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**AN ATLAS OF REDUCED DATA
OBTAINED IN A COOPERATIVE HF DIRECTIONAL
PROPAGATION EXPERIMENT OVER A 1330 KILOMETER PATH
(MARCH 1967 — MARCH 1968)**

by

ALBERT D. BAILEY
EDWARD W. ERNST
LEON J. MILLER
WALTER W. WOOD

PRL PUBLICATION NO. 344

September 1968

Technical Report No. 7

Contract N00014-67-A-0305-0002

Supported by:
Office of Naval Research
and the
Naval Electronics Systems Command



RADIOLOCATION RESEARCH LABORATORY
DEPARTMENT OF ELECTRICAL ENGINEERING
ENGINEERING EXPERIMENT STATION
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

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FOREWORD

A radio direction finder is a device which is used to measure the direction of arrival of radio waves *as received*. Sometimes the measured angle of arrival coincides with the great circle line of travel between the signal source and the receiver and, for these times, there is no problem. There are many other times when the measured angle of arrival as received or the measured bearing is, hopefully, close to the bearing of the source and then there is a problem. The report that is contained here speaks to the latter problem as it exists in the high frequency band.

Radio direction finding has a long history. One could state that the radio science was born in 1887 at the time of Hertz's experiments. Direction finding devices were being patented at least as early as 1899. Various instruments and systems have been developed and improved upon during the ensuing 70 year period. The majority of the improvements have been made in the radio direction finding instrument itself and the instrumental errors are, or can be made, vanishingly small. However, a corresponding degree of improvement in overall accuracy of measurement in the high frequency band (3-30 MHz) has not been realized; the reason given is, "we are being limited by the propagation errors".

The cooperative directional propagation experiment to be described here had a degree of control that probably has not been possible in any prior experiment. It required the cooperation of several large agencies to provide the reduced data which are shown.

The set of data provides to the designers and users of radio direction finders good, lengthy, and representative examples of the directions of arrival of radio waves *as received* under realistic conditions of

ionospherically propagated signals over an intermediate range path.

The set of data permits one to make correlations with other recorded time coincident ionospheric events which occurred during the times of observation and which may, therefore, be significant.

The set of data has been found to be useful independently in its own context. Selected cases have already demonstrated that present theories on ionospheric propagation, currently available 3-D ray tracing programs and measured ionograms obtained in the neighborhood of the region of wave interaction all lead to consistent results. This is evidenced by the very close agreement between reconstructed angles of arrival for a given time and those actually measured.

We have, for good and apparent reasons, resisted the strong desire to infer what is happening at many instances of time. Some of these "D.F. events" have been studied and reported by Dr. R. M. Jones of ESSA and Dr. N. Rao of this laboratory. Our graduate students are already involved in other aspects.

One may close by saying, "another torch has been lit and it is hoped that its rays will illuminate the problem area in HF directional propagations so that optimum solutions may be seen".

ACKNOWLEDGEMENT

The successful operation of a directional propagations experiment performed on the scale of this experiment depends upon the cooperative, untiring and persistent efforts of many people working together at their appointed tasks for a common goal. The experiment embraced the area of the USA east of the Great Divide. It is practically impossible to name all of the people within this area who contributed to the outcome of the experiment. We will attempt to name those who were immediately involved in the University of Illinois - University of Houston path.

The target transmitter and oblique incidence transmitters at the University of Houston transmitting station were supervised by Dr. Thomas Whitaker of the Department of Electrical Engineering. Mr. Samuel Anzelmo, research assistant, operated the equipment.

The path midpoint C-4 type ionosonde station near Jacksonville, Arkansas was operated by Lt. Col. (ret.) Frank Jenkins.

The receiving station (RDF station s.w. of Bondville, Illinois) required many services. System operators and station watch standers were: Eric Anderson, David Bates, Roy Beckwith, John Huff, Donald Jeanblanc, Frank Luksander, Jack Miller, Mike Rice, and Walter Wood.

Mr. Stanley Bengtson maintained and operated the vertical incidence ionosonde equipment and the oblique incidence receiving equipment.

Mr. William C. McClurg supervised the digital data recording system at the receiving site.

The reduction of the recorded data by the G-20 digital computer was directed by Dr. Edward Ernst. Mr. Roger Vossler supervised the computer operation and prepared the data files. Mr. Edward Cox prepared the CALCOMP plotter routines for making the final reduced data plots.

Preparation of the reduced data formats for publication was done by John Huff, George Morris, Walter Wood, and Jack Miller.

Mr. Jack Miller designed the special instrumentation for the measurement of the apparent elevation angle of arrival.

The very helpful and cooperative assistance of Lowell Tveten, Robert Hunsucker, Tom Georges, Dale Whittaker, and others at ESSA, Boulder, Colorado is appreciated.

Special recognition is due Dr. Edgar C. Hayden who supervised the design and construction of the radiolocation system at the University of Illinois. He also planned the installation of the Houston transmitting site. He built well! The system was used as an instrument for directional propagations research and the fruits of the experiment are given below.

TABLE OF CONTENTS

	Page
FOREWORD	iii
ACKNOWLEDGEMENT	v
TABLE OF CONTENTS	vii
LIST OF FIGURES AND PLATES	ix
1. INTRODUCTION	1
2. THE MEASURED DATA VECTOR	4
3. MEASUREMENT OF APPARENT ELEVATION ANGLE	6
4. DATA REDUCTION PROCEDURES FOR THE ATLAS	9
5. FORMAT FOR THE REDUCED DATA	11
6. THE ATLAS OF REDUCED DATA	15
7. AVAILABILITY STATEMENT	81
DISTRIBUTION LIST	82
DD FORM 1473	83

LIST OF FIGURES AND PLATES

	Page
Figure 1. Geometry for the cooperative directional propagation experiment	2
Figure 2. Format for reduced data.	12
Plate 1. Reduced data for 14 March 1967	16
2. " " " 15 March 1967	17
3. " " " 16 March 1967	18
4. " " " 17 March 1967	19
5. " " " 18 March 1967	20
Plate 6. Reduced data for 11 April 1967	21
7. " " " 12 April 1967	22
8. " " " 13 April 1967	23
9. " " " 14 April 1967	24
10. " " " 15 April 1967	25
Plate 11. Reduced data for 9 May 1967.	26
12. " " " 10 May 1967	27
13. " " " 11 May 1967	28
14. " " " 12 May 1967	29
15. " " " 13 May 1967	30
Plate 16. Reduced data for 13 June 1967.	31
17. " " " 14 June 1967.	32
18. " " " 15 June 1967.	33

LIST OF FIGURES AND PLATES (continued)

	Page
Plate 19. Reduced data for 16 June 1967.	34
20. " " " 17 June 1967.	35
Plate 21. Reduced data for 18 July 1967.	36
22. " " " 19 July 1967.	37
23. " " " 20 July 1967.	38
24. " " " 21 July 1967.	39
25. " " " 22 July 1967.	40
Plate 26. Reduced data for 15 August 1967.	41
27. " " " 16 August 1967.	42
28. " " " 17 August 1967.	43
29. " " " 18 August 1967.	44
30. " " " 19 August 1967.	45
Plate 31. Reduced data for 19 September 1967	46
32. " " " 20 September 1967	47
33. " " " 21 September 1967	48
34. " " " 22 September 1967	49
35. " " " 23 September 1967	50
Plate 36. Reduced data for 24 October 1967	51
37. " " " 25 October 1967	52
38. " " " 26 October 1967	53
39. " " " 27 October 1967	54

LIST OF FIGURES AND PLATES (continued)

	Page
Plate 40. Reduced data for 28 October 1967	55
Plate 41. Reduced data for 14 November 1967.	56
42. " " " 15 November 1967.	57
43. " " " 16 November 1967.	58
44. " " " 17 November 1967.	59
45. " " " 18 November 1967.	60
Plate 46. Reduced data for 12 December 1967.	61
47. " " " 13 December 1967.	62
48. " " " 14 December 1967.	63
49. " " " 15 December 1967.	64
50. " " " 16 December 1967.	65
Plate 51. Reduced data for 16 January 1968	66
52. " " " 17 January 1968	67
53. " " " 18 January 1968	68
54. " " " 19 January 1968	69
55. " " " 20 January 1968	70
Plate 56. Reduced data for 20 February 1968.	71
57. " " " 21 February 1968.	72
58. " " " 22 February 1968.	73
59. " " " 23 February 1968.	74
60. " " " 24 February 1968.	75

LIST OF FIGURES AND PLATES (continued)

	Page
Plate 61. Reduced data for 12 March 1968	76
62. " " " 13 March 1968	77
63. " " " 14 March 1968	78
64. " " " 15 March 1968	79
65. " " " 16 March 1968	80

1. INTRODUCTION

The geometry for the cooperative HF Directional Propagation Experiment is shown in Figure 1. The propagation path for the reduced data given in this report is the Houston, Texas to Champaign-Urbana nominal path. Exact location data on the several facilities is given on each plate in chapter 6.

A variable frequency continuous wave transmitter was located at Alta Loma, Texas, south of Houston. The transmitting antenna was a 2-bay log periodic antenna pointed toward Urbana. An oblique incidence ionosonde transmitter was also operated with the same array on a time shared basis. The duty cycle was a one-minute duration, i.e., 43 seconds of cw transmission and then 17 seconds of oblique incidence ionosonde operation.

Five C-4 type vertical incidence ionosondes were operated in the neighborhood of the path midpoint. The ESSA/ITSA group operated the four ionosondes at Springfield, Mo., Greenwood, Miss., Texarkana, Ark., and Ponca City, Okla., respectively, on a five-minute cycle. The University of Illinois operated a fifth C-4 ionosonde at the path midpoint near Jacksonville, Ark., on a one-minute cycle. The University of Illinois also operated a Granger-type v.i. ionosonde and oblique incidence ionosonde receiver at the receiving endpoint on a one-minute cycle.

The radio direction finder receiver was of the CDAA type and experience with this system has demonstrated that the instrumental error of the system is *less* than 1/2 degree in the sector of study. Accordingly, the measured bearing is considered to be a valid measure angle of arrival of the signal *as received*. The wave interference effects, the lateral deviations in azimuth and the vertical angle deviations

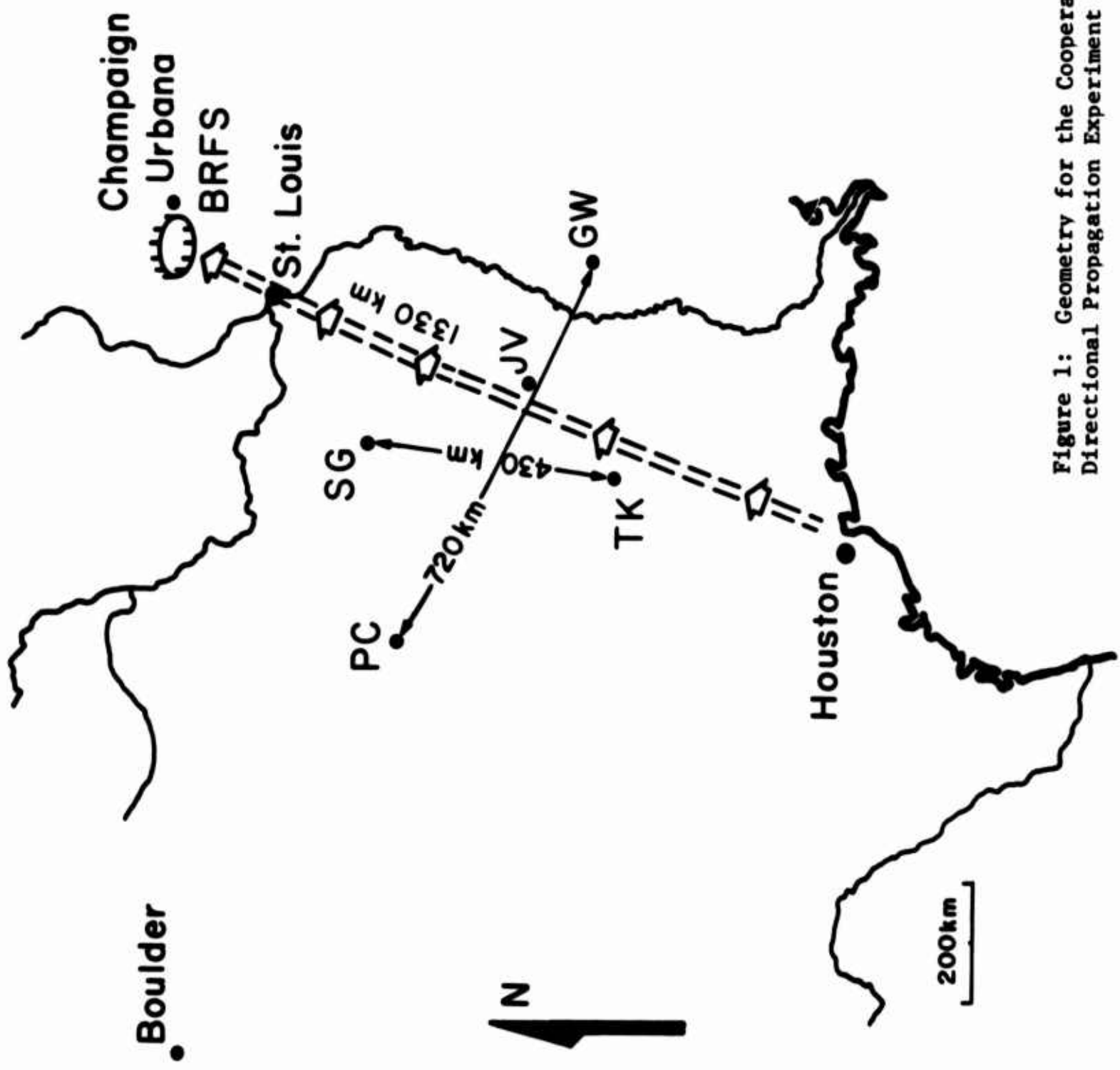


Figure 1: Geometry for the Cooperative Directional Propagation Experiment

(longitudinal deviations) are all completely assignable to the propagation path(s) through the ionospheric region in the neighborhood of the region of the path midpoint.

The ESSA/ITSA group at Boulder was carrying out experiments on the path between their Table Mountain site and Cape Kennedy. The GCB propagation paths intersected at a point near Jacksonville, Arkansas and the angle of intersection is very close to 90 degrees.

The frequency of the cw transmission from the Houston target transmitter was 8.0 MHz during the daytime hours and 12.235 MHz during the nighttime hours.

Azimuthal data (bearing and deviation plots) were recorded at two-minute intervals during the months of March through September 1967 and at one-minute intervals thereafter.

A continuous five day experiment was carried out each month during the period March 1967 through June 1968. The first thirteen months of data have been reduced and are reported later below (chapter 6). The five day period was chosen to bracket the times of the international geophysical days for each month. This permits later correlation studies of our reduced data with that of other cooperating groups.

The data obtained by the group at Boulder are reported elsewhere. The plates in chapter 6 show the availability status of v.i. ionosonde data obtained by their four ionosondes. Some "Doppler ionosonde" data obtained by Dr. T. Georges of ITSA is shown in the earlier plates of chapter 6.

2. THE MEASURED DATA VECTOR

The experiment was controlled in the sense that characteristics of the transmitter and the propagation path were either known or determinable. The receiver was instrumented to measure most but not all of the physically observable quantities. For example, the relative amplitudes of the obliquely incident propagation modes should have been monitored from the outset. The subset of data that was measured during any short observation interval constitutes a column vector in the matrix sense and it is very convenient to represent the data in this sense. Several transformations are made upon the measured column vector to produce the reduced data vector.

The measured data (column) vector consists of the following entries:

I	Interval (date, month, year)
t	Time, U.T., within the interval
f(t)	Frequency in MHz, 8.00 MHz during the daylight hours, 12.235 MHz during the dark hours
$\alpha(t)$	Indicated bearing or azimuthal angle of arrival as received
$\Delta\phi_1(t)$	Differential phase between first phantom array
$\Delta\phi_2(t)$	Differential phase between second phantom array
$\Delta\phi_3(t)$	Differential phase between third phantom array
JA,h'(f,t)	Midpoint ionogram record obtained at path midpoint near Jacksonville, Arkansas
TK,h'(f,t)	Midpoint ionogram record obtained at path midpoint near Texarkana, Arkansas
SP,h'(f,t)	Midpoint ionogram record obtained at path midpoint near Springfield, Missouri

PC,h'(f,t) Midpoint ionogram record obtained at
path midpoint near Ponca City, Oklahoma

GW,h'(f,t) Midpoint ionogram record obtained at
path midpoint near Greenwood, Mississippi

UI,h'(f,t) Midpoint ionogram record obtained at
path midpoint near Bondville, Illinois
(University of Illinois)

$\Delta t(f,t)$ Houston-Urbana oblique incidence ionogram

JA, $\Delta f(f,t)$ Doppler ionosonde data obtained at path
midpoint

UI, $\Delta f(f,t)$ Doppler ionosonde data obtained near
receiving endpoint

Coincidentally, another data vector was obtained on the Boulder to Cape Kennedy path by the ESSA/ITSA group working under the principal direction of Mr. Lowell Tveten.

There were other observers who also accumulated data vectors on the Houston transmissions.

Most of the measured raw data are maintained in various files at the University of Illinois.

3. MEASUREMENT OF APPARENT ELEVATION ANGLE

Measurements of apparent elevation angle were made using a technique originally conceived by Bailey¹. This technique was the subject of further theoretical studies by Jones, Schlicht, and Ernst², where the concept of "Phantom Antennas" was introduced, i.e., the addition of voltages from a pair of symmetrically disposed antennas (with respect to the boresight). From measurements of the differential phase angle between two such Phantom Antennas, values of elevation angle can be obtained by use of the equation:

$$\psi = \frac{2\pi d}{\lambda} \cos \theta \cos \alpha$$

where d = horizontal spacing along the boresight between the Phantom Antennas

λ = wave length of signal

α = difference between azimuthal angle of arrival of signal and azimuthal alignment of Phantom Antennas. (For these data, this angle is assumed to be zero)

ψ = differential phase angle between Phantom Antennas

θ = apparent elevation angle

It should be noted at this time that for the elevation angle data presented, the determination of the value to be used for "d" in the above equation was based upon the assumption that the phase center for the antennas of the array is located at the screen radius.

-
1. A. D. Bailey, "Some Notes on the Determination of the Vertical Angle of Arrival of HF Radio Wave and Implications in Circularly Disposed Arrays", Technical Memorandum RRL No. 263, October 27, 1964.
 2. E. C. Jones, Jr., H. C. Schlicht, and E. W. Ernst, "A Simulation Study of Elevation Angle of Arrival Measurements in the Wullenweber RDF System", Technical Note No. 3, RRL No. 306, April, 1966.

For the elevation angle data presented in this Atlas, two Phantom Antennas were used and they are identified as the Front Phantom and the Rear Phantom. The Front Phantom consisted of two adjacent antennas of the array, so selected such that the boresight of the incoming signal passed between these two antennas. The output of these two antennas was added by a RF combiner to create the Front Phantom. By the RF addition of voltages from two other symmetrically disposed antennas, the Rear Phantom was formed and it was located directly behind the Front Phantom on the boresight. To avoid ambiguity problems, the horizontal spacing along the boresight ("d" in the above equation) between the Front and Rear Phantom Antennas was restricted to a distance of one-half wave length or less for any given operating frequency.

Each Phantom Antenna was fed through RF diode switches to a matched twin-channel receiver, the Front Phantom being fed to one channel of the receiver and the Rear Phantom to the other channel. Test signals, used to measure phase drift in the receiver and phasemeter calibration, were also connected to the inputs of the receiver by means of the diode switches.

At the output of the 250 kHz IF amplifiers of each receiver, a phasemeter was connected to measure the differential phase angle between the receiver channels. The phasemeter output is an analog voltage which is proportional to the phase angle difference appearing at its input terminals. This voltage measurement was then recorded on magnetic tape for processing by the digital computer.

For every data sample, two differential phase voltage measurements proportional to elevation angle were made. These measurements were 600 milliseconds apart in time. In addition to this, phase voltage

measurements of phase drift between receiver channels and calibration of the phasemeter were performed by means of test signals connected to the receiver inputs by the diode switches.

To calculate the apparent elevation angle for each data sample, a computer program was written to perform a simple average of the two differential phase voltage measurements, after correction of these measurements for any phase drift in the receivers. Then a running-average window of 20-minutes duration was performed on the simple-average values. The 20-minute running average used here is similar to that used for the bearing calculations. When all the averaging has been completed, the differential phase angle for each data sample is then found by multiplying the averaged differential phase voltage by the phasemeter conversion constant. This gives the value for " ψ " in degrees for use in the elevation angle equation. For any given frequency, all other parameters are known and the apparent elevation angle " θ " can be calculated.

It should be stressed that the apparent elevation angle is obtained from a calculation which assumes that the effective reference phase center for each antenna is located at the screen radius. Experimental results have indicated that the effective phase center lies close to but not on the screen radius. Accordingly, the results should be interpreted as being qualitatively indicative of elevation angle of arrival. The averaged results are close to the results of 3-D ray tracing studies for the path.

4. DATA REDUCTION PROCEDURES FOR THE ATLAS

The data from which the direction of arrival of the signals is determined are recorded at the Bondville Road Field Station on magnetic tape with the High Speed Data System. The bearing deviation is computed from recorded data which includes the amplitude of the sum voltage sampled at 1° increments of scanner rotation over the designated sector of the scan. Time, the sector width, and the sector center are other data used for computing the bearing. The data tapes are then decoded, edited, the format of the information changed, and the data then becomes part of the Master RRL Data File.

The data were recorded in groups of eight successive scans taken at one or two minute intervals. Bearings were computed from the data for each scan. A sector width of 30° and a sector center of 209° has been used for most of the data reported here.

Bearings were computed using a center of gravity technique first suggested by Smith and modified by Jones. In this procedure, the largest value of the sum voltage in the scan is determined. Using this value as a reference, successive values to the right of the maximum values are examined until one of the following conditions is found:

1. The voltage falls below 0.1 of the maximum voltage.
2. A null is found as indicated by a value smaller than two successive following values.

The process is then repeated to the left of the maximum voltage. The voltage sampled between the right and left limits as determined above describe the major lobe of the response to the signal. The azimuthal coordinate of the centroid of the major lobe is then computed. This value is the bearing for the scan.

The eight bearings computed from the group of eight scans are averaged and the mean (average bearing) and the standard deviation for the group determined. The average bearing for the group and the standard deviation for the group are then plotted as a function of time. This is the bearing and deviation plot. At those times for which no data are available, no data are plotted. It should be noted that the standard deviation is plotted as (maximum value of bearing - standard deviation) versus time. Thus, a zero value for the standard deviation would be plotted at the top and increasing values toward the bottom.

The average bearings were further averaged using a conventional running average technique. This is the mean value (running average) of all average bearing values within a specified window or interval of time. The plots shown here are for window widths of 20 minutes and 2 hours. Thus, for the 20 minute window, 20 successive values of average bearing were used as input for computation of the running average. (Note: If the data were recorded at two minute intervals, only ten successive values would be used.) The running average determined is then plotted versus time. The time chosen is the time at the center of the window. The running average is recomputed for each one minute (or two minute) increment of time. If no average bearing exists for one or more of the time values included in the interval, an average is computed for those that do exist. If the time value at the center of the interval is one for which no value of average bearing exists, the data are not plotted.

All computations were made using the CDC G-20 computer operated by the Radiolocation Research Laboratory and the plots were drawn using a CALCOMP plotter.

5. FORMAT FOR THE REDUCED DATA

The reduced data for each 24-hour day are plotted as functions of Universal Time and Central Standard Time. Six characteristic types of reduced data plots are presented and the order of presentation (from top to bottom) is shown in the format of Figure 2.

A very large amount of information has been compacted into a plate. In the compacting process the size of some of the printed labels became small. We apologize for this. The printing is crisp and can be discerned and recovered readily with a reading-glass type magnifier (optical data processing). We hope the end result justifies the means that were taken here.

The first characteristic type of reduced data is the oblique ionogram data. The oblique ionograms for the path were edited for the frequency of transmission at the time, either 8 MHz or 12.235 MHz, and the delay times for the modes in evidence at that time were plotted along the ordinate axis direction. It would have helped considerably if the relative amplitude of each mode had been measured and plotted. This was done near the end of the experiment.

The second characteristic type of reduced data is the bearing *and* deviation plot. The GCB for the target transmitter was 209.12 degrees. In the lower portion of this plot is shown the measured azimuthal angle of arrival of the signal as received, or the indicated bearing. It is obtained from a short-period sample average and is labelled average bearing in that sense. At the top of the plot and projecting downwards is the magnitude of the associated standard deviation. The standard deviation often appears to be vanishingly small at night but of the order of 1° to 2° during the day. Points having a standard deviation larger

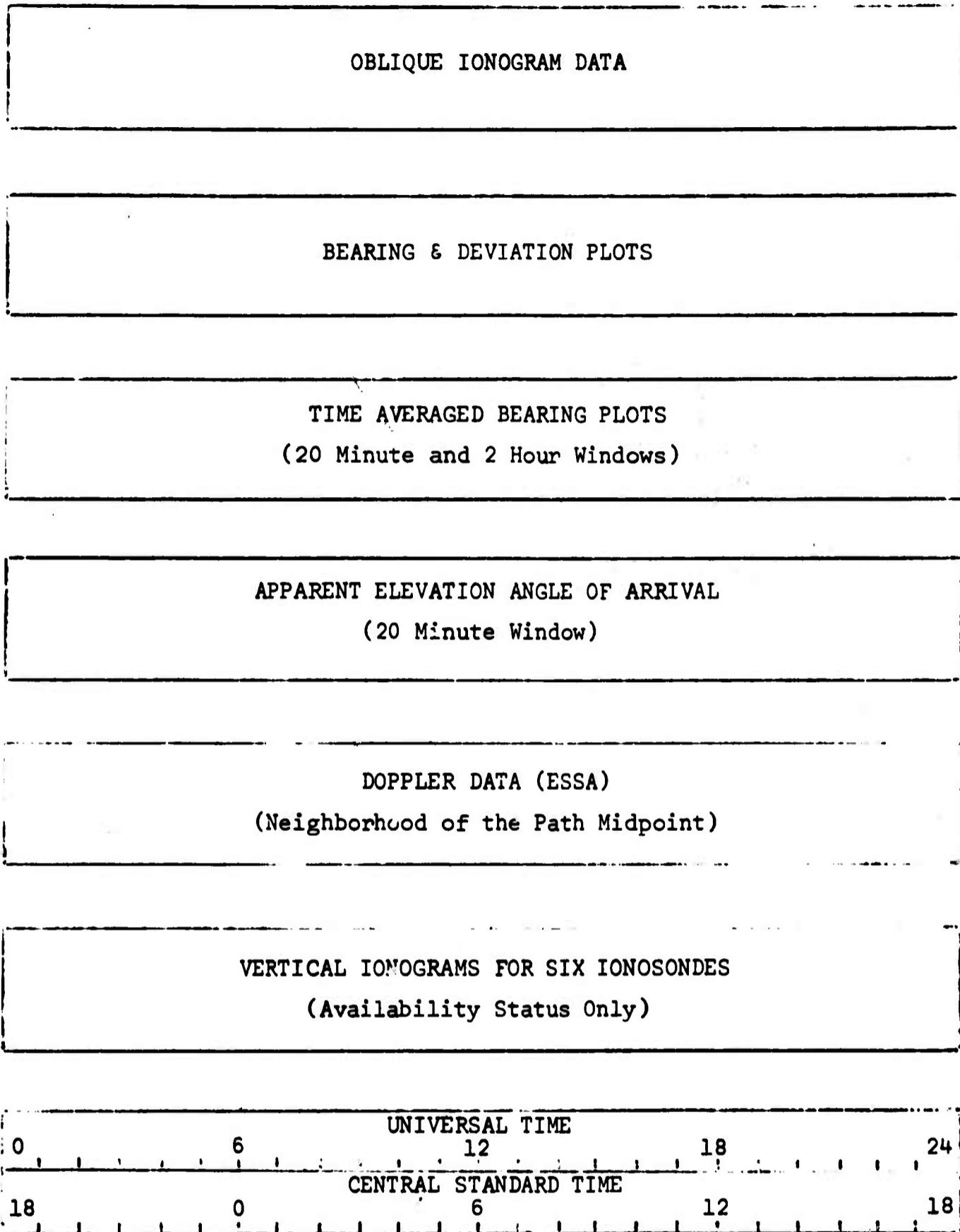


Figure 2. Format for reduced data.

than approximately 3° should probably be ignored.

The third characteristic type of data consists of time averaged bearing plots. A 20-minute window and a 2-hour window, respectively, was used. The lower plot is the 20-minute running average. It is seen that the wave interference effects have been reduced very considerably but the "quasi-20-minute period variations" appear. The upper plot is the two hour running average and it is indicative of the diurnal effects or solar effects. We also call it the "diurnal curve".

The fourth characteristic type of data is the apparent elevation angle of arrival averaged over a 20 minute period. It was pointed out earlier above that these data are more apparent than real because the effective radius of the array to be used in making the calculation is not finally established; ray tracing results indicate that the plotted curve is probably too high. The curve is indicative of the trend and demonstrates an unused capability.

The fifth characteristic type of data is the Doppler data obtained near the path midpoint. The legend on the extreme right such as 4T, 4G, 4S, 3G, etc., should be interpreted as the 4.0 MHz cw signal from Texarkana, the 4.0 MHz cw signal from Greenwood, the 4.0 MHz signal from Springfield, the 3.0 MHz signal from Greenwood, respectively, etc. What is actually plotted is the differential frequency between a transmitted cw signal and its received version. Two very stable oscillators are used; one determines the transmitted cw signal, the other determines the local oscillator frequency at the receiving site, and the difference frequency is an indicator of variations in the propagation medium along the line of travel. These data were provided by Mr. Tom Georges of ESSA.

The sixth characteristic type of data is of the "yes-no" type. It

indicates by the presence (mark) or absence (space) of points along a line the availability of vertical incidence ionosonde data for each of the six vertical incidence ionosondes involved in the experiment.

6. THE ATLAS OF REDUCED DATA

In the following sixty-five plates are contained the several families of plots of reduced data as described in the previous section.

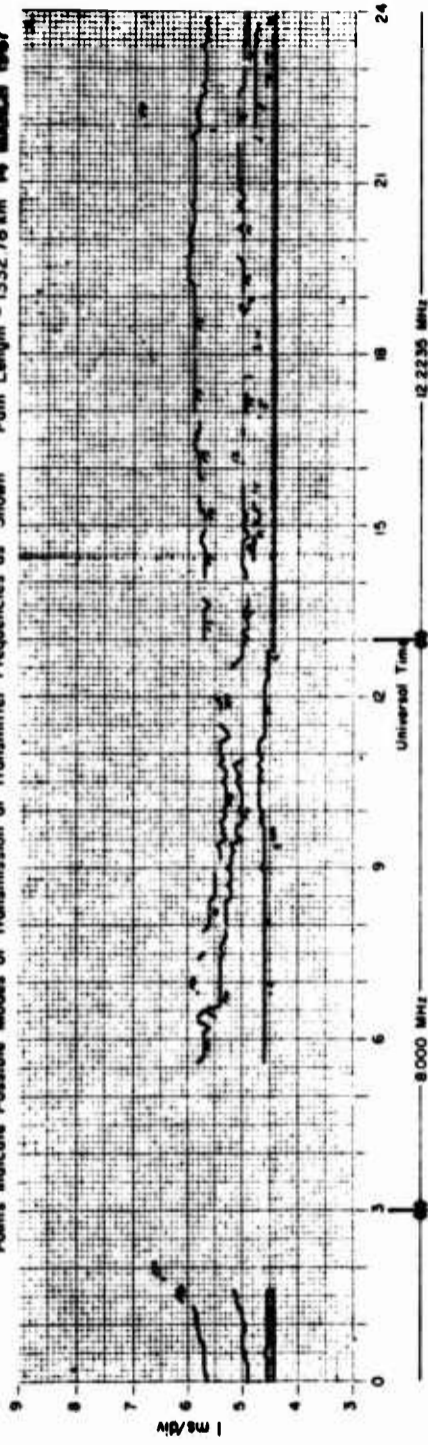
There were times when some (one or more) equipment was not functioning and for those times a gap will appear in the data.

One will note intervals where the oblique ionograms showed no evidence of propagation but an angle of arrival was recorded along with a very large standard deviation. These intervals should normally be excluded from any statistical treatment of the data.

These plates are given without further comment at this point. One must, therefore, draw his own inferences about events in time that may be of particular interest. We believe that the results truly represent directional propagation effects. The systematic error is very small by comparison, i.e., it is not significant in the statistical sense.

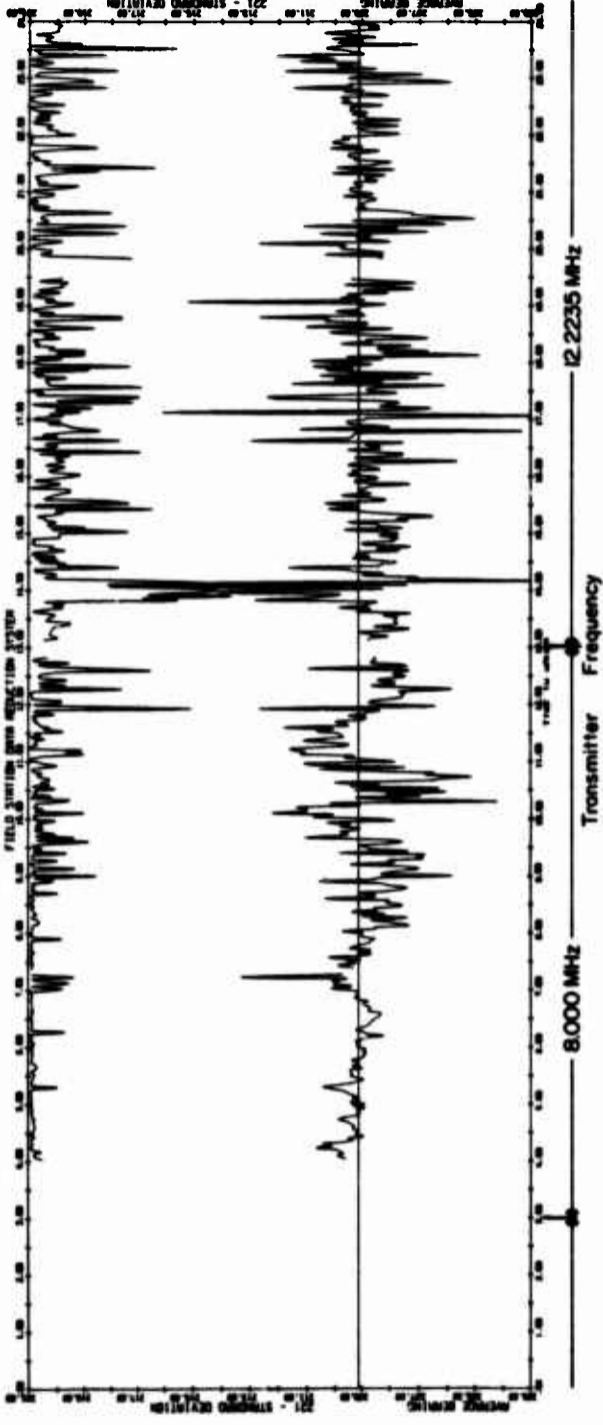
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission as Shown Path Length - 1332.78 km 14 MARCH 1967

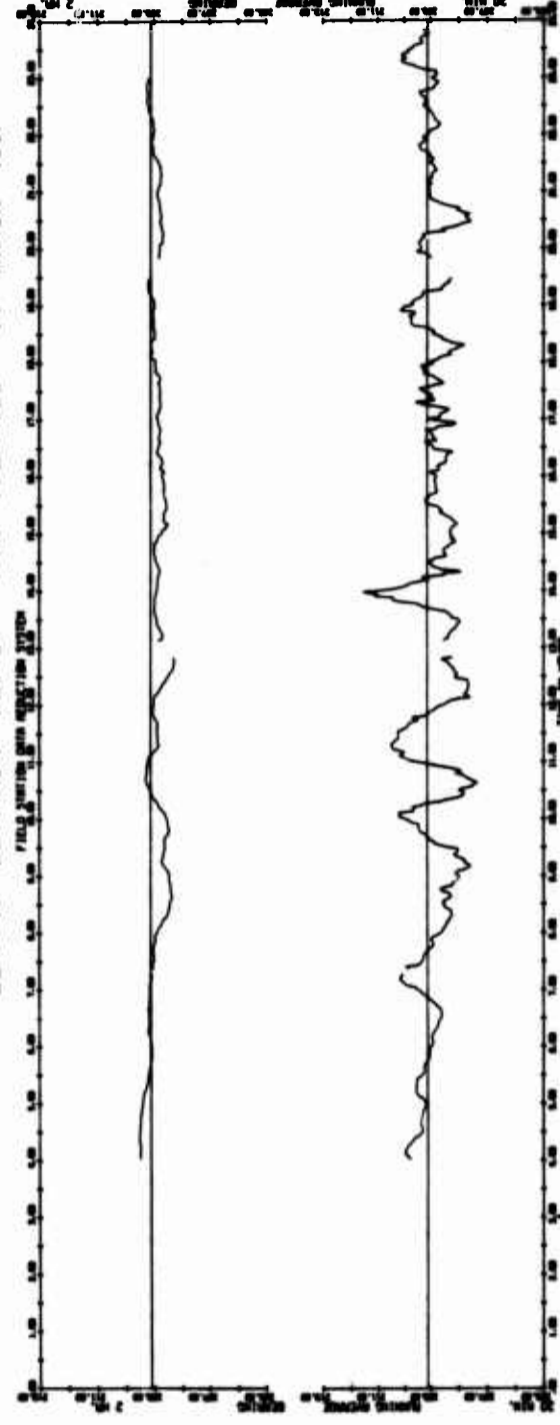


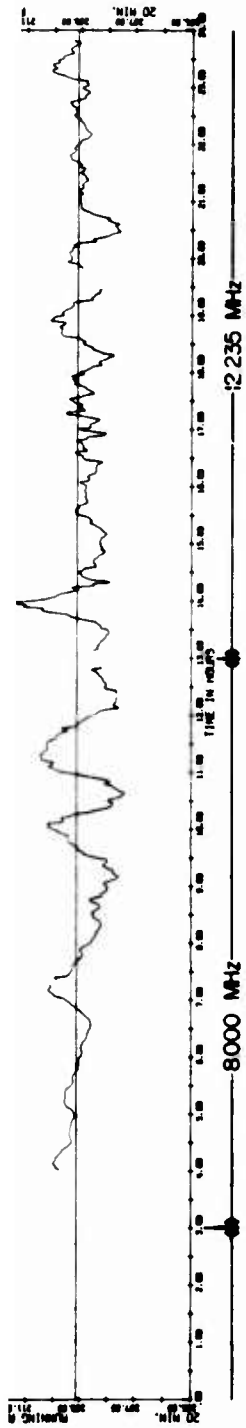
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34° 8' N, 92° 0' W
 Receiver: Wultenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 14 MARCH 1967



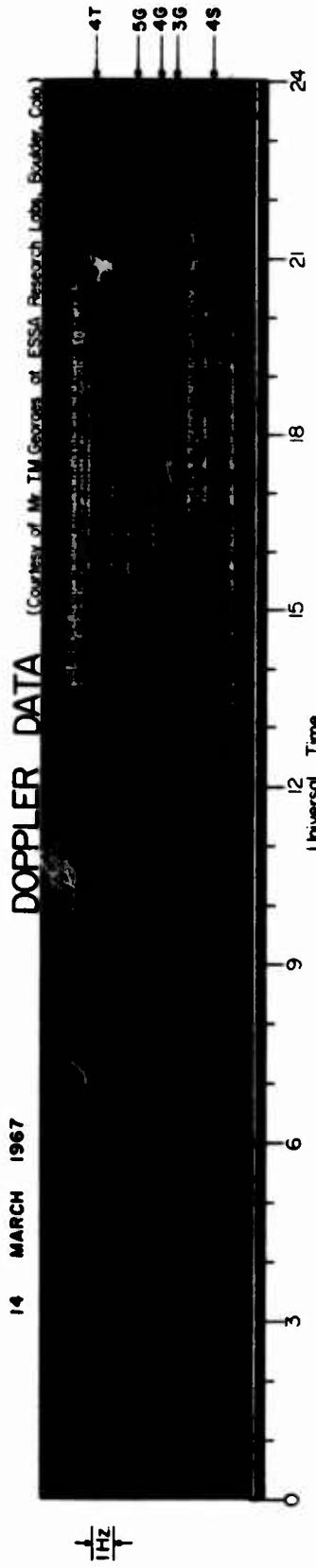
BEARING DEVIATION PLOTS - TIME AVERAGED 14 MARCH 1967





APPARENT ELEVATION ANGLE OF ARRIVAL - 20 Minute Average 14 MARCH 1967

NO DATA AVAILABLE



VERTICAL SOUNDER DATA

- TK - TEXARKANA, ARKANSAS 33.3° N, 94.0° W GW - GREENWOOD, MISSISSIPPI 33.3° N, 90.1° W
- SP - SPRINGFIELD, MISSOURI 37.1° N, 93.2° W UI - URBANA, ILLINOIS 40.0° N, 88.3° W
- PC - PONCA CITY, OKLAHOMA 37.4° N, 97.0° W JA - JACKSONVILLE, ARKANSAS 34.6° N, 92.0° W

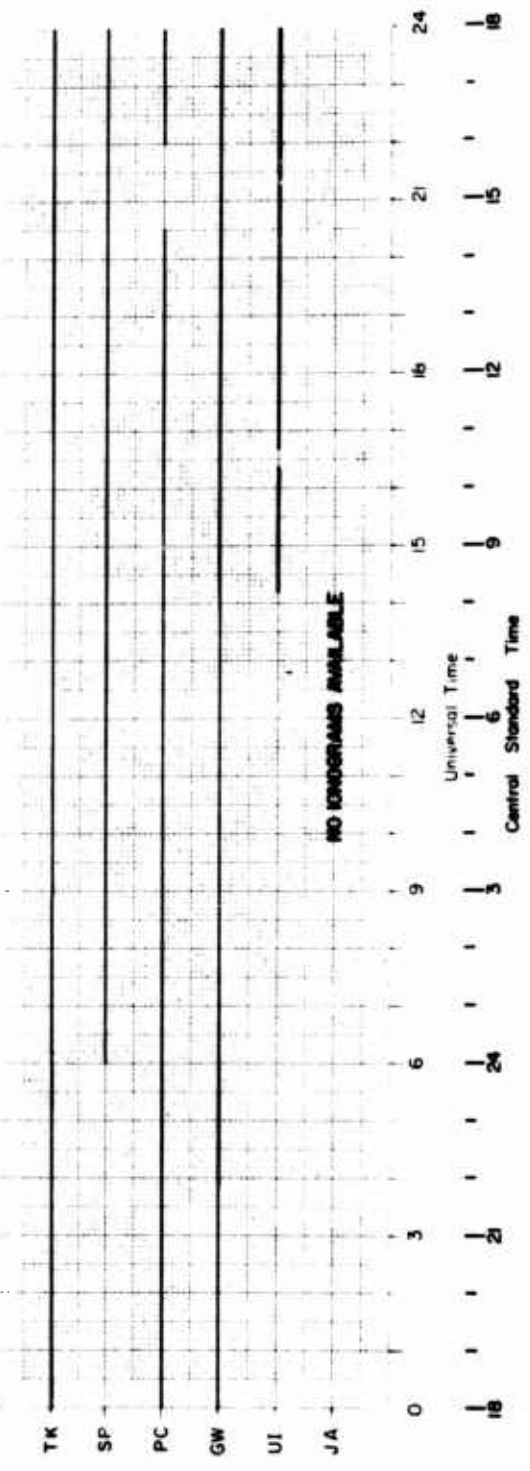
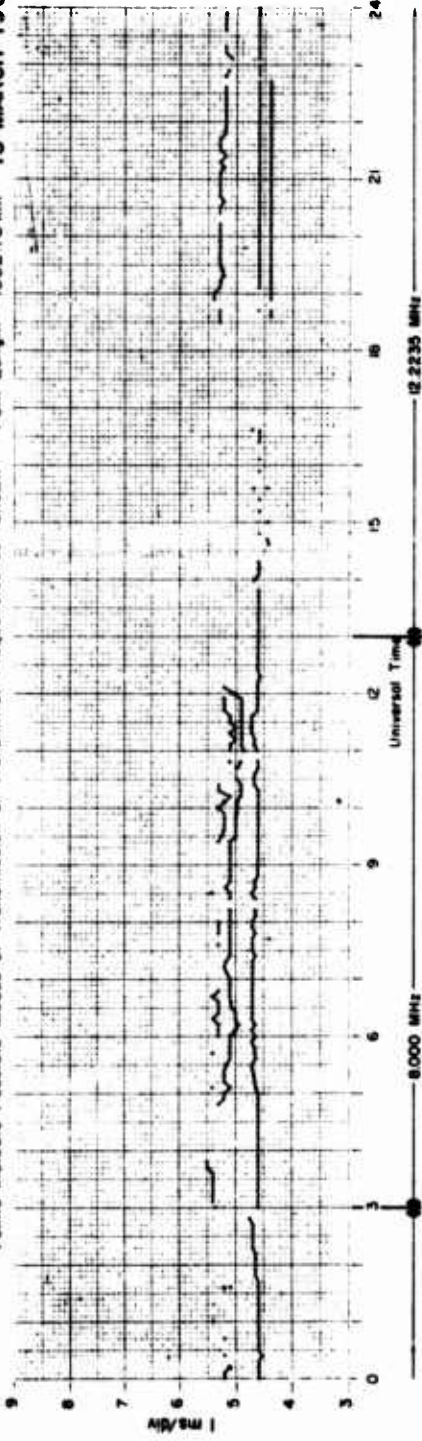


Plate 1.

14 March 1967

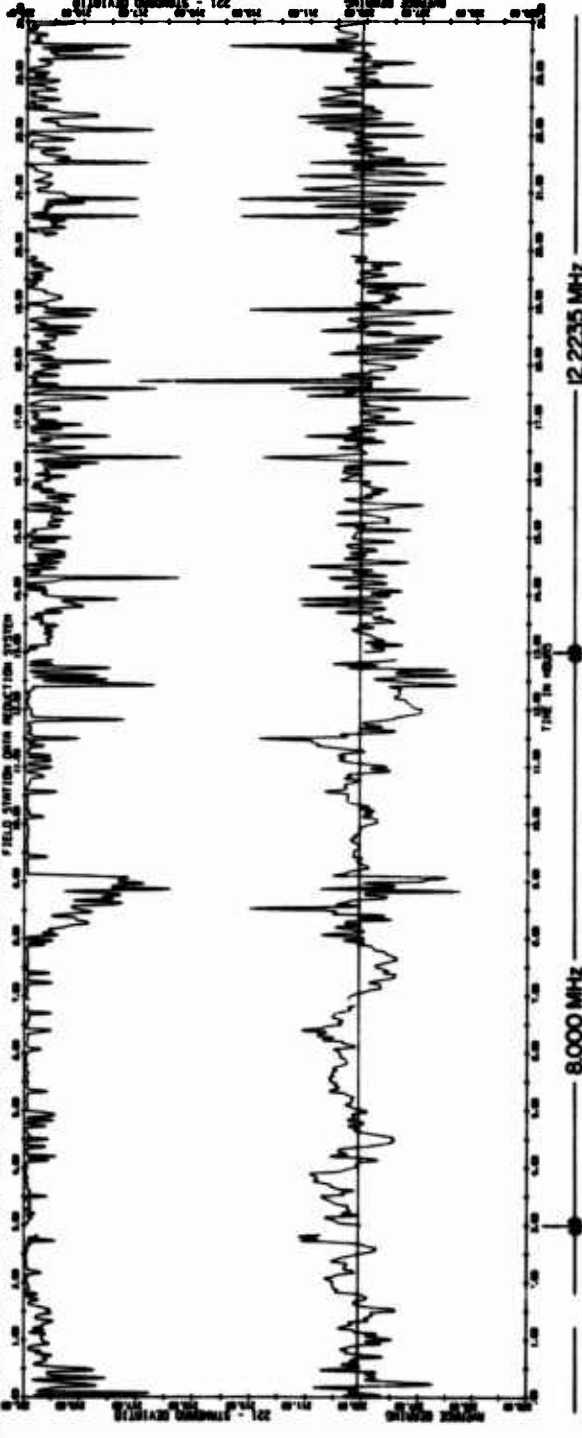
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 15 MARCH 1967

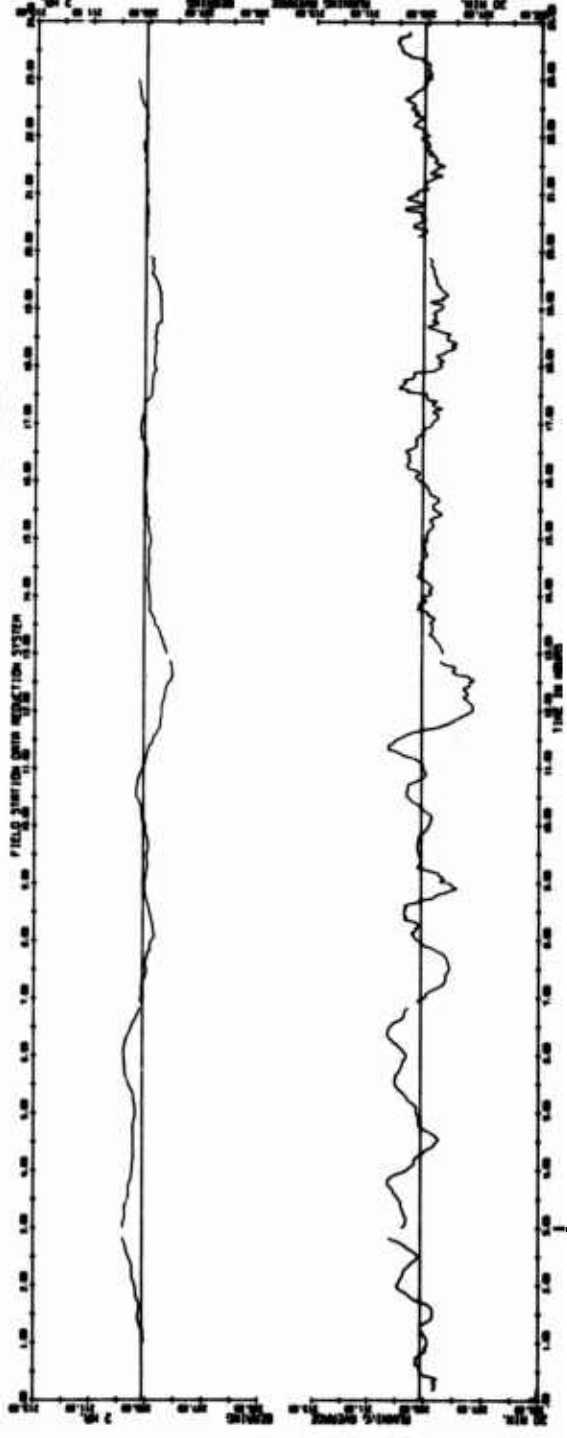


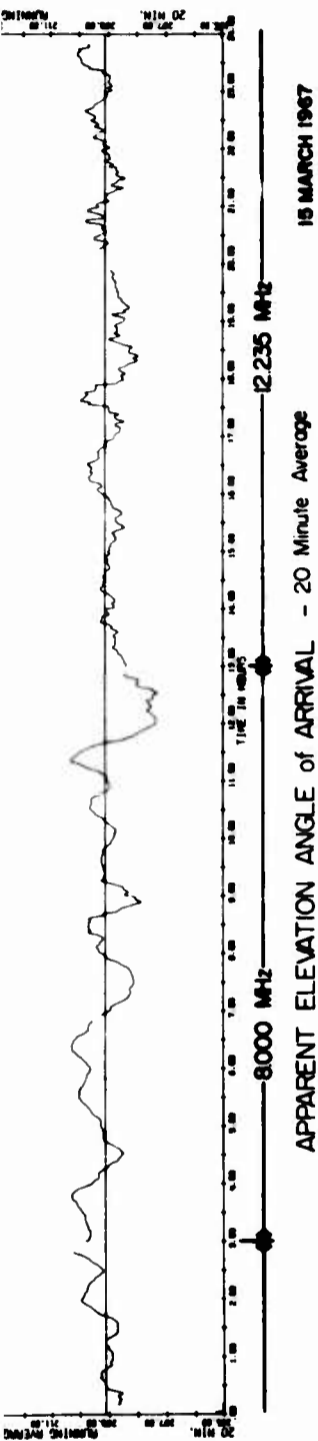
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 15 MARCH 1967



Transmitter Frequency
 BEARING DEVIATION PLOTS - TIME AVERAGED 15 MARCH 1967





NO DATA AVAILABLE

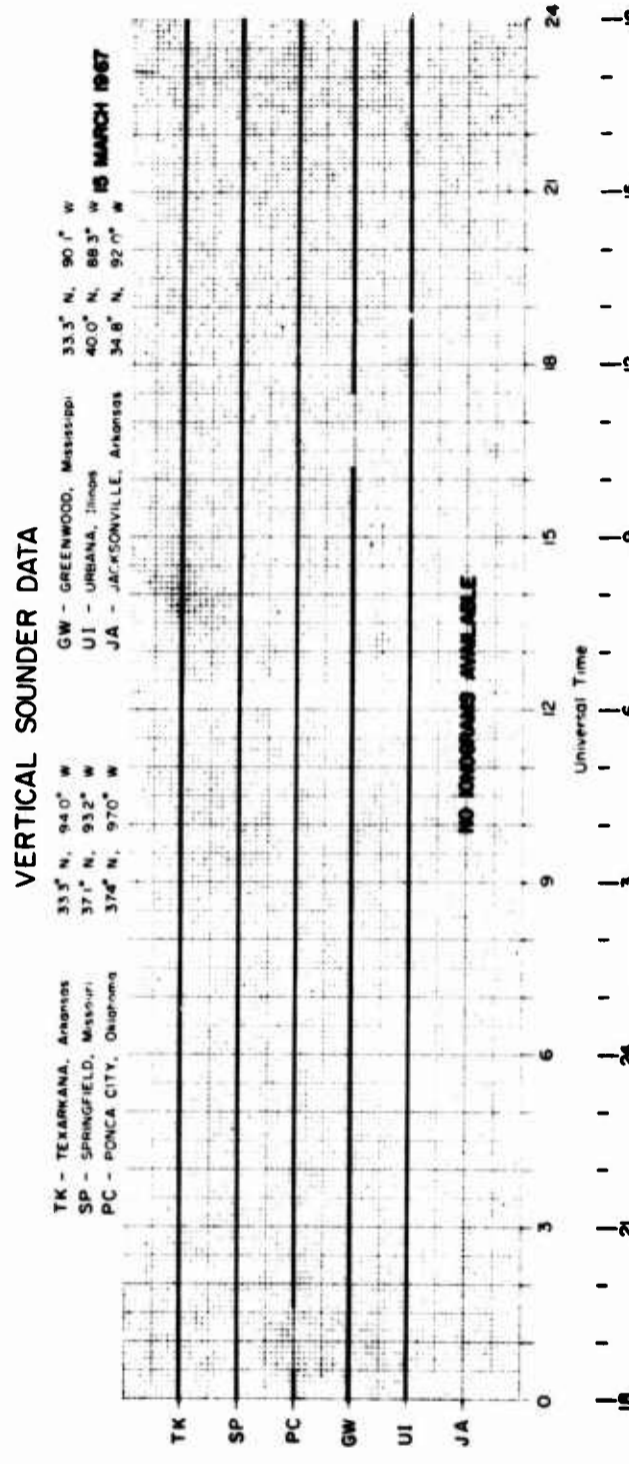
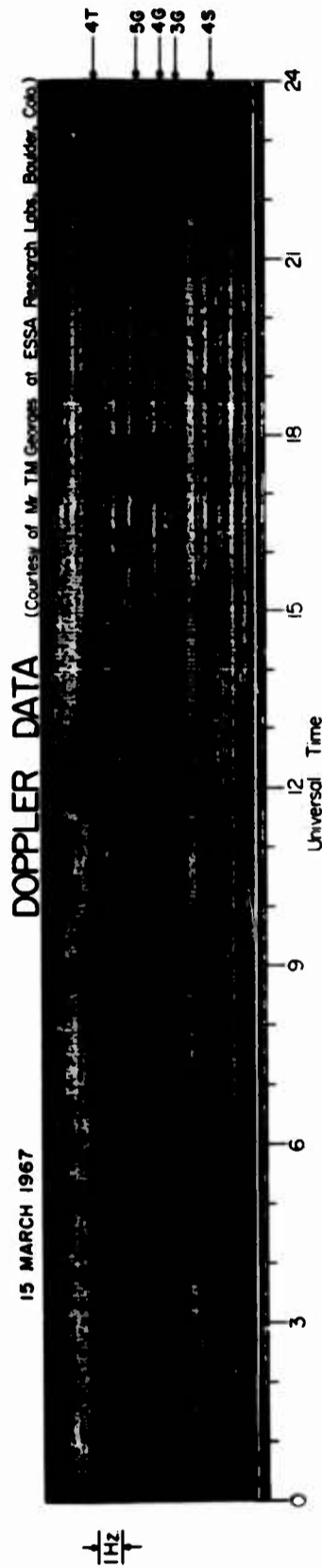
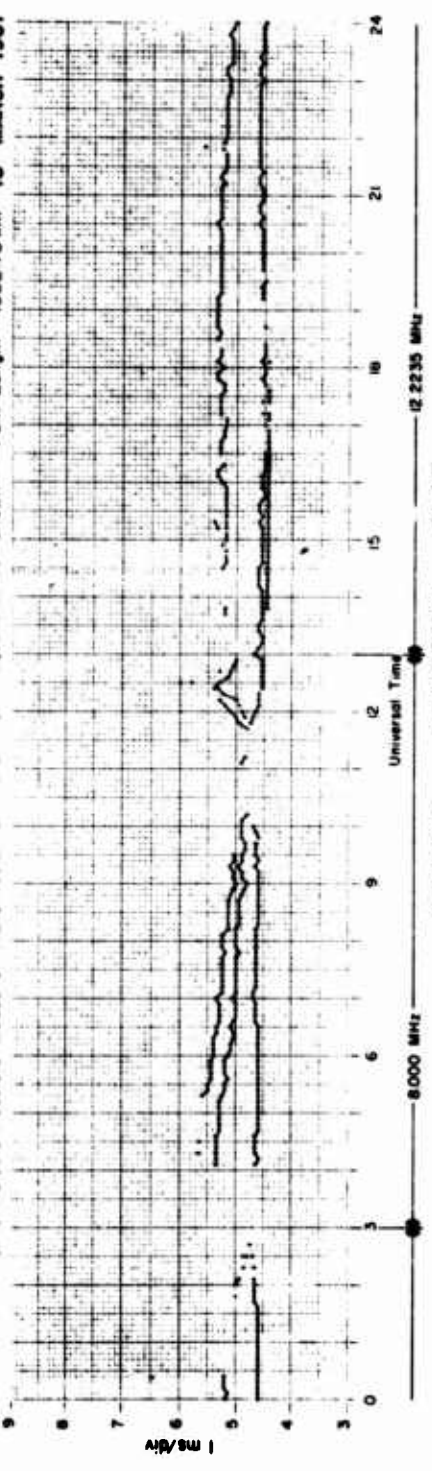


Plate 2.

15 March 1967

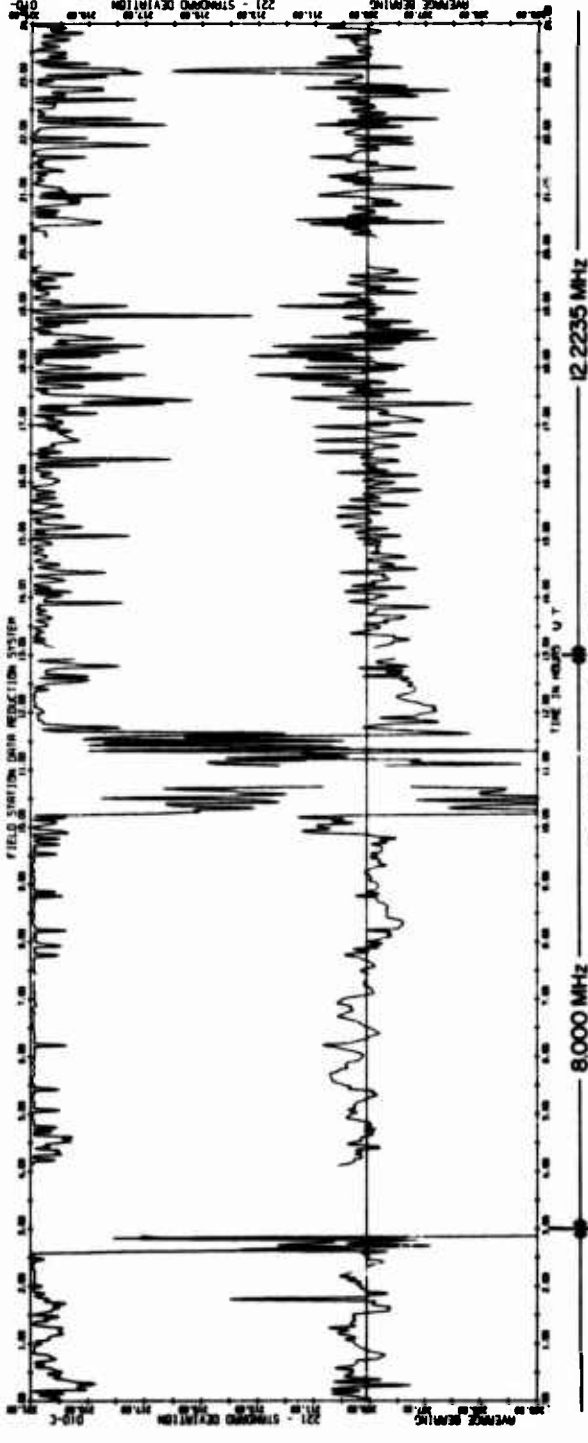
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 16 MARCH 1967

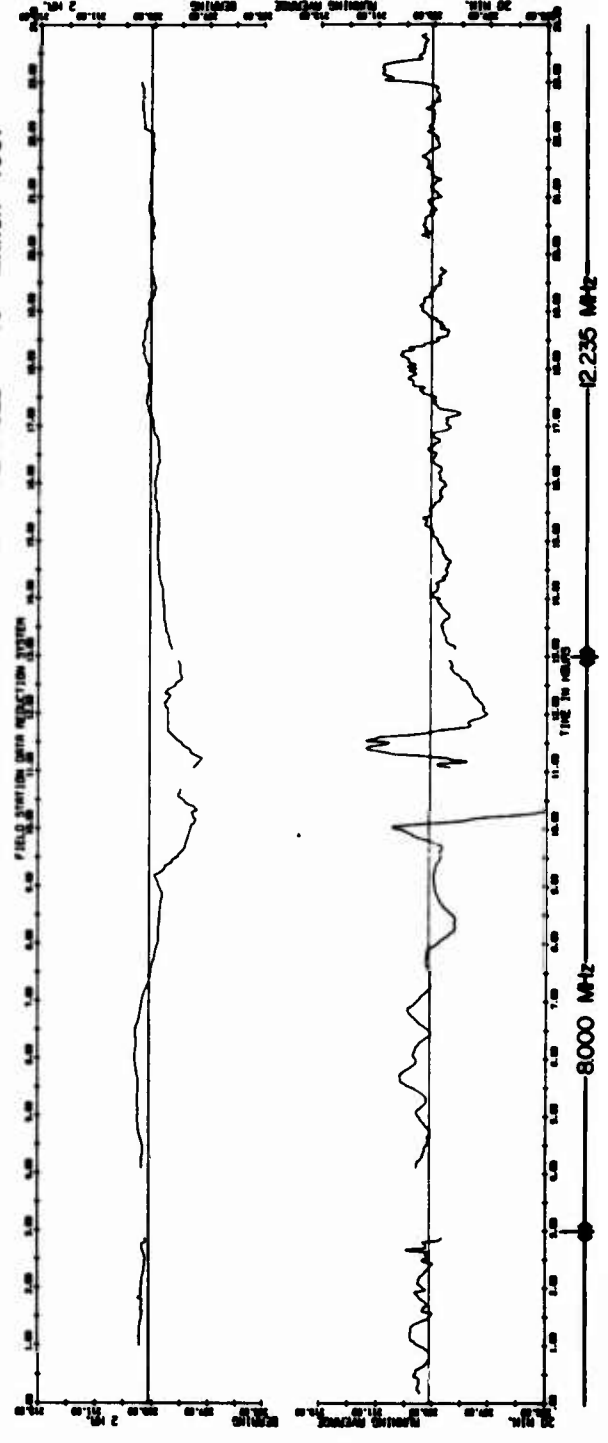


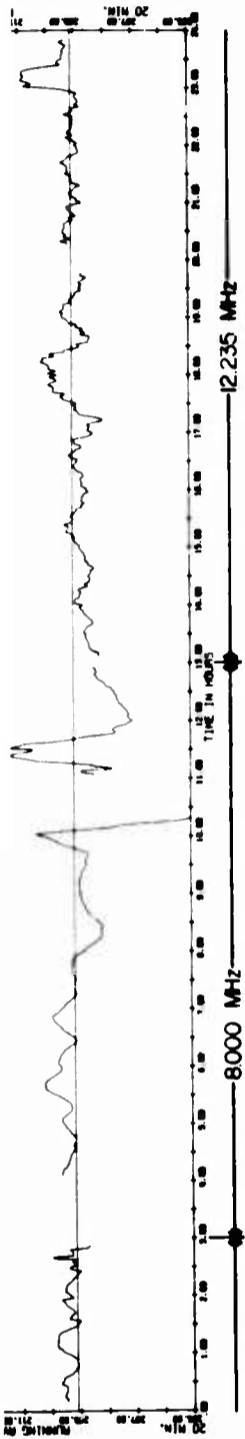
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 16 MARCH 1967



BEARING DEVIATION PLOTS - TIME AVERAGED 16 MARCH 1967

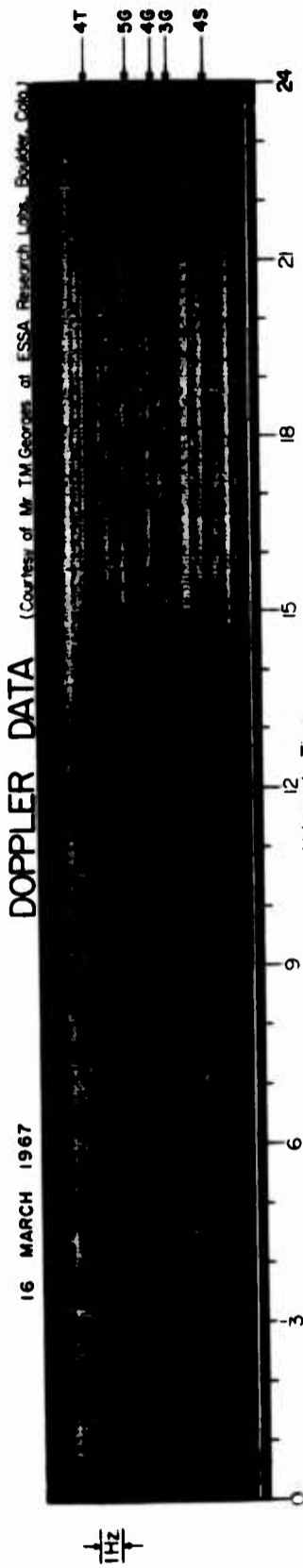




16 MARCH 1967

APPARENT ELEVATION ANGLE of ARRIVAL - 20 Minute Average

NO DATA AVAILABLE



16 MARCH 1967

DOPPLER DATA

(Courtesy of Mr TM Georais of ESSA Research Labs, Boulder, Colo)

VERTICAL SOUNDER DATA

TK - TEXARKANA, Arkansas	33° N, 94° W	GW - GREENWOOD, Mississippi	33.3° N, 90.1° W
SP - SPRINGFIELD, Missouri	37.1° N, 93.2° W	UI - URBANA, Illinois	40.0° N, 88.3° W
PC - PONCA CITY, Oklahoma	37.4° N, 97.0° W	JA - JACKSONVILLE, Arkansas	34.8° N, 92.0° W

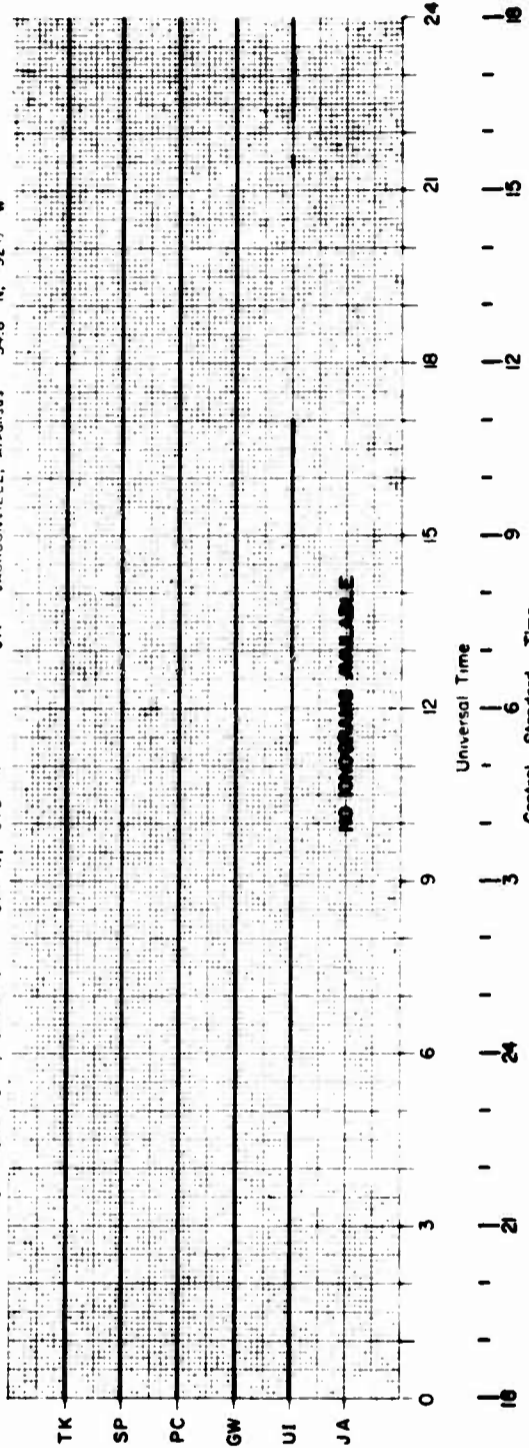


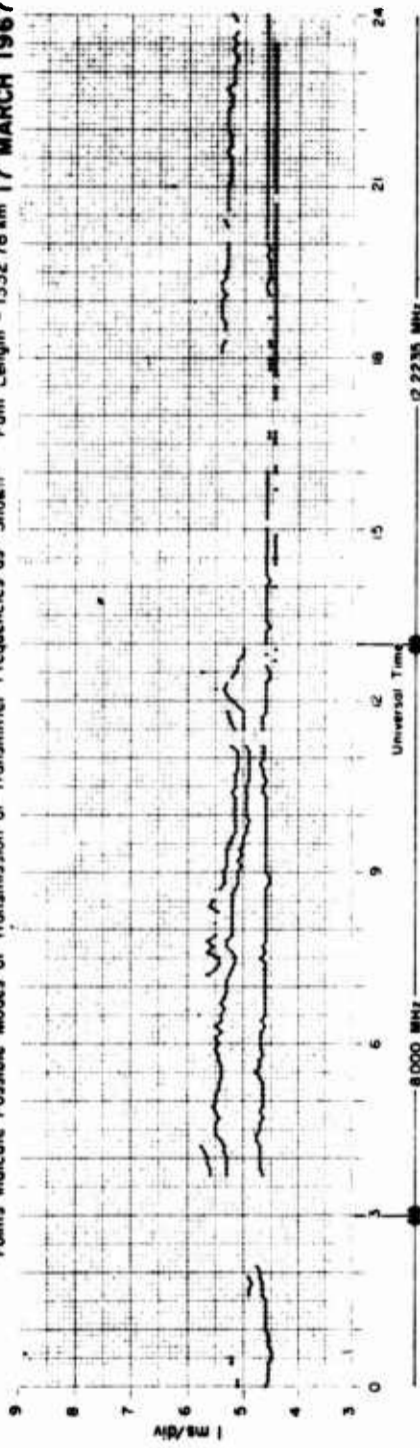
Plate 3.

16 March 1967

2

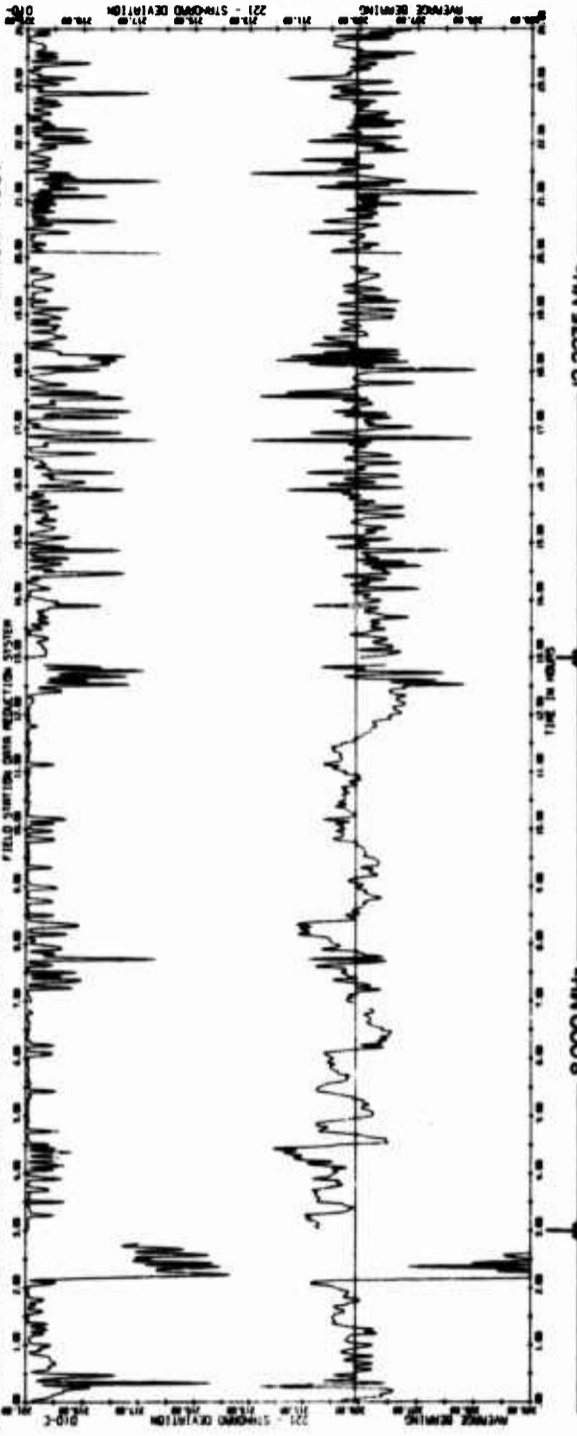
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission of Transmitter Frequencies as Shown. Path Length - 1332.78 km 17 MARCH 1967

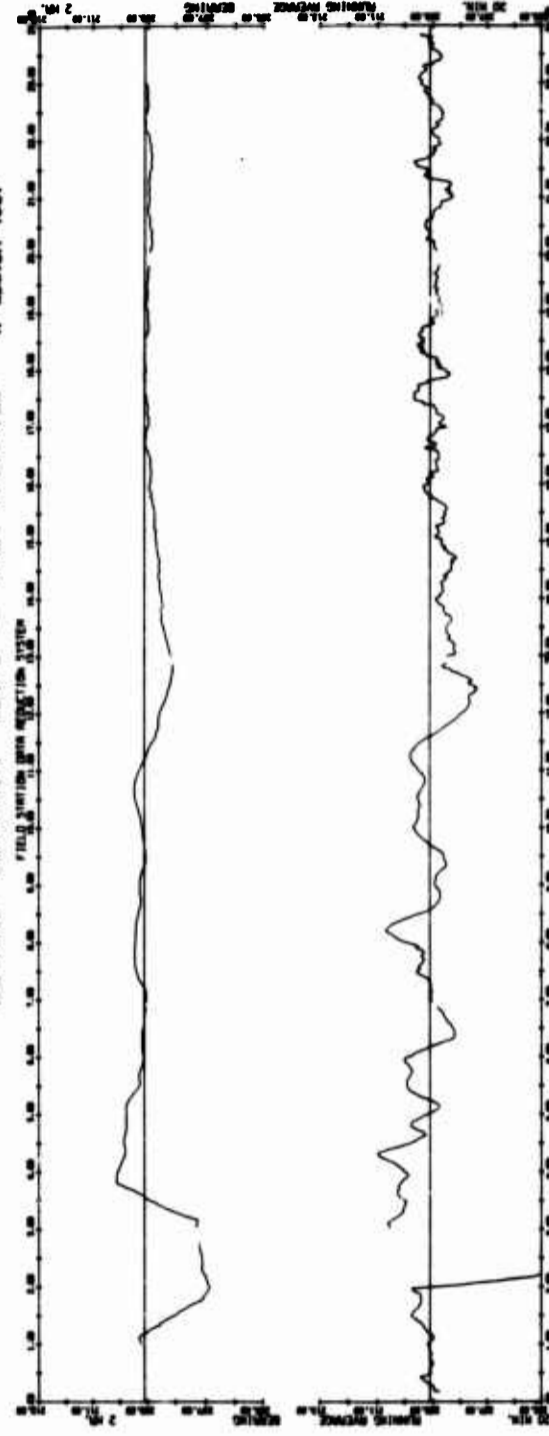


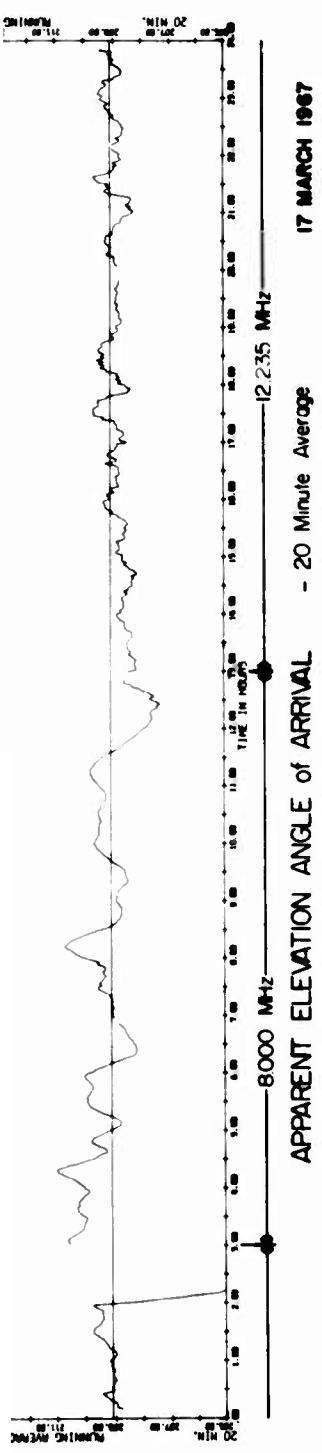
BEARING DEVIATION PLOT

Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 17 MARCH 1967

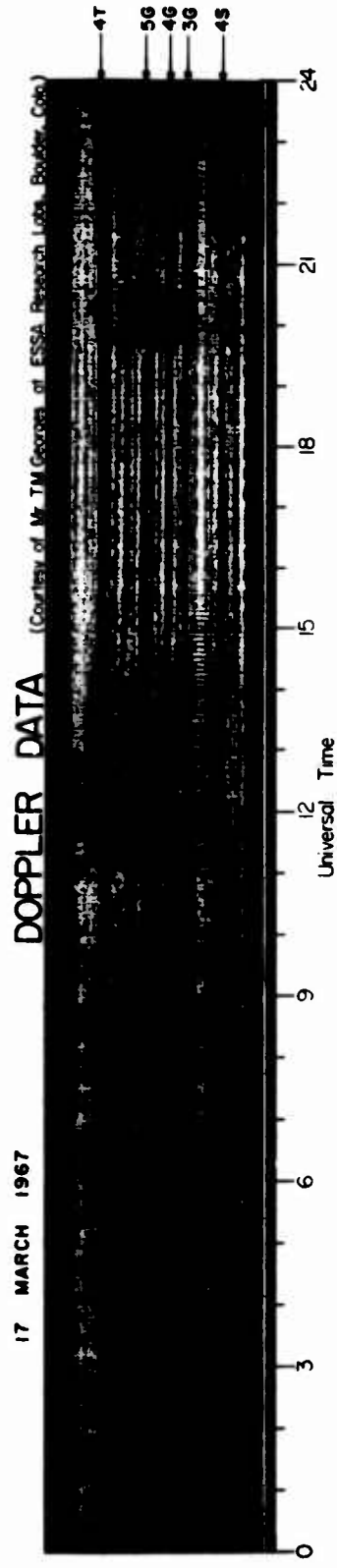


BEARING DEVIATION PLOTS - TIME AVERAGED





NO DATA AVAILABLE



VERTICAL SOUNDER DATA

TK - TEXARKANA, Arkansas	33° N, 94° W	GW - GREENWOOD, Mississippi	33° N, 90° W
SP - SPRINGFIELD, Missouri	37° N, 93° W	UI - URBANA, Illinois	40° N, 88° W
PC - PONCA CITY, Oklahoma	37° N, 97° W	JA - JACKSONVILLE, Arkansas	34° N, 92° W

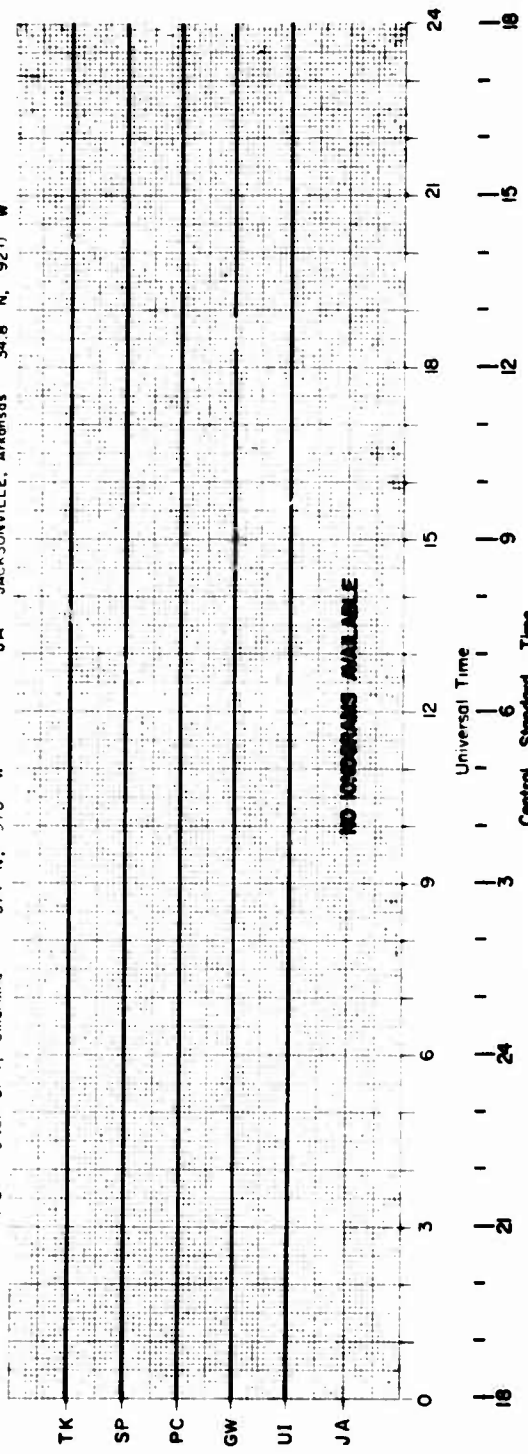
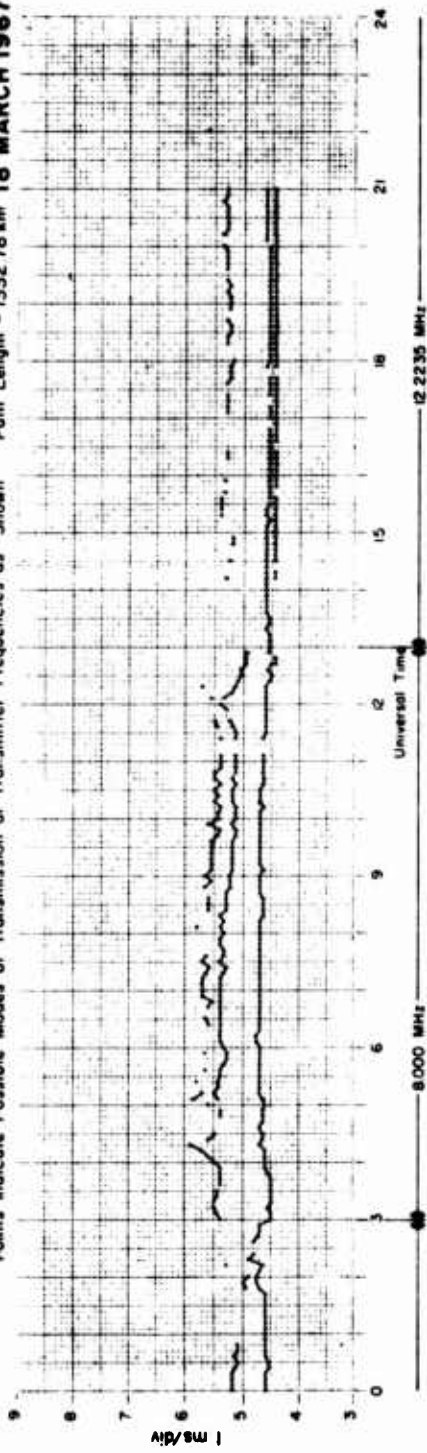


Plate 4.

17 March 1967

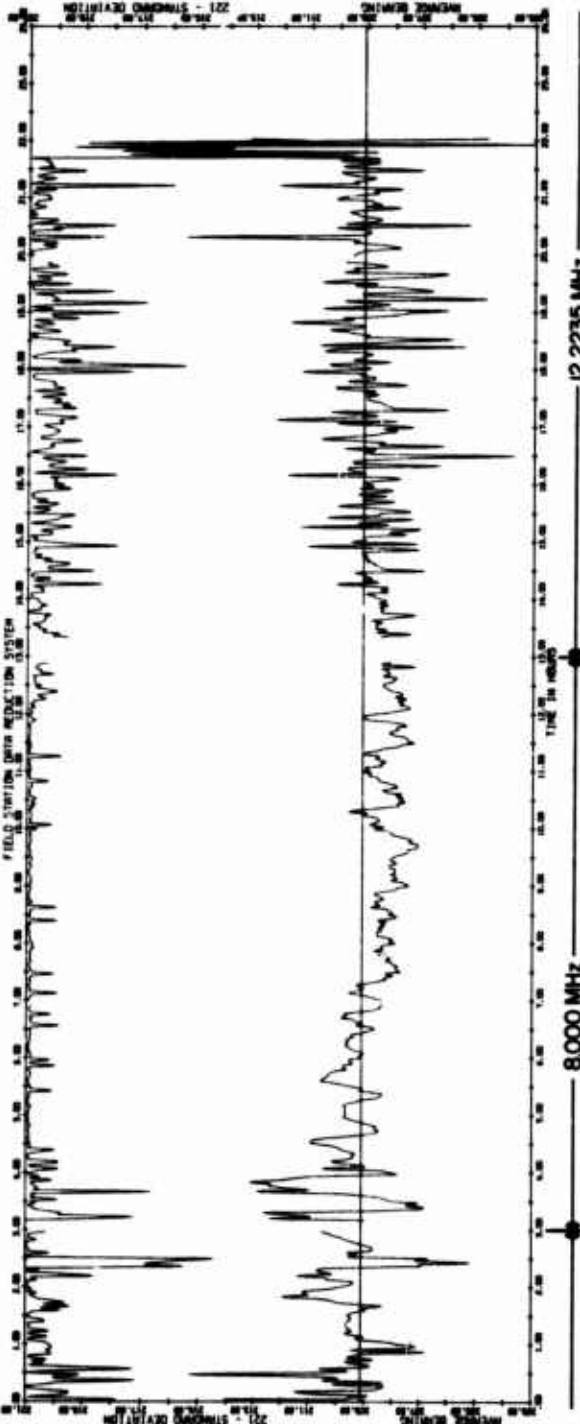
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) 10 Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 18 MARCH 1967



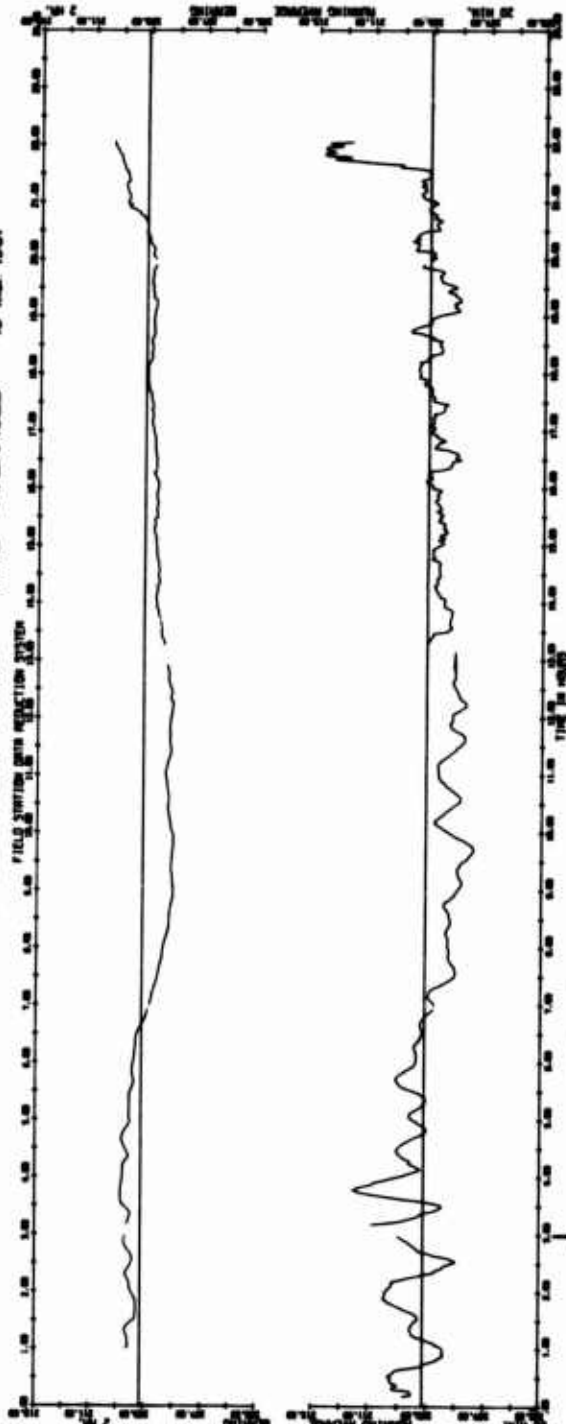
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34° 8' N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 18 MARCH 1967

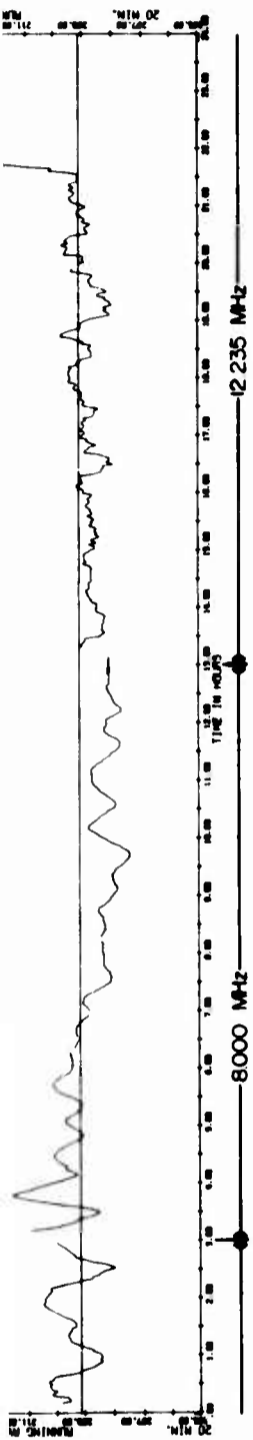


8000 MHz Transmitter Frequency 12.2235 MHz

BEARING DEVIATION PLOTS - TIME AVERAGED

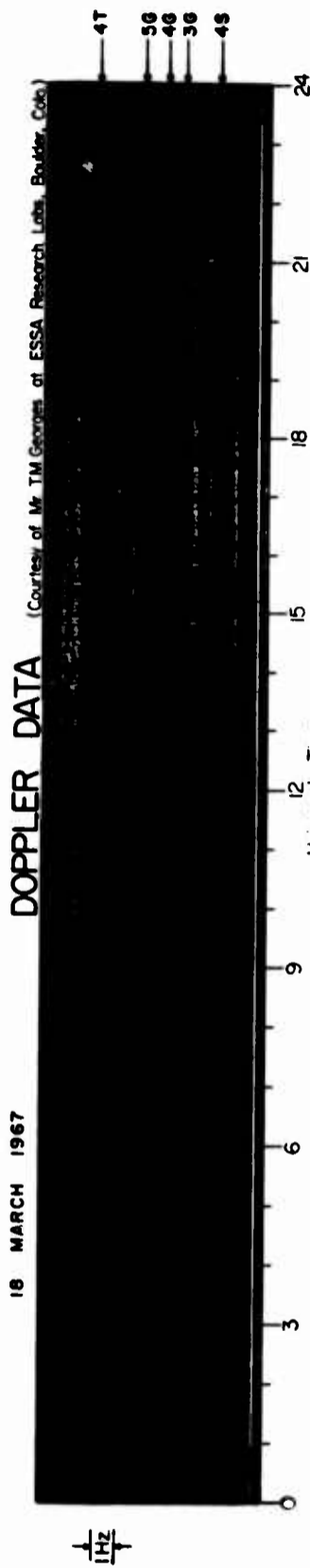


8000 MHz Transmitter Frequency 12.2235 MHz



APPARENT ELEVATION ANGLE of ARRIVAL - 20 Minute Average 18 MARCH 1967

NO DATA AVAILABLE



NO DATA AVAILABLE

VERTICAL SOUNDER DATA

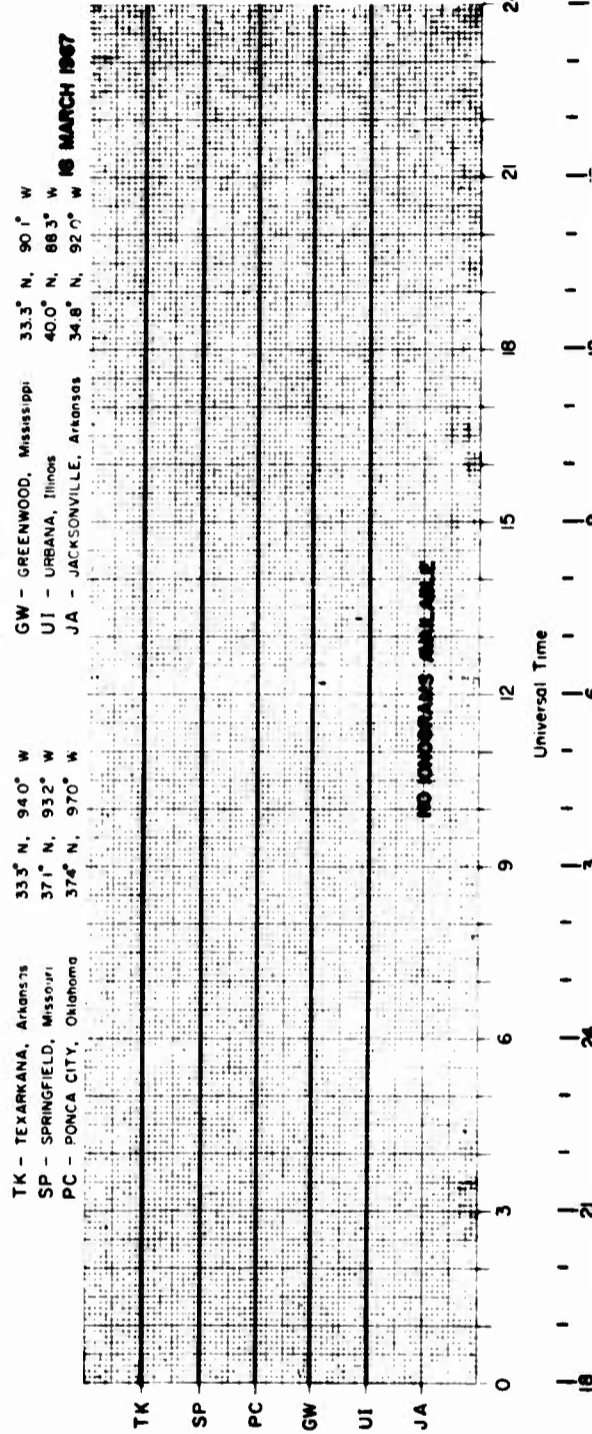
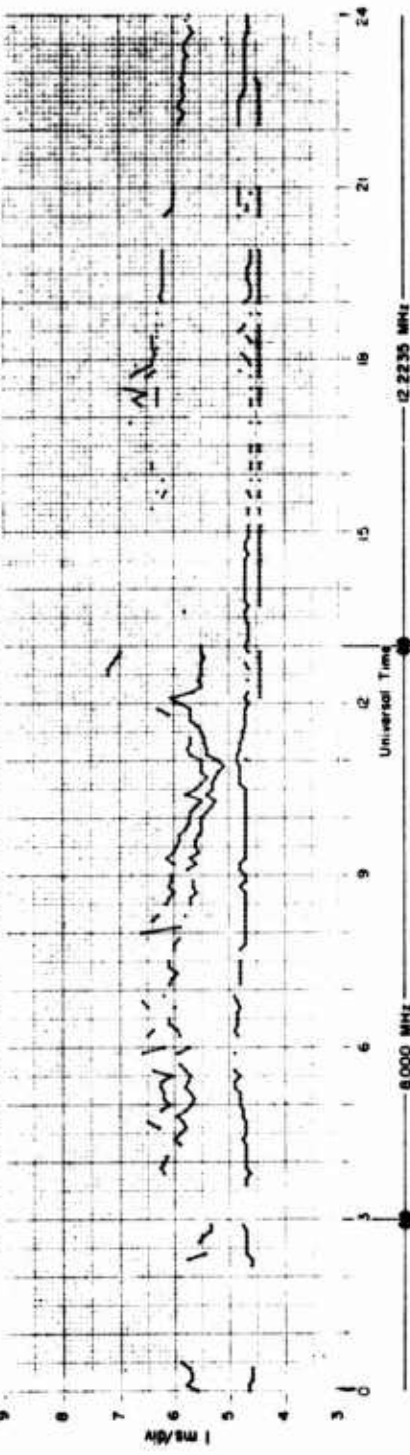


Plate 5.

18 March 1967

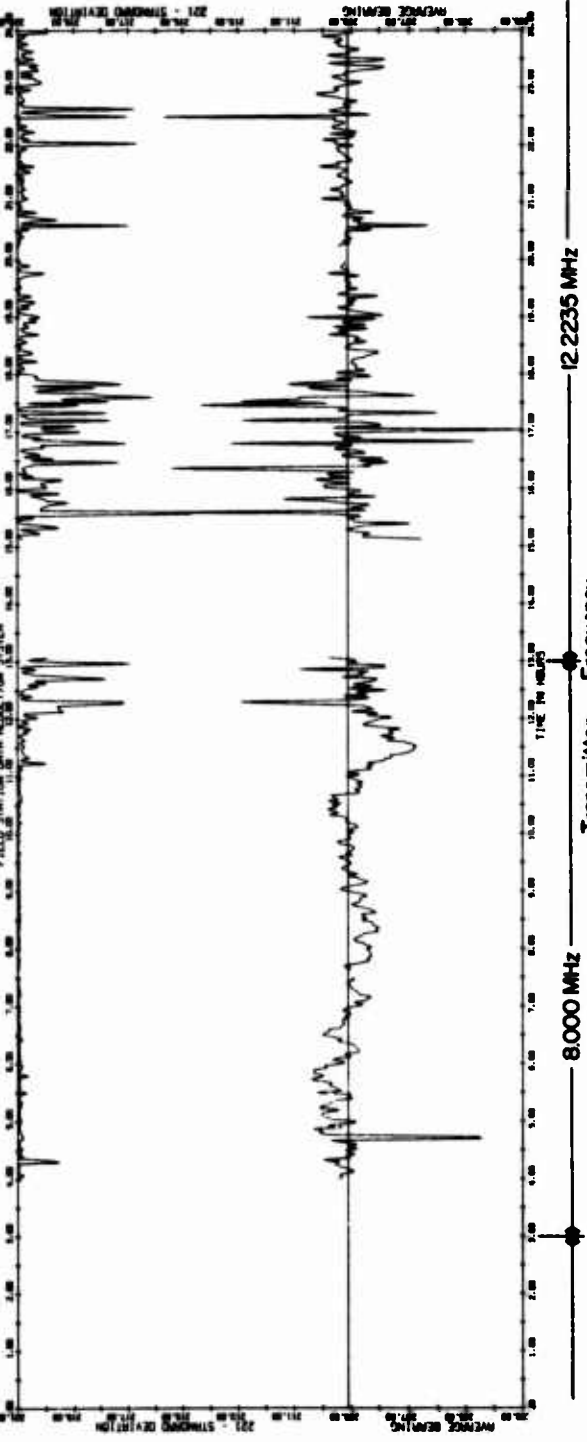
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 11 APRIL 1967

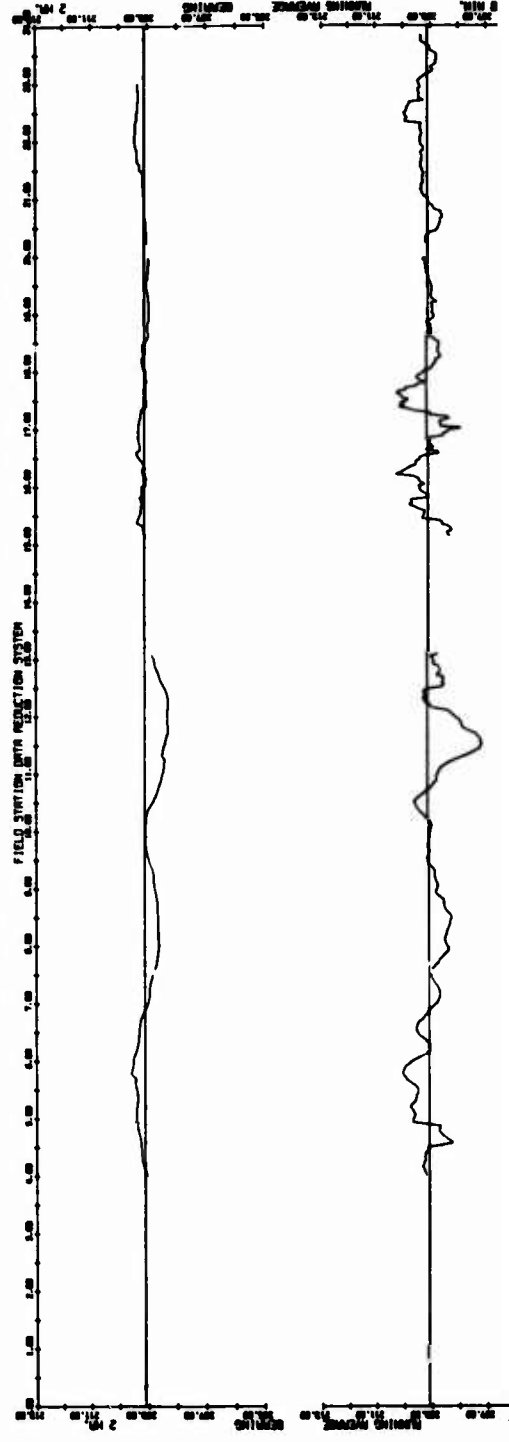


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 11 APRIL 1967



BEARING DEVIATION PLOTS - TIME AVERAGED 11 Apr. 1967



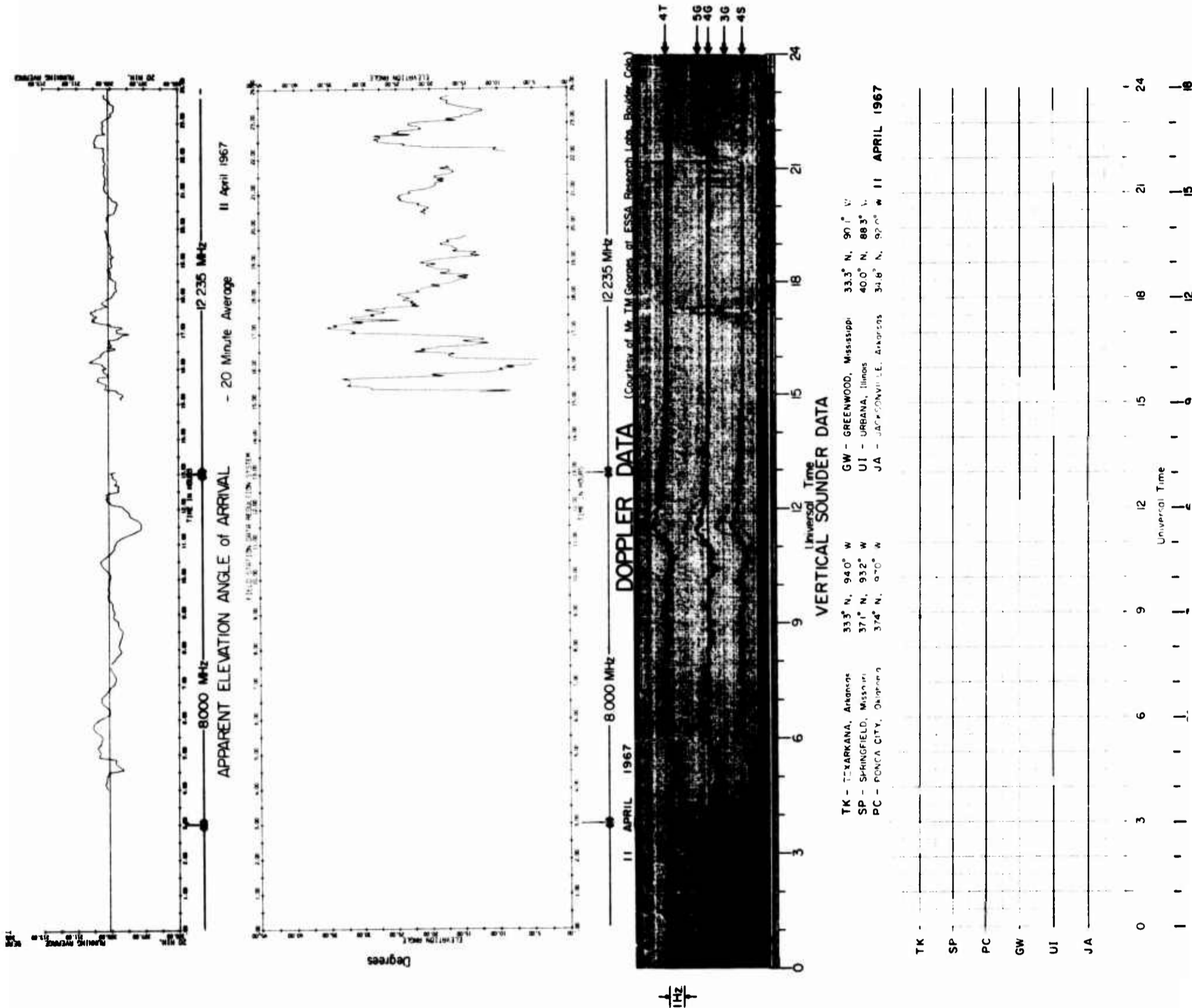
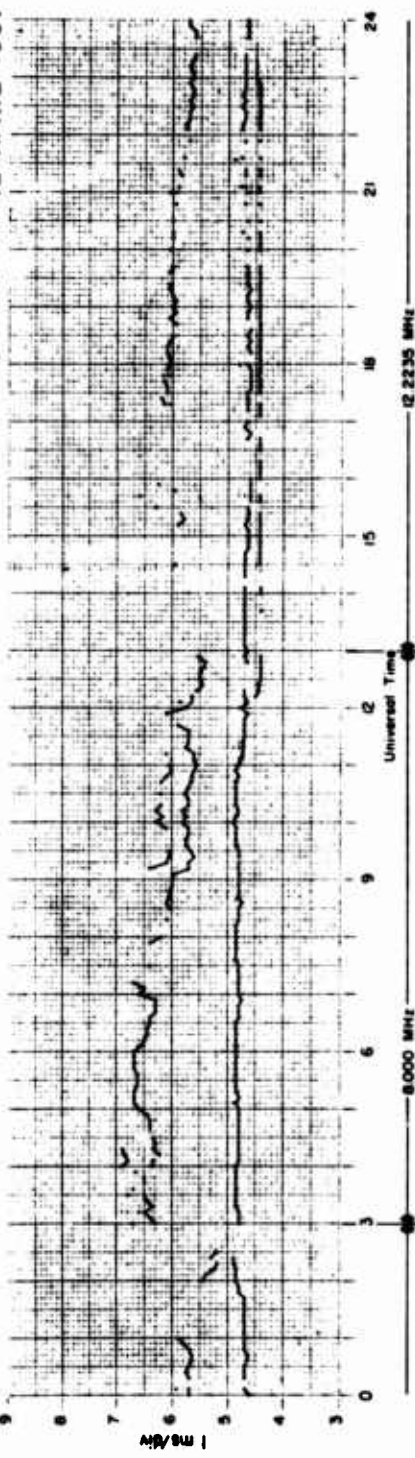


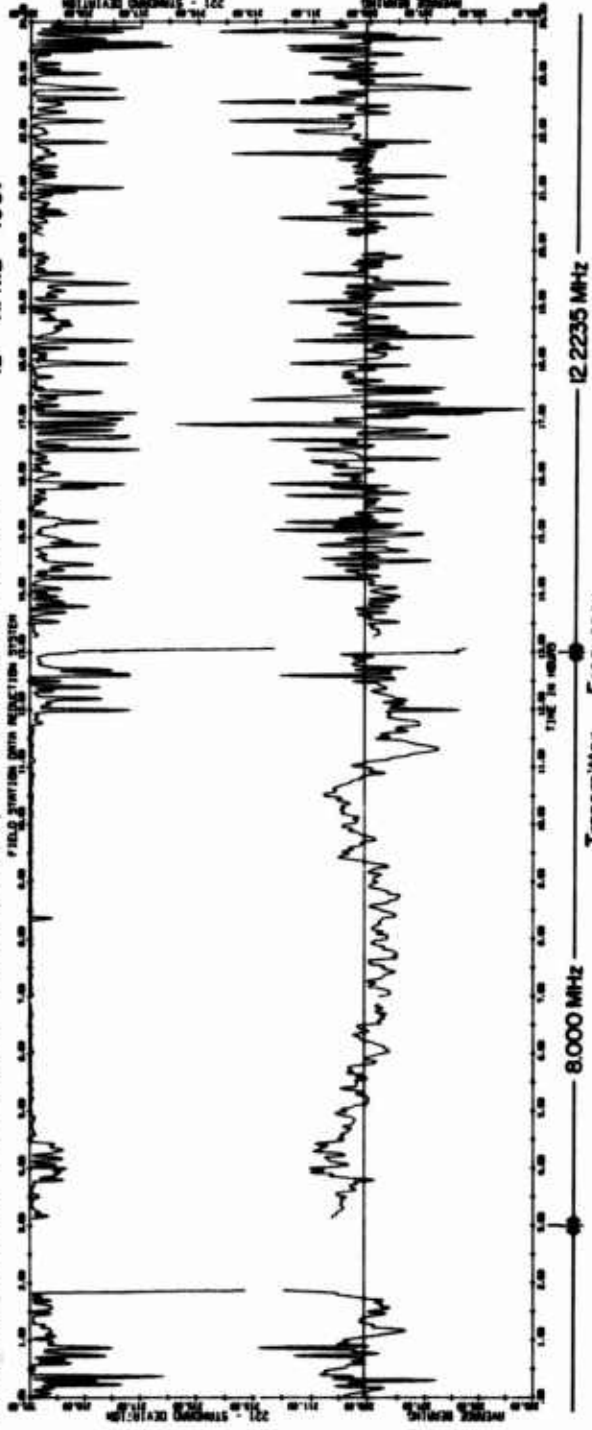
Plate 6.

