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Final Technical Report
June 1976

ENDO ATMOSPHERIC-EXO ATMOSPHERIC RADAR MODELING
(Appendix)

General Dynamics

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ROME AIR DEVELOPMENT CENTER
AIR FORCE SYSTEMS COMMAND
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This effort is concerned with the development and implementation of a set of digital computer programs that will augment the RADC digital computer radar simulation model procured under Contr F30602-72-C-0393 (01707201). The computer programs shall consist of a sequence of subroutines that correspond to separate functions such as a chaff model, target model, propagation effects and clutter model. The original radar simulation model will be expanded to include a bistatic capability and will include ECM and phase coded pulse compression re- (over)

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406 220

ceiver techniques. In addition, an interactive system has been designed for the simulation. Using an interactive display, an engineer would be able to understand what is happening by being able to observe results at several intermediate points in the problem. A picture is worth a thousand words. For example, an antenna pattern or waveform response to a target is more meaningful than a long table of numerical listings. Parts of the simulation were used by RADC for Deep Space Surveillance Radar (DSSR) waveform analysis, generating antenna patterns and tradeoffs involving phase shifter bit-size for the Advanced Space Defense Program (ASDP). The RADC radar simulation model is being used to support Seek Sail, Cobra Judy, Digital Coded Radar and Seek Sentry.

This report contains a large percentage of machine-produced copy which is not of the highest printing quality but because of economical consideration, it was determined in the best interest of the government that they be used in this publication.

This report contains Vol I, Pt 1 (Sections 1-7 and 9-10) (Pages 1-1 thru 1-5, 2-1 thru 2-24, 3-1 thru 3-35, 4-1 thru 4-23, 5-1 thru 5-6, 6-1 thru 6-39, 7-1 thru 7-30, 9-1 thru 9-3 and 10-1 thru 10-2).

Vol I, Pt 2 contains Section 8 (Pages 8-1 thru 8-174).

Vol I, Pt 3 contains Section 8 (Pages 8-175 thru 8-418).

Vol II, Pt 1 contains(Sections 1-8 and 10 & 11) (Pages 1-1, 2-1 thru 2-24, 3-1 thru 3-15, 4-1 thru 4-137, 5-1 thru 5-16, 6-1 thru 6-44, 7-1, 8-1 thru 8-26, 10-1 thru 10-4 and 11-1 thru 11-2).

Vol II, Pt 2 contains Sections 9 and 10 (Pages 9-1 thru 9-234 and Pages 10-1 thru 10-4).

Vol III contains Sections 1 thru 6 (Pages 1-1 thru 1-2, 2-1 thru 2-22, 3-1 thru 3-53, 4-1 thru 4-141, 5-1 thru 5-3 and 6-1).

Vol IV, Pt 1 contains Appendices A-K and Appendix M.

Vol IV, Pt 2 contains Appendix L.

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APPENDIX L

RADAR CROSS SECTION

ANALYTIC MODEL DESCRIPTIONS

The FORTRAN IV computer listings for each of the radar cross section models are located at the end of each of the appropriate sections L.1 through L.7. Although the programs have not been integrated into the Radar Simulation Model, they can be easily made to interface with RADSIM. In the interim they can be run as independent FORTRAN subroutines, which are stored on disc file on the RADC HIS-635 computer under USERID-CLEARY and account number 017073100380 in the following files:*

SECTION	NAME	SUB-FILE	LINES
L.1	Cylinder with Spheroidal Caps	RCSM3	10760, 11430
L.2	Hemisphere-Cylinder	RCSM3	11440, 13680
L.3	Cone, Cylinder or Frustrum	RCSM3	13690, 17460
L.4	Thin Wire	RCSM1	50, 3120
L.5	Frustrum-Cylinder-Frustrum	RCSM1	3130, 7580
L.6	Cylinder-Frustrum Combination	RCSM1	7590, 12170
L.7	Stepped Cylinder	RCSM2	50, 3710

The outputs for all programs consist of four linear arrays - EVVR, EVVI, EHHR and EHHI - which contain the real and imaginary parts of the vertically and horizontally polarized back scattered fields as a function of frequency. The fields are computed at discrete frequency increments (DF) in megahertz, between user defined limits. The low and high frequency limits are equal to (NMIN-1)*DF & (NMAX-1)*DF respectively, where NMIN and NMAX are dimensionless indices. The magnitudes of the arrays - EVVR, EVVI, EHHR and EHHI - have been scaled in order that the target cross section (in square meters) can be obtained from the sum of the squares of the corresponding real and imaginary values of the array.

* A typical use of SUBROUTINE TARGET is shown in Volume I, Part 3, Section 8.24. All subroutines in this appendix can be run using this same FORTRAN program, labelled RCSSP.

L.1 CYLINDER WITH SPHEROIDAL CAPS (RADCAT)

The far-field scattering from the RADCAT vehicle, a large cylinder with spheroidal end caps, has been formulated using an expression involving a physical optics approximation of the backscattering from a cylindrical section and a geometrical optics approximation to the scattering from a spheroid (Ref 1). The resulting expression of the scattering field is the following:

$$e(\theta) = \ell \sqrt{ka\sin\theta} \left\{\frac{\sin(k\ell\cos\theta)}{k\ell\cos\theta}\right\} e^{-i(2ka\sin\theta + \pi/4)}$$

$$+ \left\{ \frac{\sqrt{\pi}\, a^2 c}{a^2 \sin^2\theta + c^2 \cos^2\theta} \right\} e^{-i2k\left(\frac{\ell}{2}\cos\theta + \sqrt{a^2\sin^2\theta + c^2\cos^2\theta}\right)}$$

where the physical dimensions of the target and target geometry are shown in Figure L.1-1 and k = wave number = $2\pi/\lambda$.

The computer program subroutine is used to compute the field backscattered from the target for the case of vertical and horizontal polarizations with respect to the target rotational plane (defined by the target axis of symmetry and the radar line of sight). It should be noted that for the case of this particular target, the formulation of the scattered field is polarized insensitive. The inputs, outputs, restrictions, and definition of key terms of this subroutine are presented in the following paragraphs.

L.1.1 Inputs

The subroutine inputs are read from cards or passed in a common block. The used inputs passed in the common block are the following:

FC = Carrier Frequency in GHz, not necessarily the mid frequency

DF = Frequency increment in MHz

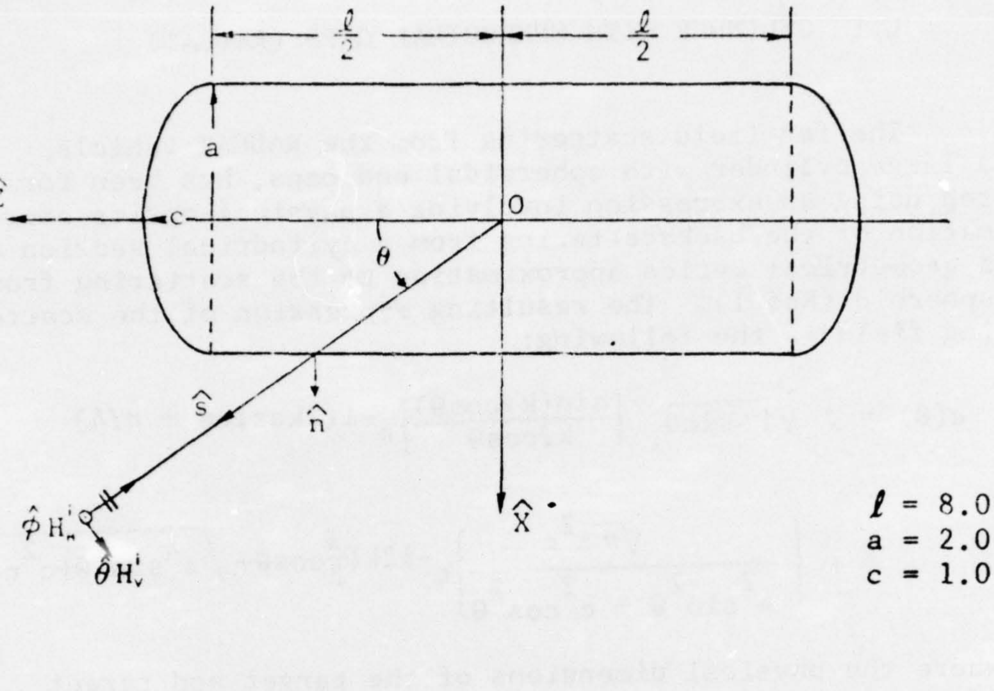


Fig. L.1-1 RADCAT TARGET GEOMETRY

NMIN = Minimum frequency index, i.e. f_{min} = DF*(NMIN-1)

NMAX = Maximum frequency index, i.e. f_{max} = DF*(NMAX-1)

The inputs which are read from a card are the following:

	MATH SYMBOL	VARIABLE	DEFINITION	COLUMNS
Card 1	a	XA	Radius of cylindrical section (feet)	1-6
	c	XC	Depth of Spheroidal Cap (feet)	7-12
	ℓ	XL	Length of cylindrisection (feet)	13-18
	θ	THETA	Azimuth angle (degrees)	19-24

L.1.2 Outputs

The outputs consist of four linear arrays EVVR, EVVI, EHHR, EHHI which contain the real and imaginary parts of the vertically and horizontally polarized back scattered fields (in meters) at frequency increments of DF between DF*(NMIN-1) and DF*(NMAX-1). The bandwidth of the output then equals DF*(NMAX-NMIN).

L.1.3 Restrictions

L.1.3.1 Physical Dimensions

As high-frequency approximations were utilized, all physical target dimensions should be large with respect to the wavelength of the illuminating field. Thus, XA, XC, and XL should be larger than the wavelength of the smallest frequency at which a computation is obtained. The condition XC < XA is also implied in the formulation of the problem.*

L.1.3.2 Output

The output arrays are passed in the argument list and a value is computed only for array locations from NMIN to NMAX.

*Also, $1 \leq$ NMIN $\leq$ NMAX ≤ 512.

L.1.3.3 Azimuth

The azimuth angle is restricted to the region between 0 and 90 degrees.

L.1.4 Definition of Key Terms Used in Subroutine

$$\text{TERM 7} = +\left\{ \frac{\sqrt{\Pi} \quad a^2 c}{a^2 \sin^2\theta + c^2 \cos^2\theta} \right\}$$

$$\text{TERM 2} = \ell\sqrt{ka\sin\theta}$$

$$\text{TERM 4} = \frac{\sin(k\ell\cos\theta)}{k\ell\cos\theta}$$

$$\text{TERM 5} = (2ka\sin\theta + \Pi/4)$$

$$\text{TERM 8} = 2k(\frac{\ell}{2}\cos\theta + \sqrt{a^2\sin^2\theta + c^2\cos^2\theta}$$

```
$        IDENT    BECAGD01,HANCOKC,017073100380,DSTOR2
$        OPTION   FORTRAN
$        FORTY    LSTIN,XREF,MAP,DECK
$        LIMITS   05,39K,0,5K
      SUBROUTINE TARGET (EVVR, EVVI, EHHR, EHHI)
C
C     * * TARGET ST-1, RADCAT, PHYSICAL 0PTICS APPROXIMATION * *
C
      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, T0
C     NMIN = MINIMUM FREQUENCY SAMPLE
C     NMAX = MAXIMUM FREQUENCY SAMPLE
C     DF   = FREQUENCY INCREMENT IN MHZ
C     FC   = CARRIER FREQUENCY IN GHZ
C
      DIMENSION EVVR(512), EVVI(512), EHHR(512), EHHI(512)
C
C     * * ALL DIMENSIONS ARE IN FEET * *
C
      READ (5, 1000) XA, XC, XL, THETA
 1000 FORMAT (4F6.2)
C
      C  = .983570
      PI = 3.141593
      KC = 2.0 * PI * FC
C     THET = ANGLE IN RADIANS CONVERTED FROM INPUT ANGLE IN DEGREES
      THET  = THETA * (PI / 180.0)
      STHT  = SIN(THET)
      CTHT  = COS(THET)
      SSTHT = STHT * STHT
      CSTHT = CTHT * CTHT
      TERM6 = (XA * XA * SSTHT) + (XC * XC * CSTHT)
      TERM  = XA * XA * XC * SQRT(PI)
      TERM7 = TERM / TERM6
C
      DO 100 I=NMIN, NMAX
      X  = (I-1)
      W = (2.0 * PI * X * DF) / 1000.0
C
      XK0 = W / C
C
      TERM1 = XK0 * XA * STHT
      TERM2 = XL * SQRT(TERM1)
C     COMPUTE K*L*SIN(THET), TEST, AND COMPUTE SIN(X)/X WHERE
C              X = K*L*SIN(THET)
      TERM3 = XK0 * XL * CTHT
      IF (TERM3 .LE. 1.0E-9) GO TO 10
      TERM4 = (SIN(TERM3)) / TERM3
      GO TO 20
   10 TERM4 = 1.0
C     COMPUTE PHASE TERM FOR CYLINDER(TERM5) AND SPHEROID(TERM8)
   20 TERM5 = (2.0 * TERM1) + (PI / 4.0)
      TERM8 = TERM3 + (2.0 * XK0 * SQRT(TERM6))
C     COMPUTE REAL AND IMAGINARY PARTS OF CYLINDRICAL (FIRSTR,FIRSTI)
C              AND OBLATE SPHEROIDAL (SECNDR,SECNDI) RETURNS
      FIRSTR = TERM2 * TERM4 * COS(TERM5)
      FIRSTI = TERM2 * TERM4 * SIN(TERM5)
      SECNDR = TERM7 * COS(TERM8)
      SECNDI = TERM7 * SIN(TERM8)


76    16 08


C
C     SUM RETURNS AND CONVERT FROM FEET TO METERS
      EVVR(I) = (FIRSTR + SECNDR) * 0.304831
```

```
      EVVI(I) = (FIRSTI + SECNDI) * 0.304831
      EHHR(I) = EVVR(I)
      EHHI(I) = EVVI(I)
  100 CONTINUE
C
      WRITE (6, 2000) THETA
 2000 FORMAT ( '        ASPECT ANGLE = ', F6.2, ' DEG')
C
      RETURN
C
      END
```

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

```
/ TARGET /

    *

* * TARGET ST-1,
RADCAT, PHYSICAL
OPTICS
APPROXIMATION * *

NMIN = MINIMUM
FREQUENCY SAMPLE
NMAX = MAXIMUM
FREQUENCY SAMPLE
DF   = FREQUENCY
INCREMENT IN MHZ
FC   = CARRIER
FREQUENCY IN GHZ

* * ALL DIMENSIONS
ARE IN FEET * *

    *
    |                01
/ READ FROM DEV /
 /     5       /
/  VIA FORMAT  /
/     1000    /
/ INTO THE LIST /
    |
    |   NOTE  02
* * * * * * * * * * *
*  LIST = XA, XC,   *
*     XL, THETA     *
* * * * * * * * * * *
    |
    |               03
*-------------------*
| C = .9835709      |
| PI = 3.141593     |
| WC = 2.0*PI*FC    |

+-----------01.07*-->*
                     |          08
     *----------------------*
     |    X = (I - 1)       |
     |        W =           |
     |  (2.0*PI*X*DF)       |
     |      /1000.0         |
     *----------------------*

         / 10 /
           |
+--------->|
           |               14
     *------------------*
     |  TERM4 = 1.0     |
     *------------------*
           |
COMPUTE PHASE TERM
FOR CYLINDER(TERM5)
AND SPHEROID(TERM8)
           |
+--------->|
 20        |               15
     *------------------*
     |     TERM5 =      |
     | (2.0*TERM1) +    |
     |    (PI/4.0)      |
     |                  |
     | TERM8 = TERM3 +  |
     | (2.0*XKO*SQRT    |
     |    (TERM6))      |
     *------------------*
           |
COMPUTE REAL AND
IMAGINARY PARTS OF
CYLINDRICAL
(FIRSTR,FIRSTI)
AND OBLATE SPHEROIDAL
(SECNDR,SECNDI)
RETURNS
           |               16
     *------------------*
     |     FIRSTR =     |
     | TERM2*TERM4*COS  |
     |     (TERM5)      |
     |     FIRSTI =     |
     | TERM2*TERM4*SIN  |
     |     (TERM5)      |
     |     SECNDR =     |
     | TERM7*COS(TERM8) |
     *------------------*
```

```
                03
*-------------------*
| C = .9835709      |
|                   |
| PI = 3.141593     |
|                   |
| WC = 2.0*PI*FC    |
*-------------------*
         |
THET = ANGLE IN
RADIANS CONVERTED
FROM INPUT ANGLE IN
DEGREES
         |
                04
*-------------------*
| THET =            |
| THETA*(PI/180.0)  |
|                   |
| STHT = SIN(THET)  |
|                   |
| CTHT = COS(THET)  |
|                   |
| SSTHT = STHT*STHT |
*-------------------*
         |
                05
*-------------------*
| CSTHT = CTHT*CTHT |
|                   |
| TERM6 =           |
| (XA*XA*SSTHT) +   |
| (XC*XC*CSTHT)     |
|                   |
| TERM =            |
| XA*XA*XC*SQRT(PI) |
*-------------------*
         |
                06
*-------------------*
| TERM7 =           |
| TERM/TERM6        |
*-------------------*
         |
         |  NOTE  07
* * * * * * * * * * *
*  BEGIN DO LOOP    *
*  100 I = NMIN,    *
*      NMAX         *
* * * * * * * * * * *

*-------------------*
| W =               |
| (2.0*PI*X*DF)     |
| /1000.0           |
*-------------------*
         |
                09
*-------------------*
| XKO = W/C         |
*-------------------*
         |
                10
*-------------------*
| TERM1 =           |
| XKO*XA*STHT       |
|                   |
| TERM2 =           |
| XL*SQRT(TERM1)    |
*-------------------*
         |
COMPUTE
K*L*SIN(THET), TEST,
AND COMPUTE SIN(X)/X
WHERE
X = K*L*SIN(THET)
         |
                11
*-------------------*
| TERM3 =           |
| XKO*XL*CTHT       |
*-------------------*
         |
         *  12
       *   *
     *       *   TRUE
   * TERM3 .LE. *-----*
     * 1.0E-9  *
       *   *
         *
         | FALSE
         |
                13
*-------------------*
| TERM4 =           |
| (SIN(TERM3))      |
| /TERM3            |
*-------------------*

*-------------------*
| FIRSTI =          |
| TERM2*TERM4*SIN   |
| (TERM5)           |
|                   |
| SECNDR =          |
| TERM7*COS(TERM8)  |
*-------------------*
         |
                17
*-------------------*
| SECNDI =          |
| TERM7*SIN(TERM8)  |
*-------------------*
         |
SUM RETURNS AND
CONVERT FROM FEET TO
METERS
         |
                18
*-------------------*
| EVVR(I) =         |
| (FIRSTR +         |
| SECNDR)*0.304831  |
|                   |
| EVVI(I) =         |
| (FIRSTI +         |
| SECNDI)*0.304831  |
|                   |
| EHHR(I) = EVVR(I) |
*-------------------*
         |
                19
*-------------------*
| EHHI(I) = EVVI(I) |
*-------------------*
         |
  100    *    20
       *   *
     *       *     NO
   * END OF DO *---+--------------->*
     * LOOP?   *                    |            21
       *   *                 -------------------
         *                  / WRITE TO DEV    /
         | YES     ....    /       6         /
         |       .  1  .  /   VIA FORMAT    /
         |       . 08  . /       2000      /
         |         .... / FROM THE LIST   /
                       -------------------
                                |
                                |  NOTE  22
                        * * * * * * * * * * *
                        *  LIST = THETA     *
                        * * * * * * * * * * *
                                |
                                |  23
                            ---------
                            * EXIT  *
                            ---------
```

FORTRAN MODULE (SCD,LIST2)

```
CARD NO   ****                          CONTENTS                                  ****
      SUBROUTINE TARGET (EVVR, EVVI, EHHR, EHHI)                                RCS3 001
C                                                                               RCS3 002
C     * * TARGET ST-1, RADCAT, PHYSICAL OPTICS APPROXIMATION * *                RCS3 003
C                                                                               RCS3 004
      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, TO                               RCS3 005
C     NMIN = MINIMUM FREQUENCY SAMPLE                                           RCS3 006
C     NMAX = MAXIMUM FREQUENCY SAMPLE                                           RCS3 007
C     DF   = FREQUENCY INCREMENT IN MHZ                                         RCS3 008
C     FC   = CARRIER FREQUENCY IN GHZ                                           RCS3 009
C                                                                               RCS3 010
      DIMENSION EVVR(512), EVVI(512), EHHR(512), EHHI(512)                      RCS3 011
C                                                                               RCS3 012
C     * * ALL DIMENSIONS ARE IN FEET * *                                        RCS3 013
C                                                                               RCS3 014
      READ (5, 1000) XA, XC, XL, THETA                                          RCS3 015
 1000 FORMAT (4F6.2)                                                            RCS3 016
C                                                                               RCS3 017
      C  = .9835709                                                             RCS3 018
      PI = 3.141593                                                             RCS3 019
      WC = 2.0 * PI * FC                                                        RCS3 020
C     THET = ANGLE IN RADIANS CONVERTED FROM INPUT ANGLE IN DEGREES             RCS3 021
      THET  = THETA * (PI / 180.0)                                              RCS3 022
```

```
      WC = 2.0 * PI * FC                                              RCS3 020
C     THET = ANGLE IN RADIANS CONVERTED FROM INPUT ANGLE IN DEGREES   RCS3 021
      THET  = THETA * (PI / 180.0)                                    RCS3 022
      STHT  = SIN(THET)                                               RCS3 023
      CTHT  = COS(THET)                                               RCS3 024
      SSTHT = STHT * STHT                                             RCS3 025
      CSTHT = CTHT * CTHT                                             RCS3 026
      TERM6 = (XA * XA * SSTHT) + (XC * XC * CSTHT)                   RCS3 027
      TERM  = XA * XA * XC * SQRT(PI)                                 RCS3 028
      TERM7 = TERM / TERM6                                            RCS3 029
C                                                                     RCS3 030
      DO 100 I=NMIN, NMAX                                             RCS3 031
      X   = (I-1)                                                     RCS3 032
      W = (2.0 * PI * X * DF) / 1000.0                                RCS3 033
C                                                                     RCS3 034
      XKO = W / C                                                     RCS3 035
C                                                                     RCS3 036
      TERM1 = XKO * XA * STHT                                         RCS3 037
      TERM2 = XL * SQRT(TERM1)                                        RCS3 038
C     COMPUTE K*L*SIN(THET), TEST, AND COMPUTE SIN(X)/X WHERE         RCS3 039
C               X = K*L*SIN(THET)                                     RCS3 040
      TERM3 = XKO * XL * CTHT                                         RCS3 041
      IF (TERM3 .LE. 1.0E-6) GO TO 10                                 RCS3 042
      TERM4 = (SIN(TERM3)) / TERM3                                    RCS3 043
      GO TO 20                                                        RCS3 044
   10 TERM4 = 1.0                                                     RCS3 045
C     COMPUTE PHASE TERM FOR CYLINDER(TERM5) AND SPHEROID(TERM8)      RCS3 046
   20 TERM5 = (2.0 * TERM1) + (PI / 4.0)                              RCS3 047
```

```
      IF (TERM3 .LE. 1.0E-4) GO TO 10                               RCS3 042
      TERM4 = (SIN(TERM3)) / TERM3                                   RCS3 043
      GO TO 20                                                       RCS3 044
   10 TERM4 = 1.0                                                    RCS3 045
C     COMPUTE PHASE TERM FOR CYLINDER(TERM5) AND SPHEROID(TERM8)     RCS3 046
   20 TERM5 = (2.0 * TERM1) + (PI / 4.0)                             RCS3 047
      TERM8 = TERM3 + (2.0 * XKD * SQRT(TERM6))                      RCS3 048
C     COMPUTE REAL AND IMAGINARY PARTS OF CYLINDRICAL (FIRSTR,FIRSTI) RCS3 049
C             AND UPDATE SPHEROIDAL (SECNDR,SECNDI) RETURNS          RCS3 050
      FIRSTR = TERM2 * TERM4 * COS(TERM5)                            RCS3 051
      FIRSTI = TERM2 * TERM4 * SIN(TERM5)                            RCS3 052
      SECNDR = TERM7 * COS(TERM8)                                    RCS3 053
      SECNDI = TERM7 * SIN(TERM8)                                    RCS3 054
C                                                                    RCS3 055
C     SUM RETURNS AND CONVERT FROM FEET TO METERS                    RCS3 056
      EVVR(I) = (FIRSTR + SECNDR) * 0.304831                         RCS3 057
      EVVI(I) = (FIRSTI + SECNDI) * 0.304831                         RCS3 058
      EHHR(I) = EVVR(I)                                              RCS3 059
      EHHI(I) = EVVI(I)                                              RCS3 060
  100 CONTINUE                                                       RCS3 061
C                                                                    RCS3 062
      WRITE (6, 2000) THETA                                          RCS3 063
 2000 FORMAT ( '       ASPECT ANGLE = ', F6.2, ' DEG')               RCS3 064
C                                                                    RCS3 065
      RETURN                                                         RCS3 066
C                                                                    RCS3 067
```

3

L.2 HEMISPHERE - CYLINDER

The far-field scattering from a hemisphere - cylinder has been formulated using the Ruck-Ufimtsev formulation of the scattering from a cylinder and a modified expression has been utilized in describing the hemispherical returns (Ref 2). The resulting expression of the scattered field is the following:

$$e(\theta)_{\{V \atop H\}} = \mp 2\sqrt{\pi} \left\{ \frac{a}{2\sqrt{3}} e^{i2kh \cos\theta} \left[\frac{2}{3} B_{21+} \pm \left(\frac{1}{0.5+\cos\frac{4\theta}{3}} \right) B_{01-} \right. \right.$$

$$\left. + Q_+ \left\{ \frac{2}{3} B_{21-} \pm \left(\frac{1}{0.5+\cos\frac{2(\pi-2\theta)}{3}} \right) B_{01+} \right\} \right]$$

$$\mp \frac{a}{4} \tan\theta \, B_{01-} e^{-i2kh \cos\theta}$$

$$\left. \mp Q_-(S) \pm Q_+ \left(CW_{v \atop o} \right) \right\}$$

where
$$B_{21\pm} = J_2(\zeta) \pm i\, J_1(\zeta)$$
$$B_{01\pm} = J_o(\zeta) \pm i\, J_1(\zeta)$$
$$\zeta = 2ka \sin\theta$$
$$Q_+ = Q(2ka(\theta - \pi/2))$$
$$Q_- = Q(2ka(\pi/2 - \theta))$$
$$k = 2\pi/\lambda = \text{wave number.}$$

In the primary equation, the upper and lower signs designate the vertically and horizontally polarized returns respectively. The factors S and CW are the sphere specular and spherical creeping-wave returns respectively. They are expanded as follows:

$$S = \frac{a}{2}\left\{1 - \frac{i}{2ka}\right\} e^{-i2k(a+h\cos\theta)}$$

$$CW_v = \frac{a}{2}(2.7162)K\left\{(1+\frac{0.54555}{K^2}) + i\frac{0.94489}{K^2}\right\}e^{-i2kh\cos\theta}\cdot$$

$$\exp\left\{-(2.20075K-\frac{0.44525}{K}) + i(\pi ka+\frac{\pi}{3}+1.27065K+\frac{0.25707}{K})\right\}$$

where $K = (ka)^{1/3}$ and the geometry of the problem is shown in Figure L.2-1. The inputs, outputs, restrictions, and definition ot key terms in the subroutine are presented in the following paragraphs.

L.2.1 INPUTS

The subroutine inputs are read from cards or passed in a common block. The parameters passed in the common block are FC, DF, NMIN, NMAX and are described in Appendix L.1.1.

The inputs read from a card are the following:

	MATHEMATICAL SYMBOL	VARIABLE	DEFINITION	COLUMNS
Card 1	a	A	Radius of hemisphere (inches)	1-10
	h	H	1/2 length of cylinder (inches)	11-20
	θ	ASPECT	Azimuth angle (degrees)	21-30

L.2.2 OUTPUTS

The data base output consists of four linear arrays, EVVR, EVVI, EHHR, EHHI, which contain the real and imaginary parts of the vertically and horizontally polarized backscattered fields (in meters) at frequency increments between NMIN and NMAX.

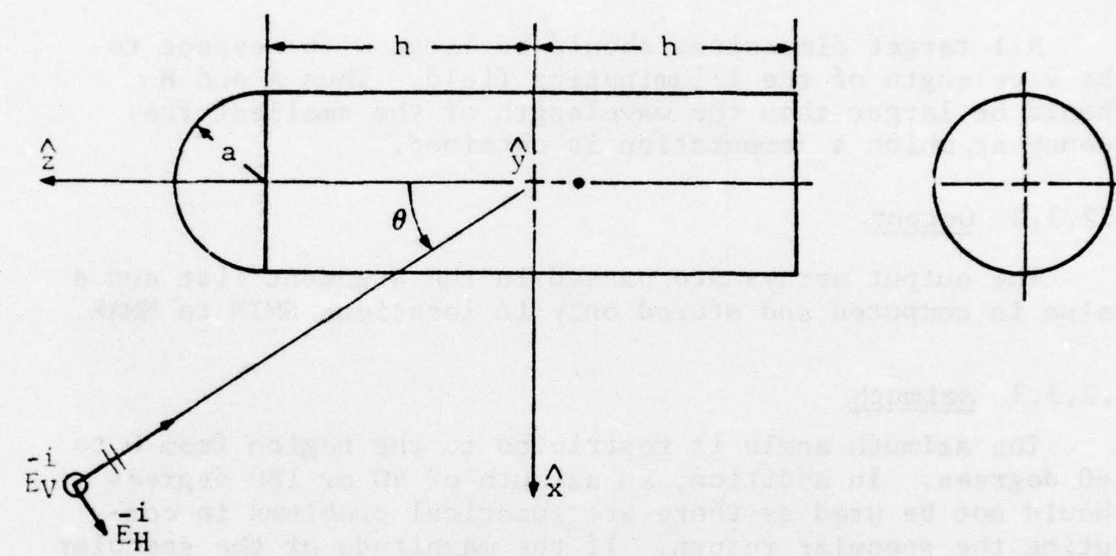


Fig. L.2.1 HEMISPHERE-CYLINDER TARGET GEOMETRY

In addition to the data-base output, if the print option is selected, the frequency, and cross-section (in dBsm) and phase for the case of both vertical and horizontal polarization will be listed.

L.2.3 Restrictions

L.2.3.1 Physical Dimensions

All target dimensions should be large with respect to the wavelength of the illuminating field. Thus A and H should be larger than the wavelength of the smallest frequency at which a computation is obtained.

L.2.3.2 Output

The output arrays are passed in the argument list and a value is computed and stored only in locations NMIN to NMAX.

L.2.3.3 Azimuth

The azimuth angle is restricted to the region from 0 to 180 degrees. In addition, an azimuth of 90 or 180 degrees should not be used as there are numerical problems in computing the specular return. If the magnitude of the specular returns are desired, azimuths of 89.99, 90.01 or 179.99 degrees should be used.

L.2.4 Definition of Key Terms Used in Subroutine

$$\text{TERM 4} = \left(\frac{1}{0.5+\cos\frac{4\theta}{3}}\right)$$

$$\text{TERM 5} = \left(\frac{1}{0.5+\cos\frac{2(\pi-2\theta)}{3}}\right)$$

$$\text{PHASE 1} = \frac{a}{2\sqrt{3}}e^{i2kh\cos\theta}$$

$$\text{TERM 2} = \zeta = 2ka \sin\theta$$

$$\text{COEFF1} = B_{01+} = J_o(\zeta) + i\, J_1(\zeta)$$

$$\text{FFVV1} = \frac{a}{2\sqrt{3}} e^{i2kh\cos\theta} \left[\frac{2}{3} B_{21+} + \left(\frac{1}{0.5+\cos\frac{4\theta}{3}} \right) B_{01-} \right.$$

$$\left. + Q_+ \left\{ \frac{2}{3} B_{21-} + \left(\frac{1}{0.5+\cos\frac{2(\pi-2\theta)}{3}} \right) B_{01+} \right\} \right]$$

$$\text{FFVV2} = -\frac{a}{4} \tan\theta\, B_{01-} e^{-i2kh\cos\theta}$$

$$\text{ARGMNT*PHASE 3} = \frac{a}{2} \left\{ 1 - \frac{i}{2ka} \right\} e^{-i2k(a+h\cos\theta)}$$

$$\text{PART 1} = \frac{a}{2}(2.7162)K \quad \exp\left\{ -(2.20075K - \frac{0.44525}{K} \right)$$

$$\text{PHASE 4} = \exp\left\{ +i(\pi ka + \frac{\pi}{3} + 1.27065K + \frac{0.25707}{K}) \right\} \bullet e^{-i2kh\cos\theta}$$

$$\text{YY} = \left\{ (1 + \frac{0.54555}{K^2}) + i\frac{0.94489}{K^2} \right\}$$

$$\text{Q PLUS} = Q_+ = Q(2ka(\theta - \pi/2)$$

$$\text{QMINUS} = Q_- = Q(2ka(\pi/2 - \theta))$$

L.2.5 Subroutines Utilized

Subfunctions:

Q(X) computes the exponential smoothing function Q for real argument x

Subroutines:

BESL (TERM 2, XJO, XJ1, XJ2) returns

JO (TERM 2) in XJO

J1 (TERM 2) in XJO

J1 (TERM 2) in XJ1

J2 (TERM 2) in XJ2

```
      SUBROUTINE TARGET (EVVR, EVVI, EHHR, EHHI)

      * * TARGET ST-5, HEMISPHERE CYLINDER, UFIMTSEV TECHNIQUE * *

      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, T0
      NMIN = MINIMUM FREQUENCY SAMPLE
      NMAX = MAXIMUM FREQUENCY SAMPLE
      DF   = FREQUENCY INCREMENT IN MHZ
      FC   = CARRIER FREQUENCY IN GHZ
      DIMENSION EVVR(512), EVVI(512), EHHR(512), EHHI(512)
     1, FREQ(512), SIGMAV(512), SIGMAH(512), PHASEV(512), PHASEH(512)
      COMPLEX COEFF1, COEFF2, PHASE1, PHASE2, PHASE3, PHASE4, FFVV, FFHH
     1, FFVV1, FFHH1,  FFVV2,  FFHH2,  FFVV3,  FFHH3,  FFVV4, CFVV, CFHH
     1 , YY

      A      = RADIUS OF HEMISPHERE
      H      = HALF THE CYLINDER LENGTH
      ASPECT = AZIMUTH ANGLE
      M1     = PRINT OPTION
      ** DIMENSIONS ARE IN INCHES AND ANGLE IS IN DEGREES * *

      READ(5,1000) A,H,ASPECT,M1
 1000 FORMAT( 3F10.0,I5)
      WRITE (6, 1111) A, H, ASPECT, M1
 1111 FORMAT(1H0, ' A = ',  F15.5 , 10X,  ' H = ', F15.5  .//
     1        1H0, ' THETA = ', F15.5, 15X, ' PRINT OPTION = ', I5

      PI     = 3.14159265358979
      PISQRT = SQRT(PI)
      PIOVR2 = PI / 2.0
      PIOVR3 = PI / 3.0
      S      = -(2.0 / 3.0)
      DTR    = PI / 180.0

      THETA  = ASPECT * DTR
      STHT   = SIN(THETA)
      CTHT   = COS(THETA)
      ZZ      = (A/4.0) * (STHT/CTHT)
      COMPUTE EDGE DIFFRACTION COEFFICIENTS
      THT403 = (4.0 * THETA) / 3.0
      THT3U4 = (2.0 * PIOVR3) - THT403
      TERM1  = (A * SIN(PIOVR3)) / 3.0
      TERM4  = 1.0 / (0.5 + COS(THT403))
      TERM5  = 1.0 / (0.5 + COS(THT3U4))
      TERM6  = S + TERM4
      TERM7  = S - TERM4
      TERM8  = S + TERM5
      TERM9  = S - TERM5
      C      = 11.80285078

      X2KCA   = 2.0 * (0.53234454*FC)        * A
      COMPUTE Q (SMOOTHING) FUNCTIONS
      ZP      = X2KCA * (THETA - PIOVR2)
      ZM      = X2KCA * (PIOVR2 - THETA)
      QPLUS   = Q(ZP)
      QMINUS  = Q(ZM)
```

```
C
C     FREQUENCY LOOP
      DO 900 I = NMIN, NMAX
      XI      = I - 1
      W       = (2.0 * PI * XI * DF) / 1000.0
      FREQ1   = XI * DF / 1000.0
      XK0     = W / C
      P       = (XK0 * A) ** (1.0 / 3.0)
      P2       = P * P
      PART1   = (A / 2.0) * 2.7162 * P * EXP((-2.20075*P) + (0.44525/P))
      TERM0   = 2.0 * XK0 * A
      TERM2   = TERM0 * STHT
      TERM3   = 2.0 * XK0 * H * CTHT
      ARGMNT   = (A/2.0) * SQRT(1.0 + (1.0 /(TERM0*TERM0)))
C
      XJ0     = 0.0
      XJ1     = 0.0
      XJ2     = 0.0
      CALL BESL (TERM2, XJ0, XJ1, XJ2)
C
      COEFF1 = CMPLX(XJ0, XJ1)
      COEFF2 = CONJG(COEFF1)
      COEFF3 = (-5) * (XJ0 + XJ2)
C
      FASE1R = TERM1 * COS(TERM3)
      FASE1I = TERM1 * SIN(TERM3)
      PHASE1 = CMPLX(FASE1R, FASE1I)
C
      FASE2R  = ZZ * COS(TERM3)
      FASE2I  = ZZ * (-SIN(TERM3))
      PHASE2 = CMPLX(FASE2R, FASE2I)
C
      ARG     = TERM0 + TERM3 - ATAN2(-1.0, TERM0)
      FASE3R = COS(ARG)
      FASE3I = -SIN(ARG)
      PHASE3 = CMPLX(FASE3R, FASE3I)
C
      ARG     = PIOVR2+(1.27065*P)+(0.25707/P)+(TERM0*PIOVR2)-TERM3
      FASE4R = COS(ARG)
      FASE4I = +SIN(ARG)
      PHASE4 = CMPLX(FASE4R, FASE4I)
C
C     CYLINDRICAL EDGE + SURFACE RETURN FROM BACK END
      FFVV1   = (QPLUS*(COEFF1*TERM8+COEFF3)+COEFF2*TERM6+COEFF3)*PHASE1
      FFHH1   = (QPLUS*(COEFF1*TERM9+COEFF3)+COEFF2*TERM7+COEFF3)*PHASE1
C
C     CYLINDRICAL SURFACE RETURN (CYLINDER-HEMISPHERE JUNCTION)
      FFVV2   = COEFF2 * PHASE2
      FFHH2   = FFVV2
C
C     HEMISPHERE SPECULAR
      FFVV3     = ARGMNT * PHASE3 * QMINUS
      FFHH3   = FFVV3
C
C     HEMISPHERE CREEPING WAVE
      YY        = CMPLX ( (1.0 +(0.54555/P2)) , (0.94489/P2) )
      FFVV4   = QPLUS * PART1 *    YY  * PHASE4
C
```

```
      FFVV      = 0.025406*(-2.0*PISQRT)*(FFVV1-FFVV2-FFVV3+FFVV4)
      FFHH      = 0.025406*( 2.0*PISQRT)*(FFHH1+FFHH2+FFHH3       )
      CFVV     = CONJG(FFVV)
      CFHH     = CONJG(FFHH)
C
      EVVR(I)    = REAL(CFVV)
      EVVI(I)    = AIMAG(CFVV)
      EHHR(I)    = REAL(CFHH)
      EHHI(I)    = AIMAG(CFHH)
C
      IF (M1) 20, 20, 10
   10 CONTINUE
C
C     DETERMINATION OF CROSS SECTION(IN DBSM) AND PHASE(IN DEGREES)
C                    FOR PRINTOUT OF RESPONSE VERSUS FREQUENCY
      FREQ(I)    = (XI + DF) / 1000.0
      SIGMAV(I)= 10.0*ALOG10(EVVR(I)*EVVR(I) + EVVI(I)*EVVI(I))
      SIGMAH(I)= 10.0*ALOG10(EHHR(I)*EHHR(I) + EHHI(I)*EHHI(I))
      PHASEV(I)= 57.29578 * ATAN2 (EVVI(I), EVVR(I))
      PHASEH(I)= 57.29578 * ATAN2 (EHHI(I), EHHR(I))
C
   20 CONTINUE
C
  900 CONTINUE
C
      IF (M1) 40, 40, 30
   30 CONTINUE
C
C     WRITE (6, 1500)
C1500 FORMAT (1H1)
C     WRITE (6, 2000)(FREQ(I), SIGMAV(I), PHASEV(I), SIGMAH(I),PHASEH(I)
C    1             , I=NMIN,NMAX)
C2000 FORMAT (1H , F10.5, 4F10.2)
   40 CONTINUE
C
      RETURN
      END
      SUBROUTINE BESL ( X, B0, B1, B2 )
C
C   * BESSEL FUNCTION SUBROUTINE UTILIZING POLYNOMIAL APPROXIMATIONS
C   * COMPUTES J0,J1,OR J2 FOR POSITIVE REAL ARGUMENTS
C   * REFERENCE (HNDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN SECTION 9.4 )
C
      S = 1.0
      IF (X .LT. 0.0) S = -1.0
      X = ABS (X)
C
      IF ( X .GT. 1.E-6 ) GO TO 5
      B0 = 1.0
      B1 = 0.0
      B2 = 0.0
      X = X * S
      RETURN
C
    5 CONTINUE
C
    1 IF ( X .GE. 3.) GO TO 9
      X1 = X/3
```

```
      X1 = X1*X1
      B = 1.+ X1*(-2.2499997+ X1*(1.2656208+ X1*(-.3163866+ X1*(.0444479
     1 +      X1*(-.0039444+ X1*2.1E-4 )))) )
      GO TO 10
C
    9 X2 = 3./X
      F0 =  .79788456 +X2*(-.77E-6 +X2*(-.00552740 +X2*(-.9512E-4 +X2*
     1        (.00137237 +X2*(-.72805E-3 +X2*0.14476E-3 )))) )
      T0 = X - .78539816 +X2*(-.04166397 +X2*(-.3954E-4 +X2*(.00262573
     1      +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))
      B = F0*COS(T0)/SQRT(X)
C
   10 B0 = B
C
    2 IF ( X .GE. 3. ) GO TO 19
      X1 = X/3
      X1 = X1*X1
      B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*
     1                  (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4))))) )
      GO TO 20
C
   19 X2 = 3./X
      F1 = .79788456 +X2*(.156E-5 +X2*(.01659667 +X2*(.00017105 +X2*
     1        (-.00249511 +X2*(.00113653 -.00020033*X2 )))))
      T1 = X - 2.35619449 +X2*(.12499612 +X2*(.565E-4 +X2*(-.00637879
     1      +X2*(.00074348 +X2*(.00079824 -0.00029166*X2 )))))
      B = F1*COS(T1)/SQRT(X)
C
   20 B1 = B * S
      X = X * S
      B2= (2./X)*B1 - B0
   50 RETURN
      END
      FUNCTION Q(Z)
C
      IF ( Z.GT. 2.) GO TO 10
      IF ( Z.LT.-2.) GO TO 20
      AZ = ABS(Z)
      P = 1.0/(1.0 + .47047*AZ)
      Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P))*EXP(-AZ*AZ)
      IF (Z) 2,4,6
    2 Q = (1.0 - Y)/2.
      RETURN
    4 Q = .5
      RETURN
    6 Q = (1.0 + Y)/2.
      RETURN
   10 Q = 1.
      RETURN
   20 Q = 0.
      RETURN
      END
```

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

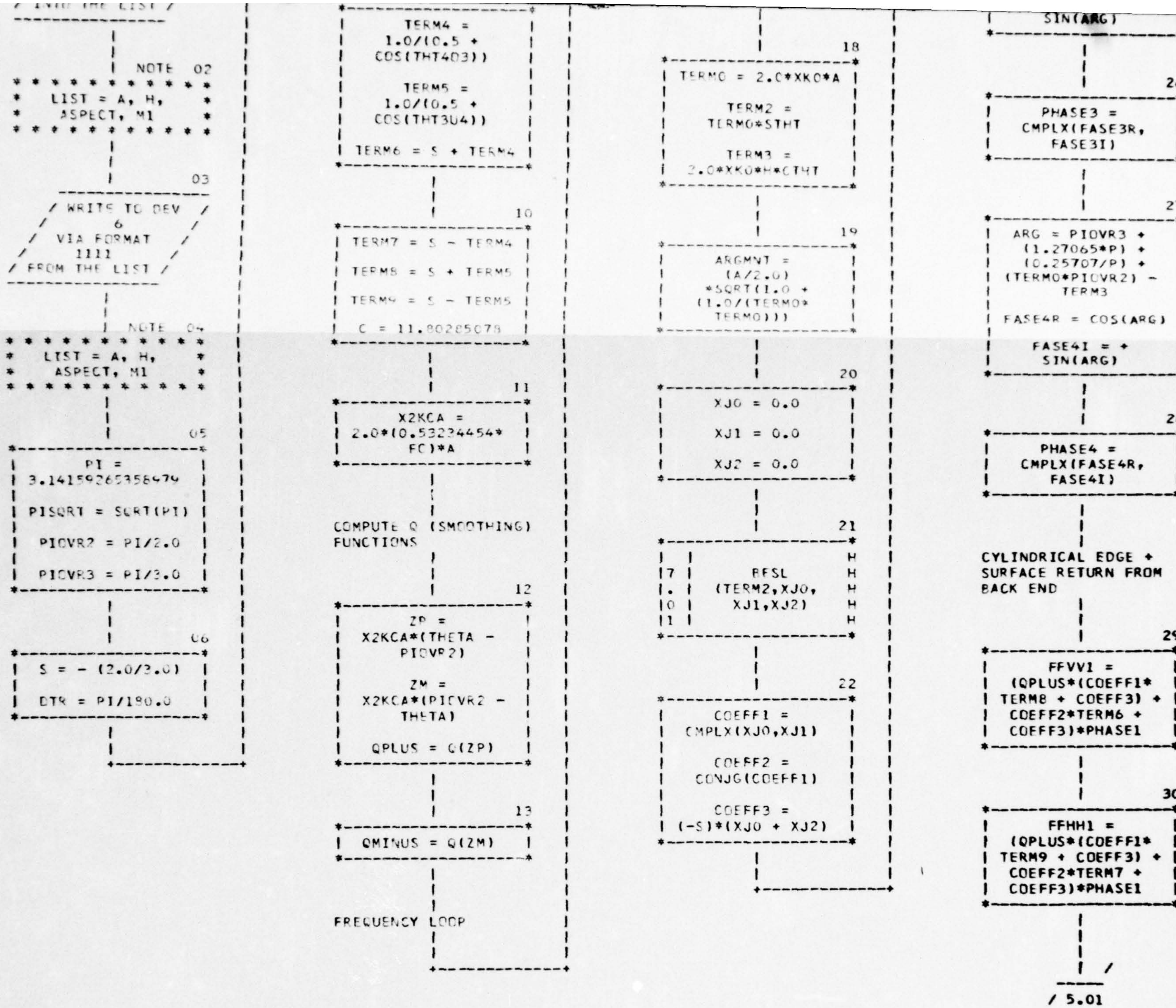
L-16

```
/ TARGET /

* * TARGET ST-5,
HEMISPHERE CYLINDER,
UFIMTSEV
TECHNIQUE * *

NMIN = MINIMUM
FREQUENCY SAMPLE
NMAX = MAXIMUM
FREQUENCY SAMPLE
DF   = FREQUENCY
INCREMENT IN MHZ
FC   = CARRIER
FREQUENCY IN GHZ

A      = RADIUS OF
HEMISPHERE
H      = HALF THE
CYLINDER LENGTH
ASPECT = AZIMUTH
ANGLE
M1     = PRINT OPTION
** DIMENSIONS ARE IN
INCHES AND ANGLE IS
IN DEGREES * *

                                01
/ READ FROM DEV 5 VIA FORMAT 1000 INTO THE LIST /

NOTE 02
LIST = A, H,
ASPECT, M1
```

```
07
THETA =
ASPECT*DTR

STHT = SIN(THETA)

CTHT = COS(THETA)

ZZ =
(A/4.0)
*(STHT/CTHT)

COMPUTE EDGE
DIFFRACTION
COEFFICIENTS

08
THT403 =
(4.0*THETA)/3.0

THT3U4 =
(2.0*PIOVR3) -
THT403

TERM1 =
(A*SIN(PIOVR3))
/3.0

09
TERM4 =
1.0/(0.5 +
COS(THT403))

TERM5 =
1.0/(0.5 +
COS(THT3U4))

TERM6 = S + TERM4
```

```
NOTE 15
BEGIN DO LOOP
900 I = NMIN,
NMAX

05.13--->

16
XI = I - 1

W =
(2.0*PI*XI*DF)
/1000.0

FREQ1 =
XI*DF/1000.0

XKO = W/C

17
P =
(XKO*A)
**(1.0/3.0)

P2 = P*P

PART1 =
(A/2.0)
*2.7162*P*EXP((-
2.20075*P) +
(0.44525/P))

18
TERMO = 2.0*XKO*A

TERM2 =
TERMO*STHT

TERM3 =
2.0*XKO*H*CTHT
```

```
23
FASE1R =
TERM1*COS(TERM3)

FASE1I =
TERM1*SIN(TERM3)

PHASE1 =
CMPLX(FASE1R,
FASE1I)

24
FASE2R =
ZZ*COS(TERM3)

FASE2I =
ZZ*(-SIN(TERM3))

PHASE2 =
CMPLX(FASE2R,
FASE2I)

25
ARG = TERMO +
TERM3 -
ATAN2(-1.0,TERMO)

FASE3R = COS(ARG)

FASE3I = -
SIN(ARG)

26
PHASE3 =
CMPLX(FASE3R,
FASE3I)
```



INTO THE LIST
NOTE 02
LIST = A, H, ASPECT, M1
03
WRITE TO DEV 6 VIA FORMAT 1111 FROM THE LIST
NOTE 04
LIST = A, H, ASPECT, M1
05
PI = 3.14159265358979
PISQRT = SQRT(PI)
PIOVR2 = PI/2.0
PIOVR3 = PI/3.0
06
S = - (2.0/3.0)
DTR = PI/180.0
TERM4 = 1.0/(0.5 + COS(THT4O3))
TERM5 = 1.0/(0.5 + COS(THT3O4))
TERM6 = S + TERM4
10
TERM7 = S - TERM4
TERM8 = S + TERM5
TERM9 = S - TERM5
C = 11.80285078
11
X2KCA = 2.0*(0.53234454*FC)*A
COMPUTE Q (SMOOTHING) FUNCTIONS
12
ZP = X2KCA*(THETA - PIOVR2)
ZM = X2KCA*(PIOVR2 - THETA)
QPLUS = Q(ZP)
13
QMINUS = Q(ZM)
FREQUENCY LOOP
18
TERM0 = 2.0*XK0*A
TERM2 = TERM0*STHT
TERM3 = 2.0*XK0*H*CTHT
19
ARGMNT = (A/2.0)*SQRT(1.0 + (1.0/(TERM0*TERM0)))
20
XJ0 = 0.0
XJ1 = 0.0
XJ2 = 0.0
21
7.01
BESL (TERM2,XJ0, XJ1,XJ2)
HHHHH
22
COEFF1 = CMPLX(XJ0,XJ1)
COEFF2 = CONJG(COEFF1)
COEFF3 = (-S)*(XJ0 + XJ2)
SIN(ARG)
26
PHASE3 = CMPLX(FASE3R, FASE3I)
27
ARG = PIOVR3 + (1.27065*P) + (0.25707/P) + (TERM0*PIOVR2) - TERM3
FASE4R = COS(ARG)
FASE4I = + SIN(ARG)
28
PHASE4 = CMPLX(FASE4R, FASE4I)
CYLINDRICAL EDGE + SURFACE RETURN FROM BACK END
29
FFVV1 = (QPLUS*(COEFF1*TERM8 + COEFF3) + COEFF2*TERM6 + COEFF3)*PHASE1
30
FFHH1 = (QPLUS*(COEFF1*TERM9 + COEFF3) + COEFF2*TERM7 + COEFF3)*PHASE1
5.01

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

```
   04.30--->*                +------------------->*
            |                |                    |
CYLINDRICAL SURFACE          |                    *   07
RETURN                       |                  *   *
(CYLINDER-HEMISPHERE         |                *       *
JUNCTION)                    |       (-/0) *            *
            |                |      +-----*      M1       *
            |                |      |      *            *
            |            01  |      |        *        *
*-----------------------*    |      |          *    *
|      FFVV2 =          |    |      |            *
|    COEFF2*PHASE2      |    |      |            | (+)
|                       |    |      |            |
|    FFHH2 = FFVV2      |    |      |            |
*-----------------------*    |      |            |
            |                |      |            |
            |                |      |            |
            |                |      |       10   |  NOTE  08
HEMISPHERE SPECULAR          |      |   * * * * * * * * * * *
            |                |      |   *      CONTINUE     *
            |                |      |   * * * * * * * * * * *
            |            02  |      |            |
*-----------------------*    |      |            |
|      FFVV3 =          |    |      |            |
|   ARGMNT*PHASE3*      |    |      |   DETERMINATION OF
|       QMINUS          |    |      |   CROSS SECTION(IN
|                       |    |      |   DBSM) AND PHASE(IN
|    FFHH3 = FFVV3      |    |      |   DEGREES)
*-----------------------*    |      |   FOR PRINTOUT OF
            |                |      |   RESPONSE VERSUS
            |                |      |   FREQUENCY
            |                |      |            |
HEMISPHERE CREEPING          |      |            |
WAVE                         |      |            |            09
            |                |      |   *-----------------------*
            |                |      |   |      FREQ(I) =        |
            |            03  |      |   |   (XI*DF)/1000.0      |
*-----------------------*    |      |   |                       |
| YY = CMPLX((1.0 +     |    |      |   |     SIGMAV(I) =       |
```

```
03
YY = CMPLX((1.0 +
(0.54555/P2)),
(0.94489/P2))

FFVV4 =
QPLUS*PART1*YY*
PHASE4

04
FFVV =
0.025406*(-2.0*
PISQRT)*(FFVV1 -
FFVV2 - FFVV3 +
FFVV4)

FFHH =
0.025406*(2.0*
PISQRT)*(FFHH1 +
FFHH2 + FFHH3)

05
CFVV =
CONJG(FFVV)

CFHH =
CONJG(FFHH)

06
EVVR(I) =
REAL(CFVV)

EVVI(I) =
AIMAG(CFVV)

EHHR(I) =
REAL(CFHH)

EHHI(I) =
AIMAG(CFHH)
```

```
FREC(I) =
(XI*DF)/1000.0

SIGMAV(I) =
10.0*ALOG10(EVVR
(I)*EVVR(I) +
EVVI(I)*EVVI(I))

10
SIGMAH(I) =
10.0*ALOG10(EHHR
(I)*EHHR(I) +
EHHI(I)*EHHI(I))

PHASEV(I) =
57.29578*ATAN2
(EVVI(I),EVVR(I))

11
PHASEH(I) =
57.29578*ATAN2
(EHHI(I),EHHR(I))

20              NOTE 12
   CONTINUE

900             13
  END OF DO
    LOOP?
YES             NO
                 4
                16
```

```
                14
(-/0)   M1
        (+)

30              NOTE 15
      CONTINUE

WRITE (6, 1500)
1500 FORMAT (1H1)
WRITE (6,
2000)(FREC(I),
SIGMAV(I), PHASEV(I),
SIGMAH(I),PHASEH(I)
I                    ,
I=NMIN,NMAX)
2000 FORMAT (1H ,
```

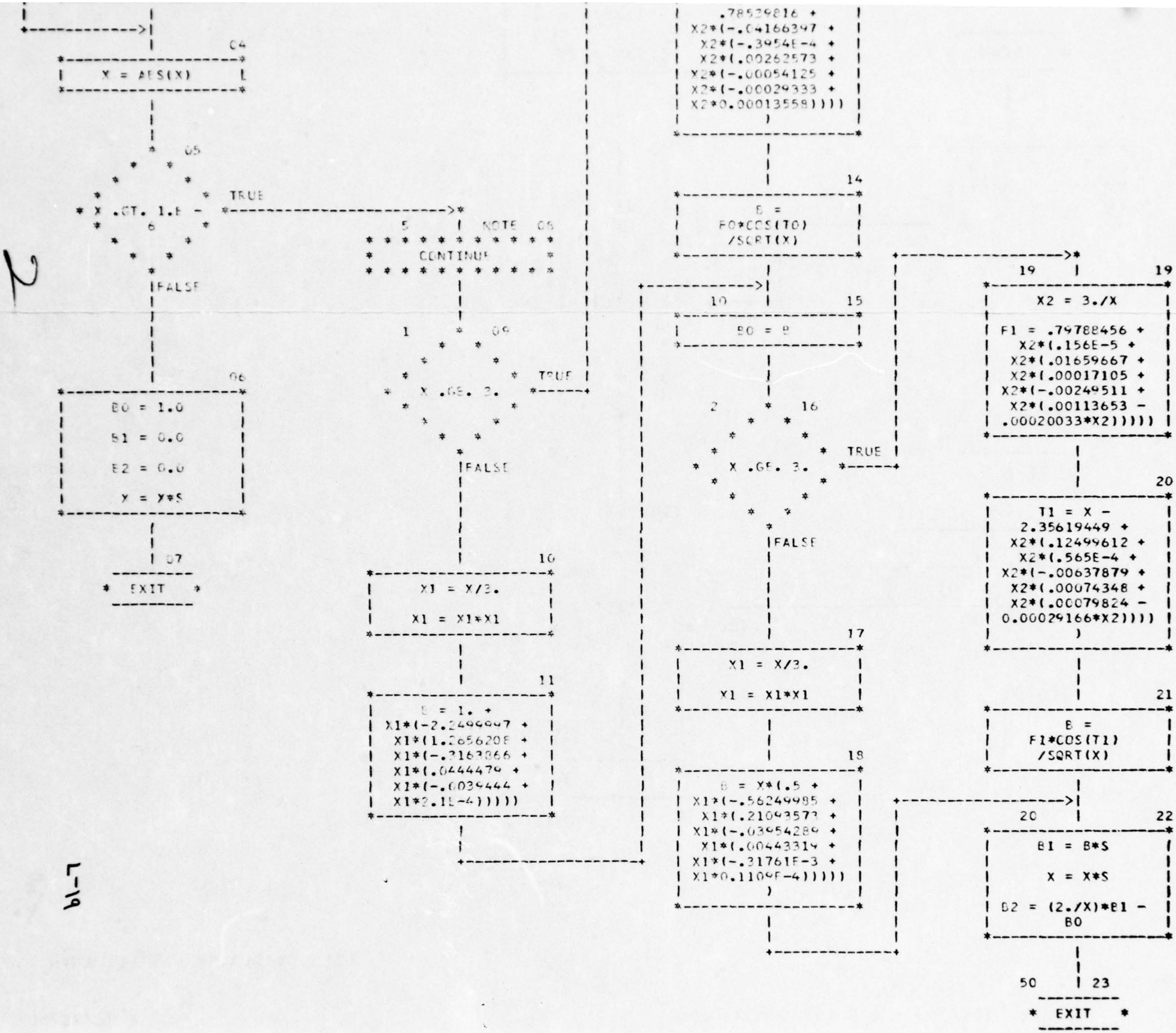
```
FFVV4)

FFHH =
0.025-06*(2.0*
PISCRT)*(FFHH1 +
FFHH2 + FFHH3)

                                  05
CFVV =
CONJG(FFVV)

CFHH =
CONJG(FFHH)

                                  06
EVVR(I) =
REAL(CFVV)

EVVI(I) =
AIMAG(CFVV)

EHHR(I) =
REAL(CFHH)

EHHI(I) =
AIMAG(CFHH)


(EVVI(I),EVVR(I))

                                  11
PHASEH(I) =
57.29578*ATAN2
(EHHI(I),EHHR(I))

20                       NOTE   12
* * * * * * * * * * *
*       CONTINUE       *
* * * * * * * * * * *

900                           13
        END OF DO          NO
          LOOP?         ---> 4
                             16
   YES


                              14
(-/0)       M1
           (+)

30                       NOTE   15
* * * * * * * * * * *
*       CONTINUE       *
* * * * * * * * * * *

WRITE (6, 1500)
1500 FORMAT (1H1)
WRITE (6,
2000)(FREQ(I),
SIGMAV(I), PHASEV(I),
SIGMAH(I),PHASEH(I)
1         ,
I=NMIN,NMAX)
2000 FORMAT (1H ,
F10.5, 4F10.2)

40                       NOTE   16
* * * * * * * * * * *
*       CONTINUE       *
* * * * * * * * * * *

                              17
         * EXIT *
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, TO
      DIMENSION EVVR(512), EVVI(512), EHHR(512), EHHI(512)
1000  FORMAT (4F6.2)
2000  FORMAT ( '      ASPECT ANGLE = ', F6.2, ' DEG')
```

CHART TITLE - SUBROUTINE BESL(X,B0,B1,B2)

```
     ----------
    /  BESL   /
    ----------

  04.21*-->*

  * BESSEL FUNCTION
 SUBROUTINE UTILIZING
 POLYNOMIAL
 APPROXIMATIONS
  * COMPUTES J0,J1,OR
 J2 FOR POSITIVE REAL
 ARGUMENTS
  * REFERENCE (HNDBK
 MATH FUNCT BY
 ABRAMOWITZ AND STEGUN
 SECTION 9.4 )

            *
            |         01
 *----------------------*                    *--------------------->*
 |      S = 1.0         |                    |            6         |            12
 *----------------------*                    |              *---------------------*
            |                                |              |     X2 = 3./X       |
            |                                |              |                     |
            *     02                         |              | F0 = .79788456 +    |
          *   *                              |              |   X2*(-.77E-6 +     |
        *       *                            |              | X2*(-.00552740 +    |
 FALSE *          *                          |              |  X2*(-.9512E-4 +    |
 *-----*  X .LT. 0.0  *                      |              |  X2*(.00137237 +    |
 |      *           *                        |              | X2*(-.72805E-3 +    |
 |        *       *                          |              | X2*0.14476E-3))))   |
 |          *   *                            |              |         )           |
 |            *                              |              *---------------------*
 |            |TRUE                          |                         |
 |            |                              |                         |
 |            |                              |                         |            13
 |            |       03                     |              *---------------------*
 *----------------------*                    |              |    T0 = X -         |
 |      S = - 1.0       |                    |              |   .78539816 +       |
 *----------------------*                    |              | X2*(-.04166397 +    |
 |            |                              |              |  X2*(-.3954E-4 +    |
 *----------->|                              |              |  X2*(.00262573 +    |
              |       04                     |              | X2*(-.00054125 +    |
 *----------------------*                    |              | X2*(-.00029333 +    |
 |      X = ABS(X)      |                    |              | X2*0.00013558))))   |
 *----------------------*                    |              |         )           |
              |
```


X = ABS(X)
04
05
X .GT. 1.E - 6
TRUE
FALSE
5 NOTE 08
CONTINUE
1 09
X .GE. 3.
TRUE
FALSE
06
B0 = 1.0
B1 = 0.0
B2 = 0.0
X = X*S
07
EXIT
10
X1 = X/3.
X1 = X1*X1
11
B = 1. +
X1*(-2.2499997 +
X1*(1.2656208 +
X1*(-.3163866 +
X1*(.0444479 +
X1*(-.0039444 +
X1*2.1E-4)))))
.78539816 +
X2*(-.04166397 +
X2*(-.3954E-4 +
X2*(.00262573 +
X2*(-.00054125 +
X2*(-.00029333 +
X2*0.00013558))))
)
14
B =
F0*COS(T0)
/SQRT(X)
10 15
B0 = B
2 16
X .GE. 3.
TRUE
FALSE
17
X1 = X/3.
X1 = X1*X1
18
B = X*(.5 +
X1*(-.56249985 +
X1*(.21093573 +
X1*(-.03954289 +
X1*(.00443319 +
X1*(-.31761E-3 +
X1*0.1109E-4)))))
)
19 19
X2 = 3./X
F1 = .79788456 +
X2*(.156E-5 +
X2*(.01659667 +
X2*(.00017105 +
X2*(-.00249511 +
X2*(.00113653 -
.00020033*X2)))))
20
T1 = X -
2.35619449 +
X2*(.12499612 +
X2*(.565E-4 +
X2*(-.00637879 +
X2*(.00074348 +
X2*(.00079824 -
0.00029166*X2))))
)
21
B =
F1*COS(T1)
/SQRT(X)
20 22
B1 = B*S
X = X*S
B2 = (2./X)*B1 -
B0
50 23
EXIT

2

CHART TITLE - FUNCTION Q(Z)

L-20

```
                 -----------
                /           /
                 -----------
                      |
                      |
                      |
                      *  03
                    *   *
                  *       *
                *           *  TRUE
              *   Z .GT. 2.   *---------------------------->*
                *           *                  10           |            09
                  *       *                    *-----------------------*
                    *   *                      |        Q = 1.          |
                      *                        *-----------------------*
                      |FALSE                                |
                      |                                     |
                      |                                     | 10
                      |                                  ----------
                      |                                 *   EXIT   *
                      |                                  ----------
                      |
                      *  04
                    *   *
                  *       *
                *           *  TRUE
              *  Z .LT. - 2.  *-----+
                *           *       |
                  *       *         |
                    *   *           |
                      *             +---------------------->*
                      |FALSE                   20           |            11
                      |                        *-----------------------*
                      |                        |        Q = 0.          |
                      |                        *-----------------------*
                      |                                     |
                      |                                     |
                      |            05                       | 12
             *------------------------*                  ----------
             |      AZ = ABS(Z)       |                 *   EXIT   *
             |                        |                  ----------
```

```
                              *       *                   |
                                *   *                     |
                                  *                       +---------------->*
                                  |FALSE                          20        |        11
                                  |                                *------------------*
                                  |                                |      Q = 0.      |
                                  |                                *------------------*
                                  |                                          |
                                  |                   05                     |
                         *------------------*                                | 12
                         |   AZ = ABS(Z)    |                           ----------
                         |                  |                           *  EXIT   *
                         | P = 1.0/(1.0 +   |                           ----------
                         |   .47047*AZ)     |
                         |                  |
                         |    Y = 1.0 -     |
                         | P*(.3480242 -    |
                         | P*(.0958798 -    |
                         | .7478556*P))     |
                         | *EXP(-AZ*AZ)     |
                         *------------------*
                                  |
                                  |
                                  *      06
                                *   *
                              *       *
                        (0) *           *  (+)
          *<-------------- *      Z      *----------------------->*
     4    |         01      *           *                  6      |        13
*------------------*          *       *                *------------------*
|      Q = .5      |            *   *                  | Q = (1.0 + Y)/2. |
*------------------*              *                    *------------------*
          |                       | (-)                           |
          |                       |                               |
          | 02                    |                               | 14
     ----------                   |                          ----------
     *  EXIT   *                  |                          *  EXIT   *
     ----------                   |                          ----------
                         2        |          07
                         *------------------*
                         | Q = (1.0 - Y)/2. |
                         *------------------*
                                  |
                                  |
                                  | 08
                             ----------
                             *  EXIT   *
                             ----------
```

2

```
      SUBROUTINE TARGET (EVVR, EVVI, EHHR, EHHI)                        RCS4 001
C                                                                       RCS4 002
C     * * TARGET ST-5, HEMISPHERE CYLINDER, UFIMTSEV TECHNIQUE * *      RCS4 003
C                                                                       RCS4 004
      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, TO                       RCS4 005
C     NMIN = MINIMUM FREQUENCY SAMPLE                                   RCS4 006
C     NMAX = MAXIMUM FREQUENCY SAMPLE                                   RCS4 007
C     DF   = FREQUENCY INCREMENT IN MHZ                                 RCS4 008
C     FC   = CARRIER FREQUENCY IN GHZ                                   RCS4 009
      DIMENSION EVVR(512), EVVI(512), EHHR(512), EHHI(512)              RCS4 010
     1, FREQ(512), SIGMAV(512), SIGMAH(512), PHASEV(512), PHASEH(512)   RCS4 011
      COMPLEX COEFF1, COEFF2, PHASE1, PHASE2, PHASE3, PHASE4, FFVV, FFHHRCS4 012
     1, FFVV1, FFHH1,  FFVV2,  FFHH2,  FFVV3,  FFHH3,  FFVV4, CFVV, CFHHRCS4 013
     1 , YY                                                             RCS4 014
C                                                                       RCS4 015
C     A      = RADIUS OF HEMISPHERE                                     RCS4 016
C     H      = HALF THE CYLINDER LENGTH                                 RCS4 017
C     ASPECT = AZIMUTH ANGLE                                            RCS4 018
C     M1     = PRINT OPTION                                             RCS4 019
C     ** DIMENSIONS ARE IN INCHES AND ANGLE IS IN DEGREES * *           RCS4 020
C                                                                       RCS4 021
      READ(5,1000) A,H,ASPECT,M1                                        RCS4 022
 1000 FORMAT( 3F10.0,I5)                                                RCS4 024
      WRITE (6, 1111) A, H, ASPECT, M1                                  RCS4 025
```

```
      C                                                                 RCS4 021
            READ(5,1000) A,H,ASPECT,M1                                  RCS4 022
       1000 FORMAT( 3F10.0,I5)                                          RCS4 024
            WRITE (6, 1111) A, H, ASPECT, M1                            RCS4 025
       1111 FORMAT(1H0, ' A = ',  F15.5 , 10X,  ' H = ', F15.5   //     RCS4 026
          1        1H0, ' THETA = ', F15.5, 15X, ' PRINT OPTION = ', I5   )  RCS4 027
      C                                                                 RCS4 028
            PI     = 3.14159265358979                                   RCS4 029
            PISQRT = SQRT(PI)                                           RCS4 030
            PIOVR2 = PI / 2.0                                           RCS4 031
            PIOVR3 = PI / 3.0                                           RCS4 032
            S      = -(2.0 / 3.0)                                       RCS4 033
            DTR    = PI / 180.0                                         RCS4 034
      C                                                                 RCS4 035
            THETA  = ASPECT * DTR                                       RCS4 036
            STHT   = SIN(THETA)                                         RCS4 037
            CTHT   = COS(THETA)                                         RCS4 038
            ZZ       = (A/4.0) * (STHT/CTHT)                            RCS4 039
      C     COMPUTE EDGE DIFFRACTION COEFFICIENTS                       RCS4 040
            THT4O3 = (4.0 * THETA) / 3.0                                RCS4 041
            THT3O4 = (2.0 * PIOVR3) - THT4O3                            RCS4 042
            TERM1  = (A * SIN(PIOVR3)) / 3.0                            RCS4 043
            TERM4  = 1.0 / (0.5 + COS(THT4O3))                          RCS4 044
            TERM5  = 1.0 / (0.5 + COS(THT3O4))                          RCS4 045
            TERM6  = S + TERM4                                          RCS4 046
            TERM7  = S - TERM4                                          RCS4 047
            TERM8  = S + TERM5                                          RCS4 048
```

L-22

```
CARD NO    ****                      CONTENTS                                  ****

 116              TERM9  = S - TERM5                                     RCS4 049
 117              C      = 11.80285078                                   RCS4 050
 118        C                                                            RCS4 051
 119              X2KCA   = 2.0 * (0.53234454*FC)        * A             RCS4 052
 120        C     COMPUTE Q (SMOOTHING) FUNCTIONS                        RCS4 053
 121              ZP      = X2KCA * (THETA - PIOVR2)                     RCS4 054
 122              ZM      = X2KCA * (PIOVR2 - THETA)                     RCS4 055
 123              QPLUS   = Q(ZP)                                        RCS4 056
 124              QMINUS  = Q(ZM)                                        RCS4 057
 125        C                                                            RCS4 058
 126        C     FREQUENCY LOOP                                         RCS4 059
 127              DO 900 I = NMIN, NMAX                                  RCS4 060
 128              XI     = I - 1                                         RCS4 061
 129              W      = (2.0 * PI * XI * DF) / 1000.0                 RCS4 062
 130              FREQ1  = XI * DF / 1000.0                              RCS4 063
 131              XKO    = W / C                                         RCS4 064
 132              P      = (XKO * A) ** (1.0 / 3.0)                      RCS4 065
 133              P2      = P * P                                        RCS4 066
 134              PART1  = (A / 2.0) * 2.7162 * P * EXP((-2.20075*P) + (0.44525/P)) RCS4 067
 135              TERMO  = 2.0 * XKO * A                                 RCS4 068
 136              TERM2  = TERMO * STHT                                  RCS4 069
 137              TERM3  = 2.0 * XKO * H * CTHT                          RCS4 070
```

```
      TERM3  = 2.0 * XKO * H * CTHT                                RCS4 070
      ARGMNT = (A/2.0) * SQRT(1.0 + (1.0 /(TERMO*TERMO)))          RCS4 071
C                                                                  RCS4 072
      XJO    = 0.0                                                 RCS4 073
      XJ1    = 0.0                                                 RCS4 074
      XJ2    = 0.0                                                 RCS4 075
      CALL BESL (TERM2, XJO, XJ1, XJ2)                             RCS4 076
C                                                                  RCS4 077
      COEFF1 = CMPLX(XJO, XJ1)                                     RCS4 078
      COEFF2 = CONJG(COEFF1)                                       RCS4 079
      COEFF3 = (-S) * (XJO + XJ2)                                  RCS4 080
C                                                                  RCS4 081
      FASE1R = TERM1 * COS(TERM3)                                  RCS4 082
      FASE1I = TERM1 * SIN(TERM3)                                  RCS4 083
      PHASE1 = CMPLX(FASE1R, FASE1I)                               RCS4 084
C                                                                  RCS4 085
      FASE2R  = ZZ * COS(TERM3)                                    RCS4 086
      FASE2I  = ZZ * (-SIN(TERM3))                                 RCS4 087
      PHASE2 = CMPLX(FASE2R, FASE2I)                               RCS4 088
C                                                                  RCS4 089
      ARG    = TERMO + TERM3 - ATAN2(-1.0, TERMO)                  RCS4 090
      FASE3R = COS(ARG)                                            RCS4 091
      FASE3I = -SIN(ARG)                                           RCS4 092
      PHASE3 = CMPLX(FASE3R, FASE3I)                               RCS4 093
C                                                                  RCS4 094
      ARG    = PIOVR3+(1.27065*P)+(0.25707/P)+(TERMO*PIOVR2)-TERM3 RCS4 095
      FASE4R = COS(ARG)                                            RCS4 096
      FASE4I = +SIN(ARG)                                           RCS4 097
```

```
      FASE2I = Z2 * (-SIN(TERM3))                                           RCS4 087
      PHASE2 = CMPLX(FASE2R, FASE2I)                                        RCS4 088
C                                                                           RCS4 089
      ARG    = TERMO + TERM3 - ATAN2(-1.0, TERMO)                           RCS4 090
      FASE3R = COS(ARG)                                                     RCS4 091
      FASE3I = -SIN(ARG)                                                    RCS4 092
      PHASE3 = CMPLX(FASE3R, FASE3I)                                        RCS4 093
C                                                                           RCS4 094
      ARG    = PIOVR3+(1.27065*P)+(0.25707/P)+(TERMO*PIOVR2)-TERM3          RCS4 095
      FASE4R = COS(ARG)                                                     RCS4 096
      FASE4I = +SIN(ARG)                                                    RCS4 097
      PHASE4 = CMPLX(FASE4R, FASE4I)                                        RCS4 098
C                                                                           RCS4 099
C     CYLINDRICAL EDGE + SURFACE RETURN FROM BACK END                       RCS4 100
      FFVV1  = (QPLUS*(COEFF1*TERM8+COEFF3)+COEFF2*TERM6+COEFF3)*PHASE1 RCS4 101
      FFHH1  = (QPLUS*(COEFF1*TERM9+COEFF3)+COEFF2*TERM7+COEFF3)*PHASE1 RCS4 102
C                                                                           RCS4 103
C     CYLINDRICAL SURFACE RETURN (CYLINDER-HEMISPHERE JUNCTION)             RCS4 104
      FFVV2  = COEFF2 * PHASE2                                              RCS4 105
      FFHH2  = FFVV2                                                        RCS4 106
```

CARD NO **** CONTENTS ****

```
      C                                                             RCS4 107
      C     HEMISPHERE SPECULAR                                     RCS4 108
            FFVV3   = ARGMNT * PHASE3 * CMINUS                      RCS4 109
            FFHH3  = FFVV3                                          RCS4 110
      C                                                             RCS4 111
      C     HEMISPHERE CREEPING WAVE                                RCS4 112
            YY      = CMPLX ( (1.0 +(0.54555/P2)) , (0.94444/P2) )  RCS4 113
            FFVV4  = CPLUS * PARTI *   YY  * PHASE4                 RCS4 114
      C                                                             RCS4 115
            FFVV    = 0.025406*(-2.0*PISQRT)*(FFVV1-FFVV2-FFVV3+FFVV4)  RCS4 116
            FFHH    = 0.025406*( 2.0*PISQRT)*(FFHH1+FFHH2+FFHH3       )  RCS4 117
            CFVV   = CONJG(FFVV)                                    RCS4 118
            CFHH   = CONJG(FFHH)                                    RCS4 119
      C                                                             RCS4 120
            EVVR(I)    = REAL(CFVV)                                 RCS4 121
            EVVI(I)    = AIMAG(CFVV)                                RCS4 122
            EHHR(I)    = REAL(CFHH)                                 RCS4 123
            EHHI(I)    = AIMAG(CFHH)                                RCS4 124
      C                                                             RCS4 125
            IF (M1) 20, 20, 10                                      RCS4 126
         10 CONTINUE                                                RCS4 127
```

```
C                                                                       RCS4 125
      IF (MI) 20, 20, 10                                                RCS4 126
   10 CONTINUE                                                          RCS4 127
C                                                                       RCS4 128
C     DETERMINATION OF CROSS SECTION(IN DBSM) AND PHASE(IN DEGREES)     RCS4 129
C                          FOR PRINTOUT OF RESPONSE VERSUS FREQUENCY    RCS4 130
      FREQ(I)    = (XI * DF) / 1000.0                                   RCS4 131
      SIGMAV(I)= 10.0*ALOG10(EVVR(I)*EVVR(I) + EVVI(I)*EVVI(I))         RCS4 132
      SIGMAH(I)= 10.0*ALOG10(EHHR(I)*EHHR(I) + EHHI(I)*EHHI(I))         RCS4 133
      PHASEV(I)= 57.29578 * ATAN2 (EVVI(I), EVVR(I))                    RCS4 134
      PHASEH(I)= 57.29578 * ATAN2 (EHHI(I), EHHR(I))                    RCS4 135
C                                                                       RCS4 136
   20 CONTINUE                                                          RCS4 137
C                                                                       RCS4 138
  900 CONTINUE                                                          RCS4 139
C                                                                       RCS4 140
      IF (MI) 40, 40, 30                                                RCS4 141
   30 CONTINUE                                                          RCS4 142
C                                                                       RCS4 143
C     WRITE (6, 1500)                                                   RCS4 144
C1500 FORMAT (1H1)                                                      RCS4 145
C     WRITE (6, 2000)(FREQ(I), SIGMAV(I), PHASEV(I), SIGMAH(I),PHASEH(I)RCS4 146
C    1                  , I=NMIN,NMAX)                                  RCS4 147
C2000 FORMAT (1H , F10.5, 4F10.2)                                       RCS4 148
   40 CONTINUE                                                          RCS4 149
C                                                                       RCS4 150
      RETURN                                                            RCS4 151
      END                                                               RCS4 152
```

