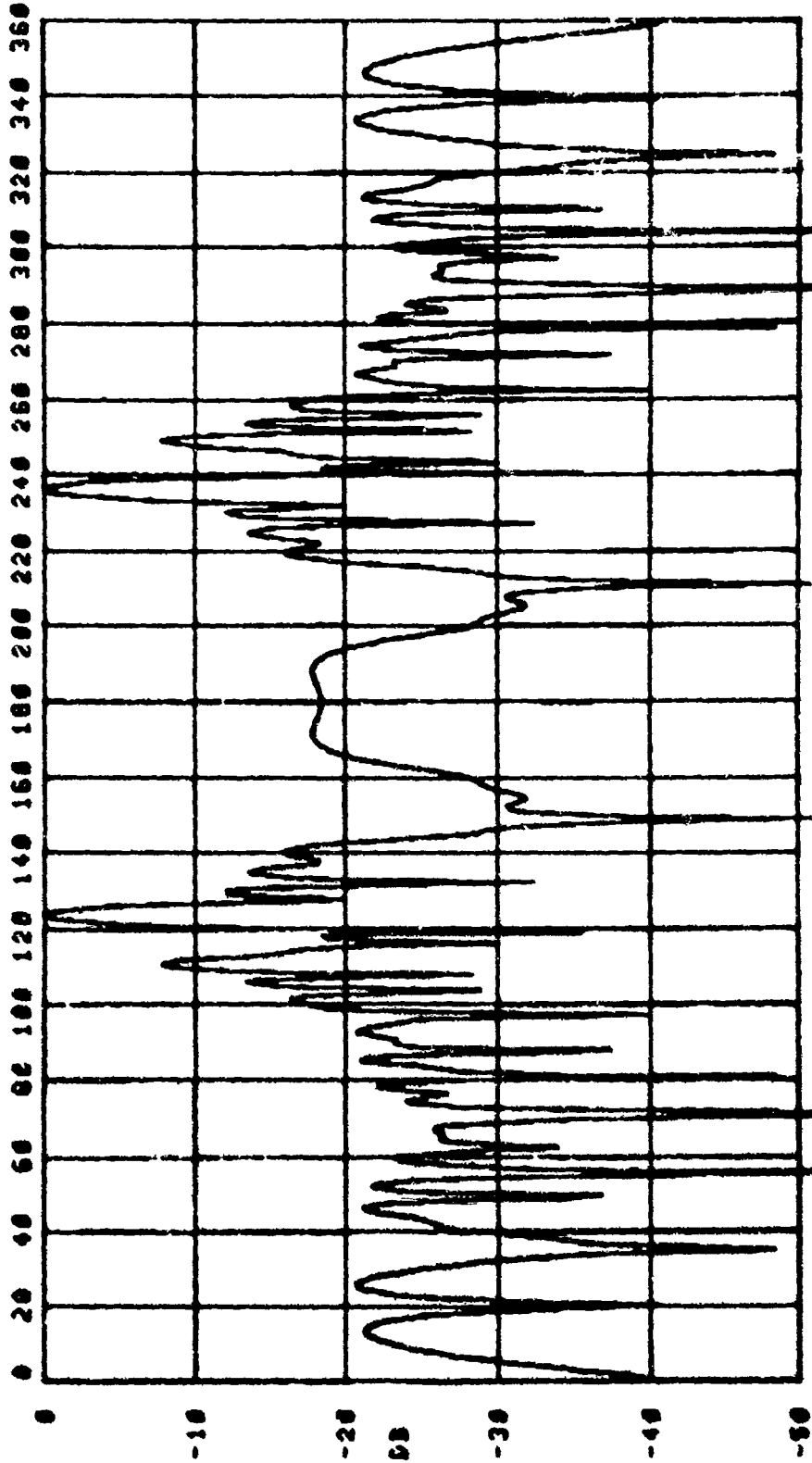


Figure B-52 Theoretical Horizontal Plane Pattern for 32 Element Array at 295 Hz for Data Point 4, 34 Off Broadside Steering. Beamwidth 3.65°, Azimuth Gain /5.1 dB.

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S27C SAMBERS BEAM PATTERN PROGRAM (T.MOGAN) 20-Feb-70 ONTLP 3.1
A: SPEAK AREA) TUNED TO 300 HZ.
B: 6.3331 FT. UNIFORM SPACING.
S: SAME

DATA POINT 4
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ. 16 ELEMENTS, -0.09 DB MAX., AC:52501,SU:52501,MT:
90.0 DEG. VERT. RESP., 124.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
7.03 DEG. 3 DB BEAM, 11.04 DB AZ. GAIN, MAX. AT 236.0 DEG. HORIZ.

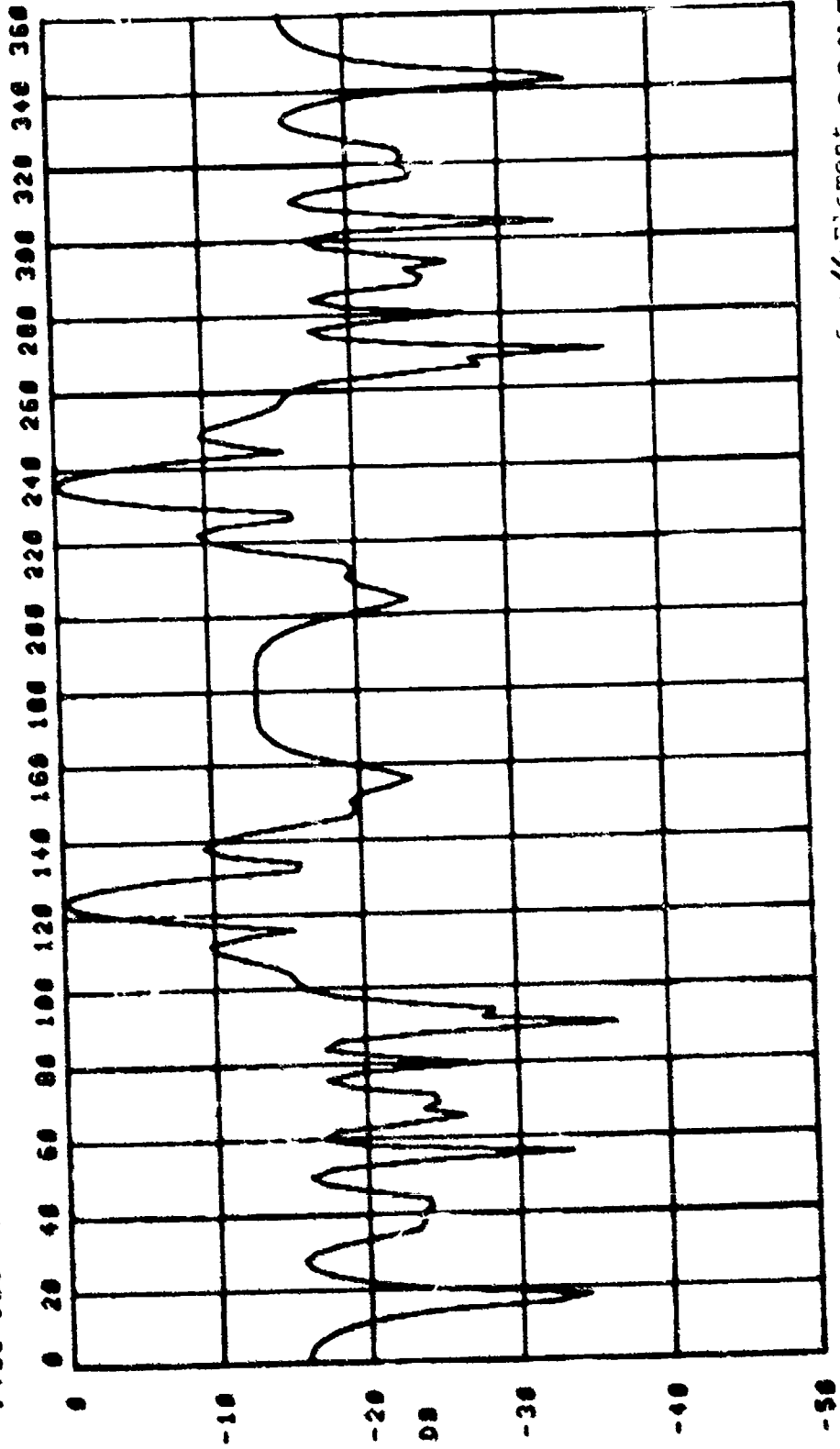


Figure B-53 Theoretical Horizontal Plane Pattern for 16 Element Array @ 295 Hz for Data Point 4, 34 Off Broadside Steering. Beamwidth 7.83, Azimuth Gain 11.8 dB.

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5150 SWIDERS BEAM PATTERN PROGRAM (T.MO:641) 15-Mar-78 ONTLBP 3.1
: 290.0 HZ. TUNED TO 300 HZ.
: 1.2333 FT. UNIFORM SPACING.
: SAME

DATA POINT 5
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 51 ELEMENTS, -0.81 DB MAX., AC:53461, SU:53461, UT:
90.0 DEG. VERT. RESP., 139.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
2.25 DEG. 3 DB BEAM, 16.32 DB AZ. GAIN, MAX. AT 139.0 DEG. HORIZ.

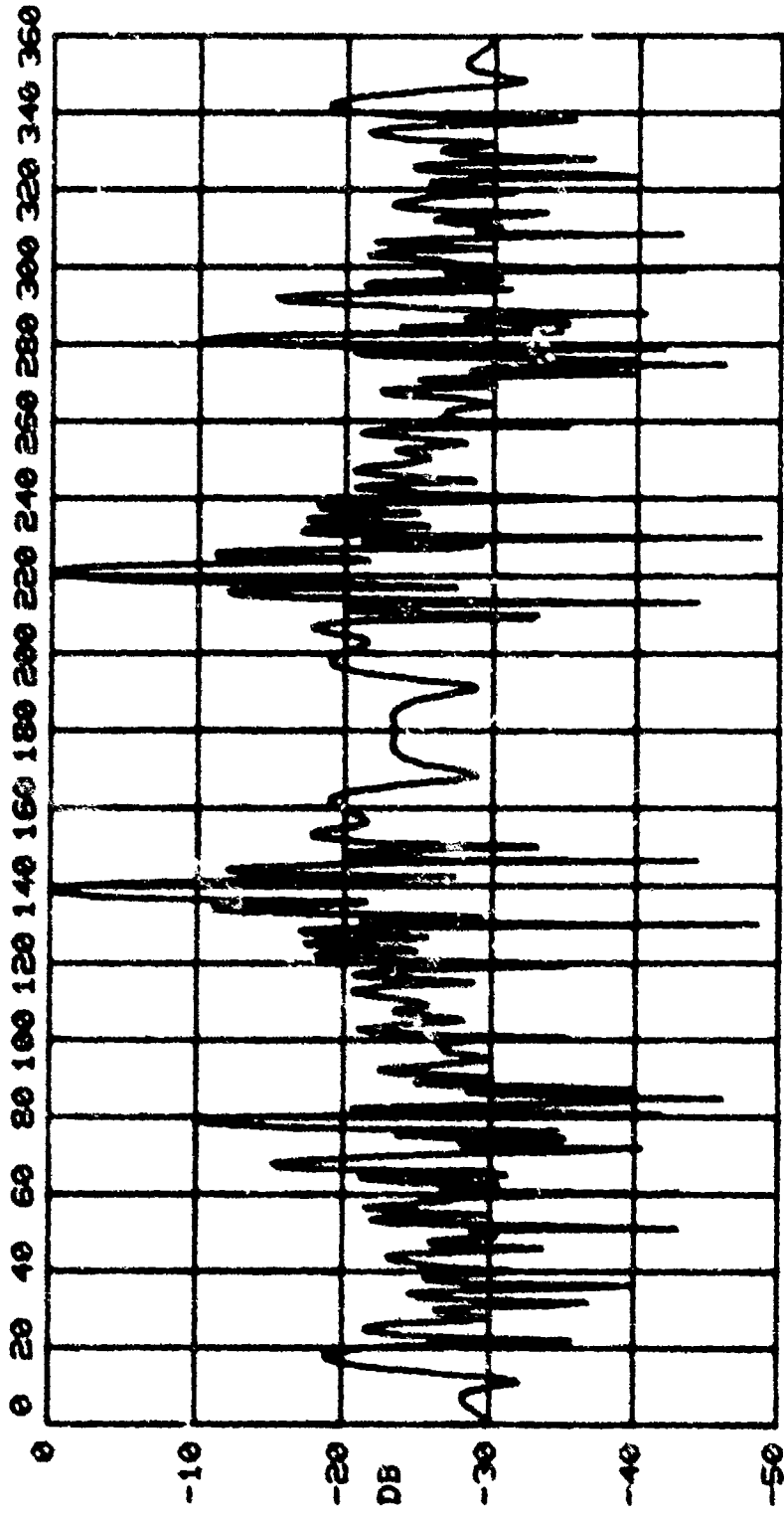


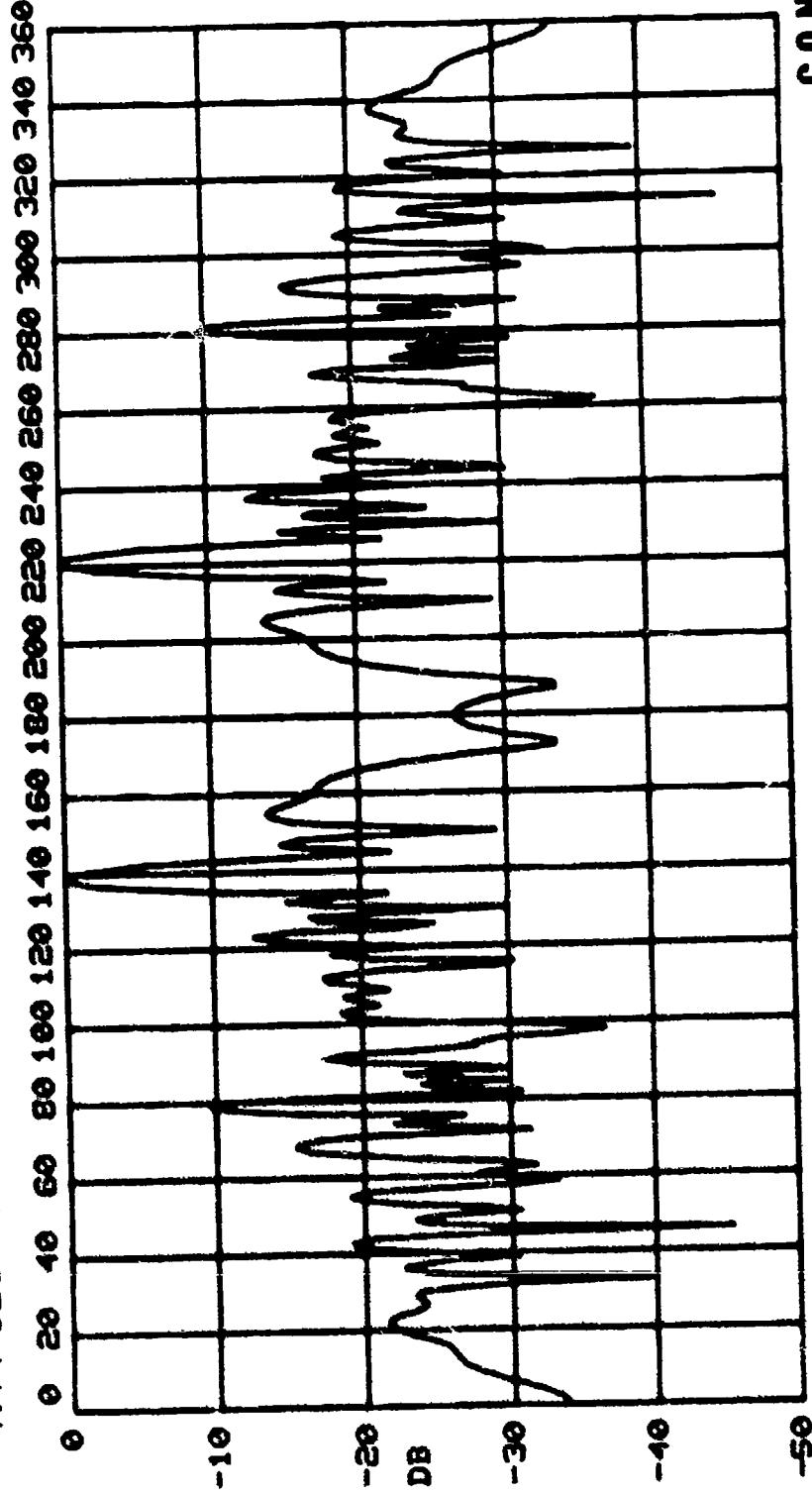
FIGURE 6-54 Theoretical Horizontal Plane Pattern for 51 Element
Array at 290 HZ for Data Points 5, 49
Steering. Beamwidth 2.25°, Azimuth Gain 16.32 DB.

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S3154 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 15-Mar-78 QNTLBP 3.1
: ARRAY ARRAY TUNED TO 300 HZ.
: 8.3333 FT. UNIFORM SPACING.
: SAME

DATA POINT 5
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 32 ELEMENTS, -0.81 DB MAX., AC:53461, SU:53461, UT:
90.0 DEG. VERT. RESP., 139.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.74 DEG. 3 DB BEAM, 14.37 DB AZ. GAIN, MAX. AT 139.0 DEG. HORIZ.



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Figure B-55 Theoretical Horizontal Plane Pattern for 32 Element Array @ 290 Hz for Data Point 5, 49 Off Broadside Steering. Beamwidth 4.74°, Azimuth Gain 14.3 dB.

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S3152 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 15-Mar-78 ONTLBP 3.1
N: 2.2253 FT. UNIFORM SPACING.
S: SAME.

DATA POINT 5
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
230.0 HZ., 16 ELEMENTS, -0.89 DB MAX., AC:53461, SU:53461, UT:
90.0 DEG. VERT. RESP., 139.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
10.21 DEG. 3 DB BEAM, 11.28 DB AZ. GAIN, MAX. AT 138.0 DEG. HORIZ.

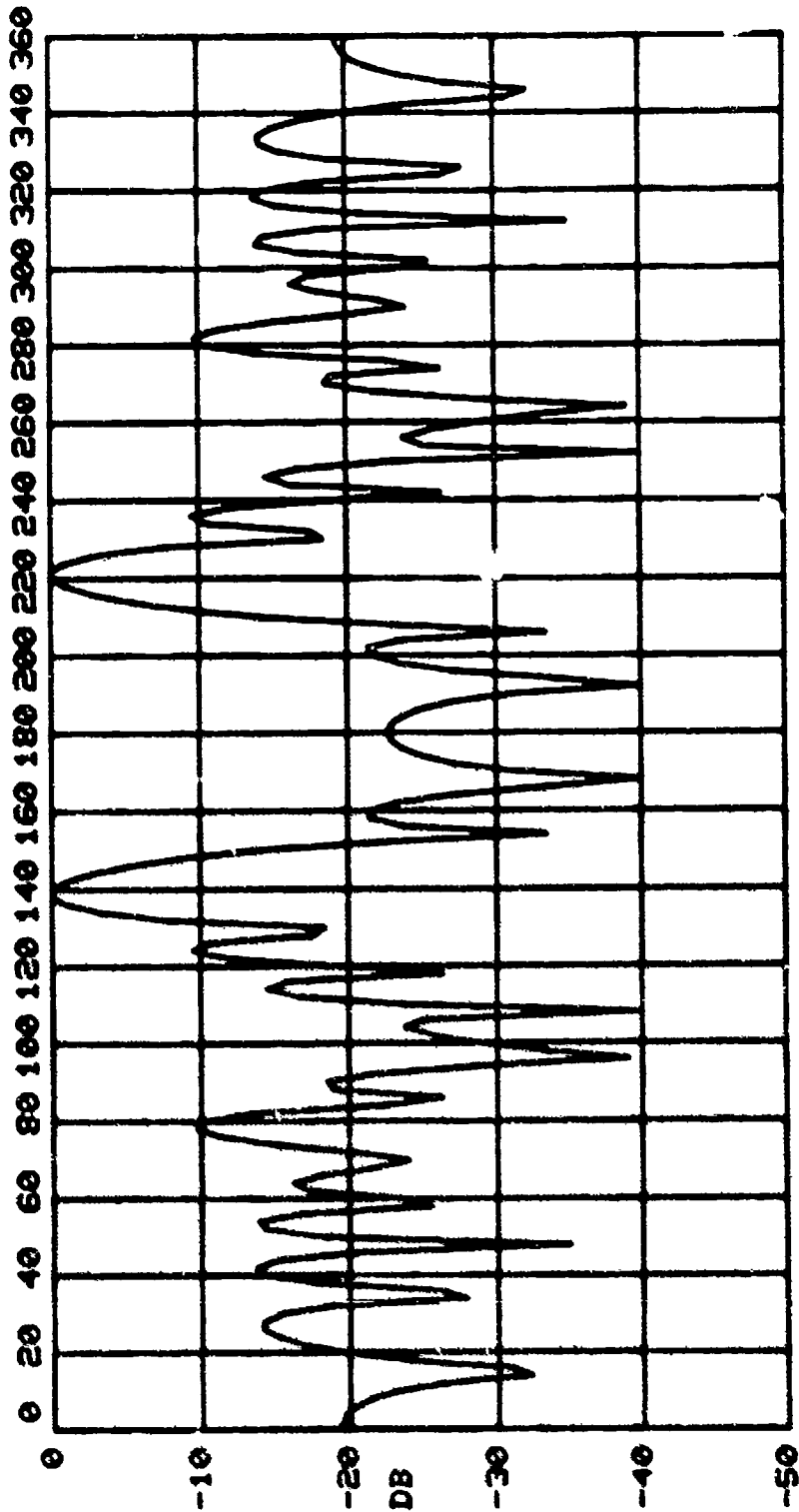


Figure B-56 Theoretical Horizontal Plane Pattern for 16 Element
Array 1290 Hz for Data Point 5, 49 Off Broadside
Steering. Beamwidth 10.21°, Azimuth Gain 11.28 dB.

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53155 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 15-Mar-78 ONTLBP 3.1

4: SPREAD ARRAY TUNED TO 300 HZ.

8: 2.3333 FT. UNIFORM SPACING.

9: SAME

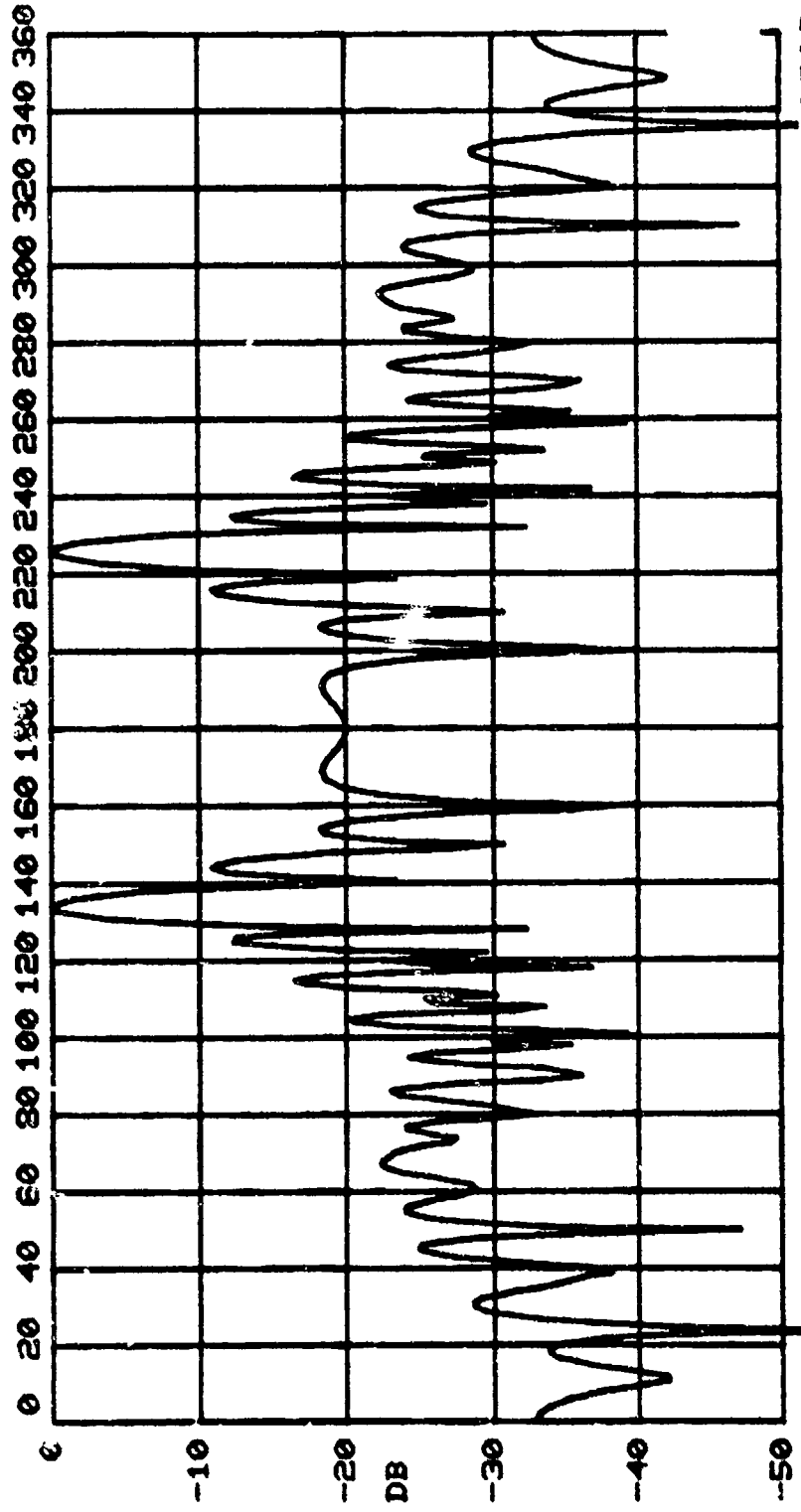
DATA POINT 5

1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.

140.0 HZ., 51 ELEMENTS, -0.18 DB MAX., AC:S3461, SU:S3461, WT:

90.0 DEG. VERT. RESP., 134.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

5.59 DEG. 3 DB BEAM, 14.21 DB AZ. GAIN, MAX. AT 134.0 DEG. HORIZ.



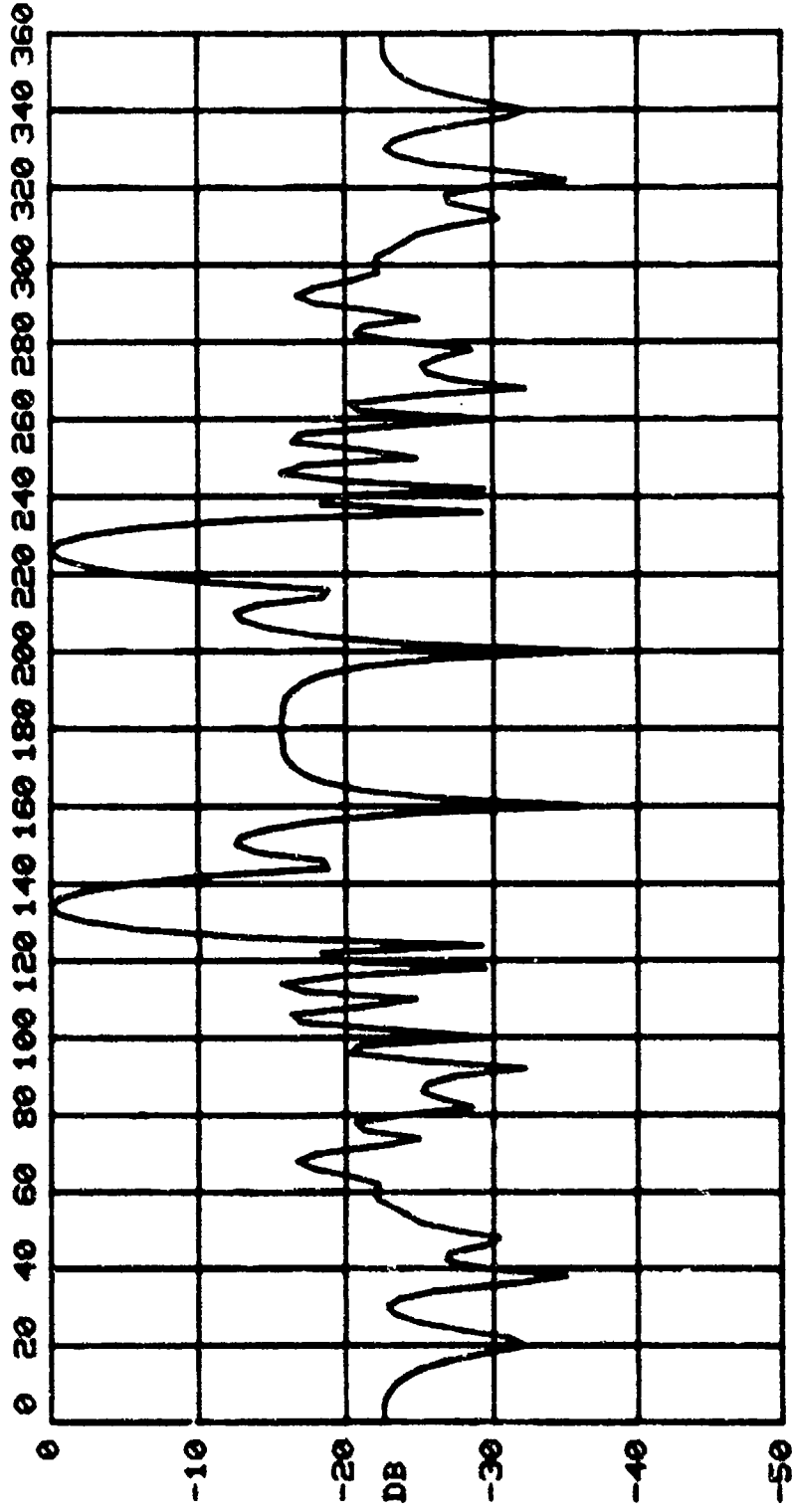
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Figure B-57 Theoretical Horizontal Plane Pattern for 5/ Element Array @ 140 Hz for Data Point 5, 49 Off Broadside Steering. Beamwidth 5.59°, Azimuth Gain 14.21 dB.

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53153 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 15-Mar-78 ONTLBP 3.1
6: SPRAY ARRAY TUNED TO 300 HZ.
9.3333 FT. UNIFORM SPACING.
9: SAME

DATA POINT 5
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 32 ELEMENTS, -0.19 DB MAX., AC:S3461, SU:S3461, WT:
90.0 DEG. VERT. RESP., 134.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
9.01 DEG. 3 DB BEAM, 12.24 DB AZ. GAIN, MAX. AT 134.0 DEG. HORIZ.



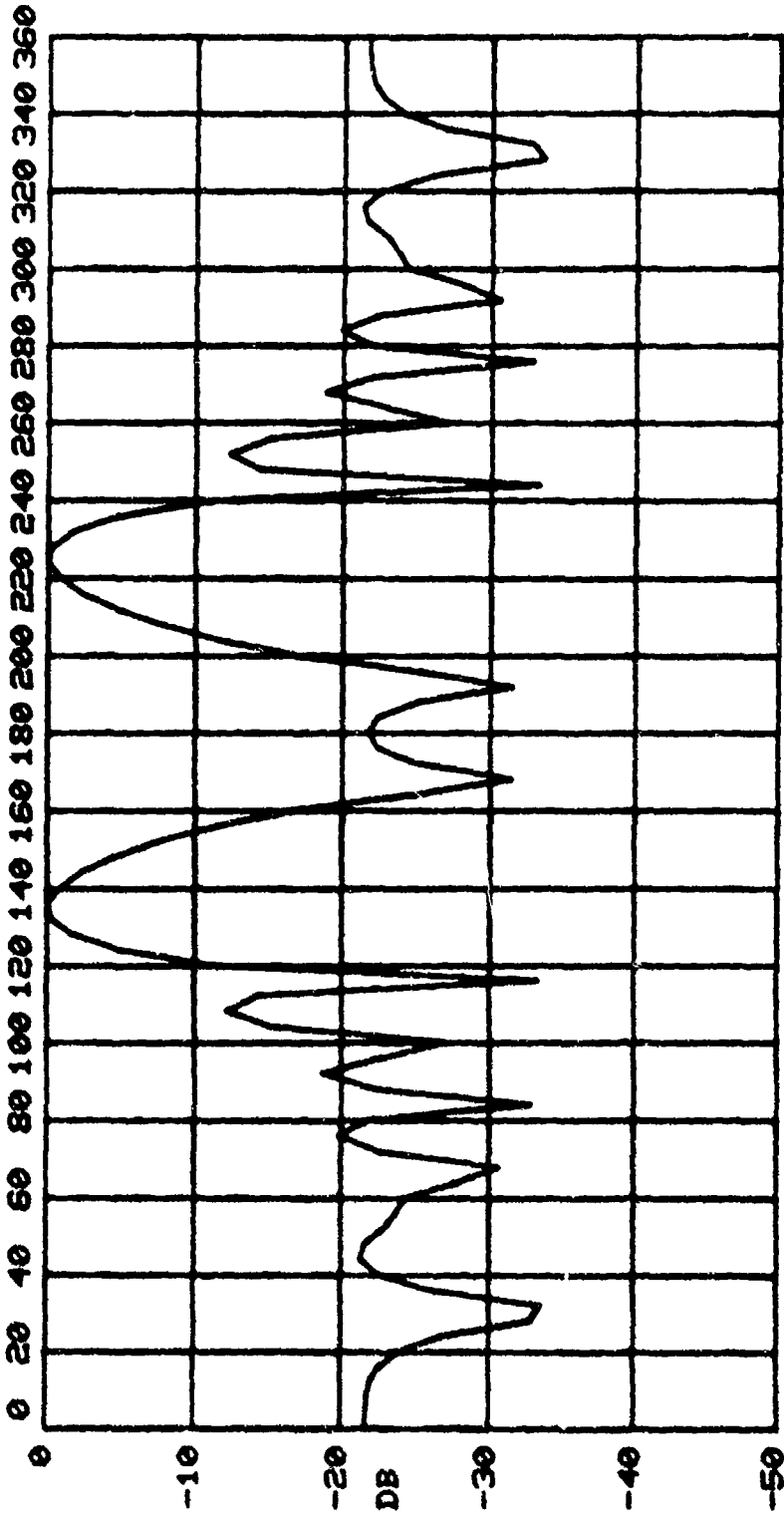
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Figure B-58 Theoretical Horizontal Plane Pattern for 32 Element Array @ 140 Hz for Data Point 5, 44° Off Broadside Steering. Beamwidth 9.01°, Azimuth Gain 12.2 dB.

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S3151 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 15-Mar-78 ONTLBP 3.1
N: SPODY ARRAY TUNED TO 300 HZ.
S: 3.333 FT. UNIFORM SPACING.
S: SAFE

DATA POINT 5
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 16 ELEMENTS, -0.20 DB MAX., AC:53461, SU:53461, UT:
90.0 DEG. VERT. RESP., 134.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
19.76 DEG. 3 DB BEAM, 9.20 DB AZ. GAIN, MAX. AT 136.0 DEG. HORIZ.



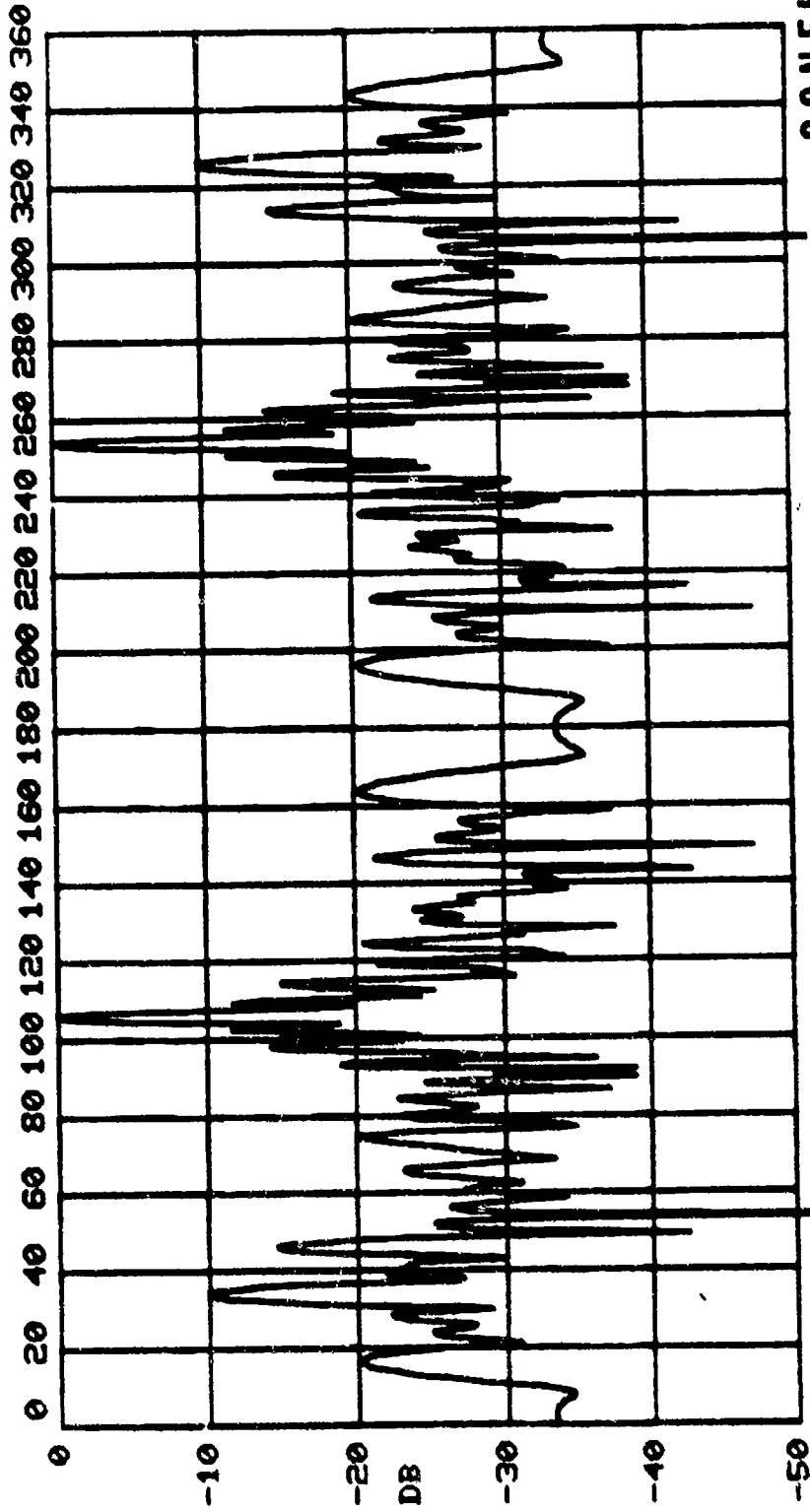
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Figure B-59 Theoretical Horizontal Plane Pattern for 16 Element
Array @ 140 Hz for Data Point 5, 48 Off Broadside
Steering. Beamwidth 19.76°, Azimuth Gain 9.2 dB.

CONFIDENTIAL

54026 SAIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
ARRAY TUNED TO 300 HZ.
2.1253 FT. UNIFORM SPACING.
SCALE

DATA POINT 6
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 51 ELEMENTS, -0.79 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 106.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
2.01 DEG. 3 DB BEAM, 17.49 DB AZ. GAIN, MAX. AT 106.0 DEG. HORIZ.



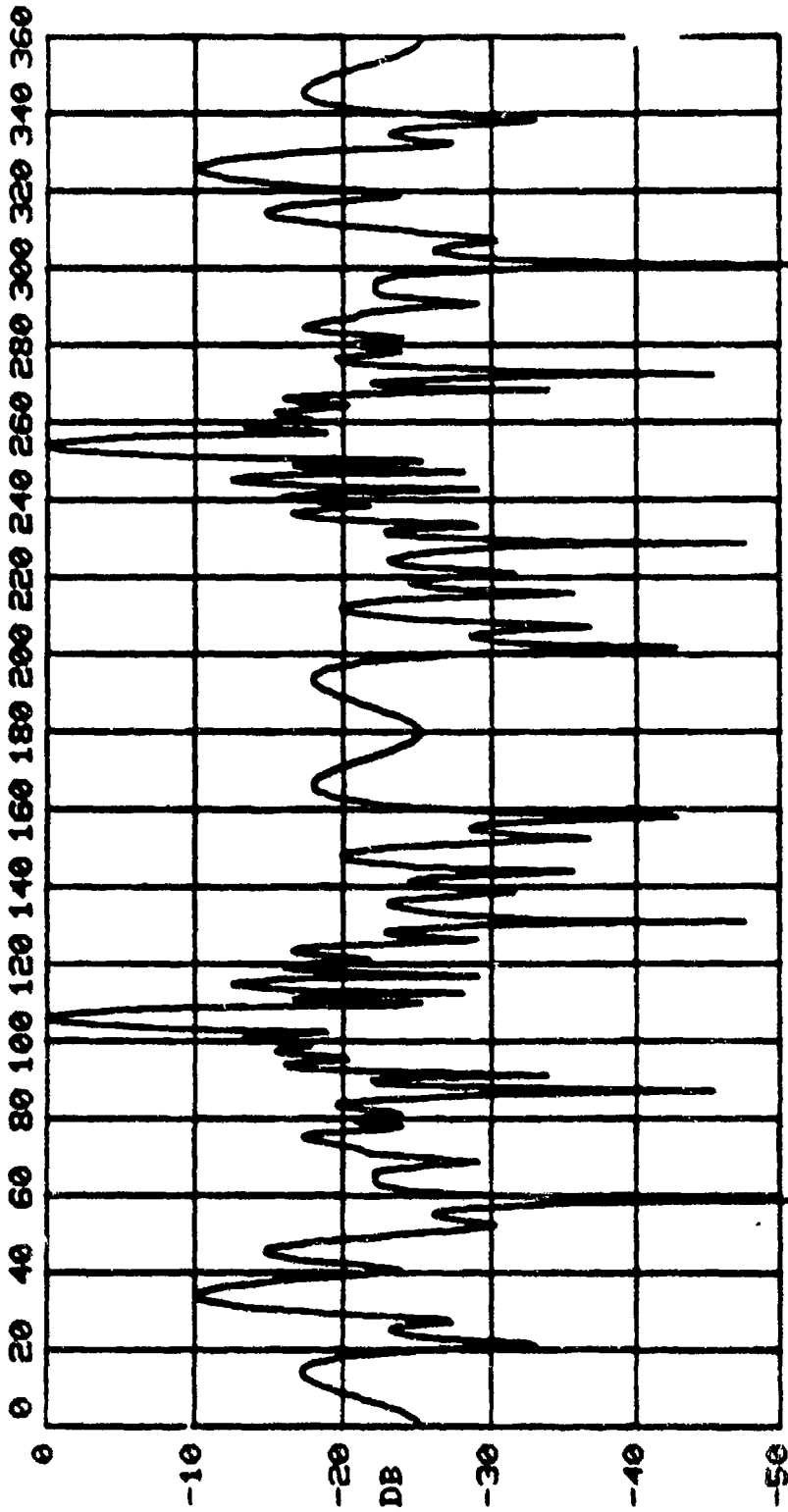
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Figure B-60 Theoretical Horizontal Plane Pattern for 51 Element Array @ 290 Hz for Data Point 6, 1/6 Off Broadside Steering. Beamwidth 2.01°, Azimuth Gain 17.4 dB.

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34024 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
: : ARRAY TUNED TO 300 HZ.
: : 3.1223 FT. UNIFORM SPACING.
: : 3.481E

DATA POINT 6
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
299.3 HZ., 32 ELEMENTS, -0.80 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 106.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.24 DEG. 3 DB BEAM, 15.34 DB AZ. GAIN, MAX. AT 106.0 DEG. HORIZ.



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Figure B-6/ Theoretical Horizontal Plane Pattern for 32 Element
Array @ 290 Hz for Data Point C, 16 Off Broadside
Steering. Beamwidth 3.24°, Azimuth Gain 15.3 dB.

CONFIDENTIAL

54212 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLEP 3.1
: ARRAY TUNED TO 300 HZ.
: 3.333 FT. UNIFORM SPACING.
: SAME

DATA POINT 6
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
250.0 HZ., 16 ELEMENTS, -0.61 DB MAX., AC: S2581, SU: S2581, UT:
90.0 DEG. VERT. RESP., 106.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.82 DEG. 3 DB BEAM, 12.53 DB AZ. GAIN, MAX. AT 105.0 DEG. HORIZ.

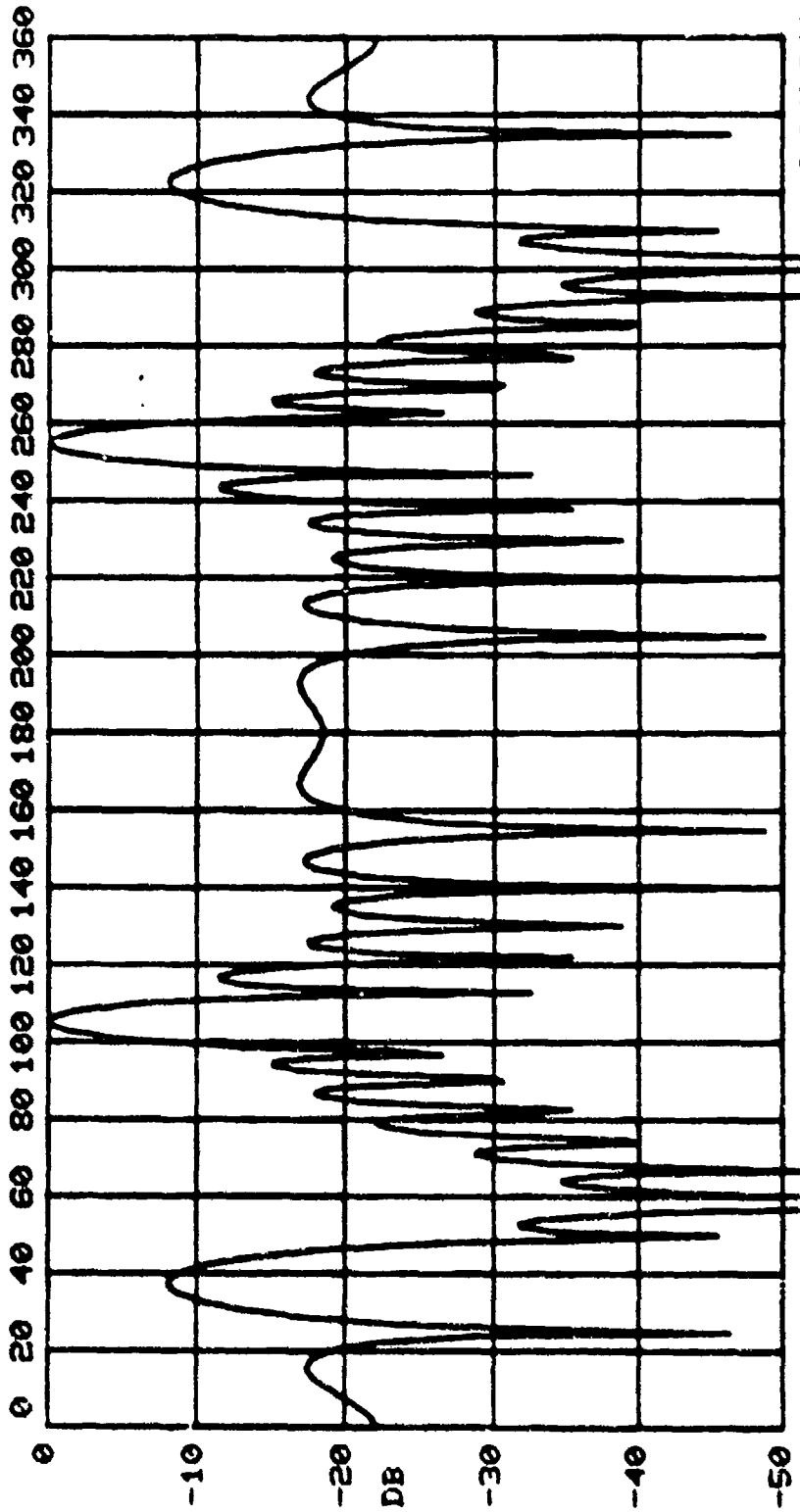


Figure B-62 Theoretical Horizontal Plane Pattern for 16 Element
array @ 240 Hz for Data Point 6, 1/6 Off Broadside
Steering. Beamwidth 6.82°, Azimuth Gain 12.5 dB.

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54035 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
ARRAY TUNED TO 300 HZ.
3.333 FT. UNIFORM SPACING.
SAME

DATA POINT 6
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
149.0 HZ., 51 ELEMENTS, -0.19 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 104.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.16 DEG. 3 DB BEAM, 15.50 DB AZ. GAIN, MAX. AT 256.0 DEG. HORIZ.

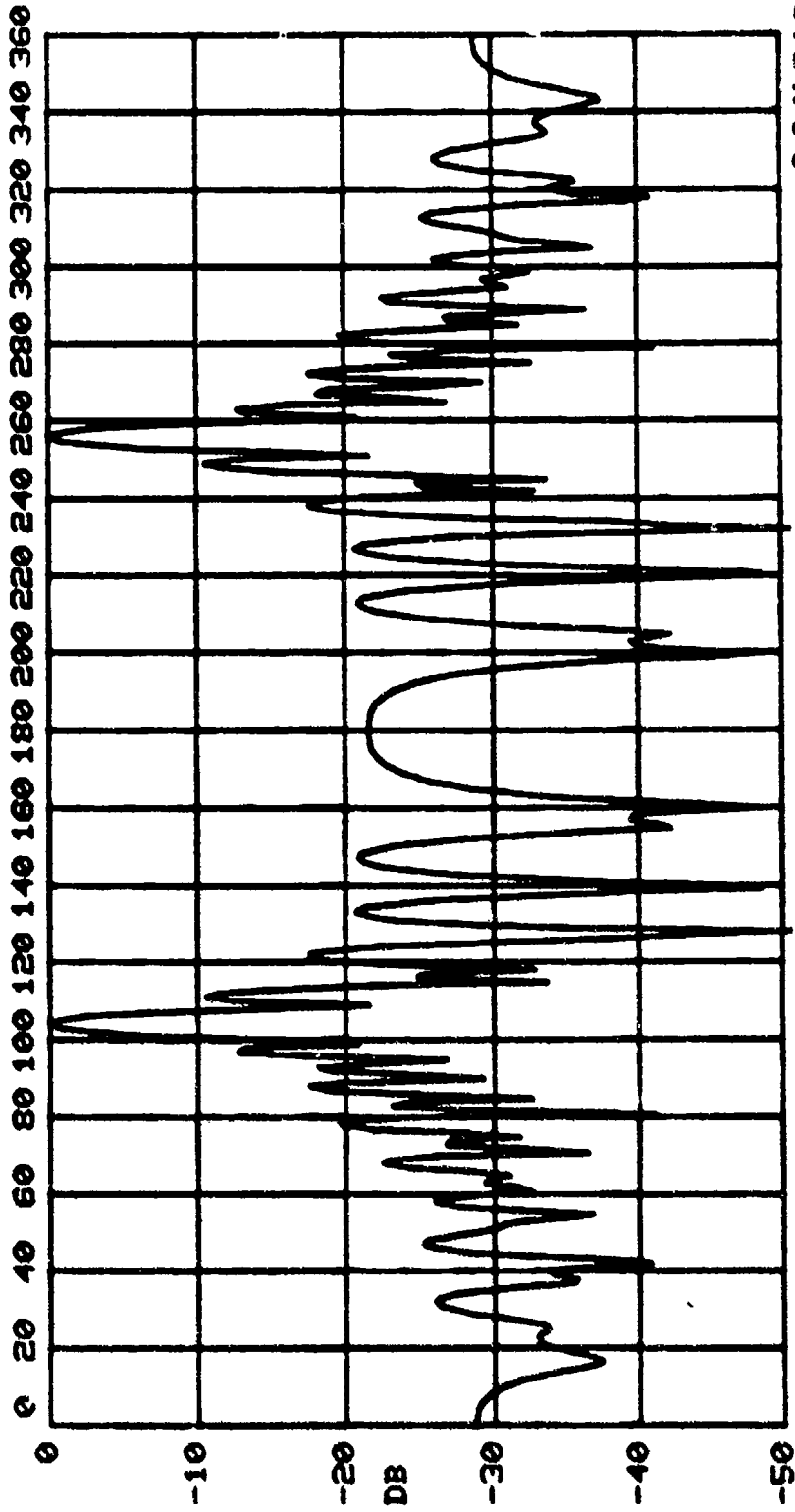


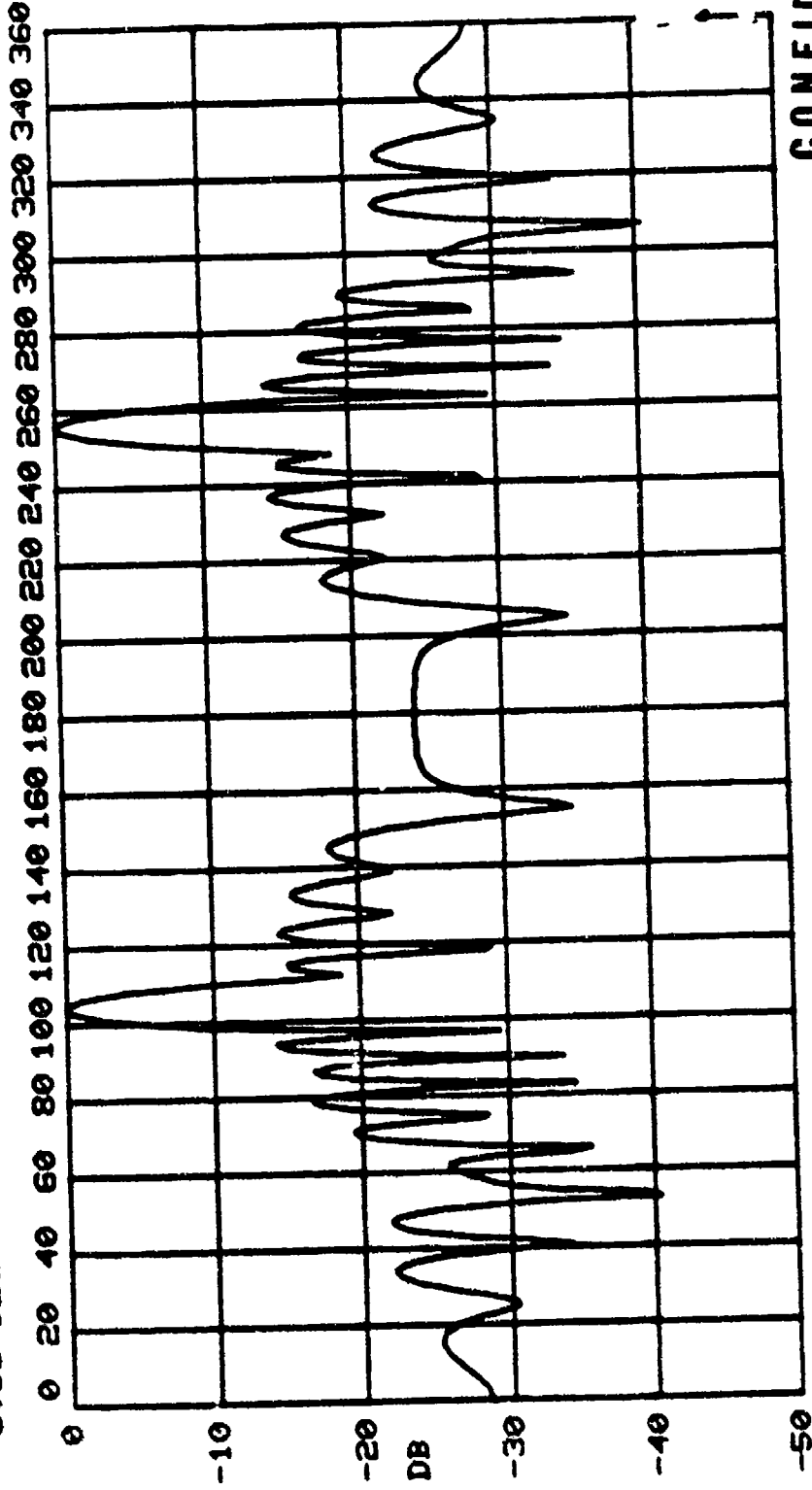
Figure B-63 Theoretical Horizontal Plane Pattern for 5 Element Array @ 140 Hz for Data Point 6, 1/4 Off Broadside Steering. Beamwidth 4.16°, Azimuth Gain 15.5 dB.

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54022 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLP 3.1
1: 37047 ARRAY TUNED TO 300 HZ.
2: 5.2223 FT. UNIFORM SPACING.
3: SAME

DATA POINT 6
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 32 ELEMENTS, -0.19 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 104.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.66 DEG. 3 DB BEAM, 13.49 DB AZ. GAIN, MAX. AT 256.0 DEG. HORIZ.



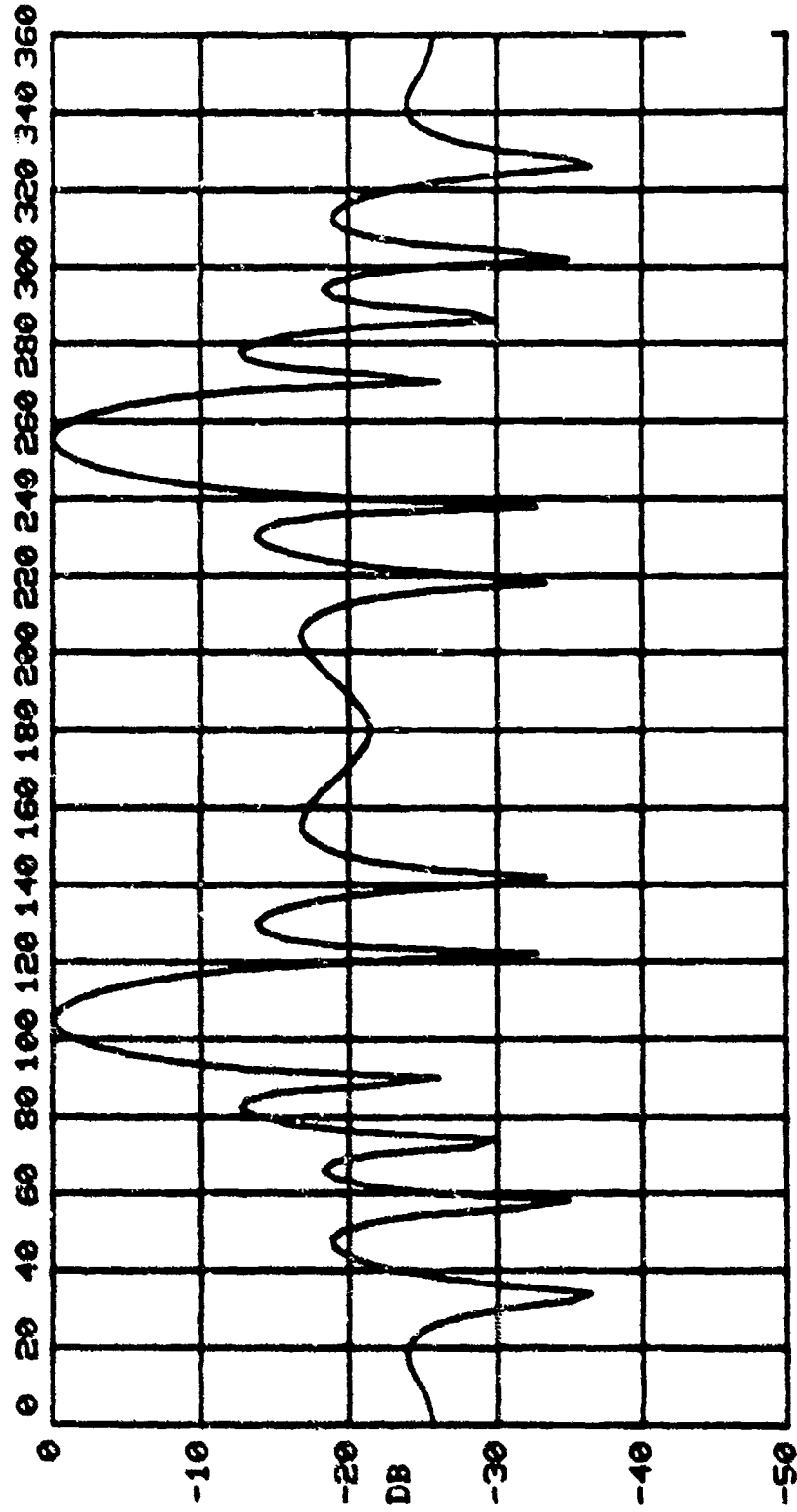
CONFIDENTIAL

Figure B-64 Theoretical Horizontal Plane Pattern for 32 Element Array @ 140 Hz for Data Point 6, 1/4 Off Broadside Steering. Beamwidth 6.66°, Azimuth Gain 13.4 dB.

CONFIDENTIAL

54021 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBF 3.1
** 5529: ARRAY TURNED TO 300 HZ.
3.3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 6
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 16 ELEMENTS, -0.17 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 104.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
14.17 DEG. 3 DB BEAM, 10.45 DB AZ. GAIN, MAX. AT 256.0 DEG. HORIZ.



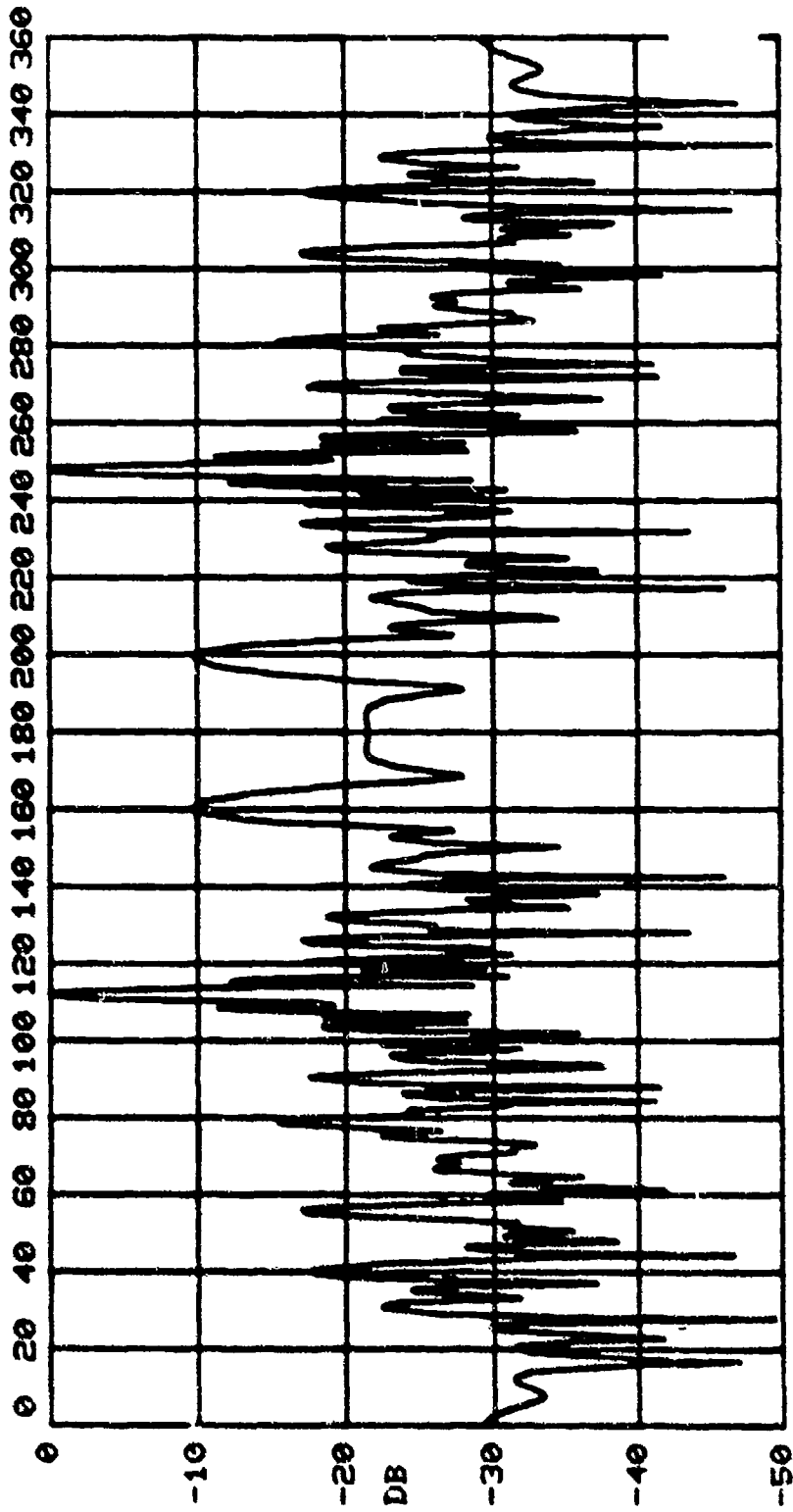
CONFIDENTIAL

Figure B-65 Theoretical Horizontal Plane Pattern for 16 Element Array @ 140 Hz for Data Point 6, 14 Steering. Beamwidth 14.17°, Azimuth Gain 10.4 dB.

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SAUNDERS BEAM PATTERN PROGRAM (T. HOGAN) 5-Apr-76 ONTLBP 3.1
ARRAY: WPA: TUNED TO 300 HZ.
ELEMENTS: 51 UNIFORM SPACING.
ELEMENT SPACING: 2.1223 FT.

DATA POINT 7
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
200.0 HZ., 51 ELEMENTS, -0.79 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 112.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
2.10 DEG. 3 DB BEAM, 17.06 DB AZ. GAIN, MAX. AT 112.0 DEG. HORIZ.



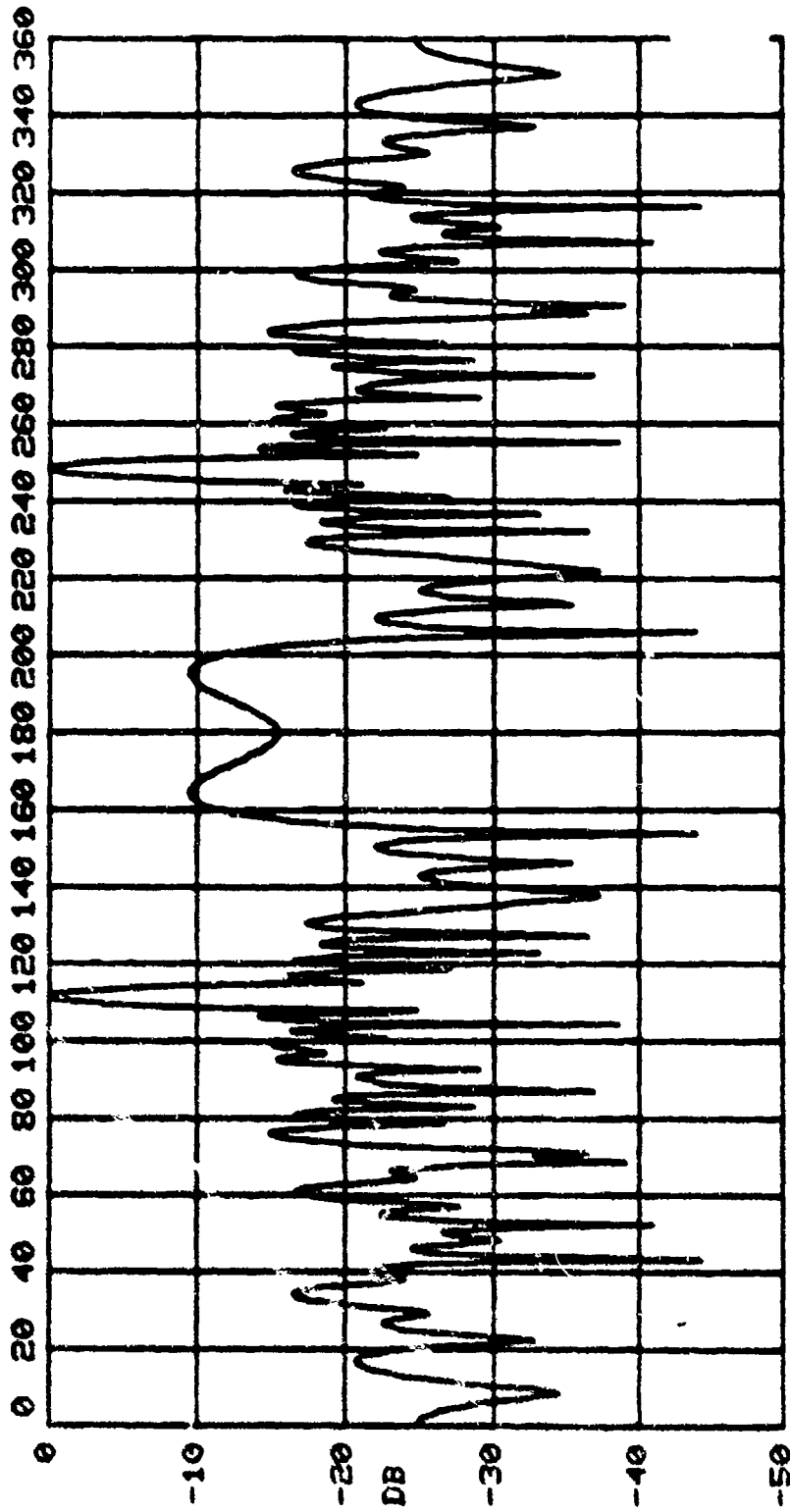
CONFIDENTIAL

Figure B-44 Theoretical Horizontal Plane Pattern for 51 Element Array @ 290 Hz for Data Point 7, 22 Off Broadside Steering. Beamwidth 2.10°, Azimuth Gain 17.0 dB.

CONFIDENTIAL

SAUNDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
ARRAY TUNED TO 300 HZ.
3.36 FT. UNIFORM SPACING.
END

DATA POINT 7
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 32 ELEMENTS, -0.81 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 111.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.36 DEG. 3 DB BEAM, 14.70 DB AZ. GAIN, MAX. AT 111.5 DEG. HORIZ.



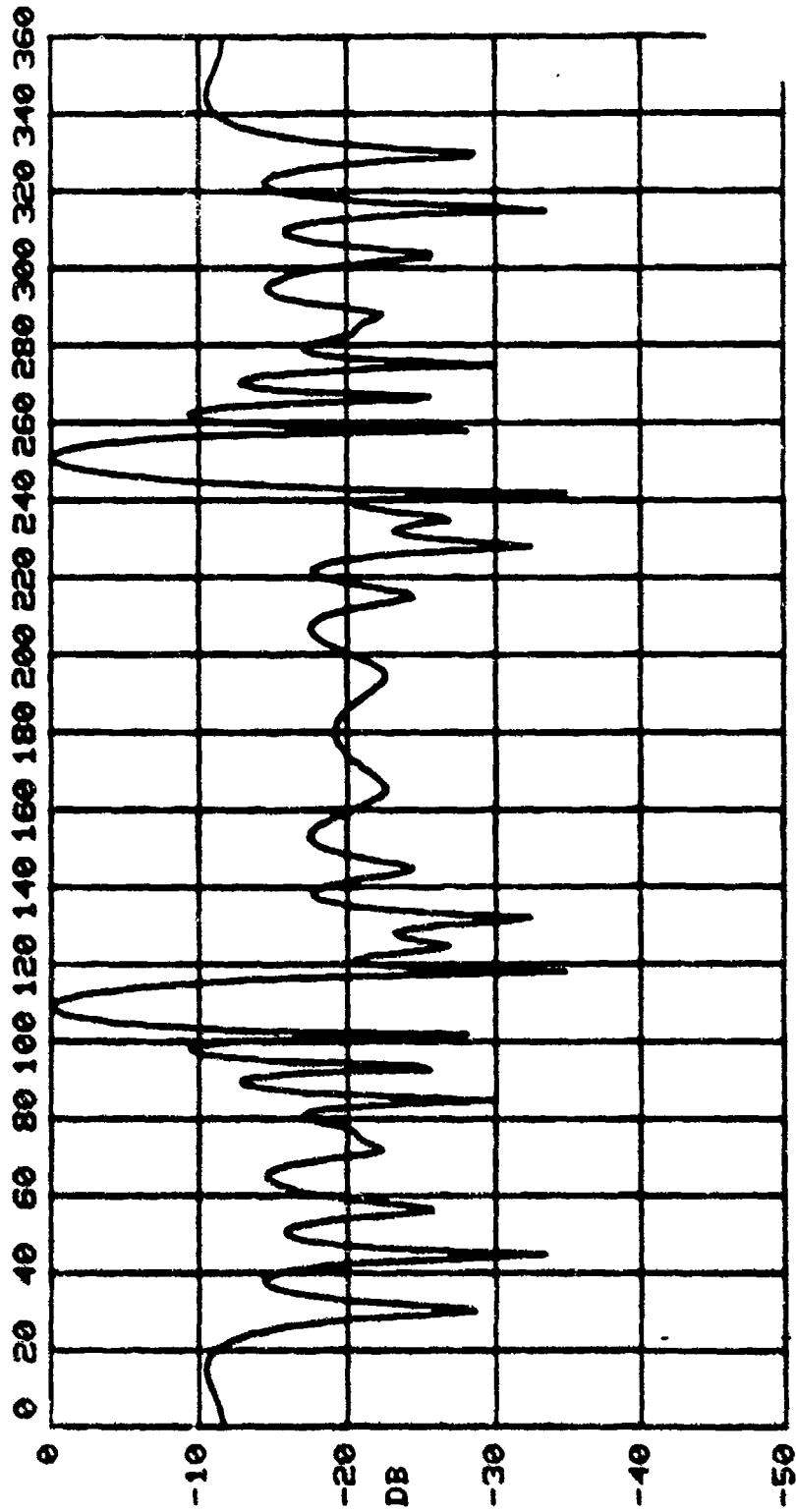
CONFIDENTIAL

Figure B-67 Theoretical Horizontal Plane Pattern for 32 Element Array @ 290 Hz for Data Point 7, 21.5 Off Broadside Steering. Beamwidth 3.36°, Azimuth Gain 14.7 dB.

CONFIDENTIAL

44222 SAUNDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLBP 3.1
ARRAY WPT: TUNED TO 300 HZ.
1.2323 FT. UNIFORM SPACING.
SCALE

DATA POINT 7
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
230.0 HZ., 16 ELEMENTS, -0.84 DB MAX., AC: S2581, SU: S2581, UT:
90.0 DEG. VERT. RESP., 109.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
7.01 DEG. 3 DB BEAM, 12.04 DB AZ. GAIN, MAX. AT 109.0 DEG. HORIZ.



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Figure B-68 Theoretical Horizontal Plane Pattern for 16 Element
Array at 290 Hz for Data Point 7, 19 Off Broadside
Steering. Beamwidth 7.0°, Azimuth Gain 12.0 dB.

CONFIDENTIAL

54020 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 QNTLBF 3.1
: 50000 ARRAN: TUNED TO 300 HZ.
: 50000 FT. UNIFORM SPACING.
: SAFE

DATA POINT 7
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ. 51 ELEMENTS, -0.18 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 126.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.98 DEG. 3 DB BEAM, 14.73 DB AZ. GAIN, MAX. AT 126.0 DEG. HORIZ.

