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User's Guide and Reference Manual for the VOACAP and REC533 Circuit Analysis Programs

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ABBREVIATIONS

BoB	Bureau of Broadcasting
CCIR	International Radio Consultative Committee
CCIR91	HFBC84 prediction program modified by CCIR WP6A in 1991
<cr>	Keyboard return or enter key
<Esc>	Keyboard Esc key
<F1>	Keyboard function key number 1
<F2>	Keyboard function key number 2
<F3>	Keyboard function key number 3
<F4>	Keyboard function key number 4
HF	High frequency
HFANT	HF antenna design program
HFBC	HF broadcast conference
HFBC84	HF propagation prediction program developed at the HFBC WARC of 1984
IFRB	International Frequency Registration Board
IONCAP	Ionospheric Communications Analysis and Prediction Program
ITS	Institute for Telecommunication Sciences
ITU	International Telecommunication Union
NTIA	National Telecommunications and Information Administration
REC533	ITS's version of the CCIR Recommendation 533 HF propagation prediction program
USIA	United States Information Agency
VOA	Voice of America
VOACAP	USIA/VOA's version of IONCAP
WARC	World Administrative Radio Conference
WP6A	Working Party 6A of CCIR Study Group 6 concerned with HF propagation

USER'S GUIDE AND REFERENCE MANUAL FOR THE VOACAP AND REC533 CIRCUIT ANALYSIS PROGRAMS

Jeanne M. Ratzloff and Greg R. Hand*

A user's guide and programmer's reference manual is presented to facilitate the use of two high frequency circuit analysis software systems called VOACAP and REC533. The guide shows how to execute the software on laptop computers and personal computers to make point-to-point predictions used to coordinate frequency assignments for broadcast planning. The guide shows how the software can be executed interactively for single circuits from menu-driven software, and for a collection of circuits in batch mode.

Key words: documentation; frequency assignments; high frequency; installation; propagation models; user's guide

1. INTRODUCTION

The software systems (models) described in this user's guide and reference manual incorporate two high frequency (HF) prediction propagation models for use on laptop and personal computers (PCs). The models are VOACAP, the Voice of America's (VOA) version of the Ionospheric Communications Analysis and Prediction Program (IONCAP); and REC533, the International Radio Consultative Committee's (CCIR) Recommendation 533 HF prediction program (CCIR, 1992). REC533 represents the improved HF propagation prediction method to be used in the future for the HF bands allocated exclusively to the broadcasting service called for in

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Recommendation Number 514 of the Final Acts of the World Administration Radio Conference for the Planning of the HF Bands Allocated to the Broadcasting Service (ITU, 1987). The HF Broadcast WARCs, (ITU, 1984, 1987), developed the underlying technical parameters that form the basis for REC533.

These models predict the expected performance of HF broadcast systems, and in doing so are useful in the planning and operation of HF transmissions for the four seasons, different sunspot activities, hours of the day, and geographic location.

REC533 is the most recent (CCIR, 1992) computerized model created by Working Party 6A (WP6A) of CCIR Study Group 6. It was created by modifying the previous CCIR-accepted propagation model Report 894 (REP894), which was an improvement upon the technical standards developed by the HF Broadcast WARCs (op cit). Comparing these models using data from the CCIR Data Bank D1 showed REC533 was a significant improvement over REP894.

This user's guide is concise and practical, written with the assumption that anyone executing these programs has a basic understanding of HF radio broadcasting, the two propagation prediction models, and the disc operating system (DOS) Version 5.0. Further information about HF radio propagation can be found in Davies (1990). Additional information about the two models can be found in Teters (1983), ITU (1984, 1987), and CCIR (1992).

This guide is organized to provide users with the information needed to install, execute, and receive the calculated results as tables or graphic figures for VOACAP and/or REC533. Section 2

describes hardware and system configuration requirements for the two computer programs. Section 3 explains how to install the programs. A list of the provided compressed files and a brief description of the subdirectories found in these files is given. The files that may be deleted by the user are also described. Section 4 describes VOACAP execution, including the input screen, the input parameters, and the options menu. Section 5 describes REC533 program execution, focusing on just the program differences from VOACAP. Section 6 describes how to release the memory-resident program **FLRUN** if the program terminates abnormally. Further information is provided in the appendices. Appendix A contains the listing of the **read.me** file found on the system diskettes. This file provides a summary of the actions needed to install and execute the program files successfully. Appendices B and C list all HELP windows for VOACAP and REC533. Finally, Appendix D contains all the output reports generated using the default parameters of the two models.

2. COMPUTER IMPLEMENTATION REQUIREMENTS

The VOACAP and REC533 software require either an IBM compatible personal computer or an IBM 386SX laptop computer. The operating system must be DOS Version 5.0 or later.

2.1 Hardware Requirements

The HF propagation prediction programs require a video graphics array (VGA) color graphics monitor to display the graphics correctly. If executed on a laptop computer, the graphics will be displayed in shades of gray.

To execute the programs efficiently, the computer must have a 80287 or 80387 (or compatible) math co-processor. Running these programs on a computer that does not have a math co-processor slows execution time drastically.

The programs and data files require nine megabytes (MB) of hard disk storage. The files created during program execution may require another one MB of storage. Therefore, a minimum of 10 MB of hard disk storage is required. VOACAP requires 520 kilobytes (kB) of random access memory (RAM), while REC533 requires only 370 kB of RAM to execute.

The programs have been designed to optionally produce hard copies on a Hewlett Packard LaserJet printer which has been configured to LPT1.

2.2 System Configuration

The computer system must be configured as follows:

File **CONFIG.SYS** must have "ANSI.SYS" defined as a device. Edit **CONFIG.SYS**, if necessary, to include the following:

```
DEVICE=C:\DOS\ANSI.SYS
```

All batch and executable files reside in a subdirectory **..\BIN**. For these files to be found, this directory must be added to the path environment variable before program execution. The file **AUTOEXEC.BAT**, found in the root directory (C:\), can be edited to include **..\BIN** in the PATH line. For this change to take affect, the file must be changed and the computer rebooted.

VOACAP's executable program, **VOACAPP.EXE** will not load unless the largest executable program size is at least 520 kilobytes (kB). To verify that the largest executable program size is sufficient, type the following:

```
MEM/C <cr>
```

Included in the information displayed on the computer screen will be the following line:

```
Largest executable program size:   ******   (***.*K)
```

The *s are replaced with the largest executable program size currently allowed on your computer. If this number is less than 520 kB reference your DOS manual for a method to increase the executable program size.

3. PROGRAM INSTALLATION

The following is a step-by-step explanation of how to install the HF prediction models VOACAP and REC533. The installation directory has been chosen for ease of explanation, the name of this directory can be changed to suit individual user needs.

A directory for file storage and program execution must be created. In this example, the directory name **ITSHFBC** is created by typing the DOS command

MKDIR ITSHFBC <cr>

The name **ITSHFBC** can be any name chosen by the user. It may also exist on any hard disk the user desires (e.g., C:, D:, etc). All software is installed in this directory.

Next the user moves into directory ITSHFBC by typing

CD ITSHFBC <cr>

NOTE: At this time the user can type "DIR <cr>" to check that the current directory is **ITSHFBC**, and that this directory is empty.

The files on the two 3.5-inch diskettes provided (labeled Number 1 and Number 2) must be copied into directory **ITSHFBC**. Type the following command:

```
COPY A:*.* <cr>
```

> **NOTE:** The floppy disk drive designated above as "A" can be designated as "B" if required by the computer's configuration.

Directory **ITSHFBC** should now contain files **HFBC1.EXE**, **HFBC2.EXE**, and **READ.ME**. File **READ.ME** contains useful information concerning program installation and execution. Please read this file before proceeding. A copy of **READ.ME** can be found in Appendix A. **HFBC1.EXE** and **HFBC2.EXE** are in a compressed self-exploding format and contain subdirectories and files. To uncompress the files enter the following:

```
HFBC1 -d -o -n <cr>
HFBC2 -d -o -n <cr>
```

See Table 1 for a list of the subdirectories contained on each compressed file.

Table 1. Subdirectories Contained in Compressed Files

COMPRESSED FILE	SUBDIRECTORY	SUBDIRECTORY DESCRIPTION
HFBC1.EXE	BIN	All executable, command, and batch files
	RASTER	Bitmap graphics image files that can be copied to HP LaserJet printers
	RUN	Directory from which user executes programs
HFBC2.EXE	ANTFILES	HF antenna description files
	DATABASE	Data base files
	FONTS	Graphic fonts
	SAVED	User-saved Circuit data files
	SCODE	TEXT and HELP screens
	NEWS	NEWS text files describing recent program modifications

Typing DIR should now produce the following list on the monitor:

```
                Directory of C:\ITSHFBC

.              <DIR>      06-23-92   5:14p
..             <DIR>      06-23-92   5:14p
ANTFILES       <DIR>      09-17-92   6:02p
BIN            <DIR>      09-17-92   6:03p
DATABASE       <DIR>      09-17-92   6:03p
FONTS          <DIR>      09-17-92   6:02p
HFBC1    EXE    1059264 11-03-92  10:24a
HFBC2    EXE     847674 11-03-92  10:28a
NEWS
RASTER         <DIR>      09-17-92   6:02p
READ     ME        9403 11-03-92  10:29a
RUN            <DIR>      09-17-92   6:02p
SAVED          <DIR>      09-17-92   6:02p
SCODE          <DIR>      09-17-92   6:02p
```

3.1 File Management

The user must execute all programs from the subdirectory **RUN**; this will cause all temporary output files to be written to this directory, making file management easier. All files in the subdirectory **RUN** may be considered temporary and can be deleted.

The only files which may be deleted are contained in subdirectories **RUN**, **RASTER**, and **SAVED**; all other subdirectories contain vital data and executable programs.

The files in the subdirectory **RASTER** are screen image bitmap files used for creating graphics on a printer. These files may also be deleted by the user at any time.

The files in the subdirectory **SAVED** are text data files that have been saved with the SAVE DATA option and are retrievable with the RETRIEVE DATA option described later. These files may be deleted at the user's discretion. The files **DEFAULT.VOA** and **DEFAULT.REC** contain the default input data for the models and should not be deleted.

Files the user may wish to customize are listed in Table 2. The fields and sorted order of these files must be maintained.

Table 2. Files in Subdirectory DATABASE that may be Customized

FILENAME	FILE FUNCTION
FREQS3.DEF	Default frequencies when <F3> key is entered.
CIRCUITS.DAT	Transmitter-to-receiver circuits with latitudes/ longitudes, antennas, and power information.
RECEIVE.DAT	Receiver latitudes/longitudes/names.
TRANSMIT.DAT	Transmitter latitudes/longitudes/names.

4. PROGRAM EXECUTION

The flow of each propagation model (VOACAP and REC533) has been modularized into three stages of general program execution: input, calculation, and output. The execution of each model is controlled by its associated .BAT file. Table 3 identifies the names of the programs controlling model execution.

Table 3. Programs Controlling Model Execution

MODEL NAME	VOACAP	REC533
.BAT FILE FLOW CONTROL	VOACAP.BAT	REC533.BAT
DATA INPUT PROGRAM	VOAINP.EXE	REC533IN.EXE
PROPAGATION CALCULATIONS	VOACAPP.EXE	REC533P.EXE
VIEW CIRCUIT OUTPUT	SCROLL.EXE	SCROLL.EXE
VIEW GRAPHIC OUTPUT	PERFORM.EXE	PERFORM.EXE

All models must be executed from the directory **\ITSHFBC\RUN**. To move into this directory, type

```
CD \ITSHFBC\RUN  <cr>
```

To begin model execution type the appropriate model name:

```
VOACAP - to execute VOACAP
REC533 - to execute REC533
```

The following discussion, although general in nature and valid for both models, gives specific examples for VOACAP.

4.1 Input Screen

After "VOACAP" has been entered to begin program execution, the VOACAP input data screen shown in Figure 1 will appear on the computer screen. The parameters shown on the computer screen are those used the last time the model was executed. If this is the first execution, internally defined values are used. (These values are the same as those that may be obtained with the **"Retrieve data"** option discussed in Section 4.2.4 by retrieving the appropriate default files (**DEFAULT.VOA** or **DEFAULT.REC**) for the model.)

The parameters that may be modified by the user are displayed on the computer screen with a gray background and black lettering (in this user's guide, they are printed with a black background and white lettering). To accept all the input data displayed, press <Esc>. To modify the data, use the arrow and tab keys to cycle through the input screen, modifying the parameters as necessary.

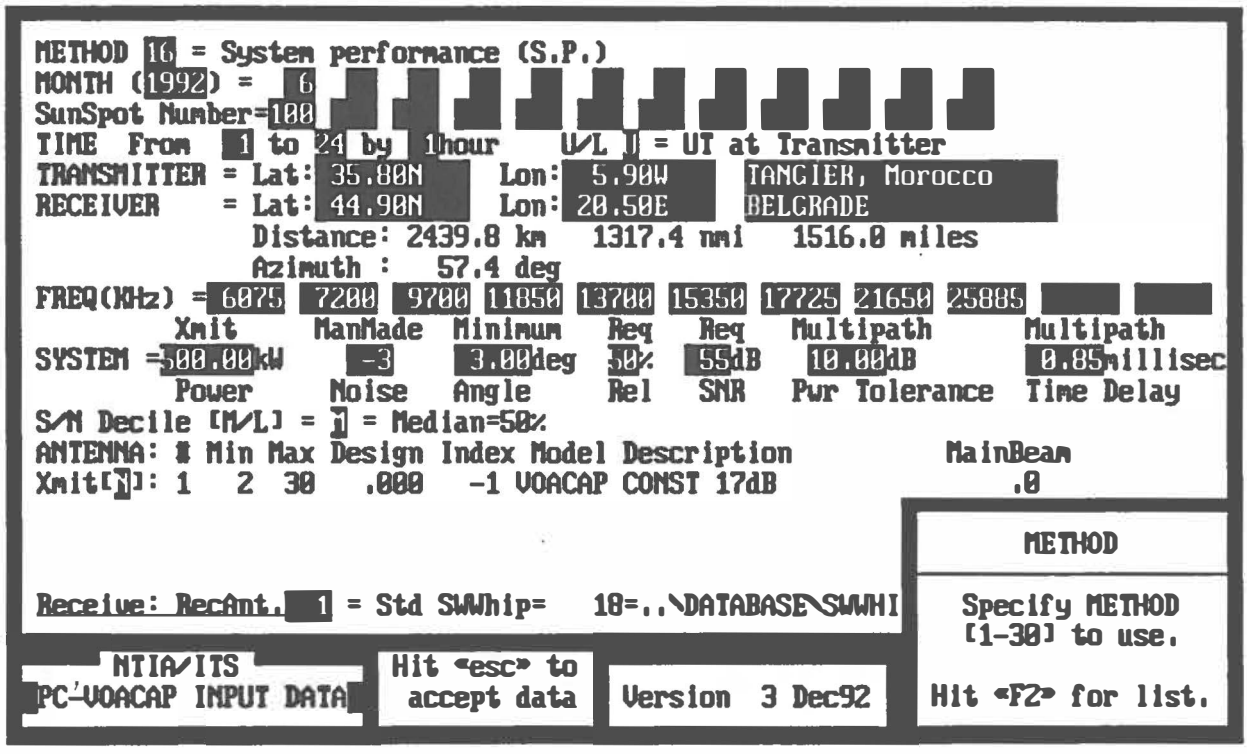

Figure 1. VOACAP data input screen.

The cursor appears in the first parameter near the top-left portion of the screen. A green HELP window will appear on the lower-right portion of the screen describing the input field the cursor currently occupies. The HELP window provides information on how to modify the parameter of interest (e.g., valid range, input format, and active function keys). All input screen HELP windows are shown in Appendix B (VOACAP) and Appendix C (REC533). If a value outside of the expected range is entered, an error message will appear at the bottom of the screen and the user will be requested to re-enter the value. Similarly, if an illegal character is entered (e.g., a letter in a numeric field), a message will again appear at the bottom of the screen. To skip past

parameters, the user can enter a <cr>, use the arrow keys ← ↑ ↓ →, or the <tab> (right) and <shift-tab> (left) keys to position the cursor in the appropriate field. The HELP windows can be toggled on and off as wished by pressing the <F1> function key.

One of the more complicated parameters, TRANSMITTER Latitude, will be used to demonstrate how to modify a parameter. Figure 2 represents the computer screen that appears when the cursor is within the transmitter latitude field.

