Table A19 List of the file, **eqellipse.stiffened.opm4.**
This file contains a complete list of the output file,
eqellipse.OPM, corresponding to the **optimized imperfect isogrid-stiffened equivalent ellipsoidal shell** for the specific case called "**eqellipse**". (See Section 8.1).

```
==========================================================================
   n      $ Do you want a tutorial session and tutorial output?
     0    $ Choose an analysis you DON'T want (1, 2,..), IBEHAV
     0    $ Choose an analysis you DON'T want (1, 2,..), IBEHAV
     1    $ NPRINT= output index (0=GOOD, 1=ok, 2=debug, 3=too much)
     2    $ Choose type of analysis (1=opt., 2=fixed, 3=sensit.) ITYPE
     5    $ How many design iterations in this run (3 to 25)?
   n      $ Take "shortcuts" for perturbed designs (Y or N)?
     2    $ Choose 1 or 2 or 3 or 4 or 5 for IDESIGN
     1    $ Choose 1 or 2 or 3 or 4 or 5 for move limits, IMOVE
   y      $ Do you want default (RATIO=10) for initial move limit jump?
   y      $ Do you want the default perturbation (dx/x = 0.05)?
   y      $ Do you want to have dx/x modified by GENOPT?
   n      $ Do you want to reset total iterations to zero (Type H)?

 ************ END OF THE  eqellipse.OPT  FILE ***********
 ************ MARCH, 2008 VERSION OF GENOPT ****************
 ******** BEGINNING OF THE  eqellipse.OPM  FILE *********


 *********************** MAIN PROCESSOR **********************
 The purpose of the mainprocessor, OPTIMIZE, is to perform,
 in a batch mode, the work specified by MAINSETUP for the case
 called eqellipse.  Results are stored in the file  eqellipse.OPM.
 Please inspect eqellipse.OPM before doing more design iterations.
 ************************************************************




 STRUCTURAL ANALYSIS FOR DESIGN ITERATION NO.   0:
0
  STRUCTURAL ANALYSIS WITH UNPERTURBED DECISION VARIABLES
 VAR. DEC. ESCAPE LINK. LINKED  LINKING   LOWER     CURRENT    UPPER      DEFINITION
  NO. VAR.  VAR.  VAR.    TO   CONSTANT   BOUND      VALUE     BOUND
```

1 Y N N 0 0.00E+00 1.00E-01 1.2453E-01 1.00E+00 skin thickness at xinput: THKSKN(1)
2 Y N N 0 0.00E+00 1.00E-01 1.6641E-01 1.00E+00 skin thickness at xinput: THKSKN(2)
3 Y N N 0 0.00E+00 1.00E-01 1.4460E-01 1.00E+00 skin thickness at xinput: THKSKN(3)
4 Y N N 0 0.00E+00 1.00E-01 1.6082E-01 1.00E+00 skin thickness at xinput: THKSKN(4)
5 Y N N 0 0.00E+00 1.00E-01 1.0412E-01 1.00E+00 skin thickness at xinput: THKSKN(5)
6 Y N N 0 0.00E+00 1.00E-01 1.0000E-01 1.00E+00 skin thickness at xinput: THKSKN(6)
7 Y N N 0 0.00E+00 1.00E-01 1.0162E-01 1.00E+00 skin thickness at xinput: THKSKN(7)
8 Y N N 0 0.00E+00 1.00E-01 1.3795E-01 1.00E+00 skin thickness at xinput: THKSKN(8)
9 Y N N 0 0.00E+00 1.00E-01 1.0201E-01 1.00E+00 skin thickness at xinput: THKSKN(9)
10 Y N N 0 0.00E+00 1.00E-01 1.0411E-01 1.00E+00 skin thickness at xinput: THKSKN(10)
11 Y N N 0 0.00E+00 1.00E-01 1.9869E-01 1.00E+00 skin thickness at xinput: THKSKN(11)
12 Y N N 0 0.00E+00 1.00E-01 1.0000E-01 1.00E+00 skin thickness at xinput: THKSKN(12)
13 Y N N 0 0.00E+00 1.00E-01 1.9779E-01 1.00E+00 skin thickness at xinput: THKSKN(13)
14 Y N N 0 0.00E+00 5.00E-01 6.6766E-01 3.00E+00 height of isogrid members at xinput: HIGHST(1)
15 Y N N 0 0.00E+00 5.00E-01 6.0783E-01 3.00E+00 height of isogrid members at xinput: HIGHST(2)
16 Y N N 0 0.00E+00 5.00E-01 9.7928E-01 3.00E+00 height of isogrid members at xinput: HIGHST(3)
17 Y N N 0 0.00E+00 2.00E-01 1.2562E+00 3.00E+00 height of isogrid members at xinput: HIGHST(4)
18 Y N N 0 0.00E+00 2.00E-01 1.1540E+00 3.00E+00 height of isogrid members at xinput: HIGHST(5)
19 Y N N 0 0.00E+00 2.00E-01 8.0422E-01 3.00E+00 height of isogrid members at xinput: HIGHST(6)
20 Y N N 0 0.00E+00 2.00E-01 1.2686E+00 3.00E+00 height of isogrid members at xinput: HIGHST(7)

21 Y N N 0 0.00E+00 2.00E-01 8.8339E-01 3.00E+00 height of isogrid members at xinput: HIGHST(8)
22 Y N N 0 0.00E+00 2.00E-01 7.0560E-01 3.00E+00 height of isogrid members at xinput: HIGHST(9)
23 Y N N 0 0.00E+00 2.00E-01 5.8445E-01 3.00E+00 height of isogrid members at xinput: HIGHST(10)
24 Y N N 0 0.00E+00 2.00E-01 5.1581E-01 3.00E+00 height of isogrid members at xinput: HIGHST(11)
25 Y N N 0 0.00E+00 2.00E-01 3.4417E-01 3.00E+00 height of isogrid members at xinput: HIGHST(12)
26 Y N N 0 0.00E+00 2.00E-01 4.6660E-01 3.00E+00 height of isogrid members at xinput: HIGHST(13)
27 Y N N 0 0.00E+00 1.00E+00 2.9154E+00 3.00E+00 spacing of the isogrid members: SPACNG
28 Y N N 0 0.00E+00 5.00E-02 9.0531E-02 1.00E+00 thickness of an isogrid stiffening member: THSTIF

BEHAVIOR FOR 1 ENVIRONMENT (LOAD SET)

CONSTRAINT BEHAVIOR DEFINITION
NUMBER VALUE

BEHAVIOR FOR LOAD SET NUMBER, ILOADX= 1

****

Start of all analyses:
Design iteration 1, Load Set 1, IMODX= 0, Dec.var.no.,IDV= 0

****

SUBROUTINE STRUCT computes seven "behaviors" (stress, collapse, bifurcation buckling, etc.). The seven behaviors are:

1. linear axisymmetric buckling of the perfect ellipsoid in order to obtain 2 or 4 axisymmetric buckling modes (NCASES = 2 or 4) which are to be used as initial imperfection shapes in the following analyses 2 - 7, listed next.
2. nonlinear axisymmetric stress with mode 1 imperfection
3. nonlinear axisymmetric stress with mode 2 imperfection
4. axisymmetric collapse with mode 1 imperfection
5. axisymmetric collapse with mode 2 imperfection
6. nonlinear bifurcation buckling with mode 1 imperfection
7. nonlinear bifurcation buckling with mode 2 imperfection.

Brief description of each of the seven analyses corresponding to the seven "behaviors" just listed:

1. Ten axisymmetric buckling modes are computed from linear analysis. Only two modes are used for imperfection shapes:
   A. The mode corresponding to the lowest buckling load, and
   B. one other mode, usually the 2nd mode.

   For each of mode 1 and mode 2, the actual imperfection is the normalized buckling modal w-deflection times an amplitude factor supplied by the user by means of "BEGIN".

   In MAINSETUP (*.OPT file) the user can choose whether or not the linear axisymmetric buckling modes, (that is, the imperfection shapes) are to be recomputed for each of the PERTURBED designs. If the user answers the prompt,
   Take "shortcuts" for perturbed designs (Y or N)?
   with "N" (NO), then the axisymmetric buckling modal imperfection shapes will be recomputed for each PERTURBED design. (This is the preferred choice, even though it leads to some high constraint gradients). If the user answers "Y" (YES), then the imperfection shapes will NOT be recomputed for the PERTURBED designs. The constraint gradients will be lower, but GENOPT will usually have a harder time finding the "global" optimum design.

2. Nonlinear axisymmetric stress analysis with "mode 1" Wimp: This analysis is performed for both +(mode 1) and -(mode 1) For each of these "sub-analyses" the following is done:
   a. The nonlinear equilibrium path is traced over the range P(design)/10. < P < P(design) in 10 steps of dP, where P(design) = design pressure and dP = P(design)/10.
   b. If the shell collapses nonlinearly (convergence failure) for P < P(design), then step 2a is redone with the range P(collapse)/10. < P < P(collapse); dP=P(collapse)/10.
   c. At the maximum load (either P(collapse) or P(design), whichever is smaller) the following quantities are computed:
      Region 1 local skin buckling load factor, BUCMIN

Region 1 isogrid member buckling load factor,   BUCMNS
Region 1 skin maximum effective stress,   SKNMAX
Region 1 isogrid member max. effective stress, STFMXS
Region 2 local skin buckling load factor,   BUCMIN
Region 2 isogrid member buckling load factor,   BUCMNS
Region 2 skin maximum effective stress,   SKNMAX
Region 2 isogrid member max. effective stress, STFMXS
Normal displacement of the shell at its apex,   ENDUV
The quantities, BUCMIN, BUCMNS, etc. may constrain the
evolution of the optimum design.

Region 1 represents the ellipsoidal cap region, and
Region 2 represents the rest of the ellipsoidal shell.
Note that typical margins contain the following strings:
  (SKNBK1(1,1)/SKNBK1A(1,1))/SKNBK1F(1,1)-1
  (SKNBK1(1,2)/SKNBK1A(1,2))/SKNBK1F(1,2)-1
with two-dimensional arrays, SKNBK1, SKNBK1A, SKNBK1F,
in this example signifying "skin buckling for mode 1".
The analogous margins,
  (SKNBK2(1,1)/SKNBK2A(1,1))/SKNBK2F(1,1)-1
  (SKNBK2(1,2)/SKNBK2A(1,2))/SKNBK2F(1,2)-1
with two-dimensional arrays, SKNBK2, SKNBK2A, SKNBK2F,
in this example signify "skin buckling for mode 2".
The "i" in the arrays *(i,j) is the load set number.
The "j" is the region number, called "Region 1" for
Region no. 1 and "Region 2" for region no. 2 above.
Region no. 1: the radial coordinate, x, 0 < x < xlimit.
Region no. 2: the radial coordinate, x,xlimit < x < xmax
where xmax is the value of the x-coord. at the equator,
and xlimit is a user-provided input datum, usually
equal to about half the semimajor axis (xlimit=a/2).
This scheme of computing minimum buckling load factors
and maximum stresses in two regions of the ellipsoidal
head and having margins for each smooths the values of
the margins from design iteration to iteration, making
it easier to find a "global" optimum design.

The quantities, BUCMIN, BUCMNS, SKNMAX, STFMXS, are
computed in SUBROUTINE PLOCAL in the BIGBOSOR4 code,

..bosdec/sources/addbosor4.src, as follows:

```
COMPUTATION OF BUCMIN: In the following code fragment
the critical buckling resultant is NSCRIT; BUCLOD(I) =
buckling load factor at nodal point I in Segment No. IS;
BUCMIN(IS) = minimum buckling load factor in Segment IS.
FCOEF = 0.5
NSCRIT = FCOEF*PI**2*CSKIN(4,4,I)/SIDE**2           (1)
NSMAX  = MIN(N1SKIN,N2SKIN)                         (2)
BUCLOD(I) = NSCRIT/ABS(NSMAX)                       (3)
BUCMIN(IS) = MIN(BUCMIN(IS),BUCLOD(I))              (4)
in which the variables used in Eqs.(1-4) are as follows:
CSKIN(i,j,I) = 6 x 6 matrix of shell wall stiffnesses at
          nodal point I
SIDE = length of a side of the equilateral triangle
      formed by the isogrid configuration
N1SKIN, N2SKIN are the meridional and hoop resultants
          in the shell skin, given by:
N1SKIN = CSKIN(1,1,I)*EPS1 + CSKIN(1,2,I)*EPS2
       +CSKIN(1,4,I)*K1   + CSKIN(1,5,I)*K2
N2SKIN = CSKIN(1,2,I)*EPS1 + CSKIN(2,2,I)*EPS2
       +CSKIN(2,4,I)*K1   + CSKIN(2,5,I)*K2

EPS1, K1 = meridional reference surface membrane
        strain and curvature change at nodal point I
EPS2, K2 = circumferential reference surface membrane
        strain and curvature change at nodal point I
```

The buckling load, NSCRIT, is for a flat equilateral
triangular piece of skin. The formula for NSCRIT is from
NACA TN-3781, July 1957 by Gerard & Becker: "Handbook of
Structural Stability, Part I - Buckling of Flat Plates".
The formula is for buckling of an equilateral flat plate
with N1SKIN = N2SKIN (compression). The result here is
approximate because in general N1SKIN is not equal to
N2SKIN, and in general the skin is not isotropic.
The prediction of the shell skin buckling load factor
should be conservative because:
a. The compressive stress resultant used in the formula
   for buckling load factor is NSMAX=MIN(N1SKIN,N2SKIN).

b. The triangular piece of skin is assumed to be flat
 when in fact it is curved.
c. The triangular piece of skin is assumed to be simply
 supported when in fact it is supported by isogrid
 stiffeners along all three edges.

COMPUTATION OF BUCMNS AND STFMXS: In the code fragment in PLOCAL that computes stiffener buckling and stress, BUCMNS(IS) and STFMXS(IS), useful definitions are:

NUSTIF = Poisson ratio for stringer/isogrid member
SIGCR = buckling stress for stringer/isogrid member
STRTIP = stress at the tip of stringer/isogrid member
STRROT = stress at the root of the stringer/isogrid
BUCSTR(I) = buckling load factor for stringer/isogrid
 at nodal point I
BUCMNS(IS)= minimum buckling load factor for stiffener
 in shell segment IS
STRSTR(I) = maximum stress in stringer/isogrid at nodal
 point I
STFMXS(IS)= maximum stress in stringer/isogrid in shell
 segment IS

The critical buckling load of stiffener is derived from formulas from ROARK: FORMULAS FOR STRESS AND STRAIN, 3rd Edition, McGraw-Hill, 1954, Table XVI, p. 312, Formulas 4 (s.s.,free) and 5 (clamped,free). Roark has
SIGCR = k*[ESTIFF/(1-NUSTIF**2)]*(TSTIFF/HEIGHT)**2
in which k is a coefficient that depends on the aspect ratio of the plate (stiffener). For long, uniformly axially compressed plates:
a. k = 0.375 if the plate is simply-supported-free
b. k = 1.1 if the plate is clamped-free
Later edition of "ROARK":
Seventh Edition by Warren C. Young and Richard G. Budynas, McGraw-Hill 2002, Chapter 15, Table 15.2, Formulas 1.d and 1.e, on p. 730

More definitions...
IRECT(1,IS) = 1 if stringer/isogrid member has a
 rectangular cross section

= 0 if stringer/isogrid member does not have
a rectangular cross section

INTEXT(1,IS)= 0 for stringer/isogrid attached to the
leftmost shell skin surface
(e.g. internal smeared stringer/isogrid)

INTEXT(1,IS)= 1 for stringer/isogrid attached to the
rightmost shell skin surface

Z(I) = distance from the shell skin leftmost surface to
the reference surface at nodal point I. (The
reference surface is where the membrane strain
and curvature changes (EPS1,K1,EPS2,K2) are
measured].