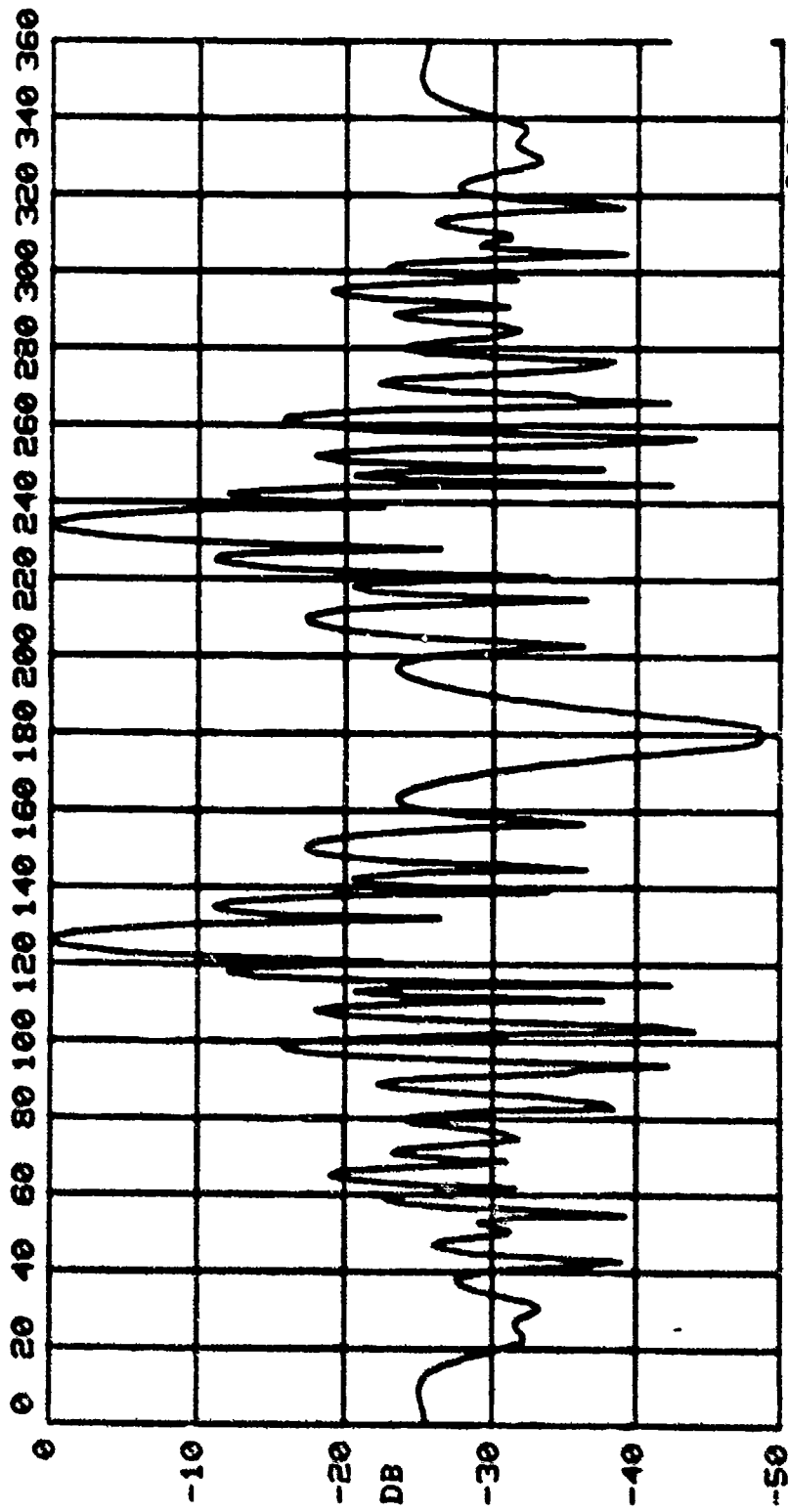


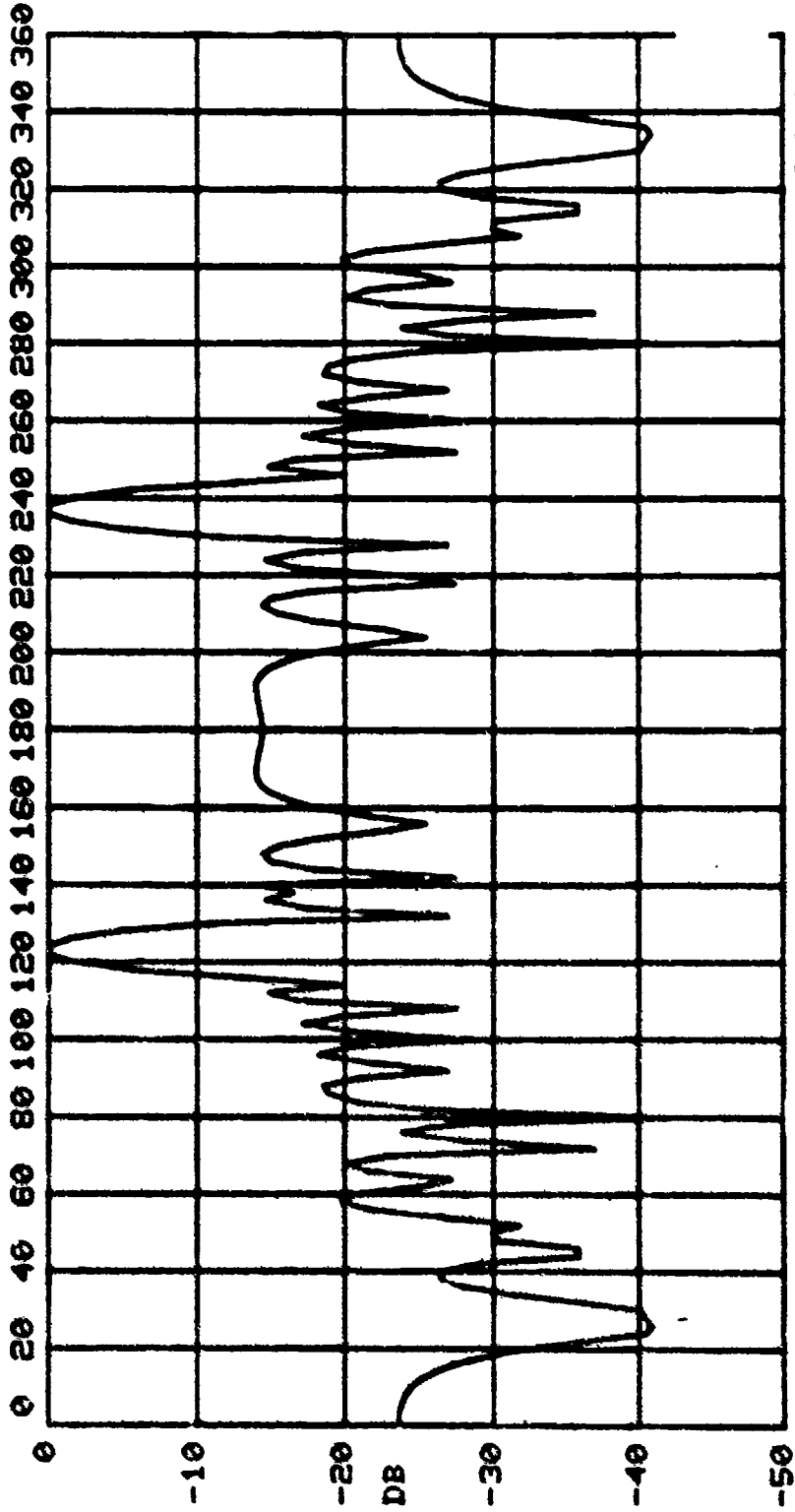
Figure B-69 Theoretical Horizontal Plane Pattern for 51 Element
Array @ 140 Hz for Data Point 7, 36 Off Broadside
Steering. Beamwidth 4.98°, Azimuth Gain 14.7 dB.

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54024 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
ARRAY TUNED TO 300 HZ.
3.2233 FT. UNIFORM SPACING.
SCALE

DATA POINT 7
1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 32 ELEMENTS, -0.35 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 123.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
7.99 DEG. 3 DB BEAM, 12.55 DB AZ. GPIN, MAX. AT 122.0 DEG. HORIZ.



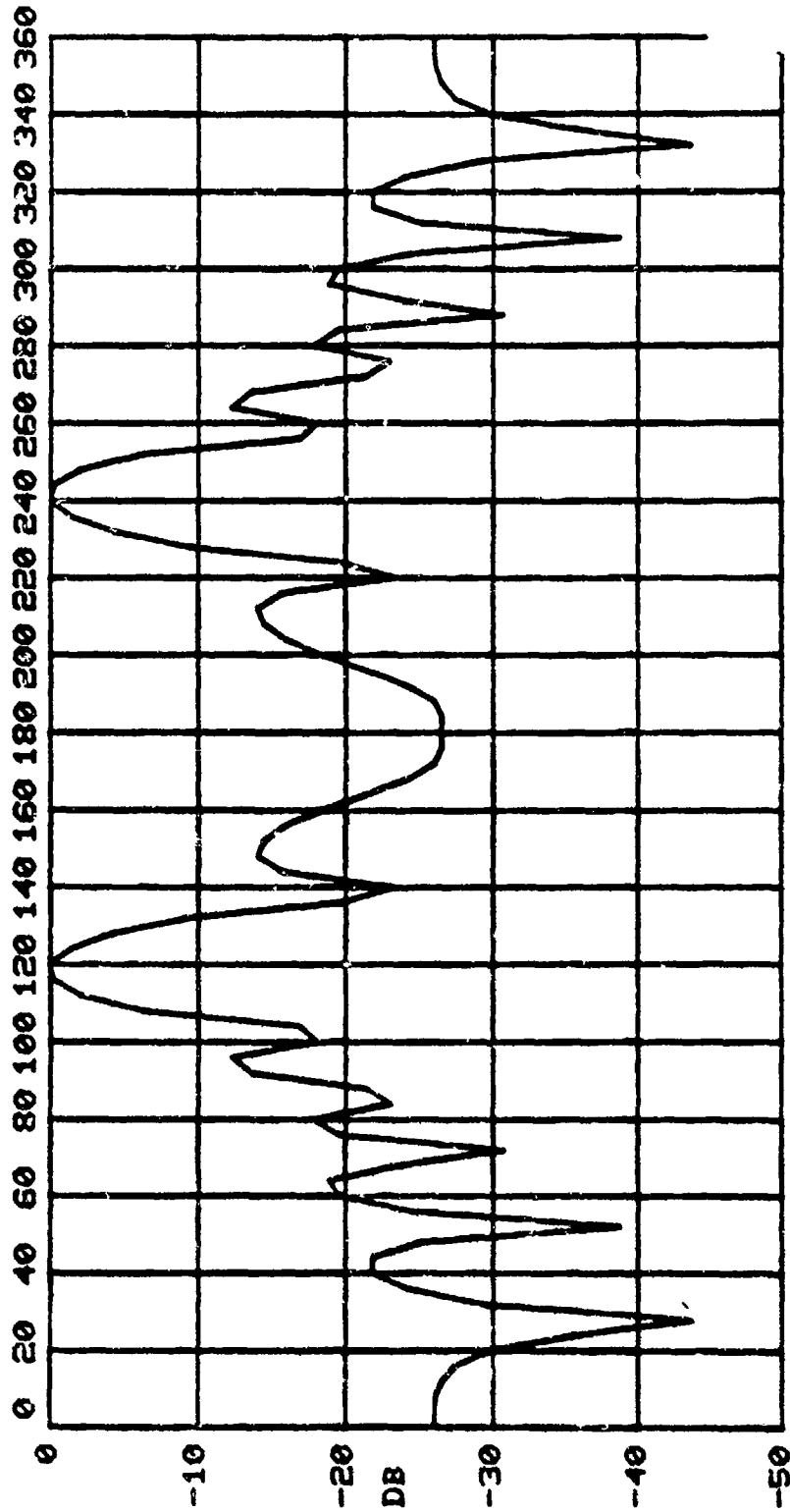
CONFIDENTIAL

Figure 8-70 Theoretical Horizontal Plane Pattern for 32 Element Array @ 140 Hz for Data Point 7, 33 Off Broadside Steering. Beamwidth 7.99°, Azimuth Gain 12.5 dB.

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64027 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLBP 3.1
A: ARRAY TUNED TO 300 HZ.
B: 3.223 FT. UNIFORM SPACING.
C: SAME

DATA POINT 7
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 16 ELEMENTS, -0.17 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 118.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
15.98 DEG. 3 DB BEAM, 10.00 DB AZ. GAIN, MAX. AT 120.0 DEG. HORIZ.



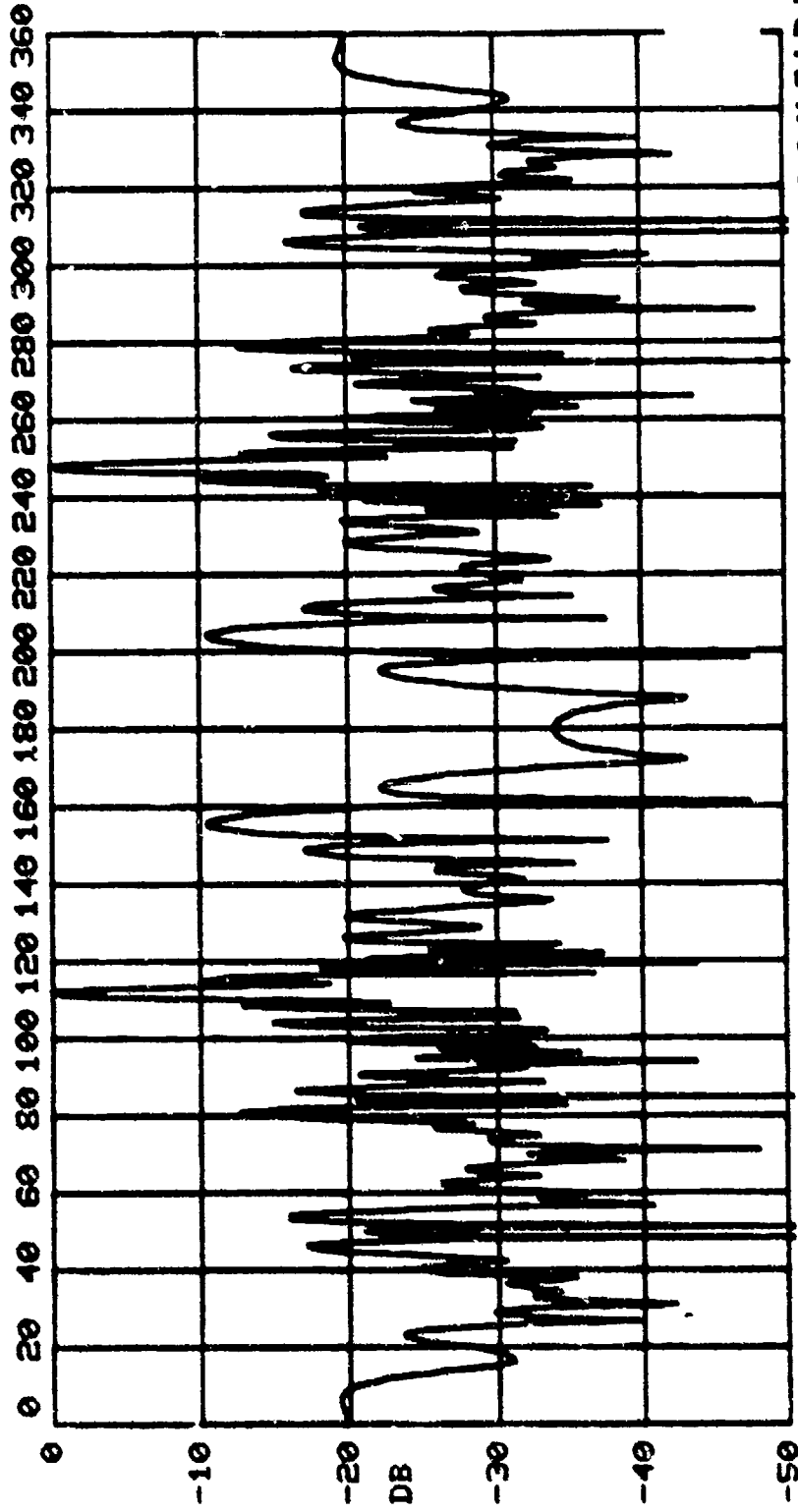
CONFIDENTIAL

Figure B-7/ Theoretical Horizontal Plane Pattern for 16 Element Array @ 140 Hz for Data Point 7, 28 Off Broadside Steering. Beamwidth 15.98°, Azimuth Gain 10.0 dB.

CONFIDENTIAL

SAUNDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
ARRAY TUNED TO 300 HZ.
UNIFORM SPACING.

DATA POINT 7
1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
51 ELEMENTS, -0.89 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 112.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
2.06 DEG. 3 DB BEAM, 17.17 DB AZ. GAIN, MAX. AT 248.0 DEG. HORIZ.



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Figure B-7a Theoretical Horizontal Plane Pattern for 51 Element Array @ 295 Hz for Data Point 7, 2.2 Off Broadside Steering. Beamwidth 2.06°, Azimuth Gain 17.1 dB.

CONFIDENTIAL

3-20-73 SAIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLBP 3.1
... 3-20-73 ARRAY TUNED TO 300 HZ.
... 3-20-73 3 FT. UNIFORM SPACING.
... 3-20-73

DATA POINT 7
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ., 32 ELEMENTS, -0.78 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 111.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.27 DEG. 3 DB BEAM, 15.12 DB AZ. GAIN, MAX. AT 111.5 DEG. HORIZ.

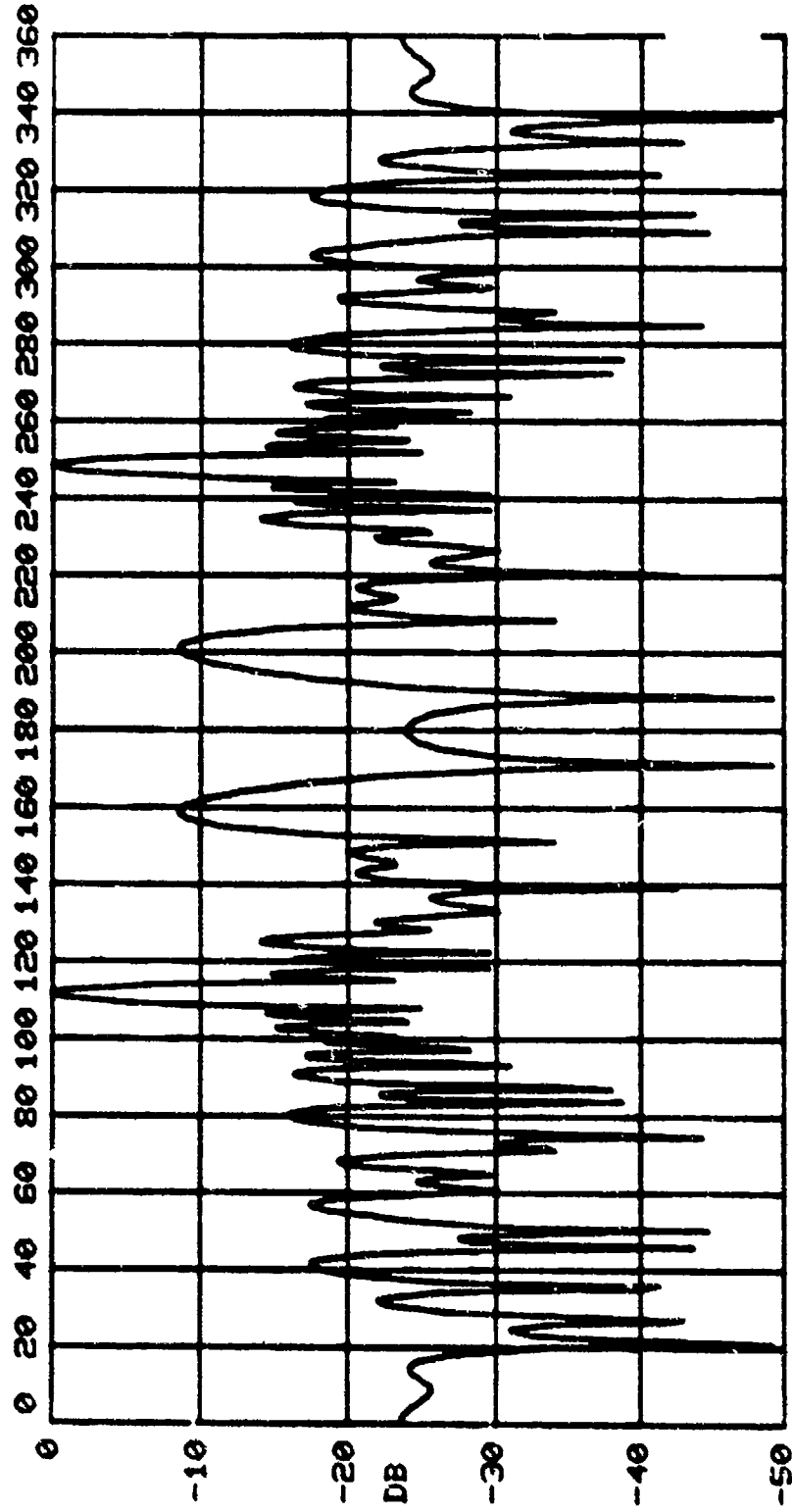


Figure B-73 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 295 Hz for Data Point 7, 2/5 Off Broadside
Steering. Beamwidth 3.27°, Azimuth Gain 15.1 dB.

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54029 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
ARRAY (GRAY) TUNED TO 300 HZ.
3.3220 FT. UNIFORM SPACING.
: SAME

DATA POINT 7
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ., 16 ELEMENTS, -0.85 DB MAX., AC:S2581, SU:S2581, WT:
90.0 DEG. VERT. RESP., 109.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.82 DEG. 3 DB BEAM, 11.73 DB AZ. GAIN, MAX. AT 109.0 DEG. HORIZ.

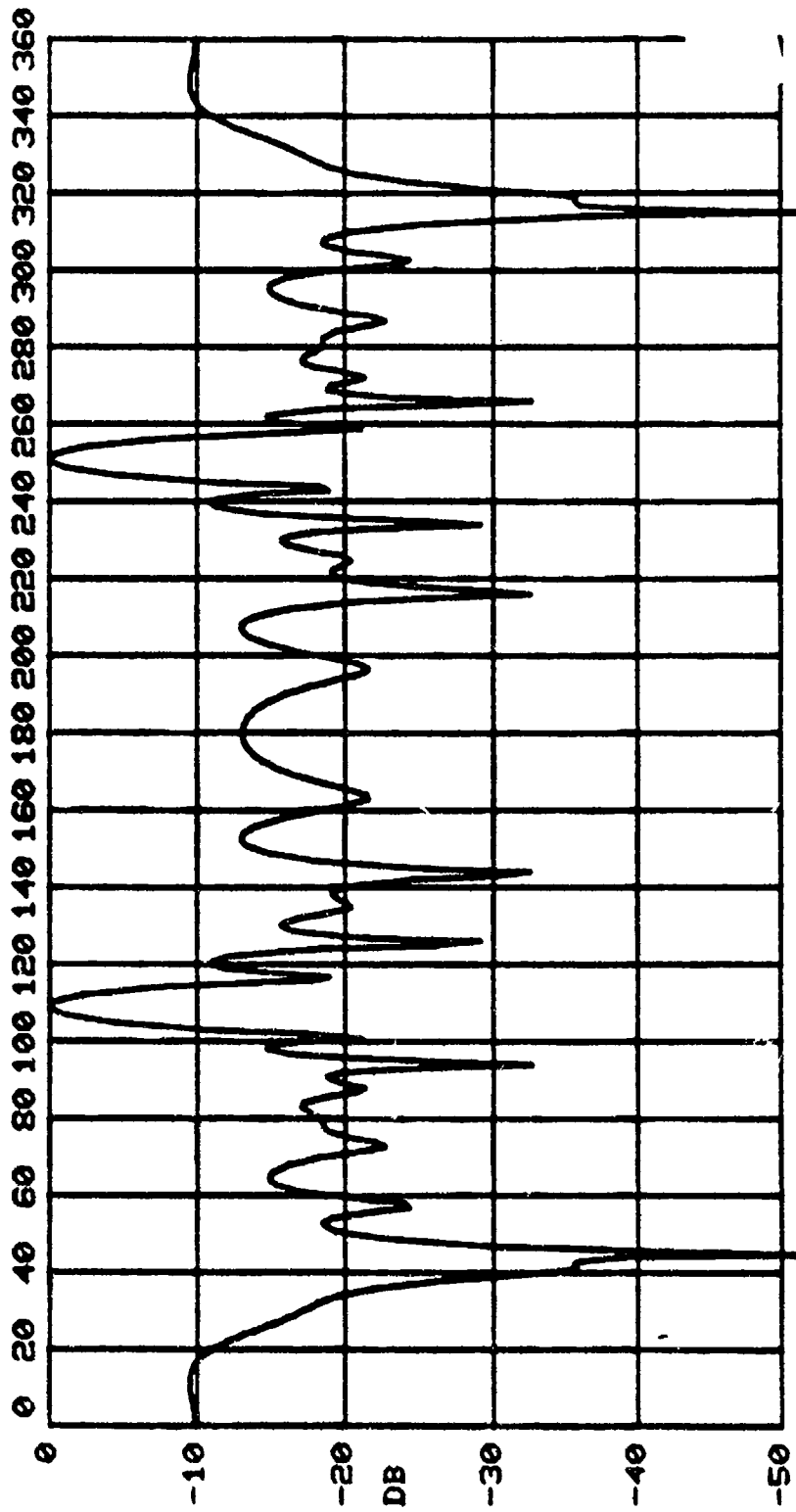
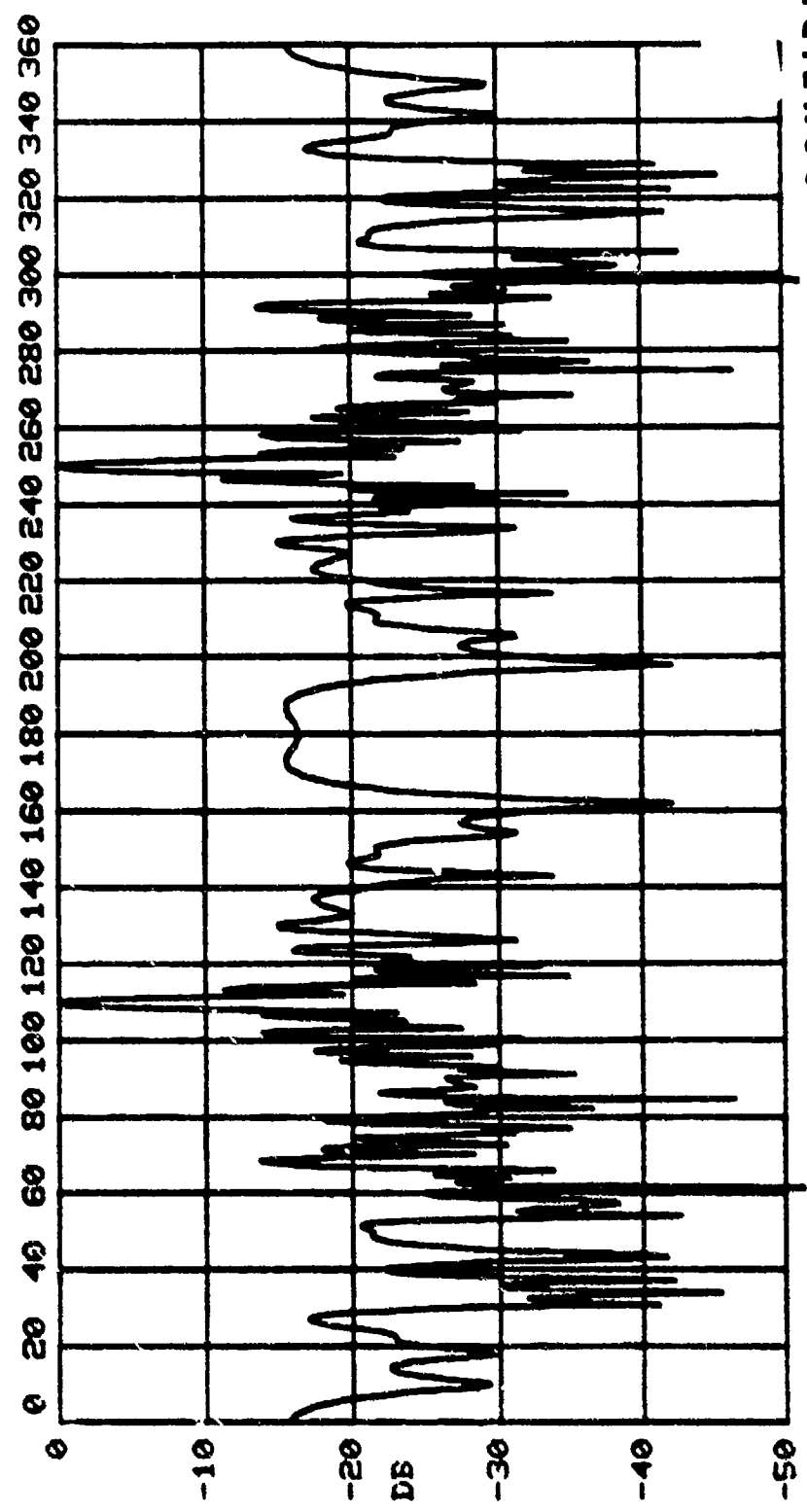


Figure B-74 Theoretical Horizontal Plane Pattern for 16 Element
Array @ 295 Hz for Data Point 7, 19 Off Broadside
Steering. Beamwidth 6.82°, Azimuth Gain 11.7 dB.

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DATA POINT 3
 1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
 290.0 HZ., 48 ELEMENTS, -0.86 DB MAX., AC:54343, SU:54343, JT:
 90.0 DEG. VERT. RESP., 110.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
 2.09 DEG. 3 DB BEAM, 16.92 DB AZ. GAIN, MAX. AT 110.0 DEG. HORIZ.



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Figure B-75 Theoretical Horizontal Plane Pattern for 48 Element
 Array @ 290 Hz for Data Point 3, 20 Off Broadside
 Steering. Beamwidth 2.09°, Azimuth Gain 16.92 dB.

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SAWYER SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLBP 3.1
ARRAY: ARRA. TUNED TO 300 HZ.
ELEMENTS: 32. UNIFORM SPACING
SITE

DATA POINT 8
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 32 ELEMENTS, -0.86 DB MAX., AC:54342, SU:54342, WT:
90.0 DEG. VERT. RESP., 110.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.30 DEG. 3 DB BEAM, 15.22 DB AZ. GAIN, MAX. AT 110.0 DEG. HORIZ.

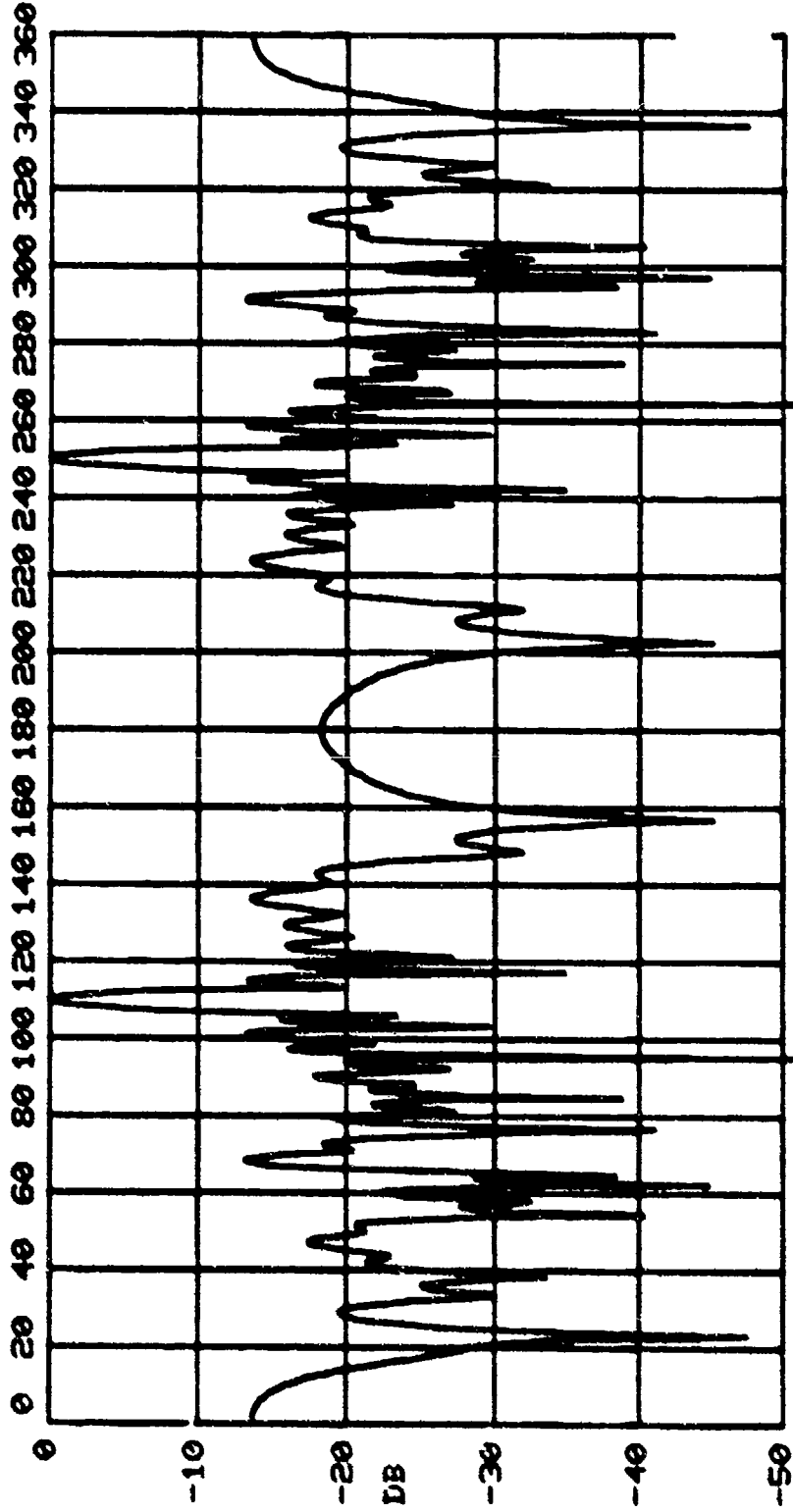


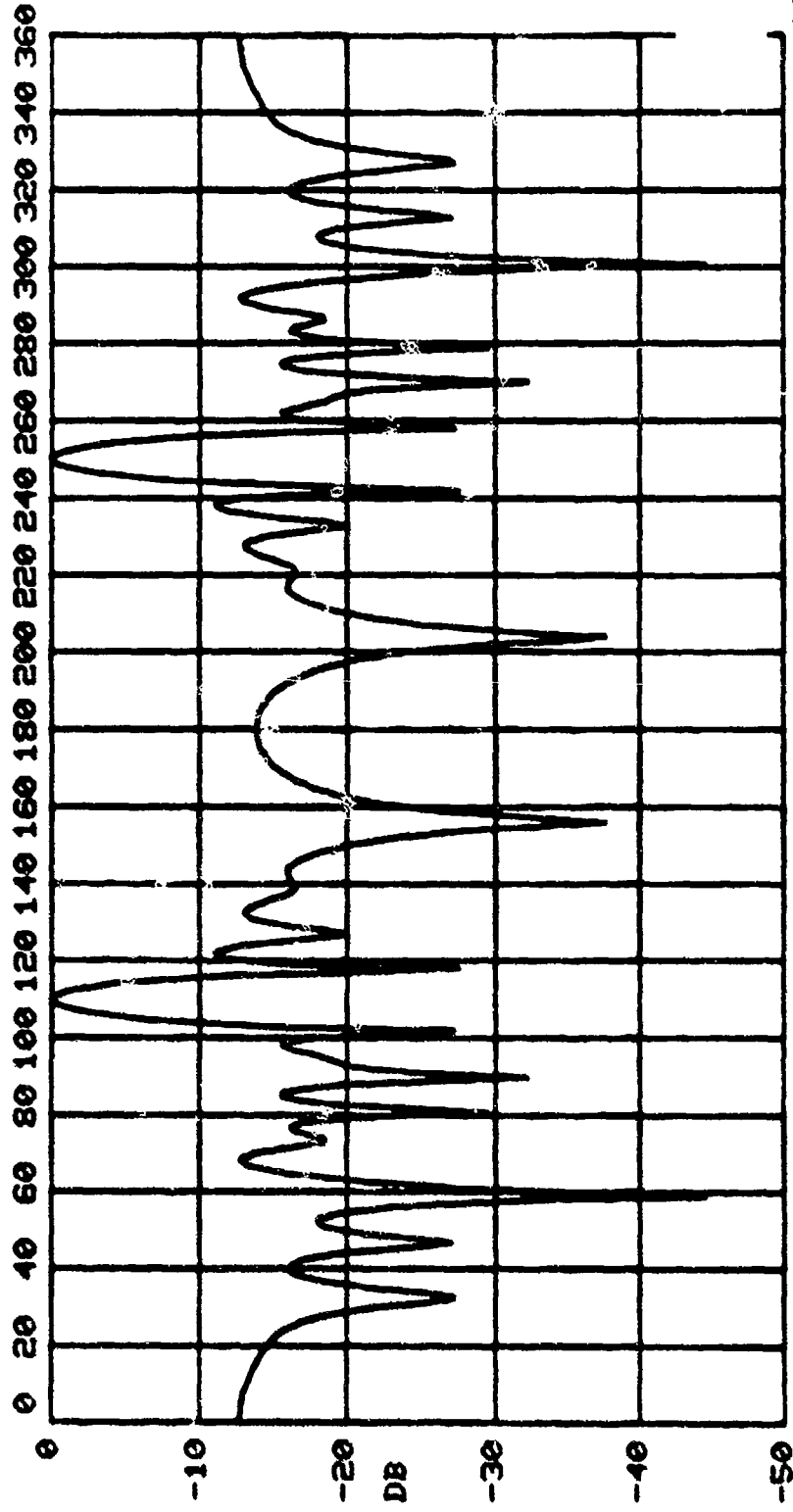
Figure E-76 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 290 Hz for Data Point 8, 20 Off Broadside
Steering. Beamwidth 3.30°, Azimuth Gain 15.22 dB.

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54024 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
ARRAY TUNED TO 300 HZ.
2.0223 FT. UNIFORM SPACING
DATE

DATA POINT 8
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 16 ELEMENTS, -0.85 DB MAX., AC:54341, SU:54341, WT:
90.0 DEG. VERT. RESP., 110.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
7.06 DEG. 3 DB BEAM, 12.12 DB AZ. GAIN, MAX. AT 110.0 DEG. HORIZ.



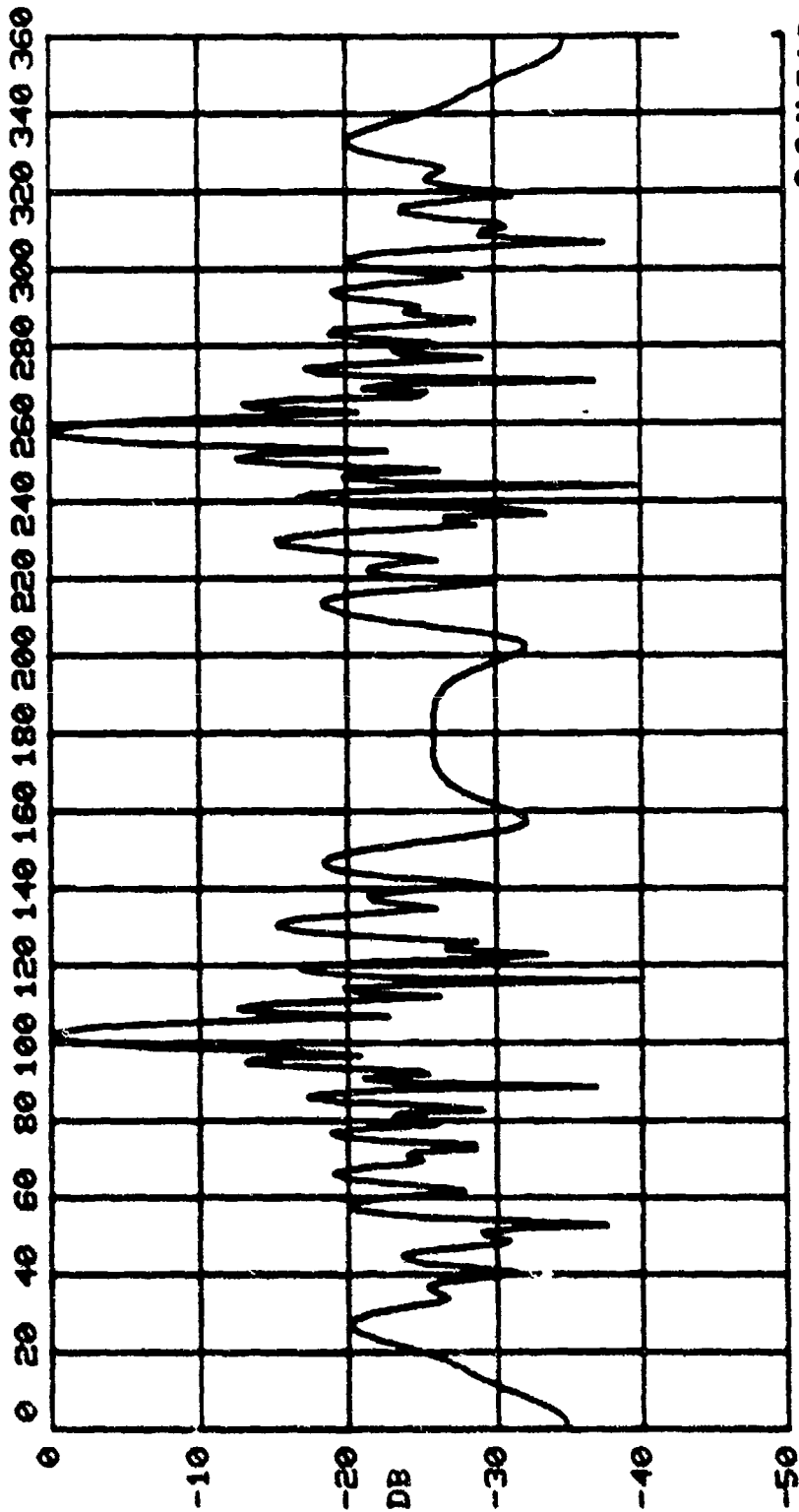
CONFIDENTIAL

Figure 2-77 Theoretical Horizontal Plane Pattern for 16 Element Array @ 290 Hz for Data Point 8, 20 Off Broadside Steering. Beamwidth 7.06°, Azimuth Gain 2.1 dB.

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SAUNDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLBP 3.1
ARRAY APPAR. TUNED TO 300 HZ.
3.2223 FT. UNIFORM SPACING
: SAME

DATA POINT 8
1.000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 48 ELEMENTS, -0.18 DB MAX., AC:54343, SU:54343, WT:
90.0 DEG. VERT. RESP., 102.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.16 DEG. 3 DB BEAM, 15.30 DB AZ. GAIN, MAX. AT 102.0 DEG. HORIZ.



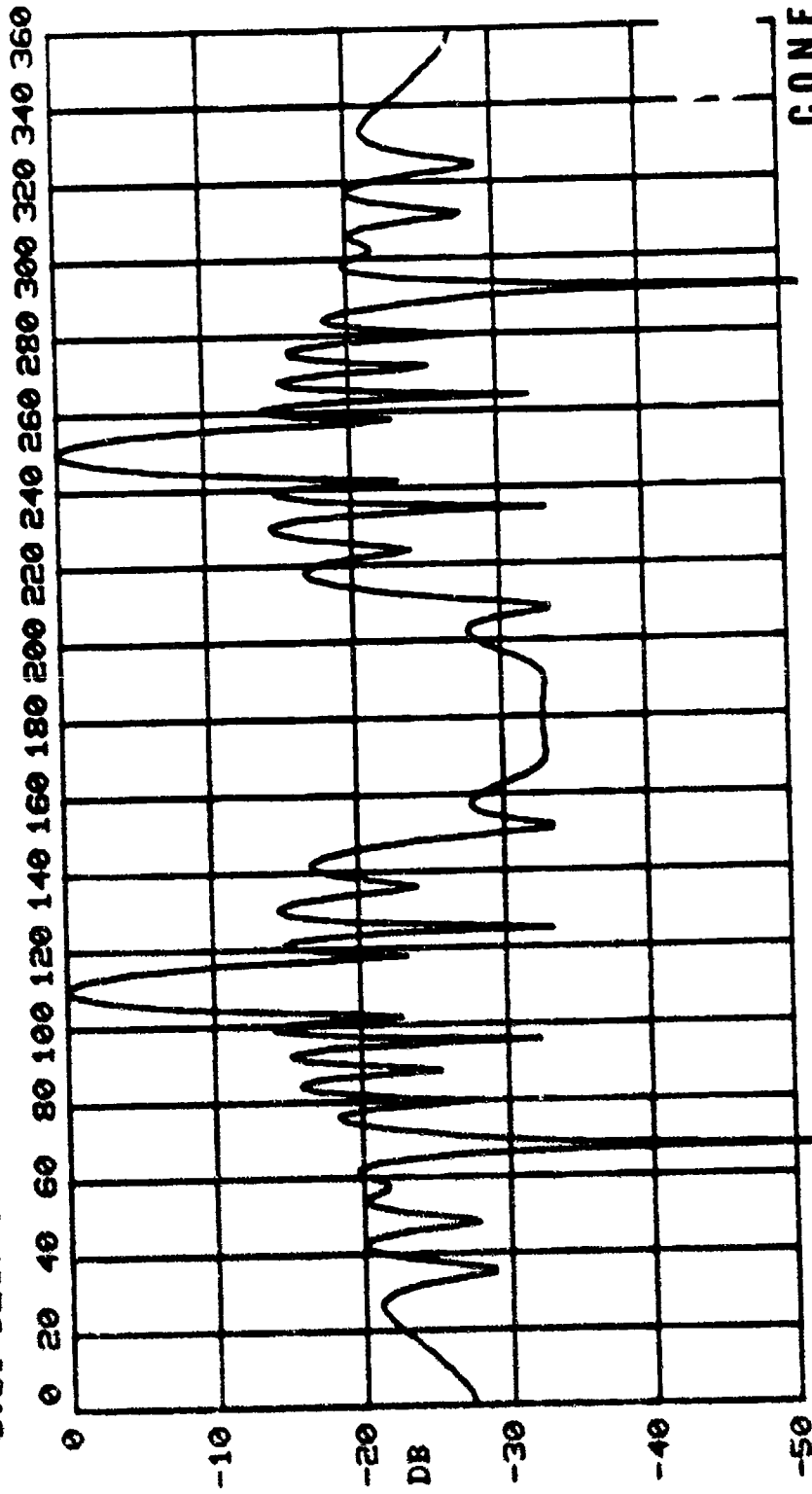
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Figure B-78 Theoretical Horizontal Plane Pattern for 48 Element Array @ 140 Hz for Data Point 8, 1/2 Off Broadside Steering. Beamwidth 4.16°, Azimuth Gain 15.3 dB.

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S412J SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
ARRAY TUNED TO 300 HZ.
2.023 FT. UNIFORM SPACING
S41E

DATA POINT 8
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 32 ELEMENTS, -0.18 DB MAX., AC:S4342, SU:S4342, WT:
90.0 DEG. VERT. RESP., 110.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.81 DEG. 3 DB BEAM, 13.36 DB AZ. GAIN, MAX. AT 110.0 DEG. HORIZ.



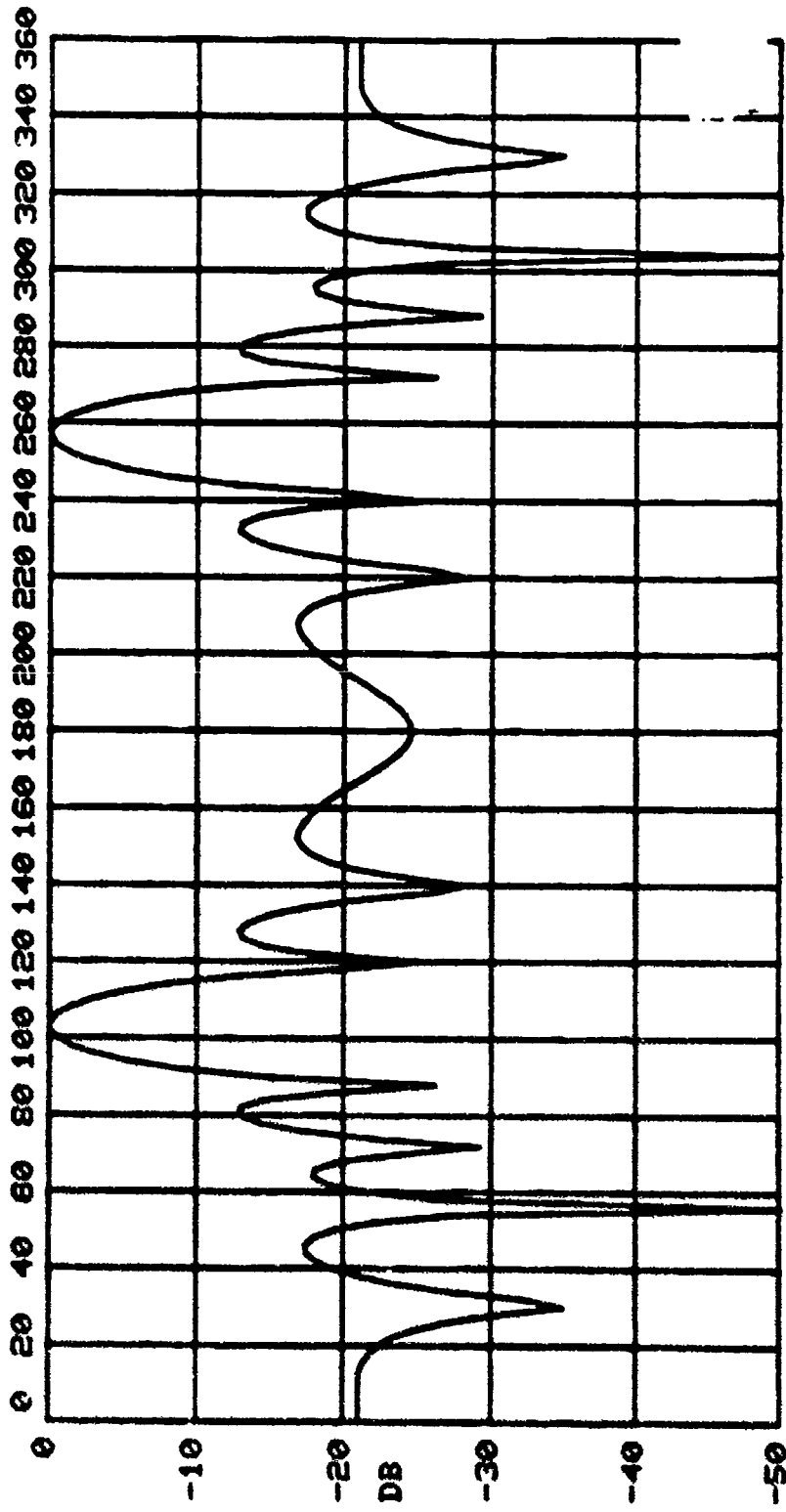
CONFIDENTIAL

Figure B-79 Theoretical Horizontal Plane Pattern for 32 Element Array @ 140 Hz for Data Point 8, 20 Off Broadside Steering. Beamwidth 6.81°, Azimuth Gain 13.3 dB.

CONFIDENTIAL

54020 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLEP 3.1
ARRAY TUNED TO 300 HZ.
S. 2231 FT. UNIFORM SPACING
DATE

DATA POINT 8
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 15 ELEMENTS, -0.22 DB MAX., AC:54341, SU:54341, WT:
90.0 DEG. VERT. RESP., 103.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
14.07 DEG. 3 DB BEAM, 10.40 DB AZ. GAIN, MAX. AT 102.0 DEG. HORIZ.



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Figure B-80 Theoretical Horizontal Plane Pattern for 16 Element Array @ 140 Hz for Data Point 8, 13 Off Broadside Steering. Beamwidth 14.07°, Azimuth Gain 10.4 dB.

CONFIDENTIAL

54000 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 ONTLEP 3.1
ARRAY TUNED TO 300 HZ.
ELEMENTS 48
SPACING UNIFORM

DATA POINT 8
1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ., 48 ELEMENTS, -0.85 DB MAX., AC:54343, SU:54343, UT:
90.0 DEG. VERT. RESP., 102.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
1.96 DEG. 3 DB BEAM, 17.04 DB AZ. GAIN, MAX. AT 102.0 DEG. HORIZ.

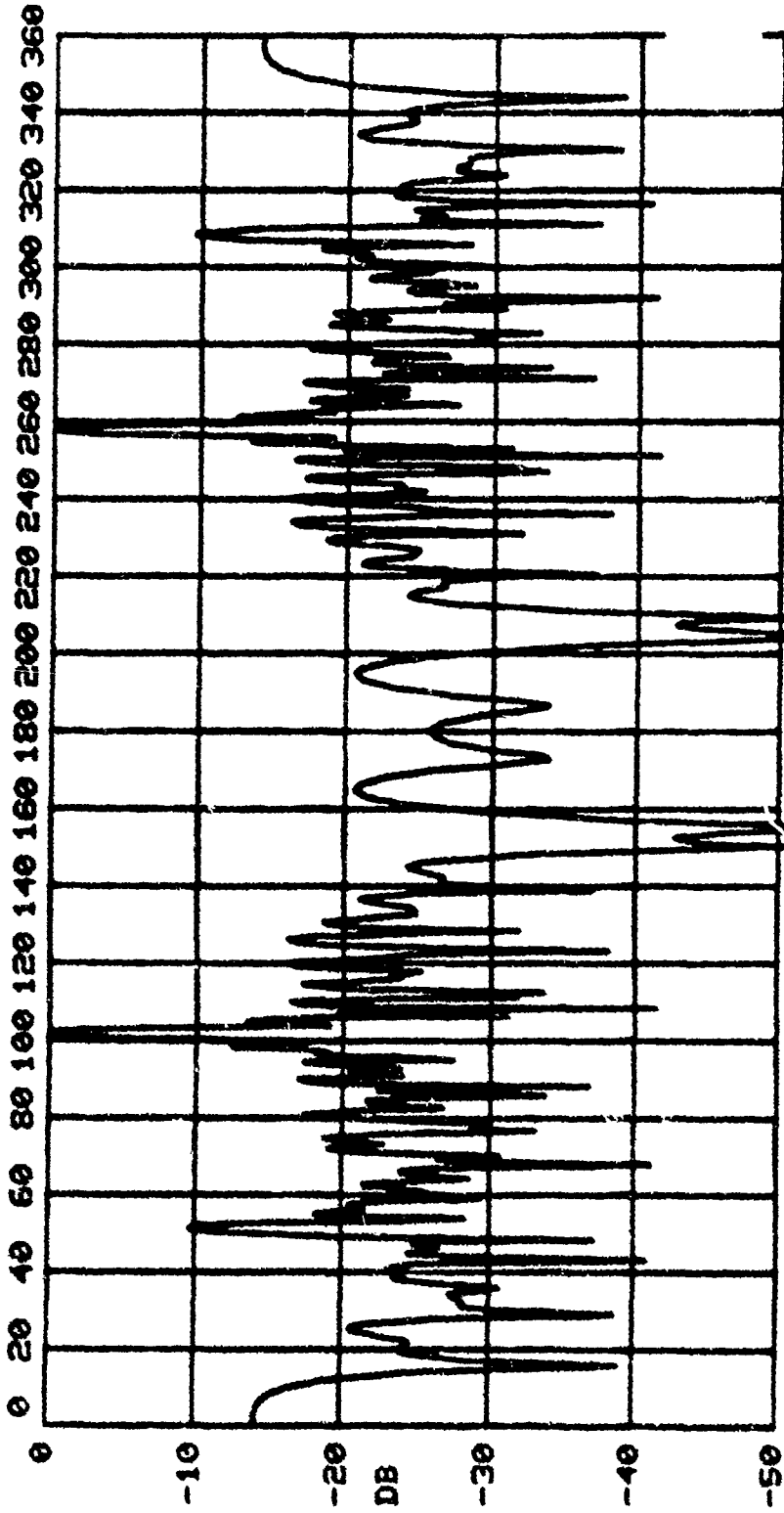


Figure B-8/ Theoretical Horizontal Plane Pattern for 48 Element Array @ 295 Hz for Data Point 8, 1/2 Off Broadside Steering. Beamwidth 1.96°, Azimuth Gain 17.0 dB.

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5406L SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
... 3000 Hz ARRAY TUNED TO 300 HZ.
... 3.223 FT. UNIFORM SPACING
... 50dB

DATA POINT 8
1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
255.0 HZ., 32 ELEMENTS, -0.84 DB MAX., AC:54342, SU:54342, UT:
90.0 DEG. VERT. RESP., 110.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
3.24 DEG. 3 DB BEAM, 14.68 DB AZ. GAIN, MAX. AT 250.0 DEG. HORIZ.

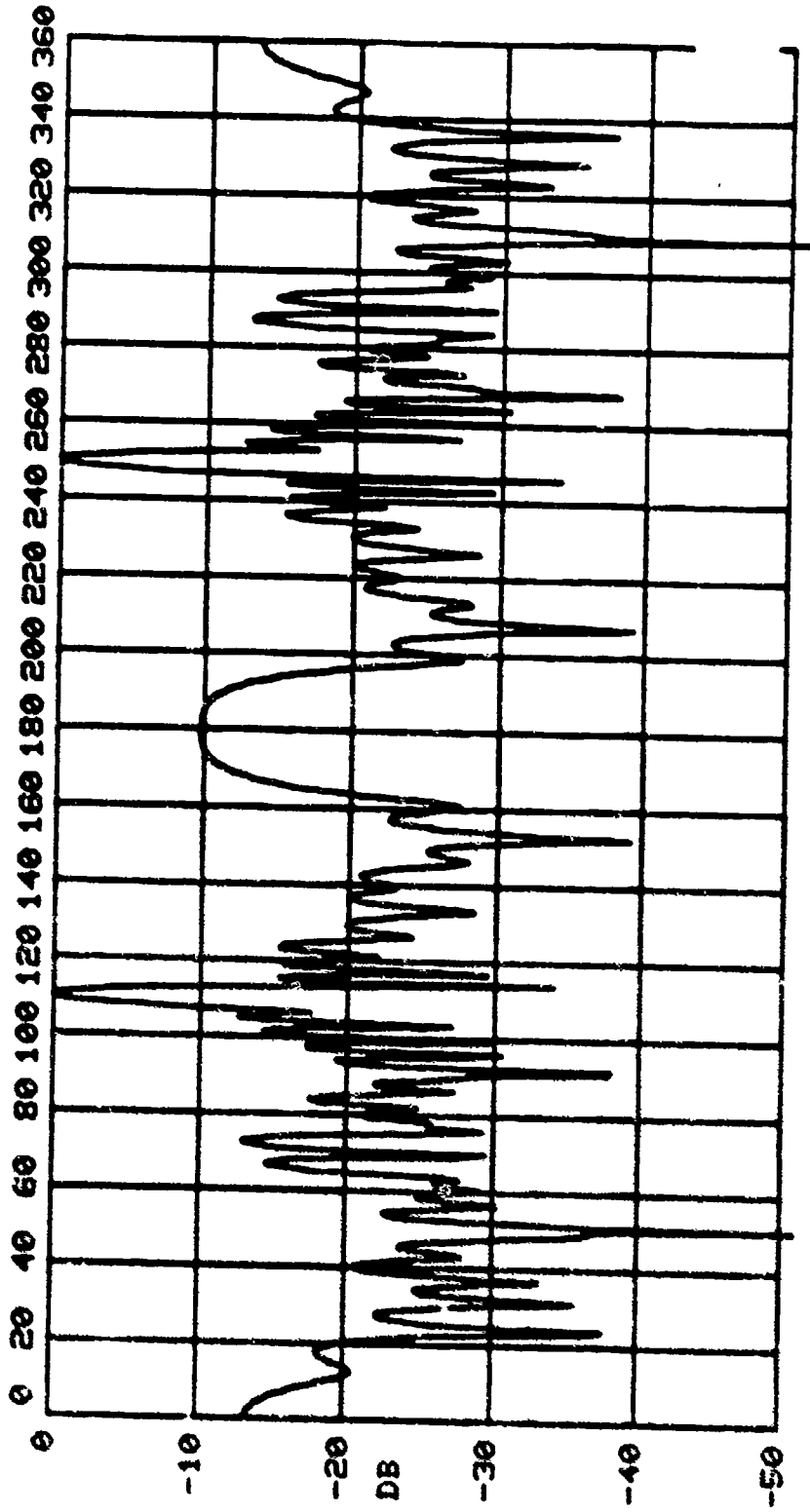


Figure B-12 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 395 Hz for Data Point 8, 20° Off Broadside
Steering. Beamwidth 3.24°, Azimuth Gain 14.68 dB.

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34021 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
... 300 HZ. ARRAY TUNED TO 300 HZ.
... 1.1220 FT. UNIFORM SPACING
... 5.000

DATA POINT 8
1400 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
255.0 HZ., 16 ELEMENTS, -0.87 DB MAX., AC:54341, SU:54341, UT:
90.0 DEG. VERT. RESP., 101.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.62 DEG. 3 DB BEAM, 12.28 DB AZ. GAIN, MAX. AT 101.0 DEG. HORIZ.

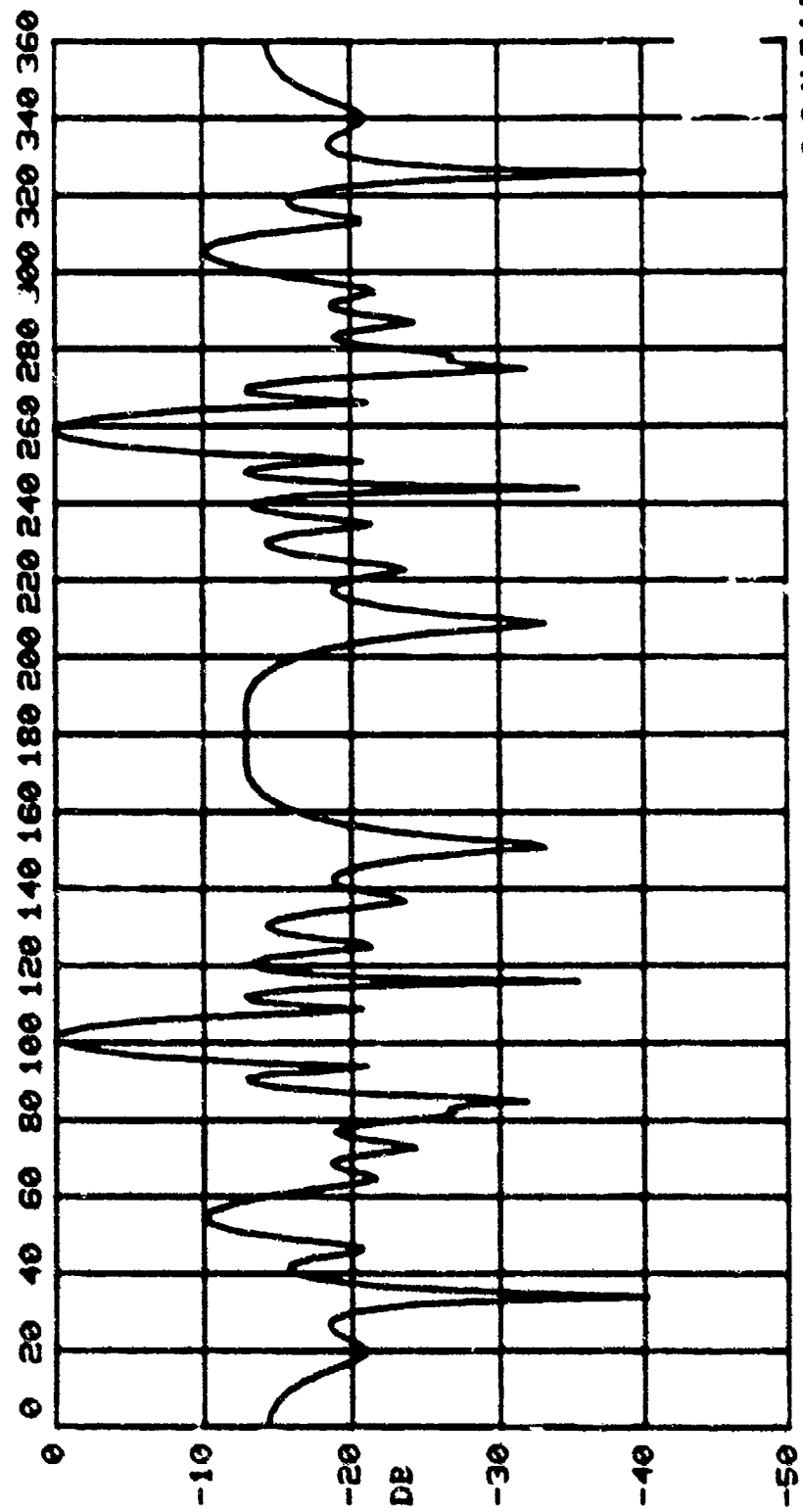


Figure E-83 Theoretical Horizontal Plane Pattern for 16 Element Array & 295 Hz for Data Point 8, // Off Broadside Steering. Beamwidth: 6.62°, Azimuth Gain /2.2 dB.

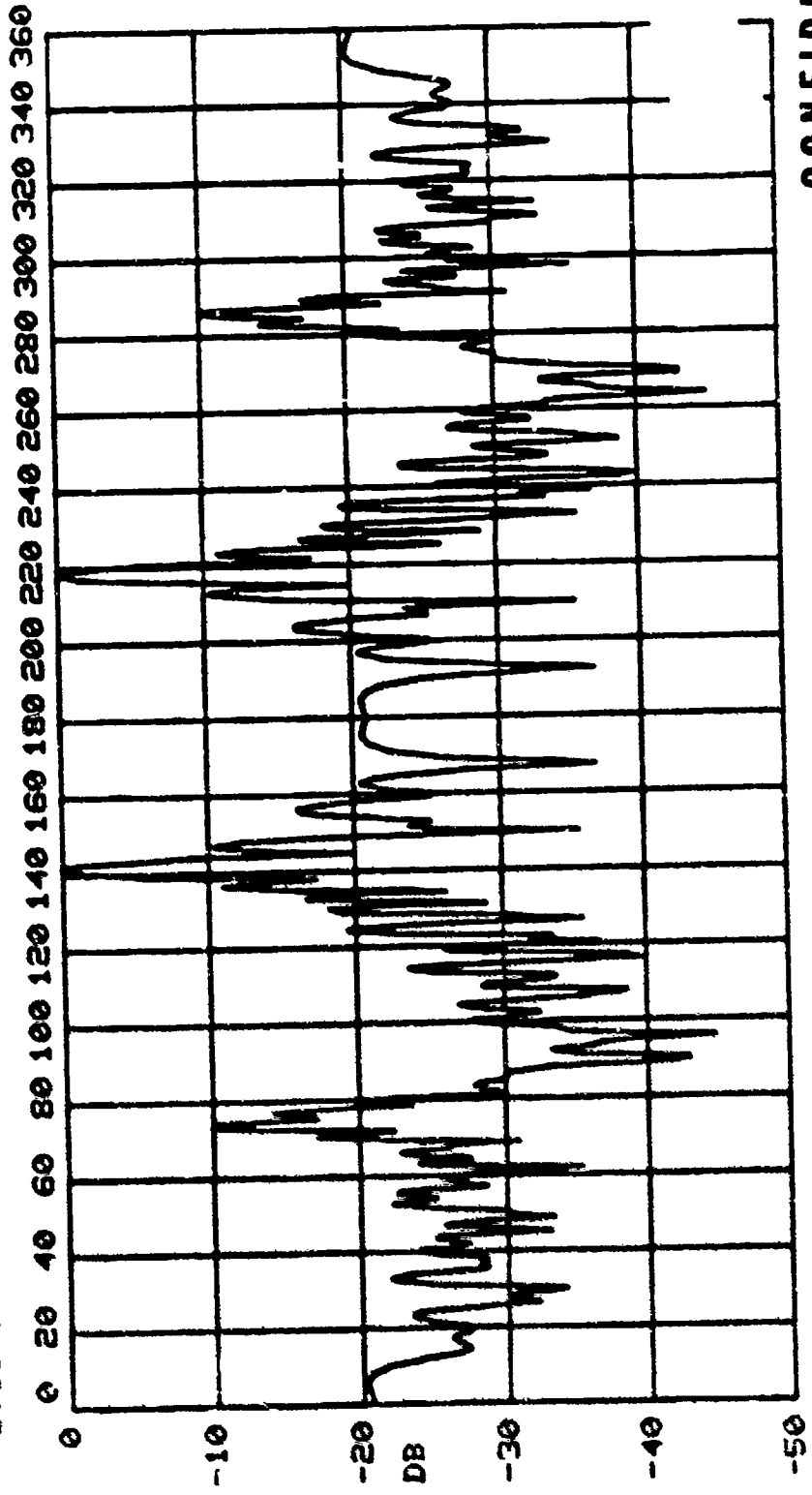
CONFIDENTIAL

CONFIDENTIAL

S105B 5-INDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLBF 3.1

ARRAY TUNED TO 300 HZ.
UNIFORM SPACING

UNIFORM WEIGHTING.
1500 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
-0.80 DB MAX., AC: S1361, SU: S1361, WT:
51 ELEMENTS, 90.0 DEG. VERT. STEER, 90.0 DEG. HORIZ. STEER, 90.0 DEG. VERT. STEER
3.11 DEG. VERT. RESP., 141.5 DEG. HORIZ. MAX. AT 141.5 DEG. HORIZ.
3 DB BEAM, 16.04 DB AZ. GAIN, MAX. AT 141.5 DEG. HORIZ.



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Figure B-54 Theoretical Horizontal Plane Pattern for 5/ Element Array 3.270 Hz for Data Point 9, 5/ Off Broadside Steering. Beamwidth 3.11, Azimuth Gain 16.0 dB.

CONFIDENTIAL

51052 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 CNTLRF 3.1
ARRAY TUNED TO 300 HZ.
3.1233 FT. UNIFORM SPACING

UNIFORM WEIGHTING.
1500 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
32 ELEMENTS, -0.61 DB MAX., AC:S1361, SU:S1361, UT:
90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.95 DEG. 3 DB BEAM, 14.21 DB AZ. GAIN, MAX. AT 141.0 DEG. HORIZ.

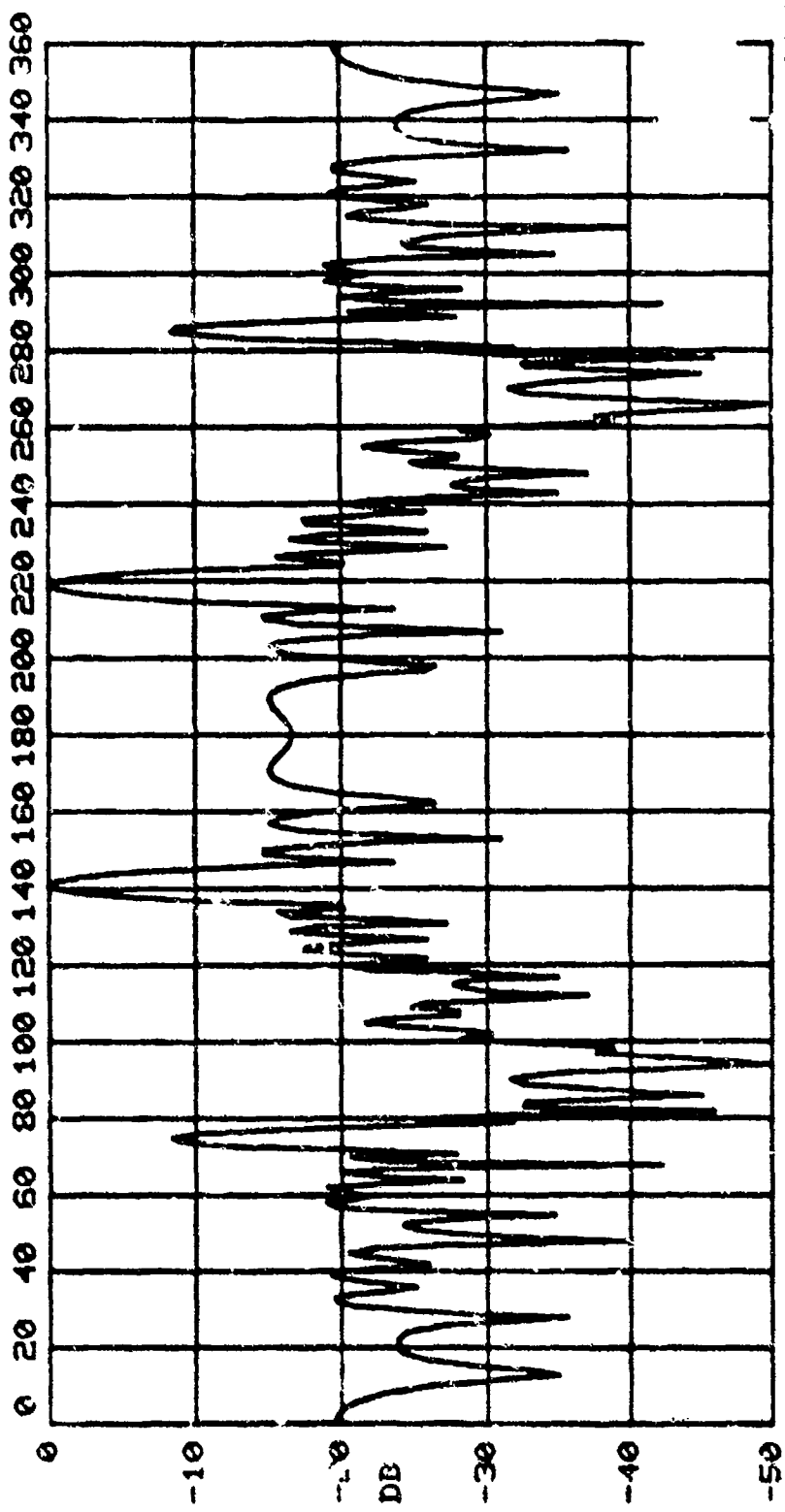


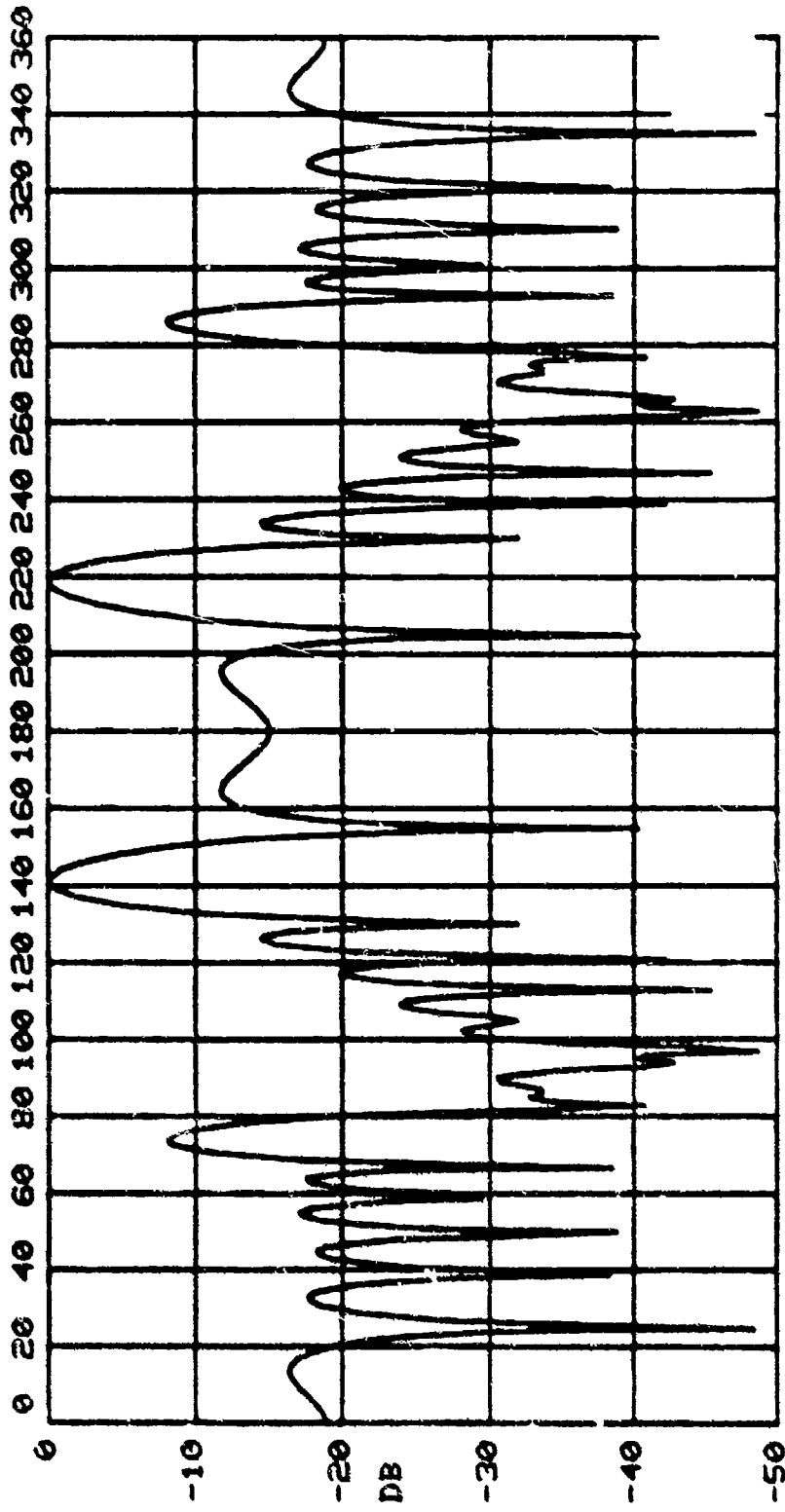
Figure B-85 Theoretical Horizontal Plane Pattern for 32 Element Array @ 290 Hz for Data Point 9, 575 Off Broadside Steering. Beamwidth 4.95°, Azimuth Gain 14.2 dB.

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11055 5 ELEMENTS BEAM PATTERN PROGRAM (T. HOSANI) 6-Jan-73 09TLBF 3.1
: 16 ELEMENTS, TUNED TO 300 MC.
: 300.0 HZ., UNIFORM SPACING
: 11.10 DB

UNIFORM WEIGHTING.
1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 16 ELEMENTS, -0.60 DB MAX., AC:51361, SU:51361, UT:
90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
10.56 DEG. 3 DB BEAM, 11.10 DB AZ. GAIN, MAX. AT 141.0 DEG. HORIZ.



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Figure B-86 Theoretical Horizontal Plane Pattern for 16 Element Array @ 290 Hz for Data Point 9, 575 Off Broadside Steering. Beamwidth 10.56°, Azimuth Gain 11.1 dB.

CONFIDENTIAL

SLIDE SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-78 ONTLEP 2.1
ARRAY TUNED TO 300 HZ.
UNIFORM SPACING

UNIFORM WEIGHTING.
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
200.0 HZ., 8 ELEMENTS, -0.56 DB MAX., AC:S1361, SU:S1361, WT:
90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
22.39 DEG. 3 DB BEAM, 7.96 DB AZ. GAIN, MAX. AT 142.0 DEG. HORIZ.

