Table 24 Run stream to obtain STAGS predictions for the case "allenrngs". There is no in-plane edge warping but overall axial bending is permitted. The panel is curved, has five stringer bays and one ring bay. The rings are included along the two curved ends of the panel.

```
=============================================================================
 command       names of input/output files
---------      ---------------------------
stagsunit      allenrngs.5bay.480.axialbending.stg (table 14)/
               allenrngs.bin, allenrngs.inp
```

*********************** IMPORTANT NOTE ***************************
The applied load, Nx = -100.0 lb/in, which is one tenth of the design load, Nx = -1000.0 lb/in. Therefore, in the STAGS runs to follow, the load factor, PA = 10.0, corresponds to the design load, Nx = -1000 lb/in that was used in the PANDA2 runs.

In all the STAGS runs executed for the generation of this report the value of Nx specified in the *.stg files is always -100.0 lb/in, not Nx = -1000.0 lb/in.
****

(copy allenrngs.bin and allenrngs.inp to a directory where STAGS is run.)
(go to the directory where STAGS is to be run.)
(activate the STAGS commands: "source ...../stags5/prc/initialize")
(run a linear bifurcation buckling analysis (INDIC=1) of the curved panel)
(the allenrngs.bin file is as follows:)

```
------------------------------------------------------------------------
 allenrngs STAGS INPUT FOR STIFFENED CYL.(STAGSUNIT=SHELL UNITS)
 1, $ INDIC=1 is bifur.buckling; INDIC=3 is nonlinear BEGIN B-1
 1, $ IPOST=1 means save displacements every IPOSTth step
 0, $ ILIST =0 means normal batch-oriented output
 0, $ ICOR  =0 means projection in; 1 means not in.
 1, $ IMPTHE=index for imperfection theory.
 0, $ ICHIST=index for crack archive option
 0, $ IFLU  =0 means no fluid interaction.
 -1 $ ISOLVR= 0 means original solver; -1 new solver.END B-1 rec
 1.000E+00, $ STLD(1) = starting load factor, System A. BEGIN C-1 rec.
 0.000E+00, $ STEP(1) = load factor increment, System A
 1.000E+00, $ FACM(1) = maximum load factor, System A
 0.000E+00, $ STLD(2) = starting load factor, System B
 0.000E+00, $ STEP(2) = load factor increment, System B
 0.000E+00, $ FACM(2) = maximum load factor, System B
 0  $ ITEMP =0 means no thermal loads. END C-1 rec.
 10000, $ NSEC= number of CPU seconds before run termination
 0., $ DELEV is eigenvalue error tolerance (0=.00001)
 0  $ IPRINT=0 means print modes, iteration data, END D-2 rec.
  1, $ NEIGS= number of eigenvalues sought.  BEGIN D-3 rec.
 2.000, $ SHIFT=initial eigenvalue shift
 0.000E+00, $ EIGA =lower bound of eigenvalue range
----------------------------------------------------------------------
```

(execute STAGS - STAGS run no. 1 for this case):

```
 command                  names of input/output files
---------                 ---------------------------
stags -b allenrngs  allenrngs.bin, allenrngs.inp/allenrngs.out2, etc.
```

(part of the STAGS output file, allenrngs.out2, is as follows:)

```
  CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES  1 THROUGH   1
                   CRITICAL LOAD FACTOR COMBINATION
   NO.    EIGENVALUE   LOAD SYSTEM A  LOAD SYSTEM B    @DOF
     1   3.367878E+00   3.367878E+00   0.000000E+00   11050
```

(run the STAGS processor, STAPL, to obtain plot of linear buckling mode)
(the input for STAPL, allenrngs.pin, is as follows:)

```
Fig.21 linear buckling of perfect shell from STAGS; case=allenrngs
  1  0  1  0  $PL-2  NPLOT,IPREP,IPRS,KDEV
     1     0     4     0     1  $PL-3  KPLOT,NUNIT,ITEM,STEP,MODE
    0.0   3  $PL-5  DSCALE,NROTS
  1   -35.84   $PL-6  IROT,ROT
  2   -13.14   $PL-6  IROT,ROT
  3    35.63   $PL-6  IROT,ROT
```

