71-9074

Consolidated Report
ANEFCO, Inc.

AP-100 CASK
USA/9074/A
REVISION 06

Dated: June 10, 1982

20943

ANEFCO CASK AP-100
CONSOLIDATED
SAFETY ANALYSIS REPORT

APPENDIX

This Appendix consolidates the ANEFCO, Incorporated Safety Analysis Report ANEFCO Cask - 100 series, dated October 26, 1976, with the ANEFCO, Incorporated Supplements dated November 18 and December 16, 1976; and January 21, February 16 and 22, 1977.

The following tabulation lists all the supplements and identifies the section of this consolidated report that deals with each supplement or supplement superseded information.

ANEFCO CASK AP-100
CONSOLIDATED
SAFETY ANALYSIS REPORT

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REVISION PAGE

Rev. No.	Issued Date	Changes		
00	October 26, 1976	None		
01	November 18, 1976	Section 1-8.6 Added		
02	December 16, 1976	Lid Lifting System Section 8.4 Tie-Down System Section 8.5 Cold, Section 9.2 Pressure Section 9.1 Free Drop Section 9.6 Drop Test Penetration Section 9.7		
03	January 21, 1977	Lid Lifting System Section 8.4 Tie-Down System Section 8.5 Bottom Corner Drop Section 9.6 Lid Corner Drop Section 9.6 Side Drop Section 9.6		
04	February 16, 1977	Closure Change Section 2 Lid Corner Drop		
05	March 12, 1982	Changes 00-04 Consolidated		
06	June 10, 1982	Changes 00-05 Consolidated to reflect elimination of duplicated changes		

APPROVED: ______________________ DATE: ______________

REVISION: ____________ DATE OF ISSUE: ____________ PAGE ______ OF ______

1.0 General Information

By application dated October 26, 1976, ANEFCO Incorporated requested approval for shipment of low specific activity radioactive material in the Model AP-100 packaging.

Based on the statements and representations contained in the application, as supplemented and compiled with this consolidated report the thermal and structural requirements of 10 CFR part 71 are analyzed to demonstrate adequacy for normal conditions of transport. The Model AP-100 was licensed by the NRC under docket number 71-9074. The package identification number as approved is USA/9074/A.

2.0 PACKAGING DESCRIPTION

A steel encased, lead shielding cask for low specific circular cylinder 92-1/4 inches high by 64 inches in diameter. The cask cavity is 87 inches deep by 60 inches diameter. The cask consists of two 3/8 inch thick cylindrical steel shells surrounding a 1-1/4 inch thick lead shield and welded to the cylindrical walls using full penetration welds. A 64 inch diameter by 3/8 inch thick steel base is welded to the cylindrical steel shells using full penetration welds. A 60 inch diameter by 3/8 inch thick steel plate is separated from the base plate by a 1 1/4 inch thick circular lead plate, and welded to the inner steel shell using full penetration welds.

The cask cover is a welded steel construction which encases a 1/2 inch thick lead plate. The 64 inch diameter by 1 1/2 inch thick cover has a 60 inch diameter by 1 inch thick lip which fits into the cavity on the closure. All welds on the cover assembly are full penetration welds. The cover is secured to the cask body using (32) 3/4 inch diameter bolts which feel through the cover to a steel bolt ring which is welded to the cask body with full penetration welds. The cask closure is sealed by (2) ethylene propylene gaskets. Four symmetrically spaced lugs are welded to the cask body for lifting and tie-down. Three removable, threaded eyes are attached to the cover for lifting. The package empty gross weight is approximately 17,700 pounds. The package gross weight is approximately 28,000 pounds.

2.1 REFERENCE DRAWINGS

Drawing SS-100, January 21, 1977 Revision C.

3.0 CONTENTS

The packaging is for the shipment of radioactive material, as a solid or solidified material which meets the requirements of low specific activity radioactive material. Solidified waste shall be enclosed in secondary containers. The maximum content weight shall not exceed 10,000 pounds. The maximum quantity of material per package shall be no greater than type A quantities of radioactive material with the weight of contents and secondary containers not to exceed 10,000 pounds.

4.0 CONTAINMENT

The structural and thermal evaluation of the AP-100 packaging shows that adequate containment is provided for normal conditions of transport. Since the package is used for shipment of low specific activity radioactive material, it need not satisfy the hypothetical accident conditions when the package is transported on a motor vehicle, railroad car, aircraft, inland water craft, or hold or deck of a seagoing vessel assigned for sole use of the licensee. The radioactive waste shall be enclosed in containers within the cask during shipment.