11 April 1967

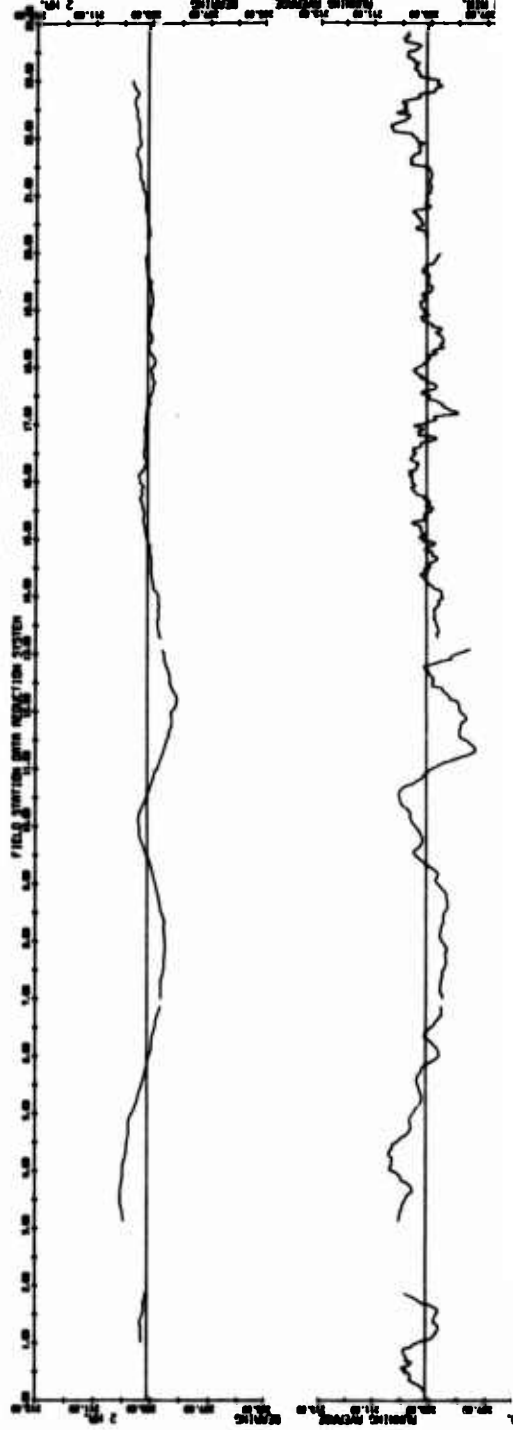
OBLIQUE IONOGRAM DATA
 Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 12 APRIL 1967



BEARING DEVIATION PLOT
 Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 12 APRIL 1967



BEARING DEVIATION PLOTS - TIME AVERAGED 12 Apr 1967



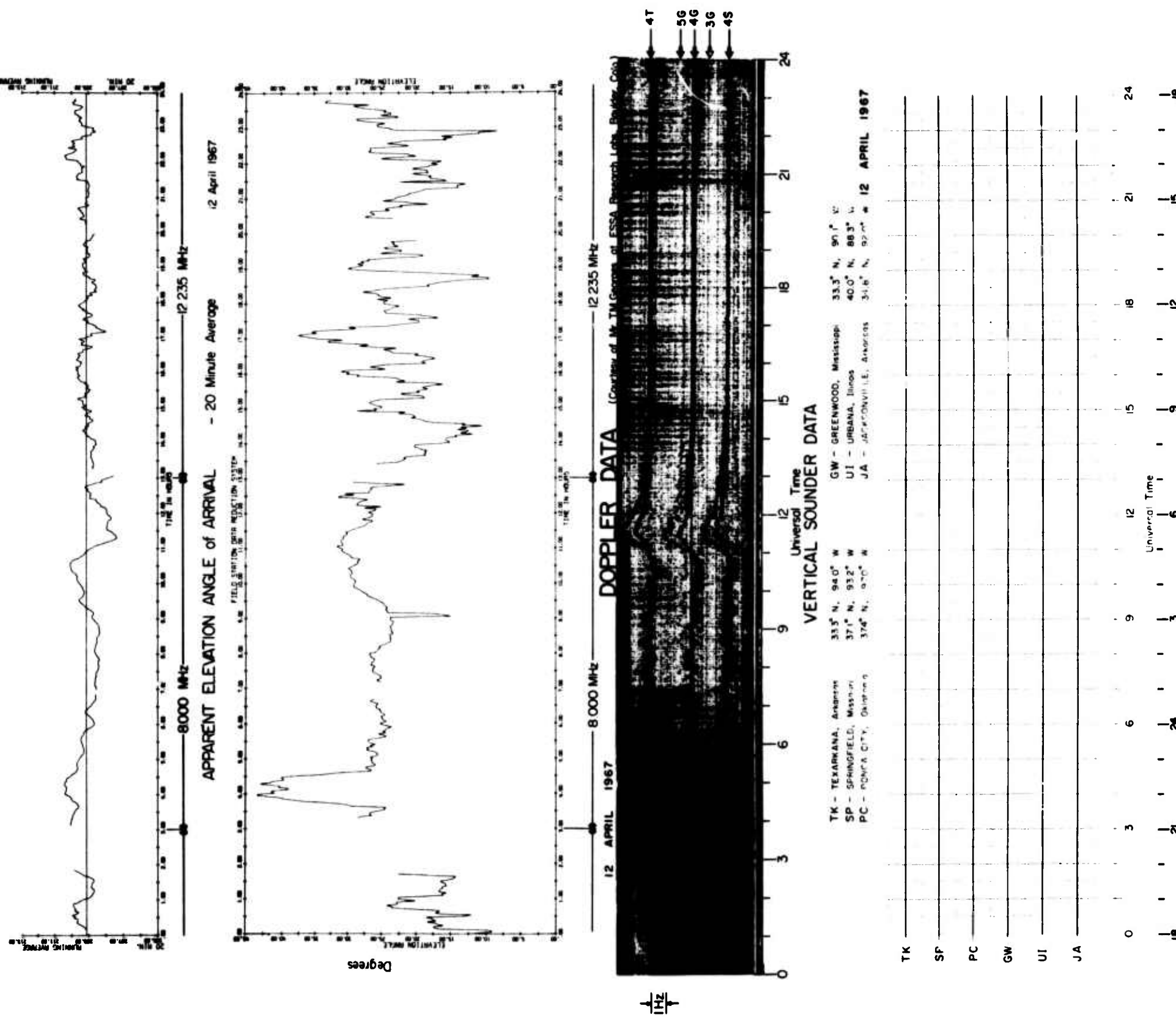
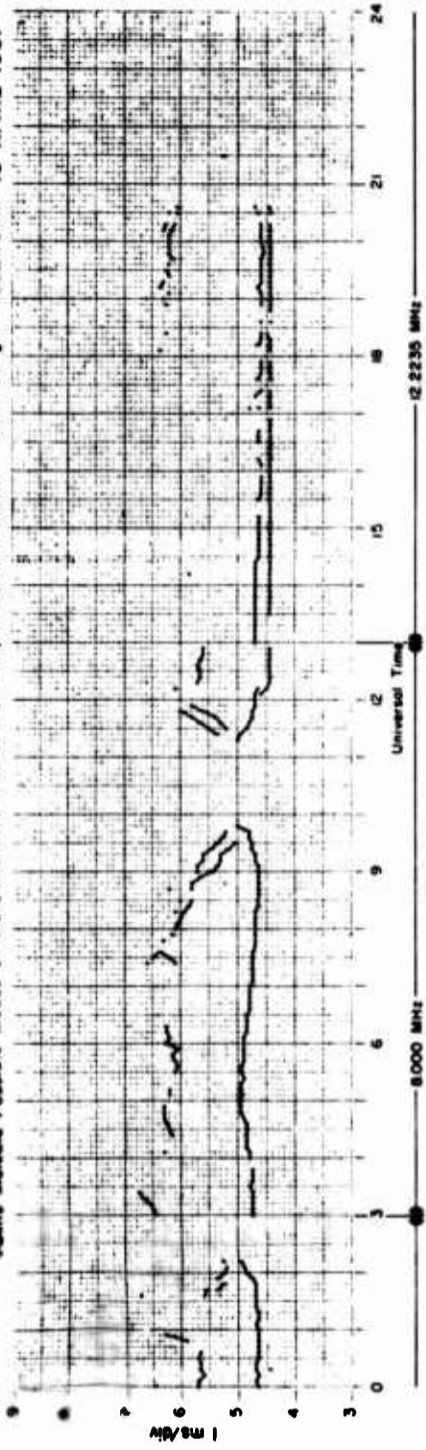


Plate 7.

12 April 1967

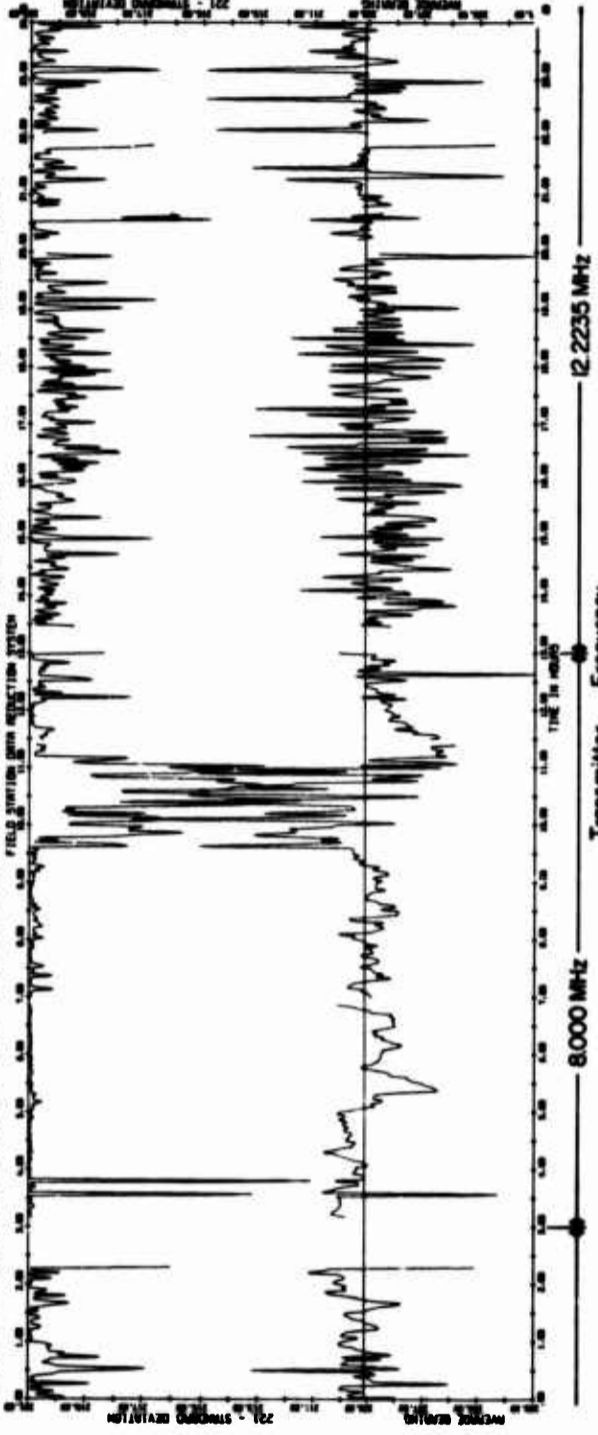
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (89° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 13 APRIL 1967

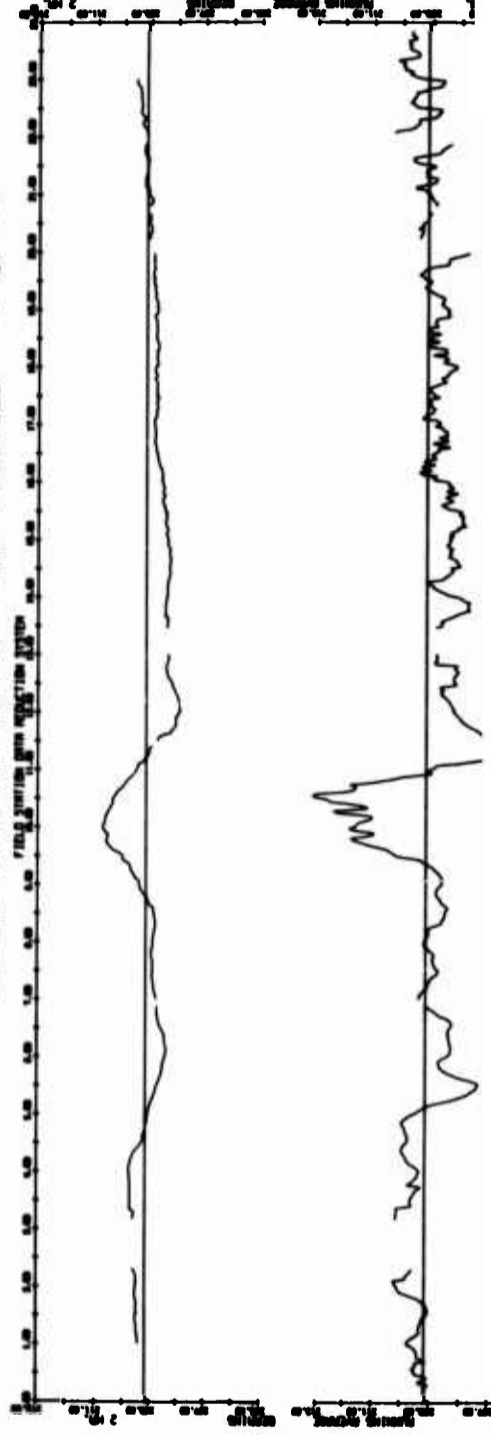


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 13 APRIL 1967



BEARING DEVIATION PLOTS - TIME AVERAGED 13 Apr 1967



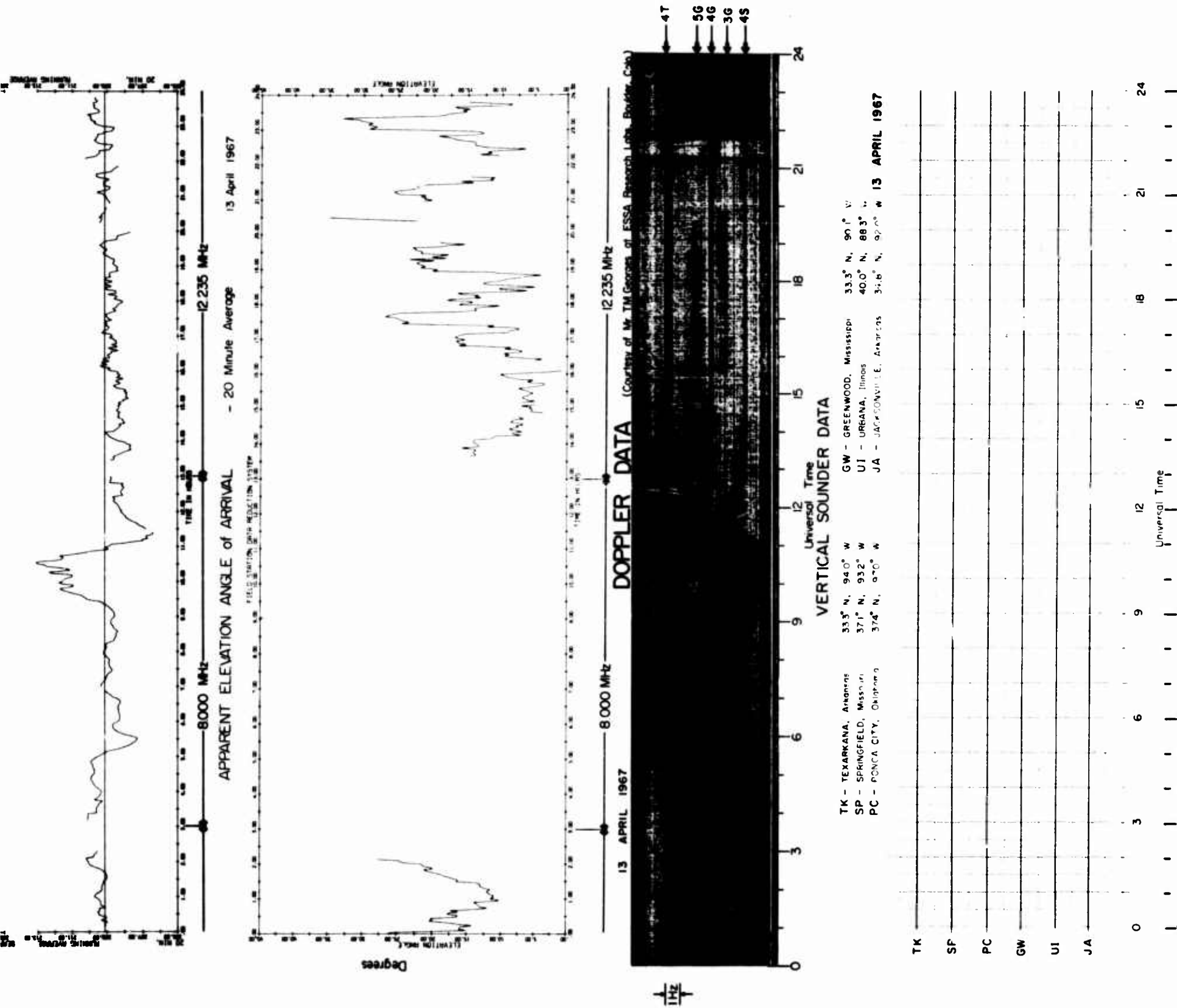


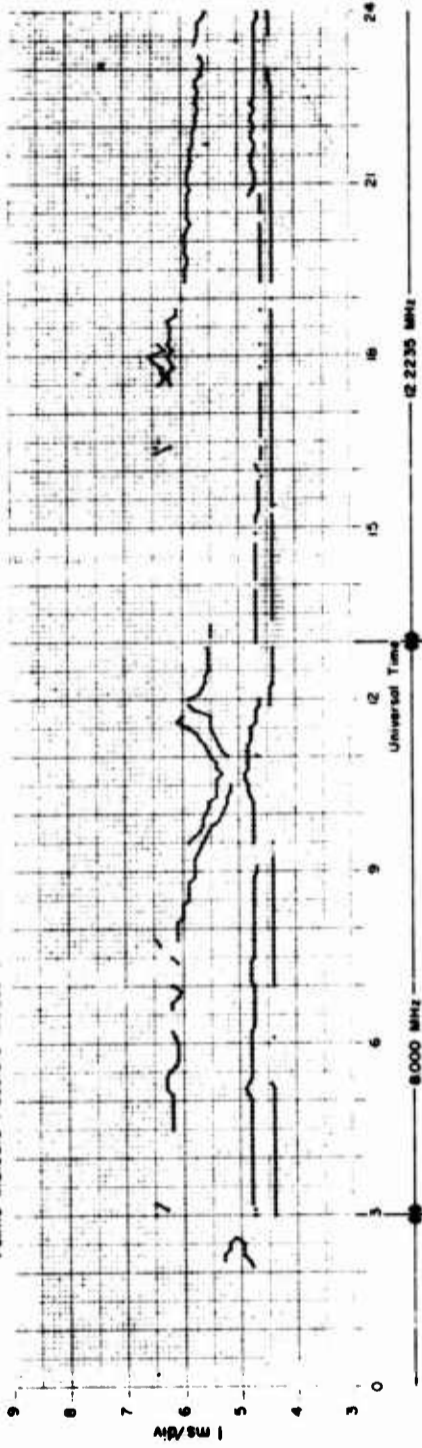
Plate 8.

13 April 1967

2

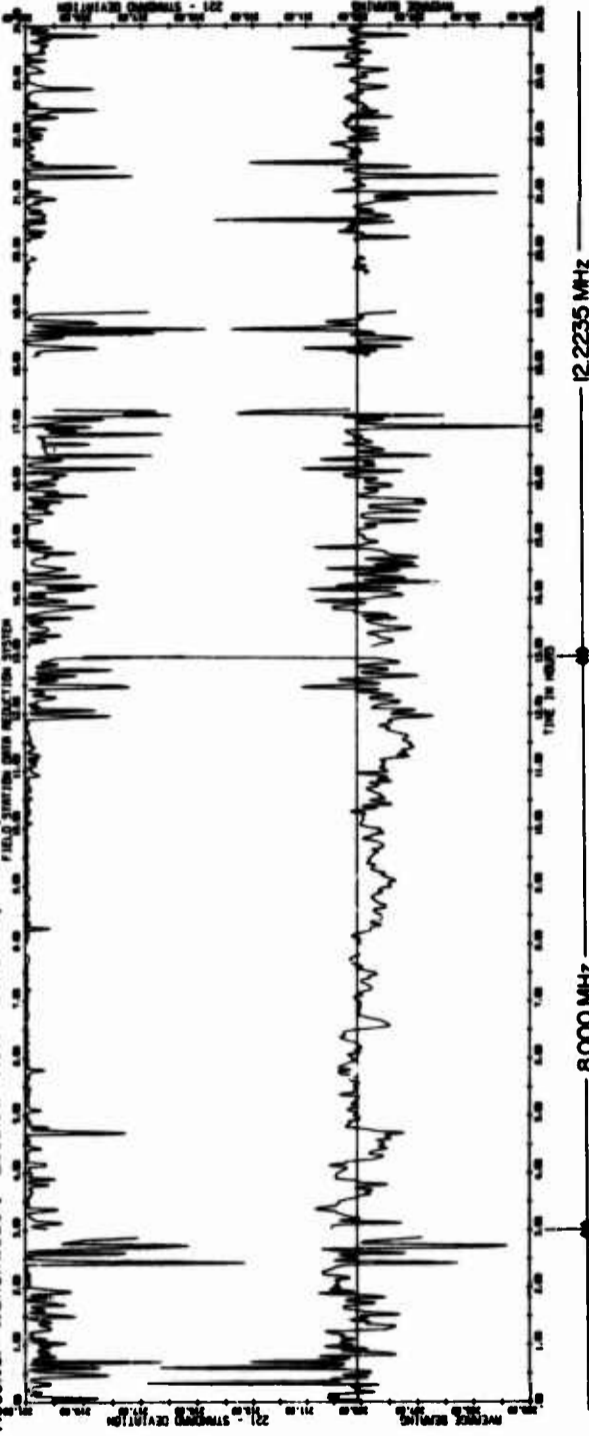
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 14 APRIL 1967

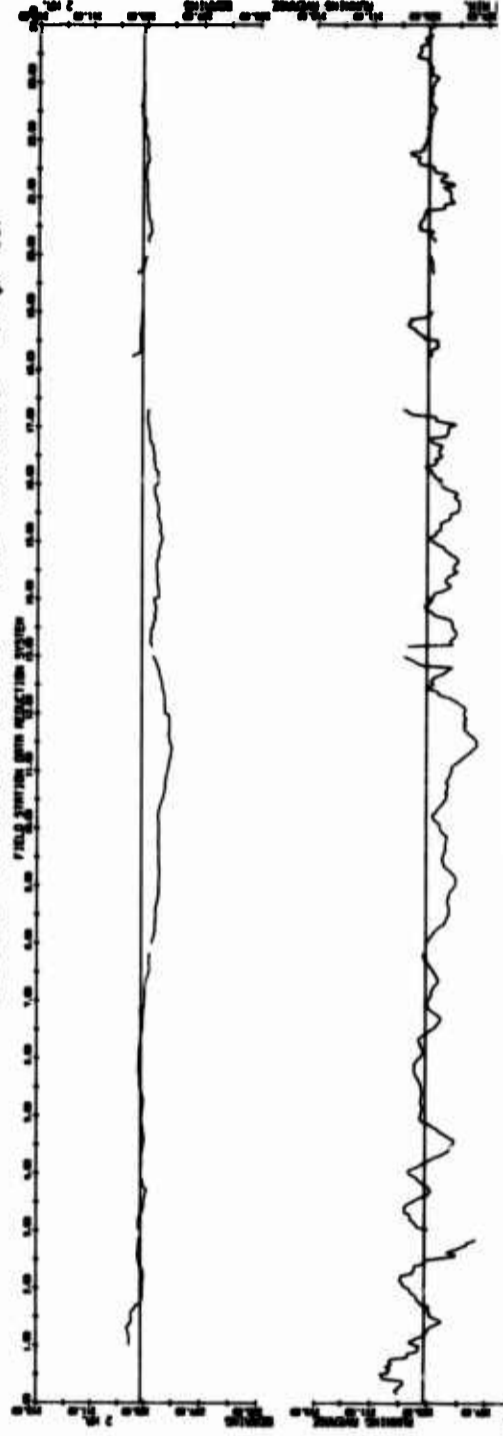


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 14 APRIL 1967



BEARING DEVIATION PLOTS - TIME AVERAGED 14 Apr 1967



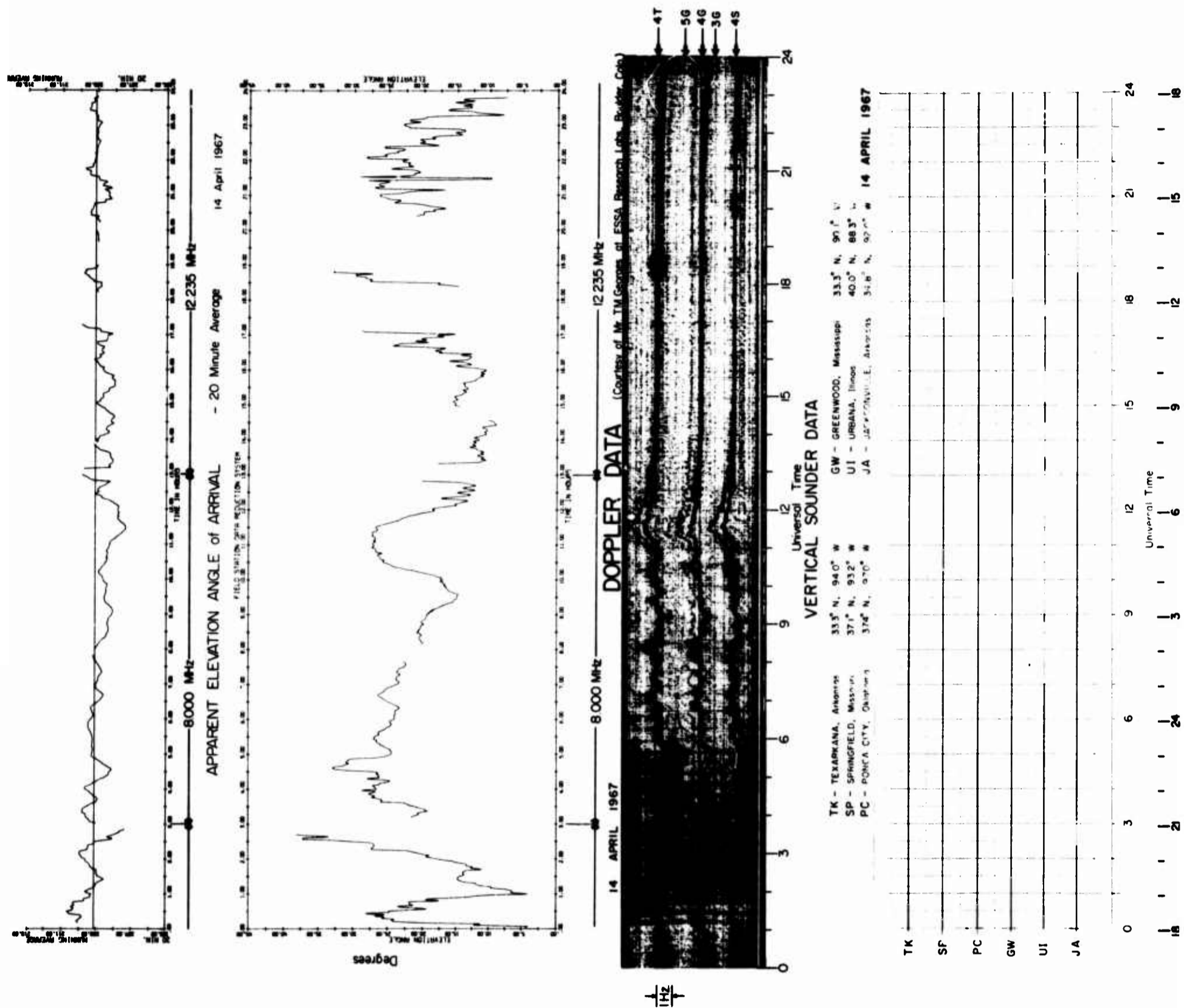


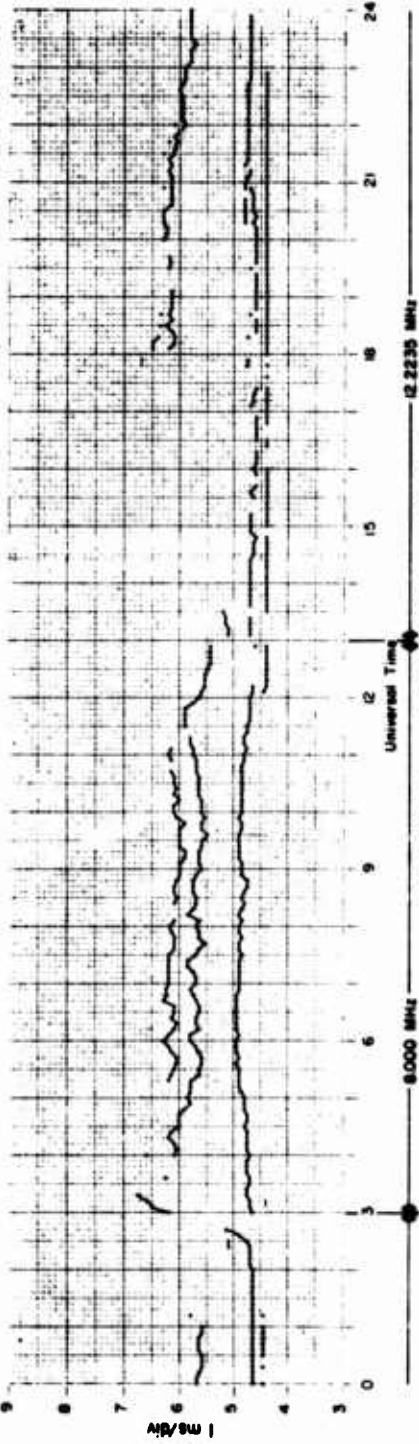
Plate 9.

14 April 1967

2

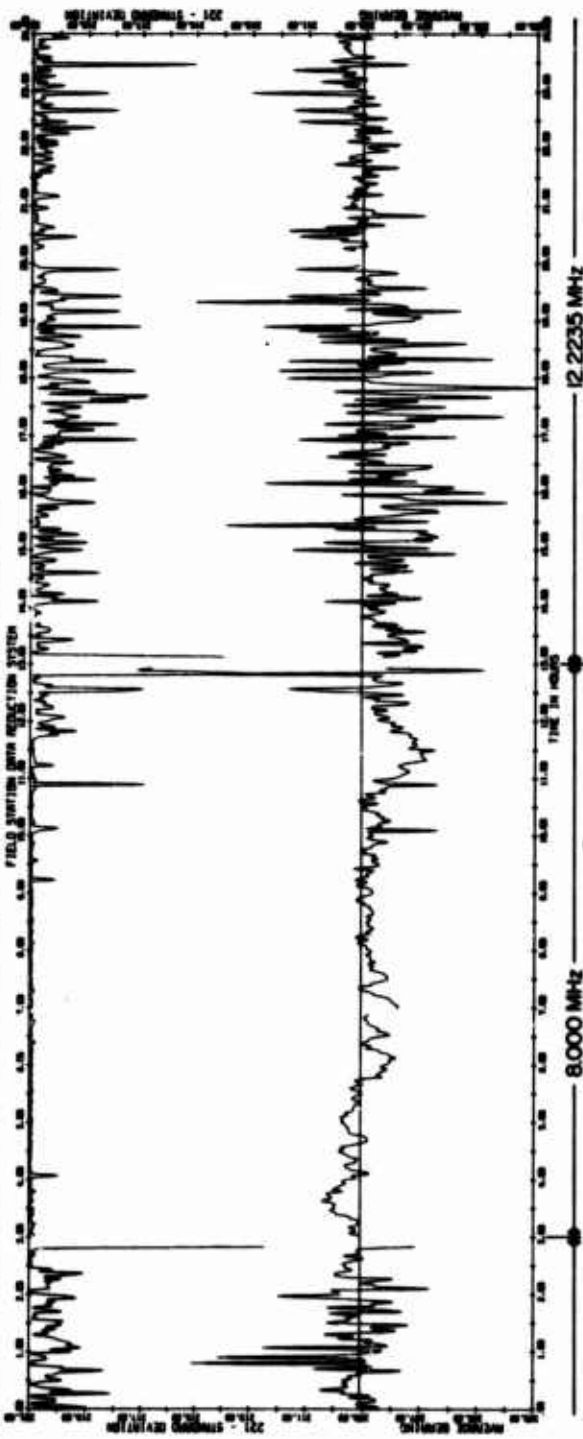
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 15 APRIL 1967

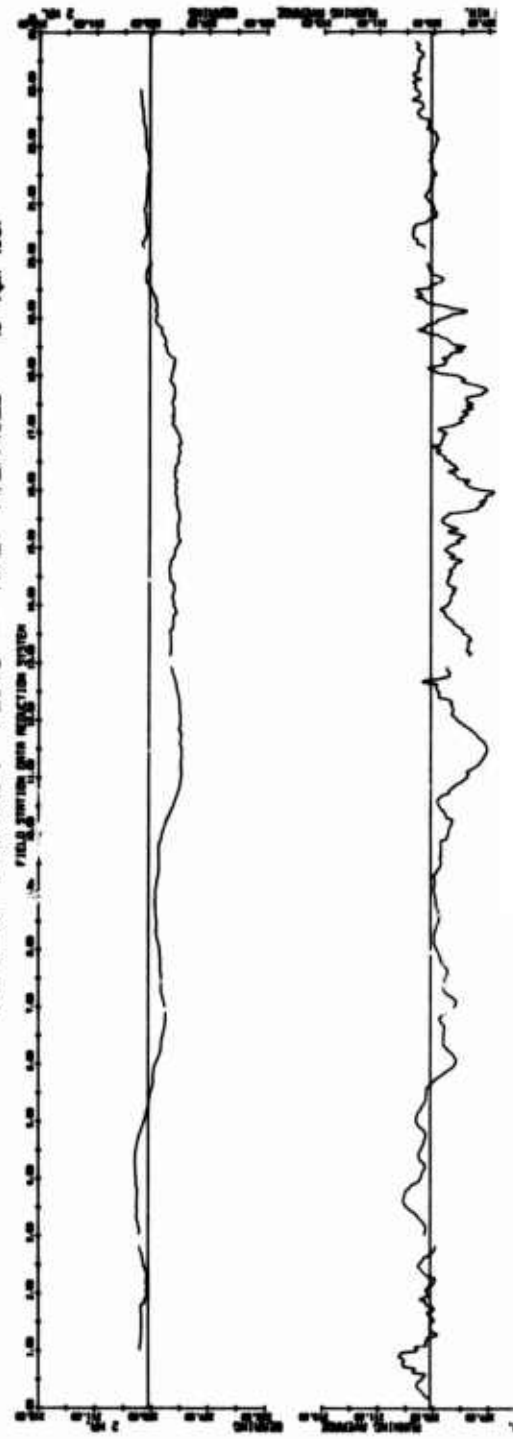


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34 8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 15 APRIL 1967



BEARING DEVIATION PLOTS - TIME AVERAGED



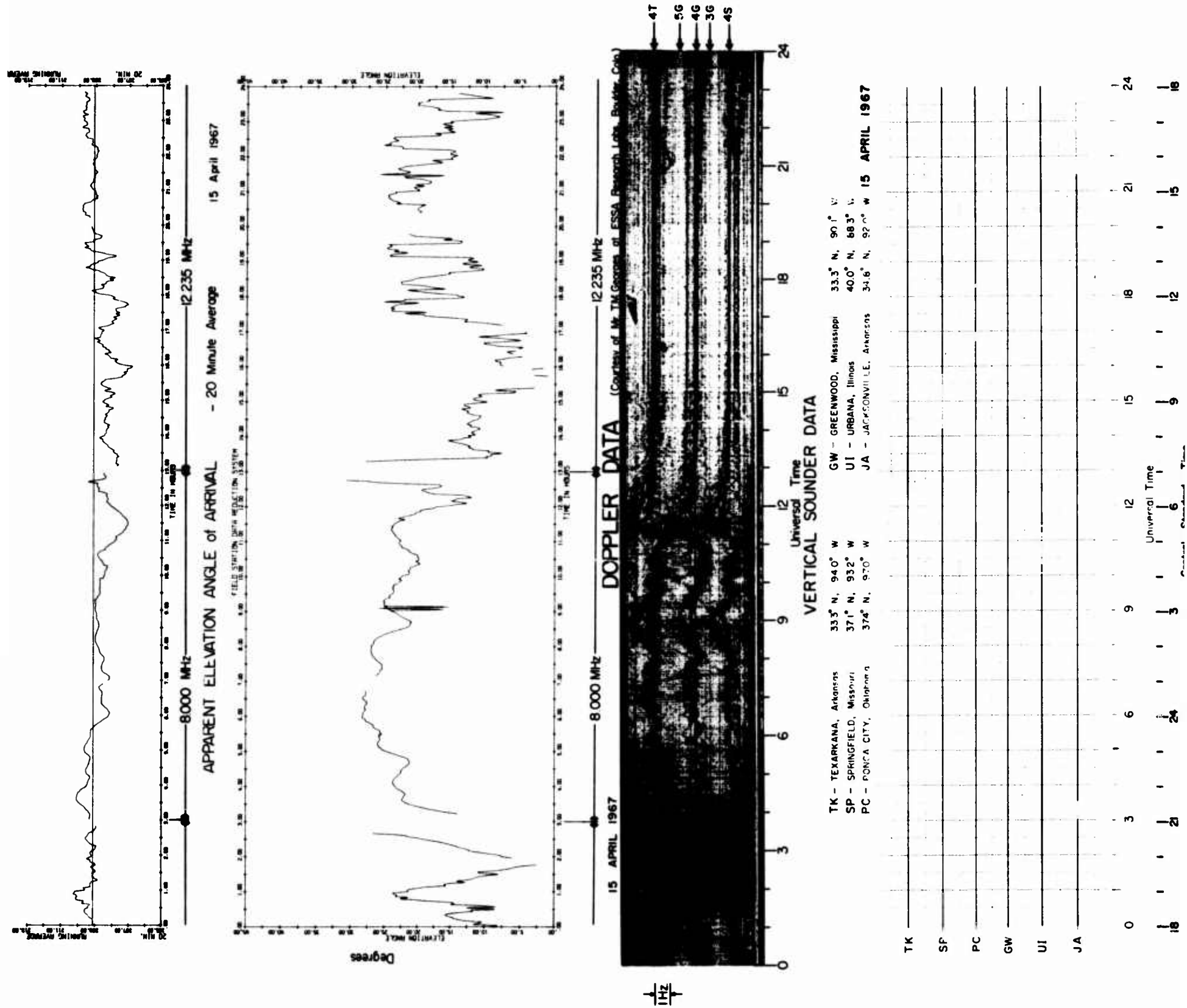


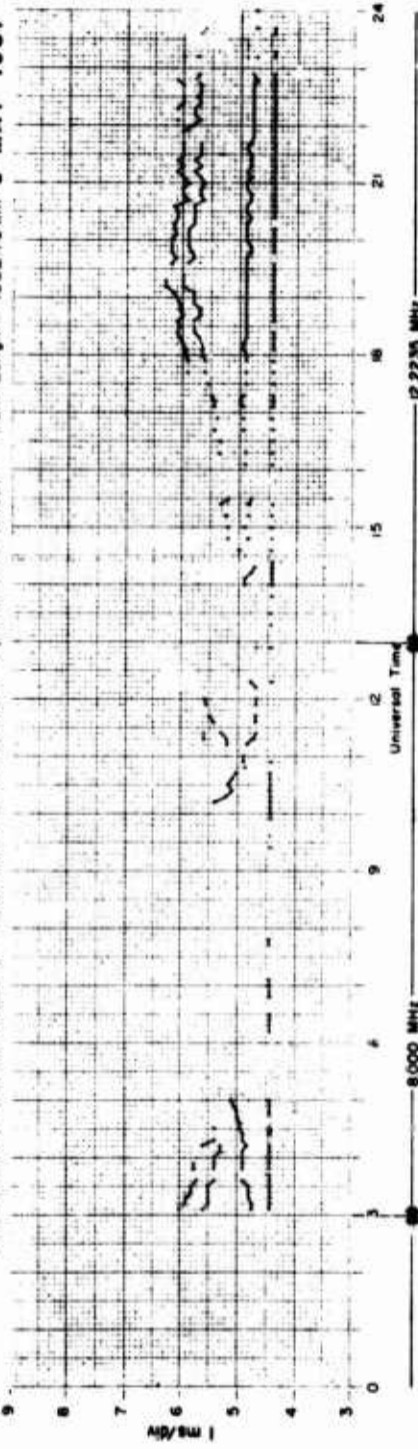
Plate 10.

15 April 1967

2

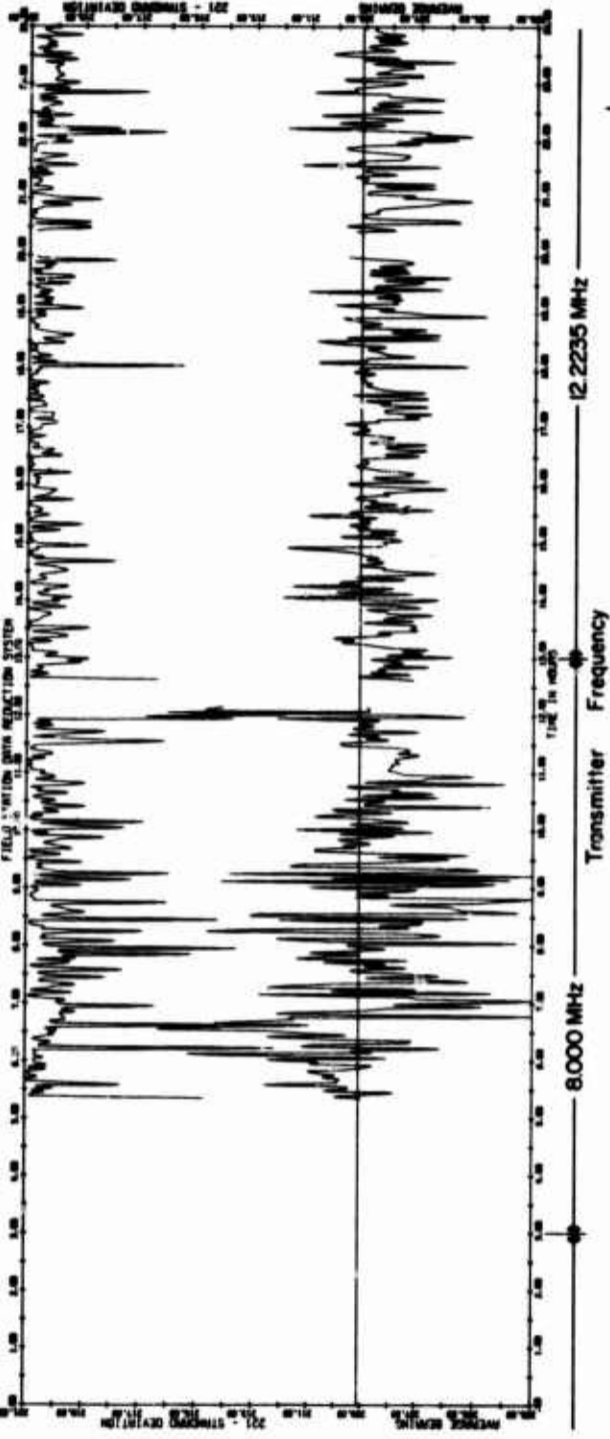
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 9 MAY 1967

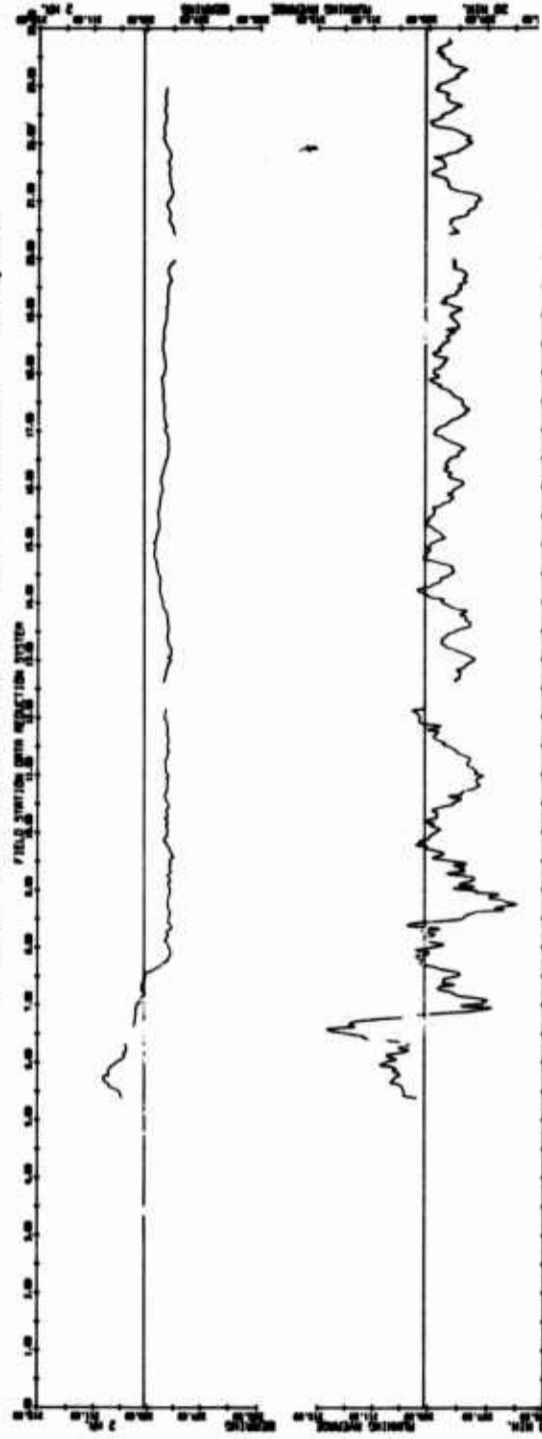


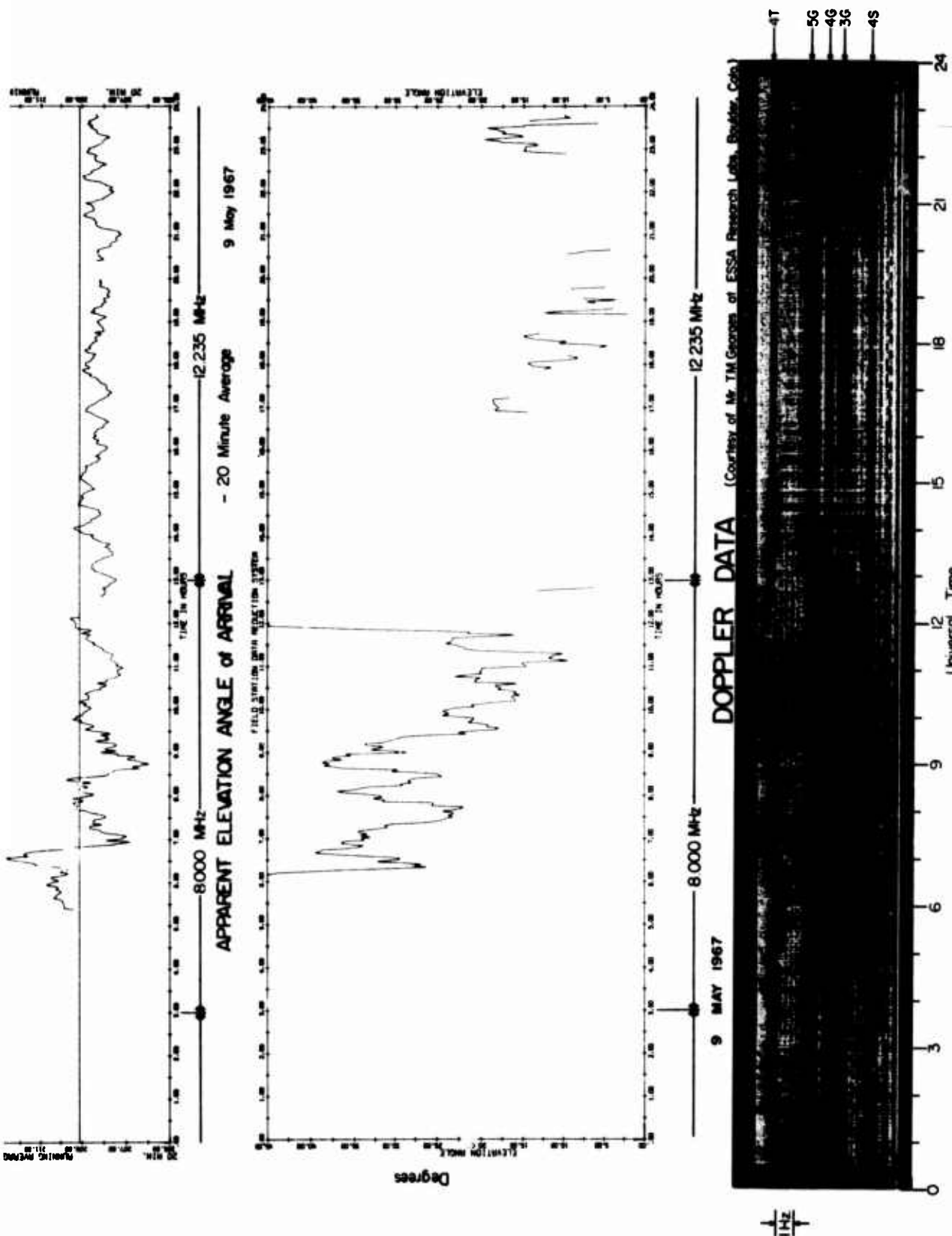
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34° 8' N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 9 MAY 1967



BEARING DEVIATION PLOTS - TIME AVERAGED





VERTICAL SOUNDER DATA

TK - TEXARKANA, Arkansas 33.3° N, 94.0° W GW - GREENWOOD, Mississippi 33.3° N, 90.1° W
 SP - SPRINGFIELD, Missouri 37.1° N, 93.2° W UI - URBANA, Illinois 40.0° N, 88.3° W
 PC - PONCA CITY, Oklahoma 37.4° N, 97.0° W JA - JACKSONVILLE, Arkansas 34.8° N, 92.0° W 9 MAY 1967

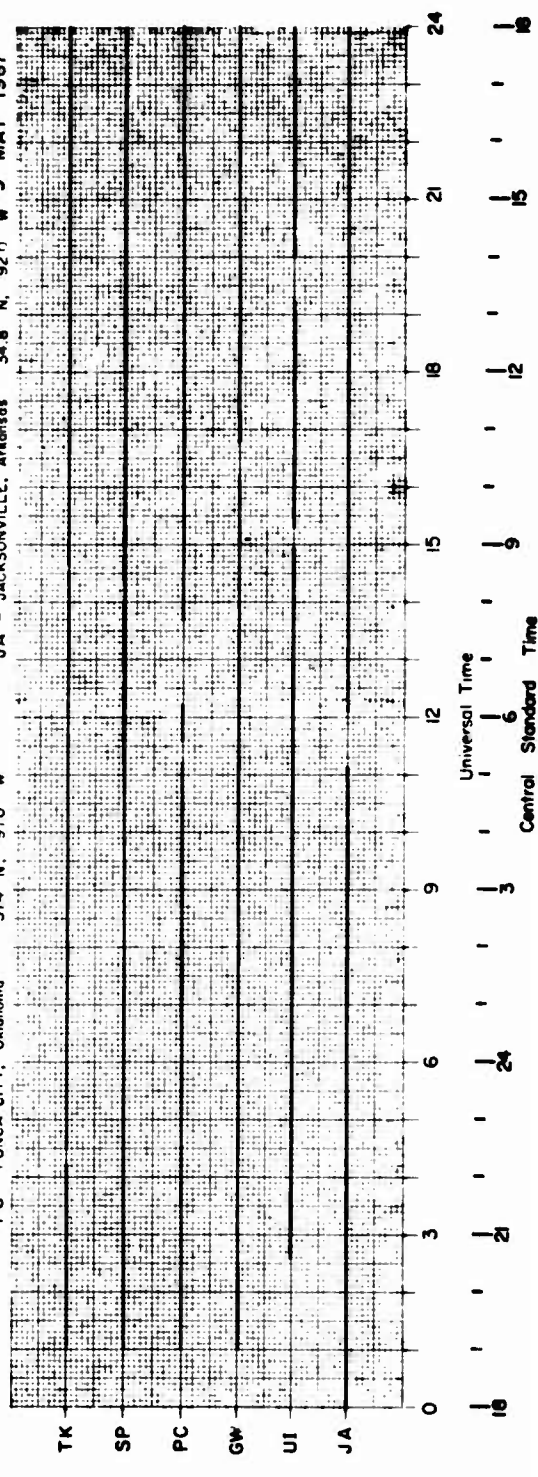
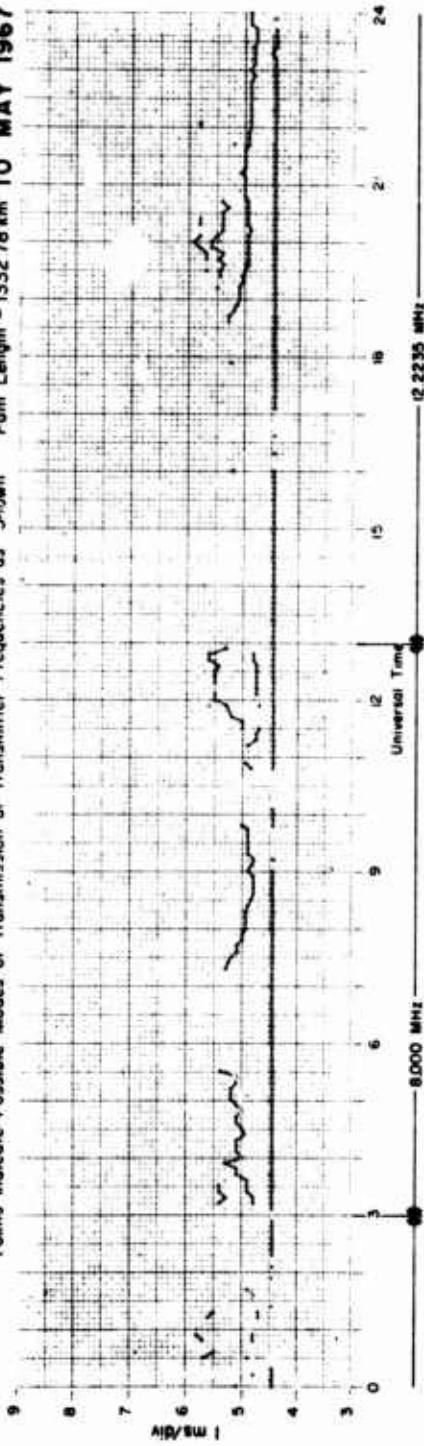


Plate 11.
 9 May 1967

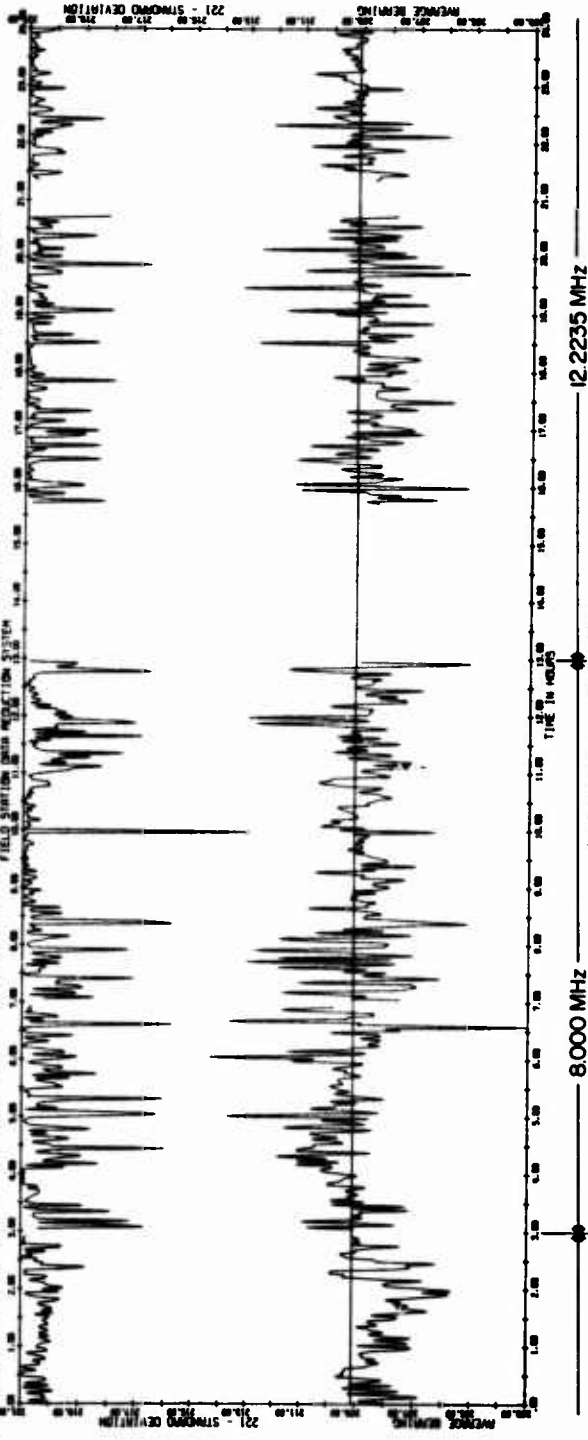
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 10 MAY 1967

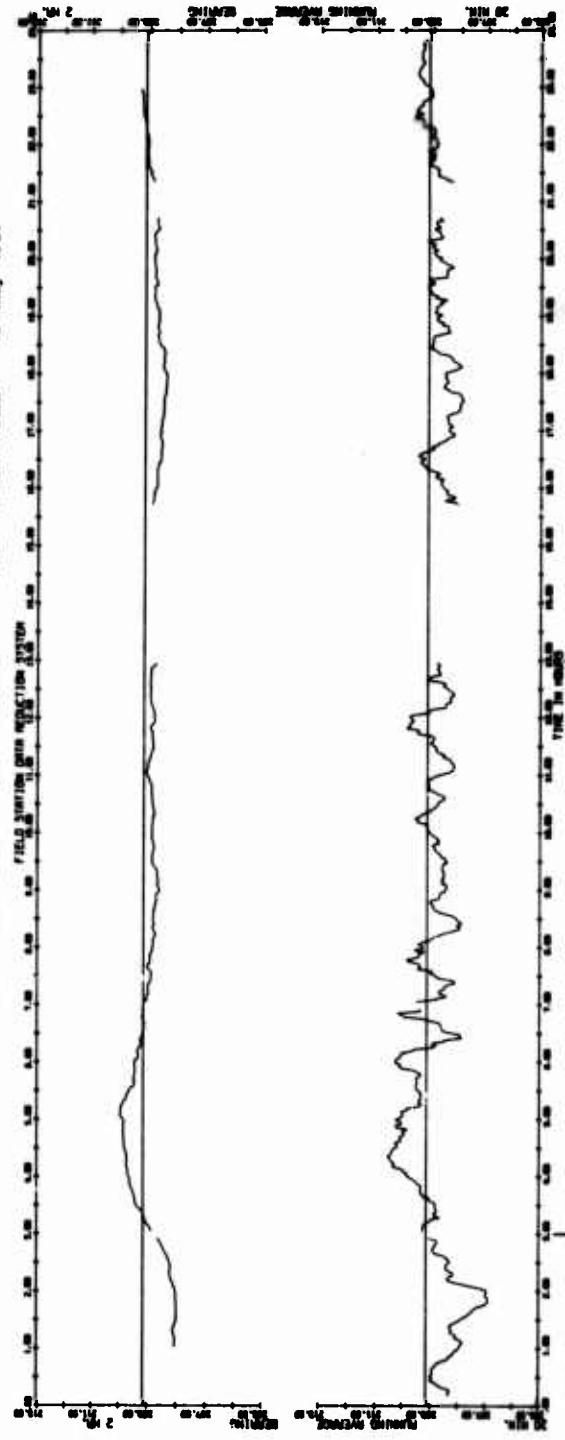


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 10 MAY 1967

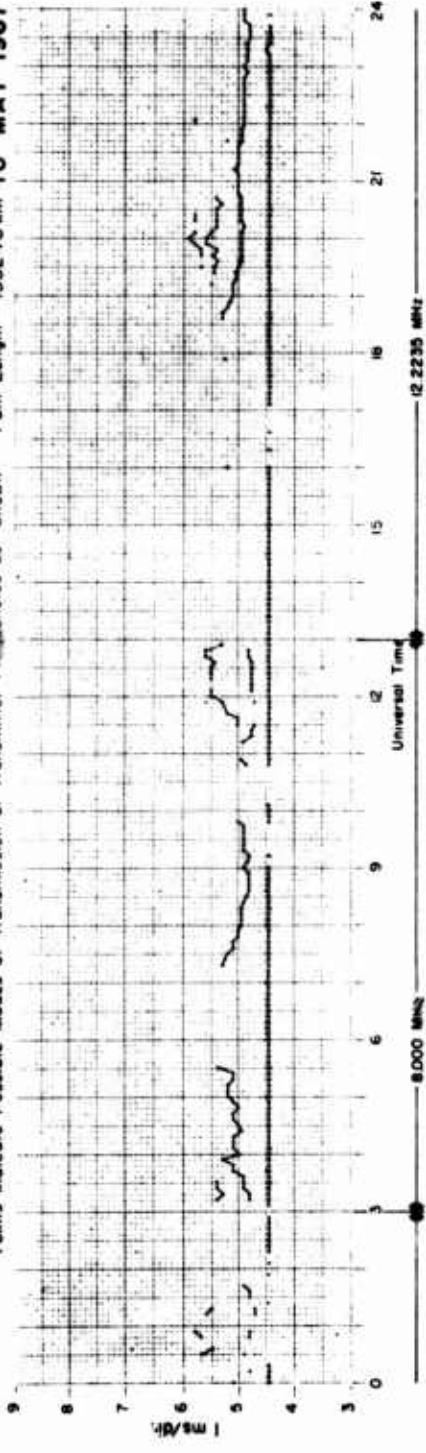


BEARING DEVIATION PLOTS - TIME AVERAGED 10 May 1967



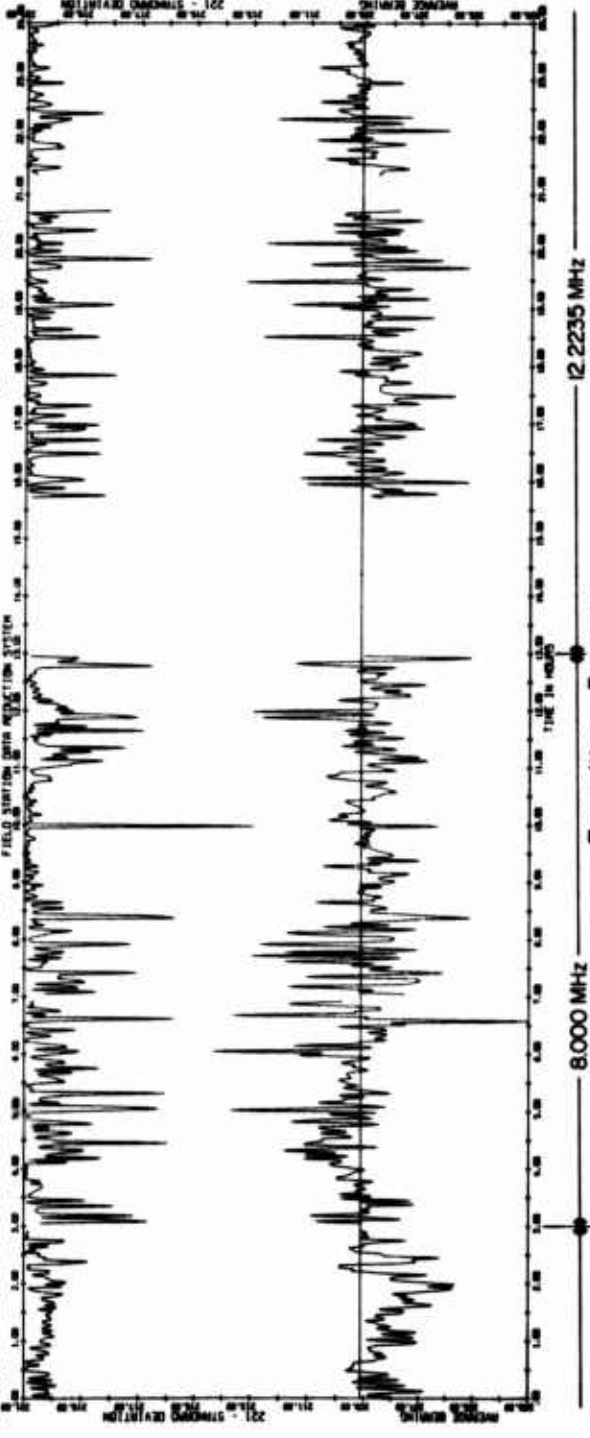
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 10 MAY 1967

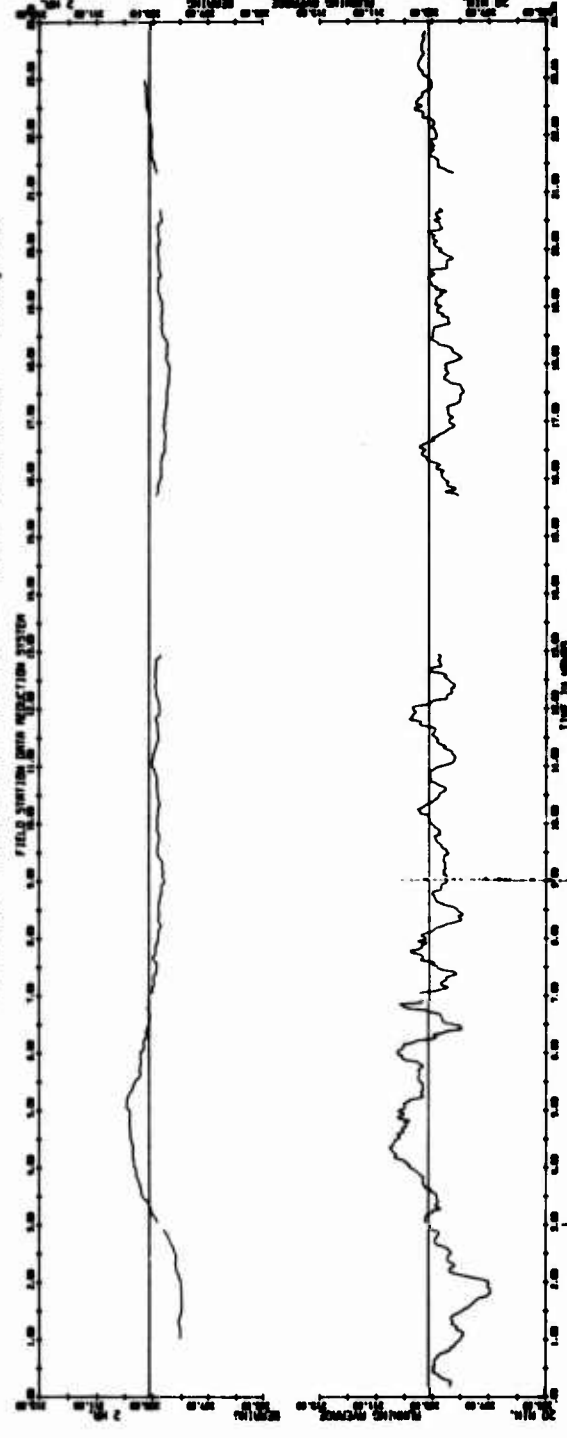


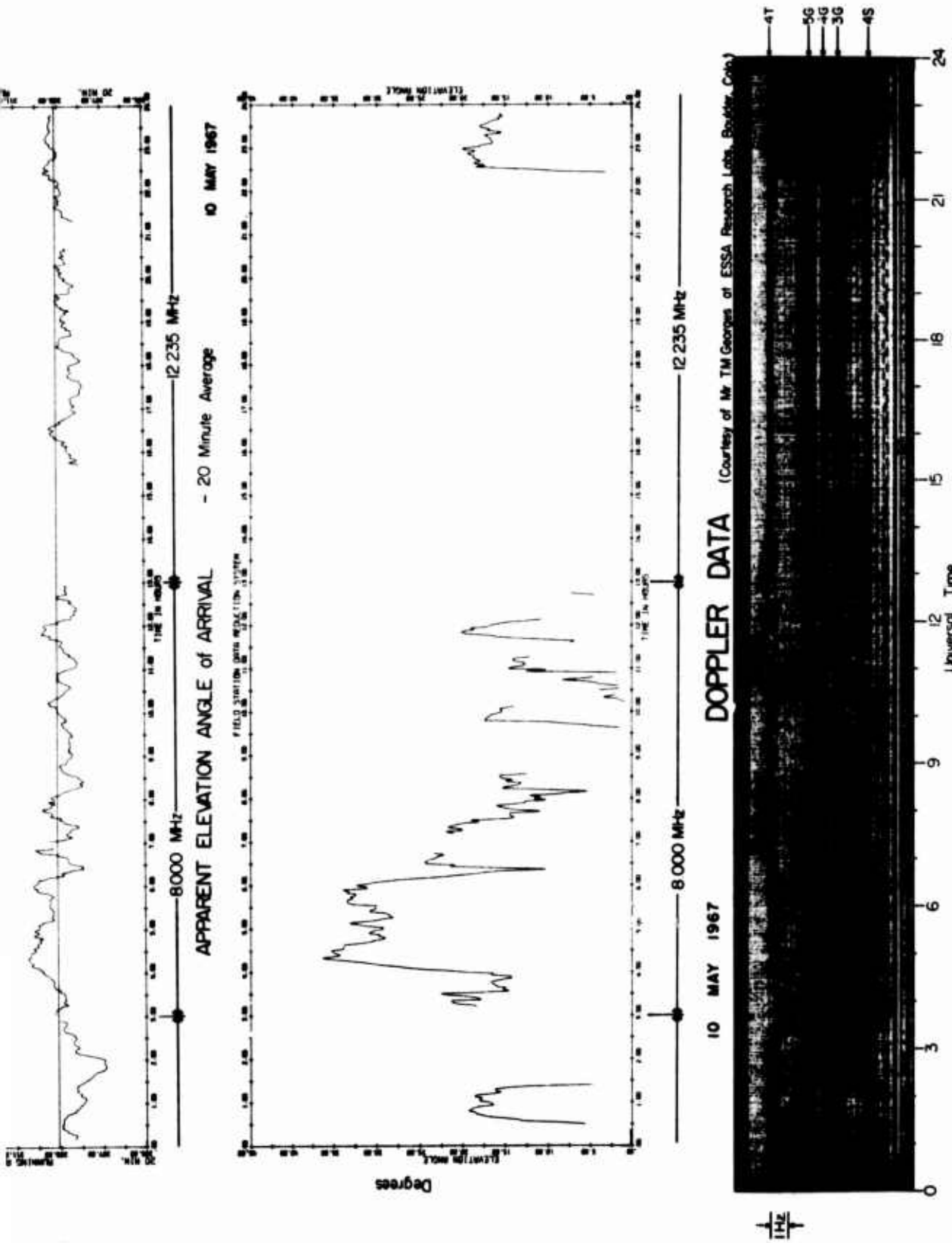
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 10 MAY 1967



BEARING DEVIATION PLOTS - TIME AVERAGED 10 MAY 1967





VERTICAL SOUNDER DATA

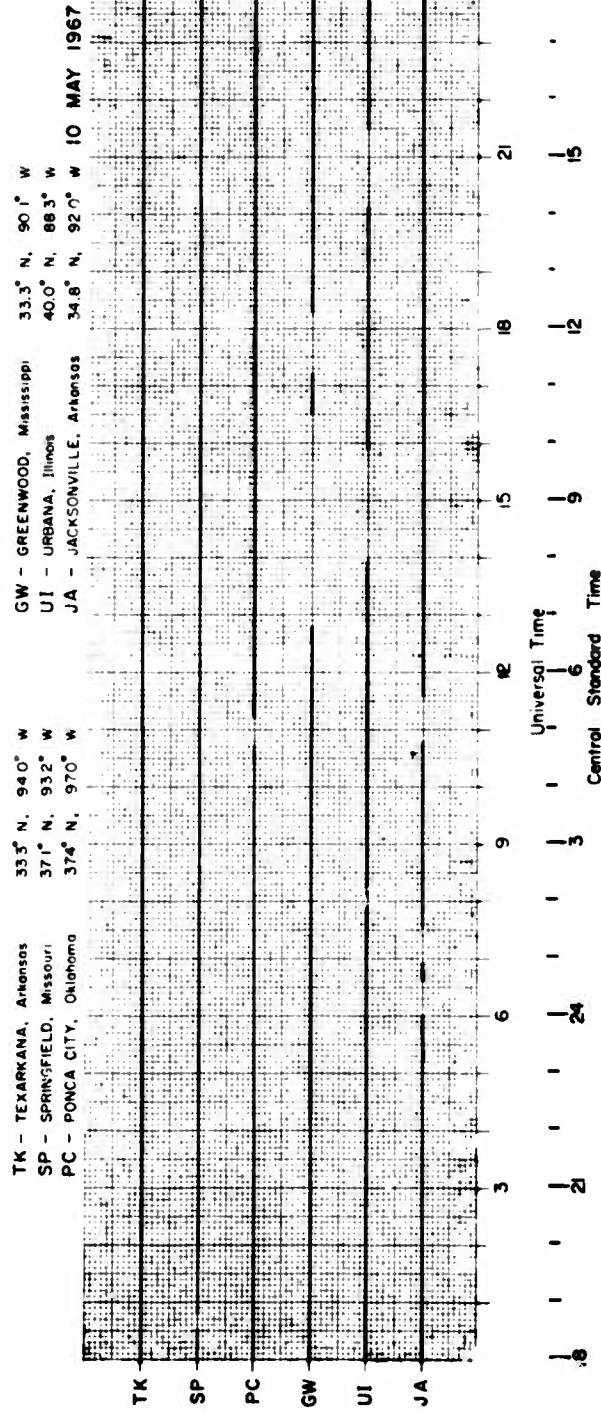
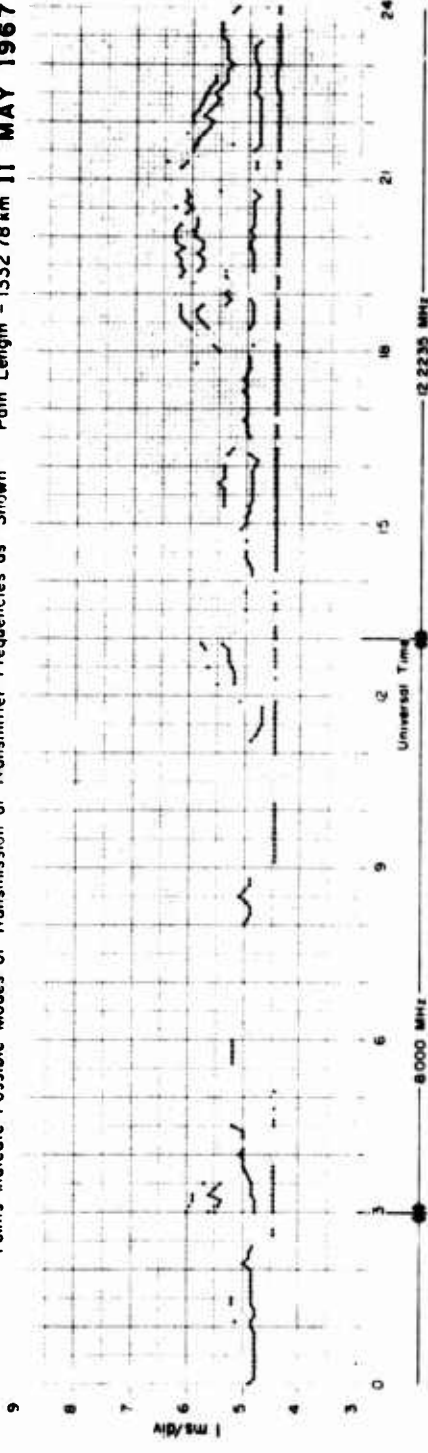


Plate 12.

10 May 1967

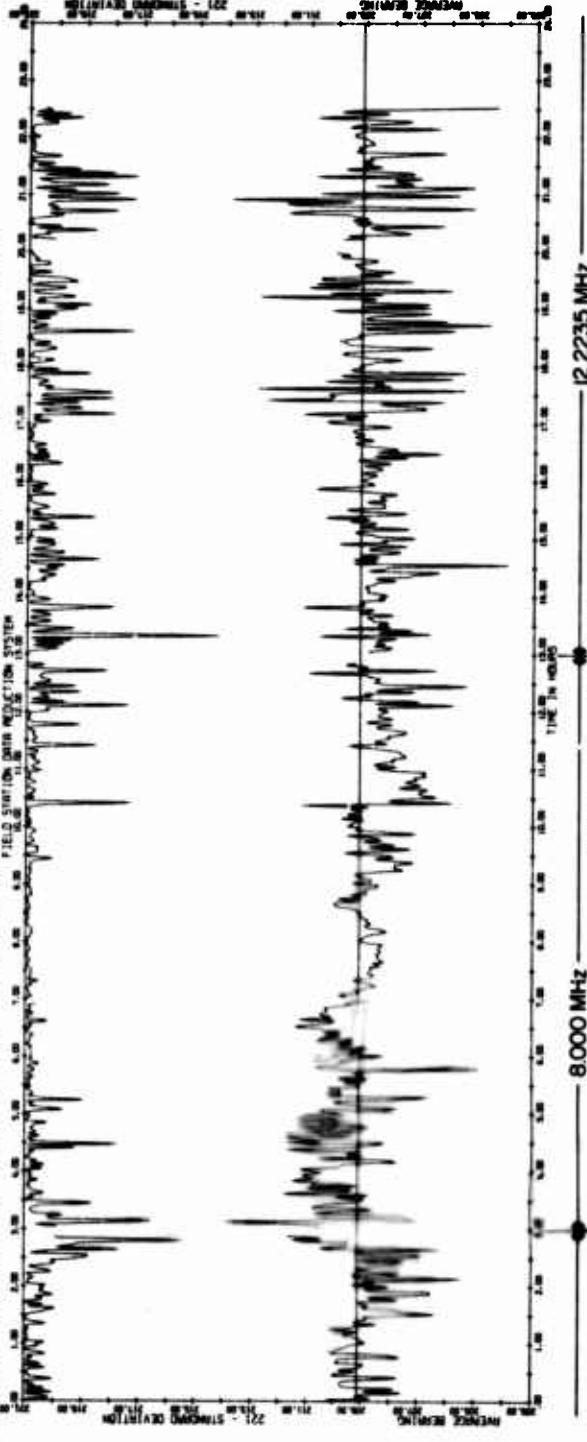
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km || MAY 1967



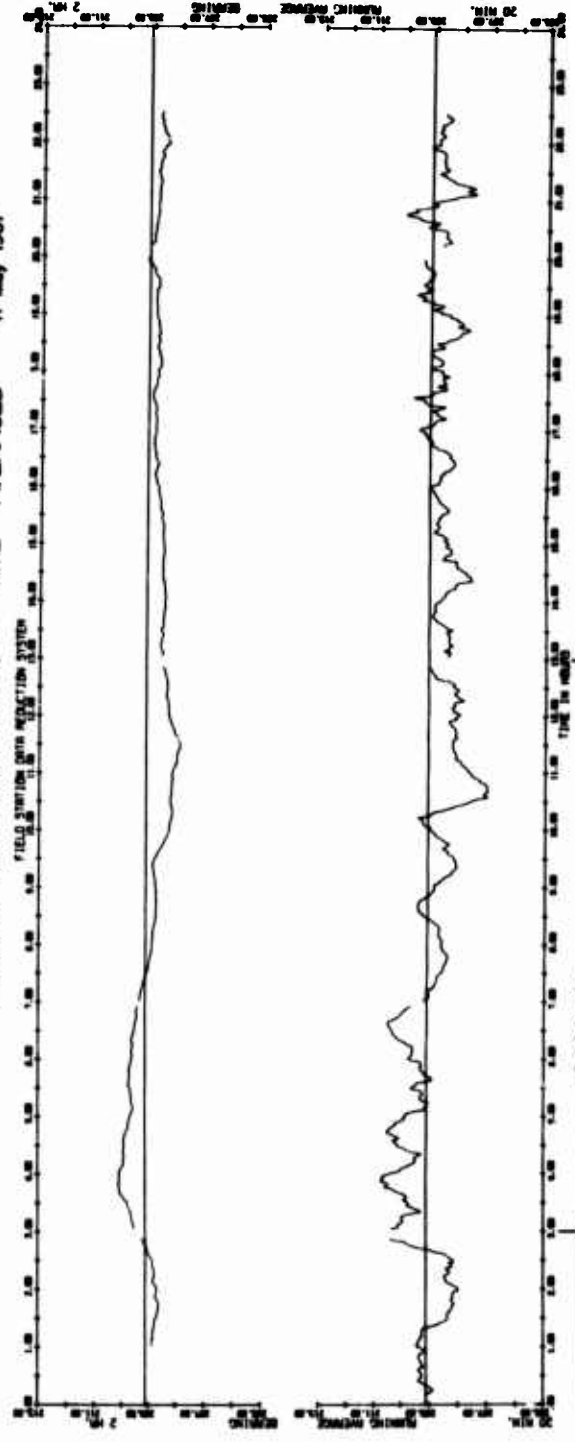
BEARING DEVIATION PLOT

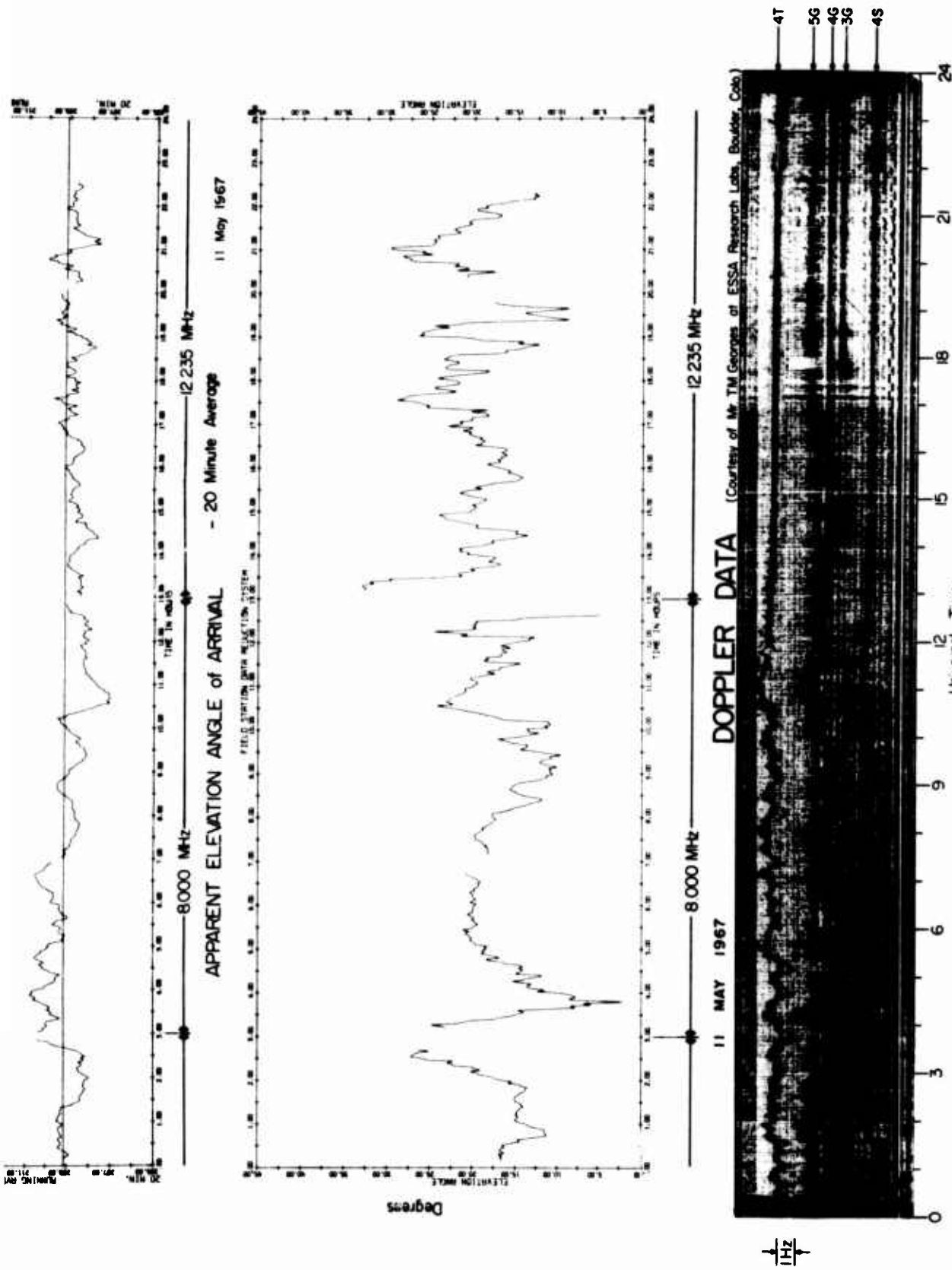
Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W || MAY 1967



BEARING DEVIATION PLOTS - TIME AVERAGED

11 May 1967





VERTICAL SOUNDER DATA

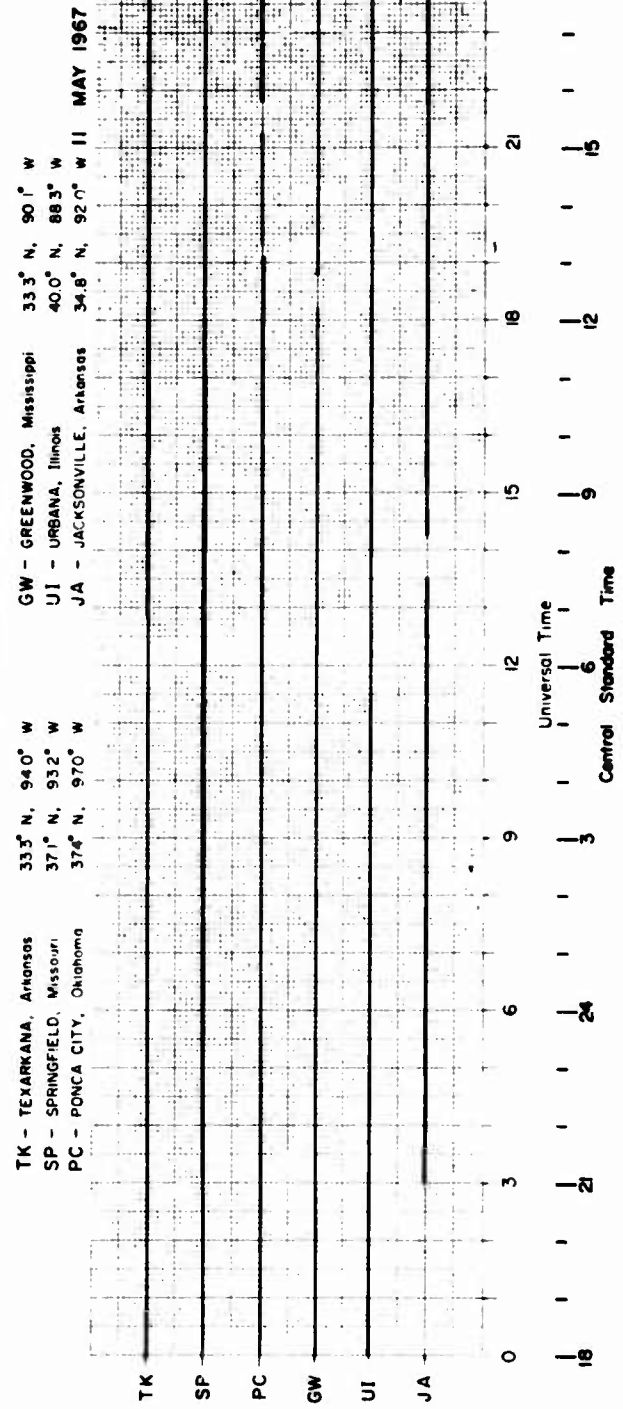
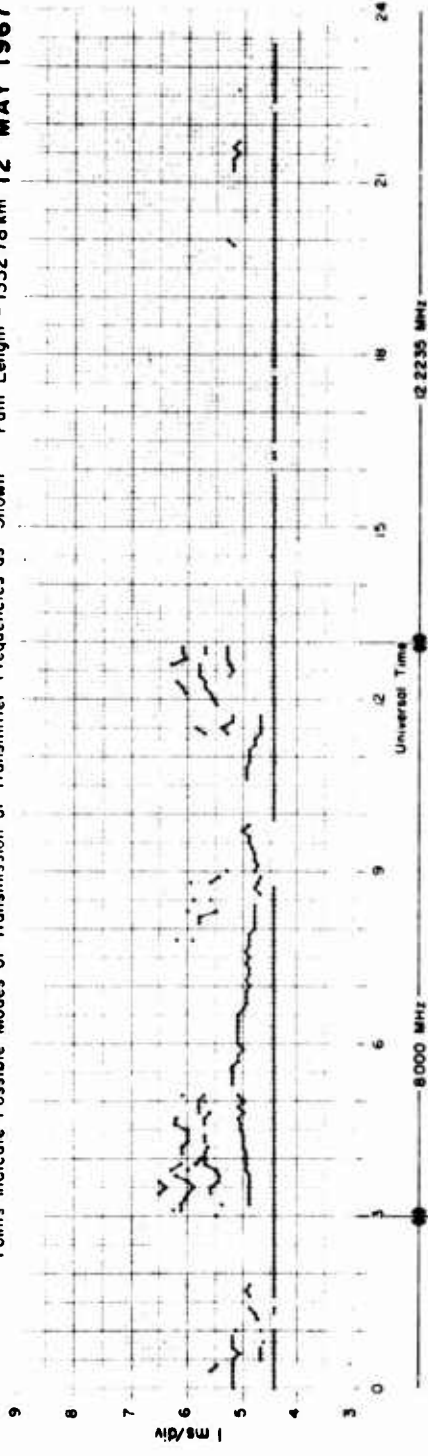


Plate 13.

11 May 1967

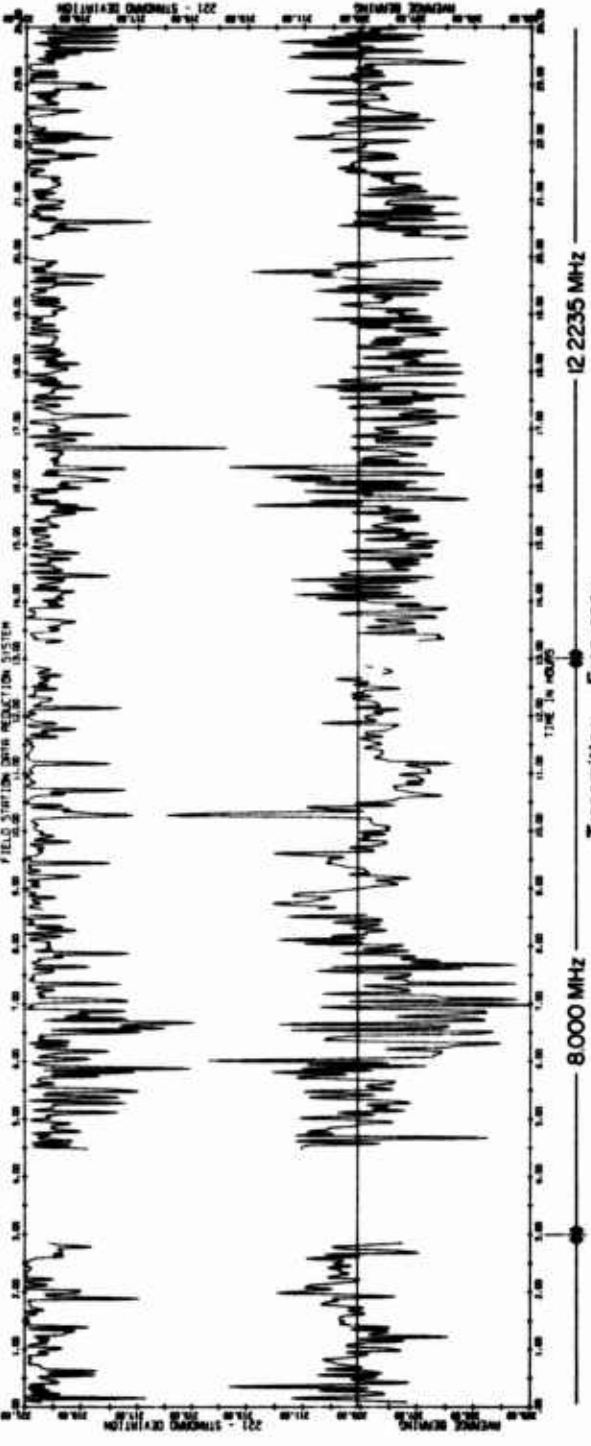
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OBLIQUE IONOGRAM DATA
 Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 12 MAY 1967

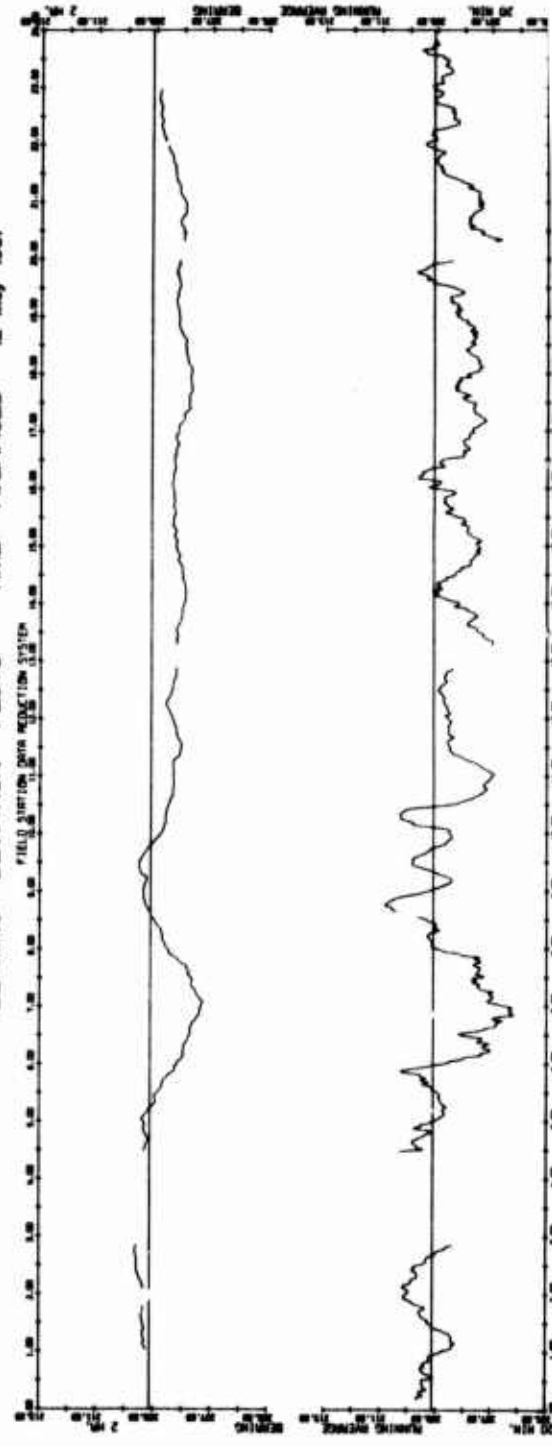


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point - Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 12 MAY 1967



BEARING DEVIATION PLOTS - TIME AVERAGED 12 May 1967



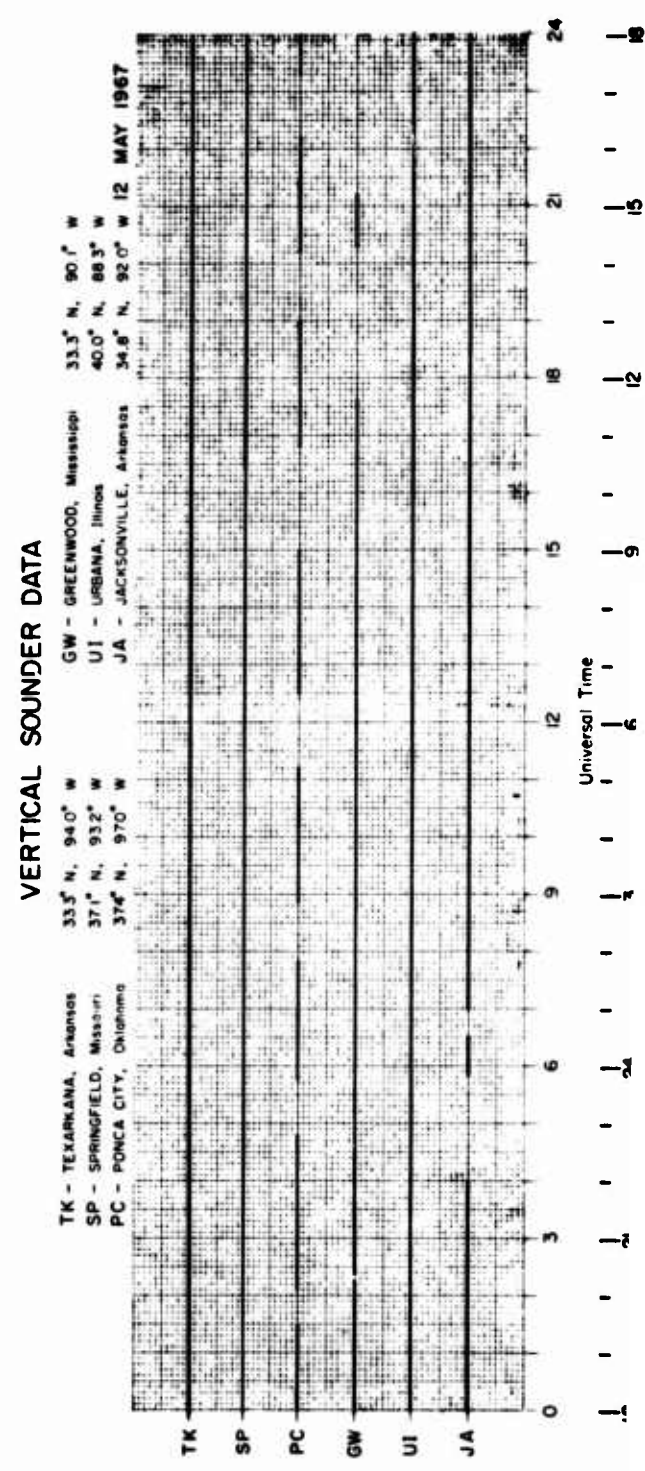
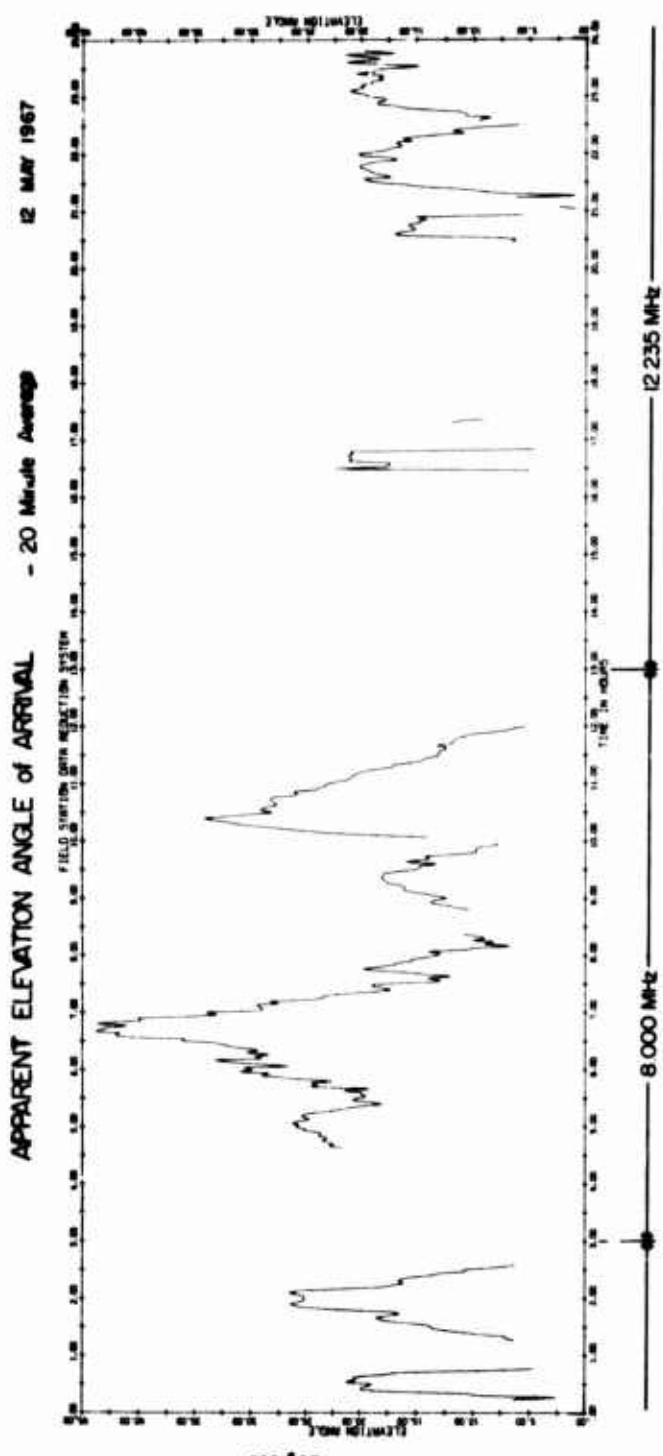
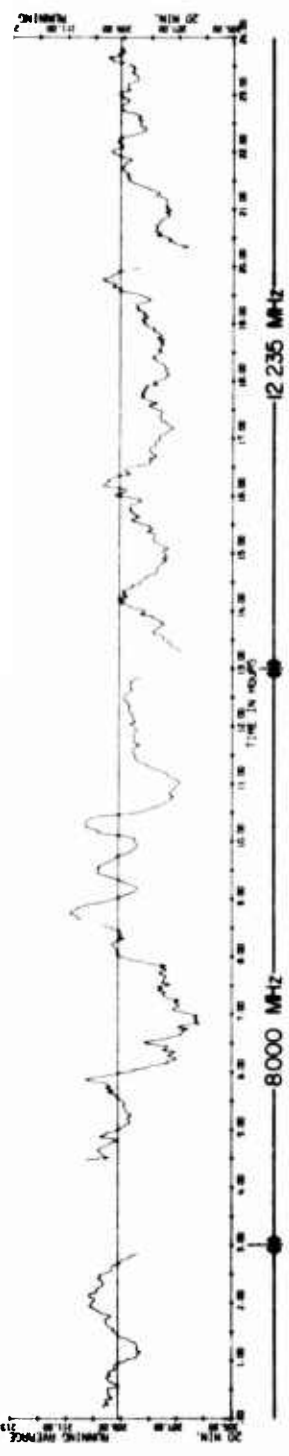
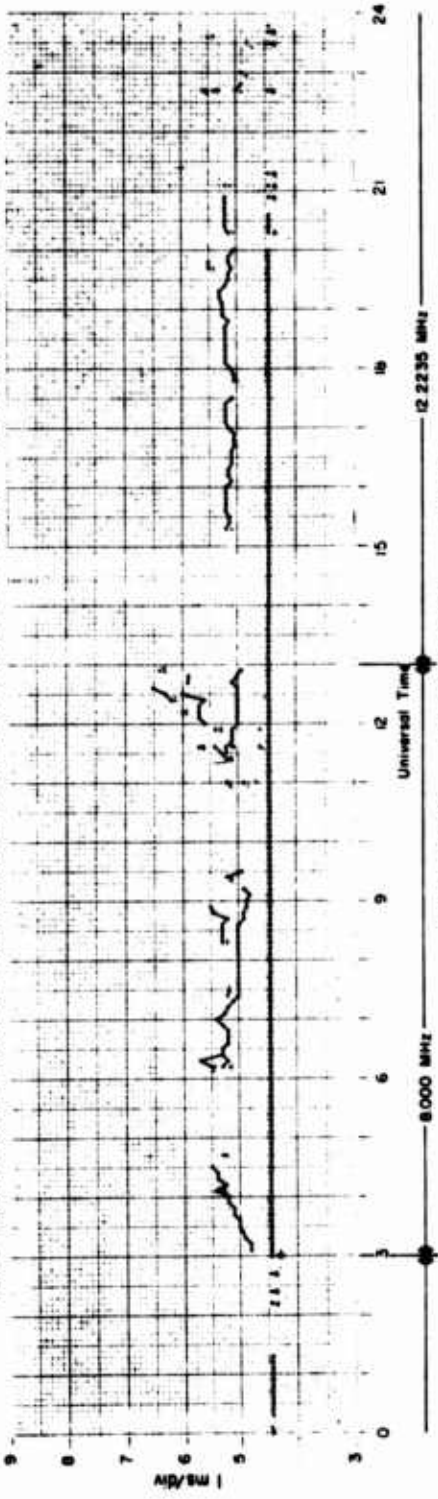


Plate 14.
 12 May 1967

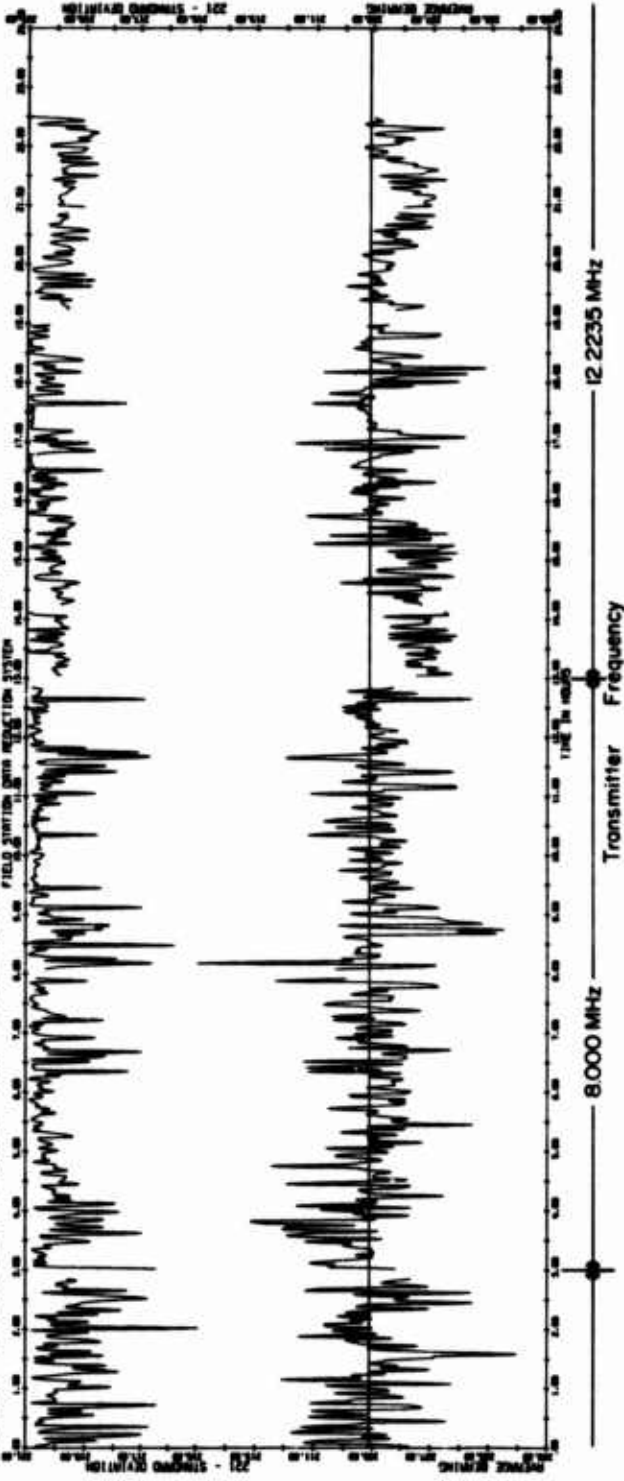
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 56" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 13 MAY 1967

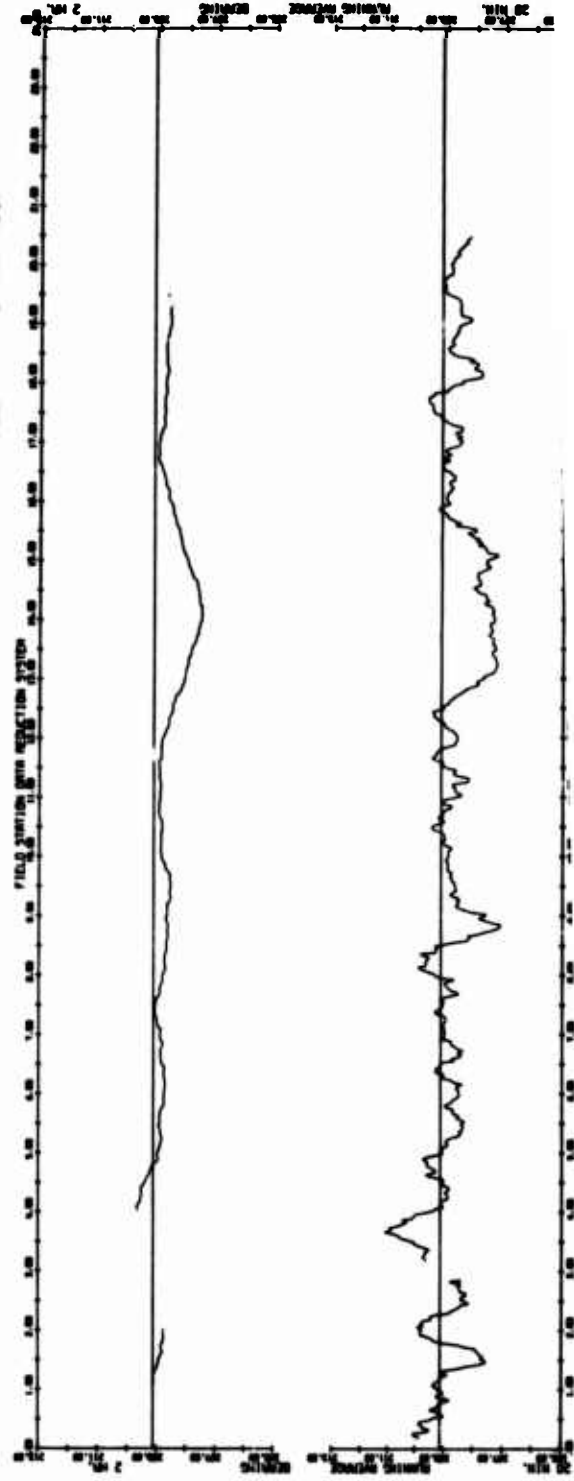


BEARING DEVIATION PLOT 13 May 1967

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W



BEARING DEVIATION PLOTS - TIME AVERAGED 13 MAY 1967



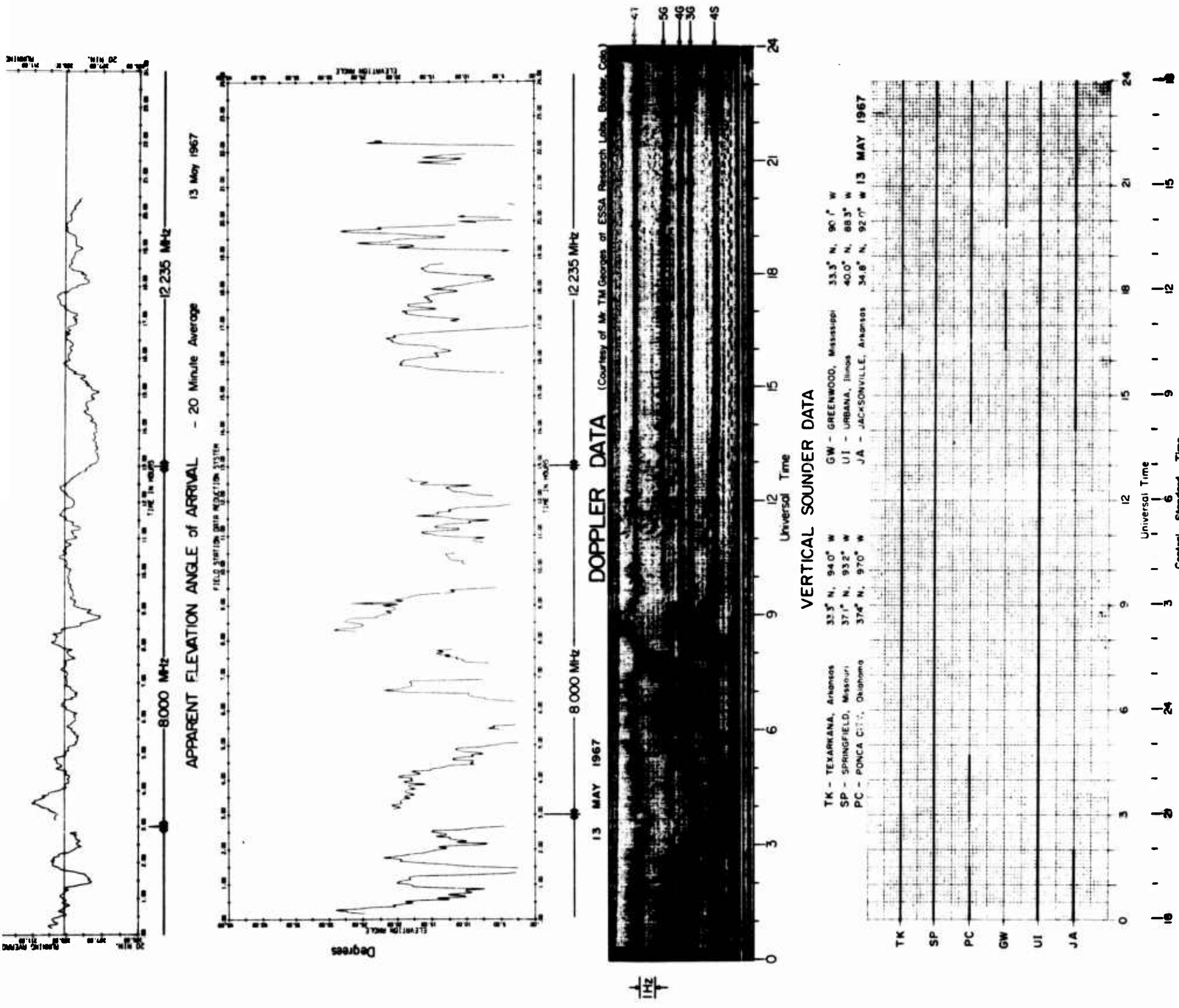
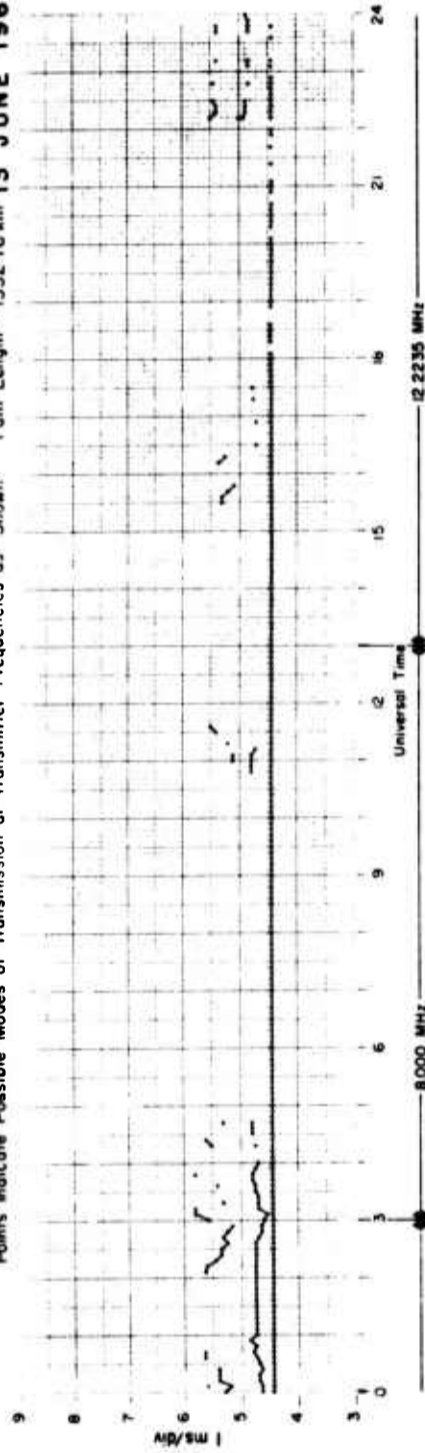


Plate 15.