T(I) = thickness of shell skin at nodal point I of
shell segment IS

ZTIP = distance from shell reference surface to the tip
of stringer/isogrid

STRTIP = stress at the tip of a smeared stringer/isogrid
member.

STFPRP(j,1,I) = properties of smeared stringer/isogrd
at nodal point I, defined as follows:

STFPRP(1,1,I) = stiffener thickness, TSTIFF
STFPRP(2,1,I) = stiffener height from nearest shell
skin surface
STFPRP(3,1,I) = stiffener spacing: SIDE*SQRT(3.)/2.
STFPRP(4,1,I) = stiffener elastic modulus

STFPRP(j,2,I), j = 1,2,3,4 = same as above, for smeared
rings.

SUBROUTINE PLOCAL has the following code for computing
buckling and stress in the stiffener/isogrid member:

```
IF (INTEXT(1,IS).EQ.0) ZTIP = -(STFPRP(2,1,I) + Z(I))
IF (INTEXT(1,IS).EQ.1) ZTIP = STFPRP(2,1,I) + T(I) -Z(I)
STRTIP = STFPRP(4,1,I)*(EPS1 - ZTIP*K1)
EDGSTF = 0.5
NUSTIF = 0.3
SIGCR =(0.375+0.7*EDGSTF)*(STFPRP(4,1,I)/(1.-NUSTIF**2))
                *(STFPRP(1,1,I)/STFPRP(2,1,I))**2
IF (STRTIP.LT.0.0) THEN
  BUCSTR(I) = SIGCR/ABS(STRTIP)
```

```
   BUCMNS(IS) = MIN(BUCMNS(IS),BUCSTR(I))
ENDIF
IF (INTEXT(1,IS).EQ.0) ZROOT = -Z(I)
IF (INTEXT(1,IS).EQ.1) ZROOT =  T(I) - Z(I)
STRROT = STFPRP(4,1,I)*(EPS1 - ZROOT*K1)
STRSTR(I) = MAX(ABS(STRTIP),ABS(STRROT))
STFMXS(IS) = MAX(STFMXS(IS),STRSTR(I))
```

The stiffener buckling load factor and maximum stress used here should be conservative compared to what happens in the case of an actual isogrid member because:

a. The compressive stress STRTIP at the tip of the stiffener is used, which in the worst case would be the maximum compressive stress over the height of the stiffener, whereas the ROARK formula for buckling is for a uniformly compressed flat plate.

b. For typical optimum designs the aspect ratio of the plate is about 2.0, for which ROARK gives a buckling coefficient, k = 0.574 for a plate simply supported along one edge and free along the opposite edge.

c. Where the isogrid members intersect the actual b.c. should probably be clamped, whereas the formula is for simple support along plate edges "b".

d. The formula for maximum stress at the stiffener tip,
   STRTIP = STFPRP(4,1,I)*(EPS1 - ZTIP*K1)
   is based on the assumption that the isogrid member is oriented meridionally. This is the worst possible orientation from the point of view of maximum stress for a stiffener attached to an axisymmetrically deformed shell.

COMPUTATION OF SKNMAX: The maximum effective stress in the skin of the shell segment IS is computed by BIGBOSOR4 as it always has been. No new coding was added to BIGBOSOR4 in order to generate SKNMAX(IS).

COMPUTATION OF ENDUV: The normal displacement w at the apex of the ellipsoidal head is computed by BIGBOSOR4 as it always has been. No new coding has been added.
NOTE: prebuckling axial displacement at the first nodal

point in the cylindrical segment (Segment NSEG) is set
to zero in the prebuckling phase of the analysis only.
This is done so that ENDUV is for the ellipsoidal head
by itself (does not include any axial deformation of the
cylindrical segment to which the ellipsoidal head is
attached).

d. Steps 2a, 2b, 2c are repeated for the negative of mode 1
that is, for -(mode 1).

e. Both +(mode 1) and -(mode 1) behavior are investigated
for both the UNPERTURBED (current) and PERTURBED designs

f. Based on the results from the +(mode 1) and -(mode 1)
nonlinear analyses, SUBROUTINE STRUCT may choose which
condition is worst for determination of the items listed
under 2c (BUCMIN, BUCMNS, etc) and which condition is
worst for determination of the collapse pressure, which
later becomes one of the margins. These choices hold for
the nonlinear stress and collapse analyses of the
PERTURBED designs (IMODX = 1).

g. It is generally best to use multiple load sets in order
to compute margins with +(modal imperfection shapes) and
-(modal imperfection shapes) separately instead of using
SUBROUTINE STRUCT to choose the worst of (+) and (-)
imperfection shapes in a single load set, as described
in f. Experience has demonstrated that processing (+)
and (-) imperfection shapes in separate load sets leads
to smoother plots of margins vs design iterations and
also to smaller minimum weights.

3. Nonlinear axisymmetric stress analysis with "mode 2" Wimp:
This analysis is performed for both +(mode 2) and -(mode 2)
in exactly the same manner as just described for mode 1.

4. Axisymmetric collapse with + or - mode 1 imperfection.
Which of the +(mode 1) or -(mode 1) imperfections is used
has already been determined as described in Steps 2a-f.
The nonlinear equilibrium path is traced over the range
PMAX/10. < P < 2.*PMAX in 20 steps of dP, where
PMAX=either P(design) or P(collapse), whichever is smaller

and dP = PMAX/10.

5. Axisymmetric collapse with + or - mode 2 imperfection.
   Which of the +(mode 2) or -(mode 2) imperfections is used
   has already been determined as described in Step 3.

6. Nonlinear bifurcation buckling with mode 1 imperfection:
   For the UNPERTURBED (current) design (IMODX=0), nonlinear
   bifurcation buckling is investigated over a range of
   circumferential wave numbers from 0 to 10 with the load
   set equal to PMAX if PMAX = P(design) or 0.9*PMAX if
   PMAX = P(collapse). This is done for BOTH +(mode 1) and for
   -(mode 1) imperfections. SUBROUTINE STRUCT decides which
   of the conditions, +(mode 1) or -(mode 1), is the worst.
   This choice holds for the mode 1 bifurcation buckling
   analyses of the PERTURBED (IMODX=1) designs.

7. Nonlinear bifurcation buckling with mode 2 imperfection:
   This is done in exactly the same way as for the mode 1
   imperfection; see Step 6.

A NOTE ABOUT DESIGN Margins...
The margins for an optimized isogrid-stiffened ellipsoidal
shell with shell skin thickness and isogrid height varying
along the meridian (callout points at the pole, at the
junctions between each toroidal segment of the equivalent
ellipsoid, and at the equator of the equivalent ellipsoid:
(case name =eqellipse   ) are as follows:

For mode 1 buckling modal imperfection shape:

```
Margins CORRESPONDING TO CURRENT DESIGN (FS= FACTOR OF SAFETY)
MAR. CURRENT
NO.   VALUE           DEFINITION
 1  2.303E-01 (CLAPS1(1)/CLAPS1A(1))/CLAPS1F(1)-1;FS=1.0
 2  9.988E-01 (GENBK1(1)/GENBK1A(1))/GENBK1F(1)-1;FS=1.0
 3  3.853E-02 (SKNBK1(1,1)/SKNBK1A(1,1))/SKNBK1F(1,1)-1;FS=1.0
 4 -1.235E-02 (SKNBK1(1,2)/SKNBK1A(1,2))/SKNBK1F(1,2)-1;FS=1.0
 5  6.174E-01 (STFBK1(1,1)/STFBK1A(1,1))/STFBK1F(1,1)-1;FS=1.0
 6  1.564E-01 (STFBK1(1,2)/STFBK1A(1,2))/STFBK1F(1,2)-1;FS=1.0
 7  6.878E-02 (SKNST1A(1,1)/SKNST1(1,1))/SKNST1F(1,1)-1;FS=1.0
```

```
 8  1.294E-02 (SKNST1A(1,2)/SKNST1(1,2))/SKNST1F(1,2)-1;FS=1.0
 9 -3.474E-02 (STFST1A(1,1)/STFST1(1,1))/STFST1F(1,1)-1;FS=1.0
10  2.015E-02 (STFST1A(1,2)/STFST1(1,2))/STFST1F(1,2)-1;FS=1.0
11  3.439E-01 (WAPEX1A(1)/WAPEX1(1))/WAPEX1F(1)-1;FS=1.0
```

For mode 2 buckling modal imperfection shape:

```
Margins CORRESPONDING TO CURRENT DESIGN (FS= FACTOR OF SAFETY)
MAR. CURRENT
NO.   VALUE           DEFINITION
12  8.393E-02 (CLAPS2(1)/CLAPS2A(1))/CLAPS2F(1)-1;FS=1.0
13  8.220E-01 (GENBK2(1)/GENBK2A(1))/GENBK2F(1)-1;FS=1.0
14  6.012E-02 (SKNBK2(1,1)/SKNBK2A(1,1))/SKNBK2F(1,1)-1;FS=1.0
15 -2.458E-02 (SKNBK2(1,2)/SKNBK2A(1,2))/SKNBK2F(1,2)-1;FS=1.0
16  2.769E+00 (STFBK2(1,1)/STFBK2A(1,1))/STFBK2F(1,1)-1;FS=1.0
17  4.838E-02 (STFBK2(1,2)/STFBK2A(1,2))/STFBK2F(1,2)-1;FS=1.0
18  9.176E-02 (SKNST2A(1,1)/SKNST2(1,1))/SKNST2F(1,1)-1;FS=1.0
19  1.170E-02 (SKNST2A(1,2)/SKNST2(1,2))/SKNST2F(1,2)-1;FS=1.0
20  1.049E-01 (STFST2A(1,1)/STFST2(1,1))/STFST2F(1,1)-1;FS=1.0
21 -1.931E-02 (STFST2A(1,2)/STFST2(1,2))/STFST2F(1,2)-1;FS=1.0
22  1.185E+00 (WAPEX2A(1)/WAPEX2(1))/WAPEX2F(1)-1;FS=1.0
```

In these margins the "A" endings in names such as "CLAPS1A" denote "allowable". The "F" endings in names such as "CLAPS1F" denote "factor of safety". The margins are equal to the corresponding behavioral constraints minus 1.0. The chart below lists names that characterize the margin depending on its value, as follows:

Designation	The most negative margin must be greater than:	The most negative margin must be less than or equal to:
"FEASIBLE"	-0.01	------
"ALMOST FEASIBLE"	-0.05	-0.01
"MILDLY UNFEASIBLE"	-0.10	-0.05
"MORE UNFEASIBLE"	-0.15	-0.10
"MOSTLY UNFEASIBLE"	-0.20	-0.15
"NOT FEASIBLE"	------	-0.20

============ Analysis No. 1 for Load Set No. 1 ============
**** Start linear axisymmetric bifurcation buckling of perfect shell. IMODX= 0
**** The purpose is to get two axisymmetric buckling modal
**** imperfection shapes: mode 1 and mode 2.
BIGBOSOR4 input file for linear buckling,perfect shell=
eqellipse.ALL1
Input file for SUBROUTINE WALL for STAGS models=
eqellipse.STAGS

*** In STRUCT: IMODX, IDV=   0   0
****** WEIGHT= 8.6101E+01
Linear buckling eigenvalues from BIGBOSOR4, EGV(i)=
2.8386E+03 3.5262E+03 4.1902E+03 4.3751E+03 5.8141E+03
6.9852E+03 9.0675E+03 1.0883E+04 1.2440E+04 1.3618E+04
Linear axisymmetric buckling pressure of perfect shell= 1.3057E+03
Buckling modal normal displacement w at apex of shell,= 1.0000E+00

********* Buckling modal imperfection shape: mode 1 **********

Buckling mode 1 imperfection in Segment no. 1 WSAVEX=
1.0000E+00 9.9981E-01 9.9742E-01 9.9006E-01 9.7787E-01
9.6118E-01 9.4028E-01 9.1554E-01 8.8741E-01 8.5638E-01
8.2339E-01 7.9756E-01 7.8772E-01

Buckling mode 1 imperfection in Segment no. 2 WSAVEX=
7.8772E-01 7.7557E-01 7.4245E-01 6.9745E-01 6.5174E-01
6.0638E-01 5.6171E-01 5.1794E-01 4.7520E-01 4.3356E-01
3.9354E-01 3.6436E-01 3.5362E-01

Buckling mode 1 imperfection in Segment no. 3 WSAVEX=
3.5363E-01 3.4297E-01 3.1481E-01 2.7802E-01 2.4185E-01
2.0674E-01 1.7269E-01 1.3964E-01 1.0758E-01 7.6473E-02
4.6659E-02 2.4964E-02 1.6991E-02

Buckling mode 1 imperfection in Segment no. 4 WSAVEX=
1.7006E-02 9.0904E-03 -1.1800E-02 -3.9009E-02 -6.5639E-02

-9.1297E-02 -1.1594E-01 -1.3950E-01 -1.6192E-01 -1.8314E-01
-2.0283E-01 -2.1667E-01 -2.2164E-01

Buckling mode 1 imperfection in Segment no. 5 WSAVEX=
-2.2163E-01 -2.2649E-01 -2.3897E-01 -2.5429E-01 -2.6800E-01
-2.7970E-01 -2.8918E-01 -2.9619E-01 -3.0050E-01 -3.0186E-01
-3.0005E-01 -2.9653E-01 -2.9471E-01

Buckling mode 1 imperfection in Segment no. 6 WSAVEX=
-2.9472E-01 -2.9263E-01 -2.8574E-01 -2.7408E-01 -2.5995E-01
-2.4399E-01 -2.2661E-01 -2.0814E-01 -1.8886E-01 -1.6898E-01
-1.4894E-01 -1.3379E-01 -1.2811E-01

Buckling mode 1 imperfection in Segment no. 7 WSAVEX=
-1.2810E-01 -1.2388E-01 -1.1251E-01 -9.7237E-02 -8.1734E-02
-6.6229E-02 -5.0763E-02 -3.5378E-02 -2.0125E-02 -5.0600E-03
 9.5711E-03 2.0297E-02 2.4246E-02

Buckling mode 1 imperfection in Segment no. 8 WSAVEX=
 2.4234E-02 2.7684E-02 3.6810E-02 4.8716E-02 6.0355E-02
 7.1518E-02 8.2140E-02 9.2155E-02 1.0149E-01 1.1007E-01
 1.1773E-01 1.2287E-01 1.2466E-01

Buckling mode 1 imperfection in Segment no. 9 WSAVEX=
 1.2463E-01 1.2636E-01 1.3060E-01 1.3536E-01 1.3907E-01
 1.4162E-01 1.4297E-01 1.4310E-01 1.4200E-01 1.3965E-01
 1.3612E-01 1.3271E-01 1.3127E-01

Buckling mode 1 imperfection in Segment no. 10 WSAVEX=
 1.3128E-01 1.2975E-01 1.2521E-01 1.1822E-01 1.1019E-01
 1.0133E-01 9.1772E-02 8.1639E-02 7.1051E-02 6.0121E-02
 4.9095E-02 4.0764E-02 3.7644E-02

Buckling mode 1 imperfection in Segment no. 11 WSAVEX=
 3.7623E-02 3.4771E-02 2.7114E-02 1.6868E-02 6.5622E-03
-3.5953E-03 -1.3511E-02 -2.3075E-02 -3.2155E-02 -4.0594E-02
-4.8117E-02 -5.3089E-02 -5.4781E-02

Buckling mode 1 imperfection in Segment no. 12 WSAVEX=
-5.4840E-02 -5.6283E-02 -5.9771E-02 -6.3694E-02 -6.6898E-02

