```
Begin static response of entire panel to normal pressure:
Axial length of panel, AXLEN=  6.8750E+01

** NOTE ** If the panel is curved it is treated as a complete
(360-degree) cylindrical shell. The axisymmetric
"hungry-horse" deformed state is computed for a single ring
spacing in Chapter 4. For curved panels, therefore, no
computations are performed for the entire panel here.
End of equilibrium calculations for entire panel
with smeared stiffeners under uniform normal pressure,
p =  4.6229E-05
***** NOTE ****** See Chapter 4 for static response of a
single "skin"-ring module of the curved panel, which is
modelled as a complete (360-degree) cylindrical shell there.
********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

**** CHAPTER 5b ****:
Next, find bending of a single skin-stringer panel
module under uniform normal pressure, p=  4.6229E-05, See
Section 9 of Ref.[1A].The panel skin is assumed to be flat
Also see Fig. 56 on p. 555 of [1A] for an example.
 LABEL NO. IN STRUCT= 9100

***** BEGIN SUBROUTINE FORCES (MODULE PRESSURE RESPONSE) *****
Purpose is to obtain resultants in each segment of the skin-
stringer single module model for input to the nonlinear static
response of single skin-stringer module to normal pressure.
See Section 10, pp 506-509, of Reference [1A].
****** END SUBROUTINE FORCES (MODULE PRESSURE RESPONSE) *******

****** BEGIN SUBROUTINE BUCKLE (MODULE PRESSURE RESPONSE) *****
****** END SUBROUTINE BUCKLE (MODULE PRESSURE RESPONSE) *******

*** NOTE ****** NOTE ****** NOTE ****** NOTE ****** NOTE ***
Because the stringers are relatively weak, the local
amplitude of "pillowing" between stringers is being reduced
by the factor, PLOCF =   1.0000E+00. See news ITEM 117(g).
*** END NOTE ***** END NOTE ***** END NOTE ***** END NOTE ***

****** BEGIN SUBROUTINE BUCKLE (MODULE PRESSURE RESPONSE) *****
See Fig. 56 in Ref.[1A] for the model and its behavior.
****** END SUBROUTINE BUCKLE (MODULE PRESSURE RESPONSE) *******

****** BEGIN SUBROUTINE MODE (MODULE PRESSURE RESPONSE) *****
****** END SUBROUTINE MODE (MODULE PRESSURE RESPONSE) *******

****** BEGIN SUBROUTINE OUTPRS (MODULE PRESSURE RESPONSE) *****
****** END SUBROUTINE OUTPRS (MODULE PRESSURE RESPONSE) *******
End of nonlinear equilibrium calculations for
panel module with uniform normal pressure, p=  4.6229E-05

****************************************************************
CHAPTER 5c (prebuckling bending between rings with beam
model) is not executed because:
(PEDG.OR.P.EQ.0.0.OR.ISKIPL.NE.0.OR.ISTIF(2).EQ.0
.OR.ISOGRD.NE.0.OR.ISTIF(1).EQ.5.OR.AXIAL.LT.2.5*B(2))
********* DESIGN PERTURBATION INDEX, IMOD=  0 *********
********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

****************************************************************
CHAPTER 6  Do PANDA-type [1B] general and inter-ring buckling
           analyses to permit later computation of
           amplification of panel bowing.

**** BEGIN SUBROUTINE BUCPAN (PRELIM. PANDA-TYPE BUCKLING) ****
**** This execution of BUCPAN is used to find the general
**** buckling load factor that is used to compute the
**** amplification of bowing from all sources except pressure.

GENERAL BUCKLING LOAD FACTOR USED FOR CALCULATION OF THE
AMPLIFICATION OF BOWING FROM ALL SOURCES EXCEPT PRESSURE.
EIGBOW(M,N)=  2.3269E+00(  3,  6)
**** END SUBROUTINE BUCPAN (PRELIM. PANDA-TYPE BUCKLING) *******

*** BEGIN BUCPAN (INTER-RING BUCKLING, SMEARED STRINGERS) ***
```

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```
*** This execution of BUCPAN is used to get amplification
*** factors for inter-ring axial bowing and inter-ring local
*** prebuckling deformations (pillowing).
 EIGPAN(M,N)=  2.1573E+00(  1,  8,  0.00E+00)
 AMPLIFICATION OF INTER-RING BOWING,         AMPLT3=  1.3526E+00
 AMPLIFICATION OF INTER-RING PREB.DEFORM., AMPLT4=  1.0697E+00
 *** END BUCPAN  (INTER-RING BUCKLING, SMEARED STRINGERS) ***
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

 *******************************************************
 CHAPTER 7  Compute distribution of loads in panel module
            skin-stringer segments, neglecting redistribution
            due to initial buckling modal imperfections
            (See Section 10 of [1A]).

 *** BEGIN SUBROUTINE FORCES (LOAD DISTRIB. IN SEGMENTS) *****
 Resultants in each segment of the skin-stringer and skin-ring
 modules are computed. The effect of prebuckling bending due to
 initial buckling modal imperfections is ignored at this time,
 but will be accounted for later when buckling load factors and
 stresses are computed. See Section 10, pp 506-509 of Ref.[1A]
 **** END SUBROUTINE FORCES (LOAD DISTRIB. IN SEGMENTS) *******
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

 *******************************************************
 CHAPTER 8  Do PANDA-type local, inter-ring, general buckling
            analyses and PANDA-type stringer web and ring web
            buckling analyses to get knockdown factors to
            compensate for lack of in-plane shear Nxy loading
            and anisotropy in discretized BOSOR4-type models.
            (See Section 11 of [1A] and Item No. 81 in [1L]).

*** BEGIN SUBROUTINE BUCPAN (KNOCKDOWN PANDA-TYPE BUCKLING) ***
**** The purpose of the following BUCPAN execution is to find:
*** LOCAL BUCKLING (buckling of skin between stiffeners):
**** a.with in-plane shear Nxy and anisotropic effects included
**** b.without in-plane shear Nxy and anisotropic effects
*** INTER-RING BUCKLING (stringers smeared out):
**** a.with in-plane shear Nxy and anisotropic effects included
**** b.without in-plane shear Nxy and anisotropic effects
*** GENERAL INSTABILITY (rings and stringers smeared out):
**** a.with in-plane shear Nxy and anisotropic effects included
**** b.without in-plane shear Nxy and anisotropic effects
*** THE PURPOSE IS TO FIND KNOCKDOWN FACTORS TO COMPENSATE
*** FOR THE ABSENCE OF IN-PLANE SHEAR AND ANISOTROPY IN BOSOR4-
*** TYPE MODELS (DISCRETIZED MODULE MODELS).
**** See Section 11, p. 509, of Reference [1].
*** NOTE: This set of calculations does NOT include the effect
***       of initial geometric buckling modal imperfections.

 Entering ALTSOL: radius, axial, circ. dimensions =  4.8000E+01  1.1458E+01  1.8617E+00
 See ITEMs 438, 444  in the file ..panda2/doc/panda2.news .
 and AIAA paper 99-1233, Proc. 40th AIAA SDM Meeting, 1999
 pp 302-345, especially pp 304-316 and associated figures.
 *** BUCKLING BETW MAJOR STIFFENERS, SMEARED SUBSTIFFENERS ***
        Number of discrete stringers, rings: NUMSTR, NUMRNG=  0   0

 No alternative solution sought because user did not want one.
 (IALTSN was set equal to zero in MAINSETUP)

 Label No. in STRUCT= 9140: Modifiers for knockdowns
 generated from use of the alternative buckling soln.(if any)
  General Instability, FKNOCK(1), EIGRT9 =  1.0000E+00  1.0000E+00
  Local Buckling,      FKNOCK(2), EIGRT7 =  1.0000E+00  1.0000E+00
**** END SUBROUTINE BUCPAN (KNOCKDOWN PANDA-TYPE BUCKL.) ******
**** Knockdown factors to account for anisotropy and/or the
**** presence of in-plane shear, in order to compensate for the
**** neglect of these in the BOSOR4-type discretized models for
**** buckling.
*************************************************************


 Conservativeness indicator, ICONSV= 1 (See panda2.news Item No. 676)
 Initial imperfections for general, panel, local buckling=
 Total out-of-roundness + modal,    W0GLOB =  1.2500E-01
 Out-of-roundness,                     WG1  =  0.0000E+00
 General buckling modal,               WG2  =  1.2500E-01
 Inter-ring buckling modal,         W0PAN =  0.0000E+00
```

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```
 Local buckling modal,                 W0LOC =  1.0000E-07
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

 *******************************************************************
 CHAPTER 9  Do BOSOR4-type "skin"-ring buckling analyses to
            compute knockdown factor to compensate for
            inherent unconservativeness of models with
            smeared rings. (See Items 509, 511, 522, and
            605 in [1L]; "skin"=skin+smeared stringers).

 Mode number  1 is      a suitable ring mode.

 Knockdown for smeared rings on cylindrical shell...
  Buckling load factor for n+dn = FNARCQ=  6.0206E+00
                               from discrete model =  4.1164E+01
  Buckling load factor for ring with bending stiffness EI:
                    pcrit=[(n+dn)**2-1]*EI/r**3/p=  4.3417E+01
  Knockdown factor, general buckling,    EIGR/EIGRNG=  9.4809E-01
 END OF SECTION ON GENERATION OF KNOCKDOWN FACTOR FOR
 COMPENSATING FOR THE UNCONSERVATIVENESS OF SMEARING RINGS
 ---------------------------------------------------------


 Knockdown for smeared rings, RNGKNZ=  9.4809E-01(FNARCQ=  6.0206E+00)
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********
****** END OF OUTPUT FROM CHAPTERs 5 - 9 with NPRINT = 0 *******
```

From CHAPTER 10.1: PANDA2 determines prebuckling bending of the shell with the general buckling modal imperfection (printed in the *.OPM file when NPRINT = 2 in the *.OPT file.

The sign conventions used in PANDA2 are described in Section 7.2 on pages 492 and 493 of the original long PANDA2 paper:

[1] Bushnell, D.,
"PANDA2 - Program for minimum weight design of stiffened,
composite, locally buckled panels", COMPUTERS AND STRUCTURES,
Vol. 25, No. 4, pp 469-605, 1987

Positive normal deflection w of the panel skin (w is called "WAMP" above) is such that the panel bends in the axial direction so as to put the panel skin in more axial tension than the tips of the stringers. (See Fig. 9 on p. 492 of the paper just cited). That is, positive w is in the same sense as positive z in Fig 9 of [1]. Positive axial curvature change, Wxx9, is in the sense that causes more compression in the panel skin than at the tips of the stringers.

Details about how the PANDA2 results listed below are obtained are given in the papers,

[4] Bushnell, D. and Bushnell, W. D.,
"Approximate method for the optimum design of ring and
stringer stiffened cylindrical panels and shells with
local, inter-ring, and general buckling modal imperfections"
Computers and Structures, Vol. 59, NO. 3, pp 489-527 (1996)

[17] Bushnell, D. and Rankin, C.C.,
"Difficulties in optimization of imperfect stiffened
cylindrical shells",
AIAA Paper 1943, 47th AIAA Structures, Structural Dynamics and
Materials Meeting, Newport RI, April 2006

See especially Tables 10 and 11 of [17].

To quote from a more recent paper,

[18] Bushnell, D.
"Optimization of an axially compressed ring and stringer
stiffened cylindrical shell with a general buckling modal
imperfection", AIAA Paper 2007-2216, 48th AIAA SDM Meeting,
Honolulu, Hawaii, April 2007

$\boxed{\text{the general buckling modal imperfection has two important effects:}}$ ← Note!!!

"A general buckling modal imperfection in a stiffened shell has two major effects:

1. The imperfect stiffened panel or shell bends as soon as any loading is applied. This prebuckling bending causes significant redistribution of stresses between the panel skin and the various stiffener parts, thus affecting significantly many local and inter-ring buckling and stress constraints (margins).

2. The "effective" circumferential curvature of an imperfect cylindrical panel or shell depends on the amplitude of the initial imperfection, on the circumferential wavelength of the critical buckling mode of the perfect and of the imperfect shell, and on the amount that the initial imperfection grows as the loading increases from zero to the design load. The "effective" circumferential radius of curvature of the imperfect and loaded cylindrical shell is larger than its nominal radius of curvature because the larger "effective" radius corresponds to the maximum local radius of the cylindrical shell with a typical inward circumferential lobe of the initial and subsequently load-amplified buckling modal imperfection. In PANDA2 this larger local "effective" radius of curvature is assumed to be the governing UNIFORM radius in the buckling equations pertaining to the imperfect shell. For the purpose of computing the general buckling load, the imperfect shell is replaced by a new perfect cylindrical shell with the larger "effective" circumferential radius. By means of this device a complicated nonlinear collapse analysis is converted into a simple approximate bifurcation buckling problem - a linear eigenvalue problem. For each type of buckling modal imperfection (general, inter-ring, local [1E]) PANDA2 computes a "knockdown" factor based on the ratio:

(buckling load factor: panel with its "effective" circumferential radius)/ (7.1)
(buckling load factor: panel with its nominal circumferential radius)"

IMPORTANT!

```
------- BEGIN PART OF THE CHAPTER 10.1 PART OF THE nasaortho.OPM FILE -------------
 *****************************************************************
 CHAPTER 10 Compute knockdown factors and prebuckling bending
            associated with initial general, inter-ring, local
            buckling modal imperfections. (See Ref.[1E].
            Also see Sections 13 and 14 and Tables 9 and 10
            of Ref.[1K]).
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

 *****************************************************************
 CHAPTER 10.1 Compute knockdown factor and prebuckling bending
              associated with GENERAL buckling modal initial
              imperfection. (See Sectons 13 and 14 and
              Tables 9 and 10 of [1K] for a detailed example)

 At 9150 in STRIMP, 7165 in BUCPAN, General instability, PERFECT shell:

 Buckling load factors are computed from Donnell theory
 EIGMNC=  2.67E+00  2.67E+00  2.67E+00  1.00E+17  1.00E+17  2.67E+00  1.00E+17
 SLOPEX=  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 MWAVEX=     3         3         3         0         0         3         0
 NWAVEX=     6         6         6         0         0         6         0
 TESTX =  5.86E-01  5.86E-01  5.86E-01  0.00E+00  0.00E+00  5.86E-01  0.00E+00

 ********* NOTE ********* NOTE ********** NOTE *********
 Factor by which general buckling modal imperfection
 amplitude will be changed for the purpose of computing
 the effective radius of curvature of the initially
 imperfect and loaded panel, AXLRED =  1.0000E+00
 Axial length in this model of the panel, A =   6.8750E+01
 Axial halfwaves in critical general mode, MBAR+DMWAVE=  3.3345E+00
 ******* END NOTE ****** END NOTE ****** END NOTE *********

 GENERAL BUCKLING EIGENV. OF PERFECT PANEL, IMOD= 0
   EILC91(m,dm,n,dn,s)=  2.3568E+00(  3, 3.345E-01,  6,-3.874E-03, 0.000E+00)


 ************ ITERATION LOOP FOR IMPERFECT PANEL ***********
 Begin iteration loop for general buckling of the imperfect
 panel. The general imperfection is amplified by the factor
 WYYAMP, which increases from iteration to iteration.

 *************** ITERATION NUMBER  1 *****************
 The radius of curvature is modified by initial imperfections:
 Orig.radius  Mod.radius  CURCHG    WYYOUT    WYYPAN    WYYLOC
 -4.800E+01 -7.680E+01  7.812E-03  0.000E+00  0.000E+00  0.000E+00
 GENERAL BUCKLING EIGENV. OF IMPERFECT PANEL, IMOD= 0
   EILOC9(m,dm,n,dn,s)=  1.6750E+00(  3, 2.669E-01,  6,-2.773E-01, 0.000E+00)
 IMPERFECTION AMPLITUDE FACTOR, WYYAMP=  4.0000E+00
 EIGEFF =RNGKNZ*(FACIM1*EILOC9 +FACIM2*FMULT2*EILC91)/(FACIM1+FMULT2*FACIM2)=  1.8028E+00
 in which FACIM1, FACIM2, and EILC91 are given by:
 FACIM1=1./(EILOC9 - 1.) =  1.4814E+00
```

```
FACIM2=1./(EILC91 - 1.) =  7.3704E-01
EILC91                  =  2.3568E+00
FMULT2                  =  1.0000E+00
RNGKNZ                  =  9.4809E-01

*** NOTE: The number of circumfer. halfwaves in the general
          buckling mode of the PERFECT panel is greater
          than that for the IMPERFECT panel or ICONSV=-1  .
          Hence,the PERFECT panel mode is used for computation
          of deformations Wxx, Wyy, Wxy in SUBROUTINE CURIMP.
ICD91, ICD9  = indicators for coordinate direction
               in which panel is longest.
General buckling mode for the PERFECT panel (PANDA theory):
(m=  3, dm=  3.35E-01, n=  6, dn= -3.87E-03, slope=  0.00E+00, ICD91= 1)
General buckling mode for the IMPERFECT panel (PANDA theory):
(m=  3, dm=  2.67E-01, n=  6, dn= -2.77E-01, slope=  0.00E+00 ICD9= 1)
(0.1 radian)/(shell wall rotation), AMPTST =  5.2502E+00

QUANTITIES USED FOR OVERALL BENDING OF IMPERFECT PANEL
(used for generation of WXX9,WYY9,WXY9), IMOD= 0:
 Amplitude of overall ovalization,                  WG1=  0.0000E+00
 Amplitude of general buckling modal imperf.,AMWIMP=  1.2500E-01
 Effective load factor for general buckling, EIGEFF=  1.8028E+00
 Number of  axial halfwaves in general mode,       m=    3
 Fractional axial halfwaves in general mode,      dm=  3.3453E-01
 Number of  circ. halfwaves in general mode,       n=    6
 Fractional circ. halfwaves in general mode,      dn= -3.8739E-03
 Slope of nodal lines in general bucklng mode,slope=  0.0000E+00
 Additional amplitude factor,                 FACIM3=  1.0000E+00
 Original imperfection is increased by 1/(EIGEFF-1)=  1.2456E+00
Amplitude of prebuckling bending due to loading, WAMP=WIMP/(EIGEFF-1.)= 1.5570E-01 in which
WIMP = Amplitude of initial buckling modal imperfection=  1.2500E-01
EIGEFF = effective buckling load factor=                  1.8028E+00
```