13 May 1967

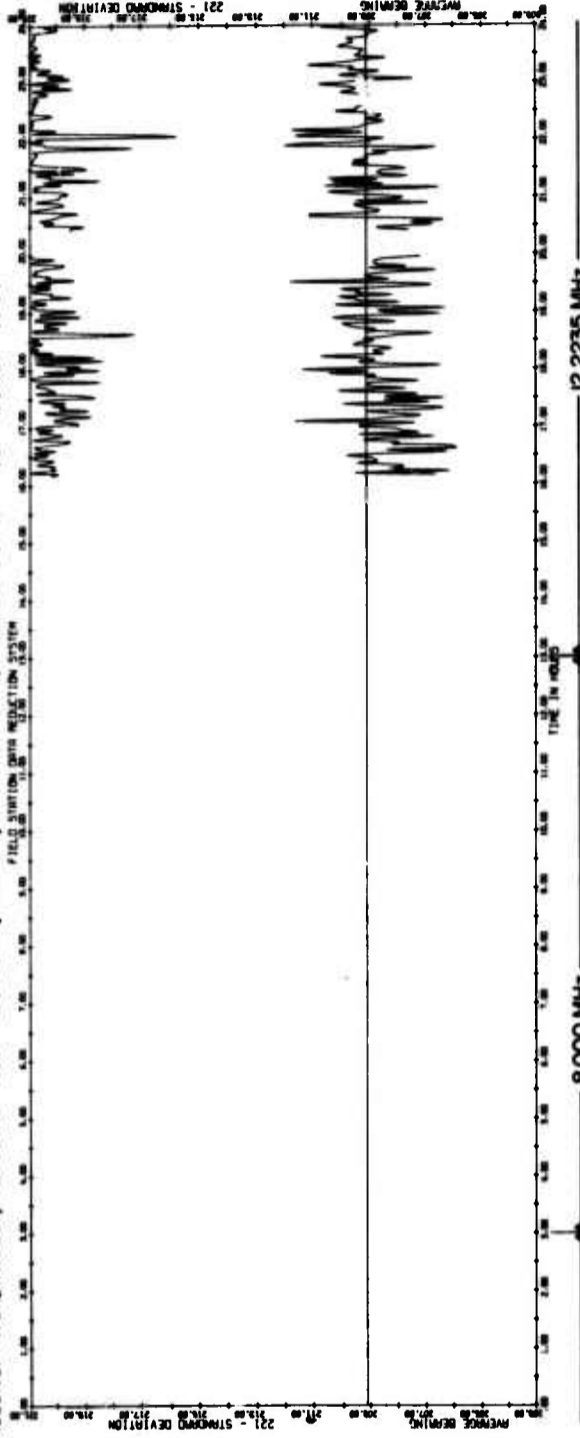
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 13 JUNE 1967

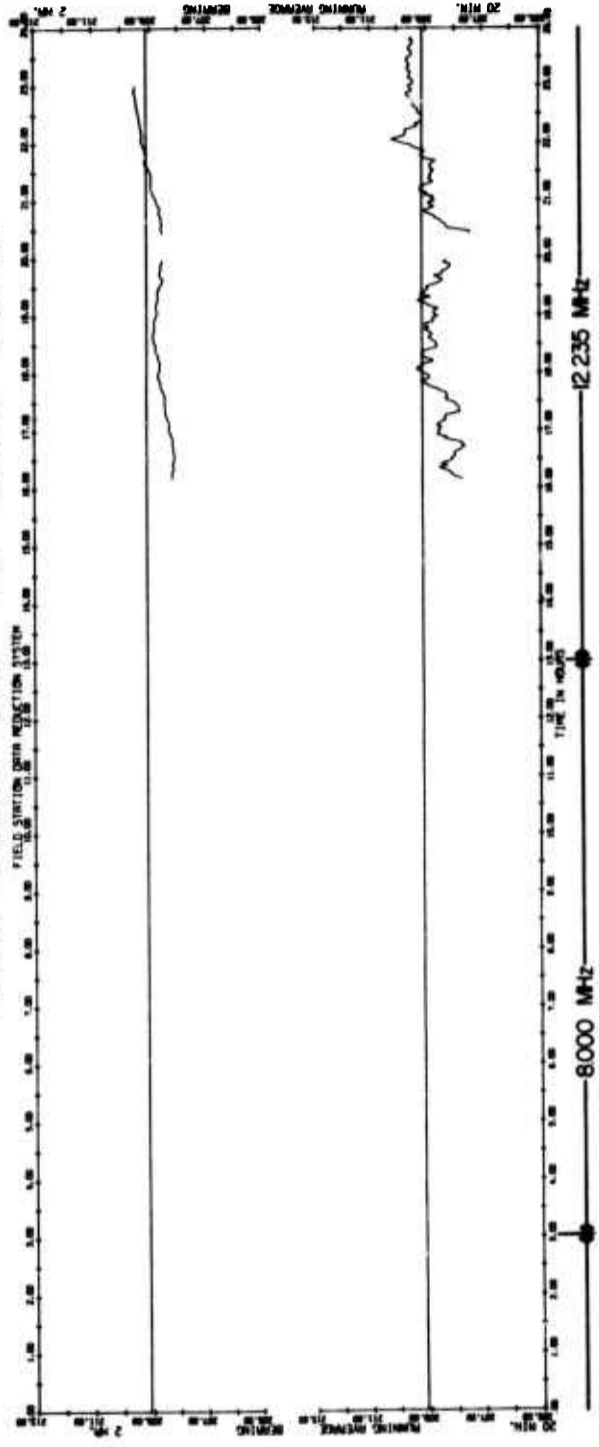


BEARING DEVIATION PLOT

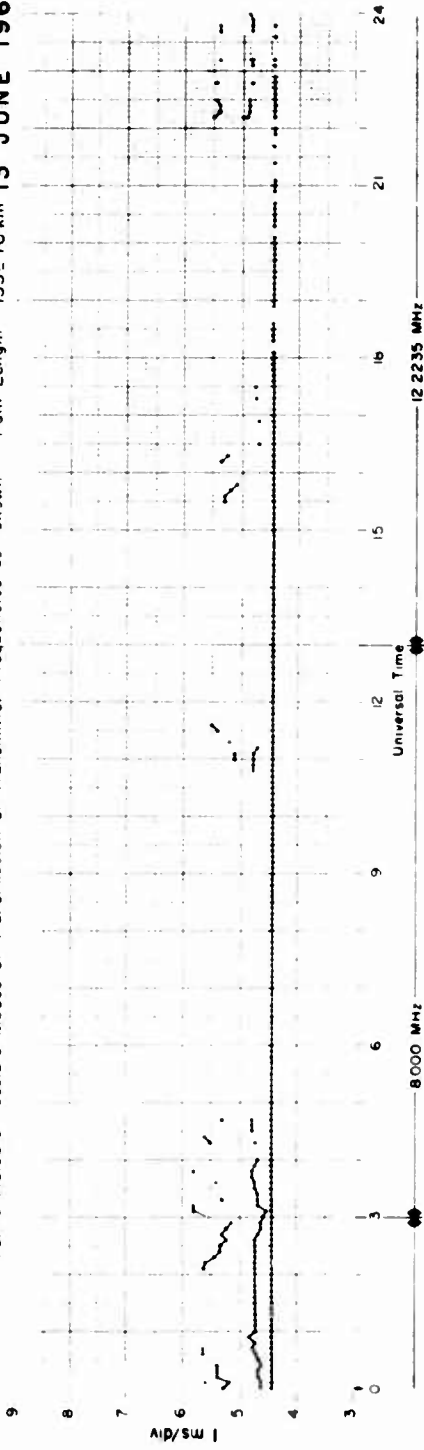
Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 13 JUNE 1967



BEARING DEVIATION PLOTS - TIME AVERAGED 13 JUNE 1967

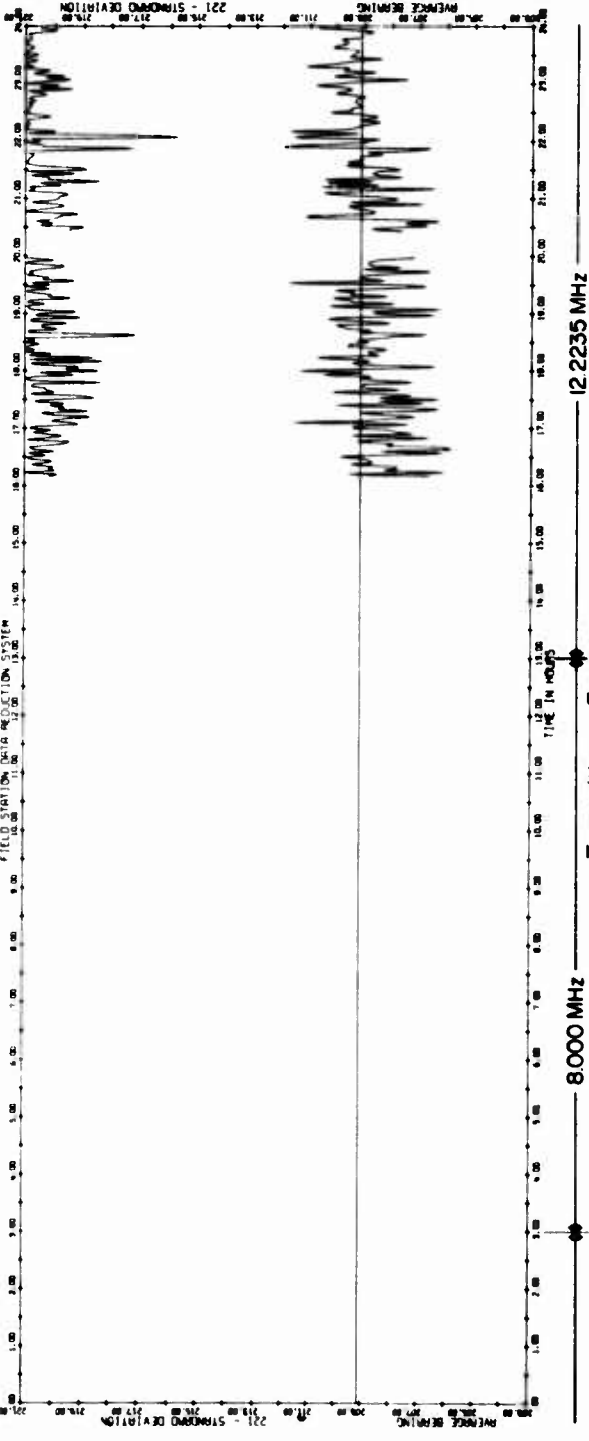


OBLIQUE IONOGRAM DATA
 Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 13 JUNE 1967



BEARING DEVIATION PLOT

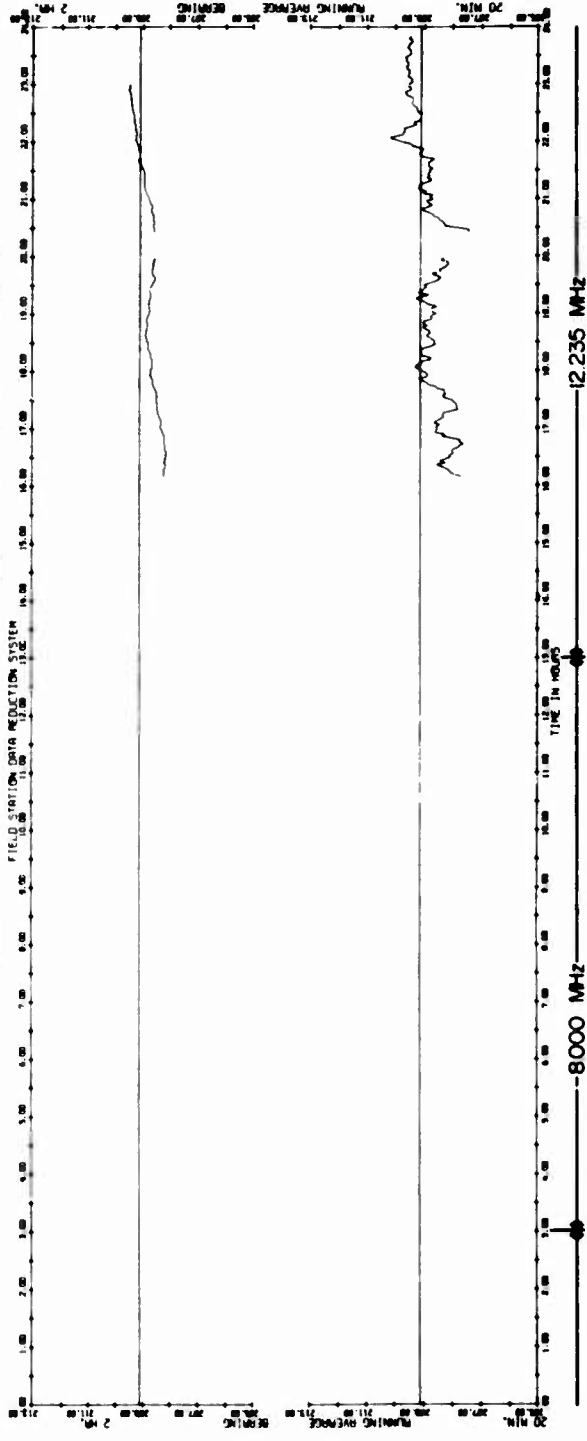
Transmitter: 10kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 13 JUNE 1967



8.000 MHz

Transmitter Frequency

BEARING DEVIATION PLOTS - TIME AVERAGED 13 June 1967



8.000 MHz

12.235 MHz

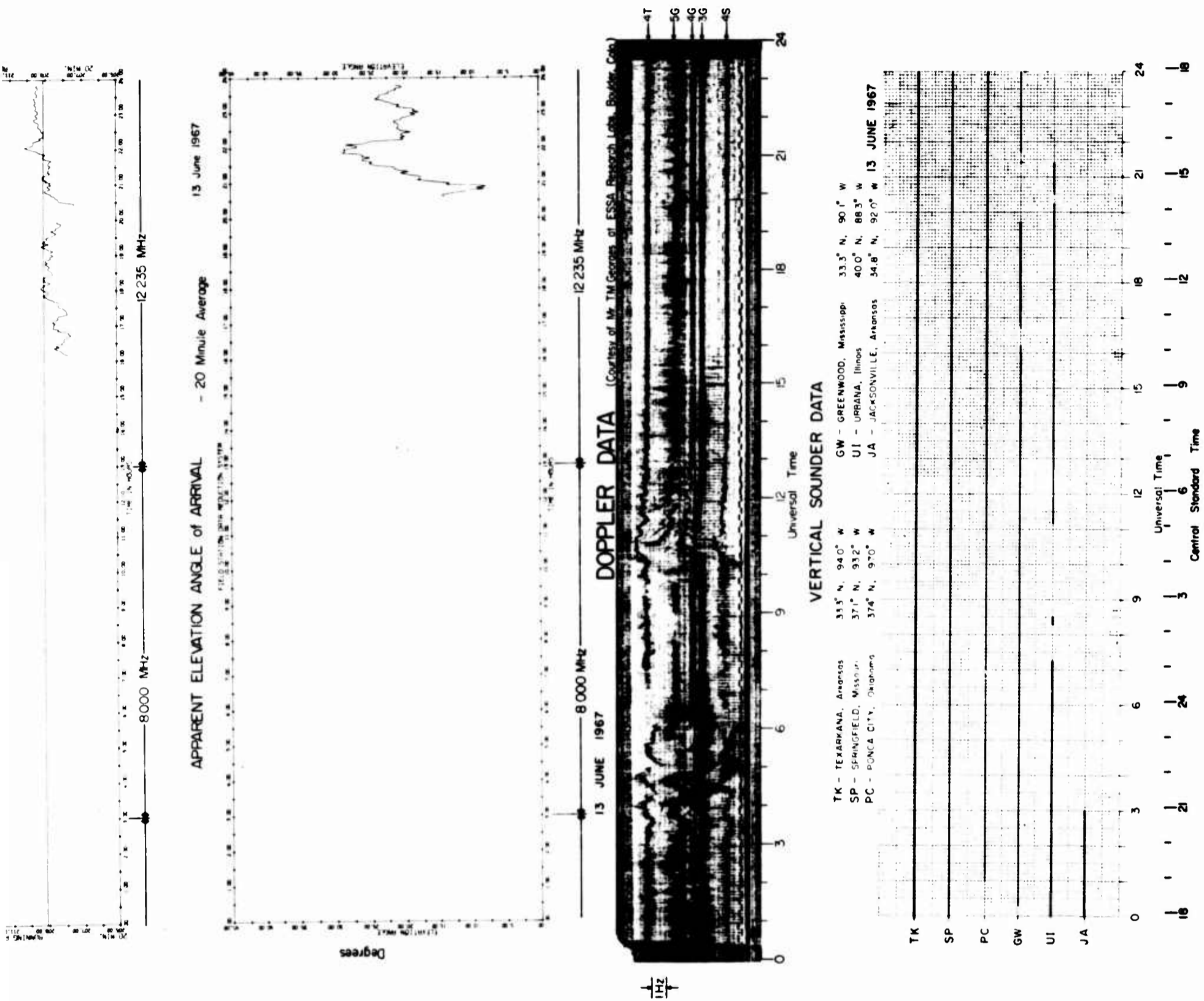
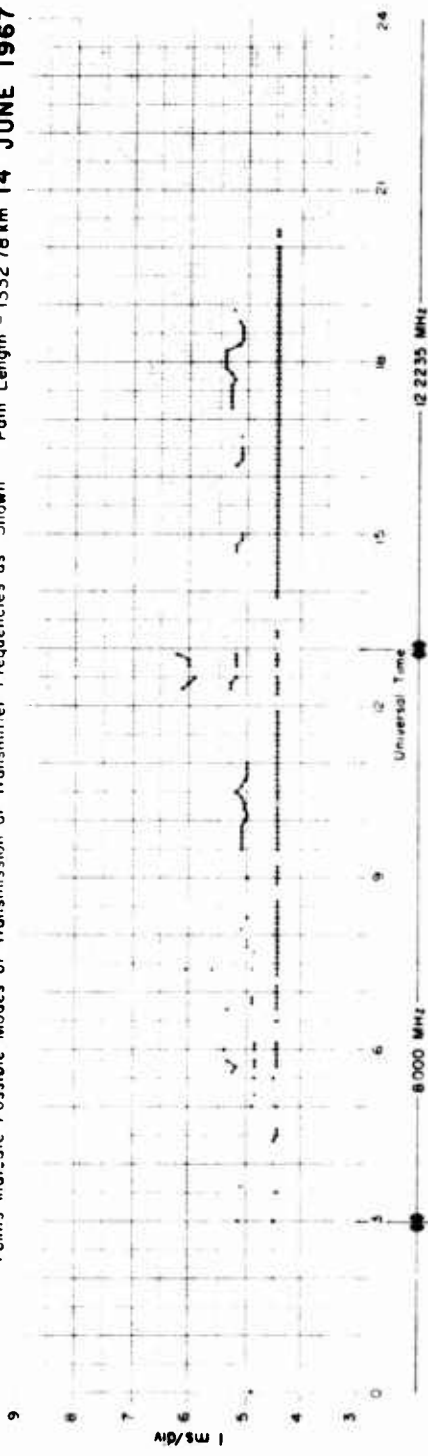


Plate 16.

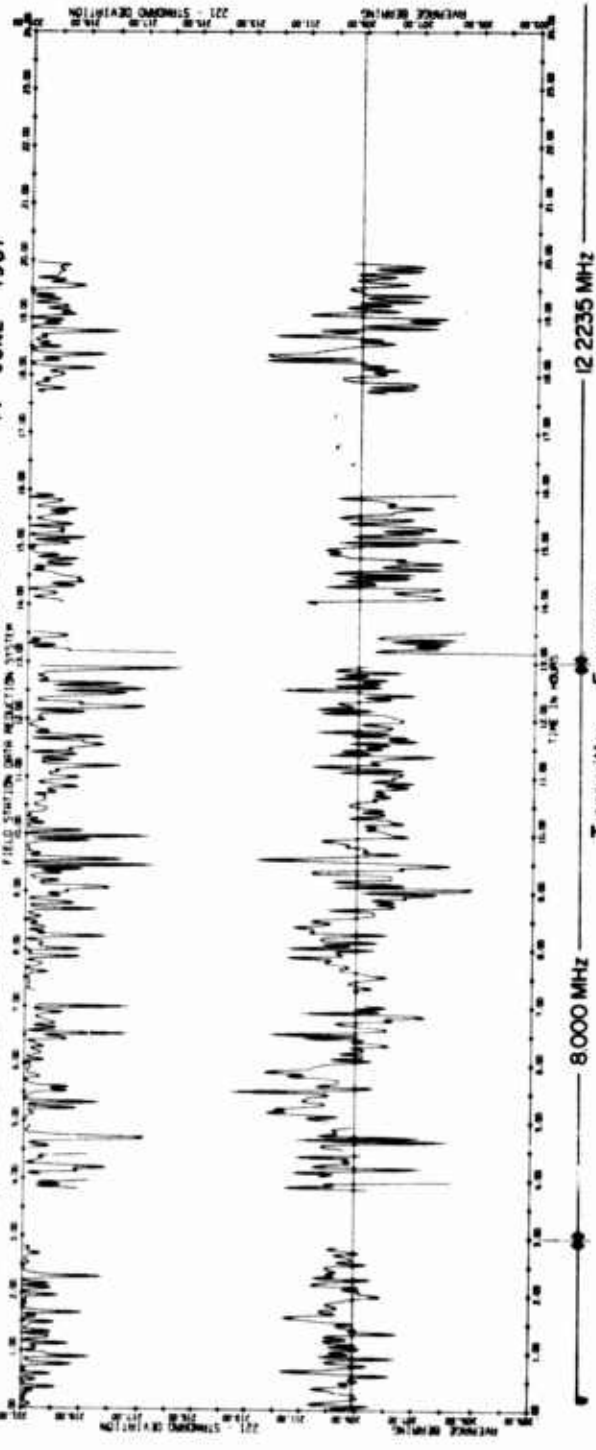
13 June 1967

OBLIQUE IONOGRAM DATA
 Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 14 JUNE 1967

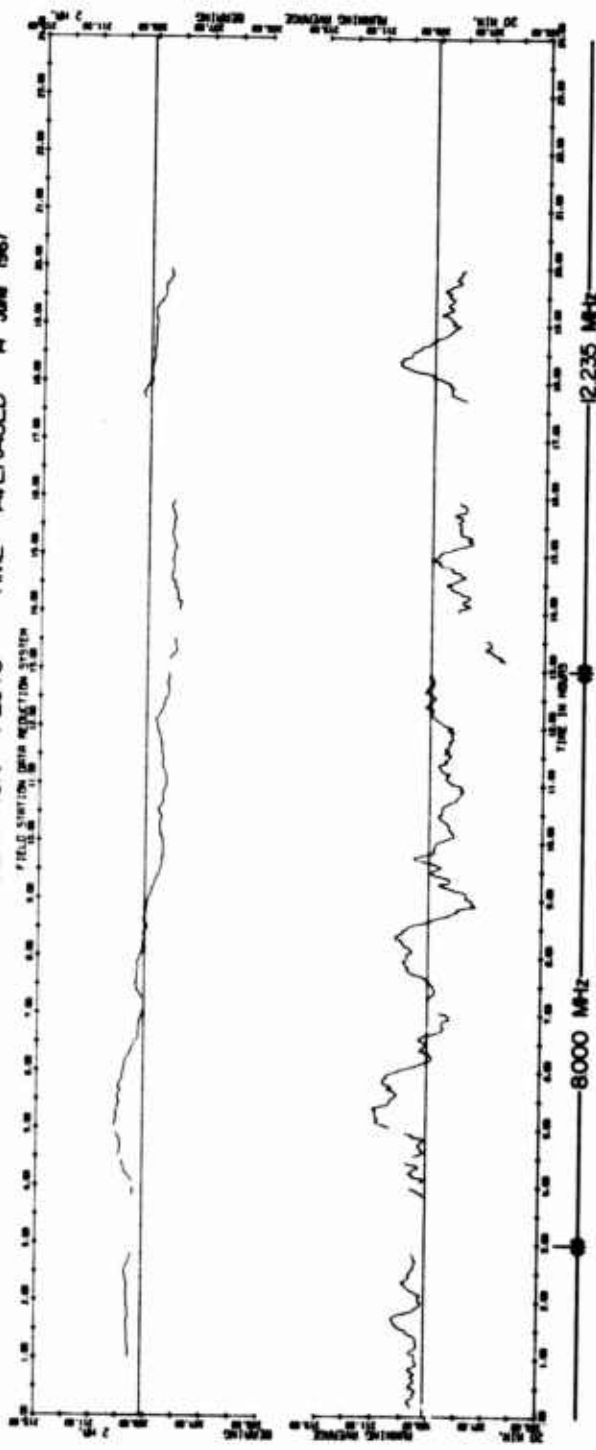


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34° 8' N, 92° 0' W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 14 JUNE 1967



BEARING DEVIATION PLOTS - TIME AVERAGED 14 June 1967



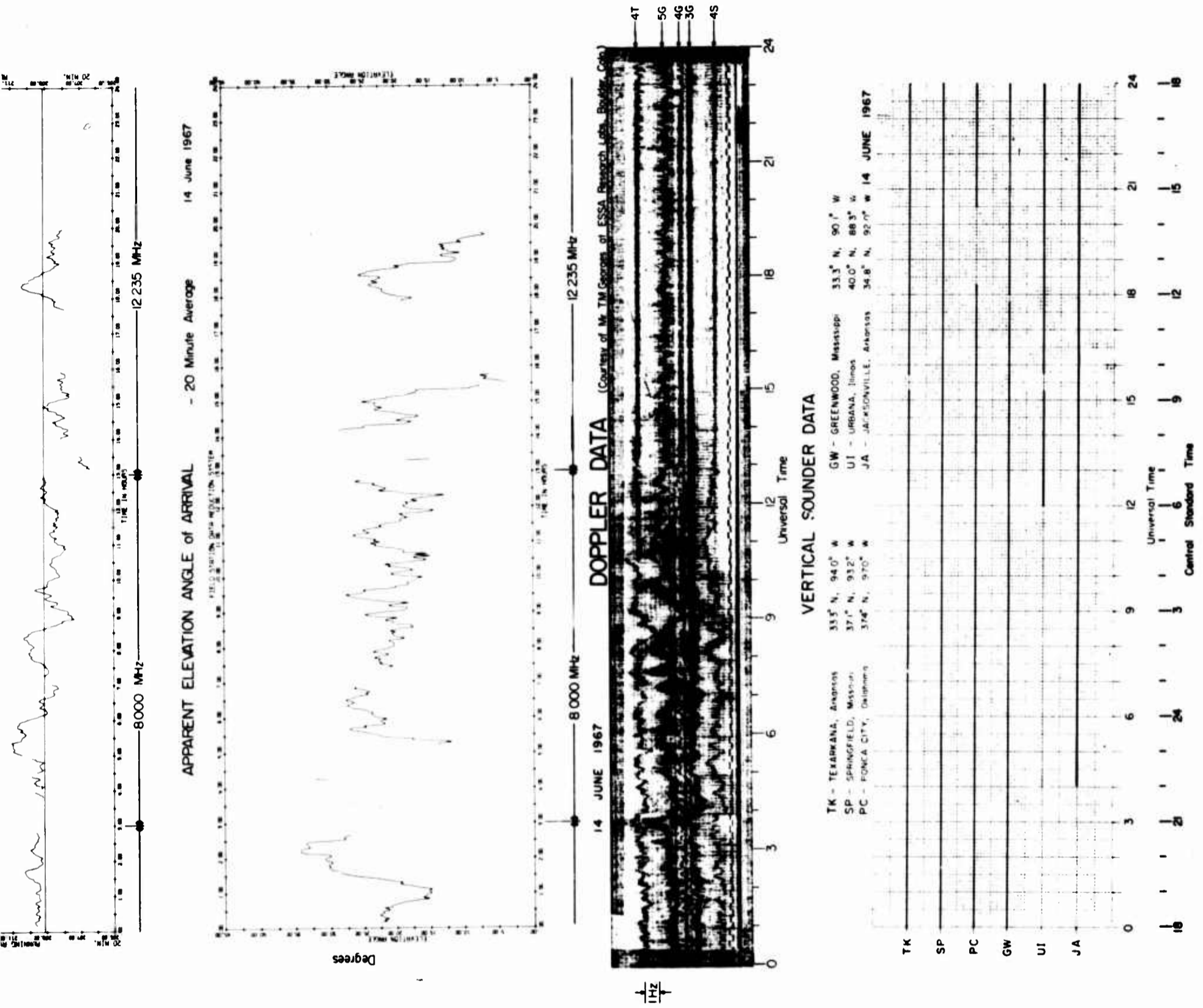
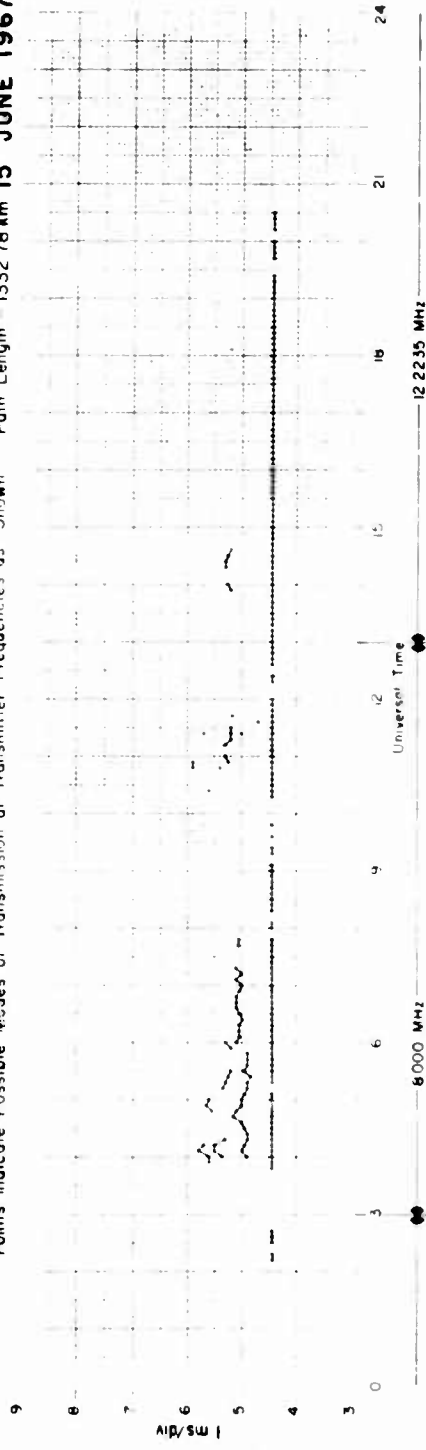


Plate 17.

14 June 1967

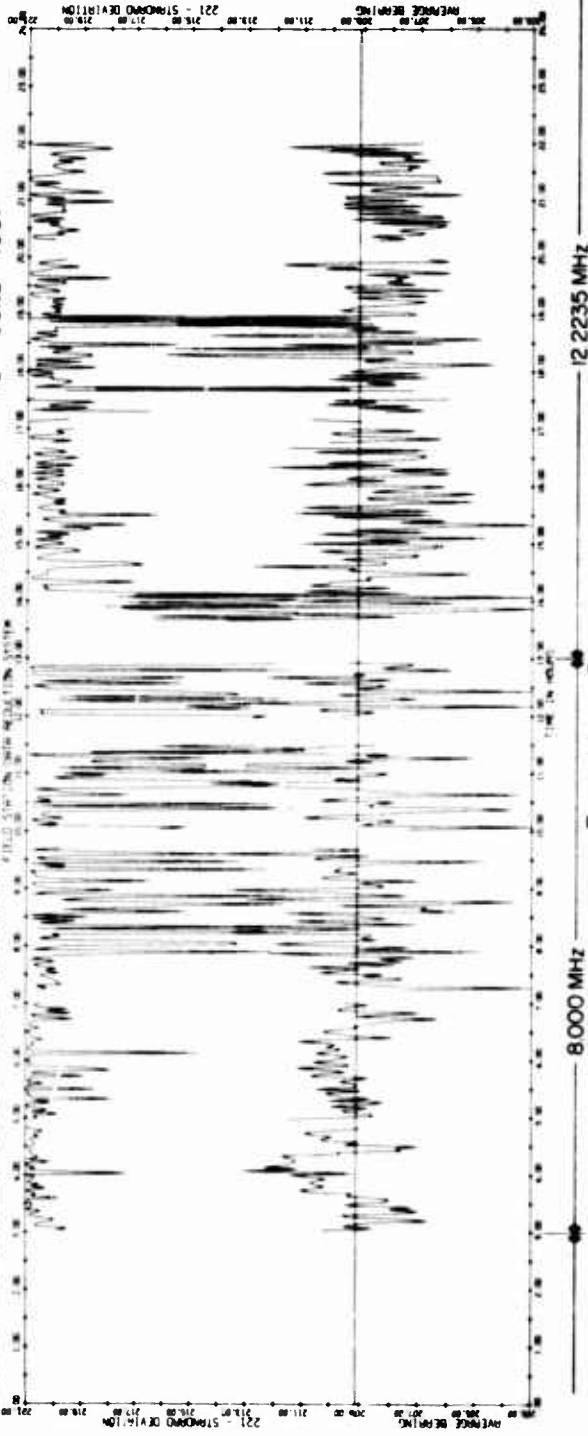
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km **15 JUNE 1967**

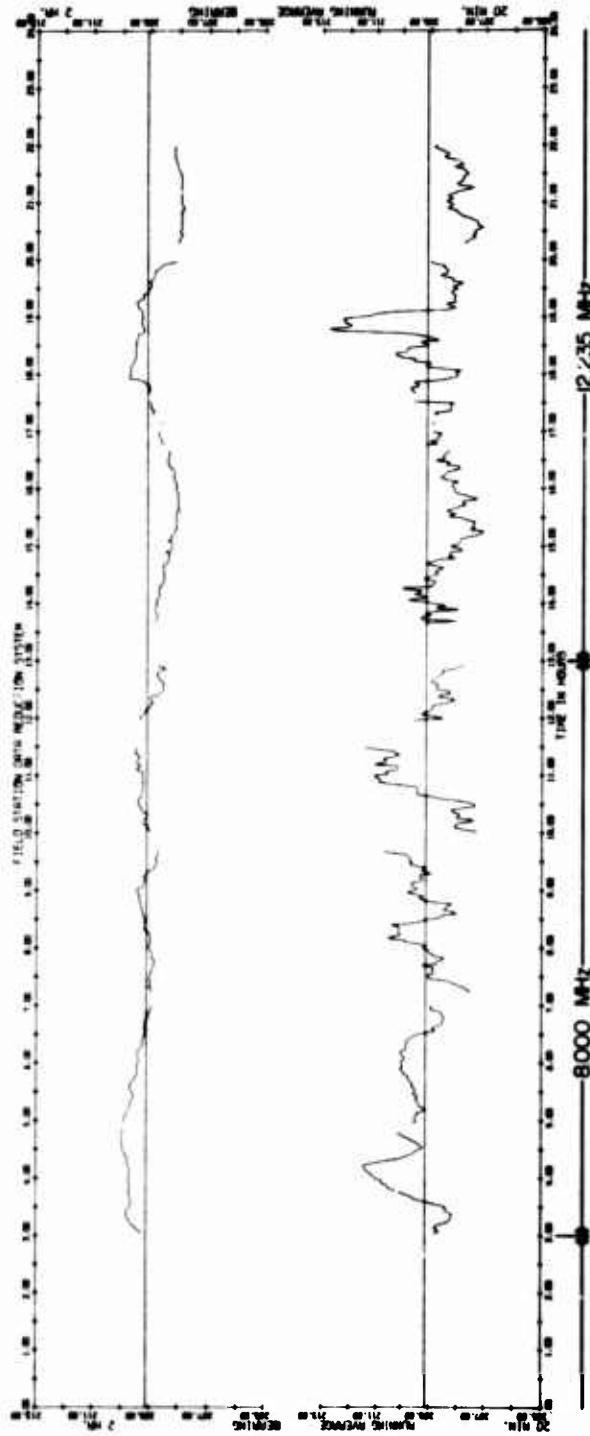


BEARING DEVIATION PLOT

Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34° 8' N, 92.0° W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W **15 JUNE 1967**

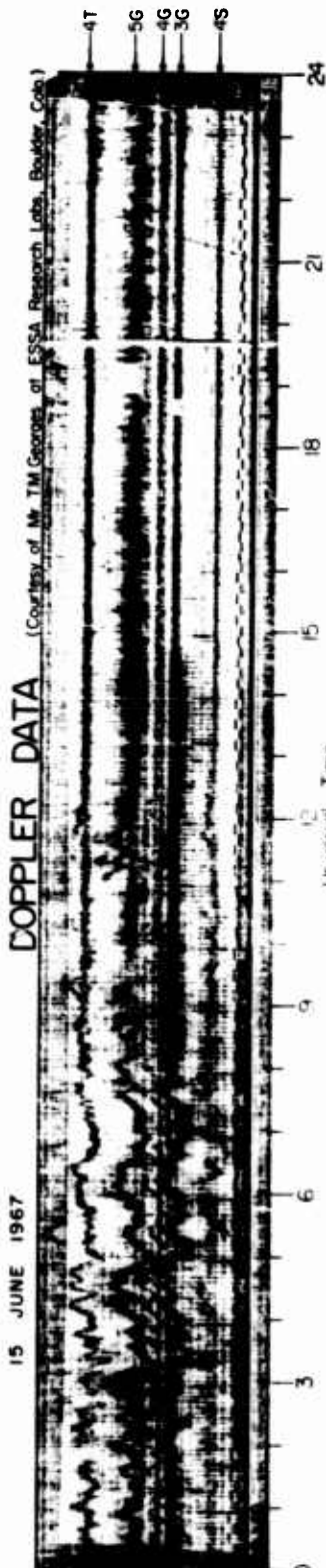
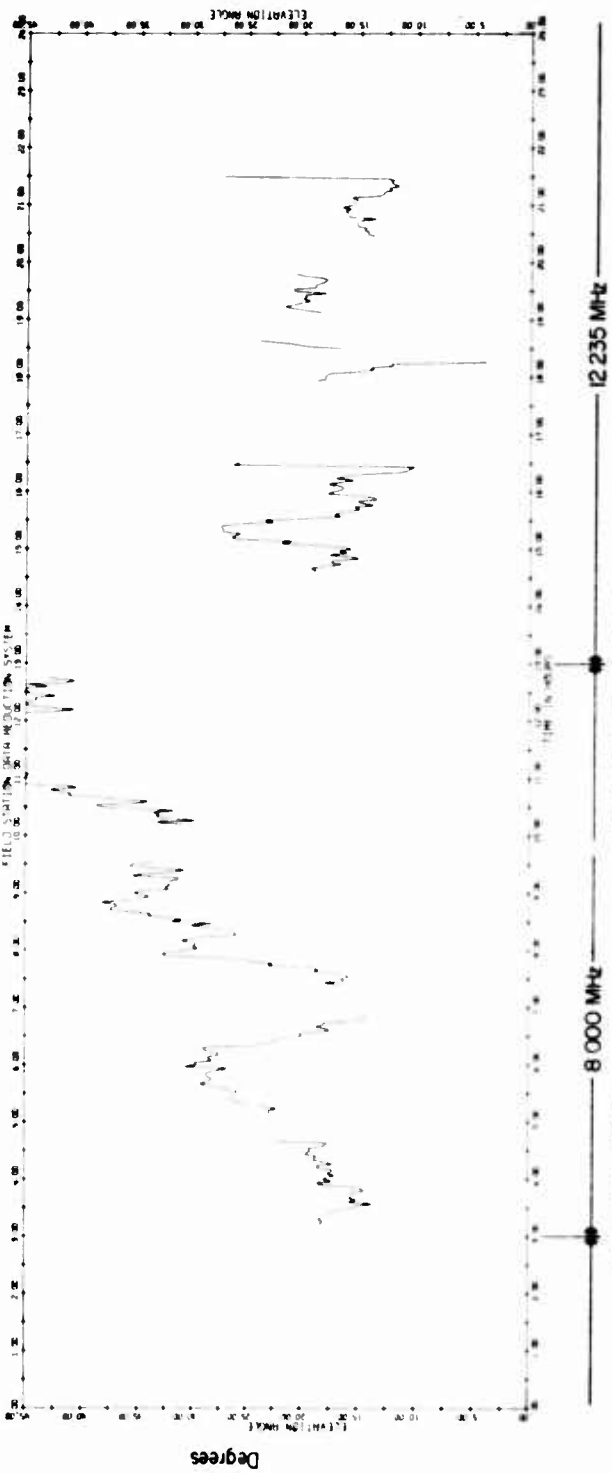


BEARING DEVIATION PLOTS - TIME AVERAGED 15 June 1967





APPARENT ELEVATION ANGLE of ARRIVAL
- 20 Minute Average
15 June 1967



VERTICAL SOUNDER DATA

TK - TEXARKANA, Arkansas 33.5° N, 94.0° W GW - GREENWOOD, Mississippi 33.3° N, 90.1° W
 SP - SPRINGFIELD, Missouri 37.1° N, 93.2° W UI - URBANA, Illinois 40.0° N, 88.3° W
 PC - PONCA CITY, Oklahoma 37.0° N, 97.0° W JA - JACKSONVILLE, Arkansas 35.8° N, 92.0° W 15 JUNE 1967

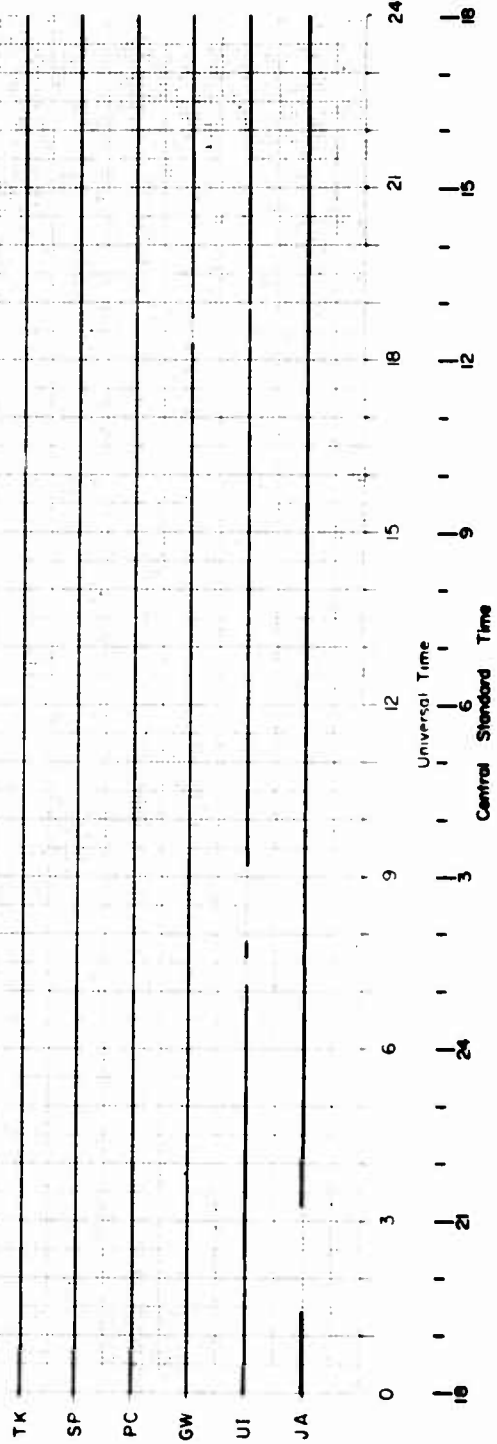
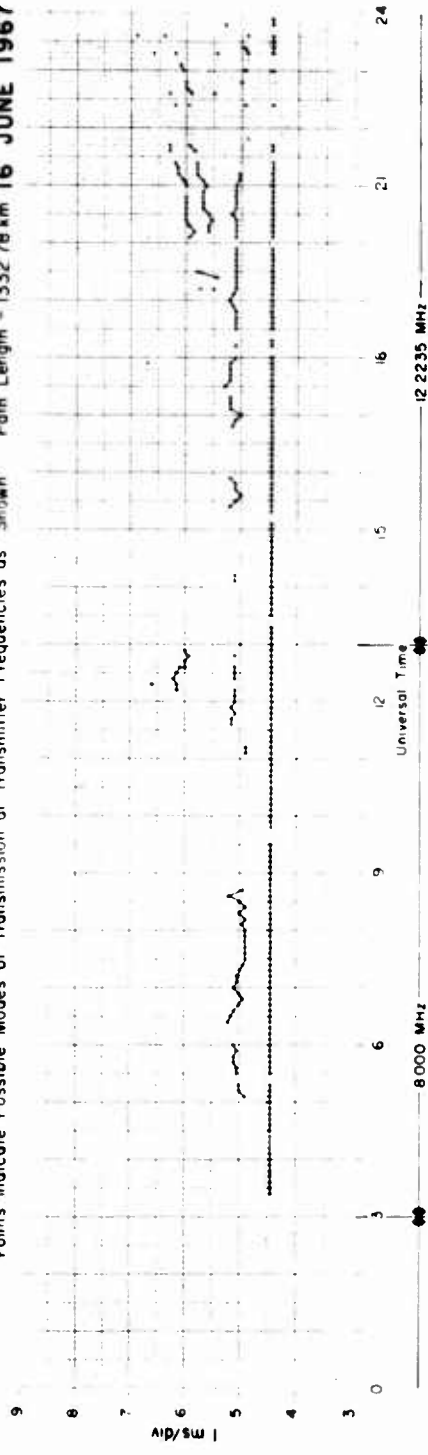


Plate 18.

15 June 1967

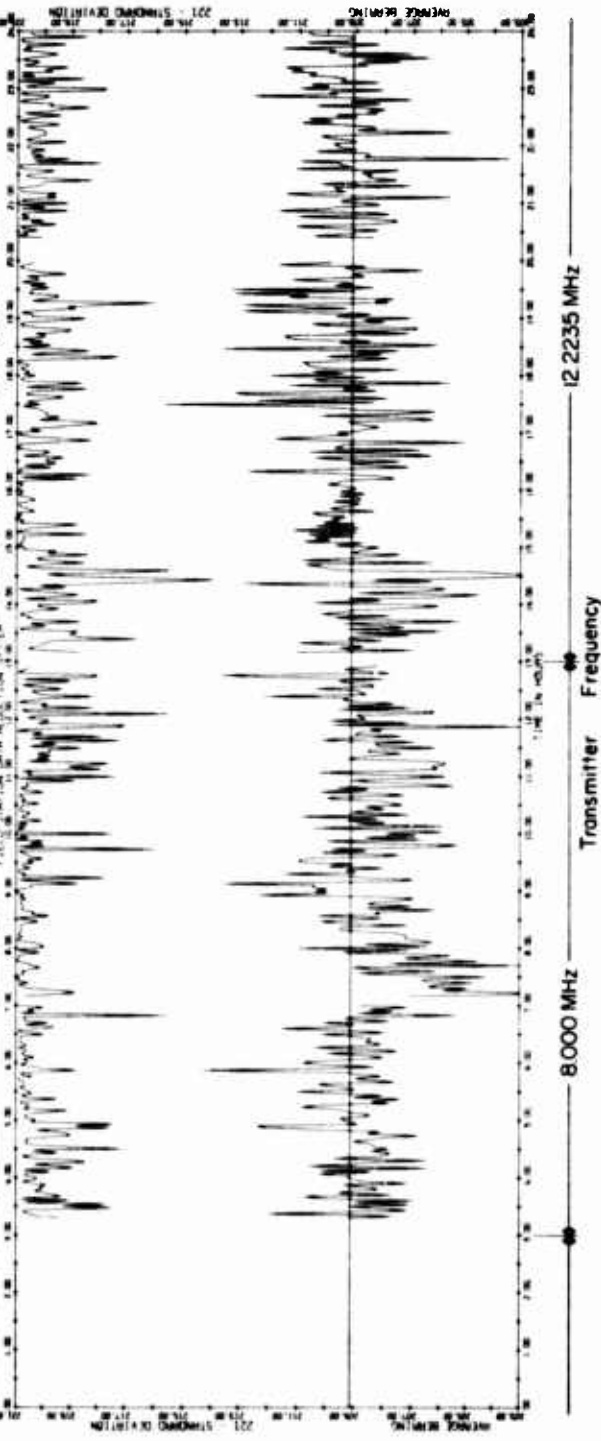
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission as Shown Path Length - 1332.78 km 16 JUNE 1967

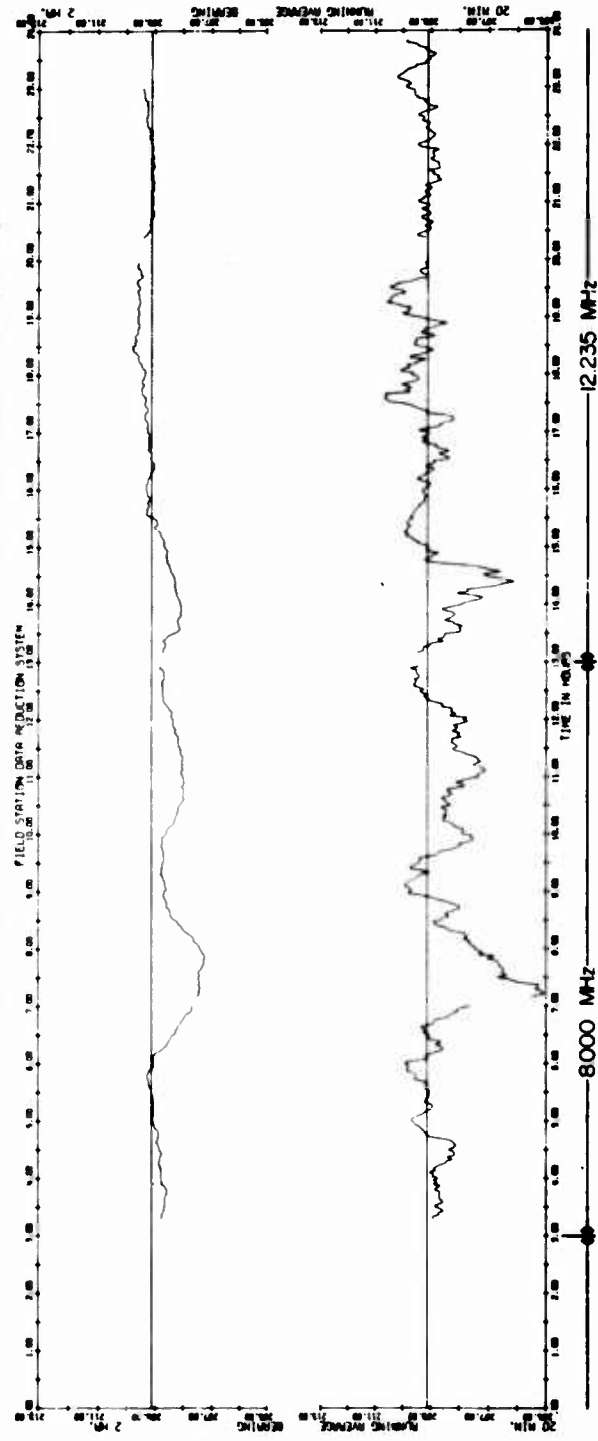


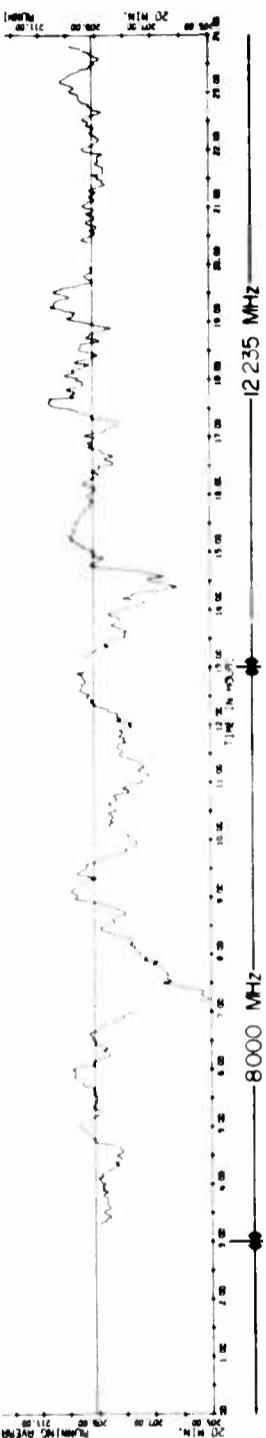
BEARING DEVIATION PLOT

Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34° 8' N, 92° 0' W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 16 JUNE 1967

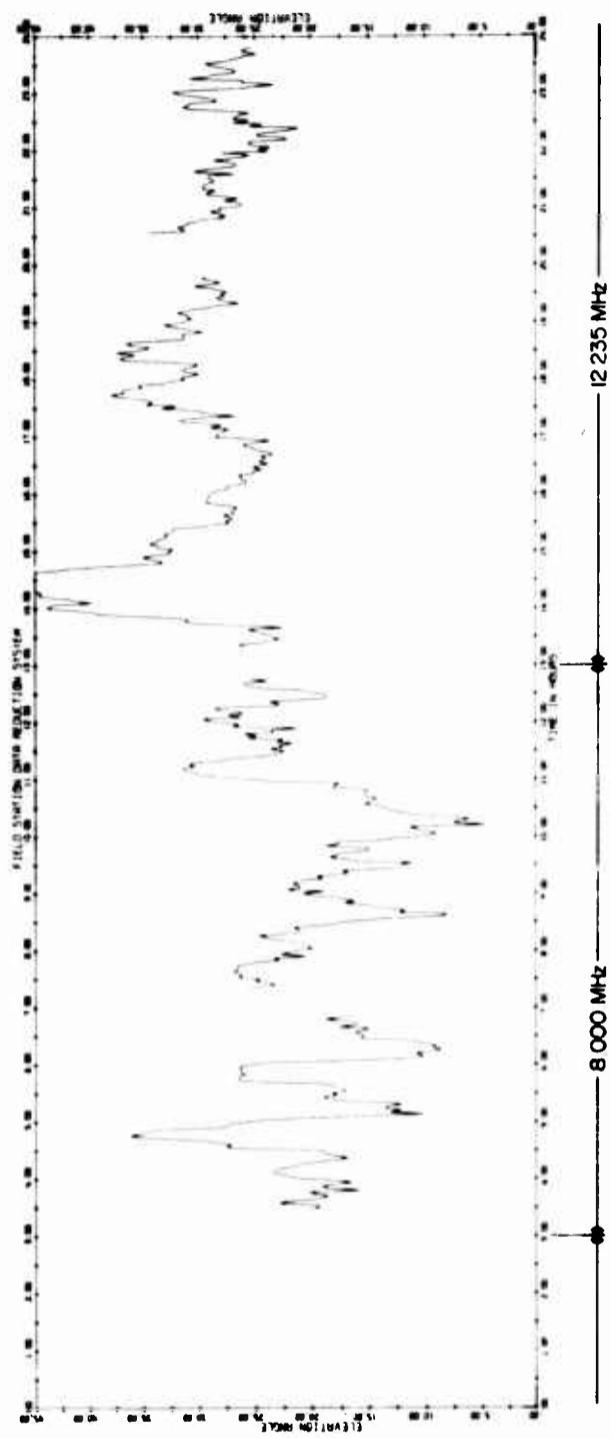


BEARING DEVIATION PLOTS - TIME AVERAGED 16 June 1967

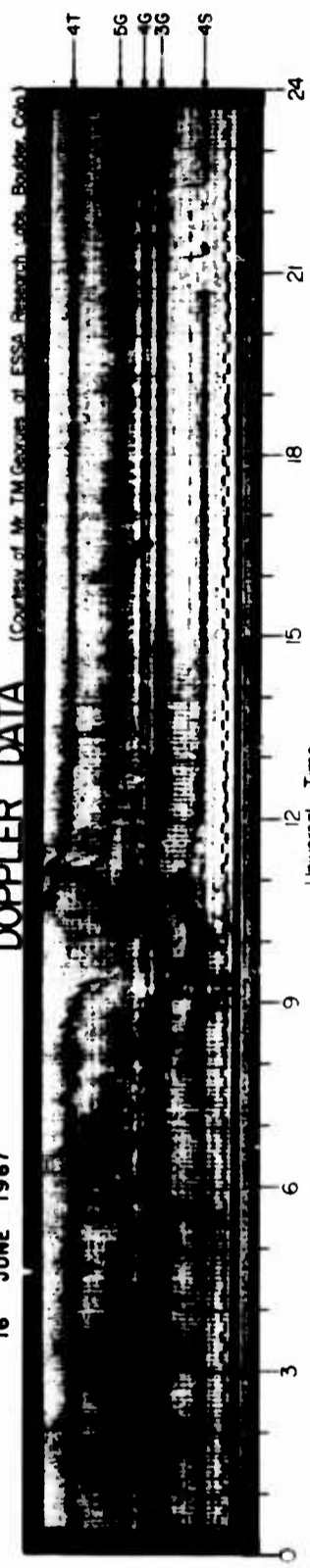




APPARENT ELEVATION ANGLE OF ARRIVAL - 20 Minute Average - 16 June 1967



DOPPLER DATA (Courtesy of Mr. T.M. Geosens of ESSA Research Labs, Boulder, Colo.)



VERTICAL SOUNDER DATA

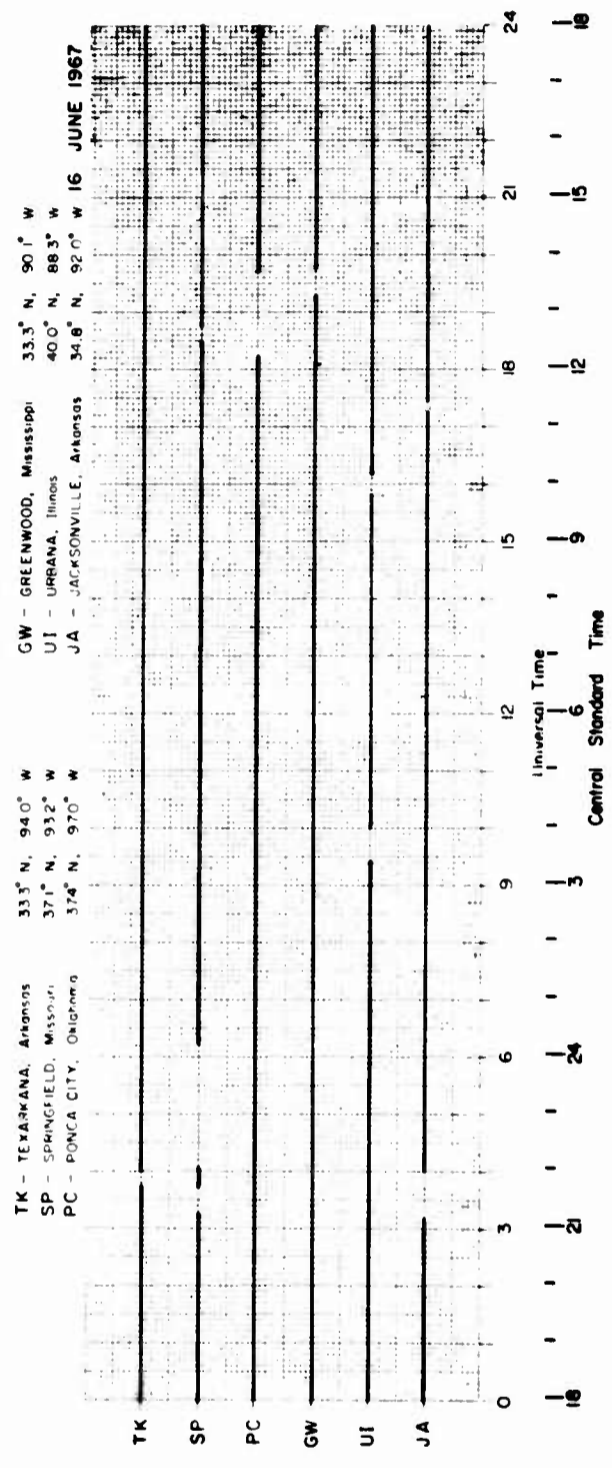
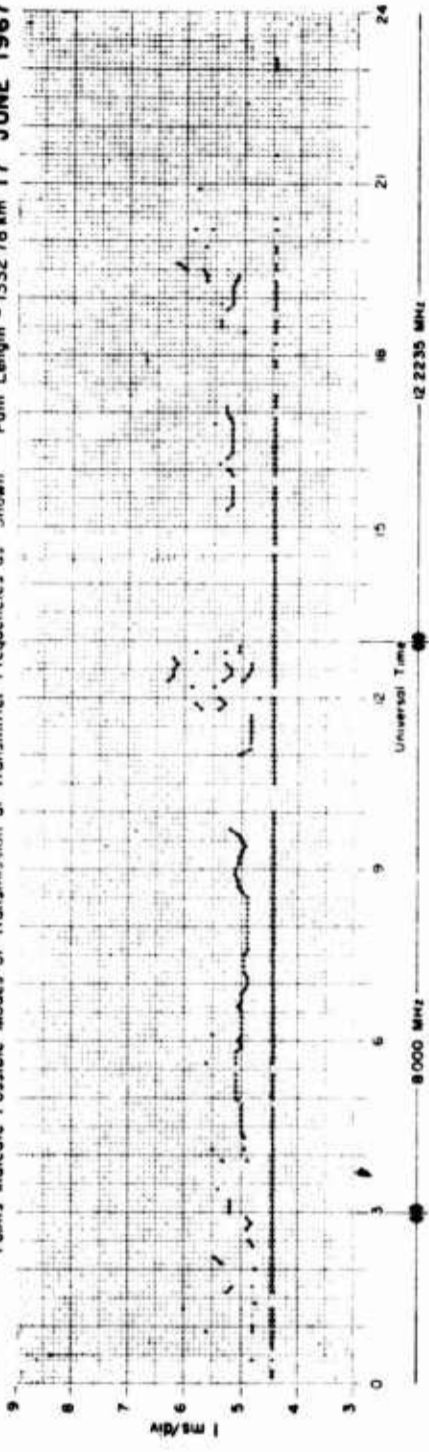


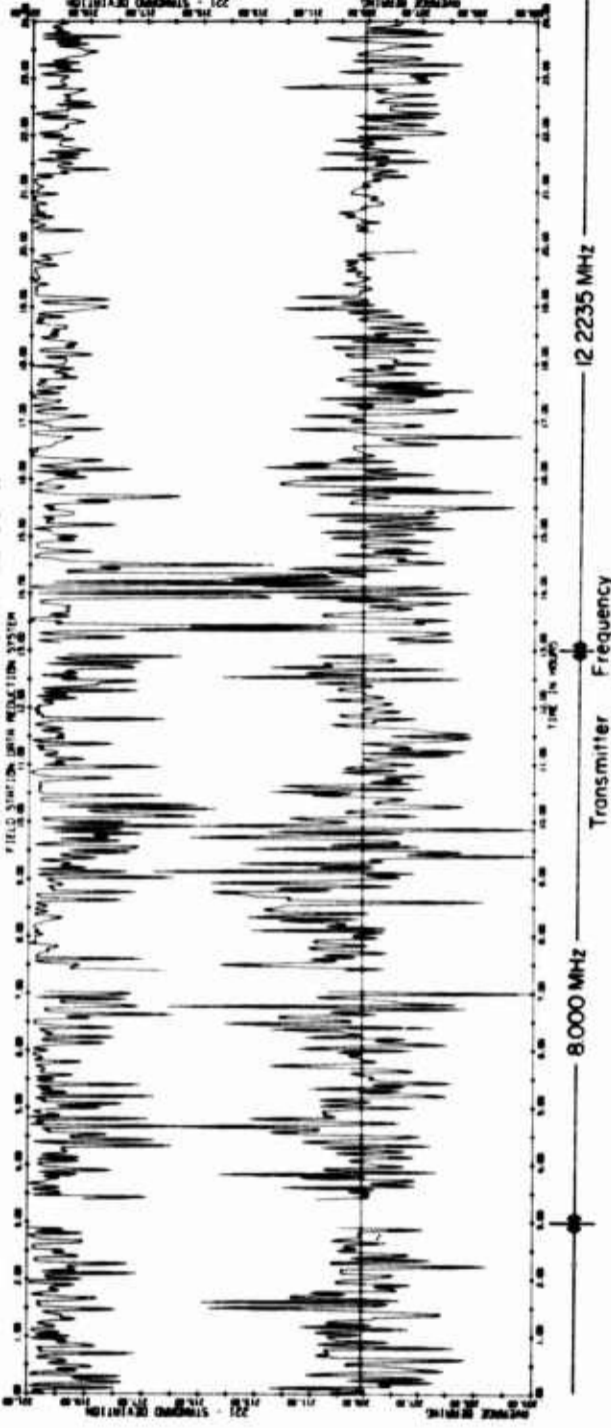
Plate 19.
16 June 1967

OBLIQUE IONOGRAM DATA

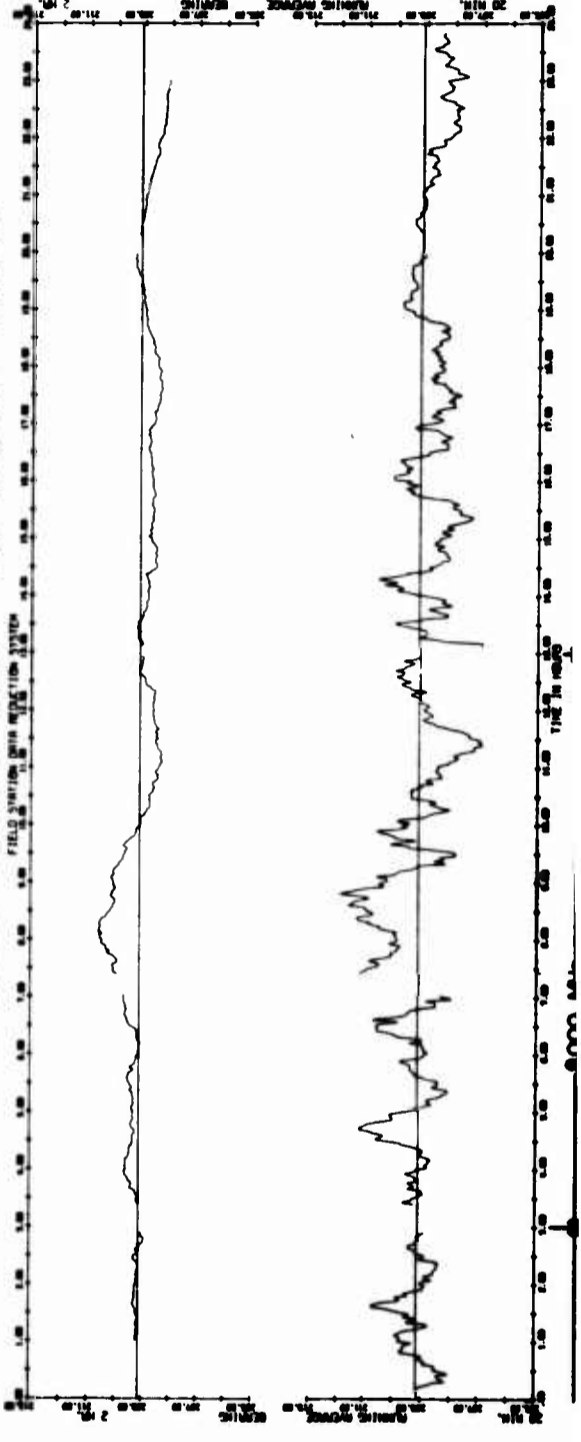
Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 17 JUNE 1967

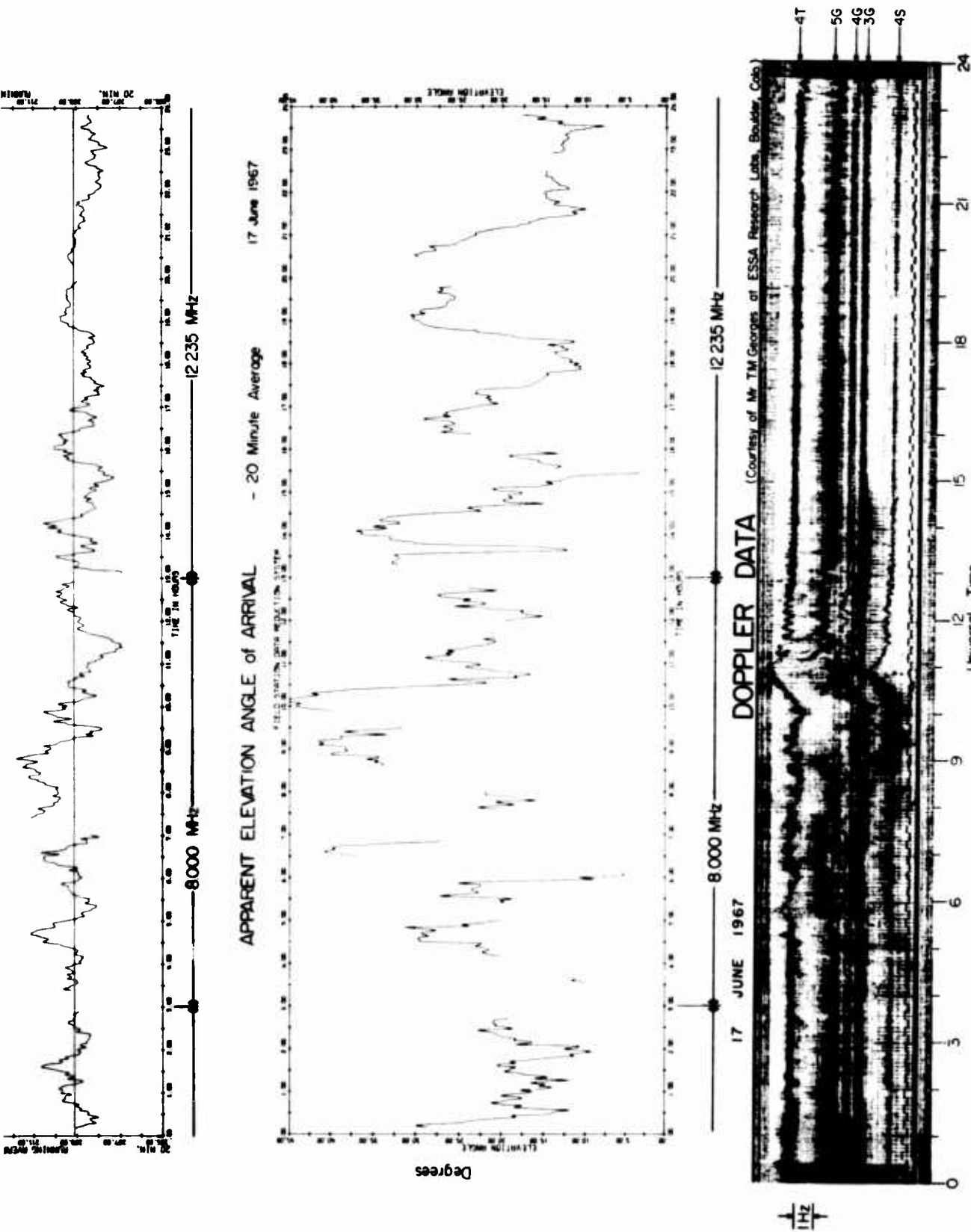


BEARING DEVIATION PLOT 17 June 1967
 Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.6° N, 92.0° W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W



BEARING DEVIATION PLOTS - TIME AVERAGED 17 June 1967





VERTICAL SOUNDER DATA

Station	Latitude	Longitude
TK - TEXARKANA, Arkansas	33.3° N	94.0° W
SP - SPRINGFIELD, Missouri	37.1° N	93.2° W
PC - PONCA CITY, Oklahoma	37.4° N	97.0° W
GW - GREENWOOD, Mississippi	33.3° N	90.1° W
UI - URBANA, Illinois	40.0° N	88.3° W
JA - JACKSONVILLE, Arkansas	34.8° N	92.0° W

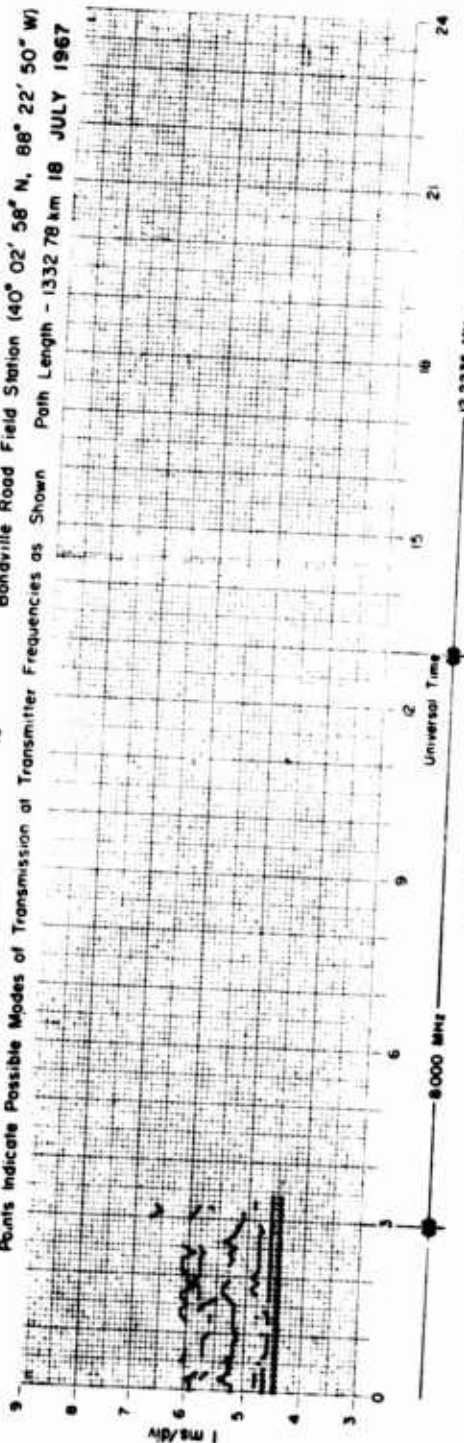
Station	0	3	6	9	12	15	18	21	24
TK									
SP									
PC									
GW									
UI									
JA									

Universal Time
Central Standard Time

Plate 20.
17 June 1967

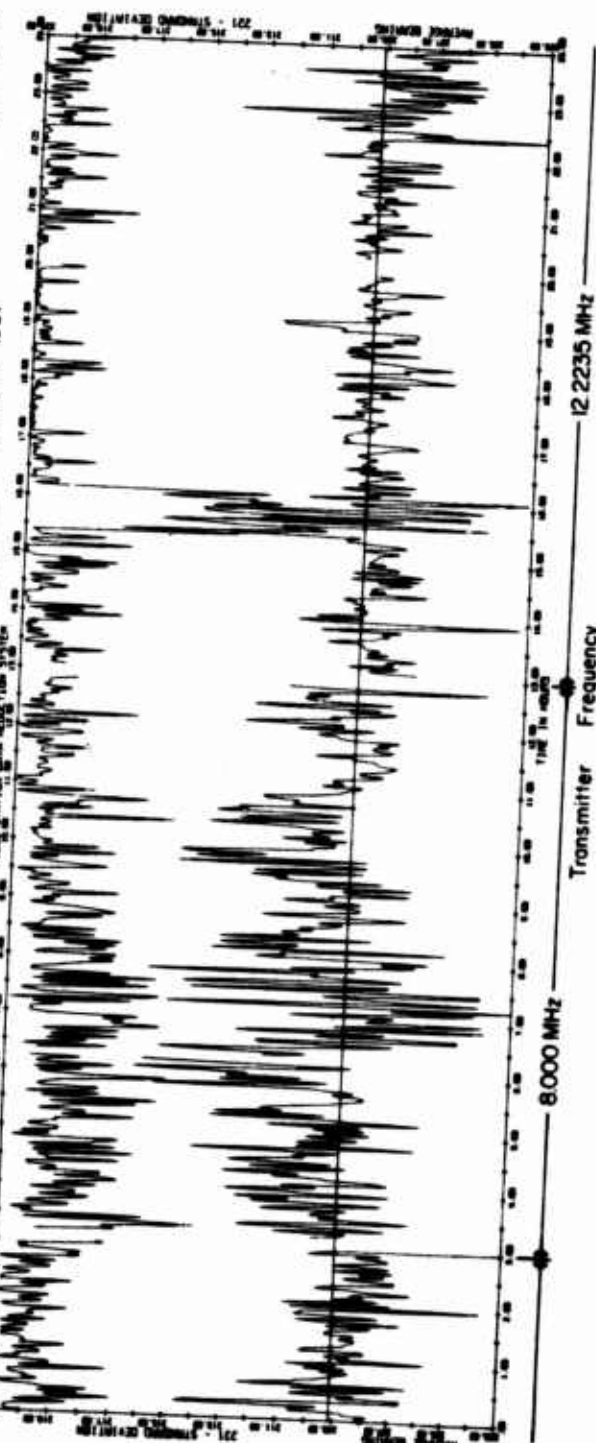
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
Points indicate possible modes of transmission at transmitter frequencies as shown. Path Length - 1332.78 km 18 JULY 1967

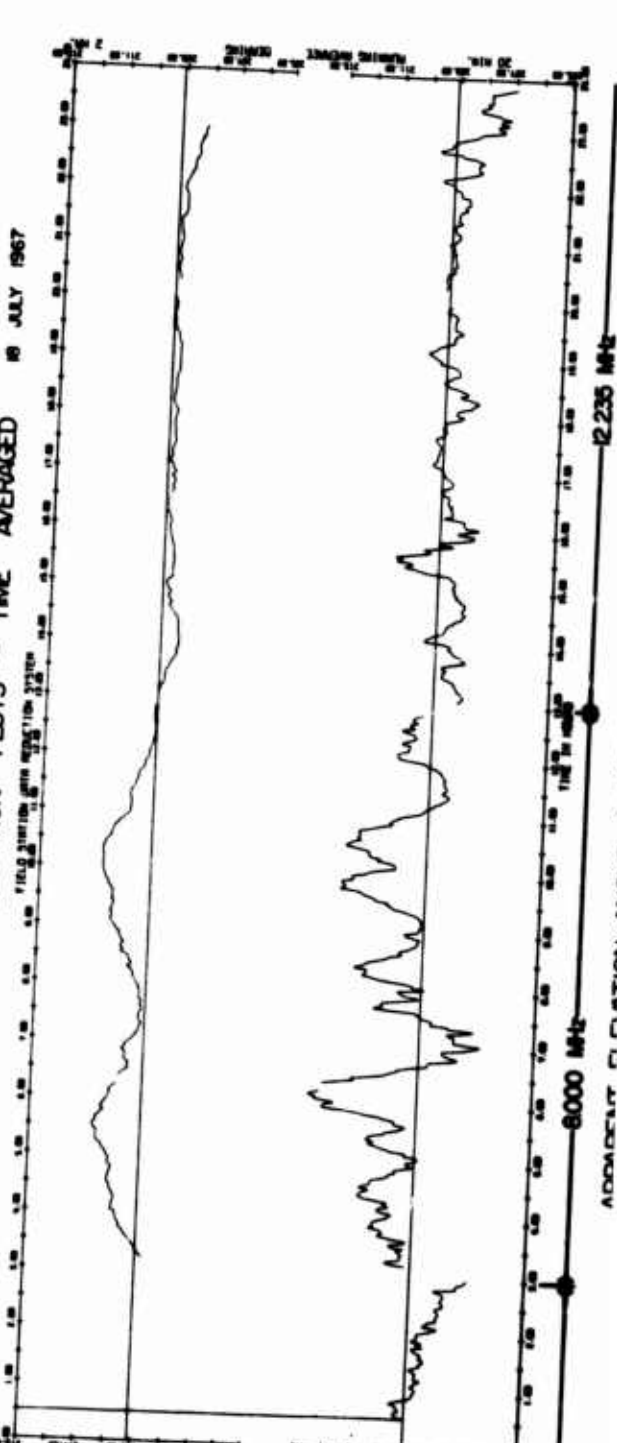


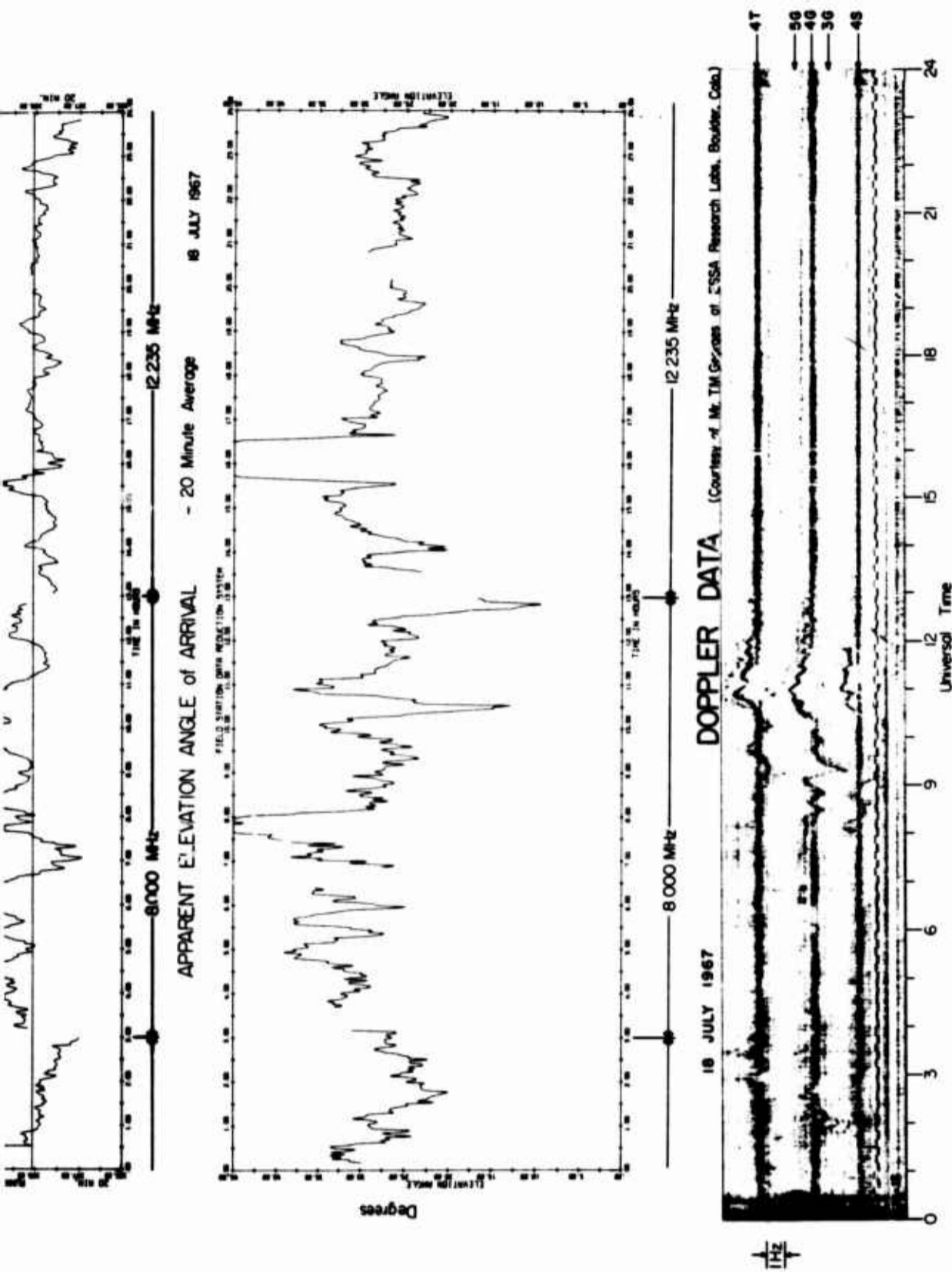
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min Intervals
Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Point Near Jackson, 34 8° N, 92.0° W
Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 18 JULY 1967



BEARING DEVIATION PLOTS - TIME AVERAGED





VERTICAL SOUNDER DATA

TK - TEXARKANA, Arkansas 33° N, 94° W GW - GREENWOOD, Mississippi 33° N, 90° W
 SP - SPRINGFIELD, Missouri 37° N, 93° W UI - URBANA, Illinois 40° N, 88° W
 PC - PONCA CITY, Oklahoma 37° N, 97° W JA - JACKSONVILLE, Arkansas 34° N, 92° W 18 JULY 1967

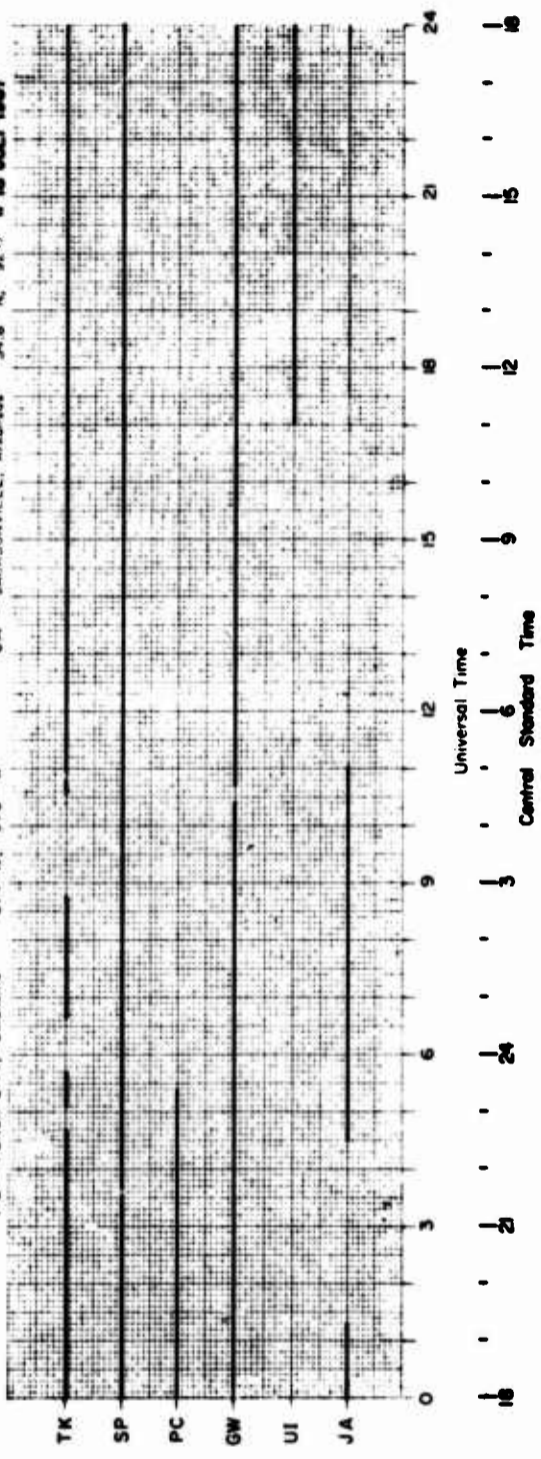
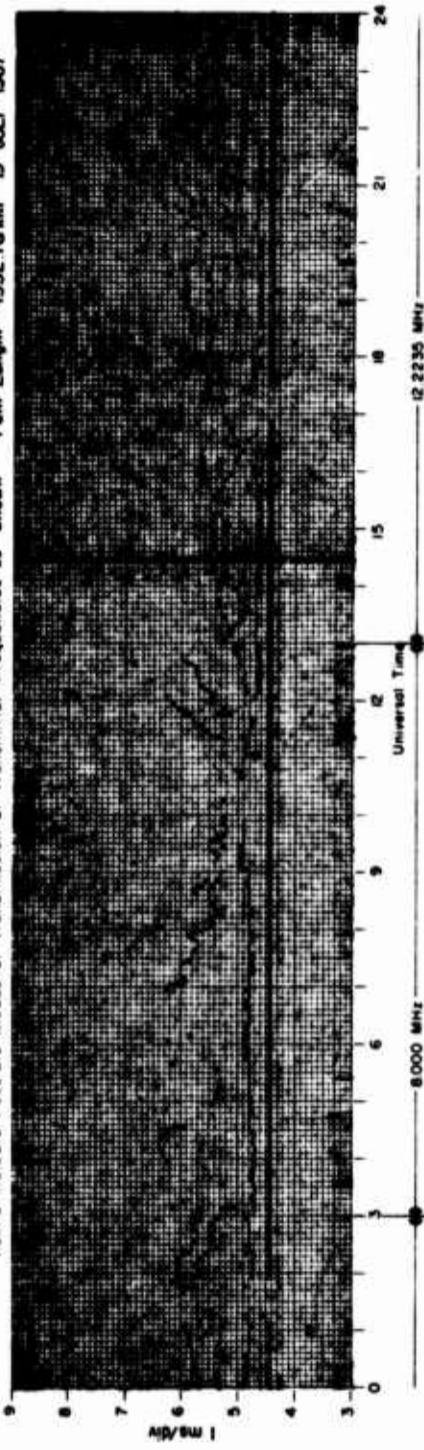


Plate 21.

