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1.0 OBJECTIVE

Perform the structural analyses of the Energy*Solutions* 3-60B Cask under drop conditions, using a 3-dimensional finite element model.

2.0 INTRODUCTION

Energy*Solutions* 3-60B 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 structural analysis of the 3-60B Cask under various drop conditions required by the code. The analyses in this document are performed using the finite element modeling techniques. A three-dimensional model of the cask that includes all its major components has been employed in the analyses. Temperature dependent material properties of the major components of the cask are used in the analyses.

Analyses of the 3-60B Cask package have been performed for hypothetical accident condition (HAC) and normal condition of transport (NCT) drop test using the methodology developed by Energy*Solutions*. The details of the analyses are documented in the proprietary document of Reference 4. The resultant impact loads during various drop tests are obtained from this document and applied to the detailed finite element model of the cask body. Every component of the cask is evaluated for its integrity during the drop tests by comparing the stress intensities with their corresponding allowable values.

The results of the analyses for various load cases are presented pictorially in stress intensity contour plots as well as in table form, with the corresponding safety factors in each component of the cask body.

3.0 REFERENCES

- 1. Energy*Solutions* Drawing No. C-002-165024-001, Rev.0, 3-60B Cask General Arrangement and Details.
- 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. Energy*Solutions* Document No. ST-557, Rev.0, Drop Analyses of the 3-60B Cask Package Using LS-DYNA Program.
- 5. ASME Boiler & Pressure Vessel Code, Section II, Part D, Materials, The American Society of Mechanical Engineers, New York, NY, 2005.

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- 6. NUREG 0481/SAND77-1872, An Assessment of Stress-Strain Data Suitable for Finite Element Elastic-Plastic Analysis of Shipping Containers, Sandia National Laboratories, 1978.
- 7. U.S. NRC Regulatory Guide 7.6, Revision 1, Design Criteria for the Structural Analysis of Shipping Cask Containment Vessels, 1978.
- 8. ANSYS, Rev. 11.0, Computer Software, ANSYS Inc., Canonsburg, PA, 2007.
- 9. Energy*Solutions* Document No. ST-501, Rev.1, Structural Analyses of the 3-60B Cask under Normal Conditions of Transport.
- 10. Energy*Solutions* Document TH-022, Rev.1, Steady State Thermal Analyses of the 3-60B Cask Using a 3-D Finite Element Model.

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4.0 MATERIAL PROPERTIES

			Strength (ksi)	V ?-	Coefficient
Matarial	Temp.	Yield	Ultimate	Membrane	Young S	of Thermal
Material	(°F)	(S_v)	(S_u)	Allowable	Modulus	Expansion
			(4)	(S_m)	(10° psi)	(10^{-6} in/in)
		(1)	(1)	(1)	(1)	(1)
	-20	25.0	70.0	16.7	28.8	-
	70	25.0	70.0	16.7	28.3	8.5
ASTM A240	100	25.0	70.0	16.7	-	8.6
Type 304L	200	21.4	66.1	16.7	27.5	8.9
	300	19.2	61.2	16.7	27.0	9.2
	400	17.5	58.7	15.8	26.4	9.5
	500	16.4	57.5	14.7	25.9	9.7
		(1)	(1)	(1)	(1)	(1)
	-20	45.0	87.0	24.9	28.8	-
ASTM A240	70	45.0	87.0	24.9	28.3	8.5
Gr. 45 &	100	45.0	87.0	24.9	-	8.6
ASTM A182	200	37.5	86.4	24.7	27.5	8.9
Gr. F45	300	33.0	81.6	23.3	27.0	9.2
	400	29.9	78.5	22.4	26.4	9.5
	500	27.8	76.4	21.8	25.9	9.7
		(1)	(1)	(1)	(1)	(1)
	-20	130	150	30	29.7	-
	70	130	150	30	29.2	6.4
ASTM A354	100	130	150	30	-	6.5
(Lid Dalta)	200	119.1	150	30	28.6	6.7
(Lid Bolts)	300	115	150	30	28.1	6.9
	400	111	150	30	27.7	7.1
	500	105.9	150	30	27.1	7.3
		(2)			(2)	(2)
	-20	-	-	-	2.43	15.65
	70	5	-	-	2.27	16.06
ASTM B29	100	-	_	-	2.21	16.22
Lead	200	-	-	-	2.01	16.70
	300	-	-	-	1.85	17.33
	400	-	_	-	1.70	18.16
	500	-	-	-	1.52	19.12

Notes:

(1) From ASME B&PV Code 2004, Section II, Part D (Reference 5).

(2) From NUREG/CR 0481 (Reference 6)

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5.0 <u>ALLOWABLE STRESSES</u>

Material →		ASTM A240 Type 304L	ASTM A182 Gr.F45 & A240 Gr. 45	ASTM A354 Gr. BD
Yield Stress, S _y		25,000 ⁽¹⁾	45,000 ⁽¹⁾	130,000 ⁽¹⁾
Ultimate Stress	s, S _u (psi)	70,000 ⁽¹⁾	87,000 ⁽¹⁾	150,000 ⁽¹⁾
Design Stress Intensity, S _m (psi)		16,700 ⁽¹⁾	24,900 ⁽¹⁾	30,000 ⁽¹⁾
	Membrane Stress	16,700 ⁽²⁾	24,900 ⁽²⁾	60,000 ⁽²⁾
Normal Conditions	Mem. + Bending Stress	25,050 ⁽²⁾	37,350 ⁽²⁾	90,000 ⁽²⁾
	Peak Stress	50,100 ⁽³⁾	$04L$ Gr.F45 & A240 Gr. 45Gr. BD $0^{(1)}$ 45,000^{(1)}130,000^{(1)} $0^{(1)}$ 87,000^{(1)}150,000^{(1)} $0^{(1)}$ 24,900^{(1)}30,000^{(1)} $0^{(2)}$ 24,900^{(2)}60,000^{(1)} $0^{(2)}$ 37,350^{(2)}90,000^{(1)} $0^{(3)}$ 74,700^{(3)}150,000^{(1)} $0^{(4)}$ 59,760^{(4)}105,000^{(1)} $0^{(4)}$ 87,000^{(4)}150,000^{(1)} $0^{(5)}$ 174,000^{(5)}300,000^{(1)}	150,000 ⁽³⁾
Hypothetical	Membrane Stress	40,080 ⁽⁴⁾	59,760 ⁽⁴⁾	105,000 ⁽⁴⁾
Accident	Mem. + Bending Stress	60,120 ⁽⁴⁾	87,000 ⁽⁴⁾	150,000 ⁽⁴⁾
Conditions	Peak Stress	140,000 ⁽⁵⁾	174,000 ⁽⁵⁾	300,000 ⁽⁵⁾

Notes:

- (1) From ASME B&PV Code 2004, Section II, Part D (Reference 5).
- (2) Established from Regulatory Guide 7.6 (Reference 7).
- (3) Regulatory Guide 7.6 (Reference 7) does not provide any criteria. These allowable values have been established here based on the ASME, Section III, Division 3, WB-3200 (Reference 5) criteria.
- (4) Regulatory Guide 7.6 (Reference 7) does not provide any criteria. ASME B&PV Code, Section III, Appendix F has been used to establish these criteria.
- (5) Regulatory Guide 7.6 (Reference 7) does not provide any criteria. The ASME Section III, Division 3, WB-3200 (Reference 5) criteria of $2S_a$ @ 10 cycles results in an unreasonably high stress allowable. This criterion is conservatively set to be $2S_u$ for limiting the peak stresses.

6.0 MODEL DESCRIPTION

The structural analyses of the 3-60B Cask under various drop test conditions have been performed using finite element modeling techniques. ANSYS finite element analysis code (Ref. 8) has been employed to perform the analyses. Since for all the drop orientations (end,

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side, corner, and slap-down), at least one plane of symmetry exists, a 180° model has been employed in all the analyses. This model has been developed from the 11.25° model developed in References 9 and 10 for the structural and thermal analyses of the cask during normal conditions of transport.

The model of the cask is made using 3-dimensional 8-node structural solid elements (ANSYS SOLID185) to represent the major components of the cask, the cask body, the lid, and the bolts. The fire shield does not provide any structural strength to the cask. Therefore, it is not included in the model.

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 contact element (CONTA174) and 3-d target segment (TARGE170) elements. These elements allow the lead to slide over the steel at the same time prevent it from penetrating the steel surface. The interface between the two plates that form the lid is also modeled by the contact-target pairs. The transition from a coarser mesh to a finer mesh, as well as bondage between various parts of the model, is also modeled using these elements.

Figure 1 shows the outline of the model depicting the material numbering. Figure 2 shows the finite element grid of the lid, seal plate, and the bolts. Figure 3 shows the finite element grid of the cask body without the lead and Figure 4 shows that of the lead. The interface between various components of the cask is modeled by target-contact surface definition. Figure 5 shows target surfaces of various contact-target pairs. The printout of the pertinent model quantities is included in Appendix 1.

Boundary Conditions

Since the model of the cask includes 180° geometry, symmetry boundary conditions are used on the cut-plane of the model in all the analyses. Also, the rigid body motion is prevented in the model by restraining it at the locations where such restraints have insignificant effect on the overall behavior of the model. This is necessary since the quasi-static analyses performed for every drop condition will result in a small net force in the plane of symmetry that will give rise to a rigid body motion.

Loading

Applied loading is described for each drop orientation under the corresponding analysis section.

Temperature

The temperature distribution under various drop conditions is obtained from the thermal analyses performed in Reference 10 and is applied as the nodal temperature in the finite element model.

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Internal Pressure

The cask internal pressure of 35 psig is applied over the nodes representing the cavity of the cask under various drop conditions in the hot environment. No internal pressures are applied during all drop conditions in the cold environment, with or without the internal decay heat.

Inertia Load

Cask body inertia, under various drop conditions, is applied as a body load. The magnitude of the inertia load is given in the corresponding analysis section. It should be noted that because of the segmentation of arc length in the finite element models, the mass of the model is always lower than the actual mass. To account for this, as well as to include the mass of miscellaneous items not included in the model, an adjustment is made in the value of acceleration due to gravity.

Cask Body Mass = $80,000 - 9,500 - 2 \times 3,800 = 62,900$ lb

Mass of the FEM = $2 \times 28,409 = 56,818$ lb

Acceleration multiplication factor = 62,900/56,818 = 1.107

7.0 ANALYSES

The finite element model (FEM) described above is analyzed for the accelerations obtained from the EnergySolutions proprietary analyses documented in Reference 4. The distribution of various loading components is described in details in the following sections.

7.1 HAC Drop Tests

7.1.1 End Drop

The following cask accelerations are obtained from Reference 4.

Cold Conditions = 104.8 g (Table 3, Reference 4)

Hot Conditions = 77.8 g (Table 3, Reference 4)

Conservatively use the maximum of the two accelerations for the analyses of all environmental conditions. Also, a factor of 1.3 is used to increase this acceleration in the analyses.

Acceleration used = $1.3 \times 104.8 = 136.2 \text{ g} \approx 150 \text{ g}$

For the quasi-static analysis of the cask under end drop test conditions the inertia loads and reactions are distributed to the cask body as shown in Figure 6.

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<u>Impact limiter Inertia</u>

The inertia load of the lower impact limiter is included as the uniform pressure on the surface where the impact limiter contacts the cask.

Mass of each Impact Limiter = 3,800 lb

Inside Radius of the Impact Limiter = 12 in (nearest node in the FEM is at 12.5 in)

Outside Radius of the Cask = 25.5 in

Pressure on the cask due to impact limiter inertia,

$$p_{\text{I.L.}} = 150 \times 3,800 / [\pi \times (25.5^2 - 12.5^2)] = 367.3 \text{ psi}$$

Payload Inertia

The payload inertia is applied as a uniform surface pressure over the lid inside surface. The lid has a radius of 17.375 in. For 9,500 lb total mass of payload, the magnitude of the pressure is:

$$p_{\text{lid}} = 150 \times 9,500 / (\pi \times 17.375^2) = 1,502.5 \text{ psi}$$

Cask Body Inertia

Cask body inertia is applied as the body force. As explained earlier, to account for the total mass of the package a factor of 1.107 is used to increase the FEM mass.

Cask Body Acceleration = $150 \times 1.107 = 166$ g

Impact Limiter Reaction

The impact limiter reaction is simulated by restraining the nodes at the impact limiter-lid interface in vertical direction.

