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24 July 1944

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NAVY DEPARTMENT

Report on

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DECLASSIFIED

ANTENNA PATTERN MEASUREMENTS ON USS WASATCH (AGC-9)

[redacted]

Distribution Unlimited

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON 20, D. C.

Approved for Public Release

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Approved by: _____
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Director

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BuShips (5)
Cominch (Readiness)(1)
CNO (Op-20-E)(1)
CO,USS **Wasatch (1)**
NRSL(1)
RadLab, MIT(1)

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UNCLASSIFIED
"R" Report 3085
April 1947

agm

DECLASSIFIED

INTRODUCTION

ANTENNA PATTERN MEASUREMENTS ON USS WASATCH (AGC-9)

0-1 CNO Speedletter Serial 0230620 of 17 May 1944 requested that pattern measurements be made on all antennas of AGC class ships. AGC-9, the USS WASATCH, was made available for pattern measurements off the Chesapeake Bay Annex of the Naval Research Laboratory on 9-10 June 1944.

0-2. Pattern measurements were made on all communication antennas, SK-2, BM, forward BN, YG-1, SG's, and SQ antennas. These patterns show the relative coverage afforded by each antenna versus relative ship's heading.

0-3 This report is divided into three sections. Section 1 deals with the pattern measurements of the communication antennas. Section 2 gives the results of measurements on the SK-2, BM, forward BN, and YG-1 antennas, while Section 3 gives the coverage patterns of the two SG and the SQ antennas.

0-4 Summary of Conclusions:

0-4-1. Some of the HF communication antenna patterns show large dips in certain directions. It is anticipated that a study of the patterns made on ships of this class will lead to specific recommendations for improving these patterns.

0-4-2. The coverage of the SK-2 and the BM are similar and quite uniform. The diagrams of the BN and BK antennas are very ragged. It seems that better performance would be obtained with one BN and one BK on each side of the ship, rather than with both BN's on one side and both BK's on the other.

0-4-3. The two SG's provide excellent composite coverage over all headings. The portable SQ equipment may be expected to have blind spots in its coverage in directions where the beam shoots through the ship's superstructure.

[redacted]

COMMUNICATION ANTENNA PATTERNS

Enclosures: (A) Tables I and II
(B) 46 Plates of Radiation Patterns

1-1 Abstract

1-1-1 On 9 June 1944 the USS WASATCH was made available to a task group of Laboratory engineers for the purpose of determining the directional characteristics of various transmitting and receiving antennas. Groups of 6 transmitting antennas were measured simultaneously with separate receiver-recorder systems set up on shore. Field intensity readings of most transmitters were made later at a more suitable location. These tests were similar to those made on somewhat different frequencies for the USS MOUNT McKINLEY on 26/29 May, 1944, which have been reported in NRL Report R-2312. It is expected that a study of the patterns obtained from several ships of the same class will lead to pertinent recommendations for improving the overall communication efficiency.

1-2 Discussion

1-2-1 The schedules shown in enclosure (A) were arranged with the ship's force prior to the arrival of the ship at the test location. The receiver used for each test is designated in the first column of these schedules. All receivers were arranged to operate recorders so that a continuous record could be obtained during the tests. The equipments were set up on the second floor of building #5 at CBA. The patterns for the receiving antennas were obtained by exciting the antennas with low power transmitters aboard ship.

1-2-2 The ship was swung in circles of approximately one-half mile diameter around a boat anchored as a marker buoy at a distance of about four and one-half miles east of the receiver location. Relative bearings of the test locations from the ship's headings were given by the ship every 30 degrees over the auxiliary communication channel and the locked-key transmissions of the transmitters under test were simultaneously broken momentarily. Radar plots of the ship were also made from building #1 at CBA in the event that poor visibility should prevent giving relative bearings from the ship. The

ship's headings as shown on the plots are believed to be accurate within plus or minus 3 degrees.

1-2-3 The receiver-recorder equipments were calibrated with signal generators to determine the correct intensity values for various recorder scale readings. Absolute values of field intensity for the transmitter-antenna tests were made at a point about 200 feet south of the Naval Boat Dock at Chesapeake Beach, Md. The ship was at anchor at a point 3 miles distance and bearing 100 degrees from the dock. The intensities measured for several of the transmitters appear to be low. It is not known whether this is a correct reading or whether some error occurred in the measurement. The work was performed in a hurried manner and chances for errors are numerous, especially when so many transmitters are operated simultaneously.

1-2-4 No information was available on the numbering scheme of the BC antennas on the yardarm. The numbers given in the schedule refer to the numbers on the antenna terminal board in Radio I.

1-2-5 No attempt has been made to correlate or analyze the data obtained. It is expected that a study of the patterns from several ships of the same class will lead to pertinent recommendations for improving the overall communication possibilities.

[redacted]

TABLE 1

Schedule 1 - Transmitting Antenna Tests

Equip	Channel	Test 1	Test 2	Test 3	Test 4
NC200	A	TCS 15 2040 Kc	TBL 18 2226 Kc	TBK 2* 2310 Kc	TBL 9* 2530 Kc
32B	B	TCS 10 2940 Kc	TCS 17 2980 Kc	TDE 6 3184 Kc	TBK 4 3270 Kc
OF 41	C	TCS 13 3475 Kc	TCS 16 3510 Kc	TBK 3* 3650 Kc	TDE 7 3780 Kc
308A	D	TCS 11 4010 Kc	TDE 5* 5450 Kc	TBL 8* 5640 Kc	TBA 1 6300 Kc
308A	E	TCS 14 8000 Kc	TBL 20 9500 Kc	TDE 10* 12000 Kc	TBM 9 12000 Kc
58	F	BC 1 140.6 Mc	BC 2 116.1[x] Mc	BC 3 116.1 Mc	BC 4 142.02 Mc

Notes:
[x]Signal failed to come up on Test 2F
*Indicates transmitter located in Radio 3

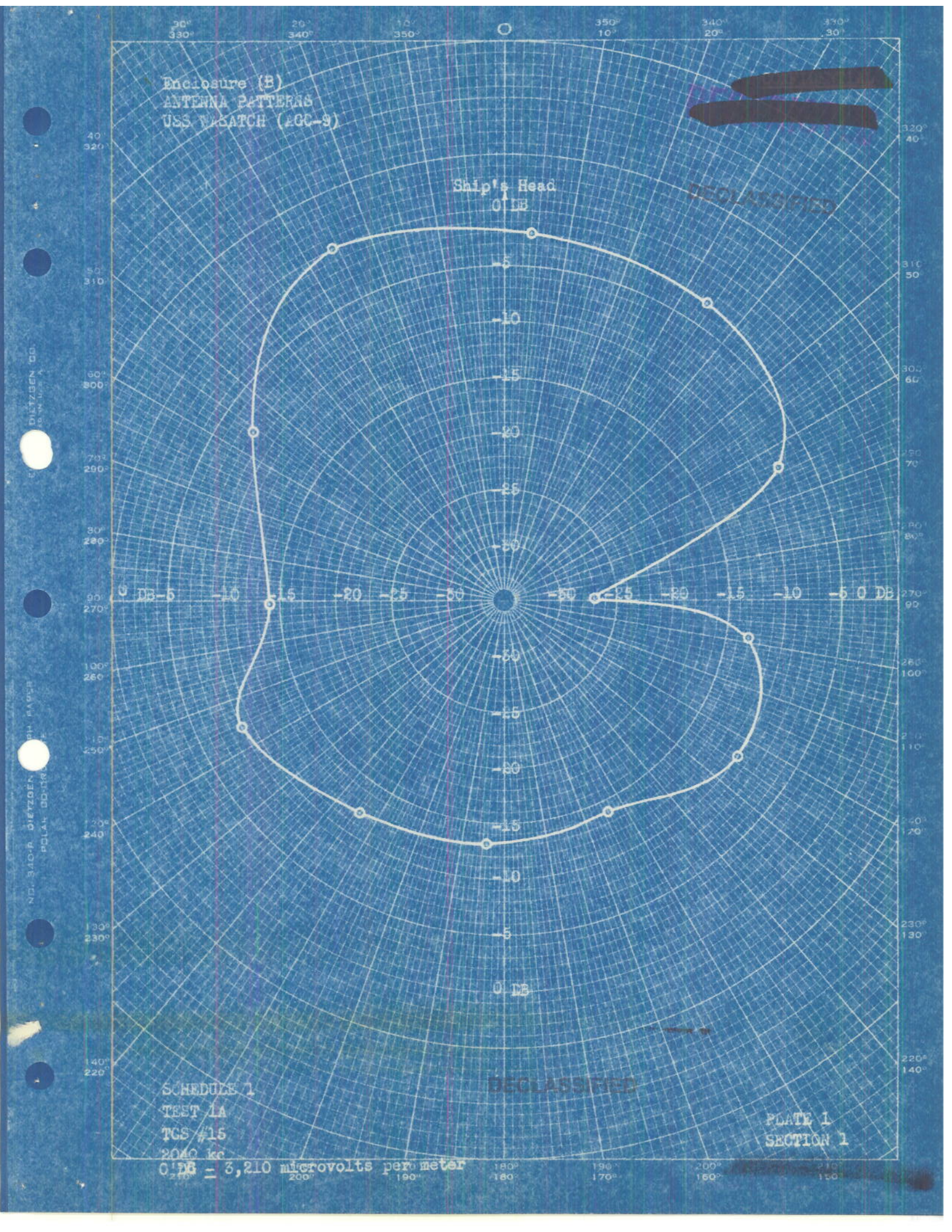
TABLE 2

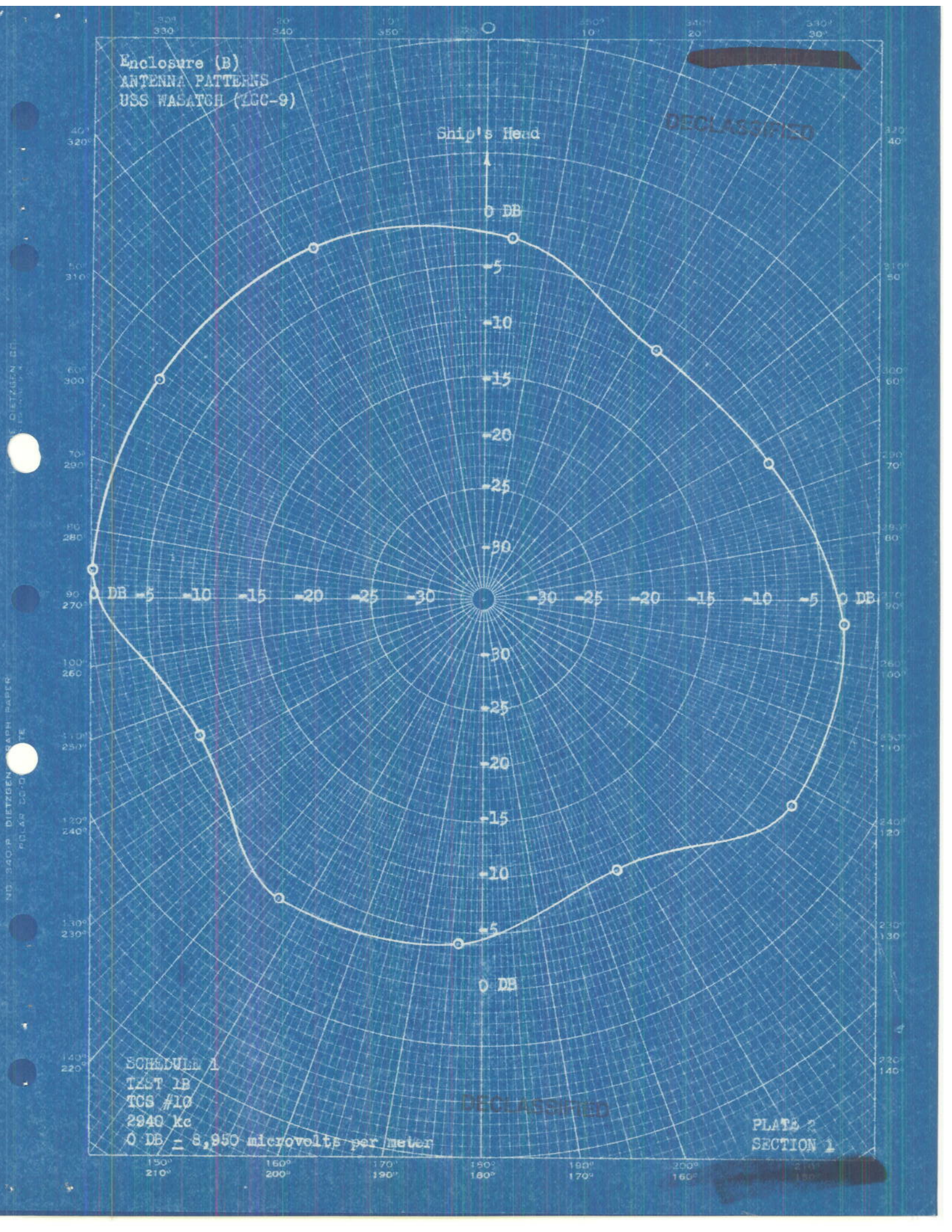
Schedule 2 - Receiving Antenna Tests

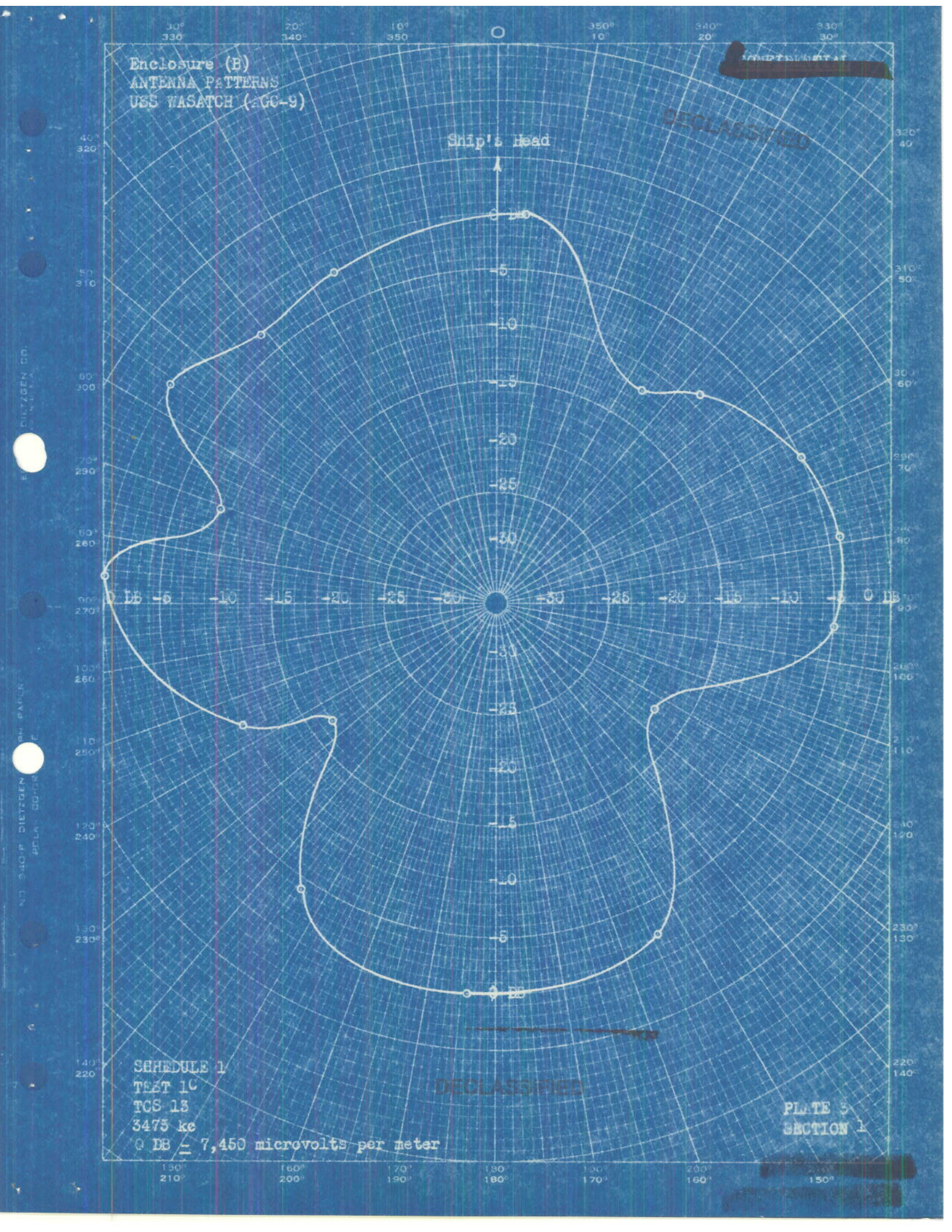
Equip	Channel	Test 1	Test 2	Test 3	Test 4	Test 5
32 B	A	Ant 1 2310 Kc	Ant 2	Ant 3 same	Ant 4	Ant 5
OF	B	Ant 6 5400 Kc	Ant 7	Ant 8 same	Ant 9	Ant 10
308A	C	Ant 11 7000 Kc	Ant 12	Ant 13 same	Ant 14	Ant 15
308A	D	Ant 16 12000 Kc	Ant 17	Ant 18 same	Ant 19	Ant 20
58	E	BC 5 142 Mc	SCR Port 24 Mc[x]	SCR Stbd 27.9 Mc	TBS Fwd. 72.5 Mc	

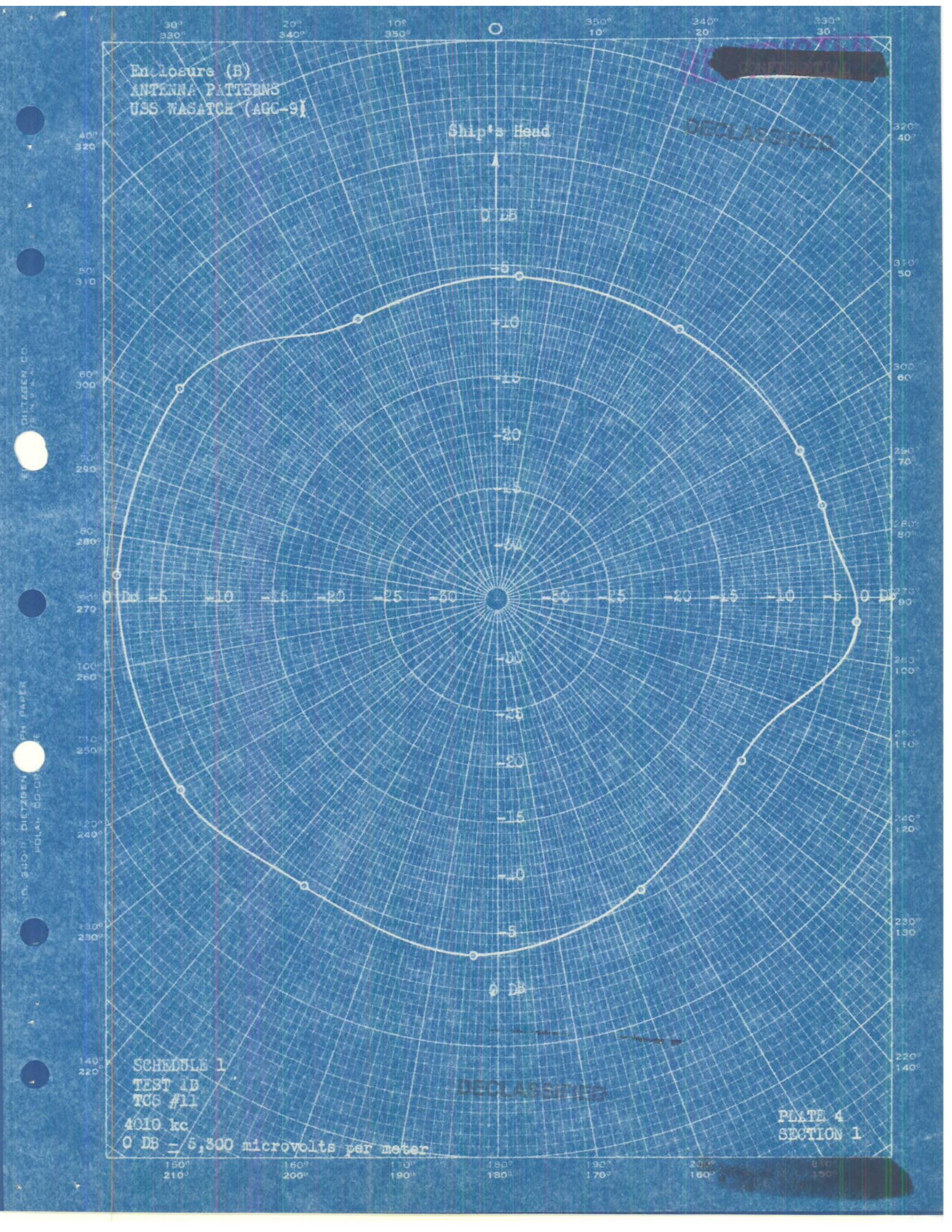
Note:
[x]Signal failed to come up on Test 2E

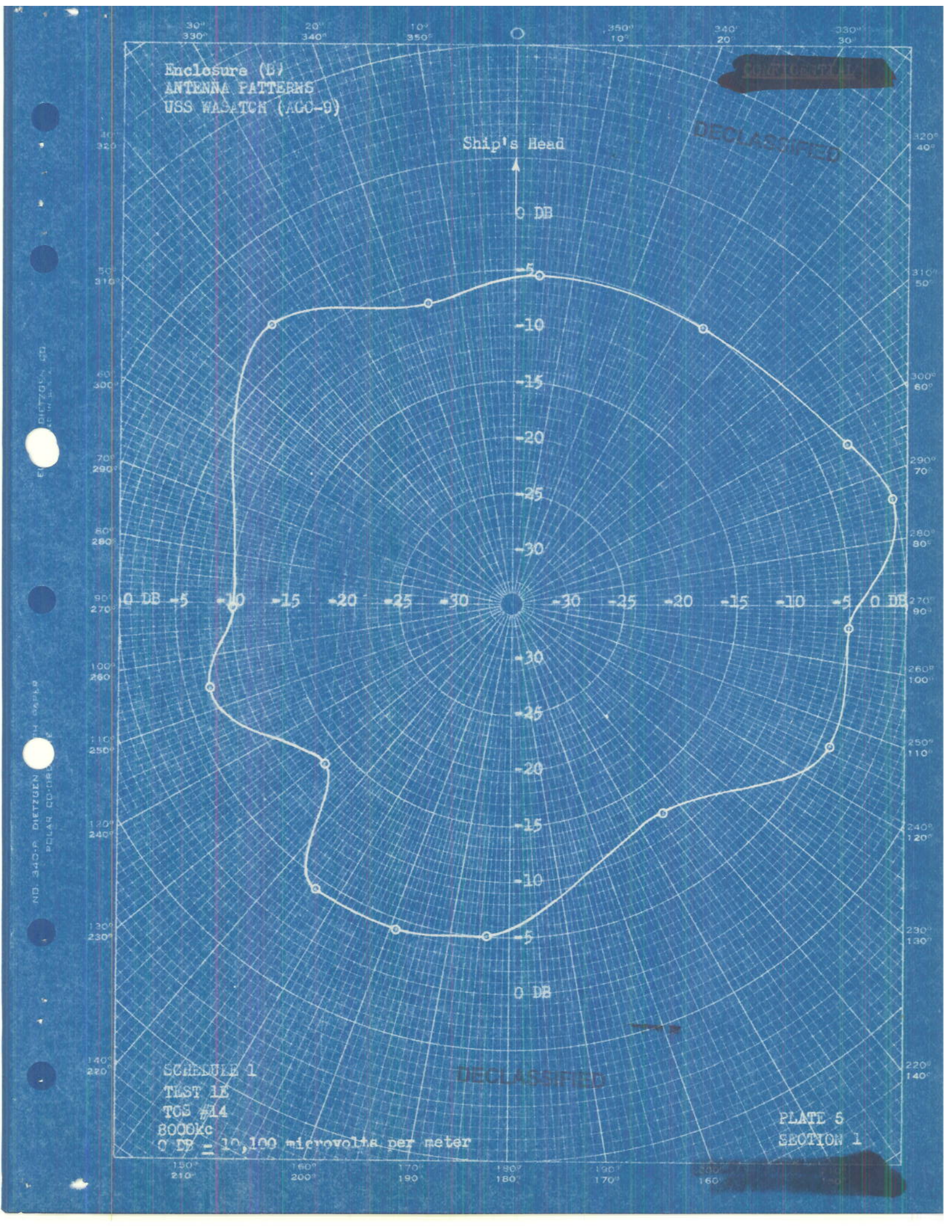
Schedule 3 - Field Intensity Tests
(Repeat of Schedule 1)

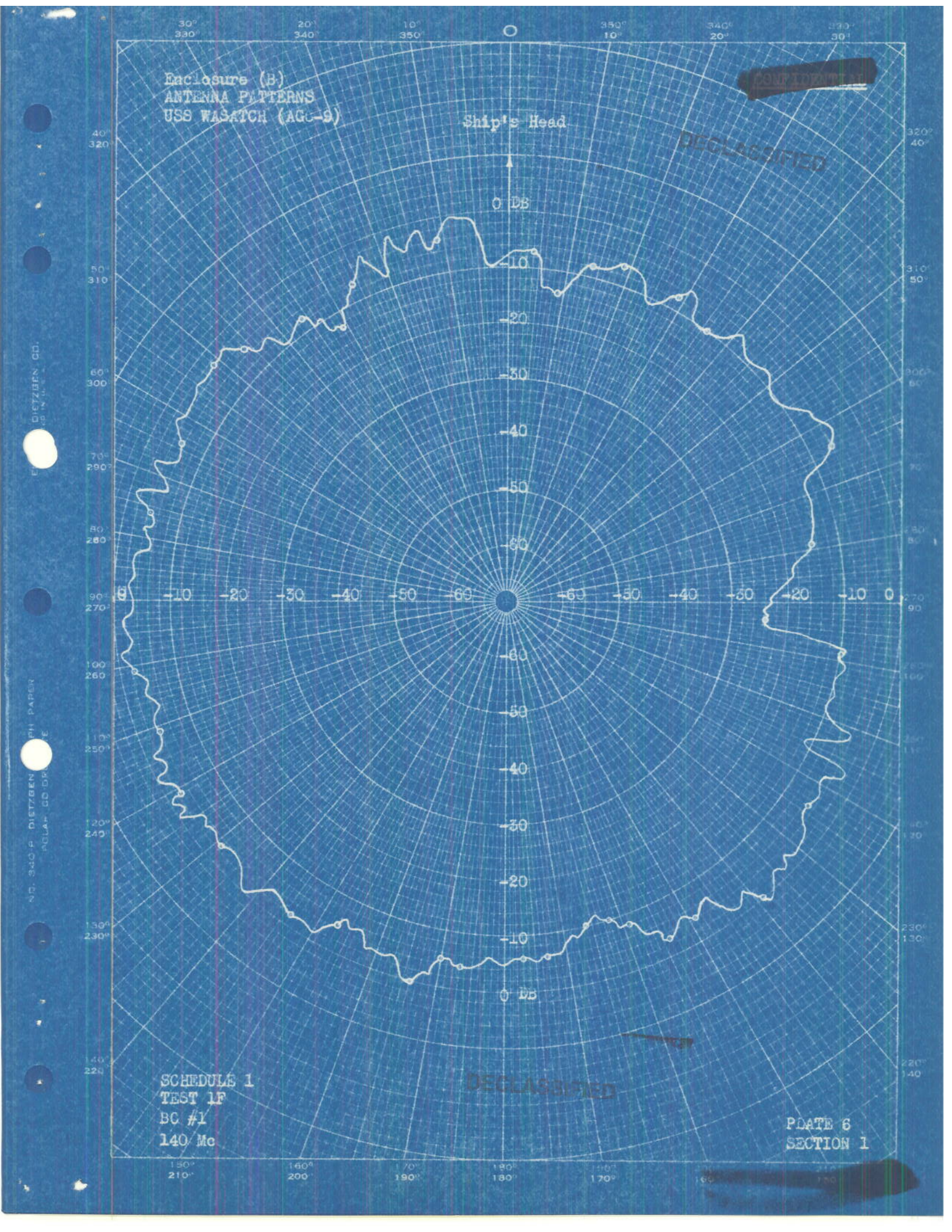


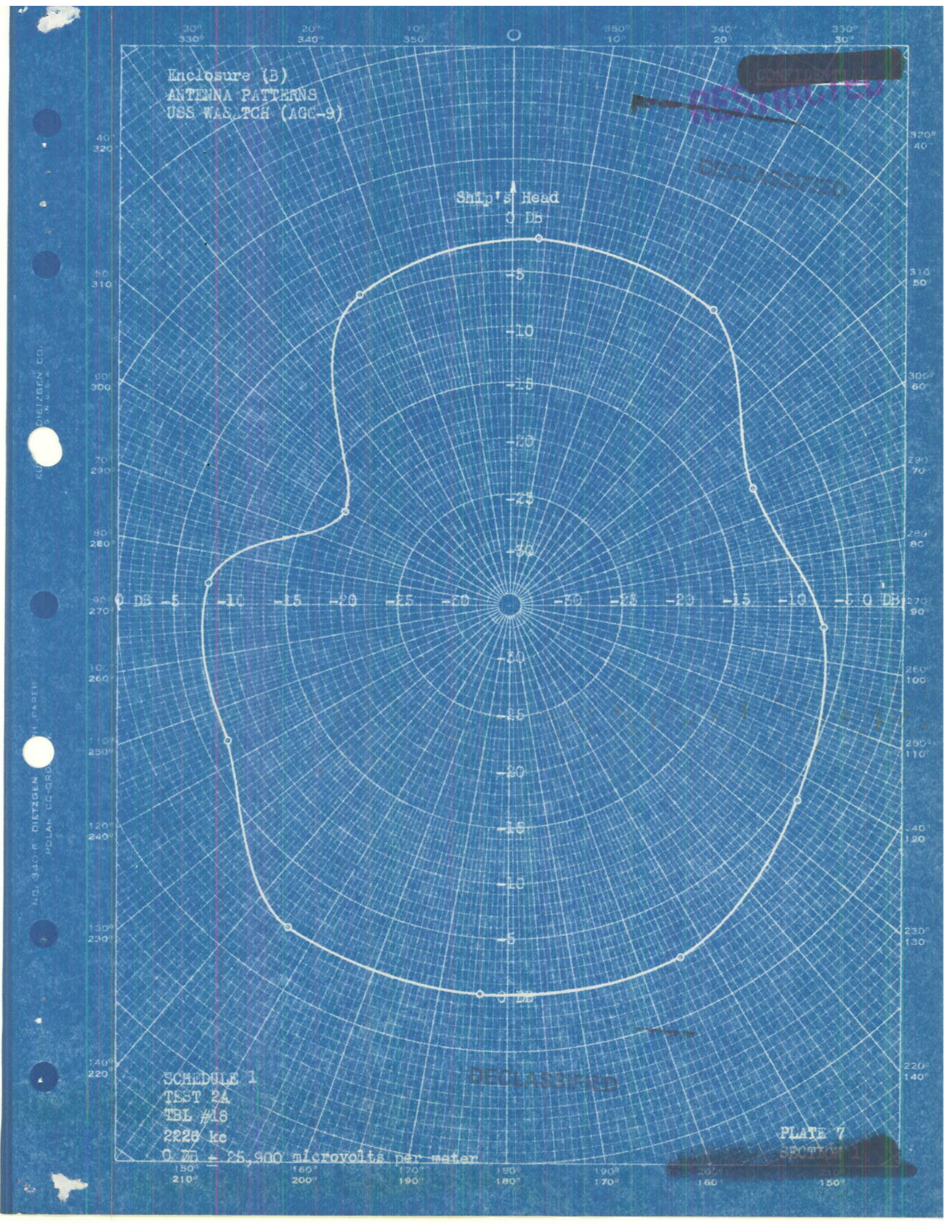

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
[redacted]
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
-30
-25
-20
-15
-10
-5
0 DB
SCHEDULE 1
TEST 1B
TCS #10
2940 kc
0 DB = 8,950 microvolts per meter
DECLASSIFIED
PLATE 2
SECTION 1
[redacted]