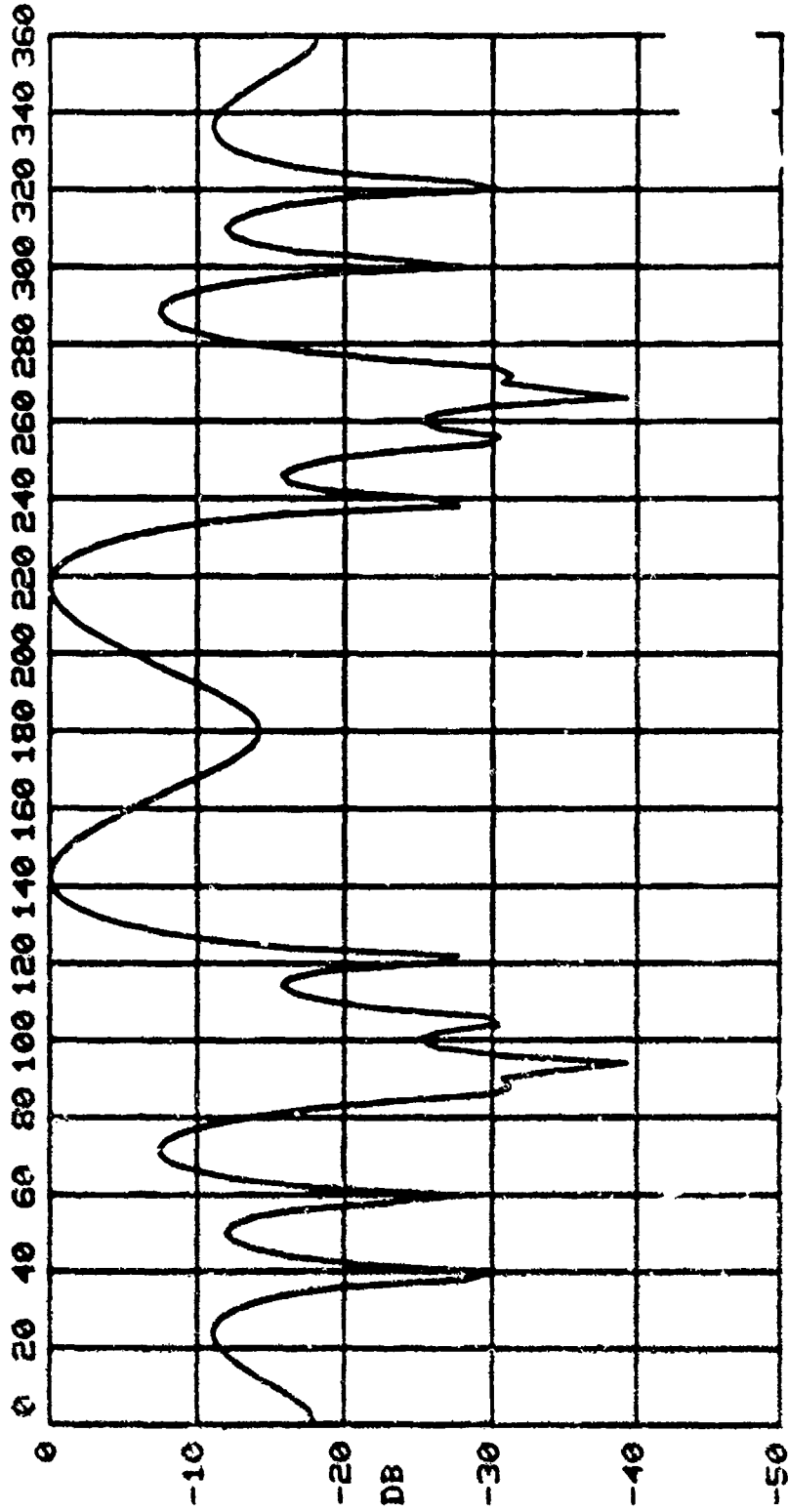


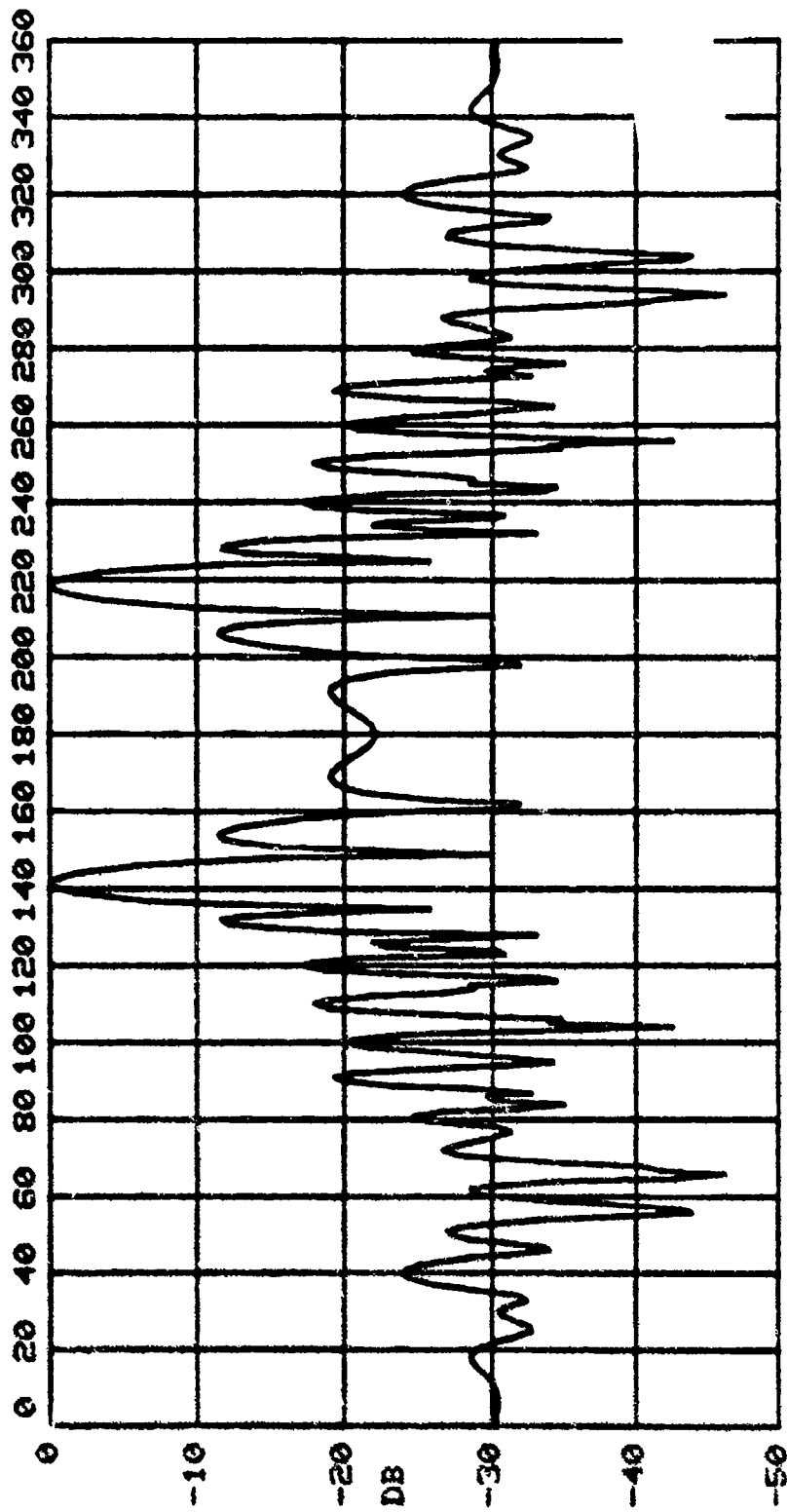
Figure B-87 Theoretical Horizontal Plane Pattern for 8 Element Array @ 290 Hz for Data Point 9, 575 Off Broadside Steering. Beamwidth 22.39°, Azimuth Gain 7.9 dB.

CONFIDENTIAL

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SIOSA SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 QNTLBP 3.1
ARRAY TUNED TO 300 HZ.
UNIFORM SPACING

UNIFORM WEIGHTING.
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 51 ELEMENTS, -0.22 DB MAX., AC:S1361, SU:S1361, UT:
90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.50 DEG. 3 DB BEAM, 13.64 DB AZ. GAIN, MAX. AT 141.0 DEG. HORIZ.



CONFIDENTIAL

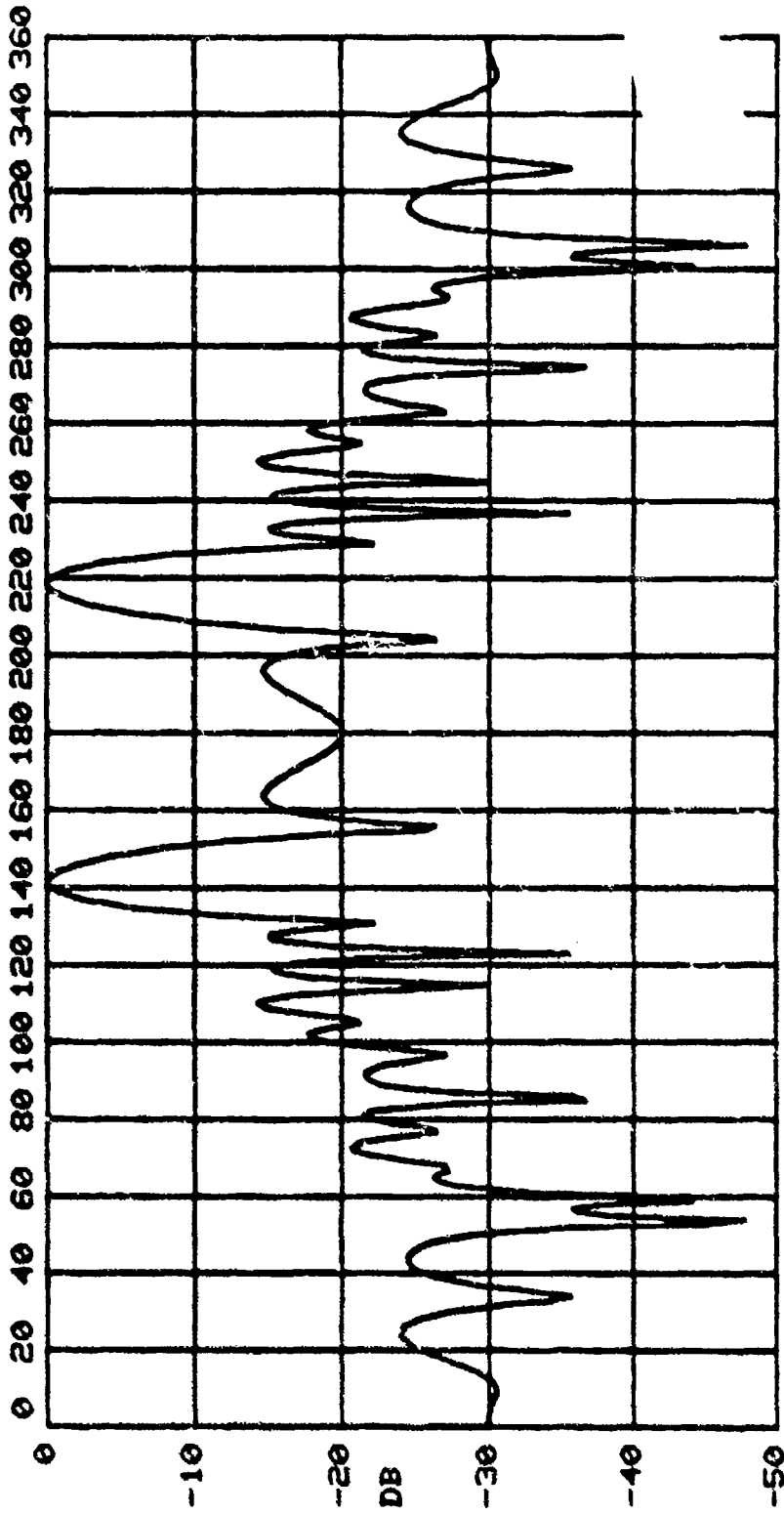
Figure B-88 Theoretical Horizontal Plane Pattern for 57 Element
Array @ 140 Hz for Data Point 9, 5750 Off Broadside
Steering. Beamwidth 6.50°, Azimuth Gain 13.64 dB.

CONFIDENTIAL

SI-057 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 UNTLRP 2.1
: 32 ELEMENT ARRAY TURNED TO 300 HZ.
: 3.2237 FT. UNIFORM SPACING

: E-ME
: 177

UNIFORM WEIGHTING.
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
149.0 HZ., 32 ELEMENTS, -0.19 DB MAX., AC: S1361, SU: S1361, UT:
90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
10.43 DEG. 3 DB BEAM, 11.74 DB AZ. GAIN, MAX. AT 141.0 DEG. HORIZ.



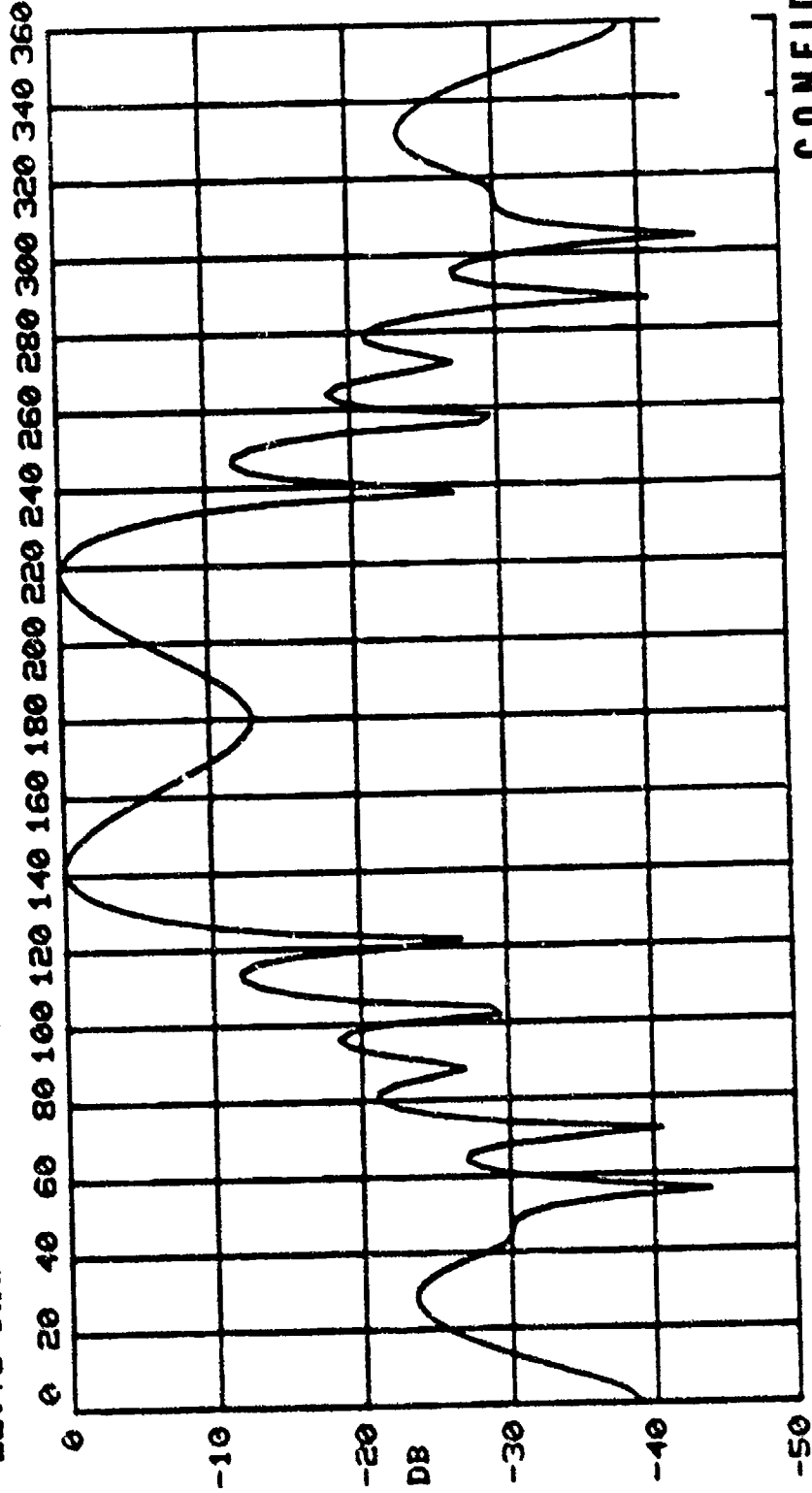
CONFIDENTIAL

Figure B-89 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 140 Hz for Data Point 9, 57.5 Off Broadside
Steering. Beamwidth 10.43°, Azimuth Gain 11.7 dB.

CONFIDENTIAL

51054 SWIDERS BEAM PATTERN PROGRAM (T. HOGAN) 6-Jan-75 UNTLRF 3.1
: 1400 HZ. 16 ELEMENTS, -0.16 DB MAX., AC:51361, SU:51361, WT:
: 140.0 HZ., 16 ELEMENTS, 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
: 90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
: 22.76 DEG. 3 DB BEAM, 8.48 DB AZ. GAIN, MAX. AT 142.0 DEG. HORIZ.

UNIFORM WEIGHTING.
1400 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 16 ELEMENTS, -0.16 DB MAX., AC:51361, SU:51361, WT:
90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
22.76 DEG. 3 DB BEAM, 8.48 DB AZ. GAIN, MAX. AT 142.0 DEG. HORIZ.



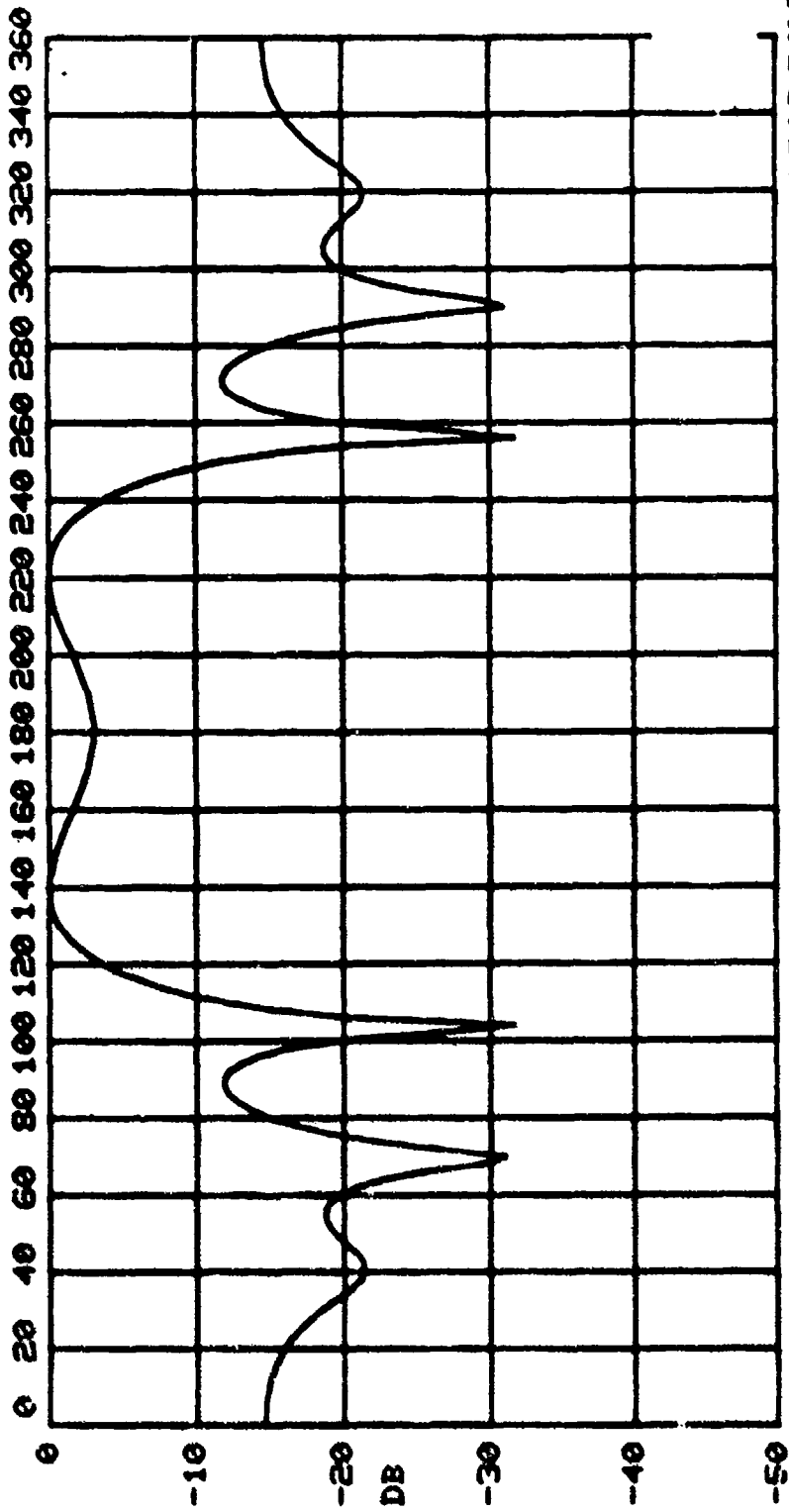
CONFIDENTIAL

Figure B-90 Theoretical Horizontal Plane Pattern for 16 Element Array @ 140 Hz for Data Point 8, 57.5 Off Broadside Steering. Beamwidth 22.76°, Azimuth Gain 8.4 dB.

CONFIDENTIAL

11:51 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-78 ONTLEP 3.1
: 1.000 HZ. TUNED TO 300 HZ.
: 1.000 FT. UNIFORM SPACING
: NAME

UNIFORM WEIGHTING.
1500 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 8 ELEMENTS, -0.14 DB MAX., AC:S1361, SU:S1361, UT:
90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
55.78 DEG. 3 DB BEAM, 5.62 DB AZ. GAIN, MAX. AT 220.0 DEG. HORIZ.



CONFIDENTIAL

Figure B-9/ Theoretical Horizontal Plane Pattern for 8 Element Array @ 140 Hz for Data Point 9, 575 Off Broadside Steering. Beamwidth 55.78°, Azimuth Gain 5.6 dB.

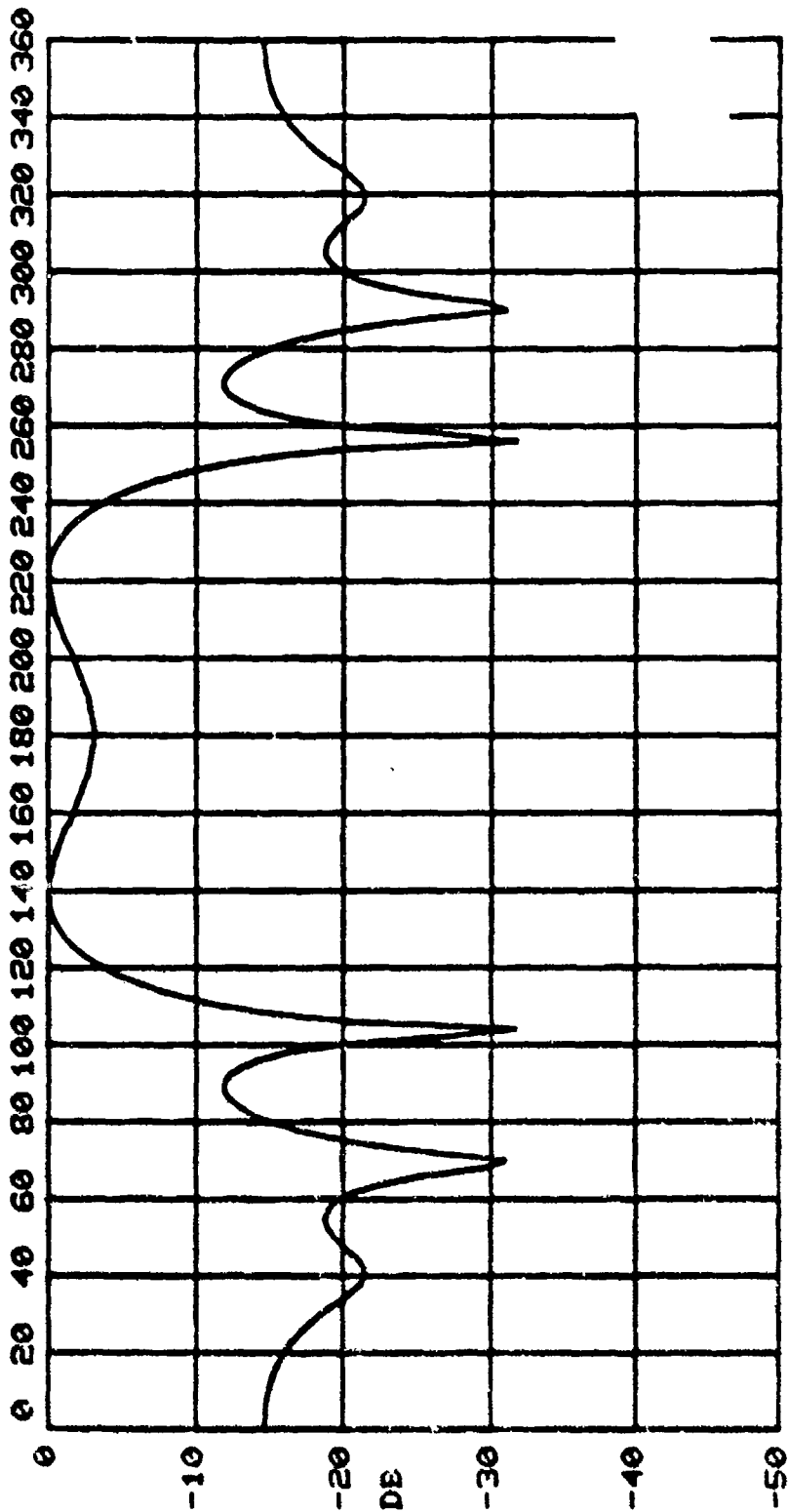
CONFIDENTIAL

51051 SWIDERS BEAM PATTERN PROGRAM (T. HOGAN) 6-Jan-78 UNTLEP 3.1
: 1000 HZ. BEAM TUNED TO 300 HZ.
: 1000 HZ. UNIFORM SPACING
: 5.62

UNIFORM WEIGHTING.

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

140.0 HZ. 8 ELEMENTS, -0.14 DB MAX., AC:51361, SU:51361, WT:
90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
55.78 DEG. 3 DB BEAM, 5.62 DB AZ. GAIN, MAX. AT 220.0 DEG. HORIZ.



CONFIDENTIAL

Figure B-92 Theoretical Horizontal Plane Pattern for 8 Element Array @ 140 Hz for Data Point 9, 5/5 Off Broadside Steering. Beamwidth 55.78°, Azimuth Gain 5.6 dB.

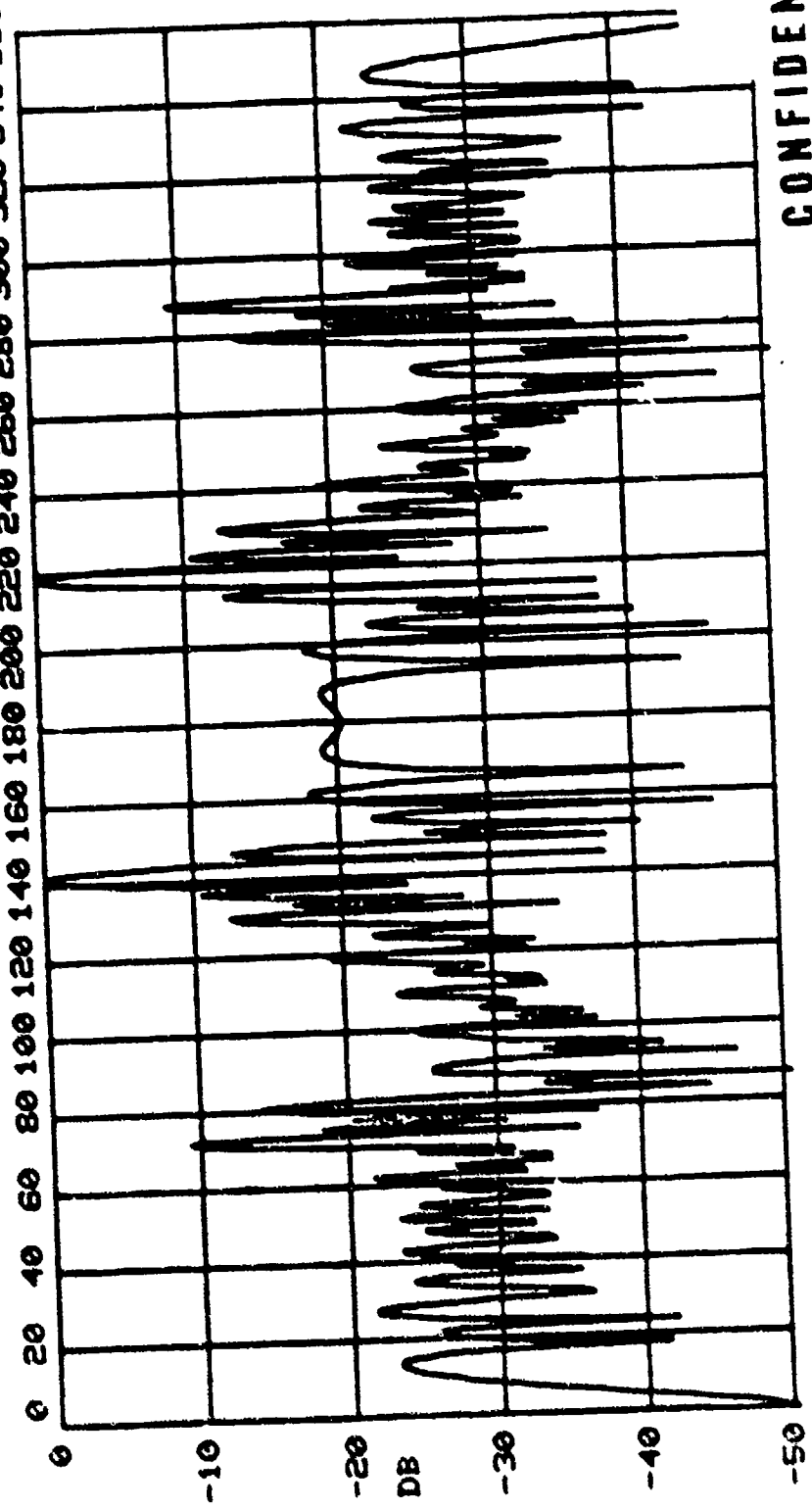
CONFIDENTIAL

ONTLEP 3.1

6-Jan-73

(T.HOJAN)

S105C EVIDERS BEAM PATTERN PROGRAM (T.HOJAN)
: 51 ELEMENTS, UNIFORM SPACING
: 3.06 DEG. 3 DB BEAM, 16.20 DB AZ. GAIN, MAX. AT 141.5 DEG. HORIZ.
: 90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
: 295.0 HZ., 51 ELEMENTS, -0.81 DB MAX., AC:S1361, SU:S1361, WT:
: UNIFORM WEIGHTING.
: 1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.



CONFIDENTIAL

Figure B-93 Theoretical Horizontal Plane Pattern for 5/Element Array & 295 Hz for Data Point 9, 57.5 Off Broadside Steering. Beamwidth 3.06°, Azimuth Gain 16.2dB.

CONFIDENTIAL

51059 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-JAN-73 ONTLEF 3.1
: 300 HZ. TUNED TO 300 HZ.
: 300 FT. UNIFORM SPACING

UNIFORM WEIGHTING.
1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ., 32 ELEMENTS, -0.86 DB MAX., AC:51361, SU:51361, WT:
90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.93 DEG. 3 DB BEAM, 14.07 DB AZ. GAIN, MAX. AT 141.0 DEG. HORIZ.

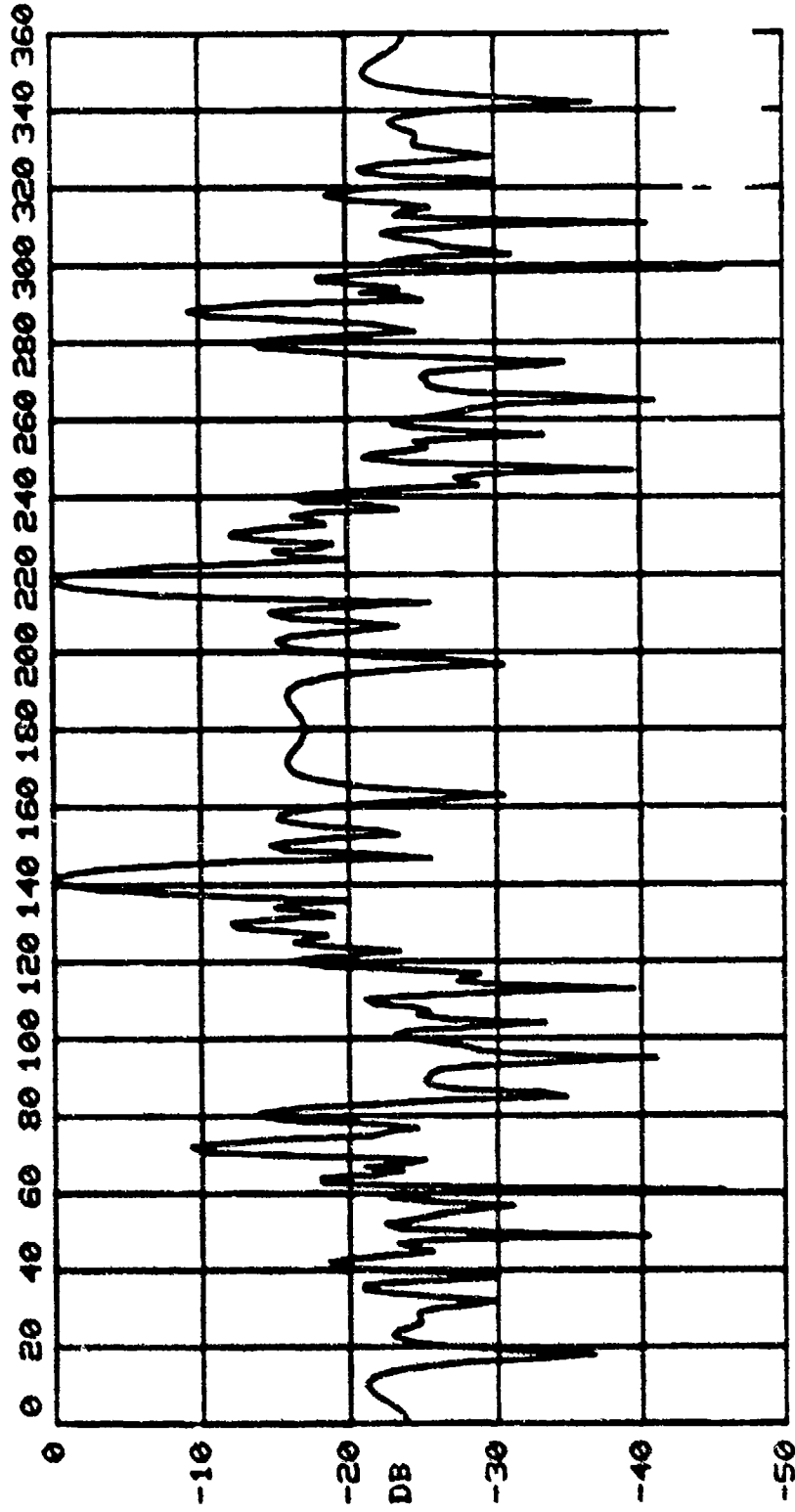


Figure B-94 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 295 Hz for Data Point 9, 9.5 Off Broadside
Steering. Beamwidth 4.93°, Azimuth Gain 14.0 dB.

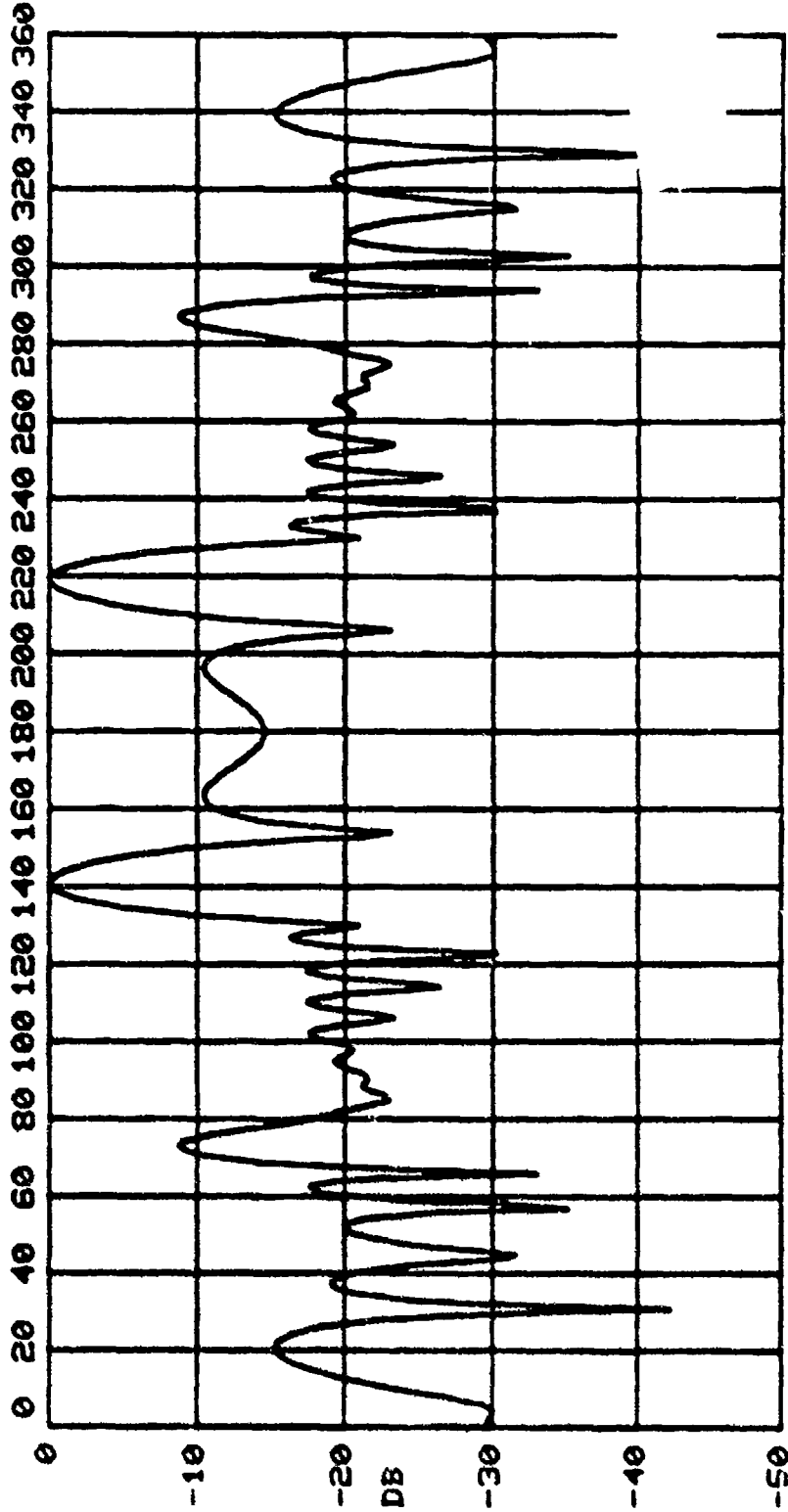
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CONFIDENTIAL

51056 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-78 ONTLEP 3.1
: 1.000 HZ. TUNED TO 300 HZ.
: 1.000 FT. UNIFORM SPACING

UNIFORM WEIGHTING.

1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
295.0 HZ., 16 ELEMENTS, -0.75 DB MAX., AC:51361, SU:51361, WT:
90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
10.30 DEG. 3 DB BEAM, 11.05 DB AZ. GAIN, MAX. AT 141.0 DEG. HORIZ.



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Figure B-95 Theoretical Horizontal Plane Pattern for 16 Element Array @ 295 Hz for Data Point 9, 57.5 Off Broadside Steering. Beamwidth 10.30°, Azimuth Gain 11.0 dB.

CONFIDENTIAL

11093 8-INDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-78 UNTLBP 3.1
: 300 HZ. (300) TUNED TO 300 HZ.
: 1.000 HZ. UNIFORM SPACING

1109

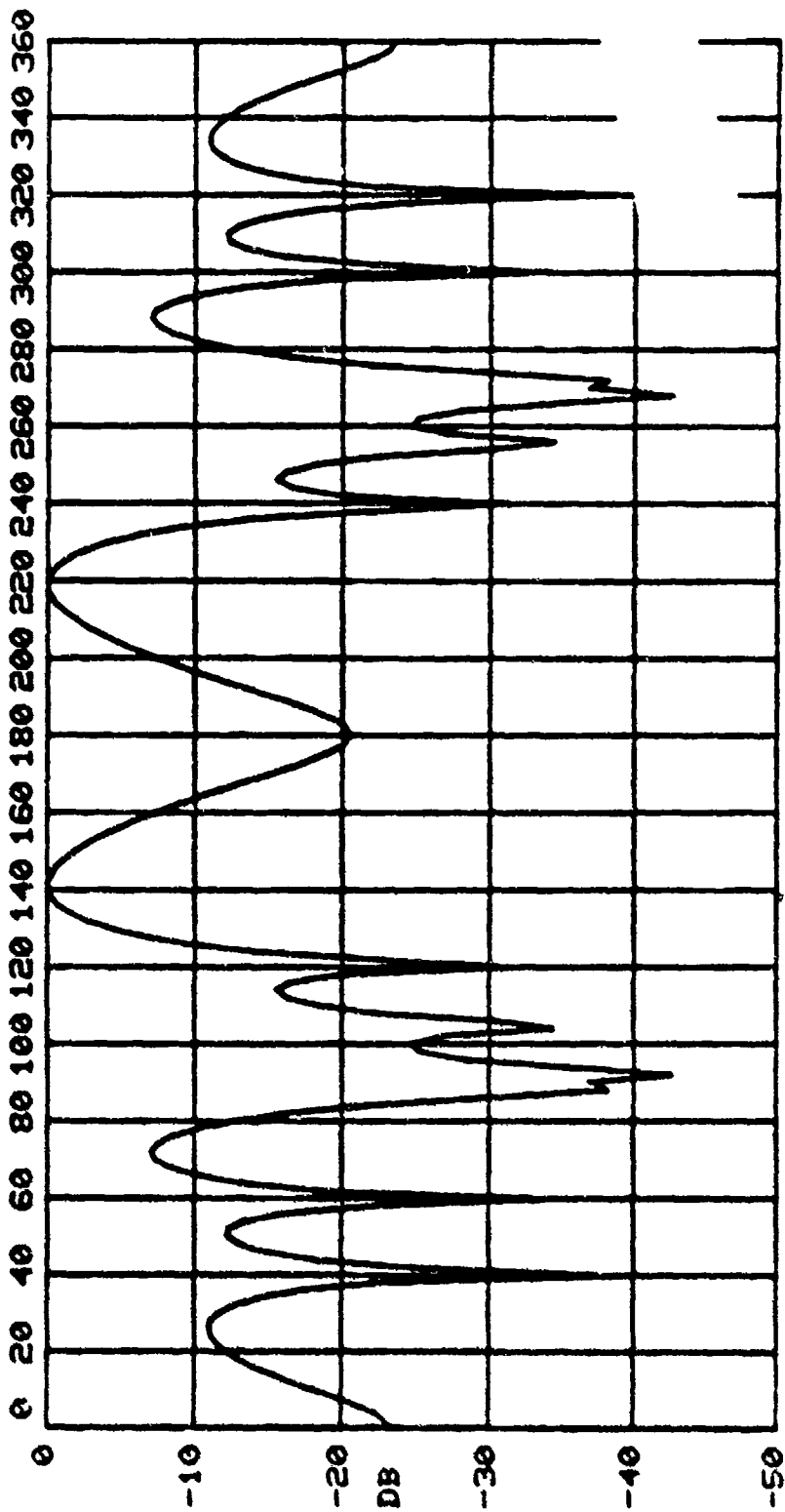
UNIFORM WEIGHTING.

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

195.0 HZ., 8 ELEMENTS, -0.63 DB MAX., AC:51361, SU:51361, WT:

90.0 DEG. VERT. RESP., 141.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

21.25 DEG. 3 DB BEAM, 8.20 DB AZ. GAIN, MAX. AT 220.0 DEG. HORIZ.



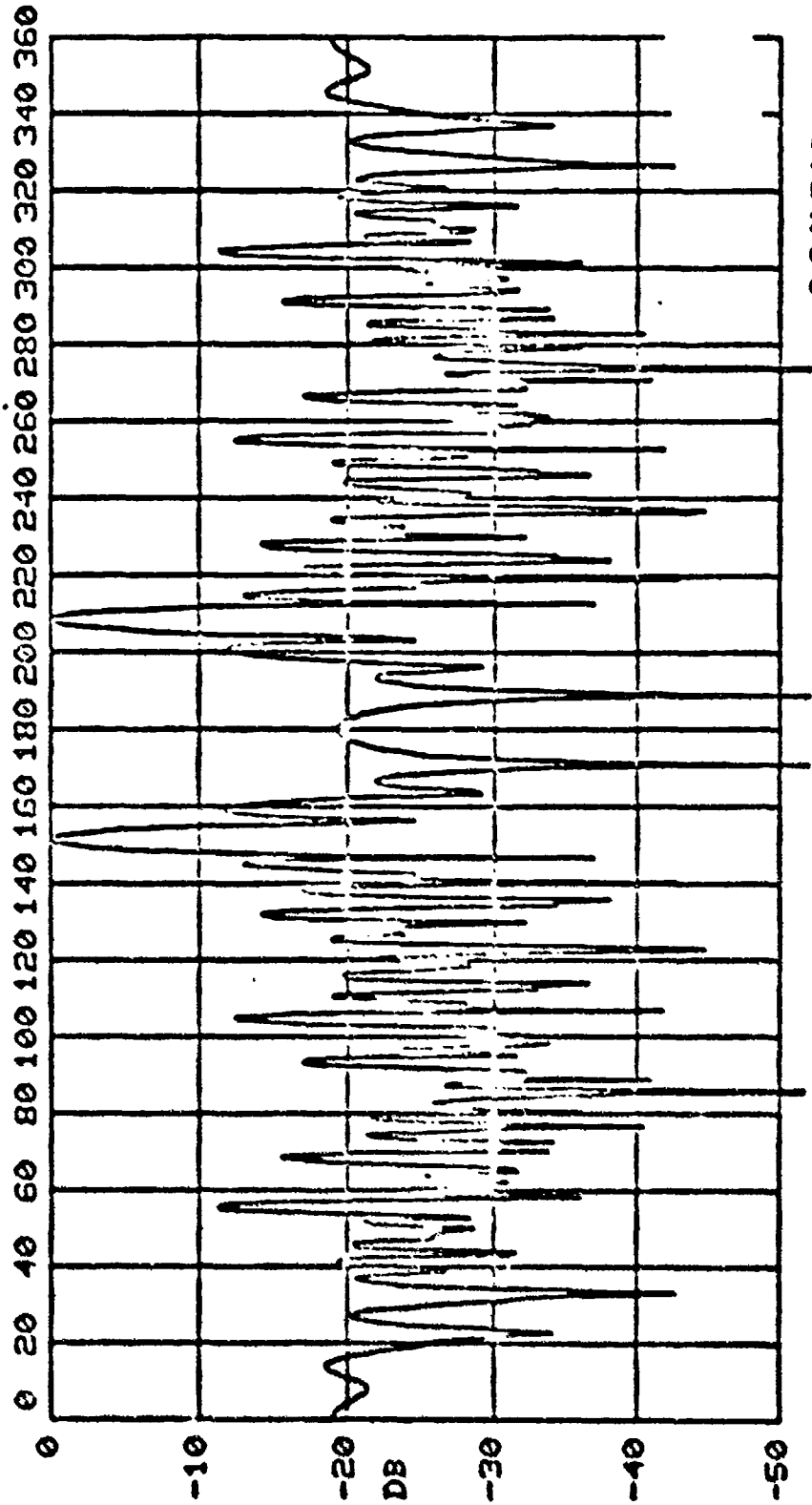
CONFIDENTIAL

Figure B-96 Theoretical Horizontal Plane Pattern for 8 Element Array @ 295 Hz for Data Point 9, 57.5 Off Broadside Steering. Beamwidth 21.25°, Azimuth Gain 8.2 dB.

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S106B SWIFERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLEF 3.1
ARRAY TUNED TO 300 HZ.
UNIFORM SPACING

DP10
UNIFORM WEIGHTING.
1500 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
250.0 HZ., 49 ELEMENTS, -0.87 DB MAX., AC:S1362, SU:S1362, WT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.12 DEG. 3 DB BEAM, 15.00 DB AZ. GAIN, MAX. AT 208.5 DEG. HORIZ.



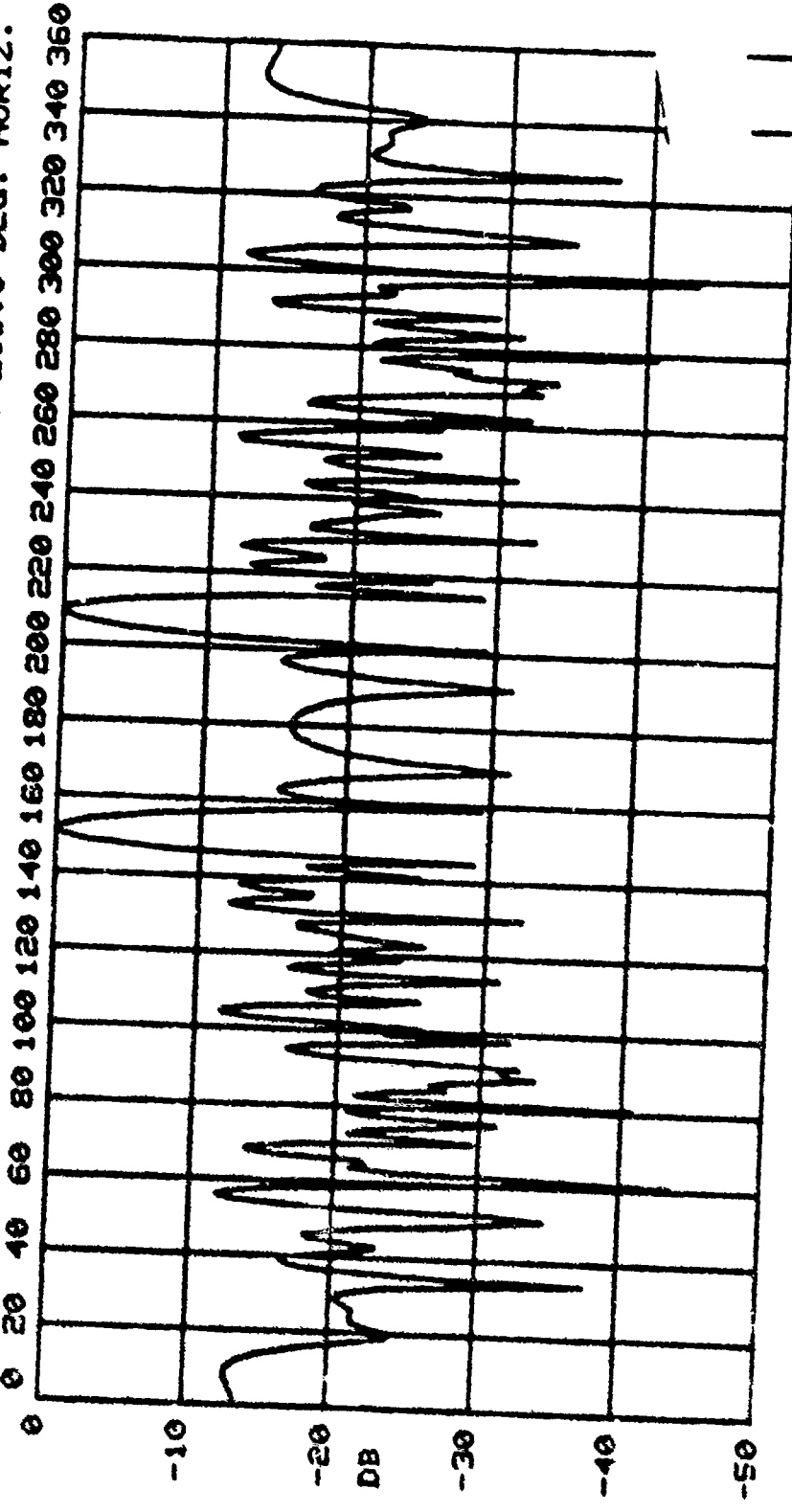
CONFIDENTIAL

Figure B-97 Theoretical Horizontal Plane Pattern for 49 Element Array @ 300 Hz for Data Point 0, 6/5 Off Broadside Steering. Beamwidth 4/12 0, Azimuth Gain 15.0 dB.

CONFIDENTIAL

51052 3-TERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLEP 3.1
: 299.0 HZ. TUNED TO 300 HZ.
: 32 ELEM. UNIFORM SPACING

UNIFORM WEIGHTING.
127.0 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
299.0 HZ. 32 ELEMENTS, -0.89 DB MAX., AC:51362, SU:51362, WT:
30.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.08 DEG. 3 DB BEAM, 13.04 DB AZ. GAIN, MAX. AT 209.0 DEG. HORIZ.



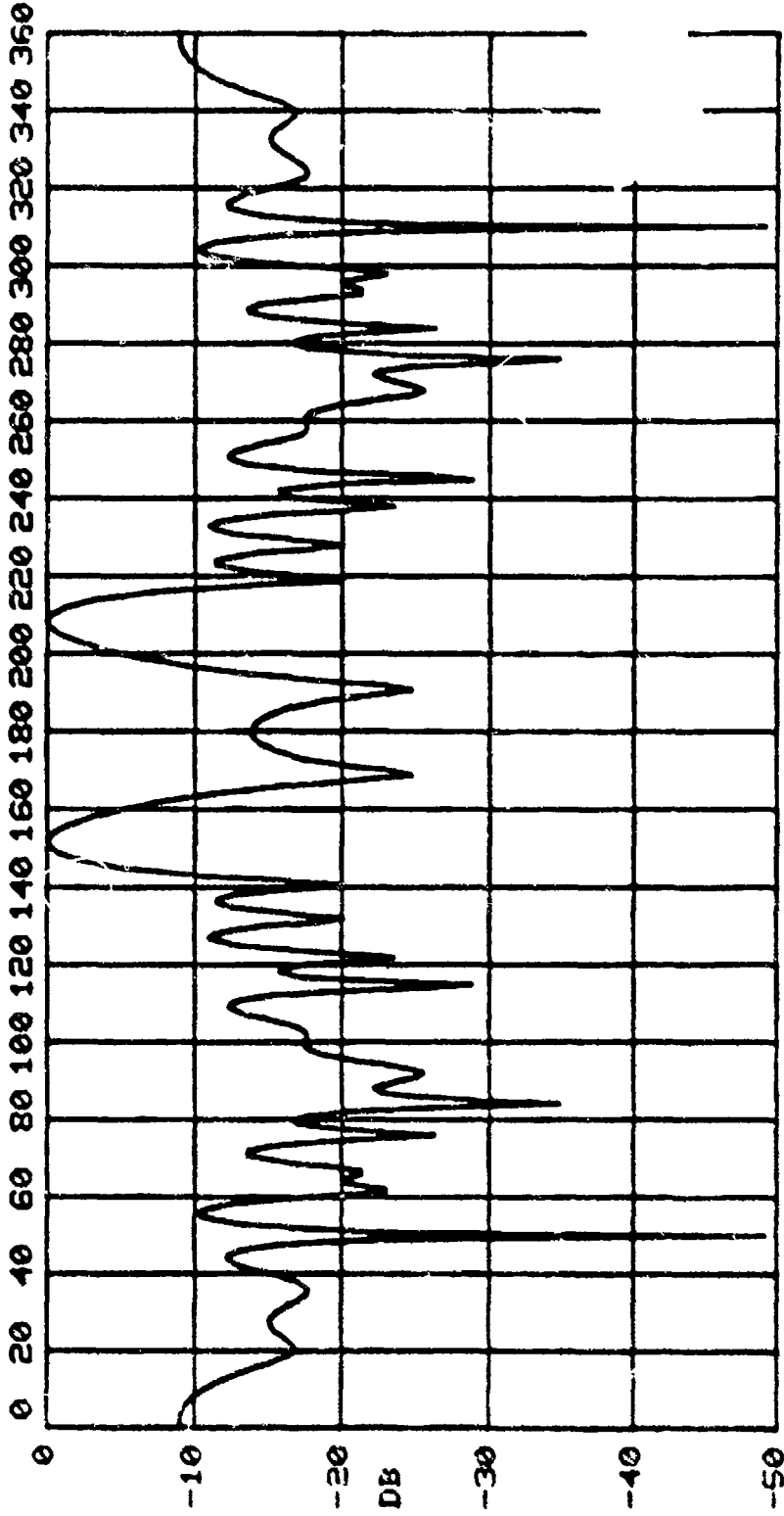
CONFIDENTIAL

Figure B-98 Theoretical Horizontal Plane Pattern for 32 Element Array & 290 Hz for Data Point 70, 6.5 Off Broadside Steering. Beamwidth 6.08°, Azimuth Gain 13.0 dB.

CONFIDENTIAL

S1065 SLIDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTLBF 3.1
: 1000 HZ. ARRAY TUNED TO 300 HZ.
: 2.000 FT. UNIFORM SPACING

UNIFORM WEIGHTING.
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 16 ELEMENTS, -0.79 DB MAX., AC:S1362,SU:S1362,WT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
11.76 DEG. 3 DB BEAM, 10.15 DB AZ. GAIN, MAX. AT 152.0 DEG. HORIZ.



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Figure B-99 Theoretical Horizontal Plane Pattern for 16 Element
Array @ 290 Hz for Data Point 10, 0.5 Off Broadside
Steering. Beamwidth 11.76°, Azimuth Gain 10.15 dB.

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SLOPE SWEEPERS FEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 ONTUSP 5.1
: 1000 HZ., TUNED TO 300 HZ.
: 1000 FT. UNIFORM SPACING

UNIFORM WEIGHTING.

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 8 ELEMENTS, -0.86 DB MAX., AC:51362, SU:51362, WT:
30.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
24.63 DEG. 3 DB BEAM, 6.81 DB AZ. GAIN, MAX. AT 152.0 DEG. HORIZ.

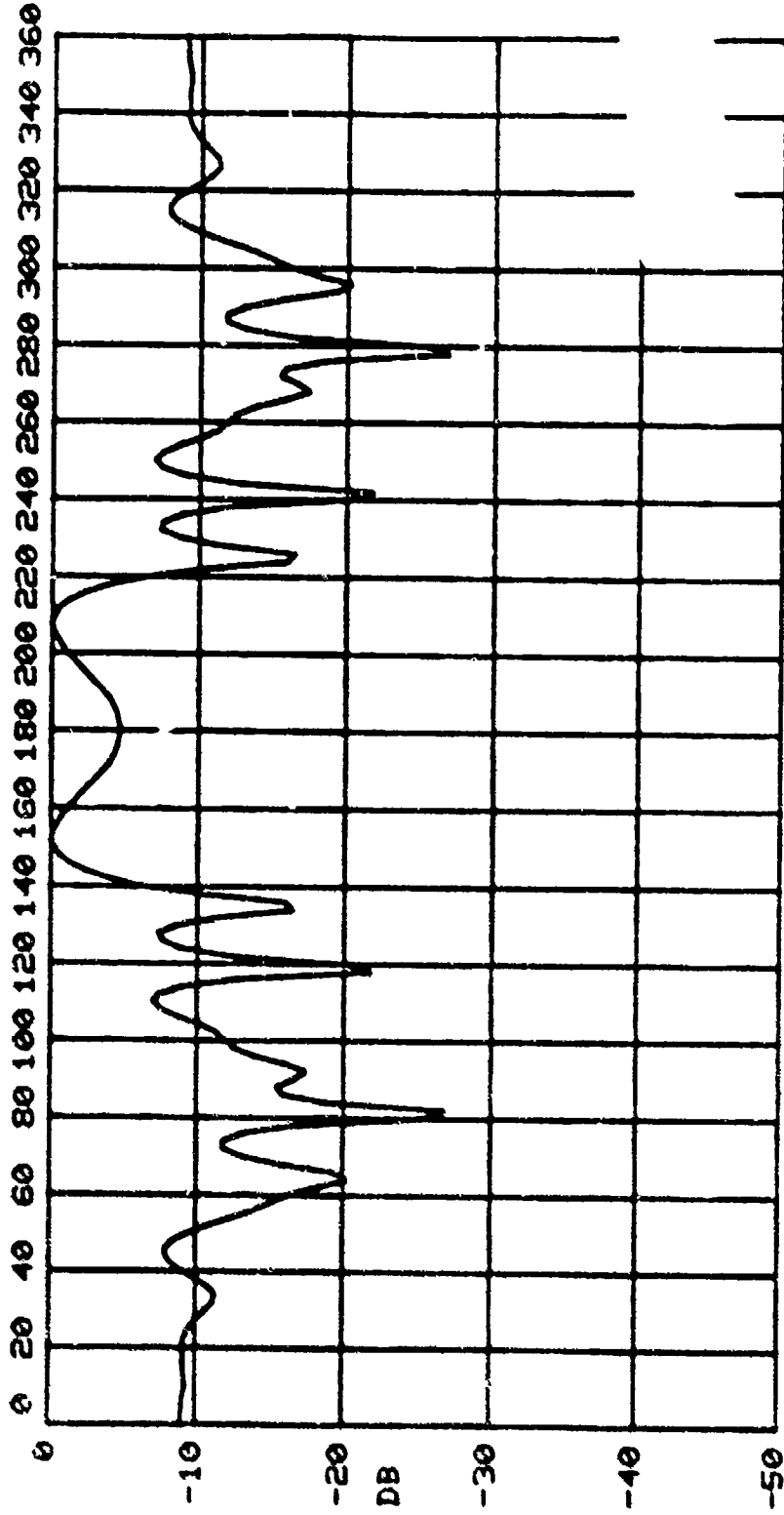


Figure B-100 Theoretical Horizontal Plane Pattern for 8 Elements
Array & 290 Hz for Data Point 10, GMS Off Broadside
Steering. Beamwidth 24.63, Azimuth Gain 6.81 dB.

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5105A 2-INDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 QNTLBF 3.1
: 1.000 HZ. TURNED TO 300 HZ.
: 1.000 HZ. UNIFORM SPACING

UNIFORM WEIGHTING.
1400 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 49 ELEMENTS, -0.22 DB MAX., AC:51362, SU:51362, UT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
2.63 DEG. 3 DB BEAM, 12.44 DB AZ. GAIN, MAX. AT 209.0 DEG. HORIZ.

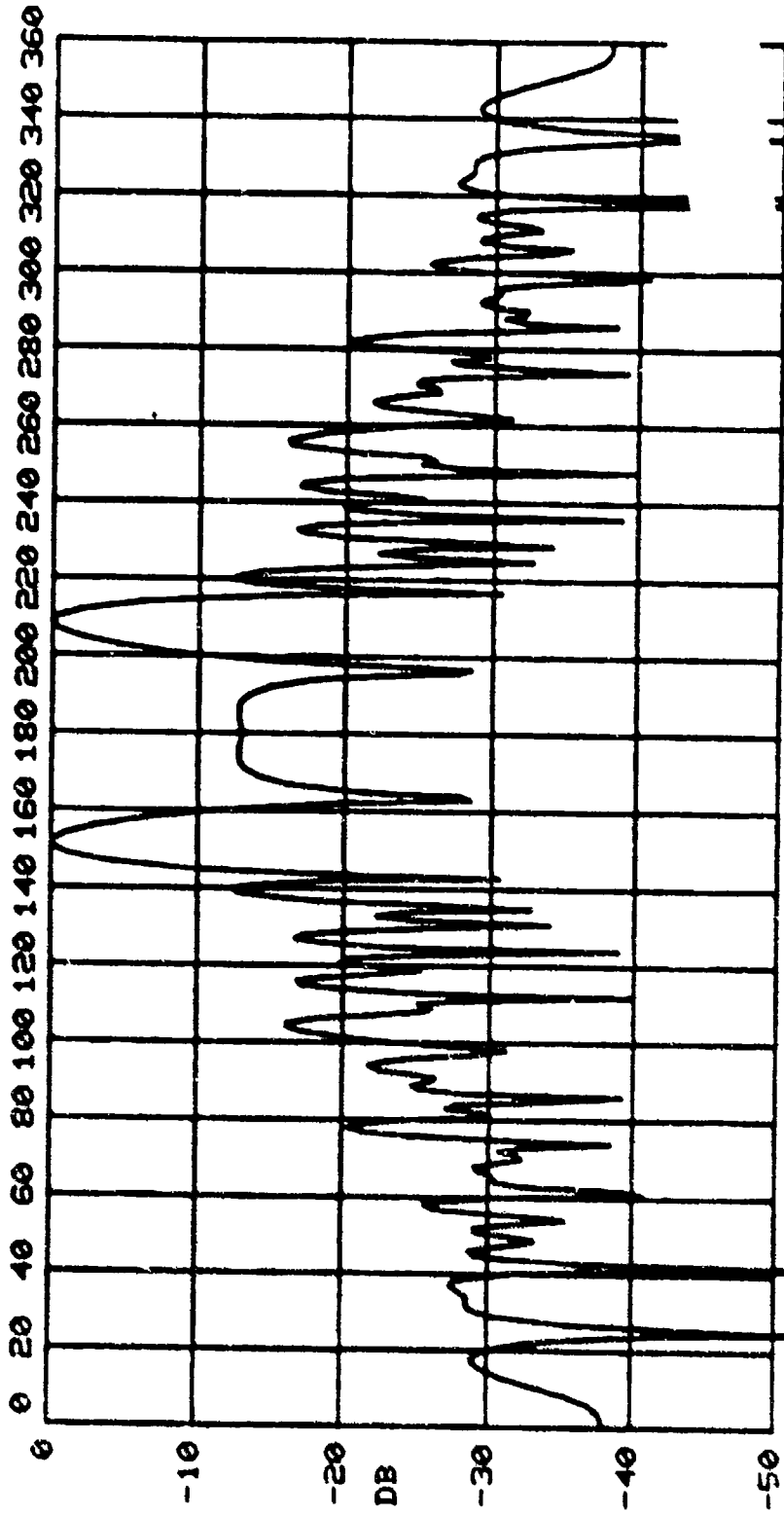


Figure B-101 Theoretical Horizontal Plane Pattern for 49 Element
Array @ 140 Hz for Data Point 10, 61.5 Off Broadside
Steering. Beamwidth 8.63°, Azimuth Gain 12.44 dB.

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S1064 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 QNTLBP 3.1

ARRAY TUBED TO 300 HZ.

UNIFORM SPACING

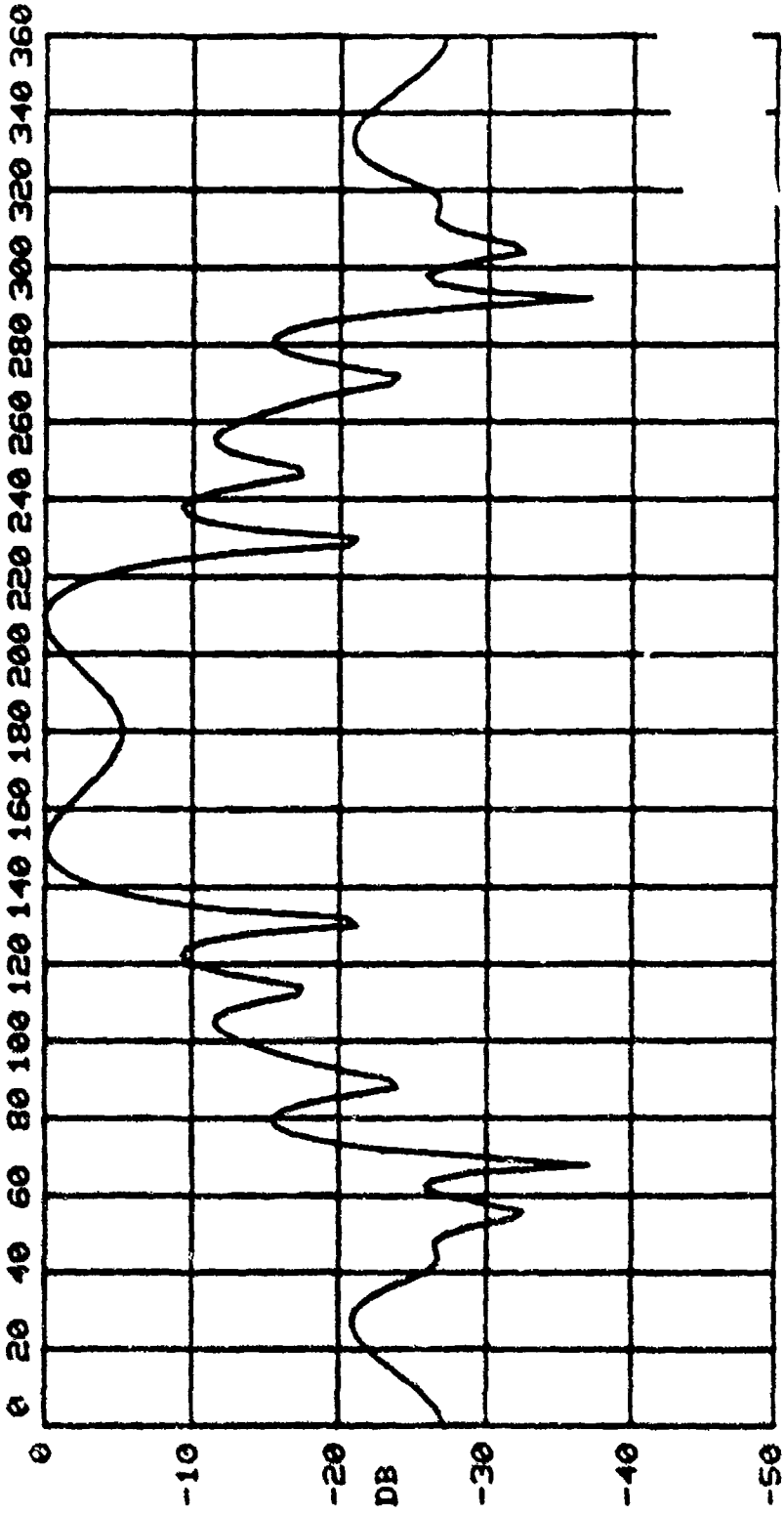
UNIFORM WEIGHTING.

1500 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

140.0 HZ., 16 ELEMENTS, -0.19 DB MAX., AC: S1362, SU: S1362, WT:

90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

25.91 DEG. 3 DB BEAM, 7.77 DB AZ. GAIN, MAX. AT 150.0 DEG. HORIZ.



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Figure B-103 Theoretical Horizontal Plane Pattern for 16 Element Array @ 140 hz for Data Point 10, 6.5 Off Broadside Steering. Beamwidth 25.91°, Azimuth Gain 7.77 dB.

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S1050 BANDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 QNTLBP 3.1
: 295 HZ. TUNED TO 300 HZ.
: 151.5 DEG. VERT. STEER. 90.0 DEG. VERT STEER
: 4.04 DEG. 3 DB BEAM, 15.04 DB AZ. GAIN, MAX. AT 208.5 DEG. HORIZ.

UNIFORM WEIGHTING.

1000 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

0.05.0 HZ. 49 ELEMENTS, -0.85 DB MAX., AC:S1362, SU:S1362, UT:

90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.04 DEG. 3 DB BEAM, 15.04 DB AZ. GAIN, MAX. AT 208.5 DEG. HORIZ.

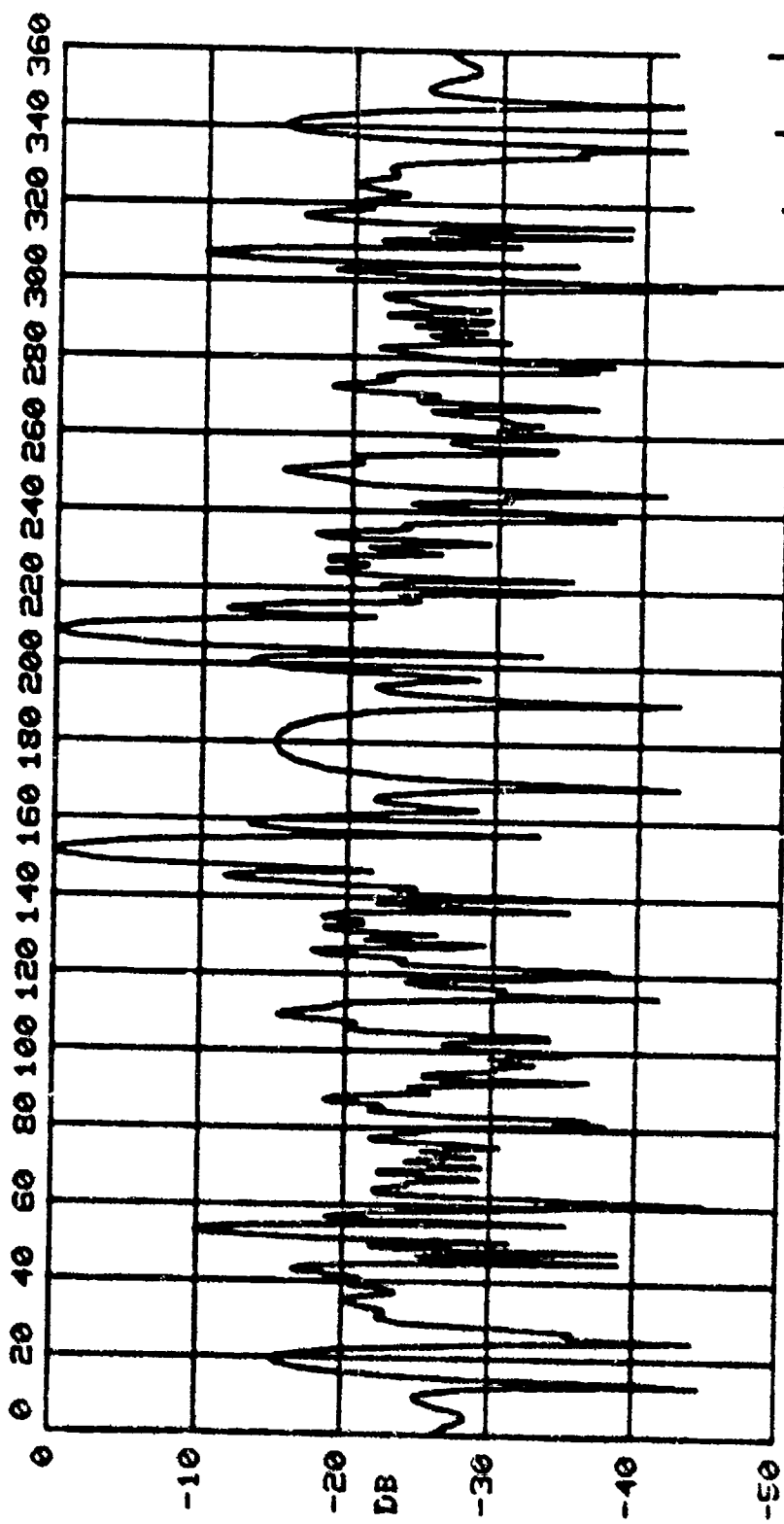


Figure B-105 Theoretical Horizontal Plane Pattern for 49 Element
Array @ 295 Hz for Data Point 10, 615 Off Broadside
Steering. Beamwidth 4.04°, Azimuth Gain 15.0 dB.

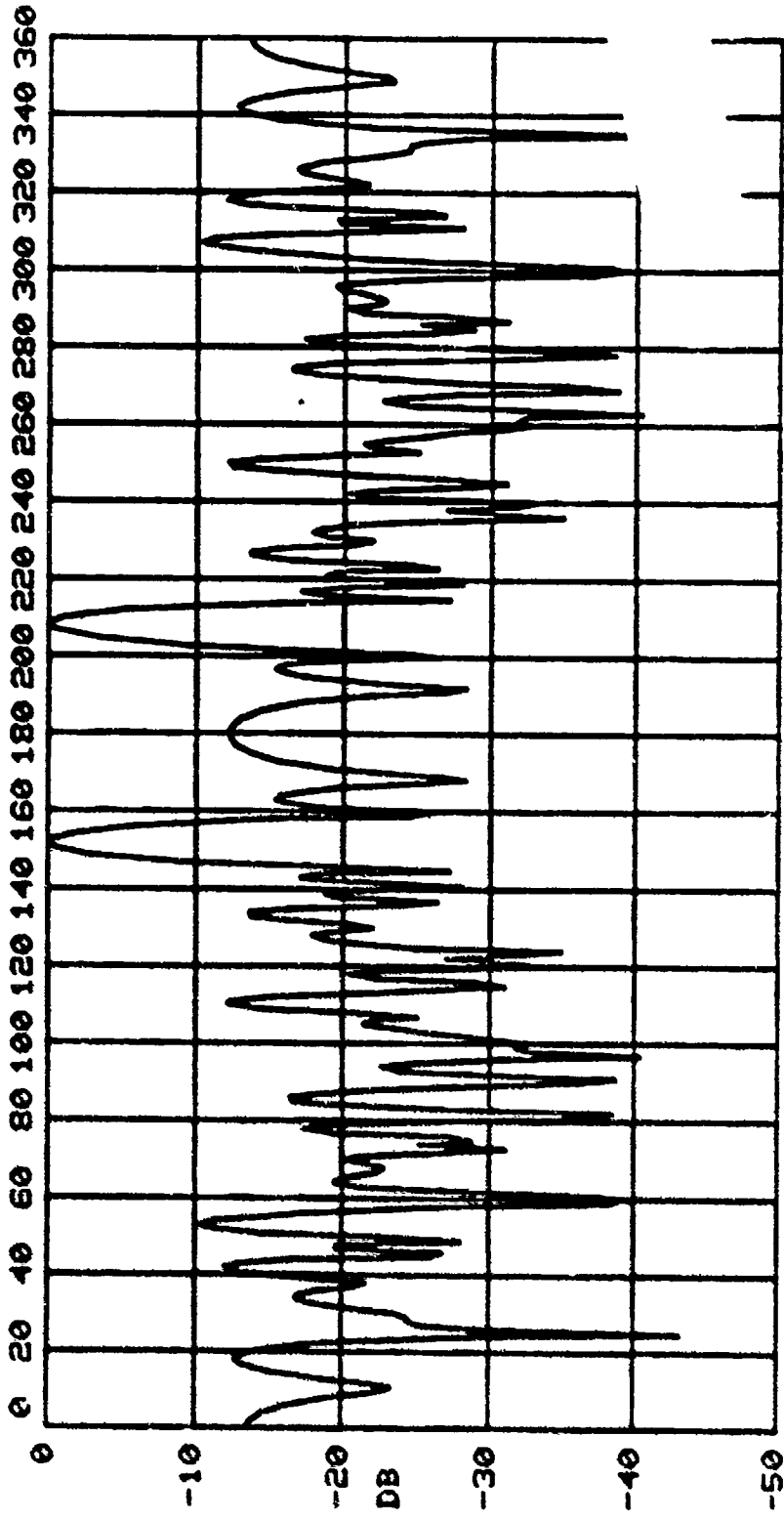
CONFIDENTIAL

array, azimuth gain 15.0 dB.

