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ANTENNA PATTERN DISTORTION COMPUTER PROGRAM, (U)
JAN 77 J PERINI, K HIRASAWA

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Phase Report
January 1977

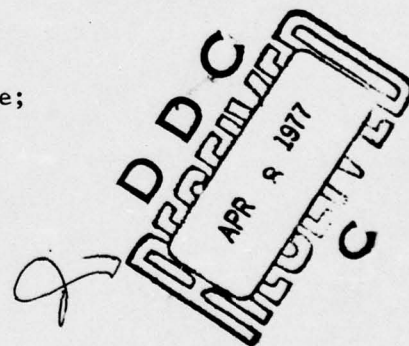
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ANTENNA PATTERN DISTORTION COMPUTER PROGRAM

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APPROVED:

Jacob Scherer
JACOB SCHERER
Project Engineer

APPROVED:

Joseph J. Naresky

JOSEPH J. NARESKY
Chief, Reliability and Compatibility Division

FOR THE COMMANDER:

John P. Huss

JOHN P. HUSS
Acting Chief, Plans Office

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Antenna Pattern Distortion Computer Program is a user oriented code that allows the engineer designing a communication antenna farm to easily enter the antennas involved by simply calling their AF number (AT1181, AT1097, AT197, and a lightning rod LR1000) and specifying their location on an arbitrary reference plane. This reformer plane may be specified as a perfectly conducting infinite ground plane if desired. The program output may be any specified horizontal or vertical pattern. It can also calculate the mutual coupling between any two		

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antennas. If the information provided by the AFCS SCREEN is available, the program can provide plots of the communication range of station when the antenna pattern, antenna power, terrain topography, and receiver sensitivity are specified for any specified aircraft altitude.

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PREFACE

This effort was conducted by Syracuse University under the sponsorship of the Rome Air Development Center Post-Doctoral Program for Air Force Communications Service (AFCS). Mr. Robert Feik and Mr. Y.S. Fu were the AFCS focal points and provided overall technical direction and guidance. The author of this report is Dr. Jose Perini, and the co-author is Dr. Kazuhiro Hirasawa.

The RADC Post-Doctoral Program is a cooperative venture between RADC and some sixty-five universities eligible to participate in the program. Syracuse University (Department of Electrical and Computer Engineering), Purdue University (School of Electrical Engineering), Georgia Institute of Technology (School of Electrical Engineering), and State University of New York at Buffalo (Department of Electrical Engineering) act as prime contractor schools with other schools participating via sub-contracts with the prime schools. The U.S. Air Force Academy (Department of Electrical Engineering), Air Force Institute of Technology (Department of Electrical Engineering), and the Naval Post Graduate School (Department of Electrical Engineering) also participate in the program.

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Further information about the RADC Post-Doctoral Program can be obtained from Jacob Scherer, RADC/RBC, Griffiss AFB, NY, 13441, telephone AV 587-2543, COMM (315) 330-2543.

The author, Dr. Jose Perini, received his B.S. degree from Escola Politécnica de São Paulo, S.P., Brazil (1952) and his Ph.D. degree from Syracuse University (1961). He joined the faculty of Syracuse University in 1962 as Assistant Professor of Electrical Engineering, advanced to Associate Professor in 1966, and to Professor in 1971. Prior to his affiliation with Syracuse University, Dr. Perini served as Assistant Professor of Electrical Engineering at Escola Politécnica de São Paulo and as Manager of the Radio Maintenance Department of Real Transportes Aereos in São Paulo. He is a consultant to the General Electric Company and Data Functions Corporation. Dr. Perini teaches graduate courses and supervises graduate student research for M.S. and Ph.D. degrees and was Director of the Syracuse University Graduate Center at Poughkeepsie from 1966 to 1968. His publications cover topics in television antennas,

fields and propagation, and signal-processing aspects of electromagnetic compatibility. He holds two antenna patents and is a member of the Institute of Electrical and Electronics Engineers.

Dr. Kazuhiro Hirasawa, the co-author, was born in Tochigi, Japan, on December 5, 1941. He received the B.S. and M.S. degrees in Electrical Engineering from Keio University, Tokyo, Japan in 1964 and 1966 respectively and the Ph.D. degree in Electrical Engineering from Syracuse University in 1971. At present he is a research Engineer in the Department of Electrical and Computer Engineering, Syracuse University.

The author wishes to acknowledge: the contributions of Dr. W.W. Everett of the RADC Post-Doctoral Program for effort during the course of the work, and in drafting the final report; the contributions of Mr. Robert Feik and Mr. Y.S Fu throughout the entire effort; Mr. Dave Pierce and Mr. Sam Zaccari for management support; Mrs. Colleen Hart, Ms. Lyn Swingle, and Mrs. Ann Buckley for administrative support and final draft preparation.

TABLE OF CONTENTS

	<u>Page</u>
ANTENNA PATTERN DISTORTION COMPUTER PROGRAM	
1. Introduction -----	1
2. Physical Layout of the Antenna Farm ---	1
3. Description of the Computer Program ---	2
4. Examples of Program Use -----	7
4.1 Example 1 -----	9
4.2 Example 2 -----	19
4.3 Example 3 -----	25
4.4 Example 4 -----	30
5. Program Limitations -----	36
Appendix A - Computer Programs Listings	

LIST OF FIGURES

	<u>Page</u>
Figure 1 Geometry and Parameters of the Simplified Program ----	38
Figure 2 Geometry and Parameters of the General Program -----	39

ANTENNA PATTERN DISTORTION COMPUTER PROGRAM

1. Introduction

Presently, when a new communication facility is designed, there is no simple way that the project engineer can predict the interaction between the many antennas that will be present in the facility. The available rules of thumb are too crude and do not really give any detailed information of the antenna pattern distortion or mutual coupling effects. Recent developments in the area of computer aided design of antennas allowed the development of a user oriented computer program that can perform an accurate analysis of existing or future antenna installations with far more detail than has been possible. The description and usage of this program is the subject of this report.

2. Physical Layout of the Antenna Farm

A system of rectangular coordinates x, y, z will be used for specifying the position of the antennas in the installation as shown in Figures 1 and 2. The vertical axis is always z and the x, y axes define a reference plane which must coincide with the installation ground plane if there is one. In this case the z_i are the heights of the base of each antenna above the ground plane. In cases where no ground plane is used, the axis x, y define an arbitrary reference plane and the z_i are the heights of the base of each antenna above this plane. When we refer to a ground plane here, we mean a metallic structure, either solid or in the form of a wire mesh of sufficiently small openings to act as a ground plane. The earth below the antenna installation is ignored by the program because usually the antennas are high

enough above the terrain. In order to control the patterns of the antennas on the installation, it is advisable to always use a ground plane extending at least four to five feet beyond the outermost antennas.

As will be described in detail later, the program has two versions:

- (1) a simplified one where only the antenna types have to be specified and
- (2) a general one where the actual dimensions of each antenna have to be specified.

Figure 1 shows the input variables for the simplified program. As can be seen, only the type (AT 1181, AT 1097, AT 197, or LR 1000 - lightning rod) and the x_i , y_i , z_i coordinates specifying the antenna positions are required.

Figure 2 shows the input variables for the general program. Besides the position x_i , y_i , z_i of each antenna, we also have to specify the antenna lengths h_i , the radii r_i , the positions of any loads ℓ_i if they exist, the loads Z_i , as well as the feed positions f_i .

In the simplified program only one antenna can be fed at a time and no loads are allowed in the other antennas which are assumed terminated by their nominal input impedances. In the general program, all antennas may be fed and can also carry one load each. This will allow the solution of more general problems such as antenna arrays or special types of antennas not included in the simplified program catalog.

3. Description of the Computer Program

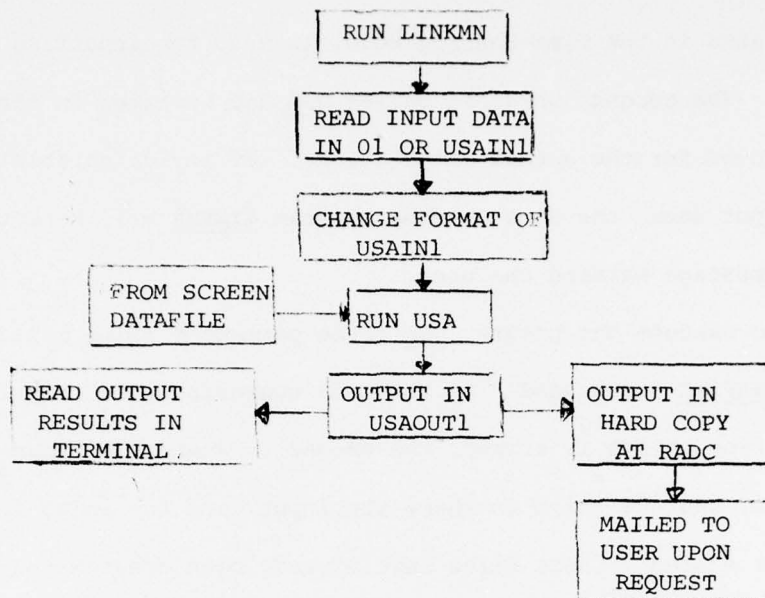
This program was designed to be used with the Honeywell 635 computer, based at RADDC, via remote terminal. It was written in FORTRAN IV language and therefore can be easily adapted to many other computers.

The program is executed in two phases. The first, which is called LINKMN and operates in the Time-Sharing Mode, is used for inputting all the pertinent data. The second, which is called USA and operates in the Remote Batch Mode, is used for the actual computations. If any detectable errors occur in the input data, the Time-Sharing Program LINKMN will detect them and print an error message warning the user.

In order to execute the program USA three permanent files called USAIN1, USAOUT1, and DATAFILE are needed. As the name suggests, the first is where the input data from LINKMN is stored, the second is where the program will write its output, and the third is where the input data for communication range contour is stored. These files have already been created and are part of the RADC program package. Presently, USAIN1 and USAOUT1 are 4 and 8 blocks^{*} long respectively, and DATAFILE is a random file (20 blocks long). This has shown to be large enough for the cases treated in this report. If more runs are needed, the size of the files may have to be increased.

After the input data is read in USAIN1 by LINKMN, the data is changed into the proper format and stored again in USAIN1. After the program USA is executed, the results will be in USAOUT1 and have to be read in the terminal. Examples of these manipulations are given in the next sections. If the communications contour is to be computed the appropriate topographic data has to be in DATAFILE by running the SCREEN program. The following block diagram summarizes the above discussion:

* One block is equal to 320 thirty two bit words.



If an unusually large problem is being run where, for example, a lot of mutual coupling coefficients are printed, the data may exceed the capacity of USAOUT1. In this case a message will be printed out and part of the output will be lost, and the size of the file USAOUT1 has to be increased.

As mentioned earlier, the input program LINKMN has been written with two options. The first, called the "SIMPLE PROGRAM", does not require any knowledge whatsoever of the limitations of the numerical technique used. The terminal requests very simple and straightforward questions and no decisions have to be made by the user. Presently, three types of commonly used AF antennas and lightning rods are allowed as input: the VHF AT 1181, the UHF AT 1097, the UHF AT 197, and the LR 1000 (a designation reserved by us to a lightning rod). In this option only the antenna whose pattern is being

computed can be fed. The second option, called the "GENERAL PROGRAM", allows the treatment of any vertical cylindrical antenna with a maximum radius of 0.1 having, at most, one feed point and one load per antenna. This option cannot compute communication contours.

If desired, the mutual coupling coefficients among the various antennas can be computed and printed out in dB when using the SIMPLE PROGRAM.

The program will also compute vertical (constant ϕ) and horizontal (constant θ) patterns. The increments $\Delta\theta$ and $\Delta\phi$ can be specified by the user. The conventional horizontal pattern is therefore computed for $\theta = 90^\circ$, the horizontal plane, but if desired, any polar angle θ can be specified. When patterns are computed, the output will be in normalized magnitude expressed in ratio (NMAG) and in dB (NMAGDB). The value of the field used for the normalization is printed out under EMAX and the gain of the antenna in the direction of EMAX (over the isotropic source) is also printed out as a ratio (GAIN) and in dB (GAINDB).

The program will also compute communication range contours for specified signal levels for up to six different airplane heights. The ranges are expressed in nautical miles.

After all the input data is fed to LINKMN, it prints out all the data as read by the computer for cross reference purposes and then gives the size of the arrays and the amount of core needed to run USA. These last two pieces of information have to be fed into USA prior to running as shown in the examples of the next sections. The purpose of this procedure is to use as

little core as possible in order to decrease the turn-around-time. If the required core exceeds 60K, a special statement is used to advise the operator and thus facilitate the execution.

In the next section we present some examples of use of this program with detailed explanations of all procedures.

NOTE: When this program is first installed in a new computer, the program LINKMN has to be run in a special way to create the necessary files for its normal execution in all other runs. LINKMN has been partitioned into four programs: LINKMN, LINKM1, LINKM2, and LINKM3 which perform different functions, and are loaded only when needed.

The following commands should be used:

```
SYSTEM ?FORT
OLD OR NEW-NEW
READY
*RUN LINKM1=;L1(NOGO)  (+)
*RUN LINKM2=;L2(NOGO)
*RUN LINKM3=;L3(NOGO)
*RUN LINKMN=;LM(NOGO)
*RUNL LM=HS;LINK(LINK1)L1;LINK(LINK2,LINK1)L@;LINK(LINK#,LINK2)L3
```

The first four RUN commands automatically create the necessary permanent files L1, L2, L3, and LM, and store the respective programs there. These four files require a total of 26 blocks of file space. The last RUNL command creates the necessary temporary file HS automatically. If desired, a permanent random file HS (43 blocks in size) can be created before the RUNL command, and the whole program stored permanently in object form for future runs.

After these steps type

```
RUN HS #USAIN1 "01"
```

Then program will start asking questions.

The random file named DATAFILE has to be created and all the necessary "Line of Sight Coverage" data has to be stored there before the program USA is run in the CARDIN system. The name DATAFILE can be changed to any name desired by modifying statement 5025 in the program USA to 5025\$:PRMFL: 03,R/W,R,BLA00001/XXX... where XXX... is the new name (maximum of eight characters). This modification should be done when lines 50, 500, 5000 are modified. See Example 4, note number 8.

4. Examples of Program Use

In the listings that follow, CR means a carriage return entered by the user. Numbers on the left-hand side margin are references to explanations that follow the run. All user responses are underlined.

The answers to the terminal questions are either numbers or words such as YES, NO, INCHES, METERS, etc. Whenever this last type of answer is requested, the user can type the whole word or just the first letter. In any event the computer recognizes only the first letter. Therefore, Y, YES, YNO are all interpreted as YES since the first letter is a Y. No blanks are allowed before the word. For example _YES (where _ is a blank) will be detected as an error and the question will be repeated again after the message: ".....INPUT ERROR, TRY AGAIN....." is typed in the terminal.

(+) For more details see Honeywell Series 600/6000, FORTRAN, Manual number BJ67, p. 3 - 22.

The computer does not take any answer until a carriage return (CR) is entered. Therefore, if an input error is detected before the CR, two procedures can be used to correct it [1]:

- (a) If the whole line is to be deleted, press simultaneously the CTRL and X keys. The computer will print DEL indicating that the whole entry has been deleted and skips to the next line waiting for the line to be re-entered.

EX:

ANTENNA POSITION X Y Z

= 100,10,0 CR

- (b) If only a few characters have to be corrected, press SHIFT and @ as many times as there are characters to be corrected.

EX:

ABD@CD is read as ABCD

AB_C@@CD is read as ABCD

N@Y is read as Y

[1] For more detailed information, see GE-600 Line GECOS III Time-Sharing FØRTRAN, manual #CPB - 1566A, Now Honeywell BR 70.

4.1 EXAMPLE 1 - In this example many errors were introduced on purpose to exercise as much as possible the error detection capability of the program.

```
CR
0110301

RADCR R&D TSS GCOS-GU3 07/16/76 AT 9.893 CHANNEL 3030

LOGON ID-BLA00001;956700160409
1 PASSWORD--
  XXXXXXXXXXXX

2 SYSTEM ?FORT
3 OLD OR NEW-NEW
  READY
4 *RUN HS #USAIN1 "01"
  ***** ENTER ANTENNA PARAMETERS *****

5 DIMENSIONS IN METERS OR INCHES ?
  =N
6 ..... INPUT ERROR, TRY AGAIN .....
7 DIMENSIONS IN METERS OR INCHES ?
8 = M
  ..... INPUT ERROR, TRY AGAIN .....
  DIMENSIONS, IN METERS OR INCHES ?
9 =M
  GROUND PLANE ?
  =YES
10 SIMPLE PROG ?
  =Y
  COUPLING COEFFICIENTS ?
  =NO
  NUMBER OF ANTENNAS
  =4
  **** ANTENNA NUMBER 1 ****
  ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
11 =1197
  ..... INPUT ERROR, TRY AGAIN .....
  ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
12 =1097
  ANTENNA POSITION X,Y,Z ON THE PLATFORM
13 =1., DEL
  0.,0.,0.
  **** ANTENNA NUMBER 2 ****
  ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
14 =1182
  ..... INPUT ERROR, TRY AGAIN .....
  ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
15 =118301
  ANTENNA POSITION X,Y,Z ON THE PLATFORM
  =0.,1.,0.
```

```

**** ANTENNA NUMBER 3 ****
ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1000
LENGTH
=2.
DIAMETER
=.009
ANTENNA POSITION X,Y,Z ON THE PLATFORM
=1.,0.,0.
**** ANTENNA NUMBER 4 ****
ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=197
ANTENNA POSITION X,Y,Z ON THE PLATFORM
=-1.,0.,0.
+++ RADIATION PATTERN +++
VERTICAL PATTERN ?
=NO
HORIZONTAL PATTERN ?
=NO
COMMUNICATION RANGE CONTOUR ?
=NO
..... INPUT ERROR, TRY AGAIN .....
16 VERTICAL PATTERN ?
=NO
HORIZONTAL PATTERN ?
=YES
THETA (DEGREES)
=90
17 90
-
FILE CODE 41 ILLEGAL CHAR; CORRECTION =0
18 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=0
..... INPUT ERROR, TRY AGAIN .....
PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.
COMMUNICATION RANGE CONTOUR ?
=NO

NUMBER OF RUNS
=1
**** RUN # 1 ****
FREQUENCY (MHZ)
=127
FED ANTENNA (#)
19 =5
..... INPUT ERROR, TRY AGAIN .....
FED ANTENNA (#)
20 =1
..... INPUT ERROR, TRY AGAIN .....
FREQUENCY (MHZ)
=127
FED ANTENNA (#)
21 =3
..... INPUT ERROR, TRY AGAIN .....
FED ANTENNA (#)
=2

```

22 DIM= M GP= Y SIMP= Y COUPL= N NR= 4
 ANT# = 1 2 3 4
 TYPE = 1097 1181 1000 197
 X = 0. 0. 1.000 -1.000
 Y = 0. 1.000 0. 0.
 Z = 0. 0. 0. 0.
 L = 0. 0. 2.000 0.
 D = 0. 0. 0.009 0.
 VER PAT= N
 HOR PAT= Y
 THETA= 90.0 PLOT INC= 10.00
 COM RNG= N

RUN# FREQ(MHZ) ANT FED(#)
 1 127.00 2

23 +++ 62 X 62 IS THE MIN DIM FOR C1, C2 +++
 +++ 27 K IS THE MIN MEMORY NEEDED +++

24 *REMOVE 01
*OLD USAIN1
 25 READY
*ASCB CD *;USAIN1
 26 LABELS?
 TAB CHARACTERS AND SETTING?
 27 *SYST CARD
OLD OR NEW-OLD USA
 READY
 28 *50 CR
*500: DIMENSION C1(62,62),C2(62,62)
 29 *5000\$:LIMITS
*5000\$:LIMITS:15,27K
 30 *LISTS 50,500,5000

500: DIMENSION C1(62,62),C2(62,62)
 5000\$:LIMITS:15,27K

READY

31 *RUN
 32 SNUB # 6818T
 CARD FORMAT,DISPOSITION ?
 33 NORM
 34 *JSTS 6818T
 6818T-01 TOO BIG
 35 *BYE
 36 **CCST: \$ 1.66 TO DATE: \$ 377.50= 8%
**ON AT 9.892 - OFF AT 10.102 ON 07/16/76

37 *BCDASC USAOUT1;*

38 LINE NUMBERS?

TAB CHARACTERS AND SETTING?

