

AD-A082 695

NAVAL OCEAN SYSTEMS CENTER SAN DIEGO CA

F/8 20/14

'SIMPLIFIED' VLF/LF MODE CONVERSION COMPUTER PROGRAMS: BRNOMC A--ETC(U)

JAN 80 D S MORFITT

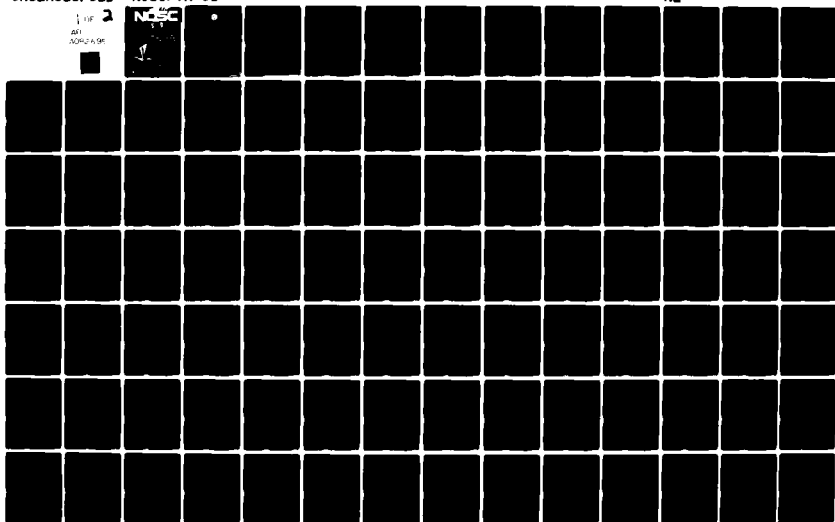
MIPR-80-563

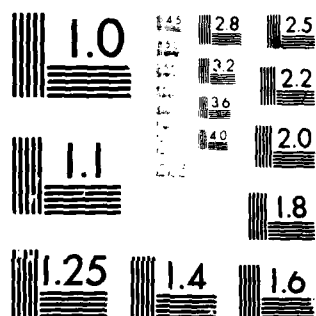
UNCLASSIFIED

NOSC/TR-514

NL

1 OF 2
ALL INFORMATION
CONTAINED
HEREIN IS UNCLASSIFIED





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

NOSC

NOSC TR 514

SELECTED
APR 4 1980
S C D

Technical Report 514

AD A 082 695

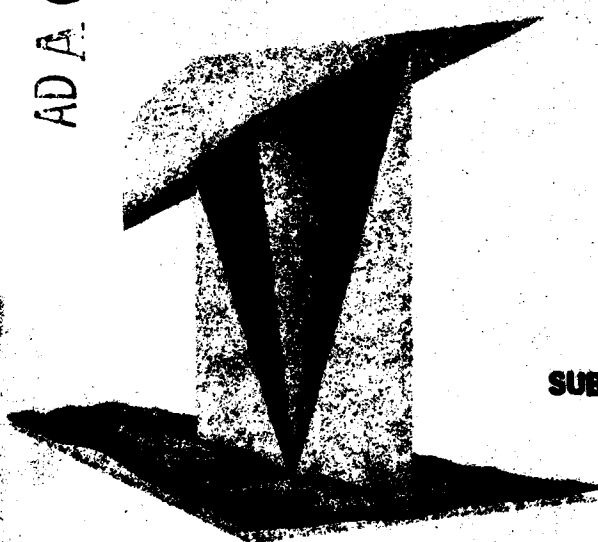
"SIMPLIFIED" VLF/LF MODE CONVERSION COMPUTER PROGRAMS; GRNDMC AND ARBNMC

DG Morfitt

January 1980

Interim Report: January - December 1979

This work sponsored by the
DEFENSE NUCLEAR AGENCY under
SUBTASK Code S99QAXH B042 and Work Unit 25



Approved for public release; distribution unlimited

NAVAL OCEAN SYSTEMS CENTER
SAN DIEGO, CALIFORNIA 92162

80 4 4 056

FILE COPY



NAVAL OCEAN SYSTEMS CENTER, SAN DIEGO, CA 92162

AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

SL GUILLE, CAPT, USN

Commander

HL BLOOD

Technical Director

ADMINISTRATIVE INFORMATION

This work, sponsored by the Defense Nuclear Agency under S99QAXH B042 work unit 25, was done by the Nuclear Effects Branch during the period 1 January 1979 through 31 December 1979. The report was approved for publication 6 January 1980.

Released by
JH Richter, Head
EM Propagation Division

Under authority of
JD Hightower, Head
Environmental Sciences Department

ACKNOWLEDGEMENT

The author is grateful to JA Ferguson, who developed the original computer algorithms which utilize disc storage rather than main frame storage, thus reducing the required memory size of the computer program..

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER (TR 514) NOSC Technical Report 514	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) <u>SIMPLIFIED VLF/LF MODE CONVERSION COMPUTER</u> <u>PROGRAMS; GRNDMC AND ARBNMC</u>	5. TYPE OF REPORT & PERIOD COVERED Interim Report 1 Jan - 31 Dec 79	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) DG MORFITT	8. CONTRACT OR GRANT NUMBER(s) DNA MIPR-80-563	9. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 6-27-04H S99QAXH/B042 532-MP20/25 ELF/VLF
10. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Ocean Systems Center San Diego, CA 92152	11. CONTROLLING OFFICE NAME AND ADDRESS Defense Nuclear Agency Washington, DC 20350	12. REPORT DATE Jan 80 13. NUMBER OF PAGES 178
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) NOSC/TR-514	15. SECURITY CLASS. (of this report) UNCLASSIFIED	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Computer Programs Ionospheric Propagation Low Frequency Very Low Frequency		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The computer programs GRNDMC and ARBNMC numerically determine vlf/lf mode conversion coefficients and mode sums for an earth-ionosphere waveguide which is inhomogeneous along the direction of propagation. GRNDMC generates values of the vertical electric field, E_z , at the ground as produced by a ground based vertical dipole source. ARBNMC calculates at an arbitrary height within the guide, all three electric field components (Continued)		

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601UNCLASSIFIED 393159
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. ABSTRACT (Continued)

(E_z , E_x and E_y) generated by an electric dipole of arbitrary orientation and height within the guide. The ARBNMC program treats air-to-air, ground-to-air or air-to-ground vlf/lf problems. It will also handle ground-to-ground propagation but is much less economical to run than GRNDMC.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

"SIMPLIFIED" VLF/LF MODE CONVERSION
COMPUTER PROGRAMS; GRNDMC AND ARBNMC

D. G. Morfitt

Accession For	
NTIS	☒
DDC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Available/or special
A	

ABSTRACT

→ The computer programs GRNDMC and ARBNMC numerically determine vlf/lf mode conversion coefficients and mode sums for an earth-ionosphere waveguide which is inhomogeneous along the direction of propagation. GRNDMC generates values of the vertical electric field, E_z , at the ground as produced by a ground based vertical dipole source. ARBNMC calculates at an arbitrary height within the guide, all three electric field components (E_z , E_x and E_y) generated by an electric dipole of arbitrary orientation and height within the guide. The ARBNMC program treats air-to-air, ground-to-air or air-to-ground vlf/lf problems. It will also handle ground-to-ground propagation but is much less economical to run than GRNDMC.

TABLE OF CONTENTS

	<u>Page</u>
I. INTRODUCTION.....	5
II. GENERAL PROGRAM DESCRIPTIONS.....	7
III. SUMMARY OF THE EQUATIONS.....	9
IV. DESCRIPTION OF PROGRAM EXECUTION.....	23
A. General Comments.....	23
B. Description of Input.....	24
C. Special Rules.....	30
D. Program Layout.....	33
E. Description of Output.....	38
V. REFERENCES.....	40
VI. FIGURES.....	42
VII. EXAMPLES.....	55
APPENDIX 1: GRNDMC FORTRAN LISTING	87
APPENDIX 2: ARBNMC FORTRAN LISTING	122

LIST OF FIGURES

- Figure 1. Dipole M orientation within the waveguide where γ is the inclination and ϕ the azimuthal orientation.
- Figure 2. Mode conversion model.
- Figure 3. Identification of the terms "accumulative (or total)" conversion coefficient, $\underline{a}^P$ and "normalized" conversion coefficient, $\bar{\underline{I}}^P$.
- Figure 4. Sunrise - sunset geometry.
- Figure 5. Program flow.
- Figure 6. Daytime high latitude propagation across the Greenland ice cap (45 kHz). (IPLTOP = 2).
- Figure 7. Propagation through the sunset terminator. (IPLTOP = 1).

I. INTRODUCTION

This outline is designed to help a knowledgeable user run the NOSC "simplified" mode conversion computer programs, GRNDMC and ARBNMC. They are modified and improved versions of those programs originally developed and described in references (1) and (2), respectively. The improvements include a considerable savings in computer core storage (more than a factor of three in the case of ARBNMC), an increase of the number of waveguide slabs from 25 to essentially an unlimited number, better formatting of the input data, especially in the reduction of from three to two cards per mode, an increase in the number of allowable modes from 5 to 20, and the number of modes to be considered may vary from one ionospheric slab to another.

The computer programs described in references 1 and 2 were developed for calculating vlf/lf field strengths in the earth-ionosphere waveguide when allowance must be made for horizontal inhomogeneity in the direction of propagation. They, GRNDMC and ARBNMC, are particularly relevant to the problem of propagating across the sunrise and sunset terminators and for propagation in an artificially disturbed environment. All of these programs are based upon a slab model, assume waveguide invariance in the direction normal to the great circle path between transmitter and receiver, and neglect reflections resulting from inhomogeneity along the direction of propagation. The field calculations, principally through waveguide modal constant inputs, allow for vertical inhomogeneity as well as anisotropy of the ionosphere.

In the GRNDMC program, field strength calculations or mode sums are generated for the vertical electric field, E_z , at the ground produced by a ground based vertical dipole. ARBNMC calculates all electric field components E_z , E_x and E_y at any receiver height within the guide (x - z is the plane of propagation) generated by electric dipole exciters of arbitrary orientation located at any height within the guide. Thus air-to-air, ground-to-air, air-to-ground, and ground-to-ground vlf/lf propagation in a horizontally inhomogeneous waveguide channel may be treated using the ARBNMC program.

Familiarity is assumed with references 4 and 5 which describe Fortran programs for obtaining waveguide mode constants and the excitation factors for electric dipoles of arbitrary orientation located at any height within the earth-ionosphere waveguide. Crucial outputs from these programs are the ground eigenangles and four independent quantities from which a tensor array

of nine excitation factors relating to end-on, broadside or vertical dipole excitation of E_z , E_x and E_y may be determined. These quantities for each mode and slab serve as input to the GRNDMC and ARBNMC programs. These quantities are obtained from the programs described in references 4 and 5 by setting the variable NPUNCH = 1.

Principal outputs of the present programs are mode conversion coefficients (in a generalized sense) and mode sum plots as a function of distance from the transmitter. Since the mode conversion coefficients are independent of the location of the horizontal inhomogeneity relative to the transmitter, provision is made for moving the inhomogeneity in increments and plotting mode sums for the incremented distances (this option is useful only if the ground conductivity and geomagnetic orientation may be regarded as constant over the path).

In section II a general description of the program options is given. Section III summarizes the relevant formulae. A description of the program input, output and operating procedures is given in section IV. Results are given in sections VI and VII. Appendix 1 gives a FORTRAN listing of GRNDMC while Appendix 2 gives a FORTRAN listing of ARBNMC.

II. GENERAL PROGRAM DESCRIPTIONS

The mode conversion programs, GRNPMC and ARBNMC, provide approximate methods for numerically determining mode conversion coefficients and mode sums for a slab model of the earth-ionosphere waveguide which is inhomogeneous along the direction of propagation (i.e., along the great circle path between transmitter and receiver). Invariance normal to the transmitter-receiver line is assumed in the calculations and reflections due to the horizontal inhomogeneity are neglected. The computational procedure used in these programs is referred to as "simplified" in that a full wave fields program for "height gain" terms is not required. The associated height gain integrals are instead performed analytically as contrasted to the more accurate full wave integration schemes used in other less simplified propagation models, such as described in reference (3).

Mode conversion programs are particularly relevant for propagation across the sunrise (or sunset) terminator and for propagation in an artificially disturbed environment. The field strength calculations allow for vertical inhomogeneity as well as anisotropy of the ionosphere.

Two distinct options are available with the present GRNPMC and ARBNMC programs. One option is for field calculations (amplitude and phase) as a function of range for a fixed location of the horizontal inhomogeneity. The second allows for field calculations at two distinct receiving points along the same great circle path as a function of position of the horizontal inhomogeneity. An important limitation of this second option is that the calculations are useful only if the ground conductivity and the geomagnetic parameters change little over the path.

GRNPMC (ground based propagation via mode conversion) is a modified version of the program described in reference 1. It generates values of the vertical electric field, E_z , at the ground as produced by a ground based vertical dipole source. The program output consists of mode conversion coefficients and a field strength plot as a function of transmitter receiver distance or as a function of location of the horizontal inhomogeneity relative to the transmitter for fixed point transmissions.

ARBNMC (for airborne propagation via mode conversion) is a modified version of the program described in reference (2). ARBNMC differs from GRNPMC

to the extent that it can be used to calculate all electric field components E_z , E_x and E_y for any receiver height within the guide (x - z is the plane of propagation) for electric dipole exciters of arbitrary orientation located at any height within the guide. Thus air-to-air, ground-to-air, air-to-ground, and ground-to-ground vlf/lf propagation in a horizontally inhomogeneous waveguide channel may be treated using the ARBNMC program. The principal outputs of this program are mode conversion coefficients and mode sum plots as a function of distance from the transmitter for the three electric field components for four orientations of the electric dipole exciter. The transmitter and receiver must be within the earth curvature dominated portion of the guide (below the ionosphere) but otherwise their altitude is arbitrary. Since the mode conversion coefficients are independent of the location of the horizontal inhomogeneity relative to the transmitter, provision is made for moving the inhomogeneity in increments and plotting mode sums for the incremented distances (again, this option is useful only if the ground conductivity and geomagnetic orientation may be regarded as constant over the path).

III. SUMMARY OF THE EQUATIONS:

In the propagation of vlf and lf terrestrial radio waves to great distances, the waves are confined within the space between the earth and the ionosphere. This space acts as a waveguide, and the "waveguide concept" is applicable for characterizing the propagated fields as a function of distance.

The waveguide mode method obtains the full wave solution for a waveguide that has the following characteristics: (1) arbitrary electron and ion density distributions and collision frequency (with height) and (2) a lower boundary which is a smooth homogeneous earth characterized by an adjustable surface conductivity and dielectric constant. This method also allows for earth curvature, ionospheric inhomogeneity, and anisotropy (resulting from the earth's magnetic field).

The energy within the waveguide is considered to be partitioned among a series of modes. Each mode represents a resonant condition, i.e., for a discrete set of angles of incidence of the waves on the ionosphere, resonance occurs and energy will propagate away from the source. The complex angles (θ) for which this occurs are called the eigenangles (or "modes"). These are obtained using the "full-wave" procedures described in references 4 and 5 by solving the determinantal equation (i.e., the modal equation):

$$F(\theta) = |\underline{R}_d(\theta) \underline{\bar{R}}(\theta) - 1| = 0 \quad (1)$$

$$\text{where } \underline{R}_d(\theta) = \begin{bmatrix} R_{\parallel d}(\theta) & R_{\perp d}(\theta) \\ R_{\perp d}(\theta) & R_{\parallel d}(\theta) \end{bmatrix} \quad (2)$$

is the complex ionospheric reflection coefficient matrix looking up into the ionosphere from height "d" and

$$\bar{R}_d(\theta) = \begin{bmatrix} \bar{R}_{||d}(\theta) & 0 \\ 0 & \bar{R}_{\perp d}(\theta) \end{bmatrix} \quad (3)$$

is the complex reflection matrix looking down from height "d" towards the ground.

The notation $\parallel$ for the R's and $\bar{R}$'s denotes vertical polarization while the notation $\perp$, denotes horizontal polarization. The first subscript on the R's refers to the polarization of the incident wave while the second applies to the polarization of the reflected wave.

The individual terms of equations (2) and (3) are:

$\parallel R_{\parallel}$ = the ratio of the reflected field in the plane of incidence to the incident field in the same plane.

$\perp R_{\perp}$ = the ratio of the reflected field perpendicular to the plane of incidence to the incident field perpendicular to the plane of incidence.

$\perp R_{\parallel}$ = the ratio of the reflected field perpendicular to the plane of incidence to the incident field in the plane of incidence.

$\parallel R_{\perp}$ = the ratio of the reflected field in the plane of incidence to the incident field perpendicular to the plane of incidence.

The ionospheric reflection matrix, R_d (equation 2) at height, d, may be obtained (from references 4 or 5) by numerical integration of differential equations given by reference 6. The differential equations are integrated by a Runge-Kutta technique starting at some height above which negligible reflection is assumed to take place. The initial condition for the integration, i.e., the starting value of R, is taken as the value of R for a sharply-bounded ionosphere at the top of the given electron density and collision frequency profiles. The method for obtaining this starting solution

is described in reference 7. The term $\bar{R}_d$ may be calculated (as in references 4 or 5) by the methods described in reference 8 in terms of solutions to Stoke's equation and their derivatives. That is, the ground reflection coefficient matrix $\bar{R}_d$, as given in equation (3), is determined in terms of independent solutions, h_1 and h_2 to Stokes' equation

$$\frac{d^2 h_{1,2}}{dz^2} + z h_{1,2} = 0 \quad (4)$$

where the functions h_1 and h_2 are modified Hankel functions of order $1/3$ (which are linearly related to Airy functions) as defined by the Computation Laboratory, Cambridge, Massachusetts, reference 9.

The propagation geometry, upon which GRNMC and ARBNMC are based, is shown in Figure 1. In this coordinate system the direction of stratification is the z direction and the direction of propagation is in the $x - z$ plane. The direction of z , which is the altitude coordinate measured normal to the curved earth's surface, is taken positive into the ionosphere. Positive x is the direction of propagation and y is normal to the plane of propagation. Thus, the fields exhibit no y dependence but have a dependence of x of the form $\exp(-iK \sin \theta x)$ where K is the magnitude of the free-space propagation vector, θ is the angle between the direction of the propagation vector and the z direction at a point in the stratified medium where the index of refraction is unity. All field quantities are assumed to have an $\exp(i\omega t)$ dependence where ω is the angular frequency. The radiating dipole source for the propagated fields is denoted in Figure 1 by $\vec{M}$. The dipole is oriented within the earth-ionosphere waveguide by the inclination angle γ and azimuthal angle ϕ .

For a vertical dipole, $\gamma = 0^\circ$ and $\phi = 0^\circ$. For a horizontal dipole $\gamma = 90^\circ$ and since ϕ is the angle between the direction of the horizontal dipole and the direction of propagation, $\phi = 0^\circ$ represents end-fire and $\phi = 90^\circ$ represents broadside launching.

The procedure used in the mode conversion model segments the earth-ionosphere waveguide into M cascaded uniform waveguides (Figure 2) where the propagation characteristics do not change within any segment. The slabs are

numbered from left to right with the total number of slabs being denoted as M. The slab labeled NTR is the slab containing the transmitter. The modal equation, equation 1, is solved by the method of either references 4 or 5 for as many modes (eigenangles, θ_j) as desired in each waveguide segment (or slab). The model allows for an arbitrary number of modes on each side of any given boundary. At any transition region (i.e., slab boundary) energy scatters from a given mode into several other modes in the adjoining slab.

Subject to the assumptions of invariance in the y-direction and the neglect of reflections from horizontal inhomogeneities, mode conversion coefficients may be computed by enforcing the boundary condition (at each slab interface) that all tangential field components must be continuous. Also, the mode conversion algorithm formulation assumes that a unit amplitude wave exists for each mode k in the transmitter region (slab NTR of figure 2). The quantities a_{jk}^p relate the energy from an incident mode, k, in the transmitter slab to j-th mode in slab p.

The "accumulative" mode conversion coefficient a_{jk}^p for the p-th slab associated with conversion from the k-th to the j-th mode expressed in terms of the coefficients for the previous (p-1)-th slab may be written in the form (reference 10).

$$\sum_{j=1}^J a_{jk}^p I_{n,j}^{p,p} = I_{n,k}^{p,p-1}, \quad p = \text{NTR} + 1 \quad (5)$$

$$= \sum_{j=1}^J a_{jk}^{p-1} [-iKs_j^{p-1} (x_p - x_{p-1})] I_{n,k}^{p,p-1}, \quad \text{NTR} + 1 \leq p < M$$

where $i = (-1)$, K is the free-space wave number, S_j is the sine of the j^{th} eigenangle for the p^{th} slab, and J is the total number of modes assumed to be important in the total field determinations.

A simplified explanation of equation (5) is demonstrated in figure 3. In the figure some important variables are:

The "normalized conversion coefficient" for the p -th slab, $\bar{I}^p$.

$$j \rightarrow \left(\bar{I}_{ji}^p \right) = i \rightarrow \left(I_{jj}^{p,p} \right)^{-1} \cdot j \rightarrow \left(I_{ji}^{p,p-1} \right) \quad (6)$$

where all terms are matrices.

The "total or accumulative conversion coefficient" for the p -th slab, a^p .

$$j \rightarrow \left(a_{jk}^p \right) = j \rightarrow \left(\bar{I}_{ji}^p \right) \quad (7)$$

$$\cdot i \rightarrow \begin{bmatrix} \exp[-i \frac{2\pi}{\lambda} S_1^{p-1}(x_p - x_{p-1})] & 0 & 0 \\ 0 & \ddots & \vdots \\ 0 & \exp[-i \frac{2\pi}{\lambda} S_i^{p-1}(x_p - x_{p-1})] & 0 \\ 0 & 0 & \ddots \\ 0 & 0 & \exp[-i \frac{2\pi}{\lambda} S_I^{p-1}(x_p - x_{p-1})] \end{bmatrix}$$

$$\cdot i \rightarrow \left(a_{ik}^{p-1} \right)$$

where again all terms are matrices. The indices are $j = 1, 2, 3 \dots J$ for the modes in slab p ; $i = 1, 2, 3 \dots I$ for the modes in slab $p-1$; and $k = 1, 2, 3 \dots K$ to the modes in the transmitter slab NTR.

If it is assumed that the transmitter is located in slab 1 (see figure 3), the required expansions for the first 4 slabs, supposing 3 modes, are:

$\tilde{a}^1 = \tilde{U}$ (i.e., the unit matrix)

$$\tilde{a}^2 = \tilde{I}^2 \cdot \left\{ \begin{array}{ccc} \exp(-i\frac{2\pi}{\lambda} S_1^1(x_2 - 0)) & 0 & 0 \\ 0 & \exp(-i\frac{2\pi}{\lambda} S_2^1(x_2 - 0)) & 0 \\ 0 & 0 & \exp(-i\frac{2\pi}{\lambda} S_3^1(x_2 - 0)) \end{array} \right\} \cdot \tilde{a}^1$$

$$\tilde{a}^3 = \tilde{I}^3 \cdot \left[\begin{array}{ccc} \exp(-i\frac{2\pi}{\lambda} S_1^2(x_3 - x_2)) & 0 & 0 \\ 0 & \exp(-i\frac{2\pi}{\lambda} S_2^2(x_3 - x_2)) & 0 \\ 0 & 0 & \exp(-i\frac{2\pi}{\lambda} S_3^2(x_3 - x_2)) \end{array} \right] \cdot \tilde{a}^2$$

$$\tilde{a}^4 = \tilde{I}^4 \cdot \left[\begin{array}{ccc} \exp(-i\frac{2\pi}{\lambda} S_1^3(x_4 - x_3)) & 0 & 0 \\ 0 & \exp(-i\frac{2\pi}{\lambda} S_2^3(x_4 - x_3)) & 0 \\ 0 & 0 & \exp(-i\frac{2\pi}{\lambda} S_3^3(x_4 - x_3)) \end{array} \right] \cdot \tilde{a}^3$$

where λ is the free space wavelength. The symbol under the various variables (i.e., a and $\bar{I}$) denotes a matrix.

Critical for the solution of the system of equation (5) is the evaluation of the integral

$$I_{jk}^{m,p} = \int_{-\infty}^{\infty} A_j^{mt} \cdot G_k^p dz \quad (9)$$

where the t denotes the adjoint and G^p is a four-element column matrix of height gains for the y and z components of the electric and magnetic field strength of the k^{th} mode in the p^{th} slab.

The column vector $G_k^p(z)$ is given by:

$$G_k^p(z) = \begin{pmatrix} e_{yk}^p(z) \\ e_{zk}^p(z) \\ h_{yk}^p(z) \\ h_{zk}^p(z) \end{pmatrix} \quad (10)$$

The term A_j^m is a four-element column matrix of height gains for an appropriate adjoint waveguide (see reference 11).

In the mode conversion model the height gain elements of A are assumed to be simply rearrangements of the elements of G and are expressed below a height b in the guide in terms of the modified Hankel functions of order $1/3$. The crucial integrals in (5) are then given in reference 10 by

$$I_{jk}^{m,p} = (S_j^m + S_k^p) \cdot \int_0^{\text{TOPHT}} (e_{yj}^m \cdot e_{yk}^p + J_{yj}^m \cdot H_{yk}^p) dz \quad (11)$$

In arriving at the final form of Equation (11), the height gains below $z = 0$ and above $z = \text{TOPHT}$ have been discarded. Also, introduced is the relation:

$$H_y(z) = e^{-\alpha z/2} h_y \quad (12)$$

It can then be shown that in the earth curvature dominated portion of the guide, H_y is linearly expressible in terms of solutions to Stokes' equation. This fact is also true for the e 's so that if the e 's and H 's are assumed to obey Stokes' equation in the range $0 \leq z \leq \text{TOPHT}$, Equation (11) becomes

$$I_{j,k}^{m,p} = \frac{1}{K} \left(\frac{\alpha}{K} \right)^{1/3} \frac{1}{(S_j^m - S_k^p)} \left[e_{yk}^k \frac{de_{yh}^m}{dq} - e_{yj}^m \frac{de_{yk}^p}{dq} + H_{yk}^p \frac{dH_{yj}^m}{dq} - H_{yj}^m \frac{dH_{jk}^p}{dq} \right]_0^b$$

if $m \neq p$ and/or $j \neq k$

$$= \frac{2S_j^m}{K} \left[\left(\frac{de_{yj}^m}{dq} \right)^2 + \left(\frac{dH_{yj}^m}{dq} \right)^2 + q((e_{yj}^m)^2 + (H_{yj}^m)^2) \right]_0^b$$

if $m = p$ and $j = k$

(13)

where e_y and H_y are given in terms of modified Hankel functions of order $1/3$. Explicitly, these relationships are

$$H_y = \frac{F_1 h_1(q_b) + F_2 h_2(q_b)}{F_1 h_1(q_o) + F_2 h_2(q_o)} \quad (14)$$

$$e_y = \frac{F_3 h_1(q_b) + F_4 h_2(q_b)}{F_3 h_1(q_o) + F_4 h_2(q_o)} \cdot f \quad (15)$$

where "b" = TOPHT in equations (13), (14) and (15). The terms F_1 , F_2 , F_3 and F_4 are given by equation (16) through (19).

$$F_1 = - \{ H_2(q_0) - i \frac{n_o^2}{N_g^2} \left(\frac{aK}{2} \right)^{1/3} (N_g^2 - S^2)^{1/2} h_2(q_0) \} \quad (16)$$

$$F_2 = H_1(q_0) - i \frac{n_o^2}{N_g^2} \left(\frac{aK}{2} \right)^{1/3} (N_g^2 - S^2)^{1/2} h_1(q_0) \quad (17)$$

$$F_3 = - \{ h_2'(q_0) - i \left(\frac{aK}{2} \right)^{1/3} (N_g^2 - S^2)^{1/2} h_2(q_0) \} \quad (18)$$

$$F_4 = h_1'(q_0) - i \left(\frac{aK}{2} \right)^{1/3} (N_g^2 - S^2)^{1/2} h_1(q_0) \quad (19)$$

$$q_z = \left(\frac{2}{aK} \right)^{-2/3} (C^2 - \frac{2}{a} (h-z)) \quad (20)$$

$$H_j(q) = h_j'(q) + \frac{1}{2} \left(\frac{2}{aK} \right)^{2/3} h_j(q) ; j = 1, 2 \quad (21)$$

$$n_z^2 = 1 - \frac{2}{a} (h-z) \quad (22)$$

$$N_g^2 = \frac{\epsilon}{\epsilon_o} - i \frac{\sigma}{\omega \epsilon_o} \quad (23)$$

where:

C = cosine of the angle of incidence at height h

h = the height at which the modified refractive index is taken to unity

K = the free space wave number

ϵ/ϵ_o = dielectric constant of the ground

σ = the ground conductivity

ω = the circular radio frequency

a = the earth's radius

The subscript on q represents the value of z at which q is evaluated. For example, q_o means that (20) is to be evaluated for $z = 0$ and q_b means that (20) is to be evaluated at $z = b$. Similarly, the subscript on n^2 represents the value of z for which (22) is to be evaluated.

Again, the functions h_1 and h_2 are modified Hankel functions of order $1/3$ as defined by the computation Laboratory at Cambridge, Massachusetts, and the primes on these quantities denote derivatives with respect to the argument.

The variable "b" in equations (20) and (22) is defined as the effective ionospheric height. The value to be assigned to this variable has been determined (reference 1) to be that height level for which the conductivity parameter, ω_r , is:

$$\omega_r = 2.5 * 10^5 \text{ sec}^{-1} \quad (24)$$

This value of "b" is the reference height (h'), as defined by Wait (reference 12) in terms of exponential profiles. In the present programs, the value of "b" is allowed to vary from slab to slab.

The column vector $G_k(z)$ of equation (10) is uniquely defined by normalizing the y component of the rf magnetic field to unity at the ground and by introducing the proper amount of TE wave at the ground which from mode theory is given in reference 10 by:

$$f = \frac{e_y}{h_y} = \left[\frac{(1 + \bar{R}_\perp) (1 - R_\parallel \bar{R}_\parallel)}{(1 + \bar{R}_\parallel) \bar{R}_\perp \bar{R}_\perp} \right]_{d=0} = \left[\frac{(1 + \bar{R}_\perp) R_\perp \bar{R}_\parallel}{(1 + \bar{R}_\parallel) (1 - \bar{R}_\perp R_\perp)} \right]_{d=0} \quad (25)$$

This value of "f" is to be substituted into equation (15).

Inputs to the GRNDMC and the ARBNMC programs for each slab "P" and each mode "j" in the slab are the ground eigenangles (θ'_j)'s and the T_j 's as defined below. The T_j 's are readily obtainable from either of the mode finding programs of references 4 or 5, as are the ground eigenangles. These "T" quantities are:

$$T_1 = \left[\frac{S^{1/2} (1 + \bar{R}_{\parallel})^2 (1 - \bar{R}_{\perp} \bar{R}_{\parallel})}{F'(\theta_j) \bar{R}_{\parallel} D_{\parallel}} \right] d \quad (26)$$

$$T_2 = \left[\frac{S^{1/2} (1 + \bar{R}_{\perp})^2 (1 - \bar{R}_{\parallel} \bar{R}_{\perp})}{F'(\theta_j) \bar{R}_{\perp} D_{22}} \right] d \quad (27)$$

$$T_3 = \left[\frac{S^{1/2} (1 + \bar{R}_{\parallel}) (1 + \bar{R}_{\perp}) \bar{R}_{\perp}}{F'(\theta_j) D_{12}} \right] d \quad (28)$$

$$T_4 = \left[\frac{\bar{R}_{\perp}}{\bar{R}_{\parallel}} \right] d \quad (29)$$

where S is the sine of the eigenangle at the reference height "h" and $F'(\theta_j)$ is the derivative of the mode equation, equation 1, evaluated at the eigenangle, θ_j . The R and $\bar{R}$'s represent, respectively, elements of the reflection matrix looking into the ionosphere and towards the ground from the level $z = d$. Consistent with the usual notation, the first subscript refers to the polarization of the incident wave and the second subscript refers to the polarization of the reflected wave and

$$D_{11} = (F_1 h_1(q_d) + F_2 h_2(q_d))^2 \quad (30)$$

$$D_{12} = (F_1 h_1(q_d) + F_2 h_2(q_d)) (F_3 h_1(q_d) + F_4 h_2(q_d)) \quad (31)$$

$$D_{22} = (F_3 h_1(q_d) + F_4 h_2(q_d))^2 \quad (32)$$

again F_1 , F_2 , F_3 , and F_4 are given by equations (16) through (19).

The mode conversion programs, as they are now programmed, require that the height variable "d" be at the ground so that in equations (26) through (32), $z = d = 0$.

The function f of equation (25), which is the ratio e_y to h_y at the ground is computed from the T 's of equations (26) through (29) as:

$$f = \frac{T_3}{T_1} \quad \text{or} \quad f = \frac{T_2}{T_3 \cdot T_4} \quad (33)$$

Define the following terms:

$$\tau_1 = D_{11} T_1, \quad \tau_2 = D_{22} T_2, \quad \tau_3 = D_{12} T_3. \quad (34)$$

In terms of the above quantities the excitation tensor elements are given as:

$$\lambda = (\lambda_{ij}) = \begin{array}{c|ccc|c} \text{Field Component} \rightarrow & E_z & E_x & E_y & \text{Exciter} \rightarrow \\ \hline & \tau_1^2 S^2 & \tau_1 S & -\tau_3 S/f & \text{Vertical} \\ \hline & -\tau_1 S & -\tau_1 & \tau_3/f & \text{End-on} \\ \hline & -\tau_3 T S/f & -\tau_3 T/f & \tau_2/f^2 & \text{Broadside} \end{array} \quad (35)$$

The columns relate to excitation of the electric field components E_z , E_x and E_y and the rows apply to excitation by a vertical dipole (λ_v), a horizontal dipole end-on (λ_E) and a horizontal dipole broadside (λ_B). Recall the geometry of the situation is such that z is taken positive into the ionosphere, that positive x is the direction of propagation and that y is normal to the plane of propagation.

Both the modal excitation factor and the modal height gain functions are needed in computing electric field strengths. The excitation factors of equation (35) must be supplemented with the height gains which are defined as following:

$$f_1(z) = \exp\left(\frac{z-d}{a}\right) (F_1 h_1(q) + F_2 h_2(q)) / (F_1 h_1(q_0) + F_2 h_2(q_0)) \quad (36)$$

$$f_2(z) = \frac{1}{ik} \frac{df_1}{dz} \quad (37)$$

$$f_3(z) = (F_3 h_1(q) + F_4 h_2(q)) f / (F_3 h_1(q_0) + F_4 h_2(q_0)) \quad (38)$$

where f_1 is the height gain for the vertical electric field E_z , f_2 is the height gain for the horizontal electric field component E_x and f_3 is for the electric field component E_y which is normal to the plane of propagation.

In terms of the excitation factors, height gains and generalized mode conversion coefficients, the electric field components E^p in the p -th slab may be written, as a function of receiver range (ρ), as follows:

$$E_n^{NTR} = \frac{Q}{[\sin(x/a)]^{1/2}} \sum_k (\lambda_{1nk}^{NTR} f_{1k}^{NTR}(z_T) \cos \gamma + \lambda_{2nk}^{NTR} f_{2k}^{NTR}(z_T) \sin \gamma \cos \phi + \lambda_{3nk}^{NTR} f_{3k}^{NTR}(z_T) \sin \gamma \sin \phi) f_{nk}^{NTR}(z_R) e^{-iK} (s_k^{NTR} - 1) \rho ; \quad (39)$$

$p = NTR$

$$E_n^P = \frac{Q}{[\sin(x/a)]^{1/2}} \sum_j \sum_k (\lambda_{1nk}^{NTR} f_{1k}^{NTR}(z_T) \cos \gamma + \lambda_{2nk}^{NTR} f_{2k}^{NTR}(z_T) \sin \gamma \cos \phi + \lambda_{3nk}^{NTR} f_{3k}^{NTR}(z_T) \sin \gamma \sin \phi) (\delta_{1n} + (1 - \delta_{1n}) s_k^{NTR} / s_j^P) f_{nj}^P(z_R) \cdot \left(a_{jk}^P \frac{s_j^P}{s_k^{NTR}} \right)$$

$$e^{-ik(s_k^{NTR} x_{NTR+1} + s_j^P (\rho - x_p) - \rho)} ; \quad p \neq NTR \quad (40)$$

The receiver altitude is z_R and the transmitter altitude z_T . The final k subscript on the λ 's and f 's denotes mode indices whereas the index n takes on the values 1, 2 and 3. Consistent with the previous definition $n = 1 \rightarrow E_z$, $n = 2 \rightarrow E_x$ and $n = 3 \rightarrow E_y$. Also, the notation "NTR" refers to the transmitter slab. The constant Q is

$$Q = 0.03248k/\sqrt{F} \quad (41)$$

with the free space wavenumber, k , in inverse km and F the frequency in kHz. The symbol δ_{ij} represents the Kronecker delta. That is

$$\delta_{ij} = 1 \quad i = j \quad (42)$$

$$\delta_{ij} = 0 \quad i \neq j$$

The angles γ and ϕ determine the orientation of the electric dipole source relative to the x , y , z coordinate system as shown in Figure 1. When executing the GRNDMC program, only the vertical E_z field is computed, the transmitter and receiver heights are both zero and $\gamma = \phi = 0$. In both GRNDMC and ARBNMC field strength amplitude is expressed in dB above a microvolt per meter for a one kilowatt radiator and phase in degrees relative to free space.

IV. DESCRIPTION OF PROGRAM EXECUTION

A. General Comments

To handle horizontal inhomogeneities, the ionosphere is divided into a series of vertical slabs, as described in section III. These slabs are labeled 1, 2, . . . , M as shown in Figure 2 and the boundaries between the slabs have coordinates $X_2, X_3, \dots, X_M$. For each slab and for each mode the ground eigenangle (θ') and the T_j 's defined by Eqs. (26) through (29) must be provided. Note that the transmitter slab is denoted as "NTR".

Several variables which are functions of the earth's magnetic field or are related to the ground conditions must first be identified. The geomagnetic field is specified by three variables. "AZIM" is the clockwise angle between magnetic north and the horizontal propagation direction in degrees east of north. "CODIP" is the complement of the magnetic dip angle in degrees. The magnetic equator is specified by "CODIP = 90". "MAGFLD" is the magnetic field intensity in webers per square meter. The ground conditions are specified by two variables. "SIGMA" is the conductivity in mhos per meter and "EPSR" is the relative dielectric constant. The mode finding programs, references 4 or 5, punch the values of these variables on the first output card of each "slab". This card is denoted as the RFACMSET card. The variables on this card are identified as:

- R: The slab reference distance in megameters.
- F: The propagation frequency, in kHz, "FREQ".
- A: The geomagnetic azimuth in degrees, "AZIM".
- C: The geomagnetic codip in degrees, "CODIP".
- M: The magnitude of the geomagnetic field in weber/square meter, "MAGFLD".
- S: The earth's conductivity in mhos/meter, "SIGMA".
- E: The relative dielectric constant of the earth, "EPSR".
- T: The height of the top of the slab, "TOPHT".

B. Description of Input

All input to the mode conversion program is given in a data deck on the standard input unit. Listings of sample input showing data deck setup are given in example I and example II. Example I illustrates the input cards for the option IPLTOP = 1, while example II shows the input for the option IPLTOP = 2.

There are two parts to the input. The first part is read in by means of a Fortran NAMELIST input format. The first card of each set of input must contain a blank in column 1 and &DATUM in columns 2-7. This is followed by at least one blank and then data items separated by commas. The data items have the following forms: (all cards must have a blank in column 1)

variable name = constant,

or

array name = set of constants, (all separated by commas),

The second part of the input follows the NAMELIST input. The first input for this part is an identification card. It has up to 40 columns of alphanumeric information and follows the control card, "DATA". The information on the identification card is used to label output plots. Following the identification card a series of punched cards (obtained from the programs described in references 4 or 5 with NPUNCH = 1) is input for each slab of the modeled earth-ionosphere waveguide. The first card is denoted as the RFACMSET and gives the value for R, FREQ, AZIM, CODIP, MAGFLD, SIGMA, EPSR and TOPHT. Next there are two cards per mode. The first of these contains the complex eigenangle at the ground (i.e., θ'_r and θ'_i) and values for the variables T_1 (Real), T_1 (Imaginary), T_2 (Real) and T_2 (Imaginary). See equations (26) and (27). The second card contains the eigenangles at the ground (θ'_r and θ'_i) (duplicate input) and T_3 (Real), T_3 (Imaginary), T_4 (Real) and T_4 (Imaginary). See equations (28) and (29). If the number of modes in any given slab is "NRMODE", there will be 2*NRMODE cards for each slab. The 2*NRMODE cards for slab No. 2 follow those for slab No. 1 and so on up to slab number M. Although ordering of modes is not critical, they are ordered according to their real parts. (The mode with the largest real part is called mode 1.)

The following variables and arrays may be specified in the NAMELIST input:

IPLTOP - Plotting option flag. If IPLTOP = 1, two plots (field amplitude in dB above a $\mu\text{v/m}$ for 1 kw radiated power versus transmitter -terminator distance for two receiver positions) are produced for each set of input. If IPLTOP = 2, a plot (field amplitude in dB above a $\mu\text{v/m}$ for 1 kw versus distance from transmitter) is produced.

XVAL - The numerical values (in km) of the X's (see Figure 2) which are the horizontal positions of the boundaries between adjacent slabs. Note that XVAL can be negative and that it is dimensioned for 50. Figure 2 illustrates that the XVAL distances are taken relative to the transmitter. The slab number is identified by ISLAB and a particular slab is identified by XVAL(ISLAB). That is, $XVAL(3) = X_3$. Note that the terminator line is taken to be the boundary XVAL(2).

RCDOPT - Option to use the RFACMSET-card values (i.e., R) for XVAL(ISLAB) values. If RCDOPT is set equal to one and IPLTOP is set equal to two, then the values used for XVAL(ISLAB) are taken from the RFACMSET card rather than from NAMELIST.

RHOMAX - Maximum horizontal distance in km at which field strengths are desired.

RHOMIN - Minimum horizontal distance in km at which field strengths are desired.

DELRHO - Horizontal increment in km for which successive field strengths are computed.

NTMAX - Number of times the transmitter - terminator separation is incremented. (NTMAX = 1 for IPLTOP = 2.)

DELTAX - Distance in km by which transmitter - terminator separation is incremented. (DELTAX = 0.0 for IPLTOP = 2.)

GAMMA or INCL - Dipole orientation angle relative to z axis (see Figure 1). Note that GAMMA is dimensioned for 4.

PHI or THETA - Dipole orientation angle relative to X axis (see Figure 1). Note that PHI is dimensioned for 4.

NRP - Number of GAMMA-PHI pairs up to 4.

TALT - Transmitter altitude in km.

RALT - Receiver altitude in km.

ICOMP - The electric field components to be computed. ICOMP = 1 is E_z , ICOMP = 2 is E_x and ICOMP = 3 is E_y .

ICMPMX - The maximum number of components which will be computed. If equals 1 only E_z . If equals 2 only E_z and E_x . If equals 3, E_z , E_x and E_y will be computed. Note that if only E_x is wanted, ICMPMX still must be set equal to 2. If only E_y is required, ICMPMX still must be set equal to 3.

TOPHT - Height above ground in km above which height gains are discarded. Note that a TOPHT for each slab is required and dimensioned for 50. If the value of TOPHT(ISLAB) is zero then the values of TOPHT used in the internal calculations within the program are taken from the RFACMSET cards.

H - Is the height in km at which the modified refractive index is unity ($n^2 = 1 - 2/a(H - z)$). a is the earth's radius. H is also the height to which the eigenangles are referred.

IH - Option which, when set to one converts the $\sin(\theta')$ to $\sin(\theta_H)$. The values of θ' are the eigenangles at the ground while the values θ_H are the eigenangles referenced at the height H. The equation is

$$\sin(\theta_H) = (1 - H/a) \sin(\theta').$$

This relation is important in computations of the excitation factors.

INTFLG - Printing option flag. INTFLG must be set to 1 if printout of height gain integrals and the "normalized" conversion coefficients are required (i.e., $\tilde{I}^{P,P}$, $\tilde{I}^{P,P^{-1}}$ and $\tilde{I}^P$ of equation 6).

IPRNTA - Printing option flag. IPRNTA must be set to 1 if printout of the "accumulated" or total mode conversion coefficients is required (i.e., g^P of equation 7).

NPRINT - Printing option flag. NPRINT equal to 1 gives a brief summary of slab input data including slab number and the number of modes for each slab. Printed out are the values of all the variables contained on the RFACMSET cards. NPRINT = 3 gives the same printed output as for NPRINT = 1, except that the values of the ground eigenangle and the values of the T's of equations (26) through (29) are also given for each slab.

ITXRX - Printing option flag. ITXRX must be set to 1 for debugging purposes.

NAPLOT - Plotting option flag. NAPLOT must be set to 1 if plots of amplitude vs. distance are required.

NPLOT - Plotting option flag. NPLOT must be set to 1 if plots of phase vs. distance are required.

SIZEX - Length of x-axis in inches.

SIZEY - Length of y-axis in inches (for amplitude).

XMIN - The value (in km) of the x-coordinate at the beginning of the x-axis.

YMIN - The value (in dB) of the y-coordinate at the beginning of the y-axis.

XINC - The change in the x-coordinate value (in km) between successive labeled tic marks.

YINC - The change in the y-coordinate value (in dB) between successive labeled tic marks.

XTIC - The distance (in inches) between tic marks along the x-axis.

YTIC - The distance (in inches) between tic marks along the y-axis (for amplitude).

NTICK - The repeat cycle for placing coordinate values at tic marks on the x-axis.

NTICY - The repeat cycle for placing coordinate values at tic marks on the y-axis (for amplitude).

SIZEP - Length of y-axis in inches (for phase).

PHSMIN - The value (in degrees) of the y-coordinate at the beginning of the y-axis.

PHSINC - The change in the y-coordinate value (in degrees) between successive labeled tic marks.

PTIC - The distance (in inches) between tic marks along the y-axis (for phase).

NTICP - The repeat cycle for placing coordinate values at tic marks on the y-axis (for phase).

FACT - The ratio of the desired plot size to the normal plot size. For example, if FACT = 2.0, all subsequent pen movements will be twice their normal size. When FACT is reset to 1.0, all plotting is normal size.

Note: For NTICK, NTICY and NTICP:

- = 1 - causes values to be placed at every tic mark
- = 2 - causes values to be placed at every second tic mark, etc.
- = 0 - suppresses all coordinate values

The end of the NAMELIST input is signaled by &END.

Initial values of the NAMELIST variables are presented in Table 1.

TABLE 1

NAMELIST VARIABLES AND INITIAL VALUES

<u>NAME</u>	<u>VALUE</u>	<u>UNITS</u>	<u>NAME</u>	<u>VALUE</u>	<u>UNITS</u>
*ICOMP	1	--	SIZEX	10.0	inches
*ICMPMX	3	--	SIZEY	8.0	inches
ITXRX	0	--	XMIN	0.0	km
INTFLG	0	--	YMIN	0.0	db
IPRNTA	0	--	XINC	1000.0	km
IPLTOP	0	--	YINC	10.0	db
NRP	1	--	XTIC	1.0	inches
NTMAX	1	--	YTIC	1.0	inches
NPRINT	1	--	NTICX	1	--
RHOMAX	0.0	--	NTICY	1	--
RHOMIN	0.0	--	RCDOPT	0	--
DEL RHO	0.0	--	IH	1	--
DELTAX	0.0	--	H	50.0	km
*GAMMA	4*0.0	degrees	*RALT	0.0	km
*PHI	4*0.0	degrees	*TALT	0.0	km
*INCL	4*0.0	degrees	SIZEP	8.0	inches
*THETA	4*0.0	degrees	PHSMIN	0.0	degrees
XVAL	50*0.0	km	PHSINC	90.0	degrees
TOPHT	50*0.0	km	PTIC	2.0	inches
NAPLOT	1	--	NTICP	1	--
NPLOT	0	--			
FACT	1.0	--			

Note: Variables denoted with asterisk (*) apply only to the ARBNMC program and not to the GRNDMC program.

C. Special Rules

Some special rules must be applied to the selection of some of the NAMELIST variables.

(1) Consider the following relationship as related to plotting:

ΔX - increment of x-scale in km/inch

$$\Delta X = \frac{XINC}{(NTICK) \cdot (XTIC)} \left\{ \frac{\text{km}}{\text{inch}} \right\}$$

Example (a). Given: $XINC = 2000 \text{ km}$

$NTICK = 2$

$XTIC = 1 \text{ inch}$

$$\Delta X = \frac{2000 \text{ km}}{2 \cdot 1 \text{ inch}} = 1000.0 \text{ km/inch}$$

Also:

ΔY - increment of y-scale in db/inch

$$\Delta Y = \frac{YINC}{(NTICY)(YTIC)} \left\{ \frac{\text{db}}{\text{inch}} \right\}$$

Example (b). Given: $YINC = 30 \text{ dB}$

$NTICY = 2$

$YTIC = 0.5 \text{ inch}$

$$\Delta Y = \frac{30 \text{ dB}}{2 \cdot (0.5) \text{ inch}} = 30 \text{ dB/inch}$$

Further:

Example (c). Given: XINC = 1000 km
NTICX = 1
XTIC = 1 inch

$$\Delta X = \frac{1000 \text{ km}}{(1) \cdot (1) \text{ inch}} = 1000 \text{ km/inch}$$

Note (1):

Example (c) shows that, if values of the axis are to be labeled at every tic mark, then NTICX = 1. Also, if XTIC is 1 inch, then $\Delta X = \text{XINC}$. Therefore, in this case XINC indicates the value of the increment of the x-scale in km/inch. In the same manner, YINC would indicate the value of the increment of the y-scale in dB/inch.

(2) Consider the following relationships:

$$\text{SIZEX} = \frac{\text{XMAX} - \text{XMIN}}{\Delta X}$$

$$\text{NTMAX} = \frac{\text{XMAX} - \text{XMIN}}{\text{DELTAX}} + 1$$

Note (2):

XMAX is not a NAMELIST variable but it must be considered when deciding on the values for the other NAMELIST variables.

Example (d). Given: DELTAX = 200.0 km
 ΔX = 1000.0 km/inch
XMIN = -2000 km
"XMAX" = 5000 km
SIZEX = ? inches
NTMAX = ? inches

$$\text{SIZEX} = \frac{\text{XMAX} - \text{XMIN}}{\Delta X}$$

$$\text{SIZEX} = \frac{5000. - (-2000)}{1000.0} = 7 \text{ inches}$$

$$\text{NTMAX} = \frac{\text{XMAX} - \text{XMIN}}{\text{DELTAX}} + 1$$

$$\text{NTMAX} = \frac{5000. - (-2000)}{200} + 1 = 36$$

(3) The following rules must be used when picking values of certain NAMELIST variables:

For "IPLTOP" = 1, Set:

$$\text{XVAL}(1) = -9999.9$$

$$\text{XVAL}(2) = \text{XMIN}$$

For "IPLTOP" = 2, Set:

$$\text{XVAL}(1) = 0.0$$

$$\text{XMIN} = 0.0$$

$$\text{NTMAX} = 1$$

$$\text{DELTAX} = 0.0$$

$$\text{RHOMIN} = \text{DELRHO}$$

$$\text{RHOMAX} \leq \text{"XMAX"}$$

(4) XVAL distances are taken relative to the transmitter (NTR). The terminator line is XVAL(2).