-6.9442E-02 -7.1423E-02 -7.2922E-02 -7.4009E-02 -7.4739E-02
-7.5151E-02 -7.5278E-02 -7.5289E-02

********* Buckling modal imperfection shape: mode 2 **********

Buckling mode 2 imperfection in Segment no. 1 WMODX2=
 1.0000E+00 9.9958E-01 9.9428E-01 9.7792E-01 9.5090E-01
 9.1403E-01 8.6820E-01 8.1455E-01 7.5438E-01 6.8920E-01
 6.2149E-01 5.6973E-01 5.5035E-01

Buckling mode 2 imperfection in Segment no. 2 WMODX2=
 5.5035E-01 5.2667E-01 4.6355E-01 3.8164E-01 3.0332E-01
 2.3077E-01 1.6462E-01 1.0511E-01 5.2240E-02 5.7982E-03
-3.4057E-02 -6.0147E-02 -6.9124E-02

Buckling mode 2 imperfection in Segment no. 3 WMODX2=
-6.9118E-02 -7.7696E-02 -9.8737E-02 -1.2272E-01 -1.4245E-01
-1.5796E-01 -1.6961E-01 -1.7777E-01 -1.8277E-01 -1.8493E-01
-1.8458E-01 -1.8286E-01 -1.8193E-01

Buckling mode 2 imperfection in Segment no. 4 WMODX2=
-1.8193E-01 -1.8085E-01 -1.7721E-01 -1.7069E-01 -1.6223E-01
-1.5199E-01 -1.4005E-01 -1.2652E-01 -1.1154E-01 -9.5226E-02
-7.7973E-02 -6.4445E-02 -5.9281E-02

Buckling mode 2 imperfection in Segment no. 5 WMODX2=
-5.9282E-02 -5.4056E-02 -3.9764E-02 -2.0126E-02 1.4207E-04
 2.0524E-02 4.0701E-02 6.0302E-02 7.8897E-02 9.5998E-02
 1.1089E-01 1.2038E-01 1.2348E-01

Buckling mode 2 imperfection in Segment no. 6 WMODX2=
 1.2348E-01 1.2635E-01 1.3282E-01 1.3893E-01 1.4237E-01
 1.4336E-01 1.4218E-01 1.3912E-01 1.3443E-01 1.2832E-01
 1.2111E-01 1.1506E-01 1.1268E-01

Buckling mode 2 imperfection in Segment no. 7 WMODX2=
 1.1267E-01 1.1086E-01 1.0581E-01 9.8630E-02 9.0867E-02
 8.2604E-02 7.3835E-02 6.4561E-02 5.4783E-02 4.4509E-02
 3.3891E-02 2.5666E-02 2.2536E-02

Buckling mode 2 imperfection in Segment no. 8 WMODX2=
 2.2543E-02 1.9766E-02 1.2200E-02 1.8232E-03 -8.9317E-03
-1.9883E-02 -3.0970E-02 -4.2121E-02 -5.3252E-02 -6.4270E-02
-7.4932E-02 -8.2683E-02 -8.5513E-02

Buckling mode 2 imperfection in Segment no. 9 WMODX2=
-8.5494E-02 -8.8304E-02 -9.5635E-02 -1.0491E-01 -1.1353E-01
-1.2125E-01 -1.2793E-01 -1.3343E-01 -1.3761E-01 -1.4036E-01
-1.4156E-01 -1.4142E-01 -1.4113E-01

Buckling mode 2 imperfection in Segment no. 10 WMODX2=
-1.4114E-01 -1.4072E-01 -1.3892E-01 -1.3509E-01 -1.2960E-01
-1.2261E-01 -1.1422E-01 -1.0457E-01 -9.3798E-02 -8.2058E-02
-6.9658E-02 -5.9961E-02 -5.6262E-02

Buckling mode 2 imperfection in Segment no. 11 WMODX2=
-5.6234E-02 -5.2818E-02 -4.3503E-02 -3.0703E-02 -1.7424E-02
-3.9152E-03 9.7028E-03 2.3275E-02 3.6602E-02 4.9426E-02
 6.1282E-02 6.9387E-02 7.2202E-02

Buckling mode 2 imperfection in Segment no. 12 WMODX2=
 7.2286E-02 7.4711E-02 8.0690E-02 8.7606E-02 9.3420E-02
 9.8150E-02 1.0191E-01 1.0480E-01 1.0692E-01 1.0835E-01
 1.0916E-01 1.0941E-01 1.0943E-01

============ Analysis No. 2 for Load Set No. 1 ============
*** Start nonlinear axisymmetric stress,+(mode 1) imperfection   IMODX= 0
BIGBOSOR4 input file for nonlinear stress,+(mode 1) imperfect=
eqellipse.ALL2P

*** Output from mode 1 INDIC=0, stress analysis; IMODX= 0 ***
Pressure multiplier, P, for all load steps=
 4.6000E+01 9.2000E+01 1.3800E+02 1.8400E+02 2.3000E+02
 2.7600E+02 3.2200E+02 3.6800E+02 4.1400E+02 4.6000E+02
End displacement, ENDUVS, for all load steps=

```
 2.8039E-02  5.6250E-02  8.4628E-02  1.1317E-01  1.4188E-01
 1.7076E-01  1.9982E-01  2.2909E-01  2.5860E-01  2.8842E-01

Local skin and smeared stiffener buckling and stress, Seg.   1
Skin buckling load factor,                    BUCMIN=  9.4633E+00 at nodal point  2
Smeared stringer/isogrid buckling load factor, BUCMNS=  2.9187E+00 at nodal point  1
Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress,  STFMXS=  8.6190E+04 at nodal point  8
Smeared ring maximum effective stress,         STFMXR=  0.0000E+00 at nodal point  0
Shell skin maximum effective stress,          SKNMAX=  4.7007E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.   2
Skin buckling load factor,                    BUCMIN=  8.6543E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS=  3.3413E+00 at nodal point  1
Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress,  STFMXS=  8.4631E+04 at nodal point  1
Smeared ring maximum effective stress,         STFMXR=  0.0000E+00 at nodal point  0
Shell skin maximum effective stress,          SKNMAX=  5.6745E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.   3
Skin buckling load factor,                    BUCMIN=  8.6478E+00 at nodal point  1
Smeared stringer/isogrid buckling load factor, BUCMNS=  1.0000E+17 at nodal point 13
Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress,  STFMXS=  3.4130E+04 at nodal point  1
Smeared ring maximum effective stress,         STFMXR=  0.0000E+00 at nodal point  0
Shell skin maximum effective stress,          SKNMAX=  6.1198E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.   4
Skin buckling load factor,                    BUCMIN=  3.0235E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS=  1.0000E+17 at nodal point 13
Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress,  STFMXS=  6.5071E+04 at nodal point 13
Smeared ring maximum effective stress,         STFMXR=  0.0000E+00 at nodal point  0
Shell skin maximum effective stress,          SKNMAX=  8.7084E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.   5
Skin buckling load factor,                    BUCMIN=  2.6863E+00 at nodal point 12
Smeared stringer/isogrid buckling load factor, BUCMNS=  1.0000E+17 at nodal point 13
Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress,  STFMXS=  6.9978E+04 at nodal point 13
```

Smeared ring maximum effective stress, STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress, SKNMAX= 8.9086E+04 at nodal point 8

Local skin and smeared stiffener buckling and stress, Seg. 6
Skin buckling load factor, BUCMIN= 2.6893E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.9258E+01 at nodal point 13
Smeared ring buckling load factor, BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 7.0013E+04 at nodal point 1
Smeared ring maximum effective stress, STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress, SKNMAX= 8.7480E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg. 7
Skin buckling load factor, BUCMIN= 3.1890E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.6103E+00 at nodal point 13
Smeared ring buckling load factor, BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 8.3139E+04 at nodal point 13
Smeared ring maximum effective stress, STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress, SKNMAX= 7.2323E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg. 8
Skin buckling load factor, BUCMIN= 4.2428E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.5813E+00 at nodal point 2
Smeared ring buckling load factor, BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.1415E+05 at nodal point 13
Smeared ring maximum effective stress, STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress, SKNMAX= 7.9991E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg. 9
Skin buckling load factor, BUCMIN= 4.2470E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.8018E+00 at nodal point 2
Smeared ring buckling load factor, BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.2476E+05 at nodal point 7
Smeared ring maximum effective stress, STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress, SKNMAX= 9.2786E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg. 10
Skin buckling load factor, BUCMIN= 4.8516E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 2.5233E+00 at nodal point 2
Smeared ring buckling load factor, BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.2200E+05 at nodal point 2

Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 9.2778E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg. 11
Skin buckling load factor,   BUCMIN= 4.5458E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS= 3.7129E+00 at nodal point 1
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.0622E+05 at nodal point 2
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 1.0543E+05 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg. 12
Skin buckling load factor,   BUCMIN= 4.5472E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 5.5937E+00 at nodal point 13
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 8.5788E+04 at nodal point 13
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 1.0541E+05 at nodal point 1

PERTURBED UNPERTURBED
Region 1 skin buckling load factor,   bskin1= 2.6863E+00 2.6863E+00
Region 1 stiffener buckling load factor,   bstif1= 2.9187E+00 2.9187E+00
Region 1 skin maximum effective stress,   sknmx1= 8.9086E+04 8.9086E+04
Region 1 stiffener max. effective stress, stfmx1= 8.6190E+04 8.6190E+04
Region 2 skin buckling load factor,   bskin2= 2.6893E+00 2.6893E+00
Region 2 stiffener buckling load factor,   bstif2= 1.5813E+00 1.5813E+00
Region 2 skin maximum effective stress,   sknmx2= 1.0543E+05 1.0543E+05
Region 2 stiffener max. effective stress, stfmx2= 1.2476E+05 1.2476E+05
Normal displacement of shell at apex,   ENDUV= 2.8842E-01 2.8842E-01

The following quantities are used to generate behavioral constraint conditions and margins:
PERTURBED UNPERTURBED
Region 1 skin buckling load factor,   bskin1= 2.6863E+00 2.6863E+00
Region 1 stiffener buckling load factor,   bstif1= 2.9187E+00 2.9187E+00
Region 1 skin maximum effective stress,   sknmx1= 8.9086E+04 8.9086E+04
Region 1 stiffener max. effective stress, stfmx1= 8.6190E+04 8.6190E+04
Region 2 skin buckling load factor,   bskin2= 2.6893E+00 2.6893E+00
Region 2 stiffener buckling load factor,   bstif2= 1.5813E+00 1.5813E+00
Region 2 skin maximum effective stress,   sknmx2= 1.0543E+05 1.0543E+05
Region 2 stiffener max. effective stress, stfmx2= 1.2476E+05 1.2476E+05

```
Normal displacement of shell at apex,       ENDUV=  2.8842E-01  2.8842E-01




============ Analysis No. 3 for Load Set No. 1 ============
*** Start nonlinear axisymmetric stress,+(mode 2) imperfection      IMODX= 0
BIGBOSOR4 input file for nonlinear stress,+(mode 2) imperfect=
eqellipse.ALL4P


*** Output from mode 2 INDIC=0, stress analysis; IMODX= 0 ***
Pressure multiplier, P, for all load steps=
 4.6000E+01  9.2000E+01  1.3800E+02  1.8400E+02  2.3000E+02
 2.7600E+02  3.2200E+02  3.6800E+02  4.1400E+02  4.6000E+02
End displacement, ENDUVS, for all load steps=
 2.9910E-02  6.0185E-02  9.0836E-02  1.2188E-01  1.5332E-01
 1.8520E-01  2.1751E-01  2.5030E-01  2.8360E-01  3.1743E-01

Local skin and smeared stiffener buckling and stress, Seg.   1
Skin buckling load factor,                    BUCMIN=  1.0223E+01 at nodal point  2
Smeared stringer/isogrid buckling load factor, BUCMNS=  1.9224E+00 at nodal point  1
Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress,  STFMXS=  1.2255E+05 at nodal point  3
Smeared ring maximum effective stress,         STFMXR=  0.0000E+00 at nodal point  0
Shell skin maximum effective stress,          SKNMAX=  5.3373E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.   2
Skin buckling load factor,                    BUCMIN=  7.3064E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS=  4.1002E+00 at nodal point  1
Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress,  STFMXS=  6.8967E+04 at nodal point  1
Smeared ring maximum effective stress,         STFMXR=  0.0000E+00 at nodal point  0
Shell skin maximum effective stress,          SKNMAX=  7.0925E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.   3
Skin buckling load factor,                    BUCMIN=  7.3011E+00 at nodal point  1
Smeared stringer/isogrid buckling load factor, BUCMNS=  1.0000E+17 at nodal point 13
Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress,  STFMXS=  4.3008E+04 at nodal point  1
```

Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 7.1210E+04 at nodal point 4

Local skin and smeared stiffener buckling and stress, Seg.   4
Skin buckling load factor,   BUCMIN= 2.9943E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.0000E+17 at nodal point 13
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 6.9629E+04 at nodal point 13
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 8.3938E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.   5
Skin buckling load factor,   BUCMIN= 2.9925E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.8143E+00 at nodal point 13
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 8.9031E+04 at nodal point 13
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 8.3974E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg.   6
Skin buckling load factor,   BUCMIN= 3.1488E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.7834E+00 at nodal point 2
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 8.9544E+04 at nodal point 1
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 6.9545E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg.   7
Skin buckling load factor,   BUCMIN= 3.4621E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.7368E+00 at nodal point 13
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 7.7081E+04 at nodal point 13
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 6.6328E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg.   8
Skin buckling load factor,   BUCMIN= 3.9860E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.7200E+00 at nodal point 2
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 7.8703E+04 at nodal point 2

Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 7.0892E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.   9
Skin buckling load factor,   BUCMIN= 3.9885E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 3.3026E+00 at nodal point 2
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 6.7528E+04 at nodal point 13
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 8.3523E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg. 10
Skin buckling load factor,   BUCMIN= 4.3321E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 4.2840E+00 at nodal point 13
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 9.1661E+04 at nodal point 13
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 8.6618E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg. 11
Skin buckling load factor,   BUCMIN= 4.8141E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS= 4.2701E+00 at nodal point 1
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.1479E+05 at nodal point 13
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 1.1436E+05 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg. 12
Skin buckling load factor,   BUCMIN= 4.8171E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 4.3387E+00 at nodal point 13
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.2331E+05 at nodal point 4
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 1.1438E+05 at nodal point 1

                                              PERTURBED UNPERTURBED
Region 1 skin buckling load factor,   bskin1= 2.9925E+00 2.9925E+00
Region 1 stiffener buckling load factor,   bstif1= 1.8143E+00 1.8143E+00
Region 1 skin maximum effective stress,   sknmx1= 8.3974E+04 8.3974E+04
Region 1 stiffener max. effective stress, stfmx1= 1.2255E+05 1.2255E+05

Region 2 skin buckling load factor,   bskin2= 3.1488E+00 3.1488E+00
Region 2 stiffener buckling load factor,   bstif2= 1.7200E+00 1.7200E+00
Region 2 skin maximum effective stress,   sknmx2= 1.1438E+05 1.1438E+05
Region 2 stiffener max. effective stress, stfmx2= 1.2331E+05 1.2331E+05
Normal displacement of shell at apex,   ENDUV= 3.1743E-01 3.1743E-01

The following quantities are used to generate behavioral constraint conditions and margins:
                                                PERTURBED UNPERTURBED
Region 1 skin buckling load factor,   bskin1= 2.9925E+00 2.9925E+00
Region 1 stiffener buckling load factor,   bstif1= 1.8143E+00 1.8143E+00
Region 1 skin maximum effective stress,   sknmx1= 8.3974E+04 8.3974E+04
Region 1 stiffener max. effective stress, stfmx1= 1.2255E+05 1.2255E+05
Region 2 skin buckling load factor,   bskin2= 3.1488E+00 3.1488E+00
Region 2 stiffener buckling load factor,   bstif2= 1.7200E+00 1.7200E+00
Region 2 skin maximum effective stress,   sknmx2= 1.1438E+05 1.1438E+05
Region 2 stiffener max. effective stress, stfmx2= 1.2331E+05 1.2331E+05
Normal displacement of shell at apex,   ENDUV= 3.1743E-01 3.1743E-01