(Execute STAPL:)

```
 command                  names of input/output files
---------                 ---------------------------
stapl allenrngs            allenrngs.pin/allenrngs.pdf
```

(view the linear buckling mode:)
acroread allenrngs.pdfallenrngs.pdf/Fig.21

(next, run nonlinear equilibrium (INDIC=3) of the same curved panel with a linear buckling modal imperfection with amplitude, Wimp=0.001 inch.)
(the new allenrngs.bin file is as follows:)

```
optimized imperfect shell, nonlinear theory (INDIC=3)
 3, $ INDIC=1 is bifur.buckling; INDIC=3 is nonlinear BEGIN B-1
 1, $ IPOST=1 means save displacements every IPOSTth step
 0, $ ILIST =0 means normal batch-oriented output
 0, $ ICOR  =0 means projection in; 1 means not in.
 1, $ IMPTHE=index for imperfection theory.
 0, $ IOPTIM=0 means bandwith optimization will be performed
 0, $ IFLU  =0 means no fluid interaction.
```

```
 -1 $ ISOLVR= 0 means original solver; -1 new solver.END B-1 rec
 1.0, $ STLD(1) = starting load factor, System A. BEGIN C-1 rec.
 1.0, $ STEP(1) = load factor increment, System A
 10.0, $ FACM(1) = maximum load factor, System A
 0.000E+00, $ STLD(2) = starting load factor, System B
 0.000E+00, $ STEP(2) = load factor increment, System B
 0.000E+00, $ FACM(2) = maximum load factor, System B
 0  $ ITEMP =0 means no thermal loads. END C-1 rec.
   0, $ ISTART=restart from ISTARTth load step.   BEGIN D-1 rec.
 2000,$ NSEC= number of CPU seconds before run termination
  5,$ NCUT = number of times step size may be cut
  -20, $ NEWT = number of refactorings allowed
-1,$ NSTRAT=-1 means path length used as independent parameter
 0.0001,$ DELX=convergence tolerance
 0. $ WUND = 0 means initial relaxation factor =1.END D-1 rec.
 0,  6, 0  $ NPATH=0: Riks method, NEIGS=no.of eigs, NSOL=0: contin.  ET-1
```

(The new allenrngs.inp file is obtained by editing the old allenrngs.inp file as follows:)

(1. change NIMPFS from 0 to 1:)

1, $ NIMPFS=number of bucklng modal imperfections.

(2. insert an additional record, as follows:)

C Begin B-4, B-5 input data, if any...

0.001   0 1 1 $B-5 WIMPFA, IMSTEP, IMMODE, IMRUN (1st imperf.)

(execute STAGS - STAGS run no. 2 for this case):

```
 command                 names of input/output files
---------                ---------------------------
stags -b allenrngs       allenrngs.bin, allenrngs.inp/allenrngs.out2, etc.
```