(5) The maximum value possible for SIZEY or SIZEP is 8 inches.

(6) For the option IPLTOP equal to 1, the criteria for modeling "sunset" or "sunrise" at the receiver are shown in figure 4a through d. Figure 4a, for sunset illustrates that the daytime mode constants (smaller value of TOPHT) are assumed for slab No. 1, while the nighttime mode constants are assumed for

slab No. 4. The mode conversion programs allow for incrementing the XVAL distances (which are distances relative to the transmitter) by the distance DELTAX. Figure 4b shows the resulting mode sum value in dB as a function of the distance between the terminator line (XVAL(2)) and the transmitter. Figures 4c and 4d illustrate the input and resulting mode sum curves for the "sunrise" condition. In this case the mode constants for nighttime are assumed for slab No. 1 while the daytime mode constants are assumed for slab 4.

(7) The mode conversion programs, as they are now formulated, require that the height "d" of equations 1, 2, 3 and 25 through 32 be set to the ground level (i.e., $d = 0$). This requires that when the T's of equations 26 through 32 are obtained from the program described in reference 4, the variable "D" in that program must be set to zero. Also, if the T's are obtained from the program described in reference 5, the variable "GRDFLG" in that program must be set to 1.

(8) The maximum number of data points (i.e., distances) for which fields can be computed is 402.

(9) The maximum number of allowable modes is 20.

(10) The maximum number of allowable slabs is 50. This value may be increased by increasing the dimensions of the variables TOPHT and XVAL.

D. Program Layout

The subroutines used in the GRNDMC and the ARBNMC mode conversion computer programs are shown in Table II.

TABLE II

Program Subroutines

GRNDMC	ARBPMC
MAIN	MAIN
CLINEQ	CLINEQ
AXISM	AXISM
MAGANG	MAGANG
MDHNKL	MDHNKL
MCSTEP	MCSTEP
HTIMTL	HTIMTL
*MCFLD (for GRNDMC)	*MCFLD (for ARBPMC)
MCFLD2	ACCUMA
*MCPLTS (for GRNDMC)	*MCPLTS (for ARBPMC)
MCPLT2	HTGAIN
	CURVE

The flow of the programs GRNDMC and ARBPMC is shown in Figure 5. Note that GRNDMC utilizes two temporary disc files and that ARBPMC utilizes four temporary disc files.

The subroutines denoted with the asterisk indicate that these subroutines are not identical in the two programs.

SUBROUTINE HTGAIN (Z, H, HFLAG)

Z is dimensioned for 2. Z(1) is set equal to the transmitter height TALT and Z(2) is set equal to the receiver height RALT. The height gain functions f_1 , f_2 and f_3 defined by Eqs. (36), (37) and (38) respectively are computed for the transmitter and receiver heights. H is the height where the modified index of refraction is one. IH = 0 indicates H = 0 and IH = 1 indicates H $\neq$ 0 in the subroutine calculations.

SUBROUTINE HTINTL (IFLG, P, INTFLG)

HTINTL calculates the height integrals defined by Eq. (6). NORM (IP,P) is an array of 20 by 20 which contains all combinations of modal integrals for the slab p. Also CAPI (IP,P⁻¹) is an array of 20 by 20 which contains all combinations of modal height gain integrals for the slab p and the previous slab p-1. IFLG is a control flag set to zero in MAIN if the slab p equals one. It is set to 1 if p is not equal to one. INTFLG is a printing option flag. It must be set to 1 if printout of NORM, CAPI and INORM ($\bar{I}^P$) is desired. Note from equation 6 that the array INORM is the normalized conversion coefficient.

SUBROUTINE MDHKNL (Z, H1, H2, H1PRME, H2PRME)

MDHKNL calculates for argument Z two independent solutions (H1 and H2) and their derivatives (H1PRME and H2PRME) of Stokes' equation by methods described in reference 9.

SUBROUTINE MAGANG (ARG, MAG, ANGLE)

MAGANG converts complex number ARG to polar form with ANGLE in degrees.

SUBROUTINE CLINEQ (A, B, X, N, NDIM, IFLAG, ERR)

CLINEQ computes the solution of simultaneous linear equations with complex coefficients. That is, it solves the matrix equation

$$A * X = B$$

for the vector X of length N, given the matrix A of size N by N and the vector B of length N by Crout's L-U decomposition. The A is destroyed by CLINEQ, NDIM is an integer variable which must be greater than or equal to N. IFLAG is an integer variable normally set to zero. Setting IFLAG = 1 bypasses the L-U decomposition of A when solutions are required for different B's. ERR is a real variable computed by CLINEQ which indicates the relative errors in the computed solution vector X.

SUBROUTINE MCSTEP (M)

MCSTEP calls for CLINEQ and provides as its output the mode conversion coefficients for the slabs NTR, NTR + 1 . . . , M for all values of NTR consistent with the input data. The mode conversion coefficients defined by equation 7 are printed out under the "A = TOTAL CONVERSION COEFFICIENTS".

SUBROUTINE AXISM

AXISM draws and labels the axes for the output plots.

SUBROUTINE CURVE (for ARBNMC)

CURVE plots the data points on the output plots.

SUBROUTINE MCFLD (for GRNDMC)

MCFLD called from MAIN if IPLTOP = 1 computes the vertical electric field at the ground produced by a ground based vertical electric dipole at RHOMIN and RHOMAX for transmitter-terminator distances ranging between XVAL (2) and NTMAX*DELTAX + XVAL (2) at intervals of DELTAX, using equations (39) and (40) with $\gamma = 0^\circ$, $\phi = 0^\circ$, $Z_T = 0$, $Z_R = 0$ and $f_1 = f_2 = f_3 = 1$.

SUBROUTINE MCFLD2 (for GRNDMC)

MCFLD2 called from MAIN if IPLTOP = 2 computes the vertical electric field at the ground produced by a ground based vertical electric dipole from RHOMIN to RHOMAX at DELRHO intervals using equations (39) and (40) for a fixed horizontal inhomogeneity. Again, $\gamma = 0^\circ$, $\phi = 0^\circ$, $Z_T = Z_R = 0$ and $f_1 = f_2 = f_3 = 1$.

SUBROUTINE MCPLTS (ITYPE) (for GRNDMC)

MCPLTS generates two plots (field amplitude in dB above a $\mu\text{v/m}$ for 1 kw radiated power (or phase in degrees) versus transmitter-terminator distance for two receiver positions) each time it is called from MCFLD. ITYPE = 1 gives amplitude plots. ITYPE = 2 gives phase plots.

SUBROUTINE MCPLT2 (ITYPE) (for GRNDMC)

MCPLT2 generates one plot (field amplitude in dB above a $\mu\text{v/m}$ for 1 kw radiated power (or phase in degrees) versus distance from transmitter) each time it is called from MCFLD2. ITYPE = 1 gives amplitude plots. ITYPE = 2 gives phase plots.

SUBROUTINE ACCUMA (for ARBNMC)

ACCUMA is the chief control routine of ARBNMC. The routine sets up the accumulated values of the "total" or accumulated conversion coefficient as a function of slab position.

SUBROUTINE MCFLD (for ARBNMC)

MCFLD when called from MAIN with IPLTOP = 1 computes the field components E_n^P defined by Eqs. (39) and (40) for transmitter height Z_T (TALT) and receiver height Z_R (RALT) for as many as four (GAMMA, PHI) pairs. GAMMA and PHI describe the orientation of the electric dipole source. Calculations are made for ranges RHOMIN and RHOMAX for distances between the transmitter and the start of the horizontal inhomogeneity ranging between XVAL (2) and NTMAX*DELTAX + XVAL (2) at intervals of DELTAX using Eqs. (39) and (40). Field amplitude outputs are in dB above a $\mu\text{v/m}$ for 1 kw radiated power and phase angles are in degrees relative to free space phase.

MCFLD when called from MAIN with IPLTOP = 2 computes the field components E_n^P defined by Eqs. (39) and (40) for transmitter height Z_T (TALT) and receiver height Z_R (RALT) for as many as four (GAMMA, PHI) pairs. Calculations are made for transmitter-receiver distances ranging from RHOMIN to RHOMAX at DELRHO intervals using Eqs. (39) and (40) for a fixed horizontal inhomogeneity. Field amplitude outputs are dB above a $\mu\text{v/m}$ for 1 kw radiated power and phase angles are in degrees relative to free space phase.

SUBROUTINE MCPLTS (ITYPE) (for ARBNMC)

MCPLTS, for IPLTOP = 1, generates six plots (three field component amplitudes in dB above a $\mu\text{v/m}$ for 1 kw radiated power (or phase in degrees) versus distance between transmitter and start of the horizontal inhomogeneity for two receiver ranges). As many as four (GAMMA, PHI) pairs are possible so that each plot can contain as many as four curves.

MCPLTS, for IPLTOP = 2, generates three plots (three field component amplitudes in dB above a $\mu\text{v/m}$ for 1 kw radiated power (or phase in degrees) versus transmitter receiver distance for a single location of the horizontal inhomogeneity). As many as four (GAMMA, PHI) pairs are possible so that each plot can contain as many as four curves.

ITYPE = 1 gives amplitude plots. ITYPE = 2 gives phase plots.

E. Description of Output

Sample output from program ARBNMC is shown in example III. This output is obtained from the input shown in example I. The output listing begins with an abbreviated listing of the NAMELIST input variables. Note that the IPLTOP = 2 option is requested. This is followed by printout of the control card "DATA" and the identification card, "PRESTON U.K. TO SONDESTROM". Next comes the printout of the NPRINT = 3 option giving slab number, the RFACMSET card values and then a listing of Θ' angles and T's for all slabs and modes. The Θ' angles are the eigenangles at the ground while the T's are the complex quantities given by equations (26) through (29).

The principal output of the mode conversion program then follows. Since INTFLG was set equal to one, values of certain parameters are printed out for each slab, P. These quantities are INORM (J,K) (i.e., $\bar{I}_{jk}^P$ of equation 6), which are the normalized conversion coefficients of mode K in slab P-1 to mode J in slab P; NORM (I,J) (i.e., $I_{ij}^{P,P}$ of equation 13), which are values of the integral between height gains of the I and J modes in slab P; and CAPI (I,K) (i.e., $I_{ik}^{P,P-1}$ of equation 13), which are values of the integrals between height gains for mode K in slab P-1 and mode I in slab P. Also, since IPRNTA was set equal to one the "total (or accumulative)" mode conversion coefficients a_{jk}^P of equation 7 are printed out. The tabulation represents the conversion from mode K in the transmitter slab to mode J in slab P.

Finally, the mode sum values for the vertical electric field (E_z) at transmitter height of 0.0 km and receiver height of 6.0 km are listed in dB above a microvolt per meter for a 1 kilowatt radiator as well as the phase in degrees referenced to free space propagation. In this example mode sums are shown for receiver locations at a distance (ρ) with ρ varying from 25 km to 4000 km at 25 km intervals. A plot of the computed fields is shown in figure 6 as compared with propagation data described in reference 13.

Example IV illustrates the output obtained from the input of example II. In this case the IPLTOP = 1 option was requested. The first part of the printout shows the NAMELIST values. Because NPRINT was set to one only a brief summary of the input data (i.e., the RFACMSET values) is printed after the "DATA" and identification cards. Also, since neither INTFLG or IPRNTA was set to one, no printout of the height gain integrals or conversion coefficients are printed out. Since IPLTOP was set equal to 1 the sample output shows mode sums for the three electric field components E_z (ICOMP = 1), E_x (ICOMP = 2) and E_y (ICOMP = 3) as a function of transmitter-receiver distance ranging from RHOMIN to RHOMAX at DELRHO intervals. It should be pointed out that the NAMELIST variable, ICOMP, must be entered in three separate calls to NAMELIST. The mode sums are listed in dB/ μ v/m for a one kilowatt radiator and the phases in degrees relative to free space. Because NRP = 4 in the input, there are four GAMMA-PHI pairs (i.e., four antenna orientations) for which the mode sums are computed. Note that TALT = 10 km and RALT = 10 km. Shown in figure 7 (a, b, c, d, e, f) are plots generated by the mode conversion program for this case.

V. REFERENCES

1. Pappert, R. A., and Shockey, L. R. [1975] Effective Ionospheric Height For a Simplified Mode Conversion Model at VLF. Naval Electronics Laboratory Center Interim Report 761.
2. Pappert, R. A. and Shockey, L. R. [1976] Simplified VLF/LF Mode Conversion Program with Allowance for Elevated, Arbitrarily Oriented Electric Dipole Antennas. Naval Electronics Laboratory Center Interim Report 77T, NTIS ADA033412, Springfield, VA.
3. Pappert, R. A. and Shockey, L. R. [1972] Mode Conversion Program for an Inhomogeneous Anisotropic Ionosphere. Naval Electronics Laboratory Center Interim Report 722, NTIS, AD743948, Springfield, VA.
4. Shetty, C. H., Pappert, R. A., Gough, Y. and Moler, W. F. [1968] A Fortran Program for Mode Constants In An Earth-Ionosphere Waveguide. Naval Electronics Laboratory Center Interim Report 683.
5. Morfitt, D. G. and Shellman, C. H. [1976] MODESRCH, an Improved Computer Program for Obtaining ELF/VLF/LF Mode Constants. Naval Electronics Laboratory Center Interim Report 77T, NTIS, ADA032573, Springfield, VA.
6. Budden, K. G., [1955] The Numerical Solution of Differential Equations Governing Reflexion of Long Radio Waves from the Ionosphere, Proceedings Royal Society (London) A227, pp. 516-537.
7. Shetty, C. H. [1968] "A General Analytic Solution for Reflection from a Sharply Bounded Anisotropic Ionosphere," Radio Science, V. 3, No. 8, pp. 792-795.
8. Pappert, R. A., E. E. Gossard, and I. J. Rothmuller, [1967], "A Numerical Investigation of Classical Approximations Used in VLF Propagation," Radio Science, V. 2, pp. 387-400.

9. Staff of the Computation Laboratory at Cambridge, Massachusetts, [1945] Tables of the Modified Hankel Functions as Order One-Third and of their Derivatives, (Harvard Univ. Press, Cambridge, MA).
10. Pappert, R. A. and Shockey, L. R. [1974] A Simplified Mode Conversion Program for VLF Propagation In the Earth-Ionosphere Waveguide. Naval Electronics Laboratory Center Interim Report 751.
11. Pappert, R. A. and Smith, R. R. [1972] Orthogonality of VLF Height Gains in the Earth Ionosphere Waveguide. Radio Science, V. 7, pp. 275-278.
12. Wait, J. R. and Spies, K. P. [1965] "Influence of Finite Ground Conductivity on the Propagation of VLF Radio Waves," Radio Science, NBS Journ. of Research, 69D, pp. 1359-1373.
13. Burgess, B. R. [1972], Royal Aircraft Establishment, Farnborough, England, letter to Commanding Officer, Naval Ocean Systems Center, San Diego, CA.

VI. FIGURES

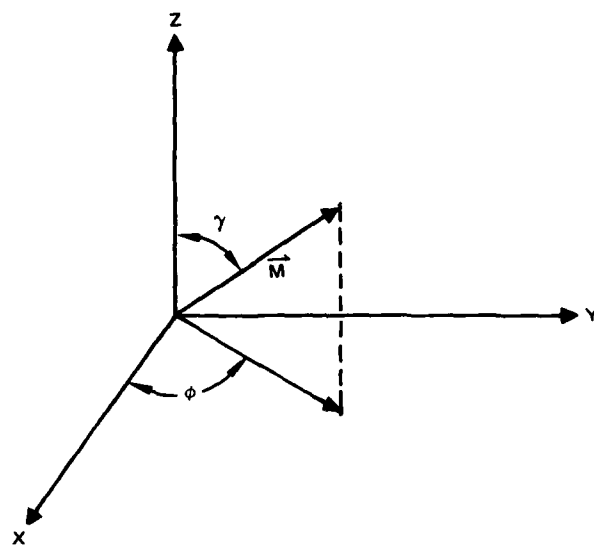


Figure 1. Dipole $\vec{M}$ orientation within the waveguide where γ is the inclination and ϕ the azimuthal orientation.

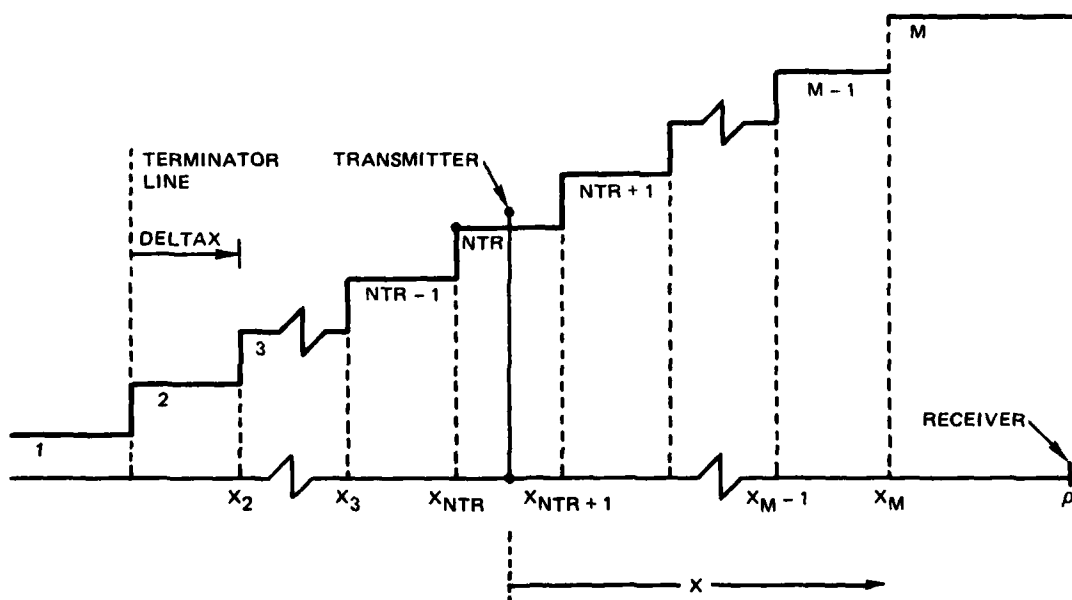


Figure 2. Mode conversion model.

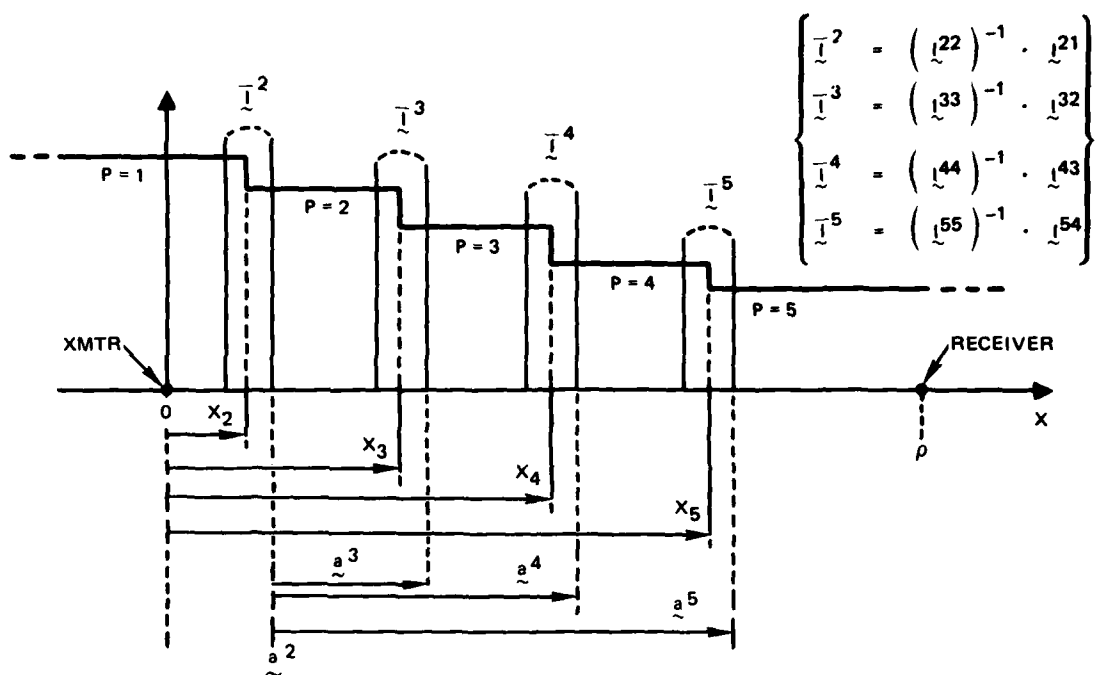
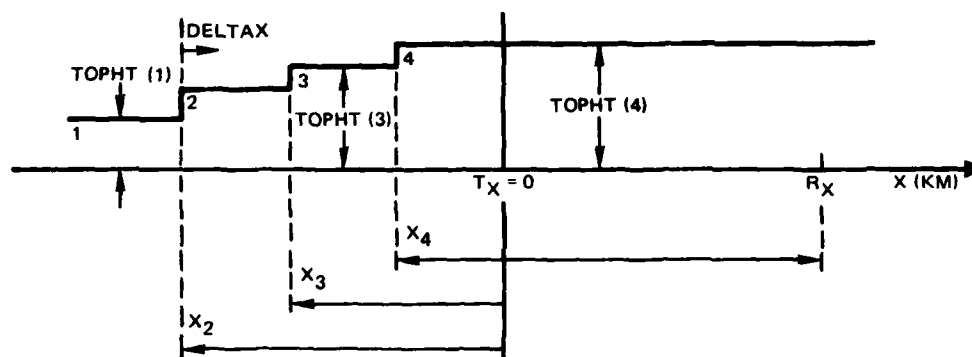
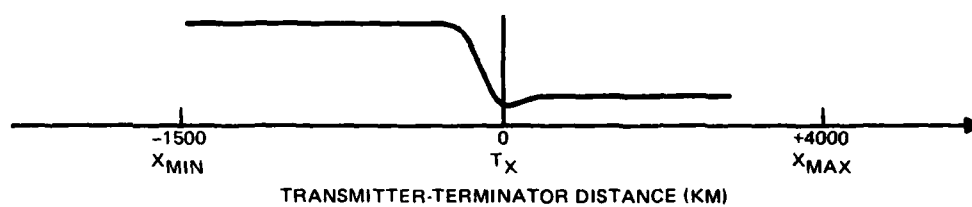


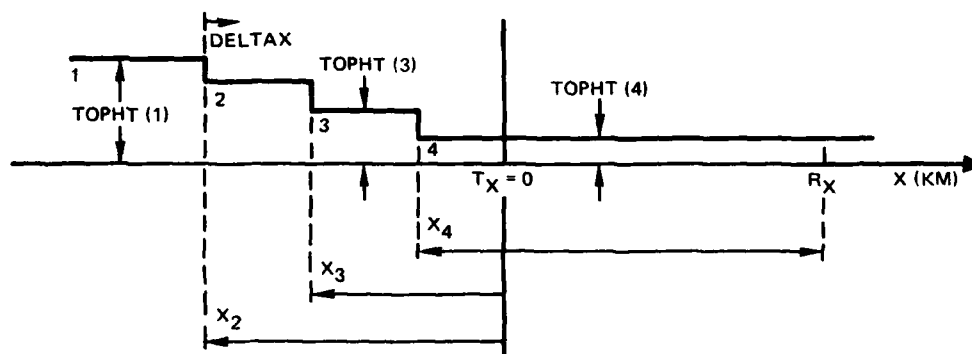
Figure 3. Identification of the terms: "accumulative (or total)" conversion coefficient, $\bar{a}^P$ and "normalized" conversion coefficient, $\bar{I}^P$.



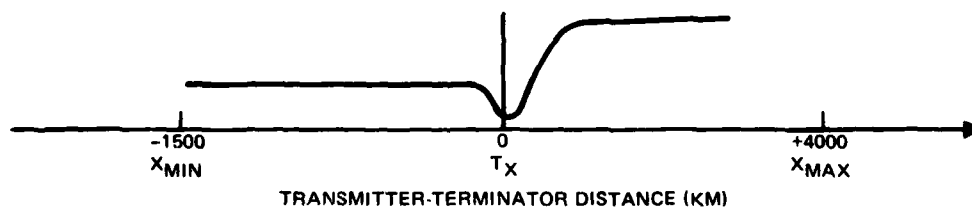
(a) SUNSET INPUT GEOMETRY FOR MOVING TERMINATOR.



(b) RESULTING FIELD STRENGTH AMPLITUDE PLOT FOR SUNSET.



(c) SUNRISE INPUT GEOMETRY FOR MOVING TERMINATOR.



(d) RESULTING FIELD STRENGTH AMPLITUDE PLOT FOR SUNRISE.

Figure 4. SUNRISE-SUNSET geometry.

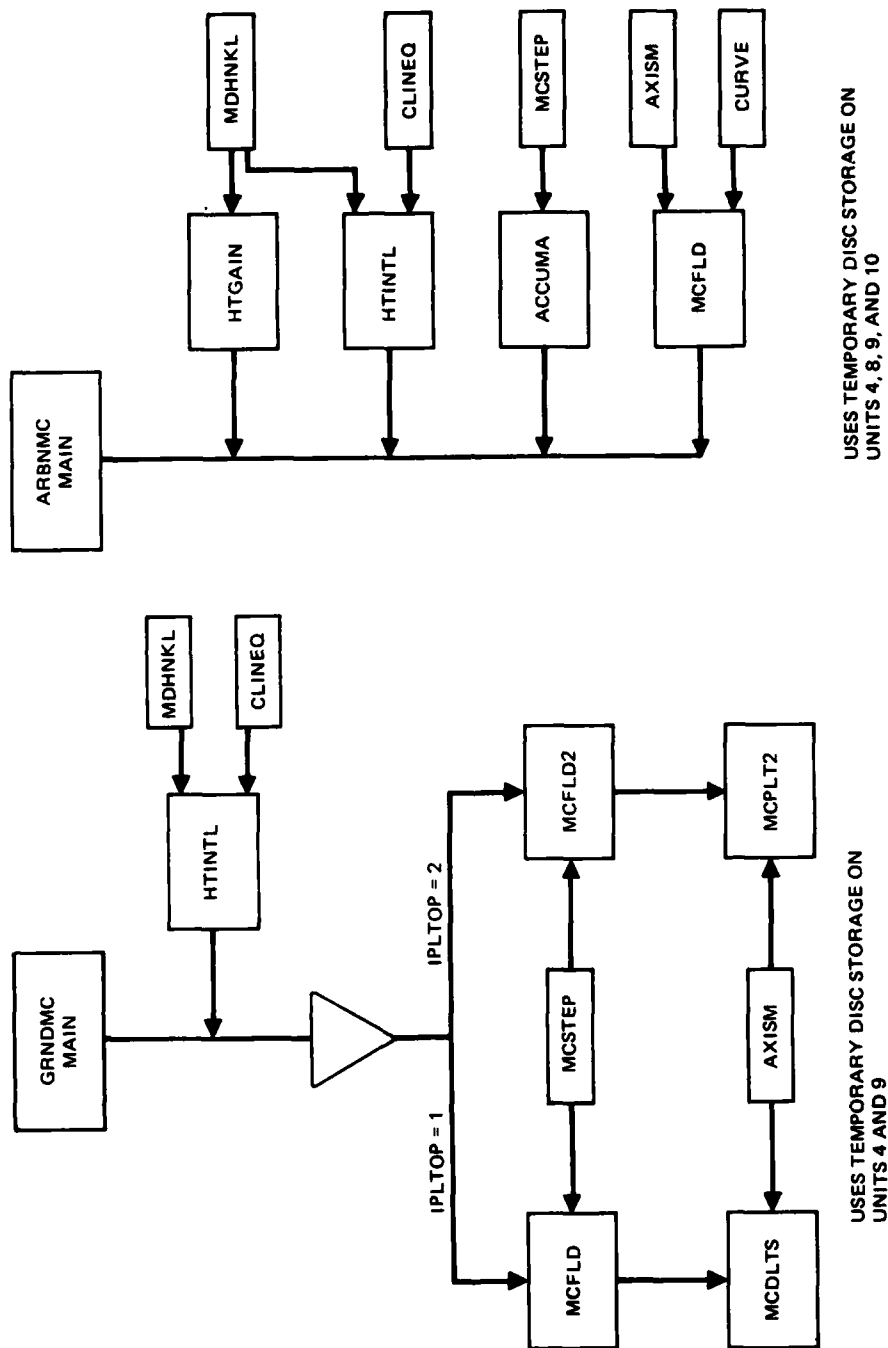


Figure 5,a. Program Flow.

SUBROUTINE "MAIN" FOR PROGRAMS
"ARBPMC" AND "GRNPMC"

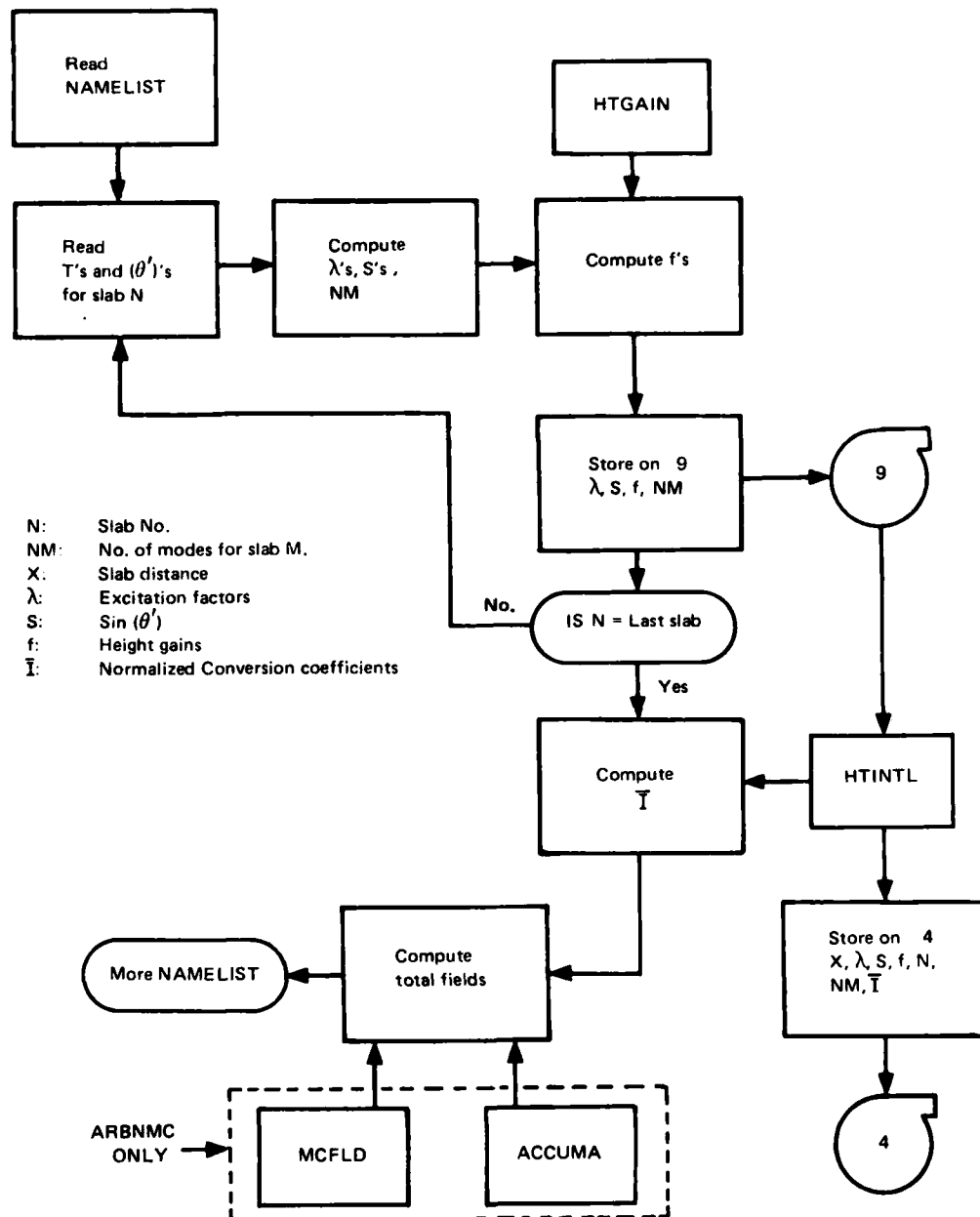


Figure 5, b. Program flow

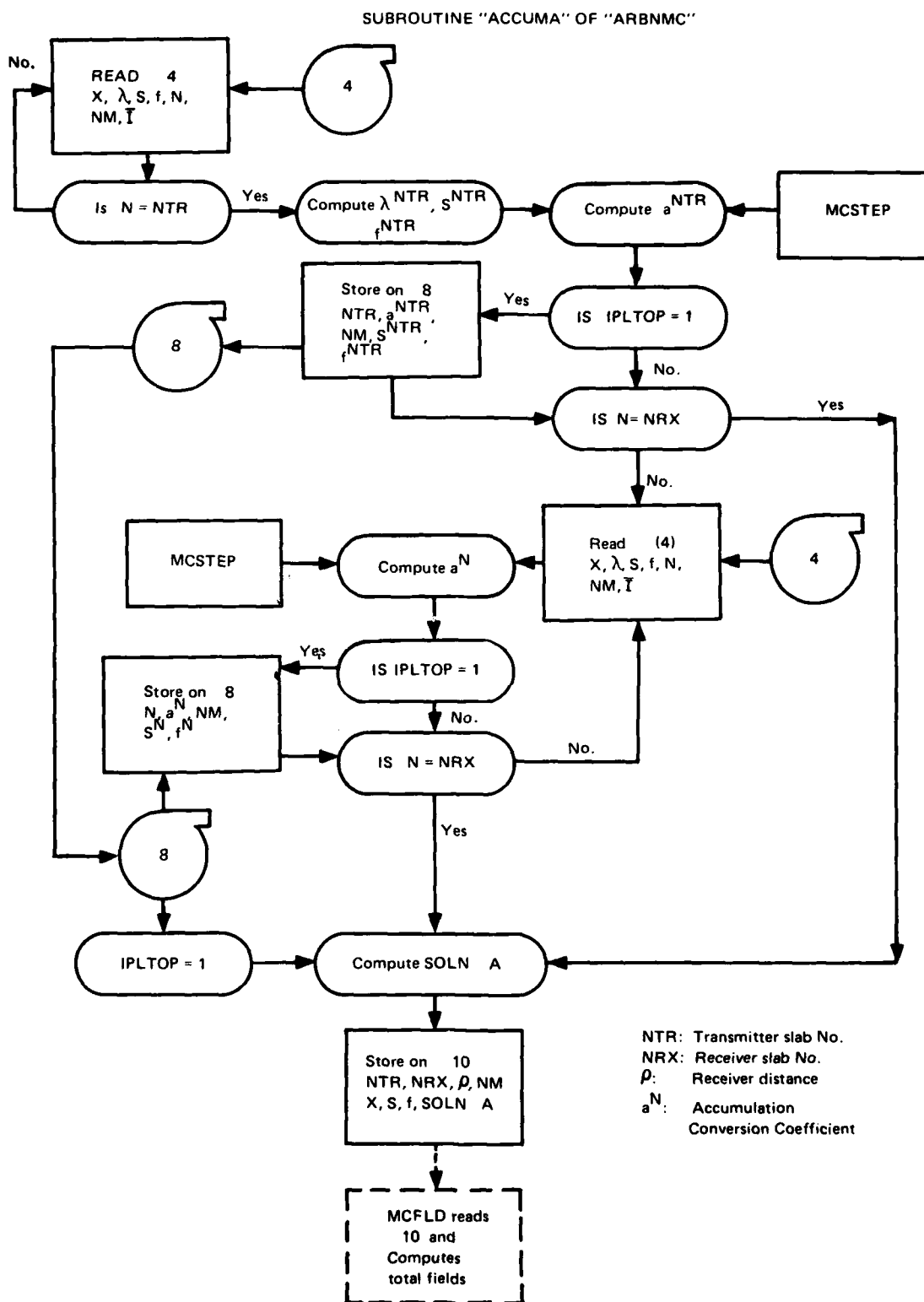


Figure 5, c. Program flow.

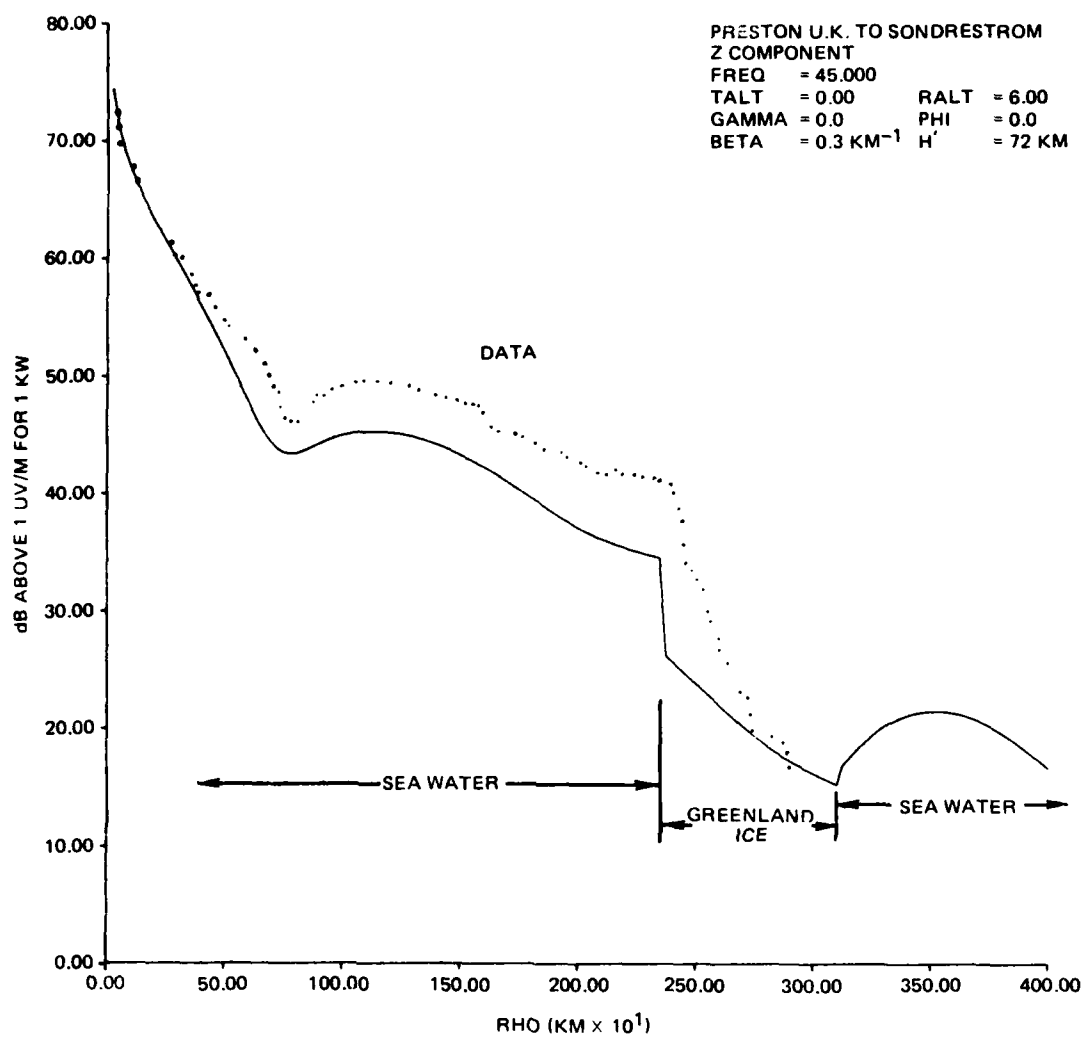


Figure 6. Daytime high latitude propagation across the Greenland ice cap (IPLTOP = 2).

a.

SUNSET HAWAII TO CALIFORNIA (B)

Z COMPONENT

FREQ= 24.908

TALT = 10.00 RALT = 10.00

RECEIVER DISTANCE = 3821.0

GAMMA=

0.0 PHI= 0.0

GAMMA=

0.0 PHI= 90.0

GAMMA=

90.0 PHI= 0.0

GAMMA=

90.0 PHI= 90.0

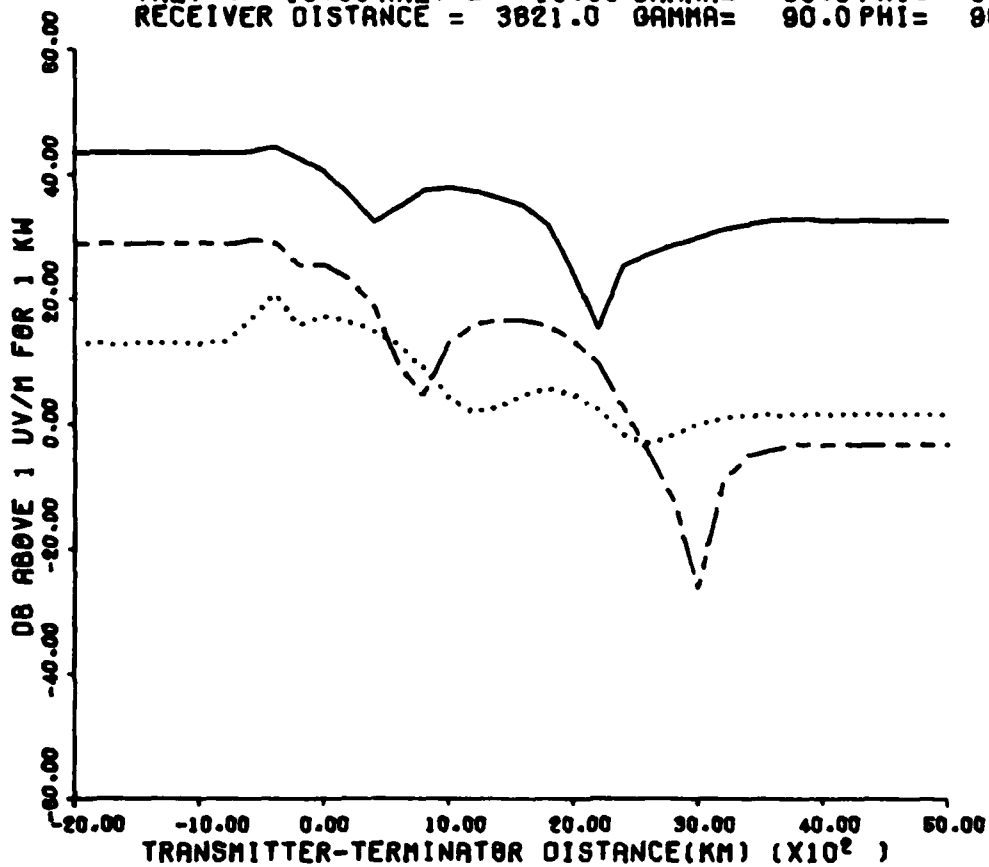


Figure 7. Propagation through the sunset terminator. (IPLTOP = 1).

b.

SUNSET HAWAII TO CALIFORNIA (B)

Z COMPONENT

FREQ= 24.908

TALT = 10.00 RALT = 10.00

RECEIVER DISTANCE = 4166.0

GAMMA=	0.0	PHI=	0.0	———
GAMMA=	0.0	PHI=	90.0	———
GAMMA=	90.0	PHI=	0.0	
GAMMA=	90.0	PHI=	90.0	----

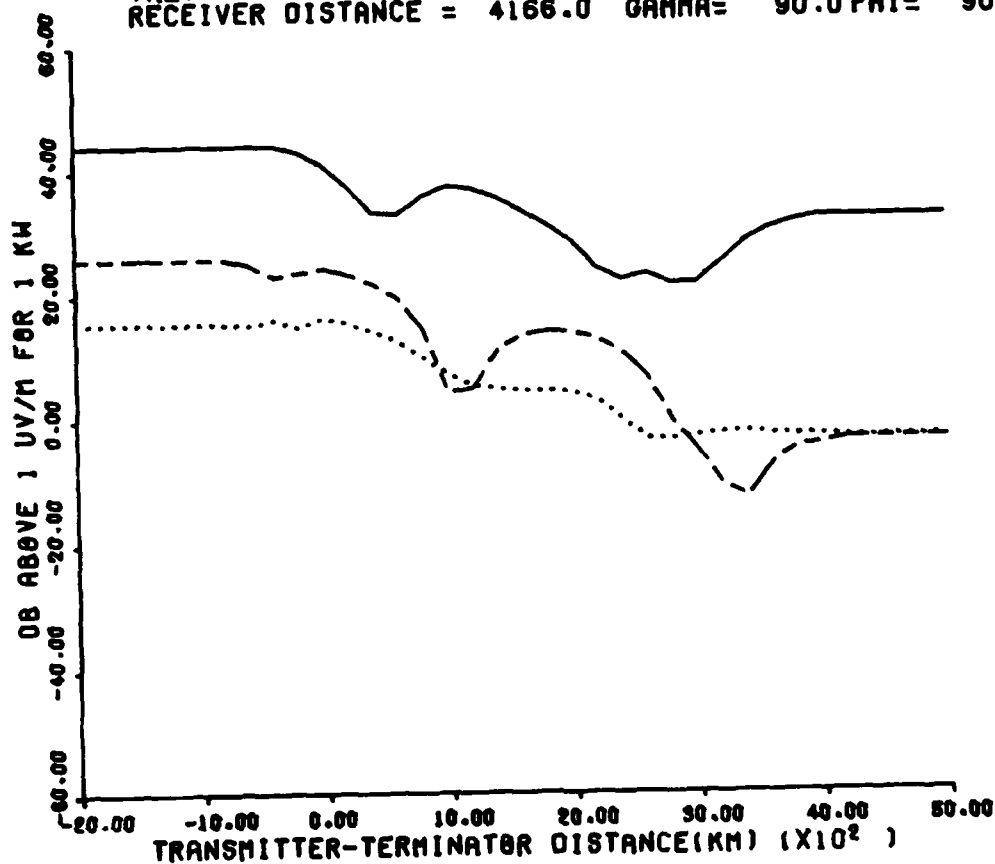


Figure 7. Continued.

c.

SUNSET HAWAII TO CALIFORNIA (8)

X COMPONENT

FREQ= 24.908

TALT = 10.00 RALT = 10.00

RECEIVER DISTANCE = 3821.0

GAMMA=

0.0

PHI=

0.0

GAMMA=

0.0

PHI=

90.0

GAMMA=

90.0

PHI=

0.0

GAMMA=

90.0

PHI=

90.0

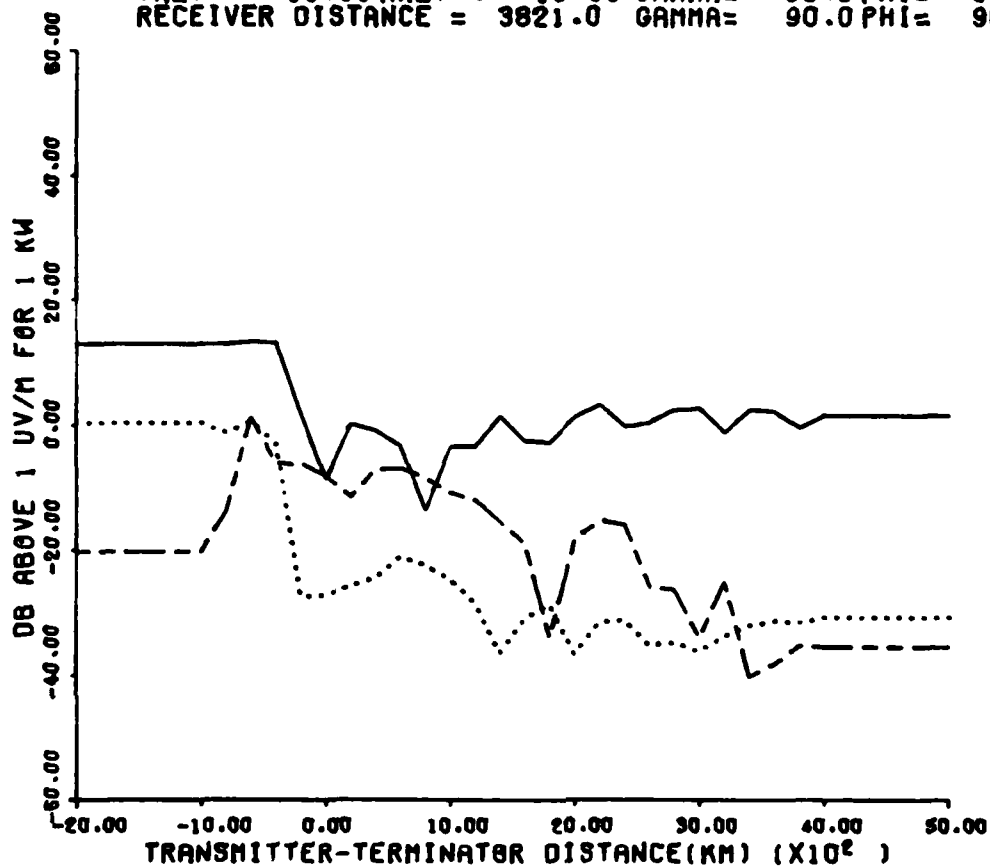


Figure 7. Continued.

d.

SUNSET HAWAII TO CALIFORNIA (B)
 X COMPONENT
 FREQ= 24.908
 TALT = 10.00 RALT = 10.00
 RECEIVER DISTANCE = 4166.0

GAMMA=	0.0	PHI=	0.0	_____
GAMMA=	0.0	PHI=	90.0	_____
GAMMA=	90.0	PHI=	0.0	
GAMMA=	90.0	PHI=	90.0	-----

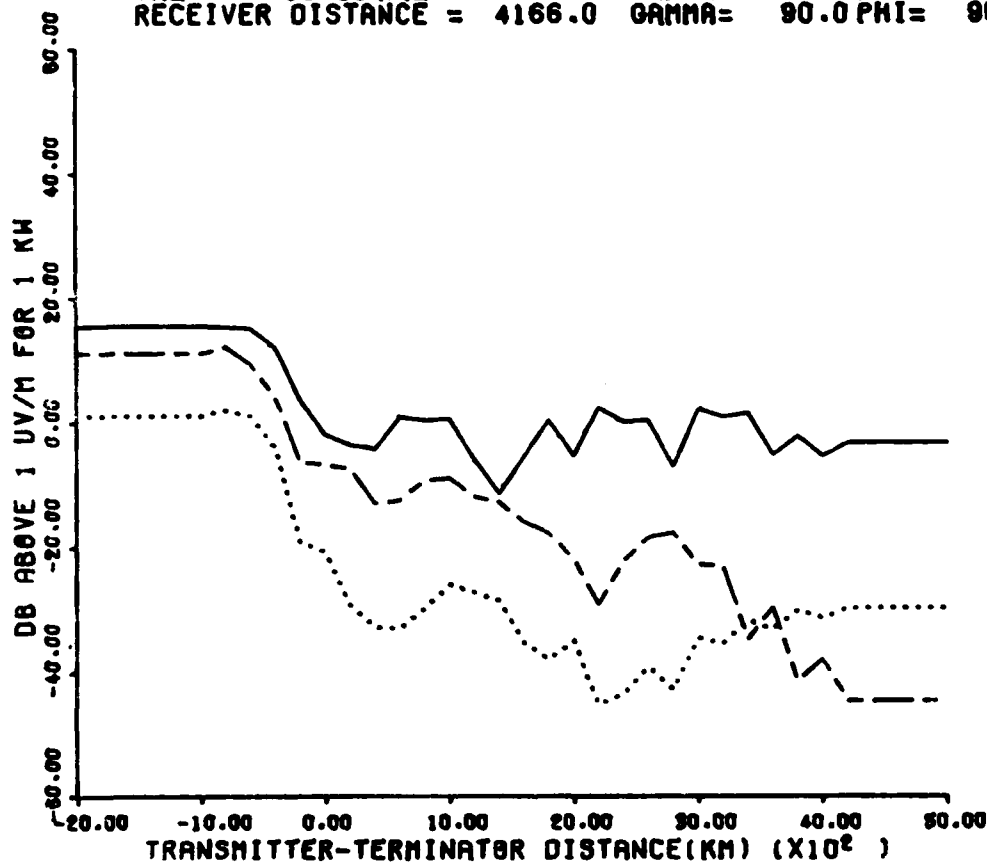


Figure 7. Continued.

e.

