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Modification of Programs CHIEF and CID To Compute Sound Radiation From An Arbitrary Body With Mixed Boundary Conditions

W. Thompson, Jr.

Pennsylvania State University
Applied Research Laboratories
P.O. Box 30
State College, PA 16804

B. Dubus

Institut Superieur d'Electronique du Nord
41 Bd Vauban
59046 Lille Cedex
France

C. M. Siders

Transducer Branch
Underwater Sound Reference Detachment
Naval Research Laboratory
P.O. Box 568337
Orlando, FL 32856-8337

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Naval Research Laboratory
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The computer program CHIEF developed over the last two decades by Naval Ocean Systems Center, San Diego, has recently been modified to allow the computation of sound radiation from arbitrarily shaped body where the normal velocity is prescribed on only part of its surface while one or more locally reacting complex impedances are assumed to cover the remainder of the surface. These impedances can range in value from zero to essentially infinity with any complex value in between. Results of some computations of far-field directivity pattern and radiation loading on simple shaped radiators with the mixed boundary conditions were compared with results available in the literature with generally good agreement.

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CONTENTS

MODIFICATION OF PROGRAMS CHIEF AND CID TO COMPUTE SOUND RADIATION FROM AN ARBITRARY BODY WITH MIXED BOUNDARY CONDITIONS

INTRODUCTION

The computer program CHIEF [1], written to compute the sound radiation from an arbitrarily shaped body, was originally developed to handle only the case of Neumann boundary conditions on the surface of the body; i.e., the case where the normal velocity is prescribed over the entire surface.

There may be situations where it is desired to know the effect of putting some material on portions of the surface of the radiator. For example, it may be interesting to see if the shape or side-lobe structure of the directivity can be favorably changed or if such a material has a deleterious effect upon the radiation efficiency of the source. A case in point is that low-impedance material (pressure-release material) is often applied to the surface of an underwater structure to effect shielding of that part from the acoustic field.

From a mathematical point of view, this class of boundary value problems characterized by mixed boundary conditions [where at least two different types of boundary conditions (Neumann, Dirchlet, or Robin), also called impedance, are prescribed on the same surface] is not amenable to exact solution. Even for a simple coordinate surface such as a perfect sphere, the mix of boundary conditions means that the solution functions of the Helmholtz equation do not form a complete orthogonal basis set over the surface. Hence, the classic solution technique of expanding the boundary condition into a generalized Fourier Series and then matching mode for mode with a similar series expression for the radiation field is not applicable. Approximate matching procedures such as point collation and least-square error determination have been tried and are discussed in the literature. [2,3]

This report discusses modifications that have been made to the programs CHIEF and CID to accommodate the situation where part or parts of the radiator are covered with one or more locally reacting arbitrary complex impedance coatings. The range of magnitude of these impedances can be from zero (perfect pressure release) to the largest value the computer can handle without exponent overflow (rigid); any value that is purely real, purely imaginary or complex, in between these extremes is allowable. Three sample problems are presented to illustrate many of the new improvements to both CID and CHIEF.

NEW FEATURES AND MODIFICATIONS TO CHIEF

The following new features have been added to the 1991 version of CHIEF.

1. CHIEF now includes the capability to describe multiple locally reacting complex impedances.

2. The cone geometry has been added to CCUNMD.

3. The routine ZRADMI has been added to calculate the radiation matrix when impedance surfaces are defined.

4. New storage allocation (Units 26 through 29) have been assigned.

NEW FEATURES AND MODIFICATIONS TO CID

The following new features have been added to the 1991 version of CID.

1. The cone geometry has been added to the SURFACE DESCRIPTION screen (see Appendix B1).

2. The impedance surface description screens have been added (see Appendix B2).

3. The DISPLAY3D [4] program used to display the CHIEF geometries uses the CID screen input.

USER INPUTS AND SUBROUTINE CALLS

This section describes the changes that have been made to the input parameters and subroutine calls since the last program release.

General Input Parameters for Impedance Surfaces

NUMZ Number of surface regions in a symmetry block that are covered with the impedance coating. (Note: The NUMZ impedance surfaces appear after the radiating surfaces.)

ZCOAT Vector that contains the complex impedance coating for each surface region in a symmetry block.

Calculation of Radiation Matrix

ZRADMI(ZMTX,NUMARS)

ZMTX Complex matrix area that must be allocated in control routine for storage of the radiation impedance matrix (NUMARS,NUMARS).

NUMARS Number of surface areas (including impedance surfaces).

SAMPLE PROBLEMS

This section contains the CHIEF drivers for various types of sample problems. Since many of the dimension statements are the same for each control program, these lines will be printed only once and are labeled VARIABLE DECLARATION.

Common Variable Declaration

```
C      ***** CONTROL 88 *****
C      PROGRAM CHIEF88 DRIVER
C      MXSREG - MAXIMUM NUMBER OF SURFACE REGIONS
C      MXIPS  - MAXIMUM NUMBER OF INTERIOR POINTS
C      MXARS  - MAXIMUM NUMBER OF SURFACE SUBDIVISIONS/SYM BLK
C      MXGAUS - MAXIMUM ORDER OF GAUSSIAN QUADRATURE
C      MXQPTS - MAXIMUM NUMBER OF QUADRATURE POINTS/SUBDIVISION
C      MXBLKS - MAXIMUM NUMBER OF SYMMETRY BLOCKS
C      MXFFP  - MAXIMUM NUMBER OF FAR-FIELD POINTS
C      MXNFP  - MAXIMUM NUMBER OF NEAR-FIELD POINTS
C      MXPTSC - MAXIMUM NUMBER OF POINT SOURCES
C      MAXCOR - MAXIMUM NUMBER OF FINITE ELEMENT NODES
C      MXFPS - MAX0(MXARS+MXIPS,MXFFP,MXNFP)

       PARAMETER (MXSREG=500)
       PARAMETER (MAXCOR=1000)
       PARAMETER (MXIPS=20)
       PARAMETER (MXARS=500)
       PARAMETER (MXGAUS=64)
       PARAMETER (MXQPTS=512)
       PARAMETER (MXBLKS=100)
       PARAMETER (MXFFP=361)
       PARAMETER (MXNFP=361)
       PARAMETER (MXPTSC=20)
       PARAMETER (MXFPS=520)
C      PARAMETER (MXFPS=MAX0(MXARS+MXIPS,MXFFP,MXNFP))
C      PARAMETER (NWDVEC=2*MXARS)
C
C  Input commons
C
       COMMON /CONST/  RHO,C
       COMMON /PRTCOM/ NUNPRT,NUNERR
       COMMON /PRTRD/  RUNID,DATE
       CHARACTER*4 RUNID
       CHARACTER*8 DATE
       COMMON /NDIAG/  NDQPTS,NDPMXS,NDVMXS,NDDECM,NDVELS,NDSPS,
      1                NDPMXF,NDVMXF,NDPMXN,NDVMXN,NDPSSP,NDEXPR,NDCOMV,
      1                NDTEMP,NDZRDB,NDPATB
       COMMON /SVALS/  NSREG,NSEQNS(MXSREG),SUL(MXSREG),SUU(MXSREG),
      1                SVL(MXSREG),SVU(MXSREG),NSU(MXSREG),NSV(MXSREG),
      1                CCS(10,MXSREG),TRNSS(3,MXSREG),IZAX(MXSREG),
      1                IORDU(MXSREG),IORDV(MXSREG),NCCEQS
       COMMON /CORD/   COORDS(MAXCOR,3)
       COMMON /IPTS/   NUMIPS,IPXS(3,MXIPS)
       REAL IPXS
       COMMON /PTSINP/ NUMPTS,PTSRCS(4,MXPTSC),PTSWT(MXPTSC),
      1                IOPTSC(MXPTSC)
       COMPLEX PTSWT
       COMMON /PLWINP/ AINC,THTINC,PHIINC,ISCATR
       COMMON /BAFFLE/ INFBAF
       COMMON /FFINP/  NUMTHP,THTPHI(2,MXFFP)
       COMMON /NFINP/  NUMFPN,NFPXS(3,MXNFP)
       REAL NFPXS
C
C  Output commons
C
       COMMON /TAPREC/ RECRD(10),IRECRD(30)
       COMMON /TAPRC1/ ARECRD(10)
       CHARACTER*4 ARECRD
       COMMON /PRGVLS/ NDIMPV,NUMARS,NUMSFP,NUMFFP,NUMNFP,NWDVEC
       COMMON /SURARS/ AREAS(MXARS)
       COMMON /ODSVEC/ TVECT(MXARS),B(MXARS),IPIVTR(MXFPS)
       COMPLEX TVECT
       COMMON /VELSPS/ VEL(MXARS),SP(MXARS)
       COMPLEX VEL,SP
       COMMON /PDISL/  POWER,DIRIND,SRCRVL
       COMMON /FFVALS/ FFP(MXFFP),PNRMFF(MXFFP),IFFNRM,RMFNRM
       COMPLEX FFP
       COMMON /TSCOM/  TGTSTH(MXFFP)
       COMMON /NFVALS/ NFP(MXNFP),PNRMNF(MXNFP),INFNRM,RMNNRM
```

```
      COMPLEX NFP
      COMMON /PTSCOM/ PTSSP(MXARS)
      COMPLEX PTSSP
      COMMON /EXTCOM/ EXTPRS(MXFPS),IEXTFG
      COMPLEX EXTPRS
      COMMON /NBPRTC/ IRHSPT,NARSPT,NPTBLK,FRQPT
      COMMON /NBPRTS/ SYMTPT
      CHARACTER*3 SYMTPT

C*************** impedance coating modifications ***************
      COMMON /COATING/ ZCOAT, NUMZ
      COMPLEX ZCOAT(500)
C  NUMZ - total number of impedance layer surfaces (NSU * NSV)
C**************************************************************

      DIMENSION CC(10), TRNS(3), IELTS(8, 300)
      REAL X1(1000), Y1(1000)

      CHARACTER*3 SYMTYP
      CHARACTER*4 FLDTYP, TAPEID, PRTTYP
      INTEGER     XIZAX, XNSEQNS, XIRG, XNSU, XNSV, XIORDU, XIORDV
      INTEGER     ICOOR, IELEM
```

Sample Run 1: Radiating Polar Cap on an Impedance Coated Spherical Baffle

This sample problem computes the acoustic radiation from a spherical source consisting of a 90° uniformly vibrating polar cap while the rest of the sphere is covered with an impedance layer. Because of axisymmetry, the azimuthal coordinate angle was taken to be 1/30 of the sphere. There are 24 regions; the first twelve regions (90°) define the polar cap. Thus, there are 12 regions with an impedance coated material.

Three cases were run using this break-up. In the first case, the impedance layer is defined as a perfect pressure-release material (ZCOAT(I)) = (0,0). In case 2, the impedance coating is defined as having ρc characteristics (ZCOAT(I)) = (ρc,0). And in case 3, the coating is defined as (ZCOAT(I)) = (10^{19},0), which simulates a rigid boundary condition. Setting ZCOAT equal to 10^{19}(real or imaginary) produces far field results identical to those generated using the CHIEF where the velocity was specified to be identically zero on the impedance coated regions.

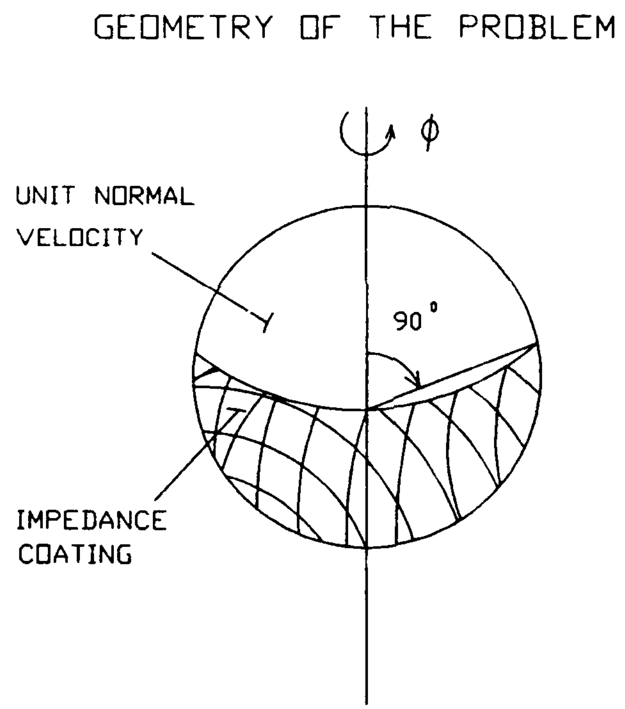

Fig. 1. 90° uniformly vibrating polar cap on an impedance-coated spherical baffle.

Program Listing of Sample Run 1

```
C     Program MRBILLT
C  SPHERE WITH IMPEDANCE COATING SURFACE

C  Variable Declarations

C      (COMMON VARIABLE DECLARATIONS GO HERE)
```

```
      COMPLEX PMATX( 1752), VMATX( 1752)
      MDSIZE =  1752
      RUNID  = 'MRBI'
      DATE   = '19-FEB-91'
      CALL INITCM
      CALL OPNSFL
      RHO    = 1000
      C      = 1500

      OPEN(UNIT=NUNPRT,FILE=RUNID//'.OUT',STATUS='NEW'
     1     FORM='FORMATTED')

C*************** impedance coating modifications ***************
      NUMZ   =      12
      N = 1


C ----- load impedance for SPHERE
      ZCOAT(N +   0) = CMPLX(0.0       , 0.0        )
      ZCOAT(N +   1) = CMPLX(0.0       , 0.0        )
      ZCOAT(N +   2) = CMPLX(0.0       , 0.0        )
      ZCOAT(N +   3) = CMPLX(0.0       , 0.0        )
      ZCOAT(N +   4) = CMPLX(0.0       , 0.0        )
      ZCOAT(N +   5) = CMPLX(0.0       , 0.0        )
      ZCOAT(N +   6) = CMPLX(0.0       , 0.0        )
      ZCOAT(N +   7) = CMPLX(0.0       , 0.0        )
      ZCOAT(N +   8) = CMPLX(0.0       , 0.0        )
      ZCOAT(N +   9) = CMPLX(0.0       , 0.0        )
      ZCOAT(N +  10) = CMPLX(0.0       , 0.0        )
      ZCOAT(N +  11) = CMPLX(0.0       , 0.0        )
      DO 99 JJ=1,3
      N=1
      IF (JJ .EQ. 1) THEN
      ZCOAT(N +  12) = CMPLX(0.0       , 0.0      )
      ZCOAT(N +  13) = CMPLX(0.0       , 0.0      )
      ZCOAT(N +  14) = CMPLX(0.0       , 0.0      )
      ZCOAT(N +  15) = CMPLX(0.0       , 0.0      )
      ZCOAT(N +  16) = CMPLX(0.0       , 0.0      )
      ZCOAT(N +  17) = CMPLX(0.0       , 0.0      )
      ZCOAT(N +  18) = CMPLX(0.0       , 0.0      )
      ZCOAT(N +  19) = CMPLX(0.0       , 0.0      )
      ZCOAT(N +  20) = CMPLX(0.0       , 0.0      )
      ZCOAT(N +  21) = CMPLX(0.0       , 0.0      )
      ZCOAT(N +  22) = CMPLX(0.0       , 0.0      )
      ZCOAT(N +  23) = CMPLX(0.0       , 0.0      )
      END IF
      IF (JJ .EQ. 2) THEN
      ZCOAT(N +  12) = CMPLX(1.5E06       , 0.0      )
      ZCOAT(N +  13) = CMPLX(1.5E06       , 0.0      )
      ZCOAT(N +  14) = CMPLX(1.5E06       , 0.0      )
      ZCOAT(N +  15) = CMPLX(1.5E06       , 0.0      )
      ZCOAT(N +  16) = CMPLX(1.5E06       , 0.0      )
      ZCOAT(N +  17) = CMPLX(1.5E06       , 0.0      )
      ZCOAT(N +  18) = CMPLX(1.5E06       , 0.0      )
      ZCOAT(N +  19) = CMPLX(1.5E06       , 0.0      )
      ZCOAT(N +  20) = CMPLX(1.5E06       , 0.0      )
      ZCOAT(N +  21) = CMPLX(1.5E06       , 0.0      )
      ZCOAT(N +  22) = CMPLX(1.5E06       , 0.0      )
      ZCOAT(N +  23) = CMPLX(1.5E06       , 0.0      )
      END IF
      IF (JJ .EQ. 3) THEN
      ZCOAT(N +  12) = CMPLX(0.0       , 1.0E19        )
      ZCOAT(N +  13) = CMPLX(0.0       , 1.0E19      )
      ZCOAT(N +  14) = CMPLX(0.0       , 1.0E19      )
      ZCOAT(N +  15) = CMPLX(0.0       , 1.0E19      )
      ZCOAT(N +  16) = CMPLX(0.0       , 1.0E19      )
      ZCOAT(N +  17) = CMPLX(0.0       , 1.0E19      )
      ZCOAT(N +  18) = CMPLX(0.0       , 1.0E19      )
      ZCOAT(N +  19) = CMPLX(0.0       , 1.0E19      )
      ZCOAT(N +  20) = CMPLX(0.0       , 1.0E19      )
      ZCOAT(N +  21) = CMPLX(0.0       , 1.0E19      )
```

```
      ZCOAT(N +  22) = CMPLX(0.0        , 1.0E19      )
      ZCOAT(N +  23) = CMPLX(0.0        , 1.0E19      )
      END IF
      N = N + (24  * 1  )

C***** ***** end of impedance coating modifications ************


C  symmetry inputs

      PI      = ACOS(-1.0)

      SYMTYP  = 'ROT'
      NBLKS   = 30
      IRHSYM  = 1
      CONVERT = 1.0

C  Surface Region inputs

      ROTLIM = PI / NBLKS
      XIRG   = 0

      DO 1 I = 1, 10
         CC(I) = 0.0
1     CONTINUE

      DO 2 I = 1, 3
         TRNS(I) = 0.0
2     CONTINUE

C -------- SPHERE               ---------

      XNSEQNS = 6
      CC( 1)  = 1.          * CONVERT
      CC( 2)  = CC(1)*CC(1)
      TRNS(1) = (0.00E+00) * CONVERT
      TRNS(2) = (3.00E+00) * CONVERT
      TRNS(3) = (0.00E+00) * CONVERT
      XIZAX   = +3
      XSUL    = 0
      XSUU    = 3.14159265
      XSVL    = -0.10472
      XSVU    = 0.10472
      XNSU    = 24
      XNSV    = 1
      XIORDU  = 4
      XIORDV  = 04
      XIRG = XIRG + 1
      CALL LDSURR(XIRG, XNSEQNS, CC, TRNS, XIZAX,
     1            XSUL, XSUU, XSVL, XSVU, XNSU, XNSV, XIORDU, XIORDV)

      NSREG = XIRG

C      CALL PLOTCHIEF(RUNID, NBLKS, SYMTYP, 1, 30.0, 60.0, 0.0)


C  Define Frequency input.

      FREQ   = 716.20

C  Generate surface P and V matrices.

      CALL SURMAT(FREQ, SYMTYP, NBLKS, PMATX, VMATX, MDSIZE)
      IF ( JJ .EQ. 1) THEN
         CALL PRTOUT('GEOM',1)
         CALL PRTOUT('AREA',1)
      END IF
```

```
C  Decompose Matrices

      CALL DECOMM(SYMTYP, NBLKS, IRHSYM, PMATX, VMATX, MDSIZE)
      CALL IOSUB(NDVELS, 10, VEL, 0)
C  Block # 1
      VEL(  1) = (1.0000, 0.0000)
      VEL(  2) = (1.0000, 0.0000)
      VEL(  3) = (1.0000, 0.0000)
      VEL(  4) = (1.0000, 0.0000)
      VEL(  5) = (1.0000, 0.0000)
      VEL(  6) = (1.0000, 0.0000)
      VEL(  7) = (1.0000, 0.0000)
      VEL(  8) = (1.0000, 0.0000)
      VEL(  9) = (1.0000, 0.0000)
      VEL( 10) = (1.0000, 0.0000)
      VEL( 11) = (1.0000, 0.0000)
      VEL( 12) = (1.0000, 0.0000)
      VEL( 13) = (0.0000, 0.0000)
      VEL( 14) = (0.0000, 0.0000)
      VEL( 15) = (0.0000, 0.0000)
      VEL( 16) = (0.0000, 0.0000)
      VEL( 17) = (0.0000, 0.0000)
      VEL( 18) = (0.0000, 0.0000)
      VEL( 19) = (0.0000, 0.0000)
      VEL( 20) = (0.0000, 0.0000)
      VEL( 21) = (0.0000, 0.0000)
      VEL( 22) = (0.0000, 0.0000)
      VEL( 23) = (0.0000, 0.0000)
      VEL( 24) = (0.0000, 0.0000)
      CALL IOSUB(NDVELS, 1, VEL, NWDVEC)

C  Generate Surface Pressures.

      CALL SURPRS(FREQ, SYMTYP, NBLKS, IRHSYM, PMATX, VMATX, MDSIZE)

      CALL PRTOUT('VEL',1)

      CALL PRTOUT('SP',1)

      FLDTYP = 'FAR '
      NUMTHP =  73
      DO 25 I = 1, NUMTHP
         THTPHI(1, I) = (I - 1) * 5
         THTPHI(2, I) = 0.0
25    CONTINUE

C  Calculate FAR Field Matrices
      CALL FLDMAT(FREQ, SYMTYP, FLDTYP, NBLKS, PMATX, VMATX, MDSIZE)

      IFFNRM =   0

C  Calculate Far-Field Pressures.
      CALL FLDPRS(FREQ, FLDTYP, NBLKS, IRHSYM, PMATX, VMATX, MDSIZE)

      CALL PRTOUT(FLDTYP, 1)
99    CONTINUE
      STOP
      END
```

The output listed below shows the input parameters for case 1. This is followed by the velocity distribution and surface pressures for all of the subdivisions. All of the symmetry strips are the same. Following the surface pressures is the normalized far-field patterns, and next are the surface pressures and patterns for cases 2 and 3.