5.0 In accordance with 10 CFR 71 Appendix A "Normal Conditions of Transport" each of the following conditions of transport were separately analyzed to determine its effect on the AP-100 package.

1. Heat: Direct sunlight at ambient temperatures of 130° F in still air.
2. Cold: An ambient temperature of -40°F in still air and shade.
3. Pressure: Atmosphere pressure of 1.5 times standard atmosphere pressure.
4. Vibration: Normal to transport mode.
5. Water Spray: 30 minutes spray.
6. Free Drop: Two foot as in excess of 20,000 pounds.
7. Penetration: 1 1/4 inch diameter, 13 pounds. 40 inches.

5.1 Solar Heat Load

According to L.B. Shappert (ORNL-NSIC-68) the solar heat load is 442 BTU/hr-sq. ft. This value must be multiplied by the local mass transmittance of the earth's atmosphere and a value of relative total radiation factor obtained from figure 5.4 (see Appendix) from ORNL-NSIC-68.

The areas for heat absorbtion are:

$A = \pi DH$ (Area of Vertical Cylinder)

$= 3.14 (65) (95)$

$= 19,400$ sq. inches.

$A = 28$ sq. feet

$A = .785D^2$ (Area of flat top)

$= .785\ (65)^2$

$= 3320$ sq. inches

$A_f = 1.92$ sq. feet

The solar heat load at 90 degrees latitude is:

$q_r = 442\ (.7)\ 0.3$

$= 93$ BTU/hr - sq. ft.

$Q_r = q_r A_r = 93\ (28)$

$= 2600$ BTU/hr.

$q_f = 442\ (.7)\ .4$

$= 124$ BTU/hr-sq. ft.

$Q_f = q_f A_f = 124\ (1.9)$

$= 236$ BTU/hr.

Total heat load is:

$Q_t = 2600 + 236$

$= 2836$ BTU/hr.

For an unfinned cask

$Q_t = h_t A\ (Ts - Ta)$

where: Q_t = total heat rejected (BTU/hr)

h_t = heat transfer coeff. for radiation and convection

A = Area of cask (sq. ft.)

T_s = Surface temperature ($^\circ$F)

T_a = Air temperature (130°F)

$h_t = h_c + h_r$

where: h_r = coeff. for radiative heat transfer
h_c = coeff. for convective heat transfer

$h_c = C\ (Ts - Ta)^{1/3}$ (McAdam - Heat Transfer McGraw Hill, N.Y., 1954)

where C = 0.19 for vertical surfaces

= 0.22 for horizontal surfaces

This equation can be used for laminar flow conditions with little loss in accuracy.

Weighting the coeff by the areas vertical and flat:

$$h = \frac{.19\ (28) + .22\ (1.92)}{29.92}$$

$$= \frac{5.32 + .423}{29.92}$$

$$= \frac{5.74}{29.92}$$

$$= 0.192$$

Since we can neglect decay heat the total heat rejection load is that due to solar heating so that using figure 5.5 from ORNL-NSIC-68 (see Appendix) for C = 0/19, E = .8 and T = 130 F we can solve^{o}for T by trial and error.

T	T	hr	hc	ht	Qt	(2836)
180	50	1.4	.7	2.1	3140	
170	40	1.27	.65	1.92	2290	
175	45	1.38	.68	2.06	2780	
176	46	1.38	.68	2.06	2830	

Thus, there is no effect from 130^{o} F ambient temperature in still air.

5.2 COLD

The material of construction of the cask are identified on drawing SS-100. They have the capability of cold temperature environment performance in excess of - 40^{o} F and are:

1. Shell material: ASTM A-36 steel
2. Lead B-29 Chemical Grade
3. Bolts: ASTM A-307
4. Seal Ethylene Propylene

The steel is fabricated with full penetration welds. The lead shield is formed, tightly wrapped around and to the inner shell, and lapped by heat fusion to produce a continuous surface. The top and bottom lead shields are sandwiched between steel sheets.

The cask is able to withstand an ambient temperature of -40° F in still air and shade. The associated differential pressure at -40°F will be insignificant:

$$-40^\circ \text{ F} \quad = 14.7 \times \frac{420}{530} \quad = 11.6 \text{ psi}$$

The material of the cask are well within operating temperatures and the cold condition will not reduce the cask effectiveness.

5.3. Factor .5 x Atmosphere Pressure

ASTM-A-193-55T Grad B-7

Minimum mechanical properties for either hot or cold rolled steel unless 2.5 inches.

