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NAVY ELECTRONICS LAB SAN DIEGO CALIF

F/G 17/1

TEST RESULTS OF SQS-23/PAIR (AN/SQQ-23) TRANSMITTER AND THE RAY--ETC(U)

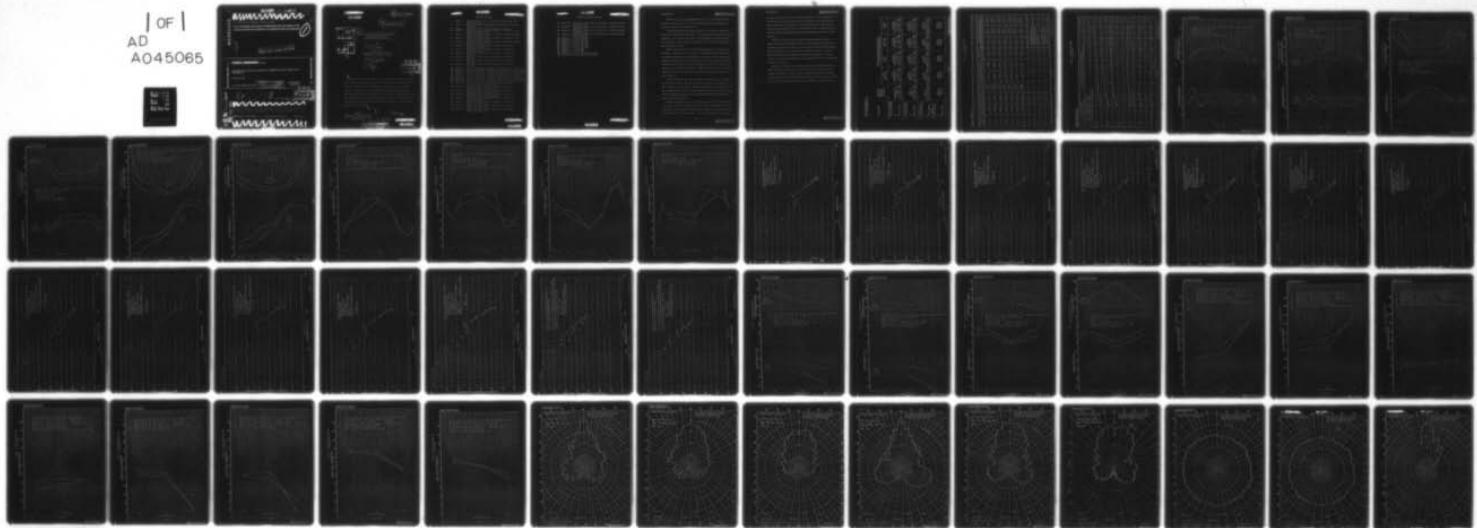
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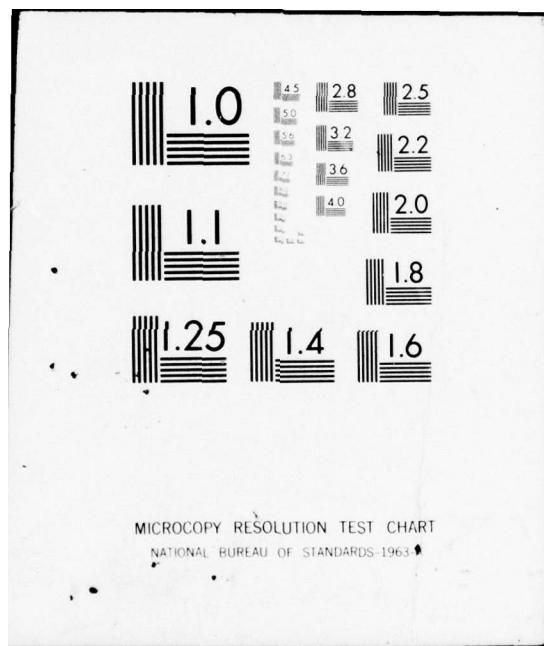
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MEI / Technical Memorandum 1060

TECHNICAL MEMORANDUM

TEST RESULTS OF SQS-23/PAIR (AN/SQQ-23) TRANSMITTER AND THE RAYTHEON TR-197
TRANSDUCER (U)

16 August 1966

H. J. Klee (NEL Code 2140)

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1060

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(6) Test Results of SQS-23/PAIR (AN/SQQ-23)
Transmitter and the
Raytheon TR-197 Transducer.

by

(10) H. J. Klee

Code 2140

U. S. Navy Electronics Laboratory
San Diego, California 92152

(11) 16 August 1966

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This technical memorandum represents a portion of the work being done on NEL Problem J714, AN/SQS-23 Performance and Integration Retrofit (PAIR) Program. It should not be construed as a formal report as its primary intent is to present some of the problems confronting project personnel and some of the preliminary conclusions. While it was originally published in a different form, it is now being included in the technical memorandum series for sake of documentation uniformity and control. Limited outside distribution is intended.

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Active testing of the SQS-23G/PAIR transmitter with Raytheon TR-197 transducer has been completed. This memorandum presents a preliminary summary of the results of the tests.

In all graphs and tables present herein, A + B refers to the transmitter drive and output connections. A + B means that transmitter A drives elements 1, 2, 3, 8 and 9 of a stave while transmitter B drives elements 4, 5, 6 and 7. In the A only, B only or the A or B mode, one transmitter drives the entire stave.

Graph 1 shows source level for all operating modes as a function of frequency. Fundamental source levels are very close to specified levels, but harmonic distortion caused harmonic source levels that are high enough (graphs 12 through 19) to be detrimental to VIS and sonic guided torpedoes. A major portion of these harmonics are generated within the "Class C" output stage of the SQS-23G transmitter. Significant reduction of the harmonic output could only be accomplished by redesign of the final stages of this power amplifier.

Graphs 2 through 7 show the variation in transducer element impedance for the TR-197 under normal PAIR operating conditions. The magnitude of the impedance varies from 20Ω to 130Ω with phase angles from -90° to $+30^\circ$. These highly variable reactive loads limit the maximum source level by high screen and plate dissipations in the transmitter output stage under the above operating conditions.

Graphs 8 through 11 present transmitter plate circuit dissipation and efficiency. Plate, screen grid, and drive voltage were adjusted to obtain the maximum possible source level consistant with the maximum power dissipation ratings for the output tubes. The output transformer was included

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as part of the plate circuit for these measurements. The dissipation in this transformer must be subtracted from the plate circuit dissipation to obtain true element dissipation. At some frequencies the plate circuit dissipation exceeds the limit set at 520 watts. This is permissible since for most PAIR operating modes the average dissipation will be less than 520 watts.

Graphs 20 through 31 present the previously mentioned data as a function of operating transducer depth. At the one-half foot depth considerable cavitation was visible in the acoustic waveform and the maximum power dissipation in the output tubes was greatly exceeded. Because of the varying depth of the transducer during normal operation, a careful look at the long term reliability of the transmitter under these operating conditions is needed.

Patterns 1 through 6 are typical patterns of the SQS-23G/PAIR transmitter with a TR-197 transducer. The relatively high side lobe levels support the previous conclusion that the beamforming delays in the TCU are not proper to form the PAIR specified transmit beam, and that transmit beams will also be a function of the active transducer type installed.

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Equipment	SSS-23G Maximum Ratings (1 unit)	PAIR Operating Requirements (with TR-197 transducer)			
		A + B RDT	A + B OMNI	A or B 300° RDT	A or B OMNI.
1. High voltage M.G.s(PP-485)					
E	2700/2450 v. 16.0 A.	2530/2500 v. 4.7 A.	2530/2500 v. 17.2 A.	2530/2500 v. 4.7 A.	2530/2500 v. 15.8 A.
I	0.9 sec. ON 11.1 sec. OFF	5.7 sec. ON 16.0 sec. OFF	0.32 sec. ON 4.0 sec. OFF	5.7 sec. ON 16.0 sec. OFF	0.32 sec. ON 4.0 sec. OFF
Duty cycle					
2. Screen grid M.G.s(PJ-519)					
E	875 v. 2.90 A.	530/500 v. 1.25 A.	530/500 v. 3.43 A.	530/500 v. 1.42 A.	530/500 v. 3.12 A.
I	0.9 sec. ON 11.1 sec. OFF	5.7 sec. ON 16.0 sec. OFF	0.32 sec. ON 4.0 sec. OFF	5.7 sec. ON 16.0 sec. OFF	0.32 sec. ON 4.0 sec. OFF
Duty cycle					
3. 325 volt					
M.G.s(PP-479)					
E	325 v. 3.0 A-0.9 sec. 1.0 A-11.1sec.	325 v. 3.25A-5.7 sec. 2.66A-16 sec.	325 v. 4.68A-3.2 sec. 2.66A-4.0 sec.	325 v. 1.73A-5.7 sec. 1.33A-16 sec.	325 v. 2.35A-3.2 sec. 1.33A-4.0 sec.
I					
Duty cycle					
4. 300/500 v. Bias supply					
E	300 v. 0.25 A. 0.12 %	300 v. 0.21 A. 0.25 %	300 v. 0.57 A. 7.4 %	300 v. 0.11 A. 25 %	300 v. 0.28 A. 7.4 %
I					
Duty cycle					

Table I

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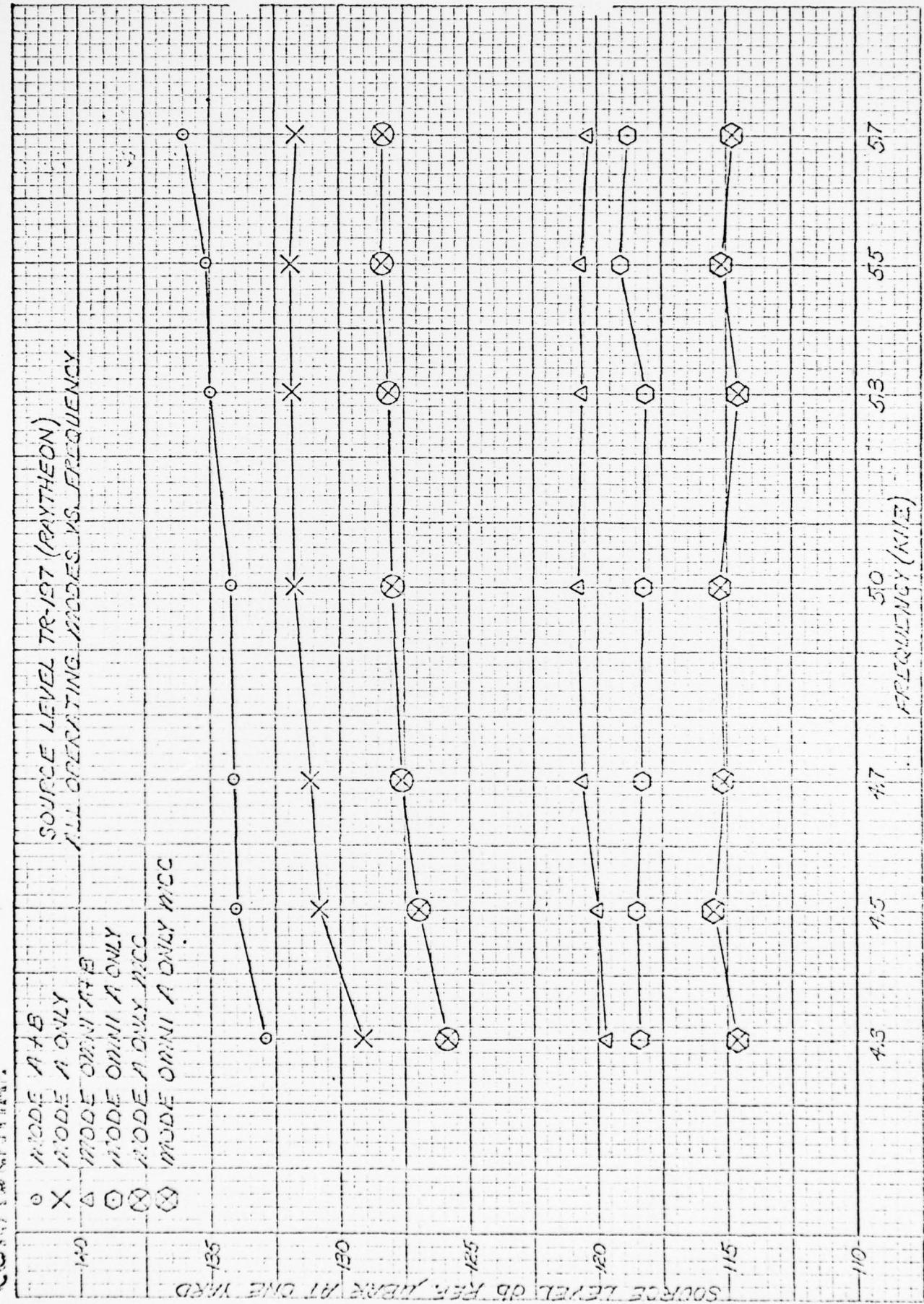
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Frequency (Mhz)	DC Input Power(kw)	AC Output Power(kw)	Acoustic Power(kw)	Directivity Index Measured	Directivity Index Theor.	Source Level (db)	Amplifier Transducer	Efficiency (per cent) Overall
4.3	15.1	7.5	4.17	25.5	24.2	133.6	13.0	23.0
4.5	22.25	8.06	5.32	26.0	25.0	134.9	36.0	24.5
4.7	23.48	8.95	5.50	26.0	25.4	135.0	38.0	24.4
5.0	23.53	5.33	5.63	26.0	25.9	135.2	35.6	23.9
5.3	22.21	12.56	5.76	26.0	26.0	135.6	30.5	24.8
5.5	20.76	12.15	5.76	26.5	26.7	135.7	63.5	27.8
5.7	28.57	10.18	5.52	6.31	26.9	136.5	54.0	29.5

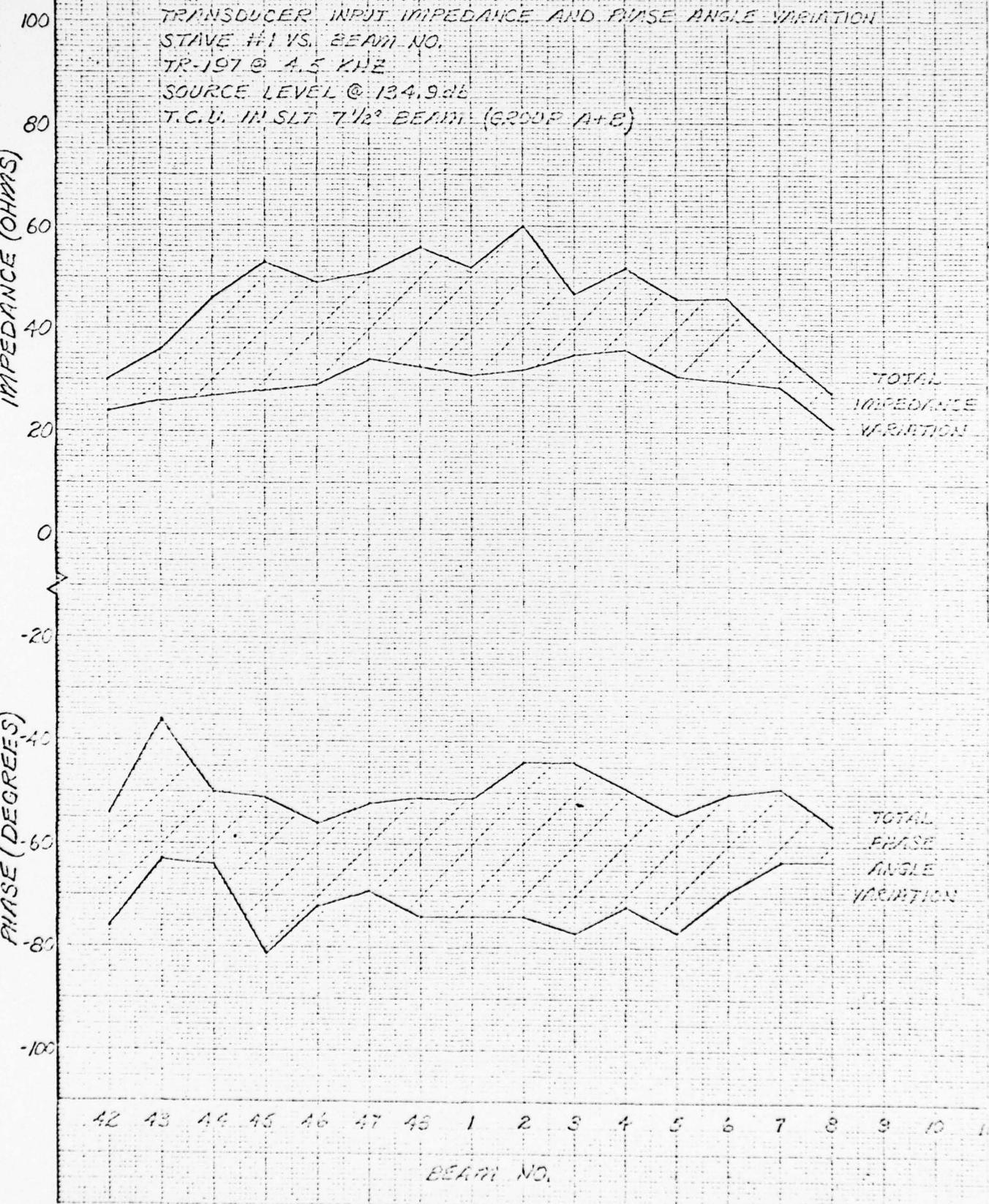
Tabulated Data
-SQS-23G/PAIR-TI
TR-197 Transdu
Mode A + B
S/3/66