<u>Model Analyses</u>

The FEM is analyzed under the above loading for hot (Load Case 1), cold with maximum decay heat (Load Case 2), and cold with no decay heat, environmental conditions. The cask body temperature for Load Cases 1 and 2 are obtained from the hot and cold environmental loading conditions of Reference 10. For Load Case 3 (no internal heat), the entire cask is assumed to be at -20°F. Figures 7 through 9 show the cask body temperature profile and the pressure distributions used in the FEM for Load Cases 1 through 3.

Figures 10 through 12 show the stress intensity plot in the cask body for the three load cases. Stress intensities are calculated in each major component of the cask and are presented in Tables 1 through 3. These tables also categorize the stresses based on the ASME code and

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compare them with the corresponding allowable value established in Section 5.0. Factors of safety based on the ratio of allowable stress to the calculated stress are also calculated.

7.1.2 Side Drop

The following cask accelerations are obtained from Reference 4.

Cold Conditions = 85.8 g (Table 3, Reference 4)

Hot Conditions = 79.5 g (Table 3, Reference 4)

Conservatively use the maximum of the two accelerations for the analyses of all environmental conditions. Also, a factor of 1.3 is used to increase this acceleration in the analyses.

Acceleration used = $1.3 \times 85.8 = 111.54 \text{ g} \approx 120 \text{ g}$

For the quasi-static analysis of the cask under side drop test conditions reactions and the inertia loads are distributed to the cask body as shown in Figure 13.

Impact Limiter Reactions

The impact limiter reactions are applied as surface pressure on the lower half of the impact limiter-cask interface. This pressure is assumed to be uniform along the axis of the cask but varies sinusoidally along the circumference. For such a distribution, the following mathematical derivation is used:

$$p(\theta) = p_0 \cos \theta \qquad -\pi/2 \le \theta \le \pi/2$$

$$F_{\nu} = \int_{-\pi/2}^{\pi/2} p_0 \cdot \cos \theta \cdot r \cdot d\theta \cdot \cos \theta$$

$$= p_0 \cdot r \int_{-\pi/2}^{\pi/2} \cos^2 \theta \, d\theta$$

$$= p_0 \cdot r \int_{-\pi/2}^{\pi/2} \frac{1}{2} \cdot (1 + \cos 2\theta) \cdot d\theta$$

$$= \frac{p_0 \cdot r}{2} \left[\theta + \frac{\sin 2\theta}{2} \right]_{-\pi/2}^{\pi/2}$$

$$= \frac{\pi \cdot r \cdot p_0}{2}$$

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$$F_{h} = \int_{-\pi/2}^{\pi/2} p_{0} \cdot \cos\theta \cdot r \cdot d\theta \cdot \sin\theta$$
$$= p_{0} \cdot r \int_{-\pi/2}^{\pi/2} \frac{1}{2} \cdot \sin 2\theta \cdot d\theta$$
$$= \frac{p_{0} \cdot r}{2} \left[\frac{-\cos 2\theta}{2} \right]_{-\pi/2}^{\pi/2}$$
$$= 0$$

Reaction of the cask at the two impact limiter locations, $2R = (80,000 - 2 \times 3,800) \times 120$

Reaction at each impact limiter location, $R = \frac{1}{2} \times (80,000 - 2 \times 3,800) \times 120 = 4.344 \times 10^6$ lb

The top impact limiter reaction is applied at the surface that has a radius of 25.5 in and extends in the axial direction over a length of 20.28 in. Thus,

 $p_0 = (2 \times 4.344 \times 10^6) / (\pi \times 25.5 \times 20.28) = 5,348 \text{ psi}$

The bottom impact limiter reaction is applied at the surface that has a radius of 25.5 in and extends in the axial direction over a length of 21.355 in. Thus,

$$p_0 = (2 \times 4.344 \times 10^6) / (\pi \times 25.5 \times 21.355) = 5,078 \text{ psi}$$

Payload Inertia

The pay load inertia load is applied as surface pressure on the lower half of the inner shell of the cask. This pressure is assumed to be uniform along the axis of the cask but varies sinusoidally along the circumference. The radius of the inner shell is 17.5 in and its length is 109 inch. Thus,

$$p_0 = (2 \times 120 \times 9,500)/(\pi \times 17.5 \times 109) = 380.5 \text{ psi}$$

Cask Body Inertia

Cask body inertia is applied as the body force. As explained earlier, to account for the total mass of the package a factor of 1.107 is used to increase the FEM mass.

Cask Body Acceleration = $120 \times 1.107 = 132.84$ g

Model Analyses

The FEM is analyzed under the above loading for hot (Load Case 1), cold with maximum decay heat (Load Case 2), and cold with no decay heat, environmental conditions. The cask body temperature for Load Cases 1 and 2 are obtained from the hot and cold environmental loading conditions of Reference 10. For Load Case 3 (no internal heat), the entire cask is

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assumed to be at -20°F. Figures 14 through 16 show the cask body temperature profile and the pressure distributions used in the FEM for Load Cases 1 through 3.

Figures 17 through 19 show the stress intensity plot in the cask body for the three load cases. Stress intensities are calculated in each major component of the cask and are presented in Tables 4 through 6. These tables also categorize the stresses based on the ASME code and compare them with the corresponding allowable value established in Section 5.0. Factors of safety based on the ratio of allowable stress to the calculated stress are also calculated.

7.1.3 Corner Drop

The following cask accelerations are obtained from Reference 4.

Cold Conditions = 49.4 g (Table 3, Reference 4)

Hot Conditions = 46.4 g (Table 3, Reference 4)

Conservatively use the maximum of the two accelerations for the analyses of all environmental conditions. Also, a factor of 1.3 is used to increase this acceleration in the analyses.

Acceleration used = $1.3 \times 49.4 = 64.22$ g ≈ 70 g

For the quasi-static analysis of the cask under corner drop test conditions reactions and the inertia loads are distributed to the cask body as shown in Figure 20.

The finite element model of the cask shows that the C.G. of the cask is 65.45 in from the bottom side of the lid. The cask has a radius of 25.5 in. Therefore, for the C.G. to be directly above the corner, the cask axis will be inclined from the vertical axis by an angle,

 $\alpha = \tan^{-1}(25.5/65.45) = 21.29^{\circ}$

Thus, the axial acceleration,

 $g_a = 70 \times Cos \ 21.29^\circ = 65.22 g$

Lateral acceleration,

 $g_l = 70 \times Sin \ 21.29^\circ = 25.42 g$

Impact Limiter Reaction

The impact limiter reaction is resolved into an axial and a lateral component. The axial



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component is applied to the lid surface at the interface with the impact limiter. The pressure is assumed to vary sinusoidally along the tangential direction. Mathematically this pressure may be represented by:

$$p(r,\theta) = p_0 \cdot \frac{r \cdot \cos\theta}{r_2} \cdot r \cdot d\theta \cdot dr \qquad -\pi/2 \le \theta \le \pi/2$$

This distribution results in the total axial load, F that can be calculated by integration as follows:

$$F = \int_{-\pi/2}^{\pi/2} \int_{r_1}^{r_2} \frac{p_0}{r_2} \cdot r \cdot \cos\theta \cdot r \cdot dr \cdot d\theta$$
$$= \frac{p_0}{r_2} \cdot \int_{-\pi/2}^{\pi/2} \cos\theta \cdot d\theta \cdot \int_{r_1}^{r_2} r^2 \cdot dr$$
$$= \frac{2}{3} \cdot \frac{p_0}{r_2} \cdot \left(r_2^3 - r_1^3\right)$$



The axial component of the impact limiter reaction,

 $R_{\rm a} = (80,000 - 3,800) \times 65.22 = 4.97 \times 10^6 \, \text{lb}$

The reaction is distributed over the lid surface annulus having an inside radius of 15 in and outside radius of 25.5 in. To get the total load R_a on the lid surface, p_0 must be,

$$p_0 = 4.97 \times 10^6 \cdot \frac{3}{2} \cdot \left(\frac{25.5}{25.5^3 - 15^3}\right) = 14,395 \text{ psi}$$

Since the lid has the bolt-hole cut-outs in this region, thereby reducing the area over which this load is applied, adjustment in the above pressure value must be made. This adjustment was manually made using the FEM. To obtain the total load of 4.97×10^6 lb, the value for p_0 was increased to 17,409 psi.

The lateral component of the impact limiter reaction was applied in the manner as described under side drop loading with the exception that the magnitude of the pressure is also varied linearly from the maximum value to zero at the top of the impact limiter edge.

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The lateral component of the impact limiter reaction is:

 $R_1 = (80,000 - 3,800) \times 25.42 = 1.937 \times 10^6$ lb

This reaction is applied at the surface that has a radius of 25.5 in and extends in the axial direction over a length of 20.28 in. Following the derivation under side drop,

 $p_0 = 2 \times [(2 \times 1.937 \times 10^6)/(\pi \times 25.5 \times 20.28)] = 4,769 \text{ psi}$

Note that a multiplier of 2 is used to account for the axial variation of the pressure.

Impact Limiter Inertia

The upper impact limiter inertia is resolved into an axial component and a lateral component. The axial component is applied in the same manner as described under end drop and the lateral component is applied in the same manner as described for the side drop impact limiter reaction.

Magnitude of the uniform pressure representing the impact limiter axial inertia is:

$$p_{\text{I.L.}} = 65.22 \times 3,800 / [\pi \times (25.5^2 - 12.5^2)] = 159.7 \text{ psi}$$

Amplitude of the sinusoidally varying pressure, representing the impact limiter lateral inertia,

$$p_0 = (2 \times 25.42 \times 3,800)/(\pi \times 25.5 \times 21.355) = 112.93$$
 psi

Payload Inertia

The payload inertia is resolved into an axial component and a lateral component. The axial component is applied to the lid in the same manner as described under the end drop. The lateral component is applied to the lower half of the inner shell as described under side drop.

Magnitude of the uniform pressure representing the payload axial inertia is:

 $p_{\text{lid}} = 65.22 \times 9,500 / (\pi \times 17.375^2) = 653.3 \text{ psi}$

Amplitude of the sinusoidally varying pressure, representing the payload lateral inertia,

$$p_0 = (2 \times 25.42 \times 9,500)/(\pi \times 17.5 \times 109) = 80.6 \text{ psi}$$

Cask Body Inertia

Cask body inertia is applied as the body force. As explained earlier, to account for the total mass of the package a factor of 1.107 is used to increase the FEM mass.

Cask Body Axial Acceleration = $65.22 \times 1.107 = 72.2$ g

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Cask Body Lateral Acceleration = 25.42×1.107 = 28.14 g

Model Analyses

The FEM is analyzed under the above loading for hot (Load Case 1), cold with maximum decay heat (Load Case 2), and cold with no decay heat, environmental conditions. The cask body temperature for Load Cases 1 and 2 are obtained from the hot and cold environmental loading conditions of Reference 10. For Load Case 3 (no internal heat), the entire cask is assumed to be at -20°F. Figures 21 through 23 show the cask body temperature profile and the pressure distributions used in the FEM for Load Cases 1 through 3.

Figures 24 through 26 show the stress intensity plot in the cask body for the three load cases. Stress intensities are calculated in each major component of the cask and are presented in Tables 7 through 9. These tables also categorize the stresses based on the ASME code and compare them with the corresponding allowable value established in Section 5.0. Factors of safety based on the ratio of allowable stress to the calculated stress are also calculated.

7.1.4 Shallow Angle Drop

As described in the Reference 4, the 3-60B cask package has also been analyzed for a shallow angle drop test. Under this test condition, the cask axis makes an angle of 15° with the horizontal plane. The lower impact limiter makes contact with the rigid target surface. This is followed by a rotation of the cask and the second impact limiter then strikes the rigid surface. With the four orientations for the drop test addressed in this document the entire spectrum of initial orientations of the cask package for the hypothetical drop test has been covered. The FEM analyses have performed for sufficiently large time durations in which both primary as well as secondary impacts, if any, take place. Thus, the slap-down effect of the shallow angle drop, as well as that during the corner-over-C.G. drop has been included in these analyses.