Output Listing of Sample Run 1

```
1
                  PROGRAM C H I E F 8 8     RUN MRBI     DATE 19-FEB-9

 REGION   NSEQNS   NSU   NSV        SUL              SUU             SVL              SVU        IORDRU   IORDRV
   1         6      24     1   0.000000E+00   0.314159E+01   -.104720E+00   0.104720E+00      4        4

 REGION - TRANSLATION (T1,T2,T3),                              IZAX
   1      0.000000E+00   0.000000E+00   0.000000E+00            3

 REGION - CCS
   1 0.1000E+01 0.1000E+01 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00 0.0000E+00

 NO. OF SURFACE AREAS =   24     NO. OF SURFACE FIELD POINTS =   24
1
                  PROGRAM C H I E F 8 8     RUN MRBI     DATE 19-FEB-9


 SURFACE AREAS (AREA#, AREA)

    1        0.17918E-02
    2        0.53447E-02
    3        0.88062E-02
    4        0.12117E-01
    5        0.15220E-01
    6        0.18063E-01
    7        0.20597E-01
    8        0.22779E-01
    9        0.24571E-01
   10        0.25942E-01
   11        0.26870E-01
   12        0.27337E-01
   13        0.27337E-01
   14        0.26870E-01
   15        0.25942E-01
   16        0.24571E-01
   17        0.22779E-01
   18        0.20597E-01
   19        0.18063E-01
   20        0.15220E-01
   21        0.12117E-01
   22        0.88062E-02
   23        0.53447E-02
   24        0.17913E-02
1
                  PROGRAM C H I E F 8 8     RUN MRBI     DATE 19-FEB-9


 FREQUENCY=   716.2  RHO=  1000.0  C=  1500.0

 SYMMETRY TYPE= ROT     NO. OF BLOCKS= 30

 VELOCITIES (BLK#,AREA#, REAL,IMAG,MAG,ANG, REAL ZCOAT, IMAG ZCOAT)

     1   1     0.100000E+01   0.000000E+00   0.100000E+01     0.00     0.000000E+00   0.000000E+00
     1   2     0.100000E+01   0.000000E+00   0.100000E+01     0.00     0.000000E+00   0.000000E+00
     1   3     0.100000E+01   0.000000E+00   0.100000E+01     0.00     0.000000E+00   0.000000E+00
     1   4     0.100000E+01   0.000000E+00   0.100000E+01     0.00     0.000000E+00   0.000000E+00
     1   5     0.100000E+01   0.000000E+00   0.100000E+01     0.00     0.000000E+00   0.000000E+00
     1   6     0.100000E+01   0.000000E+00   0.100000E+01     0.00     0.000000E+00   0.000000E+00
     1   7     0.100000E+01   0.000000E+00   0.100000E+01     0.00     0.000000E+00   0.000000E+00
     1   8     0.100000E+01   0.000000E+00   0.100000E+01     0.00     0.000000E+00   0.000000E+00
     1   9     0.100000E+01   0.000000E+00   0.100000E+01     0.00     0.000000E+00   0.000000E+00
     1  10     0.100000E+01   0.000000E+00   0.100000E+01     0.00     0.000000E+00   0.000000E+00
     1  11     0.100000E+01   0.000000E+00   0.100000E+01     0.00     0.000000E+00   0.000000E+00
     1  12     0.100000E+01   0.000000E+00   0.100000E+01     0.00     0.000000E+00   0.000000E+00
     1  13    -0.519161E+00   0.925700E+00   0.106134E+01   119.28     0.000000E+00   0.000000E+00
     1  14     0.969358E-01   0.227281E+00   0.247090E+00    66.90     0.000000E+00   0.000000E+00
     1  15     0.102795E+00   0.908740E-01   0.137204E+00    41.48     0.000000E+00   0.000000E+00
     1  16     0.839903E-01   0.131100E-01   0.850073E-01     8.87     0.000000E+00   0.000000E+00
```

1	17	0.528094E-01	-0.223428E-01	0.573414E-01	-22.93	0.000000E+00	0.000000E+00
1	18	0.240284E-01	-0.334544E-01	0.411894E-01	-54.31	0.000000E+00	0.000000E+00
1	19	0.255895E-02	-0.304915E-01	0.305987E-01	-85.20	0.000000E+00	0.000000E+00
1	20	-0.106377E-01	-0.206314E-01	0.232124E-01	-117.28	0.000000E+00	0.000000E+00
1	21	-0.168224E-01	-0.879903E-02	0.189847E-01	-152.39	0.000000E+00	0.000000E+00
1	22	-0.183030E-01	0.186566E-02	0.183978E-01	174.18	0.000000E+00	0.000000E+00
1	23	-0.175939E-01	0.961857E-02	0.200515E-01	151.33	0.000000E+00	0.000000E+00
1	24	-0.177578E-01	0.146317E-01	0.230093E-01	140.51	0.000000E+00	0.000000E+00

*** FULL VELOCITY SYMMETRY ***

1

PROGRAM C H I E F 8 8   RUN MRBI   DATE 19-FEB-9

FREQUENCY= 716.2 RHO= 1000.0 C= 1500.0

SYMMETRY TYPF= ROT   NO. OF BLOCKS= 30

SURFACE PRESSURES (BLK#,AREA#, REAL,IMAG,MAG,ANG)

1	1	0.130996E+07	0.243849E+05	0.131018E+07	1.07
1	2	0.134036E+07	0.755111E+05	0.134249E+07	3.22
1	3	0.139889E+07	0.142690E+06	0.140615E+07	5.82
1	4	0.147041E+07	0.235699E+06	0.148918E+07	9.11
1	5	0.153852E+07	0.354132E+06	0.157881E+07	12.96
1	6	0.157706E+07	0.491521E+06	0.165188E+07	17.31
1	7	0.157324E+07	0.636299E+06	0.169705E+07	22.02
1	8	0.150995E+07	0.771550E+06	0.169565E+07	27.07
1	9	0.137795E+07	0.875019E+06	0.163230E+07	32.42
1	10	0.117443E+07	0.918671E+06	0.149105E+07	38.03
1	11	0.899727E+06	0.864173E+06	0.124752E+07	43.85
1	12	0.537282E+06	0.631044E+06	0.828787E+06	49.59
1	13	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	14	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	15	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	16	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	17	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	18	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	19	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	20	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	21	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	22	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	23	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	24	0.000000E+00	0.000000E+00	0.000000E+00	0.00

*** FULL VELOCITY SYMMETRY ***

POWER OUT(KW)= 7646.250

1

PROGRAM C H I E F 8 8   RUN MRBI   DATE 19-FEB-9

FREQUENCY= 716.2 RHO= 1000.0 C= 1500.0

SYMMETRY TYPE= ROT   NO. OF BLOCKS= 30

FAR-FIELD PRESSURES (PHI,THETA,FFP(RL,IM,MAG,ANG)   ,   NORMALIZED PATTERN, SOURCE LEVEL, DI)

0.00	0.00	-.250523E+07	-.655189E+06	0.258949E+07	-165.34	0.00 *	248.3	8.52
0.00	5.00	-.248029E+07	-.656300E+06	0.256565E+07	-165.18	-0.08		
0.00	10.00	-.240739E+07	-.659422E+06	0.249607E+07	-164.68	-0.32		
0.00	15.00	-.229205E+07	-.663957E+06	0.238628E+07	-163.84	-0.71		
0.00	20.00	-.214270E+07	-.668968E+06	0.224470E+07	-162.66	-1.24		
0.00	25.00	-.196984E+07	-.673270E+06	0.208153E+07	-161.13	-1.90		
0.00	30.00	-.178384E+07	-.675539E+06	0.190747E+07	-159.26	-2.66		
0.00	35.00	-.159587E+07	-.674413E+06	0.173252E+07	-157.09	-3.49		
0.00	40.00	-.141487E+07	-.668600E+06	0.156489E+07	-154.71	-4.37		
0.00	45.00	-.124797E+07	-.656963E+06	0.141033E+07	-152.24	-5.28		
0.00	50.00	-.109996E+07	-.638582E+06	0.127188E+07	-149.86	-6.18		
0.00	55.00	-.973268E+06	-.612810E+06	0.115012E+07	-147.80	-7.05		
0.00	60.00	-.868210E+06	-.579294E+06	0.104373E+07	-146.29	-7.89		
0.00	65.00	-.783448E+06	-.537995E+06	0.950383E+06	-145.52	-8.71		
0.00	70.00	-.716384E+06	-.489182E+06	0.867471E+06	-145.67	-9.50		

0.00	75.00	-.663686E+06	-.433439E+06	0.792684E+06	-146.85	-10.28
0.00	80.00	-.621697E+06	-.371642E+06	0.724310E+06	-149.13	-11.07
0.00	85.00	-.586782E+06	-.304956E+06	0.661296E+06	-152.54	-11.86
0.00	90.00	-.555574E+06	- 234820E+06	0.603161E+06	-157.09	-12.66
0.00	95.00	-.525139E+06	- 162931E+06	0 549834E+06	-162.76	-13.46
0.00	100.00	-.493061E+06	-.912237E+05	0.501429E+06	-169.52	-14.26
0.00	105.00	-.457477E+06	-.218402E+05	0.457998E+06	-177.27	-15.05
0.00	110.00	-.417065E+06	0.429270E+05	0.419268E+06	174.12	-15.81
0.00	115.00	-.371019E+06	0.100720E+06	0.384448E+06	164.81	-16.57
0.00	120.00	-.319018E+06	0.149247E+06	0.352203E+06	154.93	-17.33
0.00	125.00	-.261194E+06	0.186452E+06	0.320916E+06	144.48	-18.14
0.00	130.00	-.198128E+06	0.210736E+06	0.289248E+06	133.23	-19.04
0.00	135.00	-.130837E+06	0 221192E+06	0.256991E+06	120.60	-20.07
0.00	140.00	-.607839E+05	0.217836E+06	0.226158E+06	105.59	-21.18
0.00	145.00	0.101391E+05	0.201777E+06	0.202031E+06	87.12	-22.16
0.00	150.00	0.796466E+05	0.175286E+06	0.192532E+06	65.56	-22.57
0.00	155.00	0.145143E+06	0.141716E+06	0.202854E+06	44.32	-22.12
0.00	160.00	0.203864E+06	0.105242E+06	0.229426E+06	27.30	-21.05
0.00	165.00	0.253066E+06	0.704420E+05	0.262687E+06	15.55	-19.88
0.00	170.00	0.290257E+06	0.417507E+05	0.293245E+06	8.19	-18.92
0.00	175.00	0.313440E+06	0.228810E+05	0.314274E+06	4.18	-18.32
0.00	180.00	0.321317E+06	0.163023E+05	0.321731E+06	2.90	-18.11
0.00	185.00	0.313440E+06	0.228810E+05	0.314274E+06	4.18	-18.32
0.00	190.00	0.290257E+06	0.417508E+05	0.293245E+06	8.19	-18.92
0.00	195.90	0.253066E+06	0.704419E+05	0.262687E+06	15.55	-19.88
0.00	200.00	0.203864E+06	0.105242E+06	0.229427E+06	27.30	-21.05
0.00	205.00	0.145143E+06	0.141716E+06	0.202854E+06	44.32	-22.12
0.00	210.00	0.796466E+05	0.175286E+06	0.192532E+06	65.56	-22.57
0.00	215.00	0.101392E+05	0.201777E+06	0.202031E+06	87.12	-22.16
0.00	220.00	-.607837E+05	0.217836E+06	0.226157E+06	105.59	-21.18
0.00	225.00	-.130837E+06	0.221192E+06	0.256991E+06	120.60	-20.07
0.00	230.00	-.198128E+06	0.210736E+06	0.289248E+06	133.23	-19.04
0.00	235.00	-.261194E+06	0.186452E+06	0.320915E+06	144.48	-18.14
0.00	240.00	-.319018E+06	0.149247E+06	0.352203E+06	154.93	-17.33
0.00	245.00	-.371019E+06	0.100720E+06	0.384448E+06	164.81	-16.57
0.00	250.00	-.417065E+06	0.429269E+05	0.419268E+06	174.12	-15.81
0.00	255.00	-.457477E+06	-.218403E+05	0.457998E+06	-177.27	-15.05
0.00	260.00	-.493061E+06	-.912238E+05	0.501429E+06	-169.52	-14.26
0.00	265.00	.525139E+06	-.162931E+06	0.549834E+06	-162.76	-13.46
0.00	270.00	-.555574E+06	- 234820E+06	0.603161E+06	-157.09	-12.66
0.00	275.00	-.586782E+06	-.304956E+06	0.661295E+06	-152.54	-11.86
0.00	280.00	-.621697E+06	-.371642E+06	0.724310E+06	-149.13	-11.07
0.00	285.00	-.663686E+06	-.433439E+06	0.792684E+06	-146.85	-10.28
0.00	290.00	-.718384E+06	-.489182E+06	0.867470E+06	-145.87	-9.50
0.00	295.00	-.783448E+06	-.537994E+06	0.950383E+06	-145.52	-8.71
0.00	300.00	-.868210E+06	-.579294E+06	0.104373E+07	-146.29	-7.89
0.00	305.00	-.973258E+06	-.612810E+06	0.115012E+07	-147.80	-7.05
0.00	310.00	-.109996E+07	-.638582E+06	0.127188E+07	-149.86	-6.18
0.00	315.00	-.124797E+07	-.656962E+06	0.141033E+07	-152.24	-5.28
0.00	320.00	-.141487E+07	-.668600E+06	0.156489E+07	-154.71	-4.37
0.00	325.00	-.159587E+07	-.674413E+06	0.173252E+07	-157.09	-3.49
0.00	330.00	-.178384E+07	-.675539E+06	0.190747E+07	-159.26	-2.66
0.00	335.00	-.196964E+07	-.673270E+06	0.208153E+07	-161.13	-1.90
0.00	340.00	-.214270E+07	-.668958E+06	0.224470E+07	-162.66	-1.24
0.00	345.00	-.229205E+07	-.663957E+06	0.238628E+07	-163.84	-0.71
0.00	350.00	-.240739E+07	-.659422E+06	0.249607E+07	-164.68	-0.32
0.00	355.00	-.248029E+07	-.656299E+06	0.256565E+07	-165.18	-0.08
0.00	360.00	-.250523E+07	-.655189E+06	0.258949E+07	-165.34	0.00

* DIRECTION FOR PATTERN NORMALIZATION

1

PROGRAM C H I E F 8 8 RUN MRBI DATE 19-FEB-9

FREQUENCY= 716.2 RHO= 1000.0 C= 1500.0

SYMMETRY TYPE= ROT NO. OF BLOCKS= 30

VELOCITIES (BLK#,AREA#, REAL,IMAG,MAG,ANG, REAL ZCOAT, IMAG ZCOAT)

1	1	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	2	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	3	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	4	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	5	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	6	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	7	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	8	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	9	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	10	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	11	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	12	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	13	-0.286403E+00	0.733958E-01	0.295658E+00	165.63	0.150000E+07	0.000000E+00
1	14	-0.112223E+00	0.163832E+00	0.198582E+00	124.41	0.150000E+07	0.000000E+00
1	15	0.411214E-02	0.145290E+00	0.145348E+00	88.38	0.150000E+07	0.000000E+00
1	16	0.660318E-01	0.925511E-01	0.113692E+00	54.49	0.150000E+07	0.000000E+00
1	17	0.855737E-01	0.366456E-01	0.930901E-01	23.18	0.150000E+07	0.000000E+00
1	18	0.758692E-01	-0.752738E-02	0.762417E-01	-5.67	0.150000E+07	0.000000E+00
1	19	0.490632E-01	-0.342943E-01	0.598606E-01	-34.95	0.150000E+07	0.000000E+00
1	20	0.152133E-01	-0.440110E-01	0.465663E-01	-70.93	0.150000E+07	0.000000E+00
1	21	-0.181975E-01	-0.406066E-01	0.446803E-01	-114.03	0.150000E+07	0.000000E+00
1	22	-0.462319E-01	-0.306854E-01	0.554885E-01	-146.43	0.150000E+07	0.000000E+00
1	23	-0.660933E-01	-0.199423E-01	0.690364E-01	-163.21	0.150000E+07	0.000000E+00
1	24	-0.764700E-01	-0.141181E-01	0.777623E-01	-169.54	0.150000E+07	0.000000E+00

*** FULL VELOCITY SYMMETRY ***

1

PROGRAM C H I E F 8 8   RUN MRBI   DATE 19-FEB-9

FREQUENCY= 716.2 RHO= 1000.0 C= 1500.0

SYMMETRY TYPE= ROT   NO. OF BLOCKS= 30

SURFACE PRESSURES (BLK#,AREA#, REAL,IMAG,MAG,ANG)

1	1	0.13[illegible]19E+07	0.106669E+06	0.135839E+07	4.51
1	2	0.137[illegible]3E+07	0.153607E+06	0.138150E+07	6.38
1	3	0.141384E+07	0.212236E+06	0.142968E+07	8.54
1	4	0.146273E+07	0.291468E+06	0.149149E+07	11.27
1	5	0.150521E+07	0.390219E+06	0.155497E+07	14.53
1	6	0.152576E+07	0.501918E+06	0.160620E+07	18.21
1	7	0.151036E+07	0.615851E+06	0.163109E+07	22.18
1	8	0.144821E+07	0.717094E+06	0.161603E+07	26.34
1	9	0.133376E+07	0.786504E+06	0.154839E+07	30.53
1	10	0.116770E+07	0.800058E+06	0.141549E+07	34.42
1	11	0.956601E+06	0.724315E+06	0.119988E+07	37.13
1	12	0.709710E+06	0.487582E+06	0.861060E+06	34.49
1	13	0.429605E+06	-0.110094E+06	0.443487E+06	-14.37
1	14	0.168335E+06	-0.245748E+06	0.297874E+06	-55.59
1	15	-0.616821E+04	-0.217935E+06	0.218023E+06	-91.62
1	16	-0.990477E+05	-0.138827E+06	0.170538E+06	-125.51
1	17	-0.128301E+06	-0.549684E+05	0.139635E+06	-156.82
1	18	-0.113604E+06	0.112911E+05	0.114363E+06	174.33
1	19	-0.735947E+05	0.514414E+05	0.897909E+05	145.05
1	20	-0.228199E+05	0.660166E+05	0.698494E+05	109.07
1	21	0.272963E+05	0.612099E+05	0.670204E+05	65.97
1	22	0.693478E+05	0.460280E+05	0.832328E+05	33.57
1	23	0.991400E+05	0.299134E+05	0.103555E+06	16.79
1	24	0.114705E+06	0.211771E+05	0.116643E+06	10.46

*** FULL VELOCITY SYMMETRY ***

POWER OUT(KW)= 7663.426

1

PROGRAM C H I E F 8 8   RUN MRBI   DATE 19-FEB-9

FREQUENCY= 716.2 RHO= 1000.0 C= 1500.0

SYMMETRY TYPE= ROT   NO. OF BLOCKS= 30

FAR-FIELD PRESSURES (PHI,THETA,FFP(RL,IM,MAG,ANG) ,   NORMALIZED PATTERN, SOURCE LEVEL, DI)

0.00	0.00	-.225230E+07	-.639591E+06	0.234135E+07	-164.15	0.00 *	247.4	7.75
0.00	5.00	-.223294E+07	-.639514E+06	0.232271E+07	-164.02	-0.07		
0.00	10.00	-.217627E+07	-.639204E+06	0.226820E+07	-163.63	-0.28		
0.00	15.00	-.208635E+07	-.638426E+06	0.218184E+07	-162.99	-0.61		
0.00	20.00	-.196939E+07	-.636783E+06	0.206978E+07	-162.08	-1.07		
0.00	25.00	-.183302E+07	-.633738E+06	0.193948E+07	-160.93	-1.64		
0.00	30.00	-.168544E+07	-.628609E+06	0.179885E+07	-159.55	-2.29		
0.00	35.00	-.153460E+07	-.620606E+06	0.165534E+07	-157.98	-3.01		
0.00	40.00	-.138751E+07	-.608855E+06	0.151522E+07	-156.31	-3.78		
0.00	45.00	-.124974E+07	-.592457E+06	0.138306E+07	-154.64	-4.57		
0.00	50.00	-.112521E+07	-.570537E+06	0.126159E+07	-153.11	-5.37		
0.00	55.00	-.101614E+07	-.542312E+06	0.115180E+07	-151.91	-6.16		
0.00	60.00	-.923236E+06	-.507165E+06	0.105337E+07	-151.22	-6.94		
0.00	65.00	-.845913E+06	-.464707E+06	0.965154E+06	-151.22	-7.70		
0.00	70.00	-.782670E+06	-.414851E+06	0.885818E+05	-152.07	-8.44		
0.00	75.00	-.731383E+06	-.357862E+06	0.814239E+06	-153.93	-9.17		
0.00	80.00	-.689582E+06	-.294408E+06	0.749800E+06	-156.88	-9.89		
0.00	85.00	-.654661E+06	-.225586E+06	0.692438E+06	-160.99	-10.58		
0.00	90.00	-.623999E+06	-.152931E+06	0.642467E+06	-166.23	-11.23		
0.00	95.00	-.595031E+06	-.783976E+05	0.600173E+06	-172.49	-11.82		
0.00	100.00	-.565256E+06	-.430427E+04	0.565273E+06	-179.56	-12.34		
0.00	105.00	-.532241E+06	0.667534E+05	0.536411E+06	172.85	-12.80		
0.00	110.00	-.493619E+06	0.132036E+06	0.510973E+06	165.02	-13.22		
0.00	115.00	-.447141E+06	0.188833E+06	0.485379E+06	157.11	-13.67		
0.00	120.00	-.390785E+06	0.234669E+06	0.455832E+06	149.01	-14.21		
0.00	125.00	-.322938E+06	0.267532E+06	0.419360E+06	140.36	-14.94		
0.00	130.00	-.242650E+06	0.286109E+06	0.375150E+06	130.30	-15.91		
0.00	135.00	-.149922E+06	0.289987E+06	0.326449E+06	117.34	-17.11		
0.00	140.00	-.459879E+05	0.279807E+06	0.283561E+06	99.33	-18.34		
0.00	145.00	0.664792E+05	0.257322E+06	0.265770E+06	75.51	-18.90		
0.00	150.00	0.183306E+06	0.225345E+06	0.290485E+06	50.87	-18.13		
0.00	155.00	0.298966E+06	0.187567E+06	0.352933E+06	32.10	-16.44		
0.00	160.00	0.406947E+06	0.146245E+06	0.433108E+06	20.02	-14.66		
0.00	165.00	0.500352E+06	0.111798E+06	0.512690E+06	12.60	-13.19		
0.00	170.00	0.572635E+06	0.823355E+05	0.578524E+06	8.18	-12.14		
0.00	175.00	0.618392E+06	0.631948E+05	0.621613E+06	5.83	-11.52		
0.00	180.00	0.634060E+06	0.565625E+05	0.636578E+06	5.10	-11.31		
0.00	185.00	0.[illegible]392E+06	0.631947E+05	0.621613E+06	5.83	-11.52		
0.00	190.00	0.572635E+06	0.823334E+05	0.578523E+06	8.18	-12.14		
0.00	195.00	0.500352E+06	0.111797E+06	0.512690E+06	12.60	-13.19		
0.00	200.00	0.406948E+06	0.148245E+06	0.433108E+06	20.02	-14.66		
0.00	205.00	0.298966E+06	0.187566E+06	0.352933E+06	32.10	-16.44		
0.00	210.00	0.183307E+06	0.225345E+06	0.290485E+06	50.87	-18.13		
0.00	215.00	0.664793E+05	0.257321E+06	0.265770E+06	75.51	-18.90		
0.00	220.00	-.459875E+05	0.279807E+06	0.283561E+06	99.33	-18.34		
0.00	225.00	-.149921E+06	0.289987E+06	0.326449E+06	117.34	-17.11		
0.00	230.00	-.242650E+06	0.286109E+06	0.375150E+06	130.30	-15.91		
0.00	235.00	-.322938E+06	0.267532E+06	0.419360E+06	140.36	-14.94		
0.00	240.00	-.390785E+06	0.234669E+06	0.455831E+06	149.01	-14.21		
0.00	245.00	-.447141E+06	0.188833E+06	0.485379E+06	157.11	-13.67		
0.00	250.00	-.493619E+06	0.132036E+06	0.510973E+06	165.02	-13.22		
0.00	255.00	-.532241E+06	0.667533E+05	0.536411E+06	172.85	-12.80		
0.00	260.00	-.565256E+06	-.430442E+04	0.565273E+06	-179.56	-12.34		
0.00	265.00	-.595031E+06	-.783976E+05	0.600173E+06	-172.49	-11.82		
0.00	270.00	-.623999E+06	-.152931E+06	0.642466E+06	-166.23	-11.23		
0.00	275.00	-.654661E+06	-.225586E+06	0.692438E+06	-160.99	-10.58		
0.00	280.00	-.689582E+06	-.294408E+06	0.749800E+06	-156.88	-9.89		
0.00	285.00	-.731382E+06	-.357862E+06	0.814239E+06	-153.93	-9.17		
0.00	290.00	-.782670E+06	-.414850E+06	0.885818E+06	-152.07	-8.44		
0.00	295.00	-.845913E+06	-.464707E+06	0.965153E+06	-151.22	-7.70		
0.00	300.00	-.923236E+06	-.507164E+06	0.105337E+07	-151.22	-6.94		
0.00	305.00	-.101614E+07	-.542312E+06	0.115180E+07	-151.91	-6.16		
0.00	310.00	-.112521E+07	-.570536E+06	0.126159E+07	-153.11	-5.37		
0.00	315.00	-.124974E+07	-.592457E+06	0.138306E+07	-154.64	-4.57		
0.00	320.00	-.138751E+07	-.608855E+06	0.151522E+07	-156.31	-3.78		
0.00	325.00	-.153460E+07	-.620605E+06	0.165534E+07	-157.98	-3.01		
0.00	330.00	-.168544E+07	-.628609E+06	0.179885E+07	-159.55	-2.29		
0.00	335.00	-.183302E+07	-.633738E+06	0.193948E+07	-160.93	-1.64		
0.00	340.00	-.196939E+07	-.636783E+06	0.206978E+07	-162.08	-1.07		
0.00	345.00	-.208634E+07	-.63842[illegible]E+06	0.218184E+07	-162.99	-0.61		
0.00	350.00	-.217627E+07	-.639204E+06	0.226820E+07	-163.63	-0.28		