============ Analysis No. 4 for Load Set No. 1 ============
** Start nonlinear axisymmetric collpse,+(mode 1) imperfection   IMODX= 0
BIGBOSOR4 input file, axisymmetric collpse, +mode 1 imperfect=
eqellipse.ALL6P

*** Output from +(mode 1) INDIC=0, collapse analysis; IMODX= 0 *********
Pressure multiplier, P, for all load steps=
 4.6000E+01 9.2000E+01 1.3800E+02 1.8400E+02 2.3000E+02
 2.7600E+02 3.2200E+02 3.6800E+02 4.1400E+02 4.6000E+02
 5.0600E+02 5.5200E+02 5.9800E+02 6.4400E+02 6.9000E+02
 7.3600E+02 7.8200E+02 8.2800E+02 8.3260E+02 8.3720E+02
 8.4180E+02 8.4640E+02 8.5100E+02 8.5560E+02 8.6020E+02
 8.6480E+02 8.6940E+02 8.7400E+02 8.7860E+02 8.8320E+02
 8.8780E+02 8.8826E+02 8.8872E+02 8.8918E+02 8.8964E+02
 8.9010E+02 8.9056E+02 8.9102E+02 8.9148E+02
End displacement, ENDUVS, for all load steps=
 2.8039E-02 5.6250E-02 8.4628E-02 1.1317E-01 1.4188E-01
 1.7076E-01 1.9982E-01 2.2909E-01 2.5860E-01 2.8842E-01

3.1864E-01 3.4943E-01 3.8102E-01 4.1382E-01 4.4851E-01
4.8631E-01 5.2972E-01 5.8489E-01 5.9161E-01 5.9865E-01
6.0608E-01 6.1395E-01 6.2233E-01 6.3134E-01 6.4110E-01
6.5179E-01 6.6368E-01 6.7715E-01 6.9288E-01 7.1211E-01
7.3788E-01 7.4110E-01 7.4449E-01 7.4809E-01 7.5193E-01
7.5606E-01 7.6055E-01 7.6550E-01 7.7105E-01

PERTURBED UNPERTURBED
Collapse pressure with +(mode 1): PSTEP(ISTEP)= 8.9148E+02 8.9148E+02

The following quantity is used to generate the behavioral constraint condition and margin:
PERTURBED UNPERTURBED
Collapse pressure with mode 1: CLAPS1(ILOADX)= 8.9148E+02 8.9148E+02

============ Analysis No. 5 for Load Set No. 1 ============
** Start nonlinear axisymmetric collpse,+(mode 2) imperfection   IMODX= 0
BIGBOSOR4 input file, axisymmetric collpse, +mode 2 imperfect=
eqellipse.ALL7P

*** Output from +(mode 2) INDIC=0, collapse analysis; IMODX= 0 *********
Pressure multiplier, P, for all load steps=
4.6000E+01 9.2000E+01 1.3800E+02 1.8400E+02 2.3000E+02
2.7600E+02 3.2200E+02 3.6800E+02 4.1400E+02 4.6000E+02
5.0600E+02 5.5200E+02 5.9800E+02 6.4400E+02 6.9000E+02
7.3600E+02 7.8200E+02 8.2800E+02 8.7400E+02 9.2000E+02
End displacement, ENDUVS, for all load steps=
2.9910E-02 6.0185E-02 9.0836E-02 1.2188E-01 1.5332E-01
1.8520E-01 2.1751E-01 2.5030E-01 2.8360E-01 3.1743E-01
3.5186E-01 3.8692E-01 4.2270E-01 4.5927E-01 4.9675E-01
5.3526E-01 5.7499E-01 6.1616E-01 6.5905E-01 7.0406E-01

PERTURBED UNPERTURBED
Collapse pressure with +(mode 2): PSTEP(ISTEP)= 9.2000E+02 9.2000E+02

The following quantity is used to generate the behavioral constraint condition and margin:
PERTURBED UNPERTURBED

Collapse pressure with mode 2: CLAPS2(ILOADX)= 9.2000E+02 9.2000E+02

============ Analysis No. 6 for Load Set No. 1 ============
** Start nonlinear bifurcation buckling,+(mode 1) imperfection   IMODX= 0
BIGBOSOR4 input file, bifurcation buckling, +(mode 1) imperf.=
eqellipse.ALL8P

******* Nonlinear overall bifurcation buckling results ******
Overall buckling, +(mode 1) imperfection shape; Applied pressure, PMAX = 4.6000E+02
*** Output from +(mode 1) INDIC=1, buckling analysis; IMODX= 0 *********

**** CRITICAL EIGENVALUE AND WAVENUMBER ****
EIGCRT= 1.5888E+03; NO. OF CIRC. WAVES, NWVCRT=   2
****

***** EIGENVALUES AND MODE SHAPES *****
EIGENVALUE(CIRC. WAVES)
==
1.8046E+03(0)
1.8932E+03(1)
1.5888E+03(2)
1.8533E+03(3)
2.5006E+03(4)
3.3465E+03(5)
4.3555E+03(6)
5.5194E+03(7)
6.8261E+03(8)
8.2624E+03(9)
9.8146E+03(10)
1.1469E+04(11)
1.3219E+04(12)
1.5061E+04(13)
1.6996E+04(14)
1.9024E+04(15)
2.1145E+04(16)
2.3359E+04(17)

```
   2.5666E+04(  18)
   2.8066E+04(  19)
   3.0559E+04(  20)
   3.3145E+04(  21)
   3.5823E+04(  22)
   3.8591E+04(  23)
   4.1449E+04(  24)
   4.4394E+04(  25)
   4.7426E+04(  26)
   5.0540E+04(  27)
   5.3732E+04(  28)
   5.6995E+04(  29)
   6.0318E+04(  30)
==========================================

**** CRITICAL NEGATIVE EIGENVALUE AND WAVENUMBER ****
EIGCRN=  0.0000E+00; NO. OF CIRC. WAVES, NWVCRN=*****
****************************************************

***** NEGATIVE EIGENVALUES AND MODE SHAPES *****
 EIGENVALUE(CIRC. WAVES)
==========================================
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
```

0.0000E+00(****)
0.0000E+00(****)
0.0000E+00(****)
0.0000E+00(****)
0.0000E+00(****)
0.0000E+00(****)
0.0000E+00(****)
0.0000E+00(****)
0.0000E+00(****)
0.0000E+00(****)
0.0000E+00(****)
0.0000E+00(****)
0.0000E+00(****)
==

Nonlinear bifurcation buckling pressure, BUCPRSP(circ.waves)= 1.1908E+03(2)
General bifurcation buckling load factor, GENBK1(ILOADX)= 2.5888E+00

PERTURBED UNPERTURBED
Nonlin. bifurcation buckling, +(mode 1):BUCPRSP= 1.1908E+03 1.1908E+03

IMODX=0: M1MULTB,NWAV1,PMAXBUC1=   1   2 4.6000E+02

The following quantity is used to generate the behavioral constraint condition and margin:
PERTURBED UNPERTURBED
Nonlin. bifurcation buckling, +(mode 1):BUCPRS = 1.1908E+03 1.1908E+03

============ Analysis No. 7 for Load Set No. 1 ============
** Start nonlinear bifurcation buckling,+(mode 2) imperfection   IMODX= 0
BIGBOSOR4 input file, bifurcation buckling, +(mode 2) imperf.=
eqellipse.ALL9P

***** Nonlinear overall bifurcation buckling results *****
Overall buckling, +(mode 2) imperfection shape; Applied pressure, PMAX = 4.6000E+02

```
** Output from +(mode 2) INDIC=1, buckling analysis;IMODX= 0 *********

**** CRITICAL EIGENVALUE AND WAVENUMBER ****
EIGCRT=  1.6818E+03; NO. OF CIRC. WAVES, NWVCRT=    2
***************************************************

***** EIGENVALUES AND MODE SHAPES *****
 EIGENVALUE(CIRC. WAVES)
==========================================
   1.7508E+03(   0)
   1.9480E+03(   1)
   1.6818E+03(   2)
   2.3983E+03(   3)
   3.4325E+03(   4)
   4.6169E+03(   5)
   5.8975E+03(   6)
   7.1725E+03(   7)
   8.3814E+03(   8)
   9.6440E+03(   9)
   1.1059E+04(  10)
   1.2661E+04(  11)
   1.4455E+04(  12)
   1.6421E+04(  13)
   1.8531E+04(  14)
   2.0757E+04(  15)
   2.3086E+04(  16)
   2.5523E+04(  17)
   2.8088E+04(  18)
   3.0802E+04(  19)
   3.3684E+04(  20)
   3.6745E+04(  21)
   3.9991E+04(  22)
   4.3425E+04(  23)
   4.7044E+04(  24)
   5.0840E+04(  25)
   5.4802E+04(  26)
   5.8910E+04(  27)
   6.3134E+04(  28)
   6.7419E+04(  29)
   7.1609E+04(  30)
```

```
=========================================

**** CRITICAL NEGATIVE EIGENVALUE AND WAVENUMBER ****
EIGCRN=  0.0000E+00; NO. OF CIRC. WAVES, NWVCRN=*****
*******************************************************

***** NEGATIVE EIGENVALUES AND MODE SHAPES *****
 EIGENVALUE(CIRC. WAVES)
=========================================
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
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   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
```

==

Nonlinear bifurcation buckling pressure, BUCPRSP(circ.waves)= 1.2336E+03(2)
General bifurcation buckling load factor, GENBK2(ILOADX)= 2.6818E+00

PERTURBED UNPERTURBED
Nonlin. bifurcation buckling, +(mode 2):BUCPRSP= 1.2336E+03 1.2336E+03

IMODX=0: M2MULTB,NWAV2,PMAXBUC2=   1   2 4.6000E+02

The following quantity is used to generate the behavioral constraint condition and margin:
PERTURBED UNPERTURBED
Nonlin. bifurcation buckling, +(mode 2):BUCPRS = 1.2336E+03 1.2336E+03

********* End of all analysis. IMODX= 0 **************

1   891.4798   collapse pressure with imperfection mode 1: CLAPS1(1)
2   2.588776   general buckling load factor, mode 1: GENBK1(1)

BEHAVIOR OVER J = number of regions for computing behavior
3   2.686344   buckling load of skin: SKNBK1(1 ,1)
4   2.689327   buckling load of skin: SKNBK1(1 ,2)

BEHAVIOR OVER J = number of regions for computing behavior
5   2.918745   buckling load factor, isogrid member, mode 1: STFBK1(1 ,1)
6   1.581270   buckling load factor, isogrid member, mode 1: STFBK1(1 ,2)

BEHAVIOR OVER J = number of regions for computing behavior
7   89086.03   maximum stress in the shell skin, mode 1: SKNST1(1 ,1)
8   105429.2   maximum stress in the shell skin, mode 1: SKNST1(1 ,2)

BEHAVIOR OVER J = number of regions for computing behavior
9   86189.76   maximum stress in isogrid stiffener, mode 1: STFST1(1 ,1)
10   124760.8   maximum stress in isogrid stiffener, mode 1: STFST1(1 ,2)
11   0.2884182   normal (axial) displacement at apex, mode 1: WAPEX1(1)
12   920.0000   collapse pressure with imperfection mode 2: CLAPS2(1)

13 2.681802 general buckling load factor, mode 2: GENBK2(1)

BEHAVIOR OVER J = number of regions for computing behavior
14 2.992498 local skin buckling load factor, mode 2: SKNBK2(1 ,1)
15 3.148841 local skin buckling load factor, mode 2: SKNBK2(1 ,2)

BEHAVIOR OVER J = number of regions for computing behavior
16 1.814337 buckling load factor for isogrid member: STFBK2(1 ,1)
17 1.720039 buckling load factor for isogrid member: STFBK2(1 ,2)

BEHAVIOR OVER J = number of regions for computing behavior
18 83974.45 maximum stress in the shell skin, mode 2: SKNST2(1 ,1)
19 114376.4 maximum stress in the shell skin, mode 2: SKNST2(1 ,2)

BEHAVIOR OVER J = number of regions for computing behavior
20 122546.8 maximum stress in isogrid stiffener, mode 2: STFST2(1 ,1)
21 123313.6 maximum stress in isogrid stiffener, mode 2: STFST2(1 ,2)
22 0.3174349 normal (axial) displacement at apex, mode 2: WAPEX2(1)

***** RESULTS FOR LOAD SET NO. 1 ******
PARAMETERS WHICH DESCRIBE BEHAVIOR (e.g. stress, buckling load)

BEH. NO.	CURRENT VALUE	DEFINITION
1	8.915E+02	collapse pressure with imperfection mode 1: CLAPS1(1)
2	2.589E+00	general buckling load factor, mode 1: GENBK1(1)
3	2.686E+00	buckling load of skin: SKNBK1(1 ,1)
4	2.689E+00	buckling load of skin: SKNBK1(1 ,2)
5	2.919E+00	buckling load factor, isogrid member, mode 1: STFBK1(1 ,1)
6	1.581E+00	buckling load factor, isogrid member, mode 1: STFBK1(1 ,2)
7	8.909E+04	maximum stress in the shell skin, mode 1: SKNST1(1 ,1)
8	1.054E+05	maximum stress in the shell skin, mode 1: SKNST1(1 ,2)
9	8.619E+04	maximum stress in isogrid stiffener, mode 1: STFST1(1 ,1)
10	1.248E+05	maximum stress in isogrid stiffener, mode 1: STFST1(1 ,2)
11	2.884E-01	normal (axial) displacement at apex, mode 1: WAPEX1(1)
12	9.200E+02	collapse pressure with imperfection mode 2: CLAPS2(1)
13	2.682E+00	general buckling load factor, mode 2: GENBK2(1)
14	2.992E+00	local skin buckling load factor, mode 2: SKNBK2(1 ,1)
15	3.149E+00	local skin buckling load factor, mode 2: SKNBK2(1 ,2)
16	1.814E+00	buckling load factor for isogrid member: STFBK2(1 ,1)

17   1.720E+00   buckling load factor for isogrid member: STFBK2(1 ,2)
18   8.397E+04   maximum stress in the shell skin, mode 2: SKNST2(1 ,1)
19   1.144E+05   maximum stress in the shell skin, mode 2: SKNST2(1 ,2)
20   1.225E+05   maximum stress in isogrid stiffener, mode 2: STFST2(1 ,1)
21   1.233E+05   maximum stress in isogrid stiffener, mode 2: STFST2(1 ,2)
22   3.174E-01   normal (axial) displacement at apex, mode 2: WAPEX2(1)

******* NOTE ******* NOTE ******* NOTE ****** NOTE ******
The phrase, "NOT APPLY", for MARGIN VALUE means that that
particular margin value is exactly zero.
*** END NOTE *** END NOTE *** END NOTE *** END NOTE *****