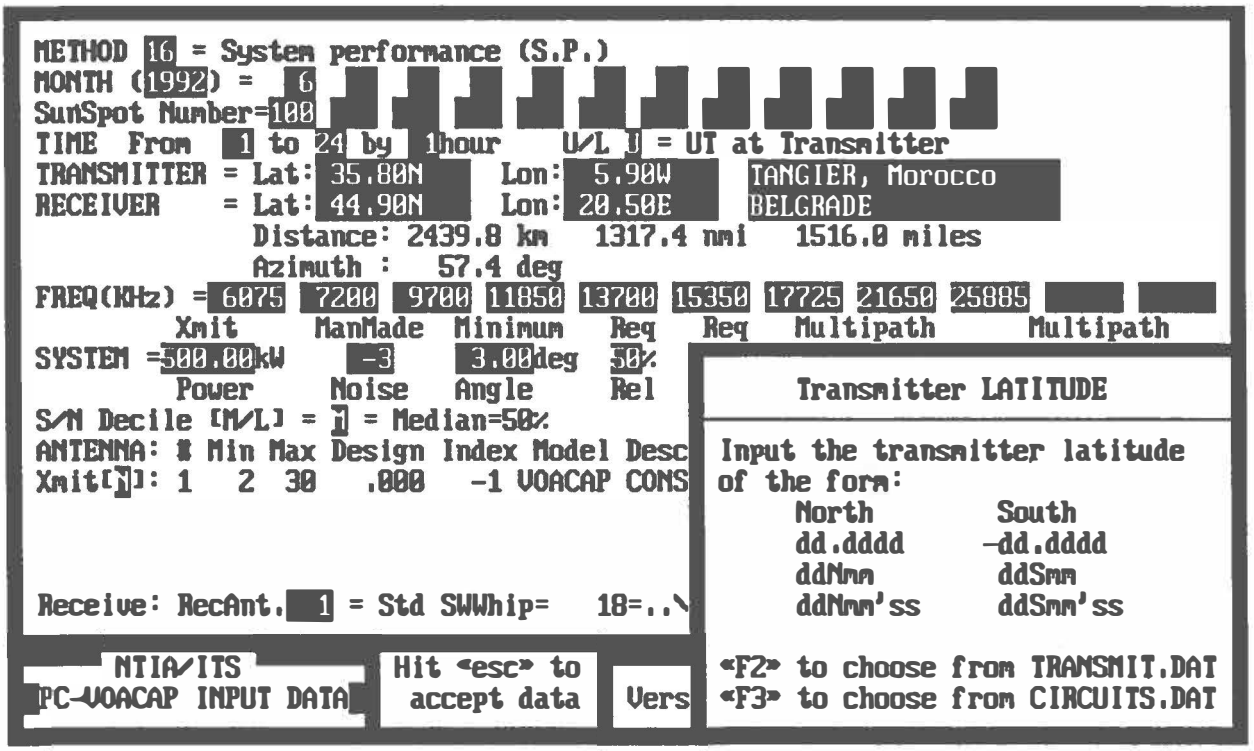

Figure 2. Transmitter latitude input screen.

Because global coordinates often appear in two formats (degrees-minutes-seconds or decimal degrees), data is accepted in either format. Thus, equivalent values for latitude may be: 30.25,

30.25n, 30N15, 30n15, 30n15'00 or even -30s15. The value of latitude will always be converted and displayed as decimal degrees (e.g., 30.25N).

Since the latitude, longitude, and name of a transmitter location rarely change, these values may be retrieved from the data file **..\DATABASE\TRANSMIT.DAT**. The user may edit this file to include all desired transmitter locations. As the HELP window indicates, pressing the <F2> function key will allow the user to select from the file **TRANSMIT.DAT**, as shown in Figure 3. To select a transmitter from this file, use the arrow keys (↑ ↓), or PageUp (PgUp) and PageDown (PgDn) keys to highlight the transmitter desired. In a large file of transmitters, the first letter of a transmitter name may be entered, causing the first name with that letter to be highlighted. **TRANSMIT.DAT** must be maintained in alphabetical order for this feature to continue to work. To select the highlighted transmitter, press <cr>. To return to the input screen without selecting a transmitter, press <Esc>. **TRANSMIT.DAT** is a simple ASCII text file that may be changed with any text editor. The latitude and longitude in this file must be in the form degrees[N/S]minutes (e.g., 39N10, 84W30).

CHOOSE TRANSMITTER LOCATION

Transmitter name	Latitude	Longitude
ASCENSION ISLAND	7S57	14W22
CINCINNATI, Ohio	39N10	84W30
COLOMBO, Ceylon	6N54	79E48
DELANO, California	35N45	119W10
GREENVILLE, N.C.	35N36	77W24
KAVALA, Greece	40N53	24E50
KIEV, USSR	50N30	30E30
MONROVIA, Liberia	6N30	11W 0
MUNICH, Germany	48N 6	11E36
RHODES, Greece	36N18	28E 0
TANGIER, Morocco	35N48	5W54
TBILISI, USSR	41N48	44E48
TINANG, Philippines	15N22	120E38
WOOFFERTON, England	51N30	0W 6

Figure 3. TRANSMIT.DAT transmitter data file.

The <F3> function key will allow selection from the file **..\CIRCUITS.DAT**; this file contains transmitter-receiver-antenna information. After the <F3> key has been pressed, the computer screen will change, as shown in Figure 4. Please note that antenna information is not displayed on this screen. As described above, the arrow keys, PgUp, and PgDn keys are used to highlight the desired circuit. Entering a <cr> selects a circuit, or pressing the <Esc> key returns to the previous screen without making a selection. If a circuit is selected, the antenna parameters are also changed.

CHOOSE TRANSMITTER ◄► RECEIVER CIRCUIT to USE					
TRANSMITTER name	Lat	Long	◄► RECEIVER name	Lat	Long
ASCENSION ISLAND	7S57	14W22	◄►BUENOS AIRES,AR.	34S35	58W22
ASCENSION ISLAND	7S57	14W22	◄►CAPETOWN, S.AFRICA	33S55	18E22
ASCENSION ISLAND	7S57	14W22	◄►RIO DE JAN., BRAZIL	23S00	43W20
ASCENSION ISLAND	7S57	14W22	◄►SANTIAGO, CHILE	33S28	70W45
CINCINNATI, OHIO	39N10	84W30	◄►AZORES	37N44	29W26
CINCINNATI, OHIO	39N10	84W30	◄►BOTSWANA	22S00	27E04
CINCINNATI, OHIO	39N10	84W30	◄►HAVANA, CUBA	23N06	82W24
CINCINNATI, OHIO	39N10	84W30	◄►MCMURDO SOUND	77S42	167W00
CINCINNATI, OHIO	39N10	84W30	◄►MONROVIA,LIBERIA	6N30	11W00
CINCINNATI, OHIO	39N10	84W30	◄►NAIROBI, KENYA	1S18	36E48
CINCINNATI, OHIO	39N10	84W30	◄►NEWFOUNDLAND	47N10	52W40
CINCINNATI, OHIO	39N10	84W30	◄►PANAMA CITY,PANAMA	9N06	79W42
CINCINNATI, OHIO	39N10	84W30	◄►SAN JUAN, P.R.	18N29	66W08
CINCINNATI, OHIO	39N10	84W30	◄►SANTIAGO, CHILE	33S30	70W48
CINCINNATI, OHIO	39N10	84W30	◄►TANGIER, MOROCCO	35N48	5W54

Figure 4. CIRCUITS.DAT circuit data file.

The parameters MONTH, Sunspot Number, and FREQ (KHz) contain a variable number of values. If two month values exist, two circuits will be calculated for all frequencies entered. If two months and two Sunspot numbers exist, four circuits will be calculated for all frequencies entered. For any graphics plots (GRAPH VOACAP, described later), only the first MONTH and Sunspot Number are used.

When an array of these parameters is modified, sorted order is maintained and duplicates are removed. Changing a value to zero removes it from the list. To insert a new value, position the cursor in one of the blank fields and enter the new value. The array is then sorted and re-displayed.

Changing the transmitter antenna parameters is done differently in VOACAP than in REC533. VOACAP provides the ability to define up to 10 different antennas for a circuit. REC533 allows a maximum of 5 antennas, which are displayed on the main data input screen. Figure 5 contains the list of supplied CCIR antennas. This can be amended by using the HFANT program. The HFANT program is a self-documented, user-friendly program which is executed as explained in Appendix A.

```
  CHOOSE CCIR TRANSMIT ANTENNA TYPE TO USE
Filename Type Description
-------- ---- -----------

CCIR.00 [ 0] ISOTROPE
CCIR.01 [ 2] HR 4/4/1
CCIR.02 [ 2] HR 4/4/.8
CCIR.03 [ 2] HR 4/4/.5
CCIR.04 [ 2] HR 4/3/.5
CCIR.05 [ 2] HR 4/2/.5
CCIR.06 [ 2] HR 4/2/.3
CCIR.07 [ 2] HR 2/4/1
CCIR.08 [ 2] HR 2/4/.8
CCIR.09 [ 2] HR 2/4/.5
CCIR.10 [ 2] HR 2/3/.5
CCIR.11 [ 2] HR 2/2/.5
CCIR.12 [ 2] HR 2/2/.3
CCIR.13 [ 2] HR 2/1/.5
CCIR.14 [ 2] HR 2/1/.3
CCIR.15 [ 2] HR 1/2/.5
CCIR.16 [ 2] HR 1/2/.3
CCIR.17 [ 2] HR 1/1/.5
CCIR.18 [ 2] HR 1/1/.3
CCIR.19 [ 4] TR 2/1/.5
CCIR.20 [ 4] TR 2/1/.3
CCIR.21 [ 4] TR 1/2/.5
CCIR.22 [ 4] TR 1/2/.3
CCIR.23 [ 4] TR 1/1/.5
CCIR.24 [ 4] TR 1/1/.3
CCIR.25 [ 8] Omni 4dB [HQ 1/.3]
```

Figure 5. Supplied CCIR antennas.

The following discusses the purpose of using multiple transmitter antennas. For very general studies where little information about the antenna is known, a generic antenna may be defined with no design frequency (e.g., HR 4/4/.5). In this instance, for every frequency calculated, the design frequency would be set equal to the operating frequency (an idealized antenna). In reality, this situation does not occur. One antenna is not valid for all frequencies from 2 to 30 MHz. Thus, if a more accurate model of an existing antenna is desired, the user can specify the frequency range for which each antenna is valid. Specifications may also be given for the design frequency (if known), and the main beam direction in degrees from North, i.e., azimuth in True bearing (T). For example, it may be that at one antenna site, there exists three physical antennas: an HR 4/4/1 valid for 2-10 MHz with main beam 45° T, an HR 4/4/.5 valid for 10-20 MHz with main beam 70° T, and an HR 2/4/.5 valid for 20-30 MHz with main beam 60° T.

For VOACAP, antennas may be selected from a list of IONCAP antennas (**..\DATABASE\VOAXMTR.DAT**), or from pre-defined CCIR antennas located in the directory **..\ANTFILES**. Antennas referenced with a negative index are IONCAP antennas. Positive values reference CCIR antennas. New CCIR antennas may be defined by running the program HFANT. REC533 may select from the CCIR antennas only. To add new antennas to the **VOAXMTR.DAT** data file, the user should be familiar with IONCAP antenna definitions (Teters, 1983).

4.2 VOACAP Options Menu

To accept the parameters on the VOACAP data input screen, press the <Esc> key. The screen will change to Figure 6.

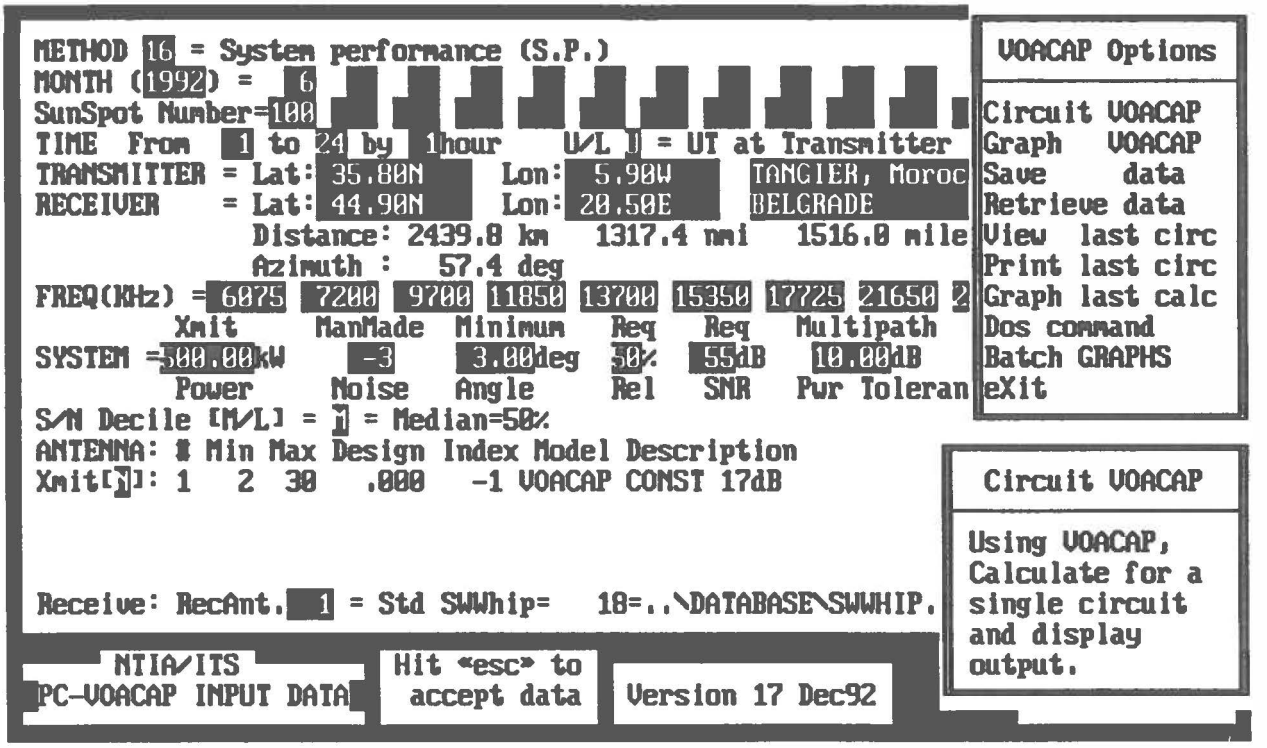

Figure 6. VOACAP options menu.

The arrow keys (↑ ↓) are used to select one of the options. In addition to the arrow keys, the following keys/letters (upper or lower case) can be entered to execute the corresponding command:

<Esc> = Edit
c = Circuit
g = Graph
s = Save data
r = Retrieve data
v = View last circuit
p = Print last circuit
d = DOS command
x = eXit program

4.2.1. Circuit VOACAP Menu Option

If the menu option "Circuit VOACAP" is selected, the program **VOACAPP.EXE** executes and produces a line-printer style report. The report is displayed to the computer screen by the program **SCROLL.EXE**. Use the arrow keys (↑ ↓ → ←) to move up, down, right, and left, and the PgUp and PgDn keys to page through the report. The <Esc> key will return to the data input screen. See Appendix D in this user's guide for a copy of the report using the input parameters defined in file **DEFAULT.VOA** and shown as the input parameters in this user's guide. This current report is stored in file **VOACAPX.OUT**, located in subdirectory **RUN**. Input data containing multiple MONTH and Sunspot Number values will produce a larger report containing results for all combinations.

4.2.2 Graph VOACAP Menu Option

The menu option "Graph VOACAP" uses VOACAP to calculate the results for all 24 hours and all integer frequencies from 2 to 30 MHz.

Once this calculation has completed, the menu shown in Figure 7 is displayed on the computer screen. The arrow keys are used to select which parameter to graph. Parameter options are

Field strength
Reliability
Signal-to-noise ratio
Table output
"All of the above"

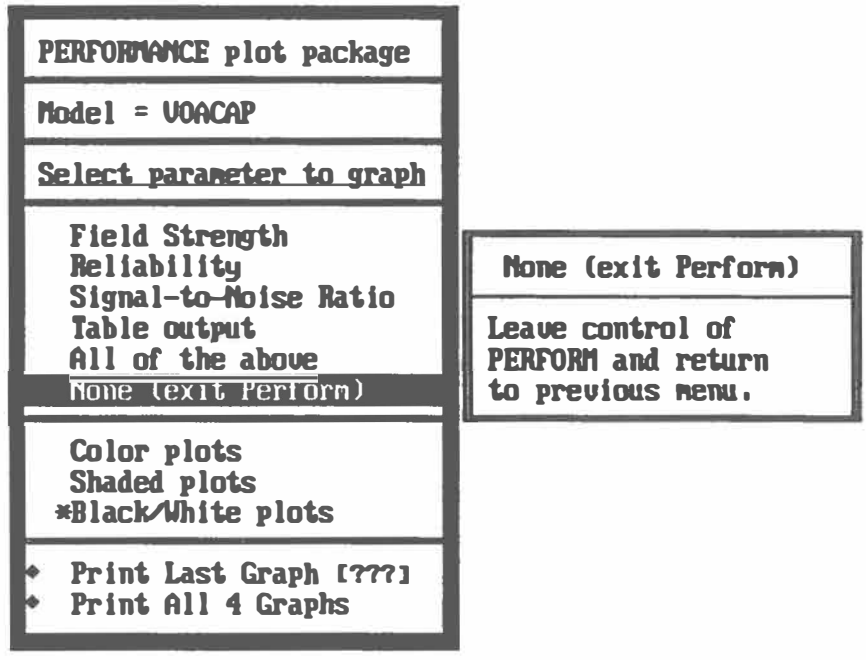

Figure 7. PERFORMANCE plot package.

Each of these options displays the output to the computer screen. Output style may be changed by selecting one of: Color, Shaded, Black/White. The user can then select to print all four graphs or just the last graph that was displayed to the computer screen. Color displays, while visually more appealing, cannot be printed to black and white printers. The output file **VOACAPG.OUT** contains all the results used to create these plots. See Appendix D for a listing of all graphs using default input parameters.

To return to the data input screen, press <Esc>, or use the arrow keys to select "None (exit Perform)" and enter a <cr>.

4.2.3 Save Data

The VOACAP data can be saved on a file specified by the user. This option allows the user to save input files and later retrieve these files for program execution, eliminating the need to regenerate repeatedly used input parameters. If a filename exists with the same name as the one being specified, the old file will be replaced. The filename specified automatically has **.VOA** (**.REC** for REC533) appended to it and is saved in the directory **..\SAVED**. A maximum of 8 characters may be given to a filename (a DOS limitation).

4.2.4 Retrieve Data

This option allows the user to retrieve a previously saved data set. The file will be located in the directory **..\SAVED**. Also located in this directory are files named **DEFAULTS.xxx**. These files contain input parameters that can be used when the user wants to execute or demonstrate the models.

4.2.5 View Last Circuit

The "View last circ" menu option displays the last circuit output report generated. The filename used to generate this circuit is listed in the HELP menu on the lower-right of the computer screen.