125,000 psi Tensile strength
105,000 psi Yield pt
269/321 Brindle hardness

at sea level atmosphere pressure = 14.64 lbs/in.^2

This is less than 1% of material specification used in the 100 series work. An analysis of the one-half atmosphere shows that the containment system can sustain this pressure condition

$$S = \frac{.5\text{x}14.\ \ 7\text{x}32}{.372} \qquad =627 \text{ psi } S_m \quad (25,000)$$

Pressure of .5 times standard atmosphere has an insignificant effect on the cask material.

5.4 The approximate natural frequency of the load cask is based on the concentric steel shells:

$$f_m = \frac{3.52}{2} \quad \frac{IEg}{Wl^3} = 118 \text{ HZ}$$

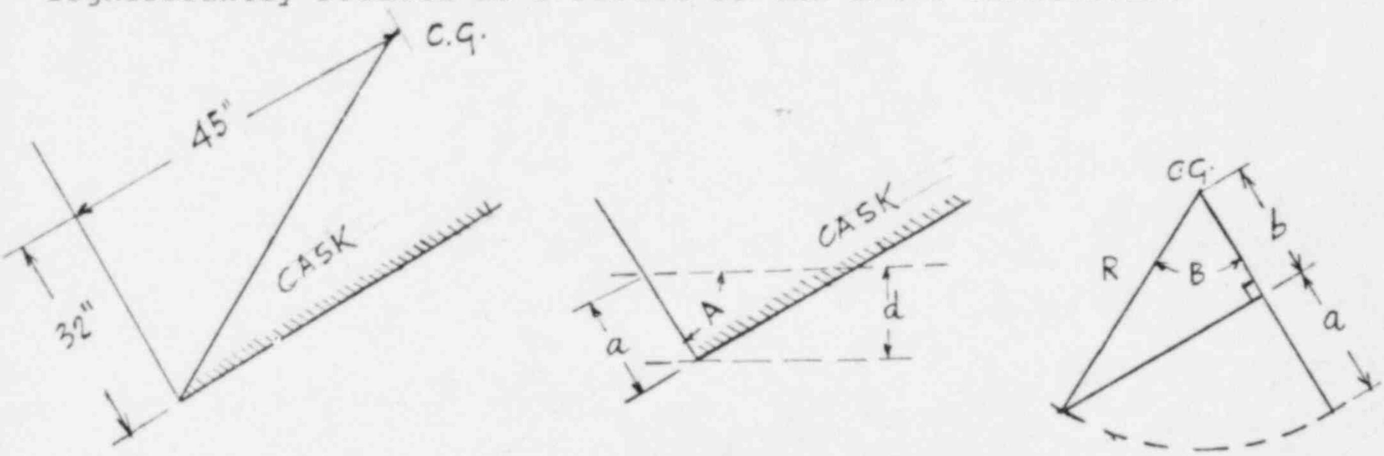
which is above the low frequency vibration range of the transport suspension system (1-20HZ).

5.5 WATER SPRAY

The design against the thirty (30) minute water spray is the step design built into the closure and machine fit flatness. There are no other surfaces to be effected by the water spray. The water spray on the package will not harm the cask material; it will actually lower the cask temperature.

5.6 TWO-FOOT FREE DROP

The following analysis for a two-foot free drop established the capability of the packaging to perform adequately for the most damaging drop orientation, including a bottom corner drop, lid corner drop, top end drop and a side drop. The analysis demonstrates that the shielding and containment properties of the package are not significantly reduced as a result of the above conditions.



$R = a + b$ $\qquad a = \frac{d}{\sin A}$ $\qquad b = R \cos B$

$\tan A = \frac{32}{45} = .711$ $\qquad A = 35^{\circ}$

The deformed section volume is:

$$V = R^3 \tan A \left(\sin B - \frac{\sin^3 B}{3} - \cos B\right)$$

The volume required to absorb the impact energy from a two foot drop, assuming a crush stress of 60,000 psi, is:

$$V = \frac{wh}{} = \frac{27,700 \times 2 \times 12}{} - 11 \text{ in.}^3$$

then:

$$K = (\sin B - \frac{\sin B}{3} - B \cos B0 = \frac{V}{R^3 \tan A}$$

$$K = \frac{11}{32^3 \times .711} = .0004$$

By trial and error calculation:

$B = 18^{\circ}$

The crush depth, by this deformation analysis, is

$d = R (1 - \cos B) \sin A$

$= 32 (1 - .9511) \; (.5736) = 9$ inches.