$E_{bb} = 2500$ volts
 $E_C^2 = 500$ volts
 Drive to Trans. = 0.14 v rms

TITEL

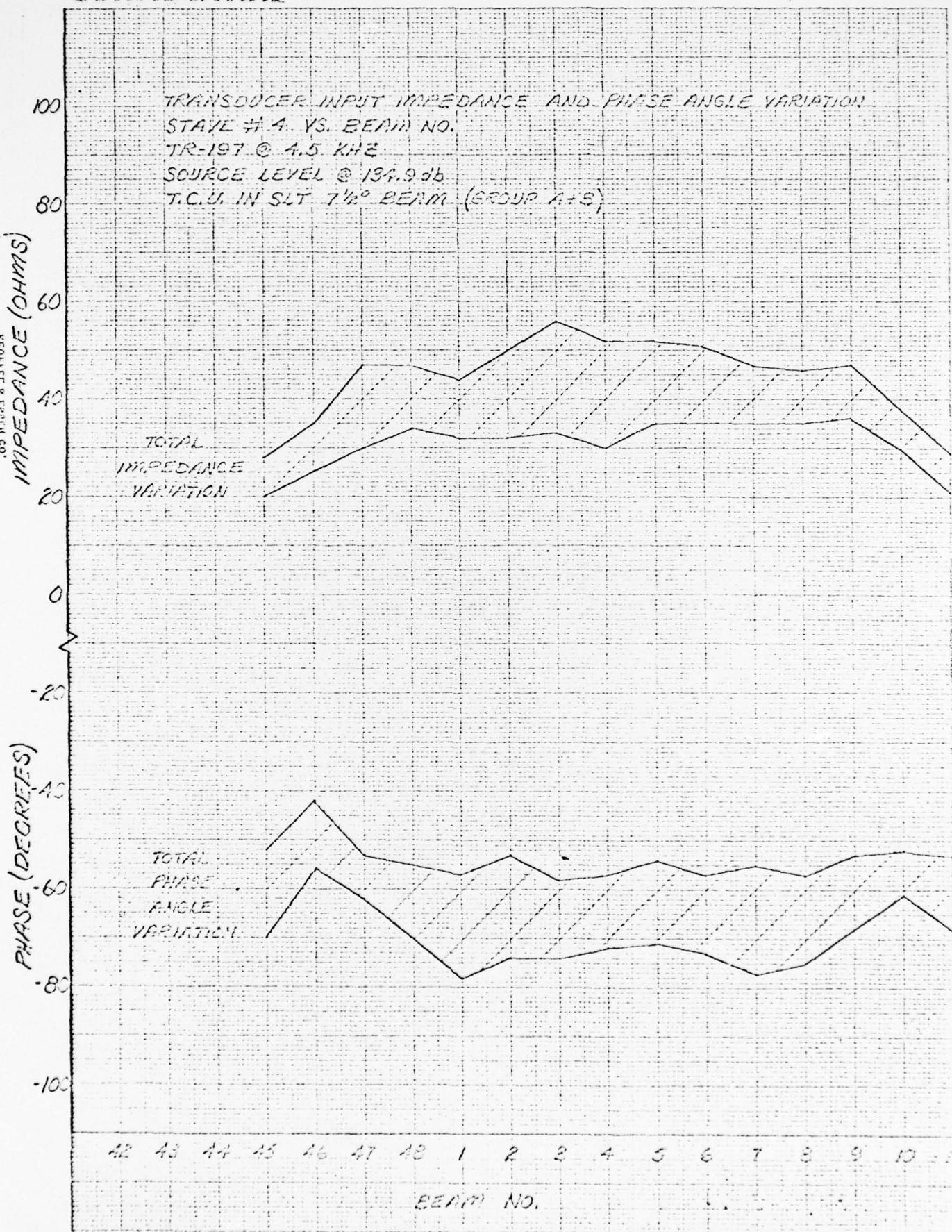


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Graph 3

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100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
550
560
570
580
590
600
610
620
630
640
650
660
670
680
690
700
710
720
730
740
750
760
770
780
790
800
810
820
830
840
850
860
870
880
890
900
910
920
930
940
950
960
970
980
990
1000

100

80

60

40

20

0

INPUT IMPEDANCE (OHMS)

TOTAL
IMPEDANCE
VARIATION

TRANSDUCER INPUT IMPEDANCE AND PHASE ANGLE VARIATION
STATE # 1 VS. BEAM NO.
ELEMENTS 1 THRU 3
TR. 197 @ 5.5 KHZ
SOURCE LEVEL @ 195.5 dB
T.C.U. IN SLT 7½° BEAM (GROUP A+E)

PHASE (DEGREES)

TOTAL
PHASE
ANGLE
VARIATION

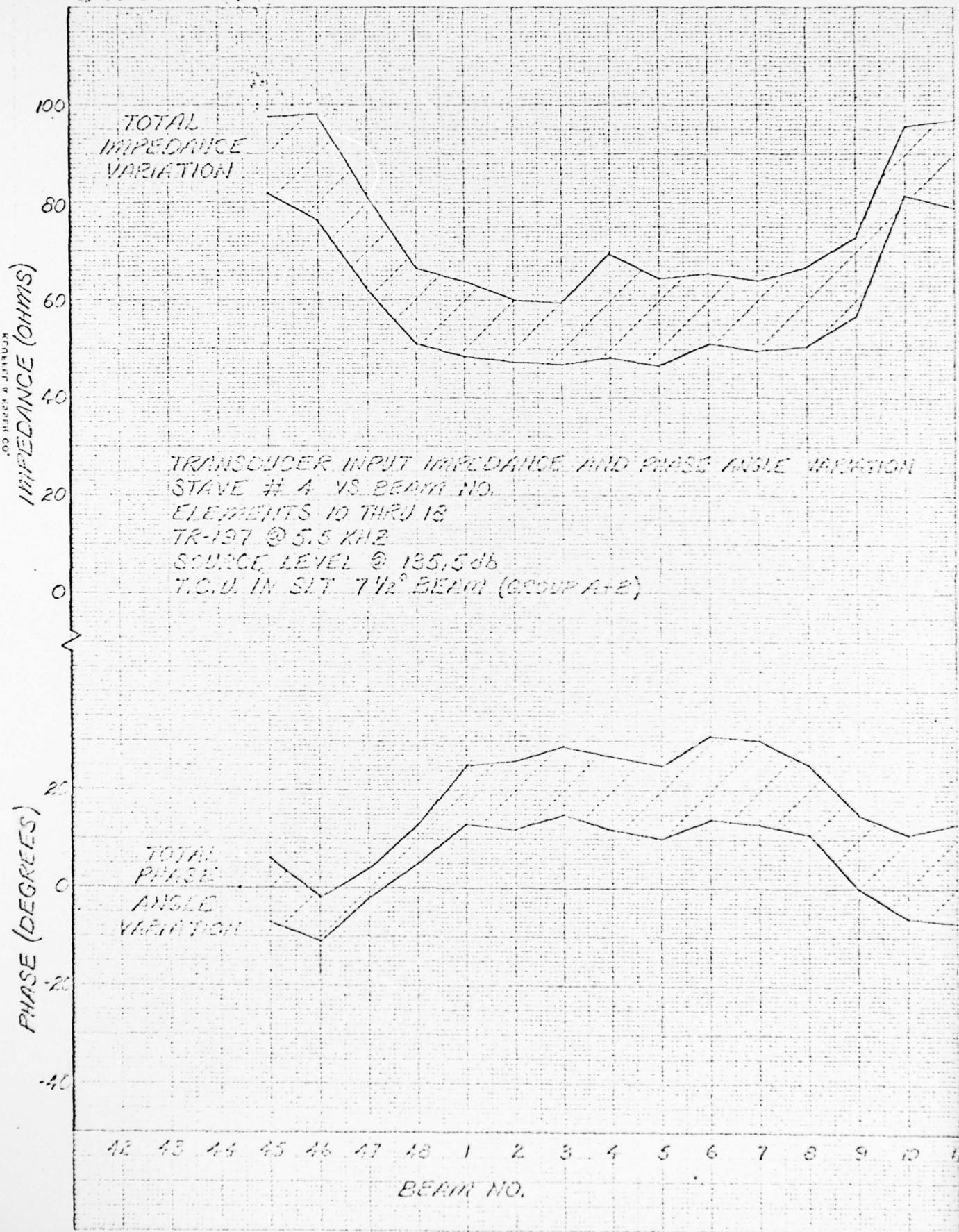
42 43 44 45 46 47 48 1 2 3 4 5 6 7 8 9 10 11

BEAM NO.

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Graph 4

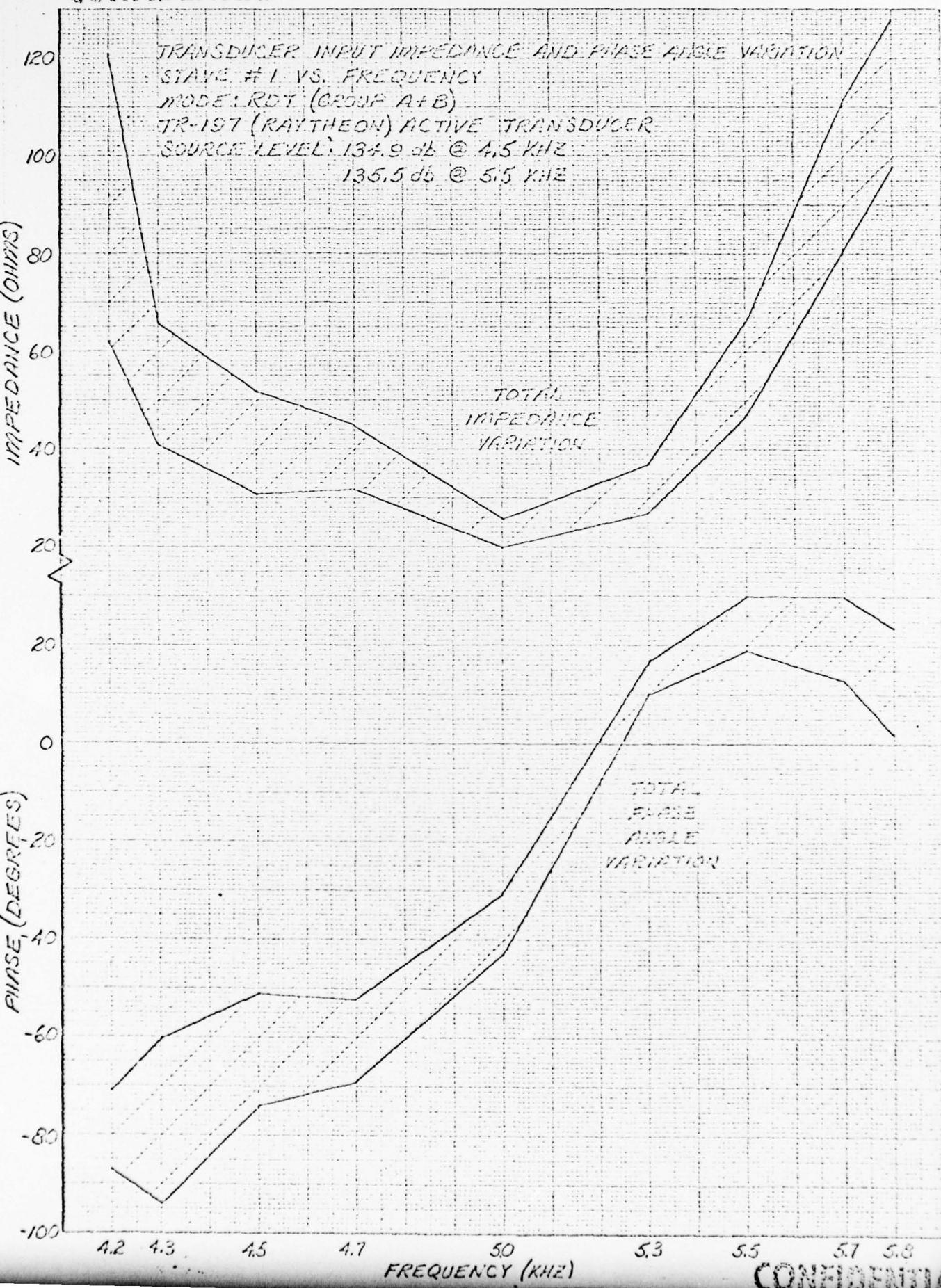
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Graph 5

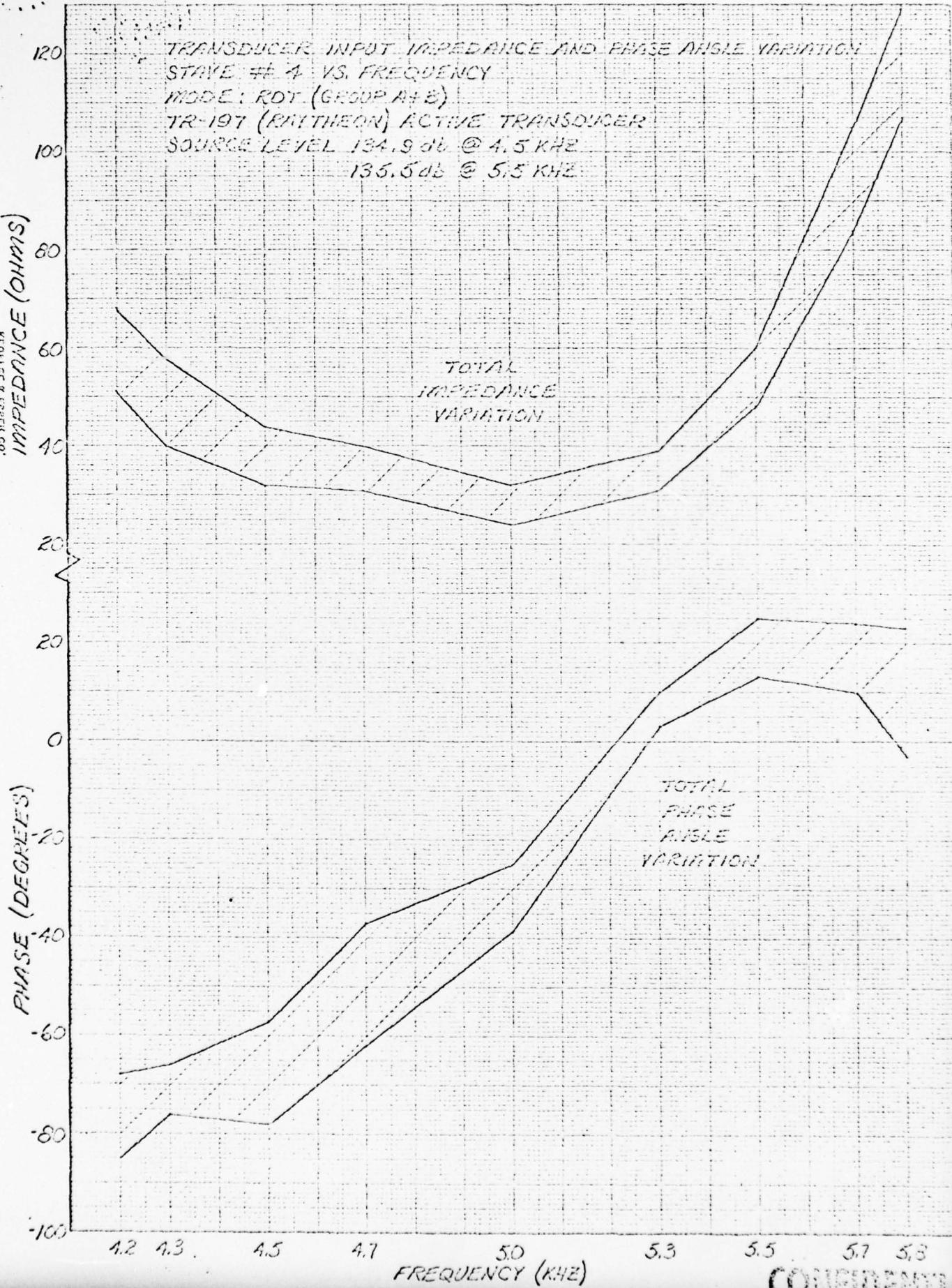
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Graph 6

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Graph 7

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SGS-23G/PWR. TRANSMITTER PLATE DISSIPATION VS. FREQUENCY

STAVE # 1

MODE: RDT (GROUP A+E)

TR-197 (RAYTHEON) ACTIVE TRANSDUCER

SOURCE LEVEL 124.9 dB @ 4.5 kHz

135.5 dB @ 5.5 kHz

(PLATE DISSIPATION INCLUDES PA. OUTPUT NETWORK)

1000

900

800

700

600

(SPLATTW) WATTS/DISSIPATION

500

400

300

200

100

0

4.2 4.3 4.5 4.7 5.0 5.3 5.5 5.7 5.8
FREQUENCY (KHZ)

Graph 8

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SQS-235/PAIR TRANSMITTER PLATE DISSIPATION VS. FREQUENCY
STAVE #4
MODE: ROT (GROUP RATE)
TR-197 (PATHEON) ACTIVE TRANSDUCER
SOURCE LEVEL 134.9 dB @ 4.5 KHZ
135.5 dB @ 5.5 KHZ
(PLATE DISSIPATION INCLUDES P.A. OUTPUT NETWORK)

WRITER & READER CO.
10 X 50 CM • VERSATILE
10 X 10 IN THE GRID PAPER

12105

DISSIPATION (WATTS)

1000
800
700
600
500
400
300
200
100
0

4.2 4.3 4.5 4.7 5.0 5.3 5.5 5.7 5.8
FREQUENCY (KHZ)

Graph 9

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SQS-235/PAR TRANSMITTER PLATE CIRCUIT EFFICIENCY VS. FREQUENCY
STAVE #1
MODE: RDT (GROUP A+B)
TR-157 (RAYTHEON) ACTIVE TRANSDUCER
SOURCE LEVEL 134.9 dB @ 4.5 kHz
135.5 dB @ 5.5 kHz

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EFFICIENCY (PERCENT)