4.2.6 Print Last Circuit

The "Print last circ" menu option prints the last circuit generated with the DOS command: PRINT filename. Again, the filename is listed in the HELP menu.

4.2.7 Graph Last Calculations

The "Graph last calc" menu option displays the PERFORMANCE plot package menu, as shown in Figure 7 and described in Section 4.2.2. This option will use the last completed calculation to generate printouts or graphs to the computer screen.

4.2.8 DOS Command

The "Dos command" option allows the user to access the DOS operating system. To return to VOACAP, type "exit."

If, while executing DOS commands, the current directory is changed, the user should return to the **RUN** directory before typing "exit." Failure to do so will cause the programs to abort.

4.2.9 Batch GRAPHS

Batch GRAPHS allows the user to select a subset from the **CIRCUITS.DAT** file to be used in plot generation.

The MONTH, Sunspot Number, and all SYSTEM parameters (except transmitter power) are user-defined on the input screen, as described in Section 4 of this user's guide.

An asterisk to the left of a circuit name indicates the circuit has been selected.

Enter <F2> to select all the transmitters and receiver circuits found in the **CIRCUITS.DAT** file. If all circuits are currently selected, <F2> will inactivate their selection.

To select/deselect a circuit, use the arrow keys to high-light a circuit and press <cr>.

To begin batch processing, press <F3>. Once this is done, each circuit that has been selected will be processed and the plots automatically dumped to LPT1. An HP LaserJet printer must be on-line. When all circuits have been processed, control will return to DOS.

The <Esc> key will abort processing and return to the input data screen.

4.2.10 EXIT Command

The "eXit" command will exit the control of the **.BAT** file and return control to DOS.

5. REC533 INTERACTIVE PROGRAM EXECUTION

Many of the input parameters and the menu options of REC533 are the same as those of VOACAP. Therefore, only REC533 procedures and parameters different from VOACAP are described here (please refer to Section 4, replacing all occurrences of VOACAP with REC533).

To move into the execution directory, type

CD \ITSHFBC\RUN <cr>

To begin program execution, enter

REC533 <cr>

Figure 8 represents the initial REC533 data input display. Refer to Appendix C, the REC533 Input Data HELP Windows, for definitions of the input data variables.

The input data can be modified, or accepted as is by entering the <Esc> key. The REC533 option menu is the same as the VOACAP options menu (refer to Section 4.2 for an explanation of the various options).

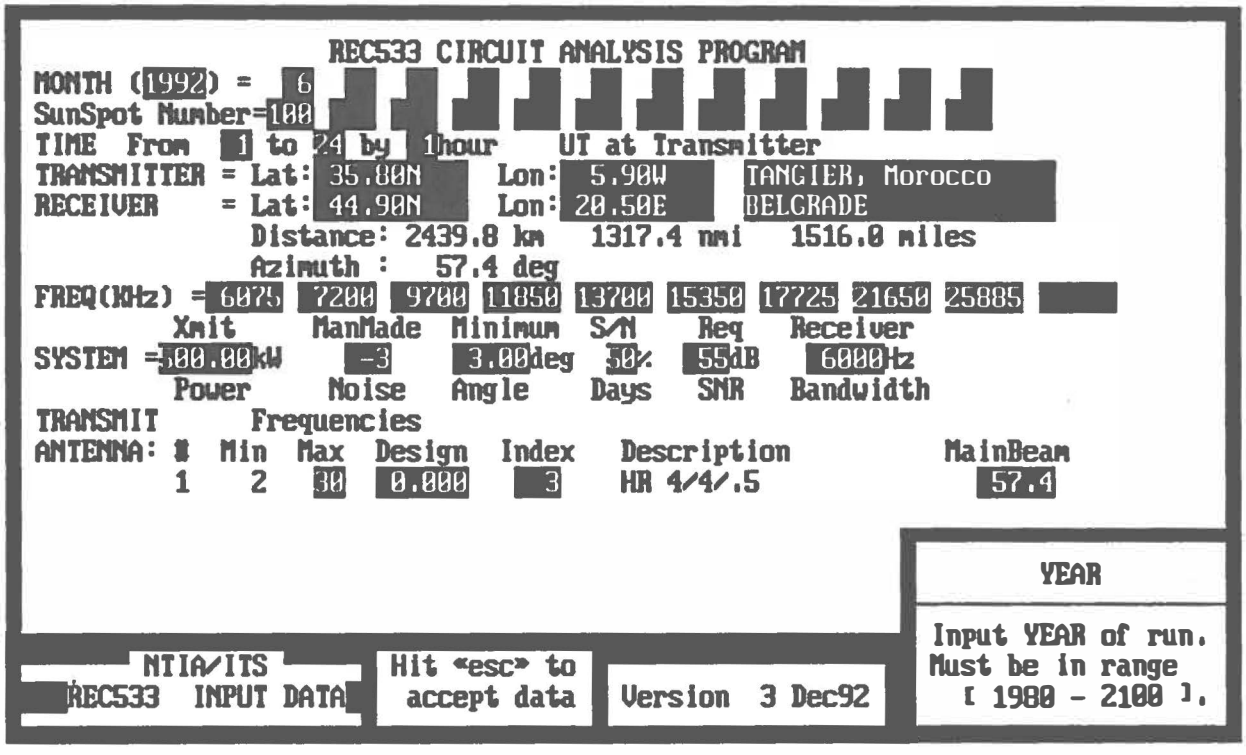

Figure 8. REC533 data input screen.

6. ABNORMAL PROGRAM TERMINATION

If a program terminates abnormally, the program FLRUN may remain in memory. FLRUN is a memory-resident program which controls the user-friendly input interface. To remove FLRUN, type the following:

FLOFF <cr>

7. REFERENCES

International Radio Consultative Committee (CCIR) (1992), Revision of Recommendation 533, CCIR HF Propagation Prediction Method, Document 6/BL/5-E, June.

Davies, K. (1990), *Ionospheric Radio* (Peter Peregrinus Ltd., London, United Kingdom).

International Telecommunication Union (ITU) (1984), World Administrative Radio Conference for the Planning of the HF Band Allocated to the Broadcasting Service, Report to the Second Session of the Conference, General Secretariat of the ITU, Geneva.

International Telecommunication Union (ITU) (1987), Final Acts of the World Administrative Radio Conference for the Planning of the HF Bands Allocated to the Broadcasting Service (HFBC-87), General Secretariat of the ITU, Geneva.

Teters, L. R. (1983), Estimating the performance of telecommunication systems using the ionospheric transmission channel - Ionospheric Communications Analysis and Prediction Program User's Manual, NTIA Report 83-127, July.

APPENDIX A: READ.ME File

11 Jan 1993

The following is a brief discussion of installing the HFANT, VOACAP, & REC533 computer programs with input and output processors developed by NTIA/ITS Boulder. Questions, comments, suggestions may be addressed to:

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The programs will be found on 2 3.5 inch diskettes in a compressed self-extracting format. The diskettes should contain:

#1 - HFBC1.EXE
- READ.ME (this file)
#2 - HFBC2.EXE

Minimum system requirements:

Memory - largest executable program [do "mem/c" command]
for REC533 = 370000 available
for VOACAP = 520000 available
Hard Disk - 10 Mbytes
VGA graphics card
ANSI.SYS in CONFIG.SYS
At least a 386 processor with math co-processor (less than this is too slow)

Sample running times for computers with co-processors:

	33 MHz 486	20 MHz 386
VOACAP graphs =	32 seconds	150 seconds
REC533 graphs =	17 seconds	70 seconds

HP LaserJet printer on LPT1 (if graphics hard copies desired)
If you do not have a HP LAserJet printer, you can still make your own copies if you have DOS 5.0 using the GRAPHICS command. The command syntax for a LaserJet is:

```
C:\DOS\GRAPHICS LASERJETII /r
C:\DOS\GRAPHICS.PRO
```

assuming C:\DOS is the directory of your DOS commands.
To print a graphic image from the screen, type:

<shift><Print Screen>

Proper installation:

```
MKDIR ITSHFBC   - this directory will contain all sub-directories
                  and should be independent of the rest of your system.
                  The name can be any name you choose.
CD ITSHFBC      - position yourself in the directory.
COPY a:*.*      - copy diskette #1 into ITSHFBC
COPY a:*.*      - copy diskette #2 into ITSHFBC
HFBC1 -d -o -n  - this will self-extract the compressed HFBC1.EXE file.
                  HFBC1 contains sub-directories BIN
                                                 RASTER
                                                 RUN
```

```
HFBC2 -d -o -n  - this will self-extract the compressed HFBC2.EXE file.
                  HFBC2 contains sub-directories DATABASE
                                                 ANTFILES
                                                 FONTS
                                                 NEWS
                                                 SAVED
                                                 SCODE
```

At this point, a DIR should produce the following:

```
 Directory of C:\ITSHFBC

.            <DIR>      06-23-92   5:14p
..           <DIR>      06-23-92   5:14p
ANTFILES     <DIR>      09-17-92   6:02p
BIN          <DIR>      09-17-92   6:03p
DATABASE     <DIR>      09-17-92   6:03p
FONTS        <DIR>      09-17-92   6:02p
HFBC1    EXE   1281787 11-06-92   1:18p
HFBC2    EXE    969815 11-06-92   1:18p
NEWS         <DIR>      12-17-92   8:02a
RASTER       <DIR>      09-17-92   6:02p
READ     ME      11593 11-06-92   1:18p
RUN          <DIR>      09-17-92   6:02p
SAVED        <DIR>      09-17-92   6:02p
SCODE        <DIR>      09-17-92   6:02p
```

Execution MUST always occur from the sub-directory RUN. All the files in RUN may be considered temporary and may be deleted. Also, the files in the sub-directory RASTER are screen image bitmap files used for creating graphics on an HP LaserJet printer and no harm is done deleting these files whenever you wish. All other sub-directories contain vital data and/or executable programs. Do not delete files other than those in the RUN or RASTER sub-directories. Files you may wish to edit for your own customization are in the DATABASE sub-directory:

```
        FREQS3.DEF    - default frequencies when the <F3> key is pressed.
        CIRCUITS.DAT  - list of transmitter to receiver circuits with
                        latitudes/longitudes, antennas, & power information.
        RECEIVE.DAT   - list of receiver latitudes/longitudes/names.
        TRANSMIT.DAT  - list of transmitter latitudes/longitudes/names.
        VOAREC.DAT    - list of valid VOACAP receive antennas
        VOAXMTR.DAT   - list of valid VOACAP transmit antennas
```

Please maintain fields and sorted order of these files. All that remains is to add the BIN directory to your PATH. All .BAT & .EXE files reside in BIN and the PATH must be set for them to be found. The best way is to change your PATH in AUTOEXEC.BAT to include "..\BIN" and re-boot.

You may now execute the programs with:

```
        HFANT          - to execute the HF antenna package to view or add
                         HF antennas to the data base.
        REC533         - to execute the input processor for REC533.
        VOACAP         - to execute the input processor for VOACAP.
```

A brief description of the contents of each directory follows:

```
        ANTFILES - contains HF antenna description files of form CCIR.xx.
                   Each file is a text file and may be viewed.
        BIN      - all .EXE, .COM, and .BAT files
                   ANTCALC.EXE  - calculate gain of CCIR or VOACAP antennas
                   BATCHSEL.EXE - select circuits for BATCH graphs processing
                   CCIRALL.BAT  - plot all CCIR antennas on HP LaserJet
                   CCIRPLT.BAT  - plot one CCIR antenna on HP LaserJet
```

```
            CCIRPLT1.EXE - program to plot CCIR antenna patterns
            DISPLAY.COM  - DISPLAY Screen module
            FLASH.COM    - controls FlashUP commands
            FLOFF.BAT    - removes FlashUP from memory
            FLRUN.EXE    - FLash up RUNtime module
            HFANT.BAT    - controls HFANT CCIR antenna execution
            HFANT8.EXE   - main CCIR antenna program
            HORZPLT.EXE  - plots horizontal antenna patterns [HFANT]
            HPJET.EXE    - plot 1 bitmap file  on HP LaserJet printer
            HPJET4.EXE   - plot 4 bitmap files on HP LaserJet printer
            LASER2C.BAT  - 80 lines of compressed text on HP printer
            LASERC.EXE   - add HP compressed print codes to text file
            PAGE.EXE     - create graphics bitmap of text file
            PERFORM.BAT  - .BAT file for PERFORM.EXE
            PERFORM.EXE  - plot propagation graphics results to screen
            REC533.BAT   - controls REC533 execution
            REC533IN.EXE - REC533 screen input moule
            REC533P.EXE  - REC533 propagation module
            SANSPLT2.EXE - Sanson-Flamstead antenna patterns [HFANT]
            SCR.BAT      - .BAT file for SCREEN.EXE
            SCREEN.EXE   - display a bitmap file on screen
            SCROLL.EXE   - allow user to scroll thru output file
            VERTPLT.EXE  - plots vertical antenna patterns [HFANT]
            VOACAP.BAT   - controls VOACAP execution
            VOACAPP.EXE  - VOACAP propagation module
            VOAINP.EXE   - VOACAP screen input moule
DATABASE  - general data base files
            CIRCUITS.DAT- list of valid circuits [MUST keep sorted]
            COEFFS.DAT  - VOACAP ionospheric coefficients
            CONST17.DAT - Constant 17dB gain transmitter antenna
            FREQS3.DEF  - default frequencies for <F3> key
            METHOD.DAT  - descriptions of VOACAP method parameter
            PARMS.DAT   - required for HFANT
            REC533.VER  - current REC533 version date
            RECEIVE.DAT - list of default receivers [MUST keep sorted]
            REP894??.BIN- REC533 & HFBC84 ionospheric coeffs @
                          month ??.
            SWWHIP.DAT  - Standard Short Wave Whip receiver antenna
            TRANSMIT.DAT- list of default transmitters[MUST keep
                          sorted]
            VOACAP.VER  - current VOACAP version date
            VOAREC.DAT  - list of valid VOACAP receive antennas
            VOAXMTR.DAT - list of valid VOACAP transmit antennas
FONTS     - MicroSoft Fortran graphic fonts (10 files)
NEWS      - Contains information files detailing changes made.
RASTER    - will hold bitmap graphics images which will be copied
            to HP LaserJet printers.
RUN       - execute directory. All files may be deleted.
SAVED     - saved circuit data files which may be retrieved.
SCODE     - TEXT and HELP screens and FLASHUP libraries.
```

The general flow of the programs follows:

The program is controlled by VOACAP.BAT [REC533.BAT]. If you understand .BAT files, please look at VOACAP.BAT for more detail. Simplistically, here is what happens:

VOAINP (the input processor) is executed
You change all parameters you wish to change.
Then hit <esc> key, which produces the options:

```
Circuit VOACAP
Graph   VOACAP
Save     data
Retrieve data
View  last circ
Print last circ
Graph last calc
Dos command
Batch GRAPHS
eXit
```

Using the arrow keys, you select one of the options. In addition to the arrow keys, <esc>=Edit, 'c'=Circuit, 'g'=Graph, 's'=Save, 'r'=Retrieve, 'v'=View, 'p'=Print, 'd'=Dos, 'b'=Batch, 'x'=eXit.

Circuit VOACAP - creates the file VOACAPx.dat in 'DECRED'(Teters, 1983) format then executes VOACAPP VOACAPx.dat VOACAPx.out This takes input from VOACAPx.dat and creates output on VOACAPx.out. Then output is displayed with 'SCROLL VOACAPx.out'. This allows you to scroll through the output file [Forward, Backward, and even Right/Left to view more than 80 columns]. The <esc> key at any time terminates this display. Control in SCROLL is done with arrow keys, HOME, END, PageUP, PageDOWN, TAB(right), ShiftTAB(left), <CR>.

Graph VOACAP - creates the file VOACAPg.dat in 'DECRED' format then executes VOACAPP VOACAPg.dat VOACAPg.out. The hours (UT) are forced 1 to 24, and incremented by 1, and the frequencies are set=-1 which flags VOACAPP to run frequencies 2 to 30 MHz by 1 MHz steps. When finished, control is passed to PERFORM which will read VOACAPg.out and allow you to graphically plot contours of Field Strength, Reliability, and Signal-to-Noise. If you have an HP LaserJet printer connected on LPT1, you will be able to produce graphics output, otherwise, you will only see graphics on the screen. NOTE, of you choose 'color' plots in PERFORM, sending these to the HP LaserJet will produce all black results!

Save data - Allows you to save the screen data in ASCII format on a file name (8 characters) that you specify.

Retrieve data - Allows you to retrieve data from a file that was saved.

View last circ - allows you to view the last results on file VOACAPx.out. Each time a circuit is calculated the previous contents of VOACAPx.out are destroyed.

Print last circ - will perform the command: PRINT VOACAPx.out which should send VOACAPx.out to your printer.

Graph last calc - will allow you to display graphs of the last "Graph VOACAP" selection without re-calculating.

Dos command - Allows you to execute a DOS command without exiting from the program.

Batch GRAPHS	- Allows you to select a subset of circuits from the ..\DATABASE\CIRCUITS.DAT file & perform calculations and plots in a non-interactive mode. Will only work if you have an HP LaserJet online to your computer. In VOACAP.BAT, the transfer of the files to the HP LaserJet has been commented out (with REM), and must be changed to allow results to be printed.
Exit	- Ends the program.

For REC533, substitute REC533 for VOACAP everywhere above.

If you abort abnormally [ctrlC], the program FLRUN may remain in memory as it is executed as a resident program. To remove it, simply type 'FLOFF'. FLRUN is FLashup RUNtime which controls the user-friendly input interface.

Good Luck!!

APPENDIX B: VOACAP Input Data HELP Windows

METHOD

Specify METHOD
[1-30] to use.

