1.0 OBJECTIVE

Perform the thermal analyses of the Energy Solutions 8-120B Cask under normal loading conditions, using finite element models.

2.0 REFERENCES

1. Energy*Solutions* Drawing No. C-110-E-0007, Rev. 14, 8-120B Shipping Cask.
2. Code of Federal Regulations, Title 10, Part 71, Packaging and Transportation of Radioactive Material, January 2003.
3. U.S. NRC Regulatory Guide 7.8, Revision 1, March 1989, Load Combinations for the Structural Analysis of Shipping Casks for Radioactive Material.
4. Heat Transfer, J.P. Holman, McGraw Hill Book Company, New York, Fifth Edition, 1981.
5. Cask Designers Guide, L.B. Shappert, et. al, Oak Ridge National Laboratory, February 1970, ORNL-NSIC-68.
6. CRC Handbook of Chemistry and Physics, Robert C. Weast and Melvin J. Astel, eds., CRC Press, Inc., Boca Raton, Florida, 62nd ed., 1981.
7. ASME Boiler & Pressure Vessel Code, 2001, Section II, Part D, Materials, American Society of Mechanical Engineers, New York, NY, 2001.
8. Rohsenow and Hartnett, Handbook of Heat Transfer, McGraw Hill Publication, 1973.
9. ANSYS, Release 13.0, ANSYS Inc., Canonsburg, PA, 2010.

3.0 INTRODUCTION

Energy*Solutions* 8-120B Cask (Reference 1) is designed as a Type B radioactive material shipping package. To be certified by the U.S.N.R.C., the cask needs to meet the requirements of 10 CFR 71 (Reference 2) and follow the guidelines of U.S.N.R.C. Regulatory Guide 7.8 (Ref. 3).

This document presents the thermal load analysis of the 8-120B Cask for the normal conditions of transportation (NCT). These conditions include the hot and cold environments - the initial loading for the free and hypothetical drop conditions. The hypothetical fire accident test condition analysis has been performed in a separate document. The analyses in this document are performed using the finite element modeling techniques. Models of the cask that includes all its major components have been employed in the analyses. Temperature dependent material properties of the major components of the cask are used in the analyses.

The results of the analyses for various load cases are presented pictorially in temperature contour plots as well as digital data format, suitable for use with a structural finite element models for obtaining the thermal stresses.

4.0 MATERIAL PROPERTIES

Temperature-Independent Metal Thermal Properties

Material	Property	Reference: Page	Value
Steel	Density	4: 536	0.2824 lb/in^3
	ε (Outside)	2: 648	0.8
	ε (Inside)	5:133	0.15
Lead	Density	4: 535	0.4109 lb/in^3
	Spec. Heat	4: 535	0.0311 Btu/lb-°F
	Melting Point	6: B-29	621.5 °F

Temperature-Dependent Metal Thermal Properties

Temp. (°F)	**Stainless Steel** (Ref. 7)		**Carbon Steel** (Ref.7)		**Lead** (Ref.8)
	Sp. Heat Btu/lb-°F	**Conductivity** $\times 10^{-3}$ Btu/sec-in-°F	**Sp. Heat** Btu/lb-°F	**Conductivity** $\times 10^{-3}$ Btu/sec-in-°F	**Conductivity** $\times 10^{-3}$ Btu/sec-in-°F
70	0.117	0.199	0.104	0.813	0.465
100	0.117	0.201	0.106	0.803	0.461
150	0.120	0.208	0.109	0.789	0.455
200	0.122	0.215	0.113	0.778	0.448
250	0.125	0.222	0.115	0.762	0.441
300	0.126	0.227	0.118	0.748	0.435
350	0.128	0.234	0.122	0.731	0.428
400	0.129	0.241	0.124	0.715	0.422
450	0.130	0.245	0.126	0.701	0.415
500	0.131	0.252	0.128	0.677	0.409
550	0.132	0.257	0.131	0.667	0.402
600	0.133	0.262	0.133	0.648	0.395
650	0.134	0.269	0.135	0.632	0.389
700	0.135	0.273	0.139	0.616	0.389
750	0.136	0.278	0.142	0.600	0.389
800	0.136	0.282	0.146	0.583	0.389
900	0.138	0.294	0.154	0.551	0.389
1,000	0.139	0.306	0.163	0.519	0.389
1,100	0.141	0.315	0.172	0.484	0.389
1,200	0.141	0.324	0.184	0.451	0.389
1,300	0.143	0.336	0.205	0.417	0.389
1,400	0.144	0.345	0.411	0.380	0.389
1,500	0.145	0.354	0.199	0.363	0.389

Temperature-Dependent Air Thermal Properties

Temp. (°F)	**Air** (Ref.4)		
	Density $\times 10^{-5}$ lb/in^3	**Sp. Heat** Btu/lb-°F	**Conductivity** $\times 10^{-7}$ Btu/sec-in-°F
70	4.3507	0.2402	3.4491
100	4.1117	0.2404	3.5787
150	3.7517	0.2408	3.9028
200	3.4676	0.2414	4.1759
250	3.2361	0.2421	4.4468
300	3.0307	0.2429	4.7037
350	2.8310	0.2438	4.9560
400	2.6730	0.2450	5.2037
450	2.5220	0.2461	5.4491
500	2.3964	0.2474	5.6875
550	2.2778	0.2490	5.9213
600	2.1684	0.2511	6.1435
650	2.0706	0.2527	6.3634
700	1.9803	0.2538	6.5810
750	1.8981	0.2552	6.7894
800	1.8177	0.2568	6.9954
900	1.6898	0.2596	7.4097
1,000	1.5712	0.2628	7.8032
1,100	1.4722	0.2659	8.1759
1,200	1.3848	0.2689	8.5440
1,300	1.3044	0.2717	8.8981
1,400	1.2350	0.2742	9.2847
1,500	1.1707	0.2766	9.7060

5.0 MODEL DESCRIPTION

The thermal analyses of the 8-120B Cask under various loading conditions have been performed using finite element modeling techniques. ANSYS finite element analysis code (Ref. 9) has been employed in performing the thermal analyses.

Two finite element models have been employed in performing the NCT thermal analyses. A three-dimensional and a 2-d axisymmetric model were used in the analyses. For the structural analyses of the loading conditions where the bolt loadings are non-uniform a three dimensional finite element model, in which the primary and secondary lid bolts can be appropriately modeled, is needed. To obtain the temperature distribution for these loading conditions a three-dimensional thermal model is used. To obtain the temperature distribution in the cask where the bolt loadings have no effect on the results, a two-dimensional axisymmetric finite element model has been used.

3-Dimensional Finite Element Model

The cask is symmetrical about a vertical plane. Therefore, a one-half model of the cask is employed in the three-dimensional model. Figure 1 shows the finite element model used in various thermal load analyses. Figures 2 and 3 are detailed views of various regions of the finite element model. Figure 4 shows the material property model numbers of various components of the cask.

The finite element model is made of 3-dimensional thermal solid elements (ANSYS SOLID70) that represent the major components of the cask, the cask body, the lid, the bolts, and the fire shield. The interstitial air gaps between the fire-shield and the cask body are modeled by 3-dimensional thermal solid elements.

The poured lead in the body is not bonded to the steel. It is free to slide over the steel surface. Therefore, the interface between the lead and the steel is modeled by pairs of 3-d 8 node thermal contact element (CONTA174) and 3-d target segment (TARGE170) elements. These elements allow the lead to slide over the steel and at the same time prevent it from penetrating the steel surface. The interface between the two plates of the lid at the weld location is also modeled by the contact-target pairs. Figure 5 shows target surfaces of various contact-target pairs.

The heat transfer by radiation between the fire-shield and the ambient air is modeled by 3-d thermal surface (ANSYS SURF152). The radiation between the outer shell and the fire-shield is modeled by superelements (ANSYS MATRIX50). These elements are formed by modeling the radiating surfaces with thermal shells (ANSYS SHELL57) and specifying the appropriate emissivity of the surfaces and the Stefan-Boltzmann constant. The heat transfer by natural convection between the fire-shield and the ambient air is simulated by 3-d thermal surface (ANSYS SURF152). The outer surfaces of the impact limiter plates, which are covered by foam, are considered to be totally insulated. The real constants used in the ANSYS finite element model, to define the characteristic of various finite elements to simulate the heat transfer by convection and radiation, are based on the derivation in the following section. The heat flux representing the internal heat load and the solar insolation is also presented in the following section.

2-Dimensional Axisymmetric Finite Element Model

The 2-d axisymmetric FEM uses the same modeling techniques as described under the 3-dimensional model, except that it uses the corresponding 2-dimensional elements. Figure 6 shows the 2-dimensional axisymmetric model.

A print-out of the model data is included in Appendix 1.

5.1 Convection Modeling

The convective heat transfer per unit area between the cask and the atmosphere, q, is governed by the equation:

$$q = hA\left(T_s - T_a\right)$$

where:

h = Heat transfer coefficient (Btu/hr-ft^2-°F)

A = Area (sq ft)

T_s = cask surface temperature (°F)

T_a = ambient temperature (°F)

The heat transfer coefficient for the natural convection is given by the following relationship (see for example Ref. 5, page 135).

$$h = C\left(T_s - T_a\right)^{1/3}$$

where, for Vertical casks,

C = 0.18 (Btu/hr-ft^2-°F$^{4/3}$)

= 3.4722×10^{-7} (Btu/sec-in^2-° F$^{4/3}$)

5.2 Radiation Modeling

The heat transfer by radiation between two nodes of a finite element model is governed by the following equation (see for example Ref. 4).

$$q = \sigma\ \varepsilon\ F\ A\left(T_I^4 - T_J^4\right)$$

where:

q = heat flow rate (Btu/hr)

σ = Stefan-Boltzmann Constant

= 1.7136×10^{-9} (Btu/hr-ft^2-R^4)

= 3.3056×10^{-15} (Btu/sec-in^2-R^4)

ε = emissivity

F = geometric form factor

A = area (sq ft)

T = temperature (°R)

I = first node number

J = second node number

Two radiation heat transfer systems are modeled: (1) radiation heat transfer between the fire shield outside surface and the environment, and (2) radiation between the fire shield inside surface and the cask shell outside surface and radiation between the cask ends and the impact limiter plates. Emissivity, area, and geometric form factors are defined in both systems.

The overall emissivity for radiation heat transfer between the fire shield and the environment is set equal to the overall emissivity, ε, for heat transfer between two infinite parallel planes as given by the following equation (Ref. 4, page 336).

$$\varepsilon = \frac{\varepsilon_1 \varepsilon_2}{\varepsilon_2 + \varepsilon_1 - \varepsilon_1 \varepsilon_2}$$

where: ε = overall emissivity

ε_1 = surface 1 emissivity

ε_2 = surface 2 emissivity

An environment emissivity coefficient of 0.9 was assumed for the normal conditions of transport. The emissivity of the outside of the fire-shield and the environment are 0.8 and 0.9, respectively. Thus, the overall emissivity is calculated by the above equation to be 0.7347. Form factor value of 1.0 is used and the area of the surface is automatically calculated by the computer program.

It should be noted that the use of 0.7347 for emissivity instead of the code specified value of 0.9 is conservative for the NCT environment as a lesser amount of heat is rejected from the cask, which results in higher cask temperatures.

The radiation between the outer shell and the fire-shield is modeled by superelements (ANSYS MATRIX50). These elements are formed by modeling the radiating surfaces with thermal shells (ANSYS SHELL57). The emissivity value is set equal to minimum emissivity of carbon steel, i.e. 0.15. Stefan-Boltzmann constant as defined above is used. The form-factor of unity is used and the appropriate radiating surface area is automatically calculated by the computer program.

5.3 Solar Insolation Modeling

The total insolation is required to be 400 gcal/cm^2 for a 12-hour period for curved surfaces according to the Code of Federal Regulations 10CFR71.71 (Ref 2). The total insolation of 400 gcal/cm^2 is divided by 12 hours of assumed sunlight to yield an average insolation rate. The average insolation rate is then multiplied by the surface emissivity specified earlier in this document (0.7347) yielding an insolation rate of 1.742×10^{-4} Btu/sec-in^2. This insolation heat load is applied to the outside surface of the fire shield.

5.4 Internal Heat Load Modeling

The internal heat load content of the 8-120B Cask has been represented in the finite element models by two different ways. In the first, the heat load is implicitly represented by a uniform heat flux over the cask cavity. In the second, it is explicitly represented by the finite element model of the waste container and the cavity air. The heat load in this case is applied as a constant heat flux over the waste container wall.

5.5.1 Implicit Internal Heat Load Modeling

The 200-Watt decay heat load is modeled as a constant heat flux over the exposed sidewall inner surface of the cask.

$$\text{Internal heat load, } q = 200\text{ W} = 200\times9.4804\times10^{-4} = 0.1896\text{ Btu/sec}$$

The cask inside diameter is 61.8" and the cavity height is 75". Thus, the heat flux on the inside surface of the cask is:

$$q_s = 0.1896/\ (\pi \times 61.8 \times 75 + 2 \times \pi/4 \times 61.8^2)$$
$$= 9.2216 \times 10^{-6}\ \text{Btu/(sec-in}^2)$$

5.5.2 Explicit Internal Heat Load Modeling

In order to obtain the temperature of the waste container and the cavity air during the NCT, they are explicitly represented in the 2-d axisymmetric finite element model with appropriate material properties. The waste container is conservatively assumed to be a cylindrical shell having the diameter and length to be approximately ½ of the corresponding cavity dimensions.

Waste Container Outside Diameter = 31", Length = 37.5", Wall Thickness = 1.0"

Container Inside Surface Area = $\pi \times (31\text{-}2) \times (37.5\text{-}2) + 2 \times [\pi \times (31\text{-}2)^2/4] = 4{,}555\ \text{in}^2$

The heat flux is applied on the inside surface of the waste container. Its magnitude is:

$$q_w = 0.1896/4{,}555 = 4.163 \times 10^{-5}\ \text{Btu/sec-in}^2$$

The cavity air is conservatively assumed to be stagnant - no convective heat transfer is assumed to take place between the waste container and the cask cavity. Thus, the heat transfer between these components takes place by means of conduction through the air and radiation between the two bodies. The air conduction is accounted for by the appropriate material properties of the finite elements representing it. The heat transfer by radiation is achieved by the ANSYS radiation sub-matrix method. Since the objective of this analysis is to obtain the waste temperature conservatively, the coefficients of emissivity for both the surfaces are assigned lower than actual values. The inside surface of the cask is either carbon steel (emissivity 0.6 to 0.7) or, if it has a liner, stainless steel (emissivity 0.54 to 0.63). For both kinds of surfaces the emissivity is assumed to be 0.2. The waste containers are made of painted carbon steel (emissivity 0.8 to 0.9), stainless steel (emissivity 0.54 to 0.63), or plastic (emissivity 0.8 to 0.9). The assumed value of the emissivity of the waste container surface is 0.4. Please note that the emissivity values quoted here have been obtained from Reference 4. The form-factor is automatically calculated by the computer program from the geometry of the two bodies. The finite element model of the cask with explicit internal heat load modeling is shown in Figure 6.