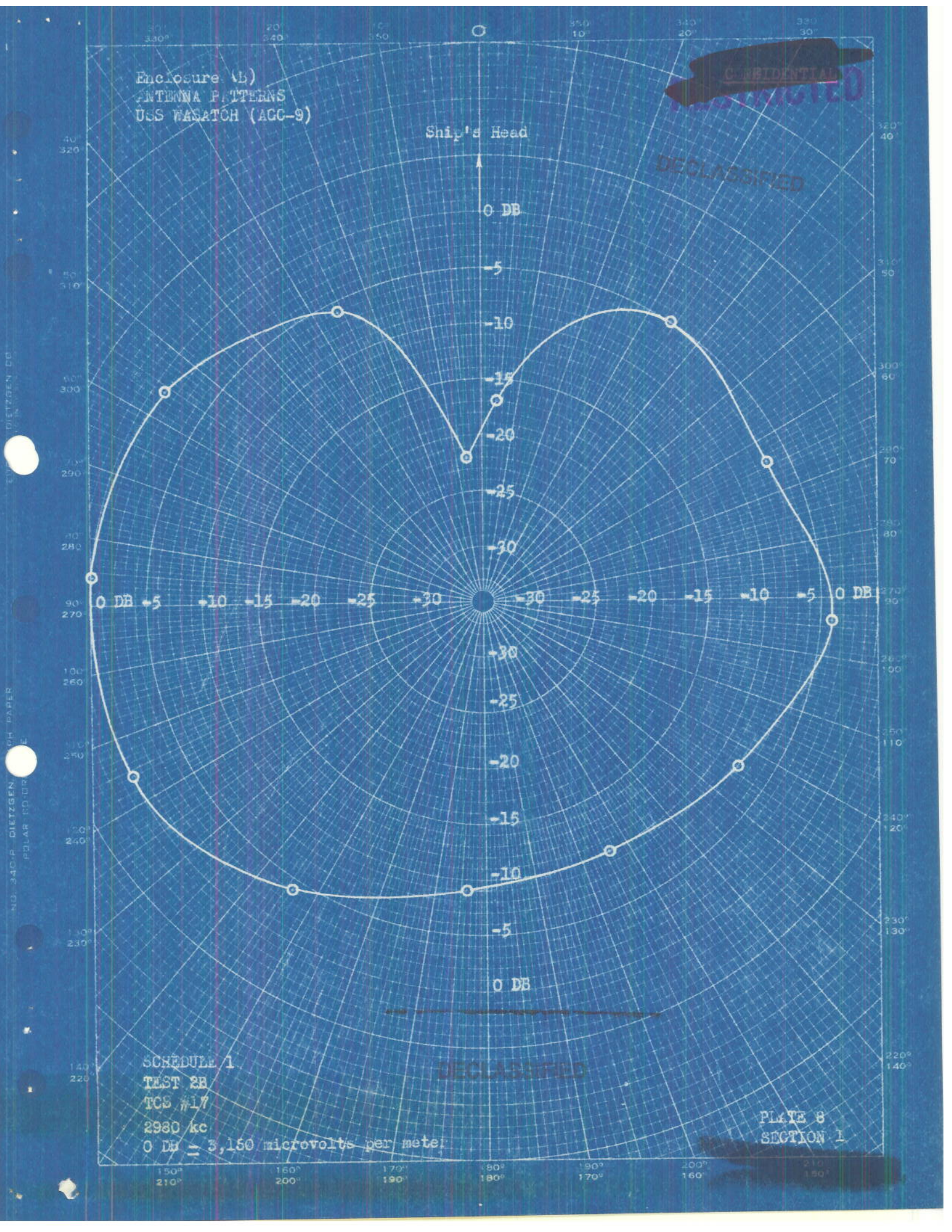

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 1
TEST 1C
TCS 13
3475 kc
0 DB = 7,450 microvolts per meter
PLATE 5
SECTION 1

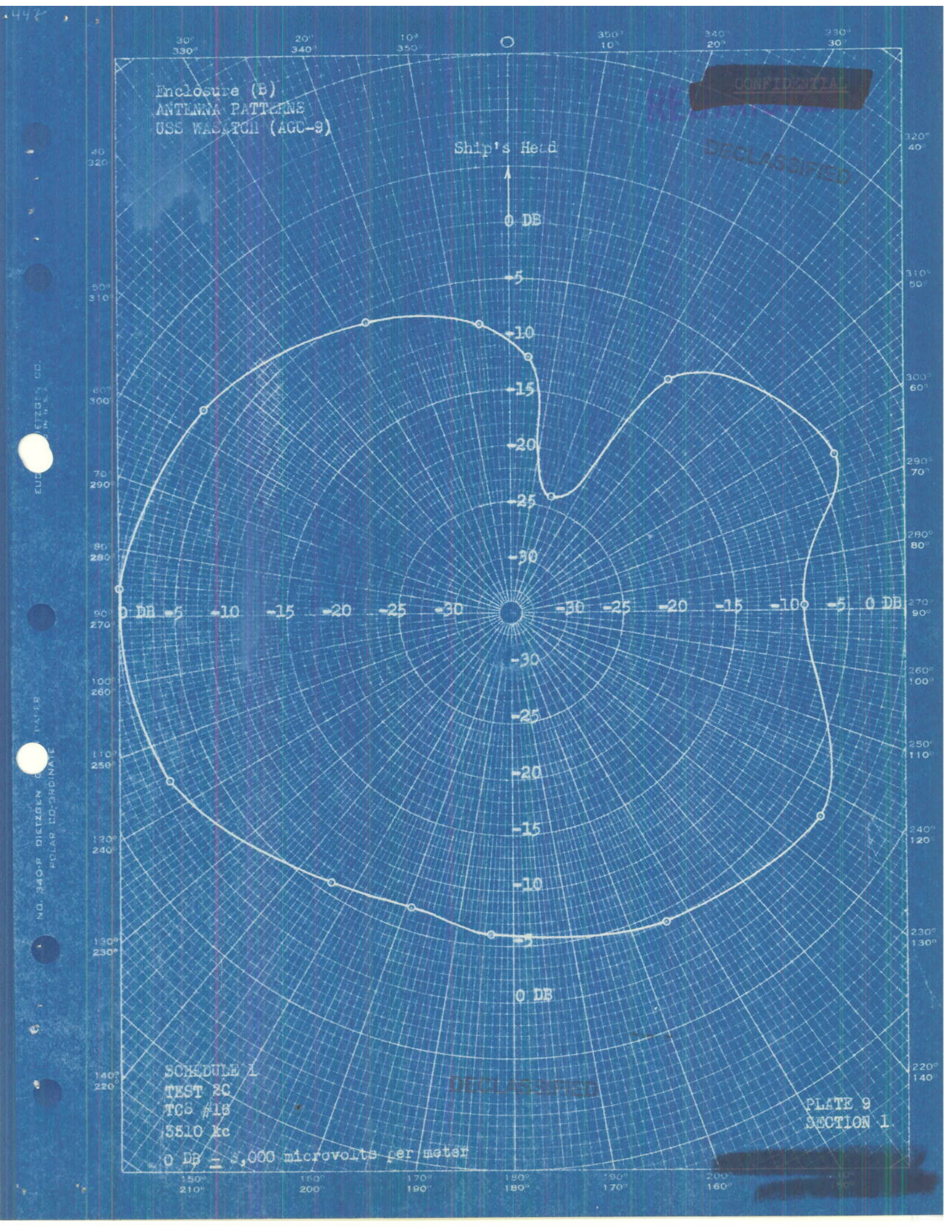



Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
-30
-25
-20
-15
-10
-5
0 DB
SCHEDULE 1
TEST 1E
TCS #14
8000kc
0 DB = 10,100 microvolts per meter
PLATE 5
SECTION 1
DECLASSIFIED
DECLASSIFIED

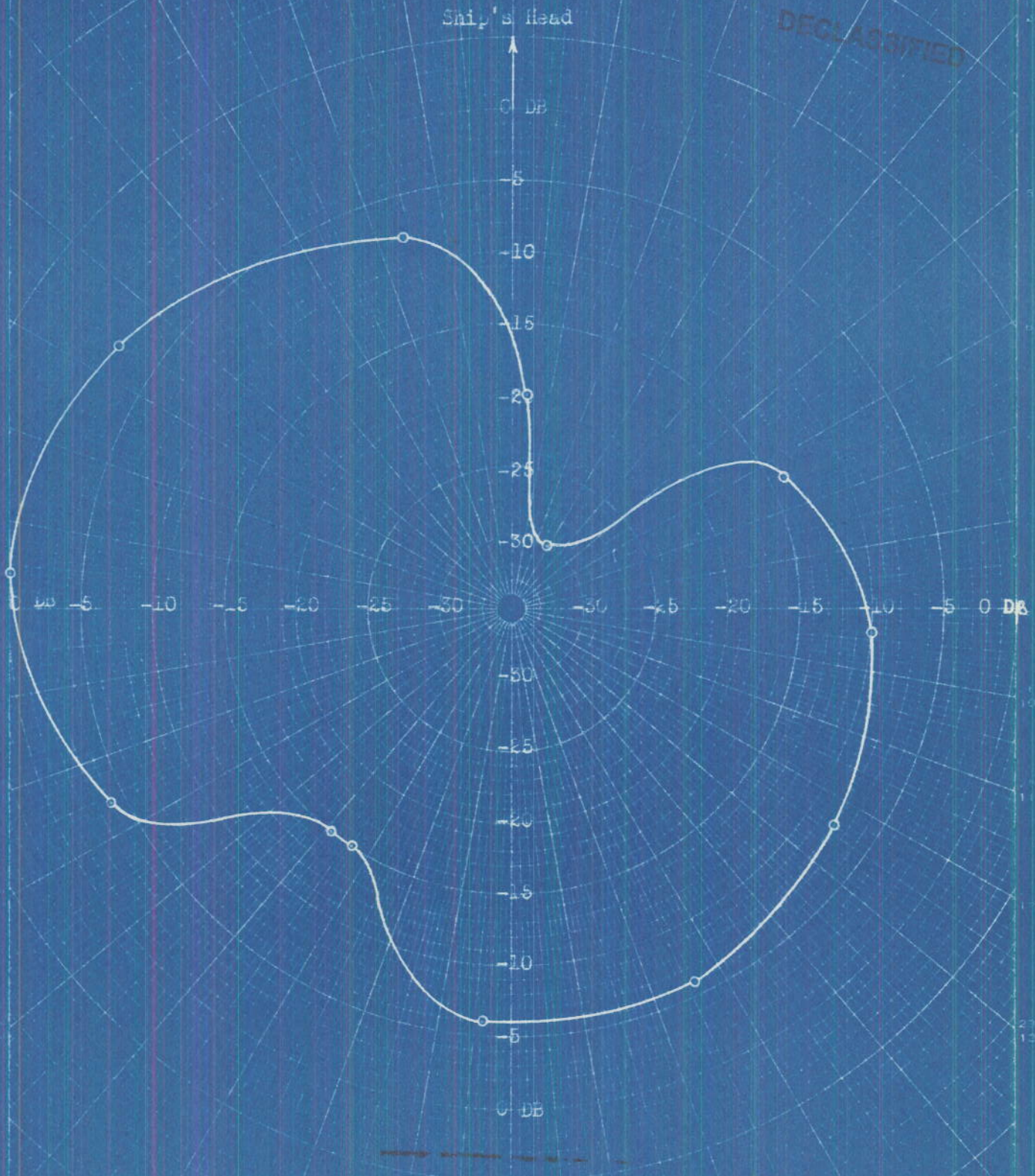

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
CONFIDENTIAL
Ship's Head
DECLASSIFIED
0 DB
-10
-20
-30
-40
-50
-60
0 -10 -20 -30 -40 -50 -60 -50 -40 -30 -20 -10 0
0 DB
SCHEDULE 1
TEST 1F
BC #1
140 Mc
DECLASSIFIED
PLATE 6
SECTION 1


Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
CONFIDENTIAL
RESTRICTED
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 1
TEST 2A
TBL #18
2220 kc
0 DB = 25,900 microvolts per meter
DECLASSIFIED
PLATE 7


Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (ACC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 1
TEST 2B
TCS #17
2980 kc
0 DB = 3,150 microvolts per meter
PLATE 8
SECTION 1
CONFIDENTIAL
RESTRICTED
DECLASSIFIED
DECLASSIFIED


Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
CONFIDENTIAL
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
-30
-25
-20
-15
-10
-5
0 DB
SCHEDULE A
TEST 2C
TCS #16
5510 kc
0 DB = 5,000 microvolts per meter
PLATE 9
SECTION 1
DECLASSIFIED
DECLASSIFIED

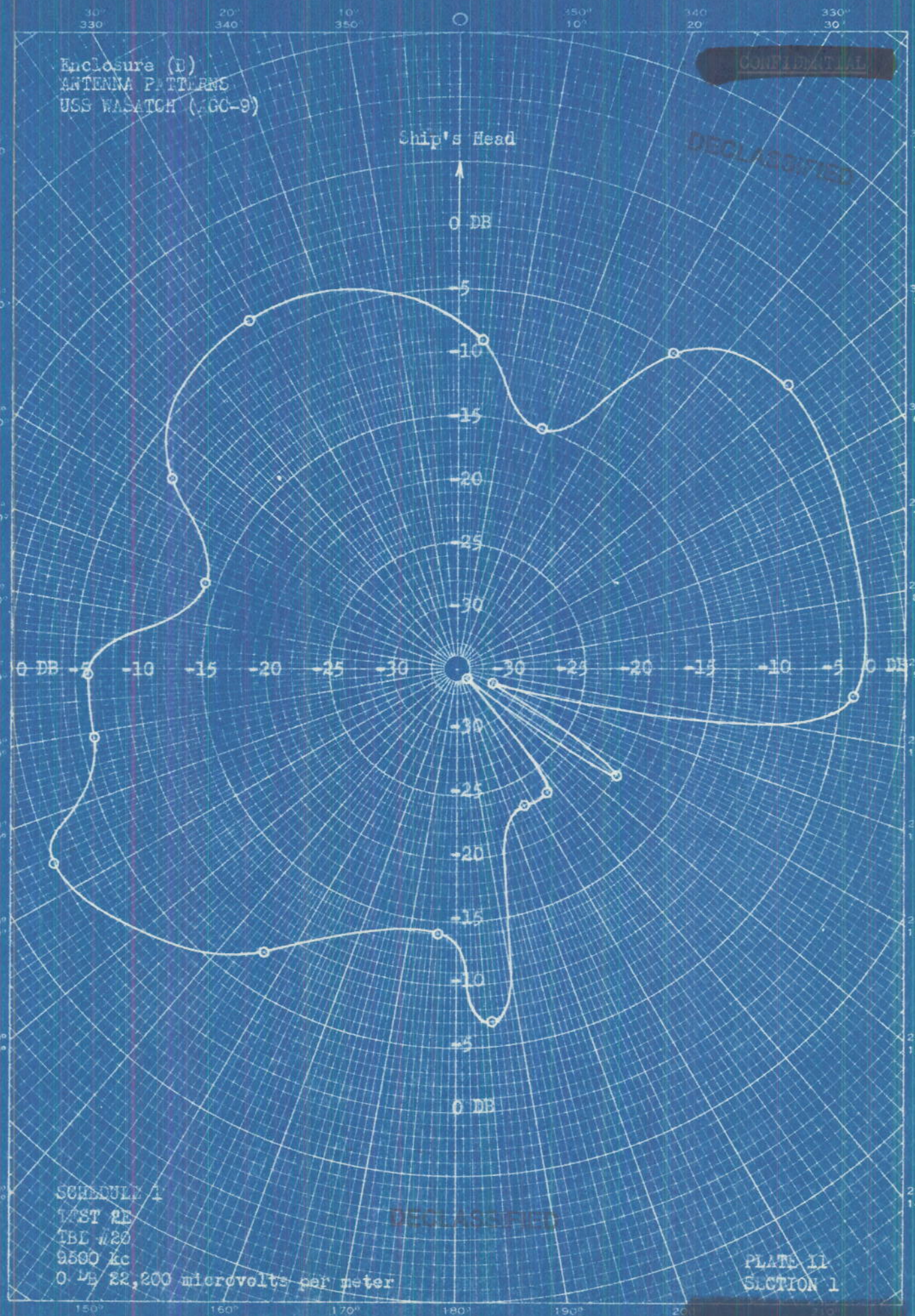
Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)

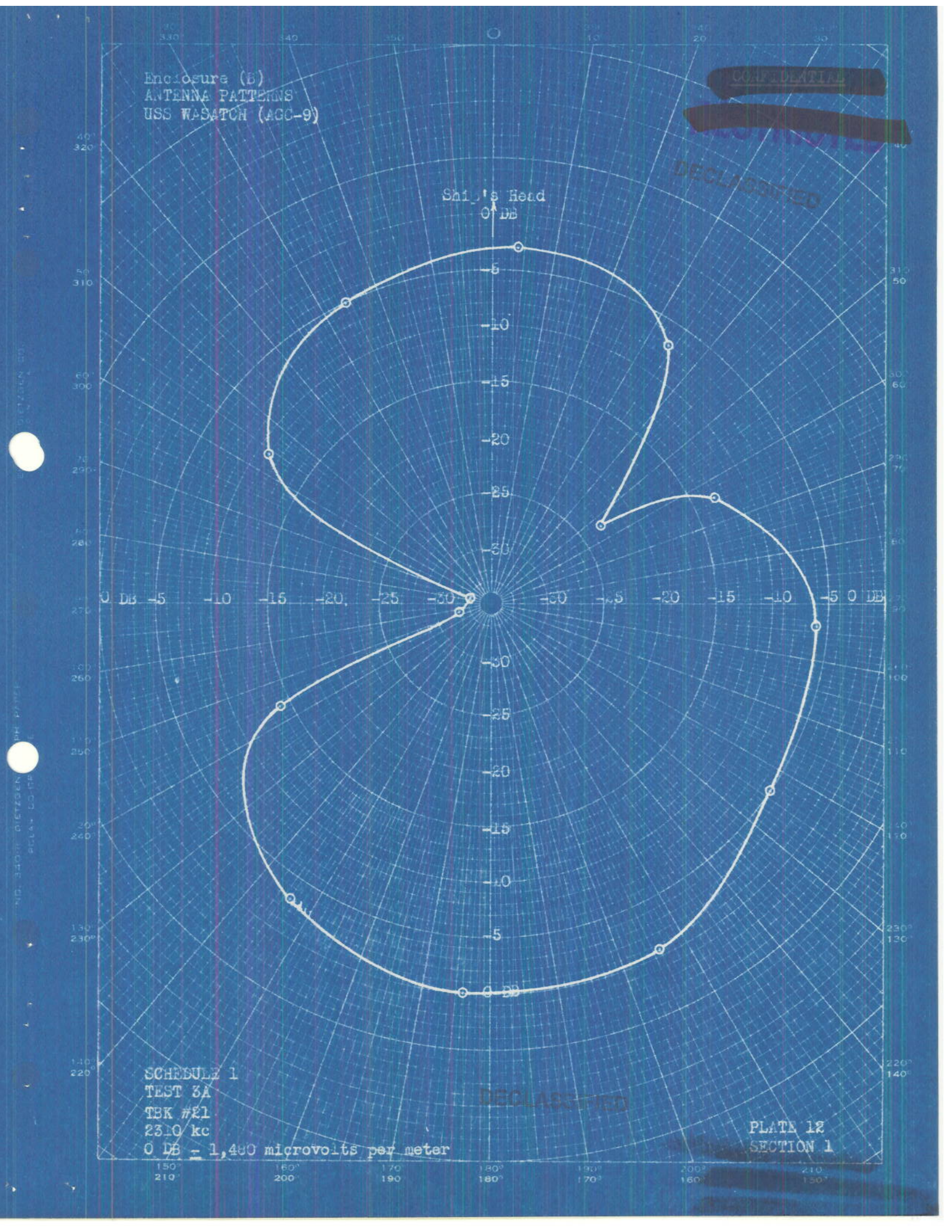


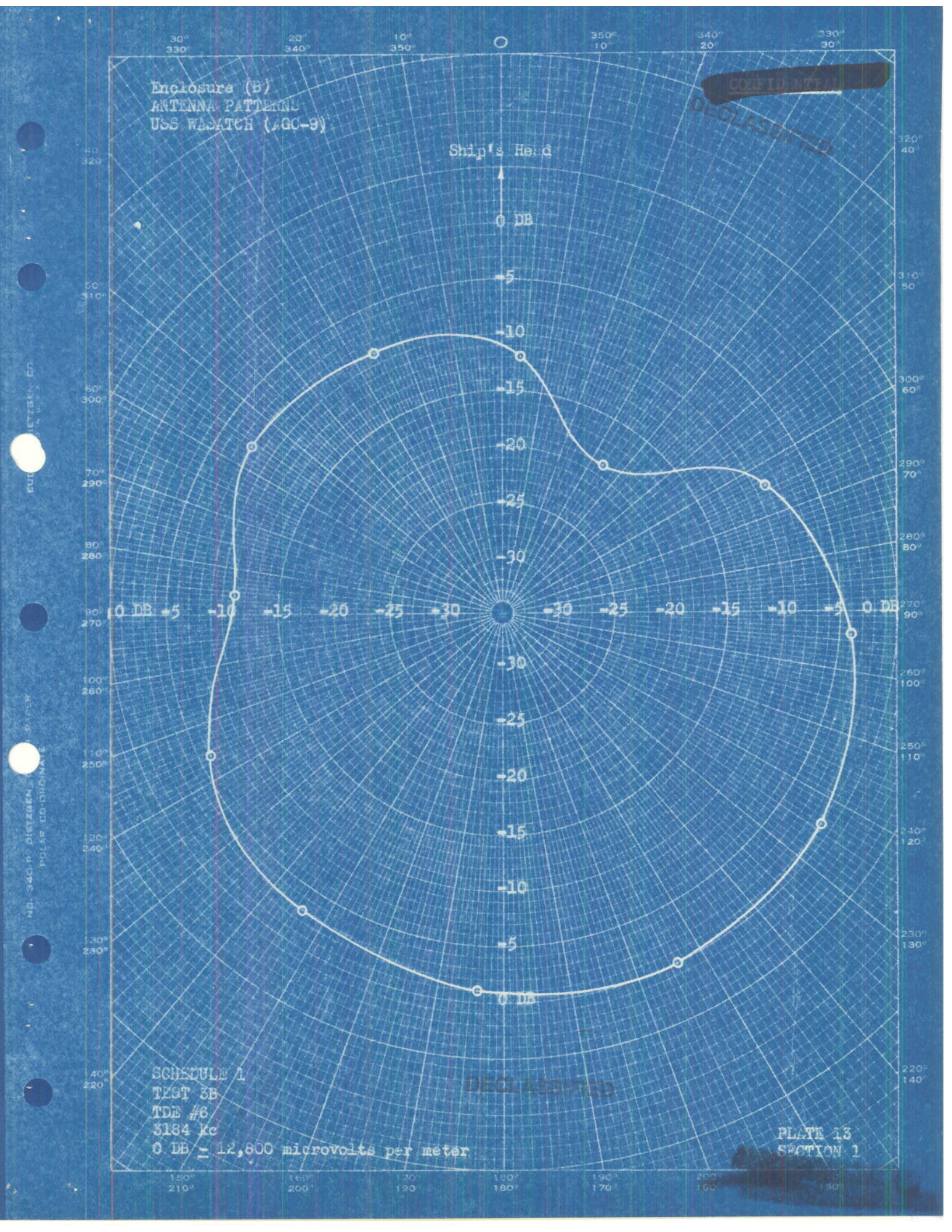
SCHEDULE 1
TEST 2D
TDE #5

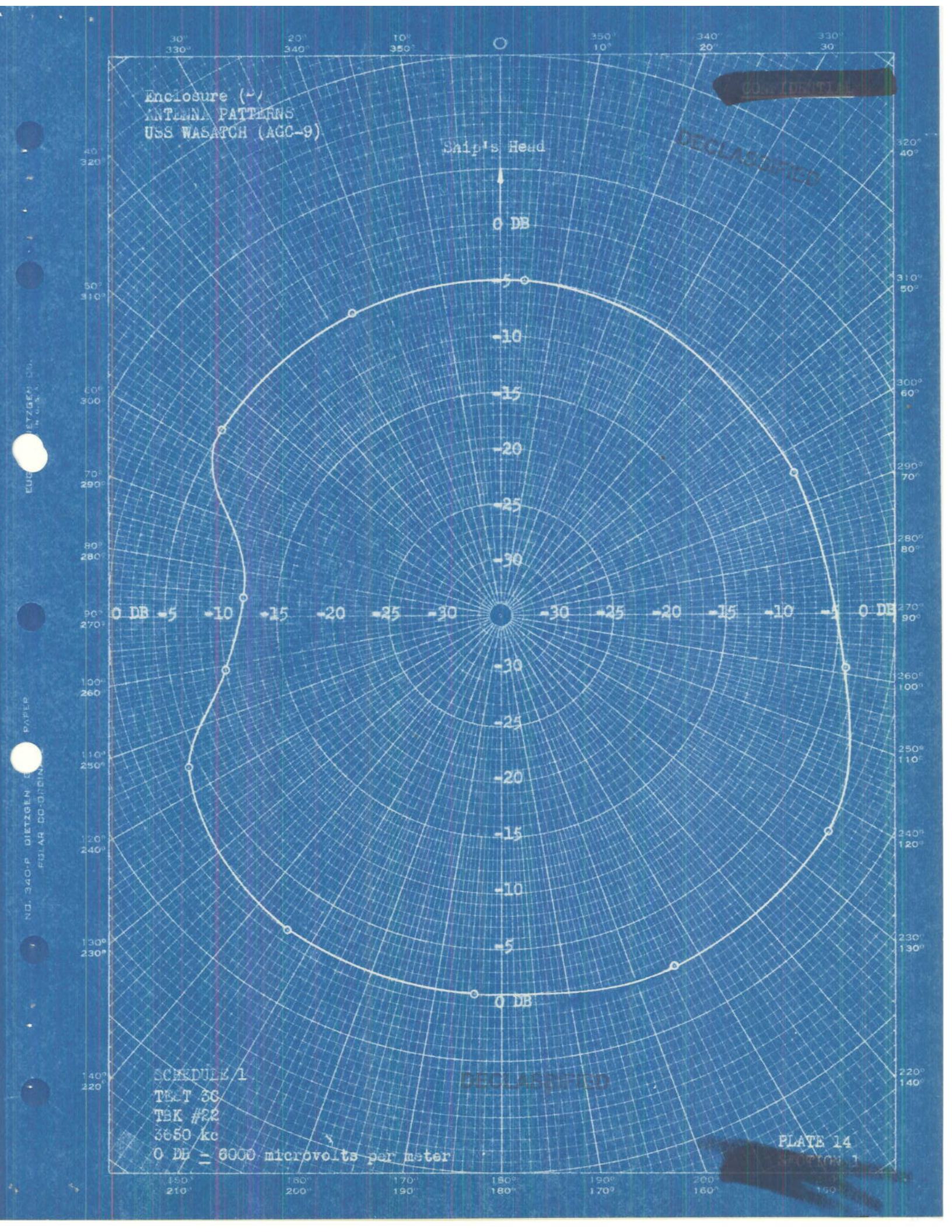
5450 kc
0 DB - 7,250 microvolts per meter