Hit «F2» for list.

BEGINNING HOUR

Specify BEGINNING and ending hours to calculate propagation.

Hours are Universal Time (UT) or Local Mean Time (LMT) at transmitter.
Valid range is [1 to 24].

YEAR

Input YEAR of run.
Must be in range
[1980 to 2100].

ENDING HOUR

Specify beginning and ENDING hours to calculate propagation.

Hours are Universal Time (UT) or Local Mean Time (LMT) at transmitter.
Valid range is [1 to 24].

MONTH

Specify month(s) to perform calculations.

«F2»	«F3»	«F4»
1,4,7,10	ALL	1

HOUR INCREMENT

Specify number of hours to increment between calculations.

Valid range is [1 to 12].

SSN

Specify SunSpot Number for propagation calculations.
«F2» sets 10, 100
«F4» sets 60
Valid range is [0 to 200].

UTM or LOCAL time

Specify whether calculations are performed in:
U = UT - Universal Time
L = LMT - Local Mean Time
at the transmitter.

Transmitter LATITUDE

Input the transmitter latitude
of the form:

North	South
dd.dddd	-dd.dddd
dd.Nmm	dd.Smm
dd.Nmm'ss	ddSmm'ss

«F2» to choose from TRANSMIT.DAT
«F3» to choose from CIRCUITS.DAT

Receiver LATITUDE

Input the receiver latitude
of the form:

North	South
dd.dddd	-dd.dddd
dd.Nmm	dd.Smm
dd.Nmm'ss	ddSmm'ss

«F2» to choose from RECEIVE.DAT
«F3» to choose from CIRCUITS.DAT

Transmitter LONGITUDE

Input the transmitter longitude
of the form:

East	West
ddd.dddd	-ddd.dddd
dddEmm	dddWmm
dddEmm'ss	dddWmm'ss

«F2» to choose from TRANSMIT.DAT
«F3» to choose from CIRCUITS.DAT

Receiver LONGITUDE

Input the receiver longitude
of the form:

East	West
ddd.dddd	-ddd.dddd
dddEmm	dddWmm
dddEmm'ss	dddWmm'ss

«F2» to choose from RECEIVE.DAT
«F3» to choose from CIRCUITS.DAT

Transmitter NAME

Input the transmitter name.
20 characters are allowed.

«F2» to choose from TRANSMIT.DAT
«F3» to choose from CIRCUITS.DAT

Receiver NAME

Input the receiver name.
20 characters are allowed.

«F2» to choose from RECEIVE.DAT
«F3» to choose from CIRCUITS.DAT

FREQUENCIES

Enter FREQUENCIES desired.
Zero fill those not used.

Range is [0 to 30000 kHz].

«F2» for defaults.
«F3» for defaults from
file=FREQS3.DEF
«F4» to zero all but 6100

Required Circuit Reliability

Specify the required circuit reliability, which is an estimate of the percentage of days within the month that the signal quality will be acceptable (Req SNR will be attained).
Range [10 to 90] Normally 90%

Transmitter Power

Specify the Transmitter Power in kWatts.

Valid range is [.01 to 999.99].

Required S/N Ratio (dB)

Specify the required ratio of the hourly median signal power relative to the hourly median noise in a 1 Hz bandwidth, which is necessary to provide the type and quality of service required. Combines with REQ REL parameter.

Man-Made NOISE in -dBW

Enter man-made noise in -dBW
(dB below a Watt).
-1 = 125 = industrial
-2 = 136 = residential
-3 = 148 = rural
-4 = 164 = remote
Other values are specified with positive values.

Multipath Power Tolerance (dB)

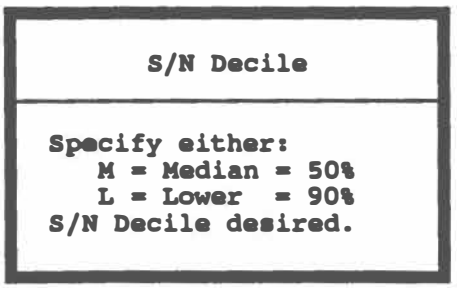
Specify the minimum tolerable power ratio between skywave modes at the receiver input terminal to permit satisfactory system performance in the presence of multiple signals.
If 0, multipath not considered.

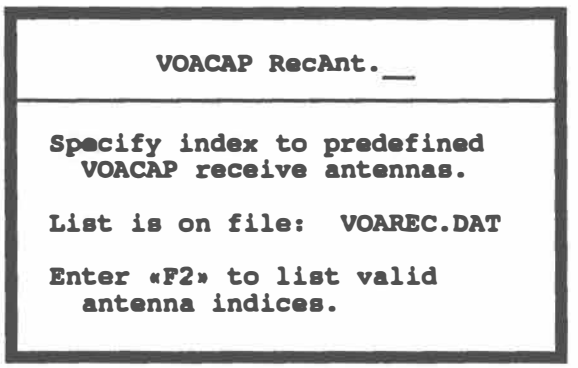
Minimum Takeoff Angle

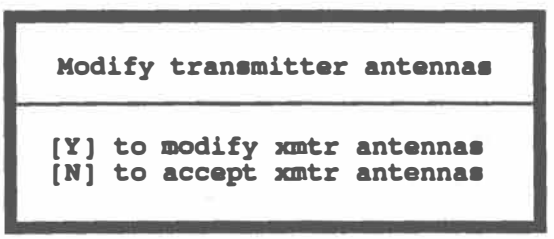
Specify Minimum Takeoff Angle of the antenna main lobe.
Normally 3.0 degrees.
Range [.01 to 40] [≤0 ≡ 3.0]

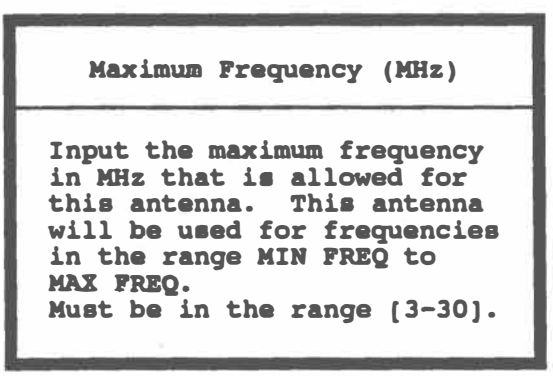
Maximum Tolerable Time Delay

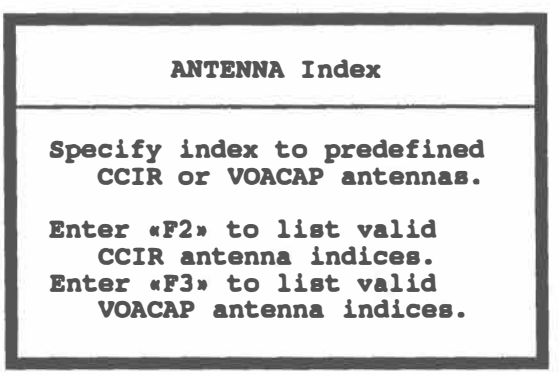
Specify the maximum tolerable difference in delay times between skywave propagation modes to permit satisfactory system performance in the presence of multiple signals.
Normally .85 milliseconds.

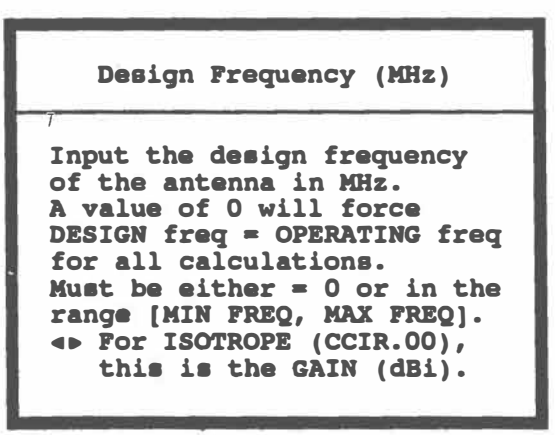

S/N Decile
Specify either:
M = Median = 50%
L = Lower = 90%
S/N Decile desired.

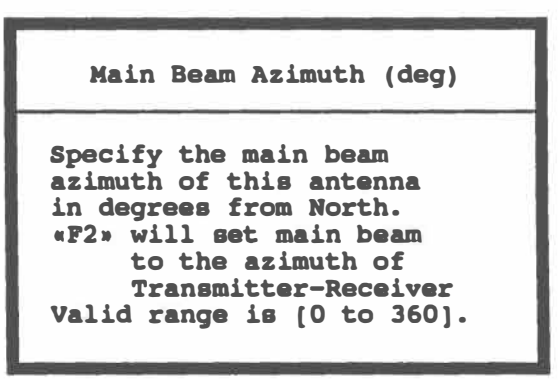

VOACAP RecAnt.__
Specify index to predefined
VOACAP receive antennas.
List is on file: VOAREC.DAT
Enter «F2» to list valid
antenna indices.


Modify transmitter antennas
[Y] to modify xmtr antennas
[N] to accept xmtr antennas


Maximum Frequency (MHz)
Input the maximum frequency
in MHz that is allowed for
this antenna. This antenna
will be used for frequencies
in the range MIN FREQ to
MAX FREQ.
Must be in the range [3-30].


ANTENNA Index
Specify index to predefined
CCIR or VOACAP antennas.
Enter «F2» to list valid
CCIR antenna indices.
Enter «F3» to list valid
VOACAP antenna indices.


Design Frequency (MHz)
Input the design frequency
of the antenna in MHz.
A value of 0 will force
DESIGN freq = OPERATING freq
for all calculations.
Must be either = 0 or in the
range [MIN FREQ, MAX FREQ].
◄► For ISOTROPE (CCIR.00),
this is the GAIN (dBi).


Main Beam Azimuth (deg)
Specify the main beam
azimuth of this antenna
in degrees from North.
«F2» will set main beam
to the azimuth of
Transmitter-Receiver
Valid range is [0 to 360].

APPENDIX C: REC533 Input Data HELP Windows

YEAR

Input YEAR of run.
Must be in range
[1980 to 2100].

BEGINNING HOUR

Specify BEGINNING and ending hours to calculate propagation.

Hours are Universal Time (UT) at transmitter.
Valid range is [1 to 24].

MONTH

Specify month(s) to perform calculations.

«F2»	«F3»	«F4»
1,4,7,10	ALL	1

ENDING HOUR

Specify beginning and ENDING hours to calculate propagation.

Hours are Universal Time (UT) at transmitter.
Valid range is [1 to 24].

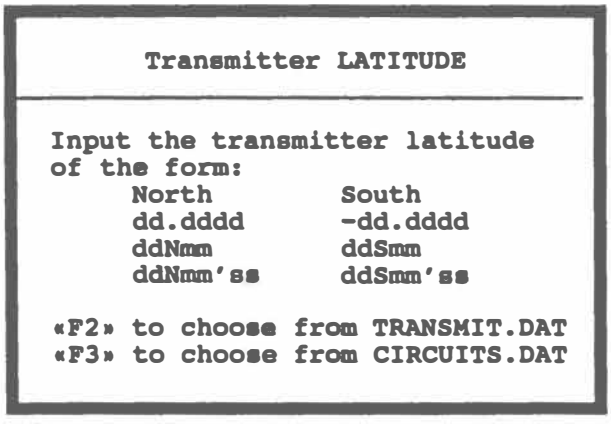
SSN

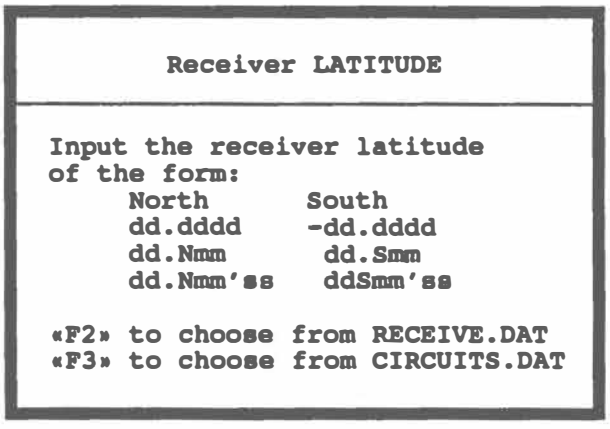
Specify SunSpot Number for propagation calculations.
«F2» sets 10, 100
«F4» sets 60
Valid range is [0 to 200].

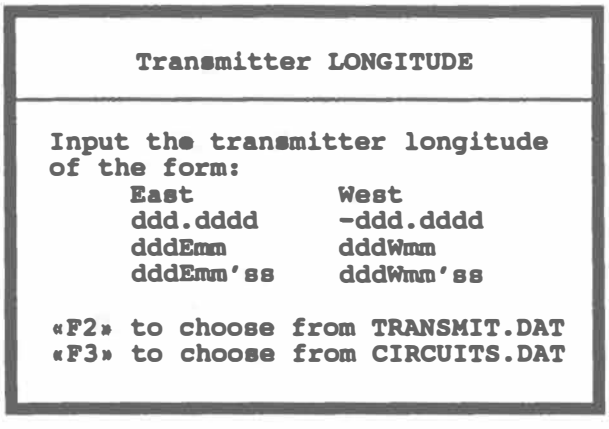
HOUR INCREMENT

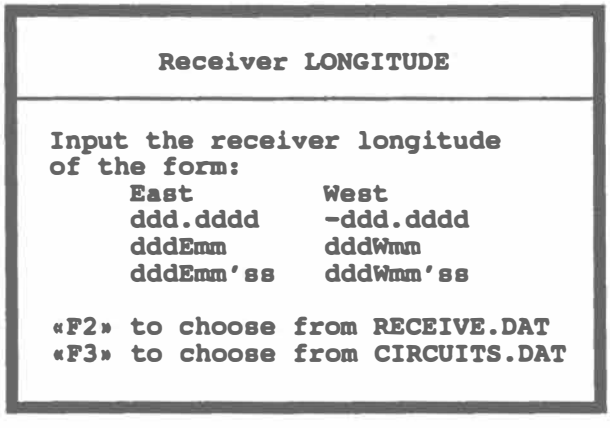
Specify number of hours to increment between calculations.

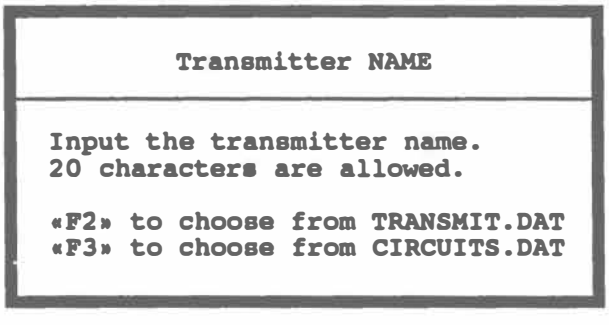
Valid range is [1 to 12].

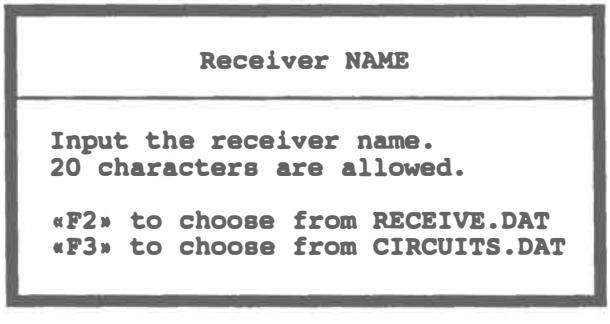

Transmitter LATITUDE
Input the transmitter latitude
of the form:
North South
dd.dddd -dd.dddd
ddNmm ddSmm
ddNmm'ss ddSmm'ss
«F2» to choose from TRANSMIT.DAT
«F3» to choose from CIRCUITS.DAT


Receiver LATITUDE
Input the receiver latitude
of the form:
North South
dd.dddd -dd.dddd
dd.Nmm dd.Smm
dd.Nmm'ss ddSmm'ss
«F2» to choose from RECEIVE.DAT
«F3» to choose from CIRCUITS.DAT


Transmitter LONGITUDE
Input the transmitter longitude
of the form:
East West
ddd.dddd -ddd.dddd
dddEmm dddWmm
dddEmm'ss dddWmm'ss
«F2» to choose from TRANSMIT.DAT
«F3» to choose from CIRCUITS.DAT


Receiver LONGITUDE
Input the receiver longitude
of the form:
East West
ddd.dddd -ddd.dddd
dddEmm dddWmm
dddEmm'ss dddWmm'ss
«F2» to choose from RECEIVE.DAT
«F3» to choose from CIRCUITS.DAT


Transmitter NAME
Input the transmitter name.
20 characters are allowed.
«F2» to choose from TRANSMIT.DAT
«F3» to choose from CIRCUITS.DAT


Receiver NAME
Input the receiver name.
20 characters are allowed.
«F2» to choose from RECEIVE.DAT
«F3» to choose from CIRCUITS.DAT

FREQUENCIES

Enter FREQUENCIES desired.
Zero fill those not used.

Range is [0 to 30000 kHz].

«F2» for defaults.
«F3» for defaults from
file=FREQS3.DEF
«F4» to zero all but 6100

S/N Percent of Days

Specify the percent of days
of the month for which the
required S/N ratio must be
attained.
Median is 50% [10 to 90]

Transmitter Power

Specify the Transmitter
Power in kWatts.

Valid range is [.01 to 999.99].

Required S/N Ratio (dB)

Specify the required S/N ratio
of the hourly median signal
power relative to the hourly
median noise in the receiver
bandwidth. [-20 to 100 dB]

Man-Made NOISE in -dBW

Enter man-made noise in -dBW
(dB below a Watt).
-1 = 125 = industrial
-2 = 136 = residential
-3 = 148 = rural
-4 = 164 = remote
Other values are specified
with positive values.