(part of the STAGS output file, allenrngs.out2, is as follows:)

```
 Final load value reached.
      Pa            Pb
   1.00000E+01   0.00000E+00

FORMING TOTAL STIFFNESS MATRIX
   DISP   KLIN   STEP   PA             PB
     22      1     15   0.100000E+02   0.000000E+00

          --------------------------------------------
          COMPACT SYSTEM-MATRIX ASSEMBLY COMPLETED ...
          # of equations in the system matrix:   30260
          # of nonzero off-diagonal entries:    952959
          --------------------------------------------
```

```
          ----------------------------------------------
          Compact-matrix VSS decomposition completed ....
          Number of renumbering schemes used ..        1
          Determinant ...  1.9531D+00 x 10**(    113255 )
          Number of negative roots ...........       244
          Estimated condition number .....   1.795513D-03
          ----------------------------------------------

 FORMING STABILITY MATRIX
    DISP   KLIN   STEP   PA            PB
      22      1     15   0.100000E+02   0.000000E+00
  NO OF MODES             SHIFT             ALPHA             BETA
            6    0.00000000E+00    0.00000000E+00    0.00000000E+00

          -------------------------------------------
          COMPACT SYSTEM-MATRIX ASSEMBLY COMPLETED ...
          # of equations in the system matrix:   30260
          # of nonzero off-diagonal entries:    952959
          -------------------------------------------

          ----------------------------------------------
          Compact-matrix VSS decomposition completed ....
          Number of renumbering schemes used ..        1
          Determinant ...  1.9531D+00 x 10**(    113255 )
          Number of negative roots ...........       244
          Estimated condition number .....   1.795513D-03
          ----------------------------------------------

 (lines skipped to save space)

  CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES  1 THROUGH   6
                     CRITICAL LOAD FACTOR COMBINATION
    NO.    EIGENVALUE   LOAD SYSTEM A  LOAD SYSTEM B    @DOF
      1   3.293947E-02   1.032939E+01   0.000000E+00    9930
      2   3.314018E-02   1.033140E+01   0.000000E+00    9500
      3   3.349807E-02   1.033498E+01   0.000000E+00    9690
      4   3.568675E-02   1.035687E+01   0.000000E+00    9440
      5   4.152035E-02   1.041520E+01   0.000000E+00    9500
      6   8.675762E-02   1.086758E+01   0.000000E+00   15700

 (lines skipped to save space)

  LIST OF LOAD STEPS AND LOAD FACTORS
  STEP       PA             PB             PX
     0  0.100000E+01  0.000000E+00
     1  0.100000E+01  0.000000E+00
     2  0.200000E+01  0.000000E+00
```

```
   3  0.261439E+01  0.000000E+00
   4  0.310785E+01  0.000000E+00
   5  0.335192E+01  0.000000E+00
   6  0.355156E+01  0.000000E+00
   7  0.384646E+01  0.000000E+00
   8  0.416020E+01  0.000000E+00
   9  0.446311E+01  0.000000E+00
  10  0.481411E+01  0.000000E+00
  11  0.532757E+01  0.000000E+00
  12  0.606739E+01  0.000000E+00
  13  0.710970E+01  0.000000E+00
  14  0.853115E+01  0.000000E+00
  15  0.100000E+02  0.000000E+00
```

(run the STAGS processor, STAPL, to obtain plot of nonlinear
equilibrium state of the panel at STEP No. 15)
(the input for STAPL, allenrngs.pin, is as follows:)

```
Fig.22 nonlinear w same view as linear buckling mode; case=allenrngs
  1  0  1  0  $PL-2  NPLOT,IPREP,IPRS,KDEV
  2   0  1  15  0 0 0  3  $PL-3
KPLOT,VIEW,ITEM,STEP,MODE,IFRNG,COLOR,ICOMP
  0.0   3  0.0  0.0  0.0 $PL-5  DSCALE,NROTS,LWSCALE,RNGMIN,RGMAX
  1  -0.35840000E+02   $PL-6  IROT,ROT
  2  -0.13140000E+02   $PL-6  IROT,ROT
  3   0.35630001E+02   $PL-6  IROT,ROT
```

(Execute STAPL:)

```
 command                  names of input/output files
---------                 ---------------------------
stapl allenrngs           allenrngs.pin/allenrngs.pdf
```
(view the nonlinear equilibrium state at STEP No. 15:)
acroread allenrngs.pdf allenrngs.pdf/Fig.22

(run the STAGS processor, STAPL, to obtain plot of outer
fiber effective stress in the panel at STEP No. 15)
(the input for STAPL, allenrngs.pin, is as follows:)

```
Fig.23 nonlinear effective stress - outer fiber; case=allenrngs
  1  0  1  0  $PL-2  NPLOT,IPREP,IPRS,KDEV
  2   0  7  15  0 0 0 0 0 2 $PL-3  KPLOT,VIEW,ITEM,STEP,MODE,IFRNG,COLOR,ICOMP,LAYR,FIBR
   0.0   3  0.0  0.0  0.0 $PL-5  DSCALE,NROTS,LWSCALE,RNGMIN,RGMAX
  1  -0.35840000E+02   $PL-6  IROT,ROT
  2  -0.13140000E+02   $PL-6  IROT,ROT
  3   0.35630001E+02   $PL-6  IROT,ROT
```

(Execute STAPL:)

```
 command                    names of input/output files
---------                   ---------------------------
stapl allenrngs             allenrngs.pin/allenrngs.pdf
```

(view the outer fiber effective stress at STEP No. 15:)
acroread allenrngs.pdf allenrngs.pdf/Fig.23

