3051-7-T = RL-2098

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THE UNIVERSITY OF MICHIGAN

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VOR PARASITIC LOOP COUNTERPOISE - II:

INTERIM REPORT NO. 7

1 February 1971 - 30 April 1971

By

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14 May 1971

Contract FA69-WA-2085, Project 330-001-03N

Contract Monitor: Mr. Sterling R. Anderson

Prepared for

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I INTRODUCTION

This is the Seventh Interim Report on Contract FA69-WA-2085, Project No. 330-001-03N, "VOR Parasitic Loop Counterpoise Systems-II," and covers the period 1 February 1971 to 30 April 1971.

During this period both ground and flight tests have been performed on the full scale parasitic loop counterpoise antenna at the Manheim Road VOR Facility. Some of the important results obtained so far are discussed in this report.

The following theoretical and numerical studies have also been carried out during this period in order to analyze some of the experimental results:

(i) the variation of the field strength at a distance of 300 feet away from a standard VOR antenna (i.e. no parasitic rings) located above a perfectly conducting plane earth,

(ii) the far-field elevation pattern of a standard VOR antenna taking into account the effect of a perfectly conducting plane earth.

II NUMERICAL STUDIES

The theoretical basis of the numerical investigation has been discussed in our previous report (3051-6-T) and will not be repeated here. The standard VOR antenna considered here is assumed to consist of the usual

Alford loops above a 150 feet diameter counterpoise and located 75 feet above a perfectly conducting plane earth. The antenna is assumed to operate on the side-band mode.

Figure 1 shows the theoretical field strength variation in a vertical plane located 300 feet away from the non-uniformly excited standard VOR antenna. In the same figure we have also shown the experimental results given in our earlier report (3051-5-T). In view of the approximations made in the theoretical analysis, the agreement between numerical and experimental results given in Figure 1 may be considered to be very good.

Figure 2 gives the theoretical far-field elevation pattern of the same standard VOR antenna located above a perfectly conducting plane earth. The important thing to observe here is the dip in the pattern around the direction $\theta = 85^o$. This dip as well as the wavy nature of the pattern in the region $60^o \leq \theta < 90^o$ are attributed to the ground reflection effects.

III EXPERIMENTAL TEST RESULTS

In this section we discuss some of the results obtained from full scale testing of the VOR parasitic loop counterpoise antenna at the Manheim Road Facility.

After the initial installation of the parasitic rings at the VOR antenna system at NAFEC, some time was spent to adjust the ring positions so as to obtain the anticipated optimum performance. This was done by ground measurement techniques discussed earlier (3051-6-T). On the basis of the results obtained from the ground measurement, there evolved two parasitic loop counterpoise antenna systems which appear to provide improved performance of a VOR system with respect to scalloping effects. These two configurations identified as Systems I and II, have the following dimensions:

System I: $2B_1 = 46.4'$, $H_1 = 3.83'$

$2B_2 = 32.5'$, $H_2 = 18.58'$,

System II: $2B_1 = 46.4'$, $H_1 = 4.75'$

$2B_2 = 32.5'$, $H_2 = 19.17'$,

where $2B$ and H are the parasitic loop diameter and height respectively.

In the following sections we discuss the results of a flight test carried out for the parasitic loop counterpoise System I. For the purpose of observing the scalloping effects during the flight test, a reflecting screen has been located at a distance of 1000 feet from the VOR antenna and on the 50^o radial line with respect to the north. The plane of the screen is inclined 45^o with respect to the 50^o radial line such that reflected waves from the screen interferes with the direct ray from the antenna in the direction 140^o away from the north. Flight test has been carried out by flying the aircraft at a constant distance of 20 miles from the VOR antenna and along a 90° arc in the region 90° to 180° away from the north. The aircraft is flown at two altitudes of 3220 feet and 6575 feet above the ground. The latter height is chosen so that the aircraft is located in the pattern null observed in the standard VOR antenna pattern. The null is due to the ground reflection (see Fig. 2).

At first, flight test data were collected for the standard VOR system (i.e. the antenna without any parasitic rings). Later preliminary data were collected from a flight test carried out for the parasitic loop counterpoise System I. Reduced data from these two tests are shown in Table I below. These results show the scalloping effects obtained with a standard VOR and with a VOR using parasitic loop counterpoise antenna.