04/26/76 INPUT LISTING AUTOFLOW CHART SET - FWD/SCL RADSIM

```
CARD NO  ****                       CONTENTS                                        ****
              SUBROUTINE BESL ( X, B0, B1, B2 )                                   RCS4 153
         C                                                                        RCS4 154
         C   * BESSEL FUNCTION SUBROUTINE UTILIZING POLYNOMIAL APPROXIMATIONS     RCS4 155
         C   * COMPUTES J0,J1,OR J2 FOR POSITIVE REAL ARGUMENTS                   RCS4 156
         C   * REFERENCE (HNDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN SECTION 9.4 )RCS4 157
         C                                                                        RCS4 158
              S = 1.0                                                             RCS4 159
              IF (X .LT. 0.0) S = -1.0                                            RCS4 160
              X = ABS (X)                                                         RCS4 161
         C                                                                        RCS4 162
              IF ( X .GT. 1.E-6 ) GO TO 5                                         RCS4 163
              B0 = 1.0                                                            RCS4 164
              B1 = 0.0                                                            RCS4 165
              B2 = 0.0                                                            RCS4 166
              X = X * S                                                           RCS4 167
              RETURN                                                              RCS4 168
         C                                                                        RCS4 169
            5 CONTINUE                                                            RCS4 170
         C                                                                        RCS4 171
            1 IF ( X .GE. 3.) GO TO 9                                             RCS4 172
              X1 = X/3.                                                           RCS4 173
              X1 = X1*X1                                                          RCS4 174
              B0 = 1.+ X1*(-2.2499997+ X1*(1.2656208+ X1*(-.3163866+ X1*(.0444479RCS4 175
```

```
    1 IF ( X .GE. 3.) GO TO 9                                              RCS4 172
      X1 = X/3.                                                            RCS4 173
      X1 = X1*X1                                                           RCS4 174
      B = 1.+ X1*(-2.2499997+ X1*(1.2656208+ X1*(-.3163866+ X1*(.0444479RCS4 175
     1 +       X1*(-.0039444+ X1*2.1E-4 )))) )                             RCS4 176
      GO TO 10                                                             RCS4 177
C                                                                          RCS4 178
    9 X2 = 3./X                                                            RCS4 179
      F0 =  .79788456 +X2*(-.77E-6 +X2*(-.00552740 +X2*(-.9512E-4 +X2*     RCS4 180
     1      (.00137237 +X2*(-.72805E-3 +X2*0.14476E-3 )))) )               RCS4 181
      T0 = X - .78539816 +X2*(-.04166397 +X2*(-.3954E-4 +X2*(.00262573     RCS4 182
     1    +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))             RCS4 183
      B = F0*COS(T0)/SQRT(X)                                               RCS4 184
C                                                                          RCS4 185
   10 B0 = B                                                               RCS4 186
C                                                                          RCS4 187
    2 IF ( X .GE. 3. ) GO TO 19                                            RCS4 188
      X1 = X/3.                                                            RCS4 189
      X1 = X1*X1                                                           RCS4 190
      B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*       RCS4 191
     1                  (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4))))) )    RCS4 192
      GO TO 20                                                             RCS4 193
C                                                                          RCS4 194
   19 X2 = 3./X                                                            RCS4 195
      F1 = .79788456 +X2*(.156E-5 +X2*(.01659667 +X2*(.00017105 +X2*       RCS4 196
     1      (-.00249511 +X2*(.00113653 -.00020033*X2 )))))                 RCS4 197
      T1 = X - 2.35619449 +X2*(.12499612 +X2*(.565E-4 +X2*(-.00637879     RCS4 198
     1    +X2*(.00074348 +X2*(.00079824 -0.00029166*X2 )))))               RCS4 199
```

```
     1    (.00137237 +X2*(-.72805E-3 +X2*0.14476E-3 )))) )                  RCS4 181
      T0 = X - .78539816 +X2*(-.04166397 +X2*(-.3954E-4 +X2*(.00262573     RCS4 182
     1    +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))              RCS4 183
      B = F0*COS(T0)/SQRT(X)                                                RCS4 184
C                                                                           RCS4 185
   10 B0 = B                                                                RCS4 186
C                                                                           RCS4 187
    2 IF ( X .GE. 3. ) GO TO 19                                             RCS4 188
      X1 = X/3.                                                             RCS4 189
      X1 = X1*X1                                                            RCS4 190
      B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*       RCS4 191
     1                 (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4))))) )      RCS4 192
      GO TO 20                                                              RCS4 193
C                                                                           RCS4 194
   19 X2 = 3./X                                                             RCS4 195
      F1 = .79788456 +X2*(.156E-5 +X2*(.01659667 +X2*(.00017105 +X2*        RCS4 196
     1    (-.00249511 +X2*(.00113653 -.00020033*X2 )))))                    RCS4 197
      T1 = X - 2.35619449 +X2*(.12499612 +X2*(.565E-4 +X2*(-.00637879      RCS4 198
     1    +X2*(.00074348 +X2*(.00079824 -0.00024166*X2 )))))                RCS4 199
      B = F1*COS(T1)/SQRT(X)                                                RCS4 200
C                                                                           RCS4 201
   20 B1 = B * S                                                            RCS4 202
      X = X * S                                                             RCS4 203
      B2= (2./X)*B1 - B0                                                    RCS4 204
   50 RETURN                                                                RCS4 205
      END                                                                   RCS4 206
```

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3

```
      FUNCTION G(Z)                                                     RCS4 207
C                                                                       RCS4 208
      IF ( Z.GT. 2.) GO TO 10                                           RCS4 209
      IF ( Z.LT.-2.) GO TO 20                                           RCS4 210
      AZ = ABS(Z)                                                       RCS4 211
      P = 1.0/(1.0 + .47047*AZ)                                         RCS4 212
      Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P))*EXP(-AZ*AZ)    RCS4 213
      IF (Z) 2,4,6                                                      RCS4 214
    2 G = (1.0 - Y)/2.                                                  RCS4 215
      RETURN                                                            RCS4 216
    4 G = .5                                                            RCS4 217
      RETURN                                                            RCS4 218
    6 G = (1.0 + Y)/2.                                                  RCS4 219
      RETURN                                                            RCS4 220
   10 G = 1.                                                            RCS4 221
      RETURN                                                            RCS4 222
   20 G = 0.                                                            RCS4 223
      RETURN                                                            RCS4 224
      END                                                               RCS4 225
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, TC
      DIMENSION EVVR(512), EVVI(512), EHHR(512), EHHI(512)
     , FREQ(512), SIGMAV(512), SIGMAH(512), PHASEV(512), PHASEH(512)
      COMPLEX COEFF1, COEFF2, PHASE1, PHASE2, PHASE3, PHASE4, FFVV, FFHH
     , FFVV1, FFHH1,  FFVV2,  FFHH2,  FFVV3,  FFHH3,  FFVV4, CFVV, CFHH
     , YY
1000  FORMAT( 3F10.0,I5)
1111  FORMAT(1HO, ' A = ',  F15.5 , 10X,  ' H = ', F15.5   //
            1HO, ' THETA = ', F15.5, 15X, ' PRINT OPTION = ', I5    )
```

L.3 CONE, CYLINDER OR FRUSTRUM

A generalized expression of the far-field scattering from a cone, cylinder, or frustrum has been formulated using the Ruck-Ufimtsev technique (Ref. 3). The resulting expression of the scattered field is the following:

$$\left\{\sqrt{\sigma}\, e^{i\phi}\right\}_{\substack{V \\ H}} = \mp\sqrt{\pi}\ \cdot$$

$$\Big\{-a_1 \Big[\left[J_2(\zeta_1)+iJ_1(\zeta_1)\right] C(n_-) \pm \left[J_o(\zeta_1)-iJ_1(\zeta_1)\right] B(n_-,\tfrac{\pi}{2}+\theta)\Big] Q(1)$$

$$-a_1 \Big[\left[J_2(\zeta_1)-iJ_1(\zeta_1)\right] C(n_-) \pm \left[J_o(\zeta_1)+iJ_1(\zeta_1)\right] B(n_-,\tfrac{\pi}{2}-\theta)\Big] Q(4)$$

$$-a_2 \Big[\left[J_2(\zeta_2)+iJ_1(\zeta_2)\right] C(n_+) \pm \left[J_o(\zeta_2)-iJ_1(\zeta_2)\right] B(n_+,\alpha+\theta)\Big] e^{i\psi}$$

$$-a_2 \Big[\left[J_2(\zeta_2)-iJ_1(\zeta_2)\right] C(n_+) \pm \left[J_o(\zeta_2)+iJ_1(\zeta_2)\right] B(n_+,\alpha-\theta)\Big] e^{i\psi} Q(3)$$

$$\pm a_1 \left[J_o(\zeta_1)-iJ_1(\zeta_1)\right] \tfrac{1}{2}\tan(\alpha+\theta) F(\tau_1) Q(1)$$

$$\pm a_1 \left[J_o(\zeta_1)+iJ_1(\zeta_1)\right] \tfrac{1}{2}\tan(\alpha-\theta) F(\tau_4) Q(34)$$

$$\mp a_2 \left[J_o(\zeta_2)-iJ_1(\zeta_2)\right] \tfrac{1}{2}\tan(\alpha+\theta) F(\tau_2) e^{i\psi} Q(1)$$

$$\mp a_2 \left[J_o(\zeta_2)+iJ_1(\zeta_2)\right] \tfrac{1}{2}\tan(\alpha-\theta) F(\tau_3) e^{i\psi} Q(34) \Big\}$$

and for $\pi/2 \leq \theta \leq \pi$,

$$\left\{\sqrt{\sigma}\, e^{i\phi}\right\}_{\substack{V\\H}} = \mp\sqrt{\pi}\ .$$

$$\Big\{-a_1\Big[\big[J_2(\zeta_1)+iJ_1(\zeta_1)\big]C(n_-)\pm\big[J_o(\zeta_1)-iJ_1(\zeta_1)\big]B(n_-,\pi-\alpha-\theta)\Big]Q(1)$$

$$-a_2\Big[\big[J_2(\zeta_2)+iJ_1(\zeta_2)\big]C(n_+)\pm\big[J_o(\zeta_2)-iJ_1(\zeta_2)\big]B(n_+,\tfrac{3\pi}{2}-\theta)\Big]e^{i\psi}$$

$$-a_2\Big[\big[J_2(\zeta_2)-iJ_1(\zeta_2)\big]C(n_+)\pm\big[J_o(\zeta_2)+iJ_1(\zeta_2)\big]B(n_+,\theta-\tfrac{\pi}{2})\Big]e^{i\psi}Q(3)$$

$$\pm a_1\big[J_o(\zeta_1)-iJ_1(\zeta_1)\big]\tfrac{1}{2}\tan(\alpha+\theta)F(\tau_1)Q(1)$$

$$\mp a_2\big[J_o(\zeta_2)-iJ_1(\zeta_2)\big]\tfrac{1}{2}\tan(\alpha+\theta)F(\tau_2)e^{i\psi}Q(1)\Big\}$$

where the geometry of the problem is shown in Figure L.3-1 and

$$C(n) = \frac{1}{n}\sin\frac{\pi}{n}\left\{\cos\frac{\pi}{n}-1\right\}^{-1},$$

$$B(n,\phi) = \frac{1}{n}\sin\frac{\pi}{n}\left\{\cos\frac{\pi}{n}-\cos\frac{2\phi}{n}\right\}^{-1},$$

$$\tau^2_{\binom{1}{2}} = 2ka_{\binom{1}{2}}\csc\alpha\cos(\alpha+\theta),$$

$$\tau^2_{\binom{3}{4}} = 2ka_{\binom{2}{1}}\csc\alpha\cos(\alpha-\theta),$$

$$\zeta_j = 2ka_j\sin\theta,$$

$$\psi = 2kh\cos\theta,$$

$$n_{\pm} = \frac{3}{2}\pm\frac{\alpha}{\pi},$$

$$Q(1) = Q(2ka_1(\pi-\alpha-\theta)),$$

$$k = 2\pi/\lambda = \text{wave number},$$

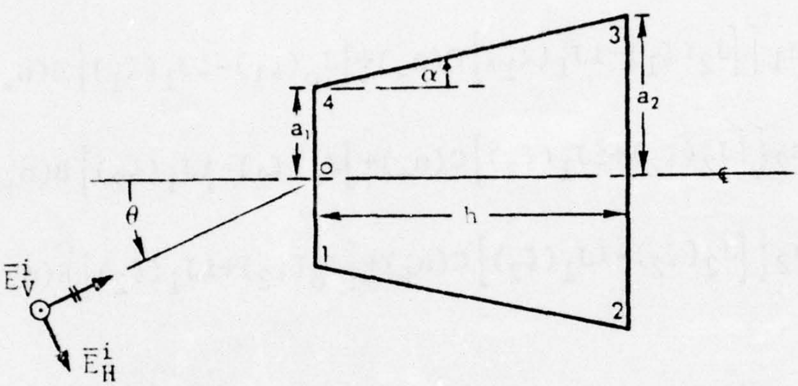


Fig. L.3-1 CONE, CYLINDER, OR FRUSTRUM SCATTERING GEOMETRY

$$Q(3) = Q(2ka_2(\alpha-\theta)(\theta-\pi/2)),$$

$$Q(34) = Q(2ka_2(\alpha-\theta)),$$

$$Q(4) = Q(2ka_1(\frac{\pi}{2}-\theta)).$$

The above solution to the scattering from a frustrum can simply be reduced to that of a right circular cylinder by setting $F(\tau i) = 0$ (i.e., $\alpha = 0$). For the case of a large right circular cone, it is important to note that numerical difficulty will be encountered if the above expressions were used to compute the scattered field near and at the conical specular aspect, $\theta = \pi/2 - \alpha$. An asymptotic solution to this problem can be expressed as

$$\lim_{\theta \to \pi/2-\alpha} \left\{\sqrt{\sigma}\, e^{i\phi}\right\}_{\substack{V\\H}} \simeq \mp\sqrt{\pi}\; a_2 e^{i\psi} \cdot$$

$$\left\{-\left[J_2(\zeta_2)+iJ_1(\zeta_2)\right]C(n_+) \pm \left[J_o(\zeta_2)-iJ_1(\zeta_2)\right] \times \left[i\frac{2}{3}ka_2 \csc\alpha \sin(\alpha+\theta)\right]\right\}.$$

The inputs, outputs, restrictions, and definition of key terms in the subroutine are presented in the following paragraphs.

L.3.1 Inputs

The subroutine inputs are read from cards or passed in a common block. The parameters passed in the common block include NMIN = minimum frequency number, NMAX = maximum frequency number, DF = frequency increment (in MHz) and FC = carrier frequency (in GHz). The inputs read from a card are the following:

	MATHEMATICAL SYMBOL	VARIABLE	DEFINITION	COLUMNS
Card 1	a_1	A1	Smaller radius of frustrum (inches)	1-10
	a_2	A2	Larger radius of frustrum (inches)	11-20
	h_2	H2	Height of frustrum (inches)	21-30
		KONFIG	=1 Frustrum =2 Cone =3 Cylinder	31-35
	θ	THETAD	Azimuth angle (degrees)	36-45

L.3.2 Outputs

The data base output consists of four linear arrays, EVVR, EVVI, EHHR, EHHI, which contain the real and imaginary parts of the vertically and horizontally polarized back scattered fields (in meters) at frequency increments spaced DF MHz from NMIN*DF to NMAX*DF.

The frequency, vertically polarized cross section, and horizontally polarized cross section are printed out if the print option KP is positive.

L.3.3 Restrictions

L.3.3.1 Physical Dimensions

All target dimensions should be large with respect to the wavelength of the illuminating field.

L.3.3.2 <u>Output</u>

The output arrays are passed in the Argument List and a value is computed and stored only in locations NMIN to NMAX.

L.3.3.3 <u>Azimuth</u>

The azimuth angle is restricted to the region from 0 to 180 degrees. In addition, although the formulation is mathematically valid at specular points, the correct computational results are not provided at these angles. Thus a small angular offset should be used at angles of 0, 180, and ($\pi/2-\alpha$) degrees.

L.3.4 Definition of Sample Terms Used in Subroutine

FSTCOX = $C(n) = \frac{1}{n} \sin \frac{\pi}{n}\left\{\cos \frac{\pi}{n} -1\right\}^{-1}$

Where $n_{\pm} = \frac{3}{2} \pm \frac{\alpha}{\pi}$

FSTCON = $C(n_-)$

FSTCOP = $C(n_+)$

TAUSQ $\left\{\begin{matrix}1\\2\end{matrix}\right\} = 2ka\begin{pmatrix}1\\2\end{pmatrix} \csc \alpha$

XOPX11 = $J_o(\xi_1)+iJ_1(\xi_1)$

XOPX12 = $J_o(\xi_2)+iJ_1(\xi_2)$

Q1 = Q(1) = $Q(2ka_1(\pi-\alpha-\theta)$

SECND 1 = $B(n_-, \frac{\pi}{2} + \theta)$

WHERE = $B(n,\emptyset) = \frac{1}{n} \sin \frac{\pi}{n}\left\{\cos \frac{\pi}{n} -\cos \frac{2\emptyset}{n}\right\}-1$

TERM 1 $\left\{\begin{matrix}V\\H\end{matrix}\right\} = -a_1\left[\left[J_2(\zeta_1)+iJ_1(\zeta_1)\right]C(n_-)\pm\left[J_o(\zeta_1)-iJ_1(\zeta_1)\right]B(n_-,\frac{\pi}{2}+\theta)\right]Q(1)$

TERM 4 $\left\{\begin{matrix}V\\H\end{matrix}\right\} = -a_1\left[\left[J_2(\zeta_1)-iJ_1(\zeta_1)\right]C(n_-)\pm\left[J_o(\zeta_1)+iJ_1(\zeta_1)\right]B(n_-,\frac{\pi}{2}-\theta)\right]Q(4)$

TERM 2 $\left\{\begin{matrix}V\\H\end{matrix}\right\} = -a_2\left[\left[J_2(\zeta_2)+iJ_1(\zeta_2)\right]C(n_+)\pm\left[J_o(\zeta_2)-iJ_1(\zeta_2)\right]B(n_+,\alpha+\theta)\right]e^{i\psi}$

$$\text{TERM 3} \left\{\begin{matrix}V\\H\end{matrix}\right\} = -a_2 \left[\left[J_2(\zeta_2)-iJ_1(\zeta_2)\right]C(n_+)\pm\left[J_o(\zeta_2)+iJ_1(\zeta_2)\right] B(n_+,\alpha-\theta)\right] e^{i\psi} Q(3)$$

$$\text{TERM 5} \left\{\begin{matrix}V\\H\end{matrix}\right\} = \pm a_1 \left[J_o(\zeta_1)-iJ_1(\zeta_1)\right]\frac{1}{2}\tan(\alpha+\theta)F(\tau_1)Q(1)$$

WHERE = the upper sign is used for V polarization and the lower sign is used for H polarization

$$ZZ = \left[J_o(\zeta_2)-iJ_1(\zeta_2)\right] \cdot \left\{\frac{1}{2}\left[i\frac{2}{3}ka_2\csc\alpha\sin(\alpha+\theta)\right]\right\}$$

$$YY = -\left[J_2(\zeta_2)+iJ_1(\zeta_2)\right]C(n_+)$$

L.3.5 Subroutines Utilized

Subfunctions:

1. FIRS (XN) computes c(n)

2. SECO (PHI, XN) computes B (n, Ø)

3. Q (X) computes the Q function value with argument x

4. F (TAU) computes the F (τ) function value

Subroutines:

BESL (ARG1, XJO, XJ1, XJ2) returns

Jo (ARG1) in XJO
J1 (ARG1) in XJ1
J2 (ARG1) in XJ2

```
      SUBROUTINE TARGET ( EVVR, EVVI, EHHR, EHHI, THETAD)
C                                                                    *
C * * * * * GENERALIZED PROGRAM FOR A FRUSTRA, CONE, OR CYLINDER  * * *
C                    (UFIMTSEV SOLUTION FOR CW)                      *
C                                                                    *
C           A1      = FRONT-END RADIUS (INCHES)                      *
C           A2      = BACK-END RADIUS (SHOULD BE .GE. A1) - (INCHES) *
C           H2      = TOTAL LENGTH (INCHES)                          *
C           ALPHA   = CONE OR FRUSTRA HALF ANGLE (DEGREES)           *
C           FREQ    = CARRIER FREQUENCY (GHZ)                        *
C           DELTHT  = ASPECT ANGLE INCREMENT (DEGREES) - (.GE. 0.1)  *
C           KONFIG  = TARGET CONFIGURATION                           *
C                     1 = FRUSTRA                                    *
C                     2 = CONE                                       *
C                     3 = CYLINDER                                   *
C                                                                    *
C * * * * ALL DIMENSIONS ARE IN INCHES AND ANGLES ARE IN DEGREES  * * *
C                                                                    *
      COMMON  MOVER, M, NMIN, NMAX, DF, FC, PW, T0
C     NMIN = MINIMUM FREQUENCY SAMPLE
C     NMAX = MAXIMUM FREQUENCY SAMPLE
C     DF   = FREQUENCY INCREMENT IN MHZ
C     FC   = CARRIER FREQUENCY IN GHZ
      DIMENSION  EVVR(512), EVVI(512), EHHR(512), EHHI(512),
     1           FREQ(512), SIGMAV(512), SIGMAH(512)
C
      COMPLEX PHASE, X0PX11, X0MX11, X0PX12, X0MX12, X2PX11, X2MX11,
     1        X2PX12, X2MX12, TERM1V, TERM1H, TERM2V, TERM2H, TERM3V,
     2      . TERM3H, TERM4V, TERM4H, TERM5V, TERM5H, TERM6V, TERM6H,
     3        TERM7V, TERM7H, TERM8V, TERM8H, FFVV, FFHH, F, FTAU1,
     4        FTAU2, FTAU3, FTAU4        ,XX,YY,ZZ
C                                                                    *
C                                                                    *
C                                                                    *
      READ(5,1000) A1,A2,H2, KONFIG, KP
 1000 FORMAT( 3F10.0,2I5 )
      ALP    = A2 - A1
      ALPHA  = ATAN2(ALP, H2)
      PI     = 3.14159265358979
      ANGLE  = (ALPHA * 180.0) / PI
C                                                                    *
      IF (KONFIG - 2) 30, 40, 50
C                                                                    *
   30 WRITE (6, 3030) H2, A1, A2, ANGLE
 3030 FORMAT (1H0///'          FRUSTRA (UFIMTSEV SOLUTION)'///'      FRUSTR
     1A LENGTH = ',F10.6,' INCHES'//'     FRONT-END RADIUS = ',F10.6,' INC
     2HES'//'      BACK-END RADIUS = ',F10.6,' INCHES'//'  FRUSTRA HALF-ANG
     3LE = ',F10.6,' DEGREES')
      GO TO 60
C                                                                    *
   40 WRITE (6, 3040) H2, A2, ANGLE
 3040 FORMAT (1H0///'            CONE (UFIMTSEV SOLUTION)'///'       CONE
     1 LENGTH = ',F10.6,' INCHES'//'          BASE RADIUS = ',F10.6,' INCH
     2ES'//'     CONE HALF-ANGLE = ',F10.6,' DEGREES')
      GO TO 60
C                                                                    *
   50 WRITE (6, 3050) H2, A2
```

```
3050 FORMAT (1H0////          CYLINDER (UFIMTSEV SOLUTION)'///      CYLIND
    1ER LENGTH = ',F10.6,' INCHES'//    CYLINDER RADIUS = ',F10.6,' IN
    2CHES')
C                                                                        *
   60 WRITE (6, 79) THETAD
   79 FORMAT(1H0, ' THETA = ' , E15.5  /// )
C                                                                        *
      C      = 11.80285078
      DTR    = PI / 180.0
      PISQRT = SQRT(PI)
      PIOVR2 = PI / 2.0
      A12        = 2.0* A1
      A22        = 2.0* A2
      H22        = 2.0* H2
      XNPOS  = (3.0 / 2.0) + (ALPHA / PI)
      XNNEG  = (3.0 / 2.0) - (ALPHA / PI)
C     COMPUTE C(N)
      FSTCOP = FIRS(XNPOS)
      FSTCON = FIRS(XNNEG)
      THETA   = THETAD * DTR
      STHT    = SIN(THETA)
      CTHT    = COS(THETA)
      APT     = ALPHA + THETA
      AMT     = ALPHA - THETA
      TANAPT = TAN(APT)
      TANAMT = TAN(AMT)
      TWOPIC      = 2.0 * PI / C
C                                                                        *
      DO 200  I = NMIN,NMAX
      XI        = I - 1
      XK0       = TWOPIC * XI * DF / 1000.0
      X2KA1      = A12 * XK0
      X2KA2      = A22 * XK0
      X2KH2      = H22 * XK0
C                                                                        *
      IF (KONFIG .EQ. 3) GO TO 70
      TAUSQ1 = X2KA1 / SIN(ALPHA)
      TAUSQ2 = X2KA2 / SIN(ALPHA)
   70 CONTINUE
C                                                                        *
      WAPT    = PIOVR2 - ACOS(0.8 * COS(ALPHA) / X2KH2)
      ARG1    = X2KA1 * STHT
      ARG2    = X2KA2 * STHT
      FASE    = X2KH2 * CTHT
      PHASE   = CMPLX (COS(FASE), SIN(FASE))
C                                                                        *
      CALL BESL (ARG1, XJ01, XJ11, XJ21)
      CALL BESL (ARG2, XJ02, XJ12, XJ22)
C                                                                        *
      X0PX11 = CMPLX(XJ01, XJ11)
      X0MX11 = CMPLX(XJ01,-XJ11)
      X0PX12 = CMPLX(XJ02, XJ12)
      X0MX12 = CMPLX(XJ02,-XJ12)
      X2PX11 = CMPLX(XJ21, XJ11)
      X2MX11 = CMPLX(XJ21,-XJ11)
      X2PX12 = CMPLX(XJ22, XJ12)
      X2MX12 = CMPLX(XJ22,-XJ12)
                                                                         *
```

```
      Q1      = Q(X2KA1 * (PI - APT))
      Q4      = Q(X2KA1 * (PIOVR2 - THETA))
      Q3      = Q(X2KA2 * ((THETA+THETA-PI) * (-AMT)) / (PIOVR2-ALPHA))
      Q3A     = Q(X2KA2 * AMT)
C                                                                      *
      IF (THETA .GT. PIOVR2) GO TO 90
C     DEFINE ANGLES FOR THET .LT. 90 DEGREES
C                                                                      *
      PHI1    = PIOVR2 + THETA
      PHI4    = PIOVR2 - THETA
      PHI2    = APT
      GO TO 98
C     DEFINE ANGLES FOR THET .GT. 90 DEGREES
   90 PHI1    = PI-APT
      PHI4    = 0.0
      PHI2    = (3.0 * PIOVR2) - THETA
C                                                                      *
   98 IF ( Q3A .EQ. 0.0 ) GO TO 99
      PHI3 = AMT
      GO TO 100
   99 PHI3 = PIOVR2 - THETA
C                                                                      *
C     COMPUTE B(N,PHI)
  100 SECND1 = SECO(PHI1, XNNEG)
      SECND4 = SECO(PHI4, XNNEG)
      SECND2 = SECO(PHI2, XNPOS)
      SECND3 = SECO(PHI3, XNPOS)
C                                                                      *
      TERM1V = 0.0
      TERM1H = 0.0
      TERM4V = 0.0
      TERM4H = 0.0
      TERM5V = 0.0
      TERM5H = 0.0
      TERM6V = 0.0
      TERM6H = 0.0
      TERM7V = 0.0
      TERM7H = 0.0
      TERM8V = 0.0
      TERM8H = 0.0
C                                                                      *
      IF (KONFIG .EQ. 2) GO TO 120
C                                                                      *
      TERM1V = -A1 * ((X2PX11 * FSTCON) + (X0MX11 * SECND1)) * Q1
      TERM1H = -A1 * ((X2PX11 * FSTCON) - (X0MX11 * SECND1)) * Q1
      TERM4V = -A1 * ((X2MX11 * FSTCON) + (X0PX11 * SECND4)) * Q4
      TERM4H = -A1 * ((X2MX11 * FSTCON) - (X0PX11 * SECND4)) * Q4
C                                                                      *
  120 TERM2V = -A2 * ((X2PX12 * FSTCOP) + (X0MX12 * SECND2)) * PHASE
      TERM2H = -A2 * ((X2PX12 * FSTCOP) - (X0MX12 * SECND2)) * PHASE
      TERM3V = -A2 * ((X2MX12 * FSTCOP) + (X0PX12 * SECND3)) * Q3*PHASE
      TERM3H = -A2 * ((X2MX12 * FSTCOP) - (X0PX12 * SECND3)) * Q3*PHASE
C                                                                      *
      IF (KONFIG .EQ. 3) GO TO 130
      IF (KONFIG .EQ. 2) GO TO 140
C                                                                      *
C     THIS SECTION NOT DONE FOR CYLINDER OR CONE
      TAU1    = TAUS01 * COS(APT)
```

```
      TAU4    = TAUSQ1 * COS(AMT)
      FTAU1   = F(TAU1)
      FTAU4   = F(TAU4)
      TERM5V = A1 * TANAPT * X0MX11 * FTAU1 * 0.5 * Q1
      TERM5H = -TERM5V
      TERM6V = A1 * TANAMT * X0PX11 * FTAU4 * 0.5 * Q3A
      TERM6H = -TERM6V
C     THIS SECTION NOT DONE FOR CYLINDER
C                  DONE FOR CONE
  140 TAU2    = TAUSQ2 * COS(APT)
      TAU3    = TAUSQ2 * COS(AMT)
      FTAU2   = F(TAU2)
      FTAU3   = F(TAU3)
      TERM7V =-A2 * TANAPT * X0MX12 * FTAU2 * 0.5 * Q1 * PHASE
      TERM7H = -TERM7V
      TERM8V =-A2 * TANAMT * X0PX12 * FTAU3 * 0.5 * Q3A* PHASE
      TERM8H = -TERM8V
C                                                                      *
      IF (KONFIG - 2) 130, 56, 130
   56 IF (ABS(APT-PIOVR2) .GT. WAPT ) GO TO 130
C     THIS SECTION USED TO COMPUTE CONE RETURN NEAR SPECULAR TO
C                  CONIC SURFACE  (THET NEAR (PI/2)-ALPHA)
      XX       = CMPLX(0.0,1.0)
      ZZ       = X0MX12 * XX * TAUSQ2 * SIN(APT) /3.0
      YY       =-X2PX12 * FSTCOP
      FFVV     =-PISQRT * A2 * PHASE * ( YY + ZZ)
      FFHH     = PISQRT * A2 * PHASE * ( YY - ZZ)
      GO TO 55
C
  130 FFVV     = -        PISQRT * (TERM1V + TERM2V + TERM3V + TERM4V +
     1                             TERM5V + TERM6V + TERM7V + TERM8V )
      FFHH     =          PISQRT * (TERM1H + TERM2H + TERM3H + TERM4H +
     1                             TERM5H + TERM6H + TERM7H + TERM8H )
C                                                                      *
   55 CONTINUE
      FFVV      = FFVV * 0.02540005
      FFHH      = FFHH * 0.02540005
C
      EVVR(I) = REAL (FFVV)
      EVVI(I) =-AIMAG(FFVV)
      EHHR(I) = REAL (FFHH)
      EHHI(I) =-AIMAG(FFHH)
C                                                                      *
      IF (KP)  77, 77, 78
   78 FREQ(I)   = XI * DF / 1000.0
      SIGMAV(I)= 10.0*ALOG10(EVVR(I)*EVVR(I) + EVVI(I)*EVVI(I))
      SIGMAH(I)= 10.0*ALOG10(EHHR(I)*EHHR(I) + EHHI(I)*EHHI(I))
   77 CONTINUE
C                                                                      *
  200 CONTINUE
C                                                                      *
C                                                                      *
C     IF (KP)  75, 75, 76
C  76 WRITE (6, 74) ( FREQ(I), SIGMAV(I), SIGMAH(I), I= NMIN, NMAX )
C  74 FORMAT (1H0, 3E15.5 )
   75 CONTINUE
C                                                                      *
C
```

```
      RETURN
      END
      FUNCTION FIRS(XN)
      PI      = 3.14159265358979
      A       = (SIN(PI / XN)) / XN
      B       = 1.0 / (COS(PI / XN) - 1.0)
      FIRS    = A * B
      RETURN
      END
      FUNCTION SECO(PHI, XN)
      PI      = 3.14159265358979
      A       = (SIN(PI / XN)) / XN
      B       = COS(PI / XN) - COS((2.0 * PHI)/ XN)
      C       = 1.0 / B
      SECO    = A * C
      RETURN
      END
      FUNCTION Q(Z)
C     Q(Z) = 0.5*(1 + ERF(Z))
C   * ERF(Z) IS EVALUATED USING A RATIONAL POLYNOMIAL APPROXIMATION
C   * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,
C   *         SECTION 7.1.26)
C
      IF ( Z.GT. 2.) GO TO 10
      IF ( Z.LT.-2.) GO TO 20
      AZ = ABS(Z)
      P = 1.0/(1.0 + .47047*AZ)
      Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P))*EXP(-AZ*AZ)
      IF (Z) 2,4,6
    2 Q = (1.0 - Y)/2.
      RETURN
    4 Q = .5
      RETURN
    6 Q = (1.0 + Y)/2.
      RETURN
   10 Q = 1.
      RETURN
   20 Q = 0.
      RETURN
      END
      SUBROUTINE BESL ( X, B0, B1, B2 )
C
C   * BESSEL FUNCTION SUBROUTINE UTILIZING POLYNOMIAL APPROXIMATIONS
C   * COMPUTES J0,J1,OR J2 FOR POSITIVE REAL ARGUMENTS
C   * REFERENCE (HNDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN SECTION 9.4 )
C
      S = 1.0
      IF (X .LT. 0.0) S = -1.0
      X = ABS (X)
C
      IF ( X .GT. 1.E-6 ) GO TO 5
      B0 = 1.0
     B1 = 0.0
      B2 = 0.0
      X = X * S
      RETURN
C
    5 CONTINUE
```

```
C
    1 IF ( X .GE. 3.) GO TO 9
      X1 = X/3.
      X1 = X1*X1
      B = 1.+ X1*(-2.2499997+ X1*(1.2656208+ X1*(-.3163866+ X1*(.0444479
     1 +       X1*(-.0039444+ X1*2.1E-4 )))) )
      GO TO 10
C
    9 X2 = 3./X
      F0 =  .79788456 +X2*(-.77E-6 +X2*(-.00552740 +X2*(-.9512E-4 +X2*
     1      (.00137237 +X2*(-.72805E-3 +X2*0.14476E-3 )))) )
      T0 = X - .78539816 +X2*(-.04166397 +X2*(-.3954E-4 +X2*(.00262573
     1    +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))
      B = F0*COS(T0)/SQRT(X)
C
   10 B0 = B
C
    2 IF ( X .GE. 3. ) GO TO 19
      X1 = X/3.
      X1 = X1*X1
      B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*
     1                (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4))))) )
      GO TO 20
C
   19 X2 = 3./X
      F1 = .79788456 +X2*(.156E-5 +X2*(.01659667 +X2*(.00017105 +X2*
     1      (-.00249511 +X2*(.00113653 -.00020033*X2 )))))
      T1 = X - 2.35619449 +X2*(.12499612 +X2*(.565E-4 +X2*(-.00637879
     1    +X2*(.00074348 +X2*(.00079824 -0.00029166*X2 )))))
      B = F1*COS(T1)/SQRT(X)
C
   20 B1 = B * S
      X = X * S
      B2= (2./X)*B1 - B0
   50 RETURN
      END
      COMPLEX FUNCTION F(TAU)
C
C     COMPUTES FTAU WHERE FTAU =(EXP(-J*TAU**2)/2*TAU)*SQRT(PI/2.)*
C                                 (C2(TAU**2) + J*S2(TAU**2))
C
      COMPLEX B, FP
      PI = 3.14159265358979
      PIO2 = PI/2.
      C1 = SQRT(PI/2.)
      C2 = 1./C1
      ATAUS = ABS(TAU)
      IF (ATAUS .LE. 0.5  )GO TO 20
C
C     FOR TAUS .GT. 0.5, FUNCTION COMPUTED USING POLYNOMIAL
C    * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,
C    *            SECTIONS  7.3.9,7.3.10,7.3.32,7.3.33)
      TAUS = SQRT(ATAUS)
      X = C2*TAUS
      XS = X*X
C
      FX = (1.0+0.926*X)/(2.0+1.792*X+3.104*XS)
      GX = 1.0/(2.0+4.142*X+3.492*XS+6.67*X*XS)
```

```
C
      CC1XS = COS(ATAUS)
      SC1XS = SIN(ATAUS)
C
      CX = 0.5 + FX*SC1XS - GX*CC1XS
      SX = 0.5 - FX*CC1XS - GX*SC1XS
C
      IF (TAU .LT. 0.0) GO TO 10
      B = CMPLX(CX,SX)
      FP = CMPLX(  COS(ATAUS), -SIN(ATAUS) )
      F = (C1*B*FP)/TAUS
      RETURN
C
   10 CONTINUE
      B = CMPLX(SX,CX)
      A = ATAUS-PIO2
      FP = CMPLX( COS(A),SIN(A) )
      F = (B*FP*C1)/TAUS
      RETURN
C
   20 CONTINUE
C     FOR TAUS .LE. 0.5, FUNCTION IS EXPANDED IN SERIES AND FIRST FEW
C                         TERMS INTEGRATED TERM BY TERM TO OBTAIN RESULT
      FP = CMPLX(COS(TAU),-SIN(TAU))
      TS = TAU*TAU
      FR = 1 - TS*( .1 - .0046296296*TS)
      FI = TAU *( .333333333 - TS*(.0238095238 - 7.57575757E-4*TS))
      B = CMPLX(FR,FI)
      F = FP*B
      RETURN
      END
```

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI,THETAD)

L-38

```
 -----------
/  TARGET  /
 -----------

      *

 *
 * * * * *
GENERALIZED PROGRAM
FOR A FRUSTRA, CONE,
OR CYLINDER  * * *
(UFIMTSEV SOLUTION
FOR CW)
 *
 *
A1      = FRONT-END
RADIUS (INCHES)
 *
A2      = BACK-END
RADIUS (SHOULD BE
.GE. A1) - (INCHES)
 *
H2      = TOTAL LENGTH
(INCHES)
 *
ALPHA  = CONE OR
FRUSTRA HALF ANGLE
(DEGREES)
 *
FREQ   = CARRIER
FREQUENCY (GHZ)
 *
DELTHT = ASPECT ANGLE
INCREMENT (DEGREES) -
(.GE. 0.1)       *
KONFIG = TARGET
CONFIGURATION
 *
1 = FRUSTRA
 *
2 = CONE
 *
3 = CYLINDER
 *
 *
 * * * * ALL
DIMENSIONS ARE IN
INCHES AND ANGLES ARE
IN DEGREES  * * *


NMIN = MINIMUM
FREQUENCY SAMPLE
NMAX = MAXIMUM
```

```
     *

     09.06--->*
       40     |          09
         ----------------
        / WRITE TO DEV  /
       /       6       /
      /  VIA FORMAT   /
     /      3040     /
    / FROM THE LIST /
    ----------------
              |
              |
              |  NOTE  10
    * * * * * * * * * * * *
    *  LIST = H2, A2,     *
    *       ANGLE         *
    * * * * * * * * * * * *
              |
              |
              |
             ...
            .   .
           .10.03.
            .   .
             ... 60
```

NMIN = MINIMUM
FREQUENCY SAMPLE
NMAX = MAXIMUM
FREQUENCY SAMPLE
DF = FREQUENCY
INCREMENT IN MHZ
FC = CARRIER
FREQUENCY IN GHZ

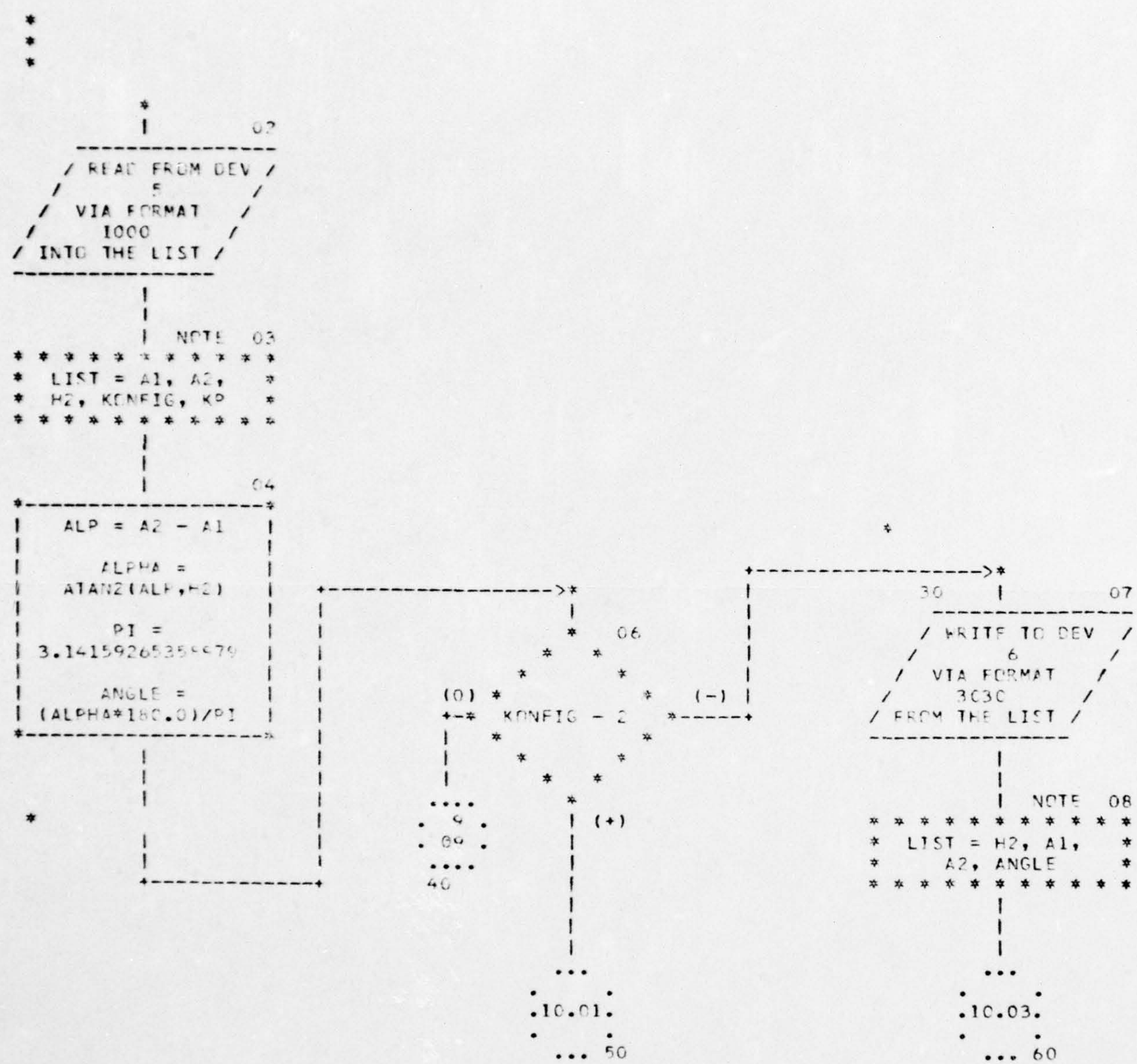


CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI,THETAD)

```
                                  +----------------------->*
                                  |                        |              09
      *                           |             *---------------------------*
                                  |             | CTHT = COS(THETA)          |
   09.06--->*                     |             |                            |
     50     |          01         |             |   APT = ALPHA +            |
      ---------------------       |             |      THETA                 |
      / WRITE TO DEV  /           |             |                            |
     /       6       /            |             |   AMT = ALPHA -            |
    /   VIA FORMAT  /             |             |      THETA                 |
   /       3050    /              |             |                            |
  / FROM THE LIST /               |             | TANAPT = TAN(APT)          |
  -----------------               |             *---------------------------*
            |                     |                        |
            |                     |                        |
            |   NOTE   02         |                        |              10
  * * * * * * * * * * * *         |             *---------------------------*
  *   LIST = H2, A2      *        |             | TANAMT = TAN(AMT)          |
  * * * * * * * * * * * *         |             |                            |
            |                     |             | TWOPIC = 2.0*PI/C          |
            |                     |             *---------------------------*
            |                     |                        |
      *                           |                        |
            |                     |                        |
   09.08*-->|                     |         *              |
     60     |          03         |                        |
      ---------------------       |                        |   NOTE   11
      / WRITE TO DEV  /           |             * * * * * * * * * * * *
     /       6       /            |             *   BEGIN DO LOOP      *
    /   VIA FORMAT  /             |             *   200 I = NMIN,      *
   /        79     /              |             *        NMAX          *
  / FROM THE LIST /               |             * * * * * * * * * * * *
  -----------------               |                        |
            |                     |             13.10--->|
```

```
/ FROM THE LIST /
-----------------
        |
        |    NOTE  04
* * * * * * * * * * *
*   LIST = THETAD   *
* * * * * * * * * * *
        |
        |                                   05
*--------------------------*
|  C = 11.80285078         |
|  DTR = PI/180.0          |
|  PISQRT = SQRT(PI)       |
|  PIOVR2 = PI/2.0         |
*--------------------------*
        |
        |                                   06
*--------------------------*
|  A12 = 2.0*A1            |
|  A22 = 2.0*A2            |
|  H22 = 2.0*H2            |
|  XNPOS =                 |
|  (3.0/2.0) +             |
|  (ALPHA/PI)              |
*--------------------------*
        |
        |                                   07
*--------------------------*
|  XNNEG =                 |
|  (3.0/2.0) -             |
|  (ALPHA/PI)              |
*--------------------------*
        |
  COMPUTE C(N)
        |
        |                                   08
*--------------------------*
|  FSTCOP =                |
|  FIRS(XNPOS)             |
*--------------------------*
```

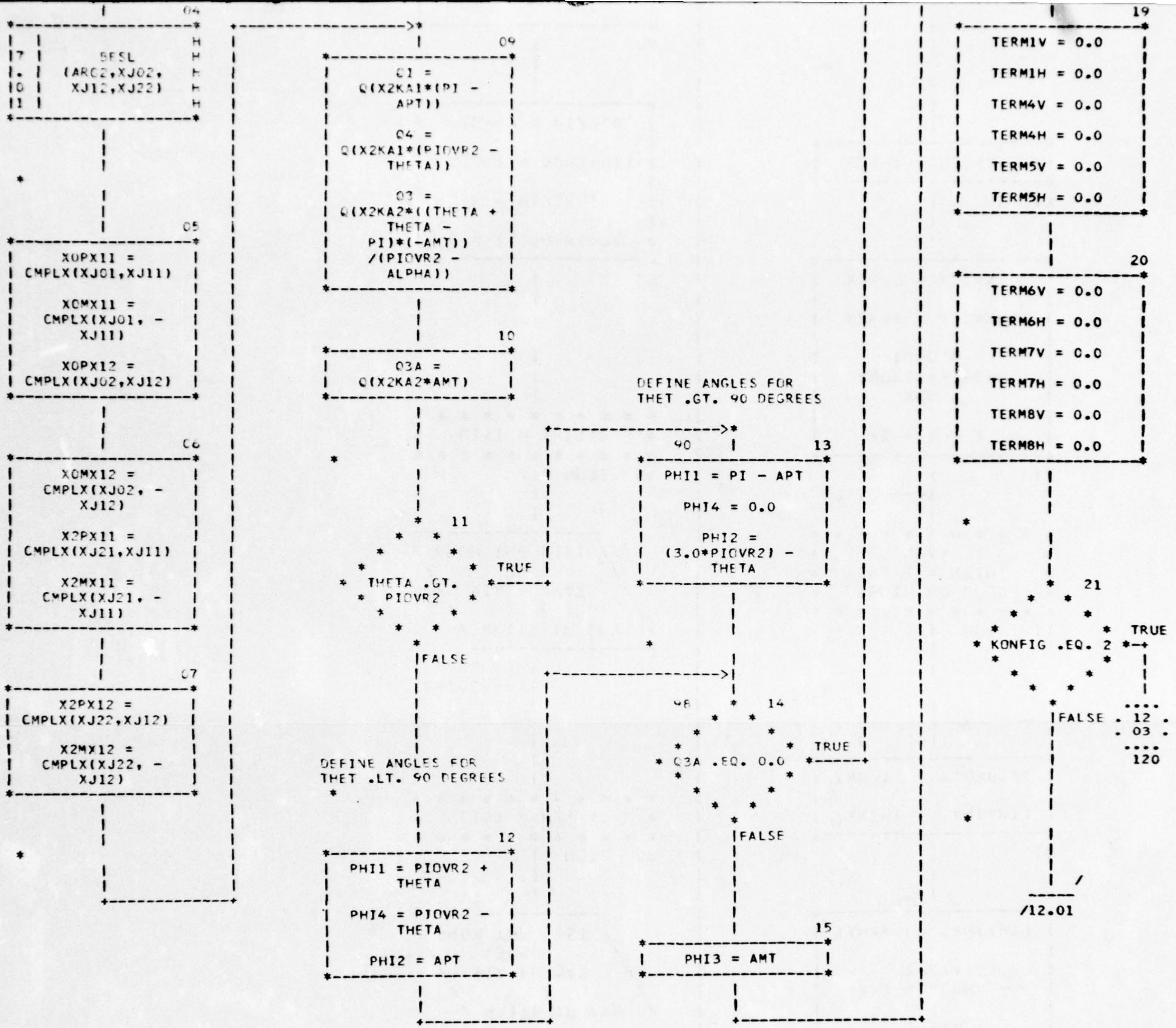
```
* * * * * * * * * * *
13.10--->|
         |                                  12
*--------------------------*
|  XI = I - 1              |
|  XKO =                   |
|  TWOPIC*XI*DF/           |
|  1000.0                  |
|  X2KA1 = A12*XKO         |
|  X2KA2 = A22*XKO         |
*--------------------------*
         |
         |                                  13
*--------------------------*
|  X2KH2 = H22*XKO         |
*--------------------------*
         |
         |
         *   14
TRUE  *     *
+-----* KONFIG .EQ. 3 *
|       *     *
|          *
|          |FALSE
|          |                                15
|   *--------------------------*
|   |  TAUSQ1 =                |
|   |  X2KA1/SIN(ALPHA)        |
|   |  TAUSQ2 =                |
|   |  X2KA2/SIN(ALPHA)        |
|   *--------------------------*
|          |
+--------->|
      70   |  NOTE  16
* * * * * * * * * * *
*     CONTINUE      *
```

```
*------------------------*
| PISQRT = SQRT(PI)      |
|                        |
| PIOVR2 = PI/2.0        |
*------------------------*
            |
            |                       06
*------------------------*
| A12 = 2.0*A1           |
|                        |
| A22 = 2.0*A2           |
|                        |
| H22 = 2.0*H2           |
|                        |
|       XNPOS =          |
|    (3.0/2.0) +         |
|    (ALPHA/PI)          |
*------------------------*
            |
            |                       07
*------------------------*
|       XNNEG =          |
|    (3.0/2.0) -         |
|    (ALPHA/PI)          |
*------------------------*
            |
     COMPUTE C(N)
            |
            |                       08
*------------------------*
|      FSTCOP =          |
|   FIRS(XNPOS)          |
|                        |
|      FSTCON =          |
|   FIRS(XNNEG)          |
|                        |
|       THETA =          |
|   THETAD*DTR           |
|                        |
| STHT = SIN(THETA)      |
*------------------------*


*------------------------*
| X2KH2 = H22*XKO        |
*------------------------*
            |
            *  14
TRUE  *          *
+-----* KONFIG .EQ. 3 *
            *
            |FALSE
            |                       15
*------------------------*
|      TAUSQ1 =          |
| X2KA1/SIN(ALPHA)       |
|                        |
|      TAUSQ2 =          |
| X2KA2/SIN(ALPHA)       |
*------------------------*
            |
+---------->|
   70       |  NOTE   16
* * * * * * * * * * * *
*       CONTINUE        *
* * * * * * * * * * * *
            |
            /
         ----
        /11.01
```

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI,THETAD)

L-40

```
10.17--->*
01
WAPT = PIOVR2 -
  ACOS(0.8*COS
  (ALPHA)/X2KH2)
ARG1 = X2KA1*STHT
ARG2 = X2KA2*STHT

02
FASE = X2KH2*CTHT
PHASE =
CMPLX(COS(FASE),
  SIN(FASE))

*

03
7.01  BESL
      (ARG1,XJ01,
      XJ11,XJ21)

04
7.01  BESL
      (ARG2,XJ02,
      XJ12,XJ22)

*

05

09
Q1 =
Q(X2KA1*(PI -
  APT))
Q4 =
Q(X2KA1*(PIOVR2 -
  THETA))
Q3 =
Q(X2KA2*((THETA +
  THETA -

/ 99 /

16
PHI3 = PIOVR2 -
  THETA

*
COMPUTE B(N,PHI)

100
17
SECND1 =
SECO(PHI1,XNNEG)
SECND4 =
SECO(PHI4,XNNEG)
SECND2 =
SECO(PHI2,XNPOS)

18
SECND3 =
SECO(PHI3,XNPOS)

*

19
TERM1V = 0.0
TERM1H = 0.0
TERM4V = 0.0
TERM4H = 0.0
TERM5V = 0.0
TERM5H = 0.0
```



04
7 . 10 11
BESL (ARG2,XJ02, XJ12,XJ22)
05
X0PX11 = CMPLX(XJ01,XJ11)
X0MX11 = CMPLX(XJ01, -XJ11)
X0PX12 = CMPLX(XJ02,XJ12)
06
X0MX12 = CMPLX(XJ02, -XJ12)
X2PX11 = CMPLX(XJ21,XJ11)
X2MX11 = CMPLX(XJ21, -XJ11)
07
X2PX12 = CMPLX(XJ22,XJ12)
X2MX12 = CMPLX(XJ22, -XJ12)
09
Q1 = Q(X2KA1*(PI - APT))
Q4 = Q(X2KA1*(PIOVR2 - THETA))
Q3 = Q(X2KA2*((THETA + THETA - PI)*(-AMT)) /(PIOVR2 - ALPHA))
10
Q3A = Q(X2KA2*AMT)
11
THETA .GT. PIOVR2
TRUE
FALSE
DEFINE ANGLES FOR THET .LT. 90 DEGREES
12
PHI1 = PIOVR2 + THETA
PHI4 = PIOVR2 - THETA
PHI2 = APT
DEFINE ANGLES FOR THET .GT. 90 DEGREES
90
13
PHI1 = PI - APT
PHI4 = 0.0
PHI2 = (3.0*PIOVR2) - THETA
98
14
Q3A .EQ. 0.0
TRUE
FALSE
15
PHI3 = AMT
19
TERM1V = 0.0
TERM1H = 0.0
TERM4V = 0.0
TERM4H = 0.0
TERM5V = 0.0
TERM5H = 0.0
20
TERM6V = 0.0
TERM6H = 0.0
TERM7V = 0.0
TERM7H = 0.0
TERM8V = 0.0
TERM8H = 0.0
21
KONFIG .EQ. 2
TRUE
FALSE
. 12 .
. 03 .
120
/12.01

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI,THETAD)

```
  11.22--->*               +------------------->*
           |          01   |                    |
 *-------------------*     |                    *     06
 |   TERM1V = -      |     |                  *   *
 |  A1*((X2PX11*     |     |                *       *
 |    FSTCON) +      |     |        TRUE  *           *
 | (XOMX11*SECND1))  |     |      +-----* KONFIG .EQ. 2 *
 |       *Q1         |     |      |       *           *
 |                   |     |      |         *       *
 |   TERM1H = -      |     |      |           *   *
 |  A1*((X2PX11*     |     |      |             *
 |    FSTCON) -      |     |      |             |FALSE
 | (XOMX11*SECND1))  |     |      |             |
 |       *Q1         |     |      |             |
 *-------------------*     |      |             |
           |               |      |             |
           |               |      |             |
           |          02   |      |             |
 *-------------------*     |      |      *
 |   TERM4V = -      |     |      |      THIS SECTION NOT DONE
 |  A1*((X2MX11*     |     |      |      FOR CYLINDER OR CONE
 |    FSTCON) +      |     |      |             |
 | (XOPX11*SECND4))  |     |      |             |
 |       *Q4         |     |      |             |             07
 |                   |     |      |      *--------------------*
 |   TERM4H = -      |     |      |      |       TAU1 =       |
 |  A1*((X2MX11*     |     |      |      | TAUSQ1*COS(APT)    |
 |    FSTCON) -      |     |      |      |                    |
 | (XOPX11*SECND4))  |     |      |      |       TAU4 =       |
 |       *Q4         |     |      |      | TAUSQ1*COS(AMT)    |
 *-------------------*     |      |      |                    |
           |               |      |      | FTAU1 = F(TAU1)    |   +------------------>*
           |               |      |      |                    |   |                   |
           |               |      |      | FTAU4 = F(TAU4)    |   |                   |
 *         |               |      |      *--------------------*   |        *          |
           |               |      |             |                 |                   |
  11.21--->|               |      |             |                 |                   |
   120     |          03   |      |             |             08  |                   |
 *-------------------*     |      |      *--------------------*   |                   *    13
 |   TERM2V = -      |     |      |      |      TERM5V =      |   |                 *   *
 |  A2*((X2PX12*     |     |      |      | A1*TANAPT*XOMX11*  |   |               *       *
```

```
11.21--->
120                         03
TERM2V = -
A2*((X2PX12*
FSTCOP) +
(XOMX12*SECND2))
*PHASE

TERM2H = -
A2*((X2PX12*
FSTCOP) -
(XOMX12*SECND2))
*PHASE

                            04
TERM3V = -
A2*((X2MX12*
FSTCOP) +
(XOPX12*SECND3))
*Q3*PHASE

TERM3H = -
A2*((X2MX12*
FSTCOP) -
(XOPX12*SECND3))
*Q3*PHASE

                 05
* KONFIG .EQ. 3 *  TRUE
FALSE . 13 .
      . 01 .
       130
```

```
                            08
TERM5V =
A1*TANAPT*XOMX11*
FTAU1*0.5*Q1

TERM5H = - TERM5V

TERM6V =
A1*TANAMT*XOPX11*
FTAU4*0.5*Q3A

                            09
TERM6H = - TERM6V

THIS SECTION NOT DONE
FOR CYLINDER
DONE FOR CONE

140                         10
TAU2 =
TAUSQ2*COS(APT)

TAU3 =
TAUSQ2*COS(AMT)

FTAU2 = F(TAU2)

FTAU3 = F(TAU3)

                            11
TERM7V = -
A2*TANAPT*XOMX12*
FTAU2*0.5*Q1*
PHASE

TERM7H = - TERM7V

TERM8V = -
A2*TANAMT*XOPX12*
FTAU3*0.5*Q3A*
PHASE

                            12
TERM8H = - TERM8V
```

```
              13
* KONFIG - 2  *  (-/+)
(0)   . 13 .
      . 01 .
       130

56            14
* ABS(APT - *  TRUE
* PIQVR2) .GT.
*    WAPT   *
FALSE . 13 .
      . 01 .
       130

THIS SECTION USED TO
COMPUTE CONE RETURN
NEAR SPECULAR TO
CONIC SURFACE  (THET
NEAR (PI/2)-ALPHA)

                            15
XX =
CMPLX(0.0,1.0)

ZZ =
XOMX12*XX*TAUSQ2*
SIN(APT)/3.0

YY = -
X2PX12*FSTCOP

                            16
FFVV = -
PISQRT*A2*PHASE*
(YY + ZZ)
```

```
TERM3V = -
A2*((X2MX12*
FSTCOP) +
(XOPX12*SECND3))
*Q3*PHASE

TERM3H = -
A2*((X2MX12*
FSTCOP) -
(XOPX12*SECND3))
*Q3*PHASE

05
* KONFIG .EQ. 3 *  TRUE
FALSE . 13 .
      . 01 .
       130
```

```
THIS SECTION NOT DONE
FOR CYLINDER
DONE FOR CONE

140                      10
TAU2 =
TAUSQ2*COS(APT)

TAU3 =
TAUSQ2*COS(AMT)

FTAU2 = F(TAU2)

FTAU3 = F(TAU3)

                         11
TERM7V = -
A2*TANAPT*XOMX12*
FTAU2*0.5*Q1*
PHASE

TERM7H = - TERM7V

TERM8V = -
A2*TANAMT*XOPX12*
FTAU3*0.5*Q3A*
PHASE

                         12
TERM8H = - TERM8V
```

```
* ABS(APT - *  TRUE
* PIQVR2) .GT.
*   WAPT   *
FALSE . 13 .
      . 01 .
       130

THIS SECTION USED TO
COMPUTE CONE RETURN
NEAR SPECULAR TO
CONIC SURFACE  (THET
NEAR (PI/2)-ALPHA)

                         15
XX =
CMPLX(0.0,1.0)

ZZ =
XOMX12*XX*TAUSQ2*
SIN(APT)/3.0

YY = -
X2PX12*FSTCOP

                         16
FFVV = -
PISQRT*A2*PHASE*
(YY + ZZ)

FFHH =
PISQRT*A2*PHASE*
(YY - ZZ)

.13.03.
   ... 55
```


3

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI,THETAD)

L-42

```
                ------------
               /  130      /
              ------------
                    |
         12.05*-->|
                    |               01
         *-----------------------*
         |      FFVV = -         |
         | PISQRT*(TERM1V +      |
         | TERM2V + TERM3V +     |
         | TERM4V + TERM5V +     |
         | TERM6V + TERM7V +     |
         |       TERM8V)         |
         *-----------------------*
                    |
                    |
                    |               02
         *-----------------------*
         |      FFHH =           |
         | PISQRT*(TERM1H +      |
         | TERM2H + TERM3H +     |
         | TERM4H + TERM5H +     |
         | TERM6H + TERM7H +     |
         |       TERM8H)         |
         *-----------------------*
                    |
                    |
                    |
         *
                    |
         12.16--->|
            55      |     NOTE   03
         * * * * * * * * * * * *
         *      CONTINUE         *
         * * * * * * * * * * * *
                    |
                    |
                    |               04
         *-----------------------*
         |      FFVV =           |
         |  FFVV*0.02540005      |
         |                       |
```

```
FFVV =
FFVV*0.02540005

FFHH =
FFHH*0.02540005

05
EVVR(I) =
REAL(FFVV)

EVVI(I) = -
AIMAG(FFVV)

EHHR(I) =
REAL(FFHH)

EHHI(I) = -
AIMAG(FFHH)

                                  +-----------13.06*-->*
06                                        77    NOTE  09
     KP        (-70)                      CONTINUE
               A
(+)                               200  END OF DO   10
                                       LOOP?        NO
                                       YES         . 10 .
                                                   . 12 .
78          07
FREQ(I) =
XI*FF/1000.0

SIGMAV(I) =
10.0*ALOG10(EVVR
(I)*EVVR(I) +
EVVI(I)*EVVI(I))
                                  IF (KP)  75, 75, 76
                                  76 WRITE (6, 74) (
                                  FREQ(I), SIGMAV(I),
                                  SIGMAH(I), I= NMIN,
                                  NMAX )
```

```
            * (-70)
      KP    *------>
                    A
     (+)

   78               67
   *-----------------*
   | FREQ(I) =       |
   | XI*FF/1000.0    |
   |                 |
   |  SIGMAV(I) =    |
   | 10.0*ALOG10(EVVR|
   |  (I)*EVVR(I) +  |
   | EVVI(I)*EVVI(I))|
   *-----------------*
            |
            |       68
   *-----------------*
   |  SIGMAH(I) =    |
   | 10.0*ALOG10(EHHR|
   |  (I)*EHHR(I) +  |
   | EHHI(I)*EHHI(I))|
   *-----------------*
            |
            +--------------+


      200    *    10
          *     *
        *         *      NO
      *  END OF DO   *--+
        *  LOOP?   *    |
          *     *       |
             *         ....
             |YES      . 10 .
             |         . 12 .
                       ....
       *
       *
   IF (KP)  75, 75, 76
   76 WRITE (6, 74) (
   FREQ(I), SIGMAV(I),
   SIGMAH(I), I= NMIN,
   NMAX )
   74 FORMAT (1P0,
   3E15.5 )
             |
        75   |  NOTE 11
   * * * * * * * * * * *
   *     CONTINUE      *
   * * * * * * * * * * *
             |
   *
             |
             | 12
         ---------
         *  EXIT  *
         ---------
```

3

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
      COMMON  MOVER, M, NMIN, NMAX, DF, FC, PW, TO
      DIMENSION  EVVR(512), EVVI(512), EHHR(512), EHHI(512),
                 FREQ(512), SIGMAV(512), SIGMAH(512)
      COMPLEX PHASE, XOPX11, XOMX11, XOPX12, XOMX12, X2PX11, X2MX11,
              X2PX12, X2MX12, TERM1V, TERM1H, TERM2V, TERM2H, TERM3V,
              TERM3H, TERM4V, TERM4H, TERM5V, TERM5H, TERM6V, TERM6H,
              TERM7V, TERM7H, TERM8V, TERM8H, EEVV, EEHH, E, ETAU1,
              ETAU2, ETAU3, ETAU4       ,XX,YY,ZZ
1000  FORMAT( 3F10.0,2I5 )
3030  FORMAT (1H0///'         FRUSTRA (UFIMTSEV SOLUTION)'//'        FRUSTR
      A LENGTH = ',F10.6,' INCHES'/'    FRONT-END RADIUS = ',F10.6,' INC
      HES'/'     BACK-END RADIUS = ',F10.6,' INCHES'/'  FRUSTRA HALF-ANG
      LE = ',F10.6,' DEGREES')
3040  FORMAT (1H0///'           CONE (UFIMTSEV SOLUTION)'//'           CONE
       LENGTH = ',F10.6,' INCHES'/'           BASE RADIUS = ',F10.6,' INCH
      ES'/'     CONE HALF-ANGLE = ',F10.6,' DEGREES')
3050  FORMAT (1H0///'        CYLINDER (UFIMTSEV SOLUTION)'//'     CYLIND
      ER LENGTH = ',F10.6,' INCHES'/'     CYLINDER RADIUS = ',F10.6,' IN
      CHES')
79    FORMAT(1H0, ' THETA = ' , E15.5  /// )
```

CHART TITLE - FUNCTION FIRS(XN)

```
        ------------
       /            /
       ------------
             |
             |
             |               01
   *-------------------------*
   |          PI =           |
   |  3.14159265358979       |
   |                         |
   |          A =            |
   |  (SIN(PI/XN))/XN        |
   |                         |
   |          B =            |
   |  1.0/(COS(PI/XN) -      |
   |         1.0)            |
   |                         |
   |       FIRS = A*B        |
   *-------------------------*
             |
             |
             | 02
        -----------
        *  EXIT   *
        -----------
```

CHART TITLE - FUNCTION SECO(PHI,XN)

```
                 -----------
                /           /
                 -----------
                      |
                      |
                      |           02
            *-----------------------*
            |        PI =           |
            |  3.14159265358979     |
            |                       |
            |        A =            |
            |   (SIN(PI/XN))/XN     |
            |                       |
            | B = COS(PI/XN) -      |
            | COS((2.0*PHI)/XN)     |
            |                       |
            |     C = 1.0/B         |
            *-----------------------*
                      |
                      |
                      |           03
            *-----------------------*
            |     SECO = A*C        |
            *-----------------------*
                      |
                      |
                      | 04
                  ----------
                 *  EXIT    *
                  ----------
```

AUTOFLOW CHART SET - FWD/SCL RADSIM

CHART TITLE - FUNCTION Q(Z)

L-46

```
Q(Z) = 0.5*(1 +
ERF(Z))
 * ERF(Z) IS
EVALUATED USING A
RATIONAL POLYNOMIAL
APPROXIMATION
 * REFERENCE (HANDBK
MATH FUNCT BY
ABRAMOWITZ AND
STEGUN,
 *               SECTION
7.1.26)

          *
          |
          *    03
        *   *
      *       *
    *           *  TRUE
  *   Z .GT. 2.   *------------------------>*
    *           *                   10      |          09
      *       *                     *-----------------------*
        *   *                       |       Q = 1.          |
          *                         *-----------------------*
          |FALSE                            |
          |                                 |
          |                                 | 10
          |                              ---------
          |                              * EXIT  *
          |                              ---------
          *    04
        *   *
      *       *
    *           *  TRUE
  *  Z .LT. - 2.  *-----+
    *           *       |
      *       *         |
        *   *           +------------------>*
          *                         20      |          11
          |FALSE                    *-----------------------*
          |                         |       Q = 0.          |
```

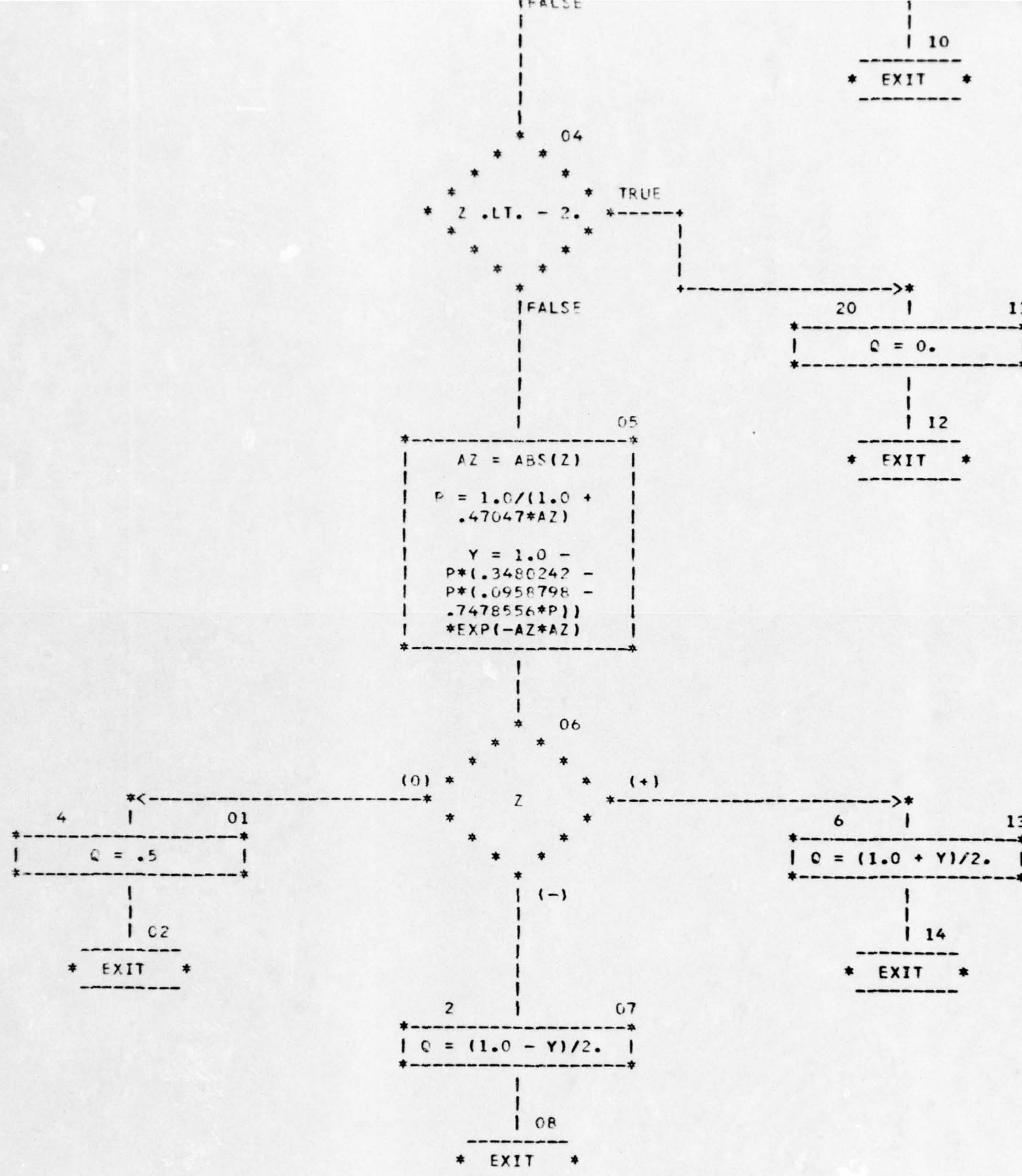

FALSE
10
EXIT
04
Z .LT. - 2.
TRUE
FALSE
20
11
Q = 0.
12
EXIT
05
AZ = ABS(Z)
P = 1.0/(1.0 + .47047*AZ)
Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P)) *EXP(-AZ*AZ)
06
Z
(0)
(+)
(-)
4
01
Q = .5
02
EXIT
6
13
Q = (1.0 + Y)/2.
14
EXIT
2
07
Q = (1.0 - Y)/2.
08
EXIT

CHART TITLE - SUBROUTINE BESL(X,B0,B1,B2)

```
        -----------
       /  BESL    /
      -----------

             *

   * BESSEL FUNCTION
  SUBROUTINE UTILIZING
  POLYNOMIAL
  APPROXIMATIONS
   * COMPUTES J0,J1,OR
  J2 FOR POSITIVE REAL
  ARGUMENTS
   * REFERENCE (HNDBK
  MATH FUNCT BY
  ABRAMOWITZ AND STEGUN
  SECTION 9.4 )

             *
             |           02
  *----------------------*
  |       S = 1.0        |
  *----------------------*
             |
             |
             |
             *   03                              +------------------>*
          *     *                                |                9  |            13
        *         *                              |             *--------------------*
 FALSE *            *                            |             |     X2 = 3./X      |
+-----*  X .LT. 0.0   *                          |             |                    |
|       *           *                            |             | F0 = .79788456 +   |
|         *       *                              |             |   X2*(-.77E-6 +    |
|           *   *                                |             | X2*(-.00552740 +   |
|             *                                  |             |  X2*(-.9512E-4 +   |
|             |TRUE                              |             |  X2*(.00137237 +   |
|             |                                  |             | X2*(-.72805E-3 +   |
|             |                                  |             | X2*0.14476E-3))))  |
|             |                                  |             |         )          |
|             |                                  |             *--------------------*
|             |          04                      |                       |
|  *----------------------*                      |                       |            14
|  |      S = - 1.0       |                      |             *--------------------*
|  *----------------------*                      |             |     T0 = X -       |
|             |                                  |             |    .78539816 +     |
+------------>|                                  |             | X2*(-.04166397 +   |
              |          05                      |             |  X2*(-.3954E-4 +   |
   *----------------------*                      |             |  X2*(.00262573 +   |
   |     X = ABS(X)       |                      |             | X2*(-.00054125 +   |
   *----------------------*                      |             | X2*(-.00029333 +   |
              |                                  |             | X2*0.00013558))))  |
```

```
05
X = ABS(X)

C6
X .GT. 1.E - 6
TRUE -> 5
FALSE

07
BC = 1.0
B1 = C.C
B2 = C.C
X = X*S

C8
* EXIT *

5   NOTE 09
CONTINUE

1   10
X .GE. 3.
TRUE
FALSE

11
X1 = X/3.
X1 = X1*X1

12
B = 1. +
X1*(-2.2499997 +
X1*(1.2656208 +
X1*(-.3163866 +
X1*(.0444479 +
X1*(-.0039444 +
X1*2.1E-4)))))

X2*(-.3954E-4 +
X2*(.00262573 +
X2*(-.00054125 +
X2*(-.00029333 +
X2*0.00013558))))
)

15
B =
F0*COS(T0)
/SQRT(X)

10   16
B0 = B

2   17
X .GE. 3.
TRUE
FALSE

18
X1 = X/3.
X1 = X1*X1

19
B = X*(.5 +
X1*(-.56249985 +
X1*(.21093573 +
X1*(-.03954289 +
X1*(.00443319 +
X1*(-.31761E-3 +
X1*0.1109E-4)))))
)

19   20
X2 = 3./X

F1 = .79788456 +
X2*(.156E-5 +
X2*(.01659667 +
X2*(.00017105 +
X2*(-.00249511 +
X2*(.00113653 -
.00020033*X2)))))

21
T1 = X -
2.35619449 +
X2*(.12499612 +
X2*(.565E-4 +
X2*(-.00637879 +
X2*(.00074348 +
X2*(.00079824 -
0.00029166*X2))))
)

22
B =
F1*COS(T1)
/SQRT(X)

20   23
B1 = B*S

X = X*S

B2 = (2./X)*B1 -
B0

50   24
* EXIT *
```

CHART TITLE - COMPLEX FUNCTION F(TAU)

L-48

```
COMPUTES FTAU WHERE
FTAU
=(EXP(-J*TAU**2)
/2*TAU)*SQRT(PI/2.)*
(C2(TAU**2) +
J*S2(TAU**2))

           *                                    +------------------->*
           |          02                        |            20      |  NOTE 07
*-----------------------*                       |         * * * * * * * * * * *
|        PI =           |                       |         *       CONTINUE      *
| 3.14159265358979      |                       |         * * * * * * * * * * *
|                       |                       |                    |
|   PI12 = PI/2.        |                       |                    |
|                       |                       |         FOR TAUS .LE. 0.5,
| C1 = SQRT(PI/2.)      |                       |         FUNCTION IS EXPANDED
|                       |                       |         IN SERIES AND FIRST
|     C2 = 1./C1        |                       |         FEW
|                       |                       |         TERMS INTEGRATED TERM
| ATAUS = ABS(TAU)      |                       |         BY TERM TO OBTAIN
*-----------------------*                       |         RESULT
           |                                    |                    |
           |                                    |                    |      08
           |                                    |         *-----------------------*
           *      03                            |         |        FP =           |
        *     *                                 |         | CMPLX(COS(TAU), -     |
      *          *                              |         |     SIN(TAU))         |
    *               *   TRUE                    |         |                       |
  *  ATAUS .LE.        *------------------------+         |   TS = TAU*TAU        |
    *    0.5        *                                     |                       |
      *          *                                        | FR = 1 - TS*(.1 -     |
        *     *                                           |  .0046296296*TS)      |
           *                                              *-----------------------*
           |FALSE                                                    |
           |                                                         |      09
           |                                              *-----------------------*
```

```
 |FALSE
 |
FOR TAUS .GT. 0.5,
FUNCTION COMPUTED
USING POLYNOMIAL
 * REFERENCE (HANDBK
MATH FUNCT BY
ABRAMOWITZ AND
STEGUN,
 *
SECTIONS
7.3.9,7.3.10,7.3.32,
7.3.33)
 |
                         04
*------------------------*
|        TAUS =          |
|     SQRT(ATAUS)        |
|                        |
|     X = C2*TAUS        |
|                        |
|      XS = X*X          |
*------------------------*
 |
                         05
*------------------------*
|     FX = (1.0 +        |
|  0.926*X)/(2.0 +       |
|      1.792*X +         |
|      3.104*XS)         |
|                        |
|    GX = 1.0/(2.0 +     |
|      4.142*X +         |
|      3.492*XS +        |
|      6.67*X*XS)        |
*------------------------*
 |
                         06
*------------------------*
|       CC1XS =          |
|     COS(ATAUS)         |
|                        |
|       SC1XS =          |
|     SIN(ATAUS)         |
*------------------------*
 |
 +--------------------------->* 11

                         09
*------------------------*
|        FI =            |
| TAU*(.333333333 -      |
| TS*(.0238095238 -      |
| 7.57575757E-4*TS)      |
|        )               |
|                        |
|  B = CMPLX(FR,FI)      |
|                        |
|     F = FP*B           |
*------------------------*
 |
 | 10
 ----------
 *  EXIT  *
 ----------

                         11
*------------------------*
|    CX = 0.5 +          |
|    FX*SC1XS -          |
|     GX*CC1XS           |
|                        |
|    SX = 0.5 -          |
|    FX*CC1XS -          |
|     GX*SC1XS           |
*------------------------*
 |
 *  12
* TAU .LT. 0.0 *  TRUE ------------------->*
 |FALSE                        10 | NOTE 15
 |                        * * * * * * * * * * *
 |                        *     CONTINUE      *
 |                        * * * * * * * * * * *
 |                                 |
 |                                 |        16
 |                        *-------------------*
 |                        | F = CMPLX(SX,CX)  |
 |                        |                   |
 |                        | A = ATAUS - PIO2  |
 |                        |                   |
 |                        |      FR =
 |                  13
*------------------------*
| F = CMPLX(CX,SX)
```