18 July 1967

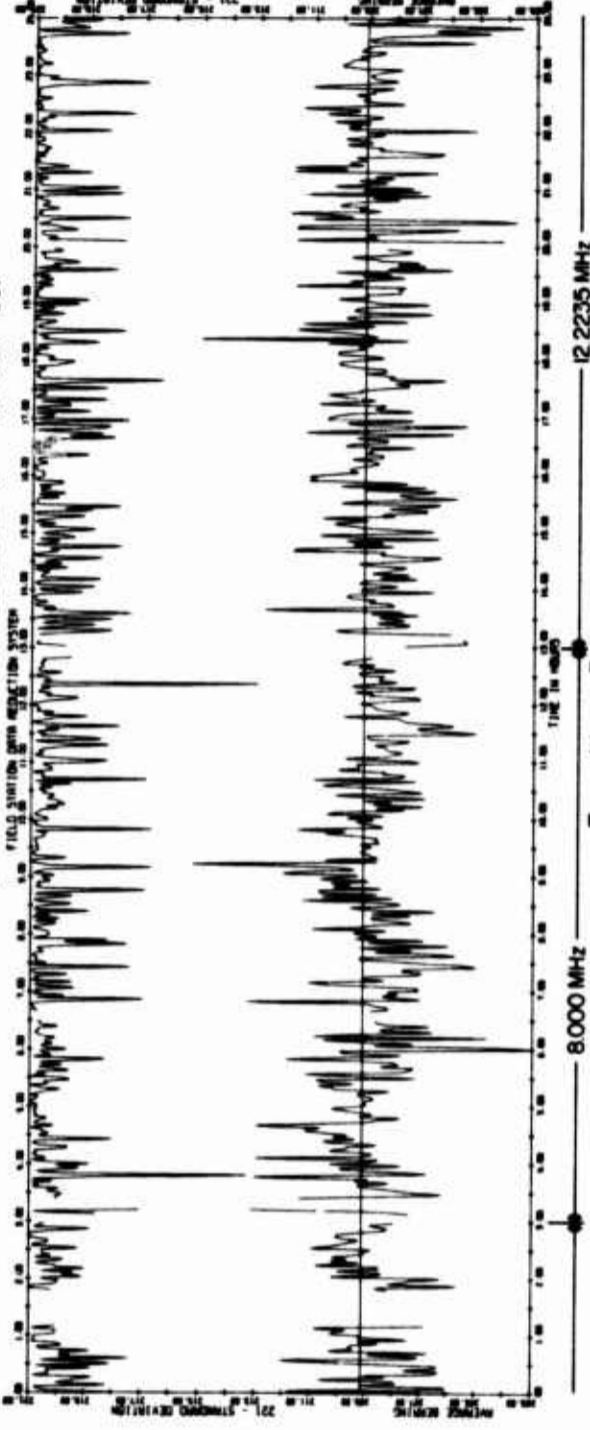
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 19 JULY 1967



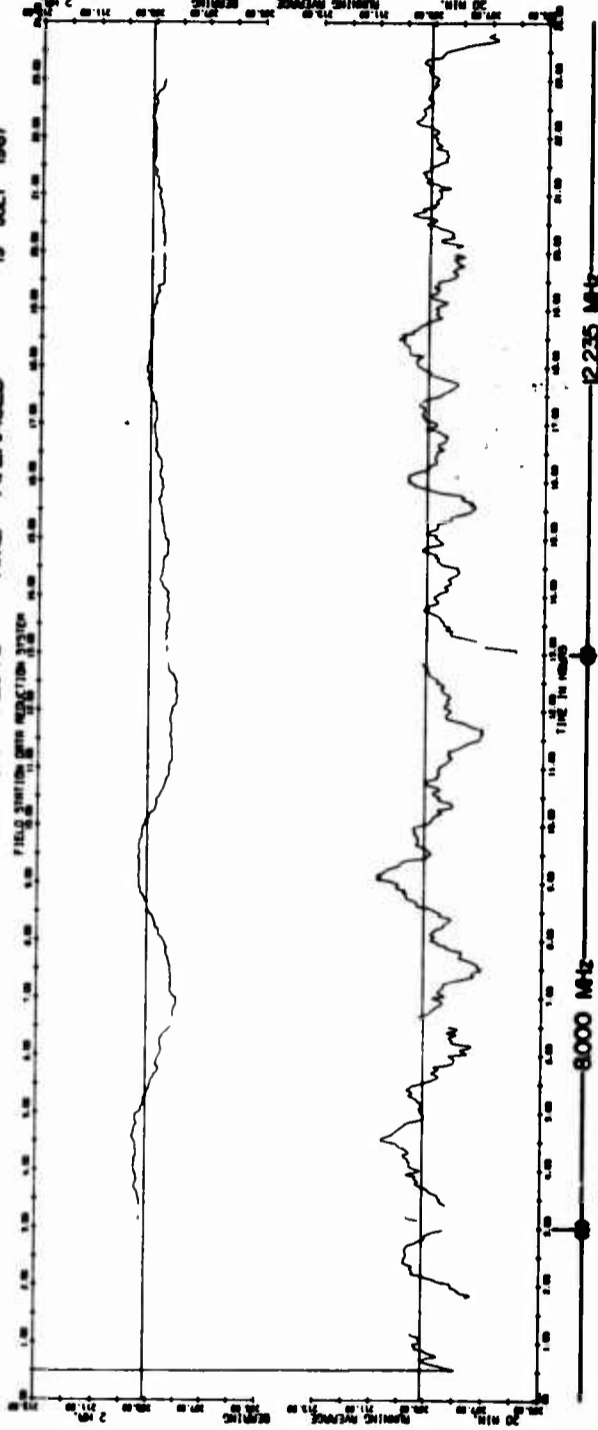
BEARING DEVIATION PLOT

Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34° 8' N, 92° 0' W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 19 JULY 1967



BEARING DEVIATION PLOTS - TIME AVERAGED

19 JULY 1967



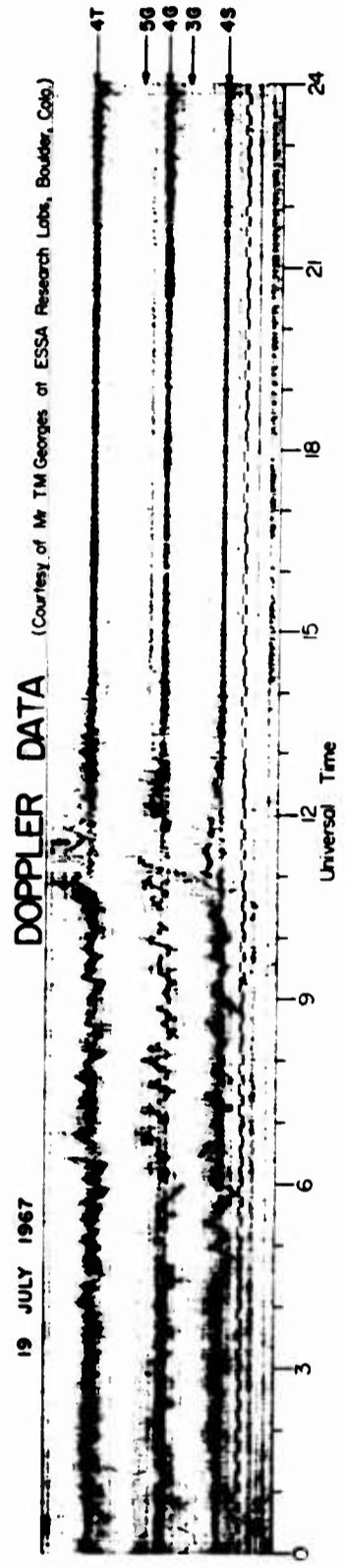
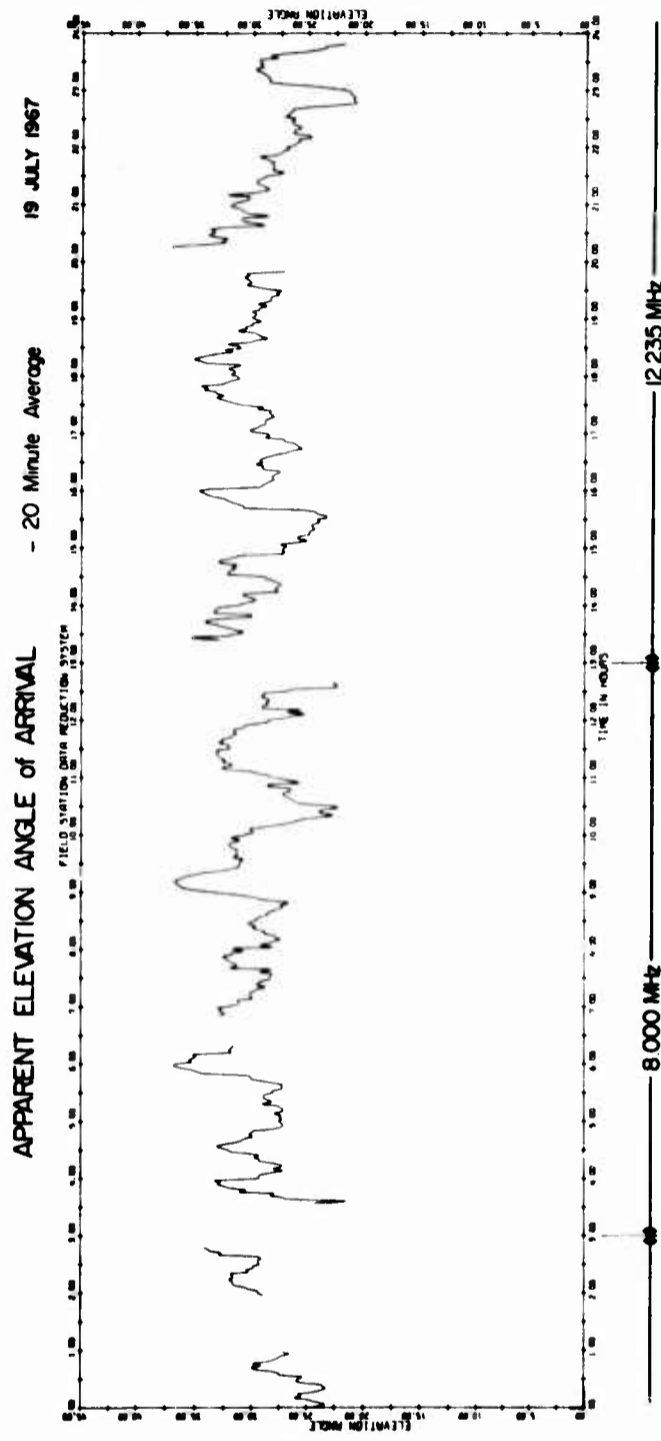
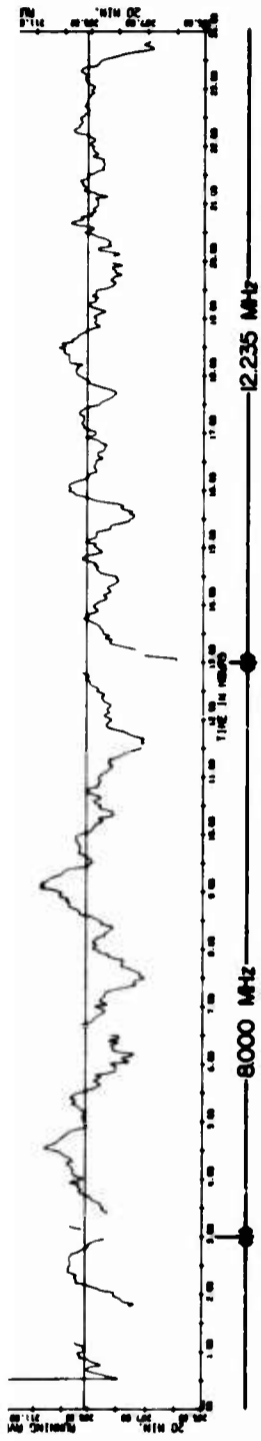
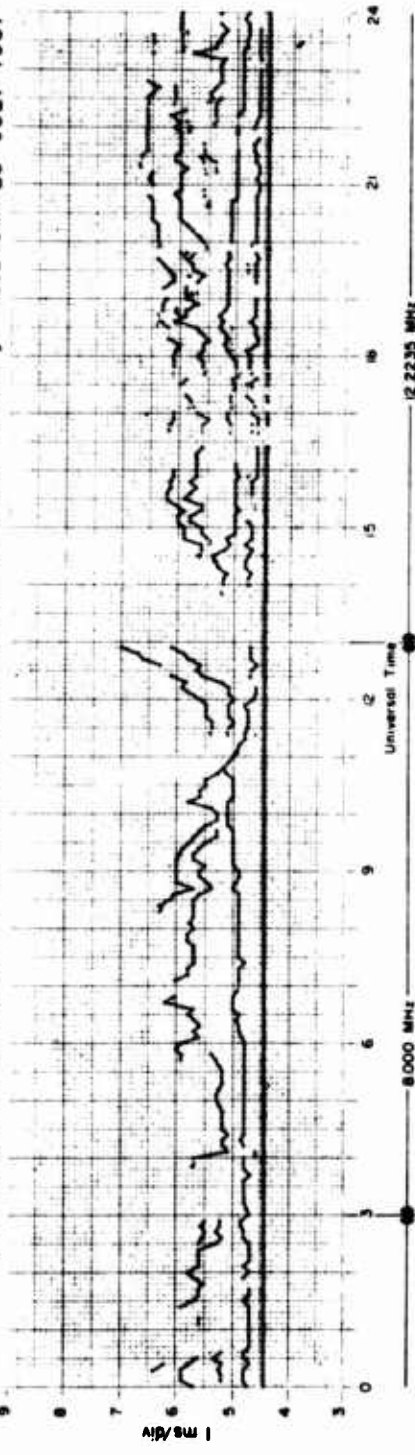


Plate 22.
 19 July 1967

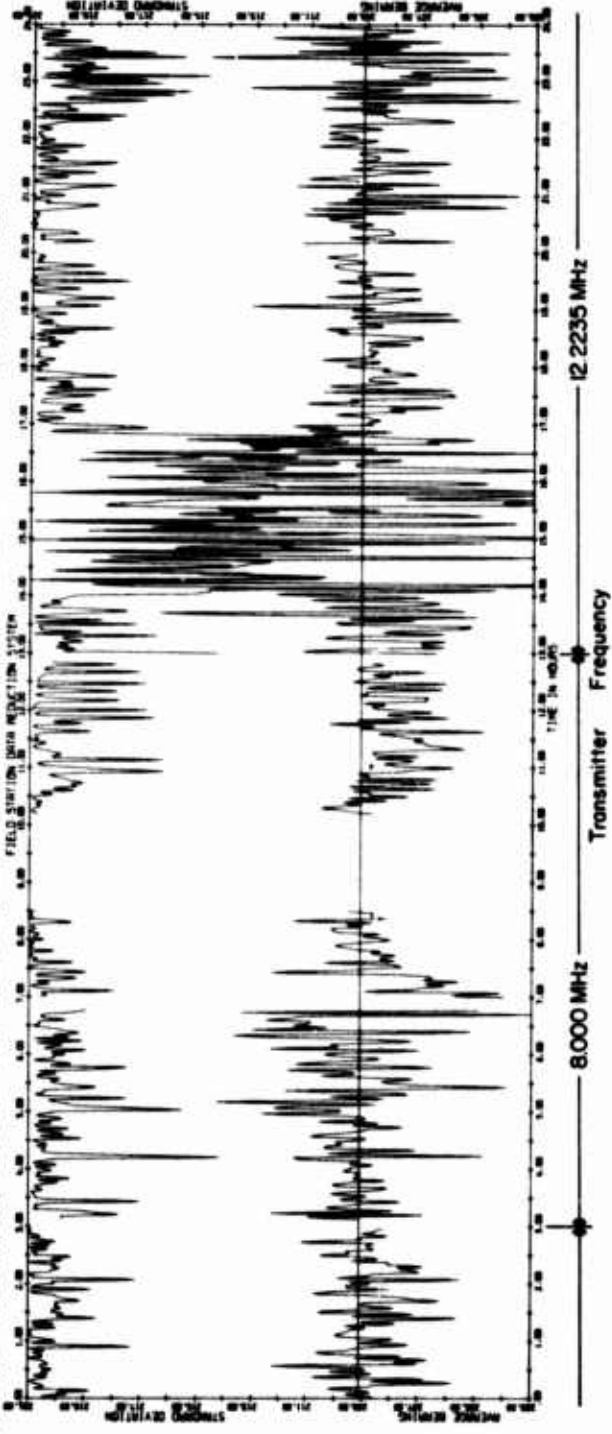
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 56" N, 88° 22' 50" W)
 Path Length - 1332.78 km 20 JULY 1967

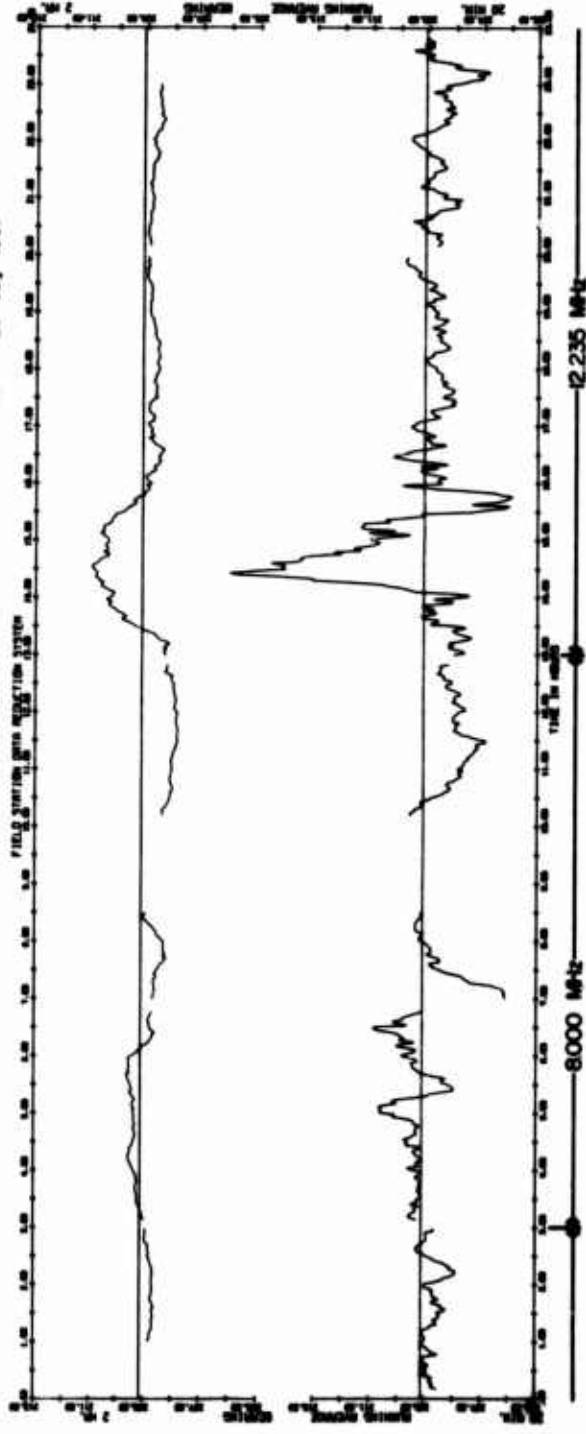


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 20 JULY 1967

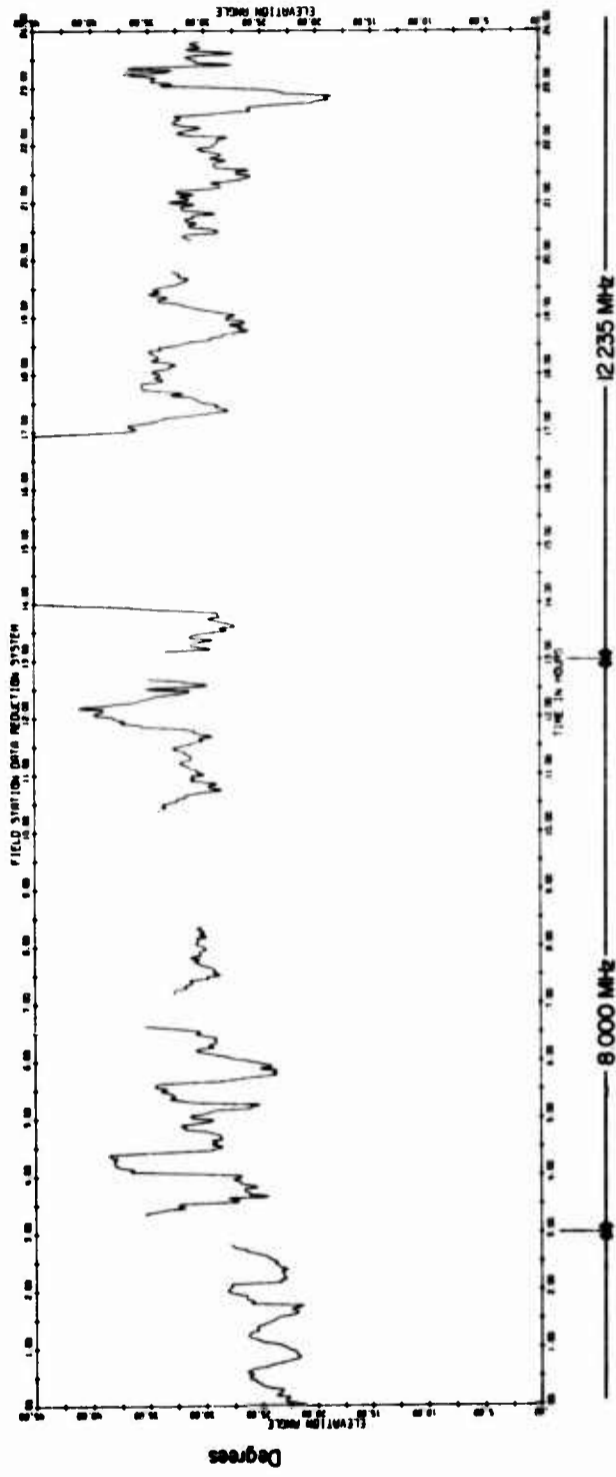


BEARING DEVIATION PLOTS - TIME AVERAGED 20 July 1967

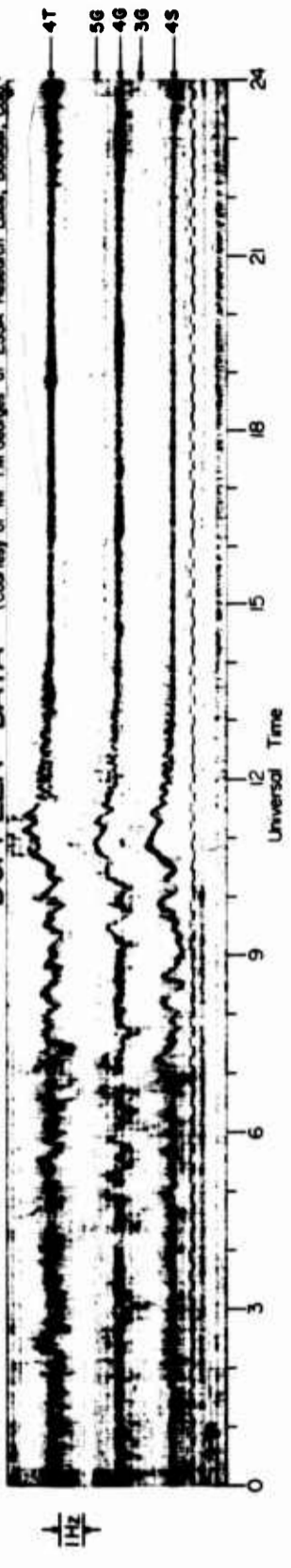




APPARENT ELEVATION ANGLE OF ARRIVAL - 20 Minute Average - 20 JULY 1967



20 JULY 1967 DOPPLER DATA (Courtesy of Mr TM Georges at ESSA Research Labs, Boulder, Colo.)



VERTICAL SOUNDER DATA

TK - TEXARKANA, Arkansas 33.5° N, 94.0° W GW - GREENWOOD, Mississippi 33.5° N, 90.1° W
 SP - SPRINGFIELD, Missouri 37.1° N, 93.2° W UI - URBANA, Illinois 40.0° N, 88.3° W
 PC - PONCA CITY, Oklahoma 37.4° N, 97.0° W JA - JACKSONVILLE, Arkansas 34.8° N, 92.0° W 20 JULY 1967

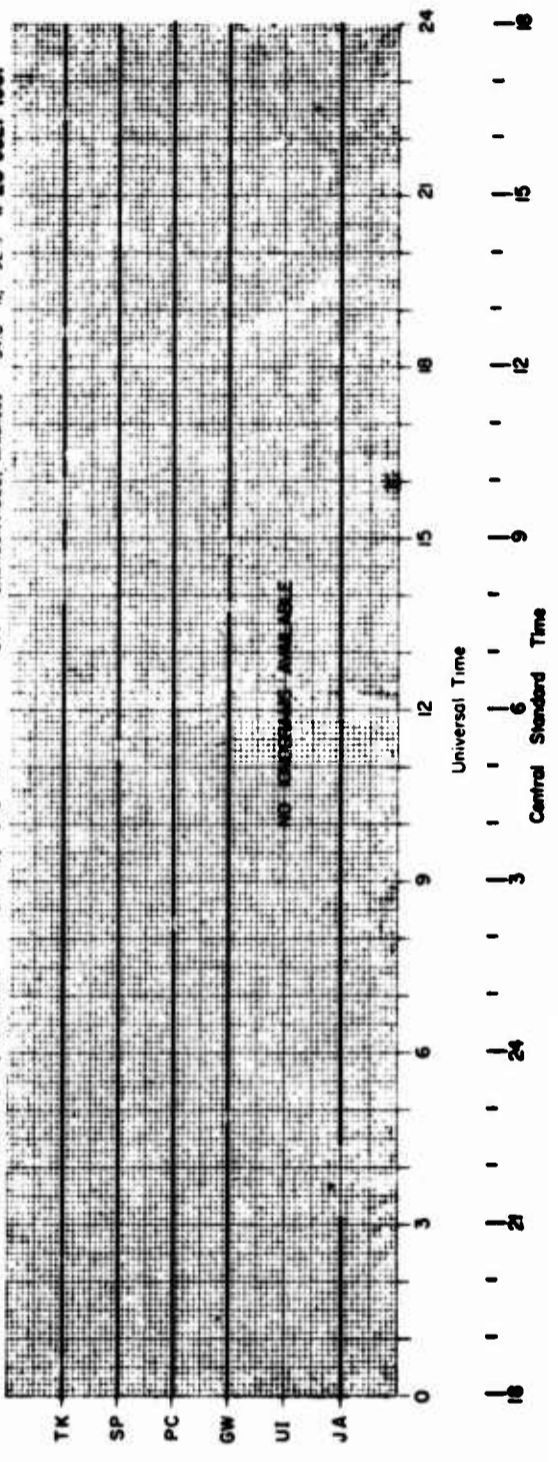
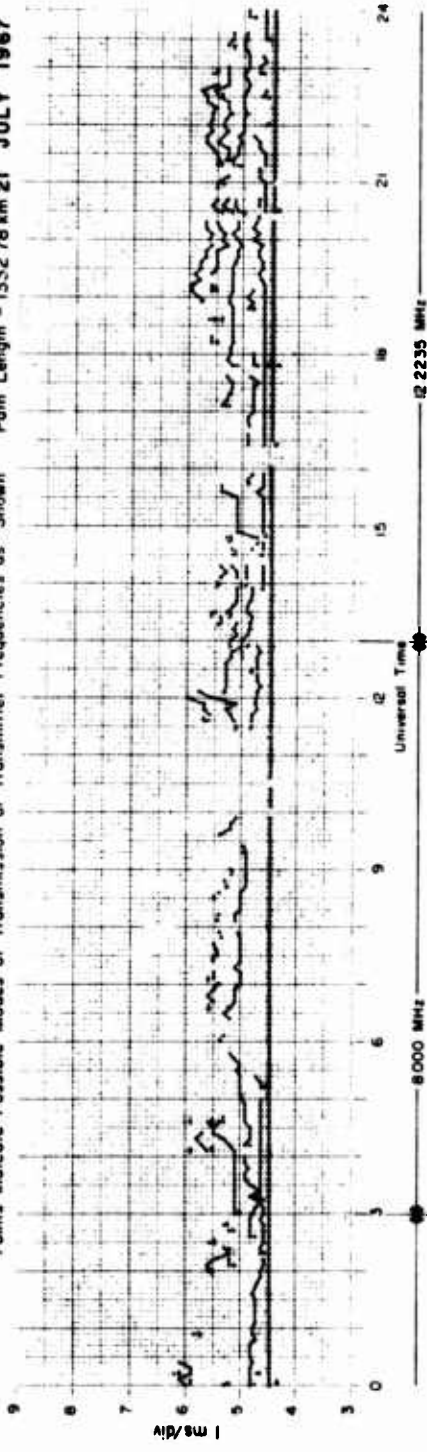


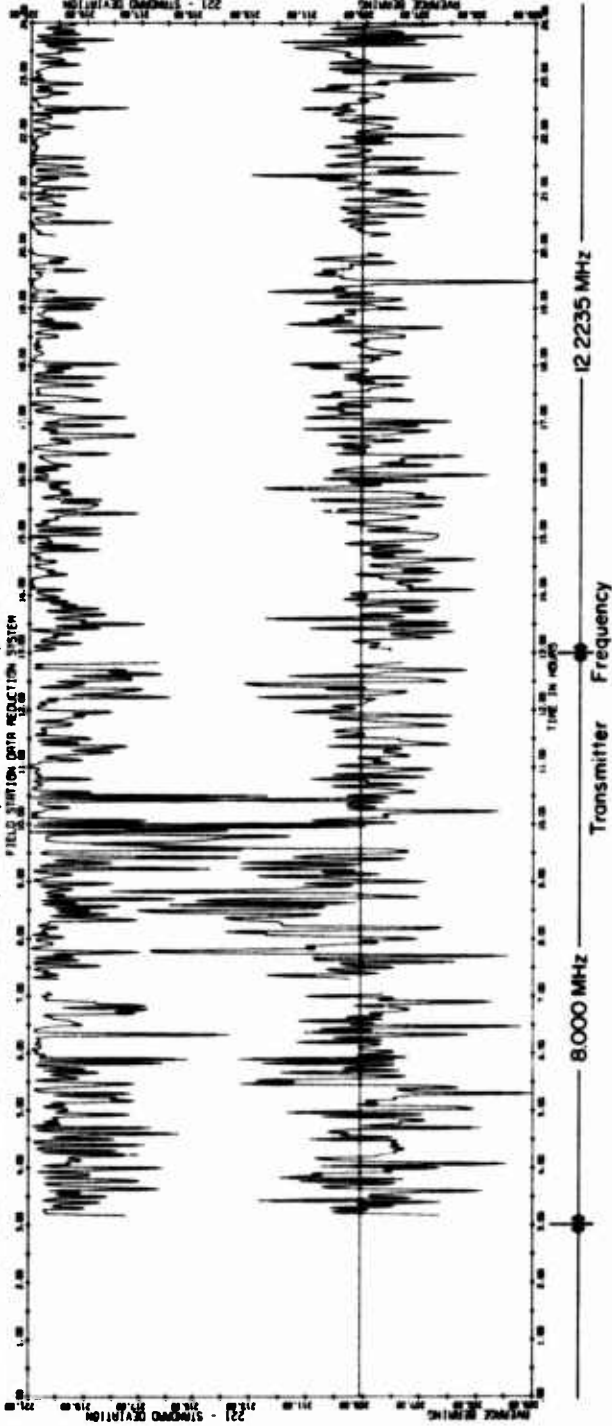
Plate 23.
20 July 1967

OBLIQUE IONOGRAM DATA

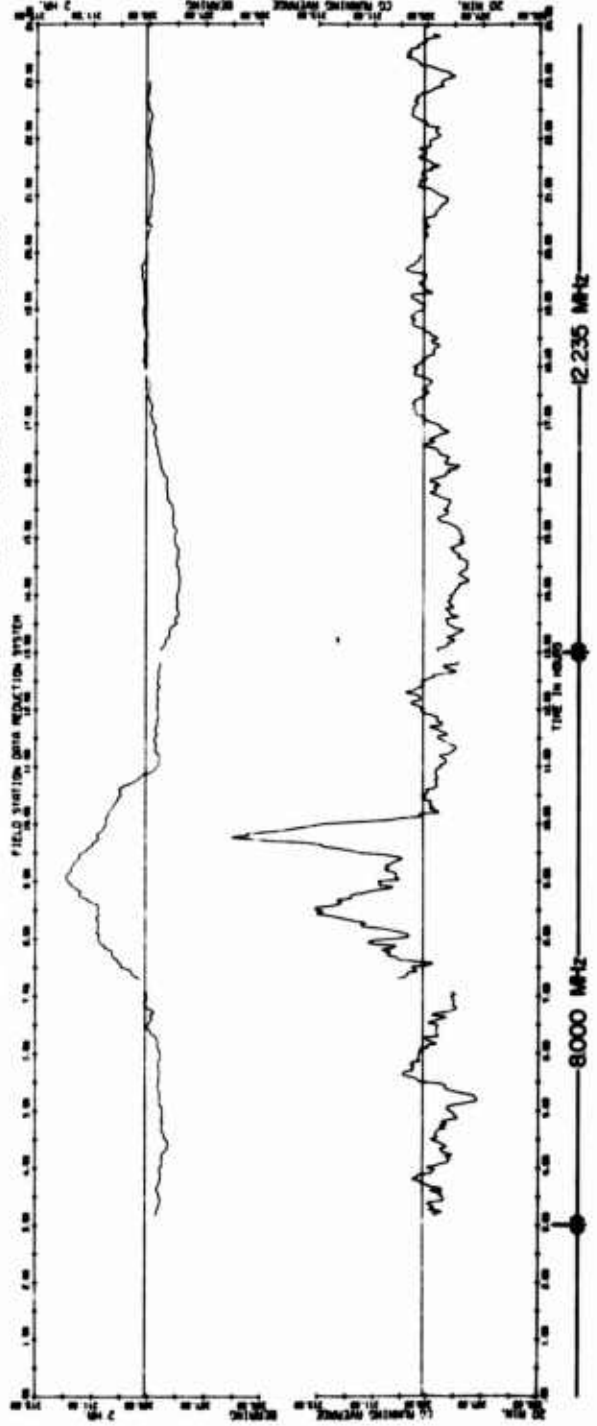
Comp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 21 JULY 1967

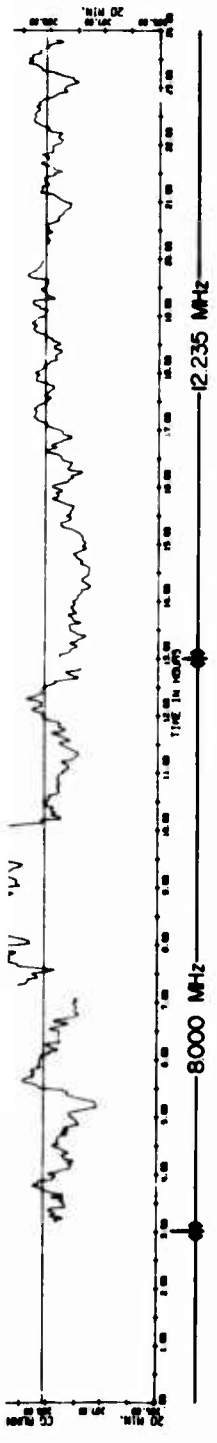


BEARING DEVIATION PLOT 21 July 1967
 Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W

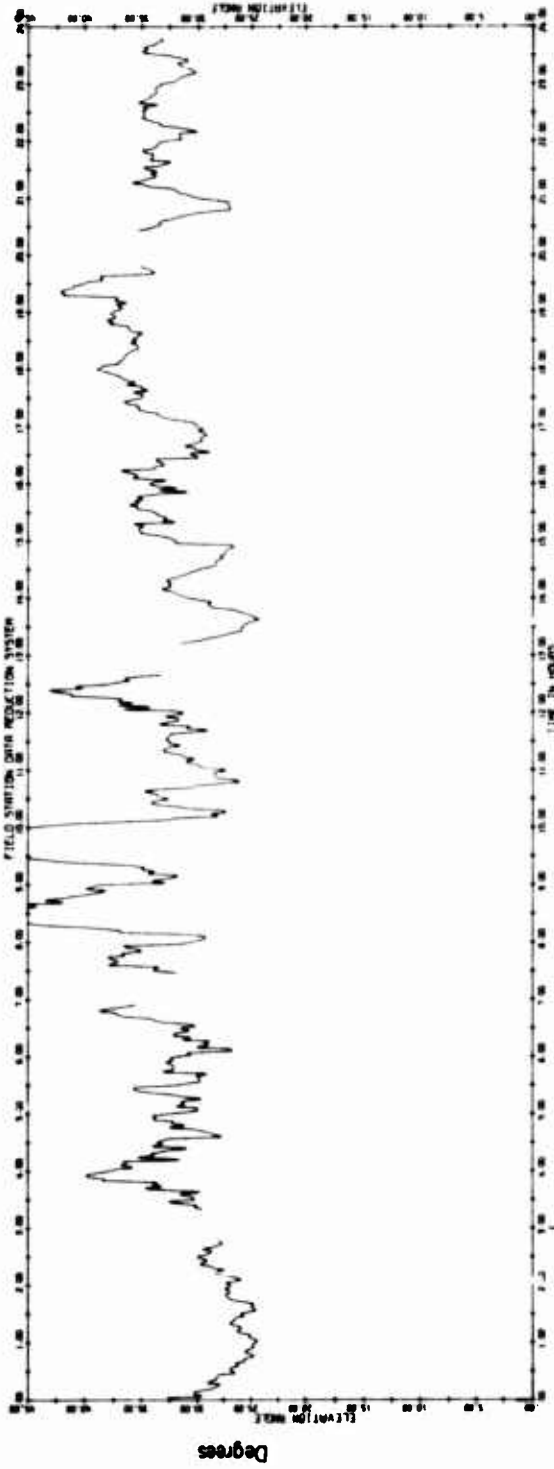


BEARING DEVIATION PLOTS - TIME AVERAGED 21 July 1967

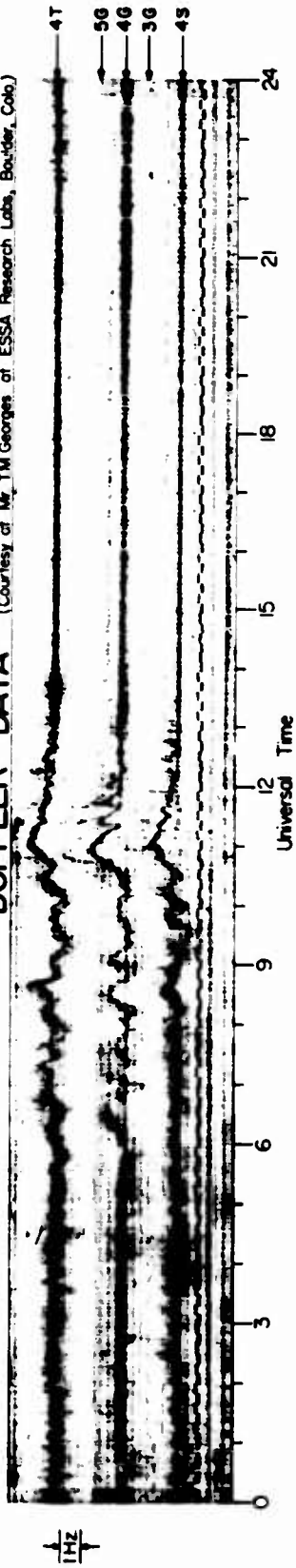




APPARENT ELEVATION ANGLE OF ARRIVAL - 20 Minute Average 21 JULY 1967



21 JULY 1967 DOPPLER DATA (Courtesy of Mr. Tom Georges of ESSA Research Labs, Boulder, Colo.)



VERTICAL SOUNDER DATA

TK - TEXARKANA, Arkansas 33.3° N, 94.0° W GW - GREENWOOD, Mississippi 33.3° N, 90.1° W
 SP - SPRINGFIELD, Missouri 37.1° N, 93.2° W UI - URBANA, Illinois 40.0° N, 88.3° W
 PC - PONCA CITY, Oklahoma 37.6° N, 97.0° W JA - JACKSONVILLE, Arkansas 34.8° N, 92.0° W 21 JULY 1967

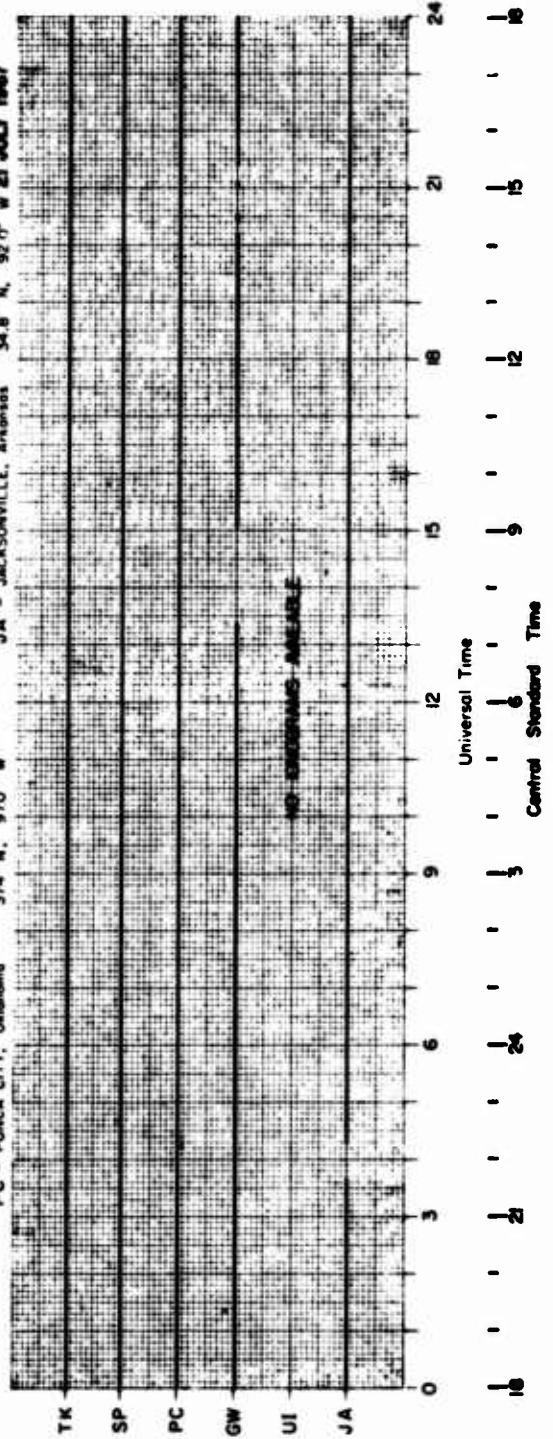


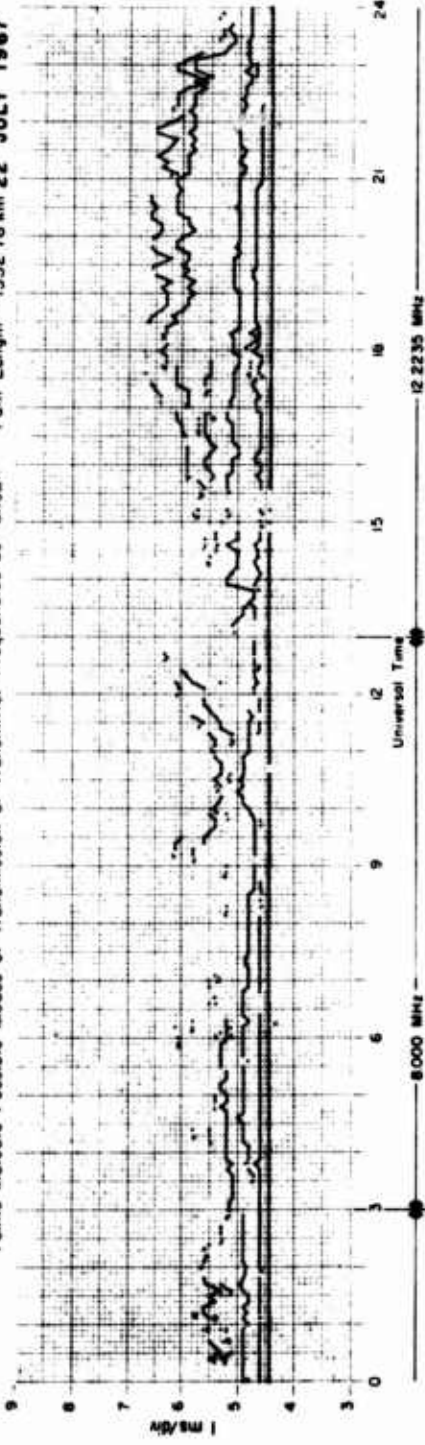
Plate 24.

21 July 1967



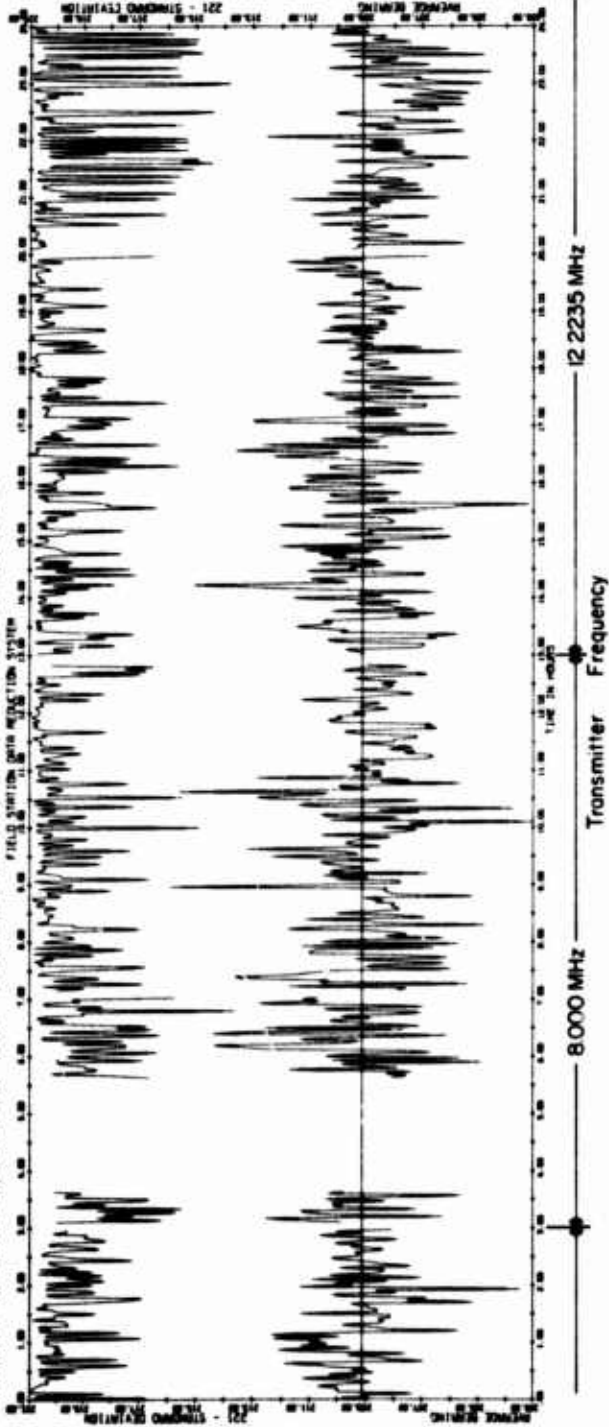
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 56" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 22 JULY 1967

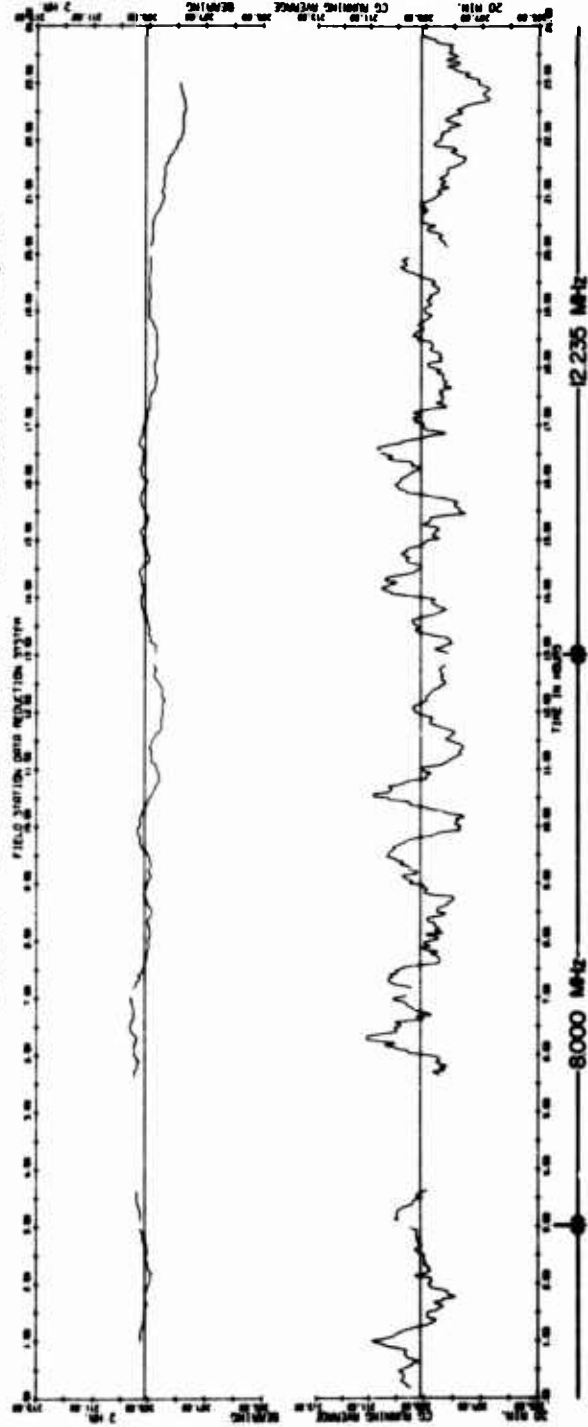


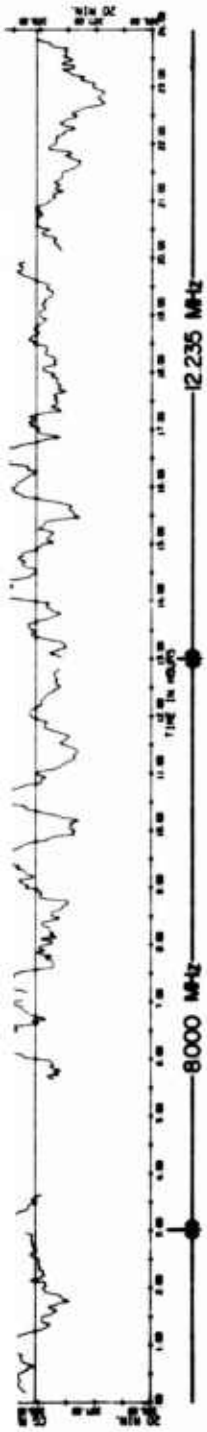
BEARING DEVIATION PLOT 22 July 1967

Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W

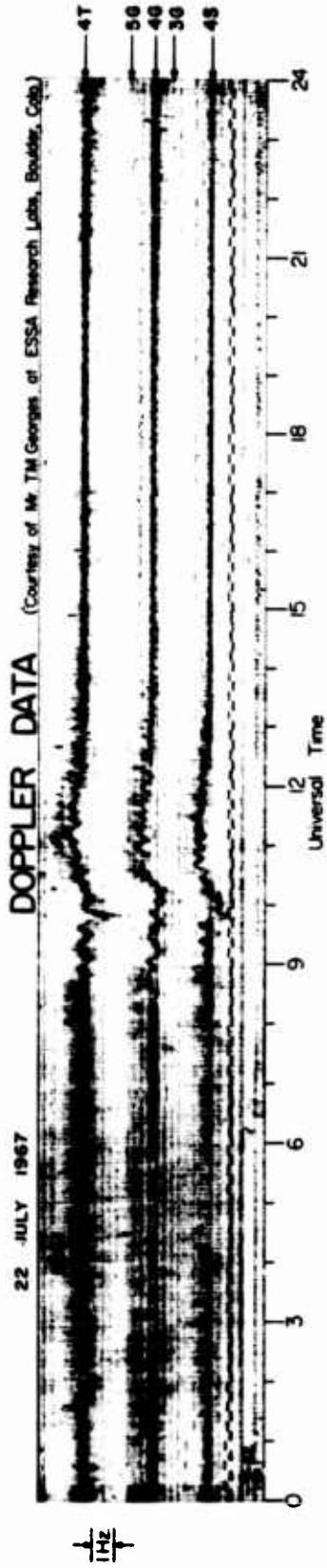
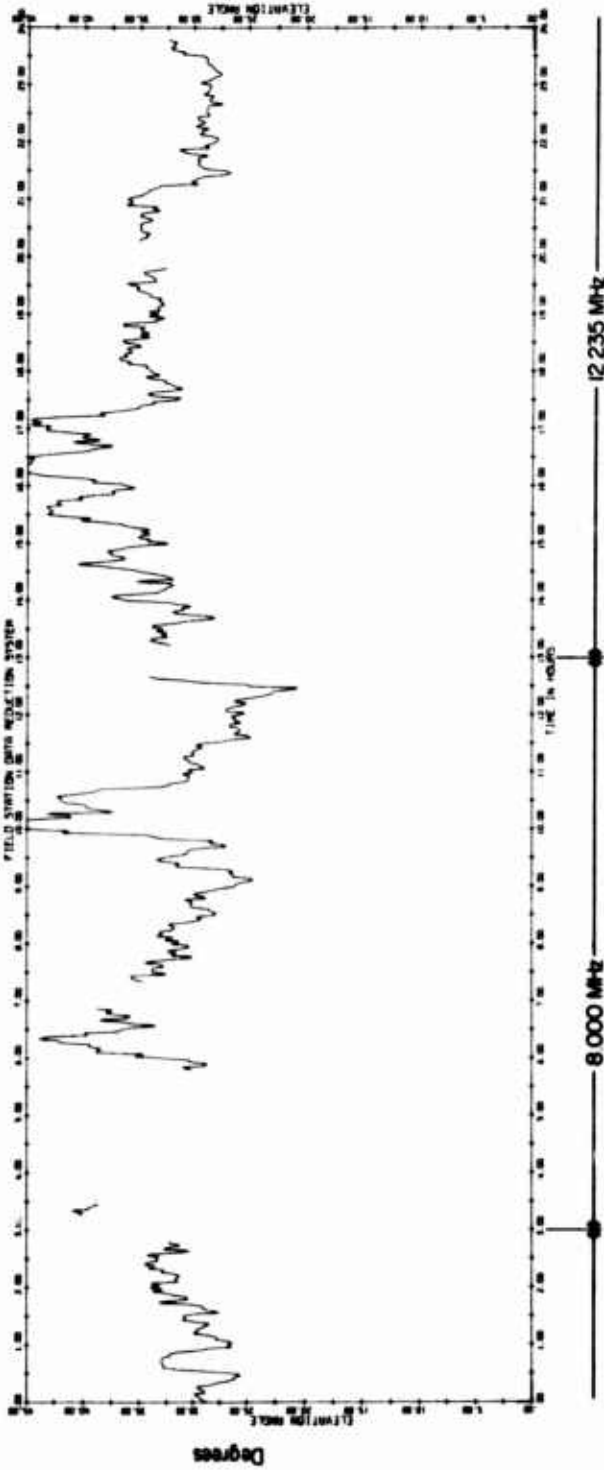


BEARING DEVIATION PLOTS - TIME AVERAGED 22 July 1967





APPARENT ELEVATION ANGLE OF ARRIVAL - 20 Minute Average 22 JULY 1967



VERTICAL SOUNDER DATA

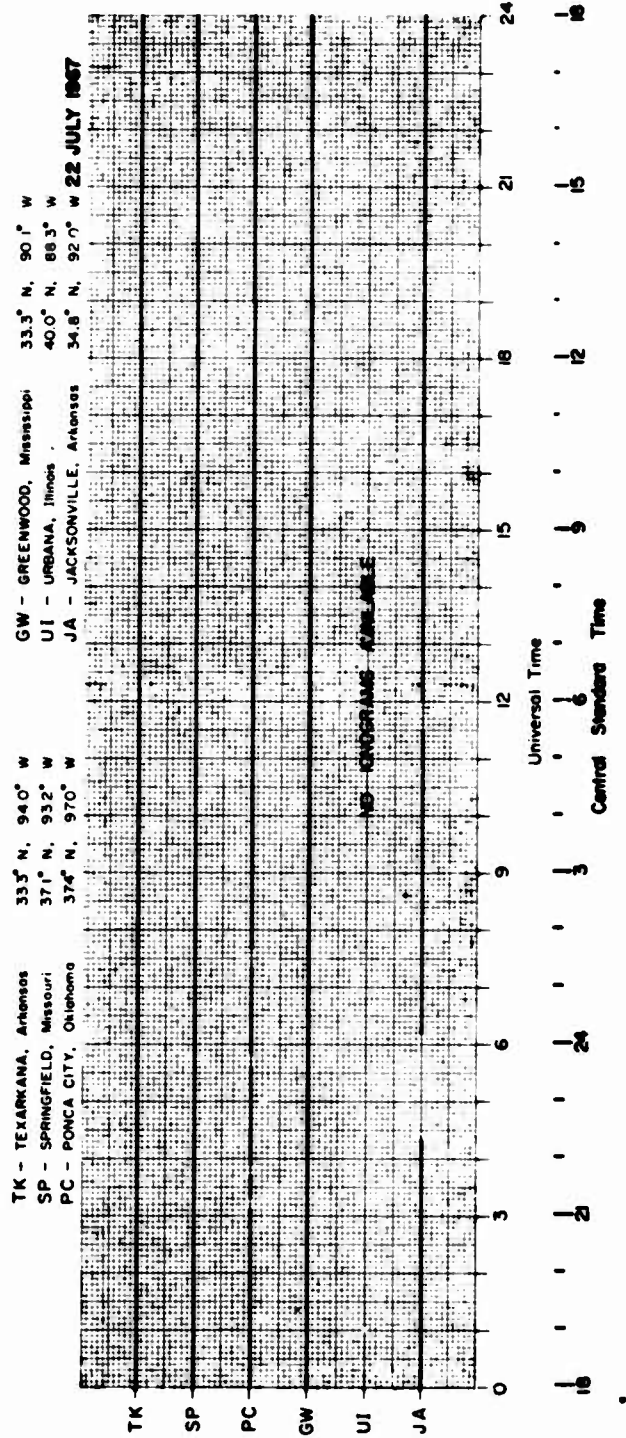
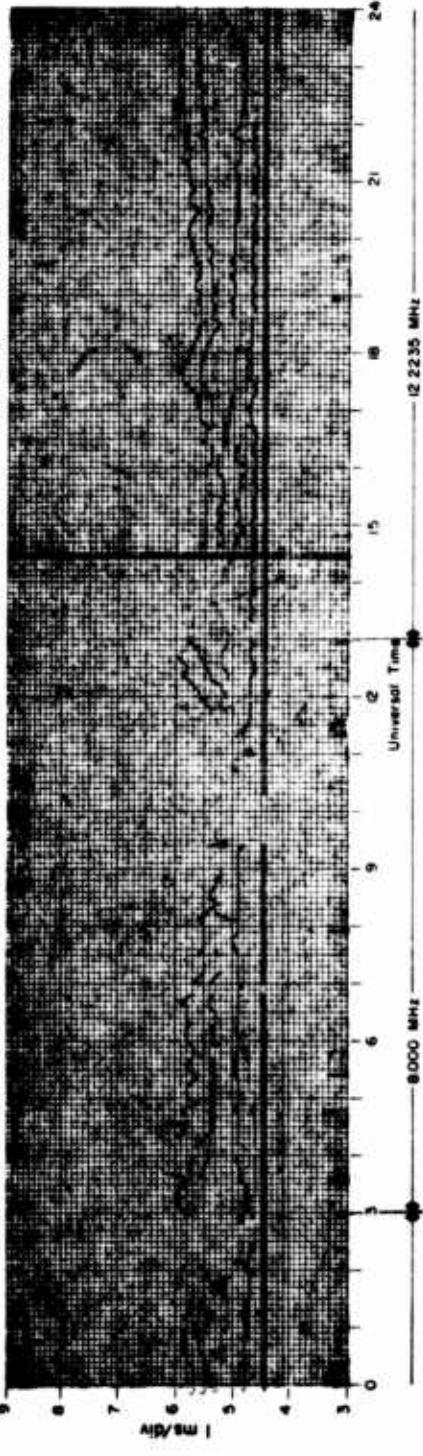


Plate 25.

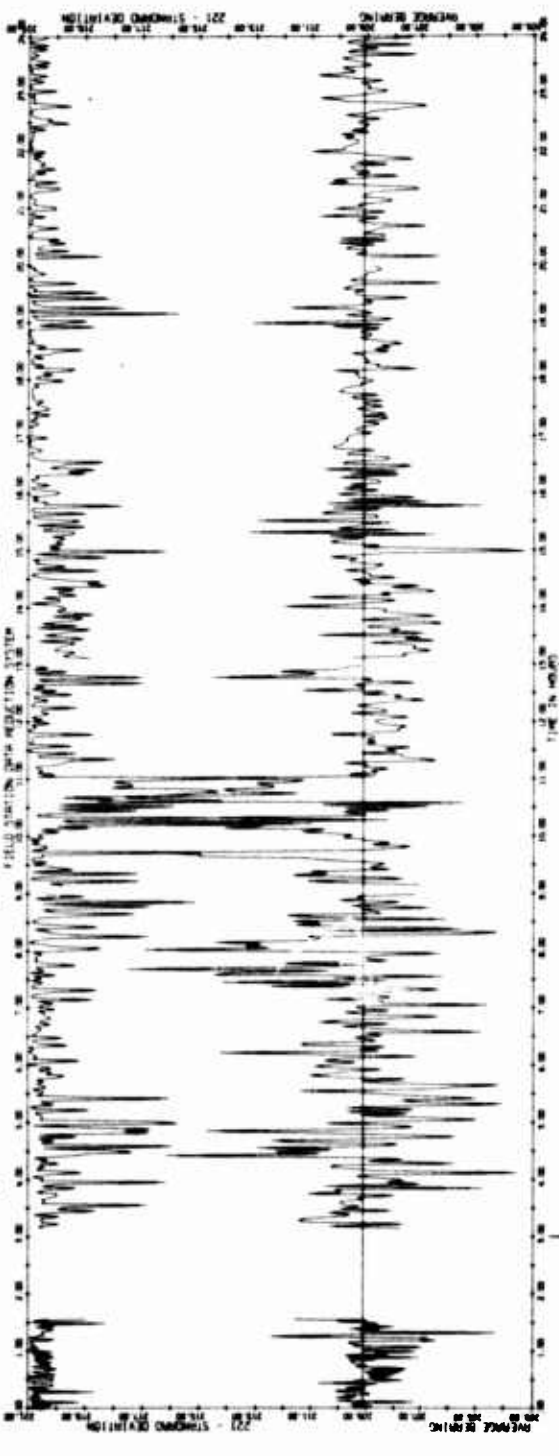
22 July 1967

OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate possible modes of transmission at transmitter frequencies as shown Path Length - 1332.78 km 6 AUGUST 1967

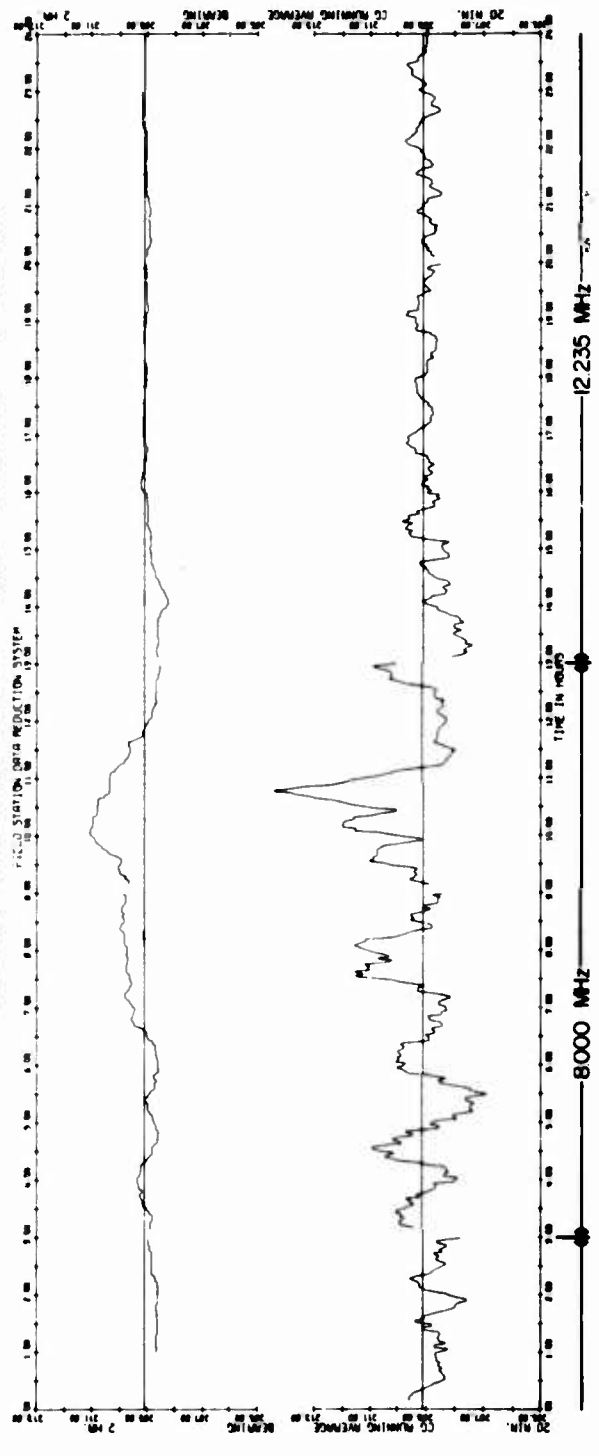


BEARING DEVIATION PLOT 15 August 1967
 Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W

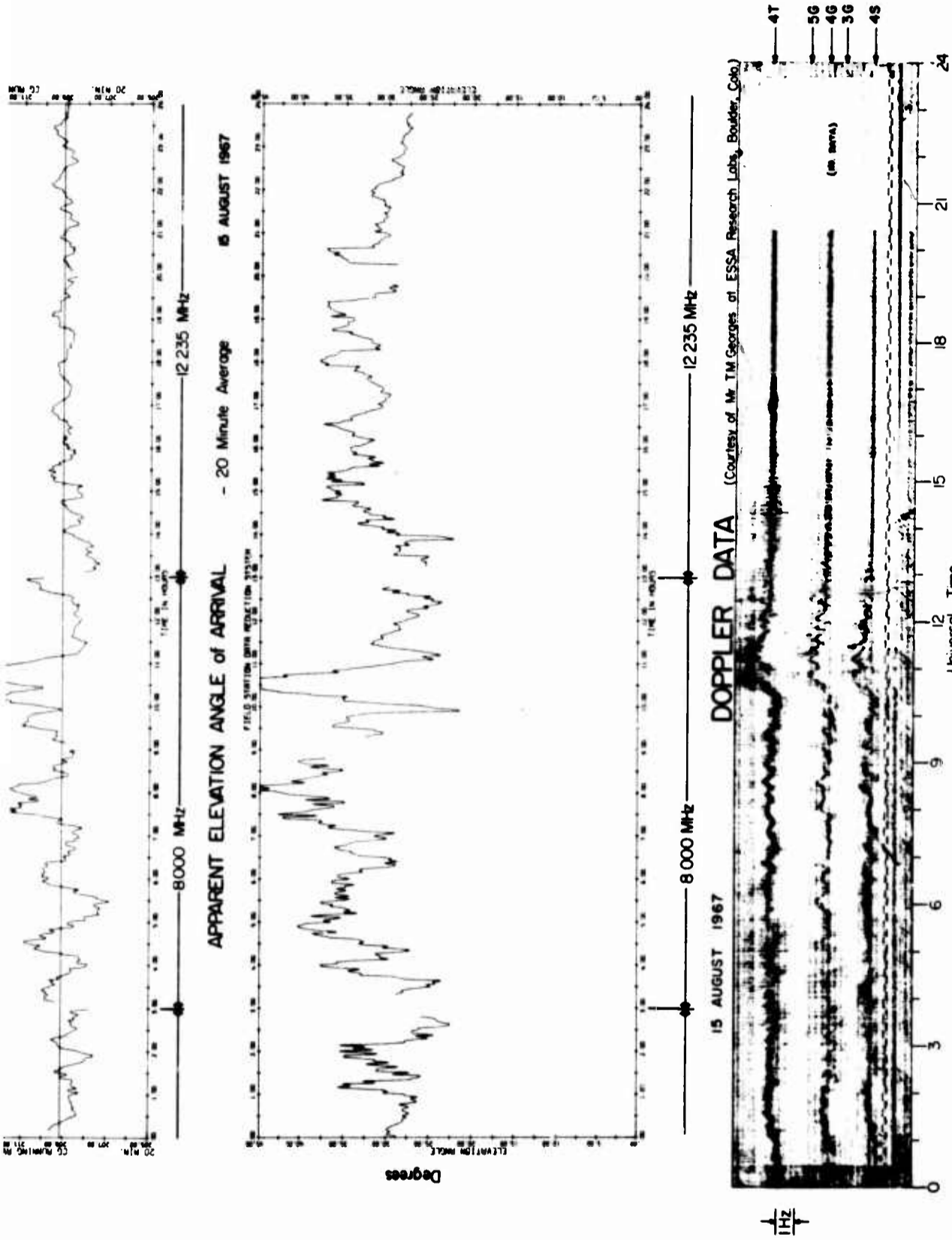


8.000 MHz Transmitter Frequency 12.235 MHz

BEARING DEVIATION PLOTS - TIME AVERAGED 6 August 1967



8.000 MHz Transmitter Frequency 12.235 MHz



VERTICAL SOUNDER DATA

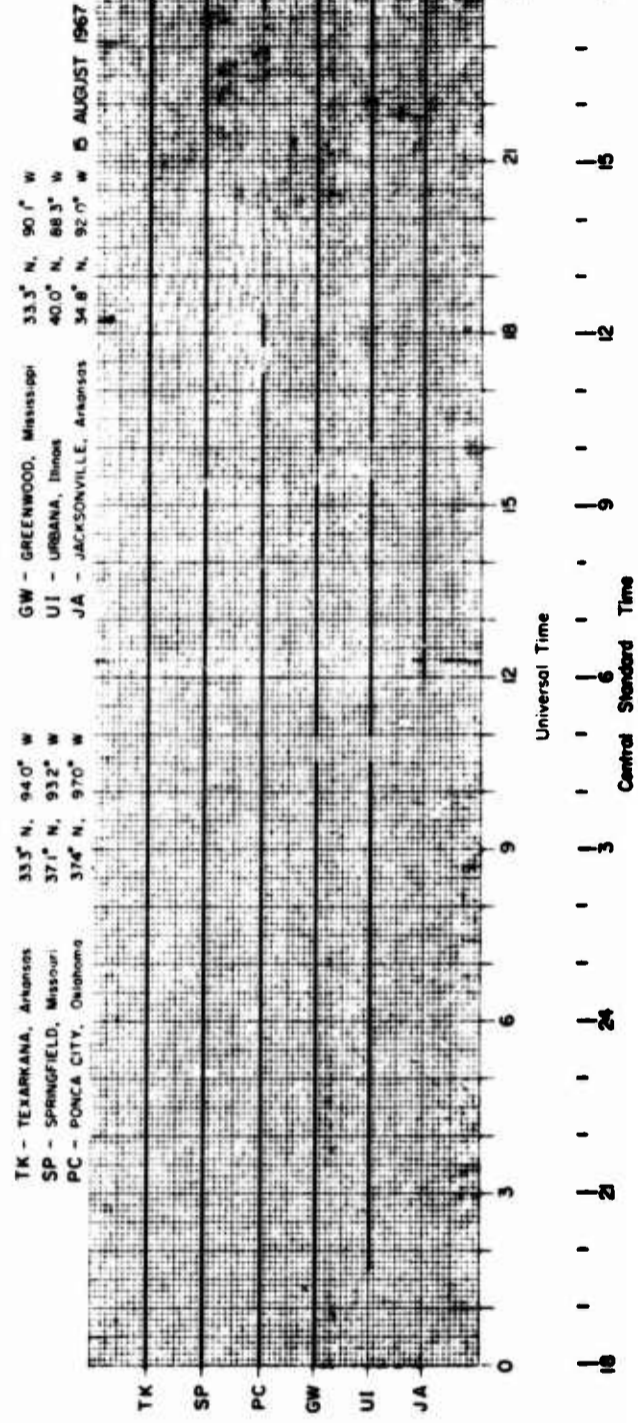
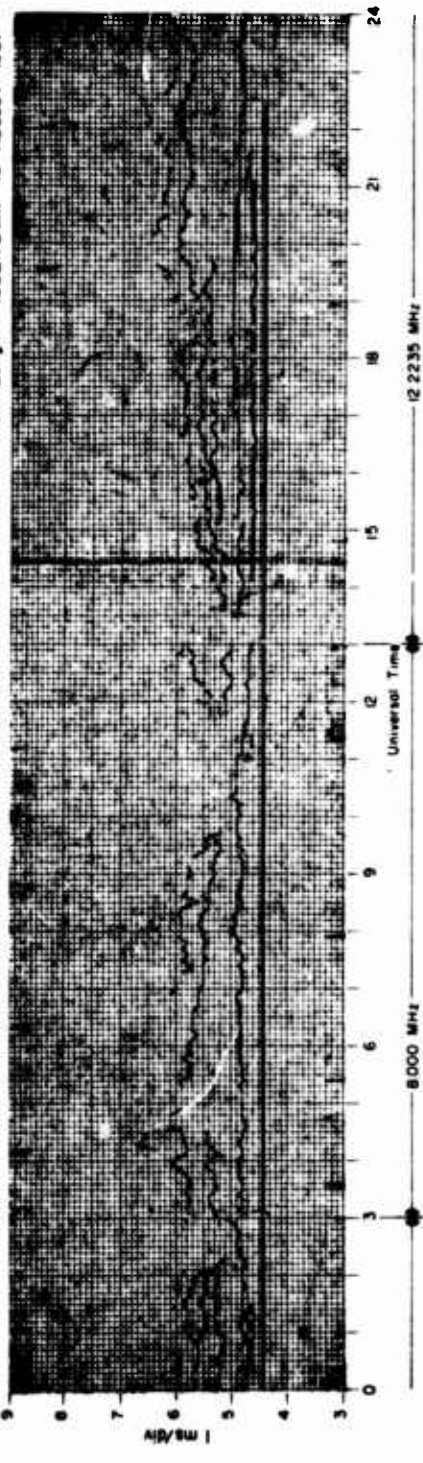


Plate 26.

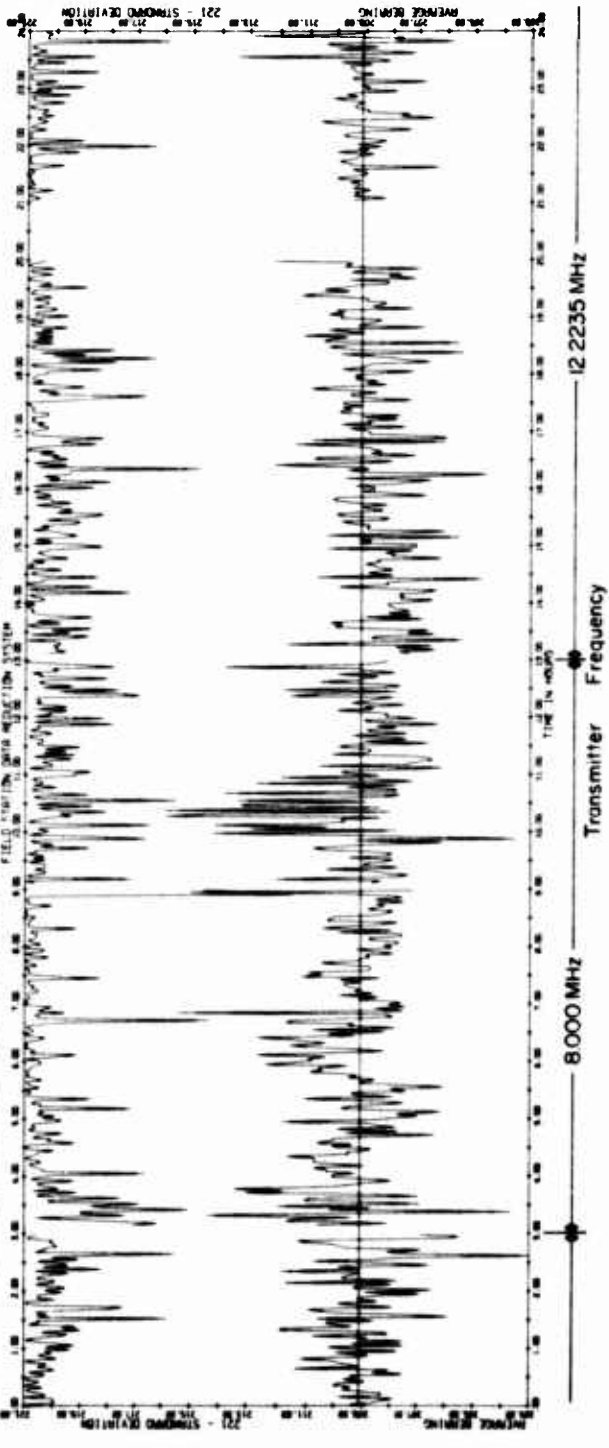
15 August 1967

OBLIQUE IONOGRAM DATA

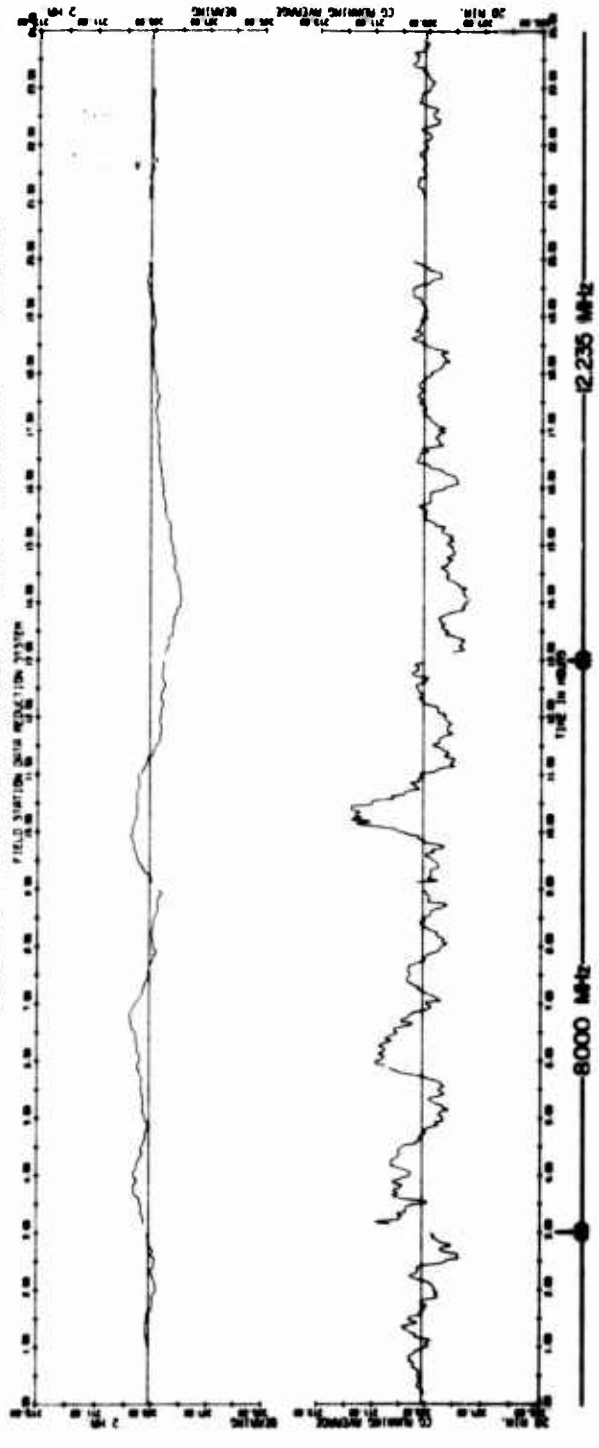
Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 16 AUGUST 1967

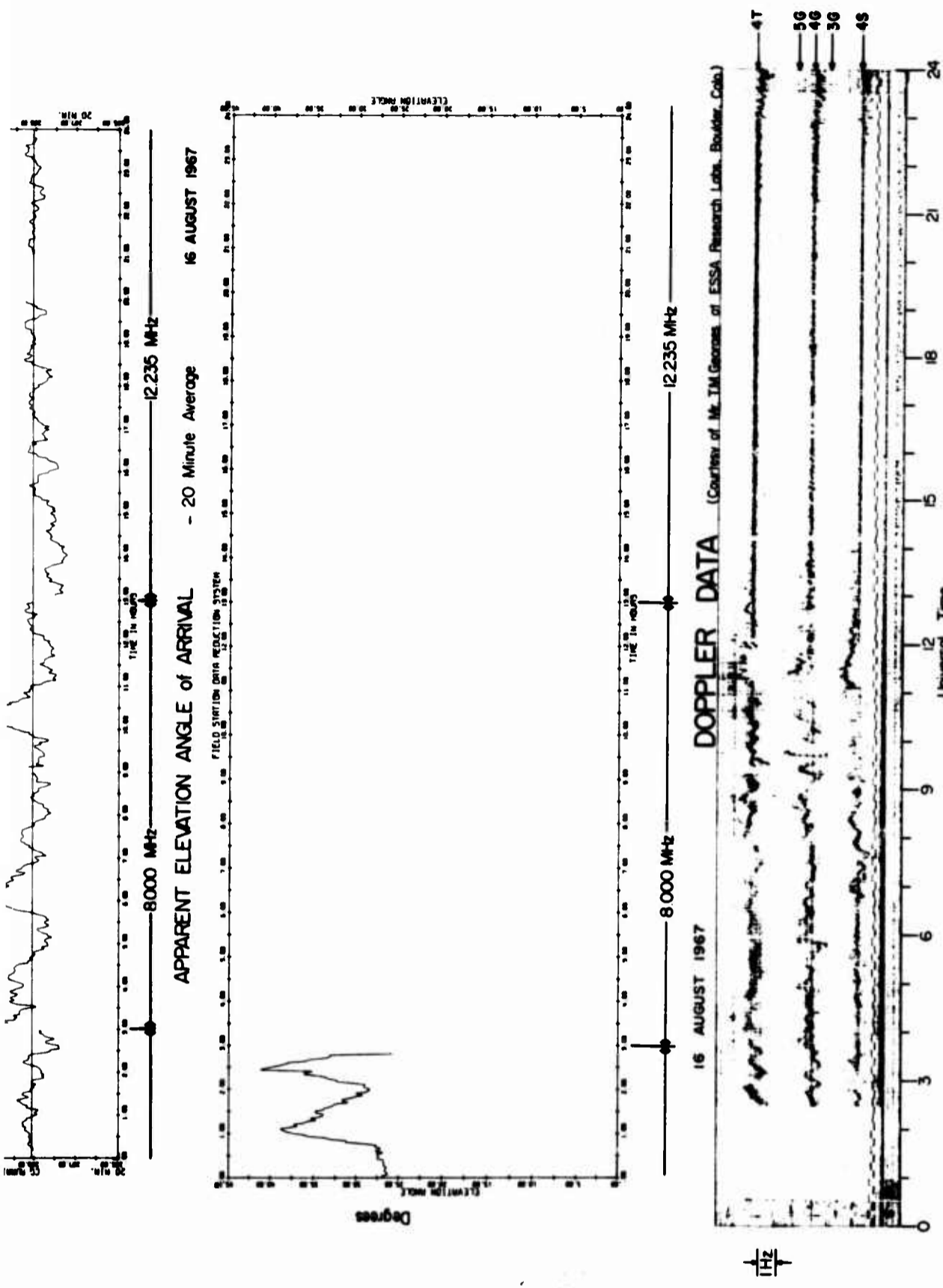


BEARING DEVIATION PLOT 16 August 1967
 Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min Intervals
 Antenna of Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34 8° N, 92 0° W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W



BEARING DEVIATION PLOTS - TIME AVERAGED 16 August 1967





TK - TEXARKANA, Arkansas	33.5° N, 94.0° W	GW - GREENWOOD, Mississippi	33.3° N, 90.1° W
SP - SPRINGFIELD, Missouri	37.1° N, 93.2° W	UI - URBANA, Illinois	40.0° N, 88.3° W
PC - PONCA CITY, Oklahoma	37.4° N, 97.0° W	JA - JACKSONVILLE, Arkansas	34.8° N, 92.0° W

16 AUGUST 1967

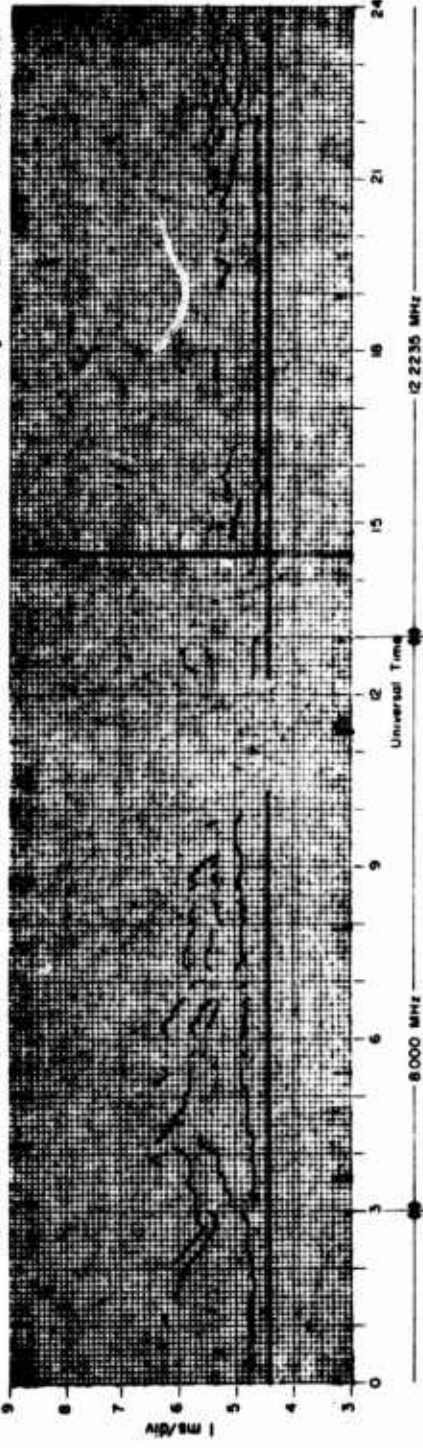
Plate 27.

16 August 1967



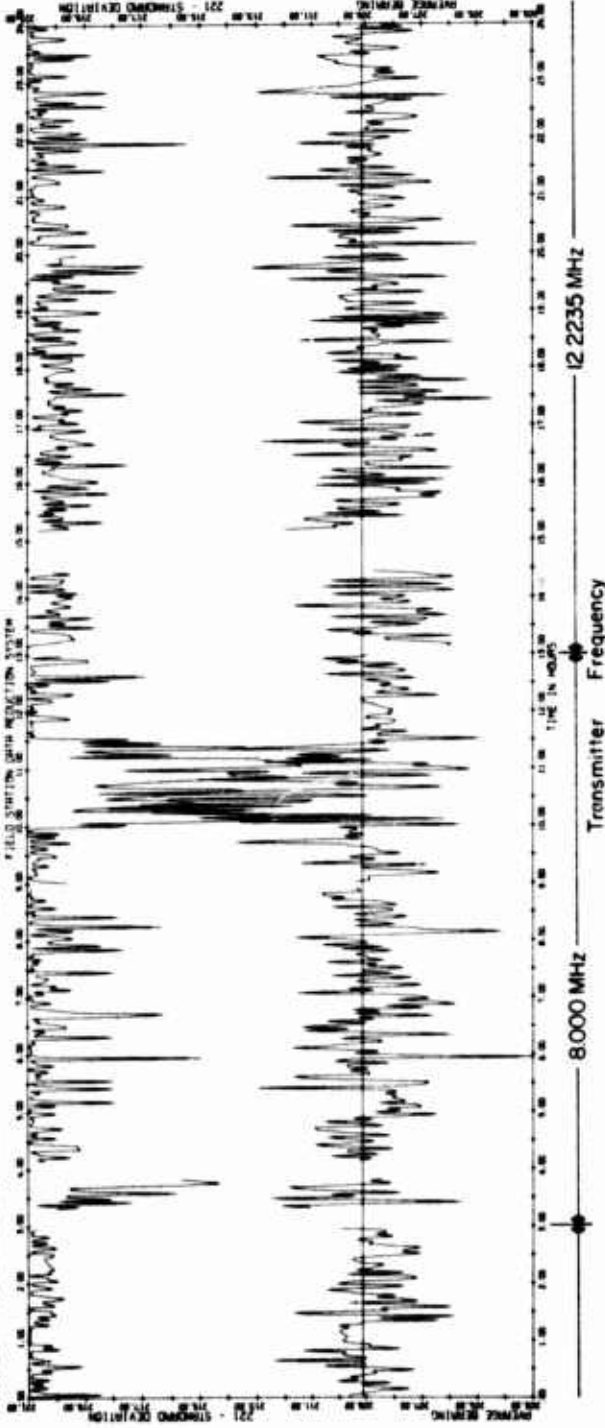
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate possible modes of transmission at transmitter frequencies as shown. Path Length - 1352.78 km. 17 AUGUST 1967

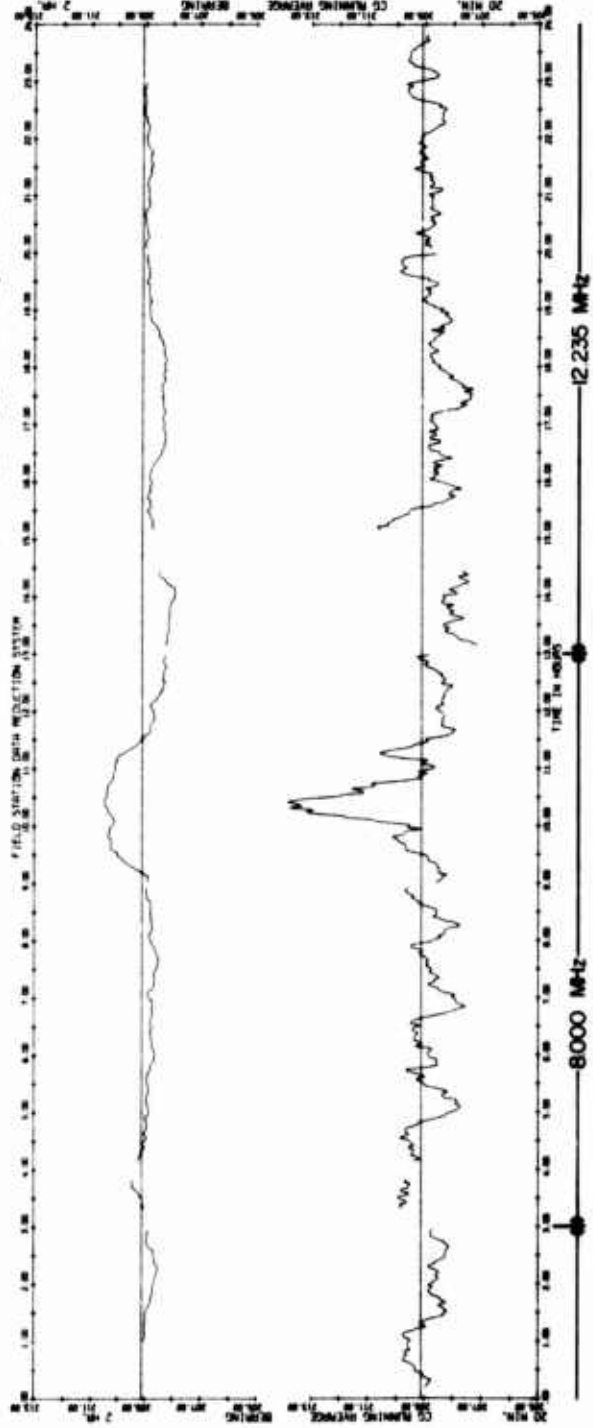


BEARING DEVIATION PLOT 17 August 1967

Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34° 8' N, 92° 0' W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W



BEARING DEVIATION PLOTS - TIME AVERAGED 17 August 1967



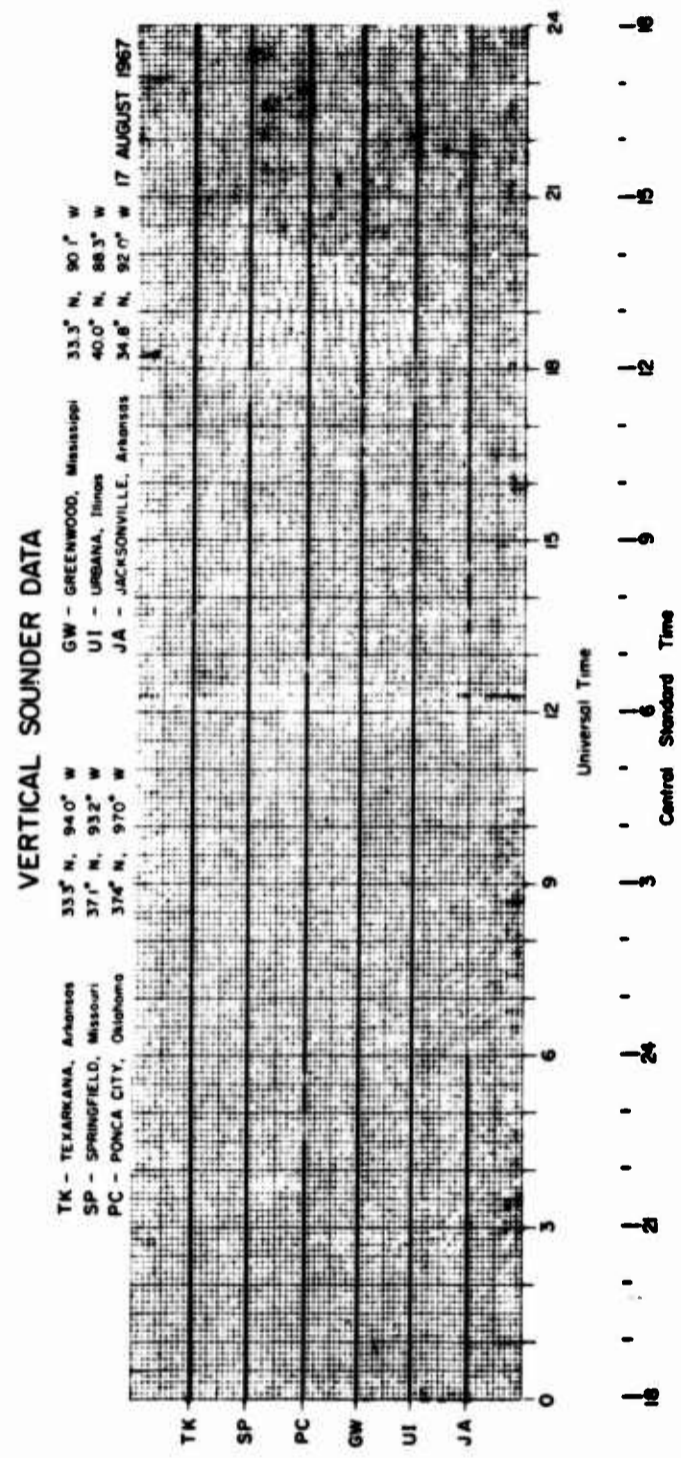
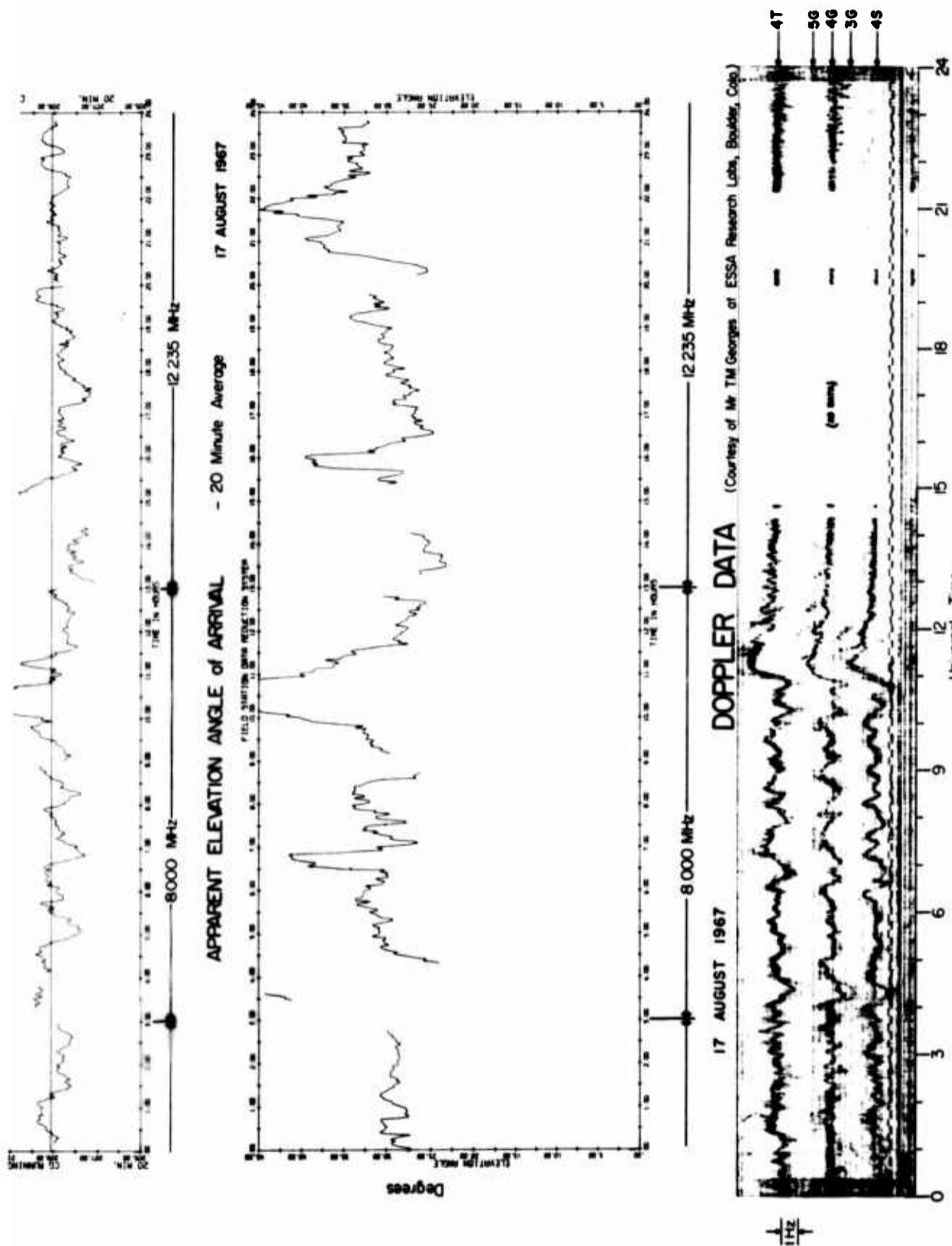


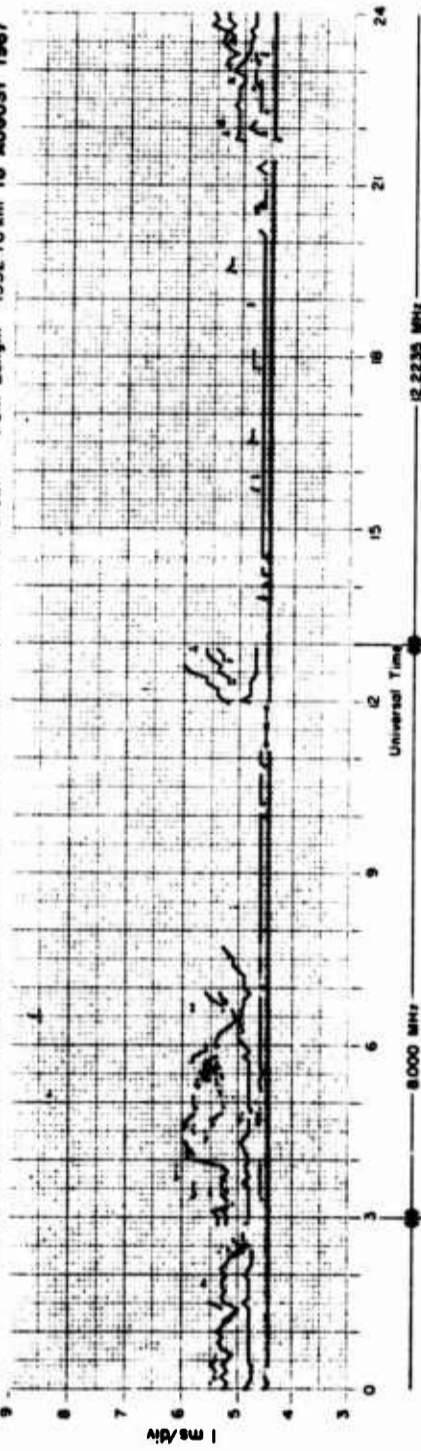
Plate 28.

17 August 1967



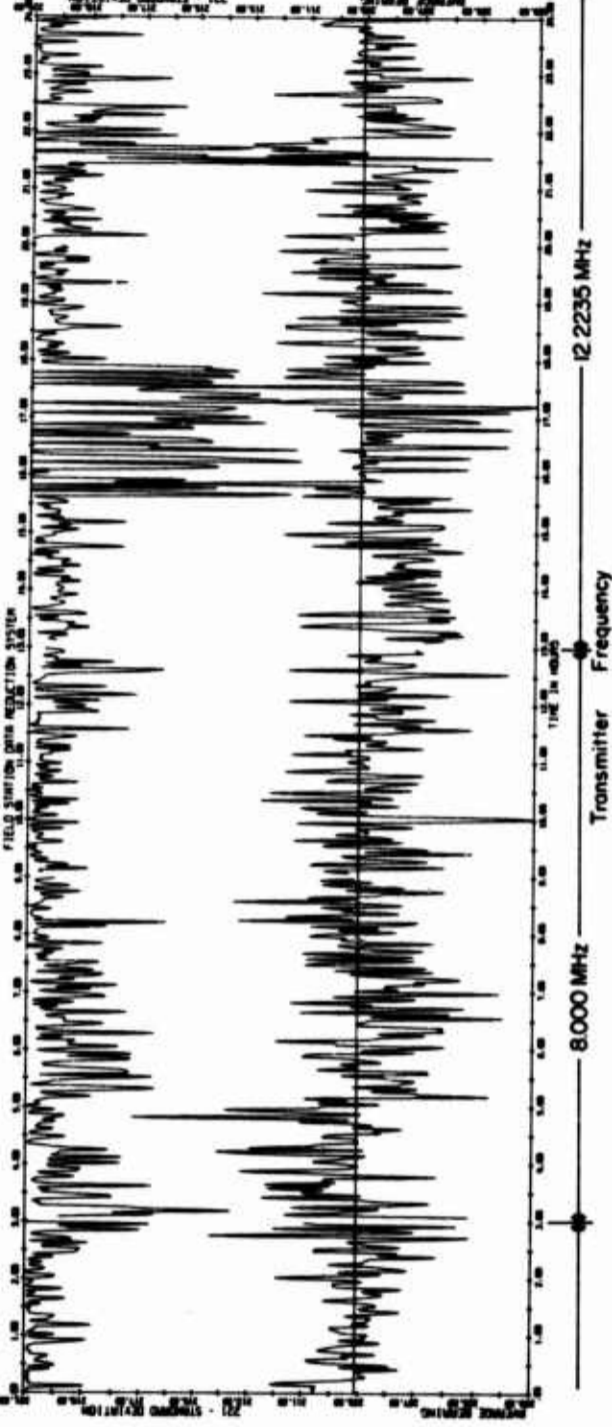
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.76 km 18 AUGUST 1967

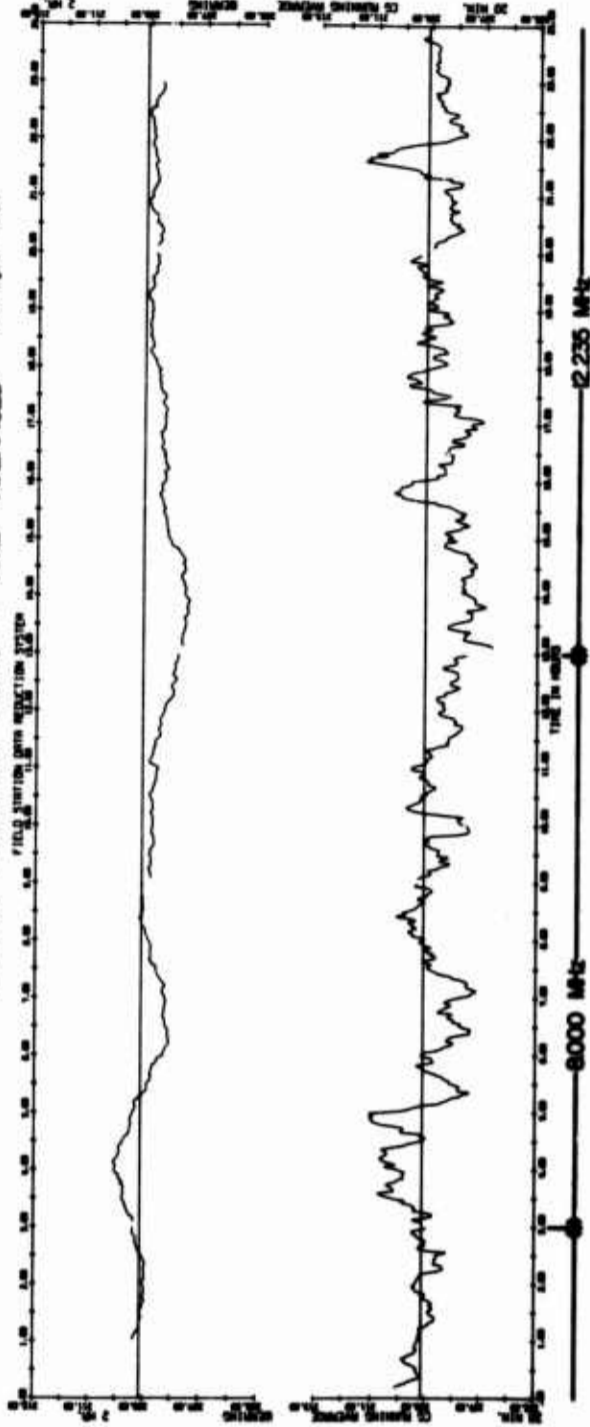


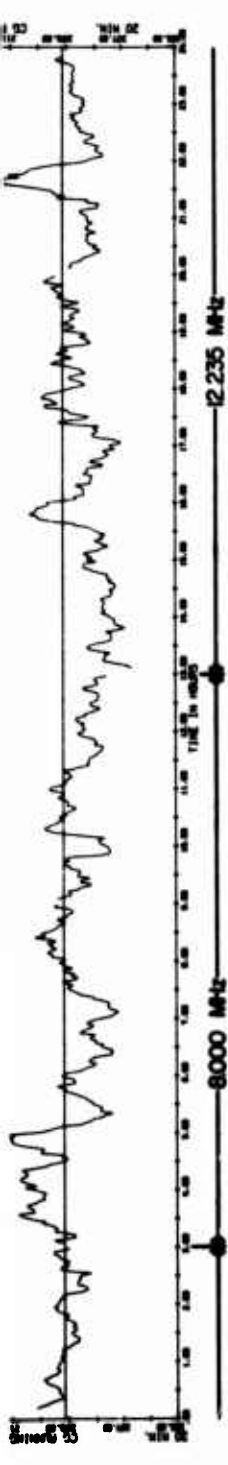
BEARING DEVIATION PLOT 18 August 1967

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
Receiver: Wultenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W

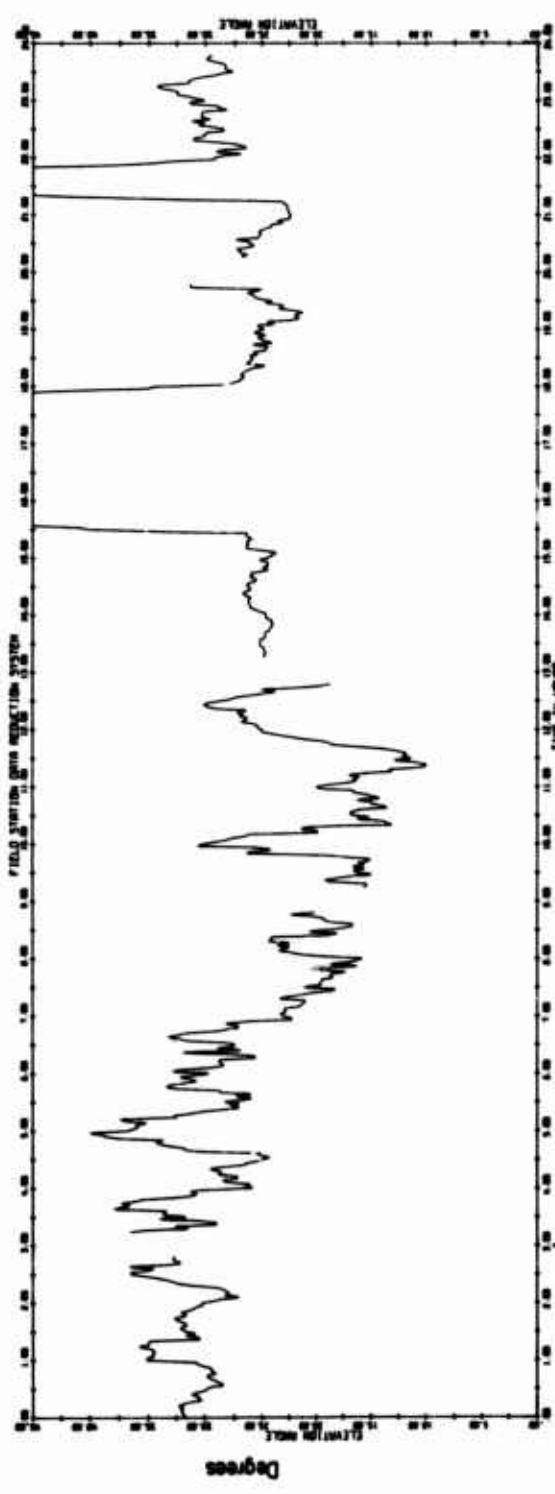


BEARING DEVIATION PLOTS - TIME AVERAGED 18 August 1967

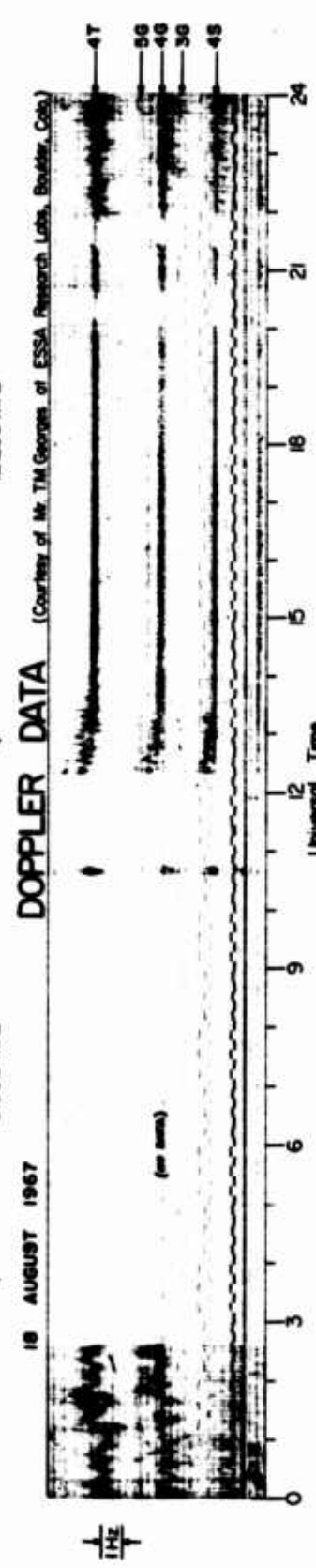




APPARENT ELEVATION ANGLE of ARRIVAL - 20 Minute Average 18 AUGUST 1967

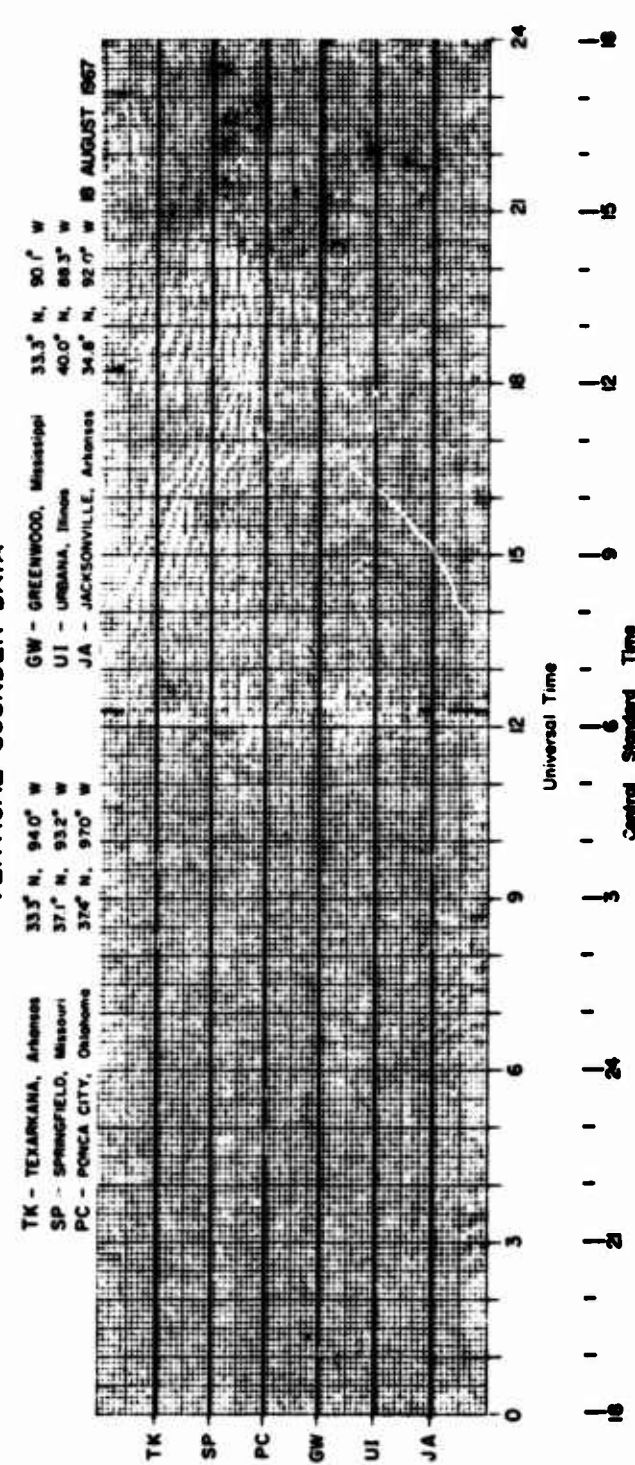


APPARENT ELEVATION ANGLE of ARRIVAL - 20 Minute Average 18 AUGUST 1967



DOPPLER DATA (Courtesy of Mr. T.M. Georges of ESSA Research Labs, Boulder, Colo.)

VERTICAL SOUNDER DATA

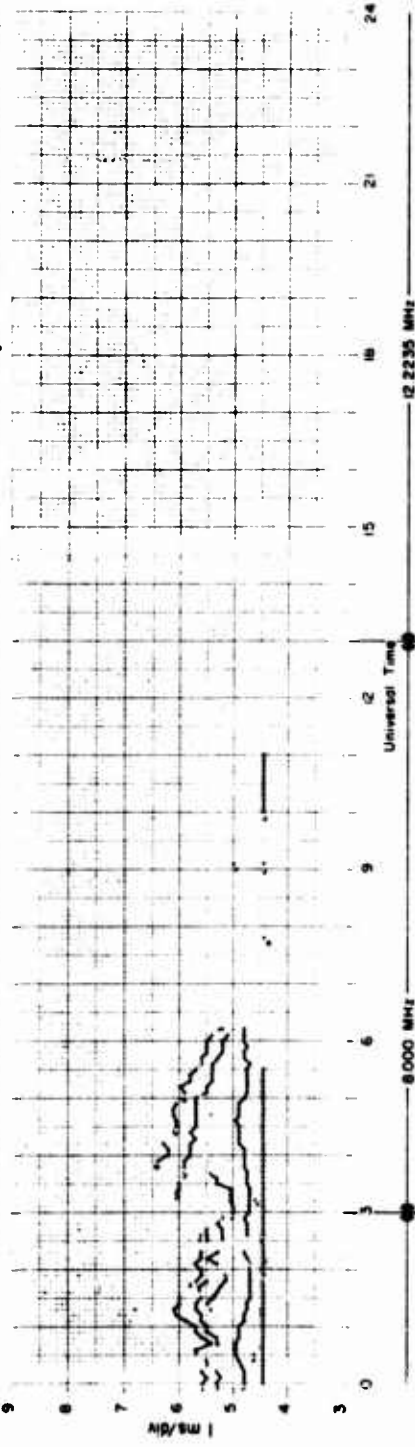


TK - TEXARKANA, Arkansas 33.5° N, 94.0° W
 SP - SPRINGFIELD, Missouri 37.1° N, 93.2° W
 PC - PONCA CITY, Oklahoma 37.4° N, 97.0° W
 GW - GREENWOOD, Mississippi 33.3° N, 90.1° W
 UI - URBANA, Illinois 40.0° N, 88.3° W
 JA - JACKSONVILLE, Arkansas 34.8° N, 92.1° W

Plate 29.
 18 August 1967

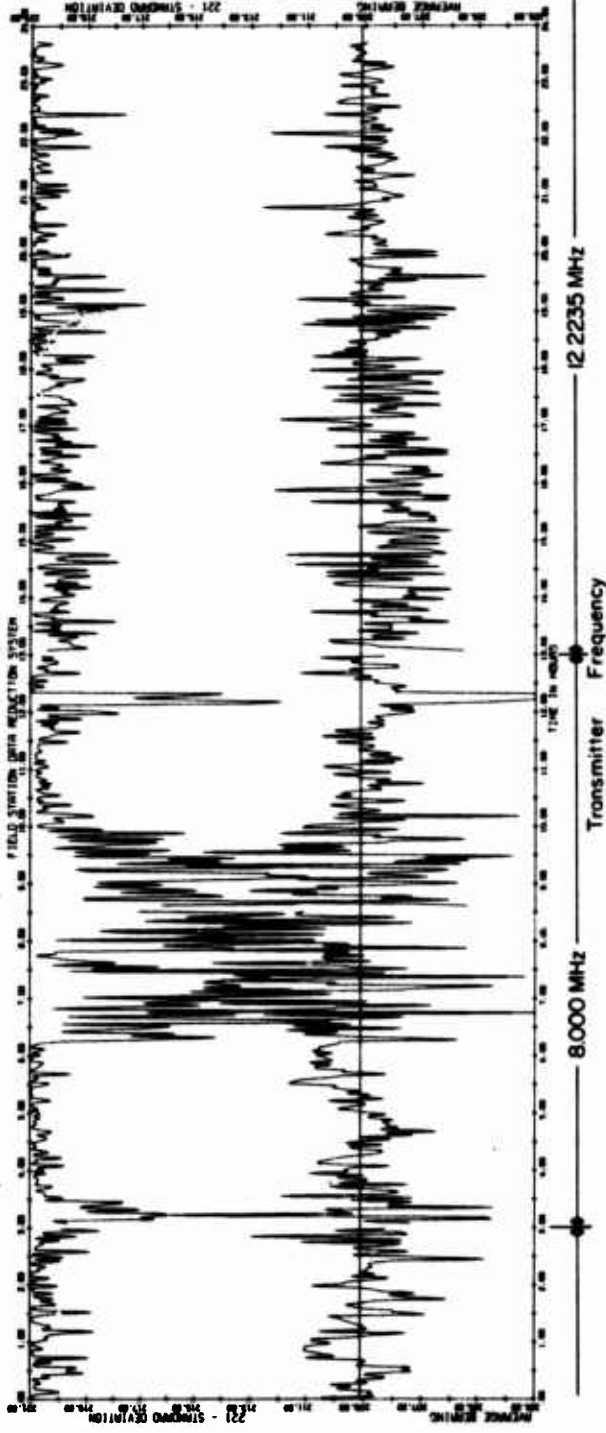
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 19 AUGUST 1967

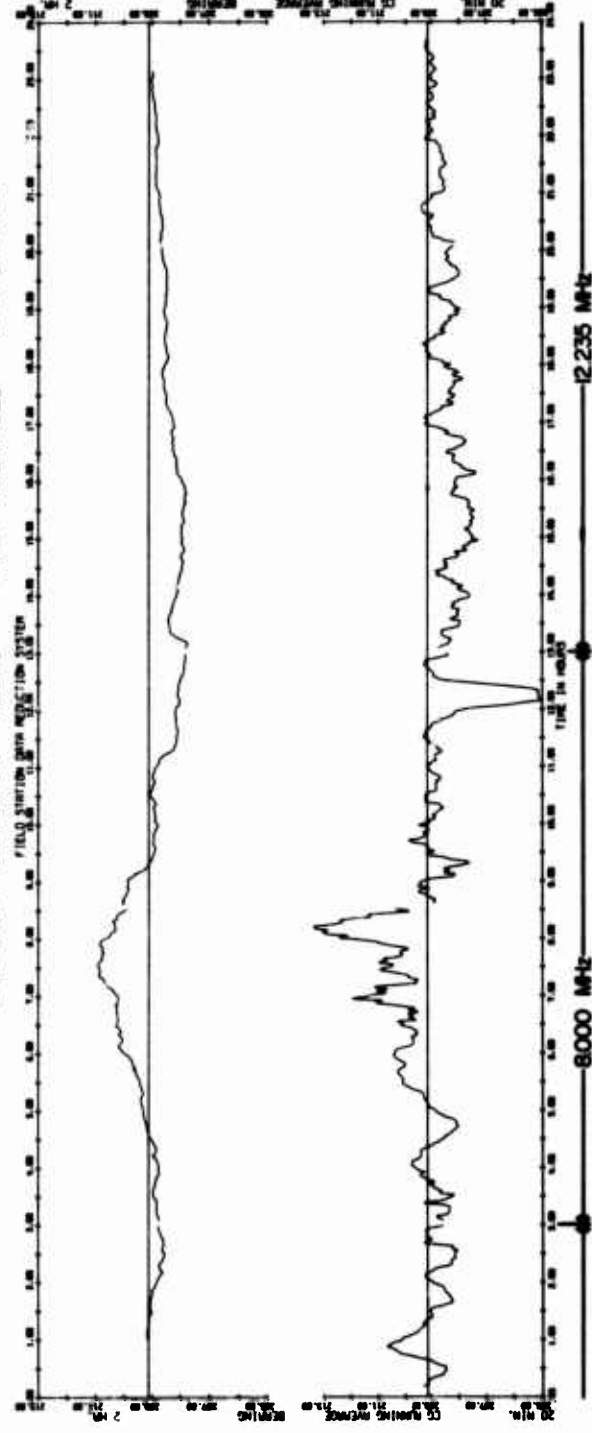


BEARING DEVIATION PLOT 19 August 1967

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W



BEARING DEVIATION PLOTS - TIME AVERAGED 19 August 1967



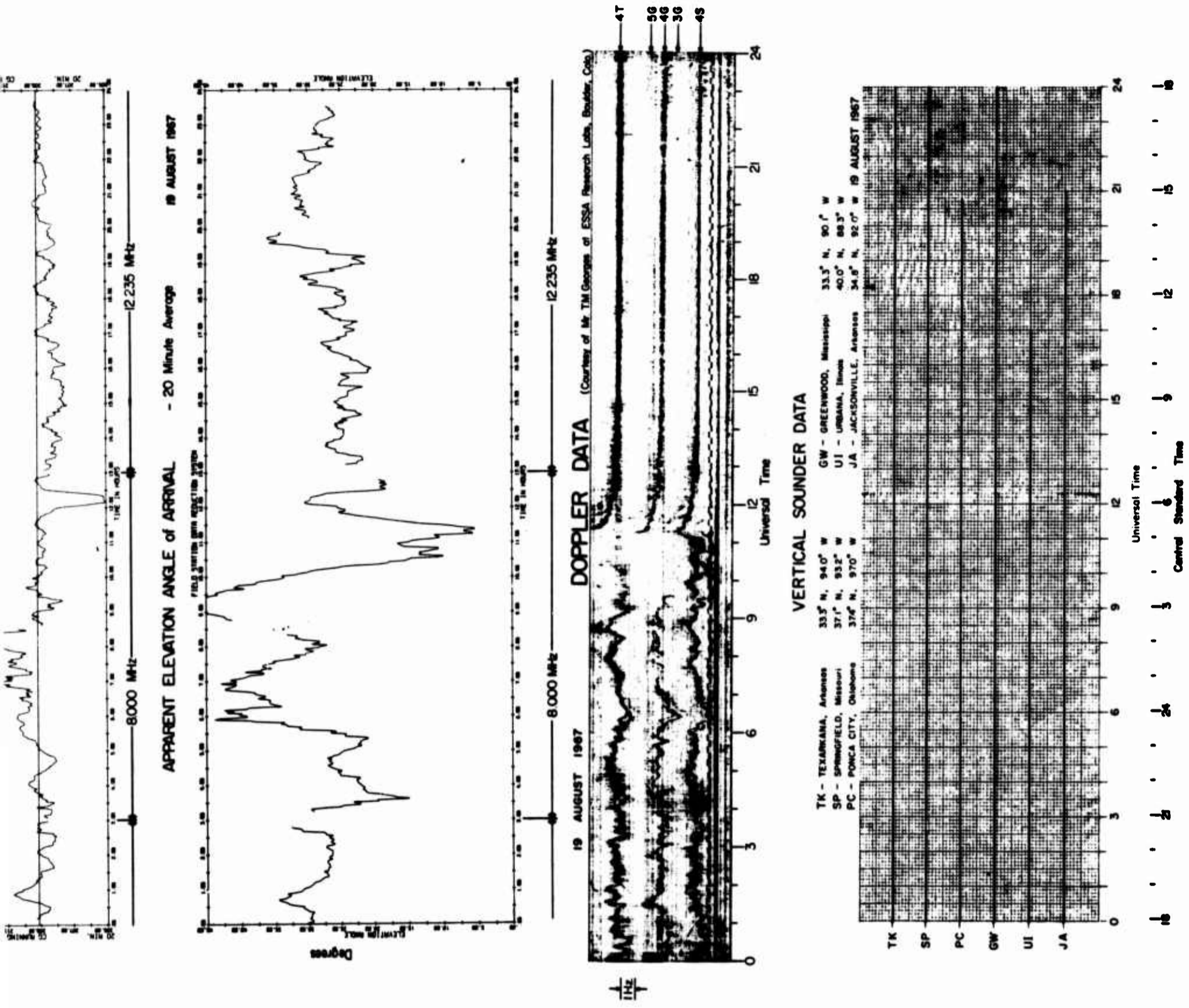
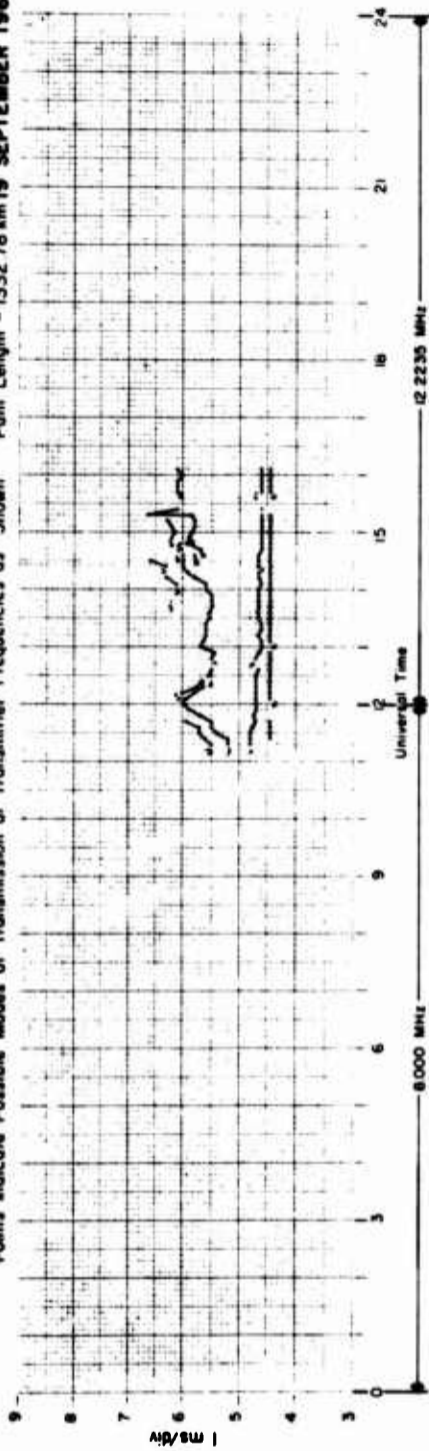


Plate 30.

