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APOLLO SPACECRAFT SYSTEMS ANALYSIS PROGRAM
TECHNICAL REPORT
TASK E-340

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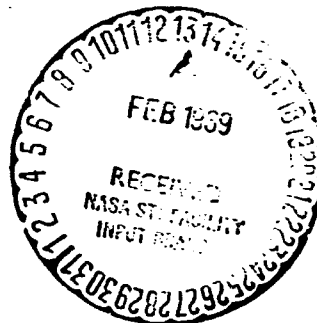
30 September 1968

RANGE COVERAGE FOR THE CSM RENDEZVOUS RADAR TRANSPONDER
ANTENNA RAISED 4° AND TILTED FORWARD 15°

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APOLLO SPACECRAFT SYSTEMS ANALYSIS PROGRAM

RANGE COVERAGE FOR THE CSM RENDEZVOUS RADAR TRANSPONDER
ANTENNA RAISED 4" AND TILTED FORWARD 15°

TASK E-34D

30 September 1968

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GENERAL

This document presents additional range coverage diagrams for the CSM Rendezvous Radar/Transponder (RR/T) using a different antenna configuration.

TRW Technical Report 05952-H354-R0-00 may be referenced for the techniques and theory used in constructing these coverage diagrams. As in the referenced report, power measurements were made on a full-scale CSM model for all combinations of roll (ϕ) varying from 0° to 358° in 2° increments, and yaw (θ) varying from 0° to 180° in 2° increments. Figure 1 shows the coordinate system employed.

The new mounting system consisted of raising the RR/T Antenna Assembly 4" above the normal mounting position and tilting it 15° forward (toward $\theta = 0^\circ$ axis).

RESULTS

The measurements presented here are of the right-hand circular component of the radiated power. The reference power level of 0 db was equivalent to a power level of 6 db relative to an isotropic antenna of linear polarization. Figure 2 contains the measured relative power data.

This relative power was converted to a range coverage using the methods of the referenced Technical Report. For example, a data plot value of 6 corresponded to the reference 0 db which represents 400 nautical miles (1 n. mi. = 6080 feet) of range coverage. Table 1 shows this relationship for all data plot values.

Polar plots of the range coverage values were constructed for three planes of interest intersecting the CSM.

Figure 3 shows the range coverage polar plot for ϕ fixed at 90° and θ varying from 0° to 180° . This means let the plane of measurement cut the CSM longitudinally. Then measure the relative power at a fixed radius in this plane, from the front of the CSM to the back, on the right-hand side from heads-up position. Convert the relative powers to range coverage values and represent the latter in a polar plot.