The results of the shallow angle drop analyses show that the second impact is more severe than the first impact. The maximum impact limiter reaction during this case is:

$$R_{\text{shallow-angle}} = 1.8 \times 10^6 \text{ lb}$$
 (Table 3, Reference 4)

The nature of impact limiter reaction in this case is very similar to that of the side drop test. The maximum impact limiter reaction during the side drop test is:

$$R_{\text{side-drop}} = \frac{1}{2} \times 3.431 \times 10^{6}$$
(Table 3, Reference 4)
= 1.715 \times 10^{6}

Thus, the shallow angle drop test will result in the impact limiter reaction that is larger than that of the side drop test by a factor of:

$$1.8/1.715 = 1.05$$

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Therefore, a factor of safety of 1.05 or larger in the cask due to HAC side drop loading will ensure that cask will satisfy the design acceptance criteria for the shallow angle drop orientation also. From the examination of results presented in Tables 4 through 6, it is observed that the minimum factor of safety is 1.07, which is larger than 1.05 needed for shallow angle drop test.

7.1.5 Lead Slump Evaluation

Analysis of the 3-60B cask package under HAC drop test has been performed in the side drop orientation with cask top-end down. Since the top end of the cask has a bolted connection between the lid and the cask body, it is more critical than the bottom-end down orientation which includes no bolted connections. However, the cask is most vulnerable, as far as lead slump is concerned, in the bottom end down orientation. To get a conservative estimate of the lead slump, structural analysis of the cask has been performed with the bottom-end down orientation. The most conservative environmental conditions (cold with no decay heat) have been employed in the analysis. Figure 27 shows the displacement plot during this drop test. The largest relative displacement of 0.3172 in is calculated at the bolting ring-lead interface. It should be noted this is the total relative displacement. In considering this to be the lead slump, the elastic recovery of the lead and steel has been neglected.

7.2 NCT Drop Tests

The distribution of the NCT drop test loading on various components of the cask, under all the drop orientations, have been obtained by linearly proportioning the corresponding loading from the HAC drop tests.

7.2.1 End Drop

The following cask accelerations are obtained from Reference 4.

Cold Conditions = 31.7 g (Table 2, Reference 4)

Hot Conditions = 25.5 g (Table 2, Reference 4)

Maximum of the two accelerations = 31.7 g

Corresponding HAC acceleration = 104.8 g

Ratio of NCT to HAC acceleration, $R_{end} = 31.7/104.8 = 0.3025$

Impact limiter Inertia

 $p_{\text{I.L.}} = 0.3025 \times 367.3 = 111.11 \text{ psi}$

Payload Inertia

 $p_{\text{lid}} = 0.3025 \times 1,502.5 = 454.5 \text{ psi}$

Title	Structu	iral Analyse	s of the 3	3-60B Cask Under Drop Conditions			
Calc. No.	ST-504	Rev.	0	Sheet	15	_of26	

Cask Body Inertia

Cask Body Acceleration = $0.3025 \times 166 = 50.2$ g

<u>Model Analyses</u>

The FEM is analyzed under the above loading for hot (Load Case 1), cold with maximum decay heat (Load Case 2), and cold with no decay heat, environmental conditions. The cask body temperature for Load Cases 1 and 2 are obtained from the hot and cold environmental loading conditions of Reference 10. For Load Case 3 (no internal heat), the entire cask is assumed to be at -20°F. Figures 28 through 30 show the cask body temperature profile and the pressure distributions used in the FEM for Load Cases 1 through 3.

Figures 31 through 33 show the stress intensity plot in the cask body for the three load cases. Stress intensities are calculated in each major component of the cask and are presented in Tables 10 through 12. These tables also categorize the stresses based on the ASME code and compare them with the corresponding allowable value established in Section 5.0. Factors of safety based on the ratio of allowable stress to the calculated stress are also calculated.

7.2.2 Side Drop

The following cask accelerations are obtained from Reference 4.

Cold Conditions = 20.2 g (Table 2, Reference 4)

Hot Conditions = 16.8 g (Table 2, Reference 4)

Maximum of the two accelerations = 20.2 g

Corresponding HAC acceleration = 85.8 g

Ratio of NCT to HAC acceleration, $R_{side} = 20.2/85.8 = 0.2354$

Impact Limiter Reactions

Top impact limiter pressure amplitude,

 $p_0 = 0.2354 \times 5,348 = 1,258.9$ psi

Bottom impact limiter pressure amplitude,

 $p_0 = 0.2354 \times 5,078 = 1,195.4$ psi

Payload Inertia

Payload inertia pressure amplitude,

Title	Structu	iral Analyse	s of the 3	-60B Cask Under Drop Conditions			
Calc. No	ST-504	Rev.	0	Sheet _	16	_of26	

 $p_0 = 0.2354 \times 380.5 = 89.57$ psi

Cask Body Inertia

Cask Body Acceleration = $0.2354 \times 132.84 = 31.27$ g

Model Analyses

The FEM is analyzed under the above loading for hot (Load Case 1), cold with maximum decay heat (Load Case 2), and cold with no decay heat, environmental conditions. The cask body temperature for Load Cases 1 and 2 are obtained from the hot and cold environmental loading conditions of Reference 10. For Load Case 3 (no internal heat), the entire cask is assumed to be at -20°F. Figures 34 through 36 show the cask body temperature profile and the pressure distributions used in the FEM for Load Cases 1 through 3.

Figures 37 through 39 show the stress intensity plot in the cask body for the three load cases. Stress intensities are calculated in each major component of the cask and are presented in Tables 13 through 15. These tables also categorize the stresses based on the ASME code and compare them with the corresponding allowable value established in Section 5.0. Factors of safety based on the ratio of allowable stress to the calculated stress are also calculated.

7.2.3 Corner Drop

The following cask accelerations are obtained from Reference 4.

Cold Conditions = 21.2 g (Table 2, Reference 4)

Hot Conditions = 17.5 g (Table 2, Reference 4)

Maximum of the two accelerations = 21.2 g

Corresponding HAC acceleration = 49.4 g

Ratio of NCT to HAC acceleration, $R_{corner} = 21.2/49.4 = 0.4292$

Impact Limiter Reactions

Lid pressure magnitude,

 $p_{\text{lid}} = 0.4292 \times 17,409 = 7,471.9 \text{ psi}$

Wall pressure amplitude,

 $p_0 = 0.4292 \times 4,769 = 2,046.9$ psi

Impact Limiter Inertia

Title	Structu	ıral Analyse	s of the 3-	60B Cask Under Drop Conditions			
Calc. No.	ST-504	Rev.	0	Sheet	17	_of	26

Baseplate pressure magnitude,

 $p_{\rm I.L.} = 0.4292 \times 159.7 = 68.54 \text{ psi}$

Wall pressure amplitude,

$$p_0 = 0.4292 \times 112.93 = 48.47$$
 psi

Payload Inertia

Lid pressure magnitude

 $p_{\rm lid} = 0.4292 \times 653.3 = 280.4 \text{ psi}$

Wall pressure amplitude,

 $p_0 = 0.4292 \times 80.6 = 34.6 \text{ psi}$

Cask Body Inertia

Cask Body Axial Acceleration = $0.4292 \times 72.2 = 30.99$ g

Cask Body Lateral Acceleration = 0.4292×28.14 = 12.1 g

<u>Model Analyses</u>

The FEM is analyzed under the above loading for hot (Load Case 1), cold with maximum decay heat (Load Case 2), and cold with no decay heat, environmental conditions. The cask body temperature for Load Cases 1 and 2 are obtained from the hot and cold environmental loading conditions of Reference 10. For Load Case 3 (no internal heat), the entire cask is assumed to be at -20°F. Figures 40 through 42 show the cask body temperature profile and the pressure distributions used in the FEM for Load Cases 1 through 3.

Figures 43 through 45 show the stress intensity plot in the cask body for the three load cases. Stress intensities are calculated in each major component of the cask and are presented in Tables 16 through 18. These tables also categorize the stresses based on the ASME code and compare them with the corresponding allowable value established in Section 5.0. Factors of safety based on the ratio of allowable stress to the calculated stress are also calculated.

8.0 CONCLUSIONS

The results of the analyses performed in this document show that the 3-60B Cask meets the design requirements during all the drop test scenarios specified in 10 CFR 71 code. Therefore, it is concluded that the cask can withstand the drop test requirements during the normal conditions of transport and the hypothetical accident conditions. It is noted that slight deformation of the cask at certain locations is expected during the hypothetical drop tests. However, the components subjected to deformations during these tests are not on the pressure

Title	Structura	al Analyse	es of the 3-60B	Cask Under Drop	o Conditions			-
Calc. No.	ST-504	Rev	0		Sheet	18	_of6	

boundary. Therefore, their deformation in no way can prevent the cask from meeting other requirements of the code. A summary of the expected deformation is as follows:

• The skirt of the bolting ring may be subjected to inelastic bending during the side, corner, and shallow angle drop tests (see Figures 17 and 26 for example). This bending will be confined to a small area near the point of impact. The skirt may bend inward at these locations.

9.0 ANSYS PRINTOUT AND DATA FILES

The printout of the important data from the program is included with this document in electronic form as Appendix 1. The following is the directory of the data on the DVD.

```
Volume in drive F is My Disc
 Volume Serial Number is E35A-63CD
 Directory of F:\
01/04/2008 11:38 AM <DIR> 1-ft Drop, Corner
12/19/2007 02:52 PM <DIR> 1-ft Drop, End
                         108,032 1-ft Drop, Result Summary.doc
01/04/2008 11:15 AM
12/19/2007 02:55 PM <DIR>
                                       1-ft Drop, Side
01/04/2008 11:44 AM <DIR>
                                       30-ft Drop, Corner
12/19/2007 02:41 PM <DIR>
                                        30-ft Drop, End
01/03/2008 04:27 PM 131,584 30-ft Drop, Resu
01/03/2008 03:02 PM <DIR> 30-ft Drop, Side
                         131,584 30-ft Drop, Result Summary.doc
               2 File(s) 239,616 bytes
               6 Dir(s)
                                      0 bytes free
```

Directory of F:\1-ft Drop, Corner

01/04/2008	01 : 42	PM	<dir></dir>	
01/04/2008	01:42	РM	<dir></dir>	
10/23/2007	02:10	РМ	10,924,071	file.cdb
10/24/2007	05:09	РM	232,390,656	file.rst
10/24/2007	10:18	AM	2,166,410	file.s01
10/24/2007	10:12	AM	2,166,410	file.s02
10/24/2007	10:14	AM	908,444	file.s03
11/20/2007	10:28	AM	97,323	file000.png
11/20/2007	10:30	AM	91,008	file001.png
11/20/2007	10:31	AM	67 , 746	file002.png
11/20/2007	10:38	AM	153,219	file003.png
11/20/2007	10:39	AM	153,673	file004.png
11/20/2007	10:39	AM	156,392	file005.png
01/03/2008	05:51	РМ	3,125	ls1Forging.lis
10/31/2007	10:34	AM	3,125	ls1Inner-Shell.lis
11/01/2007	09:22	AM	3,125	ls1Lid.lis
10/31/2007	10:44	AM	3,125	ls1Outer-Shell.lis
10/29/2007	02:02	РМ	3,002,819	ls1post.out
01/03/2008	05:52	РМ	3,125	ls2Forging.lis
10/31/2007	10 : 37	AM	3,125	ls2Inner-Shell.lis
11/01/2007	09:24	AM	3,125	ls2Lid.lis
10/29/2007	02:11	РМ	3,002,838	ls2post.out