19 August 1967

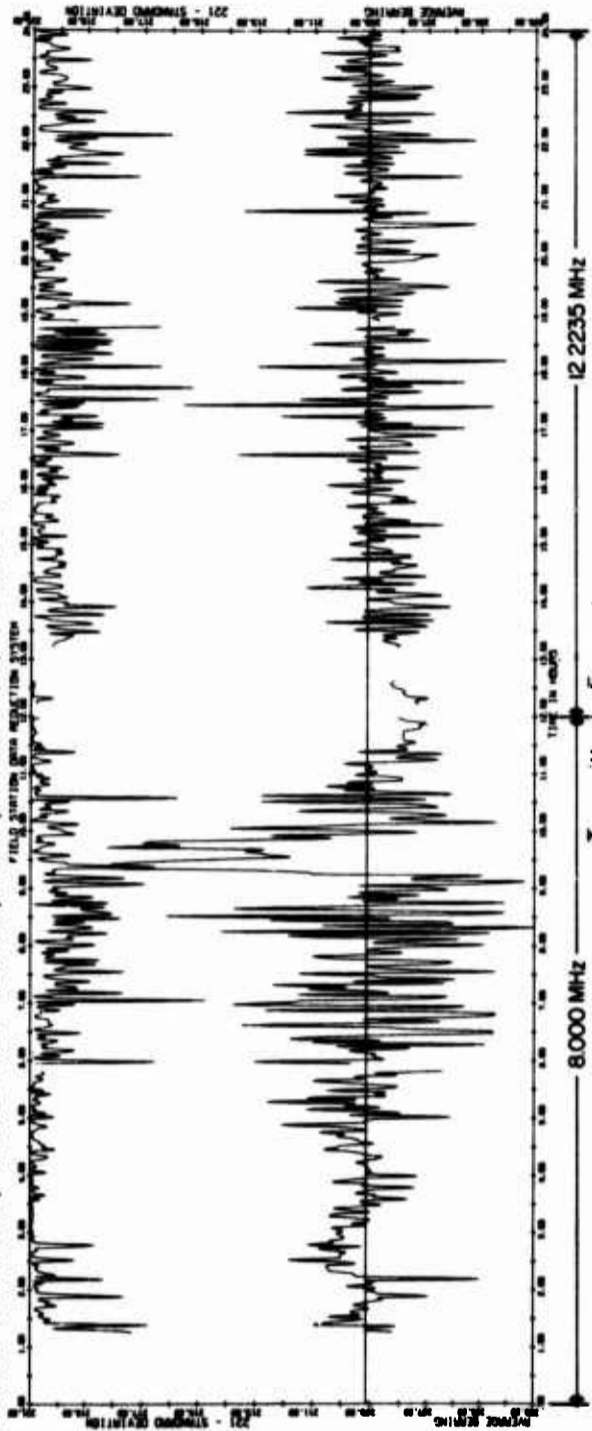
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 19 SEPTEMBER 1967

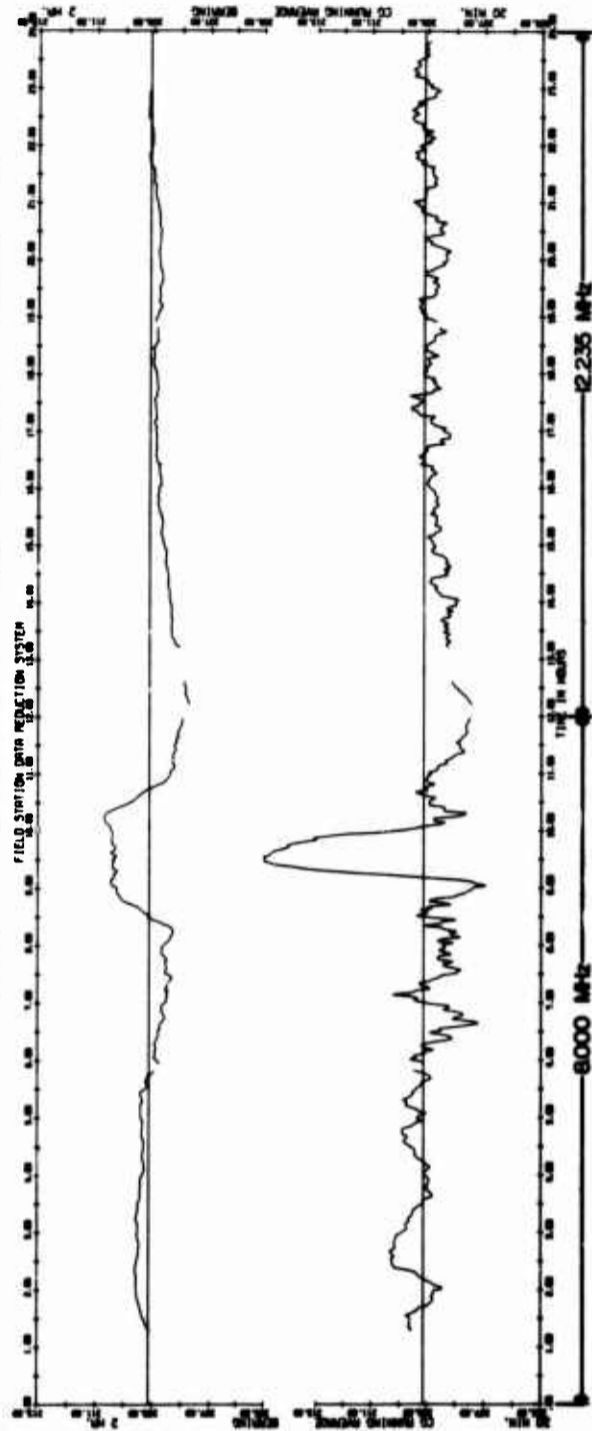


BEARING DEVIATION PLOT 19 September 1967

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W



BEARING DEVIATION PLOTS - TIME AVERAGED 19 September 1967



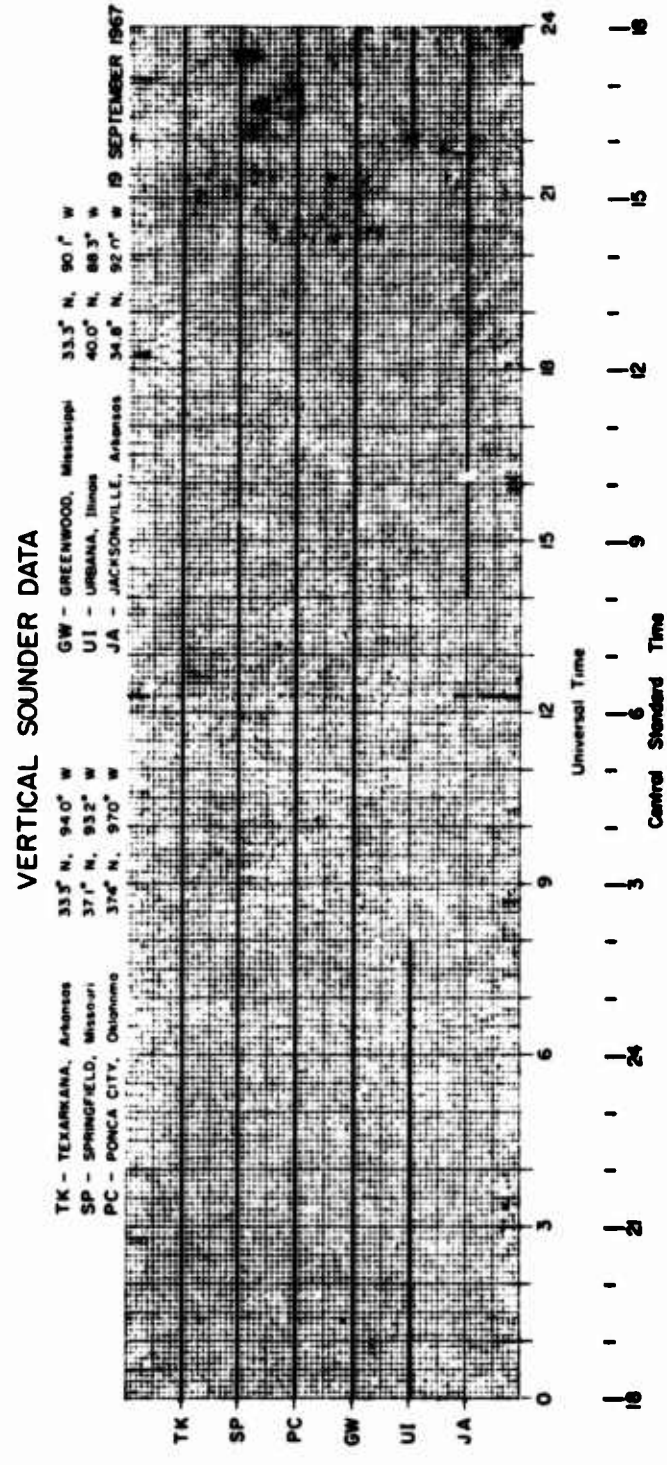
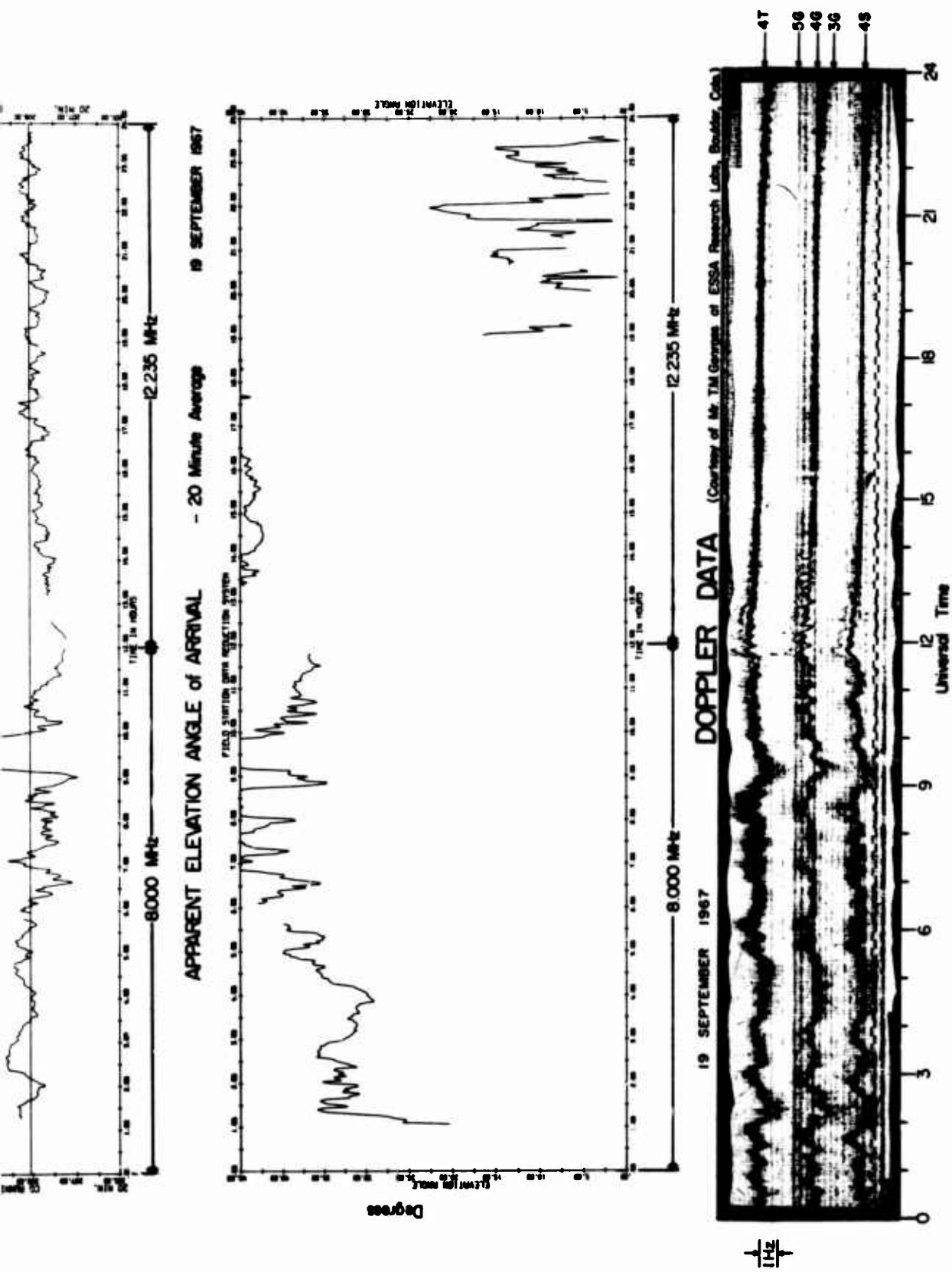
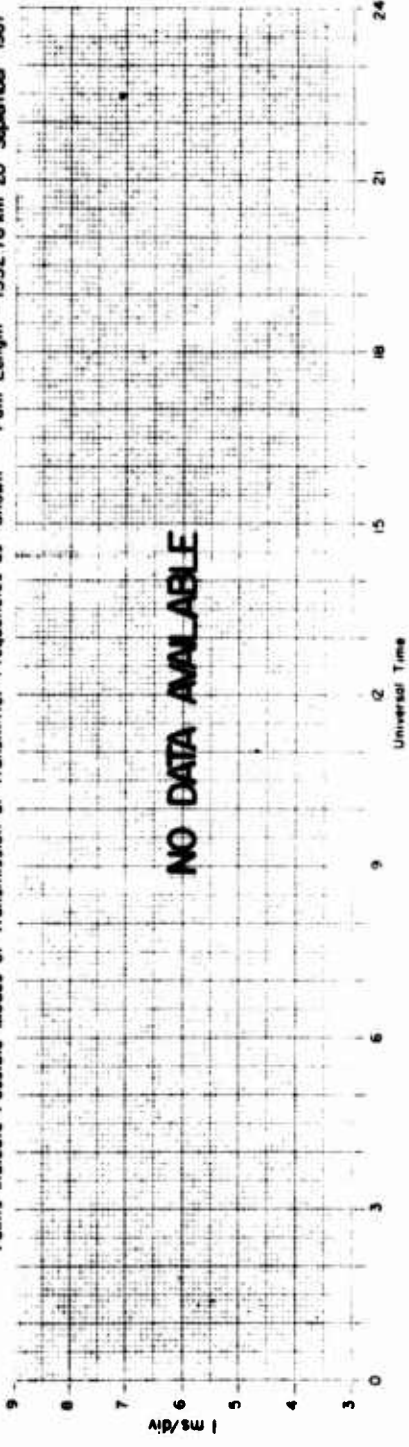


Plate 31.

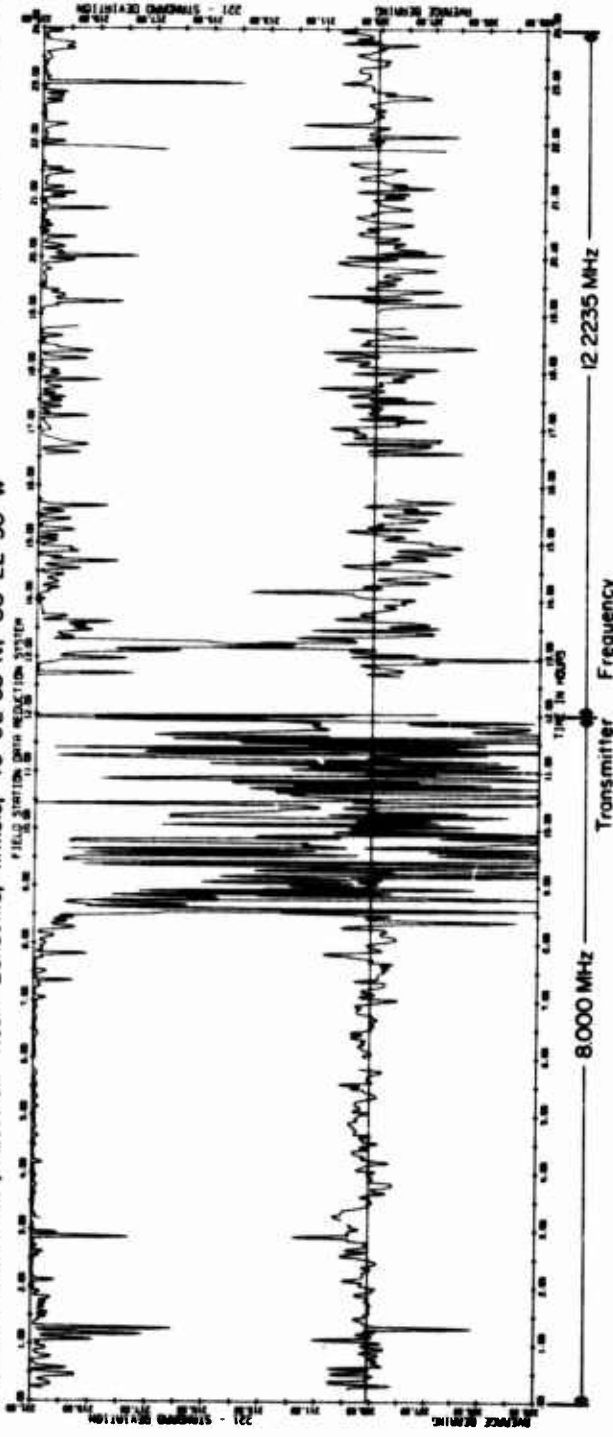
19 September 1967

OBLIQUE IONOGRAM DATA

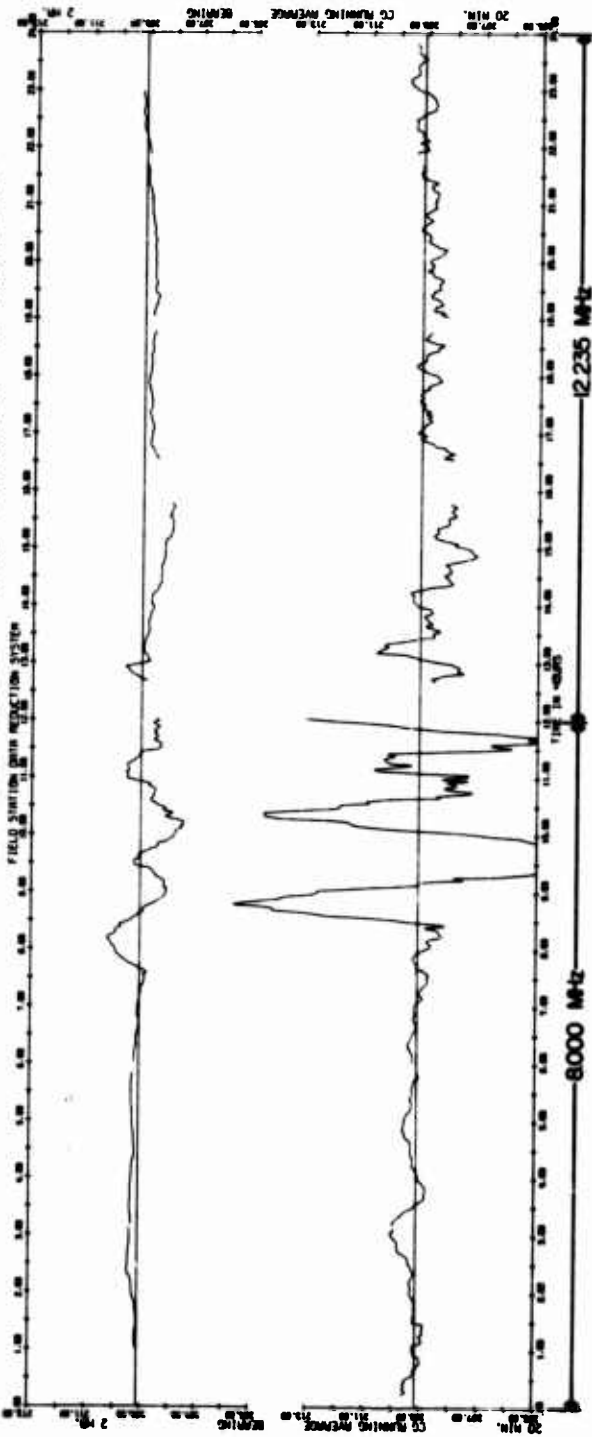
Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bonaville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 20 September 1967



BEARING DEVIATION PLOT 20 September 1967
 Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Grayler, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W



BEARING DEVIATION PLOTS - TIME AVERAGED 20 September 1967



APPARENT ELEVATION ANGLE OF ARRIVAL

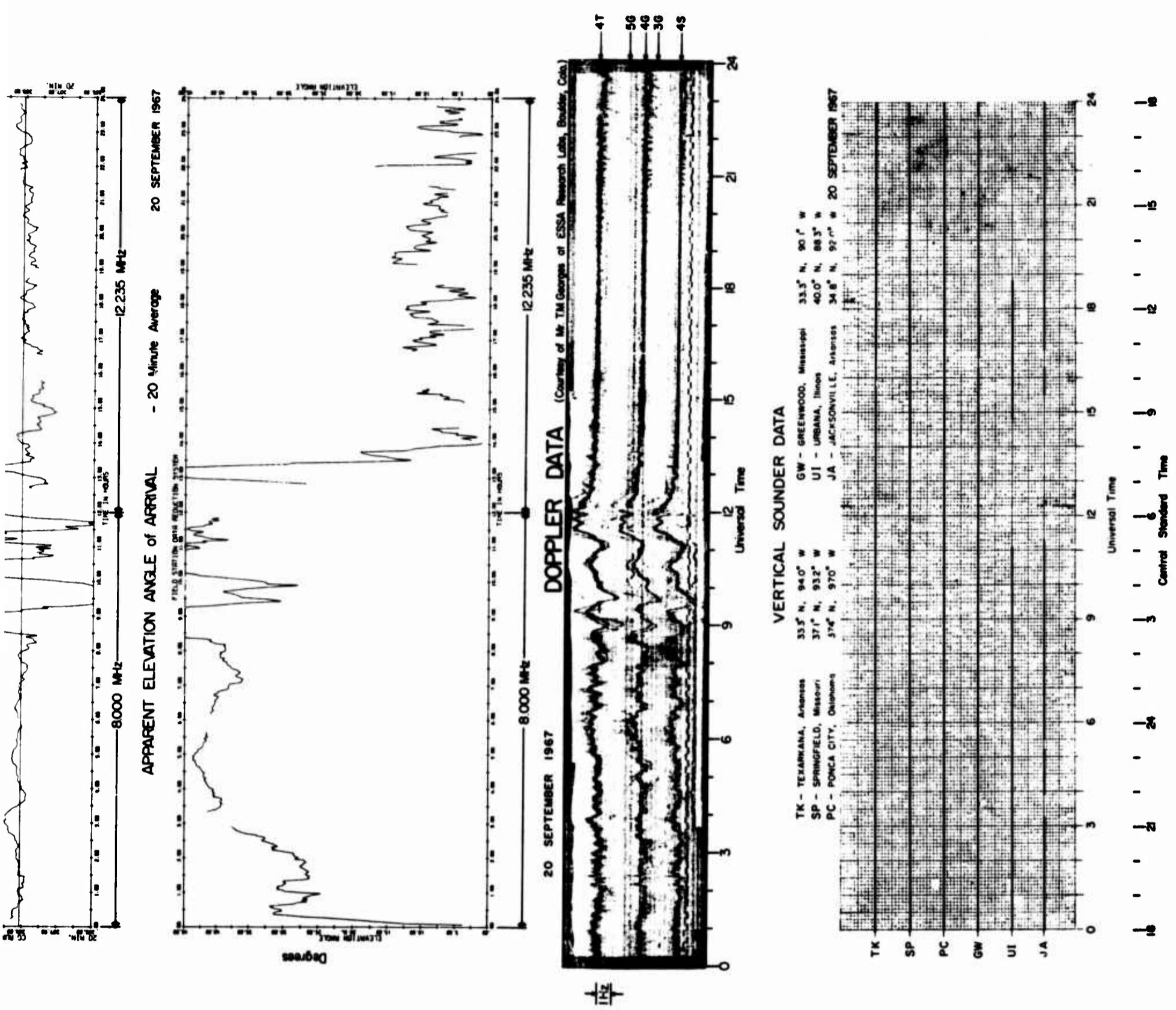
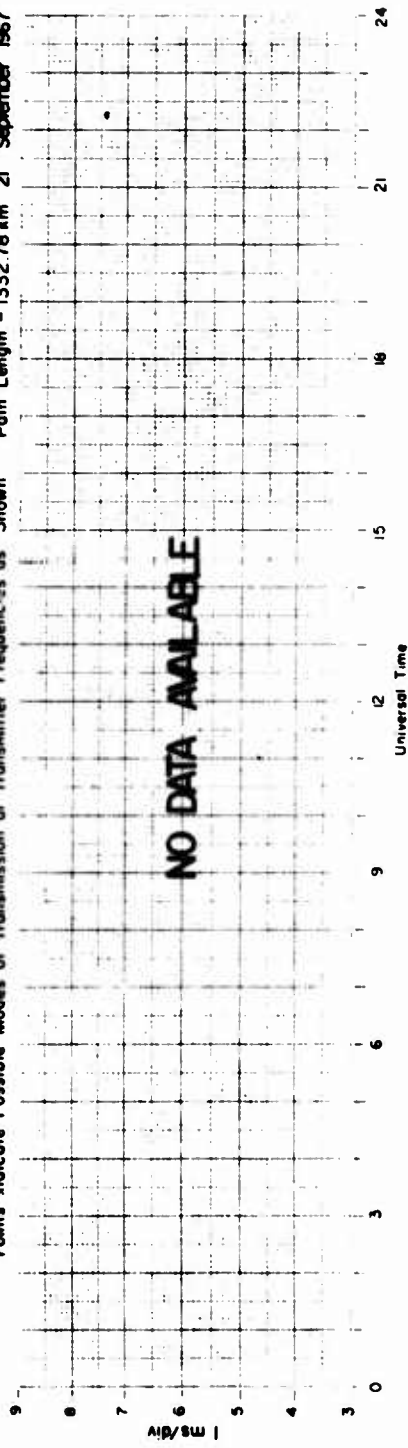


Plate 32.

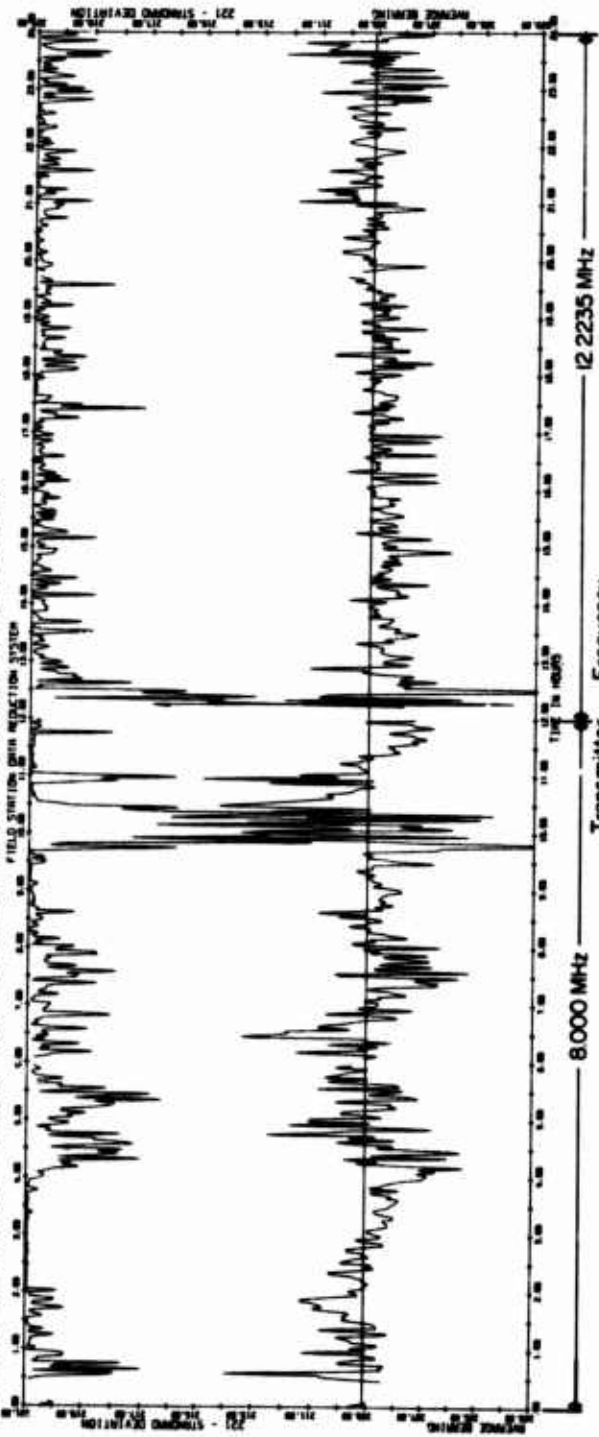
20 September 1967

OBLIQUE IONOGRAM DATA

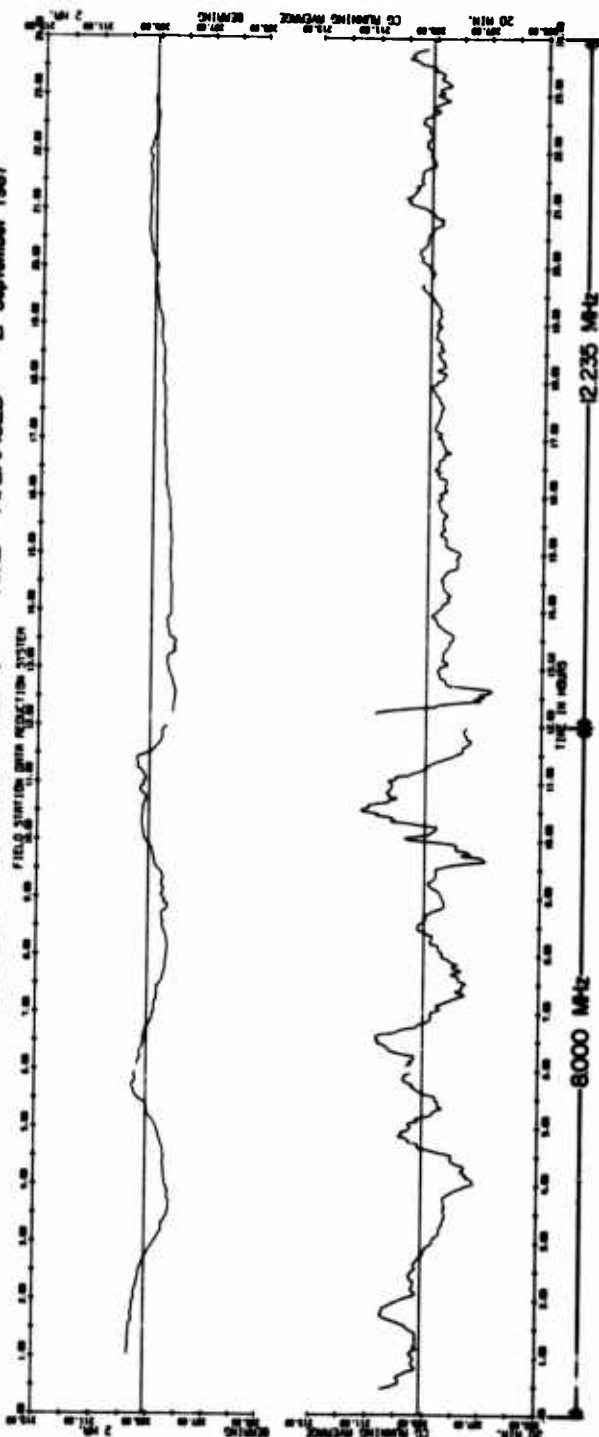
Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 21 September 1967



BEARING DEVIATION PLOT 21 September 1967
 Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W



BEARING DEVIATION PLOTS - TIME AVERAGED 21 September 1967



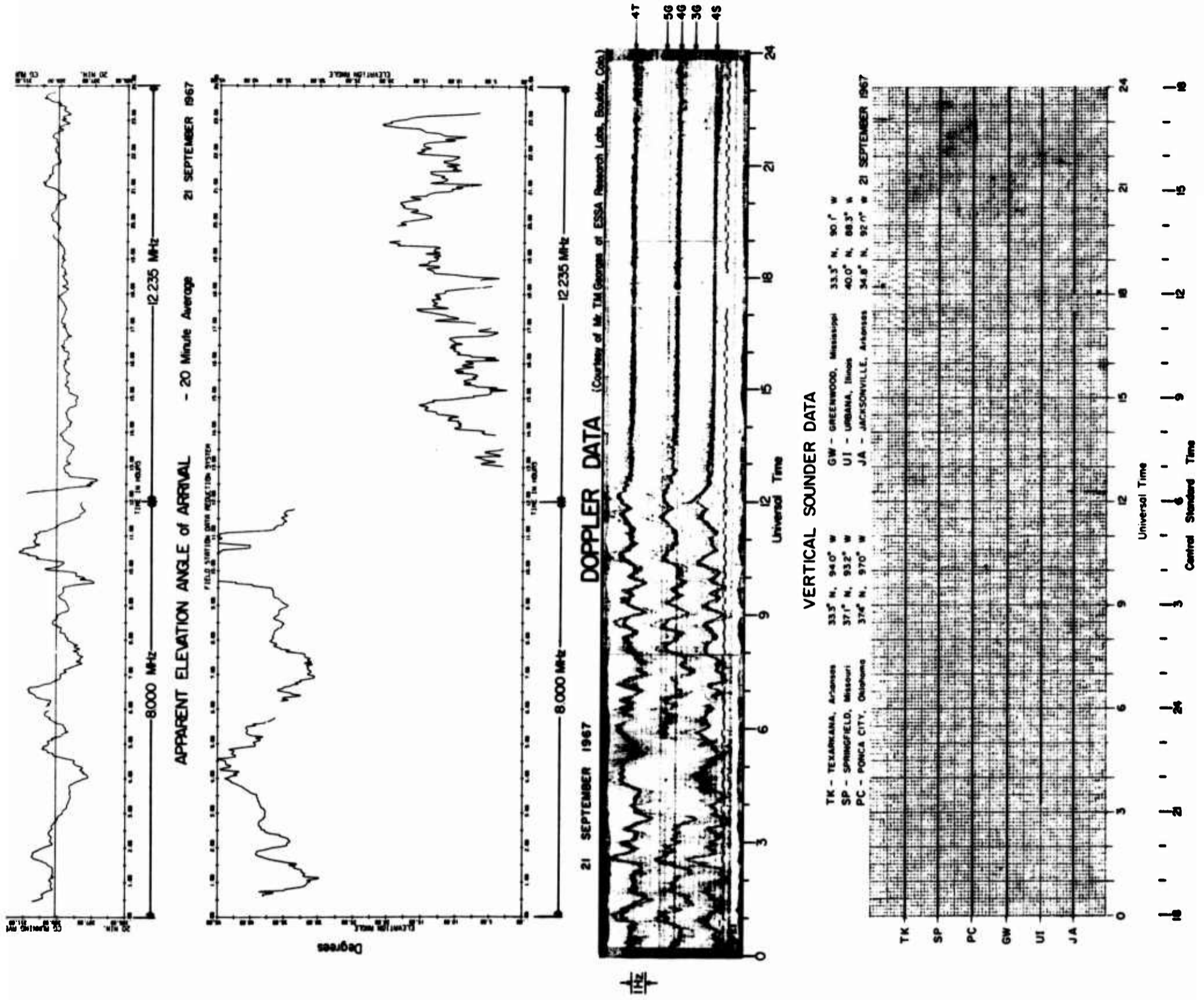


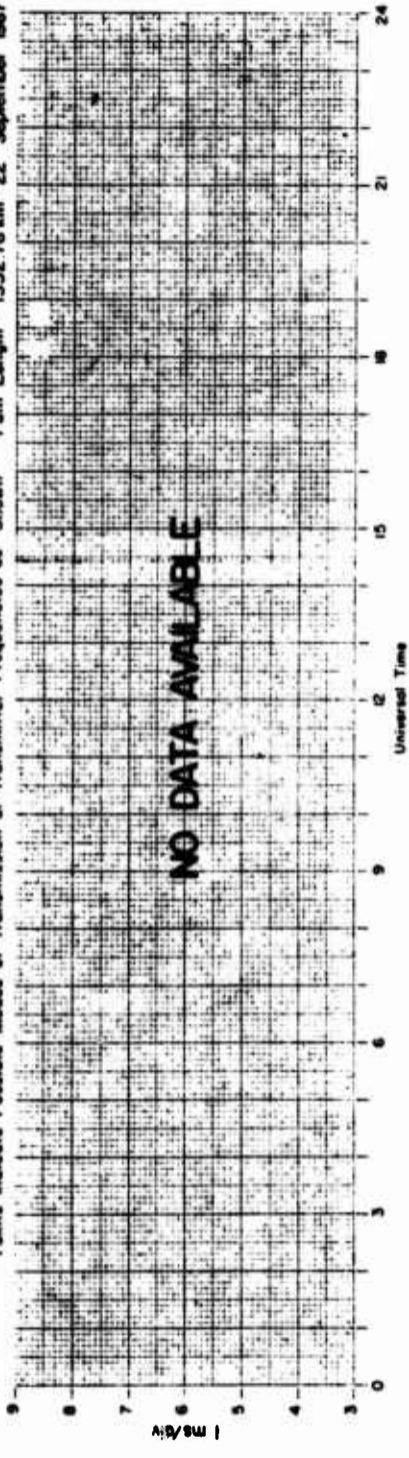
Plate 33.

21 September 1967

2

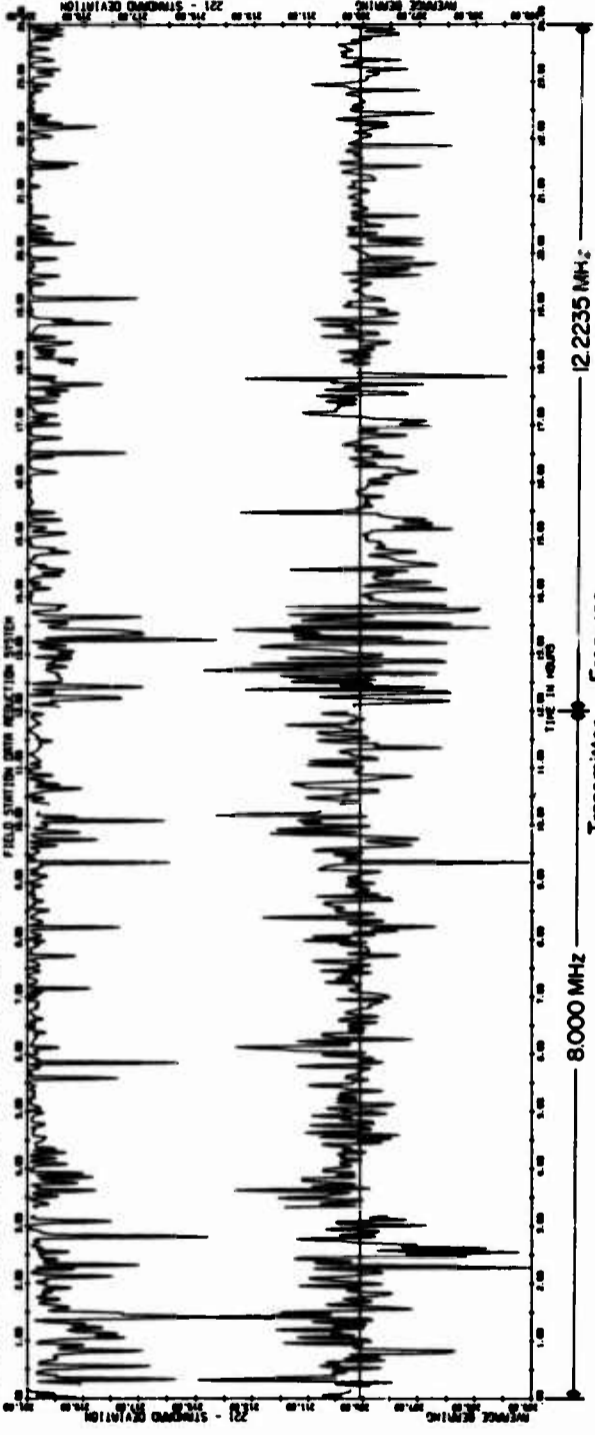
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 22 September 1967

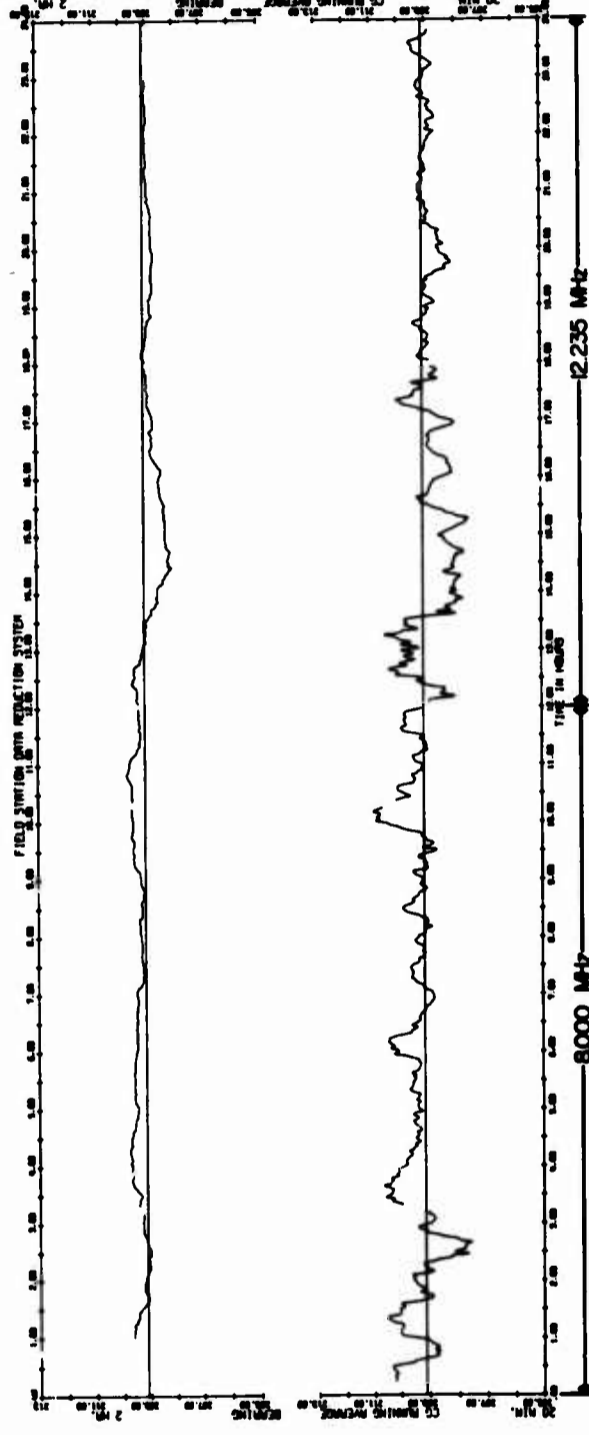


NO DATA AVAILABLE

BEARING DEVIATION PLOT 22 September 1967
 Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W



BEARING DEVIATION PLOTS - TIME AVERAGED 22 September 1967



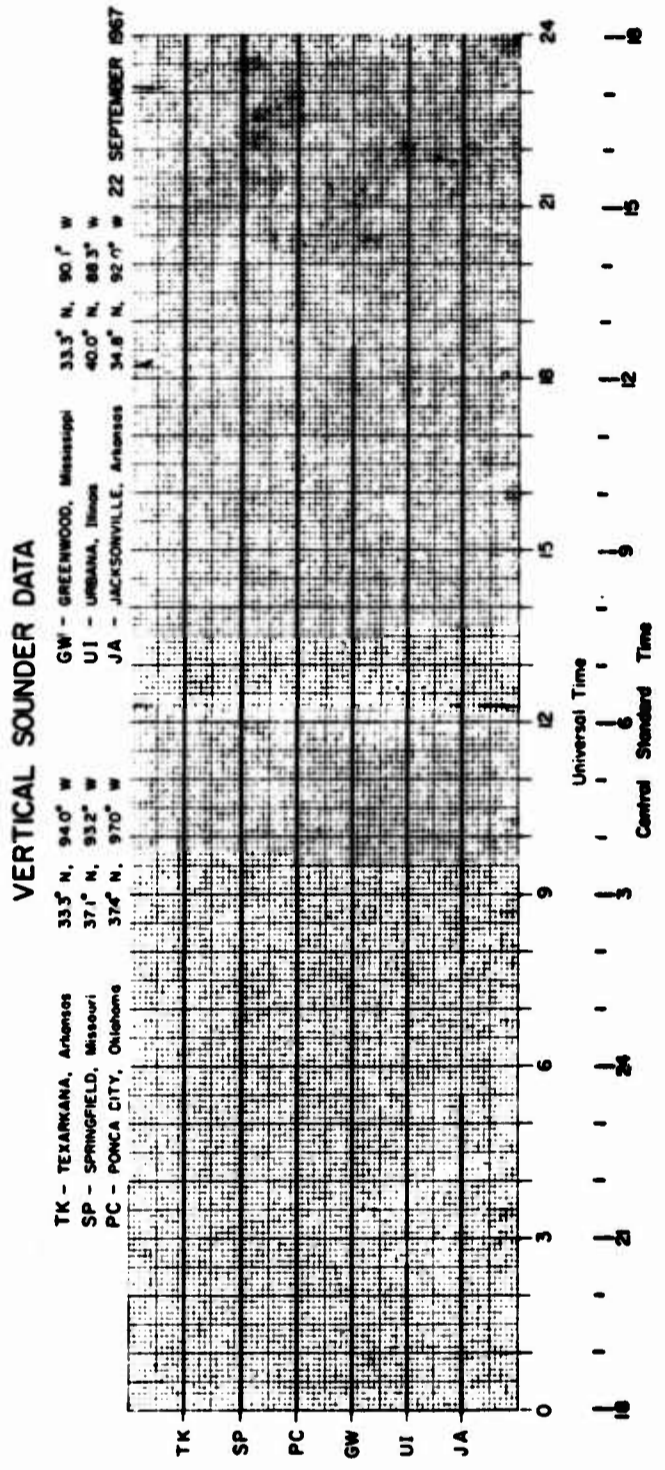
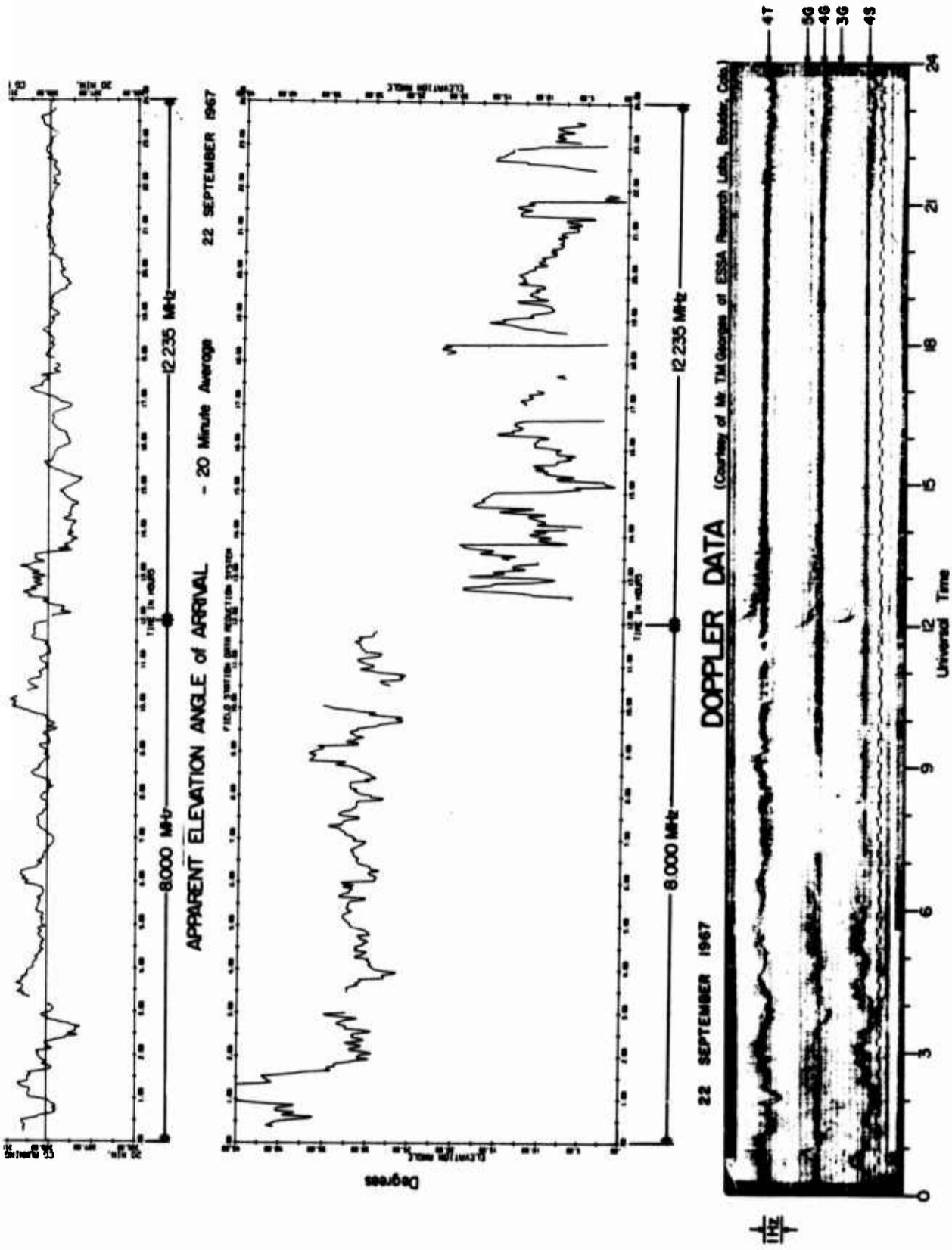
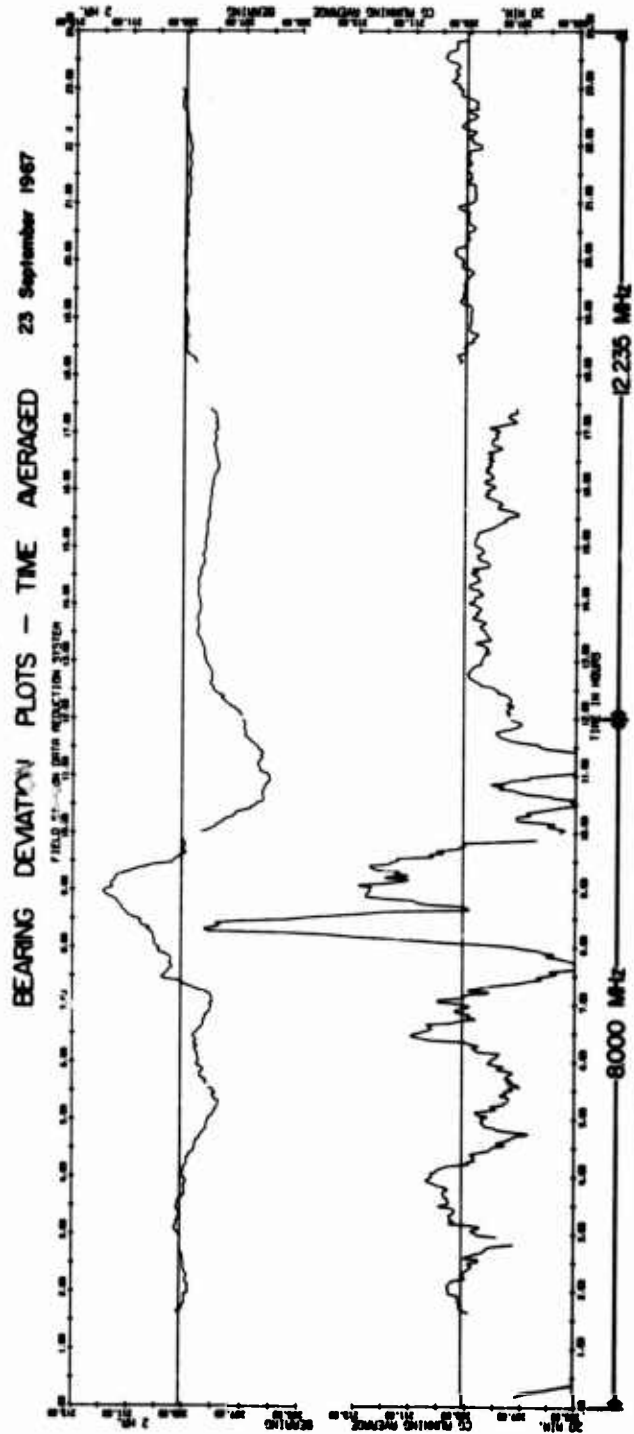
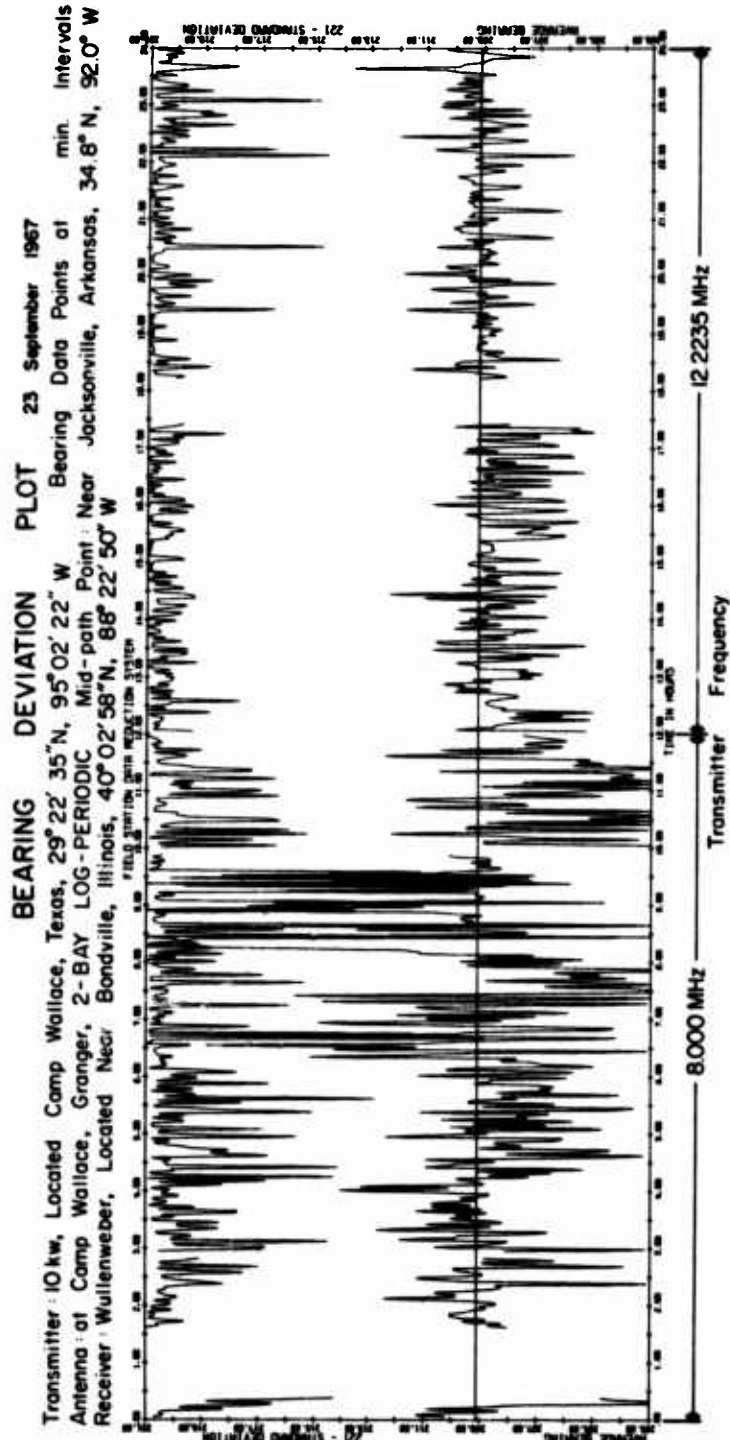
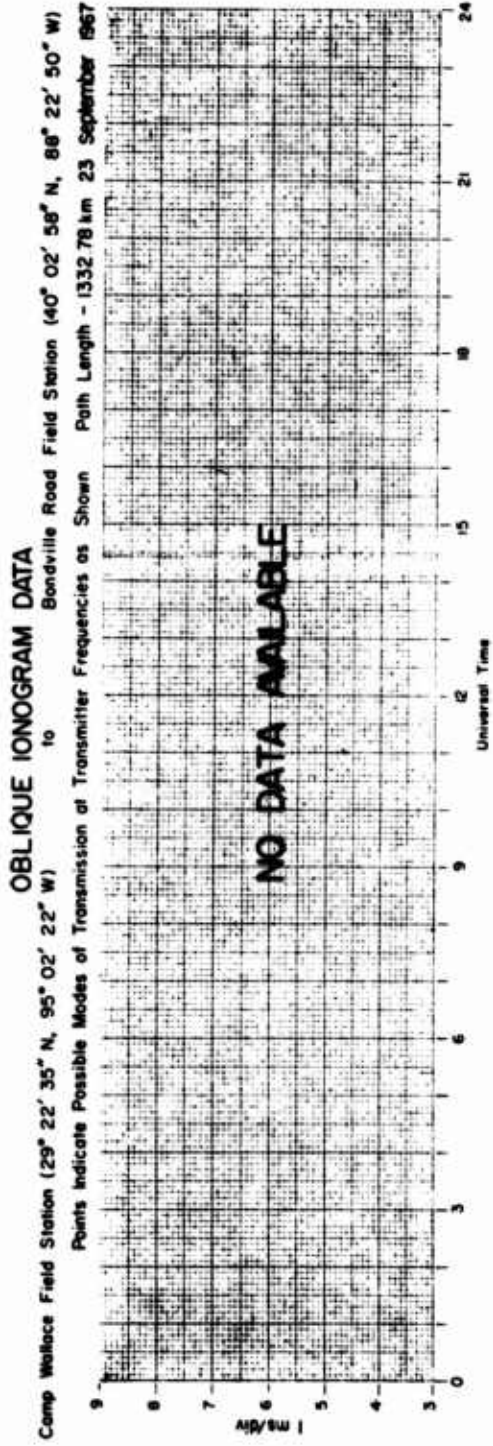


Plate 34.

22 September 1967

1



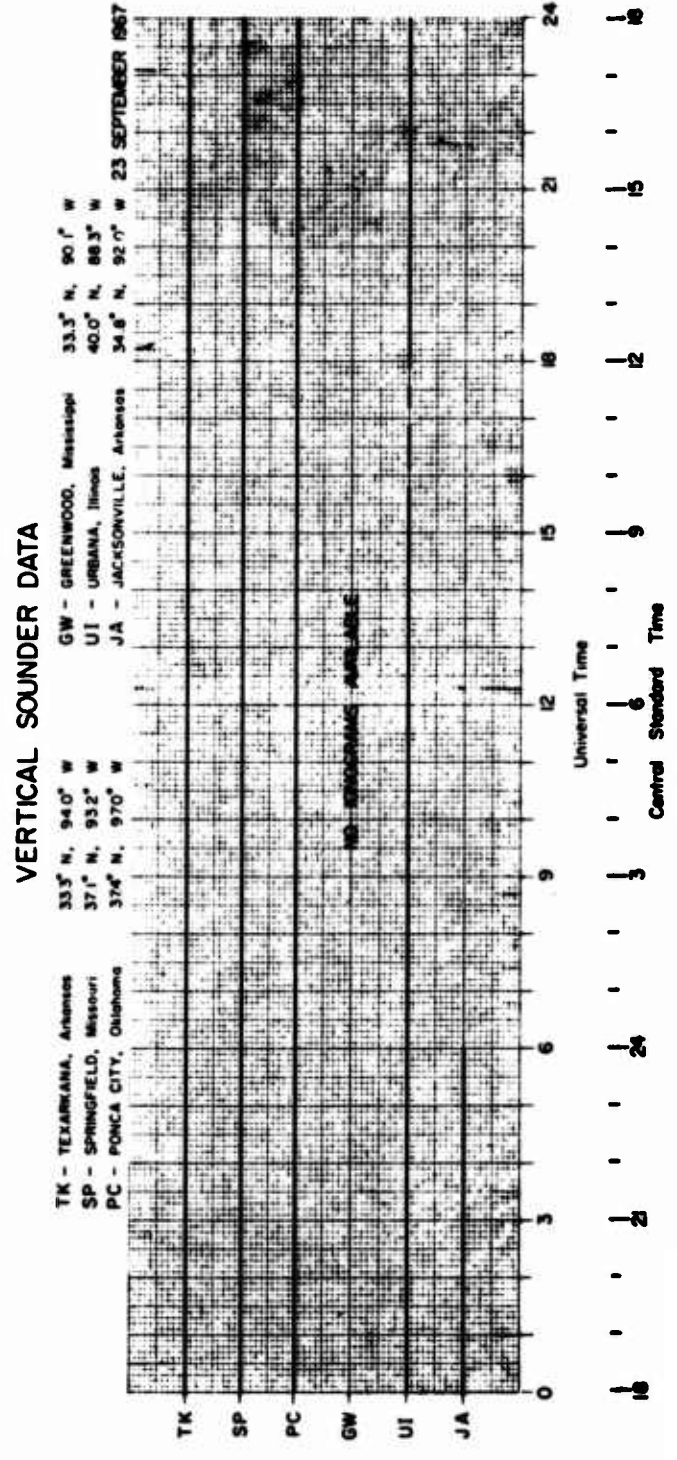
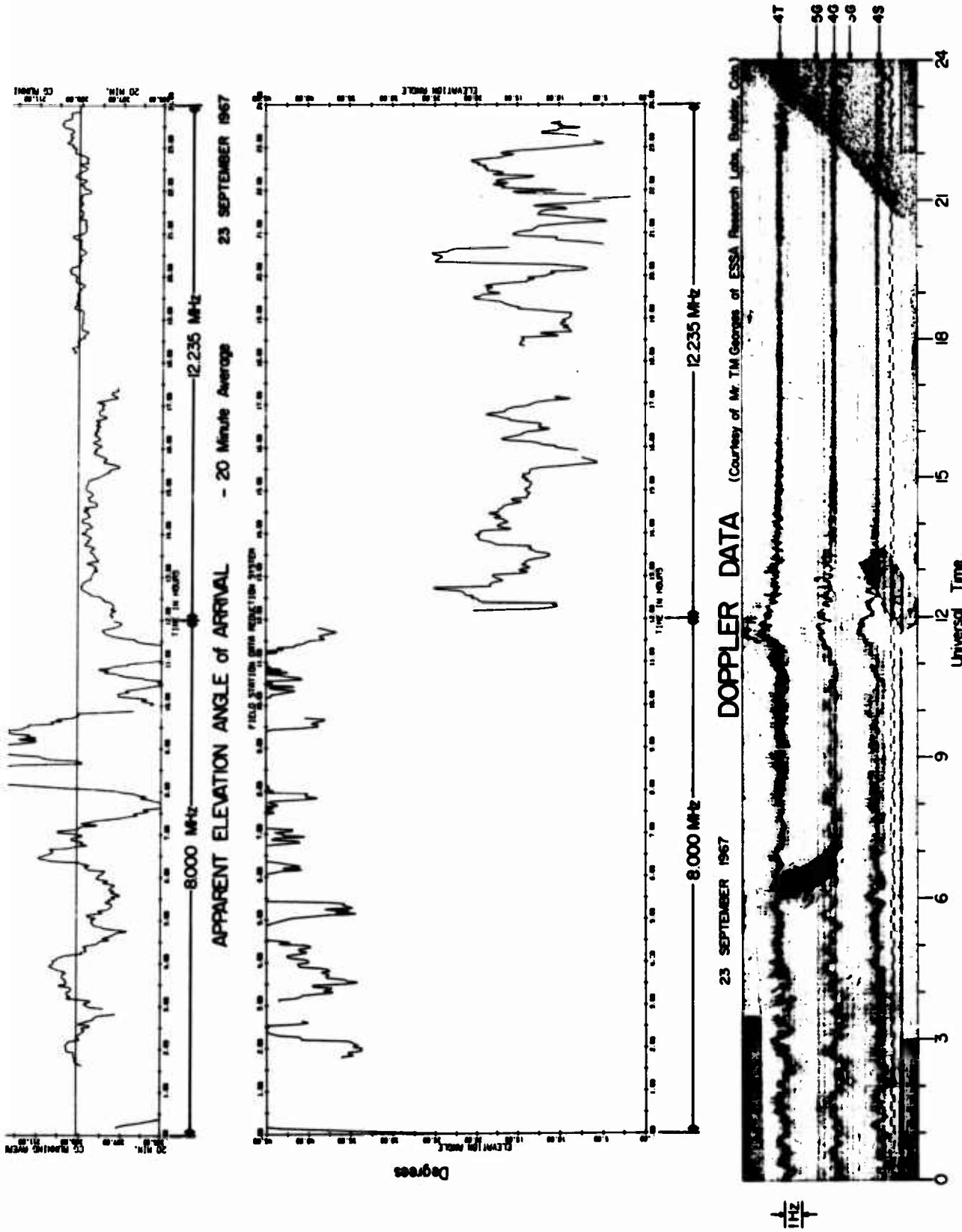
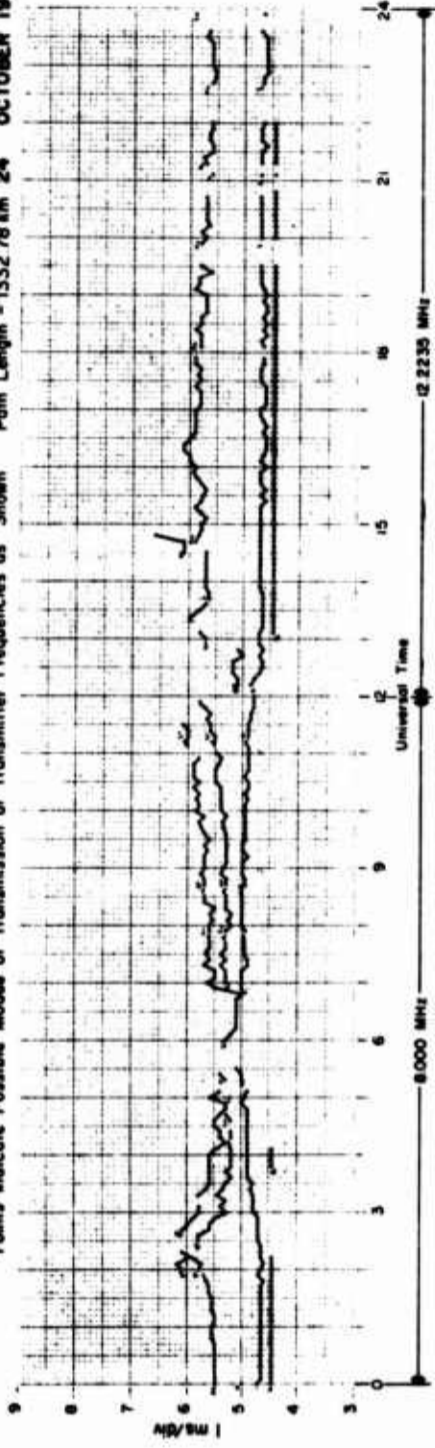


Plate 35.

23 September 1967

OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 24 OCTOBER 1967



BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34 8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 24 OCTOBER 1967

NO DATA AVAILABLE

BEARING DEVIATION PLOTS - TIME AVERAGED 24 OCTOBER 1967

NO DATA AVAILABLE

NO DATA AVAILABLE

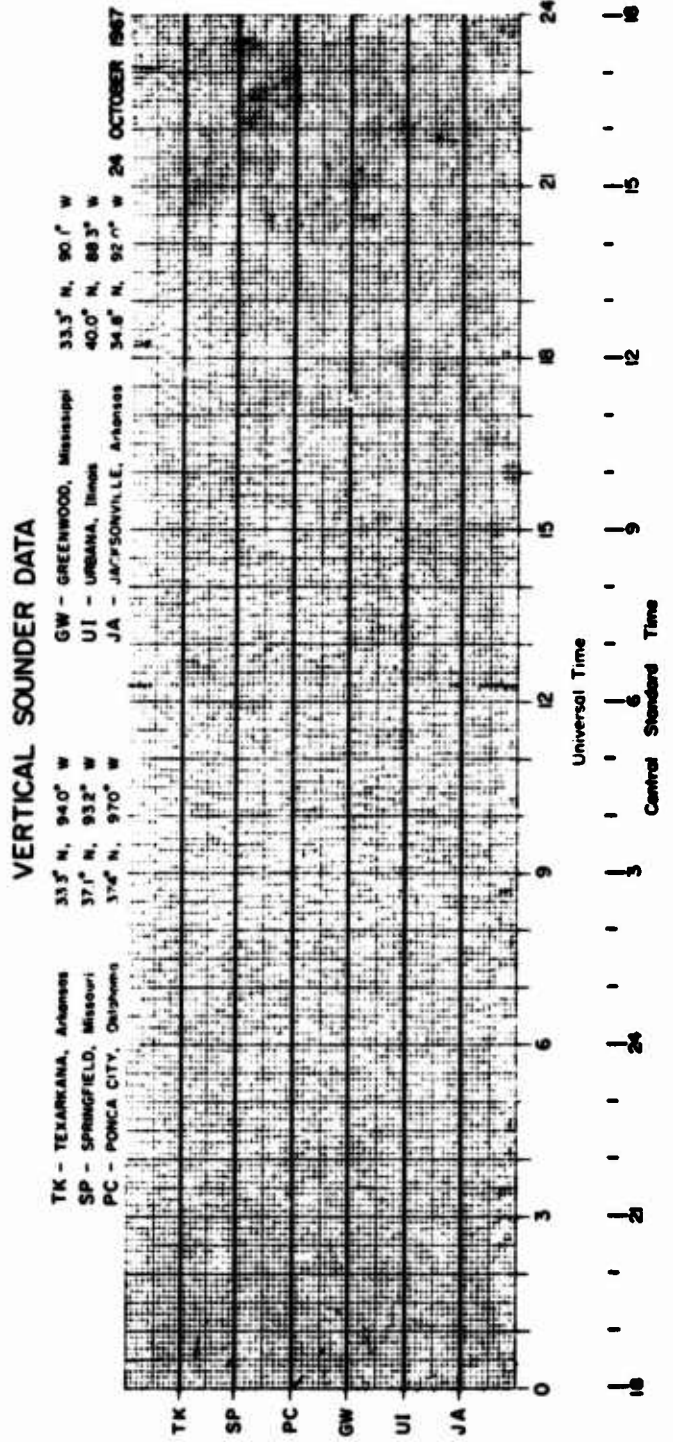
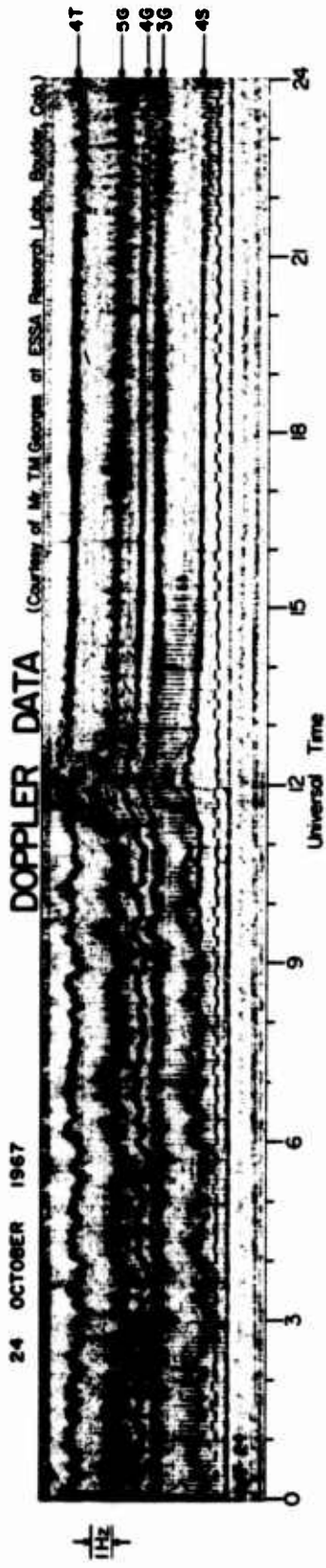
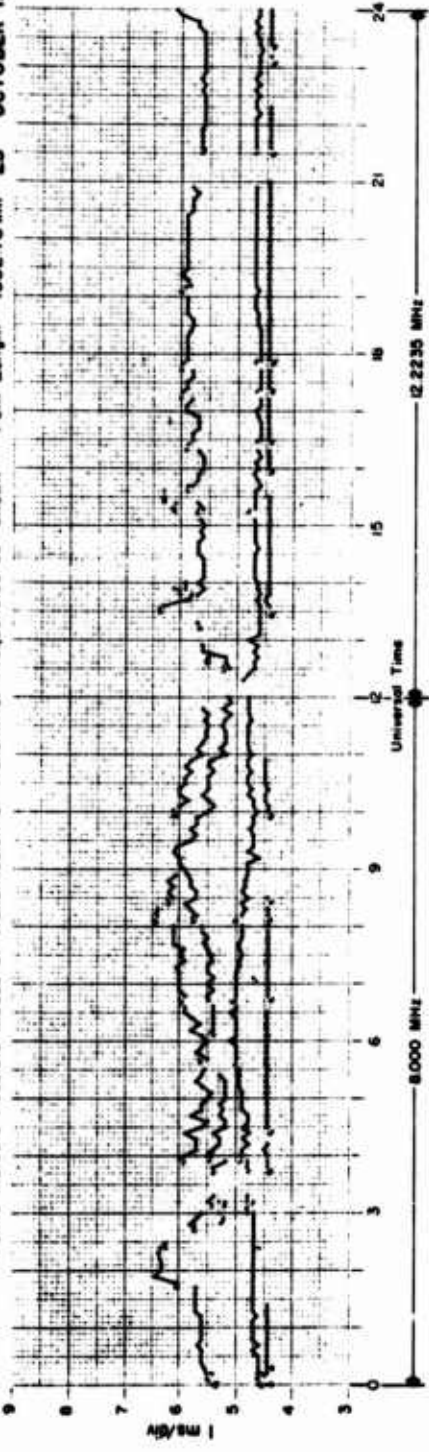


Plate 36.

24 October 1967

OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 25 OCTOBER 1967



BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
Antenna: of Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 25 OCTOBER 1967

NO DATA AVAILABLE

BEARING DEVIATION PLOTS - TIME AVERAGED 25 OCTOBER 1967

NO DATA AVAILABLE

NO DATA AVAILABLE

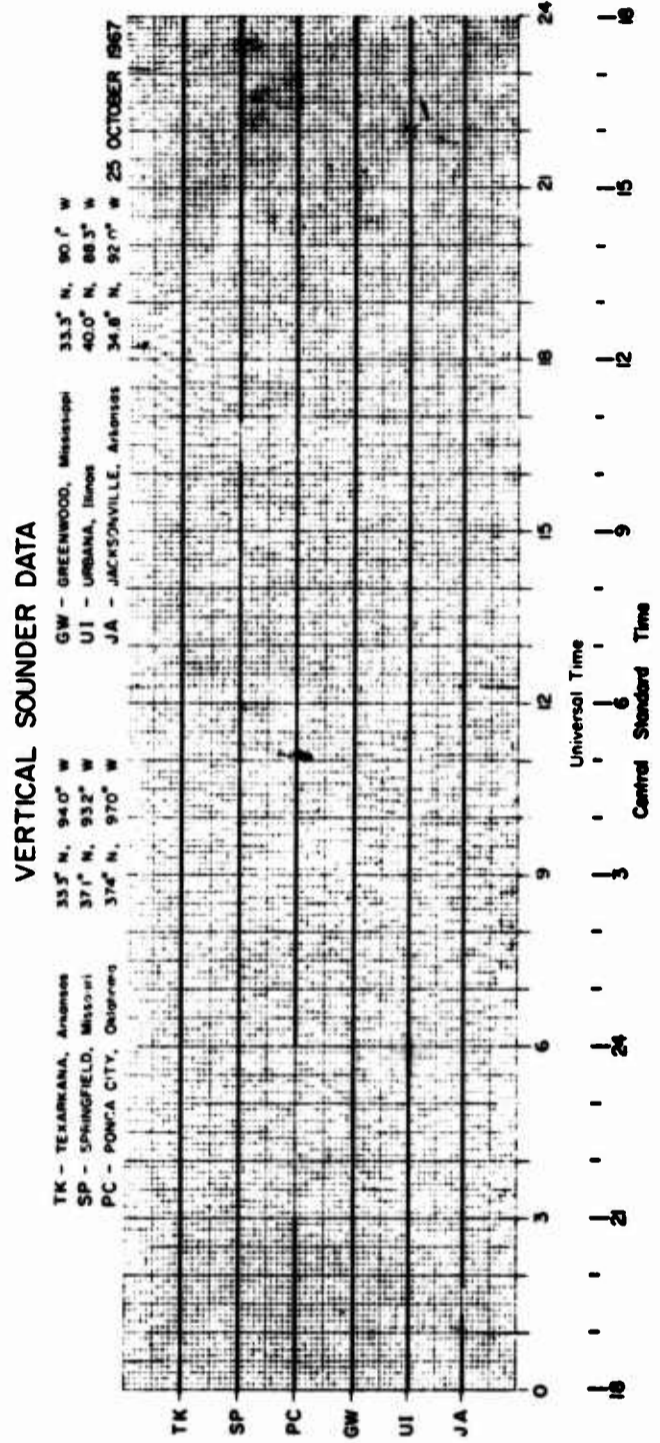
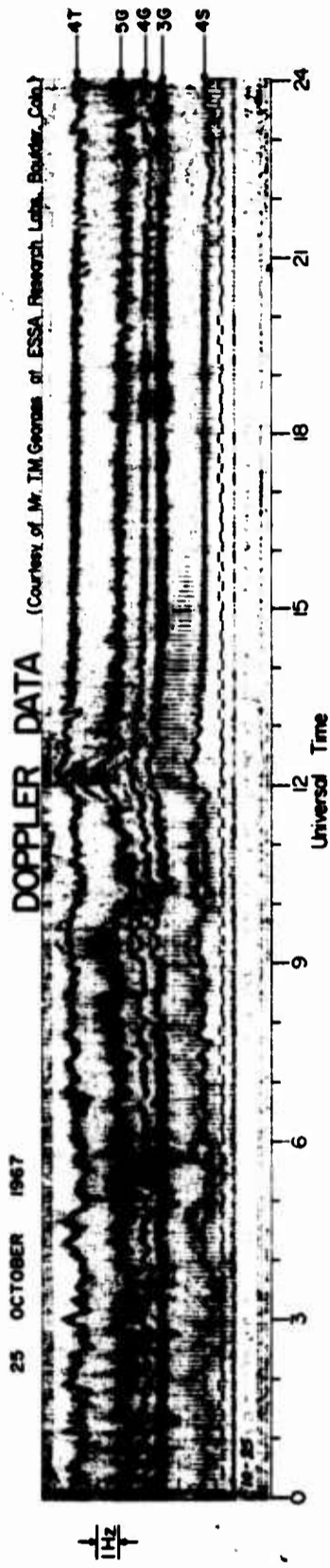
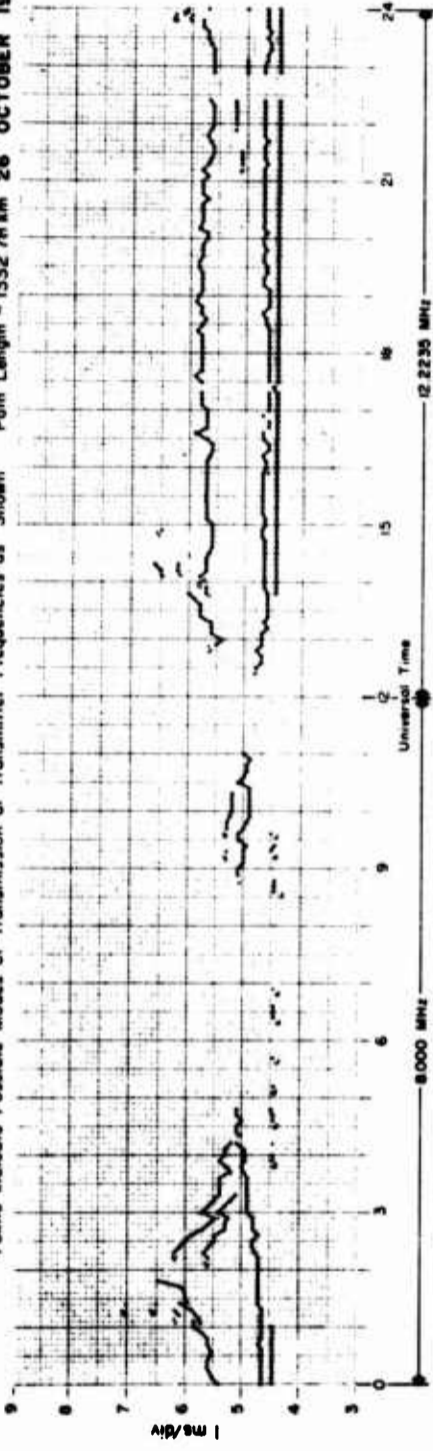


Plate 37.
25 October 1967

OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
Points indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.7R km 26 OCTOBER 1967



BEARING DEVIATION PLOT

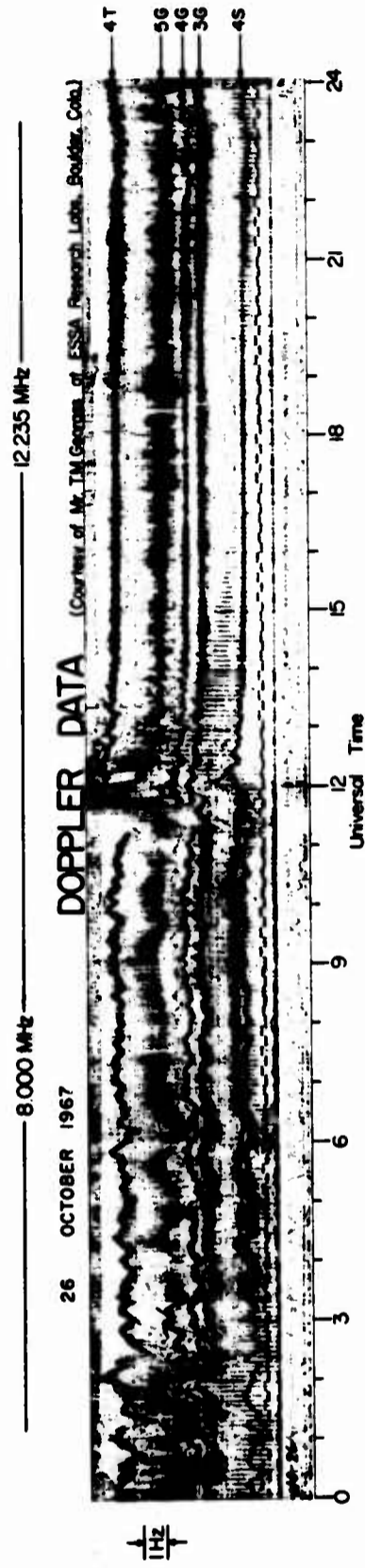
Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 26 OCTOBER 1967

NO DATA AVAILABLE

BEARING DEVIATION PLOTS - TIME AVERAGED 26 OCTOBER 1967

NO DATA AVAILABLE

NO DATA AVAILABLE



VERTICAL SOUNDER DATA

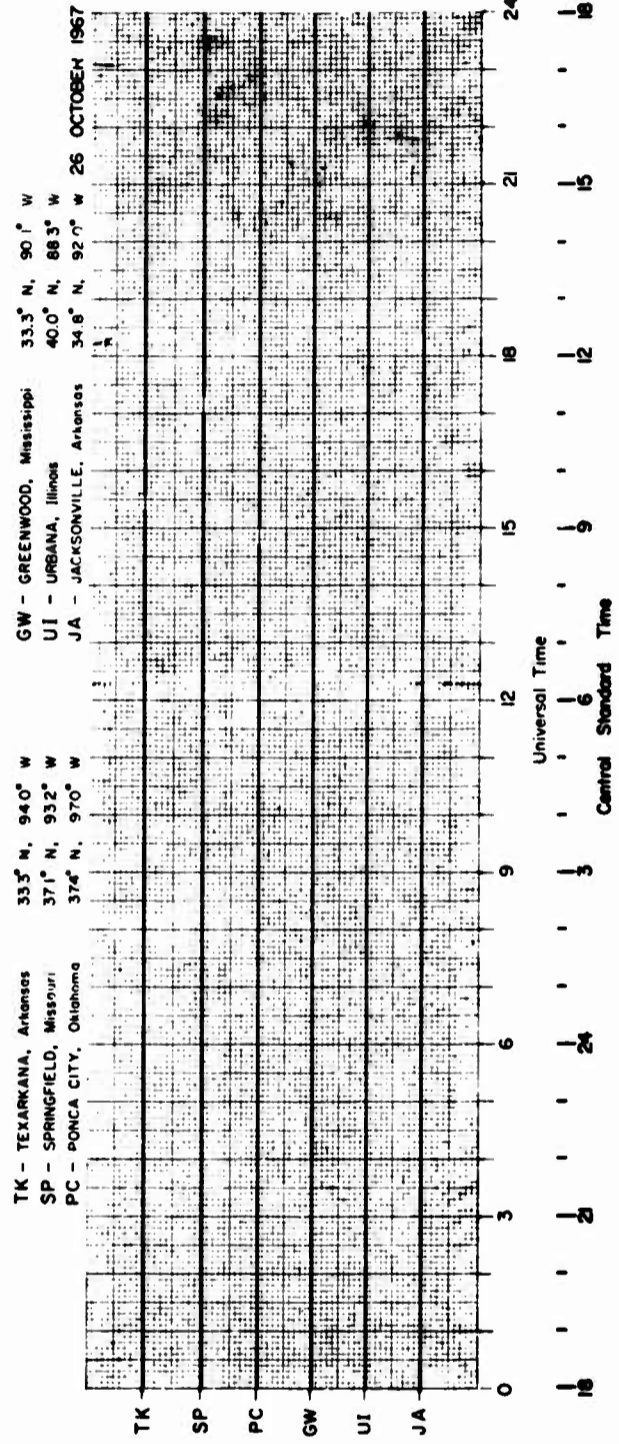
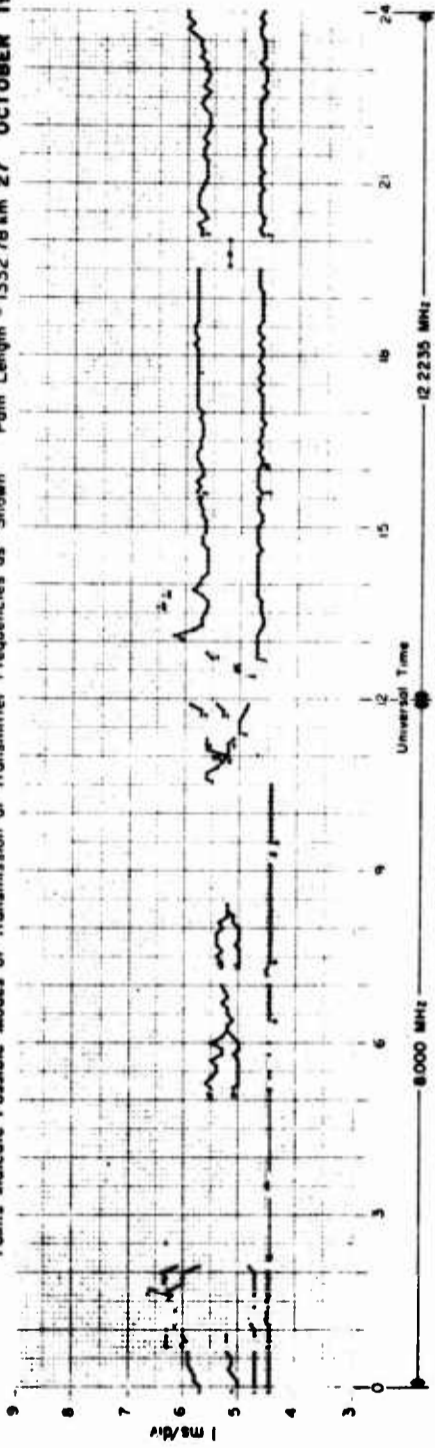


Plate 38.

26 October 1967

OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bonville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
Points indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 27 OCTOBER 1967



BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min Intervals
Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 27 OCTOBER 1967

NO DATA AVAILABLE

BEARING DEVIATION PLOTS - TIME AVERAGED 27 OCTOBER 1967

NO DATA AVAILABLE

NO DATA AVAILABLE

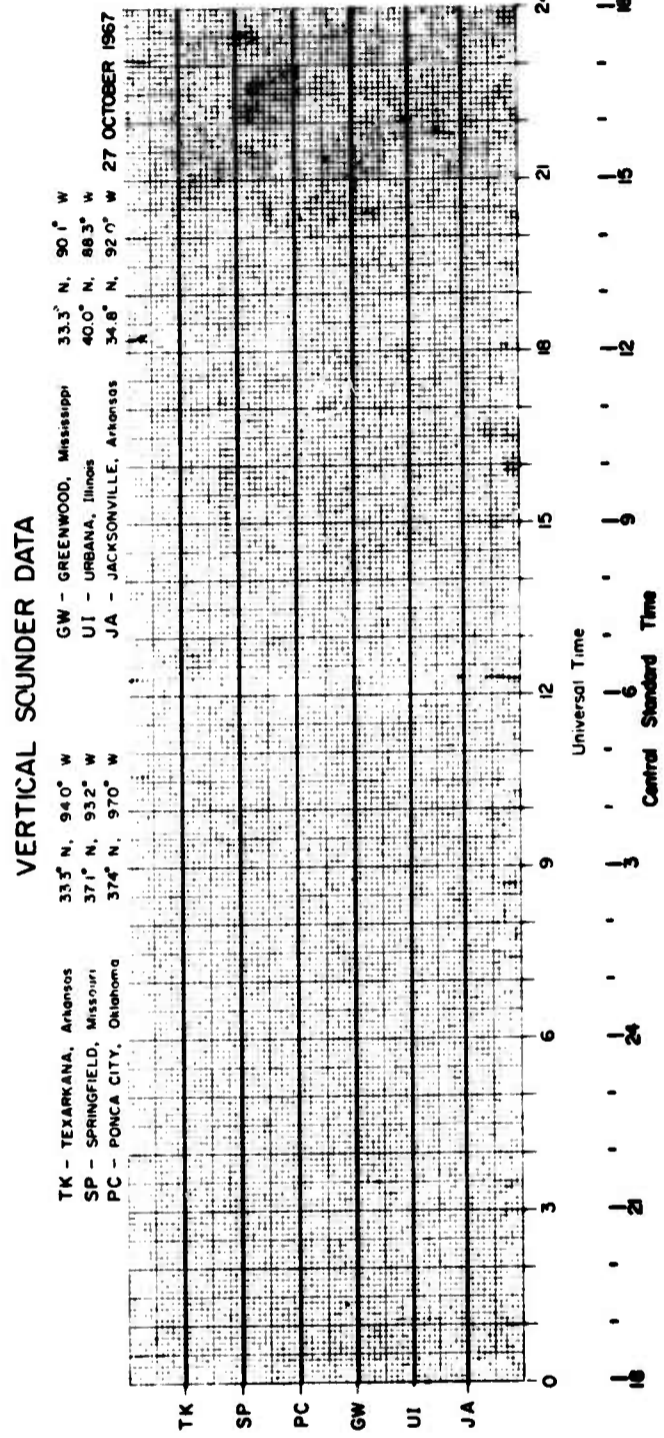
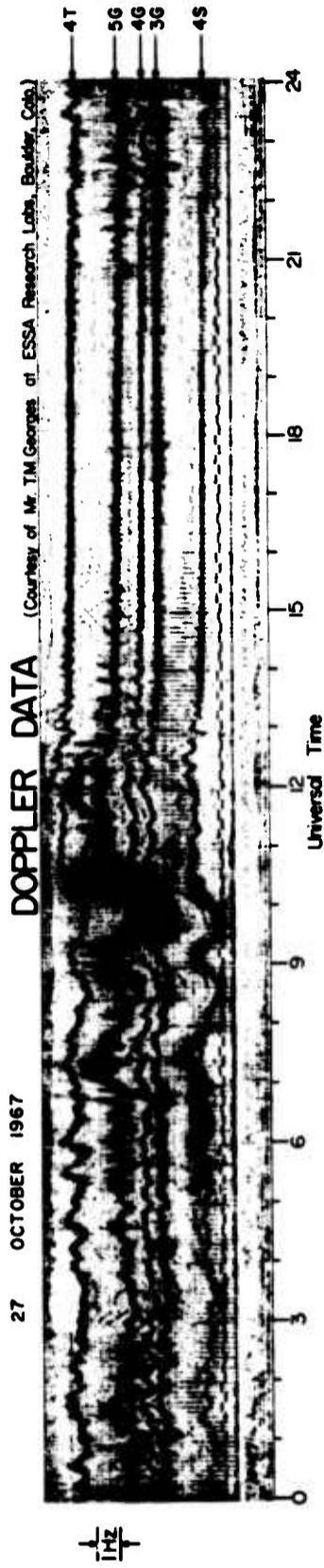
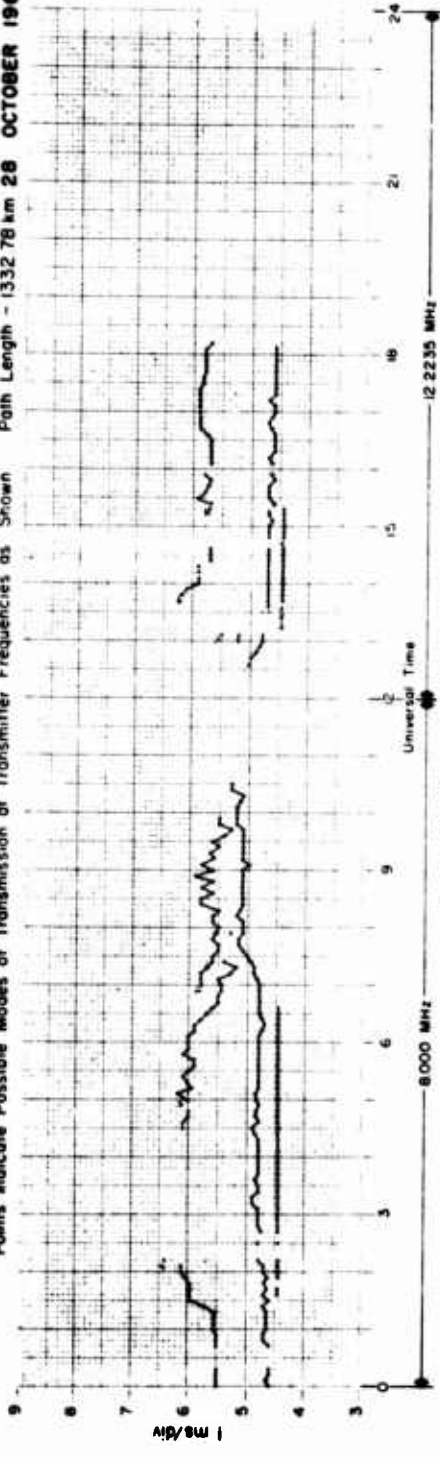


Plate 39.

27 October 1967

OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
Points indicate possible modes of transmission at transmitter frequencies as shown Path Length - 1332.78 km 28 OCTOBER 1967



BEARING DEVIATION PLOT

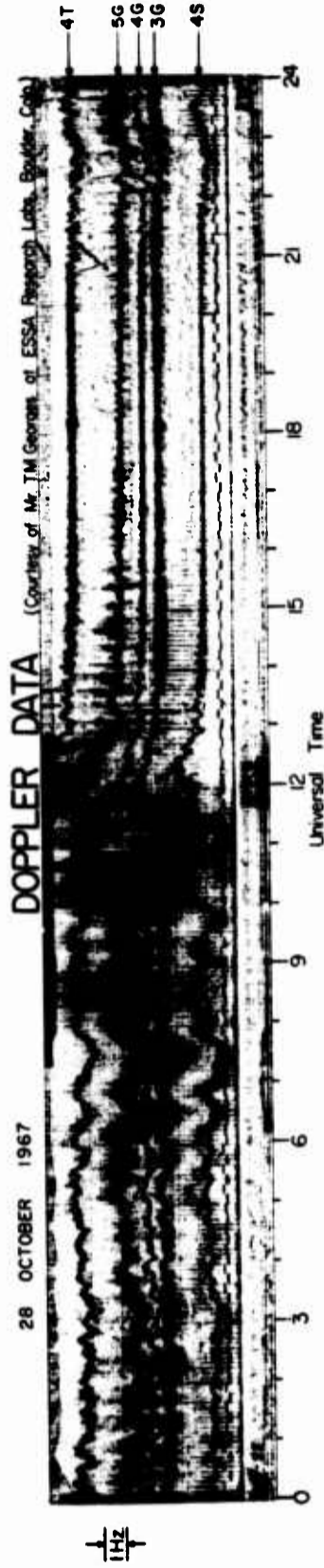
Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 28 OCTOBER 1967

NO DATA AVAILABLE

BEARING DEVIATION PLOTS - TIME AVERAGED 28 OCTOBER 1967

NO DATA AVAILABLE

NO DATA AVAILABLE



VERTICAL SOUNDER DATA

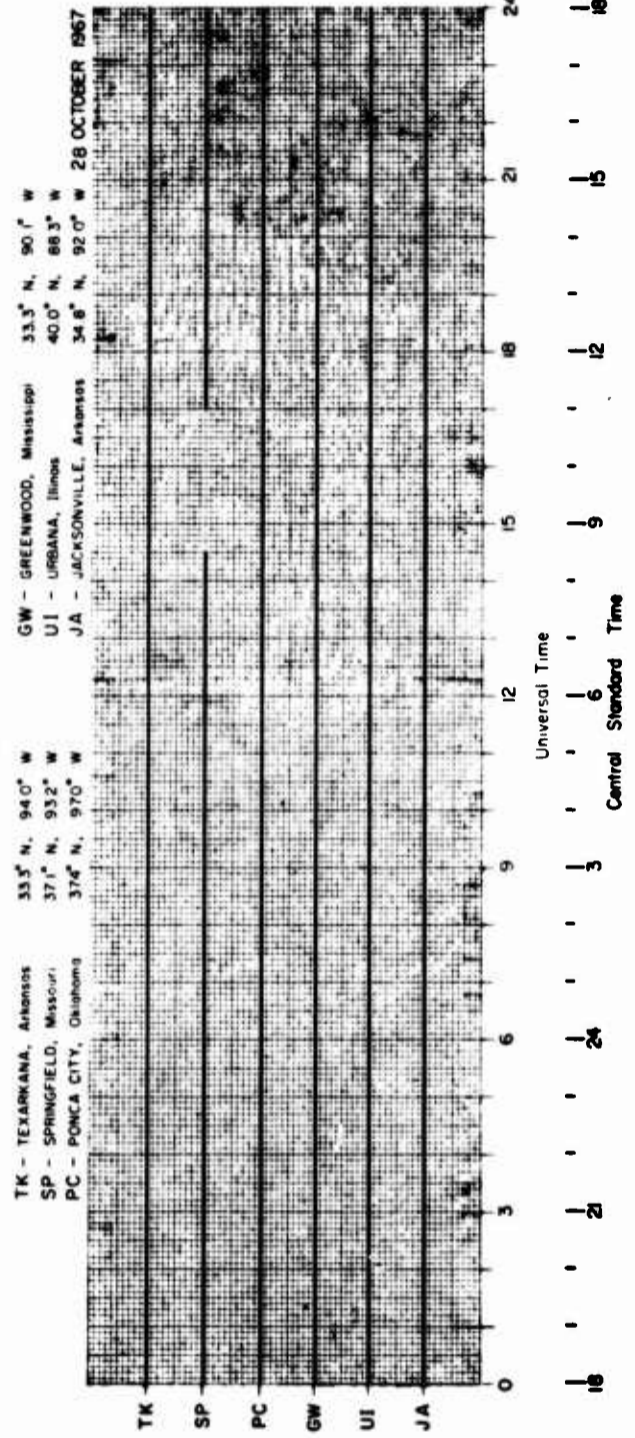
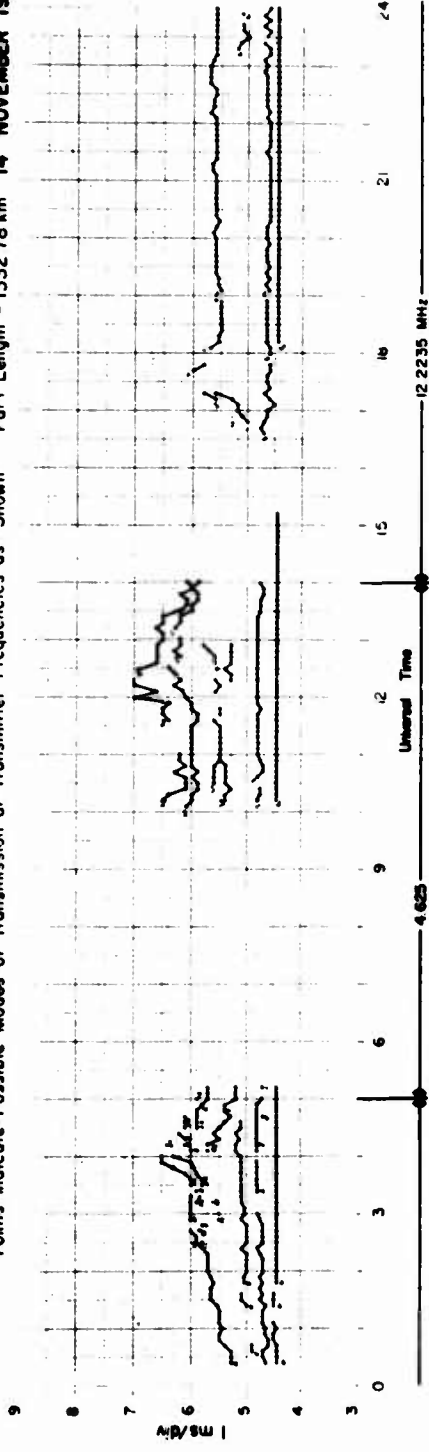


Plate 40.