39 *LIST

40 *** ANT# (FED)= 2 FREQ (MHZ)= 127.00 ***

HORIZONTAL PATTERN

THETA= 90.0

EMAX= 0.274 GAIN= 2.891 GAIN(DB)= 4.61

PHI	NMAG	NMAG(DB)
0.	0.8460	-1.45
10.	0.7352	-2.67
20.	0.6124	-4.26
30.	0.4981	-6.05
40.	0.4141	-7.66
50.	0.3737	-8.55
60.	0.3696	-8.65
70.	0.3807	-8.39
80.	0.3899	-8.18
90.	0.3927	-8.12
100.	0.3965	-8.03
110.	0.4127	-7.69
120.	0.4451	-7.03
130.	0.4893	-6.21
140.	0.5424	-5.31
150.	0.6084	-4.32
160.	0.6903	-3.22
170.	0.7807	-2.15
180.	0.8627	-1.28
190.	0.9184	-0.74
200.	0.9368	-0.57
210.	0.9172	-0.75
220.	0.8674	-1.24
230.	0.8012	-1.93
240.	0.7347	-2.68
250.	0.6839	-3.30
260.	0.6616	-3.59
270.	0.6749	-3.41
280.	0.7224	-2.82
290.	0.7933	-2.01
300.	0.8712	-1.20
310.	0.9391	-0.55
320.	0.9844	-0.14
330.	1.0000	0.
340.	0.9825	-0.15
350.	0.9307	-0.62
360.	0.8460	-1.45

READY

41 *BYE

**COST: \$ 0.47 TO DATE: \$ 390.39= 8%

**ON AT 14.370 - OFF AT 14.440 ON 07/16/76

Explanation of Example 1

1. Sign on procedure - the user enters the USER ID and PASSWORD (masked on purpose). After any entry, always enter a CR to indicate that the input is completed.
2. Request the system TFORT.
3. Call NEW since the program is in objet form in HS.
4. Request that the program HS be RUN and the output be stored in the file 01 which is the alternate name of the file USAIN1, since only numbers can be used as a file name in the system FORT. HS then starts asking questions from the user.
5. The answer to "DIMENSIONS IN METERS OR INCHES" has to be any of the following: M, METERS, I, INCHES. In this case, N was inadvertently entered.
6. The program does not recognize the answer and requests that the information be entered again.
7. Note that the computer repeats the question.
8. Again, inadvertently, a blank was entered before M and the computer rejects the input again.
9. Finally, the correct input is entered.
10. Note that YES and Y are acceptable answers.
11. A mistake in the antenna type is made.
12. The correct answer is entered.
13. In this case the user detected an error (1., instead of zero was

entered) and the input was cancelled by depressing simultaneously the keys CTRL and X. The computer prints DEL indicating that the information was deleted, skips to the next line and waits for the line to be typed over.

14. Again an input error is detected by the computer.
15. This is an example of how to correct only a few characters. The @ erased the 3 which was replaced by the 1 entered after.
16. This message is issued because this run has no output since NO COUPLING COEFFICIENTS were requested at the beginning and NO VERTICAL, HORIZONTAL PATTERNS or COMMUNICATION RANGE CONTOUR were requested now. At least one of these three answers has to be YES. Note that the computer asks the questions again.
17. A common mistake is to type the letter "O" instead of zero (Ø). The computer detected that 90 was entered instead of 9Ø.
18. The plotting increment has to be non-zero number; thus, the next two error messages.
19. The antenna specified does not exist since we have only four antennas.
20. Antenna 1 is UHF and the frequency specified is VHF, so the question FREQUENCY and FED ANTENNA are repeated.
21. Antenna 3 is a lightning rod and there is no feed.
22. This is a printout of what was just read in the computer for the user's verification. Take a moment to double check this, otherwise the whole run may be wasted. Note that the type of ANTENNA NUMBER 2 has been

corrected to 1181. DIM = M means dimensions in meters. The other answers are self explanatory.

23. This is needed information to run USA so that the minimum array sizes (62 x 62) and the minimum memory requirements (27K) are used.
24. This statement is to remove the file 01 from AFT so that access to USAIN1 can be regained.
25. These statements are used to change the data in USAIN1 from ASCII to BCD for use by USA.
26. Note the CR entered as answers to the next two questions, since no labels or tab settings are required.
27. As USA is in the Remote Batch Mode (called CARDIN) the CARDIN system is requested, followed by a call of the OLD USA program.
28. Statements 50, 500, and 5000 are modified to the present size as indicated in 23 above. The explanation of each statement is as follows [2]:

- (a) Statement 50 is used to warn the operator that a large program is coming. This should be used whenever the run size is greater than 60K. The format is the following:

Less than 60K

50CR

More than 60K

50\$:MSG1:1, (MESSAGE)

EX: 50\$MSG1:1, THIS RUN REQUIRES 71K

- (b) Statement 500 modifies the dimensions of all the arrays in USA. The format is:

```
500:DIMENSION C1(NN,NN), C2(NN,NN)
```

where NN is the value indicated in 23 above by the message

```
+ + + NN x NN IS THE MIN DIM FOR C1, C2 + + +
```

```
EX: 500:DIMENSION C1,(62,62), C2(62,62)
```

- (c) Statement 5000 specifies a running time limit and states the core requirements to run USA.

```
5000$:LIMITS:XX,YYK
```

where XX is an estimate of the running time in hundredths of an hour.

YY is the required memory in 1000 words

```
EX: 5000$:LIMITS:15,48K (.15 hours max run time)
```

29. If an error is detected (as in this case due to misspelling of LIMITS), just press CR and start the line again. Whenever the same line number is entered more than once, the computer will only use the information typed in the last time.
30. It is a good practice to request the computer to list the statements just entered. This can be done by the command `LISTS NN,MM,PP...` This will list only the specified statement numbers. Note also that statement 50 was not listed, since it is a blank now.
31. After the modifications above are verified to be correct, USA is asked to RUN.

32. The CARDIN system will assign a number to this specific run. In this case 6818T.
33. Answer NORMAL or NORM to the next question as no special card disposition is used.
34. This is a request of the status of your job. JSTS 6818T means what is the JOB STATUS of 6818T.
35. In this case, the answer was that the program STATUS was TOO BIG. The normal procedure is to disconnect the terminal and sometime later request JSTS 6818T. In case the job is small, it is possible that it will be run after a short time and therefore you may wish to keep the terminal on. Periodically, request your job status, since if the terminal is inactive for more than 10 minutes, it will be automatically disconnected.
36. BYE is the message to disconnect the terminal. If at a later time the user requests the job status and the computer replied that the job is completed with NORMAL TERMINATION, the following procedure is used to retrieve the output data:
37. The output is in file USAOUT1 but is in BCD. The user has to convert the data to ASCII. This is accomplished by this statement which reads BCD from USAOUT1, converts to ASCII and stores it in the present file which is indicated by the asterisk(*) .
38. As no line numbers or tabs are required, answer the next two questions with a CR.

39. Request a listing of the present file.
40. The desired output is printed out. Note that the angle PHI is measured clockwise from the x-axis to conform with the azimuths of SCREEN.
(See Figs. 1, 2). Note also that the magnitude of the radiation pattern is listed in ratio, as well as in DB normalized to EMAX, its maximum magnitude. The gain over the isotropic source in the direction of EMAX is also given in ratio and in DB.
41. After the listing is completed, just sign out.

NOTE: As a reference, this run took a total of 0.0246 hours, out of which .0016 hours were used for compilation. This information can be obtained from the full printouts that come out at RADC.

4.2 EXAMPLE 2 - In this example the use of multiple runs and an output with mutual couplings are illustrated.

```
SYSTEM ?FORT
OLD OR NEW-NEW
READY
*RUN HS #USAINI "01"
***** ENTER ANTENNA PARAMETERS *****

DIMENSIONS IN METERS OR INCHES ?
=1
GROUND PLANE ?
=NO
SIMPLE PROG ?
=YES
1 COUPLING COEFFICIENTS ?
=YES
NUMBER OF ANTENNAS
=3
**** ANTENNA NUMBER 1 ****
ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1181
ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,36.,0.
**** ANTENNA NUMBER 2 ****
ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1097
ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,0.,0.
**** ANTENNA NUMBER 3 ****
ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=197
ANTENNA POSITION X,Y,Z ON THE PLATFORM
=-36.,0.,0.
+++ RADIATION PATTERN +++
VERTICAL PATTERN ?
=YES
PHI (DEGREES)
=0.
PLOTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.
HORIZONTAL PATTERN ?
=YES
THETA (DEGREES)
=90.
PLOTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=15.
COMMUNICATION RANGE CONTOUR ?
=NO

2 NUMBER OF RUNS
=2
**** RUN # 1 ****
FREQUENCY (MHZ)
=118.5
FED ANTENNA (#)
=1
```

**** RUN # 2 ****
 FREQUENCY (MHZ)
=400.
 FED ANTENNA (#)
=3

3 DIM= 1 GP= N SIMP= Y COUPL= Y NR= 3
 ANT# = 1 2 3
 TYPE = 1181 1097 197
 X = 0. 0. -36.000
 Y = 36.000 0. 0.
 Z = 0. 0. 0.
 VER PAT= Y
 PHI = 0. PLOT INC= 10.00
 HOR PAT= Y
 THETA= 90.0 PLOT INC= 15.00
 CQM RNG= N

RUN#	FREQ(MHZ)	ANT	FED(#)
1	118.50	1	
2	400.00	3	

4 +++ 72 X 72 IS THE MIN DIM FOR C1, C2 +++
 +++ 29 K IS THE MIN MEMORY NEEDED +++

*REMOVE 01
*OLD USAIN1
 READY
*ASCBCD *;USAIN1
 LABELS?
 TAB CHARACTERS AND SETTING?
*SYSTEM CARD
 OLD OR NEW-OLD USA
 READY
*50
*500 DIMENSION C1(72,72),C2(72,72)
*5000\$:LIMITS:10,29K
*LISTS 50,500,5000
 500 DIMENSION C1(72,72),C2(72,72)
 5000\$:LIMITS:10,29K
 READY
*RUN
 SNUMB # 3000T
 CARD FORMAT,DISPOSITION ?
NORM
*JSTS 3000T
 3000T-01 TOO BIG
*BYE
 **COST: \$ 1.49 TO DATE: \$ 250.56= 5%
 **ON AT 14.835 - OFF AT 15.012 ON 07/13/76

5 *JSTS 3000T
 3000T OUTPUT WAITING
 IF LAST JOB SUBMITTED, STATUS WAS:
 NORMAL TERMINATION

BCDASC USAOUT1; CR
 LINE NUMBERS? CR
 TAB CHARACTERS AND SETTING? CR
*LIST

6 *** ANT# (FED)= 1 FREQ (MHZ)= 118.50 ***

7 COUPLING COEFFICIENT

ANTENNA NO.	POWER RECEIVED (DB)
2	-17.06
3	-32.92

VERTICAL PATTERN

PHI= 0.

EMAX= 0.613 GAIN= 1.367 GAIN(DB)= 1.36

THETA	NMAG	NMAG(DB)
0.	0.0082	-41.71
10.	0.1152	-18.77
20.	0.2437	-12.26
30.	0.3751	-8.52
40.	0.5044	-5.94
50.	0.6254	-4.08
60.	0.7341	-2.68
70.	0.8301	-1.62
80.	0.9127	-0.79
90.	0.9743	-0.23
100.	1.0000	0.
110.	0.9762	-0.21
120.	0.9010	-0.91
130.	0.7842	-2.11
140.	0.6410	-3.86
150.	0.4850	-6.28
160.	0.3253	-9.75
170.	0.1658	-15.61
180.	0.0085	-41.42

HORIZONTAL PATTERN

THETA= 90.0

EMAX= 0.771 GAIN= 2.166 GAIN(DB)= 3.36

PHI	NMAG	NMAG(DB)
0.	0.7739	-2.23
15.	0.7606	-2.38
30.	0.7792	-2.17
45.	0.8145	-1.78
60.	0.8550	-1.36
75.	0.8923	-0.99
90.	0.9171	-0.75
105.	0.9211	-0.71
120.	0.9006	-0.91
135.	0.8576	-1.33
150.	0.8026	-1.91
165.	0.7576	-2.41
180.	0.7479	-2.52
195.	0.7811	-2.15
210.	0.8413	-1.50
225.	0.9060	-0.86
240.	0.9583	-0.37
255.	0.9896	-0.09
270.	1.0000	0.
285.	0.9940	-0.05
300.	0.9738	-0.23
315.	0.9371	-0.56
330.	0.8829	-1.08
345.	0.8210	-1.71
360.	0.7739	-2.23

8 *** ANT# (FED)= 3 FREQ (MHZ)= 400.00 ***

COUPLING COEFFICIENT

ANTENNA NO.	POWER RECEIVED (DB)
1	-31.44
2	-16.96

VERTICAL PATTERN

PHI= 0.

EMAX= 0.765 GAIN= 2.441 GAIN(DB)= 3.87

THETA	NMAG	NMAG(DB)
0.	0.0000	-1000.00
10.	0.0801	-21.92
20.	0.2022	-13.88
30.	0.3516	-9.08
40.	0.4706	-6.55
50.	0.5512	-5.17
60.	0.6490	-3.76
70.	0.7303	-2.73
80.	0.8485	-1.43
90.	0.9409	-0.53
100.	1.0000	0.
110.	0.9781	-0.19
120.	0.8409	-1.51
130.	0.7586	-2.40
140.	0.6858	-3.28
150.	0.5570	-5.08
160.	0.4140	-7.66
170.	0.2232	-13.03
180.	0.0000	-1000.00

HORIZONTAL PATTERN

THETA= 90.0

EMAX= 0.971 GAIN= 3.933 GAIN(DB)= 5.95

PHI	NMAG	NMAG(DB)
0.	0.7412	-2.60
15.	0.7226	-2.82
30.	0.2994	-10.48
45.	0.8150	-1.78
60.	0.7041	-3.05
75.	1.0000	0.
90.	0.3722	-8.59
105.	0.7194	-2.86
120.	0.8505	-1.41
135.	0.5587	-5.06
150.	0.6341	-3.96
165.	0.5701	-4.88
180.	0.6243	-4.09
195.	0.9672	-0.29
210.	0.2934	-10.65
225.	0.7467	-2.54
240.	0.6771	-3.39
255.	0.9165	-0.76
270.	0.6596	-3.61
285.	0.5177	-5.72
300.	0.7129	-2.94
315.	0.4026	-7.90
330.	0.2257	-12.93
345.	0.2796	-11.07
360.	0.7412	-2.60

Explanation of Example 2

1. Note that the coupling coefficients have been requested.
2. Note the specification of two runs. For every run the number of the fed antenna, as well as the frequency, is requested.
3. Note DIM = I, which means dimensions in Inches.
4. Only 29K is needed with (72 x 72) arrays.
5. At a later time it was found that the job had a normal termination and the user proceeded to print out the output file.
6. Before listing the data, the antenna fed and the frequency are specified.
7. The mutual coupling coefficient is defined as the ratio of the received power at any specified antenna (terminated by 5052 in the SIMPLE PROGRAM) to the input power of the fed antenna.
8. This is the beginning of the listing for the second run.

NOTE: As a reference, this run took a total of 0.0353 hours, out of which .0016 hours were used for compilation.