Title	Structur	ral Analyses of the 3-	-60B Cask Under Drop Co	onditions			_
Calc. No.	ST-504	Rev 0		Sheet _	19	_of26	
10/31/2007	12.12 PM	3 105	ls3Basenlates lie		_		_
01/03/2008	05:52 PM	3,125	ls3Forging lis				
10/31/2007	10.38 DM	3,123 3,125	ls3Inner-Shell lie				
11/01/2007	09:26 AM	3,125	ls3Lid.lis				
10/31/2007	10:41 AM	3,125	ls30uter-Shell lie				
10/29/2007	02:15 PM	3.002.836	ls3post_out				
12/07/2007	11:14 AM	39.419	Model.txt				
, , 2007	27 File((s) 258,360,764	4 bytes				
Directory o	of F:\1-ft [Drop, End					
01/04/2008	01:44 PM	<dir></dir>					
01/04/2008	01:44 PM	<dir></dir>					
10/23/2007	02:09 PM	10,782,335	file.cdb				
10/26/2007	03:35 PM	470,548,480	file.rst				
10/24/2007	10:21 AM	2,025,280	file.s01				
10/26/2007	02:52 PM	2,025,322	file.s02				
10/26/2007	02:50 PM	767,356	file.s03				
11/20/2007	09:08 AM	47,665	file000.png				
11/20/2007	09:07 AM	70,202	file001.png				
11/20/2007	09:09 AM	41,321	file002.png				
11/20/2007	09:23 AM	75 , 876	file003.png				
11/20/2007	09:26 AM	65 , 404	file004.png				
11/20/2007	09:28 AM	63 , 501	file005.png				
10/31/2007	07:33 AM	3,125	ls1Forging.lis				
10/31/2007	07:37 AM	3,125	ls10uter-shell.lis				
10/29/2007	01:30 PM	3,002,816	ls1post.out				
10/31/2007	08:16 AM	3,125	1s2Forging.lis				
10/31/2007	08:18 AM	3,125	1s2Inner-shell.lis				
10/29/2007	01:34 PM	3,002,834	1s2post.out				
10/31/2007	09:23 AM	3,125	Is3Baseplates.lis				
10/31/2007	08:14 AM	3,125	1s3Forging.lis				
10/31/2007	09:19 AM	3,125	1s3Inner-shell.lis				
10/29/2007	01:39 PM	3,002,833	1s3post.out				
12/07/2007	11:22 AM	39,413	Model.txt				
	22 File	(s) 495,582,51.	3 bytes				
Directory o	of F:\1-ft [Drop, Side					
01/04/2008	01:46 PM	<dir></dir>					
01/04/2008	01:46 PM	<dir></dir>					
10/23/2007	02:08 PM	10,873,221	file.cdb				
10/26/2007	12:38 PM	234,946,560	file.rst				
10/24/2007	10:30 AM	2,042,171	file.s01				
10/26/2007	11:51 AM	2,042,171	file.s02				
10/26/2007	11:52 AM	784,205	file.s03				
11/20/2007	09:53 AM	137,351	file000.png				
11/20/2007	09:55 AM	121,231	file001.png				
11/20/2007	09:56 AM	93,363	file002.png				
11/20/2007	10:09 AM	154,442	file003.png				
11/20/2007	10:11 AM	138,865	file004.png				
11/20/2007	10:11 AM	141,508	file005.png				
10/31/2007	09:50 AM	3_125	ls1Foraina lis				
10/31/2007	09:29 AM	3,125	ls1Inner-Shell lie				
10/31/2007	09:32 AM	3,125	ls10uter-Shell.lis				

Title	Structura	al Analyses of the 3	-60B Cask Under Drop Co	onditions			
Calc. No.	ST-504	 Rev 0		Sheet	<u>2</u> 0	_of 2	6
10/29/2007	01:45 PM	3,002,817	ls1post.out				
10/31/2007	10:07 AM	3,125	ls2Baseplates.lis				
10/31/2007	09:52 AM	3,125	ls2Forging.lis				
10/31/2007	10:01 AM	3,125	ls20uter-Shell.lis				
10/29/2007	01.54 PM	3.002.836	ls2post out				
10/31/2007	10.08 AM	3.125	ls3Baseplates lis				
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10/31/2007	10:05 AM	2 002 024	leSoucer-Sherr.rrs				
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Directory o	of F:\30-ft 1	Drop, Corner					
01/04/2008	01:48 PM	<dir></dir>					
01/04/2008	01:48 PM	<dir></dir>	••				
10/23/2007	02:10 PM	10,924,071	file.cdb				
10/24/2007	06:17 PM	232,980,480	file.rst				
10/24/2007	12:31 PM	2,166,410	file.s01				
10/24/2007	10:45 AM	2,166,410	file.s02				
10/24/2007	10:46 AM	908,444	file.s03				
10/23/2007	10:52 AM	1,899,466	file.s04				
10/23/2007	01:00 PM	1,499,050	file.s05				
11/19/2007	05:37 PM	92,321	file000.png				
11/19/2007	05:38 PM	108,580	file001.png				
11/19/2007	05:39 PM	101,566	file002.png				
11/19/2007	05:40 PM	81,406	file003.png				
11/19/2007	05:46 PM	140,328	file004.png				
11/19/2007	05.47 PM	143.861	file005 png				
11/19/2007	05.47 PM	146.377	file006 png				
10/23/2007	07:07 AM	82 903 040	lel ret				
11/01/2007	07.07 AM	3 125	lelForging lie				
11/01/2007	11.58 AM	3 125	lellid lie				
10/20/2007	12.47 DM	3 002 820	lsipost out				
11/01/2007	12.47 PM	3,002,020	lalpost.out				
11/01/2007	12.40 PM	3,123 3,105	Larid lia				
10/20/2007	12.52 DM	3,125 2,000,000	LSZLIU.IIS				
11/01/2007	12:33 PM	J,UUZ,839 D 105	152post.out				
11/01/2007	UZ:40 PM	3,125	Lastorging.lls				
10/00/0007	12:00 PM	3,125					
10/29/2007	12:58 PM	3,002,837	1s3post.out				
12/0//2007	II:25 AM	39,421	Model.txt				
	25 File(:	s) 345,328,47	/ bytes				
Directory o	of F:\30-ft 1	Drop, End					
01/04/2008	01:50 PM	<dir></dir>					
01/04/2008	01:50 PM	<dtr></dtr>					
10/23/2000	02.00 DM	10 722 225	 file cdb				
11/12/2007	12.09 FM	10,102,333 23/ QQ1 02/	file ret				
10/21/2007	10.50 MM	204,001,024 0 005 004	$f_{1} = 0$				
11/10/0007	11.10 AM	2,023,304					
11/12/2007	II:IU AM	2,025,304	LILE.SUZ				
10/24/2007	10:55 AM	767,338	IILE.SU3				
10/17/2007	07:28 AM	81,233	tile000.png				

152,254 file001.png 103,068 file002.png

10/17/2007 07:28 AM 11/02/2007 11:27 AM 10/17/2007 09:12 AM

Title	Struct	ural Analyses of the 3-	-60B Cask Under Drop C	onditions
Calc. No	ST-504	Rev0		Sheet <u>21</u> of <u>26</u>
11/19/2007	مرم 02·20	50 207	filenna nna	
11/19/2007	02:31 PM	69_831	file004.png	
11/19/2007	02:48 PM	220.493	file005.pna	
11/19/2007	02:49 PM	95,780	file006.png	
11/19/2007	03:15 PM	135 , 573	file007.png	
11/19/2007	03:40 PM	139,867	file008.png	
11/19/2007	03:42 PM	119,828	file009.png	
11/19/2007	03:44 PM	89 , 859	file010.png	
11/19/2007	03:53 PM	206,691	file011.png	
11/19/2007	03:54 PM	176,300	file012.png	
11/20/2007	U3:54 PM	173,720	IIIEUI3.png	
10/21/2007	02.25 PM	3,002,775	Isipost.out	
10/31/200/	02:20 PM	3,11/ 2 117	152FULYING.115 s2Tnner_Chell lic	
11/01/2007	03.16 DM	ン , エエノ ス 11フ	ls21.id lis	
11/20/2007	01:18 PM	3,002.775	ls2post.out	
10/31/2007	02:33 PM	3.117	ls3Forging.lis	
10/31/2007	02:35 PM	3,117	ls3Inner-Shell.lis	
11/01/2007	03:18 PM	3,117	ls3Lid.lis	
11/20/2007	01:20 PM	3,002,775	ls3post.out	
12/07/2007	11:26 AM	39,714	Model.txt	
	29 Fil	e(s) 261,371,93	0 bytes	
Directory c	of F:\30-f	: Drop, Side		
01/04/2008	01:52 PM	<dir></dir>		
01/04/2008	01:52 PM	<dir></dir>		
10/23/2007	02:08 PM	10,873,221	file.cdb	
10/24/2007	07:00 PM	235,470,848	file.rst	
10/24/2007	10:57 AM	2,042,171	tile.s01	
10/24/2007	12:03 AM	2,042,171	IILE.SU2	
LU/24/2007	LZ:U/ PM	/84,205	filo000 mmm	
10/21/2007	04:25 PM	128,170	filo001 ppg	
11/19/2007	04:34 PM	114,190 ал заа	file002 ppg	
11/19/2007	04:21 PM	120 120	file003.png	
11/19/2007	04:38 PM	163.220	file005.png	
11/19/2007	04:39 PM	162.563	file006.pna	
11/19/2007	04:39 PM	163,381	file007.png	
10/31/2007	02:58 PM	3,125	ls1Forging2.lis	
10/31/2007	03:03 PM	3,125	ls1Inner-Shell.lis	
11/01/2007	03:23 PM	3,125	ls1Lid.lis	
10/31/2007	03:07 PM	3,125	ls1Outer-Shell.lis	
10/29/2007	12:25 PM	3,002,818	ls1post.out	
10/31/2007	03:20 PM	3,125	ls2Baseplates.lis	
10/31/2007	02:58 PM	3,125	<pre>Ls2Forging2.lis</pre>	
LU/31/2007	U3:04 PM	3,125	IsZinner-Shell.lis	
10/21/2007	03:24 PM	3,125	LSZLIQ.IIS	
10/20/2007	12.00 PM	3,125 2,000 000	ls2post out	
10/23/200/ 10/31/2007	12:29 PM	3,UU∠,83/ २ 10⊑	Is?Rasenlates lis	
10/31/2007	02.22 PM	3,123 3,125	193Forging? lie	
10/31/2007	03:05 PM	3,125	ls3Inner-Shell.lis	
11/01/2007	03:25 PM	3,125	ls3Lid.lis	
10/31/2007	03:09 PM	3,125	ls3Outer-Shell.lis	

Title	Structur	al Analyses of the 3-60E	3 Cask Under Drop Conditions	
Calc. No	ST-504	Rev 0	Sheet _	<u>22</u> of <u>26</u>
10/29/2007	12:35 PM	3,002,835 ls	3post.out	

10/29/2007	12:35 PM	3,002,835 ls3post.ou
12/07/2007	11:28 AM	40,559 Model.txt
	30 File(s)	261,270,458 bytes

10.0 APPENDICES

Appendix 1 Print-out of the ANSYS model data input

Appendix 2 Electronic data on DVD

Title	Structu	iral Analyse	s of the 3	-60B Cask Under Drop Conditions			
Calc. No	ST-504	Rev	0	Sheet _	23	_of_	26

<u>Tables</u>

(18 Pages)

Title	Structural Ana	alyses of the	e 3-60B C	ask Under Drop Conditions
Calc. No.	ST-504 Tables	Rev	0	Sheet <u>1</u> of <u>18</u>

			•	
Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	59,760	32,855	1.82
Bolting Ring	$P_m + P_b$	87,000	32,855	2.65
	F	174,000	32,855	5.30
	P _m	59,760	17,652	3.39
Inner Shell	$P_m + P_b$	87,000	17,652	4.93
	F	174,000	17,652	9.86
	P _m	40,080	31,224	1.28
Outer Shell	$P_m + P_b$	60,120	31,224	1.93
	F	140,000	31,224	4.48
	P _m	40,080	30,311	1.32
Lid	$P_m + P_b$	60,120	30,311	1.98
	F	140,000	30,311	4.62
	P _m	40,080	14,924	2.69
Base Plates	$P_m + P_b$	60,120	14,924	4.03
	F	140,000	14,924	9.38
Seal Plates	$P_m + P_b$	60,120	4,185 ⁽³⁾	14.37
	P _m	105,000	9,023	11.64
Bolts	$P_m + P_b$	150,000	9,023	16.62
	F	300,000	9,023	33.25

Stress Intensities in 3-60B Cask under 30-ft End Drop - Hot Condition

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) The maximum stress intensity in the seal plates is 51,854 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).

Title	Structural Ana	alyses of the	e 3-60B (Cask Under Drop Conditions
Calc. No.	ST-504 Tables	Rev	0	

Stress Intensities in 3-60B Cask under 30-ft End Drop - Cold Condition (Max. Decay Heat)

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	59,760	50,491	1.18
Bolting Ring	$P_m + P_b$	87,000	50,491	1.72
	F	174,000	50,491	3.45
	P _m	59,760	38,207	1.56
Inner Shell	$P_m + P_b$	87,000	38,207	2.28
	F	174,000	38,207	4.55
	P _m	40,080	24,782	1.62
Outer Shell	$P_m + P_b$	60,120	24,782	2.43
	F	140,000	24,782	5.65
	P _m	40,080	33,945	1.18
Lid	$P_m + P_b$	60,120	33,945	1.77
	F	140,000	33,945	4.12
	P _m	40,080	24,661	1.63
Base Plates	$P_m + P_b$	60,120	24,661	2.44
	F	140,000	24,661	5.68
Seal Plates	$P_m + P_b$	60,120	4,187 ⁽³⁾	14.36
	P _m	105,000	7,592	13.83
Bolts	$P_m + P_b$	150,000	7,592	19.76
	F	300,000	7,592	39.52

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) The maximum stress intensity in the seal plates is 56,497 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).