6.0 ANALYSES

The finite element model, with the implicit internal heat load modeling described in Section 5.0 is analyzed for the following loading conditions:

1. Hot Environment – This load case is based on the requirements of 10 CFR 71.71 (c) (1). The loading includes a 100° F ambient temperature, solar insolation, and maximum internal heat load. This loading is used as one of the extreme initial conditions for the normal conditions of transport (NCT) and hypothetical accident condition (HAC) test evaluation.
2. Cold Environment – This load case is based on the requirements of 10 CFR 71.71 (c) (2). The loading includes a -40° F ambient temperature, no solar insolation, and maximum internal heat load. This loading is used as one of the extreme initial conditions for the normal conditions of transport (NCT) and hypothetical accident condition (HAC) test evaluation.

3. Normal Hot - This load case is based on the requirements of 10 CFR 71.71 (b). The loading includes a 100° F ambient temperature, no solar insolation, and maximum internal heat load.
4. Normal Cold - This load case is based on the requirements of 10 CFR 71.71 (b). The loading includes a -20° F ambient temperature, no solar insolation, and maximum internal heat load.

The 2-d axisymmetric model, with the explicit heat loading, has been analyzed for the hot environment conditions. The temperatures results from this model have been used to report the waste and cavity temperatures.

7.0 RESULTS

The results of the analyses of the finite element model, with the implicit heat load modeling, are presented in Figures 7 through 10 in the form of temperature contour plots and that for the explicit heat model is presented in Figure 11. Figure 11 shows the temperature profile in the cask cavity. Figure 12 shows the temperature profile in the waste container.

Table 1 summarizes the maximum calculated temperature of various components of the cask.

Table 1
Summary of Maximum NCT Temperatures

Component	Maximum Calculated Temp.		Maximum Allowable Temperature (°F)
	Location (Node Nos.)	Value (°F)	
Fire Shield	40,028	160.6	185[(1)]
Outer Shell	1,376	161.3	[(2)]
Inner Shell	10,521	161.5	[(2)]
Lead	14,411	161.4	622[(3)]
Baseplate	2,430	162.3	[(2)]
Primary Lid	37,675	162.2	[(2)]
Secondary Lid	27,023	162.6	[(2)]
Primary Seal	25,430	161.6	180[(5)]
Secondary Seal	37,678	162.2	180[(5)]
Vent Seal	34,802	161.8	180[(5)]
Impact Limiter	27,594	161.9	[(2)]
Cask Cavity	2,029	197.87	[(4)]
Waste Container	2,041	197.92	[(2)]

NOTES:

(1) Based on the requirements of 10CFR71.43(g)
(2) Set by stress conditions.
(3) Melting point of lead.
(4) Used for establishing the cask maximum normal operating pressure (MNOP).
(5) Established based on 110% of the maximum seal temperatures.

8.0 ANSYS PRINTOUT AND DATA FILES

The printout of the important data from the program is included with this document in electronic form as Appendix 2. The complete electronic data of the input and output of the analyses are included on a CDROM in Appendix 3.

9.0 APPENDICES

Appendix 1 Print-out of the ANSYS model data

Appendix 2 Print-out of the results

Appendix 3 Electronic data on CDROM

Figures

(12 Pages)

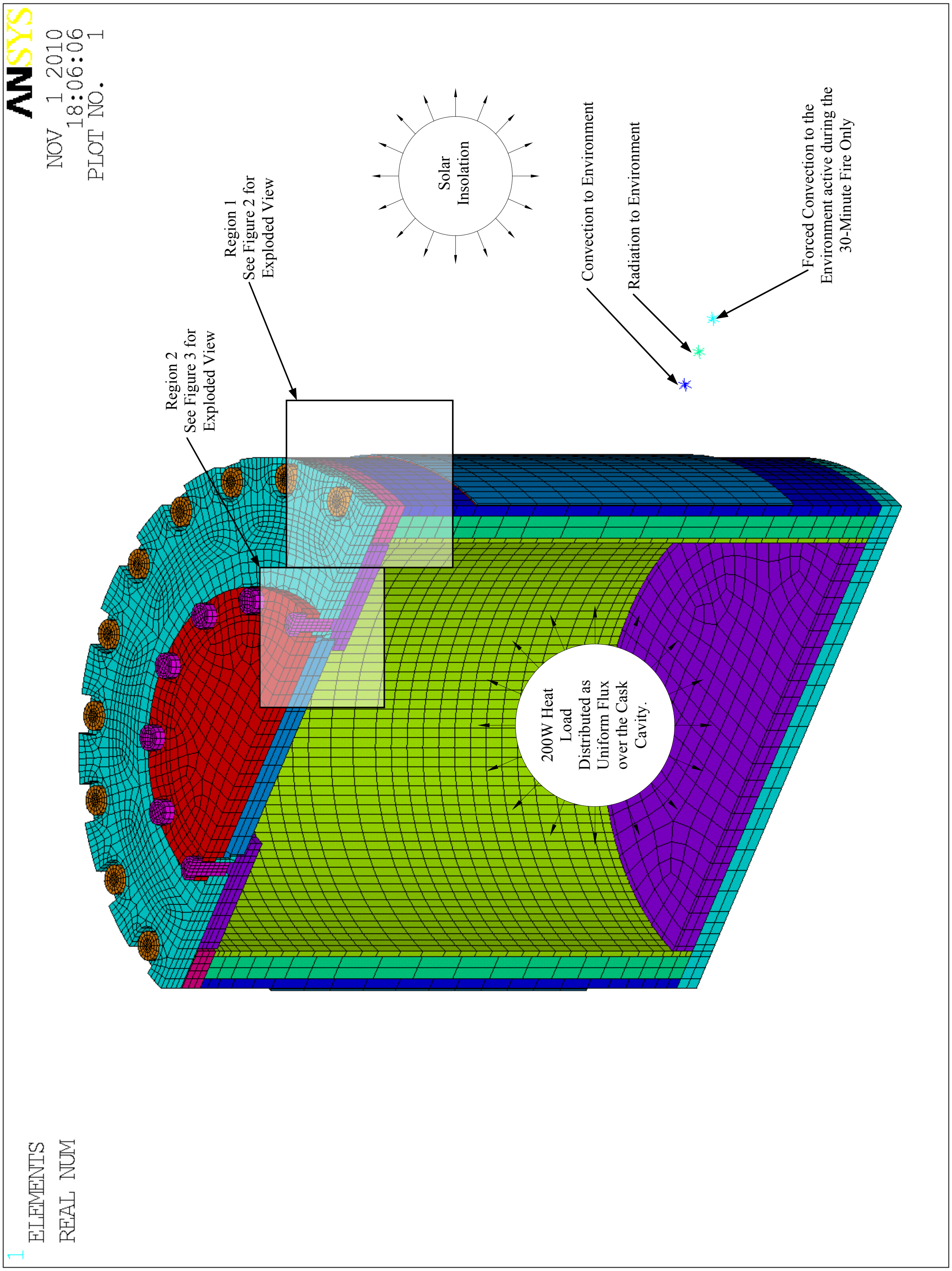

Figure 1 – 3-d Finite Element Model of the 8-120B Cask Used for the Thermal Analyses