Compare with STAGS in Fig. 57. This is outward w in this particular case with internal stringers.

```
********* NOTE ********* NOTE ********** NOTE *********
Prebuckling bending and twist from general imperfection growth:
   Wxx9,Wyy9,Wxy9,ICD9= -3.6149E-03 -2.4296E-03 -2.9636E-03    1     CURRENT DESIGN
  ****************************************************
--------- END PART OF CHAPTER 10.1 PART OF THE nasaortho.OPM FILE ---------------
```

Sign conventions are given in Section 7.2 on pp. 492 & 493 of the long 1987 PANDA2 paper.

NOTE!

Note that PANDA2 predicts that the normal deflection caused by prebuckling bending of the globally imperfect shell under the uniform axial compression, Nx = -2219 lb/in (the design load), is:

Amplitude of prebuckling bending due to loading, WAMP=WIMP/(EIGEFF-1.)= 1.5570E-01 inch

as listed above. The approximate theory used in PANDA2 that leads to this result does not predict different amplitudes for inward and outward deflection. From Fig. 51 we see that STAGS predicts different outward and inward maximum normal deflections w for the shell subjected to the design load, load factor PA = 1.0 (Nx = -2219 lb/in). This difference leads to different predictions of the behavior of the imperfect shell from STAGS and from PANDA2, STAGS, of course, being regarded as yielding the more accurate prediction. This is one of the reasons that the PANDA2 user should ALWAYS evaluate an optimum design obtained by PANDA2 by using a general-purpose computer program such as STAGS. ← IMPORTANT!

```
****** OUTPUT FROM CHAPTERs 10.2 and 10.3 with NPRINT = 0 *******
 ******************************************************
CHAPTER 10.2 Compute knockdown factor and prebuckling bending
             associated with INTER-RING buckling modal
             initial imperfection.
 INTER-RING BUCKLING EIGENV. OF "PERFECT" PANEL, IMOD= 0
   EILC81(m,dm,n,dn,s)=  1.2214E+00(  1, 0.000E+00, 63,-2.826E-01, 0.000E+00)


 ************ ITERATION LOOP FOR IMPERFECT PANEL ***********
 Begin iteration loop for inter-ring buckling of the imperfect
 panel. The inter-ring imperfection is amplified by the factor
 WYYAMP, which increases from iteration to iteration.

 *************** ITERATION NUMBER  1 *****************
 The radius of curvature is modified by initial imperfections:
 Orig.radius  Mod.radius  WYYGEN    WYYOUT    CURCHG    WYYLOC
 -4.800E+01 -7.674E+01  7.802E-03  0.000E+00  7.802E-03  0.000E+00
 The radius of curvature is modified by initial imperfections:
 Orig.radius  Mod.radius  WYYGEN    WYYOUT    CURCHG    WYYLOC
```

```
-4.800E+01 -7.674E+01  7.802E-03  0.000E+00  7.802E-03  0.000E+00
INTER-RING BUCKLING EIGENV. OF IMPERFECT PANEL, IMOD= 0
  EILOC8(m,dm,n,dn,s)=  1.2214E+00(  1, 0.000E+00, 63, 4.237E-01, 0.000E+00)
INTER-RING IMPERFECTION AMPLITUDE FACTOR, WYYAMP=  4.0000E+00
EIGEFF =FACIM1*EILOC8 +FACIM2*FMULT2*EILC81)/(FACIM1+FMULT2*FACIM2)=  1.2214E+00
in which FACIM1, FACIM2, and EILC81 are given by:
FACIM1=1./(EILOC8 - 1.) =  4.5171E+00
FACIM2=1./(EILC81 - 1.) =  4.5171E+00
EILC81                  =  1.2214E+00
FMULT2                  =  1.0000E+00

*** NOTE: The number of circ. halfwaves in the inter-ring
          buckling mode of the PERFECT panel is less than or
          equal to that for the IMPERFECT panel. Therefore,
          the IMPERFECT panel mode is used for computation
          of deformations Wxx, Wyy, Wxy in SUBROUTINE CURIMP.
ICD81, ICD8  = indicators for coordinate direction
               in which the inter-ring portion of the
               panel is longest.
Inter-ring buckling mode for the PERFECT panel (PANDA theory):
(m=  1, dm=  0.00E+00, n= 63, dn= -2.83E-01, slope=  0.00E+00, ICD81= 1)
Inter-ring buckling mode for IMPERFECT panel (PANDA theory):
(m=  1, dm=  0.00E+00, n= 63, dn=  4.24E-01, slope=  0.00E+00 ICD8= 1)

(0.1 radian)/(shell wall rotation), AMPTST =  7.5682E+08
QUANTITIES USED FOR INTER-RING BENDING OF IMPERFECT PANEL
(used for generation of WXX8,WYY8,WXY8), IMOD= 0:
 Amplitude of overall ovalization,                 WG1=  0.0000E+00
 Amplitude of inter-ring buckling modal imp.,AMWIMP= -1.0000E-10
 Effective load factor for inter-ring buck., EIGEFF=  1.2214E+00
 Number of  axial halfwaves in inter-ring mode,   m=     1
 Fractional axial halfwaves in inter-ring mode,  dm=  0.0000E+00
 Number of  circ. halfwaves in inter-ring mode,   n=    63
 Fractional circ. halfwaves in inter-ring mode,  dn=  4.2369E-01
 Slope of nodal lines in inter-ring buck.mode,slope=  0.0000E+00
 Additional amplitude factor,                FACIM3=  1.0000E+00
 Original imperfection is increased by 1/(EIGEFF-1)=  4.5171E+00

********* NOTE ********* NOTE ********** NOTE *********
Prebuckling bending and twist from inter-ring imperfection growth:
   Wxx8,Wyy8,Wxy8,ICD8= -3.3956E-11 -7.8864E-10 -1.6364E-10    1
*******************************************************
********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

*****************************************************************
CHAPTER 10.3 Compute knockdown factor and prebuckling bending
             associated with LOCAL buckling modal initial
             imperfection.
LOCAL BUCKLING EIGENV. OF "PERFECT" PANEL, IMOD= 0
  EILC71(m,dm,n,dn,s)=  6.9581E-01(  5,-1.905E-01,  1, 0.000E+00, 0.000E+00)


************ ITERATION LOOP FOR IMPERFECT PANEL ***********
Begin iteration loop for local buckling of the imperfect
panel. The local imperfection is amplified by the factor
WYYAMP, which increases from iteration to iteration.

*************** ITERATION NUMBER  1 *****************
The radius of curvature is modified by initial imperfections:
Orig.radius  Mod.radius  WYYGEN     WYYOUT     WYYPAN     CURCHG
-4.800E+01 -7.675E+01  7.802E-03  0.000E+00  6.984E-10  7.804E-03
LOCAL BUCKLING EIGENV. OF IMPERFECT PANEL, IMOD= 0
  EILOC7(m,dm,n,dn,s)=  6.9037E-01(  5,-1.560E-01,  1, 0.000E+00, 0.000E+00)
LOCAL IMPERFECTION AMPLITUDE FACTOR, WYYAMP=  4.0000E+00
EIGEFF =(FACIM1*EILOC7 +FACIM2*FMULT2*EILC71)/(FACIM1+FMULT2*FACIM2)=  6.9309E-01
in which FACIM1, FACIM2, and EILC71 are given by:
FACIM1=1./(EILOC7 - 1.) =  1.0000E+02
FACIM2=1./(EILC71 - 1.) =  1.0000E+02
EILC71                  =  6.9581E-01
FMULT2                  =  1.0000E+00

*** NOTE: The number of circ. halfwaves in the local
          buckling mode of the PERFECT panel is less than or
          equal to that for the IMPERFECT panel. Therefore,
          the IMPERFECT panel mode is used for computation
          of deformations Wxx, Wyy, Wxy in SUBROUTINE CURIMP.
ICD71, ICD7  = indicators for coordinate direction
               in which the "local" portion of the
```

```
              panel is longest.
 Local buckling mode for the PERFECT panel (PANDA theory):
 (m=  5, dm= -1.90E-01, n=  1, dn=  0.00E+00, slope=  0.00E+00, ICD71= 1)
 Inter-ring buckling mode for IMPERFECT panel (PANDA theory):
 (m=  5, dm= -1.56E-01, n=  1, dn=  0.00E+00, slope=  0.00E+00 ICD7= 1)
 (0.1 radian)/(shell wall rotation), AMPTST =  5.9259E+05
 QUANTITIES USED FOR LOCAL BENDING OF IMPERFECT PANEL
 (used for generation of WXX7,WYY7,WXY7), IMOD= 0:
  Amplitude of overall ovalization,                WG1=  0.0000E+00
  Amplitude of  local  buckling modal imperf.,AMWIMP=  1.0000E-07
  Effective load factor for  local  buckling, EIGEFF=  6.9309E-01
  Number of  axial halfwaves in  local  mode,      m=    5
  Fractional axial halfwaves in  local  mode,     dm= -1.5604E-01
  Number of  circ. halfwaves in  local  mode,      n=    1
  Fractional circ. halfwaves in  local  mode,     dn=  0.0000E+00
  Slope of nodal lines in local buckling mode, slope=  0.0000E+00
  Additional amplitude factor,                FACIM3=  1.4428E+00
  Original imperfection is increased by 1/(EIGEFF-1)=  3.2582E+00

 ********* NOTE ********* NOTE ********** NOTE *********
 Prebuckling bending and twist from local imperfection growth:
  Wxx7(1),Wyy7(1),Wxy7(1),ICD7=  7.6347E-07  1.2326E-06  0.0000E+00    1
 ******************************************************
****** END OF OUTPUT FROM CHAPTERs 10.2 and 10.3 with NPRINT = 0 *******


From CHAPTER 10.4 PANDA2 gives the following (when NPRINT = 2):

--------- BEGIN PART OF CHAPTER 10.4 PART OF THE nasaortho.OPM FILE -------------
 ========================================================
 BUCKLING LOAD FACTORS AND IMPERFECTION SENSITIVITY SUMMARY
 --------------------------------------------------------
                            LOCAL      INTER-RING      GENERAL
                          BUCKLING      BUCKLING       BUCKLING
 RATIOS OF BUCKLING LOADS FROM ARBOCZ THEORY TO THOSE FROM
 PANDA2 THEORY FOR THE PERFECT STRUCTURE:
    (ARBOCZ/PANDA2):    1.0000E+00    9.7837E-01    1.0000E+00
 --------------------------------------------------------
 KNOCKDOWN FACTORS FOR IMPERFECTIONS DERIVED FROM
 PANDA2 THEORY VS THOSE FROM ARBOCZ 1992 UPDATE OF KOITERs
 1963 SPECIAL THEORY:
 FROM PANDA2 THEORY:    9.9218E-01    1.0000E+00    7.1074E-01
 FROM ARBOCZ THEORY:    9.9706E-01    1.0000E+00    6.8873E-01
 THE GOVERNING KNOCKDOWN FACTOR FOR EACH TYPE OF BUCKLING
 (LOCAL, INTER-RING, GENERAL) IS SET EQUAL TO THE MINIMUM
 KNOCKDOWN FACTOR FOR THAT TYPE OF BUCKLING, REDUCED
 FURTHER BY THE RATIO (ARBOCZ/PANDA2) FOR THE PERFECT PANEL
 IF THE RATIO (ARBOCZ/PANDA2) IS LESS THAN UNITY:
 The ARBOCZ theory is used only if ICONSV=1. ICONSV= 1

 USED NOW IN PANDA2:    9.9218E-01    9.7837E-01    6.8873E-01       <--knockdown factors for
                                                                       imperfections
 FACTOR APPLIED TO    6.8873E-01 FOR ALTERNATIVE SOLUTION FOR
 GENERAL    BUCKLING WITH DISCRETE STIFFENERS, FKNMLT=  1.0000E+00
 FACTOR APPLIED TO    9.7837E-01 FOR ALTERNATIVE SOLUTION FOR
 INTER-RING BUCKLING WITH DISCRETE STIFFENERS, FKNMLS=  1.0000E+00

 ***NOTE*** IF THERE IS INTERNAL PRESSURE THESE KNOCKDOWN
            FACTORS MAY BE CHANGED AS NOTED BELOW.
 ========================================================
---- END OF PART OF CHAPTER 10.4 PART OF THE nasaortho.OPM FILE --------


****** OUTPUT FROM CHAPTERs 11 and 12 with NPRINT = 0 *******
 ***********************************************************
 CHAPTER 11 Get change in stress resultants, Nx, Ny, Nxy in
            various segments of the skin-stringer module
            during prebuckling bending of the imperfect shell.
            Also, do PANDA-type [1B] local, inter-ring, gen-
            eral buckling analyses and PANDA-type stringer web
            and ring web buckling analyses to get knockdown
            factors to compensate for the lack of in-plane
            shear Nxy loading and anisotropy in discretized
            BOSOR4-type models. (See Section 11 in [1A])

 In-plane shear and anisotropy are not directly accounted for
 in any of the BOSOR4-type of discretized models. In order to
 compensate for this error, knockdown factors are established
```

Knockdown for general buckling in this case in which ICONSV=1

as given below for various types of buckling. These knockdowns
account for:
 1. the effect of in-plane shear, and
 2. anisotropy [e.g. C(4,6), C(5,6)] in the panel skin.
Knockdown factors from PANDA-type analysis are as follows:
   Knockdown factor for general instability=   1.0000E+00
   Knockdown factor for local instability=   1.0000E+00
   Knockdown factor (under hat crippling)=   1.0000E+00
   Knockdown factor for inter-ring buckling=   1.0000E+00
   Knockdown factor for stringer web bucklng= 1.0000E+00
   Knockdown factor for   ring   web bucklng= 1.0000E+00
Please note that the purpose of these knockdown factors is NOT
to compensate for initial imperfections. You can account for
initial imperfections by assigning amplitudes of local, inter-
ring, and general imperfections in the forms of the local,
inter-ring and general buckling modes. And/or you can use
appropriate factors of safety (different for different
buckling modes) to compensate for initial imperfections.