Figure 4 shows the range coverage for ϕ fixed at 140° and θ varying

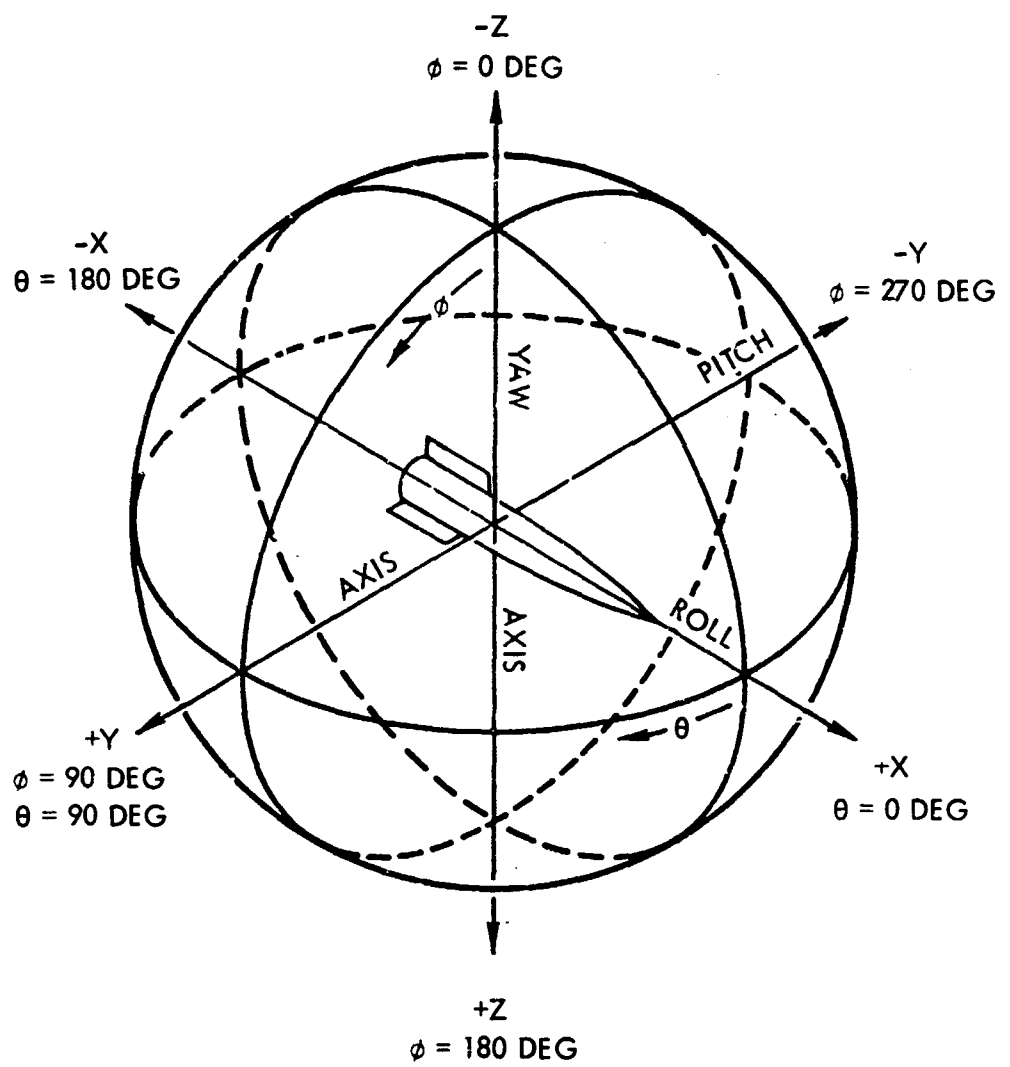