(Next, we wish to use a circumferentially varying mesh density in order better to capture the concentration of effective stress adjacent to one of the central stringers. Therefore, we redo much of what we have done so far with use of different input for STAGSUNIT. Note that we use the data listed in Table 12 as input, with the important exception that the index, IBCX0XL = 0 instead of 1, that is, overall axial bending is permitted.)

```
 command                    names of input/output files
---------                   ---------------------------
stagsunit                   allenrngs.superopt1.5bay.yvariablespacing3.480.stg:
                            table12 with IBCX0XL=0/allenrngs.bin, allenrngs.inp
```

(copy the new allenrngs.bin and allenrngs.inp to the directory where we want to run STAGS. The execute STAGS for the linear buckling analysis (INDIC=1).)

(execute STAGS - STAGS run no. 1 for this new case):

```
 command                    names of input/output files
---------                   ---------------------------
stags -b allenrngs          allenrngs.bin, allenrngs.inp/allenrngs.out2, etc.
```

(part of the STAGS output file, allenrngs.out2, is as follows:)

```
---------------------------------------------------------------------
 CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES   1 THROUGH   1
                    CRITICAL LOAD FACTOR COMBINATION
   NO.    EIGENVALUE   LOAD SYSTEM A  LOAD SYSTEM B    @DOF
     1   3.366757E+00   3.366757E+00   0.000000E+00   15366
---------------------------------------------------------------------
```

NOTE: The linear buckling mode is not displayed in this report.

(Next, run nonlinear equilibrium (INDIC=3) of the same curved panel with a linear buckling modal imperfection with amplitude, Wimp=0.001 inch.)
(the new allenrngs.bin file is the same as the second one listed above.)

(The new allenrngs.inp file is obtained as before by editing the old allenrngs.inp file as follows:)

(1. change NIMPFS from 0 to 1:)
1, $ NIMPFS=number of bucklng modal imperfections.

(2. insert an additional record, as follows:)
C Begin B-4, B-5 input data, if any...
0.001 0 1 1 $B-5 WIMPFA, IMSTEP, IMMODE, IMRUN (1st imperf.)

(execute STAGS - STAGS run no. 2 for this case):

```
 command                 names of input/output files
---------                ---------------------------
stags -b allenrngs       allenrngs.bin, allenrngs.inp/allenrngs.out2, etc.
```

(part of the STAGS output file, allenrngs.out2, is as follows:)

```
-------------------------------------------------------------------
  CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES  1 THROUGH   6
                     CRITICAL LOAD FACTOR COMBINATION
   NO.    EIGENVALUE   LOAD SYSTEM A  LOAD SYSTEM B    @DOF
     1   3.221747E-02   1.032218E+01   0.000000E+00   13066
     2   3.304165E-02   1.033042E+01   0.000000E+00   13354
     3   3.327108E-02   1.033271E+01   0.000000E+00   13216
     4   3.497139E-02   1.034971E+01   0.000000E+00   13006
     5   3.749213E-02   1.037492E+01   0.000000E+00   13216
     6   8.305713E-02   1.083057E+01   0.000000E+00   21816

(lines skipped to save space)

 LIST OF LOAD STEPS AND LOAD FACTORS
 STEP       PA            PB              PX
    0  0.100000E+01  0.000000E+00
    1  0.100000E+01  0.000000E+00
    2  0.200000E+01  0.000000E+00
    3  0.261962E+01  0.000000E+00
    4  0.312800E+01  0.000000E+00
    5  0.336072E+01  0.000000E+00
    6  0.355536E+01  0.000000E+00
    7  0.384464E+01  0.000000E+00
    8  0.398860E+01  0.000000E+00
    9  0.416219E+01  0.000000E+00
   10  0.441834E+01  0.000000E+00
   11  0.480704E+01  0.000000E+00
   12  0.533347E+01  0.000000E+00
   13  0.608481E+01  0.000000E+00
   14  0.712919E+01  0.000000E+00
   15  0.853081E+01  0.000000E+00
   16  0.100000E+02  0.000000E+00
-----------------------------------------------------------
```