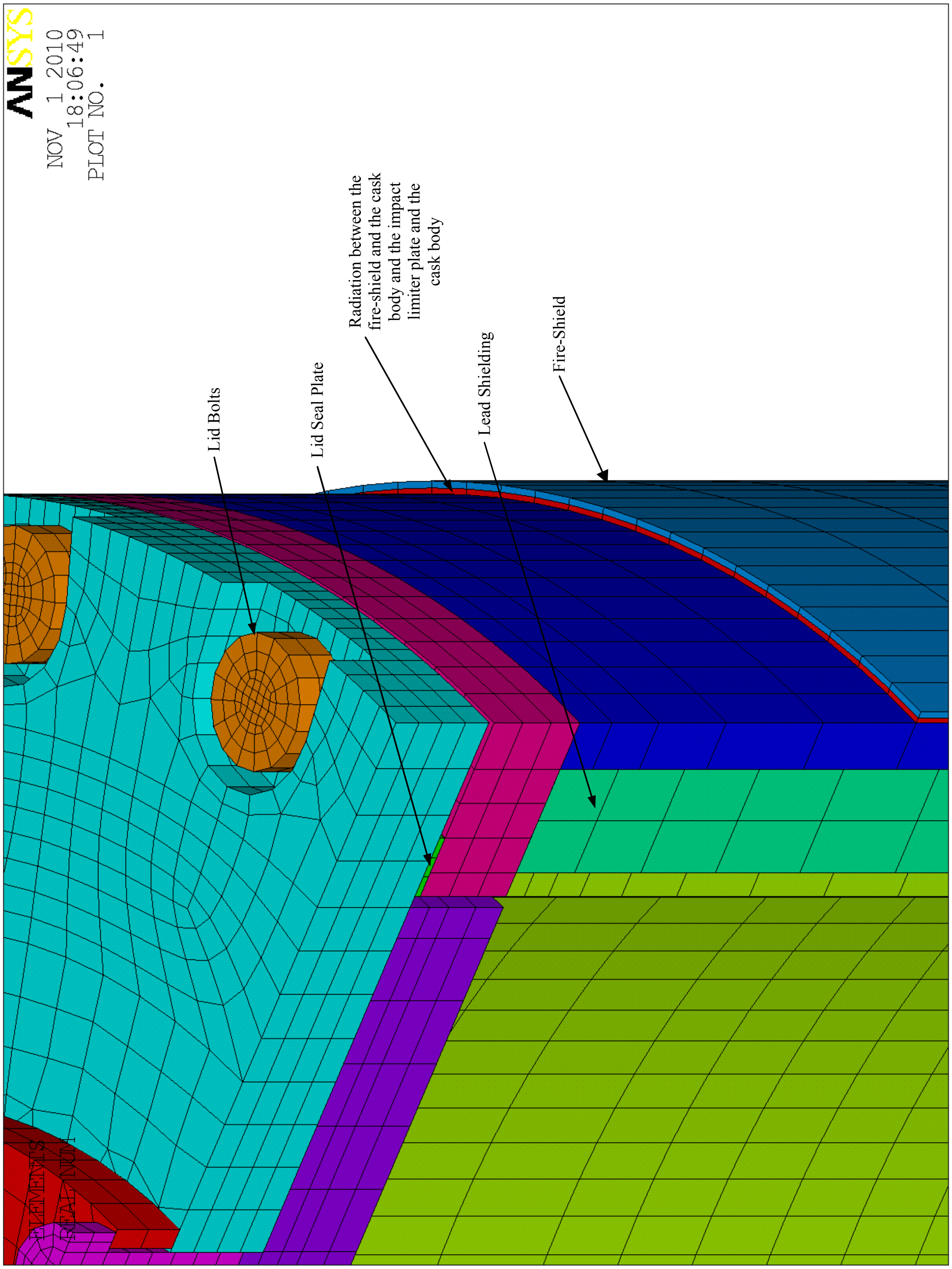

Figure 2 – Exploded View of Region 1 of Figure 1

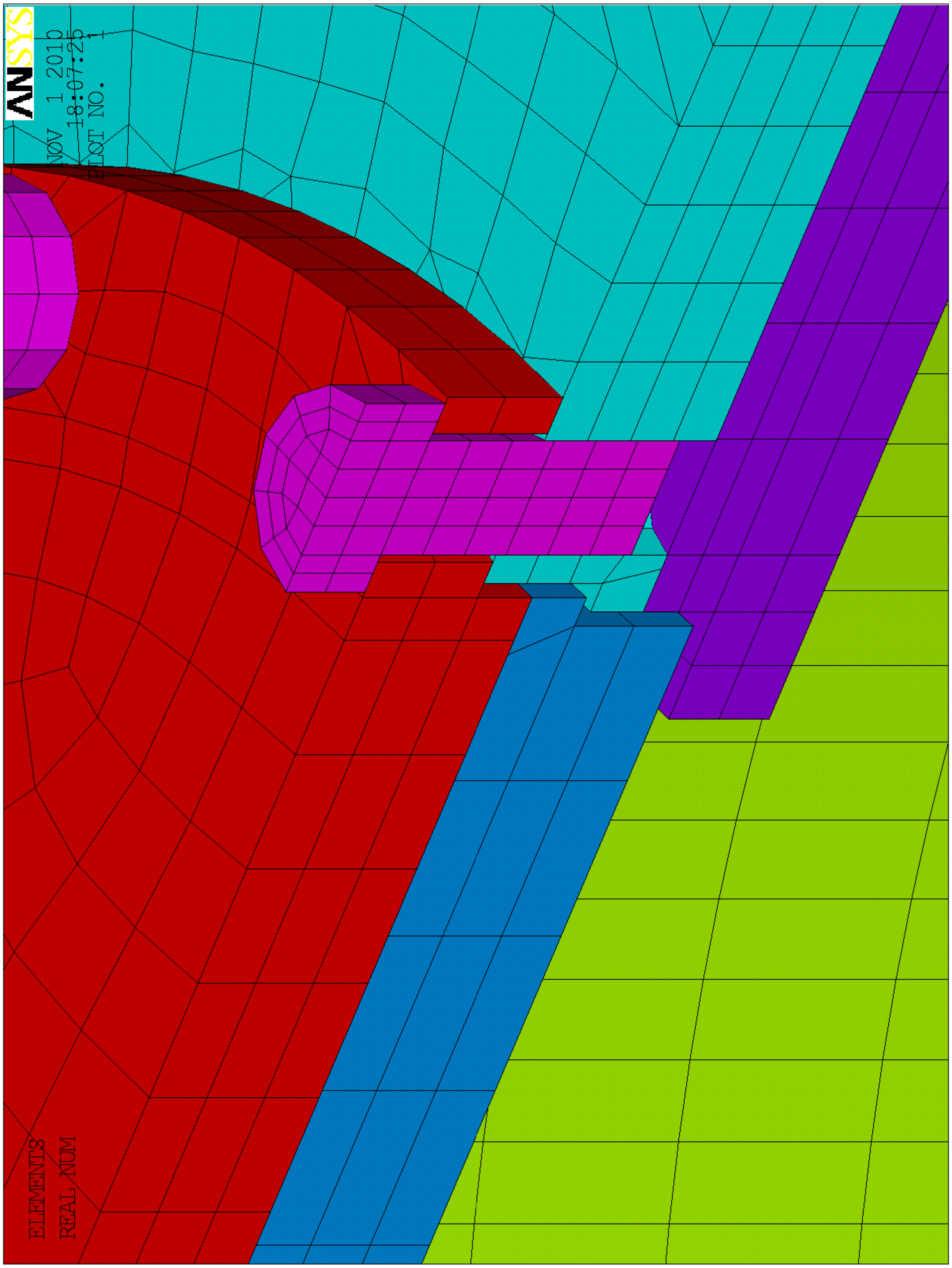

Figure 3 – Exploded View of Region 2 of Figure 1

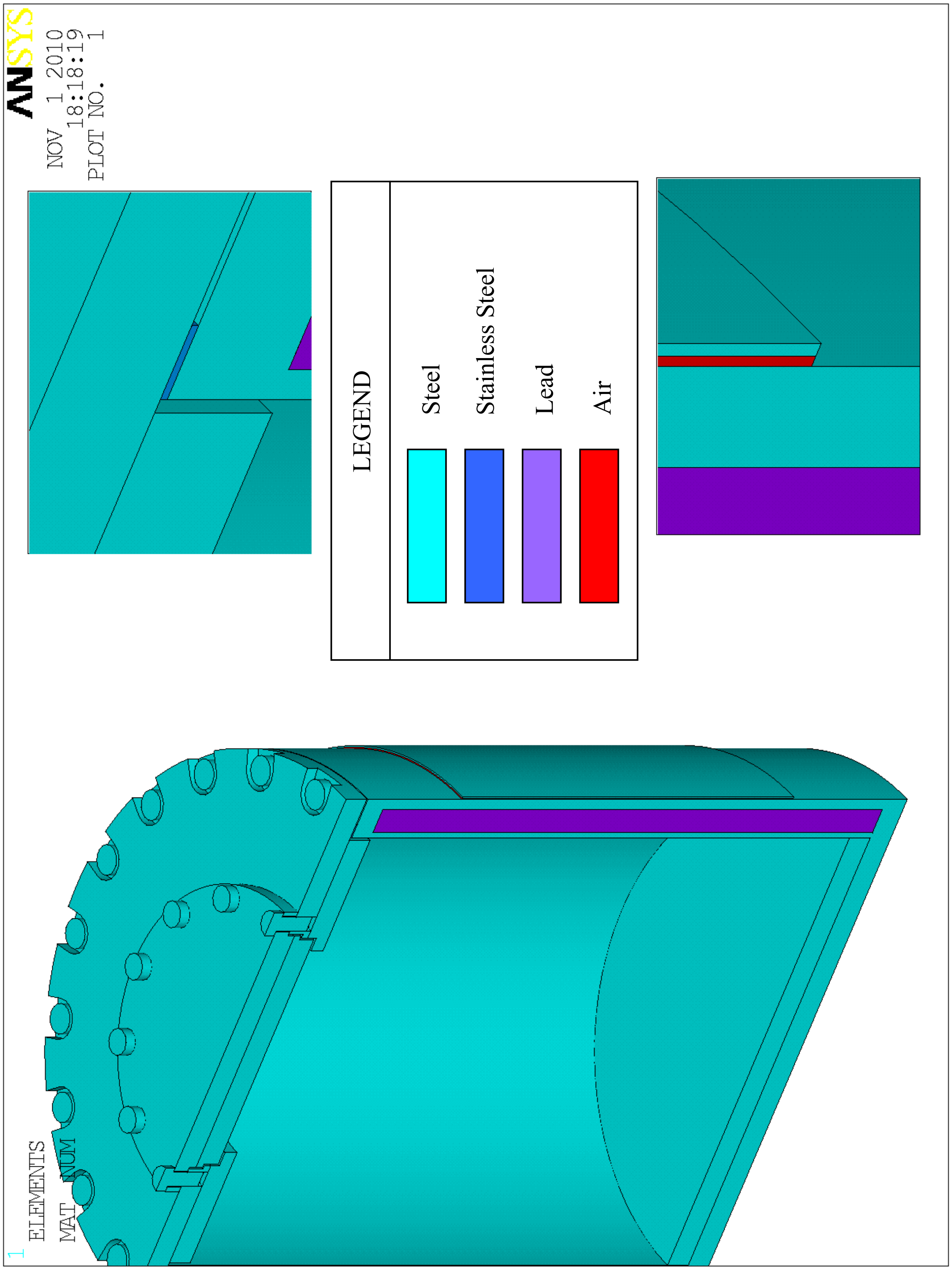

Figure 4 – Materials Used in the Finite Element Model

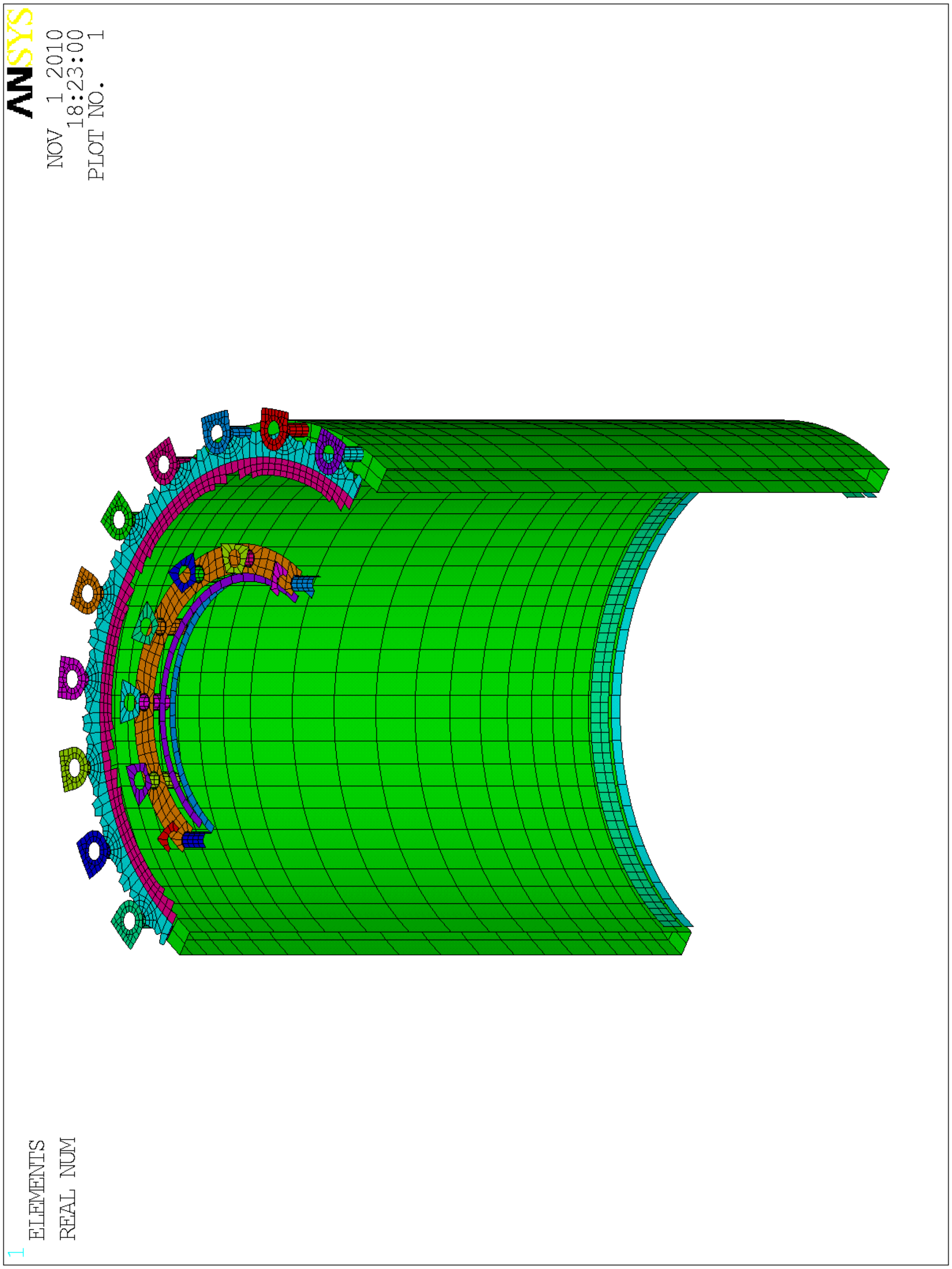

Figure 5 – Contact-Target Pair Elements (Only Target Elements Shown for Clarity)

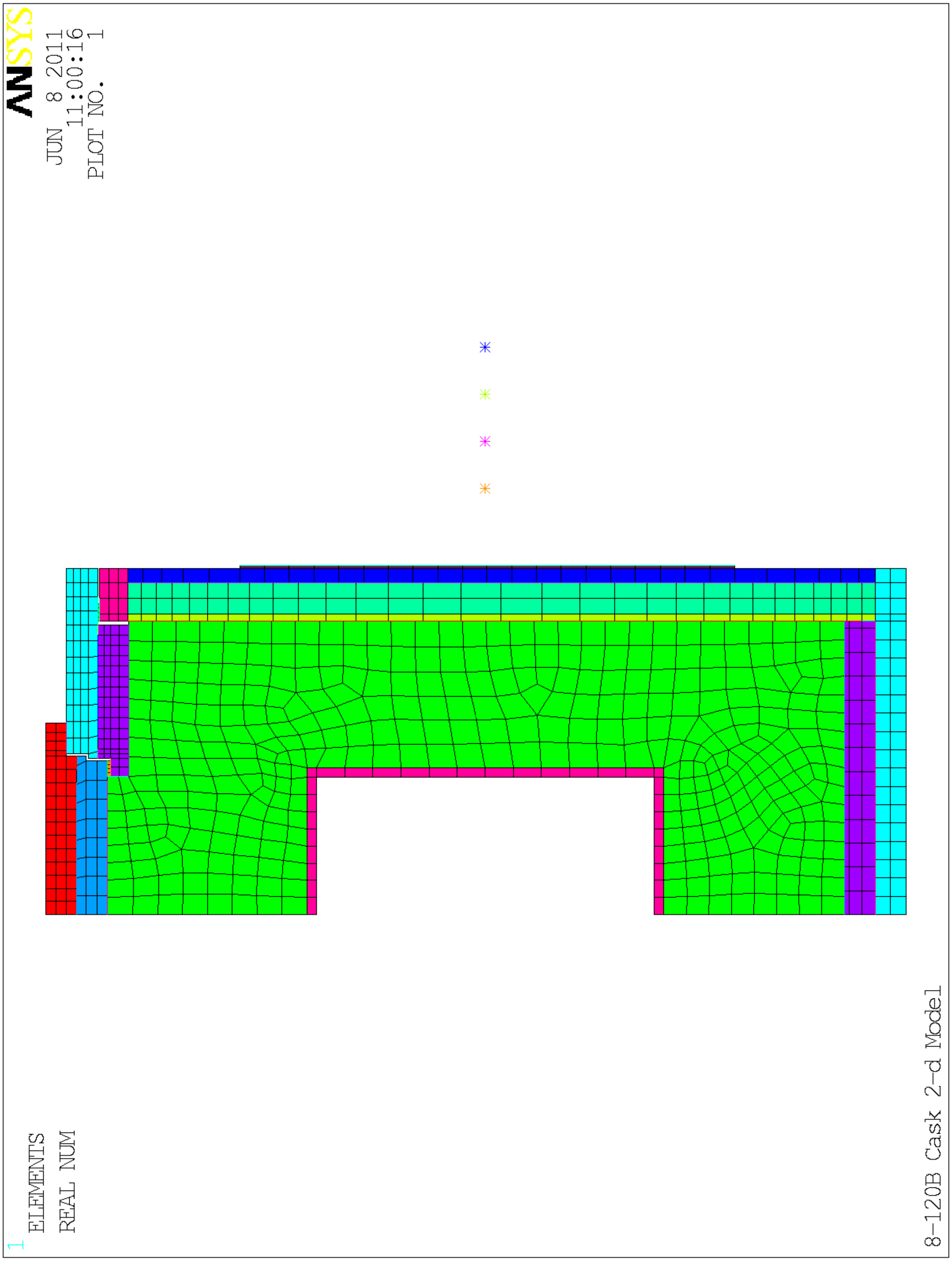

Figure 6 – 2-d Finite Element Model of the 8-120B Cask Used for the Thermal Analyses