5.6.1 BOTTOM CORNER

An analysis of the impact of the two foot drop of the cask (without the overhang) demonstrates that integrity of the shielding and containment properties of the package are not significantly impaired.

This analysis indicates the capability of the cask to perform adequatley without damage to the shielding and containment. The integrity of the cask is established by this analysis for a drop even in the most damaging drop orientation .

The deceleration is:

$$a = \frac{hg}{d}$$

where d is the crush depth and

$$f = ma = \frac{w\ a}{g} \qquad \text{and } F = \frac{wh}{d}$$

the effective deceleration is

$$a = \left[\frac{60,000 \quad (11/.9}{27,000}\right] \quad g \text{ or } 21\ g$$

Since the force on the cask is the crush stress time the cross sectional area being crushed

$$d = \frac{wh}{\sigma A}$$

so that the deceleration is:

$$a = \frac{\sigma A\ g}{w} = \left[\frac{\sigma \frac{V}{d}}{w}\right] g$$

The analysis for the crush depth from a corner drop produces no reduction of cask effectiveness. It is obvious that the cask thickness can withstand a two foot corner drop effectively from this analysis without rupture and impairment of the shielding and containment properties.

Some local permanent deformation of the corner drop would result, but the corner welds are of such design and quality that rupture would not occur.

Containment would be maintained and the deformation would not effect the shielding and containment properties.

5.6.2 A two-foot drop on the lid corner, similar to a bottom drop as analyzed in 5.6.1, produces the same one inch deformation to the overlapping lid edge without detrimental effect on the lid closure integrity. A direct corner hit on the 4" x 3" x 1/2" lid lifting bracket deforms only this bracket. The lid lifting bracket bolts are protected by the brackets. A direct corner hit on the bolt results in the deformation of the bolt into the lid due to the compression resulting in less than one inch deformation of the lid.

A lid flush with the cask outer diameter will have a realistic absorption energy characteristic.

The crush deformation depth for a two-foot drop on the lid corner is .9 inch as shown in the bottom drop analysis in response. This local deformation will result in a minor damage to the 1 1/2 inch outer steel plate of the cover lid at the point of impact. The integrity of the shielding and the containment will be maintained.

5.6.3 <u>TOP END</u>

A top end drop merely flattens out the four lid lifting brackets rather than effecting the lid retention bolt brackets or the bolt heads. The resultant deformation of the lid lifting bracket is:

$$V = \frac{wh}{k} = \frac{27,700 \times 24}{36,000 \times 4 \times 3 \times .5} = 3 \text{ inches}$$ 4"

Since the lid will be sustained in compression by the cask, the containment will be maintained with no significant force transmitted to the lid retention bolt angle brackets.

5.6.4 <u>SIDE DROP</u>

The crush deformation analysis is shown in Response 1. A side drop will produce forces on the closure lid due to the acceleration of the lid and the force on the shield closure shield. Assuming that the lid can move sideways, it will strike up against the closure ring. The bolts will not be subjected to loading since the clearance between the lid and the closure ring (0.045 to .065 in) is less than the clearance betwen the bolts and the lid holes (0.975 in.). The lid assembly weighs 2600 lbs.; at a 21 g side load, the total bearing load is 55,000 lbs. Taken over the closure ring depth of 1 in., the load is equal to 55,000 lbs/in.

From case 2c, page 517, Roark, the formula for a cylinder in a cylindrical socket is:

$$= .591 \, (PE/K_D)^{1/2}$$

where

$$K = \frac{D_1 D_2}{D_1 - D_2} = \frac{(60.035)\ (59.970)}{(60.035\ -\ 59.970)} = 55{,}400$$

$$= .591\ (55{,}000 \times 29\ 10^6)^{1/2}$$

= 3200 psi, which is acceptable

5.7 PENETRATION

The regulations for normal conditions of transport stipulate that the cask withstand the impact of a 13 pound, 1 1/2 inch diameter steel cylinder falling from a height of 40 inches onto the exposed surface most vulnerable to puncture. The work (energy) required to shear a 1 1/4 inch section of the cask is ($K\pi Dt^2\sigma$).

$$U_T = K\pi Dt^2\sigma$$

$$U_T = .39 \times 3.14 \times 1.25 \times 3.75^2 \times 25{,}200 = 5420 \text{ in./lb}$$

The kinetic energy of the falling weight is:

$$U_{DW} = 40 \times 13 = 520 \text{ in.lb}$$

The cask will not be penetrated by the falling bar. No more than a superficial dent in the steel surface of the container may result.