0.00	355.00	-.223294E+07	-.639514E+06	0.232271E+07	-164.02	-0.07
0.00	360.00	-.225230E+07	-.639591E+06	0.234135E+07	-164.15	0.00

* DIRECTION FOR PATTERN NORMALIZATION

1

PROGRAM C H I E F 8 8   RUN MRBI   DATE 19-FEB-9

FREQUENCY   716.2 RHO= 1000.0 C= 1500.0

SYMMETRY TYPE= ROT   NO. OF BLOCKS= 30

VELOCITIES (BLK#,AREA#, REAL,IMAG,MAG,ANG, REAL ZCOAT, IMAG ZCOAT)

1	1	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	2	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	3	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	4	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	5	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	6	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	7	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	8	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	9	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	10	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	11	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	12	0.100000E+01	0.000000E+00	0.100000E+01	0.00	0.000000E+00	0.000000E+00
1	13	0.329050E-14	0.566012E-13	0.566968E-13	86.67	0.000000E+00	0.100000E+20
1	14	0.243163E-13	0.353465E-13	0.429028E-13	55.47	0.000000E+00	0.100000E+20
1	15	0.312216E-13	0.166352E-13	0.353769E-13	28.05	0.000000E+00	0.100000E+20
1	16	0.300685E-13	0.175188E-14	0.301195E-13	3.33	0.000000E+00	0.100000E+20
1	17	0.238301E-13	-0.855669E-14	0.253197E-13	-19.75	0.000000E+00	0.100000E+20
1	18	0.146886E-13	-0.141628E-13	0.204044E-13	-43.96	0.000000E+00	0.100000E+20
1	19	0.439377E-14	-0.155414E-13	0.161506E-13	-74.21	0.000000E+00	0.100000E+20
1	20	-0.569057E-14	-0.136599E-13	0.147978E-13	-112.62	0.000000E+00	0.100000E+20
1	21	-0.145778E-13	-0.979933E-14	0.175653E-13	-146.09	0.000000E+00	0.100000E+20
1	22	-0.216270E-13	-0.534355E-14	0.222774E-13	-166.12	0.000000E+00	0.100000E+20
1	23	-0.264[illegible]8E-13	-0.155915E-14	0.265277E-13	-176.63	0.000000E+00	0.100000E+20
1	24	-0.289[illegible]4E-13	0.594412E-15	0.290045E-13	178.83	0.000000E+00	0.100000E+20

*** FULL VELOCITY SYMMETRY ***

1

PROGRAM C H I E F 8 8   RUN MRBI   DATE 19-FEB-9

FREQUENCY=   716.2 RHO= 1000.0 C= 1500.0

SYMMETRY TYPE= ROT   NO. OF BLOCKS= 30

SURFACE PRESSURES (BLK#,AREA#, REAL,IMAG,MAG,ANG)

1	1	0.135092E+07	0.137472E+06	0.135790E+07	5.81
1	2	0.136950E+07	0.181612E+06	0.138149E+07	7.55
1	3	0.140664E+07	0.234871E+06	0.142611E+07	9.48
1	4	0.145111E+07	0.306363E+06	0.148310E+07	11.92
1	5	0.148982E+07	0.395436E+06	0.154141E+07	14.86
1	6	0.150868E+07	0.496214E+06	0.158819E+07	18.21
1	7	0.149497E+07	0.598979E+06	0.161050E+07	21.83
1	8	0.143898E+07	0.690125E+06	0.159591E+07	25.62
1	9	0.133593E+07	0.752193E+06	0.153313E+07	29.38
1	10	0.118709E+07	0.763406E+06	0.141137E+07	32.74
1	11	0.999980E+06	0.694102E+06	0.121727E+07	34.77
1	12	0.787446E+06	0.483704E+06	0.924144E+06	31.56
1	13	0.566012E+06	-0.329050E+05	0.566968E+06	-3.33
1	14	0.353465E+06	-0.243163E+06	0.429028E+06	-34.53
1	15	0.166352E+06	-0.312216E+06	0.353769E+06	-61.95
1	16	0.175188E+05	-0.300685E+06	0.301195E+06	-86.67
1	17	-0.855669E+05	-0.238301E+06	0.253197E+06	-109.75
1	18	-0.141628E+06	-0.146886E+06	0.204044E+06	-133.96
1	19	-0.155414E+06	-0.439377E+05	0.161506E+06	-164.21
1	20	-0.136599E+06	0.569057E+05	0.147978E+06	157.38
1	21	-0.979933E+05	0.145778E+06	0.175653E+06	123.91
1	22	-0.534355E+05	0.216270E+06	0.222774E+06	103.88
1	23	-0.155915E+05	0.264818E+06	0.265277E+06	93.37

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   1  24      0.594412E+04   0.299984E+06   0.290045E+06      88.83
*** FULL VELOCITY SYMMETRY ***

POWER OUT(KW)=   7956 770

1
                    PROGRAM C H I E F 8 8     RUN MPBI     DATE 19-FEB-9

FREQUENCY=   718.2  RHO=  1000.0  C=  1500.0

SYMMETRY TYPE= ROT      NO. OF BLOCKS= 30

FAR-FIELD PRESSURES ( PHI,THETA,FFP(RE,IM,MAG,ANG)   ,       NORMALIZED PATTERN, SOURCE LEVEL, DI )
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0.00	0.00	-.218313E+07	-.600680E+06	0.226426E+07	-164.62	0.00
0.00	5.00	-.216523E+07	-.601108E+06	0.224712E+07	-164.48	-0.07
0.00	10.00	-.211282E+07	-.602237E+06	0.219698E+07	-164.09	-0.26
0.00	15.00	-.202958E+07	-.603609E+06	0.211743E+07	-163.44	-0.58
0.00	20.00	-.192112E+07	-.604498E+06	0.201398E+07	-162.53	-1.02
0.00	25.00	-.179443E+07	-.603972E+06	0.189335E+07	-161.40	-1.55
0.00	30.00	-.165704E+07	-.600953E+06	0.176265E+07	-160.07	-2.18
0.00	35.00	-.151637E+07	-.594323E+06	0.162868E+07	-158.60	-2.86
0.00	40.00	-.137904E+07	-.582973E+06	0.149720E+07	-157.08	-3.59
0.00	45.00	-.125048E+07	-.565931E+06	0.137258E+07	155.65	-4.35
0.00	50.00	-.113462E+07	-.542414E+06	0.125761E+07	-154.45	-5.11
0.00	55.00	-.103388E+07	-.511910E+06	0.115367E+07	-153.66	-5.86
0.00	60.00	-.949194E+06	-.474217E+06	0.106106E+07	-153.45	-6.58
0.00	65.00	-.880240E+06	-.429479E+06	0.979426E+06	-153.99	-7.28
0.00	70.00	-.825674E+06	-.378190E+06	0.908166E+06	-155.39	-7.94
0.00	75.00	-.783375E+06	-.321181E+06	0.846661E+06	-157.71	-8.54
0.00	80.00	-.750675E+06	- 259583E+06	0.794290E+06	-160.92	-9.10
0.00	85.00	-.724546E+06	-.194771E+06	0.750268E+06	-164.95	-9.59
0.00	90.00	-.701752E+06	-.128293E+06	0.713383E+06	-169.64	-10.03
0.00	95.00	-.678962E+06	-.617906E+05	0.681767E+06	-174.80	-10.43
0.00	100.00	-.652840E+06	0.309076E+04	0.652847E+06	179.73	-10.80
0.00	105.00	-.620150E+06	0.647910E+05	0.623525E+06	174.04	-11.20
0.00	110.00	-.577863E+06	0.121919E+06	0.590585E+06	168.09	-11.67
0.00	115.00	-.[illegible]09E+06	0.173327E+06	0.551266E+06	161.67	-12.27
0.00	120.00	-.454364E+06	0.218166E+06	0.504027E+06	154.35	-13.05
0.00	125.00	-.369681E+06	0.255928E+06	0.449626E+06	145.31	-14.04
0.00	130.00	-.268939E+06	0.286460E+06	0.392922E+06	133.19	-15.21
0.00	135.00	-.153082E+06	0.309961E+06	0.345702E+06	116.28	-16.32
0.00	140.00	-.245133E+05	0.326947E+06	0.327865E+06	94.29	-16.78
0.00	145.00	0.112824E+06	0.338207E+06	0.356529E+06	71.55	-16.06
0.00	150.00	0.253512E+06	0.344729E+06	0.427909E+06	53.67	-14.47
0.00	155.00	0.390911E+06	0.347622E+06	0.523118E+06	41.65	-12.73
0.00	160.00	0.517617E+06	0.348028E+06	0.623740E+06	33.92	-11.20
0.00	165.00	0.626080E+06	0.347032E+06	0.715826E+06	29.00	-10.00
0.00	170.00	0.709337E+06	0.345578E+06	0.789039E+06	25.97	-9.16
0.00	175.00	0.761749E+06	0.344396E+06	0.835985E+06	24.33	-8.65
0.00	180.00	0.779646E+06	0.343950E+06	0.852144E+06	23.81	-8.49
0.00	185.00	0.761749E+06	0.344397E+06	0.835985E+06	24.33	-8.65
0.00	190.00	0.709337E+06	0.345578E+06	0.789039E+06	25.97	-9 16
0.00	195.00	0 626080E+06	0.347032E+06	0.715826E+06	29.00	-10.00
0.00	200.00	0.517617E+06	0.348028E+06	0.623740E+06	33.92	-11 20
0.00	205.00	0.390912E+06	0.347622E+06	0.523118E+06	41.65	-12.73
0.00	210.00	0.253512E+06	0.344729E+06	0.427909E+06	53.67	-14.47
0.00	215.00	0.112825E+06	0.338207E+06	0.356529E+06	71.55	-16.06
0.00	220.00	-.245130E+05	0.326947E+06	0.327865E+06	94.29	-16.78
0.00	225.00	-.153082E+06	0.309961E+06	0.345702E+06	116.28	-16.32
0.00	230.00	-.268939E+06	0.286460E+06	0.392922E+06	133.19	-15.21
0.00	235.00	-.369681E+06	0.255928E+06	0.449626E+06	145.31	-14.04
0.00	240.00	-.454364E+06	0.218166E+06	0.504027E+06	154.35	-13.05
0.00	245.00	-.523309E+06	0.173327E+06	0.551266E+06	161.67	-12.27
0.00	250.00	-.577863E+06	0.121919E+06	0.590585E+06	168.09	-11.67
0.00	255.00	-.620150E+06	0.647910E+05	0.623525E+06	174.04	-11.20
0.00	260.00	-.652840E+06	0.309063E+04	0.652847E+06	179 73	-10.80
0.00	265.00	-.678961E+06	-.617905E+05	0.681767E+06	-174.80	-10.43
0.00	270.00	-.701762E+06	-.128292E+06	0.713383E+06	-169.64	-10.03
0.00	275.00	-.724546E+06	-.194770E+06	0.750268E+06	-164.95	-9.59
0.00	2[illegible]0.00	-.750674E+06	-.259583E+06	0.794289E+06	-160.92	-9.10

0.00	285.00	-.783375E+06	-.321181E+06	0.846660E+06	-157.71	-8.54		
0.00	290.00	-.825674E+06	-.378190E+06	0.908166E+06	-155.39	-7.94		
0.00	295.00	-.880240E+06	-.429478E+06	0.979425E+06	-153.99	-7.28		
0.00	300.00	-.949194E+06	-.474210E+06	0.106106E+07	-153.45	-6.58		
0.00	305.00	-.103388E+07	-.511910E+06	0.115367E+07	-153.66	-5.86		
0.00	310.00	-.113482E+07	-.542414E+06	0.125781E+07	-154.45	-5.11		
0.00	315.00	-.126048E+07	-.565930E+06	0.137258E+07	-155.65	-4.35		
0.00	320.00	-.137904E+07	-.582973E+06	0.149720E+07	-157.08	-3.59		
0.00	325.00	-.151637E+07	-.594322E+06	0.162868E+07	-158.60	-2.86		
0.00	330.00	-.165704E+07	-.600956E+06	0.176265E+07	-160.07	-2.18		
0.00	335.00	-.179443E+07	-.603972E+06	0.189334E+07	-161.40	-1.55		
0.00	340.00	-.192112E+07	-.604498E+06	0.201398E+07	-162.53	-1.02		
0.00	345.00	-.202958E+07	-.603608E+06	0.211743E+07	-163.44	-0.58		
0.00	350.00	-.211282E+07	-.602237E+06	0.219698E+07	-164.09	-0.26		
0.00	355.00	-.216523E+07	-.601108E+06	0.224712E+07	-164.48	-0.07		
0.00	360.00	-.218313E+07	-.600680E+06	0.226426E+07	-164.62	0.00 *	247.1	7.29

* DIRECTION FOR PATTERN NORMALIZATION

The agreement between the far-field directivity pattern computed by the technique described by Butler [2] and the modified CHIEF program is so close that no difference would be discerned from a plot of two sets of data. Hence, the data is listed in tabular form in Table 1.

Table 1 - Directivity Patterns For Three Different Impedance Values.

Bearing Angle	Surface Z = 0.0		Surface Z = ρc		Surface Z = RIGID	
	Ref. (2)	Modified CHIEF	Ref. (2)	Modified CHIEF	Ref. (2)	Modified CHIEF
0°	0.0 dB	0.0 dB	0.0 dB	0.0 dB	0.0 dB	0.0 dB
10°	-0.4 dB	-0.3 dB	-0.3 dB	-0.3 dB	-0.3 dB	-0.3 dB
20°	-1.2 dB	-1.2 dB	-1.1 dB	-1.1 dB	-1.1 dB	-1.0 dB
30°	-2.6 dB	-2.7 dB	-2.2 dB	-2.3 dB	-2.2 dB	-2.2 dB
40°	-4.4 dB	-4.4 dB	-3.5 dB	-3.8 dB	-3.8 dB	-3.6 dB
50°	-6.1 dB	-6.2 dB	-5.2 dB	-5.4 dB	-5.1 dB	-5.1 dB
60°	-7.7 dB	-7.9 dB	-6.9 dB	-6.9 dB	-6.7 dB	-6.6 dB
70°	-9.1 dB	-9.5 dB	-8.3 dB	-8.4 dB	-8.1 dB	-7.9 dB
80°	-11.0 dB	-11.1 dB	-9.5 dB	-9.9 dB	-8.9 dB	-9.1 dB
90°	-12.8 dB	-12.7 dB	-11.0 dB	-11.2 dB	-10.0 dB	-10.0 dB
100°	-14.4 dB	-14.3 dB	-12.0 dB	-12.3 dB	-10.6 dB	-10.8 dB
110°	-15.9 dB	-15.8 dB	-13.0 dB	-13.2 dB	-11.2 dB	-11.7 dB
120°	-17.8 dB	-17.3 dB	-14.0 dB	-14.2 dB	-13.0 dB	-13.1 dB
130°	-19.5 dB	-19.0 dB	-15.6 dB	-15.9 dB	-15.7 dB	-15.2 dB
140°	-22.4 dB	-21.2 dB	-18.7 dB	-18.3 dB	-16.2 dB	-16.8 dB
150°	-22.4 dB	-22.6 dB	-17.5 dB	-18.1 dB	-14.5 dB	-14.5 dB
160°	-20.8 dB	-21.1 dB	-14.7 dB	-14.7 dB	-12.1 dB	-11.2 dB
170°	-19.5 dB	-18.9 dB	-12.3 dB	-12.1 dB	-9.5 dB	-9.2 dB
180°	-18.9 dB	-18.1 dB	-11.5 dB	-11.3 dB	-8.5 dB	-8.5 dB

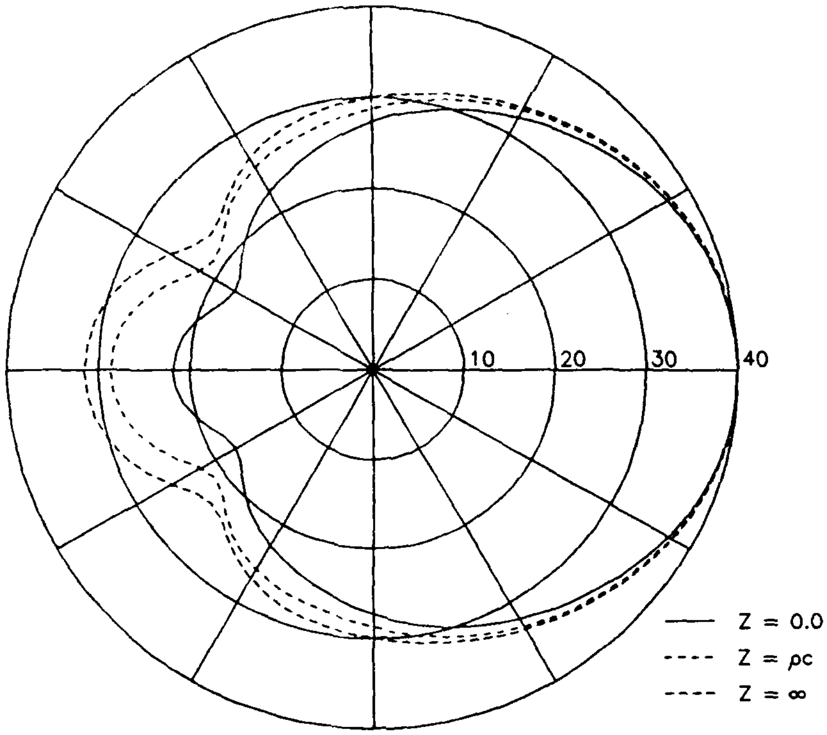

Fig. 2. Representative directivity patterns for a 90° uniformly vibrating polar cap on an impedance-coated sphere for the values of the impedance given in Table 1.

Sample Run 2: Impedance Coated Wedge With Spherical Source

This sample computes the acoustic radiation from a spherical source near a wedged-shape surface covered with an impedance material. The interesting part of this example is that the geometry is generated using equation sets 6 (spherical region), 1 (rectangular planar region), and 10 (finite element inputs).

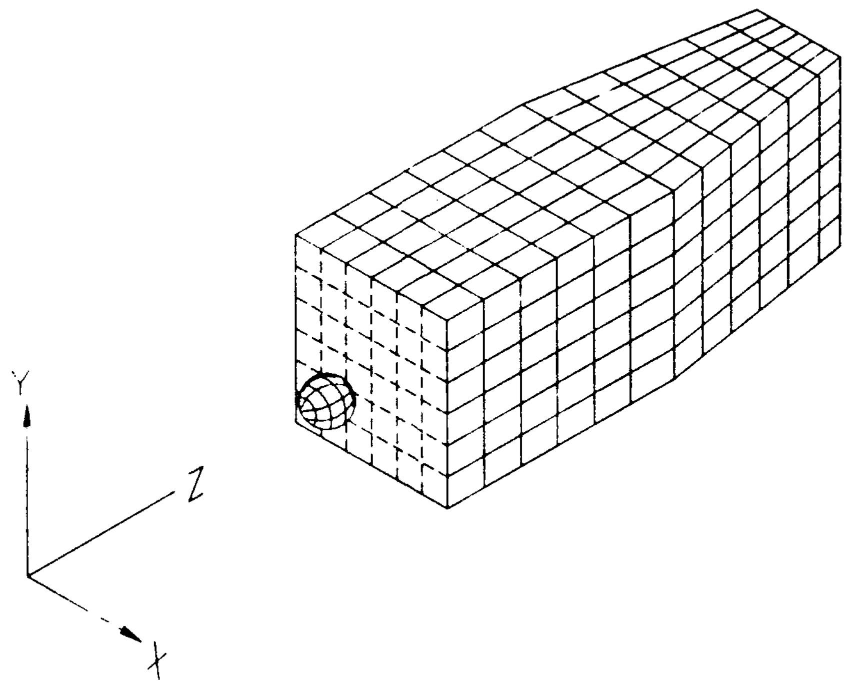

Fig. 3. Spherical source near a wedged-shaped baffle.