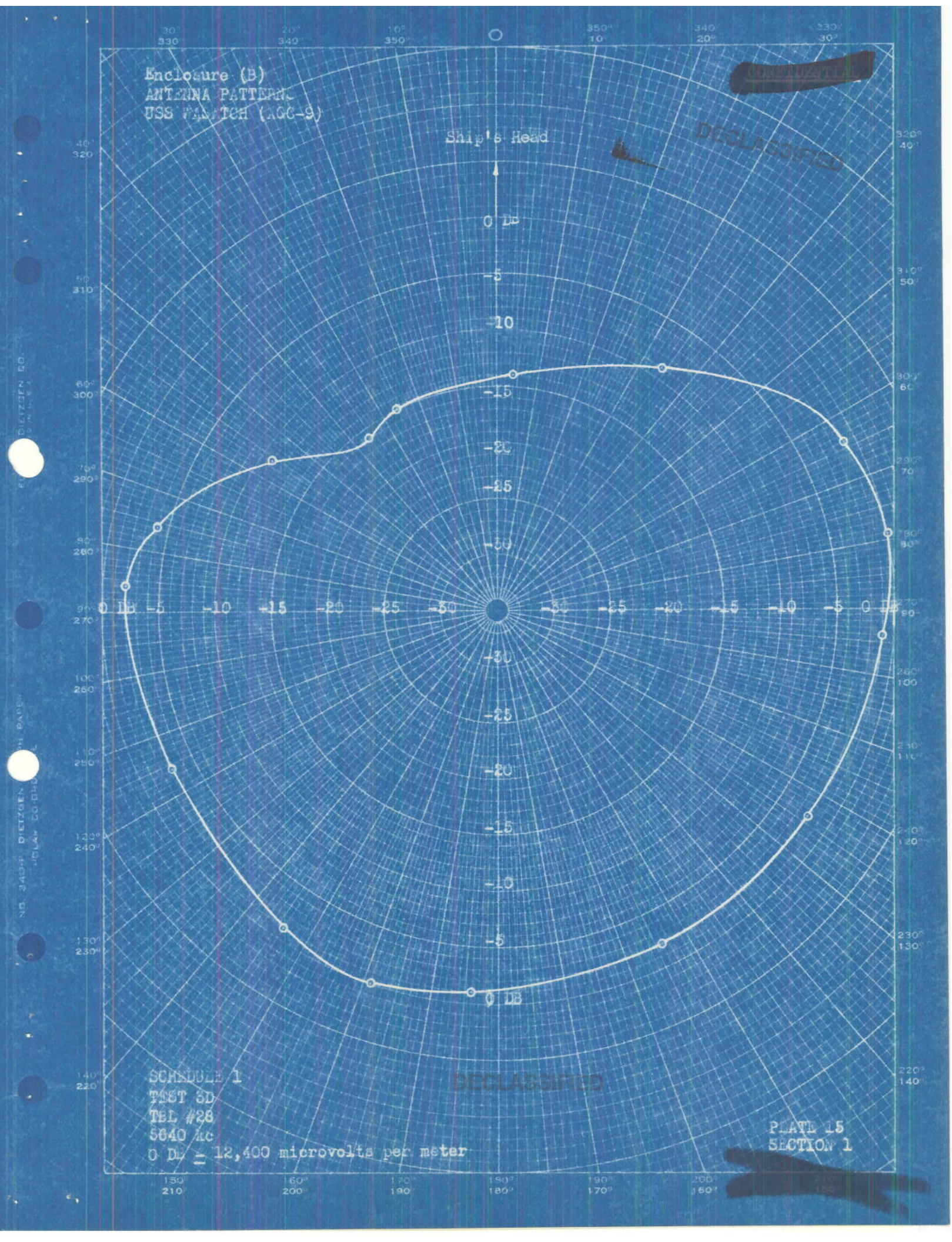
PLATE 10
SECTION 1

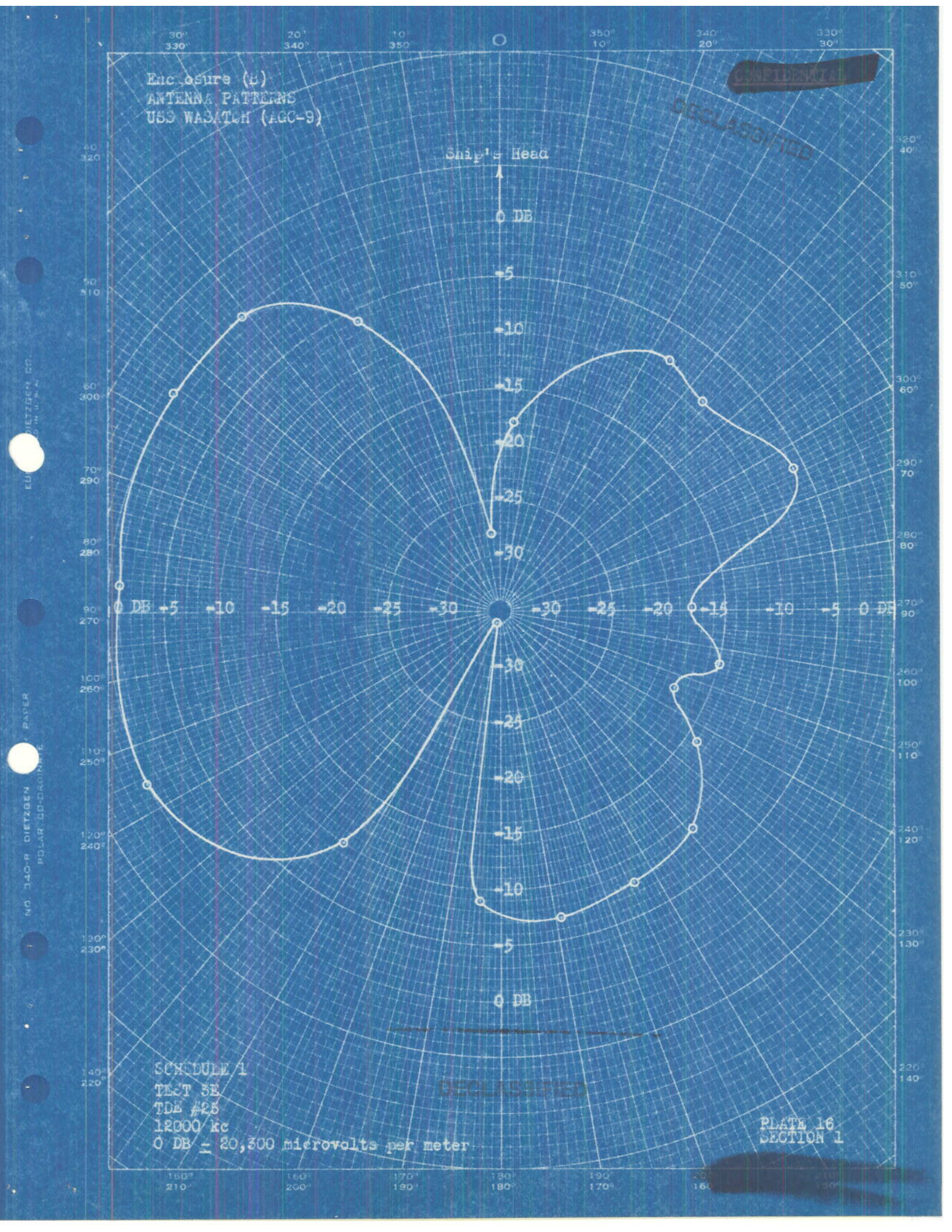

Enclosure (D)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
CONFIDENTIAL
Ship's Head
DECLASSIFIED
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 1
TEST 2E
TBL #20
9500 kc
0 DB 22,200 microvolts per meter
DECLASSIFIED
PLATE II
SECTION 1

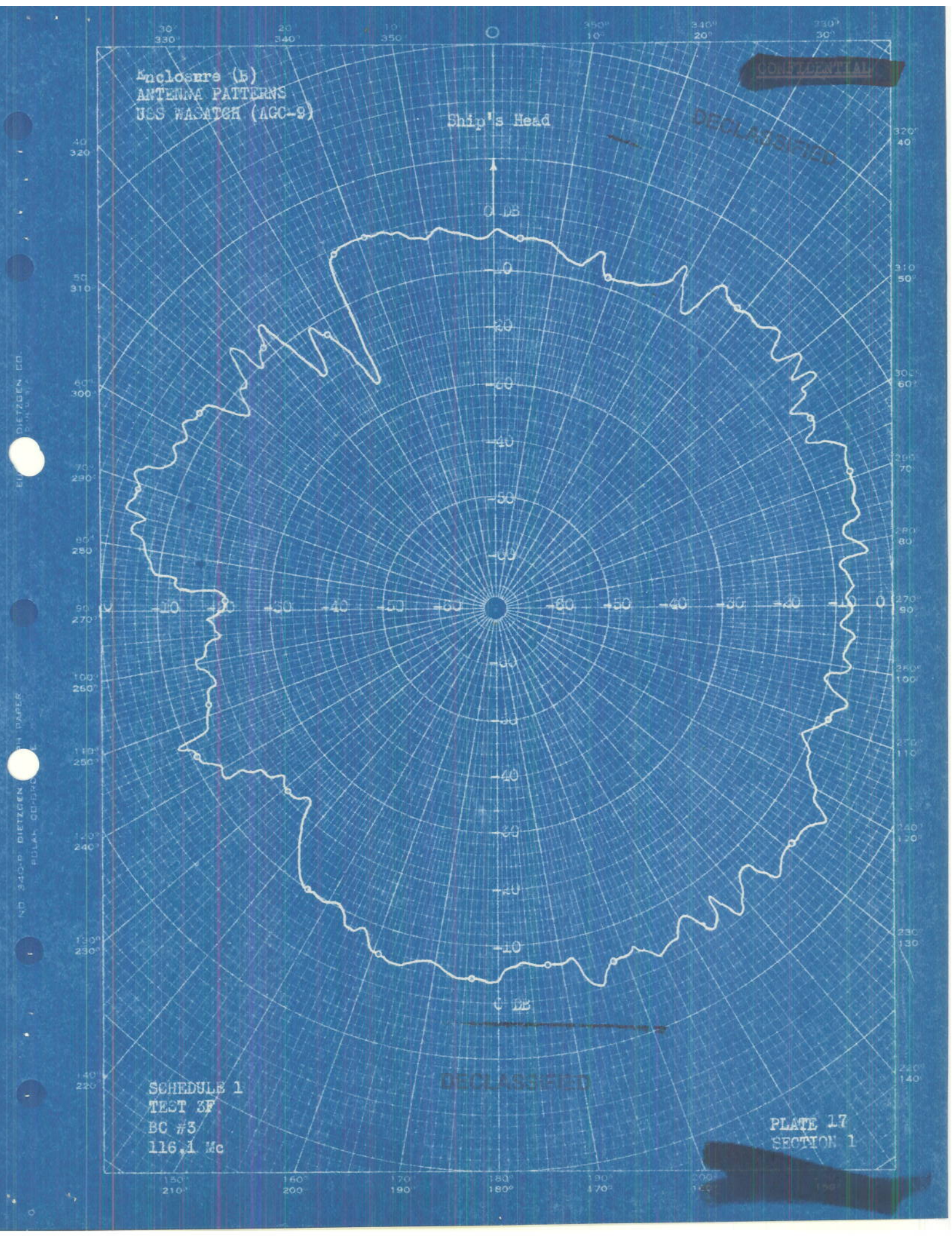

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
CONFIDENTIAL
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 1
TEST 3A
TBK #21
2310 kc
0 DB = 1,480 microvolts per meter
DECLASSIFIED
PLATE 12
SECTION 1

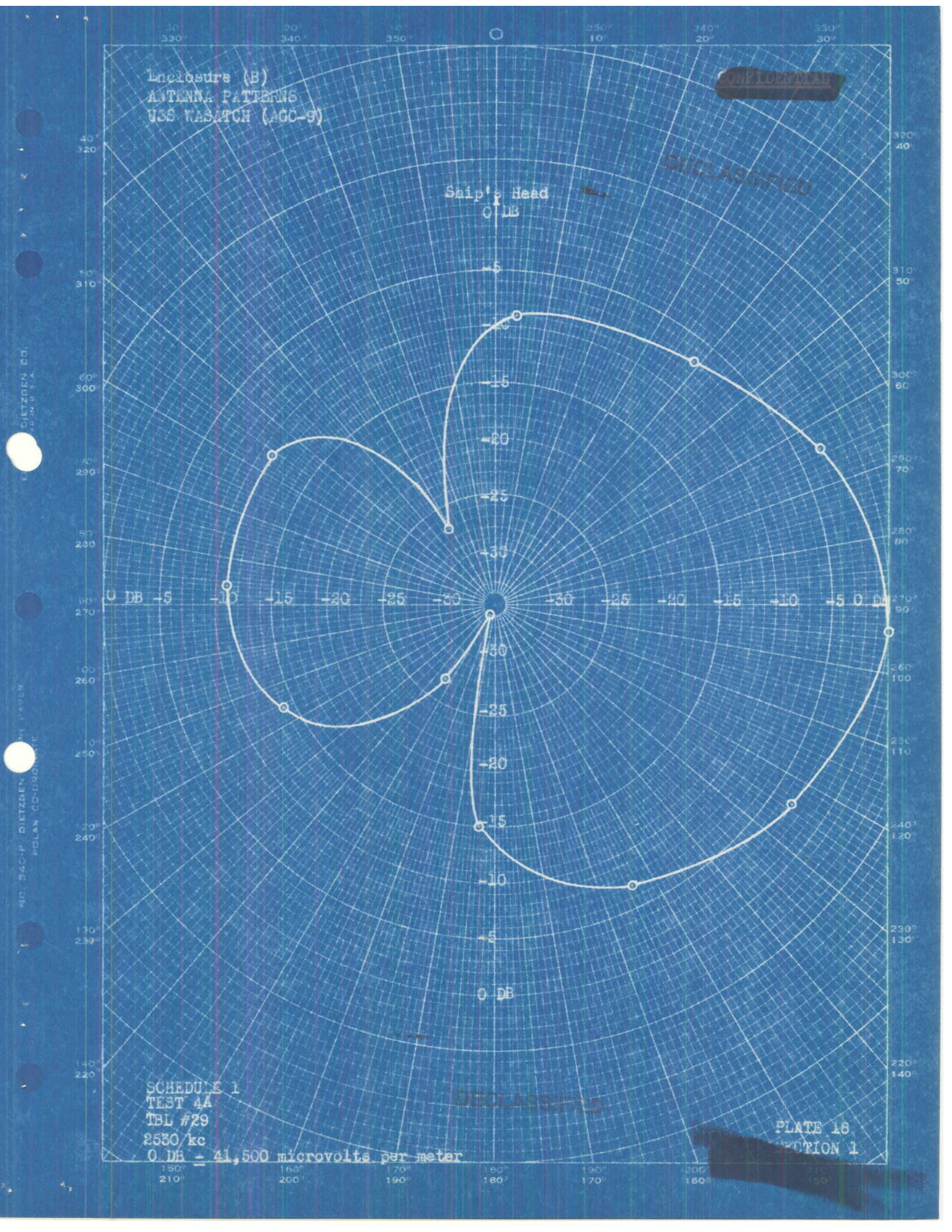

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
10 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 1
TEST 3B
TDE #6
3184 Kc
0 DB = 12,800 microvolts per meter
PLATE 13
SECTION 1
DECLASSIFIED
DECLASSIFIED

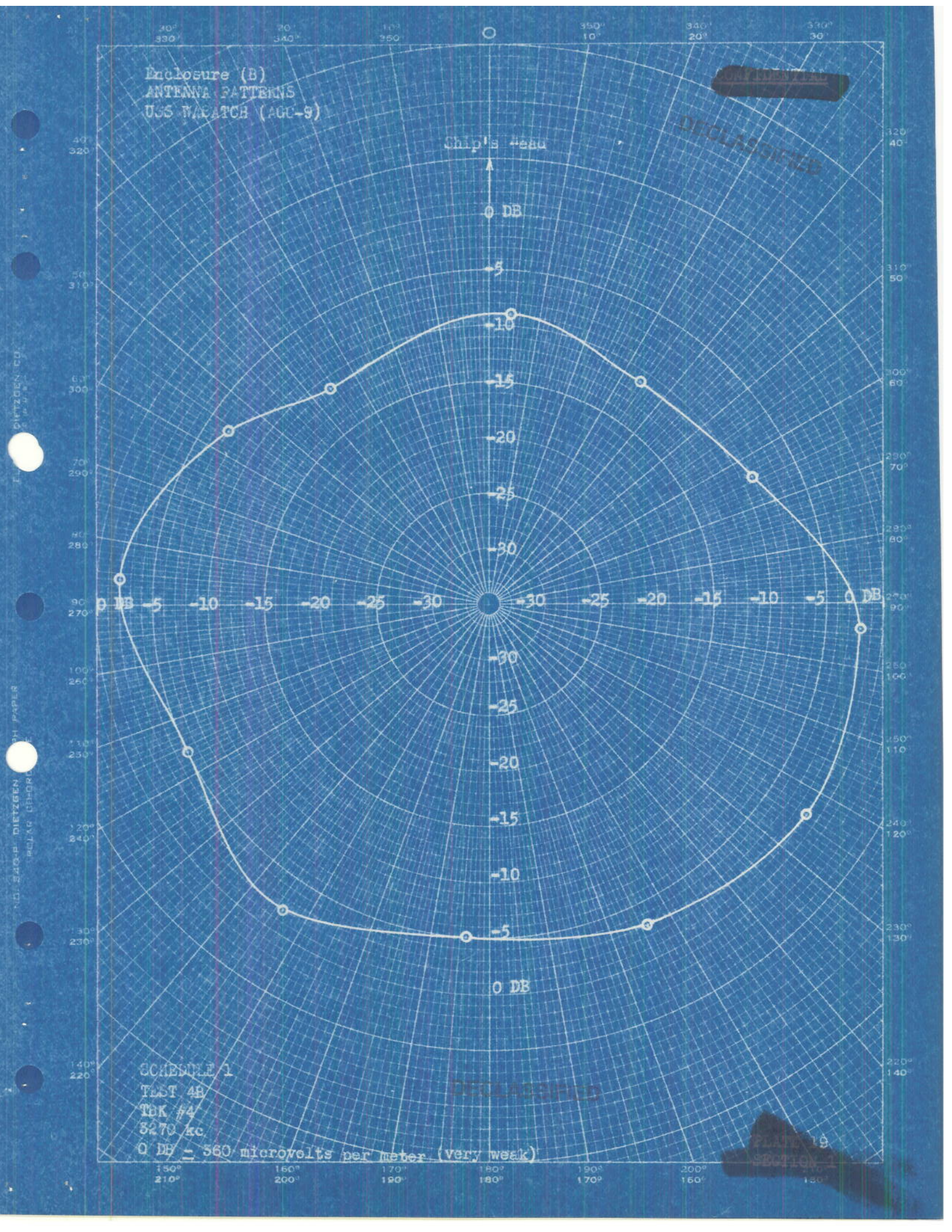


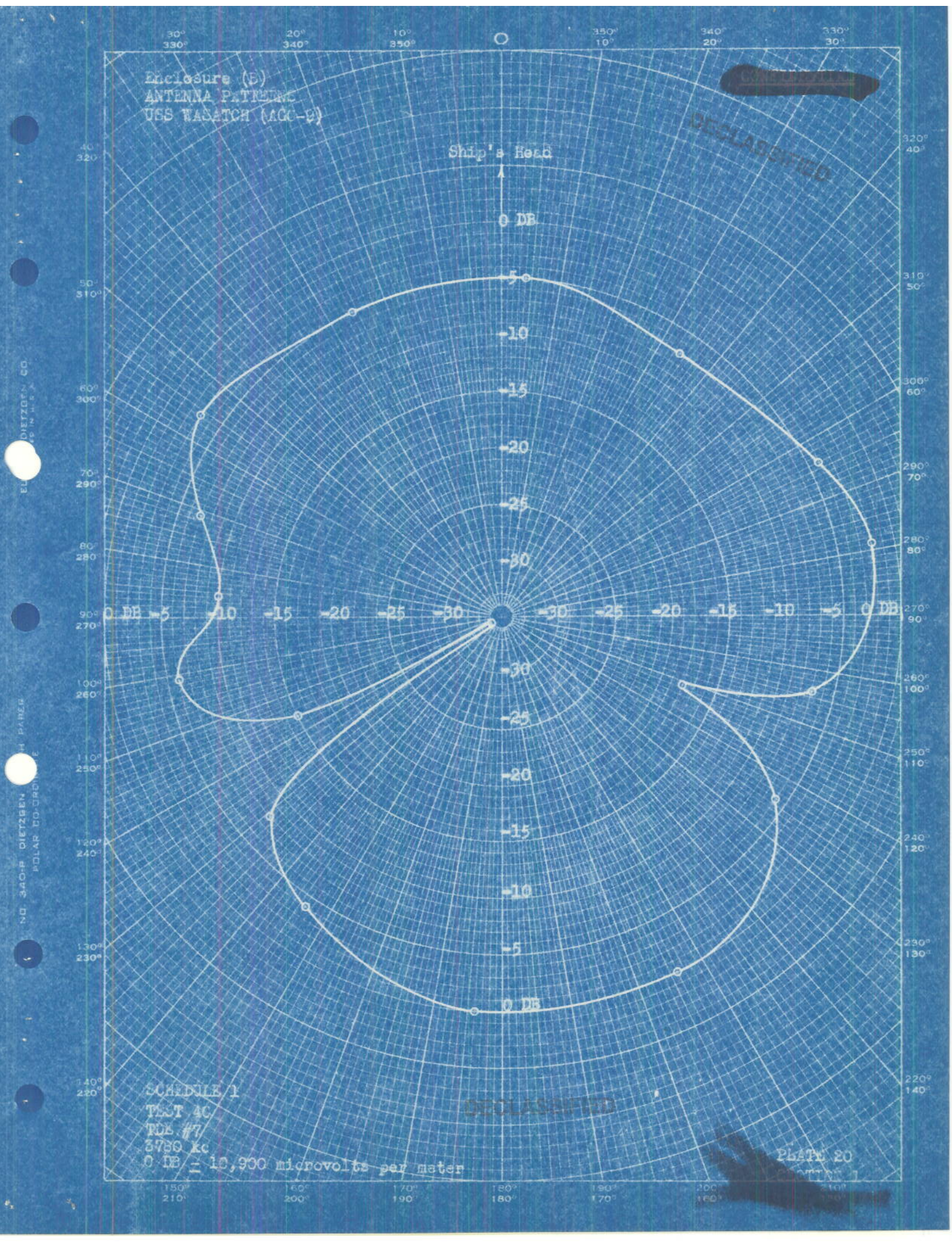

Enclosure (B)
ANTENNA PATTERN
USS MATSCH (AGC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
0 DB
SCHEDULE 1
TEST 5D
TBL #28
5640 kc
0 DB = 12,400 microvolts per meter
PLATE 15
SECTION 1
DECLASSIFIED
DECLASSIFIED

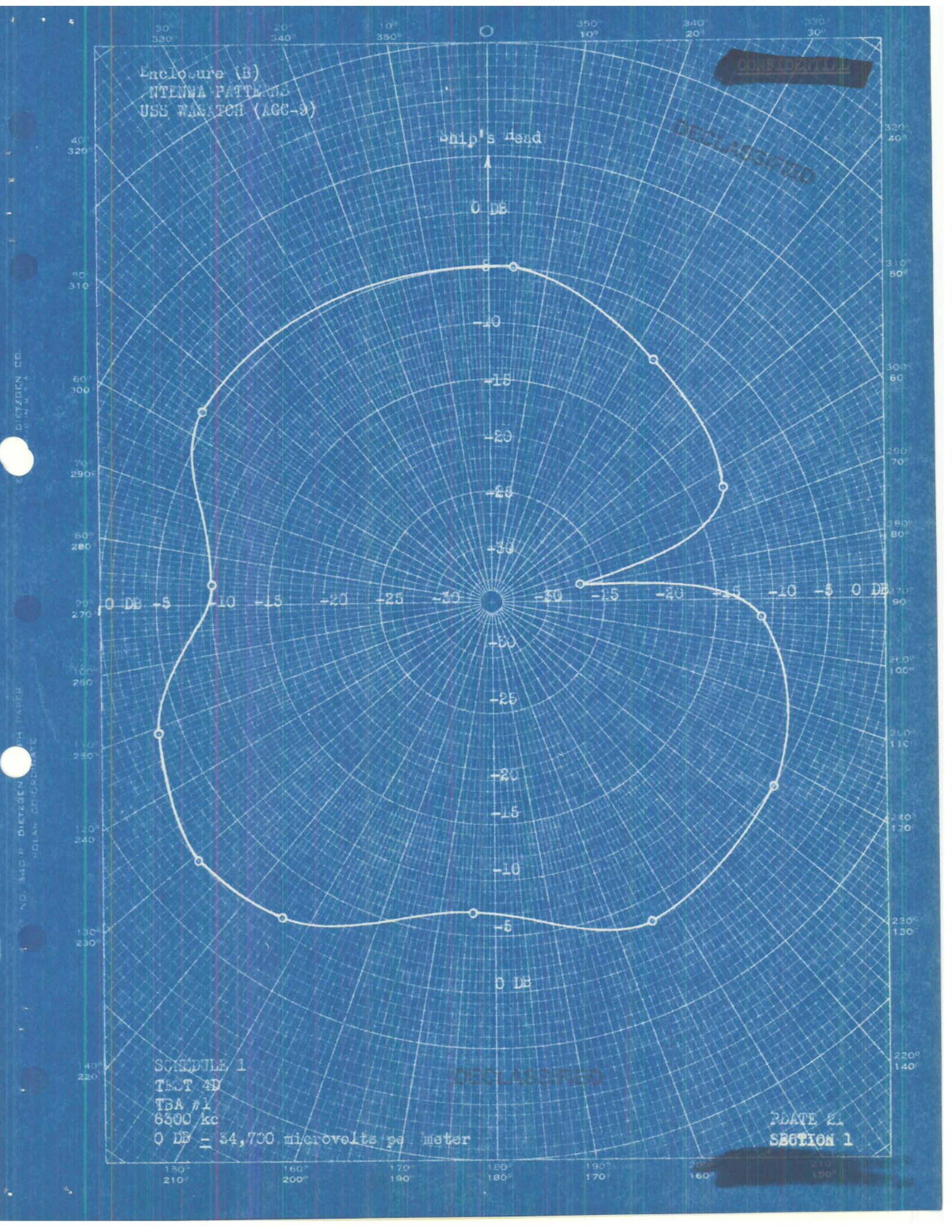

Enclosure (E)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
CONFIDENTIAL
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 1
TEST 5E
TDE #25
12000 kc
0 DB = 20,300 microvolts per meter
DECLASSIFIED
PLATE 16
SECTION 1

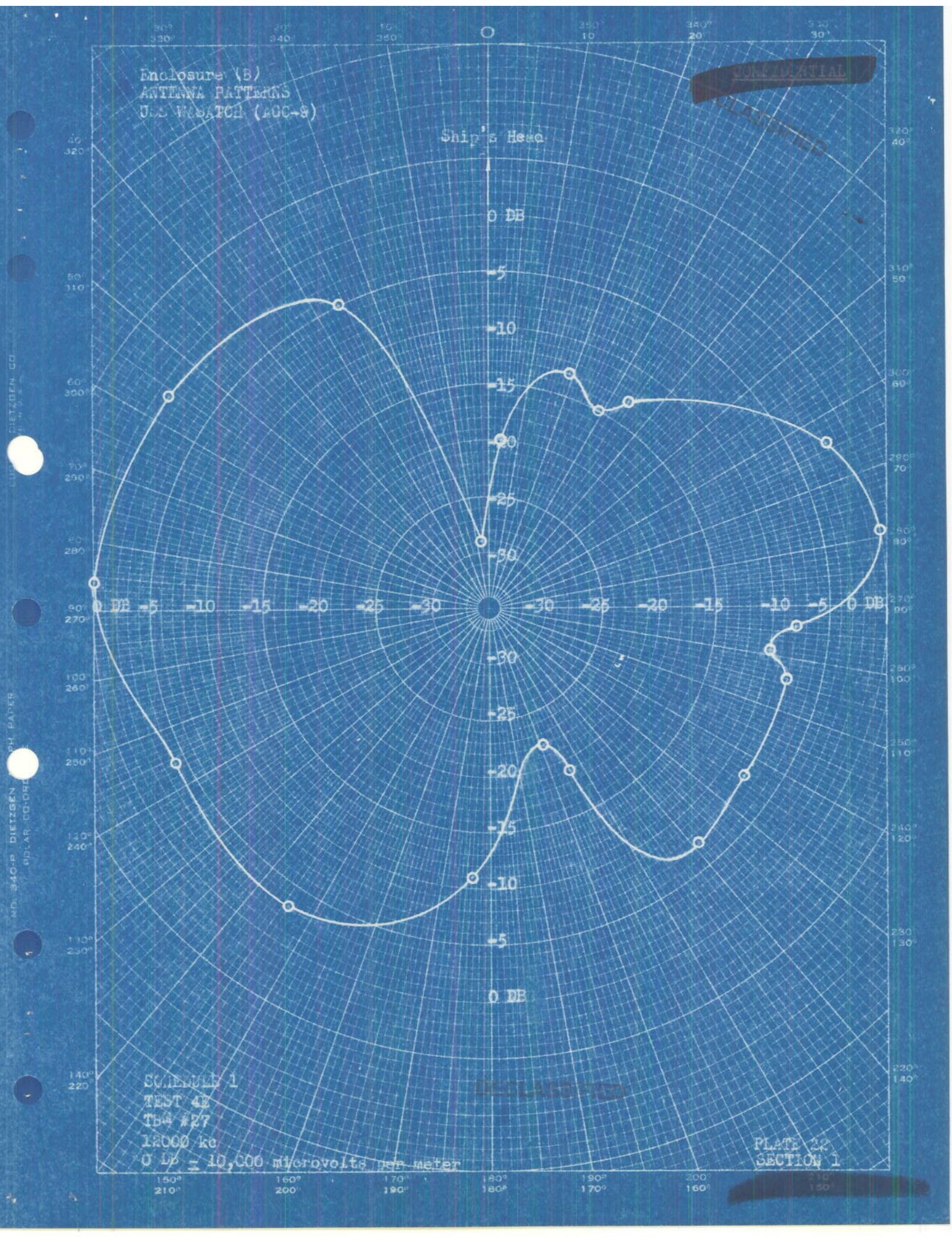

Enclosure (5)
ANTENNA PATTERNS
USS WACHTCH (AGC-9)
CONFIDENTIAL
DECLASSIFIED
Ship's Head
0 DB
-10
-20
-30
-40
-50
-60
SCHEDULE 1
TEST 3F
BC #3
116.1 Mc
PLATE 17
SECTION 1
DECLASSIFIED

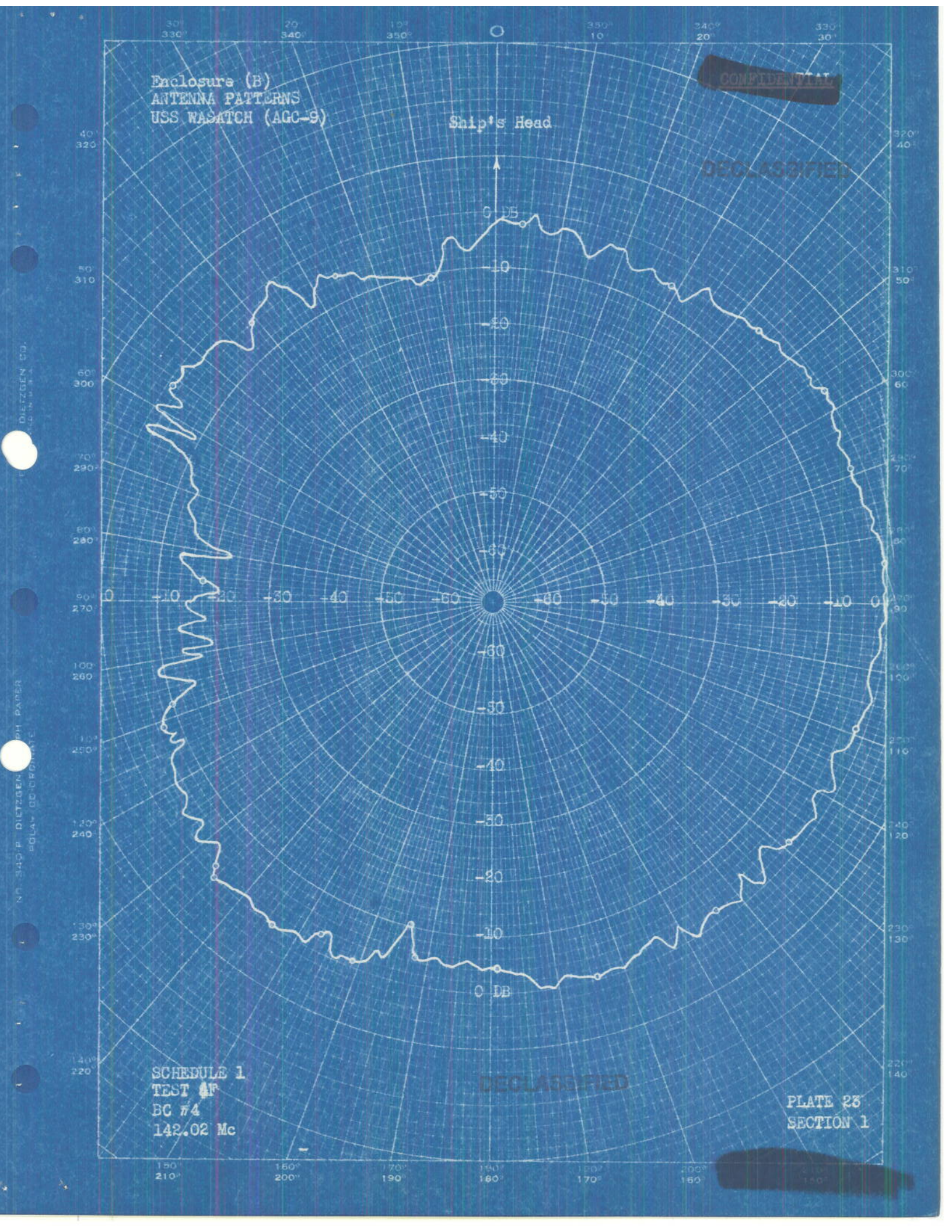

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
CONFIDENTIAL
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 1
TEST 4A
TBL #29
2530 kc
0 DB = 41,500 microvolts per meter
DECLASSIFIED
PLATE 18
ORION 1

