Table 11 Output file, try4.OPM, from OPTIMIZE for the optimized design after the first execution of SUPEROPT. This try4.OPM file has been edited slightly for ease of reading. Items in bold face are discussed in Section 8 of the text and identified by an Item Number.

=========================================================================

n $ Do you want a tutorial session and tutorial output?

0 $ Choose an analysis you DON'T want (1, 2,..), IBEHAV

2 $ NPRINT= output index (0=GOOD, 1=ok, 2=debug, 3=too much)

**Item 1** **2 $ Choose type of analysis (1=opt., 2=fixed, 3=sensit.) ITYPE**

5 $ How many design iterations in this run (3 to 25)?

n $ Take "shortcuts" for perturbed designs (Y or N)?

2 $ Choose 1 or 2 or 3 or 4 or 5 for IDESIGN

1 $ Choose 1 or 2 or 3 or 4 or 5 for move limits, IMOVE

y $ Do you want default (RATIO=10) for initial move limit jump?

y $ Do you want the default perturbation (dx/x = 0.05)?

n $ Do you want to have dx/x modified by GENOPT?

n $ Do you want to reset total iterations to zero (Type H)?

1 $ Choose IAUTOF= 1 or 2 or 3 or 4 or 5 or 6 to change X(i)

\*\*\*\*\*\*\*\*\*\*\*\* END OF THE try4.OPT FILE \*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\* AUGUST, 2010 VERSION OF GENOPT \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\* BEGINNING OF THE try4.OPM FILE \*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* MAIN PROCESSOR \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

The purpose of the mainprocessor, OPTIMIZE, is to perform,

in a batch mode, the work specified by MAINSETUP for the case

called try4. Results are stored in the file try4.OPM.

Please inspect try4.OPM before doing more design iterations.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**Item 2**: STRUCTURAL ANALYSIS FOR DESIGN ITERATION NO. 0:

STRUCTURAL ANALYSIS WITH UNPERTURBED DECISION VARIABLES

VAR. DEC. ESCAPE LINK. LINKED LINKING LOWER CURRENT UPPER DEFINITION

NO. VAR. VAR. VAR. TO CONSTANT BOUND VALUE BOUND

1 Y N N 0 0.00E+00 2.00E+01 **5.8750E+01** 1.20E+02 height from inner to outer membranes: HEIGHT

2 N N N 0 0.00E+00 0.00E+00 **8.0000E+00** 0.00E+00 radius of curvature of inner membrane: RINNER

3 N N N 0 0.00E+00 0.00E+00 **1.5000E+01** 0.00E+00 radius of curvature of outer membrane: ROUTER

4 Y N N 0 0.00E+00 3.00E-02 **4.8731E-02** 3.00E-01 thickness of the inner curved membrane: TINNER

5 Y N N 0 0.00E+00 3.00E-02 **8.0927E-02** 3.00E-01 thickness of the outer curved membrane: TOUTER

6 Y N N 0 0.00E+00 3.00E-02 **1.3853E-01** 3.00E-01 thickness of inner truss-core segment: TFINNR

7 Y Y N 0 0.00E+00 3.00E-02 **3.0000E-02** 3.00E-01 thickness of the outer truss segment: TFOUTR

8 Y Y N 0 0.00E+00 3.00E-02 **4.7662E-02** 3.00E-01 thickness of each truss-core web: TFWEBS

BIGBOSOR4 input file for: general buckling load

**Item 3: try4.BEHX1**

Changes in temperature required to create 2 total axial loads:

1. Change in temperature required to create the axial thermal

strain that generates the axial tension due to closing the

two ends of the pressurized volume (PMIDDL= 6.0000E+01)

between the inner and outer walls of the balloon in

**Item 4:** **Load Step No. 1:** **DELTAT= -1.1210E+02**

2. Change in temperature required to simulate the Poisson

axial expansion caused by the application of the outer

pressure, POUTER = 5.0000E+00 in **Load Step No. 2:** **DELT=0.00**

**Item 5:**

**GENERAL BUCKLING LOAD FACTORS AND MODES (BEHX1)**

**Item 5a: 2.9921E+00 (1 axial half-wave over LENGTH=6000 inches)**

Critical buckling load factor, GENBUK= 2.9921E+00

**Item 5b: Critical number of axial half-waves, NWVCRT = 1**

Differences in the resultants along the axis of the prismatic

balloon for each segment, J, of the first module:

**Item 6:**

**[N2VAR(J) for the total load] - [N2FIX(J) for the fixed load]=**

**N2DIFF(J),J=1,6)= -3.2748E+01 -3.2453E+01 -2.0757E+02 -4.3006E+00**

**-1.2398E+01 -1.2390E+01**

N2VAR(J) (total load) are the resultants from Load Step No. 2.

N2FIX(J) (fixed load) are the resultants from Load Step No. 1.

NOTE: The stresses used as behavioral constraints are

computed from N2VAR(J)/thickness(J). These stresses are

lower than those computed from N2FIX(J)/thickness(J).

**Item 7:** PREBUCKLING STRESS RESULTANTS IN THE FIRST MODULE

"fixed" from Load Step No. 1 total from Load Step No. 2

Seg.J Node I N1FIX(I,J) N2FIX(I,J) N1VAR(I,J) N2VAR(I,J)

1 1 4.0941E+02 2.6914E+02 3.0026E+02 2.3640E+02

2 1 9.4526E+02 6.7828E+02 8.3708E+02 6.4583E+02

**3 1 2.0636E+03 1.2948E+03 1.3718E+03 1.0872E+03**

4 1 4.9948E+02 3.8752E+02 4.8514E+02 3.8321E+02

5 1 5.1709E+02 3.8759E+02 4.7576E+02 3.7519E+02

6 1 5.1696E+02 3.8755E+02 4.7566E+02 3.7516E+02

**Item 8:**

**PREBUCKLING MEMBRANE STRESSES IN THE FIRST MODULE COMPUTED FROM**

**N1FIX/thickness, N2FIX/thickness, N1VAR/thickness, N2VAR/thickness:**

**"fixed" from Load Step No. 1 total from Load Step No. 2**

**Seg.J Node I STRS1F(I,J) STRS2F(I,J) STRS1V(I,J) STRS2V(I,J)**

**1 1 1.3647E+04 8.9714E+03 1.0009E+04 7.8798E+03**

**2 1 1.1680E+04 8.3814E+03 1.0344E+04 7.9804E+03**

**3 1 1.4897E+04 9.3462E+03 9.9020E+03 7.8479E+03**

**4 1 1.0250E+04 7.9522E+03 9.9556E+03 7.8640E+03**

**5 1 1.0849E+04 8.1320E+03 9.9820E+03 7.8719E+03**

**Item 9:**

**Newton iterations required to solve the nonlinear**

**axisymmetric pre-buckling equilibrium state for the**

**"fixed" loads (PINNER, PMIDDL, DELTAT): ITER= 7**

**Newton iterations required to solve the nonlinear**

**axisymmetric pre-buckling equilibrium state for the**

**total loads (PINNER, PMIDDL, DELTAT, POUTER): ITER= 2**

BEHAVIOR FOR LOAD SET NUMBER, ILOADX= 1

CONSTRAINT BEHAVIOR DEFINITION

NUMBER VALUE

**Item 10:**

**1 2.992076 general buckling load factor: GENBUK(1)**

BEHAVIOR OVER J = stress component number

2 10343.62 stress component in material 1: STRM1(1 ,1 )

3 0.1000000E-09 stress component in material 1: STRM1(1 ,2 )

4 7980.362 stress component in material 1: STRM1(1 ,3 )

5 0.1000000E-09 stress component in material 1: STRM1(1 ,4 )

6 0.1000000E-09 stress component in material 1: STRM1(1 ,5 )

BEHAVIOR OVER J = stress component number

7 10008.54 stress component in material 2: STRM2(1 ,1 )

8 0.1000000E-09 stress component in material 2: STRM2(1 ,2 )