28 October 1967

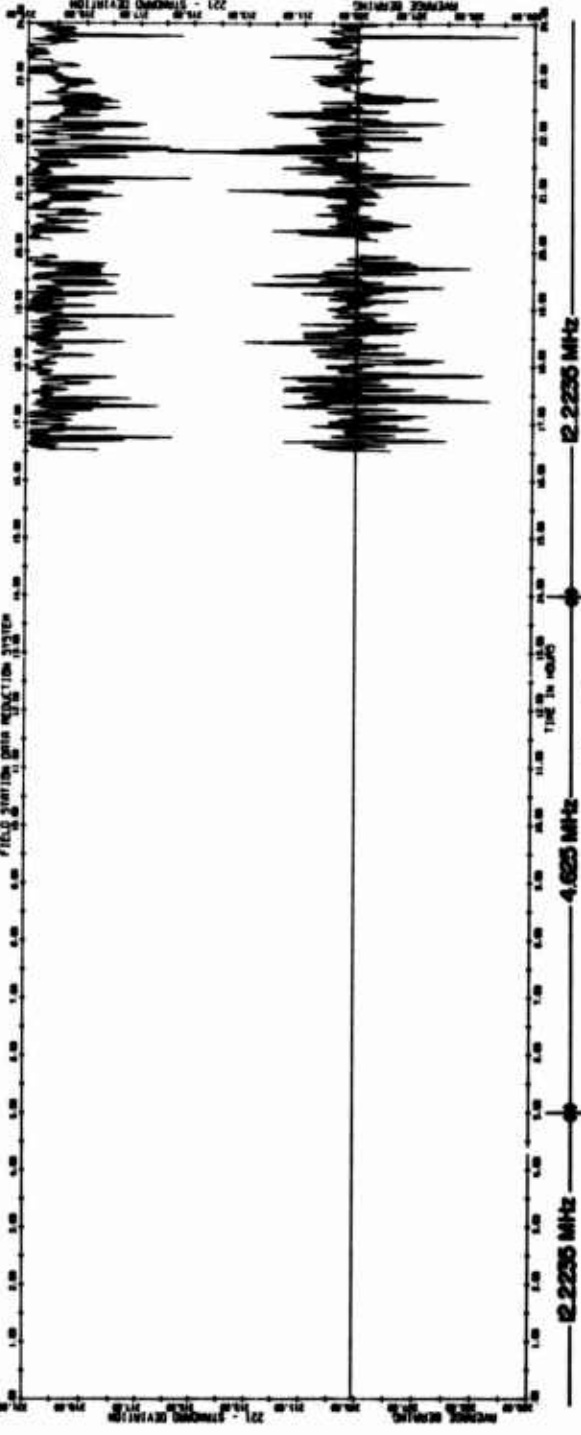
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 14 NOVEMBER 1967

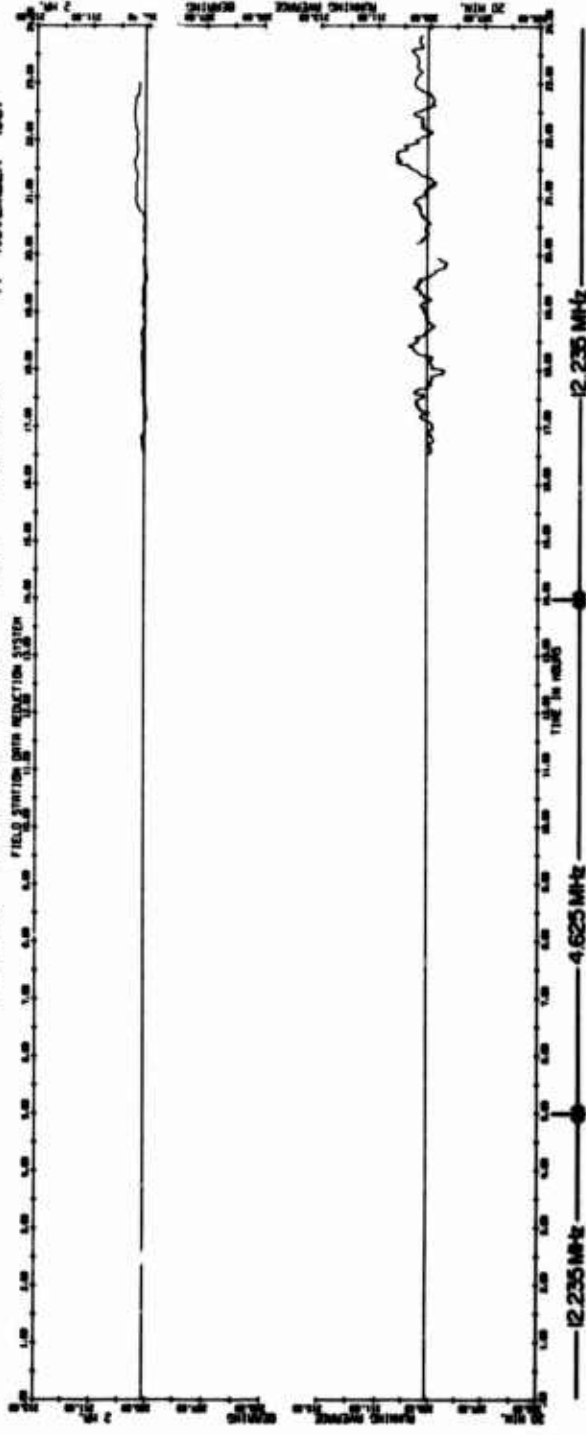


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 14 NOVEMBER 1967



BEARING DEVIATION PLOTS - TIME AVERAGED



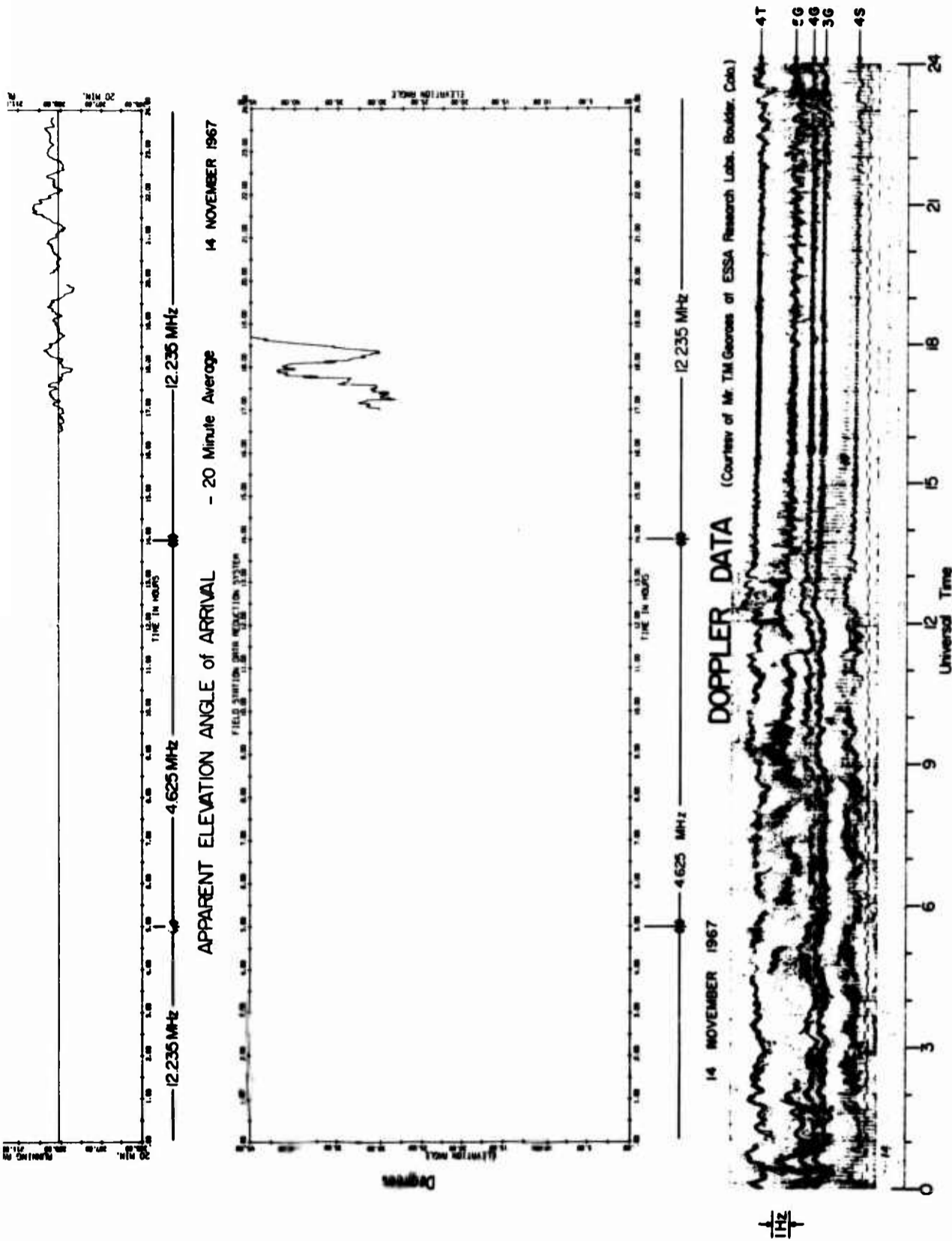


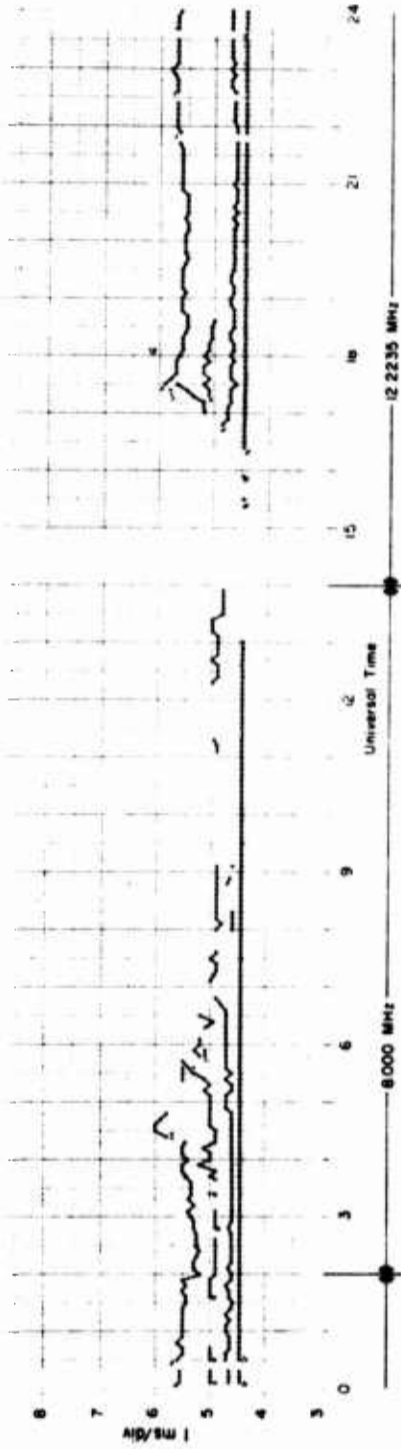
Plate 41.

14 November 1967

2

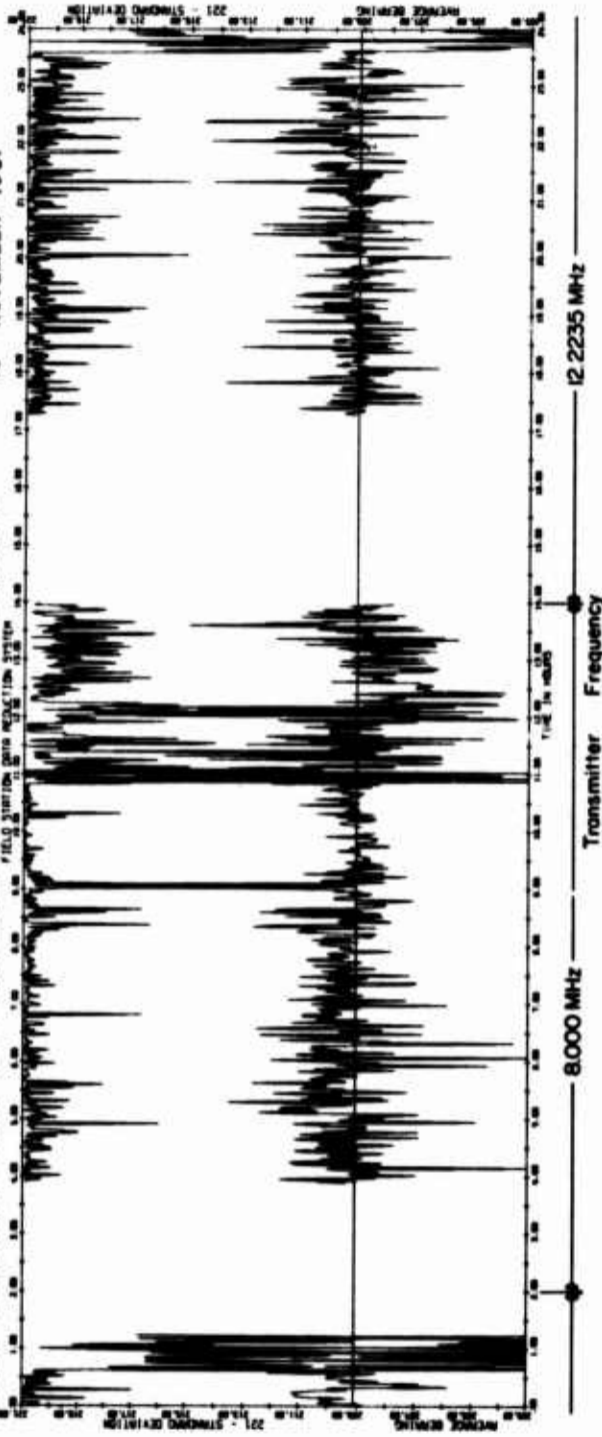
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 15 NOVEMBER 1967

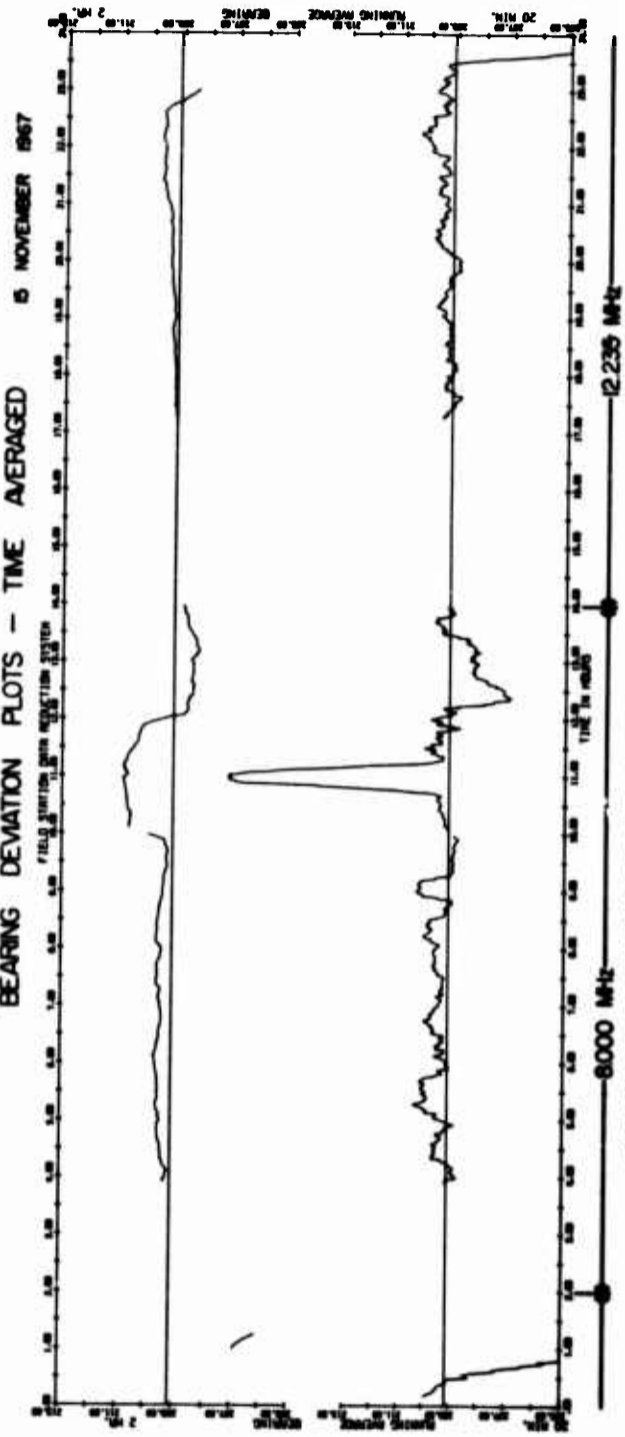


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34° 8' N, 92° 0' W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 15 NOVEMBER 1967



BEARING DEVIATION PLOTS - TIME AVERAGED



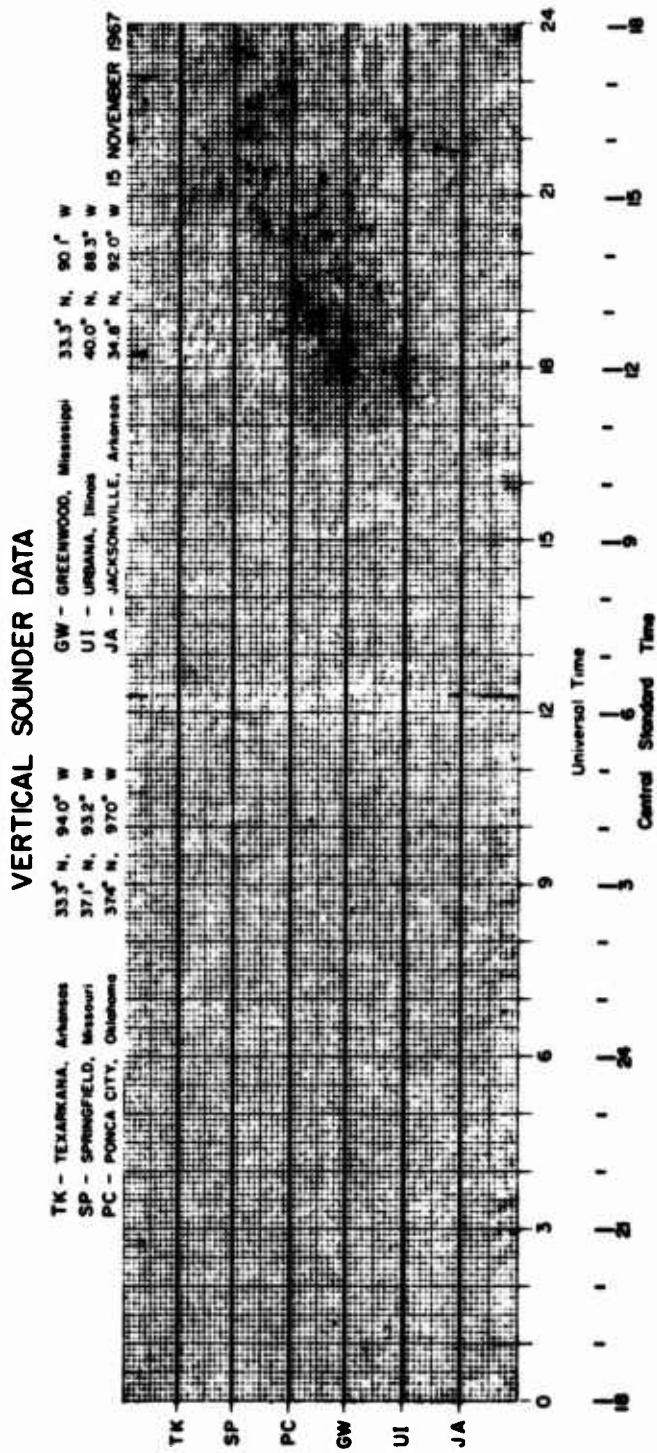
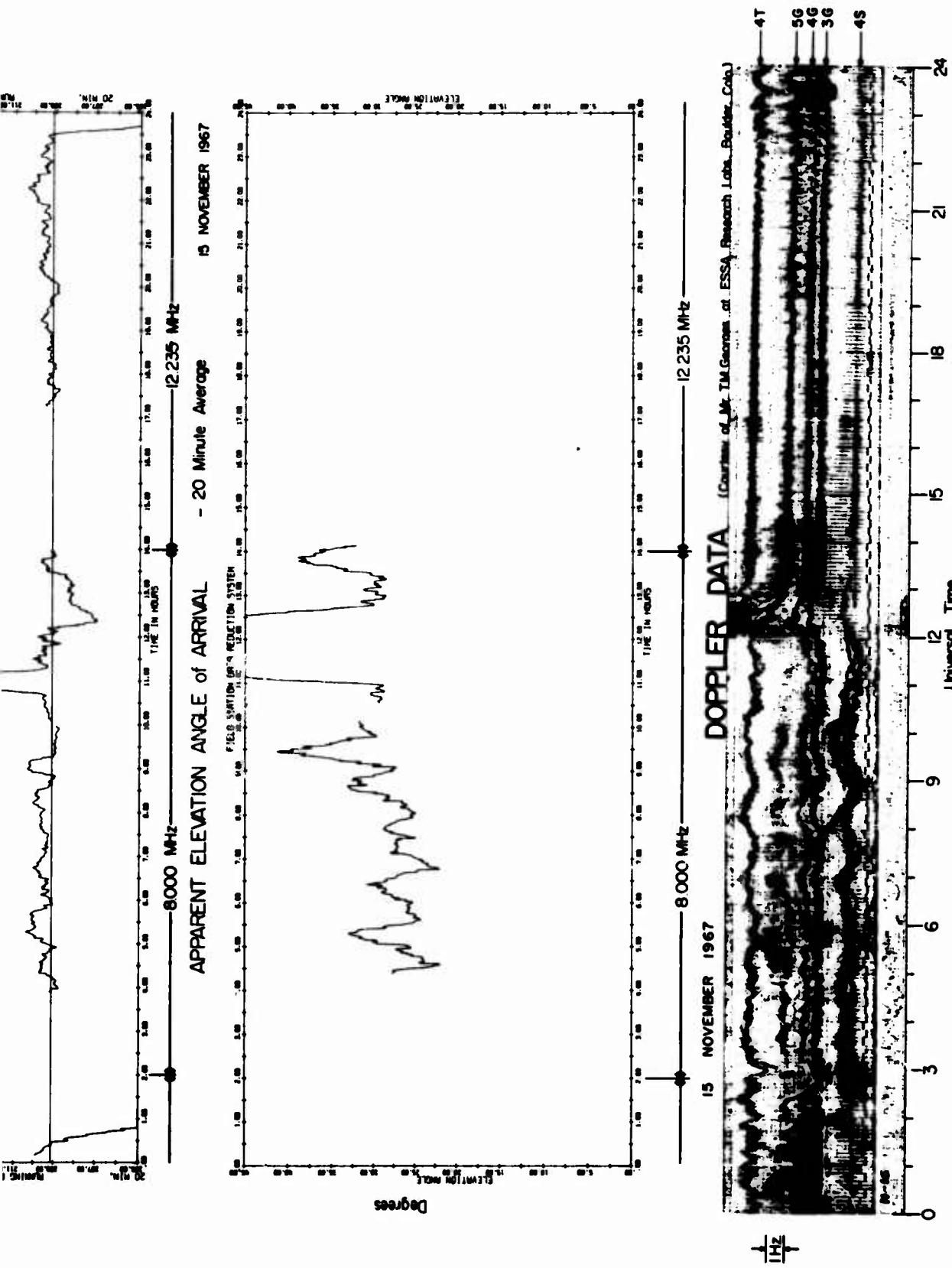
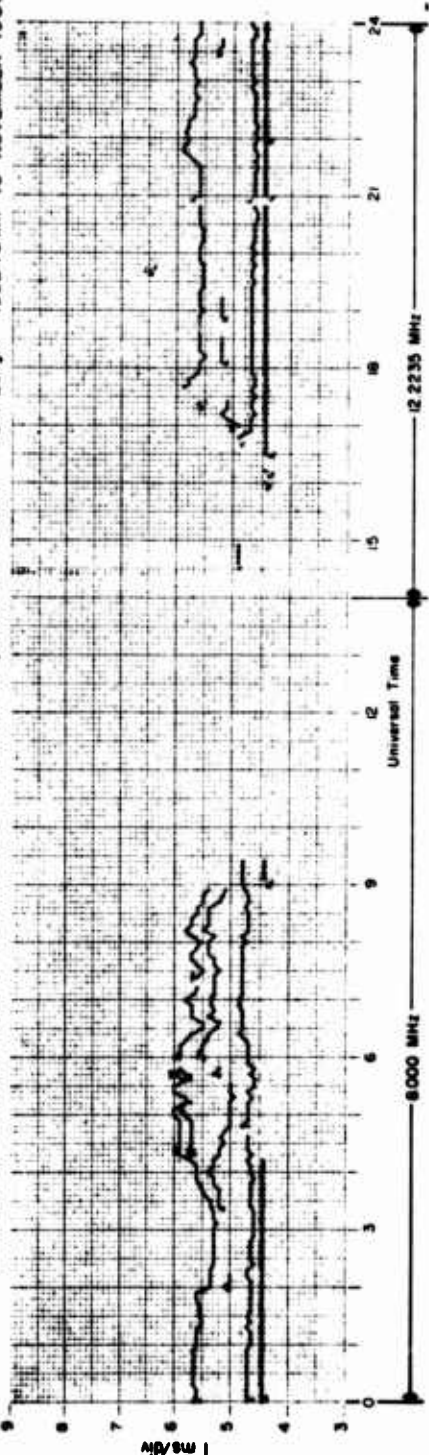


Plate 42.

15 November 1967

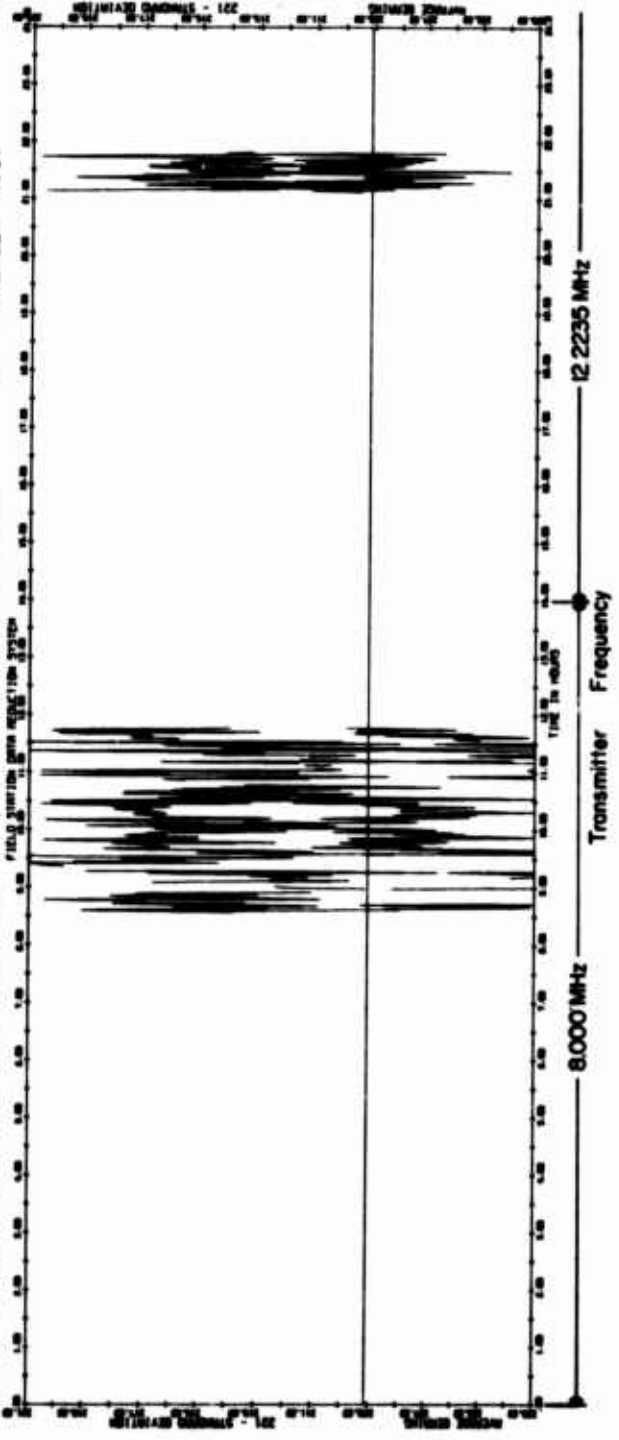
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 16 NOVEMBER 1967

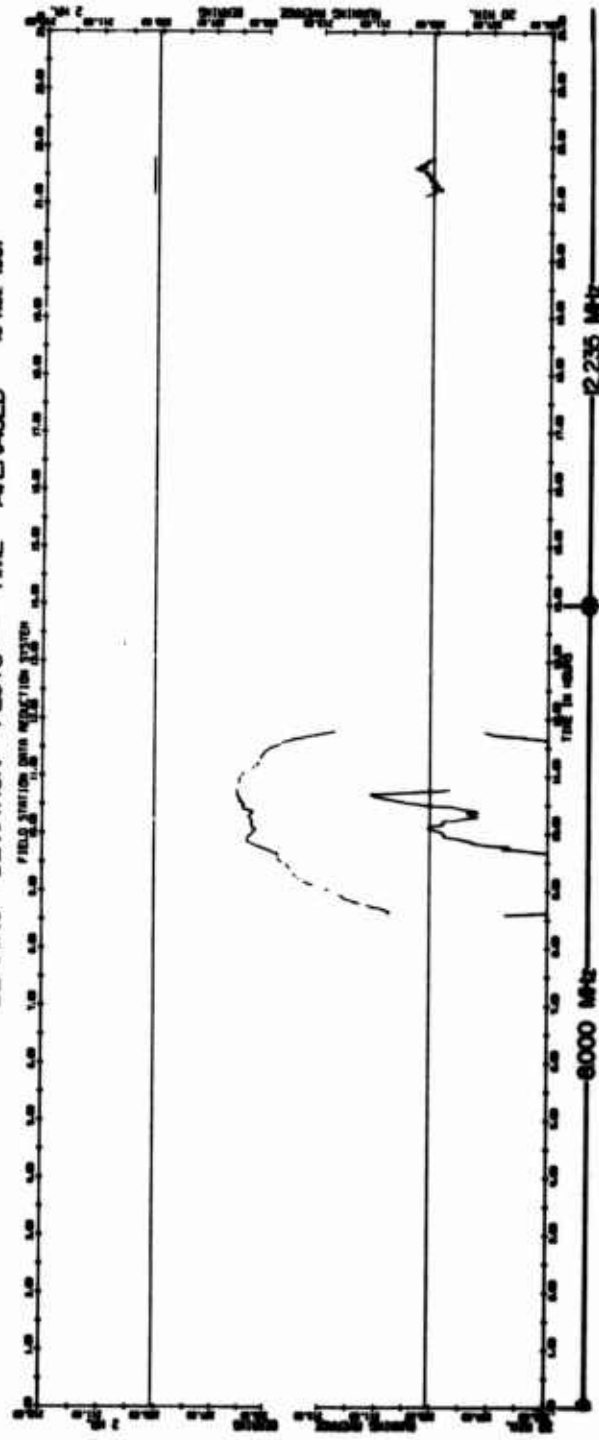


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullemeber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 16 NOVEMBER 1967



BEARING DEVIATION PLOTS - TIME AVERAGED



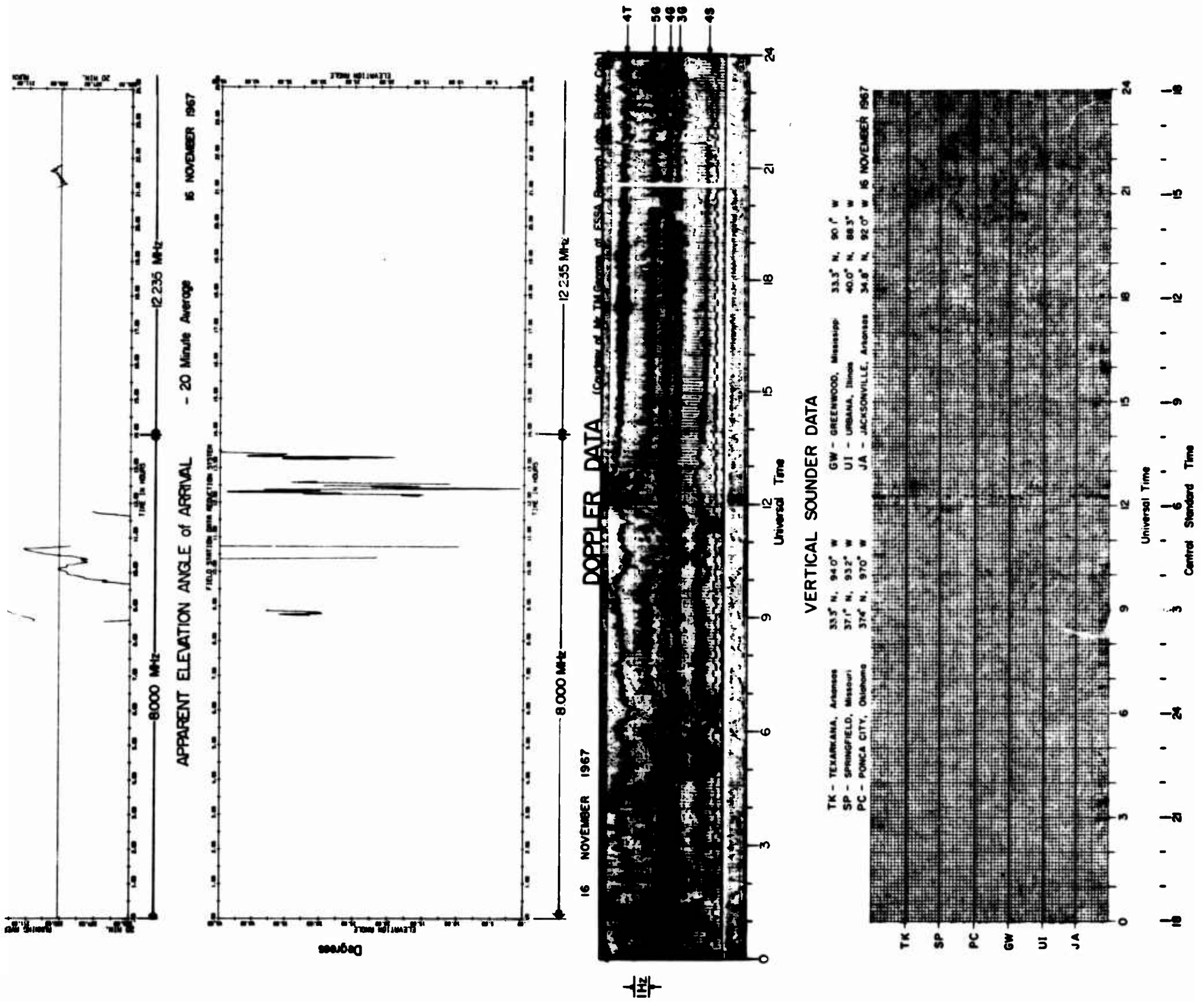


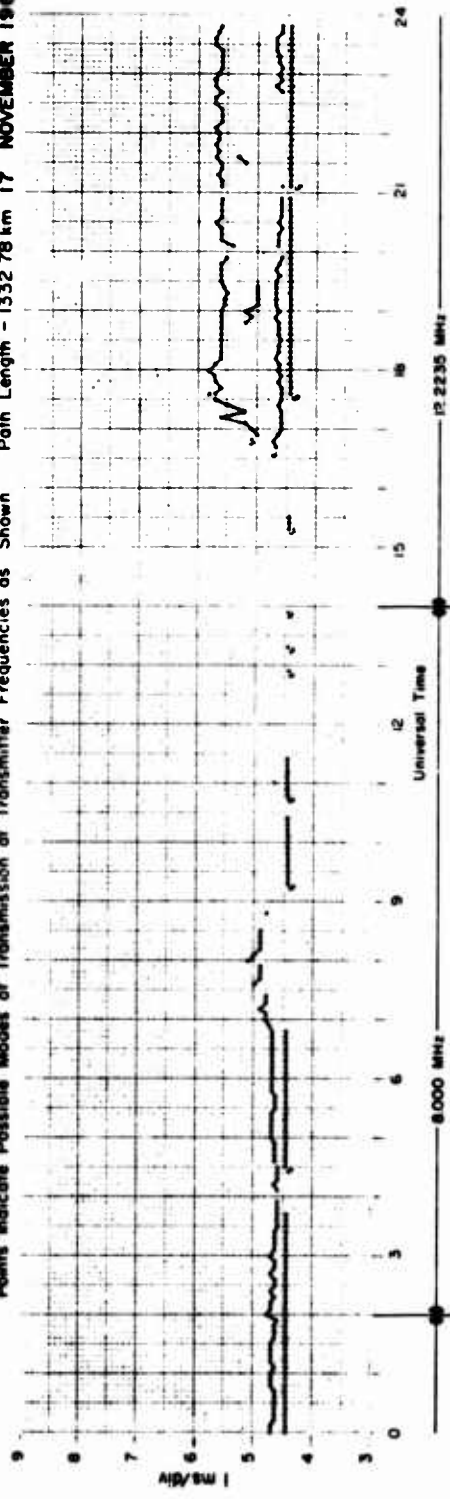
Plate 43.

16 November 1967

2

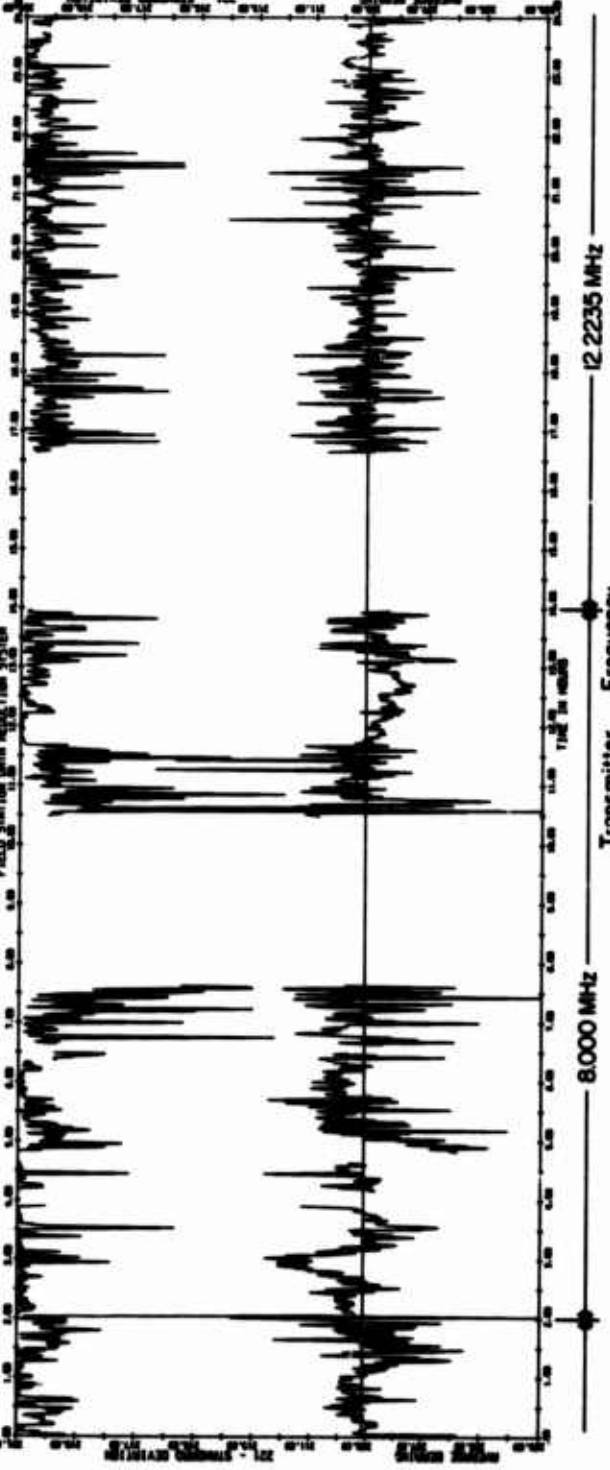
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) 10 Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 17 NOVEMBER 1967



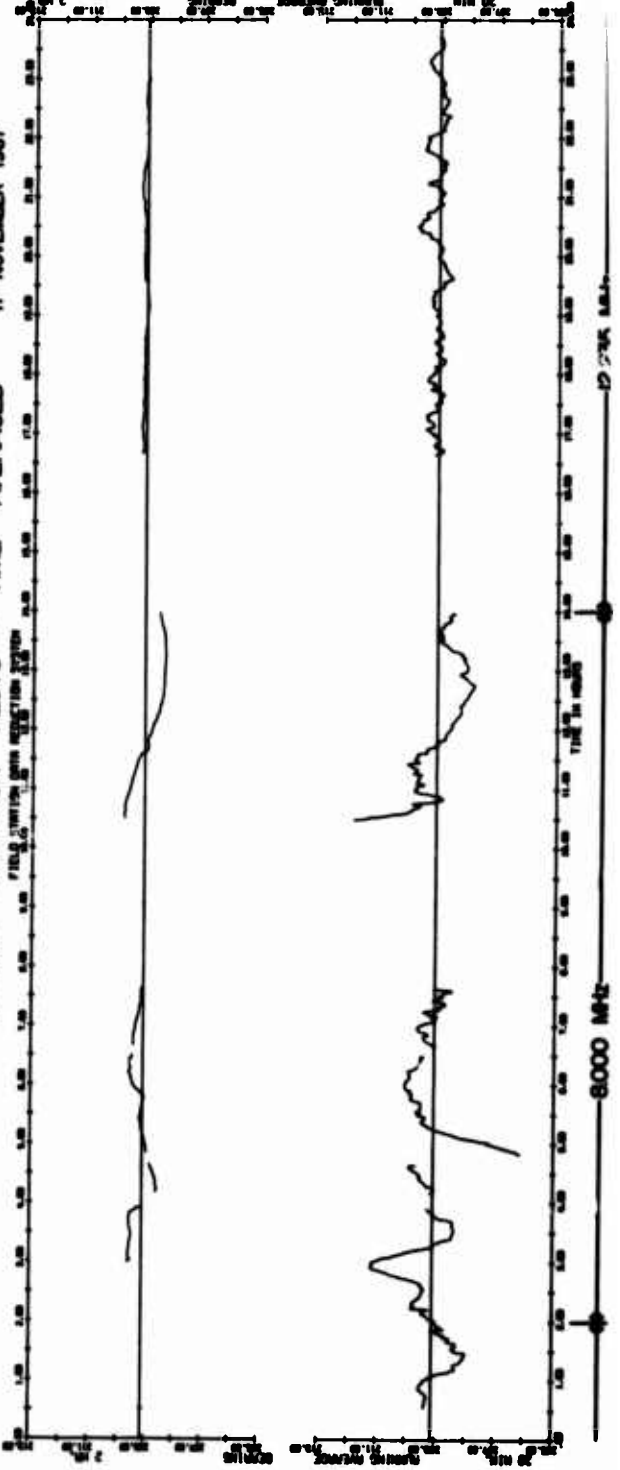
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 17 NOVEMBER 1967



BEARING DEVIATION PLOTS - TIME AVERAGED

17 NOVEMBER 1967



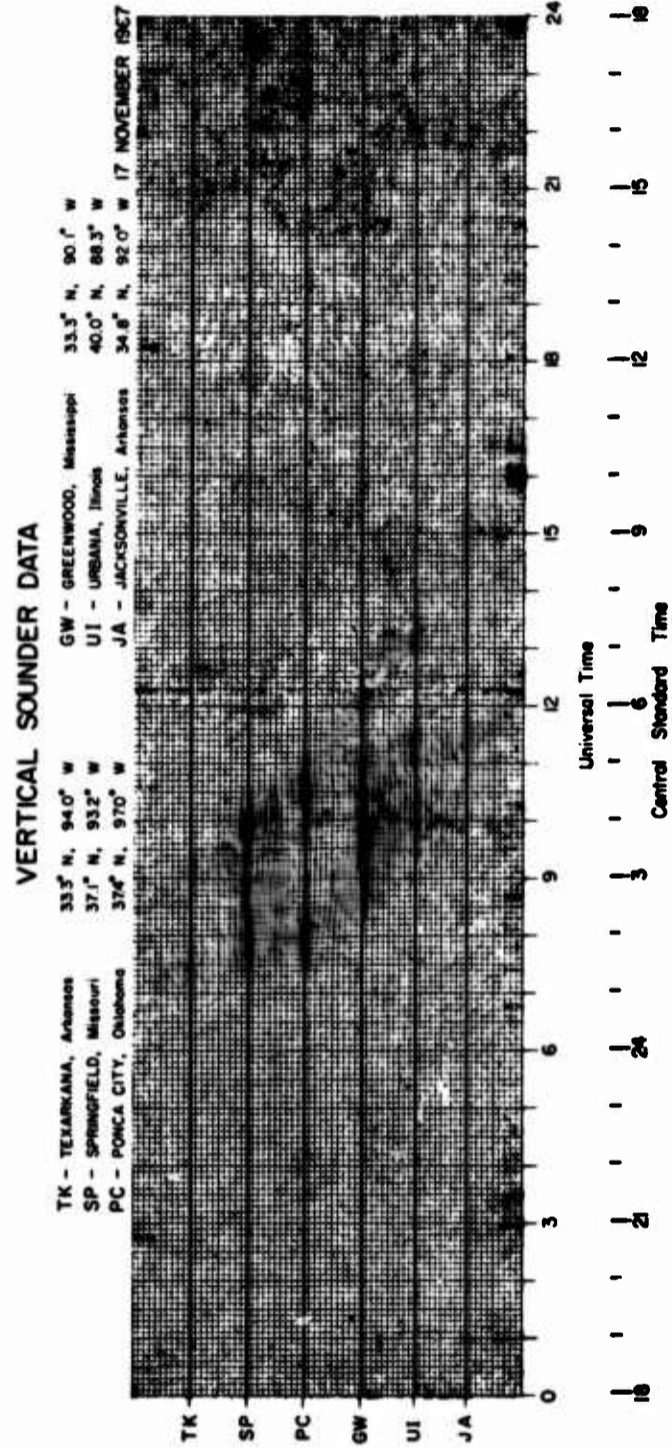
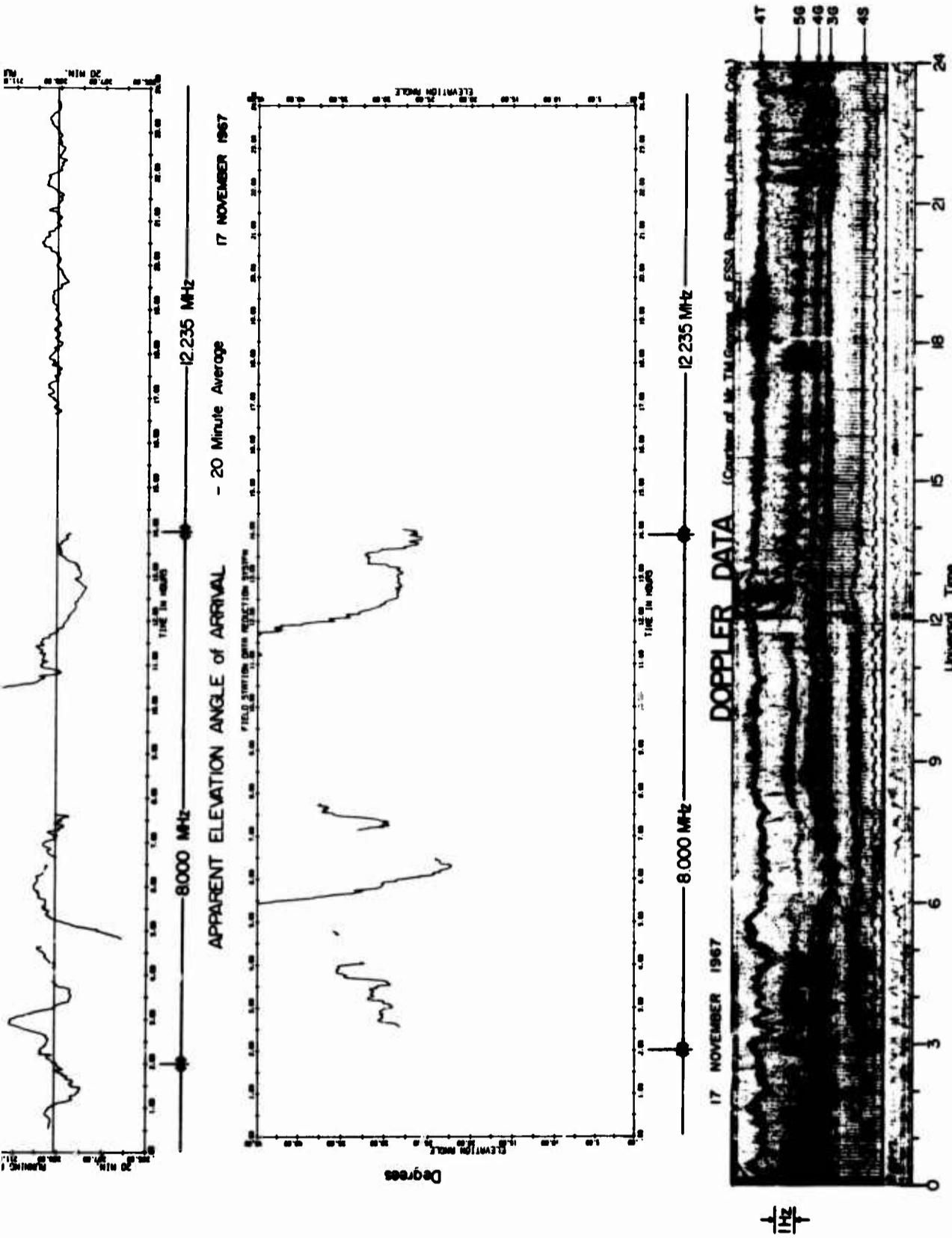
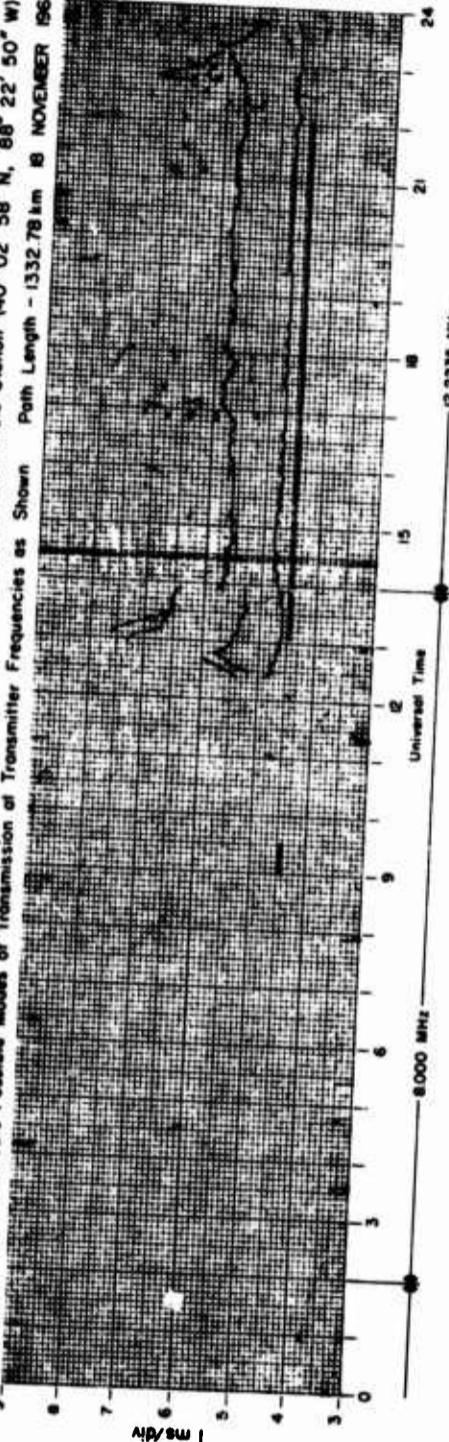
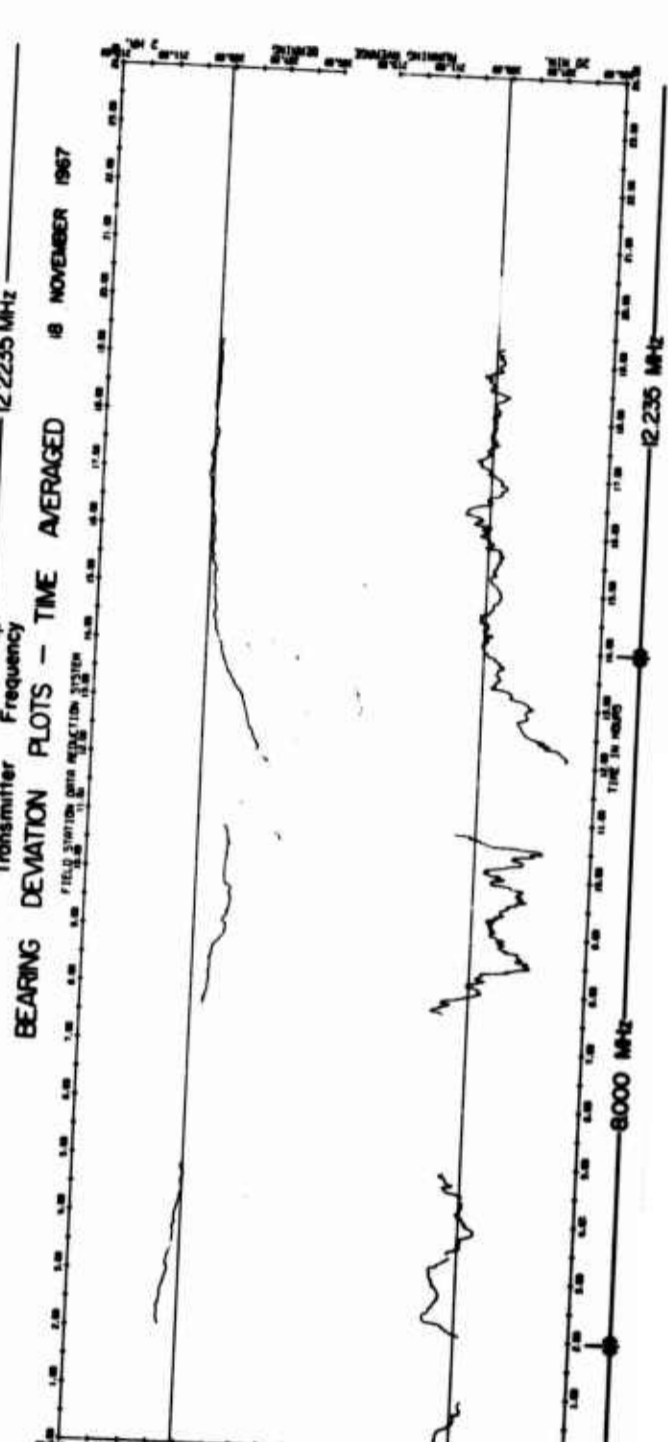
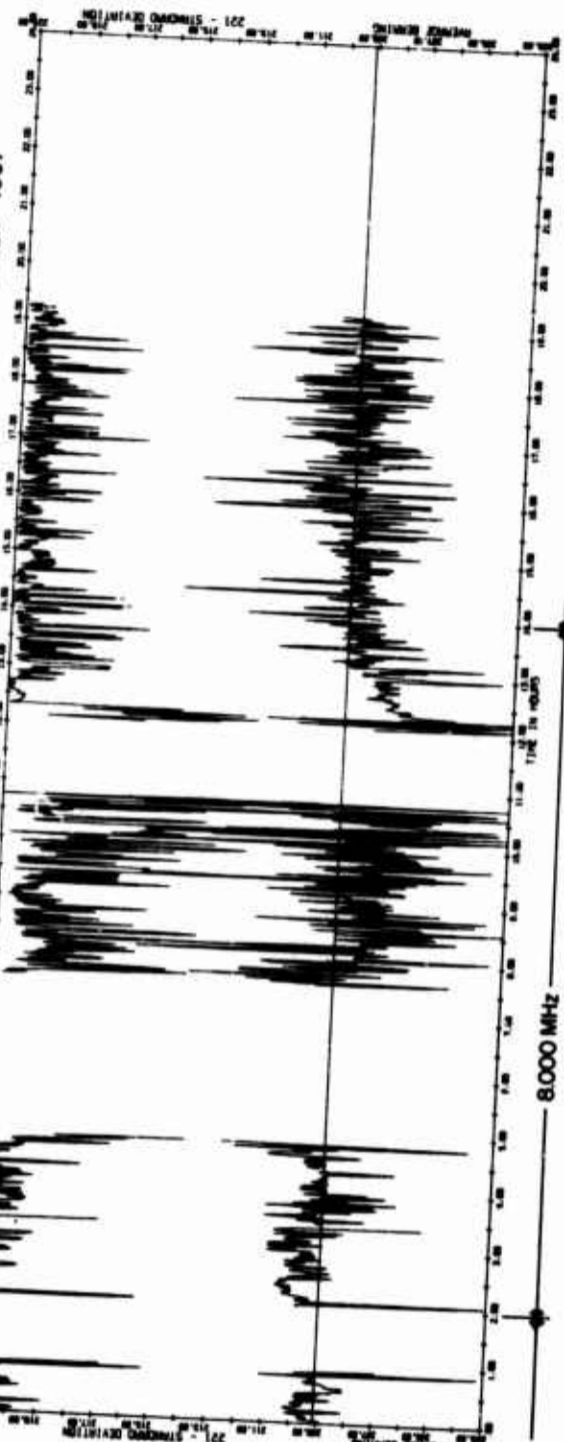


Plate 44.
17 November 1967

OBLIQUE IONOGRAM DATA
 Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 18 NOVEMBER 1967



BEARING DEVIATION PLOT
 Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W
 FIELD STATION DATA RECEIVED 18 NOVEMBER 1967



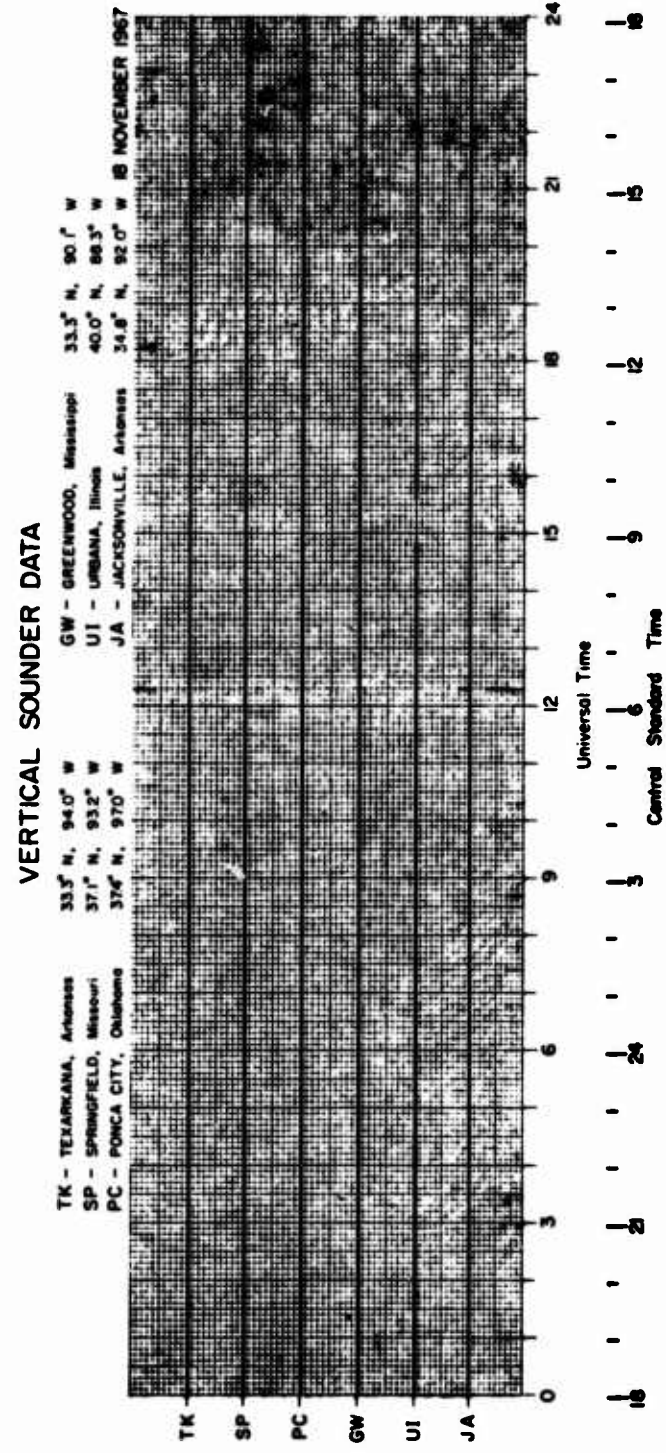
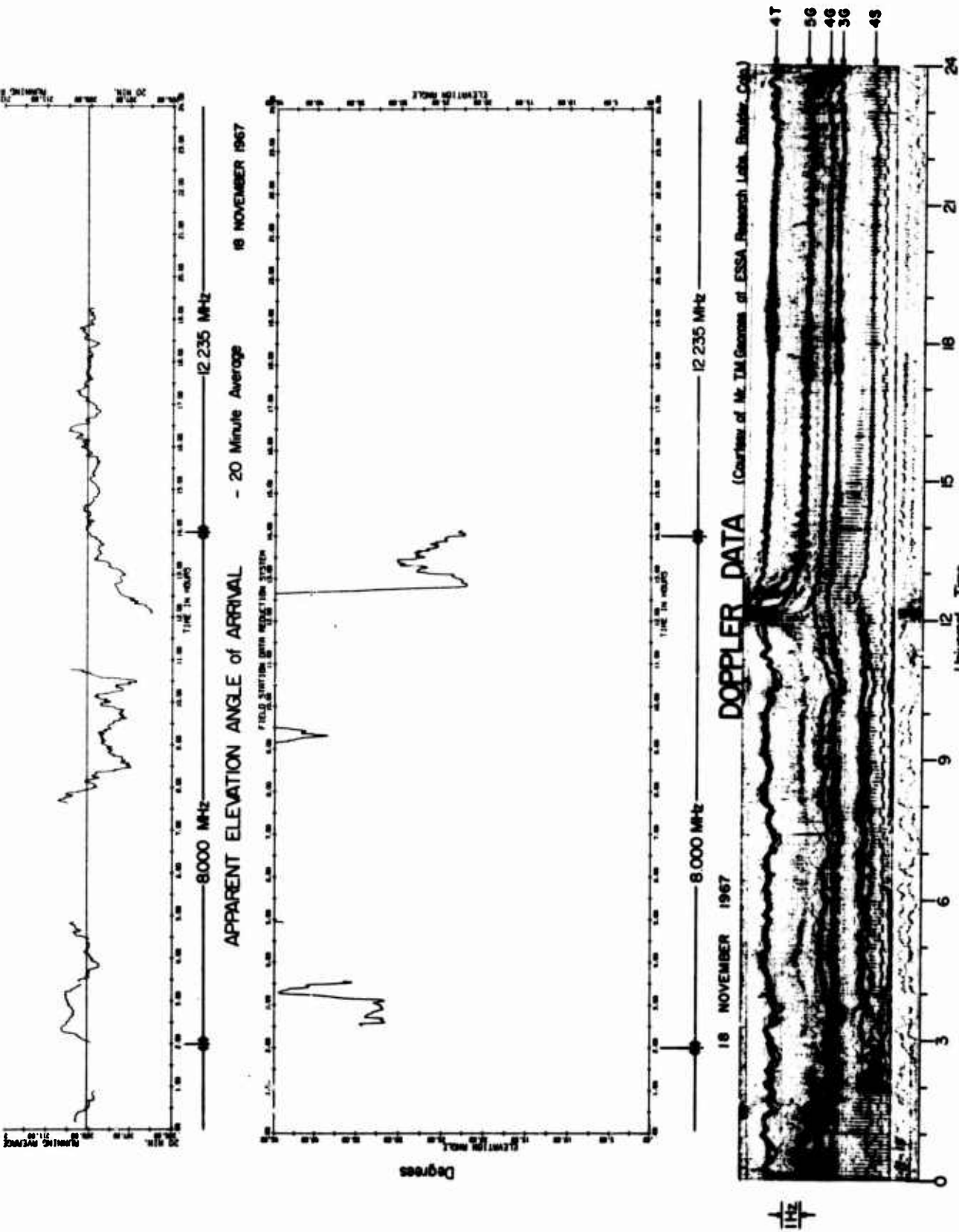
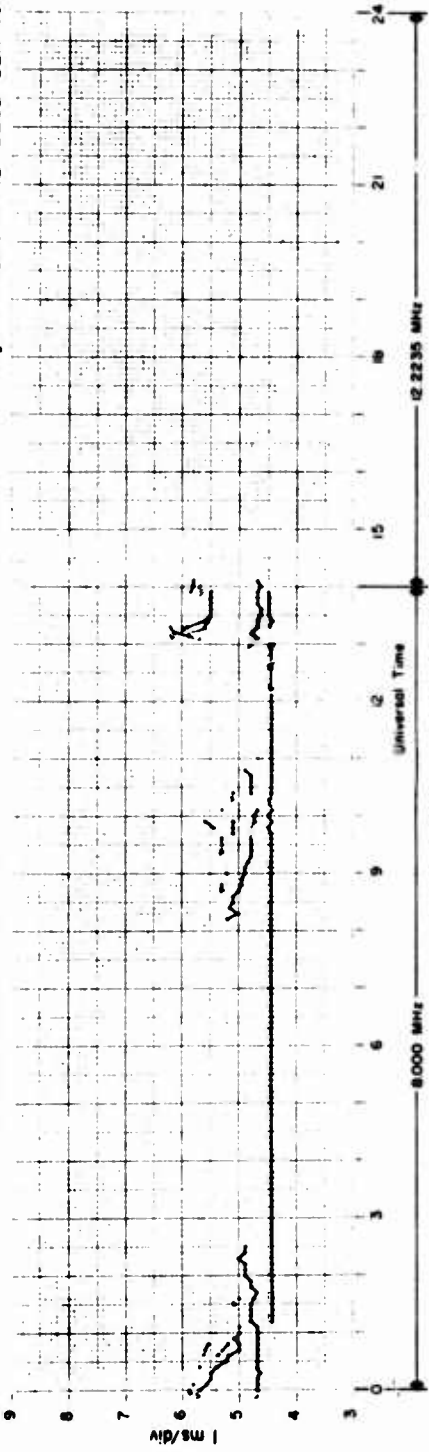
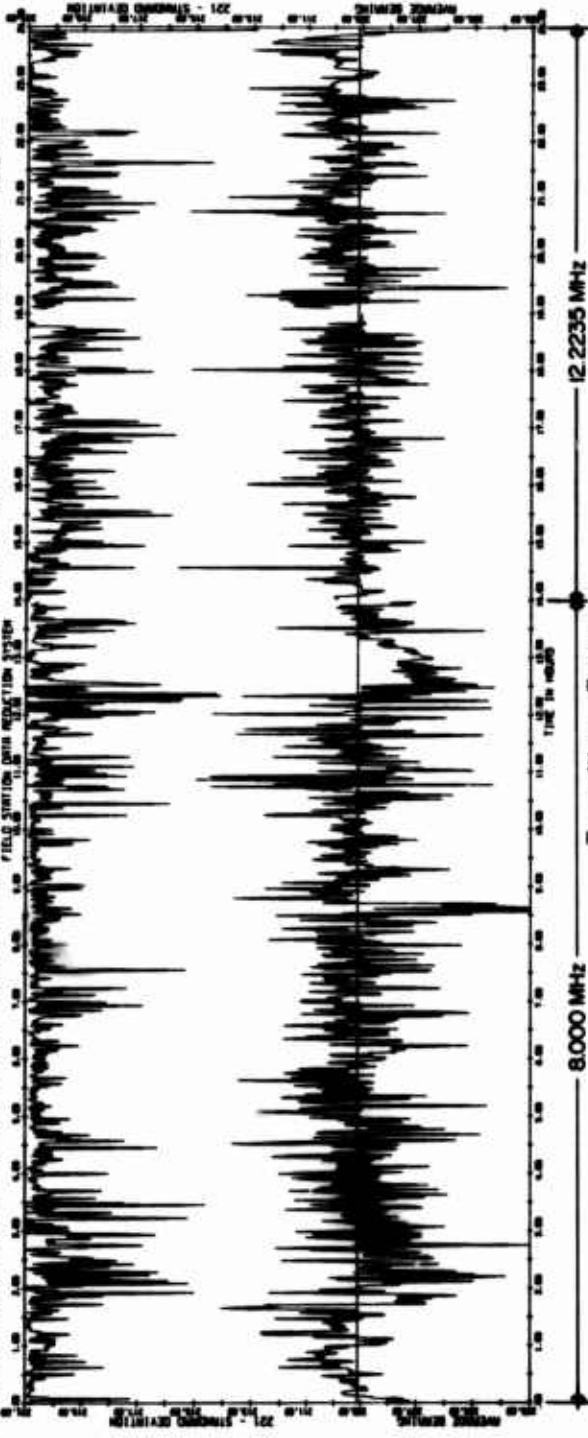


Plate 45.
18 November 1967

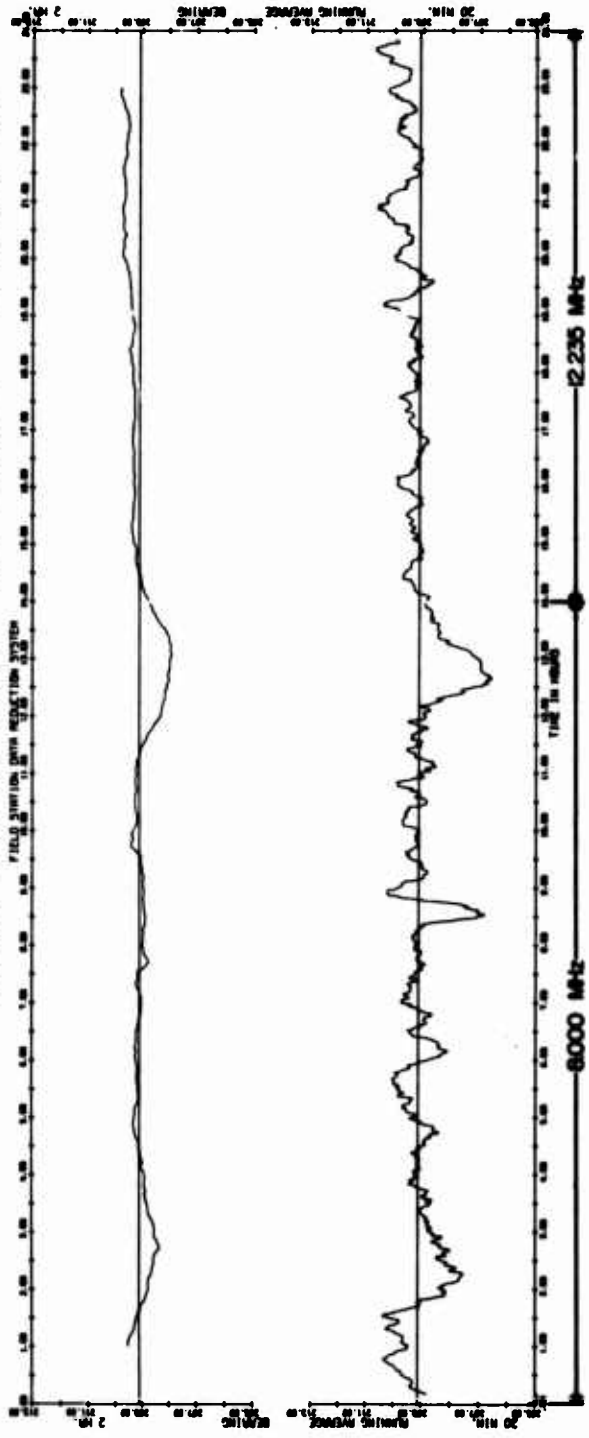
OBLIQUE IONOGRAM DATA
 Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 12 DECEMBER 1967

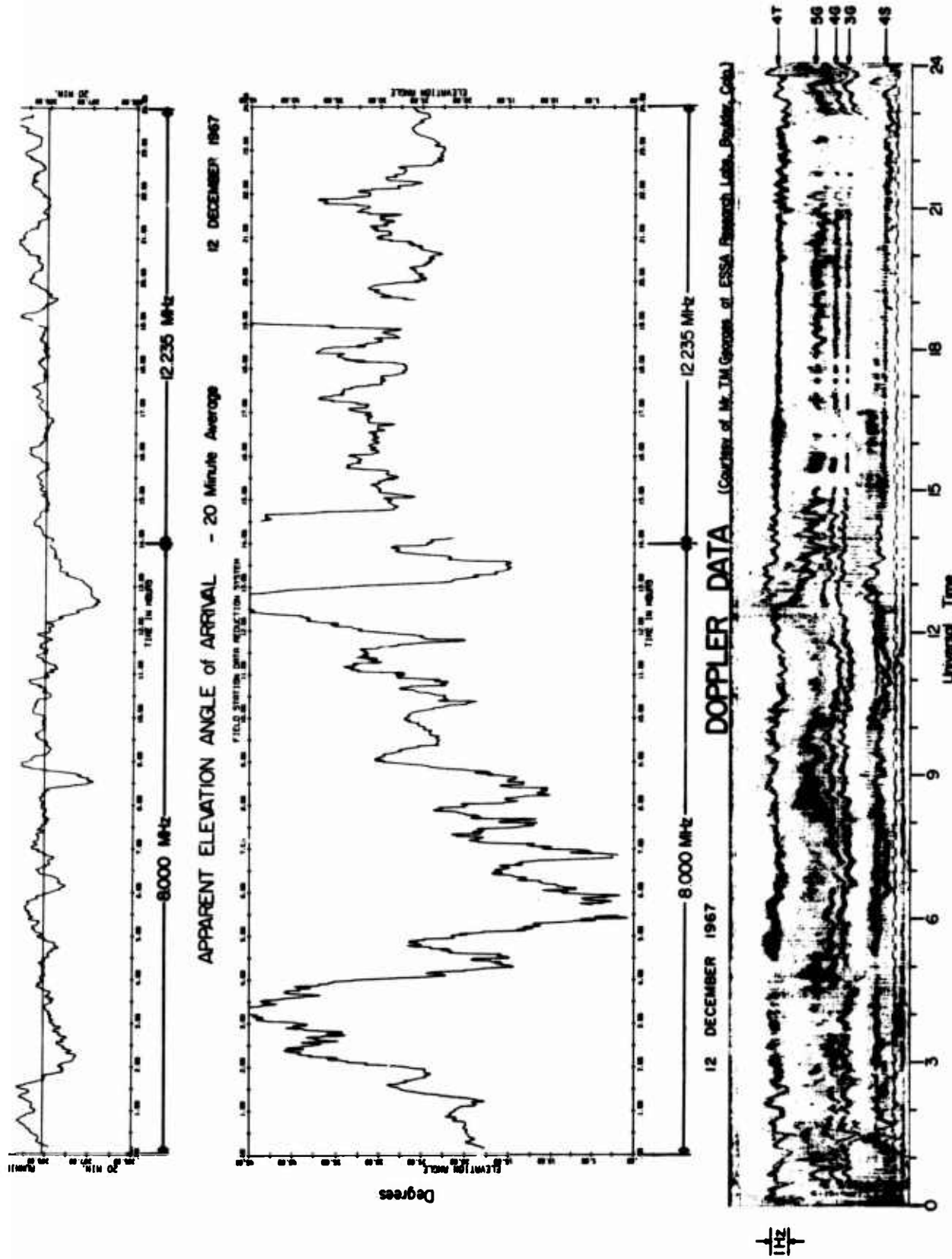


BEARING DEVIATION PLOT
 Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 12 DECEMBER 1967



BEARING DEVIATION PLOTS - TIME AVERAGED 12 DECEMBER 1967





VERTICAL SOUNDER DATA

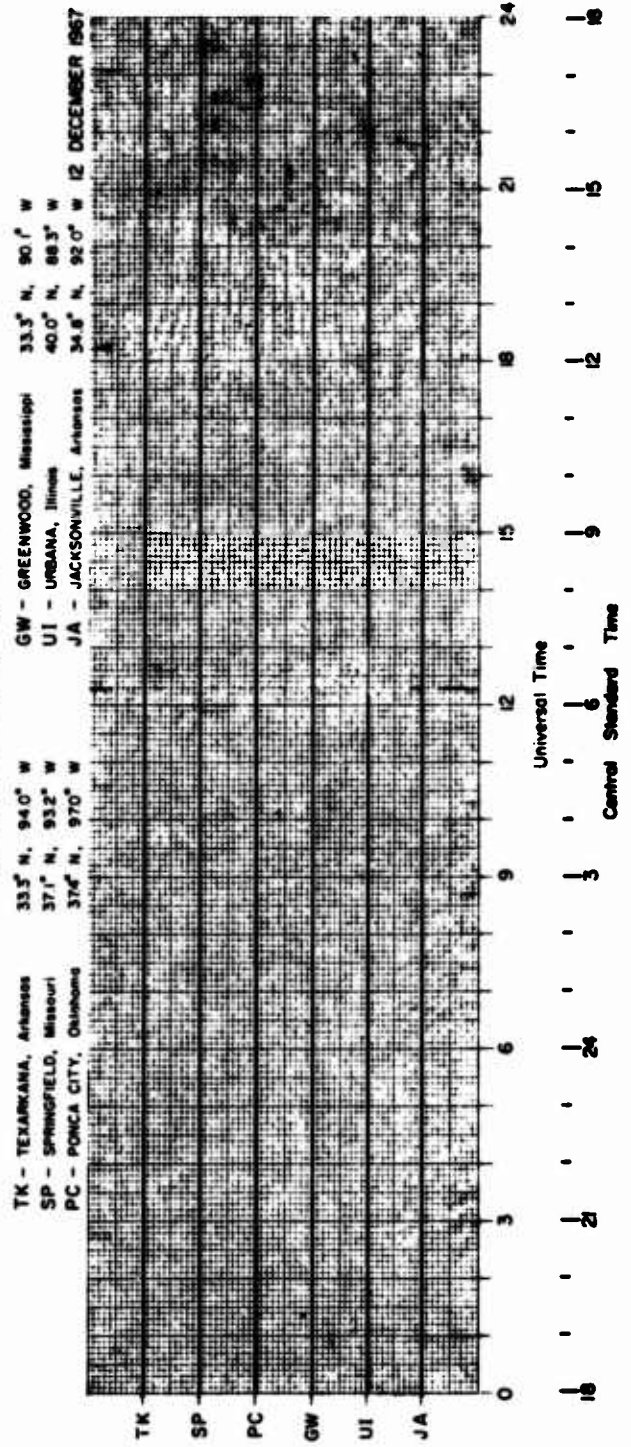


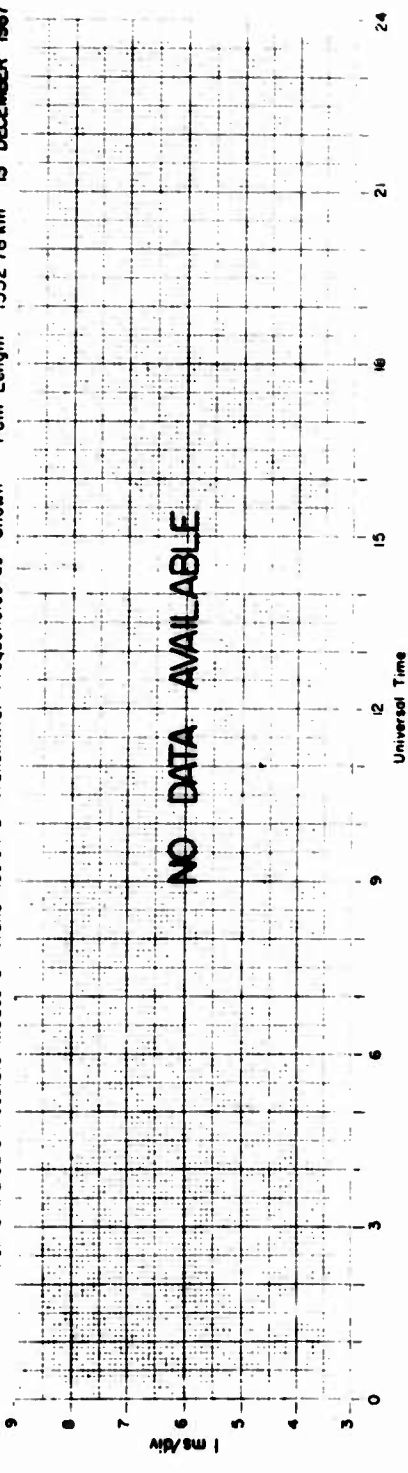
Plate 46.

12 December 1967

2

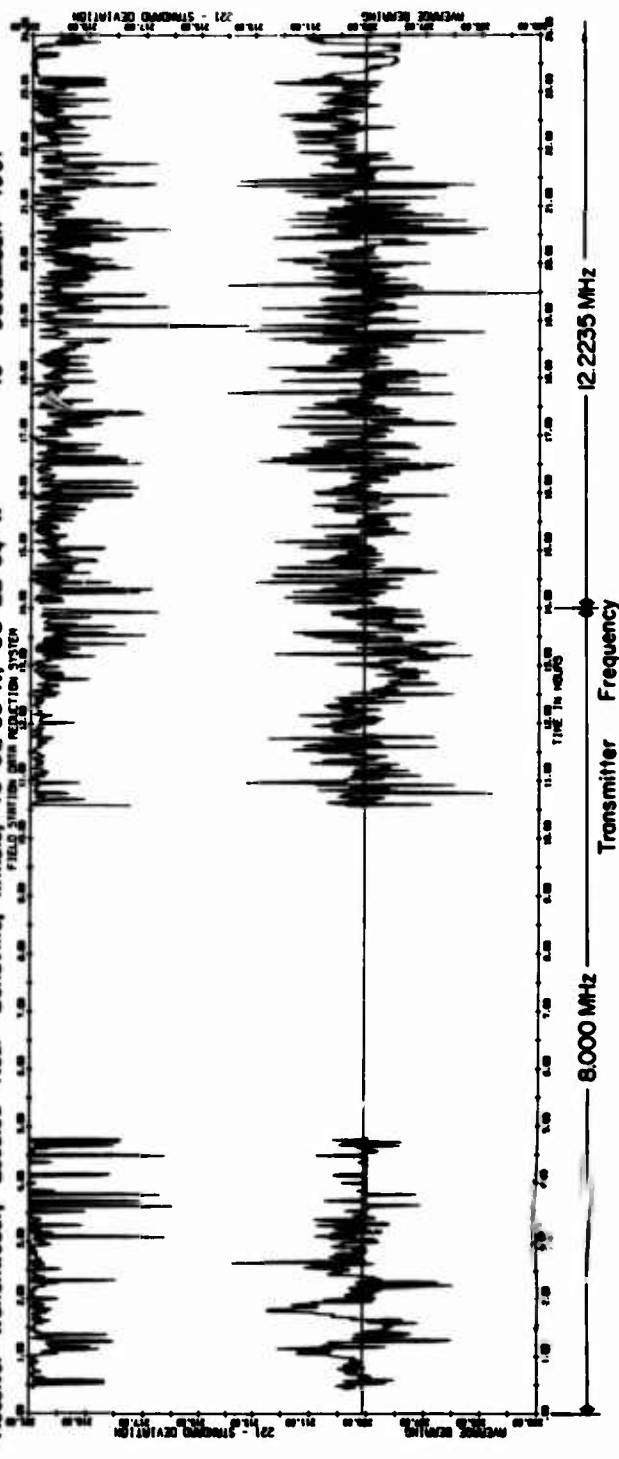
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 13 DECEMBER 1967

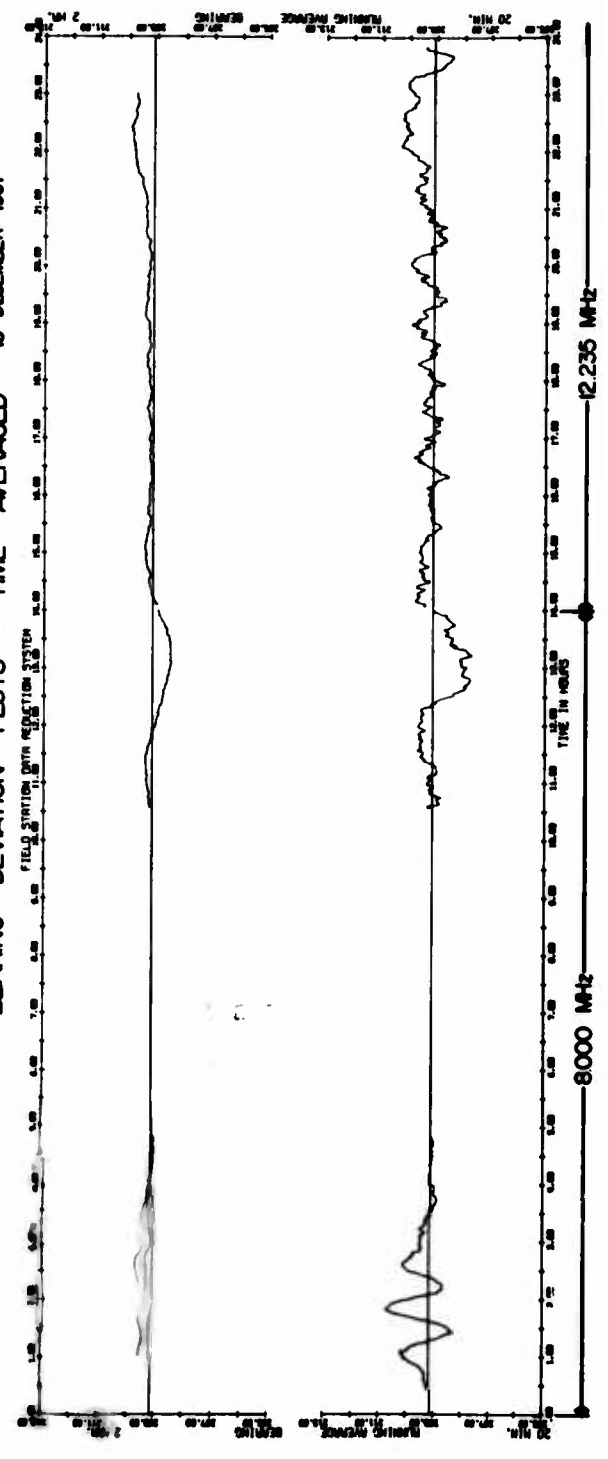


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. intervals
Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 13 DECEMBER 1967



BEARING DEVIATION PLOTS - TIME AVERAGED 13 DECEMBER 1967



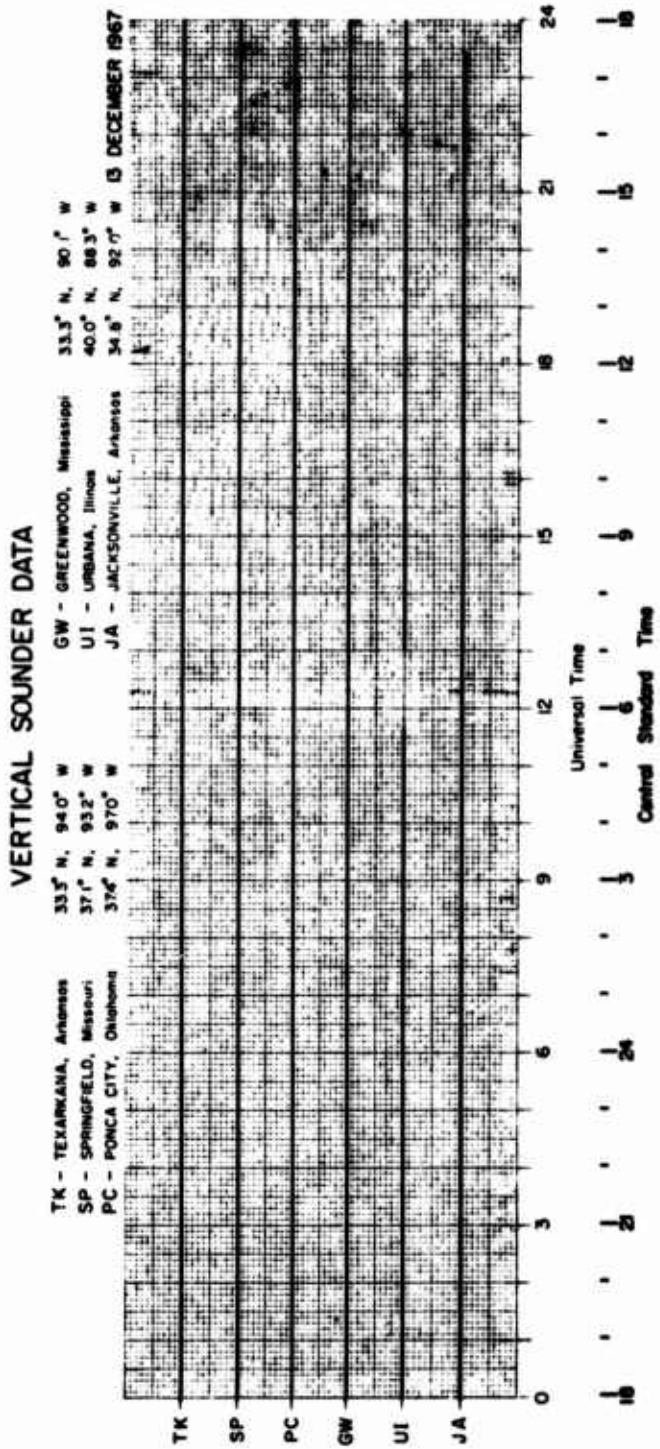
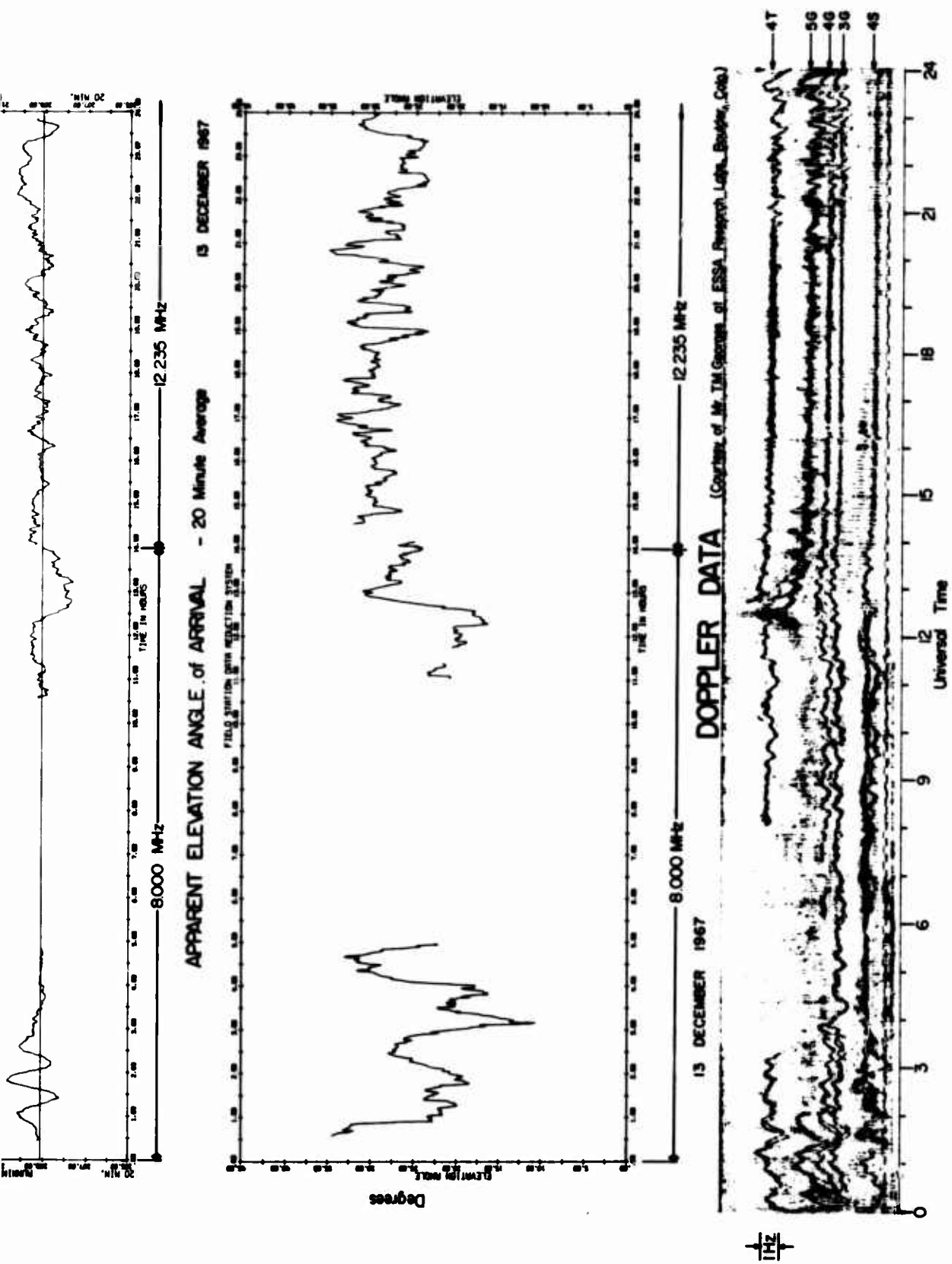
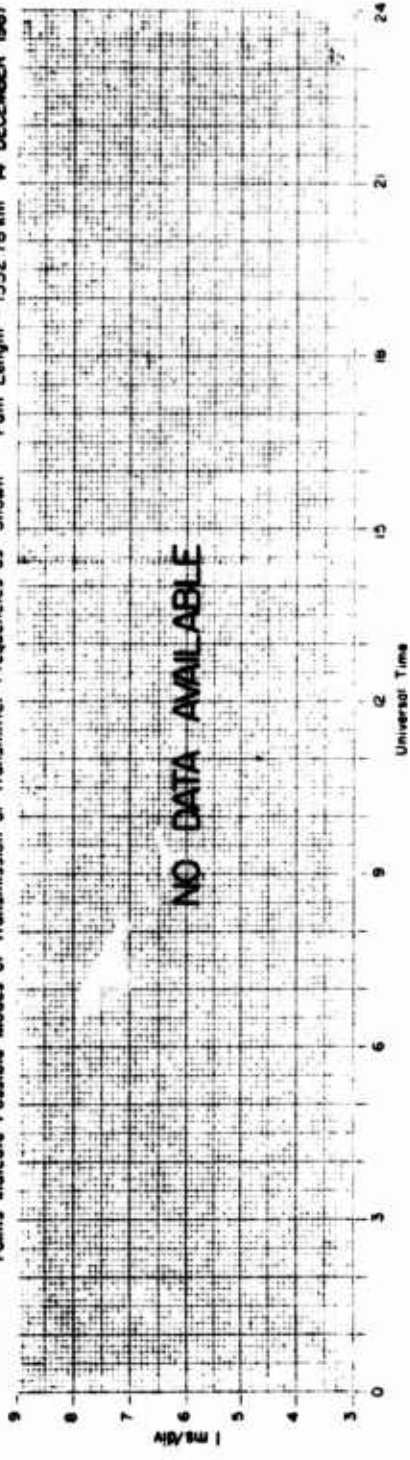


Plate 47.

13 December 1967

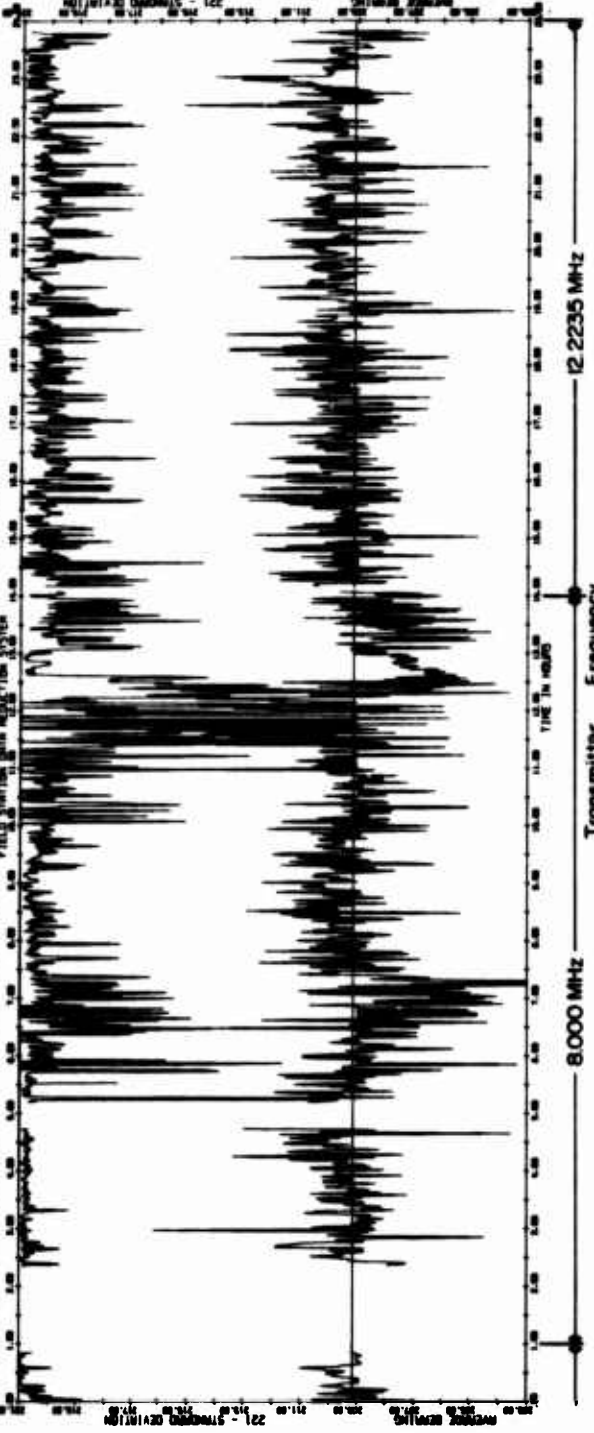
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 14 DECEMBER 1967

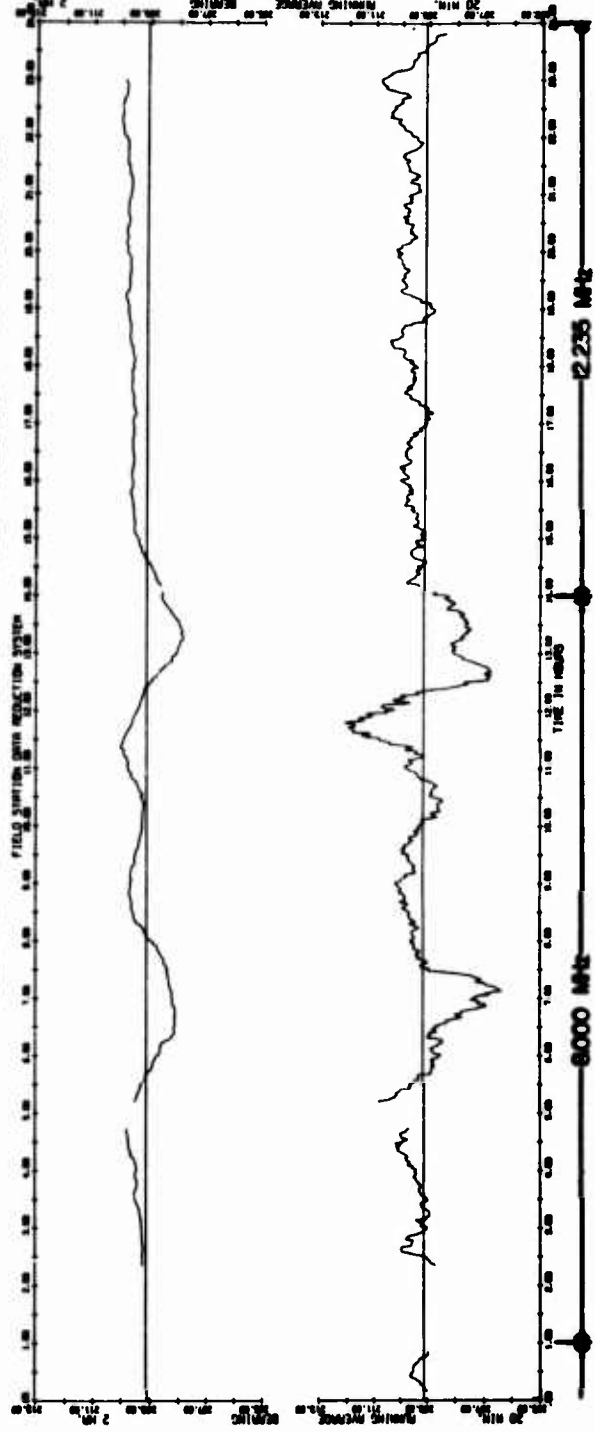


BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 14 DECEMBER 1967



BEARING DEVIATION PLOTS - TIME AVERAGED 14 DECEMBER 1967



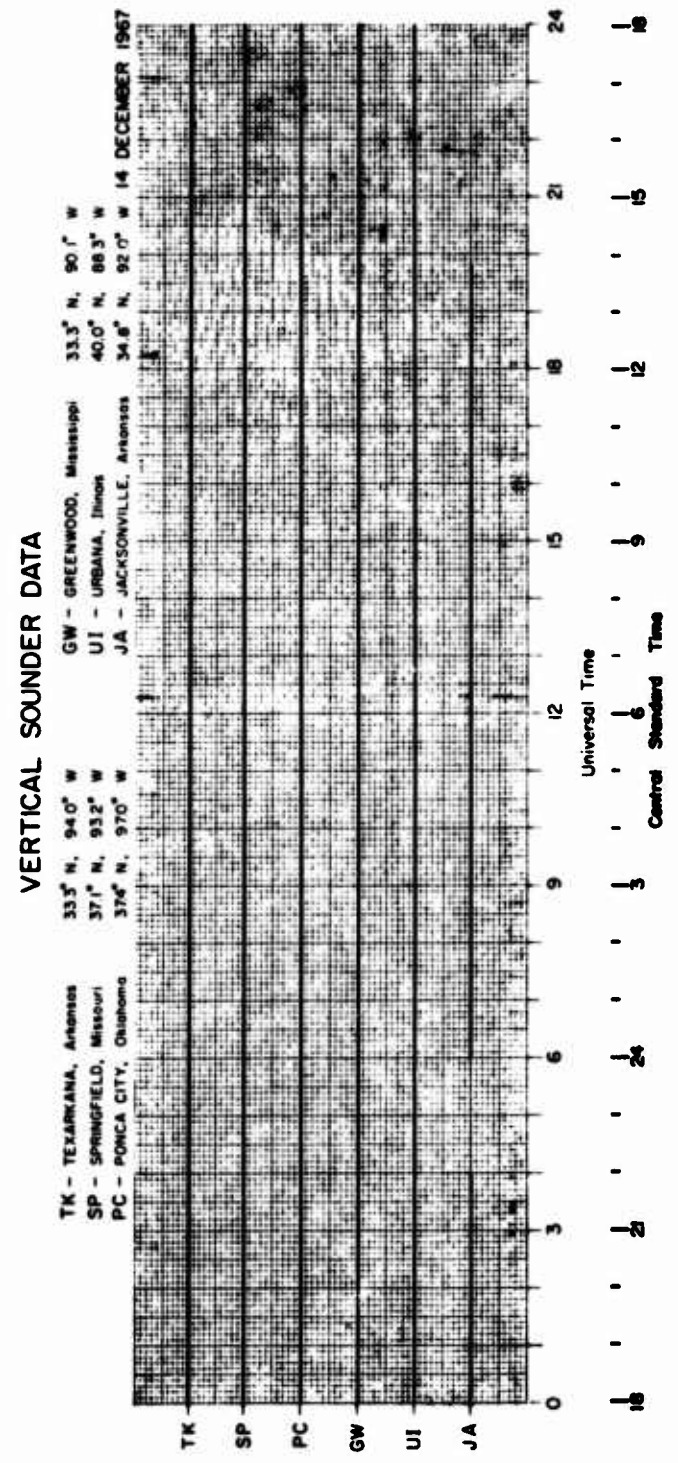
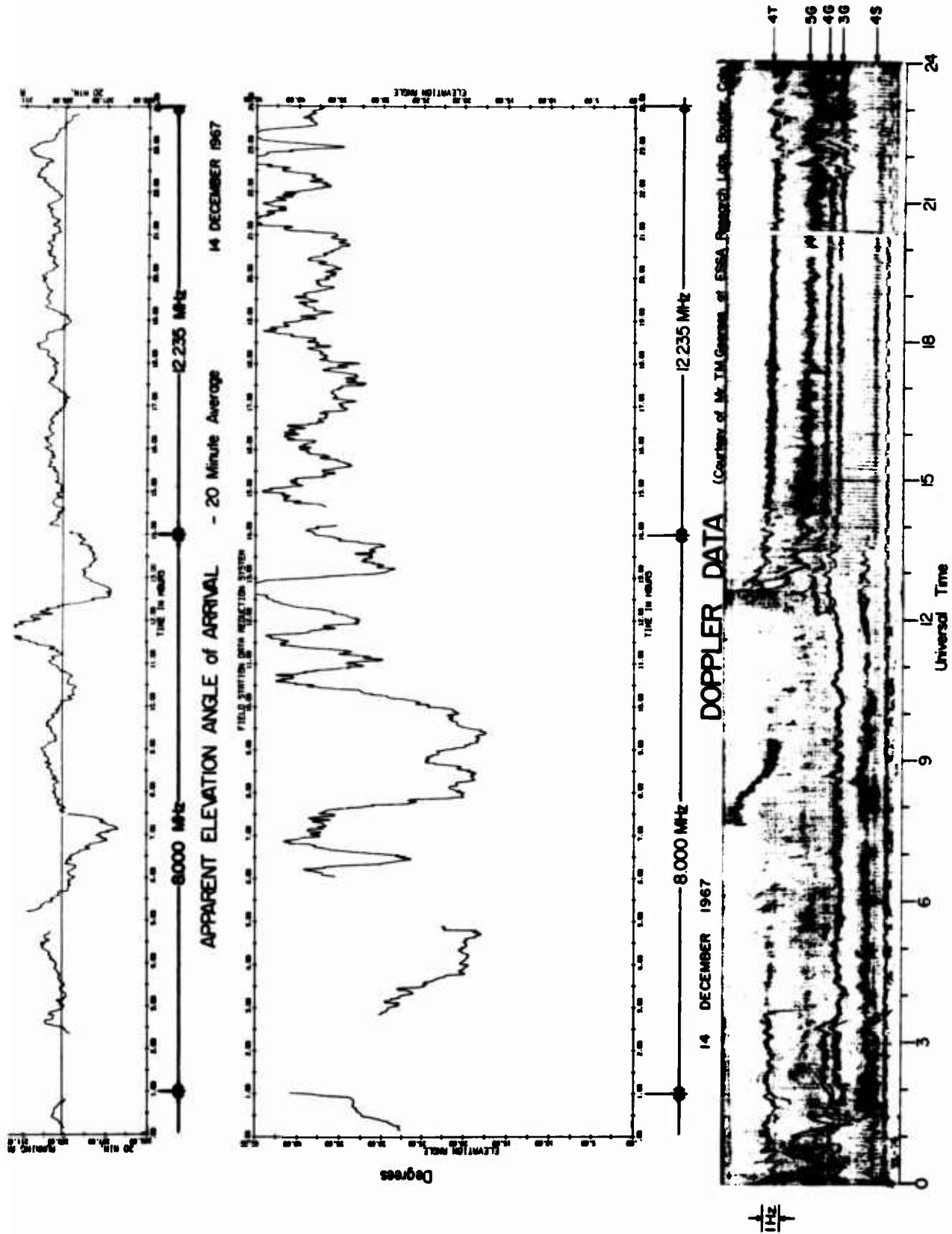


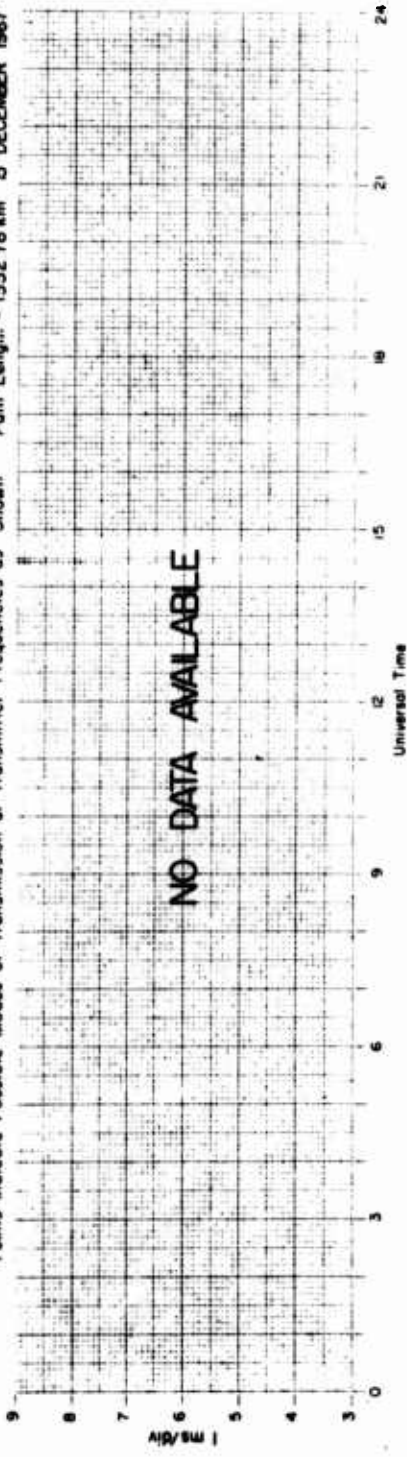
Plate 48.