SUNSET HAWAII TO CALIFORNIA (B)

Y COMPONENT

FREQ= 24.908

TALT = 10.00 RALT = 10.00

RECEIVER DISTANCE = 3821.0

GAMMA=	0.0	PHI=	0.0	---
GAMMA=	0.0	PHI=	90.0	---
GAMMA=	90.0	PHI=	0.0	
GAMMA=	90.0	PHI=	90.0	---

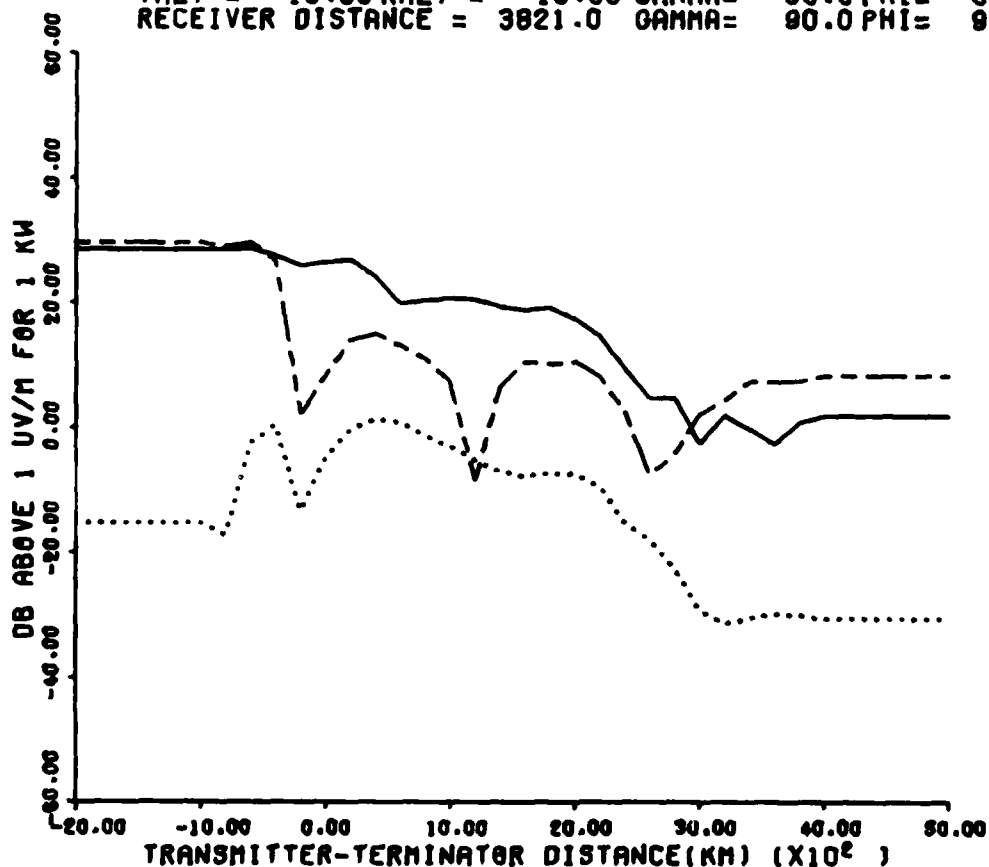


Figure 7. Continued.

f.

SUNSET HAWAII TO CALIFORNIA (B)

Y COMPONENT

FREQ= 24.908

TALT = 10.00 RALT = 10.00

RECEIVER DISTANCE = 4166.0

GAMMA=

0.0

PHI=

0.0

GAMMA=

0.0

PHI=

90.0

GAMMA=

90.0

PHI=

0.0

GAMMA=

90.0

PHI=

90.0

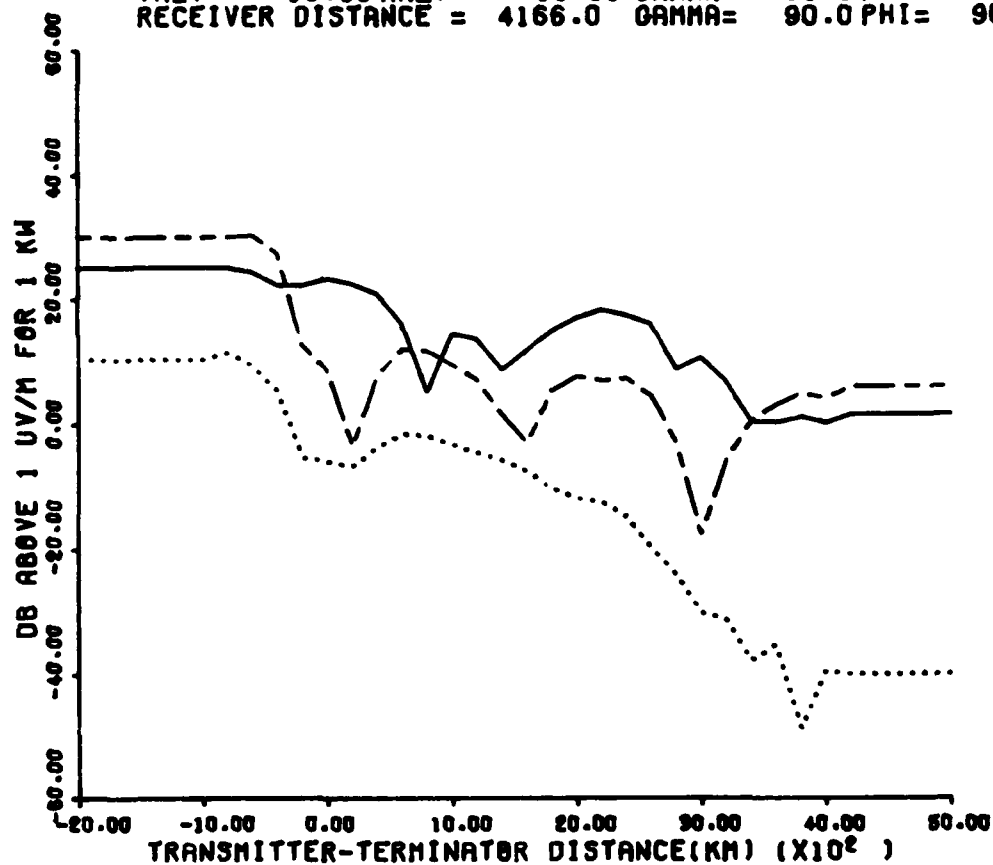


Figure 7. Continued.

VII. EXAMPLES:

Example I

```

PHLT,IL .DATA
ELT017 RL1870 11/16-14:10:18-(,0)
000001 000 NAME
000002 000 &DATUM
000003 000 RALT=6.0,TALT=0.0,
000004 000 RHOMIN=25.0,RHOMAX=4000.0,DELRHO=25.0,DELTAX=0.0,NTMAX=1,
000005 000 YMIN= 0.0,YINC=10.0,SIZEY=8.0,
000006 000 XMIN=0.0,XINC= 500.0,SIZEX=8.0,
000007 000 IPLTOP=2,
000008 000 XVAL=0.0,Z362.0,3100.0,
000009 000 INTFLG=1,IPRNTA=1,IPRINT=3,
000010 000 &END
000011 000 DATA
000012 000 PRESTON U.K. TO SONDRESTROM
000013 000 R .000 F 45.0000 A 327.000 C 16.000 M 4.880-005 S 4.640+000 E 81.0 T 72.0
000014 000 1 89.50432 -5.227691 7.68876547-004-4.26460101-004-4.61901351-013 7.40599478-015
000015 000 2 89.50432 -5.227691 1.45820227-008 1.14923771-008 3.33171375-001 1.13017417+000
000016 000 1 89.40350 -5.200752 5.63612475-005-1.35457367-004-1.79595751-012-2.75158490-012
000017 000 2 89.40350 -5.200752-1.35356545-008-1.50147295-008 3.34419385-001 1.13127953+000
000018 000 1 88.91054 -2.218521 4.29461064-003-1.67934627-002 5.28265078-015-8.55301200-014
000019 000 2 88.91054 -2.218521 1.61962495-008 3.17616551-008 3.62748194-001 1.11109295+000
000020 000 1 87.10400 -1.671932 1.09891278-004 1.15719124-006-4.58354318-011-2.50519232-011
000021 000 2 87.10400 -1.671932-2.50226939-008-6.53956631-008 3.78527377-001 1.10809810+000
000022 000 1 84.64228 -1.091651 4.73942978-005-2.01432505-002 3.34786825-013-5.50729736-013
000023 000 2 84.64228 -1.091651 3.45471309-008 1.00020680-007 4.05488681-001 1.08655921+000
000024 000
000025 000 R .000 F 45.0000 A 327.000 C 16.000 M 4.880-005 S 1.000-005 E 5.0 T 72.0
000026 000 1 89.45821 -5.220001-3.05389572-005 1.94569473-005-4.24437047-007 2.04047108-007
000027 000 2 89.45821 -5.220001 1.55486676-006-3.47085549-006 3.33677202-001 1.13072252+000
000028 000 1 89.39362 -5.190092-5.42995645-006 2.41254750-005-7.01709098-007-3.86857682-007
000029 000 2 89.39362 -5.190092-1.98778773-006 3.58369294-006 3.34649585-001 1.13131280+000
000030 000 1 87.17955 -1.683672 2.34356839-005 1.85876675-004-1.24044903-005 2.54552359+006
000031 000 2 87.17955 -1.683672 1.49351329-008-4.50114076-005 3.77780918-001 1.10834308+000
000032 000 1 86.97608 -1.835991-1.24181321-004 6.18604543-004-3.97761204-006 1.58550104+006
000033 000 2 86.97608 -1.835991-3.56925250-006 4.78808781-005 3.80167946-001 1.10961270+000
000034 000
000035 000 R .000 F 45.0000 A 327.000 C 16.000 M 4.880-005 S 4.640+000 E 81.0 T 72.0
000036 000 1 89.50432 -5.227691 7.68876547-004-4.26460101-004-4.61901351-013 7.40599478-015
000037 000 2 89.50432 -5.227691 1.45820227-008 1.14923771-008 3.33171375-001 1.13017417+000
000038 000 1 89.40350 -5.200752 5.63612475-005-1.35457367-004-1.79595751-012-2.75158490-012
000039 000 2 89.40350 -5.200752-1.35356545-008-1.50147295-008 3.34419385-001 1.13127953+000
000040 000 1 88.91054 -2.218521 4.29461064-003-1.67934627-002 5.28265078-015-8.55301200-014
000041 000 2 88.91054 -2.218521 1.61962495-008 3.17616551-008 3.62748194-001 1.11109295+000
000042 000 1 87.10400 -1.671932 1.09891278-004 1.15719124-006-4.58354318-011-2.50519232-011
000043 000 2 87.10400 -1.671932-2.50226939-008-6.53956631-008 3.78527377-001 1.10809810+000
000044 000 1 84.64228 -1.091651 4.73942978-005-2.01432505-002 3.34786825-013-5.50729736-013
000045 000 2 84.64228 -1.091651 3.45471309-008 1.00020680-007 4.05488681-001 1.08655921+000
000046 000
000047 000 R 40.0
000048 000 START
000049 000 QUIT
END ELT.

```

Example II

57

000049	000	2 82.63814	-1.051702	-2.286032	36-007	-3.552311	65-007	4.006340	73-001	2.293782	59-001
000050	000	1 79.37213	-7.99941	1.853431	08-005	-2.711294	82-003	6.238456	53-012	7.046682	52-012
000051	000	2 79.37213	-7.99941	4.019449	31-007	5.964703	36-007	4.415278	99-001	2.198597	88-001
000052	000										
000053	000	R .000 F 24.9080	A 58.500	C 39.000	M 4.310	-005	S 4.640	+000	E 81.0	T 78.0	
000054	000	1 89.69031	-4.875951	2.460417	92-003	-6.448355	15-003	-1.313214	3-012	8.071630	18-013
000055	000	2 89.69031	-4.875951	1.261730	79-007	7.002254	78-008	4.761953	54-001	1.852056	51-001
000056	000	1 89.35652	-4.525502	-3.069656	45-004	-1.234553	83-003	-1.415073	38-011	-7.283606	55-012
000057	000	2 89.35652	-4.525502	-1.497108	84-007	-1.301561	66-007	4.794364	61-001	1.865936	72-001
000058	000	1 85.75036	-6.71091	6.994434	37-004	-3.017223	35-002	-1.096486	7-012	-1.015424	14-012
000059	000	2 85.75036	-6.71091	1.563599	15-007	2.435941	76-007	5.073452	74-001	1.798804	66-001
000060	000	1 83.17259	-9.24892	5.843381	00-004	-7.429958	25-004	-1.277899	02-010	-2.844548	19-011
000061	000	2 83.17259	-9.24892	-2.285899	19-007	-4.112276	28-007	5.289363	69-001	1.808063	05-001
000062	000	1 79.83992	-6.83961	-5.722003	63-004	-2.630855	00-002	-9.087815	35-012	-1.057030	80-011
000063	000	2 79.83992	-6.83961	3.861863	04-007	6.823888	65-007	5.702868	70-001	1.752355	81-001
000064	000										
000065	000	R .000 F 24.9080	A 58.500	C 39.000	M 4.310	-005	S 4.640	+000	E 81.0	T 79.6	
000066	000	1 89.73077	-5.152571	1.999456	14-003	-3.832978	1-003	-3.036875	30-012	1.104111	16-012
000067	000	2 89.73077	-5.152571	1.074404	9-007	1.000027	49-007	6.103394	63-001	1.454531	94-001
000068	000	1 89.50095	-4.806542	-2.425493	24-004	-2.493392	68-003	-9.242746	11-012	-5.571909	42-012
000069	000	2 89.50095	-4.806542	-1.301760	83-007	-1.610141	94-007	6.133806	41-001	1.465419	61-001
000070	000	1 86.24040	-6.03171	3.858642	70-004	-2.892435	71-002	-1.616823	20-012	-1.582747	35-012
000071	000	2 86.24040	-6.03171	1.514739	23-007	2.769521	219-007	6.412398	67-001	1.422368	85-001
000072	000	1 83.71626	-7.77982	9.953975	24-004	-1.176705	92-003	-1.104756	22-010	-1.847378	11-011
000073	000	2 83.71626	-7.77982	-2.378074	7-007	-4.530771	56-007	6.605600	71-001	1.439360	75-001
000074	000	1 80.33162	-5.74621	-1.280497	77-003	-2.546962	56-002	-1.159525	51-011	-1.464341	37-011
000075	000	2 80.33162	-5.74621	3.621424	23-007	7.315969	91-007	7.006666	986-001	1.415338	78-001
000076	000										
000077	000	R .000 F 24.9080	A 58.500	C 39.000	M 4.310	-005	S 4.640	+000	E 81.0	T 81.0	
000078	000	1 89.78972	-5.399591	1.129074	28-003	-2.309911	33-003	-3.792260	02-012	4.982075	20-013
000079	000	2 89.78972	-5.399591	7.569614	71-008	6.760431	31-008	7.219898	92-001	1.302163	14-001
000080	000	1 89.58852	-5.001701	3.082673	72-004	-2.967418	61-003	-6.366040	34-012	-3.609961	56-012
000081	000	2 89.58852	-5.001701	-9.218093	67-008	-1.453346	44-007	7.253467	22-001	1.312672	37-001
000082	000	1 86.68444	-5.46311	4.834329	87-005	-2.777193	38-002	-1.936781	79-012	-2.067127	58-012
000083	000	2 86.68444	-5.46311	1.426381	96-007	2.877423	78-007	7.518320	46-001	1.285335	85-001
000084	000	1 84.15489	-6.51842	1.413395	40-003	-1.524806	523-003	-9.806026	22-011	-1.162995	08-011
000085	000	2 84.15489	-6.51842	-2.169423	304-007	-4.649366	97-007	7.689855	525-001	1.303436	10-001
000086	000	1 80.74471	-4.89571	-1.802210	08-003	-2.488410	59-002	-1.271533	303-011	-1.701103	7-011
000087	000	2 80.74471	-4.89571	3.408228	51-007	7.297777	81-007	8.063967	79-001	1.298647	63-001
000088	000	1 78.75119	-6.30472	2.569270	23-003	-2.164756	30-003	-2.635225	6-010	-3.149176	91-012
000089	000	2 78.75119	-6.30472	-4.203229	94-007	-9.328323	53-007	8.352945	37-001	1.331777	42-001
000090	000	1 75.72210	-5.36421	-3.491340	29-003	-2.141404	5-002	-5.202450	93-011	-7.134678	61-011
000091	000	2 75.72210	-5.36421	6.627465	44-007	1.300520	34-006	8.889784	59-001	1.352146	40-001
000092	000										
000093	000	R .000 F 24.9080	A 58.500	C 39.000	M 4.310	-005	S 4.640	+000	E 81.0	T 82.6	
000094	000	1 89.85394	-5.651282	5.308257	97-004	-1.456227	7-003	-3.630050	508-012	1.097768	90-013
000095	000	2 89.85394	-5.651282	5.282759	30-008	6.283023	388-008	8.263777	757-001	1.221759	40-001
000096	000	1 89.64838	-5.195731	6.195784	45-004	-2.828400	64-003	-4.664657	5-012	-2.210141	2-012
000097	000	2 89.64838	-5.195731	-6.747028	98-008	-1.151377	83-007	8.300862	209-001	1.232955	44-001
000098	000	1 87.19826	-5.06541	-2.877787	73-004	-2.640484	1-002	-2.245693	305-012	-2.445274	13-012

000099	000	2 87.19826	-506541	1.37837519-007	2.82508003-007	8.54361810-001	1.20942168-001
000100	000	1 84.61456	-544462	1.83411167-003	1.9257927-003	8.60644949-011	6.40555805-012
000101	000	2 84.61456	-544462	2.1675616-007	4.63199729-007	8.69214445-001	1.22206585-001
000102	000	1 81.18239	-418231	2.21618835-003	2.42613989-002	1.38261576-011	1.81744188-011
000103	000	2 81.18239	-418231	3.31291361-007	7.07726464-007	9.02894214-001	1.21887835-001
000104	000	1 79.19591	-507442	2.92677229-003	2.58822479-003	2.37343714-010	6.19553080-012
000105	000	2 79.19591	-507442	4.19945021-007	8.98002661-007	9.29322422-001	1.23763002-001
000106	000	1 76.23727	-456191	3.80125912-003	2.05570427-002	5.56343209-011	7.11606746-011
000107	000	2 76.23727	-456191	6.47266454-007	1.22329271-006	9.77942094-001	1.24818111-001
000108	000						
000109	000	R .000 F 24.9080	A 58.500	C 39.000	M 4.310-005	S 4.640+000	E 81.0 T 84.0
000110	000	1 89.90134	-5.849822	2.69505446-004	1.03755109-003	3.21456368-002	1.34699149-014
000111	000	2 89.90134	-5.849822	4.08981013-008	4.57839024-008	9.05733369-001	1.25168519-001
000112	000	1 89.68734	-5.359211	6.62271697-004	2.50393595-003	3.76191515-012	1.51208291-012
000113	000	2 89.68734	-5.359211	5.44264638-008	9.20538250-008	9.09529813-001	1.26204189-001
000114	000	1 87.68800	-494381	5.09559082-004	2.51694310-002	2.42715177-012	2.58023494-012
000115	000	2 87.68800	-494381	1.34943024-007	2.76973452-007	9.31343198-001	1.23312354-001
000116	000	1 85.00281	-470892	2.09836292-003	2.23402242-003	7.70132057-011	3.39874537-012
000117	000	2 85.00281	-470892	2.17315097-007	4.48215911-007	9.44166251-001	1.23727024-001
000118	000	1 81.55036	-367911	2.39606039-003	2.38209774-002	1.42310365-011	1.78059215-011
000119	000	2 81.55036	-367911	3.24104526-007	6.71439167-007	9.74082775-001	1.22308683-001
000120	000	1 79.56040	-423362	3.04706555-003	2.80827233-003	2.17351453-010	1.03768027-011
000121	000	2 79.56040	-423362	4.17741553-007	8.49616320-007	9.98150624-001	1.22338288-001
000122	000	1 76.66423	-401641	3.82294753-003	1.99857369-002	5.65521007-011	6.69829461-011
000123	000	2 76.66423	-401641	6.28280070-007	1.4193287-006	1.04203887+000	1.21036479-001
000124	000	1 74.86360	-499162	4.73303476-003	4.43684857-003	3.85922860-010	6.23331317-011
000125	000	2 74.86360	-499162	7.51892628-007	1.3384701-006	1.07480203+000	1.22354091-001
000126	000	1 72.05312	-438781	5.57353633-003	1.67846209-002	1.62254330-010	1.70214275-010
000127	000	2 72.05312	-438781	1.06848681-006	1.58193814-006	1.13485004+000	1.20781438-001
000128	000						
000129	000	R .000 F 24.9080	A 58.500	C 39.000	M 4.310-005	S 4.640+000	E 81.0 T 85.6
000130	000	1 89.93689	-6.056292	1.29746211-004	7.27717736-004	2.71399789-012	8.55948477-015
000131	000	2 89.93689	-6.056292	3.11728057-008	3.27019833-008	9.74331625-001	1.29132293-001
000132	000	1 89.72088	-5.534781	6.06993533-004	2.11921171-003	3.02807890-012	1.05171808-012
000133	000	2 89.72088	-5.534781	4.38525052-008	7.23754923-008	9.78165291-001	1.29808467-001
000134	000	1 88.32047	-545151	6.71242735-004	2.36820115-002	2.65515255-012	2.58494528-012
000135	000	2 88.32047	-545151	1.35451096-007	2.62652165-007	9.97399762-001	1.25476331-001
000136	000	1 85.43790	-415692	2.28754283-003	2.61917268-003	6.78228602-011	1.31579802-012
000137	000	2 85.43790	-415692	2.21780516-007	4.7797897-007	1.00825281+000	1.24719514-001
000138	000	1 81.94670	-326911	2.47428624-003	2.3360592-002	1.46797121-011	1.66669270-011
000139	000	2 81.94670	-326911	3.21712189-007	6.30019258-007	1.03445098+000	1.21087034-001
000140	000	1 79.95527	-353392	3.0551948-003	3.11295904-003	1.96670725-010	1.24702745-011
000141	000	2 79.95527	-353392	4.19254128-007	7.95690433-007	1.05607128+000	1.18625170-001
000142	000	1 77.11997	-356891	3.72267660-003	1.93113454-002	5.75092981-011	6.09032885-011
000143	000	2 77.11997	-356891	6.13303058-007	1.05814185-006	1.09546088+000	1.13678771-001
000144	000	1 75.31883	-420052	4.53992857-003	4.7702491-003	3.49708696-010	5.98052181-011
000145	000	2 75.31883	-420052	7.38060116-007	1.23342487-006	1.12622313+000	1.11008774-001
000146	000	1 72.59271	-392531	5.23966021-003	1.61039550-002	1.60900815-010	1.51319308-010
000147	000	2 72.59271	-392531	1.01608181-006	1.45627287-006	1.18171781+000	1.03980959-001
000148	000						

Example III

```

NAME
&DATUM
  RALT=6.0, TALT=0.0,
  RHOMIN=25.0, RHOMAX=4000.0, DELRHO=25.0, DELTAX=0.0, NTMAX=1,
  YMIN= 0.0, YINC=10.0, SIZEY=8.0,
  XMIN=0.0, XINC= 500.0, SIZEX=8.0,
  IPLTOP=2,
  XVAL=0.0, Z362=0.3100.0,
  INTFLG=1, IPRNTA=1, IPRINT=3,
&END

DATA
PRESTON U.K. TO SONDESTROM

SLAB 1 R .000 F 45.0000 A 327.000 C 16.000 M .488 S 4.640+000 E 81.0 T 72.0 MODES 5
SLAB 2 R .000 F 45.0000 A 327.000 C 16.000 M .488 S 1.000-005 E 5.0 T 72.0 MODES 4
SLAB 3 R .000 F 45.0000 A 327.000 C 16.000 M .488 S 4.640+000 E 81.0 T 72.0 MODES 5

START
INTEGRALS IN SLAB 1
NORM( 1, 1, 1) = .553704+003 - .850083+003
NORM( 1, 1, 2) = .114505+004 - .167189+003
NORM( 1, 1, 3) = -.207659+002 - .149617+002
NORM( 1, 1, 4) = -.939482+002 - .147971+003
NORM( 1, 1, 5) = .235873+002 .225954+002
NORM( 1, 2, 1) = .114505+004 - .167189+003
NORM( 1, 2, 2) = .109398+004 - .630510+004
NORM( 1, 2, 3) = -.227978+002 - .168900+001
NORM( 1, 2, 4) = -.751812+003 .684891+003
NORM( 1, 2, 5) = .314290+002 .129280+002
NORM( 1, 3, 1) = -.207659+002 - .149617+002
NORM( 1, 3, 2) = -.227978+002 - .168900+001
NORM( 1, 3, 3) = .565552+002 -.986123+001
NORM( 1, 3, 4) = .411092+002 .184084+002
NORM( 1, 3, 5) = -.241909+001 -.582611+001
NORM( 1, 4, 1) = -.939482+002 - .147971+003
NORM( 1, 4, 2) = -.751812+003 .684891+003
NORM( 1, 4, 3) = .411092+002 .184084+002
NORM( 1, 4, 4) = -.691583+004 -.359842+004
NORM( 1, 4, 5) = .215047+001 .269595+002
NORM( 1, 5, 1) = .235873+002 .225954+002
NORM( 1, 5, 2) = .314290+002 .129280+002
1.01451+003
1.15720+003
2.55944+001
1.75276+002
3.26636+001
1.15720+003
6.39930+003
2.28602+001
1.01700+003
3.39840+001
2.55944+001
2.28602+001
5.74085+001
4.50426+001
6.30837+000
1.75276+002
1.01700+003
4.50426+001
7.79598+003
2.70451+001
3.26636+001
3.39840+001
303.08
351.69
215.77
237.59
43.77
351.69
279.84
184.24
137.67
22.36
215.77
184.24
350.11
24.12
247.45
237.59
137.67
24.12
207.49
85.44
43.77
22.36

```

NORM(1, 5, 3) = -.241909+001	-.582611+001	6.30837+000	247.45
NORM(1, 5, 4) = .215047+001	.269595+002	2.70451+001	85.44
NORM(1, 5, 5) = .515578+002	.784454+001	5.21512+001	8.65

INORM = NORMALIZED CONVERSION COEFFICIENTS		SLAB NUMBER = 1	
J = 1	K = 1 INORM = .00000	.00000	.00
J = 2	K = 1 INORM = .00000	.00000	.00
J = 3	K = 1 INORM = .00000	.00000	.00
J = 4	K = 1 INORM = .00000	.00000	.00
J = 5	K = 1 INORM = .00000	.00000	.00
J = 1	K = 2 INORM = .00000	.00000	.00
J = 2	K = 2 INORM = .00000	.00000	.00
J = 3	K = 2 INORM = .00000	.00000	.00
J = 4	K = 2 INORM = .00000	.00000	.00
J = 5	K = 2 INORM = .00000	.00000	.00
J = 1	K = 3 INORM = .00000	.00000	.00
J = 2	K = 3 INORM = .00000	.00000	.00
J = 3	K = 3 INORM = .00000	.00000	.00
J = 4	K = 3 INORM = .00000	.00000	.00
J = 5	K = 3 INORM = .00000	.00000	.00
J = 1	K = 4 INORM = .00000	.00000	.00
J = 2	K = 4 INORM = .00000	.00000	.00
J = 3	K = 4 INORM = .00000	.00000	.00
J = 4	K = 4 INORM = .00000	.00000	.00
J = 5	K = 4 INORM = .00000	.00000	.00
J = 1	K = 5 INORM = .00000	.00000	.00
J = 2	K = 5 INORM = .00000	.00000	.00

J = 3	K = 5	INORM =	.00000	.00000	.00000	.00
J = 4	K = 5	INORM =	.00000	.00000	.00000	.00
J = 5	K = 5	INORM =	.00000	.00000	.00000	.00

INTEGRALS IN SLAB 2

NORM(2, 1, 1) =	-.689634+004	.150117+005	1.65200+004	114.67
NORM(2, 1, 2) =	-.206584+005	-.400823+004	2.10437+004	190.98
NORM(2, 1, 3) =	.101721+004	-.549927+002	1.01869+003	356.91
NORM(2, 1, 4) =	.272916+003	.823991+003	8.68011+002	71.67
NORM(2, 2, 1) =	-.206584+005	-.400823+004	2.10437+004	190.98
NORM(2, 2, 2) =	-.263655+005	.321492+005	4.15778+004	129.36
NORM(2, 2, 3) =	-.893243+003	-.148881+003	9.05565+002	189.46
NORM(2, 2, 4) =	.940967+003	.473870+003	1.05355+003	26.73
NORM(2, 3, 1) =	.101721+004	-.549927+002	1.01869+003	356.91
NORM(2, 3, 2) =	-.893243+003	-.148881+003	9.05565+002	189.46
NORM(2, 3, 3) =	.345989+004	.268547+004	4.37980+003	142.18
NORM(2, 3, 4) =	-.871953+003	-.102474+004	1.34551+003	229.61
NORM(2, 4, 1) =	.272916+003	.823991+003	8.68011+002	71.67
NORM(2, 4, 2) =	.940967+003	.473870+003	1.05355+003	26.73
NORM(2, 4, 3) =	-.871953+003	-.102474+004	1.34551+003	229.61
NORM(2, 4, 4) =	-.130083+004	.307805+003	1.33675+003	166.69
CABI(2, 1, 1) =	.341939+004	.224884+004	4.09262+003	33.33
CABI(2, 1, 2) =	-.327542+004	.681924+004	7.56508+003	115.66
CABI(2, 1, 3) =	.121793+003	-.185656+003	2.22040+002	303.27
CABI(2, 1, 4) =	.136890+004	-.278664+003	1.39697+003	348.49
CABI(2, 1, 5) =	-.114003+003	.360228+002	1.19559+002	162.46
CABI(2, 2, 1) =	.146325+004	.405022+004	4.30643+003	70.14
CABI(2, 2, 2) =	.141756+005	.629266+004	1.55095+004	23.94
CABI(2, 2, 3) =	.887340+002	-.189714+003	2.09440+002	295.07
CABI(2, 2, 4) =	-.102817+004	-.213743+004	2.37186+003	244.31
CABI(2, 2, 5) =	-.874805+002	.553245+002	1.03507+002	147.69
CABI(2, 3, 1) =	-.781335+001	-.744881+002	7.48968+001	264.01
CABI(2, 3, 2) =	-.522166+002	.589446+003	5.91754+002	95.06
CABI(2, 3, 3) =	.513539+002	.254595+003	2.59723+002	78.60
CABI(2, 3, 4) =	-.502198+004	.123886+004	5.17253+003	166.14
CABI(2, 3, 5) =	.736899+002	-.113204+003	1.35075+002	303.06
CABI(2, 4, 1) =	.132357+003	-.330573+002	1.36423+002	345.98
CABI(2, 4, 2) =	.704631+001	-.271107+003	2.71199+002	271.49
CABI(2, 4, 3) =	.323507+002	.231715+003	2.33962+002	82.05
CABI(2, 4, 4) =	.149650+004	-.619506+003	1.61966+003	337.51
CABI(2, 4, 5) =	.617325+002	-.131186+003	1.44985+002	295.20

INORM = NORMALIZED CONVERSION COEFFICIENTS			SLAB NUMBER = 2
J = 1	K = 1	INORM =	-2.57981-003 -1.92246-001 1.92264-001 269.23

J = 2	K = 1	INORM =	-3.10839-002	-4.14087-002	5.17773-002	233.11
J = 3	K = 1	INORM =	-1.35819-005	-1.48235-002	1.48235-002	269.95
J = 4	K = 1	INORM =	1.11251-002	-4.52524-002	4.65999-002	283.81
J = 1	K = 2	INORM =	-1.57271-002	1.57387-001	1.58170-001	95.71
J = 2	K = 2	INORM =	-2.44277-002	-3.90130-001	3.90894-001	266.42
J = 3	K = 2	INORM =	-1.47137-003	-1.64146-002	1.64804-002	264.88
J = 4	K = 2	INORM =	1.45132-002	-4.40381-002	4.63679-002	288.24
J = 1	K = 3	INORM =	-2.95272-003	1.13780-003	3.16435-003	158.93
J = 2	K = 3	INORM =	-9.94993-004	1.83987-003	2.09168-003	118.40
J = 3	K = 3	INORM =	-1.65526-002	-4.55370-002	4.84521-002	250.02
J = 4	K = 3	INORM =	-1.92979-002	-1.39794-001	1.41120-001	262.14
J = 1	K = 4	INORM =	-6.01359-004	1.29700-003	1.42963-003	114.87
J = 2	K = 4	INORM =	-6.92692-004	1.04526-003	1.25395-003	123.53
J = 3	K = 4	INORM =	8.18196-001	7.64483-001	1.11977+000	43.06
J = 4	K = 4	INORM =	-8.87768-001	-8.90408-001	1.25736+000	225.09

64

INTEGRALS IN SLAB 3

NORM(3, 1, 1) =	.553704+003	-.850083+003	1.01451+003	303.08
NORM(3, 1, 2) =	.114505+004	-.167189+003	1.15720+003	351.69
NORM(3, 1, 3) =	-.207659+002	-.149617+002	2.55944+001	215.77
NORM(3, 1, 4) =	-.939482+002	-.147971+003	1.75276+002	237.59
NORM(3, 1, 5) =	.235873+002	.225954+002	3.26636+001	43.77
NORM(3, 2, 1) =	.114505+004	-.167189+003	1.15720+003	351.69
NORM(3, 2, 2) =	.109398+004	-.630510+004	6.39930+003	279.84
NORM(3, 2, 3) =	-.227978+002	-.168900+001	2.28602+001	184.24
NORM(3, 2, 4) =	-.751812+003	.684891+003	1.01700+003	137.67
NORM(3, 2, 5) =	.314290+002	.129280+002	3.39840+001	22.36
NORM(3, 3, 1) =	-.207659+002	-.149617+002	2.55944+001	215.77
NORM(3, 3, 2) =	-.227978+002	-.168900+001	2.28602+001	184.24
NORM(3, 3, 3) =	.565552+002	-.986123+001	5.74085+001	350.11
NORM(3, 3, 4) =	-.411092+002	.184084+002	4.50426+001	24.12
NORM(3, 3, 5) =	-.241909+001	-.582611+001	6.30837+000	247.45
NORM(3, 4, 1) =	-.939482+002	-.147971+003	1.75276+002	237.59
NORM(3, 4, 2) =	-.751812+003	.684891+003	1.01700+003	137.67

NORM(3, 4, 3) =	.411092+002	.184084+002	4.50426+001	24.12
NORM(3, 4, 4) =	-.691583+004	-.359842+004	7.79598+003	207.49
NORM(3, 4, 5) =	.215047+001	.269595+002	2.70451+001	85.44
NORM(3, 5, 1) =	.235873+002	.225954+002	3.26636+001	43.77
NORM(3, 5, 2) =	.314290+002	.129280+002	3.39840+001	22.36
NORM(3, 5, 3) =	-.241909+001	-.582611+001	6.30837+000	247.45
NORM(3, 5, 4) =	.215047+001	.269595+002	2.70451+001	85.44
NORM(3, 5, 5) =	.515578+002	.784454+001	5.21512+001	8.65
CAP(3, 1, 1) =	.341939+004	.224884+004	4.09262+003	33.33
CAP(3, 1, 2) =	.146325+004	.405022+004	4.30643+003	70.14
CAP(3, 1, 3) =	-.781335+001	-.744881+002	7.48968+001	264.01
CAP(3, 1, 4) =	.132357+003	-.330573+002	1.36423+002	345.98
CAP(3, 2, 1) =	-.327542+004	.681924+004	7.56508+003	115.66
CAP(3, 2, 2) =	.141756+005	.629266+004	1.55095+004	23.94
CAP(3, 2, 3) =	-.522166+002	.589446+003	5.91754+002	95.06
CAP(3, 2, 4) =	.704631+001	-.271107+003	2.71199+002	271.49
CAP(3, 3, 1) =	.121793+003	-.185656+003	2.22040+002	303.27
CAP(3, 3, 2) =	.887340+002	-.189714+003	2.09440+002	295.07
CAP(3, 3, 3) =	.513539+002	.254595+003	2.59723+002	78.60
CAP(3, 3, 4) =	.323507+002	.231715+003	2.33962+002	82.05
CAP(3, 4, 1) =	.136890+004	-.278664+003	1.39697+003	348.49
CAP(3, 4, 2) =	-.102817+004	-.213743+004	2.37186+003	244.31
CAP(3, 4, 3) =	-.502198+004	.123886+004	5.17253+003	166.14
CAP(3, 4, 4) =	.149650+004	-.619506+003	1.61966+003	337.51
CAP(3, 5, 1) =	-.114003+003	.360228+002	1.19559+002	162.46
CAP(3, 5, 2) =	-.874805+002	.553245+002	1.03507+002	147.69
CAP(3, 5, 3) =	.736899+002	-.113204+003	1.35075+002	303.06
CAP(3, 5, 4) =	.617325+002	-.131186+003	1.44985+002	295.20

INORM = NORMALIZED CONVERSION COEFFICIENTS SLAB NUMBER = 3

J = 1 K = 1	INORM =	-2.39980-001	4.73044+000	4.73652+000	92.90
J = 2 K = 1	INORM =	-3.08277-001	-5.45127-001	6.26257-001	240.51
J = 3 K = 1	INORM =	1.09296+000	-1.67666+000	2.00144+000	303.10
J = 4 K = 1	INORM =	8.04651-003	-1.16064-003	8.12979-003	351.79
J = 5 K = 1	INORM =	1.21527-001	-9.28489-001	9.36408-001	277.46
J = 1 K = 2	INORM =	-3.82853-001	1.87386+000	1.91257+000	101.55
J = 2 K = 2	INORM =	-2.44327-001	2.31412+000	2.32698+000	96.03
J = 3 K = 2	INORM =	1.15439+000	-1.67388+000	2.03334+000	304.59
J = 4 K = 2	INORM =	8.85291-003	4.77432-003	1.00582-002	28.34
J = 5 K = 2	INORM =	1.31443-001	-9.38743-001	9.47900-001	277.97

J = 1	K = 3	INORM =	-8.08345-002	2.32540-002	8.41129-002	163.95
J = 2	K = 3	INORM =	-7.09757-003	1.37870-002	1.55067-002	117.24
J = 3	K = 3	INORM =	-1.74859-001	4.54218+000	4.54554+000	92.20
J = 4	K = 3	INORM =	5.06520-001	-4.16186-001	6.55571-001	320.59
J = 5	K = 3	INORM =	3.75751-001	-2.28882+000	2.31946+000	279.32
J = 1	K = 4	INORM =	-7.61342-002	2.65349-002	8.06258-002	160.79
J = 2	K = 4	INORM =	-7.59287-003	1.25994-002	1.47105-002	121.07
J = 3	K = 4	INORM =	2.47582-001	4.00187+000	4.00952+000	86.46
J = 4	K = 4	INORM =	-1.22341-001	1.78256-001	2.16201-001	124.46
J = 5	K = 4	INORM =	5.53141-001	-2.34087+000	2.40533+000	283.29
J = 1	K = 5	INORM =	.00000	.00000	.00000	.00
J = 2	K = 5	INORM =	.00000	.00000	.00000	.00
J = 3	K = 5	INORM =	.00000	.00000	.00000	.00
J = 4	K = 5	INORM =	.00000	.00000	.00000	.00
J = 5	K = 5	INORM =	.00000	.00000	.00000	.00

66

A = TOTAL CONVERSION COEFFICIENTS			SLAB NUMBER = 1			
J = 1	K = 1	A =	1.00000+000	.00000	1.00000+000	.00
J = 2	K = 1	A =	.00000	.00000	.00000	.00
J = 3	K = 1	A =	.00000	.00000	.00000	.00
J = 4	K = 1	A =	.00000	.00000	.00000	.00
J = 5	K = 1	A =	.00000	.00000	.00000	.00
J = 1	K = 2	A =	.00000	.00000	.00000	.00
J = 2	K = 2	A =	1.00000+000	.00000	1.00000+000	.00
J = 3	K = 2	A =	.00000	.00000	.00000	.00
J = 4	K = 2	A =	.00000	.00000	.00000	.00

J = 5	K = 2	A =	.00000	.00000	.00000	.00
J = 1	K = 3	A =	.00000	.00000	.00000	.00
J = 2	K = 3	A =	.00000	.00000	.00000	.00
J = 3	K = 3	A =	1.00000+000	.00000	1.00000+000	.00
J = 4	K = 3	A =	.00000	.00000	.00000	.00
J = 5	K = 3	A =	.00000	.00000	.00000	.00
J = 1	K = 4	A =	.00000	.00000	.00000	.00
J = 2	K = 4	A =	.00000	.00000	.00000	.00
J = 3	K = 4	A =	.00000	.00000	.00000	.00
J = 4	K = 4	A =	1.00000+000	.00000	1.00000+000	.00
J = 5	K = 4	A =	.00000	.00000	.00000	.00
J = 1	K = 5	A =	.00000	.00000	.00000	.00
J = 2	K = 5	A =	.00000	.00000	.00000	.00
J = 3	K = 5	A =	.00000	.00000	.00000	.00
J = 4	K = 5	A =	.00000	.00000	.00000	.00
J = 5	K = 5	A =	1.00000+000	.00000	1.00000+000	.00
A = TOTAL CONVERSION COEFFICIENTS						
SLAB NUMBER = 2						
J = 1	K = 1	A =	-2.57981-003	-1.92246-001	1.92264-001	269.23
J = 2	K = 1	A =	-3.10839-002	-4.14087-002	5.17773-002	233.11
J = 3	K = 1	A =	-1.35819-005	-1.48235-002	1.48235-002	269.95
J = 4	K = 1	A =	1.11251-002	-4.52524-002	4.65999-002	283.81
J = 1	K = 2	A =	-1.57271-002	1.57387-001	1.58170-001	95.71
J = 2	K = 2	A =	-2.44277-002	-3.90130-001	3.90894-001	266.42
J = 3	K = 2	A =	-1.47137-003	-1.64146-002	1.64804-002	264.88
J = 4	K = 2	A =	1.45132-002	-4.40381-002	4.63679-002	288.24

J = 1	K = 3	A =	-2.95272-003	1.13780-003	3.16435-003	158.93
J = 2	K = 3	A =	-9.94993-004	1.83987-003	2.09168-003	118.40
J = 3	K = 3	A =	-1.65526-002	-4.55370-002	4.84521-002	250.02
J = 4	K = 3	A =	-1.92979-002	-1.39794-001	1.41120-001	262.14
J = 1	K = 4	A =	-6.01359-004	1.29700-003	1.42963-003	114.87
J = 2	K = 4	A =	-6.92692-004	1.04526-003	1.25395-003	123.53
J = 3	K = 4	A =	8.18196-001	7.64483-001	1.11977+000	43.06
J = 4	K = 4	A =	-8.87768-001	-8.90408-001	1.25736+000	225.09
J = 1	K = 5	A =	1.24895-003	6.15159-004	1.39223-003	26.22
J = 2	K = 5	A =	6.19127-004	-7.52315-004	9.74318-004	309.45
J = 3	K = 5	A =	-4.34314-003	2.29728-002	2.33798-002	100.71
J = 4	K = 5	A =	-4.45312-002	7.89346-002	9.06295-002	119.43

68

A = TOTAL CONVERSION COEFFICIENTS

SLAB NUMBER = 3

J = 1	K = 1	A =	6.02529-002	-5.42874-001	5.46207-001	276.33
J = 2	K = 1	A =	3.18122-003	3.32733-003	4.60340-003	46.29
J = 3	K = 1	A =	-1.82599-001	2.87006-001	3.40169-001	122.47
J = 4	K = 1	A =	-7.26558-004	-1.92183-004	7.51545-004	194.82
J = 5	K = 1	A =	1.97466-002	8.80034-002	9.01916-002	77.35
J = 1	K = 2	A =	2.08716-003	2.94059-002	2.94799-002	85.94
J = 2	K = 2	A =	7.60149-002	-5.08875-001	5.14521-001	278.50
J = 3	K = 2	A =	-1.83876-001	2.60038-001	3.18481-001	125.26
J = 4	K = 2	A =	-3.62543-004	-1.97908-003	2.01202-003	259.62
J = 5	K = 2	A =	1.85462-002	7.70892-002	7.92887-002	76.47
J = 1	K = 3	A =	-1.45502-002	3.45842-003	1.49555-002	166.63
J = 2	K = 3	A =	-1.54532-003	1.72100-003	2.31297-003	131.92

J = 3	K = 3	A =	-4.25734-002	2.49893-001	2.53494-001	99.67
J = 4	K = 3	A =	1.75468-003	-1.32264-003	2.19733-003	322.99
J = 5	K = 3	A =	6.39667-002	-1.30959-001	1.45747-001	296.03
J = 1	K = 4	A =	-1.70989-003	5.04427-004	1.78274-003	163.56
J = 2	K = 4	A =	-2.05336-003	-2.59481-004	2.06969-003	187.20
J = 3	K = 4	A =	-1.24109-001	-2.79679-001	3.05979-001	246.07
J = 4	K = 4	A =	-1.36103-001	3.23642-001	3.51095-001	112.81
J = 5	K = 4	A =	1.64642-001	-1.58276-002	1.65401-001	354.51
J = 1	K = 5	A =	6.28086-003	3.15263-003	7.02768-003	26.65
J = 2	K = 5	A =	9.92403-004	-7.99324-004	1.27428-003	321.15
J = 3	K = 5	A =	1.07936-001	-1.03132-001	1.49287-001	316.30
J = 4	K = 5	A =	4.83196-004	6.25208-004	7.90167-004	52.30
J = 5	K = 5	A =	-7.65200-002	3.95076-002	8.61171-002	152.69

ELECTRIC FIELD STRENGTH AS A FUNCTION OF RHO

EZ				
GAMMA(DEG)= .0 PHI(DEG)= .0 TALT(KM)= .000 RALT(KM)= 6.000				
RHO(KM)	AMP(DB)	ANG(DEG)		
25.00	74.36654	98.7435		
50.00	71.15625	100.9405		
75.00	69.16570	103.0430		
100.00	67.65702	105.0526		
125.00	66.39884	106.9696		
150.00	65.28794	108.7934		
175.00	64.26905	110.5224		
200.00	63.30894	112.1535		
225.00	62.38592	113.6823		
250.00	61.48489	115.1025		
275.00	60.59480	116.4063		
300.00	59.70720	117.5832		
325.00	58.81538	118.6201		
350.00	57.91384	119.5005		
375.00	56.99800	120.2036		
400.00	56.06402	120.7038		
425.00	55.10874	120.9687		
450.00	54.12975	120.9584		
475.00	53.12562	120.6230		
500.00	52.09631	119.9017		
525.00	51.04385	118.7199		
550.00	49.97341	116.9896		
575.00	48.89485	114.6110		
600.00	47.82477	111.4794		
625.00	46.78858	107.5035		
650.00	45.82181	102.6358		
675.00	44.96836	96.9184		
700.00	44.27355	90.5255		
725.00	43.77178	83.7741		
750.00	43.47395	77.0711		
775.00	43.36293	70.8102		
800.00	43.40060	65.2770		
825.00	43.54102	60.6109		
850.00	43.74179	56.8273		
875.00	43.96962	53.8629		
900.00	44.20112	51.6183		
925.00	44.42116	49.9860		
950.00	44.62073	48.8649		
975.00	44.79494	48.1662		

1000.00	44.94155	47.8144
1025.00	45.06002	47.7465
1050.00	45.15074	47.9102
1075.00	45.21469	48.2619
1100.00	45.25310	48.7652
1125.00	45.26732	49.3893
1150.00	45.25868	50.1084
1175.00	45.22848	50.8998
1200.00	45.17791	51.7441
1225.00	45.10805	52.6244
1250.00	45.01989	53.5253
1275.00	44.91429	54.4335
1300.00	44.79201	55.3366
1325.00	44.65373	56.2236
1350.00	44.50003	57.0842
1375.00	44.33144	57.9089
1400.00	44.14843	58.6890
1425.00	43.95141	59.4161
1450.00	43.74079	60.0825
1475.00	43.51694	60.6806
1500.00	43.28027	61.2034
1525.00	43.03117	61.6441
1550.00	42.77008	61.9960
1575.00	42.49751	62.2528
1600.00	42.21399	62.4084
1625.00	41.92019	62.4568
1650.00	41.61683	62.3925
1675.00	41.30478	62.2102
1700.00	40.98501	61.9049
1725.00	40.65867	61.4723
1750.00	40.32702	60.9089
1775.00	39.99153	60.2117
1800.00	39.65378	59.3791
1825.00	39.31553	58.4107
1850.00	38.97865	57.3077
1875.00	38.64514	56.0732
1900.00	38.31704	54.7122
1925.00	37.99639	53.2321
1950.00	37.68518	51.6427
1975.00	37.38526	49.9559
2000.00	37.09825	48.1861
2025.00	36.82549	46.3495
2050.00	36.56794	44.4639
2075.00	36.32618	42.5481
2100.00	36.10032	40.6211
2125.00	35.89005	38.7019
2150.00	35.69464	36.8083
2175.00	35.51298	34.9568
2200.00	35.34368	33.1620
2225.00	35.18510	31.4361

2250.00	35.03548	29.7992
2275.00	34.89297	28.2290
2300.00	34.75574	26.7606
2325.00	34.62201	25.3875
2350.00	34.49011	24.1109
2375.00	26.20228	7.9712
2400.00	25.74950	8.8843
2425.00	25.29176	9.8499
2450.00	24.82978	10.8736
2475.00	24.36444	11.9609
2500.00	23.89675	13.1168
2525.00	23.42787	14.3460
2550.00	22.95911	15.6522
2575.00	22.49194	17.0380
2600.00	22.02796	18.5053
2625.00	21.56887	20.0540
2650.00	21.11646	21.6826
2675.00	20.67258	23.3877
2700.00	20.23904	25.1637
2725.00	19.81760	27.0029
2750.00	19.40986	28.8956
2775.00	19.01720	30.8297
2800.00	18.64074	32.7917
2825.00	18.28122	34.7664
2850.00	17.93902	36.7381
2875.00	17.61406	38.6903
2900.00	17.30589	40.6070
2925.00	17.01361	42.4730
2950.00	16.73600	44.2744
2975.00	16.47152	45.9990
3000.00	16.21841	47.6365
3025.00	15.97473	49.1789
3050.00	15.73847	50.6204
3075.00	15.50757	51.9572
3100.00	15.28000	53.1874
3125.00	16.91793	47.5218
3150.00	17.46406	43.3922
3175.00	18.01238	40.1300
3200.00	18.53882	37.5865
3225.00	19.02953	35.6219
3250.00	19.47734	34.1167
3275.00	19.87919	32.9732
3300.00	20.23437	32.1135
3325.00	20.54354	31.4760
3350.00	20.80805	31.0118
3375.00	21.02957	30.6824
3400.00	21.20992	30.4569
3425.00	21.35086	30.3109
3450.00	21.45412	30.2244
3475.00	21.52130	30.1612