100

90

80

70

60

50

40

30

20

10

0

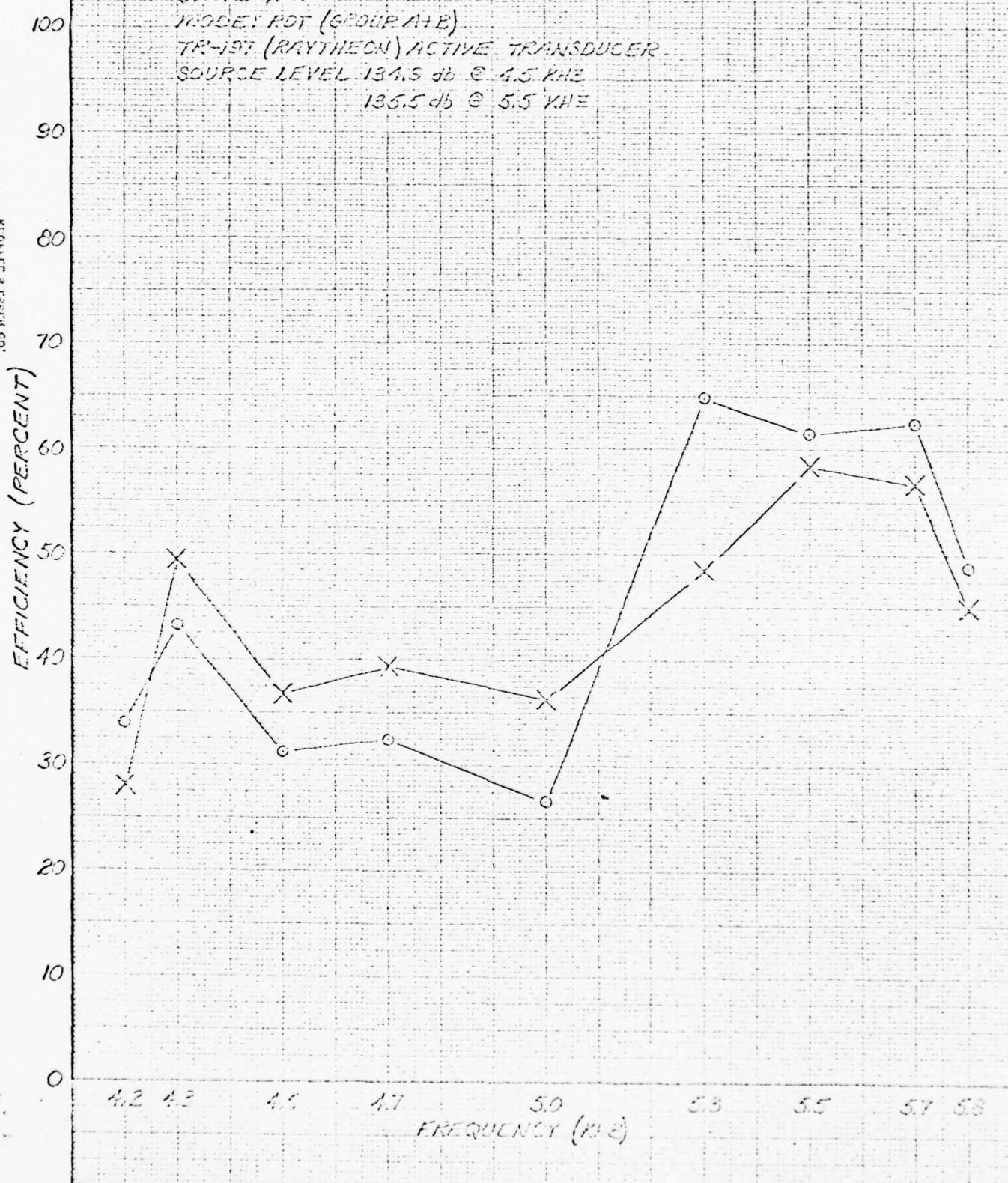
4.2 4.3 4.5 4.7 5.0 5.3 5.5 5.7 5.8
FREQUENCY (kHz)

Graph 10

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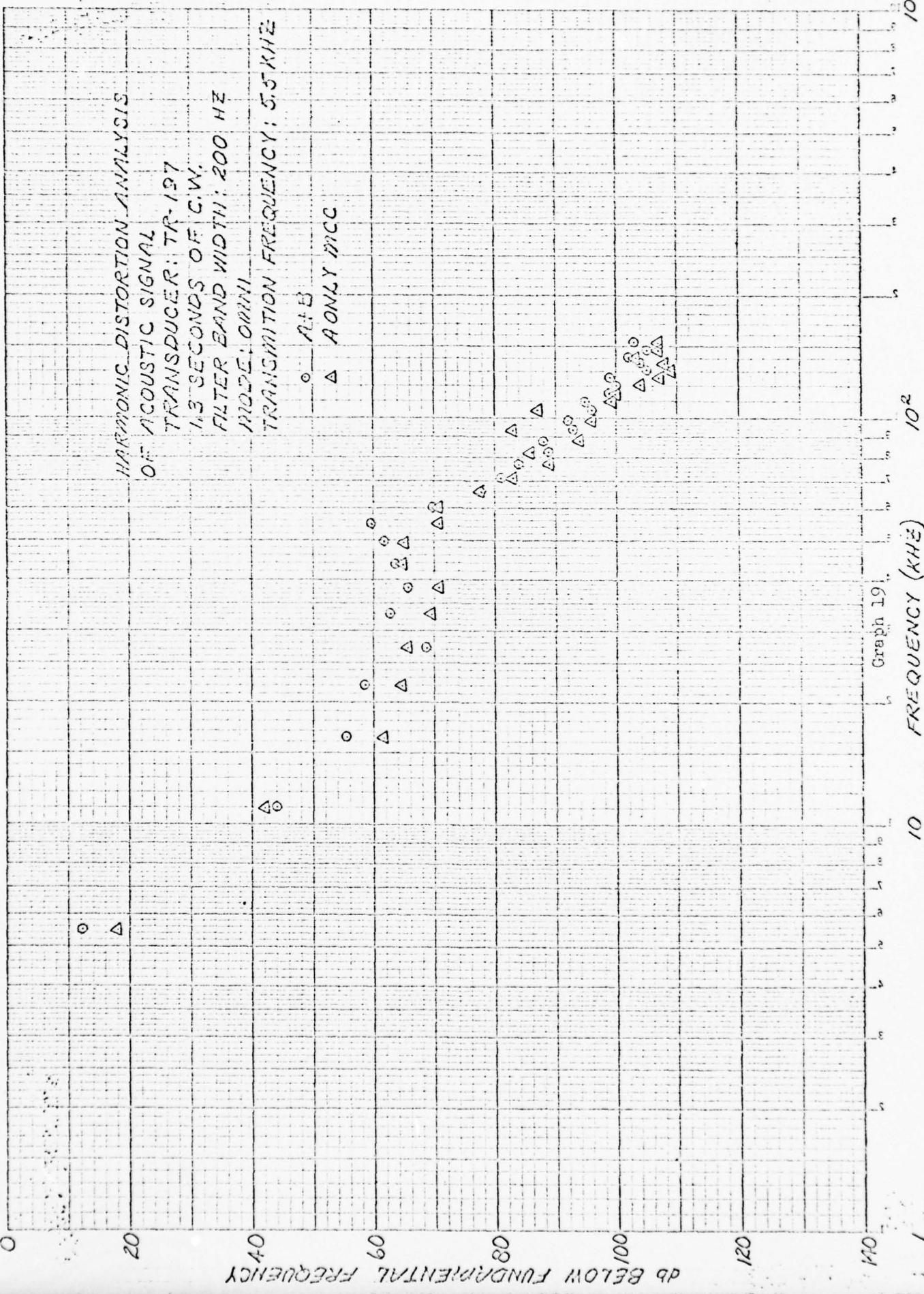
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SQS-235/PURE TRANSMITTER PLATE CIRCUIT EFFICIENCY VS. FREQUENCY
STATION #14
MODEL: POF (GROUP A+B)
TR-197 (RAYTHEON) ACTIVE TRANSDUCER
SOURCE LEVEL 134.5 db @ 4.5 KHZ
135.5 db @ 5.5 KHZ



Graph 12

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Graph 19

FREQUENCY (kHz)

10

10²

10³

Graph 19

FREQUENCY (kHz)

HARMONIC DISTORTION ANALYSIS OF ACOUSTIC SIGNAL

ACOUSTIC SIGNAL TRANSDUCER: TR-727

1.3 SECONDS OF C.W.

710 STEAM VITAMIN

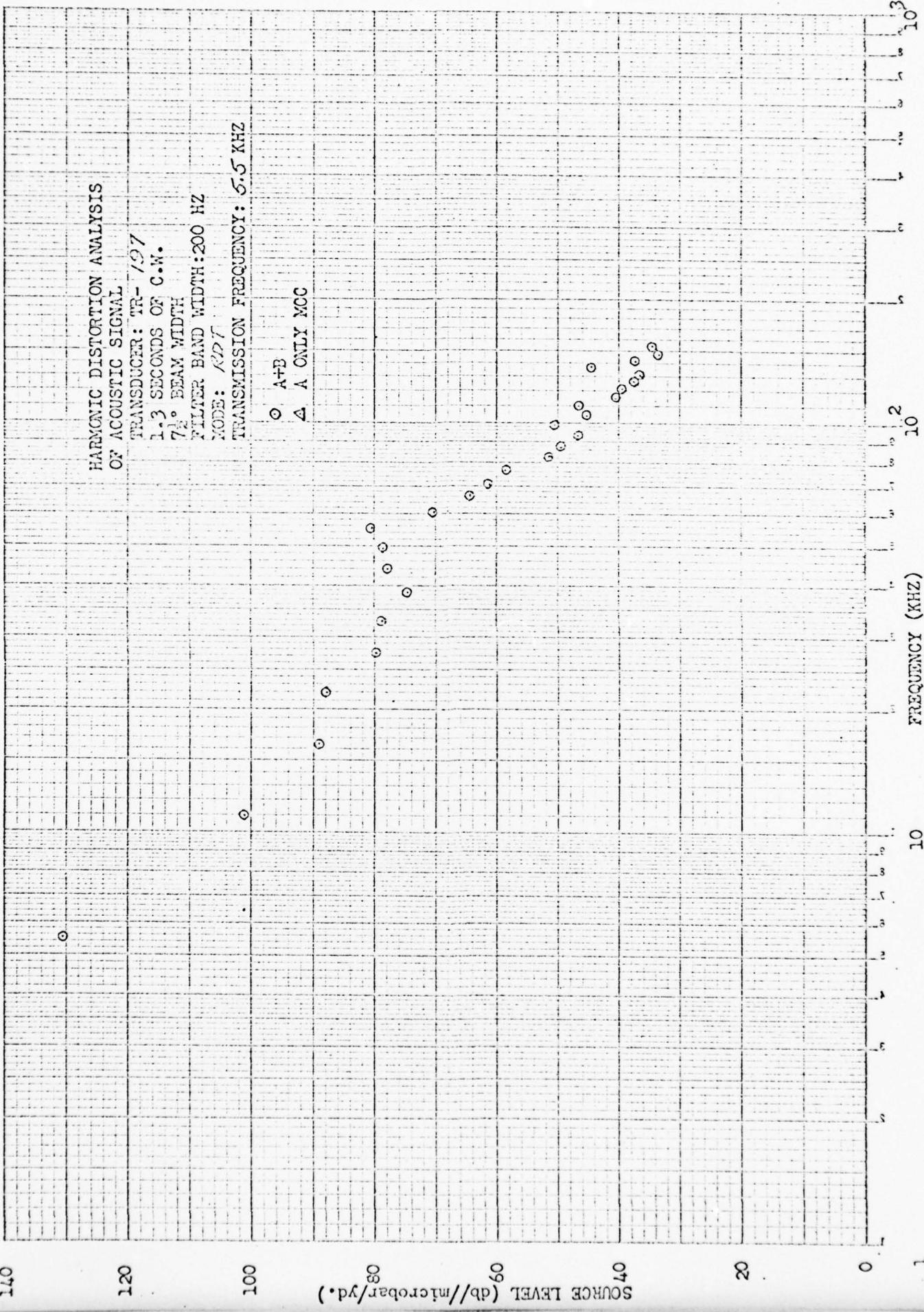
7 $\frac{1}{2}$ ° BEAM WIDTH

1/2 DEAN WEDD
PITTIE BAND LTD

FILTER BAND WIDTH: 200

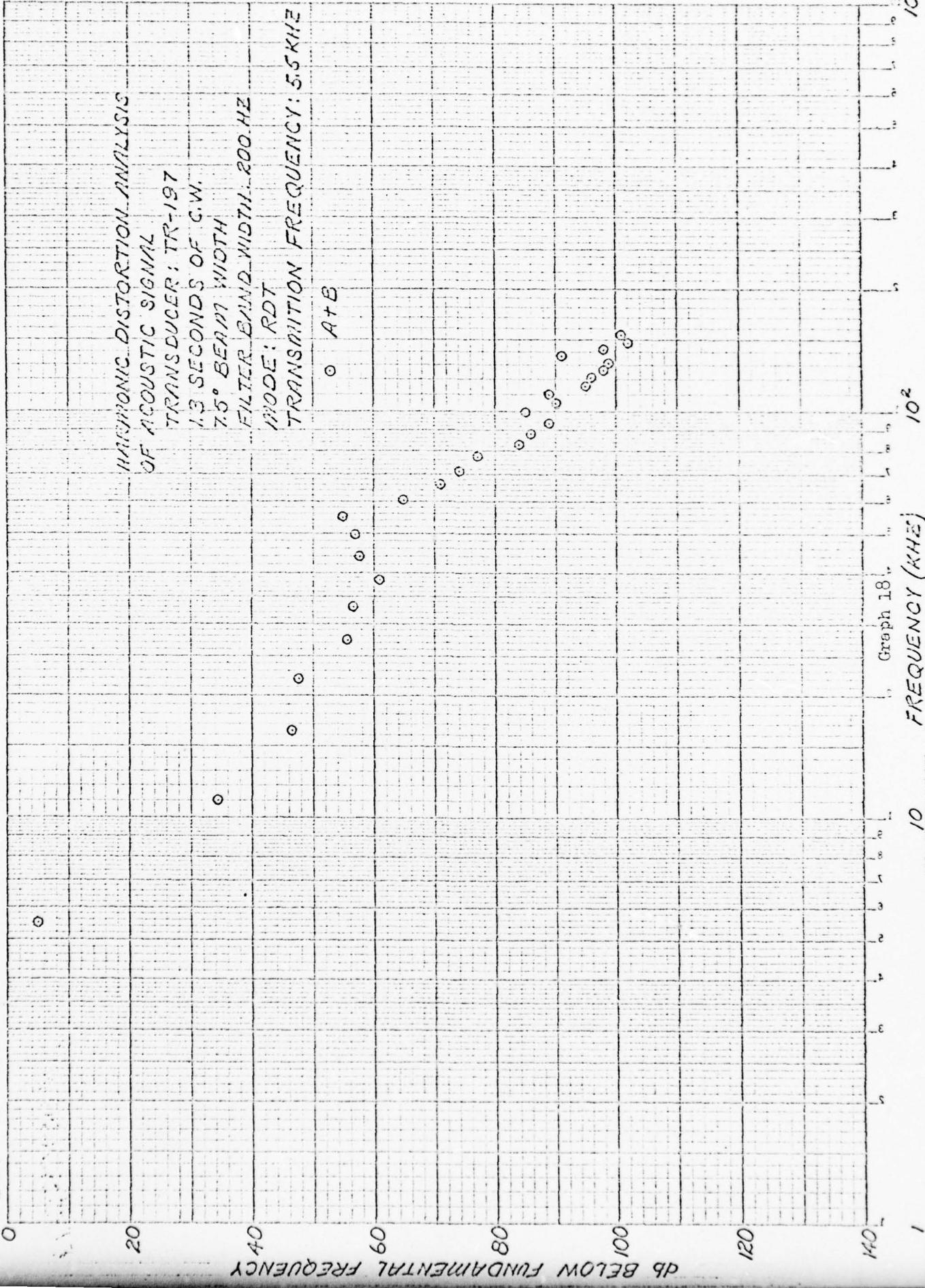
KODE: RDT

KODE: KDB1



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MICROHARMONIC DISTORTION ANALYSIS
OF ACOUSTIC SIGNAL
TRANSDUCER: TR-197
1.3 SECONDS OF C.W.
7.5° BEAM WIDTH
FILTER BANDWIDTH: 200 KHZ
MODE: RDT
TRANSITION FREQUENCY: 5.5 KHZ



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REF ID: A6420000

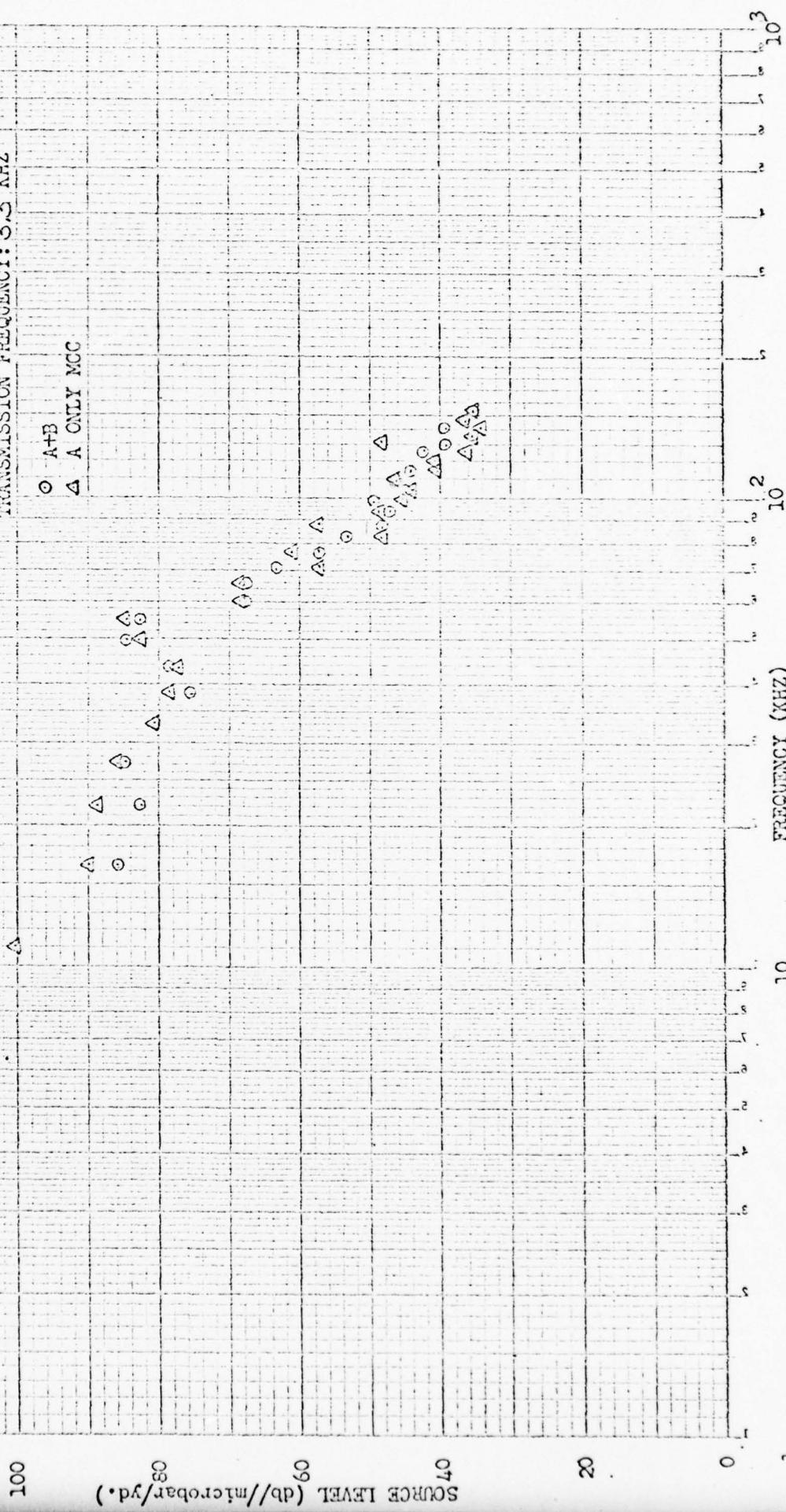
Graph 18: FREQUENCY (KHZ)