CONFIDENTIAL

S1069 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-73 UNTLBP 3.1
ARRAY TUNED TO 300 HZ.
UNIFORM SPACING

UNIFORM WEIGHTING.
32 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
32 ELEMENTS, -0.92 DB MAX., AC: S1362, SU: S1362, WT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.08 DEG. 3 DB BEAM, 13.02 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.



CONFIDENTIAL

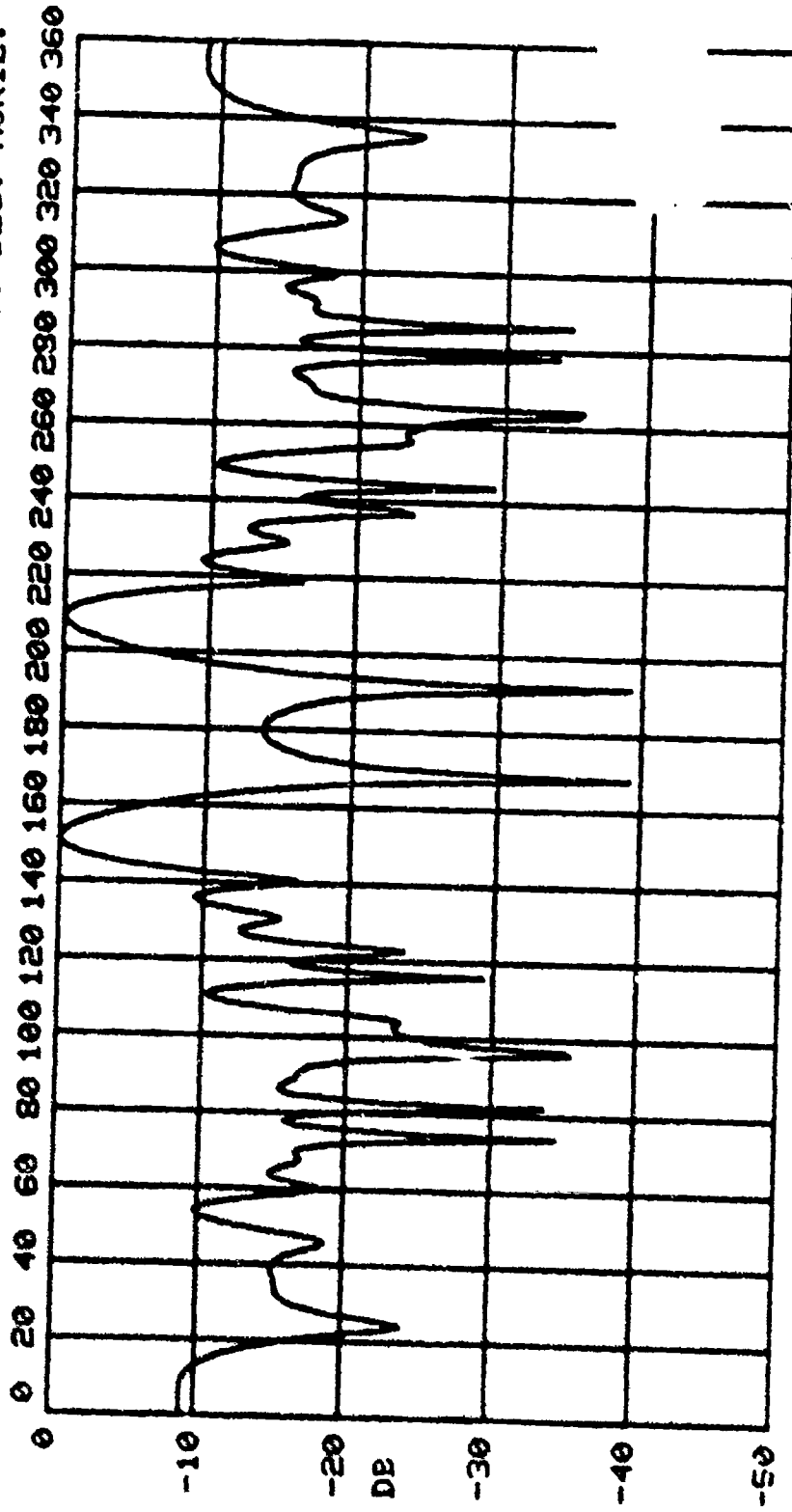
Figure B-106 Theoretical Horizontal Plane Pattern for 32 Element Array at 295 Hz for Data Point / 0, 615 Off Broadside Steering. Beamwidth 6.08°, Azimuth Gain 13.0 dB.

CONFIDENTIAL

51066 E-10ERS BEAM PATTERN PROGRAM (T. NOGAN) 6-Jan-73 QNTLR 3.1
ARRAY TUNED TO 300 HZ.
UNIFORM SPACING

UNIFORM WEIGHTING.

1500 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
16 ELEMENTS, -0.88 DB MAX., AC: S1362, SU: S1362, WT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
11.50 DEG. 3 DB BEAM, 10.04 DB AZ. GAIN, MAX. AT 151.0 DEG. HORIZ.



CONFIDENTIAL

Figure B-107 Theoretical Horizontal Plane Pattern for 16 Element Array at 300 Hz for Data Point 10, 1/5 Off Broadside Steering. Beamwidth 11.50°, Azimuth Gain 10.0 dB.

CONFIDENTIAL

S1363 SWIERS BEAM PATTERN PROGRAM (T.HOGAN) 6-Jan-78 ONTLEP 3.1
: 300 HZ. TUNED TO 300 HZ.
: 151.5 FT. UNIFORM SPACING

07/70

UNIFORM WEIGHTING.

1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.

395.0 HZ., 8 ELEMENTS, -0.57 DB MAX., AC:S1362, SU:S1362, UT:

90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER

28.95 DEG. 3 DB BEAM, 6.86 DB AZ. GAIN, MAX. AT 154.0 DEG. HORIZ.

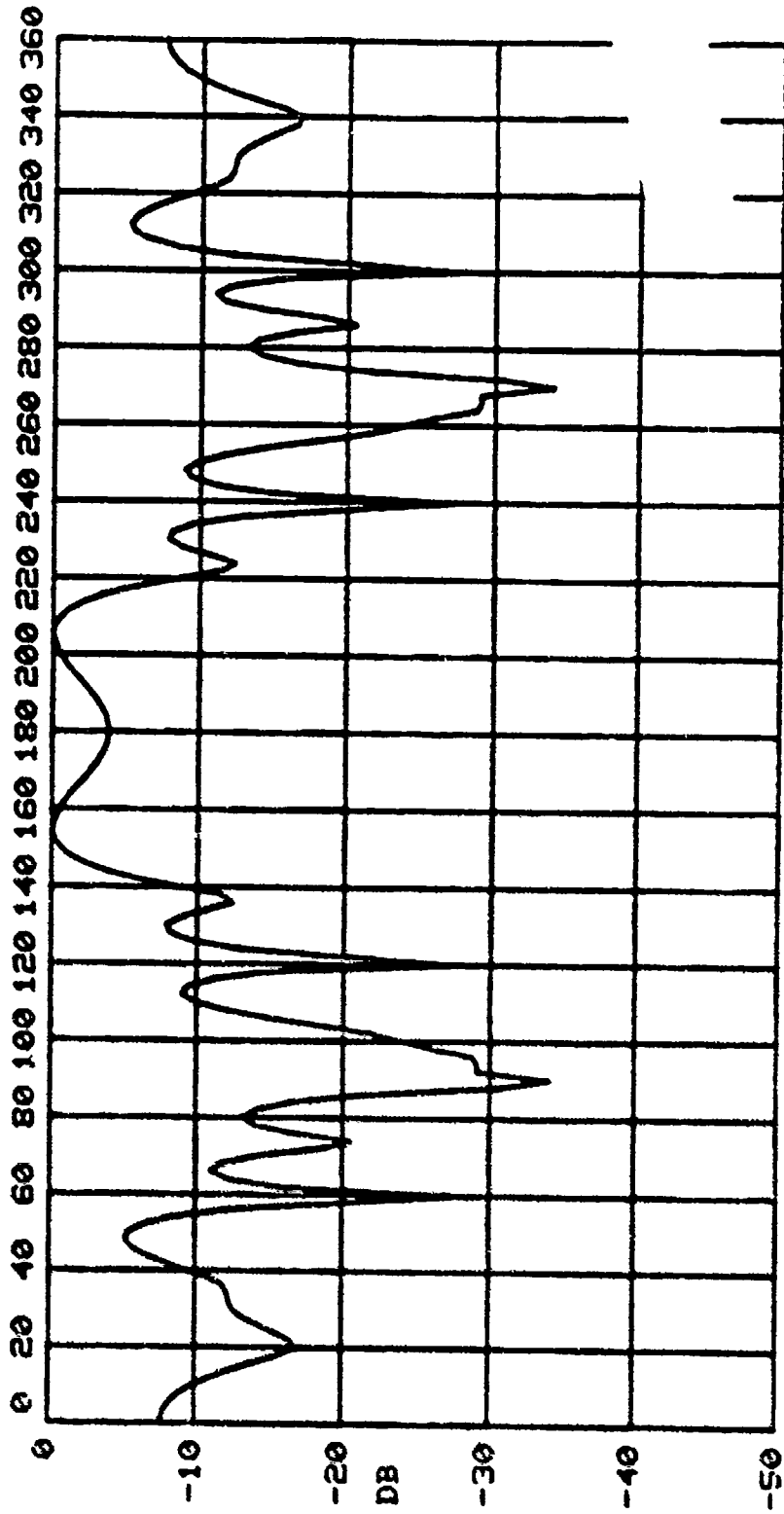


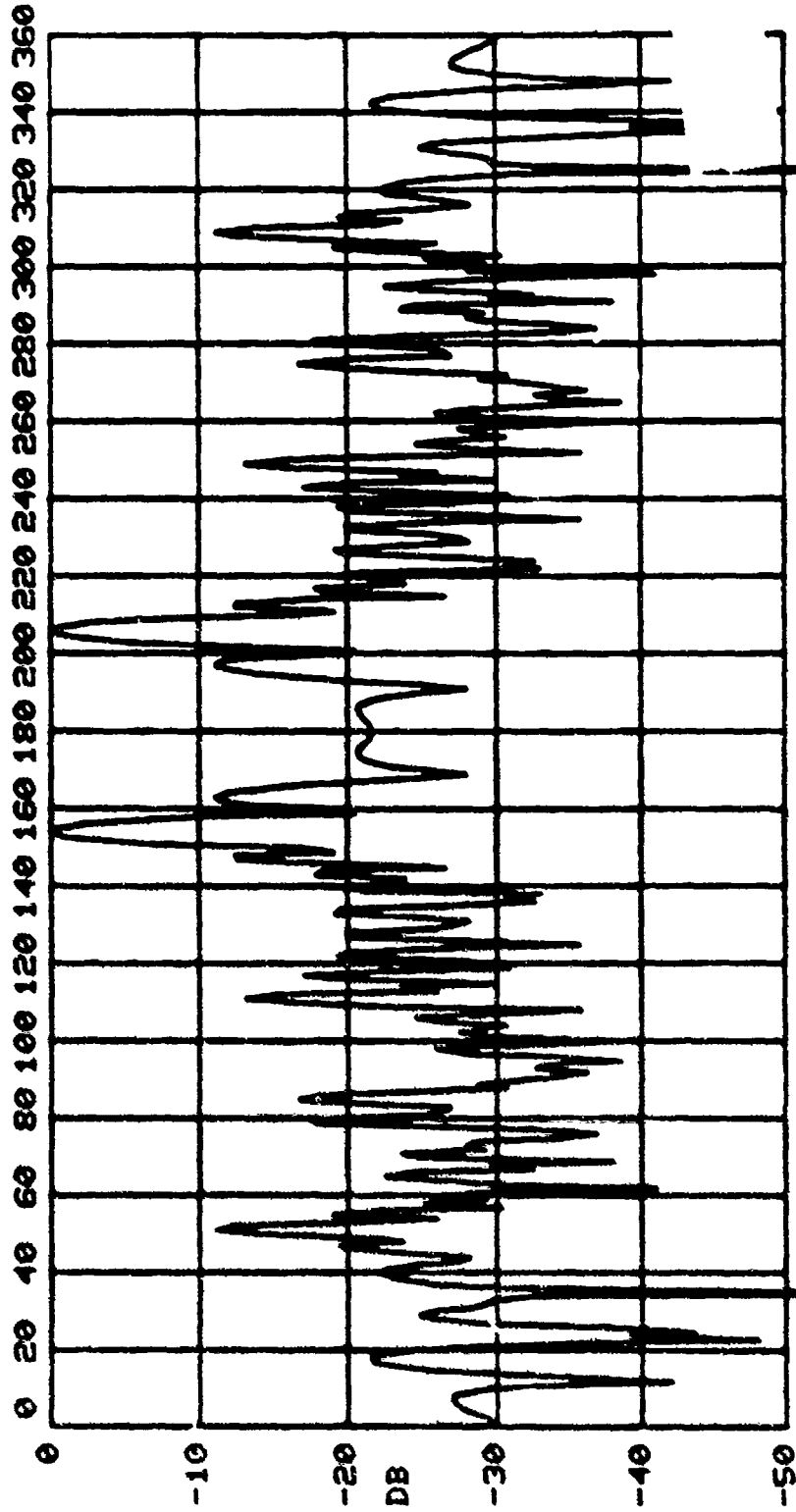
Figure B-108 Theoretical Horizontal Plane Pattern for 8 Element Array @ 295 Hz for Data Point 10, 6.5 Off Broadside Steering. Beamwidth 26.75°, Azimuth Gain 6.8 dB.

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54000 SWIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
ARRAY TUNED TO 300 HZ.
3.1233 FT. UNIFORM SPACING.
: 5412

DATA POINT 11
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
200.0 HZ., 51 ELEMENTS, -0.83 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 154.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.45 DEG. 3 DB BEAM, 14.85 DB AZ. GAIN, MAX. AT 206.0 DEG. HORIZ.



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Figure B-109 Theoretical Horizontal Plane Pattern for 5/ Element
Array @ 290 Hz for Data Point //, 64 Off Broadside
Steering. Beamwidth 4.46°, Azimuth Gain 14.8 dB.

CONFIDENTIAL

14.05 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-73 QNTLEP 3.1
... 290.0 HZ. ARRAY TUNED TO 300 HZ.
... 3.1233 FT. UNIFORM SPACING.
... 5.86

DATA POINT 11
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 32 ELEMENTS, -0.73 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 153.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
5.86 DEG. 3 DB BEAM, 13.01 DB AZ. GAIN, MAX. AT 153.0 DEG. HORIZ.

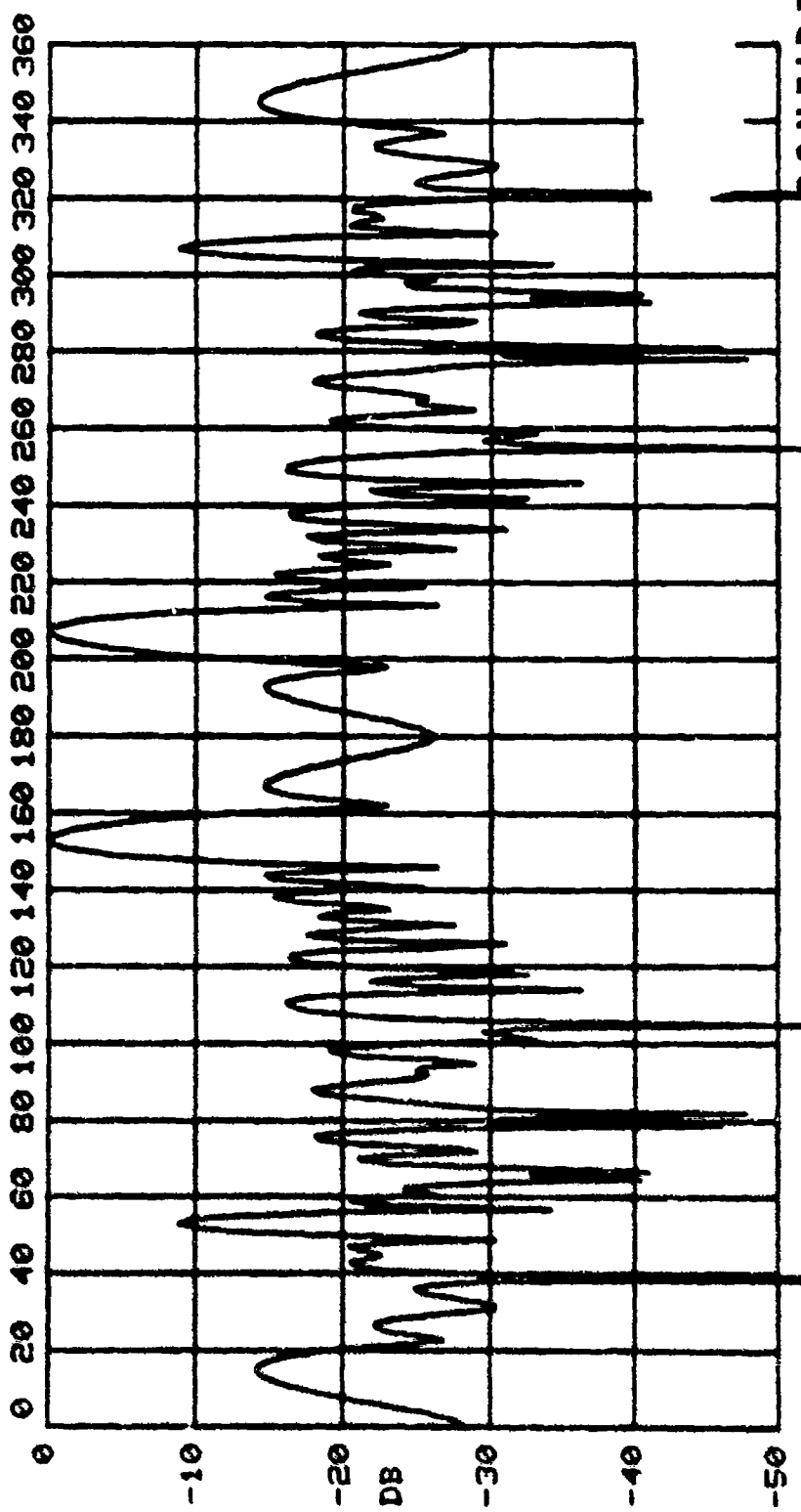


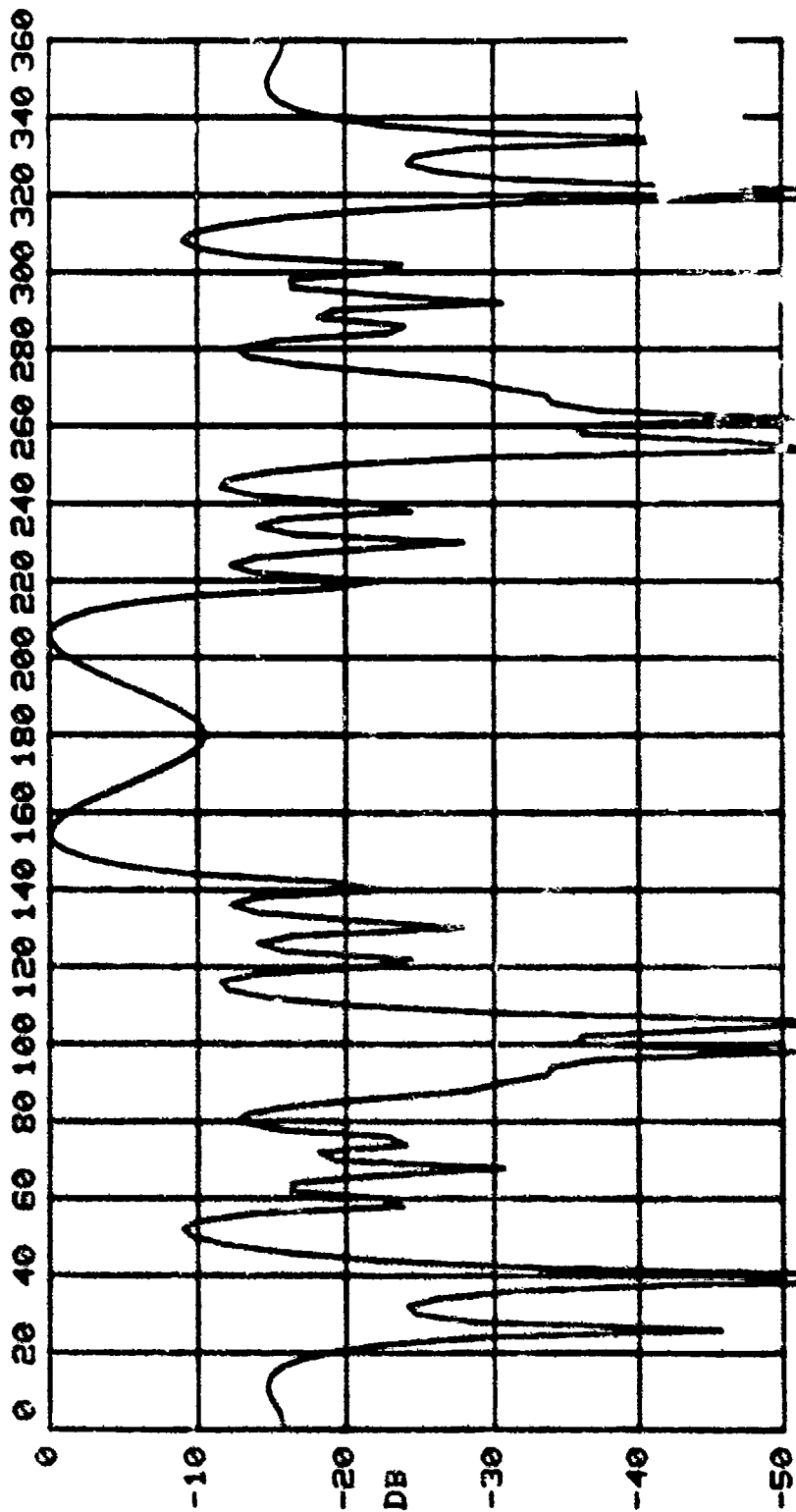
Figure B-110 Theoretical Horizontal Plane Pattern for 32 Element Array @ 290 Hz for Data Point //, 63 Off Broadside Steering. Beamwidth 6.86°, Azimuth Gain 13.0 dB.

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CONFIDENTIAL

54020 SAIDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 QNTLBP 3.1
ARRAY TUNED TO 300 HZ.
3.0233 FT. UNIFORM SPACING.
DATE

DATA POINT 11
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
290.0 HZ., 16 ELEMENTS, -0.78 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 154.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
15.94 DEG. 3 DB BEAM, 9.43 DB AZ. GAIN, MAX. AT 206.0 DEG. HORIZ.



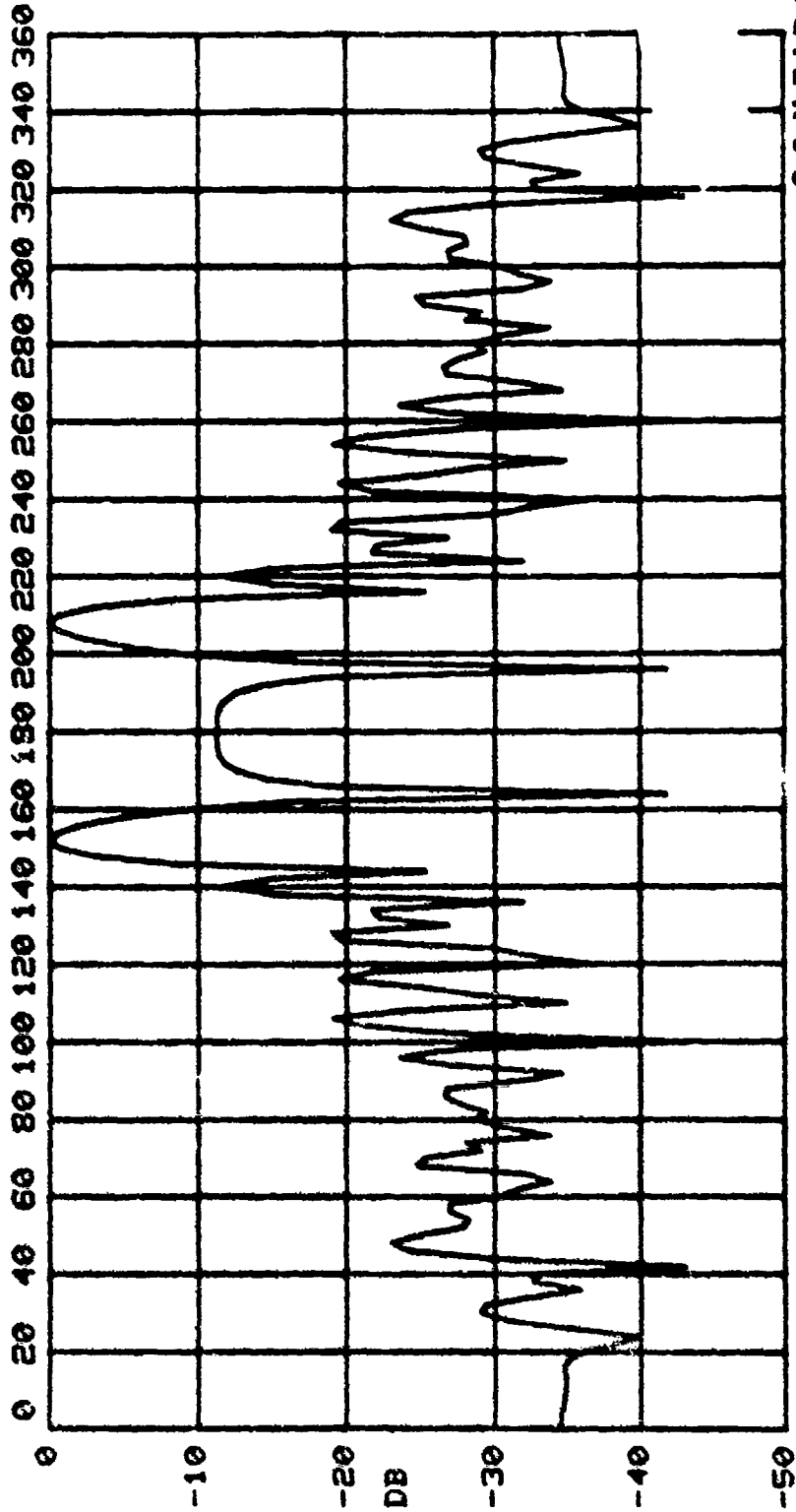
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Figure B-III Theoretical Horizontal Plane Pattern for 16 Element Array @ 290 Hz for Data Point //, 64 Off Broadside Steering. Beamwidth/5.94°, Azimuth Gain 9.4 dB.

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SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLRP 3.1
ARRAY TUNED TO 300 HZ.
5.3233 FT. UNIFORM SPACING.
: 3MHz

DATA POINT 11
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 51 ELEMENTS, -0.18 DB MAX., AC:S2581, SU:S2581, WT:
90.0 DEG. VERT. RESP., 152.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
8.69 DEG. 3 DB BEAM, 12.42 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.



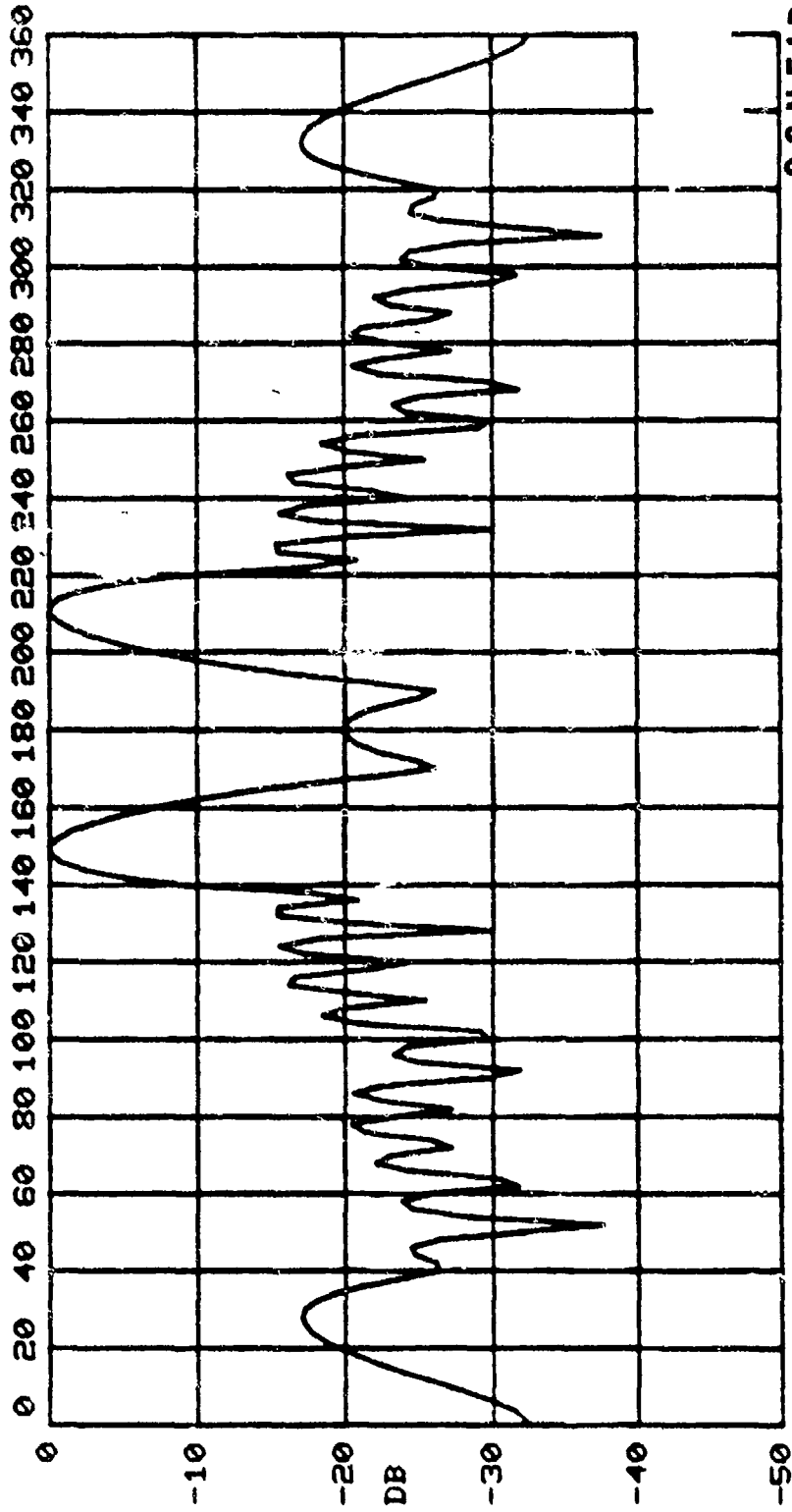
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Figure 8-112. Theoretical Horizontal Plane Pattern for 5/ Element Array ± 140 Hz for Data Point 11, 62 Off Broadside Steering. Beamwidth 8.69°, Azimuth Gain 12.42 dB.

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S402R SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 QNTLEP 3.1
ARRAY TUNED TO 300 HZ.
1.5223 FT. UNIFORM SPACING.
SCALE

DATA POINT 11
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 32 ELEMENTS, -0.31 DB MAX., AC:S2581, SU:S2581, WT:
90.0 DEG. VERT. RESP., 149.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
12.90 DEG. 3 DB BEAM, 10.91 DB AZ. GAIN, MAX. AT 150.0 DEG. HORIZ.



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Figure B-113 Theoretical Horizontal Plane Pattern for 32-Element Array @ 140 Hz for Data Point 11, 59 Off Broadside Steering. Beamwidth 12.90, Azimuth Gain 10.9 dB.

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54329 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 5-Apr-78 ONTLBP 3.1
: ARRAY ARRAY TUNED TO 300 HZ.
: 3.333 FT. UNIFORM SPACING.
: SAME

DATA POINT 11
1200 HZ. SAMPLING FREQUENCY DISTORTS PATTERN.
140.0 HZ., 16 ELEMENTS, -0.19 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 147.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
27.48 DEG. 3 DB BEAM, 7.63 DB AZ. GAIN, MAX. AT 212.0 DEG. HORIZ.

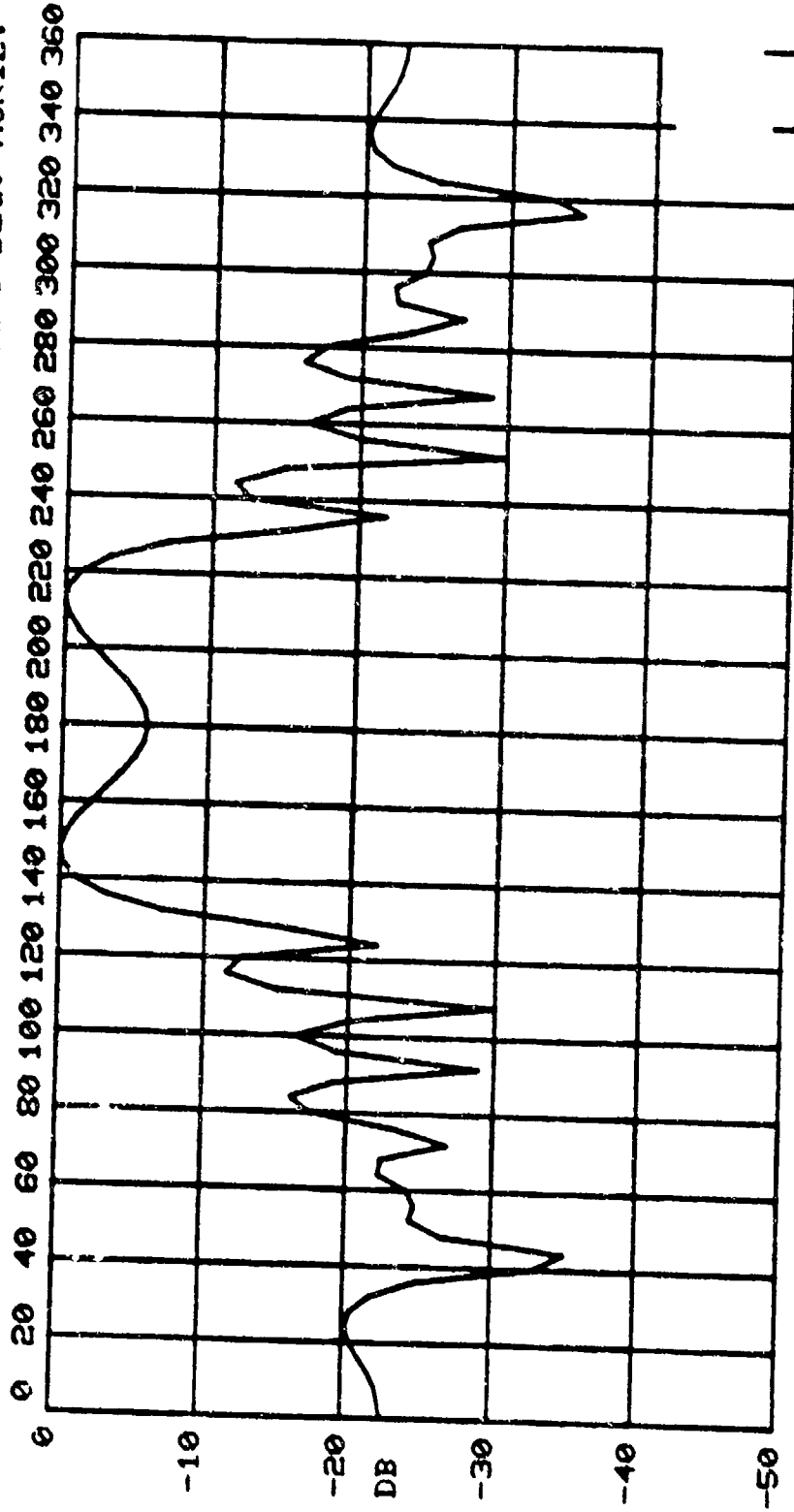


Figure B-114 Theoretical Horizontal Plane Pattern for 16 Element
Array @ 140 Hz for Data Point 11, 57 Off Broadside
Steering. Beamwidth 27.48°, Azimuth Gain 7.6 dB.

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CONFIDENTIAL

52053 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 QNTLBP 3.1
1: SPERRY ARRAY TUNED TO 300 HZ.
2: 3233 FT. UNIFORM SPACING.
3: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
290.0 HZ., 51 ELEMENTS, -0.81 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 90.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.14 DEG. 3 DB BEAM, 15.15 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.

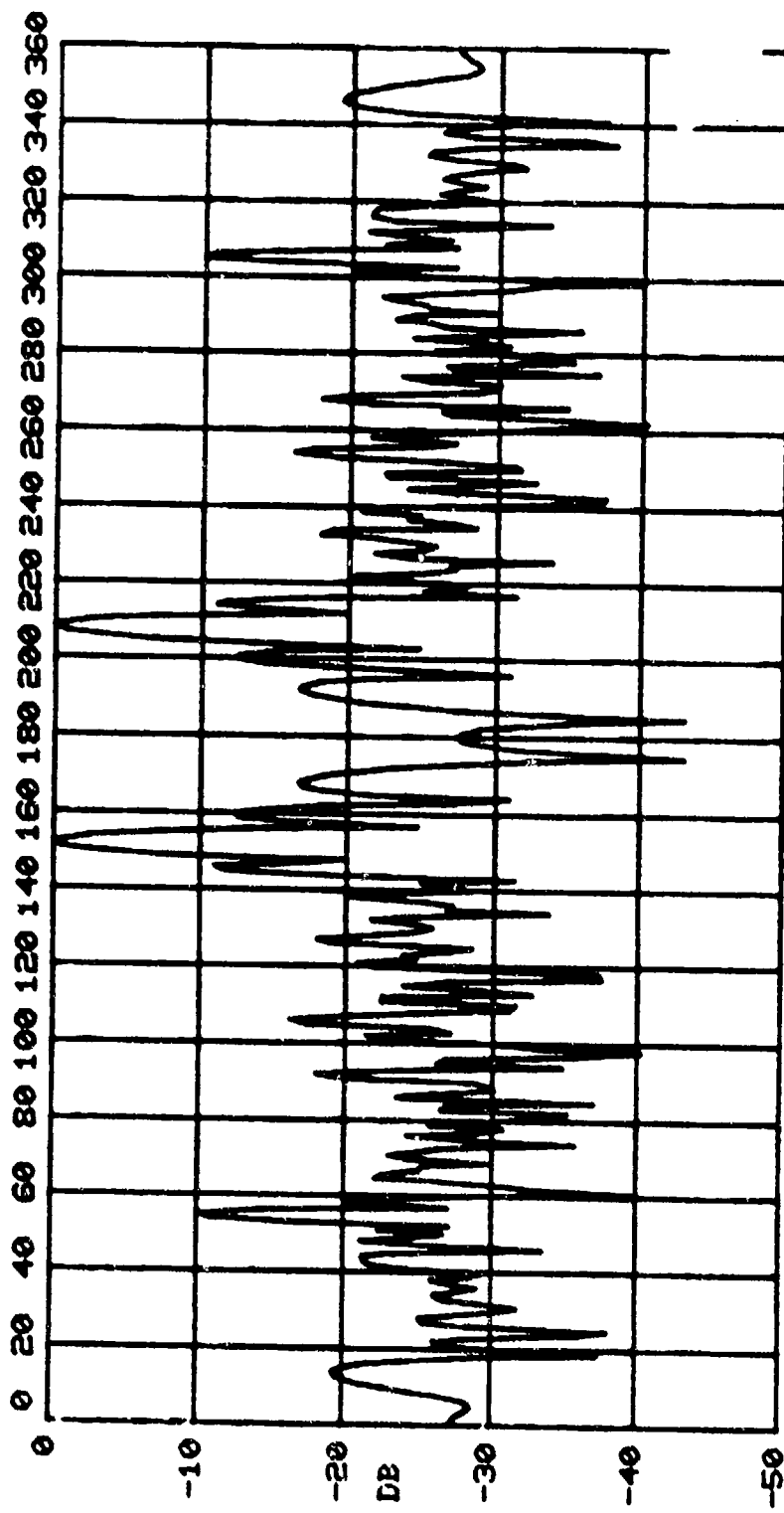


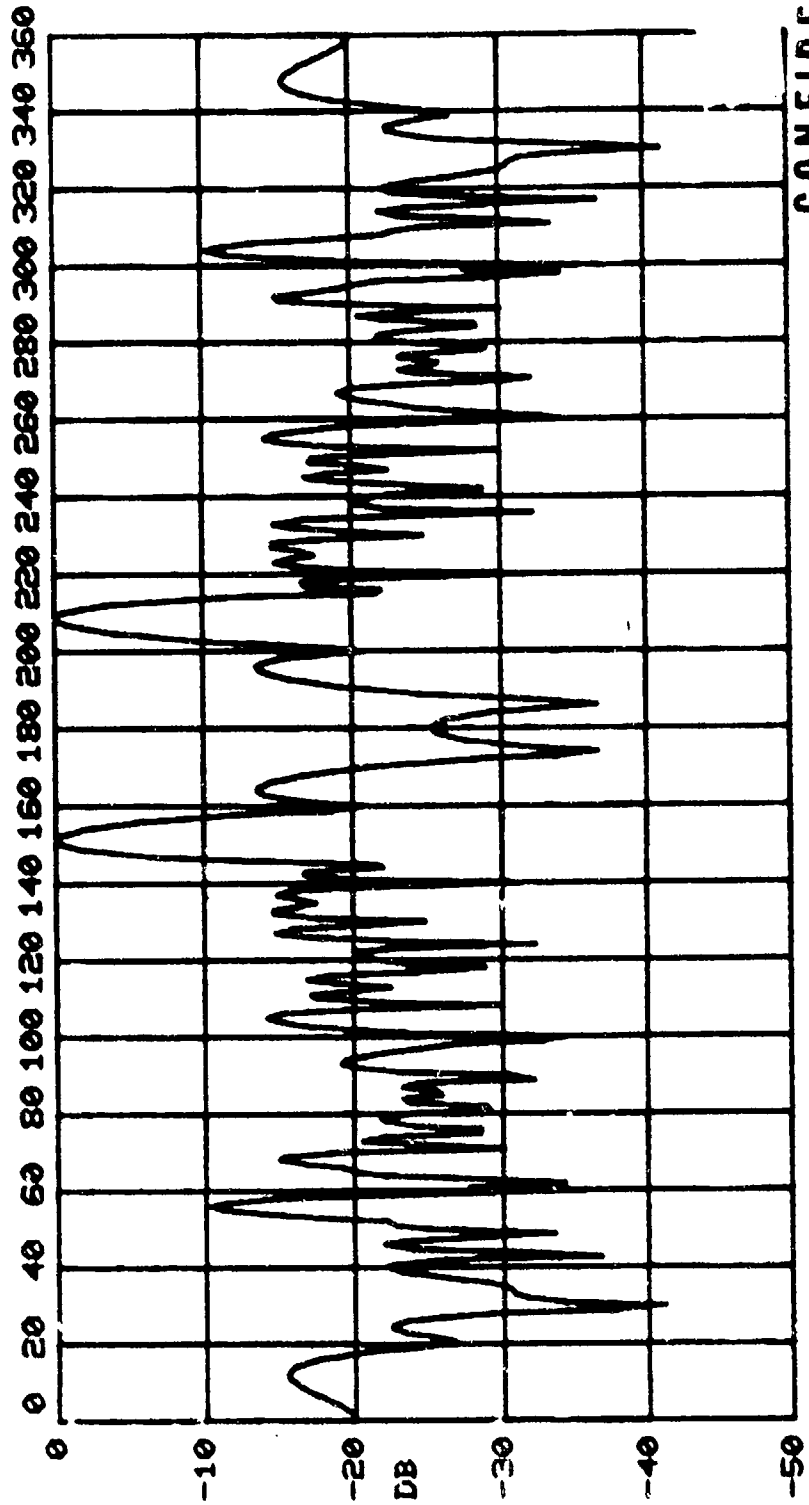
Figure G-115 Theoretical Horizontal plane Pattern for 51 Element Array @ 290 Hz for Data Point 12, 62° Off Broadside Steering. Beamwidth 4.14°, Azimuth Gain 15.1 dB.

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55265 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 ONTLBP 3.1
A: SPRAY ARRAY TUNED TO 300 HZ.
S: 8.3233 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
290.0 HZ., 32 ELEMENTS, -0.85 DB MAX., AC:52581, SU:52581, UT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.50 DEG. 3 DB BEAM, 13.14 DB AZ. GAIN, MAX. AT 209.0 DEG. HORIZ.



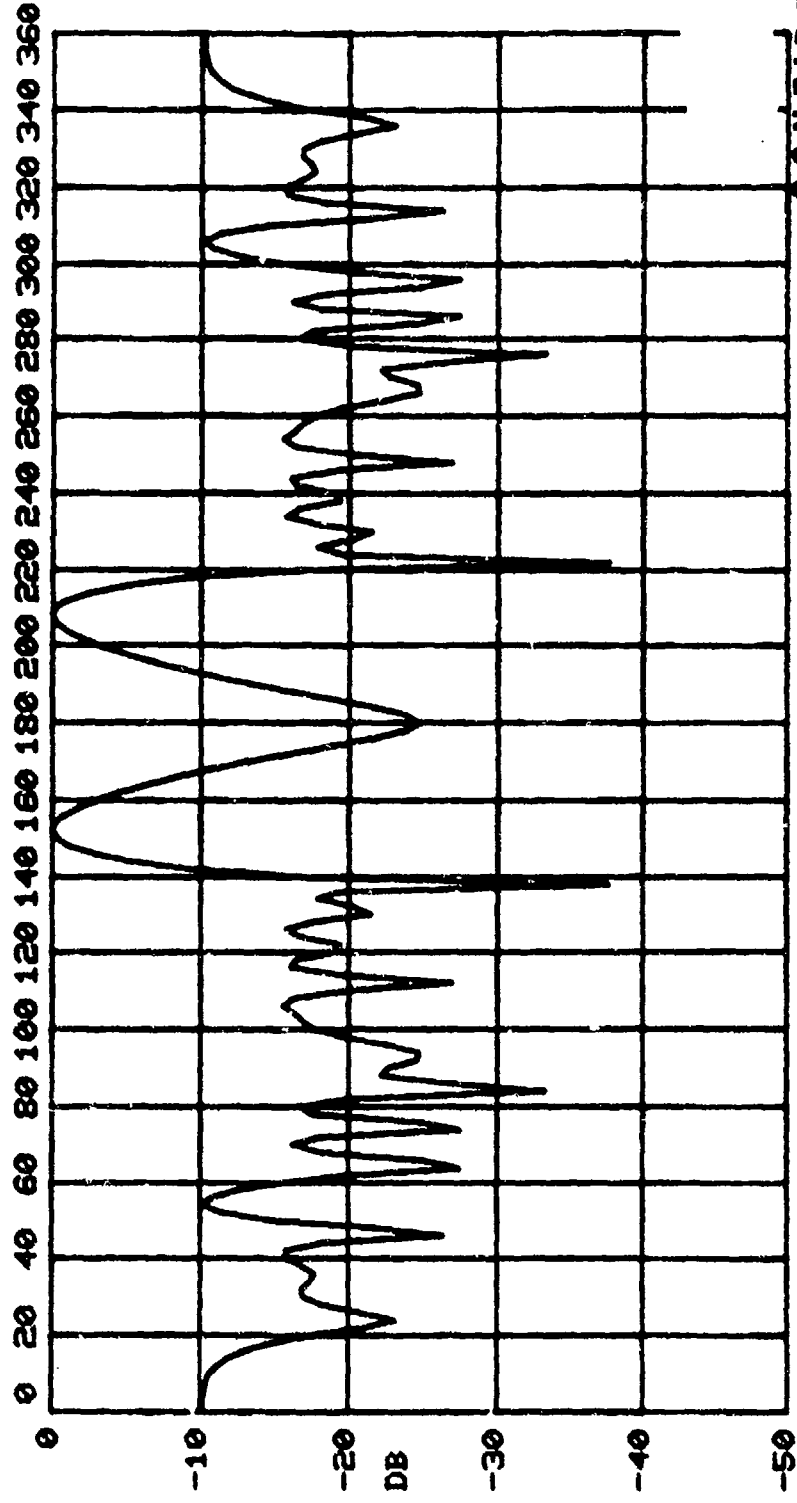
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Figure B-116 Theoretical Horizontal Plane Pattern for 32 Element Array @ 290 Hz for Data Point 12, 645 Off Broadside Steering. Beamwidth 6.50°, Azimuth Gain 13.14 dB.

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55262 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 ONTLBP 3.1
A: SPRAY ARRAY TUNED TO 300 HZ.
S: 8.3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
290.0 HZ., 16 ELEMENTS, -0.76 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
14.38 DEG. 3 DB BEAM, 9.80 DB AZ. GAIN, MAX. AT 152.0 DEG. HORIZ.



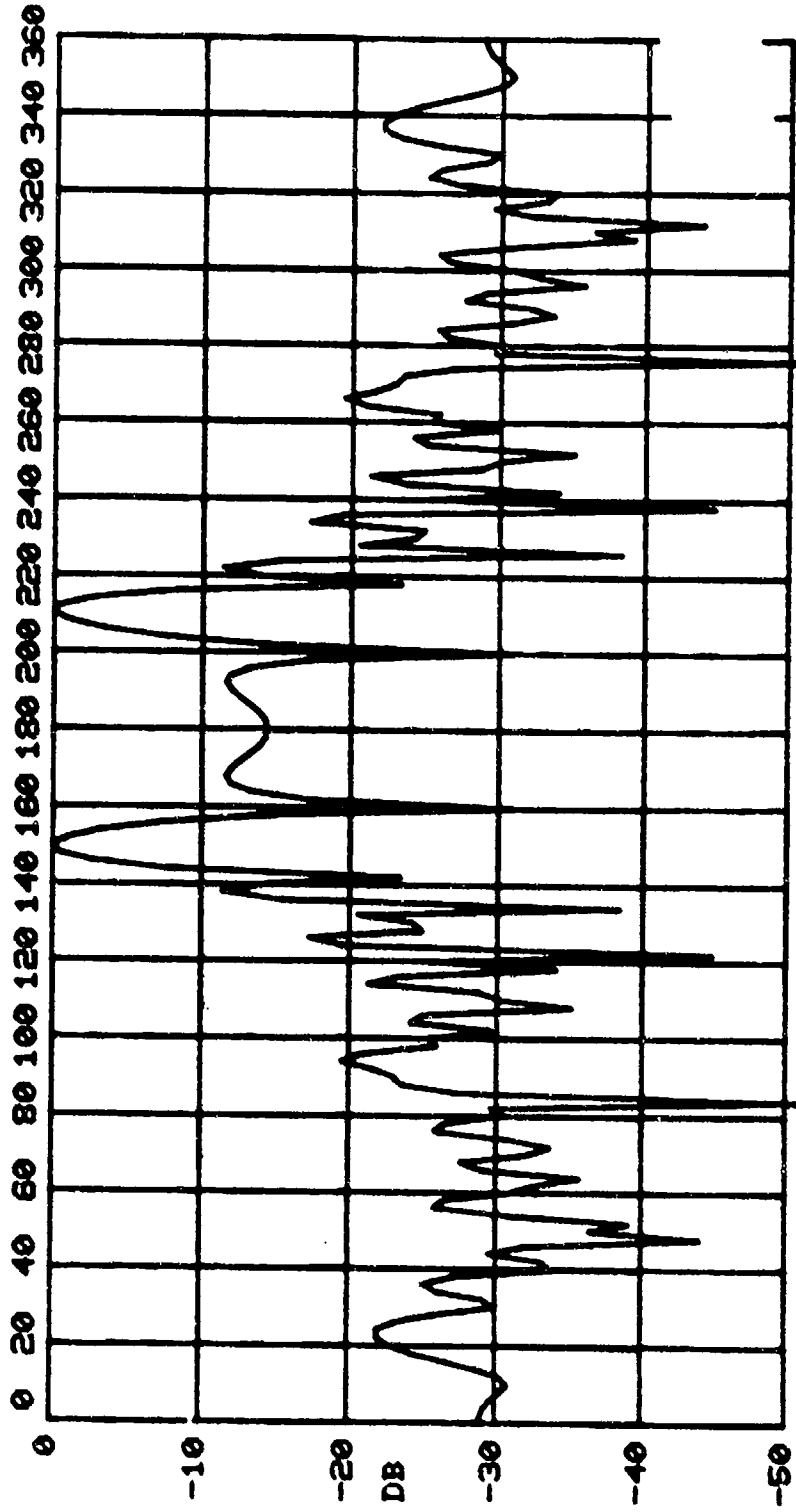
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Figure B-117 Theoretical Horizontal Plane Pattern for 16 Element
Array @ 290 Hz for Data Point 12, 61.5 Off Broadside
Steering. Beamwidth 14.38°, Azimuth Gain 9.8 dB.

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S5267 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 ONTLBP 3.1
A: EPPAY ARRAY TUNED TO 300 HZ.
S: 2.3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
140.0 HZ., 51 ELEMENTS, -0.24 DB MAX., AC:S2581, SU:S2581, UT:
90.0 DEG. VERT. RESP., 149.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
8.05 DEG. 3 DB BEAM, 12.62 DB AZ. GAIN, MAX. AT 150.0 DEG. HORIZ.



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Figure B-118 Theoretical Horizontal Plane Pattern for 5/Element
Array @ 140 Hz for Data Point 12, 51.5 Off Broadside
Steering. Beamwidth 8.05°, Azimuth Gain 12.6 dB.

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S5264 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 QNTLBP 3.1
A: SPRAY ARRAY TUNED TO 300 HZ.
S: 8.3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
140.0 HZ., 32 ELEMENTS, -0.20 DB MAX., AC:S2581, SU:S2581, WT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
13.89 DEG. 3 DB BEAM, 10.61 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.

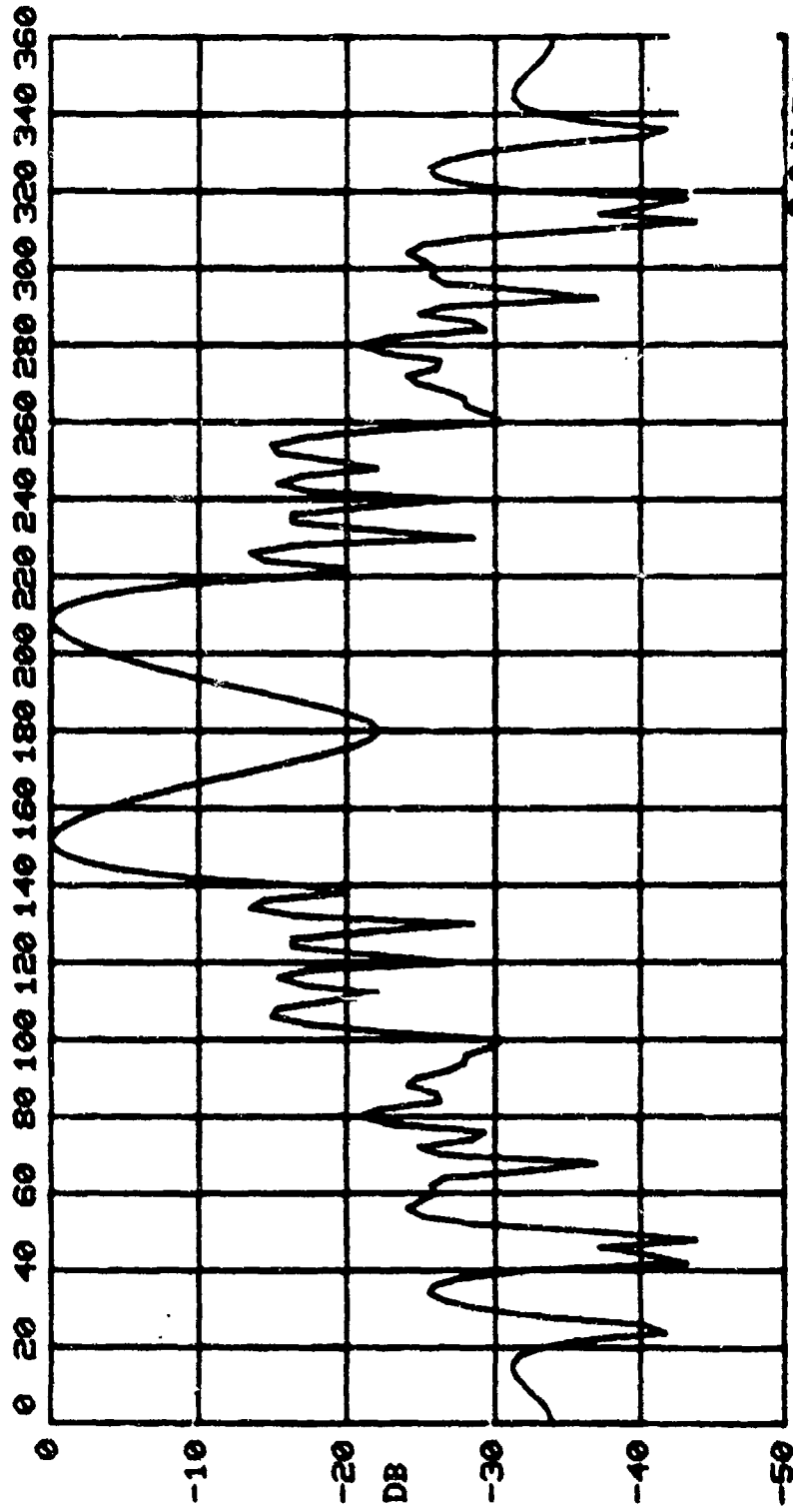


Figure B-114 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 140 Hz for Data Point 12, 6/5 Off Broadside
Steering. Beamwidth 13.89°, Azimuth Gain 10.6 dB.

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55261 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 QNTLBP 3.1
A: SPRAY ARRAY TUNED TO 300 HZ.
8.3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
140.0 HZ., 16 ELEMENTS, -0.18 DB MAX., AC:52581, SU:52581, WT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
34.91 DEG. 3 DB BEAM, 7.36 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.

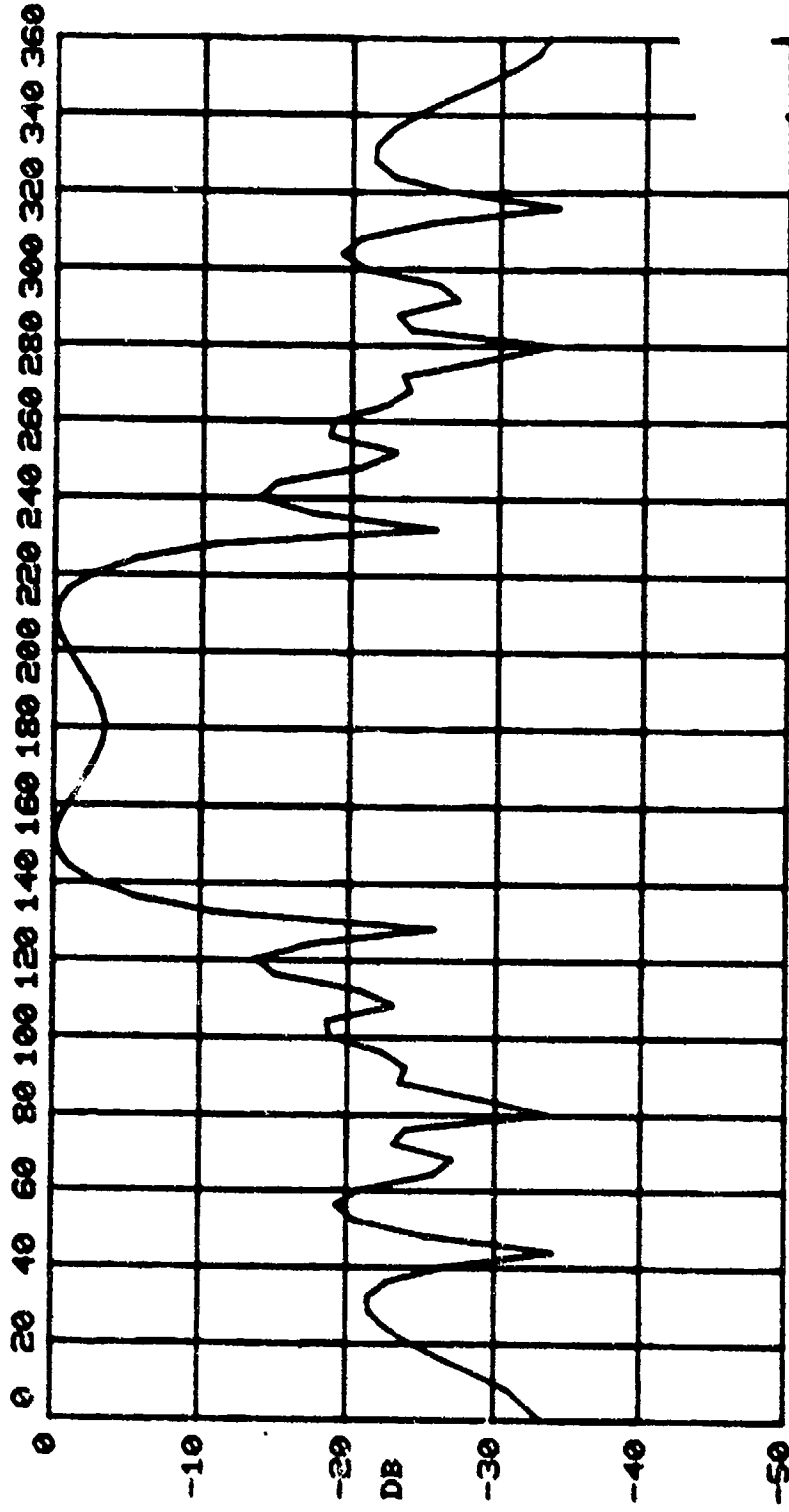


Figure B-120 Theoretical Horizontal Plane Pattern for 16 Element
Array @ 140 Hz for Data Point 12, 61.5° Off Broadside
Steering. Beamwidth 34.91°, Azimuth Gain 7.3 dB.

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55269 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 ONTLBP 3.1
M: SPEAR ARRAY TUNED TO 300 HZ.
S: 3.333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
295.0 HZ., 51 ELEMENTS, -0.89 DB MAX., AC:92581, SU:92581, UT:
90.0 DEG. VERT. RESP., 152.0 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
4.06 DEG. 3 DB BEAM, 15.12 DB AZ. GAIN, MAX. AT 152.0 DEG. HORIZ.

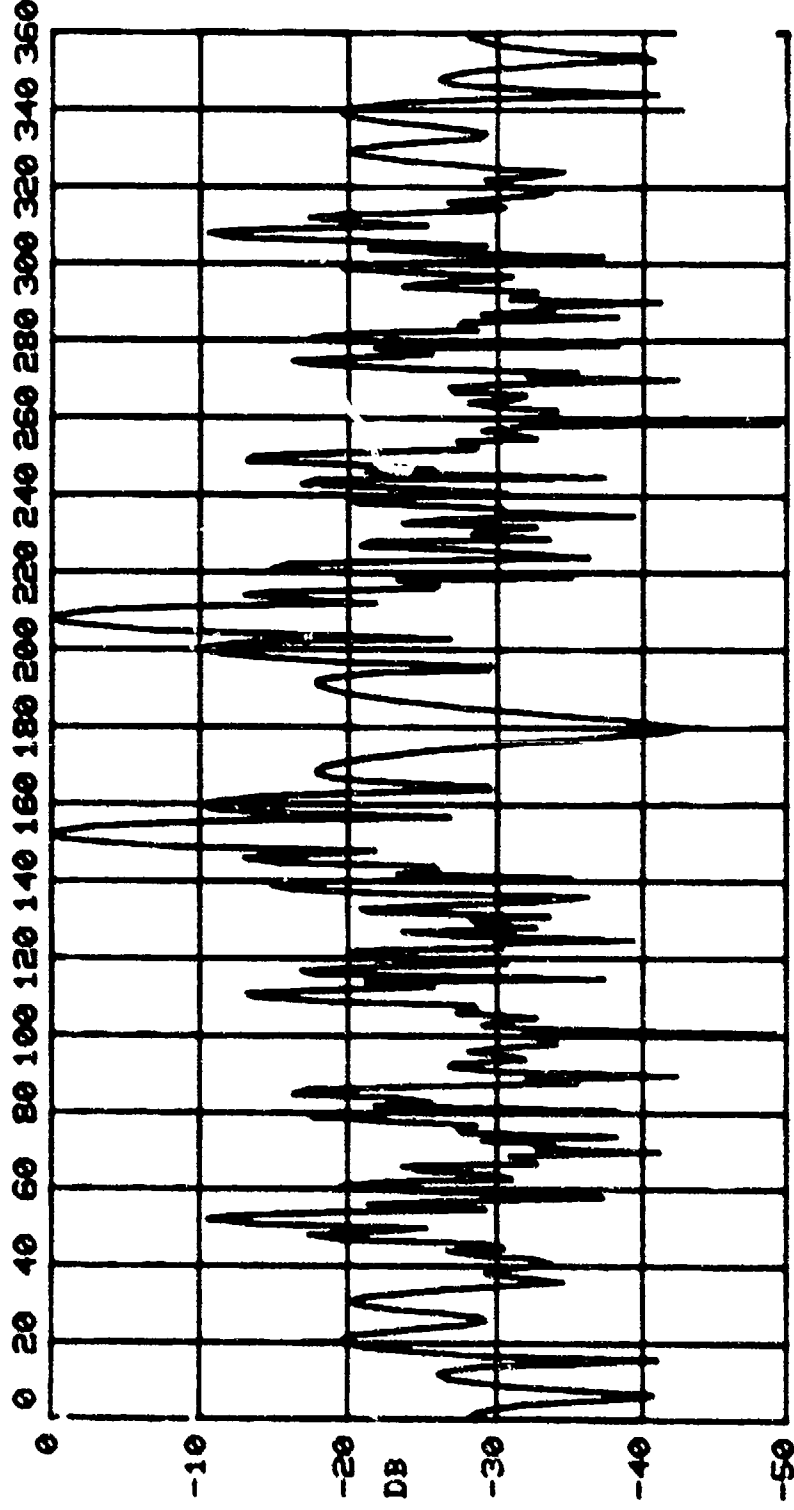


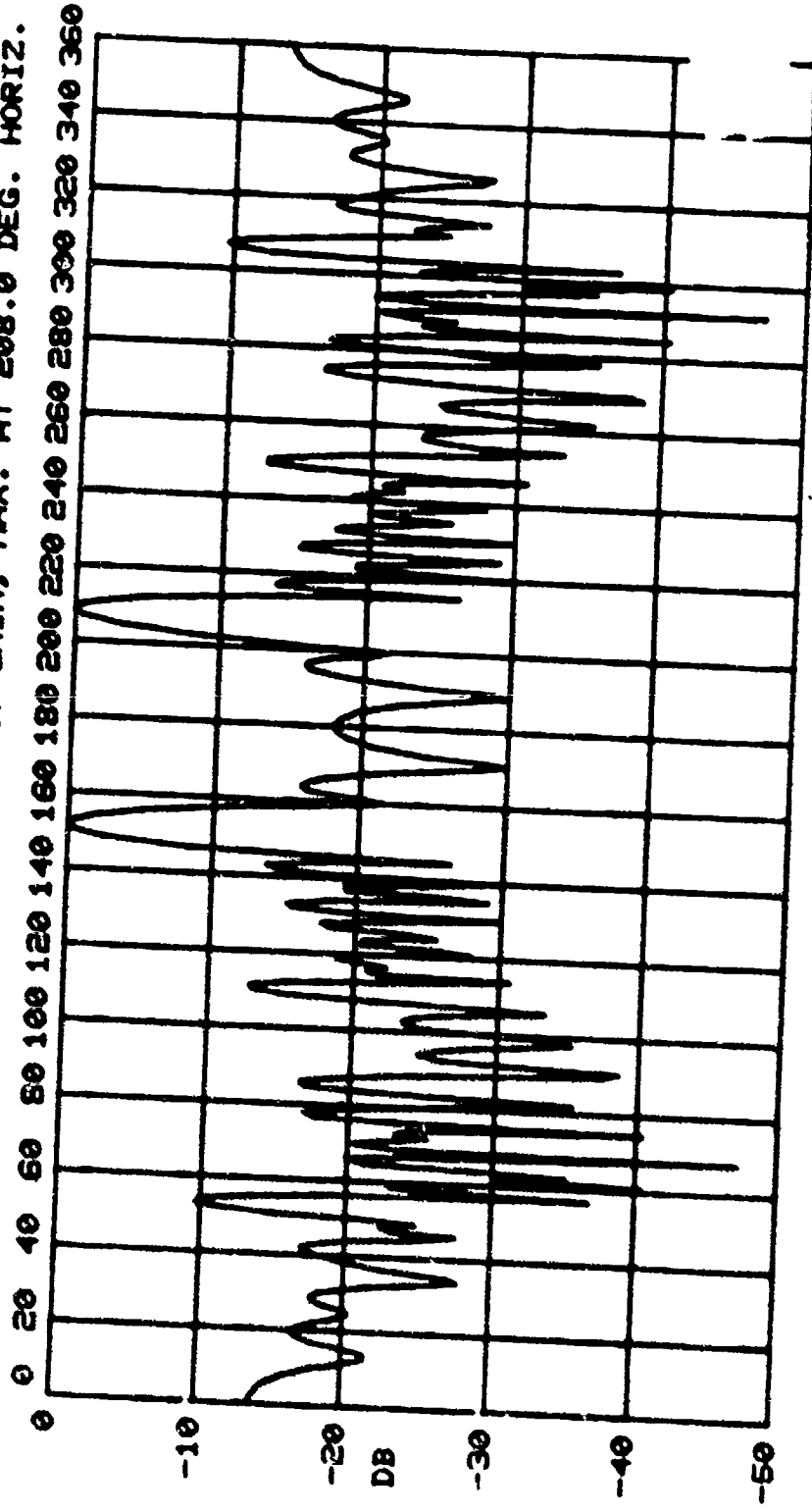
Figure 3-12) Theoretical Horizontal Plane Pattern for 5/Element Array @ 295 Hz for Data Point 12, 62 Off Broadside Steering. Beamwidth 4.06°, Azimuth Gain 15.1 dB.

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SEC66 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 ONTLBP 3.1
"1: SPRAY ARRAY TUNED TO 500 HZ.
2.3333 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
295.0 HZ., 32 ELEMENTS, -0.90 DB MAX., AC:92581, SU:92581, WT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
6.47 DEG. 3 DB BEAM, 13.07 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.



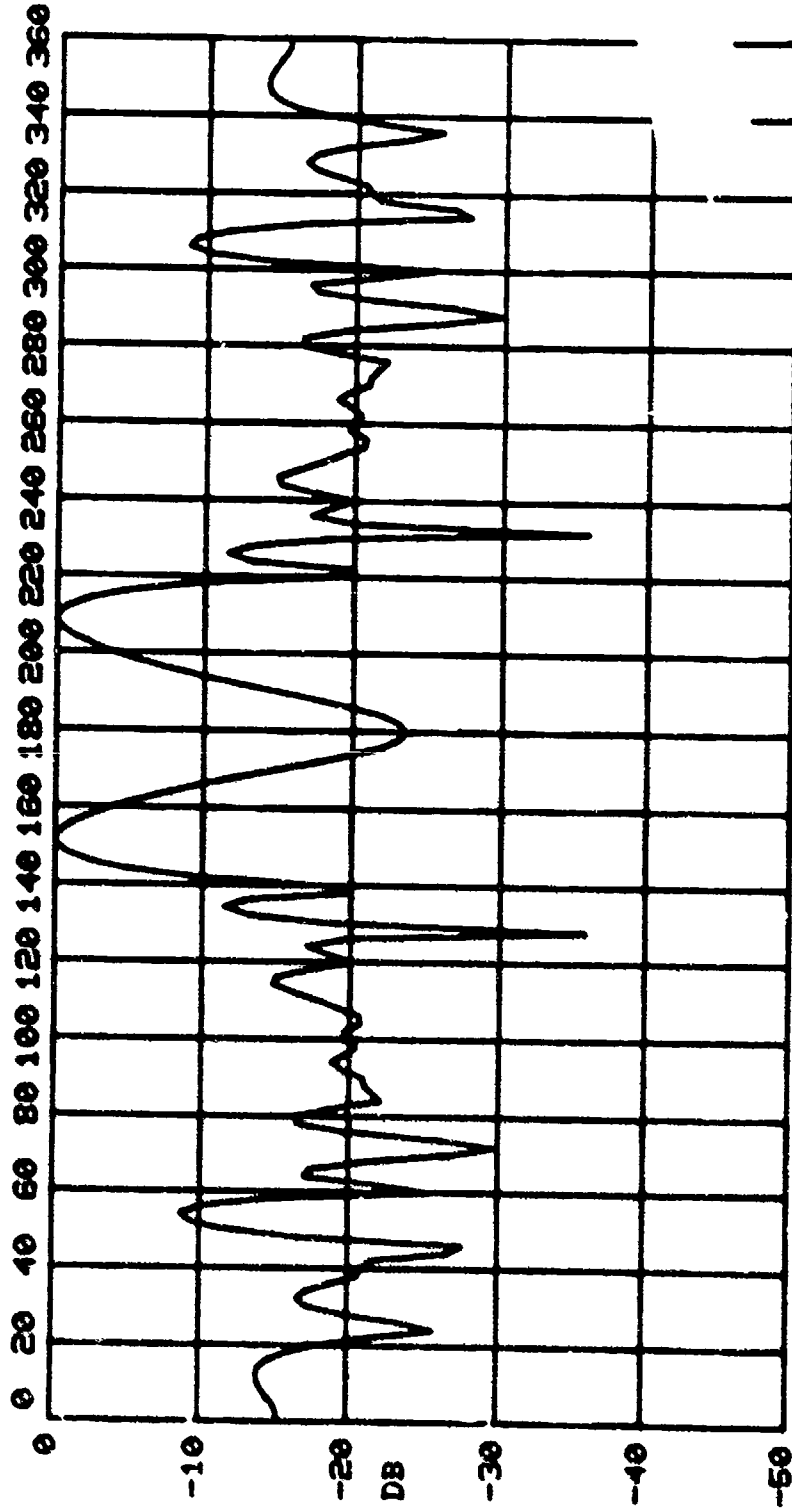
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Figure B-72 Theoretical Horizontal Plane Pattern for 32 Element
Array @ 295 Hz for Data Point 12, 645 Off Broadside
Steering. Beamwidth 6.47°, Azimuth Gain 13.0 dB.

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SS263 SANDERS BEAM PATTERN PROGRAM (T.HOGAN) 27-May-78 ONTLBP 3.1
A: SPPHY ARRAY TUNED TO 300 HZ.
S: 8.3233 FT. UNIFORM SPACING.
S: SAME

DATA POINT 12
1200 HZ SAMPLING FREQUENCY DISTORTS PATTERN
295.0 HZ., 16 ELEMENTS, -0.79 DB MAX., AC:S2581, SU:S2581, WT:
90.0 DEG. VERT. RESP., 151.5 DEG. HORIZ. STEER, 90.0 DEG. VERT STEER
13.79 DEG. 3 DB BEAM, 10.06 DB AZ. GAIN, MAX. AT 208.0 DEG. HORIZ.



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Figure B-123 Theoretical Horizontal Plane Pattern for 16 Element Array at 300 Hz for Data Point 12, 61.5 Off Broadside Steering. Beamwidth 13.79°, Azimuth Gain 10.06 dB.