TABLE I

Scalloping Effects With and Without Parasitic Rings

Radial	Standard VOR		Parasitic System I	
	Aircraft at 3220'	Aircraft at 6575'	Aircraft at 3220'	Aircraft at 6575'
130°	1.25°	4.00°	0.90°	2.00°
140°	1.5°	5.75°	1.30°	2.00°
150°	0.75°	7.00°	1.25°	2.75°

It is interesting to note that there is little change in the scalloping between the standard and the parasitic VOR system, when the aircraft is flown at a height of 3220 feet. However, when the aircraft is flown in the standard VOR pattern minimum (i.e. at a height 6575 feet), the introduction of the parasitic rrings significantly reduces the amount of scalloping. This is in agreement with our previous prediction that the high field gradient associated wi th a parasitic loop counterpoise antenna pattern would considerably improve the scalloping effects in a VOR system.

IV CONCLUSION

The full scale test results collected so far have shown that the parasitic loop counterpoise antenna, when incorporated into a VOR system, does indeed produce significant improvement in the course scalloping error. More flight tests must be carried out before a complete set of conclusive data can be provided to show the overall performance characteristics of a parasitic loop counterpoise VOR system.

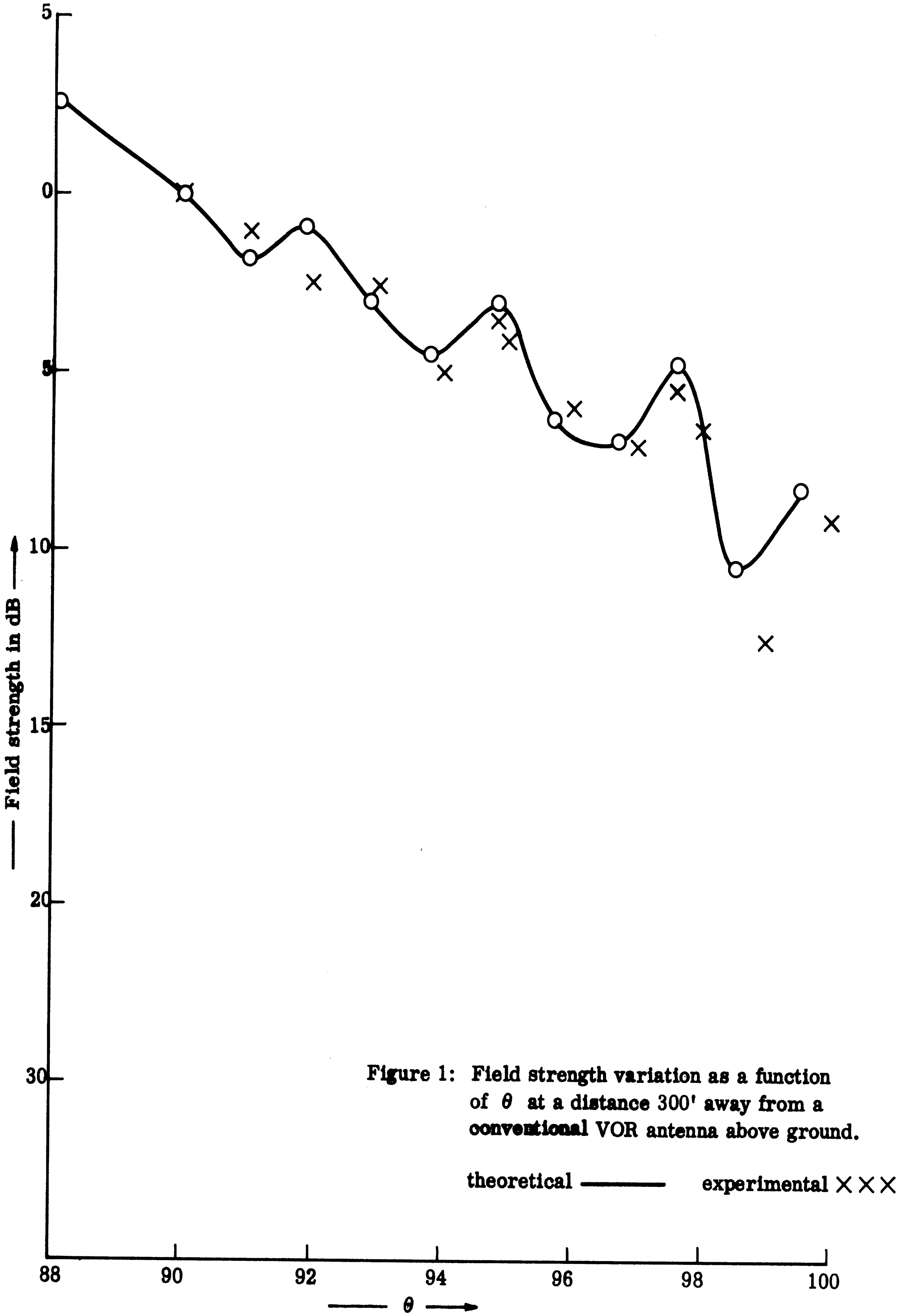

Figure 1: Field strength variation as a function of θ at a distance 300' away from a conventional VOR antenna above ground.