Program Listing of Sample Run 2

```
C     Program WEDGETES
C  WEDGE WITH VIBRATING SPHERE

C  (COMMON VARIABLE DECLARATIONS GO HERE)

      COMPLEX PMATX(14884), VMATX(14884)
      MDSIZE = 14884
      RUNID  = 'WEDG'
      DATE   = '23-OCT-90'
      CALL INITCM
      CALL OPNSFL
      RHO    = 1000
      C      = 1500

C*************** impedance coating modifications ***************
      NUMZ   =      9
      N = 1
```

```
C ---- clear impedance for sphere
      DO  10 I = N, N + (8    * 4  ) - 1
         ZCOAT(I) = CMPLX(0.0, 0.0)
 10   CONTINUE
      N = N + (8    * 4  )

C ---- clear impedance for SIDE1
      DO  20 I = N, N + (3    * 6  ) - 1
         ZCOAT(I) = CMPLX(0.0, 0.0)
 20   CONTINUE
      N = N + (3    * 6  )

C ---- clear impedance for SIDE2
      DO  30 I = N, N + (6    * 3  ) - 1
         ZCOAT(I) = CMPLX(0.0, 0.0)
 30   CONTINUE
      N = N + (6    * 3  )

C ---- clear impedance for BOTTOM
      DO  40 I = N, N + (3    * 3  ) - 1
         ZCOAT(I) = CMPLX(0.0, 0.0)
 40   CONTINUE
      N = N + (3    * 3  )

C ---- clear impedance for FE SIDE1
      DO  50 I = N, N + (1    * 18 ) - 1
         ZCOAT(I) = CMPLX(0.0, 0.0)
 50   CONTINUE
      N = N + (1    * 18 )

C ---- clear impedance for FE SIDE2
      DO  60 I = N, N + (1    * 18 ) - 1
         ZCOAT(I) = CMPLX(0.0, 0.0)
 60   CONTINUE
      N = N + (1    * 18 )

C ----- load impedance for SENSOR
      DO  70 I = N, N + (3    * 3  ) - 1
         ZCOAT(I) = CMPLX(.3e6       , 0.0        )
 70   CONTINUE
      N = N + (3    * 3  )

C*********** end of impedance coating modifications ***********

      OPEN(UNIT=NUNPRT,FILE=RUNID//'.OUT',STATUS='NEW',
     1     FORM='FORMATTED')


C  symmetry inputs

      PI      = ACOS(-1.0)

      SYMTYP  = 'REF'
      NBLKS   = 2 **   2
      IRHSYM  = 1
      CONVERT = 1.0

C  Surface Region inputs

      ROTLIM = PI / NBLKS
      XIRG   = 0

      DO 1 I = 1, 10
         CC(I) = 0.0
1     CONTINUE

      DO 2 I = 1, 3
         TRNS(I) = 0.0
2     CONTINUE

C -- ----- sphere                ---------
```

```
      XNSEQNS  = 9
      CC( 1)   = .009525     * CONVERT
      CC( 2)   = CC(1)+CC(1)
      TRNS(1) = (0.00E+00) * CONVERT
      TRNS(2) = (0.00E+00) * CONVERT
      TRNS(3) = (0.00E+00) * CONVERT
      XIZAX    = +3
      XSUL     = 0
      XSUU     = 3.1415926
      XSVL     = 0.000000
      XSVU     = 1.570796
      XNSU     = 8
      XNSV     = 4
      XIORDU   = 4
      XIORDV   = 4
      XIRG = XIRG + 1
      CALL LDSURR(XIRG, XNSEQNS, CC, TRNS, XIZAX,
     1            XSUL, XSUU, XSVL, XSVU, XNSU, XNSV, XIORDU, XIORDV)
C --------- SIDE1                       ---------

      XNSEQNS = 1
      CC( 1)   = .0508       * CONVERT
      TRNS(1) = (0.00E+00) * CONVERT
      TRNS(2) = (0.00E+00) * CONVERT
      TRNS(3) = (.0286+00) * CONVERT
      XIZAX    = +1
      XSUL     = 0          * CONVERT
      XSUU     = .0508      * CONVERT
      XSVL     = 0           * CONVERT
      XSVU     = .123825     * CONVERT
      XNSU     = 3
      XNSV     = 6
      XIORDU   = 4
      XIORDV   = 4
      XIRG = XIRG + 1
      CALL LDSURR(XIRG, XNSEQNS, CC, TRNS, XIZAX,
     1            XSUL, XSUU, XSVL, XSVU, XNSU, XNSV, XIORDU, XIORDV)
C --------- SIDE                        ---------

      XNSEQNS = 1
      CC( 1)   = .0508       * CONVERT
      TRNS(1) = (0.00E+00) * CONVERT
      TRNS(2) = (0.00E+00) * CONVERT
      TRNS(3) = (.0286+00) * CONVERT
      XIZAX    = +2
      XSUL     = 0          * CONVERT
      XSUU     = .123825    * CONVERT
      XSVL     = 0           * CONVERT
      XSVU     = .0508       * CONVERT
      XNSU     = 6
      XNSV     = 3
      XIORDU   = 4
      XIORDV   = 4
      XIRG = XIRG + 1
      CALL LDSURR(XIRG, XNSEQNS, CC, TRNS, XIZAX,
     1            XSUL, XSUU, XSVL, XSVU, XNSU, XNSV, XIORDU, XIORDV)
C --------- BOTTOM                      ---------

      XNSEQNS = 1
      CC( 1)   = .254025     * CONVERT
      TRNS(1) = (0.00E+00) * CONVERT
      TRNS(2) = (0.00E+00) * CONVERT
      TRNS(3) = (0.00E+00) * CONVERT
      XIZAX    = +3
      XSUL     = 0          * CONVERT
      XSUU     = .0254      * CONVERT
      XSVL     = 0           * CONVERT
      XSVU     = .0508       * CONVERT
      XNSU     = 3
      XNSV     = 3
      XIORDU   = 4
```

```
      XIORDV  = 4
      XIRG = XIRG + 1
      CALL LOSURR(XIRG, XNSEQNS, CC, TRNS, XIZAX,
     1           XSUL, XSUU, XSVL, XSVU, XNSU, XNSV, XIORDU, XIORDV)
C -------- FE SIDE1              ---------

      XNSEQNS =10
      CC( 1)  = 0          * CONVERT
      CC( 2)  = 0          * CONVERT
      TRNS(1) = (0.00E+00) * CONVERT
      TRNS(2) = (0.00E+00) * CONVERT
      TRNS(3) = (0.00E+00) * CONVERT
      XIZAX   = +3
      XSUL    = -1
      XSUU    = 1
      XSVL    = -1
      XSVU    = 1
      XNSU    =   1
      XNSV    =   1
      XIORDU  = 4
      XIORDV  = 4

C  Read in coordinate and element data.

      ICOOR = 0
      OPEN(UNIT=8,FILE='  IOMAGC.WED',STATUS='OLD',FORM='FORMATTED')
 1401 READ(8,1402,ERR=1403) IDUM, (COORDS(IDUM,J),J=1,3)
 1402 FORMAT(BNI10,3(BNE10.0)                                    )

      IF (IDUM .GT. ICOOR) ICOOR = IDUM
      IF (IDUM .GT. MAXCOR) THEN
         WRITE (6,*) 'Error:  Coordinate index in coordinate ' //
     +               'data is greater than MAXCOR.'
         STOP
      END IF

      GOTO 1401
 1403 CLOSE(8)

C  Display coordinate data.

      WRITE(NUNPRT,1407)
 1407 FORMAT(1H1,' COORDINATE DATA',/)
      DO 1409 I = 1, ICOOR
         WRITE(NUNPRT,1408) I, (COORDS(I,J),J=1,3)
 1408    FORMAT(I5,5X,3E15.4)
 1409 CONTINUE

      IELEM = 0
      OPEN(UNIT=8 FILE='  IOELMS.WD1',STATUS='OLD',FORM='FORMATTED')
 1404 READ(8,1405,ERR=1406) IDUM, (IELTS(J,IELEM+1),J=1,8)
 1405 FORMAT(T7,9(BNI5)                                          )
      IELEM = IELEM + 1
      GOTO 1404
 1406 CLOSE(8)

C  Display element data.

      WRITE(NUNPRT,1410)
 1410 FORMAT(//,' ELEMENT DATA',/)
      DO 1412 I = 1, IELEM
         WRITE(NUNPRT,1411) I, (IELTS(J,I),J=1,8)
 1411    FORMAT(I5,10X,8I5)
 1412 CONTINUE

      DO 1414 I = 1, IELEM
         DO 1413 J = 1, 8
            CC(J) = IELTS(J, I)
 1413    CONTINUE

         XIRG = XIRG + 1
         CALL LOSURR(XIRG, 10, CC, TRNS, XIZAX,
```

```
     1              XSUL, XSUU, XSVL, XSVU, XNSU, XNSV, XIORDU, XIORDV)
1414  CONTINUE

C -------- FE SIDE2            ---------

      XNSEQNS =10
      CC( 1)  = 0           * CONVERT
      CC( 2)  = 0           * CONVERT
      TRNS(1) = (0.00E+00) * CONVERT
      TRNS(2) = (0.00E+00) * CONVERT
      TRNS(3) = (0.00E+00) * CONVERT
      XIZAX   = -3
      XSUL    = -1
      XSUU    = 1
      XSVL    = -1
      XSVU    = 1
      XNSU    =   1
      XNSV    =   1
      XIORDU  = 4
      XIORDV  = 4

      IELEM = 0
      OPEN(UNIT=8,FILE='  IOELMS.WD2',STATUS='OLD',FORM='FORMATTED')
1504  READ(8,1505,ERR=1506) IDUM, (IELTS(J,IELEM+1),J=1,8)
1505  FORMAT(T7,9(BNI5)                                          )
      IELEM = IELEM + 1
      GOTO 1504
1506  CLOSE(8)

C  Display element data.

      WRITE(NUNPRT,1510)
1510  FORMAT(//,' ELEMENT DATA',/)
      DO 1512 I = 1, IELEM
         WRITE(NUNPRT,1511) I, (IELTS(J,I),J=1,8)
1511     FORMAT(I6,10X,8I5)
1512  CONTINUE

      DO 1514 I = 1, IELEM
         DO 1513 J = 1, 8
            CC(J) = IELTS(J, I)
1513     CONTINUE

         XIRG = XIRG + 1
         CALL LDSURR(XIRG, 10, CC, TRNS, XIZAX,
     1              XSUL, XSUU, XSVL, XSVU, XNSU, XNSV, XIORDU, XIORDV)
1514  CONTINUE


C -------- SENSOR               ---------

      XNSEQNS = 1
      CC( 1)  = .0286        * CONVERT
      TRNS(1) = (0.00E+00) * CONVERT
      TRNS(2) = (0.00E+00) * CONVERT
      TRNS(3) = (0.00E+00) * CONVERT
      XIZAX   = -3
      XSUL    = 0           * CONVERT
      XSUU    = .0508       * CONVERT
      XSVL    = 0            * CONVERT
      XSVU    = .0508        * CONVERT
      XNSU    = 3
      XNSV    = 3
      XIORDU  = 4
      XIORDV  = 4
      XIRG = XIRG + 1
      CALL LDSURR(XIRG, XNSEQNS, CC, TRNS, XIZAX,
     1            XSUL, XSUU, XSVL, XSVU, XNSU, XNSV, XIORDU, XIORDV)

      NSREG = XIRG
```

```
C      CALL PLOTCHIEF(RUNID, NBLKS, SYMTYP, 1, 30.0, 60.0, 0.0)

      CALL PRTOUT('GEOM',1)

C  Define Frequency input.

      DO 99 FREQ = 2000   , 3000   , 1000

C  Generate surface P and V matrices.

      CALL SURMAT(FREQ, SYMTYP, NBLKS, PMATX, VMATX, MDSIZE)

      CALL PRTOUT('AREA',1)

C  Decompose Matrices

      CALL DECOMM(SYMTYP, NBLKS, IRHSYM, PMATX, VMATX, MDSIZE)
      CALL IOSUB(NDVELS, 10, VEL, 0)
C  Block # 1
      VEL(  1) = (1.0000, 0.0000)
      VEL(  2) = (1.0000, 0.0000)
      VEL(  3) = (1.0000, 0.0000)
      VEL(  4) = (1.0000, 0.0000)
      VEL(  5) = (1.0000, 0.0000)
      VEL(  6) = (1.0000, 0.0000)
      VEL(  7) = (1.0000, 0.0000)
      VEL(  8) = (1.0000, 0.0000)
      VEL(  9) = (1.0000, 0.0000)
      VEL( 10) = (1.0000, 0.0000)
      VEL( 11) = (1.0000, 0.0000)
      VEL( 12) = (1.0000, 0.0000)
      VEL( 13) = (1.0000, 0.0000)
      VEL( 14) = (1.0000, 0.0000)
      VEL( 15) = (1.0000, 0.0000)
      VEL( 16) = (1.0000, 0.0000)
      VEL( 17) = (1.0000, 0.0000)
      VEL( 18) = (1.0000, 0.0000)
      VEL( 19) = (1.0000, 0.0000)
      VEL( 20) = (1.0000, 0.0000)
      VEL( 21) = (1.0000, 0.0000)
      VEL( 22) = (1.0000, 0.0000)
      VEL( 23) = (1.0000, 0.0000)
      VEL( 24) = (1.0000, 0.0000)
      VEL( 25) = (1.0000, 0.0000)
      VEL( 26) = (1.0000, 0.0000)
      VEL( 27) = (1.0000, 0.0000)
      VEL( 28) = (1.0000, 0.0000)
      VEL( 29) = (1.0000, 0.0000)
      VEL( 30) = (1.0000, 0.0000)
      VEL( 31) = (1.0000, 0.0000)
      VEL( 32) = (1.0000, 0.0000)
      VEL( 33) = (0.0000, 0.0000)
      VEL( 34) = (0.0000, 0.0000)
      VEL( 35) = (0.0000, 0.0000)
      VEL( 36) = (0.0000, 0.0000)
      VEL( 37) = (0.0000, 0.0000)
      VEL( 38) = (0.0000, 0.0000)
      VEL( 39) = (0.0000, 0.0000)
      VEL( 40) = (0.0000, 0.0000)
      VEL( 41) = (0.0000, 0.0000)
      VEL( 42) = (0.0000, 0.0000)
      VEL( 43) = (0.0000, 0.0000)
      VEL( 44) = (0.0000, 0.0000)
      VEL( 45) = (0.0000, 0.0000)
      VEL( 46) = (0.0000, 0.0000)
      VEL( 47) = (0.0000, 0.0000)
      VEL( 48) = (0.0000, 0.0000)
      VEL( 49) = (0.0000, 0.0000)
      VEL( 50) = (0.0000, 0.0000)
      VEL( 51) = (0.0000, 0.0000)
      VEL( 52) = (0.0000, 0.0000)
      VEL( 53) = (0.0000, 0.0000)
```

```
VEL( 54) = (0.0000, 0.0000)
VEL( 55) = (0.0000, 0.0000)
VEL( 56) = (0.0000, 0.0000)
VEL( 57) = (0.0000, 0.0000)
VEL( 58) = (0.0000, 0.0000)
VEL( 59) = (0.0000, 0.0000)
VEL( 60) = (0.0000, 0.0000)
VEL( 61) = (0.0000, 0.0000)
VEL( 62) = (0.0000, 0.0000)
VEL( 63) = (0.0000, 0.0000)
VEL( 64) = (0.0000, 0.0000)
VEL( 65) = (0.0000, 0.0000)
VEL( 66) = (0.0000, 0.0000)
VEL( 67) = (0.0000, 0.0000)
VEL( 68) = (0.0000, 0.0000)
VEL( 69) = (0.0000, 0.0000)
VEL( 70) = (0.0000, 0.0000)
VEL( 71) = (0.0000, 0.0000)
VEL( 72) = (0.0000, 0.0000)
VEL( 73) = (0.0000, 0.0000)
VEL( 74) = (0.0000, 0.0000)
VEL( 75) = (0.0000, 0.0000)
VEL( 76) = (0.0000, 0.0000)
VEL( 77) = (0.0000, 0.0000)
VEL( 78) = (0.0000, 0.0000)
VEL( 79) = (0.0000, 0.0000)
VEL( 80) = (0.0000, 0.0000)
VEL( 81) = (0.0000, 0.0000)
VEL( 82) = (0.0000, 0.0000)
VEL( 83) = (0.0000, 0.0000)
VEL( 84) = (0.0000, 0.0000)
VEL( 85) = (0.0000, 0.0000)
VEL( 86) = (0.0000, 0.0000)
VEL( 87) = (0.0000, 0.0000)
VEL( 88) = (0.0000, 0.0000)
VEL( 89) = (0.0000, 0.0000)
VEL( 90) = (0.0000, 0.0000)
VEL( 91) = (0.0000, 0.0000)
VEL( 92) = (0.0000, 0.0000)
VEL( 93) = (0.0000, 0.0000)
VEL( 94) = (0.0000, 0.0000)
VEL( 95) = (0.0000, 0.0000)
VEL( 96) = (0.0000, 0.0000)
VEL( 97) = (0.0000, 0.0000)
VEL( 98) = (0.0000, 0.0000)
VEL( 99) = (0.0000, 0.0000)
VEL(100) = (0.0000, 0.0000)
VEL(101) = (0.0000, 0.0000)
VEL(102) = (0.0000, 0.0000)
VEL(103) = (0.0000, 0.0000)
VEL(104) = (0.0000, 0.0000)
VEL(105) = (0.0000, 0.0000)
VEL(106) = (0.0000, 0.0000)
VEL(107) = (0.0000, 0.0000)
VEL(108) = (0.0000, 0.0000)
VEL(109) = (0.0000, 0.0000)
VEL(110) = (0.0000, 0.0000)
VEL(111) = (0.0000, 0.0000)
VEL(112) = (0.0000, 0.0000)
VEL(113) = (0.0000, 0.0000)
VEL(114) = (0.0000, 0.0000)
VEL(115) = (0.0000, 0.0000)
VEL(116) = (0.0000, 0.0000)
VEL(117) = (0.0000, 0.0000)
VEL(118) = (0.0000, 0.0000)
VEL(119) = (0.0000, 0.0000)
VEL(120) = (0.0000, 0.0000)
VEL(121) = (0.0000, 0.0000)
VEL(122) = (0.0000, 0.0000)
CALL IOSUB(NOVEL, 1, 122, NWDVEC)
```

```
C  Generate Surface Pressures.

      CALL SURPRS(FREQ, SYMTYP, NBLKS, IRHSYM, PMATX, VMATX, MDSIZE)

      CALL PRTOUT('VEL',1)

      CALL PRTOUT('SP',1)

      FLDTYP = 'FAR '
      NUMTHP =  19
      DO 25 I = 1, NUMTHP
         THTPHI(1, I) = (I - 1) * 10
         THTPHI(2, I) = 0.0
25    CONTINUE

C  Calculate FAR Field Matrices
      CALL FLDMAT(FREQ, SYMTYP, FLDTYP, NBLKS, PMATX, VMATX, MDSIZE)

      IFFNRM =   0

C  Calculate Far-Field Pressures.
      CALL FLDPRS(FREQ, FLDTYP, NBLKS, IRHSYM, PMATX, VMATX, MDSIZE)

      CALL PRTOUT(FLDTYP, 0)
99    CONTINUE

      STOP
      END
```

Output Listing of Sample Run 2

1 COORDINATE DATA

1	0.3635E-08	0.5080E-01	0.1524E+00
2	0.4627E-08	0.5080E-01	0.1694E+00
3	0.5620E-08	0.5080E-01	0.1863E+00
4	0.6612E-08	0.5080E-01	0.2032E+00
5	0.7605E-08	0.5080E-01	0.2202E+00
6	0.8597E-08	0.5080E-01	0.2371E+00
7	0.9590E-08	0.5080E-01	0.2540E+00
8	0.1693E-01	0.5080E-01	0.1524E+00
9	0.1552E-01	0.5080E-01	0.1694E+00
10	0.1411E-01	0.5080E-01	0.1863E+00
11	0.1270E-01	0.5080E-01	0.2032E+00
12	0.1129E-01	0.5080E-01	0.2202E+00
13	0.9878E-02	0.5080E-01	0.2371E+00
14	0.8467E-02	0.5080E-01	0.2540E+00
15	0.3387E-01	0.5080E-01	0.1524E+00
16	0.3104E-01	0.5080E-01	0.1694E+00
17	0.2822E-01	0.5080E-01	0.1863E+00
18	0.2540E-01	0.5080E-01	0.2032E+00
19	0.2258E-01	0.5080E-01	0.2202E+00
20	0.1976E-01	0.5080E-01	0.2371E+00
21	0.1693E-01	0.5080E-01	0.2540E+00
22	0.5080E-01	0.5080E-01	0.1524E+00
23	0.4657E-01	0.5080E-01	0.1694E+00
24	0.4233E-01	0.5080E-01	0.1863E+00
25	0.3810E-01	0.5080E-01	0.2032E+00
26	0.3387E-01	0.5080E-01	0.2202E+00
27	0.2963E-01	0.5080E-01	0.2371E+00
28	0.2540E-01	0.5080E-01	0.2540E+00
29	0.5080E-01	0.3387E-01	0.1524E+00
30	0.4657E-01	0.3387E-01	0.1694E+00
31	0.4233E-01	0.3387E-01	0.1863E+00
32	0.3810E-01	0.3387E-01	0.2032E+00
33	0.3387E-01	0.3387E-01	0.2202E+00
34	0.2963E-01	0.3387E-01	0.2371E+00
35	0.2540E-01	0.3387E-01	0.2540E+00
36	0.5080E-01	0.1693E-01	0.1524E+00
37	0.4657E-01	0.1693E-01	0.1694E+00

38	0.4233E-01	[illegible]	0.1[illegible]3E+00
39	0.3810E-01	[illegible]	0.2032E+00
40	0.3387E-01	[illegible]	0.2202E+00
41	0.2963E-01	[illegible]	0.2371E+00
42	0.2540E-01	[illegible]	0.2540E+00
43	0.5080E-01	[illegible]	0.1524E+00
44	0.4657E-01	[illegible]	0.1694E+00
45	0.4233E-01	[illegible]	0.1863E+00
46	0.3810E-01	[illegible]	0.2032E+00
47	0.3387E-01	[illegible]	0.2202E+00
48	[illegible]	[illegible]	0.2371E+00
49	0.2540E-01	[illegible]	0.2540E+00

ELEMENT DATA

1	1	2	9		[illegible]	0	0	0
2	2	3	10	[illegible]	[illegible]	0	[illegible]	0
3	3	4	11	[illegible]	[illegible]	0	0	0
4	4	5	12	[illegible]	[illegible]	0	0	0
5	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]
6	[illegible]		[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]
7	8	9	16	[illegible]	[illegible]	0	0	0
8	9	10	17	[illegible]	[illegible]	0	0	0
9	10	11	18	[illegible]	[illegible]	0	0	0
10	11	12	19	[illegible]	[illegible]	0	0	0
11	12	13	20	[illegible]	[illegible]	0	0	0
12	13	14	[illegible]	[illegible]	[illegible]	0	0	0
13	15	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0
14	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	17	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0
16	18	19	[illegible]	[illegible]	[illegible]	0	0	0
17	19	20	27	[illegible]	[illegible]	0	0	0
18	20	21	28	[illegible]	[illegible]	0	0	0
19	22	23	30	[illegible]	[illegible]	0	0	0
20	23	24	31	[illegible]	[illegible]	0	0	0
21	24	25	32	[illegible]	[illegible]	0	0	0
22	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	0
23	[illegible]	[illegible]	34	[illegible]	[illegible]	0	[illegible]	0
24	27	28	35	[illegible]	0	0	0	0
25	29	30	37	[illegible]	0	0	0	0
26	30	31	38	[illegible]	0	0	0	0
27	31	32	39	[illegible]	0	0	0	0
28	32	33	40	[illegible]	[illegible]	0	0	0
29	33	34	41	[illegible]	[illegible]	0	0	0
30	34	35	42	[illegible]	[illegible]	0	0	0
31	[illegible]	3[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
32	37	38	45	[illegible]	0	0	0	0
33	38	39	46	[illegible]	0	0	0	0
34	39	40	47	[illegible]	[illegible]	0	0	0
35	40	41	[illegible]	[illegible]		0	0	0
38	41	42	[illegible]	[illegible]	[illegible]	0	0	0