UNCLASSIFIED

APPENDIX C MEASURED BEAMWIDTH DATA (U)

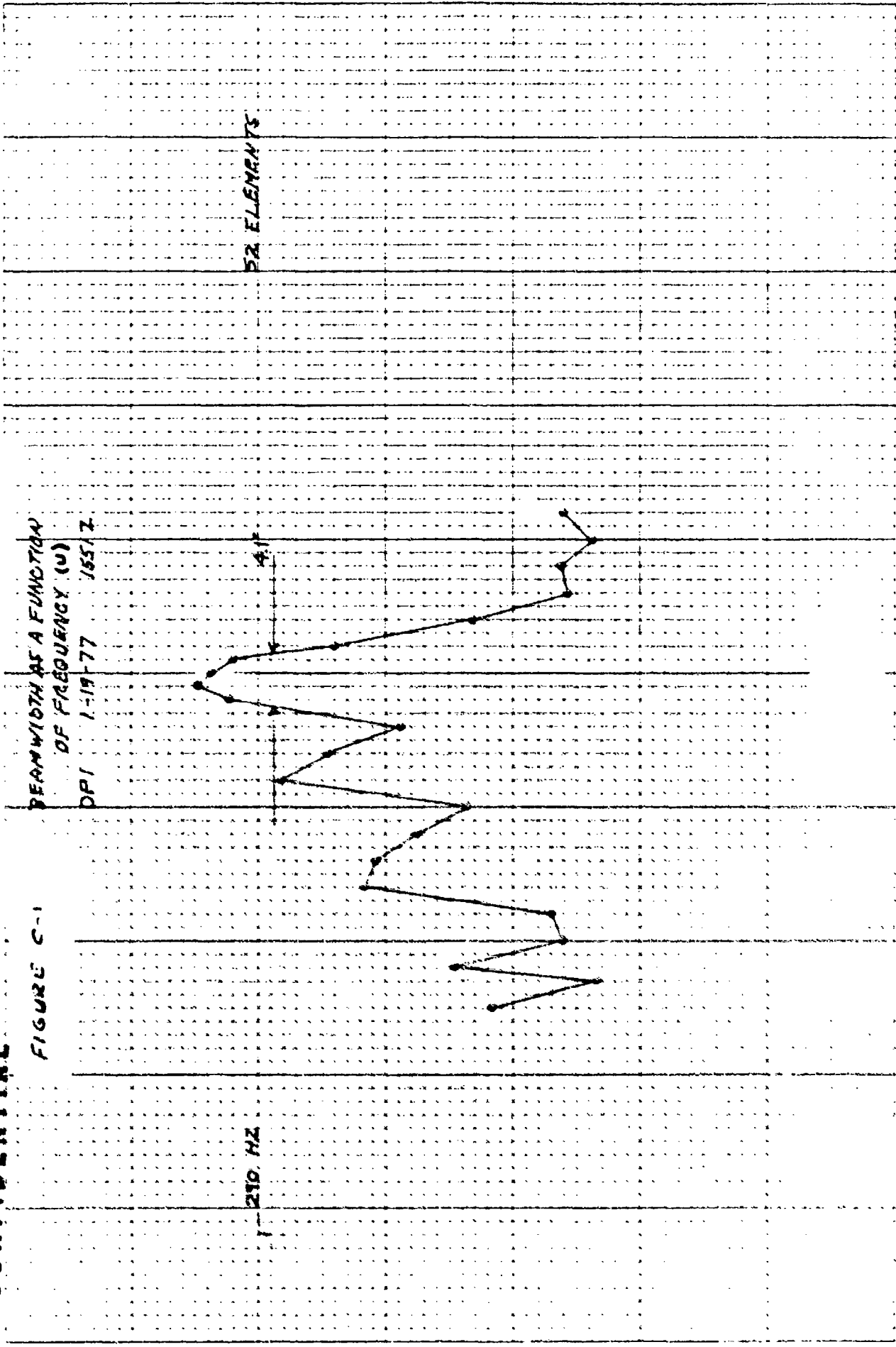
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FIGURE C-1

BEAM WIDTH AS A FUNCTION OF FREQUENCY (U)

DPI 1-19-77 1551 Z



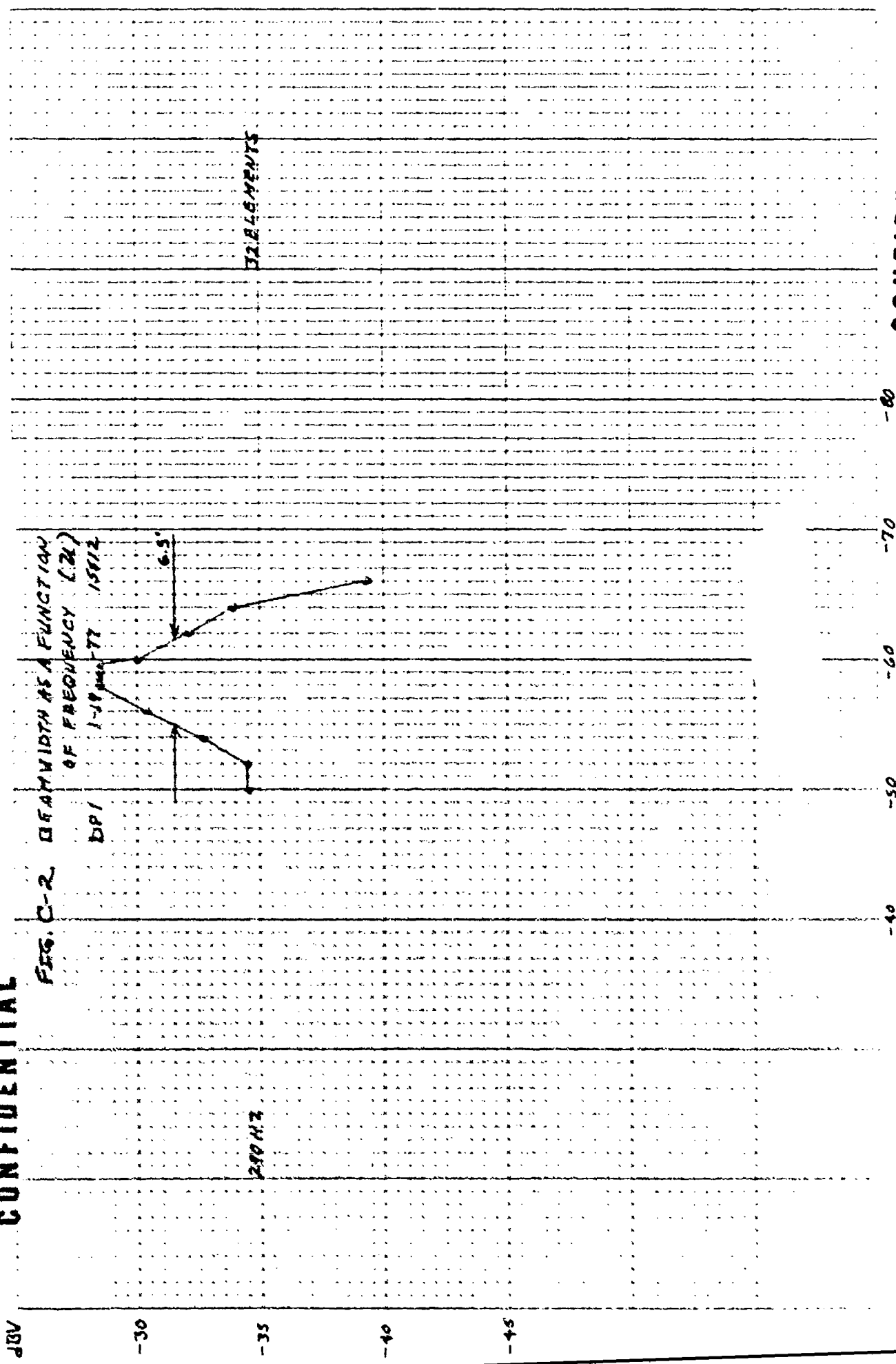
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DEGREES OFF BROADSIDE

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FIG. C-2 BEAMWIDTH AS A FUNCTION OF FREQUENCY (20)

DPI 1-19 mm-77 15012



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DEGREES OFF BROADSIDE

-40

-60

-70

-80

DB

-30

-35

-40

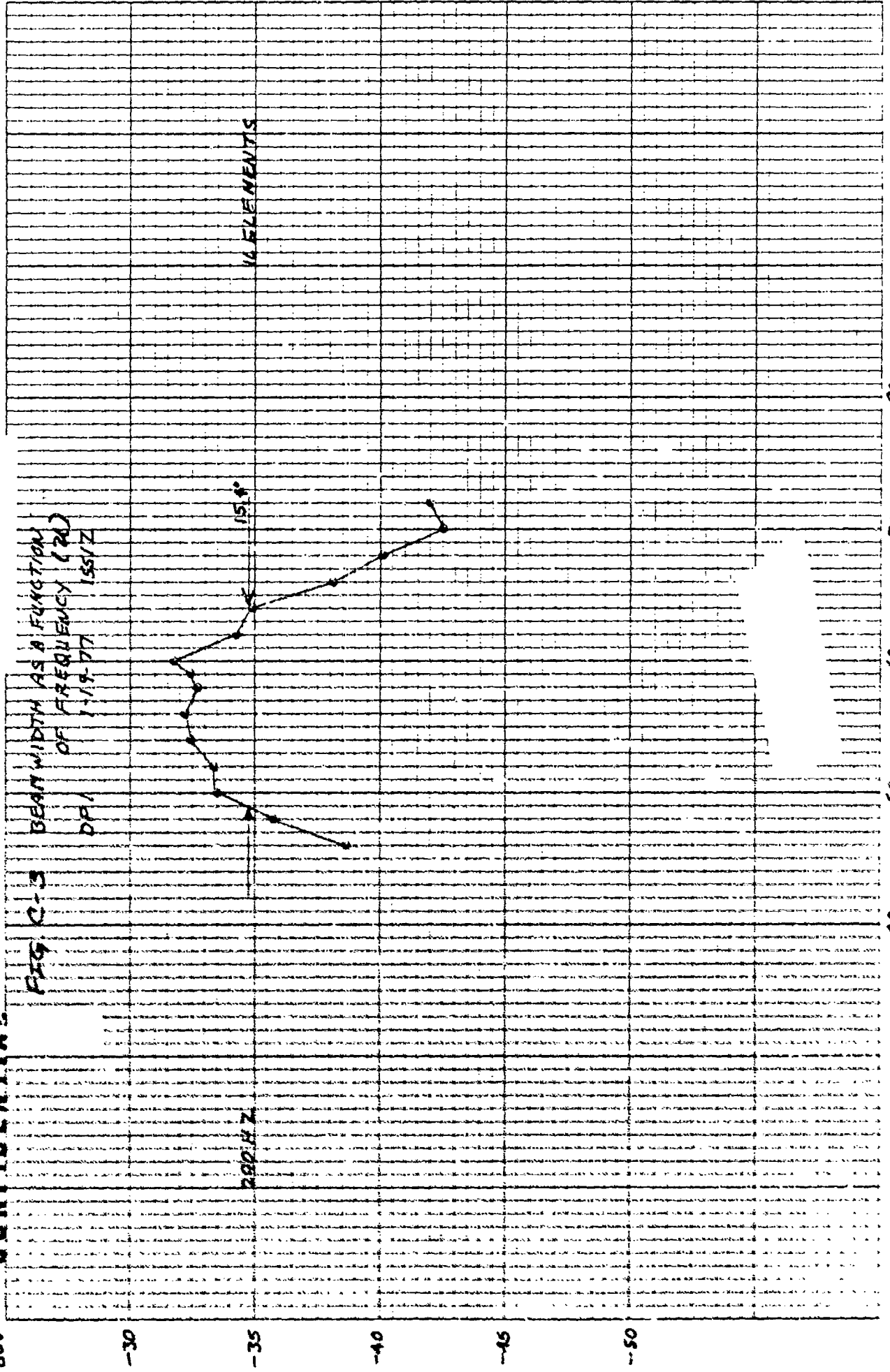
-45

250 Hz

ELEMENTS

6.5

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DEGREES OFF BROADSIDE

46 0703

NO. 2 IS RIGHT & LEANED TO THE LEFT

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FIG. C-4
BEAMWIDTH AS A FUNCTION
OF FREQUENCY (21)
DPI 1-19-77



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DEGREES OFF BROADSIDE

N

35

-40

-45

-60

-80

-70

-60

-50

-40

ELEMENTS

295.1 Hz

102 4500 0000 0000 0000 0000

46 0703

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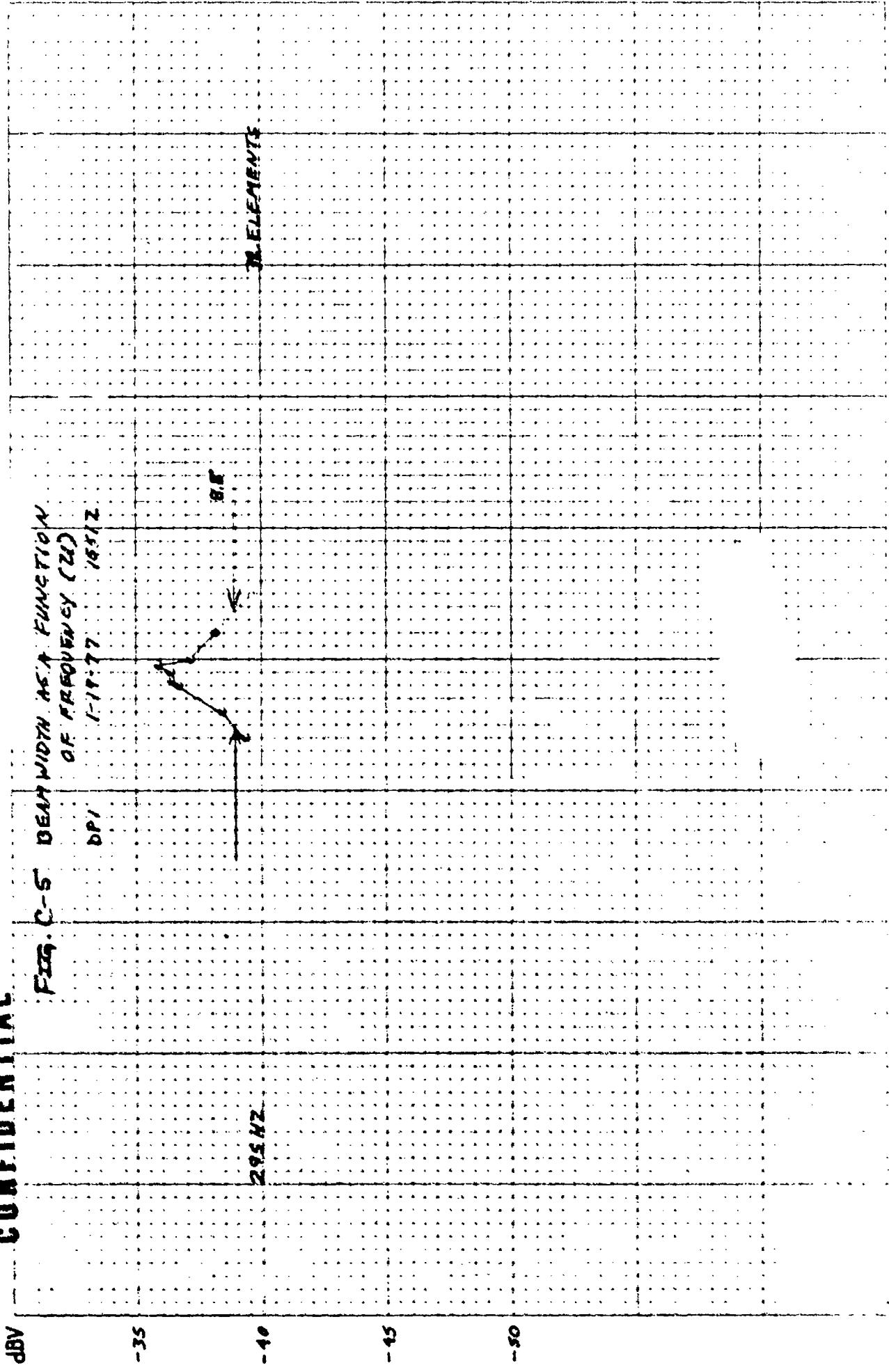


FIG. C-5 BEAM WIDTH AS A FUNCTION
 OF FREQUENCY (22)
 DPI 1-17-77 1651Z

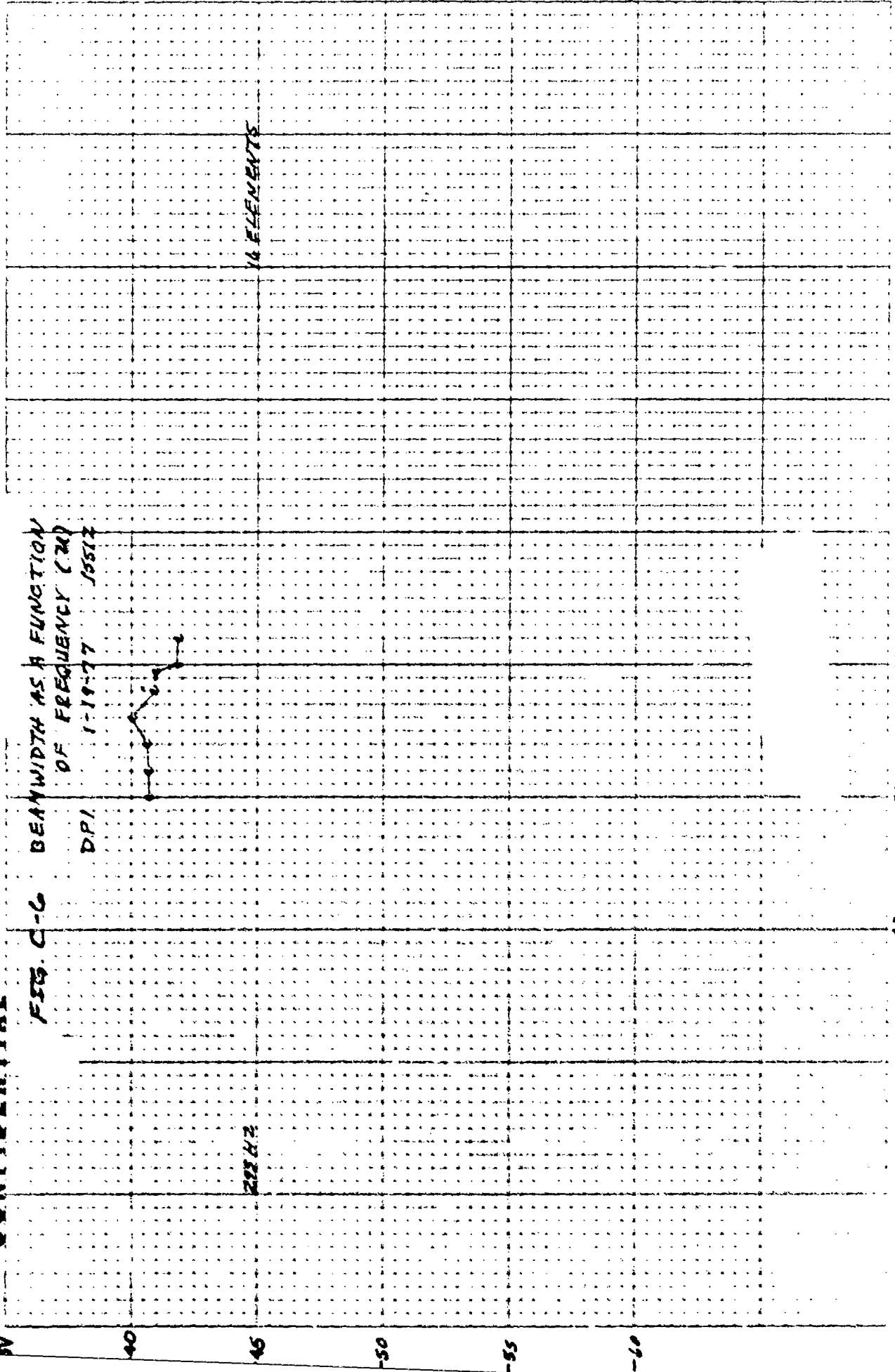
CONFIDENTIAL
 DEGREES OFF BROADSIDE

K02 50 5 10 15 20 25 30 35 40 45 50 55 60

46 0703

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FIG. C-6 BEAMWIDTH AS A FUNCTION OF FREQUENCY (MHz)
DPI 1-19-77 15512



14 ELEMENTS

22342

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DEGREES OFF BROADSIDE

-40

-50

-60

-70

-80

-40

-45

-50

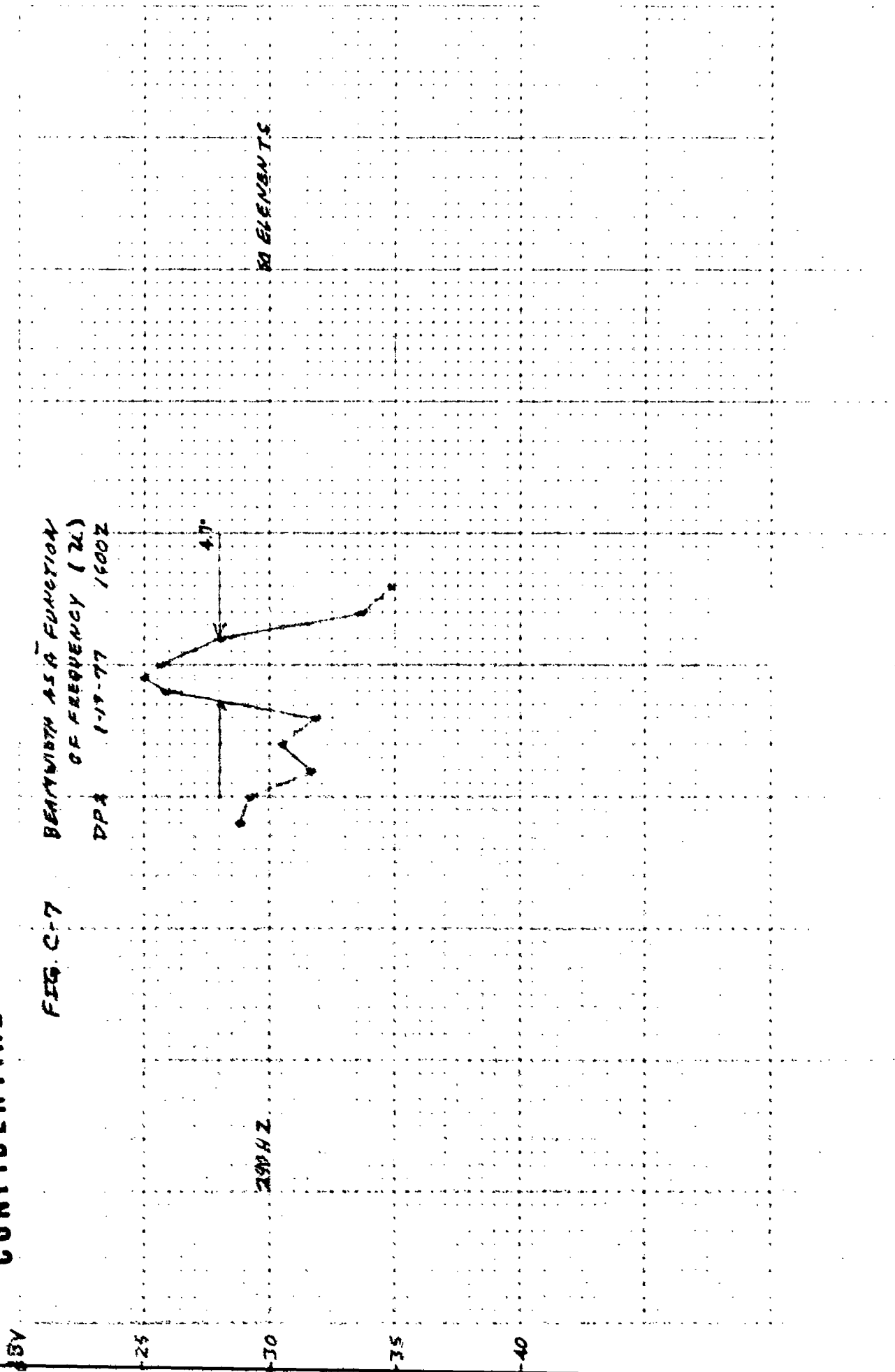
-55

-60

46 0103

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FIG. C-7 BEAMWIDTH AS A FUNCTION OF FREQUENCY (2L)
DPA 1-17-77 1500Z



20 ELEMENTS

-40 -50 -60 -70 -80
DEGREES OFF BROADSIDE

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REF ID: A60700

46 0703

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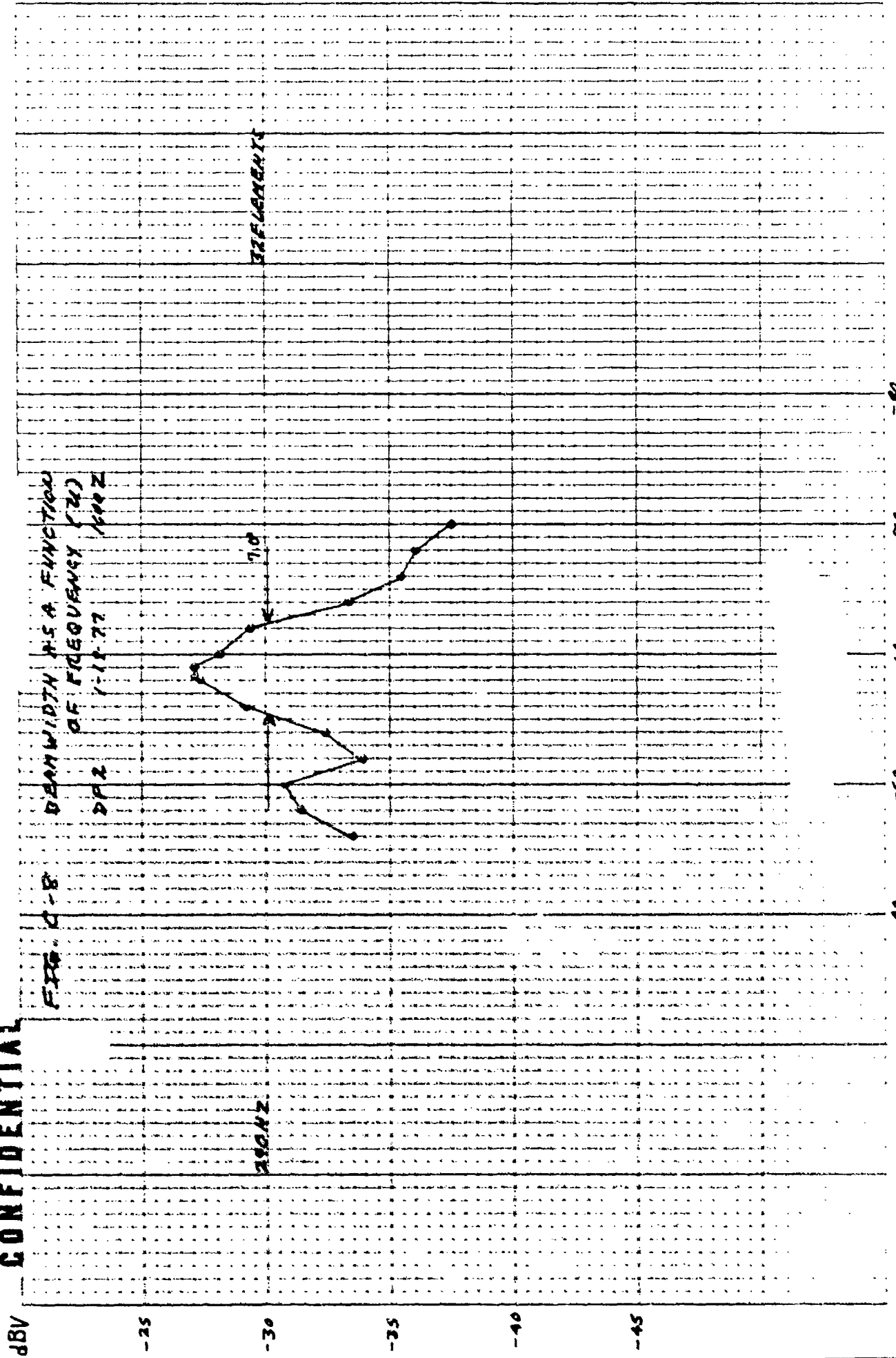


FIG. 4-8
 DEAN WIDTH U.S.A. FUNCTION
 OF FREQUENCY (Hz)
 DPAZ 1-11-77
 1600Z

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DEGREES OFF BROADSIDE

-40

-50

-60

-70

-80

-25

-30

-35

-40

-45

-50

-60

-70

-80

300HZ

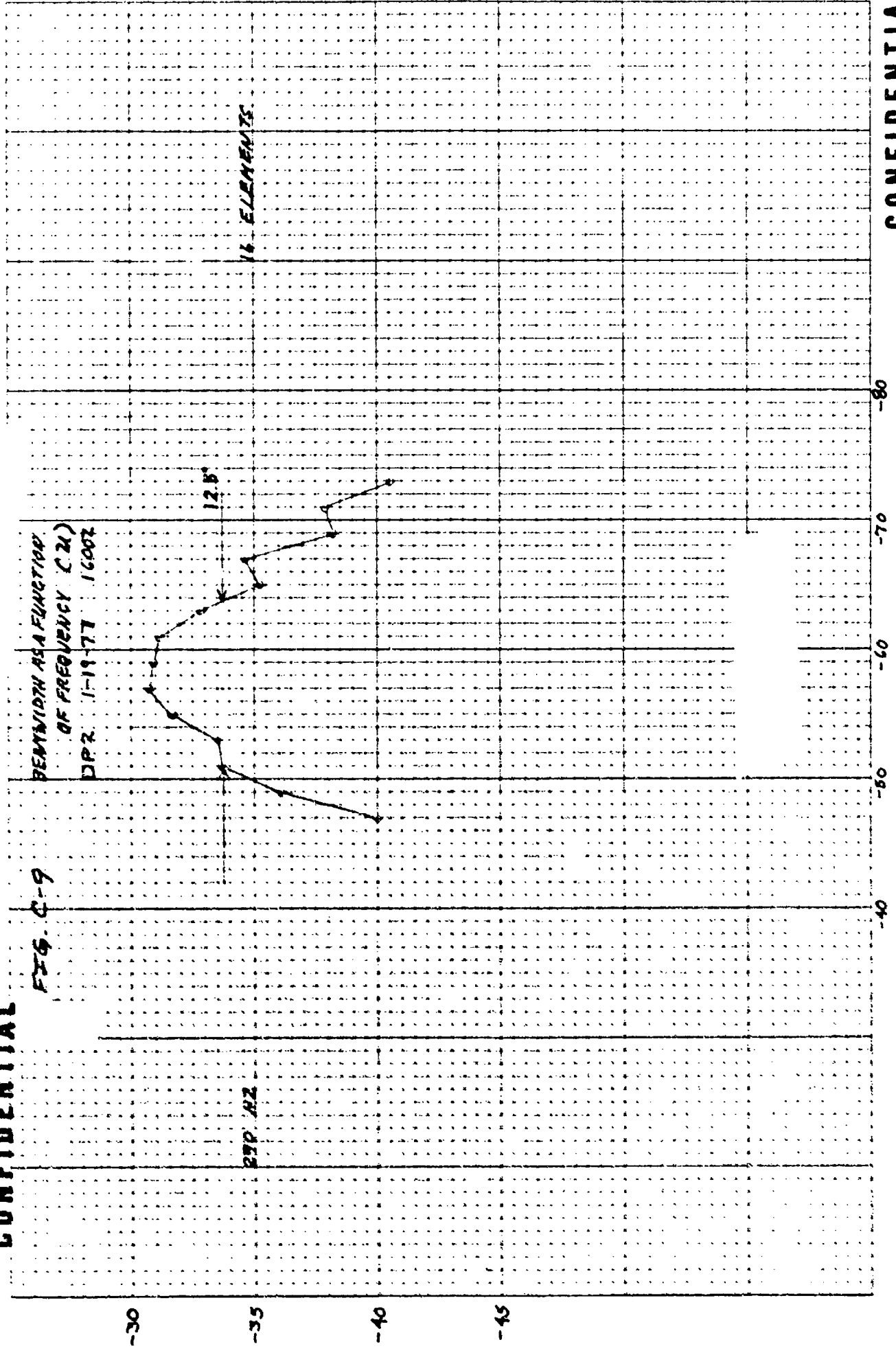
710

3750HZ

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FIG. C-9

BANDWIDTH AS A FUNCTION
OF FREQUENCY (24)
DPR 1-19-77 1600Z



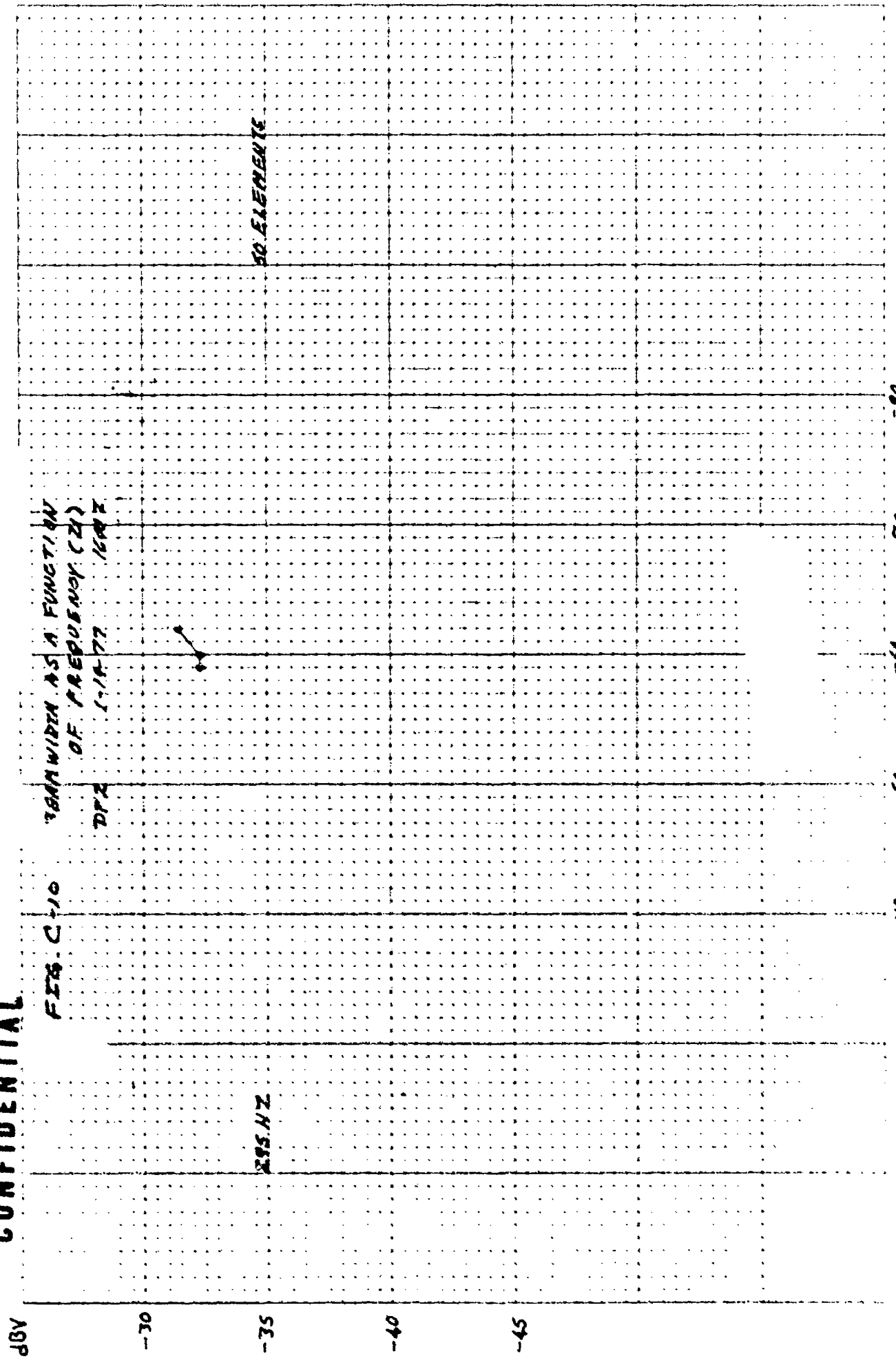
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KOE 21 JAN 1977

46 0/03

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300 MHz WIDEN AS A FUNCTION
 OF FREQUENCY (24)
 DPZ 1-1A-77 1607

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DEGREES OFF BROADSIDE

46 0703

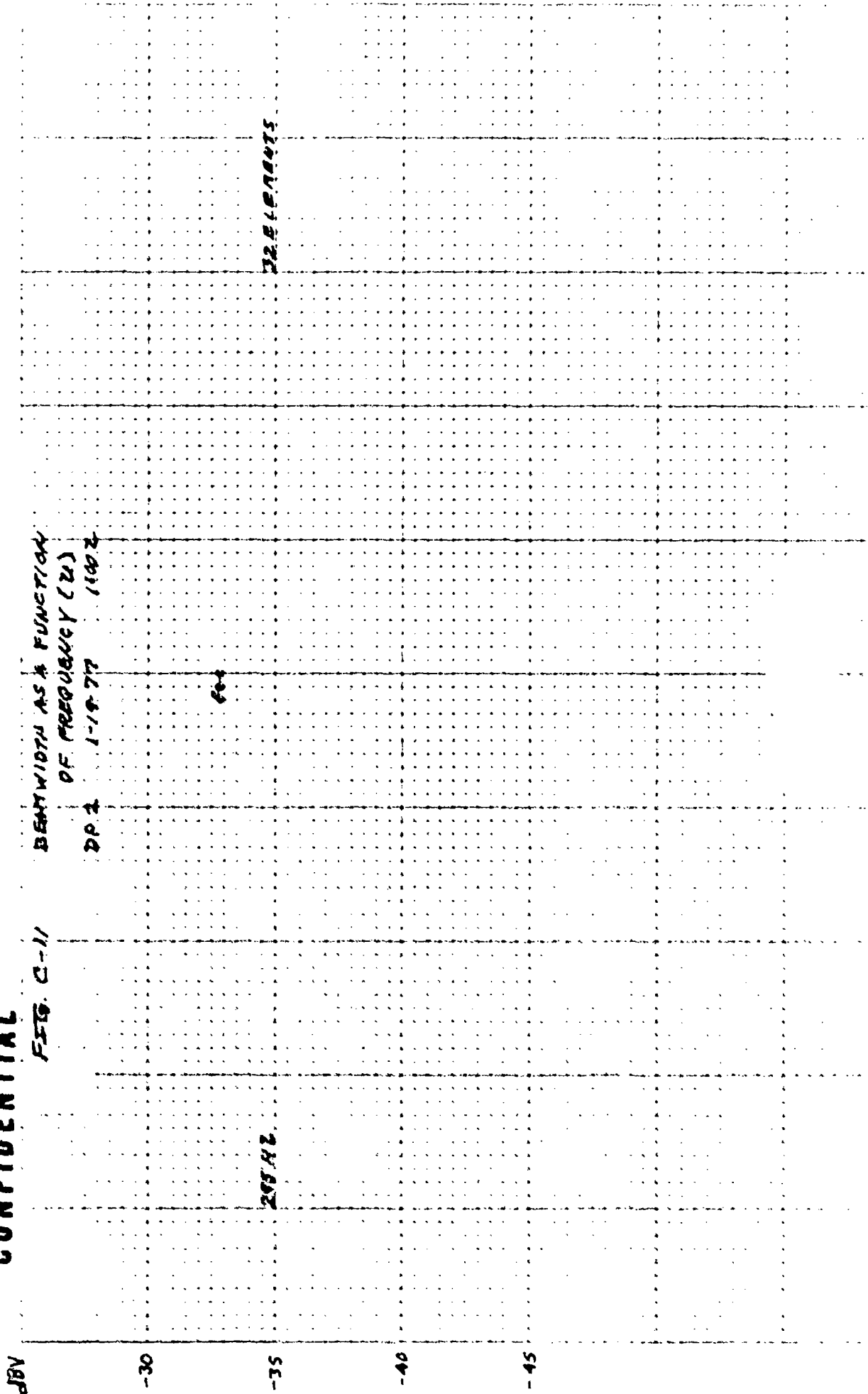
NOE 24 000 1000 0000

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FIG. C-11

BEAM WIDTH AS A FUNCTION
OF FREQUENCY (2)

DP 2 1-19-77 1100 Z



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-40 -50 -60 -70 -80
DEGREES OFF BROADSIDE

46 0103

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FIG. C-12

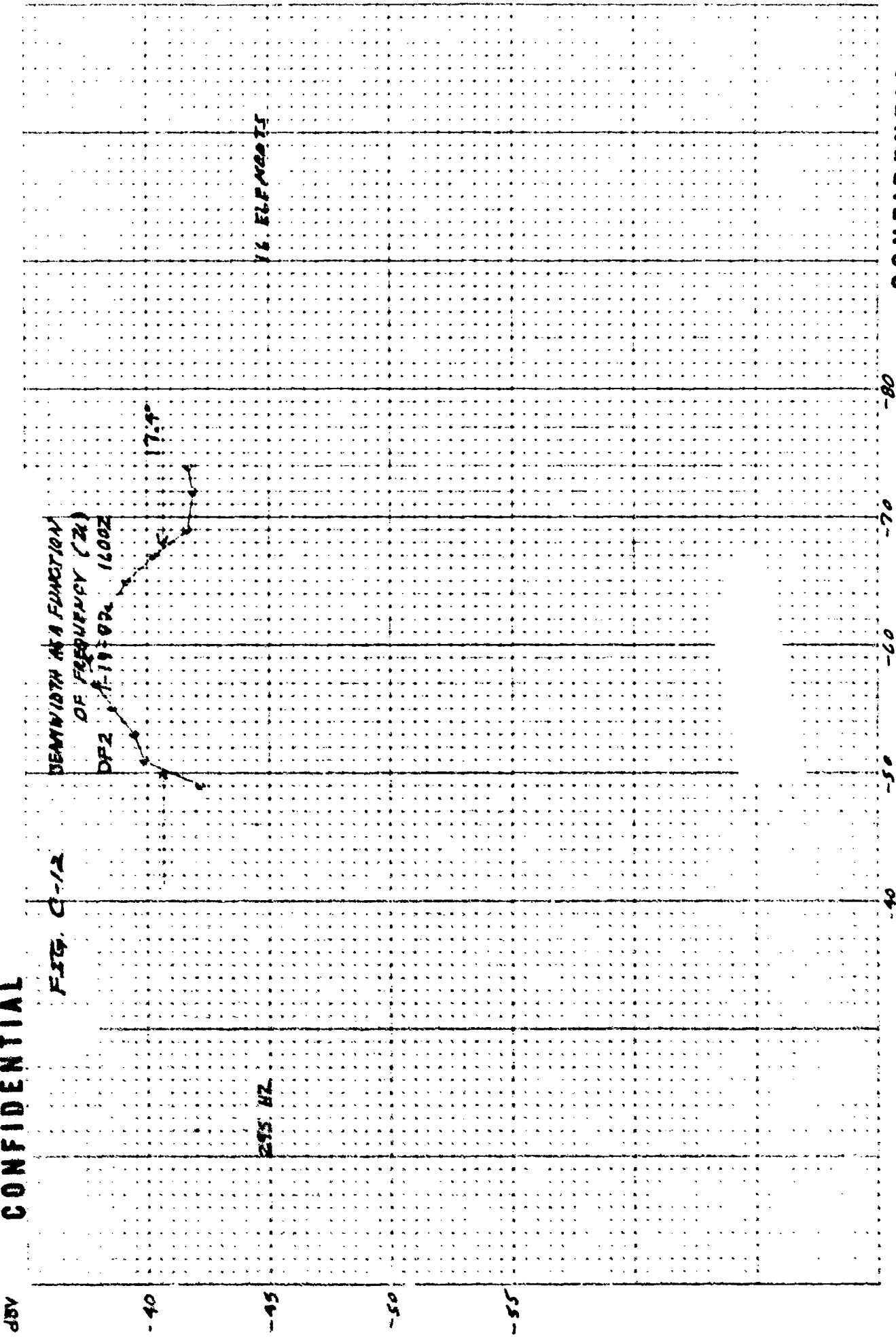
SEMINORITY AS A FUNCTION
OF FREQUENCY (K)

DP2 1-19-52 1600Z

17.5

255 HZ

1% ELP MORTS



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DEGREES OFF BROADSIDE

46 1153

NOE 1153

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FES. C-13 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (M)
UPY 2.7.77 0934Z

88P

-5

-10

-15

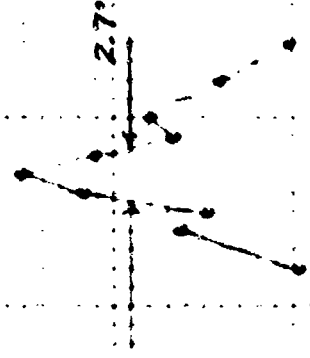
-20

-25

870 HZ

2.7°

ELEMENTS



110

120

130

140

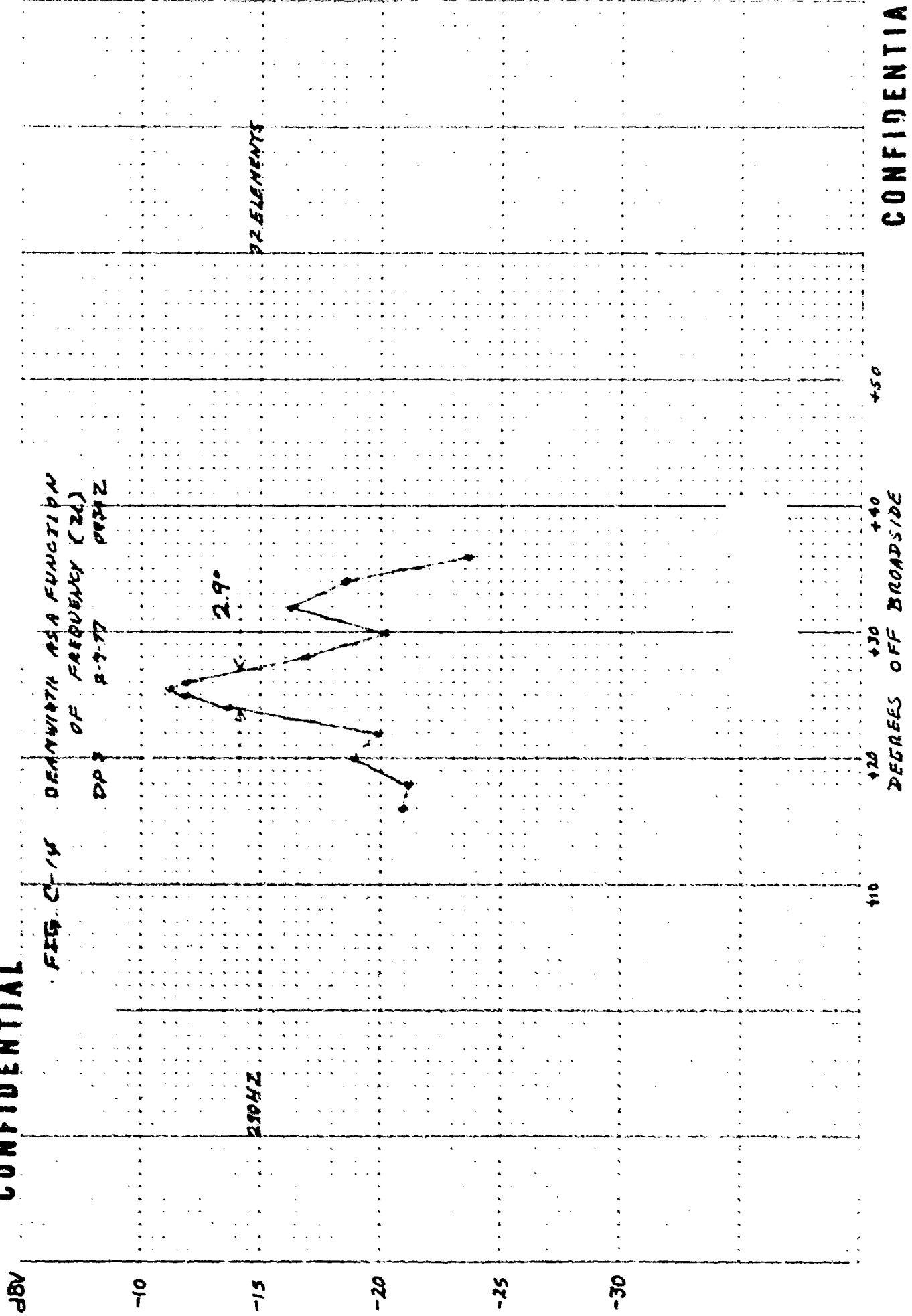
150

DEGREES OFF BROADSIDE

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FIG. C-14 DEPTH AS A FUNCTION OF FREQUENCY (24) DP 8-2-77 0934Z



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K-2 REUFFEL & LESSER CO. WASHINGTON, D.C.

46 U/US

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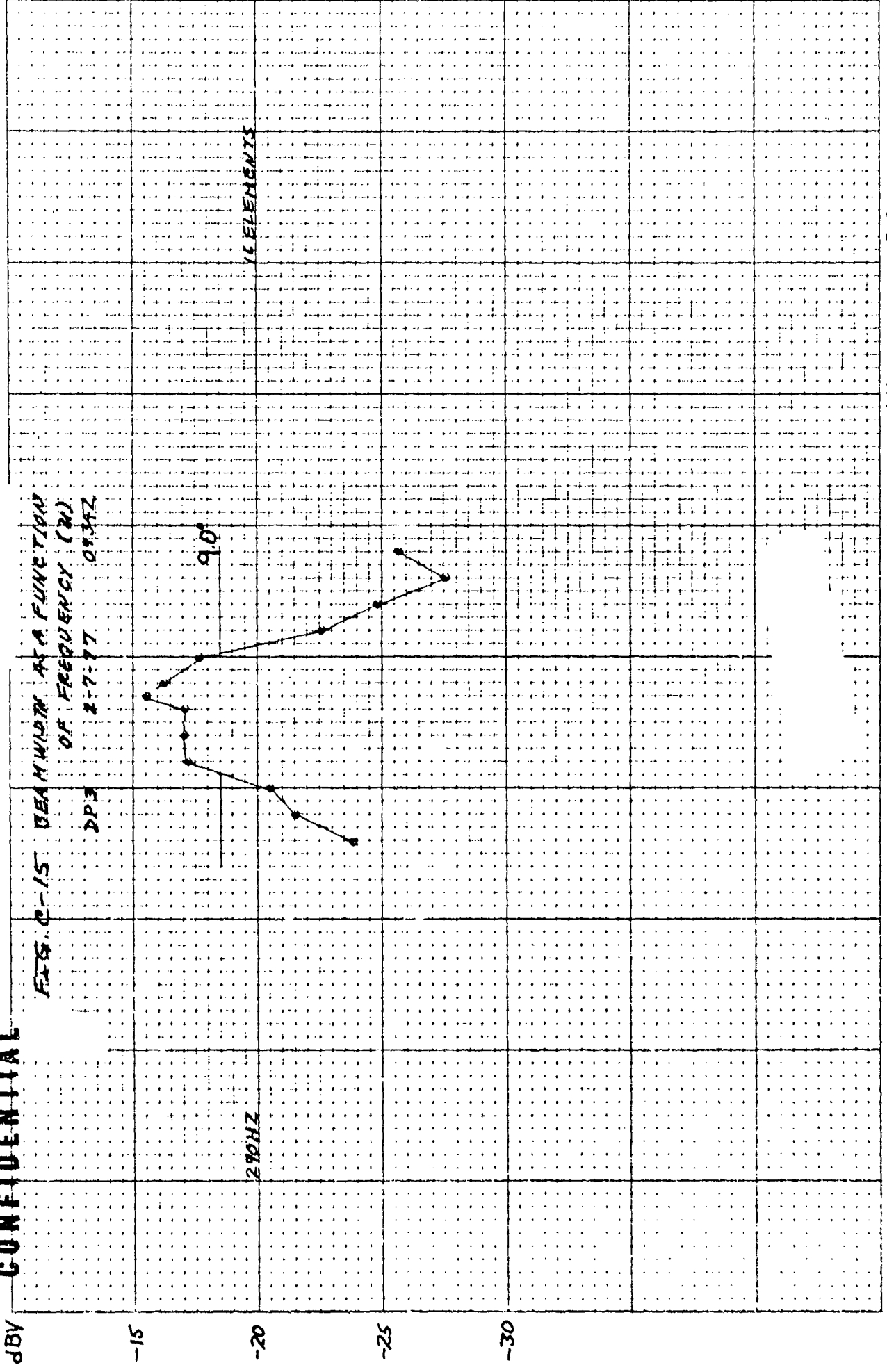


FIG. 2-15 BEAM WIDTH AS A FUNCTION OF FREQUENCY (R) DPE 2-7-77 0.5KZ

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+50

+40

+30

+20

+10

DEGREES OFF BROADSIDE

46 0/03

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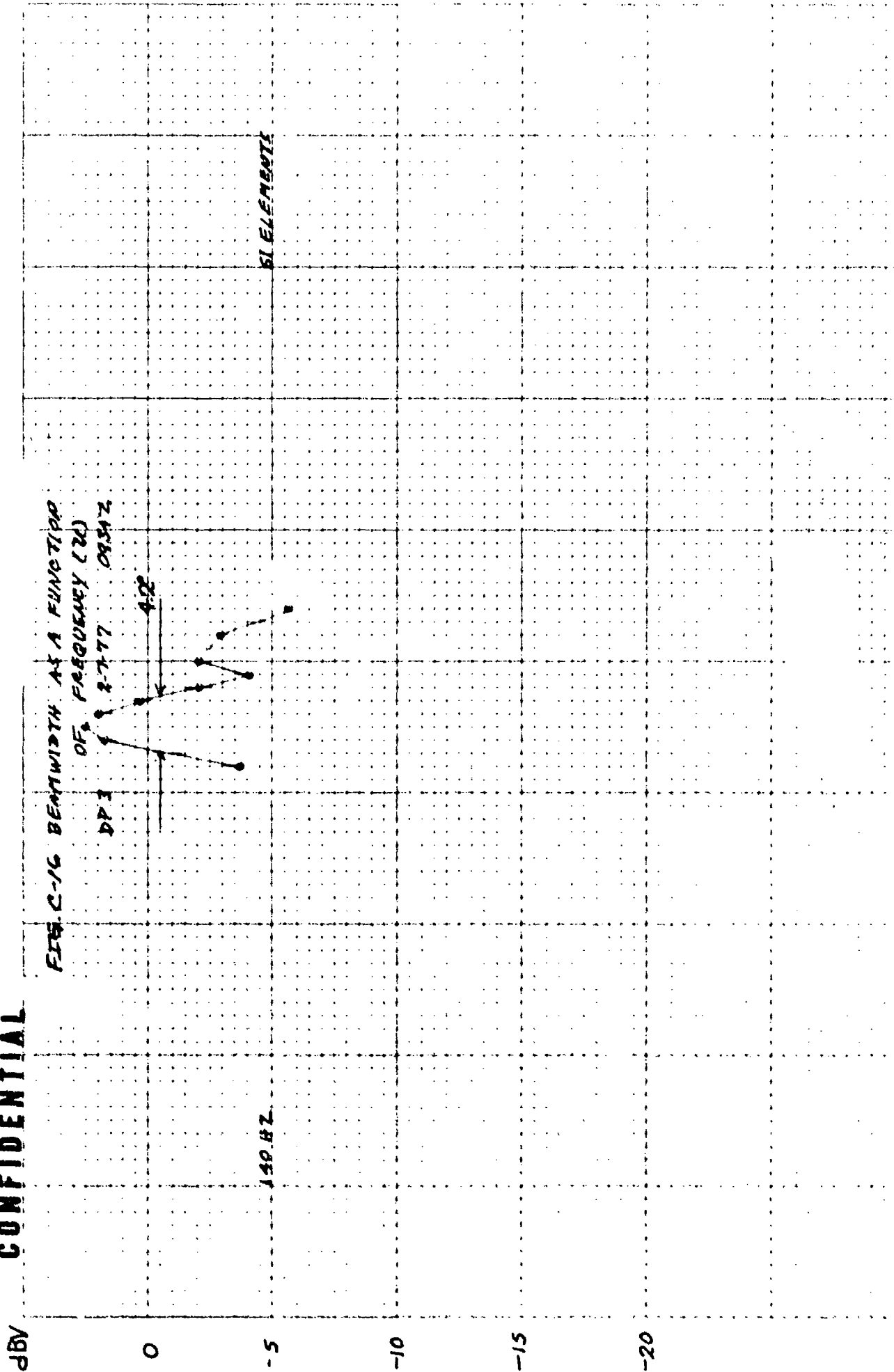


FIG. C-16 BERTWIDTH AS A FUNCTION OF FREQUENCY (20)

+50

+40

+30

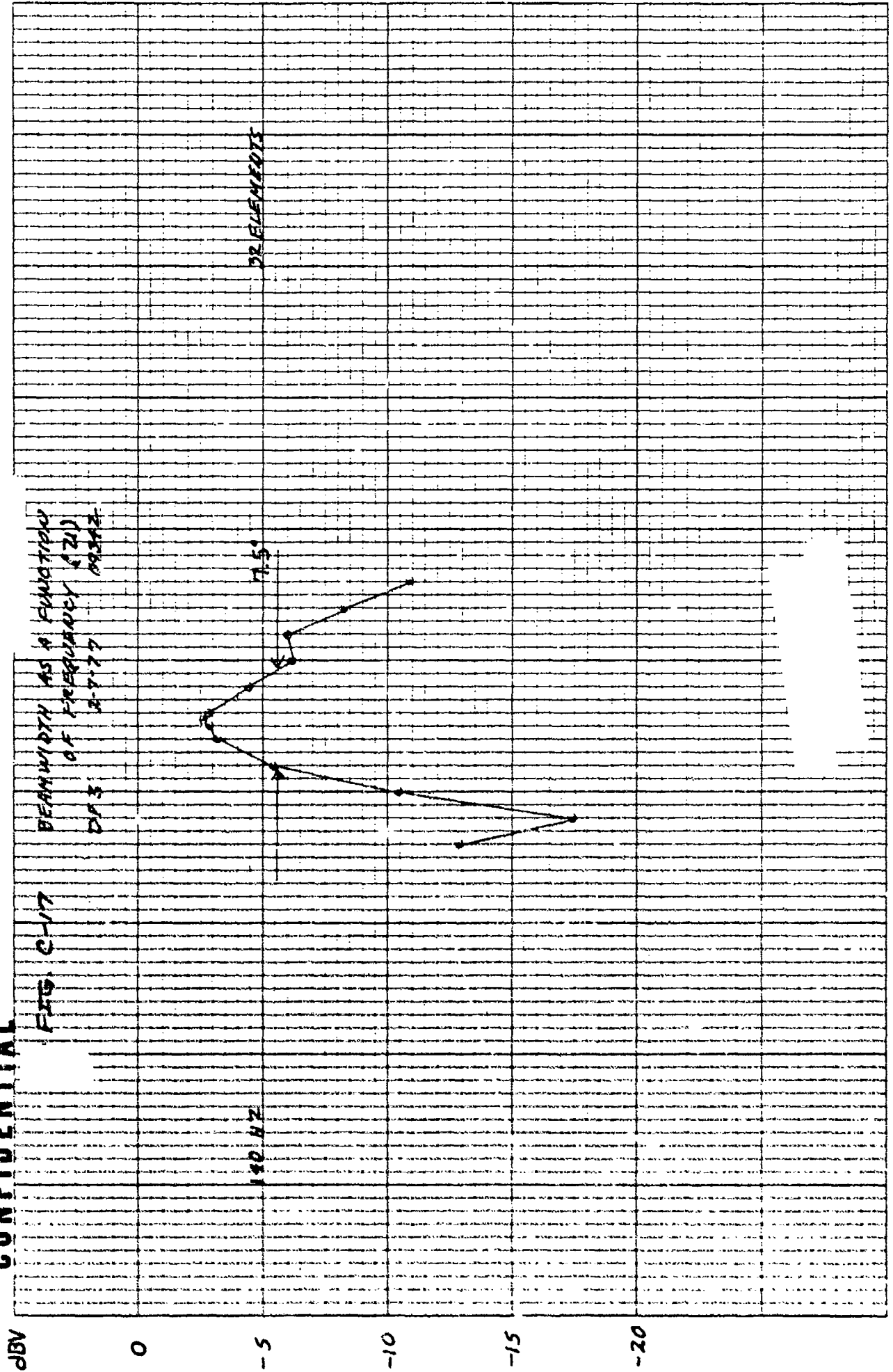
+20

+10

DEGREES OFF BROADSIDE

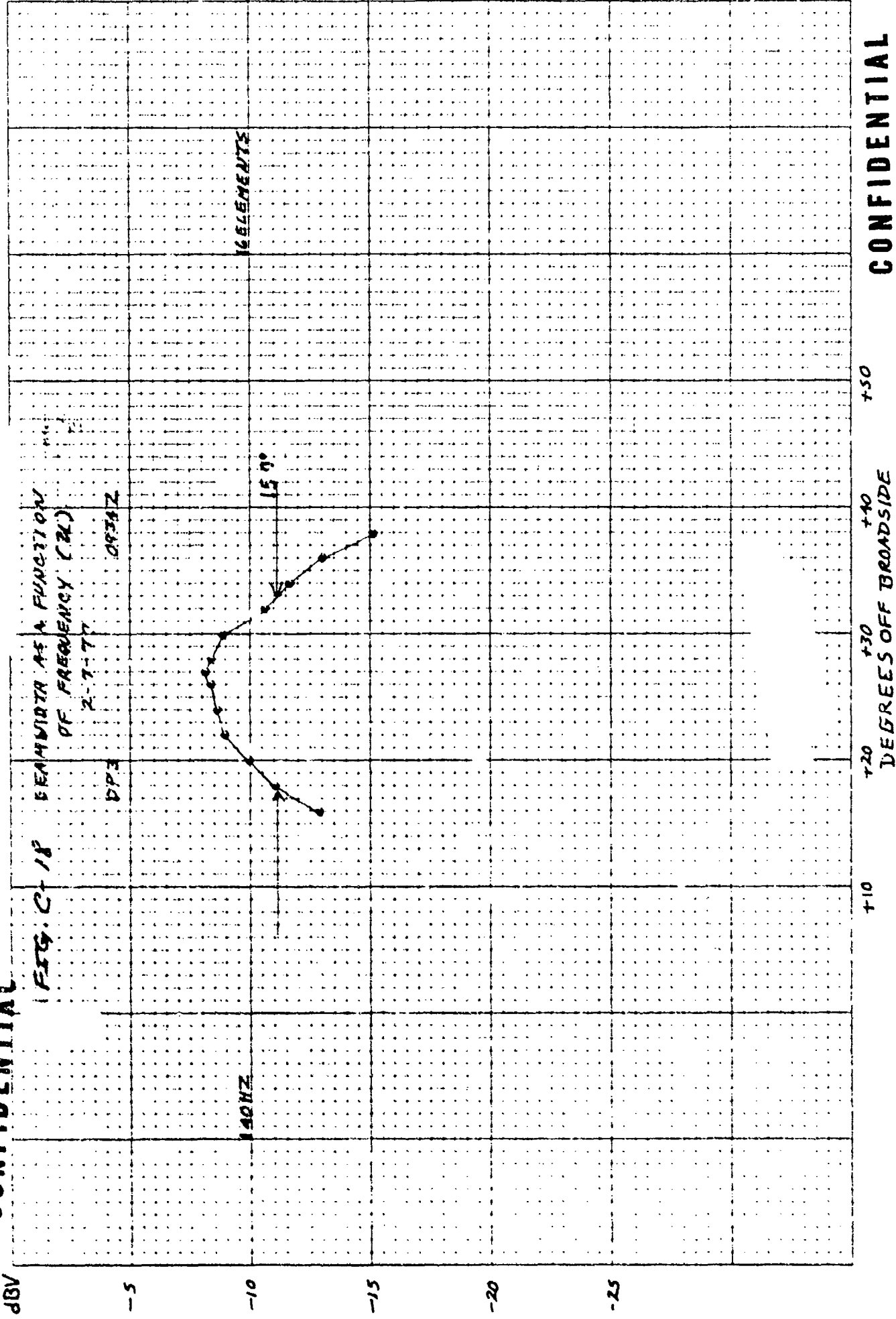
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CONFIDENTIAL



110 120 130 140 150 DEGREES OFF BROADSIDE

CONFIDENTIAL



CONFIDENTIAL

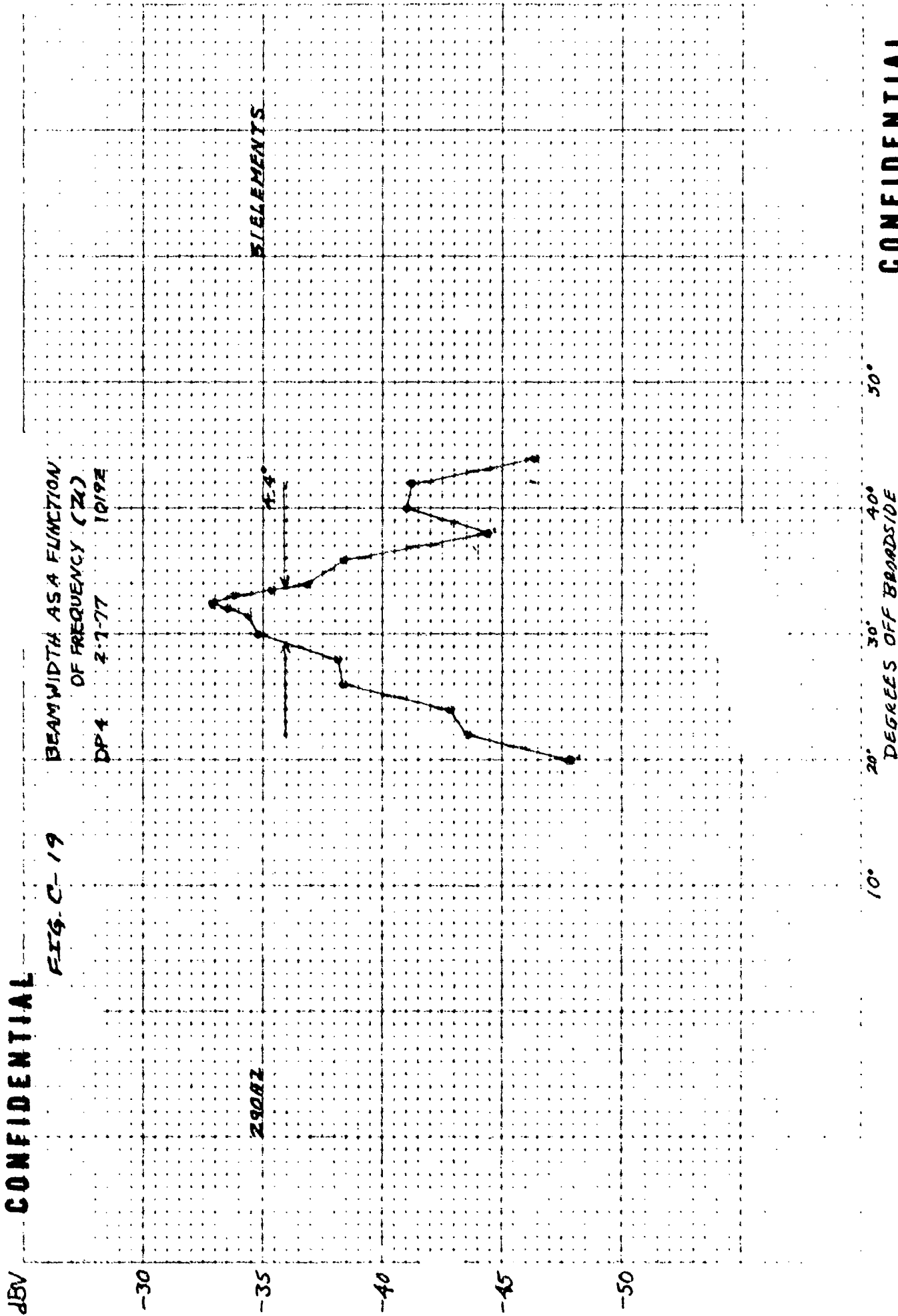
REF: [Illegible]

46 0/03

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FIG. C-19

BEAMWIDTH AS A FUNCTION
OF FREQUENCY (ZA)
DP4 2:1-77 10/92

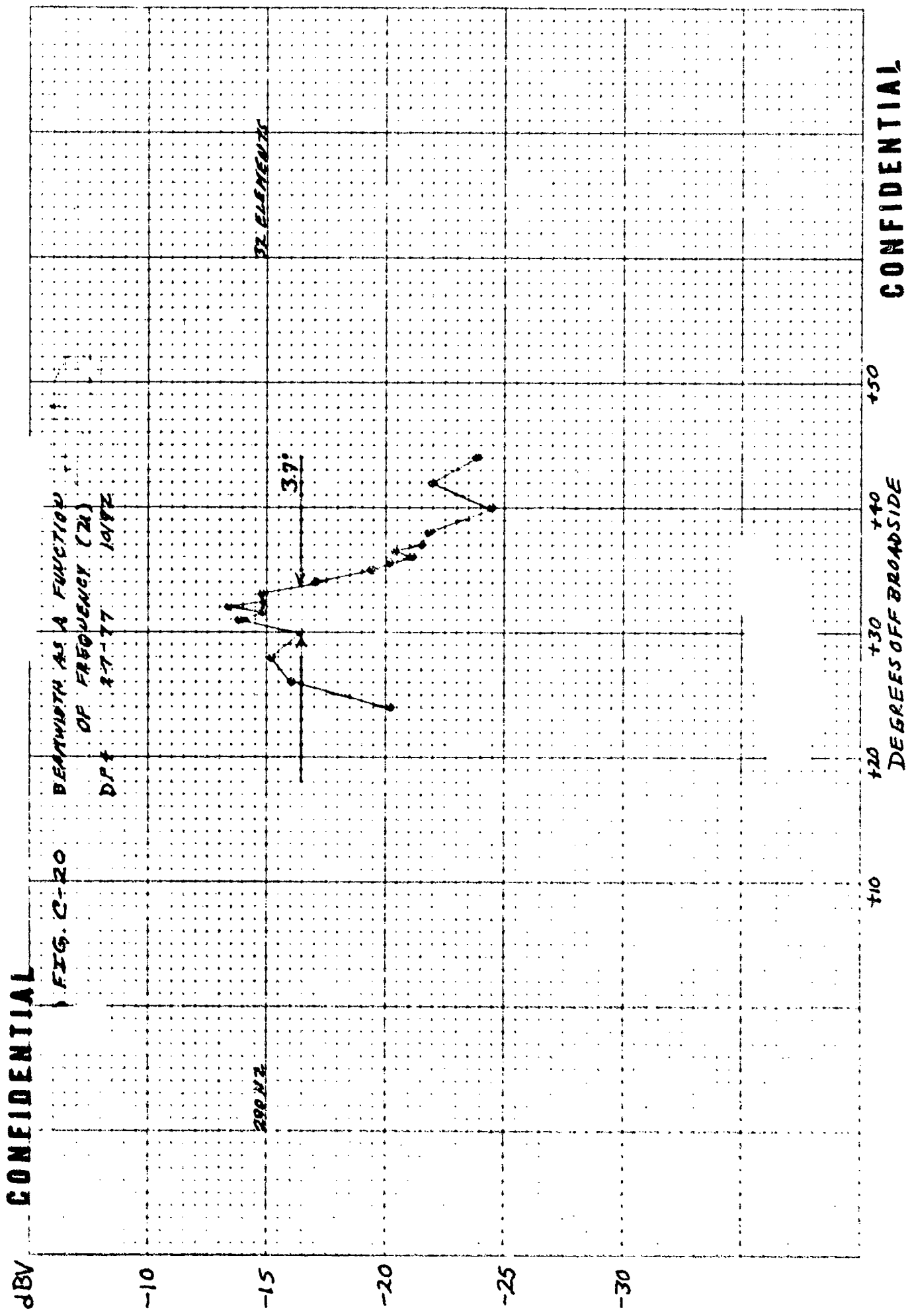


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MSE REPORT TO COMSEC ON THE VMS

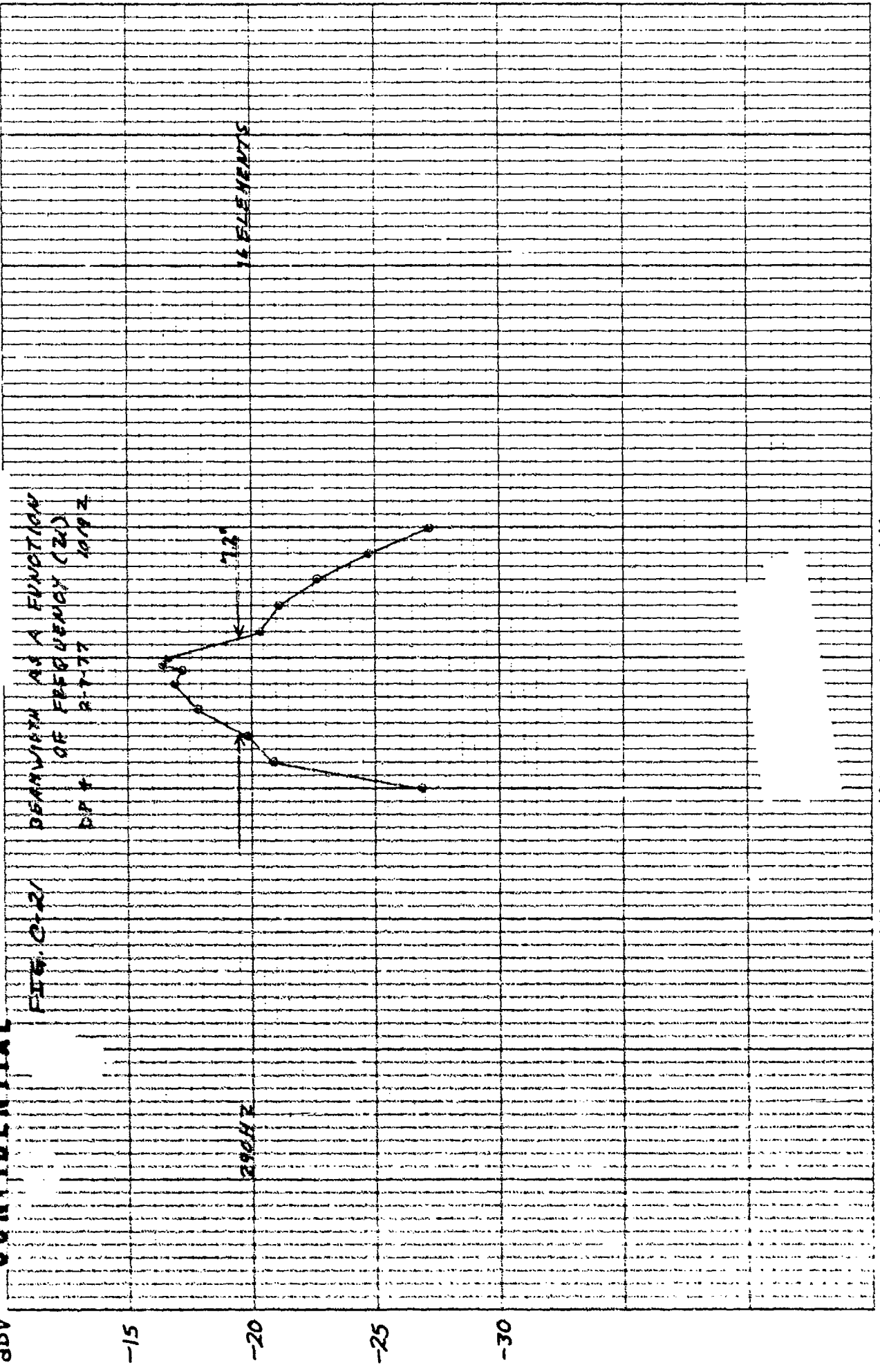
46 U/03



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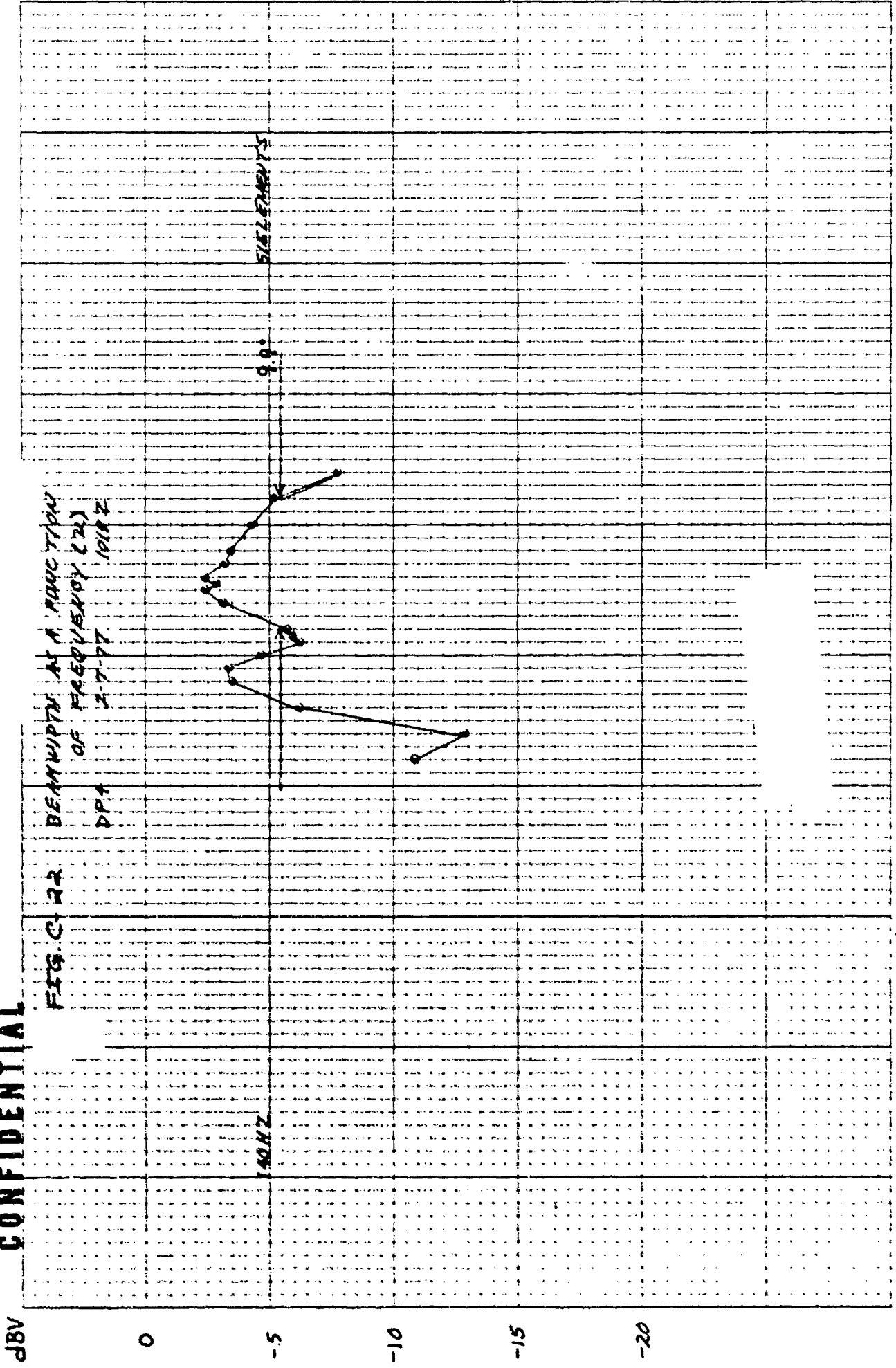
FIG. C-12
BEAMWIDTH AS A FUNCTION
OF FREQUENCY (ZU)
DP # 2-7-77
1000 Z