Y-axis: db BELOW FUNDAMENTAL FREQUENCY

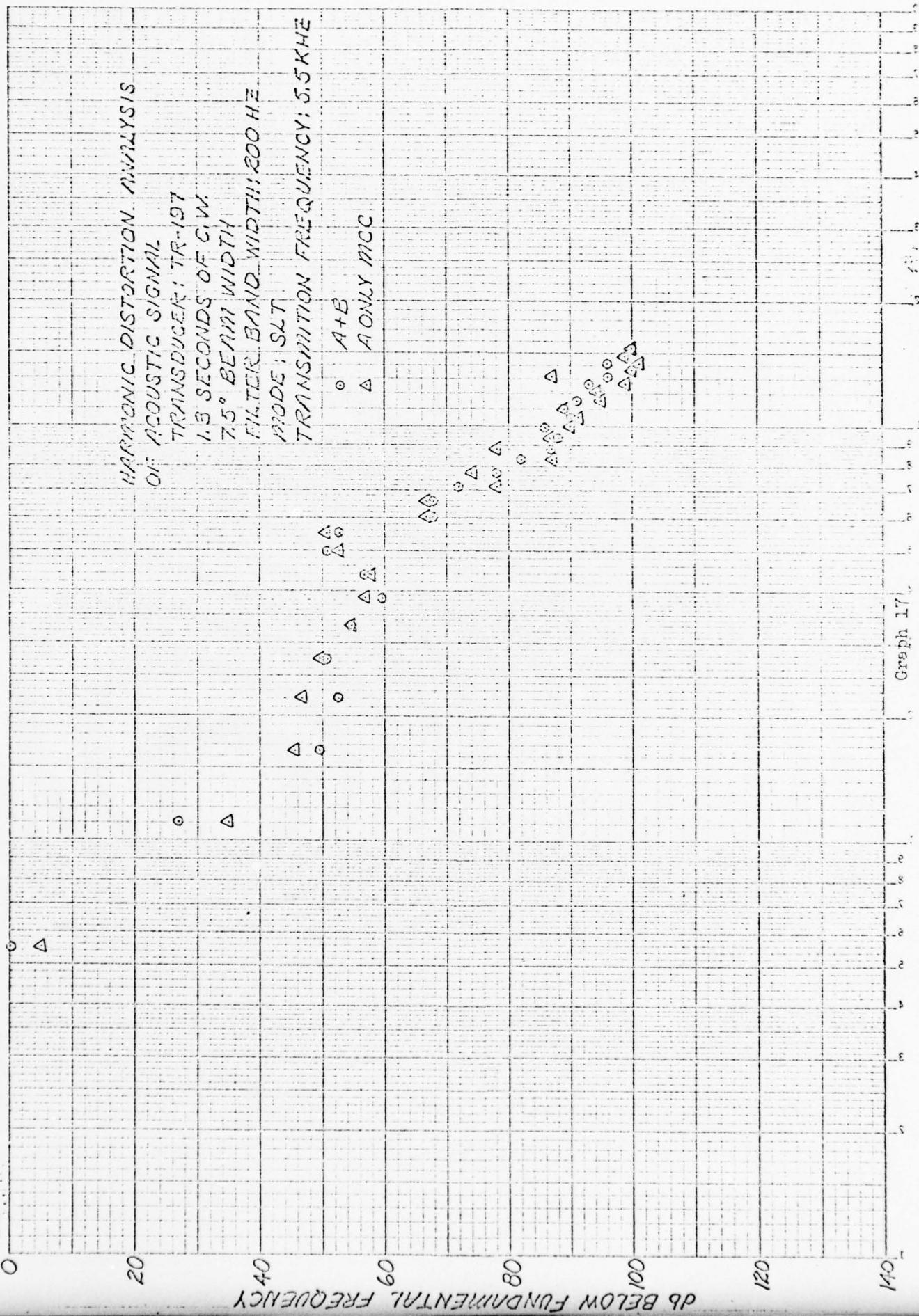
X-axis: FREQUENCY (KHZ) on a logarithmic scale from 10^2 to 10^3.

Legend: Mode A+B (Open Circles), Mode A-B (Filled Circles).

HARMONIC DISTORTION ANALYSIS
OF ACOUSTIC SIGNAL
TRANSDUCER: TR-197
1.3 SECONDS OF C.W.
71° BEAM WIDTH
FILTER BAND WIDTH: 200 Hz
NODE: S₁₇
TRANSMISSION FREQUENCY: 5.5 KHz



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Graph 17

FREQUENCY (KHz)

10²

10³

HARMONIC DISTORTION ANALYSIS
OF ACOUSTIC SIGNAL

TRANSDUCER: TR-197

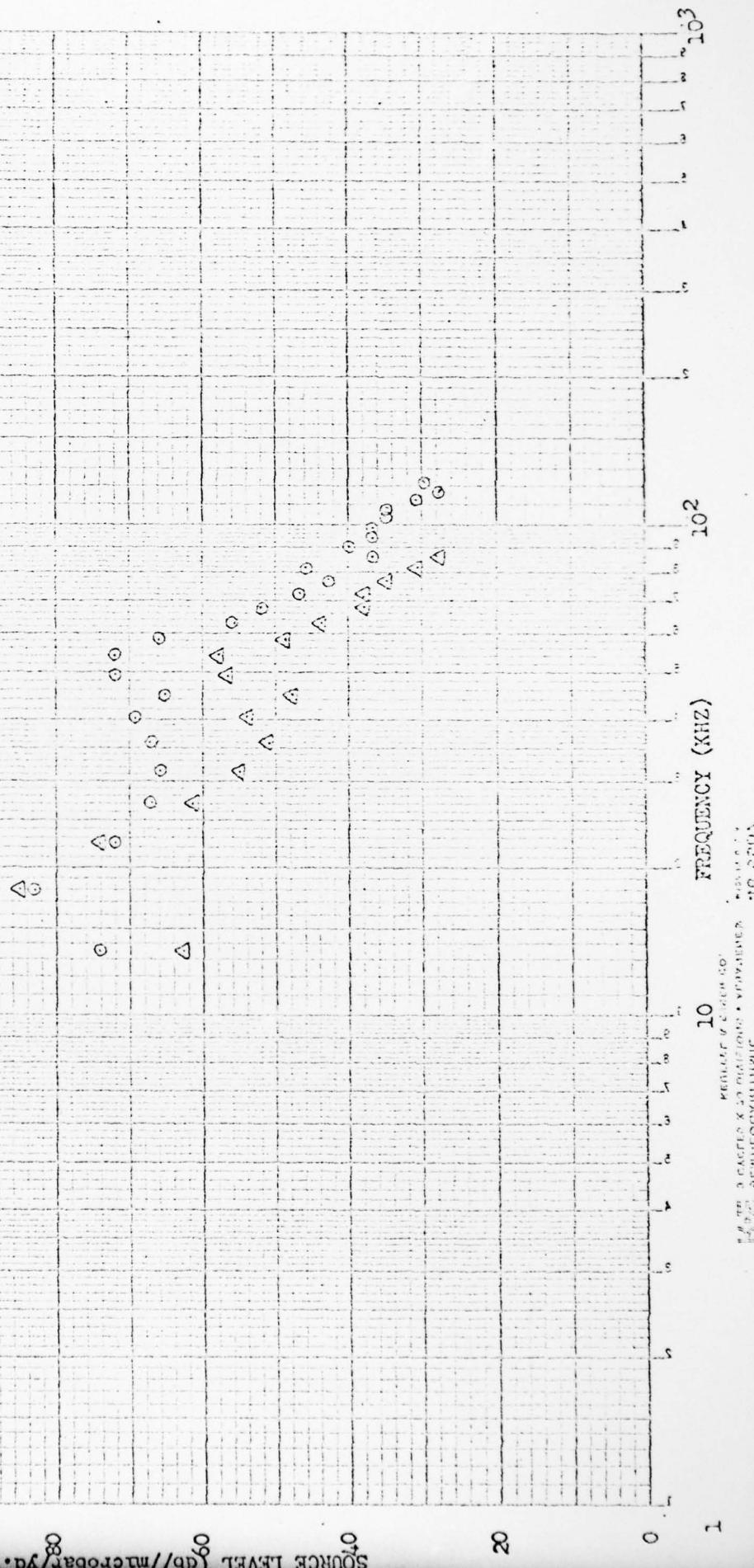
1.3 SECONDS OF C.W.