```
|        SQRT(ATAUS)         |
|                            |
|        X = C2*TAUS         |
|                            |
|        XS = X*X            |
*----------------------------*       +-------------------->*
              |                      |                     |          11
              |                      |          *----------------------*
              |               05     |          |   CX = 0.5 +         |
*----------------------------*       |          |   FX*SC1XS -         |
|  FX = (1.0 +               |       |          |   GX*CC1XS           |
|  0.926*X)/(2.0 +           |       |          |                      |
|  1.792*X +                 |       |          |   SX = 0.5 -         |
|  3.104*XS)                 |       |          |   FX*CC1XS -         |
|                            |       |          |   GX*SC1XS           |
|  GX = 1.0/(2.0 +           |       |          *----------------------*
|  4.142*X +                 |       |                     |
|  3.492*XS +                |       |                     |
|  6.67*X*XS)                |       |                     * 12
*----------------------------*       |                   *   *
              |                      |                 *       *
              |               06     |               *           *   TRUE
*----------------------------*       |             * TAU .LT. 0.0 *------------------->*
|  CC1XS =                   |       |               *           *          10   | NOTE   15
|  COS(ATAUS)                |       |                 *       *            * * * * * * * * * * *
|                            |       |                   *   *              *     CONTINUE        *
|  SC1XS =                   |       |                     *                * * * * * * * * * * *
|  SIN(ATAUS)                |       |                     |FALSE                    |
*----------------------------*       |                     |                         |
              |                      |                     |                         |           16
              +----------------------+                     |                *----------------------*
                                                           |                | F = CMPLX(SX,CX)     |
                                                           |          13    |                      |
                                                *----------------------*    | A = ATAUS - PIO2     |
                                                | B = CMPLX(CX,SX)     |    |                      |
                                                |                      |    |   FP =               |
                                                |   FP =               |    |   CMPLX(COS(A),      |
                                                |   CMPLX(COS(ATAUS),  |    |   SIN(A))            |
                                                |   - SIN(ATAUS))      |    |                      |
                                                |                      |    |   F =                |
                                                |   F =                |    |   (B*FP*C1)/TAUS     |
                                                |   (C1*B*FP)/TAUS     |    *----------------------*
                                                *----------------------*               |
                                                           |                           | 17
                                                           |                       ---------
                                                           | 14                  *   EXIT   *
                                                       ---------                   ---------
                                                     *   EXIT   *
                                                       ---------
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
      COMPLEX E, EP
      SUBROUTINE TARGET ( EVVR, EVVI, EHHR, EHHI, THETAF)                RCS5 001
C                                                                      * RCS5 002
C * * * * * GENERALIZED PROGRAM FOR A FRUSTRA, CONE, OR CYLINDER  * * * RCS5 003
C              (UFIMTSEV SOLUTION FOR CW)                              * RCS5 004
C                                                                      * RCS5 005
C        A1     = FRONT-END RADIUS (INCHES)                            * RCS5 006
C        A2     = BACK-END RADIUS (SHOULD BE .GE. A1) - (INCHES)       * RCS5 007
C        H2     = TOTAL LENGTH (INCHES)                                * RCS5 008
C        ALPHA  = CLNE LR FRUSTRA HALF ANGLE (DEGREES)                 * RCS5 009
C        FREQ   = CARFIER FRECUENCY (GHZ)                              * RCS5 010
C        DELTHT = ASPECT ANGLE INCREMENT (DEGREES) - (.GE. 0.1)        * RCS5 011
C        KONFIG = TARGET CONFIGURATION                                 * RCS5 012
C                  1 = FRUSTRA                                         * RCS5 013
C                  2 = CONE                                            * RCS5 014
C                  3 = CYLINDER                                        * RCS5 015
C                                                                      * RCS5 016
C * * * * * ALL DIMENSIONS ARE IN INCHES AND ANGLES ARE IN DEGREES  * * * RCS5 017
```

```
C                                                                  * RCS5 016
C * * * * ALL DIMENSIONS ARE IN INCHES AND ANGLES ARE IN DECREES * * * RCS5 017
C                                                                  * RCS5 018
      COMMON  MOVER, M, NMIN, NMAX, DF, FC, PW, TO                    RCS5 019
C     NMIN = MINIMUM FREQUENCY SAMPLE                                 RCS5 020
C     NMAX = MAXIMUM FREQUENCY SAMPLE                                 RCS5 021
C     DF   = FREQUENCY INCREMENT IN MHZ                               RCS5 022
C     FC   = CARRIER FREQUENCY IN GHZ                                 RCS5 023
      DIMENSION  FVVR(512), FVVI(512), FHHR(512), FHHI(512),          RCS5 024
     1           FREQ(512), SIGMAV(512), SIGMAH(512)                  RCS5 025
C                                                                     RCS5 026
      COMPLEX PHASE, XOPX11, XOMX11, XOPX12, XOMX12, X2PX11, X2MX11,  RCS5 027
     1        X2PX12, X2MX12, TERM1V, TERM1H, TERM2V, TERM2H, TERM3V, RCS5 028
     2        TERM3H, TERM4V, TERM4H, TERM5V, TERM5H, TERM6V, TERM6H, RCS5 029
     3        TERM7V, TERM7H, TERM8V, TERM8H, FFVV, FFHH, F, FTAU1,   RCS5 030
     4        FTAU2, FTAU3, FTAU4      ,XX,YY,ZZ                      RCS5 031
C                                                                  * RCS5 032
C                                                                  * RCS5 033
C                                                                  * RCS5 034
      READ(5,1000) A1,A2,H2, KONFIG, KP                               RCS5 035
 1000 FORMAT( 3F10.0,2I5 )                                            RCS5 036
      ALP    = A2 - A1                                                RCS5 037
      ALPHA  = ATAN2(ALP, H2)                                         RCS5 038
      PI     = 3.14159265358979                                       RCS5 039
      ANGLE  = (ALPHA * 180.0) / PI                                   RCS5 040
C                                                                  * RCS5 041
      IF (KONFIG - 2) 30, 40, [illegible]                             RCS5 042
```

```
     +         FTAU2, FTAU3, FTAU4      ,XX,YY,ZZ                       RCS5 031
C                                                                    * RCS5 032
C                                                                    * RCS5 033
C                                                                    * RCS5 034
      READ(5,1000) A1,A2,H2, KONFIG, KR                                RCS5 035
 1000 FORMAT( 3F10.0,2I5 )                                              RCS5 036
      ALP    = A2 - A1                                                 RCS5 037
      ALPHA  = ATAN2(ALP, H2)                                          RCS5 038
      PI     = 3.14159265358979                                        RCS5 039
      ANGLE  = (ALPHA * 180.0) / PI                                    RCS5 040
C                                                                    * RCS5 041
      IF (KONFIG - 3) 30, 40, 50                                       RCS5 042
C                                                                    * RCS5 043
   30 WRITE (6, 3030) H2, A1, A2, ANGLE                                RCS5 044
 3030 FORMAT (1H0///'         FRUSTRA (INFINITELY SOLUTION)'//'      FRUSTRCS5 045
     1A LENGTH = ',F10.6,' INCHES'/'     FRONT-END RADIUS = ',F10.6,' INCRCS5 046
     2HES'/'      BACK-END RADIUS = ',F10.6,' INCHES'/'  FRUSTRA HALF-ANGRCS5 047
     3LE = ',F10.6,' DEGREES')                                         RCS5 048
      GO TO 60                                                         RCS5 049
C                                                                    * RCS5 050
   40 WRITE (6, 3040) H2, A2, ANGLE                                    RCS5 051
 3040 FORMAT (1H0///'             CONE (INFINITELY SOLUTION)'//'      CONERCS5 052
     1 LENGTH = ',F10.6,' INCHES'/'          BASE RADIUS = ',F10.6,' INCHRCS5 053
     2ES'/'     CONE HALF-ANGLE = ',F10.6,' DEGREES')                  RCS5 054
      GO TO 60                                                         RCS5 055
```

3

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```
CARD NO   ****                         CONTENTS                                    ****

  348     C                                                                    * RCS5 056
  349        50 WRITE (6, 3050) H2, A2                                           RCS5 057
  350       3050 FORMAT (1H0///'          CYLINDER (DEIMTSEV SOLUTION)'//'    CYLINDRCS5 058
  351          1ER LENGTH = ',F10.6,' INCHES'/'     CYLINDER RADIUS = ',F10.6,' INRCS5 059
  352          2CHES')                                                           RCS5 060
  353     C                                                                    * RCS5 061
  354        60 WRITE (6, 79) THETAD                                             RCS5 062
  355        79 FORMAT(1H0, ' THETA = ' , F15.5  /// )                           RCS5 063
  356     C                                                                    * RCS5 064
  357          C       = 11.80285078                                             RCS5 065
  358          DTR     = PI / 180.0                                              RCS5 066
  359          PISQRT = SQRT(PI)                                                 RCS5 067
  360          PIOVR2 = PI / 2.0                                                 RCS5 068
  361          A12       = 2.0* A1                                               RCS5 069
  362          A22       = 2.0* A2                                               RCS5 070
  363          H22       = 2.0* H2                                               RCS5 071
  364          XNPOS   = (3.0 / 2.0) + (ALPHA / PI)                              RCS5 072
  365          XNNEG   = (3.0 / 2.0) - (ALPHA / PI)                              RCS5 073
  366     C    COMPUTE C(N)                                                      RCS5 074
  367          FSTCOP = FIRS(XNPOS)                                              RCS5 075
  368          FSTCON = FIRS(XNNEG)                                              RCS5 076
  369          THETA    = THETAD * DTR                                           RCS5 077
  370          STHT     = SIN(THETA)                                             RCS5 078
```

```
      THETA   = THETAD * DTR                                           RCS5 077
      STHT    = SIN(THETA)                                             RCS5 078
      CTHT    = COS(THETA)                                             RCS5 079
      APT     = ALPHA + THETA                                          RCS5 080
      AMT     = ALPHA - THETA                                          RCS5 081
      TANAPT = TAN(APT)                                                RCS5 082
      TANAMT = TAN(AMT)                                                RCS5 083
      TWOPIC    = 2.0 * PI / C                                         RCS5 084
C                                                                    * RCS5 085
      DO 200  I = NMIN,NMAX                                            RCS5 086
      XI      = I - 1                                                  RCS5 087
      XKO      = TWOPIC * XI * DF / 1000.0                             RCS5 088
      X2KA1     = A12 * XKO                                            RCS5 089
      X2KA2      = A22 * XKO                                           RCS5 090
      X2KH2      = H22 * XKO                                           RCS5 091
C                                                                    * RCS5 092
      IF (KONFIG .EQ. 3) GO TO 70                                      RCS5 093
      TAUSQ1 = X2KA1 / SIN(ALPHA)                                      RCS5 094
      TAUSQ2 = X2KA2 / SIN(ALPHA)                                      RCS5 095
   70 CONTINUE                                                         RCS5 096
C                                                                    * RCS5 097
      RAPT    = PIOVR2 - ACOS(0.8 * COS(ALPHA) / X2KH2)                RCS5 098
      ARG1    = X2KA1 * STHT                                           RCS5 099
      ARG2    = X2KA2 * STHT                                           RCS5 100
      FASE    = X2KH2 * CTHT                                           RCS5 101
      PHASE   = CMPLX (COS(FASE), SIN(FASE))                           RCS5 102
C                                                                    * RCS5 103
      CALL BESL (ARG1, XJ01, XJ11, XJ21)                               RCS5 104
```

```
C                                                               * RCS5 097
          KAPT   = PIOVR2 - ACOS(0.8 * COS(ALPHA) / X2KH2)          RCS5 098
          ARG1   = X2KA1 * STHT                                     RCS5 099
          ARG2   = X2KA2 * STHT                                     RCS5 100
          FASE   = X2KH2 * CTHT                                     RCS5 101
          PHASE  = CMPLX (COS(FASE), SIN(FASE))                     RCS5 102
C                                                               * RCS5 103
          CALL BESL (ARG1, XJ01, XJ11, XJ21)                        RCS5 104
          CALL BESL (ARG2, XJ02, XJ12, XJ22)                        RCS5 105
C                                                               * RCS5 106
          XOPX11 = CMPLX(XJ01, XJ11)                                RCS5 107
          XOMX11 = CMPLX(XJ01,-XJ11)                                RCS5 108
          XOPX12 = CMPLX(XJ02, XJ12)                                RCS5 109
          XOMX12 = CMPLX(XJ02,-XJ12)                                RCS5 110
          X2PX11 = CMPLX(XJ21, XJ11)                                RCS5 111
          X2MX11 = CMPLX(XJ21,-XJ11)                                RCS5 112
          X2PX12 = CMPLX(XJ22, XJ12)                                RCS5 113
```

```
CARD NO    ****                       CONTENTS                                   ****

  406            X2MX12 = CMPLX(XJ22,-XJ12)                                    RCS5 114
  407      C                                                                 * RCS5 115
  408            Q1     = Q(X2KA1 * (PI - APT))                                RCS5 116
  409            Q4     = Q(X2KA1 * (PIOVR2 - THETA))                          RCS5 117
  410            Q3     = Q(X2KA2 * ((THETA+THETA-PI) * (-AMT)) / (PIOVR2-ALPHA))  RCS5 118
  411            Q3A    = Q(X2KA2 * AMT)                                       RCS5 119
  412      C                                                                 * RCS5 120
  413            IF (THETA .GT. PIOVR2)  GO TO 90                              RCS5 121
  414      C     DEFINE ANGLES FOR THET .LT. 90 DEGREES                        RCS5 122
  415      C                                                                 * RCS5 123
  416            PHI1   = PIOVR2 + THETA                                       RCS5 124
  417            PHI4   = PIOVR2 - THETA                                       RCS5 125
  418            PHI2   = APT                                                  RCS5 126
  419            GO TO 98                                                      RCS5 127
  420      C     DEFINE ANGLES FOR THET .GT. 90 DEGREES                        RCS5 128
  421         90 PHI1   = PI-APT                                               RCS5 129
  422            PHI4   = 0.0                                                  RCS5 130
  423            PHI2   = (3.0 * PIOVR2) - THETA                               RCS5 131
  424      C                                                                 * RCS5 132
  425         98 IF ( Q3A .EQ. 0.0 ) GO TO 99                                  RCS5 133
  426            PHI3 = AMT                                                    RCS5 134
```

AD-A031 440 GENERAL DYNAMICS FORT WORTH TEX CONVAIR AEROSPACE DIV F/G 17/9
ENDO ATMOSPHERIC EXO ATMOSPHERIC RADAR MODELING. RADAR CROSS SE--ETC(U)
JUN 76 R J HANCOCK, F H CLEVELAND F30602-73-C-0380

UNCLASSIFIED RADC-TR-76-186-VOL-4-PT-2 NL

2 OF 4
AD
A031440

```
      PHI2   = (3.0 * PIOVR2) - THETA                          RCS5 131
C                                                            * RCS5 132
   98 IF ( G3A .EQ. 0.0 ) GO TO 99                             RCS5 133
      PHI3 = AMT                                               RCS5 134
      GO TO 100                                                RCS5 135
   99 PHI3 = PIOVR2 - THETA                                    RCS5 136
C                                                            * RCS5 137
C     COMPUTE B(N,PHI)                                         RCS5 138
  100 SECND1 = SECO(PHI1, XNNEG)                               RCS5 139
      SECND4 = SECO(PHI4, XNNEG)                               RCS5 140
      SECND2 = SECO(PHI2, XNPOS)                               RCS5 141
      SECND3 = SECO(PHI3, XNPOS)                               RCS5 142
C                                                            * RCS5 143
      TERM1V = 0.0                                             RCS5 144
      TERM1H = 0.0                                             RCS5 145
      TERM4V = 0.0                                             RCS5 146
      TERM4H = 0.0                                             RCS5 147
      TERM5V = 0.0                                             RCS5 148
      TERM5H = 0.0                                             RCS5 149
      TERM6V = 0.0                                             RCS5 150
      TERM6H = 0.0                                             RCS5 151
      TERM7V = 0.0                                             RCS5 152
      TERM7H = 0.0                                             RCS5 153
      TERM8V = 0.0                                             RCS5 154
      TERM8H = 0.0                                             RCS5 155
C                                                            * RCS5 156
      IF (KONFIG .EQ. 2) GO TO 120                             RCS5 157
C                                                            * RCS5 158
```

```
      TERM4V = 0.0                                                      RCS5 146
      TERM4H = 0.0                                                      RCS5 147
      TERM5V = 0.0                                                      RCS5 148
      TERM5H = 0.0                                                      RCS5 149
      TERM6V = 0.0                                                      RCS5 150
      TERM6H = 0.0                                                      RCS5 151
      TERM7V = 0.0                                                      RCS5 152
      TERM7H = 0.0                                                      RCS5 153
      TERM8V = 0.0                                                      RCS5 154
      TERM8H = 0.0                                                      RCS5 155
C                                                                      *RCS5 156
      IF (KONFIG .EQ. 2) GO TO 120                                      RCS5 157
C                                                                      *RCS5 158
      TERM1V = -A1 * ((X2PX11 * FSTCON) + (XOMX11 * SECND1)) * Q1       RCS5 159
      TERM1H = -A1 * ((X2PX11 * FSTCON) - (XOMX11 * SECND1)) * Q1       RCS5 160
      TERM4V = -A1 * ((X2MX11 * FSTCON) + (XOPX11 * SECND4)) * Q4       RCS5 161
      TERM4H = -A1 * ((X2MX11 * FSTCON) - (XOPX11 * SECND4)) * Q4       RCS5 162
C                                                                      *RCS5 163
  120 TERM2V = -A2 * ((X2PX12 * FSTCOP) + (XOMX12 * SECND2)) * PHASE    RCS5 164
      TERM2H = -A2 * ((X2PX12 * FSTCOP) - (XOMX12 * SECND2)) * PHASE    RCS5 165
      TERM3V = -A2 * ((X2MX12 * FSTCOP) + (XOPX12 * SECND3)) * Q3*PHASE RCS5 166
      TERM3H = -A2 * ((X2MX12 * FSTCOP) - (XOPX12 * SECND3)) * Q3*PHASE RCS5 167
C                                                                      *RCS5 168
      IF (KONFIG .EQ. 3) GO TO 130                                      RCS5 169
      IF (KONFIG .EQ. 2) GO TO 140                                      RCS5 170
C                                                                      *RCS5 171
```

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3

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CARD NO      ****                          CONTENTS                            ****

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  464      C      THIS SECTION NOT DONE FOR CYLINDER OR CONE                  RCS5 172
  465             TAU1    = TAUSQ1 * COS(APT)                                  RCS5 173
  466             TAU4    = TAUSQ1 * COS(AMT)                                  RCS5 174
  467             FTAU1   = F(TAU1)                                            RCS5 175
  468             FTAU4   = F(TAU4)                                            RCS5 176
  469             TERM5V = A1 * TANAPT * XOMX11 * FTAU1 * 0.5 * Q1             RCS5 177
  470             TERM5H = -TERM5V                                             RCS5 178
  471             TERM6V = A1 * TANAMT * XOPX11 * FTAU4 * 0.5 * Q3A            RCS5 179
  472             TERM6H = -TERM6V                                             RCS5 180
  473      C      THIS SECTION NOT DONE FOR CYLINDER                           RCS5 181
  474      C                 DONE FOR CONE                                     RCS5 182
  475         140 TAU2    = TAUSQ2 * COS(APT)                                  RCS5 183
  476             TAU3    = TAUSQ2 * COS(AMT)                                  RCS5 184
  477             FTAU2   = F(TAU2)                                            RCS5 185
  478             FTAU3   = F(TAU3)                                            RCS5 186
  479             TERM7V =-A2 * TANAPT * XOMX12 * FTAU2 * 0.5 * Q1 * PHASE     RCS5 187
  480             TERM7H = -TERM7V                                             RCS5 188
  481             TERM8V =-A2 * TANAMT * XOPX12 * FTAU3 * 0.5 * Q3A* PHASE     RCS5 189
  482             TERM8H = -TERM8V                                             RCS5 190
  483      C                                                                 * RCS5 191
  484             IF (KONFIG - 2) 130, 56, 130                                 RCS5 192
  485          56 IF (ABS(APT-PIOVR2) .GT. WAPT ) GO TO 130                    RCS5 193
```

```
      TERM8H = -TERM8V                                                  RCS5 190
C                                                                     * RCS5 191
      IF (KONFIG - 2) 130, 56, 130                                      RCS5 192
   56 IF (ABS(APT-PIOVR2) .GT. WAPT ) GO TO 130                         RCS5 193
C     THIS SECTION USED TO COMPUTE CONE RETURN NEAR SPECULAR TO         RCS5 194
C                 CONIC SURFACE  (THET NEAR (PI/2)-ALPHA)               RCS5 195
      XX       = CMPLX(0.0,1.0)                                         RCS5 196
      ZZ       = XOMX12 * XX * TAUSQ2 * SIN(APT) /3.0                   RCS5 197
      YY       =-X2PX12 * FSTCOP                                        RCS5 198
      FFVV     =-PISQRT * A2 * PHASE * ( YY + ZZ)                       RCS5 199
      FFHH     = PISQRT * A2 * PHASE * ( YY - ZZ)                       RCS5 200
      GO TO 55                                                          RCS5 201
C                                                                       RCS5 202
  130 FFVV    = -        PISQRT * (TERM1V + TERM2V + TERM3V + TERM4V +  RCS5 203
     1                            TERM5V + TERM6V + TERM7V + TERM8V )   RCS5 204
      FFHH    =          PISQRT * (TERM1H + TERM2H + TERM3H + TERM4H +  RCS5 205
     1                            TERM5H + TERM6H + TERM7H + TERM8H )   RCS5 206
C                                                                     * RCS5 207
   55 CONTINUE                                                          RCS5 208
      FFVV      = FFVV * 0.02540005                                     RCS5 209
      FFHH      = FFHH * 0.02540005                                     RCS5 210
C                                                                       RCS5 211
      EVVR(I) = REAL (FFVV)                                             RCS5 212
      EVVI(I) =-AIMAG(FFVV)                                             RCS5 213
      EHHR(I) = REAL (FFHH)                                             RCS5 214
      EHHI(I) =-AIMAG(FFHH)                                             RCS5 215
C                                                                     * RCS5 216
      IF (KP)  77, 77, 78                                               RCS5 217
```

```
      EHHR(I) = REAL (FFHH)                                             RCS5 214
      EHHI(I) =-AIMAG(FFHH)                                             RCS5 215
C                                                                     * RCS5 216
      IF (KP)  77, 77, 78                                               RCS5 217
   78 FREQ(I)   = XI * DF / 1000.0                                      RCS5 218
      SIGMAV(I)= 10.0*ALOG10(EVVR(I)*EVVR(I) + EVVI(I)*EVVI(I))         RCS5 219
      SIGMAH(I)= 10.0*ALOG10(EHHR(I)*EHHR(I) + EHHI(I)*EHHI(I))         RCS5 220
   77 CONTINUE                                                          RCS5 221
C                                                                     * RCS5 222
  200 CONTINUE                                                          RCS5 223
C                                                                     * RCS5 224
C                                                                     * RCS5 225
C     IF (KP)  75, 75, 76                                               RCS5 226
C  76 WRITE (6, 74) ( FREQ(I), SIGMAV(I), SIGMAH(I), I= NMIN, NMAX )    RCS5 227
C  74 FORMAT (1H0, 3E15.5 )                                             RCS5 228
   75 CONTINUE                                                          RCS5 229
C                                                                     * RCS5 230
C                                                                     * RCS5 231
      RETURN                                                            RCS5 232
      END                                                               RCS5 233
```

```
      FUNCTION FIRS(XN)                                            RCS5 234
      PI     = 3.14159265358979                                    RCS5 235
      A      = (SIN(PI / XN)) / XN                                 RCS5 236
      B      = 1.0 / (COS(PI / XN) - 1.0)                          RCS5 237
      FIRS   = A * B                                               RCS5 238
      RETURN                                                       RCS5 239
      END                                                          RCS5 240
      FUNCTION SECC(PHI, XN)                                       RCS5 241
      PI     = 3.14159265358979                                    RCS5 242
      A      = (SIN(PI / XN)) / XN                                 RCS5 243
      B      = COS(PI / XN) - COS((2.0 * PHI)/ XN)                 RCS5 244
      C      = 1.0 / B                                             RCS5 245
      SECC   = A * C                                               RCS5 246
      RETURN                                                       RCS5 247
      END                                                          RCS5 248
      FUNCTION Q(Z)                                                RCS5 249
C     Q(Z) = 0.5*(1 + ERF(Z))                                      RCS5 250
C   * ERF(Z) IS EVALUATED USING A RATIONAL POLYNOMIAL APPROXIMATION RCS5 251
C   * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,       RCS5 252
C   *            SECTION 7.1.26)                                   RCS5 253
C                                                                  RCS5 254
      IF ( Z.GT. 2.) GO TO 10                                      RCS5 255
      IF ( Z.LT.-2.) GO TO 20                                      RCS5 256
      AZ = ABS(Z)                                                  RCS5 257
      P = 1.0/(1.0 + .47047*AZ)                                    RCS5 258
```

```
      IF ( Z.GT. 2.) GO TO 10                                            RCS5 255
      IF ( Z.LT.-2.) GO TO 20                                            RCS5 256
      AZ = ABS(Z)                                                        RCS5 257
      P = 1.0/(1.0 + .47047*AZ)                                          RCS5 258
      Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P))*EXP(-AZ*AZ)     RCS5 259
      IF (Z) 2,4,6                                                       RCS5 260
    2 Q = (1.0 - Y)/2.                                                   RCS5 261
      RETURN                                                             RCS5 262
    4 Q = .5                                                             RCS5 263
      RETURN                                                             RCS5 264
    6 Q = (1.0 + Y)/2.                                                   RCS5 265
      RETURN                                                             RCS5 266
   10 Q = 1.                                                             RCS5 267
      RETURN                                                             RCS5 268
   20 Q = 0.                                                             RCS5 269
      RETURN                                                             RCS5 270
      END                                                                RCS5 271
      SUBROUTINE BESL ( X, B0, B1, B2 )                                  RCS5 272
C                                                                        RCS5 273
C   * BESSEL FUNCTION SUBROUTINE UTILIZING POLYNOMIAL APPROXIMATIONS     RCS5 274
C   * COMPUTES J0,J1,OR J2 FOR POSITIVE REAL ARGUMENTS                   RCS5 275
C   * REFERENCE (HNDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN SECTION 9.4 )RCS5 276
C                                                                        RCS5 277
      S = 1.0                                                            RCS5 278
      IF (X .LT. 0.0) S = -1.0                                           RCS5 279
      X = ABS (X)                                                        RCS5 280
C                                                                        RCS5 281
      IF ( X .GT. 1.E-6 ) GO TO 5                                        RCS5 282
```

```
    6 Q = (1.0 + Y)/2.                                                  RCS5 265
      RETURN                                                            RCS5 266
   10 Q = 1.                                                            RCS5 267
      RETURN                                                            RCS5 268
   20 Q = 0.                                                            RCS5 269
      RETURN                                                            RCS5 270
      END                                                               RCS5 271
      SUBROUTINE BESL ( X, B0, B1, B2 )                                 RCS5 272
C                                                                       RCS5 273
C   * BESSEL FUNCTION SUBROUTINE UTILIZING POLYNOMIAL APPROXIMATIONS    RCS5 274
C   * COMPUTES J0,J1,OR J2 FOR POSITIVE REAL ARGUMENTS                  RCS5 275
C   * REFERENCE (HNDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN SECTION 9.4 )RCS5 276
C                                                                       RCS5 277
      S = 1.0                                                           RCS5 278
      IF (X .LT. 0.0) S = -1.0                                          RCS5 279
      X = ABS (X)                                                       RCS5 280
C                                                                       RCS5 281
      IF ( X .GT. 1.E-6 ) GO TO 5                                       RCS5 282
      B0 = 1.0                                                          RCS5 283
      B1 = 0.0                                                          RCS5 284
      B2 = 0.0                                                          RCS5 285
      X = X * S                                                         RCS5 286
      RETURN                                                            RCS5 287
```

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3

```
CARD NO    ****                          CONTENTS                                    ****

580   C                                                                      RCS5 288
581      5 CONTINUE                                                          RCS5 289
582   C                                                                      RCS5 290
583      1 IF ( X .GE. 3.) GO TO 9                                           RCS5 291
584        X1 = X/3.                                                         RCS5 292
585        X1 = X1*X1                                                        RCS5 293
586        B = 1.+ X1*(-2.2499997+ X1*(1.2656208+ X1*(-.3163866+ X1*(.0444479RCS5 294
587       1 +      X1*(-.0039444+ X1*2.1E-4 )))) )                           RCS5 295
588        GO TO 10                                                          RCS5 296
589   C                                                                      RCS5 297
590      9 X2 = 3./X                                                         RCS5 298
591        FO =  .79788456 +X2*(-.77E-6 +X2*(-.00552740 +X2*(-.9512E-4 +X2*  RCS5 299
592       1     (.00137237 +X2*(-.72805E-3 +X2*0.14476E-3 )))) )             RCS5 300
593        TO = X - .78539816 +X2*(-.04166397 +X2*(-.3954E-4 +X2*(.00262573  RCS5 301
594       1    +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))          RCS5 302
595        B = FO*COS(TO)/SQRT(X)                                            RCS5 303
596   C                                                                      RCS5 304
597     10 BO = B                                                            RCS5 305
598   C                                                                      RCS5 306
599      2 IF ( X .GE. 3. ) GO TO 19                                         RCS5 307
600        X1 = X/3.                                                         RCS5 308
601        X1 = X1*X1                                                        RCS5 309
```

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```
     1     +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))        RCS5 302
      B = F0*COS(T0)/SQRT(X)                                           RCS5 303
C                                                                      RCS5 304
   10 B0 = B                                                           RCS5 305
C                                                                      RCS5 306
    2 IF ( X .GE. 3. ) GO TO 19                                        RCS5 307
      X1 = X/3.                                                        RCS5 308
      X1 = X1*X1                                                       RCS5 309
      B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*   RCS5 310
     1                (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4))))) )  RCS5 311
      GO TO 20                                                         RCS5 312
C                                                                      RCS5 313
   19 X2 = 3./X                                                        RCS5 314
      F1 = .79788456 +X2*(.156E-5 +X2*(.01659667 +X2*(.00017105 +X2*   RCS5 315
     1     (-.00249511 +X2*(.00113653 -.00020033*X2 )))))              RCS5 316
      T1 = X - 2.35619449 +X2*(.12499612 +X2*(.565E-4 +X2*(-.00637879  RCS5 317
     1   +X2*(.00074348 +X2*(.00079824 -0.00029166*X2 )))))            RCS5 318
      B = F1*COS(T1)/SQRT(X)                                           RCS5 319
C                                                                      RCS5 320
   20 B1 = B * S                                                       RCS5 321
      X = X * S                                                        RCS5 322
      B2= (2./X)*B1 - B0                                               RCS5 323
   50 RETURN                                                           RCS5 324
      END                                                              RCS5 325
```

```
      COMPLEX FUNCTION F(TAU)                                           RCS5 326
C                                                                       RCS5 327
C     COMPUTES FTAU WHERE FTAU =(EXP(-J*TAU**2)/2*TAU)*SQRT(PI/2.)*     RCS5 328
C                                 (C2(TAU**2) + J*S2(TAU**2))           RCS5 329
C                                                                       RCS5 330
      COMPLEX J, FP                                                     RCS5 331
      PI = 3.14159265358979                                             RCS5 332
      PIO2 = PI/2.                                                      RCS5 333
      C1 = SQRT(PI/2.)                                                  RCS5 334
      C2 = 1./C1                                                        RCS5 335
      ATAUS = ABS(TAU)                                                  RCS5 336
      IF (ATAUS .LE. 0.5  )GO TO 20                                     RCS5 337
C                                                                       RCS5 338
C     FOR TAUS .GT. 0.5, FUNCTION COMPUTED USING POLYNOMIAL             RCS5 339
C   * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,            RCS5 340
C   *                SECTIONS  7.3.9,7.3.10,7.3.32,7.3.33)              RCS5 341
      TAUS = SQRT(ATAUS)                                                RCS5 342
      X = C2*TAUS                                                       RCS5 343
      XS = X*X                                                          RCS5 344
C                                                                       RCS5 345
```

```
CARD NO    ****                        CONTENTS                                   ****

  638             FX = (1.0+0.926*X)/(2.0+1.792*X+3.104*XS)                  RCS5 346
  639             GX = 1.0/(2.0+4.142*X+3.492*XS+6.67*X*XS)                  RCS5 347
  640        C                                                               RCS5 348
  641             CC1XS = COS(ATAUS)                                         RCS5 349
  642             SC1XS = SIN(ATAUS)                                         RCS5 350
  643        C                                                               RCS5 351
  644             CX = 0.5 + FX*SC1XS - GX*CC1XS                             RCS5 352
  645             SX = 0.5 - FX*CC1XS - GX*SC1XS                             RCS5 353
  646        C                                                               RCS5 354
  647             IF (TAU .LT. 0.0) GO TO 10                                 RCS5 355
  648             B = CMPLX(CX,SX)                                           RCS5 356
  649             FP = CMPLX(  COS(ATAUS), -SIN(ATAUS) )                     RCS5 357
  650             F = (C1*B*FP)/TAUS                                         RCS5 358
  651             RETURN                                                     RCS5 359
  652        C                                                               RCS5 360
  653          10 CONTINUE                                                   RCS5 361
  654             B = CMPLX(SX,CX)                                           RCS5 362
  655             A = ATAUS-PIO2                                             RCS5 363
  656             FP = CMPLX( COS(A),SIN(A) )                                RCS5 364
  657             F = (B*FP*C1)/TAUS                                         RCS5 365
```

```
      CY = 0.5 - FX*CC1XS - GX*SC1XS                                    RCS5 353
C                                                                       RCS5 354
      IF (TAU .LT. 0.0) GO TO 10                                        RCS5 355
      B = CMPLX(CX,SX)                                                  RCS5 356
      FP = CMPLX(  COS(ATAUS), -SIN(ATAUS) )                            RCS5 357
      F = (C1*B*FP)/TAUS                                                RCS5 358
      RETURN                                                            RCS5 359
C                                                                       RCS5 360
   10 CONTINUE                                                          RCS5 361
      B = CMPLX(SX,CX)                                                  RCS5 362
      A = ATAUS-PIO2                                                    RCS5 363
      FP = CMPLX( COS(A),SIN(A) )                                       RCS5 364
      F = (B*FP*C1)/TAUS                                                RCS5 365
      RETURN                                                            RCS5 366
C                                                                       RCS5 367
   20 CONTINUE                                                          RCS5 368
C     FOR TAUS .LE. 0.5, FUNCTION IS EXPANDED IN SERIES AND FIRST FEW   RCS5 369
C                                TERMS INTEGRATED TERM BY TERM TO OBTAIN RESULT RCS5 370
      FP = CMPLX(COS(TAU),-SIN(TAU))                                    RCS5 371
      TS = TAU*TAU                                                      RCS5 372
      FR = 1 - TS*( .1 - .0046296296*TS)                                RCS5 373
      FI = TAU *( .333333333 - TS*(.0238095238 - 7.5757575757E-4*TS))   RCS5 374
      B = CMPLX(FR,FI)                                                  RCS5 375
      F = FP*B                                                          RCS5 376
      RETURN                                                            RCS5 377
      END                                                               RCS5 378
```

3

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L.4 THIN WIRE

The far-field scattering from a thin wire has been programmed using the formulation of Ufimtsev (Ref. 4 and 5). The expression includes the higher order scattering terms which arise from waves which are launched from one end of the wire, traverse the wire length, and are diffracted into space and reflected along the wire upon reaching the opposite end. These scattering mechanisms and the geometry of the problem are shown in Figure L.4-1. The ray components of the scattered field are described in References 4 and 5. The expression of the scattered field, which includes only the horizontal polarization response, is the following:

$$e(\theta) = \frac{2\sqrt{\pi}}{k} \bullet \frac{2iS(\theta)}{\sin\theta \sin 2\theta \left[\ln\left(\frac{2i}{\gamma ka \sin\theta} \right) \right]^2}$$

where $\gamma = 1.781$

$k = 2\pi/\lambda$ = wave number

$$\begin{aligned} S(\theta) = & - \left\{ \sin^4(\theta/2) \ln\left(\frac{i}{\gamma ka \sin^2 \theta/2} \right) \right\} \\ & + \left\{ e^{i2kL\cos\theta} \cos^4(\theta/2) \ln\left(\frac{i}{\gamma ka \cos^2 \theta/2} \right) \right. \\ & - e^{ikL(1+\cos\theta)} \cos^4(\theta/2) \ln\left(\frac{i}{\gamma ka \cos \theta/2} \right) 2\Psi_+ \\ & + e^{ikL(1+\cos\theta)} \sin^4(\theta/2) \ln\left(\frac{i}{\gamma ka \sin \theta/2} \right) 2\Psi_- \\ & \left. + e^{i2kL} \cos\theta \ln(i/\gamma ka)(\Psi_+)^2 \right\} \\ & + \left\{ \left[\sum_{n=0}^{\infty} e^{i2nkL\Psi 2n} \right] \left[(\Psi)^2 (\Psi_+)^2 e^{i4kL} \right. \right. \\ & + (\Psi_-)^2 e^{ikL2(1+\cos\theta)} \\ & \left. \left. - 2\Psi_+ \Psi_- \Psi e^{ikL(3+\cos\theta)} \right] \cos\theta \ln\left(\frac{i}{\gamma ka} \right) \right] \right\} \end{aligned}$$

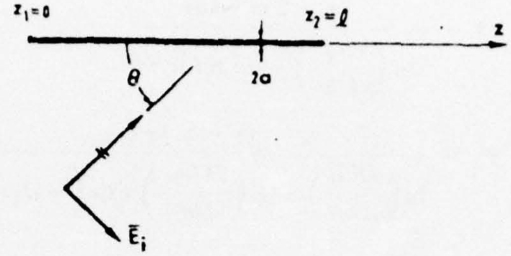

Fig. L.4-1a GEOMETRY OF A THIN WIRE

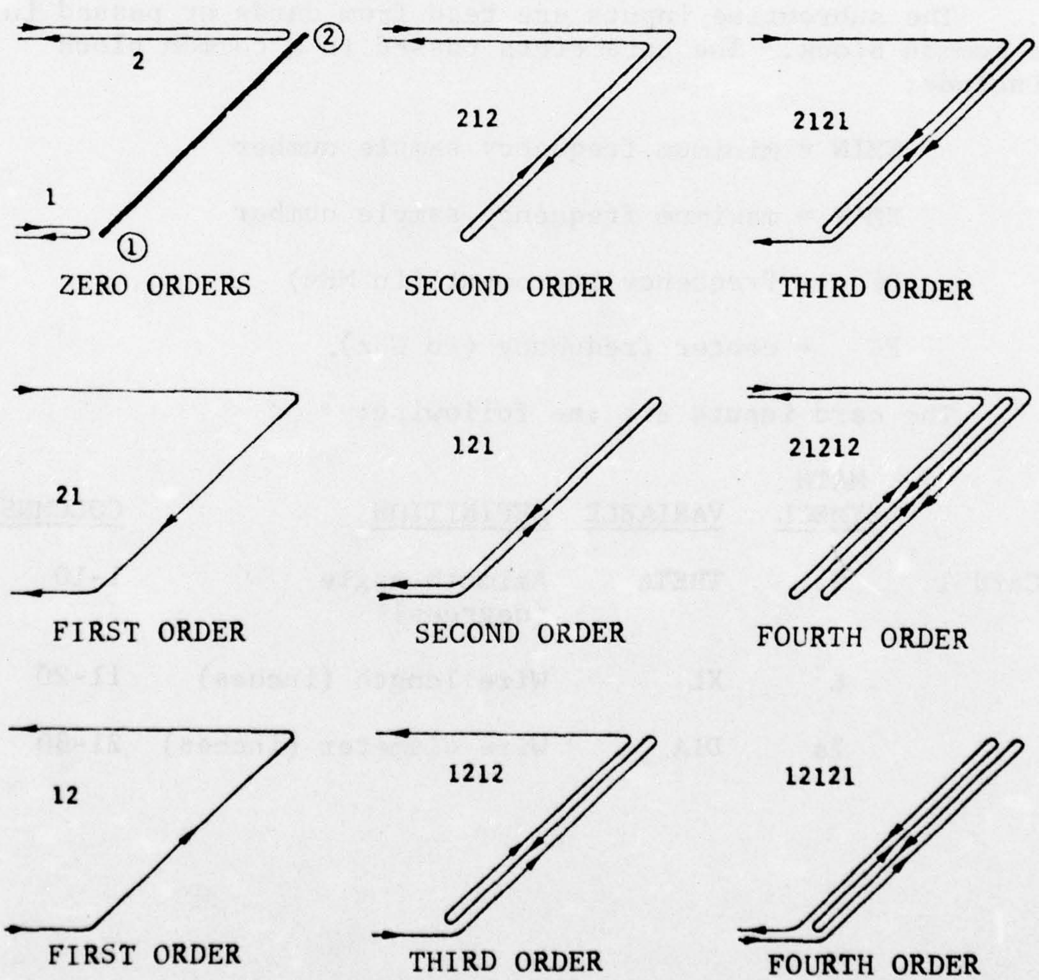

Fig. L.4-1b RAY COMPONENTS OF THE SCATTERED RETURNS and

$$\Psi = \frac{i\pi - 2\ln(\gamma ka)}{\ln\left(\frac{i2kL}{\gamma k^2a^2}\right) - E(2kL)e^{-i2kL}}$$

$$\Psi_{\pm} = \frac{i\pi - \ln(\gamma^2 q_{\pm})}{\ln\left(\frac{i2kL}{\gamma k^2a^2}\right) - E\left(\frac{2kLq_{\pm}}{k^2a^2}\right)\exp\left(-i2q_{\pm}\frac{kL}{k^2a^2}\right)}$$

$$q_{\pm} = \frac{(ka)^2}{2}(1 \mp \cos\theta)$$

$$E(x) = \int_{\infty}^{x} \frac{e^{it}}{t}\,dt.$$

L.4.1 Inputs

The subroutine inputs are read from cards or passed in a common block. The parameters passed in a common block include:

NMIN = minimum frequency sample number

NMAX = maximum frequency sample number

DF = frequency increment (in MHz)

FC = center frequency (in GHz).

The card inputs are the following:

	MATH SYMBOL	VARIABLE	DEFINITION	COLUMNS
Card 1	θ	THETA	Azimuth angle (degrees)	1-10
	L	XL	Wire length (inches)	11-20
	2a	DIA	Wire diameter (inches)	21-30

L.4.2 Outputs

The data base output consists of two linear arrays, ETTR, ETTI, which contain the real and imaginary parts of the horizontally polarized backscattered fields (in meters) at frequency increments spaced DF MHz from NMIN*DF to NMAX*DF.

If selected by setting KP to 1, the wire radar cross section (in dBsm) versus frequency will be printed out. In addition the real and imaginary parts of the exponential integral, computed in subroutine EXPI, will be printed out if KP $\neq$ 0.

L.4.3 Restrictions

L.4.3.1 Physical Dimensions

The wire length should be large with respect to the largest wavelength of the illuminating field. However, the wire radius should be much smaller than the smallest wavelength of the illuminating field.

L.4.3.2 Output

The output arrays are passed in the argument list and a value is computed and stored only in location NMIN to NMAX.

L.4.3.3 Azimuth

The azimuth angle is restricted to the region from 0.5 to 89.5 degrees.

L.4.4 Definition of Selected Terms Used in Subroutine

$$\mathrm{ST1} = - \left\{ \sin^4 (\theta/2) \ln \left(\frac{i}{\gamma k a \sin^2 \theta/2} \right) \right\}$$

$$\mathrm{SCD1} = \left\{ e^{i2kL \cos\theta} \cos^4 (\theta/2) \ln \left(\frac{i}{\gamma k a \cos^2 \theta/2} \right) \right.$$

$$\mathrm{SCD2} = - e^{ikL(1+\cos\theta)} \cos^4 (\theta/2) \ln \left(\frac{i}{\gamma k a \cos \theta/2} \right) 2\Psi_{+}$$

$$SCD3 = +e^{ikL(1+\cos\theta)}\sin^4(\theta/2)\ln\left(\frac{\quad}{\gamma ka\sin\theta/2}\right)2\Psi$$

$$SCD4 = +e^{i2kL}\cos\theta\ln(i/\gamma ka)(\Psi_+)^2$$

$$D = \frac{1}{1-\psi^2(L)\,e^{i2kL}} = \left[\sum_{n=0}^{\infty} e^{i2nkL\Psi 2n}\right]$$

$$\begin{aligned} SSS = &+\Bigg\{\left[\sum_{n=0}^{\infty} e^{i2nkL\Psi 2n}\right]\Bigg[(\Psi)^2(\Psi_+)^2e^{i4kL} \\ &+(\Psi_-)^2e^{ikL2(1+\cos\theta)} \\ &-2\,\Psi_+\Psi_-\Psi\,e^{ikL(3+\cos\theta)}\Bigg]\cos\theta\ln\left(\frac{i}{\gamma ka}\right)\Bigg\}\end{aligned}$$

$$PSIA = \Psi = \frac{i\pi - 2\ln(\gamma ka)}{\ln\left(\frac{i2kL}{\gamma k^2a^2}\right) - E(2kL)e^{-i2kL}}$$

$$PSI\begin{Bmatrix}P\\M\end{Bmatrix} = \Psi_\pm = \frac{i\pi - \ln(\gamma^2 q_\pm)}{\ln\left(\frac{i2kL}{\gamma k^2a^2}\right) - E\left(\frac{2kLq_\pm}{k^2a^2}\right)\exp\left(-i2q_\pm\frac{kL}{k^2a^2}\right)}$$

L.4.5 Subroutines

The subroutine EXPI (ARGZ, EIXR, EIXI, KP) is used to compute the real (EIXR) and imaginary (EIXI) parts of the exponential integral:

$$E(x) = \int_{\infty}^{x}\frac{e^{it}}{t}\,dt$$

where the argument X is passed as ARGZ.

RCSM1 4.4, 4.5, 4.6

6 16.87

```
$       IDENT   BECAGD01,HANCOCK,01707310038O,RCSM1
$       OPTION  FORTRAN
$       FORTY   LSTIN,XREF,MAP,DECK
$       LIMITS  05,39K,0,5K
      SUBROUTINE  TARGET  (ETTR, ETTI,XR,XI)
C
C     **  THIN WIRE CW RESPONSE    * 0.5 TO 89.5 DEGREES ASPECT ANGLE**
C     *   SOLUTION BY UFIMTSEV, SIMPLIFIED BY HONG FOR BACKSCATTER    *
C   * REFERENCE - SHORT PULSE SCATTERING BY A LONG WIRE,  BY S HONG
C   *              IEEE ON AP, VOL AP-16,NO.3, MAY 1968,PP.338-342
C
C
      COMMON MOVER,M,NMIN, NMAX, DF, FC, PW, T0
C     NMIN = MINIMUM FREQUENCY SAMPLE
C     NMAX = MAXIMUM FREQUENCY SAMPLE
C     DF   = FREQUENCY INCREMENT IN MHZ
C     FC   = CARRIER FREQUENCY IN GHZ
C
      COMPLEX    SS(100),
     A          ACLC,ALN1,  CS,    ACL2C, ST1, EXA,EXQP,EXQM,EXAP,PSIA,
     B         EXQPP,    EXQMP,PSIP,PSIM, AC1, PC1, AC2,SCD1, BC1, QC1,
     C          SCD2, DC1,SCD3, RC1, EC1,SCD4, SCD, FP8, FP9,FP10,
     D           SF1, SF2, SF3,  SF,  SP, SPC, SSS, BSC,EBSC
     E              , PIJ,     PIJ02
     F        ,CC6RL,   D   ,SB4
     G              ,EXQA,EXQM
     1  , RC9, QC9
      REAL  FRQ(512), ETTR(512), ETTI(512), SIGMA(512),XR(512),XI(512)
C
      READ(5,1000) THETA, XL, DIA, KP
C     KP = 1, PRINT OUT RCS VERSUS FREQUENCY
 1000 FORMAT (3F10.3, I2)
      WRITE(6,1100) THETA, XL, DIA
 1100 FORMAT ('0 ASPECT ANGLE = ',F7.2,'   WIRE LENGTH = ', F8.3, //,
     A  '   WIRE DIAMETER   = ', F7.4 , // , ' ( LENGTHS ARE IN INCHES )'
     B)
      IF (THETA .LT. 0.5  .OR. THETA .GT. 89.5 ) GO TO 900
      RAD = DIA/2.0
      PI = 3.1415926
      PIJ = CMPLX(0.0,PI)
      PIO2= PI/2.0
      PIJO2 = CMPLX(0.0,PIO2)
      GAM = 1.781072
      TH  = THETA * (180.0 / PI)
      CT = COS(TH)
      CTO2 = COS(TH/2.0)
      CTO2S= CTO2 * CTO2
      CTO2F= CTO2S * CTO2S
      ST = SIN (TH)
      STT = SIN(TH*2.0)
      STO2 = SIN(TH/2.0)
      STO2S = STO2 * STO2
      STO2F = STO2S * STO2S
      OPCT = 1.0+ CT
      OMCT = 1.0- CT
      AKTH = 2.0/(ST*STT)
C
      DO 800  IFW = NMIN,NMAX
      XI= IFW - 1
      FREQ    = XI * DF / 1000.0
```

```
      FRQ( IFW) = FREQ
      XK =   ( .53234454 * FREQ )
      XKL =   XK* XL
      XKA =   XK* RAD
      GKA =   GAM* XKA
      C1 = 2.0/( GKA * ST)
      ACL = ALOG ( C1 )
      ACLC =  CMPLX ( ACL, PIO2 )
      CS =((0.0, 1.0)/(ACLC*ACLC))*(-AKTH)
C
C     ** DETERMINATION OF INTEGRAL AND OTHER TERMS USED IN MULTIPLE **
C        ORDER SCATTERING
C
      C5L = ALOG( GKA)
      C6R = (2.0/XKA)*(XKL/GKA)
      C6RL= ALOG( C6R)
      CC6RL = CMPLX(C6RL,PIO2)
      EAA = XKL+2.0
      CALL EXPI ( EAA, EXRA, EXIA, 0 )
      EXQA = CMPLX( EXRA, EXIA)
      E1C= COS( EAA)
      E1S= SIN( EAA)
      RC1 = CMPLX (E1C, E1S)
      RC9     = CMPLX( E1C, -E1S )
      PSIA    = (PIJ - 2.0*C5L) / (CC6RL - EXQA*RC9)
C
      EQPA = XKL*OMCT
      CALL EXPI (EQPA, EXR, EXI, 0 )
      EXQP= CMPLX( EXR, EXI )
      E2C =COS( EQPA)
      E2S =SIN( EQPA)
      EXQPP = CMPLX( E2C,-E2S)
      C7P = GKA*GKA*OMCT/2.0
      C7PL = ALOG(C7P)
      PSIP = (PIJ - C7PL)/(CC6RL - EXQP*EXQPP)
C
      EQMA = XKL*OPCT
      CALL EXPI ( EQMA, EXRM, EXIM, 0 )
      EXQM = CMPLX( EXRM, EXIM)
      Q2      = COS(EQMA)
      Q3      = SIN(EQMA)
      QC1 = CMPLX( Q2, Q3)
      QC9     = CMPLX( Q2, -Q3 )
      C7M = GKA*GKA*OPCT/2.0
      C7ML = ALOG(C7M)
      PSIM    = (PIJ - C7ML) / (CC6RL - EXQM*QC9)
C
C     * UTIL12ATION OF FACTORS IN SCATTERED FIELD EXPRESSION *
C
C     **  FIRST ORDER SCATTERING   **
C
      C2 = 1.0 / (GKA * STO2S)
      ACL2 = ALOG (C2)
      ACL2C = CMPLX ( ACL2, PIO2 )
      ST1 = -STO2F * ACL2C
C
C     *   RETURN FROM TRAILING EDGE OF WIRE   *
C
      A1    = 1.0/(GKA* CTO2S)
      A2    = ALOG(A1)
      AC1   = CMPLX( A2,PIO2)
      P1 =   2.0*XKL*CT
      P2 = COS(P1)
      P3 = SIN(P1)
      PC1= CMPLX( P2, P3)
      AC2 = CMPLX( CTO2F,0.0)
      SCD1 = AC1*PC1*AC2
C
```

```
      B1 = 1.0/(GKA*CTO2)
      B2 = 2.0*ALOG(B1)
      BC1 = CMPLX( B2,PI)
      SCD2 =(-(QC1*AC2+BC1*PSIP))
C
      D1 = 1.0/(GKA*STO2)
      D2 = 2.0*ALOG(D1)
      DC1= CMPLX(D2,PI)
      SB4      = CMPLX( STO2F, 0.0)
      SCD3 = SB4  *(QC1*DC1*PSIM)
C
      E1 = 1.0/GKA
      E2 = ALOG( E1)
      EC1= CMPLX( E2,PIO2)
      SCD4 = CT*(RC1*EC1*PSIP*PSIP)
C
      SCD = SCD1 + SCD2 + SCD3 + SCD4
C
      FP1 = COS(4.0*XKL)
      FP2 = SIN(4.0*XKL)
      FP3 = COS(2.0*XKL+OPCT)
      FP4 = SIN(2.0*XKL+OPCT)
      FP5 = XKL*(3.0+CT)
      FP6 = COS(FP5)
      FP7 = SIN(FP5)
      FP8  = CMPLX( FP1,FP2)
      FP9  = CMPLX( FP3,FP4)
      FP10 = CMPLX( FP6,FP7)
C
      SF1 = PSIA*PSIA*PSIP*PSIP*FP8
      SF2 = PSIM*PSIM*FP9
      SF3 = -2.0*PSIP*PSIM*PSIA*FP10
      SF = (SF1+SF2+SF3)*CT*EC1
C
      D =1.0-(PSIA*PSIA)* RC1
      AD =CABS(D)
      IF (AD .LE. 1.0E-6 ) GO TO 213
      SSS =  SF/D
      GO TO 221
  213 WRITE (6, 2005)
 2005 FORMAT ('0 DENOMINATOR IS ZERO . PSIA IS TOO LARGE')
      GO TO 999
C
C     * BACKSCATTERED FIELD    *
C
  221 BSC = (ST1 + SCD + SSS)* CS
```

```
      CK1 = (4.0* PI)/(XK*XK)
      CK2 = SQRT(CK1)*0.02540
C
C     **  EBSC = SQRT(SIGMA) WITH PHASE REFERENCED TO FRONT   **
C      *                 EDGE   OF   WIRE                      *
      EBSC =(BSC* CK2)
      ETTR(IFW)= REAL(EBSC)
       XR(IFW) = ETTR(IFW)
      ETTI(IFW)=-AIMAG(EBSC)
       XI(IFW) = ETTI(IFW)
  800 CONTINUE
C
      IF (KP  NE  1)  GO TO 900
      DO 777  L = NMIN, NMAX
      SIGMA(L)   = 10.0 * ALOG10(ETTR(L)*ETTR(L) + ETTI(L)*ETTI(L))
  777 CONTINUE
C     WRITE(6,3000) (FRQ(J), SIGMA(J), J = NMIN, NMAX)
C3000 FORMAT ( '1FREQUENCY RESPONSE OF A THIN WIRE '////,   ' FREQUENCY
C    1   CROSS SECTION     ', //, (E12.4,  E15.4) )
  900 CONTINUE
  999 CONTINUE
      RETURN
      END
      SUBROUTINE EXPI ( ARGZ, EIXR, EIXI, KP)
C
C   * THIS SUBROUTINE COMPUTES THE REAL AND IMAGINARY PARTS OF THE
C   *       EXPONENTIAL INTEGRAL E(X) WHERE
C   *       E(X) =  INTEGRAL FROM X TO INFINITY OF EXP(IT)/T*DT
C   * REFERENCE - FUNCTIONS OF MATHEMATICAL PHYSICS BY MAGNUS AND
C   *                OBERHETTINGER, PP.97-98
C     KP  NE  0, PRINT OUT REAL AND IMAGINARY PARTS OF EXPONENTIAL
C               INTEGRAL
      COMPLEX  AIX,       ANTG( 100),          EIX,       FA,        F
      REAL  AINTR(100), AINTI(100)
C
      DEL = 0.000001
      GAMMA = 0.57721566
      IF ( ARGZ .LE. 1.0E-6) GO TO 50
      ABZ = ABS(ARGZ)
      DO 5  I=1,100
      AINTR(I)= 0.0
      AINTI(I)= 0.0
      ANTG(I) = CMPLX(0.0,0.0)
    5 CONTINUE
      IF (  ABZ .GE. 15) GO TO 9
C
C     THIS SERIES USED FOR  0.LT.ABS(X).LT 15
C     **  SERIES EXPANSION INVOLVING CI(X) AND SI(X)  **
C
C     E(2) =  GAM    + LN(Z) +SUM(((-1)**N)*Z**(2*N))/((2*N)*FACT(2*N))
C            +J*(     *SUM(((-1)**N)*Z**(2*N+1))/((2*N+1)*FACT(2*N+1))-
C            PIO2 )
C
      INC =1
      FAC = -(ARGZ**2)/(2.0)
      AINTR(1) =  FAC * 0.5
      AINTI(1) = FAC*(ARGZ/9.0) + ARGZ
C
   10 INC = INC + 1
      X2 =(2* INC)
```

```
      X2M = X2 -1.0
      X2P1S = (2*INC + 1 )**2
      FAC = -(FAC*ARGZ*ARGZ)/(X2M*X2)
      AINTR(INC) = FAC/X2 + AINTR(INC-1)
      AINTI(INC) = FAC*(ARGZ/X2P1S) +AINTI(INC-1)
CC
      ABR  = ABS( AINTR(INC))
      ABRM1= ABS( AINTR(INC-1))
      ABI  = ABS( AINTI(INC)  )
      ABIM1= ABS( AINTI(INC-1))
      IF ( ABS( ABR - ABRM1) .GE. DEL) GO TO 20
      IF ( ABS( ABI - ABIM1) .LE. DEL) GO TO 40
   20 CONTINUE
C
      IF ( INC .LT. 100 ) GO TO 10
      WRITE (6, 1000)
 1000 FORMAT( '0SERIES DID NOT CONVERGE ' )
      NI = INC
      GO TO 60
   40 NI= INC
   60 CONTINUE
      EIXR = AINTR(NI) + ALOG(ARGZ) + GAMMA
      EIXI = AINTI(NI) - 1.5707963
      GO TO 75
CC
C     **  ASYMPTOTIC SERIES EXPANSION FOR INT FROM INF TO X OF   **
C         (EXP(-JT)/T)*DT
C
    9 CONTINUE
      IF (  ABZ .GE. 150) GO TO 99
C     SERIES EXPANSION USED WHEN 15.LE.ABS(X).LT.150
C    * E(X) = EXP(IX)*(1/IX + 1/(IX)**2 + 2FACT/(IX)**3+...  )
C
      AIX =  CMPLX(0.0,ARGZ )
      FA = 1.0/AIX
      ANTG(1) = FA
      F  = FA*FA
      ANTG(2) = F      + ANTG(1)
      INC = 2
C
  110 INC = INC + 1
      XF = INC-1
      F = F*XF*FA
      ANTG(INC) = F + ANTG(INC-1)
      AB =  CABS (ANTG(INC))
      ABM1 =CABS (ANTG(INC-1))
      IF ( ABS(AB - ABM1) .LT. DEL) GO TO150
      IF ( INC .LE. 29) GO TO110
C
      WRITE ( 6, 1001 )
 1001 FORMAT ( ' SERIES DID NOT CONVERGE ')
      NN =  15
      GO TO 70
  150 NN = INC
   70 CONTINUE
C
      EIX = ANTG( NN )*CEXP(AIX)
      EIXR = REAL(EIX)
```

```
      EIXI = AIMAG(EIX)
      GO TO 75

      FUNCTION SET TO ZERO IF ARGUMENT ABS(X).GE.150
   99 EIXR = 0.0
      EIXI = 0.0
   75 CONTINUE

      IF ( KP .EQ. 0) GO TO 90
      WRITE (6,2000) EIXR, EIXI
 2000 FORMAT ( '0REAL PART OF E(X)= ',E15.5,//,' IMAGINARY PART OF E(X)
     A= ', E15.5 )
      GO TO 90
   50 CONTINUE
      WRITE (6, 3000)
 3000 FORMAT ('0ARGZ DID NOT TRANSFER INTO SUBROUTINE OR IS ZERO' )
   90 CONTINUE
      RETURN
      END
```

CHART TITLE - SUBROUTINE TARGET(ETTR,ETTI,XR,XI)

```
/ TARGET /

** THIN WIRE CW
RESPONSE * 0.5 TO
89.5 DEGREES ASPECT
ANGLE**
 * SOLUTION BY
UFIMTSEV, SIMPLIFIED
BY HONG FOR
BACKSCATTER *
 * REFERENCE - SHORT
PULSE SCATTERING BY A
LONG WIRE, BY S HONG
 * IEEE
ON AP, VOL
AP-16,NO.3, MAY
1968,PP.338-342

NMIN = MINIMUM
FREQUENCY SAMPLE
NMAX = MAXIMUM
FREQUENCY SAMPLE
DF = FREQUENCY
INCREMENT IN MHZ
FC = CARRIER
FREQUENCY IN GHZ

01
/ READ FROM DEV /
/ 5 /
/ VIA FORMAT /
/ 1000 /
/ INTO THE LIST /

NOTE 02
* * * * * * * * * * * * *
* LIST = THETA, XL, *
* DIA, KP *
* * * * * * * * * * * * *

KP = 1, PRINT OUT RCS
VERSUS FREQUENCY

07
PIJ02 =
CMPLX(0.0,PI02)
GAM = 1.781072
TH =
THETA*(180.0/PI)
CT = COS(TH)

08
CT02 =
COS(TH/2.0)
CT02S = CT02*CT02
CT02F =
CT02S*CT02S
ST = SIN(TH)

09
STT = SIN(TH*2.0)
ST02 =
SIN(TH/2.0)
ST02S = ST02*ST02
ST02F =
ST02S*ST02S

10
OPCT = 1.0 + CT
OMCT = 1.0 - CT
AKTH =
2.0/(ST*STT)

14
ACLC =
CMPLX(ACL,PI02)
CS =
((0.0,1.0)
/(ACLC*ACLC))
*(-AKTH)

** DETERMINATION OF
INTEGRAL AND OTHER
TERMS USED IN
MULTIPLE **
ORDER SCATTERING

15
C5L = ALOG(GKA)
C6R =
(2.0/XKA)
*(XKL/GKA)
C6RL = ALOG(C6R)
CC6RL =
CMPLX(C6RL,PI02)

16
EAA = XKL*2.0

17
|2|            H
|5|   EXPI     H
|.| (EAA,EXRA, H
|0|  EXIA,0)   H
|1|            H

23
EXQP =
CMPLX(EXR,EXI)
E2C = COS(EQPA)
E2S = SIN(EQPA)
EXQPP =
CMPLX(E2C, - E2S)

24
C7P =
GKA*GKA*OMCT/2.0
C7PL = ALOG(C7P)
PSIP = (PIJ -
C7PL)/(CC6RL -
EXQP*EXQPP)

25
EQMA = XKL*OPCT

26
|2|            H
|5|   EXPI     H
|.| (EQMA,EXRM, H
|0|  EXIM,0)   H
|1|            H

27
EXQM =
CMPLX(EXRM,EXIM)
Q2 = COS(EQMA)
Q3 = SIN(EQMA)
```

```
  /  VIA FORMAT   /
 /     1000      /
/ INTO THE LIST /
-----------------
        |
        |  NOTE  02
* * * * * * * * * * *
* LIST = THETA, XL, *
*      DIA, KP      *
* * * * * * * * * * *
        |
KP = 1, PRINT OUT RCS
VERSUS FREQUENCY
        |
        |           03
   ------------------
  / WRITE TO DEV   /
 /      6         /
/  VIA FORMAT    /
/     1100      /
/ FROM THE LIST /
-----------------
        |
        |  NOTE  04
* * * * * * * * * * *
* LIST = THETA, XL, *
*      DIA          *
* * * * * * * * * * *
        |
        *  C5
      *   *
    *       *
  *THETA .LT. *  TRUE
*   0.5 .OR.   *--+
  *THETA .GT. *   |
    * 89.5  *     |
      *   *      ....
        *       . 23 .
        |FALSE  . 09 .
        |        ....
        |        900
        |           06
*-------------------*
| RAD = DIA/2.0     |
| PI = 3.1415926    |
| PIJ =             |
| CMPLX(0.0,PI)     |
| PIO2 = PI/2.0     |
*-------------------*
```

```
| SIN(TH/2.0)       |
| STO2S = STO2*STO2 |
| STO2F =           |
| STO2S*STO2S       |
*-------------------*
        |
        |           10
*-------------------*
| OPCT = 1.0 + CT   |
| OMCT = 1.0 - CT   |
| AKTH =            |
| 2.0/(ST*STT)      |
*-------------------*
        |
        |  NOTE  11
* * * * * * * * * * *
*  BEGIN DO LOOP    *
*  800 IFW = NMIN,  *
*      NMAX         *
* * * * * * * * * * *
        |
 23.04--->|
        |           12
*-------------------*
| XI = IFW - 1      |
| FREQ =            |
| XI*DF/1000.0      |
| FRQ(IFW) = FREQ   |
| XK =              |
| (.53234454*FREQ)  |
| XKL = XK*XL       |
*-------------------*
        |
        |           13
*-------------------*
| XKA = XK*RAD      |
| GKA = GAM*XKA     |
| C1 = 2.0/(GKA*ST) |
| ACL = ALOG(C1)    |
*-------------------*
```

```
        |           16
*-------------------*
| EAA = XKL*2.0     |
*-------------------*
        |
        |           17
*-------------------*
|2 |              H
|5 |  EXPI        H
|. | (EAA,EXRA,   H
|0 |  EXIA,0)     H
|1 |              H
*-------------------*
        |
        |           18
*-------------------*
| EXQA =            |
| CMPLX(EXRA,EXIA)  |
| EIC = COS(EAA)    |
| EIS = SIN(EAA)    |
| RC1 =             |
| CMPLX(EIC,EIS)    |
*-------------------*
        |
        |           19
*-------------------*
| RC9 =             |
| CMPLX(EIC, - EIS) |
| PSIA = (PIJ -     |
| 2.0*C5L)/(CC6RL - |
| EXQA*RC9)         |
*-------------------*
        |
        |           20
*-------------------*
| EQPA = XKL*OMCT   |
*-------------------*
        |
        |           21
*-------------------*
|2 |              H
|5 |  EXPI        H
|. | (EQPA,EXR,EXI, H
|0 |  0)          H
|1 |              H
*-------------------*
```

```
        |           26
*-------------------*
|2 |              H
|5 |  EXPI        H
|. | (EQMA,EXRM,  H
|0 |  EXIM,0)     H
|1 |              H
*-------------------*
        |
        |           27
*-------------------*
| EXQM =            |
| CMPLX(EXRM,EXIM)  |
| Q2 = COS(EQMA)    |
| Q3 = SIN(EQMA)    |
| QC1 =             |
| CMPLX(Q2,Q3)      |
*-------------------*
        |
        |           28
*-------------------*
| QC9 = CMPLX(Q2, - |
| Q3)               |
| C7M =             |
| GKA*GKA*OPCT/2.0  |
| C7ML = ALOG(C7M)  |
*-------------------*
        |
        |           29
*-------------------*
| PSIM = (PIJ -     |
| C7ML)/(CC6RL -    |
| EXQM*QC9)         |
*-------------------*
        |
* UTILIZATION OF
FACTORS IN SCATTERED
FIELD EXPRESSION *
        |
** FIRST ORDER
SCATTERING   **
        |
        |  /
      ----
     /22.01
```

CHART TITLE - SUBROUTINE TARGET(FTTR,FTTI,XR,XI)

L-62

```
21.30--->*                     *------------------->*
         |           01        |                    |            07
*--------------------*         |     *--------------------------*
|      C2 =          |         |     |     E1 = 1.0/GKA         |
| 1.0/(GKA*STO2S)    |         |     |                          |
|                    |         |     |     E2 = ALOG(E1)        |
| ACL2 = ALOG(C2)    |         |     |                          |
|                    |         |     |        EC1 =             |
|     ACL2C =        |         |     |  CMPLX(E2,PIO2)          |
| CMPLX(ACL2,PIO2)   |         |     |                          |
|                    |         |     |       SCD4 =             |
|     ST1 = -        |         |     | CT*(RC1*EC1*PSIP*        |
|   STO2F*ACL2C      |         |     |       PSIP)              |
*--------------------*         |     *--------------------------*
         |                     |                 |
         |                     |                 |            08
*   RETURN FROM                |     *--------------------------*
TRAILING EDGE OF WIRE          |     |  SCD = SCD1 +            |
*                              |     |  SCD2 + SCD3 +           |
         |                     |     |       SCD4               |
         |           02        |     *--------------------------*
*--------------------*         |                 |
|      A1 =          |         |                 |            09
| 1.0/(GKA*CTO2S)    |         |     *--------------------------*
|                    |         |     |        FP1 =             |
| A2 = ALOG(A1)      |         |     |   COS(4.0*XKL)           |
|                    |         |     |                          |
|      AC1 =         |         |     |        FP2 =             |
| CMPLX(A2,PIO2)     |         |     |   SIN(4.0*XKL)           |
|                    |         |     |                          |
| P1 = 2.0*XKL*CT    |         |     |        FP3 =             |
*--------------------*         |     | COS(2.0*XKL*OPCT)        |
         |                     |     |                          |
         |           03        |     |        FP4 =             |
*--------------------*         |     | SIN(2.0*XKL*OPCT)        |
| P2 = COS(P1)       |         |     *--------------------------*
|                    |         |                 |
| P3 = SIN(P1)       |         |                 |            10
|                    |         |     *--------------------------*
|      PC1 =         |         |     | FP5 = XKL*(3.0 +         |
| CMPLX(P2,P3)       |         |     |        CT)               |
|                    |         |     |                          |
|      AC2 =         |         |     | FP6 = COS(FP5)           |
| CMPLX(CTO2F,0.0)   |         |     |                          |
|                    |         |     | FP7 = SIN(FP5)           |
|      SCD1 =        |         |     |                          |
|   AC1*PC1*AC2      |         |     |        FP8 =             |
*--------------------*         |     |  CMPLX(FP1,FP2)          |
         |                     |     *--------------------------*
```

```
PC1 =
CMPLX(P2,P3)

AC2 =
CMPLX(CTO2F,0.0)

SCD1 =
AC1*PC1*AC2

04
B1 =
1.0/(GKA*CTO2)

B2 = 2.0*ALOG(B1)

BC1 =
CMPLX(B2,PI)

SCD2 =
(-(CC1*AC2*PC1*
PSIP))

05
D1 =
1.0/(GKA*STO2)

D2 = 2.0*ALOG(D1)

DC1 =
CMPLX(D2,PI)

SB4 =
CMPLX(STO2F,0.0)

06
SCD3 =
SB4*(CC1*DC1*
PSIM)

FP5 = XKL*(3.0 +
CT)

FP6 = COS(FP5)

FP7 = SIN(FP5)

FP8 =
CMPLX(FP1,FP2)

11
FP9 =
CMPLX(FP3,FP4)

FP10 =
CMPLX(FP6,FP7)

12
SF1 =
PSIA*PSIA*PSIP*
PSIP*FP8

SF2 =
PSIM*PSIM*FP9

SF3 = -
2.0*PSIP*PSIM*
PSIA*FP10

13
SF = (SF1 + SF2 +
SF3)*CT*EC1

14
D = 1.0 -
(PSIA*PSIA)*RCI

AD = CABS(D)

15
AD .LE.
1.0E-6
TRUE ----> 213
FALSE

16
SSS = SF/D

.23.01.
... 221

17
/ WRITE TO DEV /
/ 6 /
/ VIA FORMAT /
/ 2005 /

.23.10.
... 999
```

2

CHART TITLE - SUBROUTINE TARGET(ETTR,ETTI,XR,XI)

```
                * BACKSCATTERED
               FIELD   *

                22.16--->*
                  221    |            01
               *-----------------------*
               |   BSC = (ST1 +        |
               |   SCD + SSS)*CS       |
               |                       |
               |         CK1 =         |
               |  (4.0*PI)/(XK*XK)     |
               |                       |
               |         CK2 =         |
               | SQRT(CK1)*0.02540     |
               *-----------------------*
                         |
                         |
                         |
                ** EBSC =
               SQRT(SIGMA) WITH
               PHASE REFERENCED TO
               FRONT  **
                *                 EDGE
               OF   WIRE
                *
                         |
                         |
                         |            02
               *-----------------------*
               | EBSC = (BSC*CK2)      |
               |                       |
               |    ETTR(IFW) =        |
               |    REAL(EBSC)         |
               |                       |
               |      XR(IFW) =        |
               |      ETTR(IFW)        |
```

```
                 *-------------------------*
                 | EBSC = (BSC*CK2)        |
                 |                         |
                 |     ETTR(IFW) =         |
                 |     REAL(EBSC)          |
                 |                         |
                 |     XR(IFW) =           |
                 |     ETTR(IFW)           |
                 |                         |
                 |    ETTI(IFW) = -        |
                 |    AIMAG(EBSC)          |
                 *-------------------------*
                              |
                              |
                              |           03
                 *-------------------------*
                 |     XI(IFW) =           |
                 |     ETTI(IFW)           |
                 *-------------------------*
                              |
                              |
                              |
                   800        *      04
                          *       *
                       *             *
                    *                   *      NO
                 *    END OF DO            *--+
                    *   LOOP?           *     |
                       *             *        |
                          *       *           |
                              *             ....
                              |YES        . 21 .
                              |           . 12 .
                              |             ....          +------------->*
                              |                           |               |
                              |                           |       777     *      08
                              |                           |           *       *
                              |                           |        *             *
                              *      05                   |     *                   *      NO
                          *       *                       |  *    END OF DO            *--+
                       *             *                    |     *   LOOP?           *     |
                    *                   *    TRUE         |        *             *        |
                 *    KP .NE. 1            *------+       |           *       *           |
                    *                   *         |       |               *             ....
                       *             *            |       |               |YES        . 23 .
                          *       *               |       |               |           . 07 .
                              *                   |       |               |             ....
                              |FALSE              |       |               |
                              |                   |       |               |
                              |                   |       |               |
                              |                   |       |     WRITE(6,3000)
                              |                   |       |     (FRQ(J), SIGMA(J), J
                              |     NOTE   06     |       |     = NMIN, NMAX)
                 * * * * * * * * * * * *          |       |     3000 FORMAT (
                 *     BEGIN DO LOOP     *        |       |     '1FREQUENCY RESPONSE
```

```
 *   END OF DO   *-+
   *   LOOP?   *   |
     *       *     |
       *   *       |
         *        ....
         |YES    . 21 .
         |       . 12 .
         |        ....            +------------->*
         |                        |              |
         |                        |       777    *    08
         |                        |            *   *
         *    05                  |          *       *       NO
       *   *                      |        *  END OF DO  *-+
     *       *                    |          *  LOOP?  *   |
   *           *  TRUE            |            *     *     |
 *   KP .NE. 1   *------+         |              *        ....
   *           *        |         |              |YES    . 23 .
     *       *          |         |              |       . 07 .
       *   *            |         |              |        ....
         *              |         |              |
         |FALSE         |         |              |
         |              |         |              |
         |              |         |     WRITE(6,3000)
         |              |         |     (FRQ(J), SIGMA(J), J
         |    NOTE  06  |         |     = NMIN, NMAX)
 * * * * * * * * * * *  |         |     3000 FORMAT (
 *   BEGIN DO LOOP   *  |         |     '1FREQUENCY RESPONSE
 *   777 L = NMIN,   *  |         |     OF A THIN WIRE ',//,
 *       NMAX        *  |         |     ' FREQUENCY
 * * * * * * * * * * *  |         |     1    CROSS SECTION
         |              |         |     ', //, (F12.4,
  23.08--->|            |         |     E15.4) )
         |         07   |         |              |
 *-------------------*  +---------|----21.05*--->|
 |    SIGMA(L) =     |            |       900    |   NOTE  09
 | 10.0*ALOG10(ETTR  |            |     * * * * * * * * * * *
 |   (L)*ETTR(L) +   |            |     *      CONTINUE     *
 | ETTI(L)*ETTI(L))  |            |     * * * * * * * * * * *
 *-------------------*            |              |
         |                        |      22.17--->|
         |                        |       999    |   NOTE  10
         +------------------------+     * * * * * * * * * * *
                                        *      CONTINUE     *
                                        * * * * * * * * * * *
                                                 |
                                                 | 11
                                             ---------
                                             *  EXIT  *
                                             ---------
```

3

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CHART TITLE - NON-PROCEDURAL STATEMENTS

```
              COMMON MOVER,M,NMIN, NMAX, DF, FC, PW, TO
              COMPLEX    SS(100),
                        ACLC,ALN1,  CS,    ACL2C, ST1, EXA,EXQP,EXQM,EXAP,PSIA,
                       EXQPP,     EXQMP,PSIP,PSIM, AC1, PC1, AC2,SCD1, BC1, QC1,
                        SCD2, DC1,SCD3, RC1, EC1,SCD4, SCD, FP8, FP9,FP10,
                         SF1, SF2, SF3,  SF,  SP, SPC, SSS, BSC,EBSC
                           , PIJ,    PIJ02
                       ,CC6RL,   D   ,SB4
                           ,EXQA,EXQM
         , RC9, QC9
              REAL  FRQ(512), ETTR(512), ETTI(512), SIGMA(512),XR(512),XI(512)
     1000     FORMAT (3F10.3, I2)
     1100     FORMAT ('0 ASPECT ANGLE = ',F7.2,'   WIRE LENGTH = ', F8.3, //,
                 '  WIRE DIAMETER  = ', F7.4 , // , ' ( LENGTHS ARE IN INCHES )'
              )
     2005     FORMAT ('0 DENOMINATOR IS ZERO , PSIA IS TOO LARGE')
```

CHART TITLE - SUBROUTINE EXPI(ARGZ,EIXR,EIXI,KP)

```
             -----------
            /   EXPI    /
            -----------

          21.17*-->*

          * THIS SUBROUTINE
         COMPUTES THE REAL AND
         IMAGINARY PARTS OF
         THE
          *       EXPONENTIAL
         INTEGRAL E(X) WHERE
          *       E(X) =
         INTEGRAL FROM X TO
         INFINITY OF
         EXP(IT)/T*DT
          * REFERENCE -
         FUNCTIONS OF
         MATHEMATICAL PHYSICS
         BY MAGNUS AND
          *
         OBERHETTINGER,
         PP.97-98
         KP .NE. 0, PRINT OUT
         REAL AND IMAGINARY
         PARTS OF EXPONENTIAL
         INTEGRAL

                   *
                   |          01
         *-------------------*
         |  DEL = 0.000001   |
         |                   |
         |     GAMMA =       |
         |   0.57721566      |
         *-------------------*
                   |
                   |
                   |
                   *    02
                *     *
              *         *
```

```
           *       *
         *           *   TRUE
       *   ARGZ .LE.   *------------------------>*
         *  1.0E-6   *                       50  |  NOTE  07
           *       *                      * * * * * * * * * * *
             *   *                        *     CONTINUE      *
               *                          * * * * * * * * * * *
               |FALSE                                |
               |                                     |
               |                                     |        08
               |                               -----------------
               |                              /                 /
               |                             /  WRITE TO DEV   /
               |                 03         /       6         /
   *-----------------------*               /   VIA FORMAT    /
   |  ABZ = ABS(ARGZ)      |              /      3000       /
   *-----------------------*              ------------------
               |                                  |
               |                          27.09--->|
               |        NOTE  04             90    |  NOTE  09
   * * * * * * * * * * * *                * * * * * * * * * * *
   *   BEGIN DO LOOP     *                *     CONTINUE      *
   *   5 I = 1, 100      *                * * * * * * * * * * *
   * * * * * * * * * * * *                          |
               |                                    |
 +------------>|                                    | 10
               |                 05            ---------
   *-----------------------*                  *  EXIT   *
 | |  AINTR(I) = 0.0       |                   ---------
 | |                       |
 | |  AINTI(I) = 0.0       |
 | |                       |
 | |     ANTG(I) =         |
 | |  CMPLX(0.0,0.0)       |
 | *-----------------------*
 |             |
 |             |
 |     5       *     06
 |           *   *
 |         *       *
 |  NO   *           *
 +-----*  END OF DO    *
         *  LOOP?    *
           *       *
             *   *
               *
               |YES
               |
               |
               |
               |
              ---
```