1

PROGRAM [illegible] RUN WEDG DATE 23-OCT-9

REGION	NSEQNS	NSU	NSV	SUL	SUU	SVL	SVU	IORDRU	IORDRV
1	6	3	4	0.[illegible]0000 +00	0.314159E+01	0.000000E+00	0.157080E+01	4	4
2	1	3	5	0.[illegible]0000 +00	0.5[illegible]8000E-01	0.000000E+00	0.123825E+00	4	4
3	1	[illegible]	3	0.[illegible]000[illegible] +00	0.1[illegible]3825E+00	0.000000E+00	0.508000E-01	4	4
4	1	3	3	0.[illegible]0000 +00	0.2[illegible]4000E-01	0.000000E+00	0.508000E-01	4	4
5	10	1	1	[illegible]00000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
6	10	[illegible]	[illegible]	-[illegible]0000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
7	10		[illegible]	[illegible]000[illegible]+01	0.100000[illegible]+01	-.100000E+01	0.100000E+01	4	4
8	10	1	1	-[illegible]0000[illegible]+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
9	10	1	1	-[illegible]0000[illegible]+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
10	10	1	1	[illegible]0000[illegible]+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
11	10	1	1	-[illegible]0000[illegible]+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
12	10	1	1	-[illegible]00000 +01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
13	10	1	1	-.[illegible]0000[illegible]+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
14	10	[illegible]	1	[illegible]000[illegible]+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
15	10	[illegible]	[illegible]	-[illegible]+0[illegible]	0.100000[illegible]+01	-.100000E+01	0.100000E+01	4	4

16	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
17	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
18	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
19	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
20	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
21	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
22	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
23	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
24	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
25	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
26	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
27	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
28	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
29	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
30	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
31	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
32	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
33	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
34	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
35	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
36	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
37	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
38	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
39	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
40	10	1	1	-.100000E+01	0.100000E+01	-.100000E+01	0.100000E+01	4	4
41	1	3	3	0.000000E+00	0.500000E-01	0.000000E+00	0.500000E-01	4	4

REGION - TRANSLATION (T1,T2,T3),				IZAX
1	0.000000E+00	0.000000E+00	0.000000E+00	3
2	0.000000E+00	0.000000E+00	0.286000E-01	1
3	0.000000E+00	0.000000E+00	0.286000E-01	2
4	0.000000E+00	0.000000E+00	0.000000E+00	3
5	0.000000E+00	0.000000E+00	0.000000E+00	3
6	0.000000E+00	0.000000E+00	0.000000E+00	3
7	0.000000E+00	0.000000E+00	0.000000E+00	3
8	0.000000E+00	0.000000E+00	0.000000E+00	3
9	0.000000E+00	0.000000E+00	0.000000E+00	3
10	0.000000E+00	0.000000E+00	0.000000E+00	3
11	0.000000E+00	0.000000E+00	0.000000E+00	3
12	0.000000E+00	0.000000E+00	0.000000E+00	3
13	0.000000E+00	0.000000E+00	0.000000E+00	3
14	0.000000E+00	0.000000E+00	0.000000E+00	3
15	0.000000E+00	0.000000E+00	0.000000E+00	3
16	0.000000E+00	0.000000E+00	0.000000E+00	3
17	0.000000E+00	0.000000E+00	0.000000E+00	3
18	0.000000E+00	0.000000E+00	0.000000E+00	3
19	0.000000E+00	0.000000E+00	0.000000E+00	3
20	0.000000E+00	0.000000E+00	0.000000E+00	3
21	0.000000E+00	0.000000E+00	0.000000E+00	3
22	0.000000E+00	0.000000E+00	0.000000E+00	3
23	0.000000E+00	0.000000E+00	0.000000E+00	3
24	0.000000E+00	0.000000E+00	0.000000E+00	3
25	0.000000E+00	0.000000E+00	0.000000E+00	3
26	0.000000E+00	0.000000E+00	0.000000E+00	3
27	0.000000E+00	0.000000E+00	0.000000E+00	3
28	0.000000E+00	0.000000E+00	0.000000E+00	3
29	0.000000E+00	0.000000E+00	0.000000E+00	3
30	0.000000E+00	0.000000E+00	0.000000E+00	3
31	0.000000E+00	0.000000E+00	0.000000E+00	3
32	0.000000E+00	0.000000E+00	0.000000E+00	3
33	0.000000E+00	0.000000E+00	0.000000E+00	3
34	0.000000E+00	0.000000E+00	0.000000E+00	3
35	0.000000E+00	0.000000E+00	0.000000E+00	3
36	0.000000E+00	0.000000E+00	0.000000E+00	3
37	0.000000E+00	0.000000E+00	0.000000E+00	3
38	0.000000E+00	0.000000E+00	0.000000E+00	3
39	0.000000E+00	0.000000E+00	0.000000E+00	3
40	0.000000E+00	0.000000E+00	0.000000E+00	3
41	0.000000E+00	0.000000E+00	0.000000E+00	-3

REGION - CCS

1	0.9525E-02	[illegible]	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
2	0.5080E-01	[illegible]	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
3	0.5080E-01	[illegible]	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
4	0.2540E+00	[illegible]	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
5	0.1000E+01	[illegible]	[illegible]	0.6000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
6	0.2000E+01	[illegible]	[illegible]	0.9000E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
7	0.3000E+01	[illegible]	[illegible]	0.1000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
8	0.4000E+01	0.5000E+01	[illegible]	0.1100E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
9	0.5000E+01	0.6000E+01	[illegible]	0.1200E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
10	[illegible]	[illegible]	[illegible]	0.1300E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
11	0.8000E+01	[illegible]	[illegible]	0.1500E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
12	0.9000E+01	[illegible]	[illegible]	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
13	0.1000E+02	[illegible]	[illegible]	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
14	0.1100E+02	[illegible]	[illegible]	0.1800E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
15	0.1200E+02	[illegible]	[illegible]	0.1900E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
16	0.1300E+02	[illegible]	[illegible]	0.2000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
17	0.1500E+02	[illegible]	[illegible]	0.2200E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
18	0.1600E+02	[illegible]	[illegible]	0.2300E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
19	0.1700E+02	[illegible]	[illegible]	0.2400E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
20	0.1800E+02	[illegible]	[illegible]	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
21	0.1900E+02	[illegible]	[illegible]	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
22	0.2000E+02	[illegible]	[illegible]	0.2700E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
23	0.2200E+02	[illegible]	0.3000E+02	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
24	0.2300E+02	0.2400E+02	0.3100E+02	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
25	0.2400E+02	[illegible]	0.3200E+02	0.3100E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
26	0.2500E+02	[illegible]	[illegible]	0.3200E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
27	0.2600E+02	0.2700E+02	0.3400E+02	0.3300E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
28	0.2700E+02	[illegible]	0.3500E+02	0.3400E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
29	0.2900E+02	[illegible]	[illegible]	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
30	0.3000E+02	[illegible]	[illegible]	0.3700E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
31	0.3100E+02	[illegible]	[illegible]	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
32	0.3200E+02	[illegible]	[illegible]	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
33	0.3300E+02	[illegible]	[illegible]	0.4000E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
34	0.3400E+02	[illegible]	[illegible]	0.4100E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
35	0.3600E+02	0.3700E+02	[illegible]	0.4300E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
36	0.3700E+02	0.3800E+02	0.4500E+02	0.4400E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
37	0.3800E+02	[illegible]	0.4600E+02	0.4500E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
38	0.3900E+02	[illegible]	[illegible]	[illegible]	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
39	0.4000E+02	[illegible]	[illegible]	0.4700E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
40	0.4100E+02	[illegible]	0.4900E+02	0.4800E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
41	0.2860E-01	[illegible]	0.4900E+02	0.4800E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

NO. OF SURFACE AREAS = 122   NO. OF SURFACE FIELD POINTS = 122

1

PROGRAM [illegible] 8.8   RUN WEDC   DATE 23-OCT-9

FREQUENCY= 2000.0 [illegible] 1000.0 [illegible] 1500.0

SYMMETRY TYPE= REF   NO. OF BLOCKS= 4

VELOCITIES (BLK#,AREA#, REAL,IMAG,MAG,ANG)

1	1	[illegible]	[illegible]	0.100000E+01	0.00
1	2	[illegible]	[illegible]	0.100000E+01	0.00
1	3	[illegible]	[illegible]	0.100000E+01	0.00
1	4	[illegible]	[illegible]	0.100000E+01	0.00
1	5	[illegible]	[illegible]	0.100000E+01	0.00
1	6	[illegible]	[illegible]	0.100000E+01	0.00
1	7	[illegible]	[illegible]	0.100000E+01	0.00
1	8	[illegible]	[illegible]	0.100000E+01	0.00
1	9	[illegible]	[illegible]	0.100000E+01	0.00
1	10	[illegible]	[illegible]	0.100000E+01	0.00
1	11	[illegible]	[illegible]	0.100000E+01	0.00
1	12	[illegible]	[illegible]	0.100000E+01	0.00
1	13	[illegible]	[illegible]	0.100000E+01	0.00
1	14	[illegible]	[illegible]	0.100000E+01	0.00
1	15	[illegible]	[illegible]	0.100000E+01	0.00
1	16	[illegible]	[illegible]	0.100000E+01	0.00
1	17	[illegible]	[illegible]	0.100000E+01	0.00
1	18	[illegible]	[illegible]	0.100000E+01	0.00

1	19	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	20	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	21	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	22	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	23	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	24	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	25	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	26	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	27	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	28	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	29	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	30	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	31	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	32	0.100000E+01	0.000000E+00	0.100000E+01	0.00
1	33	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	34	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	35	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	36	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	37	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	38	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	39	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	40	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	41	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	42	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	43	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	44	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	45	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	46	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	47	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	48	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	49	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	50	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	51	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	52	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	53	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	54	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	55	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	56	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	57	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	58	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	59	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	60	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	61	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	62	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	63	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	64	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	65	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	66	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	67	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	68	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	69	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	70	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	71	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	72	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	73	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	74	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	75	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	76	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	77	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	78	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	79	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	80	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	81	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	82	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	83	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	84	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	85	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	86	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	87	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	88	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	89	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	90	0.000000E+00	0.000000E+00	0.000000E+00	0.00

1	91	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	92	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	93	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	94	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	95	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	96	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	97	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	98	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	99	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	100	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	101	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	102	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	103	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	104	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	105	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	106	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	107	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	108	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	109	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	110	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	111	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	112	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	113	0.000000E+00	0.000000E+00	0.000000E+00	0.00
1	114	-0.919748E-01	-0.681887E-01	0.114495E+00	-143.45
1	115	-0.710678E-01	-0.344366E-01	0.789716E-01	-154.15
1	116	-0.495808E-01	-0.135340E-01	0.513755E-01	-164.73
1	117	-0.710671E-01	-0.344369E-01	0.789711E-01	-154.15
1	118	-0.583367E-01	-0.191611E-01	0.614030E-01	-161.82
1	119	-0.434601E-01	-0.847442E-02	0.442788E-01	-168.97
1	120	-0.495583E-01	-0.135344E-01	0.513732E-01	-164.73
1	121	-0.434585E-01	-0.847467E-02	0.442771E-01	-168.97
1	122	-0.353640E-01	-0.477029E-02	0.356843E-01	-172.32

*** FULL VELOCITY SYMMETRY ***

1

PROGRAM C H I E F 8 8   RUN WEDG   DATE 23-OCT-9

FREQUENCY= 2000.0 RHO= 1000.0 C= 1500.0

SYMMETRY TYPE= REF   NO. OF BLOCKS= 4

SURFACE PRESSURES (BLK#,AREA#, REAL,IMAG,MAG,ANG)

1	1	0.190689E+05	0.104885E+06	0.106604E+06	79.70
1	2	0.190689E+05	0.104885E+06	0.106604E+06	79.70
1	3	0.190689E+05	0.104885E+06	0.106604E+06	79.70
1	4	0.190689E+05	0.104885E+06	0.106604E+06	79.70
1	5	0.180495E+05	0.105801E+06	0.107330E+06	80.32
1	6	0.180497E+05	0.105801E+06	0.107329E+06	80.32
1	7	0.180497E+05	0.105801E+06	0.107330E+06	80.32
1	8	0.180496E+05	0.105801E+06	0.107330E+06	80.32
1	9	0.165634E+05	0.106442E+06	0.107723E+06	81.16
1	10	0.165638E+05	0.106442E+06	0.107723E+06	81.15
1	11	0.165638E+05	0.106442E+06	0.107723E+06	81.15
1	12	0.165634E+05	0.106442E+06	0.107723E+06	81.16
1	13	0.150097E+05	0.107242E+06	0.108287E+06	82.03
1	14	0.150101E+05	0.107241E+06	0.108287E+06	82.03
1	15	0.150101E+05	0.107241E+06	0.108286E+06	82.03
1	16	0.150096E+05	0.107241E+06	0.108287E+06	82.03
1	17	0.136903E+05	0.108067E+06	0.108931E+06	82.78
1	18	0.136905E+05	0.108068E+06	0.108930E+06	82.78
1	19	0.136905E+05	0.108066E+06	0.108930E+06	82.78
1	20	0.136902E+05	0.108066E+06	0.108930E+06	82.78
1	21	0.127172E+05	0.108774E+06	0.109515E+06	83.33
1	22	0.127172E+05	0.108773E+06	0.109514E+06	83.33
1	23	0.127173E+05	0.108774E+06	0.109515E+06	83.33
1	24	0.127173E+05	0.108774E+06	0.109515E+06	83.33
1	25	0.120968E+05	0.109246E+06	0.109914E+06	83.68
1	26	0.120969E+05	0.109247E+06	0.109914E+06	83.68
1	27	0.120969E+05	0.109247E+06	0.109914E+06	83.68
1	28	0.120969E+05	0.109247E+06	0.109914E+06	83.68
1	29	0.118485E+05	0.108926E+06	0.109569E+06	83.79

1	30	0.118484E+05	0.108926E+06	0.109569E+06	83.79
1	31	0.118485E+05	0.108926E+06	0.109569E+06	83.79
1	32	0.118485E+05	0.108926E+06	0.109569E+06	83.79
1	33	0.732883E+04	0.258308E+04	0.777072E+04	19.42
1	34	0.585173E+04	0.108433E+04	0.595135E+04	10.50
1	35	0.486771E+04	0.886709E+02	0.486852E+04	1.04
1	36	0.408683E+04	-0.821921E+03	0.413388E+04	-8.65
1	37	0.340278E+04	-0.114628E+04	0.359067E+04	-18.62
1	38	0.276505E+04	-0.153748E+04	0.316376E+04	-29.08
1	39	0.706355E+04	0.229893E+04	0.742824E+04	18.03
1	40	0.572969E+04	0.962305E+03	0.580994E+04	9.53
1	41	0.480182E+04	0.277307E+02	0.480190E+04	0.33
1	42	0.404604E+04	-0.655642E+03	0.409882E+04	-9.20
1	43	0.337590E+04	-0.116542E+04	0.357140E+04	-19.05
1	44	0.274827E+04	-0.154748E+04	0.315400E+04	-29.38
1	45	0.664396E+04	0.192919E+04	0.691838E+04	16.19
1	46	0.553895E+04	0.781282E+03	0.559378E+04	8.03
1	47	0.469735E+04	-0.702261E+02	0.469787E+04	-0.86
1	48	0.398068E+04	-0.712458E+03	0.404393E+04	-10.15
1	49	0.333319E+04	-0.119883E+04	0.354222E+04	-19.78
1	50	0.272385E+04	-0.156510E+04	0.314148E+04	-29.88
1	51	0.733214E+04	0.258408E+04	0.777417E+04	19.41
1	52	0.706630E+04	0.229974E+04	0.743111E+04	18.03
1	53	0.664558E+04	0.192970E+04	0.692006E+04	16.19
1	54	0.585742E+04	0.108616E+04	0.595728E+04	10.51
1	55	0.573438E+04	0.963804E+03	0.581481E+04	9.54
1	56	0.554166E+04	0.782138E+03	0.559659E+04	8.03
1	57	0.487716E+04	0.918527E+02	0.487803E+04	1.08
1	58	0.480959E+04	0.303016E+02	0.480968E+04	0.36
1	59	0.470178E+04	-0.687490E+02	0.470228E+04	-0.84
1	60	0.410283E+04	-0.616407E+03	0.414888E+04	-8.54
1	61	0.405918E+04	-0.651134E+03	0.411107E+04	-9.11
1	62	0.398815E+04	-0.709898E+03	0.405084E+04	-10.09
1	63	0.343146E+04	-0.113622E+04	0.361468E+04	-18.32
1	64	0.339943E+04	-0.115717E+04	0.359098E+04	-18.80
1	65	0.334652E+04	-0.119413E+04	0.355319E+04	-19.64
1	66	0.282[illegible]E+04	-0.151727E+04	0.320379E+04	-28.27
1	67	0.279527E+04	-0.153062E+04	0.318690E+04	-28.70
1	68	0.275083E+04	-0.155530E+04	0.316006E+04	-29.48
1	69	-0.224617E+03	-0.200137E+04	0.201393E+04	-96.40
1	70	-0.199984E+03	-0.200113E+04	0.201110E+04	-95.71
1	71	-0.130684E+03	-0.200526E+04	0.200952E+04	-93.73
1	72	-0.199928E+03	-0.200538E+04	0.201533E+04	-95.69
1	73	-0.177450E+03	-0.200476E+04	0.201259E+04	-95.06
1	74	-0.114588E+03	-0.200740E+04	0.201067E+04	-93.27
1	75	-0.145792E+03	-0.202984E+04	0.203487E+04	-94.11
1	76	-0.127149E+03	-0.202835E+04	0.203233E+04	-93.59
1	77	-0.769867E+02	-0.202799E+04	0.202945E+04	-92.17
1	78	0.230584E+04	-0.176759E+04	0.290539E+04	-37.47
1	79	0.186816E+04	-0.192666E+04	0.268366E+04	-45.88
1	80	0.145415E+04	-0.203076E+04	0.249770E+04	-54.40
1	81	0.106272E+04	-0.208606E+04	0.234116E+04	-63.00
1	82	0.692089E+03	-0.209777E+04	0.220899E+04	-71.74
1	83	0.336047E+03	-0.207086E+04	0.209795E+04	-80.78
1	84	0.228388E+04	-0.177605E+04	0.289318E+04	-37.87
1	85	0.185141E+04	-0.193147E+04	0.267550E+04	-46.21
1	86	0.144146E+04	-0.203328E+04	0.249240E+04	-54.67
1	87	0.105353E+04	-0.208721E+04	0.233803E+04	-63.22
1	88	0.686285E+03	-0.209820E+04	0.220758E+04	-71.89
1	89	0.333962E+03	-0.207028E+04	0.209704E+04	-80.84
1	90	0.223927E+04	-0.179308E+04	0.286870E+04	-38.69
1	91	0.181595E+04	-0.194219E+04	0.265890E+04	-46.92
1	92	0.141375E+04	-0.204026E+04	0.248221E+04	-55.28
1	93	0.103309E+04	-0.209267E+04	0.233378E+04	-63.73
1	94	0.672972E+03	-0.210494E+04	0.220990E+04	-72.27
1	95	0.328845E+03	-0.208215E+04	0.210798E+04	-81.03
1	96	0.214204E+04	-0.183110E+04	0.281802E+04	-40.53
1	97	0.171250E+04	-0.197426E+04	0.261350E+04	-49.06
1	98	0.131466E+04	-0.206216E+04	0.244558E+04	-57.48
1	99	0.941758E+03	-0.210342E+04	0.230462E+04	-65.88
1	100	0.590665E+03	-0.210391E+04	0.218525E+04	-74.32
1	101	0.256657E+03	-0.206788E+04	0.208374E+04	-82.92

1	102	0.214018E+04	-0.183033E+04	0.281611E+04	-40.54
1	103	0.169623E+04	-0.197963E+04	0.260693E+04	-49.41
1	104	0.129266E+04	-0.206865E+04	0.243932E+04	-58.00
1	105	0.917178E+03	-0.210939E+04	0.230015E+04	-66.50
1	106	0.564417E+03	-0.210880E+04	0.218303E+04	-75.02
1	107	0.226739E+03	-0.207149E+04	0.208386E+04	-83.75
1	108	0.214650E+04	-0.182729E+04	0.281894E+04	-40.41
1	109	0.169558E+04	-0.198024E+04	0.260698E+04	-49.43
1	110	0.128817E+04	-0.207080E+04	0.243877E+04	-58.12
1	111	0.910571E+03	-0.211201E+04	0.229994E+04	-66.68
1	112	0.556222E+03	-0.211142E+04	0.218346E+04	-75.24
1	113	0.216311E+03	-0.207386E+04	0.208511E+04	-84.05
1	114	0.275924E+05	0.204566E+05	0.343485E+05	36.55
1	115	0.213203E+05	0.103310E+05	0.236915E+05	25.85
1	116	0.148682E+05	0.406019E+04	0.154126E+05	15.27
1	117	0.213201E+05	0.103311E+05	0.236913E+05	25.85
1	118	0.175010E+05	0.574834E+04	0.184209E+05	18.18
1	119	0.130380E+05	0.254233E+04	0.132836E+05	11.03
1	120	0.148675E+05	0.406031E+04	0.154120E+05	15.27
1	121	0.130376E+05	0.254240E+04	0.132831E+05	11.03
1	122	0.106092E+05	0.143109E+04	0.107053E+05	7.68

*** FULL VELOCITY SYMMETRY ***

POWER OUT(KW)= 0.003

Sample Run 3: Conical Source With Circular Planar Baffle Radiation Matrix

The geometry for this problem was generated using DISPLAY3D[4], which is available to all CHIEF users. Run 3 computes a radiation matrix using both the subroutines ZRADMX and ZRADMI since the circular planar baffle has an impedance coating. Also the cone is a new surface in CCUNMD.

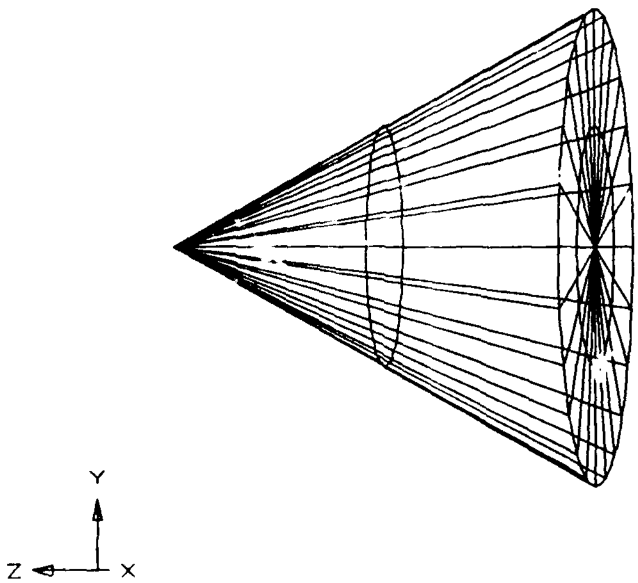

Fig. 4. A radiating cone with a circular planar baffle.