9 7879.838 stress component in material 2: STRM2(1 ,3 )

10 0.1000000E-09 stress component in material 2: STRM2(1 ,4 )

11 0.1000000E-09 stress component in material 2: STRM2(1 ,5 )

BEHAVIOR OVER J = stress component number

12 9982.016 stress component in material 3: STRM3(1 ,1 )

13 0.1000000E-09 stress component in material 3: STRM3(1 ,2 )

14 7871.880 stress component in material 3: STRM3(1 ,3 )

15 0.1000000E-09 stress component in material 3: STRM3(1 ,4 )

16 0.1000000E-09 stress component in material 3: STRM3(1 ,5 )

\*\*\*\*\* RESULTS FOR LOAD SET NO. 1 \*\*\*\*\*\*

PARAMETERS WHICH DESCRIBE BEHAVIOR (e.g. stress, buckling load)

BEH. CURRENT

NO. VALUE DEFINITION

1 2.992E+00 general buckling load factor: GENBUK(1 )

2 1.034E+04 stress component in material 1: STRM1(1 ,1 )

3 1.000E-10 stress component in material 1: STRM1(1 ,2 )

4 7.980E+03 stress component in material 1: STRM1(1 ,3 )

5 1.000E-10 stress component in material 1: STRM1(1 ,4 )

6 1.000E-10 stress component in material 1: STRM1(1 ,5 )

7 1.001E+04 stress component in material 2: STRM2(1 ,1 )

8 1.000E-10 stress component in material 2: STRM2(1 ,2 )

9 7.880E+03 stress component in material 2: STRM2(1 ,3 )

10 1.000E-10 stress component in material 2: STRM2(1 ,4 )

11 1.000E-10 stress component in material 2: STRM2(1 ,5 )

12 9.982E+03 stress component in material 3: STRM3(1 ,1 )

13 1.000E-10 stress component in material 3: STRM3(1 ,2 )

14 7.872E+03 stress component in material 3: STRM3(1 ,3 )

15 1.000E-10 stress component in material 3: STRM3(1 ,4 )

16 1.000E-10 stress component in material 3: STRM3(1 ,5 )

\*\*\*\*\*\*\* NOTE \*\*\*\*\*\*\* NOTE \*\*\*\*\*\*\* NOTE \*\*\*\*\*\* NOTE \*\*\*\*\*\*

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

particular margin value is exactly zero.

\*\*\* END NOTE \*\*\* END NOTE \*\*\* END NOTE \*\*\* END NOTE \*\*\*\*\*

\*\*\*\*\* RESULTS FOR LOAD SET NO. 1 \*\*\*\*\*\*

MARGINS CORRESPONDING TO CURRENT DESIGN (F.S.= FACTOR OF SAFETY)

**Item 11:**

**MARGIN CURRENT**

**NO. VALUE DEFINITION**

**1 -2.641E-03 (GENBUK(1 )/GENBUKA(1 )) / GENBUKF(1 )-1; F.S.= 3.00**

**2 -3.322E-02 (STRM1A(1 ,1 )/STRM1(1 ,1 )) / STRM1F(1 ,1 )-1; F.S.= 1.00**

**3 2.531E-01 (STRM1A(1 ,3 )/STRM1(1 ,3 )) / STRM1F(1 ,3 )-1; F.S.= 1.00**

**4 -8.538E-04 (STRM2A(1 ,1 )/STRM2(1 ,1 )) / STRM2F(1 ,1 )-1; F.S.= 1.00**

**5 2.691E-01 (STRM2A(1 ,3 )/STRM2(1 ,3 )) / STRM2F(1 ,3 )-1; F.S.= 1.00**

**6 1.802E-03 (STRM3A(1 ,1 )/STRM3(1 ,1 )) / STRM3F(1 ,1 )-1; F.S.= 1.00**

**7 2.703E-01 (STRM3A(1 ,3 )/STRM3(1 ,3 )) / STRM3F(1 ,3 )-1; F.S.= 1.00**

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* DESIGN OBJECTIVE \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*