Title	Structural Ana	alyses of the	e 3-60B	Cask Under Drop Conditions
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Stress Intensities in 3-60B Cask under 30-ft End Drop - Cold Condition (No Decay Heat)

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	59,760	44,400	1.35
Bolting Ring	$P_m + P_b$	87,000	60,610	1.44
	F	174,000	58,779	2.96
	P _m	59,760	43,130	1.39
Inner Shell	$P_m + P_b$	87,000	46,060	1.89
	F	174,000	43,700	3.98
	P _m	40,080	24,687	1.62
Outer Shell	$P_m + P_b$	60,120	24,687	2.44
	F	140,000	24,687	5.67
	P _m	40,080	5,482	7.31
Lid	$P_m + P_b$	60,120	35,126	1.71
	F	140,000	35,126	3.99
	P _m	40,080	27,593	1.45
Base Plates	$P_m + P_b$	60,120	27,593	2.18
	F	140,000	27,593	5.07
Seal Plates	$P_m + P_b$	60,120	4,971 ⁽³⁾	12.09
	P _m	105,000	7,442	14.11
Bolts	$P_m + P_b$	150,000	7,442	20.16
	F	300,000	7,442	40.31

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) The maximum stress intensity in the seal plates is 57,706 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).

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Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	59,760	45,960 ⁽³⁾	1.30
Bolting Ring	$P_m + P_b$	87,000	81,730 ⁽³⁾	1.07
	F	174,000	125,360	1.39
	P _m	59,760	36,420	1.64
Inner Shell	$P_m + P_b$	87,000	44,210	1.97
	F	174,000	44,216	3.94
	P _m	40,080	33,800	1.19
Outer Shell	$P_m + P_b$	60,120	44,150	1.36
	F	140,000	44,151	3.17
	P _m	40,080	26,280 ⁽⁴⁾	1.53
Lid	$P_m + P_b$	60,120	32,940 ⁽⁶⁾	1.83
	F	140,000	40,684	3.44
	P _m	40,080	31,876	1.26
Base Plates	$P_m + P_b$	60,120	31,876	1.89
	F	140,000	31,876	4.39
Seal Plates	$P_m + P_b$	60,120	45,515 ⁽⁵⁾	1.32
	P _m	105,000	57,103	1.84
Bolts	$P_m + P_b$	150,000	57,103	2.63
	F	300,000	57,103	5.25

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) Stress intensity in parts other than the skirt. The skirt is expected to deform under HAC side drop.
- (4) Average value over the section of maximum stress intensity.
- (5) The maximum stress intensity in the seal plates is 104,460 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).
- (6) The reported stress here is the maximum principle stress (tensile).

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Stress Intensities in 3-60B Cask under 30-ft Side Drop - Cold Condition (Max. Decay Heat)

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	59,760	45,210 ⁽³⁾	1.32
Bolting Ring	$P_m + P_b$	87,000	81,460 ⁽³⁾	1.07
	F	174,000	127,328	1.37
	P _m	59,760	37,560	1.59
Inner Shell	$P_m + P_b$	87,000	42,230	2.06
	F	174,000	42,230	4.12
	P _m	40,080	35,230	1.14
Outer Shell	$P_m + P_b$	60,120	47,480	1.27
	F	140,000	47,487	2.95
	P _m	40,080	27,640 ⁽⁴⁾	1.45
Lid	$P_m + P_b$	60,120	35,884 ⁽⁶⁾	1.68
	F	140,000	42,435	3.30
	P _m	40,080	26,210	1.53
Base Plates	$P_m + P_b$	60,120	50,500	1.19
	F	140,000	52,020	2.69
Seal Plates	$P_m + P_b$	60,120	46,227 ⁽⁵⁾	1.30
	P _m	105,000	55,860	1.88
Bolts	$P_m + P_b$	150,000	55,860	2.69
	F	300,000	55,860	5.37

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) Stress intensity in parts other than the skirt. The skirt is expected to deform under HAC side drop.
- (4) Average value over the section of maximum stress intensity.
- (5) The maximum stress intensity in the seal plates is 106,330 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).
- (6) The reported stress here is the maximum principle stress (tensile).

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<u>Table 6</u>

Stress Intensities in 3-60B Cask under 30-ft Side Drop - Cold Condition (No Decay Heat)

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	59,760	44,900 ⁽³⁾	1.33
Bolting Ring	$P_m + P_b$	87,000	81,360 ⁽³⁾	1.07
	F	174,000	128,091	1.36
	P _m	59,760	40,200	1.49
Inner Shell	$P_m + P_b$	87,000	43,390	2.01
	F	174,000	43,486	4.00
	P _m	40,080	36,710	1.09
Outer Shell	$P_m + P_b$	60,120	49,360	1.22
	F	140,000	49,364	2.84
	P _m	40,080	27,360 ⁽⁴⁾	1.46
Lid	$P_m + P_b$	60,120	35,719 ⁽⁶⁾	1.68
Inner Shell Outer Shell Lid Base Plates Seal Plates	F	140,000	41,878	3.34
	P _m	40,080	29,690	1.35
Base Plates	$P_m + P_b$	60,120	53,950	1.11
	F	140,000	57,405	2.44
Seal Plates	$P_m + P_b$	60,120	45,153 ⁽⁵⁾	1.33
	P _m	105,000	54,432	1.93
Bolts	$P_m + P_b$	150,000	54,432	2.76
	F	300,000	54,432	5.51

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) Stress intensity in parts other than the skirt. The skirt is expected to deform under HAC side drop.
- (4) Average value over the section of maximum stress intensity.
- (5) The maximum stress intensity in the seal plates is 103,850 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).
- (6) The reported stress here is the maximum principle stress (tensile).

Title	Structural Ana	alyses of the	e 3-60B C	ask Under Drop Conditions
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Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	59,760	41,620	1.44
Bolting Ring	$P_m + P_b$	87,000	50,330	1.73
	F	174,000	139,619	1.25
	P _m	59,760	35,571	1.68
Inner Shell	$P_m + P_b$	87,000	35,571	2.45
	F	174,000	35,571	4.89
	P _m	40,080	31,297	1.28
Outer Shell	$P_m + P_b$	60,120	31,297	1.92
	F	140,000	31,297	4.47
	P _m	40,080	27,550	1.45
Lid	$P_m + P_b$	60,120	42,817 ⁽⁴⁾	1.40
	F	140,000	100,030	1.40
	P _m	40,080	10,203	3.93
Base Plates	$P_m + P_b$	60,120	10,203	5.89
	F	140,000	10,203	13.72
Seal Plates	$P_m + P_b$	60,120	34,765 ⁽³⁾	1.73
	P _m	105,000	27,642	3.80
Bolts	$P_m + P_b$	150,000	27,642	5.43
Bolting Ring Inner Shell Outer Shell Lid Base Plates Seal Plates Bolts	F	300,000	27,642	10.85

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) The maximum stress intensity in the seal plates is 185,160 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).
- (4) The reported stress here is the maximum principle stress (tensile).

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Stress Intensities in 3-60B Cask under 30-ft Corner Drop - Cold Condition (Max. Decay Heat)

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	59,760	44,450	1.34
Bolting Ring	$P_m + P_b$	87,000	47,750	1.82
	F	174,000	130,470	1.33
	P _m	59,760	50,708	1.18
Inner Shell	$P_m + P_b$	87,000	50,708	1.72
	F	174,000	50,708	3.43
	P _m	40,080	25,953	1.54
Outer Shell	$P_m + P_b$	60,120	25,953	2.32
	F	140,000	25,953	5.39
	P _m	40,080	26,240	1.53
Lid	$P_m + P_b$	60,120	42,737 ⁽⁴⁾	1.41
	F	140,000	96,158	1.46
	P _m	40,080	16,204	2.47
Base Plates	$P_m + P_b$	60,120	16,204	3.71
	F	140,000	16,204	8.64
Seal Plates	$P_m + P_b$	60,120	37,369 ⁽³⁾	1.61
	P _m	105,000	25,437	4.13
Bolts	$P_m + P_b$	150,000	25,437	5.90
	F	300,000	25,437	11.79

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) The maximum stress intensity in the seal plates is 173,420 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).
- (4) The reported stress here is the maximum principle stress (tensile).

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Stress Intensities in 3-60B Cask under 30-ft Corner Drop - Cold Condition (No Decay Heat)

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	59,760	46,380	1.29
Bolting Ring	$P_m + P_b$	87,000	52,140	1.67
	F	174,000	126,480	1.38
	P _m	59,760	55,586	1.08
Inner Shell	$P_m + P_b$	87,000	55,586	1.57
	F	174,000	55,586	3.13
	P _m	40,080	26,917	1.49
Outer Shell	$P_m + P_b$	60,120	26,917	2.23
	F	140,000	26,917	5.20
	P _m	40,080	26,050	1.54
Lid	$P_m + P_b$	60,120	42,578 ⁽⁴⁾	1.41
	F	140,000	95,863	1.46
	P _m	40,080	21,989	1.82
Base Plates	$P_m + P_b$	60,120	21,989	2.73
	F	140,000	21,989	6.37
Seal Plates	$P_m + P_b$	60,120	37,834 ⁽³⁾	1.59
	P _m	105,000	26,079	4.03
Bolts	$P_m + P_b$	150,000	26,079	5.75
	F	300,000	26,079	11.50

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) The maximum stress intensity in the seal plates is 169,950 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).
- (4) The reported stress here is the maximum principle stress (tensile).

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<u>Table 10</u>

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	24,900	8,192	3.04
Bolting Ring	$P_m + P_b$	37,350	15,310	2.44
	F	74,700	15,342	4.87
	P _m	24,900	4,245	5.87
Inner Shell	$P_m + P_b$	37,350	4,245	8.80
	F	74,700	4,245	17.60
	P _m	16,700	13,760	1.21
Outer Shell	$P_m + P_b$	25,050	15,030	1.67
	F	50,100	15,035	3.33
	P _m	16,700	10,138	1.65
Lid	$P_m + P_b$	25,050	10,138	2.47
	F	50,100	10,138	4.94
	P _m	16,700	10,182	1.64
Base Plates	$P_m + P_b$	25,050	10,182	2.46
	F	50,100	10,182	4.92
Seal Plates	$P_m + P_b$	25,050	16,808	1.49
	Pm	60,000	6,725	8.92
Bolts	$P_m + P_b$	90,000	6,725	13.38
	F	150,000	6,725	22.30

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)

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<u>Table 11</u>

Stress Intensities in 3-60B Cask under 1-ft End Drop - Cold Condition (Max. Decay Heat)

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	24,900	16,850	1.48
Bolting Ring	$P_m + P_b$	37,350	22,960	1.63
	F	74,700	22,965	3.25
	P _m	24,900	16,310	1.53
Inner Shell	$P_m + P_b$	37,350	17,040	2.19
	F	74,700	17,043	4.38
	P _m	16,700	7,562	2.21
Outer Shell	$P_m + P_b$	25,050	7,562	3.31
	F	50,100	7,562	6.63
	P _m	16,700	10,320	1.62
Lid	$P_m + P_b$	25,050	10,320	2.43
	F	50,100	10,320	4.85
	P _m	16,700	12,590	1.33
Base Plates	$P_m + P_b$	25,050	12,590	1.99
	F	50,100	12,590	3.98
Seal Plates	$P_m + P_b$	25,050	17,356	1.44
	P _m	60,000	3,646	16.46
Bolts	$P_m + P_b$	90,000	3,646	24.68
	F	150,000	3,646	41.14

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)

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Stress Intensities in 3-60B Cask under 1-ft End Drop - Cold Condition (No Decay Heat)

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	24,900	20,970	1.19
Bolting Ring	$P_m + P_b$	37,350	28,920	1.29
	F	74,700	28,928	2.58
	P _m	24,900	20,190	1.23
Inner Shell	$P_m + P_b$	37,350	21,180	1.76
	F	74,700	21,183	3.53
	P _m	16,700	7,467	2.24
Outer Shell	$P_m + P_b$	25,050	7,467	3.35
	F	50,100	7,467	6.71
	P _m	16,700	11,125	1.50
Lid	$P_m + P_b$	25,050	11,125	2.25
	F	50,100	11,125	4.50
	P _m	16,700	10,210	1.64
Base Plates	$P_m + P_b$	25,050	17,040	1.47
	F	50,100	18,208	2.75
Seal Plates	$P_m + P_b$	25,050	19,186	1.31
	P _m	60,000	5,301	11.32
Bolts	$P_m + P_b$	90,000	5,301	16.98
	F	150,000	5,301	28.30