Receiver Bandwidth (Hz)

Specify the receiver
bandwidth in Hertz.
Valid range is :
1 - 99999 Hz.

Minimum Takeoff Angle

Specify Minimum Takeoff Angle
of the antenna main lobe.
The minimum allowed by
CCIR REC533 is 3 degrees.

Maximum Frequency (MHz)

Input the maximum frequency in MHz that is allowed for this antenna. This antenna will be used for frequencies in the range MIN FREQ to MAX FREQ.
Must be in the range [3-30].

ANTENNA Index

Specify index to predefined CCIR antennas.

Enter «F2» to list valid CCIR antenna indices.

Design Frequency (MHz)

Input the design frequency of the antenna in MHz.
A value of 0 will force DESIGN freq = OPERATING freq for all calculations.
Must be either = 0 or in the range [MIN FREQ, MAX FREQ].
◄► For ISOTROPE (CCIR.00), this is the GAIN (dBi).

Main Beam Azimuth (deg)

Specify the main beam azimuth of this antenna in degrees from North.
«F2» will set main beam to the azimuth of Transmitter-Receiver
Valid range is [0 to 360].

APPENDIX D: REPORTS

The reports and plots that can be generated with these models are given in this appendix.

CONTENTS

IONOSPHERIC COMMUNICATIONS ANALYSIS AND PREDICTION PROGRAM
VOACAP VERSION 93.0125

```
        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

TIME          1   24    1    1
MONTH      1992    6
SUNSPOT    100.
LABEL     TANGIER, Morocco    BELGRADE
CIRCUIT   35.80N     5.90W    44.90N    20.50E
SYSTEM    500.0 148. 3.00  50.55.0010.00  .85
ANTENNA       1    1    2   30      .000  -1=CONST 17dB              .0
ANTENNA       2    2    2   30      .000  -1=Std SWWhip              .0
SNR          50
FREQUENCY  6.07 7.20 9.7011.8513.7015.3517.7321.6525.89  .00  .00
METHOD       16    0
EXECUTE
QUIT
```

```
JUN     1992          SSN = 100.              Minimum Angle= 3.000 degrees
TANGIER, Morocco    BELGRADE              AZIMUTHS          N. MI.      KM
35.80 N    5.90 W - 44.90 N   20.50 E     57.41  254.73    1317.9    2440.5
XMTR   2.0 to 30.0  EXTERNAL   CONST 17dB          Azim=    .0  OFFaz= 57.4
RCVR   2.0 to 30.0  EXTERNAL   Std SWWhip          Azim=    .0  OFFaz= 57.4
POWER = 500.000 KW  3 MHz NOISE = -148.0 dBW   REQ.REL = 50%   REQ.SNR = 55.0
MULTIPATH POWER TOLERANCE = 10.0 dB   MULTIPATH DELAY TOLERANCE =   .850 ms

 1.0 16.3  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0    .0 FREQ
      1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -     - MODE
     13.7  7.8  7.8  8.1  8.7  9.5 10.9 14.7 14.7 14.7    -     - ANGLE
      8.9  8.5  8.5  8.6  8.6  8.6  8.7  9.0  9.0  9.0    -     - DELAY
      440  295  296  304  317  337  371  466  466  466    -     - V HITE
      .50 1.00 1.00  .99  .94  .82  .63  .25  .01  .00    -     - F DAYS
      124  119  118  117  117  118  120  134  176  238    -     - LOSS
       67   65   67   69   70   70   69   56   16  -45    -     - DBU
      -64  -59  -58  -59  -60  -61  -63  -77 -119 -181    -     - S DBW
     -173 -154 -157 -164 -168 -170 -172 -174 -176 -178    -     - N DBW
      108   95   99  105  108  109  109   97   58   -2    -     - SNR
      -53  -40  -44  -50  -53  -54  -54  -42   -3   57    -     - RPWRG
     1.00 1.00 1.00 1.00 1.00 1.00 1.00  .98  .56  .00    -     - REL
      .00 1.00  .00 1.00  .00  .00  .00  .00  .00  .00    -     - MPROB

 2.0 15.3  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0    .0 FREQ
      1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -     - MODE
     13.5  8.0  8.0  8.3  9.0 10.1 14.8 14.8 14.8 14.8    -     - ANGLE
      8.9  8.6  8.6  8.6  8.6  8.7  9.0  9.0  9.0  9.0    -     - DELAY
      436  300  300  308  325  352  470  470  470  470    -     - V HITE
      .50 1.00 1.00  .98  .90  .73  .49  .18  .01  .00    -     - F DAYS
      123  119  117  117  117  119  125  137  173  224    -     - LOSS
       68   65   67   69   70   70   63   52   18  -32    -     - DBU
      -64  -59  -58  -59  -60  -62  -68  -80 -116 -167    -     - S DBW
     -172 -156 -158 -164 -168 -170 -172 -174 -176 -178    -     - N DBW
      108   97  100  105  108  109  104   94   60   11    -     - SNR
      -53  -42  -45  -50  -53  -54  -49  -39   -5   44    -     - RPWRG
     1.00 1.00 1.00 1.00 1.00 1.00 1.00  .97  .61  .02    -     - REL
      .00 1.00  .00 1.00  .00  .00  .00  .00  .00  .00    -     - MPROB

 3.0 15.0  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0    .0 FREQ
      1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -     - MODE
     13.6  8.3  8.1  8.2  8.9 10.1 14.6 14.6 14.6 14.6    -     - ANGLE
      8.9  8.6  8.6  8.6  8.6  8.7  9.0  9.0  9.0  9.0    -     - DELAY
      439  308  302  306  322  352  464  464  464  464    -     - V HITE
      .50 1.00 1.00  .98  .89  .69  .45  .15  .01  .00    -     - F DAYS
      124  120  119  118  118  119  126  140  178  231    -     - LOSS
       67   63   66   68   69   69   62   50   13  -38    -     - DBU
      -64  -61  -60  -60  -61  -62  -69  -83 -121 -174    -     - S DBW
     -171 -157 -159 -164 -168 -170 -172 -174 -176 -178    -     - N DBW
      108   96  100  104  107  108  103   91   55    4    -     - SNR
      -53  -41  -45  -49  -52  -53  -48  -36    0   51    -     - RPWRG
     1.00 1.00 1.00 1.00 1.00 1.00 1.00  .97  .50  .01    -     - REL
      .00  .00  .00 1.00  .00  .00  .00  .00  .00  .00    -     - MPROB
```

```
JUN     1992          SSN = 100.              Minimum Angle= 3.000 degrees
TANGIER, Morocco    BELGRADE                AZIMUTHS          N. MI.      KM
35.80 N     5.90 W - 44.90 N   20.50 E      57.41  254.73    1317.9    2440.5
XMTR   2.0 to 30.0  EXTERNAL   CONST 17dB          Azim=    .0  OFFaz= 57.4
RCVR   2.0 to 30.0  EXTERNAL   Std SWWhip          Azim=    .0  OFFaz = 57.4
POWER = 500.000 KW  3 MHz NOISE = -148.0 dBW   REQ.REL = 50%   REQ.SNR = 55.0
MULTIPATH POWER TOLERANCE = 10.0 dB  MULTIPATH DELAY TOLERANCE =   .850 ms

 4.0 15.7  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0    .0 FREQ
      1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -     - MODE
     14.1 11.2  8.6  7.9  8.3  9.1 11.1 14.1 14.1 14.1    -     - ANGLE
      8.9  8.7  8.6  8.6  8.6  8.6  8.7  8.9  8.9  8.9    -     - DELAY
      451  379  314  299  307  327  376  451  451  451    -     - V HITE
      .50 1.00 1.00  .99  .92  .77  .55  .22  .01  .00    -     - F DAYS
      125  124  122  120  119  120  122  135  169  220    -     - LOSS
       63   59   63   67   68   69   68   54   23  -27    -     - DBU
      -68  -64  -63  -62  -62  -63  -64  -78 -112 -163    -     - S DBW
     -172 -158 -160 -164 -168 -170 -172 -174 -176 -178    -     - N DBW
      104   94   97  103  106  108  108   96   65   16    -     - SNR
      -49  -39  -42  -48  -51  -53  -53  -41  -10   39    -     - RPWRG
     1.00 1.00 1.00 1.00 1.00 1.00 1.00  .98  .69  .03    -     - REL
      .00  .00  .00 1.00  .00  .00  .00  .00  .00  .00    -     - MPROB

 5.0 17.3  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0    .0 FREQ
      1F2  2F2  2F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -     - MODE
     11.6 23.0 22.2  8.0  7.6  7.9  8.6 13.5 13.5 13.5    -     - ANGLE
      8.8  9.3  9.2  8.6  8.5  8.6  8.6  8.9  8.9  8.9    -     - DELAY
      387  302  290  301  292  298  316  436  436  436    -     - V HITE
      .50 1.00 1.00  .99  .97  .89  .74  .44  .07  .00    -     - F DAYS
      125  134  131  123  122  121  121  128  151  193    -     - LOSS
       68   49   53   63   66   67   68   61   40    0    -     - DBU
      -65  -75  -72  -65  -65  -64  -64  -71  -94 -136    -     - S DBW
     -173 -159 -161 -165 -168 -170 -172 -174 -176 -178    -     - N DBW
      108   85   89  100  103  106  108  102   82   42    -     - SNR
      -53  -30  -34  -45  -48  -51  -53  -47  -27   13    -     - RPWRG
     1.00 1.00 1.00 1.00 1.00 1.00 1.00  .99  .91  .27    -     - REL
      .00 1.00 1.00  .00  .00  .00  .00  .00  .00  .00    -     - MPROB

 6.0 19.1  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0    .0 FREQ
      1F2  2F2  2F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -     - MODE
     11.1 24.8 22.5 11.1  7.9  7.3  7.5  8.7 13.1 13.1    -     - ANGLE
      8.7  9.4  9.2  8.7  8.6  8.5  8.5  8.6  8.9  8.9    -     - DELAY
      377  326  294  376  298  285  289  316  426  426    -     - V HITE
      .50 1.00 1.00  .99  .97  .93  .84  .64  .23  .02    -     - F DAYS
      126  145  139  127  125  124  124  124  138  166    -     - LOSS
       67   37   45   59   63   68   66   67   54   27    -     - DBU
      -67  -87  -80  -69  -67  -64  -67  -66  -81 -109    -     - S DBW
     -175 -160 -162 -165 -168 -170 -172 -174 -176 -178    -     - N DBW
      108   74   82   97  101  106  105  107   95   69    -     - SNR
      -53  -19  -27  -42  -46  -51  -50  -52  -40  -14    -     - RPWRG
     1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00  .98  .76    -     - REL
      .00  .97 1.00  .00  .00  .00  .00  .00  .00  .00    -     - MPROB
```

```
JUN    1992          SSN = 100.                Minimum Angle= 3.000 degrees
TANGIER, Morocco    BELGRADE                AZIMUTHS          N. MI.      KM
35.80 N    5.90 W - 44.90 N   20.50 E     57.41  254.73    1317.9    2440.5
XMTR   2.0 to 30.0  EXTERNAL   CONST 17dB          Azim=    .0  OFFaz= 57.4
RCVR   2.0 to 30.0  EXTERNAL   Std SWWhip          Azim=    .0  OFFaz= 57.4
POWER = 500.000 KW  3 MHz NOISE = -148.0 dBW   REQ.REL = 50%   REQ.SNR = 55.0
MULTIPATH POWER TOLERANCE = 10.0 dB   MULTIPATH DELAY TOLERANCE =   .850 ms

 7.0 20.4  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
      1F2  3F1  2 E  2F2  2F2  1F2  1F2  1F2  1F2  1F2    -    - MODE
     11.2 29.2  6.3 25.1 22.8 12.1 10.0  8.4 13.0 13.0    -    - ANGLE
      8.7  9.7  8.3  9.4  9.2  8.8  8.7  8.6  8.9  8.9    -    - DELAY
      378  250   98  331  299  399  348  309  422  422    -    - V HITE
      .50 1.00 1.00 1.00  .98  .95  .90  .75  .37  .07    -    - F DAYS
      127  172  159  138  134  125  125  125  133  154    -    - LOSS
       67   14   27   48   52   64   65   67   59   39    -    - DBU
      -68 -111  -99  -80  -76  -67  -68  -66  -76  -97    -    - S DBW
     -175 -161 -163 -166 -168 -170 -172 -174 -176 -178    -    - N DBW
      108   50   64   86   92  103  104  107  101   82    -    - SNR
      -53    5   -9  -31  -37  -48  -49  -52  -46  -27    -    - RPWRG
     1.00  .29  .92 1.00 1.00 1.00 1.00 1.00  .99  .91    -    - REL
      .00  .12  .66 1.00  .00  .00  .00  .00  .00  .00    -    - MPROB

 8.0 20.6  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
      1F2  2ES  3F2  2F2  2F2  2F2  1F2  1F2  1F2  1F2    -    - MODE
     10.6  7.4 39.2 26.7 23.2 29.8 11.5  9.1 13.4 13.4    -    - ANGLE
      8.7  8.3 11.1  9.6  9.3 10.0  8.8  8.6  8.9  8.9    -    - DELAY
      363  110  364  354  304  401  385  327  432  432    -    - V HITE
      .50  .95 1.00 1.00  .99  .43  .90  .76  .39  .08    -    - F DAYS
      127  192  172  144  137  144  126  125  132  152    -    - LOSS
       67   -7   15   42   50   43   65   67   60   41    -    - DBU
      -67 -133 -111  -85  -79  -87  -68  -66  -75  -95    -    - S DBW
     -175 -161 -163 -166 -168 -170 -172 -174 -176 -178    -    - N DBW
      108   29   52   82   89   84  104  108  102   84    -    - SNR
      -53   26    3  -27  -34  -29  -49  -53  -47  -29    -    - RPWRG
     1.00  .00  .38 1.00 1.00  .92 1.00 1.00  .99  .92    -    - REL
      .00  .00  .19  .99  .98  .00  .00  .00  .00  .00    -    - MPROB

 9.0 20.3  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
      1F2  2ES  2 E  2F2  2F2  2F2  1F2  1F2  1F2  1F2    -    - MODE