3500.00	21.55391	30.1678
3525.00	21.55334	30.1733
3550.00	21.52086	30.1882
3575.00	21.45766	30.2044
3600.00	21.36486	30.2151
3625.00	21.24348	30.2141
3650.00	21.09449	30.1959
3675.00	20.91885	30.1555
3700.00	20.71745	30.0883
3725.00	20.49118	29.9897
3750.00	20.24095	29.8557
3775.00	19.96764	29.6821
3800.00	19.67221	29.4649
3825.00	19.35565	29.2000
3850.00	19.01901	28.8836
3875.00	18.66343	28.5116
3900.00	18.29017	28.0802
3925.00	17.90061	27.5855
3950.00	17.49627	27.0240
3975.00	17.07887	26.3924
4000.00	16.65028	25.6878

QUIT

END OF JOB

73

2 MINUTES

1 FRAMES 1787 PLOTWORDS

0BRKPT PRINT\$

Example IV

```

NAME
&DATUM
RHOMIN=3821.0,DEL RHO=345.0,RHOMAX=4166.0,
YMIN=-60.0,YINC=20.0,SIZEY=6.0,
XMIN=-2000.0,XINC=1000.0,SIZEX=7.0,
NTMAX=36,
DELTAX=200.0,
IPLTOP=1,
XVAL=-9999.9,-2000.0,-1900.0,-1800.0,
-1400.0,-1300.0,-1200.0,-1100.0,
NRP=4,INCL=0.0,0.0,90.0,90.0,THETA=0.0,90.0,0.0,90.0,RALT=10.0,TALT=10.0,
ICOMP=1,
NPRINT=1,
&END
DATA
SUNSET HAWAII TO CALIFORNIA (B)
SLAB 1 R .000 F 24.9080 A 58.500 C 39.000 M .431 S 4.640+000 E 81.0 T 72.0 MODES 3
SLAB 2 R .000 F 24.9080 A 58.500 C 39.000 M .431 S 4.640+000 E 81.0 T 73.6 MODES 3
SLAB 3 R .000 F 24.9080 A 58.500 C 39.000 M .431 S 4.640+000 E 81.0 T 75.0 MODES 3
SLAB 4 R .000 F 24.9080 A 58.500 C 39.000 M .431 S 4.640+000 E 81.0 T 76.6 MODES 5
SLAB 5 R .000 F 24.9080 A 58.500 C 39.000 M .431 S 4.640+000 E 81.0 T 78.0 MODES 5
SLAB 6 R .000 F 24.9080 A 58.500 C 39.000 M .431 S 4.640+000 E 81.0 T 79.6 MODES 5
SLAB 7 R .000 F 24.9080 A 58.500 C 39.000 M .431 S 4.640+000 E 81.0 T 81.0 MODES 7
SLAB 8 R .000 F 24.9080 A 58.500 C 39.000 M .431 S 4.640+000 E 81.0 T 82.6 MODES 7
SLAB 9 R .000 F 24.9080 A 58.500 C 39.000 M .431 S 4.640+000 E 81.0 T 84.0 MODES 9
SLAB 10 R .000 F 24.9080 A 58.500 C 39.000 M .431 S 4.640+000 E 81.0 T 85.6 MODES 9
SLAB 11 R .000 F 24.9080 A 58.500 C 39.000 M .431 S 4.640+000 E 81.0 T 87.0 MODES 11
START

```

ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR DISTANCE(D)

GAMMA(DEG)= .0 PHI(DEG)= .0 TALT(KM) = 10.000 RALT(KM) = 10.000

FIELD AT RHOMIN			FIELD AT RHOMAX	
D	EZ(DB)	EZ(ANG)	EZ(DB)	EZ(ANG)
-2000.0	43.353	84.75	43.915	103.81
-1800.0	43.353	84.75	43.915	103.81
-1600.0	43.353	84.75	43.915	103.81
-1400.0	43.353	84.75	43.915	103.81
-1200.0	43.353	84.75	43.915	103.81
-1000.0	43.353	84.75	43.915	103.81
-800.0	43.344	84.79	43.919	103.84
-600.0	43.556	84.34	43.942	103.74
-400.0	44.370	93.62	43.986	106.75
-200.0	42.510	116.38	42.833	115.86
.0	40.498	140.24	41.001	132.96
200.0	36.620	173.72	37.369	160.87
400.0	32.351	235.70	33.154	208.19
600.0	34.765	298.00	32.783	275.07
800.0	37.416	323.92	35.758	313.73
1000.0	37.850	337.44	37.196	331.24
1200.0	37.216	349.28	36.859	338.47
1400.0	36.145	1.50	35.276	343.02
1600.0	34.923	12.84	33.283	347.12
1800.0	31.879	18.87	30.984	351.39
2000.0	24.152	31.01	28.329	346.98
2200.0	15.330	175.53	24.023	318.28
2400.0	25.443	197.41	22.322	270.50
2600.0	27.164	208.22	23.153	238.34
2800.0	28.714	213.26	21.496	214.20
3000.0	29.894	211.63	21.518	195.04
3200.0	31.199	206.60	24.936	178.35
3400.0	31.967	203.67	28.224	173.81
3600.0	32.694	201.57	30.369	170.72
3800.0	32.854	198.45	31.399	170.26
4000.0	32.594	198.48	32.153	169.62
4200.0	32.594	198.48	32.012	167.45
4400.0	32.594	198.48	32.012	167.45
4600.0	32.594	198.48	32.012	167.45
4800.0	32.594	198.48	32.012	167.45
5000.0	32.594	198.48	32.012	167.45

ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR DISTANCE(D)

GAMMA(DEG)= .0 PHI(DEG)= 90.0 TALT(KM) = 10.000 RALT(KM) = 10.000

FIELD AT RHOMIN			FIELD AT RHOMAX		
D	EZ(DB)	EZ(ANG)	EZ(DB)	EZ(ANG)	
-2000.0	43.353	84.75	43.915	103.81	
-1800.0	43.353	84.75	43.915	103.81	
-1600.0	43.353	84.75	43.915	103.81	
-1400.0	43.353	84.75	43.915	103.81	
-1200.0	43.353	84.75	43.915	103.81	
-1000.0	43.353	84.75	43.915	103.81	
-800.0	43.344	84.79	43.919	103.84	
-600.0	43.556	84.34	43.942	103.74	
-400.0	44.370	93.62	43.986	106.75	
-200.0	42.510	116.38	42.833	115.86	
.0	40.498	140.24	41.001	132.96	
200.0	36.620	173.72	37.369	160.87	
400.0	32.351	235.70	33.154	208.19	
600.0	34.765	298.00	32.783	275.07	
800.0	37.416	323.92	35.758	313.73	
1000.0	37.850	337.44	37.196	331.24	
1200.0	37.216	349.28	36.859	338.47	
1400.0	36.145	1.50	35.276	343.02	
1600.0	34.923	12.84	33.283	347.12	
1800.0	31.879	18.87	30.984	351.39	
2000.0	24.152	31.01	28.329	346.98	
2200.0	15.330	175.53	24.023	318.28	
2400.0	25.443	197.41	22.322	270.50	
2600.0	27.164	208.22	23.153	238.34	
2800.0	28.714	213.26	21.496	214.20	
3000.0	29.894	211.63	21.518	195.04	
3200.0	31.199	206.60	24.936	178.35	
3400.0	31.967	203.67	28.224	173.81	
3600.0	32.694	201.57	30.369	170.72	
3800.0	32.854	198.45	31.399	170.26	
4000.0	32.594	198.48	32.153	169.62	
4200.0	32.594	198.48	32.012	167.45	
4400.0	32.594	198.48	32.012	167.45	
4600.0	32.594	198.48	32.012	167.45	
4800.0	32.594	198.48	32.012	167.45	
5000.0	32.594	198.48	32.012	167.45	

ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR DISTANCE(D)

GAMMA(DEG)= 90.0 PHI(DEG)= .0 TALT(KM) = 10.000 RALT(KM) = 10.000

FIELD AT RHOMIN			FIELD AT RHOMAX	
D	EZ(DB)	EZ(ANG)	EZ(DB)	EZ(ANG)
-2000.0	12.942	309.62	15.437	35.89
-1800.0	12.942	309.62	15.437	35.89
-1600.0	12.942	309.62	15.437	35.89
-1400.0	12.942	309.62	15.437	35.89
-1200.0	12.942	309.62	15.437	35.89
-1000.0	12.942	309.62	15.437	35.89
-800.0	13.165	312.10	15.339	35.32
-600.0	16.358	290.33	15.191	37.78
-400.0	20.803	350.38	15.985	36.65
-200.0	15.849	49.48	14.742	53.57
.0	17.224	80.61	16.361	79.79
200.0	16.358	115.73	15.400	111.70
400.0	14.976	147.10	14.152	144.95
600.0	12.644	175.20	12.389	178.23
800.0	8.856	203.76	9.905	213.84
1000.0	4.429	242.01	7.149	253.96
1200.0	1.884	291.37	5.413	297.18
1400.0	2.727	335.13	4.797	332.08
1600.0	4.622	5.30	4.451	359.76
1800.0	5.671	26.30	4.351	24.24
2000.0	4.864	47.47	4.303	45.33
2200.0	2.255	73.86	2.831	65.37
2400.0	-1.684	118.59	-206	95.35
2600.0	-3.055	176.03	-3.439	143.54
2800.0	-1.709	224.64	-3.404	194.57
3000.0	.018	251.89	-2.969	231.08
3200.0	1.028	266.22	-2.462	255.48
3400.0	1.402	272.10	-2.408	267.70
3600.0	1.519	273.59	-2.779	270.84
3800.0	1.518	273.52	-2.983	270.11
4000.0	1.523	274.11	-2.911	266.41
4200.0	1.523	274.11	-3.369	267.33
4400.0	1.523	274.11	-3.369	267.33
4600.0	1.523	274.11	-3.369	267.33
4800.0	1.523	274.11	-3.369	267.33
5000.0	1.523	274.11	-3.369	267.33

ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR DISTANCE(D)

GAMMA(DEG)= 90.0 PHI(DEG)= 90.0 TALT(KM) = 10.000 RALT(KM) = 10.000

FIELD AT RHOMIN			FIELD AT RHOMAX		
D	EZ(DB)	EZ(ANG)	EZ(DB)	EZ(ANG)	
-2000.0	28.928	134.32	25.824	173.24	
-1800.0	28.928	134.32	25.824	173.24	
-1600.0	28.928	134.32	25.824	173.24	
-1400.0	28.928	134.32	25.824	173.24	
-1200.0	28.928	134.32	25.824	173.24	
-1000.0	28.928	134.32	25.824	173.24	
-800.0	28.760	134.45	25.789	173.89	
-600.0	29.573	127.05	24.895	175.62	
-400.0	29.078	144.10	23.027	163.41	
-200.0	25.437	155.31	23.537	120.66	
0	25.525	166.83	24.309	130.84	
200.0	23.255	177.07	23.173	146.50	
400.0	18.773	182.93	21.757	158.58	
600.0	9.300	184.76	19.220	163.77	
800.0	4.673	23.07	14.365	163.61	
1000.0	13.123	26.28	4.228	144.42	
1200.0	16.022	34.47	4.960	27.50	
1400.0	16.745	42.03	10.997	22.53	
1600.0	16.587	50.85	13.444	26.96	
1800.0	15.691	55.72	13.924	33.64	
2000.0	13.478	55.91	13.743	40.25	
2200.0	9.621	52.54	12.761	42.36	
2400.0	2.747	49.85	10.513	40.96	
2600.0	-4.523	77.26	6.562	38.14	
2800.0	-12.053	84.66	-6.11	47.74	
3000.0	-26.259	218.39	-5.303	86.15	
3200.0	-9.125	271.03	-10.786	124.06	
3400.0	-5.039	257.53	-12.922	188.34	
3600.0	-3.973	258.64	-7.413	228.30	
3800.0	-3.187	256.87	-4.791	230.56	
4000.0	-3.201	253.11	-4.387	233.96	
4200.0	-3.201	253.11	-3.534	228.53	
4400.0	-3.201	253.11	-3.534	228.53	
4600.0	-3.201	253.11	-3.534	228.53	
4800.0	-3.201	253.11	-3.534	228.53	
5000.0	-3.201	253.11	-3.534	228.53	

NAME
 DATUM
 ICOMP=2,
 END
 START

ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR DISTANCE(D)

GAMMA(DEG)= .0 PHI(DEG)= .0 TALT(KM) = 10.000 RALT(KM) = 10.000

FIELD AT RHOMIN			FIELD AT RHOMAX	
D	EX(DB)	EX(ANG)	EX(DB)	EX(ANG)
-2000.0	12.942	129.62	15.437	215.89
-1800.0	12.942	129.62	15.437	215.89
-1600.0	12.942	129.62	15.437	215.89
-1400.0	12.942	129.62	15.437	215.89
-1200.0	12.942	129.62	15.437	215.89
-1000.0	12.942	129.62	15.437	215.89
-800.0	12.970	127.89	15.297	216.06
-600.0	13.350	130.93	15.065	218.12
-400.0	13.068	167.68	12.028	221.36
-200.0	1.805	154.20	3.485	196.33
.0	-8.690	163.69	-2.029	175.99
200.0	.063	184.67	-3.637	105.19
400.0	-.925	185.76	-4.269	119.69
600.0	-3.342	207.15	.793	135.56
800.0	-13.655	345.80	.275	133.14
1000.0	-3.387	312.79	.561	119.32
1200.0	-3.528	270.41	-5.959	86.22
1400.0	1.415	255.79	-11.460	202.11
1600.0	-2.558	225.04	-5.522	228.81
1800.0	-2.779	358.88	.321	240.71
2000.0	1.288	329.71	-5.386	278.88
2200.0	3.266	339.49	2.248	321.75
2400.0	-.315	325.54	-.025	324.72
2600.0	.371	63.37	.304	321.74
2800.0	2.486	52.44	-7.235	315.07
3000.0	2.686	58.73	2.013	12.50
3200.0	-1.213	48.45	.718	6.83
3400.0	2.483	80.01	1.462	43.18
3600.0	2.110	77.92	-5.328	31.93
3800.0	-.435	86.68	-2.321	71.98
4000.0	1.523	94.11	-5.509	57.99
4200.0	1.523	94.11	-3.369	87.33
4400.0	1.523	94.11	-3.369	87.33
4600.0	1.523	94.11	-3.369	87.33
4800.0	1.523	94.11	-3.369	87.33
5000.0	1.523	94.11	-3.369	87.33

ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR DISTANCE(D)

GAMMA(DEG)= .0 PHI(DEG)= 90.0 TALT(KM) = 10.000 RALT(KM) = 10.000

FIELD AT RHOMIN			FIELD AT RHOMAX		
D	EX(DB)	EX(ANG)	EX(DB)	EX(ANG)	
-2000.0	12.942	129.62	15.437	215.89	
-1800.0	12.942	129.62	15.437	215.89	
-1600.0	12.942	129.62	15.437	215.89	
-1400.0	12.942	129.62	15.437	215.89	
-1200.0	12.942	129.62	15.437	215.89	
-1000.0	12.942	129.62	15.437	215.89	
-800.0	12.970	127.89	15.297	216.06	
-600.0	13.350	130.93	15.065	218.12	
-400.0	13.068	167.68	12.028	221.36	
-200.0	1.805	154.20	3.485	196.33	
.0	-8.690	163.69	-2.029	175.99	
200.0	.063	184.67	-3.637	105.19	
400.0	-.925	185.76	-4.269	119.69	
600.0	-3.342	207.15	.793	135.56	
800.0	-13.655	345.80	.275	133.14	
1000.0	-3.387	312.79	.561	119.32	
1200.0	-3.528	270.41	-5.959	86.22	
1400.0	1.415	255.79	-11.460	202.11	
1600.0	-2.558	225.04	-5.522	228.81	
1800.0	-2.779	358.88	.321	240.71	
2000.0	1.288	329.71	-5.386	278.88	
2200.0	3.266	339.49	2.248	321.75	
2400.0	-.315	325.54	-.025	324.72	
2600.0	.371	63.37	.304	321.74	
2800.0	2.486	52.44	-7.235	315.07	
3000.0	2.686	58.73	2.013	12.50	
3200.0	-1.213	48.45	.718	6.83	
3400.0	2.483	80.01	1.462	43.18	
3600.0	2.110	77.92	-5.328	31.93	
3800.0	-.435	86.68	-2.321	71.98	
4000.0	1.523	94.11	-5.509	57.99	
4200.0	1.523	94.11	-3.369	87.33	
4400.0	1.523	94.11	-3.369	87.33	
4600.0	1.523	94.11	-3.369	87.33	
4800.0	1.523	94.11	-3.369	87.33	
5000.0	1.523	94.11	-3.369	87.33	

ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR DISTANCE(D)

GAMMA(DEG)= 90.0 PHI(DEG)= .0 TALT(KM) = 10.000 RALT(KM) = 10.000

FIELD AT RHOMIN			FIELD AT RHOMAX	
D	EX(DB)	EX(ANG)	EX(DB)	EX(ANG)
-2000.0	.195	350.91	1.059	131.11
-1800.0	.195	350.91	1.059	131.11
-1600.0	.195	350.91	1.059	131.11
-1400.0	.195	350.91	1.059	131.11
-1200.0	.195	350.91	1.059	131.11
-1000.0	.195	350.91	1.059	131.11
-800.0	-1.230	356.13	1.914	127.77
-600.0	.599	340.28	.977	152.97
-400.0	-3.023	97.69	-3.961	167.38
-200.0	-27.385	167.93	-19.234	157.19
.0	-27.255	235.77	-20.675	172.13
200.0	-25.756	252.28	-29.176	197.74
400.0	-24.474	259.27	-32.680	280.16
600.0	-21.032	261.03	-32.954	268.65
800.0	-22.496	263.25	-29.835	291.71
1000.0	-24.743	296.78	-26.037	300.86
1200.0	-28.438	327.88	-27.247	327.18
1400.0	-36.546	34.80	-28.549	344.53
1600.0	-30.821	130.77	-35.235	352.21
1800.0	-28.651	118.96	-37.957	251.06
2000.0	-36.686	108.90	-34.968	205.88
2200.0	-31.507	64.60	-45.181	19.97
2400.0	-31.243	42.47	-43.521	329.10
2600.0	-35.269	121.76	-39.170	29.87
2800.0	-34.797	113.50	-42.788	47.38
3000.0	-36.196	95.46	-34.549	92.84
3200.0	-33.755	74.01	-35.429	80.22
3400.0	-31.991	61.12	-31.823	91.47
3600.0	-31.290	57.94	-33.116	90.90
3800.0	-31.481	55.32	-30.176	100.96
4000.0	-30.743	58.86	-31.367	92.78
4200.0	-30.743	58.86	-29.765	106.11
4400.0	-30.743	58.86	-29.765	106.11
4600.0	-30.743	58.86	-29.765	106.11
4800.0	-30.743	58.86	-29.765	106.11
5000.0	-30.743	58.86	-29.765	106.11

ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR DISTANCE(D)

GAMMA(DEG)= 90.0 PHI(DEG)= 90.0 TALT(KM) = 10.000 RALT(KM) = 10.000

FIELD AT RHOMIN			FIELD AT RHOMAX		
D	EX(DB)	EX(ANG)	EX(DB)	EX(ANG)	
-2000.0	-20.300	201.59	11.050	290.93	
-1800.0	-20.300	201.59	11.050	290.93	
-1600.0	-20.300	201.59	11.050	290.93	
-1400.0	-20.300	201.59	11.050	290.93	
-1200.0	-20.300	201.59	11.050	290.93	
-1000.0	-20.300	201.59	11.050	290.93	
-800.0	-13.616	223.04	12.131	289.01	
-600.0	1.204	198.97	9.353	311.75	
-400.0	-6.100	229.70	3.942	307.02	
-200.0	-6.261	54.87	-6.402	355.32	
.0	-8.182	65.61	-6.879	24.82	
200.0	-11.505	138.46	-7.498	45.62	
400.0	-7.115	166.85	-12.984	69.50	
600.0	-6.977	179.38	-12.501	144.05	
800.0	-8.489	182.78	-9.290	161.16	
1000.0	-10.821	217.41	-8.984	174.49	
1200.0	-11.995	227.92	-11.972	180.10	
1400.0	-15.398	272.65	-12.805	208.46	
1600.0	-19.057	280.61	-16.061	212.35	
1800.0	-33.932	357.53	-17.885	259.62	
2000.0	-18.129	52.27	-21.925	281.10	
2200.0	-15.355	58.84	-29.236	354.31	
2400.0	-16.044	43.62	-22.271	26.59	
2600.0	-25.823	218.37	-18.473	37.35	
2800.0	-26.385	167.84	-17.782	20.63	
3000.0	-34.014	160.22	-22.787	97.10	
3200.0	-27.964	95.84	-23.065	91.38	
3400.0	-40.105	110.31	-34.675	157.49	
3600.0	-38.198	154.11	-29.608	81.02	
3800.0	-35.298	139.65	-41.342	42.04	
4000.0	-35.584	158.49	-37.892	110.41	
4200.0	-35.584	158.49	-44.579	146.60	
4400.0	-35.584	158.49	-44.579	146.60	
4600.0	-35.584	158.49	-44.579	146.60	
4800.0	-35.584	158.49	-44.579	146.60	
5000.0	-35.584	158.49	-44.579	146.60	

NAME
 DATUM
 ICOMP=3,
 AEND
 START

ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR DISTANCE(D)

GAMMA(DEG)= .0 PHI(DEG)= .0 TALT(KM) = 10.000 RALT(KM) = 10.000

FIELD AT RHOMIN			FIELD AT RHOMAX	
D	EY(DB)	EY(ANG)	EY(DB)	EY(ANG)
-2000.0	28.462	127.15	25.076	165.33
-1800.0	28.462	127.15	25.076	165.33
-1600.0	28.462	127.15	25.076	165.33
-1400.0	28.462	127.15	25.076	165.33
-1200.0	28.462	127.15	25.076	165.33
-1000.0	28.462	127.15	25.076	165.33
-800.0	28.419	127.06	24.957	165.28
-600.0	28.636	127.76	24.283	164.97
-400.0	27.345	126.33	22.238	152.32
-200.0	25.867	132.03	22.200	112.50
.0	26.449	155.13	23.320	108.54
200.0	26.787	173.76	22.433	117.68
400.0	24.021	197.26	20.866	140.75
600.0	19.692	246.01	16.052	146.63
800.0	20.415	303.42	5.049	63.46
1000.0	20.643	325.64	14.453	20.05
1200.0	20.511	336.59	13.601	10.48
1400.0	19.186	326.73	8.618	7.48
1600.0	18.736	331.72	11.792	307.57
1800.0	19.154	332.08	14.819	277.75
2000.0	17.131	321.78	16.845	282.73
2200.0	14.576	297.31	18.224	279.33
2400.0	9.314	248.62	17.301	272.36
2600.0	4.674	20.72	15.901	258.25
2800.0	4.694	345.96	8.729	238.16
3000.0	-2.583	3.12	10.483	309.05
3200.0	1.775	209.93	6.714	295.69
3400.0	-.367	126.41	.225	4.89
3600.0	-2.687	150.58	.175	159.70
3800.0	.716	164.35	1.050	116.83
4000.0	1.785	163.01	.099	137.13
4200.0	1.785	163.01	1.509	138.72
4400.0	1.785	163.01	1.509	138.72
4600.0	1.785	163.01	1.509	138.72
4800.0	1.785	163.01	1.509	138.72
5000.0	1.785	163.01	1.509	138.72

ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR DISTANCE(D)

GAMMA(DEG)= .0 PHI(DEG)= 90.0 TALT(KM) = 10.000 RALT(KM) = 10.000

FIELD AT RHOMIN			FIELD AT RHOMAX	
D	EY(DB)	EY(ANG)	EY(DB)	EY(ANG)
-2000.0	28.462	127.15	25.076	165.33
-1800.0	28.462	127.15	25.076	165.33
-1600.0	28.462	127.15	25.076	165.33
-1400.0	28.462	127.15	25.076	165.33
-1200.0	28.462	127.15	25.076	165.33
-1000.0	28.462	127.15	25.076	165.33
-800.0	28.419	127.06	24.957	165.28
-600.0	28.636	127.76	24.283	164.97
-400.0	27.345	126.33	22.238	152.32
-200.0	25.867	132.03	22.200	112.50
.0	26.449	155.13	23.320	108.54
200.0	26.787	173.76	22.433	117.68
400.0	24.021	197.26	20.866	140.75
600.0	19.692	246.01	16.052	146.63
800.0	20.415	303.42	5.049	63.46
1000.0	20.643	325.64	14.453	20.05
1200.0	20.511	336.59	13.601	10.48
1400.0	19.186	326.73	8.618	7.48
1600.0	18.736	331.72	11.792	307.57
1800.0	19.154	332.08	14.819	277.75
2000.0	17.131	321.78	16.845	282.73
2200.0	14.576	297.31	18.224	279.33
2400.0	9.314	248.62	17.301	272.36
2600.0	4.674	20.72	15.901	258.25
2800.0	4.694	345.96	8.729	238.16
3000.0	-2.583	3.12	10.483	309.05
3200.0	1.775	209.93	6.714	295.69
3400.0	-3.367	126.41	.225	4.89
3600.0	-2.687	150.58	.175	159.70
3800.0	.716	164.35	1.050	116.83
4000.0	1.785	163.01	.099	137.13
4200.0	1.785	163.01	1.509	138.72
4400.0	1.785	163.01	1.509	138.72
4600.0	1.785	163.01	1.509	138.72
4800.0	1.785	163.01	1.509	138.72
5000.0	1.785	163.01	1.509	138.72

ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR DISTANCE(D)

GAMMA(DEG)= 90.0 PHI(DEG)= .0 TALT(KM) = 10.000 RALT(KM) = 10.000

FIELD AT RHOMIN			FIELD AT RHOMAX		
D	EY(DB)	EY(ANG)	EY(DB)	EY(ANG)	
-2000.0	-15.262	24.89	10.274	105.96	
-1800.0	-15.262	24.89	10.274	105.96	
-1600.0	-15.262	24.89	10.274	105.96	
-1400.0	-15.262	24.89	10.274	105.96	
-1200.0	-15.262	24.89	10.274	105.96	
-1000.0	-15.262	24.89	10.274	105.96	
-800.0	-17.253	335.79	11.383	103.92	
-600.0	-2.541	22.57	9.308	126.66	
-400.0	.342	30.49	5.380	132.44	
-200.0	-13.435	145.65	-5.348	144.22	
.0	-4.881	145.56	-6.048	152.84	
200.0	-.387	160.63	-6.876	165.99	
400.0	1.202	181.68	-3.748	185.97	
600.0	.727	210.10	-1.690	206.98	
800.0	-1.390	243.25	-2.008	234.21	
1000.0	-3.019	282.41	-3.267	269.56	
1200.0	-5.202	314.16	-4.665	308.67	
1400.0	-7.070	346.29	-5.786	340.23	
1600.0	-7.968	9.89	-7.662	2.30	
1800.0	-7.300	24.63	-10.422	20.51	
2000.0	-7.651	30.83	-11.914	36.38	
2200.0	-9.455	38.38	-12.541	46.05	
2400.0	-15.205	50.72	-14.879	59.97	
2600.0	-17.983	115.12	-19.907	81.96	
2800.0	-22.536	138.00	-24.170	140.74	
3000.0	-29.084	187.00	-30.241	158.70	
3200.0	-31.432	245.52	-31.292	248.12	
3400.0	-30.479	263.40	-37.922	305.28	
3600.0	-29.845	264.06	-35.367	259.19	
3800.0	-30.103	255.49	-48.673	326.32	
4000.0	-30.600	250.16	-39.565	285.55	
4200.0	-30.600	250.16	-39.998	237.42	
4400.0	-30.600	250.16	-39.998	237.42	
4600.0	-30.600	250.16	-39.998	237.42	
4800.0	-30.600	250.16	-39.998	237.42	
5000.0	-30.600	250.16	-39.998	237.42	

ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR DISTANCE(D)

GAMMA(DEG)= 90.0 PHI(DEG)= 90.0 TALT(KM) = 10.000 RALT(KM) = 10.000

FIELD AT RHOMIN			FIELD AT RHOMAX		
D	EY(DB)	EY(ANG)	EY(DB)	EY(ANG)	
-2000.0	29.535	354.69	30.007	71.18	
-1800.0	29.535	354.69	30.007	71.18	
-1600.0	29.535	354.69	30.007	71.18	
-1400.0	29.535	354.69	30.007	71.18	
-1200.0	29.535	354.69	30.007	71.18	
-1000.0	29.535	354.69	30.007	71.18	
-800.0	28.963	357.39	29.999	69.64	
-600.0	29.670	345.92	30.294	79.73	
-400.0	26.560	76.02	27.138	86.05	
-200.0	2.175	158.38	12.521	97.25	
.0	8.330	273.89	8.534	113.70	
200.0	13.933	288.27	-3.651	182.87	
400.0	15.016	291.57	7.806	273.23	
600.0	13.077	304.94	11.914	283.09	
800.0	10.934	324.04	11.641	285.77	
1000.0	7.205	334.48	9.385	300.94	
1200.0	-8.528	88.03	7.099	317.81	
1400.0	6.662	126.41	1.471	320.86	
1600.0	10.467	131.01	-3.055	116.96	
1800.0	10.097	139.05	5.270	124.50	
2000.0	10.394	152.66	7.585	124.74	
2200.0	8.086	155.60	6.882	137.59	
2400.0	2.566	157.69	7.231	143.80	
2600.0	-7.566	230.79	4.405	144.85	
2800.0	-4.359	326.34	-3.199	138.92	
3000.0	2.159	355.51	-17.874	240.72	
3200.0	4.350	12.61	-5.877	335.39	
3400.0	7.293	13.54	.309	351.50	
3600.0	7.268	14.20	3.014	5.10	
3800.0	7.357	18.86	4.837	5.98	
4000.0	8.317	19.38	4.114	6.59	
4200.0	8.317	19.38	5.906	10.93	
4400.0	8.317	19.38	5.906	10.93	
4600.0	8.317	19.38	5.906	10.93	
4800.0	8.317	19.38	5.906	10.93	
5000.0	8.317	19.38	5.906	10.93	

QUIT
END OF JOB

APPENDIX 1

FORTRAN LISTING OF THE GRNDMC COMPUTER PROGRAM

```

00000000
00000020
00000800
00004550
00000090
00000110
00000120
00000160
00000220
00000140
00000190
00000200

1  MORFITT=GRNDMCA(1).MAIN
2  C  ORIGINAL DNA PROGRAM MODIFIED TO HANDLE NEGATIVE XVALS
3  IMPPLICIT REAL *8(A-H,O-Z)
4  COMMON/PLOT C/FRQP,RHQMNP,RHQMXP
5  COMMON/4/FIRST C/ IFIRST
6  COMMON/AXIS1 C/XTIC,YTIC,NTICX,NTICY
7  COMMON/ITXRX C/ITXRX
8  COMMON/TYPPLT/IPLTOP
9  COMMON/INT C/INTFLG,IPRNTA
10 COMMON/TER3/NT,NTR
11 COMMON/ENDDS C/ MAXMDS
12 COMMON/MCINPT/
13 $  XTRA(20 ),TOPHT(50),RHOMAX,RHOMIN,DELRHO,DELTAX,
14 $  EPSR,SIGMA,NRSLAB,NRMODE,NTMAX,PRMODE,NTRMDS
15 COMMON/MCSTOR/A(20,20 ),S(20 ),C(20 ),KVRAOT,KVRATT,AVRKOT,
16 $  AVRKTT,NTHSQ,CONST,OMEGA,WAVEND
17 COMMON/MCPLT/R(402),DB(402),ANG(402),IDPLOT(10),ISUB,JPLLOT,
18 $  NAPLOT,NPPLTOT
19 COMMON/XPLOT/XMIN,XINC,YMIN,YINC,SIZEZ,SIZEY
20 COMMON/PSPLOT/PHSMIN,PHSINC,SIZEP,PTIC,NTICP
21 DIMENSION BUFFER(2000)
22 DIMENSION BCD(20)
23 COMPLEX*16 STHTA,THETAH,STHTAH(20)
24 COMPLEX*16 ZERO/(0.0D0,0.0D0)/,ONE/(1.0D0,0.0D0)/
25 COMPLEX*16 THETA,A,S,C,FOFR,IM
26 COMPLEX*16 XTRA
27 COMPLEX*16 TP(20),RATIO(4),TMP1,TMP2,TMP3,TMP4
28 REAL*8 NTHSQ
29 REAL*8 KVRAOT,KVRATT
30 REAL*4 SIZEP,PHSMIN,PHSINC,PTIC
31 REAL*4 FACT
32 REAL*4 R,DB,ANG,XMIN,XINC,YMIN,YINC,SIZEZ,SIZEY
33 REAL*4 XTIC,YTIC
34 CHARACTER*4 BCD,NAME,EXEC,INPT,QUIT
35 INTEGER PRMODE,RCDOPT,CNVSCF
36
37 C
38 NAMELIST/DATUM/TOPHT,RHOMAX,NPRINT,RCDOPT,H,IH,
39 $  DELRHO,INTFLG, IPLTOP,IPRNTA,ITXRX,
40 $  RHOMIN,DELTAX,NTMAX,XVAL,
41 $  FACT,NAPLOT,NPPLTOT,
42 $  PHSMIN,PHSINC,SIZEP,PTIC,NTICP,
43 $  XMIN,XINC,YMIN,YINC,SIZEZ,SIZEY,XTIC,YTIC,NTICX,NTICY
44
45 C
46 DATA NAME/4HNAME/,INPT/4HDATA/,EXEC/4HSTAR/,QUIT/4HQUIT/
47 DATA DTR/0.0174532925D0/
48 DATA TWOPI/6.283185D0/,VELITE/2.997928D5/,ALPHA/3.14D-4/,
49 $  DEGRAD/1.745329D-2/,IM/(0.0D0,1.0D0)/
50
51 C
52 'FF1SQ' IS THE WRONSKIAN OF THE VERTICAL HEIGHT GAIN TERM
53 DATA FF1SQ/-2.124293296065372D0/
54
55 C

```

```

50 C-----
51 FACT=1.0
52 SIZEP=8.0
53 PHSMIN=0.0
54 PHSINC=90.0
55 NTICP=1
56 PTIC=2.0
57 SIZEX=10.0
58 SIZEY=8.0
59 XMIN=0.0
60 YMIN=0.0
61 XINC=1000.0
62 YINC=10.0
63 XTIC=1.0
64 YTIC=1.0
65 NTICX=1
66 NTICY=1
67 IH=1
68 H=50.000
69 CNVSCF=0
70 RCDOPT=0
71 JPLOT=0
72 NPLOT=0
73 INTFLG=0
74 MAXMDS = 20
75 MXSLAB=50
76 IFIRST =1
77 NPRINT=1
78 IPRNTA=0
79 DELTAX=0.0
80 NTMAX=1
81 IPLTOP=0
82
83 C-----
84
85
86 DO 2 J=1,MXSLAB
87 2 TOPHT(J)=0.0D0
88
89 C-----
90
91 PRINT 199
92 10 PRINT 200
93 READ(5,201,END=999) BCD
94 11 PRINT 202,BCD
95 IF(BCD(1) .EQ. NAME) GO TO 12
96 IF(BCD(1) .EQ. INPT) GO TO 20
97 IF(BCD(1) .EQ. EXEC) GO TO 30
98 IF(BCD(1) .EQ. QUIT) GO TO 999
99 GO TO 910

```

00000280

00000270

```

100 C-----
101 C
102 C
103 READ NAMELIST
104 12 READ(5,201,END=999) BCD
105 IF(SUBSTR(BCD(1),1,1) .NE. ' ') GO TO 13
106 WRITE(30,201) BCD
107 WRITE(6,202) RCD
108 GO TO 12
109 13 REWIND 30
110 DO 15 L = 1,MXSLAB
111 XVAL(L) = 0.0D0
112 15 TOPHT(L)=0.0D0
113 C
114 CALL CHKSOE
115 READ(30,DATUM)
116 CALL CHKSON
117 IF(IPLTOP .LT. 1) GO TO 909
118 IF(IPLTOP .LT. 2) GO TO 16
119 NTMAX=1
120 DELTAX=0.0
121 RHOMIN=DELRHO
122 16 CONTINUE
123 C
124 IF(NAPLOT .EQ. 1 .OR. NPLOT .EQ. 1) JPLOT=1
125 IF(JPLOT .NE. 0 .AND. IFIRST .NE. 0)CALL PLOTS(BUFFER,2000,15)00000480
126 IF(JPLOT .NE. 0 .AND. IFIRST .NE. 0)CALL PLOT(0.0,-11.0,-3)
127 IF(JPLOT .NE. 0 .AND. IFIRST .NE. 0)CALL FACTOR(FACT)
128 CAPX={1.0D0-0.5D0*ALPHA*H)
129 NT = 1
130 REWIND 30
131 GO TO 11
132 C-----
133 C
134 C
135 C
136 C
137 C
138 20 READ(5,203,END=915) IDPLOT
139 PRINT 204,IDPLOT
140 RHD=-1.0
141 ISLAB=0
142 C
143 C
144 C
145 C
146 C
147 C
148 C
149 C
150 C
151 C
152 C
153 C
154 C
155 C
156 C
157 C
158 C
159 C
160 C
161 C
162 C
163 C
164 C
165 C
166 C
167 C
168 C
169 C
170 C
171 C
172 C
173 C
174 C
175 C
176 C
177 C
178 C
179 C
180 C
181 C
182 C
183 C
184 C
185 C
186 C
187 C
188 C
189 C
190 C
191 C
192 C
193 C
194 C
195 C
196 C
197 C
198 C
199 C
200 C
201 C
202 C
203 C
204 C
205 C
206 C
207 C
208 C
209 C
210 C
211 C
212 C
213 C
214 C
215 C
216 C
217 C
218 C
219 C
220 C
221 C
222 C
223 C
224 C
225 C
226 C
227 C
228 C
229 C
230 C
231 C
232 C
233 C
234 C
235 C
236 C
237 C
238 C
239 C
240 C
241 C
242 C
243 C
244 C
245 C
246 C
247 C
248 C
249 C
250 C
251 C
252 C
253 C
254 C
255 C
256 C
257 C
258 C
259 C
260 C
261 C
262 C
263 C
264 C
265 C
266 C
267 C
268 C
269 C
270 C
271 C
272 C
273 C
274 C
275 C
276 C
277 C
278 C
279 C
280 C
281 C
282 C
283 C
284 C
285 C
286 C
287 C
288 C
289 C
290 C
291 C
292 C
293 C
294 C
295 C
296 C
297 C
298 C
299 C
300 C
301 C
302 C
303 C
304 C
305 C
306 C
307 C
308 C
309 C
310 C
311 C
312 C
313 C
314 C
315 C
316 C
317 C
318 C
319 C
320 C
321 C
322 C
323 C
324 C
325 C
326 C
327 C
328 C
329 C
330 C
331 C
332 C
333 C
334 C
335 C
336 C
337 C
338 C
339 C
340 C
341 C
342 C
343 C
344 C
345 C
346 C
347 C
348 C
349 C
350 C
351 C
352 C
353 C
354 C
355 C
356 C
357 C
358 C
359 C
360 C
361 C
362 C
363 C
364 C
365 C
366 C
367 C
368 C
369 C
370 C
371 C
372 C
373 C
374 C
375 C
376 C
377 C
378 C
379 C
380 C
381 C
382 C
383 C
384 C
385 C
386 C
387 C
388 C
389 C
390 C
391 C
392 C
393 C
394 C
395 C
396 C
397 C
398 C
399 C
400 C
401 C
402 C
403 C
404 C
405 C
406 C
407 C
408 C
409 C
410 C
411 C
412 C
413 C
414 C
415 C
416 C
417 C
418 C
419 C
420 C
421 C
422 C
423 C
424 C
425 C
426 C
427 C
428 C
429 C
430 C
431 C
432 C
433 C
434 C
435 C
436 C
437 C
438 C
439 C
440 C
441 C
442 C
443 C
444 C
445 C
446 C
447 C
448 C
449 C
450 C
451 C
452 C
453 C
454 C
455 C
456 C
457 C
458 C
459 C
460 C
461 C
462 C
463 C
464 C
465 C
466 C
467 C
468 C
469 C
470 C
471 C
472 C
473 C
474 C
475 C
476 C
477 C
478 C
479 C
480 C
481 C
482 C
483 C
484 C
485 C
486 C
487 C
488 C
489 C
490 C
491 C
492 C
493 C
494 C
495 C
496 C
497 C
498 C
499 C
500 C
501 C
502 C
503 C
504 C
505 C
506 C
507 C
508 C
509 C
510 C
511 C
512 C
513 C
514 C
515 C
516 C
517 C
518 C
519 C
520 C
521 C
522 C
523 C
524 C
525 C
526 C
527 C
528 C
529 C
530 C
531 C
532 C
533 C
534 C
535 C
536 C
537 C
538 C
539 C
540 C
541 C
542 C
543 C
544 C
545 C
546 C
547 C
548 C
549 C
550 C
551 C
552 C
553 C
554 C
555 C
556 C
557 C
558 C
559 C
560 C
561 C
562 C
563 C
564 C
565 C
566 C
567 C
568 C
569 C
570 C
571 C
572 C
573 C
574 C
575 C
576 C
577 C
578 C
579 C
580 C
581 C
582 C
583 C
584 C
585 C
586 C
587 C
588 C
589 C
590 C
591 C
592 C
593 C
594 C
595 C
596 C
597 C
598 C
599 C
600 C
601 C
602 C
603 C
604 C
605 C
606 C
607 C
608 C
609 C
610 C
611 C
612 C
613 C
614 C
615 C
616 C
617 C
618 C
619 C
620 C
621 C
622 C
623 C
624 C
625 C
626 C
627 C
628 C
629 C
630 C
631 C
632 C
633 C
634 C
635 C
636 C
637 C
638 C
639 C
640 C
641 C
642 C
643 C
644 C
645 C
646 C
647 C
648 C
649 C
650 C
651 C
652 C
653 C
654 C
655 C
656 C
657 C
658 C
659 C
660 C
661 C
662 C
663 C
664 C
665 C
666 C
667 C
668 C
669 C
670 C
671 C
672 C
673 C
674 C
675 C
676 C
677 C
678 C
679 C
680 C
681 C
682 C
683 C
684 C
685 C
686 C
687 C
688 C
689 C
690 C
691 C
692 C
693 C
694 C
695 C
696 C
697 C
698 C
699 C
700 C
701 C
702 C
703 C
704 C
705 C
706 C
707 C
708 C
709 C
710 C
711 C
712 C
713 C
714 C
715 C
716 C
717 C
718 C
719 C
720 C
721 C
722 C
723 C
724 C
725 C
726 C
727 C
728 C
729 C
730 C
731 C
732 C
733 C
734 C
735 C
736 C
737 C
738 C
739 C
740 C
741 C
742 C
743 C
744 C
745 C
746 C
747 C
748 C
749 C
750 C
751 C
752 C
753 C
754 C
755 C
756 C
757 C
758 C
759 C
760 C
761 C
762 C
763 C
764 C
765 C
766 C
767 C
768 C
769 C
770 C
771 C
772 C
773 C
774 C
775 C
776 C
777 C
778 C
779 C
780 C
781 C
782 C
783 C
784 C
785 C
786 C
787 C
788 C
789 C
790 C
791 C
792 C
793 C
794 C
795 C
796 C
797 C
798 C
799 C
800 C
801 C
802 C
803 C
804 C
805 C
806 C
807 C
808 C
809 C
810 C
811 C
812 C
813 C
814 C
815 C
816 C
817 C
818 C
819 C
820 C
821 C
822 C
823 C
824 C
825 C
826 C
827 C
828 C
829 C
830 C
831 C
832 C
833 C
834 C
835 C
836 C
837 C
838 C
839 C
840 C
841 C
842 C
843 C
844 C
845 C
846 C
847 C
848 C
849 C
850 C
851 C
852 C
853 C
854 C
855 C
856 C
857 C
858 C
859 C
860 C
861 C
862 C
863 C
864 C
865 C
866 C
867 C
868 C
869 C
870 C
871 C
872 C
873 C
874 C
875 C
876 C
877 C
878 C
879 C
880 C
881 C
882 C
883 C
884 C
885 C
886 C
887 C
888 C
889 C
890 C
891 C
892 C
893 C
894 C
895 C
896 C
897 C
898 C
899 C
900 C
901 C
902 C
903 C
904 C
905 C
906 C
907 C
908 C
909 C
910 C
911 C
912 C
913 C
914 C
915 C
916 C
917 C
918 C
919 C
920 C
921 C
922 C
923 C
924 C
925 C
926 C
927 C
928 C
929 C
930 C
931 C
932 C
933 C
934 C
935 C
936 C
937 C
938 C
939 C
940 C
941 C
942 C
943 C
944 C
945 C
946 C
947 C
948 C
949 C
950 C
951 C
952 C
953 C
954 C
955 C
956 C
957 C
958 C
959 C
960 C
961 C
962 C
963 C
964 C
965 C
966 C
967 C
968 C
969 C
970 C
971 C
972 C
973 C
974 C
975 C
976 C
977 C
978 C
979 C
980 C
981 C
982 C
983 C
984 C
985 C
986 C
987 C
988 C
989 C
990 C
991 C
992 C
993 C
994 C
995 C
996 C
997 C
998 C
999 C
1000 C

```

```

150 C      OPTION TO USE R-CARDS FOR 'XVAL(ISLAB)' VALUES
151 C      (FOR 'IPLTOP=2' OPTION ONLY)
152 IF(RCDOPT.EQ. 0) GO TO 28
153 IF(IPLTOP.EQ. 2) XVAL(ISLAB) = RR*1000.0
154
155 28 CONTINUE
156
157 C
158
159 NTHSQ=1.0+ALPHA*TOPHT(ISLAB)
160 IF(TOPHT(ISLAB).EQ. 0.000) NTHSQ=1.000+ALPHA*TH
161 BB=BB*10000.
162 PRINT 1022,ISLAB,RR,FF,AA,CC,BB,SS,EE,TH
163 IF(NPRINT.GE. 3) PRINT 1024
164
165 IF(RCDOPT.EQ. 1) GO TO 22
166 WAVE NO = TWO PI*1000.0*FREQ/VELITE
167 CONST = 0.03248*WAVE NO/DSORT(FREQ)
168 OMEGA = TWO PI*FREQ*1000.
169 KVRADOT = DEXP(DLOG(WAVE NO/ALPHA)/3.)
170 KVRATT = KVRADOT**2
171 AVRKOT = 1./KVRADOT
172 AVRKTT = AVRKOT**2*0.5
173
174 22 CONTINUE
175 IF(RHO.GT. RR) GO TO 912
176 RHO=RR
177 EPSR=EE
178 SIGMA=SS
179
180 C
181 C      READ IN T-CARDS FOR EACH SLAB
182 C
183 C
184 NM=0
185 23 READ(5,1023,END=915) INDX1,TR1,TI1,I1RM1,TMP1,TMP2
186 IF(TR1.EQ. 0.) GO TO 24
187 READ(5,1023,END=915) INDX2,TR2,TI2,I1RM2,TMP3,TMP4
188 IF(NM.EQ. 20) GO TO 233
189 IF(CDABS(TMP1).EQ. 0.000) GO TO 233
190 IF(TR1.NE. TR2.OR. TI1.NE. TI2) GO TO 234
191 IF(I1RM1.NE. I1RM2) GO TO 234
192 IF(I1RM1.EQ. 0) GO TO 911
193 NM=NM+1
194 IF(NPRINT.LT. 3) GO TO 230
195 PRINT 1025,NM,INDX1,TR1,TI1,I1RM1,TMP1,TMP2,
196 INDX2,TR2,TI2,I1RM2,TMP3,TMP4
197
198 230 TP(NM)=DCMPLX(TR1,TI1)
199 S(NM)=CDSIN(TP(NM)*DTR)
200 C(NM)=COCOS(TP(NM)*DTR)
201 STHTA=S(NM)*CAPK
202 THETAH=-IM*CDLOG(CDSORT(1.000-STHTA**2)+IM-STHTA)
203 STHTAH(NM)=CDSIN(THETAH)
204 RATIO(2*INDX1-1)=TMP1

```

```

00000500
00000510
00000520
00000530
00000540
00000550
00000560

```

```

200      RATIO(2*INDX1 )=TMP2
201      RATIO(2*INDX2-1)=TMP3
202      RATIO(2*INDX2 )=TMP4
203      IF(ITRM1 .EQ. 2) GO TO 231
204      FGFR(NM)=RATIO(3)/RATIO(1)
205      GO TO 232
206
207      231 FOFR(NM)=RATIO(2)/(RATIO(3)*RATIO(4))
208      232 CONTINUE
209      IF(IH .EQ. 0) SHTAH(NM)=S(NM)
210      XTRA(NM)=RATIO(1)*FF1SQ*SHTAH(NM)**2
211      GO TO 23
212
213      233 IF(NPRINT .LT. 3) GO TO 23
214      234 PRINT 1026, INDX1,TR1,T11,ITRM1,TMP1,TMP2,
215      $      INDX2,TR2,T12,ITRM2,TMP3,TMP4
216      IF(TR1 .NE. TR2 .OR. T11 .NE. T12) GO TO 916
217      IF(ITRM1 .NE. ITRM2) GO TO 917
218      24 IF(NPRINT .LT. 3) PRINT 1027,NM
219      NRMODE=NM
220
221      C-----
222      C
223      C      WRITE SLAB INFORMATION ON TO UNIT 9
224      C
225      C      WRITE(9) ISLAB,S,C,TP,XTRA,FOFR,NRMODE,NTHSQ,SIGMA,EPSR
226      C
227      C-----
228      C
229      C      READ IN A NEW SLAB FROM FROM INPUT DATA
230      C
231      C      GO TO 21
232      C-----
233      C
234      C      25 NRSLAB = ISLAB-1
235      C      IF(NRSLAB .LE. 1) GO TO 914
236      C      GO TO 10
237      C-----
238      C
239      C      30 CONTINUE
240      C
241      C      ALL SLABS HAVE BEEN READ IN
242      C
243      C      REWIND 9
244      C      REWIND 4
245      C-----
246      C
247      C      IF THE CONVERSION COEFFICIENTS HAVE ALREADY BEEN COMPUTED
248      C      -----SKIP TO STATEMENT 118-----
249      C      IF(CNVSCF .GT. 0) GO TO 118