***** RESULTS FOR LOAD SET NO. 1 ******
MARGINS CORRESPONDING TO CURRENT DESIGN (F.S.= FACTOR OF SAFETY)

MARGIN CURRENT
NO.   VALUE   DEFINITION
 1   6.209E-01 (CLAPS1(1)/CLAPS1A(1)) / CLAPS1F(1)-1; F.S.= 1.00
 2   1.589E+00 (GENBK1(1)/GENBK1A(1)) / GENBK1F(1)-1; F.S.= 1.00
 3   1.686E+00 (SKNBK1(1 ,1)/SKNBK1A(1 ,1)) / SKNBK1F(1 ,1)-1; F.S.= 1.00
 4   1.689E+00 (SKNBK1(1 ,2)/SKNBK1A(1 ,2)) / SKNBK1F(1 ,2)-1; F.S.= 1.00
 5   1.919E+00 (STFBK1(1 ,1)/STFBK1A(1 ,1)) / STFBK1F(1 ,1)-1; F.S.= 1.00
 6   5.813E-01 (STFBK1(1 ,2)/STFBK1A(1 ,2)) / STFBK1F(1 ,2)-1; F.S.= 1.00
 7   3.470E-01 (SKNST1A(1 ,1)/SKNST1(1 ,1)) / SKNST1F(1 ,1)-1; F.S.= 1.00
 8   1.382E-01 (SKNST1A(1 ,2)/SKNST1(1 ,2)) / SKNST1F(1 ,2)-1; F.S.= 1.00
 9   3.923E-01 (STFST1A(1 ,1)/STFST1(1 ,1)) / STFST1F(1 ,1)-1; F.S.= 1.00
10   -3.816E-02 (STFST1A(1 ,2)/STFST1(1 ,2)) / STFST1F(1 ,2)-1; F.S.= 1.00
11   1.427E+00 (WAPEX1A(1)/WAPEX1(1)) / WAPEX1F(1)-1; F.S.= 1.00
12   6.727E-01 (CLAPS2(1)/CLAPS2A(1)) / CLAPS2F(1)-1; F.S.= 1.00
13   1.682E+00 (GENBK2(1)/GENBK2A(1)) / GENBK2F(1)-1; F.S.= 1.00
14   1.992E+00 (SKNBK2(1 ,1)/SKNBK2A(1 ,1)) / SKNBK2F(1 ,1)-1; F.S.= 1.00
15   2.149E+00 (SKNBK2(1 ,2)/SKNBK2A(1 ,2)) / SKNBK2F(1 ,2)-1; F.S.= 1.00
16   8.143E-01 (STFBK2(1 ,1)/STFBK2A(1 ,1)) / STFBK2F(1 ,1)-1; F.S.= 1.00
17   7.200E-01 (STFBK2(1 ,2)/STFBK2A(1 ,2)) / STFBK2F(1 ,2)-1; F.S.= 1.00
18   4.290E-01 (SKNST2A(1 ,1)/SKNST2(1 ,1)) / SKNST2F(1 ,1)-1; F.S.= 1.00
19   4.917E-02 (SKNST2A(1 ,2)/SKNST2(1 ,2)) / SKNST2F(1 ,2)-1; F.S.= 1.00
20   -2.078E-02 (STFST2A(1 ,1)/STFST2(1 ,1)) / STFST2F(1 ,1)-1; F.S.= 1.00
21   -2.687E-02 (STFST2A(1 ,2)/STFST2(1 ,2)) / STFST2F(1 ,2)-1; F.S.= 1.00
22   1.205E+00 (WAPEX2A(1)/WAPEX2(1)) / WAPEX2F(1)-1; F.S.= 1.00

0

STRUCTURAL ANALYSIS WITH UNPERTURBED DECISION VARIABLES

VAR. NO.	DEC. VAR.	ESCAPE VAR.	LINK. VAR.	LINKED TO	LINKING CONSTANT	LOWER BOUND	CURRENT VALUE	UPPER BOUND	DEFINITION
1	Y	N	N	0	0.00E+00	1.00E-01	1.2453E-01	1.00E+00	skin thickness at xinput: THKSKN(1)
2	Y	N	N	0	0.00E+00	1.00E-01	1.6641E-01	1.00E+00	skin thickness at xinput: THKSKN(2)
3	Y	N	N	0	0.00E+00	1.00E-01	1.4460E-01	1.00E+00	skin thickness at xinput: THKSKN(3)
4	Y	N	N	0	0.00E+00	1.00E-01	1.6082E-01	1.00E+00	skin thickness at xinput: THKSKN(4)
5	Y	N	N	0	0.00E+00	1.00E-01	1.0412E-01	1.00E+00	skin thickness at xinput: THKSKN(5)
6	Y	N	N	0	0.00E+00	1.00E-01	1.0000E-01	1.00E+00	skin thickness at xinput: THKSKN(6)
7	Y	N	N	0	0.00E+00	1.00E-01	1.0162E-01	1.00E+00	skin thickness at xinput: THKSKN(7)
8	Y	N	N	0	0.00E+00	1.00E-01	1.3795E-01	1.00E+00	skin thickness at xinput: THKSKN(8)
9	Y	N	N	0	0.00E+00	1.00E-01	1.0201E-01	1.00E+00	skin thickness at xinput: THKSKN(9)
10	Y	N	N	0	0.00E+00	1.00E-01	1.0411E-01	1.00E+00	skin thickness at xinput: THKSKN(10)
11	Y	N	N	0	0.00E+00	1.00E-01	1.9869E-01	1.00E+00	skin thickness at xinput: THKSKN(11)
12	Y	N	N	0	0.00E+00	1.00E-01	1.0000E-01	1.00E+00	skin thickness at xinput: THKSKN(12)
13	Y	N	N	0	0.00E+00	1.00E-01	1.9779E-01	1.00E+00	skin thickness at xinput: THKSKN(13)
14	Y	N	N	0	0.00E+00	5.00E-01	6.6766E-01	3.00E+00	height of isogrid members at xinput: HIGHST(1)
15	Y	N	N	0	0.00E+00	5.00E-01	6.0783E-01	3.00E+00	height of isogrid members at xinput: HIGHST(2)
16	Y	N	N	0	0.00E+00	5.00E-01	9.7928E-01	3.00E+00	height of isogrid members at xinput: HIGHST(3)
17	Y	N	N	0	0.00E+00	2.00E-01	1.2562E+00	3.00E+00	height of isogrid members at xinput: HIGHST(4)
18	Y	N	N	0	0.00E+00	2.00E-01	1.1540E+00	3.00E+00	height of isogrid members at xinput: HIGHST(5)

19 Y N N 0 0.00E+00 2.00E-01 8.0422E-01 3.00E+00 height of isogrid members at xinput: HIGHST(6)
20 Y N N 0 0.00E+00 2.00E-01 1.2686E+00 3.00E+00 height of isogrid members at xinput: HIGHST(7)
21 Y N N 0 0.00E+00 2.00E-01 8.8339E-01 3.00E+00 height of isogrid members at xinput: HIGHST(8)
22 Y N N 0 0.00E+00 2.00E-01 7.0560E-01 3.00E+00 height of isogrid members at xinput: HIGHST(9)
23 Y N N 0 0.00E+00 2.00E-01 5.8445E-01 3.00E+00 height of isogrid members at xinput: HIGHST(10)
24 Y N N 0 0.00E+00 2.00E-01 5.1581E-01 3.00E+00 height of isogrid members at xinput: HIGHST(11)
25 Y N N 0 0.00E+00 2.00E-01 3.4417E-01 3.00E+00 height of isogrid members at xinput: HIGHST(12)
26 Y N N 0 0.00E+00 2.00E-01 4.6660E-01 3.00E+00 height of isogrid members at xinput: HIGHST(13)
27 Y N N 0 0.00E+00 1.00E+00 2.9154E+00 3.00E+00 spacing of the isogrid members: SPACNG
28 Y N N 0 0.00E+00 5.00E-02 9.0531E-02 1.00E+00 thickness of an isogrid stiffening member: THSTIF

BEHAVIOR FOR 2 ENVIRONMENT (LOAD SET)

CONSTRAINT BEHAVIOR DEFINITION
NUMBER VALUE

BEHAVIOR FOR LOAD SET NUMBER, ILOADX= 2

****
Start of all analyses:
Design iteration 1, Load Set 2, IMODX= 0, Dec.var.no.,IDV= 0
****

SUBROUTINE STRUCT computes seven "behaviors" (stress, collapse, bifurcation buckling, etc.). The seven behaviors are:

1. linear axisymmetric buckling of the perfect ellipsoid in order to obtain 2 or 4 axisymmetric buckling modes (NCASES = 2 or 4) which are to be used as initial imperfection shapes in the following analyses 2 - 7, listed next.
2. nonlinear axisymmetric stress with mode 1 imperfection
3. nonlinear axisymmetric stress with mode 2 imperfection

4. axisymmetric collapse with mode 1 imperfection
5. axisymmetric collapse with mode 2 imperfection
6. nonlinear bifurcation buckling with mode 1 imperfection
7. nonlinear bifurcation buckling with mode 2 imperfection.

Brief description of each of the seven analyses corresponding to the seven "behaviors" just listed:

1. Ten axisymmetric buckling modes are computed from linear analysis. Only two modes are used for imperfection shapes:
   A. The mode corresponding to the lowest buckling load, and
   B. one other mode, usually the 2nd mode.

   For each of mode 1 and mode 2, the actual imperfection is the normalized buckling modal w-deflection times an amplitude factor supplied by the user by means of "BEGIN".

```
============ Analysis No. 1 for Load Set No. 2 ============
**** Start linear axisymmetric bifurcation buckling of perfect shell. IMODX= 0
**** The purpose is to get two axisymmetric buckling modal
**** imperfection shapes: mode 1 and mode 2.
BIGBOSOR4 input file for linear buckling,perfect shell=
eqellipse.ALL1


*** In STRUCT: IMODX, IDV=       0       0
****** WEIGHT=  8.6101E+01
Linear buckling eigenvalues from BIGBOSOR4, EGV(i)=
 2.8386E+03  3.5262E+03  4.1902E+03  4.3751E+03  5.8141E+03
 6.9852E+03  9.0675E+03  1.0883E+04  1.2440E+04  1.3618E+04
Linear axisymmetric buckling pressure of perfect shell=  1.3057E+03
Buckling modal normal displacement w at apex of shell,=  1.0000E+00


********* Buckling modal imperfection shape: mode 1 **********

Buckling mode 1 imperfection in Segment no.  1 WSAVEX=
```

1.0000E+00 9.9981E-01 9.9742E-01 9.9006E-01 9.7787E-01
9.6118E-01 9.4028E-01 9.1554E-01 8.8741E-01 8.5638E-01
8.2339E-01 7.9756E-01 7.8772E-01

Buckling mode 1 imperfection in Segment no. 2 WSAVEX=
7.8772E-01 7.7557E-01 7.4245E-01 6.9745E-01 6.5174E-01
6.0638E-01 5.6171E-01 5.1794E-01 4.7520E-01 4.3356E-01
3.9354E-01 3.6436E-01 3.5362E-01

Buckling mode 1 imperfection in Segment no. 3 WSAVEX=
3.5363E-01 3.4297E-01 3.1481E-01 2.7802E-01 2.4185E-01
2.0674E-01 1.7269E-01 1.3964E-01 1.0758E-01 7.6473E-02
4.6659E-02 2.4964E-02 1.6991E-02

Buckling mode 1 imperfection in Segment no. 4 WSAVEX=
1.7006E-02 9.0904E-03 -1.1800E-02 -3.9009E-02 -6.5639E-02
-9.1297E-02 -1.1594E-01 -1.3950E-01 -1.6192E-01 -1.8314E-01
-2.0283E-01 -2.1667E-01 -2.2164E-01

Buckling mode 1 imperfection in Segment no. 5 WSAVEX=
-2.2163E-01 -2.2649E-01 -2.3897E-01 -2.5429E-01 -2.6800E-01
-2.7970E-01 -2.8918E-01 -2.9619E-01 -3.0050E-01 -3.0186E-01
-3.0005E-01 -2.9653E-01 -2.9471E-01

Buckling mode 1 imperfection in Segment no. 6 WSAVEX=
-2.9472E-01 -2.9263E-01 -2.8574E-01 -2.7408E-01 -2.5995E-01
-2.4399E-01 -2.2661E-01 -2.0814E-01 -1.8886E-01 -1.6898E-01
-1.4894E-01 -1.3379E-01 -1.2811E-01

Buckling mode 1 imperfection in Segment no. 7 WSAVEX=
-1.2810E-01 -1.2388E-01 -1.1251E-01 -9.7237E-02 -8.1734E-02
-6.6229E-02 -5.0763E-02 -3.5378E-02 -2.0125E-02 -5.0600E-03
9.5711E-03 2.0297E-02 2.4246E-02

Buckling mode 1 imperfection in Segment no. 8 WSAVEX=
2.4234E-02 2.7684E-02 3.6810E-02 4.8716E-02 6.0355E-02
7.1518E-02 8.2140E-02 9.2155E-02 1.0149E-01 1.1007E-01
1.1773E-01 1.2287E-01 1.2466E-01

Buckling mode 1 imperfection in Segment no. 9 WSAVEX=

1.2463E-01 1.2636E-01 1.3060E-01 1.3536E-01 1.3907E-01
1.4162E-01 1.4297E-01 1.4310E-01 1.4200E-01 1.3965E-01
1.3612E-01 1.3271E-01 1.3127E-01

Buckling mode 1 imperfection in Segment no. 10 WSAVEX=
1.3128E-01 1.2975E-01 1.2521E-01 1.1822E-01 1.1019E-01
1.0133E-01 9.1772E-02 8.1639E-02 7.1051E-02 6.0121E-02
4.9095E-02 4.0764E-02 3.7644E-02

Buckling mode 1 imperfection in Segment no. 11 WSAVEX=
3.7623E-02 3.4771E-02 2.7114E-02 1.6868E-02 6.5622E-03
-3.5953E-03 -1.3511E-02 -2.3075E-02 -3.2155E-02 -4.0594E-02
-4.8118E-02 -5.3089E-02 -5.4781E-02

Buckling mode 1 imperfection in Segment no. 12 WSAVEX=
-5.4840E-02 -5.6283E-02 -5.9771E-02 -6.3694E-02 -6.6898E-02
-6.9442E-02 -7.1423E-02 -7.2922E-02 -7.4010E-02 -7.4739E-02
-7.5151E-02 -7.5278E-02 -7.5289E-02

********* Buckling modal imperfection shape: mode 2 **********

Buckling mode 2 imperfection in Segment no. 1 WMODX2=
1.0000E+00 9.9958E-01 9.9428E-01 9.7792E-01 9.5090E-01
9.1403E-01 8.6820E-01 8.1455E-01 7.5438E-01 6.8920E-01
6.2149E-01 5.6973E-01 5.5035E-01

Buckling mode 2 imperfection in Segment no. 2 WMODX2=
5.5035E-01 5.2667E-01 4.6355E-01 3.8164E-01 3.0332E-01
2.3077E-01 1.6462E-01 1.0511E-01 5.2240E-02 5.7982E-03
-3.4057E-02 -6.0147E-02 -6.9124E-02

Buckling mode 2 imperfection in Segment no. 3 WMODX2=
-6.9118E-02 -7.7696E-02 -9.8737E-02 -1.2272E-01 -1.4245E-01
-1.5796E-01 -1.6961E-01 -1.7777E-01 -1.8277E-01 -1.8493E-01
-1.8458E-01 -1.8286E-01 -1.8193E-01

Buckling mode 2 imperfection in Segment no. 4 WMODX2=
-1.8193E-01 -1.8085E-01 -1.7721E-01 -1.7069E-01 -1.6223E-01
-1.5199E-01 -1.4005E-01 -1.2652E-01 -1.1154E-01 -9.5225E-02

-7.7973E-02 -6.4445E-02 -5.9281E-02

Buckling mode 2 imperfection in Segment no. 5 WMODX2=
-5.9282E-02 -5.4056E-02 -3.9764E-02 -2.0126E-02 1.4208E-04
 2.0524E-02 4.0701E-02 6.0302E-02 7.8897E-02 9.5998E-02
 1.1089E-01 1.2038E-01 1.2348E-01