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DEGREES OFF BROADSIDE

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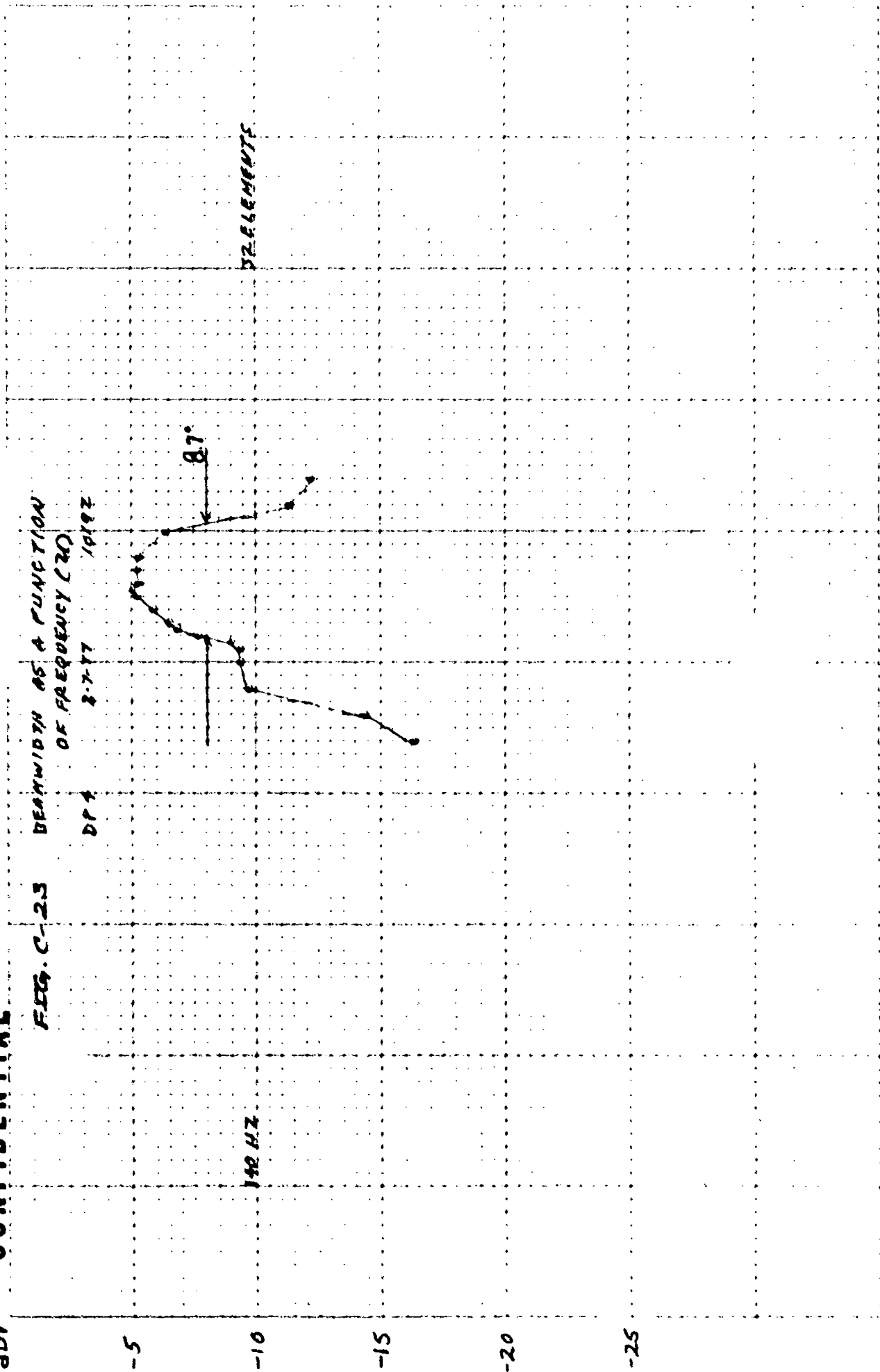


CONFIDENTIAL DEGREES OFF BROADSIDE

46 U/03

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FIG. C-23 BEAMWIDTH AS A FUNCTION OF FREQUENCY (20 DB) 2.7-17 1018Z

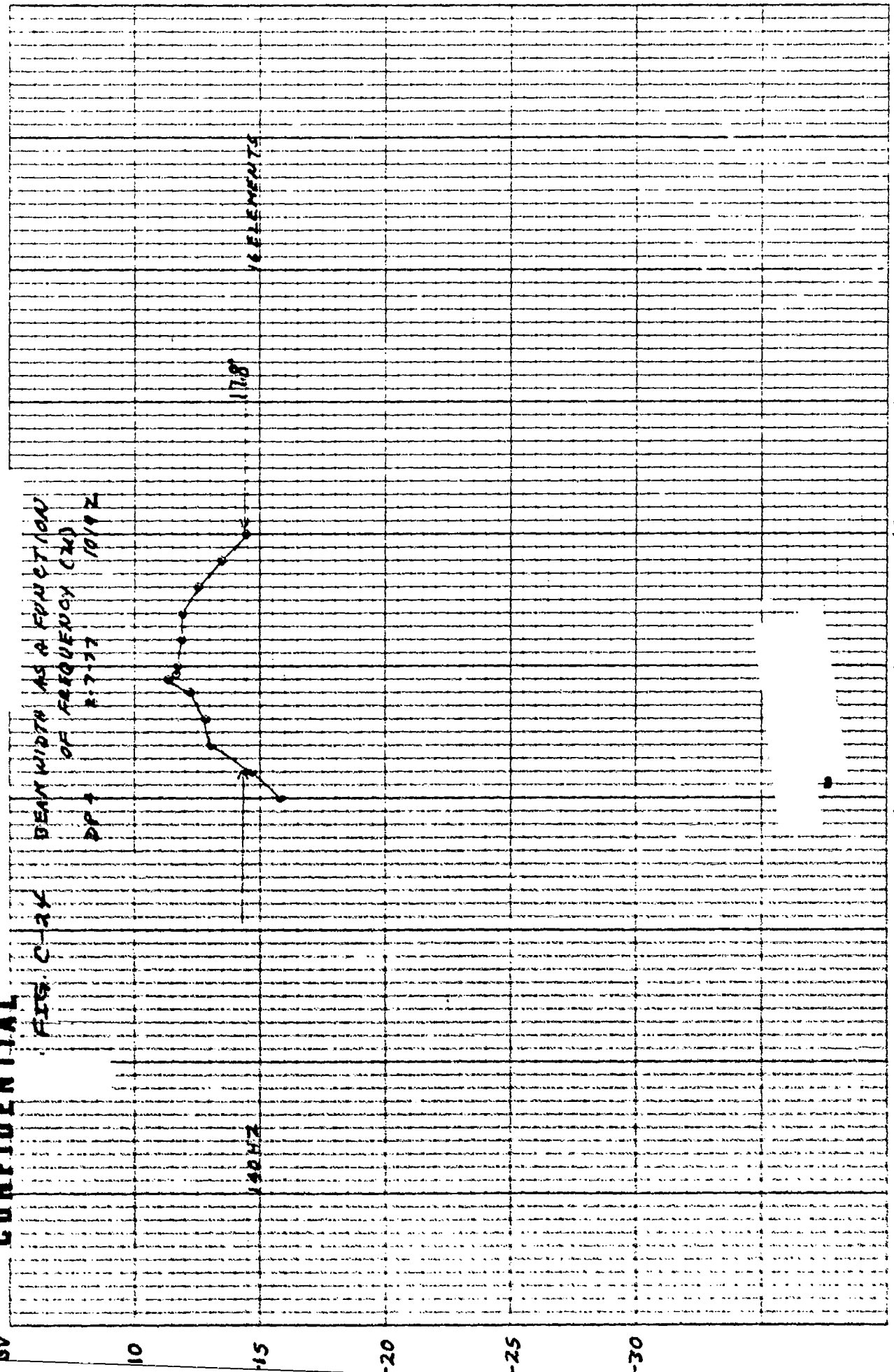


+10 +20 +30 +40 +50 DEGREES OFF B

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FIG. C-24
BEAM WIDTH AS A FUNCTION
OF FREQUENCY (2X)
PP → 10/10 Z



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46 0103

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J8V

FIG. C-25 BANDWIDTH AS A FUNCTION OF FREQUENCY (MHz)

DPS 27.77 15492

-5

5.9°

-10

290 Hz

81 ELEMENTS

-15

-20

-25

+20

+30

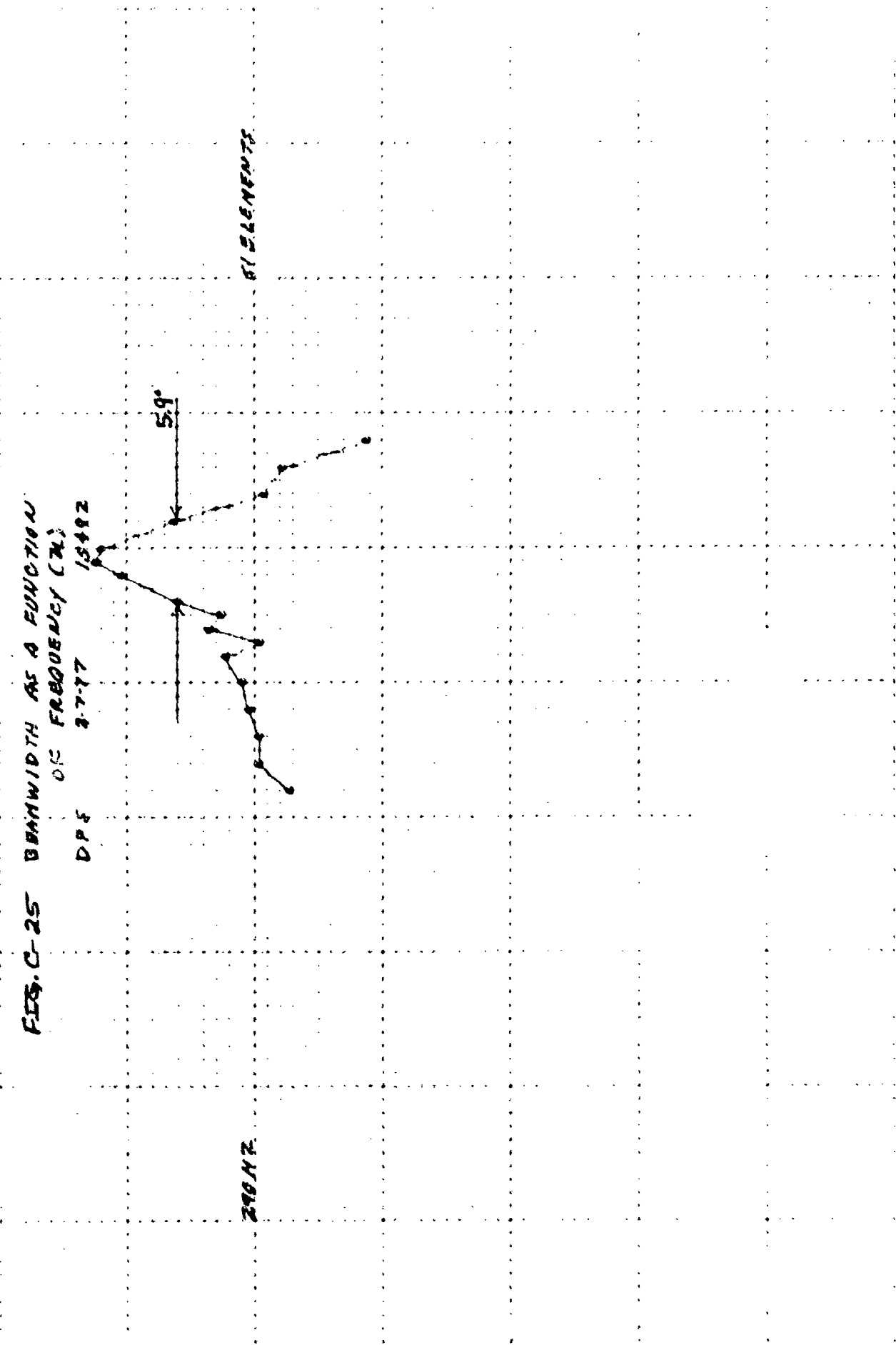
+40

+50

+60

DEGREES OFF BROADSIDE

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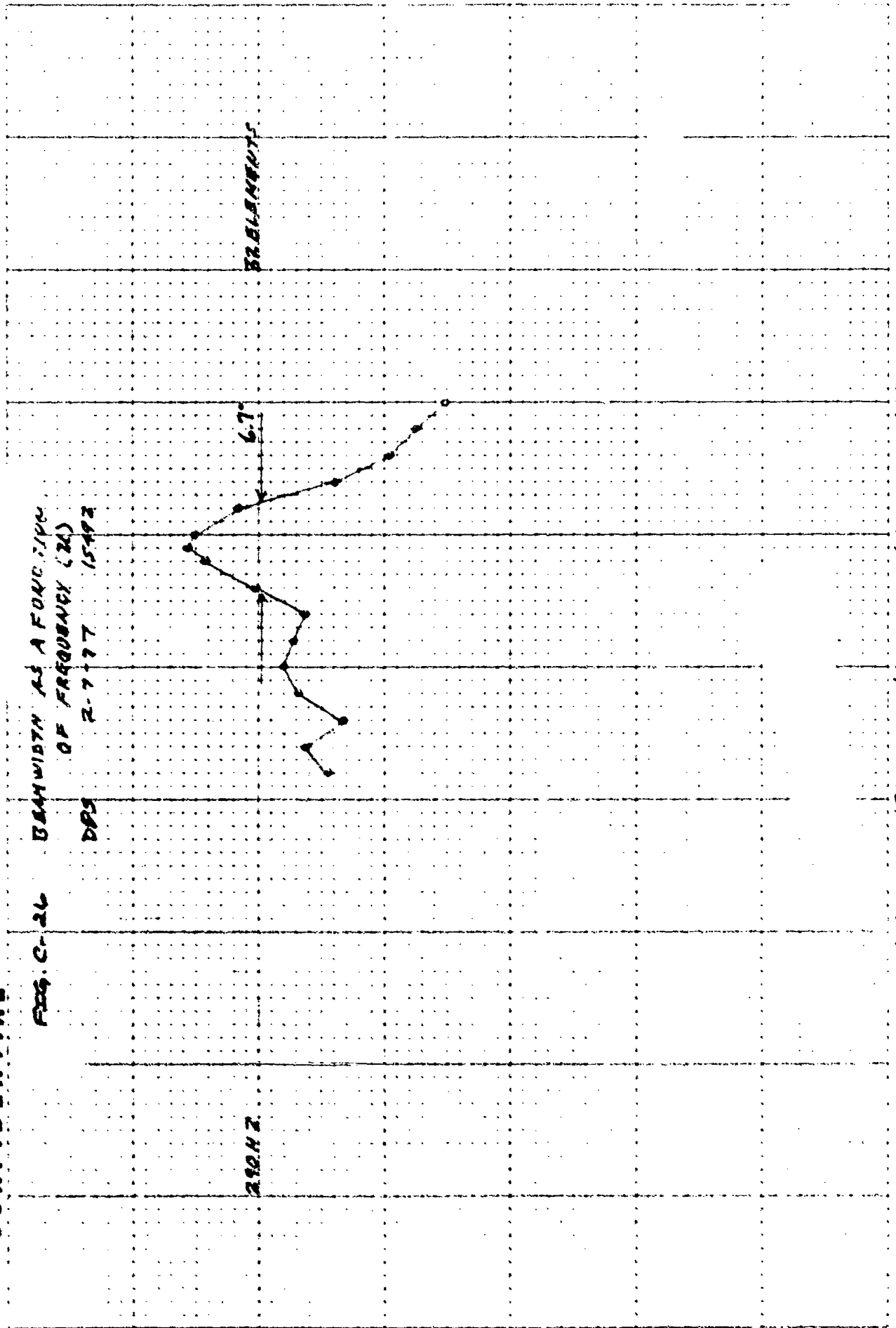
46 0103

REF. C-26

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dBV

BEAMWIDTH AS A FUNCTION
OF FREQUENCY (20)
DPS 2-7-77 15492



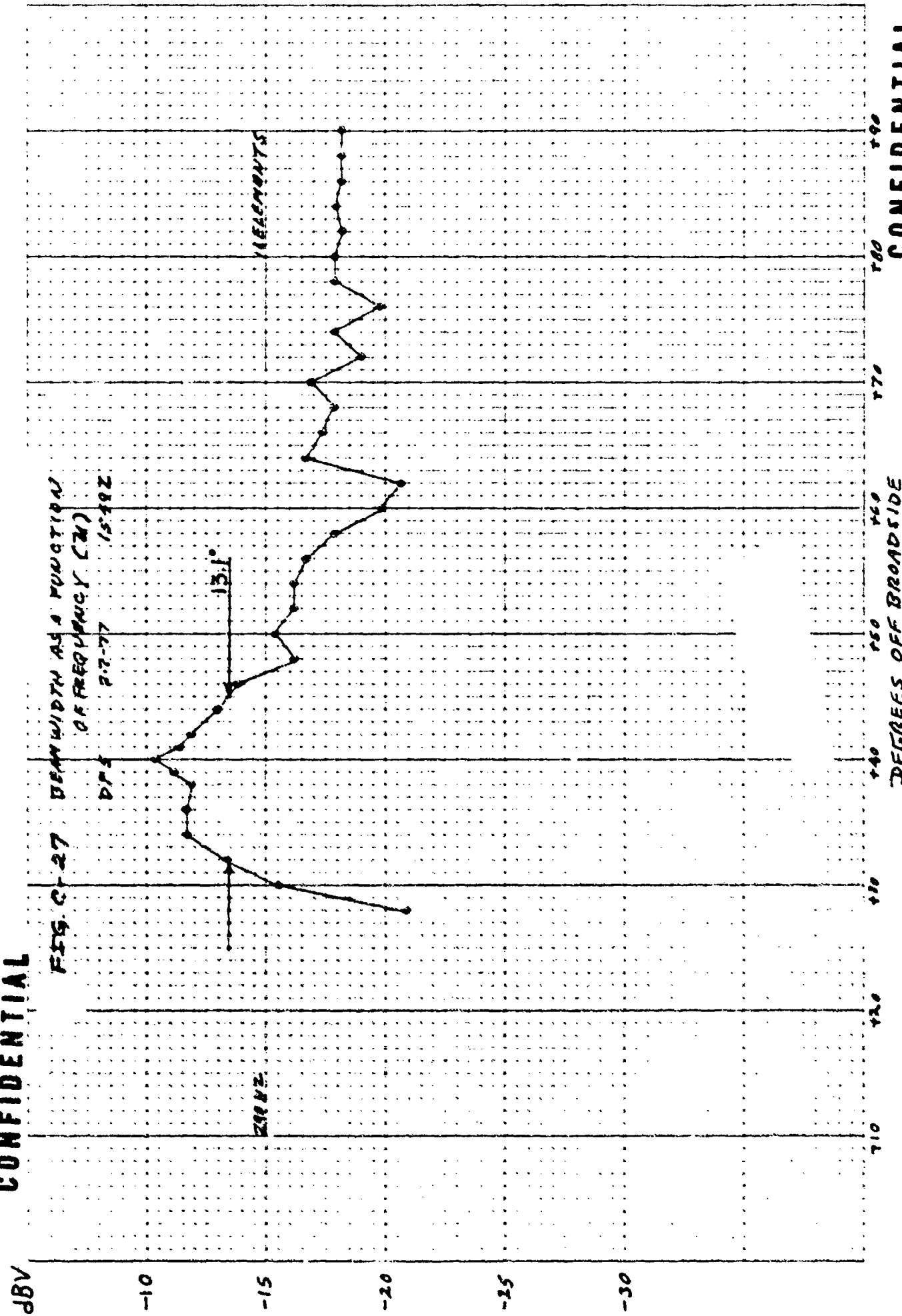
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DEGREES OFF BROADSIDE

46 U/US

CONFIDENTIAL

CONFIDENTIAL



CONFIDENTIAL

DEGREES OFF BROADSIDE

CONFIDENTIAL

dBV

46 U. 03

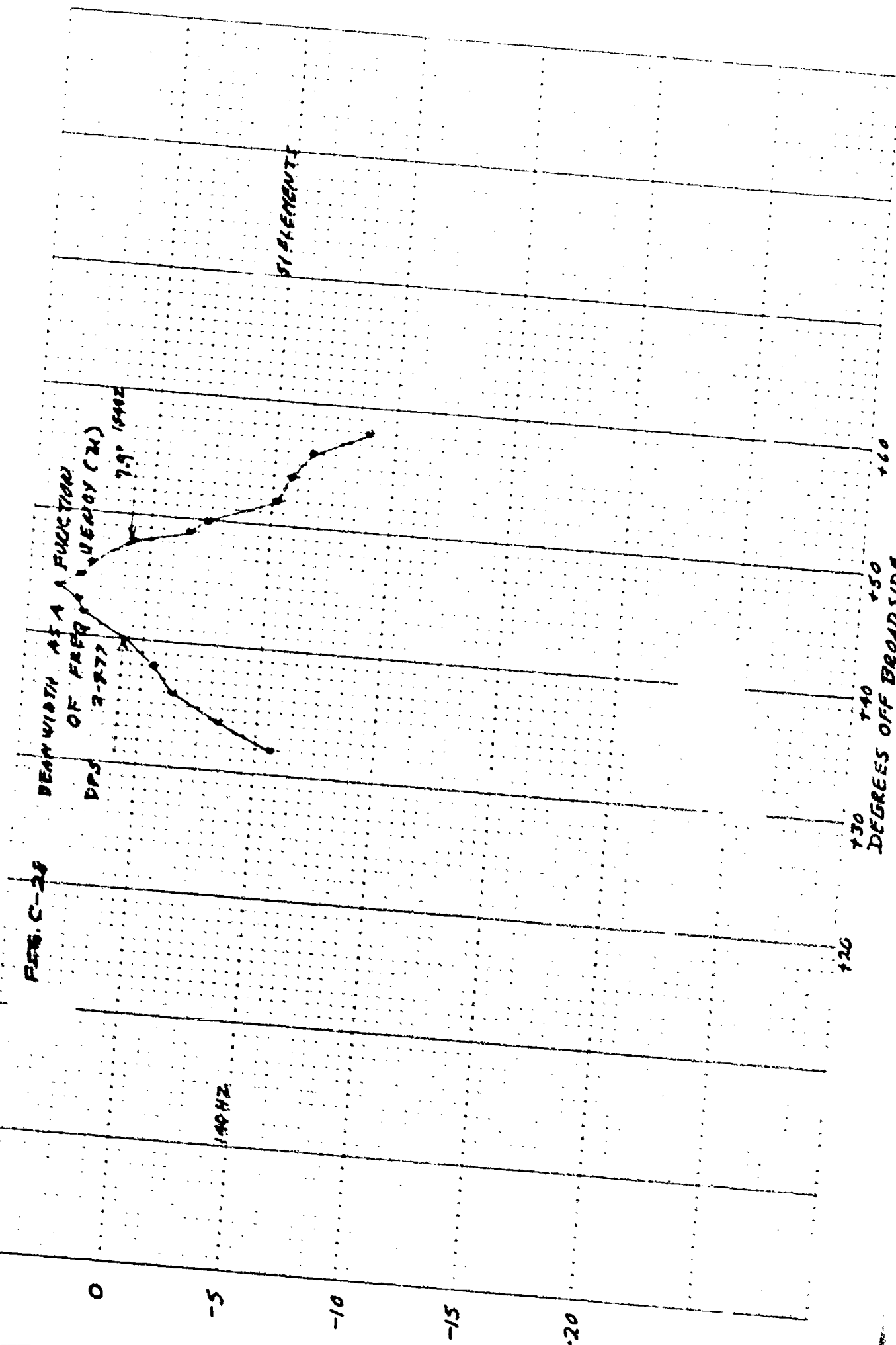
FIG. C-28

BEAM WIDTH AS A FUNCTION
OF FREQUENCY ENERGY (24)
DPS 7-877

7.9° 1840Z

140HZ

STATEMENTS

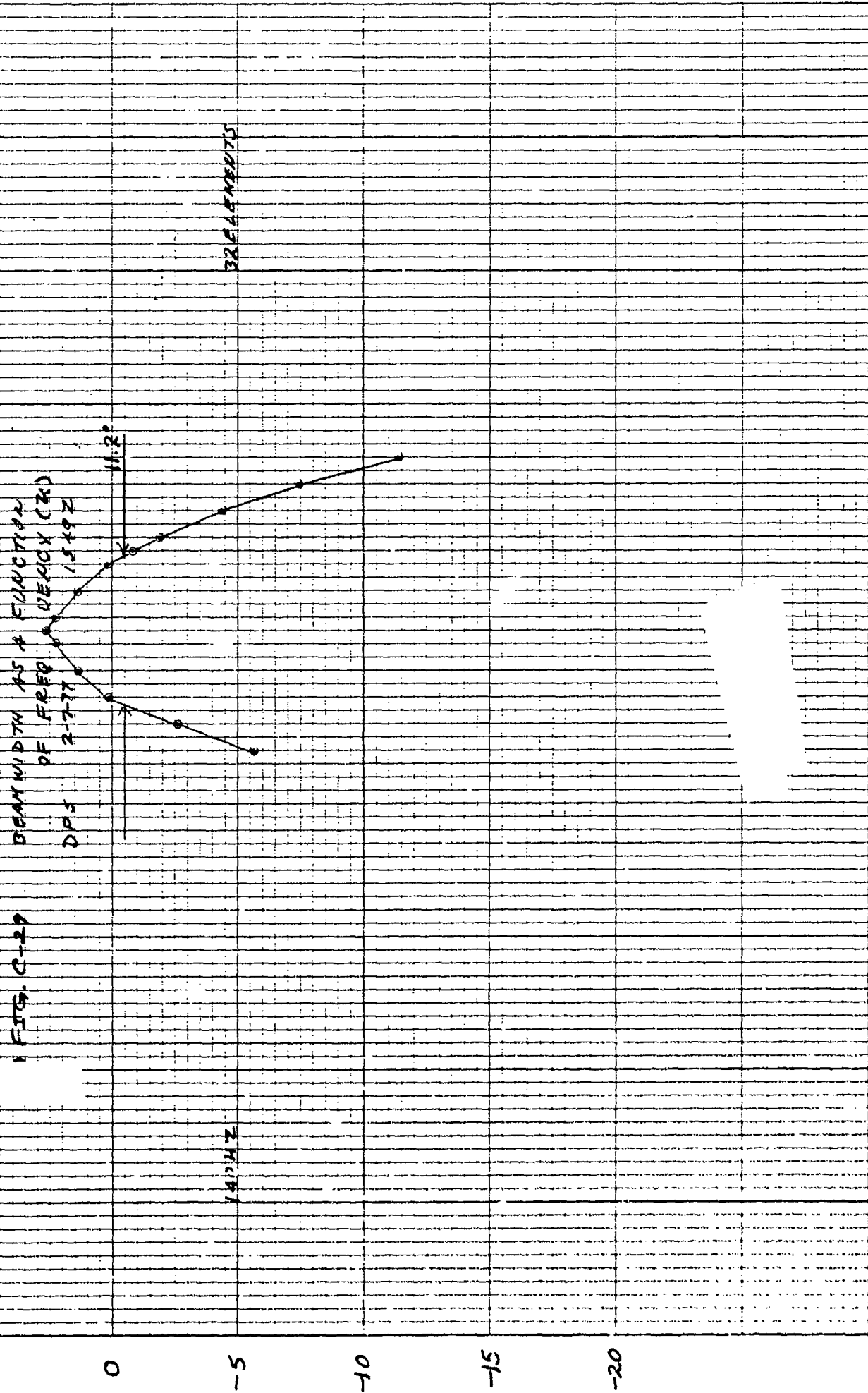


120 130 140 150 160
DEGREES OFF BROADSIDE

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DEGREES OFF BROADSIDE

DEGREES OFF BROADSIDE

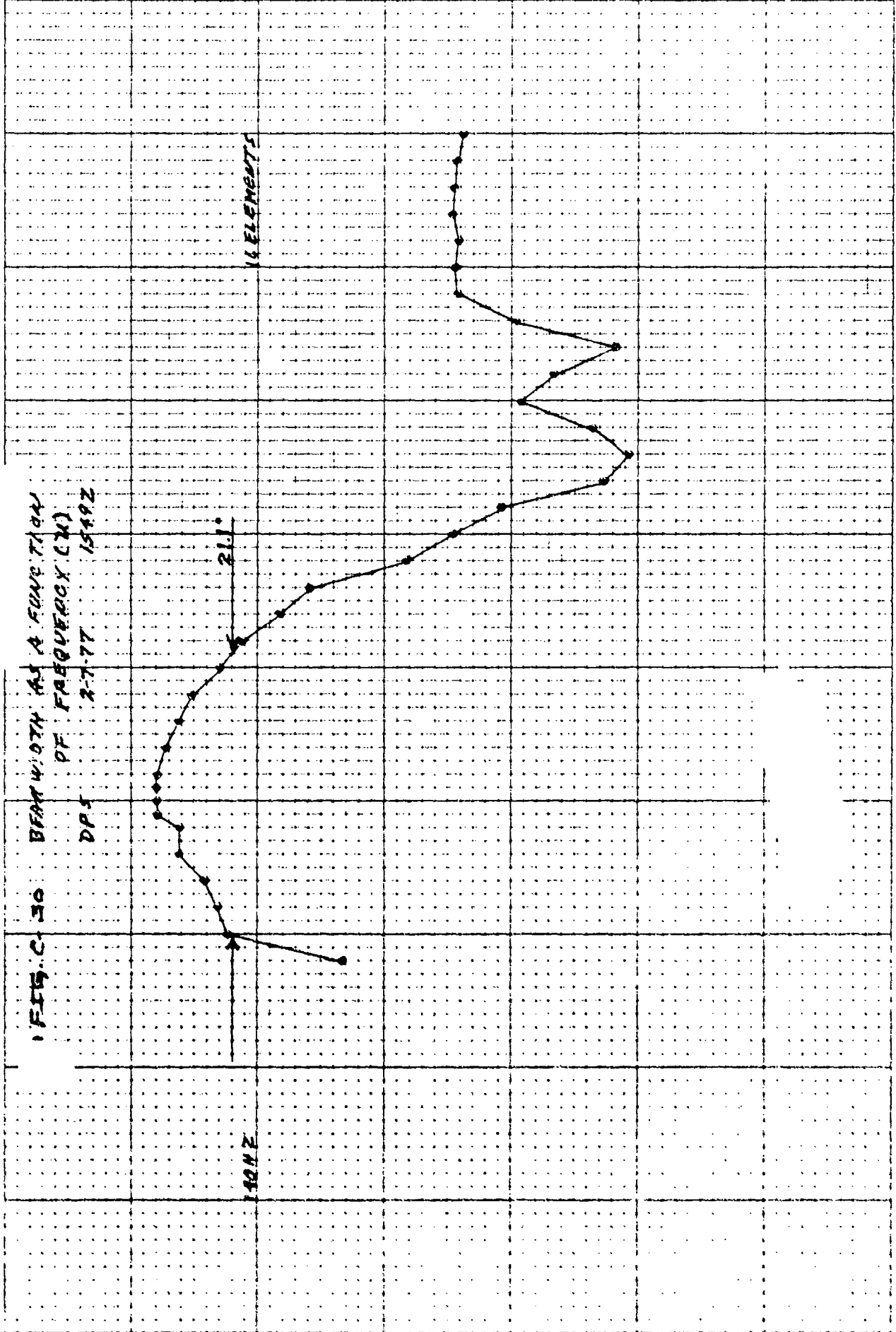
KOE
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REDFIELD & BAKER CO. WASH. D.C.

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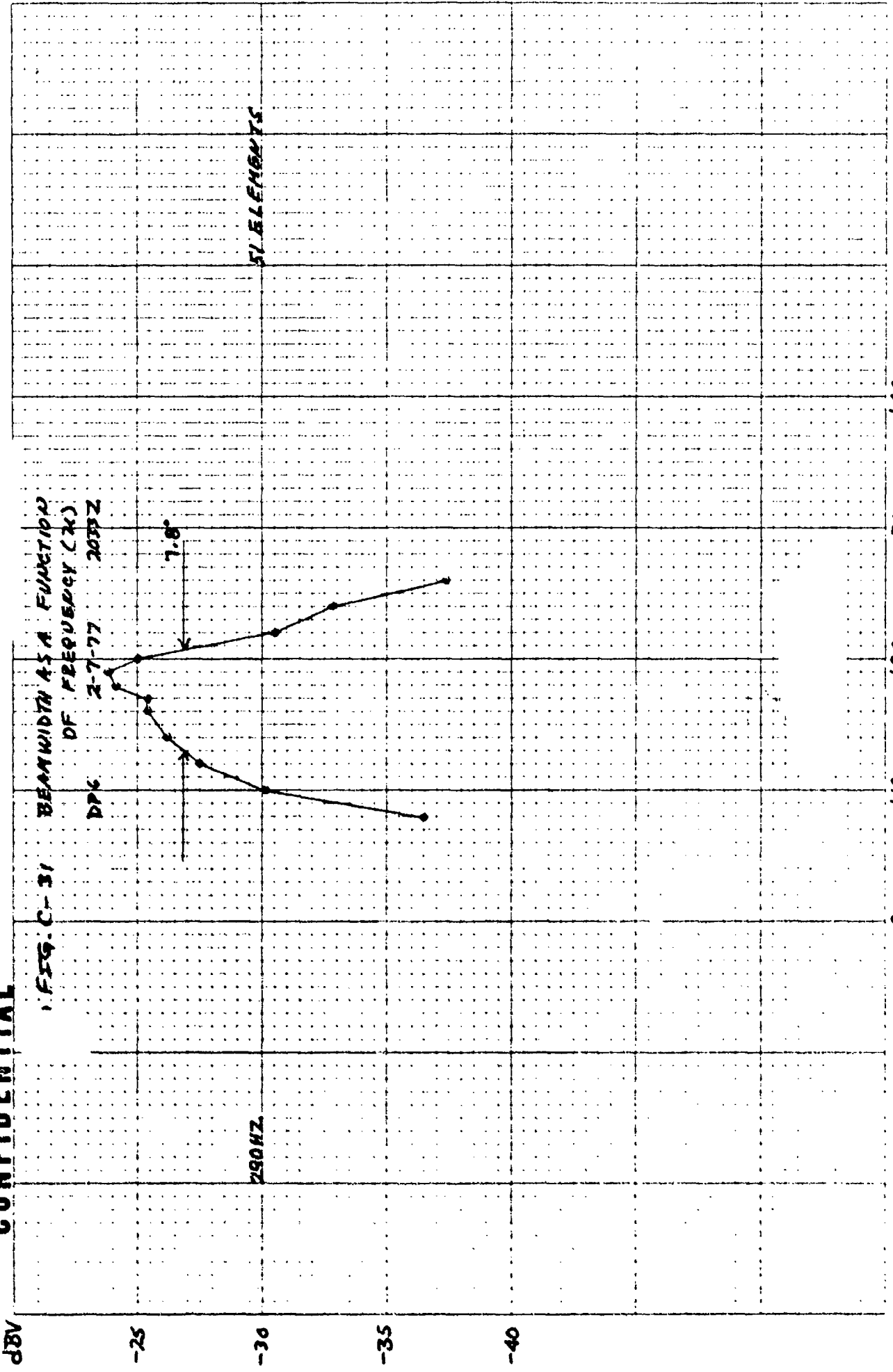
JBV

1 F15-C-50 BFM 4:07H AS A COMPTON
PF FREQUENCY (CX)
DPS 2-7-77 1519Z



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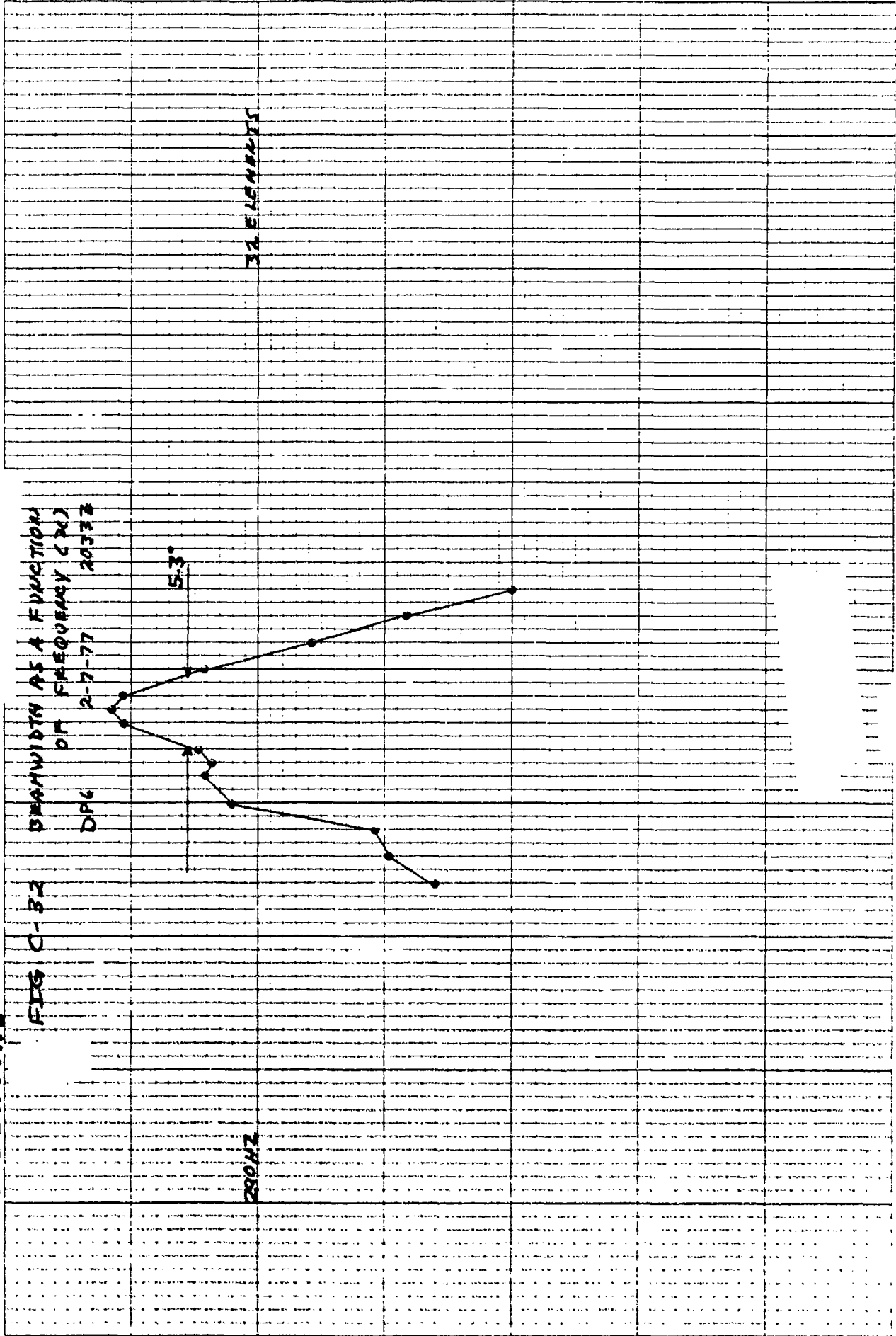
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JBV



DEGREES OFF BROADSIDE

+40

+30

+20

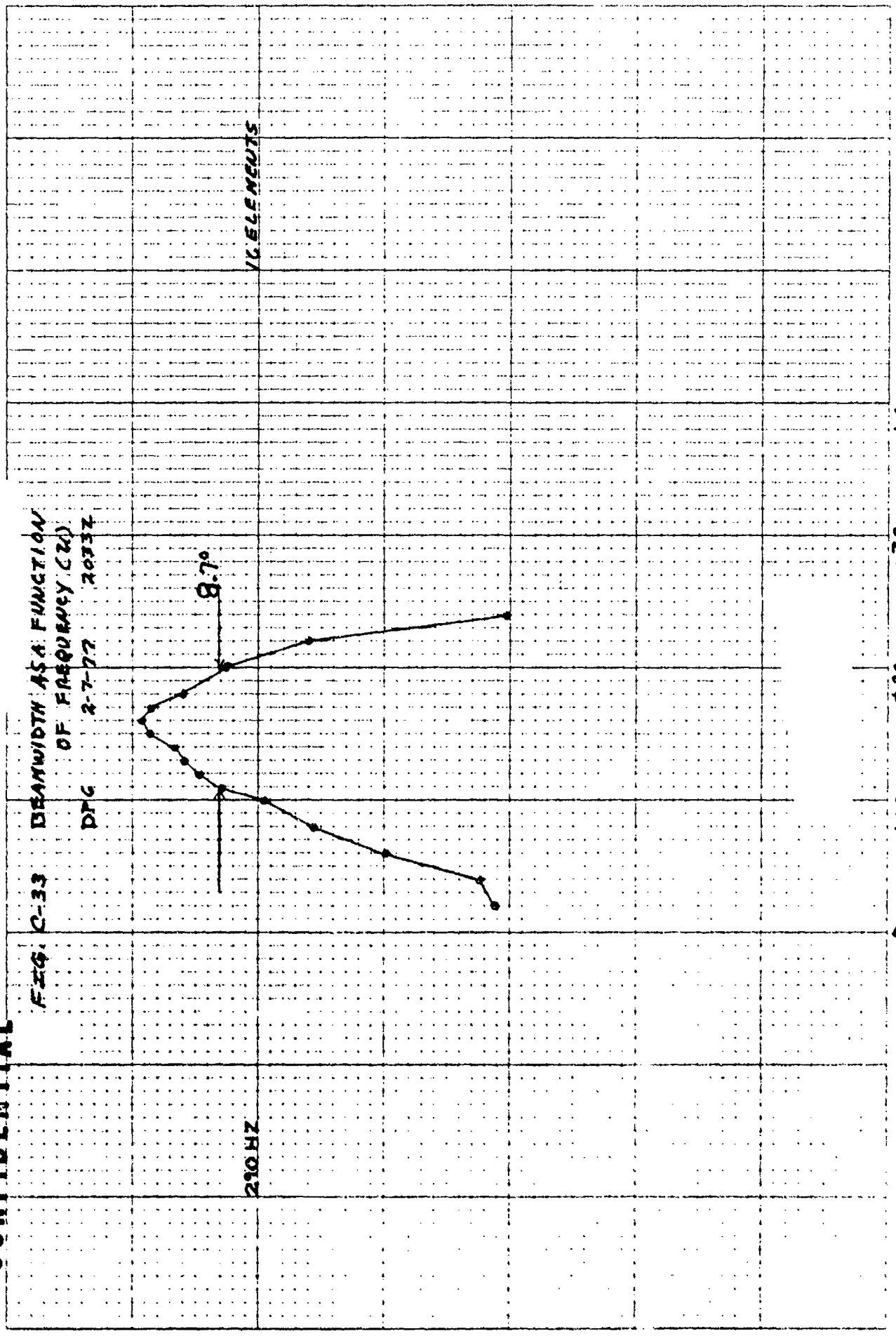
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NOE REFERENCE TO THE HIGH FREQUENCY ELEMENTS

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FIG. C-33 BEAMWIDTH AS A FUNCTION OF FREQUENCY (20)
DFG 2-7-77 2033Z

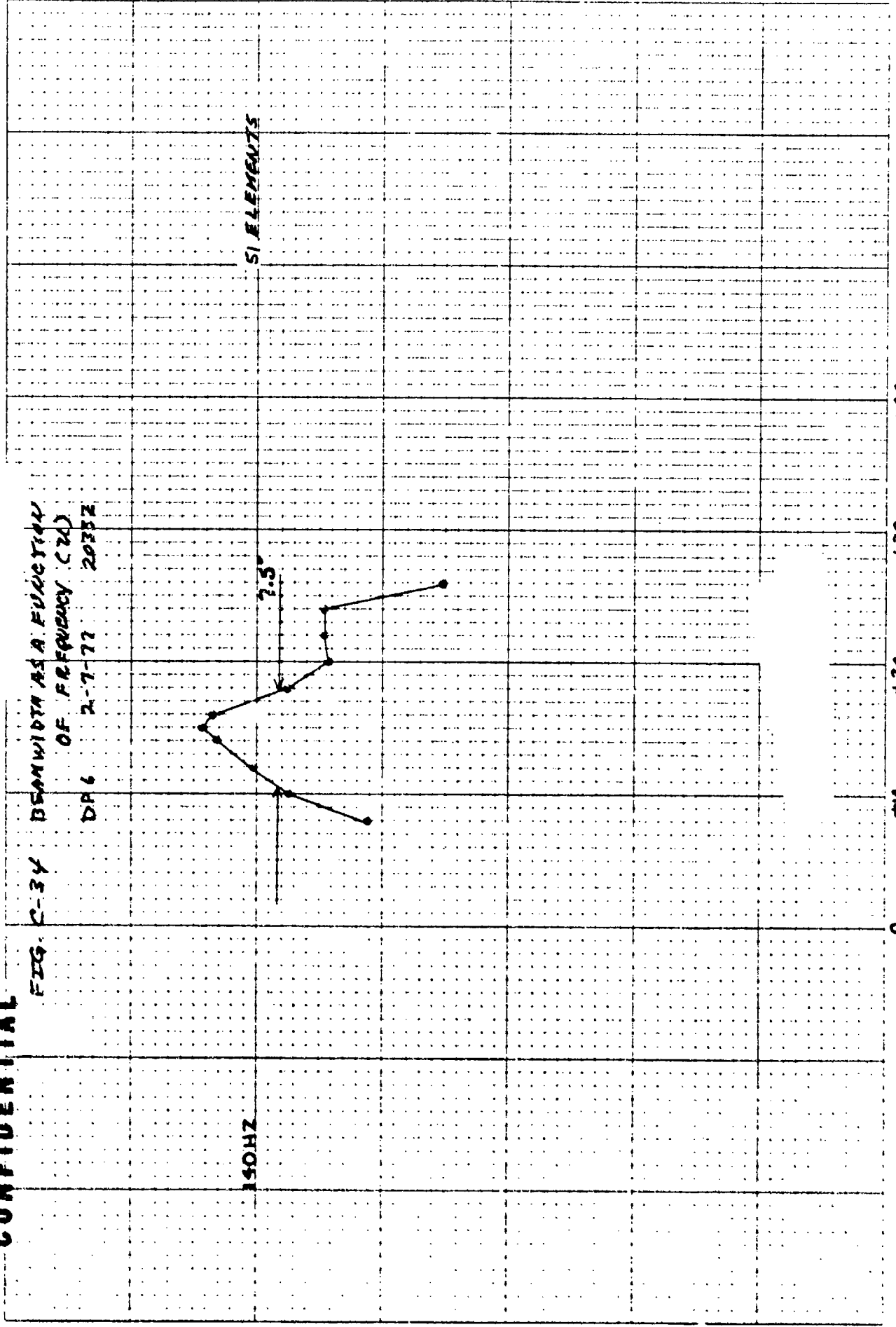


DEGREES OFF BROADSIDE

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FIG. C-34 BEAMWIDTH AS A FUNCTION OF FREQUENCY (CZ)
DPG 2-7-77 2035Z



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DEGREES OFF BROADSIDE

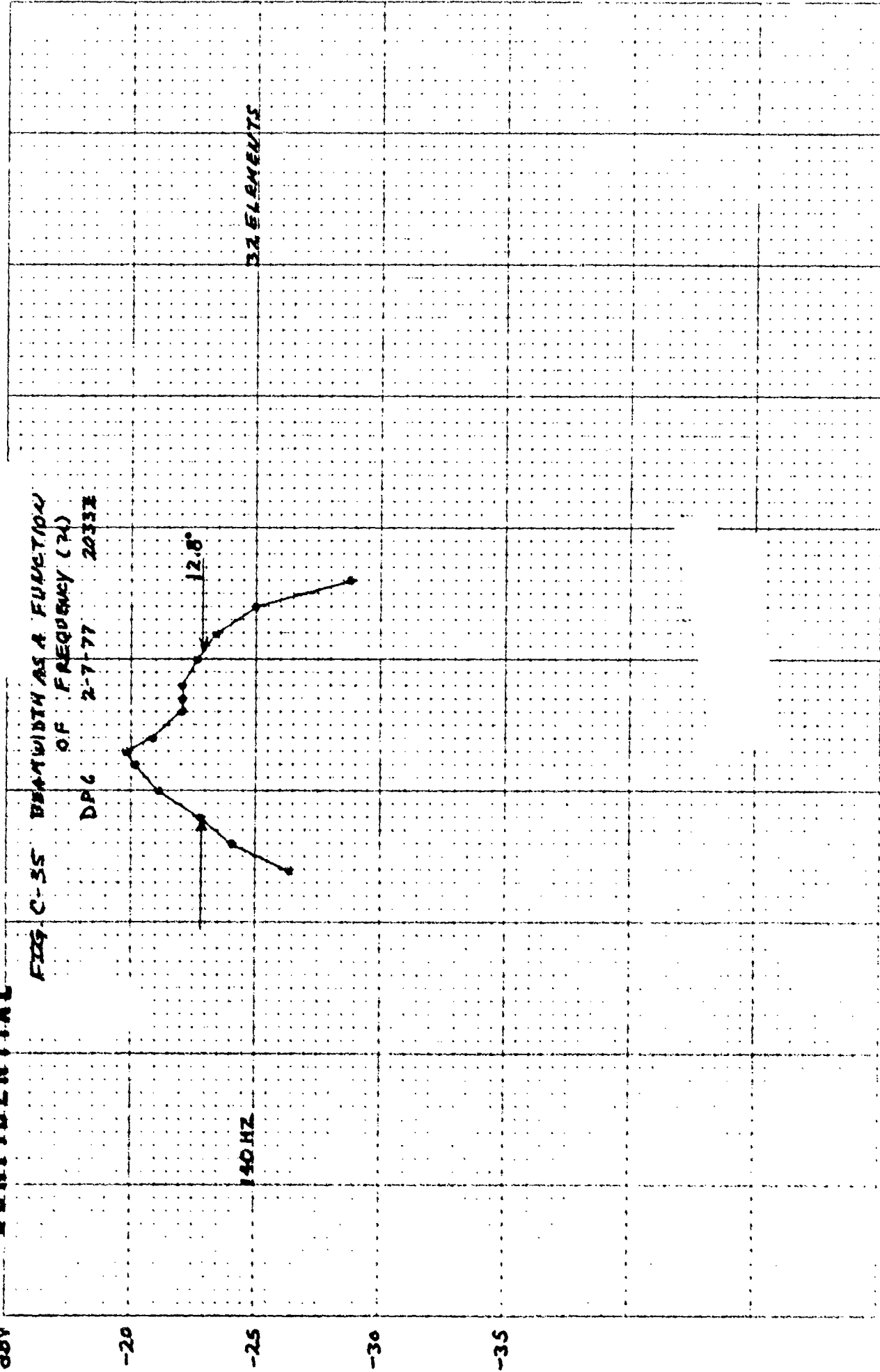
46 0703

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FIG C-35 BANDWIDTH AS A FUNCTION
OF FREQUENCY (74)

DPC 2-7-77 2033Z



DEGREES OFF BROADSIDE

+40

+30

+20

+10

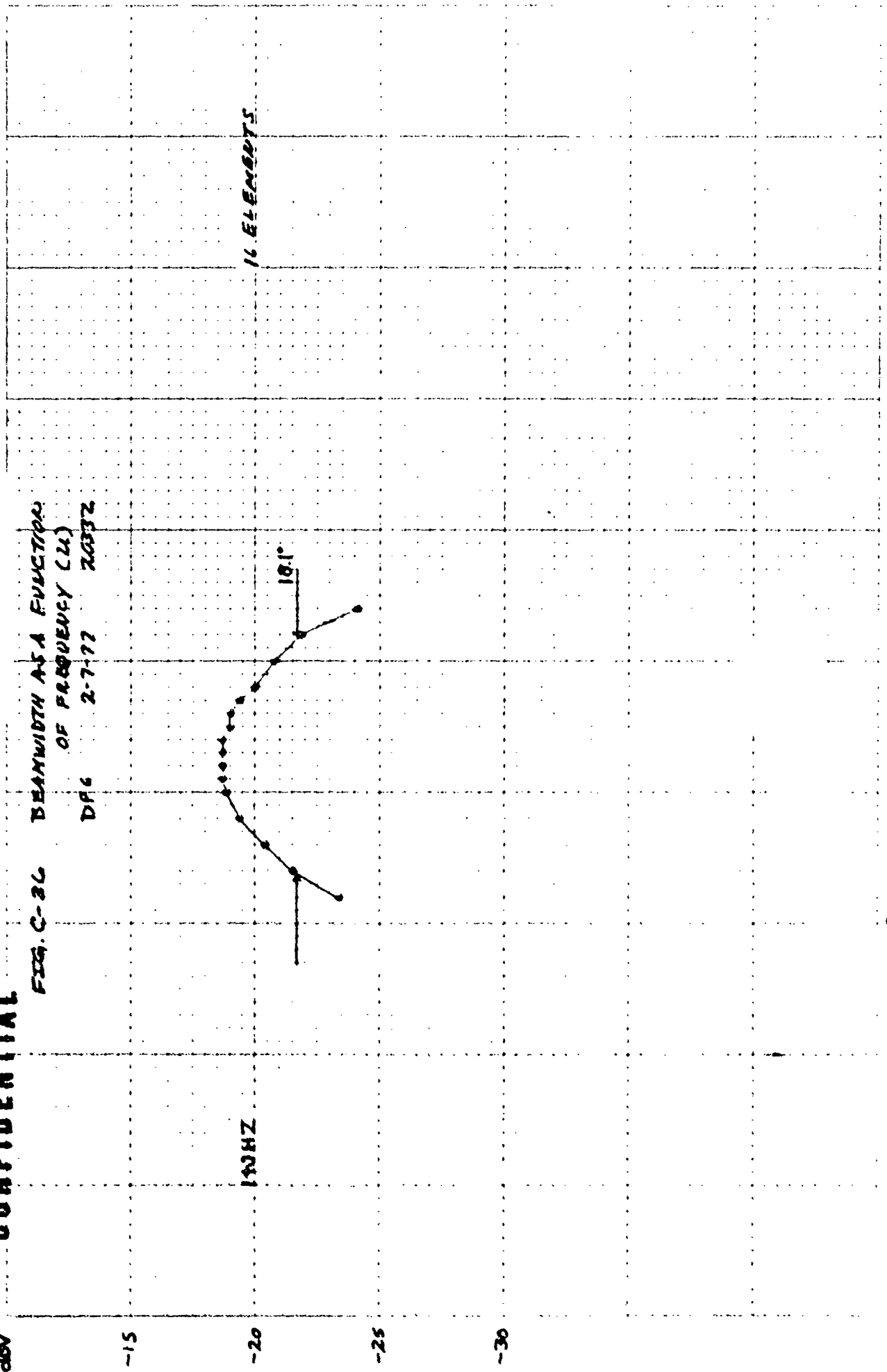
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FIG. C-36 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (LW)
DFG 2-7-77 20332

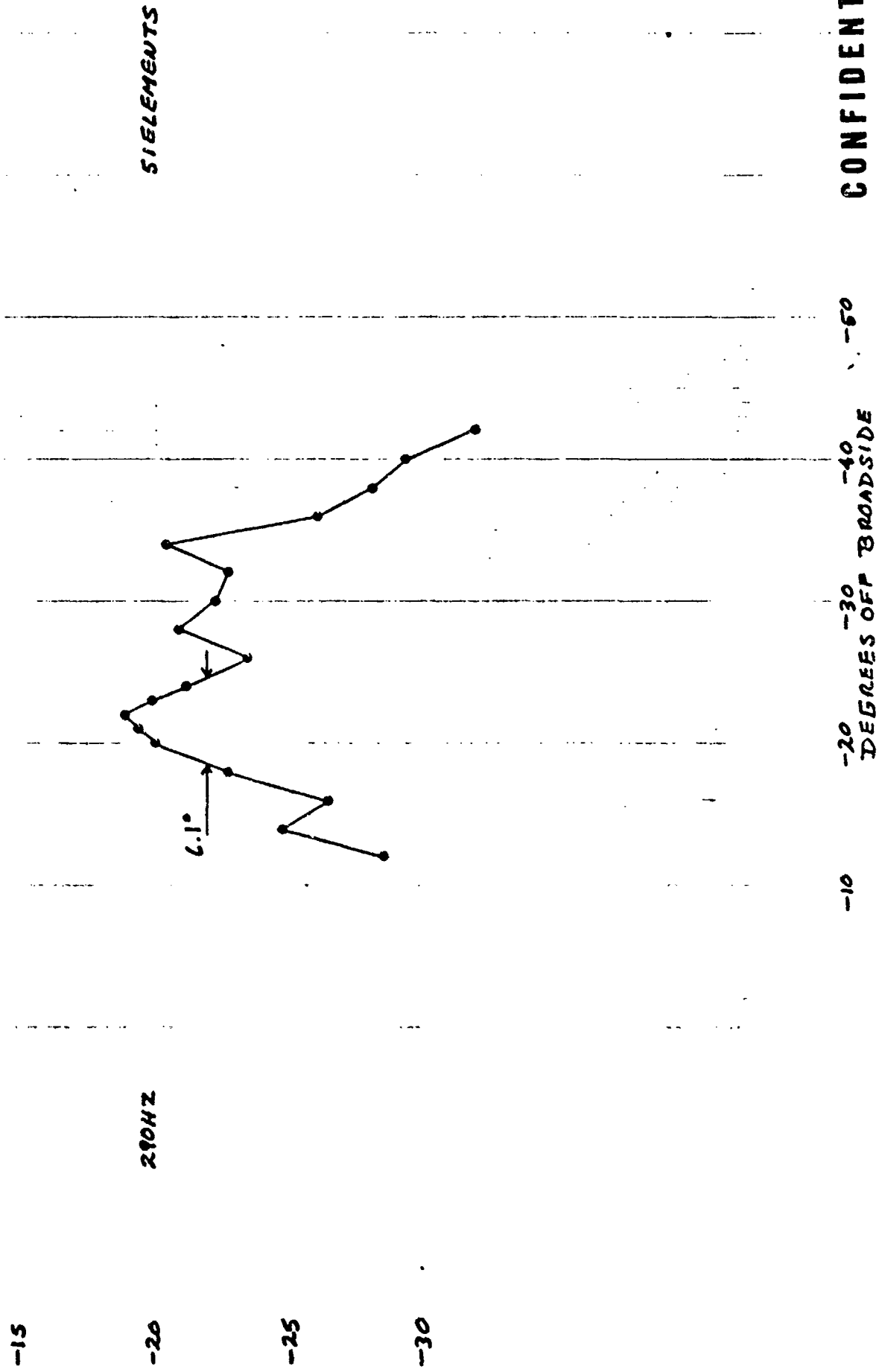


0 120 130 140
DEGREES OFF BROADSIDE

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FIG. C-37 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (74)
DP7 2-8-77 0202Z



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FIG. C-38 BANDWIDTH AS A FUNCTION OF FREQUENCY (24)
DP7 2-8-77 0301Z

-15

240HZ

32.64CMBATS

4.8°

-25

-30

-10

-20

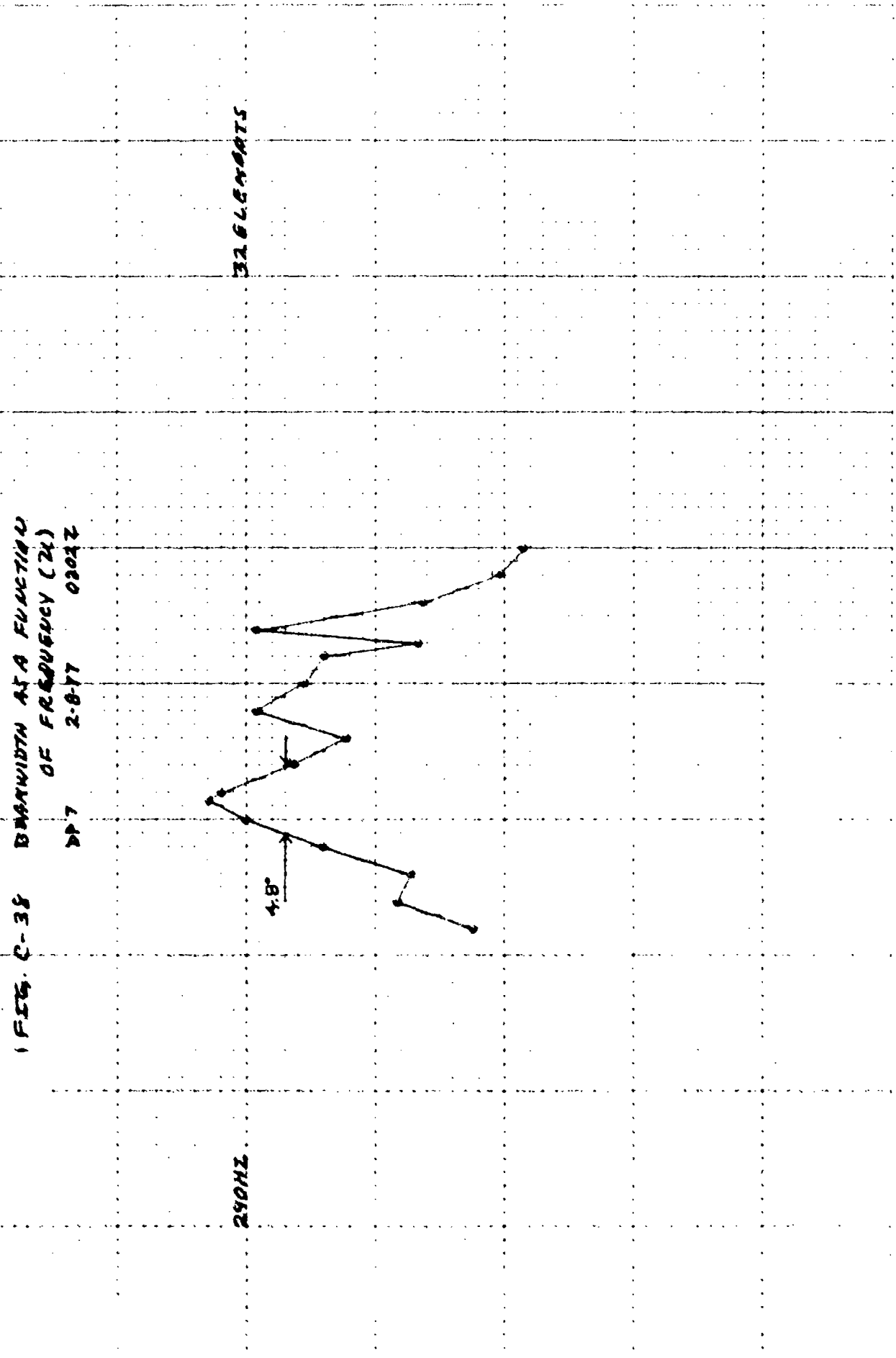
-30

-40

-50

DEGREES OFF BROADSIDE

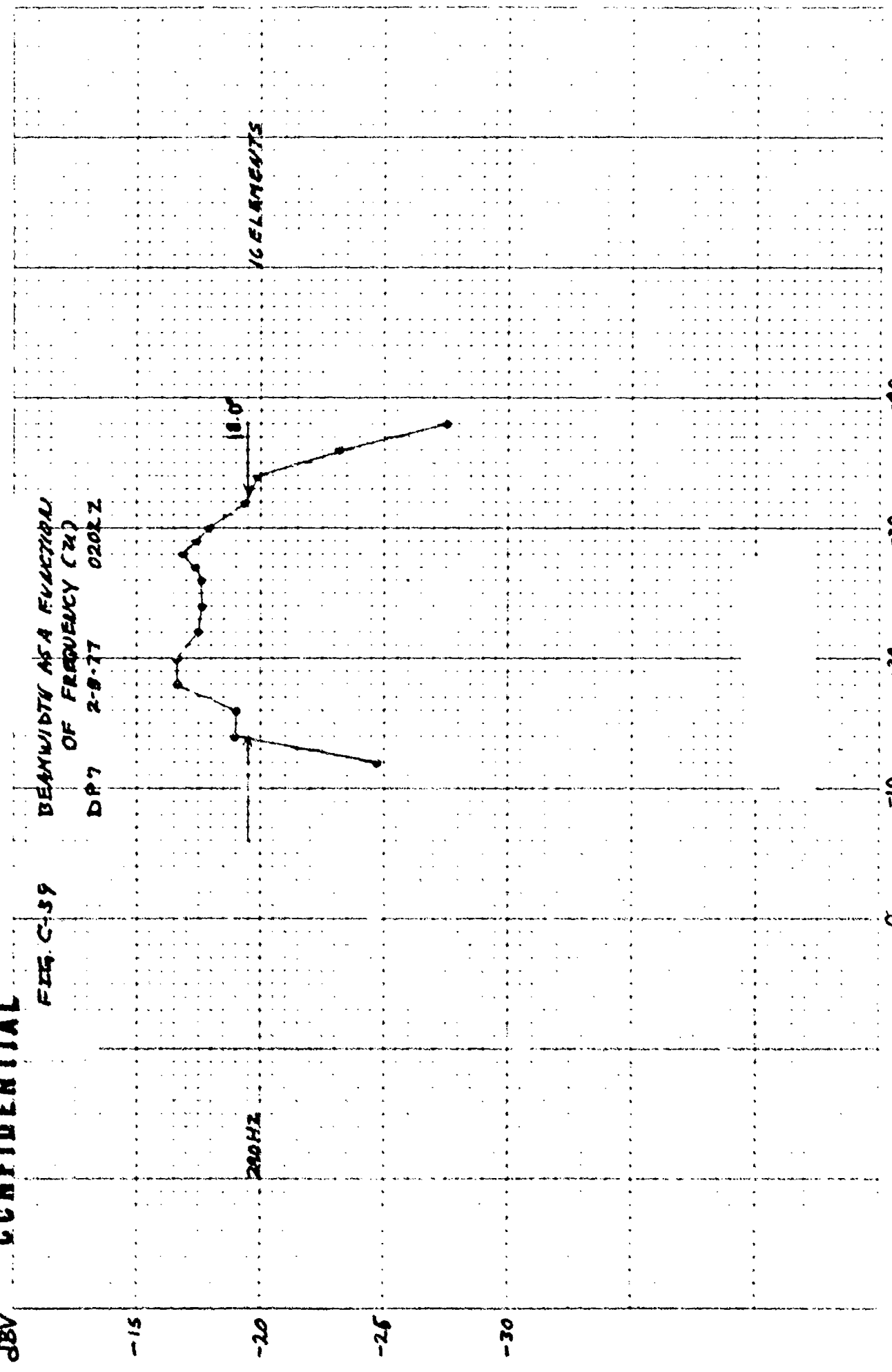
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FIG. C-39
BEAMWIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DP7 2-8-77 0202Z

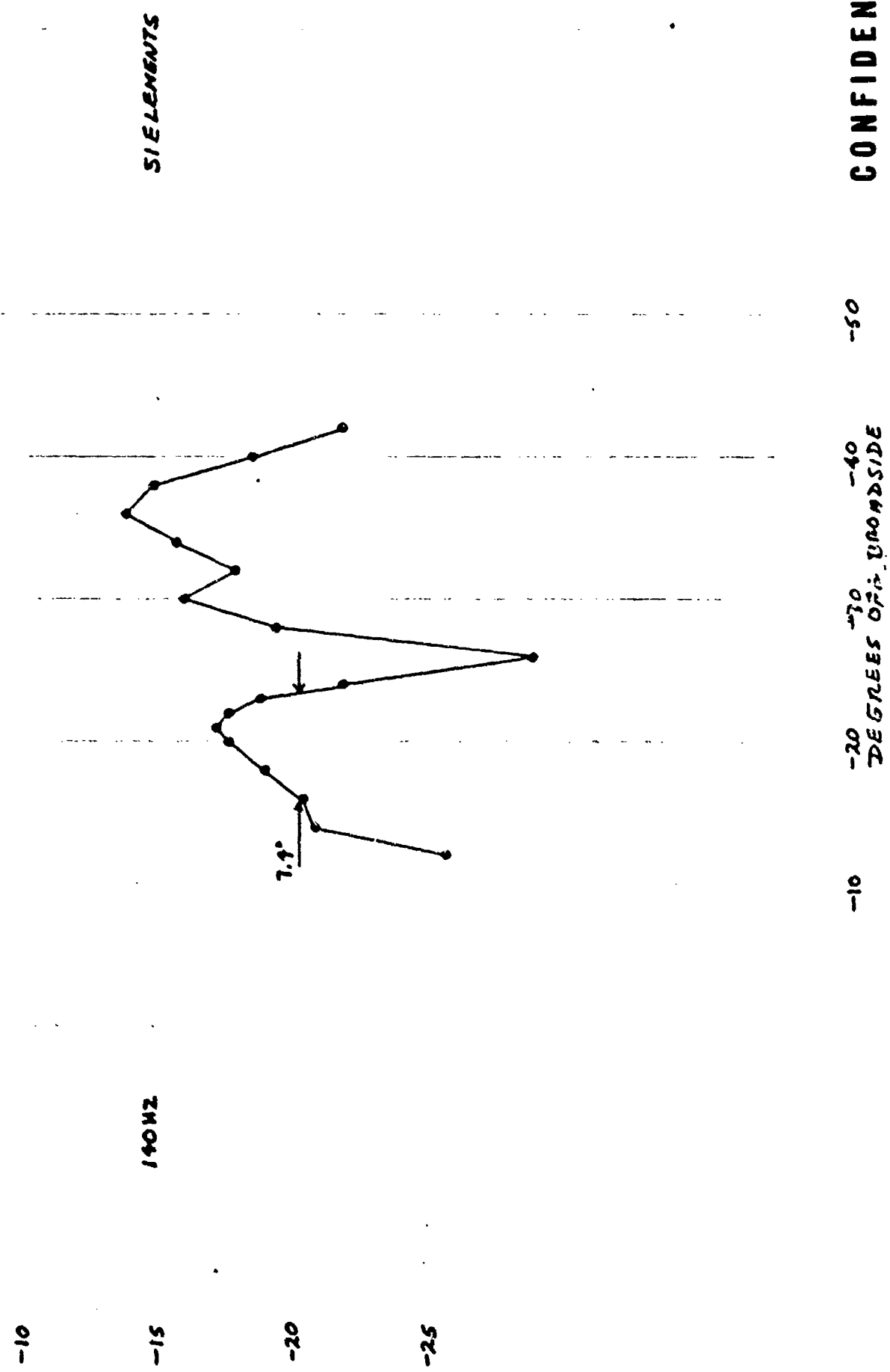


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FIG. C-40 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (ZL)
DP7 2-8-77 0202Z



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SIELEMENTS

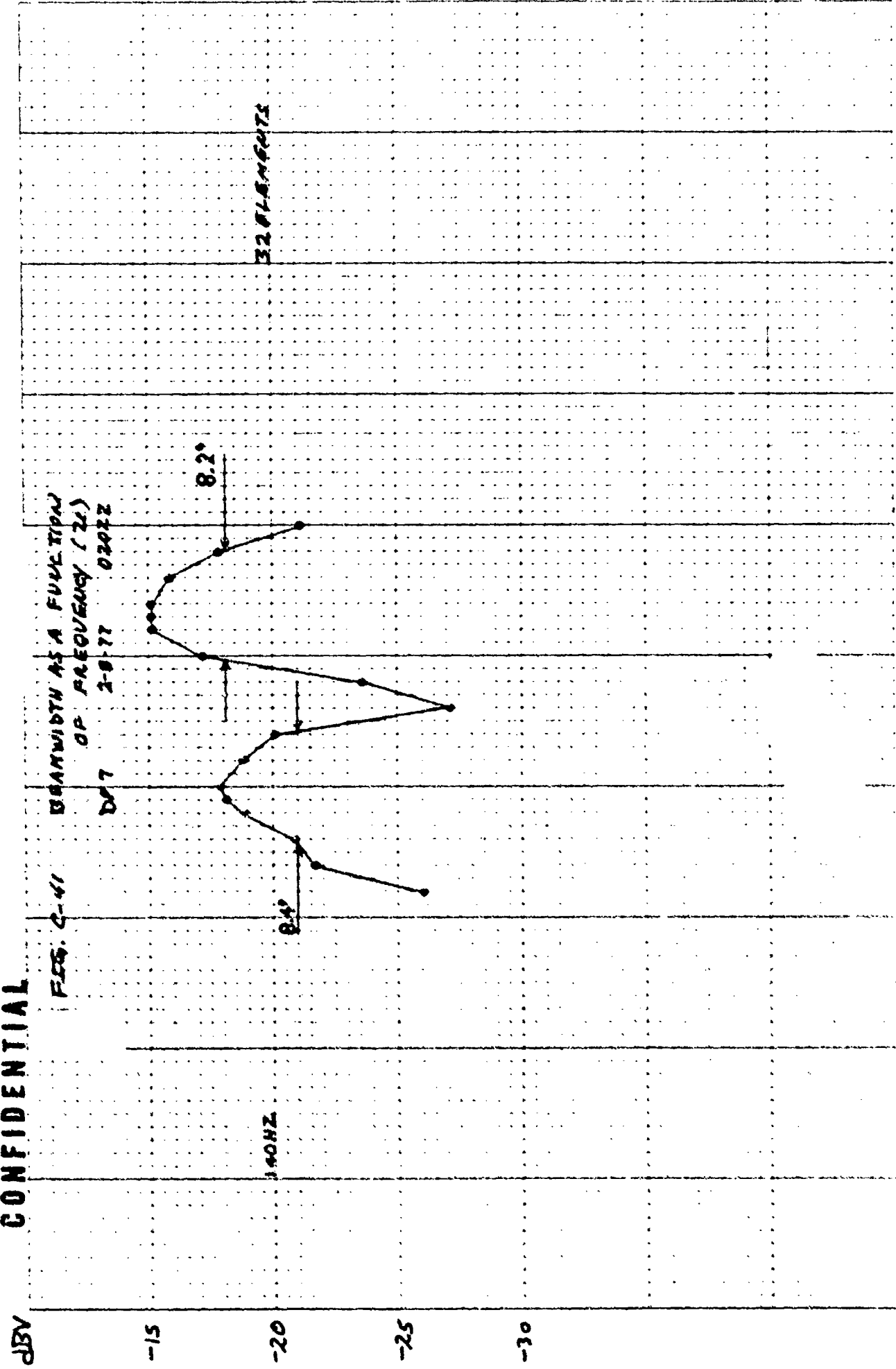
CONFIDENTIAL

-50

-20 DEGREES OFF BROADSIDE

-10

CONFIDENTIAL



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DEGREES OFF BROADSIDE

-10

-20

-30

-40

-50

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NOE BEAM WIDTH DATA

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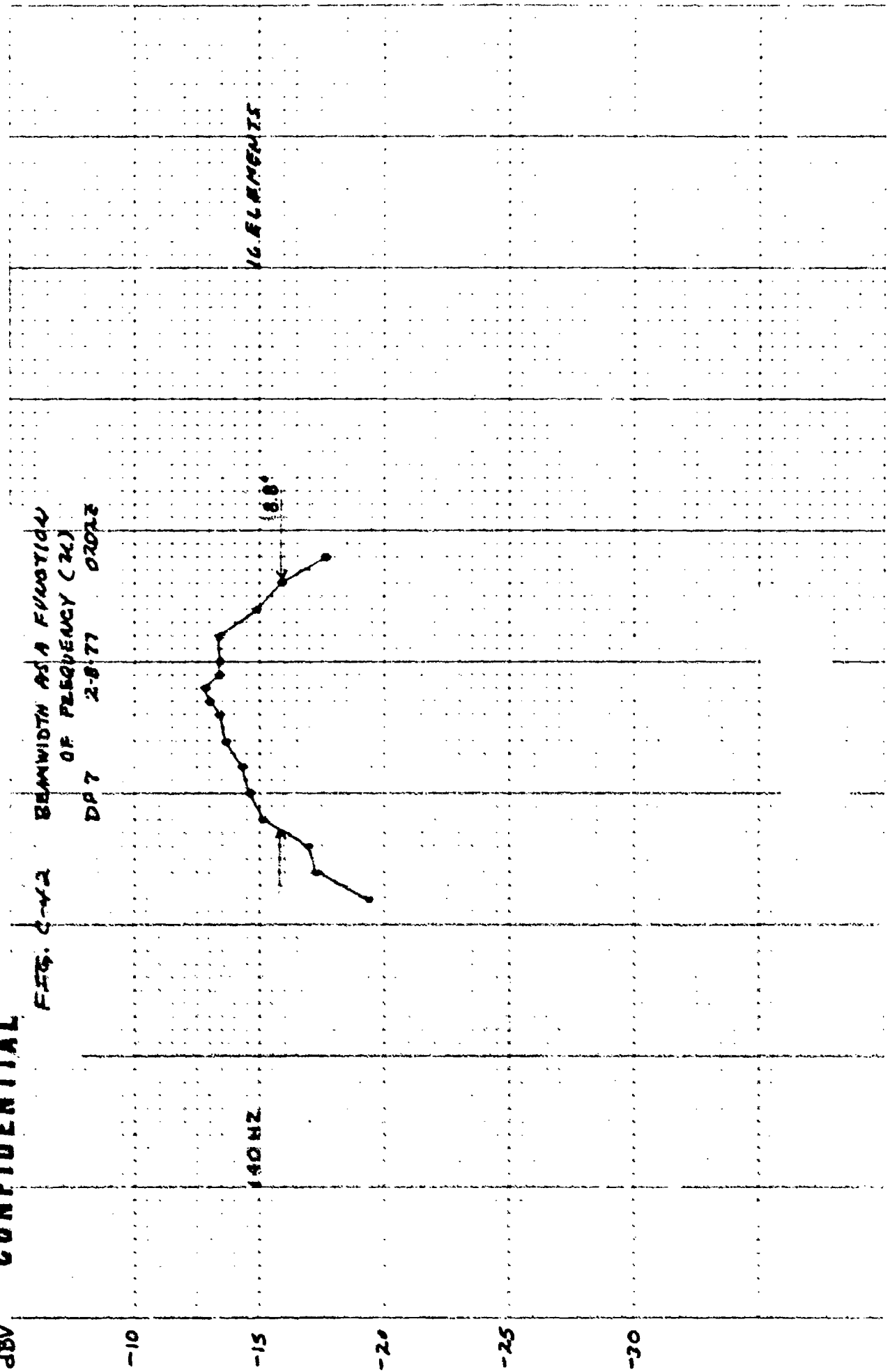
dBV