Figure 1. Spherical Coordinate System for CSM

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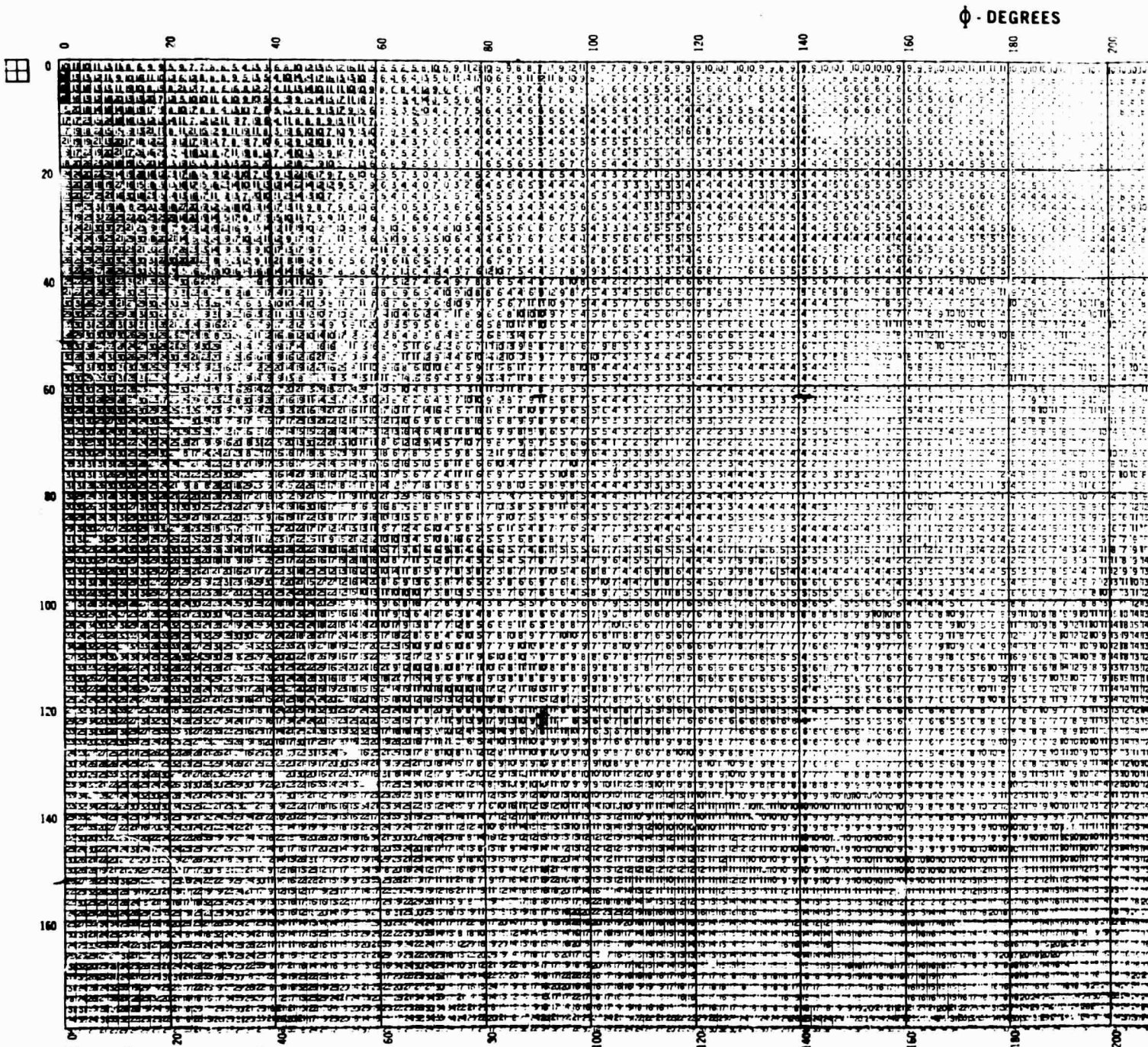
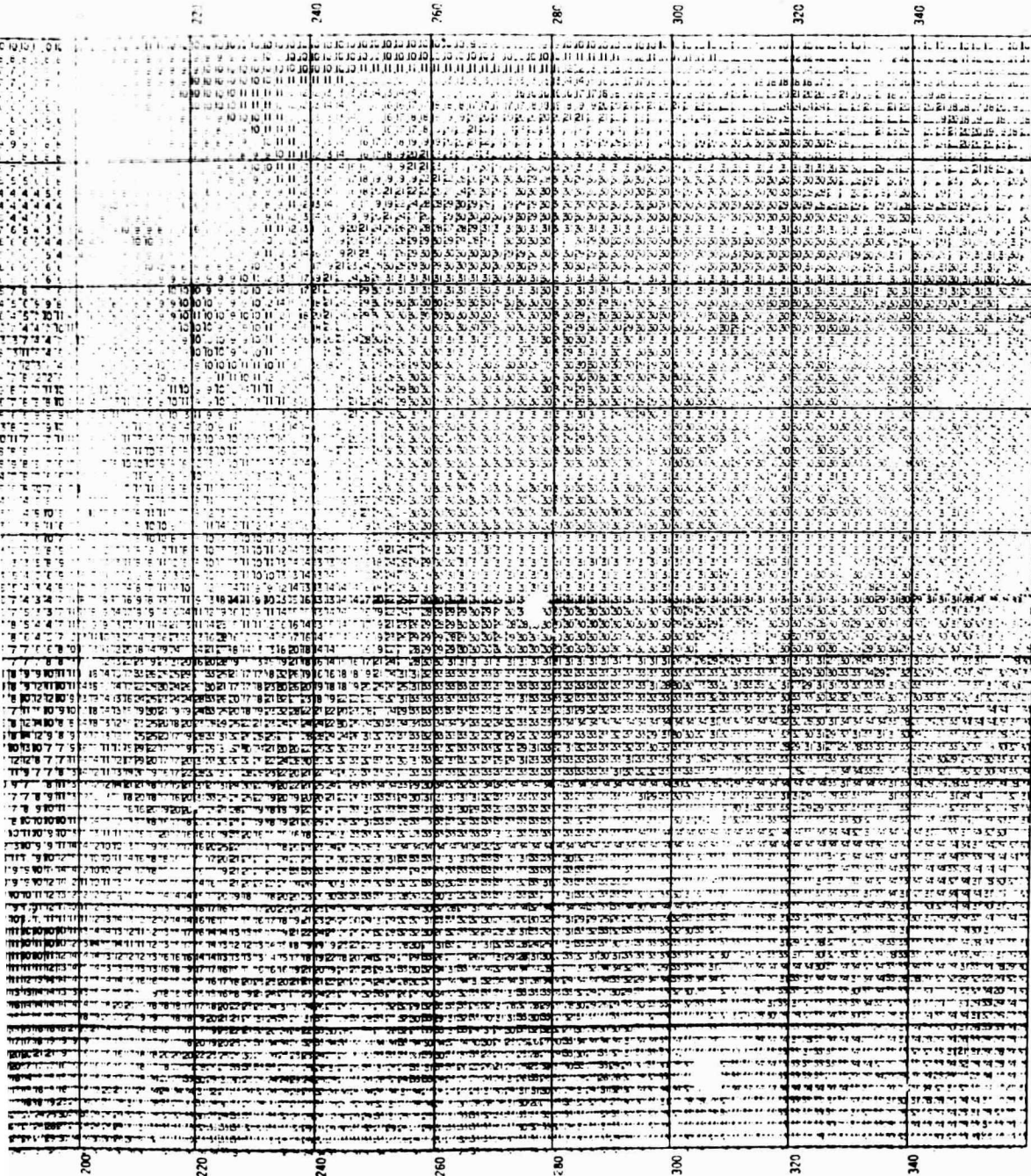