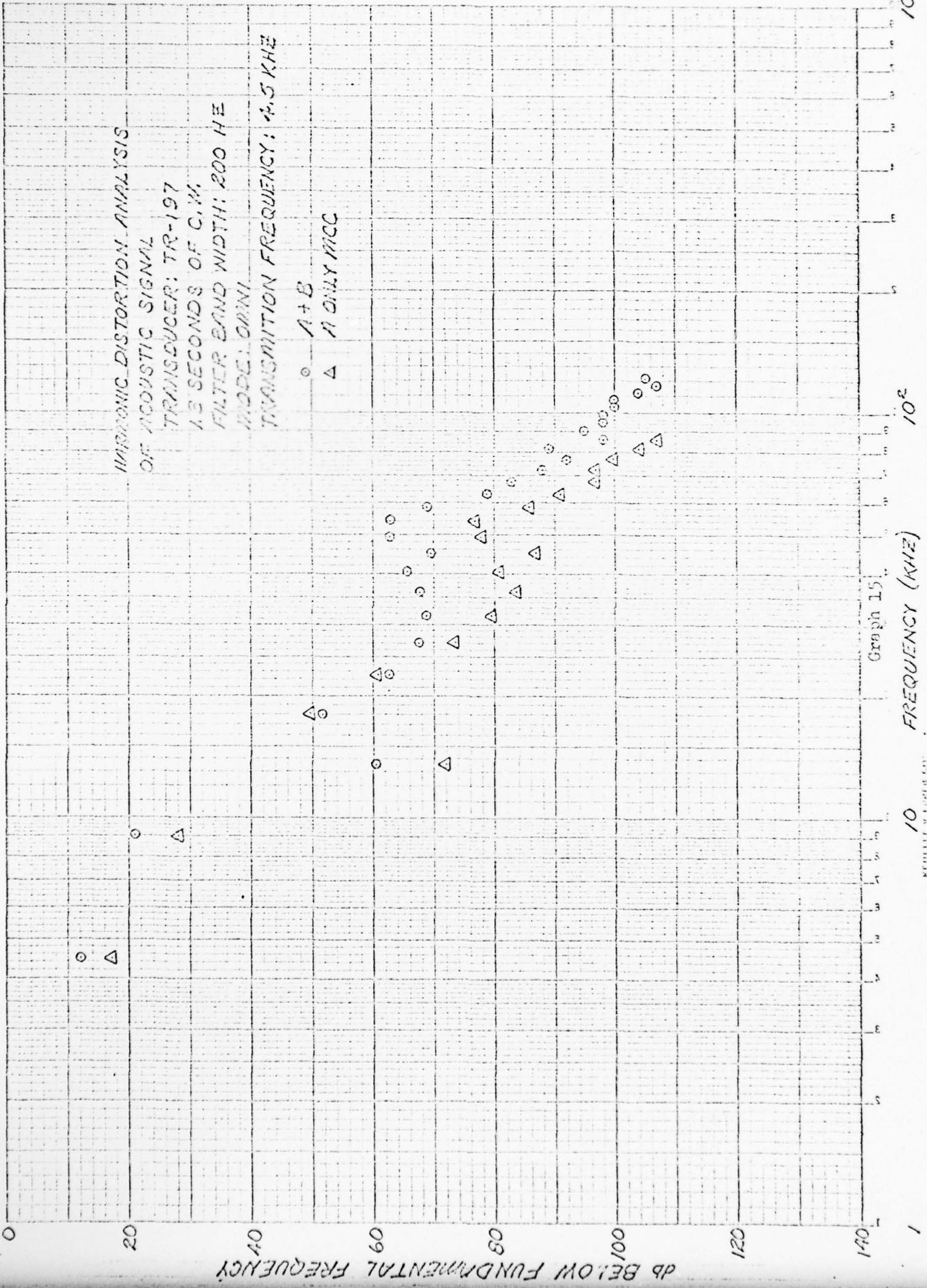
FILTER BAND WIDTH: 200 Hz

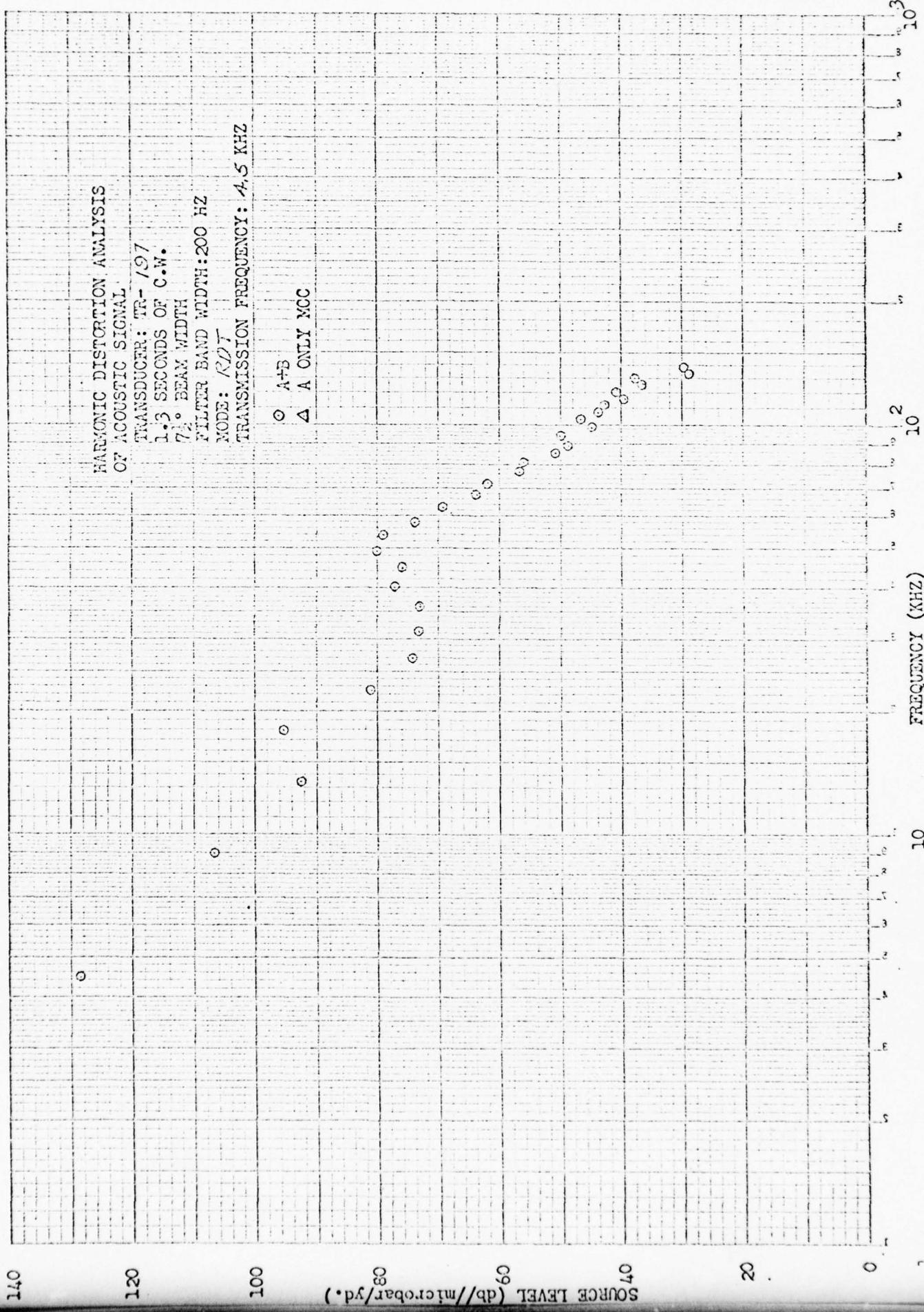
CODE: O/2744/1

TRANSMISSION FREQUENCY: 4.5 KHz

○ A+B
△ A ONLY NOC







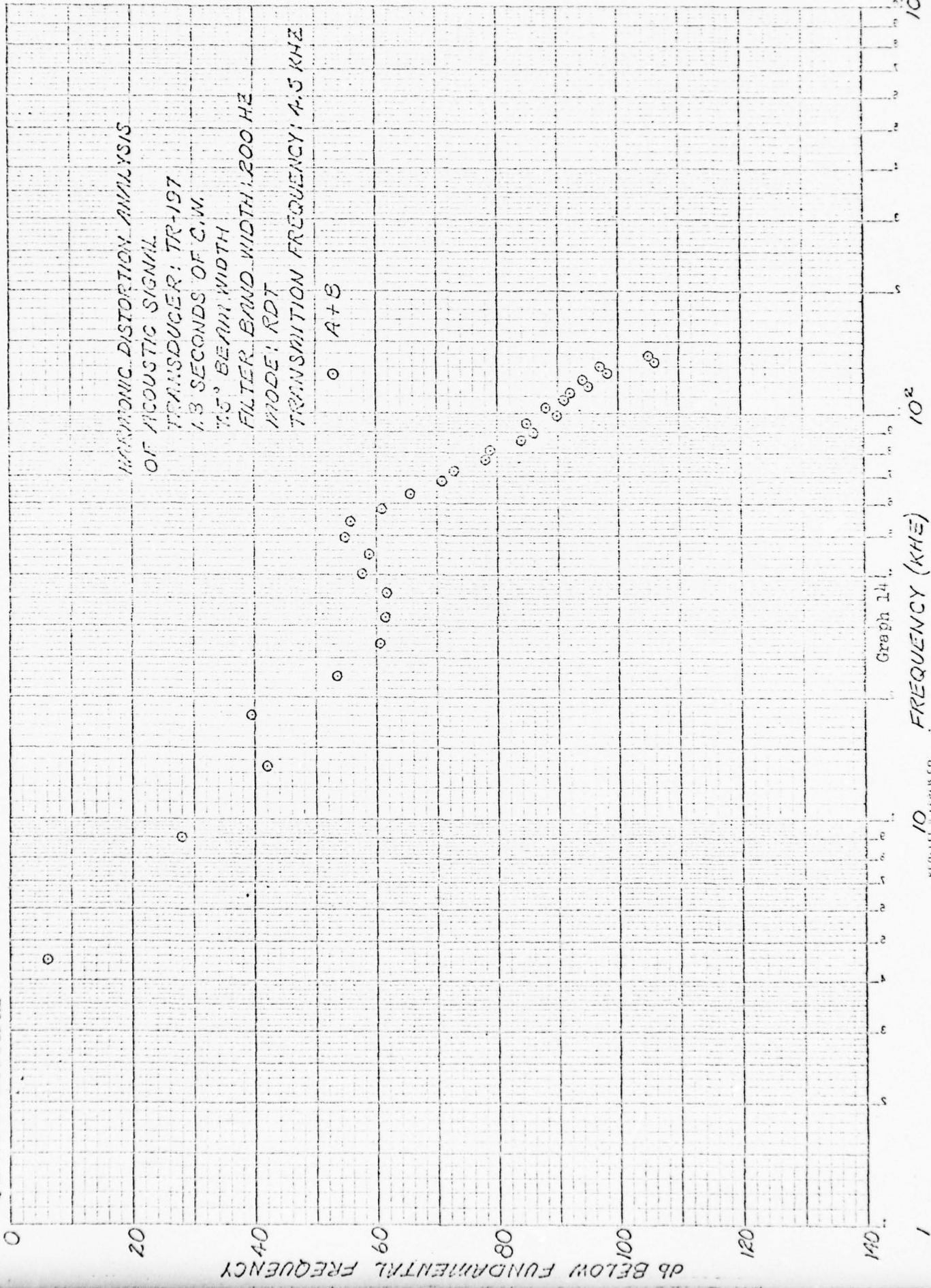
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HARMONIC DISTORTION ANALYSIS
OF ACOUSTIC SIGNAL
FROM TRANSDUCER: TR-197

1.3 SECONDS OF C.W.
7.5° BEAM WIDTH
FILTER BAND WIDTH: 200 Hz

MODE: RDT
TRANSMISSION FREQUENCY: 4.5 kHz

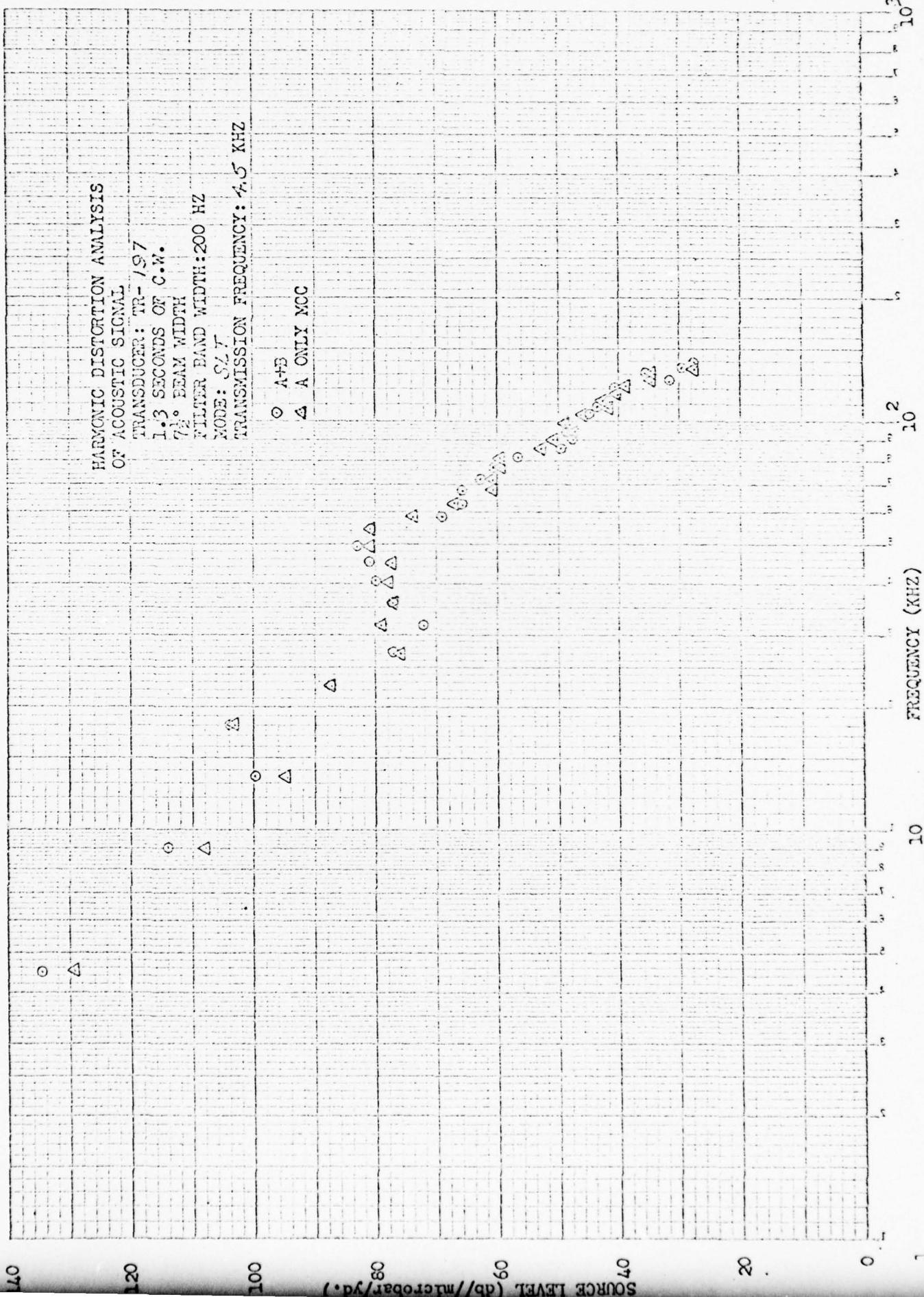
○ A + S

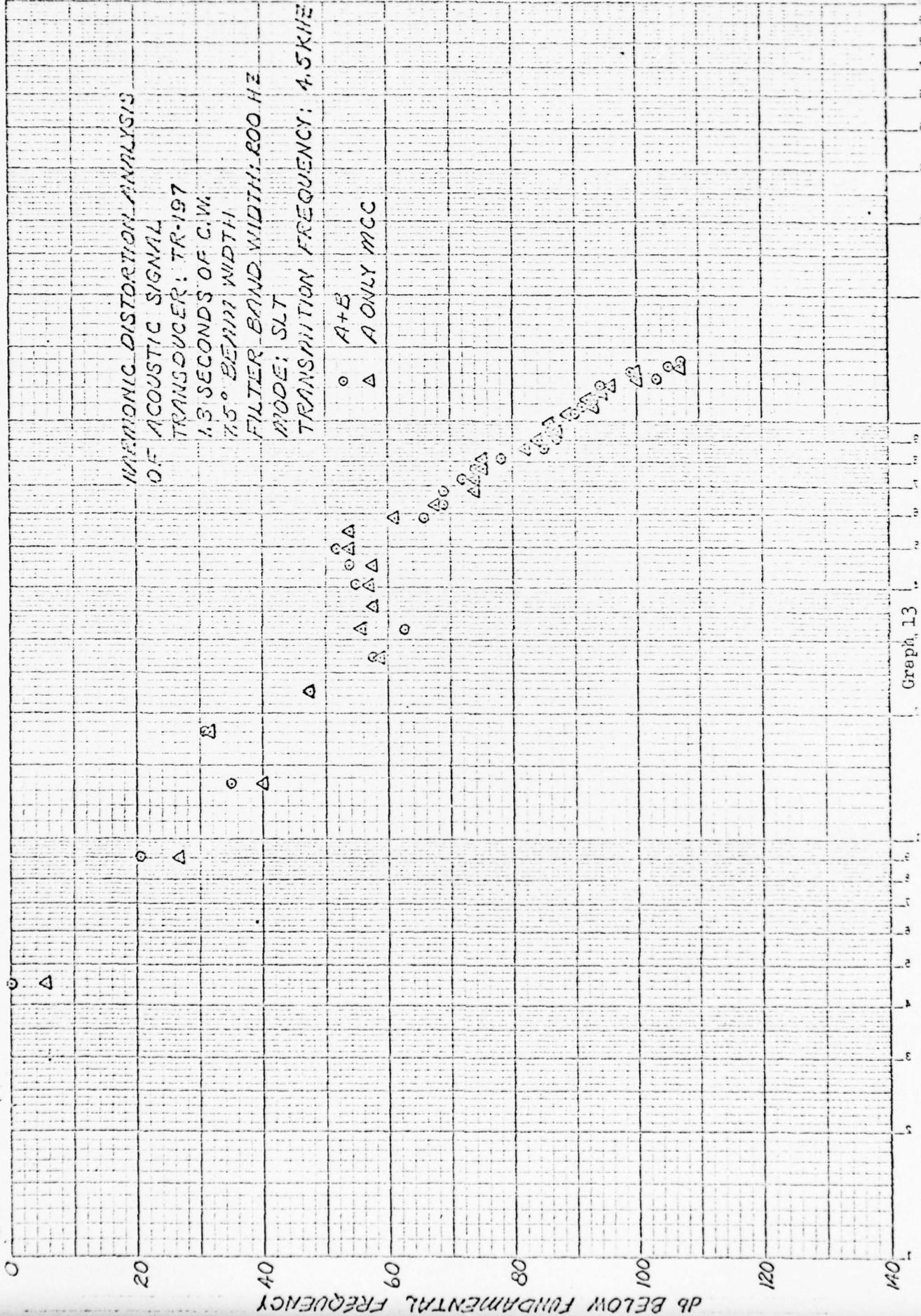


HARMONIC DISTORTION ANALYSIS
OF ACOUSTIC SIGNAL

TRANSDUCER: TR-197
1.3 SECONDS OF C.W.
7° BEAM WIDTH
FILTER BAND WIDTH: 200 Hz
MODE: S₂T
TRANSMISSION FREQUENCY: 4.5 kHz

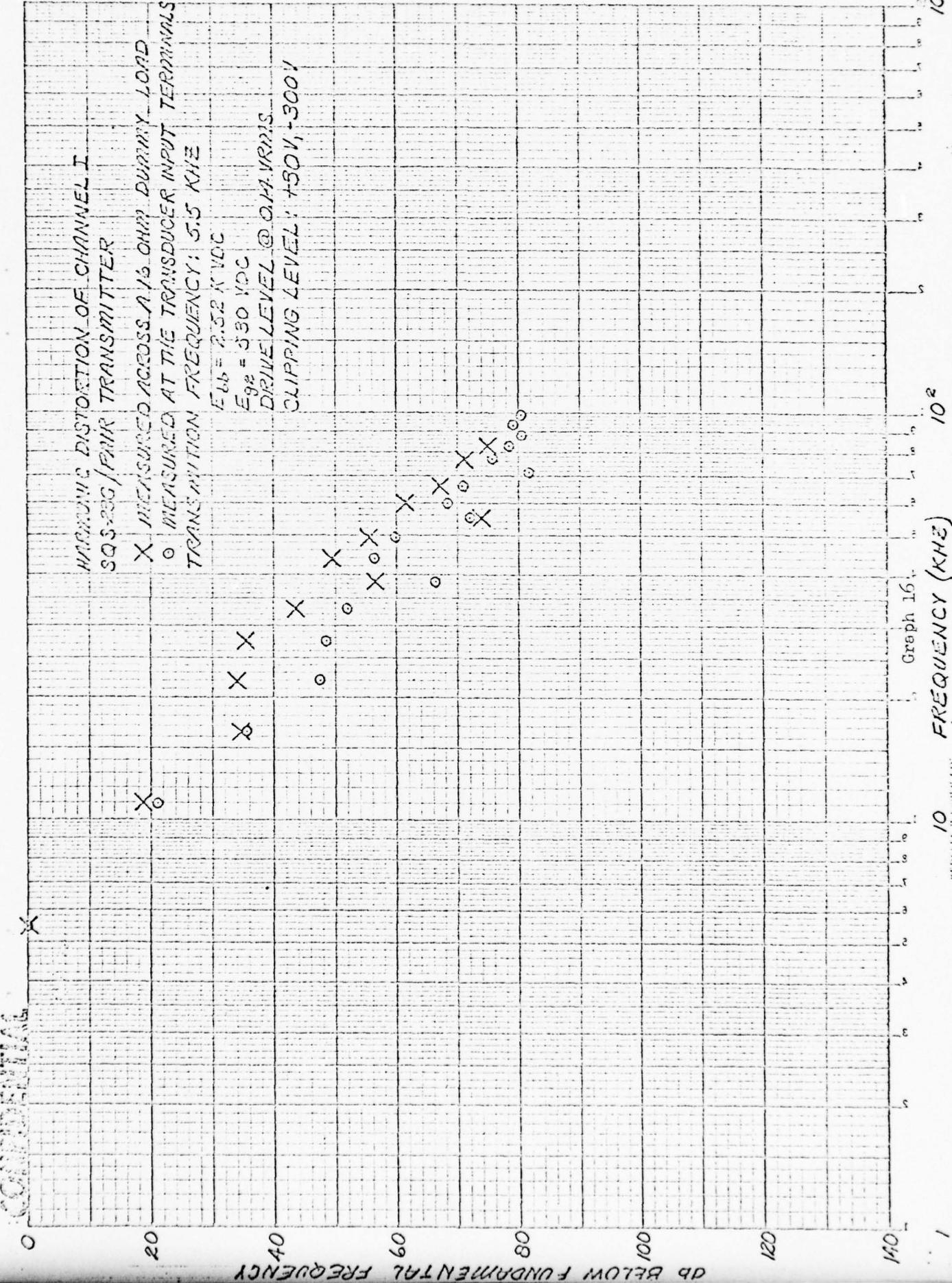
○ A+B
△ A ONLY MCC



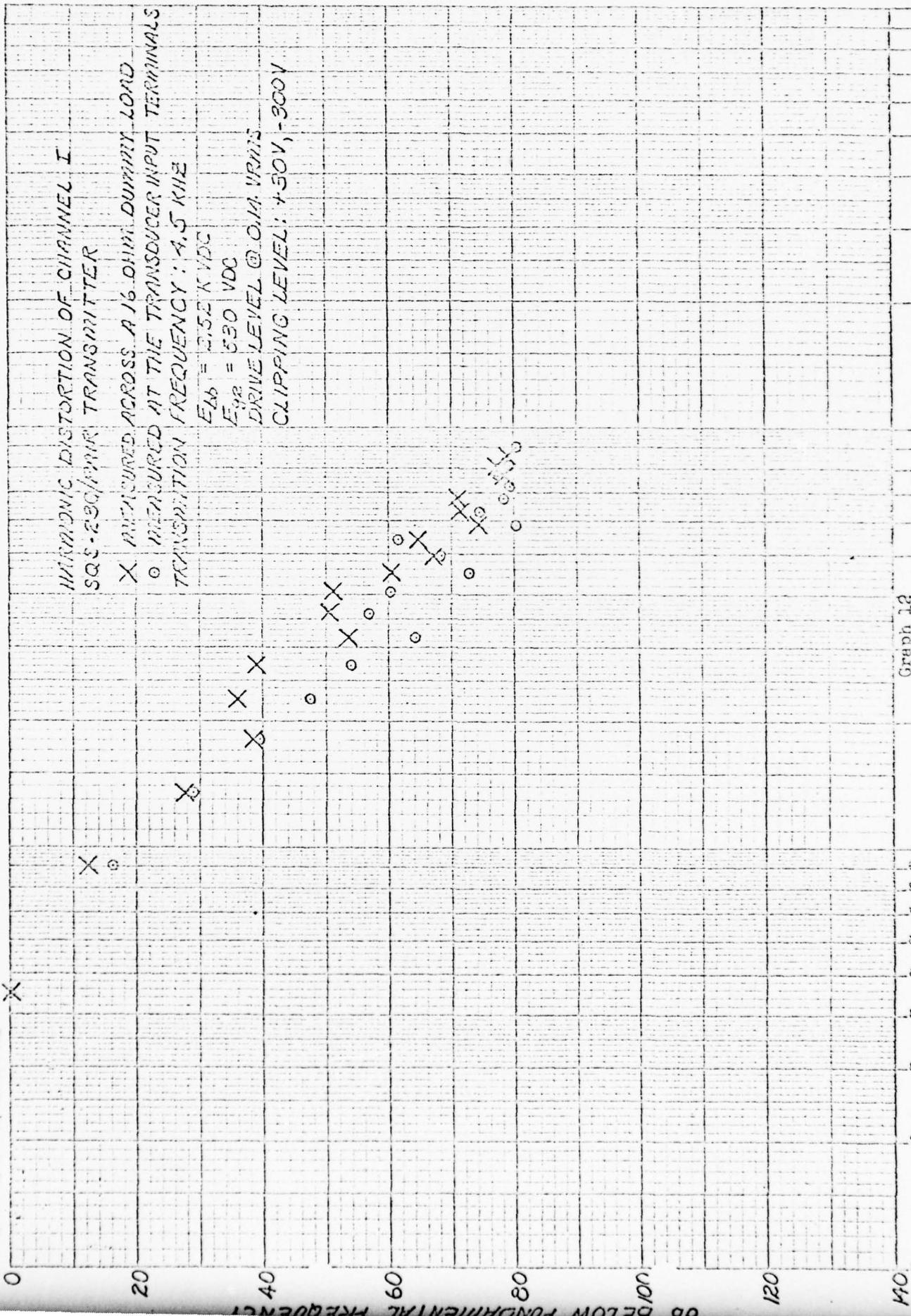


Graph 13
FREQUENCY (kHz)
 10^0 10^1 10^2

RECORDED BY GAGE CO.
RECORDED BY GAGE CO.
20 WATT COUPLED
40 PFM COUPLED



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Graph 12
FREQUENCY (KHZ)