6.0 CASK LIFTING SYSTEM

Cask lifting devices, which are a structural of the package, provide a lifting system capable of supporting three times the weight of the loaded package without generating stress in any material of the package in excess of its yield strength. When the weight (W) of the loaded cask is taken as 27,700 pounds, 3W is 83,100 pounds. Lifting devices are fabricated from two (2) inch plate carbon steel with yield strength of 36,000 psi. The bearing stress between the lifting pin and the hole for one lug is:

$$\sigma_C = \frac{1.5\ (27{,}700/4)}{2 \times 2} = \text{psi}$$

The design safety factor is 36,000/2,600 = 14. In any event, failure of the lifting device under excessive load will not impair the cask integrity or shielding.

7.0 LID LIFTING DEVICE

The lid lifting eyes used to support three times the loaded packaging is calculated to consider the induced bending loads on the lifting eyes and bolts, and the plane stresses on the lid.

7/8 inch diameter 4 UNF,

The Vertical Force on each eye (considering three times the 1950 lb. weight of the cask lid) is:

$$= \frac{F_V}{A_b} = \frac{1900}{0.634} \qquad F_V = (3/3) \qquad (3080)\text{psi}$$

the shear stress through the root area has a maximum value of

$$= \frac{F_H}{A_B}$$

where $F_A = F_V$ based on the lifting spider geometry

$$=_T \quad 3080 \text{ psi}$$

The effective stress intensity is

$$Si = 2 \ (T/2)^2 + T^2 \quad 1/2$$

$$= 2 \ \left[(1540)^2 + (3080)^2\right]1/2$$

$$= 6900 \text{ psi } S_Y = 36{,}000 \text{ psi} \ll S = 36{,}000 \text{ psi}$$

The lifting eyes can only be installed in the lid closure subsequent to the removal of the lid closure bolts. The closure assembly lifting, when engaged, will lift only the lid since the lid will no longer be secured to the cask body. The closure assembly lifting spider is attached to the lid by 7/8 inch diameter UNF eyes. The vertical force on each eye (considering three times the 2,600 lb. weight of the cask lid) is:

$$F_V = (3/4) \quad (2600) = 1950 \text{ lbs.}$$

The direct tensile stress in the bolts is $= \frac{FV}{A_b} = 1950 - 3080$

The shear stress through the root area has a maximum value of:

$$= \frac{FH}{AB}$$

where $F_A = F_V$ based on the lifting spider geometry

$= T = 3080$ psi.

The effective stress intensity is

$$Si = 2 \left[(T/2)^2 + T^2 \right]^{1/2}$$

$$= 2 \left[(1540)^2 + (3080)^2 \right]^{1/2}$$

$$= 6900 \text{ psi} \ll S_Y = 105,000 \text{ psi}$$

The lifting eyes can only be installed in the lid closure subsequent to the removal of the lid closure bolts. The closure assembly lifting, when engaged, will lift only the lid since the lid will no longer be secured to the cask body.

8.0 TIE-DOWN SYSTEM

The cask anchor points to the transport vehicle are the four lifting lugs. The resultant force on each of the four lugs is obtained by a superposing root mean square value of the three directional loading on each of the four lifting lug points. There is no yielding with 10-G longitudinal, 2-G vertical, and 5-G transverce forces. The maximum resultant force acting on each lifting lug is:

$$F_T = \left[10^2 + 5^2 + {}_2{}^2 \right]^{1/2} \quad W/4 = 2.84W = 79,000 \text{ lbs}$$

Use of the resultant tie-down force of 2.84 acting on each lug is more conservative than the regulatory design load of 3W/2 for lifting devices.

The bending stresses out the base of the lugs are:

$$S = \frac{ML}{Z_T} = \frac{1.5 \times 2.84 \times 27,700}{}$$

Where $Z_T = 29.5 \text{ in}^4$ section modulus

$S_b = 4000$ psi

The shear stress at the base of the lug is determined by

$$\tau_T = \frac{F_T}{A} = \frac{2.84 \times 27,000}{} = 3300 \text{ psi}$$

The above stresses combine to give an effective stress of

$$S = 2\left[(4000/2^2 + (3300)^2\right]^{1/2}$$

$$= 5200 \text{ psi} \ll S_Y \ (30,000)$$

The shear stresses on the body material are:

$$Psbm = \frac{2.84 \times 27,700}{3/8 \times 24} = 8750 \text{ psi} \ll 25,000 \text{ psi}$$

These stresses are less than the stress strength if the material and the welds involved, and therefore, satisfy the regulations.