Figure 2. Measured Relative Power data, IIR/T Antenna Assembly Raised 4", Tilted Forward 15°

TEST PROGRAM OR VEHICLE	S/C 101	INSTRUMENTATION SYSTEM	MSC Antenna Range	PROJECT	Apollo
DATE	9-4-68	PATTERN NO.	380	ORGANIZATION	IESD-FSB-Antenna Systems Section
ANTENNA TYPE	Double Waveguide Horn		FREQ RANGE	X-Band	
PREDOMINANT POLARIZATION	Linear		MODEL SCALE	Full	
			LOCATION OF POINT P (φ, θ)	(0, 0 90°)	
				Heads-up	

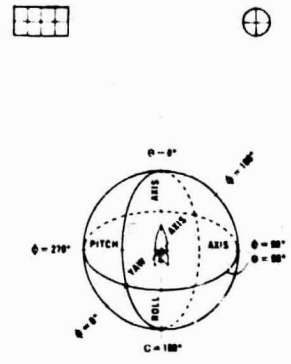
3A

ES



0
20
40
60
80
100
120
140
160

θ - DEGREES



REMARKS

GAIN PLOT POLARIZATION COMPONENT RECORDED LINEAR [] E ◻ E ◻ CIRCULAR [] RH [] LH
 GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF 6 DB RELATIVE TO AN ISOTROPIC ANTENNA OF Linear POLARIZATION
 PHASE ANGLE PLOT PHASE ANGLE RECORDED 8
 PHASE ANGLES ARE RECORDED VALUES IN DEGREES MULTIPLIED BY 10