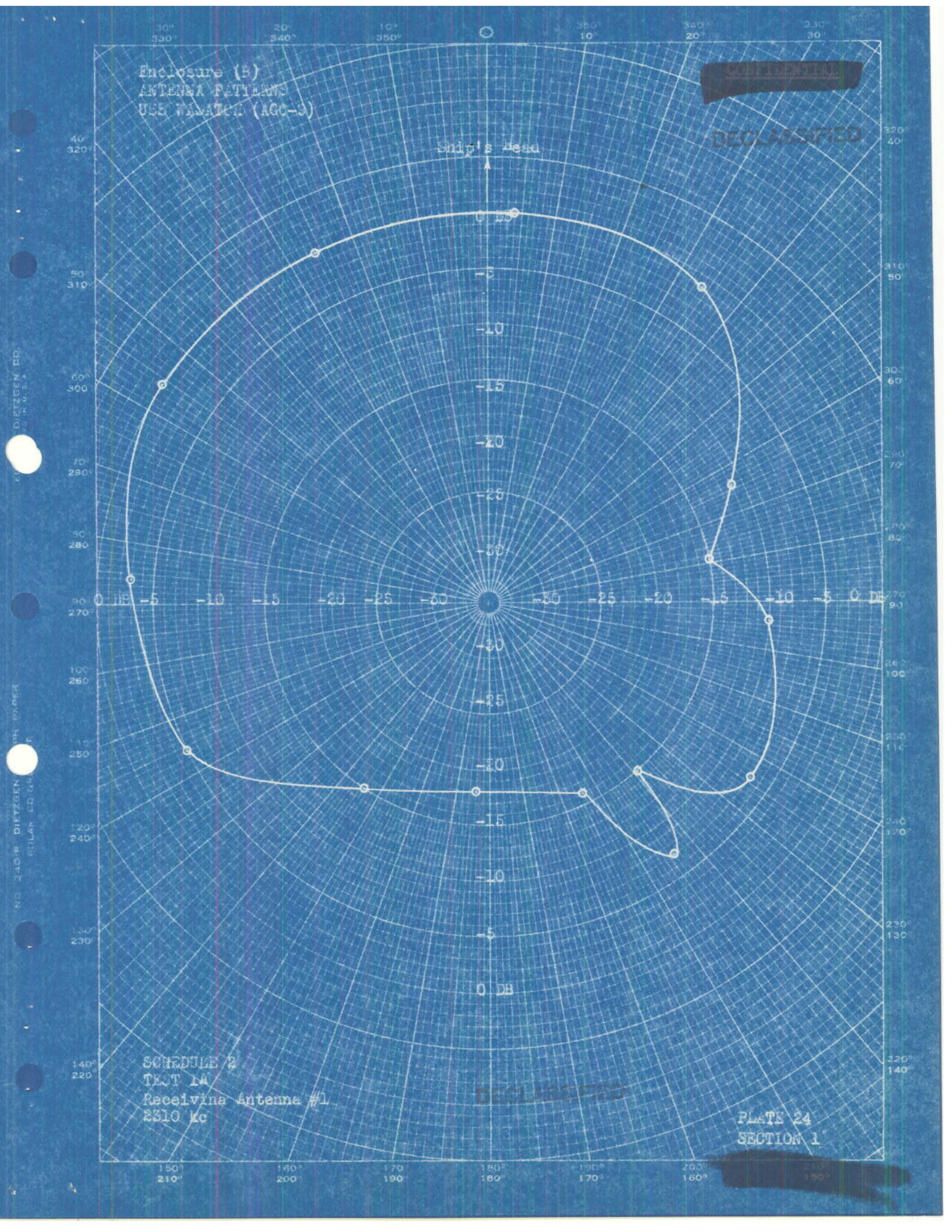

Enclosure (B)
ANTENNA PATTERNS
USS WABASH (AGC-9)
[redacted]
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 1
TEST 4B
TDK #4
3270 kc
0 DB = 560 microvolts per meter (very weak)
DECLASSIFIED

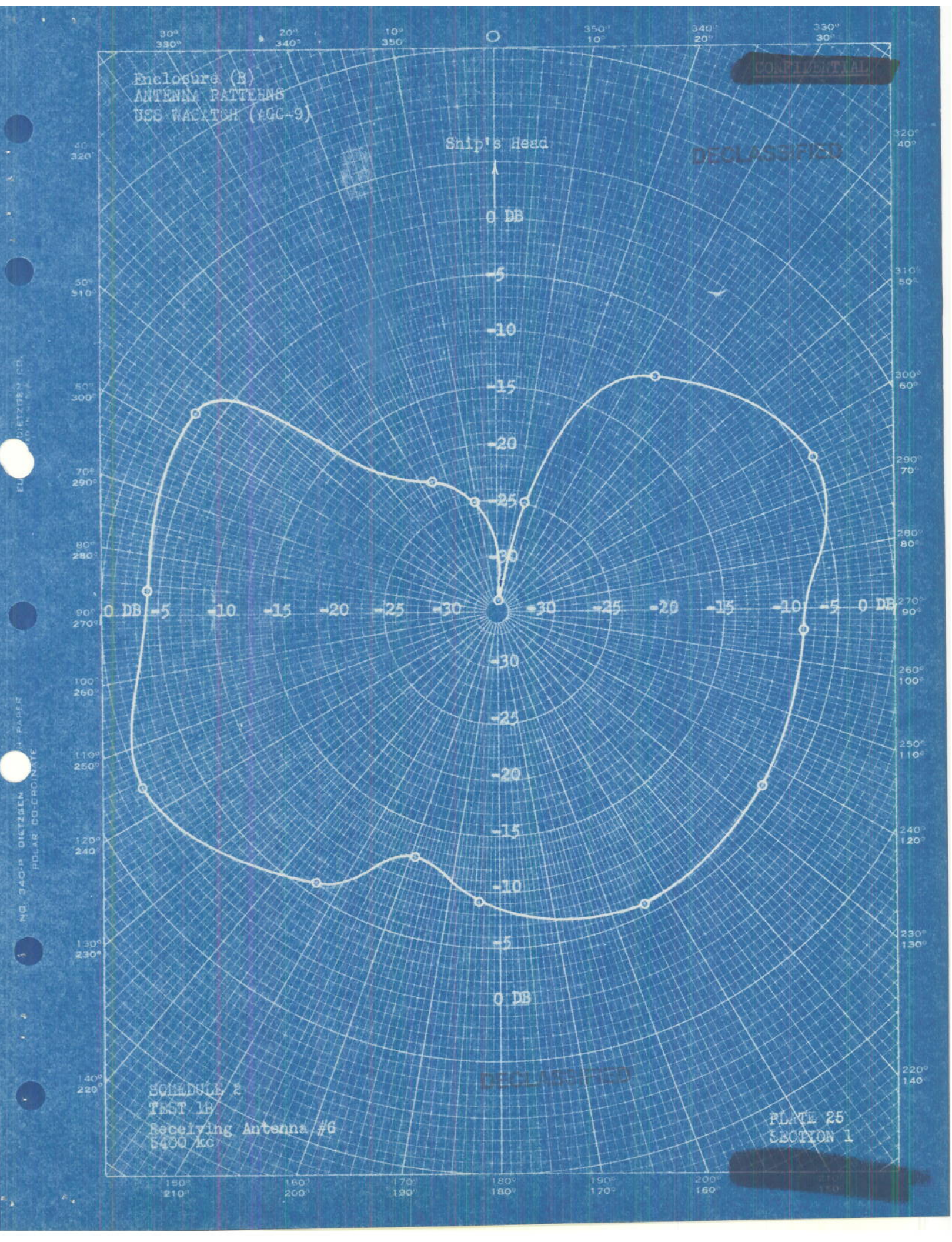

Enclosure (5)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 1
TEST 4C
TDE #7
3780 kc
0 DB = 10,900 microvolts per meter
DECLASSIFIED
DECLASSIFIED
PLATE 20

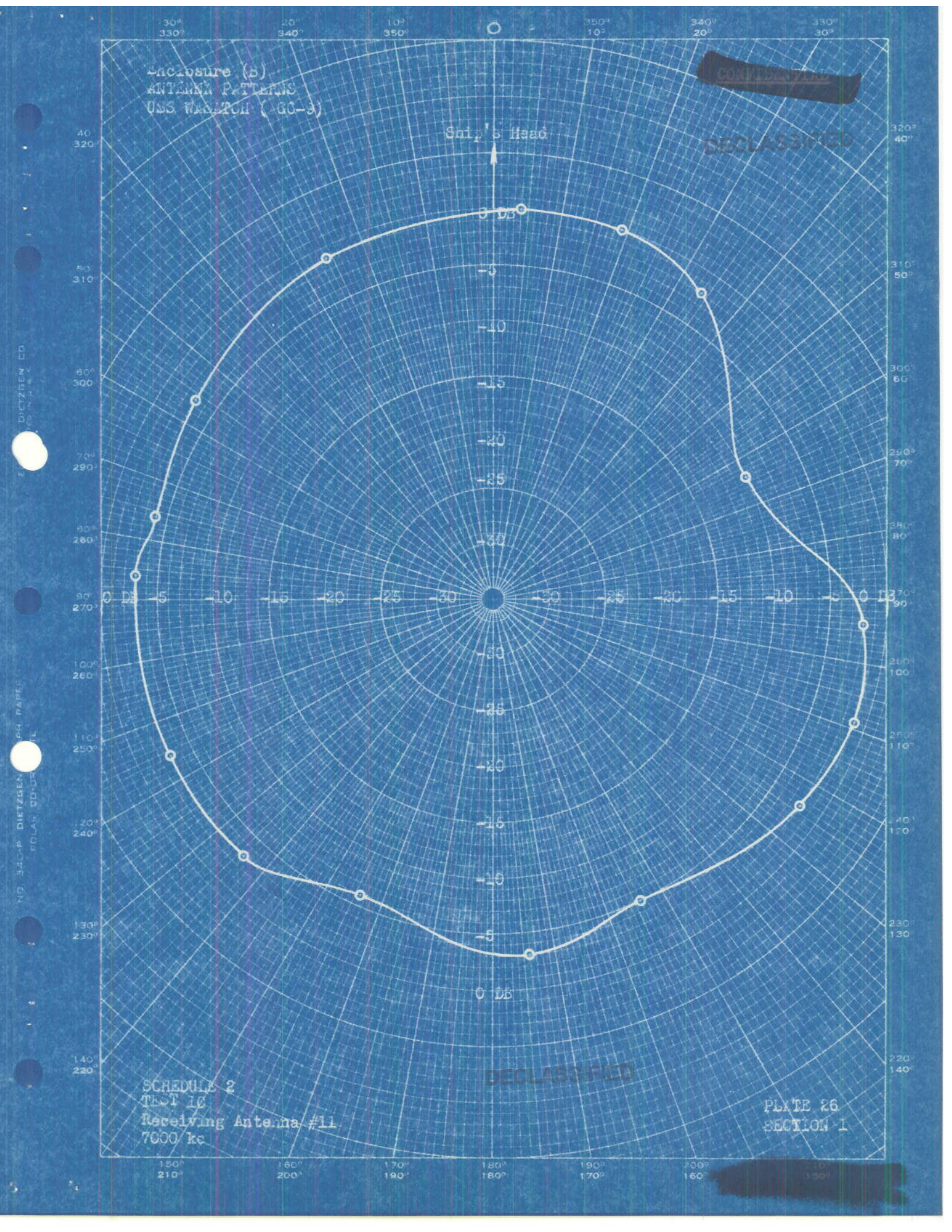

Enclosure (B)
ANTENNA PATTERNS
USS WANATCH (AGC-9)
CONFIDENTIAL
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
0 DB -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -15 -20 -15 -10 -5 0 DB
SCHEDULE 1
TEST 4D
TBA #1
6300 kc
0 DB = 34,700 microvolts per meter
DECLASSIFIED
PLATE #1
SECTION 1
CONFIDENTIAL

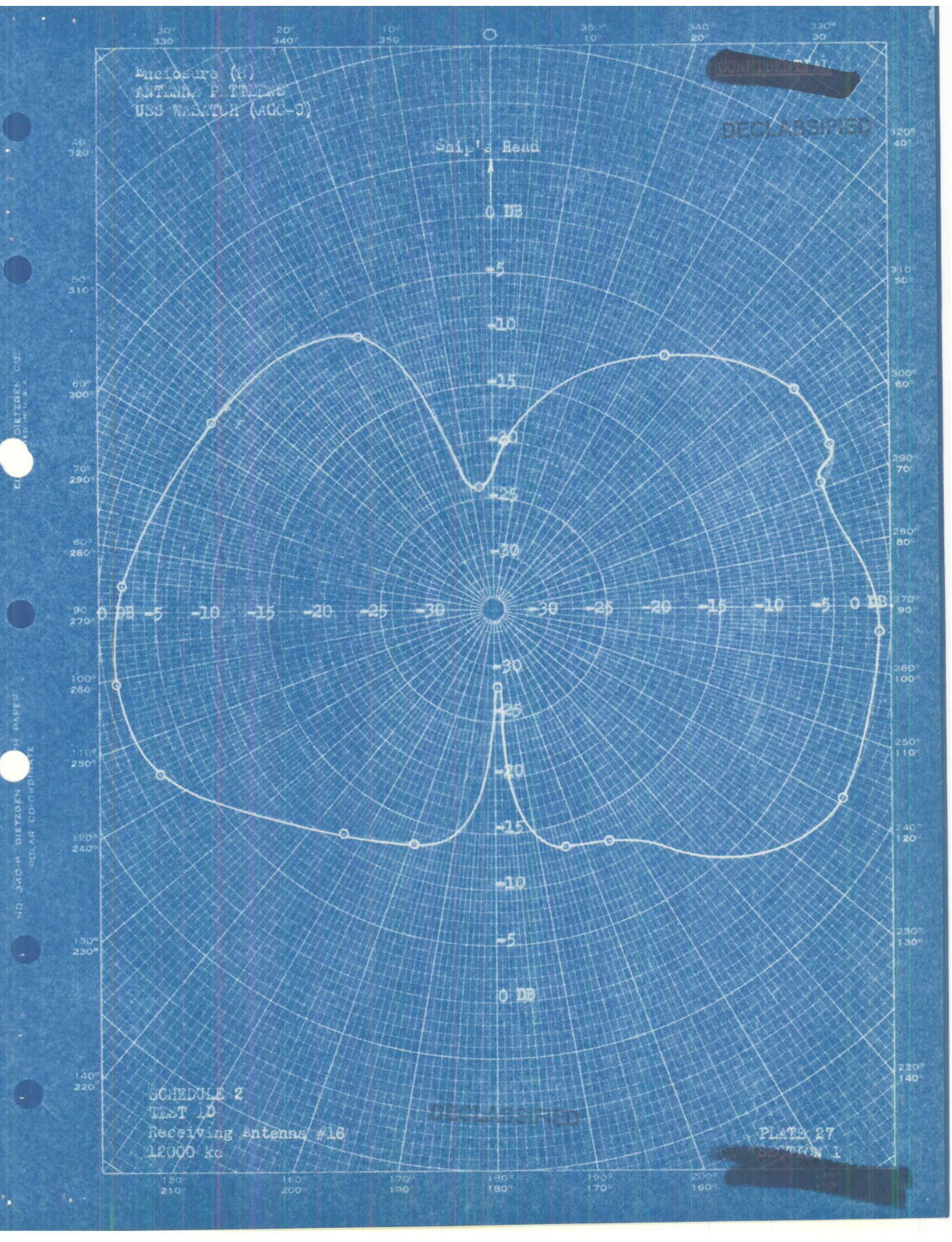

Enclosure (B)
ANTENNA PATTERNS
U.S. WEATHER (AOC-8)
CONFIDENTIAL
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 1
TEST 4E
Tb4 #27
12000 kc
0 DB = 10,000 microvolts per meter
DECLASSIFIED
PLATE 2C
SECTION 1

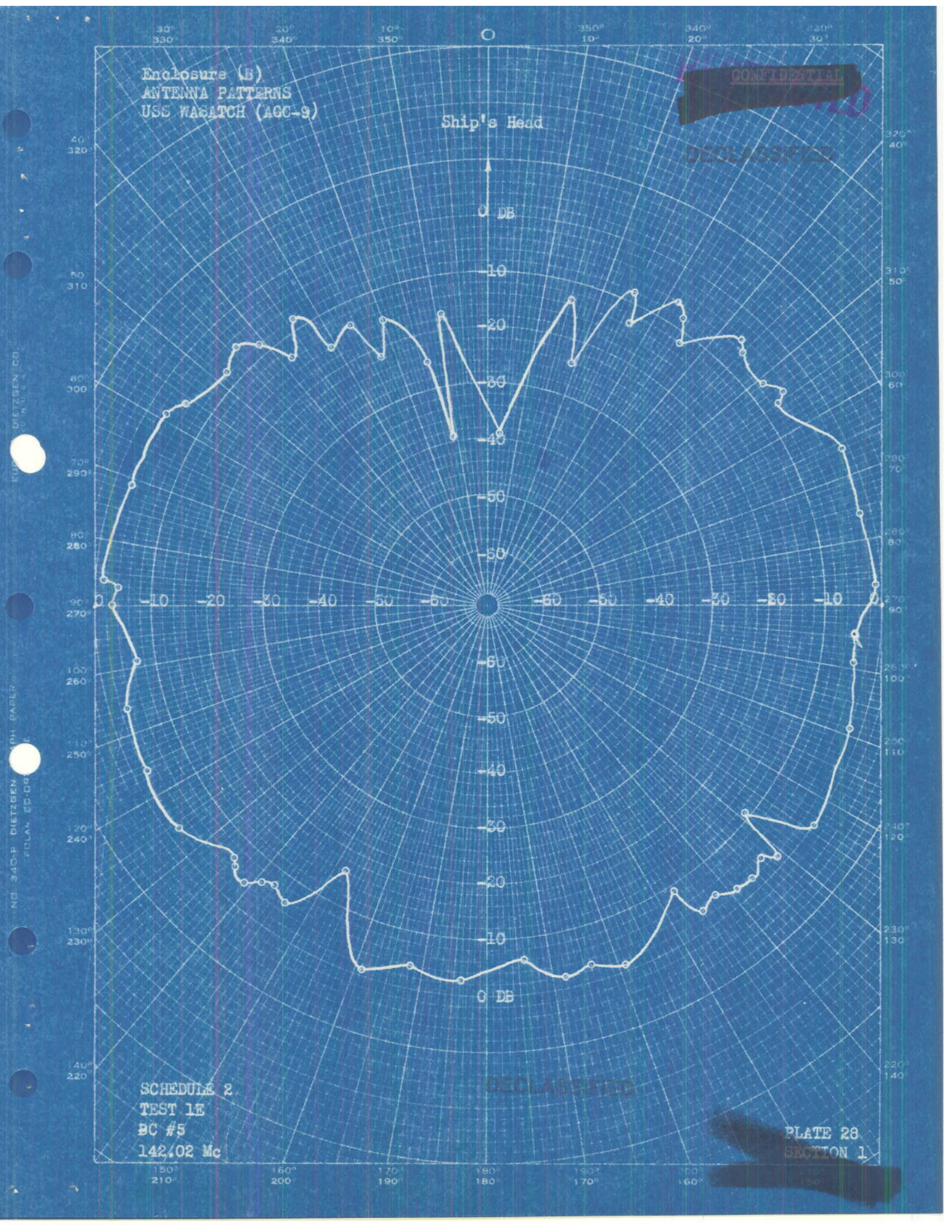

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
Ship's Head
CONFIDENTIAL
DECLASSIFIED
0 DB
-10
-20
-30
-40
-50
-60
0 -10 -20 -30 -40 -50 -60 -50 -40 -30 -20 -10 0
0 DB
SCHEDULE 1
TEST 4F
BC #4
142.02 Mc
DECLASSIFIED
PLATE 25
SECTION 1

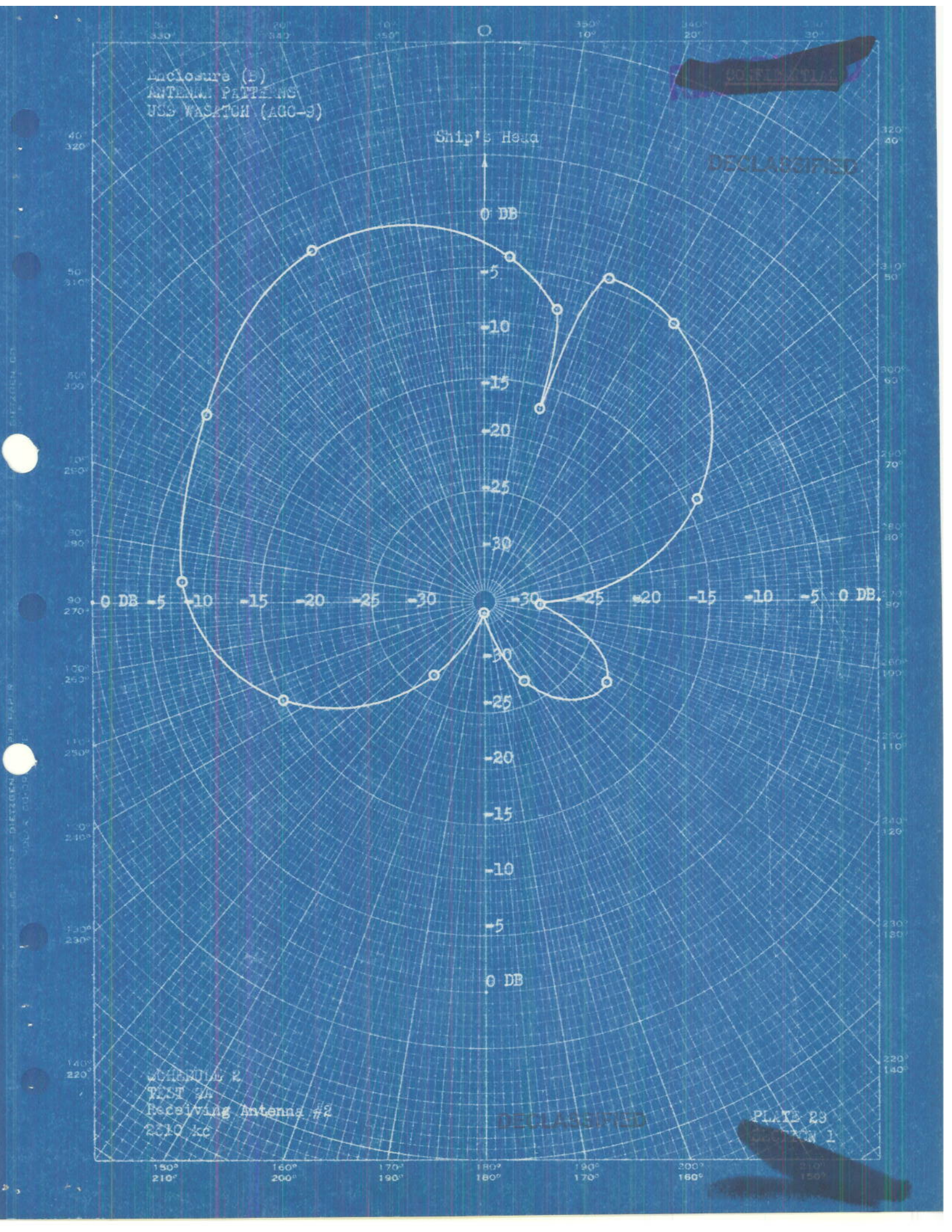

Enclosure (B)
ANTENNA PATTERNS
USS WAYNE (AGC-9)
CONFIDENTIAL
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 2
TEST 1A
Receiving Antenna #1
2510 kc
DECLASSIFIED
PLATE 24
SECTION 1

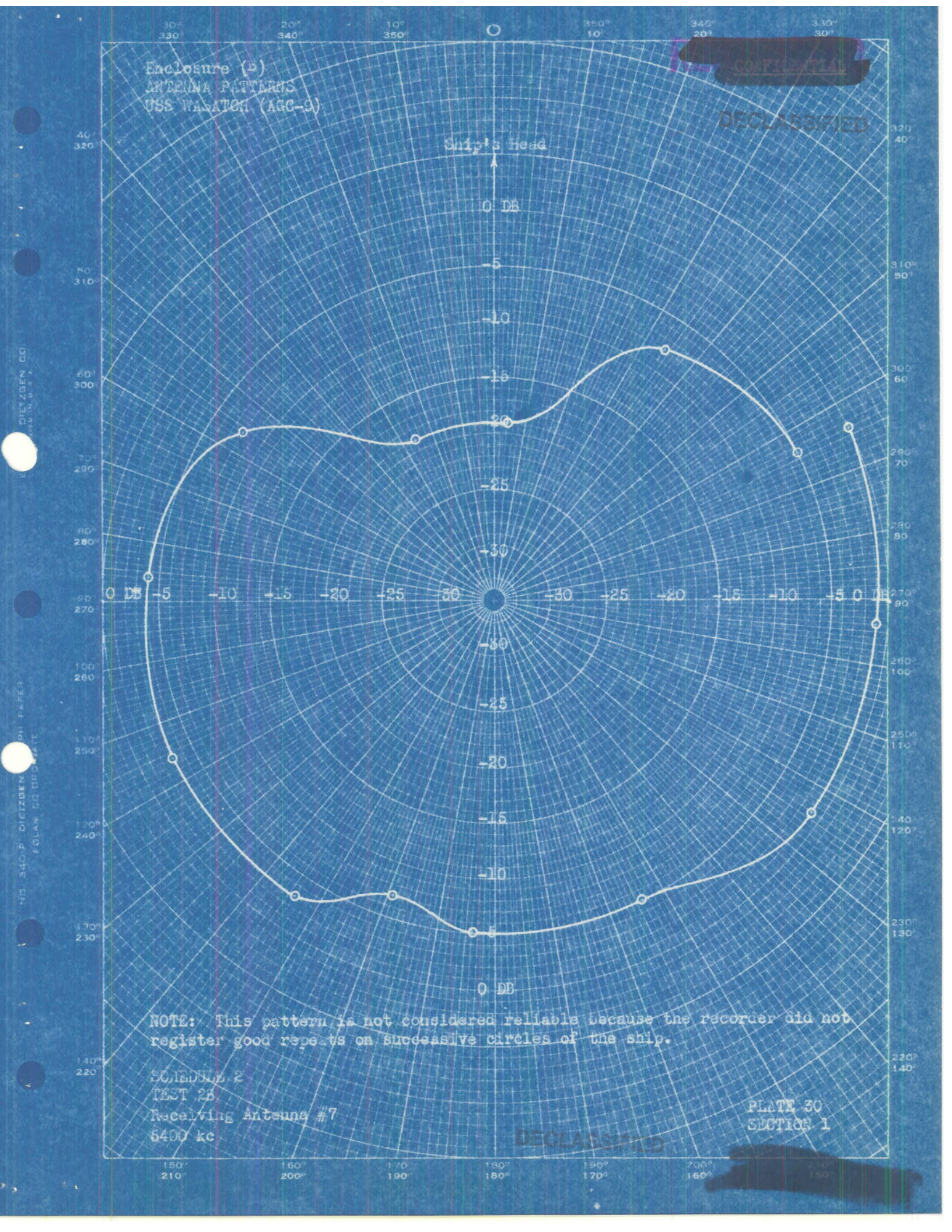

Enclosure (B)
ANTENNA PATTERNS
USS WACHTCH (DGC-9)
CONFIDENTIAL
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
0 DB
-5
-10
-15
-20
-25
-30
-30
-25
-20
-15
-10
-5
0 DB
DECLASSIFIED
SCHEDULE 2
TEST 1B
Receiving Antenna #6
5400 mc
PLATE 25
SECTION 1
CONFIDENTIAL

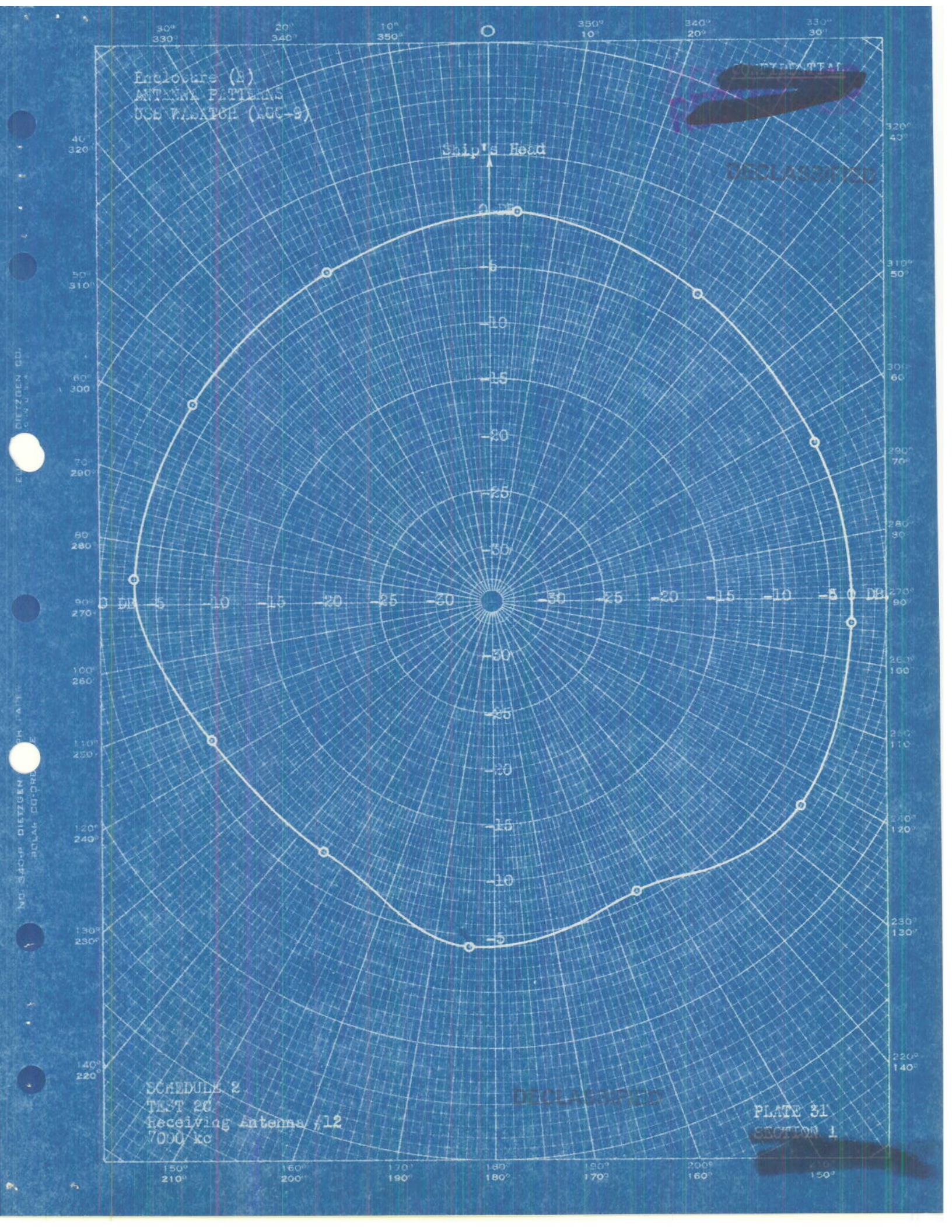

Enclosure (B)
ANTENNA PATTERNS
USS WASHTON (CG-3)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
0 DB
SCHEDULE 2
TEST 10
Receiving Antenna #11
7000 kc
PLATE 26
SECTION 1
DECLASSIFED
DECLASSIFED