Program Listing of Sample Run 3

```
C     Program CONE
C  Example Problem of a cone topped by an impedance surface

C  (COMMON VARIABLE DECLARATIONS GO HERE)

      COMPLEX PMATX(  152), VMATX(  152)
      MDSIZE =   152
      RUNID  = 'CONE'
      DATE   = '25-FEB-91'
      CALL INITCH
      CALL OPNSFL
      RHO    = 1000
      C      = 1500

C*************** impedance coating modifications ***************
      NUMZ   =      4
      N = 1
```

```
C ---- clear impedance for The Cone
      DO  10 I = N, N + (2    * 2  ) - 1
         ZCOAT(I) = CMPLX(0.0, 0.0)
 10   CONTINUE
      N   N +  (2    * 2  )

C     - ICKS imp   - for Circular Imp. Cap
      DO  20 I = N, N + (2    * 2  ) - 1
         ZCOAT(I) = CMPLX(          , 1.0E+4     )
 20   CONTINUE
      N = N + (2    * 2  )

C*********** end of impedance co   ng modifications ************

      OPEN(UNIT=NUNP T,FILE=RUNID/,   OUT',STATUS='NEW',
     1      FORM='FORMATTED')


C  symmetry inputs

      PI      = ACOS(-1.0)

      SYMTYP  = 'ROT'
      NBLKS   = 12
      IRHSYM  = 1
      CONV      .0

C  Surface Region Inputs

      ROTDIM  = PI / NBLKS
      XIRG    = 0

      DO 1 I = 1, 10
         CC(I) = 0.0
1     CONTINUE

      DO 2 I = 1, 3
         TRNS(I) = 0.0
2     CONTINUE

C -------- The Cone              ---------

      XNSEQNS =13
      CC( 1)   =  1            * CONVERT
      CC( 2)   =  2            * CONVERT
      TRNS(1)  = (0.00E+00) * CONVERT
      TRNS(2)    (0.00E+00) * CONVERT
      TRNS(3)  = (0.00E+00) * CONVERT
      XIZAX    = +3
      XSUL     = -0.26160
      XSUU     = 0.26180
      XSVL     = 0
      XSVU     =  2            * CONVERT
      XNSU     = 2
      XNSV     = 2
      XIORDU     4
      XIORDV   = 4
      XIRG = XIRG + 1
      CALL LDSURR(XIRG, XNSEQNS, CC, TRNS, XIZAX,
     1               XSUL, XSUU, XSVL, XSVU, XNSU, XNSV, XIORDU, XIORDV)
C -------- Circular Imp. Cap     ---------

      XNSEQNS = 2
      CC( 1      3             * CONVERT
      TRNS(1)  = (0.00E+00) * CONVERT
      TRNS(2)  - (0.00E+00) * CONVERT
      TRNS(3)    (0.00E+00) * CONVERT
      XIZAX    = +3
      XSUL     - 0            * CONVERT
      XSUU     -  1           * CONVERT
      XSVL     -  0.26.50
      XSVU        0.26180
```

```
      XNSU    = 2
      XNSV    = 2
      XIORDU  = 4
      XIORDV  = 4
      XIRG = XIRG + 1
      CALL LDSURR(XIRG, XNSEQNS, CC, TRNS, XIZAX,
     1            XSUL, XSUU, XSVL, XSVU, XNSU, XNSV, XIORDU, XIORDV)

      NSREG = XIRG

C      CALL PLOTCHIEF(RUNID, NBLKS, SYMTYP, 1, 30.0, 60.0, 0.0)

C  Define Frequency input.

      FREQ   = 100

C  Generate surface P and V matrices.

      CALL SURMAT(FREQ, SYMTYP, NBLKS, PMATX, VMATX, MDSIZE)

C  Decompose Matrices

      CALL DECOMM(SYMTYP, NBLKS, IRHSYM, PMATX, VMATX, MDSIZE)
      CALL IOSUB(NDVELS, 10, VEL, 0)
C  Block # 1
      VEL(  1) = (1.0000, 0.0000)
      VEL(  2) = (1.0000, 0.0000)
      VEL(  3) = (1.0000, 0.0000)
      VEL(  4) = (1.0000, 0.0000)
      VEL(  5) = (0.0000, 0.0000)
      VEL(  6) = (0.0000, 0.0000)
      VEL(  7) = (0.0000, 0.0000)
      VEL(  8) = (0.0000, 0.0000)
      CALL IOSUB(NDVELS, 1, VEL, NWDVEC)

C  Generate Surface Pressures.

      CALL SURPRS(FREQ, SYMTYP, NBLKS, IRHSYM, PMATX, VMATX, MDSIZE)

      FLDTYP = 'FAR '
      NUMTHP =  19
      DO 25 I = 1, NUMTHP
         THTPHI(1, I) = (I - 1) * 5
         THTPHI(2, I) = 0.0
25    CONTINUE

C  Calculate FAR Field Matrices
      CALL FLDMAT(FREQ, SYMTYP, FLDTYP, NBLKS, PMATX, VMATX, MDSIZE)

      IFFNRM =  19

C  Calculate Far-Field Pressures.
      CALL FLDPRS(FREQ, FLDTYP, NBLKS, IRHSYM, PMATX, VMATX, MDSIZE)

      CALL PRTOUT(FLDTYP, 0)

      STOP
      END
```

Output Listing of Sample Run 3

```
 FREQUENCY=   100.0  RHO=  1000.0  C=  1500.0

 SYMMETRY TYPE= ROT      NO. OF BLOCKS= 12

 FAR-FIELD PRESSURES ( PHI,THETA,FFP(RL,IM,MAG,ANG)    ,            NORMALIZED PATTERN, SOURCE LEVEL, DI )

    0.00     0.00  -.186832E+03  0.310326E+04  0.310888E+04    93.45        0.02
    0.00     5.00  -.186244E+03  0.310326E+04  0.310885E+04    93.43        0.02
    0.00    10.00  -.184483E+03  0.310328E+04  0.310875E+04    93.40        0.02
```

0.00	15.00	-.181564E+03	0.310330E+04	0.310860E+04	93.35	0.02		
0.00	20.00	-.177508E+03	0.310332E+04	0.310839E+04	93.27	0.01		
0.00	25.00	-.172346E+03	0.310335E+04	0.310813E+04	93.18	0.01		
0.00	30.00	-.166118E+03	0.310338E+04	0.310782E+04	93.06	0.01		
0.00	35.00	-.158870E+03	0.310341E+04	0.310748E+04	[illegible]	0.01		
0.00	40.00	-.150659E+03	0.310344E+04	0.310710E+04	92.78	0.01		
0.00	45.00	-.141546E+03	0.310346E+04	0.310669E+04	92.61	0.01		
0.00	50.00	-.131601E+03	0.310348E+04	0.310627E+04	92.43	0.01		
0.00	55.00	-.120899E+03	0.310348E+04	0.310583E+04	92.23	0.01		
0.00	60.00	-.109523E+03	0.310347E+04	0.310540E+04	92.02	0.01		
0.00	65.00	-.975579E+02	0.310344E+04	0.310498E+04	91.80	0.01		
0.00	70.00	-.850956E+02	0.310340E+04	0.310456E+04	91.57	0.00		
0.00	75.00	-.722307E+02	0.310335E+04	0.310417E+04	91.33	0.00		
0.00	80.00	-.590613E+02	0.310325E+04	0.310381E+04	91.09	0.00		
0.00	85.00	-.456876E+02	0.310314E+04	0.310348E+04	90.84	0.00		
0.00	90.00	-.322114E+02	0.310301E+04	0.310318E+04	90.59	0.00 *	189.8	-0.60

* DIRECTION FOR PATTERN NORMALIZATION

LIMITATIONS

The following existing features of CHIEF have not been addressed in the context of a partially impedance coated radiator:

- <u>Point source check</u>. There seems to be no reason that this option cannot be used in its unmodified form; the results from the modified CHIEF program supply the actual surface velocities all over the radiator which will aid one in assigning relative strengths to the hypothetical point sources.

- <u>Radiator in an infinite rigid baffle</u>. This feature has not been modified for the case of an impedance coated baffle; furthermore, the Green's function used in the existing formulation of this problem is applicable only to the case of an infinite-plane, rigid baffle.

- <u>Scattering problems</u>. This feature has not been modified for the case of a partially or totally impedance-coated scatterer; the present development in CHIEF is applicable only to rigid scatterers.

The following feature of CID exists for a partially impedance coated radiator:

- Impedance symmetry must be the same as body, even if there is no velocity symmetry.

ACKNOWLEDGMENTS

The authors wish to thank Dr. Michele McCollum for her many valuable comments. Also thanks to Mitch Bolling and Patrick Klippel for programming and verifying the CHIEF and CID modifications.

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APPENDIX A - THEORETICAL CONSIDERATION

A1: Basic Equations for Impedance Surfaces

The CHIEF program develops a matrix equation for the unknown surface pressure P of the form

$$[A]P = [B]V. \tag{A1.1}$$

Assuming the frequency is not at or near one of the so-called forbidden frequencies where the coefficient matrix A becomes ill-conditioned, or in fact its determinant vanishes, then one can solve Eq. (A1.1) for the surface pressure P. Now knowing both P and V on the surface of the radiator, CHIEF proceeds to compute the radiated pressure field at any point external to the surface; in particular, one usually wishes to know the far-field pressure distribution.

Now consider a radiator part whose surface has a prescribed normal velocity V_R while the remainder, Region I, is coated with the arbitrary complex locally reacting impedance layer Z. Neither of these regions need be a single contiguous region; i.e., the active and the impedance-coated areas could be a number of noncontiguous or, in fact, even disjoint surfaces. The subscripts R and I merely indicate a convenient subdivision of the problem into the two different boundary condition regions. Accordingly, matrix Eq. (A1.1) can be partitioned as follows:

$$\begin{bmatrix} A_{RR} & A_{RI} \\ A_{IR} & A_{II} \end{bmatrix} \begin{bmatrix} P_R \\ P_I \end{bmatrix} = \begin{bmatrix} B_{RR} & B_{RI} \\ B_{IR} & B_{II} \end{bmatrix} \begin{bmatrix} V_R \\ V_I \end{bmatrix} . \tag{A1.2}$$

Note that the impedance-coated regions are relegated to the bottom positions in the matrix equation, a choice that is followed throughout this discussion and in the modifications of the computer code. There would appear to be three sets of unknown quantities in Eq. (A1.2), the pressures P_R and P_I as well as the velocity V_I; i.e., only velocity V_R has been specified. However, while neither P_I nor V_I is known, their ratio defines, or is defined by, the impedance coating on Region I as

$$P_I/V_I = - Z. \tag{A1.3}$$

The minus sign in this equation deserves some discussion. Impedance (specific acoustic impedance) is defined as the ratio of the pressure acting on the material to the particle velocity flowing into the material. However, the development inherent in program CHIEF assumes that the positive direction of the velocity is outward from the radiator into the surrounding medium. Hence, to use the velocity designation implicit in CHIEF in the impedance definition, the minus sign is required. *[The authors wish to acknowledge particularly valuable personal communication on this subject with Professor Alan Pierce, Department of Mechanical Engineering, Pennsylvania State University.]*

Equation (A1.3) can be used to eliminate either of the unknowns P_I or V_I from Eq. (A1.2) as a function of the other. It seems more appropriate to eliminate P_I since the opposite choice would entail a division by Z and it is recognized that $Z = 0$ is a value to be used in the subsequent calculations. Accordingly, one may reformulate the matrix equation for unknown surface quantities as

$$\begin{bmatrix} A_{RR} & (-A_{RI}Z-B_{RI}) \\ A_{IR} & (-A_{II}Z-B_{II}) \end{bmatrix} \begin{bmatrix} P_R \\ V_I \end{bmatrix} = \begin{bmatrix} B_{RR} & 0 \\ B_{IR} & 0 \end{bmatrix} \begin{bmatrix} V_R \\ 0 \end{bmatrix} . \qquad (A1.4)$$

As this is formally the same as Eq. (A1.2), one may proceed to have the existing routines of CHIEF solve this modified set of equations. Once P_R and V_I are known, P_I is obtained from Eq. (A1.3). The now known surface pressure and velocities are resorted back into their respective array positions, and CHIEF proceeds from this point with the calculation of the pressure at points exterior to the radiator surface in the usual manner.

In this development, the non active portions of the surface of the vibrator are assumed to be coated with a true locally reacting impedance material which creates a boundary condition at those surfaces as described by Eq. (A1.3). This impedance can have a value (real, imaginary, or complex) from zero (perfect pressure release material) to the largest value the computer in question can accept (which approximates a rigid boundary). It should be noted, in particular, that specifying this impedance value to equal the characteristic impedance of the medium does not mean that those portions of the boundary behave as if they were acoustically transparent; i.e., because this boundary condition does not guarantee continuity of both pressure and normal particle velocity at the interface between the medium and the impedance coating, there will be reflections from the boundary even though the impedance value matches the characteristic impedance of the medium, unless the boundary is effectively planar in shape.

A2: Radiation Impedance Matrix

The radiation impedance matrix (Z_{RAD}) relates the forces and velocities on the various subdivisions as follows

$$\underset{\sim}{F} = [Z_{RAD}]\underset{\sim}{v} \qquad (A2.1)$$

However when part of a radiator, Region R, has a normal velocity $\underset{\sim}{v}_R$ while the remaining K surfaces, Region I, are coated with the arbitrary complex locally reacting impedance layer, Eq. (A2.1) can be written as

$$\begin{Bmatrix} \underset{\sim}{F}_R \\ \underset{\sim}{F}_I \end{Bmatrix} = \begin{bmatrix} [Z_{RR}] & [Z_{RI}] \\ [Z_{IR}] & [Z_{II}] \end{bmatrix} \begin{Bmatrix} \underset{\sim}{v}_R \\ \underset{\sim}{v}_I \end{Bmatrix} . \qquad (A2.2)$$

The subscripts R and I merely indicate a convenient subdivision of the problem into the two different boundary condition regions.

The radiating force is derived from Eq. (A2.2) as

$$\underset{\sim}{F}_R = [Z_{RR}]\underset{\sim}{v}_R + [Z_{RI}]\underset{\sim}{v}_I \quad . \tag{A2.3}$$

In order to determine the radiation impedance matrix for a partially coated radiator, one must write Eq. (A2.3) in the form of Eq. (A2.1). One approach is to write $\underset{\sim}{v}_I$ as a function of $\underset{\sim}{v}_R$. By substituting the equivalent form of $\underset{\sim}{v}_I$ in Eq. (A2.3), a product of $\underset{\sim}{v}_R$ and the desired radiation matrix results.

Therefore the first step is to reformulate the velocities of the impedance surfaces $\underset{\sim}{v}_I$. Because the individual terms of the matrices are needed, summation notation will be used.

For the impedance surface, the force takes the form

$$F_i = \sum_r Z_{ir} \; v_r + \sum_p Z_{ip} \; v_p, \tag{A2.4}$$

where i and p vary from (N - K + 1) to N and r varies from 1 to N - K. Note that v_r is the velocity of the radiating surface and v_i is the velocity of the impedance layer.

With the new modified CHIEF program a complex impedance quantity (Z_i) is specified such that

$$F_i = -Z_i v_i . \tag{A2.5}$$

Setting the right sides of Eqs. (A2.4) and (A2.5) equal to one another, we get

$$-Z_i v_i = \sum_r Z_{ir} \; v_r + \sum_p Z_{ip} \; v_p \quad . \tag{A2.6}$$

Upon bringing the term on the left side of Eq. (A2.6) under the summation sign and rearranging, the following equation results

$$\sum_p (-Z_{ip} - \delta_{pi} Z_p) v_p = \sum_r Z_{ir} v_r \; , \tag{A2.7}$$

where $\delta_{pi} = 1$ if $p = i$ and $\delta_{pi} = 0$ if $p \neq i$. Equation (A2.7) relates the velocities on the impedance surfaces to the velocities of the radiating surfaces and can be rewritten in matrix notation in the following way

$$\left\{ -[Z_{II}] - \begin{bmatrix} Z^{\sim}_{N-K+1} & & 0 \\ & \ddots & \\ 0 & & Z^{\sim}_{N} \end{bmatrix} \right\} \underset{\sim}{v}_I = [Z_{IR}]\underset{\sim}{v}_R, \qquad \text{(A2.8)}$$

where $Z^{\sim}$ is the prescribed complex impedance; i.e., Z_i of Eq. (A2.5). Equation (A2.8) can be simplified in the form

$$-[\overline{Z_{II}}]\underset{\sim}{v}_I = [Z_{IR}]\underset{\sim}{v}_R \qquad \text{(A2.9)}$$

or

$$\underset{\sim}{v}_I = -[\overline{Z_{II}}]^{-1}[Z_{IR}]\underset{\sim}{v}_R. \qquad \text{(A2.10)}$$

Substituting $\underset{\sim}{v}_I$ [Eq. (A2.10)] into Eq. (A2.3), we obtain

$$\underset{\sim}{F}_R = [Z_{RR}]\underset{\sim}{v}_R - [Z_{RI}][\overline{Z_{II}}]^{-1}[Z_{IR}]\underset{\sim}{v}_R \qquad \text{(A2.11)}$$

or

$$\underset{\sim}{F}_R = \left\{[Z_{RR}] - [Z_{RI}][\overline{Z_{II}}]^{-1}[Z_{IR}]\right\}\underset{\sim}{v}_R. \qquad \text{(A2.12)}$$

Equation (A2.12) can be abbreviated as

$$\underset{\sim}{F}_R = \{Z_{RAD}\}\underset{\sim}{v}_R, \qquad \text{(A2.13)}$$

where Z_{RAD} is the desired radiation impedance matrix.

APPENDIX B - CID SCREENS

B1: Cone

The screen shown in Fig. B1.1 gives the geometry description for a conical surface. Most of the screen is self explanatory except for a few items. The cone is rotated about the X3 axis with the point of the cone in the +X3 direction. In order to flip the cone about the X1, X2 plane, the maximum cone height must be negative. The minimum cone height is always set to zero. The cone is located at the (0,0,0) position and can be relocated by changing the local origin.

B2: Impedance Surfaces

Figures B2.1, B2.2, and B2.3 relate to the CHIEF impedance surface modification. Figure B2.1 looks like the CID screen of the previous revision with the exception of the "IMPEDANCE DEFS" entry. When the prompt is placed on this entry, the screen shown in Fig B2.2 appears. The user can pick any surface to be an impedance surface. The letter "I" will appear to the left of each surface description that has been selected. Furthermore, if there are any surfaces after the one selected, they will automatically be impedance surfaces and the letter "I" will also appear to the left of these surfaces. When the "EXIT" entry is chosen in the screen shown in Fig B2.2, the user's screen is updated to the screen shown in Fig B2.3.

The screen shown in Fig. B2.3 appears for every surface that was selected as an impedance surface from the previous screen (Fig. B2.2). The user has the option of selecting one impedance for an entire region or selecting several different impedances. If different impedances are selected for a region, the user has to indicate which subdivision is the first to have an impedance coating. The velocity corresponding to the impedance subdivisions is automatically set to zero in the driver program by the CID program. The CHIEF program calculates the velocities of the impedance surfaces and replaces the zeros in the velocity vector with the calculated values.

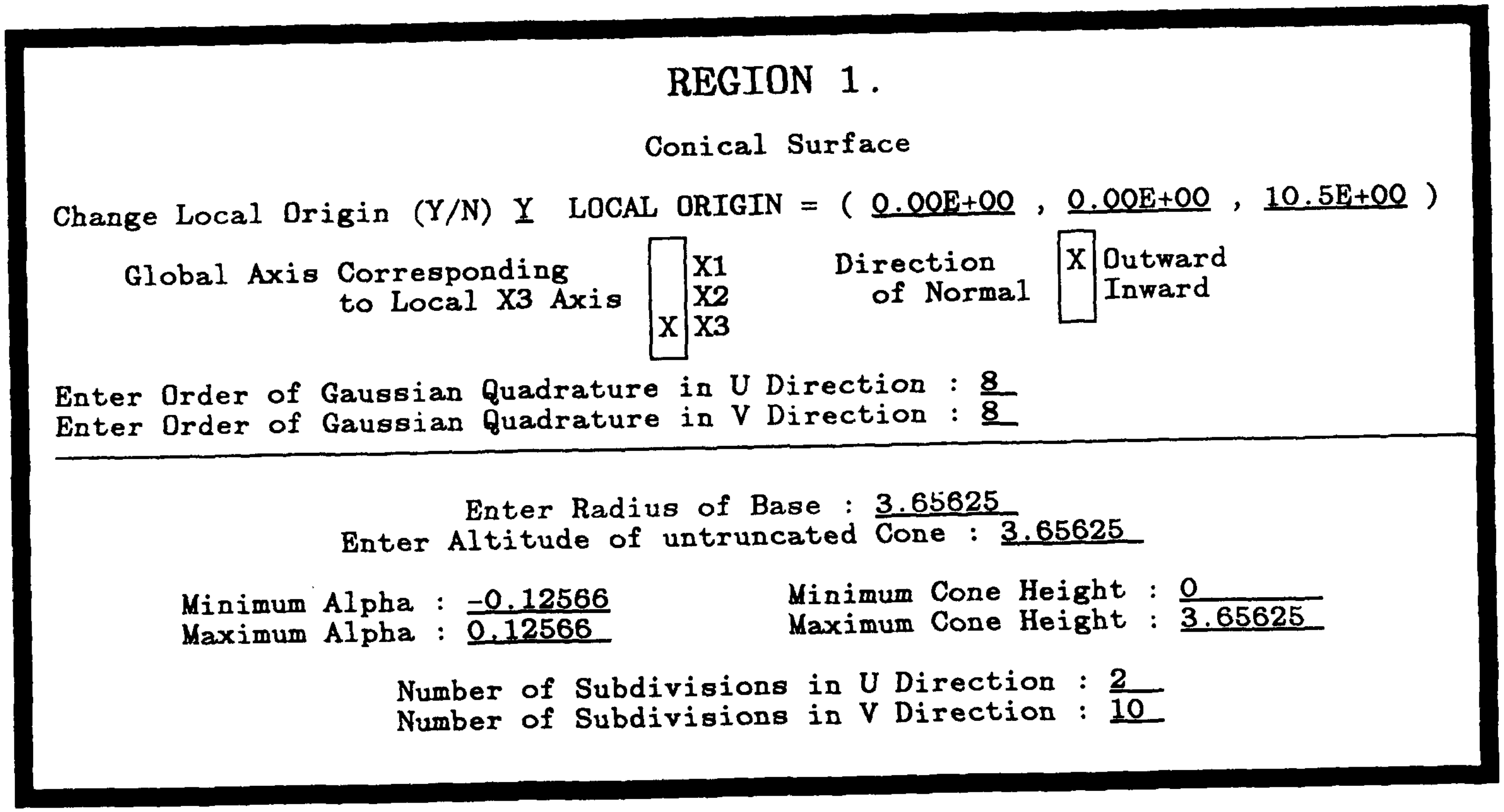

Fig. B1.1. CID screen for conical geometry.