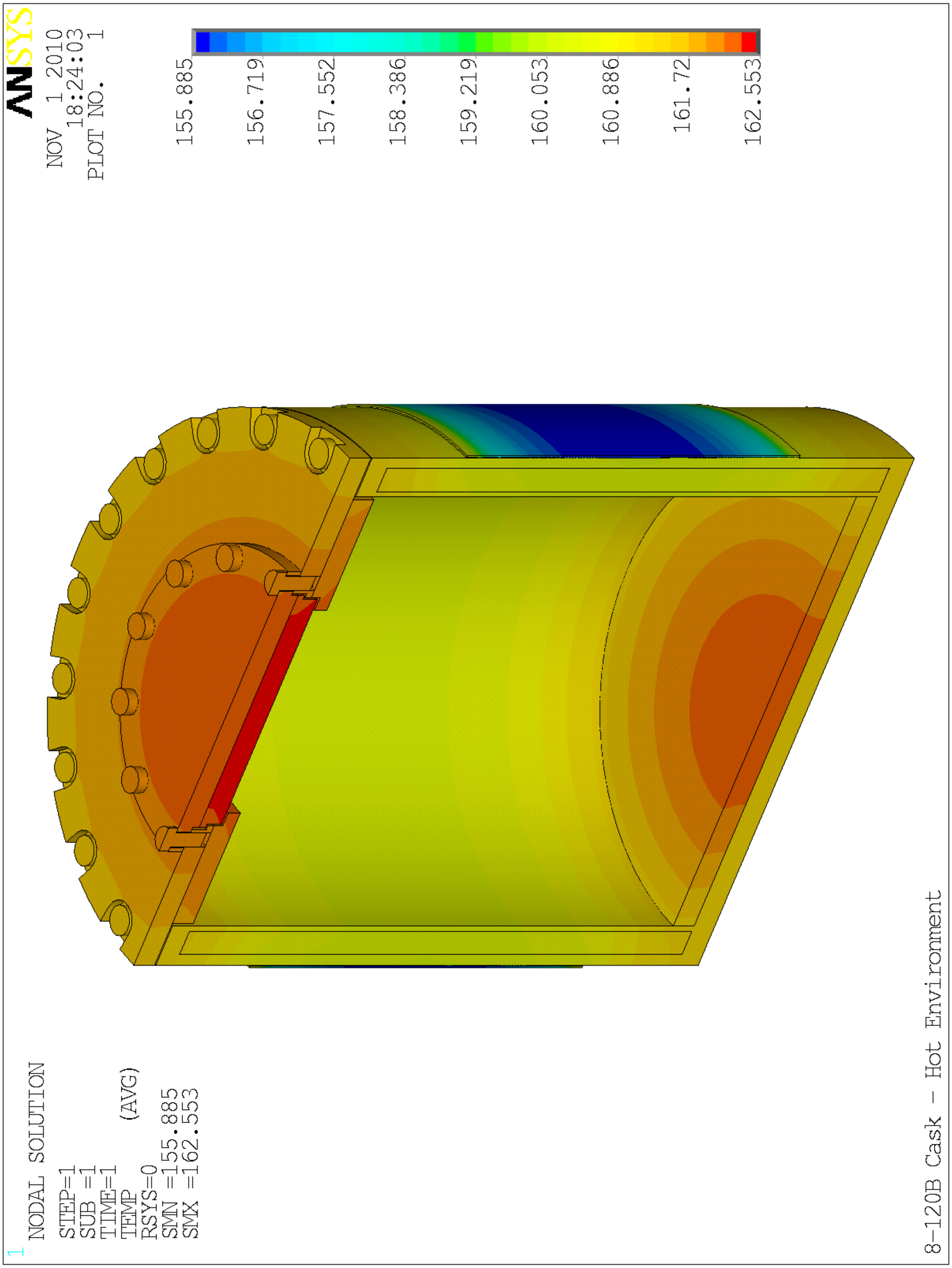

Figure 7 – Temperature Distribution – Hot Environment

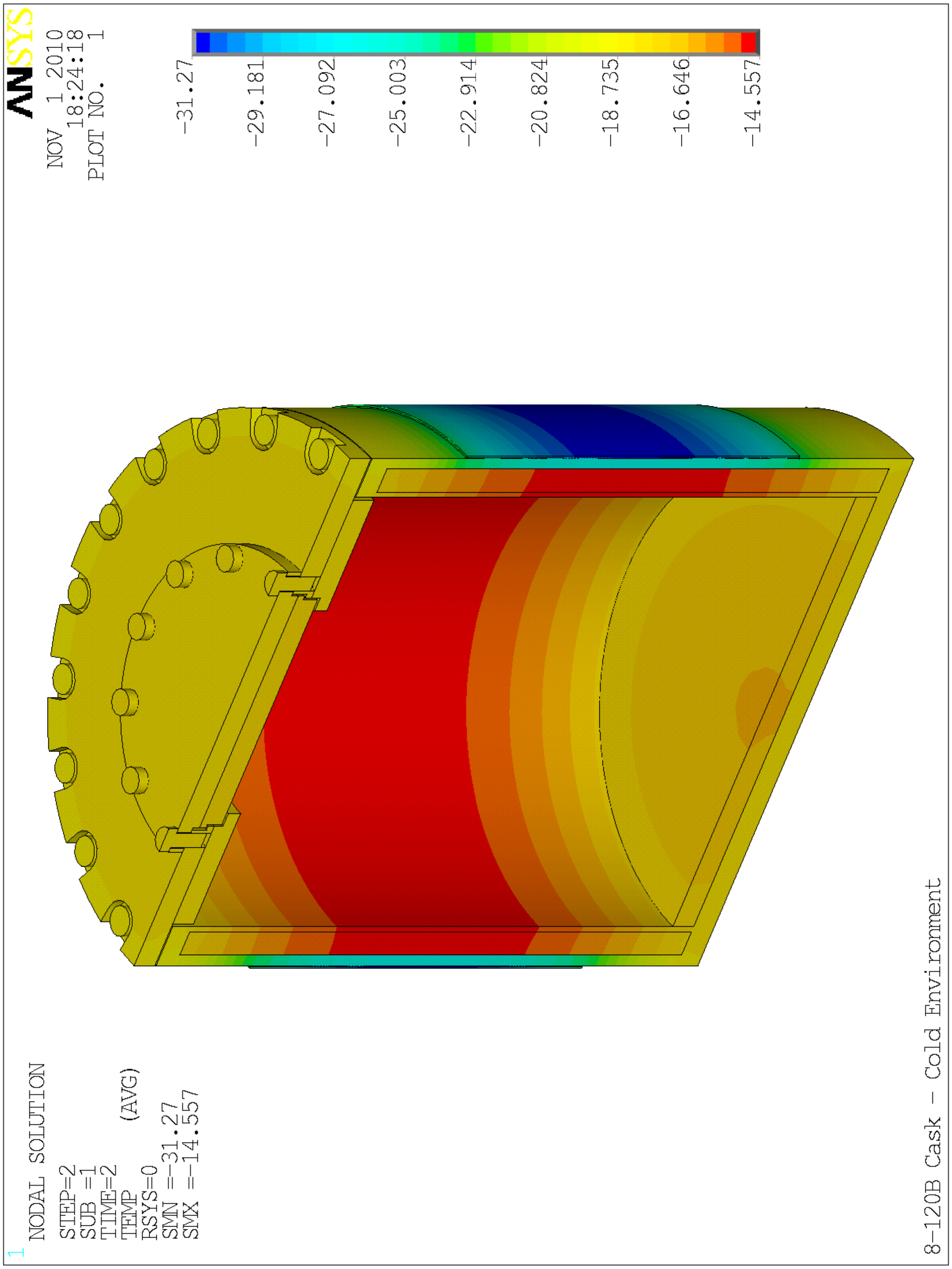

Figure 8 – Temperature Distribution – Cold Environment

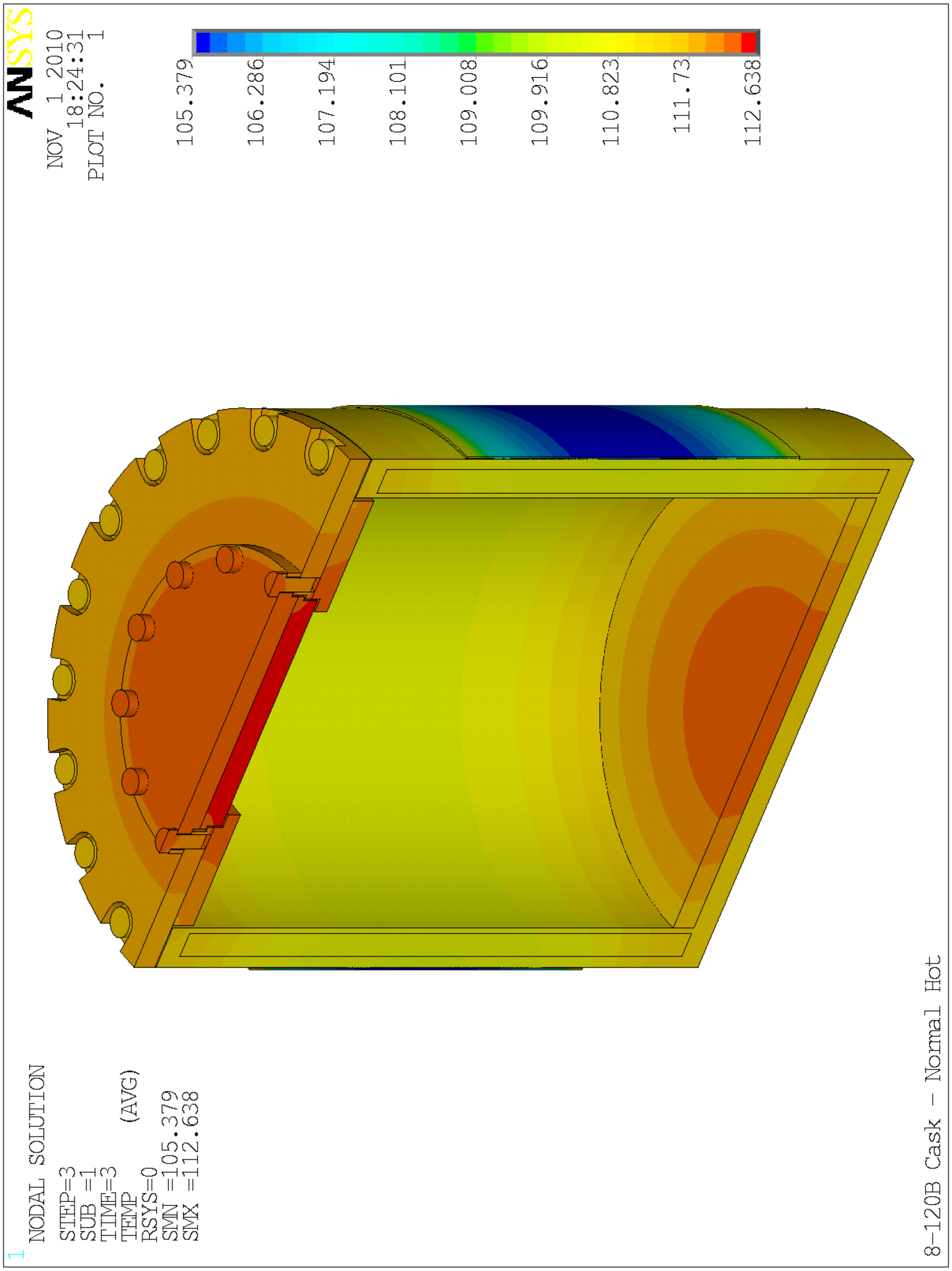

Figure 9 – Temperature Distribution – Normal Hot

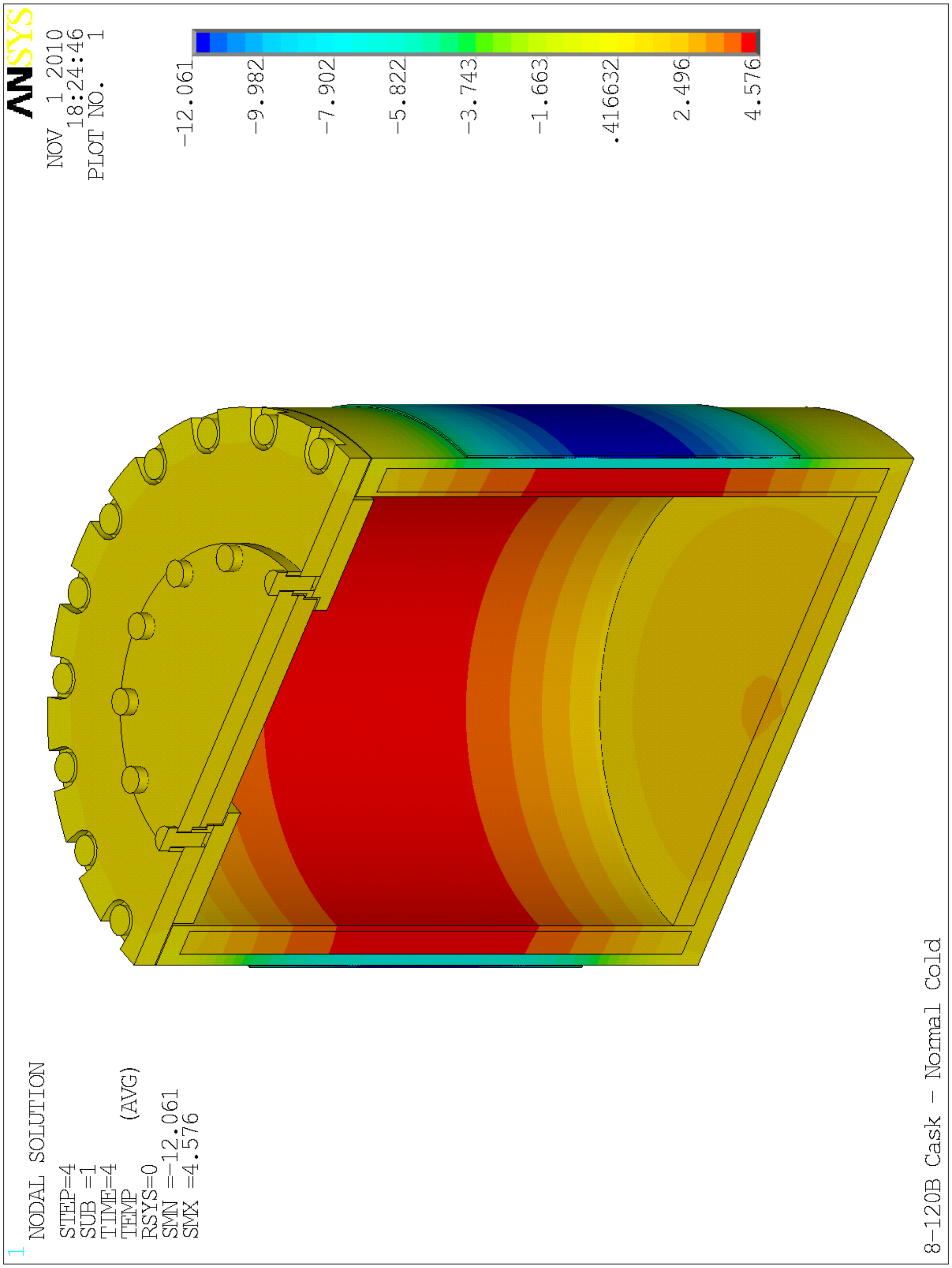

Figure 10 – Temperature Distribution – Normal Cold

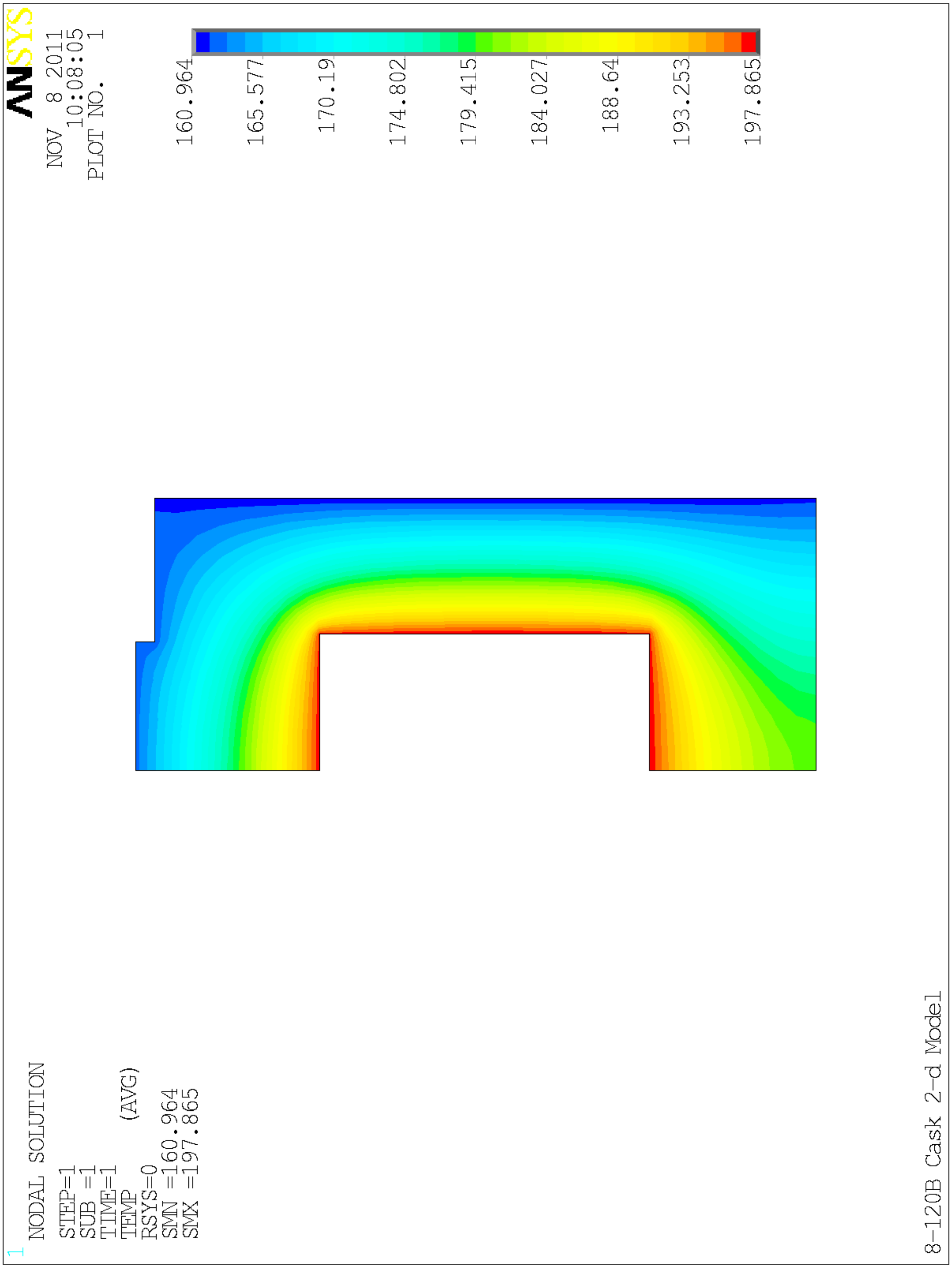

Figure 11 - Temperature Profile in the Cask Cavity (from 2-d Model)