4.3 EXAMPLE 3 - This example illustrates the use of the general program option. Note the detailed input information required.

```

SYSTEM ?FORT
OLD OR NEW-NEW
READY
*PUN HS #USAINI "01"
***** ENTER ANTENNA PARAMETERS *****

  DIMENSIONS IN METERS OR INCHES ?
  =M
  GROUND PLANE ?
  =NO
  SIMPLE PROG ?
  =N
  FREQUENCY (MHZ)
  =125.
  NUMBER OF ANTENNAS
  =3
1  AUTO SPEC #SEGS ?
  =Y
  **** ANTENNA NUMBER 1 ****
  ANTENNA LENGTH
  =1.
2  LOAD POSITION
  =0
  FEED POSITION
  =.5
3  ANTENNA RADIUS
  =.3
  ..... INPUT ERROR, TRY AGAIN .....
  ANTENNA RADIUS
  =.02
  ANTENNA POSITION X,Y,Z ON THE PLATFORM
  =0.,0.,0.
4  FEED VOLTAGE (REAL,IMAG)
  =1.,0.
5  LOAD IMPEDANCE (REAL,IMAG)
  =0.,0
  **** ANTENNA NUMBER 2 ****
  ANTENNA LENGTH
  =1.5
  LOAD POSITION
  =1.
  FEED POSITION
  =0.
  ANTENNA RADIUS
  =.03
  ANTENNA POSITION X,Y,Z ON THE PLATFORM
  =1.,0.,0.
  FEED VOLTAGE (REAL,IMAG)
  =0.,0.
6  LOAD IMPEDANCE (REAL,IMAG)
  =50.,0.

```

```

**** ANTENNA NUMBER 3 ****
ANTENNA LENGTH
=1.2
LOAD POSITION
=.8
FEED POSITION
=0.
ANTENNA RADIUS
=.03
ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,1.2,.3
FEED VOLTAGE (REAL,IMAG)
=0.0
LOAD IMPEDANCE (REAL,IMAG)
=72.,0.
+++ RADIATION PATTERN +++
VERTICAL PATTERN ?
=YES
PHI (DEGREES)
=90.
PLOTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.
HORIZONTAL PATTERN ?
=YES
THETA (DEGREES)
=90.
PLOTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.

```

```

DIM= M  GP= N  AUTO= Y  FREQ= 125.00  NR= 3
ANT# =      1      2      3
L    =  1.000    1.500    1.200
LP   =  0.      1.000    0.800
FP   =  0.500    0.      0.
R    =  0.02000  0.03000  0.03000
X    =  0.      1.000    0.
Y    =  0.      0.      1.200
Z    =  0.      0.      0.300
RE V =  1.000    0.      0.
IM V =  0.      0.      0.
RE LD=  0.      50.0    72.0
IM LD=  0.      0.      0.
VER PAT= Y
PHI   =  90.0  PLOT INC= 10.00
HOR PAT= Y
THETA=  90.0  PLOT INC= 10.00

```

```

+++ 14 X 14 IS THE MIN DIM FOR C1, C2 +++
+++ 19 K IS THE MIN MEMORY NEEDED +++

```

```

*REMOVE 01
*OLD USAINI
READY

```

*ASCBCD *;USAIN1
 LABELS?
 TAB CHARACTERS AND SETTING?
*SYSTEM CARD
OLD OR NEW-OLD USA
 READY
*50
*500: DIMENSION C1(14,14), C2(14,14)
*5000\$: LIMITS: 5, 19K
*LISTS 50, 500, 5000

500: DIMENSION C1(14,14), C2(14,14)
 5000\$: LIMITS: 5, 19K

READY

*RUN
 SNUMB # 7915T
 CARD FORMAT, DISPOSITION ?
NORM
*JSTS 7915T
 7915T-01 TOO BIG

*JSTS 7915T
 7915T JOB NOT ACCESSIBLE
 IF LAST JOB SUBMITTED, STATUS WAS:
 NORMAL TERMINATION

BCDASC USAOUT1;
 LINE NUMBERS?
 TAB CHARACTERS AND SETTING?
*LIST

VERTICAL PATTERN

PHI= 90.0

EMAX= 0.588 GAIN= 1.527 GAIN(DB)= 1.84

THETA	NMAG	NMAG(DB)
0.	0.	-1000.00
10.	0.1658	-15.61
20.	0.3625	-8.81
30.	0.5646	-4.97
40.	0.7417	-2.60
50.	0.8717	-1.19
60.	0.9499	-0.45
70.	0.9875	-0.11
80.	1.0000	0.
90.	0.9950	-0.04
100.	0.9701	-0.26
110.	0.9209	-0.72
120.	0.8483	-1.43
130.	0.7568	-2.42
140.	0.6495	-3.75
150.	0.5238	-5.62
160.	0.3737	-8.55
170.	0.1969	-14.12
180.	0.0000	-1000.00

HORIZONTAL PATTERN

THETA= 90.0

EMAX= 0.760 GAIN= 2.553 GAIN(DB)= 4.07

PRI	NMAG	NMAG(DB)
0.	0.6146	-4.23
10.	0.6752	-3.41
20.	0.6888	-3.24
30.	0.6586	-3.63
40.	0.6044	-4.37
50.	0.5593	-5.05
60.	0.5569	-5.08
70.	0.6057	-4.35
80.	0.6852	-3.28
90.	0.7696	-2.27
100.	0.8440	-1.47
110.	0.9049	-0.87
120.	0.9528	-0.42
130.	0.9862	-0.12
140.	1.0000	0.
150.	0.9884	-0.10
160.	0.9482	-0.46
170.	0.8803	-1.11
180.	0.7912	-2.03
190.	0.6968	-3.14
200.	0.6257	-4.07
210.	0.6089	-4.31
220.	0.6522	-3.71
230.	0.7273	-2.77
240.	0.7975	-1.96
250.	0.8358	-1.56
260.	0.8275	-1.65
270.	0.7696	-2.27
280.	0.6706	-3.47
290.	0.5493	-5.20
300.	0.4320	-7.29
310.	0.3458	-9.22
320.	0.3123	-10.11
330.	0.3401	-9.37
340.	0.4183	-7.57
350.	0.5203	-5.68
360.	0.6146	-4.23

READY

Explanation of Example 3

1. Each antenna is divided in a certain number of segments over which the current is assumed constant. When the answer to AUTO SPEC # SEGS? is YES, the computer uses 15 segments per wavelength for the fed antennas and between 6 to 10 per wavelength for the others depending on how far they are from the fed antenna. If the answer is NO, then the actual number of segments for each antenna has to be specified by the user.
2. When there is no lead in the antenna, enter $\emptyset$ here.
3. The maximum radius permissible is $.1\lambda$, thus the error message.
4. This indicates that this is the fed antenna. Other antennas can also be fed simultaneously in this version of the program. Therefore, the radiation pattern of an array of antennas can be calculated.
5. As this antenna has no load, enter $\emptyset, \emptyset$ here. If there was a lead, then the real and imaginary parts of the load impedance (in ohms) should be entered here.
6. This is the real and imaginary parts of the load in ohms.

NOTE: As a reference, this run took a total of 0.0030 hours, out of which .0016 hours were used for compilation.

4.4 EXAMPLE 4 - This example illustrates the use of the communication range contour program option.

```
*SYST FORT
OLD OR NEW-NEW
READY
*RUN HS #USAINI "01"
+++++ ENTER ANTENNA PARAMETERS +++++

  DIMENSIONS IN METERS OR INCHES ?
  =M
  GROUND PLANE ?
  =N
  SIMPLE PROG ?
  =Y
  COUPLING COEFFICIENTS ?
  =N
  NUMBER OF ANTENNAS
  =1
  **** ANTENNA NUMBER 1 ****
  ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
  =197
  ANTENNA POSITION X,Y,Z ON THE PLATFORM
  =0.,0.,0.
  +++ RADIATION PATTERN +++
  VERTICAL PATTERN ?
  =Y
  PHI (DEGREES)
  =0.
  PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
  =10.
  HORIZONTAL PATTERN ?
  =N
1  COMMUNICATION RANGE CONTOUR ?
  =Y
2  RECEIVER SENSITIVITY (DBM)
  =-80.
  GROUND TRANSMITTER POWER (WATT)
  =10.
+++++ ENTER SITE PARAMETERS +++++

  GROUND ELEVATION IN FEET
  =6546.
  TRANSIT ELEVATION IN FEET
  =6568.
  ANTENNA ELEVATION IN FEET
  =6586.
3  ANTENNA OFFSET FROM TRANSIT ?
  =Y
```

ENTER DISTANCE TO ANTENNA IN FEET
=0.
 4 BEARING TO ANTENNA IN DEG AND MIN (DD.MM)
=0.0
 5 USE STANDARD ALTITUDES ?
=N
 NUMBER OF ALTITUDES TO BE CALCULATED (1-6)
=6
 6 DESIRED ALTITUDES IN FEET
=1000.,5000.,10000.,15000.,20000.,35000.

{ GROUND ELEV = 6546.0 FT
 TRANSIT ELEV = 6568.0 FT
 ANTENNA ELEV = 6586.0 FT
 7 DIST TO ANT (FT) = 0.
 BEAR TO ANT(DD.MM)= 0.
 AIRCRAFT ALT'S ARE IN FT AGL.
 ALT'S= 1000.0 5000.0 10000.0 15000.0 20000.0 35000.0

NUMBER OF RUNS
=1
 **** RUN # 1 ****
 FREQUENCY (MHZ)
=320.
 FED ANTENNA (#)
=1

DIM= M GP= N SIMP= Y COUPL= N NR= 1
 ANT# = 1
 TYPE = 197
 X = 0.
 Y = 0.
 Z = 0.
 VER PAT= Y
 PHI = 0. PLOT INC= 10.00
 HOR PAT= N
 CQM RNG= Y
 REC SEN (DBM)= -80.0 GROUND TPW (WATT)= 10.0

RUN# FREQ(MHZ) ANT FED(#)
 1 320.00 1

+++ 7 X 7 IS THE MIN DIM FOR C1, C2 +++
 +++ 19 K IS THE MIN MEMORY NEEDED +++

*REMOVE 01
 *OLD USAINI
 READY
 *ASCB CD *;USAINI
 LABELS?
 TAB CHARACTERS AND SETTING?

```

*SYST CARD
OLD OR NEW-OLD USA
READY
8 { *50
  *500 DIMENSION C1(7,7),C2(7,7)
  *50005:LIMITS:5,19K
  *RUN
    SNUMB # 6849T
    CARD FORMAT,DISPOSITION ?
    NORM
  *JSTS 6849T
  6849T-01 WAIT-ALOC

```

```

*JSTS 6849T
6849T JOB NOT ACCESSIBLE
IF LAST JOB SUBMITTED, STATUS WAS:
NORMAL TERMINATION

```

```

*BCDASC USACUT1;*
LINE NUMBERS?
TAB CHARACTERS AND SETTING?
*LIST

```

```

*** ANT# (FED)= 1 FREQ (MHZ)= 320.00 ***

```

```

RECEIVER SENSITIVITY (DEM)= -80.0
TRANSMITTER POWER (WATT) = 10.0

```

VERTICAL PATTERN

```

PHI= 0.

```

```

EMAX= 24.090 GAIN= 1.934 GAIN(DB)= 2.87

```

THETA	NMAG	NMAG(DB)
0.	0.0000	-1000.00
10.	0.1622	-15.80
20.	0.3214	-9.86
30.	0.4739	-6.49
40.	0.6149	-4.22
50.	0.7392	-2.63
60.	0.8419	-1.50
70.	0.9197	-0.73
80.	0.9715	-0.25
90.	0.9980	-0.02
100.	1.0000	0.
110.	0.9769	-0.20
120.	0.9261	-0.67
130.	0.8445	-1.47
140.	0.7295	-2.74
150.	0.5819	-4.70
160.	0.4057	-7.84
170.	0.2084	-13.62
180.	0.0000	-1000.00

9 COMMUNICATION RANGE CONTOUR

ALT(FT) 1000.0 5000.0 10000.0 15000.0 20000.0 35000.0

PHI(DEG)	RANGE(NM)					
0.	6.2	29.2	53.5	55.7	55.7	55.4
6.50	5.3	25.5	47.7	55.7	55.6	55.4
10.50	5.7	27.1	50.1	55.7	55.6	55.4
20.00	5.9	28.0	51.7	55.7	55.7	55.4
30.00	8.5	37.6	55.8	55.8	55.7	55.5
31.32	5.4	25.9	48.3	55.7	55.6	55.4
35.37	5.2	25.1	46.9	55.7	55.6	55.4
40.00	6.2	29.1	53.4	55.7	55.7	55.4
50.00	6.2	29.1	53.4	55.7	55.7	55.4
60.00	5.9	27.8	51.3	55.7	55.7	55.4
65.20	4.7	23.0	43.4	55.7	55.6	55.4
70.00	6.2	29.1	53.4	55.7	55.7	55.4
75.67	6.0	28.3	52.1	55.7	55.7	55.4
85.00	7.9	35.6	55.8	55.7	55.7	55.5
90.00	6.9	32.0	55.8	55.7	55.7	55.5
116.00	13.7	52.0	55.8	55.8	55.7	55.5
123.33	16.6	55.9	55.8	55.8	55.8	55.5
148.00	45.8	55.9	55.9	55.8	55.8	55.6
155.00	30.1	55.9	55.9	55.8	55.8	55.6
159.15	25.5	55.9	55.9	55.8	55.8	55.6
159.75	39.8	55.9	55.9	55.8	55.8	55.6
162.00	55.9	55.9	55.9	55.9	55.8	55.6
163.07	41.9	55.9	55.9	55.8	55.8	55.6
163.78	55.9	55.9	55.9	55.9	55.8	55.6
166.50	55.9	55.9	55.9	55.9	55.8	55.6
171.95	9.2	39.9	55.8	55.8	55.7	55.5
173.00	6.6	30.9	55.8	55.7	55.7	55.5
173.73	5.1	24.7	46.3	55.7	55.6	55.4
174.12	5.4	25.8	48.0	55.7	55.6	55.4
175.30	4.6	22.5	42.6	55.7	55.6	55.4
176.95	5.5	26.4	49.1	55.7	55.6	55.4
177.22	4.9	23.7	44.7	55.7	55.6	55.4
177.50	5.1	24.5	46.0	55.7	55.6	55.4
178.33	4.7	22.8	43.2	55.7	55.6	55.4
179.23	5.9	27.9	51.4	55.7	55.7	55.4
179.68	5.4	26.0	48.4	55.7	55.6	55.4
180.27	5.7	27.1	50.3	55.7	55.6	55.4
180.57	5.6	26.7	49.5	55.7	55.6	55.4
182.12	5.2	25.1	47.0	55.7	55.6	55.4
182.38	5.4	25.8	48.0	55.7	55.6	55.4
182.67	5.2	25.1	47.0	55.7	55.6	55.4
183.50	5.6	26.7	49.5	55.7	55.6	55.4
184.02	4.9	23.9	45.0	55.7	55.6	55.4
184.82	4.5	22.2	42.1	55.7	55.6	55.4
186.50	4.1	20.4	38.9	55.6	55.6	55.4
187.92	4.3	21.1	40.2	55.6	55.6	55.4
191.35	2.9	14.8	28.9	42.3	55.1	55.3
192.90	3.4	17.1	33.2	48.3	55.5	55.3
199.08	2.6	13.0	25.5	37.5	49.1	55.2
200.28	2.5	12.7	24.9	36.7	48.1	55.2
203.78	2.3	11.8	23.3	34.5	45.2	55.2
205.73	3.0	15.2	29.6	43.2	55.5	55.3
206.13	3.1	15.4	30.0	43.9	55.5	55.3
206.73	2.9	14.4	28.2	41.3	53.9	55.3
207.32	2.9	14.8	28.9	42.3	55.1	55.3

208.37	3.0	15.2	29.6	43.3	55.5	55.3
219.18	1.7	8.9	17.7	26.3	34.8	55.0
221.42	1.9	9.8	19.5	28.9	38.2	55.0
222.43	2.0	10.3	20.5	30.3	40.0	55.1
222.72	2.0	10.2	20.2	29.9	39.4	55.1
225.00	2.1	10.8	21.3	31.5	41.5	55.1
226.20	2.0	10.3	20.3	30.1	39.7	55.1
227.50	2.1	10.7	21.2	31.3	41.2	55.1
228.22	2.0	10.4	20.6	30.6	40.2	55.1
235.12	1.7	8.9	17.8	26.4	34.9	55.0
235.12	1.7	8.9	17.8	26.4	34.9	55.0
235.80	1.8	9.1	18.2	27.0	35.7	55.0
238.23	1.7	8.7	17.2	25.6	33.9	55.0
239.85	1.7	8.9	17.7	26.3	34.8	55.0
240.67	1.6	8.2	16.4	24.4	32.3	54.9
244.10	1.5	7.8	15.4	23.0	30.5	52.3
244.77	1.6	8.1	16.1	24.0	31.7	54.3
246.33	1.9	9.9	19.7	29.2	38.5	55.1
254.47	2.6	13.2	25.9	38.1	49.9	55.2
254.47	2.6	13.2	25.9	38.1	49.9	55.2
254.60	2.5	12.5	24.6	36.3	47.5	55.2
257.18	2.0	10.4	20.6	30.5	40.2	55.1
267.00	2.1	10.5	20.9	30.9	40.7	55.1
271.00	1.7	8.5	17.0	25.3	33.4	54.9
272.77	1.8	9.5	18.8	27.9	36.8	55.0
275.00	2.1	10.5	20.8	30.8	40.6	55.1
275.43	2.1	10.7	21.3	31.5	41.4	55.1
276.00	2.0	10.2	20.1	29.9	39.4	55.1
279.00	2.1	10.5	20.9	30.9	40.7	55.1
288.30	2.7	13.5	26.6	39.0	51.0	55.2
289.08	2.5	12.9	25.3	37.2	48.8	55.2
294.85	3.4	16.9	32.7	47.6	55.5	55.3
295.83	3.3	16.5	32.0	46.6	55.5	55.3
296.67	3.5	17.6	34.0	49.3	55.5	55.3
302.10	3.9	19.3	37.1	53.5	55.6	55.4
303.40	4.0	19.7	37.8	54.4	55.6	55.4
303.40	4.0	19.7	37.8	54.4	55.6	55.4
306.78	3.3	16.6	32.2	46.8	55.5	55.3
309.97	4.3	21.4	40.7	55.6	55.6	55.4
311.67	5.6	26.6	49.3	55.7	55.6	55.4
312.87	5.4	26.0	48.5	55.7	55.6	55.4
312.87	5.4	26.0	48.5	55.7	55.6	55.4
317.07	6.6	30.6	55.7	55.7	55.7	55.5
317.58	6.1	28.9	53.0	55.7	55.7	55.4
318.95	6.3	29.7	54.3	55.7	55.7	55.5
320.10	7.7	34.7	55.8	55.7	55.7	55.5
320.30	8.7	38.2	55.8	55.8	55.7	55.5
320.50	8.2	36.4	55.8	55.7	55.7	55.5
321.03	8.5	37.4	55.8	55.7	55.7	55.5
321.70	8.1	36.2	55.8	55.7	55.7	55.5
322.38	9.3	40.0	55.8	55.8	55.7	55.5
327.00	11.2	45.8	55.8	55.8	55.7	55.5
334.53	9.6	41.0	55.8	55.8	55.7	55.5
334.53	9.6	41.0	55.8	55.8	55.7	55.5
336.05	8.4	37.3	55.8	55.7	55.7	55.5
336.05	8.4	37.3	55.8	55.7	55.7	55.5
336.62	7.8	35.0	55.8	55.7	55.7	55.5
338.35	8.4	37.3	55.8	55.7	55.7	55.5
341.00	8.2	36.5	55.8	55.7	55.7	55.5
350.00	7.4	33.8	55.8	55.7	55.7	55.5
350.00	7.4	33.8	55.8	55.7	55.7	55.5

Explanation of Example 4

1. A request for computation of communication range is made.
2. The program does not include the coaxial cable losses and other losses within the receiver and transmitter. If known, they should be subtracted from the actual receiver sensitivity.
3. If the answer is YES, the next two questions are asked. If the answer is NO, they are skipped.
4. The bearing is measured from the north, clockwise, and is read in degrees and minutes as DDD.MM. Ex: $1.20 \equiv 1^{\circ} 20'$.
5. If the answer is NO, the next two questions are asked. If it is YES, they are skipped and the six standard altitudes of 1,000; 5,000; 10,000; 15,000; 20,000; and 35,000 feet above ground level (AGL) are assumed.
6. This is a print out of site parameters which was just read in the computer for the user's verification.
7. These statements modify the program arrays so it can be run with the smallest core possible. If the user wants to change the name DATAFILE to any name XXX... (maximum of 8 characters) the following should be typed 5025\$:PRMFL:03,R/W,R,BLA00001/XXX...
9. This is the communication range contour output.
"Line of Sight Coverage" data of Air Force Academy, Colorado Springs, are stored in the file DATAFILE.