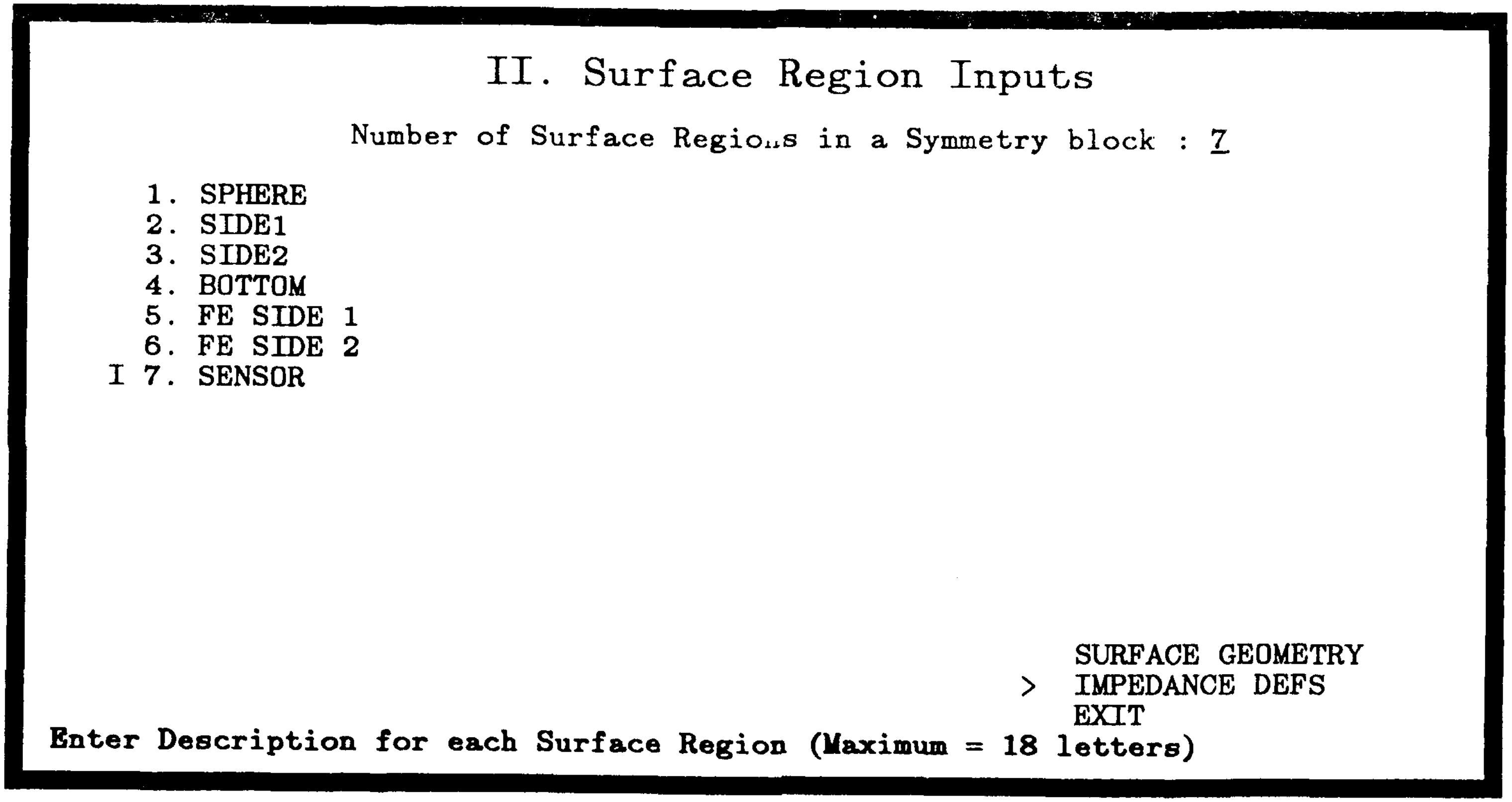

Fig. B2.1. CID screen for selecting impedance surfaces option.

```
                    II. Surface Region Inputs

        Number of Surface Regions in a Symmetry block : 7

     1. SPHERE
     2. SIDE1
     3. SIDE2
     4. BOTTOM
     5. FE SIDE 1
     6. FE SIDE 2
 > I 7. SENSOR


                                                    EXIT

Note:  Impedance Layer Surface(s) must be last.
Press <RETURN> to define/undefine as an Impedance Layer.
```

Fig. B2.2. CID screen for selecting which surfaces will have a prescribed impedance.

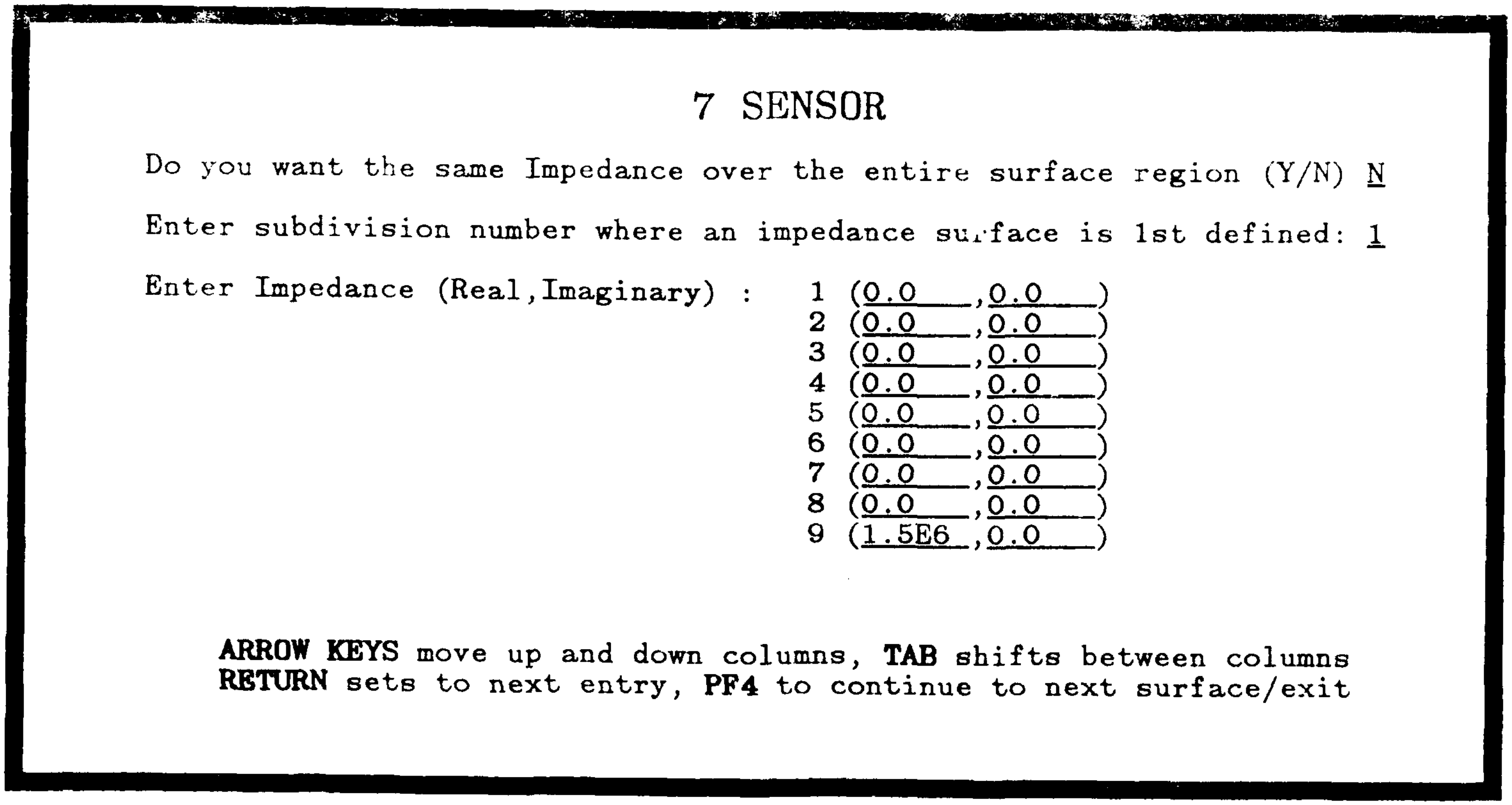

Fig. B2.3. CID screen for inputting the complex impedance.

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APPENDIX C - PROGRAM LISTINGS

C1: SURMAT

The subroutine SURMAT generates the matrices A and B of Eq. (A1.4). In addition to the new variable declarations

```
COMMON/COATING/ZCOAT NUMZ
COMPLEX ZCOAT(500),
```

the only other modification is to call the new subroutine **MTXSWZS**.

```
C----------------------------------------------------------------------
C
C  CHIFF  Version 3.10  8-FEB-1991
C
C----------------------------------------------------------------------

      SUBROUTINE SURMAT(FREQ,SYMTYP,NBLKS,PMATX,VMATX,MTXDIM)

C     GENERATION OF P AND V SURFACE MATRICES

C 17 Sep 1990 - impedance coating modifications made by DMB

      PARAMETER (MXSREG=500)
      PARAMETER (MXIPS=20)
      PARAMETER (MXA[illegible]=530)
      PARAMETER (MXGAUS=6[illegible])
      PARAMETER (MXQPTS=512)
      PARAMETER (MXBLKS=100)
      PARAMETER (MXFFP=[illegible])
      PARAMETER (MXNFP=361)

C     ****
      PARAMETER (MXFPS=520)
C     PARAMETER (MXFPS=MAX0(MXARS+MXIPS,MXFFP,MXNFP))
C     ***

      COMPLEX PMATX(MTXDIM), VMATX(MTXDIM)

      CHARACTER*3 SYMTYP

      COMMON/CONST/RHO,C
      COMMON/PRTCOM/NUNPRT,NUNERR

C 3 Jan 1991 - added temporary logical unit numbers NTEMPVEL, NTEMP1 - NTEMP3.

      COMMON/NDASG/NDQPTS,NDPMXS,NDVMXS,NDDECM,NDVELS,NDSPS,
     *             NDPMXF NDVMXF,NDPMXN,NDVMXN,NDPSSP,NDEXPR,NDCOMV,
     *             NDTEMP,NDZRDB,NDPATB,NTMPVEL,NTEMP1 NTEMP2,NTEMP3
      COMMON/SVALS/NSREG,NSEQNS(MXSREG),SUL(MXSREG),SUU(MXSREG),
     *             SVL(MXSREG),SVU(MXSREG),NSU(MXSREG),NSV(MXSREG),
     *             CC[illegible],MXSREG),TRNSS(3,MXSREG),IZAX(MXSREG),
     *             IORDU(MXSREG),IORDV(MXSREG),NCCEQS
      COMMON/IPTS/NUMIPS,IPXS(3,MXIPS)
      REA[illegible]

      COMMON/QPTS/QPS(7,MXQPTS)
      COMMON/GAUSNS/WXGAUS(MXGAUS),ROOTU(MXGAUS),ROOTV(MXGAUS),
     *              WTUV(MXGAUS+1,2)
      COMMON/FL[illegible]/FPBKI(4,MXFPS),FPC(4,MXFPS)

      COMMON/WORK/VEC1(MXARS),VEC2(MXBLKS),VEC3(MXBLKS),VEC4(MXBLKS),
     *            VEC5(MXFPS),VEC8(MXFPS)
      COMPLEX VEC2,VEC3,VEC4,VEC5,VEC8
      DIMENSION FACTRS(MXARS)
      EQUIVALENCE (FACTRS(1),VEC1(1))
```

```
      COMMON/PRGVLS/NDIMPV,NUMARS,NUMSFP,NUMFFP,NUMNFP,NWDVEC
      COMMON/SURARS/AREAS(MXARS)
      COMMON/TAPREC/RECRD(10),IRECRD(30)
      COMMON/TAPRC1/ARECRD(10)

C*********** impedance coating modifications - 17 Sep 1990 *************
      COMMON / COATING / ZCOAT, NUMZ
      COMPLEX ZCOAT(MXARS)
C***********************************************************************

      CHARACTER*4 ARECRD

      COMPLEX JRHOWP
C
C     SURMAT ERROR CHECKS
C
      IERR=0

      IF (NSREG.GT.MXSREG.OR.NSREG.LE.0) THEN
        IERR=2
        WRITE(NUNERR,1001)NSREG
1001    FORMAT(/,' ERROR IN SURMAT - NSREG=',I6)
      END IF
      IF (NBLKS.GT.MXBLKS.OR.NBLKS.LE.0) THEN
        IERR=1
        WRITE(NUNERR,1002)NBLKS
1002    FORMAT(/,' ERROR IN SURMAT - NBLKS=',I6)
      END IF
      IF (SYMTYP.NE.'REF'.AND.SYMTYP.NE.'ROT') THEN
        IERR=1
        WRITE(NUNERR,1003)SYMTYP
1003    FORMAT(/,' ERROR IN SURMAT - SYMTYP= ',A3)
      END IF
      IF (NUMIPS.GT.MXIPS.OR.NUMIPS.LT.0) THEN
        IERR=1
        WRITE(NUNERR,1004)NUMIPS
1004    FORMAT(/,' ERROR IN SURMAT - NUMIPS=',I6)
      END IF

      IF (IERR.EQ.2) STOP

      NAR=0
      DO 1110 I=1,NSREG
      NAR=NAR+NSU(I)*NSV(I)
      IF (NSEQNS(I).GT.NCCEQS.OR.NSEQNS(I).LE.0) THEN
        IERR=1
        WRITE(NUNERR,1006)I,NSEQNS(I)
1006    FORMAT(/,' ERROR IN SURMAT - REG#,NSEQNS=',2I6)
      END IF
      IZABS=IABS(IZAX(I))
      IF (IZABS.GT.3.OR.IZABS.EQ.0) THEN
        IERR=1
        WRITE(NUNERR,1007)I,IZAX(I)
1007    FORMAT(/,' ERROR IN SURMAT - REG#,IZAX=',2I6)
      END IF
      IF (NSU(I)*NSV(I).LE.0) THEN
        IERR=1
        WRITE(NUNERR,1008)I,NSU(I),NSV(I)
1008    FORMAT(/,' ERROR IN SURMAT - REG#,NSU,NSV-',3I6)
      END IF
      IORDRU=IORDU(I)
      IORDRV=IORDV(I)
      IF (IORDRU.GT.MXGAUS.OR.IORDRV.GT.MXGAUS.OR.IORDRU*IORDRV
     *          .GT.MXQPTS.OR.IORDRU*IORDRV.LE.0) THEN
        IERR=1
        WRITE(NUNERR,1009)I,IORDRU,IORDRV
1009    FORMAT(/,' ERROR IN SURMAT - REG#,IORDRU,IORDRV=',3I6)
      END IF
1110  CONTINUE

      IF (NAR.GT.MXARS.OR.NAR.LE.0) THEN
```

```
        IERR=1
        WRITE(NUNERR,1111)NAR
1111    FORMAT(/,' ERROR IN SURMAT - #OF AREAS=',I10)
      END IF
      NFP=NAR+NUMIPS
      IF (NFP.GT.MXFPS.OR.NFP.LE.0) THEN
        IERR=1
        WRITE(NUNERR,1112)NFP
1112    FORMAT(/,' ERROR IN SURMAT - #OF FIELD POINTS=',I10)
      END IF
      MTXT=NAR+NFP
      IF (MTXT.GT.MTXDIM.OR.MTXT.LE.0) THEN
        IERR=1
        WRITE(NUNERR,1113)MTXT
1113    FORMAT(/,' ERROR IN SURMAT - ',I10,' WORDS NEEDED FOR P,V')
      END IF

      IF (IERR.NE.0) STOP

      PI=ACOS(-1.0)
      TWOPI=2.0*PI
      FOURPI=4.0*PI
      ROMEGA=TWOPI*FREQ
      JRHOWP=CMPLX(0.0,ROMEGA*RHO)/FOURPI
      SMALLK=ROMEGA/C
      NDIMPV=MTXDIM

C                COMPUTE QUADRATURE POINTS FOR EACH SURFACE SUBDIVISION(AREA)
C                   STORE ON FILE/UNIT NDQPTS
C                COMPUTE FIELD POINT FOR EACH SURFACE AREA AND INTERIOR POINT
C                   STORE IN ARRAY FPBK1

      CALL IOSUB(NDQPTS,10,QPS,0)
      ISUB=0

      DO 10 I=1,NSREG
      CALL GAUSS(IORDU(I),ROOTU,WTUV(1,1),WKGAUS)
      WTUV(MXGAUS+1,1)=IORDU(I)
      CALL GAUSS(IORDV(I),ROOTV,WTUV(1,2),WKGAUS)
      WTUV(MXGAUS+1,2)=IORDV(I)

      DELSU=(SUU(I)-SUL(I))/NSU(I)
      DELSV=(SVU(I)-SVL(I))/NSV(I)
      HDELSU=0.5*DELSU
      HDELSV=0.5*DELSV
      FACTI=HDELSU*HDELSV
      UAVE=HDELSU+SUL(I)
      DO 8 J=1,NSU(I)
      VAVE=HDELSV+SVL(I)
      DO 6 K=1,NSV(I)
      ISUB=ISUB+1
      FACTRS(ISUB)=FACTI

      CALL QPTGEN(UAVE,VAVE,HDELSU,HDELSV,NSEQNS(I),CCS(1,I),
     *            TRNSS(1,I),IZAX(I),IORDU(I),IORDV(I),ROOTU,ROOTV,QPS)

      CALL IOSUB(NDQPTS,1,WTUV,2*(MXGAUS+1))
      CALL IOSUB(NDQPTS,1,QPS,7*IORDU(I)*IORDV(I))
      CALL CCUNMD(UAVE,VAVE,NSEQNS(I),CCS(1,I),TRNSS(1,I),IZAX(I),
     *            FPCK1(1,ISUB),FPBK1(2,ISUB),FPBK1(3,ISUB),D1,D2,D3,DDJ,0)

6     VAVE=VAVE+DELSV
8     UAVE=UAVE+DELSU
10    CONTINUE

      NUMARS=ISUB
      NUMFPS=ISUB
      NWDVEC=2*NUMARS

      IF(NUMIPS.NE.0) THEN
        DO 20 J=1,NUMIPS
```

```
         ISUB=ISUB+1
         DO 15 I=1,3
15       FPBK1(I,ISUB)=IPXS(I,J)
20       CONTINUE
       END IF

       NUMFPS=NUMFPS+NUMIPS
       NUMSFP=NUMFPS
       MTXTOT=NUMARS*NUMFPS

C                GENERATION OF SURFACE MATRICES
C                   P MATRICES TO FILE/UNIT NDPMXS
C                   V MATRICES TO FILE/UNIT NDVMXS

       INTTYP=1

       CALL IOSUB(NDPMXS,10,PMATX,0)
       CALL IOSUB(NDVMXS,10,VMATX,0)

       DO 50 IBLK=1,NBLKS

C      *************** SYMMETRY CONSIDERATIONS *****.*************

       IF(SYMTYP.EQ.'REF') THEN
         CALL FPREFC(IBLK,NUMFPS,INTTYP,FPBK1,FPC)
       END IF

       IF (SYMTYP.EQ.'ROT') THEN
         GAMMA=TWOPI/NBLKS
         CALL FPROTC(IBLK,GAMMA,NUMFPS,INTTYP,FPBK1,FPC)
       END IF

C      **********************************************************

       CALL MATGEN(NUMARS,NUMFPS,FACTRS,INTTYP,WTUV,MXGAUS,
     *             NDQPTS,QPC,FPC,SMALLK,PMATX,VMATX)

       IF(IBLK.EQ.1) CALL SLFINT(PMATX,VMATX,NUMARS,NUMFPS,SMALLK,INTTYP,
     *                       IORDU,IORDV,ROOTU,ROOTV,WTUV,WKGAUS,MXGAUS,
     *                       NSREG,NSEQNS,CCS,TRNSS,IZAX,SUL,SUU,SVL,SVU,
     *                       NSU,NSV,FPC,AREAS)

       DO 30 I=1,MTXTOT
       VMATX(I)=VMATX(I)*JRHOWP
30     PMATX(I)=-PMATX(I)/FOURPI

       IF(IBLK.EQ.1) THEN
         DO 40 I=1,NUMARS
         K=(I-1)*NUMFPS+I
40       PMATX(K)=PMATX(K)+0.5
       END IF

C*********** impedance coating modifications - 17 Sep 1990 *************
       CALL MTXSWZS(PMATX, VMATX, NUMARS, NUMZ, NUMIPS, ZCOAT)
C***********************************************************************

       CALL IOSUB(NDPMXS,1,PMATX,2*MTXTOT)
       CALL IOSUB(NDVMXS,1,VMATX,2*MTXTOT)

50     CONTINUE

       RECRD(1)=FREQ
       RECRD(2)=RHO
       RECRD(3)=C
       IRECRD(1)=NBLKS
       IRECRD(2)=MTXDIM
       IRECRD(3)=NUMARS
       IRECRD(4)=NUMSFP
       ARECRD(1)=SYMTYP

       RETURN
       END
```