14 December 1967



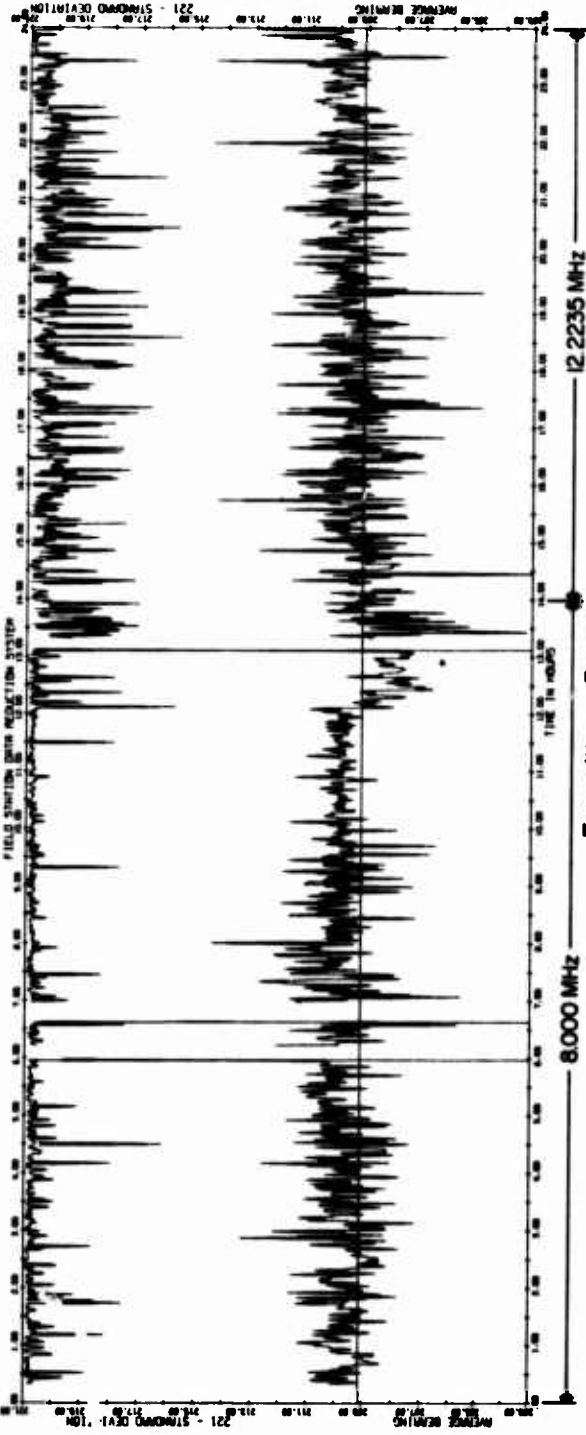
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 56" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 5 DECEMBER 1967

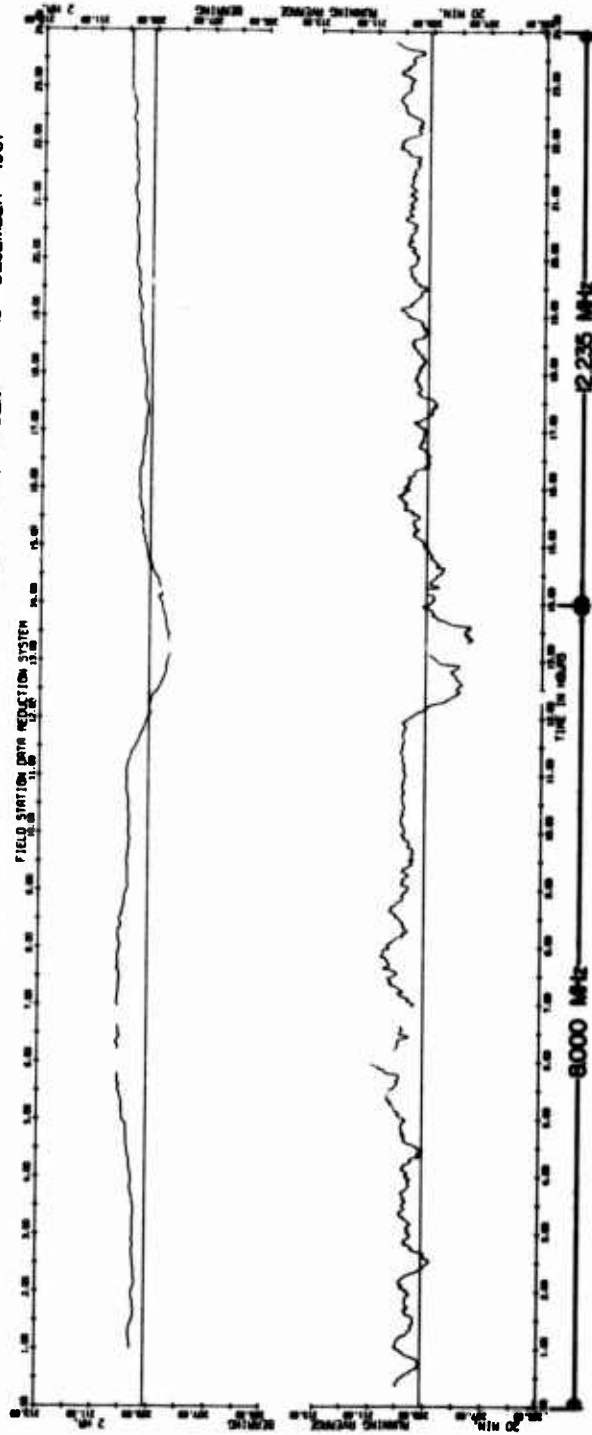


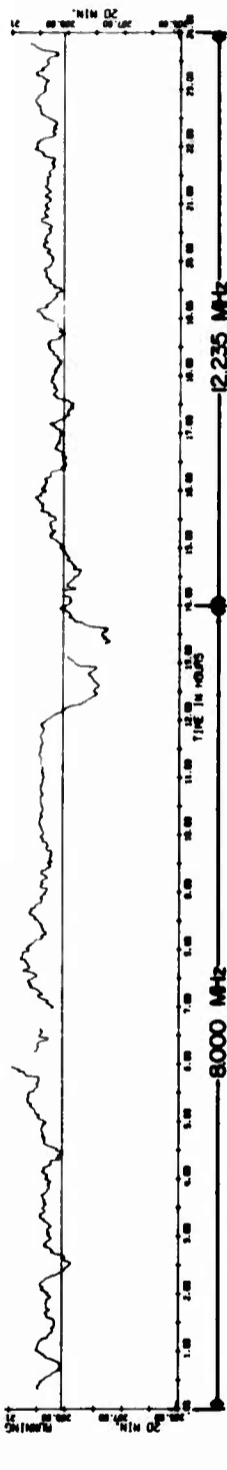
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point - Near Jacksonville, Arkansas, 34° 8' N, 92° 0' W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 15 DECEMBER 1967

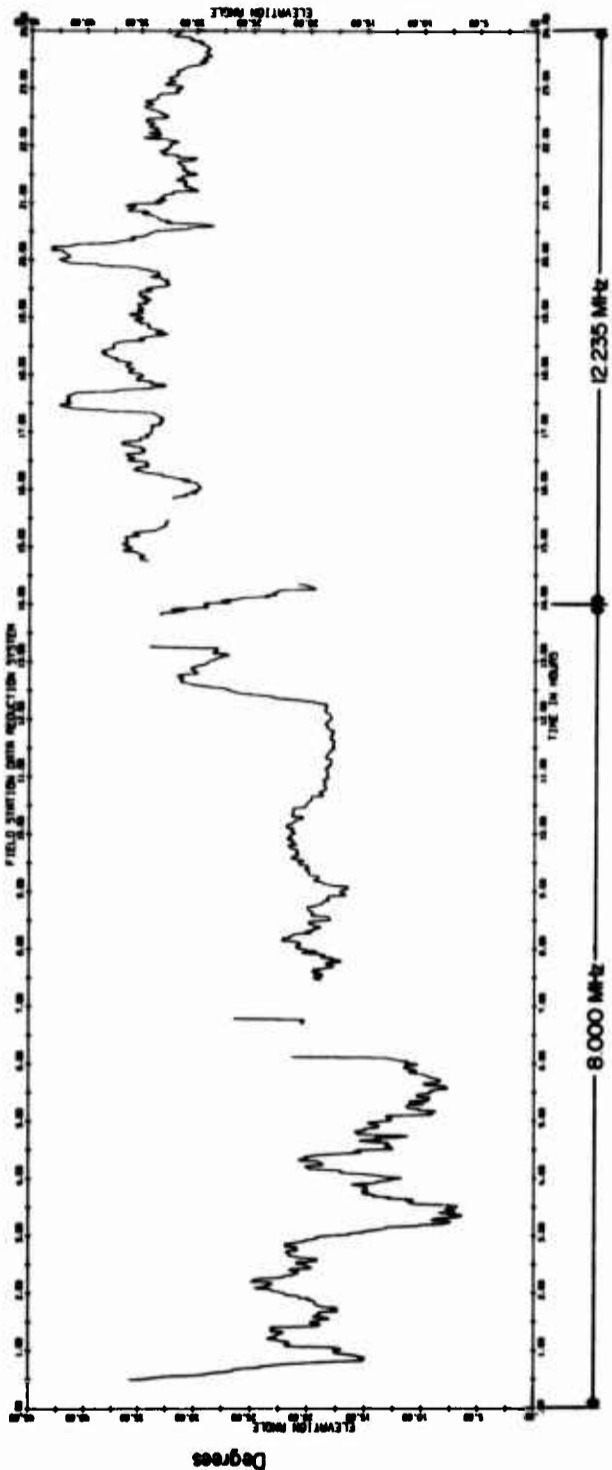


BEARING DEVIATION PLOTS - TIME AVERAGED 15 DECEMBER 1967

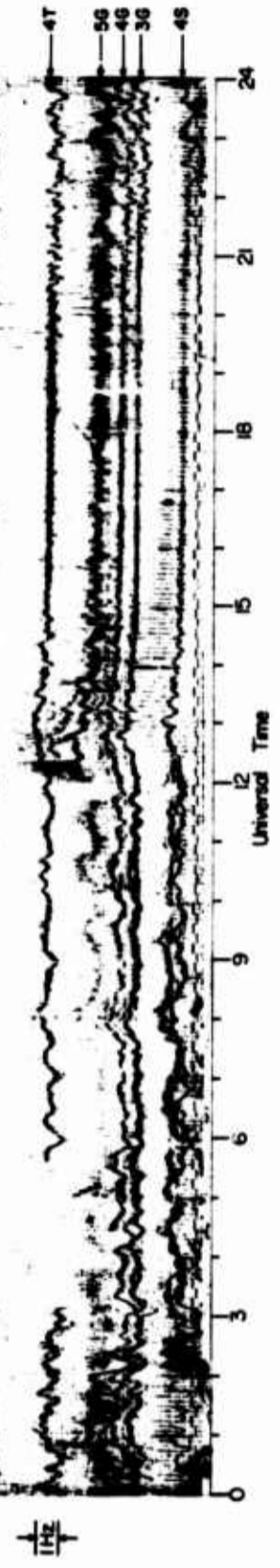




APPARENT ELEVATION ANGLE OF ARRIVAL - 20 Minute Average 15 DECEMBER 1967



15 DECEMBER 1967 DOPPLER DATA (Courtesy of Mr. TIM GEORGE of ESSA Research Labs., Boulder, Colo.)



VERTICAL SOUNDER DATA

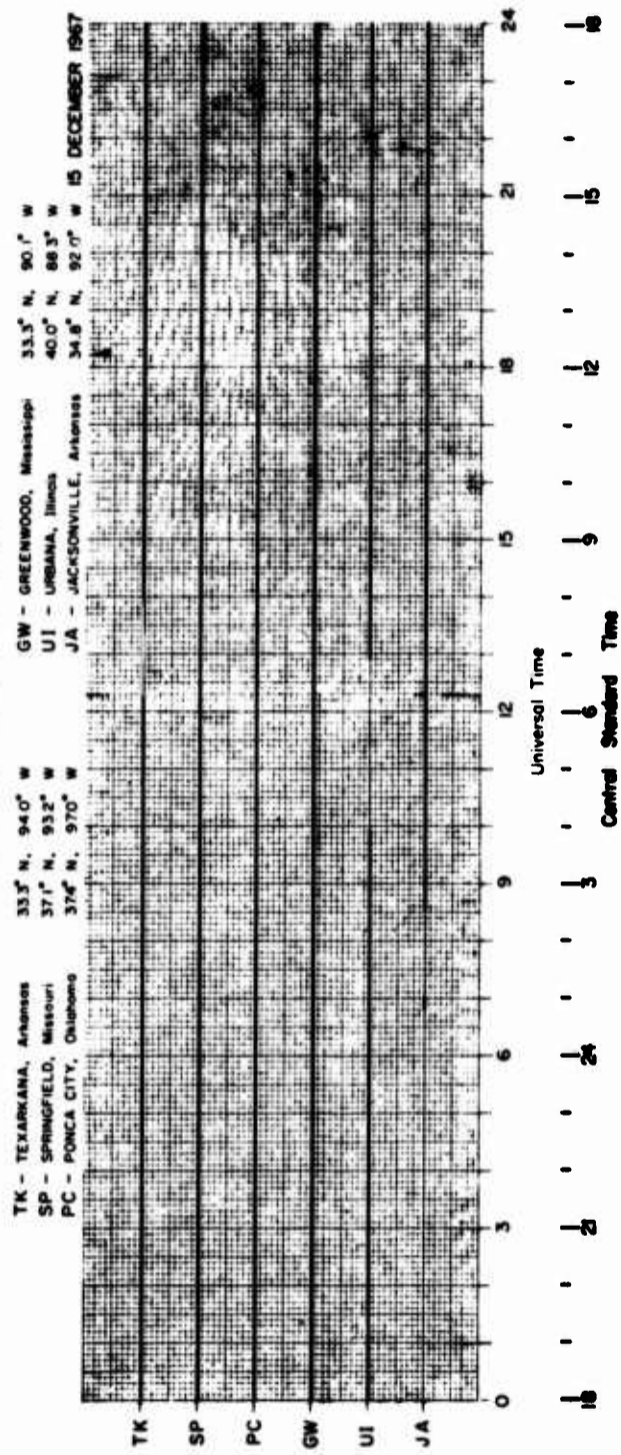
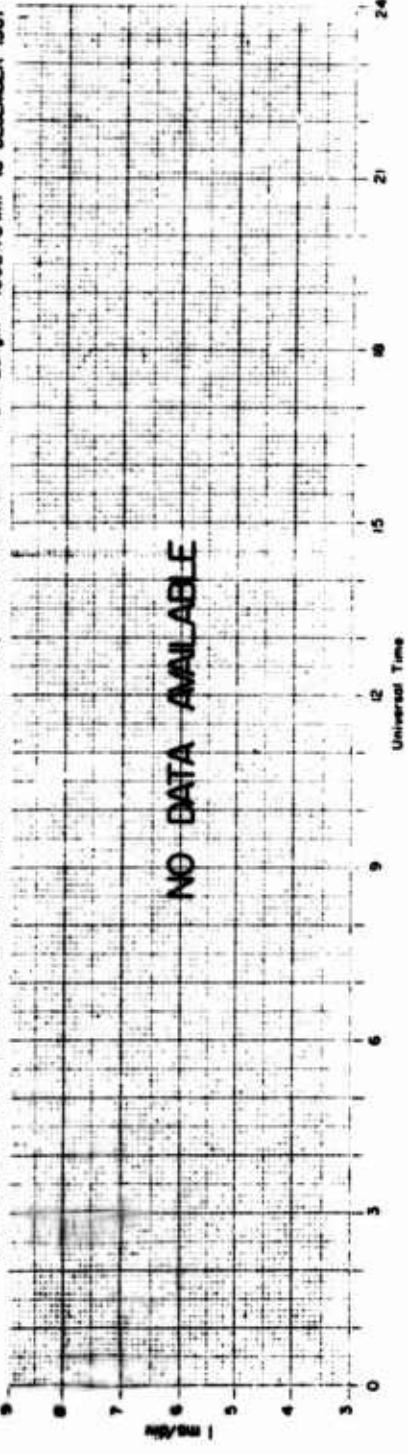


Plate 49.

15 December 1967

OBLIQUE IONOGRAM DATA
 Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 16 DECEMBER 1967



BEARING DEVIATION PLOT
 Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 16 DECEMBER 1967

NO DATA AVAILABLE

BEARING DEVIATION PLOTS - TIME AVERAGED 16 DECEMBER 1967

NO DATA AVAILABLE

NO DATA AVAILABLE

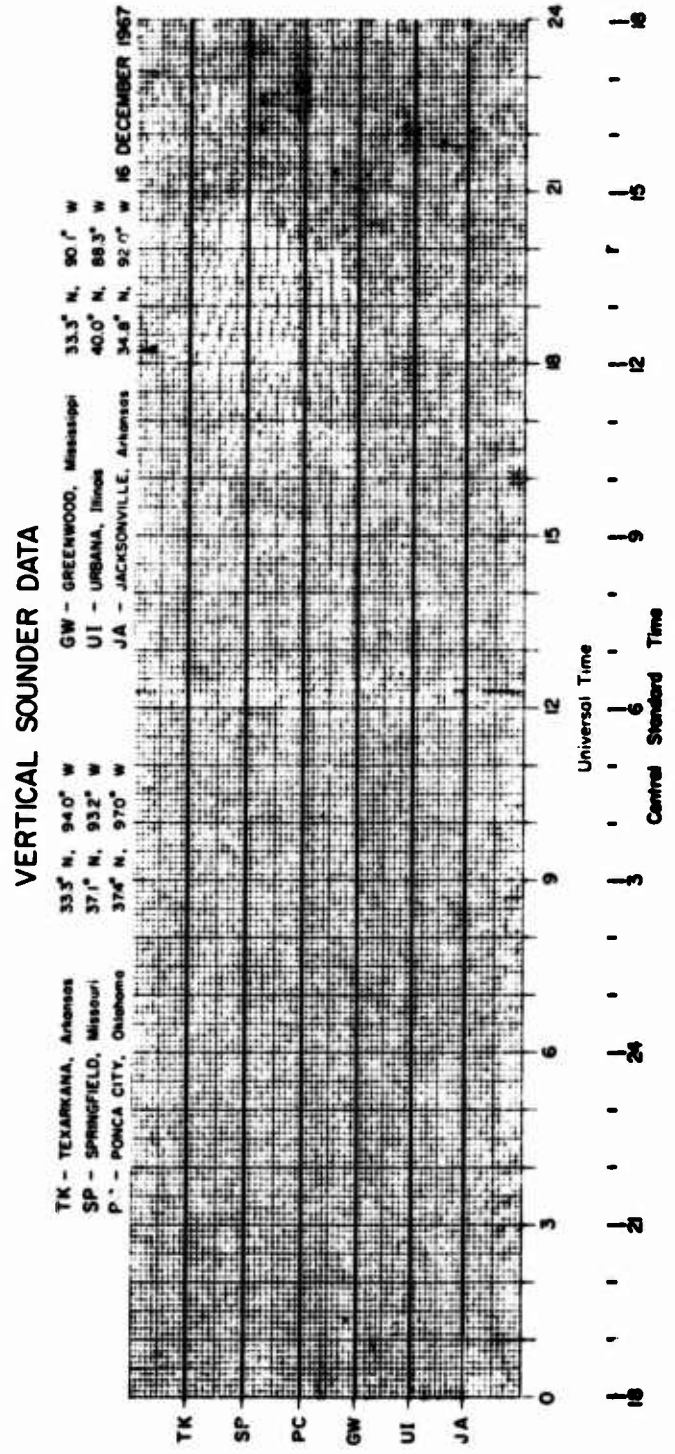
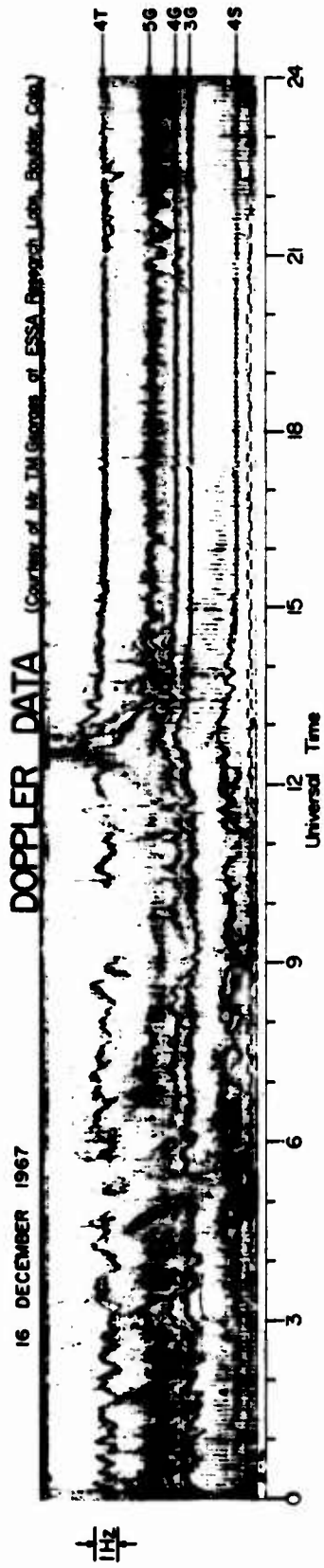


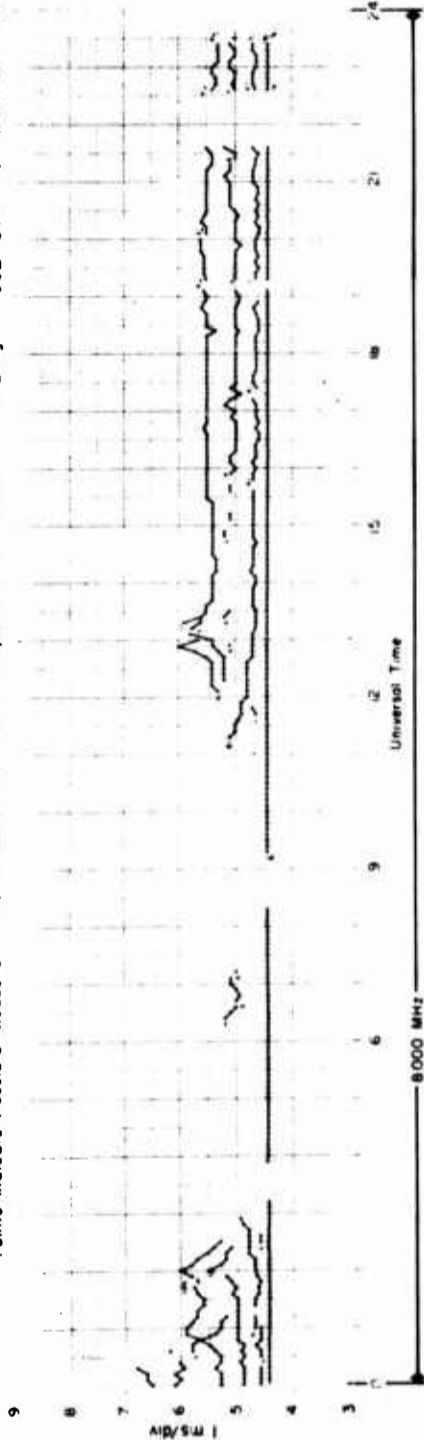
Plate 50.

16 December 1967



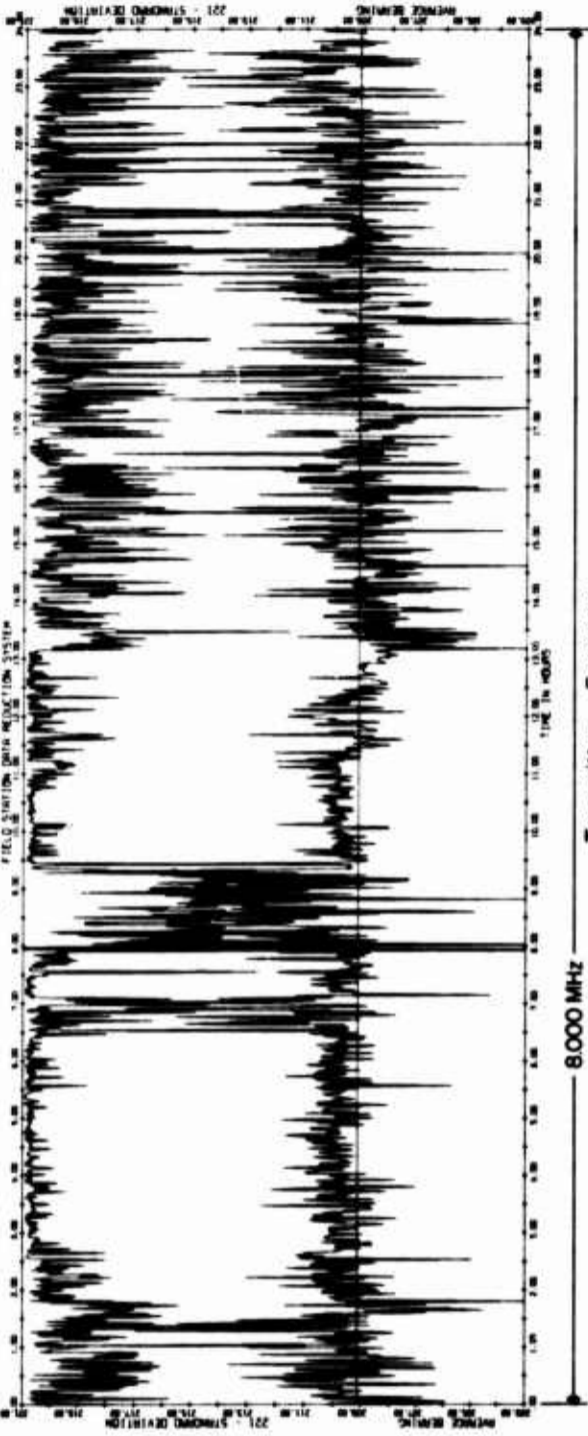
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission as Shown Path Length - 1332.78 km 16 JANUARY 1968



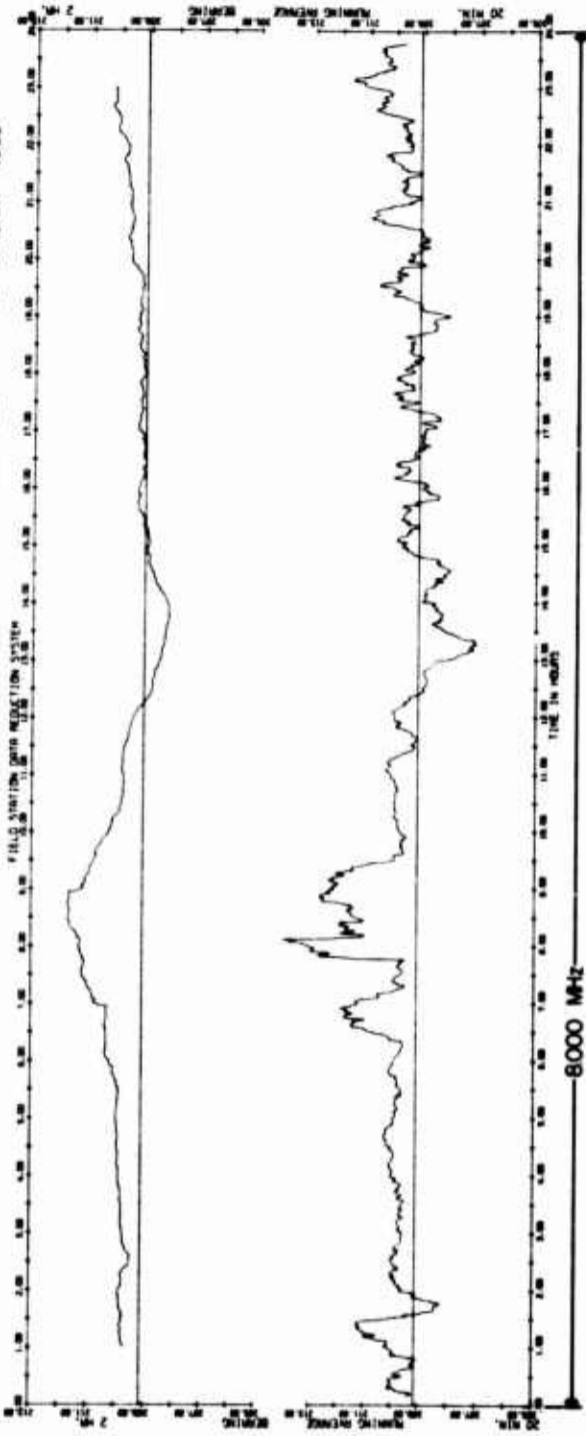
BEARING DEVIATION PLOT

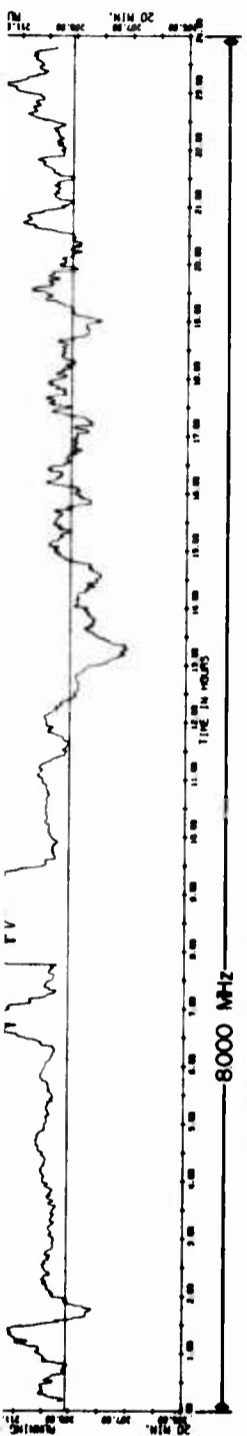
Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonvile, Arkansas, 34° 8' N, 92° 0' W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 16 JANUARY 1968



BEARING DEVIATION PLOTS - TIME AVERAGED

16 JANUARY 1968





APPARENT ELEVATION ANGLE OF ARRIVAL - 20 Minute Average 16 JANUARY 1968

NO DATA AVAILABLE

DOPPLER DATA

16 JANUARY 1968

NO DATA AVAILABLE

VERTICAL SOUNDER DATA

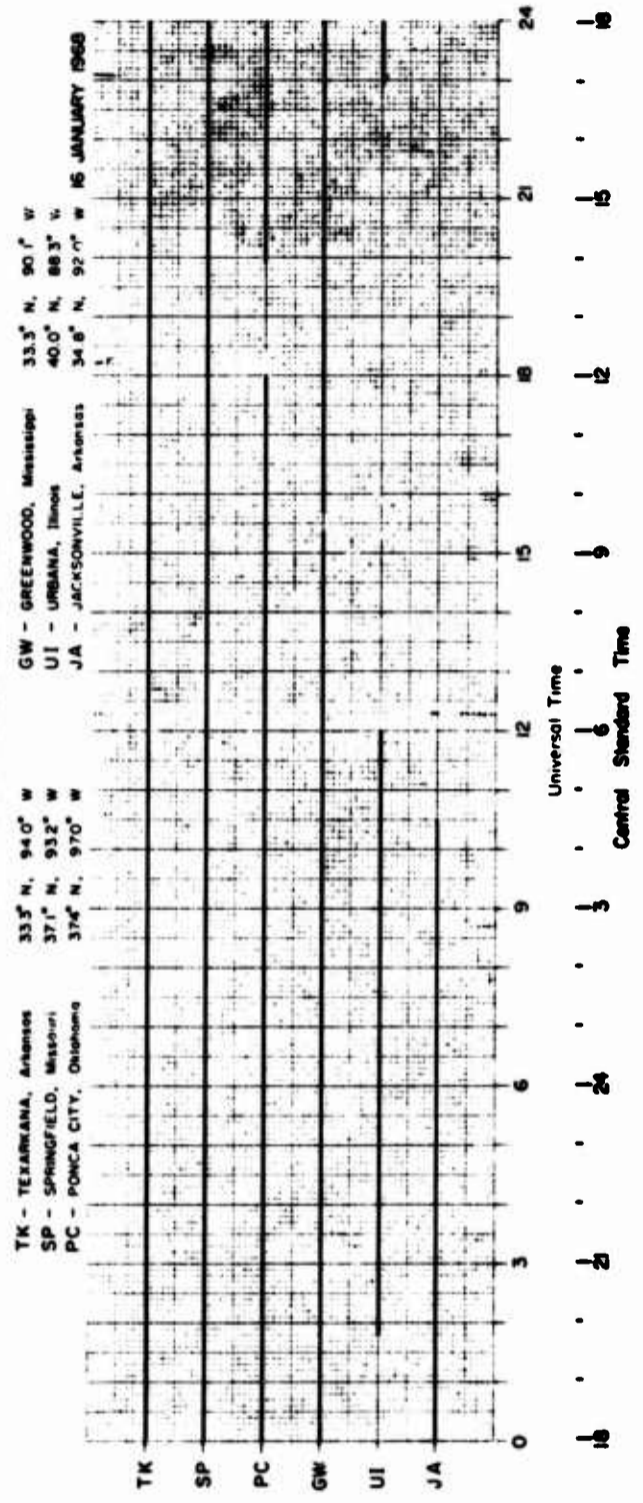
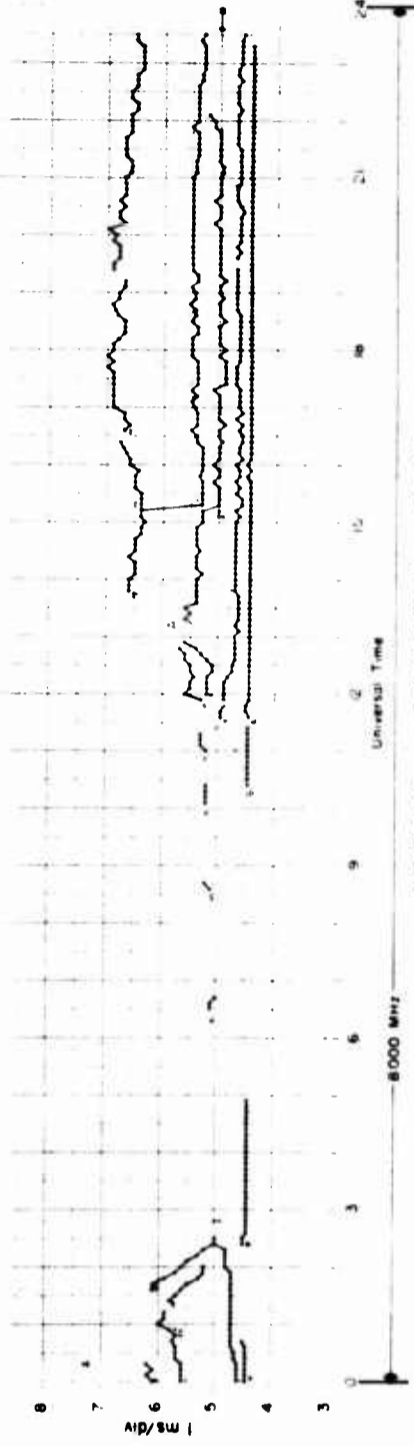


Plate 51.

16 January 1968

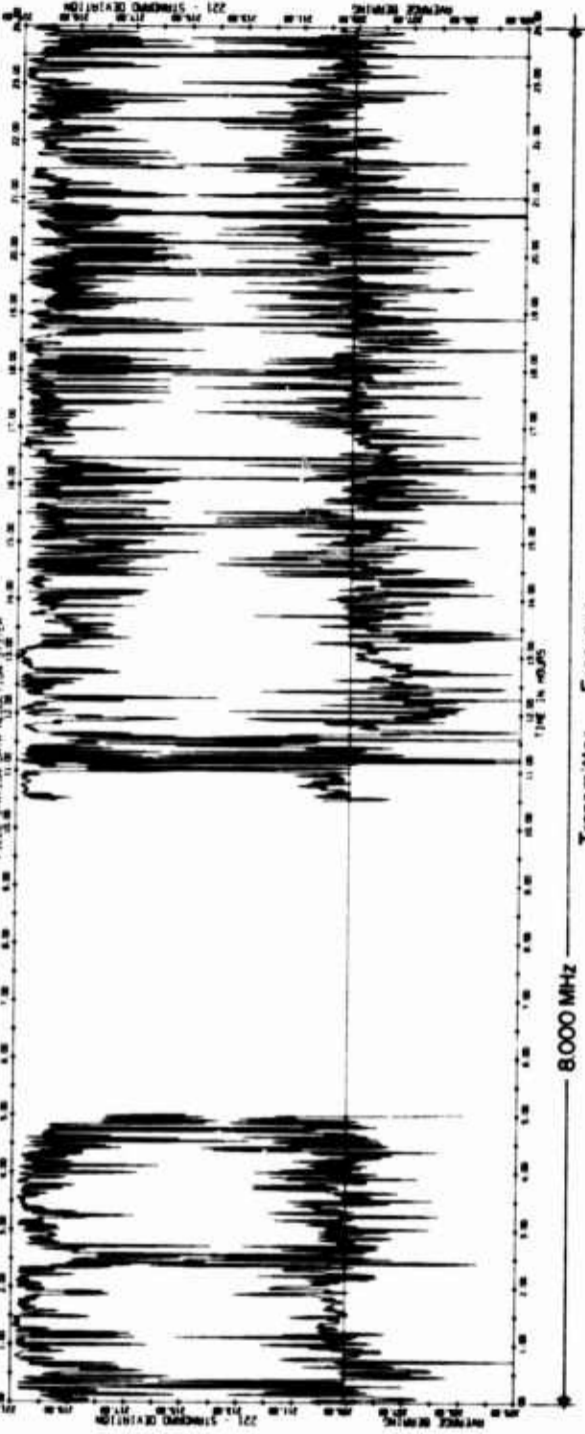
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
Points indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 17 JANUARY 1968



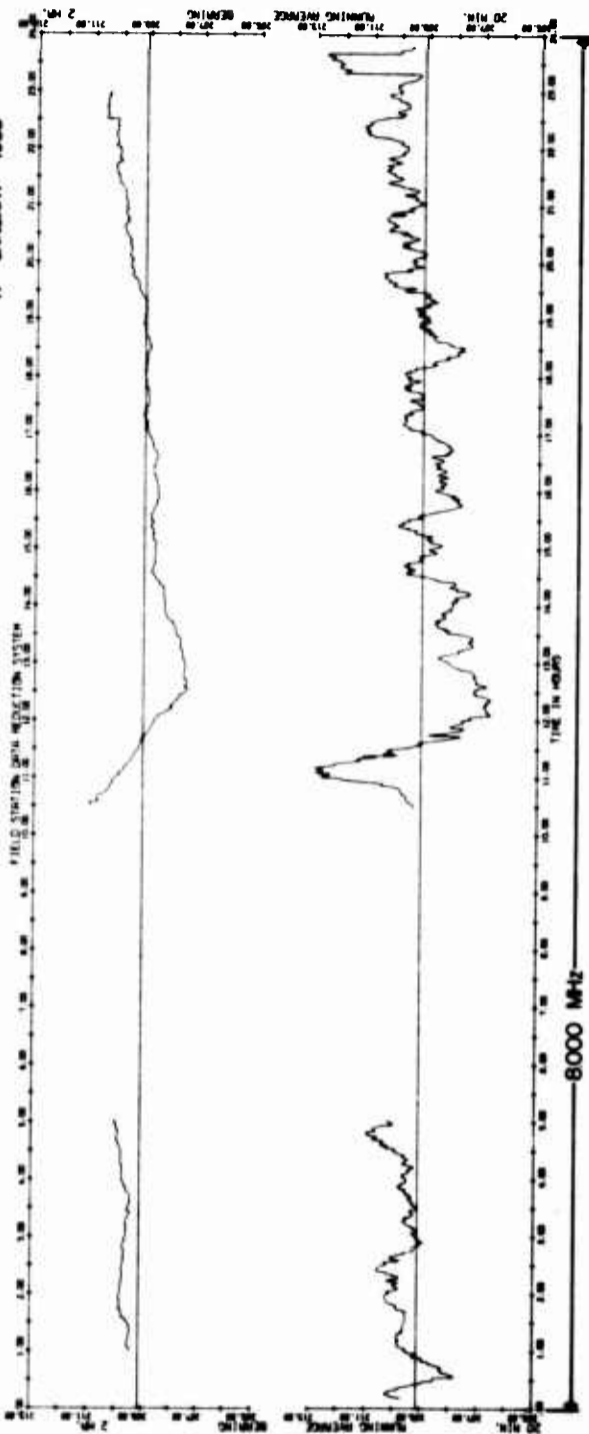
BEARING DEVIATION PLOT

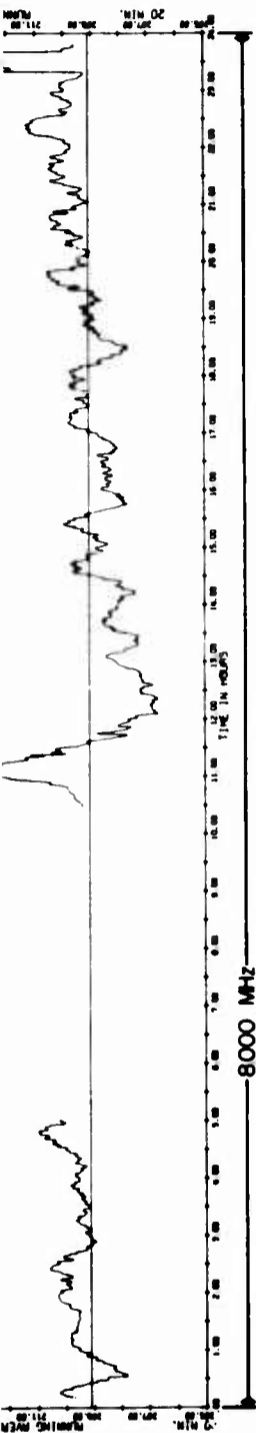
Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min Intervals
Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34° 8' N, 92° 0' W
Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 17 JANUARY 1968



Transmitter Frequency

BEARING DEVIATION PLOTS - TIME AVERAGED 17 JANUARY 1968





17 JANUARY 1968

APPARENT ELEVATION ANGLE OF ARRIVAL - 20 Minute Average

NO DATA AVAILABLE

DOPPLER DATA

17 JANUARY 1968

NO DATA AVAILABLE

VERTICAL SOUNDER DATA

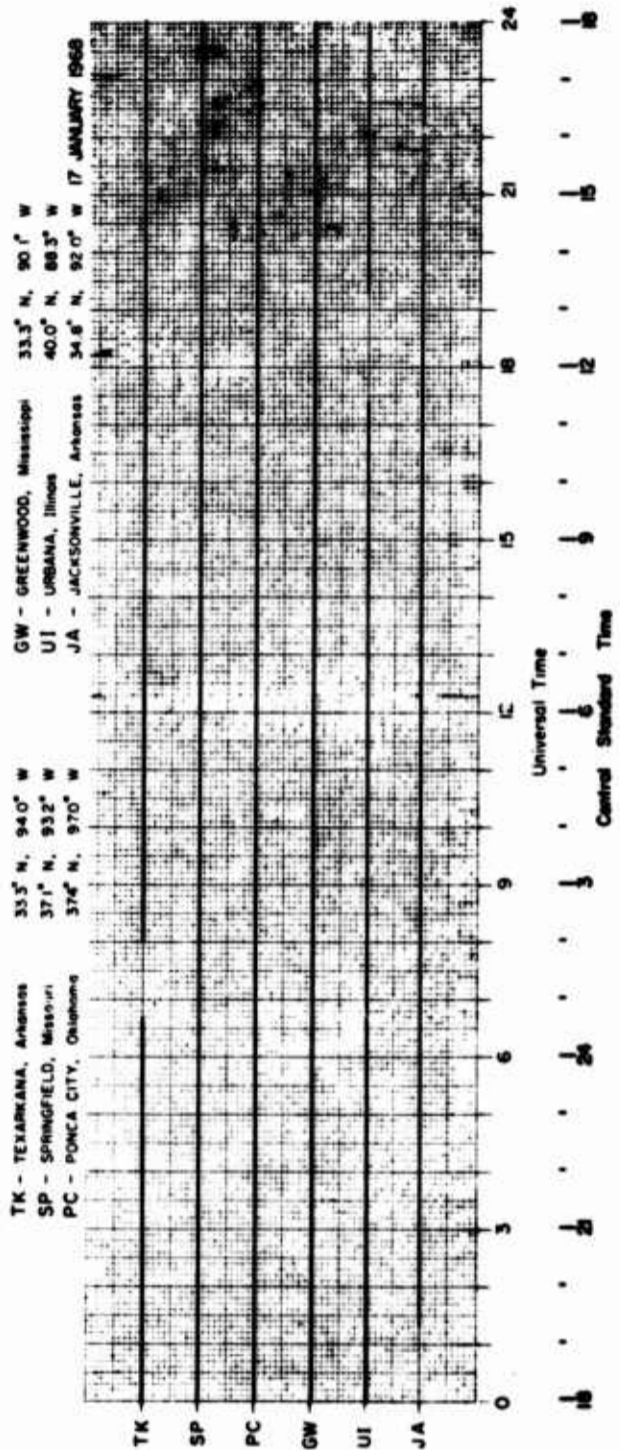
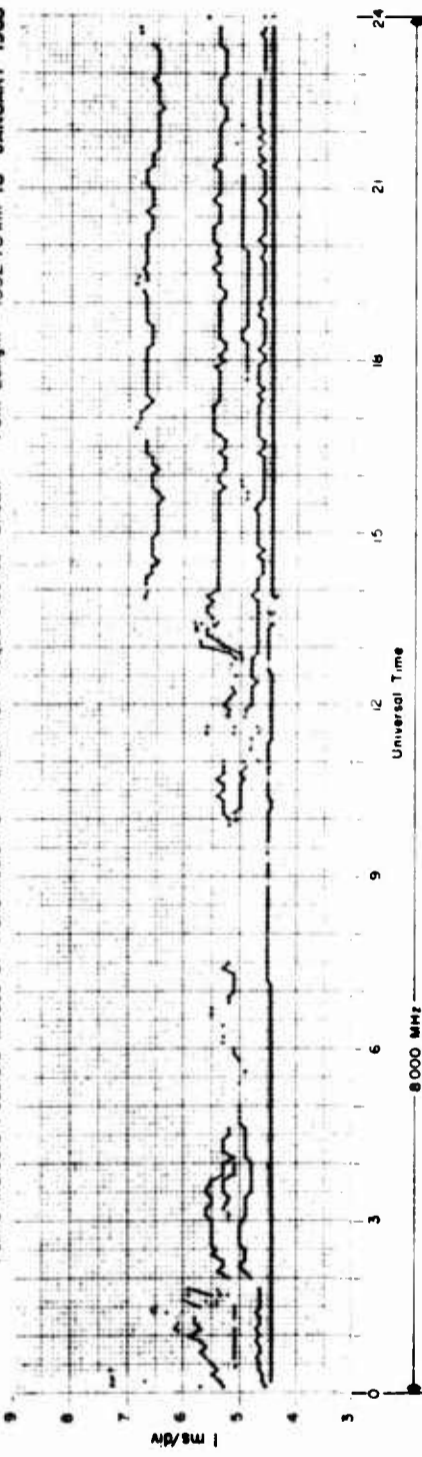


Plate 52.

17 January 1968

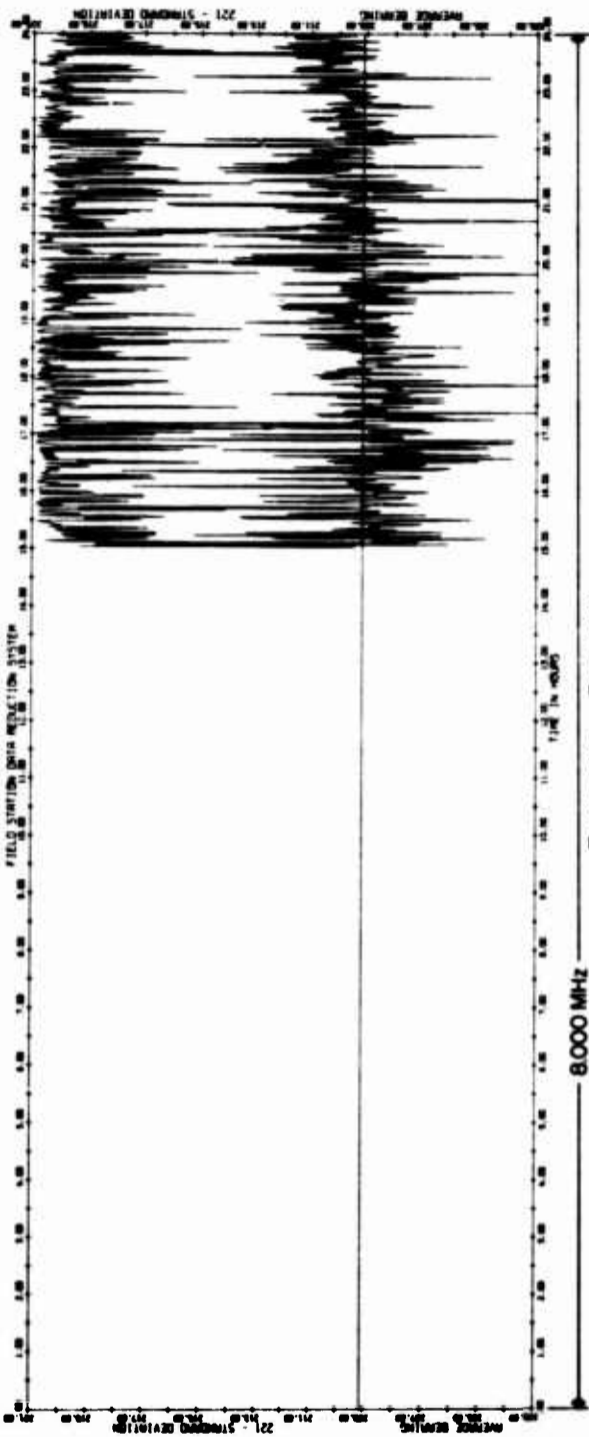
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 18 JANUARY 1968

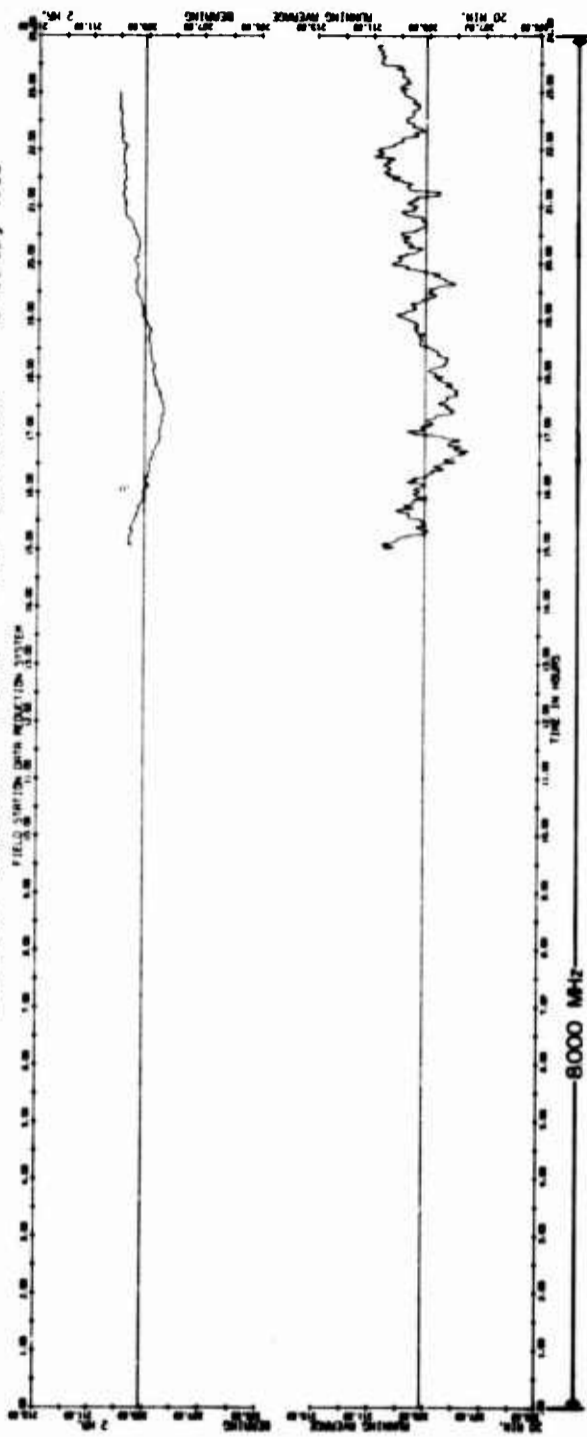


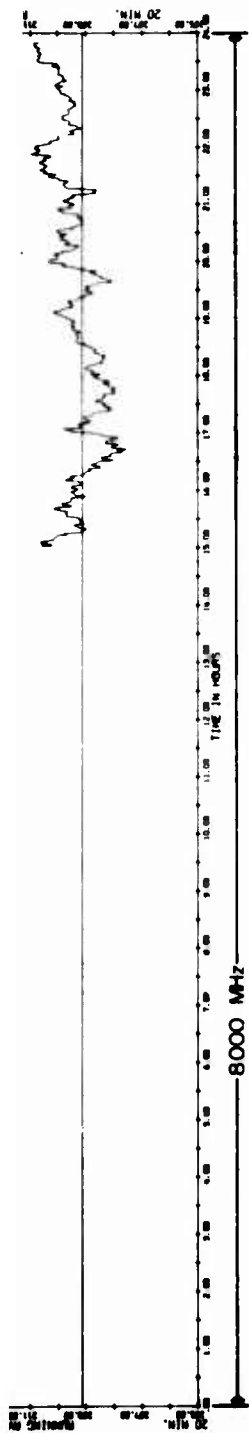
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34° 8' N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 18 JANUARY 1968



BEARING DEVIATION PLOTS - TIME AVERAGED 18 JANUARY 1968





APPARENT ELEVATION ANGLE of ARRIVAL - 20 Minute Averages 18 JANUARY 1968

NO DATA AVAILABLE

DOPPLER DATA

18 JANUARY 1968

NO DATA AVAILABLE

VERTICAL SOUNDER DATA

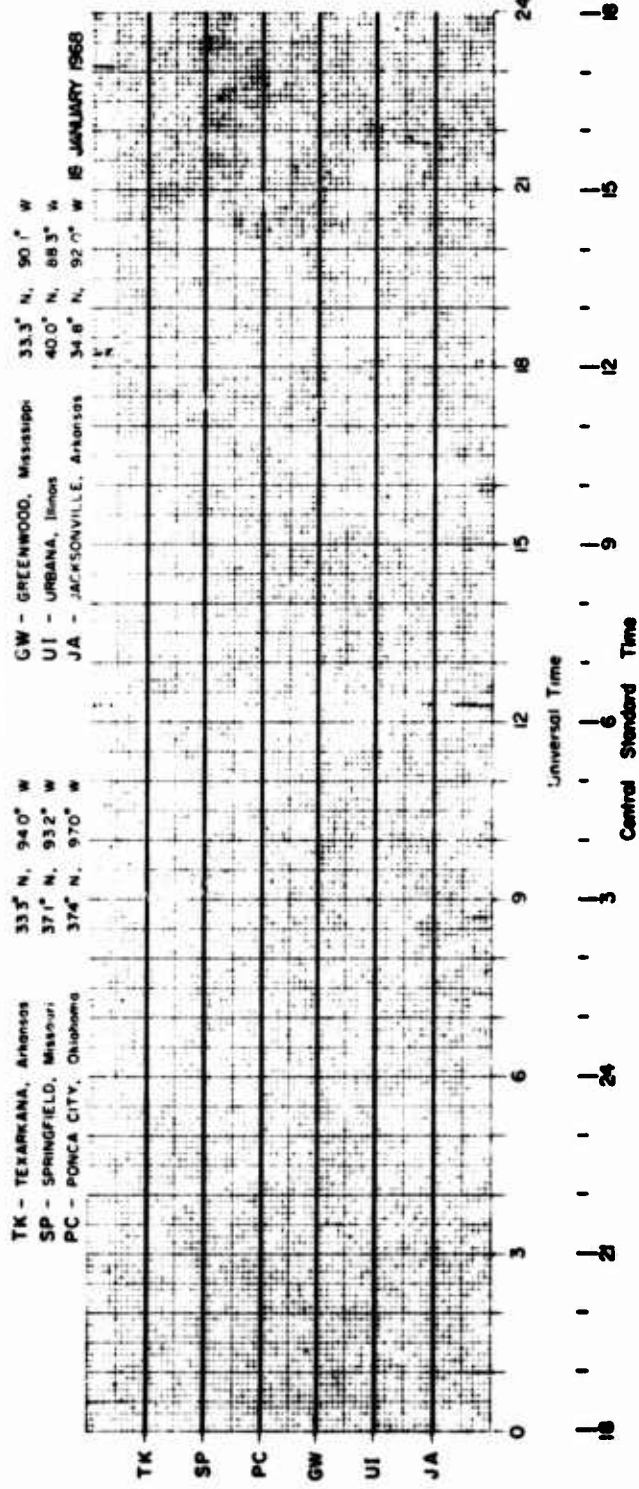


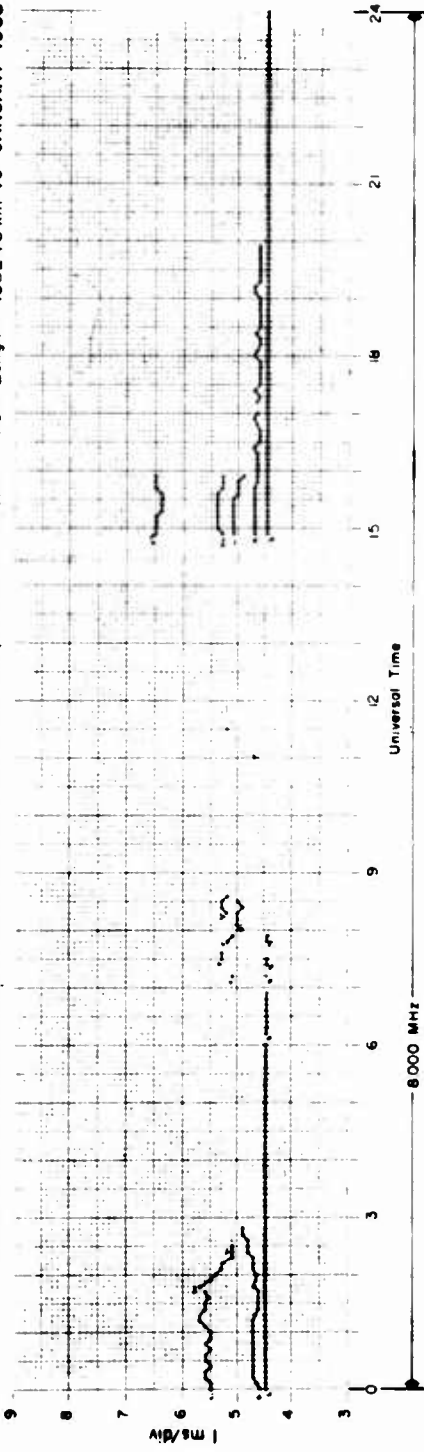
Plate 53.

18 January 1968



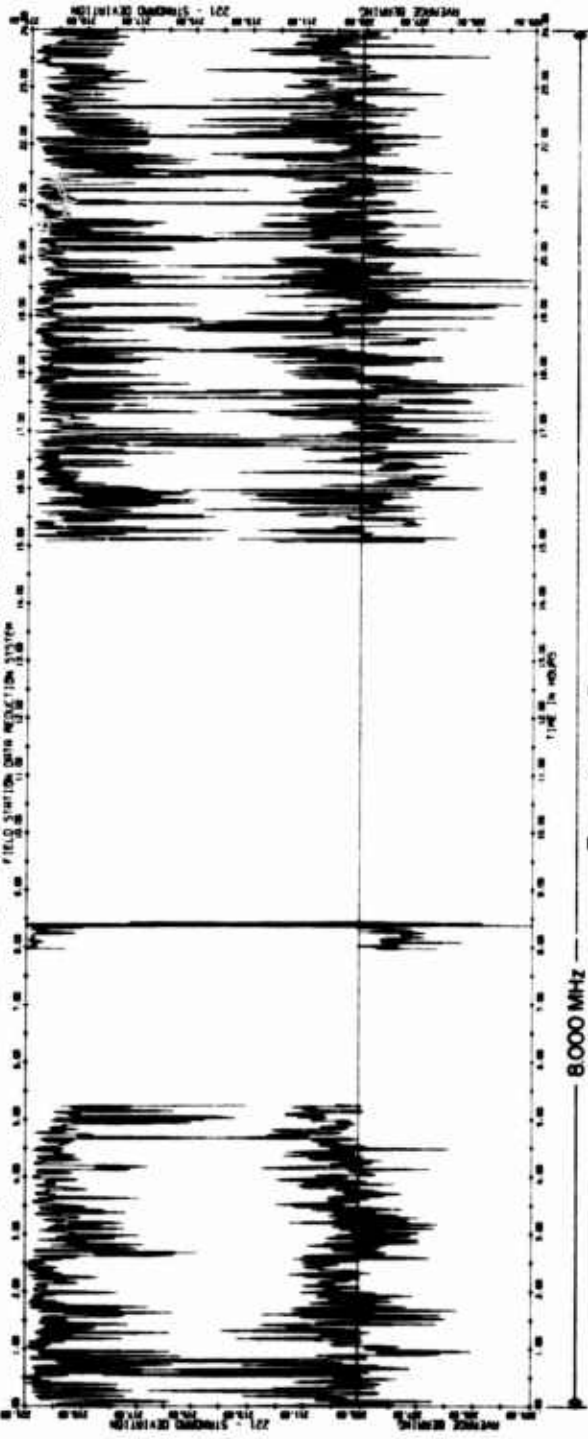
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 19 JANUARY 1968



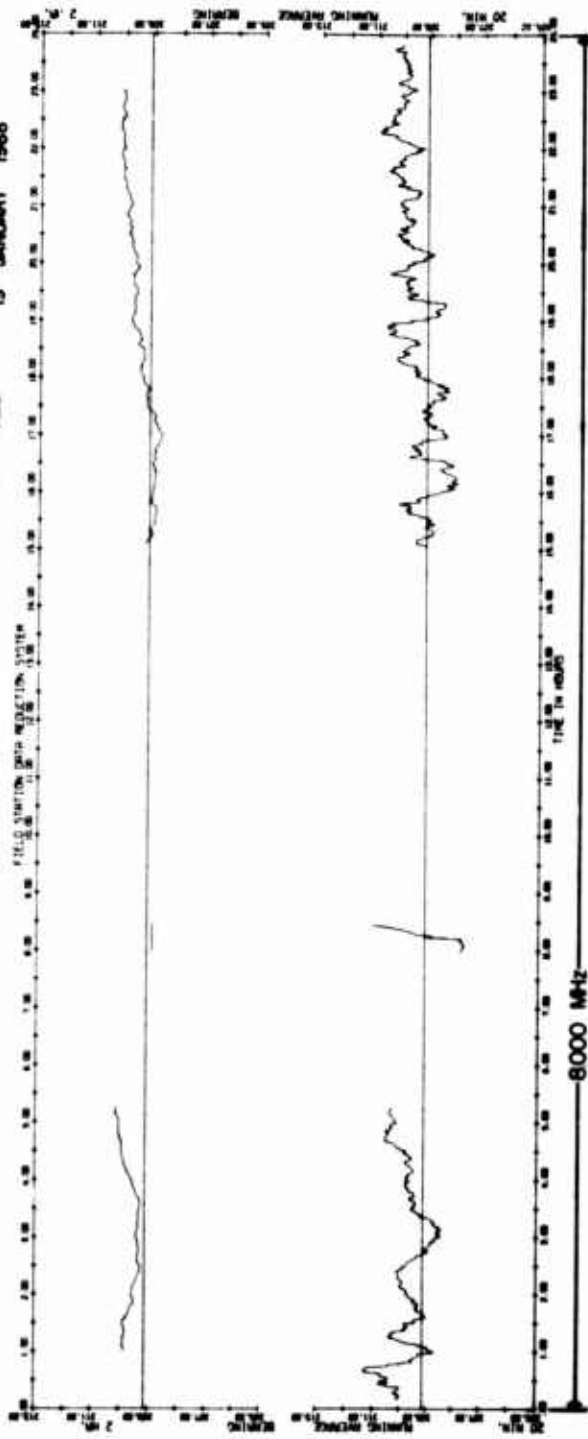
BEARING DEVIATION PLOT

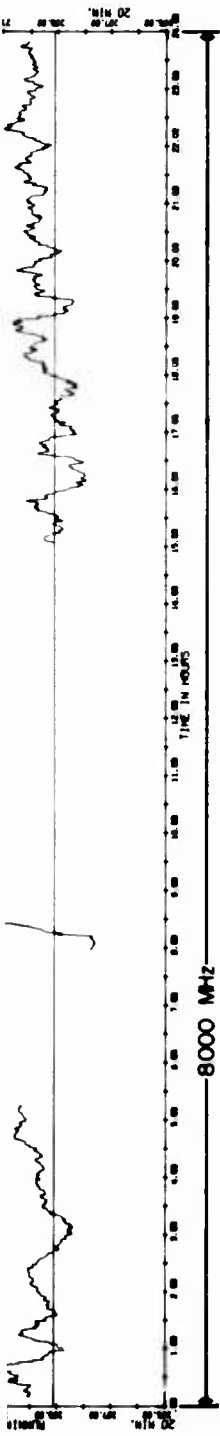
Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 19 JANUARY 1968



BEARING DEVIATION PLOTS - TIME AVERAGED

19 JANUARY 1968





NO DATA AVAILABLE

19 JANUARY 1968

DOPPLER DATA

NO DATA AVAILABLE

VERTICAL SOUNDER DATA

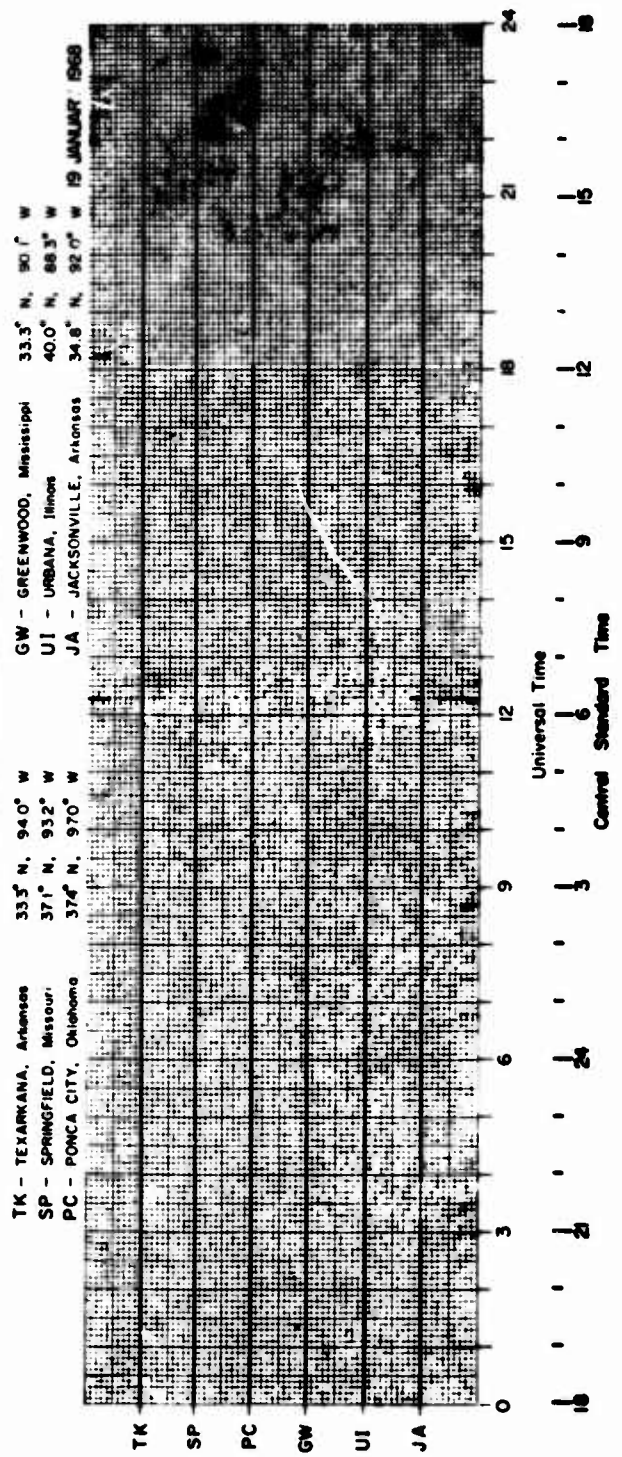
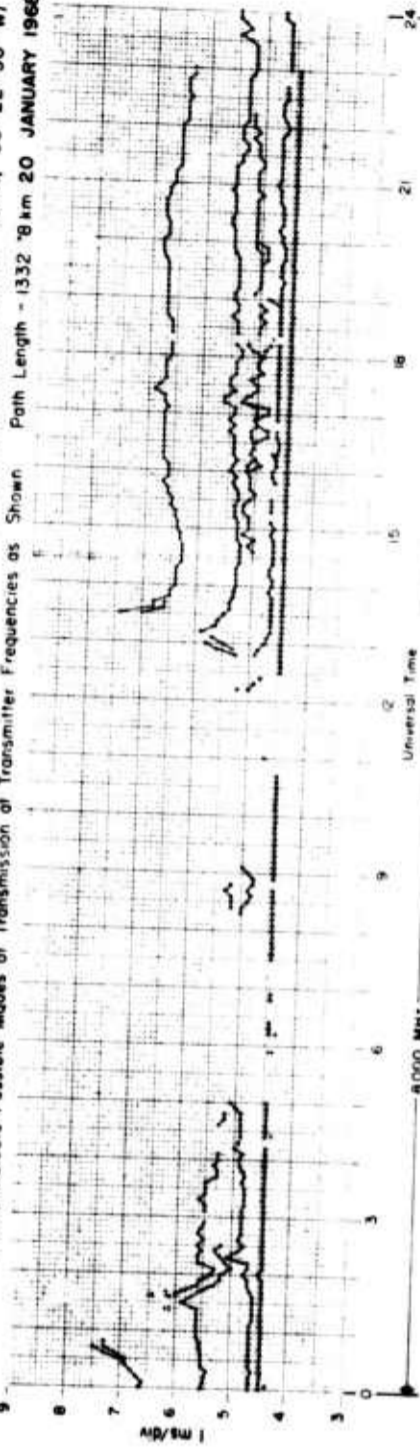


Plate 54.

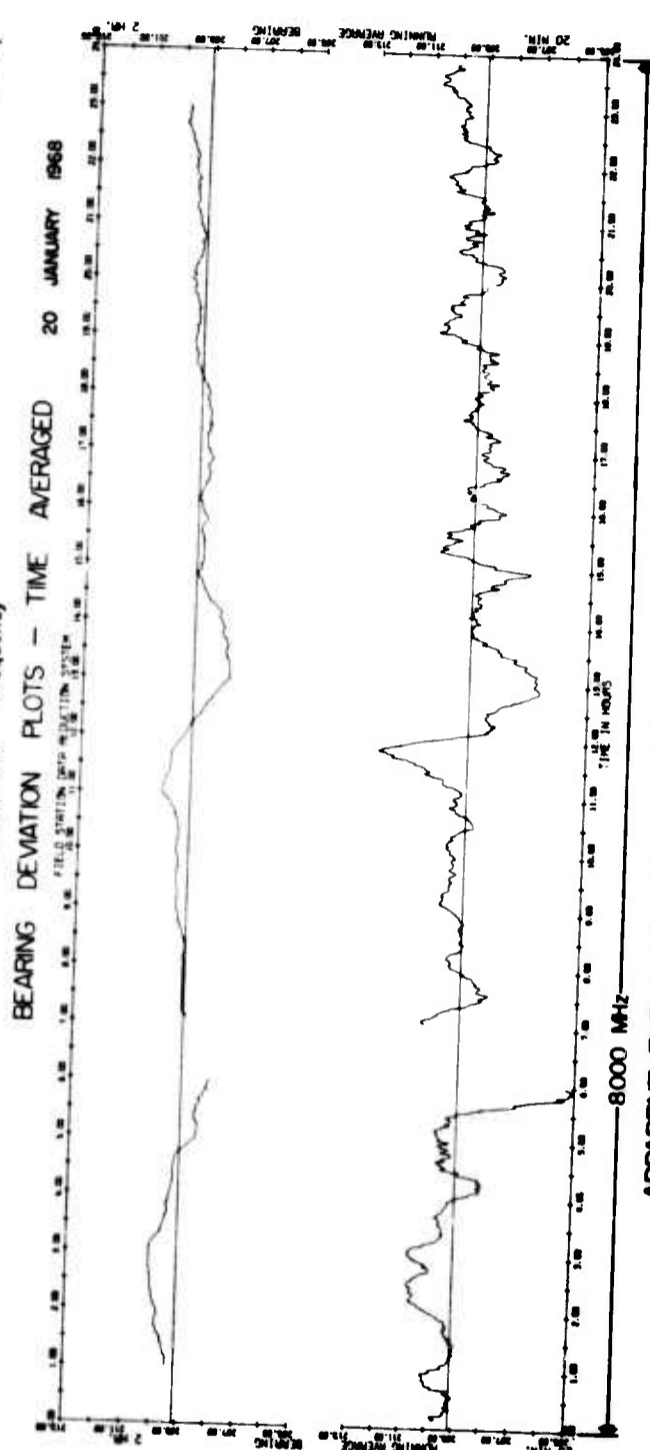
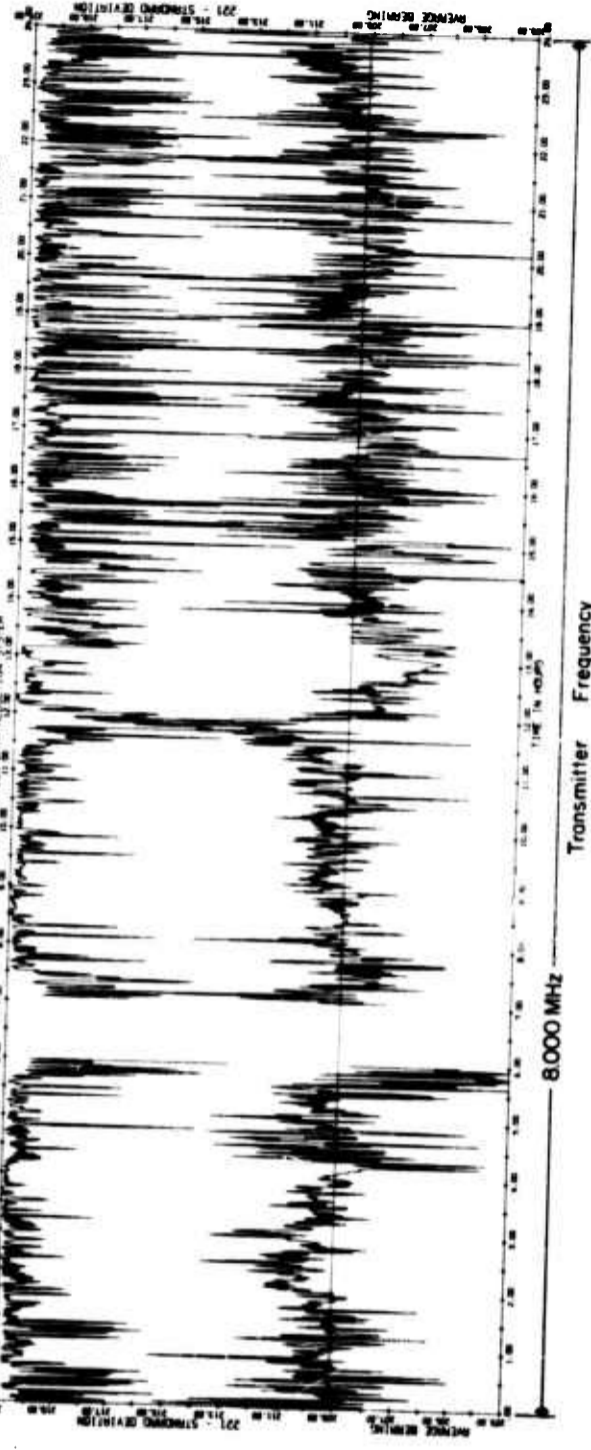
19 January 1968

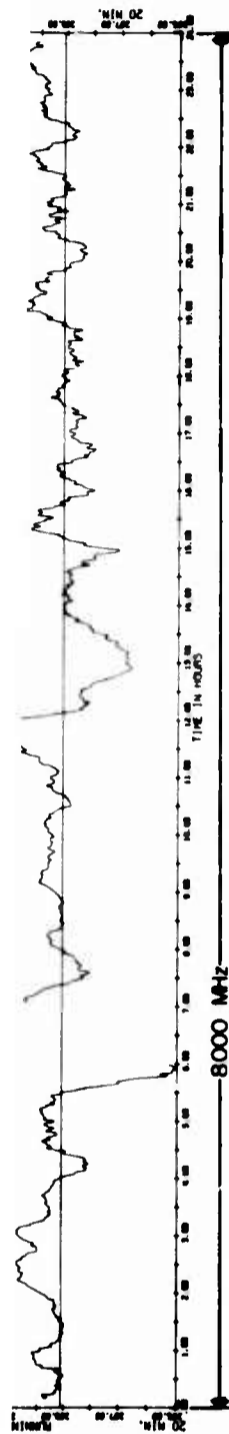


OBLIQUE IONOGRAM DATA
 Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 01' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.8 km 20 JANUARY 1968



BEARING DEVIATION PLOT
 Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34° 8' N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 20 JANUARY 1968





APPARENT ELEVATION ANGLE of ARRIVAL - 20 Minute Average 20 JANUARY 1968

NO DATA AVAILABLE

DOPPLER DATA

20 JANUARY 1968

NO DATA AVAILABLE

VERTICAL SOUNDER DATA

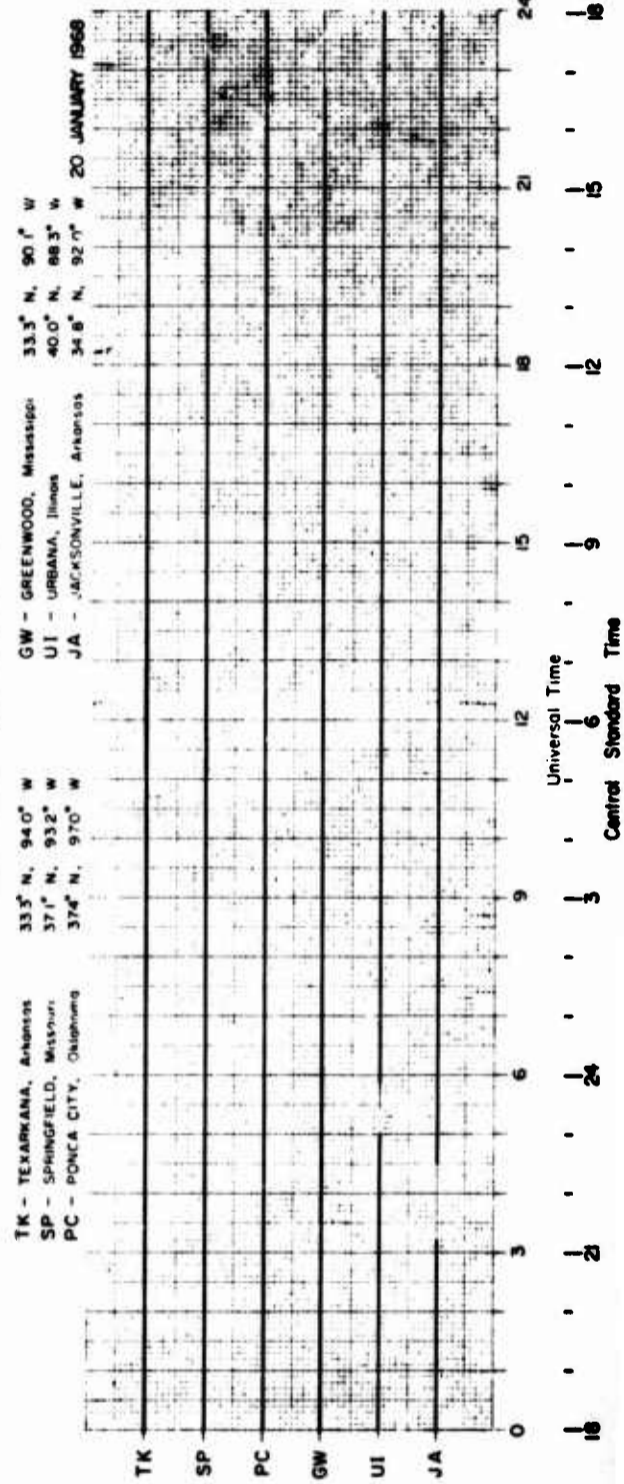
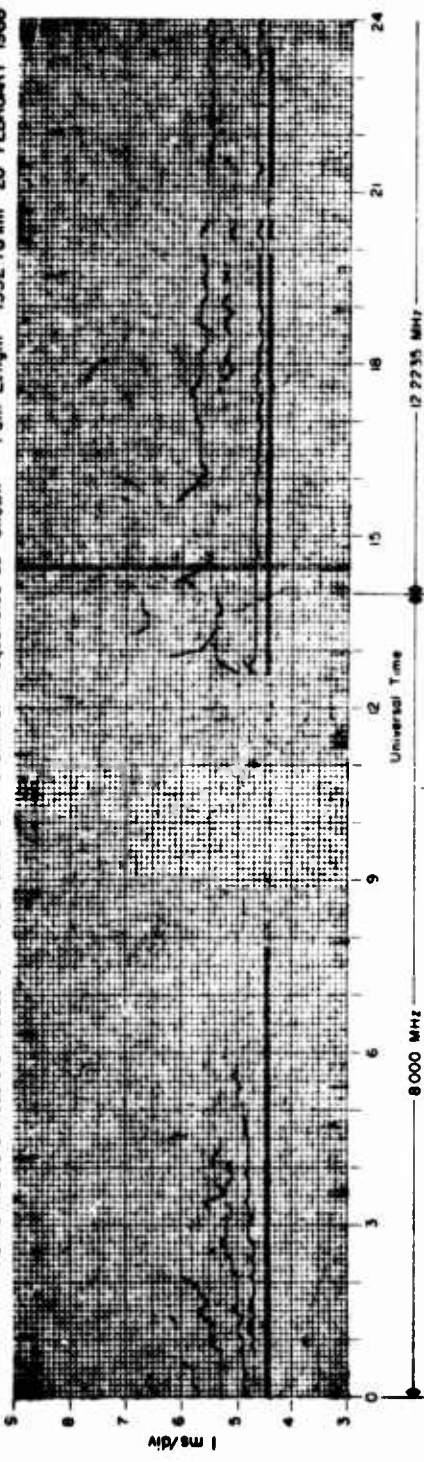


Plate 55.

20 January 1968

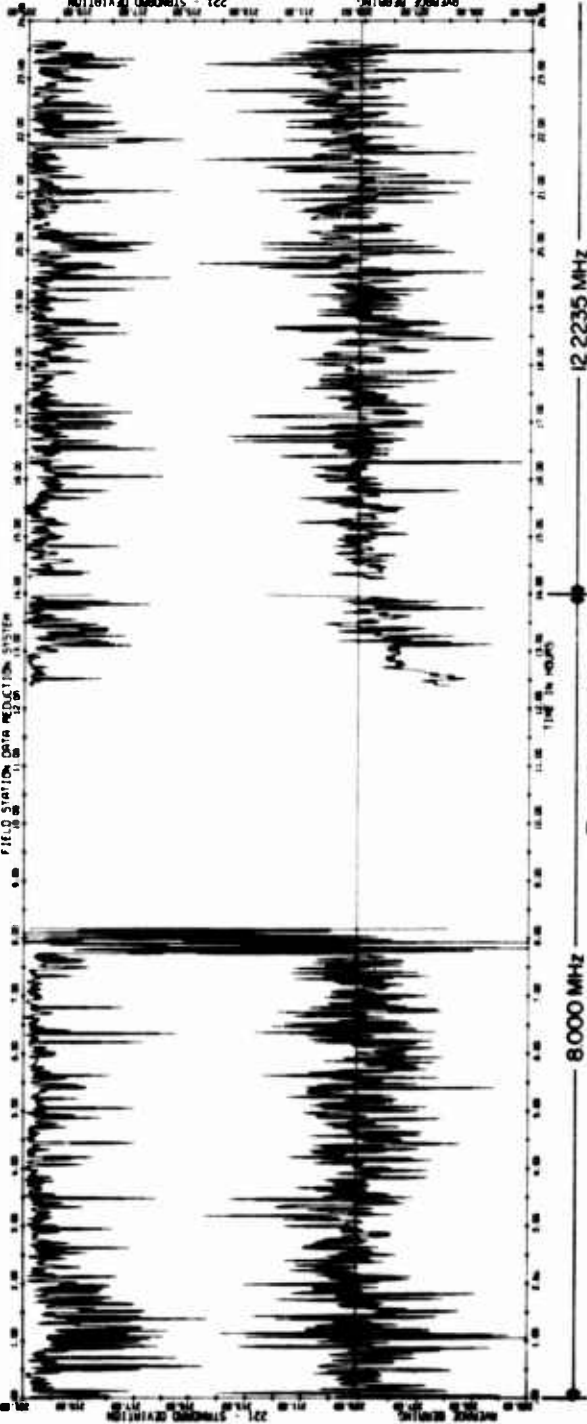
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 20 FEBRUARY 1968

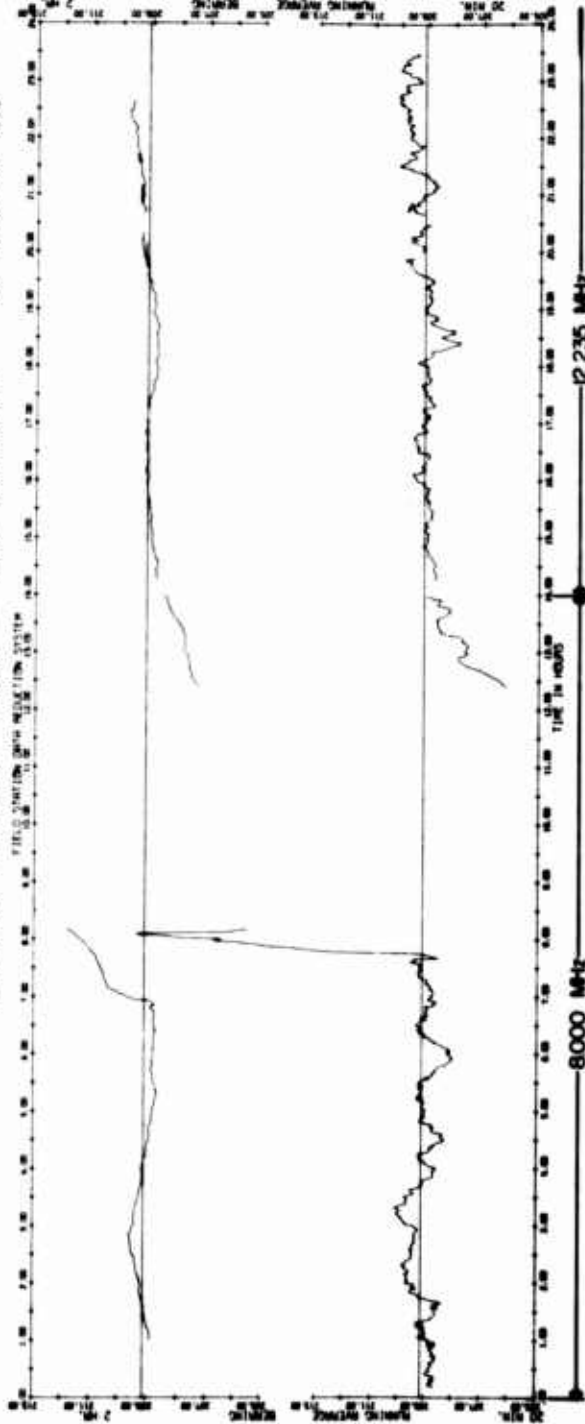


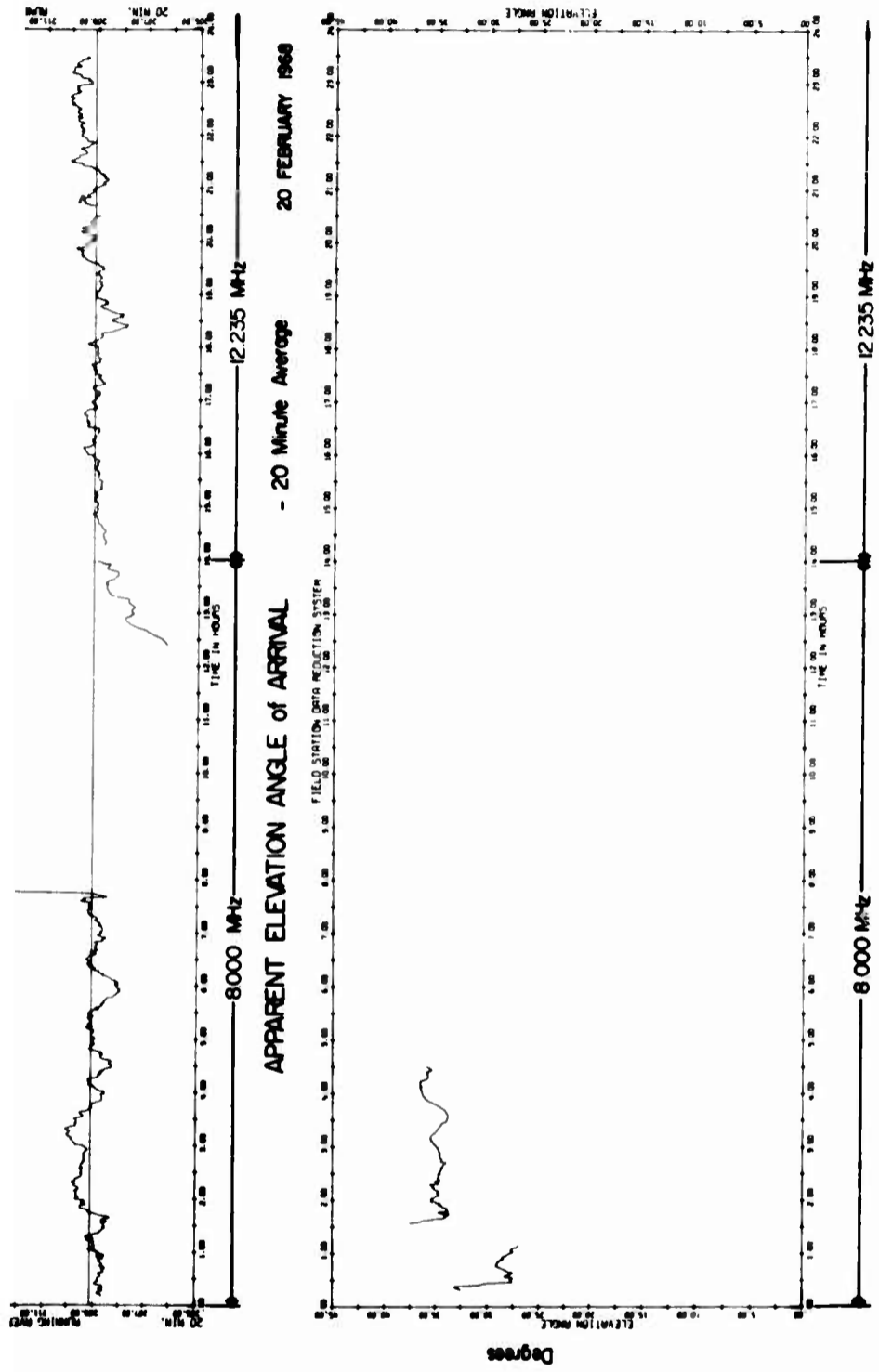
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 20 FEBRUARY 1968



BEARING DEVIATION PLOTS - TIME AVERAGED





NO DATA AVAILABLE

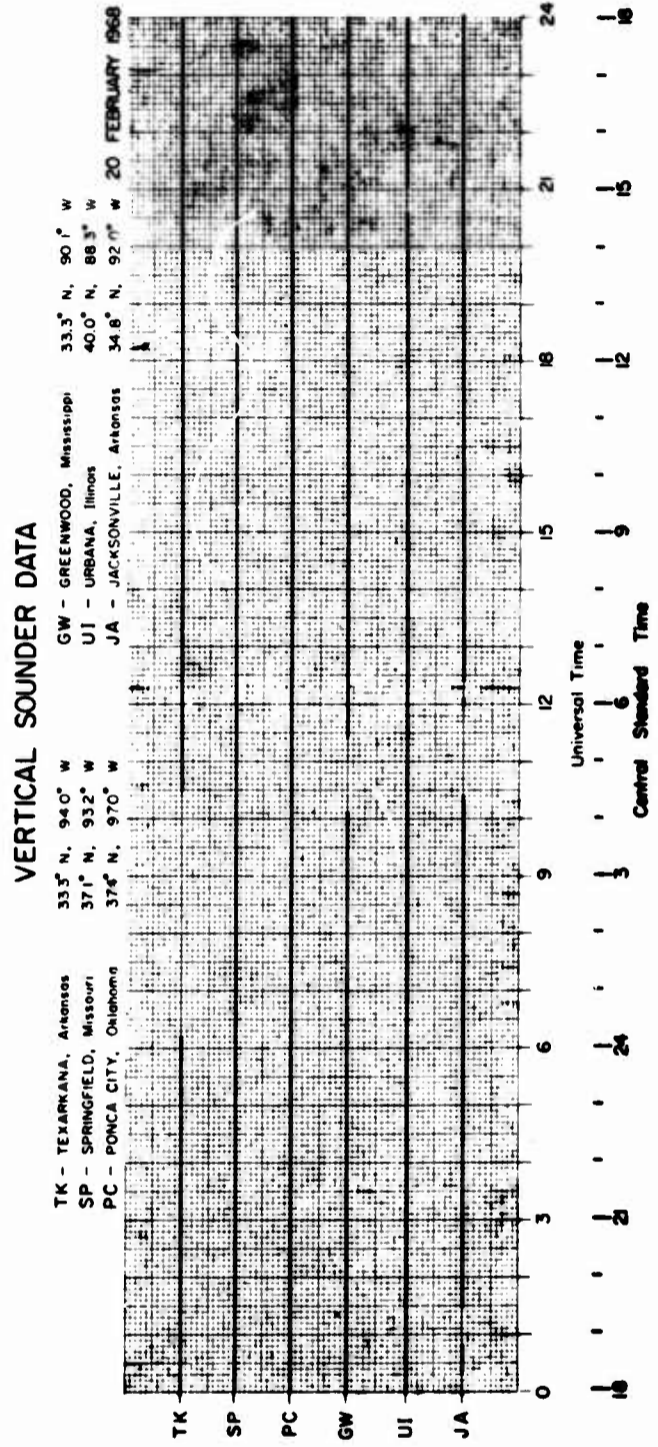
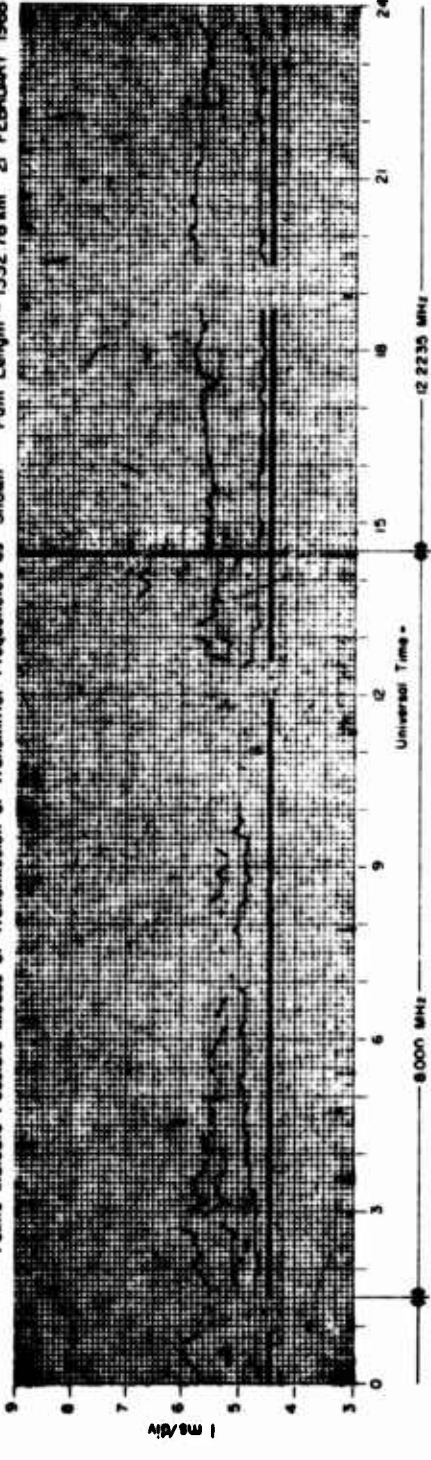


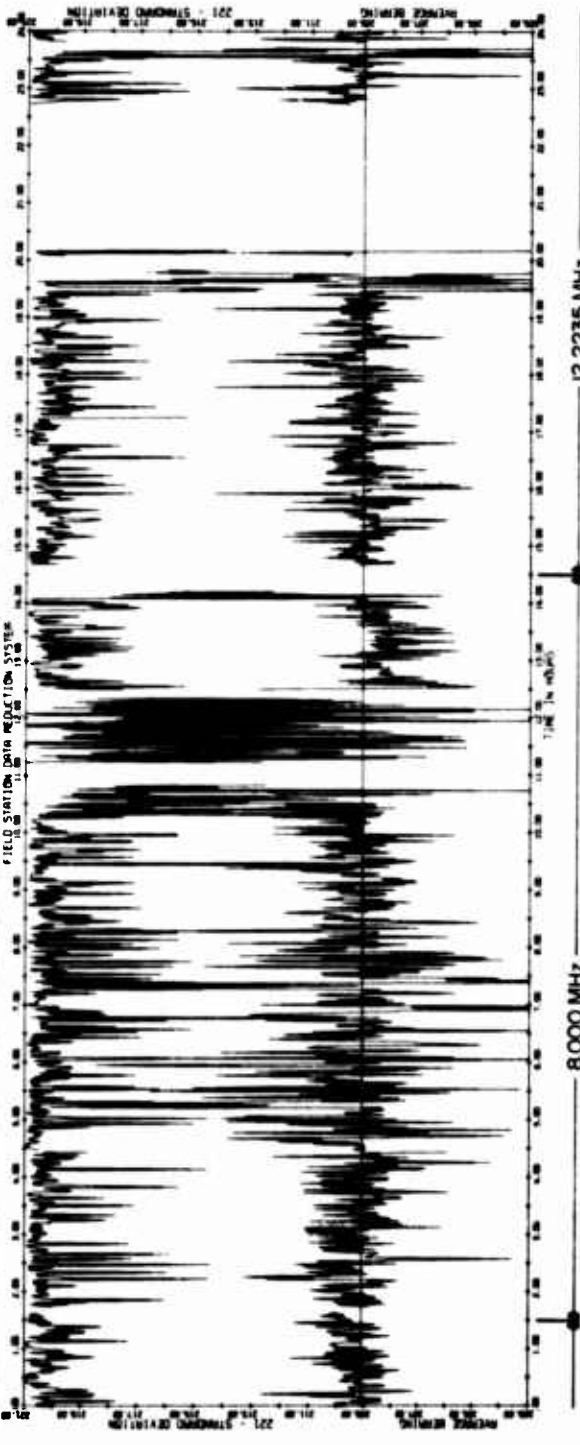
Plate 56.
20 February 1968

OBLIQUE IONOGRAM DATA

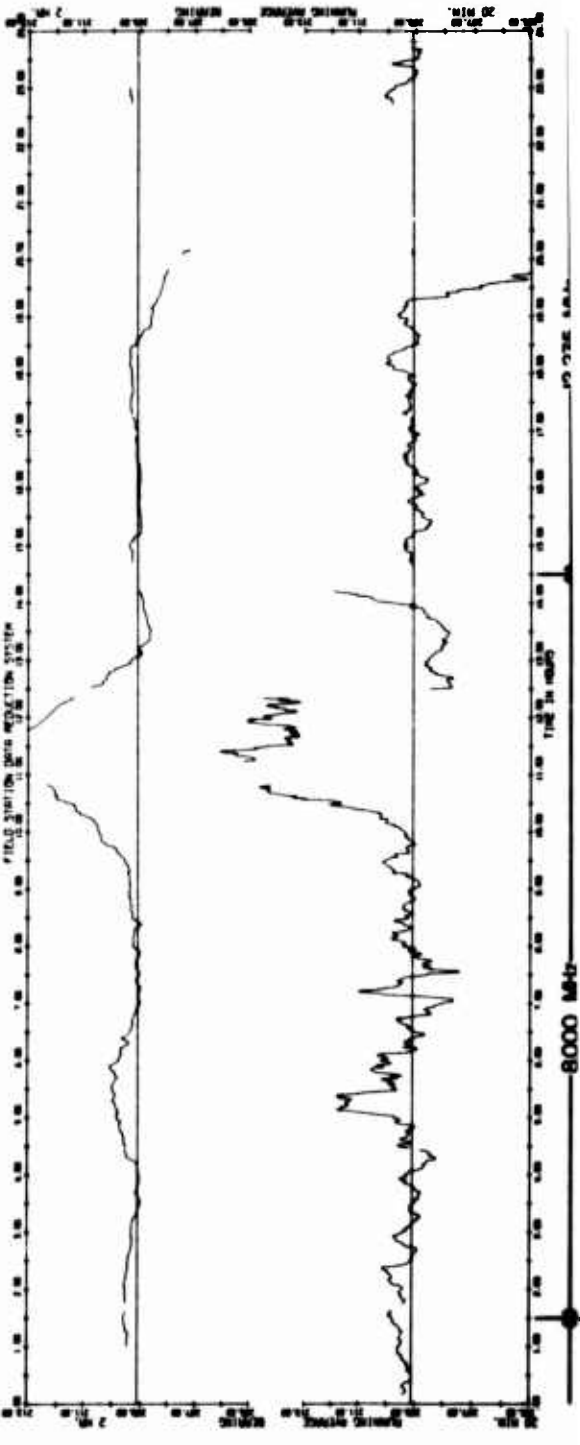
Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 21 FEBRUARY 1968

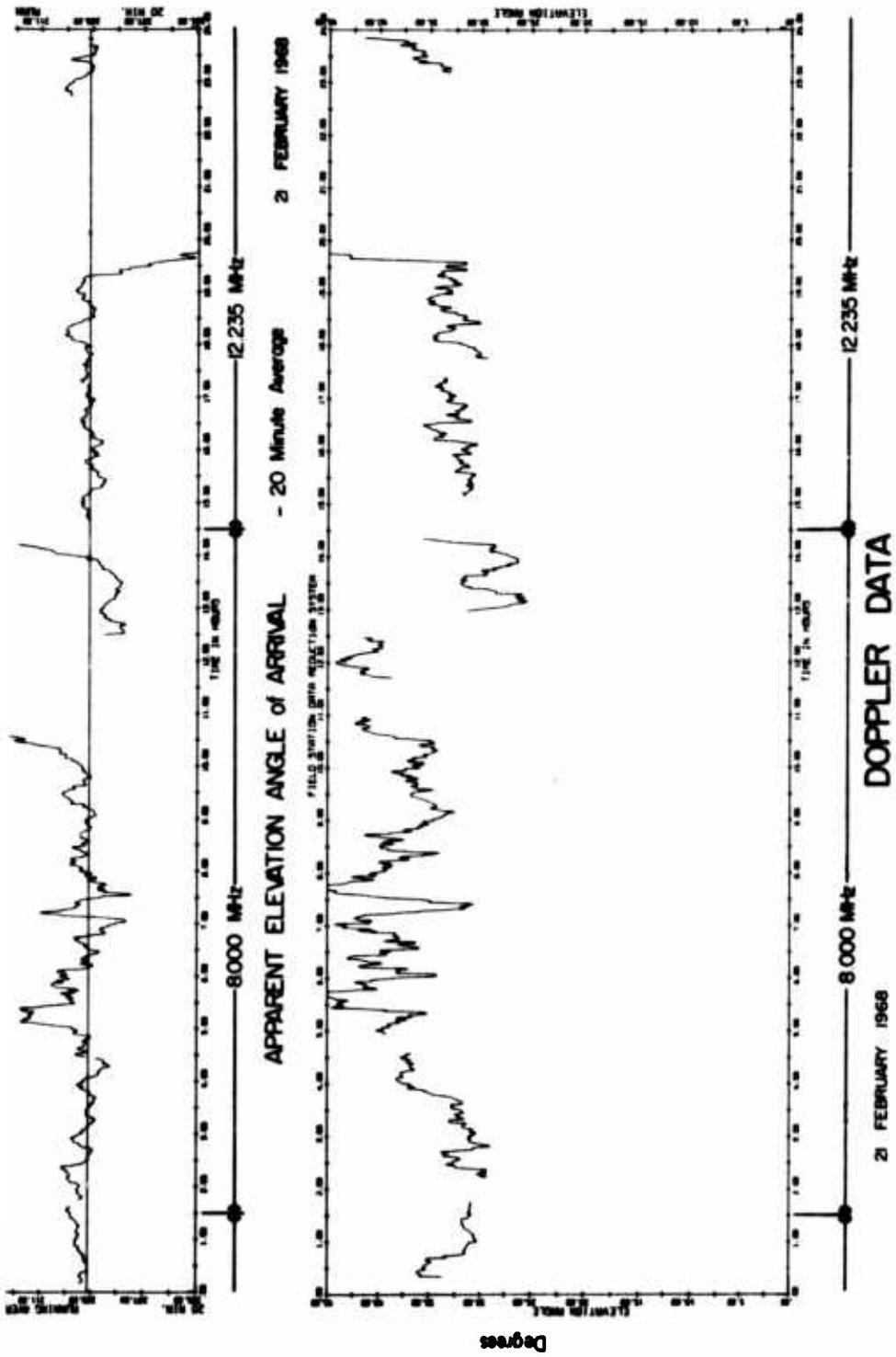


BEARING DEVIATION PLOT 21 FEBRUARY 1968
 Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34° 8' N, 92° 0' W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W



BEARING DEVIATION PLOTS - TIME AVERAGED 21 FEBRUARY 1968





NO DATA AVAILABLE

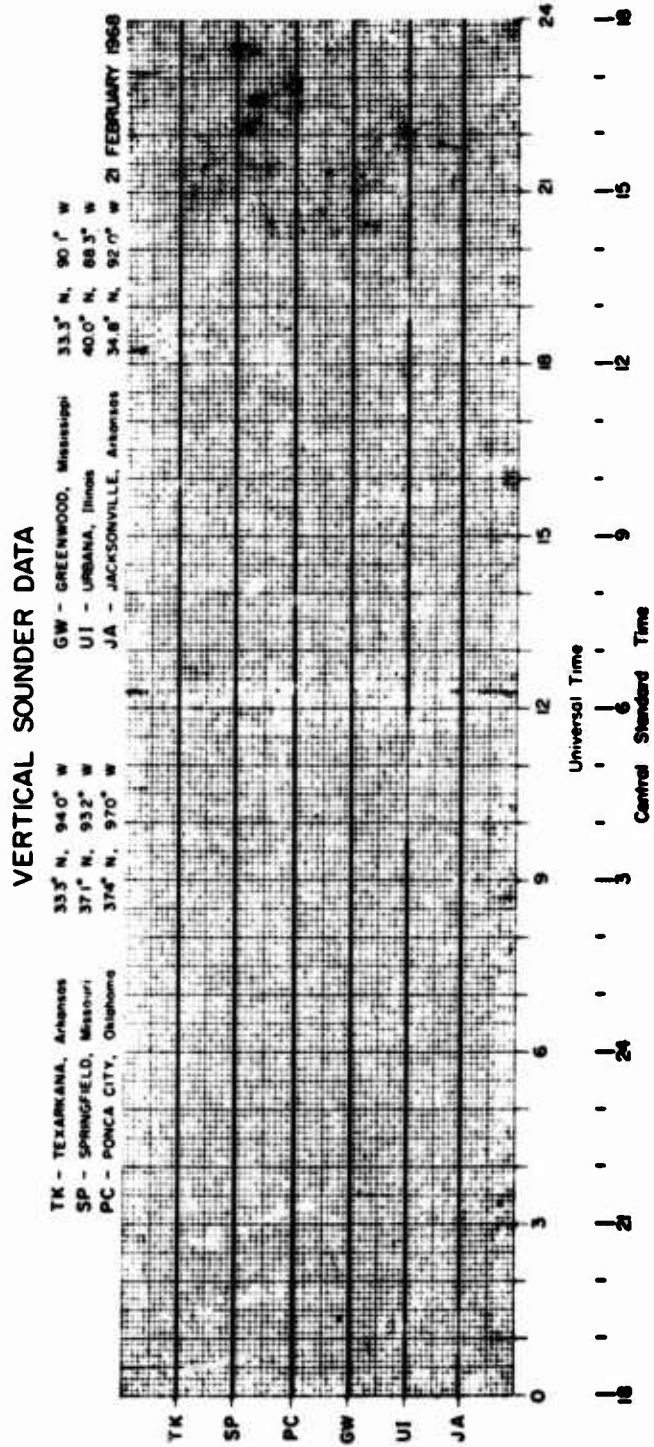
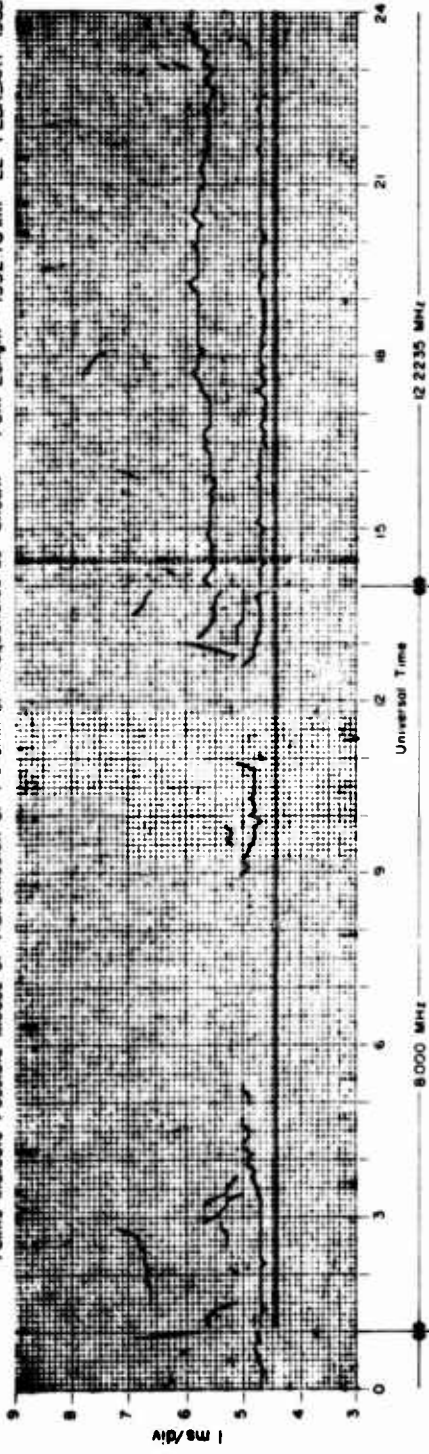


Plate 57.