Not recommended for stiffened shells for the 1st reason given at the top of p. A10.

********* DESIGN PERTURBATION INDEX, IMOD= 0 *********

****
CHAPTER 12 Obtain prebuckled state of the initially imperfect
           and loaded and bent panel or shell. This section
           includes the redistribution of Nx, Ny, Nxy in the
           various segments of the stiffened shell structure.
********* DESIGN PERTURBATION INDEX, IMOD= 0 *********
****** END OF OUTPUT FROM CHAPTERs 11 and 12 with NPRINT = 0 *******

********* CHAPTERS 13 and 14 in the nasaortho.OPM file ************
From CHAPTERS 13 and 14 (single discretized skin-stringer module model):
For more information about the "single discretized skin-stringer module
model", see the paper:

[1] Bushnell, D.,
"PANDA2 - Program for minimum weight design of stiffened,
composite, locally buckled panels", COMPUTERS AND STRUCTURES,
Vol. 25, No. 4, pp 469-605, 1987

See Figs. 9, 10, 12, 13, 17, 18, 20, 46, 80, and 90a from that paper
for examples of single skin-stringer modules.

Note that in Table 33b Margins 4 and 8, "Eff.stress:matl=1", are
equal to eachother, whereas in Table 33a the corresponding margins,
Margins 4 and 9 near the top of p. 1 of Table 33a differ by more
than a factor of two. Margin no. 4 is computed with SUBROUTINE
STRTHK whereas the other stress margin (Margin 9 in Table 33a and
Margin 8 in Table 33b) is computed with SUBROUTINE STRCON.
SUBROUTINE STRTHK accounts for any local deformation computed
in the KOITER branch (CHAPTER 16), and THE VALUE OF THE MARGIN DEPENDS
ON THE SIGN OF THE INITIAL GENERAL BUCKLING MODAL IMPERFECTION.
In contrast SUBROUTINE STRCON does not include the local deformation
computed in the KOITER branch of PANDA2, and both plus and minus
versions of the general buckling modal imperfection are processed
for each load case during the determination of the maximum effective stress.
Notice that on the upper portion of page 2 of Table 33a Margin 4 is 1.19
compared to 2.54 on the upper portion of page 1 of Table 33a. THE DIFFERENCE
IS CAUSED BY THE SIGN OF THE GENERAL BUCKLING MODAL IMPERFECTION:
positive in the first load case and negative in the second load case.

Again referring to Table 33a. The lowest (most critical) stress margins
are Margins 6 and 10 in the upper part on p. 1 of Table 33a:
"eff.stress:matl=2,STR". Margin 6 = "eff.stress:matl=2,STR,Dseg=3,node=11";
Margin 10 = "eff.stress:matl=2,STR,Iseg=3,at:TIP". In the single module
model Dseg = 3 and Iseg = 3 means "Segment 3", which is the stringer web.
Node 11 in Dseg=3 is the tip of the stringer. The high stress at the tip
of the stringer in Load Case 1 arises because the imperfect shell is
bending under the axial load in such a way that the tips of the stringers
are compressed more than their roots. The distribution of axial resultant
Nx across the height of a stringer from root to tip is given, for a POSITIVE
imperfection amplitude, Wimp = +0.125 inch (Load Case 1), by the following:
 PREBUCKLING AXIAL RESULTANTS IN STRINGER WEB: SEGMENT NO. 3
  "Eigenvalue" axial resultant, Nx(var)=
 -1.3716E+03 -1.6731E+03 -1.9745E+03 -2.2760E+03 -2.5774E+03 -2.8789E+03
 -3.1803E+03 -3.4818E+03 -3.7832E+03 -4.0847E+03 -4.3861E+03
This output appears for Load Case 1, Subcase 1 in CHAPTER 13 of the
nasaortho.OPM file from PANDA2. The stress margin corresponding to this is

given in the upper portion of page 1 of Table 33a:
Margin 6 = 0.273, "eff.stress:matl=2,STR,Dseg=3,node=11"
Node 11 is at the tip of the stringer. For Load Case 2, Subcase 1, that is, for a NEGATIVE imperfection amplitude, Wimp = -0.125 inch, the distribution of axial resultant Nx across the height of a stringer from root to tip is given in CHAPTER 13 of nasaortho.OPM by the following:

```
 PREBUCKLING AXIAL RESULTANTS IN STRINGER WEB: SEGMENT NO.  3
  "Eigenvalue" axial resultant, Nx(var)=
 -2.6162E+03 -2.3322E+03 -2.0482E+03 -1.7642E+03 -1.4802E+03 -1.1962E+03
 -9.1215E+02 -6.2814E+02 -3.4412E+02 -6.0108E+01  2.2391E+02
```

The corresponding stress margin for the NEGATIVE imperfection appears in the upper part of page 2 of Table 33a:
Margin 6 = 1.26, "eff.stress:matl=2,STR,Dseg=3,node=1"
Node 1 is at the root of the stringer.
Note that, unlike Margin 6, which is the margin computed from SUBROUTINE STRTHK and which depends on the sign of the general buckling modal imperfection, The "other" matl=2 (stringer material) stringer stress margin, "eff.stress:matl=2,STR,Iseg=3,at:TIP", that is, Margin no. 10 in Load case 1, Subcase 1 and Margin no. 11 in Load Case 2, Subcase 1, is equal to 0.287 for both load cases. This is because the stresses computed in SUBROUTINE STRCON compute the highest stress from either positive or negative amplitudes of the general buckling modal imperfection.

In this particular case (because there is very little local "post-buckling" (CHAPTER 16 in nasaortho.OPM) and because the inter-ring axisymmetric "hungry horse" deformation if very small (CHAPTER 4 in nasaortho.OPM with NPRINT=2) the stringer stress is almost entirely caused by the applied axial compression and the "global" prebuckling bending of the shell with the general buckling modal imperfection. For the POSITIVE imperfection (Load Case 1, Subcase 1) the stress computed from the largest Nx is:

stress = Nx/(web thickness) = -4386.1/0.080641 = -54390 psi. The margin corresponding to this stress is given by:

```
 margin = (allowable stress)/(effective stress x f.s.) - 1.0
        =              70000/(54390 x 0.999) - 1.0          = 0.288
```

Notice that 0.288 agrees almost exactly with Margin No. 10 in the upper part of page 1 of Table 33a and with Margin No. 11 in the upper part of page 2. For the NEGATIVE imperfection (Load Case 2, Subcase 1) the stress computed from the largest Nx is:

stress = Nx/(web thickness) = -2616.2/0.080641 = -32443 psi. The margin corresponding to this stress is given by:

```
 margin = (allowable stress)/(effective stress x f.s.) - 1.0
        =              70000/(32443 x 0.999)  - 1.0          = 1.160
```

The difference between 0.288 and Margin no. 6 = 0.273 in the upper part of page 1 of Table 33a and the difference between 1.160 and Margin no. 6 = 1.26 in the upper part of page 2 of Table 33a are caused by the slight amount of local bending in the stringer that is computed in the Koiter branch (CHAPTER 16) of PANDA2.

More information relating to Table 33a...
The amount of "global" prebuckling bending of the shell with the general buckling modal imperfection depends on what is used for the "conservativeness index", ICONSV, in the PANDA2 input file for MAINSETUP, nasaortho.OPT. The "conservative index" is described in the paper:

Bushnell, D.,
"Optimization of an axially compressed ring and stringer stiffened cylindrical shell with a general buckling modal imperfection", AIAA Paper 2007-2216, 48th AIAA SDM Meeting, Honolulu, Hawaii, April 2007.

and in the following items of the file, .../panda2/doc/panda2.news:
Items 676, 690, 694, 707, 713, 725, 741, 754, 764, 767, 768.
The amount of prebuckling bending of the globally imperfect shell depends on ICONSV because various knockdown factors used to compensate for the approximate nature of the theories used in PANDA2 depend on ICONSV. (See Table 23 for knockdown factors for ICONSV = 1 and see Tables 69 and 70 for the dependence of them and margins on ICONSV). The following list presents the prebuckling distributions of Nx in the stringer web (SEGMENT NO. 3) and the related stress margins for positive and negative amplitudes of the general buckling modal imperfection (Wimp = + & - 0.125 inch).

```
ICONSV = 1 (leads to the most conservative designs and is the preferred value):
 POSITIVE imperfection: Wimp = +0.125 inch:
 PREBUCKLING AXIAL RESULTANTS IN STRINGER WEB: SEGMENT NO.  3
  "Eigenvalue" axial resultant, Nx(var)=
 -1.3716E+03 -1.6731E+03 -1.9745E+03 -2.2760E+03 -2.5774E+03 -2.8789E+03
 -3.1803E+03 -3.4818E+03 -3.7832E+03 -4.0847E+03 -4.3861E+03
 6  2.73E-01 eff.stress:matl=2,STR,Dseg=3,node=11,layer=1,z=0.0403; MID.;FS=1.
10  2.87E-01 eff.stress:matl=2,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.

 NEGATIVE imperfection: Wimp = -0.125 inch:
 PREBUCKLING AXIAL RESULTANTS IN STRINGER WEB: SEGMENT NO.  3
  "Eigenvalue" axial resultant, Nx(var)=
 -2.6162E+03 -2.3322E+03 -2.0482E+03 -1.7642E+03 -1.4802E+03 -1.1962E+03
 -9.1215E+02 -6.2814E+02 -3.4412E+02 -6.0108E+01  2.2391E+02
 6  1.26E+00 eff.stress:matl=2,STR,Dseg=3,node=1,layer=1,z=0.0403; MID.;FS=1.
11  2.87E-01 eff.stress:matl=2,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.

ICONSV = 0 (leads to less conservative designs than ICONSV = 1):
 POSITIVE imperfection: Wimp = +0.125 inch:
 PREBUCKLING AXIAL RESULTANTS IN STRINGER WEB: SEGMENT NO.  3
  "Eigenvalue" axial resultant, Nx(var)=
 -1.4570E+03 -1.7183E+03 -1.9796E+03 -2.2409E+03 -2.5022E+03 -2.7635E+03
 -3.0248E+03 -3.2861E+03 -3.5474E+03 -3.8086E+03 -4.0699E+03
 5  3.73E-01 eff.stress:matl=2,STR,Dseg=3,node=11,layer=1,z=0.0403; MID.;FS=1.
10  3.87E-01 eff.stress:matl=2,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.

 NEGATIVE imperfection: Wimp = -0.125 inch:
 PREBUCKLING AXIAL RESULTANTS IN STRINGER WEB: SEGMENT NO.  3
  "Eigenvalue" axial resultant, Nx(var)=
 -2.5309E+03 -2.2870E+03 -2.0432E+03 -1.7993E+03 -1.5554E+03 -1.3116E+03
 -1.0677E+03 -8.2384E+02 -5.7998E+02 -3.3612E+02 -9.2259E+01
 6  1.33E+00 eff.stress:matl=2,STR,Dseg=3,node=1,layer=1,z=-0.0403; MID.;FS=1.
10  3.87E-01 eff.stress:matl=2,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.

ICONSV = -1 (leads to less conservative designs than ICONSV = 0):
 POSITIVE imperfection: Wimp = +0.125 inch:
 PREBUCKLING AXIAL RESULTANTS IN STRINGER WEB: SEGMENT NO.  3
  "Eigenvalue" axial resultant, Nx(var)=
 -1.6361E+03 -1.8132E+03 -1.9902E+03 -2.1672E+03 -2.3442E+03 -2.5213E+03
 -2.6983E+03 -2.8753E+03 -3.0524E+03 -3.2294E+03 -3.4064E+03
 5  6.44E-01 eff.stress:matl=2,STR,Dseg=3,node=11,layer=1,z=0.0403; MID.;FS=1.
10  6.57E-01 eff.stress:matl=2,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.

 NEGATIVE imperfection: Wimp = -0.125 inch:
 PREBUCKLING AXIAL RESULTANTS IN STRINGER WEB: SEGMENT NO.  3
  "Eigenvalue" axial resultant, Nx(var)=
 -2.3517E+03 -2.1921E+03 -2.0325E+03 -1.8730E+03 -1.7134E+03 -1.5538E+03
 -1.3942E+03 -1.2346E+03 -1.0750E+03 -9.1539E+02 -7.5580E+02
 5  1.48E+00 eff.stress:matl=2,STR,Dseg=3,node=1,layer=1,z=-0.0403; MID.;FS=1.
 9  6.57E-01 eff.stress:matl=2,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.
```

Note that there is a strong dependence of the effective stress margin on which value is used for ICONSV. The most conservative model, ICONSV = 1, (which is the recommended model in PANDA2) yields the lowest stress margins and the least conservative model, ICONSV = -1, yields the highest stress margins.

Still more information relating to Table 33a...
In computing the local buckling load factor from the single discretized skin-stringer module model, PANDA2 makes certain adjustments to the prebuckling load distribution over the module cross section in order to ensure that PANDA2 will not obtain unconservative designs. In this case in Load Case 1, Subcase 1 (POSITIVE general buckling modal imperfection amplitude, Wimp = +0.125 inch) the margins associated with various types of local buckling are:

```
---------------------------------------------------------------------------
 MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 1, SUBCASE NO. 1
 MAR. MARGIN
 NO.  VALUE                  DEFINITION
 1  4.98E-02 Local buckling from discrete model-1.,M=4   axial halfwaves;FS=0.99
 2  4.47E-02 Bending-torsion buckling; M=4  ;FS=0.999
 3  3.87E-02 Bending-torsion buckling: Koiter theory,M=4   axial halfwav;FS=0.99
 7  1.76E-01 (m=4   lateral-torsional buckling load factor)/(FS)-1;FS=0.999
12  1.45E-02 buckling margin stringer Iseg.3 . Local halfwaves=5  .MID.;FS=1.
```

```
13 -8.20E-03 buckling margin stringer Iseg.3 . Local halfwaves=5  .NOPO;FS=1.
16  6.79E-01 buck.(SAND);rolling only of stringers;M=45;N=0;slope=0.;FS=1.4
--------------------------------------------------------------------------------
```

The first 4 margins (1,2,3,7) represent the same phenomenon with slightly different approximations: buckling of the discretized skin-stringer single module model. The next two margins (12 and 13) are derived from closed-form solutions in which the stringer, assumed to be simply supported at its root, buckles with the same number of axial halfwaves that PANDA2 finds that is critical for the skin when a closed-form solution is used for skin buckling. The last local buckling margin (16) is derived from a closed-form solution in which the stringer web bends from root to tip. The most accurate model is the discretized skin-stringer single module model (Margins 1 and 2). In this case the POSITIVE general buckling modal imperfection is such that prebuckling bending lessens the axial compression in the skin and increases the compression at the tip of the stringer. In order to avoid obtaining unconservative designs, PANDA2, omits the lessening of the axial compression in the skin in Segments 1 and 4 of the single module cross section. When this strategy is taken PANDA2 writes rather long notes to the *.OPM file when the print index, NPRINT = 2. These notes follow:

```
********* LOAD SET 1, SUBCASE 1 Wimp = +0.125 inch...********************
----- BEGIN PART OF CHAPTER 13 PART OF THE nasaortho.OPM FILE -----------
 *******************************************************************
 CHAPTER 13 Get prebuckling stress resultants, Nx, Ny, needed
            for the discretized single-module skin-stringer
            model used for local buckling and bending-torsion
            buckling (BOSOR4-type model: see Figs. 18, 20,
            22, 97, and 98 of [1A], for examples of the
            discretized single skin-stringer BOSOR4-type
            module model.).

 Effective circumferential radius of curvature, RADNEW= -7.6747E+01

 **** NOTE ********* NOTE ********* NOTE ********* NOTE ****
 This is Segment 1 (Panel skin between adjacent stringers)
 Because of "effective width" considerations, the incremental
 AXIAL tension in the panel skin, which is generated by
 prebuckling bending of the imperfect panel, is being reset to
 zero for the buckling computations (ONLY in Segs.1 and NSEG).
 This is done because in the real world the incremental axial
 tension in the panel skin decays from its computed value at
 the hoop coordinate corresponding to the stringer station to
 nearly zero midway between adjacent stringers. Therefore, it
 is conservative to neglect the effect of this axial tension
 on the local buckling load factor computed from the discrete
 skin-stringer module. Axial tension is retained in Segment 2.
  Axial tension before the reset to zero, dNx(1)=  3.8249E+02
  Axial tension after  the reset to zero, dNx(1)= 0.0

 **** NOTE ********* NOTE ********* NOTE ********* NOTE ****
 This is Segment 1 (Panel skin between adjacent stringers)
 Because of "effective width" considerations, the incremental
 CIRCUMFERENTIAL tension in the panel skin, generated by
 prebuckling bending of the imperfect panel, is being reset to
 zero for the buckling computations (ONLY in Segs.1 and NSEG).
 This is done because in the "real world" the incremental hoop
 tension in the panel skin decays from its computed value at
 the axial coordinate corresponding to the ring station
 to nearly zero midway between adjacent rings. Therefore, it
 is conservative to neglect the effect of this hoop tension
 on the local buckling load factor computed from the discrete
 skin-stringer module. Hoop tension is retained in Segment 2.
  Hoop tension before the reset to zero, dNy(1)=  2.3928E+02
  Hoop tension after  the reset to zero, dNy(1)= 0.0
----- END OF PART OF CHAPTER 13 PART OF THE nasaortho.OPM FILE --------
```