```

UNCLASSIFIED

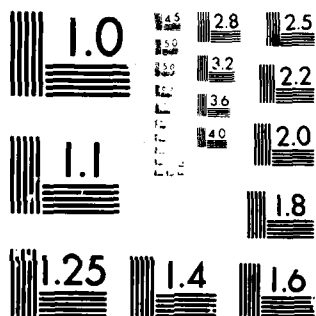
NAVSEA OCEAN SYSTEMS
 'SIMPLIFIED' VLF/LF
 JAN 80 D G MORFITT

F/6 20/14

NL

217

END
DATE
FILMED
5-80
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```

250 C      COMPUTE THE CONVERSION COEFFICIENTS FOR EACH INPUT SLAB
251 C
252 DO 555 M=1,NRSLAB
253 C
254 READ (9) ISLAB,S.C,TP,XTRA,FOFR,NRMODE,NTHSQ,SIGMA,EPSR
255 C
256 IFLG=1
257 IF(M.EQ.1) IFLG=0
258 CALL HTINTL(IFLG,M,INTFLG)
259 555 CONTINUE
260 C
261 C      CONVERSION COEFFICIENTS HAVE BEEN STORED ON UNIT 4
262 C
263 REWIND 9
264 REWIND 4
265 -----
266 C
267 C      IDENTIFY THE SLAB WHICH CONTAINS THE TRANSMITTER (I.E. NTR)
268 C
269 118 CONTINUE
270 C
271 IF(XVAL(2).GE.0.0) GO TO 111
272 DO 113 L=3,NRSLAB
273 IF(XVAL(L).GE.0.0) GO TO 114
274 113 CONTINUE
275 NTR = NRSLAB
276 GO TO 120
277 114 NTR=L-1
278 115 CONTINUE
279 GO TO 120
280 111 NTR = 1
281 120 CONTINUE
282 C
283 IF(ITRX.LT.1) GO TO 804
284 PRINT 800,NTR
285 800 FORMAT('0',' THE TRANSMITTER IS IN SLAB NO. ',15/)
286 PRINT 801
287 801 FORMAT(' ',10X,' XVAL(I) = ')
288 DO 802 I = 1,NRSLAB
289 802 PRINT 803,XVAL(I)
290 803 FORMAT(20X,F10.3/)
291 804 CONTINUE
292 C
293 FROP=FREQ
294 RHONNP=RHOMIN
295 RHONXP=RHOMAX
296 C
297 -----
298 91 IF(IPLTOP.EQ.1) CALL MCFLD
299 00000940

```

```

300                                00000950
301                                00000960
302                                00000980
303                                00000990
304                                00001000
305                                00000950
306                                00000960
307                                00000980
308                                00000990
309                                00001000
310                                00000950
311                                00000960
312                                00000980
313                                00000990
314                                00001000
315                                00000950
316                                00000960
317                                00000980
318                                00000990
319                                00001000
320                                00000950
321                                00000960
322                                00000980
323                                00000990
324                                00001000
325                                00000950
326                                00000960
327                                00000980
328                                00000990
329                                00001000
330                                00000950
331                                00000960
332                                00000980
333                                00000990
334                                00001000
335                                00000950
336                                00000960
337                                00000980
338                                00000990
339                                00001000
340                                00000950
341                                00000960
342                                00000980
343                                00000990
344                                00001000
345                                00000950
346                                00000960
347                                00000980
348                                00000990
349                                00001000

IF(IPLTOP .EQ. 2) CALL MCFLD2
NT = NT+1
DO 106 ME=1,NRSLAB
  XVAL(ME) = XVAL(ME)+DELTA
106
C-----
C
C CHECK TO SEE IF A SLAB BOUNDARY HAS MOVED PAST THE TRANSMITTER
IF(XVAL(NTR) .GE. 0. .AND. NT .LE. NTRMAX) GO TO 118
IF(NT .LE. NTRMAX) GO TO 91
C
C IFIRST = 0
CNVSCF=1
REWIND 4
REWIND 9
GO TO 10
C-----
C
C ERROR EXITS
909 PRINT 1909
910 PRINT 1910
GO TO 999
911 PRINT 1911
GO TO 999
912 PRINT 1912
GO TO 999
914 PRINT 1914
GO TO 999
915 PRINT 1915
GO TO 999
916 PRINT 1916
GO TO 999
917 PRINT 1917
C
1909 FORMAT('0','***** FIELD STRENGTH OPTION (IPLTOP) WAS NOT SET ')
1910 FORMAT('0','***** ERROR IN CONTROL CARD')
1911 FORMAT('0','***** THIS DATA DECK IS MISSING THE FOUR FLAG IN 20')
1912 FORMAT('0','***** XVALS OUT OF ORDER')
1914 FORMAT('0','***** NUMBER OF SLABS LESS THAN 2')
1915 FORMAT('0','***** END OF DATA SET ON UNIT 5')
1916 FORMAT('0','***** ERROR IN DATA SEQUENCE')
1917 FORMAT('0','***** ITEM FLAG INCONSISTENT')
C
199 FORMAT('1')
200 FORMAT(' ')
201 FORMAT(20A4)
202 FORMAT(' ',20A4)
203 FORMAT(10A4)

```

```

350 204 FORMAT(' ',10A4)
351 1001 FORMAT('END OF JOB')
352 1020 FORMAT(1X,F7.0,3(2X,F9.0),2(2X,E10.0),2(2X,E5.0))
353 1022 FORMAT('OSLAB ',12,' R',F7.3,' F',F8.4,' A',F8.3,' C',F8.3,' M',
354 $ F6.3,' S',1P10.3,' E',CP15.1,' T',F5.1)
355 1023 FORMAT(11,2F9.0,11,4E15.0)
356 1024 FORMAT(/11X,' M ID THETA')
357 1025 FORMAT(11X,12,3X,11,OP2F10.2,12,2(1X,1P2E16.8)/
358 $ 16X, 11,OP2F10.2,12,2(1X,1P2E16.8))
359 1026 FORMAT(16X, 11,OP2F10.2,12,2(1X,1P2E16.8)/
360 $ 16X, 11,OP2F10.2,12,2(1X,1P2E16.8))
361 1027 FORMAT('+',80X,' MODES',13)
362 999 CONTINUE
363 REWIND 9
364 REWIND 4
365 PRINT 1001
366 IF(JPLOT.EQ. 1) CALL PLOT(0.,0.,999)
367 STOP
368 END

```

OPRT.S GRNDMCA.HTINTL

```

MORFITT*GRNDMCA(1).HTINTL
1 SUBROUTINE HTINTL(IFLG,M,INTFLG)
2 IMPLICIT REAL*8(A-H,O-Z)
3 COMMON/NPRINT C/NPRINT
4 COMMON/MNODS C/ MAXMDS
5 COMMON/NCINPT/
6 $ XTRA(20),TOPHT(50),RHOMAX,RHOMIN,DELRHO,DELTAX,
7 $ EPSR,SIGMA,NRSLAB,NRMODE,NTMAX,PRMODE,NTRMDS
8 $ COMMON/NCSTOR/A(20,20),S(20),C(20),KVRADT,KVRATT,AVRKOT,
9 $ AVRKTT,NTHSQ,CONST,OMEGA,WAVENO
10 $ COMPLEX*16 INORM(20,20)
11 $ COMPLEX*16 PTHA,H1TA,H2TA,H1PRTA,H2PRTA,iYTHA(20),EYTHA(20),
12 $ HYTHPA(20),EYTHPA(20)
13 $ COMPLEX*16 THETA,FOFR,A,S,C,SSQ,CSQ,IM/(0.0D0,1.0D0)/,NGSQ,
14 $ SQROOT,RTIORT,P0,PTH,H10,H20,H1PRM0,H2PRM0,CAPH10,CAPH20,
15 $ A1ST,A2ND,A3RD,A4TH,DEN12,DEN34,DENMF,NURMF,
16 $ H1T,H2T,H1PRMT,H2PRMT,HYTH(20),EYTH(20),HYTHPR(20),EYTHPR(20),
17 $ HYOPR(20),EYOPR(20),EY0(20),MULT,FAC1,FAC2,NORM(20,20),PS(20),
18 $ CAPI(20,20),PHYTH(20),PHYTHPR(20),PEYTH(20),PEYTHPR(20),
19 $ PEY0(20),PEYOPR(20),PHYOPR(20),XTRA
20 $ COMPLEX*16 ZERO/(0.0D0,0.0D0)/,ONE/(1.0D0,0.0D0)/
21 REAL*8 NTHSQ,NTHSQP
22 INTEGER PRMODE
23 REAL*8 KVRADT,KVRATT
24 REAL*4 ERR
25 DATA EPSLN0/8.85434D-12/
26
27 C
28 DO 5 K=1,MAXMDS
29 DO 5 J=1,MAXMDS
30 5 INORM(J,K)=ZERO
31
32 C-----
33 DO 100 K=1,NRMODE
34 SSQ=S(K)**2
35 CSQ=C(K)**2
36 NSQ=EPSR-((IM*SIGMA/OMEGA)/EPSLN0
37 SQROOT=CDSQRT(NGSQ-SSQ)
38 RSQR=SQROOT
39 IF(RSQR.LT.0.) SQROOT=-SQROOT
40 RTIORT=1./NGSQ*SQROOT
41 P0=KVRATT*CSQ
42 PTH=KVRATT*(NTHSQ-SSQ)
43 CALL MDHKKL(P0,H10,H20,H1PRM0,H2PRM0)
44 CAPH10=H1PRM0+AVRKTT*H10
45 CAPH20=H2PRM0+AVRKTT*H20
46 A1ST=CAPH20-IM*RTIORT*KVRADT*H20
47 A2ND=CAPH10-IM*RTIORT*KVRADT*H10
48 A3RD=H2PRM0-IM*KVRADT*SQROOT*H20
49 A4TH=H1PRM0-IM*KVRADT*SQROOT*H10

```

```

50 DEN12 = H20*A2ND - H10*A1ST
51 DEN34 = H20*A4TH - H10*A3RD
52 CALL MDHKKL(PTH,H1T,H2T,H1PRMT,H2PRMT)
53
54 HYTH(K) = (H2T*A2ND - H1T*A1ST)/DEN12
55 EYTH(K) = (H2T*A4TH - H1T*A3RD)/DEN34*FOFR( K)
56 HYTHPR(K) = (H2PRMT*A2ND - H1PRMT*A1ST)/DEN12
57 EYTHPR(K) = (H2PRMT*A4TH - H1PRMT*A3RD)/DEN34*FOFR( K)
58 HYOPR(K) = (H2PRMO*A2ND - H1PRMO*A1ST)/DEN12
59 EYOPR(K) = (H2PRMO*A4TH - H1PRMO*A3RD)/DEN34*FOFR( K)
60
61 IF(IFLG.EQ.0) GO TO 100
62
63
64
65
66 PTHA = KVRATT*(NTHSQ -SSQ)
67 CALL MDHKKL(PTH,H1TA,H2TA,H1PRTA,H2PRTA)
68 HYTHA(K) = (H2TA*A2ND-H1TA*A1ST)/DEN12
69 EYTHA(K) = (H2TA*A4TH-H1TA*A3RD)/DEN34*FOFR( K)
70 HYTHPA(K) = (H2PRTA*A2ND-H1PRTA*A1ST)/DEN12
71 EYTHPA(K) = (H2PRTA*A4TH-H1PRTA*A3RD)/DEN34*FOFR( K)
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99

```

00001830
00001840
00001850

00001860
00001870
00001880
00001890
00001900
00001910
00001920

00001940
00001950
00001
00001970
000019

00002000
00002010
00002020
00002030

00002050
00002060
00002070
00002080

00002140
00002150
00002160

100 EY0(K) = FOFR(K)

COMPUTE NORM(J,K) FOR ALL SLABS

IF(INTFLG.EQ.1) PRINT 906,M
DO 240 J = 1,NRMODE
DO 240 K = 1,NRMODE
IF(J.EQ.K) GO TO 120
MULT = AVRKT/((S(J) - S(K))*WAVEND)
FAC1 = EYTH(K)*EYTHPR(J) - EYTH(J)*EYTHPR(K) + HYTH(K)*HYTHPR(J)
\$ -HYTH(J)*HYTHPR(K)
FAC2 = -EY0(K)*EYOPR(J) + EY0(J)*EYOPR(K) - HYOPR(J) + HYOPR(K)
NORM(J,K) = MULT*(FAC1+FAC2)
IF(INTFLG.EQ.0) GO TO 240
CALL MAGANG(NORM(J,K),AMAGG,ANGG)
PRINT 908,M,J,K,NORM(J,K),AMAGG,ANGG
GO TO 240

120 MULT = 2.0*(S(J)*KVRADT/WAVEND
PTH = KVRATT*(NTHSQ -S(J)**2)
PO = KVRATT*(J)**2
FAC1 = EYTHPR(J)**2 + HYTHPR(J)**2 + PTH*(EYTH(J)**2 + HYTH(J)**2)*00002140
FAC2 = -EYOPR(J)**2 - HYOPR(J)**2 - PO*(EY0(J)**2 + 1.0)
NORM(J,K) = MULT*(FAC1+FAC2)
IF(INTFLG.EQ.0) GO TO 240
CALL MAGANG(NORM(J,K),AMAGG,ANGG)

```

100 PRINT 908,M,J,K,NORM(J,K),AMAGG,ANGG
101 240 CONTINUE
102
103 C-----
104 C
105 C
106 C
107 C
108 C
109 C
110 C
111 C
112 C
113 C
114 C
115 C
116 C
117 C
118 C
119 C
120 C
121 C
122 C
123 C
124 C
125 C
126 C
127 C
128 C
129 C
130 C
131 C
132 C
133 C
134 C
135 C
136 C
137 C
138 C
139 C
140 C
141 C
142 C
143 C
144 C
145 C
146 C
147 C
148 C
149 C

```

```

150 PS(J) = S( J)
151 PHYTH(J) = HYTH(J)
152 PHYTHP(J) = HYTHPR(J)
153 PEYTH(J) = EYTH(J)
154 PEYTHP(J) = EYTHPR(J)
155 PHYOPR(J) = HYOPR(J)
156 PEYO(J) = EYO(J)
157 PEYOPR(J) = EYOPR(J)
158
159 600 CONTINUE
160 PRMODE=NRMODE
161 NTHSQP=NTHSQ
162
163 C-----
164 IF(INTFLG .LT. 1) GO TO 42
165 PRINT 900,M
166 DO 450 K=1,PRMODE
167 DO 450 J=1,NRMODE
168 CALL MAGANG(INORM(J,K),AMAGG,ANGG)
169 PRINT 901,J,K,INORM(J,K),AMAGG,ANGG
170
171 450 CONTINUE
172 42 CONTINUE
173
174 C-----
175 RETURN
176 900 FORMAT(1H0,14X,
177 $ ' INORM = NORMALIZED CONVERSION COEFFICIENTS',
178 $
179 $2X,1PE15.5,OPF9.2,/)
180 901 FORMAT(' J =',12,2X,' K =',12,2X,' INORM = ',(1PE15.5,1PE15.5),
181 $2X,1PE15.5,OPF9.2,/)
182 906 FORMAT(' OINTEGRALS IN SLAB',13,/)
183 908 FORMAT(' NORH',12,',' ,12,',' ,12,',' ,12,') =',2E13.6,
184 $10X,1PE15.5,OPF10.2)
185 910 FORMAT(' CAP',12,',' ,12,',' ,12,',' ,12,') =',2E13.6,
186 $10X,1PE15.5,OPF10.2)
187 END
188
189 00002310
190 00002320
191 00002330
192 00002340
193 00002350
194 00002360
195 00002370
196 00002380

```

0PRT.5 GRNDMCA.MCFLD

```

MORFITT*GRNDMCA(1).MCFD
1 SUBROUTINE MCFD
2 IMPLICIT REAL *8(A-H,O-Z)
3 COMPUTE FIELDS FROM XVAL MIN TO XVAL MAX FOR TWO XMTR-RCVR DISTANCES
4
5 COMMON/FIRST C/ IFIRST
6 COMMON/SNTR C/SNTR
7 COMMON/INORM C/INORM
8 COMMON/TERM/NT,NTR
9 COMMON/SPLIT/SAVED(402),Y1(402),Y2(402),ANG1(402),ANG2(402)
10 COMMON/MCINPT/
11 $ XTRA(20),TOPHT(50),RHOMAX,RHOMIN,DELPHO,DELTA,
12 $ EPSR,SIGMA,NRSLAB,NRMODE,NTMAX,PRMODE,NTRMDS
13 COMMON/MCSTOR/A(20,20),S(20),C(20),KVRATT,KVRATT,AVRKOT,
14 & AVRKOT,NTHSQ,CONST,OMEGA,WAVENO
15 COMMON/MCPLT/R(402),OB(402),ANG(402),IDPLOT(10),ISUB,JPLT,
16 $ NAPLOT,NPPLOT
17 COMPLEX*16 PS(20),PREVA(20,20),EXCNR(20),SNTR(20)
18 COMPLEX*16 THETA,A,S,C,XTRA,SOLNA(20),TS,TDBL,
19 $ IM/(0.0D0,1.0D0)/,TA,FDFR
20 COMPLEX*16 INORM(20,20)
21 REAL*8 NTHSQ
22 INTEGER PRMODE
23 REAL*4 R,DB,ANG
24 REAL*4 SAVED,Y1,Y2
25 REAL*4 ANG1,ANG2
26 REAL*8 KVRATT,KVRATT
27 DATA DTR/0.01745329252D0/
28 DATA ERAD/6.37D03/
29
30 C
31 C
32 ISUB = 0
33 M = NTR
34 RHO = RHO MIN
35 X = RHO - 1.0
36 700 IF (RHO.LE.X) GO TO 720
37 C
38 READ IN A NEW SLAB
39 C
40 10 CONTINUE
41 C
42 READ (4) NSLAB,INORM,S,C,PS,FDFR,XTRA,NRMODE,PRMODE
43 C
44 IF(NSLAB.LT. NTR) GO TO 10
45 IF(NSLAB.NE. NTR) GO TO 11
46 C
47 NTRMDS=NRMODE
48 C
49 DO 12 K=1,NTRMDS

```

```

50      EXCNTR(K)=XTRA(K)
51      SNTR(K) = S(K)
52
53      C
54      12 CONTINUE
55      11 CONTINUE
56
57      C
58      CALL MCSTEP(M)
59
60      DO 710 J = 1,NRMODE
61      SOLN A(J) = (0.000,0.000)
62      DO 710 K = 1,NTRMDS
63      IF(M.NE. NTR) GO TO 35
64      SOLN A(J) = SOLN A(J)+A( J,K)*(EXCNTR(K)/SNTR(K))
65      GO TO 710
66      35 SOLN A(J) = SOLN A(J) + A( J,K)*(EXCNTR(K)/SNTR(K)) *
67      $ CDEXP(-IM*WAVENO*SNTR(K)*XVAL(NTR+1))
68      710 CONTINUE
69
70      C
71      M = M + 1
72      X = 1.0E6
73      IF(N.LE. NRSLAB) X = XVAL(M)
74      GO TO 700
75
76      C
77      720 TA = (0.000,0.000)
78      DO 730 J = 1,NRMODE
79      IF(M-1.NE. NTR) GO TO 45
80      TB =CDEXP(-IM*WAVENO*S(J)*RHO)
81      TA = TA+SOLNA(J)*S(J)*TB
82      GO TO 730
83
84      C
85      45 TB =CDEXP(IM*WAVENO* S(J)*(XVAL(M-1)-RHO))
86      TA = TA+SOLNA(J)*S(J)*TB
87
88      C
89      730 CONTINUE
90      TA = TA*CONST/DSORT(DSIN(RHO/ERAD))
91      TDBL = TA *CDEXP (IM * WAVE NO * RHO)
92      CALL IMAGANG (TDBL, TDMAG, TDANG)
93      TSMAG = TDMAG
94      TSANG = TDANG
95      TSDB = 8.685890 * DLOG (TSMAG * 1.0E6)
96      ISUB = ISUB+1
97      R(ISUB) = RHO
98      DB(ISUB) = TSDB
99      ANG(ISUB) = TSANG
100      SAVED(NT) = XVAL(2)
101      IF(MOD(ISUB,2) .EQ. 1) Y1(NT)=DB(ISUB)
102      IF(MOD(ISUB,2) .EQ. 0) Y2(NT)=DB(ISUB)
103      IF(MOD(ISUB,2) .EQ. 1) ANG1(NT) = ANG(ISUB)
104      IF(MOD(ISUB,2) .EQ. 0) ANG2(NT) = ANG(ISUB)
105      RHO = RHO + DEL RHO

```

```

MORFITT
00002770
MORFITT
00002800

00002820
00002840
00002850

MORFITT
00002910

MORFITT
00002940
00002950
00002960
00002970
00002980
00002990
00003000
00003010
00003020
00003030
00003040
00003060
00003070
00003080
00003090
00003100

```

```

100 IF (RHO.LE.RHO MAX) GO TO 700
101 REMIND 4
102 IF(NT .EQ. NTMAX) PRINT 910
103 IF(NT .EQ. NTMAX) PRINT 920
104 IF(NT .EQ. NTMAX) PRINT 925
105 IF(NT .EQ. NTMAX) PRINT 930.(SAVED(JJ),Y1(JJ),ANG1(JJ),Y2(JJ)).
106 $ ANG2(JJ),JJ=1,NTMAX)
107 IF(JPLOT .EQ. 0) RETURN
108 IF(NT .EQ. NTMAX .AND. JPLOT .EQ. 1) GO TO 500
109 RETURN
110
111 C 500 CONTINUE
112 IF(IFIRST .EQ. 1) CALL PLOT(1.0,1.0,-3)
113 IF(NAPLOT .EQ. 1) ITYPE=1
114 IF(NAPLOT .EQ. 1) CALL MCPLTS(ITYPE)
115 IF(NPLOT .EQ. 1) ITYPE=2
116 IF(NPLOT .EQ. 1) CALL MCPLTS(ITYPE)
117 RETURN
118
119 C 910 FORMAT('1',
120 $ ' ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR
121 $ DISTANCE(D)',//)
122 920 FORMAT('1',.26X,'FIELD AT RHOMIN FIELD AT RHOMAX')
123 925 FORMAT('1',.19X,'D',.6X,2('EZ(DB) EZ(ANG)',.3X),/)
124 930 FORMAT('1',.15X,F9.2,4F9.4)
125 END

```

```

00003110
00003120
00003130
00003140
00003150
00003160
00003190
00003200
00003210
00003220
00003230
00003240
00003250
00003260

```

```

MORFITT*GRNDMCA(1).MCFD2
1 SUBROUTINE MCFD2
2 IMPLICIT REAL *8(A-H,O-Z)
3 COMPUTE FIELDS FROM XVAL MIN TO XVAL MAX FOR TWO XMTR-RCVR DISTANCES
4
5 COMMON/ FIRST C/ IFIRST
6 COMMON/ SNTR C/ SNTR
7 COMMON/ INORM C/ INORM
8 COMMON/ PREV C/ PS
9 COMMON/ TERM/ NT, NTR
10 COMMON/ SPLOT/ SAVED(402), Y1(402), Y2(402), ANG1(402), ANG2(402)
11 COMMON/ MCINPT/
12 $ XTRA(20), TOPHT(50), RHC:MAX, RHC:MIN, DELRHO, DELTAX,
13 $ EPSR, SIGMA, NRSLAB, NRMODE, NTMAX, PRMODE, NTR:CS
14 COMMON/ MCSTOR/ A(20,20), S(20), C(20), KVRATT, KVRATT, AVRKOT,
15 $ AVRKOT, NTHSQ, CONST, OMEGA, WAVENO
16 COMMON/ MCPILOT/ R(402), DB(402), ANG(402), IDPLOT(10), ISUB, JPLOT,
17 $ NAPLOT, NPLOT
18 COMPLEX*16 PS(20), PREVA(20,20), EXCNTR(20), SNTR(20)
19 COMPLEX*16 THETA, A, S, C, XTRA, SOLNA(20), TB, TDBL,
20 $ IM/(0.0001*0.0001), TA, FOFR
21 COMPLEX*16 INORM(20,20)
22 REAL*8 NTHSQ
23 INTEGER PRMODE
24 REAL*4 R, DB, ANG
25 REAL*4 SAVED, Y1, Y2
26 REAL*4 ANG1, ANG2
27 REAL*8 KVRATT, KVRATT
28 DATA DTR/0.0174532925200/
29 DATA ERAD/6.37003/
30
31 PRINT 910
32 PRINT 920, NRSLAB, (XVAL(JKL), JKL=1, NRSLAB)
33
34 PRINT 628
35 628 FORMAT('0', 22X, 'EZ' )
36 PRINT 629
37 629 FORMAT(2X, 1(9X, 'RHO(KM)', 3X, 'AMP(DB)', 3X, 'ANG(DEG)')/)
38
39 C
40 ISUB = 0
41 M = NTR
42 RHO = RHO MIN
43 X = RHO - 1.0
44 700 IF (RHO.LE.X) GO TO 720
45
46 C READ IN A NEW SLAB
47
48 10 CONTINUE
49
50 READ (4) NSLAB, INORM, S, C, PS, FOFR, XTRA, NRMODE, PRMODE

```

```

50 C
51 IF(NSLAB .LT. NTR) GO TO 10
52 IF(NSLAB .NE. NTR) GO TO 11
53
54 C
55 NTRMDS=NRMODE
56
57 DO 12 K=1,NTRMDS
58 EXCNR(K)=XTRA(K)
59 SNTR(K) = S(K)
60
61 C
62 12 CONTINUE
63 11 CONTINUE
64
65 C
66 CALL MCSTEP(M)
67
68 DO 710 J = 1,NRMODE
69 SOLN A(J) = (0.000,0.000)
70 DO 710 K = 1,NTRMDS
71 IF(M .NE. NTR) GO TO 35
72 SOLN A(J) = SOLN A(J)+A( J,K)*(EXCNR(K)/SNTR(K))
73 GO TO 710
74
75 C
76 35 SOLN A(J) = SOLN A(J) + A( J,K)*(EXCNR(K)/SNTR(K)) *
77 $ CDEXP(-IM*WAVENO*SNTR(K)*XVAL(NTR+1))
78 710 CONTINUE
79
80 C
81 M = M + 1
82 X = 1.0E6
83 IF(M .LE. NRSLAB) X = XVAL(M)
84 GO TO 700
85
86 C
87 720 TA = (0.000,0.000)
88 DO 730 J = 1,NRMODE
89 IF(M-1 .NE. NTR) GO TO 45
90 TB =CDEXP(-IM*WAVENO*S(J)*RHO)
91 TA = TA+SOLN A(J)*S(J)*TB
92 GO TO 730
93
94 C
95 45 TB =CDEXP(IM*WAVENO* S(J)*(XVAL(M-1)-RHO))
96 TA = TA+SOLN A(J)*S(J)*TB
97 730 CONTINUE
98 TA = TA*CONST/DSORT(DSIN(RHO/ERAD))
99 TDBL = TA *CDEXP (IM * WAVE NO * RHO)
100 CALL MAGANG (TDBL, TDMAG, TDANG)
101 TSMAG = TDMAG
102 TSANG = TDANG
103 TSDB = 8.685890 * LOG (TSMAG * 1.0E6)
104
105 C
106 ISUB = ISUB+1
107 R(ISUB) = RHO

```

MORFITT
00002770

MORFITT
00002800

00002820
00002840
00002850

MORFITT
00002910

MORFITT
00002940
00002950
00002960
00002970
00002980
00002990
00003000

00003010
00003020

```

100      OB(ISUB) = TSDB
101      ANG(ISUB) = TSANG
102      PRINT 608,RHO,TSDB,TSANG
103      608 FORMAT(2X,1(7X,F10.2,F10.5,F10.4))
104      RHO = RHO + DEL RHO
105      IF (RHO.LE.RHO MAX) GO TO 700
106      REWIND 4
107      IF(JPLOT .EQ. 1) GO TO 500
108      RETURN
109
110      C 500 CONTINUE
111      IF(IFIRST .EQ. 1) CALL PLOT(1.0,1.0,-3)
112      IF(NAPLOT .EQ. 1) ITYPE=1
113      IF(NAPLOT .EQ. 1) CALL MCPLT2(ITYPE)
114      IF(NPLOT .EQ. 1) ITYPE=2
115      IF(NPLOT .EQ. 1) CALL MCPLT2(ITYPE)
116      RETURN
117
118      C 910 FORMAT(' ',
119      $ ' ELECTRIC FIELD STRENGTH AS A FUNCTION OF RHO',/)
120      920 FORMAT(' ' X COORDINATES OF SLABS 1 THROUGH',12,9F10.4,/,
121      $11F10.4,////)
122      END

```

00003030
00003040

00003100
00003110

00003190

00003970
00003980
00003990
00004000
00004010

```

MORFITT*GRNDMCA(1).MCPLTS
1  SUBROUTINE MCPLTS(ITYPE)
2  COMMON/TERM/NT,NTR
3  COMMON/SPLOT/SAVE(402),Y1(402),Y2(402),ANG1(402),ANG2(402)
4  COMMON/NCPLT/R(402),DB(402),ANG(402),IDPLOT(10),ISUB,JPLOT,
5  $  NAPLOT,NPPLOT
6  COMMON/XPLOT/XMIN,XINC,YMIN,YINC,SIZEZ,SIZEY
7  COMMON/PSPLOT/PHSMIN,PHSINC,SIZEP,PTIC,NTICP
8  COMMON/AXISM C/XTIC,YTIC,NTICK,NTICY
9  REAL*8 FRQP,RHOMNP,RHOMXP
10 REAL*4 SIZEP,PHSMIN,PHSINC,PTIC
11 REAL*4 XTIC,YTIC
12 SAVED(NT+1) = XMIN
13 SAVED(NT+2) = XINC
14 Y1(NT+1) = YMIN
15 Y1(NT+2) = YINC
16 Y2(NT+1) = YMIN
17 Y2(NT+2) = YINC
18 ANG1(NT+1) = PHSMIN
19 ANG1(NT+2) = PHSINC
20 ANG2(NT+1) = PHSMIN
21 ANG2(NT+2) = PHSINC
22 IF(ITYPE.EQ. 2) GO TO 800
23
24 C
25 C
26 ITYPE=1
27 DO 900 I=1,2
28 CALL AXISM(0.,0.,'TRANSMITTER-TERMINATOR DISTANCE IN KM',-37,
29 $ SIZEZ,0.0,SAVE(NT+1),SAVE(NT+2),XTIC,NTICK)
30 IF(I.EQ. 1)
31 $ CALL AXISM(0.,0.,'DB ABOVE 1UV/M FOR 1KW',22,SIZEY,90.0,
32 $ Y1(NT+1),Y1(NT+2),YTIC,NTICY)
33 IF(I.EQ. 2)
34 $ CALL AXISM(0.,0.,'DB ABOVE 1UV/M FOR 1KW',22,SIZEY,90.0,
35 $ Y2(NT+1),Y2(NT+2),YTIC,NTICY)
36 IF(I.EQ. 1) CALL LINE(SAVE,Y1,NT,1,0.11)
37 IF(I.EQ. 2) CALL LINE(SAVE,Y2,NT,1,0.11)
38 CALL SYMBOL(1.0,(SIZEY+0.6),0.14,IDPLOT,0.0,40)
39 CALL SYMBOL(1.0,(SIZEY+0.4),0.14,'FREQ',0.0,5)
40 CALL NUMBER(1.9,(SIZEY+0.4),0.14,SNGL(FRQP),0.0,3)
41 CALL NUMBER(1.0,(SIZEY+0.2),0.14,'RECEIVER DISTANCE = ',0.0,20)
42 IF(I.EQ. 1) CALL NUMBER(3.9,(SIZEY+0.2),0.14,SNGL(RHOMNP),0.0,1)
43 IF(I.EQ. 2) CALL NUMBER(3.9,(SIZEY+0.2),0.14,SNGL(RHOMXP),0.0,1)
44 CALL PLOT(SIZEZ+5.,0.,-3)
45 900 CONTINUE
46 RETURN
47 800 CONTINUE
48 C
49 C
50 ITYPE=2
51 DO 700 I=1,2

```

00004030

00004060

00004070
00004080
00004090
00004100
00004110
00004120

00004290

00004300

```

50 CALL AXISM(0.0,0.0,'TRANSMITTER-TERMINATOR DISTANCE IN KM',-37,
51 $ SIZE,0.0,0.0,SAVED(NT+1),SAVED(NT+2),XTIC,NTICX)
52 IF(I.EQ. 1)
53 *CALL AXISM(0.0,0.0,0.0,'PHASE(DEGREES)',14,SIZEP,90.0,
54 * ANG1(NT+1),ANG1(NT+2),PTIC,NTICP)
55 IF(I.EQ. 2)
56 *CALL AXISM(0.0,0.0,0.0,'PHASE(DEGREES)',14,SIZEP,90.0,
57 * ANG2(NT+1),ANG2(NT+2),PTIC,NTICP)
58 IF(I.EQ. 1) CALL LINE(SAVED,ANG1,NT,1,0.11)
59 IF(I.EQ. 2) CALL LINE(SAVED,ANG2,NT,1,0.11)
60 CALL SYMBOL(1.0,(SIZEP+0.6),0.14,1DPLT,0.0,40)
61 CALL SYMBOL(1.0,(SIZEP+0.4),0.14,'FREQ=' ,0.0,5)
62 CALL NUMBER(1.9,(SIZEP+0.4),0.14,SNGL(FRQP),0.0,3)
63 CALL SYMBOL(1.0,(SIZEP+0.2),0.14,'RECEIVER DISTANCE = ',0.0,20)
64 IF(I.EQ. 1) CALL NUMBER(3.9,(SIZEP+0.2),0.14,SNGL(RHOMNP),0.0,1)
65 IF(I.EQ. 2) CALL NUMBER(3.9,(SIZEP+0.2),0.14,SNGL(RHOMXP),0.0,1)
66 CALL PLOT(SIZE+5.0,-3)
67 700 CONTINUE
68 RETURN
69 END

```

00004310

OPRT,5 GRNDMCA.MCPLT2

```

MORFITT=GRNDMCA(1).MCPLT2
1 SUBROUTINE MCPLT2(IITYPE)
2 COMMON/PLPLOT C/FROP,RHOMNP,RHOMXP
3 COMMON/PSPLOT/PHSMIN,PHSINC,SIZEP,PTIC,NTICP
4 COMMON/AXISM C/XTIC,YTIC,NTICX,NTICY
5 COMMON/MCPLPLOT/R(402),DB(402),ANG(402),IDPLOT(10),ISUB,JPLOT,
6 $ NAPLOT,NPPLOT
7 COMMON/XPLOT/XMIN,XINC,YMIN,YINC,SIZEX,SIZEY
8 REAL*8 FROP,RHOMNP,RHOMXP
9 REAL*4 XTIC,YTIC
10 REAL*4 SIZEP,PHSMIN,PHSINC,PTIC
11 R(ISUB+1) = XMIN
12 R(ISUB+2) = XINC
13 DB(ISUB+1) = YMIN
14 DB(ISUB+2) = YINC
15 ANG(ISUB+1) = PHSMIN
16 ANG(ISUB+2) = PHSINC
17 IF(IITYPE.EQ. 2) GO TO 800
18
19 C
20 C IITYPE = 1
21 CALL AXISM(0.0,0.0,0.7HRHQ(KM),-7,SIZEX,0.,R(ISUB+1),R(ISUB+2),
22 $ XTIC,NTICX)
23 CALL AXISM(0.0,0.0,0.22HDB ABOVE 1UV/M FOR 1KW,22,SIZEY,90.,
24 $ DB(ISUB+1),DB(ISUB+2),YTIC,NTICY)
25 CALL LINE(R,DB,ISUB,1,0,4)
26 CALL SYMBOL(1.0,(SIZEY+0.6),0.14,IDPLOT,0.0,40)
27 CALL SYMBOL(1.0,(SIZEY+0.4),0.14,FREQ=1,0.0,5)
28 CALL NUMBER(1.9,(SIZEY+0.4),0.14,SNGL(FROP),0.0,3)
29 CALL PLOT(SIZEX+5.0,-3)
30 RETURN
31
32 800 CONTINUE
33
34 C
35 C IITYPE = 2
36 CALL AXISM(0.0,0.0,0.7HRHQ(KM),-7,SIZEX,0.,R(ISUB+1),R(ISUB+2),
37 $ XTIC,NTICX)
38 CALL AXISM(0.0,0.0,'PHASE(DEGREES)',14,SIZEP,90.0,
39 $ ANG(ISUB+1),ANG(ISUB+2),PTIC,NTICP)
40 CALL LINE(R,ANG,ISUB,1,0,4)
41 CALL SYMBOL(1.0,(SIZEP+0.6),0.14,IDPLOT,0.0,40)
42 CALL SYMBOL(1.0,(SIZEP+0.4),0.14,FREQ=1,0.0,5)
43 CALL NUMBER(1.9,(SIZEP+0.4),0.14,SNGL(FROP),0.0,3)
44 CALL PLOT(SIZEX+5.0,-3)
45 RETURN
46 END
47
00004340
00004350
00004360
00004370
00004380
00004450
00004460
00004470

```

©PRT, S GRNDMCA.MCSTEP

```

MORFITT*GRNDMCA(1).MCSTEP
1 SUBROUTINE MCSTEP(M)
2 IMPLICIT REAL *8(A-H,O-Z)
3 COMMON/SNTR C/SNTR
4 COMMON/INT C/INTFLG,IPRNTA
5 COMMON/NPRINT C/NPRINT
6 COMMON /PREV C/ PS
7 COMMON/INORM C/INORM
8 COMMON/TERM/NT,NTR
9 COMMON/MCINPT/
10 $ XTRA(20 ),TOPHT(50),RHO*MAX,RHOMIN,DELRHO,DELTA*,
11 $ EPSR,SIGMA,NRSLAB,NRMODE,NTMAX,PRMODE,NTRMDS
12 COMMON/MCSTOR/A(20,20 ),S(20 ),C(20 ),KVRATT,KVRATT,AVRKOT,
13 & AVRKTT,NTHSQ,CONST,O*EGA,WAVENO
14 COMPLEX*16 PS(20),PREVA(20,20),SNTR(20)
15 COMPLEX*16 INORM(20,20)
16 COMPLEX*16 THETA,FCFR,A,S,C,
17 $ IM/(0.0D0,1.0D0)/.B(20),XTRA
18 REAL*8 NTHSQ
19 INTEGER PRMODE
20 REAL*8 KVRATT,KVRATT
21
22 MP=N-1
23 IF(M.NE.NTR) GO TO 50
24 DO 32 K=1,NTRMDS
25 DO 32 J=1,NRMODE
26 IF(J.EQ.K) GO TO 31
27 A(J,K) = (0.0D0,0.0D0)
28 GO TO 32
29 31 A(J,K) = (1.0D0,0.0D0)
30 32 CONTINUE
31 GO TO 24
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

```

00004480
00004490

00004500

00004550
00004560

00004600
00004620

00004650
00004660
00004670

00004690

33 B(L) = B(L)+INORM(L,J)+CDEXP(-IM*WAVENO* PS(J)*(XVAL(M)-

```

50      $ XVAL(MP)))*PREVA(J,K)
51      DO 27 I = 1,NRMODE
52      27 A( I,K) = B(I)
53      27 A( I,K) = B(I)*S(I)/SNTR(K)
54      DO 18 N=1,NRMODE
55      B(N) = (0.,0.)
56      29 CONTINUE
57      GO TO 24
58
59      C-----
60      C
61      C
62      C
63      C
64      C
65      C
66      C
67      C
68      C
69      C
70      C
71      C
72      C-----
73      C
74      C
75      C
76      C
77      C
78      C-----
79      C
80      C
81      C
82      C
83      C
84      C
85      C
86      C
87      C
88      C
89      C
90      C
91      C
92      C
93      C
94      C

```

FOR SLAB(MP) EQUAL TO SLAB(NTR)

21 DO 23 K = 1,NTRMDS
DO 25 L = 1,NRMODE
25 B(L) = INORM(L,K)
DO 35 J = 1,NRMODE
35 A(J,K) = B(J)
35 A(J,K) = B(J) *S(J)/SNTR(K)
23 CONTINUE
24 CONTINUE

DO 40 K=1,NTRMDS
DO 40 J=1,NRMODE
40 PREVA(J,K)=A(J,K)

IF(IPRNTA .LT. 1) GO TO 42
PRINT 900,M
DO 450 K = 1,NTRMDS
DO 450 J = 1,NRMODE
CALL MAGANG(A(J,K),AMAGG,ANGG)
PRINT 901,J,K,A(J,K),AMAGG,ANGG
450 CONTINUE
900 FORMAT(1H,14X,
\$ 'A = TOTAL CONVERSION COEFFICIENTS',6X,'SLAB NUMBER = ',12,./)
901 \$2X,1PE15.5,OPF9.2,./)
42 CONTINUE

RETURN
END

OPRT,S GRNDMCA.MDHNKL

```

MORFITT*GRNDMCA(1).MDHNKL
1 SUBROUTINE MDHNKL (Z,H1,H2,H1PRME,H2PRME)
2 IMPLICIT REAL *8 (A-H,O-Z)
3 COMPLEX*16 Z,I,H1,H2,H1PRME,H2PRME,ZPOWER,TERM1,TERM2,
4 TERM3,ZTERM,TERM,SUM1,SUM2,SUM3,SUM4,SORTZB,
5 EXP1,EXP2,EXP3,EXP4,EXP5,GM2F,GM1FP,MPower,BETA,RTZ,
6 CONST1,CONST2,CONST3,CONST4
7 DIMENSION A(23), B(23), C(23), D(23), CAP(14)
8 DATA A/
9 9.30436716930000D-01,3.10145572309700D 01,2.06763714873160D 02,0.0005010
10 5.74343652425450D 02,8.70217655190080D 02,8.28778719228640D 02,0.0005020
11 5.41685437404340D 02,2.57945446383020D 02,9.34584950663100D 01,0.0005030
12 2.86263518707400D 01,6.12100043005600D 00,1.15928038448000D 00,0.0005040
13 1.84012759441000D-01,2.48330309640000D-02,2.88420801000000D-03,0.0005050
14 2.91334142000000D-04,2.58274950000000D-05,2.02568600000000D-06,0.0005060
15 1.41557000000000D-07,8.87000000000000D-09,5.01000000000000D-10,0.0005070
16 2.60000000000000D-11,1.00000000000000D-12/
17 DATA B/
18 6.78298725140000D-01,1.13049787524000D 01,5.38332321543100D 01,0.0005100
19 1.19629404787350D 02,1.53371031778650D 02,1.27809193148880D 02,0.0005110
20 7.47422182157200D 01,3.23559386215200D 01,1.07853128738400D 01,0.0005120
21 2.85325737403000D 00,6.13603736351000D-01,1.09376780098000D-01,0.0005130
22 1.64229399550000D-02,2.10550512200000D-03,2.33167788000000D-04,0.0005140
23 2.25282890000000D-05,1.91567100000000D-06,1.44470000000000D-07,0.0005150
24 9.72900000000000D-09,5.89000000000000D-10,3.20000000000000D-11,0.0005160
25 2.00000000000000D-12,0.00000000000000D 00/
26 DATA C/
27 4.65218358460000D-01,6.20291144619000D 00,2.58454643591500D 01,0.0005190
28 5.22130593114000D 01,6.21584039421500D 01,4.87516893563900D 01,0.0005200
29 2.70842318702200D 01,1.12150194079600D 01,3.59455750255000D 00,0.0005210
30 9.18150064510000D-01,1.91281263439000D-01,3.3122966990000D-02,0.0005220
31 4.84244103800000D-03,6.05683682000000D-04,5.55018200000000D-05,0.0005230
32 6.19859900000000D-06,5.16550000000000D-07,3.82200000000000D-08,0.0005240
33 2.52800000000000D-09,1.50000000000000D-10,8.00000000000000D-12,0.0005250
34 0.00000000000000D 00,0.00000000000000D 00/
35 DATA D/
36 6.78298725140000D-01,4.52199150096200D 01,3.76832625080150D 02,0.0005280
37 1.19629404787350D 03,1.99382341312250D 03,2.0494709038206D 03,0.0005290
38 1.42010214609865D 03,7.11830649673510D 02,2.69632821846030D 02,0.0005300
39 7.98912064729000D 01,1.90217158268800D 01,3.71881052333900D 00,0.0005310
40 6.07648778323000D-01,8.42202048960000D-02,1.00262148690000D-02,0.0005320
41 1.03630127800000D-03,9.38678690000000D-05,7.51243500000000D-06,0.0005330
42 5.35074000000000D-07,3.41350000000000D-08,1.96200000000000D-09,0.0005340
43 1.02000000000000D-10,5.00000000000000D-12/
44 DATA CAP/
45 1.04166666666667D-01,8.35503472222222D-02,1.28226574556327D-01,0.0005370
46 2.91849025646140D-01,8.81627267443759D-01,3.32145828186277D 00,0.0005380
47 1.49957629868626D 01,7.89230130115870D 01,4.74451538868000D 02,0.0005390
48 3.20749009100000D 03,2.40865496000000D 04,1.98923120000000D 05,0.0005400
49 1.79190200000000D 06,1.74843770000000D 07/

```

```

50          DATA I/(0.0D0,1.0D0)/
51          DATA ROOT3/1.73205080756888D 00/
52          DATA ALPHA/8.53667218838951D-01/
53          DATA CONST1/( 2.58819045102522D-01,-9.65925826289067D-01)/
54          DATA CONST2/( 2.58819045102522D-01, 9.65925826289067D-01)/
55          DATA CONST3/(-9.65925826289067D-01, 2.58819045102522D-01)/
56          DATA CONST4/(-9.65925826289067D-01,-2.58819045102522D-01)/
57
58          ZPOWER=1.0
59          SUM3=0.0
60          SUM4=0.0
61          ZMAG=CDABS(Z)
62          IF(ZMAG .GT. 4.2) GO TO 70
63          IF(ZMAG .GE. 3.2) GO TO 10
64          N=12
65          GO TO 30
66
67          IF(ZMAG .GE. 4.1) GO TO 20
68          N=15
69          GO TO 30
70          N=23
71          SUM1=0.
72          SUM2=0.
73          ZTERM=-Z**3/200.0
74          DO 50 M=1,N
75             SUM1=SUM1+A(M)*ZPOWER
76             SUM2=SUM2+B(M)*ZPOWER
77             SUM3=SUM3+C(M)*ZPOWER
78             SUM4=SUM4+D(M)*ZPOWER
79             ZPOWER=ZPOWER*ZTERM
80          IF(CDABS(ZPOWER) .LE. 1.0D-30) GO TO 60
81          CONTINUE
82          GM2F=I*(Z*SUM2-2.*SUM1)/ROOT3
83          GPMFP=I*(SUM4+2.*Z*SUM3)/ROOT3
84          H1=Z*SUM2+GM2F
85          H2=H1-2.0*GM2F
86          H1PRME=SUM4+GPMFP
87          H2PRME=H1PRME-2.0*GPMFP
88          RETURN
89
90          SUM1=1.0
91          SUM2=1.0
92          RTZ=CDSQRT(Z)
93          SORTB=RTZ
94          ZTERM=1./RTZ
95          MPPOWER=1.0
96          TERM=-1.5/Z
97          DO 80 M=1,14
98             ZPOWER=ZPOWER*ZTERM
99             MPPOWER=MPPOWER*(-ZTERM)

```

```

100 TERM1=CAP(M)*ZPOWER
101 TERM2=CAP(M)*MPOWER
102 SUM1=SUM1+TERM1
103 SUM2=SUM2+TERM2
104 SUM3=SUM3+M*TERM1
105 SUM4=SUM4+M*TERM2
106 CONTINUE
107 SUM3=SUM3*TERM
108 SUM4=SUM4*TERM
109 EXP1=CDEXP(2.*1*SQRTZB/3.)
110 EXP2=EXP1*CONST1
111 EXP3=CONST2/EXP1
112 EXP4=CONST3*EXP1
113 EXP5=CONST4/EXP1
114 BETA=ALPHA/CDSQRT(RTZ)
115 ZREAL=Z
116 ZIMAG=-1*Z
117 IF (ZREAL.GE.0.0.OR.ZIMAG.GE.0.0)GO TO 90
118 H1=BETA*(EXP2*SUM2+EXP5*SUM1)
119 H1PRME=BETA*(EXP2*(SUM2*(-0.25/Z+1*RTZ)+SUM4)+EXP5*(SUM1*(-0.25/Z
120 $ -1*RTZ)+SUM3))
121 GO TO 110
122 H1=BETA*EXP2*SUM2
123 H1PRME=BETA*EXP2*(SUM2*(-0.25/Z+1*RTZ)+SUM4)
124 IF (ZREAL.GE.0.0.OR.ZIMAG.LT.0.0)GO TO 120
125 H2=BETA*(EXP3*SUM1+EXP4*SUM2)
126 H2PRME=BETA*(EXP3*(SUM1*(-0.25/Z-1*RTZ)+SUM3)+EXP4*(SUM2*(-0.25/Z
127 $ +1*RTZ)+SUM4))
128 RETURN
129 H2=BETA*EXP3*SUM1
130 H2PRME=BETA*EXP3*(SUM1*(-0.25/Z-1*RTZ)+SUM3)
131 RETURN
132 END

```

113

OPRT,5 GRNDMCA.MAGANG

```

MORFITT=GRNDMCA(1).MAGANG
1  SUBROUTINE MAGANG(ARG,AMAG,ANGLE)
2  IMPLICIT REAL*8 (A-H,O-Z)
3  COMPLEX*16 ARG
4  DATA RDTDEG/5.729577951D1/
5  ARG=DREAL(ARG)
6  AMAG=CDABS(ARG)
7  IF(ARGR.EQ.0.0D0 .AND. ARG1.EQ.0.0D0) GO TO 10
8  ANGLE = DATAN2(ARG1,ARGR)*RDTDEG
9  IF(ARG1.LT.0.0D0) ANGLE=ANGLE+360.0D0
10 RETURN
11
12 C
13 10 ANGLE=0.0D0
14 RETURN
15 END

```

OPRT,S GRNDMCA.AXISM