NOTE: Data in the file DATAFILE have to be stored in the following way in each azimuth direction:

```

ZZ,ELANG,DIST,RNG(1),...,RNG(6)
.   .   .   .   .   .
.   .   .   .   .   .
.   .   .   .   .   .

```

where ZZ = the azimuth angle in radians.

ELANG = the angle in radians between the screen top and the ground.

DIST = the distance between the transit and the screen.

RNG = up to six line of sight ranges in nautical miles.

As a reference, this run took a total of 0.0112 hours, out of which 0.0016 hours were used for compilation.

5. Program Limitations

The primary limitations of the program as listed in the Appendix are shown below.

a) Maximum number of runs.	10
b) Maximum number of antennas in the <u>GENERAL PROGRAM</u>	90
c) Maximum number of antennas in the <u>SIMPLE PROGRAM</u>	20
Maximum number of sub-antennas to represent antennas in the <u>SIMPLE PROGRAM</u>	90
Number of sub-antennas used to represent each antenna in the <u>SIMPLE PROGRAM</u>	
AT 1181 - 1	
AT 1097 - 5	
AT 1000 - 1	
AT 197 - 26	

d) Maximum number of segments to represent the current

on all antennas

200

e) Number of segments used to represent each antenna in

the SIMPLE PROGRAM:

$f > 200$ MHz (UHF)

with mutual coupling calculations AT 197 - 7 if fed
51 if fed

AT 1097 - 29

AT 1181 - 16

without mutual coupling calculations AT 197 - 7 if fed
39 if not fed

AT 1097 - 29 if fed

20 if not fed

AT 1181 - 12

$f \leq 200$ MHz (VHF)

with mutual coupling calculations AT 197 - 39

AT 1097 - 21

AT 1181 - 12

without mutual coupling calculations AT 197 - 26

AT 1097 - 13

AT 1181 - 12 if fed

7 if not fed

The maximum number of the segments per wavelength used for

the AT 1000 are nine in UHF and twelve in VHF.

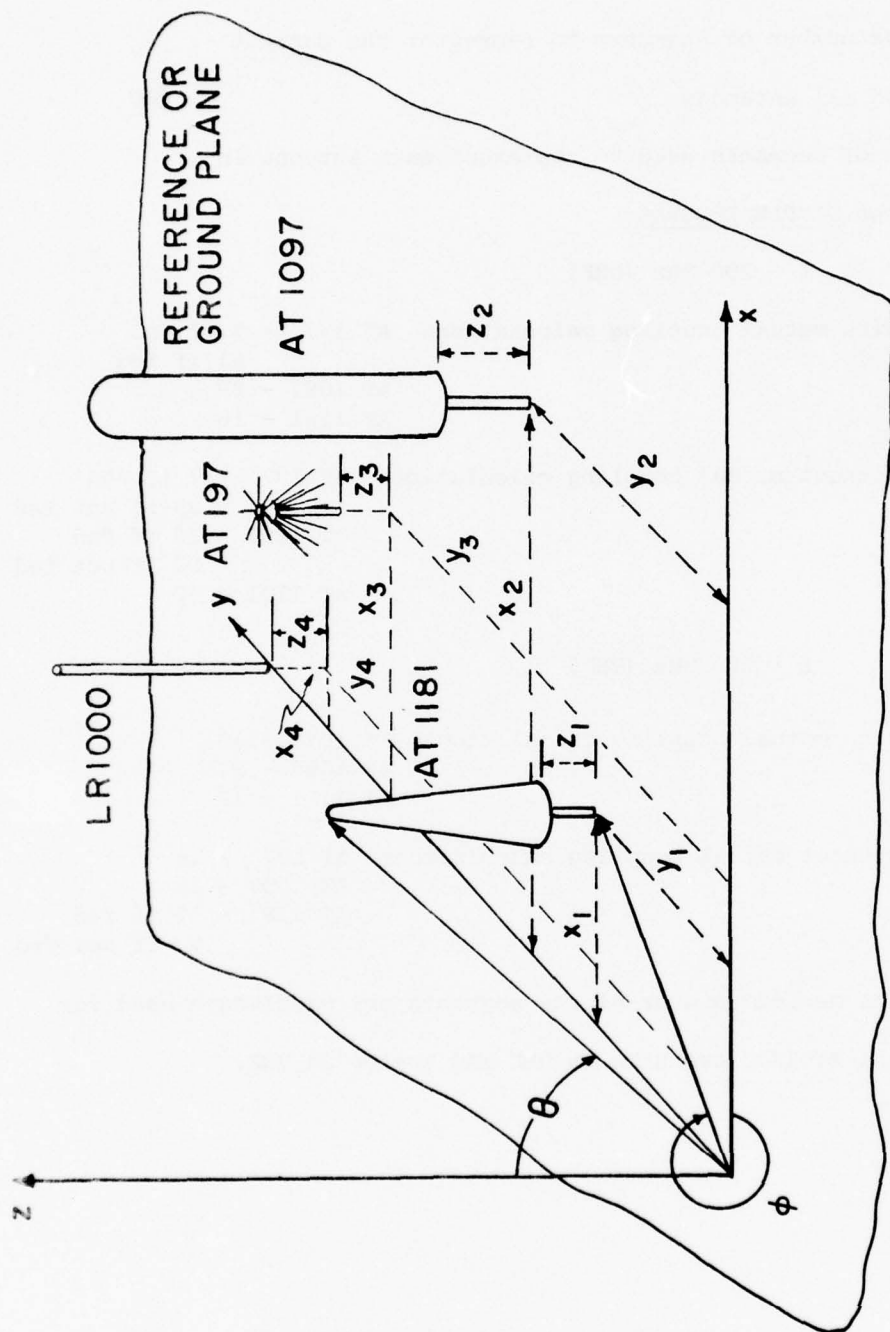


Figure 1 - Geometry and Parameters of the Simplified Program

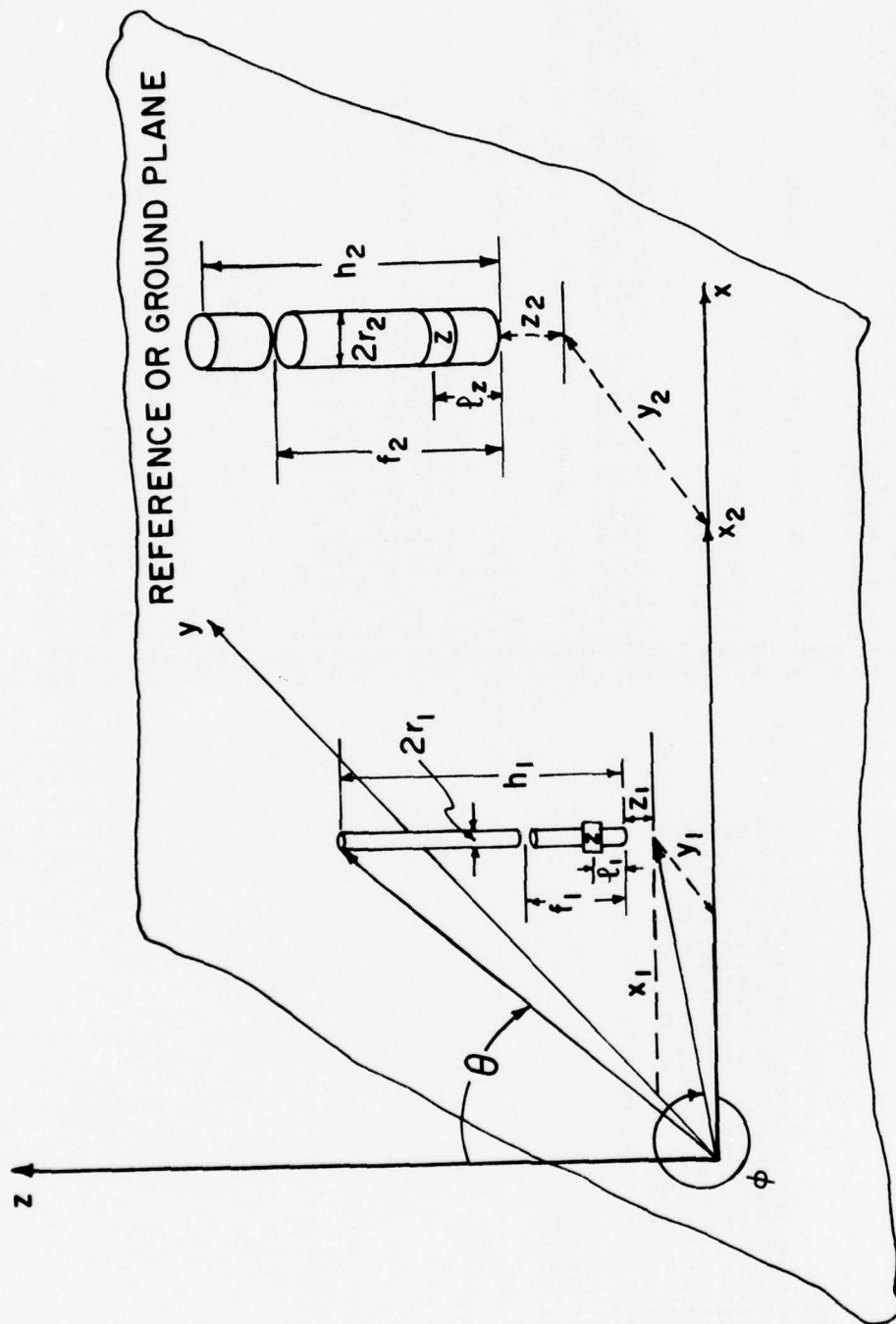


Figure 2 - Geometry and Parameters of the General Program

APPENDIX A

COMPUTER PROGRAMS

PROGRAM LINKM1

```

10 SUBROUTINE SUBA
15 COMMON A,H0,H1,H3,RA,X,Y,Z,AV,BV,AZ,BZ,NS,L1,IF,IT,XX,YY,ZZ,I2,
20,FR,IV,IIM,GP,SIMP,NV,AUTO,KW,CL,B5,AINT,AINP,APHI,ATHE
25,H4,H5,IFP,IFT,IRG,DBM,ISIMP,ICL,IALP,IALT,IRGE,IAUTO,IGP
30,SITE(13),ALT(6),GREL,TRAVEL,ANTEL,NA,DTA,BTA,APIN,PA
35 DIMENSION A(90),H0(90),H1(90),H3(90),RA(90),X(90),Y(90),
40,Z(90),AV(90),BV(90),AZ(90),BZ(90),NS(90),L1(90),IF(90),
45,IT(20),XX(20),YY(20),ZZ(20),I2(40),FR(10),IV(10),H4(20),H5(20)
50,RNG(6),STDALT(6),PA(40)
90 IY=13953782816:IN=1.4773878 8
915

```

PROGRAM LINKM2

```

15 COMMON A,H0,H1,H3,RA,X,Y,Z,AV,BV,AZ,BZ,NS,L1,IF,IT,XX,YY,ZZ,I2,
20,FR,IV,IIM,GP,SIMP,NV,AUTO,KW,CL,B5,AINT,AINP,APHI,ATHE
25,H4,H5,IFP,IFT,IRG,DBM,ISIMP,ICL,IALP,IALT,IRGE,IAUTO,IGP
30,SITE(13),ALT(6),GREL,TRAVEL,ANTEL,NA,DTA,BTA,APIN,PA
35 DIMENSION A(90),H0(90),H1(90),H3(90),RA(90),X(90),Y(90),
40,Z(90),AV(90),BV(90),AZ(90),BZ(90),NS(90),L1(90),IF(90),
45,IT(20),XX(20),YY(20),ZZ(20),I2(40),FR(10),IV(10),H4(20),H5(20)
50,RNG(6),STDALT(6),PA(40)
115 PRINT:2:+++ ENTER ANTENNA PARAMETERS +++++
118 PRINT: " "
130 CALL LINK1("LINK1")
140 CALL LINK2("LINK2")
150 CALL LINK3("LINK3")
160 STOP:END