**Item 12: CURRENT VALUE OF THE OBJECTIVE FUNCTION:**

**VAR. CURRENT**

**NO. VALUE DEFINITION**

**1 6.173E+01 weight/length of the balloon: WEIGHT**

\*\*\*\*\*\*\*\*\*\*\*\*\* \*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* DESIGN OBJECTIVE \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\* ALL 1 LOAD CASES PROCESSED \*\*\*\*\*\*\*\*\*\*\*

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

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

VAR. CURRENT

NO. VALUE DEFINITION

**Item 13:**

**1 6.000E+03 length of the cylindrical shell: LENGTH**

2 1.200E+02 inner radius of the cylindrical balloon: RADIUS

3 4.351E+05 elastic modulus, meridional direction: EMOD1(1 )

4 4.351E+05 elastic modulus, meridional direction: EMOD1(2 )

5 4.351E+05 elastic modulus, meridional direction: EMOD1(3 )

6 4.351E+05 elastic modulus, circumferential direction: EMOD2(1 )

7 4.351E+05 elastic modulus, circumferential direction: EMOD2(2 )

8 4.351E+05 elastic modulus, circumferential direction: EMOD2(3 )

9 1.673E+05 in-plane shear modulus: G12(1 )

10 1.673E+05 in-plane shear modulus: G12(2 )

11 1.673E+05 in-plane shear modulus: G12(3 )

12 1.673E+05 out-of-plane (s,z) shear modulus: G13(1 )

13 1.673E+05 out-of-plane (s,z) shear modulus: G13(2 )

14 1.673E+05 out-of-plane (s,z) shear modulus: G13(3 )

15 1.673E+05 out-of-plane (y,z) shear modulus: G23(1 )

16 1.673E+05 out-of-plane (y,z) shear modulus: G23(2 )

17 1.673E+05 out-of-plane (y,z) shear modulus: G23(3 )

18 3.000E-01 Poisson ratio: NU(1 )

19 3.000E-01 Poisson ratio: NU(2 )

20 3.000E-01 Poisson ratio: NU(3 )

21 1.000E-10 meridional coef. thermal expansion: ALPHA1(1 )

22 1.000E-10 meridional coef. thermal expansion: ALPHA1(2 )

23 1.000E-10 meridional coef. thermal expansion: ALPHA1(3 )

24 1.000E-04 circumf.coef.thermal expansion: ALPHA2(1 )

25 1.000E-04 circumf.coef.thermal expansion: ALPHA2(2 )

26 1.000E-04 circumf.coef.thermal expansion: ALPHA2(3 )

27 0.000E+00 delta-T from fabrication temperature: TEMPER(1 )

28 0.000E+00 delta-T from fabrication temperature: TEMPER(2 )

29 0.000E+00 delta-T from fabrication temperature: TEMPER(3 )

30 1.000E-01 weight density of material: DENSTY(1 )

31 1.000E-01 weight density of material: DENSTY(2 )

32 1.000E-01 weight density of material: DENSTY(3 )

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

VAR. CURRENT

NO. VALUE DEFINITION

1 0.000E+00 pressure inside the inner membrane: PINNER(1 )

2 6.000E+01 pressure between inner and outer membranes: PMIDDL(1 )

3 5.000E+00 pressure outside the outer membrane: POUTER(1 )

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

VAR. CURRENT

NO. VALUE DEFINITION

1 1.000E+00 allowable for general buckling load factor: GENBUKA(1 )

2 1.000E+04 allowable stress in material 1: STRM1A(1 ,1 )

3 1.000E+04 allowable stress in material 1: STRM1A(1 ,2 )

4 1.000E+04 allowable stress in material 1: STRM1A(1 ,3 )

5 1.000E+04 allowable stress in material 1: STRM1A(1 ,4 )

6 1.000E+04 allowable stress in material 1: STRM1A(1 ,5 )

7 1.000E+04 allowable for stress in material 2: STRM2A(1 ,1 )

8 1.000E+04 allowable for stress in material 2: STRM2A(1 ,2 )