```

MORFITT*GRNDMCA(1).AXISM
1 SUBROUTINE AXISM (X,Y,BCD,NC,SIZE,THETA,XMIN,DX,TIC,NTIC)
2
3 (X,Y)
4 COORDINATES OF THE BEGINNING OF THE AXIS
5 BCD
6 ALPHANUMERIC ARRAY CONTAINING THE AXIS LABEL
7 NC
8 NUMBER OF CHARACTERS IN AXIS LABEL. IF NC .GT. 0,
9 THE AXIS ANNOTATION WILL BE ON THE COUNTER-CLOCKWISE
10 SIDE OF THE AXIS. NC .LT. 0 PLACES THE ANNOTATION ON
11 THE CLOCKWISE SIDE
12 SIZE
13 LENGTH OF THE AXIS IN INCHES
14 THETA
15 THE ANGLE AT WHICH THE AXIS IS TO BE DRAWN
16 XMIN
17 THE VALUE OF THE COORDINATE AT THE BEGINNING OF THE
18 AXIS.
19 DX
20 THE CHANGE IN COORDINATE VALUE BETWEEN SUCCESSIVE
21 LABELED TIC-MARKS.
22 TIC
23 THE DISTANCE BETWEEN TIC-MARKS, IN INCHES
24 NTIC
25 THE REPEAT CYCLE FOR PLACING COORDINATE VALUES AT
26 TIC MARKS -
27 .EQ. 1 CAUSES VALUES TO BE PLACED AT EVERY TIC-MARK
28 .EQ. 2 CAUSES VALUES TO BE PLACED AT EVERY SECOND
29 TIC MARK, ETC.
30 .EQ. 0 SUPPRESSES ALL COORDINATE VALUES
31
32 J MARTIN JUNE 1966
33
34 DIMENSION BCD(2)
35 INTEGER ALPHA(2)
36 DATA ALPHA(1)/'(X10'//,ALPHA(2)/' ) '/'
37 SYGN=1.0
38 IF (NC) 5,10,10
39 SYGN=-1.0
40 NAC=IABS(NC)
41 SWITCH=0.0
42 TH=THETA*0.01745329
43 CTH=COS(TH)
44 STH=SIN(TH)
45 DXT=TIC*CTH
46 DYT=TIC*STH
47 N=SIZE/TIC
48 TN=N
49 XB=X
50 YB=Y
51
52 XA=X-0.05*SYGN*STH
53 YA=Y+0.05*SYGN*CTH
54 CALL PLOT (XA,YA,3)
55 DRAW TICS.*
56 DO 15 I=1,N
57 CALL PLOT (XB,YB,2)
58 XC=XB+DXT
59 YC=YB+DYT
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99

```

50	CALL PLOT (XC,YC,2)	AXI 49
51	XA=XA+DXT	AXI 50
52	YA=YA+DYT	AXI 51
53	CALL PLOT (XA,YA,2)	AXI 52
54	XB=XC	AXI 53
55	YB=YC	AXI 54
56	IF (NTIC) 25,20,25	AXI 55
57	EXPX=0.0	AXI 56
58	GO TO 90	AXI 57
59	ADX=ABS(DX)	AXI 58
60	ABSX=XMIN+DX*N/NTIC	AXI 59
61	EXPX=0.0	AXI 60
62	IF (ADX) 30,90,30	AXI 61
63	IF (ADX-100.0) 45,35,35	AXI 62
64	ADX=ADX/10.0	AXI 63
65	ABSV=ABSV/10.0	AXI 64
66	EXPX=EXPX+1.0	AXI 65
67	GO TO 30	AXI 66
68	ADX=ADX*10.0	AXI 67
69	ABSV=ABSV*10.0	AXI 68
70	EXPX=EXPX-1.0	AXI 69
71	IF (ADX-0.01) 40,90,90	AXI 70
72	M=N	AXI 71
73	MM=N+1	AXI 72
74	DO 65 I=1,MM	AXI 73
75	K=MM-I	AXI 74
76	AK=FLOAT(K)/FLOAT(NTIC)-FLOAT(K/NTIC)	AXI 75
77	IF (AK) 55,60,55	AXI 76
78	XB=XB-DXT	AXI 77
79	YB=YB-DYT	AXI 78
80	ABSV=ABSV-(ADX/NTIC)	AXI 79
81	GO TO 65	AXI 80
82	XA=XB-(0.20*SYGN-0.05)*STH-0.17143*CTH	AXI 81
83	YA=YB+(0.20*SYGN-0.05)*CTH-0.17143*STH	AXI 82
84	GO TO 70	AXI 83
85	CONTINUE	AXI 84
86	N=K/NTIC+1	AXI 85
87	DO 80 I=1,N	AXI 86
88	LABEL TICS, IN REVERSE ORDER.=	AXI 87
89	CALL NUMBER (XA,YA,0.1,ABSV,THETA,2)	AXI 88
90	ABSV = ABSV - ADX	AXI 89
91	XA=XA-DXT*FLOAT(NTIC)	AXI 90
92	YA=YA-DYT*FLOAT(NTIC)	AXI 91
93	IF (SWITCH) 80,75,80	AXI 92
94	CALL WHERE (XW,YW,FACT)	AXI 93
95	D1=SORT((XW-XT)**2+(YW-YT)**2)	AXI 94
96	D2=SORT((XW-XA)**2+(YW-YA)**2)	AXI 95
97	IF (D1-D2) 110,110,80	AXI 96
98	CONTINUE	AXI 97
99		

```

100 85 RETURN
101 90 IF (EXPX) 95,100,95
102 95 TNC=NAC+7
103 C ***** THE NEXT TWO STATEMENTS HAVE BEEN REPLACED BY DATA
104 C ***** STATEMENTS BECAUSE THE CHARACTERS DESIRED DO NOT HAVE
105 C ***** THE SAME INTEGER EQUIVALENTS ON THE 1110
106 C ALPHA(1)=240+256*(241+256*(231+256*77))
107 C ALPHA(2)=64+256*(93+256*(64+256*64))
108 GO TO 105
109 TNC=NAC
110 XT=X*(SIZE/2.0-0.07*TNC)*CTH-(-0.07*SYGN*0.4225)*STH
111 YT=Y*(SIZE/2.0-0.07*TNC)*STH+(-0.07*SYGN*0.4225)*CTH
112 IF (NTIC) 50,110,50
113 C DRAW AXIS NAME.=
114 CALL SYMBOL (XT,YT,0.14,BCD(1),THETA,NAC)
115 IF (EXPX) 120,115,120
116 SWITCH=1.0
117 IF (NTIC) 80,85,80
118 XT=XT+((TNC-6.0)*0.14)*CTH
119 YT=YT+((TNC-6.0)*0.14)*STH
120 CALL SYMBOL (XT,YT,0.14,ALPHA(1),THETA,7)
121 XT=XT+0.56*CTH-0.07*STH
122 YT=YT+0.56*STH+0.07*CTH
123 CALL NUMBER (XT,YT,0.10,EXPX,THETA,-1)
124 GO TO 115
125 END

```

117

©PRT,S GRNDMCA.CLINQ

```

AXI 98
AXI 99
AXI 100
DMP
DMP
DMP
DMP
DMP
DMP
AXI 103
AXI 104
AXI 105
AXI 106
AXI 107
AXI 108
AXI 109
AXI 110
AXI 111
AXI 112
AXI 113
AXI 114
AXI 115
AXI 116
AXI 117
AXI 118
AXI 119
AXI 120-

```

```

MORFITT*GRNDMCA(1).CLINEQ
1  SUBROUTINE CLIN EQ (A, B, X, N,
2  $ N DIM, IFLAG, ERR)
3
4  CLIN EQ USES L-U DECOMPOSITION TO
5  FIND THE TRIANGULAR MATRICES L, U
6  SUCH THAT L * U = A. L AND U ARE
7  STORED IN A. THIS FORM IS USED WITH
8  BACK-SUBSTITUTION TO FIND THE SOLN
9  X OF A * X = L * U * X = B.
10 N IS THE NUMBER OF EQUATIONS AND
11 N DIM IS THE DIMENSION OF ALL ARRAYS
12 IN THE PARAMETER LIST.
13
14 IF IFLAG = 0, L, U, AND X ARE
15 COMPUTED.
16 IF IFLAG IS NON-ZERO, IT IS ASSUMED
17 THAT L AND U HAVE BEEN COMPUTED IN
18 A PREVIOUS CALL AND ARE STILL STORED
19 IN A. THUS ONLY X IS COMPUTED.
20 ERR IS THE ESTIMATED RELATIVE
21 ERROR OF THE SOLUTION VECTOR.
22
23 COMPLEX*16 A, B, X, T
24 INTEGER*4 IROW
25 DIMENSION A(N DIM, N DIM),
26 $ B(N DIM), X(N DIM)
27 DIMENSION IROW(50), Q(50)
28 DATA EPS /1.0E-15/
29
30
31 IF (N.GT.0) GO TO 900
32 IF (IFLAG.NE.0) GO TO 600
33 DO 050 I = 1,N
34 Q(I) = 0.0
35 DO 040 J = 1,N
36 QQ = CDABS (A(I,J))
37 040 IF (Q(I).LT.QQ) Q(I) = QQ
38 IF (Q(I).EQ.0.0) GO TO 901
39 050 CONTINUE
40 ERR = EPS
41 PPIV = 0.0
42 DO 100 I = 1,N
43 100 IROW(I) = I
44
45 DO 500 L = 1,N
46 PIVOT = 0.0
47 K = L - 1
48 DO 240 I = L,N
49 IF (K.LT.1) GO TO 230

```

```

50 DO 220 J = 1,K
51 A(I,L) = A(I,L) - A(J,L) * A(I,J)
52 220 F = CDABS (A(I,L)) / Q(I)
53 IF (PIVOT.GT.F) GO TO 240
54 PIVOT = F
55 NPivot = I
56 240 CONTINUE
57 IF (PIVOT.EQ.0.0) GO TO 901
58 IF (PIV.LE.PILOT) GO TO 250
59 ERR = ERR * PIV / PILOT
60 IF (ERR.GE.1.0) GO TO 901
61 250 PIV = PILOT
62 IF (NPivot.EQ.L) GO TO 280
63 Q(NPIVOT) = Q(L)
64 J = IROW(L)
65 IROW(L) = IROW(NPIVOT)
66 IROW(NPIVOT) = J
67 DO 260 I = 1,N
68 T = A(L,I)
69 A(L,I) = A(NPIVOT,I)
70 A(NPIVOT,I) = T
71 260 CONTINUE
72 280 IF (L.EQ.N) GO TO 500
73 T = (1.000,0.000) / A(L,L)
74 K = L + 1
75 M = L - 1
76 DO 450 I = K,N
77 IF (M.LT.1) GO TO 400
78 DO 350 J = 1,M
79 350 A(L,I) = A(L,I) - A(L,J) * A(J,I)
80 400 A(L,I) = T * A(L,I)
81 450 CONTINUE
82 500 CONTINUE
83 IF (ERR.GT.1.0E-5) PRINT 998, ERR
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99

```

```

50 DO 620 I = 2,N
51 620 X(I) = (0.000,0.000)
52 J = IROW(1)
53 X(1) = B(J) / A(1,1)
54 DO 700 I = 2,N
55 J = IROW(I)
56 K = I - 1
57 DO 650 L = 1,K
58 650 X(I) = X(I) + A(I,L) * X(L)
59 X(I) = (B(J) - X(I)) / A(I,I)
60 700 CONTINUE
61 K = N - 1
62 DO 800 I = 1,K
63 J = N - I

```

```

00010000
00010100
00010200
00010300
00010400
00010500
00010600
00010700
00010800
00010900
00011000
00011100
00011200
00011300
00011400
00011500
00011600
00011700
00011800
00011900
00012000
00012100
00012200
00012300
00012400
00012500
00012600
00012700
00012800
00012900
00013000
00013100
00013200
00013300
00013400
00013500
00013600
00013700
00013800
00013900
00014000
00014100
00014200
00014300
00014400
00014500
00014600
00014700
00014800
00014900
00015000
00015100
00015200
00015300
00015400
00015500
00015600
00015700
00015800
00015900
00016000
00016100
00016200
00016300
00016400
00016500
00016600
00016700
00016800
00016900
00017000
00017100
00017200
00017300
00017400
00017500
00017600
00017700
00017800
00017900
00018000
00018100
00018200
00018300
00018400
00018500
00018600
00018700
00018800
00018900
00019000
00019100
00019200
00019300
00019400
00019500
00019600
00019700
00019800
00019900
00020000

```

```

100 M = J + 1
101 DO 800 L = M,N
102 X(J) = X(J) - X(L) * A(J,L)
103 800 CONTINUE
104 RETURN
105 C
106 900 PRINT 999
107 ERR = 1.0
108 RETURN
109 901 PRINT 997
110 ERR = 1.0
111 RETURN
112 997 FORMAT ('ERROR IN CLIN EQ. MATRIX IS SINGULAR')
113 998 FORMAT ('CAUTION-')
114 $ ' CLIN EQ HAS DECOMPOSED AN ILL-CONDITIONED MATRIX.'/,
115 $ ' RESULTS WILL HAVE RELATIVE ERROR =',E11.2)
116 999 FORMAT ('ERROR IN CLIN EQ. MATRIX SIZE GREATER THAN 50')
117 END

```

OPRT,T GRNDMCA.

MORFITT*GRNDMCA(1) ELEMENT TABLE

D	NAME	VERSION	TYPE	DATE	TIME	SEQ #	SIZE-PRE,TEXT	(CYCLE WORD)	PSRMODE	LOCATION
	HTINTL		FOR SYMB	29 MAR 79	09:34:28	1		64		1792
	HTINTL		RELOCATABLE	29 MAR 79	09:34:36	2	3	148	QTR	1856
	MCSTEP		FOR SYMB	29 MAR 79	09:34:47	3		29		2007
	MCSTEP		RELOCATABLE	29 MAR 79	09:34:49	4	3	28	QTR	2036
	MDHNKL		FOR SYMB	29 MAR 79	09:34:52	5		71		2067
	MDHNKL		RELOCATABLE	29 MAR 79	09:34:57	6	2	93	QTR	2138
	MAGANG		FOR SYMB	29 MAR 79	09:34:57	7		4		2233
	MAGANG		RELOCATABLE	29 MAR 79	09:34:58	8	2	4	QTR	2257
	AXISM		FOR SYMB	29 MAR 79	09:35:04	9		67		2243
	AXISM		RELOCATABLE	29 MAR 79	09:35:05	10	2	31	QTR	2310
	CLINEQ		FOR SYMB	29 MAR 79	09:35:08	11		63		2343
	CLINEQ		RELOCATABLE	29 MAR 79	09:35:10	12	2	46	QTR	2406
	MCPLTS		FOR SYMB -Q	09 JAN 80	12:50:18	13		33		2454
	MCPLTS		RELOCATABLE	09 JAN 80	12:50:19	14	3	36	QTR	2487
	MCPLT2		FOR SYMB -Q	09 JAN 80	12:50:21	15		20		2526
	MCPLT2		RELOCATABLE	09 JAN 80	12:50:22	16	3	20	QTR	2546
	MAIN		FOR SYMB -Q	10 JAN 80	08:48:16	17		122		2569
	MAIN		RELOCATABLE	10 JAN 80	08:48:27	18	6	105	QTR	2691
	MCFLD		FOR SYMB -Q	15 JAN 80	10:24:04	19		63		2802
	MCFLD		RELOCATABLE	15 JAN 80	10:24:16	20	4	55	QTR	2855
	MCFLD2		FOR SYMB -Q	15 JAN 80	10:24:30	21		58		2924
	MCFLD2		RELOCATABLE	15 JAN 80	10:24:49	22	4	51	QTR	2982
	PGM		MAP SYMB	15 JAN 80	10:24:51	23		1		3037
	PGM		ABSOLUTE	15 JAN 80	10:24:51	24		676	QTR	3038

121

NEXT AVAILABLE LOCATION-

ASSEMBLER PROCEDURE TABLE EMPTY

COBOL PROCEDURE TABLE EMPTY

FORTRAN PROCEDURE TABLE EMPTY

ENTRY POINT TABLE EMPTY

0BRKPT PRINTS

APPENDIX 2

FORTRAN LISTING OF THE ARBNMC COMPUTER PROGRAM

```

MORFITT*ARBNIHCA(1).MAIN
1 C SIMPLIFIED MODE CONVERSION MODEL MODIFIED TO CALCULATE FIELDS
2 C FOR AN ANTENNA OF ARBITRARY HEIGHT AND ORIENTATION.
3 C
4
5 IMPLICIT REAL*8(A-H,O-Z)
6 COMMON/FIRST C/ IFIRST
7 COMMON/AXISM C/XTIC,YTIC,NTICX,NTICY
8 COMMON/PSPLOT/PHSMIN,PHSINC,SIZEP,PTIC,NTICP
9 COMMON/ICOMP C/ICOMP,ICOMPX
10 COMMON/ITRX C/ITRX
11 COMMON/SINCOS/STHTAH,CTHTAH
12 COMMON/TYPPLT/IPLTOP
13 COMMON/HTGN/F(3,20,2)
14 COMMON/HGTEMP/FF1(20),FF3(20)
15 COMMON/INT C/INTFLG,IPRNTA
16 COMMON/TERM/NT,NTR
17 COMMON/METHODS C/ MAXMDS
18 $ XTRA(3,3,20),TOPHT(50),RHOXAX,RHOMIN,DELPHO,DELTAX,
19 $ EPSR,SIGMA,NRSLAB,NRMODE,NTMAX,PRMODE,NTRMDS
20 COMMON/MCSTOR/A(20,20),S(20),C(20),KVRADT,KVRATT,AVRKOT,
21 $ AVRKTT,NTHSQ,CONST,OMEGA,WAVENO
22 COMMON/PLOT V/ISUB,JPLDT,NRP,IDPLOT(10),NAPLOT,NPPLDT
23 COMMON/XPLOT/XMIN,XINC,YMIN,YINC,SIZEX,SIZEY
24 COMMON/HGINPT/GAMMA(4),PHI(4),TALT,RALT
25 $,SINGAM(4),COSGAM(4),SINPHI(4),COSPHI(4)
26
27 C
28 COMPLEX*16 STHTA,THETAH,STHTAH(20),CTHTAH(20)
29 COMPLEX*16 ZERO/(0.000,0.000)/,ONE/(1.000,0.000)/
30 COMPLEX*16 XTRA,F
31 COMPLEX*16 TP(20),RATIO(4),TMP1,TMP2,TMP3,TMP4
32 COMPLEX*16 FF1,FF3
33
34 C
35 DIMENSION BUFFER(2000)
36 DIMENSION BCD(20)
37 DIMENSION Z(2)
38 DIMENSION INCL(4),THETA(4)
39
40 REAL*8 NTHSQ
41 REAL*8 KVRADT,KVRATT
42 REAL*8 INCL
43 REAL*4 XMIN,XINC,YMIN,YINC,SIZEX,SIZEY
44 REAL*4 FACT
45 REAL*4 XTIC,YTIC
46 REAL*4 SIZEP,PHSMIN,PHSINC,PTIC
47 CHARACTER*4 BCD,NAME,EXEC,INPT,QUIT
48
49 C
50 INTEGER HFLAG

```

00000100
00000200
00000300
00000400

00000700
00000900
00001000
00001300
00001400

00001600
00001700
00001800
00001900

00002200
00002
00002400
00002500
00002600
00002700

00002800
00003000
00003100
00003200
00003300
00003400
00003500

00003600
00004000
00004100

00003700
00003800
00004200
00004300

50	C	INTEGER PMODE,RCDOPT,CNVSCF	00004400
51			00004500
52	C	EQUIVALENCE(INCL,GAMMA),(THETA,PHI)	
53			
54	C		00004800
55			00004900
56		NAMelist/DATUM/TOPTH,RHOMAX,NPRINT,RCDOPT,H,IH,	
57		\$ DELRHO,INTFLG, IPLTOP,IPRNTA,ITXR,ICOMP,ICMPMX,	
58		\$ RHOMIN,DELTAX,NTMAX,XVAL,	
59		\$ FACT,NAPLOT,NPLOT,	
60		\$ PHSMIN,PHSINC,SIZEP,PTIC,NTICP,	
61		\$ XMIN,XINC,YMIN,YINC,SIZE,XTIC,YTIC,NTICX,NTICY,	
62		\$ GAMMA,PHI,INCL,THETA,TALT,RALT,NRP	
63	C	DATA NAME/4HNAME/,INPT/4HDATA/,EXEC/4HSTAR/,QUIT/4HQUIT/	00005400
64		DATA DTR/0.0174532925200/	00005500
65		DATA TWOPI/6.28318500/.VELITE/2.99792805/,ALPHA/3.140-4/,	00005600
66		\$ DEGRAD/1.7453290-2/,IM/(0.000,1.000)/	00005700
67	C		00005800
68	C		00005900
69	C		00006000
70		FACT=1.0	
71		SIZEX=10.0	
72		SIZEY=8.0	
73		XMIN=0.0	
74		YMIN=0.0	
75		XINC=1000.0	
76		YINC=10.0	
77		XTIC=1.0	
78		YTIC=1.0	
79		NTICX=1	
80		NTICY=1	
81		SIZEP=8.0	
82		PHSMIN=0.0	
83		PHSINC=90.0	
84		NTICP=1	
85		PTIC=2.0	
86	C		00006100
87		ISOLNA=0	
88		ICOMP=1	
89		ICMPMX=3	
90		ITXR=0	
91		IPRNTA=0	
92		NRP=1	
93		DO 8 I=1,4	00006300
94		GAMMA(I)=0.000	00006400
95		PHI(I)=0.000	00006500
96		RALT=0.0	00006600
97		TALT=0.0	00006700
98		DELTAX=0.000	00006800
99		NTMAX=1	00006900

100	IPLTOP=0	00007100
101	IH=1	00007200
102	H=50.000	00007300
103	CNVSCF=0	00007500
104	RDOPT=0	00007700
105	NAPLOT=1	
106	NPLOT=0	
107	JPLOT=0	
108	INTFLG=0	00007900
109	MAXMDS = 20	00008000
110	MXSLAB=50	00008100
111	IFIRST =1	00008200
112	NPRINT=1	
113		-----00008400
114		00008500
115	PRINT 199	00008600
116	PRINT 200	00008700
117	READ(5,201,END=999) BCD	00008800
118	11 PRINT 202,BCD	00008900
119	IF(BCD(1) .EQ. NAME) GO TO 12	00009000
120	IF(BCD(1) .EQ. INPT) GO TO 20	00009100
121	IF(BCD(1) .EQ. EXEC) GO TO 30	00009200
122	IF(BCD(1) .EQ. QUIT) GO TO 999	00009300
123	GO TO 910	00009400
124		-----00009500
125		00009600
126	READ NAMELIST	00009700
127	12 READ(5,201,END=999) BCD	00009800
128	IF(SUBSTR(BCD(1),1,1) .NE. ' ') GO TO 13	00009900
129	WRITE(30,201) BCD	00010000
130	WRITE(6,202) BCD	00010100
131	GO TO 12	00010200
132	13 REWIND 30	00010300
133	DO 15 L = 1,MXSLAB	00010400
134	XVAL(L) = 0.000	00010500
135	15 TOPHT(L)=0.000	
136		00010700
137	CALL CHK\$OF	00010800
138	READ(30,DATUM)	00010900
139	CALL CHK\$ON	00011000
140	IF(IPLTOP .LT. 1) GO TO 909	00011100
141		
142	IF(IPLTOP .LT. 2) GO TO 16	
143	NTMAX=1	
144	DELTA=0.0	
145	RHOMIN=DELPHO	
146	16 CONTINUE	
147		
148	IF(NAPLOT .EQ. 1 .OR. NPLOT .EQ. 1) JPLOT=1	
149	IF(JPLOT .NE. 0 .AND. IFIRST .NE. 0)CALL PLOTS(BUFFER,2000,15)00011200	

```

150 IF(JPLOT .NE. 0 .AND. IFIRST .NE. 0)CALL PLOT(0.0,-11.0,-3)
151 IF(JPLOT .NE. 0 .AND. IFIRST .NE. 0)CALL FACTOR(FACT)
152 CAPK=(1.000-0.500*ALPHA+H)
153 Z(1) = TALT
154 Z(2) = RALT
155 DC 223 N=1,NRP
156 GAMMA(N) = GAMMA(N)*DEGRAD
157 PHI(N) = PHI(N)*DEGRAD
158 SINGAM(N) = DSIN(GAMMA(N))
159 COSGAM(N) = DCOS(GAMMA(N))
160 SINPHI(N) = DSIN(PHI(N))
161 COSPHI(N) = DCOS(PHI(N))
162 223 CONTINUE
163 REWIND 30
164 GO TO 11
165
166 C-----
167 C
168 READ NPUNCH=1 DATA
169 C
170 20 READ(5,203,END=915) IDPLOT
171 PRINT 204,IDPLOT
172 RHO=-1.0
173 ISLAB=0
174
175 C READ IN A SLAB FROM INPUT DATA
176 C
177 21 READ(5,1020,END=915) RR,FF,AA,CC,BB,SS,EE,TH
178 ISLAB=ISLAB+1
179 IF(RR .NE. 40. .AND. SS .EQ. 0.) GO TO 21
180 IF(RR .EQ. 40) GO TO 25
181
182 C-----
183 C
184 OPTION TO USE R-CARDS FOR 'XVAL(ISLAB)' VALUES
185 (FOR 'IPLTOP=2' OPTION ONLY)
186 IF(RCDOPT .EQ. 0) GO TO 28
187 IF(IPLTOP .EQ. 2) XVAL(ISLAB) = RR*1000.0
188 28 CONTINUE
189 C-----
190 C
191 NTHSQ=1.0+ALPHA*TOPHT(ISLAB)
192 IF(TOPHT(ISLAB) .EQ. 0.000) NTHSQ=1.000+ALPHA*TH
193 BB=BB*10000.
194 PRINT 1022,ISLAB,RR,FF,AA,CC,BB,SS,EE,TH
195 IF(INPRINT .GE. 3) PRINT 1024
196 FREQ=FF
197 IF(ISLAB .NE. 1) GO TO 22
198 WAVE NO = TWO PI*1000.0*FREQ/VELITE
199 CONST = 0.03248*WAVE NO/DSQRT(FREQ)
200 OMEGA = TWO PI*FREQ*1000.

```

```

00011300
00011400
00011500
00011600
00011700
00011800
00011900
00012000
00012100
00012200

00012500
00012600
00012700
00012800
00012900
00013000
00013100
00013200
00013300
00013400
00013500
00013600
00013700
00013800
00013900
00014000
00014100
00014200
00014300
00014400
00014500
00014600
00014700

00014900
00015000
00015100
00015200
00015300
00015400
00015500
00015600
00015700
00015800
00015900
00016000
00016100

```

```

200 KVAROT = DEXP(DLOG(WAVE NO/ALPHA)/3.)
201 KVRATT = KVAROT**2
202 AVRKOT = 1./KVAROT
203 AVRKT = AVRKOT**2*0.5
204 22 CONTINUE
205 IF(RHO .GT. RR) GO TO 912
206 RHO=RR
207 EPSR=EE
208 SIGMA=SS
209
210 C-----
211 C READ IN T-CARDS FOR EACH SLAB
212 C
213 C
214 NM=0
215 23 READ(5,1023,END=915) INDX1,TR1,TI1,ITRM1,TMP1,TMP2
216 IF(TR1 .EQ. 0.) GO TO 24
217 READ(5,1023,END=915) INDX2,TR2,TI2,ITRM2,TMP3,TMP4
218 IF(NM .EQ. 20) GO TO 233
219 IF(CDABS(TMP1) .EQ. 0.000) GO TO 233
220 IF(TR1 .NE. TR2 .OR. TI1 .NE. TI2) GO TO 234
221 IF(ITRM1 .NE. ITRM2) GO TO 234
222 IF(ITRM1 .EQ. 0) GO TO 911
223 NM=NM+1
224 IF(NPRINT .LT. 3) GO TO 230
225 PRINT 1025,NM,INDX1,TR1,TI1,ITRM1,TMP1,TMP2,
226 $ INDX2,TR2,TI2,ITRM2,TMP3,TMP4
227 230 TP(NM)=DCMLX(TR1,TI1)
228 S(NM)=CDSIN(TP(NM)*DTR)
229 C(NM)=CDCOS(TP(NM)*DTR)
230 STHA-S(NM)*CAPK
231 THETA=-IM*CDLOG(CDSQRT(1.00-STHTA**2)+IM*STHTA)
232 STHTAH(NM)=CDSIN(THETA)
233 CTHTAH(NM)=CDCOS(THETA)
234 IF(IH .EQ. 0) STHTAH(NM)=S(NM)
235 IF(IH .EQ. 0) CTHTAH(NM)=C(NM)
236
237 XTRA(1,1,NM) = TMP1*STHTAH(NM)**2
238 XTRA(1,2,NM) = TMP1*STHTAH(NM)
239 XTRA(1,3,NM) = -TMP3*STHTAH(NM)
240 XTRA(2,2,NM) = -TMP1
241 XTRA(2,3,NM) = TMP3
242 XTRA(2,1,NM) = -TMP1*STHTAH(NM)
243 XTRA(3,1,NM) = -TMP3*TMP4*STHTAH(NM)
244 XTRA(3,2,NM) = -TMP3*TMP4
245 XTRA(3,3,NM) = TMP2
246 RATIO(2*INDX1-1)=TMP1
247 RATIO(2*INDX1)=TMP2
248 RATIO(2*INDX2-1)=TMP3
249 RATIO(2*INDX2)=TMP4
250 IF(ITRM1 .EQ. 2) GO TO 231

```

```

250 FOFR(NM)=RATIO(3)/RATIO(1)
251 GO TO 232
252 231 FOFR(NM)=RATIO(2)/(RATIO(3)*RATIO(4))
253 232 CONTINUE
254 GO TO 23
255 233 IF(NPRINT .LT. 3) GO TO 23
256 234 PRINT 1026, IND1, TR1, TI1, ITRM1, TMP1, TMP2,
257 $      IND2, TR2, TI2, ITRM2, TMP3, TMP4
258 IF(TR1 .NE. TR2 .OR. TI1 .NE. TI2) GO TO 916
259 IF(ITRM1 .NE. ITRM2) GO TO 917
260 24 IF(NPRINT .LT. 3) PRINT 1027, NM
261 NRMODE=NM
262 C-----
263 C
264 C
265 C SPECIAL HEIGHT GAIN CALCULATION TO COMPUTE (D11,D12,D22)
266 WHERE( (D11=FF1*FF1), (D12=FF1*FF3) .AND (D22=FF3*FF3) )
267 FOR 'H' NOT NECESSARILY EQUAL TO ZERO.
268 C
269 HFLAG=1
270 CALL HTGAIN(Z,H,HFLAG)
271 C
272 DO 136 K=1,NRMODE
273 XTRA(1,1, K) = XTRA(1,1, K)* FF1( K)**2
274 XTRA(1,2, K) = XTRA(1,2, K)* FF1( K)**2
275 XTRA(1,3, K) = XTRA(1,3, K)* FF1( K)* FF3(K)/FOFR(K)
276 XTRA(2,1, K) = XTRA(2,1, K)* FF1( K)**2
277 XTRA(2,2, K) = XTRA(2,2, K)* FF1( K)**2
278 XTRA(2,3, K) = XTRA(2,3, K)* FF1( K)* FF3(K)/FOFR(K)
279 XTRA(3,1, K) = XTRA(3,1, K)* FF1( K)* FF3(K)/FOFR(K)
280 XTRA(3,2, K) = XTRA(3,2, K)* FF1( K)* FF3(K)/FOFR(K)
281 XTRA(3,3, K) = XTRA(3,3, K)* FF3( K)**2/(FOFR(K)**2)
282 CONTINUE
283 136 C-----
284 C
285 C
286 C COMPUTE HEIGHT GAINS FOR EACH SLAB AT BOTH TALT AND RALT HEIGHT
287 THIS CALL GIVES VALUES FOR FF1(K),FF3(K),F(1,K,TALT),F(2,K,TALT),
288 F(3,K,TALT),F(1,K,RALT),F(2,K,RALT),F(3,K,RALT)
289 FOR K = 1,NRMODE
290 C
291 HFLAG=0
292 CALL HTGAIN(Z,H,HFLAG)
293 C-----
294 C
295 C
296 C WRITE SLAB INFORMATION ON TO UNIT 9
297 C
298 WRITE(9) ISLAB,S,C,TP,XTRA,FOFR,NRMODE,NTHSQ,SIGMA,EPSR,F
299 C

```

```

300 C-----00026200
301 C      00026300
302 C      READ IN A NEW SLAB FROM FROM INPUT DATA
303 C      00026400
304 C      00026500
305 C      00026600
306 C-----00026700
307 C      00026800
308 C      25 NRSLAB = ISLAB-1
309 C      IF(NRSLAB .LE. 1) GO TO 914
310 C      GO TO 10
311 C-----00027200
312 C      00027300
313 C      30 CONTINUE
314 C      00027400
315 C      ALL SLABS HAVE BEEN READ IN
316 C      00027500
317 C      00027600
318 C      00027700
319 C      00027800
320 C-----00027900
321 C      00028000
322 C      IF THE CONVERSION COEFFICIENTS HAVE ALREADY BEEN COMPUTED
323 C      -----SKIP TO STATEMENT 117-----
324 C      IF(CNVSCF .GT. 0) GO TO 117
325 C-----00028400
326 C      00028500
327 C      COMPUTE THE CONVERSION COEFFICIENTS FOR EACH INPUT SLAB
328 C      00028600
329 C      00028700
330 C      00028800
331 C      DO 555 M=1,NRSLAB
332 C      READ (9) ISLAB,S.C,TP,XTRA,FOFR,NRMODE,NTHSQ,SIGMA,EPSR,F
333 C      IFLG=1
334 C      IF(M .EQ. 1) IFLG=0
335 C      CALL HTINTL(IFLG, M,INTFLG)
336 C      555 CONTINUE
337 C      00030200
338 C      CONVERSION COEFFICIENTS HAVE BEEN STORED ON UNIT 4
339 C      00030300
340 C      00030400
341 C      00030500
342 C-----00030600
343 C      00030700
344 C      117 CONTINUE
345 C      00030800
346 C      00030900
347 C      COMPUTE FIELD STRENGTH
348 C      00031100
349 C      IF(ISOLNA .GT. 0) GO TO 500
350 C      CALL ACCUMA
351 C      00031200
352 C      00031300

```

```

350 C 500 CONTINUE 00017000
351 C
352 C REWIND 10
353 C
354 C CALL MCFLD
355 C
356 C-----
357 C
358 C FIRST = 0
359 C ISOLNA = 1
360 C CNVSCF = 1
361 C REWIND 4
362 C REWIND 8
363 C REWIND 9
364 C REWIND 10
365 C GO TO 10
366 C-----
367 C
368 C ERROR EXITS
369 C 909 PRINT 1909
370 C GO TO 999
371 C 910 PRINT 1910
372 C GO TO 999
373 C 911 PRINT 1911
374 C GO TO 999
375 C 912 PRINT 1912
376 C GO TO 999
377 C 914 PRINT 1914
378 C GO TO 999
379 C 915 PRINT 1915
380 C GO TO 999
381 C 916 PRINT 1916
382 C GO TO 999
383 C 917 PRINT 1917
384 C
385 C 1909 FORMAT('O***** FIELD STRENGTH OPTION (IPLTOP) WAS NOT SET ')
386 C 1910 FORMAT('O***** ERROR IN CONTROL CARD')
387 C 1911 FORMAT('O***** THIS DATA DECK IS MISSING THE FOFR FLAG IN 20')
388 C 1912 FORMAT('O***** XVALS OUT OF ORDER')
389 C 1914 FORMAT('O***** NUMBER OF SLABS LESS THAN 2')
390 C 1915 FORMAT('O***** END OF DATA SET ON UNIT 5')
391 C 1916 FORMAT('O***** ERROR IN DATA SEQUENCE')
392 C 1917 FORMAT('O***** ITEM FLAG INCONSISTENT')
393 C
394 C 199 FORMAT('1')
395 C 200 FORMAT(' ')
396 C 201 FORMAT(20A4)
397 C 202 FORMAT(' ',20A4)
398 C 203 FORMAT(10A4)
399 C 204 FORMAT(' ',10A4)

```

```

400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416

1001 FORMAT('END OF JOB')
1020 FORMAT(1X,F7.0,3(2X,F8.0),2(2X,E10.0),2(2X,E5.0))
1022 FORMAT('OSLAB',I2,'R',F7.3,'F',F8.4,'A',F8.3,'C',F8.3,'M',
$ F6.3,'S',1P'E10.3,'E',OPF5.1,'T',F5.1)
1023 FORMAT(11,2F9.0,11,4E15.0)
1024 FORMAT(11X,'M ID THETA')
1025 FORMAT(11X,12.3X,11,OP2F10.2,12.2(1X,1P2E16.8)/
$ 16X,11,OP2F10.2,12.2(1X,1P2E16.8))
1026 FORMAT(16X,11,OP2F10.2,12.2(1X,1P2E16.8)/
$ 16X,11,OP2F10.2,12.2(1X,1P2E16.8))
1027 FORMAT('+',80X,'MODES',I3)
999 CONTINUE
REWIND 9
PRINT 1001
IF(JPLOT.EQ. 1) CALL PLOT(0.,0.,999)
STOP
END

00035600
00035700
00035800
00035900
00036000
00036100
00036200
00036300
00036400
00036500
00036600
00036700
00036800
00036900
00037000
00037100
00037200

```

OPRT.S ARBNMCA.HTGAIN

```

MORFITT*ARBNMCA(1).HTGAIN
1  SUBROUTINE HTGAIN(Z,H,HFLAG)
2
3  C
4  C COMPUTE EZ,EX,EY HEIGHT GAINS FOR TRANSMITTER AND RECEIVER.
5  C
6  IMPLICIT COMPLEX*16(A-H,O-Z)
7  COMMON/SINCOS/STHTAH,CTHTAH
8  COMMON/HGTEMP/FF1(20),FF3(20)
9  COMMON/HTGN/F(3,20,2)
10 COMMON/MCINPT/FOFR(20),XVAL(50),FREQ,
11 $ XTRA(3,3,20),TOPHT(50),RHOMAX,RHOMIN,DELRHO,DELTAX,
12 $ EPSR,SIGMA,NRSLAB,NRMODE,NTMAX,PRMODE,NTRMDS
13 COMMON/MCSTOR/A(20,20),S(20),C(20),KVRATT,KVRATT,AVRKOT,
14 $ AVRKTT,NTHSQ,CONST,OMEGA,WAVENO
15
16 C
17 COMPLEX*16 CDSQRT
18 COMPLEX*16 NGSQ,IM/(0.00,1.00)/
19 COMPLEX*16 STHTAH(20),CTHTAH(20)
20
21 REAL*8 DEXP
22 REAL*8 NTHSQ
23 REAL*8 XVAL,FREQ,RHOMAX,RHOMIN,DELRHO,DELTAX,EPSP, SIGMA
24 REAL*8 KVRATT,KVRATT,AVRKOT,AVRKTT,CONST,OMEGA,WAVENO
25 REAL*8 Z(2),EPSLNO/8.85434D-12/.ALPHA/3.14D-4/.FAC1
26 REAL*8 RSQR
27 REAL*8 TOPHT
28 INTEGER HFLAG
29 INTEGER PRMODE
30
31 NGSQ = EPSR-(IM*SIGMA/OMEGA)/EPSLNO
32 KH=1
33 IF(HFLAG.EQ.0) KH=2
34 DO 100 K=1,NRMODE
35 SSQ = S(K)**2
36 IF(HFLAG.EQ.1) SSQ=STHTAH(K)**2
37 SQROOT = CDSQRT(NGSQ-SSQ)
38 CSQ = C(K)**2
39 IF(HFLAG.EQ.1) CSQ=CTHTAH(K)**2
40 RSQR = SQROOT
41 IF(RSOR.LT.0.) SQROOT=-SQROOT
42 DO 100 IZ=1,KH
43 IF(HFLAG.EQ.0) Q=KVRATT*(CSQ+ALPHA*Z(IZ))
44 IF(HFLAG.EQ.0) CALL MDHNKL(Q,H1,H2,H1PRM,H2PRM)
45 IF(HFLAG.EQ.0) Q=KVRATT*CSQ
46 IF(HFLAG.EQ.1) Q=KVRATT*(CSQ-ALPHA*H)
47 CALL MDHNKL(Q,H1,H2,H1PRM,H2PRM)
48 CAPH10 = H1PRM+AVRKTT*H10
49 CAPH20 = H2PRM+AVRKTT*H20
50 FAC2 = IM*KVRATT*SQROOT
51 FAC3 = FAC2/NGSQ

```

50	IF(HFLAG .EQ. 1) FAC3=FAC3*(1.000-ALPHA*H)	00005000
51	F1 = -(CAPH20-FAC3*H20)	00005100
52	F2 = CAPH10-FAC3*H10	00005200
53	F3 = -(H2PRM0-FAC2*H20)	00005300
54	F4 = H1PRM0-FAC2*H10	00005400
55	FAC1 = DEXP(ALPHA/2.*Z(IZ))	00005500
56	FF1(K) = F1*H10+F2*H20	00005600
57	FF3(K) = F3*H10+F4*H20	00005700
58	IF(HFLAG .EQ. 1) GO TO 99	00005800
59	F(1, K, IZ) = FAC1*(F1*H1+F2*H2)	00005900
60	F(2, K, IZ) = ALPHA/(IM*2.*WAVENO)*F(1, K, IZ)+1./IM*AVRKOT*FAC1*	00006000
61	\$ (F1*H1PRM+F2*H2PRM)	00006100
62	F(3, K, IZ) = F3*H1+F4*H2	00006200
63	F(1, K, IZ) = F(1, K, IZ)/FF1(K)	00006300
64	F(2, K, IZ) = F(2, K, IZ)/FF1(K)	00006400
65	F(3, K, IZ) = F(3, K, IZ)*FOFR(K)/FF3(K)	00006500
66	99 CONTINUE	00006600
67	100 CONTINUE	00006700
68	RETURN	00006800
69	END	00006900

OPRT, S ARBNMCA.HTINTL

```

MORFITT*ARBNMCA(1).HTINTL
1 SUBROUTINE HTINTL( IFLG,M,INTFLG)
2 C
3 IMPLICIT REAL *8(A-H,O-Z)
4 C
5 COMMON/NPRINT C/NPRINT
6 COMMON/METHODS C/ MAXMDS
7 COMMON/HTGN/F(3,20,2)
8 COMMON/MCINPT/FOFR(20),XVAL(50),FREQ,
9 $ XTRA(3,3,20),TOPHT(50),RHOMAX,RHOMIN,DELRHO,DELTA,
10 $ EPSR,SIGMA,NRSLAB,NRMODE,NTMAX,PRMODE,NTRMDS
11 COMMON/MCSTOR/A(20,20),S(20),C(20),KVRAT,KVRATT,AVRKOT,
12 $ AVRKTT,NTHSQ,CONST,OMEGA,WAVENO
13 C
14 COMPLEX*16 F
15 COMPLEX*16 INORM(20,20)
16 COMPLEX*16 PTHA,H1TA,H2TA,H1PRTA,H2PRTA,HYTHA(20),EYTHA(20),
17 $ HYTHPA(20),EYTHPA(20)
18 COMPLEX*16 FOFR,A,S,C,SSQ,CSQ,IM/(0.0D0,1.0D0)/,NGSQ,
19 $ SQROOT,RTIORT,P0,PTH,H10,H20,H1PRM0,H2PRM0,CAPH10,CAPH20,
20 $ A1ST,A2ND,A3RD,A4TH,DEN12,DEN34,DENMF,NURMF,
21 $ H1T,H2T,H1PRMT,H2PRMT,HYTH(20),EYTH(20),HYTHPR(20),EYTHPR(20),
22 $ HYOPR(20),EYOPR(20),EYO(20),MULT,FAC1,FAC2,NDRM(20,20),PS(20),
23 $ CAPI(20,20),PHYTH(20),PHYTHP(20),PEYTH(20),PEYTHP(20),
24 $ PEYO(20),PEYOPR(20),PHYOPR(20),XTRA
25 COMPLEX*16 ZERO/(0.0D0,0.0D0)/,ONE/(1.0D0,0.0D0)/
26 C
27 REAL*8 NTHSQ,NTHSQP
28 REAL*8 KVRAT,KVRATT
29 REAL * 4 ERR
30 INTEGER PRMODE
31 C
32 DATA EPSLN0/8.85434D-12/
33 C
34 DO 5 K=1,MAXMDS
35 DO 5 J=1,MAXMDS
36 5 INORM(J,K)=ZERO
37 C
38 -----
39 DO 100 K = 1, NRMODE
40 SSQ = S(K)**2
41 CSQ = C(K)**2
42 NGSQ = EPSR - (IM*SIGMA /OMEGA)/EPSLN0
43 SQROOT = CDSQRT(NGSQ - SSQ)
44 RSQR = SQROOT
45 IF(RSQR .LT. 0.) SQROOT=-SQROOT
46 RTIORT = 1./NGSQ*SQROOT
47 P0 = KVRATT*CSQ
48 PTH = KVRATT*(NTHSQ -SSQ)
49

```

```

50 CALL MDHNL(P0,H10,H20,H1PRM0,H2PRM0)
51 CAPH10 = H1PRM0 + AVRKT*H10
52 CAPH20 = H2PRM0 + AVRKT*H20
53 A1ST = CAPH20 - IM*RTIORT*KVRAOT*H20
54 A2ND = CAPH10 - IM*RTIORT*KVRAOT*H10
55 A3RD = H2PRM0 - IM*KVRAOT*SQROOT*H20
56 A4TH = H1PRM0 - IM*KVRAOT*SQROOT*H10
57 DEN12 = H20*A2ND - H10*A1ST
58 DEN34 = H20*A4TH - H10*A3RD
59 CALL MDHNL(PTH,H1T,H2T,H1PRMT,H2PRMT)
60 C
61 HYTH(K) = (H2T*A2ND - H1T*A1ST)/DEN12
62 EYTH(K) = (H2T*A4TH - H1T*A3RD)/DEN34*FOFR( K)
63 HYTHPR(K) = (H2PRMT*A2ND - H1PRMT*A1ST)/DEN12
64 EYTHPR(K) = (H2PRMT*A4TH - H1PRMT*A3RD)/DEN34*FOFR( K)
65 HYOPR(K) = (H2PRM0*A2ND - H1PRM0*A1ST)/DEN12
66 EYOPR(K) = (H2PRM0*A4TH - H1PRM0*A3RD)/DEN34*FOFR( K)
67 C
68 IF(IFLG.EQ.0) GO TO 100
69 C-----
70 C
71 C NOT FIRST SLAB
72 C
73 PTHA = KVRATT*(NTHSQ -SSQ)
74 CALL MDHNL(PTHA,H1TA,H2TA,H1PRTA,H2PRTA)
75 EYTHA(K) = (H2TA*A2ND-H1TA*A1ST)/DEN12
76 EYTHPA(K) = (H2TA*A4TH-H1TA*A3RD)/DEN34*FOFR( K)
77 HYTHPA(K) = (H2PRTA*A2ND-H1PRTA*A1ST)/DEN12
78 EYTHPA(K) = (H2PRTA*A4TH-H1PRTA*A3RD)/DEN34*FOFR( K)
79 C
80 100 EY0(K) = FOFR( K)
81 C
82 C-----
83 C COMPUTE NORM(J,K) FOR ALL SLABS
84 C
85 IF(INTFLG.EQ.1) PRINT 906,M
86 DO 240 J = 1,NRMODE
87 DO 240 K = 1,NRMODE
88 IF(J.EQ.K) GO TO 120
89 MULT = AVRKT/((S( J) - S( K))*WAVEND)
90 FAC1 = EYTH(K)*EYTHPR(J) - EYTH(J)*EYTHPR(K) + HYTH(K)*HYTHPR(J)
91 $ -HYTH(J)*HYTHPR(K)
92 FAC2 = -EY0(K)*EYOPR(J) + EY0(J)*EYOPR(K) - HYOPR(K) + HYOPR(J)
93 NORM( J,K) = MULT*(FAC1+FAC2)
94 IF(INTFLG.EQ.0) GO TO 240
95 CALL MAGANG( NORM(J,K),AMAGG,ANGG)
96 PRINT 908,M,J,K,NORM(J,K),AMAGG,ANGG
97 GO TO 240
98 120 MULT = 2.0*(S( J)*KVRAOT/WAVEND
99 PTH = KVRATT*(NTHSQ -S( J)**2)

```

```

100      PO = KVRATT*( J )**2          00010200
101      FAC1 = EYTHPR(J)**2 + HYTHPR(J)**2 + PTH*(EYTH(J)**2 + HYTH(J)**2) 00010300
102      FAC2 = -EYOPR(J)**2 - HYOPR(J)**2 - PO*(EY0(J)**2 + 1.0)          00010400
103      NORM( J,K ) = MULT*(FAC1+FAC2) 00010500
104      IF(INTFLG .EQ. 0) GO TO 240    00010600
105      CALL MAGANG( NORM(J,K),AMAGG,ANGG) 00010700
106      PRINT 908,M,J,K,NORM(J,K),AMAGG,ANGG 00010800
107      240 CONTINUE                  00010900
108      C-----                    00011000
109      C                                00011100
110      C      FOR FIRST SLAB ONLY    00011200
111      C                                00011300
112      C      IF (IFLG .NE. 0) GO TO 500 00011400
113      C      PRMODE = NRMODE         00011500
114      C      DO 602 K = 1,NRMODE     00011600
115      C      PS(K) = S(K)           00011700
116      C      DO 602 J = 1,NRMODE     00011800
117      C      602 INORM(J,K) = ZERO  00011900
118      C      GO TO 850              00012000
119      C                                00012100
120      C-----                    00012200
121      C                                00012300
122      C      COMPUTE CAPI(K,J) AND INORM(K,J) FOR ALL SLABS 00012400
123      C      EXCEPT THE FIRST     00012500
124      C                                00012600
125      C      500 CONTINUE            00012700
126      C      DO 400 K = 1, NRMODE    00012800
127      C      DO 400 J = 1, PRMODE    00012900
128      C      MULT = AVRKOT/((PS(J) - S( K))*WAVENO) 00013000
129      C      FAC1 = EYTHA(K)*PEYTHP(J)-PEYTH(J)*EYTHPA(K) 00013100
130      C      $+HYTHA(K)*PHYTHP(J)-PHYTH(J)*HYTHPA(K) 00013200
131      C      FAC2 = -EY0(K)*PEYOPR(J) + PEY0(J)*EYOPR(K) -PHYOPR(J) + HYOPR(K) 00013300
132      C      CAPI( K,J) = MULT*(FAC1+FAC2) 00013400
133      C      IF(INTFLG .EQ. 0) GO TO 400 00013500
134      C      CALL MAGANG( CAPI(K,J),AMAGG,ANGG) 00013600
135      C      PRINT 910,M,K,J,CAPI(K,J),AMAGG,ANGG 00013700
136      C      400 CONTINUE            00013800
137      C                                00013900
138      C      INIT = 0                00014000
139      C      DO 700 J = 1,PRMODE      00014100
140      C      CALL CLINEQ(NORM ,CAPI (1,J),INORM(1,J) ,NRMODE,MAXMDS,INIT,ERR) 00014200
141      C      INIT = 1                00014300
142      C      IF(ABS(ERR) .GT. 0.01) PRINT 701,ERR,J 00014400
143      C      701 FORMAT('0',' ERR = ',F5.0,' J = ',I3) 00014500
144      C      700 CONTINUE            00014600
145      C                                00014700
146      C-----                    00014800
147      C      850 CONTINUE            00014900
148      C                                00015000
149      C      WRITE(4) M,INORM,S,C,PS,FOFR,XTRA,NRMODE,PRMODE,F 00009300

```



```

MORFITT*ARBNMCA(1).ACCUMA
1 SUBROUTINE ACCUMA
2
3 C
4 C
5 C
6 C
7 C
8 C
9 C
10 C
11 C
12 C
13 C
14 C
15 C
16 C
17 C
18 C
19 C
20 C
21 C
22 C
23 C
24 C
25 C
26 C
27 C
28 C
29 C
30 C
31 C
32 C
33 C
34 C
35 C
36 C
37 C
38 C
39 C
40 C
41 C
42 C
43 C
44 C
45 C
46 C
47 C
48 C
49 C

      'IPLTOP = 1'
      COMPUTE FIELDS FROM XVAL MIN TO XVAL MAX FOR TWO XMTR-RCVR DISTANCES
      AT DELTA X INTERVALS

      'IPLTOP = 2'
      COMPUTE FIELDS FROM RHO MIN TO RHO MAX
      AT DEL RHO INTERVALS.