FIG. C-42 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (24)
DP7 2-8-77 0207Z

140 HZ

16 ELEMENTS

18°



10

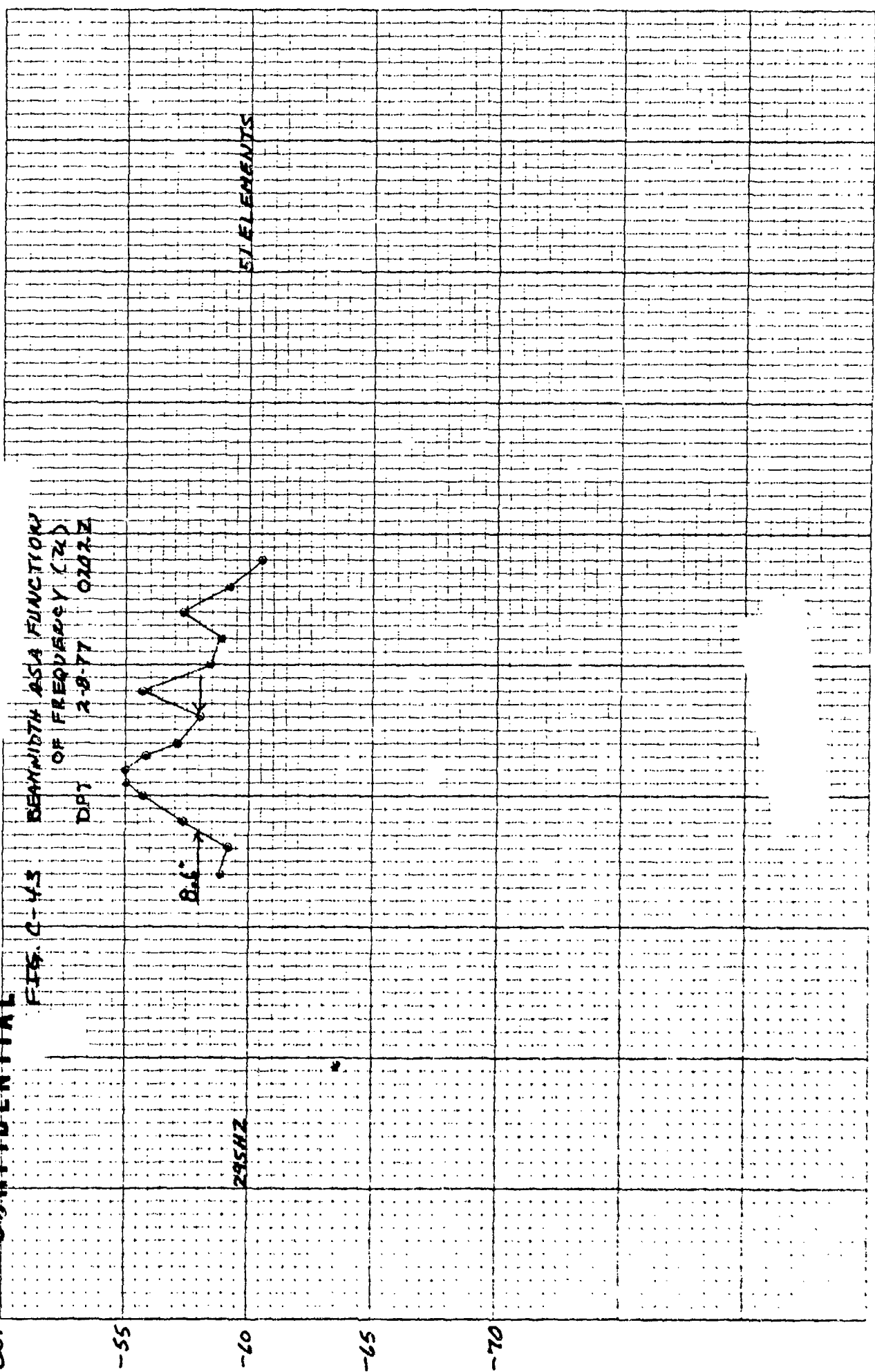
20 30 40 DEGREES OFF BROADSIDE

50

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FIG. C-43 BEAMWIDTH AS A FUNCTION OF FREQUENCY (Hz) DPT 2-8-77 0202Z



DEGREES OFF BROADSIDE -20 -30 -40 -50

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FIG 2-10-77 0702Z

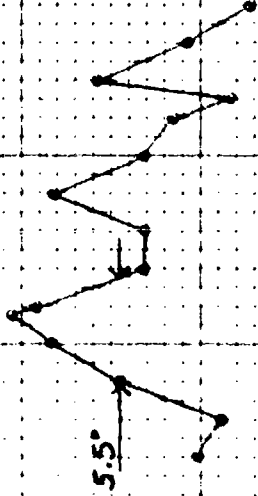
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FIG C-114 BANDWIDTH AS A FUNCTION OF FREQUENCY (24)

DP 7

2-10-77

0702Z



5.5

295HZ

12 ELEMENTS

8BV

-55

-60

-65

-70

-10

-20

-30

-40

-50

DEGREES OFF BROADSIDE

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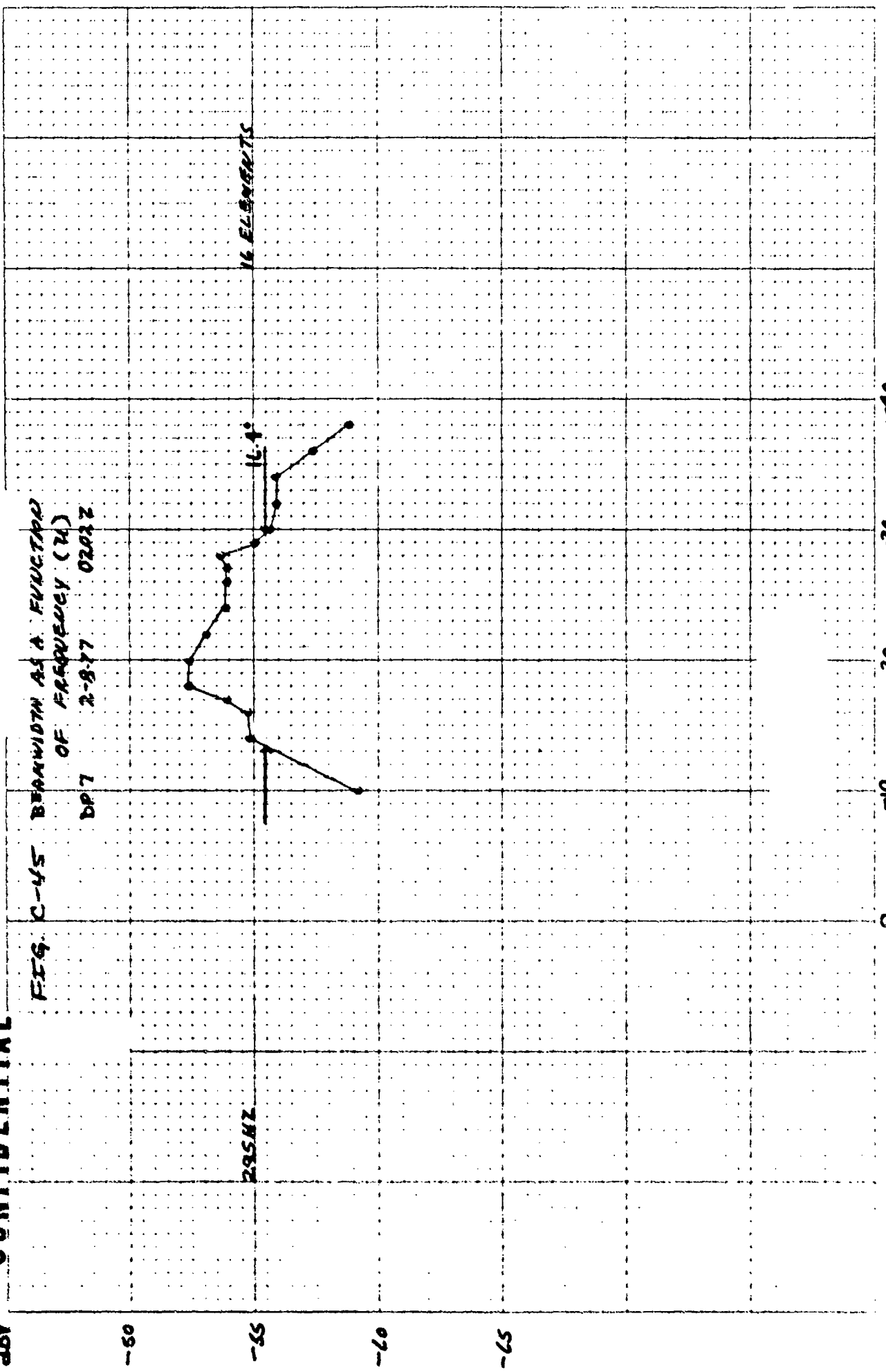


FIG. C-45 BEAMWIDTH AS A FUNCTION OF FREQUENCY (74)
DP7 2-9-77 0201Z

29.5 MHz

16 ELEMENTS

-40

-30

-20

-10

0

DEGREES OFF BROADSIDE

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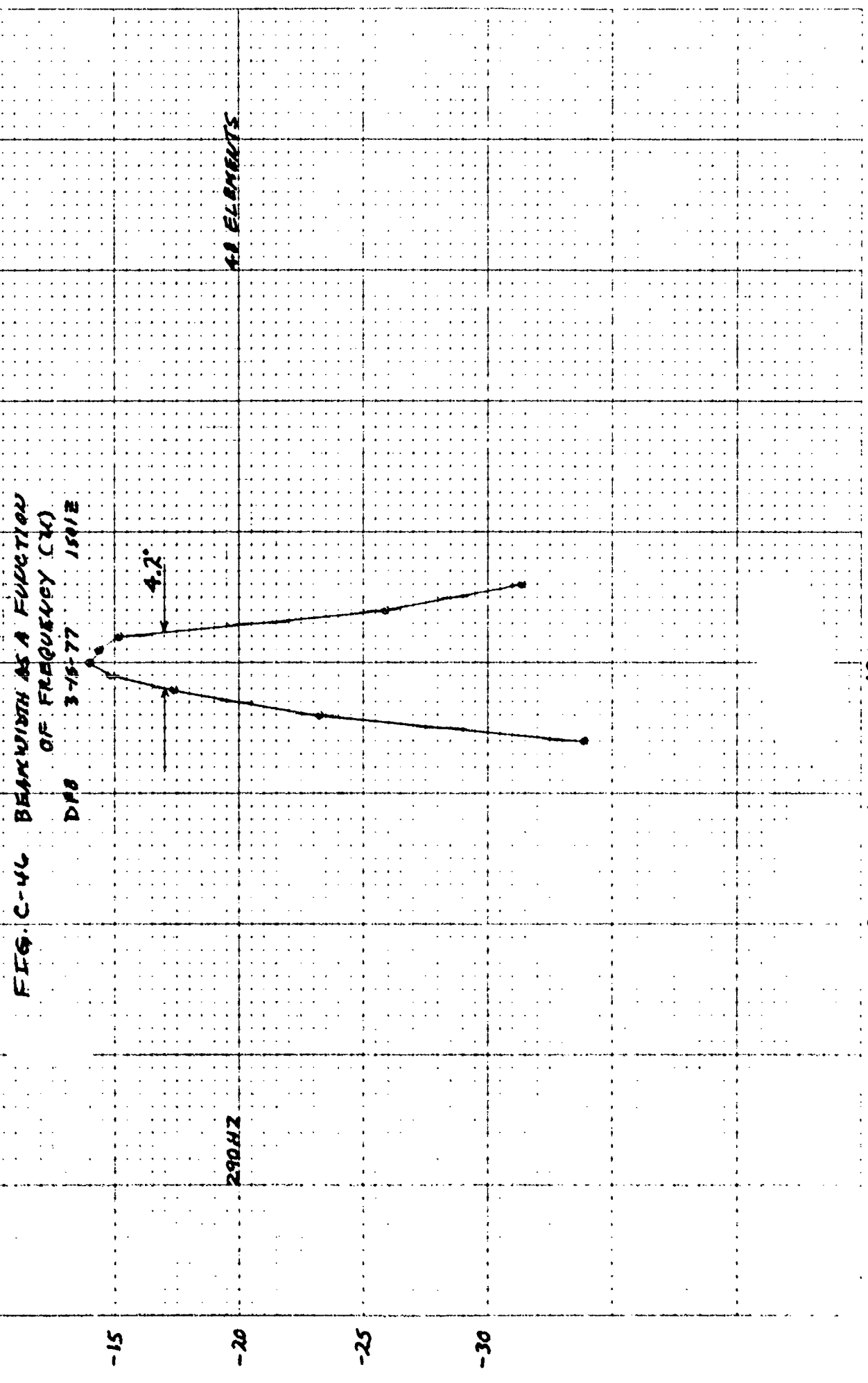


FIG. C-46 BEAMWIDTH AS A FUNCTION OF FREQUENCY (HZ)
DPO 3-15-77 15012

0 10 20 30 40
DEGREES OFF BROADSIDE

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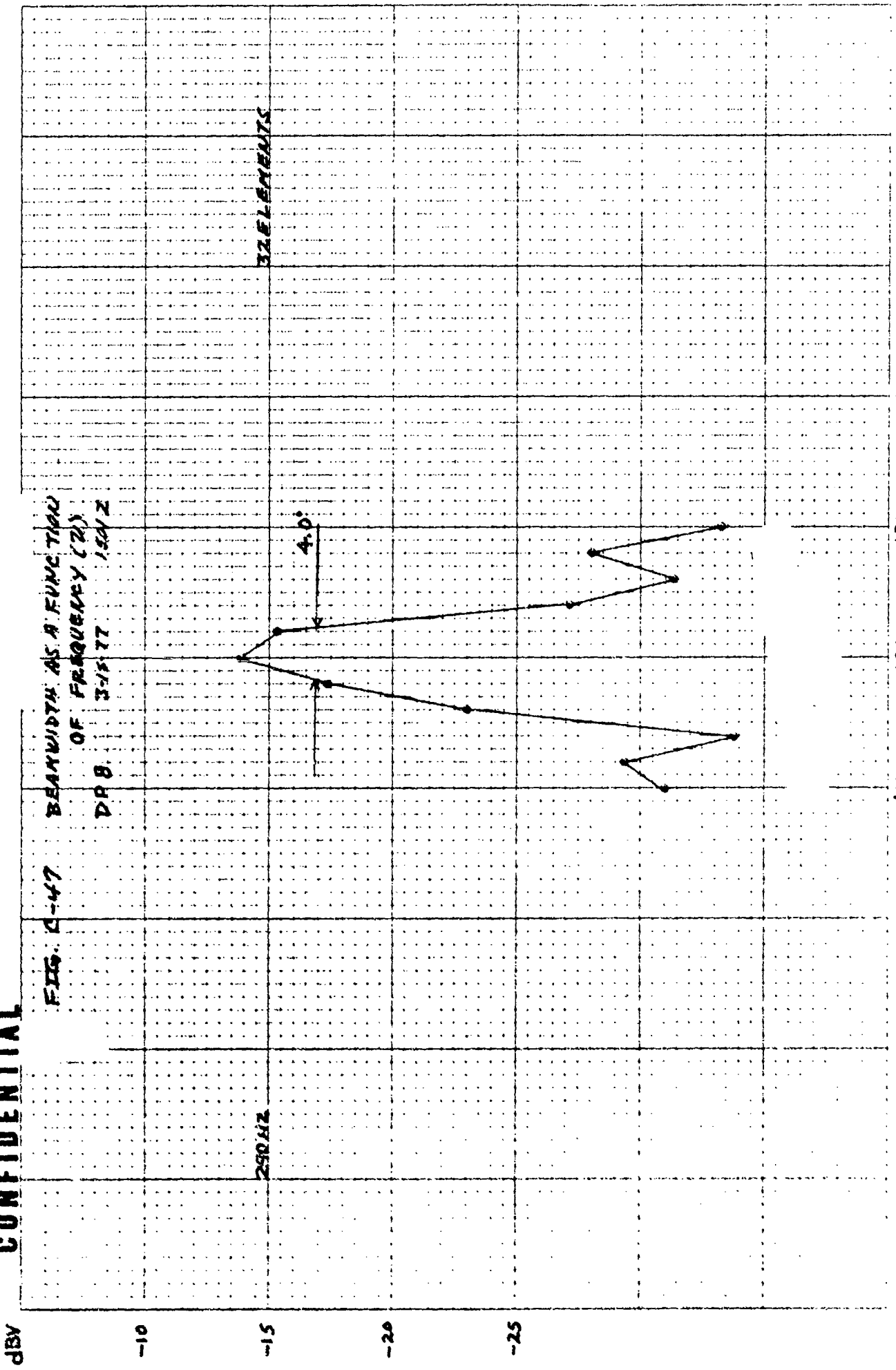


FIG. 1-47 BEAMWIDTH AS A FUNCTION OF FREQUENCY (2).
DR B. 3-15-77 15N 2

ZH052

32 ELEMENTS

4.0°

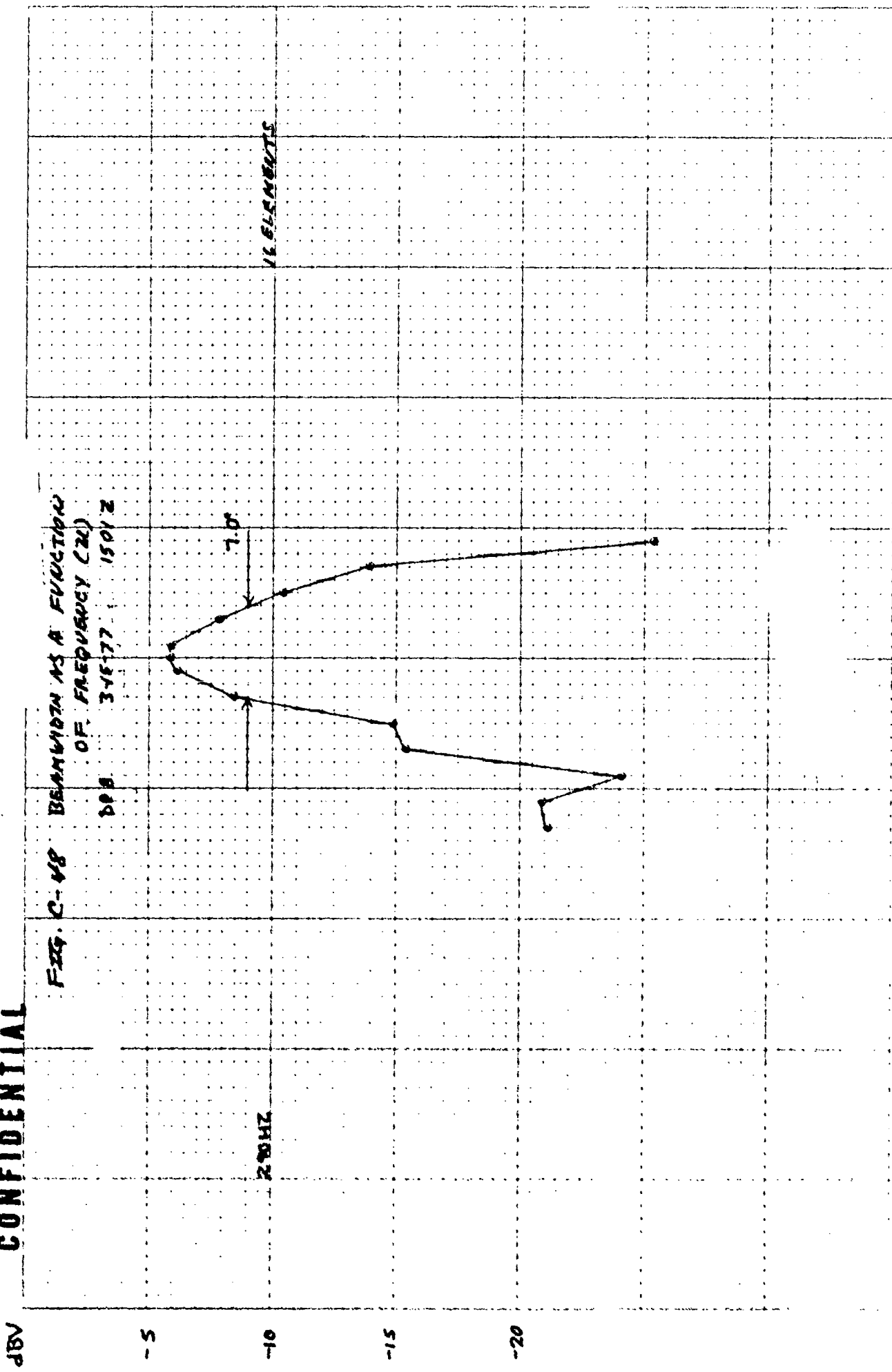
0 +10 +20 +30 +40
DEGREES OFF BROADSIDE

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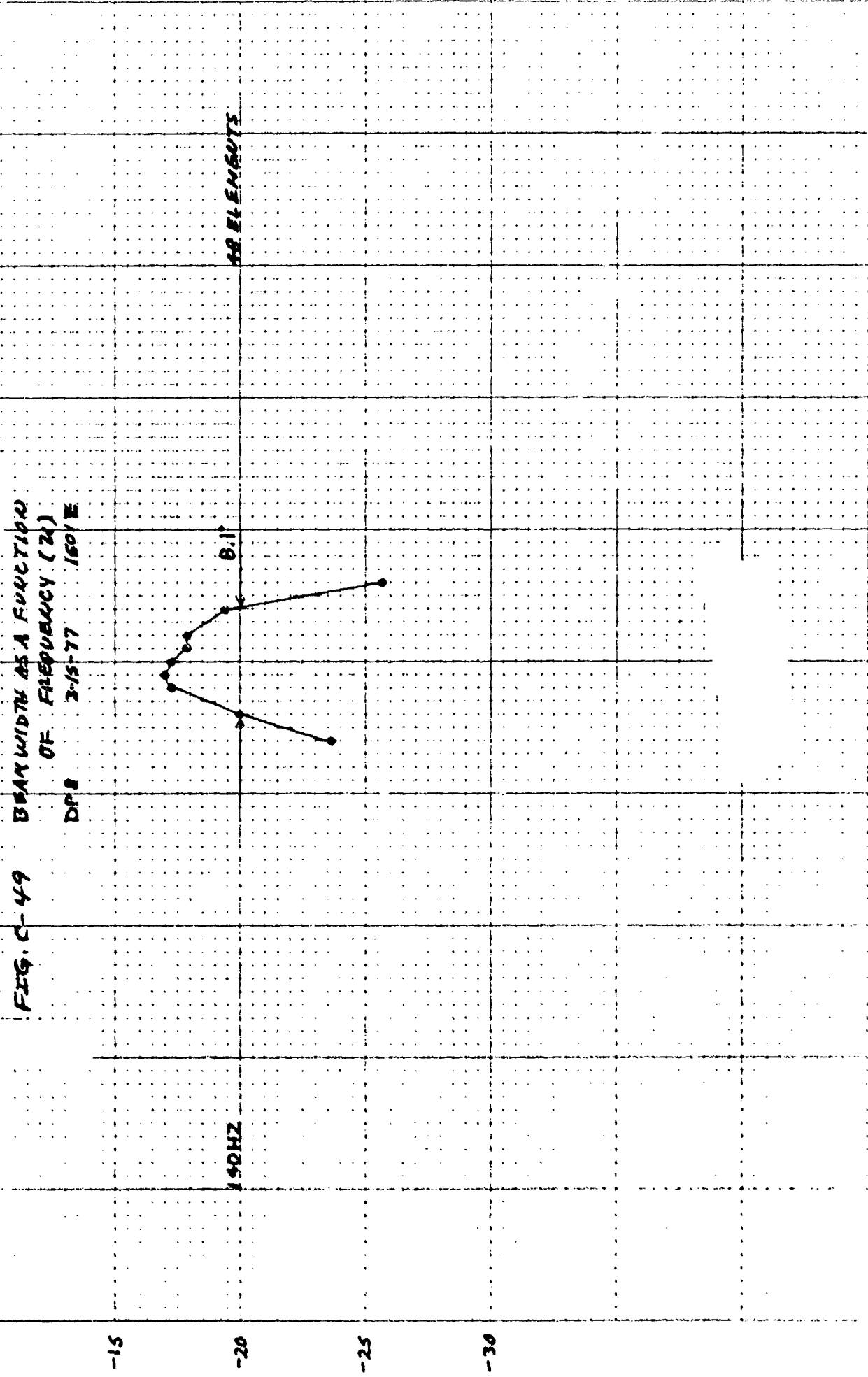


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0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 DEGREES OFF BROADSIDE

CONFIDENTIAL

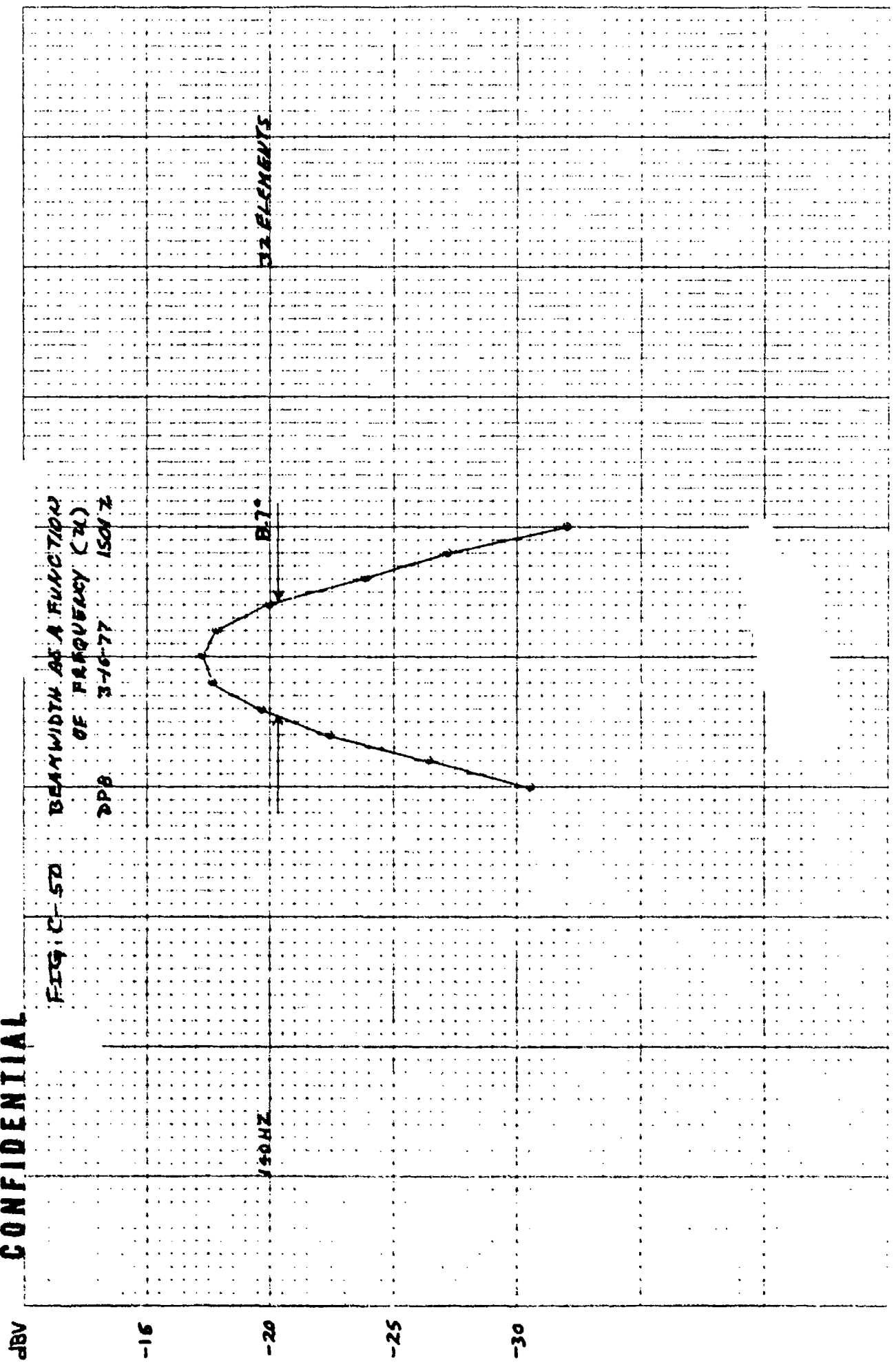
dBV



DEGREES OFF BROADSIDE

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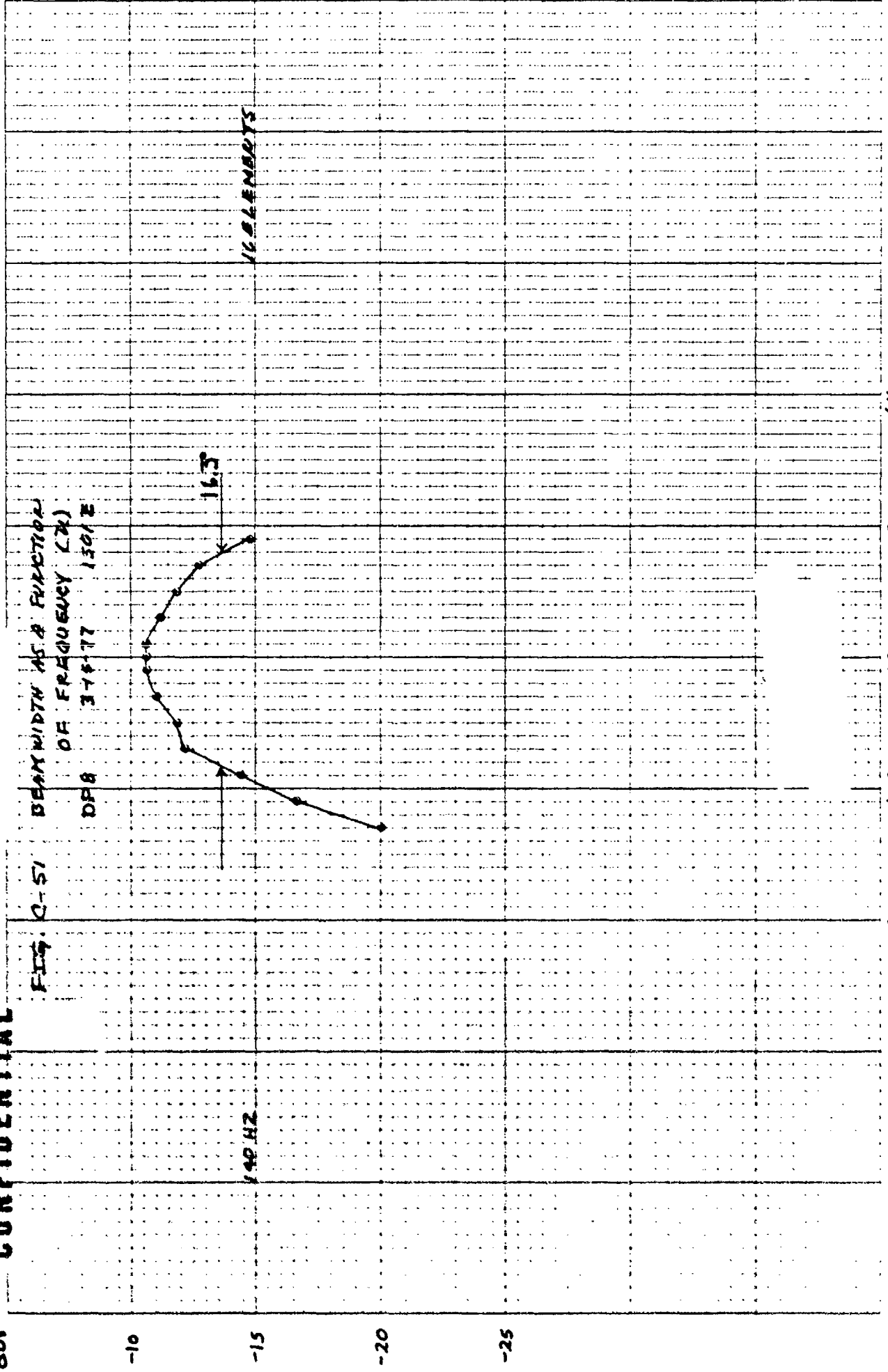
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FIG. Q-51 BEAM WIDTH AS A FUNCTION OF FREQUENCY (2K) DPB 375-77 1501E



DEGREES OFF BROADSIDE

40

+30

+20

+10

0

-10

-15

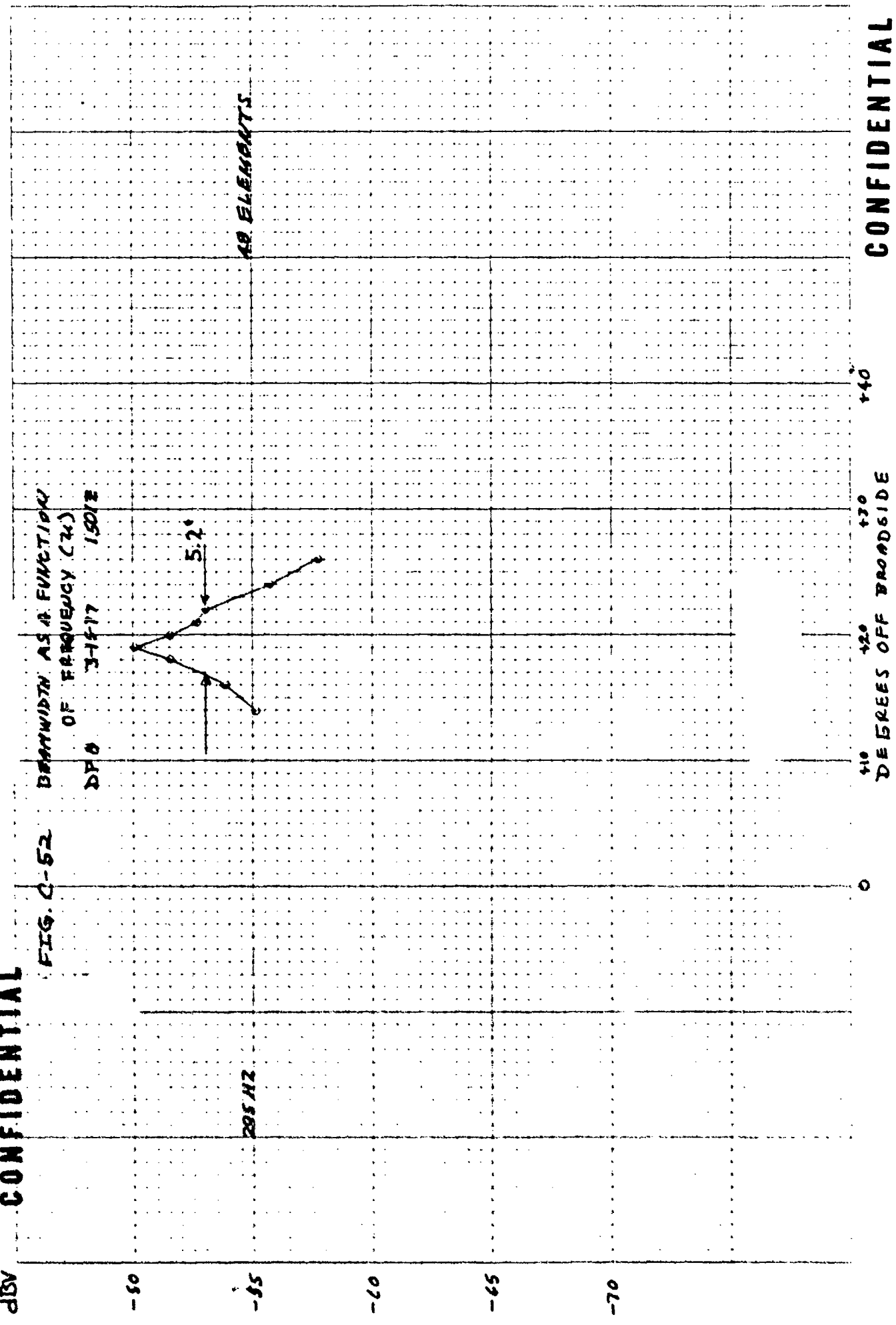
-20

-25

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FIG. Q-52 BANDWIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DPO 31417 15012



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NOE REPORT CLASSIFICATION: UNCLASSIFIED
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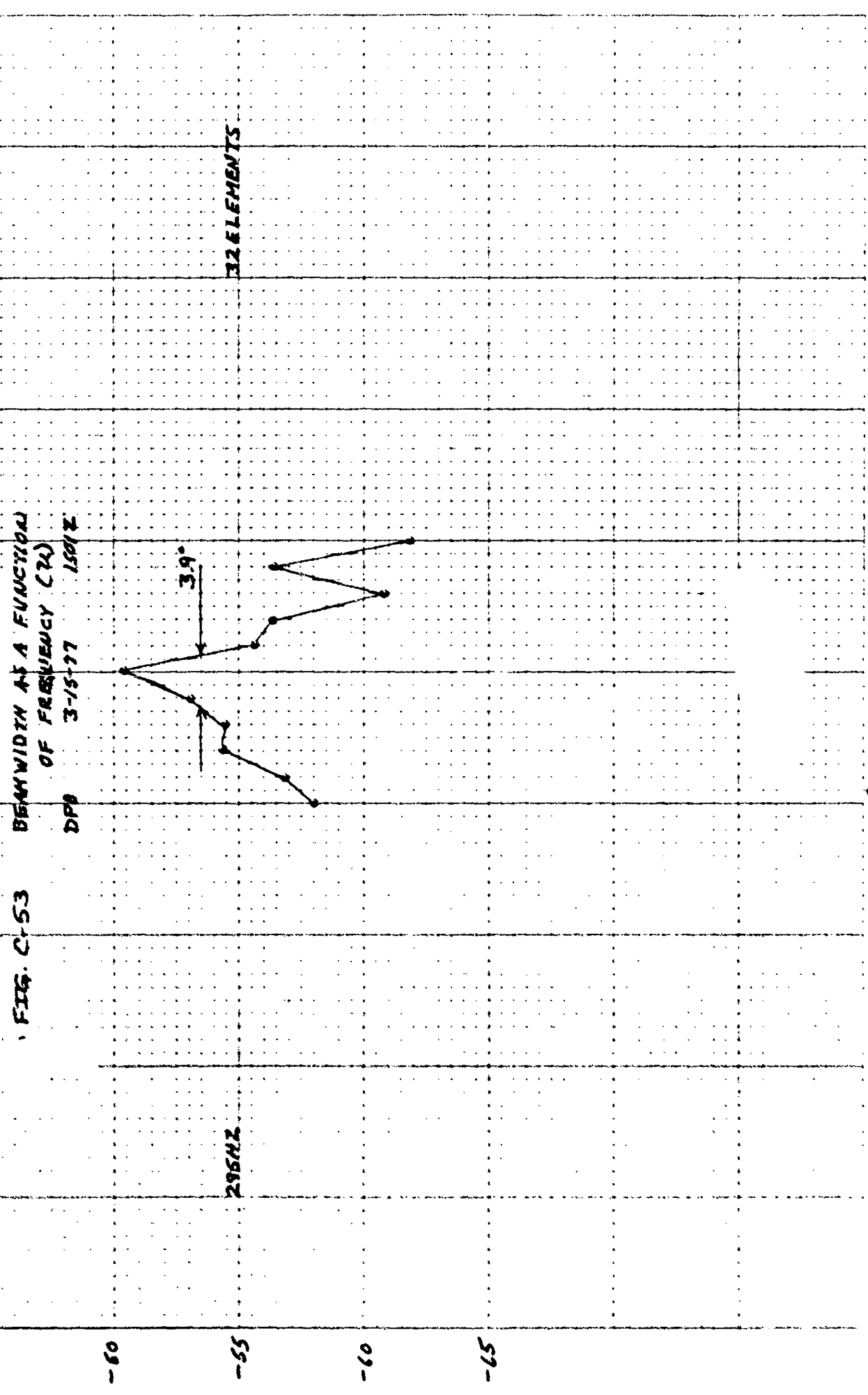


FIG. C-53 BEAMWIDTH AS A FUNCTION OF FREQUENCY (74)
 DFB 3-15-77 1501Z

296HZ

32 ELEMENTS

3.9°

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DEGREES OFF BROADSIDE

-80

-55

-60

-65

0

+10

+20

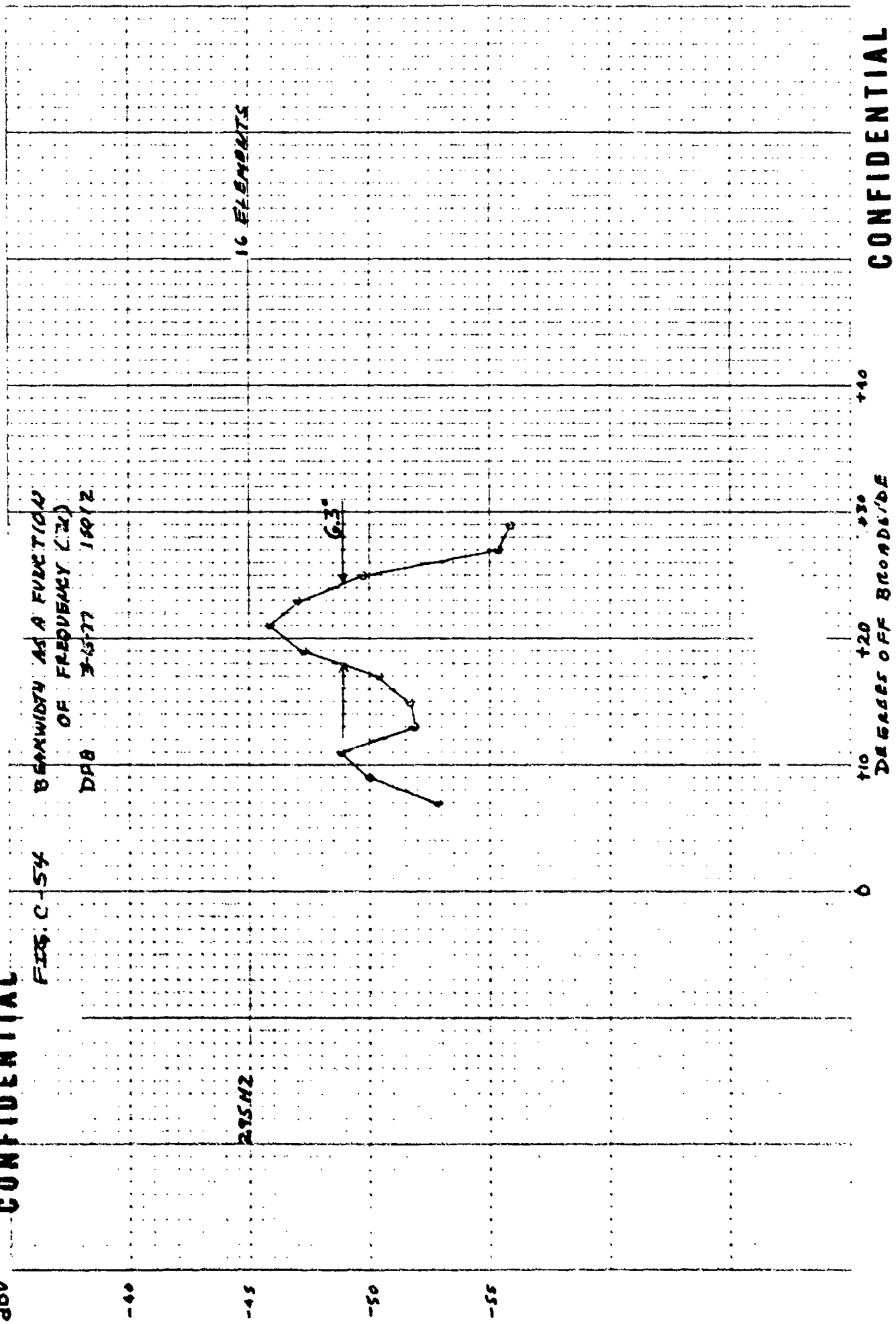
+30

+40

NOTE: THIS IS A COPY OF THE ORIGINAL RECORDING.

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FIG. C-54 BANDWIDTH AS A FUNCTION OF FREQUENCY (20) DBB 3-5777 10012



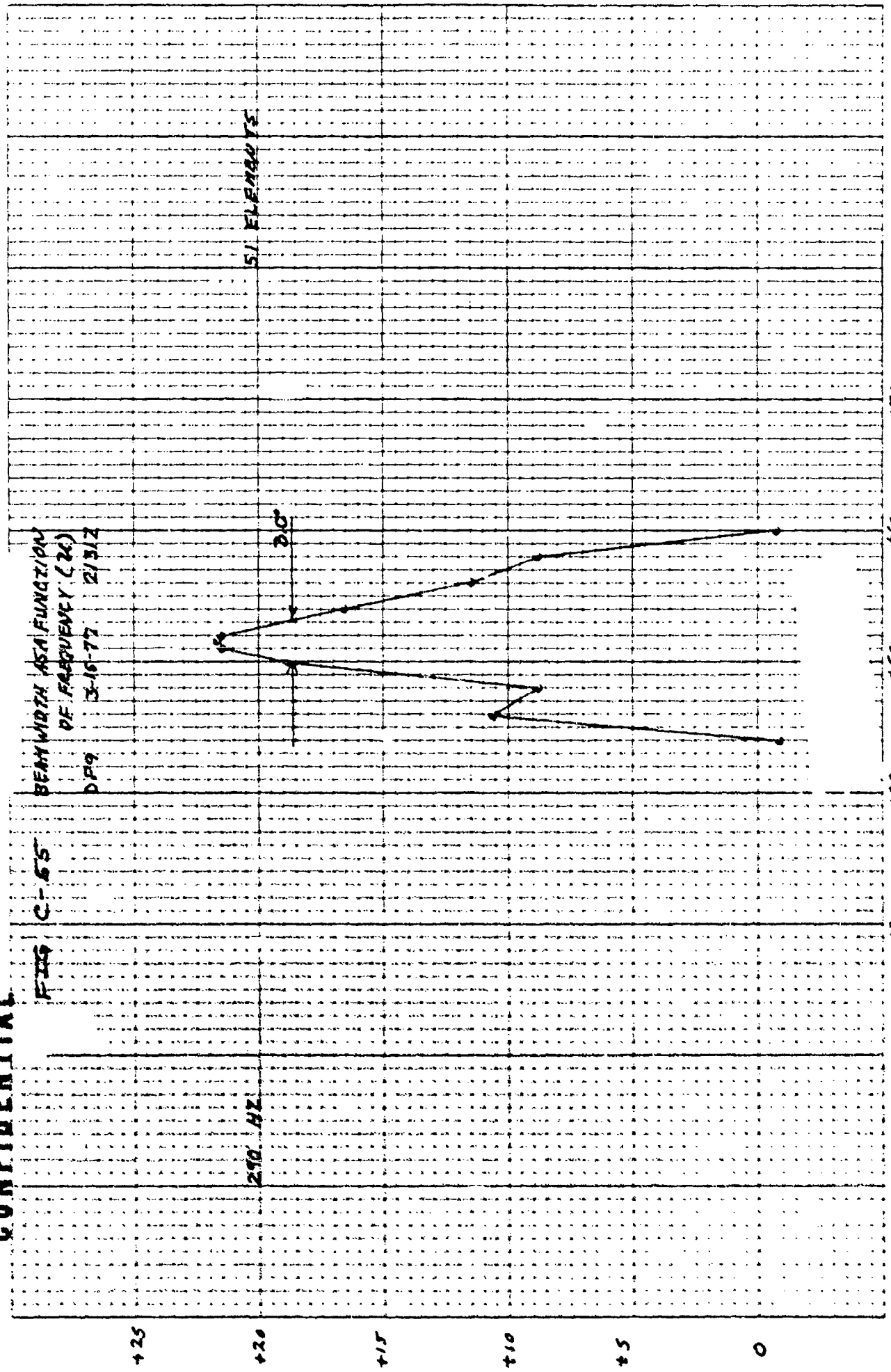
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DEGREES OFF BRANDSIDE

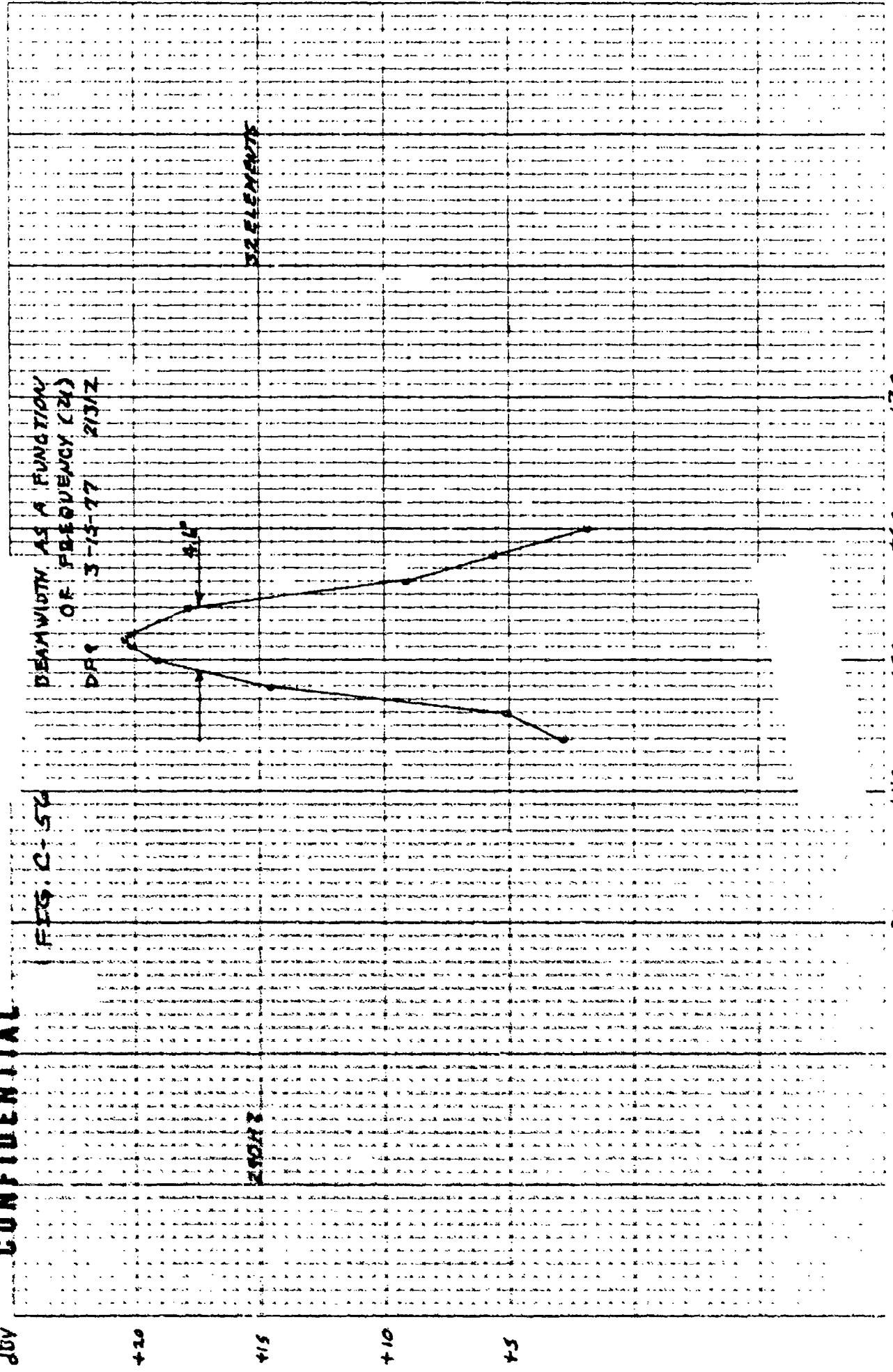
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S-94
S-95
S-96
S-97
S-98
S-99
S-100

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FIG. C-52

BEAM WIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DPR 3-15-77 2131Z



430

440

450

460

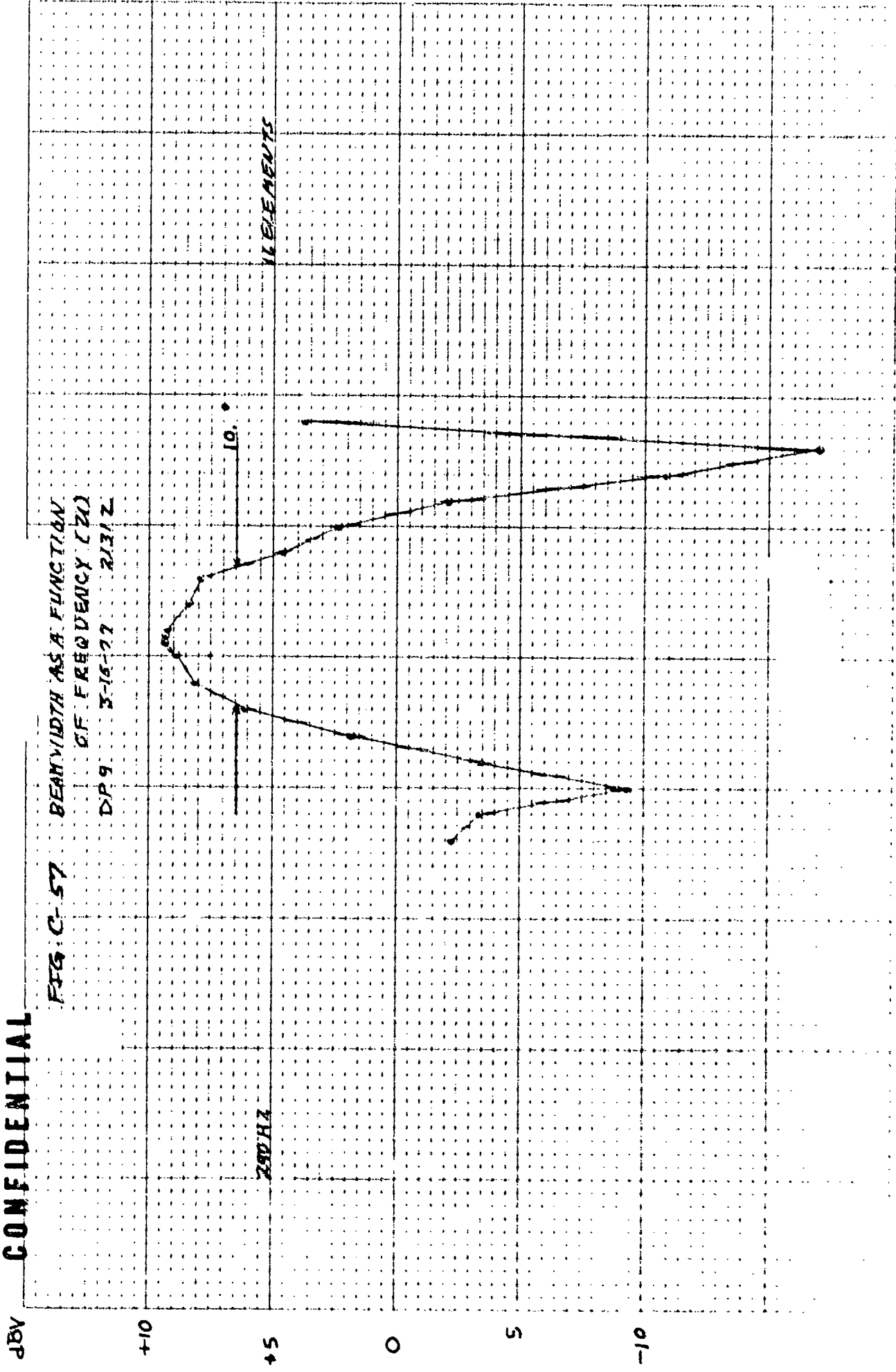
470

FREQUENCY OFF BROADSIDE

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FIG. C-57 BEAMWIDTH AS A FUNCTION OF FREQUENCY (Hz)
DP 9 5-16-77 2/3/2



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130 140 150 160 170
DEGREES OFF BROADSIDE

700 730 760 770
DEGREES OFF BROADSIDE

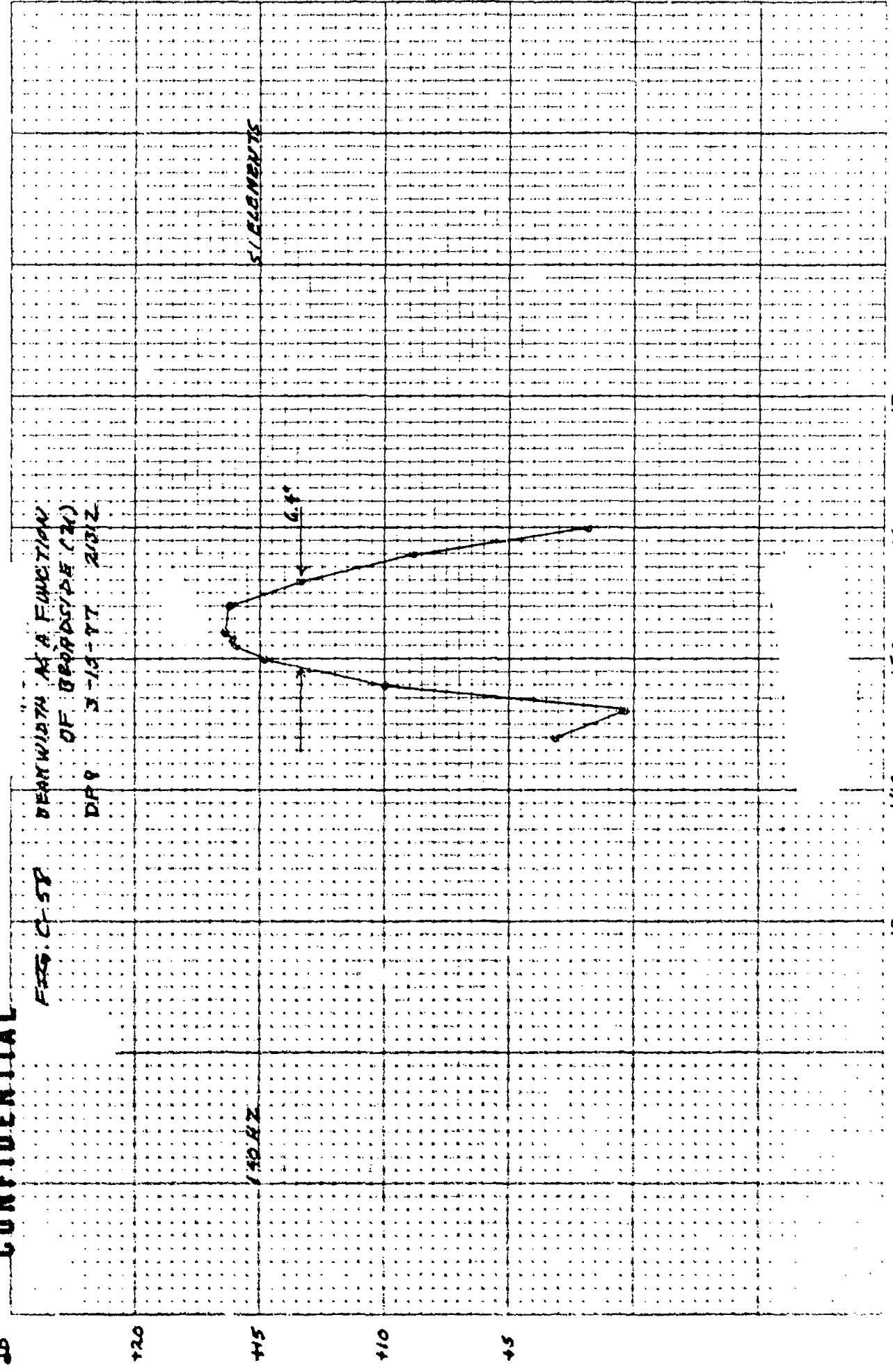
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REPRODUCED BY THE NATIONAL ARCHIVES

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FIG. C-58 BEAMWIDTH AS A FUNCTION
OF BROADSIDE (M)
DRG 3-13-77 2132



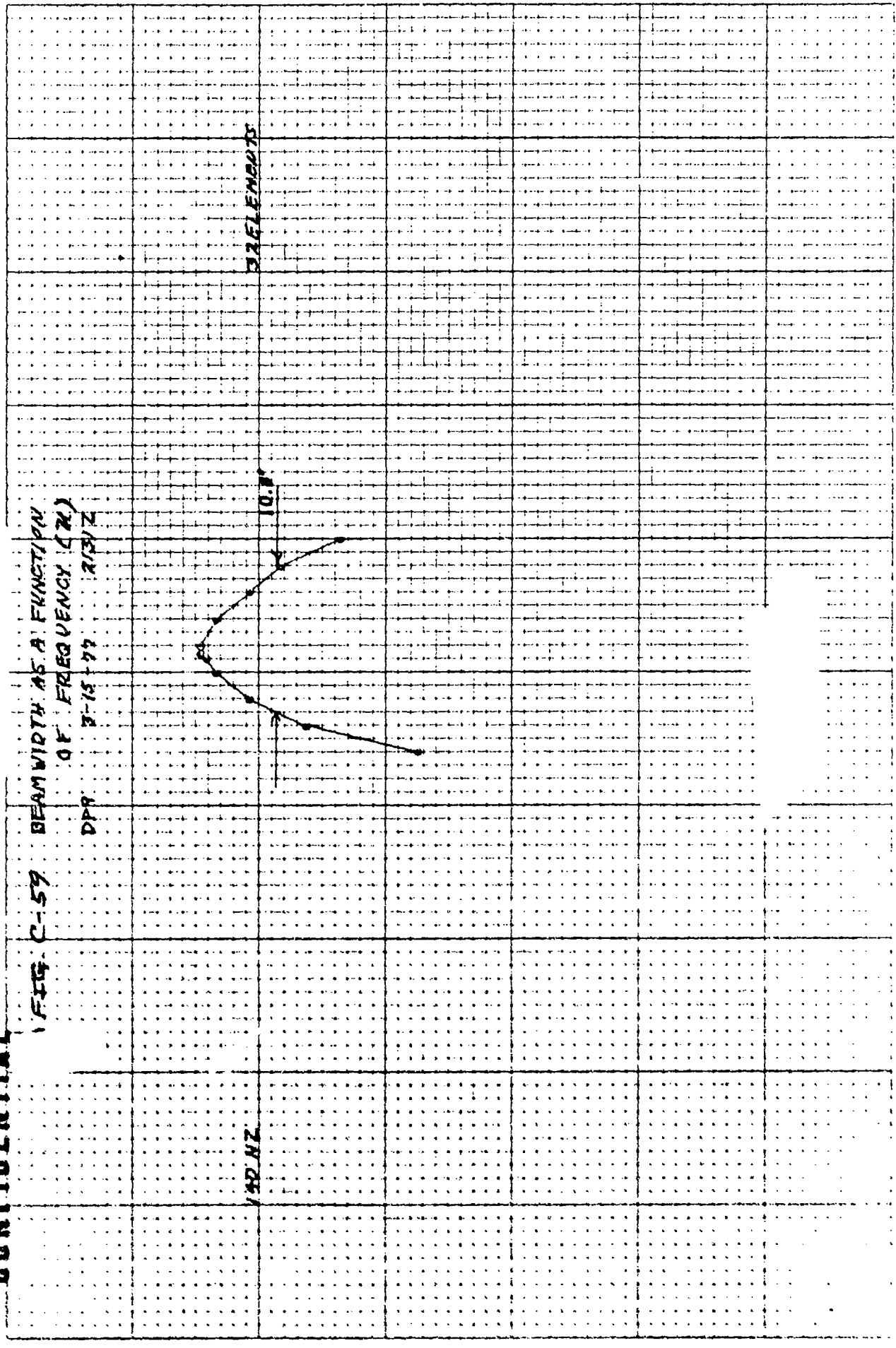
DEGREES OFF BROADSIDE

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FIG. C-59 BEAM WIDTH AS A FUNCTION OF FREQUENCY (Hz)

DPR 3-15-77 R/S/Z



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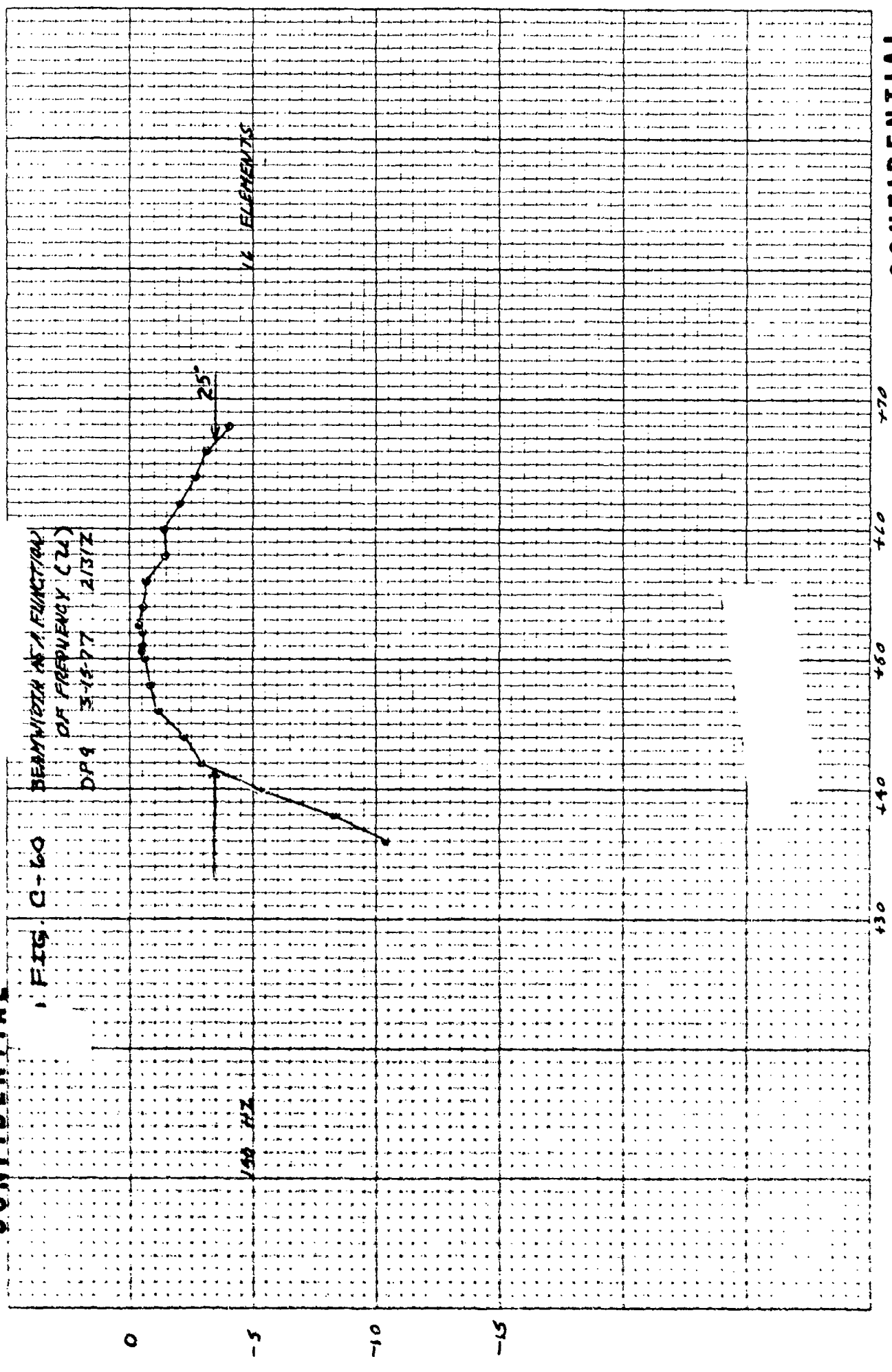
DEGREES OFF BROADSIDE

NOTE: DATA TO LINE GRAPH
FROM RESEARCH CO. AND A-11

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FIG. C-60
BANDWIDTH AS A FUNCTION
OF FREQUENCY (HZ)
DP 9 3-14-77 2131Z



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DEGREES OFF BROADSIDE

dB

0

-5

-10

-15

+30

+40

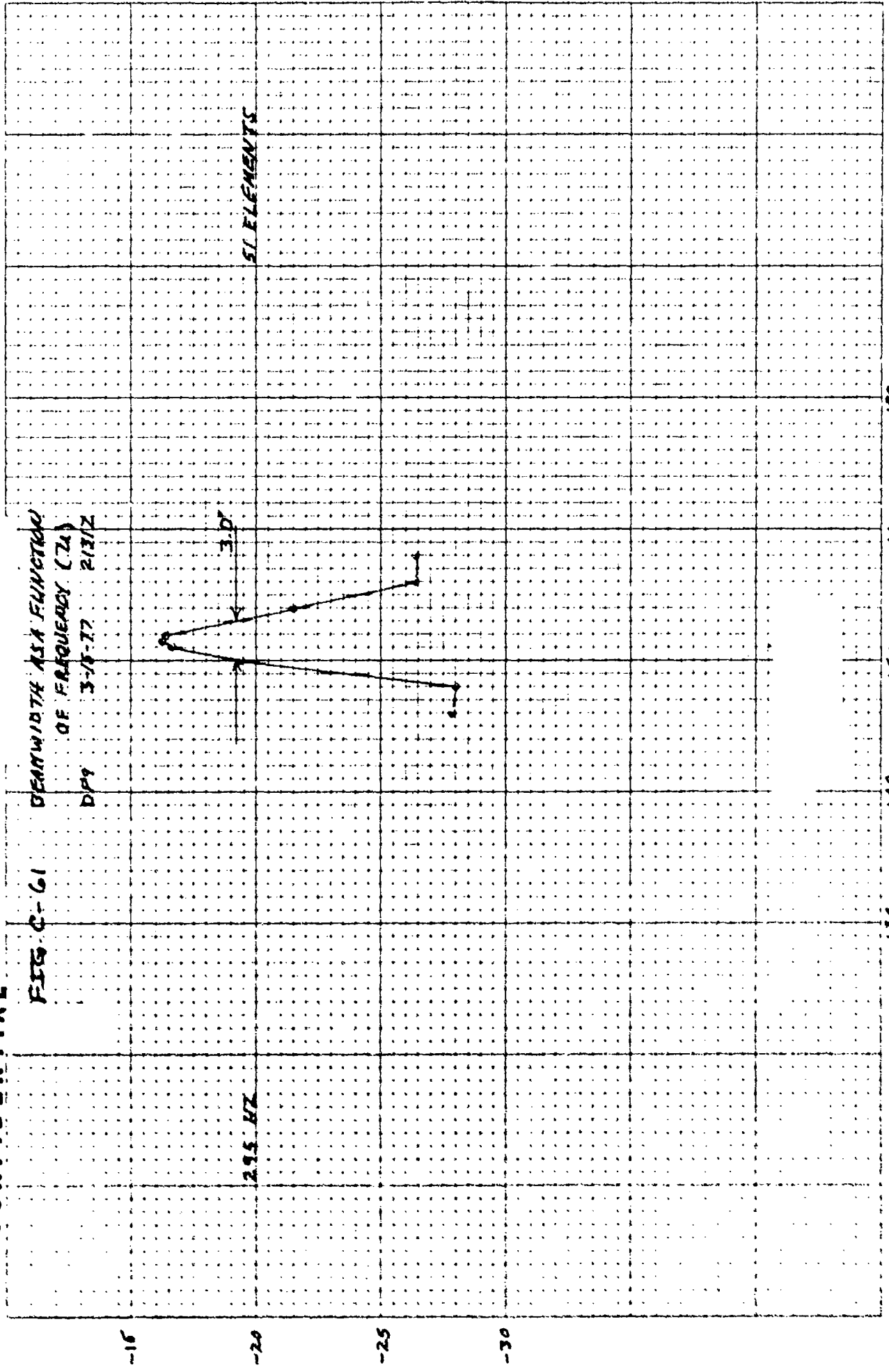
+50

+60

+70

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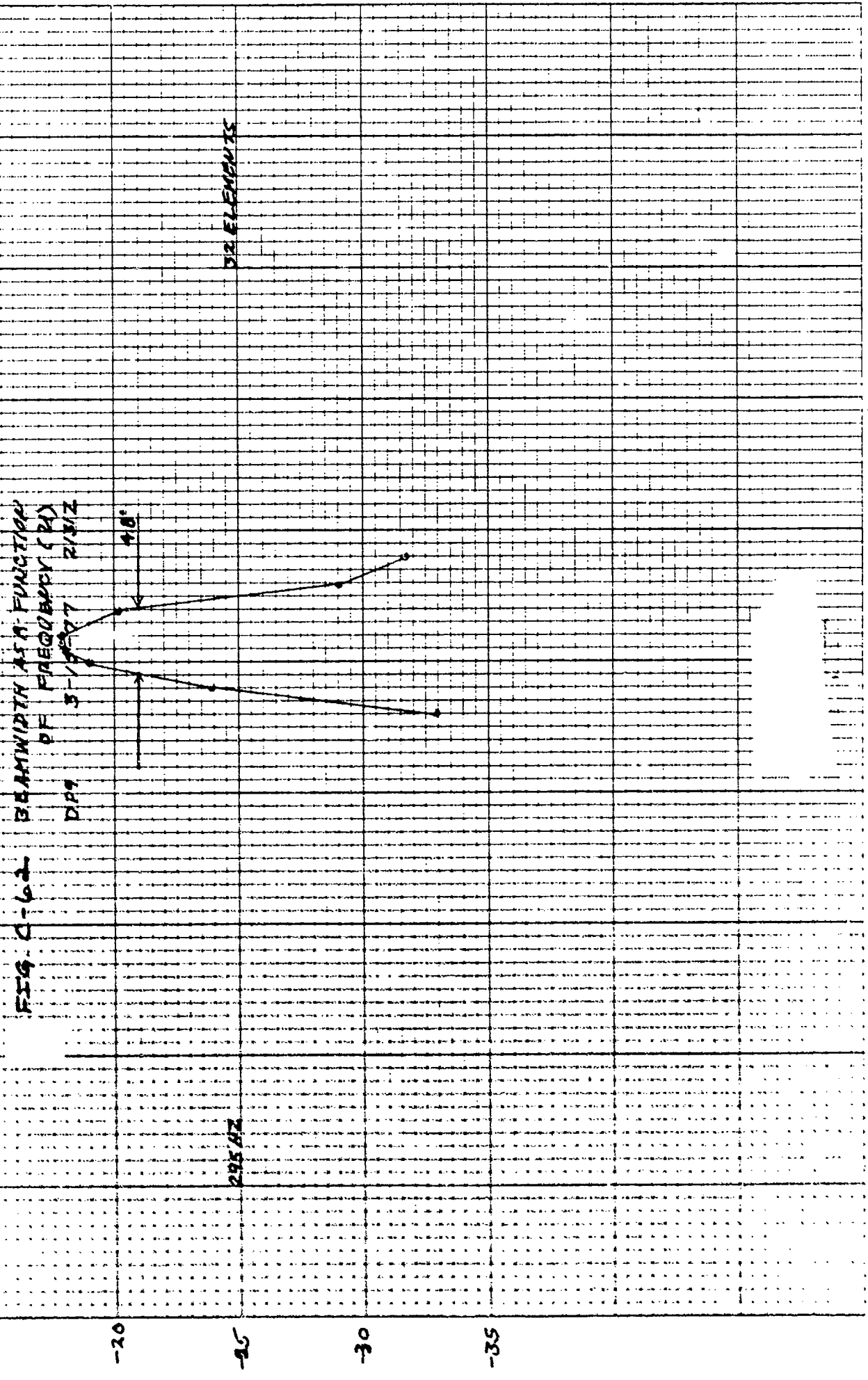
FIG. C-61 BEAMWIDTH AS A FUNCTION OF FREQUENCY (ZA)
DP9 3-18-77 2131Z