     10.3  7.4  6.1 27.8 23.9 30.4 12.5  9.8 13.9 13.9    -    - ANGLE
      8.7  8.3  8.3  9.7  9.3 10.0  8.8  8.7  8.9  8.9    -    - DELAY
      356  110   95  370  313  412  411  343  447  447    -    - V HITE
      .50  .96 1.00 1.00  .98  .39  .89  .74  .35  .06    -    - F DAYS
      127  210  193  148  140  147  127  126  133  154    -    - LOSS
       67  -27   -1   37   46   43   62   66   58   39    -    - DBU
      -68 -152 -127  -90  -83  -88  -70  -67  -76  -97    -    - S DBW
     -175 -161 -163 -166 -168 -170 -171 -173 -176 -178    -    - N DBW
      108    9   37   76   86   82  102  106  100   82    -    - SNR
      -53   46   18  -21  -31  -27  -47  -51  -45  -27    -    - RPWRG
     1.00  .00  .02 1.00 1.00  .91 1.00 1.00  .99  .91    -    - REL
      .00  .00  .02  .00  .00  .87  .00  .00  .00  .00    -    - MPROB
```

```
JUN    1992          SSN = 100.                Minimum Angle= 3.000 degrees
TANGIER, Morocco    BELGRADE                AZIMUTHS          N. MI.      KM
35.80 N    5.90 W - 44.90 N   20.50 E      57.41  254.73    1317.9    2440.5
XMTR   2.0 to 30.0  EXTERNAL   CONST 17dB            Azim=    .0  OFFaz= 57.4
RCVR   2.0 to 30.0  EXTERNAL   Std SWWhip            Azim=    .0  OFFaz= 57.4
POWER = 500.000 KW  3 MHz NOISE = -148.0 dBW   REQ.REL = 50%   REQ.SNR = 55.0
MULTIPATH POWER TOLERANCE = 10.0 dB   MULTIPATH DELAY TOLERANCE =   .850 ms

10.0 20.1  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
      1F2  2ES  2ES  2F2  2F2  2 E  2F2  1F2  1F2  1F2    -    - MODE
     10.5  7.4  7.4 28.4 24.3  7.2 30.9 10.6 14.3 14.3    -    - ANGLE
      8.7  8.3  8.3  9.8  9.4  8.3 10.1  8.7  8.9  8.9    -    - DELAY
      362  110  110  379  319  108  420  362  456  456    -    - V HITE
      .50  .96  .93 1.00  .99  .87  .09  .76  .30  .02    -    - F DAYS
      128  228  207  152  144  152  169  127  136  168    -    - LOSS
       67  -45  -18   32   43   40   23   64   55   25    -    - DBU
      -67 -171 -144  -95  -86  -91 -109  -69  -79 -111    -    - S DBW
     -175 -161 -163 -166 -168 -170 -171 -173 -176 -178    -    - N DBW
      108   -9   19   71   83   79   63  104   97   68    -    - SNR
      -53   64   36  -16  -28  -24   -8  -49  -42  -13    -    - RPWRG
     1.00  .00  .00 1.00 1.00  .96  .65 1.00  .98  .74    -    - REL
      .00  .00  .00  .00  .00  .85  .57  .00  .00  .00    -    - MPROB

11.0 20.2  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
      1F2  2ES  2ES  2F2  2F2  2 E  2F2  1F2  1F2  1F2    -    - MODE
     10.9  7.4  7.4 29.1 25.0  7.0 31.2 11.3 14.5 14.5    -    - ANGLE
      8.7  8.3  8.3  9.9  9.4  8.3 10.1  8.7  9.0  9.0    -    - DELAY
      372  110  110  390  329  106  425  381  463  463    -    - V HITE
      .50  .95  .92 1.00  .99  .91  .10  .76  .30  .02    -    - F DAYS
      129  240  216  155  146  155  170  128  137  167    -    - LOSS
       65  -57  -25   30   41   38   19   63   55   25    -    - DBU
      -70 -183 -151  -98  -88  -93 -112  -70  -80 -110    -    - S DBW
     -175 -161 -163 -166 -168 -169 -171 -173 -176 -178    -    - N DBW
      106  -22   11   68   80   76   59  103   96   68    -    - SNR
      -51   77   44  -13  -25  -21   -4  -48  -41  -13    -    - RPWRG
     1.00  .00  .00  .99 1.00  .97  .58 1.00  .98  .74    -    - REL
      .00  .00  .00  .00  .00  .83  .34  .00  .00  .00    -    - MPROB

12.0 20.2  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
      1F2  2ES  2ES  2F2  2F2  2 E  1F2  1F2  1F2  1F2    -    - MODE
     11.6  7.4  7.4 29.4 25.5  7.0 14.0 11.0 14.7 14.7    -    - ANGLE
      8.8  8.3  8.3  9.9  9.5  8.3  8.9  8.7  9.0  9.0    -    - DELAY
      388  110  110  396  337  106  448  373  467  467    -    - V HITE
      .50  .95  .91 1.00  .99  .91  .92  .76  .31  .02    -    - F DAYS
      129  242  218  155  146  156  129  129  137  167    -    - LOSS
       64  -59  -25   30   41   37   59   62   54   26    -    - DBU
      -70 -184 -152  -98  -88  -94  -72  -71  -80 -110    -    - S DBW
     -175 -160 -162 -165 -167 -169 -170 -173 -176 -178    -    - N DBW
      105  -24   11   68   79   75   98  102   96   69    -    - SNR
      -50   79   44  -13  -24  -20  -43  -47  -41  -14    -    - RPWRG
     1.00  .00  .00  .99 1.00  .96 1.00 1.00  .98  .75    -    - REL
      .00  .00  .00  .00  .00  .82  .00  .00  .00  .00    -    - MPROB
```

```
JUN     1992          SSN = 100.                Minimum Angle= 3.000 degrees
TANGIER, Morocco    BELGRADE              AZIMUTHS          N. MI.      KM
35.80 N     5.90 W - 44.90 N   20.50 E     57.41  254.73    1317.9   2440.5
XMTR   2.0 to 30.0  EXTERNAL   CONST 17dB          Azim=    .0  OFFaz= 57.4
RCVR   2.0 to 30.0  EXTERNAL   Std SWWhip          Azim=    .0  OFFaz= 57.4
POWER = 500.000 KW  3 MHz NOISE = -148.0 dBW   REQ.REL = 50%   REQ.SNR = 55.0
MULTIPATH POWER TOLERANCE = 10.0 dB   MULTIPATH DELAY TOLERANCE =   .850 ms

13.0 20.1  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
      1F2  2ES  2ES  2F2  2F2  2 E  1F2  1F2  1F2  1F2    -    - MODE
     11.8  7.4  7.4 29.4 25.9  7.1 13.7 10.7 14.8 14.8    -    - ANGLE
      8.8  8.3  8.3  9.9  9.5  8.3  8.9  8.7  9.0  9.0    -    - DELAY
      393  110  110  396  342  107  441  367  470  470    -    - V HITE
      .50  .94  .90 1.00  .99  .88  .92  .76  .30  .02    -    - F DAYS
      129  234  212  153  144  154  129  128  137  168    -    - LOSS
       65  -52   -7   32   42   38   59   63   54   25    -    - DBU
      -68 -177 -132  -96  -87  -93  -72  -70  -80 -111    -    - S DBW
     -175 -160 -162 -165 -166 -168 -170 -172 -176 -178    -    - N DBW
      107  -16   30   69   80   76   98  102   96   68    -    - SNR
      -52   71   25  -14  -25  -21  -43  -47  -41  -13    -    - RPWRG
     1.00  .00  .00  .99  .99  .93 1.00 1.00  .98  .74    -    - REL
      .00  .00  .01  .00  .00  .83  .00  .00  .00  .00    -    - MPROB

14.0 19.9  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
      1F2  2ES  2ES  2F2  2F2  2F2  1F2  1F2  1F2  1F2    -    - MODE
     13.7  7.4  7.4 29.0 26.3 32.0 13.3 10.8 14.8 14.8    -    - ANGLE
      8.9  8.3  8.3  9.9  9.6 10.2  8.9  8.7  9.0  9.0    -    - DELAY
      441  110  110  390  349  438  430  368  470  470    -    - V HITE
      .50  .94  .90 1.00  .99  .33  .91  .74  .26  .01    -    - F DAYS
      130  220  202  149  142  152  128  127  138  173    -    - LOSS
       64  -34    1   35   45   39   61   64   53   20    -    - DBU
      -70 -159 -125  -92  -84  -92  -71  -69  -81 -116    -    - S DBW
     -174 -160 -161 -164 -166 -168 -169 -172 -176 -178    -    - N DBW
      105    1   37   72   82   76   99  104   95   63    -    - SNR
      -50   54   18  -17  -27  -21  -44  -49  -40   -8    -    - RPWRG
      .99  .00  .02 1.00 1.00  .88 1.00 1.00  .98  .65    -    - REL
      .00  .00  .01  .00  .00  .85  .00  .00  .00  .00    -    - MPROB

15.0 19.8  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
      1F2  2ES  3F2  2F2  2F2  1F2  1F2  1F2  1F2  1F2    -    - MODE
     13.4  7.4 41.4 28.1 26.4 14.6 11.9 10.6 14.8 14.8    -    - ANGLE
      8.9  8.3 11.5  9.8  9.6  9.0  8.8  8.7  9.0  9.0    -    - DELAY
      434  110  394  375  349  465  396  362  469  469    -    - V HITE
      .50  .94 1.00 1.00  .99  .96  .90  .72  .23  .01    -    - F DAYS
      128  202  174  144  139  127  126  126  138  175    -    - LOSS
       65  -17   11   41   48   60   62   65   53   18    -    - DBU
      -69 -143 -115  -86  -81  -70  -69  -68  -81 -118    -    - S DBW
     -174 -160 -161 -163 -165 -167 -169 -172 -176 -178    -    - N DBW
      106   17   46   77   84   97  100  104   95   61    -    - SNR
      -51   38    9  -22  -29  -42  -45  -49  -40   -6    -    - RPWRG
     1.00  .00  .15 1.00 1.00 1.00 1.00 1.00  .98  .61    -    - REL
      .00  .00  .04  .00  .00  .00  .00  .00  .00  .00    -    - MPROB
```

```
JUN     1992          SSN = 100.              Minimum Angle= 3.000 degrees
TANGIER, Morocco    BELGRADE              AZIMUTHS          N. MI.      KM
35.80 N    5.90 W - 44.90 N   20.50 E     57.41  254.73    1317.9   2440.5
XMTR   2.0 to 30.0  EXTERNAL   CONST 17dB          Azim=    .0  OFFaz= 57.4
RCVR   2.0 to 30.0  EXTERNAL   Std SWWhip          Azim=    .0  OFFaz= 57.4
POWER = 500.000 KW  3 MHz NOISE = -148.0 dBW   REQ.REL = 50%   REQ.SNR = 55.0
MULTIPATH POWER TOLERANCE = 10.0 dB   MULTIPATH DELAY TOLERANCE =   .850 ms

16.0 20.1  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
      1F2  2 E  3F2  2F2  2F2  1F2  1F2  1F2  1F2  1F2    -    - MODE
     12.0  6.0 39.4 26.6 25.4 13.1 10.8  9.9 14.4 14.4    -    - ANGLE
      8.8  8.3 11.1  9.6  9.5  8.9  8.7  8.7  9.0  9.0    -    - DELAY
      397   95  366  353  335  425  367  346  458  458    -    - V HITE
      .50 1.00 1.00 1.00  .99  .97  .91  .75  .27  .01    -    - F DAYS
      127  182  164  140  135  126  126  125  136  171    -    - LOSS
       66    8   22   46   51   62   64   66   55   22    -    - DBU
      -68 -117 -104  -82  -78  -69  -68  -67  -79 -114    -    - S DBW
     -174 -158 -159 -161 -164 -166 -168 -172 -176 -178    -    - N DBW
      106   42   56   80   86   97  101  105   96   64    -    - SNR
      -51   13   -1  -25  -31  -42  -46  -50  -41   -9    -    - RPWRG
     1.00  .10  .54 1.00 1.00 1.00 1.00 1.00  .98  .68    -    - REL
      .00  .06  .29  .99  .00  .00  .00  .00  .00  .00    -    - MPROB

17.0 20.7  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
      1F2  2F2  2F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -    - MODE
     11.5 25.9 23.5 11.8  8.2  7.7  7.7  8.3 13.8 13.8    -    - ANGLE
      8.8  9.5  9.3  8.8  8.6  8.5  8.5  8.6  8.9  8.9    -    - DELAY
      386  343  308  392  304  293  293  307  444  444    -    - V HITE
      .50 1.00 1.00 1.00  .99  .98  .93  .80  .36  .03    -    - F DAYS
      127  150  142  130  128  126  125  124  133  163    -    - LOSS
       67   33   42   57   61   66   65   67   59   30    -    - DBU
      -67  -91  -84  -71  -69  -66  -68  -67  -76 -106    -    - S DBW
     -175 -156 -157 -160 -163 -166 -168 -172 -176 -178    -    - N DBW
      108   65   74   89   94  100  101  105  100   73    -    - SNR
      -53  -10  -19  -34  -39  -45  -46  -50  -45  -18    -    - RPWRG
     1.00  .90 1.00 1.00 1.00 1.00 1.00 1.00  .99  .81    -    - REL
      .00  .65  .96  .00  .00  .00  .00  .00  .00  .00    -    - MPROB

18.0 21.6  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
      1F2  2 E  2 E  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -    - MODE
     11.4  6.5  6.8  7.9  7.0  6.9  7.0  7.6 12.0 13.4    -    - ANGLE
      8.7  8.3  8.3  8.6  8.5  8.5  8.5  8.5  8.8  8.9    -    - DELAY
      382  100  104  298  276  274  278  291  397  433    -    - V HITE
      .50 1.00  .95 1.00 1.00  .98  .95  .85  .49  .06    -    - F DAYS
      127  137  135  128  126  125  124  123  127  154    -    - LOSS
       68   46   51   59   63   66   67   68   67   39    -    - DBU
      -67  -78  -75  -69  -67  -67  -67  -66  -67  -97    -    - S DBW
     -176 -155 -156 -161 -164 -167 -169 -172 -176 -178    -    - N DBW
      109   76   82   92   97  101  103  107  109   82    -    - SNR
      -54  -21  -27  -37  -42  -46  -48  -52  -54  -27    -    - RPWRG
     1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00  .91    -    - REL
      .00  .96 1.00  .00  .00  .99  .00  .00  .00  .00    -    - MPROB
```

```
JUN    1992          SSN = 100.                Minimum Angle= 3.000 degrees
TANGIER, Morocco    BELGRADE              AZIMUTHS          N. MI.      KM