Buckling mode 2 imperfection in Segment no. 6 WMODX2=
 1.2348E-01 1.2635E-01 1.3282E-01 1.3893E-01 1.4237E-01
 1.4336E-01 1.4218E-01 1.3912E-01 1.3443E-01 1.2832E-01
 1.2111E-01 1.1506E-01 1.1268E-01

Buckling mode 2 imperfection in Segment no. 7 WMODX2=
 1.1267E-01 1.1086E-01 1.0581E-01 9.8630E-02 9.0867E-02
 8.2604E-02 7.3835E-02 6.4561E-02 5.4783E-02 4.4509E-02
 3.3891E-02 2.5666E-02 2.2536E-02

Buckling mode 2 imperfection in Segment no. 8 WMODX2=
 2.2543E-02 1.9766E-02 1.2200E-02 1.8232E-03 -8.9317E-03
-1.9883E-02 -3.0970E-02 -4.2121E-02 -5.3252E-02 -6.4270E-02
-7.4932E-02 -8.2683E-02 -8.5513E-02

Buckling mode 2 imperfection in Segment no. 9 WMODX2=
-8.5494E-02 -8.8304E-02 -9.5635E-02 -1.0491E-01 -1.1353E-01
-1.2125E-01 -1.2793E-01 -1.3343E-01 -1.3761E-01 -1.4036E-01
-1.4156E-01 -1.4142E-01 -1.4113E-01

Buckling mode 2 imperfection in Segment no. 10 WMODX2=
-1.4114E-01 -1.4072E-01 -1.3892E-01 -1.3509E-01 -1.2960E-01
-1.2261E-01 -1.1422E-01 -1.0457E-01 -9.3798E-02 -8.2058E-02
-6.9658E-02 -5.9961E-02 -5.6262E-02

Buckling mode 2 imperfection in Segment no. 11 WMODX2=
-5.6234E-02 -5.2818E-02 -4.3503E-02 -3.0703E-02 -1.7424E-02
-3.9152E-03 9.7028E-03 2.3275E-02 3.6602E-02 4.9426E-02
 6.1282E-02 6.9387E-02 7.2202E-02

Buckling mode 2 imperfection in Segment no. 12 WMODX2=
 7.2286E-02 7.4711E-02 8.0690E-02 8.7606E-02 9.3420E-02
 9.8150E-02 1.0191E-01 1.0480E-01 1.0692E-01 1.0835E-01

```
 1.0916E-01  1.0941E-01  1.0943E-01




 ============ Analysis No. 2 for Load Set No. 2 ============
 *** Start nonlinear axisymmetric stress,-(mode 1) imperfection      IMODX= 0
 BIGBOSOR4 input file for nonlinear stress,-(mode 1) imperfect=
eqellipse.ALL2N


 *** Output from mode 1 INDIC=0, stress analysis; IMODX= 0 ***
 Pressure multiplier, P, for all load steps=
  4.6000E+01  9.2000E+01  1.3800E+02  1.8400E+02  2.3000E+02
  2.7600E+02  3.2200E+02  3.6800E+02  4.1400E+02  4.6000E+02
 End displacement, ENDUVS, for all load steps=
  4.2352E-02  8.6127E-02  1.3151E-01  1.7876E-01  2.2820E-01
  2.8028E-01  3.3567E-01  3.9542E-01  4.6127E-01  5.3669E-01

 Local skin and smeared stiffener buckling and stress, Seg.   1
 Skin buckling load factor,                    BUCMIN=  3.9282E+00 at nodal point  2
 Smeared stringer/isogrid buckling load factor, BUCMNS=  5.4718E+00 at nodal point 13
 Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
 Smeared stringer/isogrid maximum eff. stress,  STFMXS=  1.0224E+05 at nodal point  2
 Smeared ring maximum effective stress,        STFMXR=  0.0000E+00 at nodal point  0
 Shell skin maximum effective stress,          SKNMAX=  1.2052E+05 at nodal point  3

 Local skin and smeared stiffener buckling and stress, Seg.   2
 Skin buckling load factor,                    BUCMIN=  6.9070E+00 at nodal point 13
 Smeared stringer/isogrid buckling load factor, BUCMNS=  1.5913E+00 at nodal point 12
 Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
 Smeared stringer/isogrid maximum eff. stress,  STFMXS=  7.7984E+04 at nodal point  7
 Smeared ring maximum effective stress,        STFMXR=  0.0000E+00 at nodal point  0
 Shell skin maximum effective stress,          SKNMAX=  8.9581E+04 at nodal point  1

 Local skin and smeared stiffener buckling and stress, Seg.   3
 Skin buckling load factor,                    BUCMIN=  6.8926E+00 at nodal point  1
 Smeared stringer/isogrid buckling load factor, BUCMNS=  1.1519E+00 at nodal point 13
 Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
 Smeared stringer/isogrid maximum eff. stress,  STFMXS=  6.9503E+04 at nodal point  4
```

Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 7.4727E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg.   4
Skin buckling load factor,   BUCMIN= 3.1695E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.1477E+00 at nodal point 1
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 7.1231E+04 at nodal point 13
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 7.5136E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.   5
Skin buckling load factor,   BUCMIN= 3.1685E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.3509E+00 at nodal point 10
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.1764E+05 at nodal point 13
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 7.5150E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg.   6
Skin buckling load factor,   BUCMIN= 3.2980E+00 at nodal point 4
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.3683E+00 at nodal point 2
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.1803E+05 at nodal point 1
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 6.7917E+04 at nodal point 12

Local skin and smeared stiffener buckling and stress, Seg.   7
Skin buckling load factor,   BUCMIN= 3.4293E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 2.6155E+00 at nodal point 13
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 6.5714E+04 at nodal point 1
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 6.7636E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg.   8
Skin buckling load factor,   BUCMIN= 3.8518E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS= 2.5826E+00 at nodal point 2
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 6.6295E+04 at nodal point 13

```
Smeared ring maximum effective stress,        STFMXR=  0.0000E+00 at nodal point  0
Shell skin maximum effective stress,          SKNMAX=  7.1914E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.   9
Skin buckling load factor,                    BUCMIN=  3.8540E+00 at nodal point  1
Smeared stringer/isogrid buckling load factor, BUCMNS=  5.4581E+00 at nodal point  2
Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress,  STFMXS=  6.6772E+04 at nodal point 13
Smeared ring maximum effective stress,        STFMXR=  0.0000E+00 at nodal point  0
Shell skin maximum effective stress,          SKNMAX=  8.1601E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.  10
Skin buckling load factor,                    BUCMIN=  4.3444E+00 at nodal point  1
Smeared stringer/isogrid buckling load factor, BUCMNS=  3.9164E+00 at nodal point 13
Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress,  STFMXS=  1.0026E+05 at nodal point 13
Smeared ring maximum effective stress,        STFMXR=  0.0000E+00 at nodal point  0
Shell skin maximum effective stress,          SKNMAX=  8.6954E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.  11
Skin buckling load factor,                    BUCMIN=  4.8340E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS=  3.9044E+00 at nodal point  1
Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress,  STFMXS=  1.1834E+05 at nodal point 11
Smeared ring maximum effective stress,        STFMXR=  0.0000E+00 at nodal point  0
Shell skin maximum effective stress,          SKNMAX=  1.1430E+05 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.  12
Skin buckling load factor,                    BUCMIN=  4.8370E+00 at nodal point  1
Smeared stringer/isogrid buckling load factor, BUCMNS=  4.4899E+00 at nodal point 13
Smeared ring buckling load factor,            BUCMNR=  1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress,  STFMXS=  1.2154E+05 at nodal point  4
Smeared ring maximum effective stress,        STFMXR=  0.0000E+00 at nodal point  0
Shell skin maximum effective stress,          SKNMAX=  1.1431E+05 at nodal point  1

                                               PERTURBED  UNPERTURBED
Region 1 skin buckling load factor,       bskin1=  3.1685E+00  3.1685E+00
Region 1 stiffener buckling load factor,   bstif1=  1.1477E+00  1.1477E+00
Region 1 skin maximum effective stress,    sknmx1=  1.2052E+05  1.2052E+05
Region 1 stiffener max. effective stress,  stfmx1=  1.1764E+05  1.1764E+05
```

Region 2 skin buckling load factor, bskin2= 3.2980E+00 3.2980E+00
Region 2 stiffener buckling load factor, bstif2= 1.3683E+00 1.3683E+00
Region 2 skin maximum effective stress, sknmx2= 1.1431E+05 1.1431E+05
Region 2 stiffener max. effective stress, stfmx2= 1.2154E+05 1.2154E+05
Normal displacement of shell at apex, ENDUV= 5.3669E-01 5.3669E-01

The following quantities are used to generate behavioral constraint conditions and margins:

```
                                               PERTURBED  UNPERTURBED
Region 1 skin buckling load factor,       bskin1=  3.1685E+00  3.1685E+00
Region 1 stiffener buckling load factor,  bstif1=  1.1477E+00  1.1477E+00
Region 1 skin maximum effective stress,   sknmx1=  1.2052E+05  1.2052E+05
Region 1 stiffener max. effective stress, stfmx1=  1.1764E+05  1.1764E+05
Region 2 skin buckling load factor,       bskin2=  3.2980E+00  3.2980E+00
Region 2 stiffener buckling load factor,  bstif2=  1.3683E+00  1.3683E+00
Region 2 skin maximum effective stress,   sknmx2=  1.1431E+05  1.1431E+05
Region 2 stiffener max. effective stress, stfmx2=  1.2154E+05  1.2154E+05
Normal displacement of shell at apex,      ENDUV=  5.3669E-01  5.3669E-01
```

============ Analysis No. 3 for Load Set No. 2 ============
*** Start nonlinear axisymmetric stress,-(mode 2) imperfection IMODX= 0
BIGBOSOR4 input file for nonlinear stress,-(mode 2) imperfect=
eqellipse.ALL4N

*** Output from mode 2 INDIC=0, stress analysis; IMODX= 0 ***
Pressure multiplier, P, for all load steps=
4.6000E+01 9.2000E+01 1.3800E+02 1.8400E+02 2.3000E+02
2.7600E+02 3.2200E+02 3.6800E+02 4.1400E+02 4.6000E+02
End displacement, ENDUVS, for all load steps=
3.9924E-02 8.0747E-02 1.2251E-01 1.6526E-01 2.0903E-01
2.5386E-01 2.9978E-01 3.4678E-01 3.9484E-01 4.4386E-01

Local skin and smeared stiffener buckling and stress, Seg. 1
Skin buckling load factor, BUCMIN= 4.8647E+00 at nodal point 2
Smeared stringer/isogrid buckling load factor, BUCMNS= 3.6423E+00 at nodal point 13
Smeared ring buckling load factor, BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.2200E+05 at nodal point 2

Smeared ring maximum effective stress, STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress, SKNMAX= 1.0383E+05 at nodal point 3

Local skin and smeared stiffener buckling and stress, Seg. 2
Skin buckling load factor, BUCMIN= 8.8085E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.1020E+00 at nodal point 12
Smeared ring buckling load factor, BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.2191E+05 at nodal point 7
Smeared ring maximum effective stress, STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress, SKNMAX= 7.4042E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg. 3
Skin buckling load factor, BUCMIN= 8.8027E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.0785E+00 at nodal point 5
Smeared ring buckling load factor, BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 9.7738E+04 at nodal point 1
Smeared ring maximum effective stress, STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress, SKNMAX= 6.0171E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg. 4
Skin buckling load factor, BUCMIN= 3.1954E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS= 1.3035E+00 at nodal point 1
Smeared ring buckling load factor, BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 6.5633E+04 at nodal point 13
Smeared ring maximum effective stress, STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress, SKNMAX= 7.8055E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg. 5
Skin buckling load factor, BUCMIN= 2.7898E+00 at nodal point 12
Smeared stringer/isogrid buckling load factor, BUCMNS= 9.1698E+00 at nodal point 2
Smeared ring buckling load factor, BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 6.9813E+04 at nodal point 12
Smeared ring maximum effective stress, STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress, SKNMAX= 8.2542E+04 at nodal point 12

Local skin and smeared stiffener buckling and stress, Seg. 6
Skin buckling load factor, BUCMIN= 2.7915E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 3.1585E+01 at nodal point 2
Smeared ring buckling load factor, BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 6.9824E+04 at nodal point 1

Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 8.2144E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg.   7
Skin buckling load factor,   BUCMIN= 3.1702E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 2.3329E+00 at nodal point 13
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 6.8607E+04 at nodal point 1
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 7.3148E+04 at nodal point 1

Local skin and smeared stiffener buckling and stress, Seg.   8
Skin buckling load factor,   BUCMIN= 4.0972E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS= 2.2758E+00 at nodal point 2
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 8.9435E+04 at nodal point 13
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 7.6971E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg.   9
Skin buckling load factor,   BUCMIN= 4.1011E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 2.2320E+00 at nodal point 5
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.1783E+05 at nodal point 13
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 9.0706E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg. 10
Skin buckling load factor,   BUCMIN= 4.8739E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 2.5118E+00 at nodal point 2
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.2481E+05 at nodal point 5
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 9.1319E+04 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg. 11
Skin buckling load factor,   BUCMIN= 4.5637E+00 at nodal point 13
Smeared stringer/isogrid buckling load factor, BUCMNS= 3.4244E+00 at nodal point 1
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 1.1537E+05 at nodal point 2

Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 1.0505E+05 at nodal point 13

Local skin and smeared stiffener buckling and stress, Seg. 12
Skin buckling load factor,   BUCMIN= 4.5650E+00 at nodal point 1
Smeared stringer/isogrid buckling load factor, BUCMNS= 5.8590E+00 at nodal point 13
Smeared ring buckling load factor,   BUCMNR= 1.0000E+17 at nodal point 13
Smeared stringer/isogrid maximum eff. stress, STFMXS= 8.1902E+04 at nodal point 13
Smeared ring maximum effective stress,   STFMXR= 0.0000E+00 at nodal point 0
Shell skin maximum effective stress,   SKNMAX= 1.0503E+05 at nodal point 1

PERTURBED UNPERTURBED
Region 1 skin buckling load factor,   bskin1= 2.7898E+00 2.7898E+00
Region 1 stiffener buckling load factor,   bstif1= 1.0785E+00 1.0785E+00
Region 1 skin maximum effective stress,   sknmx1= 1.0383E+05 1.0383E+05
Region 1 stiffener max. effective stress, stfmx1= 1.2200E+05 1.2200E+05
Region 2 skin buckling load factor,   bskin2= 2.7915E+00 2.7915E+00
Region 2 stiffener buckling load factor,   bstif2= 2.2320E+00 2.2320E+00
Region 2 skin maximum effective stress,   sknmx2= 1.0505E+05 1.0505E+05
Region 2 stiffener max. effective stress, stfmx2= 1.2481E+05 1.2481E+05
Normal displacement of shell at apex,   ENDUV= 4.4386E-01 4.4386E-01

The following quantities are used to generate behavioral constraint conditions and margins:
PERTURBED UNPERTURBED
Region 1 skin buckling load factor,   bskin1= 2.7898E+00 2.7898E+00
Region 1 stiffener buckling load factor,   bstif1= 1.0785E+00 1.0785E+00
Region 1 skin maximum effective stress,   sknmx1= 1.0383E+05 1.0383E+05
Region 1 stiffener max. effective stress, stfmx1= 1.2200E+05 1.2200E+05
Region 2 skin buckling load factor,   bskin2= 2.7915E+00 2.7915E+00
Region 2 stiffener buckling load factor,   bstif2= 2.2320E+00 2.2320E+00
Region 2 skin maximum effective stress,   sknmx2= 1.0505E+05 1.0505E+05
Region 2 stiffener max. effective stress, stfmx2= 1.2481E+05 1.2481E+05
Normal displacement of shell at apex,   ENDUV= 4.4386E-01 4.4386E-01