Load Set 1: Wimp = +0.125"

This approximation leads to the follwing distribution of prebuckling resultants in the single discretized skin-stringer module (from CHAPTER 13 of the nasaortho.OPM file):

```
----- BEGIN ANOTHER PART OF CHAPTER 13 PART OF THE nasaortho.OPM FILE --------
      Internal Stringer

     MODULE WITH RECTANGULAR STIFFENER...
```

```
                                  !   ^
           Segment No. 3 -----> !   !
                                  !   !
                Seg. No. 2-.      !   h
                          .       !   !
     Segment No. 1-.        .     !   !         .-Seg. No. 4
                  .         .     !   V        .(same as Seg. 1)
      -----------------================================---------------
                         !<------ b2 ------->!
      !<--- Module width  =  stiffener spacing, b --->!


   EXPLODED VIEW, SHOWING LAYERS and (SEGMENT, NODE) NUMBERS

                            (3,11)
                              !
          Layer No. 1 -----> ! <---------- Layer No. k
                              !
       Layer No. 1-.          !
                   .          !
  Layer No. 1-.        .      !              .-Layer No. 1
             .          .     !             .
            .            .  (3,1)            .
  --------------    =====================    --------------
(1,1)   .   (1,11)(2,1)   . (2,6)    (2,11)(4,1)   .    (4,11)
         .                .                       .
          .                .                       .
          Layer No. m       Layer No. n     Layer No. m

 ==============================================
 BEGIN: PREBUCKLING STRESS RESULTANTS USED IN THE
 DISCRETIZED SINGLE MODULE MODEL WITH IQUICK = 0...
 ----------------------------------------------------------
 PREBUCKLING STRESS RESULTANTS AT THE FIRST NODE
 IN THE DISCRETIZED SINGLE MODULE SEGMENT NO. 1 .....
  "Total." loads, Nx(var),Ny(var),Nxy(var)= -1.2470E+03 -7.6529E+01  1.1095E+01
  "Fixed " loads, Nx(fix),Ny(fix),Nxy(fix)=  0.0000E+00  0.0000E+00  0.0000E+00
 PREBUCKLING STRESS RESULTANTS AT THE FIRST NODE
 IN THE DISCRETIZED SINGLE MODULE SEGMENT NO. 2 .....
  "Total." loads, Nx(var),Ny(var),Nxy(var)= -8.6452E+02  1.6275E+02  1.1095E+01
  "Fixed " loads, Nx(fix),Ny(fix),Nxy(fix)=  0.0000E+00  0.0000E+00  0.0000E+00
 PREBUCKLING STRESS RESULTANTS AT THE FIRST NODE
 IN THE DISCRETIZED SINGLE MODULE SEGMENT NO. 3 .....
  "Total." loads, Nx(var),Ny(var),Nxy(var)= -1.3716E+03  3.2032E-31  5.4240E-08
  "Fixed " loads, Nx(fix),Ny(fix),Nxy(fix)=  0.0000E+00  0.0000E+00  0.0000E+00
 PREBUCKLING AXIAL RESULTANTS IN STRINGER WEB: SEGMENT NO.  3
  "Eigenvalue" axial resultant, Nx(var)=
 -1.3716E+03 -1.6731E+03 -1.9745E+03 -2.2760E+03 -2.5774E+03 -2.8789E+03
 -3.1803E+03 -3.4818E+03 -3.7832E+03 -4.0847E+03 -4.3861E+03
  "   fixed    " axial resultant, Nx(fix)=
  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
 PREBUCKLING STRESS RESULTANTS AT THE FIRST NODE
 IN THE DISCRETIZED SINGLE MODULE SEGMENT NO. 4 .....
  "Total." loads, Nx(var),Ny(var),Nxy(var)= -1.2470E+03 -7.6529E+01  1.1095E+01
  "Fixed " loads, Nx(fix),Ny(fix),Nxy(fix)=  0.0000E+00  0.0000E+00  0.0000E+00
 ----------------------------------------------------
 END:  PREBUCKLING STRESS RESULTANTS USED IN THE
 DISCRETIZED SINGLE MODULE MODEL WITH IQUICK = 0...
 ==========================================================
----- END OF ANOTHER PART OF CHAPTER 13 PART OF THE nasaortho.OPM FILE --------
```

Load Set 1 (Wimp = +0.125")

Wimp = +0.125" note. Compare with Load Set 2 predictions on p. A20

The distribution of Nx and Ny just listed leads to the following results from a search for the critical local buckling load factor (output from CHAPTER 14 of nasaortho.OPM with NPRINT = 2):

```
----- BEGIN PART OF CHAPTER 14 PART OF THE nasaortho.OPM FILE --------
CHAPTER 14 Compute local buckling from BOSOR4-type
           discretized skin-stringer single module model.
           See Section 12.2 (upper table on p. 511) and
           Figs. 46c and 98b in [1A], for examples.

 BUCKLING LOAD FACTORS FROM BOSOR4-TYPE DISCRETIZED MODEL...
          (skin-stringer discretized module of local buckling)
  AXIAL     BUCKLING        KNOCKDOWN FOR    KNOCKDOWN FOR      BUCKLING
  HALF-    LOAD FACTOR     TRANSVERSE SHEAR  IN-PLANE SHEAR    LOAD FACTOR
  WAVES  BEFORE KNOCKDOWN    DEFORMATION     LOADING AND/OR  AFTER KNOCKDOWN
```

M	EIGOLD	KSTAR	ANISOTROPY KNOCK	EIGOLD*KSTAR*KNOCK
8	1.34641E+00	1.00000E+00	1.00000E+00	1.34641E+00
9	1.48412E+00	1.00000E+00	1.00000E+00	1.48412E+00
7	1.22600E+00	1.00000E+00	1.00000E+00	1.22600E+00
6	1.12932E+00	1.00000E+00	1.00000E+00	1.12932E+00
5	1.06604E+00	1.00000E+00	1.00000E+00	1.06604E+00
4	1.05666E+00	1.00000E+00	1.00000E+00	1.05666E+00
3	1.16184E+00	1.00000E+00	1.00000E+00	1.16184E+00

Buckling load factor before t.s.d.= 1.0567E+00 After t.s.d.= 1.0488E+00

4	1.05666E+00	9.92516E-01	1.00000E+00	1.04875E+00

Compare with value on p. A21

Load Set #1 (Wimp = +0.125")

NORMAL MODAL DISPLACEMENTS IN THE PANEL MODULE SHOWN ABOVE
SKIN-STRINGER PANEL MODULE HAS 4 SEGMENTS
NUMBER OF HALF-WAVES IN THE AXIAL DIRECTION, M= 4

MODAL DISPLACEMENTS FOR SEGMENT NO. 1

NODE	Z	W	WD	WDD	U	V	WDDD
1	0.00E+00	5.67E-01	0.00E+00	-1.57E+00	0.00E+00	-6.25E-04	3.77E-01
2	0.00E+00	5.64E-01	-9.64E-02	-1.55E+00	-1.02E-04	-6.24E-04	3.77E-01
3	0.00E+00	5.55E-01	-1.92E-01	-1.53E+00	-2.04E-04	-6.17E-04	3.77E-01
4	0.00E+00	5.40E-01	-2.85E-01	-1.49E+00	-3.06E-04	-6.06E-04	6.23E-01
5	0.00E+00	5.20E-01	-3.76E-01	-1.43E+00	-4.08E-04	-5.91E-04	8.63E-01
6	0.00E+00	4.94E-01	-4.63E-01	-1.36E+00	-5.10E-04	-5.70E-04	1.09E+00
7	0.00E+00	4.62E-01	-5.45E-01	-1.28E+00	-6.12E-04	-5.45E-04	1.31E+00
8	0.00E+00	4.26E-01	-6.22E-01	-1.19E+00	-7.14E-04	-5.14E-04	1.51E+00
9	0.00E+00	3.85E-01	-6.92E-01	-1.08E+00	-8.15E-04	-4.77E-04	1.70E+00
10	0.00E+00	3.40E-01	-7.56E-01	-9.68E-01	-9.16E-04	-4.33E-04	1.87E+00
11	0.00E+00	2.91E-01	-8.13E-01	-8.52E-01	-1.02E-03	-3.83E-04	1.87E+00

MODAL DISPLACEMENTS FOR SEGMENT NO. 2

NODE	Z	W	WD	WDD	U	V	WDDD
1	0.00E+00	2.91E-01	-8.13E-01	-8.37E-01	-1.02E-03	-3.83E-04	2.80E-01
2	0.00E+00	2.39E-01	-8.65E-01	-8.20E-01	-1.12E-03	-3.25E-04	2.80E-01
3	0.00E+00	1.84E-01	-9.16E-01	-8.02E-01	-1.21E-03	-2.58E-04	2.80E-01
4	0.00E+00	1.26E-01	-9.65E-01	-7.92E-01	-1.31E-03	-1.82E-04	1.66E-01
5	0.00E+00	6.44E-02	-1.01E+00	-7.90E-01	-1.41E-03	-9.50E-05	2.50E-02
6	0.00E+00	-1.59E-07	-1.04E+00	-2.31E-05	-1.46E-03	3.15E-08	1.28E+01
7	0.00E+00	-6.44E-02	-1.01E+00	7.90E-01	-1.41E-03	9.50E-05	1.28E+01
8	0.00E+00	-1.26E-01	-9.65E-01	7.92E-01	-1.31E-03	1.82E-04	2.52E-02
9	0.00E+00	-1.84E-01	-9.16E-01	8.02E-01	-1.21E-03	2.58E-04	1.67E-01
10	0.00E+00	-2.39E-01	-8.65E-01	8.20E-01	-1.12E-03	3.25E-04	2.80E-01
11	0.00E+00	-2.91E-01	-8.13E-01	8.37E-01	-1.02E-03	3.83E-04	2.80E-01

MODAL DISPLACEMENTS FOR SEGMENT NO. 3

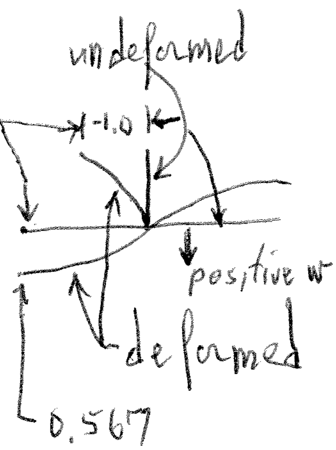
NODE	Z	W	WD	WDD	U	V	WDDD
1	-2.48E-02	-2.72E-02	-1.04E+00	-2.89E-01	1.59E-07	2.68E-08	8.01E-01
2	-1.14E-01	-1.21E-01	-1.07E+00	-2.18E-01	1.58E-07	1.65E-08	8.01E-01
3	-2.02E-01	-2.16E-01	-1.08E+00	-1.47E-01	1.57E-07	6.76E-09	8.01E-01
4	-2.91E-01	-3.13E-01	-1.09E+00	-8.50E-02	1.55E-07	-2.55E-09	6.96E-01
5	-3.80E-01	-4.10E-01	-1.10E+00	-3.60E-02	1.54E-07	-1.17E-08	5.51E-01
6	-4.69E-01	-5.08E-01	-1.10E+00	-4.91E-03	1.53E-07	-2.09E-08	3.50E-01
7	-5.58E-01	-6.06E-01	-1.10E+00	1.58E-03	1.51E-07	-3.05E-08	7.31E-02
8	-6.46E-01	-7.03E-01	-1.10E+00	-2.51E-02	1.50E-07	-4.09E-08	-3.01E-01
9	-7.35E-01	-8.01E-01	-1.11E+00	-9.58E-02	1.48E-07	-5.21E-08	-7.96E-01
10	-8.24E-01	-9.00E-01	-1.12E+00	-2.23E-01	1.46E-07	-6.47E-08	-1.44E+00
11	-9.13E-01	-1.00E+00	-1.14E+00	-3.51E-01	1.44E-07	-7.84E-08	-1.44E+00

MODAL DISPLACEMENTS FOR SEGMENT NO. 4

NODE	Z	W	WD	WDD	U	V	WDDD
1	0.00E+00	-2.91E-01	-8.13E-01	8.52E-01	-1.02E-03	3.83E-04	1.87E+00
2	0.00E+00	-3.40E-01	-7.56E-01	9.68E-01	-9.16E-04	4.33E-04	1.87E+00
3	0.00E+00	-3.85E-01	-6.92E-01	1.08E+00	-8.15E-04	4.77E-04	1.87E+00
4	0.00E+00	-4.26E-01	-6.22E-01	1.19E+00	-7.14E-04	5.14E-04	1.70E+00
5	0.00E+00	-4.62E-01	-5.45E-01	1.28E+00	-6.12E-04	5.45E-04	1.51E+00
6	0.00E+00	-4.94E-01	-4.63E-01	1.36E+00	-5.10E-04	5.70E-04	1.31E+00
7	0.00E+00	-5.20E-01	-3.76E-01	1.43E+00	-4.08E-04	5.91E-04	1.09E+00
8	0.00E+00	-5.40E-01	-2.85E-01	1.49E+00	-3.06E-04	6.06E-04	8.63E-01
9	0.00E+00	-5.55E-01	-1.92E-01	1.53E+00	-2.04E-04	6.17E-04	6.23E-01
10	0.00E+00	-5.64E-01	-9.64E-02	1.55E+00	-1.02E-04	6.24E-04	3.77E-01
11	0.00E+00	-5.67E-01	0.00E+00	1.57E+00	0.00E+00	6.25E-04	3.77E-01

**** END SUBROUTINE MODE (LOCAL BUCKLING MODE SHAPE) ******

Wimp = +0.125" Compare with the local buckling mode for Wimp = -0.125" listed on p. A21.



(In the buckling mode shape just listed look especially at the column headed "W" (normal deflection) Compare with the local buckling mode shape obtained from Load Set 2, Subcase 1, which is printed below.)

****
**** LOCAL MODE HAS STRINGER SIDESWAY ****
****
**** END OF LOCAL BUCKLING EIGENVECTOR CALC.****

A19

Compare with Load Set 1 prediction on p. A18.

```
Margin=  4.9801E-02  Local buckling from discrete model-1.,M=4   axial halfwaves;FS=0.999
Margin=  4.4709E-02  Bending-torsion buckling; M=4  ;FS=0.999
******** THE FOLLOWING BENDING-TORSION MARGIN JUST COMPUTED:
Bending-torsion buckling; M=4  ;FS=0.999
----- END OF PART OF CHAPTER 14 PART OF THE nasaortho.OPM FILE --------
******* END OF CHAPTER 13 and CHAPTER 14 OUTPUT FOR LOAD SET 1 *************
```

**** BEGIN CHAPTER 13 and CHAPTER 14 DISCUSSION AND OUTPUT FOR LOAD SET 2 *****

Corresponding to Load Case 2, Subcase 2, for which the general buckling modal imperfection is NEGATIVE, Wimp = -0.125 inch, the two notes about setting dNx and dNy equal to zero do not occur because the shape of the negative imperfection is such as to cause additional compression in the panel skin as the axial load is applied to the imperfect shell. The resulting distributions of Nx and Ny over the cross section of the single skin-stringer module are (from CHAPTER 13 of nasaortho.OPM):

LOAD SET 2, SUBCASE 1 Wimp = -0.125 inch...