9 1.000E+04 allowable for stress in material 2: STRM2A(1 ,3 )

10 1.000E+04 allowable for stress in material 2: STRM2A(1 ,4 )

11 1.000E+04 allowable for stress in material 2: STRM2A(1 ,5 )

12 1.000E+04 allowable for stress in material 3: STRM3A(1 ,1 )

13 1.000E+04 allowable for stress in material 3: STRM3A(1 ,2 )

14 1.000E+04 allowable for stress in material 3: STRM3A(1 ,3 )

15 1.000E+04 allowable for stress in material 3: STRM3A(1 ,4 )

16 1.000E+04 allowable for stress in material 3: STRM3A(1 ,5 )

PARAMETERS WHICH ARE FACTORS OF SAFETY

VAR. CURRENT

NO. VALUE DEFINITION

**Item 14:**

**1 3.000E+00 general buckling factor of safety: GENBUKF(1 )**

2 1.000E+00 factor of safety for stress in material 1: STRM1F(1 ,1 )

3 1.000E+00 factor of safety for stress in material 1: STRM1F(1 ,2 )

4 1.000E+00 factor of safety for stress in material 1: STRM1F(1 ,3 )

5 1.000E+00 factor of safety for stress in material 1: STRM1F(1 ,4 )

6 1.000E+00 factor of safety for stress in material 1: STRM1F(1 ,5 )

7 1.000E+00 factor of safety for stress in material 2: STRM2F(1 ,1 )

8 1.000E+00 factor of safety for stress in material 2: STRM2F(1 ,2 )

9 1.000E+00 factor of safety for stress in material 2: STRM2F(1 ,3 )

10 1.000E+00 factor of safety for stress in material 2: STRM2F(1 ,4 )

11 1.000E+00 factor of safety for stress in material 2: STRM2F(1 ,5 )

12 1.000E+00 factor of safety for stress in material 3: STRM3F(1 ,1 )

13 1.000E+00 factor of safety for stress in material 3: STRM3F(1 ,2 )

14 1.000E+00 factor of safety for stress in material 3: STRM3F(1 ,3 )

15 1.000E+00 factor of safety for stress in material 3: STRM3F(1 ,4 )

16 1.000E+00 factor of safety for stress in material 3: STRM3F(1 ,5 )

0 INEQUALITY CONSTRAINTS WHICH MUST BE SATISFIED

DESCRIPTION OF FILES USED AND GENERATED IN THIS RUN:

try4.NAM = This file contains only the name of the case.

try4.OPM = Output data. Please list this file and inspect

carefully before proceeding.

try4.OPP = Output file containing evolution of design and

margins since the beginning of optimization cycles.

try4.CBL = Labelled common blocks for analysis.

(This is an unformatted sequential file.)

try4.OPT = This file contains the input data for MAINSETUP

as well as OPTIMIZE. The batch command OPTIMIZE

can be given over and over again without having

to return to MAINSETUP because try4.OPT exists.

URPROMPT.DAT= Prompt file for interactive input.

For further information about files used and generated

during operation of GENOPT, give the command HELPG FILES.

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

DECIDE, SUPEROPT

IN ORDER TO AVOID FALSE CONVERGENCE OF THE DESIGN, BE SURE TO

RUN "OPTIMIZE" MANY TIMES DURING AN OPTIMIZATION AND/OR USE

THE "GLOBAL" OPTIMIZING SCRIPT, "SUPEROPT".

\*\*\*\* NOTE: It is almost always best to set the number of \*\*\*\*

\*\*\*\* iterations per execution of "OPTIMIZE" equal to 5 \*\*\*\*

\*\*\*\* in response to the following prompt in "MAINSETUP": \*\*\*\*

\*\*\*\* "How many design iterations in this run (3 to 25)?" \*\*\*\*

\*\*\*\* Hence, the \*.OPT file should almost always have the \*\*\*\*

\*\*\*\* following line in it: \*\*\*\*

\*\*\*\* "5 $ How many design iterations in this run (3 to 25)?"

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* END OF try4.OPM FILE \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

================================================================