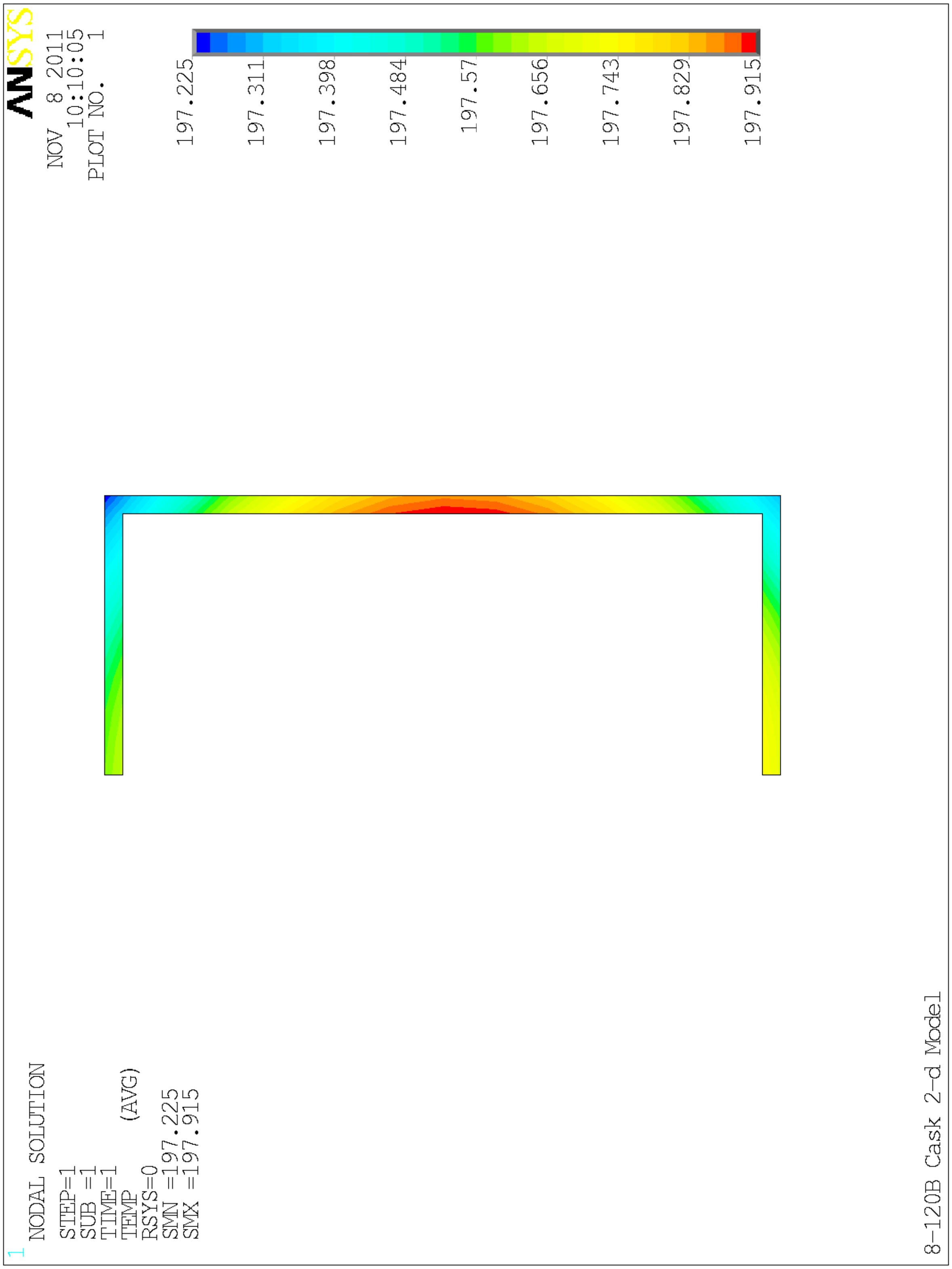

Figure 12 - Temperature Profile in the Cask Contents (from 2-d Model)

Appendix 1

Printout of the ANSYS model data

(32 Pages)

8-120B Cask NCT Analyses – ANSYS Model Data

3-Dimensional Model

(Note: The complete data printout is included on the file "3d Model\model.out", which is included on the electronic media included in the package)

```
    ***** TITLES *****

 *** YOU ARE IN   ANSYS - ENGINEERING ANALYSIS SYSTEM ***
 ANSYS Mechanical
 RELEASE  12.1      UPDATE 20091102   CUSTOMER  00222442

 INITIAL JOBNAME = file
 CURRENT JOBNAME = file

 Current Working Directory: D:\ANSYS Analyses\8-120B\Thermal\NCT

 TITLE= 8-120B Cask - Normal Cold

 MENULIST File: C:\Program Files\ANSYS Inc\v121\ANSYS\gui\en-us\UIDL\menulist121.ans

                          G L O B A L   S T A T U S

 ANSYS - Engineering Analysis System           Nov 01, 2010          11:23
 Release 12.1                00222442                  WINDOWS x64  Version

 Current working directory: D:\ANSYS Analyses\8-120B\Thermal\NCT


 MENULIST File: C:\Program Files\ANSYS Inc\v121\ANSYS\gui\en-us\UIDL\menulist121.ans

 Product(s) enabled: ANSYS Mechanical


 Total connect time. . . . .   0 hours 54 minutes
 Total CP usage. . . . . . .   0 hours  0 minutes  2.3 seconds

 J O B   I N F O R M A T I O N ---------------------------------------------

8-120B Cask - Normal Cold

 Current jobname . . . . . .file
 Initial jobname . . . . . .file

 Units . . . . . . . . . . .unknown

                                Available               Used
 Scratch Memory Space. . . .     512.000 mb         31.941 mb (  6.2%)
 Database space  . . . . . .   65535.750 mb        104.327 mb (  0.2%)

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 User menu file in use . . .%ANSYS121_DIR%\gui\en-us\UIDL\UIFUNC1.GRN
 User menu file in use . . .%ANSYS121_DIR%\gui\en-us\UIDL\UIFUNC2.GRN
 User menu file in use . . .%ANSYS121_DIR%\gui\en-us\UIDL\MECHTOOL.AUI
 Beta features . . . . . . .are not shown in the user interface

 M O D E L   I N F O R M A T I O N -----------------------------------------

 Solid model summary:

                               Largest         Number        Number
```

```
                             Number        Defined       Selected
Keypoints . . . . . . . . .     0             0             0
Lines . . . . . . . . . . .     0             0             0
Areas . . . . . . . . . . .     0             0             0
Volumes . . . . . . . . . .     0             0             0

Finite element model summary:

                            Largest        Number        Number
                             Number        Defined       Selected
Nodes . . . . . . . . . .    50005          39845         39845
Elements. . . . . . . . .    52666          40315         40315

Element types . . . . . .      150            101           n.a.
Real constant sets. . . .       92             51           n.a.
Material property sets. .        6              6           n.a.

Coupling. . . . . . . . .      162            162           n.a.
Constraint equations. . .        0              0           n.a.
Master DOFs . . . . . . .        0              0           n.a.
Dynamic gap conditions. .        0              0           n.a.

B O U N D A R Y   C O N D I T I O N   I N F O R M A T I O N ------------------

                                          Number
                                         Defined
Constraints on nodes. . . . . . . . . . .    2
Constraints on keypoints. . . . . . . . .    0
Constraints on lines. . . . . . . . . . .    0
Constraints on areas. . . . . . . . . . .    0

Forces on nodes . . . . . . . . . . . . .    0
Forces on keypoints . . . . . . . . . . .    0

Surface loads on elements . . . . . . . . 5838
Number of element flagged surfaces  . . .    0
Surface loads on lines. . . . . . . . . .    0
Surface loads on areas. . . . . . . . . .    0

Body loads on elements. . . . . . . . . .    0
Body loads on areas . . . . . . . . . . .    0
Body loads on lines . . . . . . . . . . .    0
Body loads on nodes . . . . . . . . . . .    0
Body loads on keypoints . . . . . . . . .    0

Temperatures
   Uniform temperature. . . . . . . . . .    0.000
   Offset from absolute scale . . . . . .  460.000

                                             X            Y            Z
Linear acceleration . . . . . . . . . . .  0.0000       0.0000       0.0000
Angular velocity (about global CS). . . .  0.0000       0.0000       0.0000
Angular acceleration (about global CS). .  0.0000       0.0000       0.0000
Location of reference CS. . . . . . . . .  0.0000       0.0000       0.0000
Angular velocity (about reference CS) . .  0.0000       0.0000       0.0000
Angular acceleration (about reference CS)  0.0000       0.0000       0.0000

R O U T I N E   I N F O R M A T I O N ---------------------------------------

Current routine. . . . . . . . . . . . .Preprocessing (PREP7)

Active coordinate system . . . . . . .   1 (Cylindrical)
```

```
Display coordinate system. . . . . . .   0 (Cartesian)

Current element attributes:
   Type number . . . . . . . . . . . .     5  (MATRIX50)
   Real number . . . . . . . . . . . .    94
   Material number . . . . . . . . . .     5
   Element coordinate system number. .     0

Current mesher type. . . . . . . . . .based on default element shape

Current element meshing shape 2D . . .use default element shape.

Current element meshing shape 3D . . .use default element shape.

SmrtSize Level  . . . . . . . . . . . . OFF

Global element size. . . . . . . . . .     0 divisions per line

Active coordinate system . . . . . . .   1 (Cylindrical)

Display coordinate system. . . . . . .   0 (Cartesian)

Analysis type. . . . . . . . . . . . .Static (steady-state)

Active options for this analysis type:
   Equation solver to use. . . . . . .Program Chosen

Results file . . . . . . . . . . . . .file.rth

Load step number . . . . . . . . . . .     5

Number of substeps . . . . . . . . . .     1
   Step change boundary conditions . .No

                      S O L U T I O N   O P T I O N S

  PROBLEM DIMENSIONALITY. . . . . . . . . . . . .3-D
  DEGREES OF FREEDOM. . . . . . TEMP
  ANALYSIS TYPE . . . . . . . . . . . . . . . . .STATIC (STEADY-STATE)
  OFFSET TEMPERATURE FROM ABSOLUTE ZERO . . . . .  460.00
  NEWTON-RAPHSON OPTION . . . . . . . . . . . . .PROGRAM CHOSEN
  GLOBALLY ASSEMBLED MATRIX . . . . . . . . . . .SYMMETRIC

                     L O A D   S T E P   O P T I O N S

  LOAD STEP NUMBER. . . . . . . . . . . . . . . .     5
  TIME AT END OF THE LOAD STEP. . . . . . . . . .  5.0000
  NUMBER OF SUBSTEPS. . . . . . . . . . . . . . .     1
  MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS. . . .    15
  STEP CHANGE BOUNDARY CONDITIONS . . . . . . . .    NO
  TERMINATE ANALYSIS IF NOT CONVERGED . . . . . .YES (EXIT)
  CONVERGENCE CONTROLS. . . . . . . . . . . . . .USE DEFAULTS
  PRINT OUTPUT CONTROLS . . . . . . . . . . . . .NO PRINTOUT
  DATABASE OUTPUT CONTROLS. . . . . . . . . . . .ALL DATA WRITTEN
                                                 FOR THE LAST SUBSTEP


LIST ELEMENT TYPES FROM      1 TO    150 BY      1

ELEMENT TYPE      2 IS SOLID70      3-D THERMAL SOLID
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0
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ELEMENT TYPE      4 IS SHELL57      THERMAL SHELL
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE      5 IS MATRIX50     SUPERELEMENT (SUBSTRUCTURE)
 KEYOPT( 1- 6)=        1      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE      7 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE      8 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     11 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     12 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     17 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     18 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     19 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     20 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     21 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     22 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     23 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
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 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     24 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     25 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     26 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     27 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     28 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     29 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     30 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     31 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     32 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     33 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     34 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     35 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0
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ELEMENT TYPE     36 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     37 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     38 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     39 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     40 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     41 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     42 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     43 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     44 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     45 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     46 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     47 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     48 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
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 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     49 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     50 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     51 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     52 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     53 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     54 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     55 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     56 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     57 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     58 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     59 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     60 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     61 IS TARGE170     3-D TARGET SEGMENT
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 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     62 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     63 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     64 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     65 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     66 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     67 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     68 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     69 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     70 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     71 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     72 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     73 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0
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ELEMENT TYPE     74 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     75 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     76 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     77 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     78 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     79 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     80 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     81 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     82 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     83 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     84 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     85 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     86 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
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 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     89 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     90 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     91 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     92 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     93 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     94 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     95 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     96 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     97 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     98 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     99 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE    100 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0
```

```
ELEMENT TYPE    101 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE    102 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE    103 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE    104 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE    105 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE    106 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE    109 IS TARGE170     3-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE    110 IS CONTA174     3D 8-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE    147 IS SURF152      3-D THERMAL SURFACE
 KEYOPT( 1- 6)=        0      0      0        1      1      0
 KEYOPT( 7-12)=        0      0      1        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE    148 IS SURF152      3-D THERMAL SURFACE
 KEYOPT( 1- 6)=        0      0      0        1      1      0
 KEYOPT( 7-12)=        1      4      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE    149 IS SURF152      3-D THERMAL SURFACE
 KEYOPT( 1- 6)=        0      0      0        1      1      0
 KEYOPT( 7-12)=        0      4      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE    150 IS SURF152      3-D THERMAL SURFACE
 KEYOPT( 1- 6)=        0      0      0        1      0      0
 KEYOPT( 7-12)=        0      1      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

CURRENT NODAL DOF SET IS  TEMP
 THREE-DIMENSIONAL MODEL
```

```
LIST MATERIALS        1 TO        6 BY        1
 PROPERTY= ALL

MATERIAL NUMBER       1

     TEMP        DENS
             0.2830000

     TEMP        KXX
    70.000     0.81300E-03
    100.00     0.80300E-03
    200.00     0.77800E-03
    300.00     0.74800E-03
    400.00     0.71500E-03
    500.00     0.67700E-03
    600.00     0.64800E-03
    700.00     0.61600E-03
    800.00     0.58300E-03
    900.00     0.55100E-03
    1000.0     0.51900E-03
    1100.0     0.48400E-03
    1200.0     0.45100E-03
    1300.0     0.41700E-03
    1400.0     0.38000E-03
    1500.0     0.36300E-03

     TEMP        C
    70.000     0.10330
    100.00     0.10530
    200.00     0.11210
    300.00     0.11770
    400.00     0.12340
    500.00     0.12780
    600.00     0.13220
    700.00     0.13810
    800.00     0.14520
    900.00     0.15350
    1000.0     0.16240
    1100.0     0.17100
    1200.0     0.18290
    1300.0     0.20450
    1400.0     0.40100
    1500.0     0.19820

MATERIAL NUMBER       2

     TEMP        DENS
    70.000     0.41090
    100.00     0.41090
    150.00     0.41090
    200.00     0.41090
    250.00     0.41090
    300.00     0.41090
    350.00     0.41090
    400.00     0.41090
    450.00     0.41090
    500.00     0.41090
    550.00     0.41090
    600.00     0.41090
    650.00     0.41090
    700.00     0.41090
    750.00     0.41090
    800.00     0.41090
```

```
    900.00     0.41090
    1000.0     0.41090
    1100.0     0.41090
    1200.0     0.41090
    1300.0     0.41090
    1400.0     0.41090
    1500.0     0.41090

     TEMP        KXX
    70.000     0.46500E-03
    100.00     0.46100E-03
    150.00     0.45500E-03
    200.00     0.44800E-03
    250.00     0.44100E-03
    300.00     0.43500E-03
    350.00     0.42800E-03
    400.00     0.42200E-03
    450.00     0.41500E-03
    500.00     0.40900E-03
    550.00     0.40200E-03
    600.00     0.39500E-03
    650.00     0.38900E-03
    700.00     0.38900E-03
    750.00     0.38900E-03
    800.00     0.38900E-03
    900.00     0.38900E-03
    1000.0     0.38900E-03
    1100.0     0.38900E-03
    1200.0     0.38900E-03
    1300.0     0.38900E-03
    1400.0     0.38900E-03
    1500.0     0.38900E-03

     TEMP        C
    70.000     0.31050E-01
    100.00     0.31050E-01
    150.00     0.31050E-01
    200.00     0.31050E-01
    250.00     0.31050E-01
    300.00     0.31050E-01
    350.00     0.31050E-01
    400.00     0.31050E-01
    450.00     0.31050E-01
    500.00     0.31050E-01
    550.00     0.31050E-01
    600.00     0.31050E-01
    650.00     0.31050E-01
    700.00     0.31050E-01
    750.00     0.31050E-01
    800.00     0.31050E-01
    900.00     0.31050E-01
    1000.0     0.31050E-01
    1100.0     0.31050E-01
    1200.0     0.31050E-01
    1300.0     0.31050E-01
    1400.0     0.31050E-01
    1500.0     0.31050E-01

MATERIAL NUMBER       3

     TEMP        DENS
    70.000     0.43510E-04
    100.00     0.41120E-04
```

```
150.00      0.37520E-04
200.00      0.34680E-04
250.00      0.32360E-04
300.00      0.30310E-04
350.00      0.28310E-04
400.00      0.26730E-04
450.00      0.25220E-04
500.00      0.23960E-04
550.00      0.22780E-04
600.00      0.21680E-04
650.00      0.20710E-04
700.00      0.19800E-04
750.00      0.18980E-04
800.00      0.18180E-04
900.00      0.16900E-04
1000.0      0.15710E-04
1100.0      0.14720E-04
1200.0      0.13850E-04
1300.0      0.13040E-04
1400.0      0.12350E-04
1500.0      0.11710E-04

 TEMP         KXX
70.000      0.34490E-06
100.00      0.36210E-06
150.00      0.39030E-06
200.00      0.41770E-06
250.00      0.44460E-06
300.00      0.47040E-06
350.00      0.49570E-06
400.00      0.52040E-06
450.00      0.54480E-06
500.00      0.56880E-06
550.00      0.59210E-06
600.00      0.61430E-06
650.00      0.63630E-06
700.00      0.65810E-06
750.00      0.67900E-06
800.00      0.69960E-06
900.00      0.74090E-06
1000.0      0.78040E-06
1100.0      0.81750E-06
1200.0      0.85450E-06
1300.0      0.88970E-06
1400.0      0.92850E-06
1500.0      0.97070E-06

 TEMP         C
70.000      0.24020
100.00      0.24040
150.00      0.24080
200.00      0.24140
250.00      0.24210
300.00      0.24290
350.00      0.24380
400.00      0.24500
450.00      0.24610
500.00      0.24740
550.00      0.24900
600.00      0.25110
650.00      0.25270
700.00      0.25380
750.00      0.25520
```