=========== Analysis No. 4 for Load Set No. 2 ===========
** Start nonlinear axisymmetric collpse,-(mode 1) imperfection   IMODX= 0
BIGBOSOR4 input file, axisymmetric collpse, -mode 1 imperfect=

eqellipse.ALL6N

```
 *** Output from -(mode 1) INDIC=0, collapse analysis; IMODX= 0 *********
 Pressure multiplier, P, for all load steps=
  4.6000E+01  9.2000E+01  1.3800E+02  1.8400E+02  2.3000E+02
  2.7600E+02  3.2200E+02  3.6800E+02  4.1400E+02  4.6000E+02
  5.0600E+02  5.1060E+02  5.1520E+02  5.1980E+02  5.2440E+02
  5.2900E+02  5.3360E+02  5.3820E+02  5.4280E+02  5.4740E+02
  5.5200E+02  5.5660E+02  5.5706E+02  5.5752E+02  5.5798E+02
  5.5844E+02  5.5890E+02  5.5936E+02  5.5982E+02  5.6028E+02
  5.6074E+02  5.6120E+02  5.6166E+02  5.6212E+02  5.6258E+02
  5.6304E+02  5.6350E+02
 End displacement, ENDUVS, for all load steps=
  4.2352E-02  8.6127E-02  1.3151E-01  1.7876E-01  2.2820E-01
  2.8028E-01  3.3567E-01  3.9542E-01  4.6127E-01  5.3669E-01
  6.3021E-01  6.4133E-01  6.5295E-01  6.6514E-01  6.7800E-01
  6.9166E-01  7.0629E-01  7.2213E-01  7.3953E-01  7.5904E-01
  7.8164E-01  8.0929E-01  8.1248E-01  8.1578E-01  8.1919E-01
  8.2273E-01  8.2640E-01  8.3024E-01  8.3425E-01  8.3847E-01
  8.4292E-01  8.4765E-01  8.5271E-01  8.5818E-01  8.6415E-01
  8.7080E-01  8.7839E-01

                                            PERTURBED  UNPERTURBED
 Collapse pressure with -(mode 1): PSTEP(ISTEP)=  5.6350E+02  5.6350E+02

 The following quantity is used to generate the behavioral constraint condition and margin:
                                            PERTURBED  UNPERTURBED
 Collapse pressure with mode 1: CLAPS1(ILOADX)=  5.6350E+02  5.6350E+02



 ============ Analysis No. 5 for Load Set No. 2 ============
 ** Start nonlinear axisymmetric collpse,-(mode 2) imperfection      IMODX= 0
 BIGBOSOR4 input file, axisymmetric collpse, -mode 2 imperfect=
eqellipse.ALL7N


 *** Output from -(mode 2) INDIC=0, collapse analysis; IMODX= 0 *********
```

Pressure multiplier, P, for all load steps=
 4.6000E+01 9.2000E+01 1.3800E+02 1.8400E+02 2.3000E+02
 2.7600E+02 3.2200E+02 3.6800E+02 4.1400E+02 4.6000E+02
 5.0600E+02 5.5200E+02 5.9800E+02 6.4400E+02 6.9000E+02
 7.3600E+02 7.8200E+02 8.2800E+02 8.7400E+02 9.2000E+02
End displacement, ENDUVS, for all load steps=
 3.9924E-02 8.0747E-02 1.2251E-01 1.6526E-01 2.0903E-01
 2.5386E-01 2.9978E-01 3.4678E-01 3.9484E-01 4.4386E-01
 4.9362E-01 5.4374E-01 5.9347E-01 6.4151E-01 6.8569E-01
 7.2269E-01 7.4854E-01 7.6085E-01 7.6284E-01 7.7324E-01

PERTURBED UNPERTURBED
Collapse pressure with -(mode 2): PSTEP(ISTEP)= 9.2000E+02 9.2000E+02

The following quantity is used to generate the behavioral constraint condition and margin:
PERTURBED UNPERTURBED
Collapse pressure with mode 2: CLAPS2(ILOADX)= 9.2000E+02 9.2000E+02

============ Analysis No. 6 for Load Set No. 2 ============
** Start nonlinear bifurcation buckling,-(mode 1) imperfection   IMODX= 0

** Start nonlinear bifurcation buckling,-(mode 1) imperfection   IMODX= 0
BIGBOSOR4 input file, bifurcation buckling, -(mode 1) imperf.=
eqellipse.ALL8N

******* Nonlinear overall bifurcation buckling results ******
Overall buckling, -(mode 1) imperfection shape; Applied pressure, PMAX = 4.6000E+02
*** Output from -(mode 1) INDIC=1, buckling analysis; IMODX= 0 *********

**** CRITICAL EIGENVALUE AND WAVENUMBER ****
EIGCRT= 5.8605E+02; NO. OF CIRC. WAVES, NWVCRT=   0
****

```
***** EIGENVALUES AND MODE SHAPES *****
 EIGENVALUE(CIRC. WAVES)
==========================================
  5.8605E+02(   0)
  9.8961E+02(   1)
  2.2177E+03(   2)
  3.2704E+03(   3)
  4.3261E+03(   4)
  5.3222E+03(   5)
  6.3729E+03(   6)
  7.3273E+03(   7)
  8.3619E+03(   8)
  9.5505E+03(   9)
  1.0931E+04(  10)
  1.2521E+04(  11)
  1.4315E+04(  12)
  1.6287E+04(  13)
  1.8404E+04(  14)
  2.0646E+04(  15)
  2.3000E+04(  16)
  2.5468E+04(  17)
  2.8062E+04(  18)
  3.0802E+04(  19)
  3.3708E+04(  20)
  3.6794E+04(  21)
  4.0068E+04(  22)
  4.3530E+04(  23)
  4.7176E+04(  24)
  5.0999E+04(  25)
  5.4987E+04(  26)
  5.9122E+04(  27)
  6.1089E+04(  28)
  6.1065E+04(  29)
  6.1043E+04(  30)
==========================================

**** CRITICAL NEGATIVE EIGENVALUE AND WAVENUMBER ****
EIGCRN= -7.6012E+03; NO. OF CIRC. WAVES, NWVCRN=   27
**************************************************
```

```
***** NEGATIVE EIGENVALUES AND MODE SHAPES *****
 EIGENVALUE(CIRC. WAVES)
=======================================
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
   0.0000E+00(****)
  -7.6012E+03(  27)
   0.0000E+00(****)
   0.0000E+00(****)
  -7.4524E+03(  30)
=======================================

Nonlinear bifurcation buckling pressure, BUCPRSM(circ.waves)=  7.2958E+02( 0)
General bifurcation buckling load factor, GENBK1(ILOADX)=  1.5860E+00
```

```
                                              PERTURBED  UNPERTURBED
 Nonlin. bifurcation buckling, -(mode 1):BUCPRSM=  7.2958E+02  7.2958E+02
SHELL COLLAPSES AXISYMMETRICALLY AT P=  565.5

 **************** INDIC=-2 analysis yields ***************
 SHELL COLLAPSES AXISYMMETRICALLY BEFORE NONLINEAR BIFURCA-
 TION BUCKLING WITH N =  0 CIRCUMFERENTIAL WAVES.
 *********************************************************
 IMODX=0: M1MULTB,NWAV1,PMAXBUC1=   -1    0  4.6000E+02

 The following quantity is used to generate the behavioral constraint condition and margin:
                                              PERTURBED  UNPERTURBED
 Nonlin. bifurcation buckling, -(mode 1):BUCPRS =  7.2958E+02  7.2958E+02




 ============ Analysis No. 7 for Load Set No. 2 ============
 ** Start nonlinear bifurcation buckling,-(mode 2) imperfection      IMODX= 0




 ** Start nonlinear bifurcation buckling,-(mode 2) imperfection      IMODX= 0
 BIGBOSOR4 input file, bifurcation buckling, -(mode 2) imperf.=
eqellipse.ALL9N


 ******* Nonlinear overall bifurcation buckling results ******
 Overall buckling, -(mode 2) imperfection shape; Applied pressure, PMAX =  4.6000E+02
 *** Output from -(mode 2) INDIC=1, buckling analysis; IMODX= 0 *********

 **** CRITICAL EIGENVALUE AND WAVENUMBER ****
 EIGCRT=  1.1512E+03; NO. OF CIRC. WAVES, NWVCRT=    0
 ************************************************

 ***** EIGENVALUES AND MODE SHAPES *****
  EIGENVALUE(CIRC. WAVES)
 ==========================================
```

```
  1.1512E+03(   0)
  1.6440E+03(   1)
  2.1359E+03(   2)
  2.4449E+03(   3)
  3.0720E+03(   4)
  3.9280E+03(   5)
  4.9929E+03(   6)
  6.2580E+03(   7)
  7.7005E+03(   8)
  9.3050E+03(   9)
  1.1059E+04(  10)
  1.2835E+04(  11)
  1.4485E+04(  12)
  1.6241E+04(  13)
  1.8106E+04(  14)
  2.0071E+04(  15)
  2.2135E+04(  16)
  2.4306E+04(  17)
  2.6597E+04(  18)
  2.9022E+04(  19)
  3.1592E+04(  20)
  3.4320E+04(  21)
  3.7214E+04(  22)
  4.0280E+04(  23)
  4.3521E+04(  24)
  4.6937E+04(  25)
  5.0522E+04(  26)
  5.4268E+04(  27)
  5.8162E+04(  28)
  6.2186E+04(  29)
  6.6320E+04(  30)
==========================================

**** CRITICAL NEGATIVE EIGENVALUE AND WAVENUMBER ****
EIGCRN=  0.0000E+00; NO. OF CIRC. WAVES, NWVCRN=*****
**************************************************

***** NEGATIVE EIGENVALUES AND MODE SHAPES *****
 EIGENVALUE(CIRC. WAVES)
==========================================
```

```
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
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  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
  0.0000E+00(****)
============================================

Nonlinear bifurcation buckling pressure, BUCPRSM(circ.waves)=  9.8954E+02( 0)
General bifurcation buckling load factor, GENBK2(ILOADX)=  2.1512E+00



                                              PERTURBED  UNPERTURBED
Nonlin. bifurcation buckling, -(mode 2):BUCPRSM=  9.8954E+02  9.8954E+02
```

```
IMODX=0: M2MULTB,NWAV2,PMAXBUC2=   -1    0  4.6000E+02

The following quantity is used to generate the behavioral constraint condition and margin:
                                             PERTURBED  UNPERTURBED
Nonlin. bifurcation buckling, -(mode 2):BUCPRS =  9.8954E+02  9.8954E+02


********* End of all analysis. IMODX= 0 **************


   1       563.5001      collapse pressure with imperfection mode 1: CLAPS1(2 )
   2       1.586049      general buckling load factor, mode 1: GENBK1(2 )

 BEHAVIOR OVER J =  number of regions for computing behavior
   3       3.168470      buckling load of skin: SKNBK1(2 ,1 )
   4       3.298037      buckling load of skin: SKNBK1(2 ,2 )

 BEHAVIOR OVER J =  number of regions for computing behavior
   5       1.147719      buckling load factor, isogrid member, mode 1: STFBK1(2 ,1 )
   6       1.368290      buckling load factor, isogrid member, mode 1: STFBK1(2 ,2 )

 BEHAVIOR OVER J =  number of regions for computing behavior
   7       120521.2      maximum stress in the shell skin, mode 1: SKNST1(2 ,1 )
   8       114308.5      maximum stress in the shell skin, mode 1: SKNST1(2 ,2 )

 BEHAVIOR OVER J =  number of regions for computing behavior
   9       117640.9      maximum stress in isogrid stiffener, mode 1: STFST1(2 ,1 )
  10        121541.5      maximum stress in isogrid stiffener, mode 1: STFST1(2 ,2 )
  11       0.5366920      normal (axial) displacement at apex, mode 1: WAPEX1(2 )
  12        920.0000      collapse pressure with imperfection mode 2: CLAPS2(2 )
  13        2.151174      general buckling load factor, mode 2: GENBK2(2 )

 BEHAVIOR OVER J =  number of regions for computing behavior
  14        2.789820      local skin buckling load factor, mode 2: SKNBK2(2 ,1 )
  15        2.791454      local skin buckling load factor, mode 2: SKNBK2(2 ,2 )

 BEHAVIOR OVER J =  number of regions for computing behavior
  16        1.078544      buckling load factor for isogrid member: STFBK2(2 ,1 )
  17        2.231953      buckling load factor for isogrid member: STFBK2(2 ,2 )
```

BEHAVIOR OVER J = number of regions for computing behavior

18	103826.2	maximum stress in the shell skin, mode 2: SKNST2(2 ,1)
19	105047.7	maximum stress in the shell skin, mode 2: SKNST2(2 ,2)

BEHAVIOR OVER J = number of regions for computing behavior

20	121999.7	maximum stress in isogrid stiffener, mode 2: STFST2(2 ,1)
21	124812.6	maximum stress in isogrid stiffener, mode 2: STFST2(2 ,2)
22	0.4438556	normal (axial) displacement at apex, mode 2: WAPEX2(2)

***** RESULTS FOR LOAD SET NO. 2 ******
PARAMETERS WHICH DESCRIBE BEHAVIOR (e.g. stress, buckling load)

BEH. NO.	CURRENT VALUE	DEFINITION
1	5.635E+02	collapse pressure with imperfection mode 1: CLAPS1(2)
2	1.586E+00	general buckling load factor, mode 1: GENBK1(2)
3	3.168E+00	buckling load of skin: SKNBK1(2 ,1)
4	3.298E+00	buckling load of skin: SKNBK1(2 ,2)
5	1.148E+00	buckling load factor, isogrid member, mode 1: STFBK1(2 ,1)
6	1.368E+00	buckling load factor, isogrid member, mode 1: STFBK1(2 ,2)
7	1.205E+05	maximum stress in the shell skin, mode 1: SKNST1(2 ,1)
8	1.143E+05	maximum stress in the shell skin, mode 1: SKNST1(2 ,2)
9	1.176E+05	maximum stress in isogrid stiffener, mode 1: STFST1(2 ,1)
10	1.215E+05	maximum stress in isogrid stiffener, mode 1: STFST1(2 ,2)
11	5.367E-01	normal (axial) displacement at apex, mode 1: WAPEX1(2)
12	9.200E+02	collapse pressure with imperfection mode 2: CLAPS2(2)
13	2.151E+00	general buckling load factor, mode 2: GENBK2(2)
14	2.790E+00	local skin buckling load factor, mode 2: SKNBK2(2 ,1)
15	2.791E+00	local skin buckling load factor, mode 2: SKNBK2(2 ,2)
16	1.079E+00	buckling load factor for isogrid member: STFBK2(2 ,1)
17	2.232E+00	buckling load factor for isogrid member: STFBK2(2 ,2)
18	1.038E+05	maximum stress in the shell skin, mode 2: SKNST2(2 ,1)
19	1.050E+05	maximum stress in the shell skin, mode 2: SKNST2(2 ,2)
20	1.220E+05	maximum stress in isogrid stiffener, mode 2: STFST2(2 ,1)
21	1.248E+05	maximum stress in isogrid stiffener, mode 2: STFST2(2 ,2)
22	4.439E-01	normal (axial) displacement at apex, mode 2: WAPEX2(2)

******* NOTE ******* NOTE ******* NOTE ****** NOTE ******
The phrase, "NOT APPLY", for MARGIN VALUE means that that

particular margin value is exactly zero.
*** END NOTE *** END NOTE *** END NOTE *** END NOTE *****

