DEPARTMENT OF ELECTRICAL ENGINEERING

A STUDY OF 2 GHz REGION ELECTROMAGNETIC PROPAGATION OVER SELECTED TERRAINS

PROGRESS REPORT FOR THE PERIOD FEB. 28, 1966 to SEPT. 1, 1966

Prepared Under
National Aeronautics and Space Administration
Research Grant NGR 25-001-007

ENGINEERING AND INDUSTRIAL RESEARCH STATION

MISSISSIPPI STATE UNIVERSITY
STATE COLLEGE, MISSISSIPPI

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TABLE OF CONTENTS

I. PROJECT OBJECTIVES

The principal objective of this project is to determine the propagation reliability of microwave signals in the 2 GHz frequency region in the Gulf-South Region of the United States. The approach for satisfying this objective consists of two phases.

The objective of Phase I was to review the existing literature on propagation studies in the 2 GHz frequency region. The information from the literature survey served as a guide for planning the experimental program for Phase II.

The objective of Phase II is to determine the fade margins required in order to achieve a particular propagation reliability in the 2 GHz frequency region. This propagation reliability information should be valid for various path lengths in the Gulf-South Region. The fade margin of a microwave link is defined as the ratio (usually expressed in decibels) of the median received signal power to the minimum usable signal power. The median received power is the level of the received power which is exceeded fifty percent of the time. The minimum usable power corresponds to the minimum signal level that the receiver can detect and still maintain a usable output.

Knowledge of the desired fade margin and median received signal allows the sub-systems of the transmitting and receiving stations to be determined.

II. EXPERIMENTAL RELIABILITY STUDY

A. Principal Objective of Phase II

The principal objective of Phase II is to determine the fade margins required for various path lengths in the Gulf-South area in order to achieve a particular propagation reliability in the 2 GHz frequency region. For the experimental phase of the propagation study ten different paths in this frequency region and geographical area have been instrumented to obtain propagation reliability information. The paths being monitored are all part of an extensive 2 GHz microwave system owned by Texas Eastern Transmission Corporation. The use of their system for this research has been donated by Texas Eastern in the interest of furthering the basic knowledge of microwave propagation phenomena.

In the following paragraphs the current status of the experimental phase of this research is discussed.

B. Fade Margin Data Reduction

For the reporting period ending 1 September, 1966, approximately seven months of signal distribution data have been taken. All of these data have been reduced and signal level distribution curves have been plotted for each of the ten selected paths.

Signal fading distributions have been plotted for two-week periods for each path and for a six-month total for each path.

From the six-month curves two sets of curves have been plotted. These curves show the effect of signal fading due to path length and geographical location respectively.

Path number ten located from Siloam, Kentucky, to Wheelersburg, Ohio, has an elevation angle of approximately 1.5 degrees. This path has exhibited fading activity with signal fades as deep as 25 db.

C. Fade Margin Data Analysis

A set of equations has been derived from these experimentally obtained signal level distributions which allow calculations of the fade margin required for a given propagation reliability as a function of path length and geographical location.

A digital computer program has been written, which allows calculation of the required fade margin when the desired propagation reliability, path length, and geographical location are stated. The program is written in the Fortran format.

These equations are valid for the general geographical area from Shreveport, Louisiana, to Portsmouth, Ohio, and for path lengths varying from 20 miles to 40 miles in length.

D. Cross-correlation Study

Implementation of the cross-correlation equipment using an analog computer and magnetic tape recording has been completed.

Simultaneous recordings of the AGC signals for three paths have been made and cross-correlations of these signals have been performed. There was a definite correlation of the signals and plans are being made to obtain some additional recordings.

III. CONTINUATION OF STUDY

During the period September 1, 1966, to January 31, 1967, the experimental phase will be continued and completed. This additional five-month period will complete a one-year compilation of experimental data. From these data a revised set of coefficients for the design equations will be emperically derived.