800.00	0.25680
900.00	0.25960
1000.0	0.26280
1100.0	0.26590
1200.0	0.26890
1300.0	0.27170
1400.0	0.27420
1500.0	0.27660

MATERIAL NUMBER 4

TEMP	DENS
70.000	0.28240
100.00	0.28240
150.00	0.28240
200.00	0.28240
250.00	0.28240
300.00	0.28240
350.00	0.28240
400.00	0.28240
450.00	0.28240
500.00	0.28240
550.00	0.28240
600.00	0.28240
650.00	0.28240
700.00	0.28240
750.00	0.28240
800.00	0.28240
900.00	0.28240
1000.0	0.28240
1100.0	0.28240
1200.0	0.28240
1300.0	0.28240
1400.0	0.28240
1500.0	0.28240

TEMP	KXX
70.000	0.19900E-03
100.00	0.20100E-03
150.00	0.20800E-03
200.00	0.21500E-03
250.00	0.22200E-03
300.00	0.22700E-03
350.00	0.23400E-03
400.00	0.24100E-03
450.00	0.24500E-03
500.00	0.25200E-03
550.00	0.25700E-03
600.00	0.26200E-03
650.00	0.26900E-03
700.00	0.27300E-03
750.00	0.27800E-03
800.00	0.28200E-03
900.00	0.29400E-03
1000.0	0.30600E-03
1100.0	0.31500E-03
1200.0	0.32400E-03
1300.0	0.33600E-03
1400.0	0.34500E-03
1500.0	0.35400E-03

TEMP	C
70.000	0.11700

```
    100.00     0.11700
    150.00     0.12000
    200.00     0.12200
    250.00     0.12500
    300.00     0.12600
    350.00     0.12800
    400.00     0.12900
    450.00     0.13000
    500.00     0.13100
    550.00     0.13200
    600.00     0.13300
    650.00     0.13400
    700.00     0.13500
    750.00     0.13600
    800.00     0.13600
    900.00     0.13800
    1000.0     0.13900
    1100.0     0.14100
    1200.0     0.14100
    1300.0     0.14300
    1400.0     0.14400
    1500.0     0.14500

MATERIAL NUMBER       5

     TEMP        EMIS
              0.1500000

MATERIAL NUMBER       6

     TEMP        EMIS
              0.7347000
```

2-Dimensional Model

(Note: The complete data printout is included on the file “3d Model\model.out”, which is included on the electronic media included in the package)

```
                           G L O B A L   S T A T U S

 ANSYS - Engineering Analysis System             Nov 08, 2011          10:00
 Release 13.0                 00222442                   WINDOWS x64   Version

 Current working directory: D:\ANSYS Analyses\8-120B\Thermal\Rev2\2-d Analyses\NCT


 MENULIST File: C:\Program Files\ANSYS Inc\v130\ANSYS\gui\en-us\UIDL\menulist130.ans

 Product(s) enabled: ANSYS Mechanical


 Total connect time. . . . .   0 hours  0 minutes
 Total CP usage. . . . . . .   0 hours  0 minutes  2.0 seconds

 J O B   I N F O R M A T I O N ---------------------------------------------

8-120B Cask 2-d Model

 Current jobname . . . . . .file
 Initial jobname . . . . . .file

 Units . . . . . . . . . . .unknown

                               Available              Used
 Scratch Memory Space. . . .   9600.000 mb         517.913 mb (  5.4%)
 Database space  . . . . . .  65535.750 mb           3.024 mb (  0.0%)

 User menu file in use . . .%ANSYS130_DIR%\gui\en-us\UIDL\UIMENU.GRN
 User menu file in use . . .%ANSYS130_DIR%\gui\en-us\UIDL\UIFUNC1.GRN
 User menu file in use . . .%ANSYS130_DIR%\gui\en-us\UIDL\UIFUNC2.GRN
 User menu file in use . . .%ANSYS130_DIR%\gui\en-us\UIDL\MECHTOOL.AUI
 Beta features . . . . . . .are not shown in the user interface

 M O D E L   I N F O R M A T I O N -------------------------------------------

 Solid model summary:

                              Largest         Number        Number
                               Number         Defined       Selected
 Keypoints . . . . . . . . .    101            101             18
 Lines . . . . . . . . . . .    136            136             23
 Areas . . . . . . . . . . .     43             43              6
 Volumes . . . . . . . . . .      0              0              0

 Finite element model summary:

                              Largest         Number        Number
                               Number         Defined       Selected
 Nodes . . . . . . . . . . .   2443           1074           1074
 Elements. . . . . . . . . .   1352           1210           1210

 Element types . . . . . . .     65             46           n.a.
 Real constant sets. . . . .     60             24           n.a.
 Material property sets. . .     14             10           n.a.
```

```
Coupling. . . . . . . . . .       2              2           n.a.
Constraint equations. . . .       0              0           n.a.
Master DOFs . . . . . . . .       0              0           n.a.
Dynamic gap conditions. . .       0              0           n.a.

B O U N D A R Y   C O N D I T I O N   I N F O R M A T I O N ------------------

                                         Number
                                        Defined
Constraints on nodes. . . . . . . . . . .      2
Constraints on keypoints. . . . . . . . .      0
Constraints on lines. . . . . . . . . . .      0
Constraints on areas. . . . . . . . . . .      0

Forces on nodes . . . . . . . . . . . . .      0
Forces on keypoints . . . . . . . . . . .      0

Surface loads on elements . . . . . . . .     88
Number of element flagged surfaces  . . .      0
Surface loads on lines. . . . . . . . . .      0
Surface loads on areas. . . . . . . . . .      0

Body loads on elements. . . . . . . . . .      0
Body loads on areas . . . . . . . . . . .      0
Body loads on lines . . . . . . . . . . .      0
Body loads on nodes . . . . . . . . . . .      0
Body loads on keypoints . . . . . . . . .      0

Temperatures
   Uniform temperature. . . . . . . . . .    70.000
   Offset from absolute scale . . . . . .   460.000

                                             X          Y          Z
Linear acceleration . . . . . . . . . . . 0.0000     0.0000     0.0000
Angular velocity (about global CS). . . . 0.0000     0.0000     0.0000
Angular acceleration (about global CS). . 0.0000     0.0000     0.0000
Location of reference CS. . . . . . . . . 0.0000     0.0000     0.0000
Angular velocity (about reference CS) . . 0.0000     0.0000     0.0000
Angular acceleration (about reference CS) 0.0000     0.0000     0.0000

R O U T I N E   I N F O R M A T I O N -------------------------------------

Current routine. . . . . . . . . . . .Preprocessing (PREP7)

Active coordinate system . . . . . . .   0 (Cartesian)

Display coordinate system. . . . . . .   0 (Cartesian)

Current element attributes:
   Type number . . . . . . . . . . . .    50  (MATRIX50)
   Real number . . . . . . . . . . . .    50
   Material number . . . . . . . . . .     8
   Element coordinate system number. .     0

Current mesher type. . . . . . . . . .free mesher

Current element meshing shape 2D . . .use default element shape.

Current element meshing shape 3D . . .use default element shape.

SmrtSize Level  . . . . . . . . . . . . OFF

Global element size. . . . . . . . .     0 divisions per line
```

```
Active coordinate system . . . . . . .   0 (Cartesian)

Display coordinate system. . . . . . .   0 (Cartesian)

Analysis type. . . . . . . . . . . . .Static (steady-state)

Active options for this analysis type:
   Equation solver to use. . . . . . .Program Chosen

Results file . . . . . . . . . . . . .file.rth

Load step number . . . . . . . . . . .     2

Number of substeps . . . . . . . . . .     1
   Step change boundary conditions . .No


                         Analysis Options


   New, Restart, or Expansion Pass:  NEW ANALYSIS
  Discipline (based on active DOF):  THERMAL
                     Analysis type:  STATIC


               Newton-Raphson option     PROGRAM CHOOSES
     Newton-Raphson adaptive descent     DO NOT USE ADAPT DESCENT

        Equation solver to be used  PROGRAM CHOOSES

Difference (in degrees) between absolute zero and
   the temperature system being used   460.00

LIST ELEMENT TYPES FROM      1 TO     65 BY      1

ELEMENT TYPE      1 IS PLANE55      AXI. THERMAL SOLID
 KEYOPT( 1- 6)=        0      0      1        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE      2 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE      3 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE      4 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE      5 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      0      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE      6 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
```

```
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE      7 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        2      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE      8 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE      9 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     10 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     11 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     12 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     13 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     14 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     15 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     16 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     17 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      0      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     18 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0
```

```
ELEMENT TYPE     19 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     20 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     21 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     22 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     23 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     24 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     25 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     26 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     27 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      2      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     28 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     29 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      0      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     49 IS LINK33       3-D CONDUCTION BAR
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     50 IS MATRIX50     SUPERELEMENT (SUBSTRUCTURE)
 KEYOPT( 1- 6)=        1      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
```

```
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     51 IS SURF151      2-D THERMAL SURFACE
 KEYOPT( 1- 6)=        0      0      1        1      1      0
 KEYOPT( 7-12)=        1      4      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     52 IS SURF151      2-D THERMAL SURFACE
 KEYOPT( 1- 6)=        0      0      1        1      1      0
 KEYOPT( 7-12)=        0      0      1        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     53 IS SURF151      2-D THERMAL SURFACE
 KEYOPT( 1- 6)=        0      0      1        1      1      0
 KEYOPT( 7-12)=        0      4      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     54 IS SURF151      2-D THERMAL SURFACE
 KEYOPT( 1- 6)=        0      0      1        1      1      0
 KEYOPT( 7-12)=        0      0      1        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     55 IS SURF151      2-D THERMAL SURFACE
 KEYOPT( 1- 6)=        0      0      1        1      0      0
 KEYOPT( 7-12)=        0      1      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     56 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     57 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      0      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     58 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     59 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      0      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     60 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     61 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      0      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     62 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     63 IS CONTA171     2D 2-NODE THERMAL CONTACT
```

```
 KEYOPT( 1- 6)=        2      0      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     64 IS TARGE169     2-D TARGET SEGMENT
 KEYOPT( 1- 6)=        0      0      0        0      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      0
 KEYOPT(13-18)=        0      0      0        0      0      0

ELEMENT TYPE     65 IS CONTA171     2D 2-NODE THERMAL CONTACT
 KEYOPT( 1- 6)=        2      0      0        2      0      0
 KEYOPT( 7-12)=        0      0      0        0      0      5
 KEYOPT(13-18)=        0      0      0        0      0      0

CURRENT NODAL DOF SET IS  TEMP
 THREE-DIMENSIONAL MODEL

LIST MATERIALS       1 TO      14 BY       1
 PROPERTY= ALL

MATERIAL NUMBER       1

     TEMP        DENS
    70.000     0.28180
    100.00     0.28180
    150.00     0.28180
    200.00     0.28180
    250.00     0.28180
    300.00     0.28180
    350.00     0.28180
    400.00     0.28180
    450.00     0.28180
    500.00     0.28180
    550.00     0.28180
    600.00     0.28180
    650.00     0.28180
    700.00     0.28180
    750.00     0.28180
    800.00     0.28180
    900.00     0.28180
    1000.0     0.28180
    1100.0     0.28180
    1200.0     0.28180
    1300.0     0.28180
    1400.0     0.28180
    1500.0     0.28180

     TEMP        MU
               0.000000

     TEMP        KXX
    70.000     0.81300E-03
    100.00     0.80300E-03
    150.00     0.78900E-03
    200.00     0.77800E-03
    250.00     0.76200E-03
    300.00     0.74800E-03
    350.00     0.73100E-03
    400.00     0.71500E-03
    450.00     0.70100E-03
    500.00     0.68300E-03
    550.00     0.66700E-03
    600.00     0.64800E-03
```