CHART TITLE - SUBROUTINE EXPI(ARGZ,EIXR,EIXI,KP)

L-66

```
          25.06--->*
                   |
                   *    01
                *     *
             *           *
          *                 *  TRUE
       *  ABZ  .GE.  15    *--+
          *                 *  |
             *           *     |
                *     *        |
                   *         ....
                   |FALSE  . 27 .
                   |       . 01 .
                   |         ....
                   |            9
                   |
                   |
                   |
        THIS SERIES USED FOR
        0.LT.ABS(X).LT.15
         ** SERIES EXPANSION
        INVOLVING CI(X) AND
        SI(X)  **
                   |
                   |                +--------------------->*
                   |                |                      |          06
        E(2) =  GAM   + LN(Z)       |          *----------------------*
        +SUM(((-1)**N)              |          |      ABIM1 =         |
        *Z**(2*N))/((2*N)           |          |  ABS(AINT(INC -      |
        *FACT(2*N))                 |          |        1))           |
        +J*(                        |          *----------------------*
         *SUM(((-1)**N)             |                      |
        *Z**(2*N+1))/((2*N+1)       |                      |
        *FACT(2*N+1))-              |                      |
        PIO2 )                      |                      *    07
                   |                |
```

```
 *SUM(((-1)**N)
*Z**(2*N+1))/((2*N+1)
*FACT(2*N+1))-
PI02 )
           |                                   |
           |                                   *   07
           |                                *     *
           |                             *           *
           |           02          TRUE * ABS(ABR  -  *
*--------------------*           +-----* ABRM1) .GE.   *
|      INC = 1       |           |      *    DEL      *
|                    |           |        *         *
|      FAC = -       |           |          *     *
|  (ARGZ**2)/(2.0)   |           |             *
|                    |           |             |FALSE
|    AINTR(1) =      |           |             |
|      FAC*0.5       |           |             |
|                    |           |             |
|    AINTI(1) =      |           |             |
| FAC*(ARGZ/9.0) +   |           |             |
|       ARGZ         |           |             |
*--------------------*           |             *   08
           |                     |          *     *
 26.10--->|                      |       *           *
   10      |           03        |     * ABS(ABI  -  *   TRUE
*--------------------*           |   *  ABIM1) .LE.   *------------------->*
|   INC = INC + 1    |           |     *    DEL      *              40   |          13
|                    |           |        *         *             *-------------------*
|   X2 = (2*INC)     |           |          *     *               |     NI = INC      |
|                    |           |             *                  *-------------------*
|  X2M = X2 - 1.0    |           |             |FALSE        +----------->|
|                    |           |             |             |    60   |   NOTE  14
| X2PIS = (2*INC +   |           |             |             |  * * * * * * * * * * *
|      1)**2         |           |             |             |  *     CONTINUE        *
*--------------------*           +------------>|             |  * * * * * * * * * * *
           |                      20           |  NOTE  09   |         |
           |           04       * * * * * * * * * * *        |         |          15
*--------------------*          *     CONTINUE       *       |  *-------------------*
|      FAC = -       |          * * * * * * * * * * *        |  |      EIXR =       |
|  (FAC*ARGZ*ARGZ)   |                     |                 |  |   AINTR(NI) +     |
|     /(X2M*X2)      |                     |                 |  |   ALOG(ARGZ) +    |
|                    |                     *   10            |  |      GAMMA        |
|   AINTR(INC) =     |                  *     *              |  |                   |
|     FAC/X2 +       |               *           *           |  |      EIXI =       |
|  AINTR(INC - 1)    |            *                 *  TRUE  |  |   AINTI(NI) -     |
|                    |          * INC .LT. 100      *-+      |  |    1.5707963      |
|   AINTI(INC) =     |            *                 *  |     |  *-------------------*
| FAC*(ARGZ/X2PIS)   |               *           *     |     |           |
|  + AINTI(INC - 1)  |                  *     *        |     |           |
*--------------------*                     *          ....   |          ...
           |                               |FALSE    . 26 .  |        .     .
           |                               |         . 03 .  |        .27.08.
      C                                    |          ....   |        .     .
           |                               |           10    |         ... 75
```

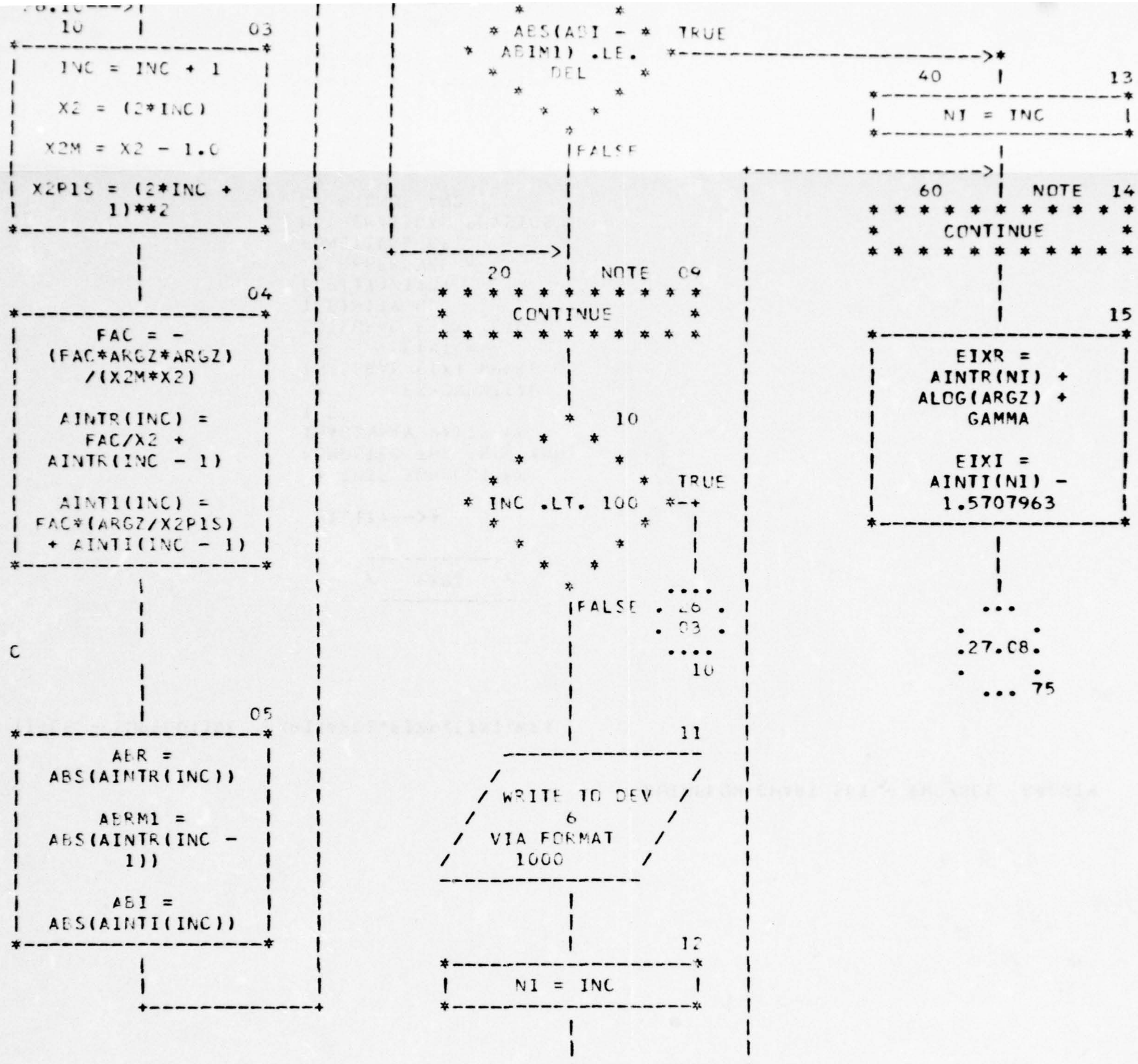
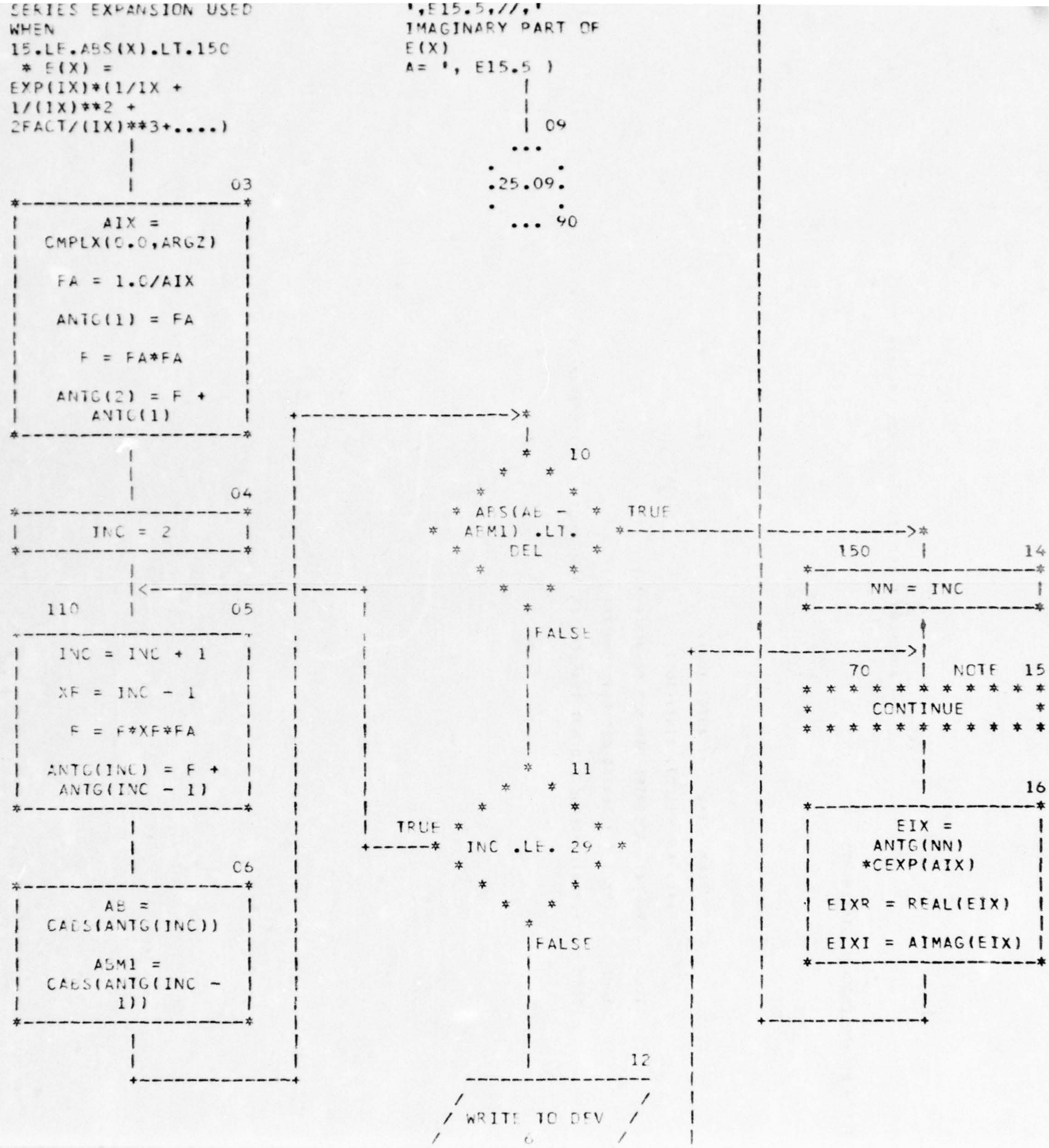

10
03
INC = INC + 1
X2 = (2*INC)
X2M = X2 - 1.0
X2P1S = (2*INC + 1)**2
04
FAC = - (FAC*ARGZ*ARGZ) /(X2M*X2)
AINTR(INC) = FAC/X2 + AINTR(INC - 1)
AINTI(INC) = FAC*(ARGZ/X2P1S) + AINTI(INC - 1)
C
05
ABR = ABS(AINTR(INC))
ABRM1 = ABS(AINTR(INC - 1))
ABI = ABS(AINTI(INC))
ABS(ABI - ABIM1) .LE. DEL
TRUE
FALSE
20
NOTE 09
CONTINUE
10
INC .LT. 100
TRUE
FALSE
26
03
10
11
WRITE TO DEV 6 VIA FORMAT 1000
12
NI = INC
40
13
NI = INC
60
NOTE 14
CONTINUE
15
EIXR = AINTR(NI) + ALOG(ARGZ) + GAMMA
EIXI = AINTI(NI) - 1.5707963
27.08.
75

CHART TITLE - SUBROUTINE EXPI(ARGZ,EIXR,EIXI,KP)

```
C
 **  ASYMPTOTIC
SERIES EXPANSION FOR
INT FROM INF TO X OF
 **
(EXP(-JT)/T)*DT                             FUNCTION SET TO ZERO
                                            IF ARGUMENT
 26.01--->*                                 ABS(X).GE.150
    9     |  NOTE  01
* * * * * * * * * * *    +------------------>*
*    CONTINUE        *    |          99      |        07
* * * * * * * * * * *    |       *-----------------------*
          |               |       |     EIXR = 0.0        |
          |               |       |                       |
          |               |       |     EIXI = 0.0        |
          *    02         |       *-----------------------*
        *   *             |                  |
      *       *           |       26.15*--->|<-------------------+
    *           *  TRUE   |          75      |  NOTE  08         |
  * ABZ .GE. 150   *------+       * * * * * * * * * * *          |
    *           *                 *      CONTINUE      *          |
      *       *                   * * * * * * * * * * *          |
        *   *                                |                    |
          *                                  |                    |
          |FALSE                                                  |
          |                       IF ( KP .EQ. 0) GO TO           |
          |                       90                              |
          |                       WRITE (6,2000) EIXR,            |
          |                       EIXI                            |
          |                       2000 FORMAT ( 'OREAL            |
          |                       PART OF E(X)=                   |
SERIES EXPANSION USED             ',E15.5,//,'                    |
WHEN                              IMAGINARY PART OF               |
15.LE.ABS(X).LT.150               E(X)                            |
 * E(X) =                         A= ', E15.5 )                   |
EXP(IX)*(1/IX +                              |                    |
1/(IX)**2 +                                  |                    |
```


SERIES EXPANSION USED WHEN 15.LE.ABS(X).LT.150 * E(X) = EXP(IX)*(1/IX + 1/(IX)**2 + 2FACT/(IX)**3+....)
',E15.5,//,' IMAGINARY PART OF E(X) A= ', E15.5)
09
.25.09.
90
03
AIX = CMPLX(0.0,ARGZ)
FA = 1.0/AIX
ANTG(1) = FA
F = FA*FA
ANTG(2) = F + ANTG(1)
04
INC = 2
110
05
INC = INC + 1
XF = INC - 1
F = F*XF*FA
ANTG(INC) = F + ANTG(INC - 1)
06
AB = CABS(ANTG(INC))
ABM1 = CABS(ANTG(INC - 1))
10
ABS(AB - ABM1) .LT. DEL
TRUE
FALSE
11
INC .LE. 29
TRUE
FALSE
12
WRITE TO DEV 6
150
14
NN = INC
70
NOTE
15
CONTINUE
16
EIX = ANTG(NN) *CEXP(AIX)
EIXR = REAL(EIX)
EIXI = AIMAG(EIX)

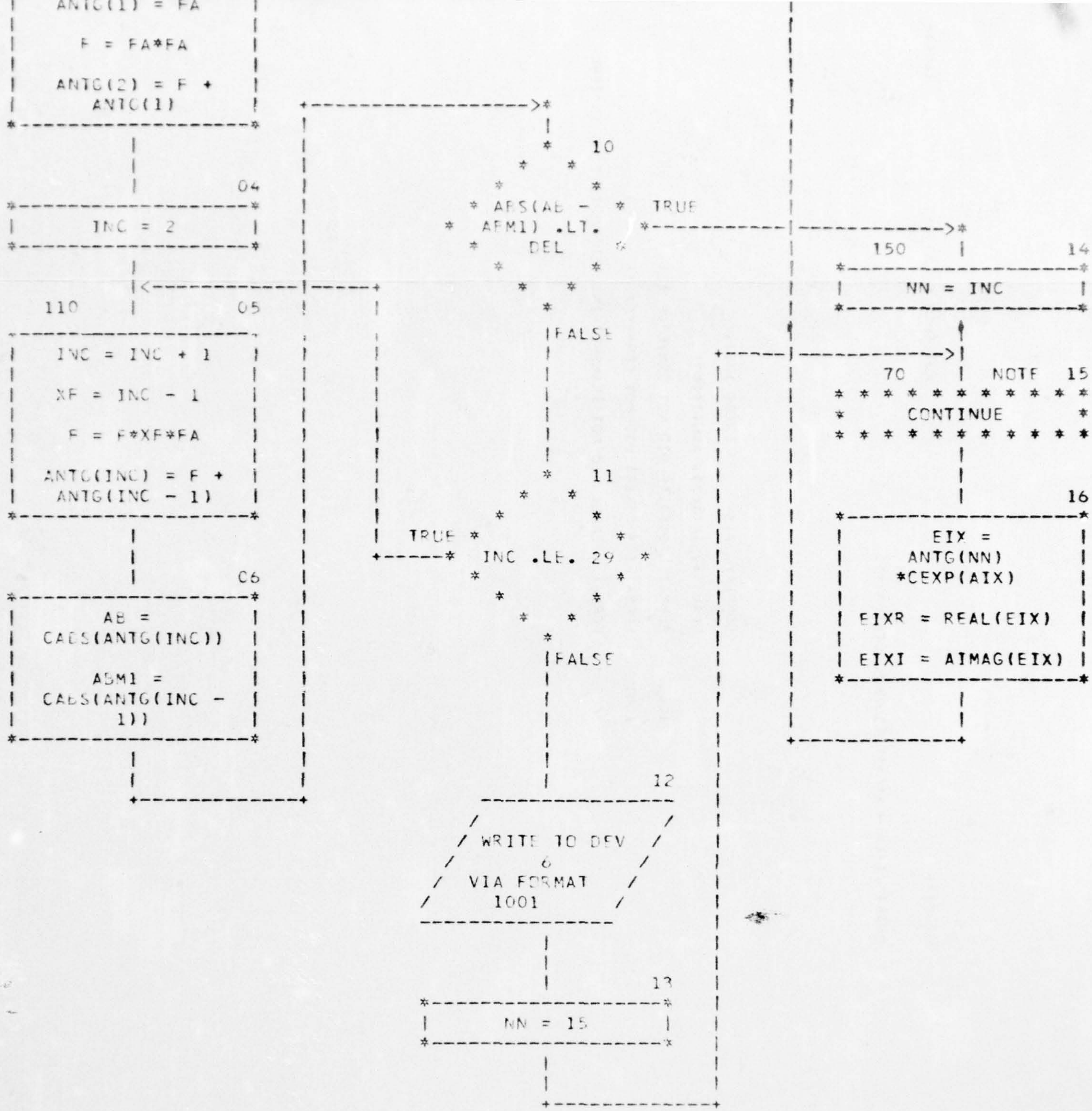

ANTG(1) = FA
F = FA*FA
ANTG(2) = F + ANTG(1)
04
INC = 2
110
05
INC = INC + 1
XF = INC - 1
F = F*XF*FA
ANTG(INC) = F + ANTG(INC - 1)
C6
AB = CABS(ANTG(INC))
ABM1 = CABS(ANTG(INC - 1))
10
ABS(AB - ABM1) .LT. DEL
TRUE
FALSE
11
INC .LE. 29
TRUE
FALSE
12
WRITE TO DEV 6 VIA FORMAT 1001
13
NN = 15
150
14
NN = INC
70
NOTE
15
CONTINUE
16
EIX = ANTG(NN) *CEXP(AIX)
EIXR = REAL(EIX)
EIXI = AIMAG(EIX)

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
          COMPLEX  AIX,      ANTG( 100),        FIX,      FA,      F
          REAL  AINTR(100), AINTI(100)
    1000  FORMAT( 'OSERIES DID NOT CONVERGE ' )
    1001  FORMAT ( ' SERIES DID NOT CONVERGE ')
    3000  FORMAT ('OARGZ DID NOT TRANSFER INTO SUBROUTINE OR IS ZERO' )
```

```
      SUBROUTINE  TARGET  (ETTR, ETTI,XR,XI)                               RCS6 001
C                                                                          RCS6 002
C     ** THIN WIRE CW RESPONSE    * 0.5 TO 89.5 DEGREES ASPECT ANGLE**     RCS6 003
C     *   SOLUTION BY UFIMTSEV, SIMPLIFIED BY HONG FOR BACKSCATTER   *     RCS6 004
C    * REFERENCE - SHORT PULSE SCATTERING BY A LONG WIRE,  BY S HONG       RCS6 005
C    *            IEEE ON AP, VOL AP-16,NO.3, MAY 1968,PP.338-342          RCS6 006
C                                                                          RCS6 007
C                                                                          RCS6 008
      COMMON MOVER,M,NMIN, NMAX, DF, FC, PW, TO                            RCS6 009
C     NMIN = MINIMUM FREQUENCY SAMPLE                                      RCS6 010
C     NMAX = MAXIMUM FREQUENCY SAMPLE                                      RCS6 011
C     DF   = FREQUENCY INCREMENT IN MHZ                                    RCS6 012
C     FC   = CARRIER FREQUENCY IN GHZ                                      RCS6 013
C                                                                          RCS6 014
      COMPLEX    SS(100),                                                  RCS6 015
     A         ACLC,ALN1,  CS,     ACL2C, ST1, EXA,EXQP,EXQM,EXAP,PSIA,    RCS6 016
     B        EXQPP,     EXQMP,PSIP,PSIM, AC1, PC1, AC2,SCD1, BC1, QC1,    RCS6 017
     C         SCD2, DC1,SCD3, RC1, EC1,SCD4, SCD, FP8, FP9,FP10,          RCS6 018
     D          SF1, SF2, SF3,  SF,  SP, SPC, SSS, BSC,EBSC                RCS6 019
     E               , PIJ,     PIJO2                                      RCS6 020
     F        ,CC6RL,    D   ,SB4                                          RCS6 021
     G               ,EXQA,EXQM                                            RCS6 022
     1  , RC9, QC9                                                         RCS6 023
      REAL  FRQ(512), ETTR(512), ETTI(512), SIGMA(512),XR(512),XI(512)     RCS6 024
C                                                                          RCS6 025
```

```
693                 1   , RC9, CC9                                                     RCS6 022
                                                                                       RCS6 023
694                 REAL  FRQ(512), ETTR(512), ETTI(512), SIGMA(512),XR(512),XI(512)   RCS6 024
695           C                                                                        RCS6 025
```



```
CARD NO       ****                       CONTENTS                                      ****

696                 READ(5,1000) THETA, XL, DIA, KP                                    RCS6 026
697           C     KP = 1, PRINT OUT RCS VERSUS FREQUENCY                             RCS6 027
698            1000 FORMAT (3F10.3, I2)                                                RCS6 028
699                 WRITE(6,1100) THETA, XL, DIA                                       RCS6 030
700            1100 FORMAT ('0 ASPECT ANGLE = ',F7.2,'   WIRE LENGTH = ', F8.3, //,    RCS6 031
701                A   '  WIRE DIAMETER  = ', F7.4 , // , ' ( LENGTHS ARE IN INCHES )'RCS6 032
702                B)                                                                  RCS6 033
703                 IF (THETA .LT. 0.5  .OR. THETA .GT. 89.5 ) GO TO 900               RCS6 034
704                 RAD = DIA/2.0                                                      RCS6 035
705                 PI = 3.1415926                                                     RCS6 036
706                 PIJ = CMPLX(0.0,PI)                                                RCS6 037
707                 PIO2= PI/2.0                                                       RCS6 038
708                 PIJO2 = CMPLX(0.0,PIO2)                                            RCS6 039
709                 GAM = 1.781072                                                     RCS6 040
710                 TH  = THETA * (180.0 / PI)                                         RCS6 041
711                 CT = COS(TH)                                                       RCS6 042
```

```
C     KP = 1, PRINT OUT RCS VERSUS FREQUENCY                              RCS6 027
 1000 FORMAT (3F10.3, I2)                                                 RCS6 028
      WRITE(6,1100) THETA, XL, DIA                                        RCS6 030
 1100 FORMAT ('0 ASPECT ANGLE = ',F7.2,'    WIRE LENGTH = ', F8.3, //,   RCS6 031
     A   '  WIRE DIAMETER   = ', F7.4 , // , ' ( LENGTHS ARE IN INCHES )'RCS6 032
     B)                                                                   RCS6 033
      IF (THETA .LT. 0.5  .OR. THETA .GT. 89.5 ) GO TO 900                RCS6 034
      RAD = DIA/2.0                                                       RCS6 035
      PI = 3.1415926                                                      RCS6 036
      PIJ = CMPLX(0.0,PI)                                                 RCS6 037
      PIO2= PI/2.0                                                        RCS6 038
      PIJO2 = CMPLX(0.0,PIO2)                                             RCS6 039
      GAM = 1.781072                                                      RCS6 040
      TH  = THETA * (180.0 / PI)                                          RCS6 041
      CT = COS(TH)                                                        RCS6 042
      CTO2 = COS(TH/2.0)                                                  RCS6 043
      CTO2S= CTO2 * CTO2                                                  RCS6 044
      CTO2F= CTO2S * CTO2S                                                RCS6 045
      ST = SIN (TH)                                                       RCS6 C46
      STT = SIN(TH*2.0)                                                   RCS6 047
      STO2 = SIN(TH/2.0)                                                  RCS6 048
      STO2S = STO2 * STO2                                                 RCS6 049
      STO2F = STO2S * STO2S                                               RCS6 050
      OPCT = 1.0+ CT                                                      RCS6 051
      OMCT = 1.0- CT                                                      RCS6 052
      AKTH = 2.0/(ST*STT)                                                 RCS6 053
C                                                                         RCS6 054
```

3

L-69a

```
      DO 300  IFW = NMIN,NMAX                                          RCS6 055
      XI= IFW - 1                                                      RCS6 056
      FREQ    = XI * DF / 1000.0                                       RCS6 057
      FRQ( IFW) = FREQ                                                 RCS6 058
      XK =  ( .53234454 * FREQ )                                       RCS6 059
      XKL =  XK* XL                                                    RCS6 060
      XKA =  XK* RAD                                                   RCS6 061
      GKA =  GAM* XKA                                                  RCS6 062
      C1 = 2.0/( GKA * ST)                                             RCS6 063
      ACL = ALOG ( C1 )                                                RCS6 064
      ACLC =  CMPLX ( ACL, PIO2 )                                      RCS6 065
      CS =((0.0, 1.0)/(ACLC*ACLC))*(-AKTH)                             RCS6 066
C                                                                      RCS6 067
C     ** DETERMINATION OF INTEGRAL AND OTHER TERMS USED IN MULTIPLE ** RCS6 068
C        ORDER SCATTERING                                              RCS6 069
C                                                                      RCS6 070
      C5L = ALOG( GKA)                                                 RCS6 071
      C6R = (2.0/XKA)*(XKL/GKA)                                        RCS6 072
      C6RL= ALOG( C6R)                                                 RCS6 073
      CC6RL = CMPLX(C6RL,PIO2)                                         RCS6 074
      EAA = XKL*2.0                                                    RCS6 075
      CALL EXPI ( EAA, EXRA, EXIA, 0 )                                 RCS6 076
      EXWA = CMPLX( EXRA, EXIA)                                        RCS6 077
      E1C= COS( EAA)                                                   RCS6 078
      E1S= SIN( EAA)                                                   RCS6 079
```

```
 747              E1C= COS( EAA)                                                        RCS6 078
 748              E1S= SIN( EAA)                                                        RCS6 079
 749              RC1 = CMPLX (E1C, E1S)                                                RCS6 080
 750              RC9     = CMPLX( E1C, -E1S )                                          RCS6 081
 751              PSIA    = (PIJ - 2.0*C5L) / (CC6RL - EXQA*RC9)                        RCS6 082
 752          C                                                                         RCS6 083
 753              EQPA = XKL*OMCT                                                       RCS6 084
```

```
04/26/76      INPUT LISTING                           AUTOFLOW CHART SET - FWD/SCL  RADSIM

  CARD NO         ****                          CONTENTS                                 ****

 754              CALL EXPI (EQPA, FXR, FXI, 0 )                                        RCS6 085
 755              EXOP= CMPLX( EXR, EXI )                                               RCS6 086
 756              E2C =COS( EQPA)                                                       RCS6 087
 757              E2S =SIN( EQPA)                                                       RCS6 088
 758              EXQPP = CMPLX( E2C,-E2S)                                              RCS6 089
 759              C7P = GKA*GKA*OMCT/2.0                                                RCS6 090
 760              C7PL = ALOG(C7P)                                                      RCS6 091
 761              PSIP = (PIJ - C7PL)/(CC6RL - EXOP*EXOPP)                              RCS6 092
 762          C                                                                         RCS6 093
 763              EQMA = XKL*OPCT                                                       RCS6 094
 764              CALL EXPI ( EQMA, EXRM, EXIM, 0 )                                     RCS6 095
 765              EXQM = CMPLX( EXRM, EXIM)                                             RCS6 096
 766              C2      = COS(EQMA)                                                   RCS6 097
```

```
      PSIP = (PIJ - C7PL)/(CC6RL - EXQP*EXQPP)                        RCS6 092
C                                                                     RCS6 093
      EQMA = XKL*OPCT                                                 RCS6 094
      CALL EXPI ( EQMA, EXRM, EXIM, 0 )                               RCS6 095
      EXQM = CMPLX( EXRM, EXIM)                                       RCS6 096
      Q2      = COS(EQMA)                                             RCS6 097
      Q3      = SIN(EQMA)                                             RCS6 098
      QC1 = CMPLX( Q2, Q3)                                            RCS6 099
      QC9     = CMPLX( Q2, -Q3 )                                      RCS6 100
      C7M = GKA*GKA*OPCT/2.0                                          RCS6 101
      C7ML = ALOG(C7M)                                                RCS6 102
      PSIM    = (PIJ - C7ML) / (CC6RL - EXQM*QC9)                     RCS6 103
C                                                                     RCS6 104
C     * UTILIZATION OF FACTORS IN SCATTERED FIELD EXPRESSION *        RCS6 105
C                                                                     RCS6 106
C     **  FIRST ORDER SCATTERING   **                                 RCS6 107
C                                                                     RCS6 108
      C2 = 1.0 / (GKA * STO2S)                                        RCS6 109
      ACL2 = ALOG (C2)                                                RCS6 110
      ACL2C = CMPLX ( ACL2, PIO2 )                                    RCS6 111
      ST1 = -STO2F * ACL2C                                            RCS6 112
```

```
C                                                         RCS6 113
C      *   RETURN FROM TRAILING EDGE OF WIRE    *         RCS6 114
C                                                         RCS6 115
       A1    = 1.0/(GKA* CTO2S)                           RCS6 116
       A2    = ALOG(A1)                                   RCS6 117
       AC1   = CMPLX( A2,PIO2)                            RCS6 118
       P1 =  2.0*XKL*CT                                   RCS6 119
       P2 = COS(P1)                                       RCS6 120
       P3 = SIN(P1)                                       RCS6 121
       PC1= CMPLX( P2, P3)                                RCS6 122
       AC2 = CMPLX( CTO2F,0.0)                            RCS6 123
       SCD1 = AC1*PC1*AC2                                 RCS6 124
C                                                         RCS6 125
       B1 = 1.0/(GKA*CTO2)                                RCS6 126
       B2 = 2.0*ALOG(B1)                                  RCS6 127
       BC1 = CMPLX( B2,PI)                                RCS6 128
       SCD2 =(-(QC1*AC2*BC1*PSIP))                        RCS6 129
C                                                         RCS6 130
       D1 = 1.0/(GKA*STO2)                                RCS6 131
       D2 = 2.0*ALOG(D1)                                  RCS6 132
       DC1= CMPLX(D2,PI)                                  RCS6 133
       SB4      = CMPLX( STO2F, 0.0)                      RCS6 134
       SCD3 = SB4  *(QC1*DC1*PSIM)                        RCS6 135
C                                                         RCS6 136
       E1 = 1.0/GKA                                       RCS6 137
```

```
805     C                                                   RCS6 136
806           E1 = 1.0/GKA                                  RCS6 137
807           E2 = ALOG( E1)                                RCS6 138
808           EC1= CMPLX( E2,PIO2)                          RCS6 139
809           SCD4 = CT*(RC1*EC1*PSIP*PSIP)                 RCS6 140
810     C                                                   RCS6 141
811           SCD = SCD1 + SCD2 + SCD3 + SCD4               RCS6 142
```



```
CARD NO   ****              CONTENTS                        ****

812     C                                                   RCS6 143
813           FP1 = COS(4.0*XKL)                            RCS6 144
814           FP2 = SIN(4.0*XKL)                            RCS6 145
815           FP3 = COS(2.0*XKL*OPCT)                       RCS6 146
816           FP4 = SIN(2.0*XKL*OPCT)                       RCS6 147
817           FP5 = XKL*(3.0+CT)                            RCS6 148
818           FP6 = COS(FP5)                                RCS6 149
819           FP7 = SIN(FP5)                                RCS6 150
820           FP8  = CMPLX( FP1,FP2)                        RCS6 151
821           FP9  = CMPLX( FP3,FP4)                        RCS6 152
822           FP10 = CMPLX( FP6,FP7)                        RCS6 153
823     C                                                   RCS6 154
824           SF1 = PSIA*PSIA*PSIP*PSIP*FP8                 RCS6 155
825           SF2 = PSIM*PSIM*FP9                           RCS6 156
```

```
      FP1 = COS(4.0*XKL)                                        RCS6 144
      FP2 = SIN(4.0*XKL)                                        RCS6 145
      FP3 = COS(2.0*XKL*OPCT)                                   RCS6 146
      FP4 = SIN(2.0*XKL*OPCT)                                   RCS6 147
      FP5 = XKL*(3.0+CT)                                        RCS6 148
      FP6 = COS(FP5)                                            RCS6 149
      FP7 = SIN(FP5)                                            RCS6 150
      FP8  = CMPLX( FP1,FP2)                                    RCS6 151
      FP9  = CMPLX( FP3,FP4)                                    RCS6 152
      FP10 = CMPLX( FP6,FP7)                                    RCS6 153
C                                                               RCS6 154
      SF1 = PSIA*PSIA*PSIP*PSIP*FP8                             RCS6 155
      SF2 = PSIM*PSIM*FP9                                       RCS6 156
      SF3 = -2.0*PSIP*PSIM*PSIA*FP10                            RCS6 157
      SF = (SF1+SF2+SF3)*CT*EC1                                 RCS6 158
C                                                               RCS6 159
      D =1.0-(PSIA*PSIA)* RC1                                   RCS6 160
      AD =CABS(D)                                               RCS6 161
      IF (AD .LE. 1.0E-6 ) GO TO 213                            RCS6 162
      SSS =  SF/D                                               RCS6 163
      GO TO 221                                                 RCS6 164
  213 WRITE (6, 2005)                                           RCS6 165
 2005 FORMAT ('0 DENOMINATOR IS ZERO , PSIA IS TOO LARGE')      RCS6 166
      GO TO 999                                                 RCS6 169
C                                                               RCS6 170
C     * BACKSCATTERED FIELD   *                                 RCS6 171
C                                                               RCS6 172
```

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3

```
  221 ESC = (ST1 + SCD + SSS)* CS                                       RCS6 173
      CK1 = (4.0* PI)/(XK*XK)                                           RCS6 174
      CK2 = SQRT(CK1)*0.02540                                           RCS6 175
C                                                                       RCS6 176
C     **  EBSC = SQRT(SIGMA) WITH PHASE REFERENCED TO FRONT  **         RCS6 177
C      *               EDGE   OF   WIRE                      *          RCS6 178
      EBSC =(ESC* CK2)                                                  RCS6 179
      ETTR(IFW)= REAL(EBSC)                                             RCS6 180
       XR(IFW) = ETTR(IFW)
      ETTI(IFW)=-AIMAG(EBSC)                                            RCS6 181
       XI(IFW) = ETTI(IFW)
  800 CONTINUE                                                          RCS6 182
C                                                                       RCS6 183
      IF (KP .NE. 1)  GO TO 900                                         RCS6 184
      DO 777  L = NMIN, NMAX                                            RCS6 185
      SIGMA(L)  = 10.0 * ALOG10(ETTR(L)*ETTR(L) + ETTI(L)*ETTI(L))      RCS6 186
  777 CONTINUE                                                          RCS6 187
C     WRITE(6,3000) (FRQ(J), SIGMA(J), J = NMIN, NMAX)                  RCS6 188
C3000 FORMAT ( '1FREQUENCY RESPONSE OF A THIN WIRE ',//,  ' FREQUENCY    RCS6 189
C    1   CROSS SECTION     ', //, (F12.4,  E15.4) )                     RCS6 190
  900 CONTINUE                                                          RCS6 191
  999 CONTINUE                                                          RCS6 192
      RETURN                                                            RCS6 193
      END                                                               RCS6 194
```

```
864          SUBROUTINE EXPI ( ARGZ, EIXR, EIXI, KP)                          RCS6 195
865     C                                                                     RCS6 196
866     C   * THIS SUBROUTINE COMPUTES THE REAL AND IMAGINARY PARTS OF THE    RCS6 197
867     C   *      EXPONENTIAL INTEGRAL E(X) WHERE                            RCS6 198
868     C   *      E(X) =  INTEGRAL FROM X TO INFINITY OF EXP(IT)/T*DT        RCS6 199
869     C   * REFERENCE - FUNCTIONS OF MATHEMATICAL PHYSICS BY MAGNUS AND     RCS6 200
```



```
CARD NO      ****                       CONTENTS                               ****

870     C   *          OBERHETTINGER, PP.97-98                               RCS6 201
871     C     KP .NE. 0, PRINT OUT REAL AND IMAGINARY PARTS OF EXPONENTIAL    RCS6 202
872     C              INTEGRAL                                               RCS6 203
873           COMPLEX  AIX,      ANTG( 100),        EIX,     FA,       F      RCS6 204
874           REAL  AINTR(100), AINTI(100)                                    RCS6 205
875     C                                                                     RCS6 206
876           DEL = 0.000001                                                  RCS6 207
877           GAMMA = 0.57721566                                              RCS6 208
878           IF ( ARGZ .LE. 1.0E-6) GO TO 50                                 RCS6 209
879           ABZ = ABS(ARGZ)                                                 RCS6 210
880           DO 5  I=1,100                                                   RCS6 211
```

```
C     KP .NE. 0, PRINT OUT REAL AND IMAGINARY PARTS OF EXPONENTIAL      RCS6 202
C                INTEGRAL                                               RCS6 203
      COMPLEX  AIX,      ANTG( 100),          EIX,      FA,        F    RCS6 204
      REAL  AINTR(100), AINTI(100)                                      RCS6 205
C                                                                       RCS6 206
      DEL = 0.000001                                                    RCS6 207
      GAMMA = 0.57721566                                                RCS6 208
      IF ( ARGZ .LE. 1.0E-6) GO TO 50                                   RCS6 209
      ABZ = ABS(ARGZ)                                                   RCS6 210
      DO 5  I=1,100                                                     RCS6 211
      AINTR(I)= 0.0                                                     RCS6 212
      AINTI(I)= 0.0                                                     RCS6 213
      ANTG(I) = CMPLX(0.0,0.0)                                          RCS6 214
    5 CONTINUE                                                          RCS6 215
      IF (  ABZ .GE. 15) GO TO 9                                        RCS6 216
C                                                                       RCS6 217
C     THIS SERIES USED FOR  0.LT.ABS(X).LT.15                           RCS6 218
C     **  SERIES EXPANSION INVOLVING CI(X) AND SI(X)   **               RCS6 219
C                                                                       RCS6 220
C     E(Z) =   GAM    + LN(Z) +SUM(((-1)**N)*Z**(2*N))/((2*N)*FACT(2*N))  RCS6 221
C            +J*(     *SUM(((-1)**N)*Z**(2*N+1))/((2*N+1)*FACT(2*N+1))-  RCS6 222
C          PIO2 )                                                       RCS6 223
C                                                                       RCS6 224
      INC =1                                                            RCS6 225
      FAC = -(ARGZ**2)/(2.0)                                            RCS6 226
      AINTR(1) =  FAC * 0.5                                             RCS6 227
      AINTI(1) = FAC*(ARGZ/4.0) + ARGZ                                  RCS6 228
```

2

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L-69e

```
C                                                      RCS6 229
   10 INC = INC + 1                                    RCS6 230
      X2 =(2* INC)                                     RCS6 231
      X2M = X2 -1.0                                    RCS6 232
      X2P1S = (2*INC + 1 )**2                          RCS6 233
      FAC = -(FAC*ARGZ*ARGZ)/(X2M*X2)                  RCS6 234
      FAC = -(FAC*ARGZ*ARGZ)/(X2M*X2)                  RCS6 234
      AINTR(INC) = FAC/X2 + AINTR(INC-1)               RCS6 235
      AINTI(INC) = FAC*(ARGZ/X2P1S) +AINTI(INC-1)      RCS6 236
CC                                                     RCS6 237
      ABR  = ABS( AINTR(INC))                          RCS6 238
      ABRM1= ABS( AINTR(INC-1))                        RCS6 239
      ABI  = ABS( AINTI(INC)  )                        RCS6 240
      ABIM1= ABS( AINTI(INC-1))                        RCS6 241
      IF ( ABS( ABR - ABRM1) .GE. DEL) GO TO 20        RCS6 242
      IF ( ABS( ABI - ABIM1) .LE. DEL) GO TO 40        RCS6 243
   20 CONTINUE                                         RCS6 244
C                                                      RCS6 245
      IF ( INC .LT. 100 ) GO TO 10                     RCS6 246
      WRITE (6, 1000)                                  RCS6 247
 1000 FORMAT( '0SERIES DID NOT CONVERGE ' )            RCS6 248
      NI = INC                                         RCS6 249
      GO TO 60                                         RCS6 250
   40 NI= INC                                          RCS6 251
   60 CONTINUE                                         RCS6 252
      FIXR = AINTR(NI) + ALOG(ARG3) + GAMMA            RCS6 253
```

```
   40 NI= INC                                                          RCS6 251
   60 CONTINUE                                                         RCS6 252
      EIXR = AINTR(NI) + ALOG(ARGZ) + GAMMA                            RCS6 253
      EIXI = AINTI(NI) - 1.5707963                                     RCS6 254
      GO TO 75                                                         RCS6 255
CC                                                                     RCS6 256
C     **  ASYMPTOTIC SERIES EXPANSION FOR INT FROM INF TO X OF  **     RCS6 257
C         (EXP(-JT)/T)*DT                                              RCS6 258
C                                                                      RCS6 259
    9 CONTINUE                                                         RCS6 260
      IF (  ABZ .GE. 150) GO TO 99                                     RCS6 261
C     SERIES EXPANSION USED WHEN 15.LE.ABS(X).LT.150                   RCS6 262
C   * E(X) = EXP(IX)*(1/IX + 1/(IX)**2 + 2FACT/(IX)**3+....)           RCS6 263
C                                                                      RCS6 264
      AIX =  CMPLX(0.0,ARGZ )                                          RCS6 265
      FA = 1.0/AIX                                                     RCS6 266
      ANTG(1) = FA                                                     RCS6 267
      F   = FA*FA                                                      RCS6 268
      ANTG(2) = F      + ANTG(1)                                       RCS6 269
      INC = 2                                                          RCS6 270
C                                                                      RCS6 271
  110 INC = INC + 1                                                    RCS6 272
      XF = INC-1                                                       RCS6 273
      F = F*XF*FA                                                      RCS6 274
      ANTG(INC) = F + ANTG(INC-1)                                      RCS6 275
      AB =  CABS (ANTG(INC))                                           RCS6 276
      ABM1 =CABS (ANTG(INC-1))                                         RCS6 277
      IF ( ABS(AB - ABM1) .LT. DEL) GO TO150                           RCS6 278
```

```
      IF (  ABZ .GE. 150) GO TO 99                                      RCS6 261
C     SERIES EXPANSION USED WHEN 15.LE.ABS(X).LT.150                    RCS6 262
C   * E(X) = EXP(IX)*(1/IX + 1/(IX)**2 + 2FACT/(IX)**3+....)            RCS6 263
C                                                                       RCS6 264
      AIX =  CMPLX(0.0,ARGZ )                                           RCS6 265
      FA = 1.0/AIX                                                      RCS6 266
      ANTG(1) = FA                                                      RCS6 267
      F   = FA*FA                                                       RCS6 268
      ANTG(2) = F      + ANTG(1)                                        RCS6 269
      INC = 2                                                           RCS6 270
C                                                                       RCS6 271
  110 INC = INC + 1                                                     RCS6 272
      XF = INC-1                                                        RCS6 273
      F = F*XF*FA                                                       RCS6 274
      ANTG(INC) = F + ANTG(INC-1)                                       RCS6 275
      AB =  CABS (ANTG(INC))                                            RCS6 276
      ABM1 =CABS (ANTG(INC-1))                                          RCS6 277
      IF ( ABS(AB - ABM1) .LT. DEL) GO TO150                            RCS6 278
      IF ( INC .LE. 29) GO TO110                                        RCS6 279
C                                                                       RCS6 280
      WRITE ( 6, 1001 )                                                 RCS6 281
 1001 FORMAT ( ' SERIES DID NOT CONVERGE ')                             RCS6 282
      NN =  15                                                          RCS6 283
      GO TO 70                                                          RCS6 284
  150 NN = INC                                                          RCS6 285
   70 CONTINUE                                                          RCS6 286
```

```
C                                                                       RCS6 287
      EIX = ANTG( NN )*CEXP(AIX)                                        RCS6 288
      EIXR = REAL(EIX)                                                  RCS6 289
      EIXI = AIMAG(EIX)                                                 RCS6 290
      GO TO 75                                                          RCS6 291
C                                                                       RCS6 292
C     FUNCTION SET TO ZERO IF ARGUMENT ABS(X).GE.150                    RCS6 293
   99 EIXR = 0.0                                                        RCS6 294
      EIXI = 0.0                                                        RCS6 295
   75 CONTINUE                                                          RCS6 296
C                                                                       RCS6 297
C     IF ( KP .EQ. 0) GO TO 90                                          RCS6 298
C     WRITE (6,2000) EIXR, EIXI                                         RCS6 299
C2000 FORMAT ( '0REAL PART OF E(X)= ',E15.5,//,' IMAGINARY PART OF E(X) RCS6 300
C    A= ', E15.5 )                                                      RCS6 301
      GO TO 90                                                          RCS6 302
   50 CONTINUE                                                          RCS6 303
      WRITE (6, 3000)                                                   RCS6 304
 3000 FORMAT ('0ARGZ DID NOT TRANSFER INTO SUBROUTINE OR IS ZERO' )     RCS6 305
   90 CONTINUE                                                          RCS6 306
      RETURN                                                            RCS6 307
      END                                                               RCS6 308
```

L.5 FRUSTRUM - CYLINDER - FRUSTRUM

The far-field scattering from a frustrum-cylinder-frustrum target configuration shown in Figure L.5-1 has been formulated using the Ruck-Ufimtsev technique (Ref. 6).

The expressions of the target frequency response are the following:

$$e(\theta)_{\left\{\substack{V\\H}\right\}} = \mp \sqrt{\pi}\Big\{g(1) + g(2) + g(3) + g(4) + g(5) + g(6) + g(7) + g(8)\Big\}$$

where (1) the g(m) are the sum of the scattering due to the uniform and non-uniform current associated with edge m

(2) The upper and lower signs correspond to vertical and horizontal polarization, respectively,

(3) e^{-iwt} harmonic time variation is assumed, and

(4) the scattering geometry is presented in Figure 5-1

For $0 < \theta < \pi/2$,

$$g(1) = a_1 e^{ip_1}\Big\{JJ_{11} - \Big[C(n_1) \mp B(n_1, \pi/2+\theta) \pm 0.5\tan(\alpha_1+\theta)F_1\Big] - C(n_1)\, JJ_{21}\Big\}$$

$$g(2) = a_2 e^{ip_2}\Big\{JJ_{12} - \Big[C(n_2) \mp B(n_2, \alpha_1+\theta) \mp 0.5\tan(\alpha_1+\theta)F_2\Big] - C(n_2)\, JJ_{22}\Big\}$$

$$g(3) = a_2 e^{ip_3}\Big\{JJ_{12} - \Big[C(n_3) \mp B(n_3, \theta) \pm 0.5\tan(\alpha_2+\theta)F_3\Big] - C(n_3)\, JJ_{22}\Big\}$$

$$g(4) = a_4 e^{ip_4}\Big\{JJ_{14} - \Big[C(n_4) \mp B(n_4, \alpha_2+\theta) \mp 0.5\tan(\alpha_2+\theta)F_4\Big] - C(n_4)\, JJ_{24}\Big\}$$

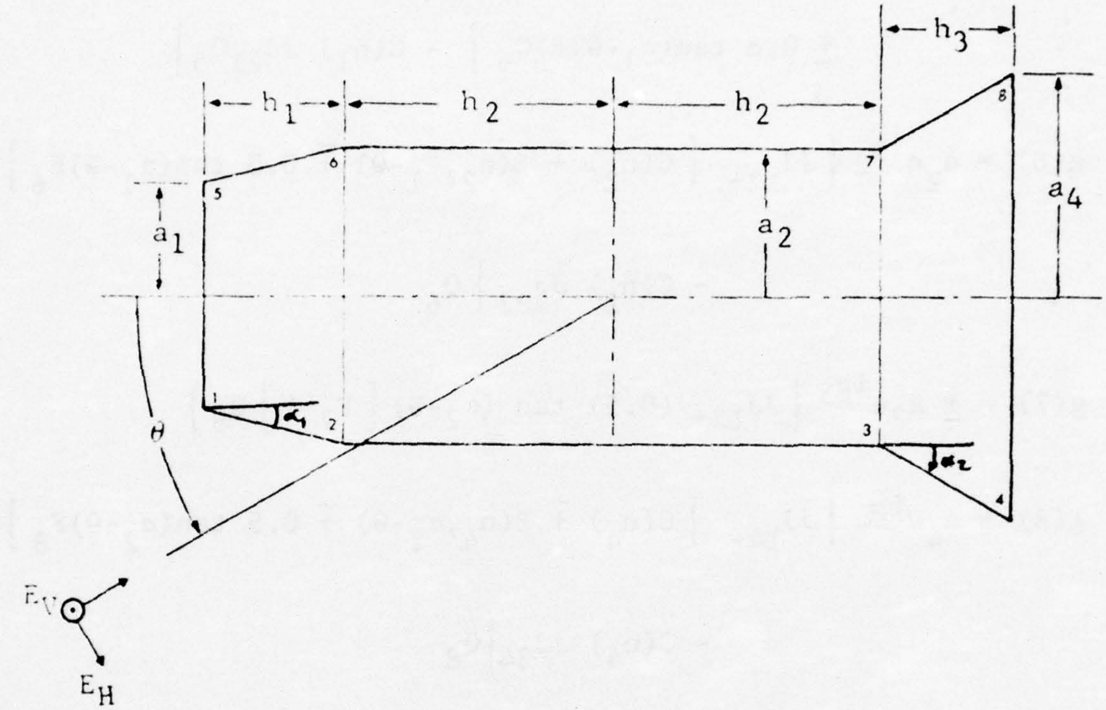

Fig. L.5-1 GEOMETRY OF FRUSTRUM-CYLINDER-FRUSTRUM

$$g(5) = a_1 e^{ip_1} \Big\{ JJ_{11+} \Big[C(n_1)Q_5 \mp B(n_1, \pi/2-\theta)Q_5$$

$$\pm 0.5 \tan(\alpha_1-\theta)F_5 Q_6 \Big] - C(n_1)\ JJ_{21}Q_5 \Big\}$$

$$g(6) = a_2 e^{ip_2} \Big\{ JJ_{12+} \Big[C(n_2) \mp B(n_2, \alpha_1-\theta) \mp 0.5 \tan(\alpha_1-\theta)F_6 \Big]$$

$$- C(n_2)\ JJ_{22} \Big\} Q_6$$

$$g(7) = \pm a_2 e^{ip_3} \Big\{ JJ_{12+} (0.5) \tan (\alpha_2-\theta) \Big[F_7-1 \Big] Q_8 \Big\}$$

$$g(8) = a_4 e^{ip_4} \Big\{ JJ_{14+} \Big[C(n_4) \mp B(n_4, \alpha_2-\theta) \mp 0.5 \tan(\alpha_2-\theta)F_8 \Big]$$

$$- C(n_4)\ JJ_{24} \Big\} Q_8$$

For $\pi/2 \quad \theta$

$$g(1) = a_1 e^{ip_1} \Big\{ JJ_{11-} \Big[C(n_1) \mp B(n_1, \pi-\theta-\alpha_1) \pm 0.5 \tan(\alpha_1+\theta)F_1 \Big]$$

$$- C(n_1)\ JJ_{21} \Big\} Q_1$$

$$g(2) = a_2 e^{ip_2} \Big\{ JJ_{12-} \Big[C(n_2)\ Q_2 \mp B(n_2, \pi-\theta)Q_2 \mp 0.5 \tan(\alpha_1+\theta)F_2 Q_1 \Big]$$

$$\mp 0.5 \tan\theta(Q_2-Q_3) - C(n_2)\ JJ_{22}Q_2 \Big\}$$

$$g(3) = a_2 e^{ip_3} \left\{ JJ_{12-} \left[C(n_3) \mp B(n_3, \pi - a_2 - \theta) \pm 0.5 \tan (a_2 + \theta) F_3 \right] \right.$$

$$\left. - C(n_3) JJ_{22} \right\} Q_3$$

$$g(4) = a_2 e^{ip_4} \left\{ JJ_{14-} \left[C(n_4) \mp B(n_4, \frac{3\pi}{2} - \theta) \mp 0.5 \tan (a_2 + \theta) F_4 Q_3 \right] \right.$$

$$\left. - C(n_4) JJ_{24} \right\}$$

$$g(8) = a_4 e^{ip_4} \left\{ JJ_{14+} \left[C(n_4) \mp B(n_4, \theta - \pi/2) \right] - C(n_4) JJ_{24} \right\}$$

$$g(5) = g(6) = g(7) = 0$$

where the upper and lower signs in the previous expressions correspond to vertical and horizontal polarization, respectively, and

$$C(n) = \frac{\sin \frac{\pi}{n}}{n} \quad \frac{1}{\cos \pi/n - 1}$$

$$B(n, \psi) = \frac{\sin \pi/n}{n} \quad \frac{1}{\cos \pi/n - \cos \frac{2\psi}{n}}$$

$$JJ_{1m\mp} = \left[J_o(2ka_m \sin\ ) \mp i\ J_1(2ka_m \sin\ ) \right]$$

$$JJ_{2m} = \left[J_o(2ka_m \sin\ ) + J_2(2ka_m \sin\ ) \right]$$

$$n_1 = 1.5 - \frac{a_1}{\pi}$$

$$n_2 = 1 + \frac{a_1}{\pi}$$

$$n_3 = 1 - \frac{a_2}{\pi}$$

$$n_4 = 1.5 + \frac{\alpha_2}{\pi}$$

$$p_1 = -2k(h_1 + h_2)\cos\theta$$

$$p_2 = -2k\ h_2 \cos\theta$$

$$p_3 = 2k\ h_2 \cos\theta$$

$$p_4 = 2k(h_2 + h_3)\cos\theta$$

$$Q_5 = Q(2ka_1(\pi/2-\theta))$$

$$Q_{\binom{6}{8}} = Q(2ka_{\binom{2}{4}}(\alpha_{\binom{1}{3}} - \theta))$$

$$Q_{\begin{pmatrix}1\\2\\3\end{pmatrix}} = Q(2ka_{\begin{pmatrix}1\\2\\2\end{pmatrix}}(\pi - \alpha_{\begin{pmatrix}1\\3\\2\end{pmatrix}} - \theta))$$

$$\tau^2{}_1 = 2ka_1 \csc{}_1 \cos(\alpha_1+\theta)$$

$$\tau^2{}_{\binom{3}{4}} = 2ka_{\binom{2}{4}} \csc{}_2 \cos(\alpha_2+\theta)$$

$$\tau^2{}_{\binom{5}{6}} = 2ka_{\binom{1}{2}} \csc{}_1 \cos(\alpha_1-\theta)$$

$$\tau^2{}_{\binom{7}{8}} = 2ka_{\binom{2}{4}} \csc{}_2 \cos(\alpha_2-\theta)$$

$$\alpha_1 = \tan^{-1} \frac{a_2-a_1}{h_1}$$

$$\alpha_2 = \tan^{-1} \frac{a_4-a_2}{h_3}$$

$$\alpha_3 = \tan^{-1} \frac{a_4 - a_2}{2h_2 + h_3}$$

$$F_m = F(\tau_m) = \frac{e^{-i\tau_m^2}}{\tau_m} \int_0^{\tau_m} e^{it^2} dt$$

$k = 2\pi/\lambda$ = wave number.

The preceeding equation can be used in computing the first-order scattering from the target; however, it does not include the effects of multiple reflection or diffraction. The cylindrical surface between edges 2 and 3 is partially shadowed for the case of aspect angles between 150 degrees and 170 degrees, but the magnitude of this surface reflection is small; therefore, this return is formulated using the physical boundaries of the cylindrical surface and the screening functions rather than the illuminated portion of the surface. The screening functions were also used in describing the effects of shadowing upon the returns from the target edges.

L.5.1 Inputs

The subroutine inputs are read from cards or passed in a common block. The parameters passed in the common block include:

NMIN = minimum frequency number

NMAX = maximum frequency number

DF = frequency increment (in MHz)

FC = carrier frequency (in GHz)

The card inputs are the following:

	MATH SYMBOL	VARIABLE	DEFINITION	COLUMNS
Card 1	θ	Aspect	Azimuth angle (degrees)	1-7
	a_1	A1	Smallest frustrum radius (inches)	8-14

MATH SYMBOL	VARIABLE	DEFINITION	COLUMNS
a_2	A2	Radius of cylinder (inches)	15-21
a_4	A4	Largest frustrum radius (inches)	22-28
h_1	H1	Length of first frustrum (inches)	29-35
h_2	H2	Half-length of cylinder (inches)	36-42
h_3	H3	Length of second frustrum (inches)	43-49

L.5.2 Outputs

The data base output consists of four linear arrays, EVVR, EVVI, EHHR, EHHI, which contain the real and imaginary parts of the vertically and horizontally polarized back-scattered fields (in meters) at frequency increments spaced DF MHz from NMIN*DF to NMAX*DF.

L.5.3 Restrictions

L.5.3.1 Physical Dimensions

All target dimensions should be large with respect to the wavelength of the illuminating field. In addition, the target dimensions should be selected such that the angles 1 and 2, of the frustra retain the basic target shape, i.e. the target does not degenerate into a cylinder. A restriction on these angles is the following:

$$15^o < \alpha_1 < 60^o$$

$$20^o < \alpha_2 < 60^o.$$

L.5.3.2 Output

The output arrays are passed in the argument list and a value is computed and stored only in locations NMIN to NMAX.

L.5.3.3 Azimuth

The azimuth angle is restricted to the region between 0 and 180 degrees. In addition the specular azimuths of 0, 90, 180, $(90 - \alpha_1)$, and $(90 - \alpha_2)$ degrees should not be used. In order to compute the response at these angles, an angular offset of approximately 0.01 degrees should be used.

L.5.4 Definitions of Selected Terms Used in Subroutines

$$\text{COFFNI} = C(n) = \frac{\sin \frac{\pi}{n}}{n} \; \frac{1}{\cos \pi/n - 1}$$

where $n = n_1 = 1.5 - \frac{\alpha_1}{\pi}$

$$\text{COEF11} = \frac{1}{\cos \pi/n - \cos \frac{2\psi}{n}}$$

where $\psi = \pi/2+\theta$ For $\theta < \pi/2$

$$\text{COEF1}\,{}^{V}_{H} = C(n_1) \mp B(n_1, \pi/2+\theta) \quad \text{For } \theta < \pi/2$$

$$\text{COEF1}\,{}^{V}_{H} = C(n_1) \mp B(n_1, \pi-\theta-\alpha_1) \quad \text{For } \theta < \pi/2$$

$$\text{PHASE 1} = e^{ip_1}$$

where $p_1 = -2k(h_1 + h_2) \cos\theta$

$$\text{FF}\,{}^{VV}_{HH}\,02 = a_2 e^{ip_2} \left\{ JJ_{12-} \left[C(n_2) \mp B(n_2, \alpha_1+\theta) \right] \right\} \text{For } \theta < \pi/2$$

$$FF\,{}^{VV}_{HH}\,09 = \mp 0.5 \tan(\alpha_1+\theta) F_2\ a_2 e^{ip_2} \left\{ JJ_{12-} \right\} \quad \text{For } \theta < \pi/2$$

$$FFVV17 = -\,C(n_2)\ JJ_{22}\ a_2 e^{ip_2} \quad \text{For } \theta < \pi/2$$

$$TERMIP = JJ_{1m\mp} = \left[J_o(2ka_m \sin\ ) \mp i\, J_1(2ka_m \sin\ ) \right] \quad \text{For } \theta < \pi/2$$

where m = 1 and the + (lower) sign is used.

L.5.5 Subroutines Used

Subfunctions:

1. Q(X) computes the exponential smoothing function
2. F(TAUS) computes the special F function

Subroutines:

BESL(SI1, XJ0, XJ1, XJ2) computes and returns

J_0(SI1) in XJ0

J_1(SI1) in XJ1

J_2(SI1) in XJ2

```
      SUBROUTINE TARGET (EVVR, EVVI, EHHR, EHHI)
C
C * * *          ST-3A -- FRUSTRA-CYLINDER-FRUSTRA (UFIMTSEV)          * * *
C
      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, T0
C     NMIN = MINIMUM FREQUENCY SAMPLE
C     NMAX = MAXIMUM FREQUENCY SAMPLE
C     DF   = FREQUENCY INCREMENT IN MHZ
C     FC   = CARRIER FREQUENCY IN GHZ
C
      COMPLEX TERM1P, TERM1M, TERM2P, TERM2M, TERM4P, TERM4M, PHASE1,
     1 PHASE2,PHASE3, PHASE4, FFVV01, FFVV02, FFVV03, FFVV04, FFVV05,
     2 FFVV06,FFVV07, FFVV08, FFVV09, FFVV10, FFVV11, FFVV12, FFVV13,
     3 FFVV14,FFVV15, FFVV16, FFVV17, FFVV18, FFVV19, FFVV20, FFVV21,
     4 FFVV22,FFHH01, FFHH02, FFHH03, FFHH04, FFHH05, FFHH06, FFHH07,
     5 FFHH08,FFHH09, FFHH10, FFHH11, FFHH12, FFHH13, FFHH14, FFHH15,
     6 FFHH16,FFHH17, FFHH18, FFHH19, FFHH20, FFHH21, FFHH22, FFVV,
     7 FFHH,  CFVV,   CFHH,   FTAU1,  FTAU2,  FTAU3,  FTAU4,  FTAU5,
     8 FTAU6, FTAU7,  FTAU8
      COMPLEX F
C
      DIMENSION EVVR(512), EVVI(512), EHHR(512), EHHI(512)
C
C * * * ALL DIMENSIONS ARE IN INCHES AND ALL ANGLES ARE IN DEGREES   * *
C
      READ(5,1000) ASPECT,A1,A2,A4,H1,H2,H3,H4,H5,M1
 1000 FORMAT(9F7.2,I2)
      WRITE (6,1010) A1,H1,A2,H2,A4,H3
 1010 FORMAT ( 31H1 ' FRUSTRA-CYLINDER-FRUSTRA  ',/
     1           30H ' UFIMTSEV-RUCK FORMULATION ',/
     2            8H   A1 = ,F8.3, 8H   H1 = ,F8.3,/
     3            8H   A2 = ,F8.3, 8H   H2 = ,F8.3,/
     4            8H   A4 = ,F8.3, 8H   H3 = ,F8.3,/)
C
       C      = 11.80285078
       PI     = 3.14159265358979
       SPI = SQRT(PI)
       DTR    = PI / 180.0
       RTD = 180.0/PI
       WC     = 2.0 * PI * FC
       XK00 = WC/C
       X2K0 = XK00+XK00
       X2K0A1 = X2K0*A1
       X2K0A2 = X2K0*A2
       X2K0A4 = X2K0*A4
C
       THETA  = ASPECT * DTR
       STHT   = SIN(THETA)
       CTHT   = COS(THETA)
       TANATT = STHT / CTHT
C
       SHADOW = (A4 - A2) / (H2 + H2 + H3)
       SHADOW = ATAN(SHADOW)
       ALPHA1 = ATAN((A2-A1)/H1)
       ALPHA2 = ATAN((A4-A2)/H3)
       X1D = ALPHA1*RTD
```

```
      X2D = ALPHA2*RTD
      X3D = SHADOW*RTD
      WRITE (6,2010) ASPECT,X1D,X2D,X3D
 2010 FORMAT ( 18H0  ASPECT ANGLE = , F8.3,/,
     1             11H  ALPHA1 = ,F8.3,/, 11H  ALPHA2 = ,F8.3,/,
     2             19H  SHADOW(ALPHA3) = ,F8.3 )
C
      SA1 = SIN(ALPHA1)
      SA2 = SIN(ALPHA2)
      A1PT = ALPHA1+THETA
      A1MT = ALPHA1-THETA
      A2PT = ALPHA2+THETA
      A2MT = ALPHA2-THETA
      TANAP1 = TAN(A1PT)
      TANAP2 = TAN(A2PT)
      CA1PTS = 2.*COS(A1PT)/SA1
      CA2PTS = 2.*COS(A2PT)/SA2
C
      XN1    = 1.5 - (ALPHA1 / PI)
      XN2    = 1.0 + (ALPHA1 / PI)
      XN3    = 1.0 - (ALPHA2 / PI)
      XN4    = 1.5 + (ALPHA2 / PI)
      CPON1 = COS(PI/XN1)
      CPON2 = COS(PI/XN2)
      CPON3 = COS(PI/XN3)
      CPON4 = COS(PI/XN4)
      TERM01 = (SIN(PI / XN1)) / XN1
      TERM02 = (SIN(PI / XN2)) / XN2
      TERM03 = (SIN(PI / XN3)) / XN3
      TERM04 = (SIN(PI / XN4)) / XN4
C     COEFNX ARE C(NX) TERMS
      COEFN1= TERM01/(CPON1 - 1.)
      COEFN2= TERM02/(CPON2 - 1.)
      COEFN3= TERM03/(CPON3 - 1.)
      COEFN4= TERM04/(CPON4 - 1.)
C
      IF (ASPECT .GT. 90.0) GO TO 10
C
C     DIFFRACTION TERMS ( C(N)-/+B(N,PHI) = COEFXX TERMS
C           COMPUTED HERE FOR THETA LT. 90
      COEF11 = 1.0 / ( CPON1 - COS((THETA+THETA+PI)/XN1))
      COEF12 = 1.0 / ( CPON2 - COS((A1PT + A1PT)    /XN2))
      COEF13 = 1.0 / ( CPON3 - COS((THETA + THETA) /XN3))
      COEF14 = 1.0 / ( CPON4 - COS((A2PT + A2PT)    /XN4))
      COEF21 = 1.0 / ( CPON1 - COS((THETA+THETA-PI)/XN1))
      COEF22 = 1.0 / ( CPON2 - COS((A1MT + A1MT)    /XN2))
      COEF24 = 1.0 / ( CPON4 - COS((A2MT + A2MT)    /XN4))
C
      COEF1V = COEFN1 - COEF11 * TERM01
      COEF1H = COEFN1 + COEF11 * TERM01
      COEF2V = COEFN2 - COEF12 * TERM02
      COEF2H = COEFN2 + COEF12 * TERM02
      COEF3V = COEFN3 - COEF13 * TERM03
      COEF3H = COEFN3 + COEF13 * TERM03
      COEF4V = COEFN4 - COEF14 * TERM04
      COEF4H = COEFN4 + COEF14 * TERM04
      COEF5V = COEFN1 - COEF21 * TERM01
      COEF5H = COEFN1 + COEF21 * TERM01
```

```
      COEF6V = COEFN2 - COEF22 * TERM02
      COEF6H = COEFN2 + COEF22 * TERM02
      COEF7V = COEFN4 - COEF24 * TERM04
      COEF7H = COEFN4 + COEF24 * TERM04
C
      TANAM1 = TAN(A1MT)
      TANAM2 = TAN(A2MT)
      CA1MTS = 2.*COS(A1MT)/SA1
      CA2MTS = 2.*COS(A2MT)/SA2
      Q6=Q(X2K0A2 * A1MT                    )
      Q8=Q(X2K0A4 * (SHADOW - THETA)        )
      GO TO 20
C
C     DIFFRACTION TERMS ( C(N)-/+B(N,PHI) = COEFXX TERMS
C          COMPUTED HERE FOR THETA GT  90
   10 COEF31    = 1.0 / (CPON1 - COS(2.0*(PI-A1PT)/XN1))
      COEF32    = 1.0 / (CPON2 - COS(2.0*(PI-THETA)/XN2))
      COEF33    = 1.0 / (CPON3 - COS(2.0*(PI-A2PT)/XN3))
      COEF34    = 1.0 / (CPON4 - COS((2.0*THETA - 3.0*PI)/XN4))
      COEF44    = 1.0 / (CPON4 - COS((2.0*THETA -    PI   )/XN4))
C
      COEF1V = COEFN1 - COEF31 * TERM01
      COEF1H = COEFN1 + COEF31 * TERM01
      COEF2V = COEFN2 - COEF32 * TERM02
      COEF2H = COEFN2 + COEF32 * TERM02
      COEF3V = COEFN3 - COEF33 * TERM03
      COEF3H = COEFN3 + COEF33 * TERM03
      COEF4V = COEFN4 - COEF34 * TERM04
      COEF4H = COEFN4 + COEF34 * TERM04
      COEF5V = COEFN4 - COEF44 * TERM04
      COEF5H = COEFN4 + COEF44 * TERM04
C
      Q1=Q(X2K0A1 * (PI-A1PT)               )
      Q2=Q(X2K0A2 * (PI - SHADOW - THETA))
      Q3=Q(X2K0A2 * (PI-A2PT)               )
   20 CONTINUE
C
      DO 900 I = NMIN, NMAX
      XI       = I - 1
      W        = (2. * PI * XI * DF) / 1000.0
      XK0      = W / C
      XK02C     = XK0 * (CTHT + CTHT)
C
      TAU1      = XK0 * A1 * CA1PTS
      TAU2      = XK0 * A2 * CA1PTS
      TAU3      = XK0 * A2 * CA2PTS
      TAU4      =XK0 * A4 * CA2PTS
      FTAU1   = F      (TAU1)
      FTAU2   = F      (TAU2)
      FTAU3   = F      (TAU3)
      FTAU4   = F      (TAU4)
C
      SI1      = 2.0 * XK0 * A1 * STHT
      SI2      = 2.0 * XK0 * A2 * STHT
      SI4      = 2.0 * XK0 * A4 * STHT
      CALL BESL  (SI1, XJ0X1, XJ1X1, XJ2X1)
      CALL BESL  (SI2, XJ0X2, XJ1X2, XJ2X2)
      CALL BESL  (SI4, XJ0X4, XJ1X4, XJ2X4)
```

```
      TERM1P = CMPLX(XJ0X1, XJ1X1)
      TERM1M = CONJG(TERM1P)
      TERM2P = CMPLX(XJ0X2, XJ1X2)
      TERM2M = CONJG(TERM2P)
      TERM4P = CMPLX(XJ0X4, XJ1X4)
      TERM4M = CONJG(TERM4P)
      TERM5  = XJ0X1 + XJ2X1
      TERM6  = XJ0X2 + XJ2X2
      TERM7  = XJ0X4 + XJ2X4
C
      PHI1     = XK02C * (H1+H2)
      PHI2     = XK02C * (H2)
      PHI3     = PHI2
      PHI4     = XK02C * (H2+H3)
      PHASE1 = CMPLX(COS(PHI1),-SIN(PHI1))
      PHASE2 = CMPLX(COS(PHI2),-SIN(PHI2))
      PHASE3 = CMPLX(COS(PHI3), SIN(PHI3))
      PHASE4 = CMPLX(COS(PHI4), SIN(PHI4))
C
      IF (ASPECT .GT. 90.0) GO TO 30
C
      TAU5     = XK0 * A1 * CA1MTS
      TAU6     = XK0 * A2 * CA1MTS
      TAU7     = XK0 * A2 * CA2MTS
      TAU8     = XK0 * A4 * CA2MTS
      FTAU5  = F      (TAU5)
      FTAU6  = F      (TAU6)
      FTAU7  = F      (TAU7)
      FTAU8  = F      (TAU8)
C
      FFVV01 = A1 * TERM1M * COEF1V * PHASE1
      FFHH01 = A1 * TERM1M * COEF1H * PHASE1
      FFVV02 = A2 * TERM2M * COEF2V * PHASE2
      FFHH02 = A2 * TERM2M * COEF2H * PHASE2
      FFVV03 = A2 * TERM2M * COEF3V * PHASE3
      FFHH03 = A2 * TERM2M * COEF3H * PHASE3
      FFVV04 = A4 * TERM4M * COEF4V * PHASE4
      FFHH04 = A4 * TERM4M * COEF4H * PHASE4
      FFVV05 = A1 * TERM1P * COEF5V * PHASE1
      FFHH05 = A1 * TERM1P * COEF5H * PHASE1
      FFVV06 = A2 * TERM2P * COEF6V * PHASE2 * Q6
      FFHH06 = A2 * TERM2P * COEF6H * PHASE2 * Q6
      FFVV07 = A4 * TERM4P * COEF7V * PHASE4 * Q8
      FFHH07 = A4 * TERM4P * COEF7H * PHASE4 * Q8
      FFVV08 = A1 * TERM1M * TANAP1 * ( 0.5) * FTAU1 * PHASE1
      FFHH08 = -FFVV08
      FFVV09 = A2 * TERM2M * TANAP1 * (-0.5) * FTAU2 * PHASE2
      FFHH09 = -FFVV09
      FFVV10 = A2 * TERM2M * TANAP2 * ( 0.5) * FTAU3 * PHASE3
      FFHH10 = -FFVV10
      FFVV11 = A4 * TERM4M * TANAP2 * (-0.5) * FTAU4 * PHASE4
      FFHH11 = -FFVV11
      FFVV12 = A1 * TERM1P * TANAM1 * ( 0.5) * FTAU5 * PHASE1 * Q6
      FFHH12 = -FFVV12
      FFVV13 = A2 * TERM2P * TANAM1 * (-0.5) * FTAU6 * PHASE2 * Q6
      FFHH13 = -FFVV13
      FFVV14 = A2 * TERM2P * TANAM2 *(-.5)*(1.-FTAU7)* PHASE3 * Q8
      FFHH14 = -FFVV14
```

```
      FFVV15 = A4 * TERM4P * TANAM2 * (-0.5) * FTAU8 * PHASE4 * Q8
      FFHH15 = -FFVV15
      FFVV16 = -A1 * COEFN1 * TERM5  * PHASE1
      FFHH16 =  FFVV16
      FFVV17 = -A2 * COEFN2 * TERM6  * PHASE2
      FFHH17 =  FFVV17
      FFVV18 = -A2 * COEFN3 * TERM6  * PHASE3
      FFHH18 =  FFVV18
      FFVV19 = -A4 * COEFN4 * TERM7  * PHASE4
      FFHH19 =  FFVV19
      FFVV20 = -A1 * COEFN1 * TERM5  * PHASE1
      FFHH20 =  FFVV20
      FFVV21 = -A2 * COEFN2 * TERM6  * PHASE2 * Q6
      FFHH21 =  FFVV21
      FFVV22 = -A4 * COEFN4 * TERM7  * PHASE4 * Q8
      FFHH22 =  FFVV22
C
      FFVV   = FFVV01 + FFVV02 + FFVV03 + FFVV04 + FFVV05 + FFVV06 +
     1         FFVV07 + FFVV08 + FFVV09 + FFVV10 + FFVV11 + FFVV12 +
     2         FFVV13 + FFVV14 + FFVV15 + FFVV16 + FFVV17 + FFVV18 +
     3         FFVV19 + FFVV20 + FFVV21 + FFVV22
      FFHH   = FFHH01 + FFHH02 + FFHH03 + FFHH04 + FFHH05 + FFHH06 +
     1         FFHH07 + FFHH08 + FFHH09 + FFHH10 + FFHH11 + FFHH12 +
     2         FFHH13 + FFHH14 + FFHH15 + FFHH16 + FFHH17 + FFHH18 +
     3         FFHH19 + FFHH20 + FFHH21 + FFHH22
C
      GO TO 40
C
   30 CONTINUE
      FFVV01 = A1 * TERM1M * COEF1V * PHASE1 * Q1
      FFHH01 = A1 * TERM1M * COEF1H * PHASE1 * Q1
      FFVV02 = A2 * TERM2M * COEF2V * PHASE2 * Q2
      FFHH02 = A2 * TERM2M * COEF2H * PHASE2 * Q2
      FFVV03 = A2 * TERM2M * COEF3V * PHASE3 * Q3
      FFHH03 = A2 * TERM2M * COEF3H * PHASE3 * Q3
      FFVV04 = A4 * TERM4M * COEF4V * PHASE4
      FFHH04 = A4 * TERM4M * COEF4H * PHASE4
      FFVV05 = A4 * TERM4P * COEF5V * PHASE4
      FFHH05 = A4 * TERM4P * COEF5H * PHASE4
      FFVV06 = A1 * TERM1M * TANAP1 * ( 0.5) * FTAU1 * PHASE1 * Q1
      FFHH06 = -FFVV06
      FFVV07 = A2 * TERM2M * TANAP1 * (-0.5) * FTAU2 * PHASE2 * Q1
      FFHH07 = -FFVV07
      FFVV08 = A2 * TERM2M * TANAP2 * ( 0.5) * FTAU3 * PHASE3 * Q3
      FFHH08 = -FFVV08
      FFVV09 = A2 * TERM2M * TANATT * ( 0.5)         * PHASE3 *(Q2-Q3)
      FFHH09 = -FFVV09
      FFVV11 = A4 * TERM4M * TANAP2 * (-0.5) * FTAU4 * PHASE4 * Q3
      FFHH11 = -FFVV11
      FFVV12 = -A1 * COEFN1 * TERM5  * PHASE1 * Q1
      FFHH12 =  FFVV12
      FFVV13 = -A2 * COEFN2 * TERM6  * PHASE2 * Q2
      FFHH13 =  FFVV13
      FFVV14 = -A2 * COEFN3 * TERM6  * PHASE3 * Q3
      FFHH14 =  FFVV14
      FFVV15 = -A4 * COEFN4 * TERM7  * PHASE4 *Q8
      FFHH15 =  FFVV15
      FFVV16 = -A4 * COEFN4 * TERM7  * PHASE4
```