Load Set 2

```
----- BEGIN PART OF CHAPTER 13 PART OF THE nasaortho.OPM FILE --------
 ==============================================
 BEGIN: PREBUCKLING STRESS RESULTANTS USED IN THE
 DISCRETIZED SINGLE MODULE MODEL WITH IQUICK = 0...
 ----------------------------------------------------------
 PREBUCKLING STRESS RESULTANTS AT THE FIRST NODE
 IN THE DISCRETIZED SINGLE MODULE SEGMENT NO. 1 .....
  "Total." loads, Nx(var),Ny(var),Nxy(var)= -1.6295E+03 -3.1581E+02  1.1095E+01
  "Fixed " loads, Nx(fix),Ny(fix),Nxy(fix)=  0.0000E+00  0.0000E+00  0.0000E+00
 PREBUCKLING STRESS RESULTANTS AT THE FIRST NODE
 IN THE DISCRETIZED SINGLE MODULE SEGMENT NO. 2 .....
  "Total." loads, Nx(var),Ny(var),Nxy(var)= -1.6295E+03 -3.1581E+02  1.1095E+01
  "Fixed " loads, Nx(fix),Ny(fix),Nxy(fix)=  0.0000E+00  0.0000E+00  0.0000E+00
 PREBUCKLING STRESS RESULTANTS AT THE FIRST NODE
 IN THE DISCRETIZED SINGLE MODULE SEGMENT NO. 3 .....
  "Total." loads, Nx(var),Ny(var),Nxy(var)= -2.6162E+03  3.2032E-31  5.4240E-08
  "Fixed " loads, Nx(fix),Ny(fix),Nxy(fix)=  0.0000E+00  0.0000E+00  0.0000E+00

 AXIAL CURVATURE CHANGES FROM SOURCES OTHER THAN
 INITIAL IMPERFECTIONS (FROM EPSLOD(4) AND ETHERM(4))...
  "Eigenvalue" axial curvature change
      CURVAR = EPSLOD(4) - FFIABT*ETHERM(4) = -1.1065E-04
  "Fixed" axial curvature change
      CURFIX = EPSLDF(4)                    =  0.0000E+00

 PREBUCKLING AXIAL RESULTANTS IN STRINGER WEB: SEGMENT NO.  3
  "Eigenvalue" axial resultant, Nx(var)=
 -2.6162E+03 -2.3322E+03 -2.0482E+03 -1.7642E+03 -1.4802E+03 -1.1962E+03
 -9.1215E+02 -6.2814E+02 -3.4412E+02 -6.0108E+01  2.2391E+02
  "  fixed   " axial resultant, Nx(fix)=
  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
 PREBUCKLING STRESS RESULTANTS AT THE FIRST NODE
 IN THE DISCRETIZED SINGLE MODULE SEGMENT NO. 4 .....
  "Total." loads, Nx(var),Ny(var),Nxy(var)= -1.6295E+03 -3.1581E+02  1.1095E+01
  "Fixed " loads, Nx(fix),Ny(fix),Nxy(fix)=  0.0000E+00  0.0000E+00  0.0000E+00
 ------------------------------------------------
 END:  PREBUCKLING STRESS RESULTANTS USED IN THE
 DISCRETIZED SINGLE MODULE MODEL WITH IQUICK = 0...
 ==========================================================
----- END OF PART OF CHAPTER 13 PART OF THE nasaortho.OPM FILE --------
```

Wimp = -0.125"

Load Set 2 (Wimp = -0.125")

This Load Set 2 Section is inserted here for easy comparison with results of Chapters 13 & 14 for Load Set 1. PANDA2 actually computes this later, of course, in connection with all the other Load Set 2 computations.

Chapter 13,14

The distribution of Nx and Ny just listed leads to the following results from a search for the critical local buckling load factor (output from CHAPTER 14 of nasaortho.OPM with NPRINT = 2):

```
----- BEGIN PART OF CHAPTER 14 PART OF THE nasaortho.OPM FILE --------
 BUCKLING LOAD FACTORS FROM BOSOR4-TYPE DISCRETIZED MODEL...
         (skin-stringer discretized module of local buckling)
  AXIAL     BUCKLING          KNOCKDOWN FOR     KNOCKDOWN FOR       BUCKLING
  HALF-    LOAD FACTOR      TRANSVERSE SHEAR   IN-PLANE SHEAR     LOAD FACTOR
  WAVES  BEFORE KNOCKDOWN     DEFORMATION      LOADING AND/OR   AFTER KNOCKDOWN
                                                ANISOTROPY
   M         EIGOLD              KSTAR             KNOCK       EIGOLD*KSTAR*KNOCK
   8       1.16046E+00       1.00000E+00       1.00000E+00       1.16046E+00
   7       1.13445E+00       1.00000E+00       1.00000E+00       1.13445E+00
```

Load Set 2 Wimp = -0.125"

```
     6      1.12940E+00      1.00000E+00      1.00000E+00      1.12940E+00
     5      1.14275E+00      1.00000E+00      1.00000E+00      1.14275E+00
 Buckling load factor before t.s.d.=  1.1294E+00 After t.s.d.=  1.1204E+00
     6      1.12940E+00      9.92005E-01      1.00000E+00      1.12037E+00
```

Compare with the Load Set 1 prediction on p. A19.

NORMAL MODAL DISPLACEMENTS IN THE PANEL MODULE SHOWN ABOVE
SKIN-STRINGER PANEL MODULE HAS 4 SEGMENTS
NUMBER OF HALF-WAVES IN THE AXIAL DIRECTION, M= 6

Load Set 2 (Wimp = -0.125")

Load Set 2: Wimp = -0.125"

MODAL DISPLACEMENTS FOR SEGMENT NO. 1

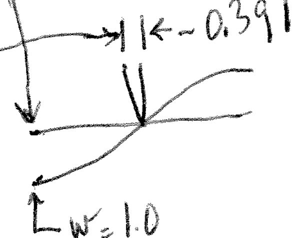
NODE	Z	W	WD	WDD	U	V	WDDD
1	0.00E+00	1.00E+00	0.00E+00	-4.00E+00	0.00E+00	1.67E-04	2.21E+00
2	0.00E+00	9.92E-01	-2.41E-01	-3.86E+00	3.10E-05	1.68E-04	2.21E+00
3	0.00E+00	9.70E-01	-4.76E-01	-3.72E+00	6.21E-05	1.67E-04	2.21E+00
4	0.00E+00	9.33E-01	-7.00E-01	-3.49E+00	9.34E-05	1.65E-04	3.66E+00
5	0.00E+00	8.83E-01	-9.08E-01	-3.18E+00	1.25E-04	1.62E-04	5.07E+00
6	0.00E+00	8.21E-01	-1.09E+00	-2.78E+00	1.57E-04	1.58E-04	6.43E+00
7	0.00E+00	7.47E-01	-1.25E+00	-2.30E+00	1.89E-04	1.53E-04	7.73E+00
8	0.00E+00	6.65E-01	-1.38E+00	-1.74E+00	2.21E-04	1.47E-04	8.95E+00
9	0.00E+00	5.76E-01	-1.46E+00	-1.12E+00	2.54E-04	1.39E-04	1.01E+01
10	0.00E+00	4.83E-01	-1.51E+00	-4.25E-01	2.87E-04	1.29E-04	1.12E+01
11	0.00E+00	3.89E-01	-1.52E+00	2.68E-01	3.20E-04	1.16E-04	1.12E+01

MODAL DISPLACEMENTS FOR SEGMENT NO. 2

NODE	Z	W	WD	WDD	U	V	WDDD
1	0.00E+00	3.89E-01	-1.52E+00	2.76E-01	3.20E-04	1.16E-04	1.39E+01
2	0.00E+00	2.95E-01	-1.47E+00	1.14E+00	3.54E-04	1.01E-04	1.39E+01
3	0.00E+00	2.06E-01	-1.37E+00	2.00E+00	3.88E-04	8.24E-05	1.39E+01
4	0.00E+00	1.25E-01	-1.22E+00	2.91E+00	4.22E-04	5.95E-05	1.47E+01
5	0.00E+00	5.52E-02	-1.01E+00	3.88E+00	4.56E-04	3.18E-05	1.55E+01
6	0.00E+00	-1.58E-07	-8.90E-01	-6.43E-05	4.73E-04	3.21E-08	-6.26E+01
7	0.00E+00	-5.52E-02	-1.01E+00	-3.88E+00	4.56E-04	-3.17E-05	-6.26E+01
8	0.00E+00	-1.25E-01	-1.22E+00	-2.91E+00	4.22E-04	-5.94E-05	1.56E+01
9	0.00E+00	-2.06E-01	-1.37E+00	-2.00E+00	3.88E-04	-8.23E-05	1.47E+01
10	0.00E+00	-2.95E-01	-1.47E+00	-1.14E+00	3.54E-04	-1.01E-04	1.39E+01
11	0.00E+00	-3.89E-01	-1.52E+00	-2.76E-01	3.20E-04	-1.16E-04	1.39E+01

MODAL DISPLACEMENTS FOR SEGMENT NO. 3

NODE	Z	W	WD	WDD	U	V	WDDD
1	-2.48E-02	-2.16E-02	-8.90E-01	2.14E+00	1.58E-07	2.54E-08	-4.30E+00
2	-1.14E-01	-9.25E-02	-7.20E-01	1.76E+00	1.53E-07	1.37E-08	-4.30E+00
3	-2.02E-01	-1.50E-01	-5.81E-01	1.38E+00	1.49E-07	3.65E-09	-4.30E+00
4	-2.91E-01	-1.96E-01	-4.73E-01	1.06E+00	1.45E-07	-5.00E-09	-3.63E+00
5	-3.80E-01	-2.33E-01	-3.91E-01	7.80E-01	1.41E-07	-1.29E-08	-3.12E+00
6	-4.69E-01	-2.65E-01	-3.32E-01	5.39E-01	1.38E-07	-2.06E-08	-2.72E+00
7	-5.58E-01	-2.93E-01	-2.94E-01	3.24E-01	1.35E-07	-2.88E-08	-2.41E+00
8	-6.46E-01	-3.17E-01	-2.74E-01	1.32E-01	1.32E-07	-3.81E-08	-2.17E+00
9	-7.35E-01	-3.41E-01	-2.70E-01	-4.23E-02	1.29E-07	-4.92E-08	-1.96E+00
10	-8.24E-01	-3.65E-01	-2.81E-01	-2.01E-01	1.27E-07	-6.28E-08	-1.79E+00
11	-9.13E-01	-3.91E-01	-3.02E-01	-3.60E-01	1.23E-07	-7.85E-08	-1.79E+00



Compare with the deformed shape on p. A19

MODAL DISPLACEMENTS FOR SEGMENT NO. 4

NODE	Z	W	WD	WDD	U	V	WDDD
1	0.00E+00	-3.89E-01	-1.52E+00	-2.68E-01	3.20E-04	-1.16E-04	1.12E+01
2	0.00E+00	-4.83E-01	-1.51E+00	4.25E-01	2.87E-04	-1.29E-04	1.12E+01
3	0.00E+00	-5.77E-01	-1.46E+00	1.12E+00	2.54E-04	-1.39E-04	1.12E+01
4	0.00E+00	-6.65E-01	-1.38E+00	1.74E+00	2.21E-04	-1.47E-04	1.01E+01
5	0.00E+00	-7.47E-01	-1.25E+00	2.30E+00	1.89E-04	-1.53E-04	8.95E+00
6	0.00E+00	-8.21E-01	-1.09E+00	2.78E+00	1.57E-04	-1.58E-04	7.73E+00
7	0.00E+00	-8.83E-01	-9.08E-01	3.18E+00	1.25E-04	-1.62E-04	6.43E+00
8	0.00E+00	-9.33E-01	-7.00E-01	3.49E+00	9.34E-05	-1.65E-04	5.07E+00
9	0.00E+00	-9.70E-01	-4.76E-01	3.72E+00	6.21E-05	-1.67E-04	3.66E+00
10	0.00E+00	-9.92E-01	-2.41E-01	3.86E+00	3.10E-05	-1.68E-04	2.21E+00
11	0.00E+00	-1.00E+00	0.00E+00	4.00E+00	0.00E+00	-1.67E-04	2.21E+00

**** END SUBROUTINE MODE (LOCAL BUCKLING MODE SHAPE) ******

(In the buckling mode shape just listed look especially at the column headed "W" (normal deflection). Compare with the local buckling mode shape obtained from Load Set 1, Subcase 1, which is printed above.

```
*******************************************
*******************************************
**** END OF LOCAL BUCKLING EIGENVECTOR CALC.****

 Margin=  1.2149E-01  Local buckling from discrete model-1.,M=6   axial halfwaves;FS=0.999
----- END OF PART OF CHAPTER 14 PART OF THE nasaortho.OPM FILE --------
```

The local buckling margins from Load Case 2, Subcase 1 are as follows:

MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 2, SUBCASE NO. 1

Load Set 2

```
MAR. MARGIN
NO.  VALUE                  DEFINITION
 1  1.21E-01 Local buckling from discrete model-1.,M=6   axial halfwaves;FS=0.99
 2  1.31E-01 Long-axial-wave bending-torsion buckling; M=1  ;FS=0.999
 3  9.57E-02 Local buckling from Koiter theory,M=6   axial halfwaves;FS=0.999
 7  9.07E-03 (m=1   lateral-torsional buckling load factor)/(FS)-1;FS=0.999
13  7.08E+00 buckling margin stringer Iseg.3 . Local halfwaves=5  .MID.;FS=1.
14 -8.22E-03 buckling margin stringer Iseg.3 . Local halfwaves=5  .NOPO;FS=1.
18  6.79E-01 buck.(SAND);rolling only of stringers;M=45;N=0;slope=0.;FS=1.4
------------------------------------------------------------------------------
**** END  CHAPTER 13 and CHAPTER 14 DISCUSSION AND OUTPUT FOR LOAD SET 2 *****
********* END CHAPTERS 13 and 14 in the nasaortho.OPM file ************
```

Load Set 2

Load Set 1

```
*********BACK TO LOAD SET 1, SUBCASE 1, Wimp = +0.125 inch*****************
```

The following output for CHAPTERS 15 - 21 in the nasaortho.OPM file is obtained when the print index, NPRINT, is set equal to 0 in the nasaortho.OPT file.