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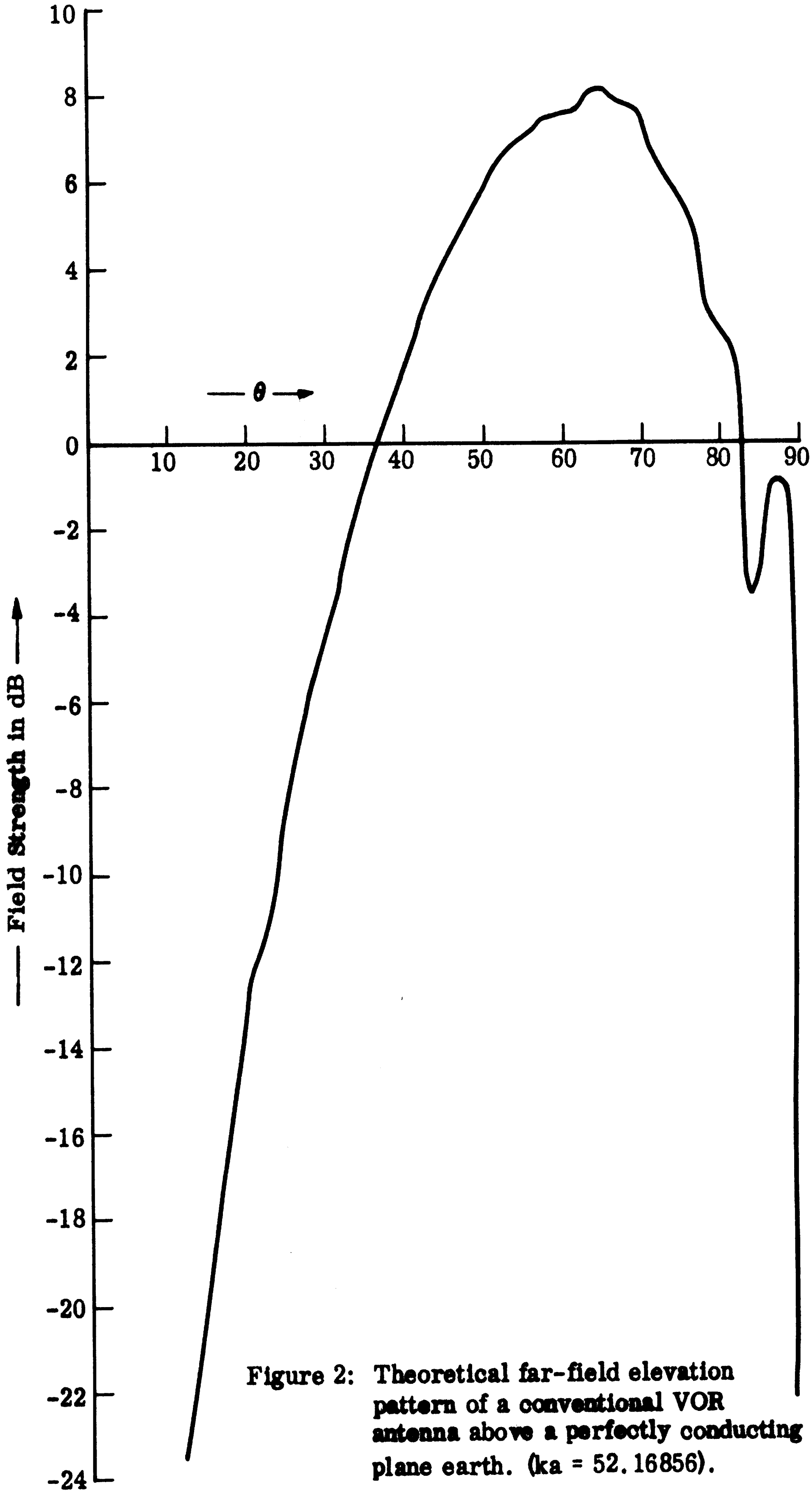

Figure 2: Theoretical far-field elevation pattern of a conventional VOR antenna above a perfectly conducting plane earth. (ka = 52.16856).