```
      FFHH16 =  FFVV16
C
      FFVV    = FFVV01 + FFVV02 + FFVV03 + FFVV04 + FFVV05 + FFVV06 +
     1          FFVV07 + FFVV08 + FFVV09          + FFVV11 + FFVV12 +
     2          FFVV13 + FFVV14 + FFVV15 + FFVV16
C
      FFHH    = FFHH01 + FFHH02 + FFHH03 + FFHH04 + FFHH05 + FFHH06 +
     1          FFHH07 + FFHH08 + FFHH09          + FFHH11 + FFHH12 +
     2          FFHH13 + FFHH14 + FFHH15 + FFHH16
C
C
   40 FFVV    = FFVV * .02539998 * SPI
      FFHH    = FFHH * .02539998 * SPI
C
      CFVV    =-CONJG(FFVV)
      CFHH    = CONJG(FFHH)
C
      EVVR(I) =REAL(CFVV)
      EVVI(I) =AIMAG(CFVV)
      EHHR(I) =REAL(CFHH)
      EHHI(I) =AIMAG(CFHH)
C
  900 CONTINUE
C
      RETURN
      END
      SUBROUTINE BESL ( X, B0, B1, B2 )
C
C   * BESSEL FUNCTION SUBROUTINE UTILIZING POLYNOMIAL APPROXIMATIONS
C   * COMPUTES J0,J1,OR J2 FOR POSITIVE REAL ARGUMENTS
C   * REFERENCE (HNDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN SECTION 9.4 )
C
      S = 1.0
      IF (X .LT. 0.0) S=-1.0
      X = ABS(X)
C
      IF ( X .GT. 1.E-6 ) GO TO 5
      B0 = 1.0
      B1 = 0.0
      B2 = 0.0
      X = X * S
      RETURN
C
    5 CONTINUE
C
    1 IF ( X .GE. 3.) GO TO 9
      X1 = X/3.
      X1 = X1*X1
      B = 1.+ X1*(-2.2499997+ X1*(1.2656208+ X1*(-.3163866+ X1*(.0444479
     1 +      X1*(-.0039444+ X1*2.1E-4 )))) )
      GO TO 10
C
    9 X2 = 3./X
      F0 =   .79788456 +X2*(-.77E-6 +X2*(-.00552740 +X2*(-.9512E-4 +X2*
     1       (.00137237 +X2*(-.72805E-3 +X2*0.14476E-3 )))) )
      T0 = X - .78539816 +X2*(-.04166397 +X2*(-.3954E-4 +X2*(.00262573
     1     +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))
      B = F0*COS(T0)/SQRT(X)
```

```
10 B0 = B

 2 IF ( X .GE. 3. ) GO TO 19
   X1 = X/3.
   X1 = X1*X1
   B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*
  1              (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4))))) )
   GO TO 20

19 X2 = 3./X
   F1 = .79788456 +X2*(.156E-5 +X2*(.01659667 +X2*(.00017105 +X2*
  1       (-.00249511 +X2*(.00113653 -.00020033*X2 )))))
   T1 = X - 2.35619449 +X2*(.12499612 +X2*(.565E-4 +X2*(-.00637879
  1     +X2*(.00074348 +X2*(.00079824 -0.00029166*X2 )))))
   B = F1*COS(T1)/SQRT(X)

20 B1 = B * S
   X = X * S
   B2= (2./X)*B1 - B0
50 RETURN
   END
   COMPLEX FUNCTION F(TAU)

   COMPUTES FTAU WHERE FTAU =(EXP(-J*TAU**2)/2*TAU)*SQRT(PI/2.)*
                          (C2(TAU**2)  + J*S2(TAU**2))

   COMPLEX B, FP
   PI = 3.14159265358979
   PIO2 = PI/2.
   C1 = SQRT(PI/2.)
   C2 = 1./C1
   ATAUS = ABS(TAU)
   IF (ATAUS .LE. 0.5 )GO TO 20

   FOR TAUS .GT. 0.5, FUNCTION COMPUTED USING POLYNOMIAL
                        APPROXIMATION
 * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,
 *           SECTIONS  7.3.  . 1.10.7.3.32,7.3.33)
   TAUS = SQRT(ATAUS)
   X = C2*TAUS
   XS = X*X

   FX = (1.0+0.926*X)/(2.0+1.792*X+3.104*XS)
   GX = 1.0/(2.0+4.142*X+3.492*XS+6.67*X*XS)

   CC1XS = COS(ATAUS)
   SC1XS = SIN(ATAUS)

   CX = 0.5 + FX*SC1XS - GX*CC1XS
   SX = 0.5 - FX*CC1XS - GX*SC1XS

   IF (TAU .LT. 0.0) GO TO 10
   B = CMPLX(CX,SX)
   FP = CMPLX(  COS(ATAUS), -SIN(ATAUS) )
   F = (C1*B*FP)/TAUS
   RETURN
```

```
   10 CONTINUE
      B = CMPLX(SX,CX)
      A = ATAUS-PIO2
      FP = CMPLX( COS(A),SIN(A) )
      F = (B*FP*C1)/TAUS
      RETURN
C
   20 CONTINUE
C     FOR TAUS .LE. 0.5, FUNCTION IS EXPANDED IN SERIES AND FIRST FEW
C                        TERMS INTEGRATED TERM BY TERM TO OBTAIN RESULT
      FP = CMPLX(COS(TAU),-SIN(TAU))
      TS = TAU*TAU
      FR = 1 - TS*( .1 - .0046296296*TS)
      FI = TAU *( .333333333 - TS*(.0238095238 - 7.57575757E-4*TS))
      B = CMPLX(FR,FI)
      F = FP*B
      RETURN
      END
      FUNCTION Q(Z)
C     Q(Z) = 0.5*(1 + ERF(Z))
C   * ERF(Z) IS EVALUATED USING A RATIONAL POLYNOMIAL APPROXIMATION
C   * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,
C   *              SECTION 7.1.26)
C
      IF ( Z.GT. 2.) GO TO 10
      IF ( Z.LT.-2.) GO TO 20
      AZ = ABS(Z)
      P = 1.0/(1.0 + .47047*AZ)
      Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P))*EXP(-AZ*AZ)
      IF (Z) 2,4,6
    2 Q = (1.0 - Y)/2.
      RETURN
    4 Q = .5
      RETURN
    6 Q = (1.0 + Y)/2.
      RETURN
   10 Q = 1.
      RETURN
   20 Q = 0.
      RETURN
      END
```

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

```
   -----------
  / TARGET   /
  -----------

       *
       |
 * * *        ST-3A
 --
 FRUSTRA-CYLINDER-
 FRUSTRA (UFIMTSEV)
  * * *

 NMIN = MINIMUM
 FREQUENCY SAMPLE
 NMAX = MAXIMUM
 FREQUENCY SAMPLE
 DF   = FREQUENCY
 INCREMENT IN MHZ
 FC   = CARRIER
 FREQUENCY IN GHZ

  * * * ALL DIMENSIONS
 ARE IN INCHES AND ALL
 ANGLES ARE IN DEGREES
  * *

       *
       |              01
  --------------------
  / READ FROM DEV /
  /      5       /
  / VIA FORMAT  /
  /    1000    /
  / INTO THE LIST /
  -----------------
       |
       |   NOTE  02
 * * * * * * * * * * * *
 *  LIST = ASPECT,     *

 +------------------>*
 |                   |             08
 |      *--------------------------*
 |      |        THETA =           |
 |      |      ASPECT*DTR          |
 |      |                          |
 |      | STHT = SIN(THETA)        |
 |      |                          |
 |      | CTHT = COS(THETA)        |
 |      |                          |
 |      |       TANATT =           |
 |      |      STHT/CTHT           |
 |      *--------------------------*
 |                   |
 |                   |             09
 |      *--------------------------*
 |      | SHADOW = (A4 -           |
 |      | A2)/(H2 + H2 +           |
 |      |       H3)                |
 |      |                          |
 |      |      SHADOW =            |
 |      |    ATAN(SHADOW)          |
 |      |                          |
 |      |      ALPHA1 =            |
 |      |    ATAN((A2 -            |
 |      |      A1)/H1)             |
 |      *--------------------------*
 |                   |
 |                   |             10
 |      *--------------------------*
 |      |      ALPHA2 =            |
 |      |    ATAN((A4 -            |
 |      |      A2)/H3)             |
 |      |                          |
 |      | X1D = ALPHA1*RTD         |
 |      |                          |
 |      | X2D = ALPHA2*RTD         |
 |      |                          |

 +------------------>*
 |                   |             16
 |      *--------------------------*
 |      |    XN1 = 1.5 -           |
 |      |    (ALPHA1/PI)           |
 |      |                          |
 |      |    XN2 = 1.0 +           |
 |      |    (ALPHA1/PI)           |
 |      |                          |
 |      |    XN3 = 1.0 -           |
 |      |    (ALPHA2/PI)           |
 |      |                          |
 |      |    XN4 = 1.5 +           |
 |      |    (ALPHA2/PI)           |
 |      *--------------------------*
 |                   |
 |                   |             17
 |      *--------------------------*
 |      |      CPON1 =             |
 |      |   COS(PI/XN1)            |
 |      |                          |
 |      |      CPON2 =             |
 |      |   COS(PI/XN2)            |
 |      |                          |
 |      |      CPON3 =             |
 |      |   COS(PI/XN3)            |
 |      |                          |
 |      |      CPON4 =             |
 |      |   COS(PI/XN4)            |
 |      *--------------------------*
 |                   |
 |                   |             18
 |      *--------------------------*
 |      |      TERM01 =            |
 |      | (SIN(PI/XN1))/XN1        |
 |      |                          |
 |      |      TERM02 =            |
 |      | (SIN(PI/XN2))/XN2        |
```

```
* * * * * * * * * * * *
*  LIST = ASPECT,      *
*  A1, A2, A4, H1,     *
*  H2, H3, H4, H5,     *
*        M1            *
* * * * * * * * * * * *
           |
           |            03
    ---------------
   / WRITE TO DEV  /
  /       6       /
 /  VIA FORMAT   /
/     1010      /
/ FROM THE LIST /
---------------
           |
           |  NOTE  04
* * * * * * * * * * * *
*  LIST = A1, H1,      *
*  A2, H2, A4, H3      *
* * * * * * * * * * * *
           |
           |            05
*----------------------*
| C = 11.80285078      |
|                      |
|       PI =           |
| 3.14159265358979     |
|                      |
|   SPI = SQRT(PI)     |
|                      |
|   DTR = PI/180.0     |
*----------------------*
           |
           |            06
*----------------------*
| RTD = 180.0/PI       |
|                      |
|  WC = 2.0*PI*FC      |
|                      |
|    XK00 = WC/C       |
|                      |
|  X2K0 = XK00 +       |
|        XK00          |
*----------------------*
           |
           |            07
*----------------------*
| X2K0A1 = X2K0*A1     |
|                      |
| X2K0A2 = X2K0*A2     |
|                      |
| X2K0A4 = X2K0*A4     |
*----------------------*
           |
```

```
| X2D = ALPHA2*RTD     |
|                      |
| X3D = SHADOW*RTD     |
*----------------------*
           |
           |            11
      ---------------
     / WRITE TO DEV  /
    /       6       /
   /  VIA FORMAT   /
  /     2010      /
 / FROM THE LIST /
 ---------------
           |
           |  NOTE  12
* * * * * * * * * * * *
*  LIST = ASPECT,      *
*  X1D, X2D, X3D       *
* * * * * * * * * * * *
           |
           |            13
*----------------------*
| SA1 = SIN(ALPHA1)    |
|                      |
| SA2 = SIN(ALPHA2)    |
|                      |
|  A1PT = ALPHA1 +     |
|        THETA         |
|                      |
|  A1MT = ALPHA1 -     |
|        THETA         |
*----------------------*
           |
           |            14
*----------------------*
|  A2PT = ALPHA2 +     |
|        THETA         |
|                      |
|  A2MT = ALPHA2 -     |
|        THETA         |
|                      |
|      TANAP1 =        |
|      TAN(A1PT)       |
|                      |
|      TANAP2 =        |
|      TAN(A2PT)       |
*----------------------*
           |
           |            15
*----------------------*
|      CA1PTS =        |
| 2.*COS(A1PT)/SA1     |
|                      |
|      CA2PTS =        |
| 2.*COS(A2PT)/SA2     |
*----------------------*
           |
```

```
| (SIN(PI/XN2))/XN2    |
|                      |
|      TERM03 =        |
| (SIN(PI/XN3))/XN3    |
*----------------------*
           |
           |            19
*----------------------*
|      TERM04 =        |
| (SIN(PI/XN4))/XN4    |
*----------------------*
           |
           |
COEFNX ARE C(NX)
TERMS
           |
           |            20
*----------------------*
|      COEFN1 =        |
| TERM01/(CPON1 -      |
|         1.)          |
|                      |
|      COEFN2 =        |
| TERM02/(CPON2 -      |
|         1.)          |
|                      |
|      COEFN3 =        |
| TERM03/(CPON3 -      |
|         1.)          |
*----------------------*
           |
           |            21
*----------------------*
|      COEFN4 =        |
| TERM04/(CPON4 -      |
|         1.)          |
*----------------------*
           |
           |
           *     22
        *     *
     *           *
  *                 *  TRUE
*   ASPECT .GT.      *--+
  *    90.0         *   |
     *           *      |
        *     *         |
           *          ....
           |FALSE   .  30 .
           |        .  12 .
           |          ....
           |           10
           |
           |  /
          ----
```

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

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```
29.22--->*
         |
DIFFRACTION TERMS (
C(N)-/+B(N,PHI) =
COEFXX TERMS
COMPUTED HERE FOR
THETA.LT. 90
         |                01
*-----------------------*
|      COEF11 =         |
|   1.0/(CPON1 -        |
|    COS((THETA +       |
| THETA + PI)/XN1))     |
|                       |
|      COEF12 =         |
|   1.0/(CPON2 -        |
|    COS((A1PT +        |
|    A1PT)/XN2))        |
*-----------------------*
         |                02
*-----------------------*
|      COEF13 =         |
|   1.0/(CPON3 -        |
|    COS((THETA +       |
|    THETA)/XN3))       |
|                       |
|      COEF14 =         |
|   1.0/(CPON4 -        |
|    COS((A2PT +        |
|    A2PT)/XN4))        |
*-----------------------*
         |                03
*-----------------------*
|      COEF21 =         |
|   1.0/(CPON1 -        |
|    COS((THETA +       |
| THETA - PI)/XN1))     |
|                       |
|      COEF22 =         |
|   1.0/(CPON2 -        |
|    COS((A1MT +        |
|    A1MT)/XN2))        |
*-----------------------*
         |                04
*-----------------------*     +---------------------->*
```

```
DIFFRACTION TERMS (
C(N)-/+B(N,PHI) =
COEFXX TERMS
COMPUTED HERE FOR
THETA.GT. 90
 29.22--->*
  10      |              12
*-----------------------*
|      COEF31 =         |
|   1.0/(CPON1 -        |
|   COS(2.0*(PI -       |
|    A1PT)/XN1))        |
|                       |
|      COEF32 =         |
|   1.0/(CPON2 -        |
|   COS(2.0*(PI -       |
|    THETA)/XN2))       |
*-----------------------*
          |              13
*-----------------------*
|      COEF33 =         |
|   1.0/(CPON3 -        |
|   COS(2.0*(PI -       |
|    A2PT)/XN3))        |
|                       |
|      COEF34 =         |
|   1.0/(CPON4 -        |
| COS((2.0*THETA -      |
|   3.0*PI)/XN4))       |
*-----------------------*
          |              14
*-----------------------*
|      COEF44 =         |
|   1.0/(CPON4 -        |
| COS((2.0*THETA -      |
|    PI)/XN4))          |
*-----------------------*
          |              15
*-----------------------*
| COEF1V = COEFN1 -     |
|   COEF31*TERM01       |
|                       |
| COEF1H = COEFN1 +     |
|   COEF31*TERM01       |
```

```
+---------------------->*
|                       |                19
|         *-----------------------*
|         |        Q1 =           |
|         | Q(X2KOA1*(PI -        |
|         |      A1PT))           |
|         |                       |
|         |        Q2 =           |
|         | Q(X2KOA2*(PI -        |
|         | SHADOW - THETA))      |
|         |                       |
|         |        Q3 =           |
|         | Q(X2KOA2*(PI -        |
|         |      A2PT))           |
|         *-----------------------*
|                       |
|         30.11--->|
|           20     |  NOTE  20
|         * * * * * * * * * * * *
|         *    CONTINUE         *
|         * * * * * * * * * * * *
|                       |
|                       |  NOTE  21
|         * * * * * * * * * * * *
|         *  BEGIN DO LOOP      *
|         *  900 I = NMIN,      *
|         *      NMAX           *
|         * * * * * * * * * * * *
|                       |
|         33.10--->|
|                       |                22
|         *-----------------------*
|         |    XI = I - 1         |
|         |                       |
|         |        W =            |
|         |  (2.*PI*XI*DF)        |
|         |     /1000.0           |
|         |                       |
|         |    XKO = W/C          |
|         |                       |
|         |      XKO2C =          |
|         | XKO*(CTHT + CTHT)     |
|         *-----------------------*
|                       |                23
|         *-----------------------*
|         |      TAU1 =           |
|         |  XKO*A1*CA1PTS        |
|         |                       |
|         |      TAU2 =           |
|         |  XKO*A2*CA1PTS        |
```

```
COEF22 =
1.0/(CPON2 -
COS((A1MT +
A1MT)/XN2))

04
COEF24 =
1.0/(CPON4 -
COS((A2MT +
A2MT)/XN4))

05
COEF1V = COEFN1 -
COEF11*TERMO1

COEF1H = COEFN1 +
COEF11*TERMO1

COEF2V = COEFN2 -
COEF12*TERMO2

06
COEF2H = COEFN2 +
COEF12*TERMO2

COEF3V = COEFN3 -
COEF13*TERMO3

COEF3H = COEFN3 +
COEF13*TERMO3

07
COEF4V = COEFN4 -
COEF14*TERMO4

COEF4H = COEFN4 +
COEF14*TERMO4

COEF5V = COEFN1 -
COEF21*TERMO1
```

```
08
COEF5H = COEFN1 +
COEF21*TERMO1

COEF6V = COEFN2 -
COEF22*TERMO2

COEF6H = COEFN2 +
COEF22*TERMO2

09
COEF7V = COEFN4 -
COEF24*TERMO4

COEF7H = COEFN4 +
COEF24*TERMO4

10
TANAM1 =
TAN(A1MT)

TANAM2 =
TAN(A2MT)

CA1MTS =
2.*COS(A1MT)/SA1

11
CA2MTS =
2.*COS(A2MT)/SA2

Q6 =
Q(X2KOA2*A1MT)

Q8 =
Q(X2KOA4*(SHADOW
- THETA))

.30.20.
... 20
```

```
15
COEF1V = COEFN1 -
COEF31*TERMO1

COEF1H = COEFN1 +
COEF31*TERMO1

COEF2V = COEFN2 -
COEF32*TERMO2

16
COEF2H = COEFN2 +
COEF32*TERMO2

COEF3V = COEFN3 -
COEF33*TERMO3

COEF3H = COEFN3 +
COEF33*TERMO3

17
COEF4V = COEFN4 -
COEF34*TERMO4

COEF4H = COEFN4 +
COEF34*TERMO4

COEF5V = COEFN4 -
COEF44*TERMO4

18
COEF5H = COEFN4 +
COEF44*TERMO4
```

```
23
TAU1 =
XKO*A1*CA1PTS

TAU2 =
XKO*A2*CA1PTS

TAU3 =
XKO*A2*CA2PTS

TAU4 =
XKO*A4*CA2PTS

24
FTAU1 = F(TAU1)

FTAU2 = F(TAU2)

FTAU3 = F(TAU3)

FTAU4 = F(TAU4)

25
SI1 =
2.0*XKO*A1*STHT

SI2 =
2.0*XKO*A2*STHT

SI4 =
2.0*XKO*A4*STHT

26
7.01  BESL
(SI1,XJOX1,
XJ1X1,XJ2X1)

/31.01
```

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

```
30.27--->*
         01
BESL
(SI2,XJ0X2,
XJ1X2,XJ2X2)

         02
BESL
(SI4,XJ0X4,
XJ1X4,XJ2X4)

         03
TERM1P =
CMPLX(XJ0X1,
XJ1X1)

TERM1M =
CONJG(TERM1P)

TERM2P =
CMPLX(XJ0X2,
XJ1X2)

         04
TERM2M =
CONJG(TERM2P)

TERM4P =
```

```
         09
ASPECT .GT.
90.0           TRUE
FALSE  . 32 .
       . 09 .
         30

         10
TAU5 =
XK0*A1*CA1MTS

TAU6 =
XK0*A2*CA1MTS

TAU7 =
XK0*A2*CA2MTS

TAU8 =
XK0*A4*CA2MTS

         11
FTAU5 = F(TAU5)

FTAU6 = F(TAU6)

FTAU7 = F(TAU7)

FTAU8 = F(TAU8)
```

```
         15
FFHH05 =
A1*TERM1P*COEF5H*
PHASE1

FFVV06 =
A2*TERM2P*COEF6V*
PHASE2*Q6

FFHH06 =
A2*TERM2P*COEF6H*
PHASE2*Q6

         16
FFVV07 =
A4*TERM4P*COEF7V*
PHASE4*Q8

FFHH07 =
A4*TERM4P*COEF7H*
PHASE4*Q8

FFVV08 =
A1*TERM1M*TANAP1*
(0.5)
*FTAU1*PHASE1

         17
FFHH08 = - FFVV08

FFVV09 =
A2*TERM2M*TANAP1*
(-0.5)
*FTAU2*PHASE2
```

```
TERM4P =
CMPLX(XJOX4,
XJ1X4)

TERM4M =
CONJG(TERM4P)

TERM5 = XJOX1 +
XJ2X1

05
TERM6 = XJOX2 +
XJ2X2

TERM7 = XJOX4 +
XJ2X4

06
PHI1 =
XK02C*(H1 + H2)

PHI2 = XK02C*(H2)

PHI3 = PHI2

PHI4 =
XK02C*(H2 + H3)

07
PHASE1 =
CMPLX(COS(PHI1),
- SIN(PHI1))

PHASE2 =
CMPLX(COS(PHI2),
- SIN(PHI2))

08
PHASE3 =
CMPLX(COS(PHI3),
SIN(PHI3))

PHASE4 =
CMPLX(COS(PHI4),
SIN(PHI4))
```

```
FTAU8 = F(TAU8)

12
FFVV01 =
A1*TERM1M*COEF1V*
PHASE1

FFHH01 =
A1*TERM1M*COEF1H*
PHASE1

FFVV02 =
A2*TERM2M*COEF2V*
PHASE2

13
FFHH02 =
A2*TERM2M*COEF2H*
PHASE2

FFVV03 =
A2*TERM2M*COEF3V*
PHASE3

FFHH03 =
A2*TERM2M*COEF3H*
PHASE3

14
FFVV04 =
A4*TERM4M*COEF4V*
PHASE4

FFHH04 =
A4*TERM4M*COEF4H*
PHASE4

FFVV05 =
A1*TERM1P*COEF5V*
PHASE1
```

```
*FTAU2*PHASE2

FFHH09 = - FFVV09

18
FFVV10 =
A2*TERM2M*TANAP2*
(0.5)
*FTAU3*PHASE3

FFHH10 = - FFVV10

FFVV11 =
A4*TERM4M*TANAP2*
(-0.5)
*FTAU4*PHASE4

19
FFHH11 = - FFVV11

FFVV12 =
A1*TERM1P*TANAM1*
(0.5)
*FTAU5*PHASE1*Q6

FFHH12 = - FFVV12

20
FFVV13 =
A2*TERM2P*TANAM1*
(-0.5)
*FTAU6*PHASE2*Q6

FFHH13 = - FFVV13

21
FFVV14 =
A2*TERM2P*TANAM2*
(-.5)*(1. -
FTAU7)*PHASE3*Q8

FFHH14 = - FFVV14

/32.01
```

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

L-90

```
                                                       ----------
                                                      /   30    /
                                                       ----------
                                                           |
 31.21--->*                                        31.09--->|
          |           01                                    | NOTE  09
*--------------------*                             * * * * * * * * * * *
| FFVV15 =           |                             *    CONTINUE       *
| A4*TERM4P*TANAM2*  |                             * * * * * * * * * * *
|   (-0.5)           |                                      |
| *FTAUS*PHASE4*Q8   |                                      |         10
|                    |                             *--------------------*
| FFHH15 = - FFVV15  |                             | FFVV01 =           |
|                    |                             | A1*TERM1M*COEF1V*  |
| FFVV16 = -         |                             |   PHASE1*Q1        |
| A1*COEFN1*TERM5*   |                             |                    |
|   PHASE1           |                             | FFHH01 =           |
*--------------------*                             | A1*TERM1M*COEF1H*  |
          |                                        |   PHASE1*Q1        |
          |           02                           |                    |
*--------------------*                             | FFVV02 =           |
| FFHH16 = FFVV16    |                             | A2*TERM2M*COEF2V*  |
|                    |                             |   PHASE2*Q2        |
| FFVV17 = -         |                             *--------------------*
| A2*COEFN2*TERM6*   |                                      |
|   PHASE2           |                                      |         11
|                    |                             *--------------------*
| FFHH17 = FFVV17    |                             | FFHH02 =           |
*--------------------*                             | A2*TERM2M*COEF2H*  |
          |                                        |   PHASE2*Q2        |
          |           03                           |                    |
*--------------------*                             | FFVV03 =           |
| FFVV18 = -         |                             | A2*TERM2M*COEF3V*  |
| A2*COEFN3*TERM6*   |                             |   PHASE3*Q3        |
|   PHASE3           |                             |                    |
|                    |                             | FFHH03 =           |
| FFHH18 = FFVV18    |                             | A2*TERM2M*COEF3H*  |
|                    |                             |   PHASE3*Q3        |
| FFVV19 = -         |                             *--------------------*
| A4*COEFN4*TERM7*   |                                      |
|   PHASE4           |                                      |         12
*--------------------*                             *--------------------*
          |                                        | FFVV04 =           |
          |           04                           | A4*TERM4M*COEF4V*  |
*--------------------*
```

```
FFVV19 =
A4*COEFN4*TERM7*
PHASE4
```

04

```
FFHH19 = FFVV19

FFVV20 = -
A1*COEFN1*TERM5*
PHASE1

FFHH20 = FFVV20
```

05

```
FFVV21 = -
A2*COEFN2*TERM6*
PHASE2*Q6

FFHH21 = FFVV21

FFVV22 = -
A4*COEFN4*TERM7*
PHASE4*Q8
```

06

```
FFHH22 = FFVV22
```

07

```
FFVV = FFVV01 +
FFVV02 + FFVV03 +
FFVV04 + FFVV05 +
FFVV06 + FFVV07 +
FFVV08 + FFVV09 +
FFVV10 + FFVV11 +
FFVV12 + FFVV13 +
FFVV14 + FFVV15 +
FFVV16 + FFVV17 +
FFVV18 + FFVV19 +
FFVV20 + FFVV21 +
FFVV22
```

08

```
FFHH = FFHH01 +
FFHH02 + FFHH03 +
FFHH04 + FFHH05 +
FFHH06 + FFHH07 +
FFHH08 + FFHH09 +
FFHH10 + FFHH11 +
FFHH12 + FFHH13 +
FFHH14 + FFHH15 +
FFHH16 + FFHH17 +
FFHH18 + FFHH19 +
FFHH20 + FFHH21 +
```

12

```
FFVV04 =
A4*TERM4M*COEF4V*
PHASE4

FFHH04 =
A4*TERM4M*COEF4H*
PHASE4

FFVV05 =
A4*TERM4P*COEF5V*
PHASE4
```

13

```
FFHH05 =
A4*TERM4P*COEF5H*
PHASE4

FFVV06 =
A1*TERM1M*TANAP1*
(0.5)
*FTAU1*PHASE1*Q1

FFHH06 = - FFVV06
```

14

```
FFVV07 =
A2*TERM2M*TANAP1*
(-0.5)
*FTAU2*PHASE2*Q1

FFHH07 = - FFVV07

FFVV08 =
A2*TERM2M*TANAP2*
(0.5)
*FTAU3*PHASE3*Q3
```

15

```
FFHH08 = - FFVV08

FFVV09 =
A2*TERM2M*TANATT*
(0.5)
*PHASE3*(Q2 - Q3)

FFHH09 = - FFVV09
```

2

```
                                                   FFVV06 =
                                              A1*TERM1M*TANAP1*
                                                    (0.5)
                                              *FTAU1*PHASE1*Q1

                                              FFHH06 = - FFVV06

  FFHH22 = FFVV22     06                                    14
                                              FFVV07 =
                                              A2*TERM2M*TANAP1*
                                                   (-0.5)
                                              *FTAU2*PHASE2*C1

                                              FFHH07 = - FFVV07

                     07                       FFVV08 =
 FFVV = FFVV01 +                              A2*TERM2M*TANAP2*
 FFVV02 + FFVV03 +                                 (0.5)
 FFVV04 + FFVV05 +                            *FTAU3*PHASE3*Q3
 FFVV06 + FFVV07 +
 FFVV08 + FFVV09 +
 FFVV10 + FFVV11 +
 FFVV12 + FFVV13 +
 FFVV14 + FFVV15 +
 FFVV16 + FFVV17 +                                          15
 FFVV18 + FFVV19 +                08          FFHH08 = - FFVV08
 FFVV20 + FFVV21 +   FFHH = FFHH01 +
     FFVV22          FFHH02 + FFHH03 +           FFVV09 =
                     FFHH04 + FFHH05 +        A2*TERM2M*TANATT*
                     FFHH06 + FFHH07 +             (0.5)
                     FFHH08 + FFHH09 +        *PHASE3*(Q2 - Q3)
                     FFHH10 + FFHH11 +
                     FFHH12 + FFHH13 +        FFHH09 = - FFVV09
                     FFHH14 + FFHH15 +
                     FFHH16 + FFHH17 +
                     FFHH18 + FFHH19 +
                     FFHH20 + FFHH21 +
                          FFHH22
                                                   /33.01

                          .33.07.
                            ... 40
```

3

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

```
   32.15--->*
            |                 01
  *-----------------------*
  |     FFVV11 =          |
  |  A4*TERM4M*TANAP2*    |
  |      (-0.5)           |
  |  *FTAU4*PHASE4*Q3     |
  |                       |
  |  FFHH11 = - FFVV11    |
  |                       |
  |     FFVV12 = -        |
  |  A1*COEFN1*TERM5*     |
  |     PHASE1*Q1         |
  *-----------------------*
            |
            |
            |                 02
  *-----------------------*
  |  FFHH12 = FFVV12      |
  |                       |
  |     FFVV13 = -        |
  |  A2*COEFN2*TERM6*     |
  |     PHASE2*Q2         |
  |                       |
  |  FFHH13 = FFVV13      |
  *-----------------------*
            |
            |
            |                 03
  *-----------------------*
  |     FFVV14 = -        |
  |  A2*COEFN3*TERM6*     |
  |     PHASE3*Q3         |
  |                       |
  |  FFHH14 = FFVV14      |
  |                       |
  |     FFVV15 = -        |
```

```
*---------------------*
|   FFVV14 = -        |
| A2*COEFN3*TERM6*    |
|    PHASE3*Q3        |
|                     |
|  FFHH14 = FFVV14    |
|                     |
|   FFVV15 = -        |
| A4*COEFN4*TERM7*    |
|    PHASE4*Q8        |
*---------------------*
          |
          |
          |          04
*---------------------*
|  FFHH15 = FFVV15    |
|                     |
|   FFVV16 = -        |
| A4*COEFN4*TERM7*    |
|     PHASE4          |
|                     |
|  FFHH16 = FFVV16    |
*---------------------*
          |
          |
          |          05
*---------------------*
|  FFVV = FFVV01 +    |
| FFVV02 + FFVV03 +   |
| FFVV04 + FFVV05 +   |
| FFVV06 + FFVV07 +   |
| FFVV08 + FFVV09 +   |
| FFVV11 + FFVV12 +   |   +------------------->*
| FFVV13 + FFVV14 +   |   |                    |          08
|  FFVV15 + FFVV16    |   |           *---------------------*
*---------------------*   |           |    CFVV = -         |
          |               |           |   CONJG(FFVV)       |
          |               |           |                     |
          |          06   |           |     CFHH =          |
*---------------------*   |           |   CONJG(FFHH)       |
|  FFHH = FFHH01 +    |   |           *---------------------*
| FFHH02 + FFHH03 +   |   |                    |
| FFHH04 + FFHH05 +   |   |                    |
| FFHH06 + FFHH07 +   |   |                    |          09
| FFHH08 + FFHH09 +   |   |           *---------------------*
| FFHH11 + FFHH12 +   |   |           |    EVVR(I) =        |
| FFHH13 + FFHH14 +   |   |           |   REAL(CFVV)        |
|  FFHH15 + FFHH16    |   |           |                     |
*---------------------*   |           |    EVVI(I) =        |
          |               |           |   AIMAG(CFVV)       |
 32.08--->|               |           |                     |
   40     |          07   |           |    EHHR(I) =        |
*---------------------*   |           |   REAL(CFHH)        |
|     FFVV =          |   |           |                     |
| FFVV*.02539998*     |   |           |    EHHI(I) =
|      SPI            |   |           |
```

```
*----------------------*
| FFVV = FFVV01 +      |
| FFVV02 + FFVV03 +    |
| FFVV04 + FFVV05 +    |
| FFVV06 + FFVV07 +    |
| FFVV08 + FFVV09 +    |
| FFVV11 + FFVV12 +    |          +------------------------>*
| FFVV13 + FFVV14 +    |          |                         |            08
|  FFVV15 + FFVV16     |          |               *----------------------*
*----------------------*          |               |     CFVV = -         |
           |                      |               |    CONJG(FFVV)       |
           |                      |               |                      |
           |             06       |               |      CFHH =          |
*----------------------*          |               |    CONJG(FFHH)       |
| FFHH = FFHH01 +      |          |               *----------------------*
| FFHH02 + FFHH03 +    |          |                         |
| FFHH04 + FFHH05 +    |          |                         |
| FFHH06 + FFHH07 +    |          |                         |            09
| FFHH08 + FFHH09 +    |          |               *----------------------*
| FFHH11 + FFHH12 +    |          |               |    EVVR(I) =         |
| FFHH13 + FFHH14 +    |          |               |   REAL(CFVV)         |
|  FFHH15 + FFHH16     |          |               |                      |
*----------------------*          |               |    EVVI(I) =         |
           |                      |               |   AIMAG(CFVV)        |
 32.08---->|                      |               |                      |
   40      |             07       |               |    EHHR(I) =         |
*----------------------*          |               |   REAL(CFHH)         |
|       FFVV =         |          |               |                      |
| FFVV*.02539998*      |          |               |    EHHI(I) =         |
|        SPI           |          |               |   AIMAG(CFHH)        |
|                      |          |               *----------------------*
|       FFHH =         |          |                         |
| FFHH*.02539998*      |          |                         |
|        SPI           |          |                         |
*----------------------*          |                 900     *   10
           |                      |                       *   *
           |                      |                     *       *
           +----------------------+                   *           *   NO
                                                    *  END OF DO    *-+
                                                      *  LOOP?    *   |
                                                        *       *     |
                                                          *   *       |
                                                            *       ....
                                                            |YES   . 30 .
                                                            |      . 22 .
                                                            |       ....
                                                            |
                                                            | 11
                                                        ---------
                                                        * EXIT  *
                                                        ---------
```

```
      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, TO
      COMPLEX TERM1P, TERM1M, TERM2P, TERM2M, TERM4P, TERM4M, PHASE1,
       PHASE2,PHASE3, PHASE4, FFVV01, FFVV02, FFVV03, FFVV04, FFVV05,
       FFVV06,FFVV07, FFVV08, FFVV09, FFVV10, FFVV11, FFVV12, FFVV13,
       FFVV14,FFVV15, FFVV16, FFVV17, FFVV18, FFVV19, FFVV20, FFVV21,
       FFVV22,FFHH01, FFHH02, FFHH03, FFHH04, FFHH05, FFHH06, FFHH07,
       FFHH08,FFHH09, FFHH10, FFHH11, FFHH12, FFHH13, FFHH14, FFHH15,
       FFHH16,FFHH17, FFHH18, FFHH19, FFHH20, FFHH21, FFHH22, FFVV,
       FFHH,  CFVV,   CFHH,   FTAU1,  FTAU2,  FTAU3,  FTAU4,  FTAU5,
       FTAU6, FTAU7,  FTAU8
      COMPLEX F
      DIMENSION FVVR(512), FVVI(512), EHHR(512), EHHI(512)
1000  FORMAT(9F7.2,I2)
1010  FORMAT ( 31H1 ' FRUSTRA-CYLINDER-FRUSTRA  ',/
                30H ' UFIMTSEV-RUCK FORMULATION ',/
                 8H   A1 = ,F8.3, 8H   H1 = ,F8.3,/
                 8H   A2 = ,F8.3, 8H   H2 = ,F8.3,/
                 8H   A4 = ,F8.3, 8H   H3 = ,F8.3,/)
2010  FORMAT ( 18H0  ASPECT ANGLE = , F8.3,/,
                11H  ALPHA1 = ,F8.3,/, 11H  ALPHA2 = ,F8.3,/,
                19H  SHADOW(ALPHA3) = ,F8.3 )
```

```
CHART TITLE - SUBROUTINE  BESL(X,B0,B1,B2)


        ------------
       /   BESL    /
       ------------

             *

   * BESSEL FUNCTION
  SUBROUTINE UTILIZING
  POLYNOMIAL
  APPROXIMATIONS
   * COMPUTES J0,J1,OR
  J2 FOR POSITIVE REAL
  ARGUMENTS
   * REFERENCE (HNDBK
  MATH FUNCT BY
  ABRAMOWITZ AND STEGUN
  SECTION 9.4 )

             *
             |                01
  *--------------------------*
  |        S = 1.0           |
  *--------------------------*
             |
             |
             |
             *    02
          *     *
        *          *
FALSE *              *
*-----*  X .LT. 0.0    *                 *------------------>*
|      *              *                  |          9        |          12
|        *          *                    |          *---------------------*
|          *     *                       |          |      X2 = 3./X      |
|             *                          |          |                     |
|             |TRUE                      |          | F0 = .79788456 +    |
|             |                          |          |   X2*(-.77E-6 +     |
|             |                          |          | X2*(-.00552740 +    |
|             |                          |          |  X2*(-.9512E-4 +    |
|             |                          |          |  X2*(.00137237 +    |
|             |                          |          | X2*(-.72805E-3 +    |
|             |                          |          | X2*0.14476E-3)))))  |
|             |                03        |          |        )            |
|  *--------------------------*          |          *---------------------*
|  |       S = - 1.0          |          |                    |
|  *--------------------------*          |                    |
|             |                          |                    |          13
*------------>|                          |          *---------------------*
              |                04        |          |     T0 = X -        |
   *--------------------------*          |          |    .78539816 +      |
   |       X = ABS(X)         |          |          | X2*(-.04166397 +    |
   *--------------------------*          |          |  X2*(-.39545E-4 +   |
              |                          |          |  X2*(.00262573 +    |
              |                          |          | X2*(-.00054125 +    |
              |                          |          | X2*(-.00029333 +    |
              *    05                    |          | X2*0.00013558))))   |
          *      *                       |          |        )            |
        *           *                    |          *---------------------*
      *               *   TRUE           |                    |
                                         |                    |          14
                                         |          *---------------------*
```

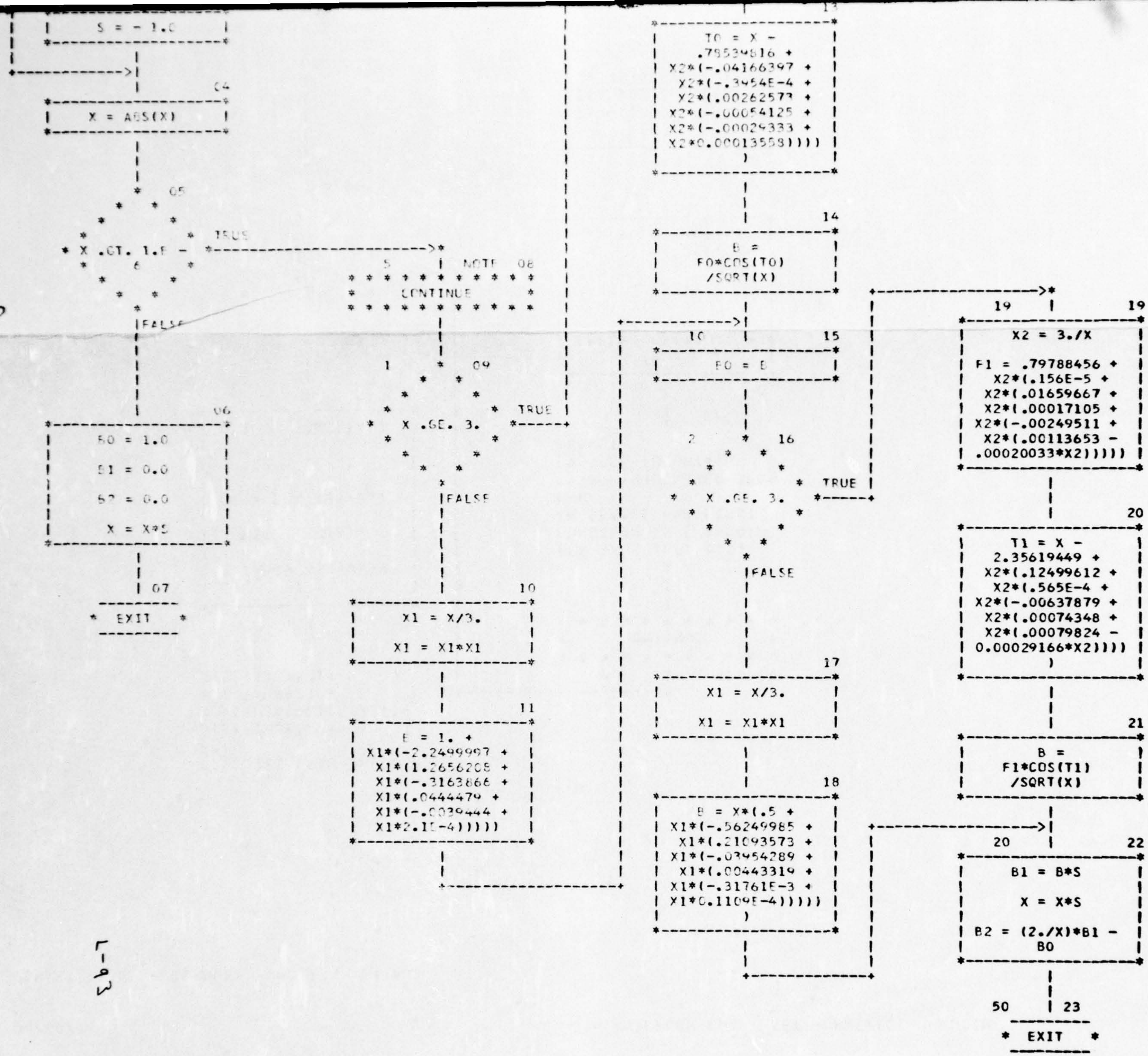

S = - 1.0
04
X = ABS(X)
05
X .GT. 1.E - 6
TRUE
FALSE
5
NOTE 08
CONTINUE
1
09
X .GE. 3.
TRUE
FALSE
06
B0 = 1.0
B1 = 0.0
B2 = 0.0
X = X*S
07
EXIT
10
X1 = X/3.
X1 = X1*X1
11
B = 1. + X1*(-2.2499997 + X1*(1.2656208 + X1*(-.3163866 + X1*(.0444479 + X1*(-.0039444 + X1*2.1E-4)))))
13
T0 = X - .78539816 + X2*(-.04166397 + X2*(-.3954E-4 + X2*(.00262573 + X2*(-.00054125 + X2*(-.00029333 + X2*0.00013558)))))
14
B = F0*COS(T0) /SQRT(X)
10
15
F0 = B
2
16
X .GE. 3.
TRUE
FALSE
17
X1 = X/3.
X1 = X1*X1
18
B = X*(.5 + X1*(-.56249985 + X1*(.21093573 + X1*(-.03954289 + X1*(.00443319 + X1*(-.31761E-3 + X1*0.1109E-4)))))))
19
19
X2 = 3./X
F1 = .79788456 + X2*(.156E-5 + X2*(.01659667 + X2*(.00017105 + X2*(-.00249511 + X2*(.00113653 - .00020033*X2)))))
20
T1 = X - 2.35619449 + X2*(.12499612 + X2*(.565E-4 + X2*(-.00637879 + X2*(.00074348 + X2*(.00079824 - 0.00029166*X2)))))
21
B = F1*COS(T1) /SQRT(X)
20
22
B1 = B*S
X = X*S
B2 = (2./X)*B1 - B0
50
23
EXIT

CHART TITLE - COMPLEX FUNCTION F(TAU)

L-94

```
          COMPUTES FTAU WHERE
          FTAU
          =(EXP(-J*TAU**2)
          /2*TAU)*SQRT(PI/2.)*
          (C2(TAU**2) +                 *------------------->*
          J*S2(TAU**2))                 |           20       | NOTE  07
                                        |           * * * * * * * * * * *
                     *                  |           *      CONTINUE     *
                     |            02    |           * * * * * * * * * * *
          *----------------------*      |                    |
          |        PI =          |      |                    |
          | 3.14159265358979     |      |                    |
          |                      |      |           FOR TAUS .LE. 0.5,
          |     PIO2 = PI/2.     |      |           FUNCTION IS EXPANDED
          |                      |      |           IN SERIES AND FIRST
          |  C1 = SQRT(PI/2.)    |      |           FEW
          |                      |      |           TERMS INTEGRATED TERM
          |      C2 = 1./C1      |      |           BY TERM TO OBTAIN
          |                      |      |           RESULT
          |  ATAUS = ABS(TAU)    |      |                    |
          *----------------------*      |                    |
                     |                  |                    |            08
                     |                  |           *----------------------*
                     |                  |           |        FP =          |
                     *   03             |           | CMPLX(COS(TAU), -    |
                  *     *               |           |    SIN(TAU))         |
               *           *            |           |                      |
            *                 *  TRUE   |           |     TS = TAU*TAU     |
          *   ATAUS .LE.        *-------*           |                      |
            *    0.5          *                     | FR = 1 - TS*(.1 -    |
               *           *                        |  .0046296296*TS)     |
                  *     *                           *----------------------*
                     *                                       |
                     |FALSE                                  |
                     |                                       |            09
                     |                              *----------------------*
                     |                              |        FI =          |
                     |                              | TAU*(.333333333 -    |
                     |                              | TS*(.0238095238 -    |
                     |                              | 7.57575757E-4*TS)    |
          FOR TAUS .GT. 0.5,                        |        )             |
          FUNCTION COMPUTED                         |                      |
```

```
FOR TAUS .GT. 0.5,
FUNCTION COMPUTED
USING POLYNOMIAL
APPROXIMATION
 * REFERENCE (HANDBK
MATH FUNCT BY
ABRAMOWITZ AND
STEGUN,
 *
SECTIONS
7.3.9,7.3.10,7.3.32,
7.3.33)

04
TAUS =
SQRT(ATAUS)

X = C2*TAUS

XS = X*X

05
FX = (1.0 +
0.926*X)/(2.0 +
1.792*X +
3.104*XS)

GX = 1.0/(2.0 +
4.142*X +
3.492*XS +
6.67*X*XS)

06
CC1XS =
COS(ATAUS)

SC1XS =
SIN(ATAUS)

09
FI =
TAU*(.333333333 -
TS*(.0238095238 -
7.57575757E-4*TS)
)

B = CMPLX(FR,FI)

F = FP*B

10
* EXIT *

11
CX = 0.5 +
FX*SC1XS -
GX*CC1XS

SX = 0.5 -
FX*CC1XS -
GX*SC1XS

12
* TAU .LT. 0.0 *   TRUE ---> 10 (NOTE 15)
FALSE

10 CONTINUE   NOTE 15

13
B = CMPLX(CX,SX)

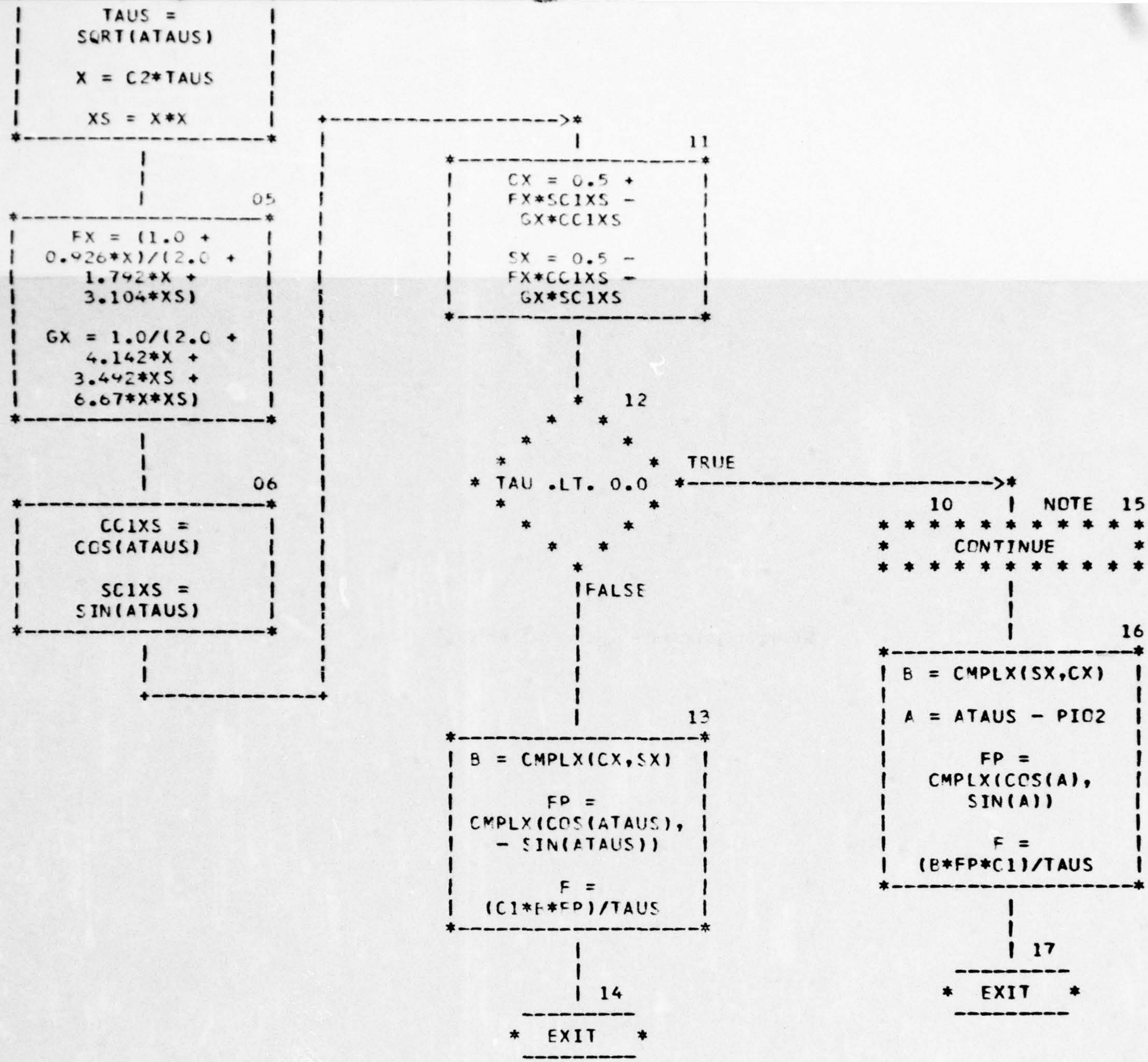
FP =
CMPLX(COS(ATAUS),
- SIN(ATAUS))

16
B = CMPLX(SX,CX)

A = ATAUS - PIO2

FP =
CMPLX(COS(A),
SIN(A))

F =
```


TAUS = SQRT(ATAUS)
X = C2*TAUS
XS = X*X
05
FX = (1.0 + 0.926*X)/(2.0 + 1.792*X + 3.104*XS)
GX = 1.0/(2.0 + 4.142*X + 3.492*XS + 6.67*X*XS)
06
CC1XS = COS(ATAUS)
SC1XS = SIN(ATAUS)
11
CX = 0.5 + FX*SC1XS - GX*CC1XS
SX = 0.5 - FX*CC1XS - GX*SC1XS
12
TAU .LT. 0.0
TRUE
FALSE
10
NOTE
15
CONTINUE
13
B = CMPLX(CX,SX)
FP = CMPLX(COS(ATAUS), - SIN(ATAUS))
F = (C1*B*FP)/TAUS
14
EXIT
16
B = CMPLX(SX,CX)
A = ATAUS - PIO2
FP = CMPLX(COS(A), SIN(A))
F = (B*FP*C1)/TAUS
17
EXIT

04/26/76 AUTOFLOW CHART SET

CHART TITLE - NON-PROCEDURAL STATEMENTS

COMPLEX B, FP

L-95

/

AUTOFLOW CHART SET - FWO/SCL RADSIM

ILE - NON-PROCEDURAL STATEMENTS

COMPLEX B, FP

L-95

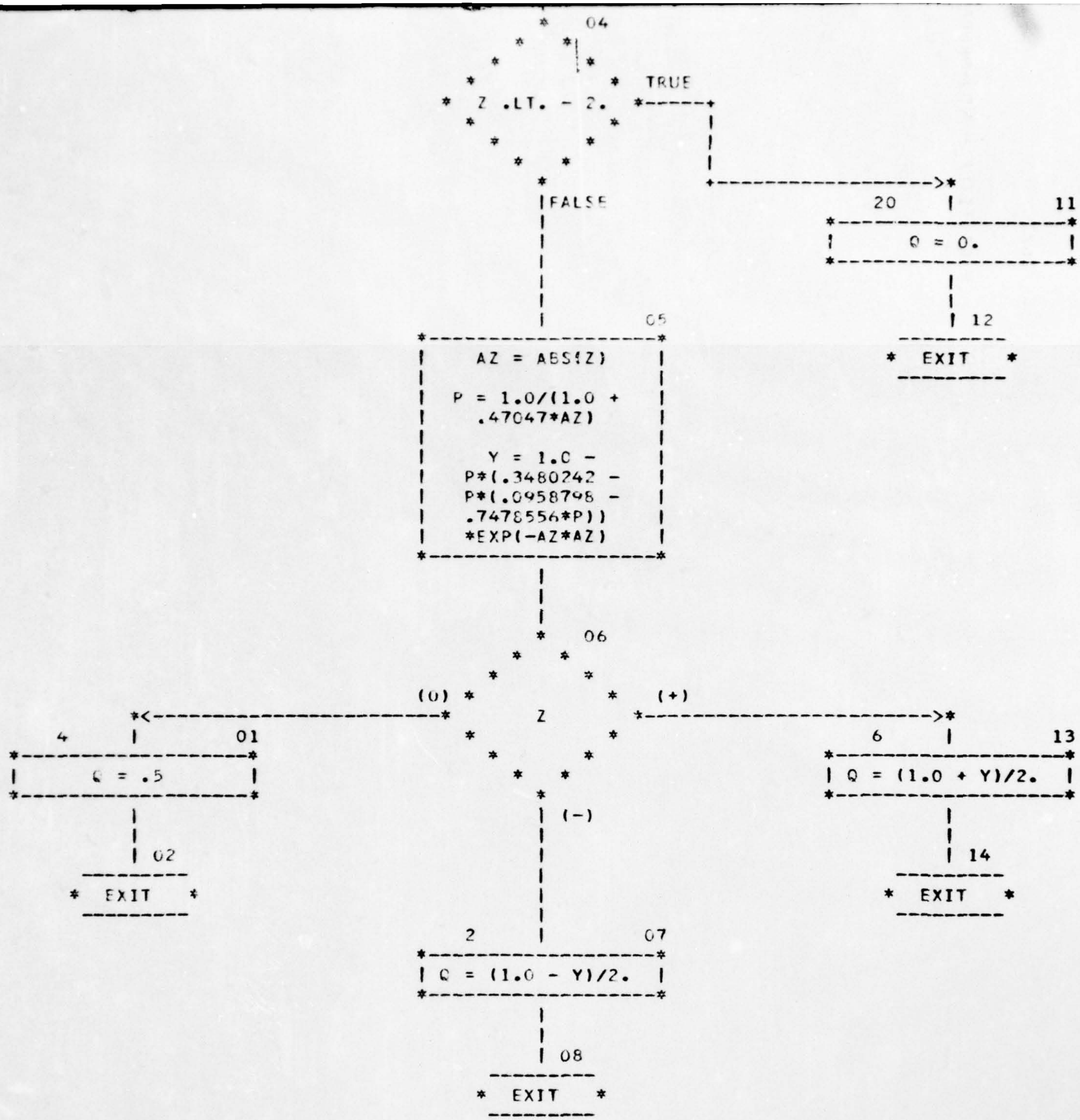
2

CHART TITLE - FUNCTION Q(Z)

L-96

```
                                          Q(Z) = 0.5*(1 +
                                          ERF(Z))
                                           * ERF(Z) IS
                                          EVALUATED USING A
                                          RATIONAL POLYNOMIAL
                                          APPROXIMATION
                                           * REFERENCE (HANDBK
                                          MATH FUNCT BY
                                          ABRAMOWITZ AND
                                          STEGUN,
                                           *         SECTION
                                          7.1.26)

                                                 *
                                                 I
                                                 *   03
                                               *   *
                                             *       *
                                           *           *  TRUE
                                         *   Z .GT. 2.   *------------------->*
                                           *           *             10      I          09
                                             *       *               *-------------------*
                                               *   *                 I       Q = 1.      I
                                                 *                   *-------------------*
                                                 IFALSE                      I
                                                 I                           I
                                                 I                           I 10
                                                 I                        ---------
                                                 I                      *   EXIT   *
                                                 I                        ---------
                                                 *   04
                                               *   *
                                             *       *
                                           *           *  TRUE
                                         *   Z .LT. - 2.  *-----+
                                           *           *        I
                                             *       *          I
                                               *   *            I
                                                 *              +------------------>*
```


04
Z .LT. - 2.
TRUE
FALSE
20
11
Q = 0.
12
EXIT
05
AZ = ABS(Z)
P = 1.0/(1.0 + .47047*AZ)
Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P)) *EXP(-AZ*AZ)
06
Z
(0)
(+)
(-)
4
01
Q = .5
02
EXIT
6
13
Q = (1.0 + Y)/2.
14
EXIT
2
07
Q = (1.0 - Y)/2.
08
EXIT

AD-A031 440 GENERAL DYNAMICS FORT WORTH TEX CONVAIR AEROSPACE DIV F/G 17/9
ENDO ATMOSPHERIC EXO ATMOSPHERIC RADAR MODELING. RADAR CROSS SE--ETC(U)
JUN 76 R J HANCOCK, F H CLEVELAND F30602-73-C-0380
UNCLASSIFIED RADC-TR-76-186-VOL-4-PT-2 NL

3 OF 4
AD
A031440

```
      SUBROUTINE TARGET (EVVR, EVVI, EHHR, EHHI)                           RCS7 001
C                                                                          RCS7 002
C * * *        ST-3A -- FRUSTRA-CYLINDER-FRUSTRA (UFIMTSEV)          * * * RCS7 003
C                                                                          RCS7 004
      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, TO                          RCS7 005
C     NMIN = MINIMUM FREQUENCY SAMPLE                                      RCS7 006
C     NMAX = MAXIMUM FREQUENCY SAMPLE                                      RCS7 007
C     DF   = FREQUENCY INCREMENT IN MHZ                                    RCS7 008
C     FC   = CARRIER FREQUENCY IN GHZ                                      RCS7 009
C                                                                          RCS7 010
      COMPLEX TERM1P, TERM1M, TERM2P, TERM2M, TERM4P, TERM4M, PHASE1,     RCS7 011
     1 PHASE2,PHASE3, PHASE4, FFVV01, FFVV02, FFVV03, FFVV04, FFVV05,     RCS7 012
     2 FFVV06,FFVV07, FFVV08, FFVV09, FFVV10, FFVV11, FFVV12, FFVV13,     RCS7 013
     3 FFVV14,FFVV15, FFVV16, FFVV17, FFVV18, FFVV19, FFVV20, FFVV21,     RCS7 014
     4 FFVV22,FFHH01, FFHH02, FFHH03, FFHH04, FFHH05, FFHH06, FFHH07,     RCS7 015
     5 FFHH08,FFHH09, FFHH10, FFHH11, FFHH12, FFHH13, FFHH14, FFHH15,     RCS7 016
     6 FFHH16,FFHH17, FFHH18, FFHH19, FFHH20, FFHH21, FFHH22, FFVV,       RCS7 017
     7 FFHH,  CFVV,   CFHH,   FTAU1,  FTAU2,  FTAU3,  FTAU4,  FTAU5,      RCS7 018
     8 FTAU6, FTAU7,  FTAU8                                                RCS7 019
      COMPLEX F                                                            RCS7 020
C                                                                          RCS7 021
      DIMENSION EVVR(512), EVVI(512), EHHR(512), EHHI(512)                 RCS7 022
C                                                                          RCS7 023
C * * * ALL DIMENSIONS ARE IN INCHES AND ALL ANGLES ARE IN DEGREES    * * RCS7 024
```

```
      COMPLEX TERM1P, TERM1M, TERM2P, TERM2M, TERM4P, TERM4M, PHASE1,   RCS7 011
     1 PHASE2,PHASE3, PHASE4, FFVV01, FFVV02, FFVV03, FFVV04, FFVV05,   RCS7 012
     2 FFVV06,FFVV07, FFVV08, FFVV09, FFVV10, FFVV11, FFVV12, FFVV13,   RCS7 013
     3 FFVV14,FFVV15, FFVV16, FFVV17, FFVV18, FFVV19, FFVV20, FFVV21,   RCS7 014
     4 FFVV22,FFHH01, FFHH02, FFHH03, FFHH04, FFHH05, FFHH06, FFHH07,   RCS7 015
     5 FFHH08,FFHH09, FFHH10, FFHH11, FFHH12, FFHH13, FFHH14, FFHH15,   RCS7 016
     6 FFHH16,FFHH17, FFHH18, FFHH19, FFHH20, FFHH21, FFHH22, FFVV,     RCS7 017
     7 FFHH,  CFVV,   CFHH,   FTAU1,  FTAU2,  FTAU3,  FTAU4,  FTAU5,    RCS7 018
     8 FTAU6, FTAU7,  FTAU8                                             RCS7 019
      COMPLEX F                                                         RCS7 020
C                                                                       RCS7 021
      DIMENSION EVVR(512), EVVI(512), EHHR(512), EHHI(512)              RCS7 022
C                                                                       RCS7 023
C * * * ALL DIMENSIONS ARE IN INCHES AND ALL ANGLES ARE IN DEGREES   * * RCS7 024
C                                                                       RCS7 025
      READ(5,1000) ASPECT,A1,A2,A4,H1,H2,H3,H4,H5,M1                    RCS7 026
 1000 FORMAT(9F7.2,I2)                                                  RCS7 028
      WRITE (6,1010) A1,H1,A2,H2,A4,H3                                  RCS7 029
 1010 FORMAT ( 31H1 ' FRUSTRA-CYLINDER-FRUSTRA   ',/                    RCS7 030
     1         30H ' UFIMTSEV-RUCK FORMULATION ',/                      RCS7 031
     2           8H   A1 = ,F8.3, 8H   H1 = ,F8.3,/                     RCS7 032
     3           8H   A2 = ,F8.3, 8H   H2 = ,F8.3,/                     RCS7 033
     4           8H   A4 = ,F8.3, 8H   H3 = ,F8.3,/)                    RCS7 034
C                                                                       RCS7 035
      C      = 11.80285078                                              RCS7 036
      PI     = 3.14159265358979                                         RCS7 037
```

2

L-96a

L-96b

```
      SPI = SQRT(PI)                                                    RCS7 038
      DTR     PI / 180.0                                                RCS7 039
      RTD = 180.0/PI                                                    RCS7 040
      WC      = 2.0 * PI * FC                                           RCS7 041
      XKOO = WC/C                                                       RCS7 042
      X2KO = XKOO+XKOO                                                  RCS7 043
      X2KOA1 = X2KO*A1                                                  RCS7 044
      X2KOA2 = X2KO*A2                                                  RCS7 045
      X2KOA4 = X2KO*A4                                                  RCS7 046
C                                                                       RCS7 047
      THETA  = ASPECT * DTR                                             RCS7 048
      STHT   = SIN(THETA)                                               RCS7 049
      CTHT   = COS(THETA)                                               RCS7 050
      TANATT = STHT / CTHT                                              RCS7 051
C                                                                       RCS7 052
      SHADOW = (A4 - A2) / (H2 + H2 + H3)                               RCS7 053
      SHADOW = ATAN(SHADOW)                                             RCS7 054
      ALPHA1 = ATAN((A2-A1)/H1)                                         RCS7 055
      ALPHA2 = ATAN((A4-A2)/H3)                                         RCS7 056
      X1D = ALPHA1*RTD                                                  RCS7 057
      X2D = ALPHA2*RTD                                                  RCS7 058
      X3D = SHADOW*RTD                                                  RCS7 059
      WRITE (6,2010) ASPECT,X1D,X2D,X3D                                 RCS7 060
 2010 FORMAT ( 18H0  ASPECT ANGLE = , F8.3,/,                           RCS7 061
     1       11H  ALPHA1 = ,F8.3,/, 11H  ALPHA2 = ,F8.3,/,              RCS7 062
```

```
1038      1       11H  ALPHA1 = ,F8.3,/, 11H  ALPHA2 = ,F8.3,/,              RCS7 062
1039      2       19H  SHADOW(ALPHA3) = ,F8.3 )                              RCS7 063
1040    C                                                                    RCS7 064
1041            SA1 = SIN(ALPHA1)                                            RCS7 065
1042            SA2 = SIN(ALPHA2)                                            RCS7 066
1043            A1PT = ALPHA1+THETA                                          RCS7 067
```



```
CARD NO    ****                     CONTENTS                              ****

1044            A1MT = ALPHA1-THETA                                          RCS7 068
1045            A2PT = ALPHA2+THETA                                          RCS7 069
1046            A2MT = ALPHA2-THETA                                          RCS7 070
1047            TANAP1 = TAN(A1PT)                                           RCS7 071
1048            TANAP2 = TAN(A2PT)                                           RCS7 072
1049            CA1PTS = 2.*COS(A1PT)/SA1                                    RCS7 073
1050            CA2PTS = 2.*COS(A2PT)/SA2                                    RCS7 074
1051    C                                                                    RCS7 075
1052            XN1     = 1.5 - (ALPHA1 / PI)                                RCS7 076
1053            XN2     = 1.0 + (ALPHA1 / PI)                                RCS7 077
1054            XN3     = 1.0 - (ALPHA2 / PI)                                RCS7 078
1055            XN4     = 1.5 + (ALPHA2 / PI)                                RCS7 079
1056            CPCN1 = COS(PI/XN1)                                          RCS7 080
1057            CPCN2 = COS(PI/XN2)                                          RCS7 081
```

```
      C                                                               RCS7 075
            XN1    = 1.5 - (ALPHA1 / PI)                              RCS7 076
            XN2    = 1.0 + (ALPHA1 / PI)                              RCS7 077
            XN3    = 1.0 - (ALPHA2 / PI)                              RCS7 078
            XN4    = 1.5 + (ALPHA2 / PI)                              RCS7 079
            CPON1 = COS(PI/XN1)                                       RCS7 080
            CPON2 = COS(PI/XN2)                                       RCS7 081
            CPON3 = COS(PI/XN3)                                       RCS7 082
            CPON4 = COS(PI/XN4)                                       RCS7 083
            TERMO1 = (SIN(PI / XN1)) / XN1                            RCS7 084
            TERMO2 = (SIN(PI / XN2)) / XN2                            RCS7 085
            TERMO3 = (SIN(PI / XN3)) / XN3                            RCS7 086
            TERMO4 = (SIN(PI / XN4)) / XN4                            RCS7 087
      C     COEFNX ARE C(NX) TERMS                                    RCS7 088
            COEFN1= TERMO1/(CPON1 - 1.)                               RCS7 089
            COEFN2= TERMO2/(CPON2 - 1.)                               RCS7 090
            COEFN3= TERMO3/(CPON3 - 1.)                               RCS7 091
            COEFN4= TERMO4/(CPON4 - 1.)                               RCS7 092
      C                                                               RCS7 093
            IF (ASPECT .GT. 90.0) GO TO 10                            RCS7 094
      C                                                               RCS7 095
```

```
C     DIFFRACTION TERMS ( C(N)-/+F(N,PHI) = COEFXX TERMS                RCS7 096
C          COMPUTED HERE FOR THETA.LT. 90                               RCS7 097
      COEF11 = 1.0 / ( CPCN1 - COS((THETA+THETA+PI)/XN1))               RCS7 098
      COEF12 = 1.0 / ( CPCN2 - COS((A1PT + A1PT)    /XN2))              RCS7 099
      COEF13 = 1.0 / ( CPCN3 - COS((THETA + THETA) /XN3))               RCS7 100
      COEF14 = 1.0 / ( CPCN4 - COS((A2PT + A2PT)    /XN4))              RCS7 101
      COEF21 = 1.0 / ( CPCN1 - COS((THETA+THETA-PI)/XN1))               RCS7 102
      COEF22 = 1.0 / ( CPCN2 - COS((A1MT + A1MT)    /XN2))              RCS7 103
      COEF24 = 1.0 / ( CPCN4 - COS((A2MT + A2MT)    /XN4))              RCS7 104
C                                                                       RCS7 105
      COEF1V = COEFN1 - COEF11 * TERMO1                                 RCS7 106
      COEF1H = COEFN1 + COEF11 * TERMO1                                 RCS7 107
      COEF2V = COEFN2 - COEF12 * TERMO2                                 RCS7 108
      COEF2H = COEFN2 + COEF12 * TERMO2                                 RCS7 109
      COEF3V = COEFN3 - COEF13 * TERMO3                                 RCS7 110
      COEF3H = COEFN3 + COEF13 * TERMO3                                 RCS7 111
      COEF4V = COEFN4 - COEF14 * TERMO4                                 RCS7 112
      COEF4H = COEFN4 + COEF14 * TERMO4                                 RCS7 113
      COEF5V = COEFN1 - COEF21 * TERMO1                                 RCS7 114
      COEF5H = COEFN1 + COEF21 * TERMO1                                 RCS7 115
      COEF6V = COEFN2 - COEF22 * TERMO2                                 RCS7 116
      COEF6H = COEFN2 + COEF22 * TERMO2                                 RCS7 117
      COEF7V = COEFN4 - COEF24 * TERMO4                                 RCS7 118
      COEF7H = COEFN4 + COEF24 * TERMO4                                 RCS7 119
C                                                                       RCS7 120
```

```
      COEF7V = COEFN4 - COEF24 * TERM04                                 RCS7 118
      COEF7H = COEFN4 + COEF24 * TERM04                                 RCS7 119
C                                                                       RCS7 120
      TANAM1 = TAN(A1MT)                                                RCS7 121
      TANAM2 = TAN(A2MT)                                                RCS7 122
      CA1MTS = 2.*COS(A1MT)/SA1                                         RCS7 123
      CA2MTS = 2.*COS(A2MT)/SA2                                         RCS7 124
      Q6=C(X2KOA2 * A1MT                )                               RCS7 125
      Q8=C(X2KOA4 * (SHADOW - THETA)    )                               RCS7 126
      GO TO 20                                                          RCS7 127
C                                                                       RCS7 128
C     DIFFRACTION TERMS ( C(N)-/+B(N,PHI) = COEFXX TERMS                RCS7 129
C           COMPUTED HERE FOR THETA.GT. 90                              RCS7 130
   10 COEF31   = 1.0 / (CPON1 - COS(2.0*(PI-A1PT)/XN1))                 RCS7 131
      COEF32   = 1.0 / (CPON2 - COS(2.0*(PI-THETA)/XN2))                RCS7 132
      COEF33   = 1.0 / (CPON3 - COS(2.0*(PI-A2PT)/XN3))                 RCS7 133
      COEF34   = 1.0 / (CPON4 - COS((2.0*THETA - 3.0*PI)/XN4))          RCS7 134
      COEF44   = 1.0 / (CPON4 - COS((2.0*THETA -    PI   )/XN4))        RCS7 135
                                                                        RCS7 136
      COEF1V = COEFN1 - COEF31 * TERM01                                 RCS7 137
      COEF1H = COEFN1 + COEF31 * TERM01                                 RCS7 138
      COEF2V = COEFN2 - COEF32 * TERM02                                 RCS7 139
      COEF2H = COEFN2 + COEF32 * TERM02                                 RCS7 140
      COEF3V = COEFN3 - COEF33 * TERM03                                 RCS7 141
      COEF3H = COEFN3 + COEF33 * TERM03                                 RCS7 142
      COEF4V = COEFN4 - COEF34 * TERM04                                 RCS7 143
      COEF4H = COEFN4 + COEF34 * TERM04                                 RCS7 144
      COEF5V = COEFN4 - COEF44 * TERM04                                 RCS7 145
```

```
C                                                                RCS7 128
C     DIFFRACTION TERMS ( C(N)-/+F(N,PHI) = COEFXX TERMS         RCS7 129
C        COMPUTED HERE FOR THETA.GT. 90                          RCS7 130
   10 COEF31   = 1.0 / (CPON1 - COS(2.0*(PI-A1PT)/XN1))          RCS7 131
      COEF32   = 1.0 / (CPON2 - COS(2.0*(PI-THETA)/XN2))         RCS7 132
      COEF33   = 1.0 / (CPON3 - COS(2.0*(PI-A2PT)/XN3))          RCS7 133
      COEF34   = 1.0 / (CPON4 - COS((2.0*THETA - 3.0*PI)/XN4))   RCS7 134
      COEF44   = 1.0 / (CPON4 - COS((2.0*THETA -   PI  )/XN4))   RCS7 135
                                                                 RCS7 136
      COEF1V = COEFN1 - COEF31 * TERM01                          RCS7 137
      COEF1H = COEFN1 + COEF31 * TERM01                          RCS7 138
      COEF2V = COEFN2 - COEF32 * TERM02                          RCS7 139
      COEF2H = COEFN2 + COEF32 * TERM02                          RCS7 140
      COEF3V = COEFN3 - COEF33 * TERM03                          RCS7 141
      COEF3H = COEFN3 + COEF33 * TERM03                          RCS7 142
      COEF4V = COEFN4 - COEF34 * TERM04                          RCS7 143
      COEF4H = COEFN4 + COEF34 * TERM04                          RCS7 144
      COEF5V = COEFN4 - COEF44 * TERM04                          RCS7 145
      COEF5H = COEFN4 + COEF44 * TERM04                          RCS7 146
C                                                                RCS7 147
      Q1=Q(X2KOA1 * (PI-A1PT)             )                      RCS7 148
      Q2=Q(X2KOA2 * (PI - SHADOW - THETA))                       RCS7 149
      Q3=Q(X2KOA2 * (PI-A2PT)             )                      RCS7 150
   20 CONTINUE                                                   RCS7 151
C                                                                RCS7 152
      DO 900 I = NMIN, NMAX                                      RCS7 153
```

3

L-96C

L-96d

```
      XI     = I - 1                                              RCS7 154
      W      = (2. * PI * XI * DF) / 1000.0                       RCS7 155
      XKO    = W / C                                              RCS7 156
      XKO2C    = XKO * (CTHT + CTHT)                              RCS7 157
C                                                                 RCS7 158
      TAU1     = XKO * A1 * CA1PTS                                RCS7 159
      TAU2     = XKO * A2 * CA1PTS                                RCS7 160
      TAU3     = XKO * A2 * CA2PTS                                RCS7 161
      TAU4     = XKO * A4 * CA2PTS                                RCS7 162
      FTAU1  = F       (TAU1)                                     RCS7 163
      FTAU2  = F       (TAU2)                                     RCS7 164
      FTAU3  = F       (TAU3)                                     RCS7 165
      FTAU4  = F       (TAU4)                                     RCS7 166
C                                                                 RCS7 167
      SI1    = 2.0 * XKO * A1 * STHT                              RCS7 168
      SI2    = 2.0 * XKO * A2 * STHT                              RCS7 169
      SI4    = 2.0 * XKO * A4 * STHT                              RCS7 170
      CALL BESL  (SI1, XJOX1, XJ1X1, XJ2X1)                       RCS7 171
      CALL BESL  (SI2, XJOX2, XJ1X2, XJ2X2)                       RCS7 172
      CALL BESL  (SI4, XJOX4, XJ1X4, XJ2X4)                       RCS7 173
      TERM1P = CMPLX(XJOX1,XJ1X1)                                 RCS7 174
      TERM1M = CONJG(TERM1P)                                      RCS7 175
      TERM2P = CMPLX(XJOX2,XJ1X2)                                 RCS7 176
      TERM2M = CONJG(TERM2P)                                      RCS7 177
      TERM4P = CMPLX(XJOX4,XJ1X4)                                 RCS7 178
```

```
1153              TERM2M = CONJG(TERM2P)
1154              TERM4P = CMPLX(XJ0X4,XJ1X4)                                RCS7 178
1155              TERM4M = CONJG(TERM4P)                                     RCS7 179
1156              TERM5  = XJ0X1 + XJ2X1                                     RCS7 180
1157              TERM6  = XJ0X2 + XJ2X2                                     RCS7 181
1158              TERM7  = XJ0X4 + XJ2X4                                     RCS7 182
1159       C                                                                 RCS7 183
04/26/76    INPUT LISTING                  AUTOFLOW CHART SET - FWD/SCL  RADSIM
 CARD NO    ****                        CONTENTS                              ****
1160              PHI1     = XK02C * (H1+H2)                                 RCS7 184
1161              PHI2     = XK02C * (H2)                                    RCS7 185
1162              PHI3     = PHI2                                            RCS7 186
1163              PHI4     = XK02C * (H2+H3)                                 RCS7 187
1164              PHASE1 = CMPLX(COS(PHI1),-SIN(PHI1))                       RCS7 188
1165              PHASE2 = CMPLX(COS(PHI2),-SIN(PHI2))                       RCS7 189
1166              PHASE3 = CMPLX(COS(PHI3), SIN(PHI3))                       RCS7 190
1167              PHASE4 = CMPLX(COS(PHI4), SIN(PHI4))                       RCS7 191
1168       C                                                                 RCS7 192
1169              IF (ASPECT .GT. 90.0) GO TO 30                             RCS7 193
1170       C                                                                 RCS7 194
1171              TAU5     = XK0 * A1 * CA1MTS                               RCS7 195
1172              TAU6     = XK0 * A2 * CA1MTS                               RCS7 196
1173              TAU7     = XK0 * A2 * CA2MTS                               RCS7 197
1174              TAU8     = XK0 * A4 * CA2MTS                               RCS7 198
1175              FTAU5  = F      (TAU5)                                     RCS7 199
1176              FTAU6  = F      (TAU6)                                     RCS7 200
1177              FTAU7  = F      (TAU7)                                     RCS7 201
```

```
      PHASE1 = CMPLX(COS(PHI1),-SIN(PHI1))                              RCS7 188
      PHASE2 = CMPLX(COS(PHI2),-SIN(PHI2))                              RCS7 189
      PHASE3 = CMPLX(COS(PHI3), SIN(PHI3))                              RCS7 190
      PHASE4 = CMPLX(COS(PHI4), SIN(PHI4))                              RCS7 191
C                                                                       RCS7 192
      IF (ASPECT .GT. 90.0) GO TO 30                                    RCS7 193
C                                                                       RCS7 194
      TAU5     = XKO * A1 * CA1MTS                                      RCS7 195
      TAU6     = XKO * A2 * CA1MTS                                      RCS7 196
      TAU7     = XKO * A2 * CA2MTS                                      RCS7 197
      TAU8     = XKO * A4 * CA2MTS                                      RCS7 198
      FTAU5  = F      (TAU5)                                            RCS7 199
      FTAU6  = F      (TAU6)                                            RCS7 200
      FTAU7  = F      (TAU7)                                            RCS7 201
      FTAU8  = F      (TAU8)                                            RCS7 202
C                                                                       RCS7 203
      FFVV01 = A1 * TERM1M * COEF1V * PHASE1                            RCS7 204
      FFHH01 = A1 * TERM1M * COEF1H * PHASE1                            RCS7 205
      FFVV02 = A2 * TERM2M * COEF2V * PHASE2                            RCS7 206
      FFHH02 = A2 * TERM2M * COEF2H * PHASE2                            RCS7 207
      FFVV03 = A2 * TERM2M * COEF3V * PHASE3                            RCS7 208
      FFHH03 = A2 * TERM2M * COEF3H * PHASE3                            RCS7 209
      FFVV04 = A4 * TERM4M * COEF4V * PHASE4                            RCS7 210
      FFHH04 = A4 * TERM4M * COEF4H * PHASE4                            RCS7 211
```

```
      FFVV05 = A1 * TERM1P * COEF5V * PHASE1                          RCS7 212
      FFHH05 = A1 * TERM1P * COEF5H * PHASE1                          RCS7 213
      FFVV06 = A2 * TERM2P * COEF6V * PHASE2 * Q6                     RCS7 214
      FFHH06 = A2 * TERM2P * COEF6H * PHASE2 * Q6                     RCS7 215
      FFVV07 = A4 * TERM4P * COEF7V * PHASE4 * Q8                     RCS7 216
      FFHH07 = A4 * TERM4P * COEF7H * PHASE4 * Q8                     RCS7 217
      FFVV08 = A1 * TERM1M * TANAP1 * ( 0.5) * FTAU1 * PHASE1         RCS7 218
      FFHH08 = -FFVV08                                                RCS7 219
      FFVV09 = A2 * TERM2M * TANAP1 * (-0.5) * FTAU2 * PHASE2         RCS7 220
      FFHH09 = -FFVV09                                                RCS7 221
      FFVV10 = A2 * TERM2M * TANAP2 * ( 0.5) * FTAU3 * PHASE3         RCS7 222
      FFHH10 = -FFVV10                                                RCS7 223
      FFVV11 = A4 * TERM4M * TANAP2 * (-0.5) * FTAU4 * PHASE4         RCS7 224
      FFHH11 = -FFVV11                                                RCS7 225
      FFVV12 = A1 * TERM1P * TANAM1 * ( 0.5) * FTAU5 * PHASE1 * Q6    RCS7 226
      FFHH12 = -FFVV12                                                RCS7 227
      FFVV13 = A2 * TERM2P * TANAM1 * (-0.5) * FTAU6 * PHASE2 * Q6    RCS7 228
      FFHH13 = -FFVV13                                                RCS7 229
      FFVV14 = A2 * TERM2P * TANAM2 *(-.5)*(1.-FTAU7)* PHASE3 * Q8    RCS7 230
      FFHH14 = -FFVV14                                                RCS7 231
      FFVV15 = A4 * TERM4P * TANAM2 * (-0.5) * FTAU8 * PHASE4 * Q8    RCS7 232
      FFHH15 = -FFVV15                                                RCS7 233
      FFVV16 = -A1 * COEFN1 * TERM5  * PHASE1                         RCS7 234
      FFHH16 =  FFVV16                                                RCS7 235
      FFVV17 = -A2 * COEFN2 * TERM6  * PHASE2                         RCS7 236
```

```
1210          FFVV16 = -A1 * COEFN1 * TERM5  * PHASE1                       RCS7 234
1211          FFHH16 =  FFVV16                                              RCS7 235
1212          FFVV17 = -A2 * COEFN2 * TERM6  * PHASE2                       RCS7 236
1213          FFHH17 =  FFVV17                                              RCS7 237
1214          FFVV18 = -A2 * COEFN3 * TERM6  * PHASE3                       RCS7 238
1215          FFHH18 =  FFVV18                                              RCS7 239
1216          FFVV19 = -A4 * COEFN4 * TERM7  * PHASE4                       RCS7 240
1217          FFHH19 =  FFVV19                                              RCS7 241
```