9.0 10 CFR 71.31 SUBPART C PACKAGE STANDARDS COMPLIANCE WITH REGULATIONS

9.1 CASK MATERIAL

The cask material will be chemically, galvanically, and otherwise compatible.

9.2 COVER HOLD DOWN DEVICE

The cask cover is secured to the cask body using (32) 3/4 inch diameter bolts which feed through the cover to a steel bolt ring which is welded to the cask body.

9.3 LIFTING SYSTEM

Four lifting devices are spaced symmetrically around the cask to provide lifting means for the cask. The lifting devices are utilized to secure the cask to the bed of the transport vehicle in a conventional tension member system without generating stress in excess of its yield strength.

9.4 TIE-DOWN SYSTEM

The package and the tie-down system is designed to withstand a force along the direction in which the vehicle travels of ten times the weight of the cask and its contents.

The cask anchor points to the transport vehicle are the four lifting lugs. The resultant force on each of the four lugs is obtained by a superposing the root mean square value of the three directional loadings on each of the four lifting lug points, the resultant force acting on each lug is given by:

$$F_T = \left[10^2 + 5^2 + 2^2\right]^{1/2} W/4 = 2.84W = 79,000 \text{ lbs}$$

Use of the resultant tie-down force of 2.84W acting on each lug is more conservative than the regulatory design load of 3W/2 for lifting devices.

The bending stresses out the base of the lugs are:

$$S_b = \frac{ML}{Z_T} = \frac{1.5 \times 2.84 \times 27,000}{29.5}$$

Where $Z_T = 29.5 \text{ in.}^4$ section modulus

SB = 4000 psi.

the shear stress at the base of the lug is determined by

$$\tau = \frac{F_T}{A_T} = \frac{2.84 \times 27,700}{24} = 3000 \text{ psi}$$

The above stresses combine to give an effective stress of:

$$S = 2\left[(4000/2)^2 + (3300)^2\right]^{1/2}$$
$$= 7700 \text{ psi} \ll S_y \ (30,000)$$

The shear stresses on the body material are

$$\sigma_{sbm} = \frac{2.84 \times 27,700}{3/8 \times 24} = 8750 \text{ psi} \ll 25,000 \text{ psi.}$$

The stresses are less than the stress strength of the material and the welds involved, and therefore satisfy the regulations. The shear stress for the loaded resultant force per lifting lug is less than the shear stress of the outer shell.

$$sbm = \frac{78,700}{(3/8)\ 4.5\ 2+4.5+2} = 16,000 \text{ psi} < 25,000 \text{ psi}$$

9.5 FAILURE OF TIE-DOWN SYSTEM

Failure of the tie-down system under excessive load will not impair the ability of the cask to meet the other requirements and a tear off will not damage the effectiveness of the cask.

9.6 COVER LIFTING SYSTEM

Three lifting pad eyes, symmetrically spaced on the cover, are used to remove the cover when the 32 bolts are released. The 1 1/4 inch pad eyes are capable of supporting three times the weight of the cask cover without generating stress in any material of the lid or the pad eye in excess of its yield strength.

9.7 EXTERNAL PRESSURE

The external pressure of 25 psig has no effect on the contents of the package. The outer shell stress (PR/t) is well within the buckling stress limit:

$$\sigma_o = \frac{25 \times 64 - 43 \text{ psi.}}{3/8}$$

Treating the lid and the bottom plate as simply supported, the stresses are

$$C \frac{q M^2}{8I} :$$

$$\sigma_1 = 1 \times 25 \times 35^2 = 6500 \text{ psi} \ll 36{,}000 \text{ psi}$$

The pressure required to buckle the shell of the outer container is much greater than 25 psi. The stress in the composite containment heads resulting from this pressure differential are not significant.

It is, therefore, concluded that the casks, with stresses well below allowable, comply with the requirements of the regulations governing external pressure effects.

10.0 10CFR71.34 EVALUATION OF THE SINGLE PACKAGE
Quality Assurance Program

Attached is ANEFCO, Inc's Quality Assurance Program for ANEFCO shipping packages for radioactive material as approved October 15, 1979. The expiration date of Docket Number 71-0001 is January 31, 1985. (See Attachment 1).

The ANEFCO AP-100 cask approval was approved in 1977, therefore, the provisions of subpart D71.51 will apply to the design quality control of the package.

10.1 NORMAL TRANSPORT AND ACCIDENT

The cask will be able to withstand conditions likely to occur both during normal transport and an accident.