      IMPLICIT REAL *8(A-H,O-Z)

      COMMON/PREVAC/PREVA
      COMMON/TERM/NT,NTR
      COMMON /MAXES/MAXCNT,MAXDSK
      COMMON /ICOMP C/ICOMP,ICMPMX
      COMMON/ITXRX C/ITXRX
      COMMON/TYPPLT/IPLTOP
      COMMON/SNTR C/SNTR
      COMMON/INORM C/INORM
      COMMON /PREV C/ PS
      COMMON/PLOT V/ISUB,JPLT,NRP,IDPLOT(10)
      COMMON/MCINPT/FOFR(20),XVAL(50),FREQ,
      $ XTRA(3,3,20),TOPHT(50),RHOMAX,RHOMIN,DELRHO,DELTAX,
      $ EPSR,SIGMA,NRSLAB,NRMODE,NTMAX,PRMODE,NTRMDS
      & AVKRTT,NTHSQ,CONST,OMEGA,WAVENO
      COMMON/HGINPT/GAMMA(4),PHI(4),TALT,RALT
      $ ,SINGAM(4),COSGAM(4),SINPHI(4),COSPHI(4)

      COMPLEX*16 ASNTRK
      COMPLEX*16 STORA(20,20)
      COMPLEX*16 PREVA(20,20)
      COMPLEX*16 F(3,20,2)
      COMPLEX*16 SOLNA(20,3,4), A,S,C,XTRA,TB,TDBL,TA,FOFR
      COMPLEX*16 PS(20),IM/(0.0D0,1.0D0)/
      COMPLEX*16 EXCNTR(3,3,20),SNTR(20),FNTR(3,20,2)
      COMPLEX*16 INORM(20,20)
      COMPLEX*16 ZERO/(0.0D0,0.0D0)/
      COMPLEX*16 ONE/(1.0D0,0.0D0)/

      REAL*4 TERMDS,RSTART,RTEMP,RSTOP
      REAL*8 KVRAT,KVRATT
      REAL*8 NTHSQ
      INTEGER PRMODE

      DATA ERAD/6.370D3/
      DATA DTR/0.01745329252D0/

```

```

50 C NT=1
51 ICOUNT=0
52
53 C IF(IPLTOP .GT. 1) XVAL(1)=0.0
54
55 C ----- 00005200
56 C 00005300
57 C 00005400
58 C 00005500
59 C 00005600
60 C 00005700
61 C 00005800
62
63 C 118 CONTINUE
64
65 C REWIND 4
66 REMIND 8
67
68 C IF(XVAL(2) .GE. 0.0) GO TO 111
69 DO 113 L=3,NRSLAB
70 IF(XVAL(L) .GE. 0.0) GO TO 114
71
72 C 113 CONTINUE
73 NTR = NRSLAB
74 GO TO 120
75
76 C 114 NTR=L-1
77 GO TO 120
78
79 C 111 NTR = 1
80 GO TO 120
81
82 C 120 CONTINUE
83
84 C IF(ITRX .LT. 1) GO TO 804
85 PRINT 800,NTR
86
87 C 800 FORMAT('0',' THE TRANSMITTER IS IN SLAB NO. ',15/)
88 PRINT 801
89
90 C 801 FORMAT(' ',10X,' XVAL(I) = ')
91 DO 802 I = 1,NRSLAB
92
93 C 802 PRINT 803,XVAL(I)
94
95 C 803 FORMAT(20X,F10.3/)
96
97 C 804 CONTINUE
98
99 C ----- 00008400
100 C 00008500
101 C 00008600
102 C 00008700
103 C 00008800
104 C 00008900
105 C 00009000
106 C 00009100
107 C 00009200
108 C 00009300
109 C 00009400
110 C 00009500
111 C 00009600
112 C 00009700
113 C 00009800
114 C 00009900
115 C 00010000
116 C 00010100
117 C 00010200
118 C 00010300
119 C 00010400
120 C 00010500
121 C 00010600
122 C 00010700
123 C 00010800
124 C 00010900
125 C 00011000
126 C 00011100
127 C 00011200
128 C 00011300
129 C 00011400
130 C 00011500
131 C 00011600
132 C 00011700
133 C 00011800
134 C 00011900
135 C 00012000
136 C 00012100
137 C 00012200
138 C 00012300
139 C 00012400
140 C 00012500
141 C 00012600
142 C 00012700
143 C 00012800
144 C 00012900
145 C 00013000
146 C 00013100
147 C 00013200
148 C 00013300
149 C 00013400
150 C 00013500
151 C 00013600
152 C 00013700
153 C 00013800
154 C 00013900
155 C 00014000
156 C 00014100
157 C 00014200
158 C 00014300
159 C 00014400
160 C 00014500
161 C 00014600
162 C 00014700
163 C 00014800
164 C 00014900
165 C 00015000
166 C 00015100
167 C 00015200
168 C 00015300
169 C 00015400
170 C 00015500
171 C 00015600
172 C 00015700
173 C 00015800
174 C 00015900
175 C 00016000
176 C 00016100
177 C 00016200
178 C 00016300
179 C 00016400
180 C 00016500
181 C 00016600
182 C 00016700
183 C 00016800
184 C 00016900
185 C 00017000
186 C 00017100
187 C 00017200
188 C 00017300
189 C 00017400
190 C 00017500
191 C 00017600
192 C 00017700
193 C 00017800
194 C 00017900
195 C 00018000
196 C 00018100
197 C 00018200
198 C 00018300
199 C 00018400
200 C 00018500
201 C 00018600
202 C 00018700
203 C 00018800
204 C 00018900
205 C 00019000
206 C 00019100
207 C 00019200
208 C 00019300
209 C 00019400
210 C 00019500
211 C 00019600
212 C 00019700
213 C 00019800
214 C 00019900
215 C 00020000
216 C 00020100
217 C 00020200
218 C 00020300
219 C 00020400
220 C 00020500
221 C 00020600
222 C 00020700
223 C 00020800
224 C 00020900
225 C 00021000
226 C 00021100
227 C 00021200
228 C 00021300
229 C 00021400
230 C 00021500
231 C 00021600
232 C 00021700
233 C 00021800
234 C 00021900
235 C 00022000
236 C 00022100
237 C 00022200
238 C 00022300
239 C 00022400
240 C 00022500
241 C 00022600
242 C 00022700
243 C 00022800
244 C 00022900
245 C 00023000
246 C 00023100
247 C 00023200
248 C 00023300
249 C 00023400
250 C 00023500
251 C 00023600
252 C 00023700
253 C 00023800
254 C 00023900
255 C 00024000
256 C 00024100
257 C 00024200
258 C 00024300
259 C 00024400
260 C 00024500
261 C 00024600
262 C 00024700
263 C 00024800
264 C 00024900
265 C 00025000
266 C 00025100
267 C 00025200
268 C 00025300
269 C 00025400
270 C 00025500
271 C 00025600
272 C 00025700
273 C 00025800
274 C 00025900
275 C 00026000
276 C 00026100
277 C 00026200
278 C 00026300
279 C 00026400
280 C 00026500
281 C 00026600
282 C 00026700
283 C 00026800
284 C 00026900
285 C 00027000
286 C 00027100
287 C 00027200
288 C 00027300
289 C 00027400
290 C 00027500
291 C 00027600
292 C 00027700
293 C 00027800
294 C 00027900
295 C 00028000
296 C 00028100
297 C 00028200
298 C 00028300
299 C 00028400
300 C 00028500
301 C 00028600
302 C 00028700
303 C 00028800
304 C 00028900
305 C 00029000
306 C 00029100
307 C 00029200
308 C 00029300
309 C 00029400
310 C 00029500
311 C 00029600
312 C 00029700
313 C 00029800
314 C 00029900
315 C 00030000
316 C 00030100
317 C 00030200
318 C 00030300
319 C 00030400
320 C 00030500
321 C 00030600
322 C 00030700
323 C 00030800
324 C 00030900
325 C 00031000
326 C 00031100
327 C 00031200
328 C 00031300
329 C 00031400
330 C 00031500
331 C 00031600
332 C 00031700
333 C 00031800
334 C 00031900
335 C 00032000
336 C 00032100
337 C 00032200
338 C 00032300
339 C 00032400
340 C 00032500
341 C 00032600
342 C 00032700
343 C 00032800
344 C 00032900
345 C 00033000
346 C 00033100
347 C 00033200
348 C 00033300
349 C 00033400
350 C 00033500
351 C 00033600
352 C 00033700
353 C 00033800
354 C 00033900
355 C 00034000
356 C 00034100
357 C 00034200
358 C 00034300
359 C 00034400
360 C 00034500
361 C 00034600
362 C 00034700
363 C 00034800
364 C 00034900
365 C 00035000
366 C 00035100
367 C 00035200
368 C 00035300
369 C 00035400
370 C 00035500
371 C 00035600
372 C 00035700
373 C 00035800
374 C 00035900
375 C 00036000
376 C 00036100
377 C 00036200
378 C 00036300
379 C 00036400
380 C 00036500
381 C 00036600
382 C 00036700
383 C 00036800
384 C 00036900
385 C 00037000
386 C 00037100
387 C 00037200
388 C 00037300
389 C 00037400
390 C 00037500
391 C 00037600
392 C 00037700
393 C 00037800
394 C 00037900
395 C 00038000
396 C 00038100
397 C 00038200
398 C 00038300
399 C 00038400
400 C 00038500
401 C 00038600
402 C 00038700
403 C 00038800
404 C 00038900
405 C 00039000
406 C 00039100
407 C 00039200
408 C 00039300
409 C 00039400
410 C 00039500
411 C 00039600
412 C 00039700
413 C 00039800
414 C 00039900
415 C 00040000
416 C 00040100
417 C 00040200
418 C 00040300
419 C 00040400
420 C 00040500
421 C 00040600
422 C 00040700
423 C 00040800
424 C 00040900
425 C 00041000
426 C 00041100
427 C 00041200
428 C 00041300
429 C 00041400
430 C 00041500
431 C 00041600
432 C 00041700
433 C 00041800
434 C 00041900
435 C 00042000
436 C 00042100
437 C 00042200
438 C 00042300
439 C 00042400
440 C 00042500
441 C 00042600
442 C 00042700
443 C 00042800
444 C 00042900
445 C 00043000
446 C 00043100
447 C 00043200
448 C 00043300
449 C 00043400
450 C 00043500
451 C 00043600
452 C 00043700
453 C 00043800
454 C 00043900
455 C 00044000
456 C 00044100
457 C 00044200
458 C 00044300
459 C 00044400
460 C 00044500
461 C 00044600
462 C 00044700
463 C 00044800
464 C 00044900
465 C 00045000
466 C 00045100
467 C 00045200
468 C 00045300
469 C 00045400
470 C 00045500
471 C 00045600
472 C 00045700
473 C 00045800
474 C 00045900
475 C 00046000
476 C 00046100
477 C 00046200
478 C 00046300
479 C 00046400
480 C 00046500
481 C 00046600
482 C 00046700
483 C 00046800
484 C 00046900
485 C 00047000
486 C 00047100
487 C 00047200
488 C 00047300
489 C 00047400
490 C 00047500
491 C 00047600
492 C 00047700
493 C 00047800
494 C 00047900
495 C 00048000
496 C 00048100
497 C 00048200
498 C 00048300
499 C 00048400
500 C 00048500
501 C 00048600
502 C 00048700
503 C 00048800
504 C 00048900
505 C 00049000
506 C 00049100
507 C 00049200
508 C 00049300
509 C 00049400
510 C 00049500
511 C 00049600
512 C 00049700
513 C 00049800
514 C 00049900
515 C 00050000
516 C 00050100
517 C 00050200
518 C 00050300
519 C 00050400
520 C 00050500
521 C 00050600
522 C 00050700
523 C 00050800
524 C 00050900
525 C 00051000
526 C 00051100
527 C 00051200
528 C 00051300
529 C 00051400
530 C 00051500
531 C 00051600
532 C 00051700
533 C 00051800
534 C 00051900
535 C 00052000
536 C 00052100
537 C 00052200
538 C 00052300
539 C 00052400
540 C 00052500
541 C 00052600
542 C 00052700
543 C 00052800
544 C 00052900
545 C 00053000
546 C 00053100
547 C 00053200
548 C 00053300
549 C 00053400
550 C 00053500
551 C 00053600
552 C 00053700
553 C 00053800
554 C 00053900
555 C 00054000
556 C 00054100
557 C 00054200
558 C 00054300
559 C 00054400
560 C 00054500
561 C 00054600
562 C 00054700
563 C 00054800
564 C 00054900
565 C 00055000
566 C 00055100
567 C 00055200
568 C 00055300
569 C 00055400
570 C 00055500
571 C 00055600
572 C 00055700
573 C 00055800
574 C 00055900
575 C 00056000
576 C 00056100
577 C 00056200
578 C 00056300
579 C 00056400
580 C 00056500
581 C 00056600
582 C 00056700
583 C 00056800
584 C 00056900
585 C 00057000
586 C 00057100
587 C 00057200
588 C 00057300
589 C 00057400
590 C 00057500
591 C 00057600
592 C 00057700
593 C 00057800
594 C 00057900
595 C 00058000
596 C 00058100
597 C 00058200
598 C 00058300
599 C 00058400
600 C 00058500
601 C 00058600
602 C 00058700
603 C 00058800
604 C 00058900
605 C 00059000
606 C 00059100
607 C 00059200
608 C 00059300
609 C 00059400
610 C 00059500
611 C 00059600
612 C 00059700
613 C 00059800
614 C 00059900
615 C 00060000
616 C 00060100
617 C 00060200
618 C 00060300
619 C 00060400
620 C 00060500
621 C 00060600
622 C 00060700
623 C 00060800
624 C 00060900
625 C 00061000
626 C 00061100
627 C 00061200
628 C 00061300
629 C 00061400
630 C 00061500
631 C 00061600
632 C 00061700
633 C 00061800
634 C 00061900
635 C 00062000
636 C 00062100
637 C 00062200
638 C 00062300
639 C 00062400
640 C 00062500
641 C 00062600
642 C 00062700
643 C 00062800
644 C 00062900
645 C 00063000
646 C 00063100
647 C 00063200
648 C 00063300
649 C 00063400
650 C 00063500
651 C 00063600
652 C 00063700
653 C 00063800
654 C 00063900
655 C 00064000
656 C 00064100
657 C 00064200
658 C 00064300
659 C 00064400
660 C 00064500
661 C 00064600
662 C 00064700
663 C 00064800
664 C 00064900
665 C 00065000
666 C 00065100
667 C 00065200
668 C 00065300
669 C 00065400
670 C 00065500
671 C 00065600
672 C 00065700
673 C 00065800
674 C 00065900
675 C 00066000
676 C 00066100
677 C 00066200
678 C 00066300
679 C 00066400
680 C 00066500
681 C 00066600
682 C 00066700
683 C 00066800
684 C 00066900
685 C 00067000
686 C 00067100
687 C 00067200
688 C 00067300
689 C 00067400
690 C 00067500
691 C 00067600
692 C 00067700
693 C 00067800
694 C 00067900
695 C 00068000
696 C 00068100
697 C 00068200
698 C 00068300
699 C 00068400
700 C 00068500
701 C 00068600
702 C 00068700
703 C 00068800
704 C 00068900
705 C 00069000
706 C 00069100
707 C 00069200
708 C 00069300
709 C 00069400
710 C 00069500
711 C 00069600
712 C 00069700
713 C 00069800
714 C 00069900
715 C 00070000
716 C 00070100
717 C 00070200
718 C 00070300
719 C 00070400
720 C 00070500
721 C 00070600
722 C 00070700
723 C 00070800
724 C 00070900
725 C 00071000
726 C 00071100
727 C 00071200
728 C 00071300
729 C 00071400
730 C 00071500
731 C 00071600
732 C 00071700
733 C 00071800
734 C 00071900
735 C 00072000
736 C 00072100
737 C 00072200
738 C 00072300
739 C 00072400
740 C 00072500
741 C 00072600
742 C 00072700
743 C 00072800
744 C 00072900
745 C 00073000
746 C 00073100
747 C 00073200
748 C 00073300
749 C 00073400
750 C 00073500
751 C 00073600
752 C 00073700
753 C 00073800
754 C 00073900
755 C 00074000
756 C 00074100
757 C 00074200
758 C 00074300
759 C 00074400
760 C 00074500
761 C 00074600
762 C 00074700
763 C 00074800
764 C 00074900
765 C 00075000
766 C 00075100
767 C 00075200
768 C 00075300
769 C 00075400
770 C 00075500
771 C 00075600
772 C 00075700
773 C 00075800
774 C 00075900
775 C 00076000
776 C 00076100
777 C 00076200
778 C 00076300
779 C 00076400
780 C 00076500
781 C 00076600
782 C 00076700
783 C 00076800
784 C 00076900
785 C 00077000
786 C 00077100
787 C 00077200
788 C 00077300
789 C 00077400
790 C 00077500
791 C 00077600
792 C 00077700
793 C 00077800
794 C 00077900
795 C 00078000
796 C 00078100
797 C 00078200
798 C 00078300
799 C 00078400
800 C 00078500
801 C 00078600
802 C 00078700
803 C 00078800
804 C 00078900
805 C 00079000
806 C 00079100
807 C 00079200
808 C 00079300
809 C 00079400
810 C 00079500
811 C 00079600
812 C 00079700
813 C 00079800
814 C 00079900
815 C 00080000
816 C 00080100
817 C 00080200
818 C 00080300
819 C 00080400
820 C 00080500
821 C 00080600
822 C 00080700
823 C 00080800
824 C 00080900
825 C 00081000
826 C 00081100
827 C 00081200
828 C 00081300
829 C 00081400
830 C 00081500
831 C 00081600
832 C 00081700
833 C 00081800
834 C 00081900
835 C 00082000
836 C 00082100
837 C 00082200
838 C 00082300
839 C 00082400
840 C 00082500
841 C 00082600
842 C 00082700
843 C 00082800
844 C 00082900
845 C 00083000
846 C 00083100
847 C 00083200
848 C 00083300
849 C 00083400
850 C 00083500
851 C 00083600
852 C 00083700
853 C 00083800
854 C 00083900
855 C 00084000
856 C 00084100
857 C 00084200
858 C 00084300
859 C 00084400
860 C 00084500
861 C 00084600
862 C 00084700
863 C 00084800
864 C 00084900
865 C 00085000
866 C 00085100
867 C 00085200
868 C 00085300
869 C 00085400
870 C 00085500
871 C 00085600
872 C 00085700
873 C 00085800
874 C 00085900
875 C 00086000
876 C 00086100
877 C 00086200
878 C 00086300
879 C 00086400
880 C 00086500
881 C 00086600
882 C 00086700
883 C 00086800
884 C 00086900
885 C 00087000
886 C 00087100
887 C 00087200
888 C 00087300
889 C 00087400
890 C 00087500
891 C 00087600
892 C 00087700
893 C 00087800
894 C 00087900
895 C 00088000
896 C 00088100
897 C 00088200
898 C 00088300
899 C 00088400
900 C 00088500
901 C 00088600
902 C 00088700
903 C 00088800
904 C 00088900
905 C 00089000
906 C 00089100
907 C 00089200
908 C 00089300
909 C 00089400
910 C 00089500
911 C 00089600
912 C 00089700
913 C 00089800
914 C 00089900
915 C 00090000
916 C 00090100
917 C 00090200
918 C 00090300
919 C 00090400
920 C 00090500
921 C 00090600
922 C 00090700
923 C 00090800
924 C 00090900
925 C 00091000
926 C 00091100
927 C 00091200
928 C 00091300
929 C 00091400
930 C 00091500
931 C 00091600
932 C 00091700
933 C 00091800
934 C 00091900
935 C 00092000
936 C 00092100
937 C 00092200
938 C 00092300
939 C 00092400
940 C 00092500
941 C 00092600
942 C 00092700
943 C 00092800
944 C 00092900
945 C 00093000
946 C 
```

100	DO 12 L=1,3	00009800
101	DO 12 K=1,NTRMDS	00009900
102	EXCNTR(N,L,K) = XTRA(N,L,K)	00010000
103	SNTR(K) = S(K)	00010100
104	FNTR(L,K,1) = F(L,K,1)	00011000
105	12 CONTINUE	
106	11 CONTINUE	
107	C	
108	C	00011200
109	C	00011300
110	CALL MCSTEP(NTR)	00011400
111	C	00011500
112	C	00011600
113	C	00011700
114	IF(IPLTOP .GT. 1) GO TO 753	00011800
115	MSAVED=NTR	00011900
116	DO 750 M=1,NTR	00012000
117	DO 751 J=1,NRMODE	00012100
118	DO 751 K=1,NTRMDS	00012200
119	IF(M .NE. NTR) STORA(J,K)=ZERO	00012300
120	IF(M .EQ. NTR) STORA(J,K)=A(J,K)	
121	751 CONTINUE	00012500
122	WRITE(8)	00012700
123	750 CONTINUE	
124	C	00012800
125	753 CONTINUE	00012900
126	C	00013000
127	C	
128	IF(IPLTOP .LT. 2) M=0	00013200
129	LOOP=0	00013300
130	C	00013600
131	91 CONTINUE	00013500
132	C	
133	IF(LOOP .GT. 0) MS=MSAVED	00013700
134	C	00013800
135	ISUB = 1	00013900
136	RHO = RHO MIN	
137	IDSFLG = 0	00014000
138	IDSCNT = 0	00014100
139	C	00014200
140	600 CONTINUE	00014300
141	C	
142	C	
143	C	
144	IF(ITRX .LT. 1) GO TO 5559	
145	PRINT 5556,RHO	
146	5556 FORMAT('O','RHO = ',F10.2)	
147	5559 CONTINUE	
148	C	00014400
149	C IDENTIFY THE SLAB WHICH CONTAINS THE RECEIVER (I.E. NRX)	00014500

```

150 C
151 IF((XVAL(2) - RHO) .GE. 0.0) GO TO 511
152 DO 513 I=3,NRSLAB
153 IF((XVAL(I) - RHO) .GE. 0.0) GO TO 514
154 513 CONTINUE
155 NRX = NRSLAB
156 GO TO 520
157 514 NRX=I-1
158 GO TO 520
159 511 NRX = 1
160 520 CONTINUE
161 C
162 IF(ITRX .LT. 1) GO TO 504
163 PRINT 500,NRX
164 500 FORMAT('0',' THE RECEIVER IS IN SLAB NO. ',I5/)
165 PRINT 501
166 501 FORMAT(' ',10X,' XVAL(I) = ')
167 DO 502 I = 1,NRSLAB
168 502 PRINT 503,XVAL(I)
169 503 FORMAT(20X,F10.3/)
170 504 CONTINUE
171 C
172 C-----
173 C
174 IF(IPLTOP .LT. 2) GO TO 9000
175 IF(IDSFLG .LT. 1) GO TO 9100
176 IF(M .EQ. NRX) GO TO 720
177 IDSCNT = IDSCNT+1
178 RSTOP = RTEMP-DELRHO
179 C
180 WRITE(10) RSTART,RSTOP,NTR,NRMODE,M,XVALM,S,F,SOLNA
181 C
182 IDSFLG = 0
183 C
184 9000 CONTINUE
185 C
186 C-----
187 C
188 THE VARIABLE 'LOOP = 1' INDICATES THAT THE SLAB CONTAINING
189 THE TRANSMITTER HAS NOT CHANGED.
190 C
191 IF(LOOP .NE. 1) GO TO 752
192 IF(RHO .GT. RHOMIN) GO TO 755
193 C
194 142 IF(NRX .EQ. MS) GO TO 143
195 MS=MS-1
196 MSAVED=MS
197 BACKSPACE 8
198 GO TO 142
199 143 CONTINUE

```

00015100
00015200
00015300
00015400
00015500
00015600
00015700
00015800
00015900
00016000
00016100
00016200

00016300
00016400
00016500
00016600
00016700
00016800
00016900

00017200
00017300
00017400

00017300
00017500
00017600
00017700
00017800

00018300
00018400

200	BACKSPACE 8		
201	READ (8)	MS, PREVA, NRMODE, NTRMDS, S, F	00018600
202	DO 132 J=1, NRMODE		00018700
203	DO 132 K=1, NTRMDS		00018800
204	132 A(J,K)=PREVA(J,K)		
205	C		
206	MR=MS		
207	C		
208	GO TO 20		00018900
209	755 CONTINUE		
210	IF(MS .EQ. NRX) GO TO 720		
211	754 IF(M .LE. MS) GO TO 51		
212	M=M-1		
213	BACKSPACE 4		
214	GO TO 754		
215	752 CONTINUE		
216	C		00019000
217	C		00019100
218			00019200
219			00019300
220	IF(M .EQ. NRX) GO TO 720		00019400
221	IF(LOOP .EQ. 1) GO TO 51		00019500
222	9100 CONTINUE		
223	IF(NSLAB .EQ. NTR) M=NTR		00019600
224	IF(NSLAB .NE. NTR) M=NSLAB		00019700
225	51 CONTINUE		00019800
226	IF(M .EQ. NTR .AND. NTR .EQ. NRX) MR=M		
227	IF(M .EQ. NTR .AND. NTR .EQ. NRX) GO TO 20		00019900
228	C		00020000
229	C		00020100
230	READ IN A NEW SLAB		00020200
231	C		
232	22 CONTINUE		00020400
233	M=M+1		00020500
234	C		00020600
235	READ (4) NSLAB, INORM, S, C, PS, FOFR, XTRA, NRMODE, PRMODE, F		00020700
236	C		00020800
237	CALL MCSTEP(M)		00020900
238	C		00021000
239	C		00021100
240	IF(IPLTOP .GT. 1) GO TO 131		00021200
241	IF(RHO .GT. RHOMIN) GO TO 131		00021300
242	MSAVED=M		00021400
243	WRITE(8)	M, A, NRMODE, NTRMDS, S, F	00021500
244	C		
245	131 CONTINUE		00021900
246	C		00022000
247	C		00022100
248	C		00022200
249	C		

```

250 IF(M .NE. NRX) GO TO 22
251 MR=M
252 -----
253 C
254 C
255 C
256 C
257 C
258 C
259 C
260 C
261 C
262 C
263 C
264 C
265 C
266 C
267 C
268 C
269 C
270 C
271 C
272 C
273 C
274 C
275 C
276 C
277 C
278 C
279 C
280 C
281 C
282 C
283 C
284 C
285 C
286 C
287 C
288 C
289 C
290 C
291 C
292 C
293 C
294 C
295 C
296 C
297 C
298 C
299 C

IF(M .NE. NRX) GO TO 22
MR=M
-----
00023100
00023200
00023300
00023400
00023500
00023600
00023800
00023900
00024000

20 CONTINUE
DO 710 N=1,NRP
DO 710 L=1,ICNPMX
DO 710 J = 1,NRMODE
SOLN A(J,L,N) = (0.0,0.0)
DO 710 K = 1,NTRMDS
IF(L .EQ. 1) ASNTRK=(ONE/SNTR(K) )
IF(L .NE. 1) ASNTRK= ONE
IF(MR .NE. NTR) GO TO 35
SOLN A(J,L,N) = SOLN A(J,L,N)
* A(J,K)*((EXCNR(1,L,K) )*FNTR(1,K,1))*
$COSGAM(N)+ EXCNR(2,L,K)*FNTR(2,K,1)*SINGAM(N)*
$COSPHI(N)+ EXCNR(3,L,K)*FNTR(3,K,1)*SINGAM(N)*
$SINPHI(N)) *ASNTRK
GO TO 710

C
35 SOLN A(J,L,N) = SOLN A(J,L,N)
* A(J,K)*((EXCNR(1,L,K) )*FNTR(1,K,1))*
$COSGAM(N)+ EXCNR(2,L,K)*FNTR(2,K,1)*SINGAM(N)*
$COSPHI(N)+ EXCNR(3,L,K)*FNTR(3,K,1)*SINGAM(N)*
$SINPHI(N)) *ASNTRK
$ *CDEXP(-IM*WAVENO*SNTR(K)*XVAL(NTR+1))
GO TO 710

C
710 CONTINUE
IDSFLG = 1
RSTART = RHO
-----
00026100
00026200
00026300
00026400

720 CONTINUE
-----
ICOUNT=ICOUNT+1
IF(ICOUNT .GT. 402) GO TO 999
XVALM=XVAL(NRX)
IF(IPLTOP .GT. 1) GO TO 888
TERMS=XVAL(2)
WRITE(10) ISUB,NT,NTR,NRMODE,NRX,TERMS,RHO,XVALM,S,F,SOLNA
888 CONTINUE
8089 CONTINUE

```

```

300 C-----
301 C
302 C
303 RHO = RHO + DEL RHO
304 RTEMP = RHO
305 ISUB = ISUB+1
306 IF (RHO.LE.RHO MAX) GO TO 600
307
308 ISUB = ISUB-1
309 MAXCNT=ICOUNT
310 IF (IPLTOP .LT. 2) GO TO 105
311
312 C-----00017300
313 C
314 RSTOP = RTEMP - DELRHO
315 IDSCNT = IDSCNT+1
316 WRITE(10) RSTART,RSTOP,NTR,NRMODE,M,XVALM,S,F,SOLNA
317
318 MAXDSK=IDSCNT
319 RETURN
320
321 C-----00017300
322 C
323 999 PRINT 998,ICOUNT
324 998 FORMAT('0','THE PROGRAM STOPS--ICOUNT = ',16,
325 *, ' IS GREATER THAN 402')
326 GO TO 997
327
328 C-----
329 C
330 105 CONTINUE
331 NT=NT+1
332 IF (NT .GT. NTMAX) GO TO 833
333 DO 106 ME=1,NRSLAB
334 XVAL(ME) = XVAL(ME)+DELTAX
335
336 C-----
337 C
338 C CHECK TO SEE IF A SLAB BOUNDARY HAS MOVED PAST THE TRANSMITTER
339
340 IF (XVAL(INTR) .GE. 0. .AND. NT .LE. NTMAX) GO TO 118
341 IF (NT .GT. NTMAX) GO TO 833
342
343 THE VARIABLE 'LOOP = 1' INDICATES THAT THE SLAB CONTAINING
344 THE TRANSMITTER HAS NOT CHANGED.
345
346 LOOP=1
347 GO TO 91
348 833 CONTINUE
349 NT=NT-1

```

00037400
00037500
00035100

350 C RETURN
351 C
352 997 CONTINUE
353 STOP
354 END
355

OPRT, S ARBNMCA.MCSTEP

```

MORFITT*ARBNMCA(1).MCSTEP
SUBROUTINE MCSTEP(M)
1
2 C
3 IMPLICIT REAL *8(A-H,O-Z)
4 COMMON/PREVAC/PREVA
5 COMMON/HTGN/F(3,20,2)
6 COMMON/SNTR C/SNTR
7 COMMON/INT C/INFLG,IPRNTA
8 COMMON/NPRNT C/NPRINT
9 COMMON/PRV C/PS
10 COMMON/INDRM C/INCRH
11 COMMON/TERM/NT,NTR
12 COMMON/MCINPT/FOFR(20),XVAL(50),FREQ,
13 $ XTRA(3,3,20),TOPHT(50),RHOMAX,RHOMIN,DELRHQ,DELTAX,
14 $ EPSR,SIGMA,NRSLAB,NRMODE,NTMAX,PRMODE,NTRMDS
15 COMMON/MCSTOR/A(20,20),S(20),C(20),KVRADT,KVRATT,AVRKOT,
16 & AVRKTT,NTHSQ,CONST,OMEGA,WAVENO
17
18 C
19 COMPLEX*16 PS(20),PREVA(20,20),SNTR(20)
20 COMPLEX*16 INORM(20,20)
21 COMPLEX*16 FOFRA,A,S,C,
22 $ IM/(0.000,1.000)/B(20),XTRA
23
24 C
25 REAL*8 NTHSQ
26 REAL*8 KVRADT,KVRATT
27 INTEGER PRMODE
28
29 C
30 MP=M-1
31 IF(M.NE.NTR) GO TO 50
32 DO 32 K=1,NTRMDS
33 DO 32 J=1,NRMODE
34 IF(J.EQ.K) GO TO 31
35 A(J,K) = (0.000,0.000)
36 GO TO 32
37
38 31 A(J,K) = (1.000,0.000)
39 32 CONTINUE
40 GO TO 24
41
42 C
43 FOR SLAB(M) NOT EQUAL TO SLAB(NTR)
44
45 C
46 50 CONTINUE
47 DO 17 N = 1,NRMODE
48 B(N) = (0.,0.)
49 IF(MP.EQ.NTR) GO TO 21
50
51 C
52 FOR SLAB(MP) NOT EQUAL TO SLAB(NTR)
53
54 C
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99

```


OPRT.S ARBNMCA.MCF LD

```

1  MORFITT*ARBNCMA(1).MCFLO
2  SUBROUTINE MCFLO
3
4  C
5  C
6  C
7  C
8  C
9  C
10 C
11 C
12 C
13 C
14 C
15 C
16 C
17 C
18 C
19 C
20 C
21 C
22 C
23 C
24 C
25 C
26 C
27 C
28 C
29 C
30 C
31 C
32 C
33 C
34 C
35 C
36 C
37 C
38 C
39 C
40 C
41 C
42 C
43 C
44 C
45 C
46 C
47 C
48 C
49 C

      'IPLTOP = 1'
      COMPUTE FIELDS FROM XVAL MIN TO XVAL MAX FOR TWO XMTR-RCVR DISTANCES
      AT DELTAX INTERVALS

      'IPLTOP = 2'
      COMPUTE FIELDS FROM RHO MIN TO RHO MAX
      AT DEL RHO INTERVALS.

      IMPLICIT REAL *B(A-H,O-Z)

      COMMON/FIRST C/ IFIRST
      COMMON/MAXES/MAXCNT,MAXDSK
      COMMON/ICOMP C/ICOMP,ICMPMX
      COMMON/ITXRX C/ITXRX
      COMMON/TYPPLT/IPLTOP
      COMMON/SNTR C/SNTR
      COMMON/INORM C/INORM
      COMMON /PREV C/ PS
      COMMON/SPLOT/SAVE(402),Y1(4,402),Y2(4,402)
      $,ANG1(4,402),ANG2(4,402)
      COMMON/MCPLT/R(402),DB(4,402),ANG(4,402)
      COMMON/PLOT V/ISUB,JPLT,NRP,IDPLOT(10),NAPLOT,NPPLOT
      COMMON/MCINPT/FOFR(20),XVAL(50),FREQ,
      $ XTRA(3,3,20),TOPHT(50),RHOMAX,RHOMIN,DELRHO,DELTAX,
      $ EPSR,SIGMA,NRSLAB,NRMODE,NTMAX,PRMODE,NTRMDS
      COMMON/MCSTOR/A(20,20),S(20),C(20),KVRATT,KVRATT,AVRKOT,
      & AVRKOT,NTHSQ,CONST,OMEGA,WAVENO
      COMMON/HGINPT/GAMMA(4),PHI(4),TALT,RALT
      $,SINGAM(4),COSGAM(4),SINPHI(4),COSPHI(4)

      COMPLEX*16 PREVA(20,20)
      COMPLEX*16 F(3,20,2)
      COMPLEX*16 SOLNA(20,3,4),TAP, A,S,C,XTRA,TB,TDBL,TA,FOFR
      COMPLEX*16 PS(20),IM/(0.0D0,1.0D0)/
      COMPLEX*16 EXCNTR(3,3,20),SNTR(20),FNTR(3,20,2)
      COMPLEX*16 INORM(20,20)
      COMPLEX*16 ZERO/(0.0D0,0.0D0)/

      REAL*8 KVRATT,KVRATT
      REAL*8 NTHSQ
      REAL*4 TERMS,RSTART,RTEMP,RSTOP
      REAL*4 R,DB,ANG,SAVE,Y1,Y2
      REAL*4 ANG1,ANG2
      INTEGER PRMODE

      DATA ERAD/6.370D3/
      DATA DTR/0.01745329252D0/

```

```

50 C
51 C-----00004900
52 C-----00005000
53 C-----00005400
54 C
55 L=ICOMP
56 IF(IPLTOP .GT. 1) GO TO 300
57 C-----00005000
58 C-----00004900
59 C
60 C
61 C THIS SECTION COMPUTES THE FIELDS AS A FUNCTION OF THE DISTANCE
62 C BETWEEN THE TRANSMITTER AND THE TERMINATOR. ALSO THE FIELDS ARE
63 C COMPUTED FROM XVAL MIN TO XVAL MAX FOR TWO XMTR-RCVR DISTANCES
64 C AT DELTAX INTERVALS
65 C
66 NTMAX2=2*NTMAX
67 I=0
68 100 CONTINUE
69 I=I+1
70 IF(I .GT. NTMAX2) GO TO 350
71 C
72 READ(10) ISUB,NT,NTR,NRMODE,M,TERMS,RHO,XVALM,S,F,SOLNA
73 C
74 GO TO 400
75 C-----
76 C-----
77 C
78 C
79 C
80 C THIS SECTION COMPUTES THE FIELDS AS A FUNCTION OF THE DISTANCE
81 C BETWEEN THE TRANSMITTER AND THE RECEIVER. ALSO THE FIELDS ARE
82 C AT DEL RHO INTERVALS.
83 C COMPUTED FROM RHO MIN TO RHO MAX
84 C
85 300 CONTINUE
86 I=1
87 ISUB=I
88 IDSKRD = 1
89 500 CONTINUE
90 READ (10) RSTART,RSTOP,NTR,NRMODE,M,XVALM,S,F,SOLNA
91 C
92 RHO=RSTART
93 C-----00017800
94 C-----
95 C
96 400 CONTINUE
97 C
98 DO 900 N=1,NRP
99 TA = (0.0,0.0)

```

```

100 DO 730 J = 1,NRMODE
101 IF(M .NE. NTR) GO TO 45
102 TB = CDEXP(-IM*WAVENO*S(J)-RHO)
103 TAP = SOLN A(J,L,N)*TB*F(L,J,2)
104 IF(L .EQ. 1) TAP=TAP*S(J)
105 TA=TAP+TA
106 GO TO 730
107
108 C
109 45 TB = CDEXP(IM*WAVENO* S(J)*(XVALM - RHO))
110 TAP = SOLN A(J,L,N)*TB*F(L,J,2)
111 IF(L .EQ. 1) TAP=TAP*S(J)
112 TA=TAP+TA
113 730 CONTINUE
114 TA = TA*CONST/DSQRT(DSIN(RHO/ERAD))
115 TDBL = TA *CDEXP (IM * WAVE NO * RHO)
116 CALL MAGANG ( TDBL, TDMAG, TDANG)
117 TSMAG = TDMAG
118 TSANG = TDANG
119 TSDB = 8.685890 * DLOG (TSMAG * 1.0E6)
120
121 C
122 R(ISUB) = RHO
123 DB( N,ISUB) = TSDB
124 ANG( N,ISUB) = TSANG
125
126 C
127 IF(IPLTOP .GT. 1) GO TO 899
128 SAVED(NT)=TERMS
129
130 C
131 IF(MOD(ISUB,2) .EQ. 1) Y1( N,NT) = DB( N,ISUB)
132 IF(MOD(ISUB,2) .EQ. 0) Y2( N,NT) = DB( N,ISUB)
133 IF(MOD(ISUB,2) .EQ. 1) ANG1( N,NT) = ANG( N,ISUB)
134 IF(MOD(ISUB,2) .EQ. 0) ANG2( N,NT) = ANG( N,ISUB)
135 899 CONTINUE
136
137 C
138 900 CONTINUE
139
140 C
141 IF(IPLTOP .GT. 1) GO TO 250
142 GO TO 100
143
144 C
145 -----00031000
146 -----00031100
147
148 250 CONTINUE
149 IF(ABS(RSTOP-RSTART) .LT. 0.0001) GO TO 800
150 I=I+1
151 ISUB=I
152 RHO=RHO+DELRHO
153 IF(RHO .LE. RSTOP) GO TO 400
154 800 IDSKRD=IDSKRD+1
155 IF(IDSKRD .LE. MAXDSK) GO TO 500
156 I=I-1
157 IF(I .EQ. MAXCNT) GO TO 670

```

```

150 PRINT 671,I,MAXCNT
151 671 FORMAT('0','DISTANCE COUNT ERROR FOR (IPLTOP = 2),'./,
152 $,I = ',16,' MAXCNT = ',16,' PROGRAM STOPS' )
153 GO TO 999
154
155 C-----00017700
156
157 C
158 C
159 C
160 350 CONTINUE
161 DO 930 N=1,NRP
162 PRINT 910
163 GAMMA(N) = GAMMA(N)/1.745329D-2
164 PGAMMA = GAMMA(N)
165 PHI(N) = PHI(N)/1.745329D-2
166 PPHI = PHI(N)
167 PRINT 927,PGAMMA,PPHI,TALT,RALT
168 PRINT 920
169 IF(ICOMP.EQ. 1) PRINT 925
170 IF(ICOMP.EQ. 2) PRINT 926
171 IF(ICOMP.EQ. 3) PRINT 928
172 DO 930 JJ=1,NTMAX
173 PRINT 908,SAVED(JJ),Y1( N,JJ),ANG1( N,JJ),Y2(N,JJ),ANG2(N,JJ)
174 CONTINUE
175 IF(JPLOT.EQ. 0) RETURN
176
177 C
178 IF(FIRST.EQ. 1) CALL PLOT(1.0,1.0,-3)
179 IF(NAPLOT.EQ. 1) ITYPE=1
180 IF(NAPLOT.EQ. 1) CALL MCPLTS(ITYPE)
181 IF(NPLOT.EQ. 1) ITYPE=2
182 IF(NPLOT.EQ. 1) CALL MCPLTS(ITYPE)
183 RETURN
184
185 C
186 908 FORMAT(' ',25X,F7.1, 1X,F8.3,1X,F7.2,25X, 1X,F8.3,1X,F7.2)
187 910 FORMAT(' ',
188 $ ' ELECTRIC FIELD STRENGTH AS A FUNCTION OF TRANSMITTER-TERMINATOR',
189 $ DISTANCE(D)'/,
190 920 FORMAT('0',26X,'FIELD AT RHOMIN',34X,'FIELD AT RHOMAX')
191 927 FORMAT('OGAMMA(DEG)='F6.1,' PHI(DEG)='F6.1,' TALT(KM) = ',
192 $ F10.3,' RALT(KM) = ',F10.3/)
193 925 FORMAT('0',26X,'D',5X,'EZ(DB)',2X,'EZ(ANG)',30X,
194 $ 'EZ(DB)',2X,'EZ(ANG)')
195 926 FORMAT('0',26X,'D',5X,'EX(DB)',2X,'EX(ANG)',30X,
196 $ 'EX(DB)',2X,'EX(ANG)')
197 928 FORMAT('0',26X,'D',5X,'EY(DB)',2X,'EY(ANG)',30X,
198 $ 'EY(DB)',2X,'EY(ANG)')
199
200 C-----00034700
201 C
202 C
203 C
204 670 CONTINUE
205 C-----00034800
206 C
207 C
208 C
209 00031200
210 00031300
211 00032000
212 00032300
213
214 00032400
215 00032500
216
217 00032900
218 00033400
219 00033500
220
221 00033900
222 00034000
223 00034100
224 00034200
225 00034400
226
227 00034700
228 00034800
229 00034900
230 00037800

```

```

200 C
201 C
202 C
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241

      'IPLTOP = 2'
      DO 630 N=1,NRP
      PRINT 610
      PRINT 620
      620 FORMAT('0')
      IF(ICOMP.EQ. 1) PRINT 628
      IF(ICOMP.EQ. 2) PRINT 631
      IF(ICOMP.EQ. 3) PRINT 632
      GAMMA(N) = GAMMA(N)/1.745329D-2
      PGAMMA = GAMMA(N)
      PHI(N) = PHI(N)/1.745329D-2
      PPHI = PHI(N)
      PRINT 627,PGAMMA,PPHI,TALT,RALT
      PRINT 629
      627 FORMAT('0',11X,'GAMMA(DEG)='F6.1,' PHI(DEG)='F6.1,' TALT(KM)='F6.1,' RALT(KM)='F10.3/')
      $ F10.3,' RALT(KM)='F10.3/)
      628 FORMAT('0',22X,'EZ' )
      631 FORMAT('0',22X,'EX' )
      632 FORMAT('0',22X,'EY' )
      629 FORMAT(2X,1(9X,'RHO(KM)',3X,'AMP(DB)',3X,'ANG(DEG)'))/ )
      DO 630 J=1,MAXCNT
      PRINT 608,R(J),DB( N,J),ANG( N,J)
      630 CONTINUE
      IF(JPLOT.EQ. 0) RETURN
      C
      IF(IFIRST.EQ. 1) CALL PLOT(1.0,1.0,-3)
      IF(NAPLOT.EQ. 1) ITYPE=1
      IF(NAPLOT.EQ. 1) CALL MCPLTS(ITYPE)
      IF(NPLOT.EQ. 1) ITYPE=2
      IF(NPLOT.EQ. 1) CALL MCPLTS(ITYPE)
      RETURN
      C
      608 FORMAT(2X,1(7X,F10.2,F10.5,F10.4))
      610 FORMAT('1',10X,
      $ 'ELECTRIC FIELD STRENGTH AS A FUNCTION OF RHO',/ )
      C-----
      C
      999 CONTINUE
      STOP
      END

```

00037900
00038000
00005200
00038600

00038900
00039100
00039200

00039900
00040000
00040100

00040400
00040500
00040700
0
00040900
00043300

00043400

```

MORFITT*ARBNCMA(1).MCPLTS
1 SUBROUTINE MCPLTS(ITYPE)
2   FOR(IPLTOP = 1)
3     MCPLTS GENERATES TWO PLOTS (FIELD AMPLITUDE IN DB ABOVE A
4     MICRO VOLT PER METER FOR 1 KW RADIATED POWER VERSUS TRANSMITTER-
5     TERMINATOR DISTANCE FOR TWO RECEIVER POSITIONS).
6   C
7   C
8   C
9   C
10  C
11  C
12  C
13  C
14  C
15  C
16  C
17  C
18  C
19  C
20  C
21  C
22  C
23  C
24  C
25  C
26  C
27  C
28  C
29  C
30  C
31  C
32  C
33  C
34  C
35  C
36  C
37  C
38  C
39  C
40  C
41  C
42  C
43  C
44  C
45  C
46  C
47  C
48  C
49  C

    FOR(IPLTOP = 2)
      MCPLTS GENERATES ONE PLOT(FIELD AMPLITUDE IN DB ABOVE A MICRO VOLT
      PER METER FOR 1 KW RADIATED POWER VERSUS DISTANCE FROM TRANSMITTER).
      FOR 'ITYPE = 1' PLOTS ARE GENERATED FOR AMPLITUDE VS. DISTANCE.
      FOR 'ITYPE = 2' PLOTS ARE GENERATED FOR PHASE(DEGREES) VS. DIST.