3B

<u>Plot No.</u>	<u>Antenna Gain (db)</u>	<u>Range</u>	<u>Plot No.</u>	<u>Antenna Gain (db)</u>	<u>Range</u>
0	6	800			
1	5	710	20	-14	79
2	4	634	21	-15	71
3	3	565	22	-16	63.5
4	2	503	23	-17	56.5
5	1	449	24	-18	50.4
6	0	400	25	-19	45.0
7	-1	356	26	-20	40.0
8	-2	318	27	-21	35.6
9	-3	283	28	-22	31.8
10	-4	252	29	-23	28.3
11	-5	225	30	-24	25.2
12	-6	200	31	-25	22.5
13	-7	178	32	-26	20.0
14	-8	159	33	-27	17.8
15	-9	142	34	-28	15.9
16	-10	126	35	-29	14.2
17	-11	112	36	-30	12.6
18	-12	100	37	-31	11.2
19	-13	89			

TABLE 1. Relationship Between the Data Plot Values Employed in Figure 2, Antenna Gain, and Range Coverage in Nautical Miles

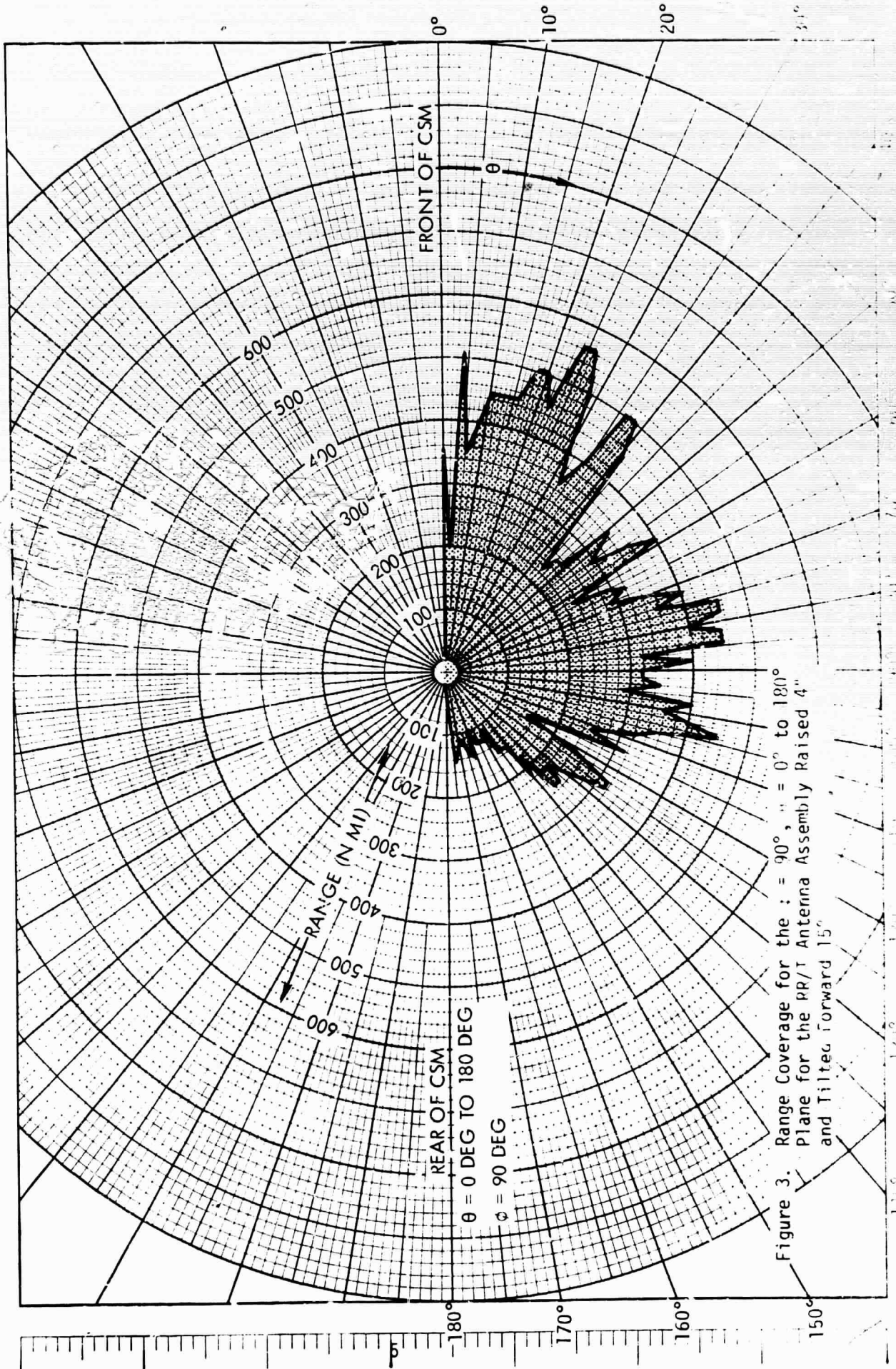


Figure 3. Range Coverage for the $\theta = 90^\circ$, $\phi = 0^\circ$ to 180°
Plane for the PR/T Antenna Assembly Raised 4"
and Tilted Forward 15°