CONFIDENCIAL
X CLIPPING LEVEL
○ MEASURED

CONFIDENCIAL

CONFIDENCIAL

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100

80

60

TOTAL
IMPEDANCE
VARIATION

40

20

0

-20

0

-20

-40

-60

TOTAL
PHASE
ANGLE
VARIATION

-80

-100

20

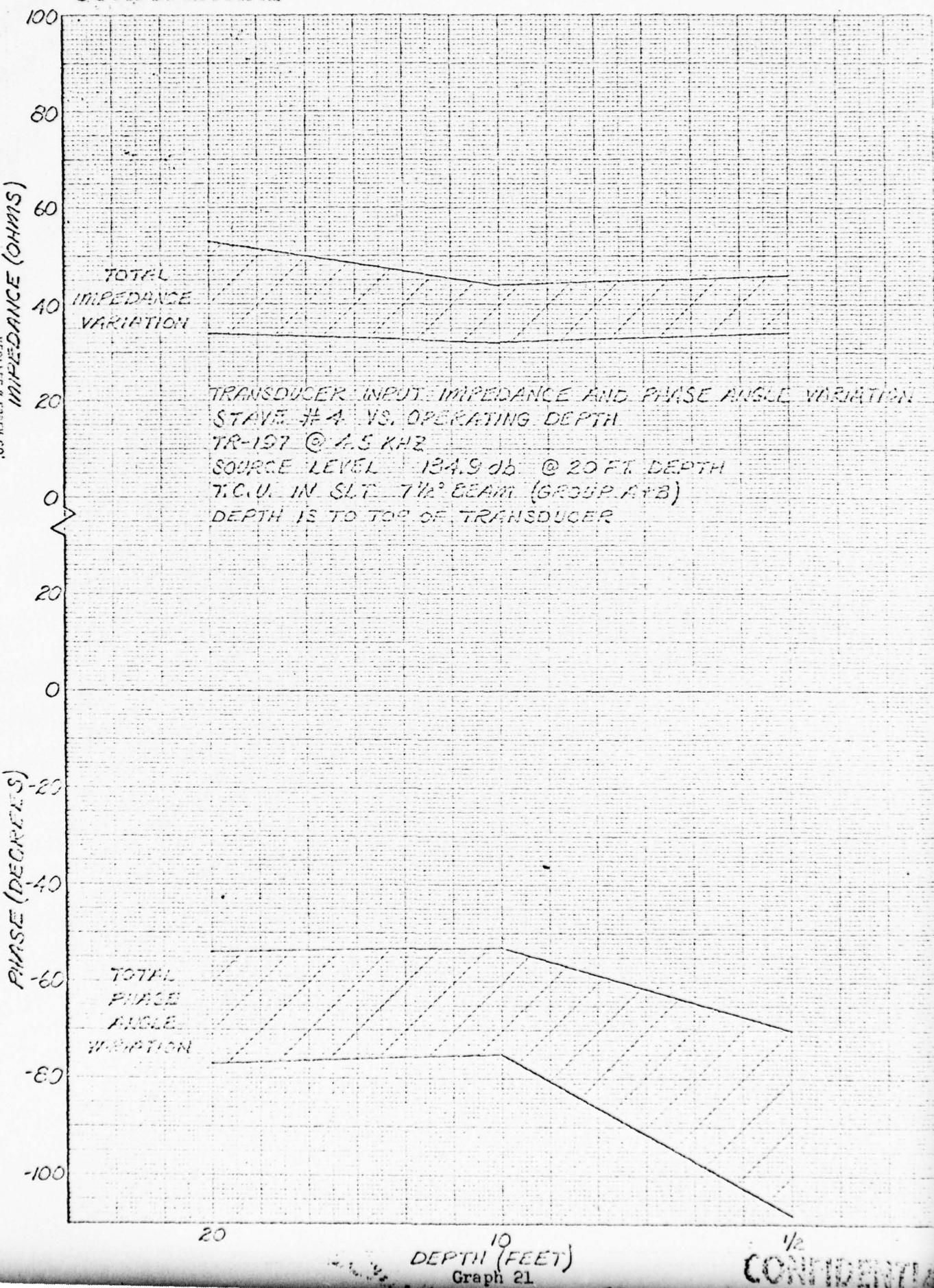
10

DEPTH (FEET)
Graph 20

1/2

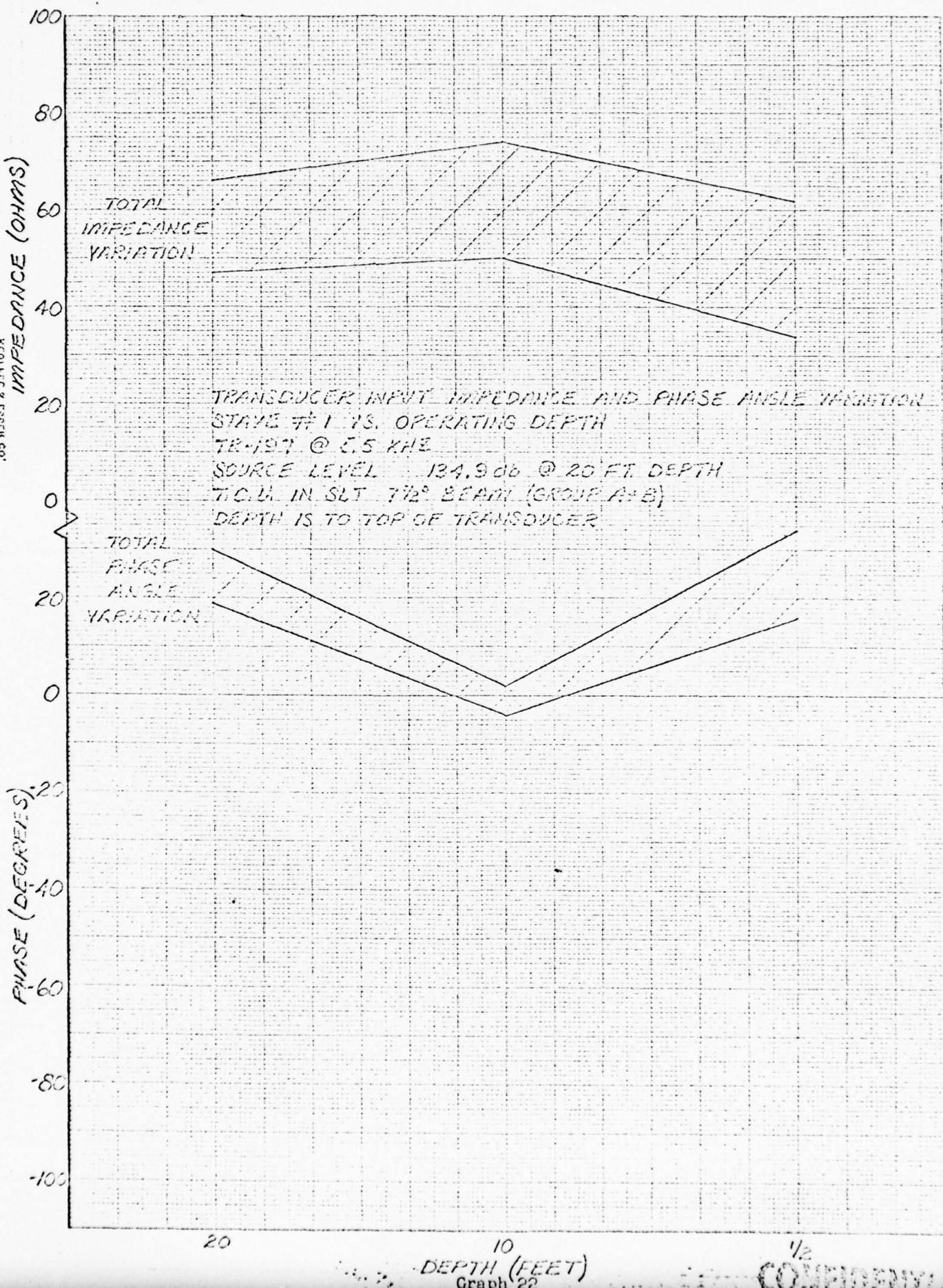
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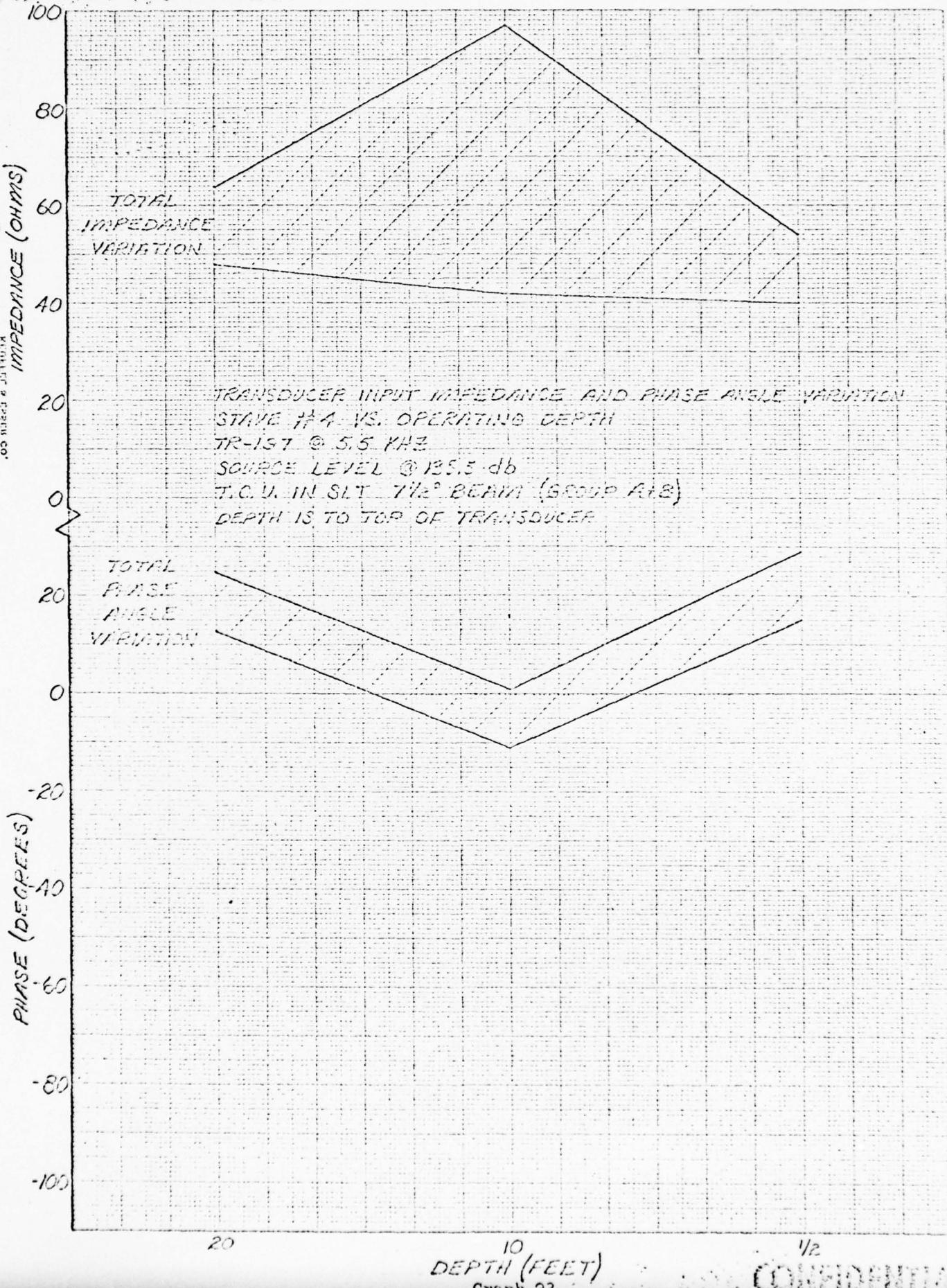
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10 X 10 TO 100 GRADUATED 40-121A

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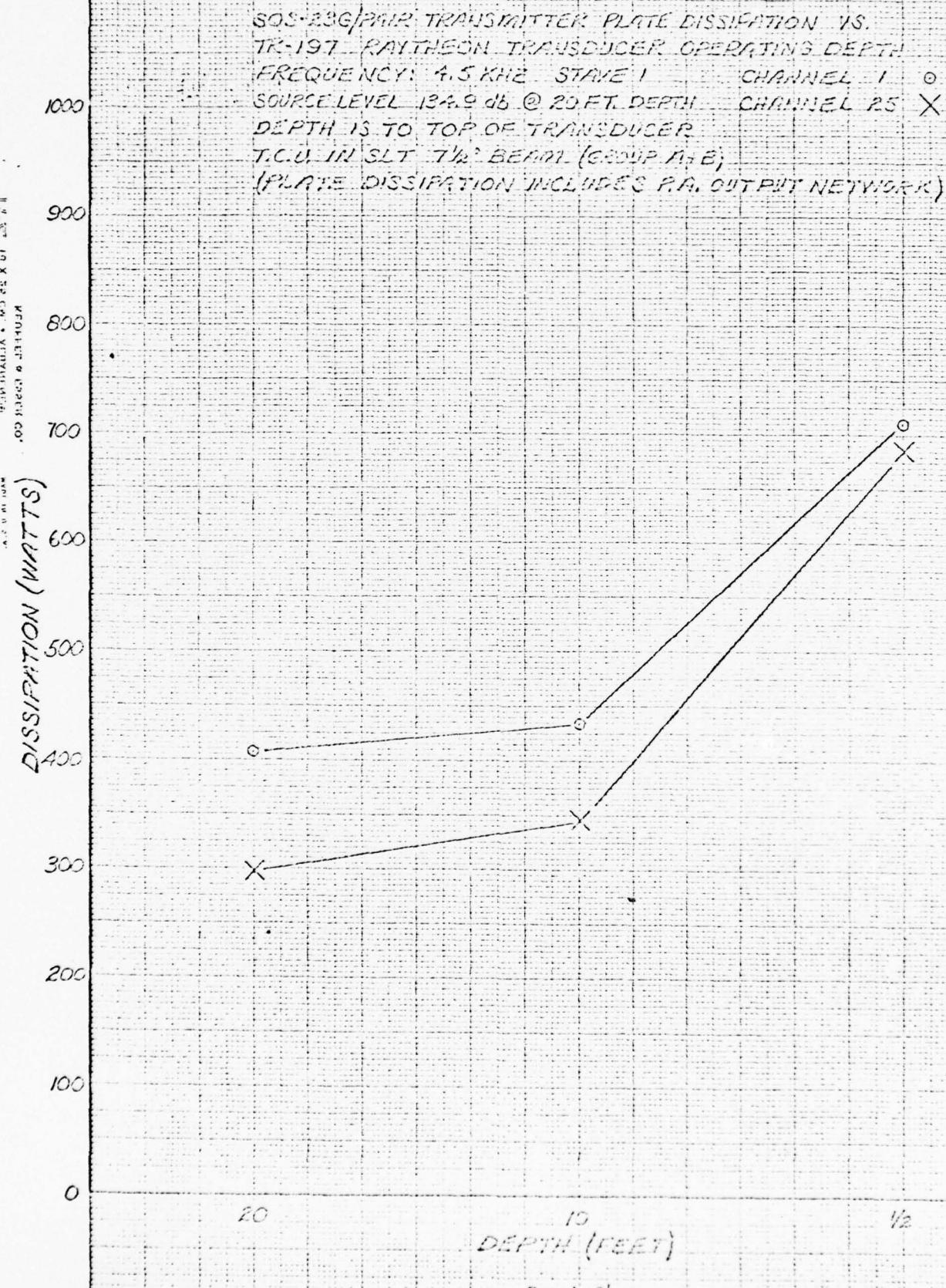
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10 X 1000 THE FOLLOWING INFORMATION
IS FOR THE USE OF THE GOVERNMENT
ONLY AND IS UNCLASSIFIED.



Graph 24

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SQS-23G /PAIR TRANSMITTER PLATE DISSIPATION VS.
TR-197 RAYTHEON TRANSDUCER OPERATING DEPTH
FREQUENCY 14.5 KHZ STAVE A CHANNEL A O
SOURCE LEVEL 134.5 dB @ 60FT. DEPTH CHANNEL 2S X
DEPTH IS TO TOP OF TRANSDUCER
T.C.U. IN SLT. 7 $\frac{1}{2}$ ° BEAMIN (GROUP A+E)
(PLATE DISSIPATION INCLUDES PA OUTPUT NETWORK)

~~CONFIDENTIAL~~
KODAK SAFETY FILM
IN VARIOUS SIZES
10X10 TO THE CENTIMETER
SIXTY FIVE

DISSIPATION (WATTS)

1000

900

800

700

600

500

400

300

200

100

0

20

10

½

DEPTH (FEET)

Graph 25

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SQS-23S /PAIR TRANSMITTER PLATE DISSIPATION VS.
TR-197 RAYTHEON TRANSDUCER OPERATING DEPTH
FREQUENCY: 5.5 KHZ STAYE I CHANNEL 1 O
SOURCE LEVEL 135.5 dB @ 20 FT. DEPTH CHANNEL 25 X
DEPTH IS TO TOP OF TRANSDUCER
T.C.U. IN SLT 7½° BEAM (GROUP A+E)
(PLATE DISSIPATION INCLUDES P.A. OUTPUT NETWORK)

1000

900

800

700

600

500

400

300

200

100

0

(SLT/mm) NO CONSIDERATION

20

10

42

DEPTH (FEET)

Graph 26

REEDER & CO.
IN X 50 C/W • VENOMATIC
WIRE WIRELESS
10 X 10 IN IN THE CIRCUIT

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SG-3-225/PAIR TRANSMITTER PLATE DISSIPATION VS
TR-157 RAYTHEON TRANSDUCER OPERATING DEPTH
FREQUENCY: 5.5 KHZ STAGE 4 CHANNEL 4 O
SOURCE LEVEL 125.5 db @ 20 FT. DEPTH CHANNEL 23 X
DEPTH IS TO TOP OF TRANSDUCER.
T.C.D. IN SLT 7½° BEAM (GROUP AHB)
(PLATE DISSIPATION INCLUDES P.A. OUTPUT NETWORK)

1962 10 X 12 CM • 4.75 X 4.75 IN. ON THE GRID
VITEL CO. READER & EXCHG CO.