```

40

```

926 ***TY=YES, IN=NO, IIN=INCHES, IME=METERS
930
945
956 IIN=9806299168:IME=1.34317 108
103 AB=0.
104 MX1=20:MX2=9
105C
106C ***MX1=MAXIMUM NUMBER OF ANTENNAS IN THE SIMPLE PROGRAM
107C ***MX2=MAXIMUM NUMBER OF ANTENNAS IN THE GENERAL PROGRAM
108C ***MX3=MAXIMUM NUMBER OF SUB-ANTENNAS IN THE SIMPLE PROGRAM
112C
116C ***ENTER DIMENSION UNITS, GROUND PLANE AND TYPE OF PROGRAM
118C
119C
120 510 PRINT:" DIMENSIONS IN METERS OR INCHES ?"
130 READ 515,IIM
140 IF(IIM-IIN) 102,1 6,102
150 1 2 IF(IIM-IIN) 1 4,106,104
160 1 4 PRINT 5:2:GO TO 511
170 502 FORMAT(" .... INPUT ERROR, TRY AGAIN .....")
180 106 PRINT:" GROUND PLANE ?"
190 READ 515,IGP
200 IF(IGP-IY) 112,116,112
210 112 IF(IGP-IIN) 114,517,114
220 114 PRINT 5:2:GO TO 106
230 116 GP=1.
233C
234C
235C ***GP=1, 1 WITH THE GROUND PLANE
236C
237C
240 515 FORMAT(1A1)
250 517 PRINT:" SIMP-E PROG ?"
260 READ 515,ISIMP
270 IF(ISIMP-IY) 124,122,124
280 122 SIMP=1:GO TO 3
283C
284C
285C ***SIMP=1, : THE SIMPLE PROGRAM
286C

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286C
287C
290 124 IF (ISIMP-IN) 126,1,1,126
300 126 PRINT 5:2:GO TO 517
303C
304C
305C
306C
307C
308C
309C
310 1" PRINT" FREQUENCY (MHZ)";READ:FR(1)
311 IF (FR(1).LE.0) PRINT 5:2
312 IF (FR(1).LE.0) GO TO 1
313 IF (FR(1).LE.0) GO TO 1
320 6 5 PRINT: "NUMBER OF ANTENNAS "READ:NN
330 IF (NN.GT.0 AND NN.E-8) GO TO 520
332 IF (NN.LE.0) PRINT 5 2:IF (NN.LE.0) GO TO 605
340 PRINT 625:GO TO 5 3
350 520 PRINT: "AUTO SPEC #SEGS ?"
360 READ 515,IAUTO
370 IF (IAUTO-1) 132,136,132
380 132 IF (IAUTO-1) 134,138,134
390 134 PRINT 5:2:GO TO 520
400 136 AUTO=1
403C
404C
405C
406C
407C
408C
409C
410 138 DO 285 1=1,NN
420 PRINT 274,1
430 274 FORMAT(" *** ANTENNA NUMBER",13," ***")
440 IF (IAUTO.EQ.1) GO TO 2
450 3 PRINT: "NUMBER OF SEGMENTS PER WAVE-LENGTH "
460 READ:FI
465 IF (FI(1).LE.0) PRINT 5:2:IF (FI(1).LE.0) GO TO 3
470 2 PRINT: "ANTENNA LENGTH"
480 READ:HQ(1)
485 IF (HQ(1).LE.0) PRINT 5:2:IF (HQ(1).LE.0) GO TO 2
490 610 PRINT: "LOAD POSITION"
500 READ:HI(1)
510 IF (HI(1).GE.0 AND HI(1).LT.H (1)) GO TO 620
520 PRINT 502:GO TO 510
530 620 PRINT: "FEED POSITION"
540 READ:HI3(1)
550 IF (HI3(1).GE.0 AND HI3(1).LT.H (1)) GO TO 622
560 PRINT 502:GO TO 520
570 622 PRINT: "ANTENNA RADIUS"
580 READ:RA(1)
585 IF (RA(1).LE.0) PRINT 502:IF (RA(1).LE.0) GO TO 622
590 IF (IIM-IME) 162,166,166
600 162 IF (RA(1)-124./FR(1)) 168,168,164
610 164 PRINT 5:2:GO TO 622
620 166 IF (RA(1)-31./FR(1)) 168,168,164
630 168 PRINT: "ANTENNA POSITION X,Y,Z ON THE PLATFORM"
640 READ:XI,Y(1),Z(1)
641 IF (IIM.EQ.IIN) FA(1)=Z(1)*.254
642 IF (IIM.EQ.IME) FA(1)=Z(1)
644 IF (IIP.LT.5 AND Z(1).GE.0) GO TO 67
645 PRINT 502:GO TO 168
650 67 PRINT: "FEED VOLTAGE (REAL,IMAG)"
660 READ:IAV(1),RV(1)
670 PRINT: "LOAD IMPEDANCE (REAL,IMAG) "
680 READ:IAZ(1),RZ(1)
690 AB=AB+AV(1)*2+BV(1)*2
700 285 CONTINUE
710 IF (ABN-1.E-8) 56,56,310
720 56 PRINT 573
730 573 FORMAT(" **<> ** << NO ANTENNAS ARE FED >>")
740 DO 57 1=1,NN
750 PRINT 274,1
760 PRINT: "FEED VOLTAGE (REAL,IMAG) "
770 57 READ:AV(1),BV(1)
780 GO TO 310
783C
784C
785C
786C
787C
788C
789C
790 310 PRINT: "COUPLING COEFFICIENTS ?"
795 CL=0
800 READ 515,ICL
810 IF (ICL-1) 172,176,172
820 172 IF (ICL-1) 174,650,174
830 174 PRINT 5 2:GO TO 300
840 176 CL=1
841C
842C
843C
844C
845C
846C
847C
848C
849C
850 650 PRINT: "NUMBER OF ANTENNAS"
860 READ:NB
862 IF (NB.LE.0) PRINT 5 2:IF (NB.LE.0) GO TO 650
864 IF (ICL.GT.5 AND NB.EQ.1) PRINT 7
865 IF (ICL.GT.5 AND NB.EQ.1) GO TO 300
866 7 FORMAT(" **<<FP>> ** << # OF ANT. GREATER THAN ONE (COUPLING COEFF. COEF.) >>")
870 IF (NB.GT.NX1) PRINT 625
880 625 FORMAT(" **<F> ** << TOO MANY ANTENNAS >>")
890 IF (NB.GT.NX1) GO TO 650
900 DO 295 1=1,NB
910 PRINT 274,1
920 530 PRINT: "ANTENNA TYPE ? (1 97, 197, 1181 OR 1000)"

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938 READ I(1), AND, IT(1), EQ, 1000) PRINT 502
939 IF (AND, EQ, 1 AND, IT(1), EQ, 1000) GO TO 680
940 IF (IT(1), EQ, 1000) 182, 586, 182
950 182 IF (IT(1), EQ, 1181) 184, 586, 184
960 184 IF (IT(1), EQ, 1197) 200, 586, 200
970 200 IF (IT(1), EQ, 1200) 202, 186, 202
980 186 PRINT " LENGTH: READ: H4(1)
988 IF (H4(1), LE, 0.0) PRINT 502; IF (H4(1), LE, 0.0) GO TO 186
990 4 PRINT " DIAMETER: READ: H5(1)
998 IF (H5(1), LE, 0.0) PRINT 502; IF (H5(1), LE, 0.0) GO TO 4
1000 60 TO 586
1010 202 PRINT 502; GO TO 538
1020 586 PRINT " ANTENA POSITION X,Y,Z ON THE PLATFORM"
1021 READ: XX(1), YY(1), ZZ(1)
1024 IF (OP, LT, 5.0) 22(1), GE, 0.0) GO TO 69
1026 PRINT 502; GO TO 586
1027 69 IF (IM, EQ, 114) FA(1)=ZZ(1)*.0254
1028 IF (IM, EQ, 114) FA(1)=ZZ(1)
1030 N9=1
1040 IF (IT(1), EQ, 1097) N9=5
1050 IF (IT(1), EQ, 1097) N9=26
1060 N9=N9+N9
1070 295 CONTINUE
1073C
1074C
1075C **NUMBER OF SUB-ANTENNAS IN THE SIMPLE PROGRAM
1076C
1077C
1080 IF (NN, GT, M2) PRINT 625
1090 IF (NN, GT, M2) STOP
1093C
1094C
1095C **RADIATION PATTERN
1096C
1097C
1100 310 PRINT "++ RADIATION PATTERN ++"
1101 310 PRINT 502; GO TO 550
1103C
1104C
1105C **ENTER VERTICAL PATTERN SPECIFICATION
1106C
1107C
1110 550 PRINT " VERTICAL PATTERN ?"
1120 READ 515, IALP
1130 IF (IALP, LT, 232, 236, 232)
1140 232 IF (IALP, LT, 234, 55, 234)
1150 234 PRINT 502; GO TO 550
1160 236 IF (P=1)
1170 79 PRINT " PHI (DEGREES) "; READ: PHI
1180 580 PRINT 360; READ: AINT
1190 IF (ABS(AINT), GE, .1) GO TO 55
1200 PRINT 502; GO TO 58

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1980 FRB=PRINT, FED ANTENNA (#):READ:IV(J)
1990 GO TO 150
1990 IF M4(I).GT..E-10) I18=1
2300 150 CONTINUE
2310 IF I18.NE.1) PRINT 152,(H4(I),I=1,NB)
2320 IF I18.NE.1) PRINT 154,(H5(I),I=1,NB)
2330 IF I18.NE.1) PRINT 156,(I1,I=1,NB)
2340 IF I18.NE.1) PRINT 158,(I2,I=1,NB)
2350 IF I18.NE.1) PRINT 160,(I3,I=1,NB)
2360 IF I18.NE.1) PRINT 162,(I4,I=1,NB)
2370 IF I18.NE.1) PRINT 164,(I5,I=1,NB)
2380 IF I18.NE.1) PRINT 166,(I6,I=1,NB)
2390 IF I18.NE.1) PRINT 168,(I7,I=1,NB)
2400 IF I18.NE.1) PRINT 170,(I8,I=1,NB)
2410 IF I18.NE.1) PRINT 172,(I9,I=1,NB)
2420 IF I18.NE.1) PRINT 174,(I10,I=1,NB)
2430 IF I18.NE.1) PRINT 176,(I11,I=1,NB)
2440 IF I18.NE.1) PRINT 178,(I12,I=1,NB)
2450 IF I18.NE.1) PRINT 180,(I13,I=1,NB)
2460 IF I18.NE.1) PRINT 182,(I14,I=1,NB)
2470 IF I18.NE.1) PRINT 184,(I15,I=1,NB)
2480 IF I18.NE.1) PRINT 186,(I16,I=1,NB)
2490 IF I18.NE.1) PRINT 188,(I17,I=1,NB)
2500 IF I18.NE.1) PRINT 190,(I18,I=1,NB)
2510 IF I18.NE.1) PRINT 192,(I19,I=1,NB)
2520 IF I18.NE.1) PRINT 194,(I20,I=1,NB)
2530 IF I18.NE.1) PRINT 196,(I21,I=1,NB)
2540 IF I18.NE.1) PRINT 198,(I22,I=1,NB)
2550 IF I18.NE.1) PRINT 200,(I23,I=1,NB)
2560 IF I18.NE.1) PRINT 202,(I24,I=1,NB)
2570 IF I18.NE.1) PRINT 204,(I25,I=1,NB)
2580 IF I18.NE.1) PRINT 206,(I26,I=1,NB)
2590 IF I18.NE.1) PRINT 208,(I27,I=1,NB)
2600 IF I18.NE.1) PRINT 210,(I28,I=1,NB)
2610 IF I18.NE.1) PRINT 212,(I29,I=1,NB)
2620 IF I18.NE.1) PRINT 214,(I30,I=1,NB)
2630 IF I18.NE.1) PRINT 216,(I31,I=1,NB)
2640 IF I18.NE.1) PRINT 218,(I32,I=1,NB)
2650 IF I18.NE.1) PRINT 220,(I33,I=1,NB)
2660 IF I18.NE.1) PRINT 222,(I34,I=1,NB)
2670 IF I18.NE.1) PRINT 224,(I35,I=1,NB)
2680 IF I18.NE.1) PRINT 226,(I36,I=1,NB)
2690 IF I18.NE.1) PRINT 228,(I37,I=1,NB)
2700 IF I18.NE.1) PRINT 230,(I38,I=1,NB)
2710 IF I18.NE.1) PRINT 232,(I39,I=1,NB)
2720 IF I18.NE.1) PRINT 234,(I40,I=1,NB)
2730 IF I18.NE.1) PRINT 236,(I41,I=1,NB)
2740 IF I18.NE.1) PRINT 238,(I42,I=1,NB)
2750 IF I18.NE.1) PRINT 240,(I43,I=1,NB)
2760 IF I18.NE.1) PRINT 242,(I44,I=1,NB)
2770 IF I18.NE.1) PRINT 244,(I45,I=1,NB)
2780 IF I18.NE.1) PRINT 246,(I46,I=1,NB)
2790 IF I18.NE.1) PRINT 248,(I47,I=1,NB)
2800 IF I18.NE.1) PRINT 250,(I48,I=1,NB)
2810 IF I18.NE.1) PRINT 252,(I49,I=1,NB)
2820 IF I18.NE.1) PRINT 254,(I50,I=1,NB)
2830 IF I18.NE.1) PRINT 256,(I51,I=1,NB)
2840 IF I18.NE.1) PRINT 258,(I52,I=1,NB)
2850 IF I18.NE.1) PRINT 260,(I53,I=1,NB)
2860 IF I18.NE.1) PRINT 262,(I54,I=1,NB)
2870 IF I18.NE.1) PRINT 264,(I55,I=1,NB)
2880 IF I18.NE.1) PRINT 266,(I56,I=1,NB)
2890 IF I18.NE.1) PRINT 268,(I57,I=1,NB)
2900 IF I18.NE.1) PRINT 270,(I58,I=1,NB)
2910 IF I18.NE.1) PRINT 272,(I59,I=1,NB)
2920 IF I18.NE.1) PRINT 274,(I60,I=1,NB)
2930 IF I18.NE.1) PRINT 276,(I61,I=1,NB)
2940 IF I18.NE.1) PRINT 278,(I62,I=1,NB)
2950 IF I18.NE.1) PRINT 280,(I63,I=1,NB)
2960 IF I18.NE.1) PRINT 282,(I64,I=1,NB)
2970 IF I18.NE.1) PRINT 284,(I65,I=1,NB)
2980 IF I18.NE.1) PRINT 286,(I66,I=1,NB)
2990 IF I18.NE.1) PRINT 288,(I67,I=1,NB)
3000 IF I18.NE.1) PRINT 290,(I68,I=1,NB)
3010 IF I18.NE.1) PRINT 292,(I69,I=1,NB)
3020 IF I18.NE.1) PRINT 294,(I70,I=1,NB)
3030 IF I18.NE.1) PRINT 296,(I71,I=1,NB)
3040 IF I18.NE.1) PRINT 298,(I72,I=1,NB)
3050 IF I18.NE.1) PRINT 300,(I73,I=1,NB)
3060 IF I18.NE.1) PRINT 302,(I74,I=1,NB)
3070 IF I18.NE.1) PRINT 304,(I75,I=1,NB)
3080 IF I18.NE.1) PRINT 306,(I76,I=1,NB)
3090 IF I18.NE.1) PRINT 308,(I77,I=1,NB)
3100 IF I18.NE.1) PRINT 310,(I78,I=1,NB)
3110 IF I18.NE.1) PRINT 312,(I79,I=1,NB)
3120 IF I18.NE.1) PRINT 314,(I80,I=1,NB)
3130 IF I18.NE.1) PRINT 316,(I81,I=1,NB)
3140 IF I18.NE.1) PRINT 318,(I82,I=1,NB)
3150 IF I18.NE.1) PRINT 320,(I83,I=1,NB)
3160 IF I18.NE.1) PRINT 322,(I84,I=1,NB)
3170 IF I18.NE.1) PRINT 324,(I85,I=1,NB)
3180 IF I18.NE.1) PRINT 326,(I86,I=1,NB)
3190 IF I18.NE.1) PRINT 328,(I87,I=1,NB)
3200 IF I18.NE.1) PRINT 330,(I88,I=1,NB)
3210 IF I18.NE.1) PRINT 332,(I89,I=1,NB)
3220 IF I18.NE.1) PRINT 334,(I90,I=1,NB)
3230 IF I18.NE.1) PRINT 336,(I91,I=1,NB)
3240 IF I18.NE.1) PRINT 338,(I92,I=1,NB)
3250 IF I18.NE.1) PRINT 340,(I93,I=1,NB)
3260 IF I18.NE.1) PRINT 342,(I94,I=1,NB)
3270 IF I18.NE.1) PRINT 344,(I95,I=1,NB)
3280 IF I18.NE.1) PRINT 346,(I96,I=1,NB)
3290 IF I18.NE.1) PRINT 348,(I97,I=1,NB)
3300 IF I18.NE.1) PRINT 350,(I98,I=1,NB)
3310 IF I18.NE.1) PRINT 352,(I99,I=1,NB)
3320 IF I18.NE.1) PRINT 354,(I100,I=1,NB)
3330 IF I18.NE.1) PRINT 356,(I101,I=1,NB)
3340 IF I18.NE.1) PRINT 358,(I102,I=1,NB)
3350 IF I18.NE.1) PRINT 360,(I103,I=1,NB)
3360 IF I18.NE.1) PRINT 362,(I104,I=1,NB)
3370 IF I18.NE.1) PRINT 364,(I105,I=1,NB)
3380 IF I18.NE.1) PRINT 366,(I106,I=1,NB)
3390 IF I18.NE.1) PRINT 368,(I107,I=1,NB)
3400 IF I18.NE.1) PRINT 370,(I108,I=1,NB)
3410 IF I18.NE.1) PRINT 372,(I109,I=1,NB)
3420 IF I18.NE.1) PRINT 374,(I110,I=1,NB)
3430 IF I18.NE.1) PRINT 376,(I111,I=1,NB)
3440 IF I18.NE.1) PRINT 378,(I112,I=1,NB)
3450 IF I18.NE.1) PRINT 380,(I113,I=1,NB)
3460 IF I18.NE.1) PRINT 382,(I114,I=1,NB)
3470 IF I18.NE.1) PRINT 384,(I115,I=1,NB)
3480 IF I18.NE.1) PRINT 386,(I116,I=1,NB)
3490 IF I18.NE.1) PRINT 388,(I117,I=1,NB)
3500 IF I18.NE.1) PRINT 390,(I118,I=1,NB)
3510 IF I18.NE.1) PRINT 392,(I119,I=1,NB)
3520 IF I18.NE.1) PRINT 394,(I120,I=1,NB)
3530 IF I18.NE.1) PRINT 396,(I121,I=1,NB)
3540 IF I18.NE.1) PRINT 398,(I122,I=1,NB)
3550 IF I18.NE.1) PRINT 400,(I123,I=1,NB)
3560 IF I18.NE.1) PRINT 402,(I124,I=1,NB)
3570 IF I18.NE.1) PRINT 404,(I125,I=1,NB)
3580 IF I18.NE.1) PRINT 406,(I126,I=1,NB)
3590 IF I18.NE.1) PRINT 408,(I127,I=1,NB)
3600 IF I18.NE.1) PRINT 410,(I128,I=1,NB)
3610 IF I18.NE.1) PRINT 412,(I129,I=1,NB)
3620 IF I18.NE.1) PRINT 414,(I130,I=1,NB)
3630 IF I18.NE.1) PRINT 416,(I131,I=1,NB)
3640 IF I18.NE.1) PRINT 418,(I132,I=1,NB)
3650 IF I18.NE.1) PRINT 420,(I133,I=1,NB)
3660 IF I18.NE.1) PRINT 422,(I134,I=1,NB)
3670 IF I18.NE.1) PRINT 424,(I135,I=1,NB)
3680 IF I18.NE.1) PRINT 426,(I136,I=1
```

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2234C
2235C **PRINT OUT THE INPUT DATA OF THE SIMPLE PROGRAM

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2200 000 PRINT 12,119,1GP,1SIMP,1CL,N8

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2280 TF,NB,GT,8,NQ=5
2290 PRINT 555,(I,I=1,NQ)
2300 PRINT 44,(I(I),I=1,NB)
2310 PRINT 66,(XX(I),I=1,NB)
2320 PRINT 28,(YY(I),I=1,NB)
2330 PRINT 30,(ZZ(I),I=1,NB)

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4

PROGRAM USA

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105 IDENT BLA00001,PRINT-KH,956700160409,KH
205 USERID BLA00001$DR,P
305 OPTION FORTRAN
505 MSG1 1, THIS PROGRAM USES 75K MEMORY
545 FORTRAN NDECK,NLSTIN
66C
67C
68C
69C
70C
71 SUBROUTINE PATT(APHI,ATHE,IW,ALT,AINT,AMAX,PIN,ALT,IY,FA)
72 COMMON X,Y,Z,X1,Y1,Z1,HC,NS,FP,AK,GP,NV,RE,AC,BC,IT,AZ,VA,ENG
73 1,GRER,PANEL,ANTELODIA,BTA,DBR,IF,IF,IRG
74 DIMENSION X(90),Y(90),Z(90),H(90),NS(90),AC(200),RNG(6),FA(40)
75 1,X1(90),Y1(90),Z1(90),IT(20),AZ(361),BC(200),ALT(6),ATH(6)
76 BK=AK*FP/3.58
77 B2=2.3437.76*6080,
78 B3=RE*.3*.3048*.5/3.
79 FX=1.E-7*AK*FP
80 J1=0
81 70 J1=J1+1
82 IF[FP,EQ.1,AND,IY,EQ.1] GO TO 31
83 IF[IT,EQ.1,AND,IY,EQ.2] GO TO 34
84 IF[ENG,EQ.1] GO TO 38
85 31 IF(J1,NE.1) ATHE=ATHE+AINT
86 GO TO 36
87 34 IF(J1,NE.1) APHI=APHI+AINT
88 36 PHI=APHI/57.29578
89 THE=ATHE/57.29578
90 GO TO 39
91C
92C
93C
94C
95C
97 38 READ(3,1) Z2,ELANG,DIST,RNG
98 IF(Z2,G.9998./57.29578) GO TO 100
99 AX=DTA*SIN(BTA)
100 AX=DTA*COS(BTA)
101 SX=DIS*STN(Z2)*.3048
102 SY=DIS*COB(Z2)*.3048
103 AIS=SQRT((SX-AX)**2+(SY-AY)**2)
104 PHI=ATAN2((SX-AX),(SY-AY))
105 IF(PHI,LT.0) PHI=PHI+2.*3.1415927
106 HSCBN=DIS*.3048*SIN(ELANG+DIST/R2)/COS(ELANG+DIST/R2)+TPANEL
107 THU=ATAN2(HSCBN-ANTELO-FX(IW),AIS)-AIS*.75/(R2*.3048)
108 THE=3.141593*.5-TTH
109 39 M=0
110 CP=COB(PHI)
111 CT=COB(TH)
112 SP=STN(PHI)
113 ST=STN(TH)