Load Set 1 again for the rest of this Appendix.

```
*********** BEGIN CHAPTERS 15 - 21 WITH NPRINT = 0 ******************
*************************************************************************
CHAPTER 15 Compute bending-torsion (low-m) buckling from
           BOSOR4-type discretized skin-stringer single
           module model. See Section 12.2 (lower table on
           p. 511) in [1A], for example.

**** BEGIN SUBROUTINE LOCAL (LOW-M LOCAL BUCKLING SEARCH) ****
 Buckling load factor from SUB. LOCAL, EIGITR(4)=  1.0487E+00
 Number of axial halfwaves between rings, NLOW=    4
 **** END SUBROUTINE LOCAL (LOW-M LOCAL BUCKLING SEARCH) ******
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

*************************************************************************
CHAPTER 16 Compute post-local buckling from the Koiter
           theory given in Ref.[1C]. See Figs. 23, 24, and
           Figs. 47-49 in [1A], Fig. 6 in [1C], and Fig. 4 in
 Bushnell, D.
 "Optimization of an axially compressed ring and stringer
 stiffened cylindrical shell with a general buckling modal
 imperfection", AIAA Paper 2007-2216, 48th AIAA SDM Meeting,
 Honolulu, Hawaii, April 2007

*** BEGIN CALCULATIONS RELATING TO THE KOITER THEORY ***
*** See Ref.[3]: Bushnell, D., "Optimization of composite,
*** stiffened, imperfect panels under combined loads for
*** service in the posbuckling regime", CMAME, vol.103,
*** pp 43-114 (1993)
** BEGIN SUBROUTINE INTMOD (INTEGRALS OF PRODUCTS OF MODES) **
 SUB.INTMOD computes the quantities given on pp 58 and 59 of
 the paper just cited.
 **** END SUBROUTINE INTMOD (INTEGRALS OF PRODUCTS OF MODES) ****
  BEFORE POSSIBLE CHANGE: INITIAL LOCAL IMPERFECTION W0=  1.00000001E-07
  AFTER POSSIBLE CHANGE: INITIAL LOCAL IMPERFECTION W0=  1.00000001E-07

***** BEGIN SUBROUTINE KOIT2 (KOITER THEORY POSTBUCKLING) ****

 ******** ENTERING KOITER BRANCH, SUBROUTINE KOIT2 *********
 This subroutine is an implementation of the theory described
 in the PANDA2 paper by David Bushnell:
     "Optimization of composite, stiffened, imperfect panels
      under combined loads for service in the postbuckling
      regime", Computer Methods in Applied Mechanics and
      Engineering, Vol. 103 (1993) 43-114 (volume in honor of
      Besselings 65th birthday).

LOCAL BIFURCATION BUCKLING LOAD FACTOR ESTIMATES
AND AMPLITUDE Wo OF LOCAL IMPERFECTION, Wo*(buckling mode)
Critical number of axial half-waves                 =  4
Slope of buckling nodal lines from Koiter Theory, m=  5.03E-03
Knockdown factor for C44, C45, C55 for transv.shear=  9.93E-01
Local buckling load Factor from Koiter-type Theory =  1.04E+00
Load Factor from BOSOR4-type panel module model     =  1.04E+00
BOSOR4-type load factor without knockdowns for
  effects of anisotropy [e.g. C(4,6)] of the skin,
  transverse shear def., or in-plane shear loading =  1.05E+00
```

```
Amplitude Wo of local imperfection                          =  1.0000E-07

Even if the load factor from Koiter-type theory is greater
than unity, the panel is in a "post-locally-buckled" state
because there is always a finite local imperfection in the
panel skin and stringer that grows under the applied loads.

Margin=  3.8676E-02  Bending-torsion buckling: Koiter theory,M=4   axial halfwav;FS=0.999

LOCAL DEFORMATION CHARACTERISTICS:
Average axial strain(not including thermal),EXAVE = -1.5931E-03
Initial local imperfection amplitude,           Wo=  1.0000E-07
Slope of local buckling nodal lines in skin     M =  5.2161E-03
Parameter "a" in the expression f*(phi +a*phi**3) =  0.0000E+00
Amplitude  f  in the expression f*(phi +a*phi**3) =  1.3169E-04
Normal displacement amplitude between stringers W =  7.4700E-05
Number of axial halfwaves at local bifurcation    =     4
Number of axial halfwaves in postbuckled regime   =  4.0000E+00
Convergence characteristic,               NOCONV  =  4


RESULTS FOR  4.0000E+00 AXIAL WAVES...
LOCAL DEFORMATION PARAMETERS:
   SLOPE, a, f        =  5.2161E-03  0.0000E+00  1.3169E-04
APPLIED STRESS RESULTANTS (Load set A):
   Nx, Ny, Nxy        = -2.2190E+03  5.0436E+00  1.1095E+01
APPLIED STRESS RESULTANTS (Load set B):
  Nxo, Nyo, Nxyo      =  0.0000E+00  0.0000E+00  0.0000E+00
STRAIN AND STRESS FROM APPLIED LOADS:
AVERAGE STRAIN COMPONENTS:
  EPS1, EPS2, EPS12  = -1.5931E-03  8.2783E-04  5.2909E-05
AVERAGE RESULTANTS IN SKIN:
N1SKIN,N2SKIN,N12SKIN= -8.0571E+02  2.0963E+02  1.1095E+01
NOTE: N1SKIN includes average of Nx in skin and stringer base.


TANGENT STIFFNESS AFTER SYMMETRIZATION
AVERAGE SKIN TANGENT STIFFNESS MATRIX
(Segments 1 and 2 averaged),    CTAN...
 5.9907E+05  1.7968E+05  3.2679E-02
 1.7968E+05  5.9909E+05  3.0990E-02
 3.2679E-02  3.0990E-02  2.0970E+05

(APPLIED LOAD)/(BUCKLING LOAD)=  9.6373E-01

NORMALIZED AVERAGE SKIN TANGENT STIFFNESS MATRIX
(CTAN(i,i)/CX(i,i,1), i=1,2,3) =    9.9988E-01  9.9992E-01  1.0000E+00
TANGENT POISSON RATIO
CTAN(1,2)/CTAN(1,1) =   2.9994E-01
NORMALIZED AVERAGE (N1skin,N12skn) COUPLING
CTAN(1,3)/CX(1,1,1) =   5.4544E-08
NORMALIZED AVERAGE (N2skin,N12skn) COUPLING
CTAN(2,3)/CX(2,2,1) =   5.1725E-08
***** END SUBROUTINE KOIT2 (KOITER THEORY POSTBUCKLING) ******
********** END OF NONLINEAR EQUILIBRIUM CALCS.************
********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

************************************************************
CHAPTER 17 Compute stresses in layers and at various
           locations in skin-stringer module model, including
           local post-buckling, if any. Compute stringer
           popoff constraints (Figs. 5 - 7 in [1A]). Local
           post-buckling such as that shown in Figs. 48 & 49
           of [1A] is included. Therefore, SUBROUTINE STRTHK
           is used.

***** BEGIN SUBROUTINE STRTHK (POSTBUCKLING STRESSES) ******
 Margin=  2.5390E+00  eff.stress:matl=1,SKN,Dseg=2,node=6,layer=1,z=-0.0248; MID.;FS=1.
 Margin=  7.6889E+06  stringer popoff margin:(allowable/actual)-1, web 1  MID.;FS=1.
 Margin=  2.7258E-01  eff.stress:matl=2,STR,Dseg=3,node=11,layer=1,z=0.0403; MID.;FS=1.
 ***** END SUBROUTINE STRTHK (POSTBUCKLING STRESSES) ********

***** BEGIN SUBROUTINE STRCON (STRESSES IN RINGS) ******
 ***** END   SUBROUTINE STRCON (STRESSES IN RINGS) ******
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

************************************************************
CHAPTER 18 Present summary of state of loaded imperfect panel
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           and give effective stiffnesses of possibly locally
           postbuckled skin-stringer module. These effective
           stiffnesses are used later for overall buckling
           and inter-ring buckling. See Table 12 in the paper
 Bushnell, D.
 "Optimization of an axially compressed ring and stringer
 stiffened cylindrical shell with a general buckling modal
 imperfection", AIAA Paper 2007-2216, 48th AIAA SDM Meeting,
 Honolulu, Hawaii, April 2007

 PANEL OVERALL & LOCAL IMPERFECTIONS AND DEFORMATION
 General out-of-roundness of cylindrical panel,WIMPG1 =  0.0000E+00
 General initial buckling modal imperfection amplitude=  1.2500E-01
 General modified imperfection amplitude, Wimp(global)=  1.2500E-01
 Local   initial imperfection amplitude, Wimp(local)  =  1.0000E-07
 Panel (inter-ring) initial imp. amplt., Wimp(panel)  =  1.0000E-10
 Bowing due to temperature effects,     W(residual)   =  0.0000E+00
 Overall (inter-ring in cyl) bowing from pressure ,Wp =  9.0976E-04
 Inter-ring bowing (flat panel) from pressure, WPRESR =  0.0000E+00
 Maximum local "pillowing" between stringers,  WLPRES =  4.3324E-04
 Inter-ring bowing due to postbucking effects, WDELKP =  0.0000E+00
 Amplitude factor for bowing except from press,AMPLIT =  1.7536E+00
 Amplitude factor for bowing due to pressure,  AMPLT2 =  1.0522E+00
 Amplitude factor for inter-ring bowing,       AMPLT3 =  1.3526E+00
 Eccentricity of application of axial loads,     ECC  =  0.0000E+00

*** BEGIN SUBROUTINE DEFCIJ (POST-LOCALLY BUCKLED CS(I,J)) ****
 Effective stiffnesses of undeformed and of
 locally deformed module segments:
                                                        Undeformed   Deformed
     Effective axial stiffness of panel SKIN + BASE =  5.9914E+05  5.9910E+05
     Effective hoop  stiffness of panel SKIN + BASE =  5.9914E+05  5.9909E+05
     Effective (1,2) stiffness of panel SKIN + BASE =  1.7974E+05  1.7970E+05
     Effective axial stiffness of stringer   WEB    =  9.7478E+05  9.7472E+05
     Effective axial stiffness of stringer   FLANGE =  0.0000E+00  0.0000E+00
     Effective shear stiffness of panel SKIN + BASE =  2.0970E+05  2.0970E+05
     Effective shear stiffness of stringer   WEB    =  3.4117E+05  3.4117E+05
     Effective shear stiffness of stringer   FLANGE =  0.0000E+00  0.0000E+00

 Integrated stringer stiffnesses...
     Effective axial stiffness of stringer,    STIFL =  4.2314E+05
     Effective first moment, Int[STIF*zdz],    STIFM =  1.9838E+05
     Effective second moment,Int[STIF*z**2dz],STIFMM=  1.2082E+05

 Constitutive law, CS(i,j), for locally deformed
 panel with smeared stringers and rings.....
       1.0222E+06  1.7970E+05  0.0000E+00  1.9838E+05  0.0000E+00  0.0000E+00
       1.7970E+05  7.4912E+05  0.0000E+00  0.0000E+00  1.3533E+05  0.0000E+00
       0.0000E+00  0.0000E+00  2.0970E+05  0.0000E+00  0.0000E+00  0.0000E+00
       1.9838E+05  0.0000E+00  0.0000E+00  1.2094E+05  3.6797E+01  0.0000E+00
       0.0000E+00  1.3533E+05  0.0000E+00  3.6797E+01  1.6067E+05  0.0000E+00
       0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  1.6929E+02

 Constitutive law, C(i,j), for locally deformed
 panel between rings with smeared stringers.....
       1.0222E+06  1.7970E+05  0.0000E+00  1.9838E+05  0.0000E+00  0.0000E+00
       1.7970E+05  5.9909E+05  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       0.0000E+00  0.0000E+00  2.0970E+05  0.0000E+00  0.0000E+00  0.0000E+00
       1.9838E+05  0.0000E+00  0.0000E+00  1.2094E+05  3.6797E+01  0.0000E+00
       0.0000E+00  0.0000E+00  0.0000E+00  3.6797E+01  1.2266E+02  0.0000E+00
       0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  1.3113E+02
 *** END   SUBROUTINE DEFCIJ (POST-LOCALLY BUCKLED CS(I,J)) ****
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

 *****************************************************************
 CHAPTER 19 Do wide-column inter-ring buckling analysis with
            possibly locally postbuckled skin-stringer module
            model. (See Figs. 20c, 22c, 46d, and 67 of [1A],
            for examples.).

*** BEGIN SUBROUTINE BUCKLE (WIDE-COLUMN BUCKLING - MODULE) ****
*** END SUBROUTINE BUCKLE (WIDE-COLUMN BUCKLING - MODULE) ****

*** BEGIN SUBROUTINE MODE (WIDE-COLUMN BUCKLING MODE SHAPE) ****
 *** END SUBROUTINE MODE (WIDE-COLUMN BUCKLING MODE SHAPE) ****

  WIDE COLUMN PANEL BUCKLING LOAD FACTOR =          2.5957E+00
```

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```
 ISKIN = 0. WIDE COLUMN BUCKLING IS IGNORED IF ISKIN = 1.
 IWIDE = 0. WIDE COLUMN BUCKLING IS IGNORED IF IWIDE = 0.
 ITIP  = 0. MODE OF BUCKLING IS STRINGER SIDESWAY IF ITIP=1
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

 **************************************************************
 CHAPTER 20 Compute width-wise wide column buckling and
            lateral-torsional buckling load factors from the
            possibly locally postbuckled skin-stringer module
            model (inter-ring buckling modes).
            See panda2.news Item Numbers 379 and 381 in [1L].
 Number of axial halfwaves=  1; Buckling load factor=  1.2469E+01
 Number of axial halfwaves=  2; Buckling load factor=  2.1572E+00
 Number of axial halfwaves=  3; Buckling load factor=  1.3395E+00
 Number of axial halfwaves=  4; Buckling load factor=  1.1746E+00
 Number of axial halfwaves=  5; Buckling load factor=  1.1692E+00
 Margin=  1.7574E-01  (m=4   lateral-torsional buckling load factor)/(FS)-1;FS=0.999
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

 **************************************************************
 CHAPTER 21 Compute "skin"-ring buckling load factor for
            computing knockdown to compensate for inherent
            unconservativeness of smeared ring models.
            (See bottom row in Fig. 30 of Ref.[1G]. Also see
            panda2.news Items 509, 511, 522, 532, 605, 617
            619, 632, 633, 676.
```

"skin" is in quotes here because: "skin" = skin + smeared stringers.

```
*** Infinite cyl, external lateral pressure) **
 Uniform external lateral pressure,          PRESS=  1.0000E+00
 Buck. circ. halfwaves from PANDA-type, NGENQQ=  6

 ** BEGIN SUB. BUCKLE ("SKIN"-RING n=   6 GENERAL BUCKLNG MODEL) **
 **  END  SUB. BUCKLE ("SKIN"-RING n=   6 GENERAL BUCKLNG MODEL) **

 ** BEGIN SUB. MODE ("SKIN"-RING n=   6 GENERAL BUCKLNG MODE) **
 **** END  SUB. MODE ("SKIN"-RING n=   6 GENERAL BUCKLNG MODE) **
 Mode shape properties for n=  6 circ. halfwaves:
 Normal displacement midway between rings,   WFIRST=  1.0000E+00
 Normal displacement midway between rings,    WLAST=  1.0000E+00
 Normal displacement in skin at web root,     WMIDQ=  9.9785E-01
 Normal displacement in ring at flange tip,    WFLG=  1.0000E+00
 Normal displacement, ring flange at web tip, WFLGW=  1.0000E+00
 Normalized difference,     ABS(WFLG-WFLGW)/WFLGMAX=  0.0000E+00
 Possible candidate for knockdown factor,     WFLGK=  1.0000E+00

 Mode number  1 is     a suitable ring mode.
 Buckling load factor BEFORE knockdown for smeared stringers=  4.1163E+01
 In this n=   6 general buckling analysis there is no knockdown
 for smeared stringers.
 NOTE: The buckling load factor,  4.1163E+01, will not be
 further reduced by the "shear/anisotropy" factor.

 Knockdown for smeared rings on cylindrical shell...
  Buckling load factor for n+dn = FNARCQ=  6.0206E+00
                              from discrete model =  4.1163E+01
  Buckling load factor for ring with bending stiffness EI:
                    pcrit=[(n+dn)**2-1]*EI/r**3/p=  4.3417E+01
  Knockdown factor, general buckling,    EIGR/EIGRNG=  9.4810E-01

 Knockdown for smeared rings, RNGKNK=  9.4810E-01(FNARCQ=  6.0206E+00)
 END OF SECTION ON GENERATION OF KNOCKDOWN FACTOR FOR
 COMPENSATING FOR THE UNCONSERVATIVENESS OF SMEARING RINGS
 ----------------------------------------------------------
************** END CHAPTERS 15 - 21 with NPRINT = 0 *********************


*********** BEGIN CHAPTER 22 WITH NPRINT = 2 *******************
From CHAPTER 22 (buckling from "skin"-ring single module model):
See the paper:

 [6] Bushnell, D., Jiang, H., and Knight, N.F.,
 "Additional buckling solutions in PANDA2", Proceedings
  40th AIAA SDM Conference, AIAA Paper 99-1233, pp 302-345
  April 1999

for details. The section starting on p. 318 entitled
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NEW "SKIN"-RING DISCRETIZED SINGLE-MODULE MODEL FOR INTER-RING
BUCKLING OF CYLINDRICAL PANELS pertains.