650.00	0.63200E-03
700.00	0.61600E-03
750.00	0.60000E-03
800.00	0.58300E-03
900.00	0.55100E-03
1000.0	0.51900E-03
1100.0	0.48400E-03
1200.0	0.45100E-03
1300.0	0.41700E-03
1400.0	0.38000E-03
1500.0	0.36300E-03

TEMP	C
70.000	0.10400
100.00	0.10600
150.00	0.10900
200.00	0.11300
250.00	0.11500
300.00	0.11800
350.00	0.12200
400.00	0.12400
450.00	0.12600
500.00	0.12800
550.00	0.13100
600.00	0.13300
650.00	0.13500
700.00	0.13900
750.00	0.14200
800.00	0.14600
900.00	0.15400
1000.0	0.16300
1100.0	0.17200
1200.0	0.18400
1300.0	0.20500
1400.0	0.41100
1500.0	0.19900

TEMP	EMIS
	0.000000

MATERIAL NUMBER 2

TEMP	DENS
70.000	0.28240
100.00	0.28240
150.00	0.28240
200.00	0.28240
250.00	0.28240
300.00	0.28240
350.00	0.28240
400.00	0.28240
450.00	0.28240
500.00	0.28240
550.00	0.28240
600.00	0.28240
650.00	0.28240
700.00	0.28240
750.00	0.28240
800.00	0.28240
900.00	0.28240
1000.0	0.28240
1100.0	0.28240
1200.0	0.28240

```
    1300.0     0.28240
    1400.0     0.28240
    1500.0     0.28240

     TEMP        MU
               0.000000

     TEMP        KXX
    70.000     0.19900E-03
    100.00     0.20100E-03
    150.00     0.20800E-03
    200.00     0.21500E-03
    250.00     0.22200E-03
    300.00     0.22700E-03
    350.00     0.23400E-03
    400.00     0.24100E-03
    450.00     0.24500E-03
    500.00     0.25200E-03
    550.00     0.25700E-03
    600.00     0.26200E-03
    650.00     0.26900E-03
    700.00     0.27300E-03
    750.00     0.27800E-03
    800.00     0.28200E-03
    900.00     0.29400E-03
    1000.0     0.30600E-03
    1100.0     0.31500E-03
    1200.0     0.32400E-03
    1300.0     0.33600E-03
    1400.0     0.34500E-03
    1500.0     0.35400E-03

     TEMP        C
    70.000     0.11700
    100.00     0.11700
    150.00     0.12000
    200.00     0.12200
    250.00     0.12500
    300.00     0.12600
    350.00     0.12800
    400.00     0.12900
    450.00     0.13000
    500.00     0.13100
    550.00     0.13200
    600.00     0.13300
    650.00     0.13400
    700.00     0.13500
    750.00     0.13600
    800.00     0.13600
    900.00     0.13800
    1000.0     0.13900
    1100.0     0.14100
    1200.0     0.14100
    1300.0     0.14300
    1400.0     0.14400
    1500.0     0.14500

MATERIAL NUMBER       3

     TEMP        DENS
    70.000     0.41090
    100.00     0.41090
    150.00     0.41090
```

200.00	0.41090
250.00	0.41090
300.00	0.41090
350.00	0.41090
400.00	0.41090
450.00	0.41090
500.00	0.41090
550.00	0.41090
600.00	0.41090
650.00	0.41090
700.00	0.41090
750.00	0.41090
800.00	0.41090
900.00	0.41090
1000.0	0.41090
1100.0	0.41090
1200.0	0.41090
1300.0	0.41090
1400.0	0.41090
1500.0	0.41090

TEMP	KXX
70.000	0.46500E-03
100.00	0.46100E-03
150.00	0.45500E-03
200.00	0.44800E-03
250.00	0.44100E-03
300.00	0.43500E-03
350.00	0.42800E-03
400.00	0.42200E-03
450.00	0.41500E-03
500.00	0.40900E-03
550.00	0.40200E-03
600.00	0.39500E-03
650.00	0.38900E-03
700.00	0.38900E-03
750.00	0.38900E-03
800.00	0.38900E-03
900.00	0.38900E-03
1000.0	0.38900E-03
1100.0	0.38900E-03
1200.0	0.38900E-03
1300.0	0.38900E-03
1400.0	0.38900E-03
1500.0	0.38900E-03

TEMP	C
70.000	0.31050E-01
100.00	0.31050E-01
150.00	0.31050E-01
200.00	0.31050E-01
250.00	0.31050E-01
300.00	0.31050E-01
350.00	0.31050E-01
400.00	0.31050E-01
450.00	0.31050E-01
500.00	0.31050E-01
550.00	0.31050E-01
600.00	0.31050E-01
650.00	0.31050E-01
700.00	0.31050E-01
750.00	0.31050E-01
800.00	0.31050E-01

900.00	0.31050E-01
1000.0	0.31050E-01
1100.0	0.31050E-01
1200.0	0.31050E-01
1300.0	0.31050E-01
1400.0	0.31050E-01
1500.0	0.31050E-01

MATERIAL NUMBER 4

TEMP	DENS
70.000	0.43510E-04
100.00	0.41120E-04
150.00	0.37520E-04
200.00	0.34680E-04
250.00	0.32360E-04
300.00	0.30310E-04
350.00	0.28310E-04
400.00	0.26730E-04
450.00	0.25220E-04
500.00	0.23960E-04
550.00	0.22780E-04
600.00	0.21680E-04
650.00	0.20710E-04
700.00	0.19800E-04
750.00	0.18980E-04
800.00	0.18180E-04
900.00	0.16900E-04
1000.0	0.15710E-04
1100.0	0.14720E-04
1200.0	0.13850E-04
1300.0	0.13040E-04
1400.0	0.12350E-04
1500.0	0.11710E-04

TEMP	KXX
70.000	0.34490E-06
100.00	0.36210E-06
150.00	0.39030E-06
200.00	0.41770E-06
250.00	0.44460E-06
300.00	0.47040E-06
350.00	0.49570E-06
400.00	0.52040E-06
450.00	0.54480E-06
500.00	0.56880E-06
550.00	0.59210E-06
600.00	0.61430E-06
650.00	0.63630E-06
700.00	0.65810E-06
750.00	0.67900E-06
800.00	0.69960E-06
900.00	0.74090E-06
1000.0	0.78040E-06
1100.0	0.81750E-06
1200.0	0.85450E-06
1300.0	0.88970E-06
1400.0	0.92850E-06
1500.0	0.97070E-06

TEMP	C
70.000	0.24020
100.00	0.24040

```
    150.00     0.24080
    200.00     0.24140
    250.00     0.24210
    300.00     0.24290
    350.00     0.24380
    400.00     0.24500
    450.00     0.24610
    500.00     0.24740
    550.00     0.24900
    600.00     0.25110
    650.00     0.25270
    700.00     0.25380
    750.00     0.25520
    800.00     0.25680
    900.00     0.25960
    1000.0     0.26280
    1100.0     0.26590
    1200.0     0.26890
    1300.0     0.27170
    1400.0     0.27420
    1500.0     0.27660

MATERIAL NUMBER       5

     TEMP        EMIS
              0.1500000

MATERIAL NUMBER       6

     TEMP        EMIS
              0.1500000

MATERIAL NUMBER       7

     TEMP        EMIS
              0.2000000

MATERIAL NUMBER       8

     TEMP        EMIS
              0.4000000

MATERIAL NUMBER      12

     TEMP        EMIS
              0.7347000

MATERIAL NUMBER      14

     TEMP        EMIS
              0.9000000

LIST DATA TABLE  ALL   FOR ALL MATERIALS

*** WARNING ***                         CP =       2.012   TIME= 10:00:21
The requested ALL table data for ALL materials does not exist.  The
TBLIST command is ignored.

                       General load step options


       Automatic time stepping     USE AUTOMATIC TIME STEPPING
            Number of substeps           1
```

```
      Time at end of load step     TIME =   0.0000
Stiffness matrix reuse options     PROGRAM DECIDES
         Reference temperature     TREF=  70.000

*** NOTE ***                            CP =       2.012   TIME= 10:00:21
No nodal body forces to list.

                      Inertia load options

           Acceleration vector     GLOBAL CARTESIAN COMPONENTS ARE:
                                     0.0000      0.0000      0.0000
       Angular velocity vector     GLOBAL CARTESIAN COMPONENTS ARE:
                                     0.0000      0.0000      0.0000
                                   SPIN SOFTENING NOT ACTIVATED
   Angular acceleration vector     GLOBAL CARTESIAN COMPONENTS ARE:
                                     0.0000      0.0000      0.0000
Reference coord. system origin     ORIGIN =  0.0000      0.0000      0.0000
       Angular velocity vector     REFERENCE COORDINATE COMPONENTS ARE:
                                     0.0000      0.0000      0.0000
   Angular acceleration vector     REFERENCE COORDINATE COMPONENTS ARE:
                                     0.0000      0.0000      0.0000
                Inertia relief     NO INERTIA RELIEF
Translational acceleration vector on components    NONE
Angular velocity vector on components    NONE
Angular acceleration vector on components    NONE

LIST CONSTRAINTS FOR SELECTED NODES         1 TO     2443 BY        1
CURRENTLY SELECTED DOF SET= TEMP

    NODE  LABEL     REAL           IMAG
     1001  TEMP   100.000000      0.00000000
     1002  TEMP   100.000000      0.00000000

*** NOTE ***                            CP =       2.012   TIME= 10:00:21
No nodal forces to list.

LIST ELEM PRESS FOR SELECTED ELEMENTS IN RANGE       1 TO    1352 BY       1

LIST NODAL SURFACE LOAD CONV FOR ALL SELECTED NODES


ELEMENT  LKEY     FACE NODES       FILM COEFFICIENT      TBULK
    640     1         645           3.472200000E-07XtraNode
                      643           3.472200000E-07XtraNode
    641     1         646           3.472200000E-07XtraNode
                      645           3.472200000E-07XtraNode
    642     1         647           3.472200000E-07XtraNode
                      646           3.472200000E-07XtraNode
    643     1         648           3.472200000E-07XtraNode
                      647           3.472200000E-07XtraNode
    644     1         649           3.472200000E-07XtraNode
                      648           3.472200000E-07XtraNode
    645     1         650           3.472200000E-07XtraNode
                      649           3.472200000E-07XtraNode
    646     1         651           3.472200000E-07XtraNode
                      650           3.472200000E-07XtraNode
    647     1         652           3.472200000E-07XtraNode
                      651           3.472200000E-07XtraNode
    648     1         653           3.472200000E-07XtraNode
                      652           3.472200000E-07XtraNode
    649     1         654           3.472200000E-07XtraNode
                      653           3.472200000E-07XtraNode
```

ELEMENT	LKEY	FACE NODES	FILM COEFFICIENT	TBULK
650	1	655	3.472200000E-07XtraNode	
		654	3.472200000E-07XtraNode	
651	1	656	3.472200000E-07XtraNode	
		655	3.472200000E-07XtraNode	
652	1	657	3.472200000E-07XtraNode	
		656	3.472200000E-07XtraNode	
653	1	658	3.472200000E-07XtraNode	
		657	3.472200000E-07XtraNode	
654	1	659	3.472200000E-07XtraNode	
		658	3.472200000E-07XtraNode	
655	1	660	3.472200000E-07XtraNode	
		659	3.472200000E-07XtraNode	
656	1	661	3.472200000E-07XtraNode	
		660	3.472200000E-07XtraNode	
657	1	662	3.472200000E-07XtraNode	
		661	3.472200000E-07XtraNode	
658	1	663	3.472200000E-07XtraNode	
		662	3.472200000E-07XtraNode	
659	1	644	3.472200000E-07XtraNode	
		663	3.472200000E-07XtraNode	

ELEMENT	LKEY	FACE NODES	FILM COEFFICIENT	TBULK
680	1	645	3.398000000E-06XtraNode	
		643	3.398000000E-06XtraNode	
681	1	646	3.398000000E-06XtraNode	
		645	3.398000000E-06XtraNode	
682	1	647	3.398000000E-06XtraNode	
		646	3.398000000E-06XtraNode	
683	1	648	3.398000000E-06XtraNode	
		647	3.398000000E-06XtraNode	
684	1	649	3.398000000E-06XtraNode	
		648	3.398000000E-06XtraNode	
685	1	650	3.398000000E-06XtraNode	
		649	3.398000000E-06XtraNode	
686	1	651	3.398000000E-06XtraNode	
		650	3.398000000E-06XtraNode	
687	1	652	3.398000000E-06XtraNode	
		651	3.398000000E-06XtraNode	
688	1	653	3.398000000E-06XtraNode	
		652	3.398000000E-06XtraNode	
689	1	654	3.398000000E-06XtraNode	
		653	3.398000000E-06XtraNode	