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)

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<u>Table 13</u>

Stress Intensities in 5-00B Cask under 1-ft Side Diop – Hot Condition

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	24,900	18,480	1.35
Bolting Ring	$P_m + P_b$	37,350	30,410	1.23
	F	74,700	30,441	2.45
	P _m	24,900	14,490	1.72
Inner Shell	$P_m + P_b$	37,350	16,470	2.27
	F	74,700	16,467	4.54
	P _m	16,700	9,915	1.68
Outer Shell	$P_m + P_b$	25,050	20,060	1.25
	F	50,100	20,069	2.50
	P _m	16,700	7,440	2.24
Lid	$P_m + P_b$	25,050	7,440	3.37
	F	50,100	7,440	6.73
	P _m	16,700	12,645	1.32
Base Plates	$P_m + P_b$	25,050	12,645	1.98
	F	50,100	12,645	3.96
Seal Plates	$P_m + P_b$	25,050	5,415 ⁽³⁾	4.63
	Pm	60,000	24,328	2.47
Bolts	$P_m + P_b$	90,000	24,328	3.70
	F	150,000	24,328	6.17

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) The maximum stress intensity in the seal plates is 22,040 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).
| Title | Structural Ana | alyses of the | e 3-60B | Cask Under Drop Conditions | | |
|-----------|----------------|---------------|---------|----------------------------|----|-------|
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<u>Table 14</u>

Stress Intensities in 3-60B Cask under 1-ft Side Drop - Cold Condition (Max. Decay Heat)

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	24,900	19,060	1.31
Bolting Ring	$P_m + P_b$	37,350	31,240	1.20
	F	74,700	31,247	2.39
	P _m	24,900	13,051	1.91
Inner Shell	$P_m + P_b$	37,350	13,051	2.86
	F	74,700	13,051	5.72
	P _m	16,700	11,240	1.49
Outer Shell	$P_m + P_b$	25,050	14,810	1.69
	F	50,100	14,816	3.38
	P _m	16,700	10,147	1.65
Lid	$P_m + P_b$	25,050	10,147	2.47
	F	50,100	10,147	4.94
	P _m	16,700	10,280	1.62
Base Plates	$P_m + P_b$	25,050	16,960	1.48
	F	50,100	18,373	2.73
Seal Plates	$P_m + P_b$	25,050	9,815 ⁽³⁾	2.55
	P _m	60,000	21,543	2.79
Bolts	$P_m + P_b$	90,000	21,543	4.18
	F	150,000	21,543	6.96

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) The maximum stress intensity in the seal plates is 26,446 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).

Title	Structural Ana	alyses of the	e 3-60B	Cask Under Drop Conditions			
Calc. No.	ST-504 Tables	Rev	0	Sheet	15	0f18	

<u>Table 15</u>

Stress Intensities in 3-60B Cask under 1-ft Side Drop - Cold Condition (No Decay Heat)

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	24,900	19,340	1.29
Bolting Ring	$P_m + P_b$	37,350	31,690	1.18
	F	74,700	31,694	2.36
	P _m	24,900	16,167	1.54
Inner Shell	$P_m + P_b$	37,350	16,167	2.31
	F	74,700	16,167	4.62
	P _m	16,700	12,440	1.34
Outer Shell	$P_m + P_b$	25,050	16,800	1.49
	F	50,100	16,807	2.98
	P _m	16,700	11,179	1.49
Lid	$P_m + P_b$	25,050	11,179	2.24
	F	50,100	11,179	4.48
	P _m	16,700	14,290	1.17
Base Plates	$P_m + P_b$	25,050	22,330	1.12
	F	50,100	24,154	2.07
Seal Plates	$P_m + P_b$	25,050	10,399 ⁽³⁾	2.41
	P _m	60,000	19,916	3.01
Bolts	$P_m + P_b$	90,000	19,916	4.52
	F	150,000	19,916	7.53

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) The maximum stress intensity in the seal plates is 24,543 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).

Title	Structural Ana	alyses of the	e 3-60B	Cask Under Drop Conditions			
Calc. No.	ST-504 Tables	Rev	0	Sheet	16	of18	

Table 16

|--|

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	24,900	19,580 ⁽⁶⁾	1.27
Bolting Ring	$P_m + P_b$	37,350	26,170 ⁽⁶⁾	1.43
	F	74,700	55,516	1.35
	P _L	24,900	13,350	1.87
Inner Shell ⁽³⁾	$P_L + P_b$	37,350	14,530	2.57
	F	74,700	14,534	5.14
	P _m	16,700	8,248	2.02
Outer Shell	$P_m + P_b$	25,050	16,270	1.54
	F	50,100	16,269	3.08
	P _m	16,700	9,966	1.68
Lid	$P_m + P_b$	25,050	18,347 ⁽⁵⁾	1.37
	F	50,100	41,359	1.21
	P _m	16,700	10,896	1.53
Base Plates	$P_m + P_b$	25,050	10,896	2.30
	F	50,100	10,896	4.60
Seal Plates	$P_m + P_b$	25,050	12,606 ⁽⁴⁾	1.99
	P _m	60,000	18,243	3.29
Bolts	$P_m + P_b$	90,000	18,243	4.93
	F	150,000	18,243	8.22

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) The stresses in the inner shell under corner drop loading are mostly longitudinal. These stresses are the highest near the impact location and subside greatly away from the plane of impact. Therefore, they are classified as average linearized stress, P_L and not P_m .
- (4) The maximum stress intensity in the seal plates is 77,292 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).
- (5) The reported stress here is the maximum principle stress (tensile).
- (6) Membrane and membrane plus bending stresses calculated in non-skirt elements.

Title	Structural Ana	alyses of the	e 3-60B C	ask Under Drop Conditions			
Calc. No.	ST-504 Tables	Rev.	0	Sheet _	17	of 18	

Table 17

Stress Intensities in 3-60B Cask under 1-ft Corner Drop - Cold Condition (Max. Decay Heat)

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	24,900	21,730 ⁽⁶⁾	1.15
Bolting Ring	$P_m + P_b$	37,350	25,680 ⁽⁶⁾	1.45
	F	74,700	52,478	1.42
	PL	37,350	26,480	1.41
Inner Shell ⁽³⁾	$P_L + P_b$	37,350	27,570	1.35
	F	74,700	27,569	2.71
	P _m	16,700	12,611	1.32
Outer Shell	$P_m + P_b$	25,050	12,611	1.99
	F	50,100	12,611	3.97
	P _m	16,700	9,943	1.68
Lid	$P_m + P_b$	25,050	18,344 ⁽⁵⁾	1.37
	F	50,100	39,239	1.28
	P _m	16,700	11,656	1.43
Base Plates	$P_m + P_b$	25,050	11,656	2.15
	F	50,100	11,656	4.30
Seal Plates	$P_m + P_b$	25,050	18,934 ⁽⁴⁾	1.32
	P _m	60,000	14,026	4.28
Bolts	$P_m + P_b$	90,000	14,026	6.42
	F	150,000	14,026	10.69

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) The stresses in the inner shell under corner drop loading are mostly longitudinal. These stresses are the highest near the impact location and subside greatly away from the plane of impact. Therefore, they are classified as average linearized stress, P_L and not P_m .
- (4) The maximum stress intensity in the seal plates is 71,591 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).
- (5) The reported stress here is the maximum principle stress (tensile).
- (6) Membrane and membrane plus bending stresses calculated in non-skirt elements.

Title	Structural Ana	alyses of the	e 3-60B C	ask Under Drop Conditions			
Calc. No.	ST-504 Tables	Rev.	0	Sheet _	18	of18	

<u>Table 18</u>

Stress Intensities in 3-60B Cask under 1-ft Corner Drop - Cold Condition (No Decay Heat)

Component	Stress Category	Allowable S.I. (psi)	Calculated S.I. ⁽¹⁾ (psi)	F.S. ⁽²⁾
	P _m	24,900	23,580 ⁽⁶⁾	1.06
Bolting Ring	$P_m + P_b$	37,350	30,260 ⁽⁶⁾	1.23
	F	74,700	49,660	1.50
	PL	37,350	30,150	1.24
Inner Shell ⁽³⁾	$P_L + P_b$	37,350	32,220	1.20
	F	74,700	32,217	2.32
	P _m	16,700	9,999	1.67
Outer Shell	$P_m + P_b$	25,050	14,390	1.74
	F	50,100	14,387	3.48
	P _m	16,700	9,940	1.68
Lid	$P_m + P_b$	25,050	18,199 ⁽⁵⁾	1.38
	F	50,100	39,298	1.27
	P _m	16,700	10,880	1.53
Base Plates	$P_m + P_b$	25,050	18,310	1.37
	F	50,100	18,310	2.74
Seal Plates	$P_m + P_b$	25,050	19,456 ⁽⁴⁾	1.29
	P _m	60,000	13,725	4.37
Bolts	$P_m + P_b$	90,000	13,725	6.56
	F	150,000	13,725	10.93

- (1) Unless otherwise indicated in this column, the peak stress intensity (F) values have been conservatively reported as P_m and $P_m + P_b$ stress intensities.
- (2) Factor of Safety, F.S. = (Allowable S.I.) / (Calculated S.I.)
- (3) The stresses in the inner shell under corner drop loading are mostly longitudinal. These stresses are the highest near the impact location and subside greatly away from the plane of impact. Therefore, they are classified as average linearized stress, P_L and not P_m .
- (4) The maximum stress intensity in the seal plates is 69,165 psi. However, the plates are under compression and the maximum stress intensity may be categorized as bearing stress. The reported stress here is the maximum principal stress (tensile).
- (5) The reported stress here is the maximum principle stress (tensile).
- (6) Membrane and membrane plus bending stresses calculated in non-skirt elements.

Title	Structu	ral Analyse	s of the 3-60B Cask Under Drop C	onditions			
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Figures

(45 Pages)



	Title Calc. No	Structural Analy ST-504 (Figures)	rses of the 3-60B Cask Under Drop (Rev0	Conditions Sheet 2	of 45
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Title	Structural Analyses	of the 3-60B Cask Under Dro	p Conditions		
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	Title_		Struct	ural An	alyses	of the	<u>3-60B</u>	Cask L	Jnder]	Drop C	Conditions		
	Calc.	No	ST-504	(Figure	es)		Rev		_		Sheet	18	of 45
NNSVS	NOV 19 2007 16:39:13 PLOT NO. 1	87.992	15993	31898	47803	63708	79613	95518	111423	127328			
	STEP=2 SUB =1 FIME=2	SL (AVG) DWX =: 174124 SWN =87.992 SWX =127328										30-ft Side Drop - Cold Condition (Max. Decay Heat)	<u>Figure 18</u> Stress Intensity Plot – 30-ft Side Drop – Load Combination No.2

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2



Title	Structural Analyses	of the 3-60B Cask Under Drop	Conditions		
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Title	Structural Analyses	of the 3-60B Cask Under Dro	p Conditions		
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Calc.	No	ST-504 (Figures)	_ Rev. _0	Sheet	27	of 4
NOV 9 2007 12:04:50 PLOT NO. 1				Maximum Relative Displacement at the Bolting Ring-Lead Interface = 0.3172 in		
	60				Condition (No Decay Heat)	Figure 27
ISPLACEMENT TEP=1 UB =1 IME=1	46025 = M				-ft Bottam End Drop - Cold C	

Title	Structural Analyses	of the 3-60B Cask Under Di	rop Conditions		
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	Title_ Calc.	. No	Stru ST-50	ctural)4 (Fi	Anal	yses (of the	<u>3-601</u> Re	B Cas ev	<u>k Und</u> 0	ler D	rop C	Conditions Sheet_	29	of 45
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	PL														oad Combination N
															· 1-ft End Drop – Lo
														cay Heat)	<u>Figure 29</u> stribution Used for
														dition (Max. Dec	ile and Pressure Di
TENTITS.	S-NORM PERATURES J=-20	<u>{=23.03</u>								·				End Drop – Cold Cor	Temperature Prof
E.T. FIMFIT	PRES-1 TEMPEI	TWAX												1-ft Br	