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CARD NO     ****                   CONTENTS                                     ****

1218          FFVV20 = -A1 * COEFN1 * TERM5  * PHASE1                       RCS7 242
1219          FFHH20 =  FFVV20                                              RCS7 243
1220          FFVV21 = -A2 * COEFN2 * TERM6  * PHASE2 * Q6                  RCS7 244
1221          FFHH21 =  FFVV21                                              RCS7 245
1222          FFVV22 = -A4 * COEFN4 * TERM7  * PHASE4 * Q8                  RCS7 246
1223          FFHH22 =  FFVV22                                              RCS7 247
1224    C                                                                   RCS7 248
1225          FFVV   = FFVV01 + FFVV02 + FFVV03 + FFVV04 + FFVV05 + FFVV06 +  RCS7 249
1226         1         FFVV07 + FFVV08 + FFVV09 + FFVV10 + FFVV11 + FFVV12 +  RCS7 250
1227         2         FFVV13 + FFVV14 + FFVV15 + FFVV16 + FFVV17 + FFVV18 +  RCS7 251
1228         3         FFVV19 + FFVV20 + FFVV21 + FFVV22                      RCS7 252
1229          FFHH   = FFHH01 + FFHH02 + FFHH03 + FFHH04 + FFHH05 + FFHH06 +  RCS7 253
```

```
      FFVV21 = -A2 * COEFN2 * TERM6  * PHASE2 * Q6                     RCS7 244
      FFHH21 =  FFVV21                                                 RCS7 245
      FFVV22 = -A4 * COEFN4 * TERM7  * PHASE4 * Q8                     RCS7 246
      FFHH22 =  FFVV22                                                 RCS7 247
C                                                                      RCS7 248
      FFVV   = FFVV01 + FFVV02 + FFVV03 + FFVV04 + FFVV05 + FFVV06 +   RCS7 249
     1         FFVV07 + FFVV08 + FFVV09 + FFVV10 + FFVV11 + FFVV12 +   RCS7 250
     2         FFVV13 + FFVV14 + FFVV15 + FFVV16 + FFVV17 + FFVV18 +   RCS7 251
     3         FFVV19 + FFVV20 + FFVV21 + FFVV22                       RCS7 252
      FFHH   = FFHH01 + FFHH02 + FFHH03 + FFHH04 + FFHH05 + FFHH06 +   RCS7 253
     1         FFHH07 + FFHH08 + FFHH09 + FFHH10 + FFHH11 + FFHH12 +   RCS7 254
     2         FFHH13 + FFHH14 + FFHH15 + FFHH16 + FFHH17 + FFHH18 +   RCS7 255
     3         FFHH19 + FFHH20 + FFHH21 + FFHH22                       RCS7 256
C                                                                      RCS7 257
      GO TO 40                                                         RCS7 258
C                                                                      RCS7 259
   30 CONTINUE                                                         RCS7 260
      FFVV01 = A1 * TERM1M * COEF1V * PHASE1 * Q1                      RCS7 261
      FFHH01 = A1 * TERM1M * COEF1H * PHASE1 * Q1                      RCS7 262
      FFVV02 = A2 * TERM2M * COEF2V * PHASE2 * Q2                      RCS7 263
      FFHH02 = A2 * TERM2M * COEF2H * PHASE2 * Q2                      RCS7 264
      FFVV03 = A2 * TERM2M * COEF3V * PHASE3 * Q3                      RCS7 265
      FFHH03 = A2 * TERM2M * COEF3H * PHASE3 * Q3                      RCS7 266
      FFVV04 = A4 * TERM4M * COEF4V * PHASE4                           RCS7 267
      FFHH04 = A4 * TERM4M * COEF4H * PHASE4                           RCS7 268
      FFVV05 = A4 * TERM4P * COEF5V * PHASE4                           RCS7 269
```

3

L-96e

```
      FFHH05 = A4 * TERM4P * COEF5H * PHASE4                              RCS7 270
      FFVV06 = A1 * TERM1M * TANAP1 * ( 0.5) * FTAU1 * PHASE1 * Q1        RCS7 271
      FFHH06 = -FFVV06                                                    RCS7 272
      FFVV07 = A2 * TERM2M * TANAP1 * (-0.5) * FTAU2 * PHASE2 * Q1        RCS7 273
      FFHH07 = -FFVV07                                                    RCS7 274
      FFVV08 = A2 * TERM2M * TANAP2 * ( 0.5) * FTAU3 * PHASE3 * Q3        RCS7 275
      FFHH08 = -FFVV08                                                    RCS7 276
      FFVV09 = A2 * TERM2M * TANATT * ( 0.5)         * PHASE3 *(Q2-Q3)    RCS7 277
      FFHH09 = -FFVV09                                                    RCS7 278
      FFVV11 = A4 * TERM4M * TANAP2 * (-0.5) * FTAU4 * PHASE4 * Q3        RCS7 279
      FFHH11 = -FFVV11                                                    RCS7 280
      FFVV12 = -A1 * COEFN1 * TERM5  * PHASE1 * Q1                        RCS7 281
      FFHH12 =  FFVV12                                                    RCS7 282
      FFVV13 = -A2 * COEFN2 * TERM6  * PHASE2 * Q2                        RCS7 283
      FFHH13 =  FFVV13                                                    RCS7 284
      FFVV14 = -A2 * COEFN3 * TERM6  * PHASE3 * Q3                        RCS7 285
      FFHH14 =  FFVV14                                                    RCS7 286
      FFVV15 = -A4 * COEFN4 * TERM7  * PHASE4 *Q8                         RCS7 287
      FFHH15 =  FFVV15                                                    RCS7 288
      FFVV16 = -A4 * COEFN4 * TERM7  * PHASE4                             RCS7 289
      FFHH16 =  FFVV16                                                    RCS7 290
C                                                                         RCS7 291
      FFVV   = FFVV01 + FFVV02 + FFVV03 + FFVV04 + FFVV05 + FFVV06 +      RCS7 292
     1         FFVV07 + FFVV08 + FFVV09          + FFVV11 + FFVV12 +      RCS7 293
```

L-96f

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                                                                                     RCS7 291
1268           FFVV   = FFVV01 + FFVV02 + FFVV03 + FFVV04 + FFVV05 + FFVV06 +        RCS7 292
1269         1          FFVV07 + FFVV08 + FFVV09          + FFVV11 + FFVV12 +        RCS7 293
1270         2          FFVV13 + FFVV14 + FFVV15 + FFVV16                            RCS7 294
1271      C                                                                          RCS7 295
1272           FFHH   = FFHH01 + FFHH02 + FFHH03 + FFHH04 + FFHH05 + FFHH06 +        RCS7 296
1273         1          FFHH07 + FFHH08 + FFHH09          + FFHH11 + FFHH12 +        RCS7 297
1274         2          FFHH13 + FFHH14 + FFHH15 + FFHH16                            RCS7 298
1275      C                                                                          RCS7 299
```

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04/26/76      INPUT LISTING                      AUTOFLOW CHART SET - FWD/SCL  RADSIM

 CARD NO      ****                        CONTENTS                                   ****

 1276     C                                                                          RCS7 300
 1277        40 FFVV   = FFVV * .02539998 * SPI                                      RCS7 301
 1278           FFHH   = FFHH * .02539998 * SPI                                      RCS7 302
 1279     C                                                                          RCS7 303
 1280           CFVV   =-CONJG(FFVV)                                                 RCS7 304
 1281           CFHH   = CONJG(FFHH)                                                 RCS7 305
 1282     C                                                                          RCS7 306
 1283           EVVR(I) =REAL(CFVV)                                                  RCS7 307
 1284           EVVI(I) =AIMAG(CFVV)                                                 RCS7 308
 1285           EHHR(I) =REAL(CFHH)                                                  RCS7 309
 1286           EHHI(I) =AIMAG(CFHH)                                                 RCS7 310
```

```
      FFHH   = FFHH * .02539998 * SP                                    RCS7 302
C                                                                       RCS7 303
      CFVV   =-CONJG(FFVV)                                              RCS7 304
      CFHH   = CONJG(FFHH)                                              RCS7 305
C                                                                       RCS7 306
      EVVR(I) =REAL(CFVV)                                               RCS7 307
      EVVI(I) =AIMAG(CFVV)                                              RCS7 308
      EHHR(I) =REAL(CFHH)                                               RCS7 309
      EHHI(I) =AIMAG(CFHH)                                              RCS7 310
C                                                                       RCS7 311
  900 CONTINUE                                                          RCS7 312
C                                                                       RCS7 313
      RETURN                                                            RCS7 314
      END                                                               RCS7 315
```

3

```
      SUBROUTINE BESL ( X, B0, B1, B2 )                                RCS7 316
C                                                                      RCS7 317
C    * BESSEL FUNCTION SUBROUTINE UTILIZING POLYNOMIAL APPROXIMATIONS  RCS7 318
C    * COMPUTES J0,J1,OR J2 FOR POSITIVE REAL ARGUMENTS                RCS7 319
C    * REFERENCE (HNDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN SECTION 9.4 )RCS7 320
C                                                                      RCS7 321
      S = 1.0                                                          RCS7 322
      IF (X .LT. 0.0) S=-1.0                                           RCS7 323
      X = ABS(X)                                                       RCS7 324
C                                                                      RCS7 325
      IF ( X .GT. 1.E-6 ) GO TO 5                                      RCS7 326
      B0 = 1.0                                                         RCS7 327
      B1 = 0.0                                                         RCS7 328
      B2 = 0.0                                                         RCS7 329
      X = X * S                                                        RCS7 330
      RETURN                                                           RCS7 331
C                                                                      RCS7 332
    5 CONTINUE                                                         RCS7 333
C                                                                      RCS7 334
    1 IF ( X .GE. 3.) GO TO 9                                          RCS7 335
      X1 = X/3.                                                        RCS7 336
      X1 = X1*X1                                                       RCS7 337
      B0 = 1.+ X1*(-2.2499997+ X1*(1.2656208+ X1*(-.3163866+ X1*(.0444479RCS7 338
     1 +      X1*(-.0039444+ X1*2.1E-4 )))) )                          RCS7 339
```

```
1315         1 +      X1*(-.0039444+ X1*2.1E-4 )))) )                        RCS7 339
1316          GO TO 10                                                        RCS7 340
1317     C                                                                    RCS7 341
1318        9 X2 = 3./X                                                       RCS7 342
1319          F0 =  .79788456 +X2*(-.77E-6 +X2*(-.00552740 +X2*(-.9512E-4 +X2*  RCS7 343
1320         1      (.00137237 +X2*(-.72805E-3 +X2*0.14476E-3 )))) )          RCS7 344
1321          T0 = X - .78539816 +X2*(-.04166397 +X2*(-.3954E-4 +X2*(.00262573  RCS7 345
1322         1    +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))        RCS7 346
1323          B = F0*COS(T0)/SQRT(X)                                          RCS7 347
1324     C                                                                    RCS7 348
1325       10 BC = B                                                          RCS7 349
1326     C                                                                    RCS7 350
1327        2 IF ( X .GE. 3. ) GO TO 19                                       RCS7 351
1328          X1 = X/3.                                                       RCS7 352
1329          X1 = X1*X1                                                      RCS7 353
1330          B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*  RCS7 354
1331         1            (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4)))))) )    RCS7 355
1332          GO TO 20                                                        RCS7 356
1333     C                                                                    RCS7 357
```



```
1334       19 X2 = 3./X                                                       RCS7 358
```

```
1328          X1 = X/3.                                                        RCS7 352
1329          X1 = X1*X1                                                       RCS7 353
1330          B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*   RCS7 354
1331         1          (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4))))) )        RCS7 355
1332          GO TO 20                                                         RCS7 356
1333      C                                                                    RCS7 357
```

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```
CARD NO    ****                       CONTENTS                                    ****

1334       19 X2 = 3./X                                                        RCS7 358
1335          F1 = .79788456 +X2*(.156E-5 +X2*(.01659667 +X2*(.00017105 +X2*   RCS7 359
1336         1    (-.00249511 +X2*(.00113653 -.00020033*X2 )))))               RCS7 360
1337          T1 = X - 2.35619449 +X2*(.12499612 +X2*(.565E-4 +X2*(-.00637879  RCS7 361
1338         1    +X2*(.00074348 +X2*(.00079824 -0.00029166*X2 )))))           RCS7 362
1339          B = F1*COS(T1)/SQRT(X)                                           RCS7 363
1340      C                                                                    RCS7 364
1341       20 B1 = B * S                                                       RCS7 365
1342          X = X * S                                                        RCS7 366
1343          B2= (2./X)*B1 - B0                                               RCS7 367
1344       50 RETURN                                                           RCS7 368
1345          END                                                              RCS7 369
```

3

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```
      COMPLEX FUNCTION F(TAU)                                           RCS7 370
C                                                                       RCS7 371
C     COMPUTES FTAU WHERE FTAU =(EXP(-J*TAU**2)/2*TAU)*SQRT(PI/2.)*     RCS7 372
C                                (C2(TAU**2) + J*S2(TAU**2))            RCS7 373
C                                                                       RCS7 374
      COMPLEX B, FP                                                     RCS7 375
      PI = 3.14159265358979                                             RCS7 376
      PIO2 = PI/2.                                                      RCS7 377
      C1 = SQRT(PI/2.)                                                  RCS7 378
      C2 = 1./C1                                                        RCS7 379
      ATAUS = ABS(TAU)                                                  RCS7 380
      IF (ATAUS .LE. 0.5  )GO TO 20                                     RCS7 381
C                                                                       RCS7 382
C     FOR TAUS .GT. 0.5, FUNCTION COMPUTED USING POLYNOMIAL             RCS7 383
C                          APPROXIMATION                                RCS7 384
C   * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,            RCS7 385
C   *          SECTIONS  7.3.9,7.3.10,7.3.32,7.3.33)                    RCS7 386
      TAUS = SQRT(ATAUS)                                                RCS7 387
      X = C2*TAUS                                                       RCS7 388
      XS = X*X                                                          RCS7 389
C                                                                       RCS7 390
      FX = (1.0+0.926*X)/(2.0+1.792*X+3.104*XS)                         RCS7 391
      GX = 1.0/(2.0+4.142*X+3.492*XS+6.67*X*XS)                         RCS7 392
C                                                                       RCS7 393
      CC1XS = COS(ATAUS)                                                RCS7 394
      SC1XS = SIN(ATAUS)                                                RCS7 395
```

```
C                                                                    RCS7 393
      CC1XS = COS(ATAUS)                                             RCS7 394
      SC1XS = SIN(ATAUS)                                             RCS7 395
C                                                                    RCS7 396
      CX = 0.5 + FX*SC1XS - GX*CC1XS                                 RCS7 397
      SX = 0.5 - FX*CC1XS - GX*SC1XS                                 RCS7 398
C                                                                    RCS7 399
      IF (TAU .LT. 0.0) GO TO 10                                     RCS7 400
      B = CMPLX(CX,SX)                                               RCS7 401
      FP = CMPLX(  COS(ATAUS), -SIN(ATAUS) )                         RCS7 402
      F = (C1*B*FP)/TAUS                                             RCS7 403
      RETURN                                                         RCS7 404
C                                                                    RCS7 405
   10 CONTINUE                                                       RCS7 406
      B = CMPLX(SX,CX)                                               RCS7 407
      A = ATAUS-PIO2                                                 RCS7 408
      FP = CMPLX( COS(A),SIN(A) )                                    RCS7 409
      F = (B*FP*C1)/TAUS                                             RCS7 410
      RETURN                                                         RCS7 411
C                                                                    RCS7 412
   20 CONTINUE                                                       RCS7 413
C     FOR TAUS .LE. 0.5, FUNCTION IS EXPANDED IN SERIES AND FIRST FEW   RCS7 414
C                         TERMS INTEGRATED TERM BY TERM TO OBTAIN RESULT RCS7 415
```

```
1384              A = ATAUS-PIO2                                                RCS7 408
1385              FP = CMPLX( COS(A),SIN(A) )                                   RCS7 409
1386              F = (B*FP*C1)/TAUS                                            RCS7 410
1387              RETURN                                                        RCS7 411
1388        C                                                                   RCS7 412
1389           20 CONTINUE                                                      RCS7 413
1390        C     FOR TAUS .LE. 0.5, FUNCTION IS EXPANDED IN SERIES AND FIRST FEW   RCS7 414
1391        C                TERMS INTEGRATED TERM BY TERM TO OBTAIN RESULT     RCS7 415
```

```
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 CARD NO          ****                      CONTENTS                          ****

1392              FP = CMPLX(COS(TAU),-SIN(TAU))                                RCS7 416
1393              TS = TAU*TAU                                                  RCS7 417
1394              FR = 1 - TS*( .1 - .0046296296*TS)                            RCS7 418
1395              FI = TAU *( .333333333 - TS*(.0238095238 - 7.57575757E-4*TS))   RCS7 419
1396              B = CMPLX(FR,FI)                                              RCS7 420
1397              F = FP*B                                                      RCS7 421
1398              RETURN                                                        RCS7 422
1399              END                                                           RCS7 423
```

```
      FUNCTION Q(Z)                                                      RCS7 424
C     Q(Z) = 0.5*(1 + ERF(Z))                                            RCS7 425
C   * ERF(Z) IS EVALUATED USING A RATIONAL POLYNOMIAL APPROXIMATION      RCS7 426
C   * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,            RCS7 427
C   *               SECTION 7.1.26)                                     RCS7 428
C                                                                        RCS7 429
      IF ( Z.GT. 2.) GO TO 10                                            RCS7 430
      IF ( Z.LT.-2.) GO TO 20                                            RCS7 431
      AZ = ABS(Z)                                                        RCS7 432
      P = 1.0/(1.0 + .47047*AZ)                                          RCS7 433
      Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P))*EXP(-AZ*AZ)     RCS7 434
      IF (Z) 2,4,6                                                       RCS7 435
    2 Q = (1.0 - Y)/2.                                                   RCS7 436
      RETURN                                                             RCS7 437
    4 Q = .5                                                             RCS7 438
      RETURN                                                             RCS7 439
    6 Q = (1.0 + Y)/2.                                                   RCS7 440
      RETURN                                                             RCS7 441
   10 Q = 1.                                                             RCS7 442
      RETURN                                                             RCS7 443
   20 Q = 0.                                                             RCS7 444
      RETURN                                                             RCS7 445
      END                                                                RCS7 446
```

L.6 CYLINDER-FRUSTRUM COMBINATION

The far-field scattering from a cylinder-frustrum combination target shown in Figure L.6.1 has been formulated using the Ruck-Ufimtsev technique (Ref. 7). The solution can be represented in the following form:

$$e(\theta) = \mp \sqrt{\pi} \Big\{ g(11) + g(12) + g(1) + g(2) + g(3) + g(4) + g(9) + g(5) + g(6) + g(7) + g(8) \Big\}$$

where g(m) represents the sum of the fringe wave scattering and the physical optics response associated with edge m and the upper and lower signs correspond to vertical and horizontal polarization, respectively.

With the use of the diffraction coefficients at the concave edges (F #1), the expressions for the g(m) are the following:

For $0 < \theta < \pi/2$

$$g(11) = a_1 e^{ip_{11}} \Big\{ JJ_{11+} \Big[C(n_c) \mp B(n_c, \tfrac{\pi}{2} - \theta) \Big] - C(n_c) JJ_{21} \Big\}$$

$$g(12) = a_1 e^{ip_{11}} \Big\{ JJ_{11-} \Big[C(n_c) \mp B(n_c, \tfrac{\pi}{2} + \theta) - C(n_c) JJ_{21} \Big\}$$

$$g(2) = a_2 e^{ip_2} \Big\{ JJ_{12-} \Big[C(n_2) \mp B(n_2, \theta+\alpha) \mp 0.5 \tan(\alpha+\theta) F_2 \Big] - C(n_2) JJ_{22} \Big\}$$

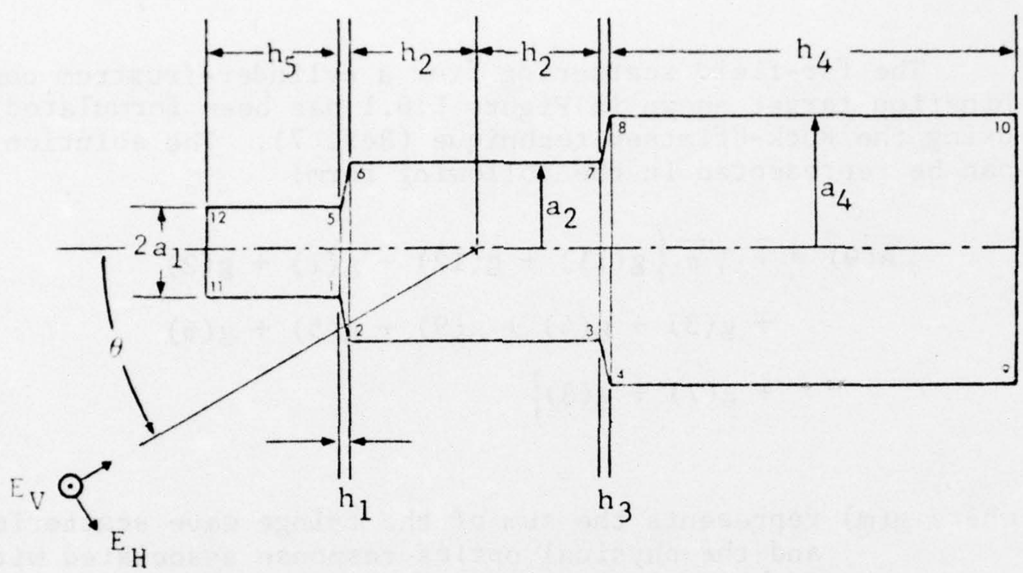

Fig. L.6-1 GEOMETRY OF CYLINDER-FRUSTRUM COMBINATION

$$g(4) = a_4 e^{ip_4} \left\{ JJ_{14-} \left[C(n_4) \mp B(n_4, \theta+\alpha) \mp 0.5 \tan(\alpha+\theta) F_4 \right] - C(n_4) JJ_{24} \right\}$$

$$g(9) = a_4 e^{ip_9} \left\{ JJ_{14-} \left[C(n_c) \mp B(n_c, \theta) \right] - C(n_c) JJ_{24} \right\}$$

$$g(1) = a_1 e^{ip_1} \left\{ JJ_{11-} \left[C(n_1) \mp B(n_1, \theta) \pm 0.5 \tan(\alpha+\theta) F_1 \right] - C(n_1) JJ_{21} \right\}$$

$$g(3) = a_3 e^{ip_3} \left\{ JJ_{12-} \left[C(n_3) \mp B(n_3, \theta) \pm 0.5 \tan(\alpha+\theta) F_3 \right] - C(n_3) JJ_{22} \right\}$$

$$g(5) = a_1 e^{ip_1} \; JJ_{11+} \left\{ \mp 0.5 \tan(\alpha-\theta) \left[1 - F_5 \right] Q_6 \right\}$$

$$g(6) = a_2 e^{ip_2} \left\{ JJ_{12+} \left[C(n_2) \mp B(n_2, \alpha-\theta) \mp 0.5 \tan(\alpha-\theta) F_6 \right] - C(n_2) JJ_{22} \right\} Q_6$$

$$g(7) = a_2 e^{ip_3} \; JJ_{12+} \left\{ \mp 0.5 \tan(\alpha-\theta) \left[1 - F_7 \right] \right\} Q_8$$

$$g(8) = a_4 e^{ip_4} \left\{ JJ_{14+} \left[C(n_4) \mp B(n_4, \alpha-\theta) \mp 0.5 \tan(\alpha-\theta) F_8 \right] - C(n_4) JJ_{24} \right\} Q_8$$

For $\pi/2 < \theta < \pi$

$$g(5) = g(6) = g(7) = g(8) = 0$$

$$g(9) = a_4 e^{ip_9} \left\{ JJ_{14-} \left[C(n_c) \mp B(n_c,\theta) \right] - C(n_c) JJ_{24} \right\}$$

$$g(10) = a_4 e^{ip_9} \left\{ JJ_{14+} \left[C(n_c) \mp B(n_c,\theta-\frac{\pi}{2}) \right] - C(n_c) JJ_{24} \right\}$$

$$g(4) = a_4 e^{ip_4} \left\{ JJ_{14-} \left[C(n_4) \mp B(n_4,\pi-\theta) \mp 0.5 \tan(\alpha+\theta) F_4 Q_1 \right] - C(n_4) JJ_{24} \right\}$$

$$g(2) = a_2 e^{ip_2} \left\{ JJ_{12-} \left[C(n_2) Q_2 \mp B(n_2,\pi-\theta) Q_2 \mp 0.5 \tan(\alpha+\theta) F_2 Q_1 \right] - C(n_2) JJ_{22} Q_2 \right\}$$

$$g(11) = a_1 e^{ip_{11}} \left\{ JJ_{11-} \left[C(n_c) \mp B(n_c,\pi-\theta) \right] - C(n_c) JJ_{21} \right\} Q_{11}$$

$$g(1) = a_1 e^{ip_1} \left\{ JJ_{11-} \left[C(n_1) \mp B(n_1,\pi-\alpha-\theta) \pm 0.5 \tan(\alpha+\theta) F_1 \right] Q_1 - C(n_1) JJ_{21} Q_1 \pm 0.5\, JJ_{11-} \tan\theta\, Q_{11} \left[1-Q_1 \right] \right\}$$

$$g(3) = a_2 e^{ip_3} \left\{ JJ_{12-} \left[C(n_3) \mp B(n_3,\pi-\alpha-\theta) \pm 0.5 \tan(\alpha+\theta) F_3 \right] Q_3 - C(n_3) JJ_{22} Q_3 \pm 0.5\, JJ_{12-} \tan\theta\, Q_2 \left[1-Q_3 \right] \right\}$$

where the upper and lower signs in the previous expressions correspond to vertical and horizontal polarizations, respectively, and

$$C(n) = \frac{\sin\frac{\pi}{n}}{n}\left(\frac{1}{\cos\frac{\pi}{n} - 1}\right)$$

$$B(n,\psi) = \frac{\sin\frac{\pi}{n}}{n}\left(\frac{1}{\cos\frac{\pi}{n} - \cos\frac{2\psi}{n}}\right)$$

$$JJ_{1m\mp} = \left[J_o(2ka_m\sin\theta) \mp i\, J_1(2ka_m\sin\theta)\right]$$

$$JJ_{2m} = \left[J_o(2ka_m\sin\theta) + J_2(2ka_m\sin\theta)\right]$$

$$n_1 = n_3 = 1 - \frac{\alpha}{\pi}$$

$$n_2 = n_4 = 1 + \frac{\alpha}{\pi}$$

$$n_c = 3/2$$

$$p_{11} = -2k(h_1 + h_2 + h_5)\cos\theta$$

$$p_1 = -2k(h_1 + h_2)\cos\theta$$

$$p_2 = -2k\, h_2\cos\theta$$

$$p_3 = 2k\, h_2\cos\theta$$

$$p_4 = 2k(h_2 + h_3)\cos\theta$$

$$p_5 = 2k(h_2 + h_3 + h_4)\cos\theta$$

$$Q_{\begin{pmatrix}6\\8\end{pmatrix}} = Q\left(2ka_{\begin{pmatrix}2\\4\end{pmatrix}}\left(\alpha_{\begin{pmatrix}4\\3\end{pmatrix}} - \theta\right)\right)$$

$$Q_{\begin{pmatrix}1\\2\\11\end{pmatrix}} = Q\left(2ka_{\begin{pmatrix}1\\2\\1\end{pmatrix}}\left(\pi - \alpha_{\begin{pmatrix}1\\3\\4\end{pmatrix}} - \theta\right)\right)$$

$$\tau^2_{\begin{pmatrix}1\\2\\3\\4\end{pmatrix}} = 2ka_{\begin{pmatrix}1\\2\\2\\4\end{pmatrix}} \csc\alpha \cos(\alpha+\theta)$$

$$\tau^2_{\begin{pmatrix}5\\6\\7\\8\end{pmatrix}} = 2ka_{\begin{pmatrix}1\\2\\2\\4\end{pmatrix}} \csc\alpha \cos(\alpha-\theta)$$

$$\alpha = \tan^{-1} \frac{a_2 - a_1}{h_1} = \tan^{-1} \frac{a_4 - a_2}{h_3}$$

$$\alpha_3 = \tan^{-1} \frac{a_4 - a_2}{h_2 + h_2 + h_3}$$

$$\alpha_4 = \tan^{-1} \frac{a_2 - a_1}{h_1 + h_5}$$

$$F_m = F(\tau_m) = \frac{e^{-i\tau^2_m}}{\tau_m} \int_0^{\tau_m} e^{it^2} dt.$$

The expression of the g(m) modified for use in the second formulation (F #2) of the scattering from the concave edges (1, 3, 5, 7) are the following:

For $\theta < \pi/2$

$$g(1) = \pm a_1 e^{ip_1} JJ_{11-} (0.5) \left[\tan(\alpha+\theta) (F_1 - 1) + \tan\theta \right]$$

$$g(3) = \pm a_3 e^{ip_3} JJ_{12-} (0.5) \left[\tan(\alpha+\theta) (F_3 - 1) + \tan\theta \right]$$

For $\theta > \pi/2$

$$g(1) = \pm a_1 e^{ip_1} JJ_{11-} (0.5) \left[\tan(\alpha+\theta) (F_1 - 1) + \tan\theta \right] Q_1$$

$$g(3) = \pm a_3 e^{ip_3} JJ_{12-} (0.5) \left[\tan(\alpha+\theta) (F_3 - 1) + \tan\theta \right] Q_1.$$

The formulations of the basic scattering from Target ST-2 involved only first-order diffraction and were obtained by using the Ruck-Ufimtsev technique. Such higher order scattering as multiple diffraction among the edges, multiple reflection between the surfaces, or scattering mechanisms involving both a creep path along the surface and edge diffraction have not been modeled. However, by comparing the signatures computed from the basic formulation with wideband measurements data, the significance of the higher-order scattering mechanisms could be determined and a decision can be made concerning which is the better formulation of the basic scattering from the concaves edges.

L.6.1 Inputs

The subroutine input parameters are read from cards or passed in a common block. The parameters passed in the common block include:

NMIN = minimum frequency sample number

NMAX = maximum frequency sample number

DF = frequency increment (in MHz)

FC = carrier frequency (in GHz)

The card inputs are the following:

	MATH SYMBOL	VARIABLE	DEFINITION	COLUMNS
Card 1	θ	Aspect	Azimuth Angle (Degrees)	1-7
	a_1	A1	Radius of smallest cylinder (Inches)	8-14
	a_2	A2	Radius of middle cylinder (Inches)	15-21
	a_4	A4	Radius of largest cylinder (Inches)	22-28
	h_1	H1L	Length of smallest frustrum (Inches)	29-35
	h_2	H2L	Half-length of middle cylinder (Inches)	36-42
	h_3	H3L	Length of largest frustrum (Inches)	43-49
	h_4	H4L	Length of largest cylinder (Inches)	50-56
	h_5	H5L	Length of smallest cylinder (Inches)	57-63

L.6.2 Outputs

The data base output consists of four linear arrays, EVVR, EVVI, EHHR, EHHI, which contain the real and imaginary parts of the vertically and horizontally polarized backscattered fields (in meters) at frequency increments of DF MHz from NMIN*DF to NMAX*DF.

L.6.3 Restrictions

L.6.3.1 Physical Dimensions

All target dimensions should be large with respect to the wavelength of the illuminating field. The target is further restricted such that two frustra form the same angle with the cylindrical surfaces, i. e., $\alpha = \tan^{-1} \frac{a_2 - a_1}{h_1} = \tan^{-1} \frac{a_4 - a_2}{h_3}$.

In addition, the basic shape should not be distorted by choosing α too close to 90 or 0 degrees. A value of $30 < \alpha < 80$ should be maintained.

In determining the shadowing of the various surfaces and edges the target geometry was further restricted such that $\alpha_3 < \alpha_4$ where these angles are defined by the equation. *This restriction applies only to the use of the* Q functions in determining the amplitude weighting of the scattered field terms due to shadowing.

L.6.3.2 Output

The output arrays are passed in the argument list and a value is computed and stored only in locations NMIN to NMAX.

L.6.3.3 Restrictions

The azimuth angle is restricted to the region between 0 and 180 degrees. In addition, the specular azimuths 0, 90, 180, $(90 - \alpha)$ should not be used. In order to compute the response at these angles, an angular offset of approximately 0.01 degrees should be used.

L.6.4 Definition of Selected Terms Used in Subroutine

$$D1 = \cos \pi/n$$

$$D11 = \frac{\sin \pi/n}{n}$$

$$E1 = \frac{1}{\cos \pi/n - 1}$$

where $n = n_1 = n_3 = 1 - \frac{\alpha}{\pi}$

$$\left\{ \begin{matrix} V \\ H \end{matrix} \right\} 1 = C(n_1) \mp B(n_1, \theta) \qquad \text{for } \theta < \pi/2$$

$$PS1 = JJ_{11-} = JJ_{1m\mp} = \left[J_o(2ka_m \sin\theta) \mp i\, J_1(2ka_m \sin\theta) \right]$$

where m = 1 and the upper (-) sign is utilized

$CC1 = C(n_1)\ JJ_{21}$

$CT1 = 0.5 \tan(\alpha + \theta) F_1$

$$C\begin{Bmatrix} V \\ H \end{Bmatrix} 1 = a_1 e^{ip_1} \Big\{ JJ_{11} - \Big[C(n_1) \mp B(n_1,\theta) \pm 0.5 \tan(\alpha+\theta) F_1 \Big]$$

$$- C(n_1) JJ_{21} \Big\} \quad \text{for } \theta < \pi/2$$

$$JJ_{21} = \Big[J_o(2ka_m \sin\theta) + J_2(2ka_m \sin\theta) \Big]$$

where m = 1

L.6.5 Subroutines Used

Subfunctions:

Q (X) returns the value of the exponential smoothing function

Subroutines:

1. BESL (XCx, Bx0, Bx1, Bx2) computes Bessel functions of first three orders for real argument Xcx and returns

   J_0 (XCx) in Bx0

   J_1 (XCx) in Bx1

   J_2 (XCx) in Bx2

2. DIFFC (VX,HX,NX,DX,DX1,EX,PHI) computes

   $$\begin{Bmatrix} VX \\ HX \end{Bmatrix} = C(N) \mp B(NX, PHI)$$

   The inputs are NX, DX, DX1, EX, and PHI and outputs are VX, and HX.

3. FTG (TSx, FTx) computes the Special F function using TSx as argument and returns value in FTx.

```
      SUBROUTINE TARGET  (EVVR,EVVI,EHHR,EHHI )
C     **   RESPONSE OF TARGET ST-2                                **
C     **   COMPUTED UTILIZING THE RUCK-UFIMTSEV EQUATIONS         **
C
      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, T0
C     NMIN = MINIMUM FREQUENCY SAMPLE
C     NMAX = MAXIMUM FREQUENCY SAMPLE
C     DF   = FREQUENCY INCREMENT IN MHZ
C     FC   = CARRIER FREQUENCY IN GHZ
      COMPLEX    PS1, PS2, PS4,PS1P,PS2P,PS4P,  C1,  C2,
     A C4,  C3,  C9, C11, FT1,       FT2, FT4, FT5, FT6, FT7, FT8,
     B CT1, CT2, CT4, CT6, CT8, C1T, C3T, C2FT, C4FT
      COMPLEX    CV1, CH1, CV2, CH2, CV3, CH3, CV4, CH4, CV5, CH5,
     A CV6, CH6, CV7, CH7, CV8, CH8, CV9, CH9,CV10,CH10,CV11,CH11,
     BCV12,CH12,  CV,  CH, CVA, CHA
      REAL N1,N2,NC,ITM
      DIMENSION  EVVR(1), EVVI(1), EHHR(1), EHHI(1)
C
C
C
C     PROGRAM CONSTANTS
C
      PI = 3.14159265358979
      PI2 = PI+PI
      PIO2 = PI/2
      HPI  = .5*PI
      SPI  = SQRT(PI)
      RTD = 180./PI
      DTR = PI/180.
      SHPI = SQRT(HPI)
      SIHPI = 1./SHPI
      ITM =0.0254
      SMIN = 1.E-4
      SMDB = -80.
      C = 11.80285078
C
      READ(5,5001) ASPECT,A1,A2,A4,H1L,H2L,H3L,H4L,H5L,M1
 5001 FORMAT(9F7.2,I2)
      WRITE(6,5010) ASPECT
 5010 FORMAT (  29H1  PROGRAM INPUT PARAMETERS  ,/,
    1           17H  ASPECT ANGLE = , F9.4 )
      WRITE (6,6001) H1L,A1,H2L,A2,H3L,A4,H4L,H5L
 6001 FORMAT( //, 7H  H1 = ,F8.4 ,7H  A1 = ,F8.4,/ ,7H  H2 = ,F8.4 ,
     A   7H  A2 = ,F8.4,/ ,7H  H3 = ,F8.4 , 7H  A4 = ,F8.4,/ ,
     B   7H  H4 = ,F8.4,/ ,7H  H5 = ,F8.4  )
C
      TH = ASPECT*DTR
C
      H12L = H1L + H2L
      H125L = H1L + H2L + H5L
      H23L = H2L + H3L
      H234L = H2L + H3L + H4L
      A21 = A2-A1
      A42 = A4-A2
C
      X1 = ATAN( A21/H1L)
```

```
      X2 = X1
      X3 = ATAN( A42/(H2L+H23L))
      X4 = ATAN( A21/(H1L+H5L))

      PIMX3 = PI-X3
      PIMX4 = PI-X4

      X1D = X1*RTD
      X2D = X2*RTD
      X3D = X3*RTD
      X4D = X4*RTD

      WRITE (6,6005) X1D,X2D,X3D,X4D
 6005 FORMAT ( ///, 8H  X1D = ,F7.3, 8H  X2D = ,F7.3, / ,
     A                 8H  X3D = ,F7.3, 8H  X4D = ,F7.3  )

      N1 = 1.-X1/PI
      N2 = 1.+X1/PI
      NC = 1.5

      D1 = COS(PI/N1)
      D2 = COS(PI/N2)
      DC = -.5

      D11 = 1./(D1-1.)
      D21 = 1./(D2-1.)
      DC1 = -2./3.

      E1 = SIN(PI/N1)/N1
      E2 = SIN(PI/N2)/N2
      EC = SIN(PI/NC)/NC

      STH = SIN(TH)
      CTH = COS(TH)

      X0 =(2.*PI)/C
      AX0=(X0/1000.)
      XAK2 = X0*FC
      AK2A1 =XAK2*A1
      AK2A2 =XAK2*A2
      AK2A4 =XAK2*A4

      XPT  = X1+TH
      C0 = TAN(XPT)*0.5
      TSP = COS(XPT)/SIN(X1)
      IF ( TH .GT. PIO2) GO TO 20
      XMT = X1-TH
      CK0 = 0.5*TAN(XMT)
      TSM = COS(XMT)/SIN(X1)
      Z6 = AK2A2*(X4-TH)
      Z8 = AK2A4*(X3-TH)
      Q8= Q(Z8)
      Q6= Q(Z6)
      DIFFC COMPUTES  C(N)-/+B(N,PHI) TERMS RETURNED AS VX,HX
      CALL DIFFC( V12, H12,NC,DC,DC1,EC, PIO2-TH )
      CALL DIFFC ( V11,H11 ,NC,DC,DC1,EC, PIO2+TH )
      CALL DIFFC ( V1,H1, N1,D1,D11,E1,TH )
      CALL DIFFC ( V2,H2, N2,D2,D21,E2, XPT  )
```

```
      CALL DIFFC ( V9,H9 ,NC,DC,DC1,EC,  TH )
      CALL DIFFC ( V6,H6,  N2,D2,D21,E2,XMT )
      GO TO 30
   20 CONTINUE
      PIMTH = PI-TH
      Z2 = AK2A2*(PIMX3-TH)
      PIMXPT = PI-X1-TH
      Z1 =   AK2A1*PIMXPT*3.
      Z11= AK2A1*(PIMX4-TH)
      Q11= Q(Z11)
      Q2 = Q(Z2)
      Q1 = Q(Z1)
C
      CALL DIFFC ( V9,H9,NC,DC,DC1,EC,  TH )
      CALL DIFFC ( V10,H10,NC,DC,DC1,EC,  TH-PI02 )
      CALL DIFFC ( V4,H4 ,N2,D2,D21,E2, PIMTH )
      CALL DIFFC ( V1,H1,  N1,D1,D11,E1,PIMXPT)
      CALL DIFFC(V11,H11,NC,DC,DC1,EC, PIMTH )
   30 CONTINUE
      DO 50  I= NMIN,NMAX
      XI = I-1
      AK =AX0*XI*DF
      AK2 = 2.0*AK
      AK2A1 = AK2*A1
      AK2A2 = AK2*A2
      AK2A4 = AK2*A4
C
      XC1=AK2A1*STH
      XC2=AK2A2*STH
      XC4=AK2A4*STH
C
      CALL BESL(XC1,B10,B11,B12)
      CALL BESL(XC2,B20,B21,B22)
      CALL BESL(XC4,B40,B41,B42)
C
C     PHASE AND AMPLITUDE TERMS FROM BESSEL FUNCTIONS
      PS1 = CMPLX( B10,-B11)
      PS2 = CMPLX( B20,-B21)
      PS4 = CMPLX( B40,-B41)
      PS1P = CONJG(PS1)
      PS2P = CONJG(PS2)
      PS4P = CONJG(PS4)
C
C     PHASE TERM USING LENGTH ALONG AXIS
      PC1 = -AK2*H12L*CTH
      PC2 = -AK2*H2L*CTH
      PC4 = AK2*H23L*CTH
      PC9 = AK2*H234L*CTH
      PC11=-AK2*H125L*CTH
C
      C1    = CMPLX(COS(PC1),SIN(PC1))
      C2    = CMPLX(COS(PC2),SIN(PC2))
      C4    = CMPLX(COS(PC4),SIN(PC4))
      C3    = CONJG(  C2)
      C9    = CMPLX(COS(PC9),SIN(PC9))
      C11   =  CMPLX(COS(PC11),SIN(PC11))
C
      C1 = A1*SPI*C1
```

```
      C3 = A2*SPI*C3
      C2 = A2*SPI*C2
      C4 = A4*SPI*C4
      C9 = A4*SPI*C9
      C11 = A1*SPI*C11

      CAUSTIC CORRECTION TERMS
      CC11 = EC*DC1*(B10+B12)
      CC1  = E1*D11*(B10+B12)
      CC2  = E2*D21*(B20+B22)
      CC3  = E1*D11*(B20+B22)
      CC4  = E2*D21*(B40+B42)
      CC9  = EC*DC1*(B40+B42)

      TSPP = TSP*AK2
      TS1= A1*TSPP
      TS2= A2*TSPP
      TS4= A4*TSPP

      IF ( TH .GT. PIO2 ) GO TO 450


      CV12 = C11*(V12*PS1P - CC11)
      CH12 = C11*(H12*PS1P - CC11)
      CV11 = C11*(V11*PS1 - CC11)
      CH11 = C11*(H11*PS1 - CC11)

      CALL FTG (TS1,FT1)
      CT1 = C0*FT1
      CV1 = C1*((V1+CT1)*PS1 - CC1)
      CH1 = C1*((H1-CT1)*PS1 - CC1)

      CALL FTG (TS2,FT2)
      CT2 = C0*FT2
      CV3 = C3*((V1+CT2)*PS2 - CC3)
      CH3 = C3*((H1-CT2)*PS2 - CC3)

      CV2 = C2*((V2-CT2)*PS2 - CC2)
      CH2 = C2*((H2+CT2)*PS2 - CC2)

      CALL FTG (TS4,FT4)
      CT4 = C0*FT4
      CV4 = C4*((V2-CT4)*PS4 - CC4)
      CH4 = C4*((H2+CT4)*PS4 - CC4)

      CV9 = C9*(V9*PS4 - CC9)
      CH9 = C9*(H9*PS4 - CC9)

      CV = CV11+CV12+CV1+CV2+CV3+CV4+CV9
      CH = CH11+CH12+CH1+CH2+CH3+CH4+CH9

      IF ( Z6 .LE.-2.)GO TO 801

      TSMM = TSM*AK2
      TS5 =TSMM*A1
      TS6 =TSMM*A2
      TS8 =TSMM*A4
```

```
      CALL FTG(TS6,FT6)
      CT6 = CK0*FT6
      CV6 = C2*((V6-CT6)*PS2P - CC2)*Q6
      CH6 = C2*((H6+CT6)*PS2P - CC2)*Q6

      CALL FTG(TS5,FT5)
      FT5 = CK0*(1.-FT5)*PS1P*C1*Q6
      CV5 = -FT5
      CH5 = +FT5

      FT7 = CK0*(1.-FT6)*PS2P*C3*Q8
      CV7 = -FT7
      CH7 = FT7

      CALL FTG(TS8,FT8)
      CT8 = CK0*FT8
      CV8 = C4*((V6-CT8)*PS4P - CC4)*Q8
      CH8 = C4*((H6+CT8)*PS4P - CC4)*Q8

      CVA = CV5 + CV6 + CV7 + CV8
      CHA = CH5 + CH6 + CH7 + CH8

      CV = CV+CVA
      CH = CH+CHA
      GO TO 801

  456 CONTINUE

C     THETA GREATER THAN PI/2

      CV9 = C9*(V9*PS4 - CC9)
      CH9 = C9*(H9*PS4 - CC9)

      CV10 = C9*(V10*PS4P - CC9)
      CH10 = C9*(H10*PS4P - CC9)

      CV4 = C4*   ( V4*PS4 - CC4)
      CH4 = C4*   ( H4*PS4 - CC4)
      CV = CV9 + CV10 +CV4
      CH = CH9 + CH10 +CH4

      IF (    Z2        .LE. -2.) GO TO 800
      CV11 = C11* (V11*PS1 - CC11)*Q11
      CH11 = C11* (H11*PS1 - CC11)*Q11

      CV2 =    C2* (V4*PS2 - CC2)*Q2
      CH2 =    C2* (H4*PS2 - CC2)*Q2

      CV = CV + CV11 + CV2
      CH = CH + CH11 + CH2
      IF (    Z1 .GT.-2.) GO TO 700
      HTTH = 0.5*(STH/CTH)
      C1T = C1*HTTH*PS1*Q11
      C3T = C3*HTTH*PS2*Q2
      CV = CV + C1T + C3T
```

```
      CH = CH - C1T - C3T
      GO TO 800
C
  700 CONTINUE
C
      CALL FTG (TS1,FT1 )
      CV1 = C1*    ((V1+C0*FT1)*PS1 - CC1 )
      CH1 = C1*    ((H1-C0*FT1)*PS1 - CC1 )
      CALL FTG (TS2,FT2 )
      CV3 = C3*    ((V1+C0*FT2)*PS2 - CC3 )
      CH3 = C3*    ((H1-C0*FT2)*PS2 - CC3 )
C
      C2FT = C2    *C0*FT2*PS2
      CALL FTG (TS4,FT4)
      C4FT = C4    *C0*FT4*PS4
C
      CV = CV +(CV1 + CV3 - C2FT - C4FT)*Q1
      CH = CH +(CH1 + CH3 + C2FT + C4FT)*Q1
C
C
  800 CONTINUE
C
  801 CONTINUE
      CV =-CV*ITM
      CH = CH*ITM
      EVVR(I) = REAL(CV)
      EVVI(I) = -AIMAG(CV)
      EHHR(I) = REAL(CH)
      EHHI(I) = -AIMAG(CH)
   50 CONTINUE
      RETURN
      END
      SUBROUTINE DIFFC ( V,H,N,D,D1,E, PHI )
      REAL N
C
      D2 = 1./(D-COS((PHI+PHI)/N))
      V  = E*(D1-D2)
      H  = E*(D1+D2)
      RETURN
      END
      SUBROUTINE BESL ( X, B0, B1, B2 )
C
C   * BESSEL FUNCTION SUBROUTINE UTILIZING POLYNOMIAL APPROXIMATIONS
C   * COMPUTES J0,J1,OR J2 FOR POSITIVE REAL ARGUMENTS
C   * REFERENCE (HNDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN SECTION 9.4 )
C
C
      S = 1.0
      IF ( X.LT. 0. ) S= -1.
      X = ABS(X)
      IF ( X .GT. 1.E-6 ) GO TO 5
      B0 = 1.0
      B1 = 0.0
      B2 = 0.0
      X = X*S
      RETURN
C
    5 CONTINUE
```

```
C
    1 IF ( X .GE. 3.) GO TO 9
      X1 = X/3.
      X1 = X1*X1
      B = 1. + X1*(-2.2499997+ X1*(1.2656208+ X1*(-.3163866+ X1*(.0444479
     1 +       X1*(-.0039444+ X1*2.1E-4 )))) )
      GO TO 10
C
    9 X2 = 3./X
      F0 =   .79788456 +X2*(-.77E-6 +X2*(-.00552740 +X2*(-.9512E-4 +X2*
     1        (.00137237 +X2*(-.72805E-3 +X2*0.14476E-3 )))) )
      T0 = X - .78539816 +X2*(-.04166397 +X2*(-.3954E-4 +X2*(.00262573
     1      +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))
      B = F0*COS(T0)/SQRT(X)
C
   10 B0 = B
C
    2 IF ( X .GE. 3. ) GO TO 19
      X1 = X/3.
      X1 = X1*X1
      B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*
     1                 (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4)))))) )
      GO TO 20
C
   19 X2 = 3./X
      F1 =  .79788456 +X2*(.156E-5 +X2*(.01659667 +X2*(.00017105 +X2*
     1       (-.00249511 +X2*(.00113653 -.00020033*X2 )))))
      T1 = X - 2.35619449 +X2*(.12499612 +X2*(.565E-4 +X2*(-.00637879
     1      +X2*(.00074348 +X2*(.00079824 -0.00029166*X2 )))))
      B = F1*COS(T1)/SQRT(X)
C
   20 B1 = B*S
      X = X*S
      B2= (2./X)*B1 - B0
   50 RETURN
      END
      SUBROUTINE FTG(TAUS,F)
C
C     COMPUTES FTAU WHERE FTAU =(EXP(-J*TAU**2)/2*TAU)*SQRT(PI/2.)*
C                                   (C2(TAU**2) + J*S2(TAU**2))
C
      COMPLEX F,FP
      PI = 3.14159265358979
      PIO2 = PI/2.
      C1 = SQRT(PI/2.)
      C2 = 1./C1
      ATAUS = ABS(TAUS)
      IF (ATAUS .LE. 0.5 )GO TO 20
C
C     FOR TAUS .GT. 0.5, FUNCTION COMPUTED USING POLYNOMIAL
C   * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,
C   *               SECTIONS  7.3.9,7.3.10,7.3.32,7.3.33)
      TAU = SQRT(ATAUS)
      X = C2*TAU
      XS = X*X
C
      FX = (1.0+0.926*X)/(2.0+1.792*X+3.104*XS)
      GX = 1.0/(2.0+4.142*X+3.492*XS+6.67*X*XS)
```

```
C
      CC1XS = COS(ATAUS)
      SC1XS = SIN(ATAUS)
C
      CX = 0.5 + FX*SC1XS - GX*CC1XS
      SX = 0.5 - FX*CC1XS - GX*SC1XS
C
      IF (TAUS .LT. 0.) GO TO 10
      F= CMPLX( CX,SX)
      FP = CMPLX(  COS(ATAUS), -SIN(ATAUS) )
      F =(C1*F*FP)/TAU
      RETURN
C
   10 CONTINUE
      F = CMPLX(SX,CX)
      A = ATAUS-PIO2
      FP = CMPLX( COS(A),SIN(A) )
      F = (F*FP*C1)/TAU
      RETURN
C
C     FOR TAUS .LE. 0.5, FUNCTION IS EXPANDED IN SERIES AND FIRST FEW
C                        TERMS INTEGRATED TERM BY TERM TO OBTAIN RESULT
   20 CONTINUE
      FP = CMPLX( COS(TAUS),-SIN(TAUS) )
      TS = TAUS*TAUS
      FR = 1 - TS*( .1 - .0046296296*TS)
      FI = TAUS*( .333333333 - TS*(.0238095238 - 7.57575757E-4*TS))
      F = CMPLX( FR,FI )
      F = FP*F
      RETURN
      END
      FUNCTION Q(Z)
C     Q(Z) = 0.5*(1 + ERF(Z))
C    * ERF(Z) IS EVALUATED USING A RATIONAL POLYNOMIAL APPROXIMATION
C    * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,
C    *             SECTION 7.1.26)
C
      IF ( Z.GT. 2.) GO TO 10
      IF ( Z.LT.-2.) GO TO 20
      AZ = ABS(Z)
      P = 1.0/(1.0 + .47047*AZ)
      Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P))*EXP(-AZ*AZ)
      IF (Z) 2,4,6
    2 Q = (1.0 - Y)/2.
      RETURN
    4 Q = .5
      RETURN
    6 Q = (1.0 + Y)/2.
      RETURN
   10 Q = 1.
      RETURN
   20 Q = 0.
      RETURN
      END
```

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

/ TARGET /

** RESPONSE OF TARGET ST-2 **

** COMPUTED UTILIZING THE RUCK-UFIMTSEV EQUATIONS **

NMIN = MINIMUM FREQUENCY SAMPLE
NMAX = MAXIMUM FREQUENCY SAMPLE
DF = FREQUENCY INCREMENT IN MHZ
FC = CARRIER FREQUENCY IN GHZ

PROGRAM CONSTANTS

02
```
PI = 3.14159265358979
PI2 = PI + PI
PIO2 = PI/2.
HPI = .5*PI
SPI = SQRT(PI)
```

03
```
RTD = 180./PI
DTR = PI/180.
```

09
```
/ WRITE TO DEV 6 VIA FORMAT 6001 FROM THE LIST /
```

NOTE 10
```
* LIST = H1L, A1, H2L, A2, H3L, A4, H4L, H5L *
```

11
```
TH = ASPECT*DTR
```

12
```
H12L = H1L + H2L
H125L = H1L + H2L + H5L
H23L = H2L + H3L
H234L = H2L + H3L + H4L
```

13
```
A21 = A2 - A1
A42 = A4 - A2
```

19
```
N1 = 1. - X1/PI
N2 = 1. + X1/PI
NC = 1.5
```

20
```
D1 = COS(PI/N1)
D2 = COS(PI/N2)
DC = - .5
```

21
```
D11 = 1./(D1 - 1.)
D21 = 1./(D2 - 1.)
DC1 = - 2./3.
```

22
```
E1 = SIN(PI/N1)/N1
E2 = SIN(PI/N2)/N2
EC = SIN(PI/NC)/NC
```

23

28
```
XMT = X1 - TH
CKO = 0.5*TAN(XMT)
TSM = COS(XMT)/SIN(X1)
Z6 = AK2A2*(X4 - TH)
```

29
```
Z8 = AK2A4*(X3 - TH)
Q8 = Q(Z8)
Q6 = Q(Z6)
```

DIFFC COMPUTES C(N)-/+B(N,PHI) TERMS RETURNED AS VX,HX

30
```
|4 |   DIFFC    H
|4 |            H
```

```
                                                   03
RTD = 180./PI
DTR = PI/180.
SHPI = SQRT(HPI)
SIHPI = 1./SHPI
                                                   04
ITM = 0.0254
SMIN = 1.E - 4
SMDB = - 80.
C = 11.80285078
                                                   05
/ READ FROM DEV 5 VIA FORMAT 5001 INTO THE LIST /
                                              NOTE 06
* LIST = ASPECT, A1, A2, A4, H1L, H2L, H3L, H4L, H5L, M1 *
                                                   07
/ WRITE TO DEV 6 VIA FORMAT 5010 FROM THE LIST /
                                              NOTE 08
* LIST = ASPECT *

A21 = A2 - A1
A42 = A4 - A2
                                                   14
X1 = ATAN(A21/H1L)
X2 = X1
X3 = ATAN(A42/(H2L + H23L))
X4 = ATAN(A21/(H1L + H5L))
                                                   15
PIMX3 = PI - X3
PIMX4 = PI - X4
                                                   16
X1D = X1*RTD
X2D = X2*RTD
X3D = X3*RTD
X4D = X4*RTD
                                                   17
/ WRITE TO DEV 6 VIA FORMAT 6005 FROM THE LIST /
                                              NOTE 18
* LIST = X1D, X2D, X3D, X4D *

EC = SIN(PI/NC)/NC
                                                   23
STH = SIN(TH)
CTH = COS(TH)
                                                   24
X0 = (2.*PI)/C
AX0 = (X0/1000.)
XAK2 = X0*FC
AK2A1 = XAK2*A1
                                                   25
AK2A2 = XAK2*A2
AK2A4 = XAK2*A4
                                                   26
XPT = X1 + TH
CO = TAN(XPT)*0.5
TSP = COS(XPT)/SIN(X1)
                                                   27
* TH .GT. PIO2 *    TRUE
FALSE   . 40 .
        . 01 .
          20

                                                   30
|4| DIFFC (V12,H12,NC, DC,DC1,EC, PIO2 - TH)   H
                                                   31
|4| DIFFC (V11,H11,NC, DC,DC1,EC, PIO2 + TH)   H
                                                   32
|4| DIFFC (V1,H1,N1,D1, D11,E1,TH)             H
                                                   33
|4| DIFFC (V2,H2,N2,D2, D21,E2,XPT)            H
                                                   34
|4| DIFFC (V9,H9,NC,DC, DC1,EC,TH)             H
                                                   35
|4| DIFFC (V6,H6,N2,D2, D21,E2,XMT)            H
                                                   36
.40.09.
... 30
```

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,FHHR,FHHI)

L-116

```
/ 20 /

39.27--->|
NOTE 01
* * * * * * * * * * * *
*       CONTINUE       *
* * * * * * * * * * * *

02
PIMTH = PI - TH
Z2 =
AK2A2*(PIMX3 -
TH)
PIMXPT = PI -
X1 - TH
Z1 =
AK2A1*PIMXPT*3.

03
Z11 =
AK2A1*(PIMX4 -
TH)
Q11 = Q(Z11)
Q2 = Q(Z2)
Q1 = Q(Z1)

04
|4 |   DIFFC            H
|4 |   (V9,H9,NC,DC,    H
|. |   DC1,EC,TH)       H
|0 |                    H
|1 |                    H

05
|4 |                    H
|4 |   DIFFC            H

-----40.10*-->*
11
X1 = I - 1
AK = AX0*XI*DF
AK2 = 2.0*AK
AK2A1 = AK2*A1
AK2A2 = AK2*A2

12
AK2A4 = AK2*A4

13
XC1 = AK2A1*STH
XC2 = AK2A2*STH
XC4 = AK2A4*STH

14
|7 |   BESL             H
|. |   (XC1,B10,B11,    H
|0 |   B12)             H
|1 |                    H

15
|7 |   BESL             H
|. |   (XC2,B20,B21,    H
|0 |   B22)             H
|1 |                    H

------------->*
20
PC1 = -
AK2*H12L*CTH
PC2 = -
AK2*H2L*CTH
PC4 =
AK2*H23L*CTH
PC9 =
AK2*H234L*CTH

21
PC11 = -
AK2*H125L*CTH

22
C1 =
CMPLX(COS(PC1),
SIN(PC1))
C2 =
CMPLX(COS(PC2),
SIN(PC2))
C4 =
CMPLX(COS(PC4),
SIN(PC4))

23
C3 = CONJG(C2)
C9 =
CMPLX(COS(PC9),
SIN(PC9))
C11 =
CMPLX(COS(PC11),
SIN(PC11))

------------->*
27
CC4 =
E2*D21*(B40 +
B42)
CC9 =
EC*DC1*(B40 +
B42)

28
TSPP = TSP*AK2
TS1 = A1*TSPP
TS2 = A2*TSPP
TS4 = A4*TSPP

29
* TH .GT. PIO2 *   TRUE --> ....
                            . 41 .
|FALSE                      . 18 .
                            ....
                            450

30
CV12 =
C11*(V12*PSIP -
CC11)
CH12 =
C11*(H12*PSIP -
CC11)
```

```
DIFFC (V9,H9,NC,DC,DC1,EC,TH)                [4.01]

05
DIFFC (V10,H10,NC,DC,DC1,EC,TH - PIO2)       [44.01]

06
DIFFC (V4,H4,N2,D2,D21,E2,PIMTH)             [44.01]

C7
DIFFC (V1,H1,N1,D1,D11,E1,PIMXPT)            [44.01]

C8
DIFFC (V11,H11,NC,DC,DC1,EC,PIMTH)           [44.01]

39.36--->
30                                NOTE 09
* * * * * * * * * * * *
*       CONTINUE       *
* * * * * * * * * * * *

                                  NOTE 10
* * * * * * * * * * * *
*    BEGIN DO LOOP     *
* 50 I = NMIN, NMAX    *
* * * * * * * * * * * *

15
BESL (XC2,B20,B21,B22)                       [7.01]

16
BESL (XC4,B40,B41,B42)                       [7.01]

PHASE AND AMPLITUDE
TERMS FROM BESSEL
FUNCTIONS

17
PS1 = CMPLX(B10, - B11)
PS2 = CMPLX(B20, - B21)
PS4 = CMPLX(B40, - B41)
PS1P = CONJG(PS1)

18
PS2P = CONJG(PS2)
PS4P = CONJG(PS4)

PHASE TERM USING
LENGTH ALONG AXIS

23
C3 = CONJG(C2)
C9 = CMPLX(COS(PC9), SIN(PC9))
C11 = CMPLX(COS(PC11), SIN(PC11))

24
C1 = A1*SPI*C1
C3 = A2*SPI*C3
C2 = A2*SPI*C2
C4 = A4*SPI*C4

25
C9 = A4*SPI*C9
C11 = A1*SPI*C11

CAUSTIC CORRECTION
TERMS

26
CC11 = EC*DC1*(B10 + B12)
CC1 = E1*D11*(B10 + B12)
CC2 = E2*D21*(B20 + B22)
CC3 = E1*D11*(B20 + B22)

30
CV12 = C11*(V12*PS1P - CC11)
CH12 = C11*(H12*PS1P - CC11)
CV11 = C11*(V11*PS1 - CC11)

31
CH11 = C11*(H11*PS1 - CC11)

32
FTG (TS1,FT1)                                [47.02]

33
CT1 = CO*FT1
CV1 = C1*((V1 + CT1)*PS1 - CC1)
CH1 = C1*((H1 - CT1)*PS1 - CC1)

34
FTG (TS2,FT2)                                [47.02]

/41.01
```

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

```
40.35--->*
01
CT2 = CO*FT2
CV3 = C3*((V1 +
CT2)*PS2 - CC3)
CH3 = C3*((H1 -
CT2)*PS2 - CC3)

02
CV2 = C2*((V2 -
CT2)*PS2 - CC2)
CH2 = C2*((H2 +
CT2)*PS2 - CC2)

03
47.02   FTG
        (TS4,FT4)

04
CT4 = CO*FT4
CV4 = C4*((V2 -
CT4)*PS4 - CC4)
CH4 = C4*((H2 +
CT4)*PS4 - CC4)

05

09
47.02   FTG
        (TS6,FT6)

10
CT6 = CKO*FT6
CV6 = C2*((V6 -
CT6)*PS2P -
CC2)*Q6
CH6 = C2*((H6 +
CT6)*PS2P -
CC2)*Q6

11
47.02   FTG
        (TS5,FT5)

12
FT5 = CKO*(1. -
FT5)*PS1P*C1*Q6
CV5 = - FT5
CH5 = + FT5

/ 450 /
40.29--->
NOTE 18
CONTINUE

THETA GREATER THAN
PI/2

19
CV9 =
C9*(V9*PS4 - CC9)
CH9 =
C9*(H9*PS4 - CC9)

20
CV10 =
C9*(V10*PS4P -
CC9)
CH10 =
C9*(H10*PS4P -
CC9)

21
CV4 =
C4*(V4*PS4 - CC4)
CH4 =
C4*(H4*PS4 - CC4)
CV = CV9 + CV10 +
CV4
CH = CH9 + CH10 +
CH4
```

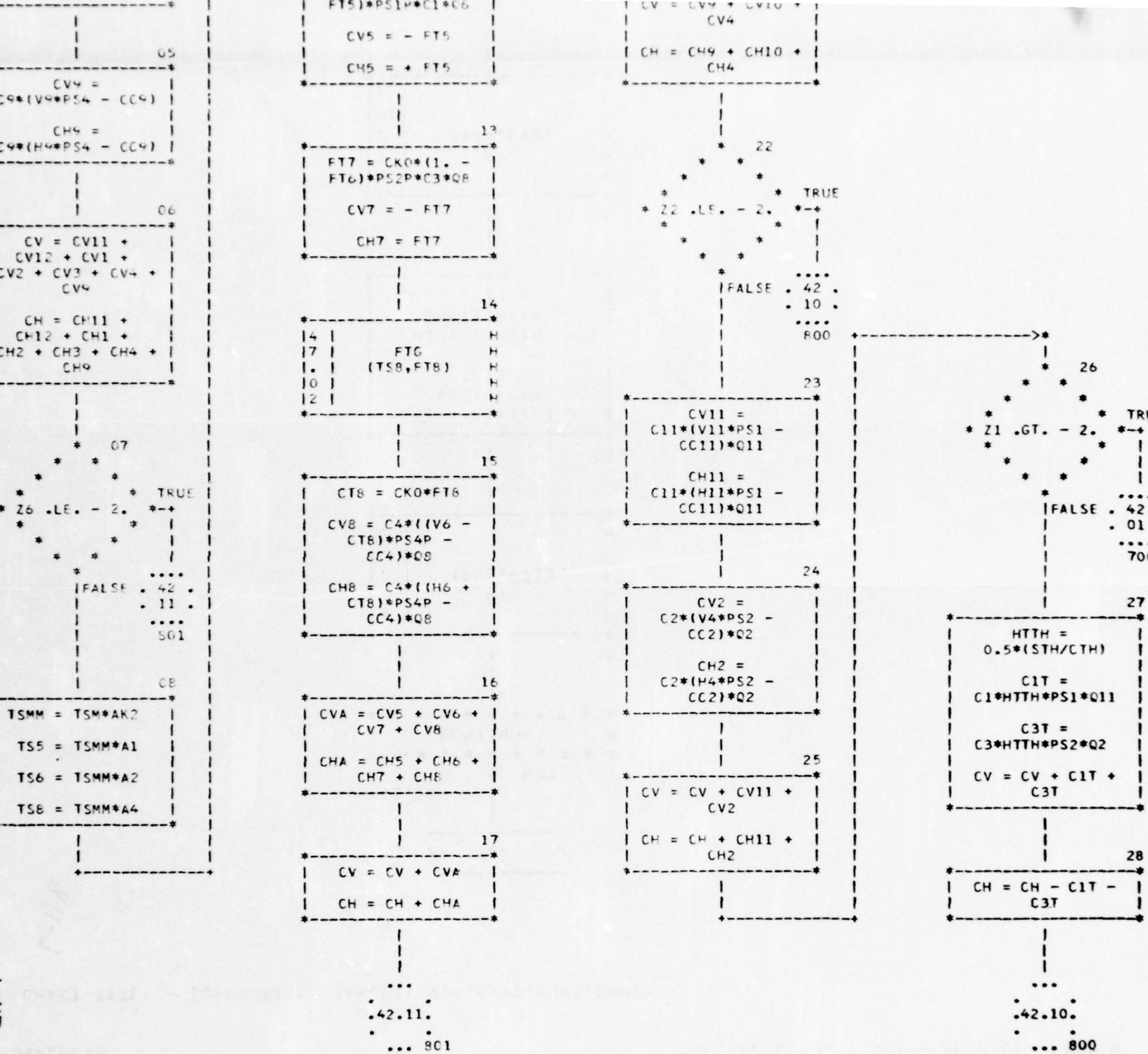
FT5)*PS1P*C1*C6
CV5 = - FT5
CH5 = + FT5
CV = CV9 + CV10 +
CV4
CH = CH9 + CH10 +
CH4
05
CV9 =
C9*(V9*PS4 - CC9)
CH9 =
C9*(H9*PS4 - CC9)
13
FT7 = CK0*(1. -
FT6)*PS2P*C3*Q8
CV7 = - FT7
CH7 = FT7
22
* Z2 .LE. - 2. *
TRUE
FALSE
42
10
800
06
CV = CV11 +
CV12 + CV1 +
CV2 + CV3 + CV4 +
CV9
CH = CH11 +
CH12 + CH1 +
CH2 + CH3 + CH4 +
CH9
14
FT6
(TS8,FT8)
23
CV11 =
C11*(V11*PS1 -
CC11)*Q11
CH11 =
C11*(H11*PS1 -
CC11)*Q11
26
* Z1 .GT. - 2. *
TRUE
FALSE
42
01
700
07
* Z6 .LE. - 2. *
TRUE
FALSE
42
11
801
15
CT8 = CK0*FT8
CV8 = C4*((V6 -
CT8)*PS4P -
CC4)*Q8
CH8 = C4*((H6 +
CT8)*PS4P -
CC4)*Q8
24
CV2 =
C2*(V4*PS2 -
CC2)*Q2
CH2 =
C2*(H4*PS2 -
CC2)*Q2
27
HTTH =
0.5*(STH/CTH)
C1T =
C1*HTTH*PS1*Q11
C3T =
C3*HTTH*PS2*Q2
CV = CV + C1T +
C3T
08
TSMM = TSM*AK2
TS5 = TSMM*A1
TS6 = TSMM*A2
TS8 = TSMM*A4
16
CVA = CV5 + CV6 +
CV7 + CV8
CHA = CH5 + CH6 +
CH7 + CH8
25
CV = CV + CV11 +
CV2
CH = CH + CH11 +
CH2
17
CV = CV + CVA
CH = CH + CHA
28
CH = CH - C1T -
C3T
.42.11.
801
.42.10.
800

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

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```
                  ------------
                 /    700     /
                  ------------
                        |
            41.26--->|
                        |    NOTE   01
            * * * * * * * * * * *
            *      CONTINUE        *
            * * * * * * * * * * *
                        |
                        |
                        |           02
            *------------------------*
            |4 |                     H
            |7 |       FTC           H
            |. |    (TS1,FT1)        H
            |0 |                     H
            |2 |                     H
            *------------------------*
                        |
                        |
                        |           03
            *------------------------*
            |  CV1 = C1*((V1 +       |
            |   C0*FT1)*PS1 -        |
            |        CC1)            |
            |                        |
            |  CH1 = C1*((H1 -       |
            |   C0*FT1)*PS1 -        |
            |        CC1)            |
            *------------------------*
                        |
                        |
                        |           04
            *------------------------*
            |4 |                     H
            |7 |       FTC           H
            |. |    (TS2,FT2)        H
            |0 |                     H
            |2 |                     H
            *------------------------*
                        |
```

```
|. |   (TS2,FT2)     H
|0 |                 H
|2 |                 H
*--------------------*
          |
          |
          |         05
*--------------------*
| CV3 = C3*((V1 +    |
|  CO*FT2)*PS2 -     |
|      CC3)          |
|                    |
| CH3 = C3*((H1 -    |
|  CO*FT2)*PS2 -     |
|      CC3)          |
*--------------------*
          |
          |
          |         06
*--------------------*
|     C2FT =         |
|  C2*CO*FT2*PS2     |
*--------------------*
          |
          |
          |         07
*--------------------*
|4 |                 H
|7 |     FTC         H
|. |   (TS4,FT4)     H
|0 |                 H
|2 |                 H      *--------------------->*
*--------------------*      |                      |        12
          |                 |           *--------------------*
          |                 |           | CV = - CV*ITM      |
          |         08      |           |                    |
*--------------------*      |           | CH = CH*ITM        |
|     C4FT =         |      |           |                    |
|  C4*CO*FT4*PS4     |      |           |  EVVR(I) =         |
*--------------------*      |           |  REAL(CV)          |
          |                 |           |                    |
          |                 |           |  EVVI(I) = -       |
          |         09      |           |   AIMAG(CV)        |
*--------------------*      |           *--------------------*
| CV = CV + (CV1 +   |      |                      |
|  CV3 - C2FT -      |      |                      |
|    C4FT)*Q1        |      |                      |        13
|                    |      |           *--------------------*
| CH = CH + (CH1 +   |      |           |  EHHR(I) =         |
|  CH3 + C2FT +      |      |           |  REAL(CH)          |
|    C4FT)*Q1        |      |           |                    |
*--------------------*      |           |  EHHI(I) = -       |
          |                 |           |   AIMAG(CH)        |
41.22*--->|                 |           *--------------------*
   E00    |    NCIL   10    |                      |
```

```
         |                                          *-------------------*
         |               08       |                 |  CV = - CV*ITM    |
*-------------------*             |                 |                   |
|      C4FT =       |             |                 |  CH = CH*ITM      |
|  C4*C0*FT4*PS4    |             |                 |                   |
*-------------------*             |                 |  EVVR(I) =        |
         |                        |                 |  REAL(CV)         |
         |               09       |                 |                   |
*-------------------*             |                 |  EVVI(I) = -      |
| CV = CV + (CV1 +  |             |                 |  AIMAG(CV)        |
|   CV3 - C2FT -    |             |                 *-------------------*
|     C4FT)*C1      |             |                          |
|                   |             |                          |         13
| CH = CH + (CH1 +  |             |                 *-------------------*
|   CH3 + C2FT +    |             |                 |  EHHR(I) =        |
|     C4FT)*C1      |             |                 |  REAL(CH)         |
*-------------------*             |                 |                   |
         |                        |                 |  EHHI(I) = -      |
 41.22*-->|                       |                 |  AIMAG(CH)        |
   800    |   NOTE  10            |                 *-------------------*
* * * * * * * * * * *             |                          |
*     CONTINUE      *             |                 50       *      14
* * * * * * * * * * *             |                      *       *
         |                        |                   *             *
 41.07*-->|                       |                 *                 *   NO
   801    |   NOTE  11            |              *     END OF DO       *--+
* * * * * * * * * * *             |                 *    LOOP?       *    |
*     CONTINUE      *             |                   *             *     |
* * * * * * * * * * *             |                      *       *        |
         |                        |                          *          ....
         |                        |                          |YES      . 40 .
         +------------------------+                          |         . 11 .
                                                             |          ....
                                                             |
                                                             | 15
                                                         ---------
                                                        *  EXIT   *
                                                         ---------
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
          COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, TO
          COMPLEX    PS1, PS2, PS4,PS1P,PS2P,PS4P,  C1,  C2,
           C4,  C3,  C9, C11, FT1,       FT2, FT4, FT5, FT6, FT7, FT8,
          CT1, CT2, CT4, CT6, CT8, C1T, C2T, C2FT, C4FT
          COMPLEX    CV1, CH1, CV2, CH2, CV3, CH3, CV4, CH4, CV5, CH5,
          CV6, CH6, CV7, CH7, CV8, CH8, CV9, CH9,CV10,CH10,CV11,CH11,
          CV12,CH12,  CV,  CH, CVA, CHA
          REAL N1,N2,NC,ITM
          DIMENSION  FVVR(1), FVVI(1), FHHR(1), FHHI(1)
5001      FORMAT(9F7.2,I2)
5010      FORMAT (  29H1  PROGRAM INPUT PARAMETERS   ,/,
                   17H  ASPECT ANGLE = , F9.4 )
6001      FORMAT( //, 7H  H1 = ,F8.4 ,7H  A1 = ,F8.4,/  ,7H  H2 = ,F8.4 ,
            7H  A2 = ,F8.4,/  ,7H  H3 = ,F8.4 , 7H  A4 = ,F8.4,/  ,
            7H  H4 = ,F8.4,/  ,7H  H5 = ,F8.4  )
6005      FORMAT ( ///, 8H  X1D = ,F7.3, 8H  X2D = ,F7.3, / ,
                      8H  X3D = ,F7.3, 8H  X4D = ,F7.3  )
```

CHART TITLE - SUBROUTINE DIFFC(V,H,N,D,D1,E,PHI)