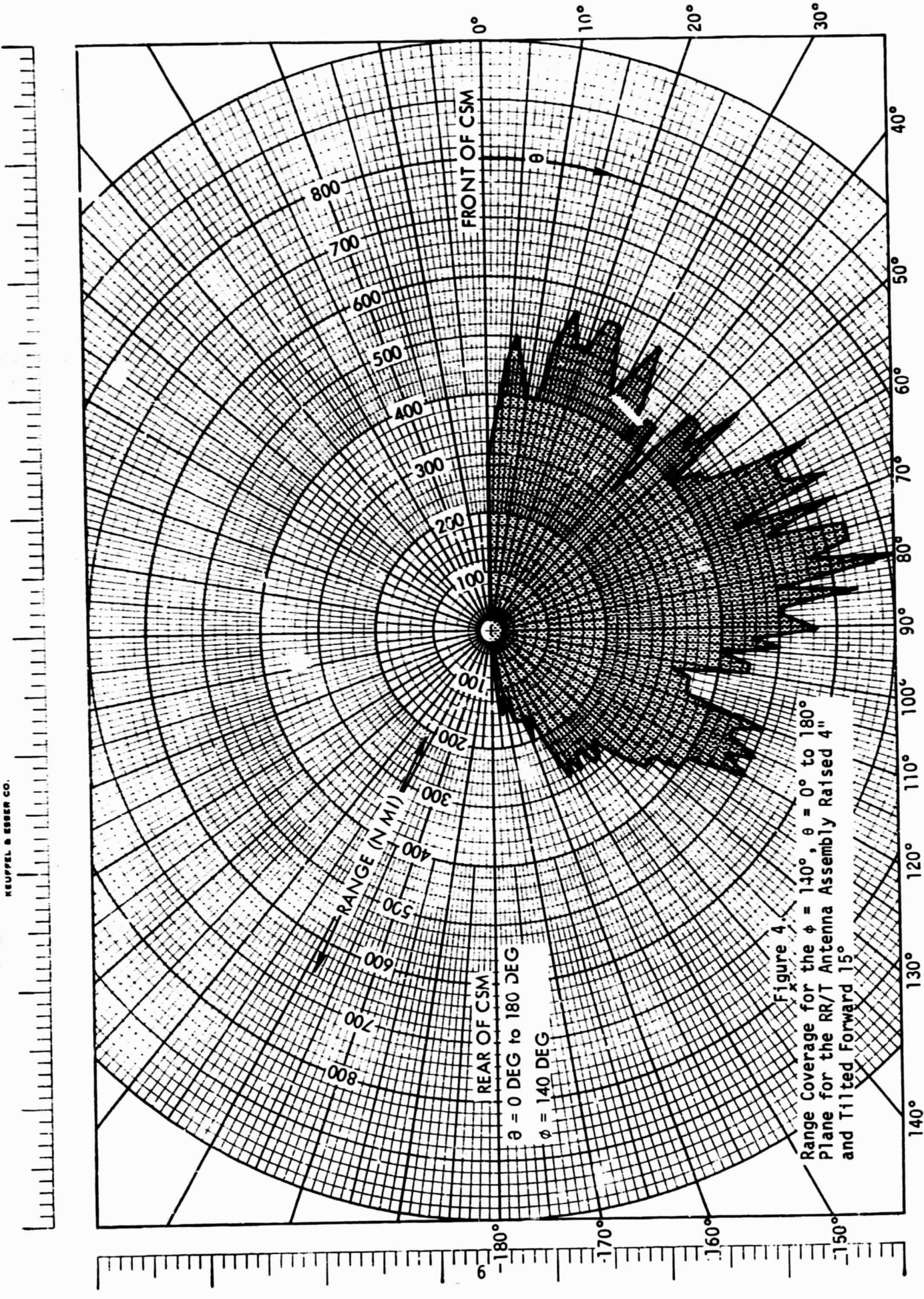


Figure 4
Range Coverage for the $\phi = 140^\circ$, $\theta = 0^\circ$ to 180°
Plane for the RR/T Antenna Assembly Raised 4"
and Tilted Forward 15°

from 0° to 180° . Here one can think of the same plane as in Figure 3, but tilted about the roll axis until the plane aligns with the RR/T Antenna Assembly. $\phi = 140^\circ$ is the angular data value closest to the desired $\phi = 140.4^\circ$. Again the relative power is measured from the front to the back at a fixed radius on the right side.

Figure 5 gives the range coverage for θ fixed at 90° and ϕ varying from 0° to 358° . This plane cuts the front of the CSM from the rear, and the power is measured at a fixed radius all the way around the roll axis.

CONCLUSIONS

A comparison of range coverage for selected angular values near the nose of the CSM was made for the three configurations in the referenced Technical Report and the configuration this report investigates. This comparison is presented in Table 2.

For all angular values sampled the range coverage for the configuration of Pattern 122 with the RR/T Antenna Assembly raised 3 1/2" and tilted forward 15° was superior.

Comparison of the polar plots of range coverage contained in this document with similar plots in the referenced Technical Report also indicated that, of the configurations tested, the configuration of Pattern No. 122 gives the best range coverage near the front of the CSM.