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Title	Structural Analyses	of the 3-60B Cask Under D	rop Conditions		
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Title	Structural Analyses of	f the 3-60B Cask Under Drog	p Conditions		
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Title	Structural Analyse	s of the 3-60B Cask Under Dro	p Conditions		
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Title	Structural Analyses of	of the 3-60B Cask Under Dro	op Conditions		
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Title	Structural Analyses of	f the 3-60B Cask Under Dro	op Conditions		
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Title	Structural Analyses	of the 3-60B Cask Under D	rop Conditions		
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Title	Structural Analyses o	f the 3-60B Cask Under D	rop Conditions		
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<u>Appendix 1</u>

Printout of the ANSYS Model Data

(16 Pages)

3-60B Cask Drop Analyses

By Dr. Mirza I. Baig

Report Generated by ANSYS

Title Listing

***** TITLES *****
*** YOU ARE IN ANSYS - ENGINEERING ANALYSIS SYSTEM ***
ANSYS Mechanical/Emag
RELEASE 11.0SP1 UPDATE 20070830 CUSTOMER 00222442
INITIAL JOBNAME = file
CURRENT JOBNAME = file
Current Working Directory: Y:\30-ft Drop\End
TITLE= 30-ft End Drop - Cold Condition (No Decay Heat)
MENULIST File: C:\Program Files\ANSYS Inc\v110\ANSYS\gui\en-us\UIDL\menulist110.ans

Global Status

GLOBAL STATUS ANSYS - Engineering Analysis System Dec 07, 2007 11:27 INTEL NT Version 00222442 Release 11.0SP1 Current working directory: Y:\30-ft Drop\End MENULIST File: C:\Program Files\ANSYS Inc\v110\ANSYS\gui\en-us\UIDL\menulist110.ans Product(s) enabled: ANSYS Mechanical/Emag Total connect time. . . . 0 hours 1 minutes Total CP usage. 0 hours 0 minutes 4.4 seconds JOB INFORMATION -----_____ 30-ft End Drop - Cold Condition (No Decay Heat) Current jobname file Initial jobname file

Used
 Available
 Used

 Scratch Memory Space...
 256.000 mb
 4.919 mb (1.9%)

 Database space
 65535.750 mb
 129.391 mb (0.2%)
 Available User menu file in use . . .C:\Program Files\ANSYS Inc\v110\ANSYS\gui\enus\uidl\UIMENU.GRN User menu file in use . . .C:\Program Files\ANSYS Inc\v110\ANSYS\gui\enus\uidl\UIFUNC1.GRN User menu file in use . . .C:\Program Files\ANSYS Inc\v110\ANSYS\gui\enus\uidl\UIFUNC2.GRN User menu file in use . . .C:\Program Files\ANSYS Inc\v110\ANSYS\gui\enus\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: Number Defined Largest Number Selected Number 0 Keypoints 0 0 0 Lines 0 Areas 0 0 0 0 0 0 0 Volumes Finite element model summary: Largest Number Number Defined Number Selected 36999 36999 37659 24352 Element types 69 65 n.a. Real constant sets. . . . 35 31 n.a. Material property sets. . . 3 3 n.a. Coupling. 0 Constraint equations. . . 0 0 n.a. 0 n.a. 0 0 Master DOFs n.a. Dynamic gap conditions. . . 0 0 n.a. BOUNDARY CONDITION INFORMATION------Number Defined Constraints on keypoints. 0 Constraints on lines. 0 Constraints on areas. 0 Forces on nodes 0 Forces on keypoints 0 Number of element flagged surfaces . . . 0

Surface loads on lines. 0 Surface loads on areas. 0 Body loads on elements. 0 Body loads on nodes 0 Body loads on keypoints 0 Temperatures 70.000 Reference temperature. Offset from absolute scale 0.000 Х Y Ζ 0.0000 166.00 0.0000 0.0000 Linear acceleration 0.0000 Angular velocity (about global CS). . . 0.0000 Angular acceleration (about global CS). . 0.0000 0.0000 0.0000 0.0000 Location of reference CS. 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 ROUTINE INFORMATION------Display coordinate system. 0 (Cartesian) Current element attributes: Type number 69 (CONTA174) Real number 35 Material number 1 0 Element coordinate system number. . 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 12 (Cartesian) Display coordinate system. 0 (Cartesian) Active options for this analysis type: Large deformation effects Not included Plasticity. Not included Equation solver to use. Program Chosen

Solution Status

SOLUTION OPTIONS

PROBLEM DIMENSIONALITY
DEGREES OF FREEDOM UX UY UZ
ANALYSIS TYPE
NEWTON-RAPHSON OPTION
GLOBALLY ASSEMBLED MATRIX
LOAD STEP OPTIONS
LOAD STEP NUMBER
TIME AT END OF THE LOAD STEP 1.0000
NUMBER OF SUBSTEPS
MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS 15
STEP CHANGE BOUNDARY CONDITIONS NO
TERMINATE ANALYSIS IF NOT CONVERGED YES (EXIT)
CONVERGENCE CONTROLS
INERTIA LOADS X Y Z
ACEL 0.0000 0.0000 166.00
PRINT OUTPUT CONTROLS NO PRINTOUT
DATABASE OUTPUT CONTROLS
ITEM FREQUENCY COMPONENT
BASI ALL

Element Type Listing

LIST ELEMENT TYPE	ES FROM	1 TO	69 BY	1	
ELEMENT TYPE	1 IS SOLII	0185	3-D 8-NODE	STRUCTURAL SOLI	D INOPR
KEYOPT(1-12) =	0 0 0	000	0 0 0	0 0 0 0	
ELEMENT TYPE	2 IS SHELI	.41	MEMBRANE SI	HELL	INOPR
KEYOPT(1-12)=	O O O	0 0	0 0 0 0	0 0 0 0	0
ELEMENT TYPE	3 IS SOLSH	1190	3-D 8-NODE	SOLID SHELL	INOPR
KEYOPT(1-12)=	0 0 0	0 0	0 0 0	0 0 0 0	0
ELEMENT TYPE	4 IS TARGE	170	3-D TARGET	SEGMENT	INOPR
KEYOPT(1-12) =	0 0 0	0 0	0 0 0	0 0 0 0	0
ELEMENT TYPE	5 IS CONTA	175	NODE-TO-SU	RFACE CONTACT	INOPR
KEYOPT(1-12)=	0 2 0	03		1	0

ELEMENT TYPE	6	IS	TARGE170		3-D TARGET SEGMENT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	0	0 0 0 0 0 0 0	
ELEMENT TYPE	7	IS	CONTA175		NODE-TO-SURFACE CONTACT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	3	0 0 0 1 2 0 0 0	-
FIFMENT TVDF	8	тq	ΠΑΡΩΕ170		3-D TARGET SEGMENT IN	NODR
KEYOPT(1-12) =	0	10		0		.1011
	0	0	0 0	0		
ELEMENT TYPE	9	τs	CONTA175		NODE-TO-SURFACE CONTACT IN	NOPR
KEYOPT(1-12) =	0	0	0 0	З		
11011(1 12)	Ũ	0	0 0	0		
ELEMENT TYPE	10	IS	TARGE170		3-D TARGET SEGMENT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	0		
	·	-		-		
ELEMENT TYPE	11	IS	CONTA175		NODE-TO-SURFACE CONTACT IN	NOPR
KEYOPT(1-12) =	0	0	0 0	3		
1.21011(1 12)	0	0	0 0	0		
ELEMENT TYPE	12	IS	TARGE170		3-D TARGET SEGMENT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	0	0 0 0 0 0 0 0	
(•	-		-		
ELEMENT TYPE	13	IS	CONTA175		NODE-TO-SURFACE CONTACT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	3	0 0 0 1 2 0 0 0	
- ()						
ELEMENT TYPE	14	IS	TARGE170		3-D TARGET SEGMENT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	0	0 0 0 0 0 0 0	
- ()						
ELEMENT TYPE	15	IS	CONTA175		NODE-TO-SURFACE CONTACT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	3	0 0 0 1 2 0 0 0	
ELEMENT TYPE	16	IS	TARGE170		3-D TARGET SEGMENT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	0	0 0 0 0 0 0 0	
ELEMENT TYPE	17	IS	CONTA175		NODE-TO-SURFACE CONTACT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	3	0 0 0 1 2 0 0 0	
ELEMENT TYPE	18	IS	TARGE170		3-D TARGET SEGMENT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	0	0 0 0 0 0 0 0	
ELEMENT TYPE	19	IS	CONTA175		NODE-TO-SURFACE CONTACT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	3	0 0 0 1 2 0 0 0	
ELEMENT TYPE	20	IS	TARGE170		3-D TARGET SEGMENT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	0	0 0 0 0 0 0 0	
ELEMENT TYPE	21	IS	CONTA175		NODE-TO-SURFACE CONTACT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	3	0 0 0 1 2 0 0 0	
ELEMENT TYPE	22	IS	TARGE170		3-D TARGET SEGMENT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	0	0 0 0 0 0 0 0	
ELEMENT TYPE	23	IS	CONTA175	~	NODE-TO-SURFACE CONTACT IN	NOPR
KEYOPT (1-12) =	0	0	0 0	3	0 0 0 1 2 0 0 0	
	~ 4	- ~				
ELEMENT TYPE	24	1S	TARGE170	0	3-D TARGET SEGMENT IN	NOPR
КЕТОРТ (I-12) =	U	U	υU	U		

ELEMENT TYPE KEYOPT(1-12) =	25 0	IS 0	CONTA174 0 0	3	3D 8 0	8-NODE 0 0	SURF-SUR 1 2	F CONTACT 0 5	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	26 0	IS 0	TARGE170 0 0	0	3-D 0	TARGEI 0 0	r segment 0 0	0 0	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	27 0	IS 0	CONTA174 0 0	3	3D 8 0	8-NODE 0 0	SURF-SUR 1 2	F CONTACT 0 5	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	28 0	IS 0	TARGE170 0 0	0	3-D 0	TARGEI 0 0	r segment 0 0	0 0	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	29 0	IS 0	CONTA174 0 0	3	3D 8 0	8-NODE 0 0	SURF-SUR 1 2	F CONTACT 0 5	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	30 0	IS 0	TARGE170 0 0	0	3-D 0	TARGET 0 0	r segment 0 0	0 0	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	31 0	IS 0	CONTA174 0 0	3	3D 8 0	8-NODE 0 0	SURF-SUR 1 2	F CONTACT 0 5	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	32 0	IS 0	TARGE170 0 0	0	3-D 0	TARGEI 0 0	r segment 0 0	0 0	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	33 0	IS 0	CONTA174 0 0	3	3D 8 0	8-NODE 0 0	SURF-SUR 1 2	F CONTACT 0 5	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	38 0	IS 0	TARGE170 0 0	0	3-D 0	TARGEI 0 0	r segment 0 0	0 0	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	39 0	IS 0	CONTA174 0 0	3	3D 8 0	8-NODE 0 0	SURF-SUR 1 2	F CONTACT 0 5	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	40 0	IS 0	TARGE170 0 0	0	3-D 0	TARGET 0 0	r segment 0 0	0 0	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	41 0	IS 0	CONTA174 0 0	3	3D 8 0	8-NODE 0 0	SURF-SUR 1 2	F CONTACT 0 5	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	42 0	IS 0	TARGE170 0 0	0	3-D 0	TARGET 0 0	r segment 0 0	0 0	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	43 0	IS 0	CONTA174 0 0	3	3D 8 0	8-NODE 0 0	SURF-SUR 1 2	F CONTACT 0 5	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	44 0	IS 0	TARGE170 0 0	0	3-D 0	TARGEI 0 0	r segment 0 0	0 0	0	INOPR
ELEMENT TYPE KEYOPT(1-12)=	45 0	IS 0	CONTA174 0 0	3	3D 8 0	8-NODE 0 0	SURF-SUR 1 2	F CONTACT 0 5	0	INOPR
ELEMENT TYPE KEYOPT(1-12) =	46 0	IS 0	TARGE170 0 0	0	3-D 0	TARGEI 0 0	r segment 0 0	0 0	0	INOPR
ELEMENT TYPE KEYOPT(1-12)=	47 0	IS 2	CONTA174 0 2	3	3D 8 0	8-NODE 0 0	SURF-SUR 1 2	F CONTACT 0 6	0	INOPR