(run the STAGS processor, STAPL, to obtain plot of outer
fiber effective stress in the panel at STEP No. 16)
(the input for STAPL, allenrngs.pin, is as follows:)

```
------------------------------------------------------------------------
Fig.24 nonlinear effective stress - outer fiber; case=allenrngs
  1  0  1  0  $PL-2  NPLOT,IPREP,IPRS,KDEV
  2   0  7  16  0 0 0 0 0 2 $PL-3  KPLOT,VIEW,ITEM,STEP,MODE,IFRNG,COLOR,ICOMP,LAYR,FIBR
   0.0   3  0.0  0.0  0.0 $PL-5  DSCALE,NROTS,LWSCALE,RNGMIN,RGMAX
  1  -0.35840000E+02   $PL-6  IROT,ROT
  2  -0.13140000E+02   $PL-6  IROT,ROT
  3   0.35630001E+02   $PL-6  IROT,ROT
------------------------------------------------------------------------
```

(Execute STAPL:)

```
 command                  names of input/output files
---------                 ---------------------------
stapl allenrngs           allenrngs.pin/allenrngs.pdf
```

(view the outer fiber effective stress at STEP No. 16:)
acroread allenrngs.pdf allenrngs.pdf/Fig.24

(run the STAGS processor, STAPL, to obtain plot of inner
fiber effective stress in the panel at STEP No. 16)
(the input for STAPL, allenrngs.pin, is as follows:)

```
------------------------------------------------------------------------
Fig.25 nonlinear effective stress - inner fiber; case=allenrngs
  1  0  1  0  $PL-2  NPLOT,IPREP,IPRS,KDEV
  2   0  7  16  0 0 0 0 0 0 $PL-3  KPLOT,VIEW,ITEM,STEP,MODE,IFRNG,COLOR,ICOMP,LAYR,FIBR
   0.0   3  0.0  0.0  0.0 $PL-5  DSCALE,NROTS,LWSCALE,RNGMIN,RGMAX
  1  -0.35840000E+02   $PL-6  IROT,ROT
  2  -0.13140000E+02   $PL-6  IROT,ROT
  3   0.35630001E+02   $PL-6  IROT,ROT
------------------------------------------------------------------------
```

(Execute STAPL:)

```
 command                  names of input/output files
---------                 ---------------------------
stapl allenrngs           allenrngs.pin/allenrngs.pdf
```

(view the inner fiber effective stress at STEP No. 16:)
acroread allenrngs.pdf allenrngs.pdf/Fig.25

(Next, we wish to obtain a plot of the amplitude of typical inward and outward post-local buckles in the skin of the curved panel vs load factor, PA. We run the STAGS processor, xytrans, with the following input data (allenrngs.pxy file):

```
------------------------------------------------------------
P                    $ (P)lotps or (S)pread_Sheet output
```

```
allenrngs          $ STAGS solution 'Case Name'
F                  $ (F)ull or (C)ondensed Model
Y                  $ (Y)es-(N)o: setup data for another plot
 5                 $ x-axis variable = choice (1 to 15)
   1817            $ node no. (0 = ask for Unit,Row,Col)
3                  $ comp no., dis,vel,acc (1-6) = u,v,w,ru,rv,rw
S                  $ (G)lobal or (S)hell ref surface
N                  $ (Y)es-(N)o: specify x-variable scale factor
 2                 $ y-axis variable = choice (1 to 15)
N                  $ (Y)es-(N)o: specify y-variable scale factor
N                  $ (Y)es-(N)o: specify subrange of loadsteps
Y                  $ (Y)es-(N)o: plotted points start at origin
Y                  $ (Y)es-(N)o: setup data for another plot
 5                 $ x-axis variable = choice (1 to 15)
   2527            $ node no. (0 = ask for Unit,Row,Col)
3                  $ comp no., dis,vel,acc (1-6) = u,v,w,ru,rv,rw
S                  $ (G)lobal or (S)hell ref surface
N                  $ (Y)es-(N)o: specify x-variable scale factor
 2                 $ y-axis variable = choice (1 to 15)
N                  $ (Y)es-(N)o: specify y-variable scale factor
N                  $ (Y)es-(N)o: specify subrange of loadsteps
Y                  $ (Y)es-(N)o: plotted points start at origin
N                  $ (Y)es-(N)o: setup data for another plot
```

(The output from xytrans is the file, allenrngs.plt. With some editing for an appropriate title, x-y axes labels, and legends, and after copying the edited allenrngs.plt file into a file called "allenrngs.w.input", and after typing the following command:

/home/progs/bin/plotps.linux < allenrngs.w.input > allenrngs.w.ps

we obtain Fig. 26. The beginning of the input file for /home/progs/bin/plotps.linux, that is, the file called allenrngs.w.input, has the following lines:)

```
# Global directives, load normal deflection curves from STAGS
=title(Fig.26 STAGS normal displacement w at postbuckled peaks near panel center)
=xlabel(5-bay, radius=50 inches: normal displacement w (inches))
=ylabel(Axial load factor, PA; Nonlinear STAGS runs; case=allenrngs)
# data set 1
+legend(case = allenrngs: STAGS prediction for Radius = 50 inches; Node 1817; inward buckle)
+setmarker( 0)
   0.000000E+00    0.000000E+00
   2.149390E-03    1.000000E+00
   3.660131E-03    2.000000E+00
   3.245000E-03    2.619623E+00
  -1.176384E-03    3.127999E+00
  -5.735684E-03    3.360725E+00
```

```
 -9.951585E-03   3.555365E+00
 -1.494020E-02   3.844637E+00
 -1.697490E-02   3.988599E+00
 -1.929555E-02   4.162193E+00
 -2.256354E-02   4.418338E+00
```

etc.

(The PANDA2/STAGS user can generate introductory lines for other *.input files by analogy.)

(We can obtain the endshortening vs load factor in the same way. The input to the STAGS processor, xytrans, (allenrngs.pxy.1 file) is as follows:)

```
--------------------------------------------------------------
P                  $ (P)lotps or (S)pread_Sheet output
allenrngs          $ STAGS solution 'Case Name'
F                  $ (F)ull or (C)ondensed Model
Y                  $ (Y)es-(N)o: setup data for another plot
 5                 $ x-axis variable = choice (1 to 15)
      1            $ node no. (0 = ask for Unit,Row,Col)
1                  $ comp no., dis,vel,acc (1-6) = u,v,w,ru,rv,rw
S                  $ (G)lobal or (S)hell ref surface
N                  $ (Y)es-(N)o: specify x-variable scale factor
 2                 $ y-axis variable = choice (1 to 15)
N                  $ (Y)es-(N)o: specify y-variable scale factor
N                  $ (Y)es-(N)o: specify subrange of loadsteps
Y                  $ (Y)es-(N)o: plotted points start at origin
N                  $ (Y)es-(N)o: setup data for another plot
--------------------------------------------------------------
```

(The plot from the STAGS prediction of load-endshortening is included in Fig.27. In Fig. 27 the load-endshortening curve predicted by STAGS is compared with that predicted by PANDA2.)

************************ IMPORTANT NOTE ***************************

The overall discrepancy between the two curves in Fig.27 is caused primarily by the presence of overall axial bending in the STAGS model which is absent in the PANDA2 post-local-buckling model. PANDA2 does not account for the shift in neutral axis caused by local post-buckling of the panel skin. See the discussion in connection with Fig. 28 for more on the "neutral axis shift".

The points on the curve labeled "PANDA2..." are obtained from those in Fig. 8 by multiplication of the axial strain by the distance between rings, 9.7793 inches, and by replacement of the axial load Nx with the load factor, PA.

The post-local-buckling theory in PANDA2 is described in detail in the paper:

Bushnell, D., "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

Briefly, the PANDA2 local post-buckling model is based on the assumption that the panel is infinitely long and flat, and the variation of local post-buckling modal displacement is sinusoidal in the axial direction. One of the unknowns in the PANDA2 theory is an axial wavelength quantity that is permitted to vary continuously, as is displayed in Fig. 20. The PANDA2 local post-buckling theory has no "mode jumping" of the sort that is often encountered in STAGS case that involve significant local post-buckling behavior.