35.80 N    5.90 W - 44.90 N   20.50 E     57.41  254.73    1317.9   2440.5
XMTR   2.0 to 30.0  EXTERNAL   CONST 17dB          Azim=    .0  OFFaz= 57.4
RCVR   2.0 to 30.0  EXTERNAL   Std SWWhip          Azim=    .0  OFFaz= 57.4
POWER = 500.000 KW  3 MHz NOISE = -148.0 dBW   REQ.REL = 50%   REQ.SNR = 55.0
MULTIPATH POWER TOLERANCE = 10.0 dB   MULTIPATH DELAY TOLERANCE =   .850 ms

19.0 21.8  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0    .0 FREQ
      1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -     - MODE
     11.6 10.7  7.9  6.6  6.5  6.6  6.9  7.5 10.8 13.2    -     - ANGLE
      8.8  8.7  8.6  8.5  8.5  8.5  8.5  8.5  8.7  8.9    -     - DELAY
      388  366  298  268  265  268  274  289  368  429    -     - V HITE
      .50 1.00 1.00 1.00 1.00  .98  .96  .86  .52  .08    -     - F DAYS
      127  130  128  126  124  123  122  122  126  151    -     - LOSS
       68   53   57   62   66   68   68   69   68   42    -     - DBU
      -67  -71  -69  -66  -65  -65  -65  -65  -67  -94    -     - S DBW
     -176 -154 -156 -161 -165 -168 -170 -173 -176 -178    -     - N DBW
      109   84   88   95  100  104  105  108  110   85    -     - SNR
      -54  -29  -33  -40  -45  -49  -50  -53  -55  -30    -     - RPWRG
     1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00  .93    -     - REL
      .00 1.00 1.00 1.00  .00 1.00  .00  .00  .00  .00    -     - MPROB

20.0 21.3  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0    .0 FREQ
      1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -     - MODE
     11.9  7.2  6.7  6.5  6.6  6.9  7.2  7.9 13.4 13.4    -     - ANGLE
      8.8  8.5  8.5  8.5  8.5  8.5  8.5  8.6  8.9  8.9    -     - DELAY
      395  281  271  265  268  274  282  299  433  433    -     - V HITE
      .50 1.00 1.00 1.00  .99  .98  .95  .83  .45  .05    -     - F DAYS
      126  125  125  124  122  121  121  121  129  156    -     - LOSS
       68   58   61   65   67   69   69   70   62   37    -     - DBU
      -66  -66  -65  -64  -63  -63  -64  -64  -72  -99    -     - S DBW
     -176 -154 -156 -162 -166 -169 -171 -173 -176 -178    -     - N DBW
      110   88   91   98  103  106  107  109  104   80    -     - SNR
      -55  -33  -36  -43  -48  -51  -52  -54  -49  -25    -     - RPWRG
     1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00  .99  .89    -     - REL
      .00 1.00 1.00 1.00  .00  .99  .00  .00  .00  .00    -     - MPROB

21.0 20.3  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0    .0 FREQ
      1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -     - MODE
     13.7  6.9  6.7  6.8  7.0  7.3  7.8  8.7 13.7 13.7    -     - ANGLE
      8.9  8.5  8.5  8.5  8.5  8.5  8.5  8.6  8.9  8.9    -     - DELAY
      440  274  271  272  277  285  295  318  440  440    -     - V HITE
      .50 1.00 1.00 1.00  .99  .97  .92  .77  .31  .02    -     - F DAYS
      127  124  124  122  121  120  120  121  133  167    -     - LOSS
       64   60   62   66   69   69   70   70   58   26    -     - DBU
      -70  -64  -64  -62  -62  -63  -63  -64  -76 -110    -     - S DBW
     -175 -154 -157 -162 -166 -169 -171 -173 -176 -178    -     - N DBW
      105   90   93  100  105  106  108  110  100   69    -     - SNR
      -50  -35  -38  -45  -50  -51  -53  -55  -45  -14    -     - RPWRG
      .99 1.00 1.00 1.00 1.00 1.00 1.00 1.00  .99  .76    -     - REL
      .00 1.00 1.00  .00  .00  .00  .00  .00  .00  .00    -     - MPROB
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JUN     1992          SSN = 100.              Minimum Angle= 3.000 degrees
TANGIER, Morocco    BELGRADE              AZIMUTHS          N. MI.      KM
35.80 N    5.90 W - 44.90 N   20.50 E     57.41  254.73    1317.9   2440.5
XMTR   2.0 to 30.0  EXTERNAL   CONST 17dB          Azim=    .0  OFFaz= 57.4
RCVR   2.0 to 30.0  EXTERNAL   Std SWWhip          Azim=    .0  OFFaz= 57.4
POWER = 500.000 KW  3 MHz NOISE = -148.0 dBW   REQ.REL = 50%   REQ.SNR = 55.0
MULTIPATH POWER TOLERANCE = 10.0 dB   MULTIPATH DELAY TOLERANCE =   .850 ms

 22.0 19.3  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
       1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -    - MODE
      14.0  7.0  6.9  7.1  7.4  7.8  8.3  9.6 14.0 14.0    -    - ANGLE
       8.9  8.5  8.5  8.5  8.5  8.5  8.6  8.6  8.9  8.9    -    - DELAY
       448  276  276  279  287  296  308  339  448  448    -    - V HITE
       .50 1.00 1.00 1.00  .99  .96  .89  .69  .19  .01    -    - F DAYS
       127  123  123  120  119  119  120  121  139  180    -    - LOSS
        64   62   64   68   69   70   70   70   53   13    -    - DBU
       -70  -63  -62  -61  -61  -62  -63  -64  -82 -123    -    - S DBW
      -175 -154 -157 -163 -167 -170 -171 -173 -176 -178    -    - N DBW
       105   91   95  102  106  108  109  110   95   56    -    - SNR
       -50  -36  -40  -47  -51  -53  -54  -55  -40   -1    -    - RPWRG
       .99 1.00 1.00 1.00 1.00 1.00 1.00 1.00  .98  .51    -    - REL
       .00 1.00 1.00  .00 1.00  .00  .00  .00  .00  .00    -    - MPROB

 23.0 18.4  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
       1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -    - MODE
      14.2  7.2  7.2  7.4  7.8  8.2  8.9 10.8 14.2 14.2    -    - ANGLE
       8.9  8.5  8.5  8.5  8.5  8.6  8.6  8.7  8.9  8.9    -    - DELAY
       455  281  281  286  295  306  322  369  455  455    -    - V HITE
       .50 1.00 1.00 1.00  .98  .93  .83  .59  .09  .00    -    - F DAYS
       127  123  121  119  119  119  119  122  147  195    -    - LOSS
        63   62   65   69   69   70   70   69   45   -2    -    - DBU
       -70  -62  -61  -60  -61  -62  -62  -64  -90 -138    -    - S DBW
      -174 -154 -157 -163 -167 -170 -172 -174 -176 -178    -    - N DBW
       105   92   96  103  106  108  109  109   87   40    -    - SNR
       -50  -37  -41  -48  -51  -53  -54  -54  -32   15    -    - RPWRG
       .99 1.00 1.00 1.00 1.00 1.00 1.00 1.00  .94  .24    -    - REL
       .00 1.00 1.00  .00  .99  .00  .00  .00  .00  .00    -    - MPROB

 24.0 17.4  6.1  7.2  9.7 11.9 13.7 15.4 17.7 21.6 25.9   .0   .0 FREQ
       1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2  1F2    -    - MODE
      14.4  7.6  7.6  7.9  8.3  8.9  9.7 14.4 14.4 14.4    -    - ANGLE
       9.0  8.5  8.5  8.5  8.6  8.6  8.7  9.0  9.0  9.0    -    - DELAY
       459  290  291  297  308  322  342  459  459  459    -    - V HITE
       .50 1.00 1.00  .99  .97  .89  .76  .45  .03  .00    -    - F DAYS
       126  121  120  118  118  119  120  128  158  214    -    - LOSS
        63   63   66   69   69   70   69   62   33  -21    -    - DBU
       -69  -61  -60  -60  -61  -62  -63  -71 -101 -157    -    - S DBW
      -173 -154 -157 -163 -167 -170 -172 -174 -176 -178    -    - N DBW
       104   93   97  104  107  109  109  103   75   21    -    - SNR
       -49  -38  -42  -49  -52  -54  -54  -48  -20   34    -    - RPWRG
       .99 1.00 1.00 1.00 1.00 1.00 1.00  .99  .85  .05    -    - REL
       .00 1.00 1.00 1.00  .00  .00  .00  .00  .00  .00    -    - MPROB
*****END OF RUN*****     VOACAP 93.0125
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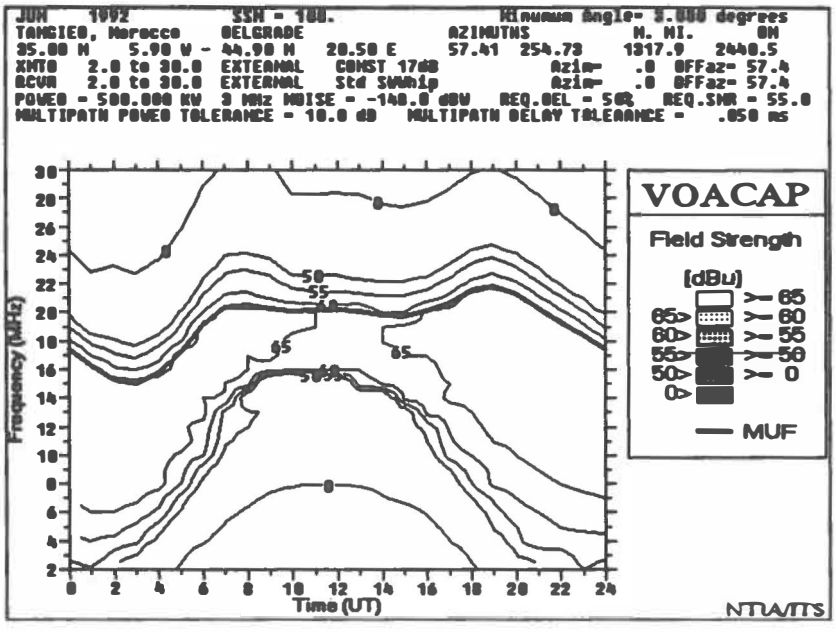
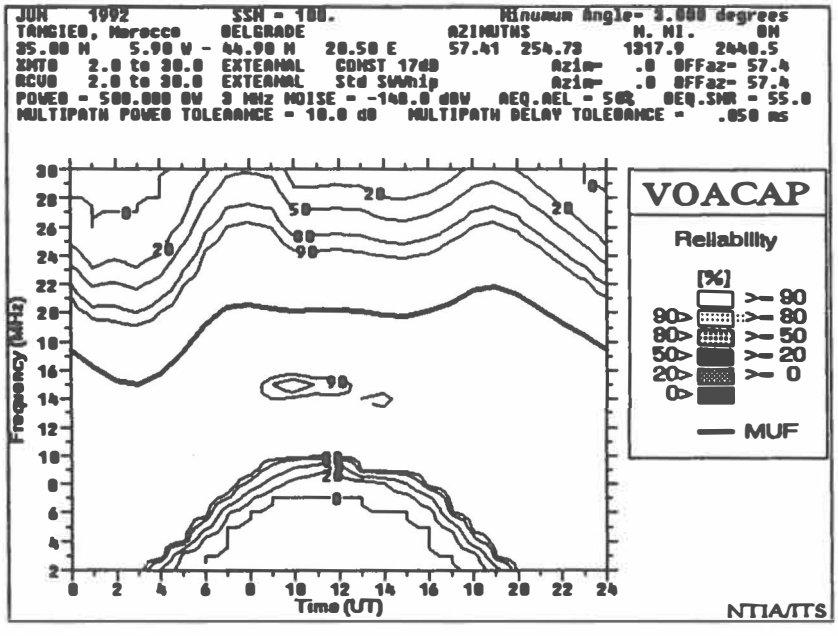
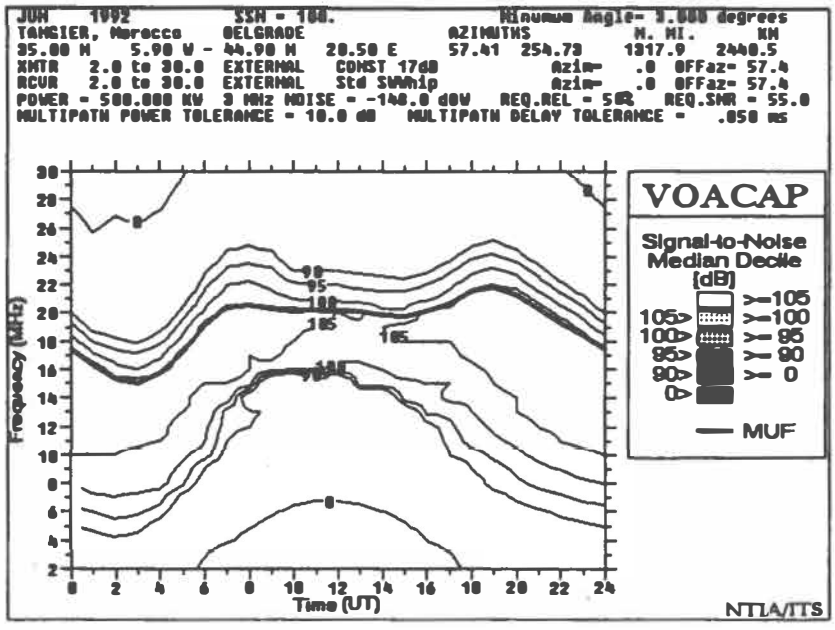

JUN 1992 SSN = 100. Minumum Angle= 3.000 degrees
TANGIER, Morocco BELGRADE AZIMUTHS N. MI. KM
35.00 N 5.90 W - 44.90 N 20.50 E 57.41 254.73 1317.9 2440.5
XMTR 2.0 to 30.0 EXTERNAL CONST 17dB Azim= .0 OFFaz= 57.4
RCVR 2.0 to 30.0 EXTERNAL Std SWWhip Azim= .0 OFFaz= 57.4
POWER = 500.000 KW 3 MHz NOISE = -140.0 dBW REQ.REL = 50% REQ.SNR = 55.0
MULTIPATH POWER TOLERANCE = 10.0 dB MULTIPATH DELAY TOLERANCE = .050 ms
VOACAP
Field Strength
[dBu]
>= 65
>= 60
>= 55
>= 50
>= 0
MUF
Frequency (MHz)
Time (UT)
NTIA/ITS


JUN 1992 SSN = 100. Minumum Angle= 3.000 degrees
TANGIER, Morocco BELGRADE AZIMUTHS N. MI. KM
35.00 N 5.90 W - 44.90 N 20.50 E 57.41 254.73 1317.9 2440.5
XMTR 2.0 to 30.0 EXTERNAL CONST 17dB Azim= .0 OFFaz= 57.4
RCVR 2.0 to 30.0 EXTERNAL Std SWWhip Azim= .0 OFFaz= 57.4
POWER = 500.000 KW 3 MHz NOISE = -140.0 dBW REQ.REL = 50% REQ.SNR = 55.0
MULTIPATH POWER TOLERANCE = 10.0 dB MULTIPATH DELAY TOLERANCE = .050 ms
VOACAP
Reliability
[%]
>= 90
>= 80
>= 50
>= 20
>= 0
MUF
Frequency (MHz)
Time (UT)
NTIA/ITS



NTIA/ITS Model = VOACAP Field Strength

JUN 1992 SSN = 100. Minimum Angle= 3.000 degrees
TANGIER, Morocco BELGRADE AZIMUTHS N. MI. KM
35.80 N 5.90 W - 44.90 N 20.50 E 57.41 254.73 1317.9 2440.5
XMTR 2.0 to 30.0 EXTERNAL CONST 17dB Azim= .0 OFFaz= 57.4
RCVR 2.0 to 30.0 EXTERNAL Std SWWhip Azim= .0 OFFaz= 57.4
POWER = 500.000 KW 3 MHz NOISE = -140.0 dBW REQ.REL = 50% REQ.SNR = 55.0
MULTIPATH POWER TOLERANCE = 10.0 dB MULTIPATH DELAY TOLERANCE = .050 ms

UT>	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400
MUF>	16.3	15.7	19.1	20.6	20.1	20.2	19.9	20.1	21.4	21.3	19.2	17.4
30.000	-60	-65	-12	10	-21	-19	-29	-27	-2	-6	-38	-62
29.000	-60	-63	-2	19	-9	-7	-17	-16	9	6	-26	-62
28.000	-56	-52	8	27	3	4	-4	-3	20	17	-13	-60
27.000	-46	-40	17	34	14	15	7	9	30	27	-1	-36
26.000	-33	-28	26	40	24	26	19	21	38	36	12	-23
25.000	-21	-16	34	46	34	34	29	31	44	44	23	-9
24.000	-9	-4	41	51	42	42	38	40	52	51	34	5
23.000	3	8	47	56	48	48	46	47	57	56	43	18
22.000	14	19	52	59	54	53	51	53	61	61	50	30
21.000	25	29	56	61	58	57	56	58	64	64	56	40
20.000	35	39	60	63	61	60	60	61	66	66	61	49
19.000	43	46	63	64	63	62	62	63	68	68	64	55
18.000	51	53	65	65	64	63	63	64	69	69	66	60
17.000	56	58	67	66	65	64	64	65	70	70	68	64
16.000	61	62	67	66	66	65	65	66	70	70	69	67
15.000	65	65	66	66	66	65	65	66	70	70	69	69
14.000	67	67	65	65	65	65	65	66	69	69	69	69
13.000	68	68	64	63	63	63	63	64	67	67	67	68
12.000	68	68	62	61	61	61	61	62	65	65	65	66
11.000	67	67	59	58	58	58	58	59	62	62	62	63
10.000	65	64	55	54	54	54	54	55	58	58	58	59
9.000	62	61	50	49	49	49	49	50	53	53	53	54
8.000	58	57	44	43	43	43	43	44	47	47	47	48
7.000	53	52	37	36	36	36	36	37	40	40	40	41
6.000	47	46	29	28	28	28	28	29	32	32	32	33
5.000	40	39	20	19	19	19	19	20	23	23	23	24
4.000	32	31	10	9	9	9	9	10	13	13	13	14
3.000	23	22	-1	-2	-2	-2	-2	-1	2	2	2	3
2.000	13	12	-13	-14	-14	-14	-14	-13	-10	-10	-10	-9

UT>	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400

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JUN 1992 SSN = 100.

TANGIER, Morocco	BELGRADE	AZIMUTHS	SP	N. MI.	KM
35.80 N 5.90 W	44.90 N 20.50 E	57.41	254.73	1318.1	2440.9

MIN ANG 3.0 DEG, PWR 500.0000 KW
TRANSMIT 2. to 30. CCIR.[3]=HR 4/4/.5 Azim= 57.4 OFFaz= .0
RECEIVE 2. to 30. CCIR.[0]=Isotropic Azim= .0 OFFaz= .0
NOISE CATEGORY 3 S/N 50% of Days @ 55 dB in 6000 Hz RX Bandwidth

UT	MUF											LUF	FOT	OPMUF
1	15.3	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	5.3	16.3	19.1
	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	15	4	4	6	9	11	15	16	17	18	0 ANGL			
	70	67	69	73	74	74	68	55	44	35	-999 DBU			
	70	57	60	67	71	73	68	56	46	38	-999 S/N			
	.87	.59	.72	.85	.91	.90	.84	.52	.21	.07	.00 FS/N			
2	14.4	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	4.1	15.3	17.9
	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	15	4	5	7	10	13	16	16	17	18	0 ANGL			
	70	68	70	73	74	72	60	51	41	32	-999 DBU			
	69	59	62	68	72	71	60	52	43	34	-999 S/N			
	.85	.68	.76	.87	.88	.88	.67	.36	.14	.01	.00 FS/N			
3	14.1	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	5.2	13.8	16.3
	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	15	4	5	7	10	14	15	16	17	18	0 ANGL			
	71	67	69	73	74	72	60	51	42	33	-999 DBU			
	70	61	63	69	72	71	60	52	43	35	-999 S/N			
	.86	.72	.79	.87	.88	.88	.67	.37	.15	.02	.00 FS/N			