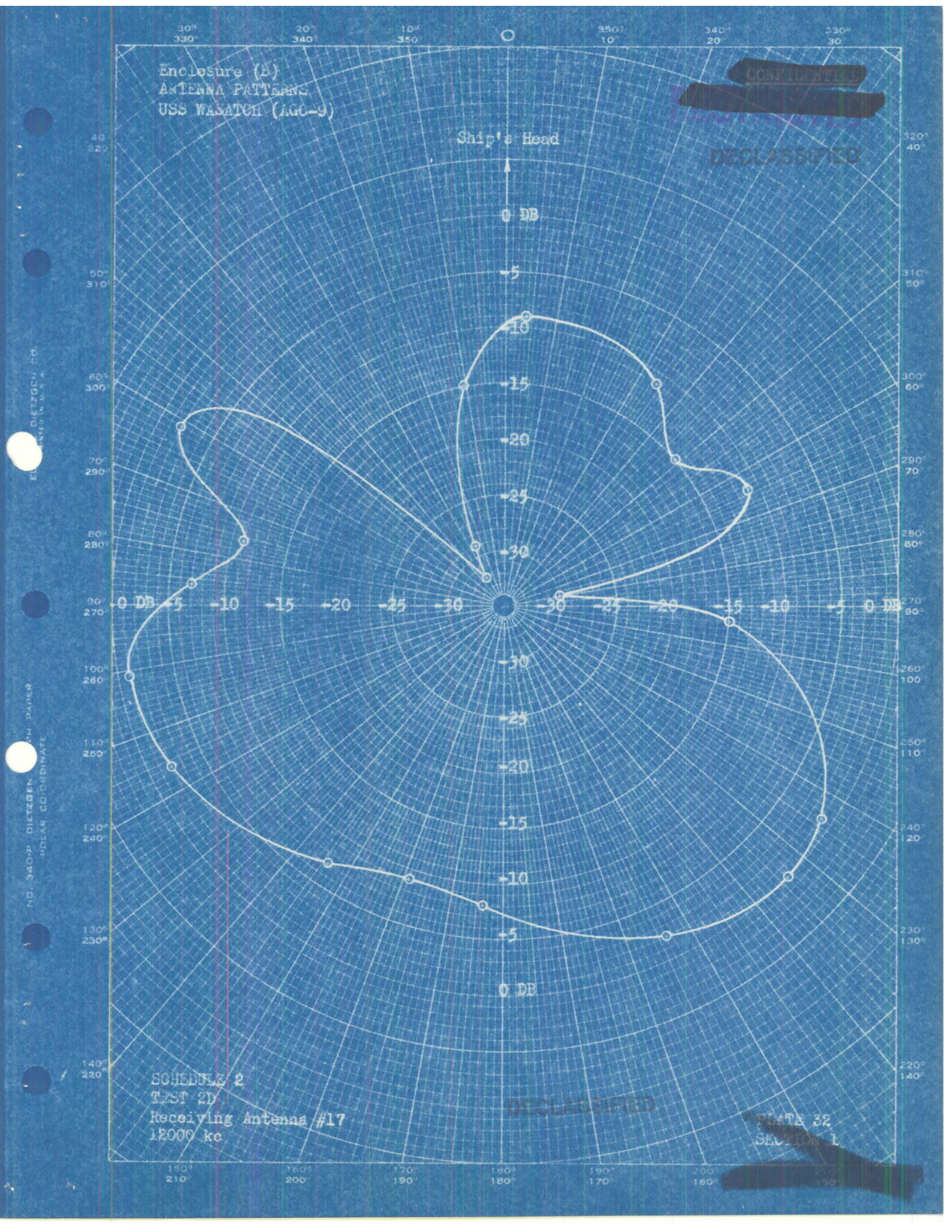

Enclosure (B)
ANTENNA PATTERN
USS WATCH (AGC-9)
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
-30
-25
-20
-15
-10
-5
0 DB
SCHEDULE 2
TEST 1D
Receiving Antenna #16
12000 kc
DECLASSIFIED
PLATE 27

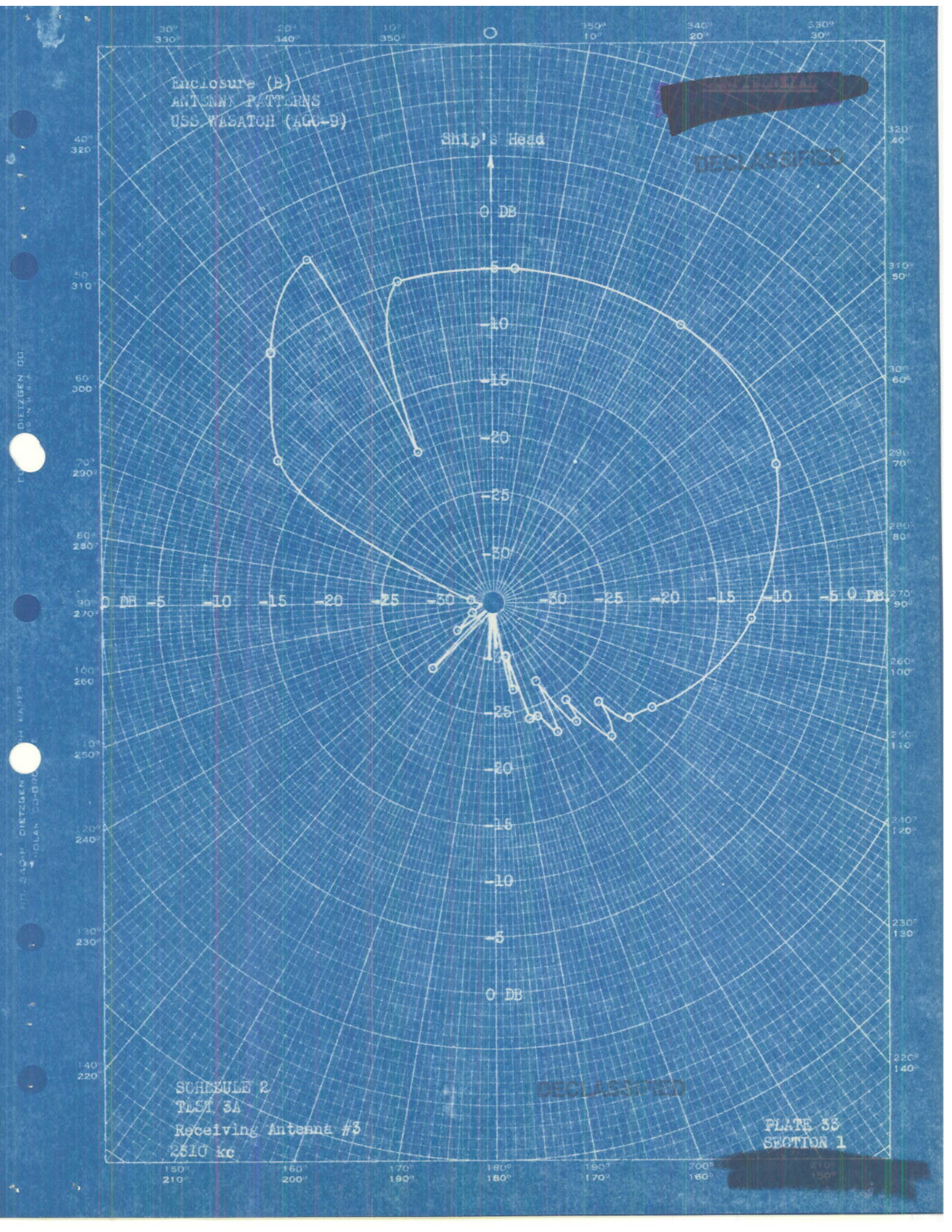

Enclosure (B)
ANTENNA PATTERNS
USS WABASH (AGC-9)
Ship's Head
0 DB
-10
-20
-30
-40
-50
-60
0 DB
SCHEDULE 2
TEST 1E
BC #5
142.02 Mc
PLATE 28
SECTION 1

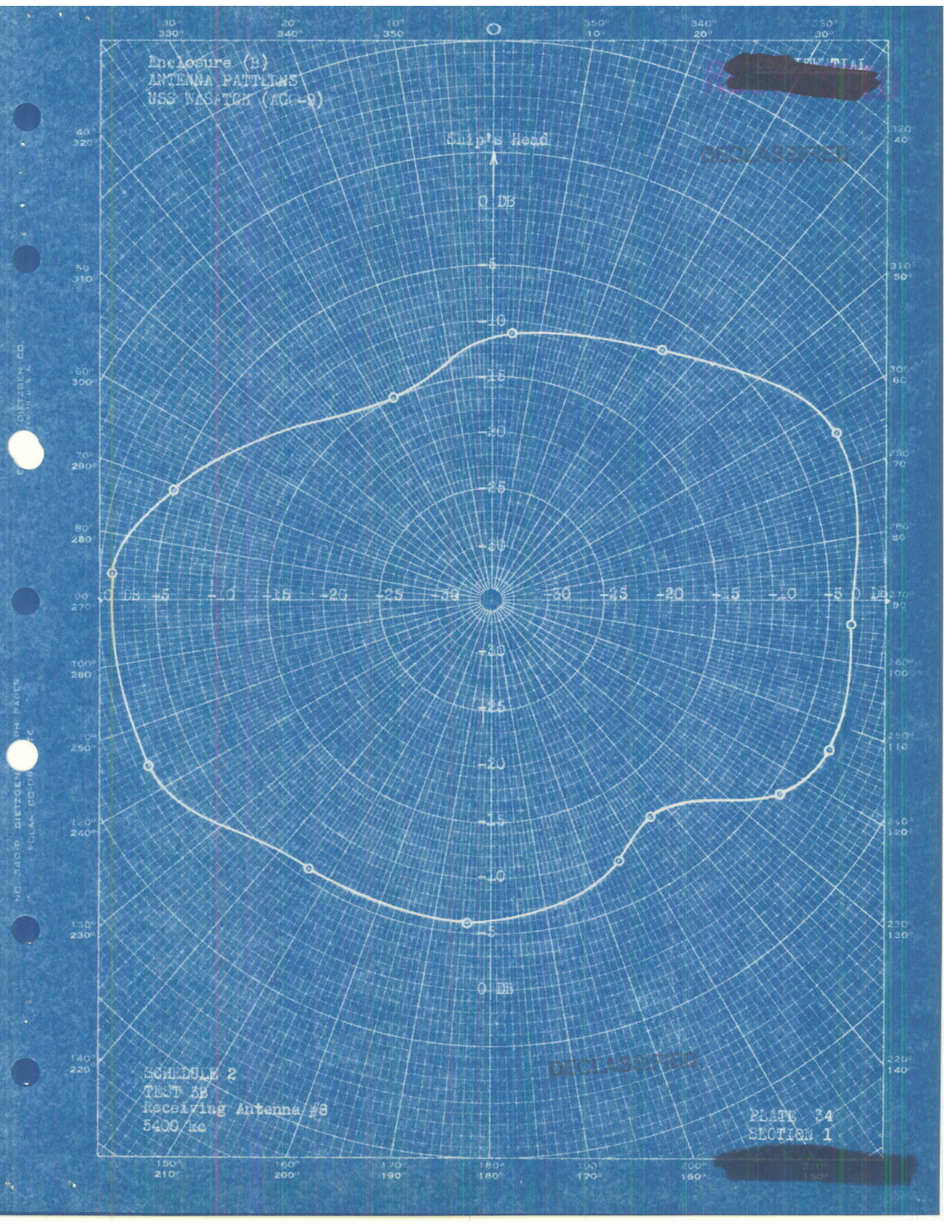

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB.
SCHEDULE 2
TEST 2A
Receiving Antenna #2
2210 kc
PLATE 23
SECTION 1
CONFIDENTIAL
DECLASSIFIED
DECLASSIFIED


Enclosure (B)
ANTENNA PATTERNS
USS WALATCH (AGC-9)
CONFIDENTIAL
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
NOTE: This pattern is not considered reliable because the recorder did not register good repeats on successive circles of the ship.
SCHEDULE 2
TEST 2B
Receiving Antenna #7
6400 kc
PLATE 30
SECTION 1
DECLASSIFIED

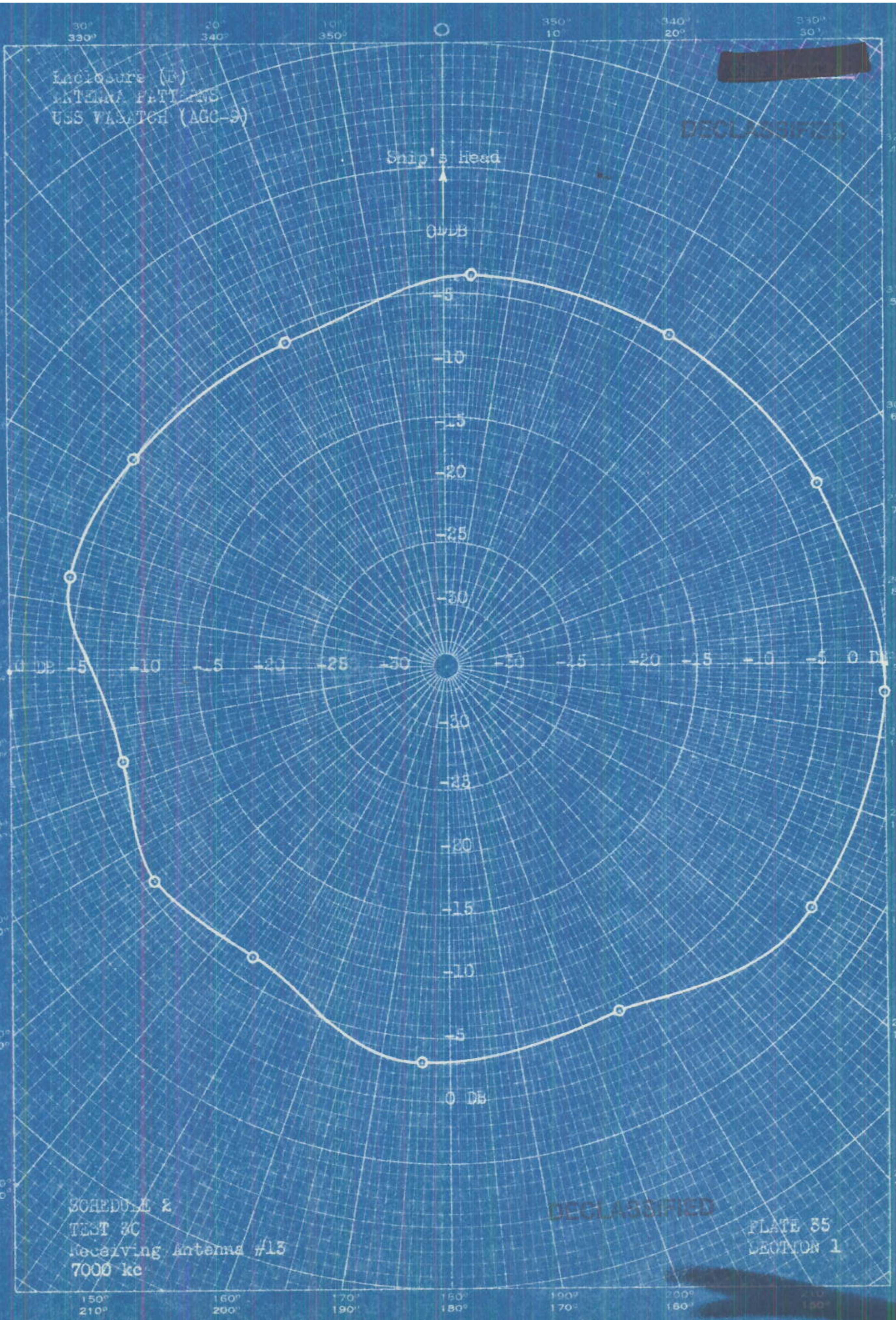

Enclosure (A)
ANTENNA PATTERNS
USS WALKER (DDE-794)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
SCHEDULE 2
TEST 2E
Receiving Antenna #12
7000 kc
PLATE 31
SECTION 1
DECLASSIFIED
CONFIDENTIAL


Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 2
TEST 2D
Receiving Antenna #17
12000 kc
DECLASSIFIED
DECLASSIFIED

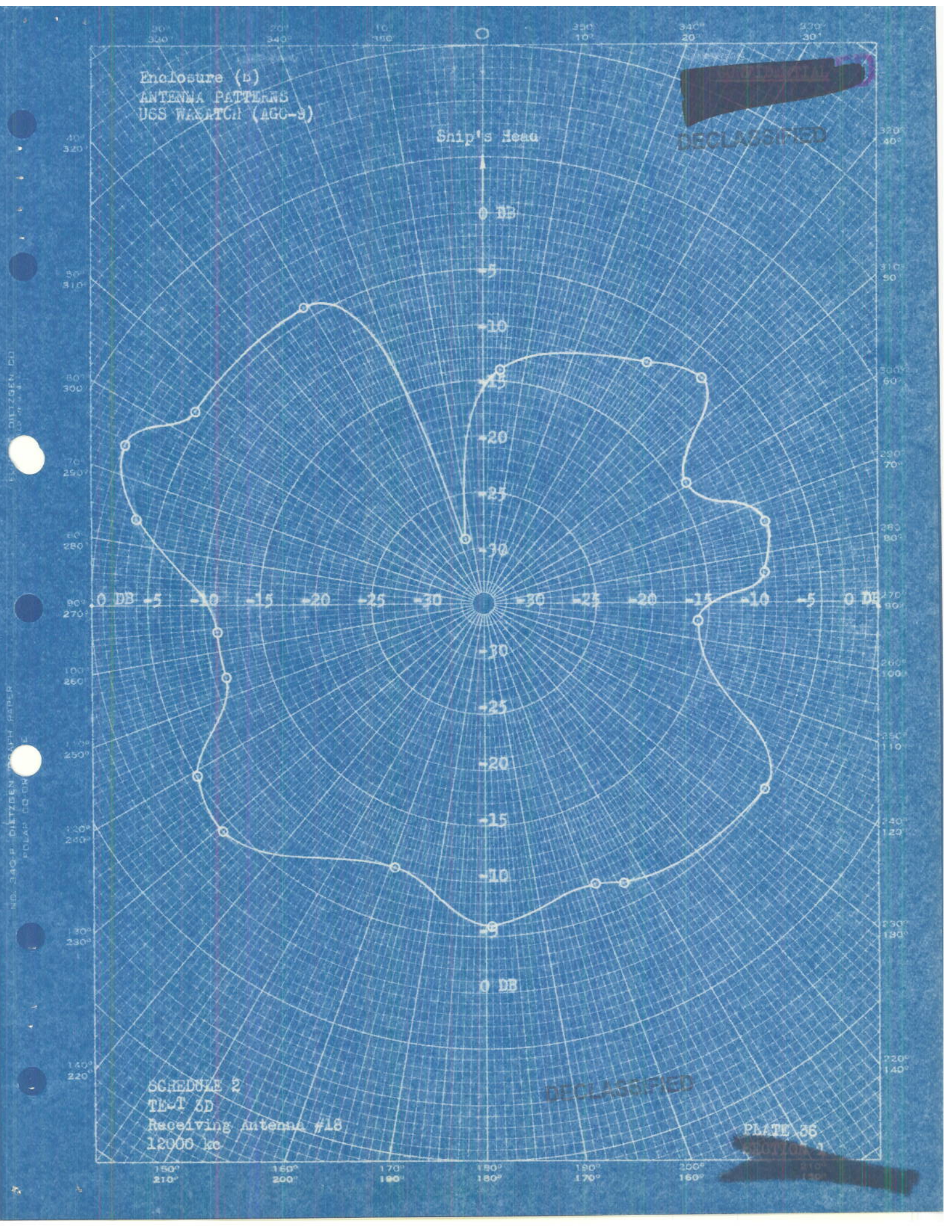

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 2
TEST 3A
Receiving Antenna #3
2810 kc
PLATE 35
SECTION 1
DECLASSIFIED
DECLASSIFIED

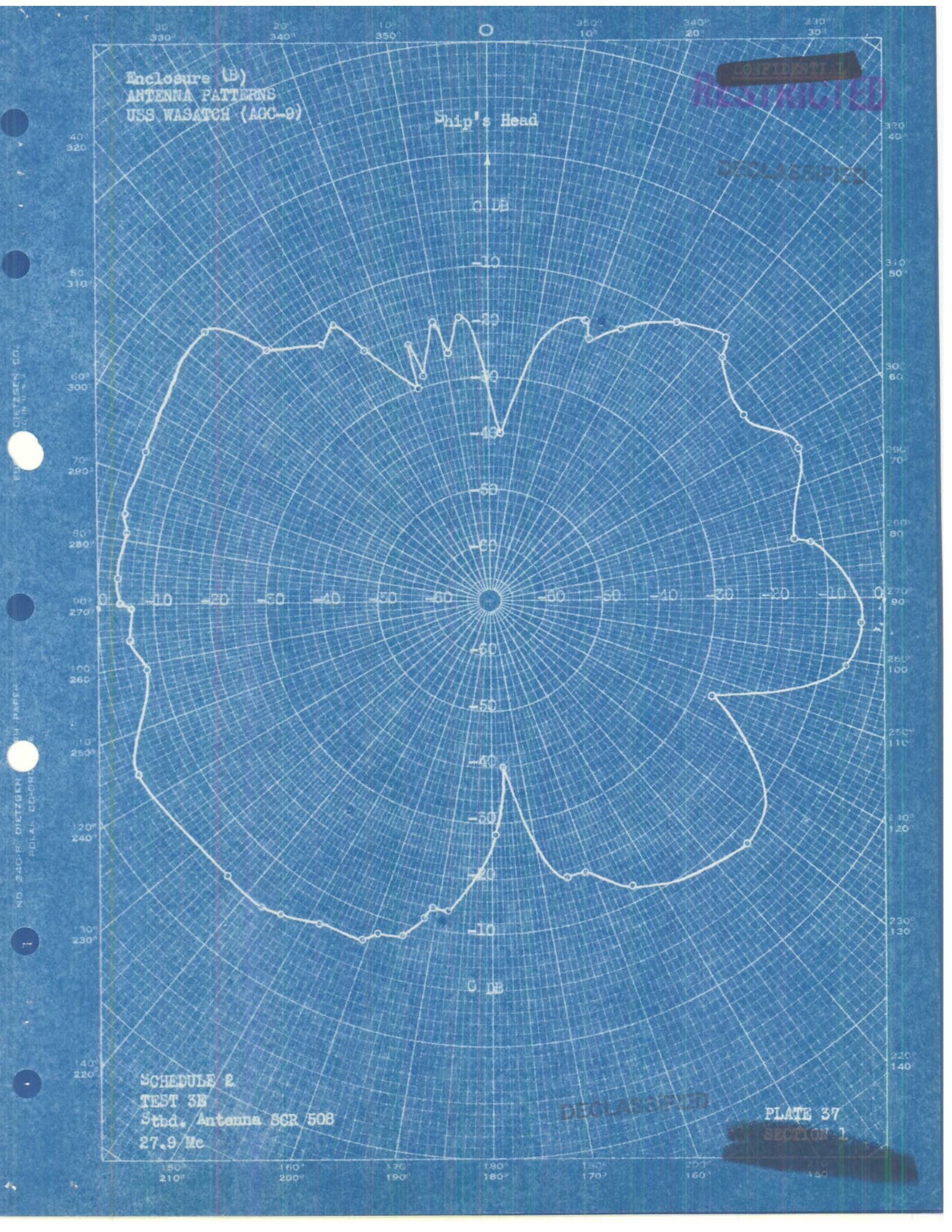

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
[redacted]
Ship's Head
DECLASSIFIED
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
-30
-25
-20
-10
-5
0 DB
DECLASSIFIED
SCHEDULE 2
TEST 3B
Receiving Antenna #8
5400 kc
PLATE 34
SECTION 1
[redacted]

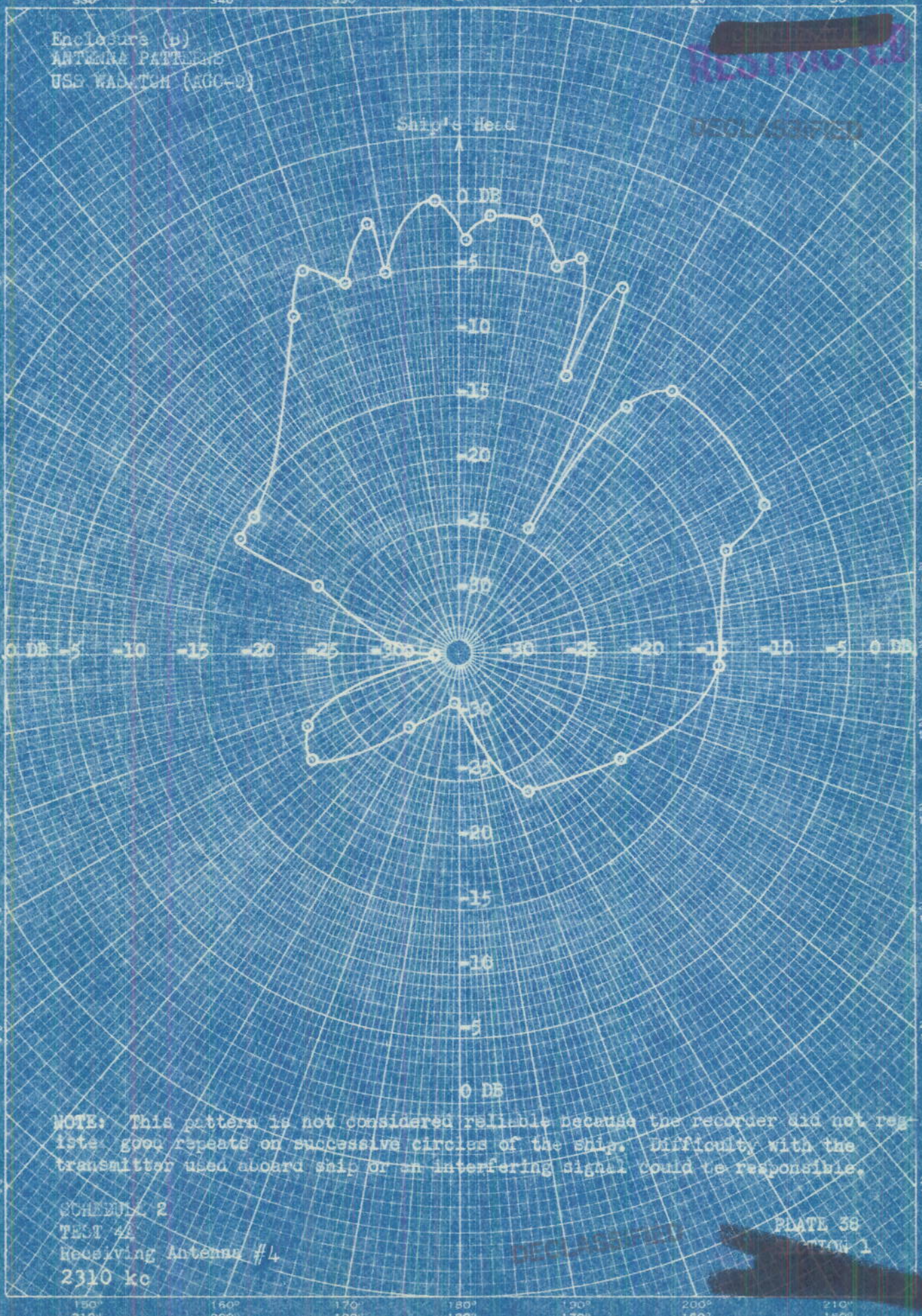
[redacted]

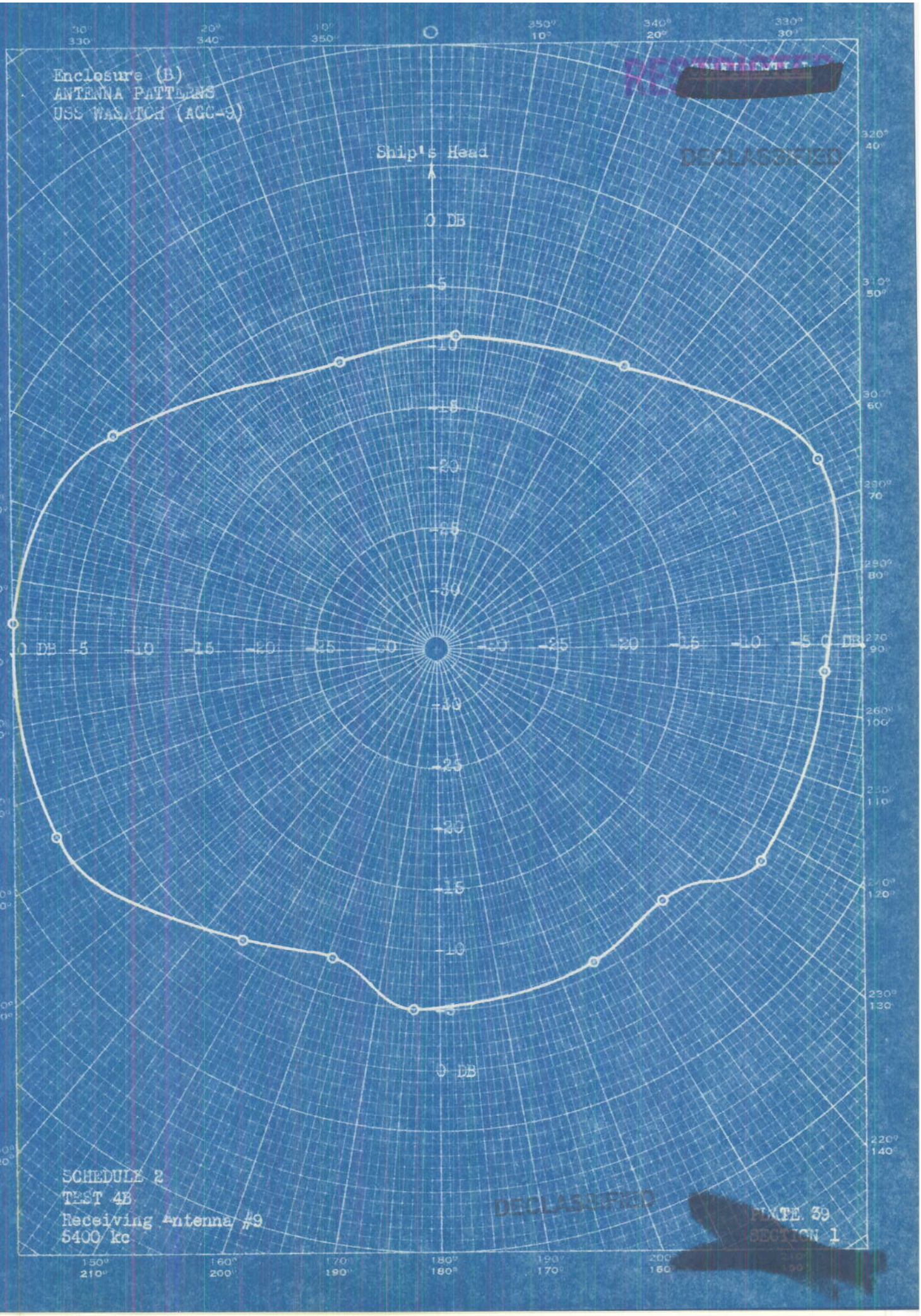


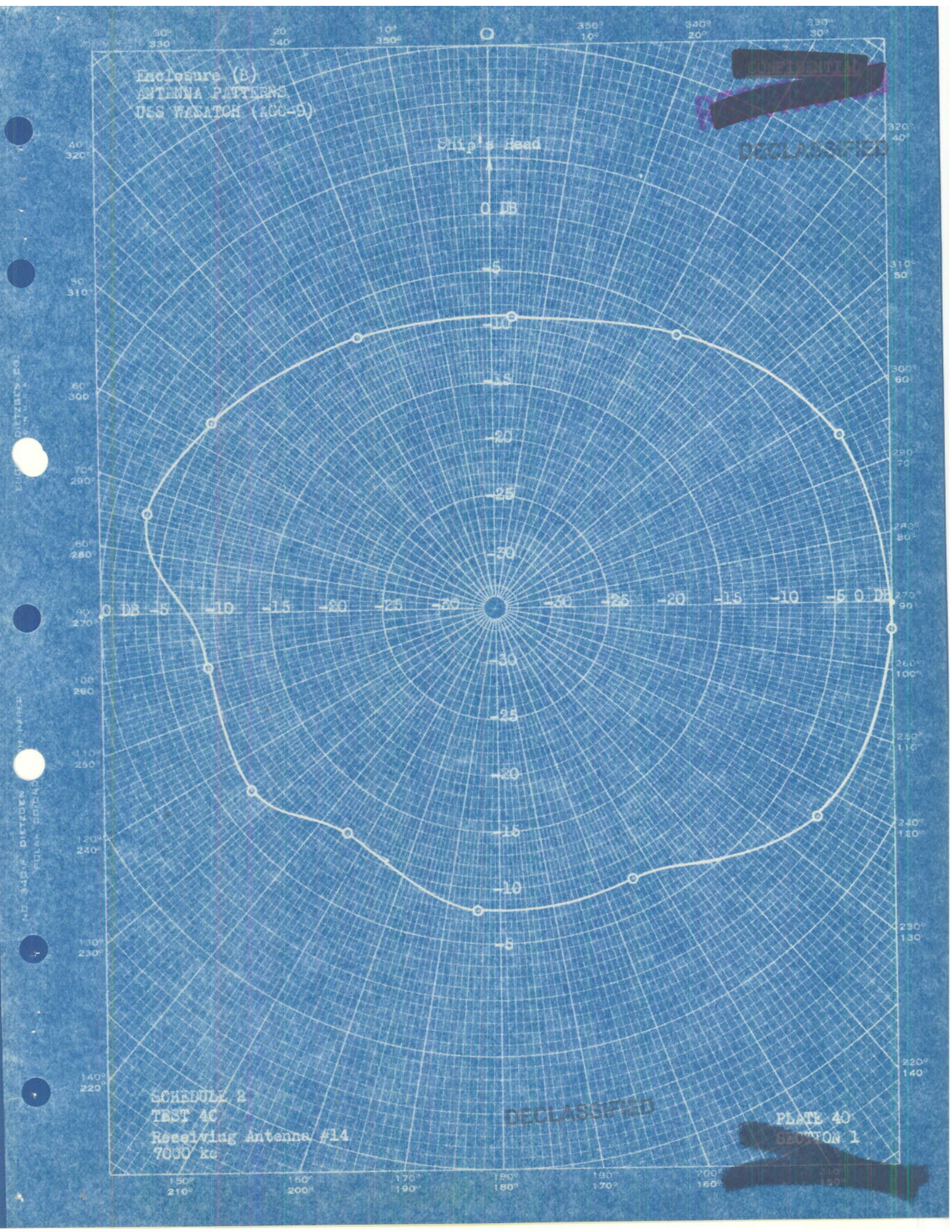
[redacted]