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```

114 AE=0.
115 BE=0.
116 NX=NE
117 IF(ME,EQ.0) NX=NN
118 I=0
119 DO 20 KS=1,NX
120 NK=1
121 MM=0
122 IF(NB,EQ.0) GO TO 3
123 IF(IT,KS).EQ.1097) NK=5
124 IF(IT,KS).EQ.197) NK=26
125 IF(MK,EQ.26,AND,KS,EQ.1W) NK=1
126 3 DO 20 KQ=1,NK
127 MM=0
128 I=1
129 IF(MK,NE.26) GO TO 56
130 IF(KQ,14) 50,50,54
131 50 IF(KQ,EQ.2) GO TO 56
132 MM=1
133 GO TO 56
134 54 MM=3
135 56 IF(X-1) 10,10,45
136 55 IF(MK,EQ.0) GO TO 5
137 IF(KQ,GT.3,AND,KQ,NE.15) GO TO 10
138 5 J=J-1
139 MM=NS(JJ)
140 10 NSI=NS(I)
141 NC=1
142 IF(GP) 12,14,12
143 12 IF(ZI) 14,13,14
144 13 NC=0
145 14 AK=NSI+NS
146 IF(KQ,GT.14) NG=0
147 IF(MK,EQ.26,AND,KQ,NE.2) AN=AN-1,
148 DO 20 J=1,NSI
149 A1=J-2+NS
150 NM=J
151 AK=GP
152 IF(J-1) 17,15,17
153 15 IF(ZI) 17,16,17
154 16 AA=0.
155 17 AP=1,AA
156 AN=1,AA
157 DO 20 L=1,3
158 AX=L
159 KK=L
160 A=1+AX*.5
161 IF(L,NE.2) GO TO 32
162 A2=1,
163 IF(MK,EQ.1,AND,J,EQ,NSI) NK=2
164 IF(MK,EQ.3,AND,J,EQ.1) NK=2
165 32 BB=KK

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BEST AVAILABLE COPY

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166 DO 20 X=1,KK
167 IF(J.NE.1.AND.L.EQ.1) GO TO 35
168 T=X(I)-X(I)
169 T2=Y(I)-Y(I)
170 T3=Z(I)-Z(I)
171 DK=ROI(J)*AN*.5
172 IF(M.NE.1.OR.J.NE.NSI) GO TO 60
173 IF(K.NE.2.AND.L.NE.3) GO TO 60
174 I=0
175 T2=0
176 T3=1
177 DK=.0075
178 GO TO 65
179#60 IF(M.NE.3.OR.J.NE.1) GO TO 65
180 IF(K.NE.1.AND.L.NE.3) GO TO 58
181#65 EO=SQRT(X(I)+T2-T3*T3)
182 DA=DK*A*/RO
183 P=X(I)+DA*T1
184 P=Y(I)+DA*T2
185 P=Z(I)+DA*T3
186 SS=DK*.5*.3.141593
187 IF(L.NE.2) A2=.5
188 DD=A*.DK/BB
189 DT=1*.C+CP*T2*CT*SP)/RO
190 DS=-13*SI/RO
191 PS=BX*(PX*CP+PY*SP)*SI
192 P3=COS(P3)
193 P4=SIN(P3)
194 P5=BX*CT*P2
195 P5=SIN(P2)
196 P6=COS(P2)
197#35 P1=P3*AC(N)+P4*BC(N)
198 P2=P3*BC(N)+P4*AC(N)
199 CS=P5*(DI*AP+DS*AP)
200 CC=P6*(DI*AM+DS*AP)
201 AE=AE-(P1*QC-P2*QS)*DD
202 BE=BE-(P1*QS-P2*QC)*DD
203#20 CONTINUE
204 BB=AE+BE*BE
205 AZ(J1)=FX*SORT(BB)
206 IF(IG.EQ.1.AND.IY.EQ.3) GO TO 72
207 IF(AZ(J1).GT.AMAX) AMAX=AZ(J1)
208 IF(IE.EQ.1.AND.IY.EQ.1.AND.ATHE.LE.AIT+.001-AINT) GO TO 70
209 IF(IT.EQ.1.AND.IY.EQ.2.AND.APHI.LE.AIT+.001-AINT) GO TO 70
210 GMAX=AMAX*MAX/PIN/30.
211 GDB=10*.ALOG10(GMAX)
212 WBITS(2,280) AMAX,GMAX,GDB
213 WBITS(6,280) AMAX,GMAX,GDB
214#280 FORMAT(/,E14.4,*,F6.3,*,GAIN=(DB)=*,F6.2)
215 GO TO 100
216 72 BPR=AZ(J1)/(BK*SORT(120.*DBM))
217 DO 80 I=1,NA
218 UU=RMG(I)*1852./F3
219 VV=ALT(I)*.3048*GRE1+R3
220 WM=ATEL*PA(IW)*R3
221 RR=SQRT(VV*.2+WM*.2-.**VV*VW*VW)
222 ALF=.1
223 IF(RR.EQ.1.VV-WW) ALF=(WM*.2+VV*.2-BER*.2)/(2.*VV*VV)
224 PPP=ARCOS(ALF)
225 IF(RR.EQ.1.8P) RMG(I)=R3*PPP/1852.
226 RG=1.E-5
227 IF(RMG(I).GT.1.E-8) RG=RMG(I)*.852.
228 QQ1=ALT(I)*.3048*GRE1-ATEL*PA(IW)/R3
229 QQ=ATN(QQ1)-RG/(R3*.2)
230 IF(RR.LT.RR) COC=TTT
231 ATN1=QQ*.57.29578
232 CONTINUE
233 ATN1=PHI*.57.29578
234 ATN1=90.-TH*.57.29578
235 WRITE(2,74) APH1,(RMG(I),I=1,NA)
236 WRITE(6,74) APH1,(RMG(I),I=1,NA)
237 74 FORMAT(F7.2,X,6F8.1/(6F8.1))
238 GO TO 70
239 RETURN
240 END
250# FORTAN NDECK,NLISTIN
251 SUBROUTINE FUV(DD,DE,YG,SUM,NDIM)
252 DIMENSION IB(13)
253 SUM=0
254 NDH=NDIM/211
255 DO 10 I=2,NDIM
256 HH=.5*DE
257 IF(I.LE.NDH) HH=.5*DD
258 SUM=SUM+HH*Y9(I)+Y9(I-1)
259#10 CONTINUE
260 RETURN
261 END
262# FORTAN NDECK,NLISTIN
263 FUNCTION ELP(P)
264 IF(P-1.) 3,5,0
265#4 WRITE(6,100) P
266 STOP
267#100 FORMAT(10X,'ILLEGAL ARGUMENT FOR ELP, ARG= ',E13.4)
268#5 ELP=.1
269 RETURN
270#3 AM1=-.P
271 ELP=.1+AM1*(.463015+.1077812*AM1-(2.452727+.0412496
272 X *AM1)*ALOG(AM1))
273 RETURN
274 END
275# FORTAN NDECK,NLISTIN
276 FUNCTION ELP(P)
277 IF(P-1.) 3,4,4
278#4 WRITE(6,100) P
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279 STOP
280#100 FORMAT(10X,'ILLEGAL ARGUMENT FOR ELK, ARG=',E13.4)
281#3 AM1=1-P
282 AM1=1-3.86294*AM1*(.1119+23+.0725298*AM1)-(.5+AM1*
283 X(.1213+78+.0288739*AM1))*ALOG(AM1)
284 RETURN
285 END
295$ FORTRAN NDECK,NLSTIN
296C
297C
298C *** CALCULATE THE ANTENNA POSITION (X,Y,Z) AND (X',Y',Z')
299C
300C
301 SUBROUTINE PRZ
302 COMMON X,Z,X1,Y1,Z1,HC,NS,PP,AK,GF,NK,NB,AC,BC,IT,AZ,NA,ENG
303 1,GRGL,FRAN,EL,ANTEL,DTA,ETA,DEM,IFP,IFT,IRG
304 DIMENSION H(90),X(90),Y(90),Z(90),X1(90),Y1(90),Z1(90)
305 1,NS(90),AC(200),BC(200),IT(20),AZ(361),ENG(6)
306 1,NS(90),AC(200),BC(200),IT(20),AZ(361),ENG(6)
307 NX=NN
308 IF(NB) 2,2,1
309 1 IF(NB,NE,0) READ(1,20) (IT(I),I=1,NB)
310 NX=NB
311 THO=15.0
312 PHO=0.
313 INX=THO*.0174533
314 C=COS(THX)
315 SIT=S*N(THX)
316#2 L=0
317 DO 319 IS=1,NX
318 NK=1
319 IF(NB,LO,0) GO TO 318
320 IF(IT,IS,EO,1097) NK=5
321 IF(IT,IS,EO,197) NK=26
322#318 DO 315 LQ=1,NK
323 L=L+1
324 AIS=LQ
325 IF(NB,EO,0) GO TO 305
326 IF(IT,IS,NE,197) GO TO 305
327 IF(LQ=2) 305,305,303
328#303 IF(LQ=14) 312,312,308
329#305 X1(L)=X(L)
330 Y1(L)=Y(L)
331 Z1(L)=Z(L)+H(L)
332 GO TO 315
333#308 PH1=30.*(ALS-15.)+PHO
334 PHX=PH1*.0174533
335 X1(L)=X(L)+H(L)*COS(PHX)
336 Y1(L)=Y(L)+H(L)*SIN(PHX)
337 Z1(L)=Z(L)
338 GO TO 315
339#312 PH1=30.*(ALS-3.)*PHO
340 PHX=PH1*.0174533
341
342 X1(L)=X(L)
343 Z1(L)=Z(L)
344 Y1(L)=Y1(L)+H(L)*SITCOS(PHX)
345 X1(L)=Y1(L)+H(L)*SIT*SIN(PHX)
346 Z1(L)=Z1(L)+H(L)*C
347#315 CONTINUE
348#319 CONTINUE
349#20 FORMAT(15,15I4)
350 RETURN
351 END
352 FORTRAN NDECK,NLSTIN
353 SUBROUTINE Q2B(K1,LG,IT,19,MX,MZ,KX,NP)
354 COMMON X,Z,X1,Y1,Z1,HC,NS,PP,AK,GF,NK,NB,AC,BC,IT,AZ,NA,ENG
355 1,GRGL,FRAN,EL,ANTEL,DTA,ETA,DEM,IFP,IFT,IRG
356 DIMENSION X(90),Y(90),Z(90),X1(90),Y1(90),Z1(90),AC(200),BC(200)
357 1,X1(90),Y1(90),Z1(90),IT(20),AZ(361),ENG(6)
358 J=0
359 DO 20 I=KX,K1
360 J=J+NP(I)
361 CONTINUE
362 MX=I-J
363 MZ=0
364 M1=L9+1
365 M2=L9+18
366 DO 50 J=Y1,M2
367 MZ=MZ+NS(J)
368 CONTINUE
369 RETURN
370 END
371 FORTRAN NDECK,NLSTIN
372
373 *** CALCULATE THE NORMALIZED RADIATION PATTERN
374
375 SUBROUTINE NPAT(AMAX,AIT,AINT)
376 COMMON X,Y,Z,X1,Y1,Z1,HC,NS,PP,AK,GF,NK,NB,AC,BC,IT,AZ,NA,ENG
377 1,GRGL,FRAN,EL,ANTEL,DTA,ETA,DEM,IFP,IFT,IRG
378 DIMENSION X(90),Y(90),Z(90),X1(90),Y1(90),Z1(90)
379 1,H(90),NS(90),AC(200),BC(200),IT(20),ENG(6)
380 I=0
381 ATH=-AINT
382 ATR=ATH+AIT
383 I=I+1
384 PH=Z(I)/AMAX
385 IF(PH,IT,1,E-5) GO TO 252
386 FDB=20.*ALOG10(FM)
387 GO TO 254
388 FDB=-1000.
389 WRITE(6,88) ATH,FM,FDB
390#254 WRITE(7,88) ATH,FM,FDB
391