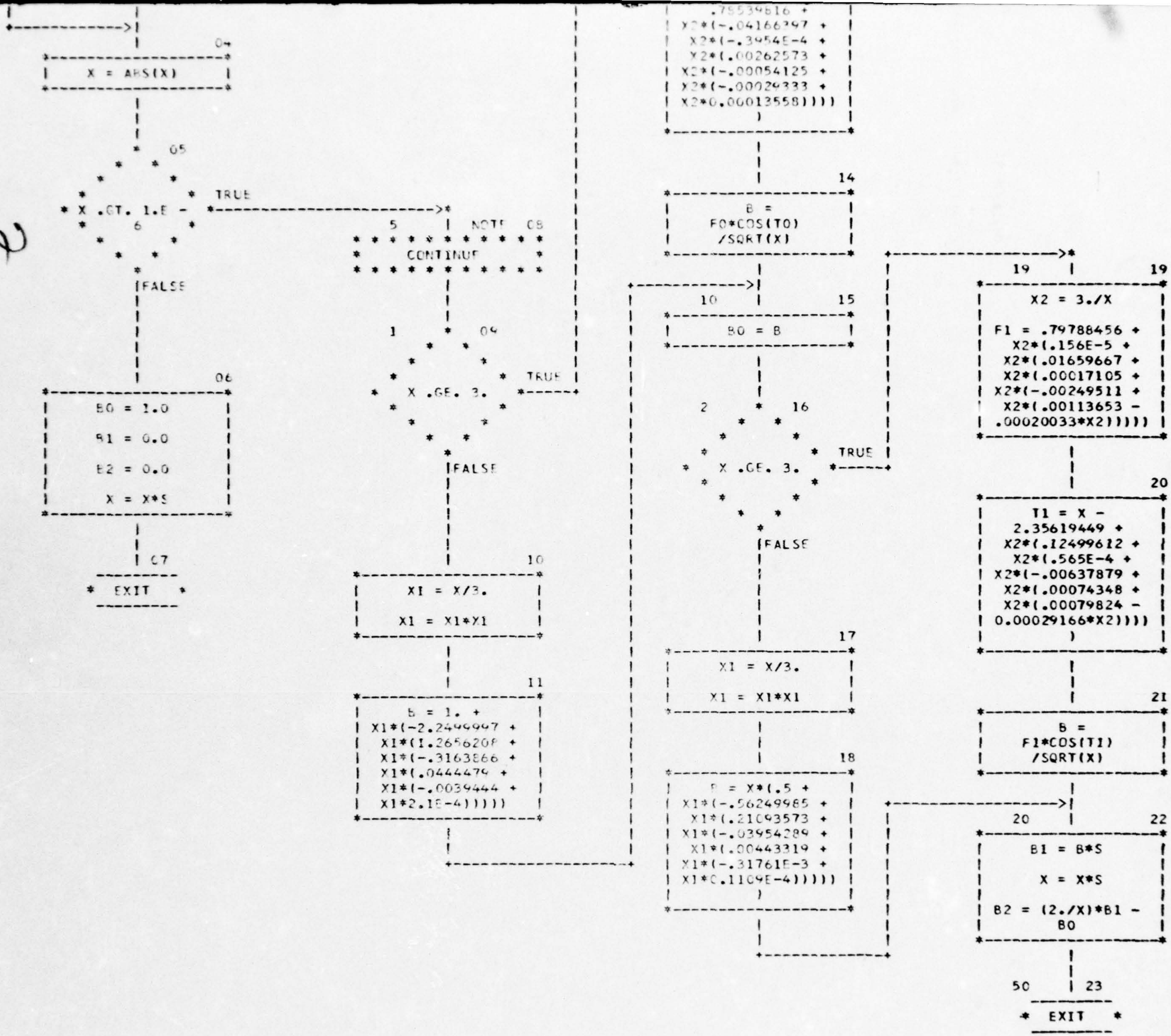
```
              ------------
             /  DIFFC   /
            ------------
                  |
         34.30*-->|
                  |            01
     *-------------------------*
     |     D2 = 1./(D -        |
     |      COS((PHI +         |
     |       PHI)/N))          |
     |                         |
     |   V = E*(D1 - D2)       |
     |                         |
     |   H = E*(D1 + D2)       |
     *-------------------------*
                  |
                  |
                  | 02
              ----------
             *  EXIT    *
              ----------
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

REAL N

CHART TITLE - SUBROUTINE BESL(X,B0,B1,B2)

```
   ------------
  /   BESL    /
  ------------

        *

 * BESSEL FUNCTION
SUBROUTINE UTILIZING
POLYNOMIAL
APPROXIMATIONS
 * COMPUTES J0,J1,OR
J2 FOR POSITIVE REAL
ARGUMENTS
 * REFERENCE (HNDBK
MATH FUNCT BY
ABRAMOWITZ AND STEGUN
SECTION 9.4 )

        *                                   *------------------->*
        |          01                       |          9         |       12
*------------------*                        |     *------------------------*
|     S = 1.0      |                        |     |    X2 = 3./X            |
*------------------*                        |     |                         |
        |                                   |     | F0 = .79788456 +        |
        *  02                               |     |   X2*(-.77E-6 +         |
FALSE *   *                                 |     | X2*(-.00552740 +        |
*-----*  X .LT. 0.  *                       |     |   X2*(-.9512E-4 +       |
|       *   *                               |     |   X2*(.00137237 +       |
|         *                                 |     | X2*(-.72805E-3 +        |
|         |TRUE                             |     | X2*0.14476E-3))))       |
|         |        03                       |     |          )              |
*------------------*                        |     *------------------------*
|     S = - 1.     |                        |                |
*------------------*                        |                |       13
*-------->|                                 |     *------------------------*
          |        04                       |     |    T0 = X -             |
*------------------*                        |     |    .78539816 +          |
|    X = ABS(X)    |                        |     | X2*(-.04166397 +        |
*------------------*                        |     |   X2*(-.39546-4 +       |
          |                                 |     |   X2*(.00262573 +       |
          |                                 |     | X2*(-.00054125 +        |
          *    05                           |     | X2*(-.00029333 +        |
                                            |     | X2*0.00013558))))       |
                                            |     |          )              |
                                            |     *------------------------*
```

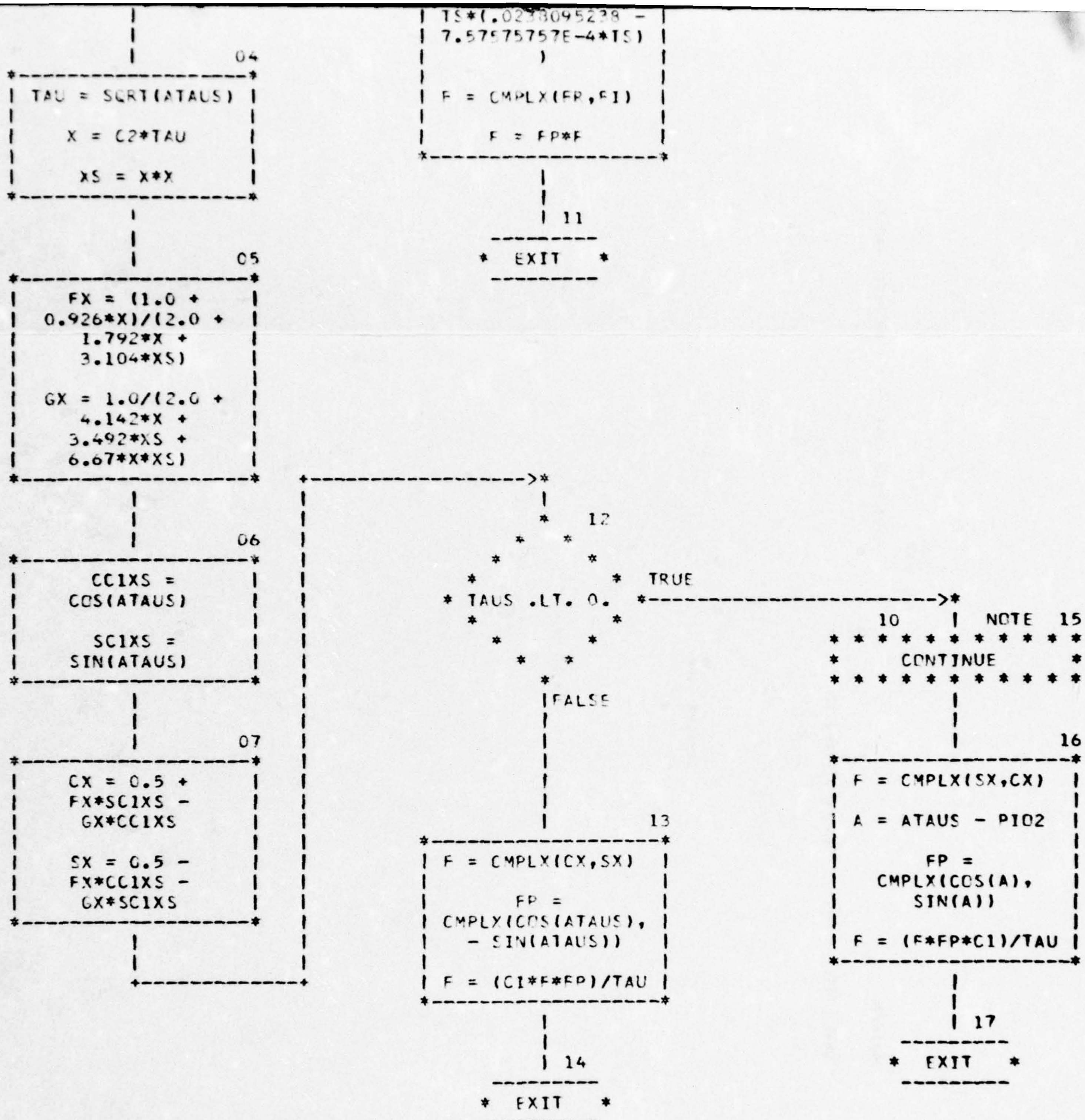


X = ABS(X)
04
X .GT. 1.E - 6
05
TRUE
FALSE
BO = 1.0
B1 = 0.0
B2 = 0.0
X = X*S
06
EXIT
07
5
NOTE 08
CONTINUE
1
X .GE. 3.
09
TRUE
FALSE
X1 = X/3.
X1 = X1*X1
10
B = 1. +
X1*(-2.2499997 +
X1*(1.2656208 +
X1*(-.3163866 +
X1*(.0444479 +
X1*(-.0039444 +
X1*2.1E-4)))))
11
.79539816 +
X2*(-.04166397 +
X2*(-.3954E-4 +
X2*(.00262573 +
X2*(-.00054125 +
X2*(-.00029333 +
X2*0.00013558))))
)
B =
F0*COS(T0)
/SQRT(X)
14
10
BO = B
15
2
X .GE. 3.
16
TRUE
FALSE
X1 = X/3.
X1 = X1*X1
17
B = X*(.5 +
X1*(-.56249985 +
X1*(.21093573 +
X1*(-.03954289 +
X1*(.00443319 +
X1*(-.31761E-3 +
X1*0.1109E-4)))))
)
18
19
X2 = 3./X
F1 = .79788456 +
X2*(.156E-5 +
X2*(.01659667 +
X2*(.00017105 +
X2*(-.00249511 +
X2*(.00113653 -
.00020033*X2)))))
19
T1 = X -
2.35619449 +
X2*(.12499612 +
X2*(.565E-4 +
X2*(-.00637879 +
X2*(.00074348 +
X2*(.00079824 -
0.00029166*X2))))
)
20
B =
F1*COS(T1)
/SQRT(X)
21
20
B1 = B*S
X = X*S
B2 = (2./X)*B1 -
BO
22
50
EXIT
23

CHART TITLE - SUBROUTINE FTG(TAUS,F)

```
           -----------
          /   FTG     /
          -----------

        40.32*-->*

       COMPUTES FTAU WHERE
       FTAU
       =(EXP(-J*TAU**2)
       /2*TAU)*SQRT(PI/2.)*
       (C2(TAU**2) +
       J*S2(TAU**2))

                 *
                 |          02
       *--------------------*
       |       PI =         |
       | 3.14159265358979   |
       |                    |
       |   PIO2 = PI/2.     |
       |                    |
       | C1 = SQRT(PI/2.)   |
       |                    |
       |    C2 = 1./C1      |
       |                    |
       | ATAUS = ABS(TAUS)  |           FOR TAUS .LE. 0.5,
       *--------------------*           FUNCTION IS EXPANDED
                 |                      IN SERIES AND FIRST
                 |                      FEW
                 |                      TERMS INTEGRATED TERM
                 |                      BY TERM TO OBTAIN
                 *   03                 RESULT
               *   *
             *       *       +------------------->*
           *           * TRUE |          20     |  NOTE  08
         *  ATAUS .LE.  *-----+         * * * * * * * * * * *
           *   0.5     *                *      CONTINUE     *
             *       *                  * * * * * * * * * * *
               *   *                              |
                 *                                |
                 |FALSE                           |         09
                 |                      *--------------------*
                 |                      |        FP =        |
                                        | CMPLX(COS(TAUS)-   |
```

```
FALSE

FOR TAUS .GT. 0.5,
FUNCTION COMPUTED
USING POLYNOMIAL
 * REFERENCE (HANDBK
MATH FUNCT BY
ABRAMOWITZ AND
STEGUN,
 *
SECTIONS
7.3.9,7.3.10,7.3.32,
7.3.33)

04
TAU = SQRT(ATAUS)
X = C2*TAU
XS = X*X

05
FX = (1.0 +
0.926*X)/(2.0 +
1.792*X +
3.104*XS)

GX = 1.0/(2.0 +
4.142*X +
3.492*XS +
6.67*X*XS)

06
CCIXS =
COS(ATAUS)

SCIXS =
SIN(ATAUS)

07

09
FP =
CMPLX(COS(TAUS),
 - SIN(TAUS))

TS = TAUS*TAUS

FR = 1 - TS*(.1 -
.0046296296*TS)

10
FI =
TAUS*(.333333333
 -
TS*(.0238095238 -
7.57575757E-4*TS)
)

F = CMPLX(FR,FI)

F = FP*F

11
* EXIT *

12
* TAUS .LT. 0. *   TRUE ---->
FALSE

10   NOTE 15
* CONTINUE *

16
```


04
TAU = SQRT(ATAUS)
X = C2*TAU
XS = X*X
05
FX = (1.0 + 0.926*X)/(2.0 + 1.792*X + 3.104*XS)
GX = 1.0/(2.0 + 4.142*X + 3.492*XS + 6.67*X*XS)
06
CC1XS = COS(ATAUS)
SC1XS = SIN(ATAUS)
07
CX = 0.5 + FX*SC1XS - GX*CC1XS
SX = 0.5 - FX*CC1XS - GX*SC1XS
TS*(.0238095238 - 7.57575757E-4*TS))
F = CMPLX(FR,FI)
F = FP*F
11
EXIT
12
TAUS .LT. 0.
TRUE
FALSE
13
F = CMPLX(CX,SX)
FP = CMPLX(COS(ATAUS), - SIN(ATAUS))
F = (CI*F*FP)/TAU
14
EXIT
10
NOTE 15
CONTINUE
16
F = CMPLX(SX,CX)
A = ATAUS - PIO2
FP = CMPLX(COS(A), SIN(A))
F = (F*FP*C1)/TAU
17
EXIT

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3

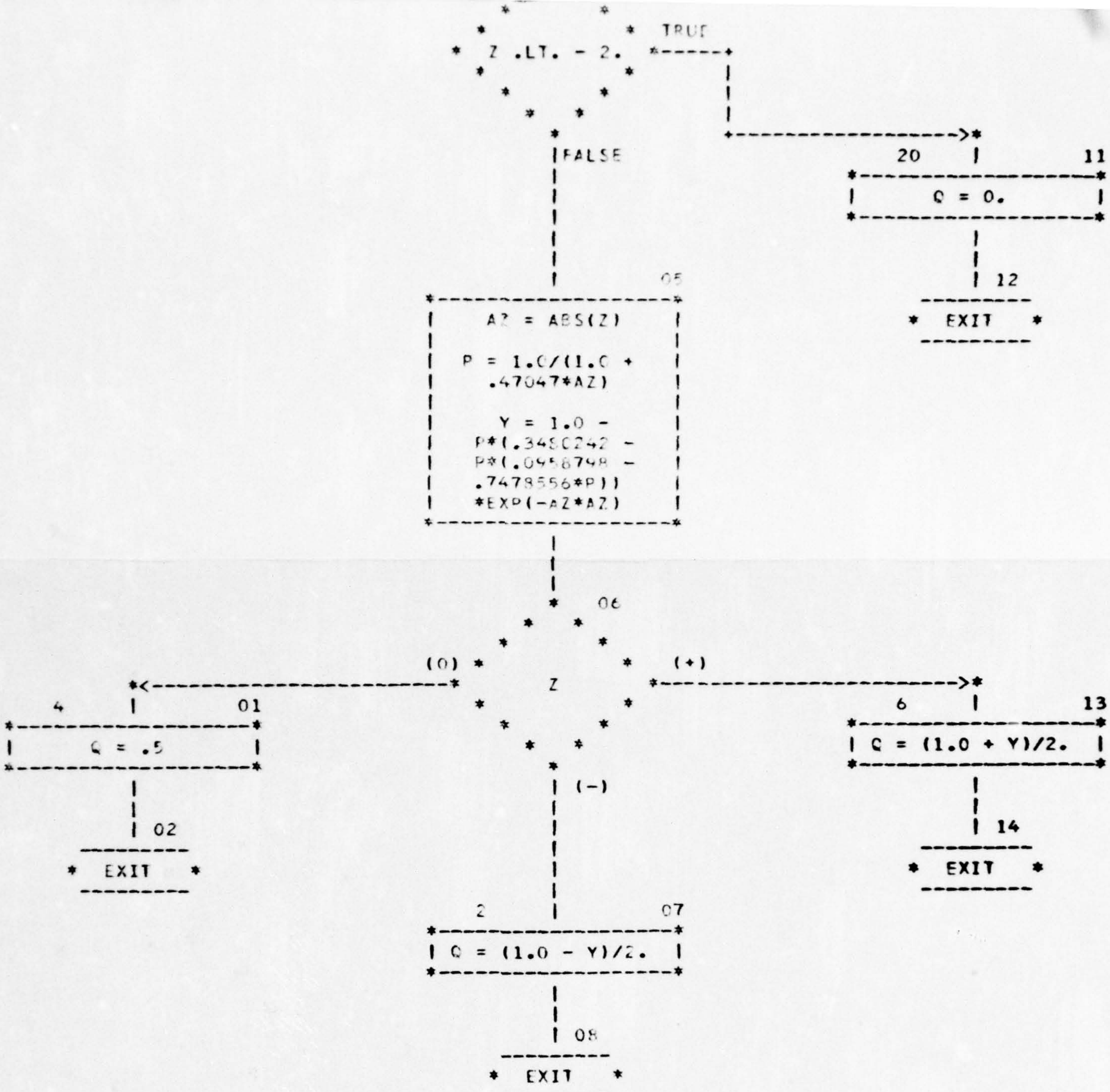
CHART TITLE - NON-PROCEDURAL STATEMENTS

COMPLEX F,FP

CHART TITLE - FUNCTION Q(Z)

```
                     Q(Z) = 0.5*(1 +
                     ERF(Z))
                      * ERF(Z) IS
                     EVALUATED USING A
                     RATIONAL POLYNOMIAL
                     APPROXIMATION
                      * REFERENCE (HANDBK
                     MATH FUNCT BY
                     ABRAMOWITZ AND
                     STEGUN,
                      *            SECTION
                     7.1.26)

                             *
                             |
                             *  03
                           *   *
                         *       *
                       *           *  TRUE
                     *   Z .GT. 2.   *------------------->*
                       *           *              10      |        09
                         *       *                *-------------------*
                           *   *                  |      Q = 1.       |
                             *                    *-------------------*
                             |FALSE                       |
                             |                            |
                             |                            | 10
                             |                        ----------
                             |                       *  EXIT   *
                             |                        ----------
                             *  04
                           *   *
                         *       *
                       *           *  TRUE
                     *  Z .LT. - 2.  *-----+
                       *           *       |
                         *       *         |
                           *   *           |
                             *             +------------------>*
                             |FALSE                 20          |          11
```


Z .LT. - 2.
TRUE
FALSE
20
11
Q = 0.
12
EXIT
05
AZ = ABS(Z)
P = 1.0/(1.0 + .47047*AZ)
Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P)) *EXP(-AZ*AZ)
06
Z
(0)
(+)
(-)
4
01
Q = .5
02
EXIT
6
13
Q = (1.0 + Y)/2.
14
EXIT
2
07
Q = (1.0 - Y)/2.
08
EXIT

```
      SUBROUTINE TARGET  (EVVR,EVVI,EHHR,EHHI )                    RCS8 001
C     **   RESPONSE OF TARGET ST-2                          **     RCS8 002
C     **   COMPUTED UTILIZING THE BUCK-CHIMISEV EQUATIONS   **     RCS8 003
C                                                                  RCS8 004
      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, TO                  RCS8 005
C     NMIN = MINIMUM FREQUENCY SAMPLE                              RCS8 006
C     NMAX = MAXIMUM FREQUENCY SAMPLE                              RCS8 007
C     DF   = FREQUENCY INCREMENT IN MHZ                            RCS8 008
C     FC   = CARRIER FREQUENCY IN GHZ                              RCS8 009
      COMPLEX    PS1, PS2, PS4,PS1P,PS2P,PS4P,  C1,  C2,           RCS8 010
     A  C4,  C3,  C9, C11, FT1,      FT2, FT4, FT5, FT6, FT7, FT8,  RCS8 011
     B CT1, CT2, CT4, CT6, CT8, C1T, C3T, C2FT, C4FT               RCS8 012
      COMPLEX    CV1, CH1, CV2, CH2, CV3, CH3, CV4, CH4, CV5, CH5,  RCS8 013
     A CV6, CH6, CV7, CH7, CV8, CH8, CV9, CH9,CV10,CH10,CV11,CH11,  RCS8 014
     BCV12,CH12,  CV,  CH, CVA, CHA                                RCS8 015
      REAL N1,N2,NC,ITM                                            RCS8 016
      DIMENSION  EVVR(1), EVVI(1), EHHR(1), EHHI(1)                RCS8 017
C                                                                  RCS8 018
C                                                                  RCS8 019
C                                                                  RCS8 020
C     PROGRAM CONSTANTS                                            RCS8 021
C                                                                  RCS8 022
      PI = 3.14159265358979                                        RCS8 023
      PI2 = PI+PI                                                  RCS8 024
      PIO2 = PI/2.                                                 RCS8 025
      HPI  = .5*PI                                                 RCS8 026
```

```
                                                                              RCS8 023
1446              PI2 = PI+PI                                                 RCS8 024
1447              PIO2 = PI/2.                                                RCS8 025
1448              HPI  = .5*PI                                                RCS8 026
1449              SPI  = SQRT(PI)                                             RCS8 027
```

2


```
CARD NO      ****                    CONTENTS                                      ****

1450              RTD = 180./PI                                               RCS8 028
1451              DTR = PI/180.                                               RCS8 029
1452              SHPI = SQRT(HPI)                                            RCS8 030
1453              SIHPI = 1./SHPI                                             RCS8 031
1454              ITM =0.0254                                                 RCS8 032
1455              SMIN = 1.E-4                                                RCS8 033
1456              SMDB = -80.                                                 RCS8 034
1457              C = 11.80285078                                             RCS8 035
1458         C                                                                RCS8 036
1459              READ(5,5001) ASPECT,A1,A2,A4,H1L,H2L,H3L,H4L,H5L,M1         RCS8 037
1460         5001 FORMAT(9F7.2,I2)                                            RCS8 039
1461              WRITE(6,5010) ASPECT                                        RCS8 040
1462         5010 FORMAT (  24H1  PROGRAM INPUT PARAMETERS  ,/,               RCS8 041
1463            1        17H  ASPECT ANGLE = , F9.4 )                         RCS8 042
1464              WRITE (6,6001) H1L,A1,H2L,A2,H3L,A4,H4L,H5L                 RCS8 043
1465         6001 FORMAT( //, ...
```

```
      SHPI = SQRT(HPI)                                            RCS8 030
      SIHPI = 1./SHPI                                             RCS8 031
      ITM =0.0254                                                 RCS8 032
      SMIN = 1.E-4                                                RCS8 033
      SMDB = -80.                                                 RCS8 034
      C = 11.80285078                                             RCS8 035
C                                                                 RCS8 036
      READ(5,5001) ASPECT,A1,A2,A4,H1L,H2L,H3L,H4L,H5L,M1         RCS8 037
 5001 FORMAT(9F7.2,I2)                                            RCS8 039
      WRITE(6,5010) ASPECT                                        RCS8 040
 5010 FORMAT (  29H1  PROGRAM INPUT PARAMETERS  ,/,               RCS8 041
     1        17H  ASPECT ANGLE = , F9.4 )                        RCS8 042
      WRITE (6,6001) H1L,A1,H2L,A2,H3L,A4,H4L,H5L                 RCS8 043
 6001 FORMAT( //, 7H  H1 = ,F8.4 ,7H  A1 = ,F8.4,/  ,7H  H2 = ,F8.4 ,   RCS8 044
     A  7H  A2 = ,F8.4,/  ,7H  H3 = ,F8.4 , 7H  A4 = ,F8.4,/  ,   RCS8 045
     B  7H  H4 = ,F8.4,/  ,7H  H5 = ,F8.4  )                      RCS8 046
C                                                                 RCS8 047
      TH = ASPECT*DTR                                             RCS8 048
C                                                                 RCS8 049
      H12L = H1L + H2L                                            RCS8 050
      H125L = H1L + H2L + H5L                                     RCS8 051
      H23L = H2L + H3L                                            RCS8 052
      H234L = H2L + H3L + H4L                                     RCS8 053
      A21 = A2-A1                                                 RCS8 054
      A42 = A4-A2                                                 RCS8 055
C                                                                 RCS8 056
```

3

L-125a

L-125b

```
      X1 = ATAN( A21/H1L)                                        RCS8 057
      X2 = X1                                                    RCS8 058
      X3 = ATAN( A42/(H2L+H23L))                                 RCS8 059
      X4 = ATAN( A21/(H1L+H5L))                                  RCS8 060
C                                                                RCS8 061
      PIMX3 = PI-X3                                              RCS8 062
      PIMX4 = PI-X4                                              RCS8 063
C                                                                RCS8 064
      X1D = X1*RTD                                               RCS8 065
      X2D = X2*RTD                                               RCS8 066
      X3D = X3*RTD                                               RCS8 067
      X4D = X4*RTD                                               RCS8 068
C                                                                RCS8 069
      WRITE (6,6005) X1D,X2D,X3D,X4D                             RCS8 070
 6005 FORMAT ( ///, 8H   X1D = ,F7.3, 8H   X2D = ,F7.3, / ,      RCS8 071
     A               8H   X3D = ,F7.3, 8H   X4D = ,F7.3   )      RCS8 072
C                                                                RCS8 073
      N1 = 1.-X1/PI                                              RCS8 074
      N2 = 1.+X1/PI                                              RCS8 075
      NC = 1.5                                                   RCS8 076
C                                                                RCS8 077
      D1 = COS(PI/N1)                                            RCS8 078
      D2 = COS(PI/N2)                                            RCS8 079
      DC = -.5                                                   RCS8 080
C                                                                RCS8 081
      D11 = 1./(D1-1.)                                           RCS8 082
```

```
1501          DC = -.5                                   RCS8 080
1502     C                                               RCS8 081
1503          D11 = 1./(D1-1.)                           RCS8 082
1504          D21 = 1./(D2-1.)                           RCS8 083
1505          DC1 = -2./3.                               RCS8 084
1506     C                                               RCS8 085
1507          E1 = SIN(PI/N1)/N1                         RCS8 086
```



```
CARD NO   ****           CONTENTS                        ****
1508          E2 = SIN(PI/N2)/N2                         RCS8 087
1509          FC = SIN(PI/NC)/NC                         RCS8 088
1510     C                                               RCS8 089
1511          STH = SIN(TH)                              RCS8 090
1512          CTH = COS(TH)                              RCS8 091
1513     C                                               RCS8 092
1514          XO =(2.*PI)/C                              RCS8 093
1515          AXO=(XO/1000.)                             RCS8 094
1516          XAK2 = XO*FC                               RCS8 095
1517          AK2A1 =XAK2*A1                             RCS8 096
1518          AK2A2 =XAK2*A2                             RCS8 097
1519          AK2A4 =XAK2*A4                             RCS8 098
1520     C                                               RCS8 099
```

```
      AXO=(X0/1000.)                                                    RCS8 094
      XAK2 = X0*FC                                                      RCS8 095
      AK2A1 =XAK2*A1                                                    RCS8 096
      AK2A2 =XAK2*A2                                                    RCS8 097
      AK2A4 =XAK2*A4                                                    RCS8 098
C                                                                       RCS8 099
      XPT  = X1+TH                                                      RCS8 100
      CO = TAN(XPT)*0.5                                                 RCS8 101
      TSP = COS(XPT)/SIN(X1)                                            RCS8 102
      IF ( TH .GT. PIO2) GO TO 20                                       RCS8 103
      XMT = X1-TH                                                       RCS8 104
      CKO = 0.5*TAN(XMT)                                                RCS8 105
      TSM = COS(XMT)/SIN(X1)                                            RCS8 106
      Z6 = AK2A2*(X4-TH)                                                RCS8 107
      Z8 = AK2A4*(X3-TH)                                                RCS8 108
      Q8= Q(Z8)                                                         RCS8 109
      Q6= Q(Z6)                                                         RCS8 110
C     DIFFC COMPUTES  C(N)-/+B(N,PHI) TERMS RETURNED AS VX,HX           RCS8 111
      CALL DIFFC( V12, H12,NC,DC,DC1,EC, PIO2-TH )                      RCS8 112
      CALL DIFFC ( V11,H11 ,NC,DC,DC1,EC, PIO2+TH )                     RCS8 113
      CALL DIFFC ( V1,H1, N1,D1,D11,E1,TH )                             RCS8 114
```

```
      CALL DIFFC ( V2,H2, N2,D2,D21,E2, XPT  )                          RCS8 115
      CALL DIFFC ( V9,H9 ,NC,DC,DC1,EC, TH )                            RCS8 116
      CALL DIFFC ( V6,H6, N2,D2,D21,E2,XMT )                            RCS8 117
      GO TO 30                                                          RCS8 118
   20 CONTINUE                                                          RCS8 119
      PIMTH = PI-TH                                                     RCS8 120
      Z2 = AK2A2*(PIMX3-TH)                                             RCS8 121
      PIMXPT = PI-X1-TH                                                 RCS8 122
      Z1 =  AK2A1*PIMXPT*3.                                             RCS8 123
      Z11= AK2A1*(PIMX4-TH)                                             RCS8 124
      Q11= Q(Z11)                                                       RCS8 125
      Q2 = Q(Z2)                                                        RCS8 126
      Q1 = Q(Z1)                                                        RCS8 127
C                                                                       RCS8 128
      CALL DIFFC ( V9,H9,NC,DC,DC1,EC, TH )                             RCS8 129
      CALL DIFFC ( V10,H10,NC,DC,DC1,EC, TH-PIO2 )                      RCS8 130
      CALL DIFFC ( V4,H4 ,N2,D2,D21,E2, PIMTH )                         RCS8 131
      CALL DIFFC ( V1,H1, N1,D1,D11,E1,PIMXPT)                          RCS8 132
      CALL DIFFC(V11,H11,NC,DC,DC1,EC, PIMTH )                          RCS8 133
   30 CONTINUE                                                          RCS8 134
      DO 50  I= NMIN,NMAX                                               RCS8 135
      XI = I-1                                                          RCS8 136
      AK =AX0*XI*DF                                                     RCS8 137
      AK2 = 2.0*AK                                                      RCS8 138
      AK2A1 = AK2*A1                                                    RCS8 139
```

```
1559         AK2 = 2.0*AK                                          RCS8 138
1560         AK2A1 = AK2*A1                                        RCS8 139
1561         AK2A2 = AK2*A2                                        RCS8 140
1562         AK2A4 = AK2*A4                                        RCS8 141
1563   C                                                           RCS8 142
1564         XC1=AK2A1*STH                                         RCS8 143
1565         XC2=AK2A2*STH                                         RCS8 144
```



```
CARD NO      ****                 CONTENTS                              ****

1566         XC4=AK2A4*STH                                         RCS8 145
1567   C                                                           RCS8 146
1568         CALL BESL(XC1,B10,B11,B12)                            RCS8 147
1569         CALL BESL(XC2,B20,B21,B22)                            RCS8 148
1570         CALL BESL(XC4,B40,B41,B42)                            RCS8 149
1571   C                                                           RCS8 150
1572   C     PHASE AND AMPLITUDE TERMS FROM BESSEL FUNCTIONS       RCS8 151
1573         PS1 = CMPLX( B10,-B11)                                RCS8 152
1574         PS2 = CMPLX( B20,-B21)                                RCS8 153
1575         PS4 = CMPLX( B40,-B41)                                RCS8 154
1576         PS1P = CONJG(PS1)                                     RCS8 155
1577         PS2P = CONJG(PS2)                                     RCS8 156
1578         PS4P = CONJG(PS4)                                     RCS8 157
```

```
C                                                                 RCS8 146
      CALL BESL(XC1,B10,B11,B12)                                  RCS8 147
      CALL BESL(XC2,B20,B21,B22)                                  RCS8 148
      CALL BESL(XC4,B40,B41,B42)                                  RCS8 149
C                                                                 RCS8 150
C     PHASE AND AMPLITUDE TERMS FROM BESSEL FUNCTIONS             RCS8 151
      PS1 = CMPLX( B10,-B11)                                      RCS8 152
      PS2 = CMPLX( B20,-B21)                                      RCS8 153
      PS4 = CMPLX( B40,-B41)                                      RCS8 154
      PS1P = CONJG(PS1)                                           RCS8 155
      PS2P = CONJG(PS2)                                           RCS8 156
      PS4P = CONJG(PS4)                                           RCS8 157
C                                                                 RCS8 158
C     PHASE TERM USING LENGTH ALONG AXIS                          RCS8 159
      PC1 = -AK2*H12L*CTH                                         RCS8 160
      PC2 = -AK2*H2L*CTH                                          RCS8 161
      PC4 = AK2*H23L*CTH                                          RCS8 162
      PC9 = AK2*H234L*CTH                                         RCS8 163
      PC11=-AK2*H125L*CTH                                         RCS8 164
C                                                                 RCS8 165
      C1    = CMPLX(COS(PC1),SIN(PC1))                            RCS8 166
      C2    = CMPLX(COS(PC2),SIN(PC2))                            RCS8 167
      C4    = CMPLX(COS(PC4),SIN(PC4))                            RCS8 168
      C3    = CONJG(  C2)                                         RCS8 169
      C9    = CMPLX(COS(PC9),SIN(PC9))                            RCS8 170
      C11   =  CMPLX(COS(PC11),SIN(PC11))                         RCS8 171
C                                                                 RCS8 172
```

3

L-125C

L-125d

```
      C1 = A1*SPI*C1                                      RCS8 173
      C3 = A2*SPI*C3                                      RCS8 174
      C2 = A2*SPI*C2                                      RCS8 175
      C4 = A4*SPI*C4                                      RCS8 176
      C9 = A4*SPI*C9                                      RCS8 177
      C11 = A1*SPI*C11                                    RCS8 178
C                                                         RCS8 179
C     CAUSTIC CORRECTION TERMS                            RCS8 180
      CC11 = EC*DC1*(B10+B12)                             RCS8 181
      CC1  = E1*D11*(B10+B12)                             RCS8 182
      CC2  = E2*D21*(B20+B22)                             RCS8 183
      CC3  = E1*D11*(B20+B22)                             RCS8 184
      CC4  = E2*D21*(B40+B42)                             RCS8 185
      CC9  = EC*DC1*(B40+B42)                             RCS8 186
C                                                         RCS8 187
      TSPP = TSP*AK2                                      RCS8 188
      TS1= A1*TSPP                                        RCS8 189
      TS2= A2*TSPP                                        RCS8 190
      TS4= A4*TSPP                                        RCS8 191
C                                                         RCS8 192
      IF ( TH .GT. PIO2 ) GO TO 450                       RCS8 193
C                                                         RCS8 194
C                                                         RCS8 195
      CV12 = C11*(V12*PSIP - CC11)                        RCS8 196
      CH12 = C11*(H12*PSIP - CC11)                        RCS8 197
```

```
1617         CV12 = C11*(V12*PS1P - CC11)                         RCS8 196
1618         CH12 = C11*(H12*PS1P - CC11)                         RCS8 197
1619         CV11 = C11*(V11*PS1 - CC11)                          RCS8 198
1620         CH11 = C11*(H11*PS1 - CC11)                          RCS8 199
1621      C                                                       RCS8 200
1622         CALL FTG (TS1,FT1)                                   RCS8 201
1623         CT1 = CO*FT1                                         RCS8 202
```



```
CARD NO    ****                   CONTENTS                        ****

1624         CV1 = C1*((V1+CT1)*PS1 - CC1)                        RCS8 203
1625         CH1 = C1*((H1-CT1)*PS1 - CC1)                        RCS8 204
1626      C                                                       RCS8 205
1627         CALL FTG (TS2,FT2)                                   RCS8 206
1628         CT2 = CO*FT2                                         RCS8 207
1629         CV3 = C3*((V1+CT2)*PS2 - CC3)                        RCS8 208
1630         CH3 = C3*((H1-CT2)*PS2 - CC3)                        RCS8 209
1631      C                                                       RCS8 210
1632         CV2 = C2*((V2-CT2)*PS2 - CC2)                        RCS8 211
1633         CH2 = C2*((H2+CT2)*PS2 - CC2)                        RCS8 212
1634      C                                                       RCS8 213
1635         CALL FTG (TS4,FT4)                                   RCS8 214
1636         CT4 = CO*FT4                                         RCS8 215
```

```
      CH3 = C3*((H1-CT2)*PS2 - CC3)                          RCS8 209
C                                                            RCS8 210
      CV2 = C2*((V2-CT2)*PS2 - CC2)                          RCS8 211
      CH2 = C2*((H2+CT2)*PS2 - CC2)                          RCS8 212
C                                                            RCS8 213
      CALL FTC (TS4,FT4)                                     RCS8 214
      CT4 = C0*FT4                                           RCS8 215
      CV4 = C4*((V2-CT4)*PS4 - CC4)                          RCS8 216
      CH4 = C4*((H2+CT4)*PS4 - CC4)                          RCS8 217
C                                                            RCS8 218
      CV9 = C9*(V9*PS4 - CC9)                                RCS8 219
      CH9 = C9*(H9*PS4 - CC9)                                RCS8 220
C                                                            RCS8 221
      CV = CV11+CV12+CV1+CV2+CV3+CV4+CV9                     RCS8 222
      CH = CH11+CH12+CH1+CH2+CH3+CH4+CH9                     RCS8 223
C                                                            RCS8 224
      IF ( Z6 .LE.-2.)GO TO 801                              RCS8 225
C                                                            RCS8 226
      TSMM = TSM*AK2                                         RCS8 227
      TS5 =TSMM*A1                                           RCS8 228
      TS6 =TSMM*A2                                           RCS8 229
      TS8 =TSMM*A4                                           RCS8 230
```

```
C                                                    RCS8 231
C                                                    RCS8 232
C                                                    RCS8 233
      CALL FTG(TS6,FT6)                              RCS8 234
      CT6 = CKO*FT6                                  RCS8 235
      CV6 = C2*((V6-CT6)*PS2P - CC2)*Q6              RCS8 236
      CH6 = C2*((H6+CT6)*PS2P - CC2)*Q6              RCS8 237
C                                                    RCS8 238
      CALL FTG(TS5,FT5)                              RCS8 239
      FT5 = CKO*(1.-FT5)*PS1P*C1*Q6                  RCS8 240
      CV5 = -FT5                                     RCS8 241
      CH5 = +FT5                                     RCS8 242
C                                                    RCS8 243
      FT7 = CKO*(1.-FT6)*PS2P*C3*Q8                  RCS8 244
      CV7 = -FT7                                     RCS8 245
      CH7 = FT7                                      RCS8 246
C                                                    RCS8 247
      CALL FTG(TS8,FT8)                              RCS8 248
      CT8 = CKO*FT8                                  RCS8 249
      CV8 = C4*((V6-CT8)*PS4P - CC4)*Q8              RCS8 250
      CH8 = C4*((H6+CT8)*PS4P - CC4)*Q8              RCS8 251
C                                                    RCS8 252
      CVA = CV5 + CV6 + CV7 + CV8                    RCS8 253
      CHA = CH5 + CH6 + CH7 + CH8                    RCS8 254
C                                                    RCS8 255
                                                     RCS8 256
```

```
1675          CHA = CH5 + CH6 + CH7 + CH8                              RCS8 254
1676    C                                                              RCS8 255
1677          CV = CV+CVA                                              RCS8 256
1678          CH = CH+CHA                                              RCS8 257
1679          GO TO 801                                                RCS8 258
1680    C                                                              RCS8 259
1681      450 CONTINUE                                                 RCS8 260
```



```
CARD NO   ****                   CONTENTS                              ****

1682    C                                                              RCS8 261
1683    C     THETA GREATER THAN PI/2                                  RCS8 262
1684    C                                                              RCS8 263
1685          CV9 = C9*(V9*PS4 - CC9)                                  RCS8 264
1686          CH9 = C9*(H9*PS4 - CC9)                                  RCS8 265
1687    C                                                              RCS8 266
1688          CV10 = C9*(V10*PS4P - CC9)                               RCS8 267
1689          CH10 = C9*(H10*PS4P - CC9)                               RCS8 268
1690    C                                                              RCS8 269
1691          CV4 = C4*    ( V4*PS4 - CC4)                             RCS8 270
1692          CH4 = C4*    ( H4*PS4 - CC4)                             RCS8 271
1693          CV = CV9 + CV10 +CV4                                     RCS8 272
1694          CH = CH9 + CH10 +CH4                                     RCS8 273
```

```
      CV9 = C9*(V9*PS4 - CC9)                                          RCS8 264
      CH9 = C9*(H9*PS4 - CC9)                                          RCS8 265
C                                                                      RCS8 266
      CV10 = C9*(V10*PS4P - CC9)                                       RCS8 267
      CH10 = C9*(H10*PS4P - CC9)                                       RCS8 268
C                                                                      RCS8 269
      CV4 = C4*    ( V4*PS4 - CC4)                                     RCS8 270
      CH4 = C4*    ( H4*PS4 - CC4)                                     RCS8 271
      CV = CV9 + CV10 +CV4                                             RCS8 272
      CH = CH9 + CH10 +CH4                                             RCS8 273
C                                                                      RCS8 274
      IF (    Z2      .LE. -2.) GO TO 800                              RCS8 275
C                                                                      RCS8 276
      CV11 = C11* (V11*PS1 - CC11)*Q11                                 RCS8 277
      CH11 = C11* (H11*PS1 - CC11)*Q11                                 RCS8 278
C                                                                      RCS8 279
      CV2 =    C2* (V4*PS2 - CC2)*Q2                                   RCS8 280
      CH2 =    C2* (H4*PS2 - CC2)*Q2                                   RCS8 281
C                                                                      RCS8 282
      CV = CV + CV11 + CV2                                             RCS8 283
      CH = CH + CH11 + CH2                                             RCS8 284
      IF (    Z1 .GT.-2.) GO TO 700                                    RCS8 285
      HTTH = 0.5*(STH/CTH)                                             RCS8 286
      C1T = C1*HTTH*PS1*Q11                                            RCS8 287
      C3T = C3*HTTH*PS2*Q2                                             RCS8 288
```

3

L-125e

L-125f

```
      CV = CV + C1T + C3T                                               RCS8 289
      CH = CH - C1T - C3T                                               RCS8 290
      GO TO 800                                                         RCS8 291
C                                                                       RCS8 292
  700 CONTINUE                                                          RCS8 293
C                                                                       RCS8 294
      CALL FTG (TS1,FT1 )                                               RCS8 295
      CV1 = C1*   ((V1+CO*FT1)*PS1 - CC1 )                              RCS8 296
      CH1 = C1*   ((H1-CO*FT1)*PS1 - CC1 )                              RCS8 297
      CALL FTG (TS2,FT2 )                                               RCS8 298
      CV3 = C3*   ((V1+CO*FT2)*PS2 - CC3 )                              RCS8 299
      CH3 = C3*   ((H1-CO*FT2)*PS2 - CC3 )                              RCS8 300
C                                                                       RCS8 301
      C2FT = C2   *CO*FT2*PS2                                           RCS8 302
      CALL FTG (TS4,FT4)                                                RCS8 303
      C4FT = C4   *CO*FT4*PS4                                           RCS8 304
C                                                                       RCS8 305
      CV = CV +(CV1 + CV3 - C2FT - C4FT)*Q1                             RCS8 306
      CH = CH +(CH1 + CH3 + C2FT + C4FT)*Q1                             RCS8 307
C                                                                       RCS8 308
C                                                                       RCS8 309
  800 CONTINUE                                                          RCS8 310
C                                                                       RCS8 311
  801 CONTINUE                                                          RCS8 312
      CV =-CV*ITM                                                       RCS8 313
```

```
      CH = CH +(CH1 + CH3 + C2FT + C4FT)*Q1                             RCS8 307
C                                                                       RCS8 308
C                                                                       RCS8 309
  800 CONTINUE                                                          RCS8 310
C                                                                       RCS8 311
  801 CONTINUE                                                          RCS8 312
      CV =-CV*ITM                                                       RCS8 313
      CH = CH*ITM                                                       RCS8 314
      EVVR(I) = REAL(CV)                                                RCS8 315
      EVVI(I) = -AIMAG(CV)                                              RCS8 316
      EHHR(I) = REAL(CH)                                                RCS8 317
      EHHI(I) = -AIMAG(CH)                                              RCS8 318
   50 CONTINUE                                                          RCS8 319
      RETURN                                                            RCS8 320
      END                                                               RCS8 321
```

```
      SUBROUTINE DIFFC ( V,H,N,D,D1,E, PHI )                          RCS8 322
      REAL N                                                          RCS8 323
C                                                                     RCS8 324
      D2 = 1./(D-COS((PHI+PHI)/N))                                    RCS8 325
      V  = E*(D1-D2)                                                  RCS8 326
      H  = E*(D1+D2)                                                  RCS8 327
      RETURN                                                          RCS8 328
      END                                                             RCS8 329
```

L-1259

```
      SUBROUTINE BESL ( X, B0, B1, B2 )                                RCS8 330
C                                                                      RCS8 331
C  * BESSEL FUNCTION SUBROUTINE UTILIZING POLYNOMIAL APPROXIMATIONS     RCS8 332
C  * COMPUTES J0,J1,OR J2 FOR POSITIVE REAL ARGUMENTS                   RCS8 333
C  * REFERENCE (HNDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN SECTION 9.4 )RCS8 334
C                                                                      RCS8 335
C                                                                      RCS8 336
      S = 1.0                                                          RCS8 337
      IF ( X.LT. 0. ) S= -1.                                           RCS8 338
      X = ABS(X)                                                       RCS8 339
      IF ( X .GT. 1.E-6 ) GO TO 5                                      RCS8 340
      B0 = 1.0                                                         RCS8 341
      B1 = 0.0                                                         RCS8 342
      B2 = 0.0                                                         RCS8 343
      X = X*S                                                          RCS8 344
      RETURN                                                           RCS8 345
C                                                                      RCS8 346
```

```
      SUBROUTINE FTG(TAUS,F)                                            RCS8 384
C                                                                       RCS8 385
C     COMPUTES FTAU WHERE FTAU =(EXP(-J*TAU**2)/2*TAU)*SQRT(PI/2.)*     RCS8 386
C                                  (C2(TAU**2) + J*S2(TAU**2))          RCS8 387
C                                                                       RCS8 388
      COMPLEX F,FP                                                      RCS8 389
      PI = 3.14159265358979                                             RCS8 390
      PIO2 = PI/2.                                                      RCS8 391
      C1 = SQRT(PI/2.)                                                  RCS8 392
      C2 = 1./C1                                                        RCS8 393
      ATAUS = ABS(TAUS)                                                 RCS8 394
      IF (ATAUS .LE. 0.5  )GO TO 20                                     RCS8 395
C                                                                       RCS8 396
C     FOR TAUS .GT. 0.5, FUNCTION COMPUTED USING POLYNOMIAL             RCS8 397
C    * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,           RCS8 398
C    *             SECTIONS  7.3.9,7.3.10,7.3.32,7.3.33)                RCS8 399
      TAU = SQRT(ATAUS)                                                 RCS8 400
      X = C2*TAU                                                        RCS8 401
      XS = X*X                                                          RCS8 402
C                                                                       RCS8 403
      FX = (1.0+0.926*X)/(2.0+1.792*X+3.104*XS)                         RCS8 404
      GX = 1.0/(2.0+4.142*X+3.492*XS+6.67*X*XS)                         RCS8 405
C                                                                       RCS8 406
      CC1XS = COS(ATAUS)                                                RCS8 407
      SC1XS = SIN(ATAUS)                                                RCS8 408
C                                                                       RCS8 409
```

```
      CX = 0.5 + FX*SCIXS - GX*CCIXS                                   RCS8 409
      SX = 0.5 - FX*CCIXS - GX*SCIXS                                   RCS8 410
C                                                                      RCS8 411
                                                                       RCS8 412
      IF (TAUS .LT. 0.) GO TO 10                                       RCS8 413
      F= CMPLX( CX,SX)                                                 RCS8 414
      FP = CMPLX(  COS(ATAUS), -SIN(ATAUS) )                           RCS8 415
      F =(C1*F*FP)/TAU                                                 RCS8 416
      RETURN                                                           RCS8 417
C                                                                      RCS8 418
   10 CONTINUE                                                         RCS8 419
      F = CMPLX(SX,CX)                                                 RCS8 420
      A = ATAUS-PIO2                                                   RCS8 421
      FP = CMPLX( COS(A),SIN(A) )                                      RCS8 422
      F = (F*FP*C1)/TAU                                                RCS8 423
      RETURN                                                           RCS8 424
C                                                                      RCS8 425
C     FOR TAUS .LE. 0.5, FUNCTION IS EXPANDED IN SERIES AND FIRST FEW  RCS8 426
C                             TERMS INTEGRATED TERM BY TERM TO OBTAIN RESULT RCS8 427
   20 CONTINUE                                                         RCS8 428
      FP = CMPLX( COS(TAUS),-SIN(TAUS) )                               RCS8 429
      TS = TAUS*TAUS                                                   RCS8 430
      FR = 1 - TS*( .1 - .0046296296*TS)                               RCS8 431
      FI = TAUS*( .333333333 - TS*(.0238095238 - 7.57575757E-4*TS))    RCS8 432
      F = CMPLX( FR,FI )                                               RCS8 433
      F = FP*F                                                         RCS8 434
      RETURN                                                           RCS8 435
      END                                                              RCS8 436
```

L-125j

```
      5 CONTINUE                                                        RCS8 347
C                                                                       RCS8 348
      1 IF ( X .GE. 3.) GO TO 9                                         RCS8 349
        X1 = X/3.                                                       RCS8 350
        X1 = X1*X1                                                      RCS8 351
        B = 1.+ X1*(-2.2499997+ X1*(1.2656208+ X1*(-.3163866+ X1*(.0444479RCS8 352
       1 +     X1*(-.0039444+ X1*2.1E-4 )))) )                          RCS8 353
        GO TO 10                                                        RCS8 354
C                                                                       RCS8 355
      9 X2 = 3./X                                                       RCS8 356
        F0 =  .79788456 +X2*(-.77E-6 +X2*(-.00552740 +X2*(-.9512E-4 +X2*  RCS8 357
       1     (.00137237 +X2*(-.72805E-3 +X2*0.14476E-3 )))) )           RCS8 358
        T0 = X - .78539816 +X2*(-.04166397 +X2*(-.3954E-4 +X2*(.00262573  RCS8 359
       1    +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))        RCS8 360
        B = F0*COS(T0)/SQRT(X)                                          RCS8 361
C                                                                       RCS8 362
     10 B0 = B                                                          RCS8 363
C                                                                       RCS8 364
      2 IF ( X .GE. 3. ) GO TO 19                                       RCS8 365
        X1 = X/3.                                                       RCS8 366
        X1 = X1*X1                                                      RCS8 367
        B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*  RCS8 368
       1             (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4))))) )    RCS8 369
        GO TO 20                                                        RCS8 370
```

```
    2 IF ( X .GE. 3. ) GO TO 19                                         RCS8 365
      X1 = X/3.                                                         RCS8 366
      X1 = X1*X1                                                        RCS8 367
      B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*    RCS8 368
     1           (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4))))) )        RCS8 369
      GO TO 20                                                          RCS8 370
C                                                                       RCS8 371
   19 X2 = 3./X                                                         RCS8 372
      F1 = .79788456 +X2*(.156E-5 +X2*(.01659667 +X2*(.00017105 +X2*    RCS8 373
     1     (-.00249511 +X2*(.00113653 -.00020033*X2 )))))               RCS8 374
      T1 = X - 2.35619449 +X2*(.12499612 +X2*(.565E-4 +X2*(-.00637879   RCS8 375
     1    +X2*(.00074348 +X2*(.00079824 -0.00029166*X2 )))))            RCS8 376
      B = F1*COS(T1)/SQRT(X)                                            RCS8 377
C                                                                       RCS8 378
   20 B1 = B*S                                                          RCS8 379
      X = X*S                                                           RCS8 380
      B2= (2./X)*B1 - B0                                                RCS8 381
   50 RETURN                                                            RCS8 382
      END                                                               RCS8 383
```

```
      FUNCTION Q(Z)
C     Q(Z) = 0.5*(1 + ERF(Z))
C     * ERF(Z) IS EVALUATED USING A RATIONAL POLYNOMIAL APPROXIMATION
C     * REFFRENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,
C     *          SECTION 7.1.26)
C
      IF ( Z.GT. 2.) GO TO 10
      IF ( Z.LT.-2.) GO TO 20
      AZ = ABS(Z)
      P = 1.0/(1.0 + .47047*AZ)
      Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P))*EXP(-AZ*AZ)
      IF (Z) 2,4,6
    2 Q = (1.0 - Y)/2.
      RETURN
    4 Q = .5
      RETURN
    6 Q = (1.0 + Y)/2.
      RETURN
   10 Q = 1.
      RETURN
   20 Q = 0.
      RETURN
      END
```

L-125K

L.7 STEPPED - CYLINDER

The far-field scattering from a stepped-cylinder target configuration shown in Figure L.7-1 has been formulated using the basic Ruck-Ufimtsev technique and a rough approximation of the multiple reflections of the field components between the cylindrical and flat surfaces (Ref. 8).. The basic scattering formulation is the following:

$$e(\theta)_{\{V \atop H\}} = \mp\sqrt{\pi}\left\{ g(11) + g(12) + g(1) + g(2) + g(3) + g(4) + g(9) + g(5) + g(6) + g(7) + g(8) + g(10)\right\}$$

where g(m) represents the sum of the fringe wave scattering and physical optics response associated with edge m.

For $0 < \theta < \pi/2$,

$$g(12) = a_1 e^{ip_{11}}\left\{JJ_{11+}\left[C(1.5) \mp B(1.5, \pi/2-\theta)\right] - C(1.5)JJ_{21}\right\}$$

$$g(11) = a_1 e^{ip_{11}}\left\{JJ_{11-}\left[C(1.5) \mp B(1.5, \pi/2+\theta)\right] - C(1.5)JJ_{21}\right\}$$

$$g(2) = a_2 e^{ip_2}\left\{JJ_{12-}\left[C(1.5) \mp B(1.5, \pi/2+\theta)\right] - C(1.5)JJ_{22}\right\}$$

$$g(4) = a_4 e^{ip_4}\left\{JJ_{14-}\left[C(1.5) \mp B(1.5, \pi/2+\theta)\right] - C(1.5)JJ_{24}\right\}$$

$$g(9) = a_4 e^{ip_9}\left\{JJ_{14-}\left[C(1.5) \mp B(1.5, \theta)\right] - C(1.5)JJ_{24}\right\}$$

$$g(1) = \pm a_1 e^{ip_2}\left\{0.5\ JJ_{11-}\left[\tan\theta + \cot\theta\right]\right\}$$

$$g(3) = \pm a_2 e^{ip_4}\left\{0.5\ JJ_{12-}\left[\tan\theta + \cot\theta\right]\right\}$$

$$g(6) = a_2 e^{ip_2}\left\{JJ_{12+}\left[C(1.5) \mp B(1.5, \pi/2-\theta)\right] - C(1.5)JJ_{22}\right\} Q_6 IQ_6$$

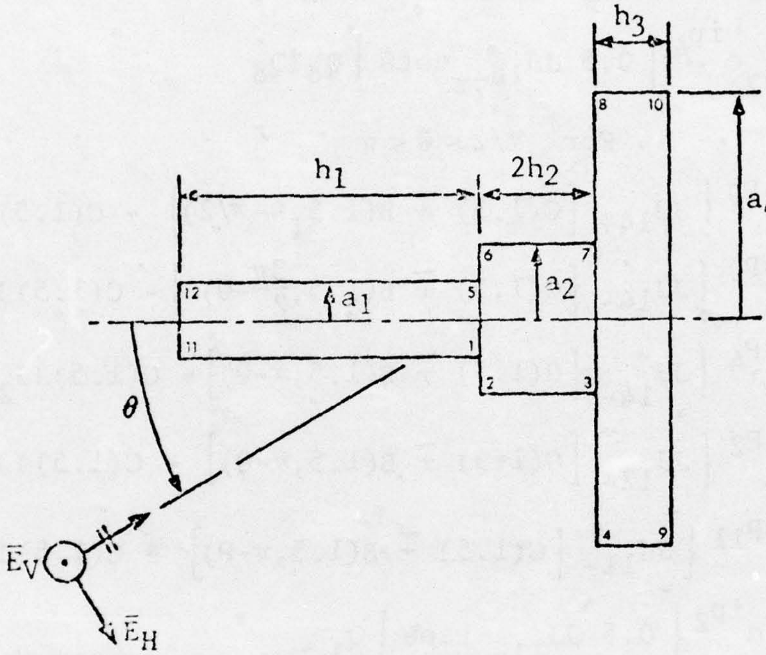


Fig. L.7-1 GEOMETRY OF STEPPED-CYLINDER

$$g(8) = a_4 e^{ip_4} \left\{ JJ_{14+} \left[C(1.5) \mp B(1.5, \pi/2-\theta) \right] - C(1.5) JJ_{24} \right\} Q_8 IQ_8$$

$$g(5) = \pm a_{s_5} e^{ip_2} \left\{ 0.5 \; JJ_{1s_5+} \cot\theta \right\} Q_6 IQ_6$$

$$g(7) = \mp a_{s_7} e^{ip_4} \left\{ 0.5 \; JJ_{1s_7+} \cot\theta \right\} Q_8 IQ_8$$

For $\pi/2 < \theta < \pi$

$$g(10) = a_4 e^{ip_9} \left\{ JJ_{14+} \left[C(1.5) \mp B(1.5, \theta-\pi/2) \right] - C(1.5) JJ_{24} \right\}$$

$$g(9) = a_4 e^{ip_9} \left\{ JJ_{14-} \left[C(1.5) \mp B(1.5, \tfrac{3\pi}{2}-\theta) \right] - C(1.5) JJ_{24} \right\}$$

$$g(4) = a_4 e^{ip_4} \left\{ JJ_{14-} \left[C(1.5) \mp B(1.5, \pi-\theta) \right] - C(1.5) JJ_{24} \right\} Q_4$$

$$g(2) = a_2 e^{ip_2} \left\{ JJ_{12-} \left[C(1.5) \mp B(1.5, \pi-\theta) \right] - C(1.5) JJ_{22} \right\} Q_2$$

$$g(11) = a_1 e^{ip_{11}} \left\{ JJ_{11-} \left[C(1.5) \mp B(1.5, \pi-\theta) \right] - C(1.5) JJ_{21} \right\} Q_{11}$$

$$g(1) = \pm a_1 e^{ip_2} \left\{ 0.5 \; JJ_{11-} \tan\theta \right\} Q_1$$

$$g(3) = \pm a_2 e^{ip_4} \left\{ 0.5 \; JJ_{12-} \tan\theta \right\} Q_3$$

where the upper and lower signs in the previous equations correspond to the case of vertical and horizontal polarization, respectively, and

$$C(n) = \frac{\sin \frac{\pi}{n}}{n} \left[\frac{1}{\cos \frac{\pi}{n} - 1} \right]$$

$$B(n,\emptyset) = \frac{\sin \frac{\pi}{n}}{n} \left[\frac{1}{\cos \frac{\pi}{n} - \cos \frac{2\emptyset}{n}} \right]$$

$$JJ_{1m\mp} = J_o(2ka_m \sin\theta) \mp J_1(2ka_m \sin\theta)$$

$$JJ_{2m} = J_o(2ka_m\sin\theta) + J_2(2ka_m\sin\theta)$$

$$p_{11} = -2k(h_1 + h_2)\cos\theta$$

$$p_2 = -2k\,h_2\cos\theta$$

$$p_4 = 2k\,h_2\cos\theta$$

$$p_5 = 2k(h_2 + h_3)\cos\theta$$

$$Q_{\binom{6}{8}} = Q\left(2ka_{\binom{2}{4}}\left(\alpha_{\binom{1}{3}} - \theta\right)\right) \quad ; \quad Q_1 = Q\left(2ka_1\left(\tfrac{\pi}{2}+\delta-\theta\right)\right)$$

$$Q_{\binom{11}{2}} = Q\left(2ka_{\binom{1}{2}}\left(\pi-\alpha_{\binom{3}{2}}-\theta\right)\right) \quad ; \quad Q_3 = Q\left(2ka_2\left(\tfrac{\pi}{2}+\delta-\theta\right)\right)$$

$$\delta = \frac{\pi}{12}$$

$$Q_4 = Q(2ka_4(\pi-\theta))$$

$$IQ_n = \begin{cases} 1 \text{ for } Q_n > 0.5 \\ 0 \text{ otherwise} \end{cases}$$

$$\alpha_1 = \tan^{-1}\left(\frac{a_2-a_1}{h_1}\right)$$

$$\alpha_2 = \tan^{-1}\left(\frac{a_4-a_2}{2h_2}\right)$$

$$\alpha_3 = \tan^{-1}\left(\frac{a_4-a_1}{h_1+2h_2}\right)$$

$$Q(z) = 0.5\left[1 + \text{erf}(z)\right]$$

$$a_{s_5} = a_1 + h_1\tan\theta$$

$$a_{s_7} = \begin{cases} a_2 + 2h_2\tan\theta, \text{ for } \theta < \alpha_1 \\ a_1 + (2h_2+h_1)\tan\theta, \text{ for } \alpha_1 < \theta < \alpha_3 \end{cases}$$

Most of the equations can be obtained in a logical and straight-forward manner from the well defined procedures of the Ruck-Ufimtsev high-frequency scattering technique. Unfortunately, no first-order technique can be used to obtain an accurate formulation of the scattering from surfaces and edges which are partially shadowed or just within the shadow region. The screening functions of the Ruck-Ufimtsev technique have been used in computing the response of several aerospace targets at aspect angles in which some of the target surfaces and edges are shadowed; however, the use of these functions is a first-order approximation, and multiple diffraction and reflection must be considered in order to accurately describe scattered returns from shadowed target regions.

The formulation of the multiple scattering between the surfaces adjacent to the concave edge structures is expressed in the following equations, where the "*" is used to distinguish these expressions from the first order approximations on page L-126:

$$g(1^*) = \sqrt{4k}\, A_1^* \, e^{ip_1^*}$$

$$g(3^*) = \sqrt{4k}\, A_3^* \, e^{ip_3^*}$$

$$g(13^*) = \sqrt{4k}\, A_{13}^* \, e^{ip_{13}^*}$$

where
$$A_1^* = \sqrt{a_1}\, h_1 \sin\theta \qquad \text{for } \theta < \alpha_1$$
$$= \sqrt{a_1}(a_2 - a_1)\cos\theta \qquad \theta \ge \alpha_1$$

$$A_3^* = \sqrt{a_2}\, 2h_2 \sin\theta \qquad \text{for } \theta < \alpha_2$$
$$= \sqrt{a_2}(a_4 - a_2)\cos\theta \qquad \theta \ge \alpha_2$$

$$A_{13}^* = \sqrt{a_1}\left\{h_1 \sin\theta - (a_2 - a_1)\cos\theta\right\} \qquad \alpha_1 \le \theta \le \alpha_3$$
$$= \sqrt{a_1}\left\{(a_4 - a_2)\cos\theta - 2h_2 \sin\theta\right\} \qquad \alpha_3 < \theta < \alpha_2$$

and $p_1^* = -2k(a_1 \sin\theta + h_2 \cos\theta)$

$$p_3^* = -2k(a_2 \sin\theta - h_2 \cos\theta)$$

$$p_{13}^* = -2k(a_1 \sin\theta - h_2 \cos\theta)$$

This approximate representation of the multiple reflected fields cannot be considered to be an exact or rigorous formulation of the scattering mechanisms involved. Nontheless, this preliminary analytical expression is simple, and the computed results do provide a realistic measure of the target scattering.

L.7.1 Inputs

The subroutine inputs are read from cards or passed in common blocks. The parameters passed in unlabeled common include:

NMIN = minimum frequency sample number

NMAX = maximum frequency sample number

DF = frequency increment (in MHz)

FC = carrier frequency or center frequency (in GHz)

The parameters passed in a labeled common block include:

ASPECT = azimuth angle (in degrees)

ITT = Read data option set to 1 or 2

= 1 Read target dimensions from input card

= 2 Use dimensions input on prior read

The card inputs are the following:

	MATH SYMBOL	VARIABLE	DEFINITION	COLUMNS
Card 1	a_1	A1	Smallest cylinder radius (inches)	1 - 8
	a_2	A2	Middle cylinder radius (inches)	9 - 16
	a_4	A4	Largest cylinder radius (inches)	17 - 24
	h_1	H1	Length of smallest cylinder (inches)	25 - 32
	h_2	H2	Half-length of middle cylinder (inches)	33 - 40
	h_3	H3	Length of largest cylinder (inches)	41 - 48

L.7.2 Outputs

The data base output consists of four linear arrays, EVVR, EVVI, EHHR, EHHI, which contain the real and imaginary parts of the vertically and horizontally polarized backscattered fields (in meters) at frequency increments of DF MHz from NMIN*DF to NMAX*DF.

L.7.3 Restrictions

L.7.3.1 Physical Dimensions

All target dimensions should be large with respect to the wavelength of the illuminating field. In formulating the Q functions to approximate the effects of shadowing on an edge or surface, the assumption that $\alpha_1 < \alpha_3 < \alpha_2$ was utilized, since this angle relationship was exhibited in the geometry of the target for which the formulation was developed. If this angular relationship is not present, the arguments of the Q functions must be modified.

L.7.3.2 Output

The output arrays are passed in the argument list and a value is computed and stored only in locations NMIN to NMAX.

L.7.3.3 Restrictions

The azimuth angle is restricted to the region between 0 and 180 degrees. In addition, the specular azimuth of 0, 90, and 180 should not be used.

In order to compute the response of these angles, an angular offset of approximately 0.01 degrees should be used.

L.7.4 Definitions of Selected Terms Used in Subroutine

SV12 = $C(1.5) \mp B(1.5, \pi/2-\theta)$ for $\theta < \pi/2$

PH1P = JJ_{11+}

$= JJ_{1m\mp} = J_o(2ka_m \sin\theta) \mp J_1(2ka_m \sin\theta)$

where $m = 1$ and the lower (+) sign is used

BCIX = $C(1.5)JJ_{21}$

where BC1 = JJ_{21}

$= JJ_{2m} = J_o(2ka_m \sin\theta) + J_2(2ka_m \sin\theta)$

where m = 1

C11 = $e^{ip_{11}}$

where $p_{11} = -2k(h_1 + h_2)\cos\theta$

CV12 = $a_1 e^{ip_{11}} \left\{ JJ_{11+} [C(1.5) \mp B(1.5, \pi/2-\theta)] - C(1.5)JJ_{21} \right\}$

for $\theta < \pi/2$

CV6 = $g(6) = a_2 e^{ip_2} \left\{ JJ_{12+} [C(1.5) \mp B(1.5, \pi/2-\theta)] - C(1.5)JJ_{22} \right\} Q_6 IQ_6$

$$PSD1 = p_1^* = -2k(a_1 \sin\theta) + h_2 \cos\theta)$$

$$AD1 = A_1^* = \sqrt{a_1} h_1 \sin\theta \qquad \text{for } \theta < \alpha_1 \text{, and}$$

$$AD1 = A_1^* = \sqrt{a_1}(a_2 - a_1)\cos\theta \qquad \text{for } \theta \geq \alpha_1$$

L.7.5 Subroutines Used

Subfunctions:

1. Q(X) returns the value of the exponential smoothing function.

Subroutines:

1. BESL(XCx, BJx0 BJx1, BJx2) computes the Bessel functions of order 1, 2, and 3 for real argument XCX and returns

   J_o (XCx) in BJx0

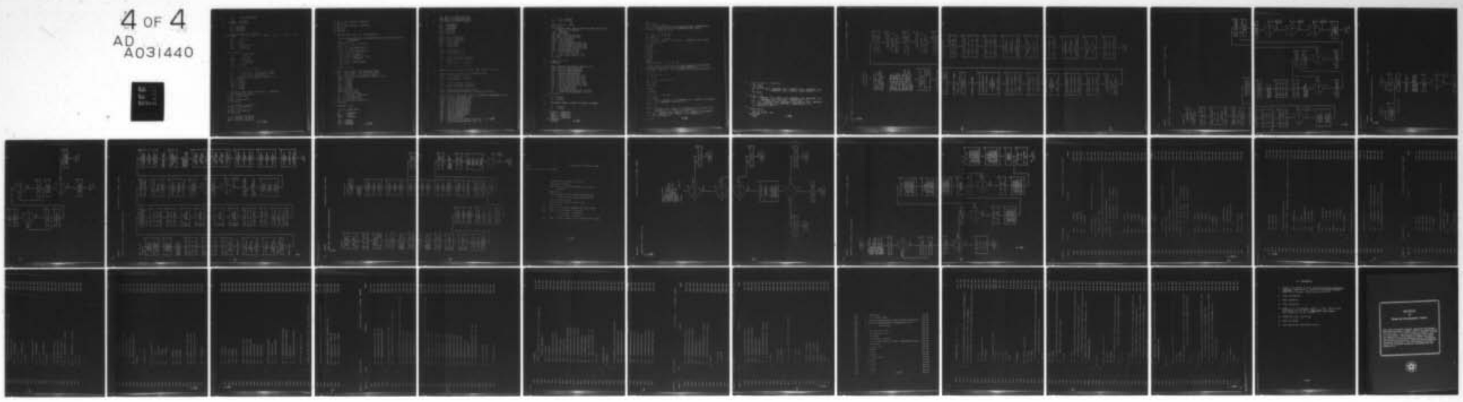
   J_1 (XCx) in BJx1

   J_2 (XCx) in BJx2

```
$      IDENT   BECAGD01,HANCOCK,017073100380
$      OPTION  FORTRAN
$      FORTY   LSTIN,XREF,MAP,DECK
$      LIMITS  05,39K,0,5K
      SUBROUTINE TARGET (EVVR, EVVI, EHHR, EHHI)
C
C     **  RESPONSE OF STEPPED CYLINDERS (MODEL 43)      **
C     **  COMPUTED USING THE RUCK UFIMTSEV TECHNIQUE    **
C
      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, T0
C     NMIN = MINIMUM FREQUENCY SAMPLE
C     NMAX = MAXIMUM FREQUENCY SAMPLE
C     DF   = FREQUENCY INCREMENT IN MHZ
C     FC   = CARRIER FREQUENCY IN GHZ
      COMMON /TARS / ASPECT,ITT
C     ITT SET TO 1 TO READ INPUT DIMENSIONS
C         SET TO 2 WHEN TARGET DIMENSIONS DO NOT CHANGE
C
      COMPLEX PH1, PH2, PH4, PH1P, PH2P, PH4P, C11, C2, C4, C9,
     1         PH5P, PH7P
      COMPLEX  SV,SH
      COMPLEX CV12,CH12, CV11,CH11, CV2,CH2, CV4,CH4, CV9,CH9,
     1         CV10,CH10, CV1, CV3, CV6,CH6, CV8,CH8, CV5, CV7
      COMPLEX CD1, CD2, CD3, CAD
      DIMENSION EVVR(1), EVVI(1), EHHR(1), EHHI(1)
C
      GO TO ( 5,6 ), ITT
    5 CONTINUE
C     PROGRAM CONSTANTS
C
      PI           = 3.14159265358979
      FTK          =  53234454
      FTKDF    =  53234454*(DF/1000.)
      PIO2         = PI/2.
      SPI          = SQRT(PI)
      AITM         = 0.0254026
      SPIK = SPI*AITM
      TPIO2        = 3.*PIO2
      DTR          = PI/180.
      RTD          = 180./PI
      DLT      = 15.*DTR
C
      READ (5,5001)            A1, A2, A4, H1, H2, H3
 5001 FORMAT ( 7F8.0)
      WRITE (6,6001) ASPECT
 6001 FORMAT ( '1  PROGRAM INPUT PARAMETERS',//,' THETA =',F9.3 )
      WRITE (6,6002) A1,H1,A2,H2,A4,H3
 6002 FORMAT ( '0   A1 =', F7.4,'    H1 =',F7.4,/,
     1          '   A2 =', F7.4,'    H2 =',F7.4,/,
     2          '   A4 =', F7.4,'    H3 =',F7.4 )
C
      TH2          = H2+H2
      TH2PH1       = TH2+H1
      A21          = A2-A1
      A41          = A4-A1
      A42          = A4-A2
      SA1  = SQRT(A1)
      SA2  = SQRT(A2)
C
      ALF1     = ATAN(A21/H1)
```

AD-A031 440 GENERAL DYNAMICS FORT WORTH TEX CONVAIR AEROSPACE DIV F/G 17/9
ENDO ATMOSPHERIC EXO ATMOSPHERIC RADAR MODELING. RADAR CROSS SE--ETC(U)
JUN 76 R J HANCOCK, F H CLEVELAND F30602-73-C-0380
UNCLASSIFIED RADC-TR-76-186-VOL-4-PT-2 NL

4 OF 4
AD
A031440



END
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12-76

```
      ALF3    = ATAN(A41/TH2PH1)
C
      PIMAL2  = PI-ALF2
      PIMAL3  = PI-ALF3
C
      X1D = ALF1*RTD
      X2D = ALF2*RTD
      X3D = ALF3*RTD
C
      WRITE (6,6005) X1D,X2D,X3D
 6005 FORMAT ( '   ALF1 = ',F8.3,/,'   ALF2 = ',F8.3,/,'   ALF3 = ',F8.3)
C
      TKFC    = FTK*FC*2.
      XN      = 1.5
      XNO2    = XN/2.
      SOXN    = SIN(PI/XN)/XN
      CXN     = -SOXN/XN
      CPON    = COS(PI/XN)
C
    6 CONTINUE
      TH          = ASPECT*DTR
      STH         = SIN(TH)
      CTH         = COS(TH)
      TANTH       = STH/CTH
      CK1         = 0.5*TANTH
      CKV         = 0.5/TANTH
      C1PCV = CK1+CKV
C
      IF ( TH .GT. PIO2) GO TO 20
C
      B12     = SOXN/(CPON - COS((PIO2-TH)/XNO2))
      B11     = SOXN/(CPON - COS((PIO2+TH)/XNO2))
      B9      = SOXN/(CPON - COS(TH/XNO2))
C     EDGE DIFFRACTION COEFFICIENTS (THETA.LT.PI/2)
      SV12 = CXN-B12
      SH12 = CXN+B12
      SV11 = CXN-B11
      SH11 = CXN+B11
      SV9  = CXN-B9
      SH9  = CXN+B9
C
C     EFFECTIVE AREA (DOUBLY REFLECTED ) TERMS(ADX)
      IF (TH-ALF1) 51,52,52
   51 AD1  = SA1*H1*STH
      GO TO 53
   52 AD1  = SA1*A21*CTH
   53 CONTINUE
C
      IF (TH-ALF2) 54,55,55
   54 AD2  = SA2*TH2*STH
      GO TO 56
   55 AD2  = SA2*A42*CTH
   56 CONTINUE
C
      IF (TH-ALF1) 57,58,58
   58 IF (TH-ALF2) 59,59,57
   59 IF (TH-ALF3) 60,61,61
```

```
60 AD3  = SA1*(H1*STH - A21*CTH)
   GO TO 63
61 AD3  = SA1*(A42*CTH - TH2*STH)
   GO TO 63
57 AD3 = 0
63 CONTINUE

   ASSUMED THAT  ALF3 .GT. (ALF1 OR ALF2 )

   SMOOTHING FUNCTIONS AND ILLUMINATED AREA USING SLIDING SHADOW
            BOUNDARIES
   ISWA3  = 1
   IF ( TH .GT. ALF3 ) GO TO 25
   ISWA3  = 2
     Q6   = Q(TKFC*A2*(ALF1-TH))
   IF (Q6 .LE. 0.5 ) Q6 = 0.
     Q8   = Q(TKFC*A4*(ALF3-TH))
   IF (Q8 .LE. 0.5 ) Q8 = 0.
     AS5  = A1 + H1*TANTH
     IF ( TH .GT. ALF1 ) GO TO 14
     AS7  = A2 + TH2*TANTH
     GO TO 25
14   AS7  = A1 + TH2PH1*TANTH
     GO TO 25

   THETA .GT. PI/2

20 B10 = SOXN/(CPON - COS((TH-PIO2)/XNO2))
   B9  = SOXN/(CPON - COS((TPIO2-TH)/XNO2))
   B11 = SOXN/(CPON - COS((PI-TH)/XNO2))
   EDGE DIFFRACTION COEFFICIENTS (THETA.GT.PI/2)
   SV10 = CXN-B10
   SH10 = CXN+B10
   SV9  = CXN-B9
   SH9  = CXN+B9
   SV11 = CXN-B11
   SH11 = CXN+B11
   XALF = PIO2+DLT-TH
   SMOOTHING FUNCTIONS
   Q1    = Q(TKFC*A1*XALF)
   Q2   = Q(TKFC*A2*(PIMAL2-TH))
   Q3    = Q(TKFC*A2*XALF)
   Q4   = Q(TKFC*A4*(PI-TH))
   Q11 = Q(TKFC*A1*(PIMAL3-TH))
25 CONTINUE

   FREQUENCY LOOP

   DO 30 I = NMIN,NMAX
   XI      = I-1
   AK      = XI*FTKDF
   AK2     = AK+AK
   AK2S    = AK2*STH

   XC1   = A1*AK2S
   XC2   = A2*AK2S
   XC4   = A4*AK2S
```

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```
      CALL BESL(XC1,BJ10,BJ11,BJ12)
      CALL BESL(XC2,BJ20,BJ21,BJ22)
      CALL BESL(XC4,BJ40,BJ41,BJ42)
C
      BC1  = BJ10+BJ12
      BC2  = BJ20+BJ22
      BC4  = BJ40+BJ42
      BC1X = BC1*CXN
      BC2X = BC2*CXN
      BC4X = BC4*CXN
C
      PH1P = CMPLX(BJ10,BJ11)
      PH2P = CMPLX(BJ20,BJ21)
      PH4P = CMPLX(BJ40,BJ41)
      PH1  = CONJG(PH1P)
      PH2  = CONJG(PH2P)
      PH4  = CONJG(PH4P)
C
      PS11 = -AK2*(H2+H1)*CTH
      PS2  = -AK2*H2*CTH
      PS9  =  AK2*(H2+H3)*CTH
C
      C11  = CMPLX(COS(PS11),SIN(PS11))
      C2   = CMPLX(COS(PS2),SIN(PS2))
      C4   = CONJG(C2)
      C9   = CMPLX(COS(PS9),SIN(PS9))
C
      IF ( TH .GT. PIO2 ) GO TO 35
C
C     GENERAL REGION (THETA .GT. ALF3 .AND. THETA .LT. PI/2)
C
C     PHASE OF DOUBLY REFLECTED  SCATTERING TERMS
      PSD1 = -AK2*(A1*STH + H2*CTH)
      PSD2 = -AK2*(A2*STH - H2*CTH)
      PSD3 = -AK2*(A1*STH - H2*CTH)
C
      CD1  = CMPLX(COS(PSD1),SIN(PSD1))
      CD2  = CMPLX(COS(PSD2),SIN(PSD2))
      CD3  = CMPLX(COS(PSD3),SIN(PSD3))
C
C     DOUBLY REFLECTED SCATTERING (TOTAL)
      CAD  = SQRT(AK2+AK2)*(AD1*CD1 + AD2*CD2 + AD3*CD3)
C
C     RUCK-UFIMTSEV SCATTERING (THETA.LT.90,EDGES ILLUMINATED AT 90)
      CV12 = A1*C11*(SV12*PH1P-BC1X)
      CH12 = A1*C11*(SH12*PH1P-BC1X)
      CV11 = A1*C11*(SV11*PH1-BC1X)
      CH11 = A1*C11*(SH11*PH1-BC1X)
      CV2  = A2*C2*(SV11*PH2-BC2X)
      CH2  = A2*C2*(SH11*PH2-BC2X)
      CV4  = A4*C4*(SV11*PH4-BC4X)
      CH4  = A4*C4*(SH11*PH4-BC4X)
      CV9  = A4*C9*(SV9*PH4-BC4X)
      CH9  = A4*C9*(SH9*PH4-BC4X)
      CV1  = A1*C2*PH1*C1PCV
      CV3  = A2*C4*PH2*C1PCV
      SV   = CV12+CV11+CV2+CV4+CV9 +CV1 +CV3
      SH   = CH12+CH11+CH2+CH4+CH9 -CV1 -CV3
```

```
C
      SV    = SV + CAD/SPI
      SH    = SH + CAD/SPI
C
      GO TO (40,34), ISWA3
   34 CONTINUE
C     AZIMUTH NEAR ZERO, ADD IN FAR EDGE TERMS WHICH ARE
C           DIRECTLY ILLUMINATED
      XCS5 = AS5*AK2S
      XCS7 = AS7*AK2S
      CALL BESL(XCS5,B50,B51,B52)
      CALL BESL(XCS7,B70,B71,B72)
      PH5P = CMPLX(B50,B51)
      PH7P = CMPLX(B70,B71)
      CV6   = A2*C2*(PH2P*SV12-BC2X)*Q6
      CH6   = A2*C2*(PH2P*SH12-BC2X)*Q6
      CV8   = A4*C4*(PH4P*SV12-BC4X)*Q8
      CH8   = A4*C4*(PH4P*SH12-BC4X)*Q8
      CV5   =-AS5*C2*PH5P*CKV*Q6
      CV7   =-AS7*C4*PH7P*CKV*Q8
      SV    = CV6 + CV8 +CV5+CV7 + SV
      SH    = CH6 + CH8 -CV5-CV7 + SH
      GO TO 40
C
C     THETA .GT. PI/2
   35 CONTINUE
C
C     RUCK-UFIMTSEV SCATTERING (THETA.GT.90)
      CV10 = A4*C9*(PH4P*SV10-BC4X)
      CH10 = A4*C9*(PH4P*SH10-BC4X)
      CV9   = A4*C9*(PH4*SV9-BC4X)
      CH9   = A4*C9*(PH4*SH9-BC4X)
      CV4   = A4*C4*(PH4*SV11-BC4X)*Q4
      CH4   = A4*C4*(PH4*SH11-BC4X)*Q4
      CV2   = A2*C2*(PH2*SV11-BC2X)*Q2
      CH2   = A2*C2*(PH2*SH11-BC2X)*Q2
      CV11 = A1*C11*(PH1*SV11-BC1X)*Q11
      CH11 = A1*C11*(PH1*SH11-BC1X)*Q11
      CV1   = A1*C2*PH1*CK1*Q1
      CV3   = A2*C4*PH2*CK1*Q3
      SV    = CV10+CV9+CV4+CV2+CV11 +CV1+CV3
      SH    = CH10+CH9+CH4+CH2+CH11 -CV1-CV3
   40 CONTINUE
C
      SV =-SV*SPIK
      SH = SH*SPIK
C
C     REFERENCE PHASE TO FRONT OF SECOND CYLINDER
C
      SV    = SV*C4
      SH    = SH*C4
C
      EVVR(I) = REAL(SV)
      EVVI(I) =-AIMAG(SV)
      EHHR(I) = REAL(SH)
      EHHI(I) =-AIMAG(SH)
   30 CONTINUE
      RETURN
```

```
      END
      FUNCTION Q(Z)
C     Q(Z) = 0.5*(1 + ERF(Z))
C   * ERF(Z) IS EVALUATED USING A RATIONAL POLYNOMIAL APPROXIMATION
C   * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,
C   *                SECTION 7.1.26)
C
      IF ( Z.GT. 2. ) GO TO 10
      IF ( Z.LT.-2. ) GO TO 20
      AZ = ABS(Z)
      P = 1.0/(1.0 + .47047*AZ)
      Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P))*EXP(-AZ*AZ)
      IF (Z) 2,4,6
    2 Q = (1.0 - Y)/2.
      RETURN
    4 Q = .5
      RETURN
    6 Q = (1.0 + Y)/2.
      RETURN
   10 Q = 1.
      RETURN
   20 Q = 0.
      RETURN
      END
      SUBROUTINE BESL ( X, B0, B1, B2 )
C
C   * BESSEL FUNCTION SUBROUTINE UTILIZING POLYNOMIAL APPROXIMATIONS
C   * COMPUTES J0,J1,OR J2 FOR POSITIVE REAL ARGUMENTS
C   * REFERENCE (HNDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN SECTION 9.4 )
C
      S = 1.0
      IF (X .LT. 0.0) S=-1.0
      X = ABS(X)
C
      IF ( X .GT. 1.E-6 ) GO TO 5
      B0 = 1.0
      B1 = 0.0
      B2 = 0.0
      X = X * S
      RETURN
C
    5 CONTINUE
C
    1 IF ( X .GE. 3. ) GO TO 9
      X1 = X/3.
      X1 = X1*X1
      B = 1.+ X1*(-2.2499997+ X1*(1.2656208+ X1*(-.3163866+ X1*(.0444479
     1 +        X1*(-.0039444+ X1*2.1E-4 )))) )
      GO TO 10
C
    9 X2 = 3./X
      F0 =   .79788456 +X2*(-.77E-6 +X2*(-.00552740 +X2*(-.9512E-4 +X2*
     1      (.00137237 +X2*(-.72805E-3 +X2*0.14476E-3 )))) )
      T0 = X - .78539816 +X2*(-.04166397 +X2*(-.3954E-4 +X2*(.00262573
     1     +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))
      B = F0*COS(T0)/SQRT(X)
C
   10 B0 = B
```

```
C
    2 IF ( X .GE. 3. ) GO TO 19
      X1 = X/3.
      X1 = X1*X1
      B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*
     1                (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4))))) )
      GO TO 20
C
   19 X2 = 3./X
      F1 = .79788456 +X2*(.156E-5 +X2*(.01659667 +X2*(.00017105 +X2*
     1     (-.00249511 +X2*(.00113653 -.00020033*X2 )))))
      T1 = X - 2.35619449 +X2*(.12499612 +X2*(.565E-4 +X2*(-.00637879
     1   +X2*(.00074348 +X2*(.00079824 -0.00029166*X2 )))))
      B = F1*COS(T1)/SQRT(X)
C
   20 B1 = B * S
      X = X * S
      B2= (2./X)*B1 - B0
   50 RETURN
      END
```

CHART TITLE - SUBROUTINE TARGET(EVVR.EVVI,FFF.....)