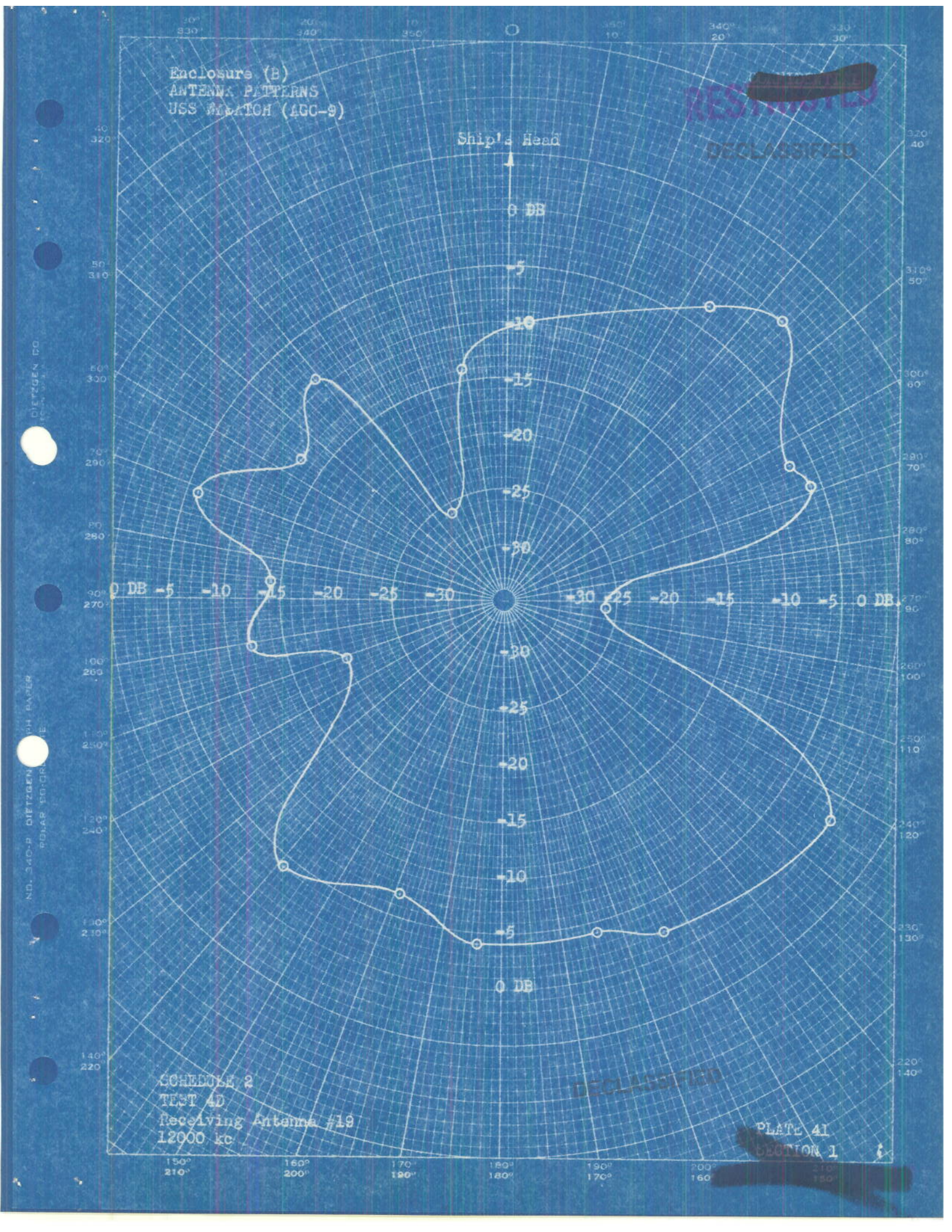


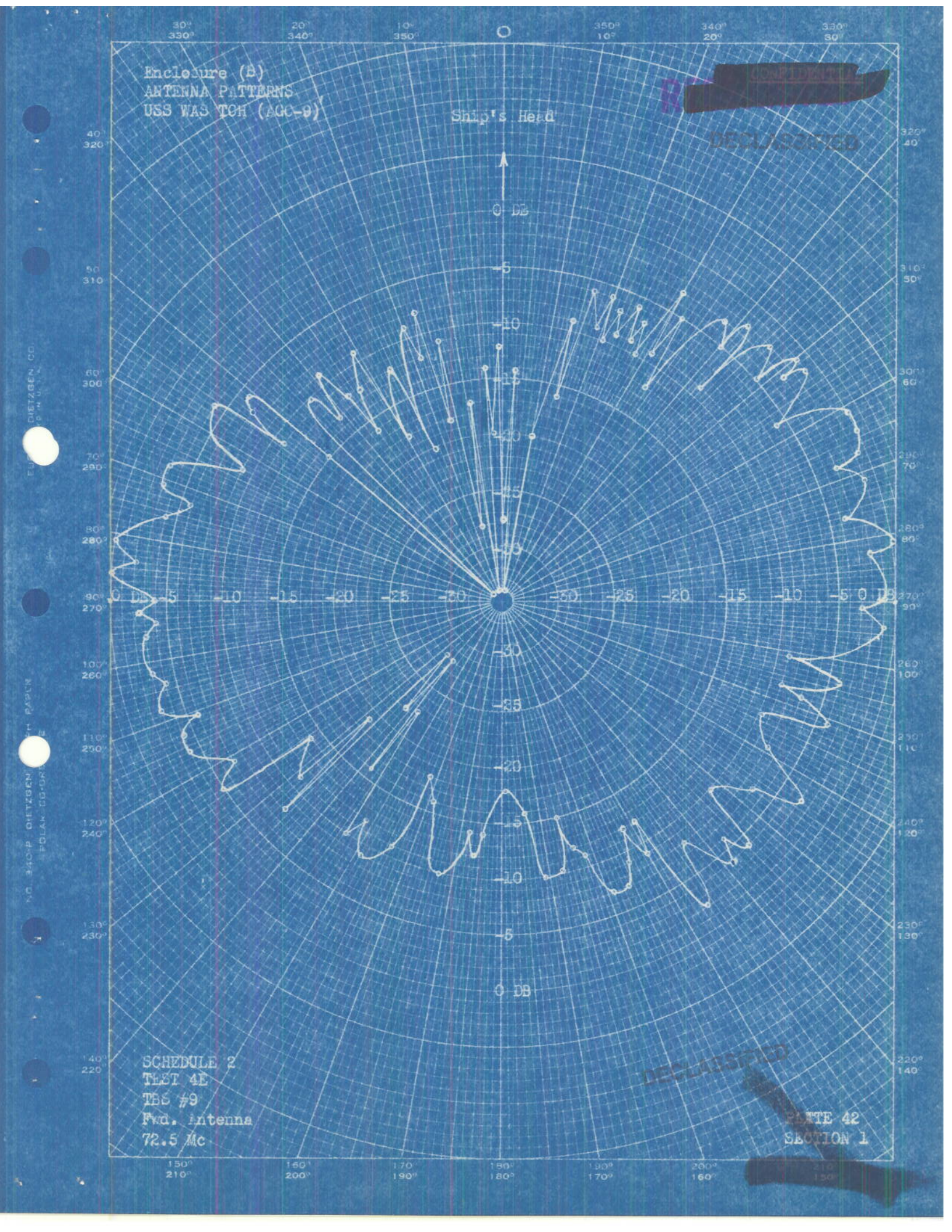

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
CONFIDENTIAL
RESTRICTED
DECLASSIFIED
Ship's Head
0 DB
-10
-20
-30
-40
-50
-60
0 -10 -20 -30 -40 -50 -60 -50 -40 -30 -20 -10 0
0 DB
SCHEDULE 2
TEST 3E
Stbd. Antenna SCR 508
27.9 Mc
DECLASSIFIED
PLATE 37
SECTION 1

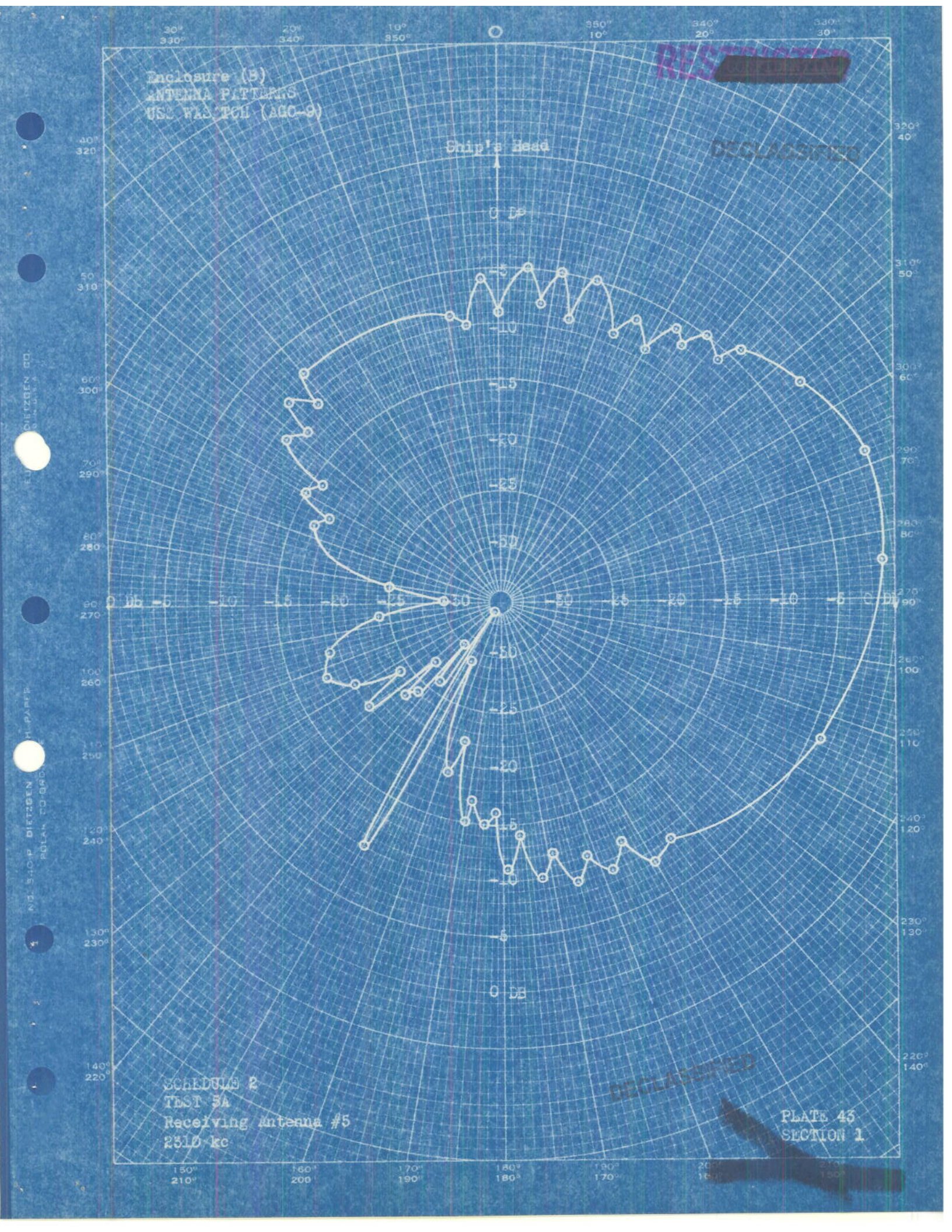

Enclosure (B)
ANTENNA PATTERNS
USS WASHTON (AGC-2)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
0 DB
-5
-10
-15
-20
-25
-30
-25
-20
-15
-10
-5
0 DB
NOTE: This pattern is not considered reliable because the recorder did not register good repeats on successive circles of the ship. Difficulty with the transmitter used aboard ship or an interfering signal could be responsible.
SCHEDULE 2
TEST 42
Receiving Antenna #4
2310 kc
PLATE 38

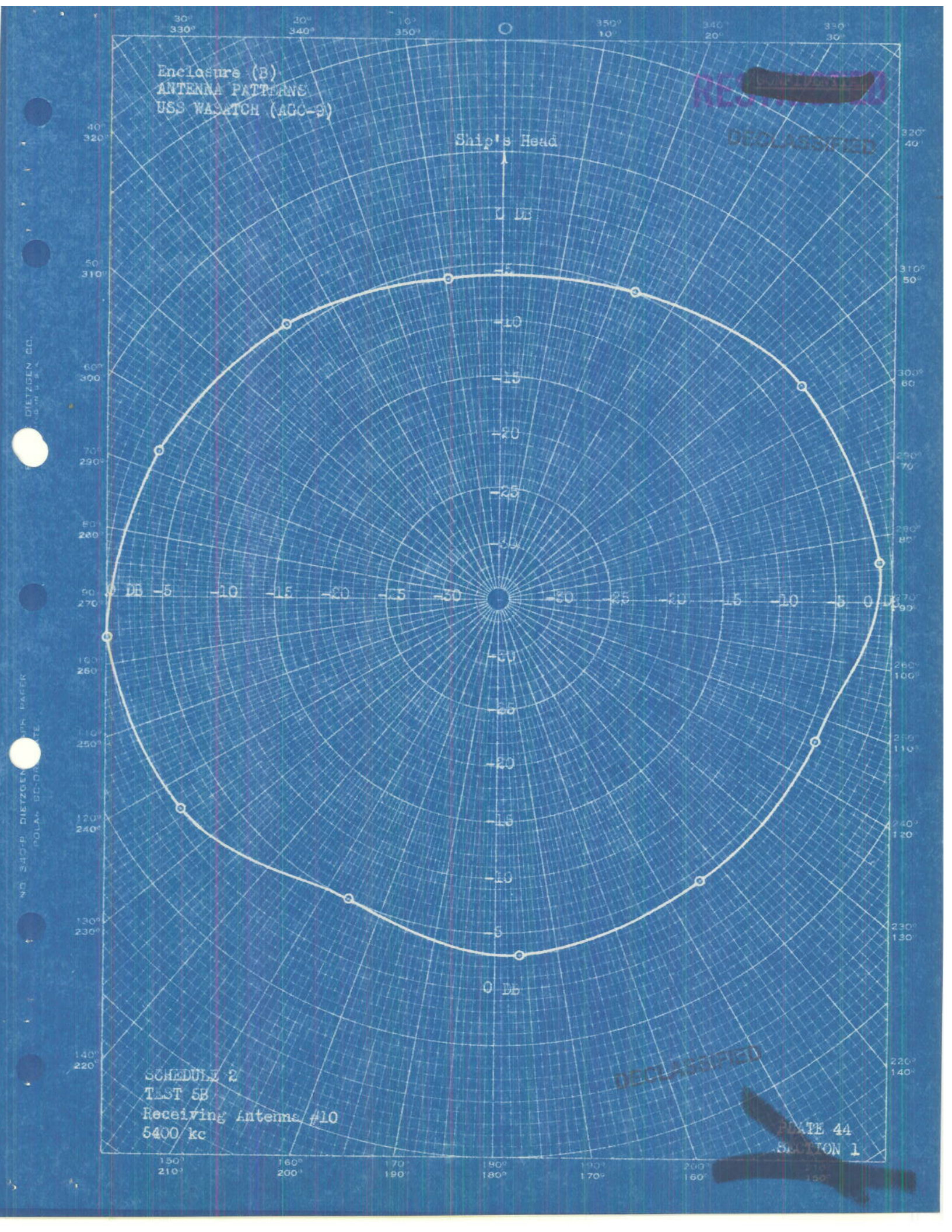

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
-35
-40
0 DB -5 -10 -15 -20 -25 -30 -35 -40 -25 -20 -15 -10 -5 0 DB
SCHEDULE 2
TEST 4B
Receiving Antenna #9
5400 kc
DECLASSIFIED
DECLASSIFIED
PLATE 39
SECTION 1

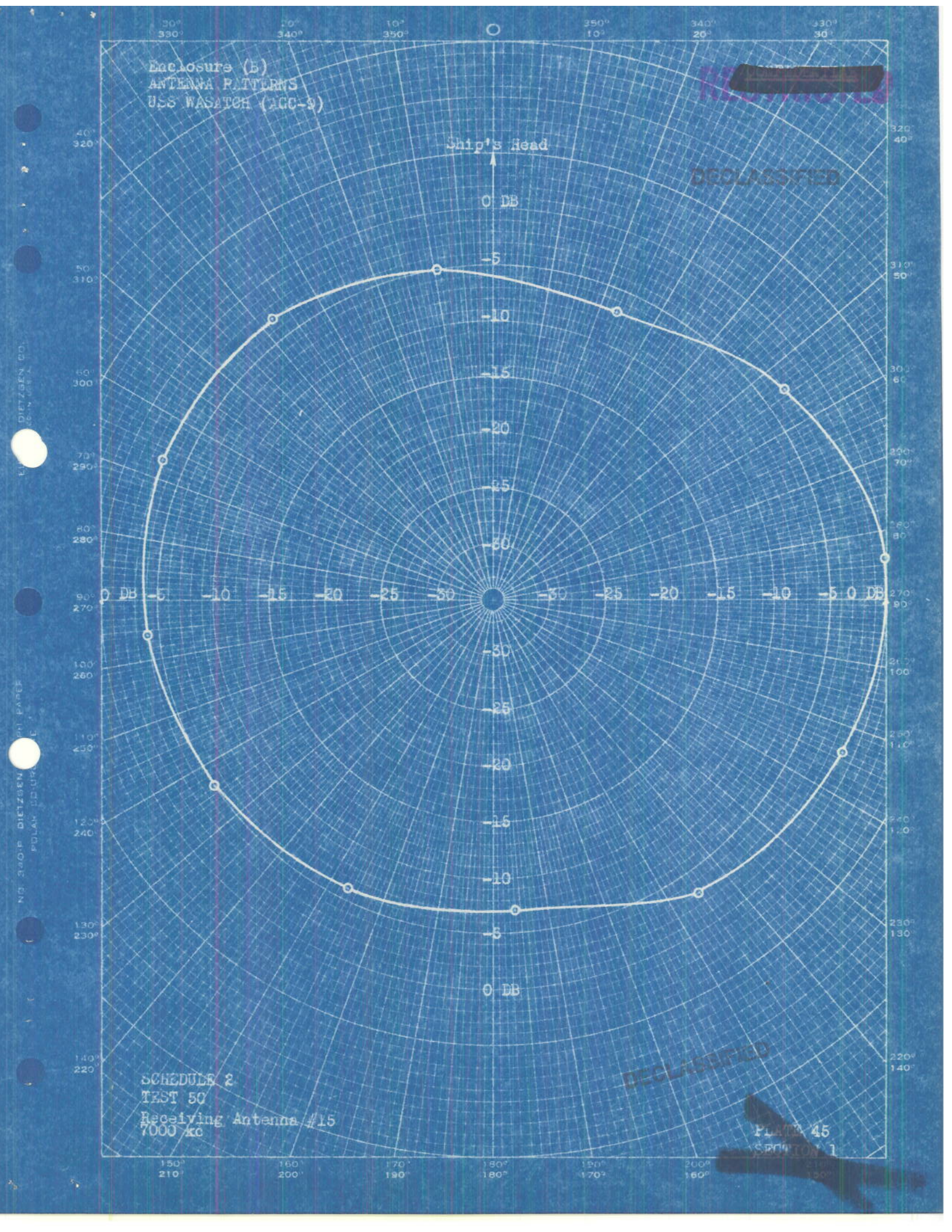

Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (ACC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
SCHEDULE 2
TEST 4C
Receiving Antenna #14
7030 kc
PLATE 40
SECTION 1
DECLASSIFIED
DECLASSIFIED

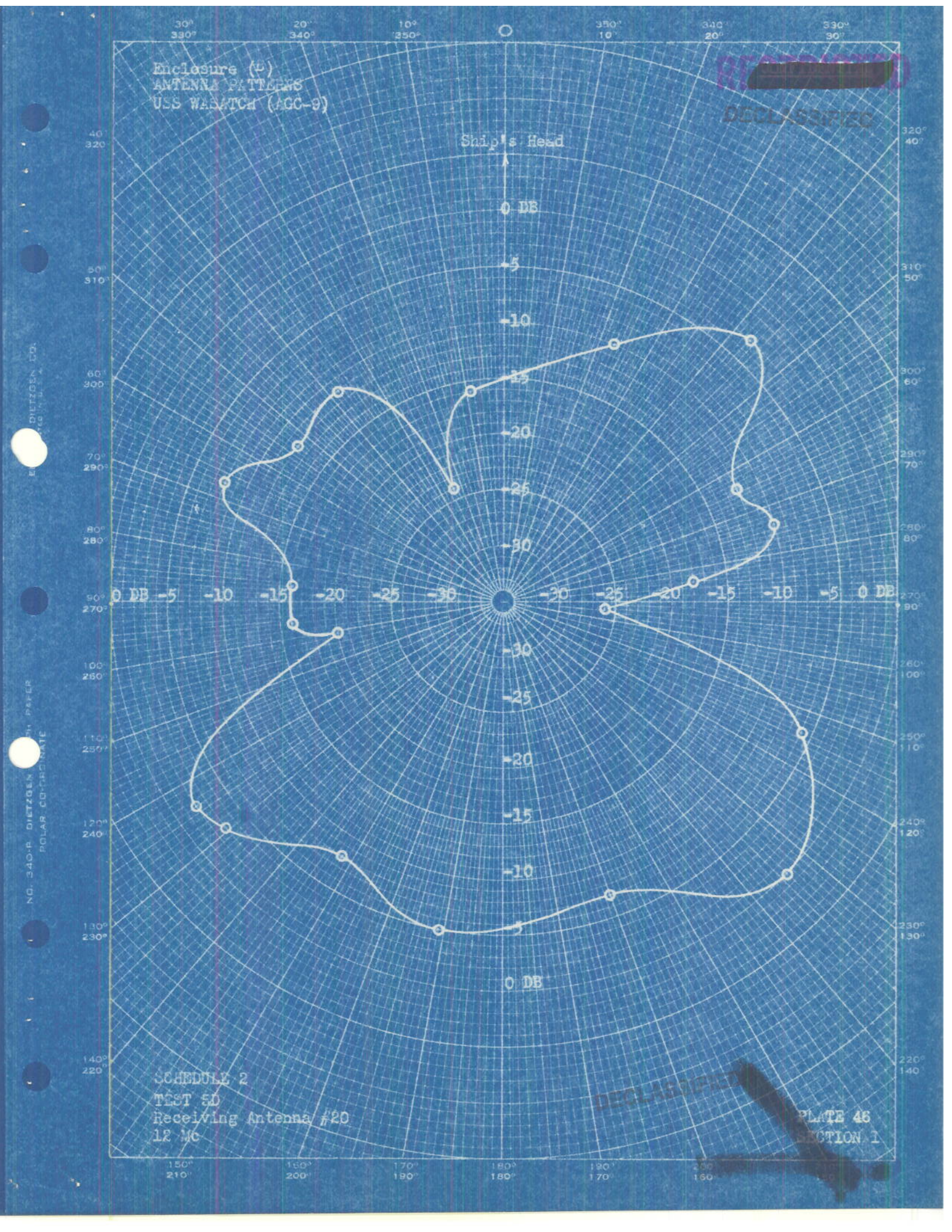

Enclosure (B)
ANTENNA PATTERNS
USS MISAICH (AGC-9)
RESTRICTED
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30
-30 -25 -20 -15 -10 -5 0 DB
0 DB
SCHEDULE 2
TEST 4D
Receiving Antenna #19
12000 kc
DECLASSIFIED
PLATE 41
SECTION 1


Enclosure (E)
ANTENNA PATTERNS
USS WAS TOH (AGC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
-35
0 DB -5 -10 -15 -20 -25 -30 -35 -30 -25 -20 -15 -10 -5 0 DB
-30
-35
-20
-5
-10
-5
0 DB
SCHEDULE 2
TEST 4E
TBS #9
Fwd. Antenna
72.5 Mc
PLATE 42
SECTION 1
CONFIDENTIAL
DECLASSIFIED
DECLASSIFIED


Enclosure (5)
ANTENNA PATTERNS
USS WASHTON (AGC-9)
RESTRICTED
DECLASSIFIED
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
-25
-20
-15
-10
-5
0 DB
0 Db -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 Db
SCHEDULE 2
TEST 5A
Receiving Antenna #5
2310 kc
DECLASSIFIED
PLATE 43
SECTION 1


Enclosure (B)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
0 Db
SCHEDULE 2
TEST 5B
Receiving Antenna #10
5400 kc
PLATE 44
SECTION 1
DECLASSIFIED
DECLASSIFIED


Enclosure (5)
ANTENNA PATTERNS
USS WASATCH (ACC-3)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -25 -20 -15 -10 -5 0 DB
-30
-25
-20
-15
-10
-5
0 DB
SCHEDULE 2
TEST 50
Receiving Antenna #15
7000 kc
DECLASSIFIED
DECLASSIFIED


Enclosure (4)
ANTENNA PATTERNS
USS WASATCH (AGC-9)
Ship's Head
0 DB
-5
-10
-15
-20
-25
-30
0 DB -5 -10 -15 -20 -25 -30 -20 -25 -20 -15 -10 -5 0 DB
SCHEDULE 2
TEST 5D
Receiving Antenna #20
12 MC
PLATE 46
SECTION I
DECLASSIFIED
NO. 340-P DIETZGEN POLAR CO-ORDINATE

SECTION 2

Coverage Diagrams of Radar Equipments on U.S.S. Wasatch (AGC-9).

Enclosures: Graphs (Plates 1 through 12).

2-1. This report covers tests made on the radar and IFF antennas of the AGC-9 on 10 June 1944 near the Naval Research Laboratory Chesapeake Bay Annex. Measurements were made on the SK-2, BM, forward BN, and YG-1 antennas. Data on the SK-2, amidships BN, BK, and YG-1 antennas of the AGC-7 taken during a similar test are included for further information.

2-2. In obtaining the coverage diagram for a non-directional antenna, the antenna was excited with a low power cw oscillator. The signal was received on an APR-1 receiver aboard a test vessel (YP-354) which circled the ship at approximately 2000 yards. The range and bearing of the YP-354 were recorded every 30 seconds by the SG operator and were relayed to the YP-354, where an observer recorded the received signal for various relative bearings. The procedure for a directional antenna was identical, except that the antenna was kept trained on the test vessel by means of the bearings obtained on the SG. For the YG-1 antenna, which rotates at 2 r.p.m. it was necessary to note the peak reading as the beam swept past.

2-3. The YG-1 pattern was obtained in a manner similar to the coverage diagrams, except that the antenna was held fixed while the YP-354 circled the ship. In previous tests this method of obtaining antenna patterns was used exclusively. Here, however, the SK-2 and BM patterns were taken with the YP-354 anchored at 2000 yards and 290° relative. The antenna was rotated manually and the signal received on the APR-1 recorded for various relative bearings.

2-4. The observed signal strengths were corrected to a range of 2000 yards by the following formulas:

For vertical polarization,

$$F_{2000} = F_d \cdot \frac{d}{2000} \left[(1-k)^2 + 4k \cos^2 \frac{\phi}{2} \right]^{-\frac{1}{2}}$$

and for horizontal polarization,

$$F_{2000} = F_d \cdot \frac{d}{2000} \left[2 \sin \left(0.122^\circ \cdot \frac{f h_t h_r}{d} \right) \right]^{-1}$$

where

F_{2000} = field strength at 2000 yards.

F_d = field strength at d yards.

d = range in yards.

h_t = height of transmitting antenna in feet.

h_r = height of receiving antenna in feet (28 ft.).

f = frequency in megacycles per second.

k = absolute value of reflection coefficient of sea water at frequency used.

$\Phi = \zeta - \alpha$

α = phase lag in degrees on reflection for sea water.

ζ = phase lag in degrees due to path difference of direct and reflected rays = $0.244^\circ \cdot \frac{h_t h_r}{d}$

2-5. The relative field strength which would have been observed at a range of 2000 yards was then plotted against relative bearing for each of the runs. The results are given in Plates 1 to 11, which are largely self-explanatory. The coverage diagrams may be interpreted as the relative maximum ranges at which aircraft may be detected at different bearings, providing the comparison is made on aircraft at the same angle of elevation. This follows from the law of radar response which states that received power is inversely proportional to the fourth power of the range, in the case of aircraft. The present coverage patterns are plotted in "one-way" field strength, so that the received power in radar operation will be proportional to the fourth power of these curves. Thus maximum range is proportional to the coverage curves. On surface targets the maximum range is proportional to the square root of the coverage curve because of the inverse eighth power of the distance law which applies in that case.