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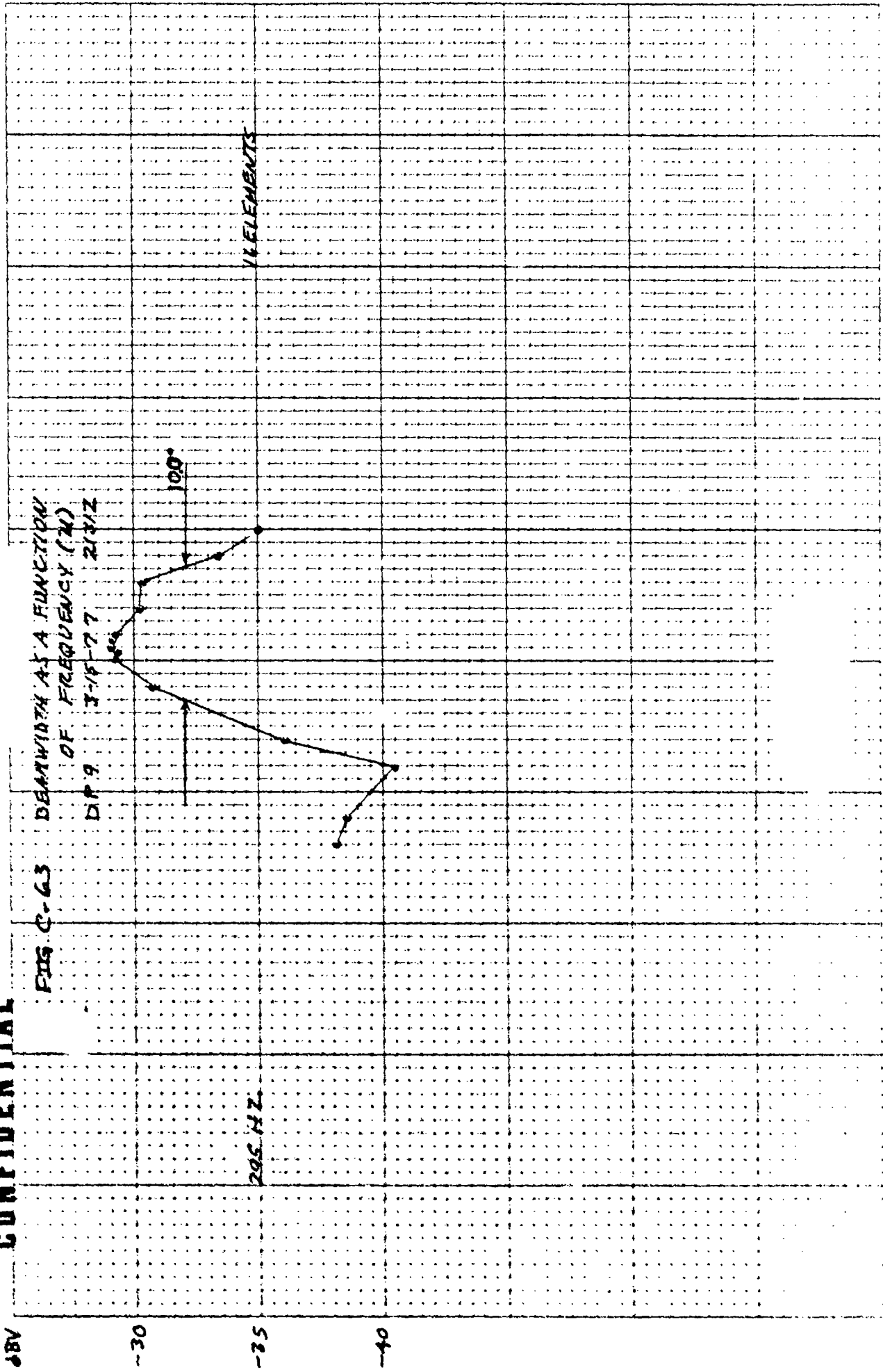


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130 140 150 160 170

dB

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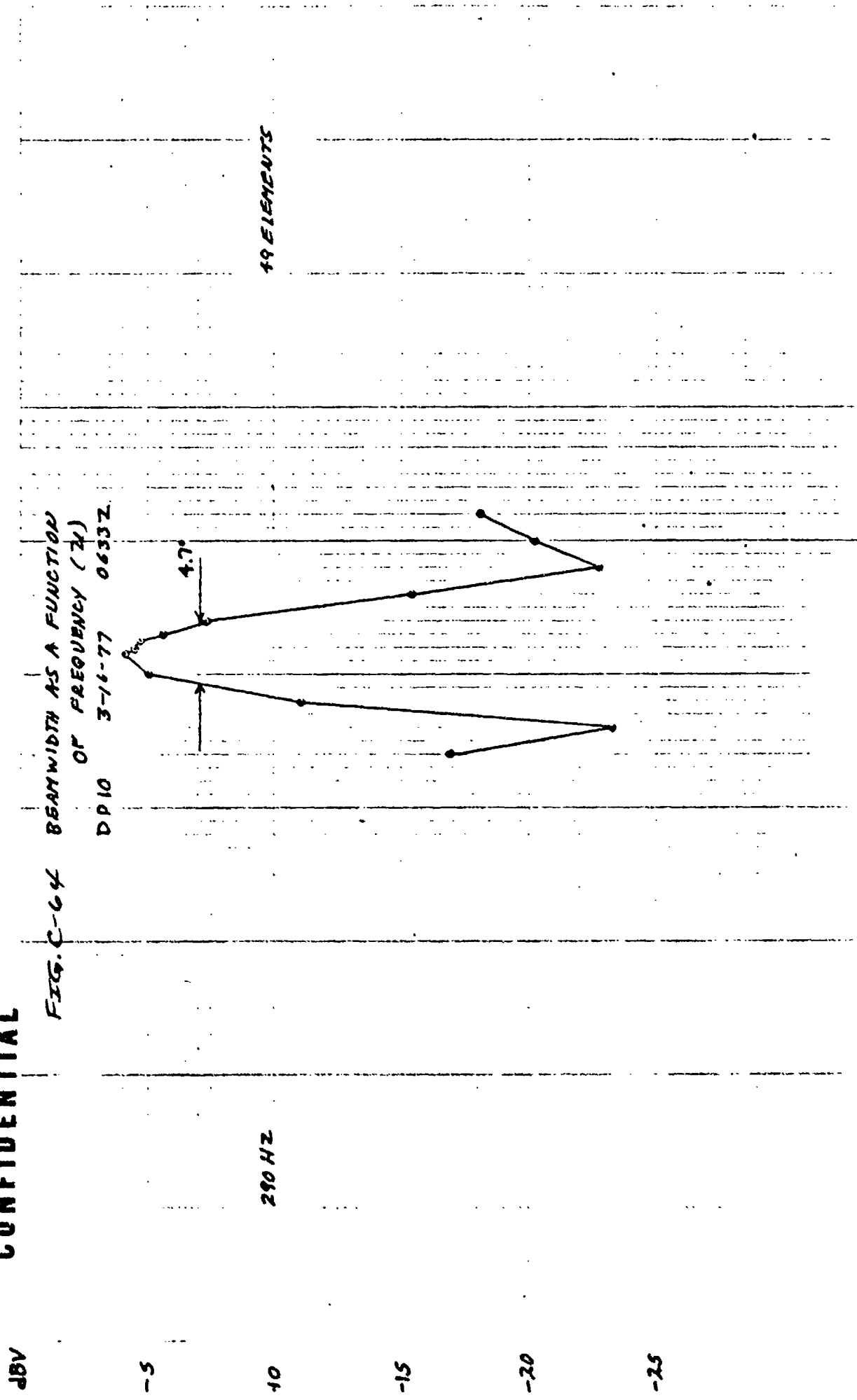


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FIG. C-64 BEAMWIDTH AS A FUNCTION OF FREQUENCY (Hz)
DP10 3-16-77 0633Z



+40 +50 +60 +70 +80
DEGREES OFF BROADSIDE

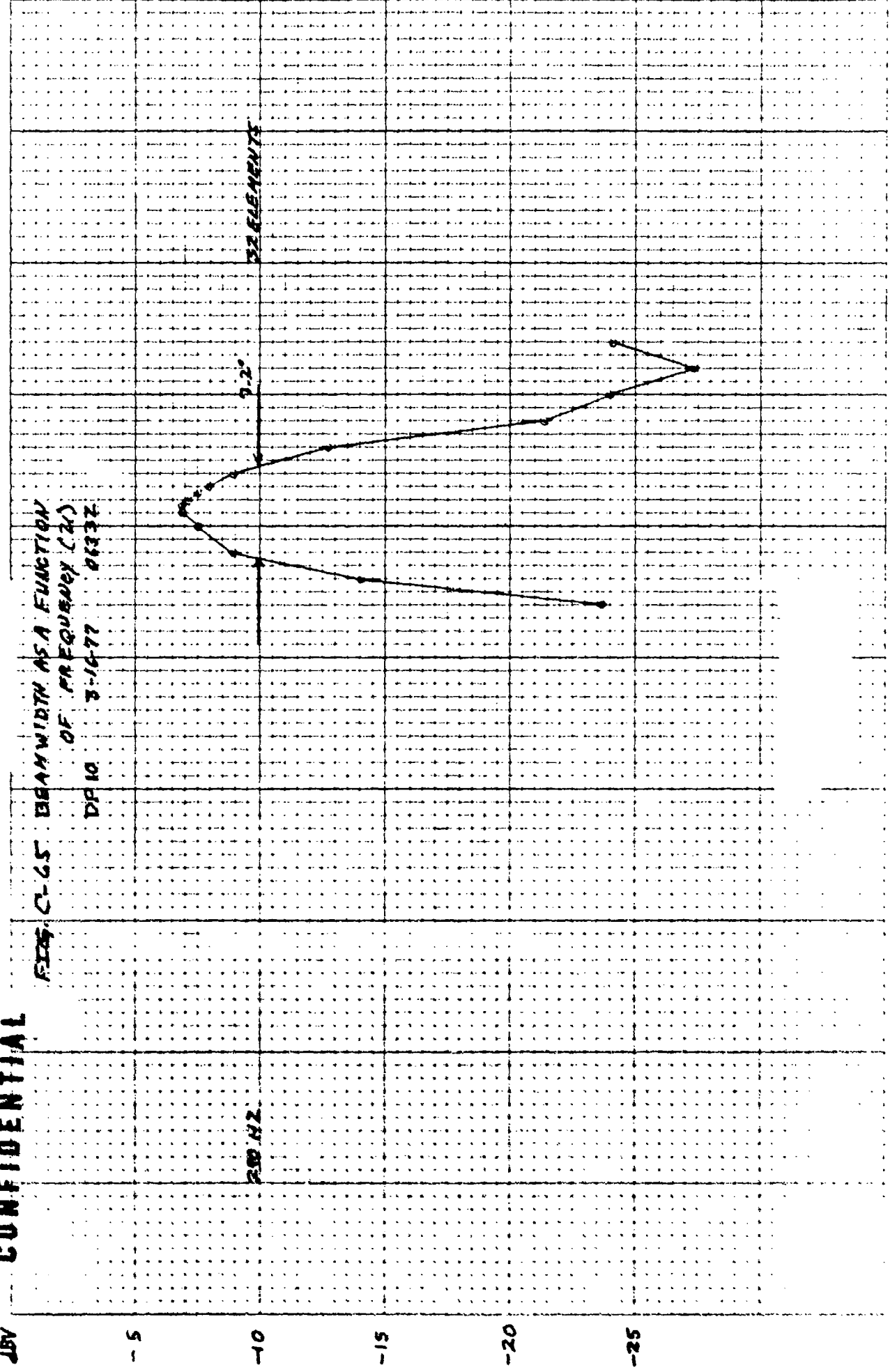
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REF: C-65 BANDWIDTH AS A FUNCTION OF FREQUENCY (2)

DP 10 3-16-77 0133Z

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DEGREES OFF BROADSIDE

+30

+40

+50

+60

+70

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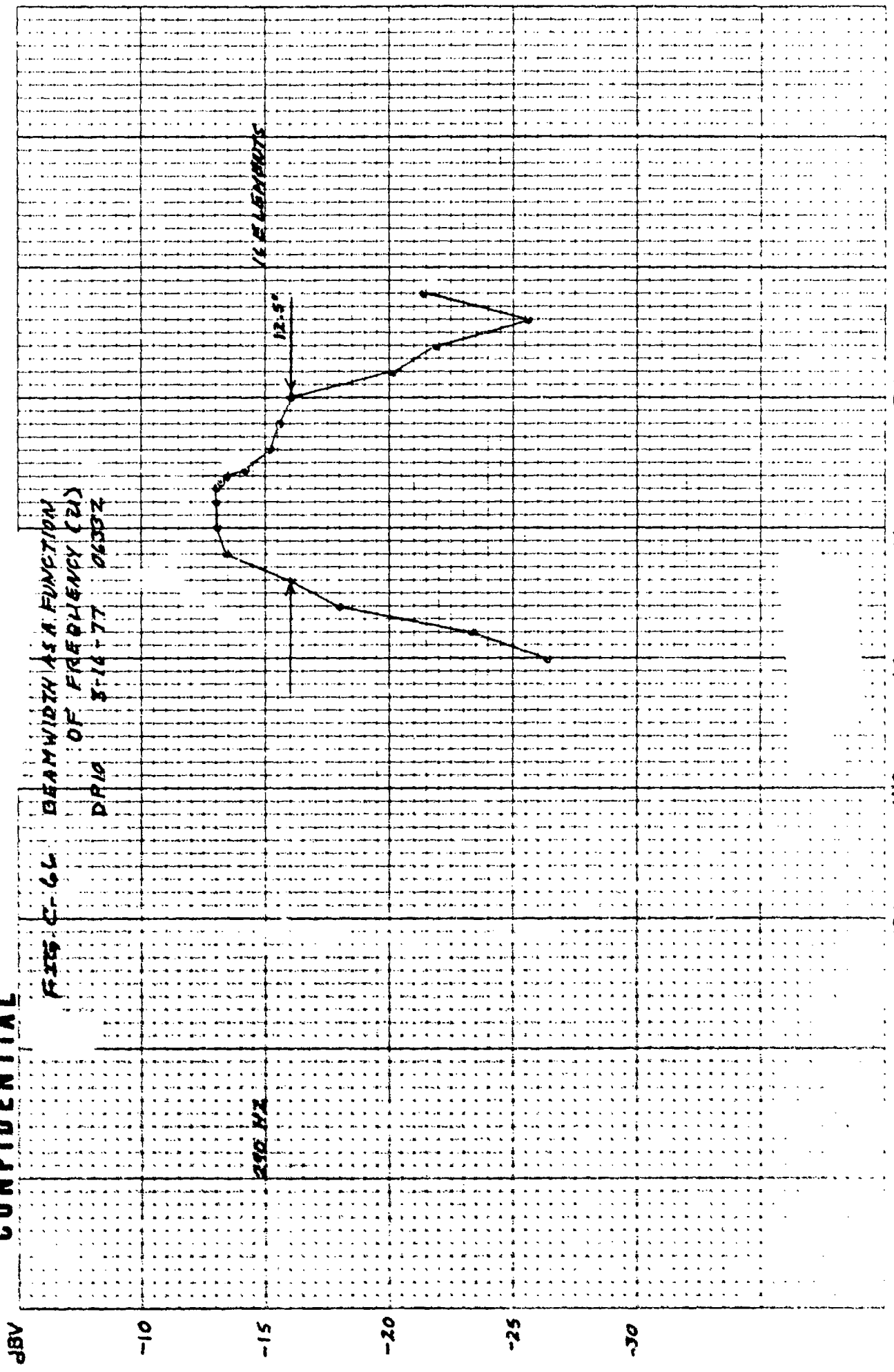


FIG. C-66 BEAMWIDTH AS A FUNCTION
 OF FREQUENCY (21)
 DR10 8-16-77 0633Z

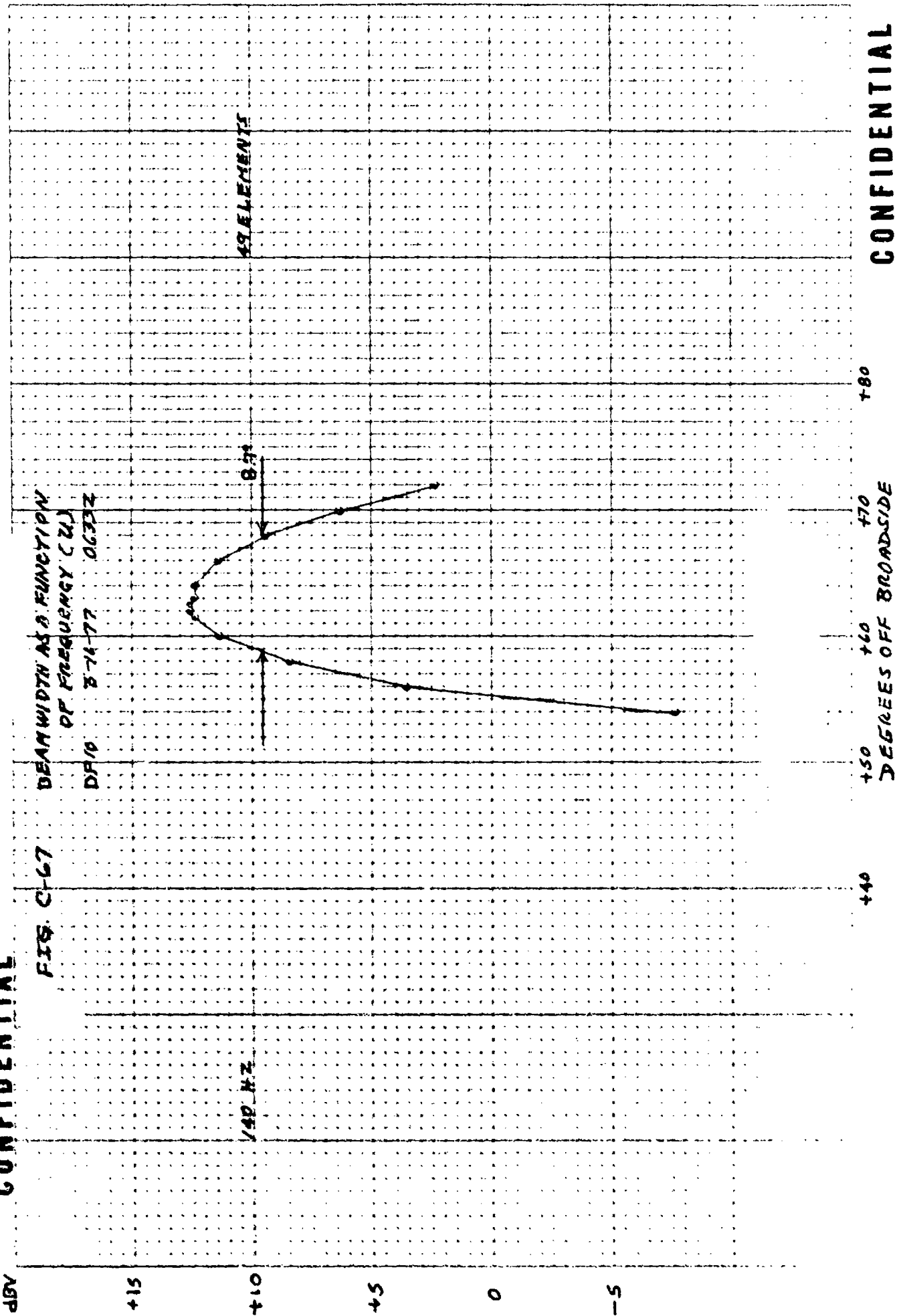
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DEGREES OFF BROADSIDE

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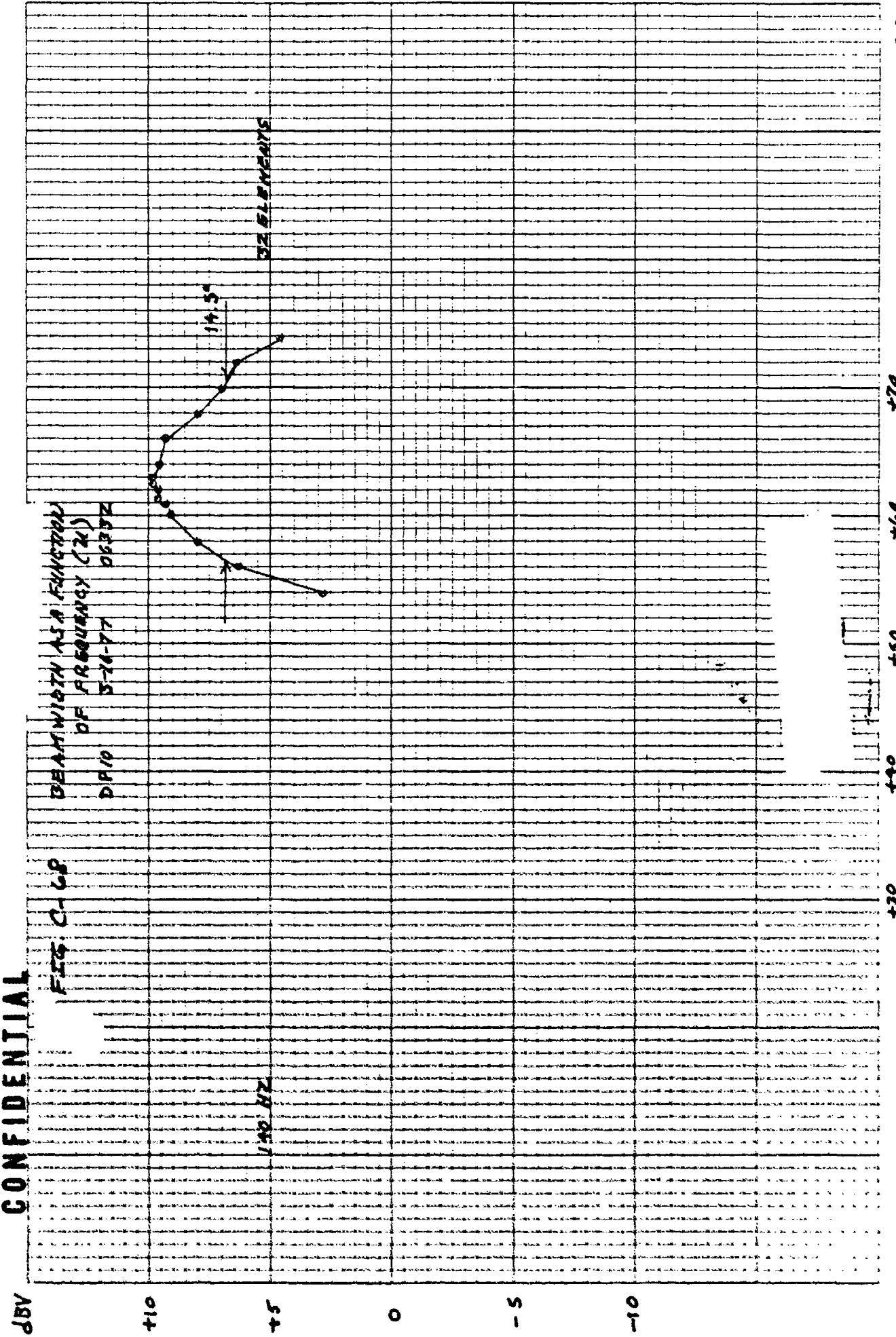
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+20 +30 +40 +50 +60 +70

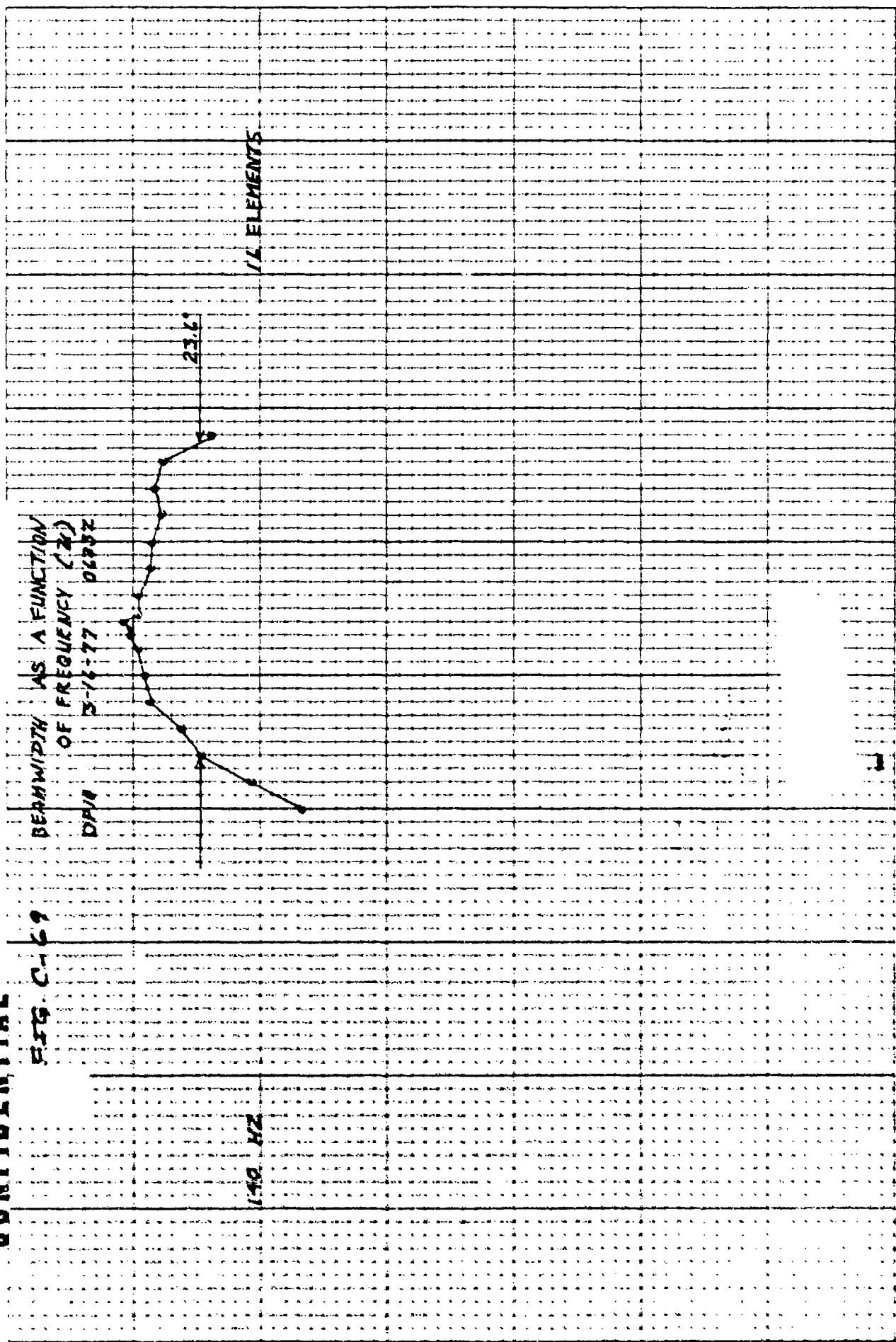
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FIG. C-69

BEAMWIDTH AS A FUNCTION
OF FREQUENCY (MHz)
DPM 5-16-77 0629Z



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DEGREES OFF BROADSIDE

140

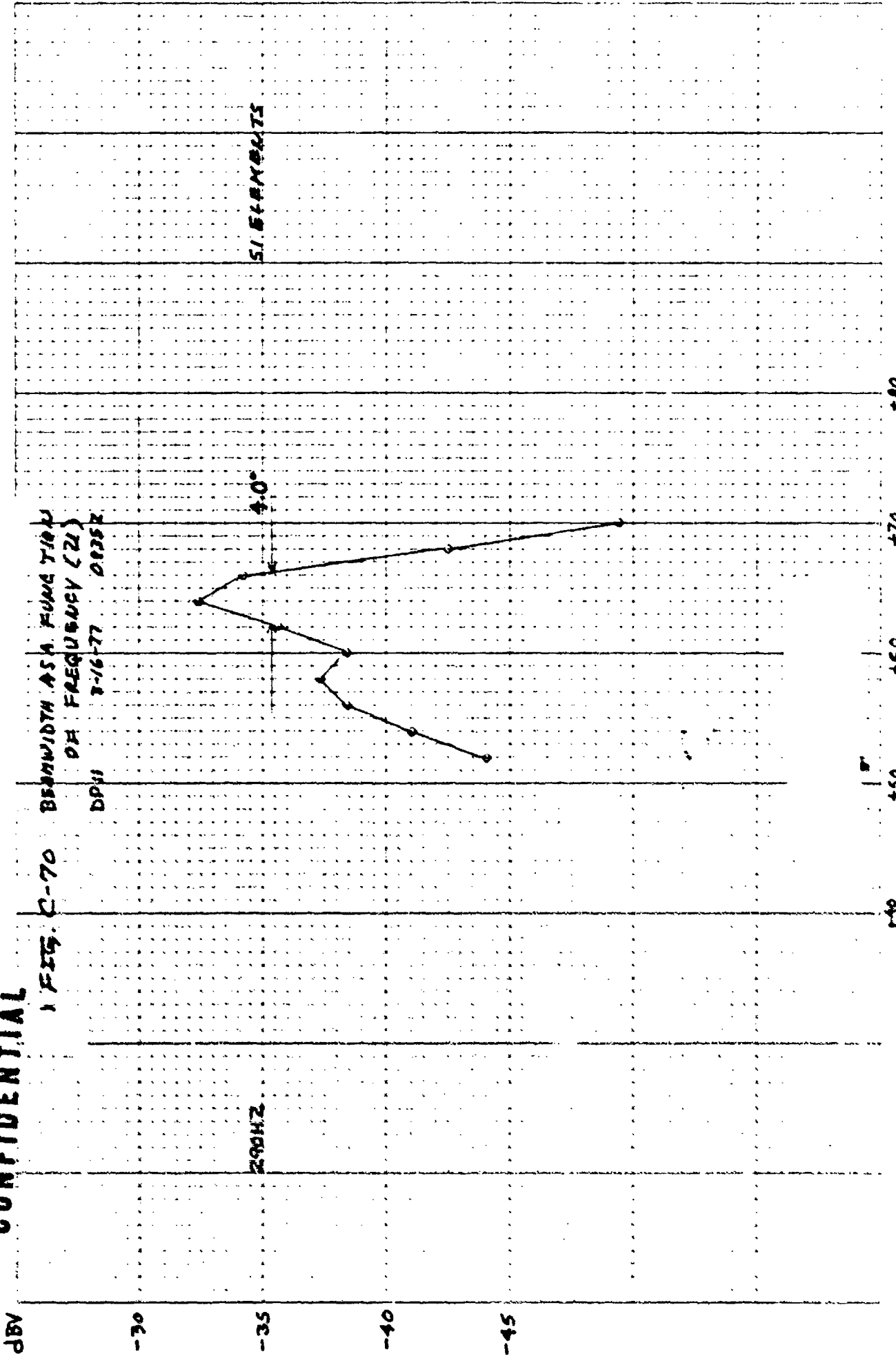
150

160

170

180

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1 FIG. C-70 BANDWIDTH AS A FUNCTION OF
OF FREQUENCY (ZL)
DPII 3-16-77 0135Z

200HZ

51.54MHz

DEGREES OFF BROADSIDE

+80

+70

+60

+50

+40

-30

-35

-40

-45

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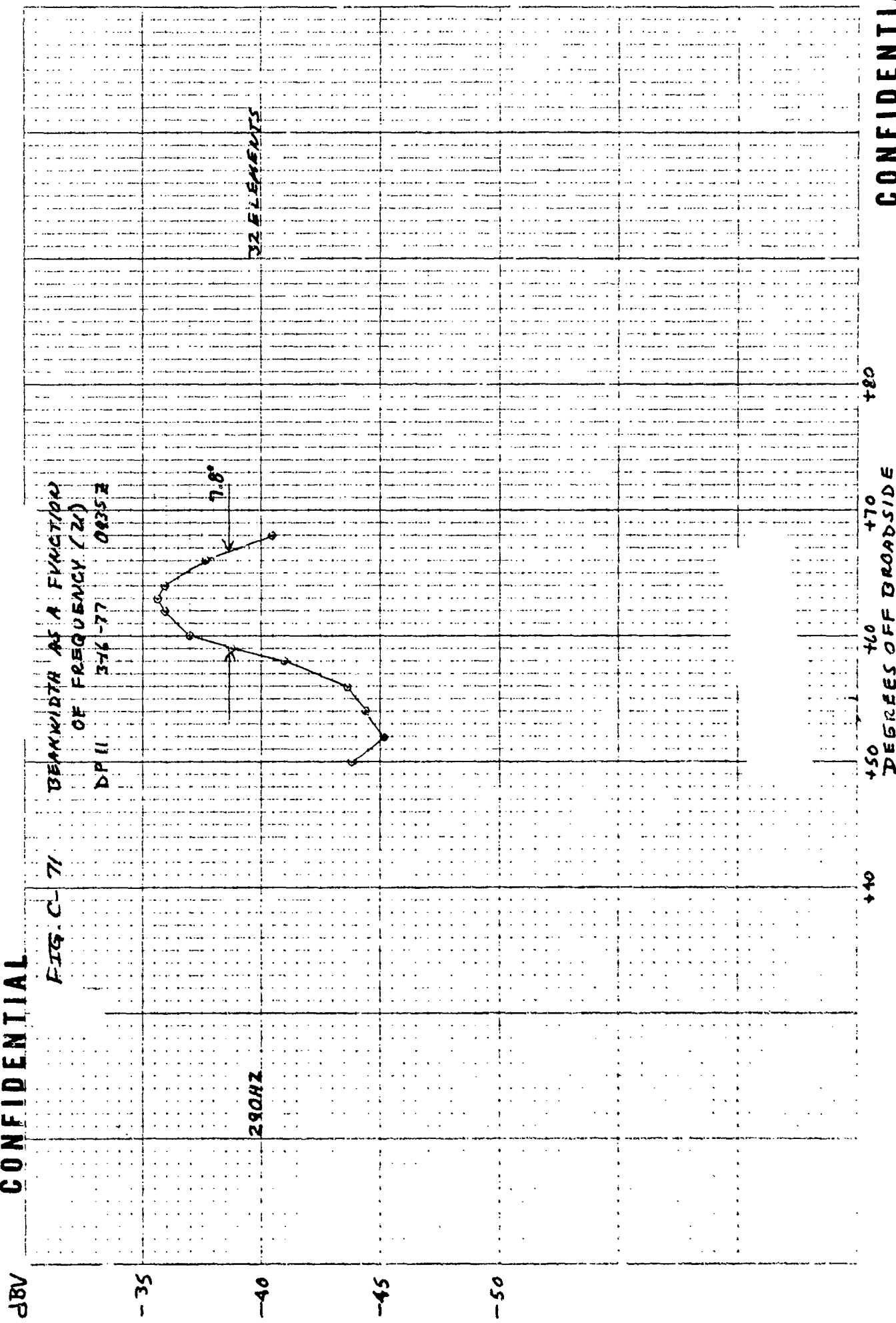


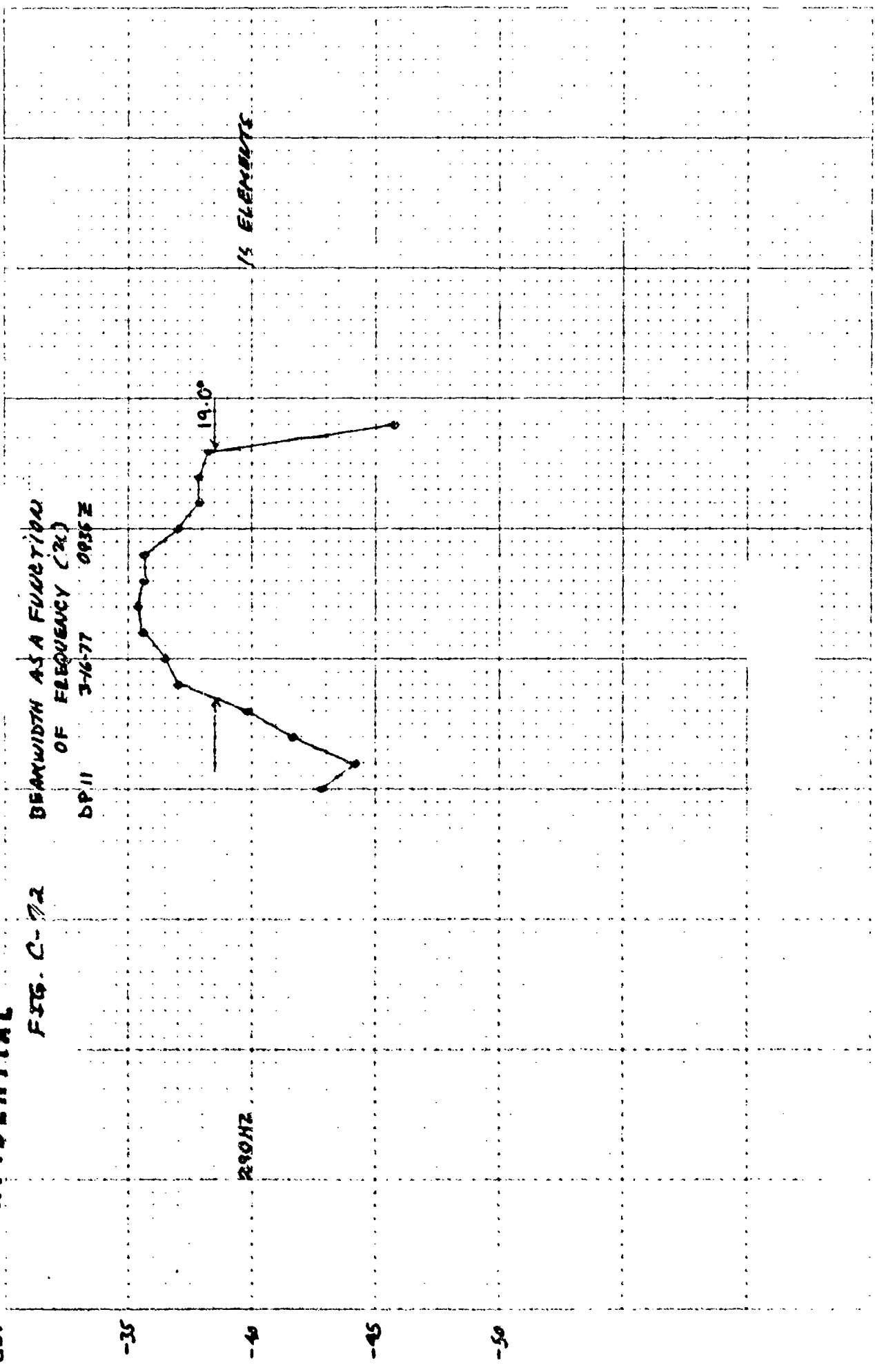
FIG. C-71 BEAMWIDTH AS A FUNCTION OF FREQUENCY (21)

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FIG. C-72

BEAMWIDTH AS A FUNCTION
OF FREQUENCY (Hz)
DP11 3-16-77 0935Z



290HZ

1/3 ELEMENTS

19.0°

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DEGREES OFF BEAMSIDE

+110 +120 +130 +140 +150 +160 +170

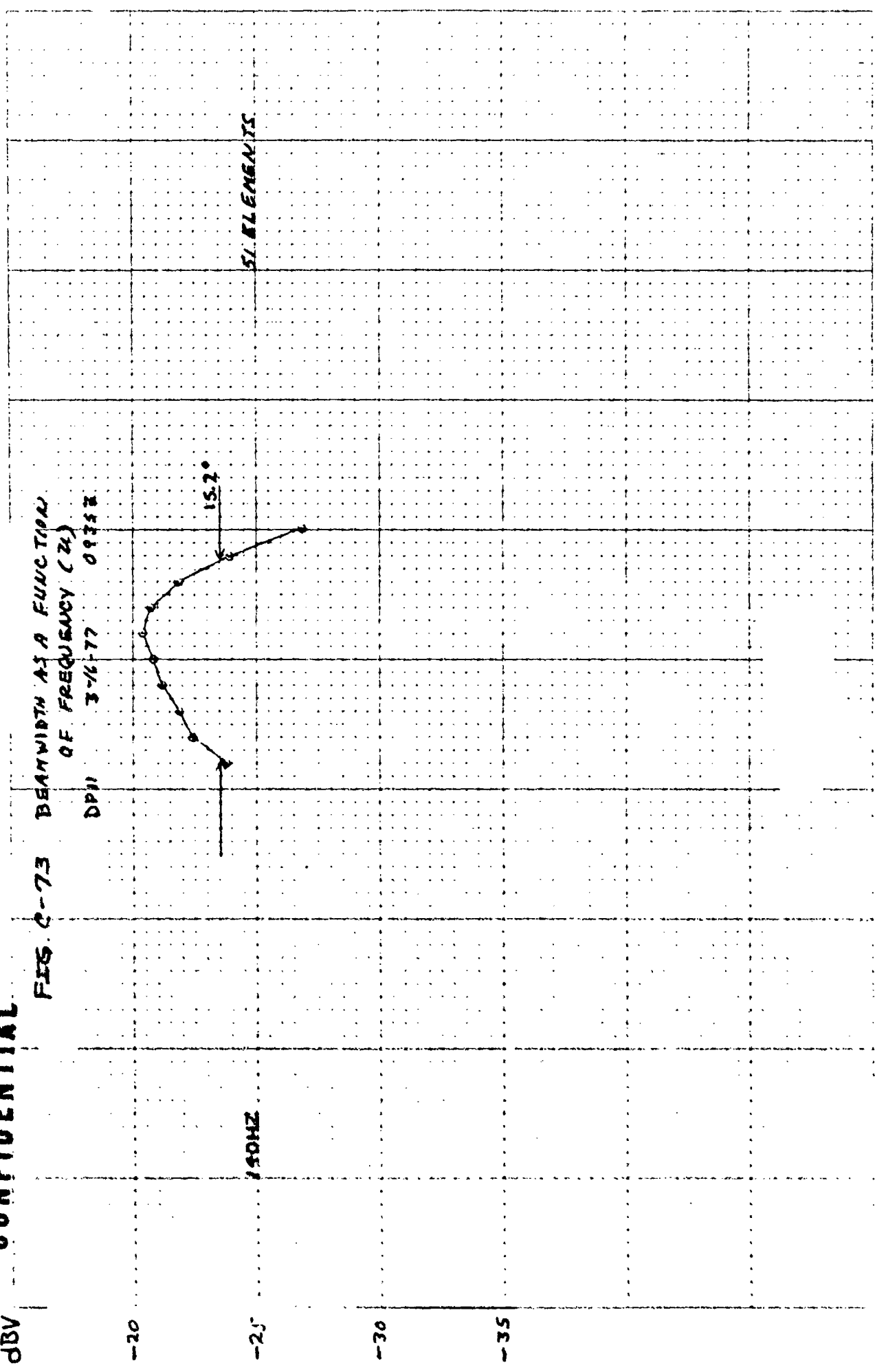
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FOR SCHEMATIC DRAWING

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FIG. Q-73 BEAMWIDTH AS A FUNCTION OF FREQUENCY (24)
DPI 3-16-77 0935Z



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140 150 160 170 180
DEGREES OFF BROADSIDE

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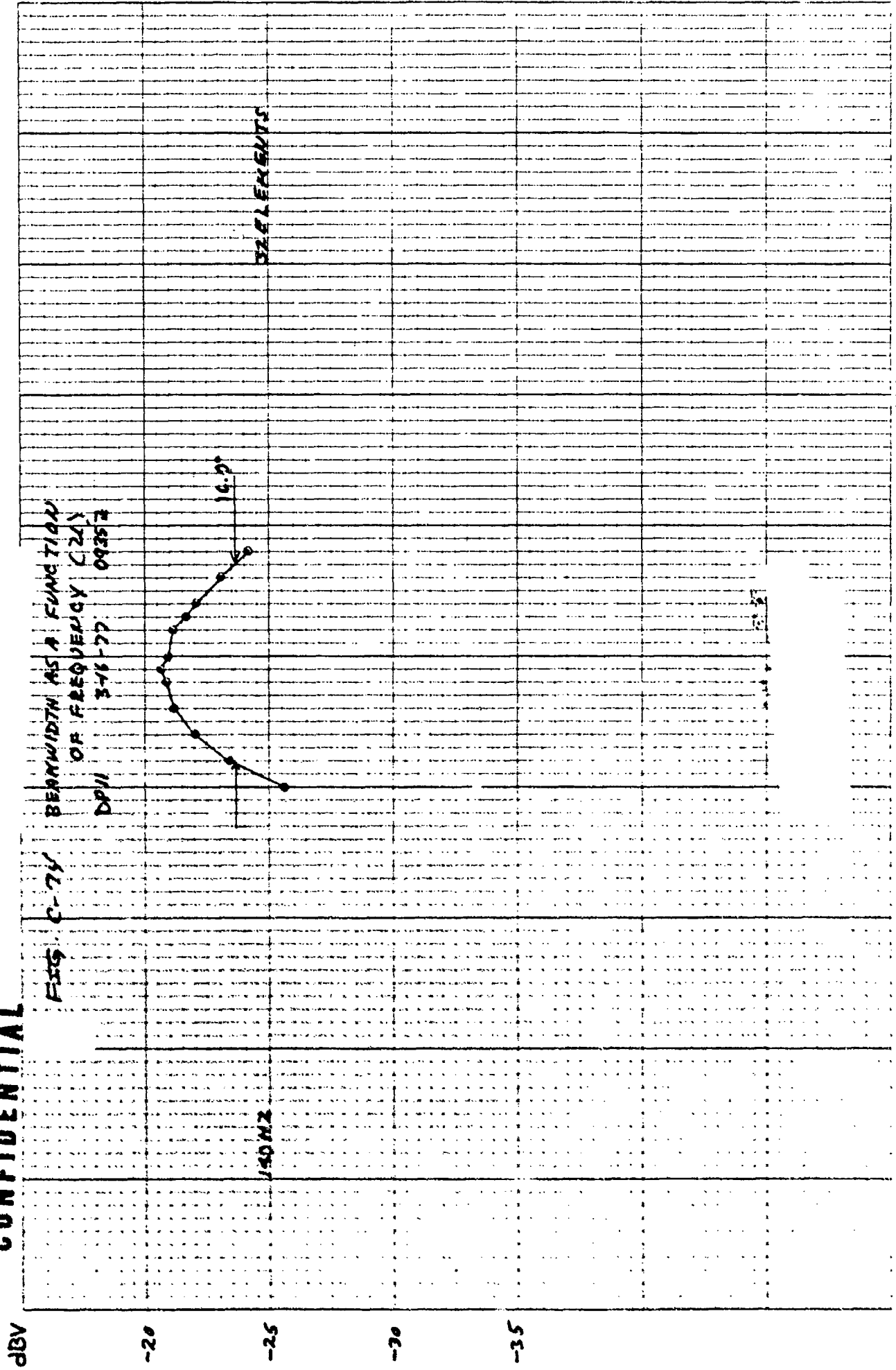
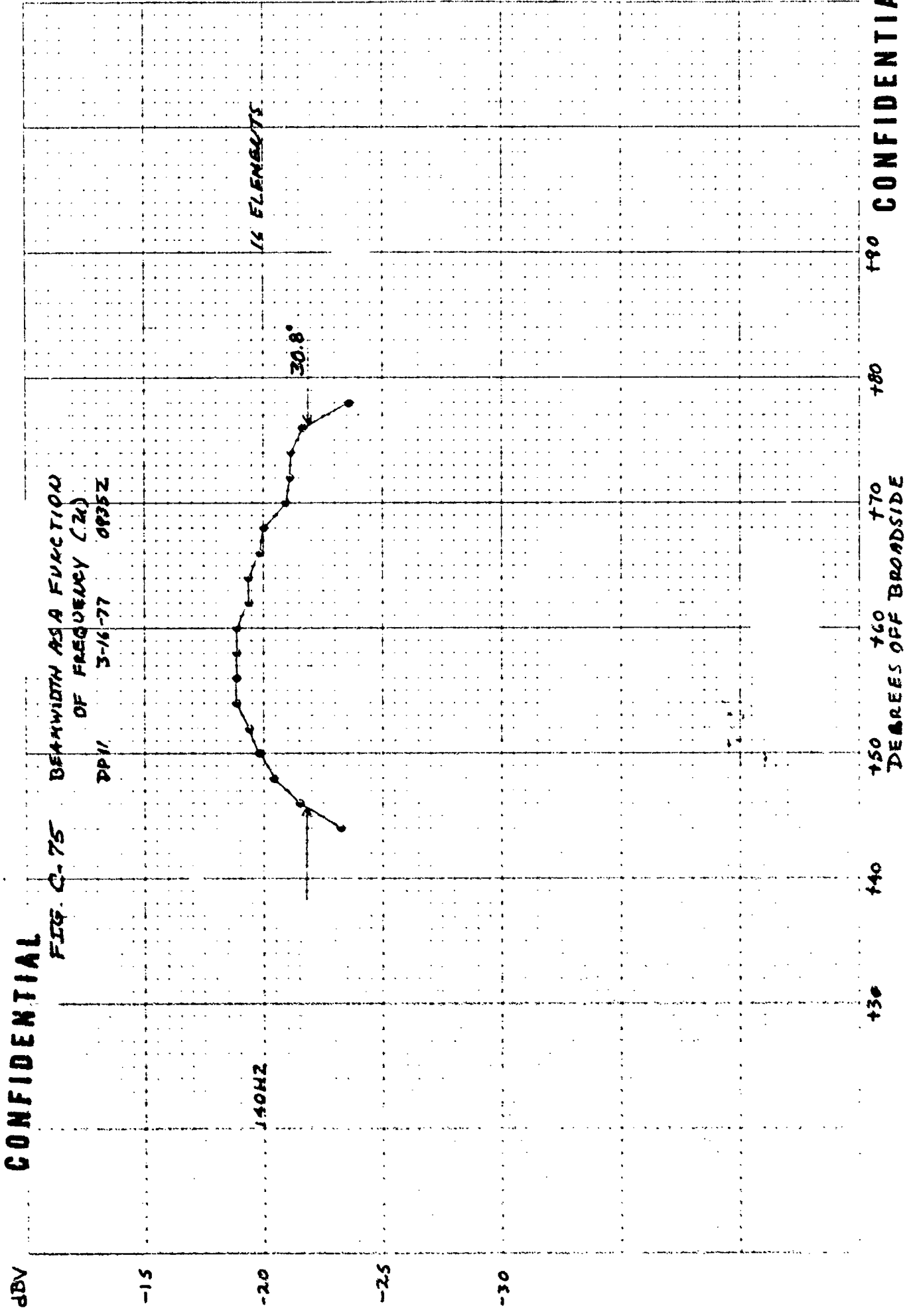


FIG. C-74 BEAMWIDTH AS A FUNCTION
 OF FREQUENCY (24)
 DPH 3-16-77 0935Z

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FIG. C-75 BEAMWIDTH AS A FUNCTION OF FREQUENCY (2)

DPII 3-16-77 0935Z



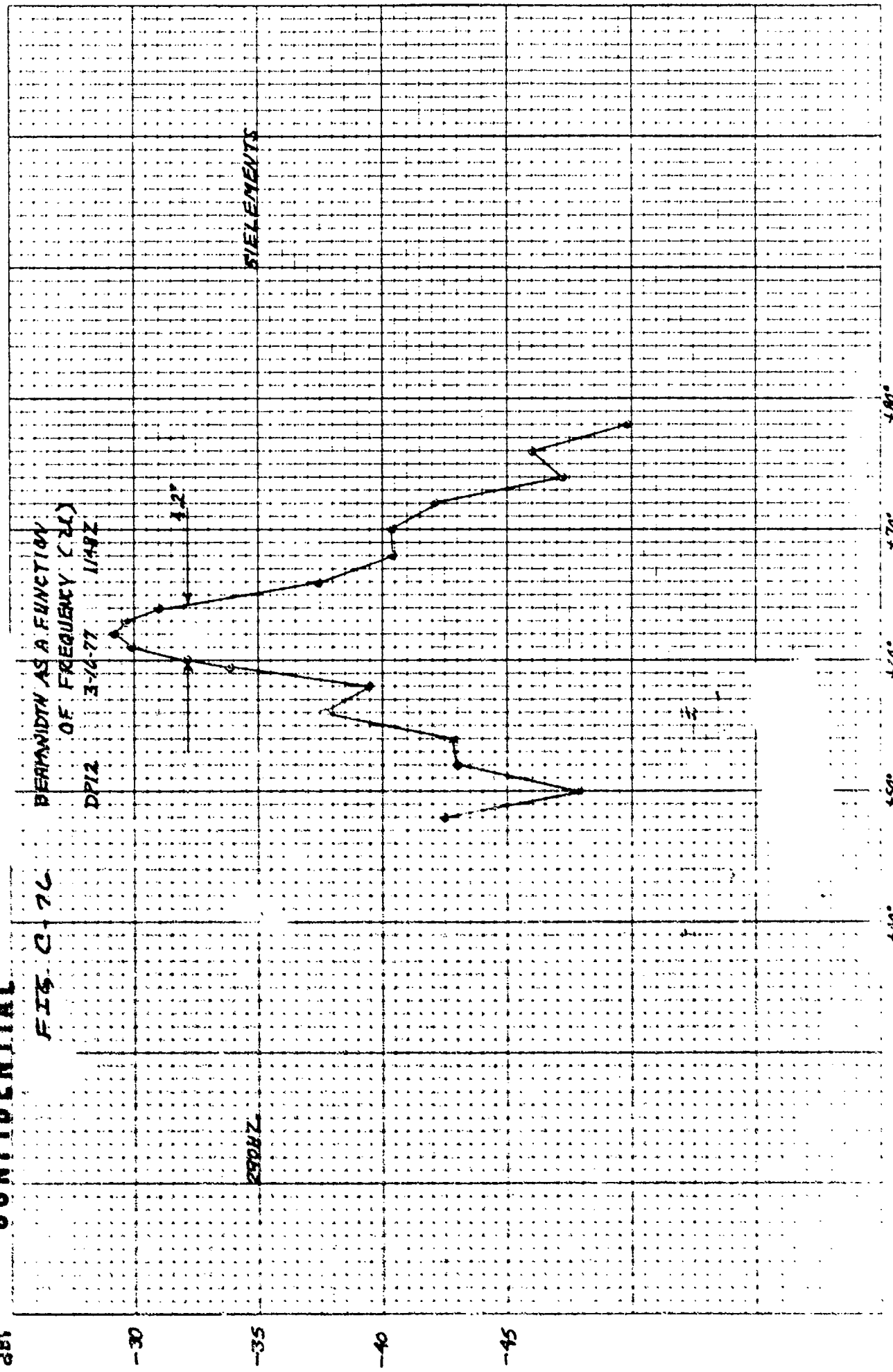
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FIG. C-76

BEAMWIDTH AS A FUNCTION
OF FREQUENCY (CIC)
DPI2 3-16-77 1149Z



DEGREES OFF BROADSIDE

+40°

+50°

+60°

+70°

+80°

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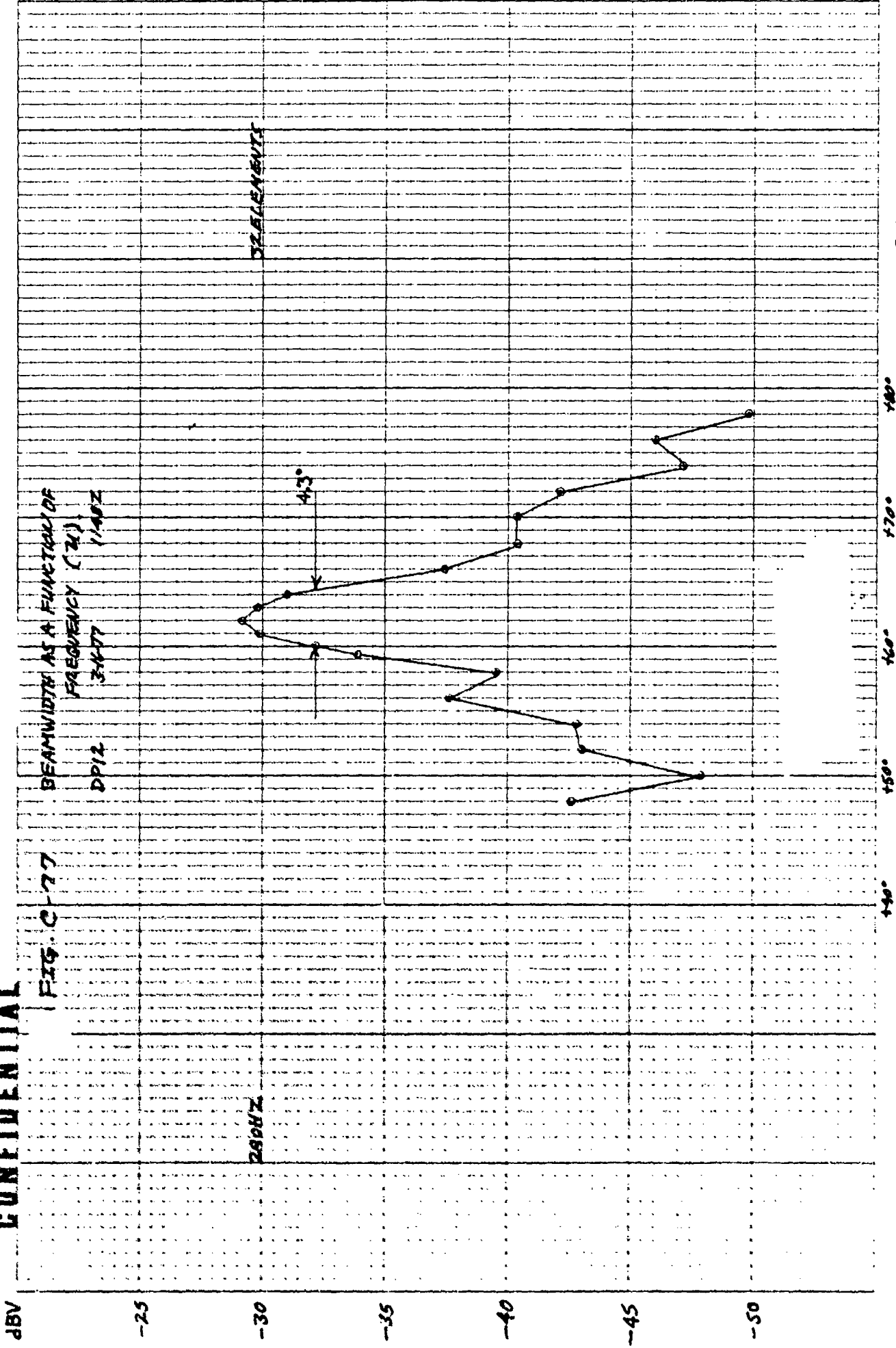


FIG. C-77

28.98Z

22.62Z

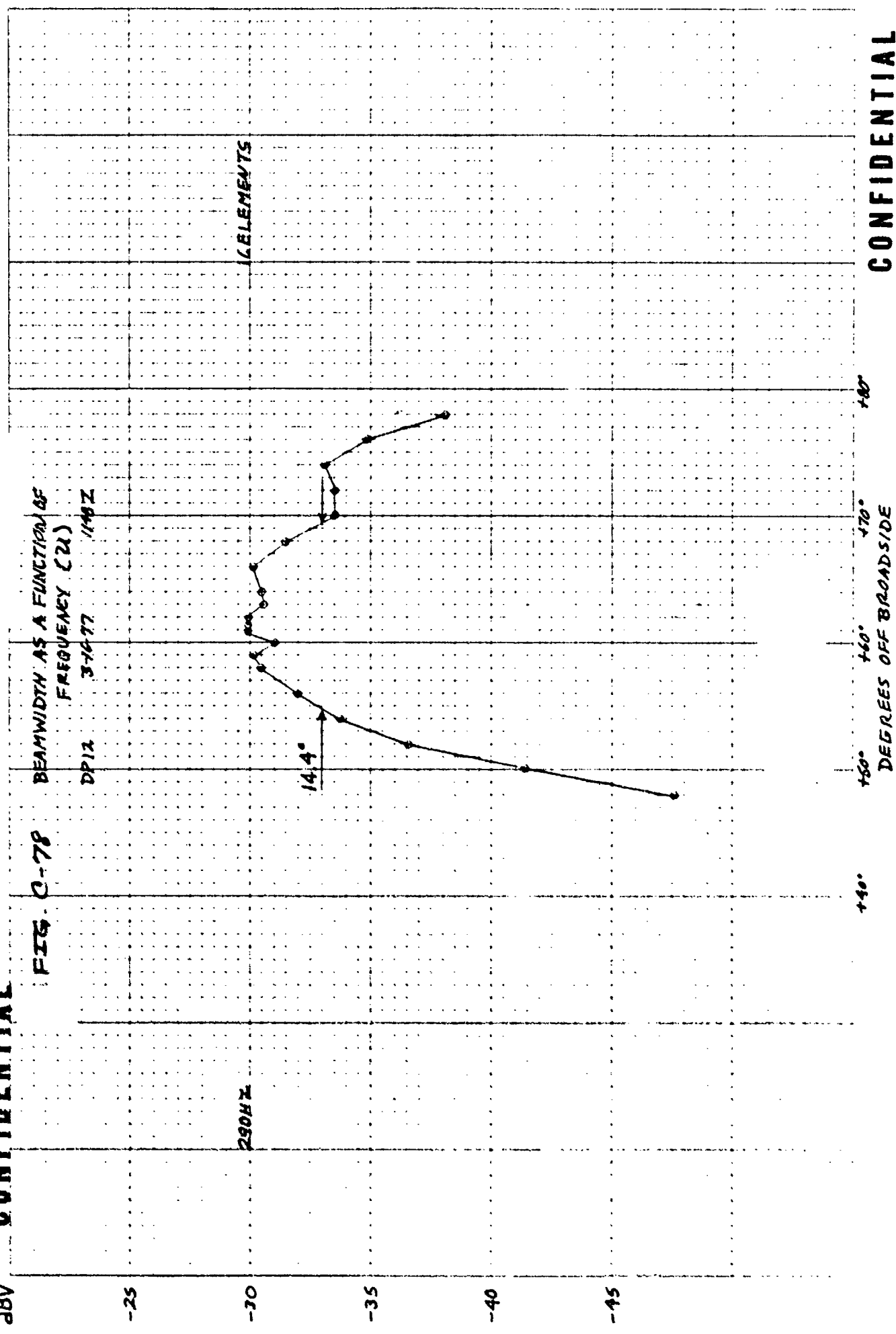
4.3°

DEGREES OFF BROADSIDE

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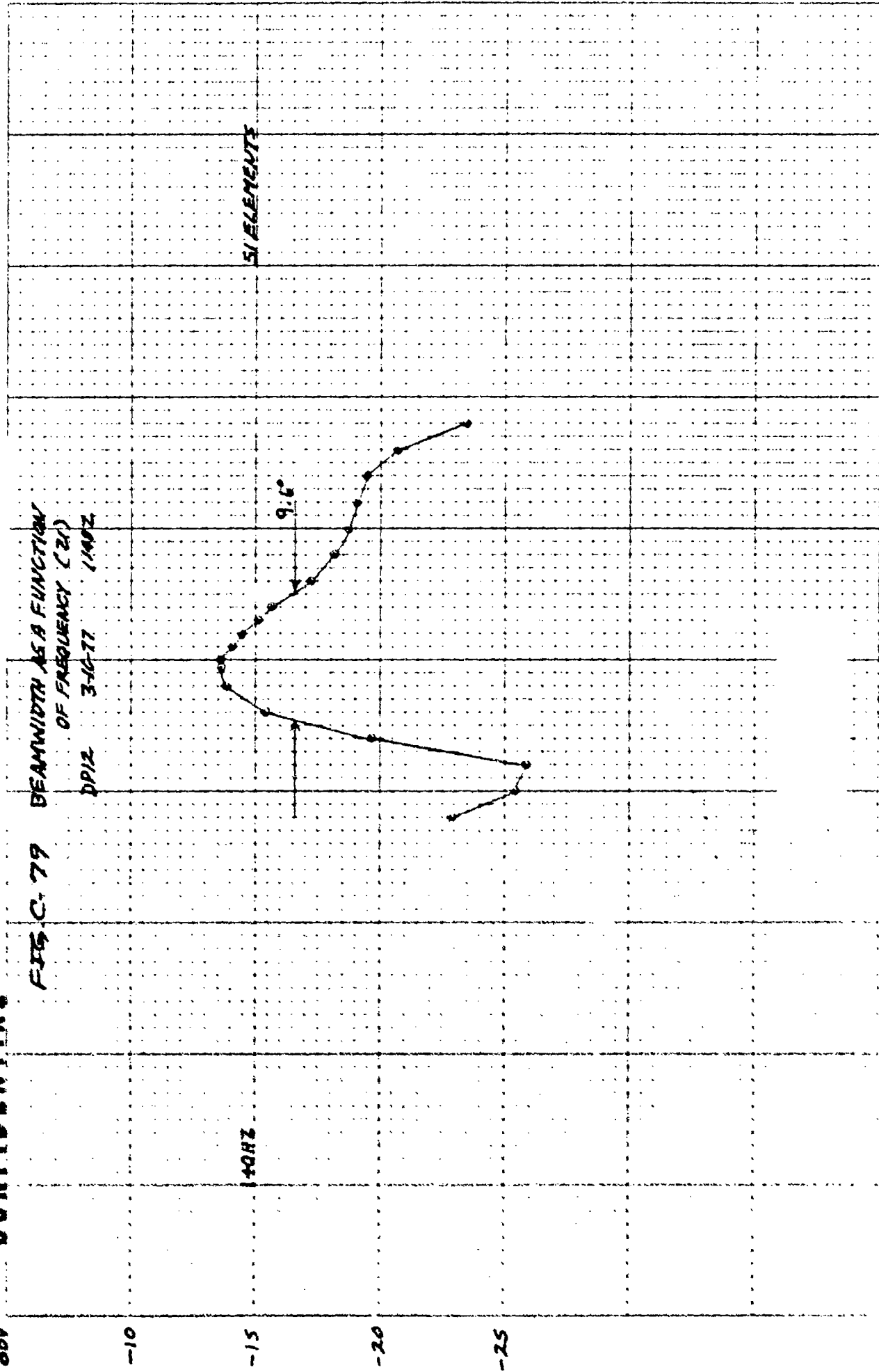
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46 0/03

FIG. C-79 BEAMWIDTH AS A FUNCTION
OF FREQUENCY (2 θ)

DP12 3-10-77 1140Z



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140° 150° 160° 170° 180°
DEGREES OFF BROADSIDE

46 01/03

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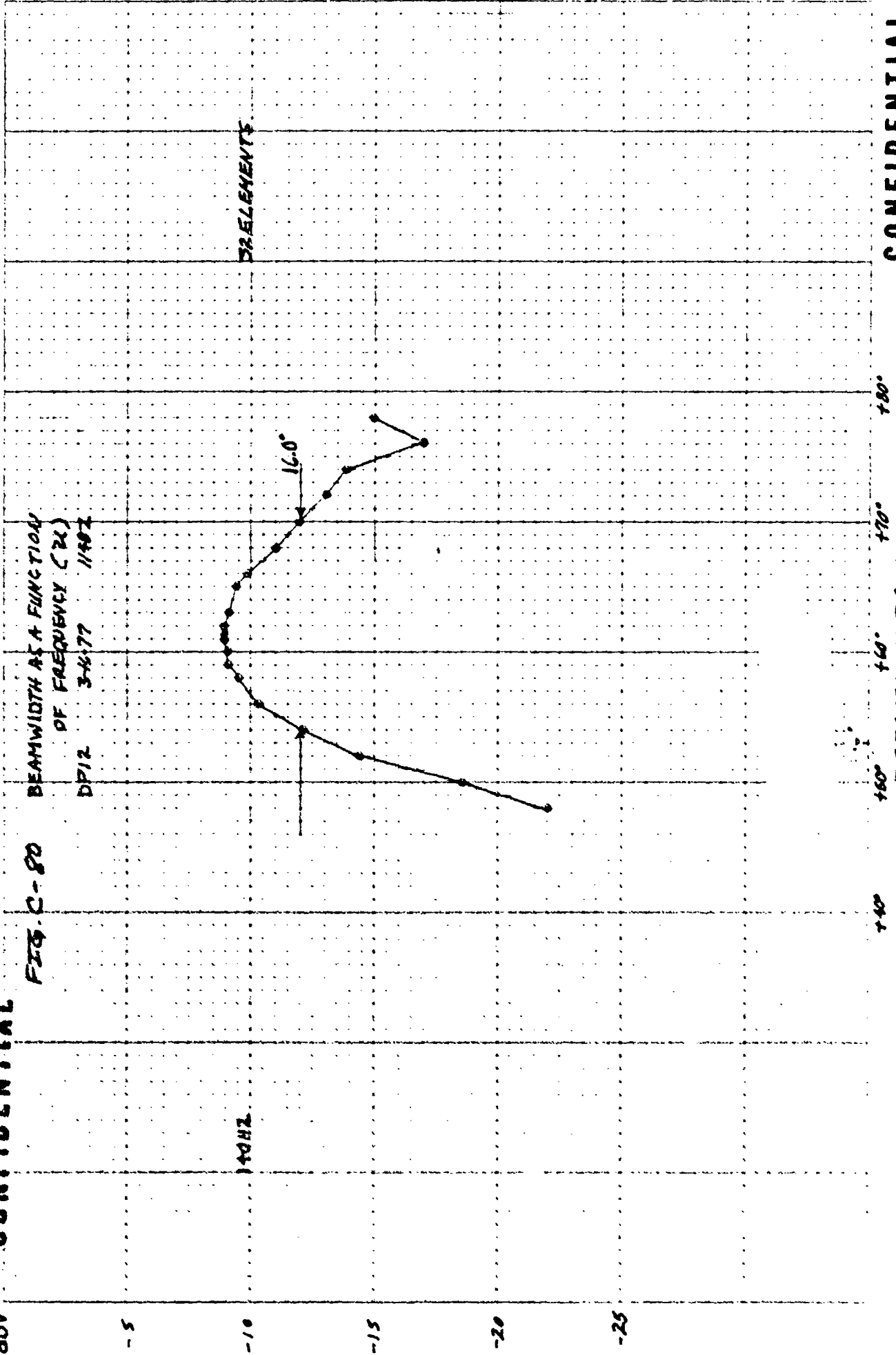
FIG. C-80

BEAMWIDTH AS A FUNCTION
OF FREQUENCY (Hz)

DP12 3-6-77 1180Z

140HZ

3 ELEMENTS



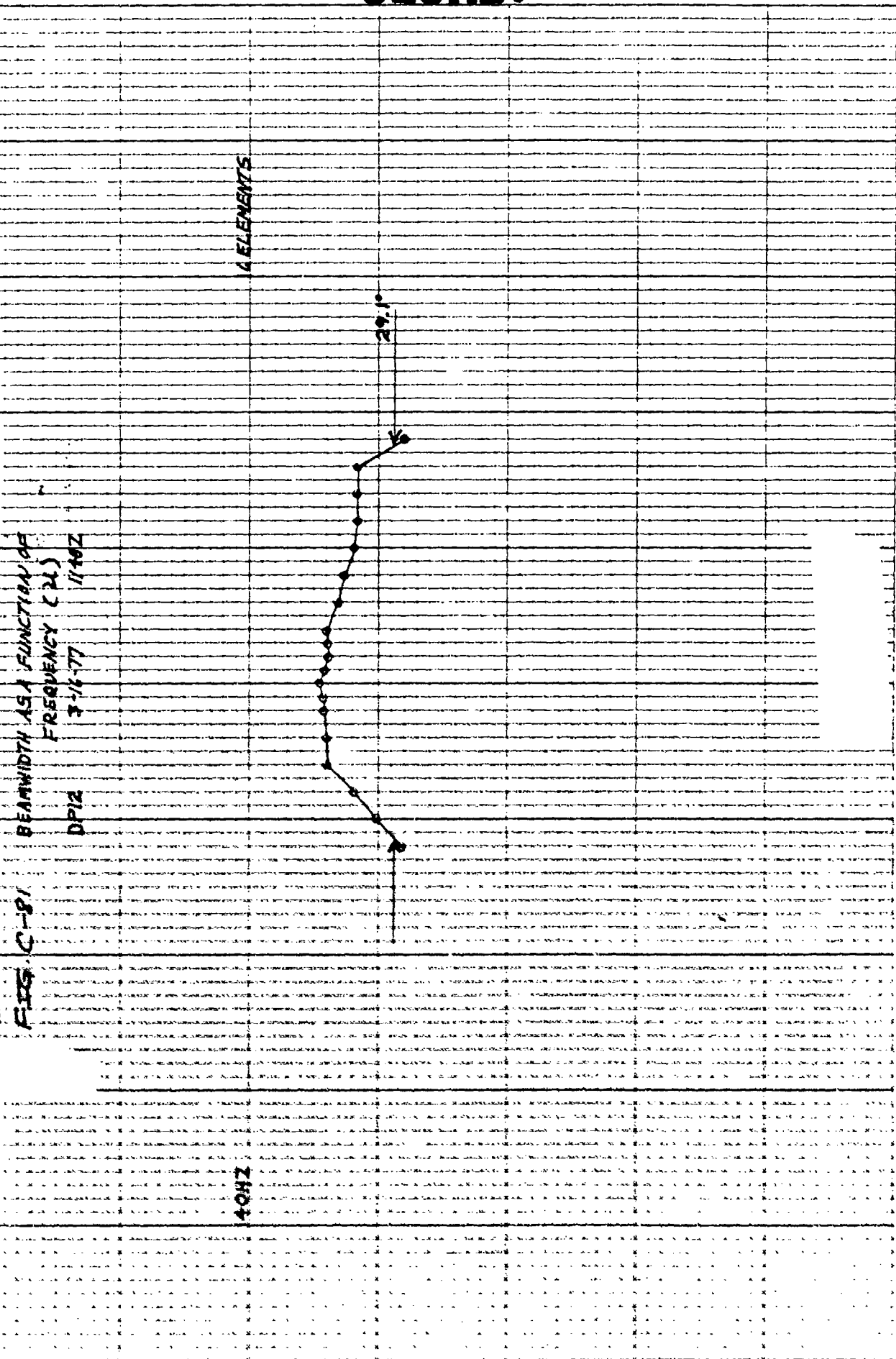
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JBV

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SECRET

DEGREES OFF BROADSIDE

+40

+60

+80

+100

+100

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Report Number	Personal Author	Title	Publication Source (Originator)	Pub. Date	Current Availability	Class.
Unavailable	Bossard, David C.	ACOUSTIC ANALYSIS/ASEPS	Wagner Associates	780726	ADA076268	U
NRLMR3832	Heitmeyer, R., et al.	PRELIMINARY RESULTS OF AN ANALYSIS OF BEAM NOISE IN THE MEDITERRANEAN (U)	Naval Research Laboratory	780901	ADC ND _{file 220}	U
Unavailable	Watrous, B. A.	PARKA I OCEANOGRAPHIC DATA COMPENDIUM	Naval Ocean R&D Activity	781101	ADB115967	U
Unavailable	Dunbar, B., et al.	LAMBDA PROCESSING LABORATORY AND ENGINEERING SUPPORT, FINAL REPORT 1 JANUARY 1977 - 31 OCTOBER 1978	Texas Instruments, Inc.	781129	ND	U
Unavailable	Blumen, L. S., et al.	ASTRAL MODEL. VOLUME 2: SOFTWARE IMPLEMENTATION	Science Applications, Inc.	790101	ADA956122	U
Unavailable	Spofford, C. W.	ASTRAL MODEL. VOLUME 1: TECHNICAL DESCRIPTION	Science Applications, Inc.	790101	ADA956124	U
Unavailable	Townsend, R., et al.	SELF-TENSIONING ACOUSTICAL HORIZONTAL LINE ARRAY (SPRAY) DATA ANALYSIS. FINAL REPORT OF BEARING STAKE TESTS JANUARY THRU MARCH 1977. VOLUME IA. OVERALL PROGRAM PERFORMANCE RESULTS WITH TEST RESULTS SUMMARY	Sanders Associates, Inc.	790101	ADC017573	U
Unavailable	Unavailable	SELF-TENSIONING ACOUSTICAL HORIZONTAL LINE ARRAY (SPRAY) DATA ANALYSIS. FINAL REPORT OF BEARING STAKE TESTS JANUARY THRU MARCH 1977. VOLUME IB. DETAILED DESCRIPTION, TEST RESULTS	Sanders Associates, Inc.	790101	ADC017574	U
Unavailable	Unavailable	SELF-TENSIONING ACOUSTICAL HORIZONTAL LINE ARRAY (SPRAY) DATA ANALYSIS. FINAL REPORT OF BEARING STAKE TESTS JANUARY THRU MARCH 1977. VOLUME II. DATA ANALYSIS FACILITY AND DATA REDUCTION METHODOLOGY	Sanders Associates, Inc.	790109	ADC017575	U
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