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467 IF(ATH,LE,AIT+.001-AINT) GO TO 10
468#88 FORMAT(P5.0,P10.4,P10.2)
469 RETURN
470 END
488$ FORTAN NDECK,NLSTIN
489$ LIMITS ,30000.0
490C
491C
492C
493C
494C
495C
496 COMMON X,Y,Z,X1,Y1,Z1,HQ,NS,FP,AK,GP,NN,NB,AC,BC,IT,AZ,NA,RNG
497 1 GREL,TRANSEL,ANTEL,DTA,ETA,DBM,IEP,IFT,IRG
498 DIMENSION C(150,150),C2(150,150)
499 1 AZ(361),X1(90),NS(90),IF(90),Z(90),AV(90),BV(90)
500 2 AP(5),BP(5),Z2(5),AQ(5),BQ(5),LR(20),AT(20),C5(3,3),BC(200)
501 3 A3(13),B3(13),C3(5,16),C4(5,16),FR(10),IV(10),C6(3,3)
502 4 B2(90),X1(90),Y1(90),Z1(90),S3(5),EF(+),FF(4),NP(20),ALT(6)
503 CALL FANSTZ(03,9)
504 NS=11
505 NG=13
506 AN=NS-1
507 CN=NG-1
508
509C
510C
511C
512C
513C
514C
515C
516C
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531C
532C
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IF(ATH,LE,AIT+.001-AINT) GO TO 10
 FORMAT(P5.0,P10.4,P10.2)
 RETURN
 END
 FORTAN NDECK,NLSTIN
 LIMITS ,30000.0
 *** MAIN PROGRAM
 COMMON X,Y,Z,X1,Y1,Z1,HQ,NS,FP,AK,GP,NN,NB,AC,BC,IT,AZ,NA,RNG
 1 GREL,TRANSEL,ANTEL,DTA,ETA,DBM,IEP,IFT,IRG
 DIMENSION C(150,150),C2(150,150)
 1 AZ(361),X1(90),NS(90),IF(90),Z(90),AV(90),BV(90)
 2 AP(5),BP(5),Z2(5),AQ(5),BQ(5),LR(20),AT(20),C5(3,3),BC(200)
 3 A3(13),B3(13),C3(5,16),C4(5,16),FR(10),IV(10),C6(3,3)
 4 B2(90),X1(90),Y1(90),Z1(90),S3(5),EF(+),FF(4),NP(20),ALT(6)
 CALL FANSTZ(03,9)
 NS=11
 NG=13
 AN=NS-1
 CN=NG-1
 *** READ FILE USAIN1
 READ(1,10) NB,NN,KW,IT2,GP,CL
 READ(1,12) (HO(I),I=1,NN)
 READ(1,14) (BA(I),I=1,NN)
 READ(1,12) (X(I),I=1,NN)
 READ(1,12) (Y(I),I=1,NN)
 READ(1,12) (Z(I),I=1,NN)
 DO 4 I=1,NN
 B2(I)=0
 IF(I12,NE,0) READ(1,16) (BZ(I),I=1,NN)
 FORMAT(4F8.1,F9.6,2F6.1)
 READ(1,18) IEP,IFT,IRG,ATHE,APHI,AINT,AINEP
 IF(IRC,EQ,1) READ(1,17) GREL,TRANSEL,ANTEL,DTA,BTA,DBM,APIN
 IF(IRC,EQ,1) READ(1,12) (FA(I),I=1,NN)
 IF(IRC,EQ,1) READ(1,15) NA,(ALI(I),I=1,NA)
 DD=DBM
 DBM=1.E-3*10.**(DBM*.1)
 FORMAT(I3,(6F8.1))
 *** SPECIFY ANTENNA POSITION (X,Y,Z) AND (X1,Y1,Z1)
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990      ONE=K*P
995      ONE=ONE*EPS
1000      KK=ONE/3.EB
1010      XL=K*KK
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1018      K2=2
1019      IF(GP,EQ.0.) K2=1
1020      BLO=ALOG(2.)
1022      I1=0
1024      K3=0
1030      K=0
1032      NX=NB
1034      IF(NB,EQ.0) NX=NN
1040      DO 325 KS=1,NX
1041      MK=0
1042      NK=1
1043      NP(KS)=0
1044      IF(NB,EQ.0) GO TO 8
1045      IU=-1
1046      IF(IT(KS),EQ.1097) NK=5
1048      IF(IT(KS),EQ.197) NK=26
1049      IF(KK,EQ.26.AND.IW,EQ.KS) NK=1
1050#8      DO 324 KQ=1,NK
1052      K=K+1
1053      IF(KK,EQ.1.AND.KQ,GT.3.AND.KQ,NE.15) GO TO 324
1054      L=0
1056      MV=0
1080      K9=K-1
1090      KG=1
1100      IF(GP,NE.0..AND.Z(K),EQ.0.) KG=0
1110      AS=NS(K)+KG
1112      IF(NK=26) 298,290,298
1113#290      IF(KQ=2) 295,298,292
1114#292      IF(KQ=14) 295,295,294
1115#294      MV=2
1116      AS=AS-1.
1117      GO TO 294
1118#295      MV=1
1119      AS=AS-1.
1124#298      DK=KQ(K)/AS
1126      NP(KS)=NP(KS)+NS(K)
1130      IF(K,EQ.1) GO TO 26
1140#182      II=I+NS(K9)
1150#26      NSK=NS(K)
1155      J=0
1156      DO 80 LS=1,NX
1157      NL=1
1158      ML=0

```

*** CALCULATE THE GENERALIZED IMPEDANCE MATRIX C1,C2

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1160      ONE=K*P
1161      ONE=ONE*EPS
1162      KK=ONE/3.EB
1164      XL=K*KK
1166#9      DO 80 LQ=1,NL
1167      L=1+1
1172      L9=L-1
1190      KG=0
1192      KQ=1
1195      IF(K,NE.1.OR.PA(L),IT,.02*ALAM) KG=0
1197      IF(GP,NE.0..AND.Z(K),EQ.0.) KG=0
1200      LG=1
1210      IF(GP) 126,128,126
1220#126      IF(Z11) 128,127,128
1230#127      LG=0
1240#128      AT=NS(L)+LG
1241      MW=0
1242      IF(NL=26) 288,281,288
1243#281      IF(LQ=2) 285,288,282
1244#282      IF(LQ=14) 285,285,284
1245#284      MW=2
1246      AT=AT-1.
1247      GO TO 288
1251#285      MW=1
1253      AT=AT-1.
1257#288      DL=HOLL*.5/AT
1258      IF(K,NE.1.OR.PA(L),IT,.02*ALAM) LG=0
1266      ALP=DL*.5
1269      XKD=X*ALP
1272      AP1=1.005*ALP
1275      AKL=A*ALP
1278      XDXKD=XKD
1281      AW=2.*ALP/AN
1284      IF(LQ) 28,26,180
1285#180      IF(ML,EQ.0) GO TO 134
1286      IF(LQ,GT.3.AND.LQ,NE.15) GO TO 28
1287#134      J=J+NS(L9)
1290#28      NSL=NS(L)
1293      DO 460 KK=1,K2
1300      NI=1
1301      G=3-2*KK
1302      IF(KK=1) 162,146,162
1305#146      IF(NB) 148,164,148
1306#148      IF(KS=15) 440,430,440
1307#430      IF(LS,EQ.1) GO TO 440
1308      IF(IU,EQ.0) GO TO 440
1309      IF(IU,GT.0) GO TO 460
1311      L8=26
1312      IS(IT,LS),EQ.197.AND.LS,NE.IW) GO TO 435
1313      IF(IT,LS),NE.1097) GO TO 440
1314      IF(LS,EQ.IW.AND.CL,EQ.0.) GO TO 440
1315      L8=5

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1316#435	IX=LS	1381	IF(II(KS),EQ,1000) GO TO 31
1317	K1=LS-1	1382	IF(KK-1) 31,25,31
1318	IU=0	1383#25	IF(ML,EQ,26,OR,NK,EQ,26) GO TO J2
1319	DO 438 JX=1,K1	1385	IF(L-X) 78,27,31
1320	IF(L8-10) 445,445,443	1386#27	IF(N1-1) 29,29,72
1321#443	IF(JX,EQ,IN,OR,II(JX),NE,197) GO TO 438	1387#29	IF(K9) 173,31,173
1322	GO TO 445	1389#173	IF(K8) 31,31,174
1323#445	IF(II(JX),NE,1097,OR,(JX,EQ,IN,AND,CL,EQ,0.)) GO TO 438	1390#174	CC=C3(KR,N)
1325#448	IU=IU+1	1391	CD=CU(K9,N)
1326	KX=JX	1392	GO TO 76
1327#438	CONTINUE	1393#32	IF(KS,NE,LS) GO TO 31
1328	IF(IU,EQ,0) GO TO 440	1395	IF(KK,EQ,2) GO TO 11
1329	CALL QZP(K1,L8,II,L9,MX,MZ,KX,NF)	1398	IF(ML,EQ,1) GO TO 11
1335	DO 450 I=1,MZ	1399	IF(KQ,LE,3,AND,LQ,LE,3) GO TO 31
1336	MP=MX+I	1400	IF(LQ,NE,3,AND,LQ,NE,15) GO TO 36
1337	KH=II+I	1401	IF(KQ,GT,3,AND,KQ,NE,15) GO TO 37
1338	DO 450 JX=1,MZ	1402	GO TO 31
1339	MO=MX+JX	1403#36	IF(KQ,EQ,3,OR,KQ,EQ,15) GO TO 31
1340	LN=II+JX	1404	JR=0
1341	C1(KR,LN)=C1(MP,MO)	1405	JR=0
1342	C2(KR,LN)=C2(MP,MO)	1406	IF(KQ,GE,4,AND,KQ,NE,15) JP=NS(K)
1343#450	CONTINUE	1407	IF(LQ,GE,4,AND,LQ,NE,15) JQ=NS(L)
1344	GO TO 460	1408	GO TO 40
1345#440	IF(K9) 164,164,138	1409#11	IF(KQ,GT,2) GO TO 31
1346#138	IF(K-L) 164,139,164	1410	IF(LQ,LE,3,OR,LQ,EQ,15) GO TO 31
1347#139	IF(ML,EQ,26,OR,II(KS),EQ,1000) GO TO 164	1411	CC=C5(M,N)
1348	DO 152 K5=1,K9	1412	CD=C6(M,N)
1349	RR=RA(K5)+BA(K)	1413	GO TO 76
1350	HH=HO(K5)+HO(K)	1414#31	ZL1=N-1+L3
1351	HN=NS(K5)+NS(K)	1415	CC=0.
1352	HH=RR+RR+HH+HH+HN	1416	CD=0.
1353	IF(RH-1,2+6) 150,152,152	1419	MC=4
1354#150	DO 156 K7=1,K3	1422	IF(K,NE,L,OR,RA(L),L1,Q2*ALAM) MC=1
1355	K8=K7	1425	DO 69 MN=1,MC
1356	IF(LR(K7)-K5) 156,154,156	1427	IF(MC,EQ,1) GO TO 35
1357#156	CONTINUE	1428	IF(N-N1) 34,35,34
1358#154	GO TO 164	1434#34	IF(MN-3) 64,35,35
1359#152	CONTINUE	1437#35	MN=M-1
1360	GO TO 164	1440	ZL=ZL1+ZL1-1.5+AMN
1361#162	IF(ZL1) 164,158,164	1443	IF(MC,EQ,4) GO TO 329
1362#158	M1=2	1446	ZL=ZL1+.5
1363#164	KP=(K-1)*Q2+(K-L)**2	1447	IF(GP,NE,0,AND,Z(L),EQ,0.) ZL=ZL-1
1364	DO 455 N=1,MSK	1450	JO=11-(KX-1)*4
1365	KH=II+M	1451	IF(NL,LE,K) GO TO 108
1366	IF(KP) 23,22,23	1452	IF(ML,EQ,0) JO=7-(KK-1)*2
1367#22	IF(NL,EQ,26) GO TO 23	1453	IF(ML,EQ,0,AND,CL,EQ,0.) JQ=S
1371	M1=M	1454#108	IF(KS,NE,LS) JQ=3
1374#23	ZKM=1+K	1455	QJ=JO-1
1375	ZKR=2(K)+DK*2K	1456	KR=JQ/2+1
1376	IF(GP,NE,0,AND,Z(K),EQ,0.) ZK=ZK-1	1458	QR=KT-1
1377	DO 78 N=M1,MSL	1459	JY=1
1380	LN=J+M	1460	IF(N,EQ,N1,OR,JQ,EQ,3) GO TO 361

1461 JY=2
1462 AJ(I)=X(JJ)
1463 B3(I)=B3(JT)
1464#361 JT=JQ
1466 DO 360 JJ=JY,JT
1467 AJ=JJ-1
1468 DL=HO(L)/AT
1469 IF(JJ,LE,RT) DD=DL/QJ
1470 DE=DL/QJ
1471 ZD=(ZL+AJ/QJ)*DL
1472 ZQ=BA(L)
1473 Y=X(L)-X(LY)
1474 Z=Y(L)-Y(L)
1475 Z3=Z(L)-Z(L)
1476 R1=SQRT(T1*T1+T2*T2+T3*T3)
1477 IF(JJ,LE,RT,OR,MW,NE.1) GO TO 363
1478 IF(M,NE,NSL) GO TO 363
1479 DL=HX
1480 DE=DL/QJ
1481 RQ=.002
1482 X1=0.
1483 X2=0.
1484 X3=1.
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1503 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
1504 IF(M,NE.1) GO TO 366
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1525 Z1=Z(L)
1526 R1=SQRT(T1*T1+T2*T2+T3*T3)
1527 GO TO 370
1528 IF(JJ,GT,RT,OR,MW,NE.2) GO TO 366
1529 IF(M,NE.1) GO TO 366
1530 DL=HX
1531 DD=DL/QJ
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1534 Z1=0.
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2039 R1=1.
2040 X1=X(L)
2041 Y1=Y(L)
2042 Z1=Z(L)
2043 R1=SQRT(T1*T1+T2*T2+T3*T3)
2044 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2045 IF(M,NE.1) GO TO 366
2046 DL=HX
2047 DD=DL/QJ
2048 RQ=.002
2049 Y1=0.
2050 Z1=0.
2051 R1=1.
2052 X1=X(L)
2053 Y1=Y(L)
2054 Z1=Z(L)
2055 R1=SQRT(T1*T1+T2*T2+T3*T3)
2056 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2057 IF(M,NE.1) GO TO 366
2058 DL=HX
2059 DD=DL/QJ
2060 RQ=.002
2061 Y1=0.
2062 Z1=0.
2063 R1=1.
2064 X1=X(L)
2065 Y1=Y(L)
2066 Z1=Z(L)
2067 R1=SQRT(T1*T1+T2*T2+T3*T3)
2068 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2069 IF(M,NE.1) GO TO 366
2070 DL=HX
2071 DD=DL/QJ
2072 RQ=.002
2073 Y1=0.
2074 Z1=0.
2075 R1=1.
2076 X1=X(L)
2077 Y1=Y(L)
2078 Z1=Z(L)
2079 R1=SQRT(T1*T1+T2*T2+T3*T3)
2080 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2081 IF(M,NE.1) GO TO 366
2082 DL=HX
2083 DD=DL/QJ
2084 RQ=.002
2085 Y1=0.
2086 Z1=0.
2087 R1=1.
2088 X1=X(L)
2089 Y1=Y(L)
2090 Z1=Z(L)
2091 R1=SQRT(T1*T1+T2*T2+T3*T3)
2092 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2093 IF(M,NE.1) GO TO 366
2094 DL=HX
2095 DD=DL/QJ
2096 RQ=.002
2097 Y1=0.
2098 Z1=0.
2099 R1=1.
2100 X1=X(L)
2101 Y1=Y(L)
2102 Z1=Z(L)
2103 R1=SQRT(T1*T1+T2*T2+T3*T3)
2104 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2105 IF(M,NE.1) GO TO 366
2106 DL=HX
2107 DD=DL/QJ
2108 RQ=.002
2109 Y1=0.
2110 Z1=0.
2111 R1=1.
2112 X1=X(L)
2113 Y1=Y(L)
2114 Z1=Z(L)
2115 R1=SQRT(T1*T1+T2*T2+T3*T3)
2116 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2117 IF(M,NE.1) GO TO 366
2118 DL=HX
2119 DD=DL/QJ
2120 RQ=.002
2121 Y1=0.
2122 Z1=0.
2123 R1=1.
2124 X1=X(L)
2125 Y1=Y(L)
2126 Z1=Z(L)
2127 R1=SQRT(T1*T1+T2*T2+T3*T3)
2128 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2129 IF(M,NE.1) GO TO 366
2130 DL=HX
2131 DD=DL/QJ
2132 RQ=.002
2133 Y1=0.
2134 Z1=0.
2135 R1=1.
2136 X1=X(L)
2137 Y1=Y(L)
2138 Z1=Z(L)
2139 R1=SQRT(T1*T1+T2*T2+T3*T3)
2140 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2141 IF(M,NE.1) GO TO 366
2142 DL=HX
2143 DD=DL/QJ
2144 RQ=.002
2145 Y1=0.
2146 Z1=0.
2147 R1=1.
2148 X1=X(L)
2149 Y1=Y(L)
2150 Z1=Z(L)
2151 R1=SQRT(T1*T1+T2*T2+T3*T3)
2152 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2153 IF(M,NE.1) GO TO 366
2154 DL=HX
2155 DD=DL/QJ
2156 RQ=.002
2157 Y1=0.
2158 Z1=0.
2159 R1=1.
2160 X1=X(L)
2161 Y1=Y(L)
2162 Z1=Z(L)
2163 R1=SQRT(T1*T1+T2*T2+T3*T3)
2164 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2165 IF(M,NE.1) GO TO 366
2166 DL=HX
2167 DD=DL/QJ
2168 RQ=.002
2169 Y1=0.
2170 Z1=0.
2171 R1=1.
2172 X1=X(L)
2173 Y1=Y(L)
2174 Z1=Z(L)
2175 R1=SQRT(T1*T1+T2*T2+T3*T3)
2176 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2177 IF(M,NE.1) GO TO 366
2178 DL=HX
2179 DD=DL/QJ
2180 RQ=.002
2181 Y1=0.
2182 Z1=0.
2183 R1=1.
2184 X1=X(L)
2185 Y1=Y(L)
2186 Z1=Z(L)
2187 R1=SQRT(T1*T1+T2*T2+T3*T3)
2188 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2189 IF(M,NE.1) GO TO 366
2190 DL=HX
2191 DD=DL/QJ
2192 RQ=.002
2193 Y1=0.
2194 Z1=0.
2195 R1=1.
2196 X1=X(L)
2197 Y1=Y(L)
2198 Z1=Z(L)
2199 R1=SQRT(T1*T1+T2*T2+T3*T3)
2200 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2201 IF(M,NE.1) GO TO 366
2202 DL=HX
2203 DD=DL/QJ
2204 RQ=.002
2205 Y1=0.
2206 Z1=0.
2207 R1=1.
2208 X1=X(L)
2209 Y1=Y(L)
2210 Z1=Z(L)
2211 R1=SQRT(T1*T1+T2*T2+T3*T3)
2212 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2213 IF(M,NE.1) GO TO 366
2214 DL=HX
2215 DD=DL/QJ
2216 RQ=.002
2217 Y1=0.
2218 Z1=0.
2219 R1=1.
2220 X1=X(L)
2221 Y1=Y(L)
2222 Z1=Z(L)
2223 R1=SQRT(T1*T1+T2*T2+T3*T3)
2224 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2225 IF(M,NE.1) GO TO 366
2226 DL=HX
2227 DD=DL/QJ
2228 RQ=.002
2229 Y1=0.
2230 Z1=0.
2231 R1=1.
2232 X1=X(L)
2233 Y1=Y(L)
2234 Z1=Z(L)
2235 R1=SQRT(T1*T1+T2*T2+T3*T3)
2236 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2237 IF(M,NE.1) GO TO 366
2238 DL=HX
2239 DD=DL/QJ
2240 RQ=.002
2241 Y1=0.
2242 Z1=0.
2243 R1=1.
2244 X1=X(L)
2245 Y1=Y(L)
2246 Z1=Z(L)
2247 R1=SQRT(T1*T1+T2*T2+T3*T3)
2248 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2249 IF(M,NE.1) GO TO 366
2250 DL=HX
2251 DD=DL/QJ
2252 RQ=.002
2253 Y1=0.