21 February 1968

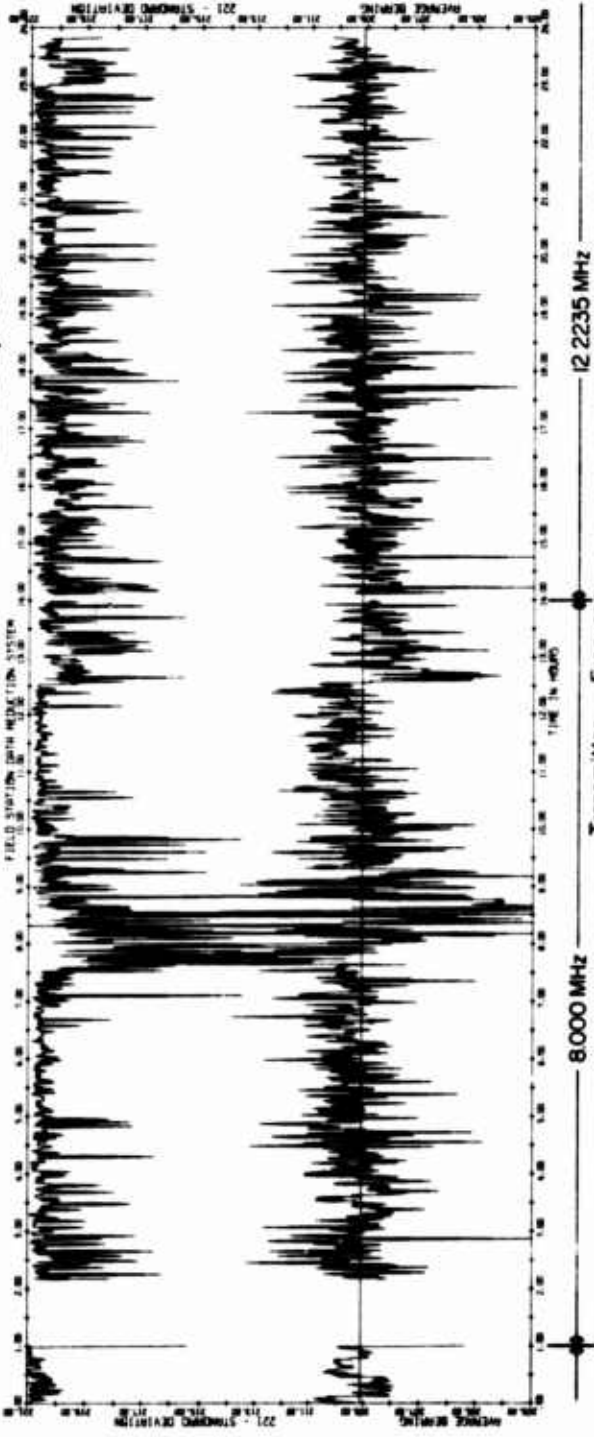
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Path Length - 1332.78 km 22 FEBRUARY 1968

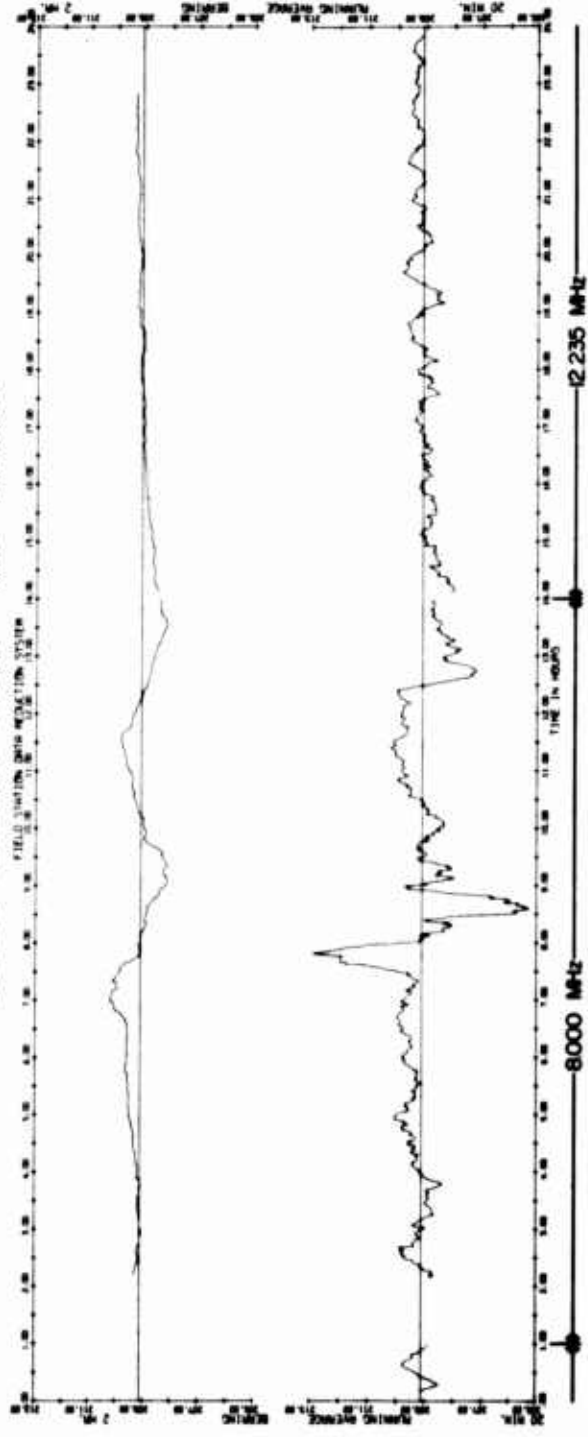


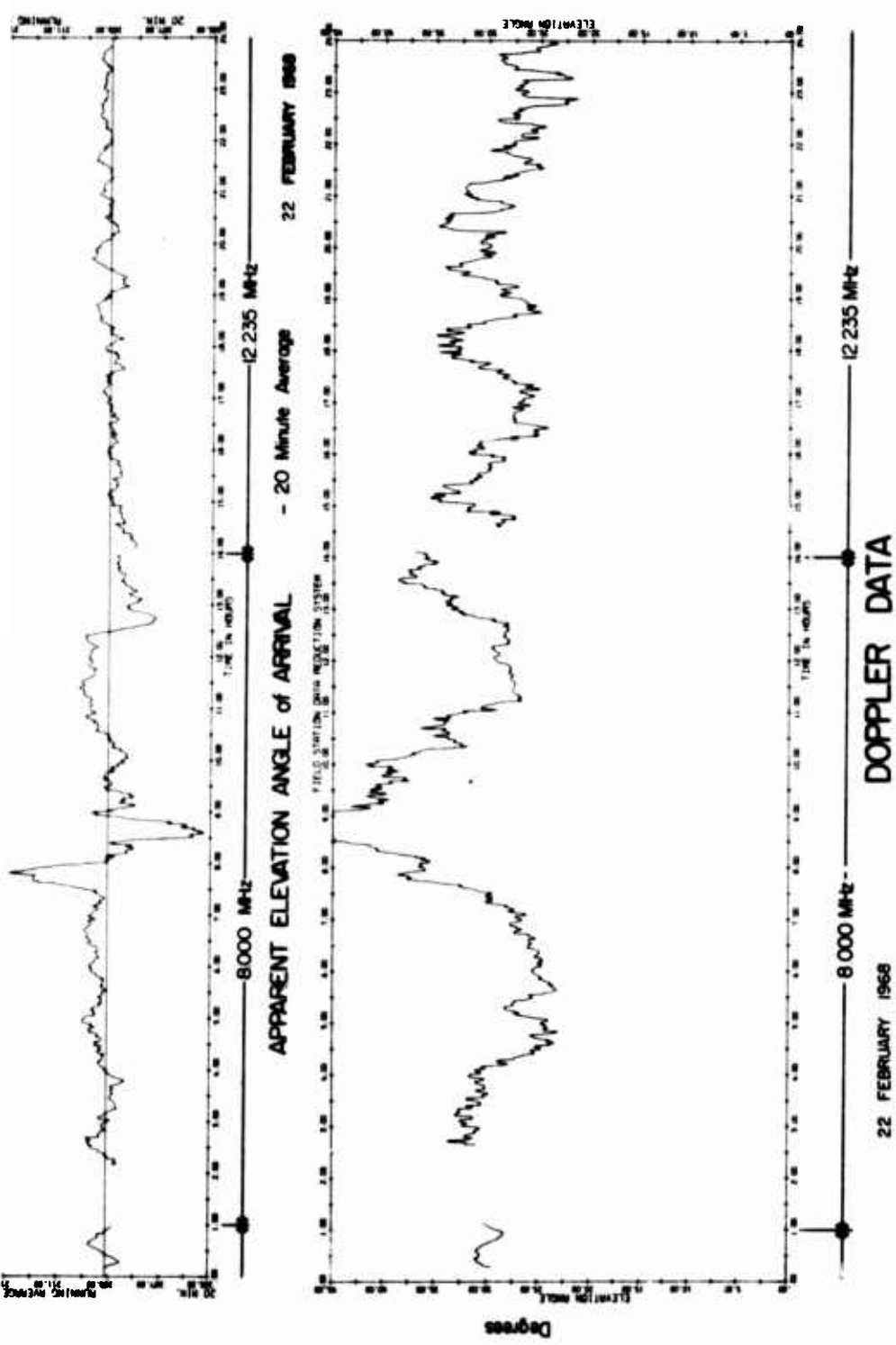
BEARING DEVIATION PLOT

Transmitter 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34° 8' N, 92° 0' W
 Receiver Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 22 February 1968



BEARING DEVIATION PLOTS - TIME AVERAGED 22 FEBRUARY 1968





NO DATA AVAILABLE

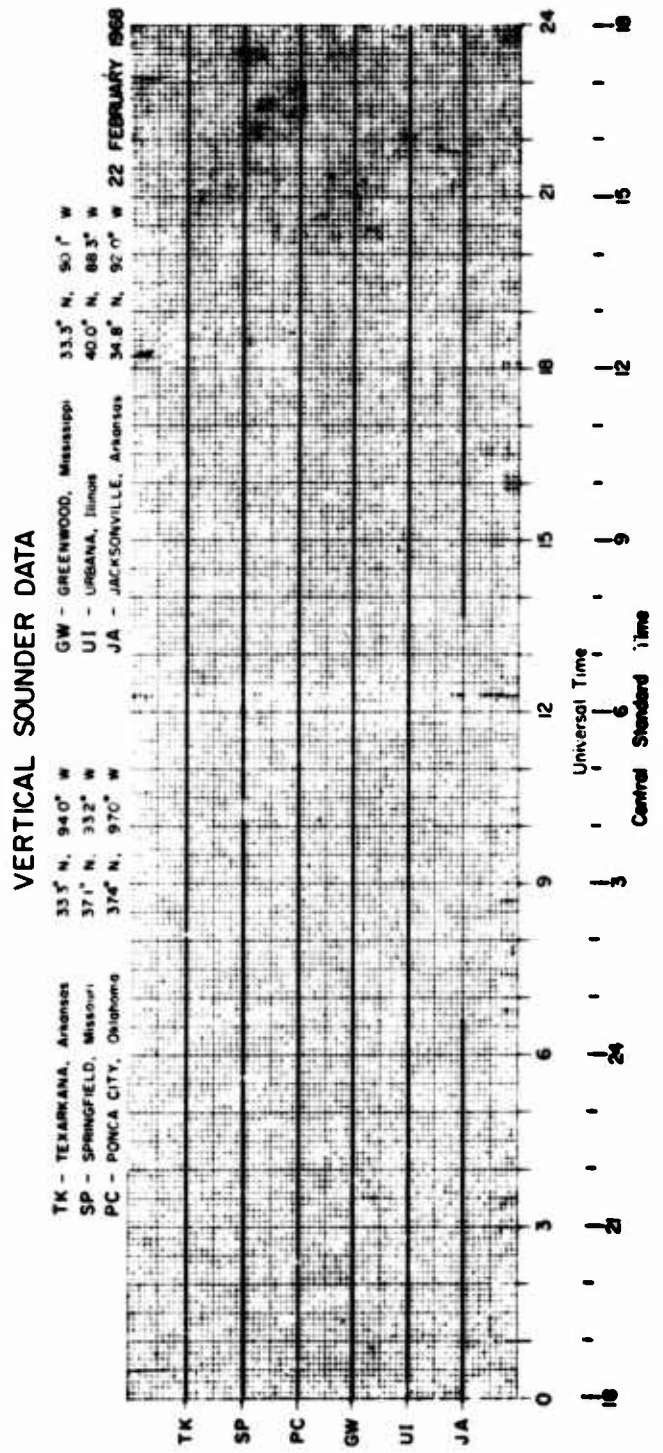
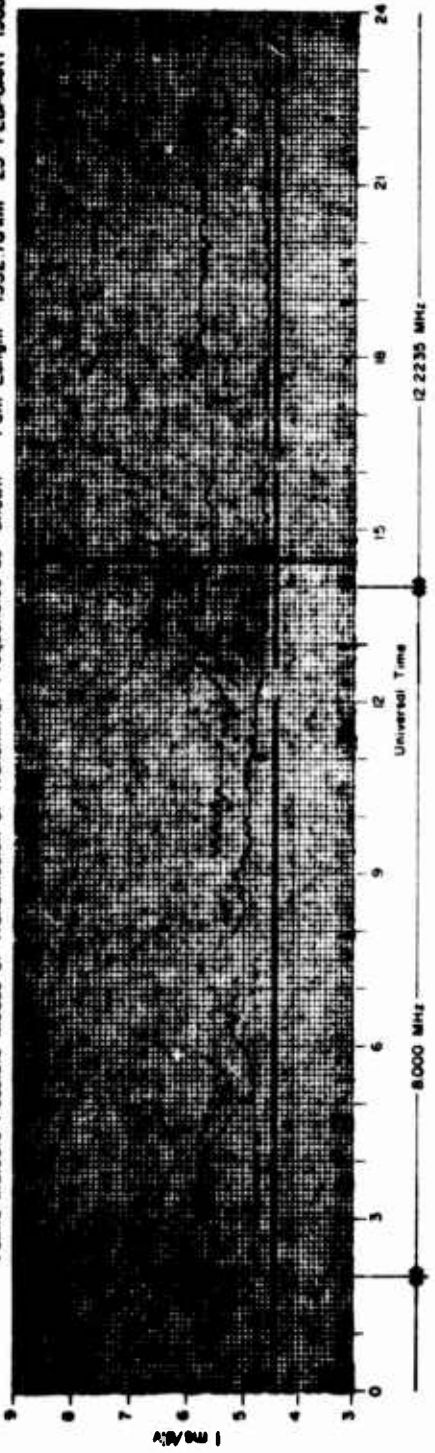


Plate 58.

22 February 1968

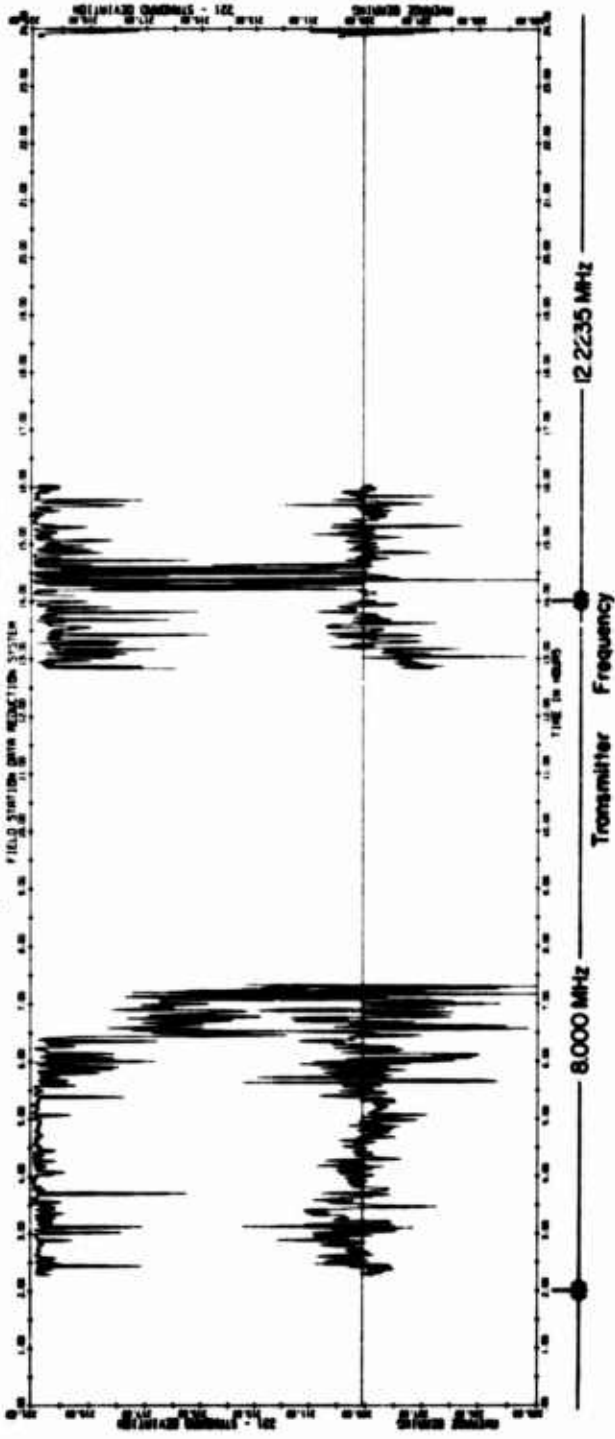
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 23 FEBRUARY 1968

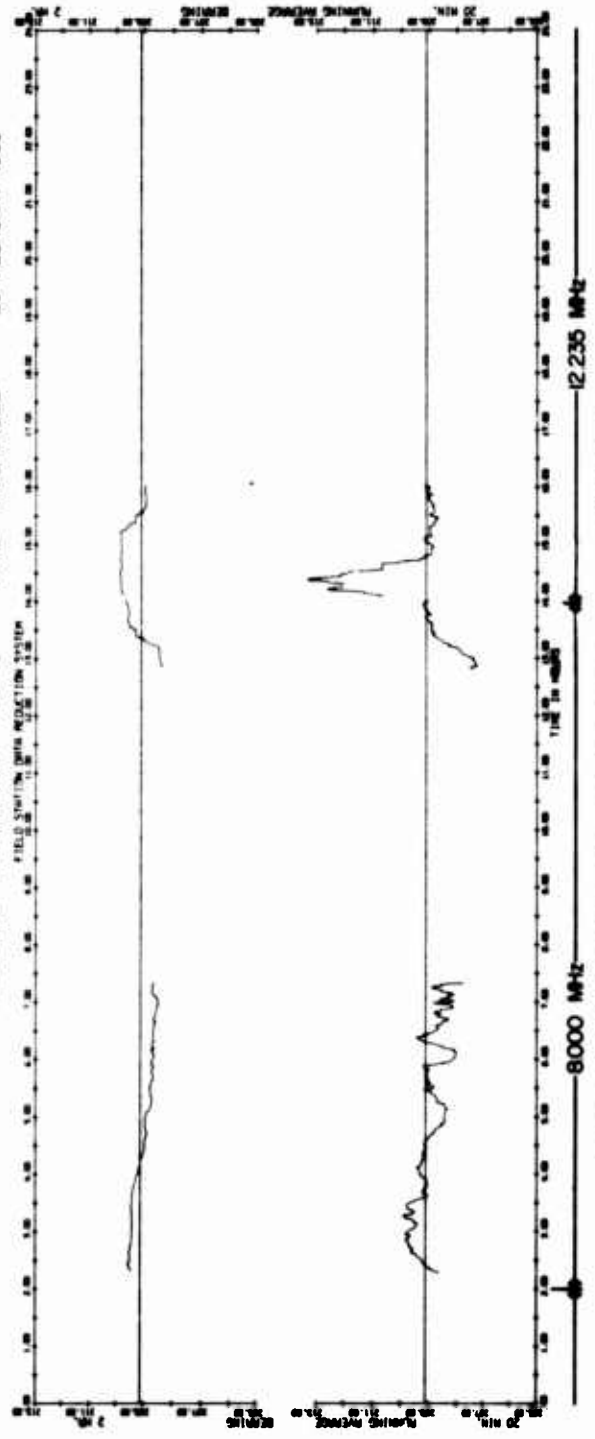


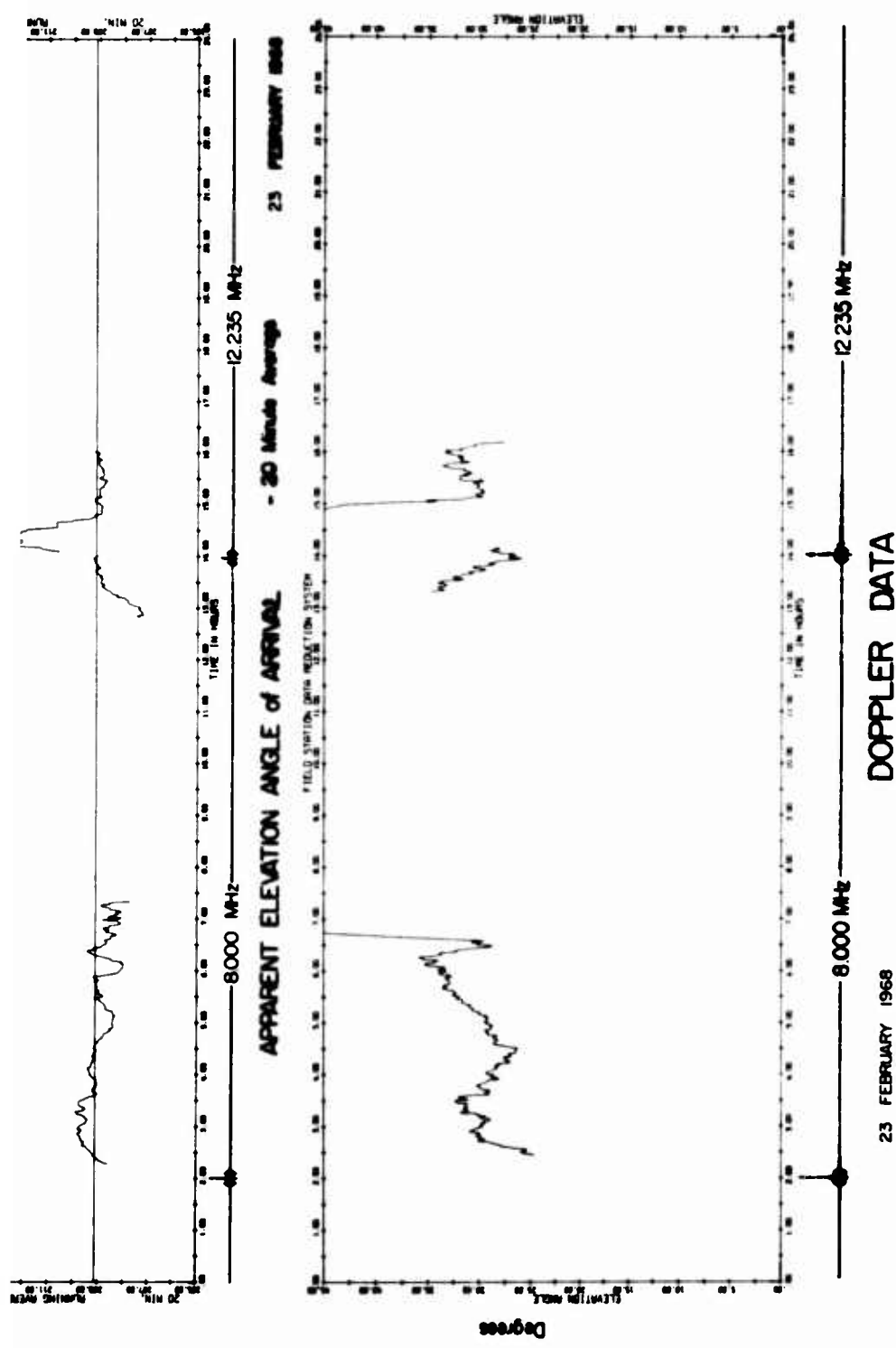
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 23 FEBRUARY 1968



BEARING DEVIATION PLOTS - TIME AVERAGED 23 FEBRUARY 1968





NO DATA AVAILABLE

VERTICAL SOUNDER DATA

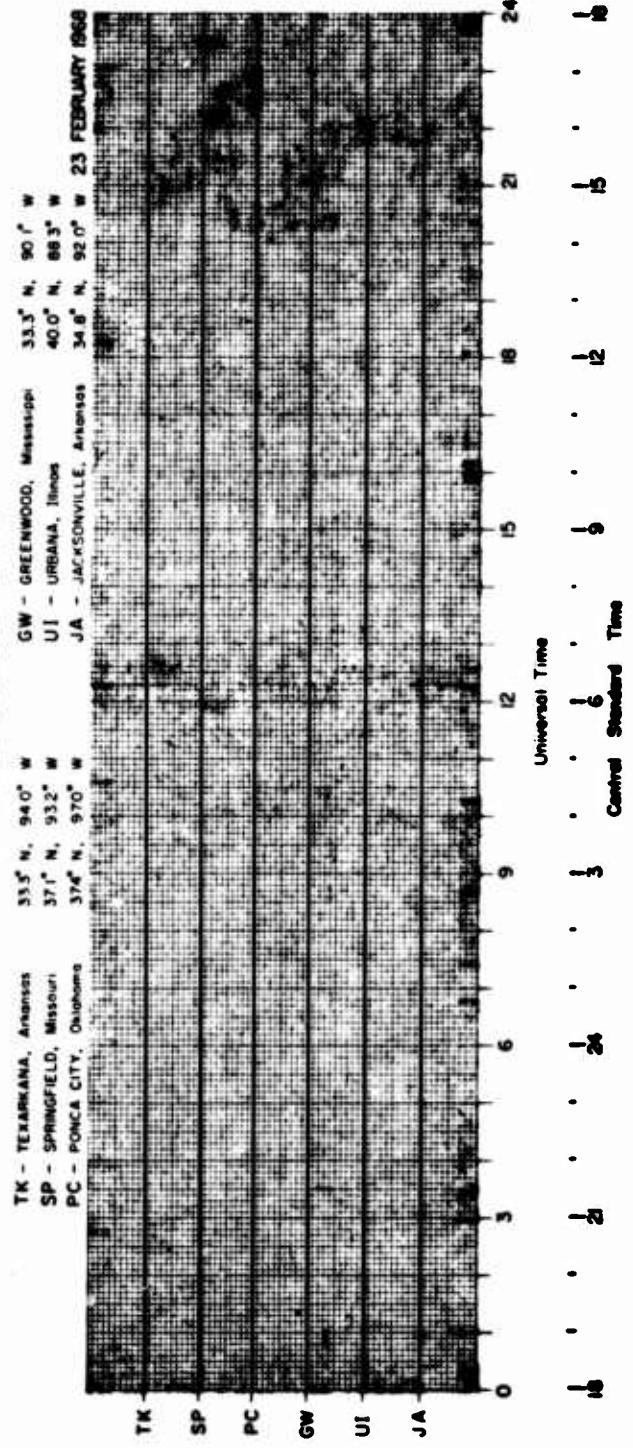
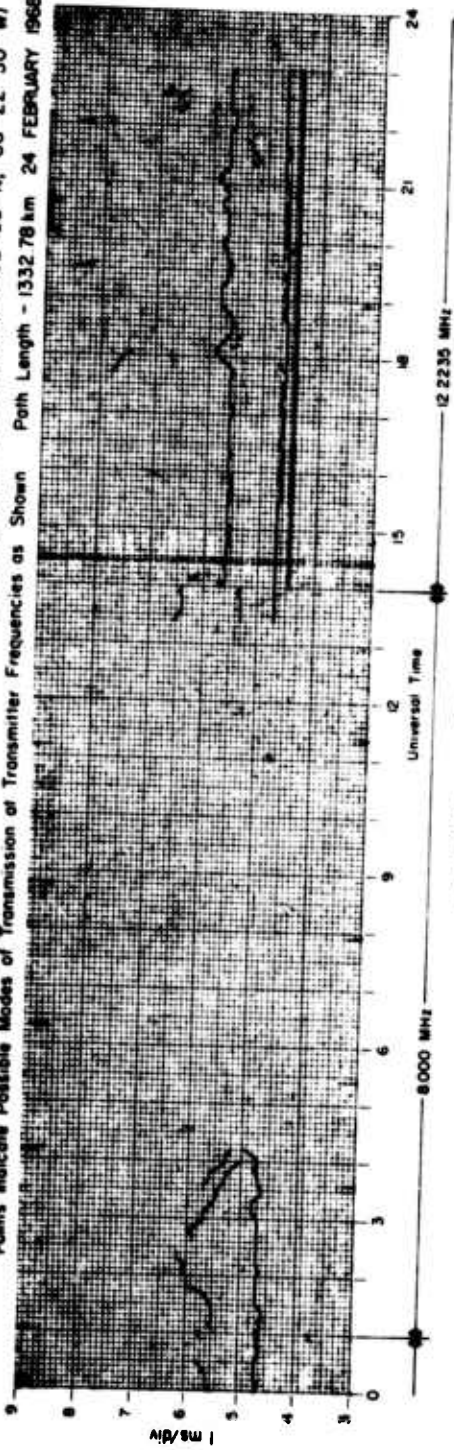


Plate 59.

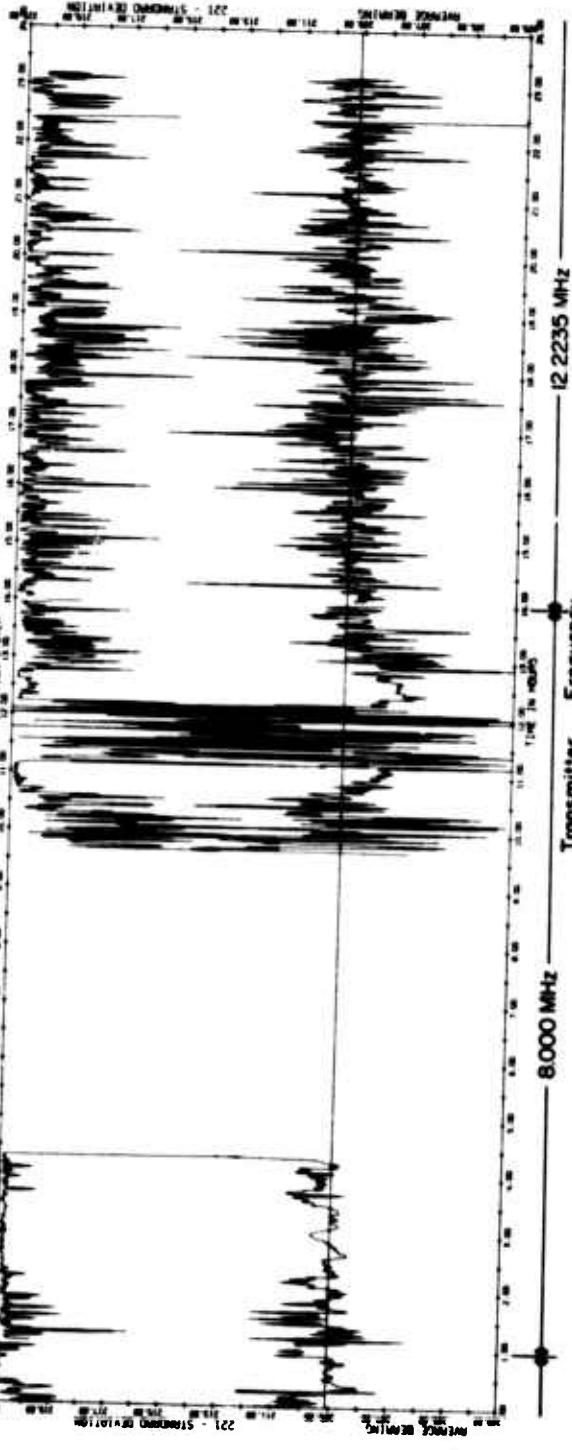
23 February 1968



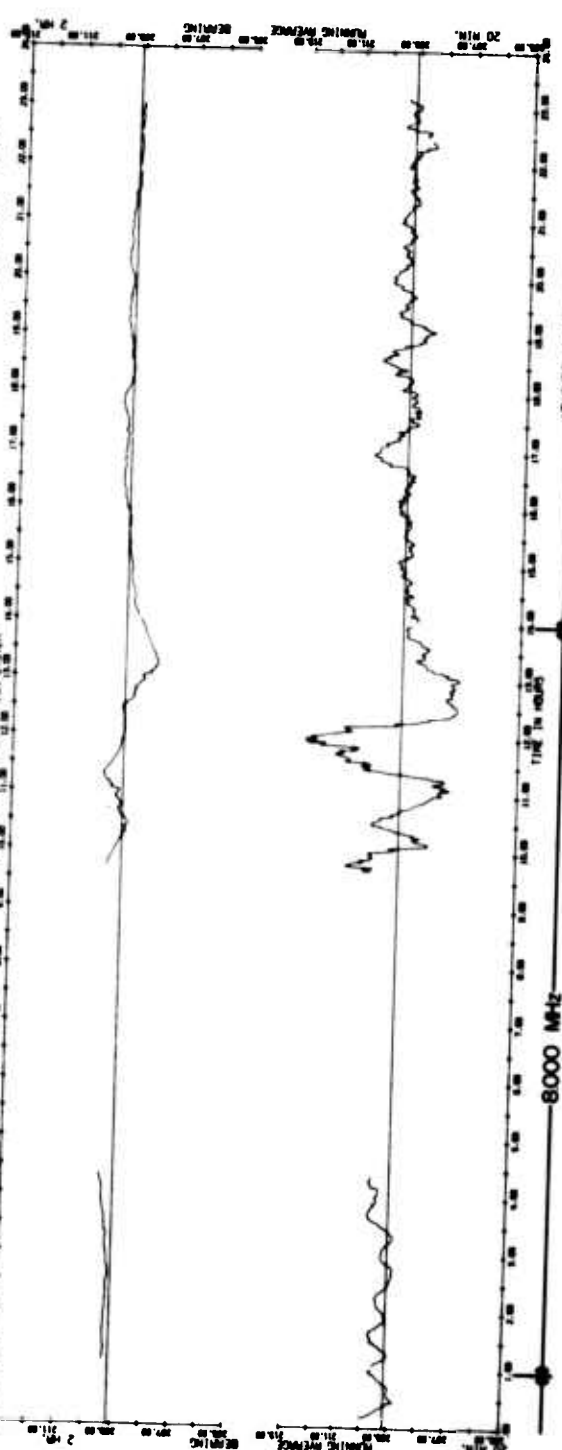
OBLIQUE IONOGRAM DATA
 Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 24 FEBRUARY 1968

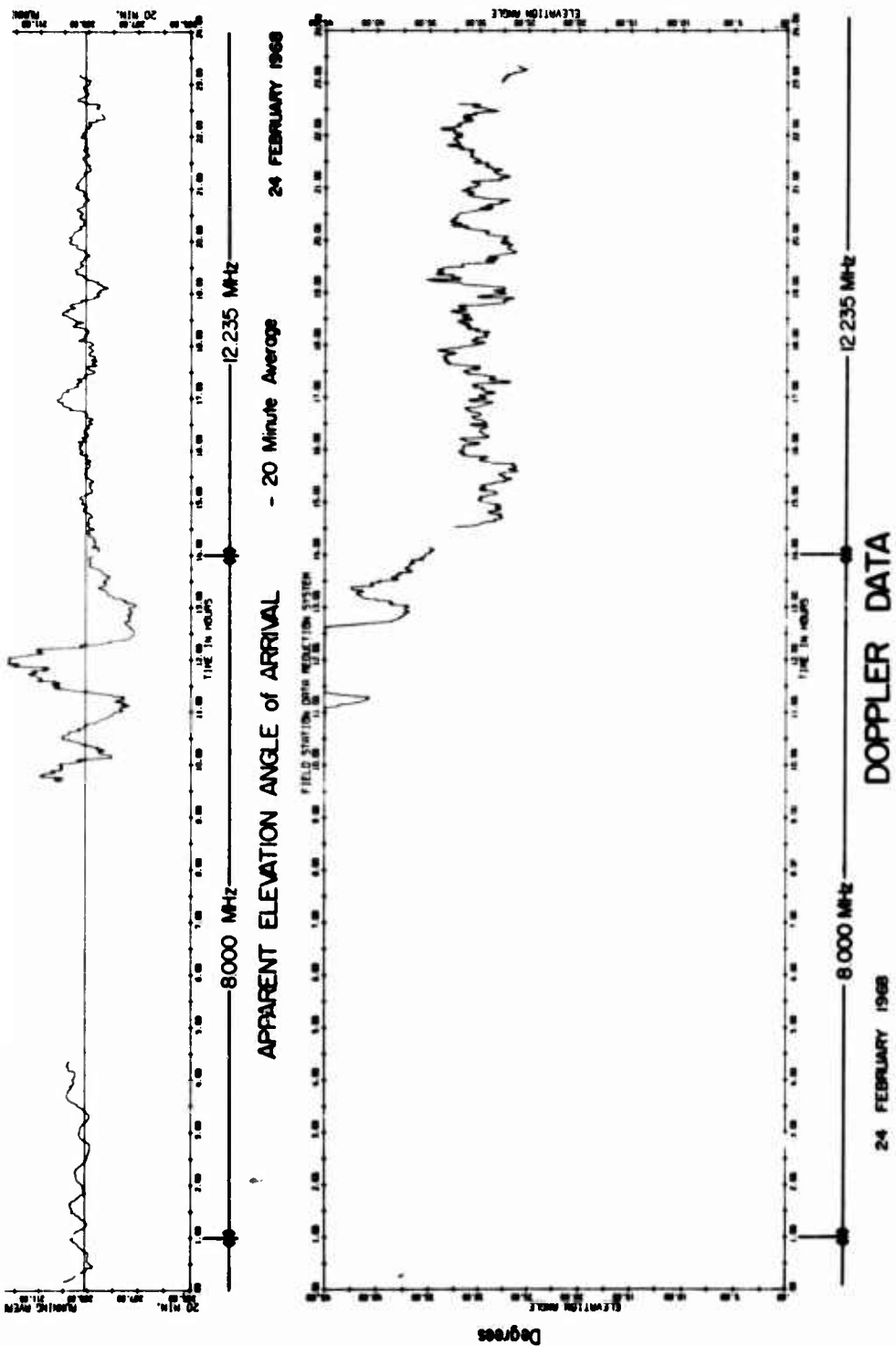


BEARING DEVIATION PLOT
 Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min Intervals
 Antenna of Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 24 FEBRUARY 1968



BEARING DEVIATION PLOTS - TIME AVERAGED 24 FEBRUARY 1968





NO DATA AVAILABLE

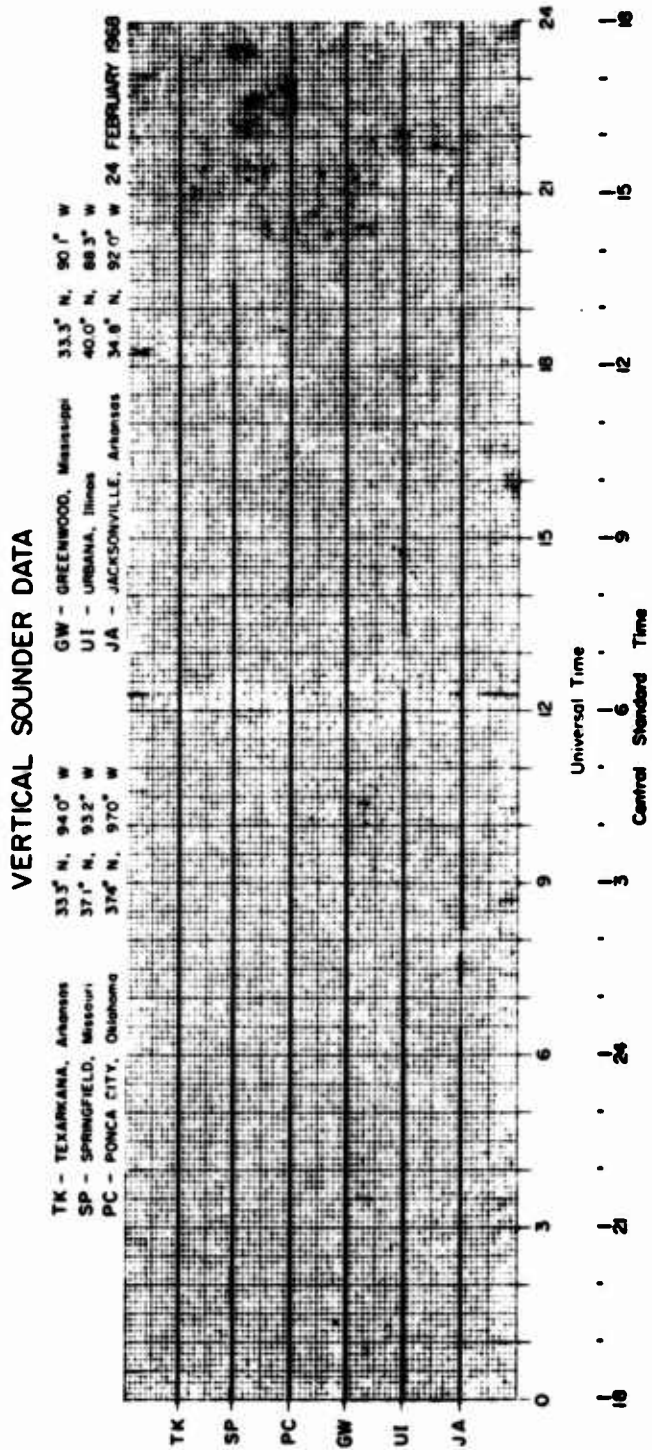


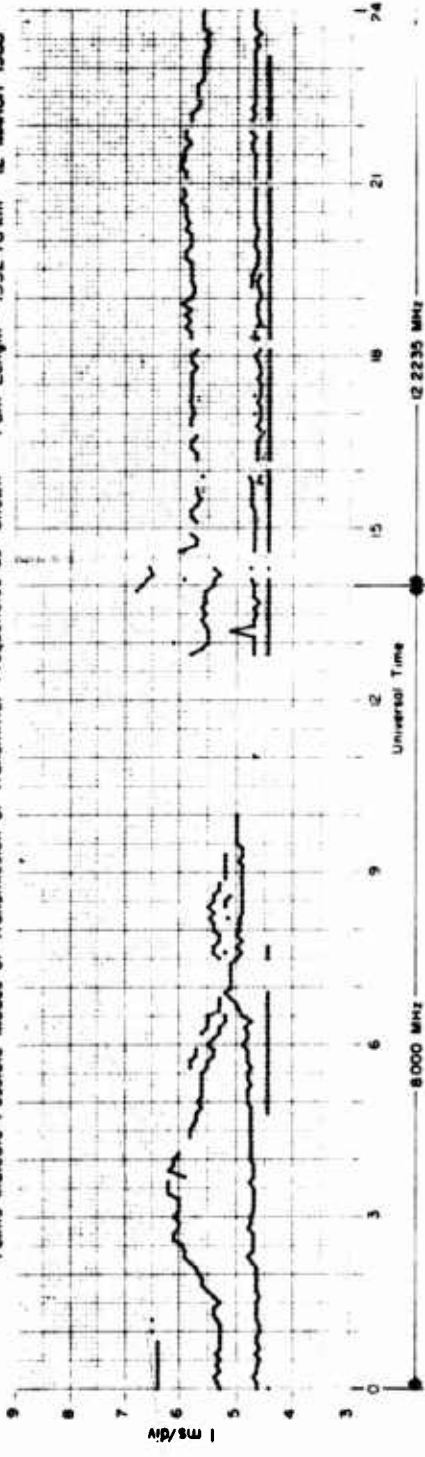
Plate 60.

24 February 1968

2

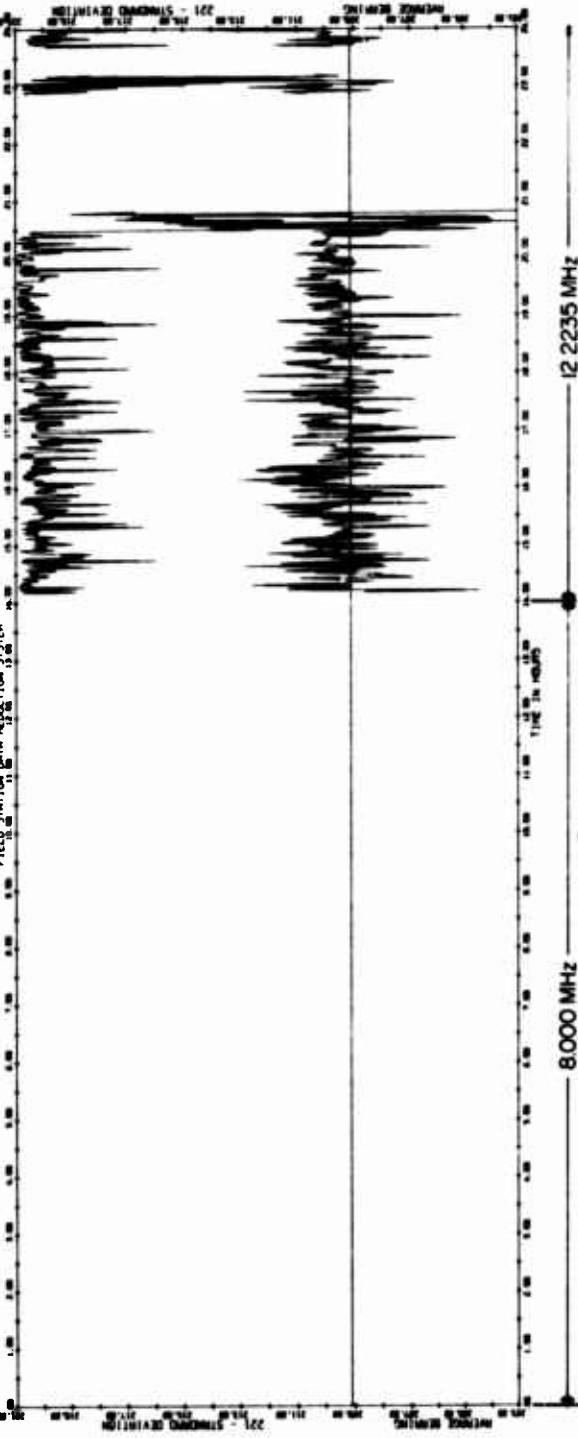
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 12 MARCH 1968

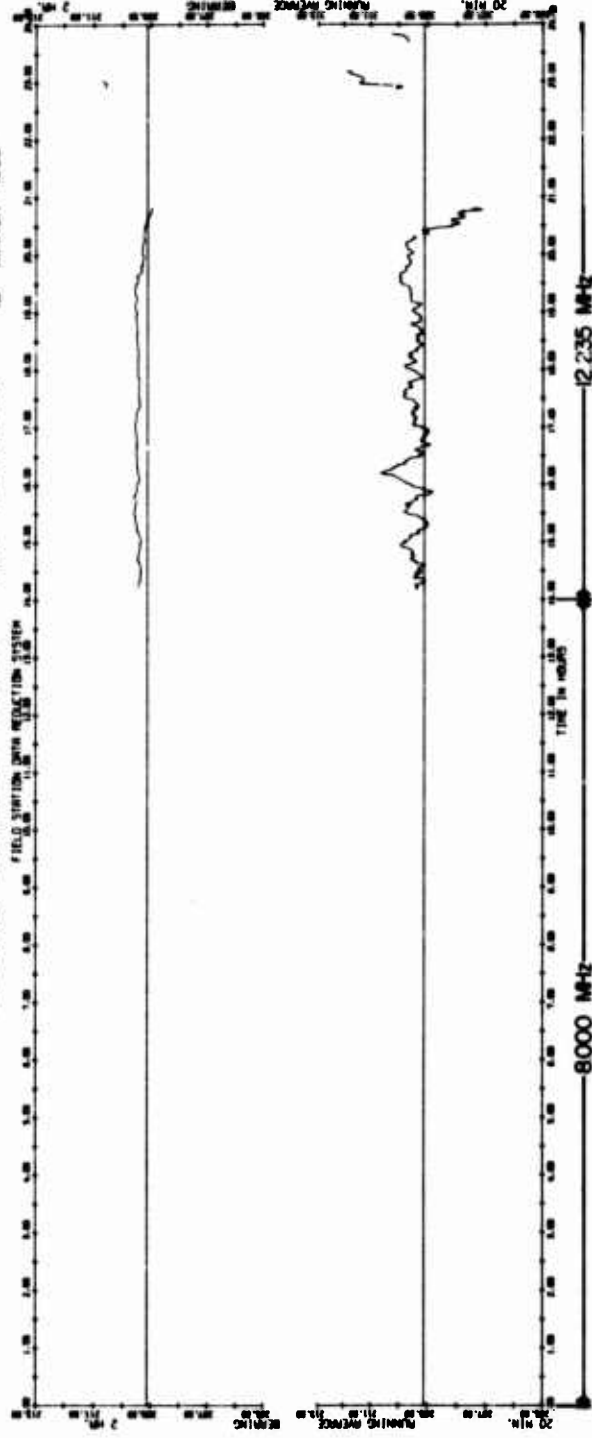


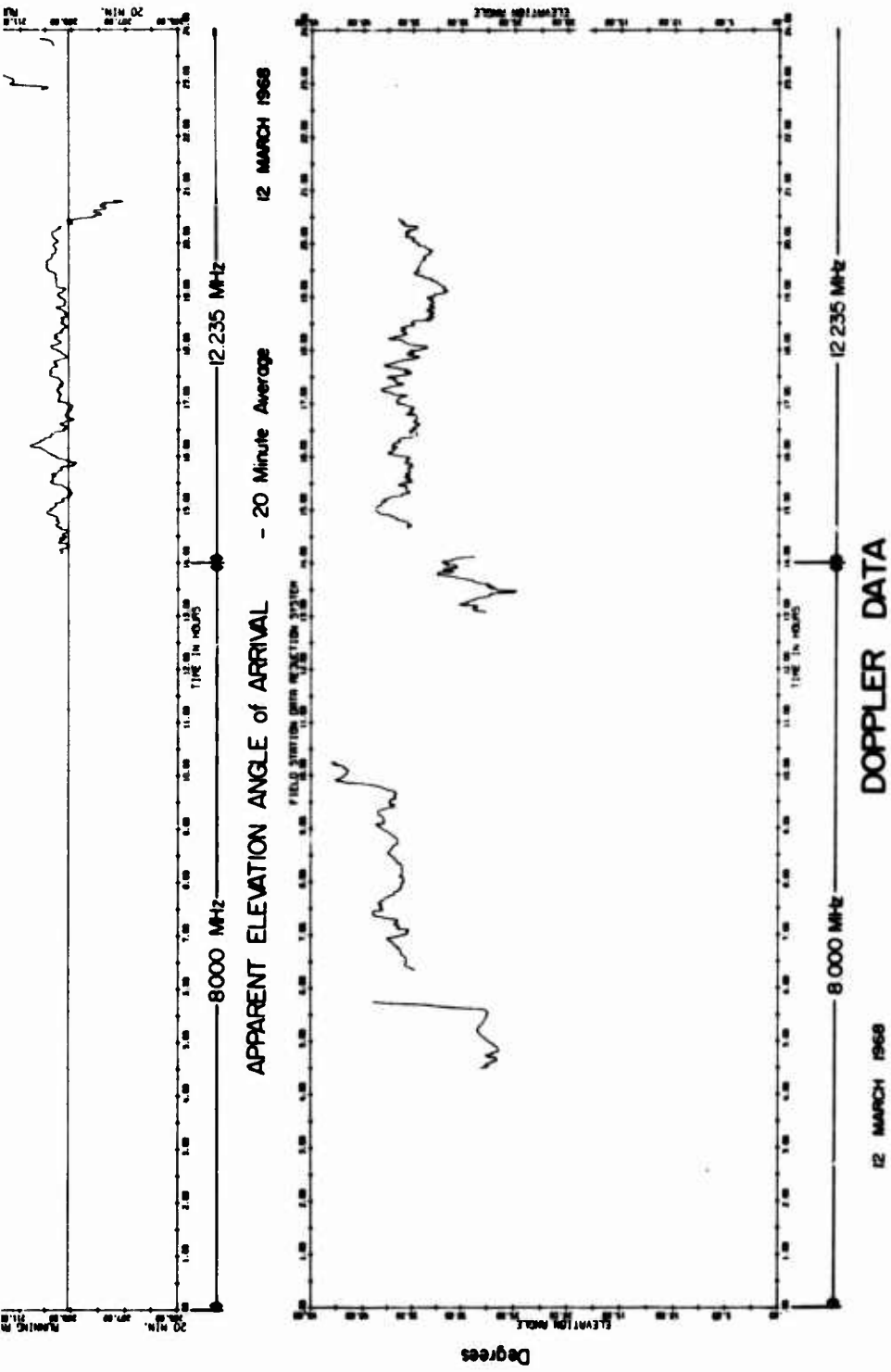
BEARING DEVIATION PLOT 12 March 1968

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min Intervals
 Antenna of Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W



BEARING DEVIATION PLOTS - TIME AVERAGED 12 MARCH 1968





NO DATA AVAILABLE

VERTICAL SOUNDER DATA

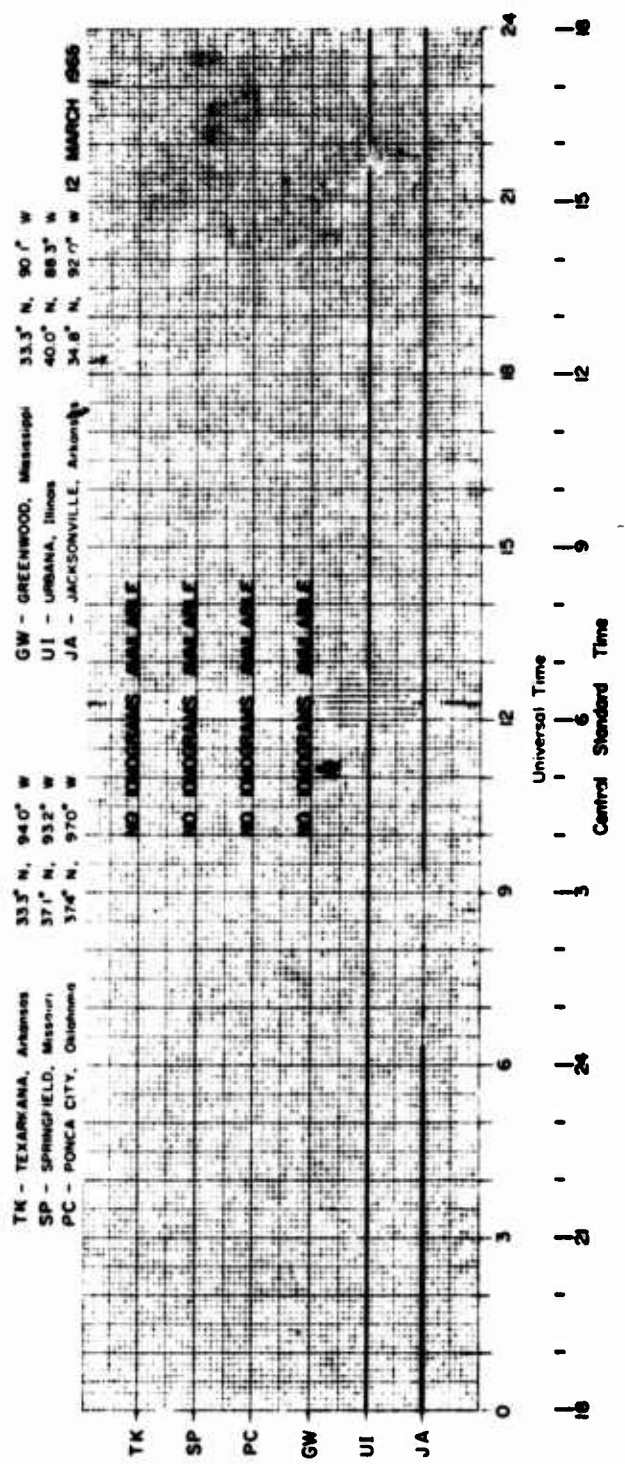


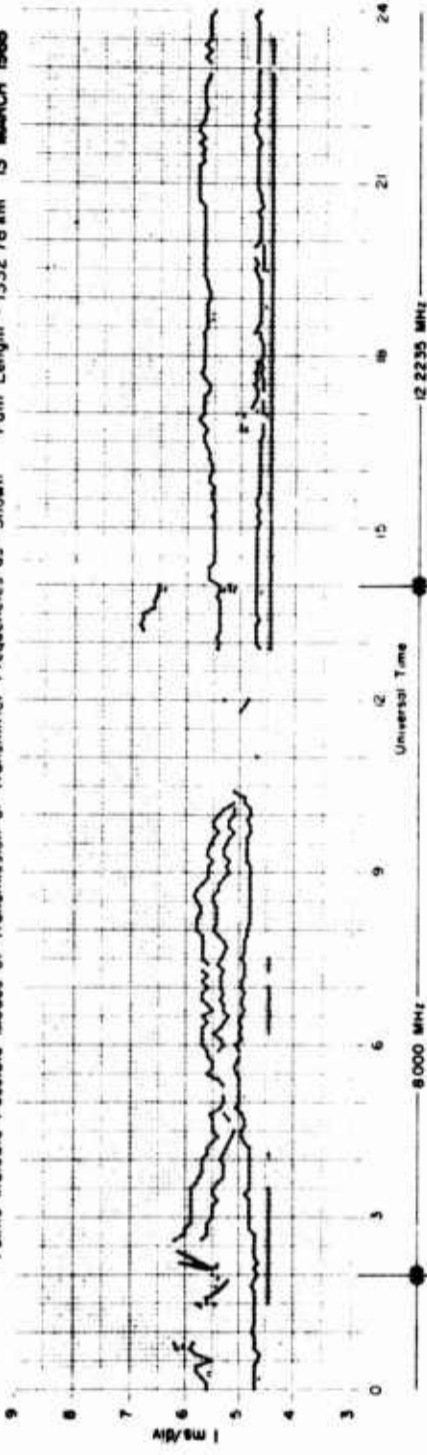
Plate 61.

12 March 1968

OBLIQUE IONOGRAM DATA

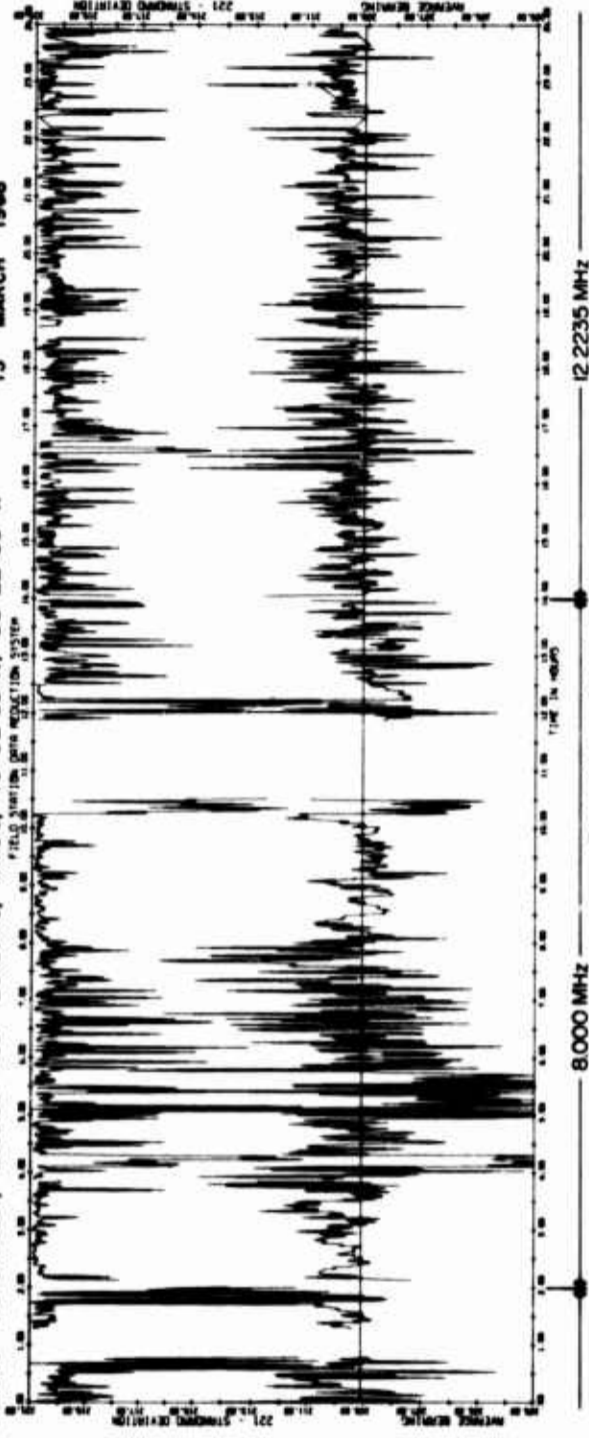
Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)

Points indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 13 MARCH 1968

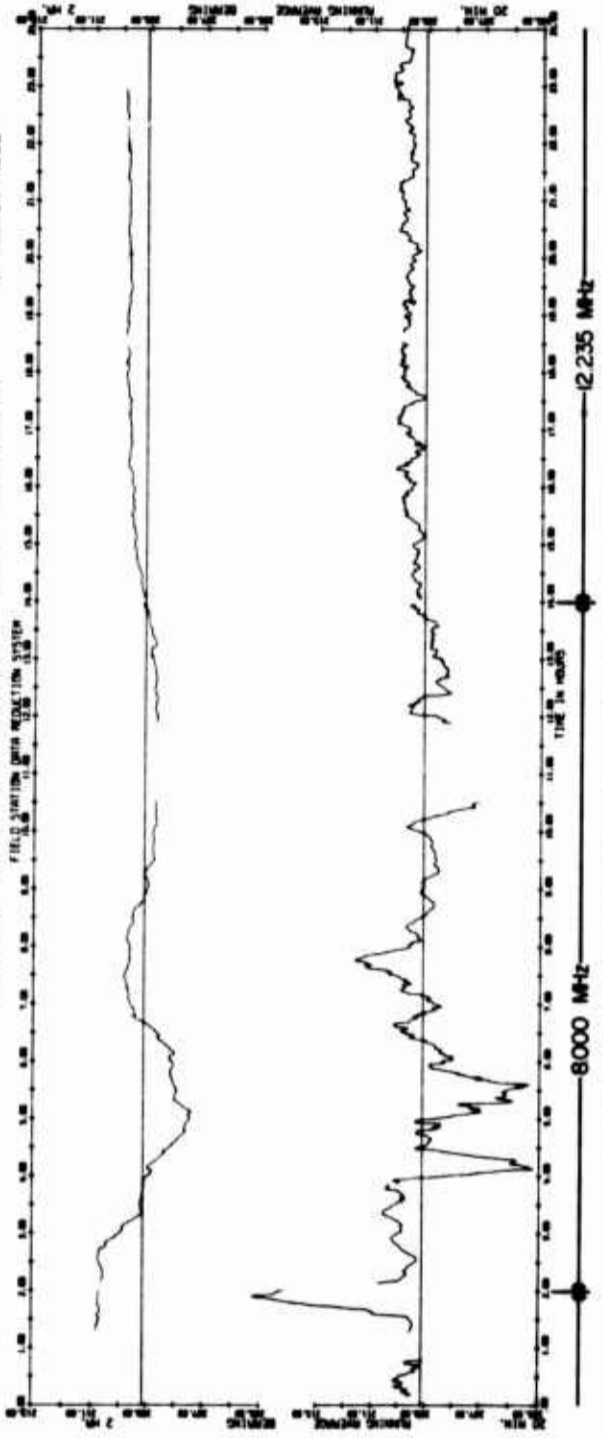


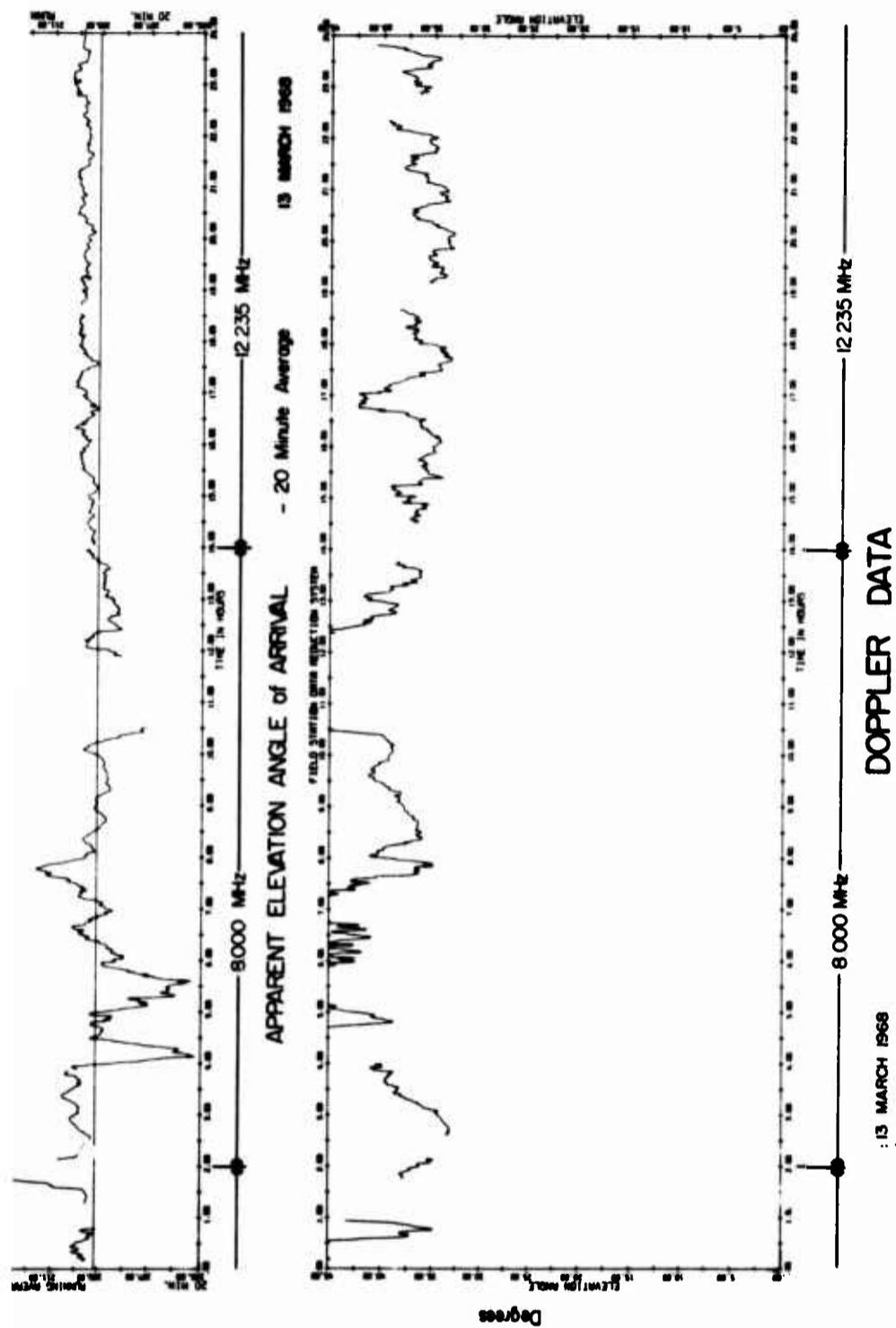
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point - Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wultenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 13 MARCH 1968



BEARING DEVIATION PLOTS - TIME AVERAGED 13 MARCH 1968





NO DATA AVAILABLE

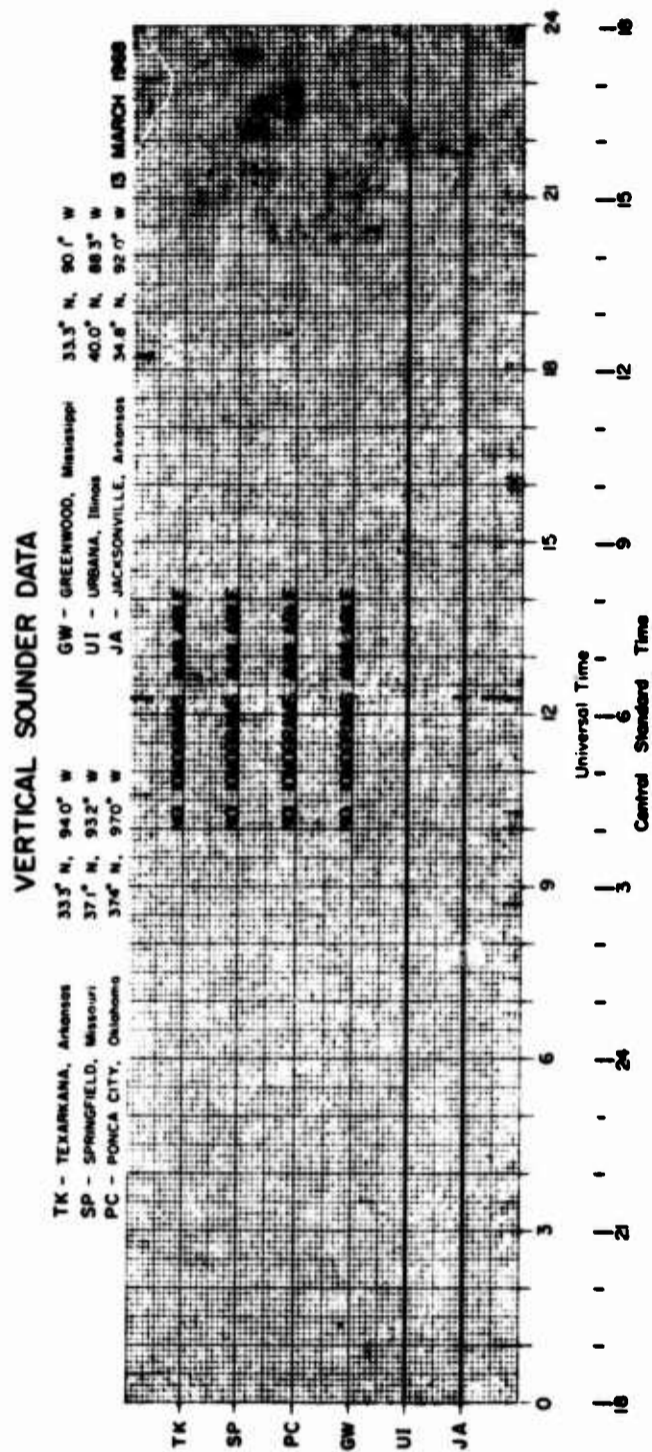


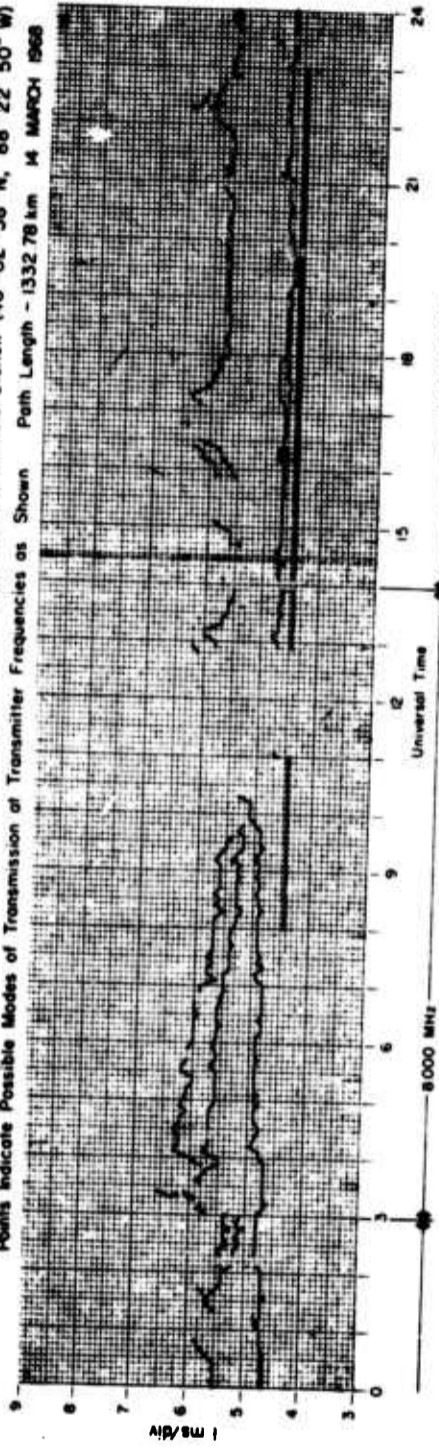
Plate 62.

13 March 1968

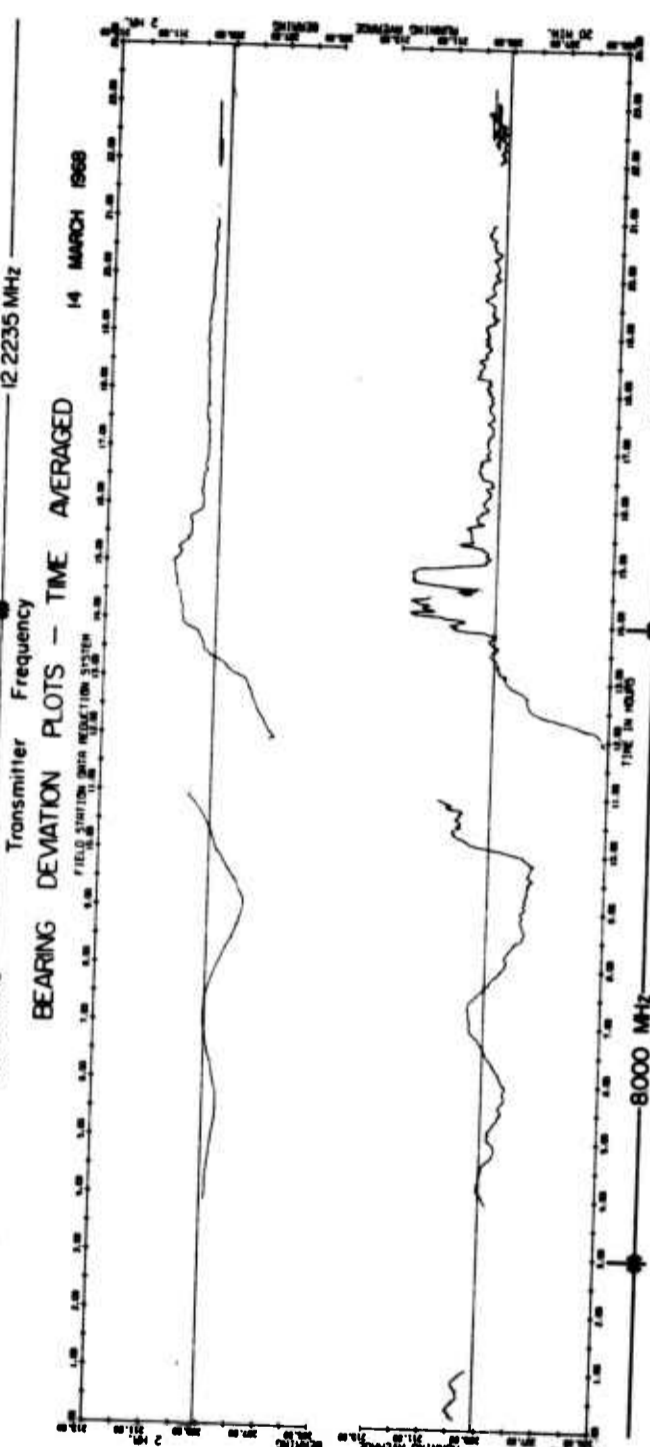
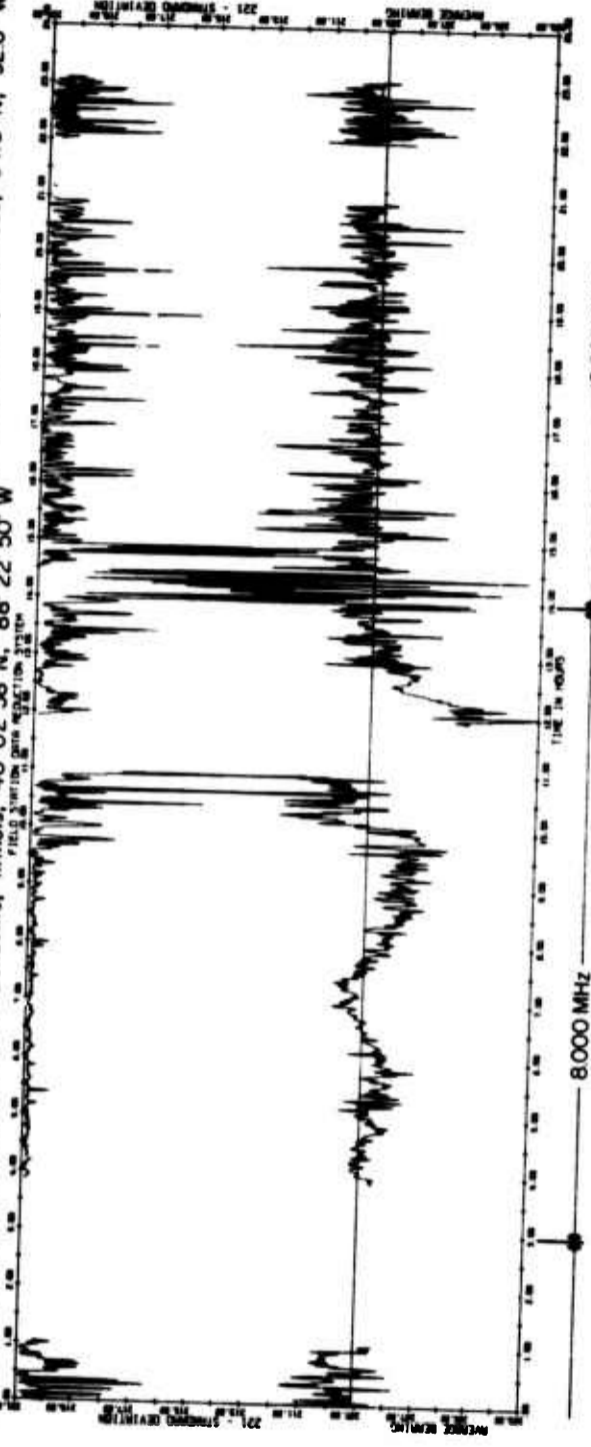


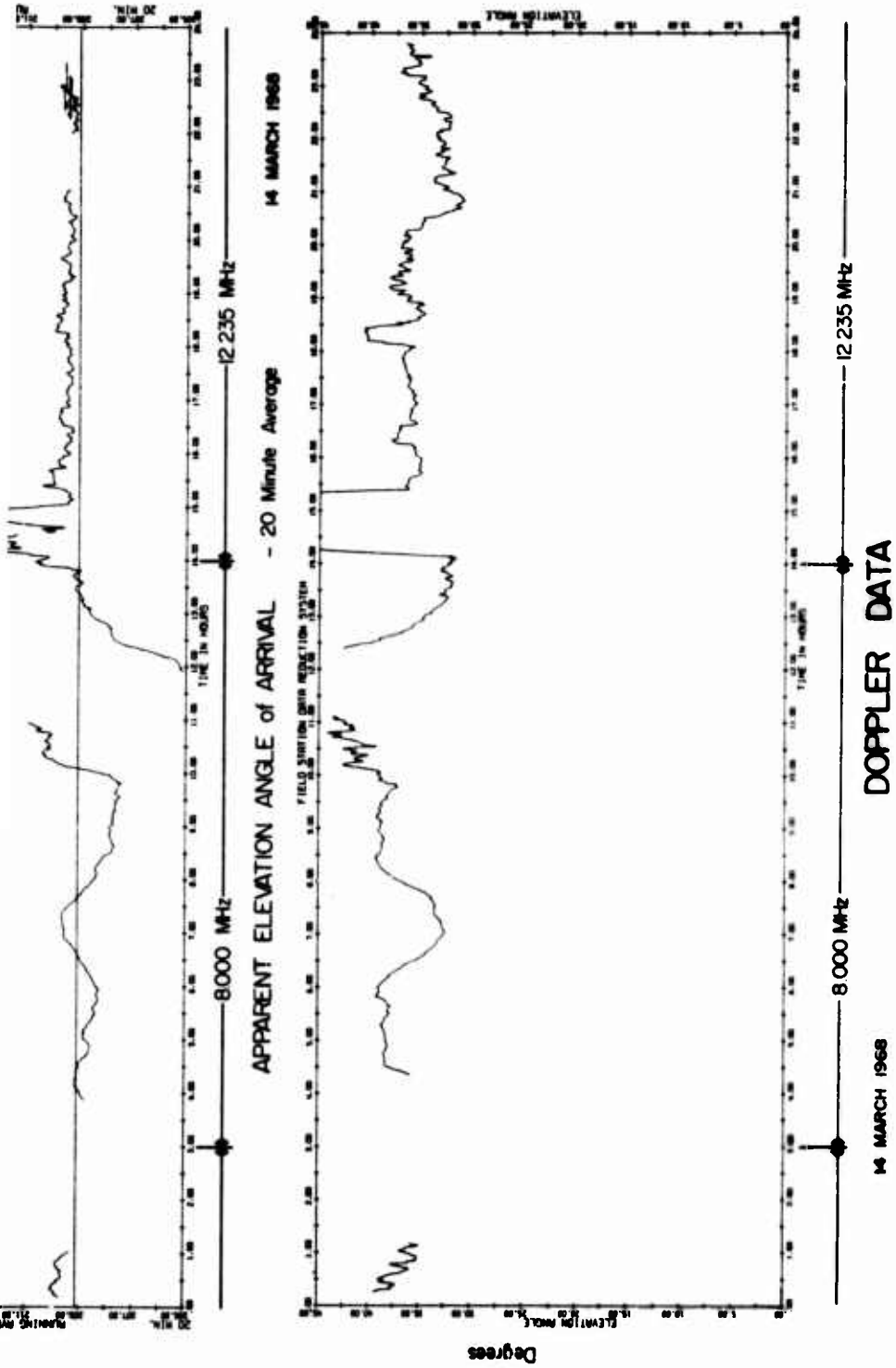
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission of Transmitter Frequencies as Shown Path Length - 1332.78 km 14 MARCH 1968



BEARING DEVIATION PLOT 14 MARCH 1968
 Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antennas: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonvillle, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W





NO DATA AVAILABLE

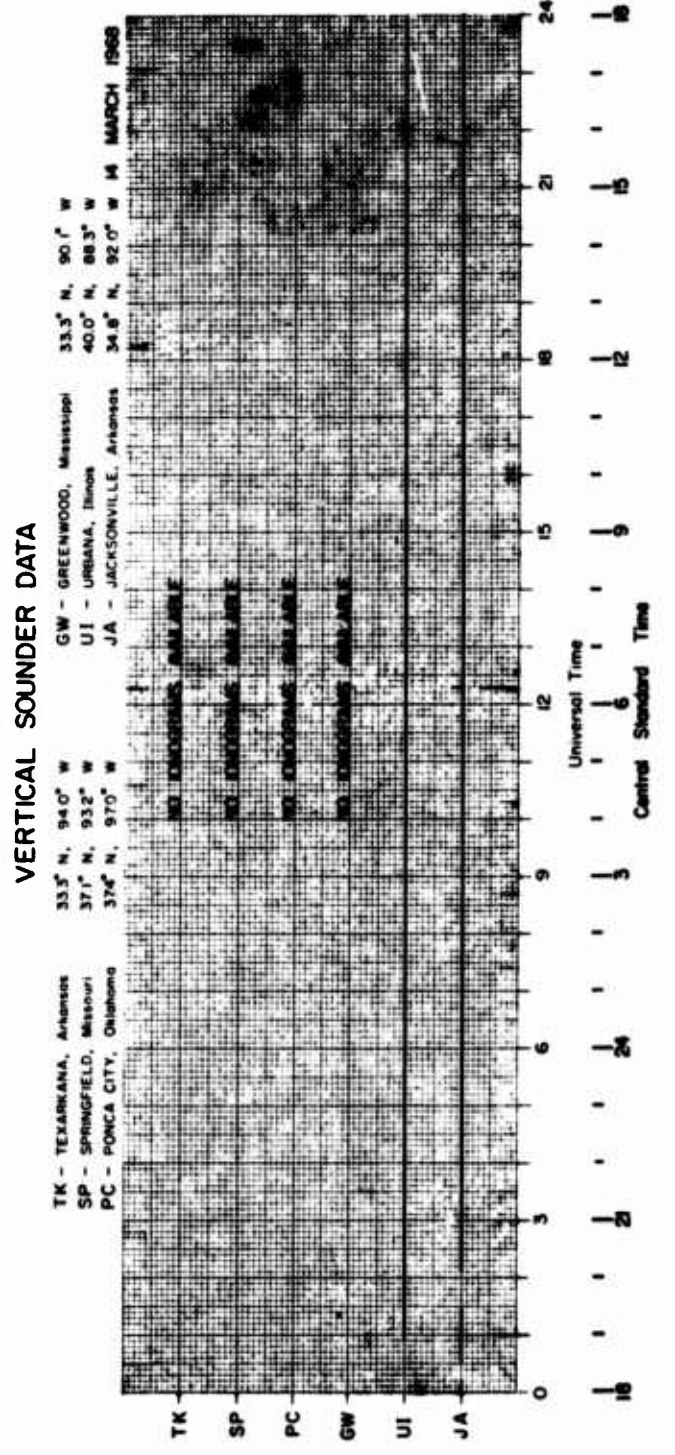
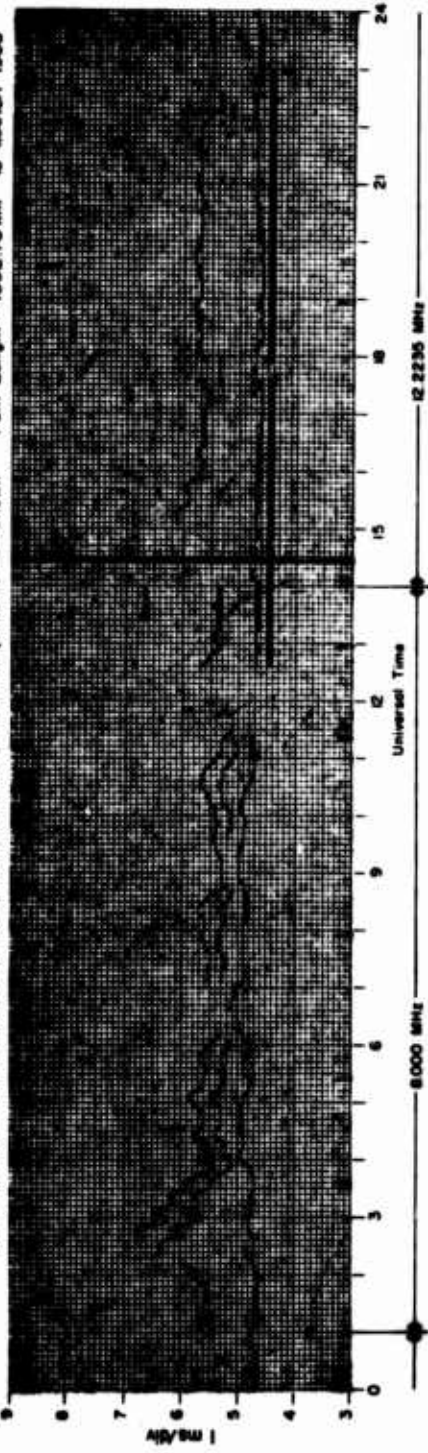


Plate 63.
14 March 1968

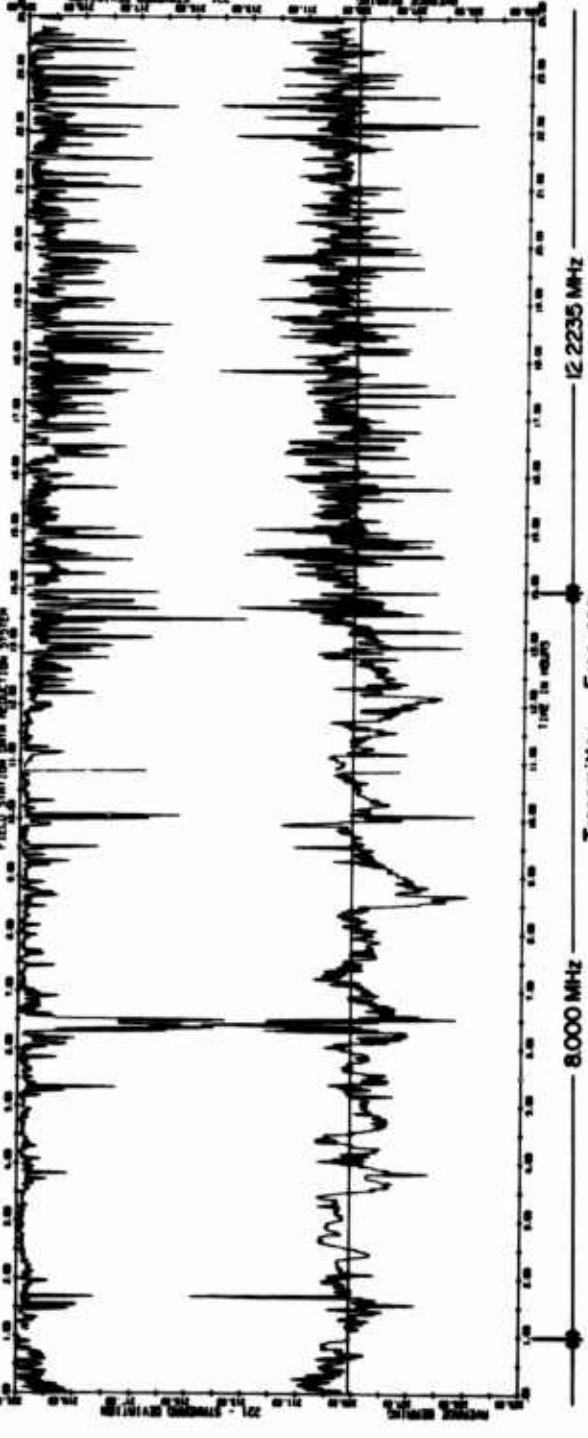
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission at Transmitter Frequencies as Shown Path Length - 1332.78 km 5 MARCH 1968

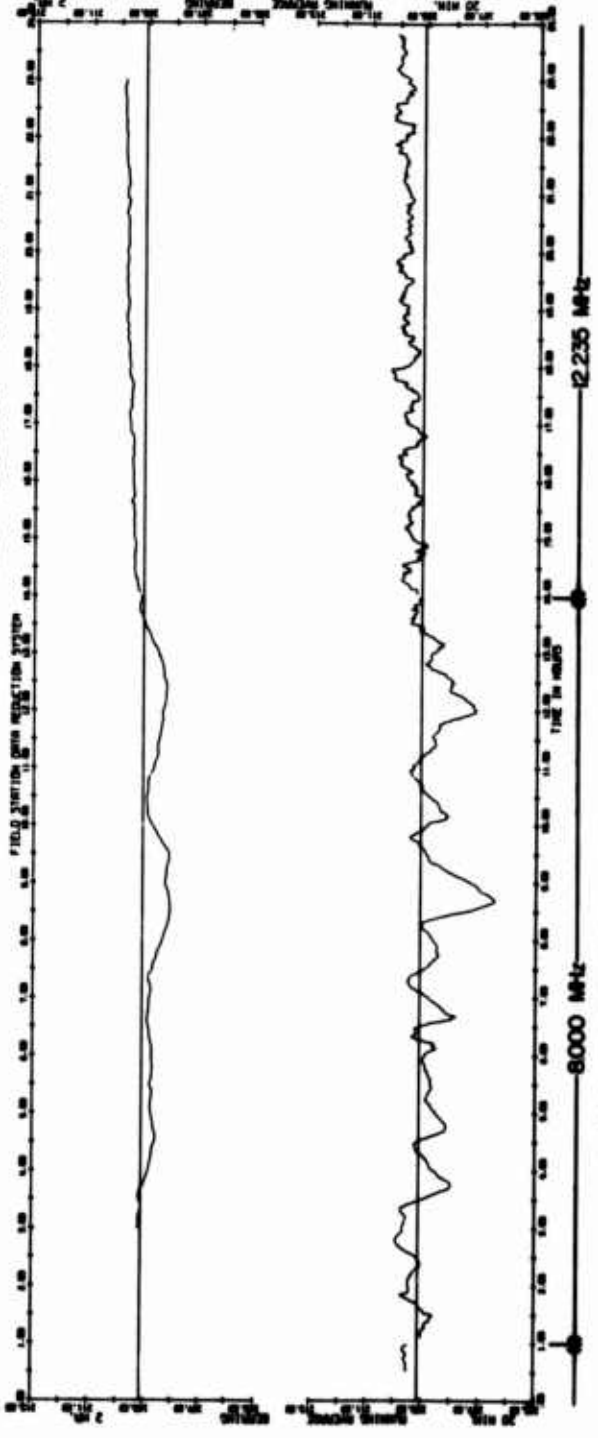


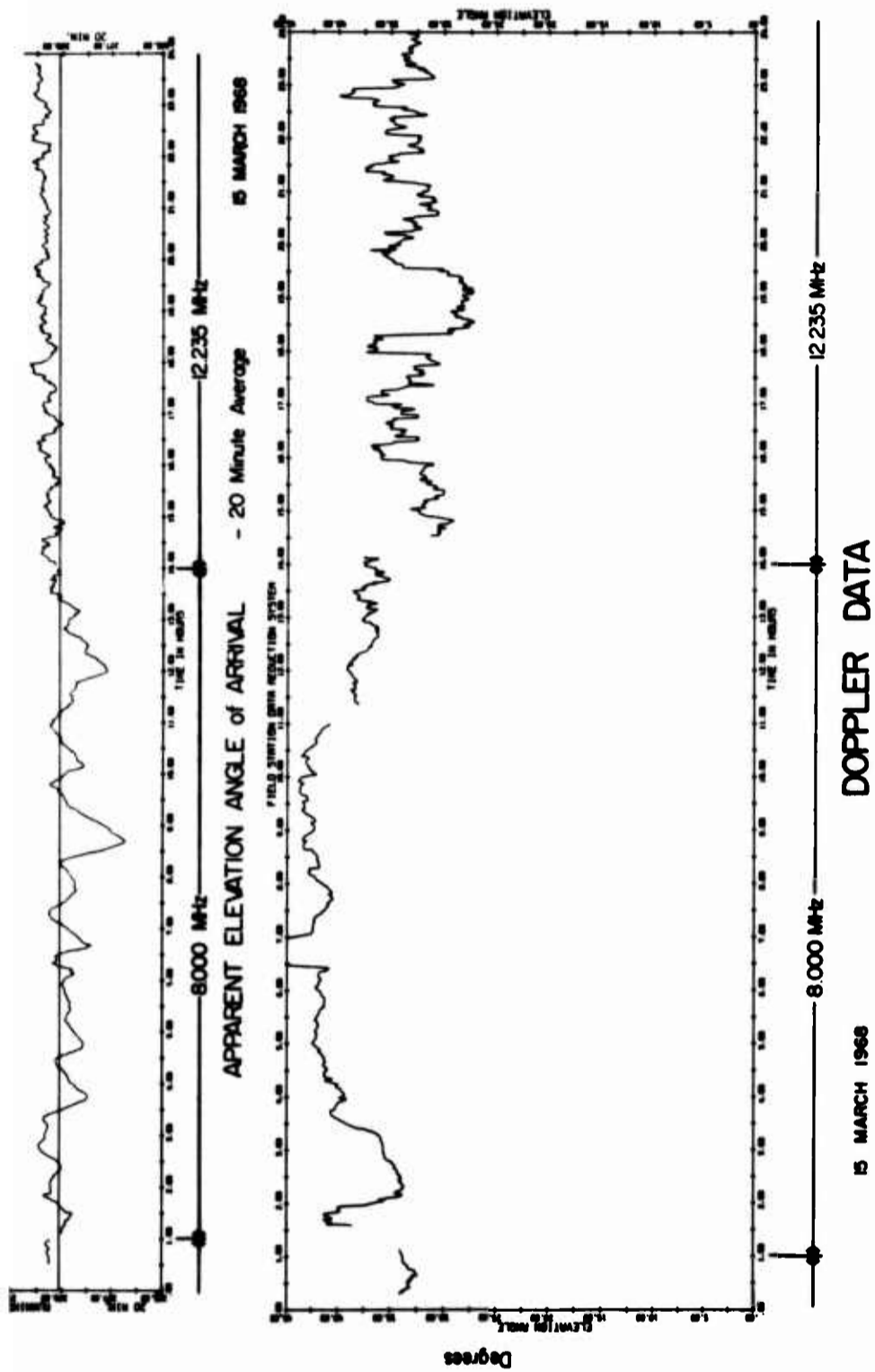
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min. Intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point: Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 15 MARCH 1968



BEARING DEVIATION PLOTS - TIME AVERAGED 5 MARCH 1968





NO DATA AVAILABLE

VERTICAL SOUNDER DATA

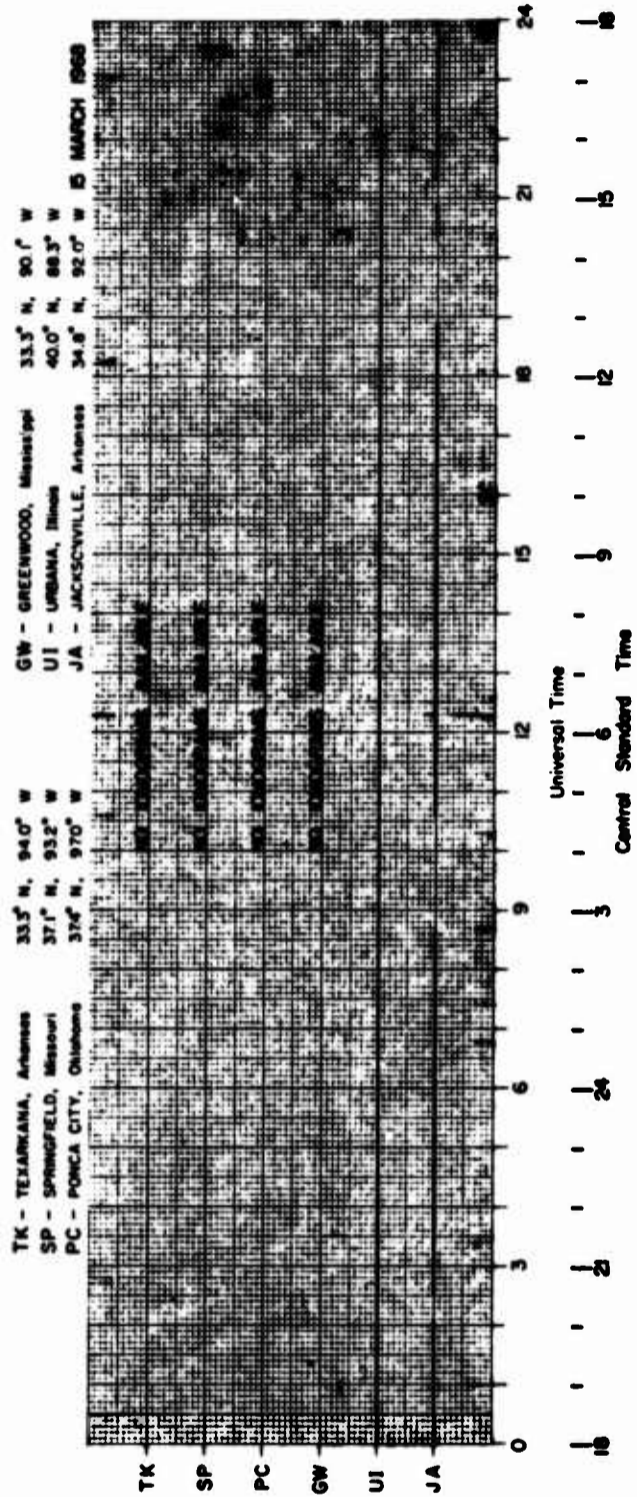
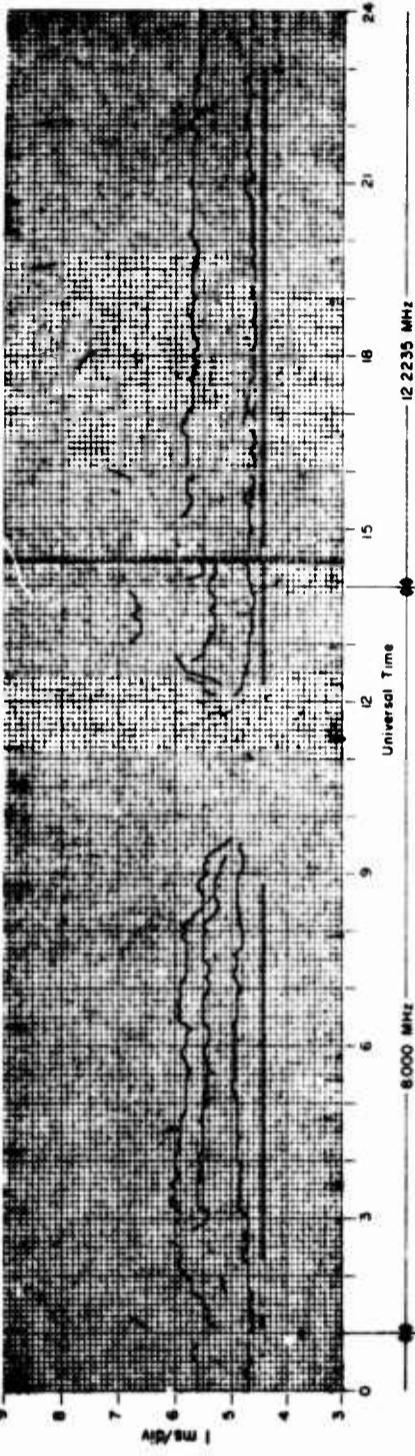


Plate 64.

15 March 1968

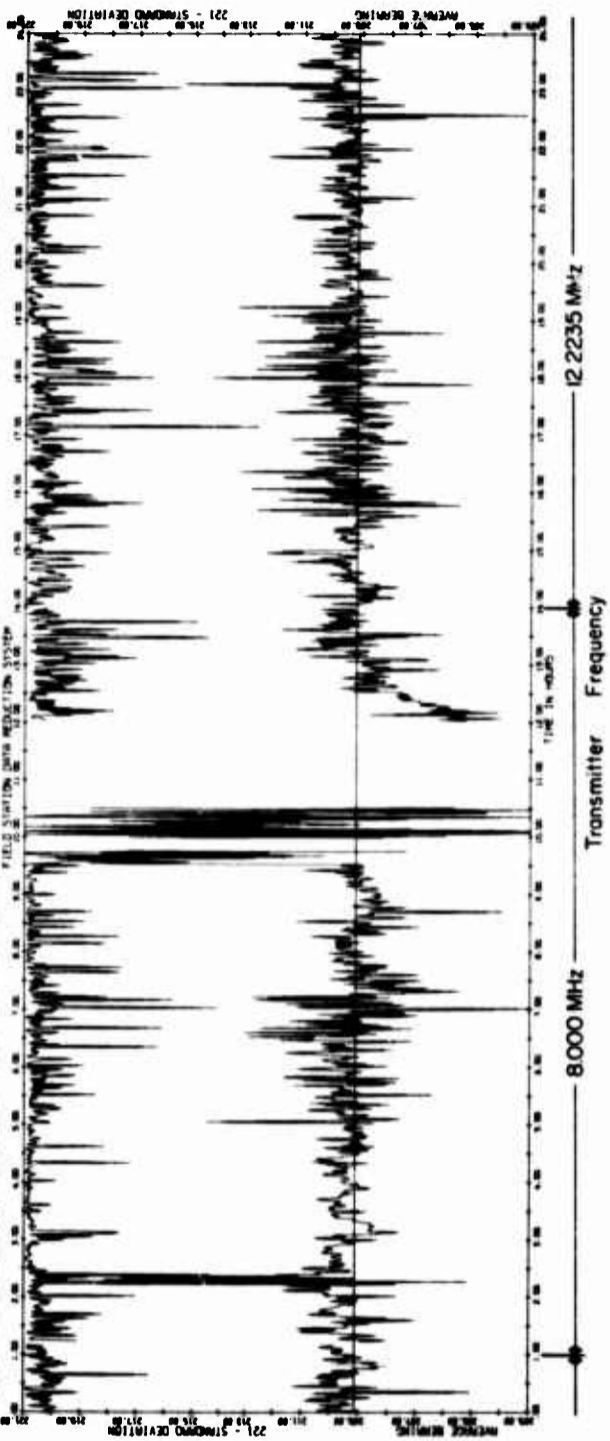
OBLIQUE IONOGRAM DATA

Camp Wallace Field Station (29° 22' 35" N, 95° 02' 22" W) to Bondville Road Field Station (40° 02' 58" N, 88° 22' 50" W)
 Points Indicate Possible Modes of Transmission as Shown Path Length - 1332.78 km 16 MARCH 1968

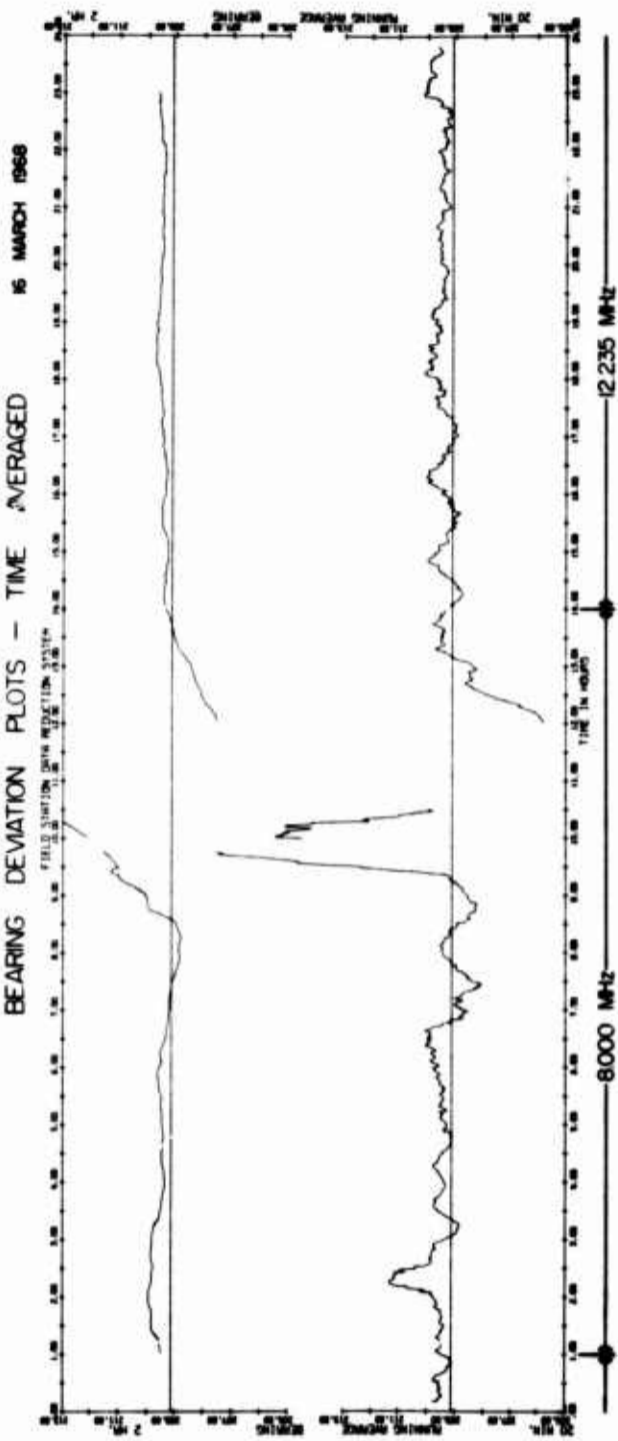


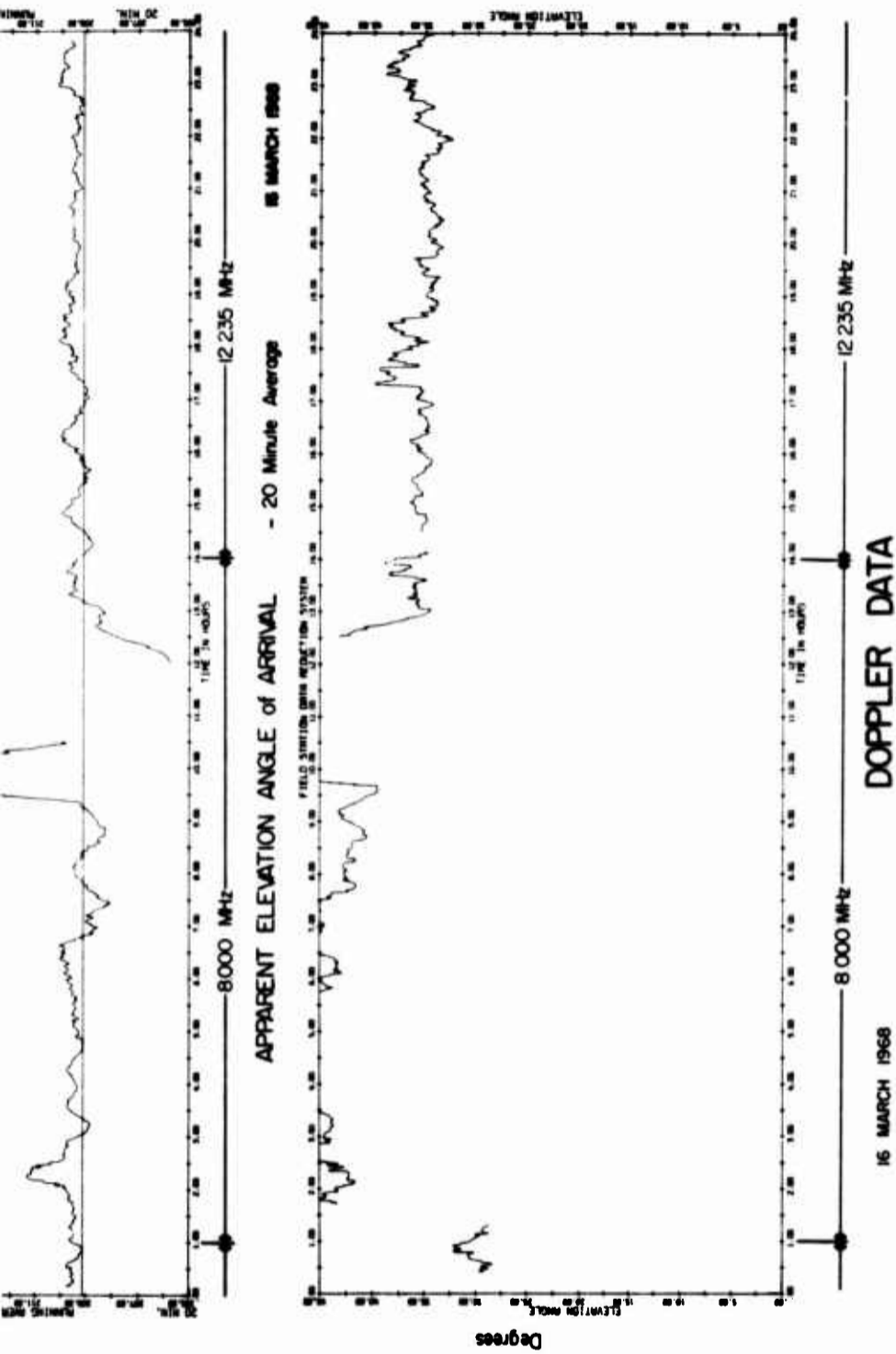
BEARING DEVIATION PLOT

Transmitter: 10 kw, Located Camp Wallace, Texas, 29° 22' 35" N, 95° 02' 22" W Bearing Data Points at min intervals
 Antenna: at Camp Wallace, Granger, 2-BAY LOG-PERIODIC Mid-path Point Near Jacksonville, Arkansas, 34.8° N, 92.0° W
 Receiver: Wullenweber, Located Near Bondville, Illinois, 40° 02' 58" N, 88° 22' 50" W 16 MARCH 1968



BEARING DEVIATION PLOTS - TIME AVERAGED





NO DATA AVAILABLE

VERTICAL SOUNDER DATA

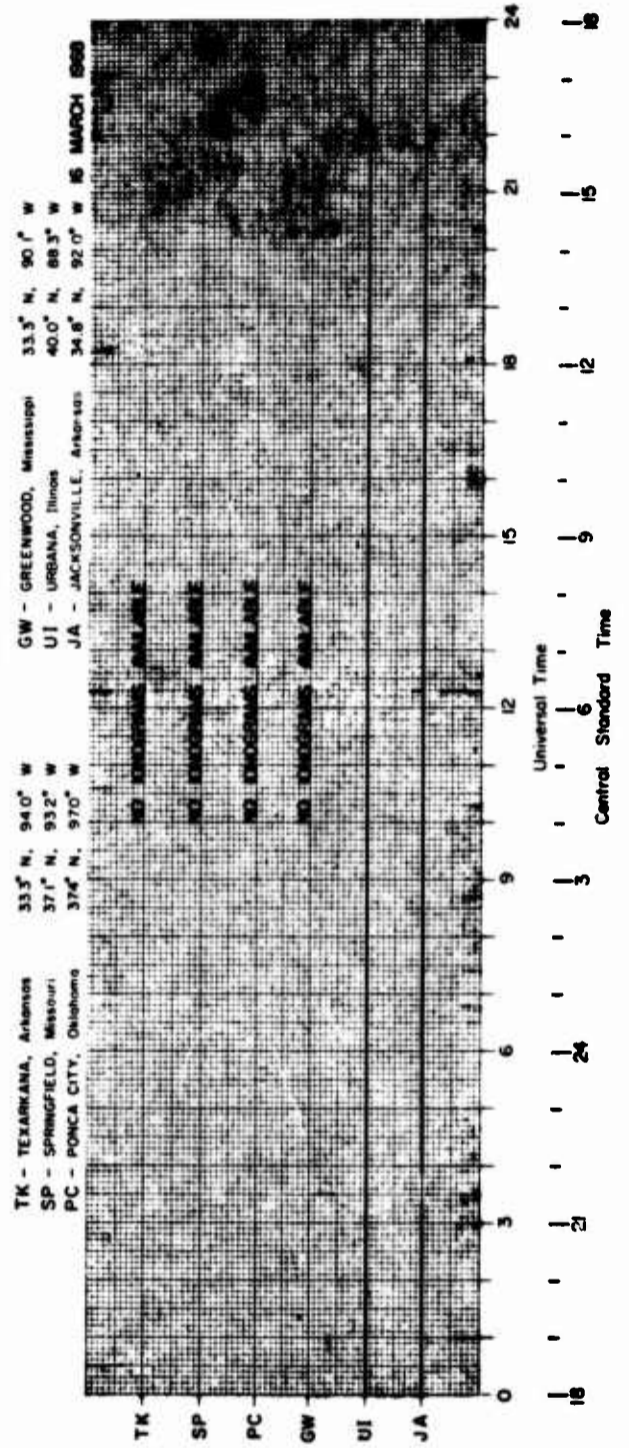


Plate 65.

16 March 1968

7. AVAILABILITY STATEMENT

The data from which the bearing and deviation plots have been made is available in tabular and punched card format for a nominal charge.

Each point of data includes the following information:

- 1) Date
- 2) Time
- 3) Average bearing (average of eight successive scans)
- 4) Standard deviation for the group of eight

Vertical incidence ionogram data for the Jacksonville station, vertical incidence ionogram data for the receiving endpoint and oblique ionosonde data for the path are available for a nominal charge.

All of the above data are available from the Radiolocation Research Laboratory.

Data for the other vertical incidence ionosondes may be obtained from the Data Center at ESSA, Boulder, Colorado.

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R&D		
<i>(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)</i>		
1. ORIGINATING ACTIVITY (Corporate author) University of Illinois Urbana, Illinois		2a. REPORT SECURITY CLASSIFICATION Unclassified
2a. GROUP		
2. REPORT TITLE AN ATLAS OF REDUCED DATA OBTAINED IN A COOPERATIVE HF DIRECTIONAL PROPAGATION EXPERIMENT OVER A 1330 KILOMETER PATH		
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) RRL Publication No. 344, Technical Report No. 7		
3. AUTHOR(S) (Last name, first name, initial) BAILEY, ALBERT D. MILLER, LEON J. ERNST, EDWARD W. WOOD, WALTER W.		
6. REPORT DATE September 1968	7a. TOTAL NO. OF PAGES 81	7b. NO. OF REFS
8a. CONTRACT OR GRANT NO. N00014-67-A-0305-0002	9a. ORIGINATOR'S REPORT NUMBER(S) RRL Publication No. 344	
a. PROJECT AND TASK NO.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
c.		
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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Office of Naval Research	
13. ABSTRACT <p>This is a collection of reduced data, arranged in chronological order. The data were obtained on a 1330 km propagation path between Alta Loma, Texas and Bondville, Illinois.</p> <p>Data for 13 months, 5 days per month are included (65 days). Each daily chart contains:</p> <ol style="list-style-type: none">1. Oblique ionograms (propagation modes)2. Bearing deviation plots (azimuth)3. Average deviation plots (20 minute and 2 hour)4. Elevation angle of arrival5. Doppler data6. Vertical ionograms (availability information)		

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1 JAN 64

Unclassified
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Propagation Path Bearing Deviation Plots Oblique Ionograms Elevation Angle						

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