C2: SURPRS

The subroutine SURPRS solves matrix equation (A1.4) for unknown quantities. In addition to the new variable declarations

```
COMMON/COATING/ZCOAT,NUMZ
COMPLEX ZCOAT(500),
```

the subroutine SURPRS computes the remaining surface pressures from Eq. (A1.3) and then places the values of the velocities on the impedance-coated regions back into the array VEL (into the last NUMZ positions). The [B] matrix of Eq. (A1.2) is not actually modified to create the indicated right hand side coefficent matrix of Eq. (A1.4); rather the indicated elements B_{RI} and B_{II} are left intact. This can be corrected, however, by inputting zero values into corresponding positions in the velocity vector on the right hand side of Eq. (A1.4). It is critically necessary, therefore, that one initially specify zero values for what would appear to be the velocities on the impedance coated regions.

```
C------------------------------------------------------------------------
C
C  CHIEF  Version 3.10  8-FEB-1991
C
C------------------------------------------------------------------------

      SUBROUTINE SURPRS(FREQ,SYMTYP,NBLKS,IRHSYM,CMTX,CMTEMP,MTXDIM)

C     BUILDS RIGHT HAND SIDE,
C     SOLVES EQUATIONS, AND COMBINES SOLUTIONS USING SYMMETRY WEIGHTS
C     TO OBTAIN SURFACE PRESSURES

C 17 Sep 1990 - impedance coating modifications made by DMB

C  7 Jan 1990 - bug fix of SURPRS made by PJK

      PARAMETER (MXARS=500)
      PARAMETER (MXBLKS=100)
      PARAMETER (MXIPS=20)
      PARAMETER (MXFFP=361)
      PARAMETER (MXNFP=361)

C     ****
      PARAMETER (MXFPS=520)
C     PARAMETER (MXFPS=MAX0(MXARS+MXIPS,MXFFP,MXNFP))
C     ***

      COMPLEX CMTX(MTXDIM),CMTEMP(MTXDIM)

      CHARACTER*3 SYMTYP

      COMMON/CONST/RHO,C
      COMMON/PRTCOM/NUNPRT,NUNERR

C 3 Jan 1991 - added temporary logical unit numbers TEMPVEL, TEMP1 - TEMP3.

      COMMON/NDASG/NDQPTS,NDPMXS,NDVMXS,NDDECM,NDVELS,NDSPS,
     *             NDPMXF,NDVMXF,NDPMXN,NDVMXN,NDPSSP,NDEXPR,NDCOMV,
     *             NDTEMP,NDZROB,NDPATB,NTMPVEL,NTEMP1,NTEMP2,NTEMP3
      COMMON/PRGVLS/NDIMPV,NUMARS,NUMSFP,NUMFFP,NUMNFP,NWDVEC
      COMMON/PLWINP/AINC,THTINC,PHIINC,ISCATR
      COMMON/BAFFLE/INFRIG
      COMMON/MODAL/IMODAL,IUSEFQ

      COMMON/WORK/VEC1(MXARS),VEC2(MXBLKS),VEC3(MXBLKS),VEC4(MXBLKS),
     *            VEC5(MXFPS),VEC6(MXFPS)
      COMPLEX VEC2,VEC3,VEC4,VEC5,VEC6
      COMPLEX ROOTUN(MXBLKS), SYMWTS(MXBLKS), PRSWTS(MXBLKS)
      COMPLEX X(MXFPS), CRHS(MXFPS), CSOLN(MXFPS)
      EQUIVALENCE (ROOTUN(1),VEC2(1))
```

```
      EQUIVALENCE (SYMWTS(1),VEC3(1))
      EQUIVALENCE (PRSWTS(1),VEC4(1))
      EQUIVALENCE (X(1),VEC5(1))
      EQUIVALENCE (CSOLN(1),VEC5(1))
      EQUIVALENCE (CRHS(1),VEC6(1))

      COMMON/ODSVEC/TVECT(MXARS),B(MXARS),IPIVTR(MXFPS)
      COMPLEX TVECT
      COMMON/VELSPS/VEL(MXARS),SP(MXARS)
      COMPLEX VEL,SP
      COMMON/PDISL/POWER,DIRIND,SRCLVL
      COMMON/SURARS/AREAS(MXARS)
      COMMON/EXTCOM/EXTPRS(MXFPS),IEXTFG
      COMPLEX EXTPRS
      COMMON/NBPRTC/IRHSPT,NARSPT,NPTBLK,FRQPT
      COMMON/NBPRTS/SYMTPT
      CHARACTER*3 SYMTPT

C************ impedance coating modifications - 17 Sep 1990 ************
      COMMON /COATING/ ZCOAT, NUMZ
      COMPLEX ZCOAT(MXARS)
C*********************************************************************

      IRHSPT=IRHSYM
      FRQPT=FREQ
      SYMTPT=SYMTYP

C
C     SURPRS ERROR CHECKS
C
      IERR=0

      IF (NBLKS.GT.MXBLKS.OR.NBLKS.LE.0) THEN
        IERR=1
        WRITE(NUNERR,1002)NBLKS
1002    FORMAT(/,' ERROR IN SURPRS - NBLKS=',I6)
      END IF
      IF (SYMTYP.NE.'REF'.AND.SYMTYP.NE.'ROT') THEN
        IERR=1
        WRITE(NUNERR,1003)SYMTYP
1003    FORMAT(/,' ERROR IN SURPRS - SYMTYP= ',A3)
      END IF

      IF (IERR.NE.0) STOP

      NWDMTX=2*NUMSFP*NUMARS
      NWDVEC=2*NUMARS

      CALL IOSUB(NDDECM,10,CMTX,0)
      CALL IOSUB(NDTEMP,10,CSOLN,0)
      CALL IOSUB(NDCOMV,10,CMTX,0)

      IF(IRHSYM.EQ.0) THEN
        NBSOLN=NBLKS
        DIVSR=NBLKS
      ELSE
        NBSOLN=1
        DIVSR=1.0
      END IF

      DO 100 ISOLN=1,NBSOLN

C     *************** SYMMETRY CONSIDERATIONS ******************

      IF(SYMTYP.EQ.'REF') CALL REFSWT(ISOLN,NBLKS,SYMWTS)

      IF(SYMTYP.EQ.'ROT') THEN

      IF(ISOLN.EQ.1) THEN
        PI=ACOS(-1.0)
```

```
          TWOPI=2.0*PI
          ARG=0.0
          DELARG=TWOPI/NBLKS
          DO 10 I=1,NBLKS
          ROOTUN(I)=CMPLX(COS(ARG),SIN(ARG))
10        ARG=ARG+DELARG
        END IF

        CALL ROTSWT(ISOLN,NBLKS,ROOTUN,SYMWTS)

        END IF

C       **********************************************************

        IF(ISCATR.EQ.0)THEN
        CALL IOSUB(NDCOMV,2,CMTX,NWDMTX)

        CALL COMBMX(X,VEL,NUMARS,1,NDVELS,NWDVEC,NBSOLN,SYMWTS)

        CALL MXMLTV(CMTX,X,CRHS,NUMSFP,NUMARS)
        ELSE
        DO 16 I=1,NUMSFP
16      CRHS(I)=(0.0,0.0)
        ENDIF

        IF(IEXTFG.NE.0) THEN
          CALL COMBMX(X,EXTPRS,NUMSFP,1,NDEXPR,2*NUMSFP,NBSOLN,SYMWTS)
          DO 18 I=1,NUMSFP
18        CRHS(I)=CRHS(I)+X(I)
        END IF

        DO 20 I=1,NUMSFP
20      CRHS(I)=CRHS(I)/DIVSR

        IF(INFRIG.EQ.0) THEN
        CALL IOSUB(NDDECM,2,CMTX,NWDMTX)
        CALL IOSUB(NDDECM,2,TVECT,3*MXARS+MXFPS)
        CALL ODS(2,CMTX,NUMSFP,NUMARS,TVECT,B,IPIVTR,CRHS,CSOLN)
        ELSE
        DO 25 I=1,NUMARS
25      CSOLN(I)=2.0*CRHS(I)
        END IF

        CALL IOSUB(NDTEMP,1,CSOLN,NWDVEC)

100     CONTINUE


        CALL IOSUB(NDSPS,10,SP,0)
        CALL IOSUB(NDVELS,10,VEL,0)

C ************* this rewind added as part of 7 Jan 1991 bug fix **************
        CALL IOSUB(NTMPVEL,10,VEL,0)
C ****************************************************************************

        POWER=0.0

        DO 200 ISOLN=1,NBSOLN


C       *************** SYMMETRY CONSIDERATIONS *******************


        IF(SYMTYP.EQ.'REF') THEN
        CALL REFSWT(ISOLN,NBLKS,SYMWTS)
          DO 5 I=1, NBLKS
5         PRSWTS(I)=SYMWTS(I)
        ENDIF

        IF(SYMTYP.EQ.'ROT') THEN
```

```
      CALL ROTSWT(ISOLN,NBLKS,ROOTUN,SYMWTS)
      PRSWTS(1)=SYMWTS(1)
      IF(NBLKS.NE.1) THEN
        DO 12 I=2,NBLKS
12      PRSWTS(I)=SYMWTS(NBLKS-I+2)
      END IF
      END IF


C     ***********************************************************


      CALL COMBMX(SP,CSOLN,NUMARS,1,NDTEMP,NWDVEC,NBSOLN,PRSWTS)

      IF (ISCATR .EQ. 0)CALL IOSUB(NDVELS,2,VEL,NWDVEC)

C************ impedance coating modifications - 17 Sep 1990 ************
      DO 401 I = NUMARS - NUMZ + 1, NUMARS
         VEL(I) = SP(I)
         SP(I) = -SP(I) * ZCOAT(I)
401   CONTINUE
C**********************************************************************

C***********Bug fix of problem with Velocities starts here - 7 Jan 1991

C Modified when the velocity was stored in files for the impedance
C calculations.

      CALL IOSUB(NTMPVEL,1,VEL,NWDVEC)

      CALL IOSUB(NDSPS,1,SP,NWDVEC)
      IF(ISCATR.NE.0.)GO TO 200
      DO 150 I=1,NUMARS
150   POWER=POWER+REAL(SP(I)*CONJG(VEL(I)))*AREAS(I)

200   CONTINUE

      CALL IOSUB(NTMPVEL,10,VEL,0)
      CALL IOSUB(NDVELS,10,VEL,0)

C     WRITE MATICES CONTAINED IN NTMPVEL TO NDVELS

      DO 225 I=1,NBSOLN
         CALL IOSUB(NTMPVEL,2,VEL,NWDVEC)
         CALL IOSUB(NDVELS,1,VEL,NWDVEC)
225   CONTINUE
***************** end of 7 Jan 1991 mods ***********************************

      IF(IMODAL.NE.0)THEN
      CALL IOSUB(NDTEMP,10,SP,0)
      DO 300 ISOLN=1,NBSOLN
      CALL IOSUB(NDTEMP,2,SP,NWDVEC)
  300 CALL IOSUB(NDSPS,1,SP,NWDVEC)
      ENDIF

      IF(IRHSYM.EQ.1)POWER=NBLKS*POWER
      POWER=POWER/1000.

      IEXTFG=0

      RETURN
      END
```

C3: MTXSWZS

The subroutine MTXSWZS creates the modified coefficient matrices of Eq. (A1.4) from those of Eq. (A1.2). Note that this formulation allows for NUMIPS number of interior points, and consequently the matrices A and B in this subroutine are not necessarily square. Further note that the B matrix of Eq. (A1.2) is not modified to create the exact right hand coefficient matrix of Eq. (A1.4). This is legitimate provided one does not input zero values for the corresponding positions in the velocity vector on the right-hand side of Eq. (A1.4). Also note that the impedance-coated regions are always associated with the latter storage positions in matrices A and B and in the arrays SP and VEL regardless of where the regions actually are on the surface of the radiator.

```
C-----------------------------------------------------------------------------
C
C  CHIEF  Version 3.10  8-FEB-1991
C
C  MTXSWZS.FOR was added to CHIEF in September 1990 by W. Thompson
C-----------------------------------------------------------------------------

      SUBROUTINE MTXSWZS(A, B, N, NZ, NUMIPS, ZC)

C************************************************************************
C  required in CHIEF for impedance coating cases.
C  NOTE:  matrix B in eqn AP=BV is not modified.
C************************************************************************

      COMPLEX A(N+NUMIPS, N), B(N+NUMIPS, N), ZC(500)

      NN = N + NUMIPS

      DO 20 I = 1, NN
         DO 10 J = N - NZ + 1, N
            A(I, J) = -A(I, J) * ZC(J) - B(I, J)
10       CONTINUE
20    CONTINUE

      RETURN
      END
```

C4: ZRADMI

The subroutine ZRADMI is called from the CHIEF driver and is used to calculate the radiation matrix only when impedance surfaces are present. When impedance surfaces are present, both ZRADMX and ZRADMI are called.

```
C-----------------------------------------------------------------------------
C
C  CHIEF  Version 3.10  8-FEB-1991
C
C-----------------------------------------------------------------------------

      SUBROUTINE ZRADMI(ZMTX, NUMARS)

C  ZRADMI() is a subroutine that corrects the radiation impedance matrix
C  when an arbitrary impedance layer exists on the surface.
C
C  Subroutines used:  MATRIXINV()

      PARAMETER (MXARS = 500)

C impedance layer commons...
      COMPLEX ZCOAT(500)
```

```
      COMMON / COATING / ZCOAT, NUMZ

      COMPLEX ZRR(MXARS, MXARS)
      COMPLEX ZIR(MXARS, MXARS)
      COMPLEX ZRI(MXARS, MXARS)
      COMPLEX ZII(MXARS, MXARS)
      COMPLEX INVZII(MXARS, MXARS)
      COMPLEX TEMP2(MXARS, MXARS)
      COMPLEX TEMP3(MXARS, MXARS)
      REAL TEMP4(MXARS * 2, MXARS * 2)
      REAL TEMP5(MXARS * 2, MXARS * 2)
      INTEGER ITEMP(MXARS)

      INTEGER IFIRST, ILAST
      INTEGER RFIRST, RLAST

      COMPLEX ZMTX
      DIMENSION ZMTX(NUMARS, NUMARS)

C  The radiation impedance matrix is computed assuming there are no
C  impedance surfaces.  This matrix ZMTX has dimensions NUMARS x NUMARS.
C  ZMTX is partitioned into 4 matrices, ZRR, ZRI, ZIR, and ZII whose
C  sizes depend upon the number of impedance surfaces.

      RFIRST = 1
      RLAST  = NUMARS - NUMZ
      IFIRST = NUMARS - NUMZ + 1
      ILAST  = NUMARS

      DO 30 J = RFIRST, RLAST
         DO 10 K = RFIRST, RLAST
            ZRR(K, J) = ZMTX(K, J)
10       CONTINUE
         DO 20 K = IFIRST, ILAST
            ZIR(K - RLAST, J) = ZMTX(K, J)
20       CONTINUE
30    CONTINUE

      DO 60 J = IFIRST, ILAST
         DO 40 K = RFIRST, RLAST
            ZRI(K, J - RLAST) = ZMTX(K, J)
40       CONTINUE
         DO 50 K = IFIRST, ILAST
            ZII(K - RLAST, J - RLAST) = ZMTX(K,J)
50       CONTINUE
60    CONTINUE

C  The impedance coatings are added to the diagonal elements of the
C  ZII matrix.

      DO 70 J = 1, NUMZ
         ZII(J, J) = ZII(J, J) + ZCOAT(J + RLAST)
70    CONTINUE

C  In order to invert the complex matrix ZII, we partitioned it into
C  a real matrix, TEMP4, that is 4 times larger as follows:
C
C           +-                                  -+
C           |     Real ZII       -Imaginary ZII  |
C           |                                    |
C           |  Imaginary ZII       Real ZII      |
C           +-                                  -+
C
C  and inverted this larger real matrix.

      DO 90 J = 1, NUMZ
         DO 80 K = 1, NUMZ
            TEMP4(       K,        J) =  REAL(ZII(K, J))
            TEMP4(NUMZ + K, NUMZ + J) =  REAL(ZII(K, J))
            TEMP4(NUMZ + K,        J) =  AIMAG(ZII(K, J))
            TEMP4(       K, NUMZ + J) = -AIMAG(ZII(K, J))
80       CONTINUE
```

```
90    CONTINUE

      CALL MATRIXINV(TEMP4, TEMP5, ITEMP, NUMZ*2, MXARS*2)

C  After inversion, the result is still partitioned in the same way.
C  The real and imaginary parts of the inverse are now recombined into
C  the complex array INVZII.
C
C         +-                                          -+
C         |      ** Real INVZII **     -Imaginary INVZII  |
C         |                                            |
C         |   ** Imaginary INVZII **     Real INVZII      |
C         +-                                          -+

      DO 110 J = 1, NUMZ
         DO 100 K = 1, NUMZ
            INVZII(K, J) = CMPLX(TEMP5(K, J), TEMP5(NUMZ + K, J))
100      CONTINUE
110   CONTINUE

C  ZRI is multiplied by the inverse of ZII and put into the TEMP2 array.

      DO 140 J = 1, NUMZ
         DO 130 K = RFIRST, RLAST
            TEMP2(K, J) = 0.0
            DO 120 L = 1, NUMZ
               TEMP2(K, J) = TEMP2(K, J) + ZRI(K, L) * INVZII(L, J)
120         CONTINUE
130      CONTINUE
140   CONTINUE

C  Temp2 is multiplied by ZIR and put into the array TEMP3

      DO 170 J = RFIRST, RLAST
         DO 160 K = RFIRST, RLAST
            TEMP3(K, J) = 0.0
            DO 150 L = 1, NUMZ
               TEMP3(K, J) = TEMP3(K, J) + TEMP2(K, L) * ZIR(L, J)
150         CONTINUE
160      CONTINUE
170   CONTINUE

C  ZMTX is now the correct radiation impedance matrix and is passed
C  back to the CHIEF driver.  (Note the size of ZMTX is larger than
C  the size actually needed.

      DO 190 J = RFIRST, RLAST
         DO 180 K = RFIRST, RLAST
            ZMTX(K, J) = ZRR(K, J) - TEMP3(K, J)
180      CONTINUE
190   CONTINUE

      RETURN
      END
```

C5: MATRIXINV

The subroutine MATRIXINV is called from ZRADMI. This subroutine inverts a matrix and calls the subroutine DECOMP and SOLVER.

```
C-----------------------------------------------------------------------
C
C  CHIEF  Version 3.10  8-FEB-1991
C
C-----------------------------------------------------------------------

      SUBROUTINE MATRIXINV(MAT, INV, INDEX, N, S)

C  Inverts a matrix (MAT)
```

```
C  Subroutines used:  DECOMP(), SOLVER()

      INTEGER N      ! defines size of array to be inverted (N x N)
      INTEGER S      ! size of storage area (S x S) (may be larger than array)
      INTEGER INDEX  ! used in bookeeping.
      REAL    MAT    ! array to be inverted (destroyed when done)
      REAL    INV    ! holds inverted array when done.
      INTEGER D      ! +1 or -1 depending on even or odd number of row changes

      DIMENSION MAT(S, S), INV(S, S), INDEX(S)

      DO 20 I = 1, N
         DO 10 J = 1, N
            INV(I, J) = 0.0
10       CONTINUE
         INV(I, I) = 1.0
20    CONTINUE

      CALL DECOMP(MAT, N, S, INDEX, D)

      DO 30 J = 1, N
         CALL SOLVER(MAT, N, S, INDEX, INV(1, J))
30    CONTINUE

      RETURN
      END
```

C6: DECOMP

The subroutine DCOMP performs a matrix decomposition.

```
C-----------------------------------------------------------------------
C
C  CHIEF  Version 3.10  8-FEB-1991
C
C-----------------------------------------------------------------------

      SUBROUTINE DECOMP(A, N, NP, INDX, D)

C  Matrix Decomposition routine.

      PARAMETER (NMAX = 100, TINY = 1.0E - 20)
      DIMENSION A(NP, NP), INDX(N), VV(NMAX)

      D = 1.0
      DO 12 I = 1, N
         AAMAX = 0.0
         DO 11 J = 1, N
            IF (ABS(A(I, J)) .GT. AAMAX) AAMAX = ABS(A(I, J))
11       CONTINUE
         IF (AAMAX .EQ. 0.0) PAUSE 'Singular matrix.'
         VV(I) = 1.0 / AAMAX
12    CONTINUE

      DO 19 J = 1, N

         IF (J .GT. 1) THEN
            DO 14 I = 1, J - 1
               SUM = A(I, J)
               IF (I .GT. 1) THEN
                  DO 13 K = 1, I - 1
                     SUM = SUM - A(I, K) * A(K, J)
13                CONTINUE
                  A(I, J) = SUM
               ENDIF
14          CONTINUE
         ENDIF
```

```
         AAMAX = 0.0

         DO 16 I = J, N
            SUM = A(I, J)
            IF (J .GT. 1) THEN
               DO 15 K = 1, J - 1
                  SUM = SUM - A(I, K) * A(K, J)
15             CONTINUE
               A(I, J) = SUM
            ENDIF
            DUM = VV(I) * ABS(SUM)
            IF (DUM .GE. AAMAX) THEN
               IMAX = I
               AAMAX = DUM
            ENDIF
16       CONTINUE

         IF (J .NE. IMAX) THEN
            DO 17 K = 1, N
               DUM = A(IMAX, K)
               A(IMAX, K) = A(J, K)
               A(J, K) = DUM
17          CONTINUE
            D = -D
            VV(IMAX) = VV(J)
         ENDIF

         INDX(J) = IMAX

         IF(J .NE. N) THEN
            IF(A(J, J) .EQ. 0.0) A(J, J) = TINY
            DUM = 1.0 / A(J, J)
            DO 18 I = J + 1, N
               A(I, J) = A(I, J) * DUM
18          CONTINUE
         ENDIF

19    CONTINUE

      IF(A(N, N) .EQ. 0.0) A(N, N) = TINY

      RETURN
      END
```

C7: SOLVER

The subroutine solves a matrix equation.

```
C------------------------------------------------------------------------
C
C  CHIEF  Version 3.10  8-FEB-1991
C
C------------------------------------------------------------------------

      SUBROUTINE SOLVER(A, N, NP, INDX, B)

C  This routine solves the set of N linear equations A . X = B

      DIMENSION A(NP, NP), INDX(N), B(N)

      II = 0
      DO 12 I = 1, N
         LL = INDX(I)
         SUM = B(LL)
         B(LL) = B(I)
         IF (II .NE. 0) THEN
            DO 11 J = II, I - 1
               SUM = SUM - A(I, J) * B(J)
11          CONTINUE
```

```
         ELSE IF (SUM .NE. 0.0) THEN
            II = I
         ENDIF
         B(I) = SUM
12    CONTINUE

      DO 14 I = N, 1, -1
         SUM = B(I)
         IF(I .LT. N) THEN
            DO 13 J = I + 1, N
               SUM = SUM - A(I, J) * B(J)
13          CONTINUE
         ENDIF
         B(I) = SUM / A(I, I)
14    CONTINUE

      RETURN
      END
```

C8: INITCM

```
C-----------------------------------------------------------------------
C
C  CHIEF  Version 3.10  8-FEB-1991
C
C-----------------------------------------------------------------------

      SUBROUTINE INITCM

      PARAMETER (MXSREG=500)

      COMMON/CONST/RHO,C
      COMMON/PRTCOM/NUNPRT,NUNERR

C 3 Jan 1991 - added temporary logical unit numbers NTEMPVEL, NTEMP1 - NTEMP3.

      COMMON/NDASG/NDQPTS,NDPMXS,NDVMXS,NDDECM,NDVELS,NDSPS,
     *             NDPMXF,NDVMXF,NDPMXN,NDVMXN,NDPSSP,NDEXPR,NDCOMV,
     *             NDTEMP,NDZRDB,NDPATB,NTMPVEL,NTEMP1,NTEMP2,NTEMP3
      COMMON/SVALS/NSREG,NSEQNS(MXSREG),SUL(MXSREG),SUU(MXSREG),
     *             SVL(MXSREG),SVU(MXSREG),NSU(MXSREG),NSV(MXSREG),
     *             CCS(10,MXSREG),TRNSS(3,MXSREG),IZAX(MXSREG),
     *             IORDU(MXSREG),IORDV(MXSREG),NCCEQS
      COMMON/PLWINP/AINC,THTINC,PHIINC,ISCATR
      COMMON/BAFFLE/INFRIG
      COMMON/MODAL/IMODAL,IUSEFQ

      RHO=1000.
      C=1500.

C************** changed NCCEQS to 13 to add cone - 19 Sep 1990 **********
C     NUMBER OF EQUATION SETS IN CCUNMD
      NCCEQS=13
C***********************************************************************

C     UNIT DESIGNATORS FOR MASS STORAGE
      NDQPTS=10
      NDPMXS=11
      NDVMXS=12
      NDDECM=13
      NDVELS=14
      NDSPS=15
      NDPMXF=16
      NDVMXF=17
      NDPMXN=18
      NDVMXN=19
      NDPSSP=20
      NDEXPR=21
      NDCOMV=22
      NDTEMP=23
```

```
      NDZRDB=24
      NDDATR=25

C 3 Jan 1991 - added temporary logical unit numbers TEMPVEL, TEMP1 - TEMP3.

      NTMPVEL = 26
      NTEMP1 = 27
      NTEMP2 = 28
      NTEMP3 = 29

C     PRINT UNIT DESIGNATORS
      NUNPRT=6
      NUNERR=6
C     PLANE WAVE VALUES
      AINC=0.0
      ISCATR=0
C     INFINITE RIGID BAFFLE VALUE
      INFRIG=0
C     MODAL MATRIX COMPUTATION FLAG
      IMODAL=0
      IUSEFQ=0

      RETURN
      END
```