DISSIPATION (WATTS)

1000

900

800

700

600

500

400

300

200

100

0

20

10

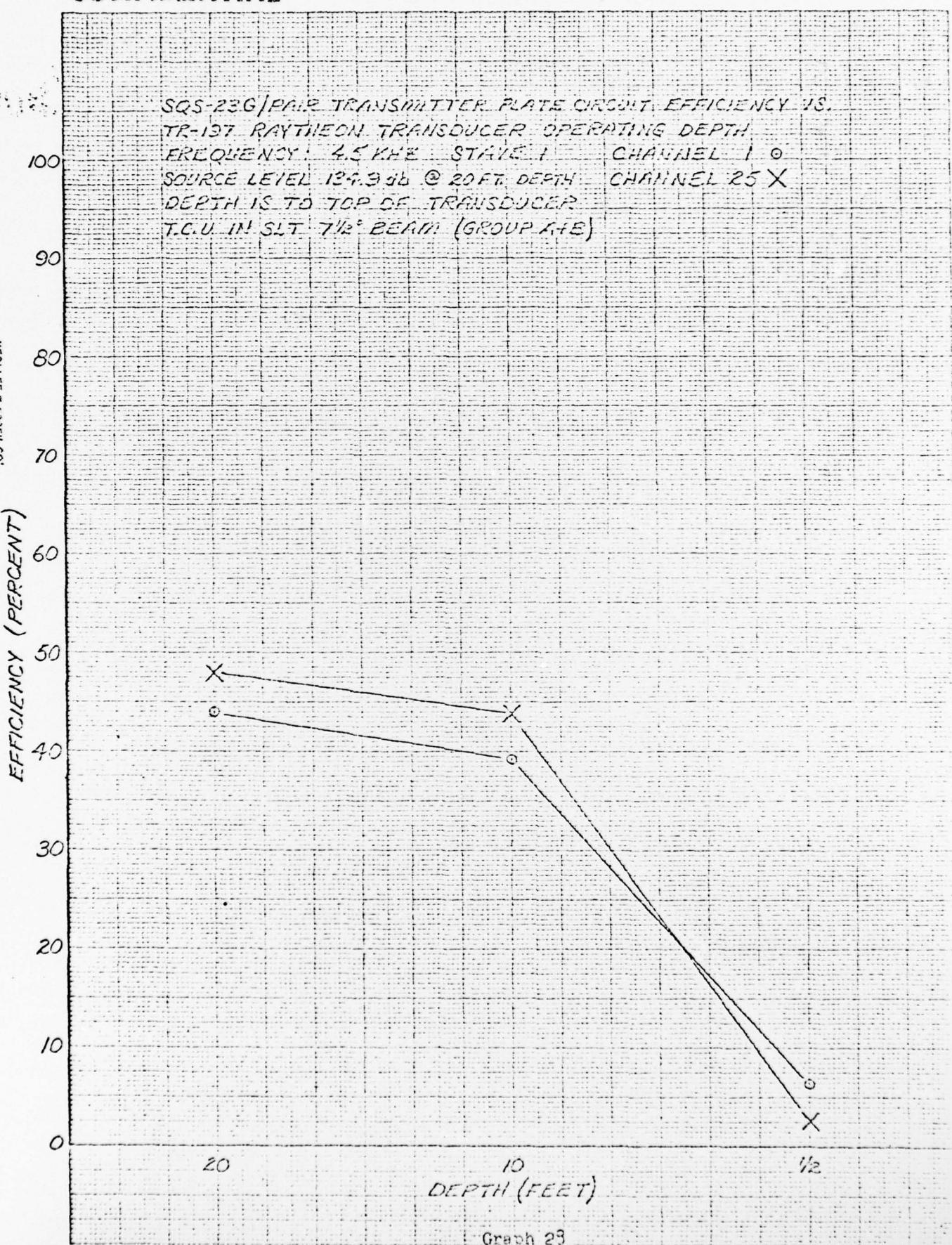
42

DEPTH (FEET)

Graph 27

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Graph 23

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SQS-23G/PAIR TRANSMITTER PLATE CIRCUIT EFFICIENCY VS.
TR-197 RAYTHEON TRANSMITTER OPERATING DEPTH
FREQUENCY: 4.5 KHZ STAVE 4 CHANNEL 4 O
SOURCE LEVEL 131.9 dB @ 20FT. DEPTH CHANNEL 28 X
DEPTH IS TO TOP OF TRANSDUCER
T.C.U. IN SLT 7½° BEAM (GROUP A+E)

100

90

80

70

60

50

40

30

20

10

0

EFFICIENCY (PERCENT)

20

10

4

DEPTH (FEET)

Graph 29.

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SQS-23G/PAIR TRANSMITTER PLATE CIRCUIT EFFICIENCY VS.
TR-197 RAYTHEON TRANSDUCER OPERATING DEPTH
FREQUENCY: 5.5 KHZ STAVE 1 CHANNEL 1 O
SOURCE LEVEL 125.5 dB @ 20 FT. DEPTH CHANNEL 25 X
DEPTH IS TO TOP OF TRANSDUCER
T.C.U. IN SLT 7½° BEAM? (GROUP A+B)

1942-1952 100 YEARS OF THE CENTENNIAL
WILLIAM & ELLIOTT CO., INC.
1912

EFFICIENCY (PERCENT)

100
90
80
70
60
50
40
30
20
10
0

20

10

1½

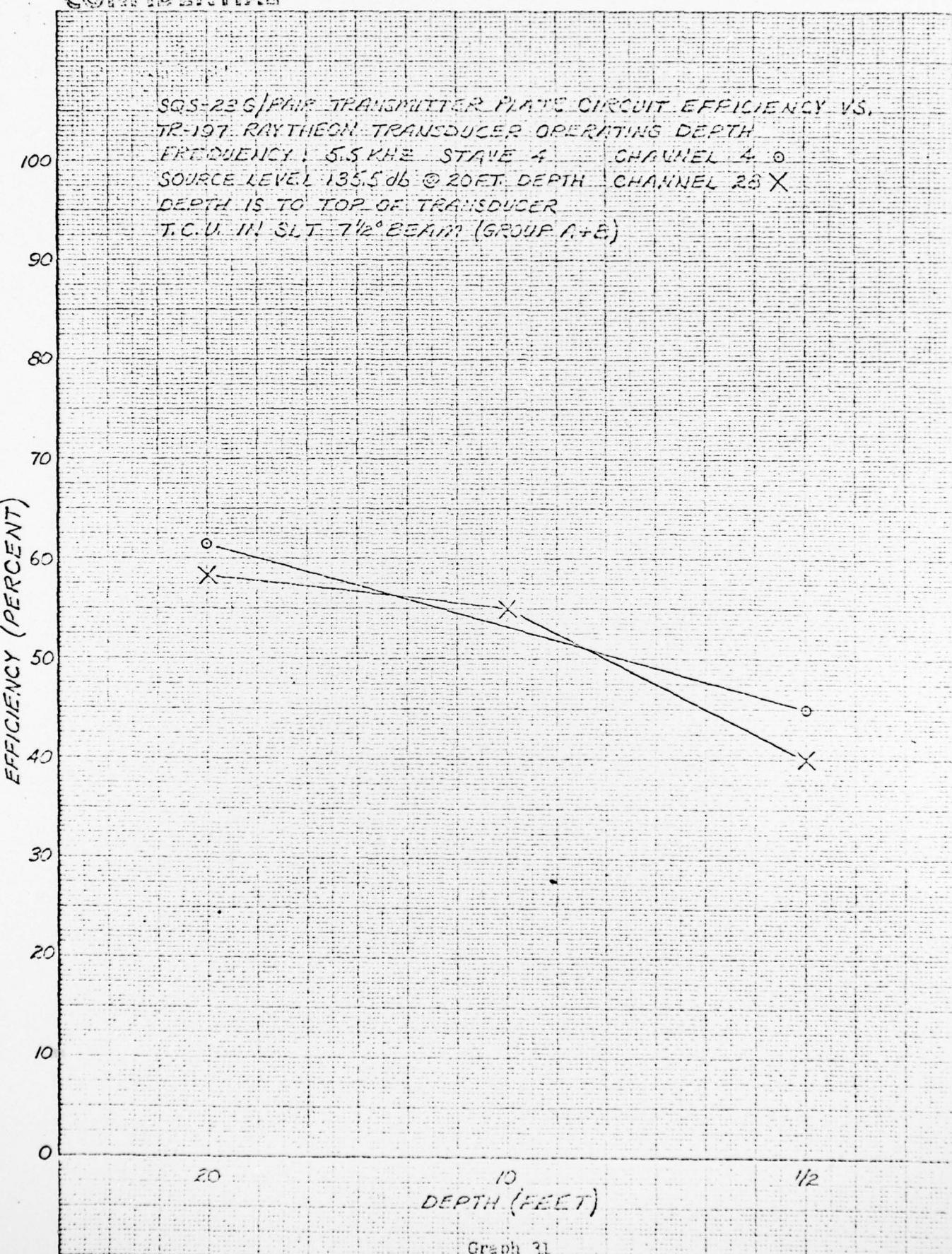
DEPTH (FEET)

Graph 30

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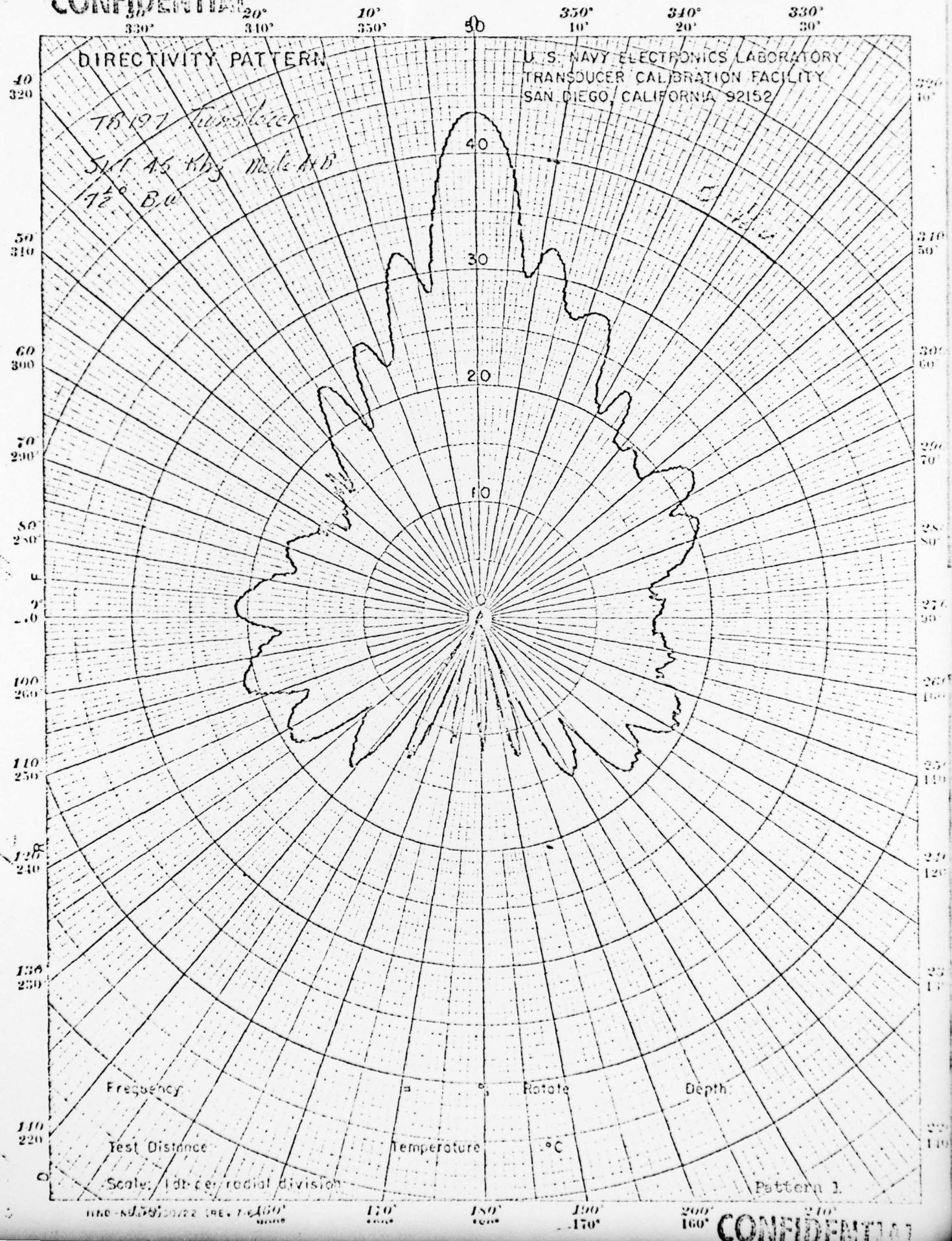
STANDBY
10 X 3 CM GRIDLINE
KODAK SAFETY FILM
KODAK SAFETY FILM



Graph 31

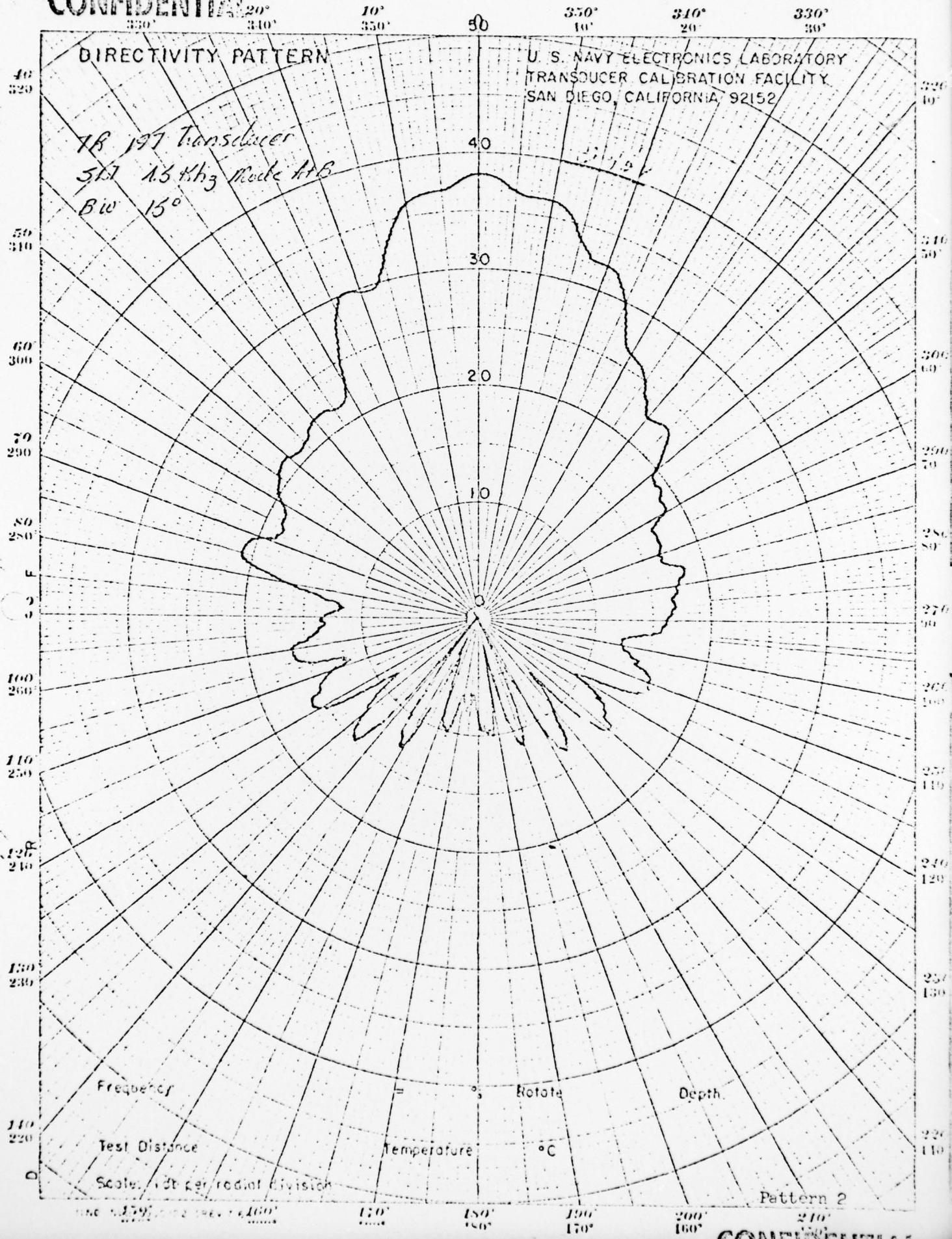
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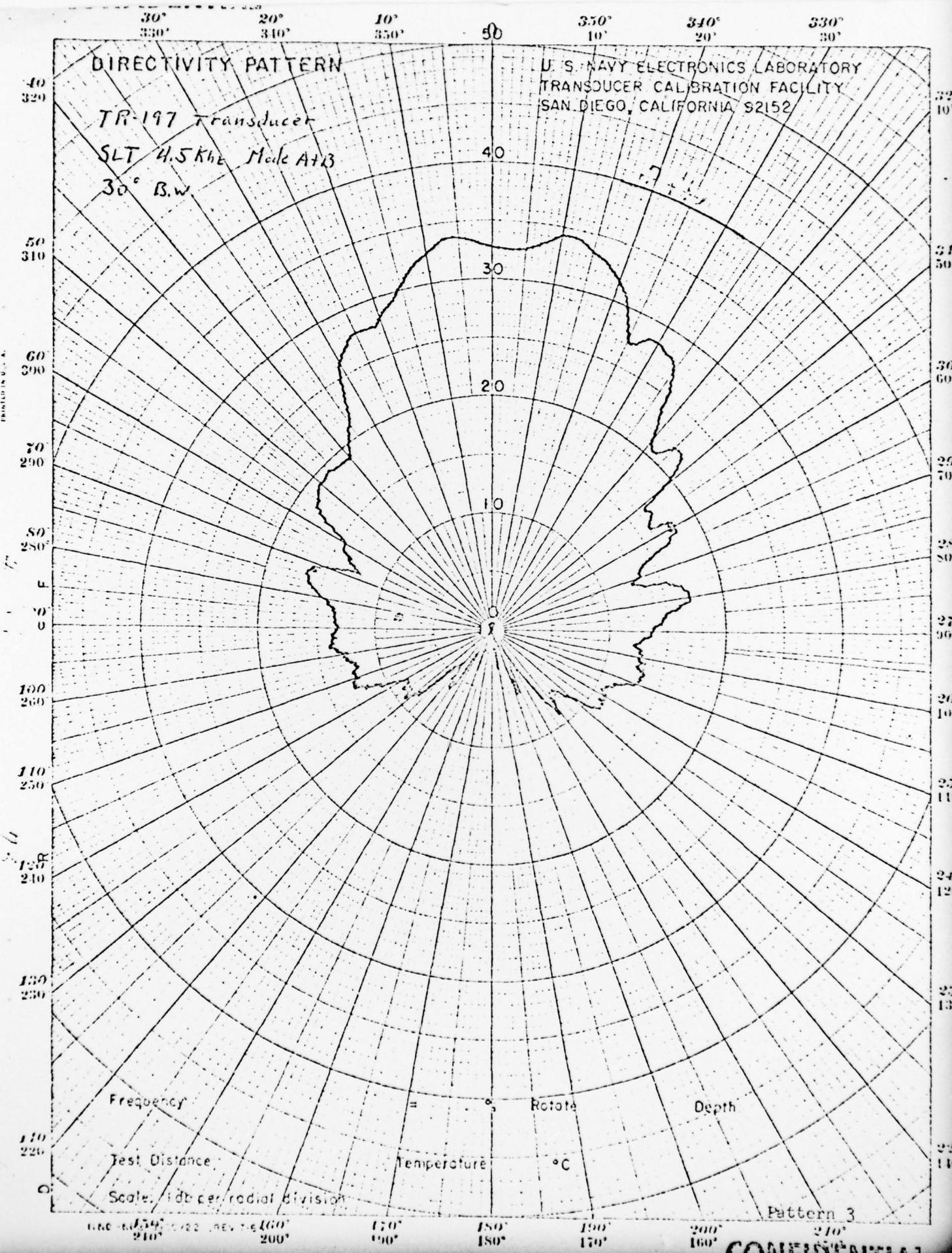