11. STANDARD FOR NORMAL CONDITIONS OF TRANSPORT FOR SINGLE PACKAGE 10 CFR 71.34

11.1 NORMAL CONDITIONS OF TRANSPORT

The cask will not be damaged by the normal conditions of transport.

11.2 NO RADIATION RELEASE

There will be no release of radioactive materials from the solidified waste in the containment vessel.

11.3 EFFECTIVENESS OF CASK

Under normal conditions of transport, the effectiveness of the cask will be maintained at all times.

11.4 SHIPPING ONLY SOLIDIFIED WASTE MATERIALS

Canisters to be shipped in the cask will contain only solid or solidified waste materials.

11.5 NO VENTING OR SEALS

The cask will need no venting or seals, as no gas or vapor will be released from the containment canister. A cover seal is installed to preclude water spray.

12. HYPOTHETICAL ACCIDENT CONDITIONS FOR A SINGLE PACKAGE 10CFR 71.36

12.1 FUNCTIONAL AFTER ACCIDENT

The cask will be designed and constructed so that subjected to accident conditions, it will not be damaged excessively and will remain functional.

13. CASK COMPLIANCE WITH STANDARDS

13.1 NO CHEMICAL OR GALVANIC REACTION

The ANEFCO LSA Casks L-100 are to be constructed of steel and lead with no chemical or galvanic reaction between these materials or between the canister or the solidified wastes in the canister and their materials or construction is foreseen.

13.2 POSITIVE LID CLOSURE

The cask is equipped with a positive closure lid with(32) 3/4" bolts to secure the lid to the cask body and a lead wire seal to present inadvertent opening of the cask.

ANEFCO CASK AP-100 LOADING PROCEDURE

I. PURPOSE

The purpose of this procedure is to define the safe handling and the proper radiological controls necessary for receiving, loading and dispatching of CASK AP-100.

II. REFERENCES

1. ANSI N 14.10.1, "Administrative Guide for Packaging and Transporting Radioactive Materials."

2. 49 CFR 173.389 to 173.398, "Materials Transportation Bureau, DOT, Subchapter C, Hazardous Materials, Shippers General Requirements for Shipment and Packaging Radioactive Materials."

3. 10 CFR 20 - Standards for Protection Against Radiation

III. LIMITATIONS AND PRECAUTION

1. ANEFCO - NRC Certificate of Compliance 9074.

2. Insure the cask lid seal is in good condition prior to shipment.

3. CAUTION: Always use a calibrated hard torque wrench only, according to the torque procedure (Attachment "A",) to prevent damage to bolts and cask threads.

4. If, while detorquing the cask head, it is determined that the head has backed off unevenly and is binding, the head must be retorqued and detorquing operations restored.

5. If any abnormalities are discovered with the cask, cask head, head gasket, or the cask equipment, notify ANEFCO at the main headquarters, telephone, (203-431-3358) obtain advice on continual use of the equipment and follow such advice.

IV. PROCEDURE

*Utilize steps 3,4,5, and 19 only if removal of the cask from the trailer is required for loading.

1. Upon receiving the cask onsite, perform radiation surveys.

IV. PROCEDURE (Cont't)

2. Position cask and trailer into the handling bay.

*3. Detach the tie-downs from the cask.

*4. Attach lifting assembly to cask lifting eyes.

*5. Lift cask from trailer and lower to the bay floor.

6. Place poly-sheeting or equivalent onto floor insuring that enough plastic is in place to cover the floor when the cask lid is placed on it.

7. Remove the 32 cask lid bolts. Attach lid lifting assembly to the lid lifting eyes.

8. Slowly lift the AP-100 lid until there is large enough opening to take and internal radiation survey. (Both smear Test and Dose Rate Assessment).

9. Place cask lid onto plastic from step number 6.

10. Remove the AP-100 lid lifting assembly if required.

11. Perform radiation survey of the liner.

12. Lift the liner and place it into the AP-100 cask cavity.

13. Place any necessary shoring around the liner, if required.

14. Attach the cask lid lifting assembly and place the cask lid onto the AP-100 cask in accordance with positioning marks.

15. Monitor cask radiation. CAUTION: A potential radiation streaming hazard exists when the cask is loaded when the cask lid is not torqued down.

*16. Install the 32 cask lid bolts and torque to 75 ft-lbs. See Attachment #1.

17. Monitor and record the cask radiation levels.

IV. PROCEDURE (Cont'd)

18. Check the cask surfaces for contamination. Decon cask surfaces if necessary.

19. Load the cask onto the trailer and fasten tie-downs.

20. Perform the final cask survey on the trailer. Attach the appropriate labeling and placards.

21. Authorize the shipment to the disposal site, when the shipping requirements are met and all shipping documents are complete.