***** RESULTS FOR LOAD SET NO. 2 ******
MARGINS CORRESPONDING TO CURRENT DESIGN (F.S.= FACTOR OF SAFETY)

```
MARGIN CURRENT
NO.    VALUE          DEFINITION
 1    2.455E-02  (CLAPS1(2 )/CLAPS1A(2 )) / CLAPS1F(2 )-1; F.S.=  1.00
 2    5.860E-01  (GENBK1(2 )/GENBK1A(2 )) / GENBK1F(2 )-1; F.S.=  1.00
 3    2.168E+00  (SKNBK1(2 ,1 )/SKNBK1A(2 ,1 )) / SKNBK1F(2 ,1 )-1; F.S.=  1.00
 4    2.298E+00  (SKNBK1(2 ,2 )/SKNBK1A(2 ,2 )) / SKNBK1F(2 ,2 )-1; F.S.=  1.00
 5    1.477E-01  (STFBK1(2 ,1 )/STFBK1A(2 ,1 )) / STFBK1F(2 ,1 )-1; F.S.=  1.00
 6    3.683E-01  (STFBK1(2 ,2 )/STFBK1A(2 ,2 )) / STFBK1F(2 ,2 )-1; F.S.=  1.00
 7   -4.325E-03  (SKNST1A(2 ,1 )/SKNST1(2 ,1 )) / SKNST1F(2 ,1 )-1; F.S.=  1.00
 8    4.979E-02  (SKNST1A(2 ,2 )/SKNST1(2 ,2 )) / SKNST1F(2 ,2 )-1; F.S.=  1.00
 9    2.005E-02  (STFST1A(2 ,1 )/STFST1(2 ,1 )) / STFST1F(2 ,1 )-1; F.S.=  1.00
10   -1.268E-02  (STFST1A(2 ,2 )/STFST1(2 ,2 )) / STFST1F(2 ,2 )-1; F.S.=  1.00
11    3.043E-01  (WAPEX1A(2 )/WAPEX1(2 )) / WAPEX1F(2 )-1; F.S.=  1.00
12    6.727E-01  (CLAPS2(2 )/CLAPS2A(2 )) / CLAPS2F(2 )-1; F.S.=  1.00
13    1.151E+00  (GENBK2(2 )/GENBK2A(2 )) / GENBK2F(2 )-1; F.S.=  1.00
14    1.790E+00  (SKNBK2(2 ,1 )/SKNBK2A(2 ,1 )) / SKNBK2F(2 ,1 )-1; F.S.=  1.00
15    1.791E+00  (SKNBK2(2 ,2 )/SKNBK2A(2 ,2 )) / SKNBK2F(2 ,2 )-1; F.S.=  1.00
16    7.854E-02  (STFBK2(2 ,1 )/STFBK2A(2 ,1 )) / STFBK2F(2 ,1 )-1; F.S.=  1.00
17    1.232E+00  (STFBK2(2 ,2 )/STFBK2A(2 ,2 )) / STFBK2F(2 ,2 )-1; F.S.=  1.00
18    1.558E-01  (SKNST2A(2 ,1 )/SKNST2(2 ,1 )) / SKNST2F(2 ,1 )-1; F.S.=  1.00
19    1.423E-01  (SKNST2A(2 ,2 )/SKNST2(2 ,2 )) / SKNST2F(2 ,2 )-1; F.S.=  1.00
20   -1.639E-02  (STFST2A(2 ,1 )/STFST2(2 ,1 )) / STFST2F(2 ,1 )-1; F.S.=  1.00
21   -3.856E-02  (STFST2A(2 ,2 )/STFST2(2 ,2 )) / STFST2F(2 ,2 )-1; F.S.=  1.00
22    5.771E-01  (WAPEX2A(2 )/WAPEX2(2 )) / WAPEX2F(2 )-1; F.S.=  1.00
```

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*******************************************************
******************** DESIGN OBJECTIVE *******************
*************                    ***********
   CURRENT VALUE OF THE OBJECTIVE FUNCTION:

VAR.   CURRENT
NO.    VALUE          DEFINITION
 1    8.610E+01  weight of the equivalent ellipsoidal head: WEIGHT
```

************* ************

******************* DESIGN OBJECTIVE ******************

****

*********** ALL 2 LOAD CASES PROCESSED ***********

****

PARAMETERS WHICH ARE ALWAYS FIXED. NONE CAN BE DECISION VARIAB.

VAR. NO.	CURRENT VALUE	DEFINITION
1	0.000E+00	x-coordinates for ends of segments: xinput(1)
2	2.555E+00	x-coordinates for ends of segments: xinput(2)
3	5.666E+00	x-coordinates for ends of segments: xinput(3)
4	8.754E+00	x-coordinates for ends of segments: xinput(4)
5	1.180E+01	x-coordinates for ends of segments: xinput(5)
6	1.477E+01	x-coordinates for ends of segments: xinput(6)
7	1.763E+01	x-coordinates for ends of segments: xinput(7)
8	1.964E+01	x-coordinates for ends of segments: xinput(8)
9	2.126E+01	x-coordinates for ends of segments: xinput(9)
10	2.270E+01	x-coordinates for ends of segments: xinput(10)
11	2.387E+01	x-coordinates for ends of segments: xinput(11)
12	2.454E+01	x-coordinates for ends of segments: xinput(12)
13	2.475E+01	x-coordinates for ends of segments: xinput(13)
14	2.475E+01	length of semi-major axis: ainput
15	1.238E+01	length of semi-minor axis of ellipse: binput
16	1.763E+01	max. x-coordinate for x-coordinate callouts: xlimit
17	2.000E-01	thickness of the cylindrical shell: THKCYL
18	2.475E+01	radius of the cylindrical shell: RADCYL
19	0.000E+00	length of the cylindrical segment: LENCYL
20	2.000E-01	amplitude of the axisymmetric imperfection: WIMP
21	1.600E+07	elastic modulus: EMATL
22	2.500E-01	Poisson ratio of material: NUMATL
23	4.155E-04	mass density of material: DNMATL

PARAMETERS WHICH ARE ENVIRONMENTAL FACTORS (e.g. loads, temps.)

VAR. NO.	CURRENT VALUE	DEFINITION
1	4.600E+02	uniform external pressure: PRESS(1)

2 4.600E+02 uniform external pressure: PRESS(2)

PARAMETERS WHICH ARE CLASSIFIED AS ALLOWABLES (e.g. max. stress)

VAR. NO.	CURRENT VALUE	DEFINITION
1	5.500E+02	allowable pressure for axisymmetric collapse: CLAPS1A(1)
2	5.500E+02	allowable pressure for axisymmetric collapse: CLAPS1A(2)
3	1.000E+00	allowable general buckling load factor (use 1.0): GENBK1A(1)
4	1.000E+00	allowable general buckling load factor (use 1.0): GENBK1A(2)
5	1.000E+00	allowable buckling load factor: SKNBK1A(1 ,1)
6	1.000E+00	allowable buckling load factor: SKNBK1A(2 ,1)
7	1.000E+00	allowable buckling load factor: SKNBK1A(1 ,2)
8	1.000E+00	allowable buckling load factor: SKNBK1A(2 ,2)
9	1.000E+00	allowable for isogrid stiffener buckling (Use 1.): STFBK1A(1 ,1)
10	1.000E+00	allowable for isogrid stiffener buckling (Use 1.): STFBK1A(2 ,1)
11	1.000E+00	allowable for isogrid stiffener buckling (Use 1.): STFBK1A(1 ,2)
12	1.000E+00	allowable for isogrid stiffener buckling (Use 1.): STFBK1A(2 ,2)
13	1.200E+05	allowable stress for the shell skin: SKNST1A(1 ,1)
14	1.200E+05	allowable stress for the shell skin: SKNST1A(2 ,1)
15	1.200E+05	allowable stress for the shell skin: SKNST1A(1 ,2)
16	1.200E+05	allowable stress for the shell skin: SKNST1A(2 ,2)
17	1.200E+05	allowable stress in isogrid stiffeners: STFST1A(1 ,1)
18	1.200E+05	allowable stress in isogrid stiffeners: STFST1A(2 ,1)
19	1.200E+05	allowable stress in isogrid stiffeners: STFST1A(1 ,2)
20	1.200E+05	allowable stress in isogrid stiffeners: STFST1A(2 ,2)
21	7.000E-01	allowable normal (axial) displacement at apex: WAPEX1A(1)
22	7.000E-01	allowable normal (axial) displacement at apex: WAPEX1A(2)
23	5.500E+02	allowable pressure for axisymmetric collapse: CLAPS2A(1)
24	5.500E+02	allowable pressure for axisymmetric collapse: CLAPS2A(2)
25	1.000E+00	allowable general buckling load factor (use 1.0): GENBK2A(1)
26	1.000E+00	allowable general buckling load factor (use 1.0): GENBK2A(2)
27	1.000E+00	allowable skin buckling load factor (use 1.0): SKNBK2A(1 ,1)
28	1.000E+00	allowable skin buckling load factor (use 1.0): SKNBK2A(2 ,1)
29	1.000E+00	allowable skin buckling load factor (use 1.0): SKNBK2A(1 ,2)
30	1.000E+00	allowable skin buckling load factor (use 1.0): SKNBK2A(2 ,2)
31	1.000E+00	allowable for isogrid stiffener buckling (Use 1.): STFBK2A(1 ,1)
32	1.000E+00	allowable for isogrid stiffener buckling (Use 1.): STFBK2A(2 ,1)
33	1.000E+00	allowable for isogrid stiffener buckling (Use 1.): STFBK2A(1 ,2)
34	1.000E+00	allowable for isogrid stiffener buckling (Use 1.): STFBK2A(2 ,2)
35	1.200E+05	allowable stress for the shell skin: SKNST2A(1 ,1)

36 1.200E+05 allowable stress for the shell skin: SKNST2A(2 ,1)
37 1.200E+05 allowable stress for the shell skin: SKNST2A(1 ,2)
38 1.200E+05 allowable stress for the shell skin: SKNST2A(2 ,2)
39 1.200E+05 allowable stress in isogrid stiffeners: STFST2A(1 ,1)
40 1.200E+05 allowable stress in isogrid stiffeners: STFST2A(2 ,1)
41 1.200E+05 allowable stress in isogrid stiffeners: STFST2A(1 ,2)
42 1.200E+05 allowable stress in isogrid stiffeners: STFST2A(2 ,2)
43 7.000E-01 allowable normal (axial) displacement at apex: WAPEX2A(1)
44 7.000E-01 allowable normal (axial) displacement at apex: WAPEX2A(2)
PARAMETERS WHICH ARE FACTORS OF SAFETY

VAR. CURRENT
NO. VALUE DEFINITION
1 1.000E+00 factor of safety for axisymmetric collapse: CLAPS1F(1)
2 1.000E+00 factor of safety for axisymmetric collapse: CLAPS1F(2)
3 1.000E+00 factor of safety for general buckling: GENBK1F(1)
4 1.000E+00 factor of safety for general buckling: GENBK1F(2)
5 1.000E+00 factor of safety for skin buckling: SKNBK1F(1 ,1)
6 1.000E+00 factor of safety for skin buckling: SKNBK1F(2 ,1)
7 1.000E+00 factor of safety for skin buckling: SKNBK1F(1 ,2)
8 1.000E+00 factor of safety for skin buckling: SKNBK1F(2 ,2)
9 1.000E+00 factor of safety for isogrid stiffener buckling: STFBK1F(1 ,1)
10 1.000E+00 factor of safety for isogrid stiffener buckling: STFBK1F(2 ,1)
11 1.000E+00 factor of safety for isogrid stiffener buckling: STFBK1F(1 ,2)
12 1.000E+00 factor of safety for isogrid stiffener buckling: STFBK1F(2 ,2)
13 1.000E+00 factor of safety for skin stress: SKNST1F(1 ,1)
14 1.000E+00 factor of safety for skin stress: SKNST1F(2 ,1)
15 1.000E+00 factor of safety for skin stress: SKNST1F(1 ,2)
16 1.000E+00 factor of safety for skin stress: SKNST1F(2 ,2)
17 1.000E+00 factor of safety for stress in isogrid member: STFST1F(1 ,1)
18 1.000E+00 factor of safety for stress in isogrid member: STFST1F(2 ,1)
19 1.000E+00 factor of safety for stress in isogrid member: STFST1F(1 ,2)
20 1.000E+00 factor of safety for stress in isogrid member: STFST1F(2 ,2)
21 1.000E+00 factor of safety for WAPEX: WAPEX1F(1)
22 1.000E+00 factor of safety for WAPEX: WAPEX1F(2)
23 1.000E+00 factor of safety for axisymmetric collapse: CLAPS2F(1)
24 1.000E+00 factor of safety for axisymmetric collapse: CLAPS2F(2)
25 1.000E+00 factor of safety for general buckling: GENBK2F(1)
26 1.000E+00 factor of safety for general buckling: GENBK2F(2)
27 1.000E+00 factor of safety for local skin buckling: SKNBK2F(1 ,1)

28 1.000E+00 factor of safety for local skin buckling: SKNBK2F(2 ,1)
29 1.000E+00 factor of safety for local skin buckling: SKNBK2F(1 ,2)
30 1.000E+00 factor of safety for local skin buckling: SKNBK2F(2 ,2)
31 1.000E+00 factor of safety for isogrid stiffener buckling: STFBK2F(1 ,1)
32 1.000E+00 factor of safety for isogrid stiffener buckling: STFBK2F(2 ,1)
33 1.000E+00 factor of safety for isogrid stiffener buckling: STFBK2F(1 ,2)
34 1.000E+00 factor of safety for isogrid stiffener buckling: STFBK2F(2 ,2)
35 1.000E+00 factor of safety for skin stress: SKNST2F(1 ,1)
36 1.000E+00 factor of safety for skin stress: SKNST2F(2 ,1)
37 1.000E+00 factor of safety for skin stress: SKNST2F(1 ,2)
38 1.000E+00 factor of safety for skin stress: SKNST2F(2 ,2)
39 1.000E+00 factor of safety for stress in isogrid member: STFST2F(1 ,1)
40 1.000E+00 factor of safety for stress in isogrid member: STFST2F(2 ,1)
41 1.000E+00 factor of safety for stress in isogrid member: STFST2F(1 ,2)
42 1.000E+00 factor of safety for stress in isogrid member: STFST2F(2 ,2)
43 1.000E+00 factor of safety for WAPEX: WAPEX2F(1)
44 1.000E+00 factor of safety for WAPEX: WAPEX2F(2)

0 INEQUALITY CONSTRAINTS WHICH MUST BE SATISFIED

DESCRIPTION OF FILES USED AND GENERATED IN THIS RUN:

eqellipse.NAM = This file contains only the name of the case.
eqellipse.OPM = Output data. Please list this file and inspect
carefully before proceeding.
eqellipse.OPP = Output file containing evolution of design and
margins since the beginning of optimization cycles.
eqellipse.CBL = Labelled common blocks for analysis.
(This is an unformatted sequential file.)
eqellipse.OPT = This file contains the input data for MAINSETUP
as well as OPTIMIZE. The batch command OPTIMIZE
can be given over and over again without having
to return to MAINSETUP because eqellipse.OPT exists.
URPROMPT.DAT= Prompt file for interactive input.

For further information about files used and generated
during operation of GENOPT, give the command HELPG FILES.

Menu of commands: CHOOSEPLOT, OPTIMIZE, MAINSETUP, CHANGE,
DECIDE, SUPEROPT

IN ORDER TO AVOID FALSE CONVERGENCE OF THE DESIGN, BE SURE TO RUN "OPTIMIZE" MANY TIMES DURING AN OPTIMIZATION AND/OR USE THE "GLOBAL" OPTIMIZING SCRIPT, "SUPEROPT".

********************* END OF eqellipse.OPM FILE *****************

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