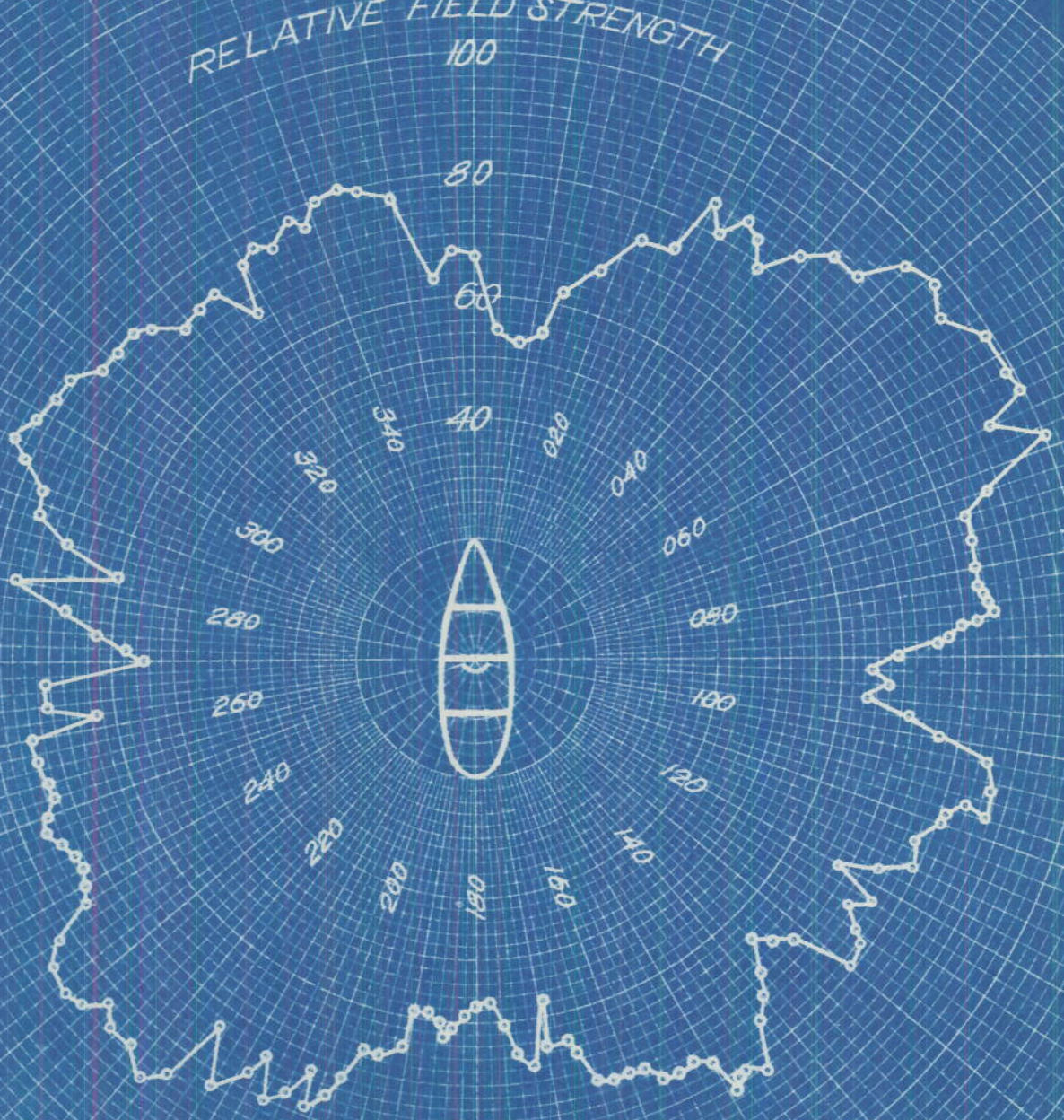
2-6. Most of the dips in the coverage patterns are due to definite parts of the ship's superstructure, such as the SK-2, SG, and YG-1 antennas and their masts, the yard arms, and the king posts. Some of the fine structure in the patterns may be due to the vertical feeders to the communication antennas. It should be borne in mind that metal parts a few degrees below the level of the antenna may obstruct the wave that would otherwise reflect from the water and thus produce a dip in the coverage pattern.

[redacted]

2-7. The coverage of the SK-2 and the BM are similar and quite uniform, with the exception of a slight dip near 000° and a rather broad one near 180°. The diagrams of the BN's and BK's are extremely ragged. Since the worst dip occurs on the side of the ship opposite the antenna, it seems that better performance would be obtained with one BN and one BK on each side of the ship, rather than with both BN's on one side and both BK's on the other.

2-8. It is felt that the antenna patterns obtained by the method used here are quite reliable. The SK-2 has a beam width (at half power) of 27° and no lobes greater than 6%. The BM has a beam width of 20° and lobes as high as 31%, while the width of the YG-1 pattern is 46° with a 13% lobe.

2-9. Plate 12 is an approximate theoretical vertical coverage diagram of the SK-2, showing the locations of the lobes and nulls for an antenna height of 110 feet.



COVERAGE OF SK-2 ANTENNA
USS MT. McKINLEY
AGC-7

27 MAY 1944

PLATE 1

SEC. 2

KEUFFEL & ESSER CO. N[illegible] 343B
POLAR CO-ORDINATE

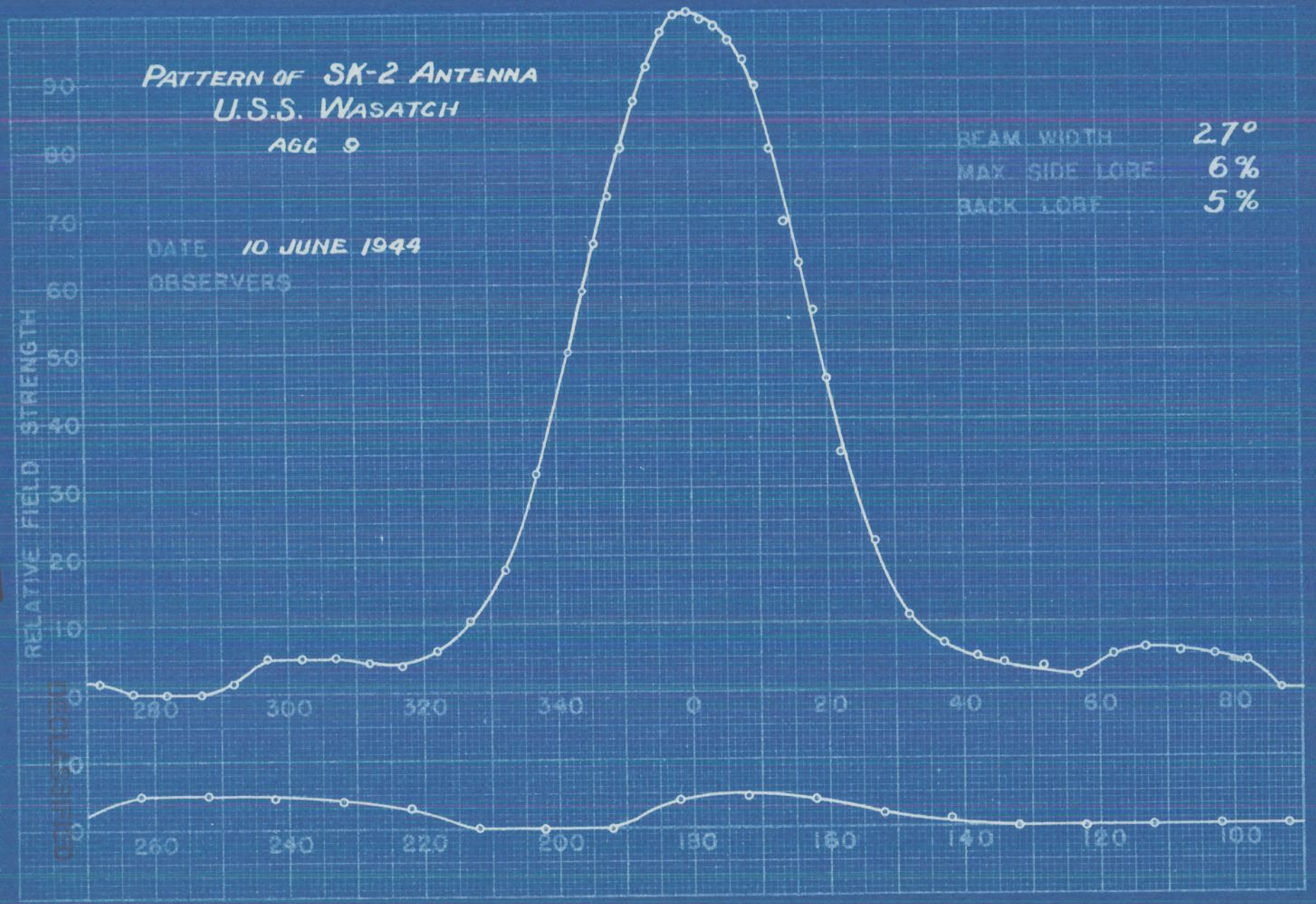
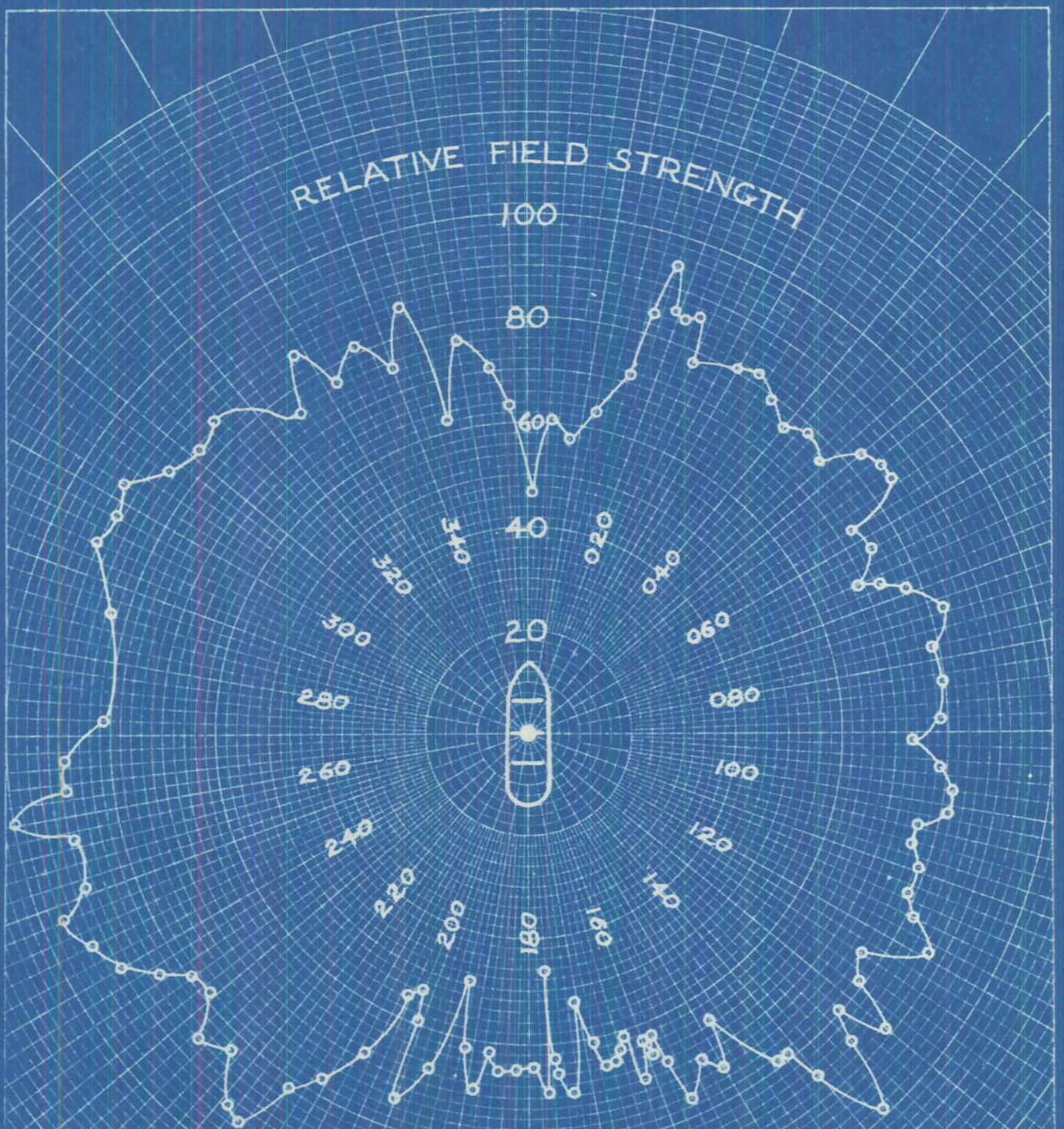


PLATE 2

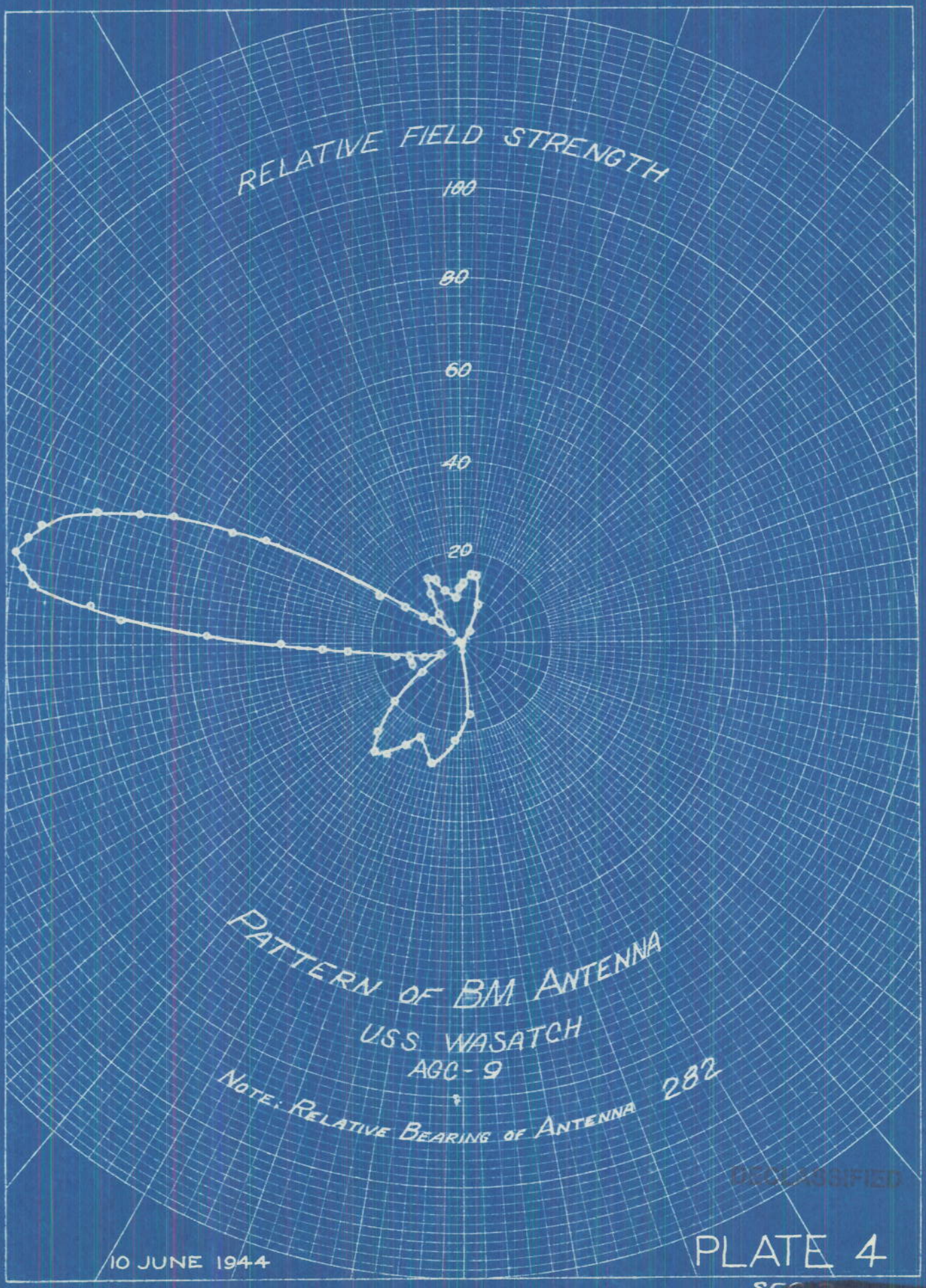


COVERAGE OF BM ANTENNA
USS WASATCH
AGC-9

10 JUNE 1944

PLATE 3

SEC. 2



PATTERN OF BM ANTENNA

USS WASATCH
AGC-9

NOTE: RELATIVE BEARING OF ANTENNA 282

10 JUNE 1944

PLATE 4

SEC-12

KEUFFEL & ESSER CO. N.Y. NO. 3448
POLAR CO-ORDINATE
MADE IN U.S.A.

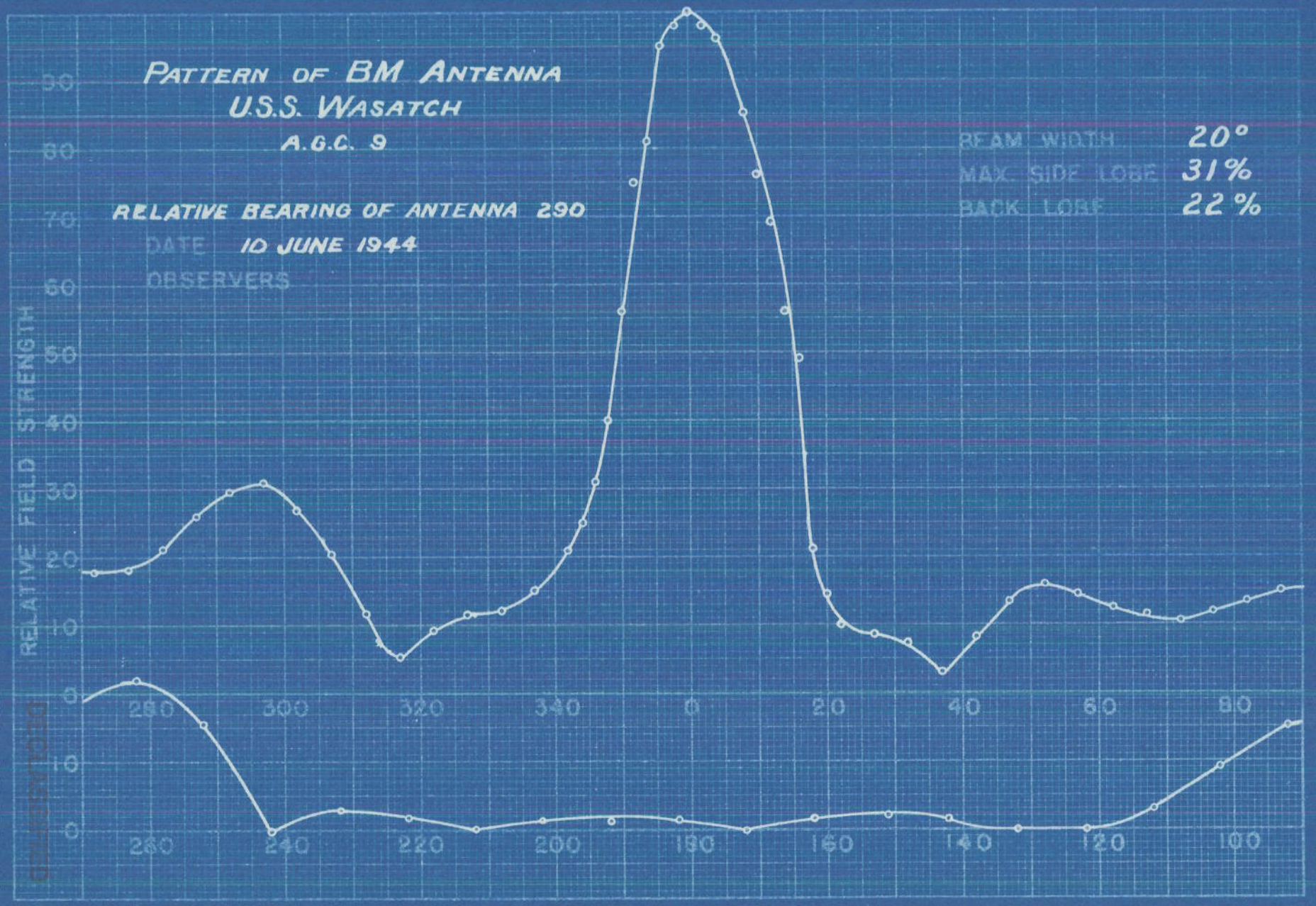
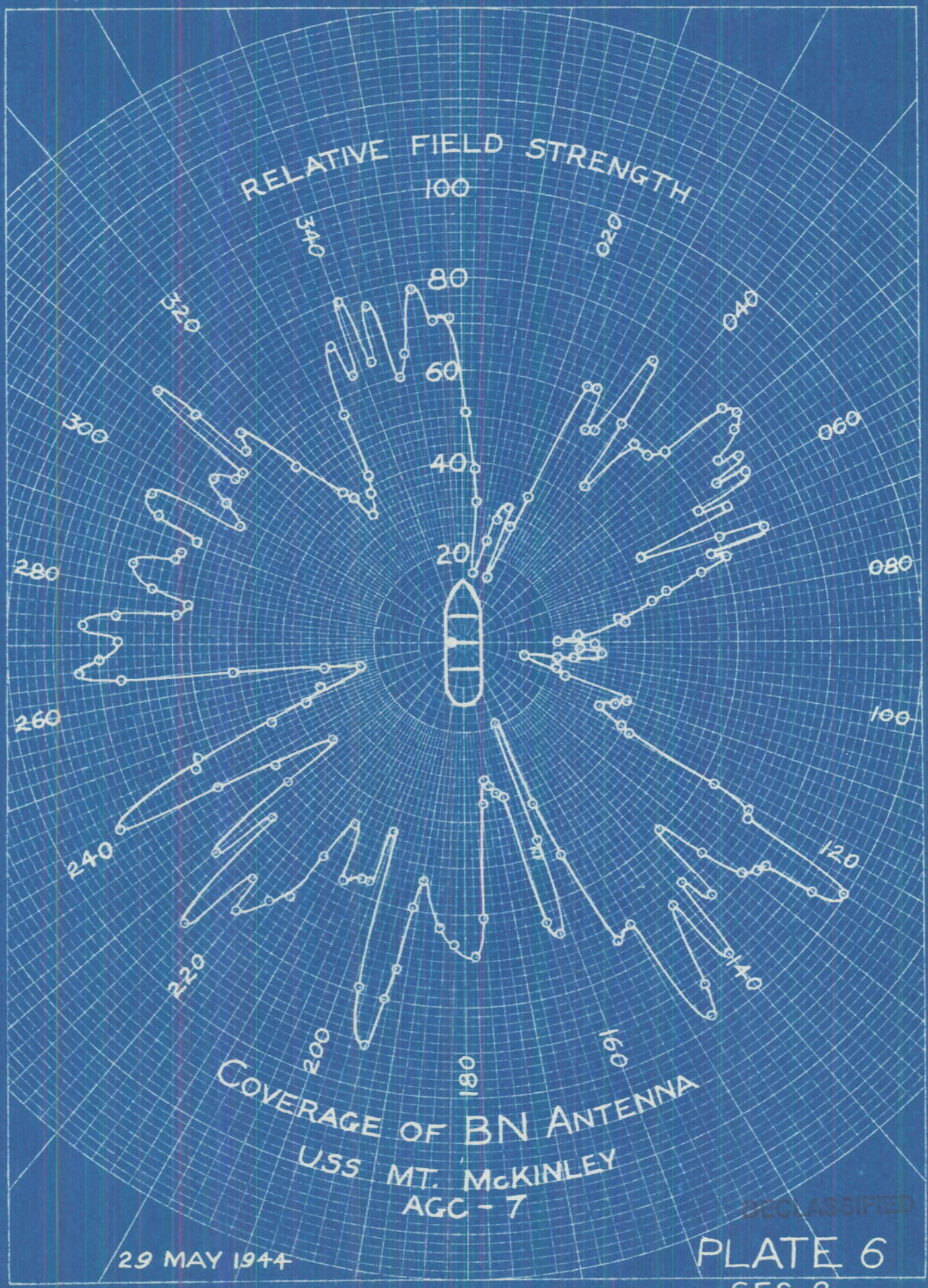