22. Notify ANEFCO, Inc. (203-431-3358) that the shipment is in route to the disposal site.

*CAUTION: USE HAND WRENCH ONLY

ANEFCO CASK AP-100 UNLOADING PROCEDURE

I. PURPOSE

The purpose of this procedure is to define the safe handling and the proper radiological controls necessary for receiving, unloading and dispatching of CASK AP-100.

II. REFERENCES

1. ANSI N 14.10.1, "Administrative Guide for Packaging and Transporting Radioactive Materials."

2. 49 CFR 173.389 to 173.398, "Materials Transportation Bureau, DOT, Subchapter C, Hazardous Materials, Shippers General Requirements for Shipment and Packaging Radioactive Materials."

3. 10 CFR 20 - Standards for Protection against Radiation.

III. LIMITATIONS AND PRECAUTIONS

1. ANEFCO - NRC Certificate of Compliance 9074.

2. Insure the cask lid seal is in good condition prior to shipment.

3. If while detorquing the cask lid it is determined that the lid has backed off unevenly and is binding, the lid must be retorqued and detorquing operations restored.

4. CAUTION: a potential radiation streaming hazard exists when the cask is loaded with the cask head not torqued down.

IV. PROCEDURE

* Utilize steps 3,4,5, and 19 only if removal of the cask from the trailer is required for unloading.

1. Upon receiving the cask onsite, perform radiation surveys.

2. Position cask and trailer into the handling bay.

*3. Detach the tie-downs from the cask.

*4. Attach lifting assembly to cask lifting eyes.

*5. Lift cask from trailer and lower to the bay floor.

IV. PROCEDURE (Cont't)

6. Place poly-sheeting or equivalent onto floor insuring that enough plastic is in place to cover the floor when the cask lid is placed on it.

7. Remove the 32 cask lid bolts. Attach lid lifting assembly to the lid lifting eyes.

8. Slowly lift the AP-100 lid until there is a large enough opening to take an internal radiation survey. (Both Smear Test and Dose Rate Assessment).

9. Place cask lid onto plastic from step number 6.

10. Remove the AP-100 lid lifting assembly if required.

11. Perform radiation survey of the liner.

12. Lift the liner and remove it from the AP-100 cask.

13. Replace any internal shoring inside cask if utilized.

14. Attach the cask lid lifting assembly and place the cask lid onto the AP-100 cask in accordance with positioning marks.

15. Monitor cask radiation.

16. Install the 32 cask lid bolts and hand tighten. See Attachment #1.

17. Monitor and record the cask radiation levels.

18. Check the cask surfaces for contamination. Decon cask surfaces if necessary.

*19. Load the cask onto the trailer and fasten tie-downs.

20. Perform the final cask survey on the trailer. Attach the appropriate labeling and placards.

21. Authorize the shipment to leave disposal site, when the shipping requirements are met and all shipping documents are complete.

22. Notify ANEFCO, Inc. (203-431-3358) that the shipment is leaving the disposal site.

CAUTION: USE HAND WRENCH ONLY

15. Maintenance Program

AP-100 MAINTENANCE TESTS

MAINTENANCE PROGRAM

The maintenance program is established to ensure continued performance of the cask.

1. The cask will be routinely inspected prior to each departure to the reactor site.
2. In addition, periodic inspections of the cask will be made requiring testing and/or replacement of critical components as follows:

   a. STRUCTURAL

   On a quarterly basis, inspect lifting assemblies closely for cracks or other signs of failure. If signs of failure are found, replace lift assembly and perform acceptance structural tests.

   b. LEAK AND PRESSURE TESTS

   On a quarterly basis, test the cask cavity with hydrostatic pressure of 100 psig. If leak is found, repair it and retest.

   On an annual basis, test the cask cavity with hydrostatic pressure of 150 psig. If a leak is found, repair it and retest.

   c. CASK-O-SEAL AND SHIELD PLUG CASKET

   On a quarterly basis, test the containment cavity with 100 psig. If the pressure over a 10 minute interval drops, find the cause, repair, and rerun test. On an annual basis, test containment cavity with 150 psig. If the pressure over a 10 minute interval drops, find the cause, repair, and rerun test.

d. <u>CASK SURFACE</u>

On a regular basis, when the cask is returned to the site, inspect the cask surface for damage for decontamination problems. If the cask surface is damaged, repair it and grind and polish smooth.