ELEMENT TYPE	48	IS	TARGE170		3-D TARGET SEGMENT INC	OPR
KEYOPT (1-12) =	0	0	0 0	0	0 0 0 0 0 0 0 0	
ELEMENT TYPE KEYOPT(1-12) =	49 0	IS 0	CONTA174 0 0	3	3D 8-NODE SURF-SURF CONTACTINC00120)PR
ELEMENT TYPE KEYOPT(1-12) =	50 0	IS 0	TARGE170 0 0	0	3-D TARGET SEGMENT INC 0 0 0 0 0 0 0)PR
ELEMENT TYPE KEYOPT(1-12) =	51 0	IS 0	CONTA175 0 0	3	NODE-TO-SURFACE CONTACTINC001200)PR
ELEMENT TYPE KEYOPT(1-12) =	52 0	IS 0	TARGE170 0 0	0	3-D TARGET SEGMENT INC 0 0 0 0 0 0 0)PR
ELEMENT TYPE KEYOPT(1-12) =	53 0	IS 0	CONTA175 0 0	3	NODE-TO-SURFACE CONTACTINC001200)PR
ELEMENT TYPE KEYOPT(1-12) =	54 0	IS 0	TARGE170 0 0	0	3-D TARGET SEGMENT INC 0)PR
ELEMENT TYPE KEYOPT(1-12) =	55 0	IS 0	CONTA174 0 0	3	3D 8-NODE SURF-SURF CONTACT INC 0 0 1 2 0 1 0)PR
ELEMENT TYPE KEYOPT(1-12) =	56 0	IS 0	TARGE170 0 0	0	3-D TARGET SEGMENT INC 0)PR
ELEMENT TYPE KEYOPT(1-12) =	57 0	IS 0	CONTA175 0 0	3	NODE-TO-SURFACE CONTACTINC001200)PR
ELEMENT TYPE KEYOPT(1-12)=	58 0	IS 0	TARGE170 0 0	0	3-D TARGET SEGMENT INC 0)PR
ELEMENT TYPE KEYOPT(1-12) =	59 0	IS 0	CONTA174 0 0	3	3D 8-NODE SURF-SURF CONTACTINC00120001200)PR
ELEMENT TYPE KEYOPT(1-12)=	60 0	IS 0	TARGE170 0 0	0	3-D TARGET SEGMENT INC 0)PR
ELEMENT TYPE KEYOPT(1-12)=	61 0	IS 0	CONTA174 0 0	3	3D 8-NODE SURF-SURF CONTACTINC00120)PR
ELEMENT TYPE KEYOPT(1-12)=	62 0	IS 0	TARGE170 0 0	0	3-D TARGET SEGMENT INC 0)PR
ELEMENT TYPE KEYOPT(1-12) =	63 0	IS 0	CONTA174 0 0	3	3D 8-NODE SURF-SURF CONTACTINC001200)PR
ELEMENT TYPE KEYOPT(1-12)=	64 0	IS 0	TARGE170 0 0	0	3-D TARGET SEGMENT INC 0)PR
ELEMENT TYPE KEYOPT(1-12)=	65 0	IS 0	CONTA174 0 0	3	3D 8-NODE SURF-SURF CONTACT INC 0 0 0 1 2 0 0)PR
ELEMENT TYPE KEYOPT(1-12)=	66 0	IS 0	TARGE170 0 0	0	3-D TARGET SEGMENT INC 0 0 0 0 0 0 0 0)PR

ELEMENT TYPE
KEYOPT (1-12) =67ISCONTA174
03D8-NODE
0SURF-SURF
1CONTACT
0INOPRELEMENT TYPE
KEYOPT (1-12) =68ISTARGE170
03-DTARGET
0SEGMENT
000001100PRELEMENT TYPE
KEYOPT (1-12) =69ISCONTA174
03D8-NODE
0SURF-SURF
0CONTACT
0INOPRELEMENT TYPE
KEYOPT (1-12) =69ISCONTA174
03D8-NODE
0SURF-SURF
0CONTACT
0INOPRCURRENT NODAL DOF SET IS
HREE-DIMENSIONAL MODELUXUXUXUXUX

Real Constant Listing

LIST REAL SETS	1 TC)	35 BY	1		
REAL CONSTANT 0.0000	SET 0.0000	3	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	3	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	3	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	3	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET	3	ITEMS 25 TO	25		
REAL CONSTANT 0.0000	SET 0.0000	4	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	4	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	4	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	4	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET	4	ITEMS 25 TO	25		
REAL CONSTANT 0.0000	SET 0.0000	5	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	5	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	5	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000

REAL CONSTANT 0.0000	SET 1.0000	5	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET	5	ITEMS 25 TO	25		
REAL CONSTANT 0.0000	SET 0.0000	6	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	6	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	6	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	6	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET	6	ITEMS 25 TO	25		
REAL CONSTANT 0.0000	SET 0.0000	7	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	7	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	7	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	7	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET	7	ITEMS 25 TO	25		
REAL CONSTANT 0.0000	SET 0.0000	8	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	8	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	8	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	8	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET	8	ITEMS 25 TO	25		
REAL CONSTANT 0.0000	SET 0.0000	9	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	9	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000

REAL CONSTANT 0.0000	SET 0.0000	9	ITEMS 13 TC 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	9	ITEMS 19 TC 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET	9	ITEMS 25 TC	25		
REAL CONSTANT 0.0000	SET 0.0000	10	ITEMS 1 TC 1.0000) 6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	10	ITEMS 7 TC 0.10000E+21	0 12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	10	ITEMS 13 TC 1.0000) 18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	10	ITEMS 19 TC 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET	10	ITEMS 25 TC	25		
REAL CONSTANT 0.0000	SET 0.0000	11	ITEMS 1 TC 1.0000) 6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	11	ITEMS 7 TC 0.10000E+21	0 12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	11	ITEMS 13 TC 1.0000	0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	11	ITEMS 19 TC 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET	11	ITEMS 25 TC	25		
REAL CONSTANT 0.0000	SET 0.0000	12	ITEMS 1 TC 1.0000) 6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	12	ITEMS 7 TC 0.10000E+21	0 12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	12	ITEMS 13 TC 1.0000) 18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	12	ITEMS 19 TC 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET	12	ITEMS 25 TC	25		
REAL CONSTANT 0.0000	SET 0.0000	13	ITEMS 1 TC 1.0000) 6 0.10000	0.0000	0.0000

REAL CONSTANT 0.0000	SET 0.0000	13	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	13	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	13	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	14	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	14	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	14	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	14	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	15	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	15	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	15	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	15	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	16	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	16	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	16	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	16	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	17	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	17	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	17	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	17	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000

REAL CONSTANT 0.0000	SET 0.0000	20	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	20	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	20	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	20	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	21	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	21	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	21	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	21	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	22	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	22	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	22	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	22	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	23	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	23	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	23	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	23	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	24	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	24	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	24	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000

REAL CONSTANT 0.0000	SET 1.0000	24	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET 0.0000	24	ITEMS 25 TO 0.0000	30 0.0000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	25	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	25	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	25	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	25	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	26	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	26	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	26	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	26	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET 0.0000	26	ITEMS 25 TO 0.0000	30 0.0000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	27	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	27	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	27	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	27	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET 0.0000	27	ITEMS 25 TO 0.0000	30 0.0000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	28	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	28	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	28	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000

REAL CONSTANT 0.0000	SET 1.0000	28	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	29	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	29	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	29	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	29	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 10.000	SET 0.0000	29	ITEMS 25 TO 0.0000	30 0.0000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	30	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	30	ITEMS 7 TO 17320.	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	30	ITEMS 13 TO 0.0000	18 0.0000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	30	ITEMS 19 TO 1.0000	24 0.0000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	31	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	31	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	31	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	31	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	32	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	32	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	32	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	32	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	33	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000

REAL CONSTANT 0.0000	SET 0.0000	33	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	33	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	33	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	34	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	34	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	34	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	34	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000
REAL CONSTANT 0.0000	SET 0.0000	35	ITEMS 1 TO 1.0000	6 0.10000	0.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	35	ITEMS 7 TO 0.10000E+21	12 0.0000	1.0000	0.0000
REAL CONSTANT 0.0000	SET 0.0000	35	ITEMS 13 TO 1.0000	18 0.0000	1.0000	0.50000
REAL CONSTANT 0.0000	SET 1.0000	35	ITEMS 19 TO 1.0000	24 0.0000	0.0000	1.0000

Material Properties Listing

LIST MATERIALS PROPERTY= ALL	1 TO	3 BY	1			
PROPERTY TABLE TEMPERATURE	EX MAT=	1 NUM. TEMPERATURE	POINTS= 6 DATA T	EMPERATURE	DATA	
70.000	0.28300E+08	100.00	0.28100E+08	200.00	0.27600E+08	
300.00	0.27000E+08	400.00	0.26500E+08	500.00	0.25800E+08	
PROPERTY TABLE TEMPERATURE 70.000 300.00	NUXY MAT= DATA 7 0.30000 0.30000	1 NUM. IEMPERATURE 100.00 400.00	POINTS= 6 DATA T 0.30000 0.30000	EMPERATURE 200.00 500.00	DATA 0.30000 0.30000	
PROPERTY TABLE	ALPX MAT=	1 NUM.	POINTS= 6	REFERENCE	TEMP. = 70.00	
TEMPERATURE	DATA :	TEMPERATURE	DATA T	EMPERATURE	DATA	
70.000	0.85000E-05	100.00	0.86000E-05	200.00	0.89000E-05	
300.00	0.92000E-05	400.00	0.95000E-05	500.00	0.97000E-05	

PROPERTY TABLE TEMPERATURE 0.0000	DENS MAT= DATA 0.28300	1 NUM. TEMPERATURE	POINTS= DATA	1 TEMPERATURE	DATA
PROPERTY TABLE TEMPERATURE 0.0000	MU MAT= DATA 0.30000	1 NUM. TEMPERATURE	POINTS= DATA	1 TEMPERATURE	DATA
PROPERTY TABLE TEMPERATURE 70.000 300.00	EX MAT= DATA 0.29900E+08 0.29900E+08	2 NUM. TEMPERATURE 3 100.00 3 400.00	POINTS= DATA 0.29900E+0 0.29900E+0	6 TEMPERATURE 8 200.00 8 500.00	DATA 0.29900E+08 0.29900E+08
PROPERTY TABLE TEMPERATURE 70.000 300.00	NUXY MAT= DATA 0.30000 0.30000	2 NUM. TEMPERATURE 100.00 400.00	POINTS= DATA 0.30000 0.30000	6 TEMPERATURE 200.00 500.00	DATA 0.30000 0.30000
PROPERTY TABLE TEMPERATURE 70.000 300.00	ALPX MAT= DATA 0.65000E-05 0.65000E-05	2 NUM. TEMPERATURE 5 100.00 5 400.00	POINTS= DATA 0.65000E-0 0.65000E-0	6 REFERENCE TEMPERATURE 5 200.00 5 500.00	TEMP. = 70.00 DATA 0.65000E-05 0.65000E-05
PROPERTY TABLE TEMPERATURE 0.0000	DENS MAT= DATA 0.28300	2 NUM. TEMPERATURE	POINTS= DATA	1 TEMPERATURE	DATA
PROPERTY TABLE TEMPERATURE -40.000 100.00 400.00	EX MAT= DATA 0.24600E+0 0.22100E+0 0.17000E+0	3 NUM. TEMPERATURE 7 -20.000 7 200.00 7 500.00	POINTS= DATA 0.24300E+0 0.20100E+0 0.15200E+0	8 TEMPERATURE 7 70.000 7 300.00 7	DATA 0.22700E+07 0.18500E+07
PROPERTY TABLE TEMPERATURE 81.000 392.00	NUXY MAT= DATA 0.40000 0.40000	3 NUM. TEMPERATURE 212.00 513.00	POINTS= DATA 0.40000 0.40000	6 TEMPERATURE 302.00 621.00	DATA 0.40000 0.40000
PROPERTY TABLE TEMPERATURE -40.000 100.00 400.00	ALPX MAT= DATA 0.15560E-04 0.16220E-04 0.18160E-04	3 NUM. TEMPERATURE 4 -20.000 4 200.00 4 500.00	POINTS= DATA 0.15650E-0 0.16700E-0 0.19120E-0	8 REFERENCE TEMPERATURE 4 70.000 4 300.00 4	TEMP. = 70.00 DATA 0.16060E-04 0.17330E-04
PROPERTY TABLE TEMPERATURE 0.0000	DENS MAT= DATA 0.41000	3 NUM. TEMPERATURE	POINTS= DATA	1 TEMPERATURE	DATA

Title	Structural Analyses of the 3-60B Cask Under Drop Conditions						
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<u>Appendix 2</u>

Electronic Data on DVD

(1 DVD)