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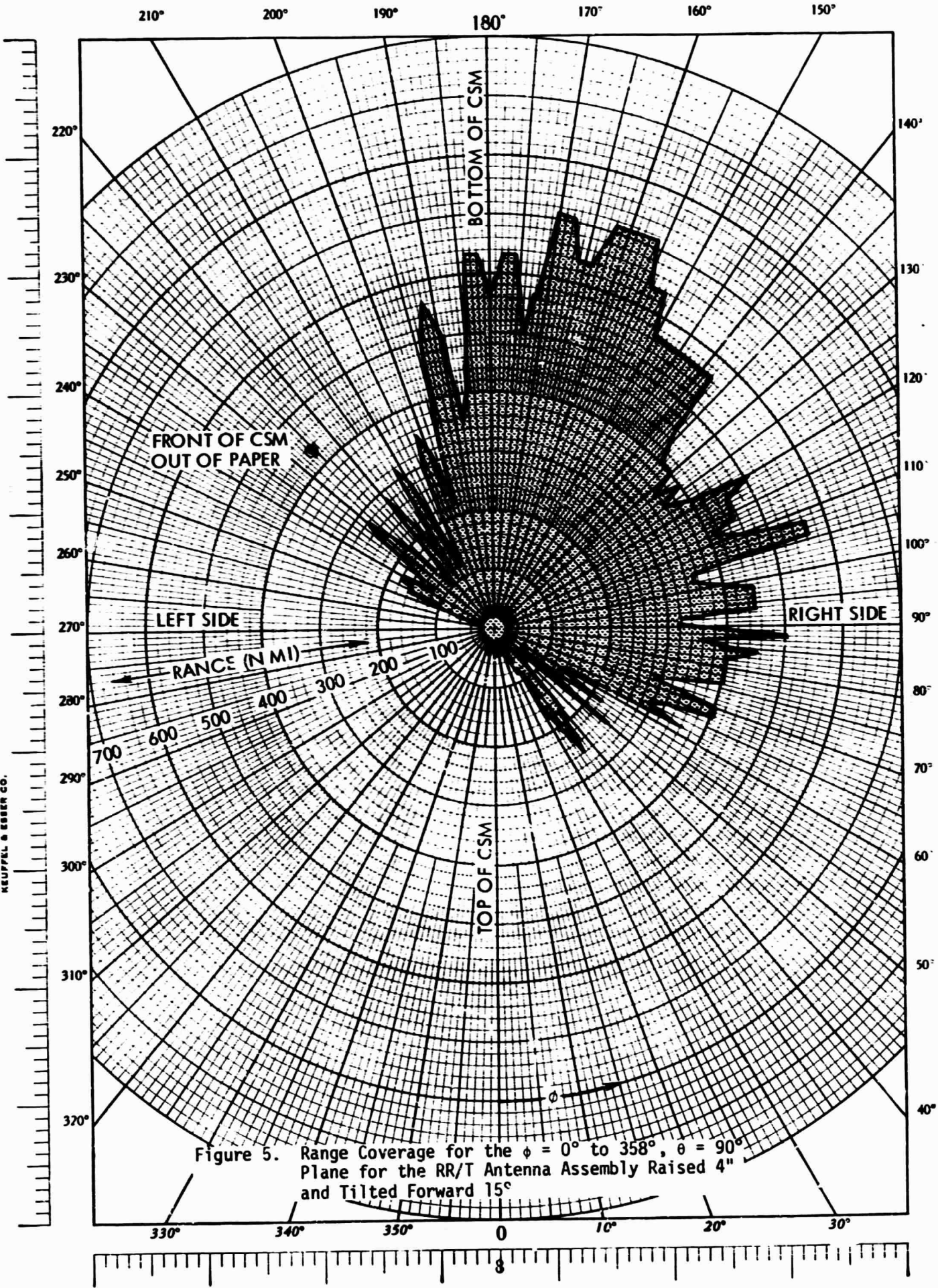


Figure 5. Range Coverage for the $\phi = 0^\circ$ to 358° , $\theta = 90^\circ$ Plane for the RR/T Antenna Assembly Raised 4" and Tilted Forward 15°

RANGE COVERAGE IN NAUTICAL MILES

RR/T

PATTERN NO.	ANTENNA ASSEMBLY CONFIGURATION	RANGE COVERAGE IN NAUTICAL MILES											
		$\phi = 0^\circ$			$\phi = 90^\circ$			$\phi = 140^\circ$					
		$\theta = 2^\circ$	$\theta = 4^\circ$	$\theta = 6^\circ$	$\theta = 2^\circ$	$\theta = 4^\circ$	$\theta = 6^\circ$	$\theta = 2^\circ$	$\theta = 4^\circ$	$\theta = 6^\circ$			
127	Flush Mounted	225	178	100	225	318	356	142	126	283			
140	Raised 1/2" Tilted Forward 15°	400	225	178	356	503	565	318	449	634			
122	Raised 3 1/2" Tilted Forward 15°	400	318	283	565	710	895	565	710	710			
180	Raised 4" Tilted Forward 15°	200	178	159	200	503	356	356	449	503			

TABLE 2. Range Coverage vs Selected Angular Positions For Each Configuration Tested