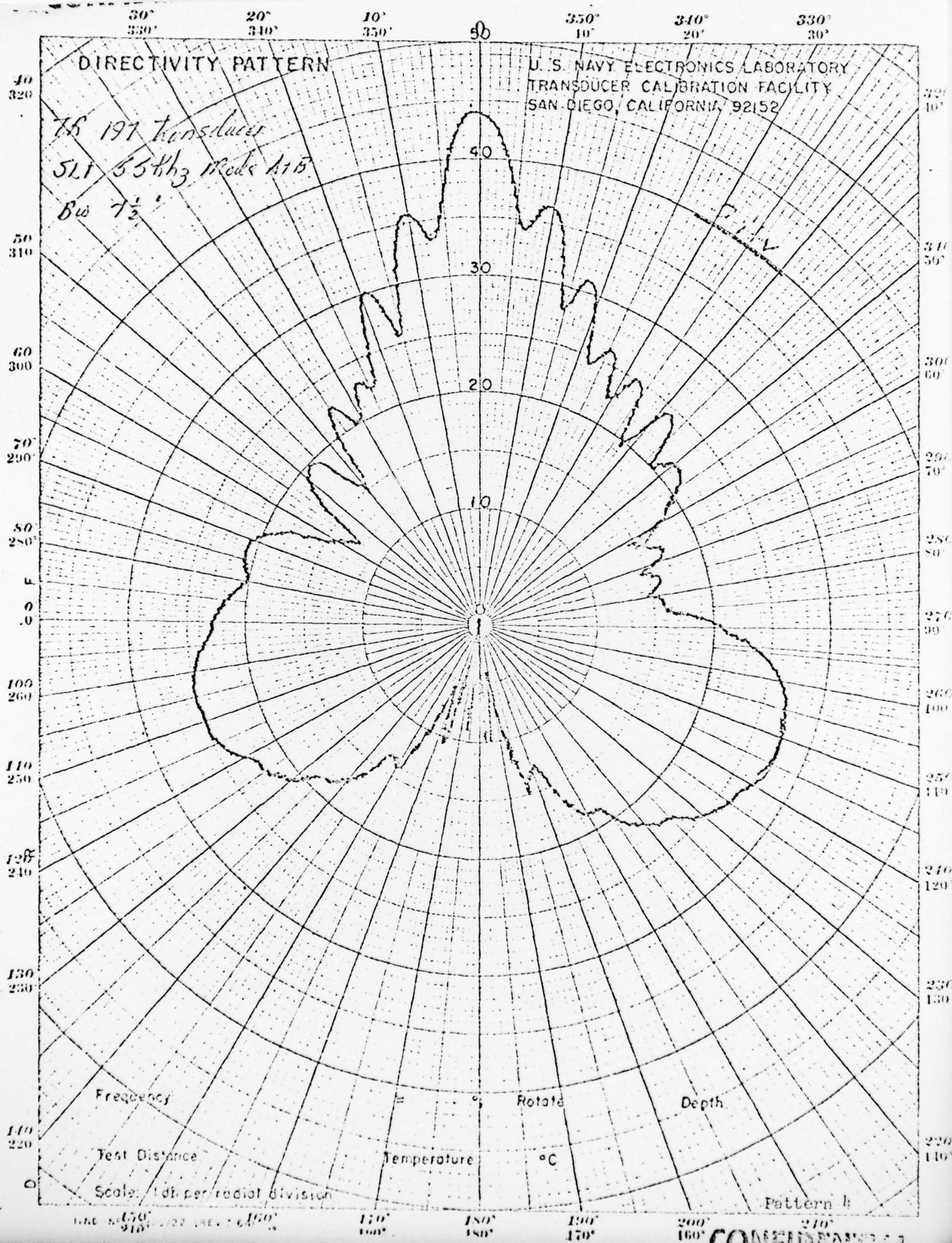
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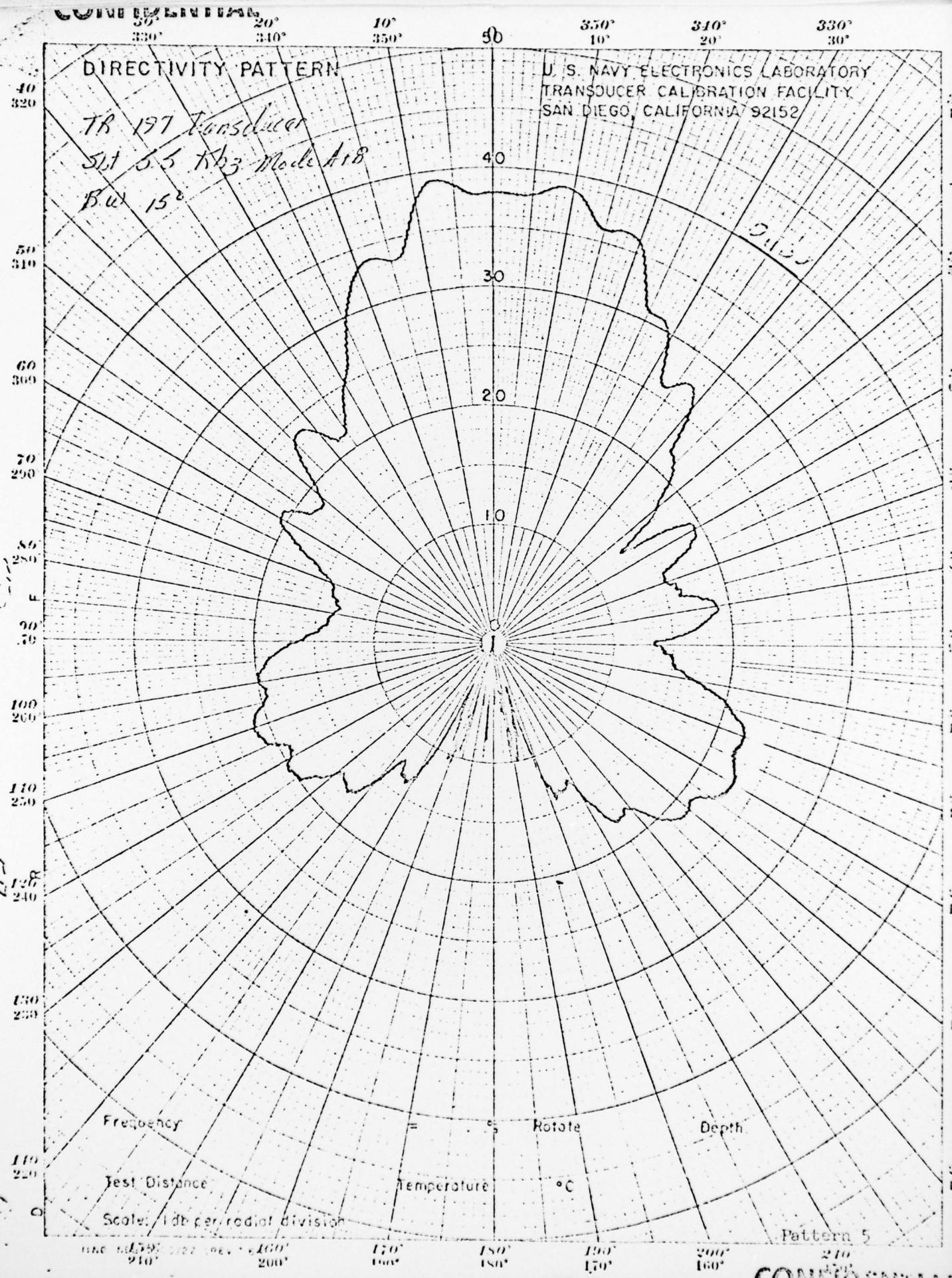


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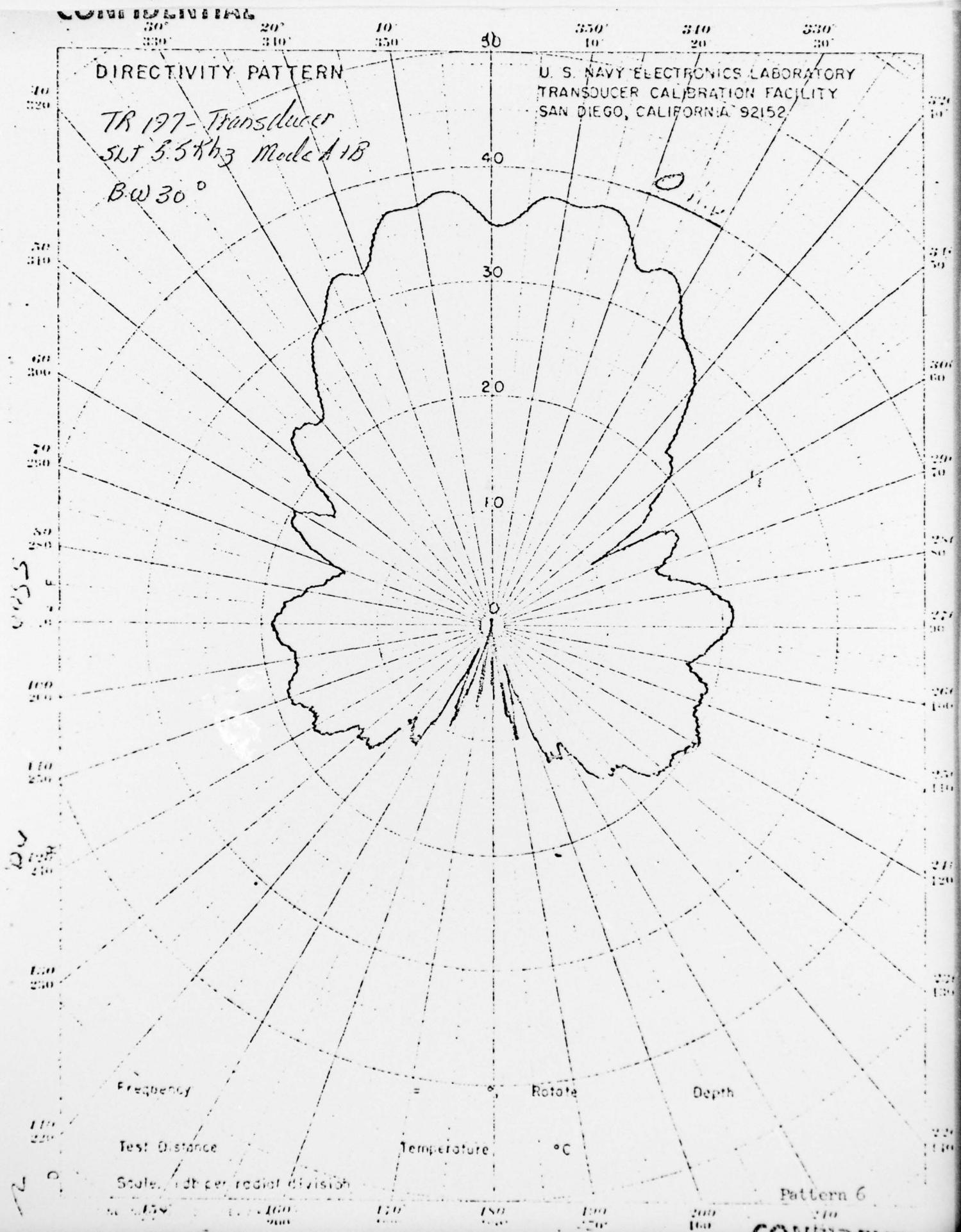




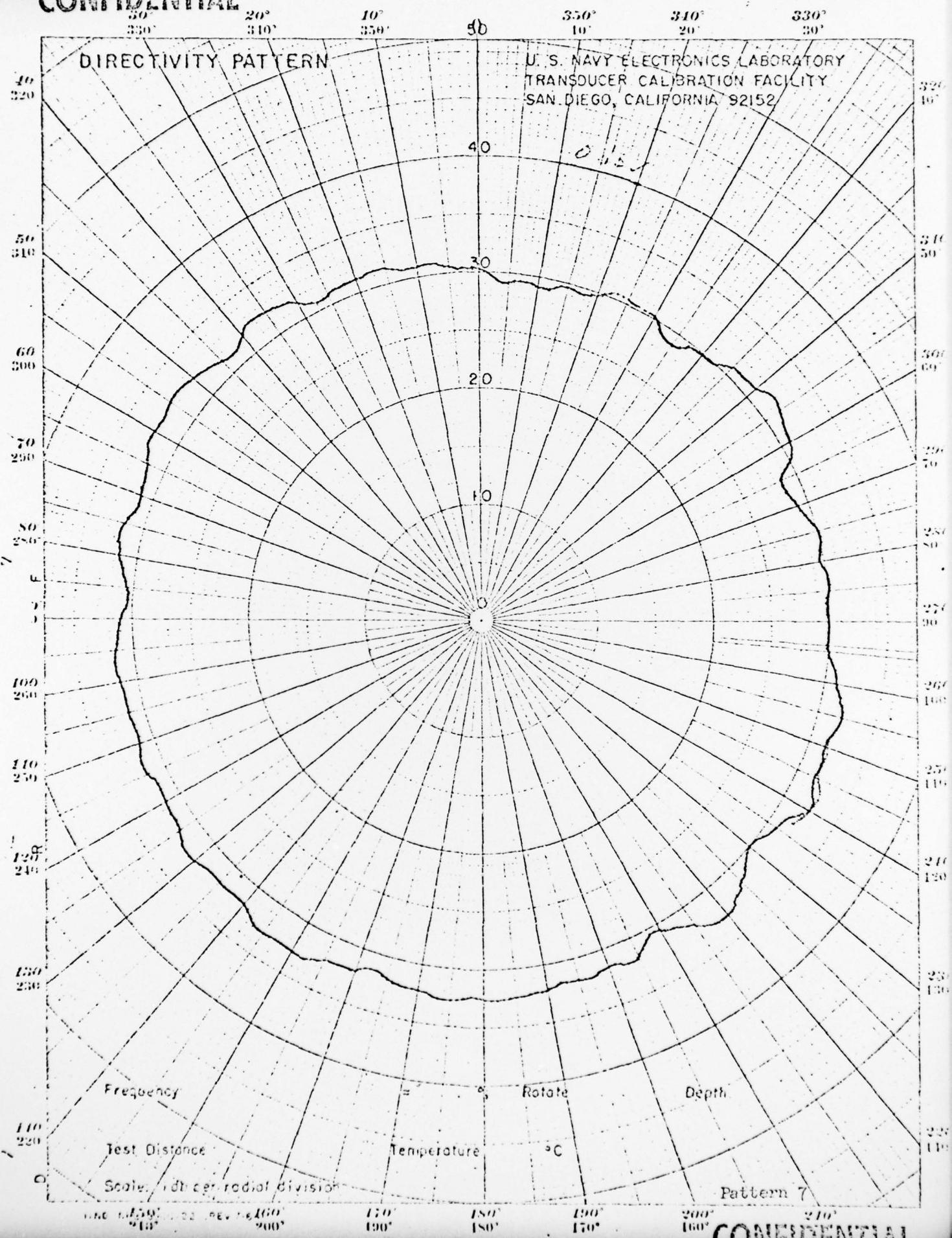
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