      COMMON/AXISM C/XTIC,YTIC,NTICX,NTICY
      COMMON/TYPPLT/IPLTOP
      COMMON /MAXES/MAXCNT,MAXDSK
      COMMON/ICOMP C/ICOMP,ICOMP:MX
      COMMON/TERM/NT,NTR
      COMMON/PLOT V/ISUB,JPLT,NRP,IDPLOT(10),NAPLOT,NPPLOT
      COMMON/SPLOT/SAVE(402),Y1(4,402),Y2(4,402)
      $,ANG1(4,402),ANG2(4,402)
      COMMON/MCPLT/R(402),DB(4,402),ANG(4,402)
      COMMON/XPLOT/XMIN,XINC,YMIN,YINC,SIZE,SIZE,SIZE
      COMMON/PSPLT/PHSMIN,PHSINC,SIZE,PTIC,NTICP
      COMMON/HGINPT/GAMMA(4),PHI(4),TALT,RALT
      $,SINGAM(4),COSGAM(4),SINPHI(4),COSPHI(4)
      COMMON/MCINPT/FDPR(20),XVAL(50),FREQ,
      $ XTRA(3,3,20),TOPHT(50),RHOMAX,RHOMIN,DELRHO,DELTAX,
      $ EPSR,SIGMA,NRSLAB,NRWODE,NTMAX,PRMODE,NTRMDS
      COMMON/MCSTOR/A(20,20),S(20),C(20),KVRAT,KVRATT,AVRKOT,
      $ AVRKTT,NTHSQ,CONST,OMEGA,WAVENTO

      COMPLEX*16 XTRA,A,S,C,FDFR

      REAL*8 XVAL,FREQ,RHOMAX,RHOMIN,DELRHO,DELTAX,EPSPR,SIGMA,TOPHT
      REAL*8 ZT,ZR
      REAL*8 SINGAM,COSGAM,SINPHI,COSPHI
      REAL*8 GAMMA,PHI,TALT,RALT
      REAL*8 KVRAT,KVRATT,NTHSQ

      REAL*4 R,DB,ANG,SAVE,Y1,Y2
      REAL*4 ANG1,ANG2
      REAL*4 XMIN,XINC,YMIN,YINC,SIZE,SIZE
      REAL*4 XTIC,YTIC
      REAL*4 SIZEP,PHSMIN,PHSINC,PTIC

      REAL*4 XCURVE(2)/D.,1./,YCURV1(2)/2*.2/,YCURV2(2)/2*.4/,
      $ YCURV3(2)/2*.6/,YCURV4(2)/2*.8/

```

00002200
00002300
00002400
00001600
00001700
00001800
00001900

```

50 C
51   COMPLEX*16 COMP(3)/'Z COMPONENT
52   $ 'Y COMPONENT
53   'X COMPONENT
54   00037700
55   INTEGER PRMODE
56   DIMENSION Y(402)
57   DIMENSION GAMMAD(4),PHID(4)
58   ZT=TALT
59   ZR=RALT
60
61   IF(IPLTOP.GT. 1) GO TO 400
62   NTOTAL=NTMAX
63   NMPLTS=2
64   SAVED(NTOTAL+1) = XMIN
65   SAVED(NTOTAL+2) = XINC
66   IF(ITYPE.EQ. 2) GO TO 401
67   Y(NTOTAL+1) = YMIN
68   Y(NTOTAL+2) = YINC
69   WMIN = YMIN
70   WINC = YINC
71   WTIC = YTIC
72   NTICW = NTICY
73   SIZEW = SIZEY
74   GO TO 402
75 401 CONTINUE
76   Y(NTOTAL+1) = PHSMIN
77   Y(NTOTAL+2) = PHSINC
78   WMIN = PHSMIN
79   WINC = PHSINC
80   WTIC = PTIC
81   NTICW = NTICP
82   SIZEW = SIZEP
83 402 CONTINUE
84   GO TO 450
85
86 C
87 400 CONTINUE
88   NTOTAL=MAXCNT
89   NMPLTS=1
90   R(NTOTAL+1) = XMIN
91   R(NTOTAL+2) = XINC
92   IF(ITYPE.EQ. 2) GO TO 403
93   Y(NTOTAL+1) = YMIN
94   Y(NTOTAL+2) = YINC
95   WMIN = YMIN
96   WINC = YINC
97   WTIC = YTIC
98   NTICW = NTICY
99   SIZEW = SIZEY
100  GO TO 404

```

```

100 403 CONTINUE
101   Y(NTOTAL+1) = PHSMIN
102   Y(NTOTAL+2) = PHSINC
103   WMIN = PHSMIN
104   WINC = PHSINC
105   WTIC = PTIC
106   NTICW = NTICP
107   SIZEW = SIZEP
108 404 CONTINUE
109 450 CONTINUE
110
111   DO 900 I=1,NMPLTS
112
113     IF(IPLTOP .EQ. 1)
114       $CALL AXISM(0.0,0.0,0.0,'TRANSMITTER-TERMINATOR DISTANCE(KM)',-35,
115       $ SIZEX,0.0,SAVED(NTOTAL+1),SAVED(NTOTAL+2),XTIC,NTICX)
116
117     IF(IPLTOP .EQ. 2)
118       $CALL AXISM(0.0,0.0,0.0,'RHO(KM)',-7,
119       $ SIZEX,0.0, R(NTOTAL+1), R(NTOTAL+2),XTIC,NTICX)
120
121     'ITYPE = 1'
122     IF(ITYPE .EQ. 1)
123       $CALL AXISM(0.0,0.0,0.0,'DB ABOVE 1 UV/M FOR 1 KW',24,SIZEW,90.0,
124       $ Y(NTOTAL+1),Y(NTOTAL+2),WTIC,NTICW)
125
126     'ITYPE = 2'
127     IF(ITYPE .EQ. 2)
128       $CALL AXISM(0.0,0.0,0.0,'PHASE(DEGREES)',14,SIZEW,90.0,
129       $ Y(NTOTAL+1),Y(NTOTAL+2),WTIC,NTICW)
130
131     DO 600 J=1,NRP
132       GO TO (1,2,3,4),J
133       1 JJ=1
134       2 GO TO 5
135       3 JJ=3
136       4 GO TO 5
137       5 JJ=5
138       6 GO TO 5
139       7 JJ=7
140       8 CONTINUE
141
142     DO 500 K=1,NTOTAL
143
144       IF(ITYPE .EQ. 2) GO TO 300
145       IF(IPLTOP .GT. 1) Y(K) = DB(J,K)
146       IF(IPLTOP .LT. 2 .AND. 1 .EQ. 1) Y(K) = Y1(J,K)
147       IF(IPLTOP .LT. 2 .AND. 1 .EQ. 2) Y(K) = Y2(J,K)
148       GO TO 301
149

```

```

150 300 CONTINUE
151 IF(IPLTOP .GT. 1) Y(K) = ANG(J,K)
152 IF(IPLTOP .LT. 2 .AND. 1 .EQ. 1) Y(K) = ANG1(J,K)
153 IF(IPLTOP .LT. 2 .AND. 1 .EQ. 2) Y(K) = ANG2(J,K)
154 301 CONTINUE
155 500 CONTINUE
156 C
157 IF(IPLTOP .EQ. 2)
158 $CALL CURVE(R, Y, NTOTAL, XMIN, WMIN, XINC, WINC, JJ)
159 IF(IPLTOP .EQ. 1)
160 $CALL CURVE(SAVED, Y, NTOTAL, XMIN, WMIN, XINC, WINC, JJ)
161 CONTINUE
162 C
163 CALL SYMBOL(0.5, (SIZEW+1.0), 0.14, IDPLOT, 0.0, 0.40)
164 CALL SYMBOL(0.5, (SIZEW+0.8), 0.14, COMP(ICOMP), 0.0, 0.16)
165 CALL SYMBOL(0.5, (SIZEW+0.6), 0.14, 'FREQ=', 0.0, 0.5)
166 CALL NUMBER(1.4, (SIZEW+0.6), 0.14, SNGL(FREQ), 0.0, 0.3)
167 CALL SYMBOL(0.5, (SIZEW+0.4), 0.14, 'TALT =', RALT = '0.0, 0.21)
168 CALL NUMBER(1.7, (SIZEW+0.4), 0.14, SNGL(TALT), 0.0, 0.2)
169 CALL NUMBER(3.7, (SIZEW+0.4), 0.14, SNGL(RALT), 0.0, 0.2)
170 C
171 IF(IPLTOP .GT. 1) GO TO 650
172 CALL SYMBOL(0.5, (SIZEW+0.2), 0.14, 'RECEIVER DISTANCE =', 0.0, 0.20)
173 IF(1 .EQ. 1) CALL NUMBER(3.4, (SIZEW+0.2), 0.14, SNGL(RHOMIN), 0.0, 0.1)
174 IF(1 .EQ. 2) CALL NUMBER(3.4, (SIZEW+0.2), 0.14, SNGL(RHOMAX), 0.0, 0.1)
175 650 CONTINUE
176 C
177 CALL SYMBOL(4.5, (SIZEW+0.8), 0.14, 'GAMMA= PHI=', 0.0, 0.17)
178 CALL NUMBER(5.7, (SIZEW+0.8), 0.14, SNGL(GAMMA(1)), 0.0, 0.1)
179 CALL NUMBER(7.2, (SIZEW+0.8), 0.14, SNGL(PHI(1)), 0.0, 0.1)
180 IF(NRP .LT. 2) GO TO 700
181 CALL SYMBOL(4.5, (SIZEW+0.6), 0.14, 'GAMMA= PHI=', 0.0, 0.17)
182 CALL NUMBER(5.7, (SIZEW+0.6), 0.14, SNGL(GAMMA(2)), 0.0, 0.1)
183 CALL NUMBER(7.2, (SIZEW+0.6), 0.14, SNGL(PHI(2)), 0.0, 0.1)
184 IF(NRP .LT. 3) GO TO 700
185 CALL SYMBOL(4.5, (SIZEW+0.4), 0.14, 'GAMMA= PHI=', 0.0, 0.17)
186 CALL NUMBER(5.7, (SIZEW+0.4), 0.14, SNGL(GAMMA(3)), 0.0, 0.1)
187 CALL NUMBER(7.2, (SIZEW+0.4), 0.14, SNGL(PHI(3)), 0.0, 0.1)
188 IF(NRP .LT. 4) GO TO 700
189 CALL SYMBOL(4.5, (SIZEW+0.2), 0.14, 'GAMMA= PHI=', 0.0, 0.17)
190 CALL NUMBER(5.7, (SIZEW+0.2), 0.14, SNGL(GAMMA(4)), 0.0, 0.1)
191 CALL NUMBER(7.2, (SIZEW+0.2), 0.14, SNGL(PHI(4)), 0.0, 0.1)
192 700 CONTINUE
193 C
194 CALL PLOT(8.0, SIZEW, -3)
195 CALL CURVE(XCURVE, YCURV4, 2.0, 0.0, 0.0, 1.0, 1.0, 0.1)
196 IF(NRP .LT. 2) GO TO 800
197 CALL CURVE(XCURVE, YCURV3, 2.0, 0.0, 0.0, 1.0, 1.0, 0.3)
198 IF(NRP .LT. 3) GO TO 800
199 CALL CURVE(XCURVE, YCURV2, 2.0, 0.0, 0.0, 1.0, 1.0, 0.5)

```

```

200 IF(NRP .LT. 4) GO TO 800
201 CALL CURVE(XCURVE,YCURV1,2.0,0.0,0.0,1.0,1.0,7)
202 CONTINUE
203 800 CALL PLOT(-8.0,-SIZEW,-3)
204 C
205 CALL PLOT(SIZEX+5.0,0.0,-3)
206 CONTINUE
207 RETURN
208 C
209 END

```

OPRT,S ARBNMCA.MDHNKL

```

MORFITT*ARBWCA(1).MDHNKL
1 SUBROUTINE MDHNKL (Z,H1,H2,H1PRME,H2PRME)
2 C COMPUTE MODIFIED HANKEL FUNCTIONS OF ORDER ONE THIRD
3 IMPLICIT REAL *8 (A-H,O-Z)
4 COMPLEX*16 CDSQRT,CDEXP
5 REAL*8 CDABS
6 COMPLEX*16 Z,I,H1,H2,H1PRME,H2PRME,ZPOWER,TERM1,TERM2,
7 TERM3,ZTERM,TERM,SUM1,SUM2,SUM3,SUM4,SORTZB,
8 EXP1,EXP2,EXP3,EXP4,EXP5,GM2F,GMWFP,POWER,BETA,RTZ,
9 CONST1,CONST2,CONST3,CONST4
10 DIMENSION A(23), B(23), C(23), D(23), CAP(14)
11 DATA A/
12 $ 9.30436716930000D-01,3.10145572309700D 01,2.06763714873160D 02,0.0001200
13 $ 5.74343652425450D 02,8.70217655190080D 02,8.28778719228640D 02,0.0001300
14 $ 5.41685437404340D 02,2.57945446383020D 02,9.34524950603100D 01,0.0001400
15 $ 2.66263518707400D 01,6.1210043005600D 00,1.15928038448000D 00,0.0001500
16 $ 1.84012759441000D-01,2.48330309500000D-02,2.88420201000000D-03,0.0001600
17 $ 2.91334142000000D-04,2.58274950000000D-05,2.02568600000000D-06,0.0001700
18 $ 1.41557000000000D-07,8.87000000000000D-09,5.01000000000000D-10,0.0001800
19 $ 2.60000000000000D-11,1.00000000000000D-12/
20 DATA B/
21 $ 6.78298725140000D-01,1.13049787524000D 01,5.383232321543100D 01,0.0002100
22 $ 1.19629404787350D 02,1.53371031778650D 02,1.27809193148880D 02,0.0002200
23 $ 7.47422182157200D 01,3.23559386215200D 01,1.07853128738400D 01,0.0002300
24 $ 2.85325737403000D 00,6.13603736351000D-01,1.09376780098000D-01,0.0002400
25 $ 1.64229399550000D-02,2.10550512200000D-03,2.33167788000000D-04,0.0002500
26 $ 2.25282890000000D-05,1.91567100000000D-06,1.44470000000000D-07,0.0002600
27 $ 9.72900000000000D-09,5.89000000000000D-10,3.20000000000000D-11,0.0002700
28 $ 2.00000000000000D-12,0.00000000000000D 00/
29 DATA C/
30 $ 4.65218358460000D-01,6.20291144619000D 00,2.58454643591500D 01,0.0003000
31 $ 5.22130593114000D 01,6.21584039421500D 01,4.87516893603900D 01,0.0003100
32 $ 2.70842718702200D 01,1.12150194079600D 01,3.59455750255000D 00,0.0003200
33 $ 9.18150064510000D-01,1.91281263439000D-01,3.31222866990000D-02,0.0003300
34 $ 4.84244103800000D-03,6.05683682000000D-04,6.55501820000000D-05,0.0003400
35 $ 6.19859900000000D-06,5.16550000000000D-07,3.62200000000000D-08,0.0003500
36 $ 2.52800000000000D-09,1.50000000000000D-10,8.00000000000000D-12,0.0003600
37 $ 0.00000000000000D 00,0.00000000000000D 00/
38 DATA D/
39 $ 6.78298725140000D-01,4.52199150096200D 01,3.76832625080150D 02,0.0003900
40 $ 1.19629404787350D 03,1.99382341312250D 03,2.04347090382060D 03,0.0004000
41 $ 1.42010214609850D 03,7.11830649673510D 02,2.69632821845030D 02,0.0004100
42 $ 7.98912064729000D 01,1.90217158268800D 01,3.71881052333900D 00,0.0004200
43 $ 6.07648776323000D-01,8.42202048960000D-02,1.00262145690000D-02,0.0004300
44 $ 1.03630127800000D-03,9.38678690000000D-05,7.51243500000000D-06,0.0004400
45 $ 5.35074000000000D-07,3.41350000000000D-08,1.96200000000000D-09,0.0004500
46 $ 1.02000000000000D-10,5.00000000000000D-12/
47 DATA CAP/
48 $ 1.04166666666667D-01,8.35503472222222D-02,1.28226574556327D-01,0.0004800
49 $ 2.91849026464140D-01,8.81627267443758D-01,3.32140828186277D 00,0.0004900

```

```

50          $ 1.49957629868626D 01,7.89230130115870D 01,4.74451538868000D 02,00005000
51          $ 3.20749009100000D 03,2.40865496000000D 04,1.98923120000000D 05,00005100
52          $ 1.79190200000000D 06,1.74843770000000D 07,
53
54          C      DATA I/(0.00,1.00)/
55          DATA ROOT3/1.73205080756888D 00/
56          DATA ALPHA/B.53667218838951D-01/
57          DATA CONST1/( 2.58819045102522D-01, -9.65925826289067D-01)/
58          DATA CONST2/( 2.58819045102522D-01, 9.65925826289067D-01)/
59          DATA CONST3/(-9.65925826289067D-01, 2.58819045102522D-01)/
60          DATA CONST4/(-9.65925826289067D-01, -2.58819045102522D-01)/
61
62          C      ZPOWER=1.0
63          SUM3=0.0
64          SUM4=0.0
65          ZMAG=CDABS(Z)
66          IF(ZMAG .GT. 4.2) GO TO 70
67          IF(ZMAG .GE. 3.2) GO TO 10
68          N=12
69          GO TO 30
70          IF(ZMAG .GE. 4.1) GO TO 20
71          N=15
72          GO TO 30
73          N=23
74          SUM1=0.
75          SUM2=0.
76          ZTERM=-Z**3/200.0
77          DO 50 M=1,N
78             SUM1=SUM1+A(M)*ZPOWER
79             SUM2=SUM2+B(M)*ZPOWER
80             SUM3=SUM3+C(M)*ZPOWER
81             SUM4=SUM4+D(M)*ZPOWER
82             ZPOWER=ZPOWER*ZTERM
83             IF(CDABS(ZPOWER) .LE. 1.0D-30) GO TO 60
84          CONTINUE
85          GM2F=1/(Z*SUM2-2.*SUM1)/ROOT3
86          GPMFP=1/(SUM4+2.*Z*SUM3)/ROOT3
87          H1=Z*SUM2+GM2F
88          H2=H1-2.0*GM2F
89          H1PRME=SUM4+GPMFP
90          H2PRME=H1PRME-2.0*GPMFP
91          RETURN
92
93          C      SUM1=1.0
94          SUM2=1.0
95          RTZ=CDSQRT(Z)
96          SORTZB=RTZ*Z
97          ZTERM=1/SQRTZB
98          MPOWER=1.0
99          TERM=-1.5/Z

```

```

100 DO 80 M=1,14
101 ZPOWER=ZPOWER*ZTERM
102 MPPOWER=MPPOWER*(-ZTERM)
103 TERM1=CAP(M)*ZPOWER
104 TERM2=CAP(M)*MPPOWER
105 SUM1=SUM1+TERM1
106 SUM2=SUM2+TERM2
107 SUM3=SUM3+M*TERM1
108 SUM4=SUM4+M*TERM2
109 CONTINUE
110 SUM3=SUM3*TERM
111 SUM4=SUM4*TERM
112 EXP1=CDEXP(2.*I*SQRTZB/3.)
113 EXP2=EXP1*CONST1
114 EXP3=CONST2/EXP1
115 EXP4=CONST3*EXP1
116 EXP5=CONST4/EXP1
117 BETA=ALPHA/CDSORT(RTZ)
118 ZREAL=Z
119 ZIMAG=-I*Z
120 IF (ZREAL.GE.0.0.OR.ZIMAG.GE.0.0)GO TO 90
121 H1=BETA*(EXP2*SUM2+EXP5*SUM1)
122 H1PRME=BETA*(EXP2*(SUM2*(-0.25/Z+I*RTZ)+SUM4)+EXP5*(SUM1*(-0.25/Z
123 -I*RTZ)+SUM3))
124 GO TO 110
125 H1=BETA*EXP2*SUM2
126 H1PRME=BETA*EXP2*(SUM2*(-0.25/Z+I*RTZ)+SUM4)
127 IF (ZREAL.GE.0.0.OR.ZIMAG.LT.0.0)GO TO 120
128 H2=BETA*(EXP3*SUM1+EXP4*SUM2)
129 H2PRME=BETA*(EXP3*(SUM1*(-0.25/Z-I*RTZ)+SUM3)+EXP4*(SUM2*(-0.25/Z
130 +I*RTZ)+SUM4))
131 RETURN
132 H2=BETA*EXP3*SUM1
133 H2PRME=BETA*EXP3*(SUM1*(-0.25/Z-I*RTZ)+SUM3)
134 RETURN
135 END

```

OPRT, S ARBNMCA.MAGANG

```

MORFITT*ARBNMCA(1).MAGANG
1  SUBROUTINE MAGANG(ARG,AMAG,ANGLE)
2  IMPLICIT REAL*8 (A-H,O-Z)
3  COMPLEX*16 ARG
4  DATA RTDEG/5.729577951D1/
5  ARGR=DREAL(ARG)
6  ARGJ=DIMAG(ARG)
7  AMAG=CDABS(ARG)
8  IF(ARGR .EQ. 0.0D0 .AND. ARGJ .EQ. 0.0D0) GO TO 10
9  ANGLE = DATAN2(ARGJ,ARGR)*RTDEG
10 IF(ARGJ .LT. 0.0D0) ANGLE=ANGLE+360.0D0
11 RETURN
12
13 C 10 ANGLE=0.0D0
14 RETURN
15 END

```

```

00000100
00000200
00000300
00000400
00000500
00000600
00000700
00000800
00000900
00001000
00001100
00001200
00001300
00001400
00001500

```

OPRT,S ARBNMCA.CURVE

```

MORFITT*ARBNNCA(1).CURVE
1 SUBROUTINE CURVE(X,Y, NRPTS,XMIN,YMIN,XINC,YINC,LINE)
2
3 C X,Y,UP MUST BE DIMENSIONED AT LEAST NRPTS
4 C XMIN,YMIN ARE X,Y ORIGIN IN USER UNITS
5 C XINC,YINC ARE X,Y SCALES IN USER UNITS PER INCH
6 C
7 C LINE=1: SOLID
8 C 2: LONG DASH
9 C 3: MEDIUM DASH
10 C 4: SHORT DASH
11 C 5: DOTTED
12 C 6: SHORT + LONG DASH
13 C 7: SHORT + SHORT + LONG DASH
14 C
15 C LOGICAL UPI,UP2
16 C DIMENSION IPEN(10),JOC(7),X(NRPTS),Y(NRPTS)
17 C DATA IPEN/3,2,3,2,3,2,2,2,2/,JOC/18, 61, 56, 54, 52, 11, 36/
18 C DATA DELR/.1/,UPI/.FALSE./,UP2/.FALSE./
19 C
20 C IF(LINE) 1,2,3
21 C KK=MOD(LINE,7)+7
22 C GO TO 4
23 C KK=0
24 C GO TO 4
25 C KK=MOD(LINE,7)
26 C KK=KK+1
27 C JOC=JOC(KK)/10
28 C JC=JOC(KK)-10*JO
29 C
30 C J=1
31 C IP=2
32 C IF(KK.EQ. 6) IP=3
33 C DR=0.
34 C RHO1=0.
35 C RHO2=DELX
36 C PX1=(X(1)-XMIN)/XINC
37 C PY1=(Y(1)-YMIN)/YINC
38 C IF(UP1) GO TO 10
39 C
40 C GO TO FIRST POSITION WITH PEN UP
41 C CALL PLOT(PX1,PY1,3)
42 C
43 C DO 40 I=2,NRPTS
44 C PX2=(X(I)-XMIN)/XINC
45 C PY2=(Y(I)-YMIN)/YINC
46 C IF(UP2) GO TO 22
47 C IF(UP1) GO TO 37
48 C IF(KK.EQ. 2) GO TO 38
49 C DELX=PX2-PX1
CURVE001
CURVE002
CURVE003
CURVE004
CURVE005
CURVE006
CURVE007
CURVE008
CURVE009
CURVE010
CURVE011
CURVE012
CURVE013
CURVE014
CURVE015
CURVE017
CURVE018
CURVE019
CURVE021
CURVE022
CURVE023
CURVE024
CURVE025
CURVE026
CURVE027
CURVE028
CURVE029
CURVE030
CURVE031
CURVE033
CURVE034
CURVE035
CURVE037
CURVE038
CURVE040
CURVE041
CURVE042
CURVE043

```

```

50 DELY=PY2-PY1
51 RHO=SQRT(DELX**2+DELY**2)
52 RHO1=RHO1+RHO
53 IF(RHO2 .GT. RHO1) GO TO 38
54 DELX=DELX+DELR/RHO
55 DELY=DELY+DELR/RHO
56 DX 6=DELX*.1
57 DY 6=DELY*.1
58 IF(DR .EQ. 0.) GO TO 20
59 DX=DELX+DR/DELR
60 DY=DELY+DR/DELR
61 PX1=PX1+DX
62 PY1=PY1+DY
63 GO TO 21
64 IF(RHO2 .GT. RHO1) GO TO 38
65 PX1=PX1+DELX
66 PY1=PY1+DELY
67 CALL PLOT(PX1,PY1,IP)
68 IF(MK .EQ. 6) CALL PLOT(PX1+DX6,PY1+DY6,2)
69 J=J+1
70 IP=IPEN(JO+MOD(J,JC))
71 RHO2=RHO2+DELR
72 GO TO 20
73 DR=0.
74 RHO1=0.
75 RHO2=DELR
76 GO TO 39
77 C PEN HAS BEEN UP, PREPARE TO LOWER PEN
78 CALL PLOT(PX2,PY2,3)
79 GO TO 39
80 CALL PLOT(PX2,PY2,IP)
81 DR=RHO2-RHO1
82 PX1=PX2
83 PY1=PY2
84 UP1=UP2
85 CONTINUE
86 RETURN
87 END

```

```

CURVE044
CURVE045
CURVE046
CURVE047
CURVE048
CURVE049
CURVE050
CURVE051
CURVE052
CURVE053
CURVE054
CURVE055
CURVE056
CURVE057
CURVE058
CURVE059
CURVE060
CURVE061
CURVE062
CURVE063
CURVE064
CURVE065
CURVE066
CURVE067
CURVE068
CURVE069
CURVE070
CURVE071
CURVE072
CURVE073
CURVE074
CURVE075
CURVE076
CURVE077
CURVE078
CURVE079
CURVE080
CURVE081

```

```

MORFITT*ARBNMCA(1) .AXISM
1 SUBROUTINE AXISM (X,Y,BCD,NC,SIZE,THETA,XMIN,DX,TIC,NTIC)
2
3 C (X,Y)
4 C BCD
5 C NC
6 C
7 C
8 C
9 C SIZE
10 C THETA
11 C XMIN
12 C
13 C DX
14 C
15 C TIC
16 C NTIC
17 C
18 C
19 C
20 C
21 C
22 C
23 C
24 C
25 C
26 C
27 C
28 C
29 C
30 C
31 C
32 C
33 C
34 C
35 C
36 C
37 C
38 C
39 C
40 C
41 C
42 C
43 C
44 C
45 C
46 C
47 C
48 C
49 C

COORDINATES OF THE BEGINNING OF THE AXIS
ALPHANUMERIC ANRAY CONTAINING THE AXIS LABEL
NUMBER OF CHARACTERS IN AXIS LABEL. IF NC .GT. 0,
THE AXIS ANNOTATION WILL BE ON THE COUNTER-CLOCKWISE
SIDE OF THE AXIS. NC .LT. 0 PLACES THE ANNOTATION ON THE
CLOCKWISE SIDE
LENGTH OF THE AXIS IN INCHES
THE ANGLE AT WHICH THE AXIS IS TO BE DRAWN
THE VALUE OF THE COORDINATE AT THE BEGINNING OF THE
AXIS.
THE CHANGE IN COORDINATE VALUE BETWEEN SUCCESSIVE
LABELED TIC-MARKS.
THE DISTANCE BETWEEN TIC-MARKS, IN INCHES
THE REPEAT CYCLE FOR PLACING COORDINATE VALUES AT
TIC MARKS -
.EQ. 1 CAUSES VALUES TO BE PLACED AT EVERY TIC-MARK
.EQ. 2 CAUSES VALUES TO BE PLACED AT EVERY SECOND
TIC MARK, ETC.
.EQ. 0 SUPPRESSES ALL COORDINATE VALUES

J MARTIN JUNE 1966

DIMENSION BCD(2)
INTEGER ALPHA(2)
DATA ALPHA(1) / (X10',ALPHA(2) / ' ) /
SYGN=1.0
IF (NC) 5,10,10
SYGN=-1.0
NAC=IABS(NC)
SWITCH=0.0
TH=THETA*0.01745329
CTH=COS(TH)
STH=SIN(TH)
DXT=TIC*CTH
DYT=TIC*STH
N=SIZE/TIC
TN=N
XB=X
YB=Y
XA=X-0.05*SYGN*STH
YA=Y+0.05*SYGN*CTH
CALL PLOT (XA,YA,3)
DRAW TICS.=
DO 15 I=1,N
CALL PLOT (XB,YB,2)
XC=XB+DXT
YC=YB+DYT

```

50	CALL PLOT (XC,YC,2)	AXI 49
51	XA=XA+DXT	AXI 50
52	YA=YA+DYT	AXI 51
53	CALL PLOT (XA,YA,2)	AXI 52
54	XB=XC	AXI 53
55	YB=YC	AXI 54
56	IF (NTIC) 25,20,25	AXI 55
57	EXPX=0.0	AXI 56
58	GO TO 90	AXI 57
59	ADX=ABS(DX)	AXI 58
60	C CALCULATE VALUE OF LAST LABELED TIC.=	AXI 59
61	ABSV=XMIN+DX*N/NTIC	AXI 60
62	EXPX=0.0	AXI 61
63	IF (ADX) 30,90,30	AXI 62
64	IF (ADX-100.0) 45,35,35	AXI 63
65	ADX=ADX/10.0	AXI 64
66	ABSV=ABSV/10.0	AXI 65
67	EXPX=EXPX+1.0	AXI 66
68	GO TO 30	AXI 67
69	ADX=ADX*10.0	AXI 68
70	ABSV=ABSV*10.0	AXI 69
71	EXPX=EXPX-1.0	AXI 70
72	IF (ADX-0.01) 40,90,90	AXI 71
73	M=N	AXI 72
74	MM=N+1	AXI 73
75	DO 65 I=1,MM	AXI 74
76	K=MM-I	AXI 75
77	AK=FLOAT(K)/FLOAT(NTIC)-FLOAT(K/NTIC)	AXI 76
78	IF (AK) 55,60,55	AXI 77
79	XB=XB-DXT	AXI 78
80	YB=YB-DYT	AXI 79
81	ABSV=ABSV-(ADX/NTIC)	
82	GO TO 65	AXI 80
83	XA=XB-(0.20*SYGN-0.05)*STH-0.17143*CTH	AXI 81
84	YA=YB+(0.20*SYGN-0.05)*CTH-0.17143*STH	AXI 82
85	GO TO 70	AXI 83
86	CONTINUE	AXI 84
87	N=K/NTIC+1	AXI 85
88	DO 80 I=1,N	AXI 86
89	LABEL TICS, IN REVERSE ORDER.=	AXI 87
90	CALL NUMBER (XA,YA,0.1,ABSV,THETA,2)	AXI 88
91	ABSV = ABSV - ADX	
92	XA=XA-DXT*FLOAT(NTIC)	AXI 90
93	YA=YA-DYT*FLOAT(NTIC)	AXI 91
94	IF (SWITCH) 80,75,80	AXI 92
95	CALL WHERE (XW,YW,FACT)	AXI 93
96	D1=SQRT((XW-YT)**2+(YW-YT)**2)	AXI 94
97	D2=SQRT((XW-XA)**2+(YW-YA)**2)	AXI 95
98	IF (D1-D2) 110,110,80	AXI 96
99	CONTINUE	AXI 97

```

100      85      RETURN
101      90      IF (EXPX) 95,100.95
102      95      TNC=NAC+7
103      C ***** THE NEXT TWO STATEMENTS HAVE BEEN REPLACED BY DATA
104      C ***** STATEMENTS BECAUSE THE CHARACTERS DESIRED DO NOT HAVE
105      C ***** THE SAME INTEGER EQUIVALENTS ON THE 1110
106      C      ALPHA(1)=240+256*(241+256*(231+256*77))
107      C      ALPHA(2)=64+256*(53+256*(64+256*64))
108      GO TO 105
109      100      TNC=NAC
110      105      XT=X+(SIZE/2.0-0.07*TNC)*CTH-(-0.07+SYGN*0.4225)*STH
111      YT=Y+(SIZE/2.0-0.07*TNC)*STH+(-0.07+SYGN*0.4225)*CTH
112      IF (NTIC) 50,110.50
113      C      DRAW AXIS NAME.=
114      110      CALL SYM30L (XT,YT,0.14,BCD(1),THETA,NAC)
115      IF (EXPX) 120,115,120
116      115      SWITCH=1.0
117      IF (NTIC) 80,85,80
118      120      XT=XT+((TNC-6.0)*0.14)*CTH
119      YT=YT+((TNC-6.0)*0.14)*STH
120      CALL SYMBOL (XT,YT,0.14,ALPHA(1),THETA,7)
121      XT=XT+0.56*CTH-0.07*STH
122      YT=YT+0.56*STH+0.07*CTH
123      CALL NUMBER (XT,YT,0.10,EXPX,THETA,-1)
124      GO TO 115
125      END

```

```

AXI 98
AXI 99
AXI 100
D/P
D/P
D/P
D/P
D/P
AXI 103
AXI 104
AXI 105
AXI 106
AXI 107
AXI 108
AXI 109
AXI 110
AXI 111
AXI 112
AXI 113
AXI 114
AXI 115
AXI 116
AXI 117
AXI 118
AXI 119
AXI 120-

```

```

1      MORFIT*ARBINCA(1).CLINEQ
2      SUBROUTINE CLIN EQ (A, B, X, N,
3      $ N DIM, IFLAG, ERR)
4
5      C
6      C CLIN EQ USES L-U DECOMPOSITION TO
7      C FIND THE TRIANGULAR MATRICES L, U
8      C SUCH THAT  $L * U = A$ . L AND U ARE
9      C STORED IN A. THIS FORM IS USED WITH
10     C BACK-SUBSTITUTION TO FIND THE SOLN
11     C X OF  $A * X = L * U * X = B$ .
12     C N IS THE NUMBER OF EQUATIONS AND
13     C N DIM IS THE DIMENSION OF ALL ARRAYS
14     C IN THE PARAMETER LIST.
15
16     C IF IFLAG = 0, L, U, AND X ARE
17     C COMPUTED.
18     C IF IFLAG IS NON-ZERO, IT IS ASSUMED
19     C THAT L AND U HAVE BEEN COMPUTED IN
20     C A PREVIOUS CALL AND ARE STILL STORED
21     C IN A. THUS ONLY X IS COMPUTED.
22     C ERR IS THE ESTIMATED RELATIVE
23     C ERROR OF THE SOLUTION VECTOR.
24
25     C
26     C COMPLEX*16 A, B, X, T
27     C INTEGER*4 IROW
28     C DIMENSION A(N DIM, N DIM),
29     C $ B(N DIM), X(N DIM)
30     C DIMENSION IROW(50), Q(50)
31     C DATA EPS /1.0E-15/
32
33     C
34     C IF (N.GT.50) GO TO 900
35     C IF (IFLAG.NE.0) GO TO 600
36     C DO 050 I = 1,N
37     C Q(I) = 0.0
38     C DO 040 J = 1,N
39     C QQ = CDABS (A(I,J))
40     C 040 IF (Q(I).LT.QQ) Q(I) = QQ
41     C IF (Q(I).EQ.0.0) GO TO 901
42     C 050 CONTINUE
43     C ERR = EPS
44     C PPIV = 0.0
45     C DO 100 I = 1,N
46     C IROW(I) = I
47     C
48     C DO 500 L = 1,N
49     C PIVOT = 0.0
50     C K = L - 1
51     C DO 240 I = L,N
52     C IF (K.LT.1) GO TO 230

```

```

00000100
00000200
00000300
00000400
00000500
00000600
00000700
00000800
00000900
00001000
00001100
00001200
00001300
00001400
00001500
00001600
00001700
00001800
00001900
00002000
00002100
00002200
00002300
00002400
00002500
00002600
00002700
00002800
00002900
00003000
00003100
00003200
00003300
00003400
00003500
00003600
00003700
00003800
00003900
00004000
00004100
00004200
00004300
00004400
00004500
00004600
00004700
00004800
00004900

```

```

50 DO 220 J = 1,K
51 A(I,L) = A(I,L) - A(J,L) * A(I,J)
52 F = CDABS (A(I,L)) / Q(I)
53 IF (PIVOT.GT.F) GO TO 240
54 PIVOT = F
55 NPIVOT = I
56 CONTINUE
57 IF (PIVOT.EQ.0.0) GO TO 901
58 IF (PIV.LE.PIVOT) GO TO 250
59 ERR = ERR + PPIV / PIVOT
60 IF (ERR.GE.1.0) GO TO 901
61
62 250 PPIV = PIVOT
63 IF (NPIVOT.EQ.L) GO TO 280
64 Q(NPIVOT) = Q(L)
65 J = IROW(L)
66 IROW(L) = IROW(NPIVOT)
67 IROW(NPIVOT) = J
68 DO 260 I = 1,N
69 T = A(L,I)
70 A(L,I) = A(NPIVOT,I)
71 A(NPIVOT,I) = T
72 CONTINUE
73 280 IF (L.EQ.N) GO TO 500
74 T = (1.000,0.000) / A(L,L)
75 K = L + 1
76 M = L - 1
77 DO 450 I = K,N
78 IF (M.LT.1) GO TO 400
79 DO 350 J = 1,M
80 A(L,I) = A(L,I) - A(L,J) * A(J,I)
81 A(L,I) = T * A(L,I)
82 CONTINUE
83 450 CONTINUE
84 IF (ERR.GT.1.0E-5) PRINT 998, ERR
85
86 C
87
88 600 DO 620 I = 2,N
89 X(I) = (0.000,0.000)
90 J = IROW(1)
91 X(1) = B(J) / A(1,1)
92 DO 700 I = 2,N
93 J = IROW(I)
94 K = I - 1
95 DO 650 L = 1,K
96 X(I) = X(I) + A(I,L) * X(L)
97 X(I) = (B(J) - X(I)) / A(I,1)
98 CONTINUE
99 K = N - 1
100 DO 800 I = 1,K
101 J = N - I

```

```

100 M = J + 1
101 DO 800 L = M, N
102 X(J) = X(J) - X(L) * A(J, L)
103 800 CONTINUE
104 RETURN
105 C
106 900 PRINT 999
107 ERR = 1.0
108 RETURN
109 901 PRINT 997
110 ERR = 1.0
111 RETURN
112 997 FORMAT ('ERROR IN CLIN EQ, MATRIX IS SINGULAR')
113 998 FORMAT ('CAUTION-')
114 $ ' CLIN EQ HAS DECOMPOSED AN ILL-CONDITIONED MATRIX.' /,
115 $ ' RESULTS WILL HAVE RELATIVE ERROR =', E11.2)
116 999 FORMAT ('ERROR IN CLIN EQ, MATRIX SIZE GREATER THAN 50')
117 END

```

```

00010000
00010100
00010200
00010300
00010400
00010500
00010600
00010700
00010800
00010900
00011000
00011100
00011200
00011300
00011400
00011500
00011600
00011700

```

©PRT, T ARBNMCA.

MORFITT*ARBNMCA(1) ELEMENT TABLE

D NAME	VERSION	TYPE	DATE	TIME	SEQ #	SIZE	PRE,TEXT	(CYCLE WORD)	PSRMODE	LOCATION
HTGAIN		FOR SYMB	29 MAR 79	09:09:08	1	1	37	5 0 1		1792
HTGAIN		RELOCATABLE	29 MAR 79	09:09:13	2	3	56		QTR	1829
HTINTL		FOR SYMB	29 MAR 79	09:09:21	3	103	103	5 0 1		1886
HTINTL		RELOCATABLE	29 MAR 79	09:09:32	4	3	148		QTR	1991
CURVE		FOR SYMB	29 MAR 79	09:10:12	5	43	43	5 0 1		2142
CURVE		RELOCATABLE	29 MAR 79	09:10:13	6	2	17		QTR	2185
AXISM		FOR SYMB	29 MAR 79	09:10:17	7	67	67	5 0 1		2204
AXISM		RELOCATABLE	29 MAR 79	09:10:20	8	2	31		QTR	2271
MDHNKL		FOR SYMB	29 MAR 79	09:10:27	9	73	73	5 0 1		2304
MDHNKL		RELOCATABLE	29 MAR 79	09:10:33	10	2	93		QTR	2377
MAGANG		FOR SYMB	29 MAR 79	09:10:36	11	9	9	5 0 1		2472
MAGANG		RELOCATABLE	29 MAR 79	09:10:36	12	2	4		QTR	2481
CLINEQ		FOR SYMB	29 MAR 79	09:10:41	13	63	63	5 0 1		2487
CLINEQ		RELOCATABLE	29 MAR 79	09:10:43	14	2	46		QTR	2550
MCSTEP		FOR SYMB -Q	23 JUL 79	09:32:17	15	73	73	5 0 1		2598
MCSTEP		RELOCATABLE	23 JUL 79	09:32:19	16	4	28		QTR	2671
ACCUMA		FOR SYMB -Q	19 NOV 79	10:47:02	17	196	196	5 0 1		2703
ACCUMA		RELOCATABLE	19 NOV 79	10:47:23	18	4	92		QTR	2899
MAIN		FOR SYMB -Q	10 JAN 80	15:04:56	19	275	275	5 0 1		2995
MAIN		RELOCATABLE	10 JAN 80	15:05:34	20	7	151		QTR	3270
MCFLD		FOR SYMB -Q	10 JAN 80	15:05:55	21	124	124	5 0 1		3428
MCFLD		RELOCATABLE	10 JAN 80	15:06:59	22	5	71		QTR	3552
MCPLTS		FOR SYMB -Q	15 JAN 80	10:24:00	23	69	69	5 0 1		3628
MCPLTS		RELOCATABLE	15 JAN 80	10:24:17	24	4	61		QTR	3697
PGM		MAP SYMB	15 JAN 80	10:24:17	25	1	1	5 0 1		3762
PGM		ABSOLUTE	15 JAN 80	10:24:17	26	783	783		QTR	3763

171

NEXT AVAILABLE LOCATION-

ASSEMBLER PROCEDURE TABLE EMPTY

COBOL PROCEDURE TABLE EMPTY

FORTRAN PROCEDURE TABLE EMPTY

ENTRY POINT TABLE EMPTY

08RKPT PRINT\$

INITIAL DISTRIBUTION LIST

Department of Defense

Assistant Secretary of Defense
CMD, CONT, COMM & INTELL
Department of Defense
Washington, DC 20301
O1CY ATTN M. Epstein
O1CY ATTN J. Babcock

Director
Command Control Technical Center
ATTN: C-650
11440 Isaac Newton Square, N.
Reston, VA 22091

Director
Command Control Technical Center
ATTN: C-312
Room ME682, The Pentagon
Washington, DC 20301

Director
Defense Advanced Research Project
Agency
Architect Building
1400 Wilson Blvd.
Arlington, VA 22209
O1CY ATTN Nuclear Monitoring Rsch
O1CY ATTN Strategic Tech. Office

Defense Communication Engineering Center
1860 Wiehle Avenue
Reston, VA 22090
O1CY ATTN Code R220 M. Horowitz
O1CY ATTN Code R720 John Worthington
O1CY Code R410 James W. McLean
O1CY Code R103

Director
Defense Communications Agency
Washington, DC 20305
O1CY ATTN Code 810 R. W. Rostron
O1CY ATTN Code 480
O1CY ATTN Code 101B MAJ Rood

Defense Communications Agency
WMCCS System Engineering Org
Washington, DC 20305
O1CY ATTN R. L. Crawford

Defense Technical Information Center
Cameron Station
Alexandria, VA 22314
12CY ATTN TC

Director
Defense Intelligence Agency
Washington, DC 20301
O1CY ATTN DIAST-5
O1CY ATTN DIAAP Albert L. Wise
O1CY ATTN DB-4C Edward OFarrell

Director
Defense Nuclear Agency
Washington, DC 20305
O1CY ATTN DDST
O1CY ATTN TISI Archives
O3CY ATTN TITL Tech. Library
O3CY ATTN RAAE
O1CY ATTN STVL

Commander
Field Command
Defense Nuclear Agency
Kirtland AFB, NM 87115
O1CY ATTN FCPR

Director
Interservice Nuclear Weapons School
Kirtland AFB, NM 87115
O1CY ATTN Document Control

Director
Joint Strat TGT Planning Staff JCS
Offutt AFB
Omaha, NB 68113
O1CY ATTN JPST CAPT D. G. Goetz

Chief
Livermore Division Fld Command DNA
Lawrence Livermore Laboratory
P.O. Box 808
Livermore, CA 94550
O1CY ATTN FCPRL

Director
National Security Agency
FT. George G. Meade, MD 20755
O1CY ATTN W65
O1CY ATTN Oliver H. Bartlett W32
O1CY ATTN Technical Library
O1CY ATTN John Skillman R52

OJCS/J-3
The Pentagon
Washington, DC 20301
(Operations)
O1CY ATTN WMMCCS Eval OFC Mr. Toma

OJCS/J-5
The Pentagon
Washington, DC 20301
(Plans & Policy)
O1CY ATTN Nuclear Division

Under Secy of Defense for Research
and Engineering
Department of Defense
Washington, DC 20301
O1CY ATTN S&SS (OS)

Department of the Army

Commander/Director
Atmospheric Sciences Laboratory
US Army Electronics Command
White Sands Missile Range, NM 88002
O1CY ATTN DELAS-AE-M F. E. Niles

Commander
Harry Diamond Laboratories
2800 Powder Mill Rd.
Adelphi, MD 20783
O1CY ATTN DELHD-NP Francis N. Wimenitz
O1CY ATTN Mildred H. Weiner DRXDO-II

Commander
US Army Electronics Command
Fort Monmouth, NJ 07703
O1CY ATTN DRSEL-RD
O1CY ATTN J. E. Quigley

Commander
US Army Foreign Science & Tech. Center
220 7th Street, NE
Charlottesville, VA 22901
O1CY ATTN R. Jones
O1CY ATTN P. A. Crowley

Commander
US Army Nuclear Agency
7500 Backlick Road
Building 2073
Springfield, VA 22150
O1CY ATTN MONA-WE J. Berberet

Chief
US Army Research Office
P.O. Box 12211
Triangle Park, NC 27709
O1CY ATTN DRXRD-ZC

Department of the Navy

Chief of Naval Operations
Navy Department
Washington, DC 20350
O1CY ATTN OP 941
O1CY ATTN OP-604C3
O1CY ATTN OP 943 LCDR Huff
O1CY ATTN OP 981

Chief of Naval Research
Navy Department
Arlington, VA 22217
O1CY ATTN Code 402
O1CY ATTN Code 420
O1CY ATTN Code 421
O1CY ATTN Code 461
O1CY ATTN Code 464

Commanding Officer
Naval Intelligence Support Center
4301 Suitland Rd. Bldg. 5
Washington, DC 20390

Commander
Naval Ocean Systems Center
San Diego, CA 92152
O1CY ATTN Code 81 H.D. Smith
O3CY ATTN Code 532
O1CY ATTN Code 532 William F. Moler

Director
Naval Research Laboratory
Washington, DC 20375
O1CY ATTN Code 5410 John Davis
O1CY ATTN Code 7701 Jack D. Brown
O1CY ATTN Code 5461 Trans. Iono. Prop.
O1CY ATTN Code 5465 Prop. Applications
O1CY ATTN Code 5460 Electromag. Prop. Br
O2CY ATTN Code 2600 Tech. Library

Officer-in-Charge
Naval Surface Weapons Center
White Oak, Silver Spring, MD 20910
O1CY ATTN Code WA501 Navy Nuc Prgms Off.
O1CY ATTN Code WX21 Tech. Library

Commander
Naval Telecommunications Command
NAVTELCOM Headquarters
4401 Massachusetts Ave, NW
Washington, DC 20390
O1CY ATTN Code 24C

Commanding Officer
Navy Underwater Sound Laboratory
Fort Trumbull
New London, CT 06320
O1CY ATTN Peter Bannister
O1CY ATTN D. A. Miller

Director
Strategic Systems Project Office
Navy Department
Washington, DC 20376
O1CY ATTN NSP-2141

Department of the Air Force

Commander
ADC/DC
ENT AFB, CO 80912
O1CY ATTN DC Mr. Long

Commander
ADCOM/XPD
ENT AFB, CO 80912
O1CY ATTN XPQDQ
O1CY ATTN XP

AF Geophysics Laboratory, AFSC
Hanscom AFB, MA 01731
O1CY ATTN CRU S. Horowitz
O1CY ATTN PHP Jules Aarons
O1CY ATTN OPR James C. Ulwick
O1CY OPR Alva T. Stair
O2CY SUOL Research Library

AF Weapons Laboratory, AFSC
Kirtland AFB, NM 87117
O2CY ATTN SUL
O1CY ATTN SAS John M. Kamm
O1CY ATTN DYC CAPT L. Wittwer

AFTAC
Patrick AFB, FL 32925
O1CY ATTN TN
O1CY ATTN TD-3
O1CY ATTN TD-5
O1CY ATTN TF/MAJ Wiley

Air Force Avionics Laboratory, AFSC
Wright-Patterson AFB, OH 45433
O1CY ATTN AAD

Commander
Foreign Technology Division, AFSC
Wright-Patterson AFB, OH 45433
O1CY ATTN ETD B. L. Ballard

HQ USAF/RD
Washington, DC 20330
O1CY ATTN RDQ

Headquarters
North American Air Defense Command
1500 East Boulder
Colorado Springs, CO 80912
O1CY ATTN Chief Scientist

Commander
Rome Air Development Center, AFSC
Griffiss AFB, NY 13440
O1CY ATTN EMTLD Doc. Library

Commander
Rome Air Development Center, AFSC
Hanscom AFB, MA 01731
O1CY ATTN EEP John Rasmussen

SAMSO/MN
Norton AFB, CA 92409
(Minuteman)
O1CY ATTN NMML LTC Kennedy

Commander in Chief
Strategic Air Command
Offutt AFB, NB 68113
O1CY ATTN NRT
O1CY ATTN XPFS MAJ Brian G. Stephan
O1CY ATTN DOK Chief Scientist

US Energy Research and Dev. Admin.

Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, NM 87115
OICY ATTN Doc Con for D. W. Sherwood

Department of Energy
Division of Headquarters Services
Library Branch G-043
Washington, DC 20545
OICY ATTN Doc Con for Allen Labowitz

Division of Military Application
Department of Energy
Washington, DC 20545
OICY ATTN Doc Con for Donald I. Gale

University of California
Lawrence Livermore Laboratory
P.O. Box 808
Livermore, CA 94550
OICY ATTN Glenn C. Werth L-216
OICY ATTN Tech. Info Dept L-3

Los Alamos Scientific Laboratory
P.O. Box 1663
Los Alamos, NM 87545
OICY ATTN Doc Con for T. F. Taschek
OICY ATTN Doc Con for D. R. Westervelt
OICY ATTN Doc Con for P. W. Keaton
OICY ATTN Doc Con for J. H. Coon

Sandia Laboratories
Livermore Laboratory
P.O. Box 969
Livermore, CA 94550
OICY ATTN Doc Con for B. E. Murphey
OICY ATTN Doc Con for T. B. Cook ORG 8000

Sandia Laboratories
P.O. Box 5800
Albuquerque, NM 87115
OICY ATTN Doc Con for Space Proj Div
OICY ATTN Doc Con for A. D. Thornbrough
ORG 1245
OICY ATTN Doc Con for W. C. Myra
OICY ATTN Doc Con for 3141 Sandia Rpt Coll

Other Government

Department of Commerce
National Bureau of Standards
Washington, DC 20234
OICY ATTN Raymond T. Moore

Department of Commerce
Office of Telecommunications
Institute for TELCOM Science
Boulder, CO 80302
OICY ATTN William F. Utlaut
OICY ATTN L. A. Berry
OICY ATTN A. Glenn Jean
OICY ATTN D. D. Crombie
OICY ATTN J. R. Wait

Department of Transportation
Office of the Secretary
TAD-44.1, Room 10402-B
400 7th Street, SW
Washington, DC 20590
OICY ATTN R. L. Lewis
OICY ATTN R. H. Doherty

Department of Defense Contractors

Aeronomy Corporation
217 S. Neil Street
Champaign, IL 61820
OICY ATTN S. A. Bowhill

Aerospace Corporation
P.O. Box 92957
Los Angeles, CA 90009
OICY ATTN Irving M. Garfunkel

Analytical Systems Engineering Corp.
5 Old Concord Rd.
Burlington, MA 01803
OICY ATTN Radio Sciences

Boeing Company, The
P.O. Box 3707
Seattle, WA 98124
OICY ATTN Glenn A. Hall
OICY ATTN J. F. Kenney

University of California
at San Diego
Marine Physical Lab of the
Scripps Institute of Oceanography
San Diego, CA 92132
OICY ATTN Henry G. Booker

Computer Sciences Corporation
P.O. Box 530
6565 Arlington Blvd
Falls Church, VA 22046
OICY ATTN D. Blumberg

University of Denver
Colorado Seminary
Denver Research Institute
P.O. Box 10127
Denver, CO 80210
OICY ATTN Donald Dubbert
OICY ATTN Herbert Rend

Develco
530 Logue Avenue
Mountain View, CA 94040
OICY ATTN L. H. Rorden

ESL, Inc.
495 Java Drive
Sunnyvale, CA 94086
OICY ATTN James Marshall

General Electric Company
Space Division
Valley Forge Space Center
Goddard Blvd King of Prussia
P.O. Box 8555
Philadelphia, PA 19101
OICY ATTN M. H. Bortner
Space Science Lab.

General Electric Company
TEMPO-Center for Advanced Studies
816 State Street
P.O. Drawer QQ
Santa Barbara, CA 93102
OICY ATTN B. Gambill
O2CY ATTN DASIAC
OICY ATTN Don Chandler
OICY ATTN Warren S. Knapp

Geophysical Institute
University of Alaska
Fairbanks, AK 99701
OICY ATTN T. N. Davis
OICY ATTN Neal Brown
OICY Technical Library

GTE Sylvania, Inc.
Electronics Systems GRP
Eastern Division
77 A Street
Needham, MA 02194
OICY ATTN Marshal Cross

IIT Research Institute
10 West 35th Street
Chicago, IL 60616
OICY ATTN Technical Library

University of Illinois
Department of Electrical Engineering
Urbana, IL 61803
O2CY ATTN Aeronomy Laboratory

Johns Hopkins University
Applied Physics Laboratory
Johns Hopkins Road
Laurel, MD 20810
OICY ATTN Document Librarian
OICY ATTN J. Newland
OICY P. T. Komiske

Lockheed Missiles & Space Co, Inc.
3251 Hanover Street
Palo Alto, CA 94304
OICY ATTN E. E. Gaines
OICY ATTN W. L. Imhof D/52-12
OICY ATTN J. B. Reagan D/52-12
OICY ATTN R. G. Johnson D/52-12

Lowell Research Foundation
450 Aiken Street
Lowell, MA 01854
OICY ATTN Dr. Bibl

M.I.T. Lincoln Laboratory
P.O. Box 73
Lexington, MA 02173
OICY ATTN Dave White
OICY ATTN J. H. Pannell L-246
OICY ATTN D. M. Towle

Mission Research Corporation
735 State Street
Santa Barbara, CA 93101
01CY ATTN R. Hendrick
01CY ATTN F. Fajen
01CY ATTN M. Scheibe
01CY ATTN J. Gilbert
01CY ATTN C. L. Longmire

Mitre Corporation
P.O. Box 208
Bedford, MA 01730
01CY ATTN G. Harding

Pacific-Sierra Research Corp.
1456 Cloverfield Blvd.
Santa Monica, CA 90404
01CY ATTN E. C. Field, Jr.

Pennsylvania State University
Ionosphere Research Laboratory
318 Electrical Engineering East
University Park, PA 16802
02CY ATTN Ionospheric Rsch Lab.

R&D Associates
P.O. Box 9695
Marina Del Rey, CA 90291
01CY ATTN Forrest Gilmore
01CY ATTN William J. Karzas
01CY ATTN Phyllis Greifinger
01CY ATTN Carl Greifinger
01CY ATTN H. A. Ory
01CY ATTN Bryan Gabbard
01CY ATTN R. P. Turco

Rand Corporation
1700 Main Street
Santa Monica, CA 90406
02CY ATTN Technical Library
01CY ATTN Cullen Crain

SRI International
333 Ravenswood Avenue
Menlo Park, CA 94025
01CY ATTN E. T. Pierce
01CY ATTN Donald Neilson
01CY ATTN George Carpenter
01CY ATTN W. G. Chestnut
01CY ATTN J. R. Peterson
01CY ATTN Gary Price

Stanford University
Radio Science Laboratory
Stanford, CA 94305
01CY ATTN R. A. Helliwell
01CY ATTN A. Fraser-Smith
01CY ATTN J. Katsufakis

TRW Defense & Space Sys. Group
One Space Park
Redondo Beach, CA 90278
01CY ATTN Saul Altschuler
01CY ATTN Dianna Dee

Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91103
01 Cy ATTN: Ernest K. Smith
Mail Code: 144-B13

ED
80