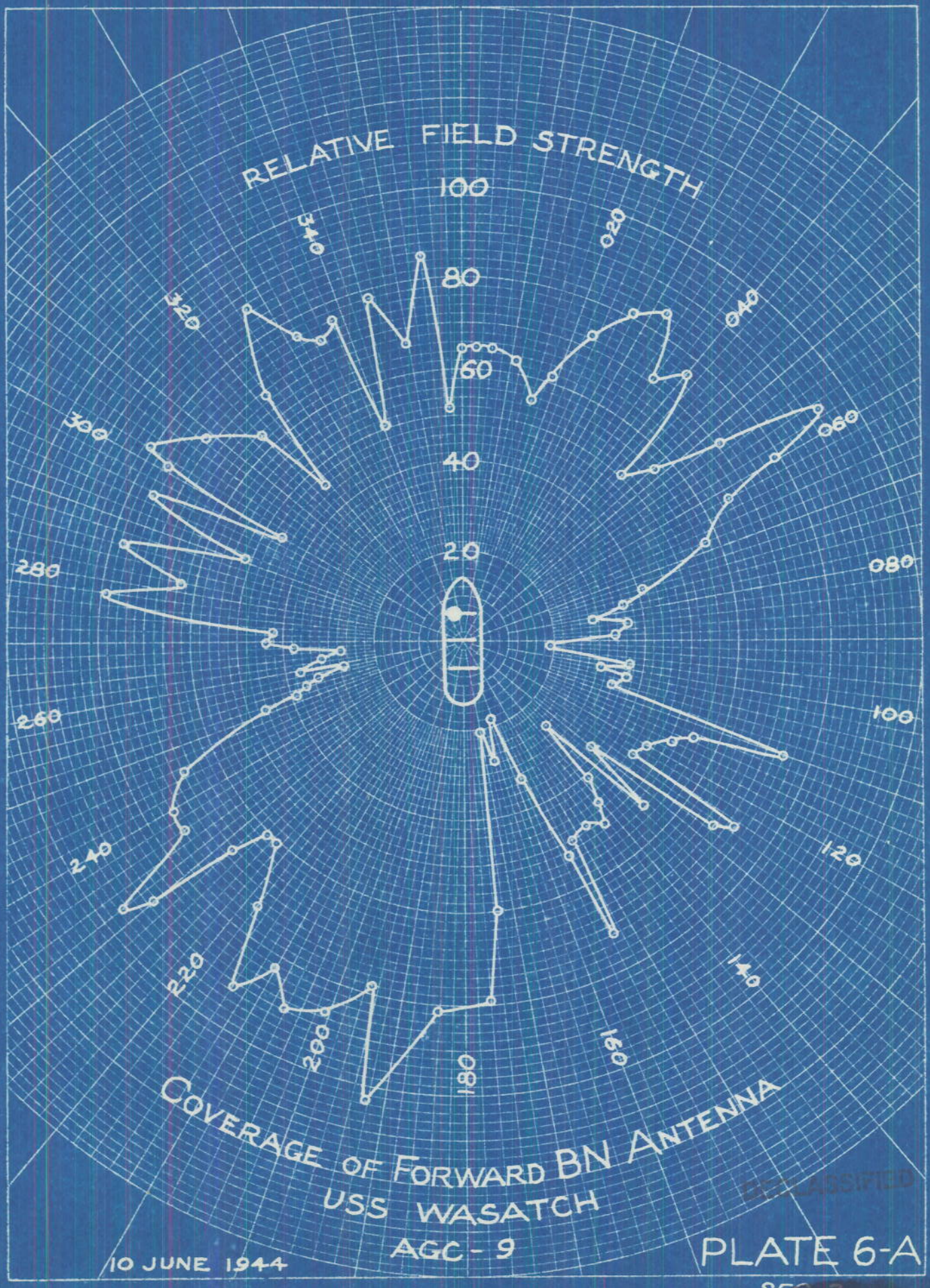
PLATE 5



COVERAGE OF BN ANTENNA
USS MT. McKINLEY
AGC - 7

29 MAY 1944

PLATE 6
SEC. 2

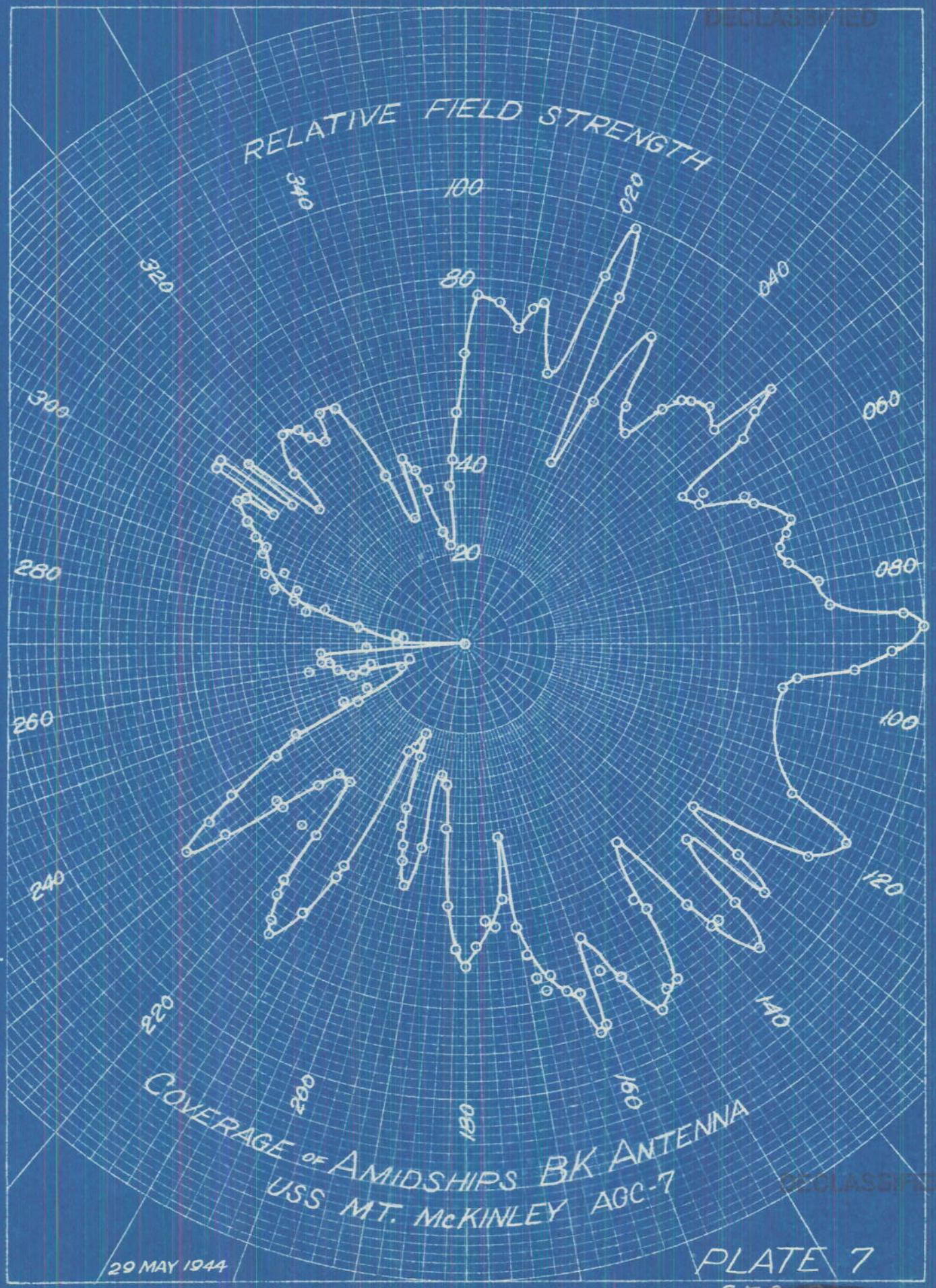


COVERAGE OF FORWARD BN ANTENNA
USS WASATCH
AGC - 9

10 JUNE 1944

PLATE 6-A

SEC. 2



COVERAGE OF AMIDSHIPS BK ANTENNA
USS MT. McKINLEY AGC-7

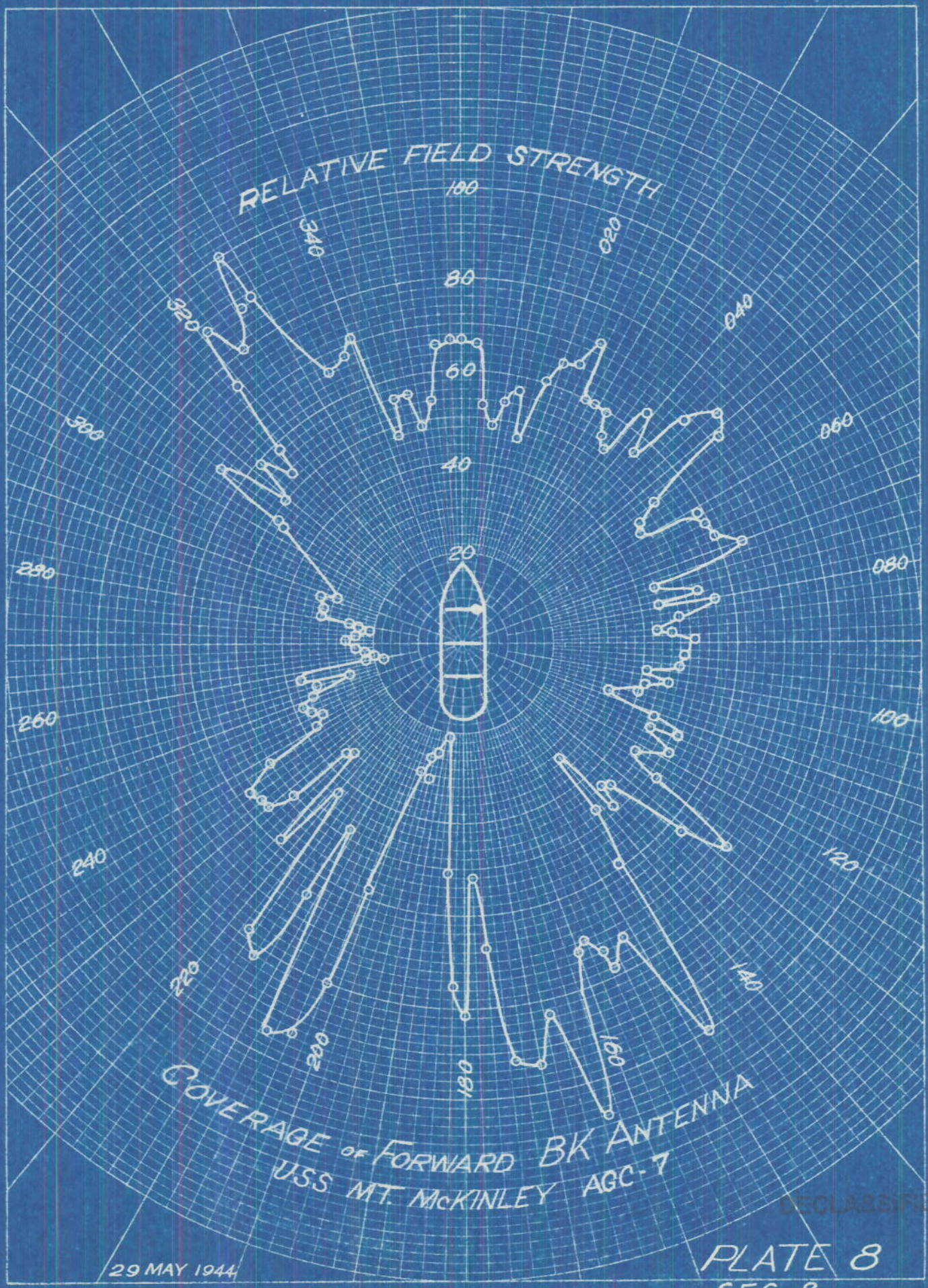
29 MAY 1944

PLATE 7

SEC. 2

KEUFFEL & ESSER CO. N.Y. NO. 2438

POLAR CO-ORDINATE

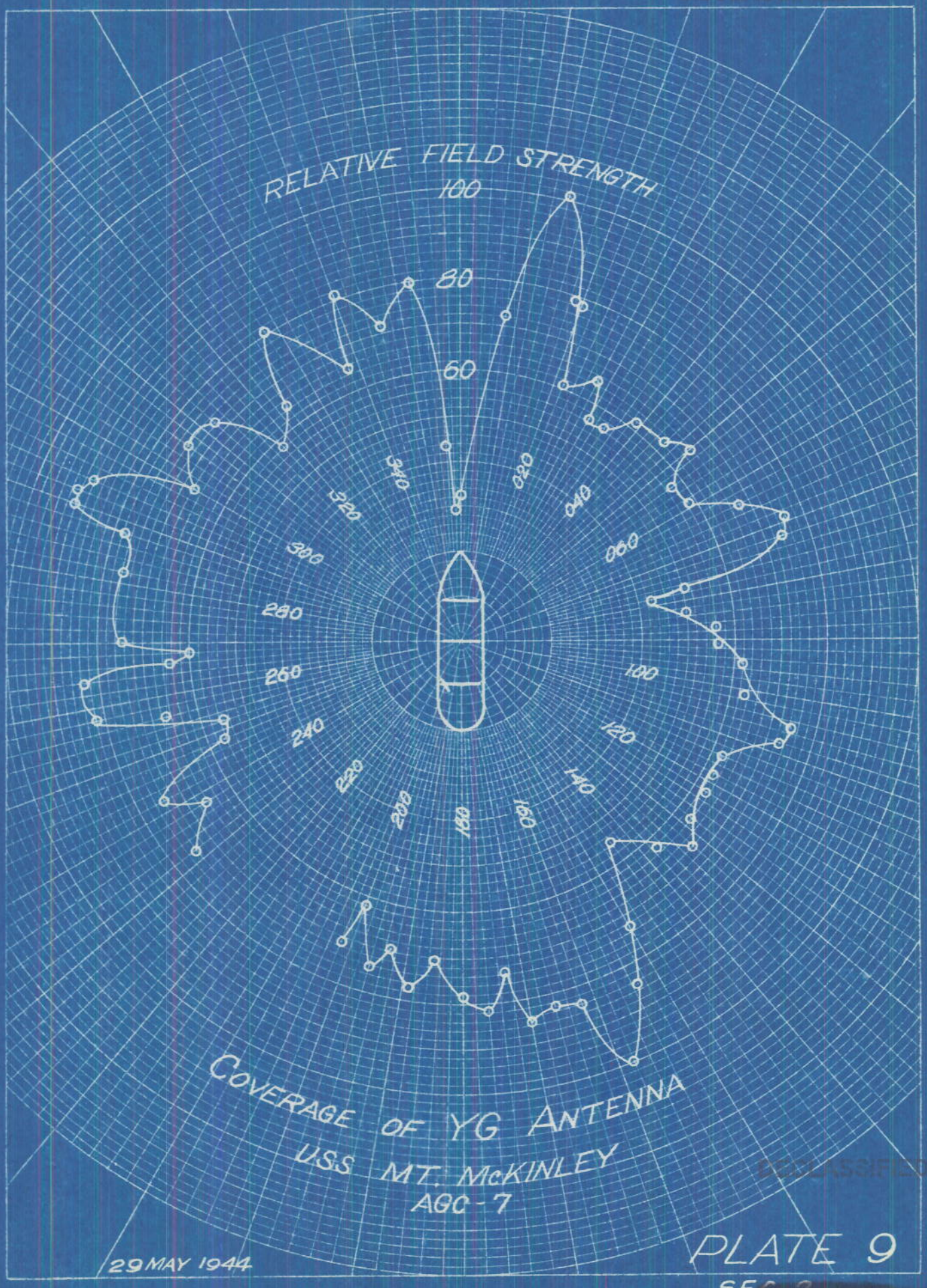


COVERAGE OF FORWARD BK ANTENNA
USS MT. McKINLEY AGC-7

29 MAY 1944

PLATE 8
SEC. 2

KEUFFEL & ESSER CO. N.Y. NO. 3438
POLAR COORDINATE



COVERAGE OF YG ANTENNA
USS MT. McKINLEY
AGC-7

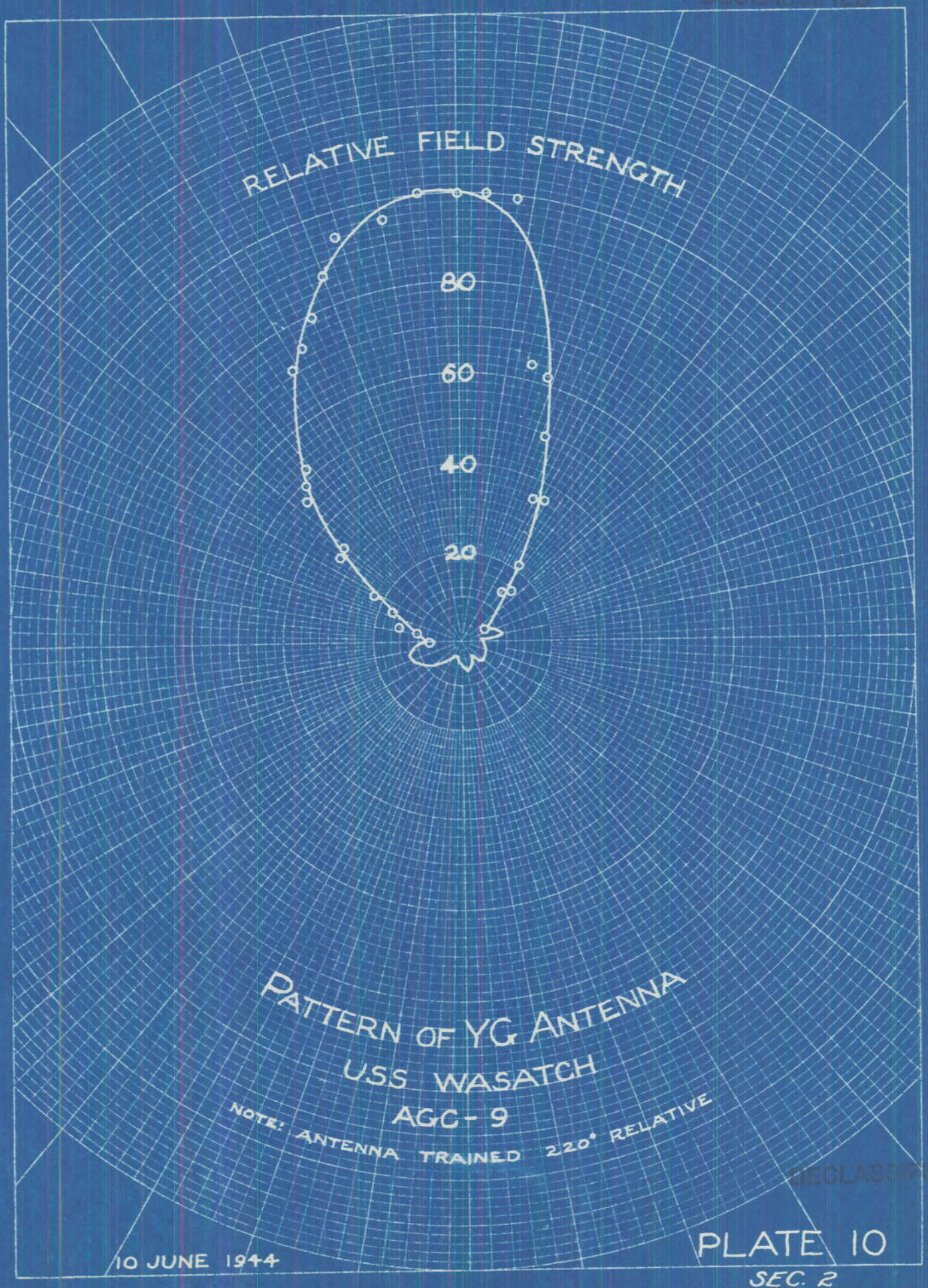
29 MAY 1944

PLATE 9

SEC. 2

KEUFFEL & ESSER CO. N.Y. NO. 3418

POLAR CO-ORDINATE



PATTERN OF YG ANTENNA
USS WASATCH
AGC-9

NOTE: ANTENNA TRAINED 220° RELATIVE

10 JUNE 1944

PLATE 10

SEC. 2

KEUFFEL & ESSER CO. N.Y. NO. 3418
POLAR COORDINATES

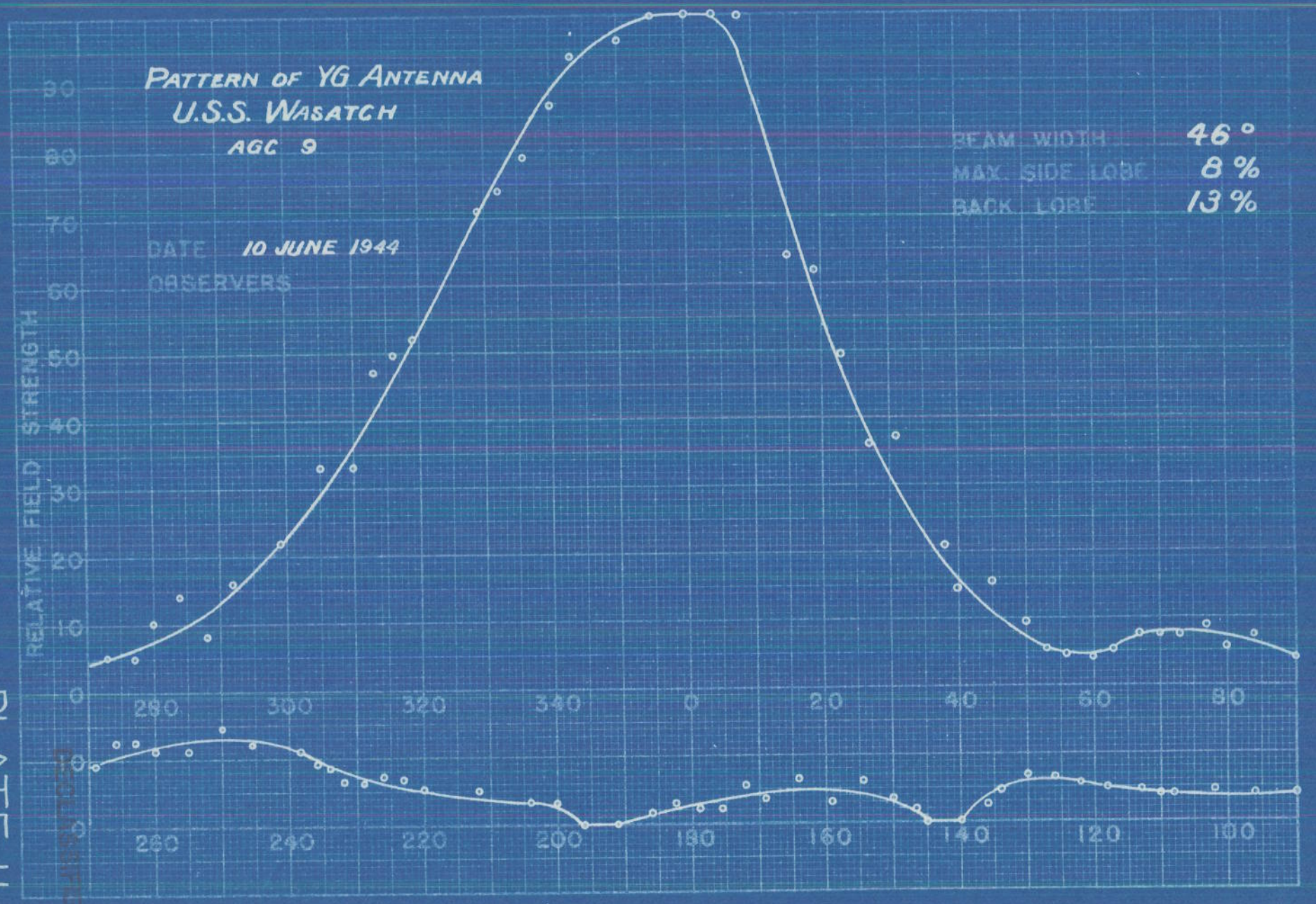


PLATE II
SEC. 2

CONFIDENTIAL

DECLASSIFIED

SK-2 VERTICAL COVERAGE DIAGRAM - ANTENNA HT. 110 FT.

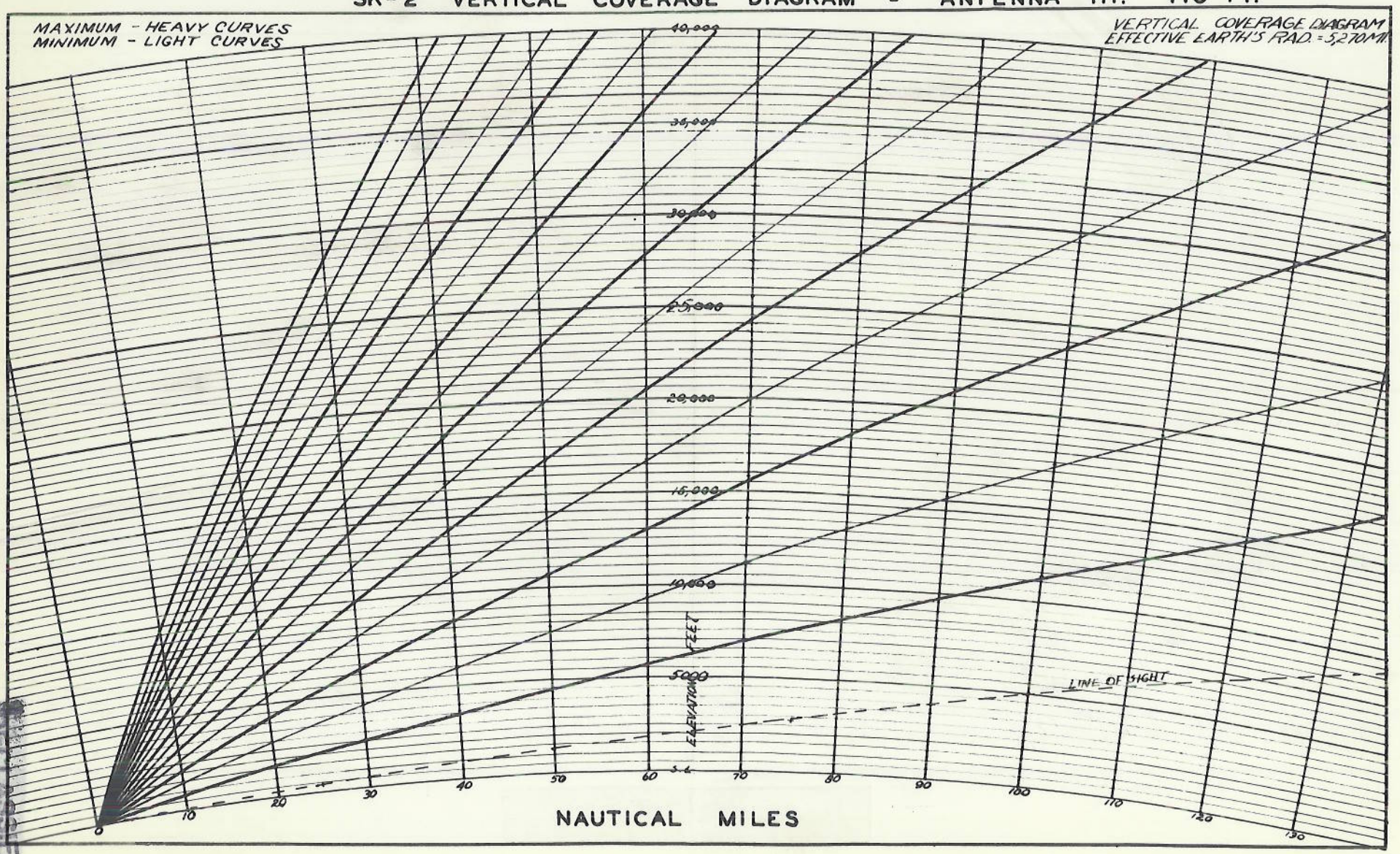


PLATE 12
SEC. 2

SECTION 3

ANTENNA MEASUREMENTS OF SG AND SQ EQUIPMENT ON USS WASATCH (AGC-9)

Enclosures: Graphs (Plates 1 to 3)

3-1. Procedure

3-1-1. Antenna measurements were made on 10 June 1944 of the "Forward" SG, the "After" SG, and the SQ equipment installed on the U. S. S. WASATCH (AGC-9).

3-1-2. Identical procedures were followed in testing each of the three pieces of equipment. Measurements were taken from the YP-354, which circled the anchored AGC at a range of approximately 3,000 yards. A superheterodyne receiver which had been previously calibrated in the Laboratory and whose output was displayed on an oscilloscope was used to measure the received signal.

3-1-3. The enclosed graphs give relative bearings versus relative signal strength in db. The bearing readings are correct to within 3 degrees, while the signal strength is correct to within 2 db. Specimen readings are shown by X marks. The patterns have been smoothed to eliminate known spurious effects.

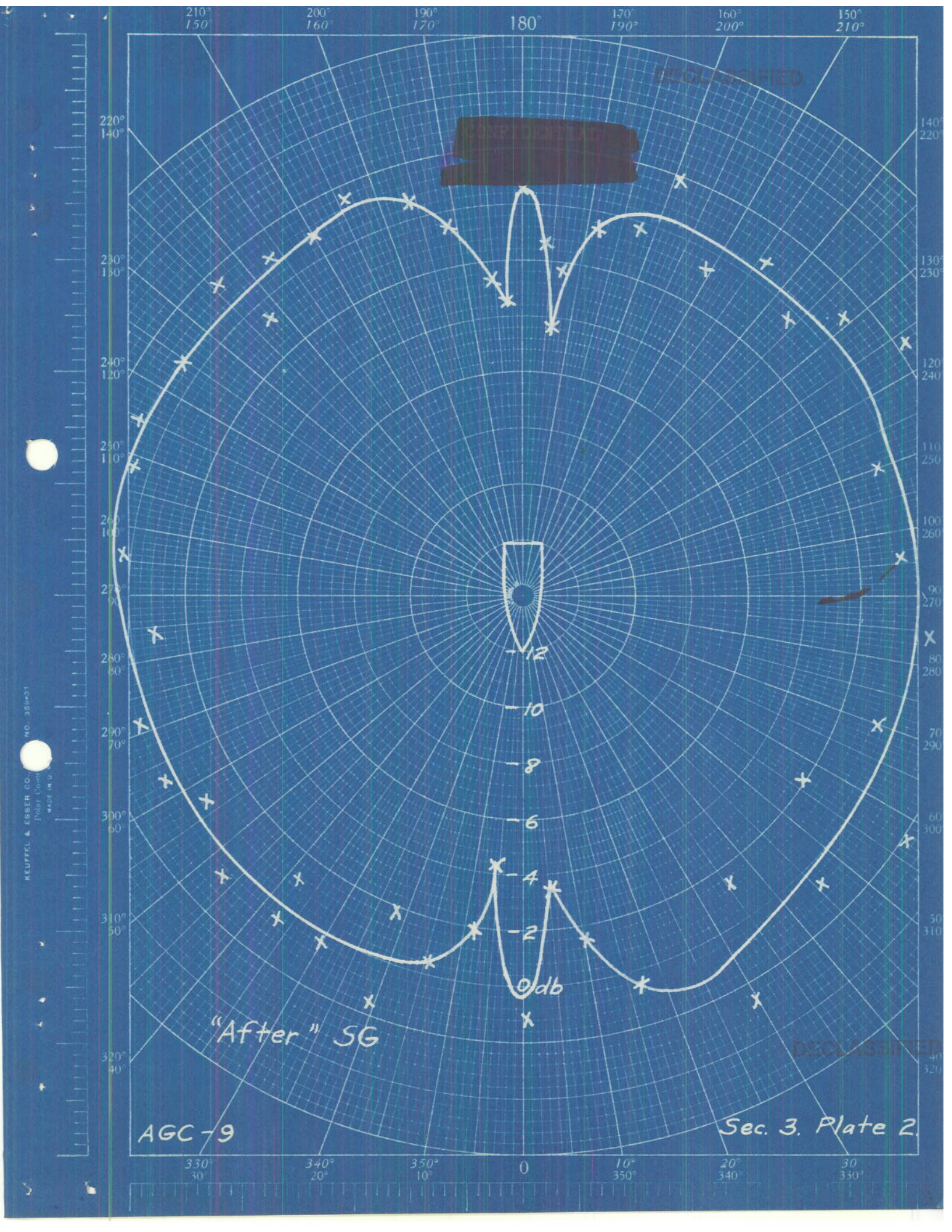
3-2. Discussion

3-2-1. Plate (1) shows that the "Forward" SG has weak signal areas at 140° Relative and 200° Relative. These are caused by the starboard after king post and the port after king post respectively. These king posts also cause weak signal areas in the pattern of the "after" SG as seen from Plate 2. However, these areas are found at Relative 175° and Relative 185°, and hence the composite coverage is good. The forward king posts affect the "After" SG pattern in the areas 005° Relative and 355° Relative. However, these areas are adequately covered by the "Forward" SG.

3-2-2. The SQ is portable equipment. While this test was being made, it was mounted on the flight deck. Because of the particular position in which it was situated, weak signal areas were noted at Relative 10° and Relative 350°. These were caused by the forward king posts. Because of the after superstructure, no signal was obtained between the relative bearings 150° and 220°. A slight change in the exact position of the SQ antenna would perceptibly change the location and extent of this "blind spot."

3-3. Conclusion

3-3-1. The composite of these three radar equipments gives excellent coverage over the entire 360 degrees.


210° 150°
200° 160°
190° 170°
180°
170° 190°
160° 200°
150° 210°
220° 140°
230° 130°
240° 120°
250° 110°
260° 100°
270° 90°
280° 80°
290° 70°
300° 60°
310° 50°
320° 40°
330° 30°
340° 20°
350° 10°
0
10° 350°
20° 340°
30 330°
140° 220°
130° 230°
120° 240°
110° 250°
100° 260°
90° 270°
80° 280°
70° 290°
60° 300°
50° 310°
40° 320°
-12
-10
-8
-6
-4
-2
0db
"After" SG
AGC-9
Sec. 3. Plate 2.
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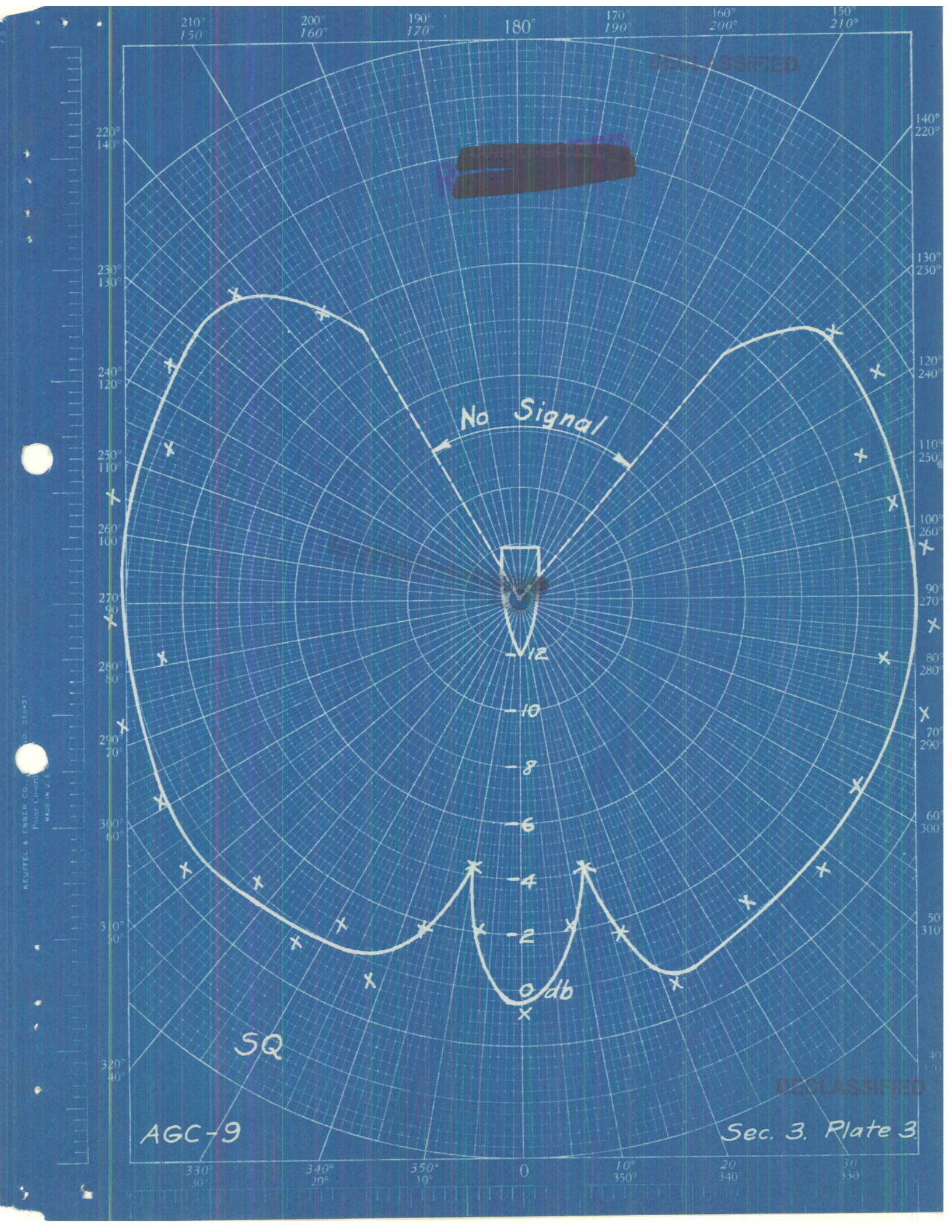
210° 150°
200° 160°
190° 170°
180°
170° 190°
160° 200°
150° 210°
140° 220°
130° 230°
120° 240°
110° 250°
100° 260°
90° 270°
80° 280°
70° 290°
60° 300°
50° 310°
40° 320°
30° 330°
20° 340°
10° 350°
0
No Signal
-12
-10
-8
-6
-4
-2
0 db
SQ
AGC-9
Sec. 3. Plate 3.
DECLASSIFIED
DECLASSIFIED