As will be seen later, the PANDA2 prediction shown in Fig. 27 is later compared by results from a STAGS model in which overall axial bending is prevented. This overall axial bending is prevented in the STAGS model by setting the new STAGSUNIT index, IBCX0XL=1 in the *.STG file, per the following new entry in the *.STG

```
 1  $ Stringer web axial displacement index, IBCX0XL=0 or 1
```

This new entry in the *.STG file is described in Section 2.2, entitled "Item No. 797 in the File, ...panda2/doc/panda2.news" in the file, allenrngs.readme.
****

(The input data for STAPL for the in-plane u deformation in the third stringer, numbering stringers from the bottom right of Fig. 25, are listed next. The quantity u is the axial (horizontal) in-plane displacement in the stringer web.)

```
--------------------------------------------------------------
Fig.28 nonlinear u in third stringer ; case=allenrngs
  1  0  1  0  $PL-2  NPLOT,IPREP,IPRS,KDEV
  2   1  1  16  0 0 0  1  $PL-3  KPLOT,VIEW,ITEM,STEP,MODE,IFRNG,COLOR,ICOMP
    4                 $     shell unit number to be included in the plot
  0.0   3  0.0  0.0  0.0 $PL-5  DSCALE,NROTS,LWSCALE,RNGMIN,RGMAX
  1  90.0   $PL-6  IROT,ROT
  2   0.0   $PL-6  IROT,ROT
  3   0.0   $PL-6  IROT,ROT
--------------------------------------------------------------
```

(Execute STAPL:)

```
 command                  names of input/output files
---------                 ---------------------------
stapl allenrngs           allenrngs.pin/allenrngs.pdf
```

(view the u-displacement in the third stringer at STEP No. 16:)
acroread allenrngs.pdf allenrngs.pdf/Fig. 28

*************************** IMPORTANT NOTE ********************************
In Fig. 28 the location of the panel skin is at the lower edge of the stringer. The overall axial bending occurs because the skin is locally buckled. Axial bending begins at the axial load corresponding to local buckling and is caused by the shift in the neutral axis of the stiffened panel. This shift in the neutral axis arises because the

locally buckled skin has about half the axial stiffness of the unbuckled skin. The overall axial bending occurs because in this STAGS model the distribution of applied axial compression remains constant throughout the loading process. Therefore, for axial loads exceeding the local linear bifurcation buckling load, there exists an effective applied bending moment equal to the axial load times the shift in the neutral axis from its location in the unbuckled panel to its location in the locally buckled panel. Since the skin is attached along the lower edge of the stringer displayed in Fig. 28, the neutral axis of the locally buckled panel lies above that for the unbuckled panel. Therefore, the panel, as represented in Fig. 28, bends upward. In Fig. 25 this bending is downward. It is hard to see in that figure. If the reader holds a straight-edge connecting the two end points of the root of one of the middle stringers (stringer no. 3, for example) he or she can more easily detect the overall inward (downward) axial bending of the locally post-buckled curved panel depicted in Fig. 22 rather than in Fig. 25.
****

(The input data for STAPL for the in-plane v deformation of the third stringer, numbering stringers from the bottom right of Fig. 25, are listed next. The quantity v is the cross-wise (vertical) in-plane displacement in the stringer web.)

```
----------------------------------------------------------------
Fig.29 nonlinear v in third stringer ; case=allenrngs
  1  0  1  0  $PL-2  NPLOT,IPREP,IPRS,KDEV
  2   1  1  16  0 0 0  2  $PL-3  KPLOT,VIEW,ITEM,STEP,MODE,IFRNG,COLOR,ICOMP
     4                    $      shell unit number to be included in the plot
  0.0   3  0.0  0.0  0.0 $PL-5  DSCALE,NROTS,LWSCALE,RNGMIN,RGMAX
  1  90.0   $PL-6  IROT,ROT
  2   0.0   $PL-6  IROT,ROT
  3   0.0   $PL-6  IROT,ROT
----------------------------------------------------------------
```

(Execute STAPL:)

```
 command                  names of input/output files
---------                 ---------------------------
stapl allenrngs           allenrngs.pin/allenrngs.pdf
```

(view the v-displacement in the third stringer at STEP No. 16:)
acroread allenrngs.pdf allenrngs.pdf/Fig. 29

In Fig. 29 the location of the panel skin is at the lower edge of the stringer. The quantity v is the cross-wise (vertical) displacement in the stringer web. v is negative at the midlength of the stringer because the sign convention in this particular STAGS model has positive v in the stringer in the same direction as positive normal displacement w in the panel skin along the line of intersection of the root of the stringer web with the panel skin. Positive normal displacement w in the panel skin is in the radially outward direction.
===