4	15.0	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	5.4	14.7	17.3
	1F2	2E	2E	1F2	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	13	7	7	6	8	10	14	14	15	16	0 ANGL			
	72	62	61	71	73	74	67	56	47	39	-999 DBU			
	72	57	56	68	71	73	67	57	48	41	-999 S/N			
	.89	.59	.55	.85	.90	.90	.82	.58	.27	.09	.00 FS/N			
5	16.8	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	9.4	16.4	19.3
	1F2	2E	2E	1F2	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	10	7	7	10	10	10	10	10	10	10	0 ANGL			
	73	47	52	69	71	72	72	65	55	48	-999 DBU			
	73	43	48	66	69	71	72	66	56	50	-999 S/N			
	.90	.13	.23	.82	.87	.87	.89	.80	.54	.31	.00 FS/N			
6	18.8	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	11.6	18.4	21.6
	1F2	3F2	2E	2E	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	10	35	7	7	10	10	10	10	10	10	0 ANGL			
	72	31	39	50	68	69	70	72	59	51	-999 DBU			
	73	27	36	48	66	69	70	72	60	53	-999 S/N			
	.90	.01	.03	.19	.83	.87	.87	.89	.67	.43	.00 FS/N			

JUN 1992 SSN = 100.

TANGIER, Morocco	BELGRADE	AZIMUTHS	SP	N. MI.	KM
35.80 N 5.90 W	44.90 N 20.50 E	57.41	254.73	1318.1	2440.9

MIN ANG 3.0 DEG, PWR 500.0000 KW
TRANSMIT 2. to 30. CCIR.[3]=HR 4/4/.5 Azim= 57.4 OFFaz= .0
RECEIVE 2. to 30. CCIR.[0]=Isotropic Azim= .0 OFFaz= .0
NOISE CATEGORY 3 S/N 50% of Days @ 55 dB in 6000 Hz RX Bandwidth

UT	MUF											LUF	FOT	OPMUF
7	20.0	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0	FREQ	12.9	19.5	23.0
	1F2	3F2	3F2	2E	2E	1F2	1F2	1F2	1F2	1F2	0	MODE			
	10	36	36	7	7	10	10	10	10	10	0	ANGL			
	71	17	26	42	49	67	68	70	61	53	-999	DBU			
	72	14	24	40	47	66	68	71	63	55	-999	S/N			
	.88	.01	.01	.04	.17	.82	.87	.87	.73	.50	.00	FS/N			
8	20.1	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0	FREQ	13.4	19.7	23.1
	1F2	3F2	3F2	3F2	2E	1F2	1F2	1F2	1F2	1F2	0	MODE			
	11	37	37	37	7	11	11	11	11	11	0	ANGL			
	70	7	18	35	43	64	66	68	60	52	-999	DBU			
	71	4	16	34	42	64	66	69	62	54	-999	S/N			
	.87	.01	.01	.01	.06	.78	.83	.84	.71	.47	.00	FS/N			
9	19.8	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0	FREQ	13.3	19.3	22.7
	1F2	3F2	3F2	3F2	2E	1F2	1F2	1F2	1F2	1F2	0	MODE			
	12	38	38	38	7	12	12	12	12	12	0	ANGL			
	68	0	12	30	37	62	64	67	58	50	-999	DBU			
	69	-3	10	29	36	62	64	67	60	53	-999	S/N			
	.85	.01	.01	.01	.01	.73	.79	.82	.66	.39	.00	FS/N			
10	19.6	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0	FREQ	13.3	19.2	22.5
	1F2	3F2	3F2	3F2	2E	1F2	1F2	1F2	1F2	1F2	0	MODE			
	13	40	40	40	7	13	13	13	13	13	0	ANGL			
	67	-5	8	27	33	61	63	66	57	49	-999	DBU			
	68	-8	6	26	32	60	63	66	58	51	-999	S/N			
	.83	.01	.01	.01	.01	.68	.76	.80	.61	.35	.00	FS/N			
11	19.7	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0	FREQ	13.3	19.3	22.7
	1F2	3F2	3F2	3F2	2E	1F2	1F2	1F2	1F2	1F2	0	MODE			
	13	40	40	40	7	13	13	13	13	13	0	ANGL			
	66	-8	6	25	31	60	62	65	57	49	-999	DBU			
	67	-11	4	24	30	59	62	65	58	51	-999	S/N			
	.82	.01	.01	.01	.01	.65	.74	.78	.61	.35	.00	FS/N			
12	19.8	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0	FREQ	13.4	19.4	22.8
	1F2	3F2	3F2	3F2	2E	1F2	1F2	1F2	1F2	1F2	0	MODE			
	13	40	40	40	7	13	13	13	13	13	0	ANGL			
	66	-9	6	25	31	60	62	65	57	49	-999	DBU			
	67	-11	3	23	29	59	62	65	58	51	-999	S/N			
	.82	.01	.01	.01	.01	.63	.72	.78	.62	.35	.00	FS/N			

JUN 1992 SSN = 100.

TANGIER, Morocco	BELGRADE	AZIMUTHS	SP	N. MI.	KM
35.80 N 5.90 W	44.90 N 20.50 E	57.41	254.73	1318.1	2440.9

MIN ANG 3.0 DEG, PWR 500.0000 KW
TRANSMIT 2. to 30. CCIR.[3]=HR 4/4/.5 Azim= 57.4 OFFaz= .0
RECEIVE 2. to 30. CCIR.[0]=Isotropic Azim= .0 OFFaz= .0
NOISE CATEGORY 3 S/N 50% of Days @ 55 dB in 6000 Hz RX Bandwidth

UT	MUF											LUF	FOT	OPMUF
13	19.8	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	13.3	19.3	22.7
	1F2	3F2	3F2	3F2	2E	1F2	1F2	1F2	1F2	1F2	0 MODE			
	13	40	40	40	7	13	13	13	13	13	0 ANGL			
	67	-6	8	27	33	60	63	65	57	49	-999 DBU			
	67	-8	5	25	31	59	62	65	58	51	-999 S/N			
	.82	.01	.01	.01	.01	.64	.72	.78	.62	.35	.00 FS/N			
14	19.5	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	12.9	19.1	22.4
	1F2	3F2	3F2	3F2	2E	1F2	1F2	1F2	1F2	1F2	0 MODE			
	13	40	40	40	7	13	13	13	13	13	0 ANGL			
	67	0	12	30	36	62	64	66	57	49	-999 DBU			
	68	-3	9	27	33	59	62	66	58	51	-999 S/N			
	.82	.01	.01	.01	.01	.66	.74	.79	.60	.35	.00 FS/N			
15	19.4	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	12.6	18.9	22.3
	1F2	3F2	3F2	3F2	2E	1F2	1F2	1F2	1F2	1F2	0 MODE			
	13	39	39	39	7	13	13	13	13	13	0 ANGL			
	68	8	19	34	41	63	65	67	57	49	-999 DBU			
	68	4	15	30	37	60	63	67	58	52	-999 S/N			
	.83	.01	.01	.01	.02	.68	.76	.81	.61	.36	.00 FS/N			
16	19.7	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	12.2	19.2	22.6
	1F2	3F2	3F2	2E	2E	1F2	1F2	1F2	1F2	1F2	0 MODE			
	12	38	38	7	7	12	12	12	12	12	0 ANGL			
	69	17	27	40	47	65	67	68	59	51	-999 DBU			
	70	11	21	34	42	61	64	67	60	53	-999 S/N			
	.85	.01	.01	.01	.08	.71	.78	.82	.66	.41	.00 FS/N			
17	20.4	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	11.4	20.0	23.5
	1F2	3F2	2E	2E	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	11	37	7	7	11	11	11	11	11	11	0 ANGL			
	71	28	37	49	66	68	69	70	63	54	-999 DBU			
	72	21	29	41	60	63	66	69	64	56	-999 S/N			
	.88	.01	.01	.07	.69	.77	.82	.85	.76	.53	.00 FS/N			
18	21.2	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	10.6	20.7	24.4
	1F2	2E	2E	2E	2E	1F2	1F2	1F2	1F2	1F2	0 MODE			
	12	7	7	7	7	5	6	8	12	13	0 ANGL			
	72	43	49	58	57	69	70	72	66	54	-999 DBU			
	73	34	40	50	51	64	68	71	67	57	-999 S/N			
	.89	.02	.08	.27	.29	.79	.86	.88	.83	.56	.00 FS/N			

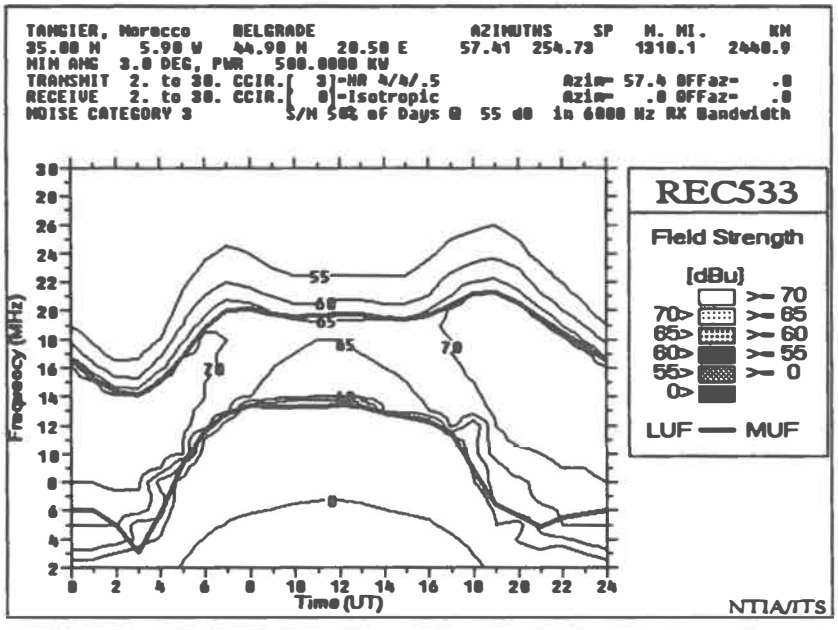
JUN 1992 SSN = 100.

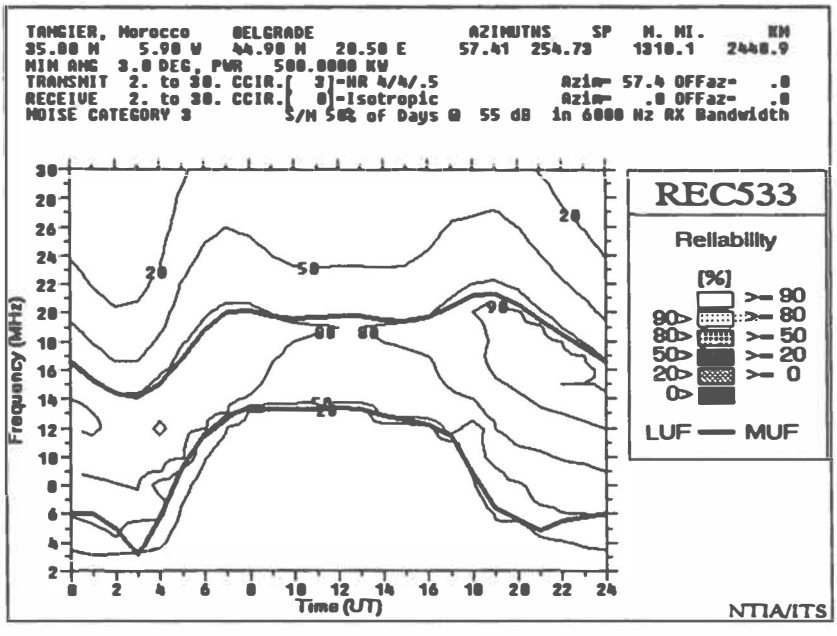
TANGIER, Morocco	BELGRADE	AZIMUTHS	SP	N. MI.	KM
35.80 N 5.90 W	44.90 N 20.50 E	57.41	254.73	1318.1	2440.9

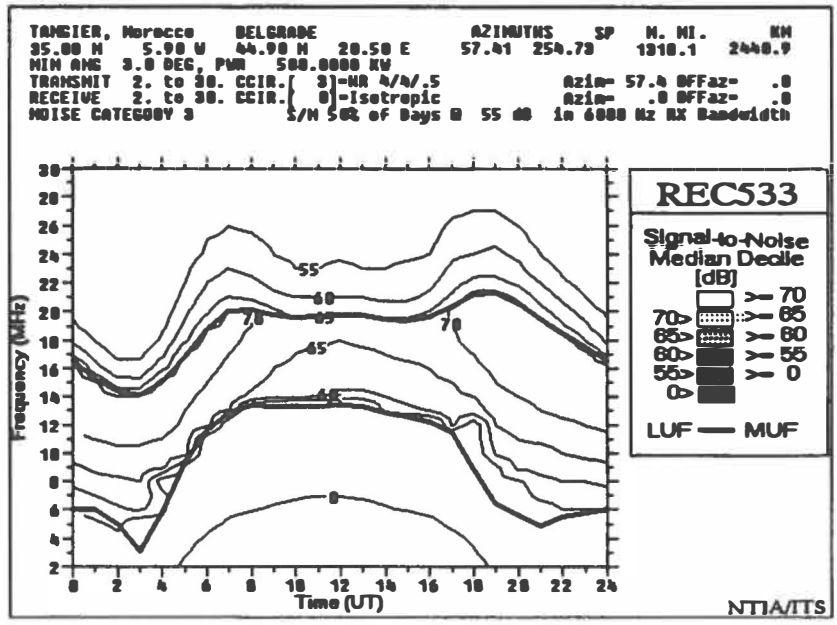
MIN ANG 3.0 DEG, PWR 500.0000 KW
TRANSMIT 2. to 30. CCIR.[3]=HR 4/4/.5 Azim= 57.4 OFFaz= .0
RECEIVE 2. to 30. CCIR.[0]=Isotropic Azim= .0 OFFaz= .0
NOISE CATEGORY 3 S/N 50% of Days @ 55 dB in 6000 Hz RX Bandwidth

UT	MUF											LUF	FOT	OPMUF
19	21.3	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	7.4	20.8	24.5
	1F2	2F2	2E	1F2	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	13	14	7	4	5	6	6	8	13	13	0 ANGL			
	72	61	63	67	70	71	73	74	67	55	-999 DBU			
	73	51	54	60	64	68	71	73	69	57	-999 S/N			
	.90	.33	.42	.69	.80	.86	.90	.90	.85	.58	.00 FS/N			
20	20.6	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	7.8	20.2	23.7
	1F2	2F2	2F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	13	15	16	4	5	6	7	9	13	14	0 ANGL			
	72	62	61	69	71	73	74	74	64	53	-999 DBU			
	73	52	51	62	66	70	72	74	65	55	-999 S/N			
	.91	.33	.32	.75	.84	.89	.92	.92	.79	.51	.00 FS/N			
21	19.5	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	6.8	20.7	24.4
	1F2	2F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	14	15	3	4	5	7	8	11	14	15	0 ANGL			
	72	63	67	70	72	73	74	74	59	50	-999 DBU			
	72	51	57	63	67	71	73	74	61	52	-999 S/N			
	.90	.30	.60	.77	.86	.90	.94	.92	.69	.36	.00 FS/N			
22	18.5	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	6.0	19.6	23.1
	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	14	3	4	5	6	8	9	13	15	16	0 ANGL			
	71	66	68	71	73	74	74	73	55	46	-999 DBU			
	72	55	58	64	69	72	73	73	57	48	-999 S/N			
	.89	.50	.62	.79	.88	.92	.91	.91	.57	.27	.00 FS/N			
23	17.5	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	6.0	18.6	21.9
	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	15	3	4	5	7	9	10	15	16	16	0 ANGL			
	70	66	68	71	73	74	74	67	52	43	-999 DBU			
	71	55	58	65	70	72	73	67	53	45	-999 S/N			
	.88	.51	.66	.81	.89	.92	.91	.83	.43	.19	.00 FS/N			
24	16.5	6.1	7.2	9.7	11.9	13.7	15.4	17.7	21.6	25.9	.0 FREQ	5.9	17.5	20.6
	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	1F2	0 MODE			
	15	4	4	6	8	10	12	15	16	17	0 ANGL			
	70	67	68	72	74	74	73	60	48	39	-999 DBU			
	70	56	59	66	71	73	73	61	50	42	-999 S/N			
	.88	.53	.67	.83	.90	.90	.90	.69	.30	.12	.00 FS/N			

End-of-Run


TANGIER, Morocco BELGRADE AZIMUTHS SP M. MI. KM
35.80 N 5.90 W 44.90 N 20.50 E 57.41 254.73 1310.1 2448.9
MIN ANG 3.0 DEG, PWR 500.0000 KW
TRANSMIT 2. to 30. CCIR.[3]-HR 4/4/.5 Azim= 57.4 OFFaz= .0
RECEIVE 2. to 30. CCIR.[0]-Isotropic Azim= .0 OFFaz= .0
NOISE CATEGORY 3 S/N 50% of Days @ 55 dB in 6000 Hz RX Bandwidth
REC533
Field Strength
[dBu]
70> >= 70
65> >= 65
60> >= 60
55> >= 55
0> < 0
LUF — MUF
Frequency (MHz)
Time (UT)
NTIA/ITS


TANGIER, Morocco BELGRADE AZIMUTHS SP M. MI. KM
35.80 N 5.90 W 44.90 N 20.50 E 57.41 254.73 1310.1 2448.9
MIN ANG 3.0 DEG, PWR 500.0000 KW
TRANSMIT 2. to 30. CCIR.[3]-HR 4/4/.5 Azim= 57.4 OFFaz= .0
RECEIVE 2. to 30. CCIR.[0]-Isotropic Azim= .0 OFFaz= .0
NOISE CATEGORY 3 S/N 50% of Days @ 55 dB in 6000 Hz RX Bandwidth
REC533
Reliability
[%]
90> >= 90
80> >= 80
50> >= 20
20> < 20
0>
LUF — MUF
Frequency (MHz)
Time (UT)
NTIA/ITS



NTIA/ITS Model = REC533 Field Strength

TANGIER, Morocco BELGRADE AZIMUTHS SP N. MI. KM
35.80 N 5.90 W 44.90 N 20.50 E 57.41 254.73 1318.1 2440.9
MIN ANG 3.0 DEG, PWR 500.0000 KW
TRANSMIT 2. to 30. CCIR.[3]=HR 4/4/.5 Azim= 57.4 OFFaz= .0
RECEIVE 2. to 30. CCIR.[0]=Isotropic Azim= .0 OFFaz= .0
NOISE CATEGORY 3 S/N 50% of Days @ 55 dB in 6000 Hz RX Bandwidth

UT>	2oo	4oo	6oo	8oo	10oo	12oo	14oo	16oo	18oo	20oo	22oo	24oo
OPMUF>	17.9	17.3	21.6	23.1	22.5	22.0	22.4	22.6	24.4	23.7	23.1	20.6
MUF>	14.4	15.0	10.8	20.1	19.6	19.8	19.5	19.7	21.2	20.6	18.6	16.6
FOT>	15.3	14.7	10.4	19.7	19.2	19.4	19.1	19.2	20.7	20.2	19.6	17.6
LUF>	6.0	5.8	11.6	13.4	13.3	13.4	12.9	12.2	8.8	6.6	6.5	6.0
30.000	24	32	46	47	44	44	44	46	48	46	39	32
29.000	26	33	47	48	46	46	45	47	49	48	41	34
28.000	28	35	49	49	47	47	46	48	51	49	43	36
27.000	30	37	50	51	48	48	48	49	52	51	44	37
26.000	32	38	51	52	49	49	49	51	54	53	46	39
25.000	34	40	53	54	50	50	50	52	56	55	48	41
24.000	36	42	54	55	52	52	52	54	58	57	50	43
23.000	38	44	56	57	54	54	54	56	61	60	52	46
22.000	40	46	58	59	56	56	56	58	66	63	55	47
21.000	42	48	60	62	58	59	58	60	72	67	57	50
20.000	46	50	63	65	62	63	62	65	72	73	60	52
19.000	48	53	66	69	67	66	67	69	72	74	66	55
18.000	50	56	72	68	66	66	66	69	72	74	72	59
17.000	63	69	71	68	65	64	66	68	72	74	74	63
16.000	67	63	71	67	64	63	66	67	71	74	74	71
15.000	62	72	70	66	63	62	63	67	70	73	74	73
14.000	71	74	70	65	61	60	62	66	69	73	74	74
13.000	73	74	69	45	38	36	61	65	68	72	73	74
12.000	74	74	68	43	34	32	37	47	66	71	73	74
11.000	74	73	64	40	30	28	33	44	68	71	72	73
10.000	73	72	61	36	29	27	31	42	68	69	71	72
9.000	72	70	48	31	23	21	26	37	67	69	70	71
8.000	71	67	43	25	16	14	20	32	65	63	69	70
7.000	69	62	38	16	6	3	11	26	48	61	67	68
6.000	67	62	30	6	-6	-10	-1	16	42	62	66	66
5.000	66	58	20	-23	-67	-73	-39	-10	34	63	65	65
4.000	63	54	-4	-73	-123	-136	-106	-46	23	56	59	63
3.000	56	48	-32	-124	-191	-207	-167	-87	6	52	51	59
2.000	44	41	-73	-198	-286	-293	-266	-147	-21	48	47	50
UT>	2oo	4oo	6oo	8oo	10oo	12oo	14oo	16oo	18oo	20oo	22oo	24oo

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15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

A user's guide and programmer's reference manual is presented to facilitate the use of two high frequency circuit analysis software systems called VOACAP and REC533. The guide shows how to execute the software on laptop computers and personal computers to make point-to-point predictions used to coordinate frequency assignments for broadcast planning. The guide shows how the software can be executed interactively for single circuits from menu-driven software, and for a collection of circuits in batch mode.

16. Key Words *(Alphabetical order, separated by semicolons)*

documentation; frequency assignments; high frequency; installation; propagation models; user's guide

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