----- BEGIN PART OF CHAPTER 22 PART OF THE nasaortho.OPM FILE --------
 CHAPTER 22 Compute "skin"-ring buckling load factors for:
           1. medium-n inter-ring buckling mode (See
              rightmost three mode shapes in top row of
              Fig. 30 of Ref.[1G]),
           2. high-n inter-ring buckling mode (See rightmost
              mode shape in middle row of Fig. 30, Ref.[1G]),
           3. low-n inter-ring buckling mode (See leftmost
              mode shape in top row of Fig. 30, Ref.[1G]).

*** BEGIN "SKIN"-RING BUCKLING, DISCRETE MODULE MODEL) **

 Constitutive law, C(i,j), for locally deformed
 panel between rings with smeared stringers.....
       1.0222E+06  1.7970E+05  0.0000E+00  1.9838E+05  0.0000E+00  0.0000E+00
       1.7970E+05  5.9909E+05  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
       0.0000E+00  0.0000E+00  2.0970E+05  0.0000E+00  0.0000E+00  0.0000E+00
       1.9838E+05  0.0000E+00  0.0000E+00  1.2094E+05  3.6797E+01  0.0000E+00
       0.0000E+00  0.0000E+00  0.0000E+00  3.6797E+01  1.2266E+02  0.0000E+00
       0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00  1.3113E+02

 **** PREBUCKLING LOADS IN "SKIN"-RING DISCRETIZED MODULE ****
 --------------------------------------------------------------
 Circ. waves, Discretized seg., Seg. type, N,ISEG,JSEG=    63     1     1
 Integrated constitutive diagonal, (C(i,i),i=1,6), Seg. 1
  1.0222E+06  5.9909E+05  2.0970E+05  1.2094E+05  1.2266E+02  1.3113E+02
 Total axial nodal point resultants, (Nx+Nxo)=
 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03
 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03
 Total circ. nodal point resultants, (Ny+Nyo)=
 -7.1498E+01 -7.1689E+01 -7.2244E+01 -7.3151E+01 -7.4391E+01 -7.5935E+01
 -7.7749E+01 -7.9789E+01 -8.2004E+01 -8.4335E+01 -8.6707E+01
 Fixed axial nodal point resultants, Nxo=
  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
 Fixed circ. nodal point resultants, Nyo=
  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
 --------------------------------------------------------------
 Circ. waves, Discretized seg., Seg. type, N,ISEG,JSEG=    63     2     1
 Integrated constitutive diagonal, (C(i,i),i=1,6), Seg. 2
  1.0222E+06  5.9909E+05  2.0970E+05  1.2094E+05  1.2266E+02  1.3113E+02
 Total axial nodal point resultants, (Nx+Nxo)=
 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03
 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03
 Total circ. nodal point resultants, (Ny+Nyo)=
 -8.6707E+01 -8.8276E+01 -8.9800E+01 -9.1256E+01 -9.2620E+01 -9.3864E+01
 -9.2620E+01 -9.1256E+01 -8.9800E+01 -8.8276E+01 -8.6707E+01
 Fixed axial nodal point resultants, Nxo=
  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
 Fixed circ. nodal point resultants, Nyo=
  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
 --------------------------------------------------------------
 Circ. waves, Discretized seg., Seg. type, N,ISEG,JSEG=    63     3     3
 Integrated constitutive diagonal, (C(i,i),i=1,6), Seg. 3
  1.0768E+06  1.0768E+06  3.7688E+05  7.1207E+02  7.1207E+02  2.4923E+02
 Eigenvalue hoop resultants in ring web from bending:
  resultant at web root, DLWBR1=  4.3008E+02; at tip, DLWBR2= -3.8057E+03
 Fixed hoop resultants in ring web:
  resultant at web root, WBROTF=  0.0000E+00; at tip, WBTIPF=  0.0000E+00
 Total meridional nodal point resultants, (Nx+Nxo)=
  1.9543E+01  1.7589E+01  1.5635E+01  1.3680E+01  1.1726E+01  9.7717E+00
  7.8173E+00  5.8630E+00  3.9087E+00  1.9543E+00  0.0000E+00
 Total circ. nodal point resultants, (Ny+Nyo)=
  9.5501E+02  5.3335E+02  1.1171E+02 -3.0991E+02 -7.3152E+02 -1.1531E+03
 -1.5747E+03 -1.9963E+03 -2.4178E+03 -2.8394E+03 -3.2609E+03
 Fixed meridional nodal point resultants, Nxo=
  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
 Fixed circ. nodal point resultants, Nyo=
  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
 --------------------------------------------------------------
```

Ring Web with WIMP = +0.125" (Load Set 1)

```
Circ. waves, Discretized seg., Seg. type, N,ISEG,JSEG=    63     4     1
Integrated constitutive diagonal, (C(i,i),i=1,6), Seg. 4
 1.0222E+06  5.9909E+05  2.0970E+05  1.2094E+05  1.2266E+02  1.3113E+02
Total axial nodal point resultants, (Nx+Nxo)=
-2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03
-2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03 -2.2190E+03
Total circ. nodal point resultants, (Ny+Nyo)=
-8.6707E+01 -8.4335E+01 -8.2004E+01 -7.9789E+01 -7.7749E+01 -7.5935E+01
-7.4391E+01 -7.3151E+01 -7.2244E+01 -7.1689E+01 -7.1498E+01
Fixed axial nodal point resultants, Nxo=
 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
Fixed circ. nodal point resultants, Nyo=
 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
=============================================================

BUCKLING LOAD FACTORS FROM BOSOR4-TYPE DISCRETIZED MODEL...
          (skin-smeared-stringer-ring discretized module)
 HOOP     BUCKLING        KNOCKDOWN FOR    KNOCKDOWN FOR      BUCKLING
 HALF-    LOAD FACTOR    TRANSVERSE SHEAR  IN-PLANE SHEAR    LOAD FACTOR
 WAVES  BEFORE KNOCKDOWN   DEFORMATION     LOADING AND/OR  AFTER KNOCKDOWN
                                             ANISOTROPY
   n        EIGOLD            KSTAR             KNOCK      EIGOLD*KSTAR*KNOCK
  63      1.28211E+00      1.00000E+00      9.99999E-01     1.28211E+00
  68      1.34031E+00      1.00000E+00      9.99999E-01     1.34031E+00
  58      1.23831E+00      1.00000E+00      9.99999E-01     1.23831E+00
  53      1.21185E+00      1.00000E+00      9.99999E-01     1.21185E+00
  49      1.20610E+00      1.00000E+00      9.99999E-01     1.20610E+00
  45      1.21766E+00      1.00000E+00      9.99999E-01     1.21766E+00
Buckling load factor before t.s.d.=  1.2061E+00 After t.s.d.=  1.1879E+00
  49      1.20610E+00      9.84916E-01      9.99999E-01     1.18790E+00
Buckling load factor from SUB. LOCAL, EIGITR(16)=  1.1879E+00
Number of axial halfwaves between rings, NSTART=  49
*** END   SUB. LOCAL ("SKIN"-RING BUCKLING, DISCRETE MODEL) **

**** BEGIN SUB. MODE ("SKIN"-RING MODULE BUCKLING MODE) ****

(lines skipped to save space)

AMPLIT.OF BUCKLING MODE MIDWAY BETWEEN RINGS, WMID =  8.5807E-02
AMPLIT.OF BUCKLING MODE AT   RING   WEB TIP,  WTIP =  1.0000E+00
AMPLIT.OF BUCKLING MODE AT   RING   MIDWEB,  WCRIP =  3.6907E-01
AMPLIT.OF BUCKLING MODE AT  RING FLANGE TIP,, WFLG =  0.0000E+00
      Internal Ring

     MODULE WITH RECTANGULAR STIFFENER...

                                    !   ^
          Segment No. 3 -----> !   !
                                    !   !
              Seg. No. 2-.      !   h
                              .     !   !
     Segment No. 1-.        .   !   !          .-Seg. No. 4
                      .       .  !   V          .(same as Seg. 1)
       --------------===================================--------------
                     !<------ b2 ------->!
       !<--- Module width  =  stiffener spacing, b --->!


  EXPLODED VIEW, SHOWING LAYERS and (SEGMENT, NODE) NUMBERS

                                (3,11)
                                    !
            Layer No. 1 -----> ! <---------- Layer No. k
                                    !
         Layer No. 1-.              !
                            .       !
  Layer No. 1-.           .        !               .-Layer No. 1
                 .       .          !               .
               .          .   (3,1)                  .
  --------------    =====================    --------------
(1,1)    .    (1,11)(2,1)    . (2,6)    (2,11)(4,1)   .     (4,11)
          .                    .                         .
           .                    .                         .
            Layer No. m         Layer No. n      Layer No. m
```

'skin'-ring single module buckling mode

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NORMAL MODAL DISPLACEMENTS IN THE PANEL MODULE SHOWN ABOVE
"SKIN"-RING PANEL MODULE HAS 4 SEGMENTS
NUMBER OF HALF-WAVES IN THE CIRC. DIRECTION, n= 49

MODAL DISPLACEMENTS FOR SEGMENT NO. 1

NODE	Z	W	WD	WDD	U	V	WDDD
1	0.00E+00	8.58E-02	0.00E+00	-5.42E-03	0.00E+00	1.82E-03	4.18E-05
2	0.00E+00	8.53E-02	-2.32E-03	-5.41E-03	7.07E-05	1.81E-03	4.18E-05
3	0.00E+00	8.38E-02	-4.64E-03	-5.39E-03	1.42E-04	1.78E-03	4.18E-05
4	0.00E+00	8.13E-02	-6.95E-03	-5.36E-03	2.12E-04	1.73E-03	6.92E-05
5	0.00E+00	7.78E-02	-9.25E-03	-5.32E-03	2.83E-04	1.66E-03	9.80E-05
6	0.00E+00	7.34E-02	-1.15E-02	-5.26E-03	3.53E-04	1.57E-03	1.28E-04
7	0.00E+00	6.79E-02	-1.38E-02	-5.19E-03	4.23E-04	1.45E-03	1.58E-04
8	0.00E+00	6.15E-02	-1.60E-02	-5.11E-03	4.93E-04	1.32E-03	1.91E-04
9	0.00E+00	5.42E-02	-1.82E-02	-5.02E-03	5.61E-04	1.17E-03	2.25E-04
10	0.00E+00	4.59E-02	-2.03E-02	-4.90E-03	6.29E-04	1.00E-03	2.60E-04
11	0.00E+00	3.68E-02	-2.24E-02	-4.79E-03	6.96E-04	8.07E-04	2.60E-04

MODAL DISPLACEMENTS FOR SEGMENT NO. 2

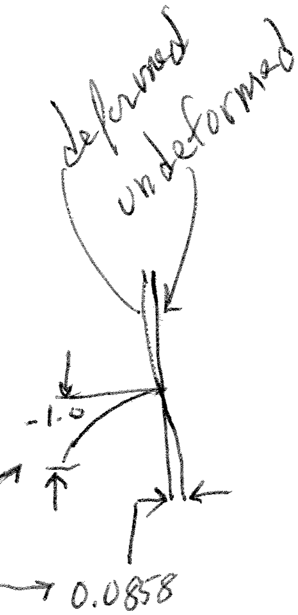
NODE	Z	W	WD	WDD	U	V	WDDD
1	0.00E+00	3.68E-02	-2.24E-02	-4.78E-03	6.96E-04	8.07E-04	3.68E-04
2	0.00E+00	3.02E-02	-2.37E-02	-4.68E-03	7.37E-04	6.67E-04	3.68E-04
3	0.00E+00	2.32E-02	-2.51E-02	-4.57E-03	7.77E-04	5.17E-04	3.68E-04
4	0.00E+00	1.58E-02	-2.63E-02	-4.46E-03	8.15E-04	3.56E-04	4.03E-04
5	0.00E+00	8.09E-03	-2.76E-02	-4.33E-03	8.50E-04	1.83E-04	4.43E-04
6	0.00E+00	-1.17E-17	-2.82E-02	2.85E-16	8.67E-04	0.00E+00	1.51E-02
7	0.00E+00	-8.09E-03	-2.76E-02	4.33E-03	8.50E-04	-1.83E-04	1.51E-02
8	0.00E+00	-1.58E-02	-2.63E-02	4.46E-03	8.15E-04	-3.56E-04	4.43E-04
9	0.00E+00	-2.32E-02	-2.51E-02	4.57E-03	7.77E-04	-5.17E-04	4.03E-04
10	0.00E+00	-3.02E-02	-2.37E-02	4.68E-03	7.37E-04	-6.67E-04	3.68E-04
11	0.00E+00	-3.68E-02	-2.24E-02	4.78E-03	6.96E-04	-8.07E-04	3.68E-04

MODAL DISPLACEMENTS FOR SEGMENT NO. 3

NODE	Z	W	WD	WDD	U	V	WDDD
1	-2.48E-02	1.67E-04	-2.82E-02	-1.25E+00	7.31E-18	-2.03E-19	1.39E+00
2	-2.00E-01	-2.51E-02	-2.33E-01	-1.01E+00	6.89E-18	-5.49E-19	1.39E+00
3	-3.76E-01	-8.15E-02	-3.89E-01	-7.67E-01	6.51E-18	-8.09E-19	1.39E+00
4	-5.51E-01	-1.62E-01	-5.06E-01	-5.69E-01	6.17E-18	-1.00E-18	1.13E+00
5	-7.27E-01	-2.59E-01	-5.92E-01	-4.06E-01	5.87E-18	-1.17E-18	9.30E-01
6	-9.02E-01	-3.69E-01	-6.51E-01	-2.71E-01	5.62E-18	-1.34E-18	7.69E-01
7	-1.08E+00	-4.87E-01	-6.89E-01	-1.65E-01	5.42E-18	-1.55E-18	6.04E-01
8	-1.25E+00	-6.11E-01	-7.12E-01	-9.67E-02	5.24E-18	-1.84E-18	3.91E-01
9	-1.43E+00	-7.37E-01	-7.28E-01	-8.27E-02	5.09E-18	-2.23E-18	7.96E-02
10	-1.60E+00	-8.66E-01	-7.49E-01	-1.51E-01	4.93E-18	-2.77E-18	-3.91E-01
11	-1.78E+00	-1.00E+00	-7.82E-01	-2.20E-01	4.76E-18	-3.45E-18	-3.91E-01

MODAL DISPLACEMENTS FOR SEGMENT NO. 4

NODE	Z	W	WD	WDD	U	V	WDDD
1	0.00E+00	-3.68E-02	-2.24E-02	4.79E-03	6.96E-04	-8.07E-04	2.60E-04
2	0.00E+00	-4.59E-02	-2.03E-02	4.90E-03	6.29E-04	-1.00E-03	2.60E-04
3	0.00E+00	-5.42E-02	-1.82E-02	5.02E-03	5.61E-04	-1.17E-03	2.60E-04
4	0.00E+00	-6.15E-02	-1.60E-02	5.11E-03	4.93E-04	-1.32E-03	2.25E-04
5	0.00E+00	-6.79E-02	-1.38E-02	5.19E-03	4.23E-04	-1.45E-03	1.91E-04
6	0.00E+00	-7.34E-02	-1.15E-02	5.26E-03	3.53E-04	-1.57E-03	1.58E-04
7	0.00E+00	-7.78E-02	-9.25E-03	5.32E-03	2.83E-04	-1.66E-03	1.28E-04
8	0.00E+00	-8.13E-02	-6.95E-03	5.36E-03	2.12E-04	-1.73E-03	9.80E-05
9	0.00E+00	-8.38E-02	-4.64E-03	5.39E-03	1.42E-04	-1.78E-03	6.92E-05
10	0.00E+00	-8.53E-02	-2.32E-03	5.41E-03	7.07E-05	-1.81E-03	4.18E-05
11	0.00E+00	-8.58E-02	0.00E+00	5.42E-03	0.00E+00	-1.82E-03	4.18E-05



**** END SUB. MODE ("SKIN"-RING MODULE BUCKLING MODE) ****

(In the buckling mode shape just listed look especially at the column headed "W" (normal deflection).