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```
                  ------------
                 /  TARGET   /
                 ------------

                      *                 +------------------>*
                                        |                   |  NOTE  08
    **  RESPONSE OF                     |        * * * * * * * * * * * *
   STEPPED CYLINDERS                    |        *  LIST = A1, A2,    *
   (MODEL 43)      **                   |        *  A4, H1, H2, H3    *
    **  COMPUTED USING                  |        * * * * * * * * * * * *
   THE RUCK UFIMTSEV                    |                   |
   TECHNIQUE  **                        |                   |
                                        |                   |        09
                                        |             ------------------
                                        |             / WRITE TO DEV   /
   NMIN = MINIMUM                       |            /      6         /
   FREQUENCY SAMPLE                     |           /  VIA FORMAT    /
   NMAX = MAXIMUM                       |          /     6001       /
   FREQUENCY SAMPLE                     |         / FROM THE LIST  /
   DF    = FREQUENCY                    |         ----------------
   INCREMENT IN MHZ                     |                   |
   FC    = CARRIER                      |                   |
   FREQUENCY IN GHZ                     |                   |  NOTE  10
   ITT SET TO 1 TO READ                 |        * * * * * * * * * * * *
   INPUT DIMENSIONS                     |        *   LIST = ASPECT    *
   SET TO 2 WHEN TARGET                 |        * * * * * * * * * * * *
   DIMENSIONS DO NOT                    |                   |
   CHANGE                               |                   |
                                        |                   |        11
                      *                 |             ------------------
                      |           02    |             / WRITE TO DEV   /
   *------------------------*           |            /      6         /
   |   COMPUTED CO TO       |           |           /  VIA FORMAT    /
   |      FOR  ITT          |           |          /     6002       /
   *------------------------*           |         / FROM THE LIST  /
   |  5             50.03   |           |         ----------------
   |  6             51.05   |           |                   |
   *------------------------*           |                   |
                      |                 |                   |  NOTE  12
                      |                 |        * * * * * * * * * * * *
                      |                 |        *  LIST = A1, H1,    *
   IF OUTSIDE THE RANGE                 |        *  A2, H2, A4, H3    *
```

```
|  6          51.05  |
*--------------------*
          |
          |
          |
IF OUTSIDE THE RANGE
          |
 50.02--->|
    5     |  NOTE  03
* * * * * * * * * * * *
*      CONTINUE       *
* * * * * * * * * * * *
          |
          |
          |
PROGRAM CONSTANTS
          |
          |
          |              04
*--------------------*
|        PI =        |
| 3.14159265358979   |
|                    |
|  FTK = .53234454   |
|                    |
|      FTKDF =       |
|  .53234454*(DF/    |
|      1000.)        |
|                    |
|   PIO2 = PI/2.     |
*--------------------*
          |
          |
          |              05
*--------------------*
|  SPI = SQRT(PI)    |
|                    |
| AITM = 0.0254026   |
|                    |
|  SPIK = SPI*AITM   |
|                    |
|  TPIO2 = 3.*PIO2   |
*--------------------*
          |
          |
          |              06
*--------------------*
|   DTR = PI/180.    |
|                    |
|   RTD = 180./PI    |
|                    |
|   DLT = 15.*DTR    |
*--------------------*
          |
```

```
          |
          |
          |  NOTE  12
* * * * * * * * * * * *
*  LIST = A1, H1,     *
*  A2, H2, A4, H3     *
* * * * * * * * * * * *
          |
          |
          |              13
*--------------------*
|   TH2 = H2 + H2    |
|                    |
| TH2PH1 = TH2 + H1  |
|                    |
|    A21 = A2 - A1   |
|                    |
|    A41 = A4 - A1   |
*--------------------*
          |
          |
          |              14
*--------------------*
|    A42 = A4 - A2   |
|                    |
|  SA1 = SQRT(A1)    |
|                    |
|  SA2 = SQRT(A2)    |
*--------------------*
          |
          |
          |              15
*--------------------*
|       ALF1 =       |
|   ATAN(A21/H1)     |
|                    |
|       ALF2 =       |
|   ATAN(A42/TH2)    |
|                    |
|       ALF3 =       |
| ATAN(A41/TH2PH1)   |
*--------------------*
          |
          |
          |              16
*--------------------*
|   PIMAL2 = PI -    |
|       ALF2         |
|                    |
|   PIMAL3 = PI -    |
|       ALF3         |
*--------------------*
          |
```

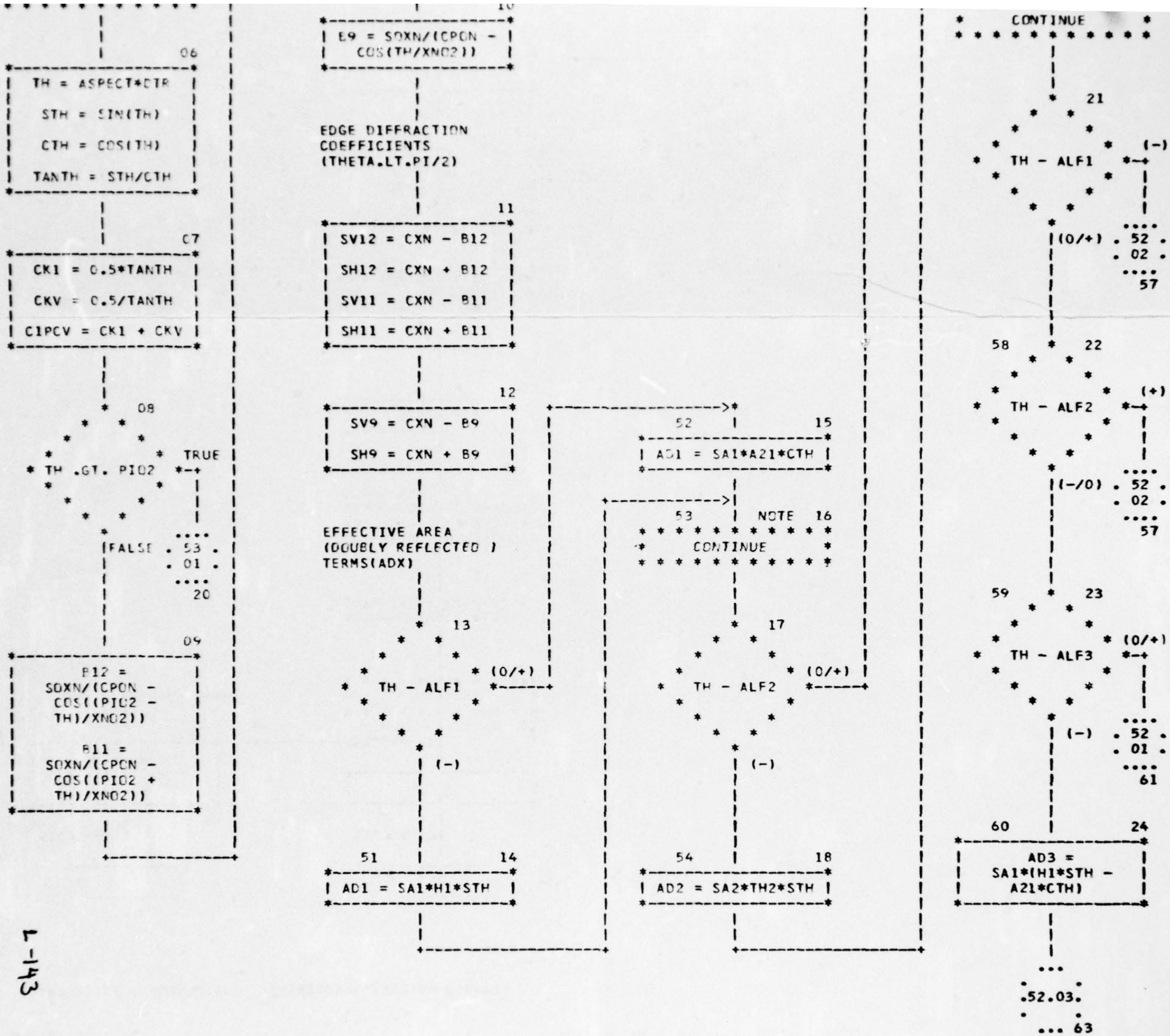
```
|      FTKDF =         |     |         | SA1 = SQRT(A1)        |
|  .53234454*(DF/      |     |         |                       |
|      1000.)          |     |         | SA2 = SQRT(A2)        |
|                      |     |         *-----------------------*
|   PIO2 = PI/2.       |     |                     |
*----------------------*     |                     |
           |                 |                     |           15
           |                 |         *-----------------------*
           |            05   |         |        ALF1 =         |
*----------------------*     |         |    ATAN(A21/H1)       |
|  SP1 = SQRT(PI)      |     |         |                       |
|                      |     |         |        ALF2 =         |
| AITM = 0.0254026     |     |         |    ATAN(A42/TH2)      |
|                      |     |         |                       |
|  SPIK = SPI*AITM     |     |         |        ALF3 =         |
|                      |     |         | ATAN(A41/TH2PH1)      |
|  TPIO2 = 3.*PIO2     |     |         *-----------------------*
*----------------------*     |                     |
           |                 |                     |
           |                 |                     |           16
           |            06   |         *-----------------------*
*----------------------*     |         |   PIMAL2 = PI -       |
|  DTR = PI/180.       |     |         |       ALF2            |
|                      |     |         |                       |
|  RTD = 180./PI       |     |         |   PIMAL3 = PI -       |
|                      |     |         |       ALF3            |
|  DLT = 15.*DTR       |     |         *-----------------------*
*----------------------*     |                     |
           |                 |                     |
           |                 |                     |           17
           |            07   |         *-----------------------*
      ----------------       |         | X1D = ALF1*RTD        |
     / READ FROM DEV /       |         |                       |
    /       5       /        |         | X2D = ALF2*RTD        |
   /  VIA FORMAT   /         |         |                       |
  /      5001     /          |         | X3D = ALF3*RTD        |
 / INTO THE LIST /           |         *-----------------------*
----------------             |                     |
           |                 |                     |
           |                 |                     |  /
           +-----------------+                   -----
                                                /51.01
```

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

```
 50.17--->*
          |             01
   ----------------------
   / WRITE TO DEV      /
  /       6           /
 /   VIA FORMAT      /
/       6005        /
/ FROM THE LIST    /
--------------------
          |
          |
          |  NOTE   02
* * * * * * * * * * * *
* LIST = X1D, X2D,    *
*          X3D        *
* * * * * * * * * * * *
          |
          |
          |             03
*---------------------*
| TKFC = FTK*FC*2.    |
|                     |
|      XN = 1.5       |
|                     |
|    XNO2 = XN/2.     |
|                     |
|       SOXN =        |
|   SIN(PI/XN)/XN     |
|                     |
|   CXN = - SOXN/XN   |
*---------------------*
          |
          |
          |             04
*---------------------*
| CPON = COS(PI/XN)   |
*---------------------*
          |
 50.02--->|
    6     |  NOTE   05
* * * * * * * * * * * *
*      CONTINUE       *
* * * * * * * * * * * *
          |
          |             06
*---------------------*
| TH = ASPECT*DTR     |


+------------------->*
|                    |        10
|          *-------------------*
|          | E9 = SOXN/(CPON - |
|          |   COS(TH/XNO2))   |
|          *-------------------*
|                    |


+------------------------>*
|           55        |          19
|          *---------------------*
|          | AD2 = SA2*A42*CTH   |
|          *---------------------*
|                     |
|     +-------------->|
|     |     56        |  NOTE   20
|     |    * * * * * * * * * * * *
|     |    *      CONTINUE       *
|     |    * * * * * * * * * * * *
|     |               |
```



06
TH = ASPECT*DTR
STH = SIN(TH)
CTH = COS(TH)
TANTH = STH/CTH
07
CK1 = 0.5*TANTH
CKV = 0.5/TANTH
C1PCV = CK1 + CKV
08
TH .GT. PIO2
TRUE
FALSE
53
01
20
09
B12 = SOXN/(CPON - COS((PIO2 - TH)/XNO2))
B11 = SOXN/(CPON - COS((PIO2 + TH)/XNO2))
10
E9 = SOXN/(CPON - COS(TH/XNO2))
EDGE DIFFRACTION COEFFICIENTS (THETA.LT.PI/2)
11
SV12 = CXN - B12
SH12 = CXN + B12
SV11 = CXN - B11
SH11 = CXN + B11
12
SV9 = CXN - B9
SH9 = CXN + B9
EFFECTIVE AREA (DOUBLY REFLECTED) TERMS(ADX)
13
TH - ALF1
(0/+)
(-)
51
14
AD1 = SA1*H1*STH
52
15
AD1 = SA1*A21*CTH
53
NOTE
16
CONTINUE
17
TH - ALF2
(0/+)
(-)
54
18
AD2 = SA2*TH2*STH
CONTINUE
21
TH - ALF1
(-)
(0/+)
52
02
57
58
22
TH - ALF2
(+)
(-/0)
52
02
57
59
23
TH - ALF3
(0/+)
(-)
52
01
61
60
24
AD3 = SA1*(H1*STH - A21*CTH)
52.03.
63

L-143

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

L-144

```
      -----------                          -----------
     /    61    /                         /    57    /
     -----------                          -----------
          |                                    |
 51.23--->|                          51.21*--->|
          |             01                     |             02
*-------------------------*          *-------------------------*
|         AD3 =           |          |        AD3 = 0          |
|  SA1*(A42*CTH -         |          *-------------------------*
|       TH2*STH)          |                    |
*-------------------------*    +---------51.24*-->|
          |                |          63       |   NOTE   03
          |                |          * * * * * * * * * * * *
          +----------------+          *       CONTINUE        *
                                      * * * * * * * * * * * *
                                               |
                                               |
                                      ASSUMED THAT  ALF3
                                      .GT. (ALF1 OR ALF2 )
                                               |
                                               |
                                      SMOOTHING FUNCTIONS
                                      AND ILLUMINATED AREA
                                      USING SLIDING SHADOW
                                      BOUNDARIES
                                               |
                                               |             04
                                      *-------------------------*
                                      |       ISWA3 = 1         |
                                      *-------------------------*
                                               |
                                               |
                                               *    05
                                            *     *
                                         *           *
                                      *                 *   TRUE
                                    * TH .GT. ALF3       *--+
                                      *                 *   |
                                         *           *      |
                                            *     *        ....
                                               *
                                               |FALSE    . 53 .
                                               |         . 07 .
                                               |          ....
                                               |           25
                                               |
                                               |             06
                                      *-------------------------*
                                      |       ISWA3 = 2         |    +------------------>*
                                      |                         |
```

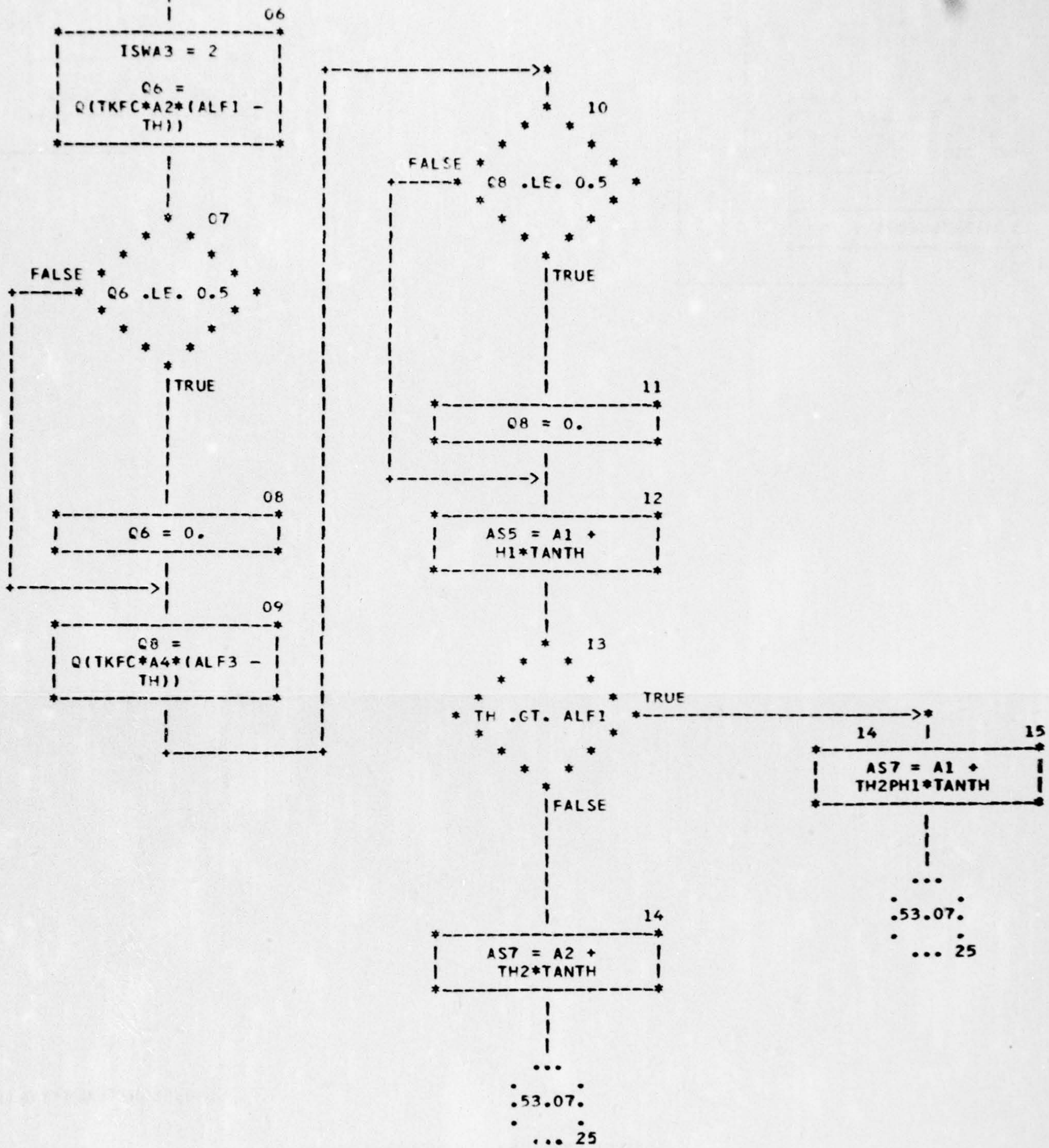

06
ISWA3 = 2
Q6 =
Q(TKFC*A2*(ALF1 -
TH))
07
Q6 .LE. 0.5
FALSE
TRUE
08
Q6 = 0.
09
Q8 =
Q(TKFC*A4*(ALF3 -
TH))
10
Q8 .LE. 0.5
FALSE
TRUE
11
Q8 = 0.
12
AS5 = A1 +
H1*TANTH
13
TH .GT. ALF1
TRUE
FALSE
14
AS7 = A2 +
TH2*TANTH
.53.07.
... 25
14
15
AS7 = A1 +
TH2PH1*TANTH
.53.07.
... 25

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

```
THETA .GT. PI/2

51.08--->*
20                      01
B10 =
SOXN/(CPON -
COS((TH -
PIO2)/XNO2))

B9 = SOXN/(CPON -
COS((TPIO2 -
TH)/XNO2))

                        02
B11 =
SOXN/(CPON -
COS((PI -
TH)/XNO2))

EDGE DIFFRACTION
COEFFICIENTS
(THETA.GT.PI/2)

                        03
SV10 = CXN - B10
SH10 = CXN + B10
SV9 = CXN - B9
SH9 = CXN + B9

                        04
SV11 = CXN - B11
```

```
NOTE 09
* * * * * * * * * * *
*   BEGIN DO LOOP   *
* 30 I = NMIN, NMAX *
* * * * * * * * * * *

54.22--->
                        10
XI = I - 1
AK = XI*FTKDF
AK2 = AK + AK
AK2S = AK2*STH

                        11
XC1 = A1*AK2S
XC2 = A2*AK2S
XC4 = A4*AK2S

                        12
7.01  BESL
(XC1,BJ10,
BJ11,BJ12)

                        13
7.01  BESL
(XC2,BJ20,
BJ21,BJ22)
```

```
                        18
PH2 = CONJG(PH2P)
PH4 = CONJG(PH4P)

                        19
PS11 = -
AK2*(H2 + H1)*CTH

PS2 = -
AK2*H2*CTH

PS9 = AK2*(H2 +
H3)*CTH

                        20
C11 =
CMPLX(COS(PS11),
SIN(PS11))

C2 =
CMPLX(COS(PS2),
SIN(PS2))

C4 = CONJG(C2)

                        21
C9 =
CMPLX(COS(PS9),
SIN(PS9))

                        22
                  TRUE
```

```
                        24
CD1 =
CMPLX(COS(PSD1),
SIN(PSD1))

CD2 =
CMPLX(COS(PSD2),
SIN(PSD2))

CD3 =
CMPLX(COS(PSD3),
SIN(PSD3))

DOUBLY REFLECTED
SCATTERING (TOTAL)

                        25
CAD = SQRT(AK2 +
AK2)*(AD1*CD1 +
AD2*CD2 +
AD3*CD3)

RUCK-UFIMTSEV
SCATTERING
(THETA.LT.90,EDGES
ILLUMINATED AT 90)

                        26
CV12 =
A1*C11*(SV12*
PH1P - BC1X)

CH12 =
A1*C11*(SH12*
PH1P - BC1X)

CV11 =
```

```
SV9 = CXN - B9
SH9 = CXN + B9

04
SV11 = CXN - B11
SH11 = CXN + B11
XALF = PIO2 +
DLT - TH

SMOOTHING FUNCTIONS

05
Q1 =
Q(TKFC*A1*XALF)
Q2 =
Q(TKFC*A2*
(PIMAL2 - TH))
Q3 =
Q(TKFC*A2*XALF)

06
Q4 =
Q(TKFC*A4*(PI -
TH))
Q11 =
Q(TKFC*A1*
(PIMAL3 - TH))

52.05*-->
25          NOTE  07
* * * * * * * * * * * *
*     CONTINUE        *
* * * * * * * * * * * *

FREQUENCY LOOP
```

```
13
7.01  BESL
(XC2,BJ20,
BJ21,BJ22)

14
7.01  BESL
(XC4,BJ40,
BJ41,BJ42)

15
BC1 = BJ10 + BJ12
BC2 = BJ20 + BJ22
BC4 = BJ40 + BJ42
BC1X = BC1*CXN

16
BC2X = BC2*CXN
BC4X = BC4*CXN

17
PH1P =
CMPLX(BJ10,BJ11)
PH2P =
CMPLX(BJ20,BJ21)
PH4P =
CMPLX(BJ40,BJ41)
PH1 = CONJG(PH1P)
```

```
C9 =
CMPLX(COS(PS9),
SIN(PS9))

22
* TH .GT. PIO2 *   TRUE
FALSE  . 54 .
       . 12 .
         35

GENERAL REGION (THETA
.GT. ALF3 .AND. THETA
.LT. PI/2)

PHASE OF DOUBLY
REFLECTED  SCATTERING
TERMS

23
PSD1 = -
AK2*(A1*STH +
H2*CTH)
PSD2 = -
AK2*(A2*STH -
H2*CTH)
PSD3 = -
AK2*(A1*STH -
H2*CTH)
```

```
26
CV12 =
A1*C11*(SV12*
PH1P - BC1X)
CH12 =
A1*C11*(SH12*
PH1P - BC1X)
CV11 =
A1*C11*(SV11*PH1
- BC1X)

27
CH11 =
A1*C11*(SH11*PH1
- BC1X)
CV2 =
A2*C2*(SV11*PH2 -
BC2X)
CH2 =
A2*C2*(SH11*PH2 -
BC2X)

28
CV4 =
A4*C4*(SV11*PH4 -
BC4X)
CH4 =
A4*C4*(SH11*PH4 -
BC4X)
CV9 =
A4*C9*(SV9*PH4 -
BC4X)

29
CH9 =
A4*C9*(SH9*PH4 -
BC4X)
CV1 =
A1*C2*PH1*C1PCV
CV3 =
A2*C4*PH2*C1PCV

/54.01
```

2

CHART TITLE - SUBROUTINE TARGET(EVVR,EVVI,EHHR,EHHI)

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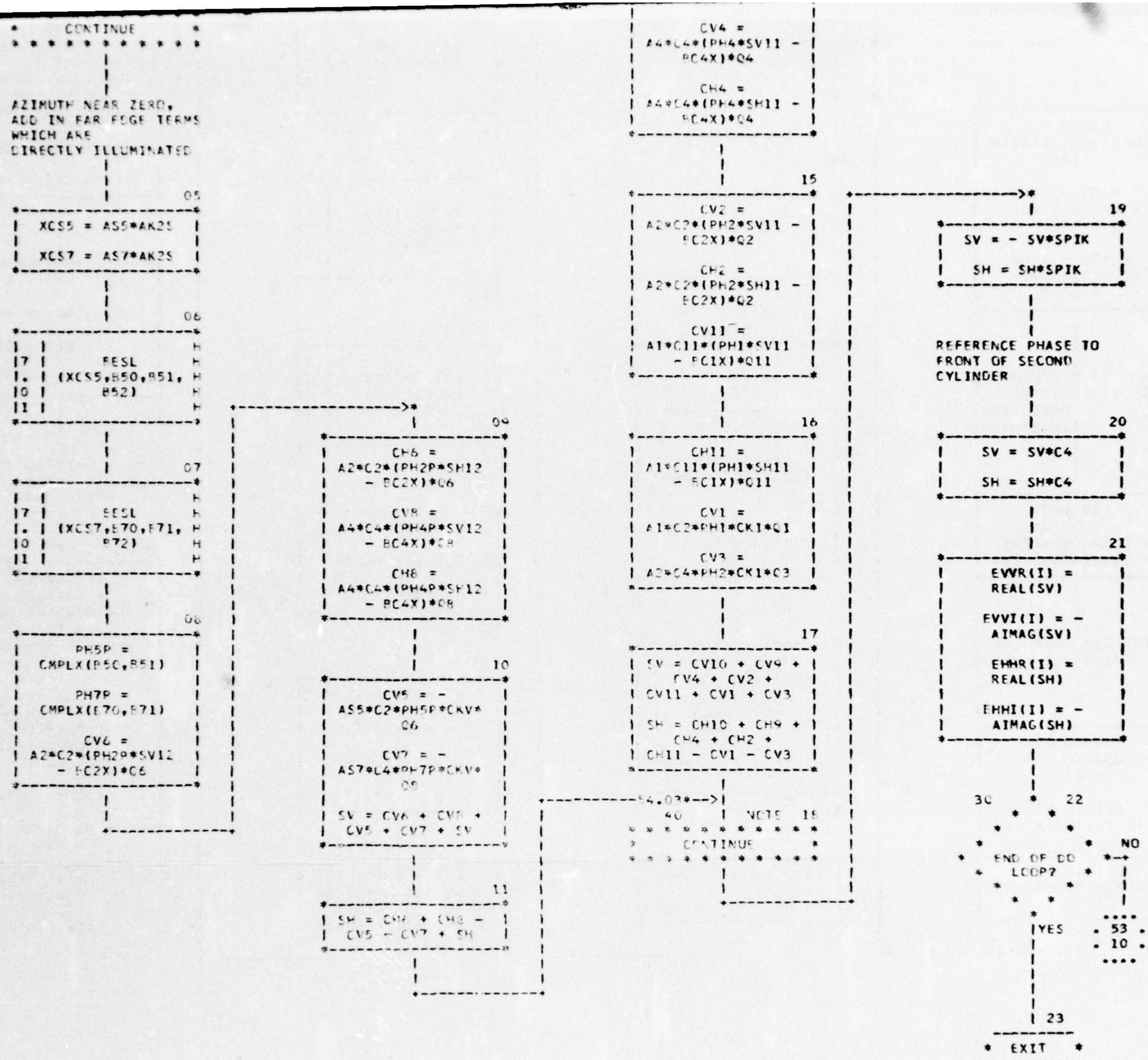
```
 53.29--->*
          |         01
*-------------------*
| SV = CV12 +       |
| CV11 + CV2 +      |
| CV4 + CV9 + CV1 + |
|   CV3             |
|                   |
| SH = CH12 +       |
| CH11 + CH2 +      |
| CH4 + CH9 - CV1 - |
|   CV3             |
*-------------------*
          |
          |         02
*-------------------*
| SV = SV + CAD/SPI |
|                   |
| SH = SH + CAD/SPI |
*-------------------*
          |
          |         03
*-------------------*
|  COMPUTED GO TO   |
|   FOR  ISWA3      |
*-------------------*
| 40         54.18  |
| 34         54.04  |
*-------------------*
          |
          |
IF OUTSIDE THE RANGE
          |
 54.03--->|
   34     |  NOTE 04
* * * * * * * * * * *
*     CONTINUE      *
* * * * * * * * * * *
          |
          |
AZIMUTH NEAR ZERO,
ADD IN FAR EDGE TERMS
WHICH ARE
DIRECTLY ILLUMINATED
          |
          |         05
*-------------------*
| XCS5 = AS5*AK2S   |
|                   |
| XCS7 = AS7*AK2S   |
*-------------------*


THETA .GT. PI/2

 53.22--->*
   35     |  NOTE 12
* * * * * * * * * * *
*     CONTINUE      *
* * * * * * * * * * *
          |
          |
RUCK-UFIMTSEV
SCATTERING
(THETA.GT.90)
          |
          |         13
*-------------------*
|     CV10 =        |
| A4*C9*(PH4P*SV10  |
|     - BC4X)       |
|                   |
|     CH10 =        |
| A4*C9*(PH4P*SH10  |
|     - BC4X)       |
|                   |
|     CV9 =         |
| A4*C9*(PH4*SV9 -  |
|     BC4X)         |
*-------------------*
          |
          |         14
*-------------------*
|     CH9 =         |
| A4*C9*(PH4*SH9 -  |
|     BC4X)         |
|                   |
|     CV4 =         |
| A4*C4*(PH4*SV11 - |
|     BC4X)*Q4      |
|                   |
|     CH4 =         |
| A4*C4*(PH4*SH11 - |
|     BC4X)*Q4      |
*-------------------*
          |
          |         15
*-------------------*  *------------------>*
|     CV2 =         |  |                   |          19
| A2*C2*(PH2*SV11 - |  |         *-------------------*
|     BC2X)*Q2      |  |         | SV = - SV*SPIK    |
|                   |  |         |                   |
|     CH2 =         |  |         | SH = SH*SPIK      |
```


CONTINUE
AZIMUTH NEAR ZERO, ADD IN FAR EDGE TERMS WHICH ARE DIRECTLY ILLUMINATED
05
XCS5 = AS5*AK2S
XCS7 = AS7*AK2S
06
7.01
FESL (XCS5,B50,B51, B52)
07
7.01
EESL (XCS7,E70,E71, E72)
08
PH5P = CMPLX(B50,B51)
PH7P = CMPLX(E70,E71)
CV6 = A2*C2*(PH2P*SV12 - BC2X)*Q6
09
CH6 = A2*C2*(PH2P*SH12 - BC2X)*Q6
CV8 = A4*C4*(PH4P*SV12 - BC4X)*Q8
CH8 = A4*C4*(PH4P*SH12 - BC4X)*Q8
10
CV5 = - AS5*C2*PH5P*CKV* Q6
CV7 = - AS7*C4*PH7P*CKV* Q9
SV = CV6 + CV8 + CV5 + CV7 + SV
11
SH = CH6 + CH8 - CV5 - CV7 + SH
CV4 = A4*C4*(PH4*SV11 - BC4X)*Q4
CH4 = A4*C4*(PH4*SH11 - BC4X)*Q4
15
CV2 = A2*C2*(PH2*SV11 - BC2X)*Q2
CH2 = A2*C2*(PH2*SH11 - BC2X)*Q2
CV11 = A1*C11*(PH1*SV11 - BC1X)*Q11
16
CH11 = A1*C11*(PH1*SH11 - BC1X)*Q11
CV1 = A1*C2*PH1*CK1*Q1
CV3 = A2*C4*PH2*CK1*Q3
17
SV = CV10 + CV9 + CV4 + CV2 + CV11 + CV1 + CV3
SH = CH10 + CH9 + CH4 + CH2 + CH11 - CV1 - CV3
54.03
40
NOTE 18
CONTINUE
19
SV = - SV*SPIK
SH = SH*SPIK
REFERENCE PHASE TO FRONT OF SECOND CYLINDER
20
SV = SV*C4
SH = SH*C4
21
EVVR(I) = REAL(SV)
EVVI(I) = - AIMAG(SV)
EHHR(I) = REAL(SH)
EHHI(I) = - AIMAG(SH)
30
22
END OF DO LOOP?
NO
53
10
YES
23
EXIT

2

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
      COMMON MOVER, M, NMIN, NMAX, DF, FC, PW, TC
      COMMON /TARS / ASPECT,ITT
      COMPLEX PH1, PH2, PH4, PH1P, PH2P, PH4P, C11, C2, C4, C9,
            PH5P, PH7P
      COMPLEX  SV,SH
      COMPLEX CV12,CH12, CV11,CH11, CV2,CH2, CV4,CH4, CV9,CH9,
            CV10,CH10, CV1, CV3, CV6,CH6, CV8,CH8, CV5, CV7
      COMPLEX CD1, CD2, CD3, CAD
      DIMENSION EVVR(1), EVVI(1), EHHR(1), EHHI(1)
5001  FORMAT ( 7F8.0)
6001  FORMAT ( '1  PROGRAM INPUT PARAMETERS',//,' THETA =',F9.3 )
6002  FORMAT ( '0  A1 =', F7.4,'   H1 =',F7.4,/,
            '  A2 =', F7.4,'   H2 =',F7.4,/,
            '  A4 =', F7.4,'   H3 =',F7.4 )
6005  FORMAT ( '  ALF1 = ',F8.3,/,'  ALF2 = ',F8.3,/,'  ALF3 = ',F8.3)
```

CHART TITLE - FUNCTION Q(Z)

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```
                              Q(Z) = 0.5*(1 +
                              ERF(Z))
                               * ERF(Z) IS
                              EVALUATED USING A
                              RATIONAL POLYNOMIAL
                              APPROXIMATION
                               * REFERENCE (HANDBK
                              MATH FUNCT BY
                              ABRAMOWITZ AND
                              STEGUN,
                               *          SECTION
                              7.1.26)

                                   *
                                   |
                                   *    03
                                 *   *
                               *       *
                             *           *  TRUE
                           *   Z .GT. 2.   *---------------------->*
                             *           *                  10     |       09
                               *       *                  *-------------------*
                                 *   *                    |      Q = 1.       |
                                   *                      *-------------------*
                                   |FALSE                          |
                                   |                               |
                                   |                               | 10
                                   |                           ---------
                                   |                         *   EXIT   *
                                   |                           ---------
                                   *    04
                                 *   *
                               *       *
                             *           *  TRUE
                           *  Z .LT. - 2.  *-----+
                             *           *       |
                               *       *         |
                                 *   *           +---------------->*
                                   *
```

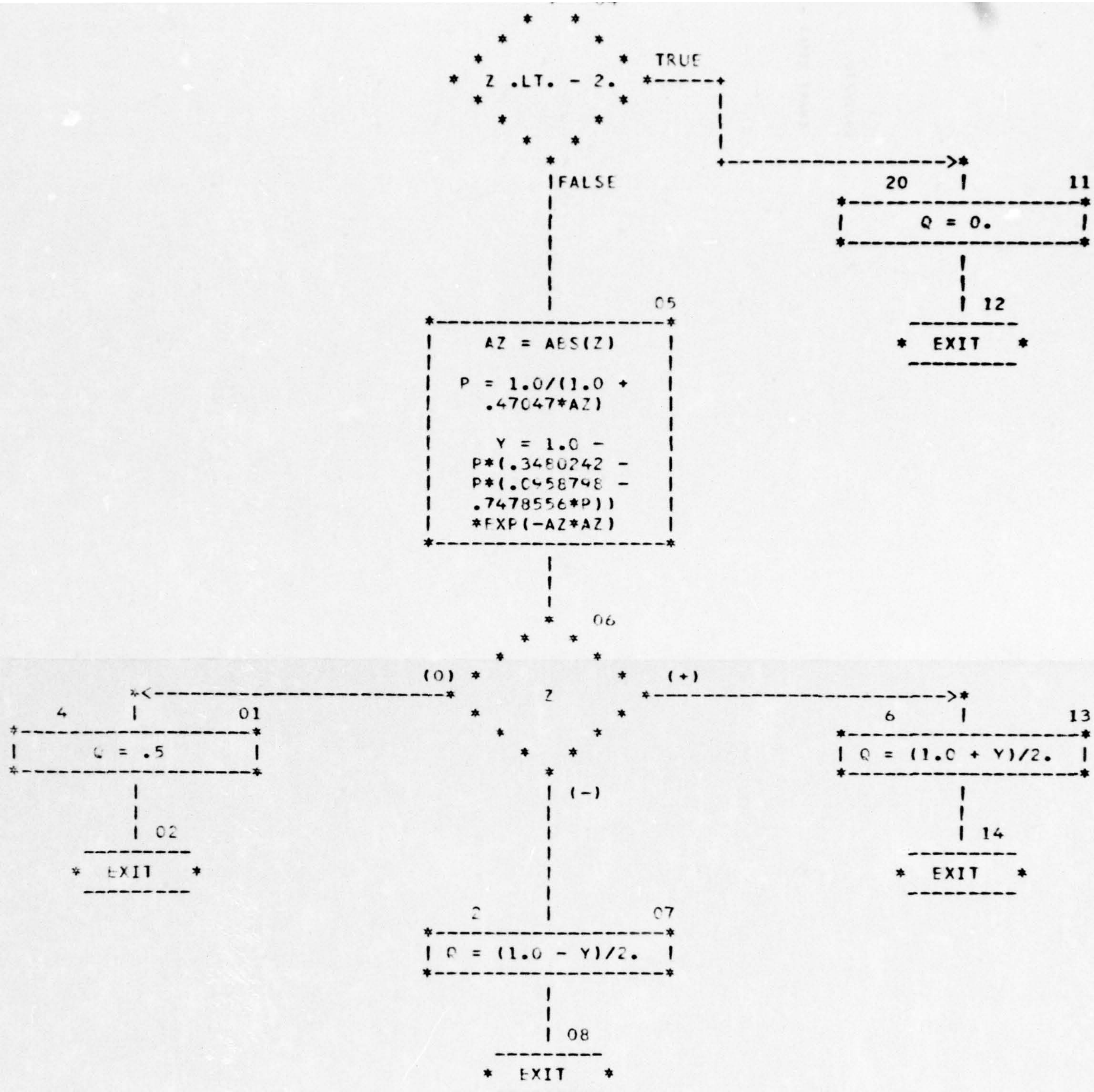

Z .LT. - 2.
TRUE
FALSE
20
11
Q = 0.
12
EXIT
05
AZ = ABS(Z)
P = 1.0/(1.0 + .47047*AZ)
Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P)) *EXP(-AZ*AZ)
06
Z
(0)
(+)
(-)
4
01
Q = .5
02
EXIT
6
13
Q = (1.0 + Y)/2.
14
EXIT
2
07
Q = (1.0 - Y)/2.
08
EXIT

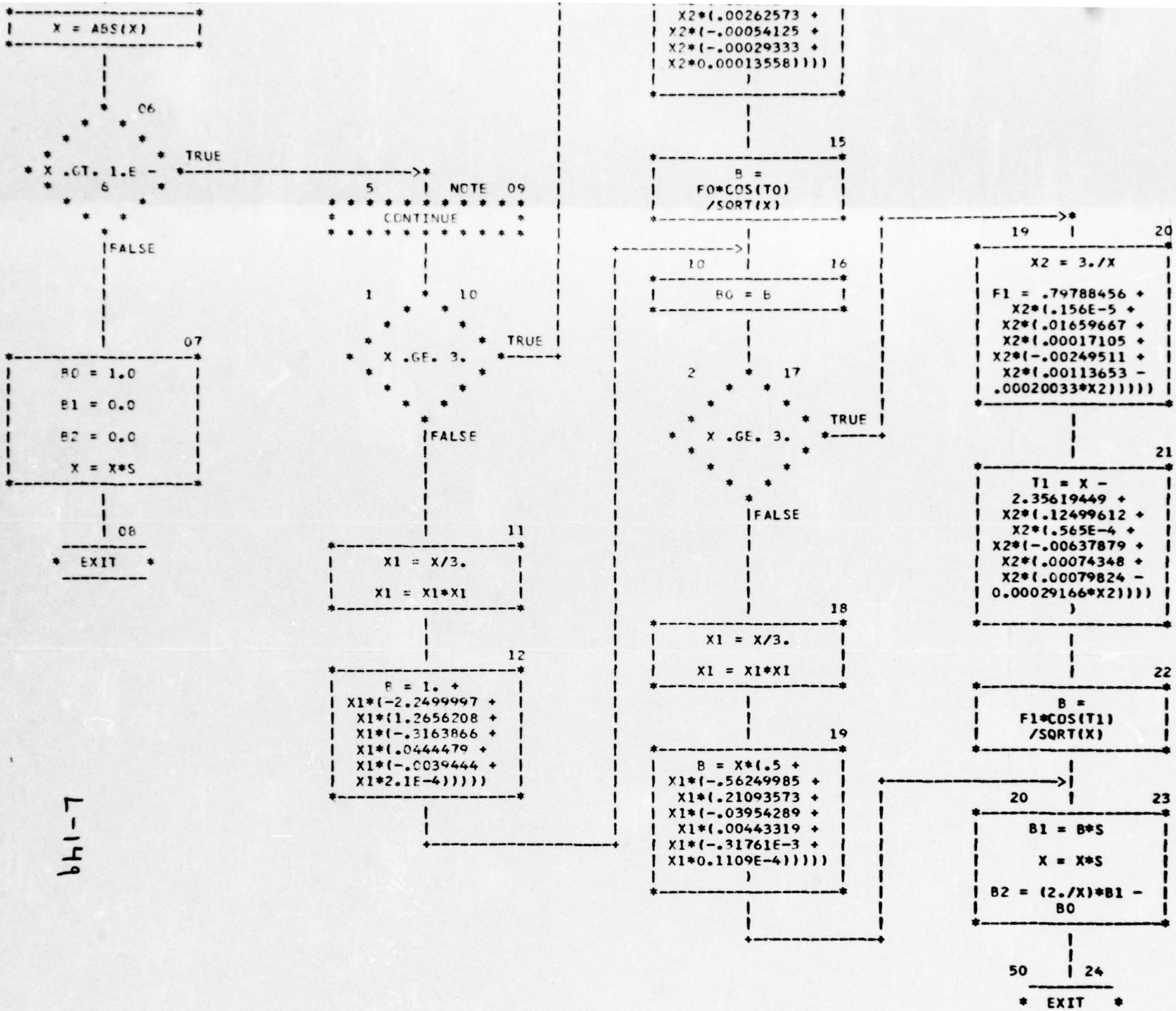
CHART TITLE - SUBROUTINE BESL(X,F0,B1,B2)

```
  -----------
 /   BESL    /
 -----------
       *

 * BESSEL FUNCTION
SUBROUTINE UTILIZING
POLYNOMIAL
APPROXIMATIONS
 * COMPUTES J0,J1,OR
J2 FOR POSITIVE REAL
ARGUMENTS
 * REFERENCE (HNDBK
MATH FUNCT BY
ABRAMOWITZ AND STEGUN
SECTION 9.4 )

         *
         |             02
*-----------------------*
|        S = 1.0        |
*-----------------------*
         |
         |
         *   03
       *   *
     *       *
FALSE *          *
+----* X .LT. 0.0  *
|     *          *
|       *      *
|         *  *
|          *
|          |TRUE
|          |
|          |           04
|*-----------------------*
||      S = - 1.0        |
|*-----------------------*
|          |
+--------->|
           |           05
*-----------------------*
|      X = ABS(X)       |
*-----------------------*
           |
           |
           *   06


+------------------->*
|        9   |              13
|    *-------------------------*
|    |      X2 = 3./X          |
|    |                         |
|    | F0 = .79788456 +        |
|    |   X2*(-.77E-6 +         |
|    | X2*(-.00552740 +        |
|    |   X2*(-.9512E-4 +       |
|    |   X2*(.00137237 +       |
|    | X2*(-.72805E-3 +        |
|    | X2*0.14476E-3))))       |
|    |          )              |
|    *-------------------------*
|                |
|                |              14
|    *-------------------------*
|    |      T0 = X -           |
|    |     .78539816 +         |
|    | X2*(-.04166397 +        |
|    |   X2*(-.3954E-4 +       |
|    |   X2*(.00262573 +       |
|    | X2*(-.00054125 +        |
|    | X2*(-.00029333 +        |
|    | X2*0.00013558))))       |
|    |          )              |
|    *-------------------------*
|                |
```



X = ABS(X)
06
X .GT. 1.E - 6
TRUE
FALSE
07
B0 = 1.0
B1 = 0.0
B2 = 0.0
X = X*S
08
EXIT
5 NOTE 09
CONTINUE
1 10
X .GE. 3.
TRUE
FALSE
11
X1 = X/3.
X1 = X1*X1
12
B = 1. +
X1*(-2.2499997 +
X1*(1.2656208 +
X1*(-.3163866 +
X1*(.0444479 +
X1*(-.0039444 +
X1*2.1E-4)))))
X2*(.00262573 +
X2*(-.00054125 +
X2*(-.00029333 +
X2*0.00013558))))
)
15
B =
F0*COS(T0)
/SQRT(X)
10 16
B0 = B
2 17
X .GE. 3.
TRUE
FALSE
18
X1 = X/3.
X1 = X1*X1
19
B = X*(.5 +
X1*(-.56249985 +
X1*(.21093573 +
X1*(-.03954289 +
X1*(.00443319 +
X1*(-.31761E-3 +
X1*0.1109E-4)))))
)
19 20
X2 = 3./X
F1 = .79788456 +
X2*(.156E-5 +
X2*(.01659667 +
X2*(.00017105 +
X2*(-.00249511 +
X2*(.00113653 -
.00020033*X2)))))
21
T1 = X -
2.35619449 +
X2*(.12499612 +
X2*(.565E-4 +
X2*(-.00637879 +
X2*(.00074348 +
X2*(.00079824 -
0.00029166*X2))))
)
22
B =
F1*COS(T1)
/SQRT(X)
20 23
B1 = B*S
X = X*S
B2 = (2./X)*B1 -
B0
50 24
EXIT

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```
CARD NO        ****                         CONTENTS                                        ****

  1914               TPI02       = 3.*PI02                                              RCS1 034
  1915               DTR         = PI/180.                                              RCS1 035
  1916               RTD         = 180./PI                                              RCS1 036
  1917               DLT     = 15.*DTR                                                  RCS1 037
  1918         C                                                                        RCS1 038
  1919               READ (5,5001)        A1, A2, A4, H1, H2, H3                        RCS1 039
  1920          5001 FORMAT ( 7F8.0)                                                    RCS1 040
  1921               WRITE (6,6001) ASPECT                                              RCS1 042
  1922          6001 FORMAT ( '1  PROGRAM INPUT PARAMETERS',//,' THETA =',F9.3 )        RCS1 043
  1923               WRITE (6,6002) A1,H1,A2,H2,A4,H3                                   RCS1 044
  1924          6002 FORMAT ( '0  A1 =', F7.4,'   H1 =',F7.4,/,                         RCS1 045
  1925             1          '  A2 =', F7.4,'   H2 =',F7.4,/,                          RCS1 046
  1926             2          '  A4 =', F7.4,'   H3 =',F7.4 )                           RCS1 047
  1927         C                                                                        RCS1 048
  1928               TH2         = H2+H2                                                RCS1 049
  1929               TH2PH1      = TH2+H1                                               RCS1 050
  1930               A21         = A2-A1                                                RCS1 051
  1931               A41         = A4-A1                                                RCS1 052
  1932               A42         = A4-A2                                                RCS1 053
  1933               SA1   = SQRT(A1)                                                   RCS1 054
  1934               SA2   = SQRT(A2)                                                   RCS1 055
```

```
      DLT    = 15.*DTR                                                  RCS1 037
C                                                                       RCS1 038
      READ (5,5001)          A1, A2, A4, H1, H2, H3                     RCS1 039
 5001 FORMAT ( 7F8.0)                                                   RCS1 040
      WRITE (6,6001) ASPECT                                             RCS1 042
 6001 FORMAT ( '1  PROGRAM INPUT PARAMETERS',//,' THETA =',F9.3 )       RCS1 043
      WRITE (6,6002) A1,H1,A2,H2,A4,H3                                  RCS1 044
 6002 FORMAT ( '0  A1 =', F7.4,'   H1 =',F7.4,/,                        RCS1 045
     1          '  A2 =', F7.4,'   H2 =',F7.4,/,                        RCS1 046
     2          '  A4 =', F7.4,'   H3 =',F7.4 )                         RCS1 047
C                                                                       RCS1 048
      TH2       = H2+H2                                                 RCS1 049
      TH2PH1    = TH2+H1                                                RCS1 050
      A21       = A2-A1                                                 RCS1 051
      A41       = A4-A1                                                 RCS1 052
      A42       = A4-A2                                                 RCS1 053
      SA1  = SQRT(A1)                                                   RCS1 054
      SA2  = SQRT(A2)                                                   RCS1 055
C                                                                       RCS1 056
      ALF1     = ATAN(A21/H1)                                           RCS1 057
      ALF2     = ATAN(A42/TH2)                                          RCS1 058
      ALF3     = ATAN(A41/TH2PH1)                                       RCS1 059
C                                                                       RCS1 060
      PIMAL2   = PI-ALF2                                                RCS1 061
      PIMAL3   = PI-ALF3                                                RCS1 062
```

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2

L-1496

1

```
      C                                                                 RCS1 063
          X1D = ALF1*RTD                                                RCS1 064
          X2D = ALF2*RTD                                                RCS1 065
          X3D = ALF3*RTD                                                RCS1 066
      C                                                                 RCS1 067
          WRITE (6,6005) X1D,X2D,X3D                                    RCS1 068
       6005 FORMAT ( '  ALF1 = ',F8.3,/,'  ALF2 = ',F8.3,/,'  ALF3 = ',F8.3) RCS1 069
      C                                                                 RCS1 070
          TKFC    = FTK*FC*2.                                           RCS1 071
          XN      = 1.5                                                 RCS1 072
          XNO2    = XN/2.                                               RCS1 073
          SDXN    = SIN(PI/XN)/XN                                       RCS1 074
          CXN     = -SDXN/XN                                            RCS1 075
          CPDN    = COS(PI/XN)                                          RCS1 076
      C                                                                 RCS1 077
        6 CONTINUE                                                      RCS1 078
          TH          = ASPECT*DTR                                      RCS1 079
          STH         = SIN(TH)                                         RCS1 080
          CTH         = COS(TH)                                         RCS1 081
          TANTH       = STH/CTH                                         RCS1 082
          CK1         = 0.5*TANTH                                       RCS1 083
          CKV         = 0.5/TANTH                                       RCS1 084
          C1PCV = CK1+CKV                                               RCS1 085
      C                                                                 RCS1 086
          IF ( TH .GT. PIO2) GO TO 20                                   RCS1 087
```

```
1965      C                                                           RCS1 086
1966            IF ( TH .GT. PIO2) GO TO 20                           RCS1 087
1967      C                                                           RCS1 088
1968            B12     = SCXN/(CPON - COS((PIO2-TH)/XNO2))           RCS1 089
1969            B11     = SCXN/(CPON - COS((PIO2+TH)/XNO2))           RCS1 090
1970            E9      = SCXN/(CPON - COS(TH/XNO2))                  RCS1 091
1971      C     EDGE DIFFRACTION COEFFICIENTS (THETA.LT.PI/2)         RCS1 092
```

```
04/26/76      INPUT LISTING                 AUTOFLOW CHART SET - FWD/SCL  RADSIM

 CARD NO      ****                         CONTENTS                       ****

 1972           SV12 = CXN-E12                                        RCS1 093
 1973           SH12 = CXN+E12                                        RCS1 094
 1974           SV11 = CXN-B11                                        RCS1 095
 1975           SH11 = CXN+B11                                        RCS1 096
 1976           SV9  = CXN-E9                                         RCS1 097
 1977           SH9  = CXN+E9                                         RCS1 098
 1978     C                                                           RCS1 099
 1979     C     EFFECTIVE AREA (DOUBLY REFLECTED ) TERMS(ADX)         RCS1 100
 1980           IF (TH-ALF1) 51,52,52                                 RCS1 101
 1981        51 AD1   = SA1*H1*STH                                    RCS1 102
 1982           GO TO 53                                              RCS1 103
 1983        52 AD1   = SA1*A21*CTH                                   RCS1 104
```

```
C     EFFECTIVE AREA (DOUBLY REFLECTED ) TERMS(ADX)                     RCS1 100
      IF (TH-ALF1) 51,52,52                                             RCS1 101
   51 AD1  = SA1*H1*STH                                                 RCS1 102
      GO TO 53                                                          RCS1 103
   52 AD1  = SA1*A21*CTH                                                RCS1 104
   53 CONTINUE                                                          RCS1 105
C                                                                       RCS1 106
      IF (TH-ALF2) 54,55,55                                             RCS1 107
   54 AD2  = SA2*TH2*STH                                                RCS1 108
      GO TO 56                                                          RCS1 109
   55 AD2  = SA2*A42*CTH                                                RCS1 110
   56 CONTINUE                                                          RCS1 111
C                                                                       RCS1 112
      IF (TH-ALF1) 57,58,58                                             RCS1 113
   58 IF (TH-ALF2) 59,59,57                                             RCS1 114
   59 IF (TH-ALF3) 60,61,61                                             RCS1 115
   60 AD3  = SA1*(H1*STH - A21*CTH)                                     RCS1 116
      GO TO 63                                                          RCS1 117
   61 AD3  = SA1*(A42*CTH - TH2*STH)                                    RCS1 118
      GO TO 63                                                          RCS1 119
   57 AD3 = 0                                                           RCS1 120
```

```
C       SMOOTHING FUNCTIONS                                     RCS1 154
        Q1    = Q(TKFC*A1*XALF)                                 RCS1 155
        Q2    = Q(TKFC*A2*(PIMAL2-TH))                          RCS1 156
        Q3    = Q(TKFC*A2*XALF)                                 RCS1 157
        Q4    = Q(TKFC*A4*(PI-TH))                              RCS1 158
        Q11 = Q(TKFC*A1*(PIMAL3-TH))                            RCS1 159
   25 CONTINUE                                                  RCS1 160
C                                                               RCS1 161
C       FREQUENCY LOOP                                          RCS1 162
C                                                               RCS1 163
        DO 30 I = NMIN,NMAX                                     RCS1 164
        XI       = I-1                                          RCS1 165
        AK       = XI*FTKDF                                     RCS1 166
        AK2      = AK+AK                                        RCS1 167
        AK2S     = AK2*STH                                      RCS1 168
C                                                               RCS1 169
        XC1   = A1*AK2S                                         RCS1 170
        XC2   = A2*AK2S                                         RCS1 171
        XC4   = A4*AK2S                                         RCS1 172
C                                                               RCS1 173
        CALL BESL(XC1,BJ10,BJ11,BJ12)                           RCS1 174
        CALL BESL(XC2,BJ20,BJ21,BJ22)                           RCS1 175
        CALL BESL(XC4,BJ40,BJ41,BJ42)                           RCS1 176
C                                                               RCS1 177
        BC1   = BJ10+BJ12                                       RCS1 178
```

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L-149d

```
      BC2  = FJ20+BJ22                                                  RCS1 179
      BC4  = BJ40+BJ42                                                  RCS1 180
      EC1X = EC1*CXN                                                    RCS1 181
      EC2X = EC2*CXN                                                    RCS1 182
      EC4X = EC4*CXN                                                    RCS1 183
C                                                                       RCS1 184
      PH1P = CNPLX(BJ10,FJ11)                                           RCS1 185
      PH2P = CMPLX(BJ20,BJ21)                                           RCS1 186
      PH4P = CMPLX(BJ40,BJ41)                                           RCS1 187
      PH1  = CONJG(PH1P)                                                RCS1 188
      PH2  = CONJG(PH2P)                                                RCS1 189
      PH4  = CONJG(PH4P)                                                RCS1 190
C                                                                       RCS1 191
      PS11 = -AK2*(H2+H1)*CTH                                           RCS1 192
      PS2  = -AK2*H2*CTH                                                RCS1 193
      PS9  =  AK2*(H2+H3)*CTH                                           RCS1 194
C                                                                       RCS1 195
      C11  = CMPLX(COS(PS11),SIN(PS11))                                 RCS1 196
      C2   = CMPLX(COS(PS2),SIN(PS2))                                   RCS1 197
      C4   = CONJG(C2)                                                  RCS1 198
      C9   = CMPLX(COS(PS9),SIN(PS9))                                   RCS1 199
C                                                                       RCS1 200
      IF ( TH .GT. PIO2 ) GO TO 35                                      RCS1 201
C                                                                       RCS1 202
C     GENERAL REGION (THETA .GT. ALF3 .AND. THETA .LT. PI/2)            RCS1 203
```

```
2081    C                                                                         RCS1 202
2082    C     GENERAL REGION (THETA .GT. ALF3 .AND. THETA .LT. PI/2)              RCS1 203
2083    C                                                                         RCS1 204
2084    C     PHASE OF DOUBLY REFLECTED  SCATTERING TERMS                         RCS1 205
2085          PSD1 = -AK2*(A1*STH + H2*CTH)                                       RCS1 206
2086          PSD2 = -AK2*(A2*STH - H2*CTH)                                       RCS1 207
2087          PSD3 = -AK2*(A1*STH - H2*CTH)                                       RCS1 208
```



```
CARD NO   ****                        CONTENTS                                    ****

2088    C                                                                         RCS1 209
2089          CD1  = CMPLX(COS(PSD1),SIN(PSD1))                                   RCS1 210
2090          CD2  = CMPLX(COS(PSD2),SIN(PSD2))                                   RCS1 211
2091          CD3  = CMPLX(COS(PSD3),SIN(PSD3))                                   RCS1 212
2092    C                                                                         RCS1 213
2093    C     DOUBLY REFLECTED SCATTERING (TOTAL)                                 RCS1 214
2094          CAF  = SQRT(AK2*AK2)*(AD1*CD1 + AD2*CD2 + AD3*CD3)                  RCS1 215
2095    C                                                                         RCS1 216
2096    C     RUCK-UFIMTSEV SCATTERING (THETA.LT.90,EDGES ILLUMINATED AT 90)      RCS1 217
2097          CVI2 = A1*CI1*(SVI2*PHIP-ECIX)                                      RCS1 218
2098          CHI2 = A1*CI1*(SHI2*PHIP-ECIX)                                      RCS1 219
2099          CVI1 = A1*CI1*(SVI1*PHI-ECIX)                                       RCS1 220
2100          CHI1 = A1*CI1*(SHI1*PHI-ECIX)                                       RCS1 221
```

```
C                                                                   RCS1 216
C      RUCK-UFIMTSEV SCATTERING (THETA.LT.90,EDGES ILLUMINATED AT 90)  RCS1 217
       CV12 = A1*C11*(SV12*PH1P-BC1X)                               RCS1 218
       CH12 = A1*C11*(SH12*PH1P-BC1X)                               RCS1 219
       CV11 = A1*C11*(SV11*PH1-BC1X)                                RCS1 220
       CH11 = A1*C11*(SH11*PH1-BC1X)                                RCS1 221
       CV2  = A2*C2*(SV11*PH2-BC2X)                                 RCS1 222
       CH2  = A2*C2*(SH11*PH2-BC2X)                                 RCS1 223
       CV4  = A4*C4*(SV11*PH4-BC4X)                                 RCS1 224
       CH4  = A4*C4*(SH11*PH4-BC4X)                                 RCS1 225
       CV9  = A4*C9*(SV9*PH4-BC4X)                                  RCS1 226
       CH9  = A4*C9*(SH9*PH4-BC4X)                                  RCS1 227
       CV1  = A1*C2*PH1*C1PCV                                       RCS1 228
       CV3  = A2*C4*PH2*C1PCV                                       RCS1 229
       SV   = CV12+CV11+CV2+CV4+CV9 +CV1 +CV3                       RCS1 230
       SH   = CH12+CH11+CH2+CH4+CH9 -CV1 -CV3                       RCS1 231
C                                                                   RCS1 232
       SV   = SV + CAD/SPI                                          RCS1 233
       SH   = SH + CAD/SPI                                          RCS1 234
C                                                                   RCS1 235
       GO TO (40,34), ISWAP                                         RCS1 236
```

```
   34 CONTINUE                                                  RCS1 237
C      AZIMUTH NEAR ZERO, ADD IN FAR EDGE TERMS WHICH ARE       RCS1 238
C            DIRECTLY ILLUMINATED                               RCS1 239
      XCS5 = AS5*AK25                                           RCS1 240
      XCS7 = AS7*AK25                                           RCS1 241
      CALL BESL(XCS5,B50,B51,B52)                               RCS1 242
      CALL BESL(XCS7,B70,B71,B72)                               RCS1 243
      PH5P = CMPLX(B50,B51)                                     RCS1 244
      PH7P = CMPLX(B70,B71)                                     RCS1 245
      CV6  = A2*C2*(PH2P*SV12-BC2X)*06                          RCS1 246
      CH6  = A2*C2*(PH2P*SH12-BC2X)*06                          RCS1 247
      CV8  = A4*C4*(PH4P*SV12-BC4X)*08                          RCS1 248
      CH8  = A4*C4*(PH4P*SH12-BC4X)*08                          RCS1 249
      CV5  =-AS5*C2*PH5P*CKV*06                                 RCS1 250
      CV7  =-AS7*C4*PH7P*CKV*08                                 RCS1 251
      SV   = CV6 + CV8 +CV5+CV7 + SV                            RCS1 252
      SH   = CH6 + CH8 -CV5-CV7 + SH                            RCS1 253
      GO TO 40                                                  RCS1 254
C                                                               RCS1 255
C      THETA .GT. PI/2                                          RCS1 256
   35 CONTINUE                                                  RCS1 257
C                                                               RCS1 258
C      RUCK-UFIMTSEV SCATTERING (THETA.GT.90)                   RCS1 259
      CV10 = A4*C9*(PH4P*SV10-BC4X)                             RCS1 260
      CH10 = A4*C9*(PH4P*SH10-BC4X)                             RCS1 261
```

```
2139           CV10 = A4*C9*(PH4P*SV10-BC4X)                        RCS1 260
2140           CH10 = A4*C9*(PH4P*SH10-BC4X)                        RCS1 261
2141           CV9  = A4*C9*(PH4*SV9-BC4X)                          RCS1 262
2142           CH9  = A4*C9*(PH4*SH9-BC4X)                          RCS1 263
2143           CV4  = A4*C4*(PH4*SV11-BC4X)*Q4                      RCS1 264
2144           CH4  = A4*C4*(PH4*SH11-BC4X)*Q4                      RCS1 265
2145           CV2  = A2*C2*(PH2*SV11-BC2X)*Q2                      RCS1 266
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CARD NO      ****                   CONTENTS                             ****

2146           CH2  = A2*C2*(PH2*SH11-BC2X)*Q2                      RCS1 267
2147           CV11 = A1*C11*(PH1*SV11-BC1X)*Q11                    RCS1 268
2148           CH11 = A1*C11*(PH1*SH11-BC1X)*Q11                    RCS1 269
2149           CV1  = A1*C2*PH1*CK1*Q1                              RCS1 270
2150           CV3  = A2*C4*PH2*CK1*Q3                              RCS1 271
2151           SV   = CV10+CV9+CV4+CV2+CV11 +CV1+CV3                RCS1 272
2152           SH   = CH10+CH9+CH4+CH2+CH11 -CV1-CV3                RCS1 273
2153        40 CONTINUE                                             RCS1 274
2154     C                                                          RCS1 275
2155           SV =-SV*SPIK                                         RCS1 276
2156           SH = SH*SPIK                                         RCS1 277
2157     C                                                          RCS1 278
2158     C     REFERENCE PHASE TO FRONT OF SECOND CYLINDER
```

```
CARD NO   ****                        CONTENTS                              ****

2146            CH2  = A2*C2*(PH2*SH11-RC2X)*Q2                        RCS1 267
2147            CV11 = A1*C11*(PH1*SV11-RC1X)*Q11                      RCS1 268
2148            CH11 = A1*C11*(PH1*SH11-RC1X)*Q11                      RCS1 269
2149            CV1  = A1*C2*PH1*CK1*Q1                                RCS1 270
2150            CV3  = A2*C4*PH2*CK1*Q3                                RCS1 271
2151            SV   = CV10+CV9+CV4+CV2+CV11 +CV1+CV3                  RCS1 272
2152            SH   = CH10+CH9+CH4+CH2+CH11 -CV1-CV3                  RCS1 273
2153         40 CONTINUE                                               RCS1 274
2154      C                                                            RCS1 275
2155            SV =-SV*SPIK                                           RCS1 276
2156            SH = SH*SPIK                                           RCS1 277
2157      C                                                            RCS1 278
2158      C     REFERENCE PHASE TO FRONT OF SECOND CYLINDER            RCS1 279
2159      C                                                            RCS1 280
2160            SV   = SV*C4                                           RCS1 281
2161            SH   = SH*C4                                           RCS1 282
2162      C                                                            RCS1 283
2163            EVVR(I) = REAL(SV)                                     RCS1 284
2164            EVVI(I) =-AIMAG(SV)                                    RCS1 285
2165            EHHR(I) = REAL(SH)                                     RCS1 286
2166            EHHI(I) =-AIMAG(SH)                                    RCS1 287
2167         30 CONTINUE                                               RCS1 288
2168            RETURN                                                 RCS1 289
2169            END                                                    RCS1 290
```

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3

```
      FUNCTION Q(Z)                                                     RCS1 291
C     Q(Z) = 0.5*(1 + ERF(Z))                                           RCS1 292
C   * ERF(Z) IS EVALUATED USING A RATIONAL POLYNOMIAL APPROXIMATION     RCS1 293
C   * REFERENCE (HANDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN,            RCS1 294
C   *            SECTION 7.1.26)                                        RCS1 295
C                                                                       RCS1 296
      IF ( Z.GT. 2.) GO TO 10                                           RCS1 297
      IF ( Z.LT.-2.) GO TO 20                                           RCS1 298
      AZ = ABS(Z)                                                       RCS1 299
      P = 1.0/(1.0 + .47047*AZ)                                         RCS1 300
      Y = 1.0 - P*(.3480242 - P*(.0958798 - .7478556*P))*EXP(-AZ*AZ)    RCS1 301
      IF (Z) 2,4,6                                                      RCS1 302
    2 Q = (1.0 - Y)/2.                                                  RCS1 303
      RETURN                                                            RCS1 304
    4 Q = .5                                                            RCS1 305
      RETURN                                                            RCS1 306
    6 Q = (1.0 + Y)/2.                                                  RCS1 307
      RETURN                                                            RCS1 308
   10 Q = 1.                                                            RCS1 309
      RETURN                                                            RCS1 310
   20 Q = 0.                                                            RCS1 311
      RETURN                                                            RCS1 312
      END                                                               RCS1 313
```

```
      SUBROUTINE BESL ( X, B0, B1, B2 )                                 RCS1 314
C                                                                       RCS1 315
C   * BESSEL FUNCTION SUBROUTINE UTILIZING POLYNOMIAL APPROXIMATIONS    RCS1 316
C   * COMPUTES J0,J1,OR J2 FOR POSITIVE REAL ARGUMENTS                  RCS1 317
C   * REFERENCE (HNDBK MATH FUNCT BY ABRAMOWITZ AND STEGUN SECTION 9.4 )RCS1 318
C                                                                       RCS1 319
      S = 1.0                                                           RCS1 320
      IF (X .LT. 0.0) S=-1.0                                            RCS1 321
      X = ABS(X)                                                        RCS1 322
C                                                                       RCS1 323
      IF ( X .GT. 1.E-6 ) GO TO 5                                       RCS1 324
      B0 = 1.0                                                          RCS1 325
      B1 = 0.0                                                          RCS1 326
      B2 = 0.0                                                          RCS1 327
      X = X * S                                                         RCS1 328
      RETURN                                                            RCS1 329
C                                                                       RCS1 330
    5 CONTINUE                                                          RCS1 331
C                                                                       RCS1 332
    1 IF ( X .GE. 3.) GO TO 9                                           RCS1 333
      X1 = X/3.                                                         RCS1 334
      X1 = X1*X1                                                        RCS1 335
      B0 = 1.+ X1*(-2.2499997+ X1*(1.2656208+ X1*(-.3163866+ X1*(.0444479RCS1 336
     1 +      X1*(-.0039444+ X1*2.1E-4 )))) )                           RCS1 337
      GO TO 10                                                          RCS1 338
```

```
      X1 = X/3.                                                        RCS1 334
      X1 = X1*X1                                                       RCS1 335
      B = 1.+ X1*(-2.2499997+ X1*(1.2656208+ X1*(-.3163866+ X1*(.0444479RCS1 336
     1 +      X1*(-.0039444+ X1*2.1E-4 )))) )                          RCS1 337
      GO TO 10                                                         RCS1 338
C                                                                      RCS1 339
    9 X2 = 3./X                                                        RCS1 340
      F0 =  .79788456 +X2*(-.77E-6 +X2*(-.00552740 +X2*(-.9512E-4 +X2*  RCS1 341
     1     (.00137237 +X2*(-.72805E-3 +X2*0.14476E-3 )))) )            RCS1 342
      T0 = X - .78539816 +X2*(-.04166397 +X2*(-.3954E-4 +X2*(.00262573  RCS1 343
     1    +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))          RCS1 344
      B = F0*COS(T0)/SQRT(X)                                           RCS1 345
C                                                                      RCS1 346
   10 B0 = B                                                           RCS1 347
C                                                                      RCS1 348
    2 IF ( X .GE. 3. ) GO TO 19                                        RCS1 349
      X1 = X/3.                                                        RCS1 350
      X1 = X1*X1                                                       RCS1 351
      B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*   RCS1 352
     1                   (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4)))))) )   RCS1 353
      GO TO 20                                                         RCS1 354
C                                                                      RCS1 355
   19 X2 = 3./X                                                        RCS1 356
      F1 = .79788456 +X2*(.156E-5 +X2*(.01659667 +X2*(.00017105 +X2*   RCS1 357
     1     (-.00249511 +X2*(.00113653 -.00020033*X2 )))))              RCS1 358
      T1 = X - 2.35619449 +X2*(.12499612 +X2*(.565E-4 +X2*(-.00637879  RCS1 359
     1    +X2*(.00074348 +X2*(.00079824 -0.00029166*X2 )))))           RCS1 360
      B = F1*COS(T1)/SQRT(X)                                           RCS1 361
```

```
     1     +X2*(-.00054125 +X2*(-.00029333 +X2*0.00013558 )))))          RCS1 344
       B = F0*COS(T0)/SQRT(X)                                            RCS1 345
C                                                                        RCS1 346
    10 B0 = B                                                            RCS1 347
C                                                                        RCS1 348
     2 IF ( X .GE. 3. ) GO TO 19                                         RCS1 349
       X1 = X/3.                                                         RCS1 350
       X1 = X1*X1                                                        RCS1 351
       B = X*( .5 +X1*(-.56249985 +X1*(.21093573 +X1*(-.03954289 +X1*    RCS1 352
     1                (.00443319 +X1*(-.31761E-3 +X1*0.1109E-4)))))) )   RCS1 353
       GO TO 20                                                          RCS1 354
C                                                                        RCS1 355
    19 X2 = 3./X                                                         RCS1 356
       F1 = .79788456 +X2*(.156E-5 +X2*(.01659667 +X2*(.00017105 +X2*    RCS1 357
     1      (-.00249511 +X2*(.00113653 -.00020033*X2 )))))               RCS1 358
       T1 = X - 2.35619449 +X2*(.12499612 +X2*(.565E-4 +X2*(-.00637879   RCS1 359
     1     +X2*(.00074348 +X2*(.00079824 -0.00029166*X2 )))))            RCS1 360
       B = F1*COS(T1)/SQRT(X)                                            RCS1 361
C                                                                        RCS1 362
    20 B1 = B * S                                                        RCS1 363
       X = X * S                                                         RCS1 364
       B2= (2./X)*B1 - B0                                                RCS1 365
    50 RETURN                                                            RCS1 366
       END                                                               RCS1 367
```

L.8 REFERENCES

1. Liang, C.S. and R. W. Clay, Improved Wideband Scattering Analysis, RADC-TR-73-11, (Rome Air Development Center, Rome, N.Y., January, 1973) pp. 29-52 AD#758245.

2. Ibid, pp. 159-162

3. Ibid, pp. A1-B7

4. Ibid, pp. C1-C15

5. Hong, S., S. L. Borrison, and D. P. Ford, "Short Pulse Scattering by Long Wire", IEEE Trans. Ant. Prop., Vol. AP-16, No. 3, pp. 338-339

6. Liang, Op. Cit., pp. 81-110

7. Ibid, pp. 53-80

8. This reference was intentionally omitted.

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