2254 Z1=0.
2255 R1=1.
2256 X1=X(L)
2257 Y1=Y(L)
2258 Z1=Z(L)
2259 R1=SQRT(T1*T1+T2*T2+T3*T3)
2260 IF(JJ,LE,RT,OR,MW,NE.2) GO TO 366
2261 IF(M,NE.1) GO TO 366
2262 DL=HX
2263 DD=DL/QJ
2264 RQ=.002
2265 Y1=0.
2266 Z1=0.
2267 R1=1.
2

1737 D2=P2K+2H*U3/R0
1740 W2=(P2L-D1)/SD
1743 W2=(P2L-D1)/SD
1746 W2=(P2L-G-D21)/SD
1749 R4=SQRT(C)
1752 R5=SQRT(P4*2+P5*2+P6*2+P0*2)
1755 X2=XK*R4
1758 SR=SIN(XR)
1761 CR=COS(XR)
1764 X2=XK*R5
1767 ST=SIN(XT)
1770 CT=COS(XT)
1773 Z2=2H-DK*(2-AJX)
1774 IF(ABS(Z1).LT.1.E-15) Z1=0.
1776 W2=Z1*Z1
1779 IF(JX-1) 380,380,384
1782#380 WD=RS*R5
1785 W2=XI*VD
1788 E2=30.*((-SR/R4+CS*ST/RS)/SN-ZI*(ST-XI*CT)/WR)
1791 E2=30.*((-CR/R4+CS*CT/RS)/SN-ZI*(CT+XI*ST)/WR)
1794 E2=30.*((-2H*SR/R4-ZI*CS*ST/RS)/SN-(XT*WS*CT+(WD-WS)*ST
1797 1 J/WR)/SD
1800 E2=30.*((-2H*CR/R4-ZI*CS*CT/RS)/SN-((WD-WS)*CT-XI*WS*ST
1803 1 J/WR)/SD
1806 GO TO 386
1809#384 WD=R4*R4
1812 W2=XI*VD
1815 E2=30.*((-ST/RS+CS*SR/R4)/SN+ZI*(SR-XR*CR)/WR)
1818 E2=30.*((-CT/RS+CS*CR/R4)/SN+ZI*(CR+XR*SR)/WR)
1820 Z2=2H-DK
1821 E2=30.*((-2H*CS*SR/R4+ZI*ST/RS)/SN+(XR*WS*CR+(WD-WS)*SR
1824 1 J/WR)/SD
1827 E2=30.*((-2H*CS*CR/R4+ZI*CT/RS)/SN+((WD-WS)*CR-XR*WS*SR
1830 1 J/WR)/SD
1833#386 E2=E3*WX+E1*U1/R0
1836 F2=E4*WX+E2*U1/R0
1839 E2=E3*WY+E1*U2/R0
1842 F2=E4*WY+E2*U2/R0
1845 E2=E3*WZ+E1*U3/R0
1848 F2=E4*WZ+E2*U3/R0
1851 A3(JJJ)=((E1*Y1+EY*Y2)*G+EZ*Y3)/R1+A3(JJ)
1854#350 B3(JJJ)=((F1*Y1+FY*Y2)*G+FZ*Y3)/R1+B3(JJ)
1855#360 CONTINUE
1856 IF(KS-15) 362,364,362
1857#362 E2=A3(2)*((DD+DE)
1858 E2=B3(2)*((DD+DE)
1859 GO TO 368
1860#364 CALL FUN(DD,DE,A3,EF,JQ)
1861 CALL FUN(DD,DE,B3,EG,JQ)
1862#368 AQ(FN)=-EF
1866 BQ(FN)=-EG
1870 AM=1.

1916 GO TO 57
1919#329 P2L=2(L)*DL*ZL
1920 PL=1.
1921 IF(G) 330,335,335
1922#330 PL=1.
1929#335 R3=OK*.5
1930 R3=DL*.5
1936 XX=X(X)-X(L)
1941 YY=Y(X)-Y(L)
1946 S3(1)=P2K-P21*G
1947 S3(2)=S3(1)+R33*43
1948 S3(3)=S3(1)-R33-43
1949 S3(4)=S3(1)+R33-43
1950 S3(5)=S3(1)-R33+43
1960 OX=OMR*X40*DK*DL
1960 DO 60 I=1,5
1990 Z2(I)=S3(I)
1992 C=XX*2+YY*2+Z2(I)*2+PA(1)*2
1994 Z2=Z2(I)*Z2(I)
2000 A2=CL*Z
2010 B=SQRT(C)
2020 ABZ=ABS(Z2(I))
2030 IF(B=10.*ALP) 42,38,38
2040 ACOS=COS(XK*B)/(2.*AK*B)
2070#38 B2IN=SIGN(XK*B)/(2.*AK*B)
2080 Z2=2J/C
2090 IF(ZR*.LT.1.E-10) ZR2=0.
2095 ZR2=ZR2*ZR2
2100 DR2=ALP*ALP/C
2110 H2=1+.3.*ZR2/6.+(3.-30.*ZR2+35.*ZR4)/40.*DR2
2120 A2=Z2/6.-DR2*(1.-12.*ZR2+15.*ZR4)/40.
2130 A2=A2*1.E5
2135 X2R=1.E5*XD*ZR4/120.
2140 PST1=1.+DR2*H+XD*(A2+X2R)*1.E-5
2150 PST2=XKD*(H+XD*(3.*ZR2-5.*ZR4)/40.)*ALP/B
2160 GO TO 50
2290#42 C=AA*2+ZJ
2300 B=SQRT(C)
2310 ACOS=COS(XK*B)/AK
2320 B2IN=SIGN(XK*B)/AK
2330 A2=XL*B*.5
2340 A1=(1.-X1*C*.5)/AKL
2350 A2=XL*.5/AKL
2360 B2X1=1.-5*XL*(C*.25*(ALP*ALP/3.+C*AA1/12.))
2370 B1=XK*B*(1.-XL*C/6.)/AKL
2380 B2=XX*XL*B*.5/AKL
2390 DO 45 M2=1,N5
2400 BM=M2-1
2410 Z2=ALP*((BN+BM)/AN-1.)
2420 Z2=Z2(I)-2P
2430 Z2=4.*AA*ZY*ZX
2440 Z2=SQRT(Z3)

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2850      P=1,AA/23
2860      B3I2)=ELR(P)*Z2
2870      IF(AB2-AP1) 45,45,39
2880#39   A3I2)=ELR(P)/Z2
2890#45   CONTINUE
2900      CALL FUN(AW,AV,B3,B5,N5)
2910      IF(AB2-AP1) 46,46,44
2920#44   CALL FUN(AW,AV,A3,A5,N5)
2930      GO TO 48
2940#46   A1=1
2950      IF(AB2-1.8-5) 52,53,53
2960#52   A1=2
2970#53   DO 47 M2=1,N6
2980      BN=M2-1
2990      TP=AK*.25*BN/CN
3000      S=SIN(TP)
3010      Y3=ALP*ALP+AA*S*S*A1*A1
3020      Y2=ALP*SIN(TP)
3030      Y7=Y2/(A1+RA(L))
3040#47   A3I2)=ALOG(Y7)
3050      CALL FUN(CN,CW,A3,A4,N6)
3060      AS=A1*(.5*AK*BL0+2.*WA4)*.5
3070#48   PSI1=A0+A1*A5+A2*B5
3080      PSI2=30+B1*A5+B2*B5
3090#50   A1(1)=ACOS*PSI1-B5IN*PSI2
3100      B1(1)=B5IN*PSI1+ACOS*PSI2
3110#60   CONTINUE
3120#56   AQ(MN)=OX*BP(1)+(BP(4)+BP(5)-BP(2)-BP(3))/CMP
3130      BQ(MN)=CX*AP(1)-(AP(4)+AP(5)-AP(2)-AP(3))/ONP
3140      GO TO 69
3150#64   AQ(MN)=AQ(MN+2)
3160      BQ(MN)=BQ(MN+2)
3170      AM=.75
3180#68   IF(MN-1) 55,55,54
3190#54   IF(MN-4) 57,55,55
3200#55   AM=.25
3210#57   CC=AQ(MN)*AM+CC
3220#69   CD=BQ(MN)*AM+CD
3230      IF(KK+E2.2) GO TO 76
3240      IF(KS+E5.15-OR.ML.EQ.0) GO TO 41
3250      IF(KQ.GT.2) GO TO 41
3260      IF(LQ.E2.3-OR.LQ.EQ.15) GO TO 49
3270#41   IF(ML.E2.26-OR.IT(KS).EQ.1000) GO TO 76
3280      IF(KP) 76,160,76
3290#160   IF(MB) 161,76,161
3300#161   IF(M-1) 167,166,167
3310#166   K3=K3+1
3320#167   C3(K3,M)=CC
3330      C4(K3,M)=CD
3340      LR(K3)=K
3350      GO TO 76
3360#49   C5(M,N)=CC
3370      C6(M,N)=CD
3380      I3=15
3390      IF(KQ.E2.15) I3=3
3400      I1=KM-NS(K)+{KQ-I3}
3410      J1=LN+NS(I)+{I2+I3-KQ}
3420      GO TO 43
3430      I1=KM-TP
3440      J1=LN-J2
3450      C1(KM,LN)=C1(I1,J1)
3460      C2(KM,LN)=C2(I1,J1)
3470      GO TO 78
3480      K1=KM-1
3490      L2=LN-1
3500      C1(KM,LN)=C1(K1,L2)
3510      C2(KM,LN)=C2(K1,L2)
3520      C1(LN,KM)=C1(KM,LN)
3530      C2(LN,KM)=C2(KM,LN)
3540      GO TO 78
3550      C1(KM,LN)=CC+C1(KM,LN)
3560      C2(KM,LN)=CD+C2(KM,LN)
3570      IF(KK.E2.1-AND.(NL.NE.26-AND.NK.NE.26)) GO TO 79
3580      CONTINUE
3590      CONTINUE
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3240#102      CONTINUE
3250      LS=LR(M)
3260      LR(M)=LR(K)
3270      LR(K)=LS
3280      STOR=C1(K,M)
3290      STOR=C2(K,M)
3300      SD=STOR1*STOR1+STOR2*STOR2
3310      DO 107 J=1,NX
3320      STOR1=C1(K,J)
3330      STOR2=C2(K,J)
3340      C1(K,J)=C1(M,J)
3350      C2(K,J)=C2(M,J)
3360      C1(M,J)=(STOR1*STOR1+STOR2*STOR2)/SD
3370#107      C2(M,J)=(STOR2*STOR1-STOR1*STOR2)/SD
3380      C1=C1(M,M)
3390      C1(M,M)=(C1(M,M)*STOR1+C2(M,M)*STOR2)/SD
3400      C2(M,M)=(C2(M,M)*STOR1-C1(M,M)*STOR2)/SD
3410      DO 114 I=1,NX
3420      IF(I,M) 112,118,112
3430#112      ST1=C1(I,M)
3440      ST2=C2(I,M)
3450      C1(I,M)=0
3460      C2(I,M)=0
3470      DO 110 J=1,NX
3480      C1(I,J)=C1(I,J)-C1(M,J)*ST1+C2(M,J)*ST2
3490      C2(I,J)=C2(I,J)-C2(M,J)*ST1+C1(M,J)*ST2
3500#110      CONTINUE
3510#118      CONTINUE
3520      DO 109 J=1,NX
3530#114      LRJ=LR(J)
3540      DO 113 I=1,NX
3550      T=C1(I,LRJ)
3560      T2=C2(I,LRJ)
3570      C1(I,LRJ)=C1(I,J)
3580      C2(I,LRJ)=C2(I,J)
3590      C1(I,J)=T
3600#113      C2(I,J)=T2
3610      LRJ=J
3620      LR(J)=LR(LRJ)
3630      LR(LRJ)=J
3640      IF(J-LR(J)) 114,109,114
3650#109      CONTINUE
3660      ITIN=0
3670      DO 65 I=1,NM
3680      AC(I)=0
3690      BC(I)=0
3700      DO 51 J=1,NX
3712      ABV=AV(J)**2+BV(J)**2
3714      IF(ABV,1,1E-8) GO TO 51
3716      K=IF(J)
3720      AC(I)=AC(I)+C1(I,K)*AV(J)-C2(I,K)*BV(J)
3725      BC(I)=BC(I)+C1(I,K)*BV(J)+C2(I,K)*AV(J)
3730#51      CONTINUE
3740#65      CONTINUE
3743C
3744C
3745C
3746C
3747C
3750
3760      PIN=0
3770      MX=1
3780      AA=1
3790      DO 246 I=1,NM
3800      K=IF(I)
3810      IF(NB,NE,0) GO TO 244
3815      IF(I,EQ,1) GO TO 242
3820      IF(I,EQ,2) GO TO 240
3830#242      MX=MX+NS(I)
3840#244      IF(K,EQ,MX,AND,Z(I),EQ,0,AND,GP,EQ,1) AA=.5
3845#246      PIN=PIN+AA*(AC(K)*AV(I)+BC(K)*BV(I))
3850      CONTINUE
3860      IF(IG,EQ,0) APIN=PIN
3865      IF(IG,EQ,0) GO TO 316
3870      IPIN=PIN+1
3880      IF(IPIN,GT,1) GO TO 316
3890      PSQ=SQRT(APIN/PIN)
3900      DO 312 I=1,NM
3910      AV(I)=AV(I)*PSQ
3920      BV(I)=BV(I)*PSQ
3930      IF(IPIN,EQ,1) GO TO 314
3940      IF(C1,EQ,0) GO TO 70
3980C
3988C
3990C
3991C
3992C
4005      WRITE(2,63)
4010      WRITE(6,63)
4015#63      FORMAT(//, ' COUPLING COEFFICIENT')
4020      WRITE(2,120)
4025      WRITE(6,120)
4030#120      FORMAT(/, ' ANTENNA NO.      POWER RECEIVED (DB)')
4035      N=0
4040      DO 140 I=1,NB
4045      MX=1
4050      IF(IT(I),EQ,197) NX=26
4055      IF(IT(I),EQ,1097) NX=5
4060      PRE=0
4065      DO 130 K=1,NX

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4070 M=M+1
4075 IF(IX, EQ, 26, AND, K, GT, 2) GO TO 130
4080 J=L(I, M)
4085 PREPARE=AZ[N]*(AC(J)*AC(J)+BC(J)*BC(J))
4090#130 CONTINUE
4095 IF(I, EQ, 1, OR, IT(I), EQ, 1000) GO TO 140
4100 A=PRE/DIN
4102 NDB=100
4105 IF(A, GT, 1, E-10) NDB=10.*ALOG10(A)
4110 WRITE(2, 125) I, ADB
4115 WRITE(6, 125) I, ADB
4120#125 FORMAT(16, 13X, F10.2)
4125#140 CONTINUE
4130#70 IF(IPT, EQ, 0) GO TO 82
4198C
4199C
4200C
4201C
4202C
4220 WRITE(6, 71)
4230 WRITE(2, 71)
4240#71 FORMAT(//, ' VERTICAL PATTERN')
4250 WRITE(2, 73) APHI
4260 WRITE(6, 73) APHI
4270#73 FORMAT(/, ' PHI=', F7.1)
4280#74 FORMAT(/, ' THETA' NMAG NMAG(DB))
4290 AIT=91
4300 IF(OP, EQ, 1.) AIT=91
4305 AMAX=0.
4310 ATH=0.
4315 IX=1
4320 CALL PAIT(APHI, ATHE, IM, AIT, AINT, AMAX, APIN, ALT, IY, FA)
4390 WRITE(2, 74)
4400 WRITE(6, 74)
4410 CALL NPAT(AMAX, AIT, AINT)
4420#82 IF(IPT, EQ, 0) GO TO 83
4423C
4424C
4425C
4426C
4427C
4430 WRITE(6, 201)
4440 WRITE(2, 201)
4450#201 FORMAT(//, ' HORIZONTAL PATTERN')
4460 WRITE(2, 81) ATHE
4470 WRITE(6, 81) ATHE
4480#81 FORMAT(/, ' THETA=', F7.1)
4490#85 FORMAT(/, ' PHI' NMAG NMAG(DB))
4500 AMAX=0.
4510 IY=2
4580 AIP=361.
4581 APH=0.

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4582 CALL PAIT(APH, ATHE, IM, AIP, AINE, AMAX, APIN, ALT, IY, FA)
4590 WRITE(2, 85)
4600 WRITE(6, 85)
4610 CALL NPAT(AMAX, AIP, AINE)
4615#83 IF(IREG, EQ, 0) GO TO 100
4638C
4639C
4640C
4641C
4642C
4650 WRITE(2, 86)
4660 WRITE(6, 86)
4670#86 FORMAT(/, ' COMMUNICATION RANGE CONTOUR')
4680 WRITE(2, 99) (ALT(I), I=1, NA)
4690 WRITE(6, 99) (ALT(I), I=1, NA)
4700#87 FORMAT(/, ' PHI( DEG)', 12X, ' RANGE(MM)')
4705 WRITE(2, 87)
4706 WRITE(6, 87)
4708#99 FORMAT(/, ' ALT(FT)', 6F8.1/(9X, 6F8.1))
4710 IY=3
4720 CALL PAIT(APHI, ATHE, IM, AIT, AINE, AMAX, APIN, ALT, IY, FA)
4730 CONTINUE
4895 STOP
4900 END
4910S EXECUTE
5000S LIMITS 50.55K
5010S PRMEL 02, R/W, S, BLA00001/USACUT1
5020S PRMEL 01, R/W, S, BLA00001/USAIN1
5025S PRMEL 03, R/W, R, BLA00001/DATAFILE
5030S ENDJOB

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*** CALCULATE THE VERTICAL RADIATION PATTERN

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*** CALCULATE THE HORIZONTAL RADIATION PATTERN

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METRIC SYSTEM

BASE UNITS:

Quantity	Unit	SI Symbol	Formula
length	metre	m	...
mass	kilogram	kg	...
time	second	s	...
electric current	ampere	A	...
thermodynamic temperature	kelvin	K	...
amount of substance	mole	mol	...
luminous intensity	candela	cd	...

SUPPLEMENTARY UNITS:

plane angle	radian	rad	...
solid angle	steradian	sr	...

DERIVED UNITS:

Acceleration	metre per second squared	...	m/s
activity (of a radioactive source)	disintegration per second	...	(disintegration)/s
angular acceleration	radian per second squared	...	rad/s
angular velocity	radian per second	...	rad/s
area	square metre	...	m
density	kilogram per cubic metre	...	kg/m
electric capacitance	farad	F	A·s/V
electrical conductance	siemens	S	A/V
electric field strength	volt per metre	...	V/m
electric inductance	henry	H	V·s/A
electric potential difference	volt	V	W/A
electric resistance	ohm	...	V/A
electromotive force	volt	V	W/A
energy	joule	J	N·m
entropy	joule per kelvin	...	J/K
force	newton	N	kg·m/s
frequency	hertz	Hz	(cycle)/s
illuminance	lux	lx	lm/m
luminance	candela per square metre	...	cd/m
luminous flux	lumen	lm	cd·sr
magnetic field strength	ampere per metre	...	A/m
magnetic flux	weber	Wb	V·s
magnetic flux density	tesla	T	Wb/m
magnetomotive force	ampere	A	...
power	watt	W	J/s
pressure	pascal	Pa	N/m
quantity of electricity	coulomb	C	A·s
quantity of heat	joule	J	N·m
radiant intensity	watt per steradian	...	W/sr
specific heat	joule per kilogram-kelvin	...	J/kg·K
stress	pascal	Pa	N/m
thermal conductivity	watt per metre-kelvin	...	W/m·K
velocity	metre per second	...	m/s
viscosity, dynamic	pascal-second	...	Pa·s
viscosity, kinematic	square metre per second	...	m/s
voltage	volt	V	W/A
volume	cubic metre	...	m
wavenumber	reciprocal metre	...	(wave)/m
work	joule	J	N·m

SI PREFIXES:

Multiplication Factors	Prefix	SI Symbol
1 000 000 000 000 = 10 ¹²	tera	T
1 000 000 000 = 10 ⁹	giga	G
1 000 000 = 10 ⁶	mega	M
1 000 = 10 ³	kilo	k
100 = 10 ²	hecto*	h
10 = 10 ¹	deka*	da
0.1 = 10 ⁻¹	deci*	d
0.01 = 10 ⁻²	centi*	c
0.001 = 10 ⁻³	milli	m
0.000 001 = 10 ⁻⁶	micro	μ
0.000 000 001 = 10 ⁻⁹	nano	n
0.000 000 000 001 = 10 ⁻¹²	pico	p
0.000 000 000 000 001 = 10 ⁻¹⁵	femto	f
0.000 000 000 000 000 001 = 10 ⁻¹⁸	atto	a

* To be avoided where possible.

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