```
******* NOTE ********** NOTE ******** NOTE *********
Discretized "skin"-ring module buckling mode involves
significant sidesway of the ring web.
***** END NOTE ****** END NOTE ***** END NOTE *********
```

Margin= 1.6338E-01 Ring sidesway buk., discrete model, n=49 circ.halfwaves;FS=0.999

(lines skipped to save space)

Next, explore "skin"-ring module buckling from n= 73 to 219 circ. waves.
Minimum buckling load factor found so far, EIGBEF= 1.1879E+00
Corresponding critical number of circ. waves, n= 49

No critical (minimum) eigenvalue detected in high-n range.
Therefore, no "hi-n" buckling margin for the discretized
"skin"-ring single module will be recorded.
Maximum number of circ. waves, NMAXRG= 231

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```
 Minimum eigenvalue in N-range, EIGMNH=  1.4817E+00

 Next, explore "skin"-ring module buckling from n=   1 to   44 circ. waves.
 n circ. waves   Buckling Load Factor

(lines skipped to save space)

 No critical (minimum) eigenvalue detected in low-n range.
 Therefore, no "lo-n" buckling margin for the discretized
 "skin"-ring single module will be recorded.
*********** END CHAPTER 22 WITH NPRINT = 2 ******************


*********** BEGIN CHAPTERS 23 - 28 WITH NPRINT = 0 ******************
 ****************************************************************
 CHAPTER 23 Compute stresses in layers and at various
            locations in modules for both positive and
            negative imperfection amplitudes from SUBROUTINE
            STRCON (local postbuckling neglected). See [1L]
            (panda2.news) Items 36b,d,w, 41b, and Section E
            of Table 122.6 in Item 122.

***** BEGIN SUBROUTINE STRCON (IQUICK = 1 TYPE STRESSES) ******
 Margin=  1.1436E+00  eff.stress:matl=1,SKN,Iseg=1,at:n=1,layer=1,z=-0.0248;-MID.;FS=1.
 Margin=  2.8699E-01  eff.stress:matl=2,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.
 Margin=  4.3989E-01  eff.stress:matl=3,RNG,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.
 ***** END   SUBROUTINE STRCON (IQUICK = 1 TYPE STRESSES) ******
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

 ****************************************************************
 CHAPTER 24 Present short summary of redistribution of stress
            resultants, Nx, Ny, Nxy, caused by prebuckling
            bending of an initially imperfect shell.
            See Section 6.0 in [1K], for example.

 Additional resultants (Nx,Ny) in panel skin from
 global and inter-ring bending of imperfect panel:
            Additional axial resultant, dNx = -3.8247E+02
            Additional  hoop resultant, dNy = -2.3929E+02
   Additional in-plane shear resultant, dNxy=  0.0000E+00

 Additional axial resultants dNx along webs and flanges of
 stringers from global and inter-ring bending of imperfect panel:
     Additional Nx in  base  of stringer, dNx = -3.8248E+02
     Additional Nx at webtip of stringer, dNx = -2.3049E+03
     Additional Nx in flange of stringer, dNx =  0.0000E+00

 Additional axial resultants dNx along webs and flanges of
 rings from global and inter-ring bending of imperfect panel:
     Additional Nx in  base  of   ring,   dNx = -2.6296E+02
     Additional Nx at webtip of   ring,   dNx = -3.8057E+03
     Additional Nx in flange of   ring,   dNx =  0.0000E+00
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********
```

These are used when IQUICK=1 and for certain stress & local stiffener segment buckling margins

```
 ****************************************************************
 CHAPTER 25 Compute buckling load factors from PANDA-type
            theory for the various segments of a stringer and
            a ring. Typical buckling modes are displayed in
            Figs. 5 and 6 of Ref.[1B].

***** BEGIN SUBROUTINE STFEIG (BUCKLING IN STIFFENERS) ******
 Margin=  1.4450E-02  buckling margin stringer Iseg.3 . Local halfwaves=5  .MID.;FS=1.
 ***** END   SUBROUTINE STFEIG (BUCKLING IN STIFFENERS) ******

***** BEGIN SUBROUTINE STFEIG (NO POSTBUCKLING EFFECT) ******
 Margin= -8.1967E-03  buckling margin stringer Iseg.3 . Local halfwaves=5  .NOPO;FS=1.
 ******* END SUBROUTINE STFEIG (NO POSTBUCKLING EFFECT) ******
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

 ****************************************************************
 CHAPTER 26 Compute local, inter-ring, general buckling load
            factors from PANDA-type models [1B] and from
            "alternative" (double-trigonometric series
            expansion) models, Ref.[1G]. Also compute
            sandwich wall behavior [1F], if applicable.
            Also, compute buckling load factors appropriate
            when substiffeners are present.
```

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```
*** BEGIN SUBROUTINE BUCPAN (PANDA-TYPE BUCKLING LOADS) ****

 Sanders theory is used for these buckling calculations in this case.
 Local buckling load factors & mode shapes before any knockdown factors applied:
 EIGMNC=  5.46E+00  1.00E+17  2.22E+00  1.00E+17  2.22E+00  2.22E+00  1.00E+17
 SLOPEX=  2.00E-02  0.00E+00  1.00E-02  0.00E+00  0.00E+00  1.00E-02  0.00E+00
 MWAVEX=    4          0         8         0         8         8         0
 NWAVEX=    1          0         1         0         1         1         0
 NOTE: The buckling nodal line slopes, SLOPEX, are as
 defined in Fig. 9a or Fig. 9b of the 1987 "Theoretical
 basis of the PANDA...",if NWAVEX > 0; that is, there
 has not yet been any inversion of SLOPEX when 9b holds.

 LOCAL BUCKLING FROM PANDA-TYPE THEORY [1B] AFTER KNOCKDOWN FOR t.s.d.:
 EIGLOC =   2.1997E+00(m=   8,n=   1)

 INTER-RING BUCKLING load factors and (axial, circumfer.) halfwaves:
 Sanders theory is used for these buckling calculations in this case.
 INTER-RING BUCKLING FROM PANDA-TYPE THEORY [1B]
    AFTER KNOCKDOWN FOR t.s.d. AND FOR SMEARED STRINGERS:
 EIGSS =   2.4864E+00(m=   1,n=  13)
 Inter-ring eigenvalue with panel as flat:
 EIGSS2=   2.2203E+00(m=   1,n=   4)

 Simple-support inter-ring buckling with smeared stringers
 is not recorded as a margin because this type of buckling
 has been superseded by the results from the discretized
 inter-ring module model, for which inter-ring buckling
 load factors have been computed in the range from n =     1
 to n =   231 circumferential halfwaves.
 The critical simple-support inter-ring buckling model has   13
 circ. half waves, which lies within this range.

 Entering ALTSOL: radius, axial, circ. dimensions =  4.8000E+01  1.1458E+01  1.1170E+01
 See ITEMs 438, 444  in the file ..panda2/doc/panda2.news .
 and AIAA paper 99-1233, Proc. 40th AIAA SDM Meeting, 1999
 pp 302-345, especially pp 304-316 and associated figures.
 ***INTER-RING BUCKLING, N-STRINGER-BAY PATCH, SMEARED SUBSTF **
        Number of discrete stringers, rings: NUMSTR, NUMRNG=  7  2

 No alternative solution sought because user did not want one.
 (IALTSN was set equal to zero in MAINSETUP)

 Sanders theory is used for these buckling calculations in this case.
 General buckling load factors & mode shapes before any knockdown factors applied:
 EIGMNC=  2.62E+00  2.62E+00  2.62E+00  1.00E+17  1.00E+17  2.62E+00  6.21E+00
 SLOPEX=  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00  0.00E+00
 MWAVEX=    3          3         3         0         0         3         4
 NWAVEX=    6          6         6         0         0         6         0
 NOTE: The buckling nodal line slopes, SLOPEX, are as
 defined in Fig. 9a or Fig. 9b of the 1987 "Theoretical
 basis of the PANDA...",if NWAVEX > 0; that is, there
 has not yet been any inversion of SLOPEX when 9b holds.

 Entering ALTSOL: radius, axial, circ. dimensions =  4.8000E+01  5.7292E+01  1.1170E+01
 See ITEMs 438, 444  in the file ..panda2/doc/panda2.news .
 and AIAA paper 99-1233, Proc. 40th AIAA SDM Meeting, 1999
 pp 302-345, especially pp 304-316 and associated figures.
 *** GENERAL BUCKLING, N x M BAY PATCH, SMEARED SUBSTIFFRS ***
        Number of discrete stringers, rings: NUMSTR, NUMRNG=  7  6

 No alternative solution sought because user did not want one.
 (IALTSN was set equal to zero in MAINSETUP)
 General buckling loads AFTER knockdown for t.s.d.
 Number of circumferential halfwaves in buckling pattern=  6.0000E+00
 Buckling load factor BEFORE knockdown for smeared stringers=  2.4811E+00
 Buckling load factor AFTER  knockdown for smeared stringers=  2.3268E+00

 General buckling load factor before and after knockdown:
 EIGGEN(before modification by 5 factors below)      =  2.3268E+00
 Knockdown factor from modal imperfection(s)         =  6.8873E-01
 Knockdown factor for smearing rings on cyl. shell   =  9.4810E-01
 Knockup factor to avoid twice accounting for t.s.d.=  1.0000E+00
 1st modifying factor, FKNMOD=1 or 1/(EIG9X*FMDKD9)  =  1.0000E+00
 2nd modifying factor, EIGMR9=1 or EIGGNX/EIGGEN     =  1.0000E+00
 After knockdn,EIGGEN*FKNOCK(9)*(RNGKNK/SHRFCT)*FKNMOD*EIGMR9=  1.5193E+00
 in which
 EIG9X  = lambda(ARBOCZ)/lambda(original PANDA-type theory)=  1.0000E+00
```

Compare with STAGS, Figs. 46(a) & 46(b) (perfect shell)

Compare with STAGS Fig. 35 (perfect shell)

Compare with STAGS in Figs. 18 & 19

Knockdown factors when ICONSV=1

```
       lambda(ARBOCZ)=perfect panel buckling from ARBOCZ theory
       lambda(PANDA) =perfect panel buckling from PANDA  theory
 FMDKD9 = 1 or 0.9/EIG9X =  1.0000E+00
 EIGGNX = eigenvalue for perfect panel from alternate solution
 Margin=  5.2086E-01  buck.(SAND);simp-support general buck;M=3;N=6;slope=0.;FS=0.999

 Smeared stringer with rolling before and after knockdown:
 EIGRSS(before knockdown by 2 factors below)          =  2.4620E+00
 Knockdown factor from inter-ring modal imperfection=  9.7837E-01
 Modifying factor, FKNMOD=1 or 1/(EIG8X*FMDKD8)      =  1.0000E+00
 After knockdown, EIGRSS*FKNOCK(8)*FKNMOD            =  2.4088E+00
 in which
 EIG8X  = lambda(ARBOCZ)/lambda(original PANDA-type theory)=  9.7837E-01
       lambda(ARBOCZ)=perfect panel buckling from ARBOCZ theory
       lambda(PANDA) =perfect panel buckling from PANDA  theory
 FMDKD8 = 1 or 0.9/EIG8X =  1.0000E+00

 Inter-ring buckling with smeared stringers and ring rolling
 is not recorded as a margin because this type of buckling
 has been superseded by the results from the discretized
 inter-ring module model, for which inter-ring buckling
 load factors have been computed in the range from n =     1
 to n =   231 circumferential halfwaves.
 The critical inter-ring-buckling-with-ring-rolling model has   14
 circ. half waves, which lies within this range.
 Margin=  1.6084E+01  buck.(SAND);rolling with smear rings; M=172;N=1;slope=0.;FS=0.999
 Margin=  6.7862E-01  buck.(SAND);rolling only of stringers;M=45;N=0;slope=0.;FS=1.4

 Stringer rolling from PANDA-type theory [1B]:
 PANDA-type buckling load factor, EIGRLL(2)(m,n,slope)=  2.3501E+00(  45,0,0)

 Ring rolling without participation of the panel skin
 is not recorded as a margin because this type of buckling
 has been superseded by the results from the discretized
 "skin"-ring module model, for which buckling load factors
 have been computed in the range from n =     1 to n =   231 circ. halfwaves.
 The critical ring-rolling-without-participation-of-the-panel-skin model has   50
 circ. half waves, which lies within this range.
 Margin=  1.5261E+01  buck.(SAND);rolling only axisym.rings;M=0;N=0;slope=0.;FS=1.4

 Axisymmetric ring rolling from PANDA-type theory [1B]:
 PANDA-type buckling load factor, EIGRLL(4)(m,n,slope)=  2.2766E+01(0,   0,0)
 ****  END SUBROUTINE BUCPAN (PANDA-TYPE BUCKLING LOADS) ****
 *** END   SUBROUTINE BUCPAN (PANDA-TYPE BUCKLING LOADS) ****
 Margin=  6.2670E+02  (Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

 ************************************************************
 CHAPTER 27 Compute the objective function (e.g. WEIGHT).

 Objective (weight of PANDA2 model of panel), OBJ =  1.0014E+02
 ********* DESIGN PERTURBATION INDEX, IMOD=  0 *********

 ************************************************************
 CHAPTER 28 Present design, loading, and margins for the
            current load set and subcase. See Table 6 in
 Bushnell, D.
 "Optimization of an axially compressed ring and stringer
 stiffened cylindrical shell with a general buckling modal
 imperfection", AIAA Paper 2007-2216, 48th AIAA SDM Meeting,
 Honolulu, Hawaii, April 2007

 ANALYSIS: ITYPE=2;  IQUICK=0;  LOAD SET 1;  SUBCASE 1:
 LOADING: Nx, Ny, Nxy, Mx, My =  -2.22E+03 -2.22E-03  1.11E+01  0.00E+00  0.00E+00
          Nxo, Nyo, pressure  =   0.00E+00  0.00E+00  4.62E-05
 BUCKLING LOAD FACTORS FOR LOCAL BUCKLING FROM KOITER v. BOSOR4 THEORY:
  Local buckling load factor from KOITER theory =  1.0376E+00 (flat skin)
  Local buckling load factor from BOSOR4 theory =  1.0437E+00 (flat skin)

 MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 1, SUBCASE NO. 1
 MAR. MARGIN
 NO.  VALUE                DEFINITION
 1  4.98E-02 Local buckling from discrete model-1.,M=4   axial halfwaves;FS=0.99
 2  4.47E-02 Bending-torsion buckling; M=4  ;FS=0.999
 3  3.87E-02 Bending-torsion buckling: Koiter theory,M=4   axial halfwav;FS=0.99
 4  2.54E+00 eff.stress:matl=1,SKN,Dseg=2,node=6,layer=1,z=-0.0248; MID.;FS=1.
 5  7.69E+06 stringer popoff margin:(allowable/actual)-1, web 1  MID.;FS=1.
 6  2.73E-01 eff.stress:matl=2,STR,Dseg=3,node=11,layer=1,z=0.0403; MID.;FS=1.
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 7  1.76E-01 (m=4   lateral-torsional buckling load factor)/(FS)-1;FS=0.999
 8  1.63E-01 Ring sidesway buk., discrete model, n=49  circ.halfwaves;FS=0.999
 9  1.14E+00 eff.stress:matl=1,SKN,Iseg=1,at:n=1,layer=1,z=-0.0248;-MID.;FS=1.
10  2.87E-01 eff.stress:matl=2,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.
11  4.40E-01 eff.stress:matl=3,RNG,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.
12  1.45E-02 buckling margin stringer Iseg.3 . Local halfwaves=5  .MID.;FS=1.
13 -8.20E-03 buckling margin stringer Iseg.3 . Local halfwaves=5  .NOPO;FS=1.
14  5.21E-01 buck.(SAND);simp-support general buck;M=3;N=6;slope=0.;FS=0.999
15  1.61E+01 buck.(SAND);rolling with smear rings; M=172;N=1;slope=0.;FS=0.999
16  6.79E-01 buck.(SAND);rolling only of stringers;M=45;N=0;slope=0.;FS=1.4
17  1.53E+01 buck.(SAND);rolling only axisym.rings;M=0;N=0;slope=0.;FS=1.4
18  6.27E+02 (Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
*********** END CHAPTERS 23 - 28 WITH NPRINT = 0 ******************
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End of a rather long discussion of PANDA2 results that lead to Table 33a
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