ELEMENT	LKEY	FACE NODES	FILM COEFFICIENT	TBULK
690	1	655	3.398000000E-06XtraNode	
		654	3.398000000E-06XtraNode	
691	1	656	3.398000000E-06XtraNode	
		655	3.398000000E-06XtraNode	
692	1	657	3.398000000E-06XtraNode	
		656	3.398000000E-06XtraNode	
693	1	658	3.398000000E-06XtraNode	
		657	3.398000000E-06XtraNode	
694	1	659	3.398000000E-06XtraNode	
		658	3.398000000E-06XtraNode	
695	1	660	3.398000000E-06XtraNode	
		659	3.398000000E-06XtraNode	
696	1	661	3.398000000E-06XtraNode	
		660	3.398000000E-06XtraNode	
697	1	662	3.398000000E-06XtraNode	

		661	3.398000000E-06XtraNode
698	1	663	3.398000000E-06XtraNode
		662	3.398000000E-06XtraNode
699	1	644	3.398000000E-06XtraNode
		663	3.398000000E-06XtraNode

LIST NODAL SURFACE LOAD HFLU FOR ALL SELECTED NODES

ELEMENT	LKEY	FACE NODES	HEAT FLUX
720	1	645	1.742000000E-04
		643	1.742000000E-04
721	1	646	1.742000000E-04
		645	1.742000000E-04
722	1	647	1.742000000E-04
		646	1.742000000E-04
723	1	648	1.742000000E-04
		647	1.742000000E-04
724	1	649	1.742000000E-04
		648	1.742000000E-04
725	1	650	1.742000000E-04
		649	1.742000000E-04
726	1	651	1.742000000E-04
		650	1.742000000E-04
727	1	652	1.742000000E-04
		651	1.742000000E-04
728	1	653	1.742000000E-04
		652	1.742000000E-04
729	1	654	1.742000000E-04
		653	1.742000000E-04

ELEMENT	LKEY	FACE NODES	HEAT FLUX
730	1	655	1.742000000E-04
		654	1.742000000E-04
731	1	656	1.742000000E-04
		655	1.742000000E-04
732	1	657	1.742000000E-04
		656	1.742000000E-04
733	1	658	1.742000000E-04
		657	1.742000000E-04
734	1	659	1.742000000E-04
		658	1.742000000E-04
735	1	660	1.742000000E-04
		659	1.742000000E-04
736	1	661	1.742000000E-04
		660	1.742000000E-04
737	1	662	1.742000000E-04
		661	1.742000000E-04
738	1	663	1.742000000E-04
		662	1.742000000E-04
739	1	644	1.742000000E-04
		663	1.742000000E-04

ELEMENT	LKEY	FACE NODES	HEAT FLUX
740	3	2013	4.163000000E-05
		2014	4.163000000E-05
741	3	2014	4.163000000E-05
		2015	4.163000000E-05
742	3	2015	4.163000000E-05
		2016	4.163000000E-05
743	3	2016	4.163000000E-05

		2017	4.163000000E-05
744	3	2017	4.163000000E-05
		2018	4.163000000E-05
745	3	2018	4.163000000E-05
		2019	4.163000000E-05
746	3	2019	4.163000000E-05
		2020	4.163000000E-05
747	3	2020	4.163000000E-05
		2012	4.163000000E-05
749	4	2012	4.163000000E-05
		2046	4.163000000E-05
750	4	2046	4.163000000E-05
		2045	4.163000000E-05

ELEMENT	LKEY	FACE NODES	HEAT FLUX
751	4	2045	4.163000000E-05
		2044	4.163000000E-05
752	4	2044	4.163000000E-05
		2043	4.163000000E-05
753	4	2043	4.163000000E-05
		2042	4.163000000E-05
754	4	2042	4.163000000E-05
		2041	4.163000000E-05
755	4	2041	4.163000000E-05
		2040	4.163000000E-05
756	4	2040	4.163000000E-05
		2039	4.163000000E-05
757	4	2039	4.163000000E-05
		2038	4.163000000E-05
758	4	2038	4.163000000E-05
		2037	4.163000000E-05
759	4	2037	4.163000000E-05
		2036	4.163000000E-05
760	4	2036	4.163000000E-05
		2035	4.163000000E-05

ELEMENT	LKEY	FACE NODES	HEAT FLUX
762	1	2050	4.163000000E-05
		2049	4.163000000E-05
763	1	2051	4.163000000E-05
		2050	4.163000000E-05
764	1	2052	4.163000000E-05
		2051	4.163000000E-05
765	1	2053	4.163000000E-05
		2052	4.163000000E-05
766	1	2054	4.163000000E-05
		2053	4.163000000E-05
767	1	2055	4.163000000E-05
		2054	4.163000000E-05
768	1	2056	4.163000000E-05
		2055	4.163000000E-05
769	1	2035	4.163000000E-05
		2056	4.163000000E-05

Appendix 2

Print-out of the Results

(5 Pages)

8-120B Cask NCT Analyses – FEM Analyses Results

3-d Model Results

```
c***  Fire Shield

ESEL  FOR LABEL= REAL  FROM      15 TO      15 BY       1

     880  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ESEL  COMMAND.

ERSE  FOR LABEL= TYPE  FROM       1 TO       3 BY       1

     880  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ERSE  COMMAND.

SELECT      ALL NODES HAVING ANY ELEMENT IN ELEMENT SET.

    1944 NODES (OF    39845  DEFINED) SELECTED FROM
     880 SELECTED ELEMENTS BY NELE COMMAND.

MAXIMUM ABSOLUTE VALUES
NODE      40028
VALUE    160.58

c***  Outer Shell

ESEL  FOR LABEL= REAL  FROM      10 TO      10 BY       1

    1760  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ESEL  COMMAND.

ERSE  FOR LABEL= TYPE  FROM       1 TO       3 BY       1

    1760  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ERSE  COMMAND.

SELECT      ALL NODES HAVING ANY ELEMENT IN ELEMENT SET.

    3726 NODES (OF    39845  DEFINED) SELECTED FROM
    1760 SELECTED ELEMENTS BY NELE COMMAND.

MAXIMUM ABSOLUTE VALUES
NODE       1376
VALUE    161.34

c***  Inner Shell

ESEL  FOR LABEL= REAL  FROM       9 TO       9 BY       1

    2720  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ESEL  COMMAND.

ERSE  FOR LABEL= TYPE  FROM       1 TO       3 BY       1

    2720  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ERSE  COMMAND.

SELECT      ALL NODES HAVING ANY ELEMENT IN ELEMENT SET.
```

```
    5670 NODES (OF    39845  DEFINED) SELECTED FROM
    2720 SELECTED ELEMENTS BY NELE COMMAND.

MAXIMUM ABSOLUTE VALUES
NODE      10521
VALUE    161.47

c***  Lead

ESEL  FOR LABEL= REAL  FROM      11 TO      11 BY       1

    1440  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ESEL  COMMAND.

ERSE  FOR LABEL= TYPE  FROM       1 TO       3 BY       1

    1440  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ERSE  COMMAND.

SELECT      ALL NODES HAVING ANY ELEMENT IN ELEMENT SET.

    2331 NODES (OF    39845  DEFINED) SELECTED FROM
    1440 SELECTED ELEMENTS BY NELE COMMAND.

MAXIMUM ABSOLUTE VALUES
NODE      14411
VALUE    161.41

c***  Baseplates

ESEL  FOR LABEL= REAL  FROM      12 TO      13 BY       1

    2296  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ESEL  COMMAND.

ERSE  FOR LABEL= TYPE  FROM       1 TO       3 BY       1

    2296  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ERSE  COMMAND.

SELECT      ALL NODES HAVING ANY ELEMENT IN ELEMENT SET.

    3607 NODES (OF    39845  DEFINED) SELECTED FROM
    2296 SELECTED ELEMENTS BY NELE COMMAND.

MAXIMUM ABSOLUTE VALUES
NODE       2430
VALUE    162.33

c***  Primary Lid

ESEL  FOR LABEL= REAL  FROM       1 TO       2 BY       1

    7344  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ESEL  COMMAND.

ERSE  FOR LABEL= TYPE  FROM       1 TO       3 BY       1
```

```
    7344  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ERSE  COMMAND.

SELECT      ALL NODES HAVING ANY ELEMENT IN ELEMENT SET.

   10590 NODES (OF    39845  DEFINED) SELECTED FROM
    7344 SELECTED ELEMENTS BY NELE COMMAND.

MAXIMUM ABSOLUTE VALUES
NODE      37675
VALUE    162.16

c***  Secondary Lid

ESEL  FOR LABEL= REAL  FROM       3 TO       4 BY       1

    1098  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ESEL  COMMAND.

ERSE  FOR LABEL= TYPE  FROM       1 TO       3 BY       1

    1098  ELEMENTS (OF    40315  DEFINED) SELECTED BY  ERSE  COMMAND.

SELECT      ALL NODES HAVING ANY ELEMENT IN ELEMENT SET.

    1835 NODES (OF    39845  DEFINED) SELECTED FROM
    1098 SELECTED ELEMENTS BY NELE COMMAND.

MAXIMUM ABSOLUTE VALUES
NODE      27023
VALUE    162.55

c***  Primary Seal

NSEL  FOR LABEL= NODE  FROM   25430 TO   25430 BY       1

       1  NODES (OF    39845  DEFINED) SELECTED BY  NSEL  COMMAND.

PRINT DOF  NODAL SOLUTION PER NODE

 ***** POST1 NODAL DEGREE OF FREEDOM LISTING *****

 LOAD STEP=     1  SUBSTEP=     1
  TIME=    1.0000      LOAD CASE=   0

   NODE      TEMP
  25430   161.55

MAXIMUM ABSOLUTE VALUES
NODE      25430
VALUE    161.55

c***  Secondary Seal
```

```
NSEL  FOR LABEL= NODE  FROM   37678 TO   37678 BY       1

       1  NODES (OF    39845  DEFINED) SELECTED BY  NSEL  COMMAND.
PRINT DOF  NODAL SOLUTION PER NODE

 ***** POST1 NODAL DEGREE OF FREEDOM LISTING *****

 LOAD STEP=     1  SUBSTEP=     1
  TIME=    1.0000      LOAD CASE=   0

   NODE      TEMP
  37678   162.15

MAXIMUM ABSOLUTE VALUES
NODE       37678
VALUE     162.15

c***  Vent Seal

NSEL  FOR LABEL= NODE  FROM   34802 TO   34802 BY       1

       1  NODES (OF    39845  DEFINED) SELECTED BY  NSEL  COMMAND.

PRINT DOF  NODAL SOLUTION PER NODE

 ***** POST1 NODAL DEGREE OF FREEDOM LISTING *****

 LOAD STEP=     1  SUBSTEP=     1
  TIME=    1.0000      LOAD CASE=   0

   NODE      TEMP
  34802   161.82

MAXIMUM ABSOLUTE VALUES
NODE       34802
VALUE     161.82

c***  Impact Limiters

NSEL  FOR LABEL= NODE  FROM   27594 TO   27594 BY       1

       1  NODES (OF    39845  DEFINED) SELECTED BY  NSEL  COMMAND.

PRINT DOF  NODAL SOLUTION PER NODE

 ***** POST1 NODAL DEGREE OF FREEDOM LISTING *****

 LOAD STEP=     1  SUBSTEP=     1
  TIME=    1.0000      LOAD CASE=   0

   NODE      TEMP
  27594   161.89

MAXIMUM ABSOLUTE VALUES
```

```
NODE       27594
VALUE     161.89
```

2-d Model Results

```
c***  Cavity Air


ESEL  FOR LABEL= REAL  FROM      17 TO      17 BY       1

     355  ELEMENTS (OF     1210  DEFINED) SELECTED BY  ESEL  COMMAND.

ERSE  FOR LABEL= TYPE  FROM       1 TO       1 BY       1

     355  ELEMENTS (OF     1210  DEFINED) SELECTED BY  ERSE  COMMAND.

SELECT      ALL NODES HAVING ANY ELEMENT IN ELEMENT SET.

     412 NODES (OF     1074  DEFINED) SELECTED FROM
     355 SELECTED ELEMENTS BY NELE COMMAND.


MAXIMUM ABSOLUTE VALUES
NODE        2029
VALUE     197.87

c***  Contents


ESEL  FOR LABEL= REAL  FROM      16 TO      16 BY       1

      58  ELEMENTS (OF     1210  DEFINED) SELECTED BY  ESEL  COMMAND.

ERSE  FOR LABEL= TYPE  FROM       1 TO       1 BY       1

      30  ELEMENTS (OF     1210  DEFINED) SELECTED BY  ERSE  COMMAND.

SELECT      ALL NODES HAVING ANY ELEMENT IN ELEMENT SET.

      62 NODES (OF     1074  DEFINED) SELECTED FROM
      30 SELECTED ELEMENTS BY NELE COMMAND.


MAXIMUM ABSOLUTE VALUES
NODE        2041
VALUE     197.92
```

Appendix 3

Electronic Data on CDROM

(1 CDROM)

```
 Volume in drive E is TH-027
 Volume Serial Number is 1B9C-7679

 Directory of E:\

11/08/2011  01:46 PM    <DIR>          2-D Model
11/08/2011  01:47 PM    <DIR>          3-D Model
               0 File(s)              0 bytes

 Directory of E:\2-D Model

11/08/2011  01:46 PM    <DIR>          .
11/08/2011  02:18 PM    <DIR>          ..
10/31/2011  12:16 PM            65,536 annulus-sub.sub
10/31/2011  12:16 PM            59,964 ansub.out
10/31/2011  03:06 PM           131,072 cavity-sub.sub
10/31/2011  03:06 PM           337,229 cavsub.out
11/08/2011  11:04 AM            15,592 Component-Temp.out
11/08/2011  11:04 AM         5,046,272 file.db
11/08/2011  11:01 AM         2,031,616 file.rth
11/08/2011  10:08 AM            32,365 file001.png
11/08/2011  10:10 AM            22,124 file002.png
11/08/2011  10:58 AM           207,574 model.out
              10 File(s)      7,949,344 bytes

 Directory of E:\3-D Model

11/08/2011  01:47 PM    <DIR>          .
11/08/2011  02:18 PM    <DIR>          ..
07/23/2010  04:55 PM        30,474,240 annulus15.sub
06/07/2011  01:21 PM           898,985 Component-Temp.out
06/01/2011  10:44 AM        85,196,800 file.db
07/23/2010  05:01 PM       145,620,992 file.rth
11/01/2010  05:06 PM           191,514 file000.png
08/11/2010  07:37 AM           141,351 file001.png
11/01/2010  05:06 PM           194,097 file002.png
11/01/2010  05:07 PM           135,924 file003.png
11/01/2010  05:09 PM           120,951 file004.png
11/01/2010  05:18 PM           116,068 file005.png
11/01/2010  05:23 PM           162,507 file006.png
11/01/2010  05:24 PM           147,415 file008.png
11/01/2010  05:24 PM           143,242 file009.png
11/01/2010  05:24 PM           144,466 file010.png
11/01/2010  05:24 PM           142,474 file011.png
11/01/2010  10:24 AM         2,892,976 model.out
              16 File(s)    266,724,002 bytes

     Total Files Listed:
              26 File(s)    274,673,346 bytes
               6 Dir(s)               0 bytes free
```